Black-Throated Green Warbler, Bay-Breasted Warbler and Cape May Warbler
Conservation Management Plan

2014–2019

Alberta Species at Risk Conservation Management Plan No. 10
Black-Throated Green Warbler,
Bay-Breasted Warbler and Cape May Warbler
Conservation Management Plan

2014–2019

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PREFACE

Albertans are fortunate to share their province with a diversity of wild species. A small number of these species are classified as *Species of Special Concern* because they have characteristics that make them particularly sensitive to human activities or natural events. Special conservation measures are necessary to ensure that these species do not become *Endangered* or *Threatened*.

Conservation management plans are developed for *Species of Special Concern* to provide guidance for land and resource management decisions that affect the species and their habitat. These plans are intended to be a resource tool for Environment and Sustainable Resource Development (ESRD) staff.

Conservation management plans provide background information including species biology, threats to species and habitat, and inventory/monitoring history. Plans also provide a goal, objectives, and actions (management recommendations). Management recommendations are typically categorised into inventory and monitoring needs; habitat management and conservation; education and communication; and additional management considerations as required.

Conservation management plans are generally prepared by an ESRD biologist who has been designated as the provincial species lead. Writers from outside ESRD are occasionally sought to prepare plans for species for which there is little in-house expertise. In order to ensure accuracy and utility, each plan is reviewed by a species expert and designated provincial representatives from different ESRD programs. In some cases there may be additional reviewers from staff, industry, and other agencies.

Conservation management plans are internal guidance documents. They are implemented under the guidance of the species lead and are “living” documents that can be revised at any time as required. Conservation management plans are more succinct than the recovery plans that are prepared for *Endangered* and *Threatened* species and do not involve participation of a multi-stakeholder team.

Conservation management plans are approved by the Director of Fish and Wildlife Policy. Plans will be reviewed annually by the species lead and updated if necessary, and a more in-depth review will occur five years after a plan’s approval.
EXECUTIVE SUMMARY

In Alberta, the black-throated green warbler (Setophaga virens) has been designated a Species of Special Concern, and the bay-breasted warbler (Setophaga castanea) and Cape May warbler (Setophaga tigrina) have been recommended for Species of Special Concern status due to perceived population declines and projected future habitat loss. All three species are neotropical migrants that breed in the Canadian boreal forest.

The black-throated green warbler is associated with old mixedwood and deciduous stands and is considered a mature and interior forest species. The bay-breasted and Cape May warblers are associated with old coniferous stands and are considered late-successional forest specialists. All three species are sensitive to habitat loss, alteration, and fragmentation; primary threats come from industrial activities. For successful management of these species in Alberta, habitat requirements at both the stand and landscape scales need to be considered. Habitat management for these warbler species will benefit a variety of resident and migratory avian species.

This plan recommends various ways to conserve warbler populations and habitat, including: long-term community-level surveys and detailed demographic studies; maintaining old coniferous stands in large blocks with minimal edge (for bay-breasted and Cape May warblers); maintaining old mixedwood forests with an overstory composed of large white spruce and paper birch in large blocks with minimal edge (for black-throated green warbler); using caution with spruce budworm control (bay-breasted and Cape May warblers are considered spruce budworm specialists); and improved collaboration with stakeholders and communication with the public. Integration of the listed recommendations into current land management practices would help protect habitat and favour conservation of these songbirds and other avian species.

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1.0 INTRODUCTION

The black-throated green warbler (Setophaga virens) has been designated a Species of Special Concern in Alberta because of perceived population declines and projected future habitat loss (Endangered Species Conservation Committee 2001). The bay-breasted warbler (Setophaga castanea) and Cape May warbler (Setophaga tigrina) have been recommended for Species of Special Concern status in Alberta for the same reasons (Endangered Species Conservation Committee 2002a, 2002b). In the General Status of Alberta Wild Species 2010, all three are classified as Sensitive (Alberta Environment and Sustainable Resource Development 2012a).

These species are protected under both the federal Migratory Birds Convention Act and Alberta’s Wildlife Act. At the federal level, they are considered as Secure (species that show a trend of decline in numbers in Canada, but remain relatively widespread or abundant; Environment Canada 2012a, b). About 98% and 99% of the Cape May and Bay-breasted warblers’ breeding populations, respectively, are in Canada. The International Union for Conservation of Nature (IUCN) Red List status for these species is Least Concern, owing to large ranges and population sizes and slow declines (IUCN 2013).

Alberta’s Endangered Species Conservation Committee (ESCC) has made the following recommendations for these three species (ESCC 2001, 2002a,b):

1. Designating the species as Species of Special Concern.
2. Developing mechanisms to identify and implement conservation and management strategies for the three species.
3. Enhancing programs to collect information on each species’ population size, distribution and trend. Reassessing the status of the species within five years.
4. Conserving and managing habitat for the three species.
5. Securing appropriate management strategy, including funding and personnel, for conservation actions.

1.1 Distribution, Habitat Requirements and Breeding Biology

These three warbler species are neotropical migratory songbirds and members of the Parulidae family. They arrive in Alberta in mid- to late May, and fall migration occurs between mid-August and mid-September (Lesser Slave Lake Bird Observatory, unpublished data). They spend 30–40% of their annual cycle on the breeding ground (Morse and Poole 2005, Venier et al. 2011). Wintering grounds range from Mexico and Central America (black-throated green; Morse and Poole 2005) to Central America and northern South America (bay-breasted; Venier et al. 2011), and the Caribbean islands (Cape May; Baltz and Latta 1998).

