Environment Canada Environnement Canada

Bird Conservation Strategy for Bird Conservation Region 6: Boreal Taiga Plains

October 2013



Canada

Cat. No.: CW66-317/2-2012E-PDF

ISBN 978-1-100-21061-2

Aussi disponible en français

Preface

Environment Canada led the development of all-bird conservation strategies in each of Canada's Bird Conservation Regions (BCRs) by drafting new strategies and integrating new and existing strategies into an all-bird framework. These integrated all-bird conservation strategies will serve as a basis for implementing bird conservation across Canada, and will also guide Canadian support for conservation work in other countries important to Canada's migrant birds. Input to the strategies from Environment Canada's conservation partners is as essential as their collaboration in implementing their recommendations.

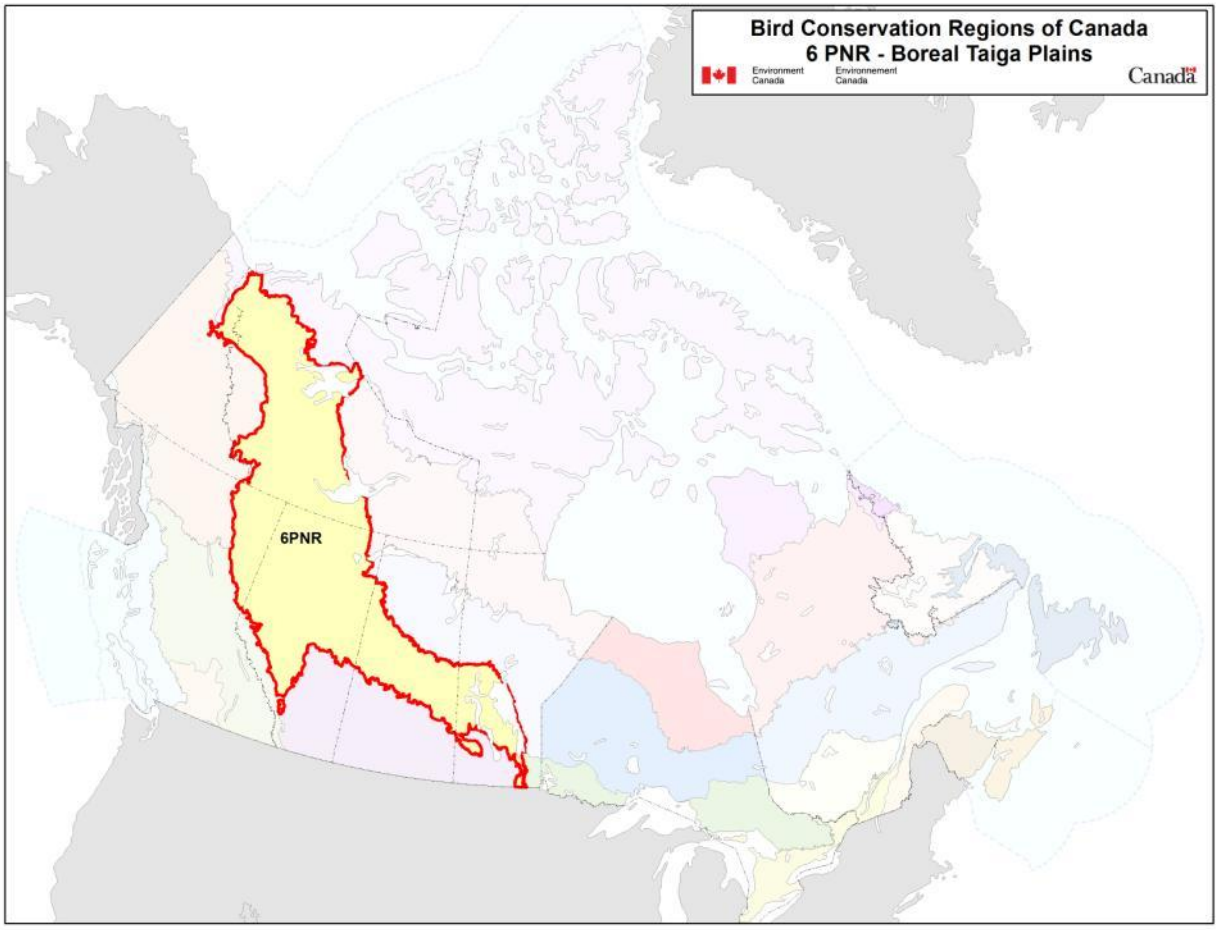
Environment Canada has developed national standards for strategies to ensure consistency of approach across BCRs. Bird Conservation Strategies will provide the context from which specific implementation plans can be developed for each BCR, building on the programs currently in place through Joint Ventures or other partnerships. Landowners including Aboriginal peoples will be consulted prior to implementation.

Conservation objectives and recommended actions from the conservation strategies will be used as the biological basis to develop guidelines and beneficial management practices that support compliance with regulations under the *Migratory Birds Convention Act, 1994*.

Acknowledgements

C. Lisa Mahon and Thea Carpenter were the main authors of this document that follows templates developed by Alaine Camfield, Judith Kennedy and Elsie Krebs with the help of the BCR planners in each of the Canadian Wildlife Service regions throughout Canada. K. Calon, A. Camfield, W. Fleming, T.J. Habib, K.C. Hannah, J. Kennedy, E. Kuczynski, and K. St. Laurent did all of the initial work to refine species priority lists, assess objectives and threats, and research habitat associations as well as producing drafts of the plan and populating the database. S. J. Song and D. Duncan provided a comprehensive review. However, work of this scope cannot be accomplished without the contribution of other colleagues who provided or validated technical information, commented on earlier draft versions of the strategy and supported the planning process. We would like to thank the following people: Erin Bayne, Fred Bunnell, Eric Butterworth, Wendy Calvert, Suzanne Carriere, Gordon Court, Brenda Dale, Ken DeSmet, Elston Dzus, Keith Hobson, Vicky Johnston, Kevin Kardynal, Glenn Mack, Craig Machtans, Julienne Morissette, Cindy Paszkowski, George Phinney, Mark Phinney, Gigi Pitoello, Doug Tate, Jennie Rausch, Myra Robertson, Mike Russell, Pam Sinclair, Stuart Slattery and Steve VanWilgenburg.

Bird Conservation Strategy for Bird Conservation Region 6: Boreal Taiga Plains



Recommended citation:

Environment Canada. 2013. *Bird Conservation Strategy for Bird Conservation Region 6: Boreal Taiga Plains.* Canadian Wildlife Service, Environment Canada. Edmonton, Alberta. 288 pp.

Table of Contents

Executive Summary

Bird Conservation Region 6: Boreal Taiga Plains is comprised of two Canadian Ecozones: the Taiga Plains in the north and the Boreal Plains in the south. This large region extends from the Northwest Territories in the north to Alberta, Saskatchewan and Manitoba in the south. The largest portion of the BCR is in the Northwest Territories (36%), with 1% in Yukon, 8% in northeast British Columbia, 33% in Alberta, 13% in central Saskatchewan and 9% in south-central Manitoba.

BCR 6 contains gently rolling or undulating landscapes due to the influence of glaciers during the most recent ice ages. Vegetation is dominated by the boreal forest, a diverse mixture of forest types including coniferous stands dominated by either white spruce (*Picea glauca*) or black spruce (*Picea mariana*), deciduous stands containing mixtures of trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*), and mixed wood stands composed of trembling aspen, balsam poplar, white birch (*Betula papyrifera*), and white spruce. Forest stands are interspersed with wetlands in the form of: lakes and ponds; marshes; swamps; and herb, shrub or tree-dominated bogs and fens. Major river systems include the Mackenzie, Peace, Athabasca and North Saskatchewan.

We evaluated 288 bird species that occur within BCR 6 and designated 120 species as priority bird species. All bird groups are represented, with 52% of the priority list consisting of landbirds, 12% shorebirds, 18% waterbirds and 18% waterfowl. Consistent with the representation of wetland habitats across the BCR, 66% of priority species are associated with wetland habitat classes. Following wetlands, there is prominent association with shrub/early successional (43%), waterbodies (42%), cultivated and managed areas (40%), deciduous (35%), and mixed forest (32%).

Population objectives are difficult to assess for many BCR 6 priority species due to limited or unavailable population trend data (e.g., evaluation of temporal patterns of change over multiple sample periods) for many boreal forest species. Existing monitoring programs (landbirds, waterfowl) are biased due to inadequate route coverage. Many landbird species (irruptive species, nomadic species, primary cavity nesters/woodpeckers, grouse, diurnal raptors, nocturnal raptors, species at risk), almost all waterbird and shorebird species, and cavity-nesting waterfowl species are not adequately monitored using existing monitoring programs.

Human disturbance is concentrated in the southern portions of the BCR (Boreal Plains Ecozone). The current dominant threats to priority species in BCR 6 include: agriculture, transportation and service corridors (linear features/disturbances in the form of roads, railways, power/utility lines, pipelines), biological resource use (forest harvesting), human

intrusions and disturbance (motorized recreational activities), natural system modifications (fire suppression, dam construction and operation), invasive and other problematic species, and pollution (agricultural, forestry and energy sector effluents; oil spills). Additional low-intensity threats currently include residential and commercial development, and energy production and mining (conventional oil and natural gas deposits, non-conventional bitumen deposits).

The primary conservation issue in BCR 6 is ensuring the availability of suitable breeding habitat for priority species. Specific conservation actions are recommended across many categories; however, the most prominent categories are site/area management (managing protected areas and other resource lands for conservation), site/area protection (establishing or expanding public or private parks, reserves and protected areas) and research. Future recommended actions include both monitoring and research. Monitoring and research initiatives highlight the specific actions required to: (1) develop and implement adequate long-term monitoring programs (e.g., programs that deliver reliable estimates of population trend) for each bird group (landbirds, shorebirds, waterbirds, waterfowl); (2) predict the impact of current and alternative land and resource activities on populations; (3) examine the causes of population declines; and (4) develop the methods, data products, tools, and partnerships required to calculate habitat-based population objectives within BCR 6.

The key messages for priority bird species and all bird species that occur within BCR 6 are:

- Categorical population objectives are difficult to assess due to limited or unavailable population trend data for boreal landbird, shorebird, waterbird, and cavity-nesting waterfowl species. The development and implementation of new monitoring programs for all bird groups in order to provide reliable estimates of population trend will be a high priority in BCR 6.
- Although BCR 6 is largely intact, the continued high rate of resource development in the southern portion of the BCR presents a potential risk to bird populations. Programs to anticipate and predict the impact of current and alternative land and resource development on bird populations will be needed to assess risk to populations. A combination of bird-habitat and landscape simulation models will be required to quantify expected future changes in population size in response to land use change.
- Conservation objectives and actions will need to focus on the conservation and management of suitable habitats. This will require the development of habitat suitability measures in the form of qualitative habitat ratings or quantitative habitat use measures (e.g., bird-habitat models) for each priority species.
- Approaches will be required to identify the amount of habitat required to meet categorical and associated numerical population objectives for priority species (e.g., translate BCR-scale population objectives into habitat-based population objectives).

Introduction: Bird Conservation Strategies

Context

This document is one of a suite of Bird Conservation Region strategies (BCR strategies) that have been drafted by Environment Canada for all regions of Canada. These strategies respond to Environment Canada's need for integrated and clearly articulated bird conservation needs to support the implementation of Canada's migratory birds program, both domestically and internationally. This suite of strategies builds on existing conservation plans for the four "bird groups" (landbirds,[1] shorebirds,[2] waterbirds[3] and waterfowl[4]) in most regions of Canada, as well as on national and continental plans, and includes birds under provincial/territorial jurisdiction. These new strategies also establish standard conservation planning methods across Canada and fill gaps, as previous regional plans do not cover all areas of Canada or all bird groups.

These strategies present a compendium of required actions based on the general philosophy of achieving scientifically based desired population levels as promoted by the four pillar initiatives of bird conservation. Desired population levels are not necessarily the same as minimum viable or sustainable populations but represent the state of the habitat/landscape at a time prior to recent dramatic population declines in many species from threats known and unknown. The threats identified in these strategies were compiled using currently available scientific information and expert opinion. The corresponding conservation objectives and actions will contribute to stabilizing populations at desired levels.

The BCR strategies are not highly prescriptive. In most cases, practitioners will need to consult additional information sources at local scales to provide sufficient detail to implement the recommendations of the strategies. Tools such as beneficial management practices will also be helpful in guiding implementation. Partners interested in participating in the implementation of these strategies, such as those involved in the habitat Joint Ventures established under the North American Waterfowl Management Plan (NAWMP), are familiar with the type of detailed implementation planning required to coordinate and undertake on-the-ground activities.

Strategy Structure

Section 1 of this strategy presents general information about the BCR and the subregion, with an overview of the six elements[i] that provide a summary of the state of bird conservation at the sub-regional level. Section 2 provides more detail on the threats, objectives and actions for priority species grouped by each of the broad habitat types in the subregion. Section 3 presents additional widespread conservation issues that are not specific to a particular habitat or were not captured by the threat assessment for individual species, as well as research and monitoring needs, and threats to migratory birds while they are outside of Canada. The approach and methodology are summarized in the appendices, but details are available in a separate document[5]. A national database houses all the underlying information summarized in this strategy and is available from Environment Canada.

[i] The six elements are: Element 1– priority species assessment; Element 2 – habitat associations; Element 3 – population objectives; Element 4 – threat assessment; Element 5 – conservation objectives; Element 6 – recommended actions.

Characteristics of Bird Conservation Region 6

BCR 6-Boreal Taiga Plains includes two Canadian Ecozones: the Taiga Plains in the north and the Boreal Plains in the south. In the north, BCR 6 extends from the Mackenzie Mountains and Mackenzie Delta in the northwest toward the treeline in the east. In the south, BCR 6 extends from the Rocky Mountains to Lake Winnipeg, bordered to the south by the Prairie Ecozone and to the north by the Canadian Shield. The Taiga Plains consist of broad lowlands and plateaus with a climate characterized by short, cool summers and long, cold winters. The Boreal Plains consist of low-lying valleys and plains with a climate characterized by short, warm summers and long, cold winters. Both ecozones contain gently rolling or undulating landscapes due to the influence of glaciers during the most recent ice ages. Major river systems include the Mackenzie, Peace, Athabasca and North Saskatchewan.

Figure 1. Aerial view of boreal forest typical of BCR 6 in northern Alberta, Canada.
Photo: © Jonathan Martin-DeMoor

BCR 6 is dominated by the boreal forest, which is a forested landscape growing on a mosaic of glacial till, lacustrine deposits and peaty organic soils in poorly drained depressions interspersed with wetlands that include lakes, ponds, marshes, swamps, bogs and fens (Fig. 1). The resulting forested landscape has a high diversity of site types over relatively short distances[6] (Fig. 2 and 3). The interaction of natural disturbance agents with landscape heterogeneity contributes to the ecological diversity of the boreal forest. Disturbance agents include fire events (varying in severity, size, frequency and pattern), as well as wind, disease and insect outbreaks (defoliators and woody tissue feeders). Forest composition within the boreal is determined by climate, slope, elevation, soil types, drainage, nutrient availability, disturbance history and successional pathways. Tree species richness in the boreal forest is relatively low, despite the large extent of this forest type.

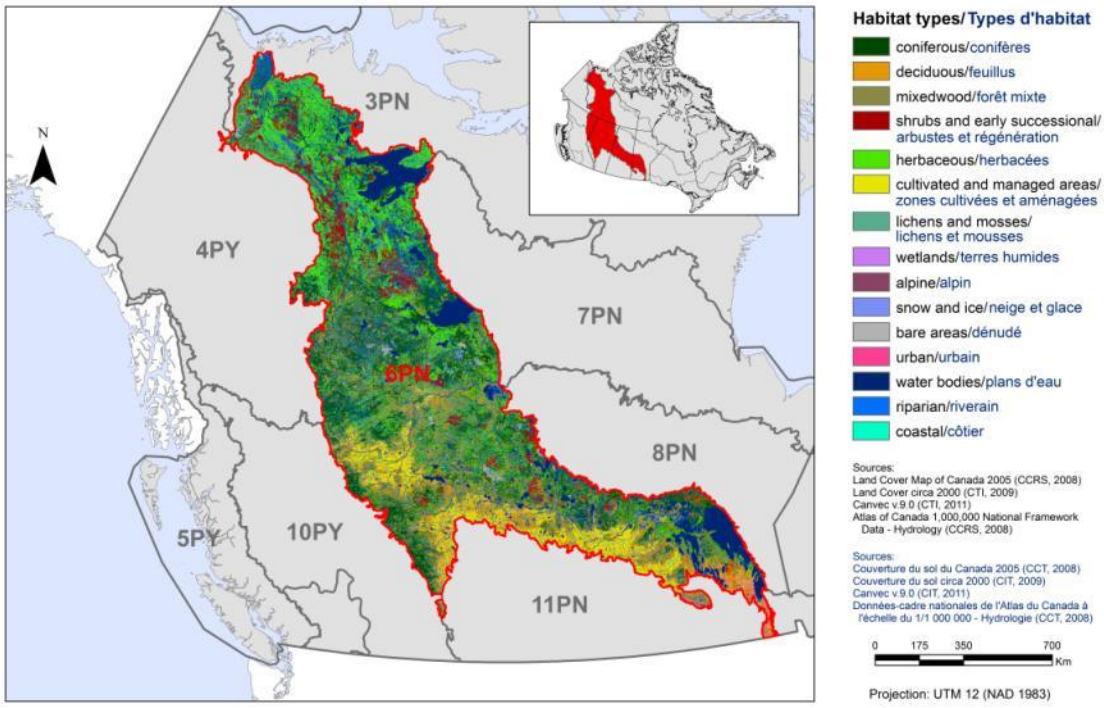


Figure 2. Land cover in BCR 6: Boreal Taiga Plains, without wetlands. Wetlands are difficult to separate without dominating the image, so they are displayed preferentially in Figure 3.

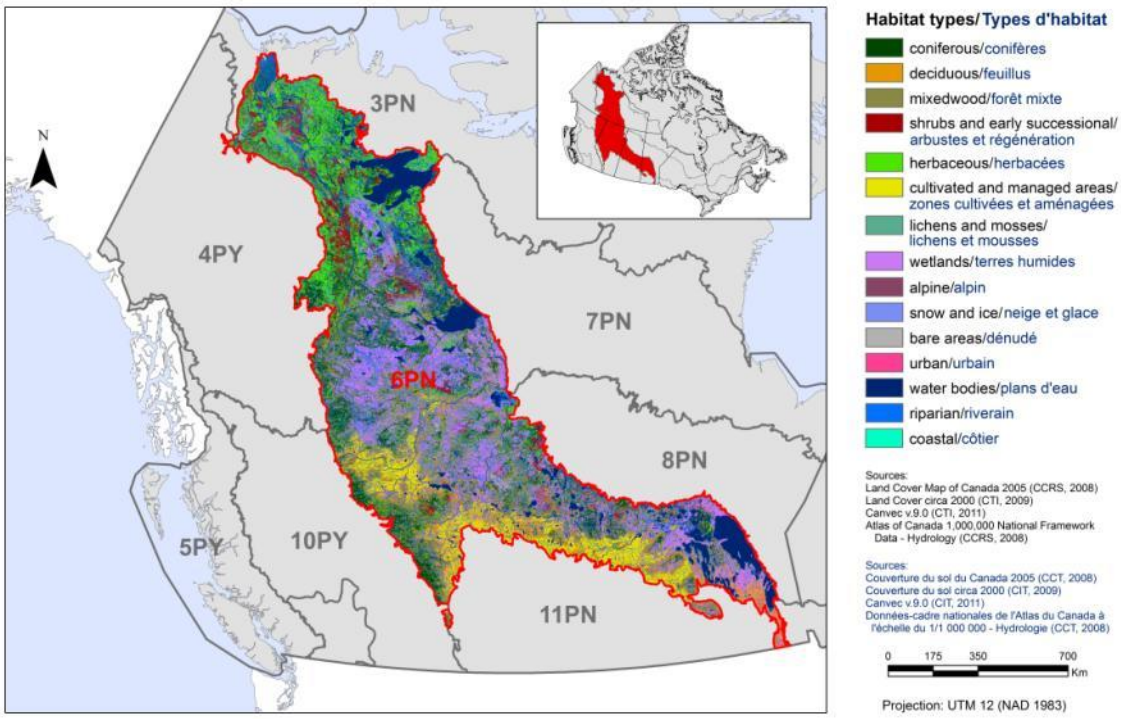


Figure 3. Land cover in BCR 6: Boreal Taiga Plains with wetlands displayed preferentially.

In the Taiga Plains, approximately 75% of the land surface is boreal forest, with remaining areas composed of shrubland, tundra or barren land. In the north, forests are open stunted stands of white spruce, while in the south forests are primarily closed-canopy black spruce. Jack pine and Alaska paper birch grow on drier, south-facing slopes (Fig. 4). In the southern area of the Slave Lowlands, white spruce and balsam poplar are found in species-rich mixed forests (Fig. 5, Fig. 6). The Taiga Plains is also dominated by the Mackenzie River, Canada's longest river, and the Mackenzie Delta, Canada's largest delta. The delta is composed of a complex of channels, streams and >25 000 wetlands. These small (<10 ha) and shallow (< 4 m) floodplain wetlands cover up to 50% of the Delta's surface area and are highly productive.

Figure 4. Hardwood forest habitat class typical of the Boreal Plains Ecozone (southern portion of BCR 6).
© Environment Canada. Photo: C. Lisa Mahon

The Boreal Plains of British Columbia are found on the flat Alberta Plateau and are composed of black spruce, tamarack and white spruce forests, **peatlands**[ii], and fens. The Boreal Plains of Alberta also contain the conifer-dominated forest type described above but are dominated by the Central and Dry Mixedwoods, which are composed of trembling aspen, balsam poplar, paper birch and white spruce. Jack pine dominates forests at drier sites, and balsam fir mixes with white spruce and deciduous species in moister sites. At higher elevations in the Alberta foothills, lodgepole pine is a dominant species. Moving east, the boreal forest steps down to the lower and flatter Saskatchewan Plains. In Saskatchewan and Manitoba, the Boreal Plains are composed of mid-boreal upland and lowland habitats, which are similar in composition and structure to the mixed woods of Alberta. The Manitoba Plain is dominated by lakes including Lake Winnipeg and Lake Winnipegosis. Along the southern border of the Boreal Plains, closed-canopy forests transition to open woodland and grassland habitats that have been modified by agriculture.

Figure 5. The Brown Creeper is a priority species in BCR 6 because of expert opinion. This unusual and highly specialized tree climber ascends trees spirally while searching the bark crevices for arthropod prey. It is found in the southern portions of BCR 6. This species is associated with old coniferous, mixed wood, and deciduous forests containing specific structural attributes like standing dead trees (snags) with sloughing bark for nesting and large live trees with deeply furrowed bark for foraging. Find the nest in the photo above. Photo: © Todd Mahon

The northern regions of the Taiga Plains have relatively low levels of human modification with sparse human settlement and roads (only nine communities with census populations >600) and minimal industrial development. Historically, economic activity in the Taiga Plains included only fishing and wildlife hunting for both Aboriginal and commercial uses, oil and gas development in Norman Wells and Cameron Hills, and exploration in the Beaufort Sea and Mackenzie Delta, and the building of transportation infrastructure in the form of pipelines and the Dempster Highway. Proposed future development includes a 1200 km pipeline that would deliver natural gas from reserves off the Beaufort Sea coast through the Mackenzie River Valley to markets in southern Canada and the United States.

[ii] Terms in bold throughout this document are defined in the Glossary in Appendix C.

Figure 6. **The Northern Goshawk is a priority species in BCR 6 because of regional stewardship and general status rank. This raven-sized raptor can maneuver with speed and agility through forest stands and is found throughout BCR 6. This species is associated with a variety of mature and old forest types (deciduous, mixed wood) but requires stands with a closed canopy for protection of nest sites and an open understory for unobstructed hunting flyways (main prey is red and ground squirrels, grouse, snowshoe hare, and forest landbirds like thrushes, jays and woodpeckers).**
Photo: © Todd Mahon

The southern regions of the Boreal Plains in Alberta, Saskatchewan and Manitoba and in the Peace River area are characterized by agricultural deforestation (replacement of forest to non-forest land use), which began in the early 1900s and continues today. This area has been permanently modified by agricultural practices that include cultivated croplands (primarily grains), hay (tame hay) and pasture (improved and unimproved pasture). The central region and northern regions of the Boreal Plains have been modified by human settlement; forestry; oil and gas exploration and development (conventional forms that include natural gas wells and oil wells and non-conventional forms that include bitumen extraction in the form of mine sites and in-situ operations); agriculture; ranching; and water diversion and dams for water storage, hydroelectricity and industrial uses (cooling and tailings ponds). Industrial activities and associated infrastructure development—roads, railway lines, power lines, seismic lines, pipelines, oil and gas wells, harvest units, mine sites—that are used for accessing, developing and transporting people, resources and services have altered the boreal plains ecozone through habitat loss, habitat degradation and **habitat subdivision** (often called fragmentation). The extent and density of industrial activities and infrastructure in the boreal forest facilitates the introduction and expansion of alien (non-native) and native plant and animal species. Fire suppression has been altering natural wildfire regimes, which generate diverse ecosystem composition, structure, productivity, and habitat values and create the ecological diversity that is characteristic of the boreal forest.

