

*Conservation Assessment
for
Bay-Breasted Warbler (*Dendroica Castanea*)*



Photo: BD Cottrille

USDA Forest Service, Eastern Region

December 26, 2002

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Table of Contents

EXECUTIVE SUMMARY 4
ACKNOWLEDGEMENTS 4
NOMENCLATURE AND TAXONOMY 5
DESCRIPTION OF SPECIES 5
LIFE HISTORY..... 6
POPULATION BIOLOGY AND VIABILITY 8
HABITAT 9
DISTRIBUTION AND ABUNDANCE 10
CONSERVATION STATUS 11
POTENTIAL THREATS AND MONITORING 11
**SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT
PROTECTION..... 12**
SUMMARY OF EXISTING MANAGEMENT ACTIVITIES..... 13
PAST AND CURRENT CONSERVATION ACTIVITIES 13
RESEARCH AND MONITORING 14
REFERENCES..... 15
APPENDICES 21

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 Bay-breasted Warbler (*Dendroica castanea*). The primary focus of this conservation assessment is on information relevant to Region 9 of the United States Department of Agriculture Forest Service.

The Bay-breasted Warbler is a neotropical migrant that inhabits boreal coniferous forests in a broad band, primarily, across central and eastern Canada. It breeds in northern spruce-fir forests, feeding and nesting in the dense foliage of these conifers. It winters in Panama and northern South America. Males and females are fairly large relative to other members of the genus *Dendroica*, being 13 to 14 cm long and weighing about 13 g. Bay-breasted Warbler numbers have been reported to dramatically increase and decrease in synchrony with outbreaks and declines of the spruce budworm (*Choristoneura fumiferana*), a key food item. Its North American breeding distribution is closely correlated with that of spruce and fir in the boreal forest. The greatest threat to the breeding range of the Bay-breasted Warbler is the reduction in the area of old-growth spruce and fir of the boreal forest. Both nesting habitat and food supply (spruce budworm) are at risk when reductions or alterations of these forest areas occurs. Spraying insecticides to control spruce budworm can have direct toxic affect on this Warbler (inhibition of brain acetylcholinesterase activity). Winter habitat degradation and loss is also a threat, as commercial and residential development activity continues to reduce the forested habitats in the tropics.

No specific or dedicated management activities have been attempted for the Bay-breasted Warbler in Region 9. If management activities are developed and implemented, they should address ecological sustainability. No past or current conservation activities in Region 9 are known to be relevant to the Bay-breasted Warbler. However, the adoption of an ecosystem-centered forest management perspective within Region 9 would likely help conserve inconspicuous boreal birds such as the Bay-breasted Warbler. No surveying, monitoring or research specific to the Bay-breasted Warbler has occurred or is occurring within the National Forests of Region 9, although some generalized bird monitoring is occurring. Modifications to a point-count survey protocol could improve the monitoring of Bay-breasted Warblers in National Forests. Considering the limited extent of its habitat within these forests, its migratory behavior and inconspicuous nature, declines in the abundance of Bay-breasted Warblers in Region 9 forests could easily be overlooked.

ACKNOWLEDGEMENTS

Thanks are extended to Ed Lindquist, Forest Wildlife Biologist, Superior National Forest, for the opportunity to prepare this document. This conservation assessment was improved by the review and comments of JoAnn Hanowski and Jim Lind.

NOMENCLATURE AND TAXONOMY

Class:	Aves
Order:	Passeriformes
Family:	Parulidae
Genus:	Dendroica
Binomial Name:	<i>Dendroica castanea</i>
Subspecies:	None
Common Name:	Bay-breasted Warbler
Synonyms:	None
American Ornithologist's Union Code:	BBWA

DESCRIPTION OF SPECIES

The Bay-breasted Warbler is a neotropical migrant that inhabits boreal coniferous forests in a broad band, primarily, across central and eastern Canada. It breeds in northern spruce forests, feeding and nesting in the dense foliage of these conifers (Williams 1996). It winters in Panama and northern South America (Eisenmann 1957, Morton 1980).