Black-throated green warbler
The breeding range includes the southern portion of the boreal, mixed and deciduous forests of northeastern North America (Morse and Poole 2005). In Alberta, the breeding
range extends from the border with British Columbia to Cold Lake, and from Wood Buffalo National Park to the lower Athabasca River drainage, with few records from the northwest of the province (Fig. 1; see also Norton 1999, Alberta Biodiversity Monitoring Institute 2012, Boreal Avian Modelling Project 2012a).

In western Canada, the black-throated green warbler occurs in spruce forests, mixedwood stands dominated by large spruce (Salt 1973, Semenchuk 1992, Hobson and Bayne 2000a), and deciduous-dominated mixedwood forests (Robichaud and Villard 1999, Hannah 2006) of the boreal mixedwood, boreal foothills, and boreal uplands ecoregions (Strong and Leggat 1981). These stands are usually 100–130 years of age, with a canopy composed of white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*; Hannah 2006). In Alberta, the highest densities of black-throated green warbler have been recorded in closed mature mixedwood, open mature deciduous, and closed young mixedwood stands (0.7–1/ha), and to a lesser extent in closed mature coniferous stands (0.5/ha; density estimates for the Boreal Taiga Plains Bird Conservation Region [BCR 6], Boreal Avian Monitoring Project 2012a). Estimates of territory size range from 0.8 to 2.2 ha (F. Schmiegelow and T. Hannah, unpublished data cited by Norton 1999). As noted by Kirk et al. (2012), the species occurs in a wide variety of forest types, but the contribution of the different stand types to overall population viability is unclear. Nonetheless, the species has often been considered as an indicator of mature forests, a mature forest specialist (Westworth and Telfer 1993, Kirk et al. 1996, Schmiegelow and Hannon 1999, Venier and Pearce 2005, Zitske et al. 2011), a forest interior specialist (Morse and Poole 2005, Villard et al. 2007, Kardynal et al. 2012), and a species sensitive to habitat alteration (Norton and Hannon 1997, Guénette and Villard 2005, Atwell et al. 2008).

The black-throated green warbler forages mainly on insects, particularly caterpillars (Bent 1953, Morse 1976) found in large diameter white spruce (diameter at breast height [dbh] = ca. 50 cm; Robichaud and Villard 1999, Hannah 2006). Large white spruce (dbh = ca. 50 cm) are also preferred as song posts. Paper birch (*Betula papyrifera*; dbh = ca. 20 cm) is the preferred nesting substrate, but other tree species including white spruce and balsam poplar are also used (Robichaud and Villard 1999, Hannah 2006). The black-throated green warbler builds an open-cup nest composed of twigs, grass, birch bark, lichen and spider silk, located anywhere along a branch, or adjacent to the trunk and usually between 1–3 m (but up to 20 m) from the ground (Morse and Poole 2005). Generally, 3–5 eggs are laid and renesting attempts after failure have been documented for this species (Morse and Poole 2005).

**Bay-breasted warbler**

During the breeding season, the bay-breasted warbler is associated with old coniferous stands of the Canadian boreal forest. The range of this songbird in Alberta encompasses most of the forested portion of the province, excluding the Rocky Mountains, and its southern boundary corresponds with the southern limit of the Boreal Forest Natural Region and Lower Foothills Natural Subregion (Fig. 2, see also Norton 2001a, Alberta Biodiversity Monitoring Institute 2012, Boreal Avian Modelling Project 2012b).
Stands used by the bay-breasted warbler are usually dominated by white spruce or balsam fir (*Abies balsamea*). Bogs, swamps, younger, more open stands, and mixedwood stands can also be used (Venier et al. 2011), especially at high population levels of spruce budworm (*Choristoneura fumiferana*; Venier et al. 2009, Venier and Holmes 2010). In Alberta, the highest densities of territorial males (1/ha) have been reported in closed mature coniferous stands and, to a lesser extent (0.1–0.3/ha), in open mature coniferous and closed or young mixedwood stands composed of trembling aspen, balsam poplar, or paper birch (density estimates for the Boreal Taiga Plains [BCR 6], Boreal Avian Monitoring project 2012b). Hence, this species is considered a late-successional forest specialist (Hobson and Bayne 2000a, Kirk and Hobson 2001, Rempel 2007). Negative effects of habitat fragmentation have been reported for this species in many Canadian provinces (Drolet et al. 1999, Hobson and Bayne 2000b, Rempel 2007), as have negative effects of habitat alteration (Guénette and Villard 2005).

The bay-breasted warbler forages mainly on insects and spiders in conifer foliage (Cumming 2004, Venier et al. 2011). While in the boreal forest, it forages intensively on spruce budworms and forest tent caterpillars (*Malacosoma disstria*), which often leads to large annual population fluctuations during infestations of these prey species (Venier and Holmes 2010). Territory size is estimated at approximately 1.5 ha (Sabo 1980), but the species can be gregarious in years of high food abundance (Venier et al. 2011). Typically, the bay-breasted warbler builds open-cup nests about 5 m above the ground (range 1–20 m) in dense conifer trees, usually white spruce, and lays 5–6 eggs (range 3–7; reviewed by Venier et al. 2011). Larger clutch sizes have been reported during insect outbreaks (MacArthur 1958). There is no information available on renesting events for this species. However, this behaviour is common in other warbler species and may be expected to occur if the initial nesting attempt fails early in the breeding season (Morse and Poole 2005, Porneluzi et al. 2011).