Protected areas within BCR 6 include a variety of federal, provincia, and international sites. The total land area covered by protected areas in BCR 6 is 150,700 km^2 or 11.0% of the BCR. Federal protected areas include Agriculture and Agri-Food Canada sites (0.08% of BCR), Environment Canada sites that include Migratory Bird Sanctuaries (0.01% of BCR) and National Wildlife Areas (0.0005% of BCR), and Parks Canada sites (5.4% of BCR). Provincial/territorial protected areas include Provincial and Territorial Parks (3.0% of BCR). Other designated protected areas include Ramsar sites (Wetlands of International Importance: 1.2% of BCR) and Important Bird Areas (3.8% of BCR). Important Bird Areas (IBAs) within BCR 6 range in size from approximately 1 km^2 to >9 000 km^2 and include Lower Mackenzie River Islands, Middle Mackenzie River Islands, Beaver Lake, Lesser Slave Lake Provincial Park, Cumberland Marshes, and Saskatchewan River

Delta. RAMSAR Sites within BCR 6 range in size from 470 km^2 to >9 000 km^2 and include Whooping Crane Summer Range and Peace-Athabasca Delta. Parks Canada sites within BCR 6 range in size from <1 km^2 to >35 000 km^2 and include Nahanni National Park Reserve, Naats'ihch'oh National Park Reserve, Wood Buffalo National Park and Prince Albert National Park. Note that there is some overlap in protected areas within BCR 6 (most notably Ramsar and IBA sites that overlap Parks Canada sites). Our individual estimates above summarize the proportion of each type of protected area within BCR 6.

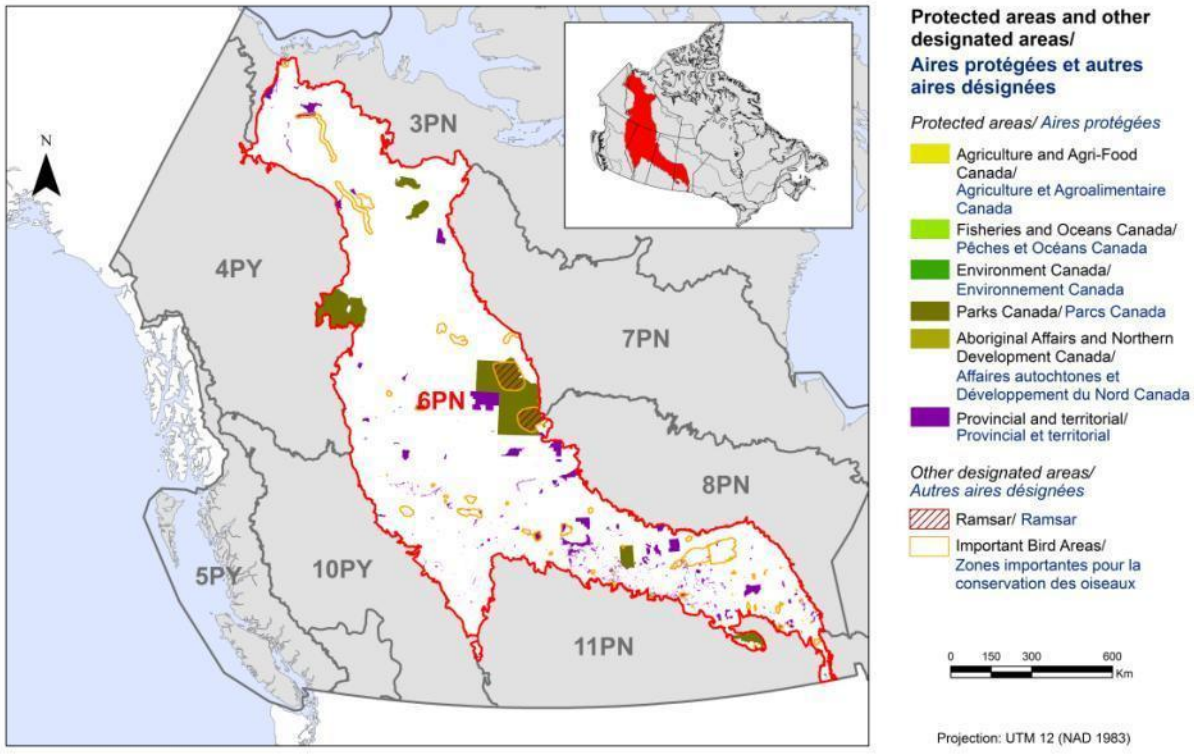


Figure 7. Map of protected areas and designated areas in BCR 6: Boreal Taiga Plains.

Section 1: Summary of Results – All Birds, All Habitats

Element 1: Priority Species Assessment

These Bird Conservation Strategies identify "priority species" from all regularly occurring bird species in each BCR subregion (see Appendix A). Species that are vulnerable due to population size, distribution, population trend, abundance and threats are included because of their "conservation concern". Some widely distributed and abundant "stewardship" species are also included. Stewardship species are included because they typify the national or regional avifauna and/or because they have a large proportion of their range and/or continental population in the subregion; many of these species have some conservation concern, while others may not require specific conservation effort at this time. Species of management concern are also included as priority species when they are at (or above) their desired population objectives but require ongoing management because of their socio-economic importance as game species or because of their impacts on other species or habitats (see Appendix B for methodologies on the priority species selection process).

The purpose of the prioritization exercise is to focus implementation efforts on the issues of greatest significance for Canadian avifauna. Table 1 provides a full list of all priority species and their reason for inclusion. Tables 2 and 3 summarize the number of priority species in BCR 6 by bird group and by the reason for priority status.

Table 1. Priority species in BCR 6, population objectives and the reason for priority status.
Note: A single species can be on the priority list for more than one reason.

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Alder Flycatcher	Landbird	Increase 50%						Y	Y				
American Kestrel	Landbird	Assess/Maintain										Y	
American Three-toed	Landbird	Assess/Maintain										Y	

[i] Assessed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as E, Endangered; T, Threatened; SC, Special Concern.
[ii] Species listed on Schedule 1 of the *Species at Risk Act* as E, Endangered; T, Threatened; SC, Special Concern (Species at Risk Public Registry[ii])
[iii] *Provincially Listed* indicates species legally protected under provincial/territorial legislation:
Alberta's *Wildlife Act*, British Columbia's *Wildlife Act*, Saskatchewan's *The Wildlife Act* , Manitoba's *The Endangered Species Act*, Northwest Territories' *Species at Risk (NWT) Act*, or the Yukon Territory's *Wildlife Act* (Note that SP stands for "Specially Protected" in YT).
[iv] Species of national/continental concern identified by bird group protocols using continental conservation plans ([1, 2, 3, 4]).
[v] Species of regional concern identified by bird group protocols using continental (shorebirds and waterbirds) or BCR-specific (landbirds, waterfowl) data. Note: For shorebirds, final decisions were based on information additional to continental plans that was found in the U.S. Shorebird Conservation Plan. These shorebird listings are considered the most current.
[vi] Landbirds identified as Stewardship Species in the continental PIF North American Plan [1].
[vii] Landbirds identified as regional stewardship species using BCR-specific data.
[viii] NAWMP: North American Waterfowl Management Plan continental Breeding or Non-breeding need priority rankings (North American Waterfowl Management Plan, Plan Committee, 2004[4]); included as additional information to explain continental concern listings for waterfowl species that were included as priorities with a ranking of "Moderately High" and above.
[ix] Breeding Need or Non-breeding Need rankings from Waterfowl Conservation Region 6 and 6.1 in Table B-2 of the North American Waterfowl Management Plan 2004 Implementation Framework (where multiple values are available, the highest is noted in the table here); included as additional information to explain regional concern listings for waterfowl.
[x] General Status Rank of ≤3 (At Risk, May be at Risk, or Sensitive) in any province or territory overlapping with the BCR. See Appendix B text for more detail.
[xi] Expert review indicates that at species was added to the priority list as a result of expert opinion. Species removed are in Appendix A, Table A2.

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Woodpecker													
Baltimore Oriole	Landbird	Increase 50%										Y	
Bank Swallow	Landbird	Assess/Maintain										Y	
Barn Swallow	Landbird	Increase 50%	T									Y	
Barred Owl	Landbird	Assess/Maintain			SC (AB)							Y	
Bay-breasted Warbler	Landbird	Increase 50%				Y						Y	
Black-backed Woodpecker	Landbird	Assess/Maintain						Y				Y	
Black-billed Cuckoo	Landbird	Increase 100%					Y						
Black-billed Magpie	Landbird	Assess/Maintain							Y				
Blackburnian Warbler	Landbird	Assess/Maintain				Y		Y				Y	
Blackpoll Warbler	Landbird	Assess/Maintain										Y	
Black-throated Green Warbler	Landbird	Increase 50%			SC (AB)	Y		Y				Y	
Bobolink	Landbird	Increase 50%	T			Y						Y	
Bohemian Waxwing	Landbird	Assess/Maintain						Y	Y				
Boreal Chickadee	Landbird	Increase 100%						Y				Y	
Boreal Owl	Landbird	Assess/Maintain										Y	Y
Broad-winged Hawk	Landbird	Assess/Maintain										Y	
Brown Creeper	Landbird	Assess/Maintain											Y
Canada Warbler	Landbird	Recovery objective	T	T	E (MB)	Y						Y	
Cape May Warbler	Landbird	Assess/Maintain				Y		Y				Y	

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Chimney Swift	Landbird	Recovery objective	T	T	T(MB)	Y						Y	
Clay-colored Sparrow	Landbird	Increase 50%							Y				
Common Nighthawk	Landbird	Recovery objective	T	T	T (MB)	Y						Y	
Common Yellowthroat	Landbird	Increase 100%										Y	
Connecticut Warbler	Landbird	Assess/Maintain				Y		Y	Y			Y	
Eastern Phoebe	Landbird	Increase 100%										Y	
Eastern Whip-poor-will	Landbird	Recovery objective	T	T	T (MB)	Y						Y	
Golden-winged Warbler	Landbird	Recovery objective	T	T		Y						Y	
Gray-headed Chickadee	Landbird	Assess/Maintain										Y	Y
Great Gray Owl	Landbird	Assess/Maintain							Y			Y	
Harris's Sparrow	Landbird	Assess/Maintain				Y						Y	
Le Conte's Sparrow	Landbird	Assess/Maintain							Y			Y	
Least Flycatcher	Landbird	Increase 50%							Y			Y	
Loggerhead Shrike	Landbird	Recovery objective	T	T	SC (AB), E (MB)							Y	
Merlin	Landbird	Assess/Maintain							Y				
Mountain Bluebird	Landbird	Assess/Maintain										Y	
Mourning Warbler	Landbird	Increase 100%				Y		Y					Y
Nelson's Sparrow	Landbird	Assess/Maintain				Y			Y				

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Northern Flicker	Landbird	Increase 50%							Y				
Northern Goshawk	Landbird	Assess/Maintain							Y			Y	
Northern Harrier	Landbird	Increase 100%					Y					Y	
Northern Hawk Owl	Landbird	Assess/Maintain										Y	
Northern Shrike	Landbird	Assess/Maintain						Y				Y	
Olive-sided Flycatcher	Landbird	Recovery objective	T	T		Y						Y	
Peregrine Falcon *anatum/tundrius*	Landbird	Assess/Maintain	SC	SC	T(AB), E (MB), SP (YT)			Y				Y	
Pileated Woodpecker	Landbird	Maintain current										Y	
Purple Martin	Landbird	Assess/Maintain										Y	
Red-headed Woodpecker	Landbird	Recovery objective	T	T		Y						Y	
Rusty Blackbird	Landbird	Increase 100%	SC	SC		Y						Y	
Sedge Wren	Landbird	Maintain current										Y	
Sharp-tailed Grouse	Landbird	Assess/Maintain						Y				Y	
Short-eared Owl	Landbird	Increase 100%	SC	SC	T (MB)	Y						Y	
Smith's Longspur	Landbird	Assess/Maintain				Y						Y	Y
Sprague's Pipit	Landbird	Recovery objective	T	T	SC (AB), T (MB)	Y	Y					Y	
Spruce Grouse	Landbird	Assess/Maintain						Y	Y				

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Western Tanager	Landbird	Assess/Maintain										Y	
Western Wood-Pewee	Landbird	Increase 50%										Y	
White-throated Sparrow	Landbird	Increase 50%				Y		Y				Y	
White-winged Crossbill	Landbird	Maintain current				Y		Y					
Yellow-bellied Sapsucker	Landbird	Assess/Maintain						Y	Y				
American Golden-Plover	Shorebird	Increase 100%				Y	Y					Y	
Greater Yellowlegs	Shorebird	Assess/Maintain				Y	Y					Y	
Hudsonian Godwit	Shorebird	Assess/Maintain				Y	Y					Y	
Killdeer	Shorebird	Increase 50%				Y	Y						
Least Sandpiper	Shorebird	Increase 100%					Y					Y	
Lesser Yellowlegs	Shorebird	Increase 100%					Y						
Marbled Godwit	Shorebird	Increase 50%				Y	Y						
Red-necked Phalarope	Shorebird	Increase 50%				Y	Y					Y	
Semipalmated Sandpiper	Shorebird	Increase 100%				Y	Y					Y	Y
Short-billed Dowitcher	Shorebird	Increase 100%				Y	Y					Y	
Solitary Sandpiper	Shorebird	Increase 50%				Y	Y						
Upland Sandpiper	Shorebird	Increase 100%					Y					Y	
Whimbrel	Shorebird	Migrant (no population objective)				Y	Y					Y	Y
Wilson's Phalarope	Shorebird	Increase 100%				Y	Y						

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Wilson's Snipe	Shorebird	Increase 100%					Y						
American Bittern	Waterbird	Increase 50%				Y	Y					Y	
American White Pelican	Waterbird	Assess/Maintain			Red (BC)	Y	Y					Y	
Arctic Tern	Waterbird	Increase 50%				Y	Y						
Black Tern	Waterbird	Increase 100%				Y	Y					Y	
Black-crowned Night-Heron	Waterbird	Increase 50%										Y	
Bonaparte's Gull	Waterbird	Assess/Maintain				Y	Y						
California Gull	Waterbird	Assess/Maintain				Y	Y						
Caspian Tern	Waterbird	Maintain current										Y	
Common Loon	Waterbird	Assess/Maintain				Y	Y						
Common Tern	Waterbird	Assess/Maintain				Y	Y						
Eared Grebe	Waterbird	Assess/Maintain				Y	Y						
Forster's Tern	Waterbird	Increase 50%				Y	Y					Y	
Herring Gull	Waterbird	Increase 50%				Y	Y						
Horned Grebe	Waterbird	Increase 50%	SC			Y	Y					Y	
Pacific Loon	Waterbird	Assess/Maintain				Y	Y					Y	
Pied-billed Grebe	Waterbird	Assess/Maintain										Y	
Red-necked Grebe	Waterbird	Assess/Maintain											Y
Sora	Waterbird	Assess/Maintain				Y	Y					Y	
Virginia Rail	Waterbird	Assess/Maintain				Y	Y						

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Western Grebe	Waterbird	Increase 50%			SC (AB)	Y	Y					Y	
Whooping Crane	Waterbird	Recovery objective	E	E	E (AB, MB, SK)	Y	Y					Y	
Yellow Rail	Waterbird	Increase 50%	SC	SC		Y	Y					Y	
American Wigeon	Waterfowl	Increase 50%				Y	Y			Mod High	High		
Barrow's Goldeneye	Waterfowl	Maintain current								Moderate		Y	
Blue-winged Teal	Waterfowl	Maintain current				Y	Y			Mod High	Mod High		
Bufflehead	Waterfowl	Assess/Maintain					Y			Moderate	High		
Cackling Goose	Waterfowl	Assess/Maintain				Y	Y			High	High		
Canvasback	Waterfowl	Maintain current				Y	Y			Mod High	Mod High		
Common Goldeneye	Waterfowl	Maintain current				Y	Y			Mod High	High		
Gadwall	Waterfowl	Assess/Maintain					Y			Moderate	Mod High		
Green-winged Teal	Waterfowl	Maintain current					Y			Moderate	High	Y	
Lesser Scaup	Waterfowl	Increase 50%				Y	Y			High	Highest	Y	
Lesser Snow Goose (Western Arctic)	Waterfowl	Decrease					Y			Above Objective	High		
Long-tailed Duck	Waterfowl	Increase 100%				Y	Y			Mod High	Mod High	Y	
Mallard	Waterfowl	Maintain current				Y	Y			High	High		

Table 1 continued

Priority species	Bird group	Population objective	COSEWIC[i]	SARA[ii]	Provincial listing[iii]	National/continental concern[iv]	Regional concern[v] (landbirds, waterfowl)	Continental stewardship[vi] (landbirds only)	Regional stewardship[vii] (landbirds only)	NAWMP priority[viii] (waterfowl only)	NAWMP rank[ix] (waterfowl only)	General Status Rank[x]	Expert review[xi]
Northern Pintail	Waterfowl	Increase 50%				Y	Y			High	High	Y	
Northern Shoveler	Waterfowl	Maintain current					Y			Moderate	Mod High		
Redhead	Waterfowl	Maintain current				Y	Y			Mod High	Mod High		
Ring-necked Duck	Waterfowl	Assess/Maintain					Y			Moderate	High		
Surf Scoter	Waterfowl	Increase 50%				Y	Y			Mod High	Mod High	Y	
Trumpeter Swan (Rocky Mountain)	Waterfowl	Assess/Maintain			T (AB), E (MB), SP(YT)	Y	Y			High	Highest	Y	
Tundra Swan (Eastern)	Waterfowl	Assess/Maintain					Y			Mod Low	High	Y	
White-winged Scoter	Waterfowl	Increase 50%			SC (AB)	Y	Y			Mod High	High	Y	

Table 2. Summary of priority species by bird group in BCR 6.

Bird Group	Total Species	Total Priority Species	Percent Listed as Priority	Percent of Priority List
Landbird	204	62	30%	52%
Shorebird	17	15	88%	12%
Waterbird	33	22	67%	18%
Waterfowl	34	21	62%	18%
Total	**288**	**120**	**42%**	**100%**

Note: For waterfowl, species totals include sub-species populations, as designated by NAWMP. For example, Tundra Swan (Eastern) and Lesser Snow Goose (Western Arctic) are included as species.

Table 3. Number of priority species in BCR 6 by reason for priority status.

Reason for Priority Listing[i]	Landbirds	Shorebirds	Waterbirds	Waterfowl
COSEWIC	14	0	3	0
Federal SARA listed	12	0	2	0
Provincially listed	10	0	3	2
NAWMP[ii]	-	-	-	20
National/Continental Concern	22	11	18	13
Regional Concern	3	15	18	20
National/Continental Stewardship	16	-	-	-
Regional Stewardship	14	-	-	-
Management Concern[iii]	-	-	-	1
General Status Rank	49	9	13	9
Expert Opinion	5	2	1	0

[i] A single species can be on the priority list for more than one reason. Note that not all reasons for inclusion apply to every bird group (indicated by "-"). Refer to Table 1 above for additional definitions regarding reasons for priority rankings.

[ii] NAWMP indicates species ranked in the North American Waterfowl Management Plan [4] as having Highest, High or Moderately High breeding or non-breeding conservation and/or monitoring need in the BCR.

[iii] Management Concern indicates that a species is included as a priority because the population is above its numerical objective (waterfowl only).

Element 2: Habitats Important to Priority Species

Identifying the broad habitat requirements for each priority species within the BCR allowed species to be grouped by shared habitat-based conservation issues and actions (see Appendix B for details on how species were assigned to standard habitat categories). If many priority species associated with the same habitat face similar conservation issues, then conservation action in that habitat may support populations of several priority species. BCR strategies use a modified version of the standard land cover classes developed by the United Nations[7] to categorize habitats, and species were often assigned to more than one habitat class.

Figure 8 provides a summary of habitat associations for priority species in BCR 6 (i.e., habitats used by priority species). Habitat associations should not be interpreted as ranked measures of habitat use, habitat ratings or habitat preference. Instead, this figure represents the total number of priority species associated with a particular habitat class. In BCR 6, for example, many priority species are associated with wetland habitats.

Appendix B – Element 2 contains a complete list of all broad habitat class associations for all priority species (Table B2).

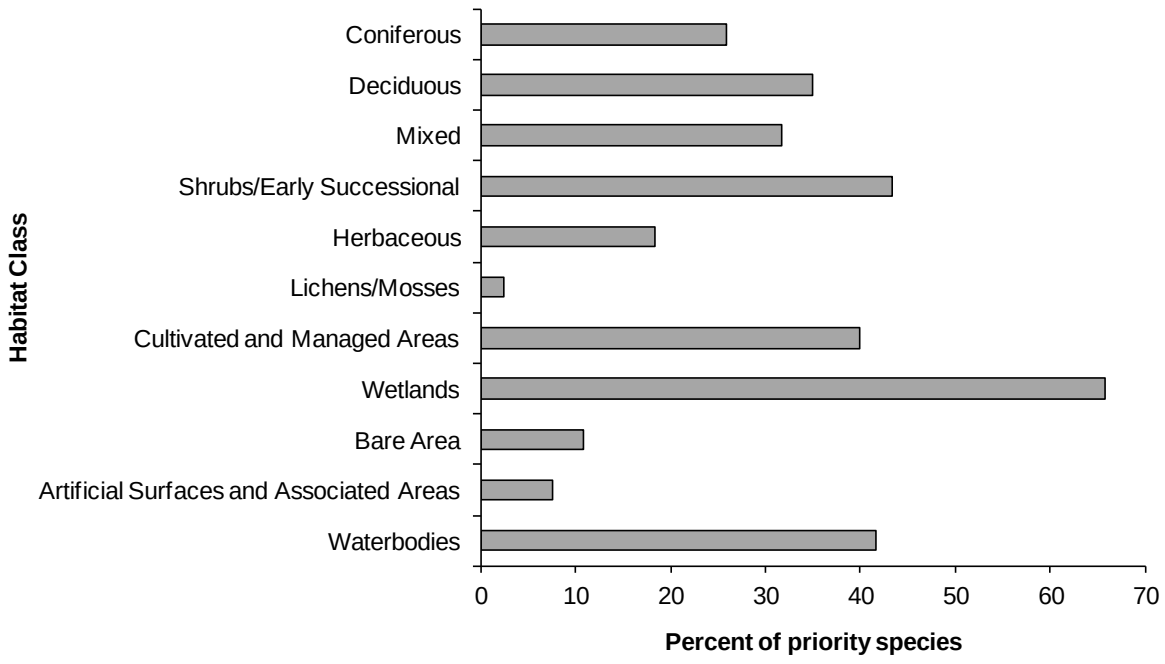


Figure 8. Percent of priority species associated with each habitat class in BCR 6.
Note that values add to more than 100% because each species may be associated with more than one habitat.

Element 3: Population Objectives

Population objectives allow us to measure and evaluate conservation success. The objectives in this strategy are assigned to categories and are based on a quantitative or qualitative assessment of species' population trends. If the population trend of a species is unknown, the objective is set as "assess and maintain", and a monitoring objective is given (see Appendix B). For any species listed under the *Species at Risk Act* (SARA) or under provincial/territorial endangered species legislation, Bird Conservation Strategies defer to population objectives in available Recovery Strategies and Management Plans. The ultimate measure of conservation success will be the extent to which population objectives have been reached over the next 40 years. Population objectives do not currently factor in feasibility of achievement, but are held as a standard against which to measure progress.

Figure 9 summarizes the proportion of BCR 6 priority species associated with each categorical population objective. The highest proportion of priority species in BCR 6 fall into the category Assess/Maintain, which can indicate a large population increase or an uncertain or unknown population trend (see Table B3 for population objective definitions).