Males and females are fairly large relative to other members of the genus *Dendroica*, being 13 to 14 cm long and weighing about 13 g (Williams 1996). Wing chord measurements from preserved specimens were reported to average 7 cm (Greenberg 1984). The first nuptial plumage is acquired by a prenuptial molt that occurs before the birds come north (Bent 1953). This molt affects most of the body plumage and wing coverts to produce a deep chestnut crown, paler throat and lateral stripes, black sides of the head and forehead, olive-gray back streaked with black, rich buff patches on the sides of the neck, and black wing coverts that are plumbeous-edged and white-tipped (Dwight 1900). Adults have a complete postnuptial molt, mainly in July. The adult male has distinctive alternate (breeding) plumage with a black face, chestnut crown, throat and sides, cream-colored neck patch and belly, and two prominent white wing-bars. Breeding adult females are duller in coloration than the males. They lack the black face markings and the chestnut crown and throat, but retain the distinctive white wing-bars of the male (Williams, 1996).

The Bay-breasted Warbler in basic (non breeding) plumage is most easily confused with the basic-plumaged Blackpoll Warbler; both having dull olive upper parts with streaking, slightly yellowish under parts, and white wing-bars. However, Bay-breasted Warblers usually have some trace of chestnut wash on the sides, less streaking on the above parts

and unstreaked under parts (Bent 1953, Williams 1996). It can also be confused with the basic-plumaged Pine Warbler, which lacks the streaked back of the Bay-breasted Warbler but possesses white (vs. cream-colored) under-tail coverts (Williams 1996). The Bay-breasted Warbler is also distinguishable from the Blackpoll and Pine Warblers by the dark or black coloration of its legs and feet, and dark undersides of its toes (Kaufman 1990, Curson et al. 1994).

The Bay-breasted Warbler produces low-volume songs composed of very high, thin, squeaking notes that are quite uniform in pitch (Williams 1996). The song is similar to that of the Blackburnian, Black-poll, Black and White, and Cape May Warblers but is generally louder (G.W. Thayer to Dr. Chapman *in* Bent 1953: page 386). The song is delivered (with frequency) throughout the day and the female's singing from the nest, in response to the male, is markedly weaker than the males, being barely distinguishable from that of the Blackburnian (P. Phillip and B. Bowdish *in* Bent 1953, page 386). Songs are typically comprised of five to ten high-pitched, lisping notes rendered as *see-atzee-atzee-atzee-atzee* or *seetzy-seetzy, seetzy, seetzy-see* (Griscom and Sprunt 1957), uttered in such a rapid succession that a continuous sound is produced. Vocalizations are typically two-noted syllables with one note shorter than the other; however, a less typical single-noted syllable with each one of nearly equal length is also possible (Borror Laboratory of Bioacoustics *in* Williams 1996, Fig. 2 page 7). Two song types are recognized. Accented and unaccented (Ficken and Ficken 1962) or first and second category (Spector 1992). The accented, or first category, song has an accented ending and it predominates early in the breeding season during male-female communication. The unaccented, or second category, song lacks the accented ending and it is used for male-male communication after nesting has initiated (Ficken and Ficken 1962, Williams 1996). As summarized by Williams (1996) and references therein, other sounds associated the Bay-breasted Warbler include:

- **Call Note** – A high-pitched, loud, and buzzy note, *sip* or *see*; also a rare, loud, sweet *chip* (Getty 1993, Curson et al. 1994).
- **Alarm Call** – A sharp-sounding metallic *chip* and a *tititi* call (Mendall 1937, Ficken and Ficken 1962).
- **Release Calls** – Short, repeated notes used after release from mist nets; presumably to reestablish contact with flock members (Ingold 1988).
- **Nonvocal Sounds** – A bill snap, made by the mandibles closing shut, in aggressive circumstances (Ficken and Ficken 1962).

LIFE HISTORY

Migration

The Bay-breasted Warbler is a strongly migratory neotropical species that winters in southern Central America and northwestern South America, and breeds in northeastern North America (Williams 1996). Generally, departure from breeding territories occurs in August and September, arrival at wintering territories begins in October, departure from

wintering territories occurs in April, and return to breeding territories occurs during May and June (Greenberg 1984).

The fall migration occurs primarily through the eastern United States in a wide band bounded by the eastern plains states and the Atlantic coast (Williams 1996). Mortality data from lighthouse and tower locations indicate that few Bay-Breasted Warblers migrate through the southeastern United States in the fall (Nesbit 1970). Studies of the fall migration suggest that the predominant migration path of adult birds is farther west than that of first-year birds (Ralph 1981, Hall 1981, Stewart 1986). Fall migration responses are affected by favorable weather; i.e. high pressure, clear skies and strong northwest wind conditions (Williams 1996).