**Cape May warbler**

The breeding range of the Cape May warbler covers most of the Canadian boreal forest (Baltz and Latta 1998). In Alberta, the breeding range extends from Hinton to Cold Lake in the south, occupying most forested areas of the province north to the border with the Northwest Territories (Fig. 3; see also Alberta Biodiversity Monitoring Institute 2012, Boreal Avian Modelling Project 2012c).

Throughout its breeding range, the Cape May warbler is associated with old coniferous forests (Baltz and Latta 1998). The species is uncommon and locally distributed in Alberta, as a result of its relatively narrow habitat requirements. It is found primarily in pure stands of mature or old white spruce or fir (*Abies* spp.), and conifer-dominated mixedwood stands composed of trembling aspen and paper birch (Semenchuk 1992). Individuals sing, feed and nest high in the spruce canopy (Baltz and Latta 1998).

Territory size is estimated between 0.4–0.7 ha (Kendeigh 1947, Crawford and Jennings 1989). In Alberta, the highest densities of territorial males have been recorded in closed mature coniferous stands (1/ha) and, to a lesser extent, in open mature coniferous and open mixedwood stands (0.5–0.6/ha; density estimates for the Boreal Taiga Plains [BCR 6], Boreal Avian Monitoring project 2012c). This species has been considered a late-
successional forest specialist (Kirk and Hobson 2001) vulnerable to habitat loss, alteration and fragmentation (A. J. Erskin, cited by Baltz and Latta 1998; Meiklejohn and Hughes 1999).

The Cape May warbler forages mainly on caterpillars, beetles and spiders, from mature spruces and firs (Baltz and Latta 1998). It has a unique semitubular tongue that allows for the consumption of nectar and fruit during migration and winter months (Baltz and Latta 1998). The Cape May warbler is also considered a spruce budworm specialist. Indeed, the annual variation in abundance of this prey has been shown to generate large fluctuations in population size of the Cape May warbler (reviewed by Venier and Holmes 2010). Early studies from Bent (1953) and MacArthur (1958) reported an average of 6 eggs laid per nest, with a range of 4–9. This large variation in clutch size is hypothesized to result from an adaptive response to budworm outbreaks (i.e. increased food supply), which would allow for a rapid increase in population size (reviewed by Venier and Holmes 2010). Nest cups are made of sphagnum moss (Sphagnum sp.), spruce twigs and other plant material, and are usually located at the top of conifers in thick foliage near the trunk (ca. 10–18 m high; reviewed by Baltz and Latta 1998). There is no information available on renesting events; however, this behaviour is common in other warbler species and is likely to occur if the initial nesting attempt fails early in the breeding season (Morse and Poole 2005, Porneluzi et al. 2011). Owing to the relative rarity of this species, the basic details about its breeding biology (e.g., reproductive success) remain unknown and are based mainly on studies from Ontario (Kendeigh 1947) and Maine (MacArthur 1958), with limited sample sizes. No recent studies have contributed to our understanding of population dynamics.
Figure 1. Black-throated green warbler distribution in Alberta.
Figure 2. Bay-breasted warbler distribution in Alberta.
Figure 3. Cape May warbler distribution in Alberta.
1.2 Population Trends

Data from the Breeding Bird Survey (BBS) suggest that nationally: the black-throated green warbler declined by 1.2% annually from 1999–2009; the bay-breasted warbler declined by 3% annually from 1970–2009; and the Cape May warbler declined by 5.3% annually from 1999–2009 (Environment Canada 2012b). Data from the Lesser Slave Lake Bird Observatory suggest substantially lower abundances of these three warbler species compared to other more common boreal songbirds. See Appendix 1 for more details about population trends.

1.3 Threats to Populations

The observed national decline is significantly correlated with decreasing spruce budworm populations (Venier and Holmes 2010). Predators of nests, adults and fledglings are poorly documented (Venier et al. 2011), but these three warbler species are likely vulnerable to several predators that prey on songbirds breeding in similar habitat (e.g., mammals, raptors, and corvids; Bayne and Hobson 1997, Cotterill and Hannon 1999, Ball et al. 2009). Although the specific causes of mortality of these three species are unknown, it is safe to assume that they would be equally or more vulnerable to the numerous sources of mortality reported to explain the overall continental decline in songbirds (Stutchbury 2007). Human land use and infrastructure (Robinson and Wilcove 1994, Donovan and Flather 2002, Bayne et al. 2012), climate change (Butler 2000, Wilson et al. 2011), bioaccumulation of pollutants (Fairbrother et al. 2004), species invasion (Gurevich and Padilla 2004, Loss et al. 2012) and infectious diseases (Dhondt et al. 1998, LaDeau et al. 2007) are all also potential causes for the observed decline in these three species.

Human activities often result in habitat loss, i.e. conversion of suitable habitat into unsuitable habitat, and fragmentation, i.e. dissection of remaining habitat, which are important causes of population declines in North American songbirds (e.g., Robbins et al. 1989, Böhning-Gaese et al. 1993, Robinson et al. 1995, Schmiegelow and Mönkkönen 2002). More moderate human activities that cause habitat alteration instead of loss can still have significant effects on songbird populations — particularly those of late-successional forest specialists — because the resulting habitat, while still usable, is often of lower quality (Guénette and Villard 2005, Pérot and Villard 2009, Vanderwel et al. 2009). Habitat loss, alteration and fragmentation in Alberta’s forests are mainly caused by forestry, agriculture, oil and gas activities, natural disturbances (insect outbreaks and forest fires), and urban expansion. Human activities encountered by these three warbler species at migratory stopovers and on their wintering grounds can also threaten populations.