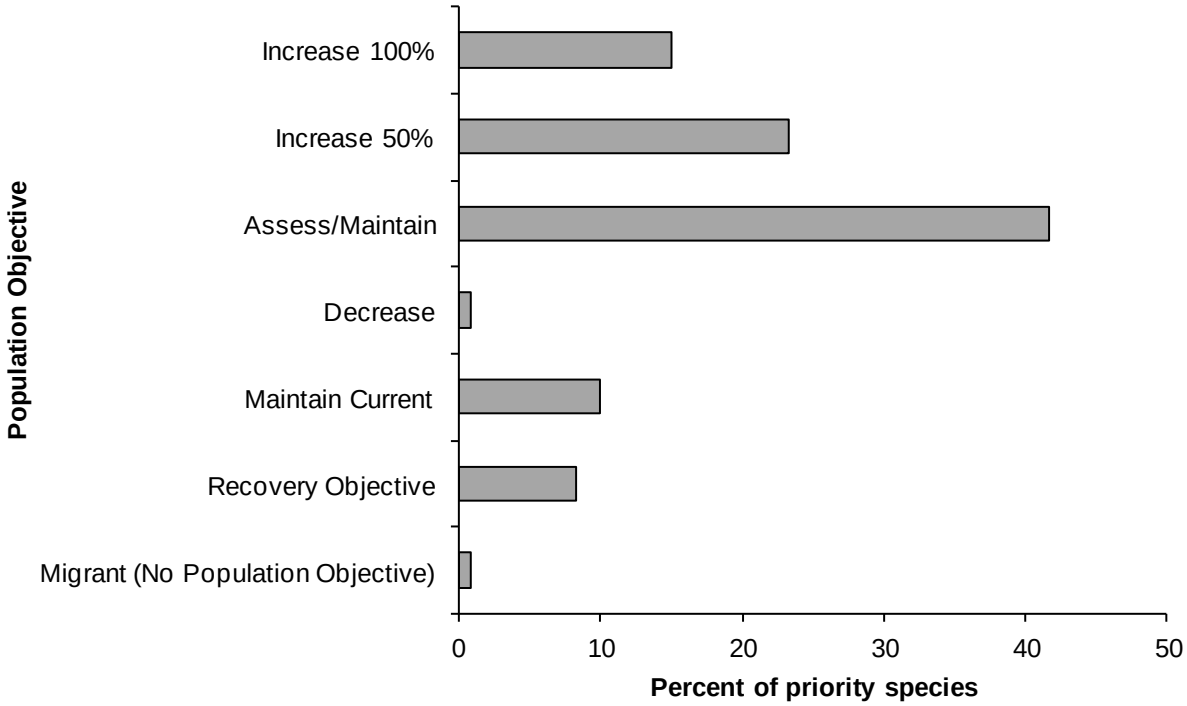


Figure 9. Percent of priority species that are associated with each population objective category in BCR 6.

Element 4: Threat Assessment for Priority Species

The threats assessment process (see Appendix B) identifies threats believed to have a population-level effect on individual priority species. These threats are assigned a relative magnitude (Low, Medium, High, Very High), based on their scope (the proportion of the species' range within the subregion that is impacted) and severity (the relative impact on the priority species' population). This allows us to target conservation actions towards threats with the greatest effects on suites of species or in broad habitat classes. Some well-known conservation issues (such as predation by domestic cats or climate change) may not be identified in the literature as significant threats to populations of an individual priority species and therefore may not be captured in the threat assessment. However, they merit attention in conservation strategies because of the large numbers of individual birds affected in many regions of Canada. We have incorporated them in a separate section on Widespread Issues, but, unlike other threats, they are not ranked.

Below we briefly describe the dominant threats (medium magnitude or higher) influencing individual priority species and low-intensity threats influencing multiple species and habitats in BCR 6 (as summarized in Figure 10 below). For each threat category, we describe the primary threat and the specific activity associated with this threat in BCR 6. We also describe how the specific activity associated with the threat influences the priority species (through reduced survival or reduced reproductive success or output) or the habitat associated with the priority species (habitat loss, subdivision or degradation). In BCR 6, identified threats and their associated scope (proportion of the species range impacted by the threat), severity (the relative impact of the threat on the population within the area affected) and magnitude (combination of scope and severity) scores apply primarily to the Boreal Plains ecozone (southern portion of BCR 6). Within the Taiga Plains ecozone (northern portion of BCR 6), only 4-Transportation and Service Corridors and 8-Invasive and Other Problematic Species and Genes have been identified as threats. Although these threats have a medium and high overall magnitude in BCR 6, they are low-intensity threats in the Taiga Plains ecozone due to the low density of industrial development and human settlements within relatively small portions of the ecozone.

Dominant Threats in BCR 6 (magnitude medium or higher):

- 2 – Agriculture and Aquaculture: Primary threat is deforestation for agriculture along the southern boundary and the Peace River area of BCR 6 resulting from the permanent removal of forest stands for non-forest land use. Forest stands have been cleared for crop production, hay production and pastures. These activities result in direct habitat loss, subdivision and degradation due to the loss of specific structural attributes for bird species that depend on standing live, dead and diseased trees for nesting and foraging within the boreal transition area (transition between boreal forest and grassland biomes) and the boreal forest.

- 5 – Biological Resource Use: Primary threat is from large-scale forest harvesting, which occurs throughout the southern and central portions of BCR 6. Most forest harvesting is conducted under area-based or volume-based tenure systems. Harvested timber is sent to saw mills, pulp mills, oriented strand board operations, plywood/panel board operations, fiberboard operations and secondary manufacturing operations. Harvesting activities occur throughout the mixed wood, deciduous (hardwood) and coniferous forest types primarily during the winter months, although timber cruising, silviculture and other activities occur during the summer months. These activities result in habitat loss, subdivision and degradation because forest harvest operations cannot simulate **natural disturbance regimes** and natural forest dynamics. For example, forest harvesting procedures do not simulate the full range of natural disturbance agents that influence boreal forest ecosystems (e.g., fire, insects, disease, drought, floods) or the characteristic features of these natural disturbance agents (e.g., frequency, size, shape and severity). In addition, forest harvesting procedures do not simulate the stand-level structural features found in the forest canopy, forest understory and forest floor that are often associated with specific disturbance agents (e.g., standing dying or dead trees, coarse woody debris).

- 6 – Human Intrusions and Disturbance: Primary threat is recreational activities like off-road vehicles (trucks, all-terrain-vehicles in summer and snowmobiles in winter) in terrestrial habitats, and motorboats and jet-skis in aquatic habitats. These activities can disrupt territorial behaviour, pair-bonding, nesting, foraging and roosting due to interference (flushing of incubating females), noise, dust/water and potential damage to nest sites (trampling, swamping/flooding, destruction). These activities result in habitat degradation and reduced reproductive success or output. Increased access into remote areas can also result in increased mortality due to legal or illegal (poaching) hunting and collecting (5 – Biological Resource Use).

- 7 – Natural System Modifications: Primary threat is fire suppression. The combination of an active wildfire regime and a mosaic of terrain differences has generated the diversity of ecosystem composition, structure, productivity and habitat values that are characteristic of the boreal forest. The divergence between natural fire disturbance regimes and current forest management strategies has resulted in key differences between natural and managed landscapes including forest pattern (spatial and temporal distribution of seral stages across all forest types) and forest structure (presence of key structural attributes associated with ecosystem integrity). These stand- and landscape-level changes result in habitat loss, habitat degradation and reduced reproductive success or output by priority birds.

- 8 – Invasive and Other Problematic Species and Genes: Primary threat is invasive non-native/alien species in the form of vascular and non-vascular plants and invertebrates (earthworms) and vertebrates (fish) that can disrupt community dynamics. Problematic native species such as European Starlings and Brown-headed Cowbirds can result in increased competition, predation and, with the latter species, parasitism. The extent

and intensity of disturbance in the southern and central portions of BCR 6 has resulted in the extensive movement of various forms of transportation (cars, trucks, all-terrain-vehicles, planes, boats) and the creation of human-disturbed habitats that may facilitate the introduction of invasive species and the transmission/dispersal of problematic native species. These activities result in habitat subdivision and degradation due to changes in plant and animal species composition and structure, predator-prey dynamics (e.g., soil arthropod prey and predators), and community/ecosystem structure and processes. These activities can also result in reduced reproductive success or output due to increased competition among species for nest sites and food, increased rates of nest predation, and increased nest parasitism on naive hosts.

- 9 – Pollution: Primary threat is the production of industrial effluents from: coal extraction methods, bitumen (oil sands) extraction methods (mining and in-situ techniques), oil and natural gas extraction sites (well sites), oil and gas transmission sites (pipelines), oil and gas production and refining sites, and mine/quarries (limestone, sand, gravel). In addition, agricultural and forestry effluents are produced as a result of agricultural pesticide and herbicide use and pulp mill discharges/emissions. These activities can result in both reduced survival of adults and juveniles and reduced reproductive success or output due to direct and indirect exposure.

- 11 – Climate Change and Severe Weather: Primary threats are changes in weather events outside the **natural range of variation** that alter natural disturbance agents (e.g., fire, insects, disease), tree species composition and vegetation communities. In addition, long-term changes include predicted shifts in ecosystem boundaries (gradual northward progression of tree line and replacement of southern forests with grasslands) and declines in water availability. These events are predicted to change the availability of key habitats and will affect bird distribution, occurrence and abundance within all areas of BCR 6.

- 12 – Other Direct Threats: Primary threat is lack of knowledge regarding causes of population decline. Some species such as the Lesser Scaup, Semipalmated Sandpiper and Least Sandpiper are in decline throughout the region, but reasons for decline remain unknown.

Low-Intensity Threats in BCR 6:

- 1 – Residential and Commercial Development: Primary threat is continued development of large, medium and small settlements that include housing and buildings (urban areas, suburbs, towns, villages, vacation homes, schools, hospitals, offices) and all associated commercial and industrial areas. These threats are most intense within the southern regions of BCR 6 (boreal transition area) where habitat loss, subdivision and degradation due to land clearing (forest and non-forest habitats), wetland drainage and road construction are occurring at a rapid rate.

- 3 – Energy Production and Mining: Primary threat is the continued high rate of exploration and development of both conventional oil and gas fields and non-conventional bitumen (oil sands) deposits (mining and in-situ methods) within the central regions of BCR 6. Bitumen deposits within the Boreal Plains include the Peace River, Athabasca and Cold Lake Oil Sands Deposits. Approximately 20% of all bitumen extraction occurs using open mines in the mineable oil sands area found within the Athabasca Oil Sands Area; the remaining 80% of all bitumen extraction occurs using in-situ techniques like **steam-assisted gravity drainage (SAGD)**. Activities associated with non-conventional exploration and development at both mine and in-situ sites include the actual footprint associated with these developments and a large amount of associated infrastructure (seismic lines, pipelines, primary and secondary roads, access roads, power and utility lines and stations, railways, well sites, industrial plants, human settlements, camps). Activities associated with conventional oil and gas field exploration and development include extensive infrastructure (see above), which occurs throughout large areas of the Boreal Plains ecozone. The result is both intensive and extensive energy exploration and development that has resulted in both direct habitat loss (loss of habitat due to alienating or non-successional human disturbance activities), but also indirect habitat change. Habitat change can result in changes in habitat quality from habitat subdivision, perforation, degradation and edge effects.

- 4 – Transportation and Service Corridors: Primary threat is the creation of linear features/disturbances in the form of roads (highways, primary, secondary), railways, pipelines, seismic lines and power/utility lines. These activities occur in all habitat types during oil and gas exploration and development, winter and summer forest harvest operations, and human and industrial expansion to support the movement of people, resources and power across BCR 6. These activities result in habitat loss, subdivision and degradation due to clearing of vegetation, creation of noise and dust generated by machinery and vehicles, disruption of predator-prey dynamics, alteration of water regimes from disturbance to hydrological systems, and transmission/dispersal of invasive species.

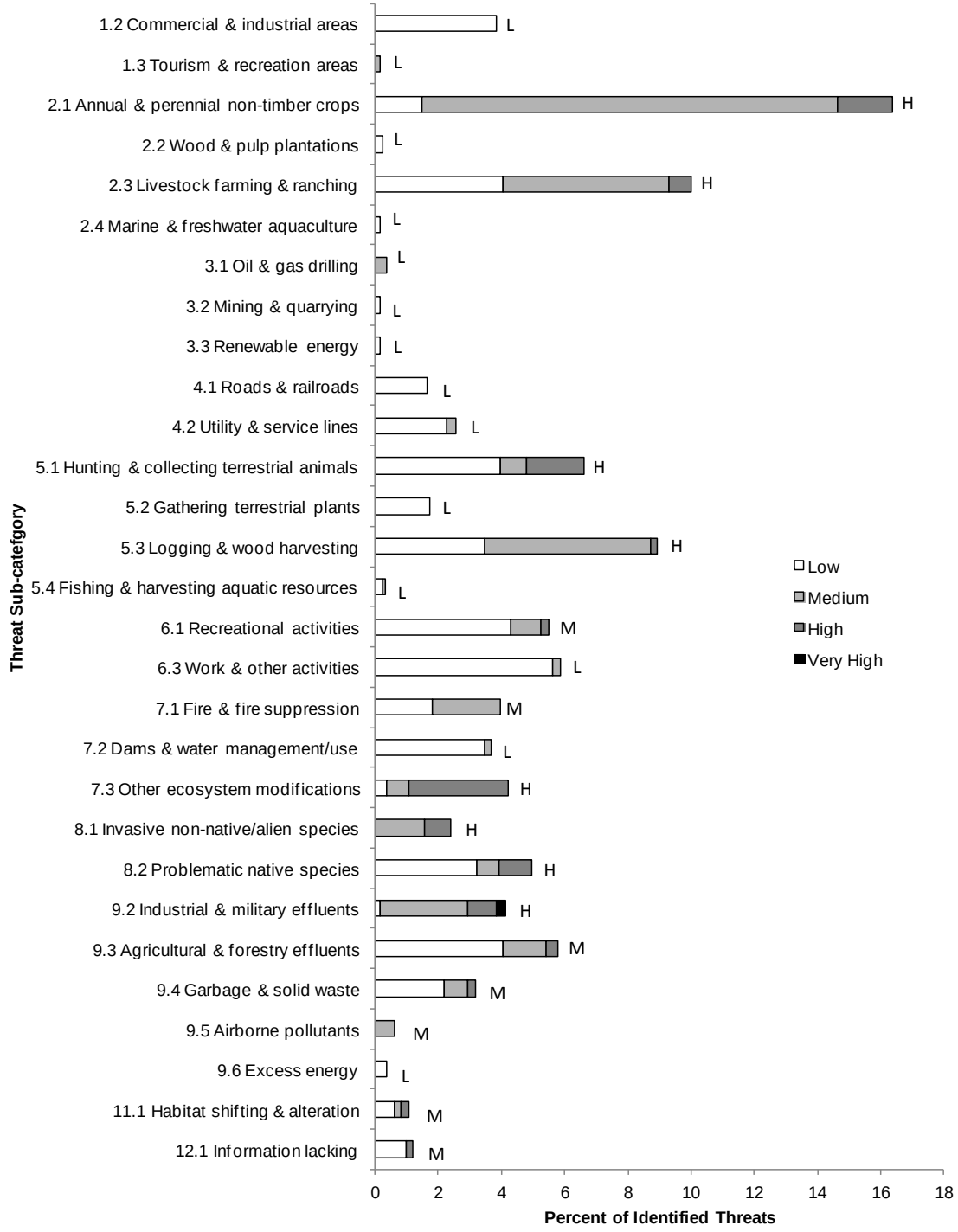


Figure 10. Percent of identified threats to priority species within BCR 6 by threat sub-category.
Each bar represents the percent of the total number of threats identified in each threat sub-category in BCR 6 (for example, if 100 threats were identified in total for all priority species in BCR 6, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). Shading in the bars (VH = very high, H = high, M = medium and L = low) represents the rolled-up magnitude of all threats in each threat subcategory in the BCR. (See Appendix 2 for details on how magnitude was assessed).
Note: Threat sub-categories were primarily taken from the IUCN-CMP classification of direct threats to biodiversity[186] (see Appendix B for details).

Table 4. Relative magnitude of identified threats to priority species within BCR 6 by threat category and broad habitat class.

Overall ranks were generated through a roll-up procedure described in Kennedy et al. (2012)[5]. L represents Low Magnitude threats; M = Medium; H = High; VH = Very High. Blank cells indicate that no priority species had threats identified in the threat category/habitat combination.

Threat category	Habitat class											
	Coniferous	Deciduous	Mixed	Shrub/Early Successional	Herbaceous	Cultivated and Managed	Lichens/Mosses	Bare Areas	Artificial Surfaces	Wetlands	Waterbodies, Snow and Ice	Overall
Overall	**H**	**H**	**H**	**H**	**M**	**H**	**L**	**H**	**M**	**H**	**H**	
1 Residential & commercial development	L	L	L	L	L	L		L	L	L	L	**L**
2 Agriculture & aquaculture	M	H	M	H	H	H		L	L	H	H	**H**
3 Energy production & mining	L	L	L	L	L	L						**L**
4 Transportation & service corridors	L	L	L	L	L	L		L	L	M	L	**L**
5 Biological resource use	H	H	H	H	M	M	L	M	L	H	H	**H**
6 Human intrusions & disturbance	L	L	L	L	L	L	L	M	M	M	H	**M**
7 Natural system modifications	H	VH	H	H	M	H		H	H	H	H	**H**
8 Invasive & other problematic species & genes	M	H	H	H	M	H		H	L	VH	H	**H**
9 Pollution	M	H	H	H	M	VH		H	M	H	H	**H**
11 Climate change & severe weather	M		L	L	L	L	L	L		M	M	**M**
12 Other direct threats				L	L	M	L	L	M	M	M	**M**

Threats to priority species while they are outside Canada during the non-breeding season were also assessed and are presented in the Threats Outside Canada section.

Element 5: Conservation Objectives

Conservation objectives were designed to address threats and information gaps that were identified for priority species. They describe the environmental conditions and research and monitoring that are thought to be necessary for progress towards population objectives and to understand underlying conservation issues for priority bird species. As conservation objectives are reached, they will collectively contribute to achieving population objectives. Whenever possible, conservation objectives were developed to benefit multiple species and/or respond to more than one threat (see Appendix B).

Conservation objectives were developed for threats identified for individual species and assessed at a magnitude of medium or greater. Conservation objectives fall into broad conservation categories and are identified in Figure 11. Within BCR 6, most conservation objectives fall into the conservation category Ensure Adequate Habitat, suggesting that objectives associated with maintaining the availability of suitable habitat for priority species are of primary importance.

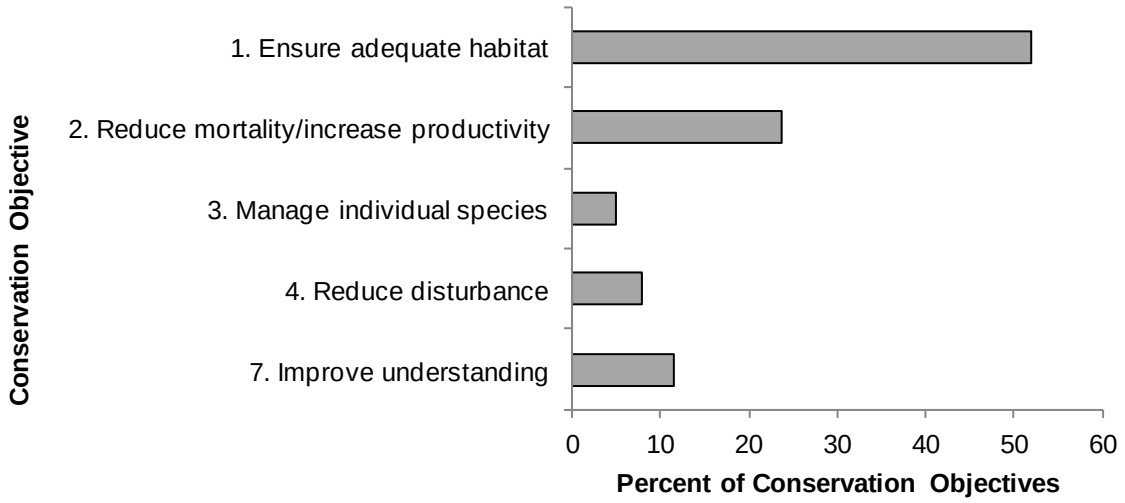


Figure 11. Percent of all conservation objectives assigned to each conservation objective category in BCR 6.

Element 6: Recommended Actions

Recommended actions indicate on-the-ground activities that will help to achieve the conservation objectives (Fig. 8). Actions are strategic rather than highly detailed and prescriptive (see Appendix B). Whenever possible, recommended actions benefit multiple species and/or respond to more than one threat. Recommended actions defer to or support those provided in recovery documents for species at risk at the federal, provincial or territorial level, but will usually be more general than those developed for individual species.

Conservation actions were developed for identified conservation objectives. Conservation actions fall into specific conservation action categories and sub-categories and are identified in Figure 12. Within BCR 6, most conservation actions fall into the conservation sub-categories Site/Area Management (management of protected areas and other resource lands for conservation) and Site/Area Protection (establishing or expanding public or private parks, reserves and other protected areas).

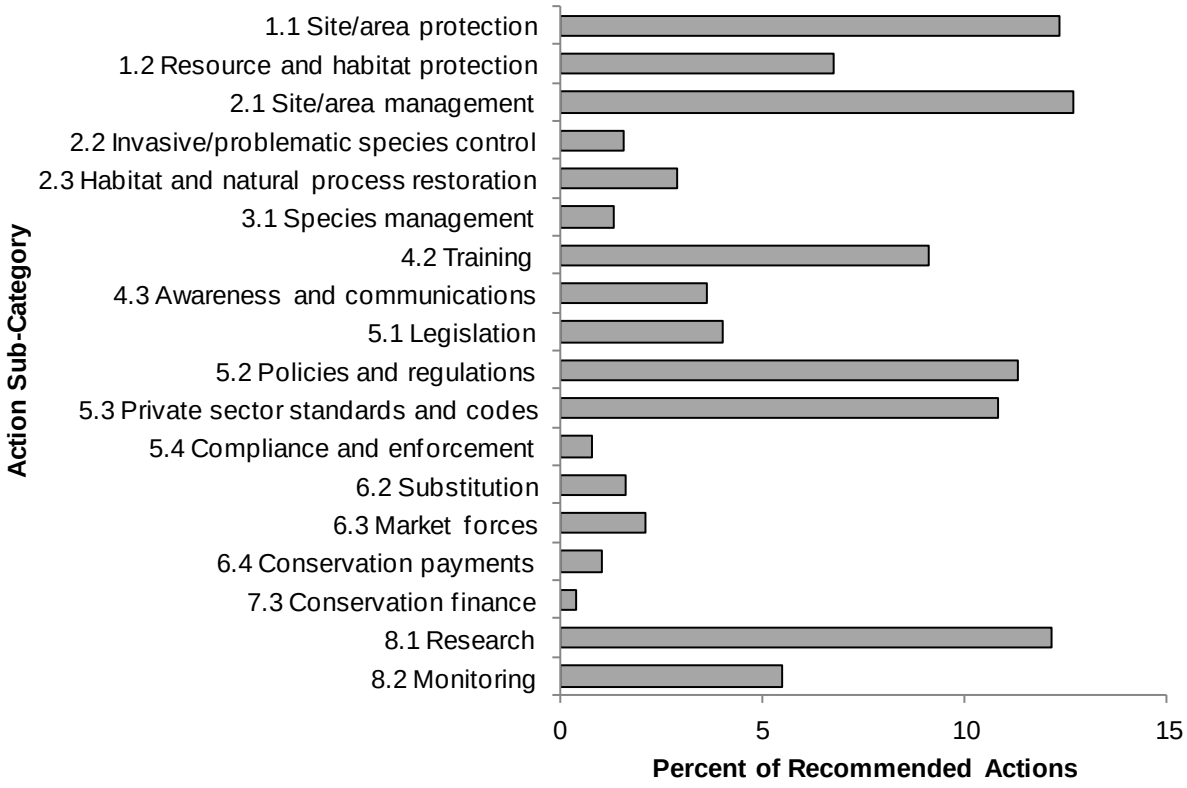


Figure 12. Percent of recommended actions assigned to each sub-category in BCR 6.
"Research" and "monitoring" refers to specific species where additional information is required. For a discussion of broad-scale research and monitoring requirements, see Research and Population Monitoring Needs.

Section 2: Conservation Needs by Habitat

The following sections provide more detailed information on priority species, their threats and conservation objectives within each of the broad habitat classes that occur in BCR 6. Where appropriate, habitat information is provided at a finer scale than the broad habitat categories in order to coincide with other land management exercises in the region. Some species do not appear in the threats table because their low-level threats have not been assigned objectives or actions and/or identified threats are addressed in the Widespread Issues section of the strategy.

Coniferous

BCR 6 contains a large coniferous forest component, including large areas of stunted black and white spruce forests in the north, black spruce and tamarack forests in **peatlands** throughout the north and central regions, white spruce forests in mesic areas in central and southern areas, and jack pine in dry upland areas in central and southern areas (Fig. 13). Fire and insect disturbances are the principal natural processes that have shaped this habitat by maintaining a wide variety of stand ages throughout the region. However, modern fire suppression coupled with forestry are changing historical forest dynamics and altering forest age-structure. Non-merchantable conifer tree species such as black spruce are becoming older on average, while merchantable tree species such as white spruce are becoming younger.