The spring migration is trans-gulf. Bay-breasted Warblers that winter at lower, more tropical, latitudes have fewer external indicators of seasonality available and therefore rely more on an endogenous clock (Williams 1996). Data collected between 1970 and 1987 indicate that birds migrating from Central or South America arrive an average of 17 days later in eastern Massachusetts than those migrating from the southern United States (Hagan et al. 1991). Northbound migratory stopovers are shorter relative to many other warblers, being only about two weeks in duration (Keast 1980a).

The Bay-breasted Warbler is a nocturnal migrant. The migrations of the Bay-breasted and Blackpoll Warblers overlap in the United States (Midwest and southeast) during the fall and these two birds were very often confused/misidentified in basic plumage until more definitive distinctions became known in the 1930's (Williams 1996). There is no strong evidence, however, that the trans-gulf migrating Bay-breasted Warbler travels along the western Atlantic Ocean (as does the Blackpoll) during the fall migration (Nisbet 1970).

Sexual Behavior and Courtship

There is a paucity of information on these topics for the Bay-breasted Warbler. They are presumably seasonally monogamous (Williams 1996). However, Sealy (1979) reports that the relationships are quite flexible with pair bonds being established quickly and perhaps opportunistically. Males are solitary on breeding grounds and will attack and chase each other in breeding areas especially when food supplies are superabundant (Morse 1978). The sex ratio has been estimated to be 2:1 (female to male) per data obtained from tower mortalities in Florida during migration from 1973 through 1975 (Crawford 1978).

Nest Characteristics

Bay-breasted Warblers typically nest on horizontal branches of spruce, preferably black spruce *Picea mariana*, or balsam fir of dense coniferous forests (Williams 1996). The mean nest height has been reported to be from 3.3 to 4.9 meters above ground (MacArthur 1958) and is usually 1.5 to 3.0 m out from the trunk (Williams 1996). Mendall (1937) described a nest to be large but compact, constructed externally of small

spruce and fir twigs and dried grass, lined with fine grass, black rootlets and moss setae. Construction details presented in Bent (1953) and Williams (1996) corroborate this description. The dimensions of several nests were recorded (inches) to range from 2 to 2^{3/4} outside depth, 1^{1/4} to 1^{1/2} inside depth, 3^{1/2} to 5 outside diameter, and 2^{1/10} to 2^{2/3} inside diameter (Mendall 1937). The nests are usually constructed in the densest portion of the branch foliage and they are often located just below a branch that could possibly provide shade and shelter (Williams 1996). The female builds the nest (Williams 1996) and she, exclusively, incubates the eggs (Mendall 1937).

POPULATION BIOLOGY AND VIABILITY

The clutch size is commonly five and occasionally six eggs; range four to seven eggs (Mendall 1937, Bent 1953, Griscom and Sprunt 1957). There is one clutch and one brood per season (Williams 1996). The incubation period is 12 to 13 days and incubation is by the female only (Bent 1953, Griscom and Sprunt 1957). Young depart the nest 10 to 11 days after hatch and they remain close to the nest as the adults continue to feed them (Mendall 1937). Longevity was estimated to be three years and five months, based on recovery of a single banded adult female (Klimkiewicz and Futcher 1989). Long-term (1966 – 1999) survey-wide Breeding Bird Survey (BBS) data showed a slight (2.6 %), nonsignificant decrease in population; however, short-term (1980 – 1999) data for the northern spruce/hardwoods forest revealed a significant ($P < 0.05$) decrease of 3.7 %. These decreasing trends could be indicative of human activities that impact the availability of food supply in the primary breeding areas of Canada (Williams 1996).

Bay-breasted Warbler numbers have been reported to dramatically increase and decrease in synchrony with outbreaks and declines of the spruce budworm (*Choristoneura fumiferana*), a key food item. Morris et al. (1958) reported a 12-fold increase in population, from 10 to 120 pairs per 40 ha, during spruce budworm outbreaks over a ten-year period in the Green River Watershed of New Brunswick Canada. MacArthur (1958) reported substantial population increases and observed greater clutch sizes during spruce budworm outbreaks in 1956 and 1957 in New England. Conversely, strong declines in warbler populations are known to be associated with the passing of such outbreaks (Kendeigh 1947, Morse 1980). The relationship between food supply and population dynamics during spruce budworm outbreaks was studied by Morse (1978) who concluded that: 1) bird numbers were inadequate to populate an outbreak area more intensely, 2) budworms were not the only food item available to the birds and 3) territorial behavior could be limiting the extent of population increases. Populations of four to six species of *Dendroica*, including *Dendroica castanea*, are able to co-exist due to subtle species-specific differences in foraging behavior and location (Morse 1980, Greenberg 1984). Recent work by Holling (1988) and Niemi et al. (1998) further emphasize the importance of relationships between insects and insectivorous birds to forest ecosystems.