1.3.1. Forestry Sector

Current forestry practices are directed at maximizing the rate and volume of timber and pulp harvested. Pressure from forestry operations in British Columbia and Alberta is threatening the amount of suitable habitat remaining for these three warbler species, particularly within the western extent of the bay-breasted warbler and Cape May
warbler’s ranges (reviewed by Cooper et al. 1997a,b; Norton 2001a,b). Older stands are
targeted first for harvest, which reduces the amount of old forest on the landscape. This,
coupled with a short rotation age (ca. 70 years), leads to a younger landscape overall
(Schneider et al. 2003). In Saskatchewan, the black-throated green warbler occurred more
frequently in stands of post-rotation age (100–110 years after clearcuts; Cumming and
Diamond 2002). As well, silvicultural practices can lead to habitat alteration by the
“unmixing of the mixedwoods” (Hobson and Bayne 2000a), where the structure and
composition of diverse mixedwood stands are lost when stands are replanted with single
species post-harvest. These land practices result in an immediate and long-term reduction
of suitable warbler breeding habitat.

Although alternative harvesting techniques such as variable retention and aggregated
harvest are being explored, their potential to reduce warbler population declines in
Alberta is largely unknown. Studies of alternative harvesting techniques have shown that
there were significantly lower abundances of black-throated green warbler in harvested
stands than in control plots in Alberta (Norton and Hannon 1997) and elsewhere

Potvin and Bertrand (2004) suggested that mature forest patches of more than 50 ha are
required to maintain bay-breasted warbler populations. In Alberta and elsewhere, the
black-throated green warbler is generally absent from some small forest remnants (<100
ha; Askins and Philbrick 1987, Hobson and Bayne 2000b, Hannah 2006). Significant
edge avoidance was also observed in the black-throated green warbler in Alberta (Villard
et al. 2007). Edge avoidance may also occur due to increased predation or microclimate
effects (Hagan et al. 1996, Flaspohler et al. 2001), and may lead to a reduction in the
functional area of the remaining patch (Villard 1998). In Alberta, neither nest predation
nor nest parasitism appears to have increased due to fragmentation from forestry
(Cotterill and Hannon 1999, Song and Hannon 1999). Predation pressure may become
more significant when landscape conversion reaches a threshold level, as in some
agricultural landscapes (Koper and Schmiegelow 2006).

Creation of roads as a result of forest management also dissects remaining stands and
increases edge habitat, which can have negative effects permeating into the forest interior
(Hobson and Bayne 2000b, Rempel 2007). Lower densities have also been reported near
roads (Merrill et al. 1998, Ortega and Capen 2002). In Ontario, the bay-breasted warbler
is associated with undisturbed areas and low edge density (<18.5 m/ha; Rempel 2007,
see also Hobson and Bayne 2000b).

The landscape context surrounding forest remnants also needs to be taken into account, as
the degree of regional fragmentation can affect local bird abundance (Vernier et al. 2002,
Venier and Pearce 2007). Highly unsuitable habitat surrounding remnants may result in
songbirds being reluctant to cross gaps between patches of good habitat, thereby reducing
connectivity (Bélisle and Desrochers 2002, Brotons et al. 2003). Even large remnants
may be considered unsuitable habitat if they are isolated, or the composition of
surrounding habitat impedes movements (Bélisle and Desrochers 2002, Brotons et al
In New Brunswick, habitat loss at local and landscape scales was associated with lower apparent survival, explaining at least partially the reduced occurrence of black-throated green warbler in these landscapes (Zitske et al. 2011). In Quebec, Drolet et al. (1999) showed that the bay-breasted warbler was absent from landscapes with < 55% forest cover.

Habitat corridors have been explored as a landscape feature that may mitigate the effects of fragmentation, but their efficacy remains largely unknown (Hannon and Schmiegelow 2002). For example, in Quebec, the probability that the black-throated green warbler crossed gaps decreased sharply with gaps larger than 25–40 m wide (Rail et al. 1997). In New England, Meiklejohn and Hughes (1999) found lower abundances in buffer strips (< 100 m wide) than within reference sites (see also Freedman et al. 1981, Darveau et al. 1995, Hanowski et al. 2003). However, Darveau et al. (1995) suggest that 60-m wide buffer strips could support forest-dwelling birds.

For successful management of these species in Alberta, habitat requirements at both the stand and landscape scales need to be considered. Research projects in Alberta examining songbird response to forestry have been unable to make conclusions regarding the effects on these species, largely because of their low abundance. However, it is likely that populations in Alberta respond similarly to habitat loss and alteration as do populations elsewhere in the breeding range or other forest specialists for which empirical data are available (Vanderwel et al. 2009).

1.3.2. Energy Sector
An increase in energy exploration and development in Alberta in recent years has resulted in habitat loss, alteration, and fragmentation in late-successional forests, through the creation of permanent structures (compressor stations, wellheads, in situ oil extraction) and linear features (roads, seismic lines, pipelines; see Bayne et al. 2005, Lankau et al. in review and references therein). Seismic line density can reach up to 10 km per km$^2$ in some townships (Lee and Boutin 2006). Currently, regulations exist for revegetating seismic lines, but specific guidelines are lacking. Additional negative effects on songbirds resulting from oil and gas activities include reduced abundance and breeding success in areas near chronic industrial noise such as compressor stations (Habib et al. 2007, Bayne et al. 2008), and mortality caused by oil industry flare stacks (Bjorge 1987).