There are 31 priority species that use coniferous forests, primarily landbirds, and 4 of those meet the criteria for stewardship species. Many of the landbirds considered here are listed based on their provincial general status rank (Table 5).

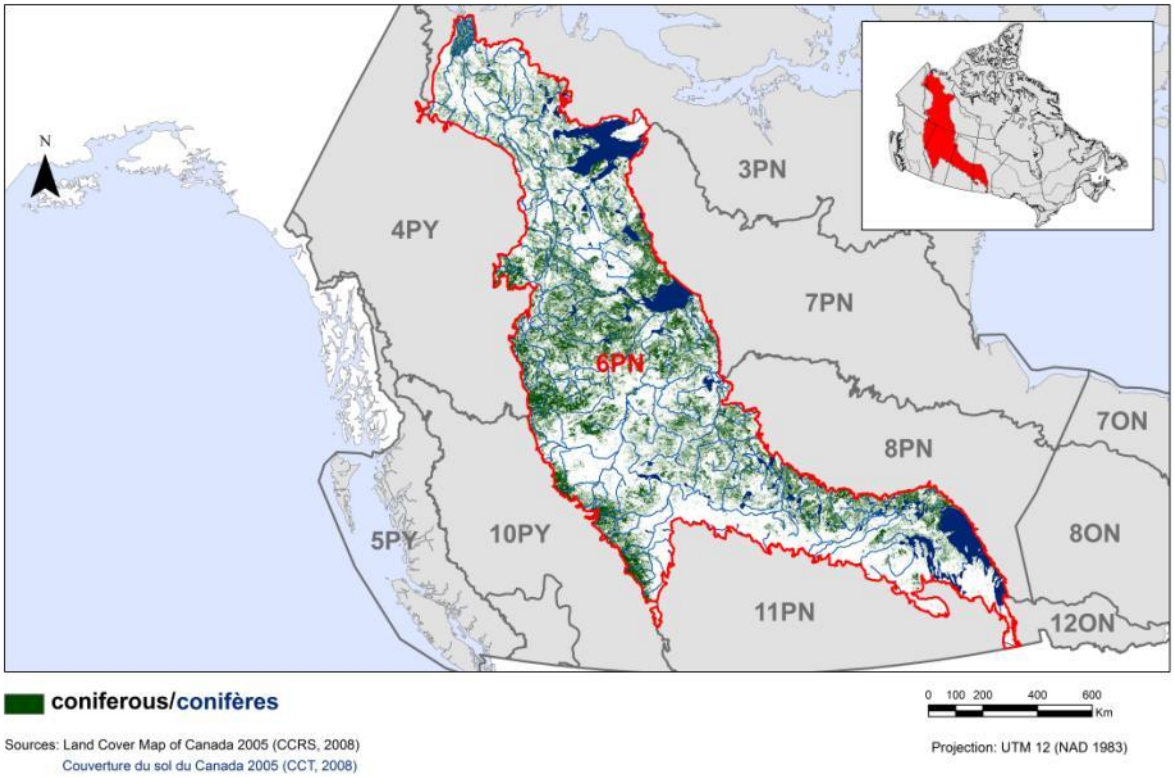


Figure 13. Map of coniferous habitat in BCR 6: Boreal Taiga Plains, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

The primary human impacts on coniferous habitats are the alteration of forest composition, age, distribution and spatial structure through forest harvesting (threat sub-category 5.3), fire suppression (sub-category 7.1), and oil and gas development (sub-category 3.1) (Fig. 14). Old white spruce stands, along with mixed stands, are targeted by forestry companies because of their high value, and this has direct effects on several species that are associated with this habitat (e.g., Boreal Owl, Bay-breasted Warbler, Blackburnian Warbler, Black-throated Green Warbler). Clearing of forest for crops (sub-category 2.1) and livestock ranching (sub-category 2.3) also impact structural composition of coniferous forest habitats through removal of mature or old seral stages. In the near future, jack pine and lodgepole pine stands may be affected by mountain pine beetle, which is currently moving into forests within Alberta. Widespread and intensive mortality of conifers by mountain pine beetles, combined with large-scale salvage logging efforts, have the potential to negatively impact many forest-dwelling birds and pose unique conservation problems. Conversely, insectivorous birds such as Black-backed Woodpeckers, Bay-breasted Warblers and Cape May Warblers may also be impacted by the control of outbreaks for insect prey including mountain pine beetle and spruce budworm (sub-category 7.3). The most important conservation actions in coniferous habitats are adherence to **ecosystem management** practices, which include the maintenance of forest pattern (spatial and temporal distribution of seral stages across all forest types) and forest structure (presence of key structural attributes associated with ecosystem integrity) (Table 6). Improved emulation

of natural fire regimes and protection of key areas of coniferous habitat are also important conservation actions.

Table 5. Priority species that use coniferous habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American Three-toed Woodpecker	Recently disturbed; mature to old-growth	Snags	Assess/Maintain					Y	
Bay-breasted Warbler	Old-growth white spruce/fir	Spruce budworm specialist	Increase 50%		Y			Y	
Black-backed Woodpecker	Recently disturbed forest (fire); mature to old-growth	Snags	Assess/Maintain		Y			Y	
Blackburnian Warbler	Mature to old white spruce-balsam fir		Assess/Maintain		Y			Y	
Blackpoll Warbler	Black spruce		Assess/Maintain		Y			Y	
Black-throated Green Warbler	Old white spruce	Paper birch	Increase 50%	Y	Y			Y	
Bohemian Waxwing	White and black spruce and pine	Ripening fruit; proximity to water	Assess/Maintain		Y		Y		
Bonaparte's Gull	Low coniferous trees	Islands for nesting	Assess/Maintain		Y	Y			
Boreal Chickadee	All boreal forest types	Snags	Increase 100%		Y			Y	
Boreal Owl	Mature to old black spruce, white spruce, balsam fir	Cavities	Assess/Maintain					Y	Y
Brown Creeper	Old-growth	Snags	Assess/Maintain						Y
Cape May Warbler	Mature to old-growth spruce, fir	Tall spruce with mossy understory; spruce budworm specialist	Assess/Maintain		Y			Y	
Gray-headed Chickadee	Sparse trees/taiga		Assess/Maintain					Y	Y
Greater Yellowlegs	All types near water		Assess/Maintain		Y	Y		Y	
Great Gray Owl	All types	Secondary cavities; open areas	Assess/Maintain				Y	Y	
Harris's Sparrow	Black spruce, white spruce, tamarack		Assess/Maintain		Y			Y	
Lesser Yellowlegs	All types near water		Increase 100%			Y			
Mountain Bluebird	Open or scattered woodlands associated with grassland habitat	Open areas of short grasses for foraging; snags or	Assess/Maintain					Y	

Table 5 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
		damaged trees with cavities for nesting							
Northern Hawk Owl	Dead/dying trees	Natural and secondary cavities; snags; open areas	Assess/Maintain					Y	
Northern Shrike	Taiga and taiga-tundra zone		Assess/Maintain		Y			Y	
Olive-Sided Flycatcher	All types		Recovery Objective	Y	Y			Y	
Pileated Woodpecker	Old-growth white spruce	Snags	Maintain Current					Y	
Rusty Blackbird	Coniferous wetlands		Increase 100%	Y	Y			Y	
Short-billed Dowitcher	Black spruce		Increase 100%		Y	Y		Y	
Solitary Sandpiper	All types near water		Increase 50%		Y	Y			
Spruce Grouse	Open northern taiga; young successional lodgepole & jackpine (post-fire)		Assess/Maintain		Y		Y		
Western Tanager	Open old-growth		Assess/Maintain					Y	
Western Wood-Pewee	Open forest		Increase 50%					Y	
White-throated Sparrow	All types/stages		Increase 50%		Y			Y	
White-winged Crossbill	Mature to old-growth		Maintain Current		Y				
Yellow-bellied Sapsucker	Old-growth		Assess/Maintain		Y		Y		

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion. The age classes for forest-associated habitats are defined as follows. Herb: 0–10 years; Shrub/Herb: 11–20 years; Pole/Sapling: 21–40 years; Young Forest: 41–60 years (deciduous, mixed wood) or 41–80 years (conifer); Mature Forest: 61–80 years (deciduous, mixed wood) or 81–100 years (conifer); Old-Growth Forest: greater than 80 years (deciduous, mixed wood) or greater than 100 years (conifer).

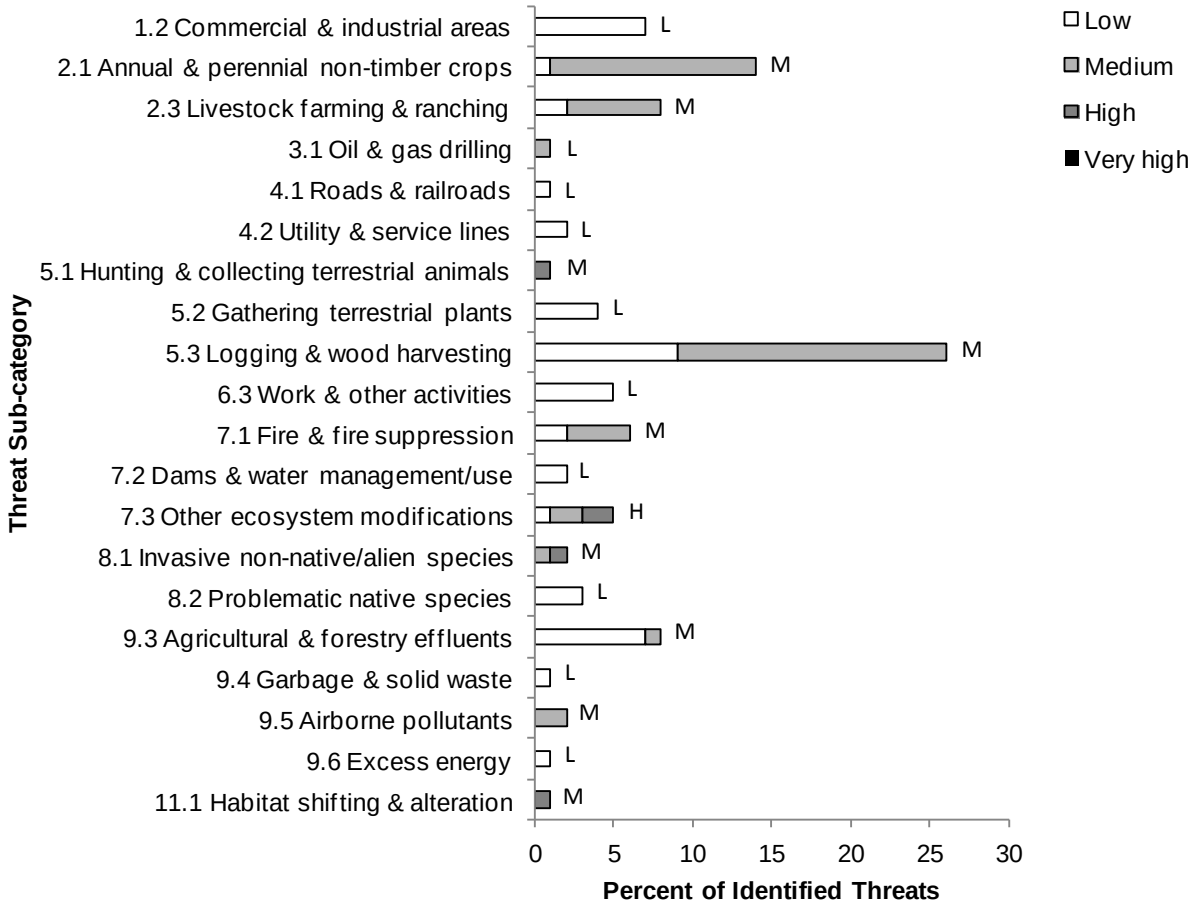


Figure 14. Percent of identified threats to priority species in coniferous habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in coniferous habitat (for example, if 100 threats were identified in total for all priority species in coniferous habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in coniferous habitat is shown at the end of each bar (also presented in Table 4: Relative magnitude of identified threats to priority species within BCR 6 by threat category and broad habitat class).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 6. Threats addressed, conservation objectives, recommended actions and priority species affected for coniferous habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber Crops	Removal of mature and older seral coniferous trees for agriculture results in direct habitat loss and indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan cultivation to maintain large, contiguous stands of coniferous forest throughout the region by representing the size, shape, and spatial and temporal arrangement of all conifer forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older conifer forest (i.e., white spruce) and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	Bay-breasted Warbler Black-throated Green Warbler Bonaparte's Gull Boreal Owl Brown Creeper Great Gray Owl Greater Yellowlegs Northern Shrike Rusty Blackbird Short-billed Dowitcher Spruce Grouse Solitary Sandpiper Western Wood-Pewee White-throated Sparrow	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with ecological and social values.	The potential expansion in various resource extraction activities warrants careful consideration of land use values and the creation of balanced land use policy. We provide two examples of land use planning in the BCR. British Columbia's Land and Resource Management Plans (LRMP) are cooperatively developed sub-regional land use plans. An LRMP provides strategic level direction and priorities for using and managing Crown land resources and identifies ways to achieve community economic, environmental, and social objectives. Alberta's Land Use Framework (LUF) is new blueprint for land use planning, management, and decision-making. The goal is to better manage private and public lands and natural resources to achieve long-term economic, ecological, and social goals.		8
					Implement policy changes that prevent the loss of mature and old seral conifer forest for agricultural development in the southern portion of the BCR.	The high biodiversity value and low agricultural potential of these forests warrants retention of remaining, intact forests.		

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.3 Livestock Farming and Ranching	Clearing of forest for grazing, and grazing in forested crown lands results in habitat loss and habitat degradation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan grazing to maintain large, contiguous stands of coniferous forest throughout the region by representing the size, shape, and spatial and temporal arrangement of all conifer forest types and stand age classes at a regional scale.	5.2 Policies and Regulations	Implement policy changes that prevent the loss of mature and old seral conifer forest for agricultural development in the southern portion of the BCR and the habitat modification from grazing in crown lands.		Black-throated Green Warbler Boreal Owl Great Gray Owl Northern Shrike Rusty Blackbird Solitary Sandpiper Spruce Grouse Western Wood-Pewee	
5.1 Hunting and Collecting Terrestrial Animals	Sustainable landbird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted landbirds.	3.1 Species management	Set conservative harvest rates for legally hunted species using best available information.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	Spruce Grouse	9
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.			9 10
				8.2 Monitoring	Support for long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area protection	Conserve and manage habitat of hunted species. Maintain a system of static habitat reserves on crown lands to ensure protection of mature and older conifer forest and to function as ecological benchmark areas.	Ensuring that there is structurally diverse habitat for the hunted species (size, shape, spatial arrangement of forest habitat types; important key attributes associated with forest habitat types include: forest composition, forest structure, coarse woody debris, standing dead wood, soil organic layer) will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
5.2 Gathering Terrestrial Plants	Peat mining results in habitat loss and degradation.	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Limit peat mining to maintain large, contiguous stands of coniferous forest throughout the region by representing the size, shape, and spatial and temporal arrangement of all conifer forest types and stand age classes at a regional scale.	1.1 Site/area protection	Protect large complexes of bogs and fens so that the size, shape and spatial arrangement of these habitats are represented at a regional scale.	Conservation of large intact **peatlands** will ensure that there is habitat available for peatland nesting bird species.	Bonaparte's Gull Greater Yellowlegs Short-billed Dowitcher Solitary Sandpiper	13
				2.1 Site/Area Management	Management should favour leaving large intact areas of **peatland** containing a mosaic of ponds and lakes representing the size, shape and spatial arrangement of these waterbody **ecosites** at a regional scale.	Zoning areas (to designate mine and no-mine areas) will decrease edge effects and will increase habitat value to birds and other wildlife.		11
				8.1 Research	Continued research of more sustainable mining techniques as well as restoration techniques for **peatlands** that have been previously mined.	There are relatively few published studies on effects of peat mining on wildlife in western Canada, including ways to mitigate negative impacts. Increased research effort will allow for better practices in the industry.		12
				4.3 Awareness and communications	Promote awareness of detrimental and irreparable effects of peat mining on the environment.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives will increase awareness of impacts by consumers.		
				6.2 Substitution	Promote use of alternatives to peat moss in gardening such as compost and mulch.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives will increase awareness of impacts by consumers.		
5.3 Logging and Wood Harvesting	Removal of mature and older seral coniferous trees results in direct habitat loss and indirect	1.2 Maintain the size, shape and configuration of habitat within the	Plan forestry to maintain large, contiguous stands of coniferous forest	5.2 Policies and Regulations	Modify existing provincial forest management planning standards to provide for the retention of older seral conifer forest.	Existing forest management planning standards do not adequately account for the habitat requirements of mature or older coniferous forest-inhabiting migratory birds.	American Three-toed Woodpecker Bay-breasted Warbler	

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	effects of habitat **subdivision** and isolation.	**natural range of variation**	throughout the region by representing the size, shape, and spatial and temporal arrangement of all conifer forest types and stand age classes at a regional scale.		Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The potential expansion in various resource extraction activities warrants careful consideration of land use values and the creation of balanced land use policy.	Black-backed Woodpecker Blackburnian Warbler Blackpoll Warbler Black-throated Green Warbler Bonaparte's Gull Boreal Chickadee Boreal Owl Brown Creeper Cape May Warbler Gray-headed Chickadee Great Gray Owl Greater Yellowlegs Lesser Yellowlegs Northern Hawk Owl Olive-sided Flycatcher Pileated Woodpecker Short-billed Dowitcher Spruce Grouse Solitary Sandpiper Western Tanager Western Wood-Pewee White-throated Sparrow White-winged Crossbill Yellow-bellied Sapsucker	
				1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older conifer forest (i.e., white spruce) and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).		13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14
				6.2 Substitution	Refine and promote alternative structural dimensional wood products (e.g., engineered wood products) to address and replace the market demand for products currently supplied by harvesting mature and old-growth trees.	Large diameter trees are often targeted for use as structural dimensional lumber in the construction of various buildings, so developing alternative building products may alter demand and protect the resource.		
				4.3 Awareness & communications	Communicate the development and marketing of alternative wood products throughout the building and home renovation industries.	The transition from natural building materials to engineered ones requires additional marketing and communication.		
7.1 Fire and Fire Suppression	Fire suppression reduces the amount and limits the distribution of	1.3 Ensure the continuation of natural processes that	Re-establish natural fire return intervals in unmanaged/low	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older conifer forest	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the	American Three-toed Woodpecker Black-backed	13

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	burned forest habitat.	maintain bird habitat	management areas of the region to ensure an adequate supply of burned forest.		(i.e., white spruce) and to function as ecological benchmark areas.	establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	Woodpecker Brown Creeper Mountain Bluebird Northern Hawk Owl Olive-sided Flycatcher	
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14
				4.3 Awareness & Communications	Promote awareness of the ecological benefits regarding the role of fire in natural landscapes.	The current negative view of wildfire has created a societal bias that threatens the ability of land managers to restore the ecological role and value of fire in natural landscapes.		8
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The ability to restore natural ecosystem processes and function warrants careful consideration of land use values and the creation of balanced land use policy.		15
					Develop "free-to-burn" or prescribed fire protocols to promote and retain high-value burned forest within the natural fire-return interval, distributed both spatially and temporally, throughout the region.	Protocols and policies would need to be developed prior to the re-establishment of naturally occurring wildfire or **prescribed burning** within the natural fire return interval.		16 17
					Develop stricter policies and penalties for debris-burning and other human-induced forms of fire ignition in non-target habitats.	Many fires are ignited through the burning of debris or other careless acts which might be prevented through the development of stricter policies and penalties.		
				8.0 Research and Monitoring	Continue to evaluate the ecological, financial, and social value of existing fire suppression policy through research and monitoring.			

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
7.2 Dams and Water Management/Use	Changes in flow regimes may reduce water availability, strand or flood nests, or reduce natural variability in water levels	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	Greater Yellowlegs Short-billed Dowitcher	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
7.3 Other Ecosystem Modifications	Control of outbreaks of forest insect pests (e.g., forest tent caterpillar, spruce budworm) greatly reduces an important food resource for specialist birds.	7.1 Improve population/demographic monitoring	Research predator-prey relationships between forest insect pests and their avian predators.	8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of forest insect pests has been linked to declining abundance of avian predators, but it is unclear whether insect abundance can be controlled by avian predators when below outbreak densities.	Bay-breasted Warbler Cape May Warbler	21 22
				8.2 Monitoring	Support monitoring of both insect outbreaks and bird species at suitable spatial and temporal scales to improve knowledge of predator-prey population dynamics.			
7.3 Other Ecosystem Modifications	Control of beetle outbreaks (e.g., mountain pine beetle, spruce beetle) removes an important food resource.	1.3 Ensure the continuation of natural processes that maintain bird habitat	Manage beetle outbreaks in a way that minimizes impact on Black-backed Woodpeckers.	2.1 Site/area management; 5.3 Private sector standards and codes; 2.2 Invasive/problematic species control; 2.3 Habitat and natural process restoration	Limit **salvage harvest** of mountain pine beetle-infested trees to maintain biodiversity values at regional and stand scales (e.g., retain structure and composition; retain live undamaged and damaged trees, coarse woody debris, dead trees).	Management strategies should be based on scientific knowledge about natural disturbances and recovery processes, ecological effects of **salvage harvesting**, and lessons from case studies around the world. Management objectives must consider both economic and ecological values. The high conservation value of areas recently infected by forest insect outbreaks for cavity-nesting birds and other organisms warrants some retention of these forests. For Black-backed Woodpeckers in particular, snags and beetle-killed trees containing bark borers are a critical food resource, and are likely the limiting factor for this species. Elimination of nesting sites may also reduce woodpecker density; if woodpecker populations are maintained, localized insect outbreaks may attract them via a "birdfeeder effect" to take advantage of these short-term resource pulses and potentially control outbreaks.	Black-backed Woodpecker	23 24 25 26 27
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation	8.1 Research	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Olive-sided Flycatcher Western Wood-Pewee	28 29

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
			action to reverse the decline.		Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Support increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus.	8.0 Research and Monitoring	Promote funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	Great Gray Owl	30
8.1 Invasive Non-native/Alien Species	European Starlings and House Sparrows exclude native species from nesting cavities.	3.1 Reduce competition with invasive species	Limit population size of invasive European Starlings and House Sparrows to ensure a sufficient supply of nest cavities for native birds.	8.1 Research	Identify key areas where nest cavities are limiting native birds due to cavities being occupied by European Starlings and House Sparrows. Add nest boxes to increase cavity availability for primary and secondary cavity nesters.	Exclusion of native birds from nest cavities is widespread, but population-level effects are largely unknown.	Mountain Bluebird	31
				2.2 Invasive/problematic species control	Promote control of European Starlings and House Sparrows in key areas to increase the availability of nesting cavities for native birds.			
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Black-throated Green Warbler Brown Creeper	32 33 34

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
8.2 Problematic Native Species	Increased nest predation by generalist predators may limit populations.	2.5 Reduce parasitism/predation	Improve nesting/fledgling success by limiting nest predation by generalist predators.	8.1 Research	Determine causes of increased nest predation and/or abundance of generalist nest predators (e.g., human development, edge effects, linear features, increased rodent density due to agriculture).	Landscape impacts on nest predation rates may be complex and operate at multiple spatial scales, and are therefore difficult to measure and quantify.	Black-throated Green Warbler	34
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	Bohemian Waxwing Lesser Yellowlegs	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
9.3 Agricultural and Forestry Effluents	Pesticides used to control forest pests may have direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Decrease chemical pesticide use to limit potential toxic effects and maintain insect prey populations.	6.2 Substitution	Replace chemical insecticides with microbial agents (e.g., *Bacillus thuringiensis*, or *Bt*) or lepidopteran-specific insecticides (e.g., tebufenozide, also known as MIMIC) that have low toxicity to vertebrates.	Tennessee Warblers were not significantly affected by application of the lepidopteran-specific pesticides *Bt* or MIMIC.	American Three-toed Woodpecker Bay-breasted Warbler Blackburnian Warbler	37

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of spruce budworm has been linked to declining abundance of avian predators, but it is unclear whether spruce budworm abundance can be controlled by avian predators when below outbreak densities.	Black-throated Green Warbler Cape May Warbler White-throated Sparrow	22
					Continue researching the non-target effects of pesticides on non-target species.			
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is restricted.	White-throated Sparrow	38 39
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38
9.5 Air-borne pollutants	Acid precipitation degrades habitat quality.	1.5 Reduce habitat degradation from contaminants	Reduce emissions of air-borne pollutants.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Blackpoll Warbler Rusty Blackbird	
				5.3 Private sector standards and codes	Encourage industries to employ spatial and climatic modeling in order to minimize emissions during times or at locations when pollution would be most damaging.	For example, emissions from a coal-fired power plant could be minimized when wind patterns would carry pollution to more sensitive areas, either by delaying activity or reallocating energy production to other facilities. Altering the spatial and temporal distribution of emissions could have economic benefits for polluters (i.e., if the tax on emissions is lower in/at less-damaging locations/times). This is an improvement on a cap-and-trade system, which may		40

Table 6 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						be capable of lowering total emissions, but is unable to minimize the damage caused for a given level of emissions.		
9.6 Excess Energy	Lower density observed in areas affected by noise from compressor stations on pipelines.	4.2 Reduce disturbance from industrial or work activity	Reduce noise levels at industrial sites.	5.3 Private sector standards and codes	Beneficial management practices for construction of new compressor stations should include noise suppression technology, and existing stations should be retrofitted with noise-suppressing technology.	Retrofitting existing compressor stations to reduce the decibel level mitigates noise impacts on forest songbirds.	White-throated Sparrow	41
11.1 Habitat shifing and alteration					See Climate Change in Widespread Issues for Priority Species in BCR 6 (Table 28)		Bonaparte's Gull	

Note: Only threats ranked as medium magnitude or higher in coniferous habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for coniferous habitat (Table 5) but not listed in the associated threats table (Table 6 above). These priority species either have no known threats in coniferous habitat or have known threats in coniferous habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Harris' Sparrow, for example, is associated with coniferous habitat but does not appear in Table 6 because identified threats for Harris' Sparrows in this habitat were ranked as low (e.g., 1.2 Commercial and industrial areas). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Deciduous

Deciduous trees occur throughout BCR 6; however, pure deciduous forest is primarily found along the southern border of the Boreal Plains Ecozone in the transition area between aspen parkland and boreal forest (Fig. 15). Deciduous forests include pure balsam poplar stands associated with medium and large river flood plains throughout the BCR and upland aspen forests that are found throughout the BCR.