Diet

Major food items of the Bay-breasted Warbler during the breeding season are Lepidoptera larvae (MacArthur 1958) and other insects including various beetles and flies, canker and measuring worms, locusts and grasshoppers, dragonflies and ants (Griscom and Sprunt 1957). In addition to the spruce budworm, the black-headed budworm (*Alceris variana*) can also be a food source during outbreaks (Morris et al. 1958, Gage et al. 1970). A thorough quantitative analysis of spruce budworm consumption during an outbreak resulted in a mean of 2.9 budworms per stomach (SD 2.7, n = 41) and an estimated 13,570 budworms eaten per hectare (Crawford and Jennings 1989). Extralimital nesting of Bay-breasted Warbler was shown to be associated with its consumption of forest tent caterpillars (*Malacosoma disstria* Hbn.) (Sealy 1979).

During the fall migration, Bay-breasted Warblers will consume berries of the Virginia creeper and mulberry (Griscom and Sprunt 1957) and fruits of the dogwood (Mueller and Mueller 1976). While wintering in the tropics, fruits serve as the primary food source; however, when dry, insects will also be consumed (Morton 1980, Greenberg 1984).

HABITAT

Breeding

The Bay-breasted Warbler mainly breeds in dense, boreal forests of mature spruce and fir (Bent 1953, Curson et al. 1994, Williams 1996). It will also inhabit old mixed-wood stands and prefers moist, swampy areas to dry, upland locations (Sabo 1980, Hobson and Bayne 2000, Kirk and Hobson 2001). Extralimital nesting in a deciduous habitat, largely devoid of conifers, was reported in association with an outbreak of forest tent caterpillars (Sealy 1979). Foraging microhabitat preferences are the inner portions of midlevel branches that are among the large lichen-covered (scant foliage) limbs of conifers; also the inner portions of conifer branches among the dead limbs at lower heights (MacArthur 1958, Morse 1978 and 1980). Less than 30 % of its life cycle occurs on breeding grounds (Winkler et al. 1992).

Migration

In contrast to the strong preference for conifers during the breeding season, the Bay-breasted Warbler is found in a wider range of habitats during both the spring and fall migrations. Williams (1996) found them in mixed hardwood-fir forests in New Hampshire during both the fall and spring migrations, as well as in tamarack (fall) and the tops of oak (spring). In Wisconsin, they were also observed to be in the tops of oak and elm (Robbins 1991).

Winter

The Bay-breasted Warbler typically resides in the moist forests and woodlands of the Panama Canal Zone, being more common in the older than in the younger forests of

Barro Colorado Island (Greenberg 1984). It is also found in mature forests and young second-growth stands in the Pirre region of Darien Panama (Greenberg 1984). There are also reports of Bay-breasted Warblers wintering in northern South America (Hilty 1980 and Lefebvre et al. 1994). Foraging microhabitat preferences are very diverse in the winter. It occasionally seeks insects along roads and on lawns but primarily does so by gleaning the upper branches, twigs and leaves of broad-leafed trees and shrubs (Williams 1996). It tends to forage for insects on the upper side of foliage (Greenberg 1984) and it will also take fruit (Greenberg 1984 and Martin 1985).

DISTRIBUTION AND ABUNDANCE

The Bay-breasted Warbler has a North American distribution that spans from the southwestern Northwest Territories and eastern British Columbia; east to the northern Great Lakes, New England, Nova Scotia and southern Newfoundland (Curson et al. 1994). Its North American breeding distribution is closely correlated with that of spruce and balsam fir in the boreal forest (Williams 1996). The vast majority (90 %) of its breeding range is in Canada (Sodhi and Paszkowski 1995). In Canada, breeding is confirmed in Alberta (northern and central), Saskatchewan (northwest and central), Ontario (central), Quebec (southern), New Brunswick, Prince Edward Island and Nova Scotia (Williams 1996); also, in a very limited area on the southern shore of Lake Manitoba (Sealy 1979). Their presence in British Columbia has been documented (Weber and Cannings 1990, Cooper et al. 1997). In the U.S., breeding is confirmed in Minnesota (northeastern), Michigan (northern), Vermont (northeastern), the northern portions of New Hampshire and Maine; the southern limit of its breeding range is the Adirondack Mountains of New York (Williams 1996). One adult male specimen, in breeding plumage, established a first record for Oregon (McCaskie 1964). The breeding season distribution of the Bay-breasted Warbler, based on Breeding Bird Survey (BBS) data, is shown in Appendix 1.