1.3.3. Agriculture
One type of habitat loss occurs where mature forests are converted for agriculture at the southern extent of the boreal forest (Hobson et al. 2002). Habitat fragmentation associated with agricultural expansion may lead to an increase in the abundance of nest parasites (i.e. brown-headed cowbird) and predators (Robinson et al. 1995, Bayne and Hobson 1997). Parasitism by brown-headed cowbirds has been reported in black-throated green warblers, but its effect on population dynamics remains unknown (Morse and Poole 2005). Parasitism by brown-headed cowbirds has also been reported for the Cape May warbler (Friedmann and Kiff 1985) and bay-breasted warbler (Sealy 1979), but may be rare because there is little overlap between the ranges and preferred habitat types of
these species (Venier et al. 2011). Nonetheless, predation and parasitism rates are often higher in forests fragmented by agricultural systems compared to those fragmented by forest management (Bayne and Hobson 1997).

1.3.4. Natural Disturbances (insect outbreak and forest fire)
Fluctuations in spruce budworm outbreaks have been shown to regulate population densities of bay-breasted and Cape May warblers (Patten and Burger 1998, Sleep et al. 2009, Venier and Holmes 2010); these species are considered to be spruce budworm specialists (Venier et al. 2009, Venier and Holmes 2010). In Canada, the abundance of spruce budworm in a given year is a good predictor of the population levels of these two warblers in the following year (Sleep et al. 2009). The effects of spruce budworm outbreaks on songbirds are usually positive, and no change in clutch size has been reported in black-throated green warbler during outbreaks; however increasing intraspecific competition from other songbirds could negatively influence the abundance of this species (Patten and Burger 1998). Conversely, the modification of the stand structure and composition following an infestation would support higher abundance of black-throated green warbler (DesGranges and Rondeau 1995).

Currently, aerial spraying of biological insecticides is used in Alberta to control spruce budworm outbreaks from epidemic to endemic levels (Alberta Sustainable Resource Development 2002). Chemical insecticides for spruce budworm were replaced in Canada in the early 1990s by bacterial insecticides that target the insect’s digestive system (van Frankenhuysen 1990). This greatly reduces the potential direct impacts on songbirds’ health (Pearce et al. 1976, Pearce and Garrity 1981, Venier et al. 2011). Spraying is effective at maintaining spruce budworm population levels locally (S. Ranasinghe pers. comm., cited by Norton 2001a), and might result in negative effects on spruce budworm specialists. However, the abundance of bay-breasted warblers was higher in sites protected from a budworm outbreak (controlled by insecticides) than those monitored 10 years post-outbreak (DesGranges and Rondeau 1995; see also Venier and Holmes 2010). Venier et al. (2011) also suggest that spraying is an unlikely cause for the overall decrease in population levels of bay-breasted warblers because it takes place over a small proportion of the species’ breeding range. A similar response can be expected for the Cape May warbler (Norton 2001b). The effects of spruce budworm control on the population dynamics of black-throated green warblers breeding in Alberta remain unknown.

Forest fire is an important component of stand dynamics in the boreal forest and occurs over a large spatial extent. For example, from 2002–2011, the annual average area burned in Alberta was 220 875 ha, while the annual mean number of wildfires was 1541 (Alberta Environment and Sustainable Resource Development 2012b). Wildfires result in habitat loss for late-successional forest specialists, but the duration of this negative effect is unknown. Hence, the response of these warblers to forest fire remains unknown in the province, but a study in Northern Minnesota showed that the bay-breasted warbler was common in a jack-pine–black-spruce forest prior to a fire and was seen only sporadically even 30 years after the fire occurred (Haney et al. 2008). Also in Minnesota, Shulte and Niemi (1998) showed that bay-breasted warbler was more abundant in harvested areas
(clearcuts with patches of residual trees) than in burned stands (years 2 and 3 post-fire). Yet, in northern Georgia, the species had similar densities among controls and burns of different severities and showed no relationships with time since fire during the first six years post-fire (Rush et al. 2012).

1.3.5. Urban Expansion
According to Alberta Treasury Board and Finance (2012), under a scenario of medium growth rate, the population is expected to increase by over 2 million people and reach about 6 million by 2041. In Ontario, the black-throated green warbler shows lower abundance in developed (housing/cottage) versus undeveloped areas (Ford and Flaspohler 2010). Recent studies suggest that millions of birds die annually from collisions with houses and other buildings (Bayne et al. 2012, Machtans et al. 2013). Furthermore, between 100 and 350 million birds are preyed upon annually by cats in Canada (Blancher 2013). Although these numbers might reflect a low proportion of all birds breeding in Canada, this source of mortality can have disproportionately negative effects on species with low population sizes, especially when considering the cumulative effects of all other sources of human land use.

1.3.6. Winter and Migration Stopover Habitat
All the threats listed above also apply to winter and migration stopover habitat (Mehlman et al. 2004, reviewed by Stutchbury 2007). Rappole and McDonald (1994) suggest that habitat degradation on the wintering grounds may be a key factor underlying observed declines of migratory songbirds (see also Faaborg et al. 2010). Recent studies have determined that lower-quality winter habitat can influence reproductive output during the breeding season through carry-over effects (Norris et al. 2004, Holmes 2007), and have highlighted the importance of understanding species’ status throughout their annual cycle (Sillett and Holmes 2002, Greenberg and Marra 2005).