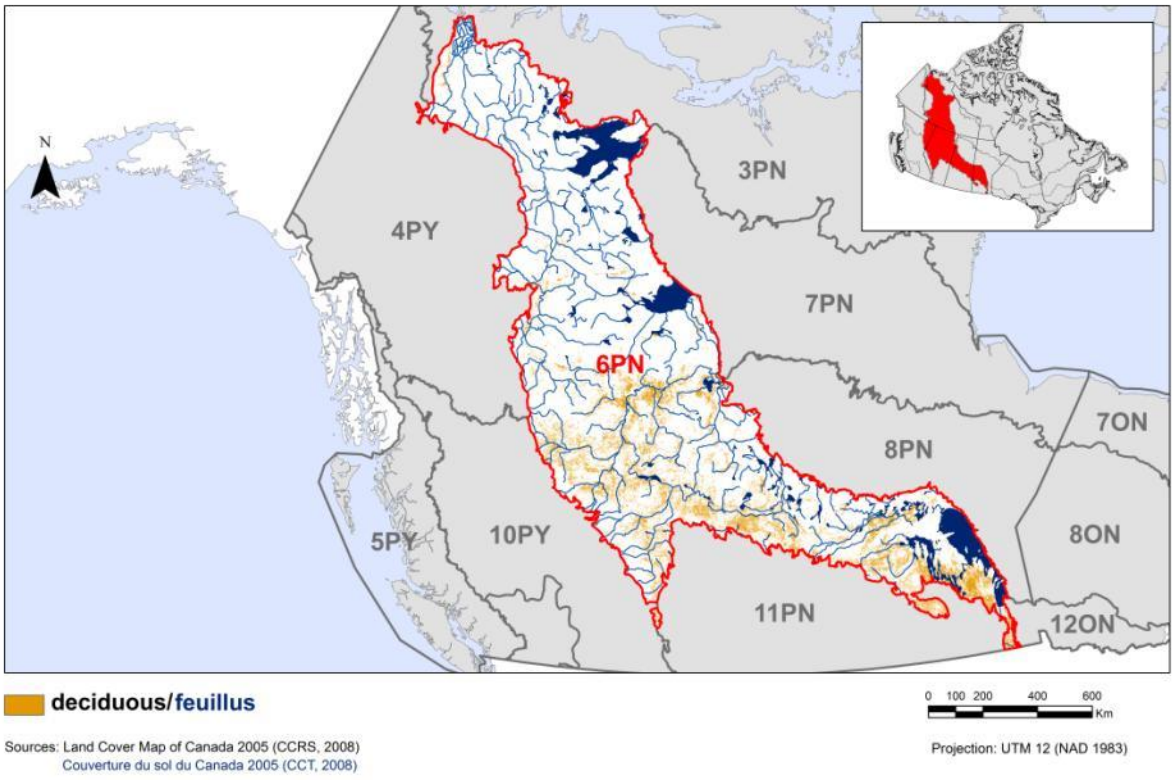


Figure 15. Map of deciduous habitat in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

Forty-two priority species have associations with deciduous forests, and of these species, most are landbirds (Table 7). Priority species utilize a broad range of sub-habitat classes within deciduous forest, with many species showing preference for specific tree species (e.g., Black-throated Green Warbler) or specific ages of deciduous stands (e.g., Alder Flycatcher). SARA-listed or COSEWIC-assessed species with specific recovery objectives occur primarily in the eastern portion of the aspen parkland (e.g., Chimney Swift, Eastern Whip-poor-will, Golden-winged Warbler, Red-headed Woodpecker), where habitat loss from agricultural impacts are likely a major factor in bird population declines.

The primary threats to deciduous habitats are alterations to forest age structure and spatial composition (Fig. 16). Forest harvesting (threat sub-category 5.3), agriculture planning (sub-category 2.1) and livestock grazing practices (sub-category 2.3) impact the size, shape and

configuration of deciduous forest through removal of old and mature seral stages. Deciduous habitat is critical to maintaining a diversity of priority species from Barred Owls, Black-throated Green Warblers and Pileated Woodpeckers that utilize mature to old growth forest, to Eastern Whip-Poor-Wills that use early-successional habitats. Insect pest control (sub-category 7.3) is another agriculture and forestry practice that can impact priority species by influencing the availability of insect and amphibian prey. A widespread issue that ranks high in deciduous habitat is pollution from industrial contaminants (sub-category 9.2). See Section 3 for further information on widespread issues in BCR 6.

The most important management action/activity for priority species within deciduous forests is to maintain large contiguous areas of aspen forest within the highly modified aspen parkland region (Table 8). Proper management of forest resources to maintain a diversity of aspen stands (seral stage/age and composition) is important throughout the BCR. Management of water resources may play an important role in maintaining balsam poplar stands within the flood plains of river systems throughout the BCR.

Table 7. Priority species that use deciduous habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Alder Flycatcher	Aspen parkland/boreal transition		Increase 50%		Y		Y		
American Kestrel	Aspen parkland	Nest trees and perches	Assess/Maintain					Y	
Baltimore Oriole	Aspen parkland; **riparian**		Increase 50%					Y	
Barred Owl	Mature to old-growth		Assess/Maintain	Y				Y	
Barrow's Goldeneye	Aspen parkland	Nest sites	Maintain Current					Y	
Bay-breasted Warbler	Old-growth	Spruce budworm specialist	Increase 50%		Y			Y	
Black-billed Cuckoo	Open forest, edges	Responds to insect outbreaks	Increase 100%			Y			
Blackpoll Warbler	Old -growth forest		Assess/Maintain					Y	
Black-throated Green Warbler	Old-growth	Paper birch	Increase 50%	Y	Y			Y	
Bohemian Waxwing	All types	Ripening fruit; proximity to water	Assess/Maintain		Y		Y		
Boreal Owl	Mature to old aspen, poplar, birch	Natural and secondary cavities; snags	Assess/Maintain					Y	Y
Broad-winged Hawk	All types		Assess/Maintain					Y	
Brown Creeper	Mature to old-growth		Assess/Maintain						Y
Bufflehead	Aspen/poplar	Secondary cavity nester (abandoned NOFL nests)	Assess/Maintain			Y			
Canada Warbler	All types	Dense nest cover	Recovery Objective	Y	Y			Y	
Canvasback	Aspen parkland		Maintain Current		Y	Y			
Chimney Swift	Old-growth	Chimneys/cavities for nest sites and communal roosts	Recovery Objective	Y	Y			Y	
Clay-colored Sparrow	Second-growth to mature		Increase 50%				Y		
Common Goldeneye	Aspen		Maintain Current		Y	Y			
Common Yellowthroat	All types	Thicket/dense shrub understory; near water	Increase 100%					Y	
Connecticut Warbler	Mature to old-growth		Assess/Maintain		Y		Y	Y	
Eastern Phoebe	Aspen parkland; edges	Overhang for nest site (natural or human-made)	Increase 100%					Y	
Eastern Whip-poor-will	Post-fire early- to mid-successional aspen/birch	Open understory	Recovery Objective	Y	Y			Y	

Table 7 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Golden-winged Warbler	scattered trees; large and tall (>15m) residual trees after harvest or fire; Mature forest	Open areas	Recovery Objective	Y	Y			Y	
Great Grey Owl	Mature to old-growth		Assess/Maintain				Y	Y	
Greater Yellowlegs	Young	Open areas; burned over areas; bog nearby	Assess/Maintain		Y	Y		Y	
Green-winged Teal	Aspen	Pond or marsh nearby	Maintain Current			Y		Y	
Harris's Sparrow	All types	River/stream nearby	Assess/Maintain		Y			Y	
Least Flycatcher	Young to old-growth		Increase 50%				Y	Y	
Lesser Yellowlegs	All types near water		Increase 100%			Y			
Mallard	All types near water		Maintain Current		Y	Y			
Mountain Bluebird	Open or scattered woodlands associated with grassland habitat	Open areas of short grasses for foraging; snags or damaged trees with cavities for nesting	Assess/Maintain					Y	
Mourning Warbler	Young to old-growth		Increase 100%		Y				Y
Northern Flicker	Large dead/dying trees and snags	Snags	Increase 50%				Y		
Northern Goshawk	All types with tall trees	Open understory	Assess/Maintain				Y	Y	
Pileated Woodpecker	Old-growth	Snags	Maintain Current					Y	
Purple Martin	Aspen	Near pond	Assess/Maintain					Y	
Red-headed Woodpecker	All types; **riparian**	Snags	Recovery Objective	Y	Y			Y	
Sharp-tailed Grouse	Mature		Assess/Maintain		Y			Y	
Western Wood-Pewee	All types		Increase 50%					Y	
White-throated Sparrow	All types		Increase 50%		Y			Y	
Yellow-bellied Sapsucker	Young to old-growth aspen		Assess/Maintain		Y		Y		

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion. The age classes for forest-associated habitats are defined as follows. Herb: 0–10 years; Shrub/Herb: 11–20 years; Pole/Sapling: 21–40 years; Young Forest: 41–60 years (deciduous, mixed wood) or 41–80 years (conifer); Mature

Forest: 61–80 years (deciduous, mixed wood) or 81–100 years (conifer); Old-Growth Forest: greater than 80 years (deciduous, mixed wood) or greater than 100 years (conifer).

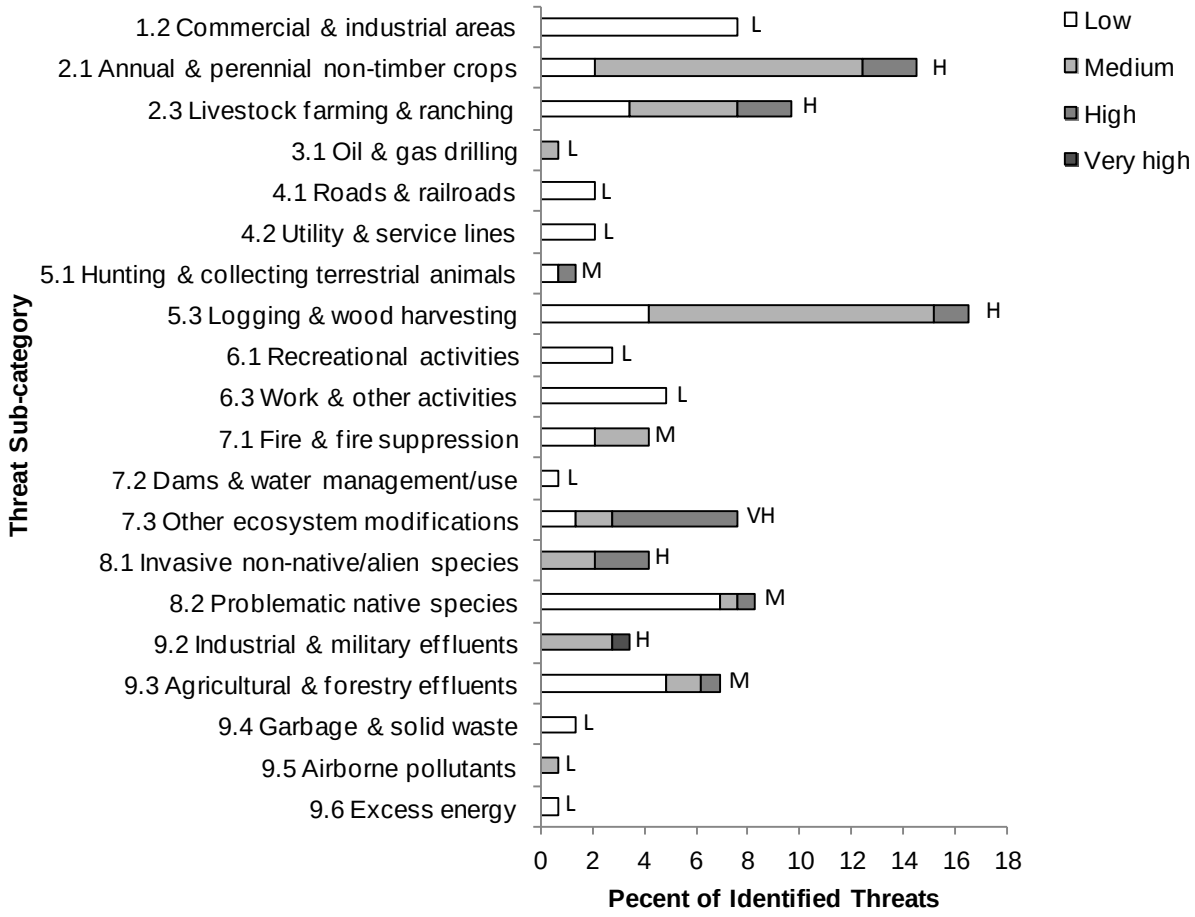


Figure 16. Percent of identified threats to priority species in deciduous habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in deciduous habitat (for example, if 100 threats were identified in total for all priority species in deciduous habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in deciduous habitat is shown at the end of each bar (also presented in Table 4: Relative magnitude of identified threats to priority species within BCR 6 by threat category and broad habitat class).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 8. Threats addressed, conservation objectives, recommended actions and priority species affected for deciduous habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber Crops	Removal of mature and older seral deciduous trees results in direct habitat loss and indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan agriculture to maintain large, contiguous stands of deciduous forest throughout the region by representing the size, shape, and spatial and temporal arrangement of all deciduous forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	American Kestrel Bay-breasted Warbler Black-billed Cuckoo Black-throated Green Warbler Boreal Owl Brown Creeper Canada Warbler Canvasback Clay-colored Sparrow Common Yellowthroat Eastern Phoebe Eastern Whip-poor-will Golden-winged Warbler Great Gray Owl Greater Yellowlegs Green-winged Teal Mallard Red-headed Woodpecker Sharp-tailed Grouse Western Wood-Pewee White-throated Sparrow	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The potential expansion in various resource extraction activities warrants careful consideration of land use values and the creation of balanced land use policy. We provide two examples of land use planning in the BCR. British Columbia's Land and Resource Management Plans (LRMP) are cooperatively developed sub-regional land use plans. An LRMP provides strategic level direction and priorities for using and managing Crown land resources and identifies ways to achieve community economic, environmental, and social objectives. Alberta's Land Use Framework (LUF) is new blueprint for land use planning, management, and decision-making. The goal is to better manage private and public lands and natural resources to achieve long-term economic, ecological, and social goals.		8
					Implement policy changes that prevent the loss of deciduous forest for agricultural development in the southern portion of the BCR.	The high biodiversity value and low agricultural potential of these forests warrants retention of remaining, intact forests.		
2.3 Livestock Farming and Ranching	Removal of mature and older seral deciduous trees results in direct habitat loss and	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan livestock grazing to maintain large, contiguous stands of deciduous	5.2 Policies and Regulations	Implement policy changes that prevent the loss of deciduous forest for agricultural development in the southern portion of the BCR.	The high biodiversity value and low agricultural potential of these forests warrants retention of remaining, intact forests and maintenance (e.g., habitat quality) of existing forests.	Black-billed Cuckoo Black-throated Green Warbler Boreal Owl Canvasback	

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	indirect effects of habitat **subdivision** and isolation. Grazing in stands results in habitat degradation.		forest throughout the region by representing the size, shape, and spatial and temporal arrangement of all deciduous forest types and stand age classes at a regional scale.				Clay-colored Sparrow Eastern Phoebe Eastern Whip-poor-will Golden-winged Warbler Great Gray Owl Green-winged Teal Mallard Red-headed Woodpecker Sharp-tailed Grouse Western Wood-Pewee	
5.1 Hunting and Collecting Terrestrial Animals	Sustainable landbird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative harvest rates for legally hunted species using best available information.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	Sharp-tailed Grouse	9
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.			9 10
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area protection	Conserve and manage habitat of hunted species. Maintain a system of static habitat reserves on crown lands to ensure protection of mature and older conifer forest and to function as ecological benchmark areas.	Ensuring that there is structurally diverse habitat for the hunted species (size, shape, spatial arrangement of forest habitat types; import key attributes associated with forest habitat types include: forest composition, forest structure, coarse woody debris, standing dead wood, soil organic layer) will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	Illegal hunting and collecting of raptors.	2.8 Reduce mortality from legal or illegal hunting, and	Support compliance with hunting and other	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American Kestrel	

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
		persecution	regulations that govern take of birds.					
5.3 Logging and Wood Harvesting	Removal of mature and older seral deciduous trees results in direct habitat loss and indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan forestry to maintain large, contiguous stands of deciduous forest throughout the region by representing the size, shape, and spatial and temporal arrangement of all deciduous forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	Barred Owl Barrow's Goldeneye Bay-breasted Warbler Blackpoll Warbler Black-throated Green Warbler Boreal Owl Broad-winged Hawk Brown Creeper Bufflehead Canada Warbler Chimney Swift Common Goldeneye Great Gray Owl Greater Yellowlegs Least Flycatcher Lesser Yellowlegs Northern Flicker Northern Goshawk Pileated Woodpecker Purple Martin Red-headed Woodpecker Western Wood-Pewee White-throated Sparrow Yellow-bellied Sapsucker	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14 8
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The potential expansion in various resource extraction activities warrants careful consideration of land use values and the creation of balanced land use policy. We provide two examples of land use planning in the BCR. British Columbia's Land and Resource Management Plans (LRMP) are cooperatively developed sub-regional land use plans. An LRMP provides strategic level direction and priorities for using and managing Crown land resources and identifies ways to achieve community economic, environmental, and social objectives. Alberta's Land Use Framework (LUF) is new blueprint for land use planning, management, and decision-making. The goal is to better manage private and public lands and natural resources to achieve long-term economic, ecological, and social goals.		
					Modify existing provincial forest management planning standards to mandate the retention of older seral deciduous forest.	Existing forest management planning standards do not adequately account for the habitat requirements of mature or older deciduous forest-inhabiting migratory birds.		
7.1 Fire and Fire Suppression	Fire Suppression reduces the amount and limits the	1.3 Ensure the continuation of natural processes that maintain	Re-establish natural fire return intervals in	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous forest and to	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of	Brown Creeper Clay-colored Sparrow Mountain Bluebird	13

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	distribution of burned forest habitat.	bird habitat	portions of the region to ensure an adequate supply of burned forest.		function as ecological benchmark areas.	additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	Northern Flicker Purple Martin Sharp-tailed Grouse	
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14
				4.3 Awareness & Communications	Promote awareness of the ecological benefits and misconceptions regarding the role of fire in natural landscapes.	The current negative view of wildfire has created a societal bias that threatens the ability of land managers to restore the ecological role and value of fire in natural landscapes.		8
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The ability to restore natural ecosystem processes and function warrants careful consideration of land use values and the creation of balanced land use policy.		15
					Develop "free-to-burn" or prescribed fire protocols to promote and retain high-value burned forest within the natural fire-return interval, distributed both spatially and temporally, throughout the region.	Protocols and policies would need to be developed prior to the re-establishment of naturally occurring wildfire or **prescribed burning** within the natural fire return interval.		16 17
					Develop stricter policies and penalties for debris-burning and other human-induced forms of fire ignition in non-target habitats.	Many fires are ignited through the burning of debris or other careless acts which might be prevented through the development of stricter policies and penalties.		
				8.0 Research and Monitoring	Continue to evaluate the ecological, financial, and social value of existing fire suppression policy through research and monitoring.	Given the limited effectiveness of existing fire suppression policy, the efficacy of this policy needs to be evaluated within an active **adaptive management** framework.		
7.2 Dams and Water Management/Use	Changes in flow regimes may reduce water availability, strand or flood nests, or reduce natural variability in water levels	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	Greater Yellowlegs	18

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
7.3 Other Ecosystem Modifications	Control of outbreaks of forest insect pests (e.g., forest tent caterpillar) greatly reduces an important	7.1 Improve population/demographic monitoring	Research predator-prey relationships between forest insect pests and	8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Predation by birds is capable of keeping low-density forest tent caterpillar populations in check, but it is unclear what mechanisms allow its density to rise above the level where they can be controlled by predation and thus initiate outbreaks.	Baltimore Oriole Bay-breasted Warbler	21 22

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	food resource for specialist birds.		their avian predators.	8.2 Monitoring	Support monitoring of both insect outbreaks and bird species at suitable spatial and temporal scales to improve knowledge of predator-prey population dynamics.			
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	8.1 Research	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Alder Flycatcher Chimney Swift Eastern Phoebe Eastern Whip-poor-will Least Flycatcher Purple Martin Western Wood-Pewee	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Support increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
7.3 Other Ecosystem Modifications	Range-wide decline in amphibian prey may be contributing to decline of this species.	7.4 Improve understanding of causes of population declines	Increased research of implications of amphibian decline on predators.	8.1 Research	Understand the extent to which the Broad-winged Hawk specializes on amphibians and undertake to understand reason for the decline of amphibians.		Broad-winged Hawk	42
				8.2 Monitoring	Support a variety of monitoring programs for diurnal raptors (breeding season surveys, banding stations).			
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus.	8.0 Research and Monitoring	Provide funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	American Kestrel Great Gray Owl	30
8.1 Invasive Non-native/Alien Species	European Starlings and House Sparrows exclude native species from nesting cavities.	3.1 Reduce competition with invasive species	Limit population size of invasive European Starlings and House Sparrows to ensure a	8.1 Research	Identify key areas where nest cavities are limiting native birds due to cavities being occupied by European Starlings and House Sparrows. Add nest boxes to increase cavity availability for primary and secondary cavity nesters.	Exclusion of native birds from nest cavities is widespread, but population-level effects are largely unknown.	Mountain Bluebird Northern Flicker Purple Martin	31

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
			sufficient supply of nest cavities for native birds.	2.2 Invasive/problematic species control	Promote control of European Starlings and House Sparrows in key areas to increase the availability of nesting cavities for native birds.			
8.1 Invasive Non-native/Alien Species	Non-native earthworms may be impacting the Eastern Whip-poor-will by altering their forest floor habitat.	7.4 Improve understanding of causes of population declines	Understand effect to which non-native earthworms affect birds such as the Eastern Whip-poor-will and increase awareness in the spread of invasive earthworms.	8.1 Research	Undertake research to understand the interactions between non-native earthworms and forest birds. Research the mechanisms of earthworm transmission and dispersal.		Eastern Whip-poor-will	43
				4.3 Awareness and communications	Increase awareness on the spread of non-native earthworms; discourage dumping of bait worms on land or water (should be put in garbage), clean vehicle tires before moving between forest sites, freeze compost, etc.	Impacts that non-native earthworms may have on other species are not well understood. Measures to understand these impacts and reduce the dispersal of non-native earthworms should be undertaken.		44
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	2.5 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Black-throated Green Warbler Brown Creeper Canada Warbler Eastern Phoebe Golden-winged Warbler Mourning Warbler	32 33 34
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
				8.2 Monitoring	Support monitoring of Brown-headed Cowbirds throughout the boreal forest at suitable spatial and temporal scales. Both on -road and off-road survey protocols are needed to understand distribution and			