Its winter distribution is Tropical American; spanning from Panama to western Columbia and northwestern Venezuela, also occasionally north to Costa Rica (Curson et al. 1994). It is a fairly-common to common resident in Panama, predominantly in the lowland rainforests of the Caribbean slope, on the Pacific slope and on Barro Colorado Island (Keast 1980b and Greenberg 1984). It is also considered to be fairly common, to common in northwestern and northern Columbia, and northwestern Venezuela (Williams 1996). It has been recorded as a casual transient and winter resident in the Dominican Republic and Puerto Rico (Arendt 1992). Despite being a neotropical migrant, the species is frequently recorded in the 48 contiguous states (see Appendix 2) during Christmas Bird Counts (CBC). These data should be interpreted with caution however because they are very likely representative of late migrants and not true, winter residents.

The absolute abundance of Bay-breasted Warblers is difficult to estimate because of the observational and identification challenges presented by their preference for dense macro and micro habitats of the boreal forest, their tendency to inconspicuously nest and feed in the mid to top canopy area, their small physical size and their soft, extremely high-pitched vocalizations. In spite of these obstacles, the BBS has generated tabular and

graphic presentations of count data for the Bay-breasted Warbler from 1966 through 2000 that indicate a trend of declining abundance (Appendix 3). These data need to be evaluated with caution however because they are not statistically significant (Sauer et al. 2001).

CONSERVATION STATUS

Globally, The Nature Conservancy (TNC) Heritage Status conservation ranking system gives the Bay-breasted Warbler a "G5" ranking, meaning the species is demonstrably widespread, abundant and secure (NatureServe 2002). Nationally for the U.S., TNC ranks the Bay-breasted Warbler as "N5", meaning the species is demonstrably widespread, abundant and secure. For most of the states comprising the Eastern Region of the USDA Forest Service (CT, DE, IL, IN, MD, NJ, PA, RI, WV and WI) the ranking SZN (migratory – irregular, transitory and dispersed) applies. An unranked status designation (S?) applies to the eastern-region states of MN, MO and OH. Its status in ME (S5) and NH (S4) is ranked as secure and apparently secure, respectively. An imperiled status ranking (S2) is assigned to the eastern-region states of IA (non-breeding), MI and NY. The state of Vermont has a critically imperiled ranking for the breeding population (S1B) of the Bay-breasted Warbler (NatureServe 2002). In Alberta Canada, the species is on the “Blue List” indicating it is at risk. This designation is primarily due to concerns that population declines may be associated with the loss of old-growth habitats. The Alberta Natural Heritage Information Centre (ANHIC) has assigned it a provincial rank of S2S3; which indicates that, although its status is uncertain, there is concern over its scarcity (Norton 2001). In the Canadian province of British Columbia it is ranked as S2; meaning it is imperiled and on the “Red List” of vulnerable or sensitive species (Cooper et al. 1997).

POTENTIAL THREATS AND MONITORING

Present or Threatened Risks to Habitat or Range

The greatest threat to the breeding range of the Bay-breasted Warbler is the reduction in the area of old-growth spruce (*Picea* spp.) and fir (*Abies* spp.) of the boreal forest. Both nesting habitat and food supply (spruce budworm) are at risk when reductions or alterations of these forest areas occurs (Niemi et al. 1998). Shorter forest-harvesting cycles and planting species that are more resistant to spruce budworm, such as jack pine (*Pinus banksiana*), are practices that will create habitats that are less attractive to this warbler (Erskine 1992). Reducing older coniferous and mixed-wood stands, and replacing them with pure stands of tree species less suitable to its nesting and feeding activities will negatively impact the Bay-breasted Warbler (Hobson and Bayne 2000, Kirk and Hobson 2001, Norton 2001). Spraying insecticides to control spruce budworm can have direct toxic affect (inhibition of brain acetylcholinesterase activity) on this warbler (Busby et al. 1991) in addition to the indirect affect of reducing a key food item. Winter habitat degradation and loss is also a threat, as commercial and residential development activity continues to deplete the forest canopy in Central America and northern South America (Erskine 1992, Petit et al. 1993, Norton 2001).