The population of black-throated green warblers in Saskatchewan declined from 1972 to 1992, and events on the wintering grounds have been suggested as a potential factor underlying this pattern (Kirk et al. 1997). Very little information is available on the ecology of black-throated green warblers during migration, but migratory stopover sites are often located in areas with high human densities, and many have been lost or altered because of development (Morse and Poole 2005). However, this species may be less threatened by tropical deforestation than other neotropical migrants, as it occupies a large wintering range and uses a broad range of habitats (Morton 1992).

While bay-breasted warblers are found in both primary and second-growth forests during migration and the non-breeding season, their geographic distribution on the wintering grounds is quite limited (reviewed by Venier et al. 2011). This may lead to higher conservation priorities if population levels continue to decline.
2.0 GOALS AND OBJECTIVES

2.1 Goal

Maintain breeding populations of black-throated green warblers, bay-breasted warblers and Cape May warblers throughout their historical range in Alberta.

2.2 Objectives

1. **Inventory, monitoring and assessment**: Continue monitoring boreal bird populations in Alberta to understand population sizes, distributions and trends, and habitat requirements of these warbler species.

2. **Habitat conservation and management**: Implement appropriate habitat conservation and management practices.

3. **Research**: Address the important gaps in our knowledge of the population dynamics of these warbler species in Alberta.

4. **Education and communication**: Improve education of and communication with government, industry, public and landowners about the importance of habitat conservation and neotropical migrants.

3.0 MANAGEMENT ACTIONS

3.1 Monitoring and Assessment

Community-level surveys such as line transects and point counts are important tools for documenting presence/absence, relative abundance, and coarse-scale habitat associations of bird species. These surveys can be more easily applied over larger spatial scales than can more intensive local demographic studies. However, demographic studies using techniques such as spot-mapping and mark-recapture are critical to understanding population dynamics and growth rates. They would provide information about the mechanisms underlying the status of these three warbler species in Alberta. The bay-breasted and Cape May warblers can be difficult to detect during surveys because their song is high, thin and quiet. Thus, care should be taken when training observers and planning sampling efforts. Sampling methods and protocols should also be standardized to simplify comparisons between studies (e.g., meta-analyses) and trend analyses. Trend analyses should be conducted every five years to implement proactive adaptive management and conservation actions (Wilhere 2002, Norton 2005, McDonald-Madden et al. 2010).

There are currently several projects monitoring these warbler populations in Alberta. These projects are being conducted by universities and colleges, consulting firms, industry, and both government and non-governmental organizations. Continued long-
term monitoring is critical to detect changes in population size, distribution and trend, and habitat associations. Below are some examples of monitoring programs taking place in the province:

- **Alberta Biodiversity Monitoring Institute**
  - Established in 2003, this initiative includes broad-scale surveys throughout Alberta, including remote areas of the province (Alberta Biodiversity Monitoring Institute 2012; see also Stadt et al. 2006, Nielsen et al. 2009).

- **Alberta Breeding Bird Atlas**
  - This volunteer-based monitoring initiative aids in identifying the distribution and abundance of Alberta birds (Federation of Alberta Naturalists 2007).

- **Breeding Bird Survey**
  - Broad-scale, long-term roadside surveys are used to monitor the status and trends of North American bird populations (Sauer et al. 2007).

- **Calling Lake Fragmentation Project**
  - Ongoing since 1993, this intensive landscape experiment explores the effect of forest fragmentation due to harvesting on the songbird community (principal investigators: Dr. E. M. Bayne and Dr. F. K. A. Schmiegelow).

- **Ecosystem Management by Emulating Natural Disturbance (EMEND)**
  - This long-term project examines the effects of variable retention after harvest and forest regeneration on ecosystem integrity (project leaders: Dr. J. R. Spence and Dr. J. Volney).

- **Alberta Migration Monitoring stations (Lesser Slave Lake Bird Observatory, Beaverhill Bird Observatory, Inglewood Bird Sanctuary, and Owl Moon Environmental Inc. in the Fort McMurray region)**
  - These stations use banding and the MAPS program (Monitoring Avian Productivity and Survival) to collect information on changes in bird populations, including abundance, sex and age ratios, and routes and timing of migration.

- **Integrated Monitoring Plan for the Oil Sands: terrestrial biodiversity component (Canadian Wildlife Service):**
  - The collection of point count data is used to monitor habitat disturbances by oil sands development and to improve bird-habitat density models.

Communication and collaboration between stakeholders and researchers are required to achieve a more complete understanding of the status these three warblers and the effects
of conservation actions. Examples of such work are currently conducted by the Boreal Avian Modelling Project (http://www.borealbirds.ca/), Ebird (http://ebird.org/content/ebird), and Boreal Songbird Initiative (http://www.borealbirds.org/index.shtml). All data should be stored in the Fisheries and Wildlife Management Information System (FWMIS) — a standardized data collection, storage and retrieval system for both government and the public (Alberta Environment and Sustainable Resource Development 2012c).

3.2 Habitat Conservation and Management

In Alberta, these warbler species breed exclusively in the Boreal Forest and Foothills natural regions. Black-throated green warblers breed exclusively in spruce forests, mixedwood stands dominated by large spruce, and deciduous-dominated mixedwood stands. For bay-breasted and Cape May warblers, higher densities are reached in mature and old coniferous forests, and all three species show a strong association with mature and interior forests (Boreal Avian Modelling project 2012a,b,c). The recommendations for stand and landscape management apply to all these habitats types.