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					habitat use patterns throughout the boreal forest.			
8.2 Problematic Native Species	Increased nest predation by generalist predators may limit populations.	2.5 Reduce parasitism/predation	Improve nesting/fledgling success by limiting nest predation by generalist predators.	8.1 Research	Determine causes of increased nest predation and/or abundance of generalist nest predators (e.g., human development, edge effects, linear features, increased rodent density due to agriculture).	Landscape impacts on nest predation rates may be complex and operate at multiple spatial scales, and are therefore difficult to measure and quantify.	Black-throated Green Warbler Canada Warbler Mourning Warbler	34
8.2 Problematic Native Species	Defoliation by overabundant white-tailed deer reduces habitat quality.	3.2 Reduce competition with problematic native species	Reduce white-tailed deer density.	2.2 Invasive/problem-atic species control	Increase harvest quotas for white-tailed deer and/or implement culling programs.		Canada Warbler Least Flycatcher Mourning Warbler	
				8.1 Research	Examine underlying causes leading to increased white-tailed deer density, such as logging/forest **subdivision**, agriculture, and climate change.			
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	American Kestrel Bufflehead Canvasback Mallard Northern Goshawk	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	American Kestrel Baltimore Oriole Black-billed Cuckoo Bohemian Waxwing Common Yellowthroat Lesser Yellowlegs Red-headed Woodpecker	
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			35 36
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
9.3 Agricultural and Forestry Effluents	Pesticides used to control forest pests may have direct (toxic) and indirect (e.g., decreased prey	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Decrease chemical pesticide use to limit potential toxic effects and	6.2 Substitution	Replace chemical insecticides with microbial agents (e.g., *Bacillus thuringiensis*, or *Bt*) or lepidopteran-specific insecticides (e.g., tebufenozide, also known as MIMIC) that have low	Tennessee Warblers were not significantly affected by application of the lepidopteran-specific pesticides *Bt* or MIMIC.	Bay-breasted Warbler Black-throated White-throated Sparrow	37

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	abundance) effects.		maintain insect prey populations.		toxicity to vertebrates.			
				8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of spruce budworm has been linked to declining abundance of avian predators, but it is unclear whether spruce budworm abundance can be controlled by avian predators when below outbreak densities.		22
					Continue researching the non-target effects of pesticides on non-target species.			
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is restricted.	Canvasback White-throated Sparrow	38 39
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38
9.5 Air-borne pollutants	Acid precipitation degrades habitat quality.	1.5 Reduce habitat degradation from contaminants	Reduce emissions of air-borne pollutants.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
				5.3 Private sector standards and codes	Encourage industries to employ spatial and climatic modeling in order to minimize emissions during times or at locations when pollution would be most damaging.	For example, emissions from a coal-fired power plant could be minimized when wind patterns would carry pollution to more sensitive areas, either by delaying activity or reallocating energy production to other facilities. Altering the spatial and temporal distribution of emissions could have economic benefits for polluters (i.e., if the tax on emissions is lower in/at less-damaging locations/times). This is an improvement on a cap-and-trade system, which may be capable of lowering total emissions, but is unable to minimize the damage caused for a given level of emissions.	Blackpoll Warbler	40

Table 8 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
9.6 Excess Energy	Lower density observed in areas affected by noise from compressor stations on pipelines.	4.2 Reduce disturbance from industrial or work activity	Reduce noise levels at industrial sites.	5.3 Private sector standards and codes	Beneficial management practices for construction of new compressor stations should include noise suppression technology, and existing stations should be retrofitted with noise-suppressing technology.	Retrofitting existing compressor stations to reduce the decibel level mitigates noise impacts on forest songbirds.	White-throated Sparrow	41

Note: Only threats ranked as medium magnitude or higher in deciduous habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for deciduous habitat (Table 7) but not listed in the associated threats table (Table 8 above). These priority species either have no known threats in deciduous habitat or have known threats in deciduous habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Harris' Sparrow, for example, is associated with deciduous habitat but does not appear in Table 8 because identified threats for Harris' Sparrows in this habitat were ranked as low (e.g., 4.2 Utility and service lines). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Mixed Wood

Mixed wood forests occur throughout BCR 6 and are typically dispersed within more extensive coniferous forest wherever disturbance or soils have allowed a substantial deciduous component to develop (Fig. 17). Thirty-eight priority species have been identified as using mixed wood forests, most of which are landbirds. Of these, nine are considered stewardship species (Table 9).

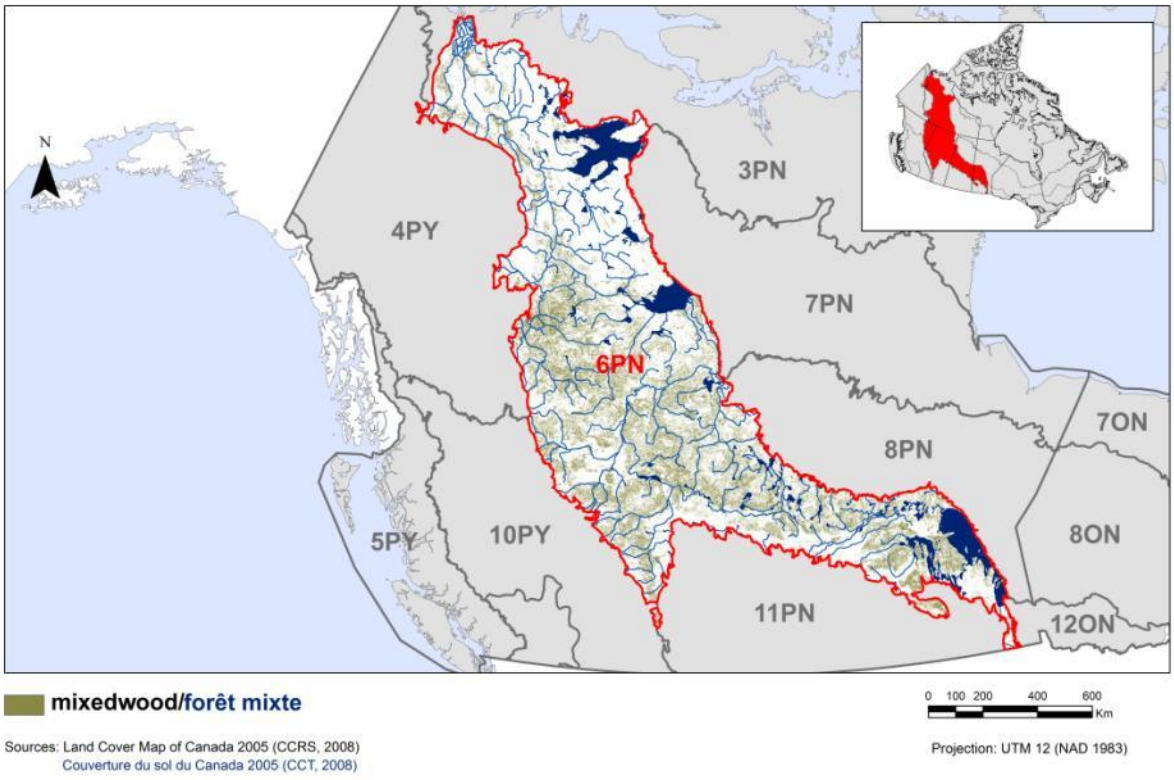


Figure 17. Map of mixed wood forest habitat in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

The primary threat in the mixed wood habitat class is large-scale forest harvesting (threat sub-category 5.3; Fig. 18). The mature and old-growth mixed wood forests in northern Alberta and Saskatchewan are considered valuable to forest companies because of the presence of large saw logs (primarily white spruce). Declines in insect populations due to the control of forest pests and additional unknown causes (sub-category 7.3) also pose a significant threat to insectivorous bird species using mixed wood habitat.

The most important conservation actions are **ecosystem management** practices for the protection of biodiversity, including maintenance of forest pattern (spatial and temporal distribution of seral stages across all forest types) and forest structure (presence of key structural attributes associated with ecosystem integrity) (Table 10). This also includes post-harvest reforestation that includes both coniferous and deciduous species (i.e., the original

forest composition, rather than a single species that leads to an “unmixing” of the mixed woods[45]). Research is required in order to better understand the role of old mixed wood forests in maintaining the populations of several migrant songbirds (e.g., Bay-breasted Warbler, Blackburnian Warbler, Black-throated Green Warbler, Western Tanager), for which declines are being noted, but information is still lacking.

Table 9. Priority species that use mixed wood habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American Kestrel	Young to early-successional post-fire	Nest trees/perches	Assess/Maintain					Y	
American Three-toed Woodpecker	Old-growth	Snags	Assess/Maintain					Y	
Barred Owl	Mature to old-growth	Nest sites and high prey abundance	Assess/Maintain	Y				Y	
Bay-breasted Warbler	Young to old-growth conifer dominated	Spruce budworm specialist	Increase 50%		Y			Y	
Black-backed Woodpecker	Burned-over areas	Snags	Assess/Maintain		Y			Y	
Blackburnian Warbler	Mature to old conifer-dominated		Assess/Maintain		Y			Y	
Blackpoll Warbler	Conifer-dominated		Assess/Maintain					Y	
Black-throated Green Warbler	Old-growth	Paper birch in understory	Increase 50%	Y	Y			Y	
Bohemian Waxwing	Conifer-dominated	Ripening fruit; proximity to water	Assess/Maintain		Y		Y		
Boreal Chickadee	Old-growth	Snags	Increase 100%		Y			Y	
Boreal Owl	Mature to old-growth	Natural and secondary cavities; snags	Assess/Maintain					Y	Y
Broad-winged Hawk	Deciduous-dominates; 11-30 years post-fire/harvest		Assess/Maintain					Y	
Brown Creeper	Conifer-dominated	Snags	Assess/Maintain						Y
Canada Warbler	Deciduous-dominated; 6-30 years post-disturbance	Dense understory	Recovery Objective	Y	Y			Y	
Cape May Warbler	Conifer-dominated	Tall spruce for perches; mossy understory; spruce budworm specialist	Assess/Maintain		Y			Y	
Common Nighthawk	Regenerating	Open ground	Recovery Objective	Y	Y			Y	
Common Yellowthroat	Regenerating to young, deciduous-dominated	Thicket/dense understory; proximity to water	Increase 100%					Y	
Connecticut Warbler	Young to old-growth deciduous-dominated		Assess/Maintain		Y		Y	Y	
Eastern Whip-poor-will	Early- to mid-successional	Open understory; clearings	Recovery Objective	Y	Y			Y	

Table 9 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Gray-headed Chickadee	Sparse trees/taiga		Assess/Maintain					Y	Y
Great Gray Owl	Conifer-dominated		Assess/Maintain				Y	Y	
Least Flycatcher	Young to old deciduous-dominated		Increase 50%				Y	Y	
Lesser Yellowlegs	All types near water		Increase 100%			Y			
Merlin	Semi-open	Abandoned nests of other species; near water	Assess/Maintain				Y		
Mountain Bluebird	Open or scattered woodlands associated with grassland habitat	Open areas of short grasses for foraging; snags or damaged trees with cavities for nesting	Assess/Maintain					Y	
Mourning Warbler	Young deciduous-dominated		Increase 100%		Y				Y
Northern Flicker	All types; **riparian**	Snags	Increase 50%				Y		
Northern Goshawk	Mature to old-growth	Open understory	Assess/Maintain				Y	Y	
Olive-sided Flycatcher	Coniferous-dominated	Tall trees or snags; openings (bogs, harvest, fire, water)	Recovery Objective	Y	Y			Y	
Pileated Woodpecker	Old-growth; young with large residual trees	Snags	Maintain Current					Y	
Rusty Blackbird	Conifer-dominated		Increase 100%		Y			Y	
Smith's Longspur	Sparse low trees		Assess/Maintain		Y			Y	Y
Spruce Grouse	All types		Assess/Maintain		Y		Y		
Western Tanager	Old-growth coniferous-dominated		Assess/Maintain					Y	
Western Wood-Pewee	All types		Increase 50%					Y	
White-throated Sparrow	All types		Increase 50%		Y			Y	
White-winged Crossbill	Mature to old-growth conifer-dominated	Coniferous seed crops	Maintain Current		Y				
Yellow-bellied Sapsucker	Old-growth deciduous-dominated		Assess/Maintain		Y		Y		

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion. The age classes for forest-associated habitats are defined as follows. Herb: 0–10 years; Shrub/Herb: 11–20 years; Pole/Sapling: 21–40 years; Young Forest: 41–60 years (deciduous, mixed wood) or 41–80 years (conifer); Mature

Forest: 61–80 years (deciduous, mixed wood) or 81–100 years (conifer); Old-Growth Forest: greater than 80 years (deciduous, mixed wood) or greater than 100 years (conifer).

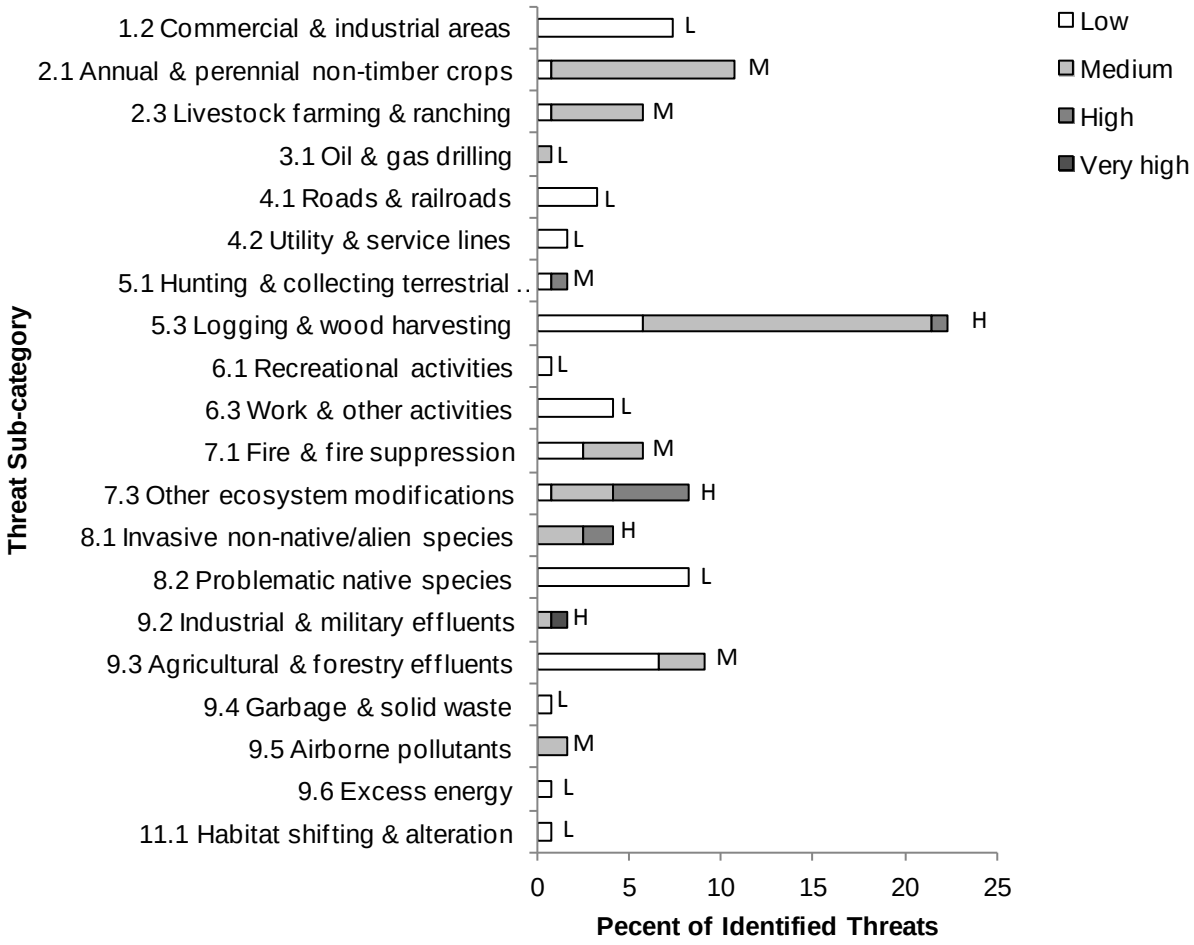


Figure 18. Percent of identified threats to priority species in mixed wood habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in mixed wood habitat (for example, if 100 threats were identified in total for all priority species in mixed wood habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in mixed wood habitat is shown at the end of each bar (also presented in Table 4).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 10. Threats addressed, conservation objectives, recommended actions and priority species affected for mixed wood habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber Crops	Removal of forest results in direct habitat loss and the indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan agriculture to maintain large, contiguous stands of mixed forest throughout the region, by representing the size, shape, and spatial and temporal arrangements or stands across a continuum of proportional species representation.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous and coniferous forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	American Kestrel Bay-breasted Warbler Black-throated Green Warbler Boreal Owl Brown Creeper Canada Warbler Common Yellowthroat Eastern Whip-poor-will Great Gray Owl Rusty Blackbird Spruce Grouse Western Wood-Pewee White-throated Sparrow	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14 8
2.3 Livestock Farming and Ranching	Removal of forest results in direct habitat loss and the indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan livestock grazing to maintain large, contiguous stands of mixed forest throughout the region, by representing the size, shape, and spatial and temporal arrangements or stands across a continuum of proportional species representation.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous and coniferous forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	Black-throated Green Warbler Boreal Owl Eastern Whip-poor-will Great Gray Owl Rusty Blackbird Spruce Grouse Western Wood-Pewee	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14 8
5.1 Hunting and Collecting Terrestrial Animals	Sustainable landbird hunting within legal limits can aid in species	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted	3.1 Species management	Set conservative harvest rates for legally hunted species using best available information.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates	Spruce Grouse	9

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.		species.			should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.		
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.			9 10
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area protection	Conserve and manage habitat of hunted species. Maintain a system of static habitat reserves on crown lands to ensure protection of mature and older deciduous and coniferous forest and to function as ecological benchmark areas.	Ensuring that there is structurally diverse habitat for the hunted species (size, shape, spatial arrangement of forest habitat types; import key attributes associated with forest habitat types include: forest composition, forest structure, coarse woody debris, standing dead wood, soil organic layer) will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	Illegal hunting and collecting of raptors.	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American Kestrel	
5.3 Logging and Wood Harvesting	Removal of mature and older seral deciduous and coniferous trees results in direct habitat loss and indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan forestry to maintain large, contiguous stands of mixed forest throughout the region, by representing the size, shape, and spatial and temporal	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous and coniferous forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	American Three-toed Woodpecker Barred Owl Bay-breasted Warbler Black-backed Woodpecker Blackburnian Warbler Blackpoll Warbler Black-throated Green Warbler	13

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
			arrangements or stands across a continuum of proportional species representation.	1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.	Boreal Chickadee Boreal Owl Broad-winged Hawk Brown Creeper Canada Warbler Cape May Warbler Gray-headed Chickadee Great Gray Owl Least Flycatcher Lesser Yellowlegs Northern Flicker Northern Goshawk Olive-sided Flycatcher Pileated Woodpecker Spruce Grouse Western Tanager Western Wood-Pewee White-throated Sparrow White-winged Crossbill Yellow-bellied Sapsucker	14
				2.3 Habitat and natural process restoration; 5.3 Private sector standards and codes; 7.2 Alliance and partnership development	Encourage **mixed wood management** that replants harvested forests with a mixture of deciduous and conifer tree species to restore natural forest composition and structure.	Current regeneration standards do not require cutover areas to be restored to their original composition. Research advances have been made by partnerships such as Alberta's **Mixed wood Management** Association, which is a partnership between eight forestry companies, the provincial government, and the University of Alberta.		46 47
7.1 Fire and Fire Suppression	Fire Suppression reduces the amount and limits the distribution of burned forest habitat.	1.3 Ensure the continuation of natural processes that maintain bird habitat	Re-establish natural fire return intervals in portions of the region to ensure an adequate supply of burned forest.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of mature and older deciduous and coniferous forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	American Three-toed Woodpecker Black-backed Woodpecker Brown Creeper Common Nighthawk Mountain Bluebird Northern Flicker Olive-sided Flycatcher	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				4.3 Awareness & Communications	Promote awareness of the ecological benefits and misconceptions regarding the role of fire in natural landscapes.	The current negative view of wildfire has created a societal bias that threatens the ability of land managers to restore the ecological role and value of fire in natural landscapes.		8
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The ability to restore natural ecosystem processes and function warrants careful consideration of land use values and the creation of balanced land use policy.		15
					Develop "free-to-burn" or prescribed fire protocols to promote and retain high-value burned forest within the natural fire-return interval, distributed both spatially and temporally, throughout the region.	Protocols and policies would need to be developed prior to the re-establishment of naturally occurring wildfire or **prescribed burning** within the natural fire return interval.		16
					Develop stricter policies and penalties for debris-burning and other human-induced forms of fire ignition in forested areas.	Many fires are ignited through the burning of debris or other careless acts which might be prevented through the development of stricter policies and penalties.		17
				8.0 Research and Monitoring	Continue to evaluate the ecological, financial, and social value of existing fire suppression policy through research and monitoring.	Given the limited effectiveness of existing fire suppression policy, the efficacy of this policy needs to be evaluated within an active **adaptive management** framework.		
7.3 Other Ecosystem Modifications	Control of outbreaks of forest insect pests (e.g., forest tent caterpillar, spruce budworm) greatly reduces an important food resource for specialist birds.	7.1 Improve population/demographic monitoring	Research predator-prey relationships between forest insect pests and their avian predators.	8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of forest insect pests has been linked to declining abundance of avian predators, but it is unclear whether insect abundance can be controlled by avian predators when below outbreak densities.	Bay-breasted Warbler Canada Warbler Cape May Warbler	21
				8.2 Monitoring	Support monitoring of both insect outbreaks and bird species at suitable spatial and temporal scales to improve knowledge of predator-prey population dynamics.			
7.3 Other Ecosystem Modifications	Control of beetle outbreaks (e.g., mountain pine beetle, spruce beetle) removes an	1.3 Ensure the continuation of natural processes that maintain bird habitat	Manage beetle outbreaks in a way that minimizes impact on Black-backed	2.1 Site/area management; 5.3 Private sector standards and codes; 2.2	Limit **salvage harvest** of mountain pine beetle-infested trees to maintain biodiversity values at regional and stand scales (e.g., retain structure and composition; retain live undamaged	Management strategies should be based on scientific knowledge about natural disturbances and recovery processes, ecological effects of **salvage harvesting**, and lessons from case studies around the world.	Black-backed Woodpecker	23 24 25 26 27

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	important food resource.		Woodpeckers.	Invasive/problematic species control; 2.3 Habitat and natural process restoration	and damaged trees, coarse woody debris, dead trees).	Management objectives must consider both economic and ecological values. The high conservation value of areas recently infected by forest insect outbreaks for cavity-nesting birds and other organisms warrants some retention of these forests. For Black-backed Woodpeckers in particular, snags and beetle-killed trees containing bark borers are a critical food resource, and are likely the limiting factor for this species. Elimination of nesting sites may also reduce woodpecker density; if woodpecker populations are maintained, localized insect outbreaks may attract them via a "birdfeeder effect" to take advantage of these short-term resource pulses and potentially control outbreaks.		
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation actions to reverse the decline.	8.1 Research	Increase research efforts studying reasons for decline in aerial insects, and ways to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Common Nighthawk Eastern Whip-poor-will Least Flycatcher Olive-sided Flycatcher Western Wood-Pewee	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Support increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
7.3 Other Ecosystem Modifications	Range-wide decline in amphibian prey may be contributing to decline of this	7.4 Improve understanding of causes of population declines	Increased research of implications of amphibian decline on predators.	8.1 Research	Understand the extent to which the Broad-winged Hawk specializes on amphibians and undertake to understand reason for the decline of amphibians.		Broad-winged Hawk	42