Commercial, Recreational, Scientific, or Educational Overutilization

Relevant information and data do not exist to evaluate these factors as present or potential risks. Relative to the habitat issues (above) these factors probably would not pose significant risks to the Bay-breasted Warbler.

Disease and Predation

The Brown-headed Cowbird (*Molothrus ater*) can contribute to brood parasitism of the Bay-breasted Warbler when their breeding ranges overlap; however, such overlap occurs infrequently (Sealy 1979 and Williams 1996). Many species of birds and mammals, such as red squirrels (Mendall 1937), will prey upon young in the nest but very little specific data are available. There is no information on the effects of diseases or parasites.

Inadequacy of Existing Regulatory Mechanisms

No specific inadequacies are noted. However, regulatory mechanisms that do not address conservation and sustainable use of natural resources associated with the breeding habitat of the Bay-breasted Warbler would be considered inadequate. Generally speaking, regulatory mechanisms that allow for or encourage the development or conversion of forested land for commercial or residential use in the tropics are detrimental to the Bay Breasted Warbler, along with the registration and label expansion of insecticides for forest applications.

Other Natural or Human Factors Affecting Continued Existence of Species

Migrants returning to breeding areas in the Maritime Provinces are susceptible to unseasonably high levels of precipitation (Morris et al. 1958). Hurricanes and droughts can be directly and indirectly hazardous to neotropical migrants passing through the Caribbean area (Arendt 1992). The development of areas for the production of oil and gas can reduce the availability of suitable habitat (Norton 2001). Collisions with tall, stationary objects such as broadcasting and communication towers have resulted in mortality (Seets and Bohlen 1977, Crawford 1978). The overall effect of these factors on populations of the Bay-breasted Warbler are unknown.

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION

No specific habitat protection within Region 9 is known to exist for the Bay-breasted Warbler. Due to its boreal distribution, only the northernmost portions of Region 9 contain areas where habitat protection and management may be useful. Current reserves of old-growth conifers, specifically spruce and fir, should provide some degree of perpetual habitat for Bay-breasted Warblers. Given that some amount of the suitable habitat in Region 9 that is privately owned, a habitat protection plan for the Bay-breasted Warbler should be based on an ecosystem management perspective and be coordinated

across ownership and management boundaries. Because the primary North American range of *D. castanea* is central and eastern Canada, it is essential to coordinate conservation efforts with provincial government agencies.

The maintenance of old-growth coniferous forest is often problematic due to the economic potential of these areas to the forest products industry. Potential areas that may help maintain or increase late-successional spruce/fir-dominated forests include Research Natural Areas (RNA), State Natural Areas (SNA), Shipstead-Newton-Nolan lands, riparian setbacks, scenic rivers, and wilderness areas. Late-successional spruce/fir stands could be targets for future RNA, SNA, and wilderness designation to conserve areas that will assure that *D. castanea* is a component of the avian community.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

No specific or dedicated management activities have been attempted for the Bay-breasted Warbler (Williams 1996, Norton 2001). If management activities are developed and implemented, they should address the concept of ecological sustainability (Urban et al. 1987). With respect to the Bay-breasted Warbler, the concept of ecological sustainability should incorporate the conservation of old-growth spruce and fir stands. Data from Hobson and Bayne (2000) indicate that vegetation and structural characteristics should be considered when prescribing sustainable forestry objectives; even for somewhat marginal Bay-breasted Warbler habitat. Kirk and Hobson (2001) recommend that jack pine mixed-woods be managed by using shelterwood or selective cuts, and that the rotational age of some stands be increased in order to maintain avian diversity in boreal region of north-central Saskatchewan. Management activities should also recognize and take advantage of the highly specialized and unique ability of the Bay-breasted Warbler to consume the spruce budworm. Research indicates that the time between spruce budworm outbreaks can be prolonged by the feeding activities of insectivorous birds such as the Bay-breasted Warbler (Holling 1988).

PAST AND CURRENT CONSERVATION ACTIVITIES

No past or current conservation activities in Region 9 are known to be relevant to the Bay-breasted Warbler. However, the adoption of an ecosystem-centered forest management perspective within Region 9 would likely help conserve inconspicuous boreal species such as the Bay-breasted 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; including those associated with old-growth conifers (Imbeau et al. 2001). 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 birds of the boreal forest (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.