Implementation of these recommendations could be assisted by modelling the amount of habitat available given alternative scenarios of human land use (e.g., ALCES - www.alces.ca) or by using spatially explicit approaches to optimize the amount of habitat protected given different predicted economic opportunities (e.g., Marxan; Game and Grantham 2008).

The following recommendations should be considered when developing both landscape-level plans (such as forest management plans, land-use framework regional plans, etc.) as well as operational policies and plans (such as wildlife standards and guidelines, forestry operational ground rules, etc.).

Stand-Level Management

- Forest Age
  - Blocks of old forest (stands > 100 years old) should be maintained on the landscape to support high densities (Boreal Avian Modelling Project 2012a,b,c) and for the persistence of late-successional forest specialists.

- Forest Composition
  - Conservation efforts should ensure that white spruce and balsam fir are maintained in coniferous and mixedwood stands and that reforestation corresponds to pre-harvest conditions or mimics natural disturbance regimes (Robichaud and Villard 1999).
    - Large diameter trees are key habitat features for these species (especially black-throated green warbler: > 50 cm dbh for white spruce and > 20 cm dbh for paper birch) and they should be maintained to provide required local conditions.
Forest Configuration

- Remnant forest blocks should be larger than 50 ha (Potvin and Bertrand 2004). Note that other songbirds with similar territory size have been shown to be absent from forest blocks < 100 ha (Hannah 2006). However, maintaining breeding populations might require substantially larger blocks of forest than what is needed to maintain the probability of presence of a species (e.g., Poulin et al. 2008).

- Because of negative edge effects, edge density and the edge-to-area ratio of remnant patches should be minimized (< 18.5 m/ha; Rempel 2007). Creation of linear features (i.e. roads, cutlines and pipelines) should be minimized in areas with large patches of high-quality breeding habitat.

Landscape-Level Management

- The bulk of industrial activities should be conducted during the non-breeding season (1 August–30 April) to prevent the destruction or disturbance of birds and their nests (see *Migratory Birds Convention Act*).

- The boreal landscape needs to be managed at a broad spatial scale with consideration of cumulative effects of all human land use (Schneider et al. 2003, 2011; Aumann et al. 2007).

- Human activities should be modified to mimic natural disturbances over large forest landscapes (e.g., use aggregated harvest blocks to emulate fire regimes; Carlson and Kurz 2007). Elaboration of specific mitigation programs is also imperative to minimize the lifespan of industrial footprints (MacDonald et al. 2012).

- The amount, composition, and distribution of late-successional stands should be monitored to ensure that they are present in adequate proportions on the landscape and meet conservation targets. Rompré et al. (2010) suggest that most sensitive forest species could be maintained with at least 40% of residual forest maintained on the landscape, but Drolet et al. (1999) showed that more than 55% of residual forest is required for maintaining the bay-breasted warbler.

- Contiguous areas of boreal forest (e.g., reserve networks) should be protected from human development to serve as refugia and ensure the existence of source populations (population growth rate > 1), which could be used as ecological benchmarks.

- Alberta’s landscapes are subject to intensive human activities, and static reserves may not ensure a continuing presence of suitable habitat (Leroux et
Hence, implementing dynamic reserve design may be worth exploring.

- Consideration should be given to the use of multi-species or umbrella species models to achieve landscape targets for these warblers because it is not feasible to set habitat targets for all individual species when developing plans.

### 3.3 Research

To implement efficient adaptive management strategies, efforts should address the following gaps in our knowledge of the ecology, particularly breeding biology, of these three warblers in Alberta:

- Determine habitat-specific breeding success, productivity (e.g., number of young produced per unit area), and other vital rates such as survival, dispersal and recruitment, by using a combination of mark-recapture studies and genetic/stable isotopes analyses.

- Very little information exists on bay-breasted and Cape May warbler density and reproductive success within areas of spruce budworm outbreaks in the province. The short- and long-term implications of aerial spraying should be investigated.

- Provincial and species-specific estimates of mortality owing to collisions with houses and buildings should be generated while accounting for expected population growth rate of Albertans.

- Information collected through these first three actions should be used to generate demographic models providing habitat-specific population growth rates.

- Determine the mechanisms underlying habitat-specific variation in population growth rate (availability of resources, abundance of nest predators, human disturbance, etc.).

- Determine the patch size and landscape configuration that supports the highest densities of the three species and the most productive individuals.

- Use all of the above information to model the future status of these species, based on alternative scenarios of human land use, to inform stakeholders and determine the most efficient management strategies.

- Evaluate the potential of modelling the response of an umbrella species (i.e., a “species that requires large areas of suitable habitat to maintain viable populations and whose requirements for persistence are believed to encapsulate those of an array of associated species”; Carignan and Villard 2002) to determining simultaneously how populations of these warblers and other species with similar habitat requirements respond to human land use.

### 3.4 Education and Communication

Although the song of the black-throated green warbler is unique, it often forages high in mature trees and may not be recognized by untrained observers. Similarly, bay-breasted and Cape May warblers forage high in trees, and their songs can easily be confused with other songbird species breeding in similar habitat. Brochures (or other outreach materials)
would be an important tool for describing these species and their habitat needs, as well as communicating the conservation needs of these warblers and other bird species facing similar threats. It is essential to maintain communication with government, public, industry and landowners regarding breeding habitat description, timing of breeding, and why these species are sensitive to human disturbance. Also important is to emphasize the benefits of maintaining large tracts of old forest for a variety of resident and migratory species inhabiting the boreal forest. Such information could be communicated by interpretive programs and visitor centres of provincial and federal parks, presentations to schools and recreational clubs, and in the media. Monitoring the effectiveness of these programs is critical to maximize their efficiency.