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	species.							
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus.	8.0 Research and Monitoring	Provide funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	American Kestrel Great Gray Owl	30
8.1 Invasive Non-native/Alien Species	European Starlings and House Sparrows exclude native species from nesting cavities.	3.1 Reduce competition with invasive species	Limit population size of invasive European Starlings and House Sparrows to ensure a sufficient supply of nest cavities for native birds.	8.1 Research	Identify key areas where nest cavities are limiting native birds due to cavities being occupied by European Starlings and House Sparrows. Add nest boxes to increase cavity availability for primary and secondary cavity nesters.	Exclusion of native birds from nest cavities is widespread, but population-level effects are largely unknown.	Mountain Bluebird Northern Flicker	31
				2.2 Invasive/problematic species control	Promote control of European Starlings and House Sparrows in key areas to increase the availability of nesting cavities for native birds.			
8.1 Invasive Non-native/Alien Species	Non-native earthworms may be impacting the Eastern Whip-poor-will by altering their forest floor habitat.	7.4 Improve understanding of causes of population declines	Understand effect to which non-native earthworms affect birds such as the Eastern Whip-poor-will and increase awareness in the spread of invasive earthworms.	8.1 Research	Undertake research to understand the interactions between non-native earthworms and forest birds. Research the mechanisms of earthworm transmission and dispersal.		Eastern Whip-poor-will	
				4.3 Awareness and communications	Increase awareness on the spread of non-native earthworms; discourage dumping of bait worms on land or water (should be put in garbage), clean vehicle tires before moving between forest sites, freeze compost, etc.	Impacts that non-native earthworms may have on other species are not well understood. Measures to understand these impacts and reduce the dispersal of non-native earthworms should be undertaken.		44
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Black-throated Green Warbler Brown Creeper Canada Warbler Mourning Warbler	32 33 34

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
8.2 Problematic Native Species	Increased nest predation by generalist predators may limit populations.	2.5 Reduce parasitism/predation	Improve nesting/fledgling success by limiting nest predation by generalist predators.	8.1 Research	Determine causes of increased nest predation and/or abundance of generalist nest predators (e.g., human development, edge effects, linear features, increased rodent density due to agriculture).	Landscape impacts on nest predation rates may be complex and operate at multiple spatial scales, and are therefore difficult to measure and quantify.	Black-throated Green Warbler Canada Warbler Mourning Warbler	34
8.2 Problematic Native Species	Defoliation by overabundant white-tailed deer reduces habitat quality.	3.2 Reduce competition with problematic native species	Reduce white-tailed deer density.	2.2 Invasive/problematic species control	Increase harvest quotas for white-tailed deer and/or implement culling programs.		Canada Warbler Least Flycatcher Mourning Warbler	
				8.1 Research	Examine underlying causes leading to increased white-tailed deer density, such as logging/forest **subdivision**, agriculture, and climate change.			
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory/policy options to 1) evaluate risk of species and 2) reduce high risk emissions.	Stricter emission policies and upgrading to new technologies will reduce/eliminates harmful emissions.	American Kestrel Northern Goshawk	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	American Kestrel Bohemian Waxwing Common Yellowthroat Lesser Yellowlegs Merlin	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food			

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
9.3 Agricultural and Forestry Effluents	Pesticides used to control forest pests may have direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Decrease chemical pesticide use to limit potential toxic effects and maintain insect prey populations.	6.2 Substitution	Replace chemical insecticides with microbial agents (e.g., *Bacillus thuringiensis*, or *Bt*) or lepidopteran-specific insecticides (e.g., tebufenozide, also known as MIMIC) that have low toxicity to vertebrates.	Tennessee Warblers were not significantly affected by application of the lepidopteran-specific pesticides *Bt* or MIMIC.	American Three-toed Woodpecker Bay-breasted Warbler Blackburnian Warbler Black-throated Cape May Warbler White-throated Sparrow	37
				8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of spruce budworm has been linked to declining abundance of avian predators, but it is unclear whether spruce budworm abundance can be controlled by avian predators when below outbreak densities.		22
					Continue researching the non-target effects of pesticides on non-target species.			
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is restricted.	White-throated Sparrow	38 39
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38

Table 10 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
9.5 Air-borne pollutants	Acid precipitation degrades habitat quality.	1.5 Reduce habitat degradation from contaminants	Reduce emissions of air-borne pollutants.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Blackpoll Warbler Rusty Blackbird	
				5.3 Private sector standards and codes	Encourage industries to employ spatial and climatic modeling in order to minimize emissions during times or at locations when pollution would be most damaging.	For example, emissions from a coal-fired power plant could be minimized when wind patterns would carry pollution to more sensitive areas, either by delaying activity or reallocating energy production to other facilities. Altering the spatial and temporal distribution of emissions could have economic benefits for polluters (i.e., if the tax on emissions is lower in/at less-damaging locations/times). This is an improvement on a cap-and-trade system, which may be capable of lowering total emissions, but is unable to minimize the damage caused for a given level of emissions.		40
9.6 Excess Energy	Lower density observed in areas affected by noise from compressor stations on pipelines.	4.2 Reduce disturbance from industrial or work activity	Reduce noise levels at industrial sites.	5.3 Private sector standards and codes	Beneficial management practices for construction of new compressor stations should include noise suppression technology, and existing stations should be retrofitted with noise-suppressing technology.	Retrofitting existing compressor stations to reduce the decibel level mitigates noise impacts on forest songbirds.	White-throated Sparrow	41

Note: Only threats ranked as medium magnitude or higher in mixed wood habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for mixed wood habitat (Table 9) but not listed in the associated threats table (Table 10 above). These priority species either have no known threats in mixed wood habitat or have known threats in mixed wood habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Connecticut Warbler, for example, is associated with mixed wood habitat but does not appear in Table 10 because identified threats for Connecticut Warblers in this habitat were ranked as low (e.g., 1.2 Commercial and industrial areas). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Shrub/Early Successional

The shrub and early successional habitat class covers areas in BCR 6 where vegetation is shrubby due to successional stage, disturbance status and site condition (e.g., shrub-dominated areas adjacent to streams, rivers and lakes or in poor soils/poor climates; Fig. 19). This category can include shrub habitats that differ in density—thickets (≥ 65% crown closure), shrubland (65%–15% crown closure), sparse (15%–4% crown closure), and scattered (4%–1% crown closure); and height--high (5 m–3 m), medium high (3 m–0.5 m) and dwarf (<0.5 m). Fifty-two priority species in BCR 6 are associated with this habitat class (Table 11).

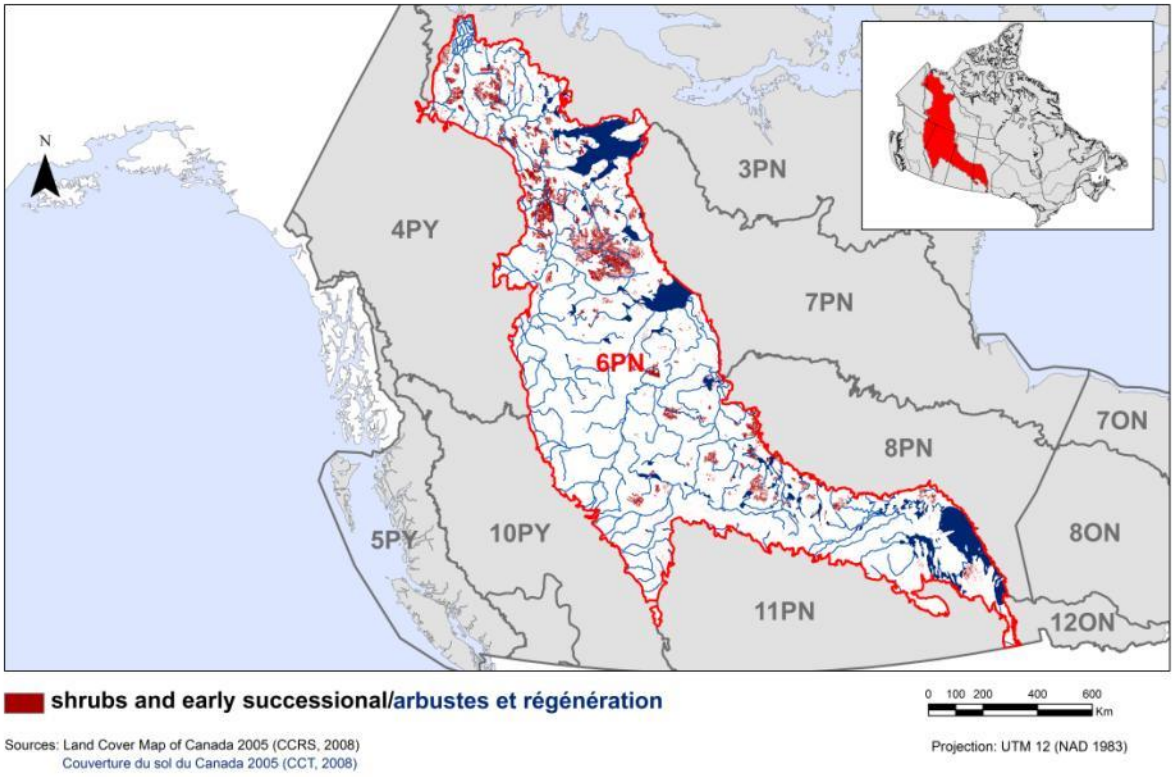


Figure 19. Map of shrubs and early successional habitat in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

Shrub/early successional habitat is the result of natural disturbance events and non-natural disturbances like forest harvesting and oil and gas exploration and development. The main human impacts to priority species in shrub/early successional habitat are the removal of shrub/early successional stages for crops (threat sub-category 2.1) or rangeland (sub-category 2.3) and wildfire suppression (sub-category 7.1; Fig 20). Although wood harvesting practices may lead to creation of new shrub/early successional habitats, harvesting can also decrease or modify early successional habitats through silvicultural practices that intensify regeneration and alter natural community composition (sub-category 5.3). Wildfire suppression limits the creation of new disturbance-associated early seral habitats, but new patches created by forest

harvesting provide suitable habitat for some species. Key to maintaining species that use or require this habitat is the reintroduction/maintenance of natural fire and other **natural disturbance regimes** and the use of forest harvest practices that mimic the full range of natural disturbance events (Table 12).

Table 11. Priority species that use shrub/early successional habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Alder Flycatcher	Early-successional, second-growth deciduous (11–30 years post-fire/harvest)		Increase 50%		Y		Y		
American Golden-Plover	Sparse, low vegetation		Increase 100%		Y	Y		Y	
American Kestrel	Recently disturbed (0–10 years post-fire and post-harvest); early-successional	Nest trees/perches	Assess/Maintain					Y	
American Three-toed Woodpecker	Burned -over areas	Snags	Assess/Maintain					Y	
American Wigeon	Upland brush and grass		Increase 50%		Y	Y			
Black-backed Woodpecker	Burned-over areas	Snags	Assess/Maintain		Y			Y	
Black-billed Cuckoo	Dense brushy thickets		Increase 100%			Y			
Black-billed Magpie	Shrub-steppe; **riparian**		Assess/Maintain				Y		
Blackpoll Warbler	Young/early successional post-fire/harvest		Assess/Maintain					Y	
Bohemian Waxwing	Young/early successional post-fire/harvest	Ripening fruit; proximity to water	Assess/Maintain		Y		Y		
Cape May Warbler	Taiga coniferous forest	Tall spruce for perches; mossy understory; spruce budworm specialist	Assess/Maintain		Y			Y	
Clay-colored Sparrow	Recently disturbed and second-growth		Increase 50%				Y		
Common Nighthawk	All types	Open Areas	Recovery Objective	Y	Y			Y	
Common Yellowthroat	**Riparian** dense shrubs/thickets	Near water	Increase 100%					Y	
Eastern Phoebe	Recently disturbed (0–10 years post-fire)	Overhang for nest site (natural or human-made structure)	Increase 100%					Y	

Table 11 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Gadwall	Shrubs	Interstitial grass	Assess/Maintain			Y			
Golden-winged Warbler	Early-successional; post-disturbance (4–15 years); regenerating aspen; Bur oak open savannah		Recovery Objective	Y	Y			Y	
Greater Yellowlegs	Willow	Lichen/moss/sedge understory	Assess/Maintain		Y	Y		Y	
Green-winged Teal	Dense shrubs; brush thickets		Maintain Current			Y		Y	
Harris's Sparrow	Northern boreal-tundra		Assess/Maintain		Y			Y	
Hudsonian Godwit	All types near water		Assess/Maintain		Y	Y		Y	
Le Conte's Sparrow	Recently disturbed (0–10 years post-harvest)		Assess/Maintain				Y	Y	
Least Flycatcher	Recently disturbed forest (0–10 years post-harvest/fire)		Increase 50%				Y	Y	
Lesser Snow Goose (Western Arctic)	Low shrubs	Near water	Decrease			Y			
Loggerhead Shrike	Shrubs or small trees; thorny buffaloberry, willow and caragana	Natural or human-made perches and impaling stations; Interstitial grass	Recovery Objective	Y				Y	
Long-tailed Duck	Dwarf shrubs	Wetlands, freshwater islands	Increase 100%			Y		Y	
Mallard	All types near water		Maintain Current			Y			
Mourning Warbler	Recently disturbed (0–10 years post-harvest/fire)		Increase 100%		Y				Y
Northern Flicker	Recently disturbed and young deciduous (0–10 years post-harvest/fire)	Dead or dying trees; snags	Increase 50%				Y		
Northern Goshawk	Shrub-steppe; clearcuts	Open understory	Assess/Maintain				Y	Y	
Northern Harrier	**Riparian** woodland; dense shrubs		Increase 100%			Y		Y	

Table 11 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Northern Hawk Owl	Recently burned forests (0–10 years post-fire)	Natural and secondary cavities; snags	Assess/Maintain					Y	
Northern Pintail	All types near water		Increase 50%		Y	Y		Y	
Northern Shoveler	All types near water		Maintain Current			Y			
Northern Shrike	Taiga and taiga-tundra zone; trees >1m tall		Assess/Maintain		Y			Y	
Olive-sided Flycatcher	Recently disturbed forest (0–10 years post-harvest/fire)	Tall trees/snags ; natural or human-made forest openings (bogs, harvest, fire, water)	Recovery Objective	Y	Y			Y	
Purple Martin	Burned over forest/logged areas	Snags	Assess/Maintain					Y	
Rusty Blackbird	Recently disturbed (0v10 years post-fire; willow/alder		Increase 100%	Y	Y			Y	
Semipalmated Sandpiper	Sparse shrubs		Increase 100%		Y	Y		Y	Y
Sharp-tailed Grouse	Shrub-steppe; early-successional	Recent burns for lek sites; interstitial grass	Assess/Maintain		Y			Y	
Short-billed Dowitcher	All types near water		Increase 100%		Y	Y		Y	
Short-eared Owl	Mature to old-growth	Open areas	Increase 100%	Y	Y			Y	
Smith's Longspur	Transitional zone between tundra and tree line		Increase 100%		Y			Y	Y
Solitary Sandpiper	Recently disturbed (0–10 years post-harvest		Increase 50%		Y	Y			
Surf Scoter	All types near water		Increase 50%			Y		Y	
Upland Sandpiper	All types near water		Increase 100%			Y		Y	
Western Tanager	Recently disturbed, second-growth forest (0–10 years post-harvest/fire)		Assess/Maintain					Y	
Western Wood-Pewee	Recently disturbed forest (0–10 years post-fire); **riparian**		Increase 50%					Y	
White-throated Sparrow	All types		Increase 50%		Y			Y	

Table 11 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
White-winged Scoter	Low shrubs and herbaceous vegetation	Islands	Increase 50%			Y		Y	
Wilson's Snipe	All types near water		Increase 100%			Y			
Yellow-bellied Sapsucker	Recently disturbed (0-10 years post-fire/harvest)	Large live, residual trees	Assess/Maintain		Y		Y		

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion. The age classes for forest-associated habitats are defined as follows. Herb: 0–10 years; Shrub/Herb: 11–20 years; Pole/Sapling: 21–40 years; Young Forest: 41–60 years (deciduous, mixed wood) or 41–80 years (conifer); Mature Forest: 61–80 years (deciduous, mixed wood) or 81–100 years (conifer); Old-Growth Forest: greater than 80 years (deciduous, mixed wood) or greater than 100 years (conifer).

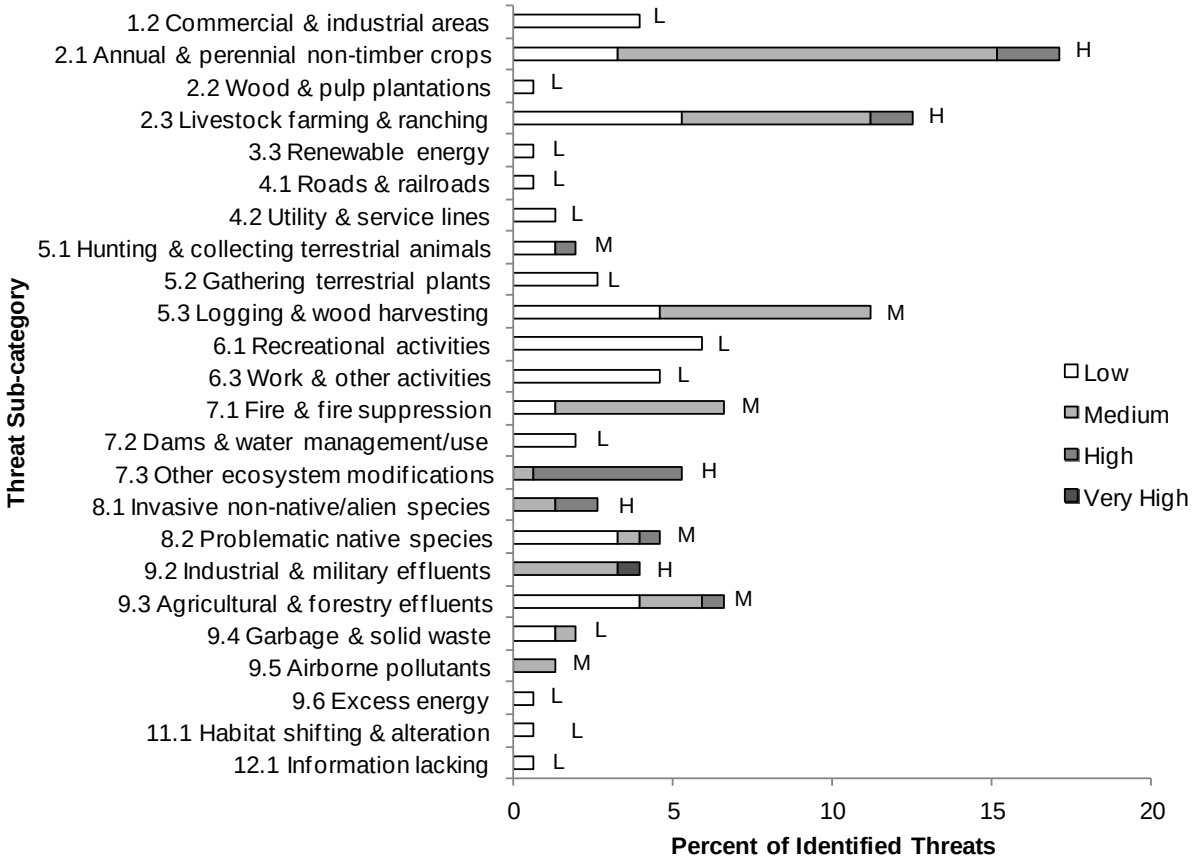


Figure 20. Percent of identified threats to priority species in shrub/early successional habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in shrub/early successional habitat (for example, if 100 threats were identified in total for all priority species in shrub/early successional habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in shrub/early successional habitat is shown at the end of each bar (also presented in Table 4).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 12. Threats addressed, conservation objectives, recommended actions and priority species affected for shrub/early successional habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber Crops	Removal of shrubs or other early successional vegetation results in direct habitat loss and the indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan agriculture to maintain shrub and early successional throughout the region. Represent the size, shape, and spatial and temporal arrangement of early successional forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to maintain the supply, distribution and proportional species representation within the **natural range of variation**.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent the size, shape, and spatial distribution of all naturally occurring habitat types, including grassland and shrubland habitats.	American Kestrel American Wigeon Clay-colored Sparrow Common Yellowthroat Eastern Phoebe Gadwall Golden-winged Warbler Greater Yellowlegs Green-winged Teal Hudsonian Godwit Le Conte's Sparrow Loggerhead Shrike Mallard Northern Harrier Northern Pintail Northern Shoveler Northern Shrike Rusty Blackbird Sharp-tailed Grouse Short-billed Dowitcher Short-eared Owl Solitary Sandpiper Upland Sandpiper Western Wood-Pewee White-throated Sparrow White-winged Scoter	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14 8

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.2 Wood and Pulp Plantations	Failure to maintain natural grassland and shrubland habitats limits habitat for this species.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan wood plantations to maintain native grassland and early successional habitats throughout the region. Represent the size, shape, and spatial and temporal arrangement of early successional forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of young seral stages, natural grassland, and shrubland habitat and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent the size, shape, and spatial distribution of all naturally occurring habitat types, including grassland and shrubland habitats.	Sharp-tailed Grouse	13
2.3 Livestock Farming and Ranching	Removal of shrubs or other early successional vegetation results in direct habitat loss and the indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan livestock grazing to maintain shrub and early successional throughout the region. Represent the size, shape, and spatial and temporal arrangement of early successional forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to maintain the supply, distribution and proportional species representation within the **natural range of variation**.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent the size, shape, and spatial distribution of all naturally occurring habitat types, including grassland and shrubland habitats.	American Wigeon Clay-colored Sparrow Eastern Phoebe Gadwall Golden-winged Warbler Green-winged Teal	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.	Le Conte's Sparrow Loggerhead Shrike Mallard Northern Harrier Northern Pintail Northern Shoveler Northern Shrike Rusty Blackbird Sharp-tailed Grouse Short-eared Owl Solitary Sandpiper Western Wood-Pewee White-winged Scoter	14 8
				5.3 Private sector standards and codes	Regulate stocking rates of animals (<25% available forage) in regenerating cutblocks to minimize impacts to timber objectives.	Regulation of stocking rates is essential for the integration of sustained timber yield and grazing.		48
5.1 Hunting and Collecting	Sustainable landbird hunting within legal	7.2 Improve harvest monitoring	Maintain sustainable	3.1 Species management	Set conservative harvest rates for legally hunted species using best available	Careful management of hunted populations is important to ensure hunting is not affecting	Black-billed Magpie Sharp-tailed Grouse	9

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
Terrestrial Animals	limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.		populations of legally hunted species.		information.	sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by surveys.		
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.			9 10
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area protection	Conserve and manage habitat of hunted species. Maintain a system of habitat reserves on crown lands to ensure protection of shrub and early successional habitats.	Ensuring that there is structurally diverse habitat for the hunted species (size, shape, spatial arrangement of all habitat types) will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	Illegal hunting and collecting of raptors.	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American Kestrel	
5.1 Hunting and Collecting Terrestrial Animals	Sustainable shorebird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted shorebirds.	3.1 Species management	Set conservative limits on legally hunted species using best available science.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species population numbers and trends as well as aspects of a species life history. Number of individuals taken should be verified by survey.	Wilson's Snipe	9 10 110
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			
				1.1 Site/area protection	Conserve and manage species habitat in areas where hunting occurs.	Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.2 Gathering Terrestrial Plants	Peat mining results in habitat loss and degradation.	1.2 Maintain the size, shape and configuration of	Maintain young **peatlands** throughout the	1.1 Site/area protection	Protect large complexes of bogs and fens including lakes and ponds contained within them across their **natural range of variation**,	Conservation of large intact **peatlands** will ensure that there is habitat available for **peatland** nesting bird species.	Greater Yellowlegs Hudsonian Godwit Short-billed	13

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
		habitat within the **natural range of variation**	region by representing the size, shape, and spatial and temporal arrangement of early successional forest types and stand age classes at a regional scale.		through **fee simple** purchase, **conservation easements**, or creation of parks/protected areas.		Dowitcher Solitary Sandpiper	
				2.1 Site/Area Management	Management should favour leaving large intact areas of **peatland** containing a mosaic of ponds and lakes representing the size, shape and spatial arrangement of these waterbody **ecosites** at a regional scale.	Zoning areas (to designate mine and no-mine areas) will decrease edge effects and will increase habitat value to birds and other wildlife.		11
				8.1 Research	Continued research of more sustainable mining techniques as well as restoration techniques for **peatlands** that have been previously mined.	There are relatively few published studies on effects of peat mining on wildlife in western Canada, including ways to mitigate negative impacts. Increased research effort will allow for better practices in the industry.		12
				4.3 Awareness and communications	Promote awareness of detrimental and irreparable effects of peat mining on environment.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives may assist in the conservation of this resource.		
				6.2 Substitution	Promote use of alternatives to peat moss in gardening such as compost and mulch.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives may assist in the conservation of this resource.		
5.3 Logging and Wood Harvesting	Removal of early successional forest results in direct habitat loss and indirect effects of habitat **subdivision** and isolation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan forestry to maintain the size, shape, and spatial and temporal arrangement of early successional forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of early seral deciduous and conifer forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent the size, shape, and spatial distribution of all naturally occurring habitat types, including early seral forest habitats.	American Three-toed Woodpecker Black-backed Woodpecker Blackpoll Warbler Cape May Warbler Greater Yellowlegs	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.	Least Flycatcher Northern Flicker Northern Goshawk Olive-sided Flycatcher	14 8