RESEARCH AND MONITORING

Existing Surveys, Monitoring, and Research

Increased interest in and awareness of neotropical migrants, such as the Bay-breasted Warbler, has prompted the development of strategies to monitor these species (Finch and Stangel 1993). The monitoring task group of the National Fish and Wildlife Foundation's Neotropical bird Conservation Program has developed guidance for three levels of bird monitoring in specific habitats of the National Forests (Manley and Monitoring Task Group 1993). Despite this impetus for study, no surveying, monitoring or research specifically focusing on the Bay-breasted Warbler has occurred or is occurring within the National Forests of Region 9. Generalized bird monitoring efforts are active, however, within the Superior and Chippewa National Forests in Minnesota and the Chequamegon-Nicolet National Forests in Wisconsin (Hanowski and Niemi 1994 and Howe et al. 1997). Given the limited extent of suitable Bay-breasted Warbler habitat within Region 9 forests, some species-specific research and monitoring should be encouraged. Considering its migratory behavior and inconspicuous nature, declines in the abundance of Bay-breasted Warblers could easily be overlooked without enhanced research and monitoring efforts.

Survey Protocol

Point counts are excellent for determining relative abundances of singing passerines such as the Bay-breasted Warbler. Refinements to point-count methodology, specific to applications in National Forests, have been proposed (Hanowski and Niemi 1994, 1995). Bay-breasted Warbler surveys in National Forests could benefit from the following modifications to point-count protocol:

- Observer training that includes testing the ability to identify birds by song/call, a hearing test for all frequencies (125 to 8000 hertz), and techniques to standardize the gathering of field data.
- On-road survey points should be randomly selected and be representative of distinct habitat types; e.g. old-growth spruce and fir for the Bay breasted Warbler.
- Off-road survey points should be used as supplements to cover key habitats that are not adequately represented by the established on-road points.

Research Priorities

Williams (1996) suggests the following future research priorities for the Bay-breasted Warbler:

- Control and physiology of migration
- Metabolism and temperature regulation
- Nesting information; such as mating systems, sex ration, pair formation, site selection and building, egg-laying and reproductive success (in the absence of spruce budworm outbreaks)
- Song information; including development, patterns and repertoire, geographic variation, and social context
- Investigations focusing on the effects of habitat destruction within both breeding and wintering areas.

Other research priorities that could provide a greater understanding of the ecology and distribution of *D. castanea* would include:

- A better understanding of the ecology of forest tent caterpillars and the effects of their outbreaks on the home-range size and population dynamics of the Bay-breasted Warbler.
- Improved understanding of factors that affect nesting success; e.g. nest predation.
- Investigating the direct and indirect effects on *D. castanea* resulting from the control of spruce budworm with insecticides.
- Monitoring the abundance response of the species under various silvicultural and timber harvesting practices associated with old-growth spruce and fir stands.
- Evaluate its utility as a global-climate-change indicator given its potential sensitivity to temperature changes.