4.0 SUMMARY

The black-throated green warbler is considered a mature and interior forest species, and the bay-breasted and Cape May warblers are considered late-successional forest specialists. All three species face multiple threats resulting from industrial activities — the amount of habitat lost, altered and fragmented by such activities is cause for concern regarding the viability of many wildlife species in Alberta. Long-term community-level surveys as well as detailed demographic studies are needed to adequately monitor these three warbler species and to determine the amount and spatial configuration of the optimal habitat required for maintaining source populations. Integration of the listed recommendations into current land management practices would help protect habitat and favour conservation of these songbirds.

Particularly important to ensure population persistence of these warblers in Alberta is to maintain old coniferous stands and old mixedwood forests with an overstory that comprises large white spruce and paper birch. These stand types should be maintained in large blocks with minimal edge. Control of spruce budworms should be applied with caution, as bay-breasted and Cape May warblers are considered spruce budworm specialists and their population levels are correlated with the abundance of this prey. A key step in effectively managing black-throated green warbler populations is the collaboration of the different stakeholders in sharing of knowledge and minimizing cumulative effects on the landscape.

This conservation management plan should be considered a “living document”, and any new and relevant information should be incorporated when available. A complete review of this plan should take place every five years to include new population and habitat data and adjust the conservation recommendations accordingly. The review should be led by Alberta Fish and Wildlife Division, in consultation with boreal songbird experts and other stakeholders.
5.0 LITERATURE CITED


Stutchbury, B. 2007. Silence of the songbirds: how we are losing the world’s songbirds and what we can do to save them. Walker Publishing Company, Pennsylvania, USA.


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6.0 APPENDIX 1. POPULATION TRENDS

Black-throated green warbler
Data from the Bird Breeding Survey (BBS) suggest that the black-throated green warbler is relatively stable nationally, with reported declines of 1.2% annually from 1999–2009 and 0.5% annually from 1989–2009 (Environment Canada 2012b). Since 1970, the black-throated green warbler is considered to have shown “little change” (< 25% decrease), and the reliability of the estimated trend is “high” (status category is likely to be correct, or at worst within one status category of the actual species status; Environment Canada 2012b). BBS data for the Boreal Taiga Plains Bird Conservation Region (BCR 6), which covers most of the species’ breeding range in Alberta, show a significant increase in population size from 1970–2009 (17.2% annually), but it declined by 8.3% and 7.0% annually since 1989 and 1999, respectively (Environment Canada 2012a). From 1994–2012, only 102 black-throated green warblers have been captured and banded at the Lesser Slave Lake Bird Observatory compared to 6024, 4296 and 9054 American redstarts (Setophaga ruticilla), Tennessee warblers (Oreothlypis peregrina) and yellow-rumped warblers (Setophaga coronata), respectively. These results suggest substantially lower abundance in this species compared to other more common boreal songbirds. Significant population declines have been documented in a long-term study in Alberta (Schmiegelow et al. 1997, Schmiegelow and Hannon 1999, Hannah 2006).

Bay-breasted warbler
Data from the BBS suggest that the Canadian population of the bay-breasted warbler declined by 3% annually from 1970–2009 and by 5.2% annually from 1989 to 2009 (Environment Canada 2012b). Since 1970, it is considered to have shown “moderate decrease” (≥ 25% and < 50% decrease), and the reliability of the estimated trend is “low” owing mostly to poor coverage of the breeding range (Environment Canada 2012b). BBS data for BCR 6, which covers most of the species’ breeding range in Alberta, show a significant increase in population size from 1989–2009, but the importance of this trend decreases and becomes non-significant when only data from 1999–2009 are considered (Environment Canada 2012a). From 1994–2012, only 103 bay-breasted warblers have been captured and banded at the Lesser Slave Lake Bird Observatory compared to 6024, 4296 and 9054 American redstarts, Tennessee warblers and yellow-rumped warblers, respectively. These results suggest substantially lower abundance in this late-successional forest specialist compared to other more common boreal songbirds.

Cape May warbler
Data from the BBS suggest that the Canadian population of the Cape May warbler declined by 5.3% annually from 1999–2009 and 4.2% annually from 1989–2009 (Environment Canada 2012b). Since 1970, it is considered to have shown “moderate decrease” (≥ 25% and < 50% decrease), and the reliability of the estimated trend is “medium” (significant uncertainty about the status category, but is likely to be within one status category of that assigned, and not off by more than 2 status categories; Environment Canada 2012b). BBS data for BCR 6, which covers most of the species’ breeding range in Alberta, show a significant increase in population size from 1970–2009 (20.7% annually) and 1989–2009 (23.6%), but population levels have been relatively
constant (2.0 % increase) between 1999 and 2009 (Environment Canada 2012a). From 1994–2012, only 132 Cape May warblers have been captured and banded at the Lesser Slave Lake Bird Observatory compared to 6024, 4296 and 9054 American redstarts, Tennessee warblers and yellow-rumped warblers, respectively. These results suggest substantially lower abundance in this late-successional forest specialist compared to other more common boreal songbirds.
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