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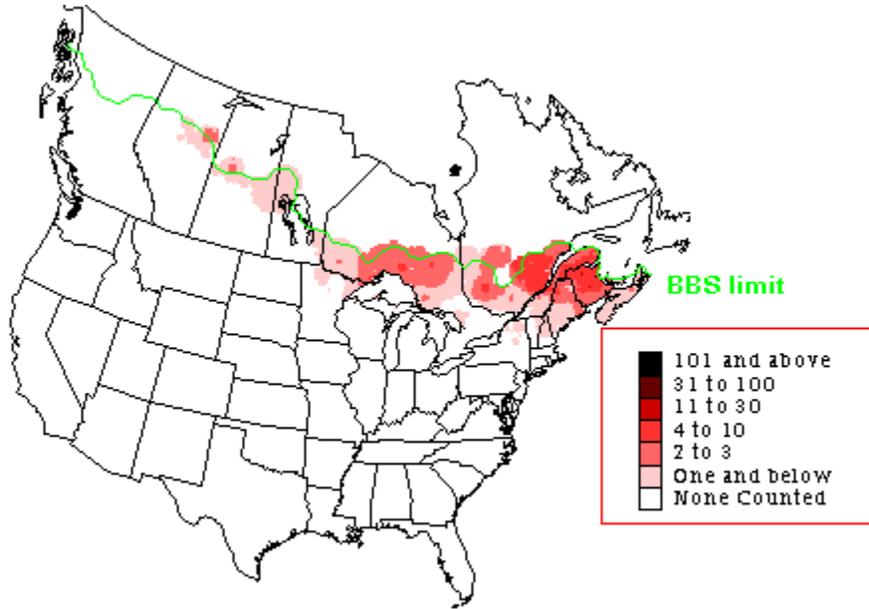
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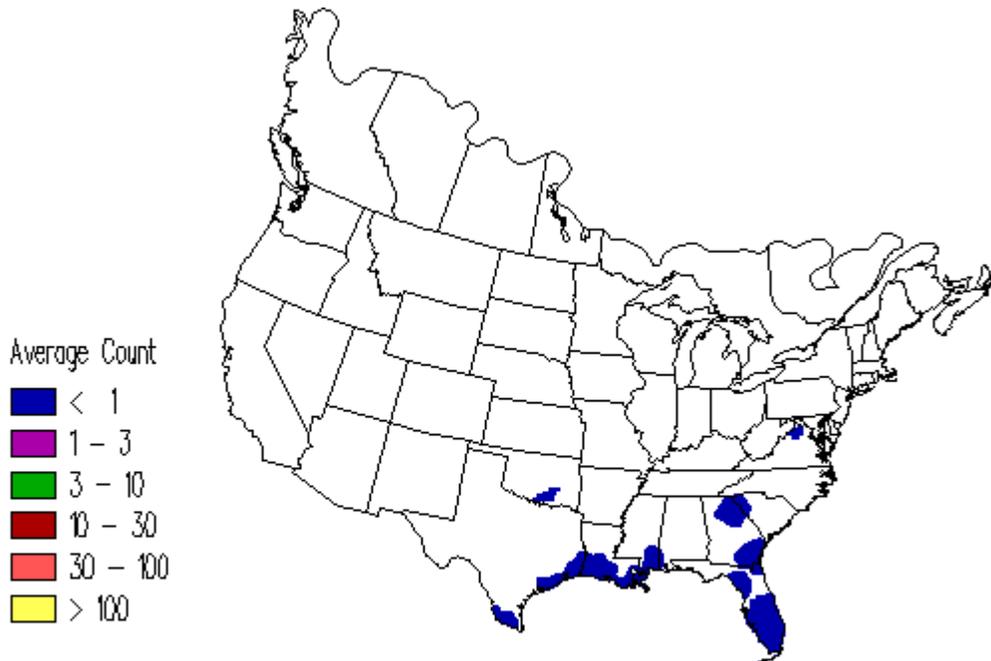
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APPENDICES

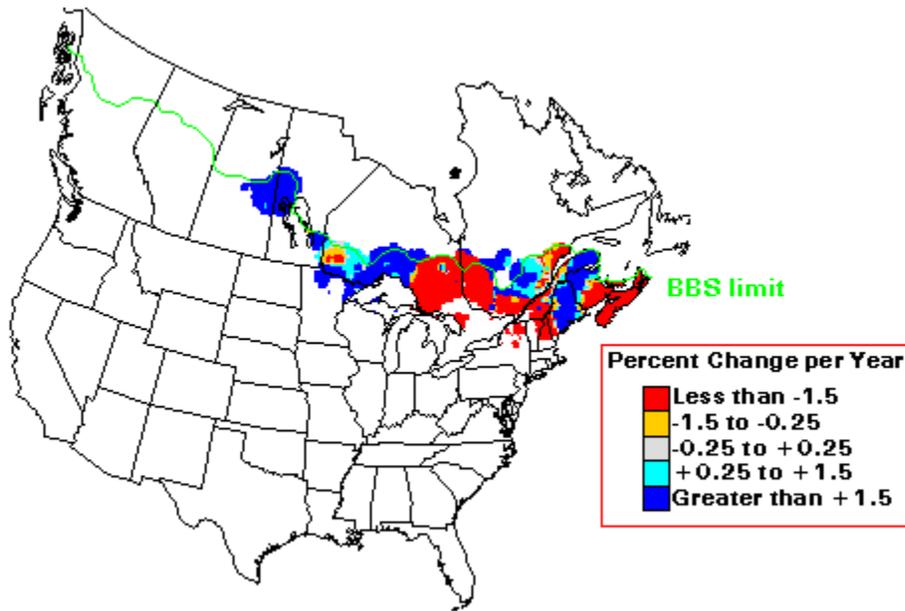
Appendix 1: Summer distribution of the Bay-breasted Warbler based on BBS data.



Appendix 2: Winter distribution of the Bay-breasted Warbler based on CBC data.



Appendix 3: Population trends for the Bay-breasted Warbler as determined from BBS data.



Count-data plot for the closed boreal forest.