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The potential expansion in various resource extraction activities warrants careful consideration of land use values and the creation of balanced land use policy. British Columbia's Land and Resource Management Plans (LRMP) are cooperatively developed sub-regional land use plans. An LRMP provides strategic level direction and priorities for using and managing Crown land resources and identifies ways to achieve community economic, environmental, and social objectives.	Purple Martin Short-billed Dowitcher Solitary Sandpiper Upland Sandpiper Western Tanager Western Wood-Pewee White-throated Sparrow Yellow-bellied Sapsucker	
				5.3 Private sector standards and codes	Promote **"free-to-grow"** standards in regenerating cutblocks, with less reliance on intensive silviculture practices, which can detrimentally impact the composition and structure of early-successional forest.	To maintain and maximize native biodiversity, less intensive silvicultural practices should be adopted in certain portions of the region.		49
7.1 Fire and Fire Suppression	Fire Suppression reduces the amount and limits the distribution of burned forest habitat.	1.3 Ensure the continuation of natural processes that maintain bird habitat	Re-establish natural fire return intervals in portions of the region to ensure an adequate supply of burned forest.	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of early seral deciduous and conifer forest and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent the size, shape, and spatial distribution of all naturally occurring habitat types, including early seral forest habitats.	American Three-toed Woodpecker Black-backed Woodpecker Clay-colored Sparrow Common Nighthawk Le Conte's Sparrow Northern Flicker Northern Hawk Owl Olive-sided Flycatcher Purple Martin Sharp-tailed Grouse	13
				1.2 Resource and habitat protection	Maintain a system of dynamic "floating" reserves in areas allocated under forest land tenure agreements.	The dynamic and ephemeral nature of habitats within this region, which is still influenced by various forms of natural disturbance, might require the creation of spatially and temporally variable protected areas.		14
				4.3 Awareness & Communications	Promote awareness of the ecological benefits and misconceptions regarding the role of fire in natural landscapes.	The current negative view of wildfire has created a societal bias that threatens the ability of land managers to restore the ecological role and value of fire in natural landscapes.		8
				5.2 Policies and Regulations	Develop land use/management policy that balances economic development with biodiversity conservation and other values.	The ability to restore natural ecosystem processes and function warrants careful consideration of land use values and the creation of balanced land use policy.		15
					Develop "free-to-burn" or prescribed fire protocols to promote and retain high-value burned forest within the natural fire-return interval, distributed both spatially and temporally, throughout the region.	Protocols and policies would need to be developed prior to the re-establishment of naturally occurring wildfire or **prescribed burning** within the natural fire return interval.		16

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					Develop stricter policies and penalties for debris-burning and other human-induced forms of fire ignition in forested areas.	Many fires are ignited through the burning of debris or other careless acts which might be prevented through the development of stricter policies and penalties.		17
				8.0 Research and Monitoring	Continue to evaluate the ecological, financial, and social value of existing fire suppression policy through research and monitoring.	Given the limited effectiveness of existing fire suppression policy, the efficacy of this policy needs to be evaluated within an active **adaptive management** framework.		
7.2 Dams and Water Management/Use	Changes in flow regimes may reduce water availability, strand or flood nests, or reduce natural variability in water levels	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	Greater Yellowlegs Hudsonian Godwit Short-billed Dowitcher	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted		19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated			

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
7.3 Other Ecosystem Modifications	Control of outbreaks of forest insect pests (e.g., forest tent caterpillar, spruce budworm) greatly reduces an important food resource for specialist birds.	7.1 Improve population/demographic monitoring	Research predator-prey relationships between forest insect pests and their avian predators.	8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of forest insect pests has been linked to declining abundance of avian predators, but it is unclear whether insect abundance can be controlled by avian predators when below outbreak densities.	Cape May Warbler	21
				8.2 Monitoring	Support monitoring of both insect outbreaks and bird species at suitable spatial and temporal scales to improve knowledge of predator-prey population dynamics.			
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	8.1 Research	Increase research efforts studying reasons for decline in aerial insects, and ways to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Alder Flycatcher Common Nighthawk Eastern Phoebe Least Flycatcher Olive-sided Flycatcher Purple Martin Western Wood-Pewee	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus.	8.0 Research and Monitoring	Provide funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	American Kestrel Short-eared Owl	30
8.1 Invasive Non-native/Alien Species	European Starlings and House Sparrows exclude native species from nesting cavities.	3.1 Reduce competition with invasive species	Limit population size of invasive European Starlings and House Sparrows to ensure	8.1 Research	Identify key areas where nest cavities are limiting native birds due to cavities being occupied by European Starlings and House Sparrows. Add nest boxes to increase cavity availability for primary and secondary cavity	Exclusion of native birds from nest cavities is widespread, but population-level effects are largely unknown.	Northern Flicker Purple Martin	31

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
			a sufficient supply of nest cavities for native birds.		nesters.			
				2.2 Invasive/ problematic species control	Promote control of European Starlings and House Sparrows in key areas to increase the availability of nesting cavities for native birds.			
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/ problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Eastern Phoebe Golden-winged Warbler Le Conte's Sparrow Mourning Warbler	32 33 34
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
8.2 Problematic Native Species	Increased nest predation by generalist predators may limit populations.	2.5 Reduce parasitism/predation	Improve nesting/fledgling success by limiting nest predation by generalist predators.	8.1 Research	Determine causes of increased nest predation and/or abundance of generalist nest predators (e.g., human development, edge effects, linear features, increased rodent density due to agriculture).	Landscape impacts on nest predation rates may be complex and operate at multiple spatial scales, and are therefore difficult to measure and quantify.	Mourning Warbler	34
8.2 Problematic Native Species	Defoliation by overabundant white-tailed deer reduces habitat quality.	3.2 Reduce competition with problematic native species	Reduce white-tailed deer density.	2.2 Invasive/ problematic species control	Increase harvest quotas for white-tailed deer and/or implement culling programs.		Least Flycatcher Mourning Warbler	
				8.1 Research	Examine underlying causes leading to increased white-tailed deer density, such as logging/forest **subdivision**, agriculture, and climate change.			

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	American Kestrel Mallard Northern Goshawk Northern Shoveler Surf Scoter White-winged Scoter	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	American Kestrel American Wigeon Black-billed Cuckoo Bohemian Waxwing Common Yellowthroat Loggerhead Shrike Northern Harrier	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
9.3 Agricultural and Forestry Effluents	Pesticides used to control forest pests may have direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Decrease chemical pesticide use to limit potential toxic effects and maintain insect prey populations.	6.2 Substitution	Replace chemical insecticides with microbial agents (e.g., *Bacillus thuringiensis*, or *Bt*) or lepidopteran-specific insecticides (e.g., tebufenozide, also known as MIMIC) that have low toxicity to vertebrates.	Tennessee Warblers were not significantly affected by application of the lepidopteran-specific pesticides *Bt* or MIMIC.	American Three-toed Woodpecker Cape May Warbler White-throated Sparrow	37
				8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of spruce budworm has been linked to declining abundance of avian predators, but it is unclear whether spruce budworm abundance can be controlled by avian predators when below outbreak densities.		22
					Continue researching the non-target effects of pesticides on non-target species.			
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is	Lesser Snow Goose (Western Arctic) Long-tailed Duck White-throated Sparrow	38 39

Table 12 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						restricted.		
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38
9.5 Air-borne pollutants	Acid precipitation degrades habitat quality.	1.5 Reduce habitat degradation from contaminants	Reduce emissions of air-borne pollutants.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
				5.3 Private sector standards and codes	Encourage industries to employ spatial and climatic modeling in order to minimize emissions during times or at locations when pollution would be most damaging.	For example, emissions from a coal-fired power plant could be minimized when wind patterns would carry pollution to more sensitive areas, either by delaying activity or reallocating energy production to other facilities. Altering the spatial and temporal distribution of emissions could have economic benefits for polluters (i.e., if the tax on emissions is lower in/at less-damaging locations/times). This is an improvement on a cap-and-trade system, which may be capable of lowering total emissions, but is unable to minimize the damage caused for a given level of emissions.	Blackpoll Warbler Rusty Blackbird	40
9.6 Excess Energy	Lower density observed in areas affected by noise from compressor stations on pipelines.	4.2 Reduce disturbance from industrial or work activity	Reduce noise levels at industrial sites.	5.3 Private sector standards and codes	Beneficial management practices for construction of new compressor stations should include noise suppression technology, and existing stations should be retrofitted with noise-suppressing technology.	Retrofitting existing compressor stations to reduce the decibel level mitigates noise impacts on forest songbirds.	White-throated Sparrow	41

Note: Only threats ranked as medium magnitude or higher in shrub/early successional habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for shrub/early successional habitat (Table 11) but not listed in the associated threats table (Table 12 above). These priority species either have no known threats in shrub/early successional habitat or have known threats in shrub/early successional habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Harris's Sparrow, for example, is associated with shrub/early successional habitat but does not appear in Table 12 because identified threats for Harris's Sparrows in this habitat were ranked as low (e.g., 4.2 Utility and service lines). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Herbaceous

The herbaceous habitat class includes native grassland, herb-dominated meadows and unimproved pasture (natural grassland areas used for grazing that may contain both native and invasive non-native species). In BCR 6, naturally occurring grasslands have historically been found within the transition zone between the boreal forest and the prairies, as well as in the Peace River lowlands. Large areas of "improved" pasture (natural grasslands that have been partially or completely planted with non-native species) now exist in place of many of these native grasslands, both in the southern part of the BCR and the Peace River region (Fig. 21). Note that the map representing herbaceous habitat classes includes some wetland habitat classes (herb-dominated fens and bogs, marshes) as indicated by the extensive herbaceous coverage. The herbaceous habitat class map was produced using Land Cover of Canada 2005 (CCRS, 2008), while the wetland habitat class map was produced using Land Cover circa 2000 (CTI, 2009). Differences in the habitat class categories of these two satellite-derived habitat layers have resulted in substantial spatial overlap between the herbaceous and wetland habitat classes.

Grassland birds are exhibiting continent-wide declines, and are declining more than any other habitat-affiliated bird group. Of the 21 priority species that use herbaceous habitats in BCR 6, 4 that exclusively use native grassland habitat are federally protected under SARA (Table 13).

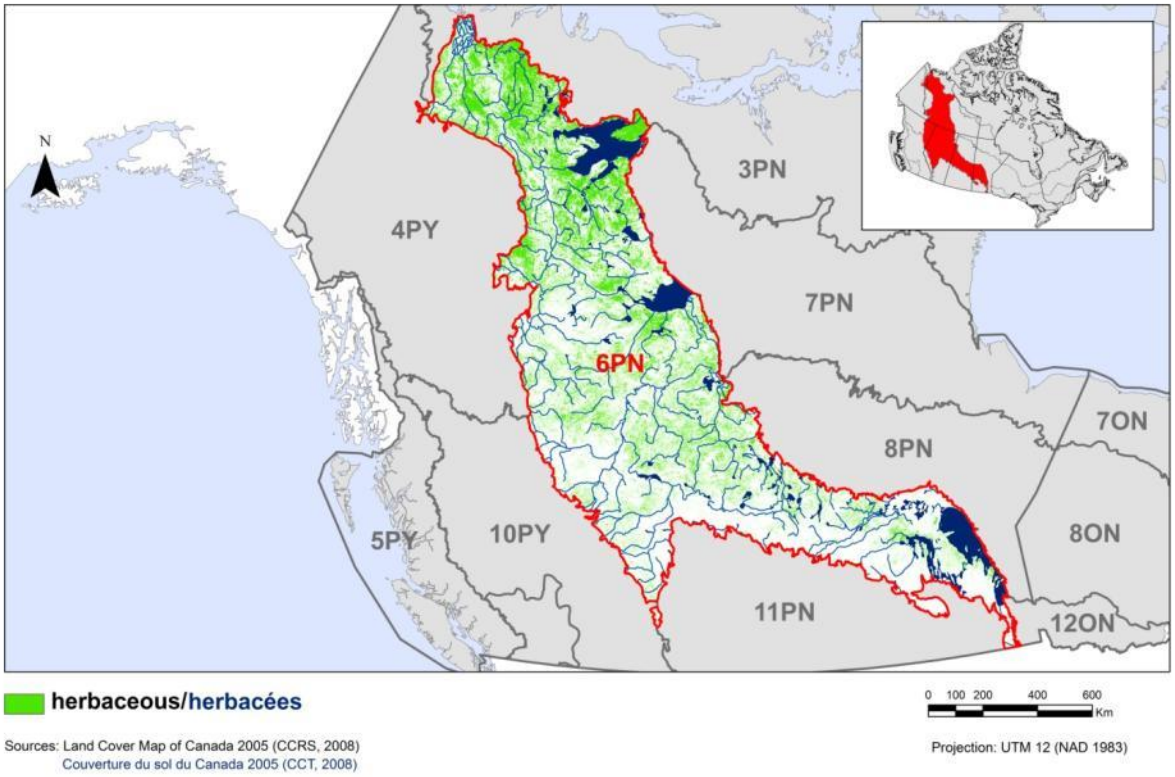


Figure 21. Map of herbaceous habitat in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

While grasslands form only a small portion of the BCR, they are under intense pressure, with almost no native grassland remaining; most of the native grassland in BCR 6 has been modified for agricultural purposes (threat sub-categories 2.1 and 2.3, Fig. 22). Most of the conversion of native grasslands occurred in the past, but pressures continue in the present. Loss of native grassland to agricultural expansion or intensification, grazing practices that degrade grassland habitats and facilitate invasive plants, and agricultural practices such as pesticide spraying and hayfield mowing during the breeding season are the largest ongoing threats to birds that use herbaceous habitats. In areas of naturally occurring grasslands, forest encroachment due to fire suppression is also a significant contributor to habitat loss (threat sub-category 7.1). Key actions to conserve grassland birds include: protection of remaining native grasslands, management of grazing to avoid habitat degradation and maintain habitat suitability for priority species, encouraging the use of beneficial management practices for biodiversity and bird conservation in agriculture, and reintroduction of natural fire regimes (Table 14).

Table 13. Priority species that use herbaceous habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American Bittern	Native grassland	Adjacent to wetlands; emergent vegetation	Increase 50%		Y	Y		Y	
American Golden-Plover	Subarctic/montane tundra		Increase 100%		Y	Y		Y	
Barn Swallow	Grassland	Overhang for nest site (human-made structure); water for mud to build nest	Increase 50%	Y				Y	
Black-billed Magpie	Grassland		Assess/Maintain				Y		
Blue-winged Teal	Grassland		Maintain Current		Y	Y			
Bobolink	Grassland	Large forbs for nest cover	Increase 50%	Y	Y			Y	
Gadwall	Native grassland		Assess/Maintain			Y			
Green-winged Teal	Grassland		Maintain Current			Y		Y	
Herring Gull	Grassland	Low vegetation; bush, log, rock or other large object for nest cover	Increase 50%		Y	Y			
Killdeer	Native grassland/pasture		Increase 50%		Y	Y			
Le Conte's Sparrow	Native grassland		Assess/Maintain				Y	Y	
Loggerhead Shrike	Native grassland	Natural or human-made perches and impaling stations	Recovery Objective	Y				Y	
Marbled Godwit	Native grassland	Prefer native grass to tame	Increase 50%		Y	Y			
Mountain Bluebird	Grassland/rangeland	Low, open areas for foraging; scattered woodlands with snags; cavities for nesting	Assess/Maintain					Y	
Northern Harrier	Native grassland		Increase 100%			Y		Y	
Northern Shoveler	Grassland/rangeland		Maintain Current			Y			
Semipalmated Sandpiper	Native grassland		Increase 100%		Y	Y		Y	Y
Sharp-tailed Grouse	Grassland/rangeland		Assess/Maintain		Y			Y	

Table 13 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Short-eared Owl	Native grassland	Open areas for foraging; prey availability	Increase 100%	Y	Y			Y	
Sprague's Pipit	Native grassland	Native grassland patches >150 ha	Recovery Objective	Y	Y	Y		Y	
Wilson's Phalarope	Native grassland	Near wetlands (<100 m)	Increase 100%		Y	Y			

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

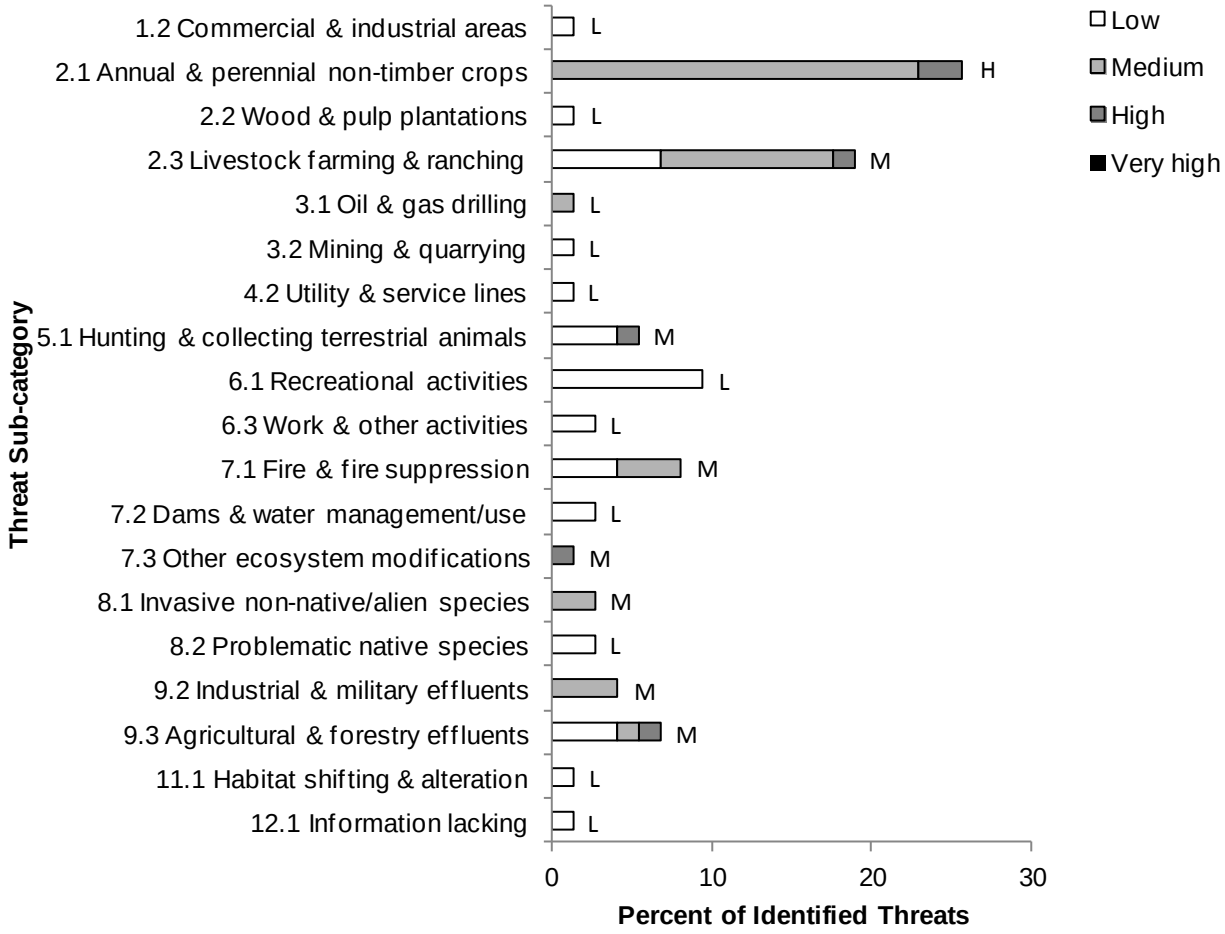


Figure 22. Percent of identified threats to priority species in herbaceous habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in herbaceous habitat (for example, if 100 threats were identified in total for all priority species in herbaceous habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in herbaceous habitat is shown at the end of each bar (also presented in Table 4).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 14. Threats addressed, conservation objectives, recommended actions and priority species affected for herbaceous habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber Crops	Insufficient amount and connectivity of intact natural habitat suitable for bird population recovery.	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Retain functional blocks of intact natural grassland habitat.	1.1 Site/area protection and 1.2 Resource and habitat protection	Support the spatially targeted securement of privately owned high value conservation lands through the use of **conservation easement** agreements and **fee simple** purchase by eligible land trusts or governments.	Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. The Conservation Reserve Program in the United states is a useful model for a large-scale land retirement program.	American Bittern Blue-winged Teal Bobolink Gadwall Green-winged Teal Killdeer Le Conte's Sparrow Loggerhead Shrike Marbled Godwit Northern Harrier Northern Shoveler Sharp-tailed Grouse Short-eared Owl Sprague's Pipit Wilson's Phalarope	60 61 62 63 64 65 66 67 68 69 70 71
				4.1 Formal education and 4.2 Training	Promote training in **precision agriculture** technology (GPS, remote sensing, yield mapping, profitability mapping) to identify areas in cultivated fields with negative profitability that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		72 73 109
2.1 Annual and Perennial Non-Timber Crops	Mowing can lead to nest destruction.	2.9 Reduce nest destruction	Reduce nest destruction caused by mowing.	5.3 Private sector standards and codes	Defer mowing until after nesting and brood rearing.	Late-season mowing following the breeding season prevents nest destruction, and may provide valuable habitat for some species in subsequent years (e.g., Bobolink).	Bobolink Northern Harrier Short-eared Owl	50 51
2.2 Wood and Pulp Plantations	Failure to maintain natural grassland and shrubland habitats limits habitat for this species.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan wood plantations to maintain native grassland and early successional habitats throughout the region. Represent the size, shape, and spatial and temporal arrangement of native grassland and shrubland classes at	1.1 Site/Area Protection	Maintain a system of habitat reserves on crown lands to ensure protection of young seral stages and to function as ecological benchmark areas.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent the size, shape, and spatial arrangement of all habitat types including grassland habitats.	Sharp-tailed Grouse	13

Table 14 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
			a regional scale.					
2.3 Livestock Farming and Ranching	Livestock overgrazing reduces structural heterogeneity of vegetation; complex heterogeneous structure is required for successful reproduction.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	Blue-winged Teal Bobolink Gadwall Green-winged Teal Le Conte's Sparrow Loggerhead Shrike Northern Harrier Northern Shoveler Sharp-tailed Grouse Short-eared Owl Sprague's Pipit	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		53 55 56 57
2.3 Livestock Farming and Ranching	Trampling by livestock may reduce nest success.	2.4 Reduce incidental mortality	Reduce mortality caused by livestock trampling.	5.3 Private sector standards and codes	Defer grazing until after the breeding season.	Trampling by livestock may be a significant source of mortality in some grassland-nesting birds, and avoiding grazing during the breeding period would benefit several species.	Northern Harrier Sprague's Pipit	58
5.1 Hunting and Collecting Terrestrial Animals	Sustainable landbird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative harvest rates for legally hunted species using best available information.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.		9
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.		Black-billed Magpie Sharp-tailed Grouse	9 10
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area protection	Conserve and manage habitat of hunted species. Maintain a system of static habitat reserves on crown lands to ensure protection of grassland habitats as	Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90

Table 14 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					ecological benchmark areas.			
5.1 Hunting and Collecting Terrestrial Animals	Waterbirds and shorebirds persecuted for various reasons (e.g., considered a pest, mistaken for other species, egging).	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American Bittern Killdeer	
				4.3 Awareness and communications	Promote awareness and education regarding inappropriately persecuted species of birds.			
7.1 Fire and Fire Suppression	Encroaching woody vegetation is reducing habitat quality and availability; homogenous vegetation reduces nesting opportunities for multiple species.	1.3 Ensure the continuation of natural processes that maintain bird habitat	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	Bobolink Le Conte's Sparrow Mountain Bluebird Sharp-tailed Grouse Sprague's Pipit	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		53 55 56 57
7.1 Fire and Fire Suppression	Repeated burning of tall vegetation reduces nesting cover.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	American Bittern	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this		53 55 56 57

Table 14 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		
7.2 Dams and Water Management/Use	Changes in flow regimes may reduce water availability, strand or flood nests, or reduce natural variability in water levels.	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	American Bittern Herring Gull	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted		19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20

Table 14 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	8.1 Research	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Barn Swallow	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus.	8.0 Research and Monitoring	Provide funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	Short-eared Owl	30
8.1 Invasive Non-native/Alien Species	Lower densities when exotic plant species are present.	3.5 Prevent and control the spread of invasive and exotic species	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	Sprague's Pipit	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		53 55 56 57
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by	Le Conte's Sparrow Sprague's Pipit	32 33 34

Table 14 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					(SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	species at risk can be a cost-effective management strategy.		
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Blue-winged Teal Mallard Northern Shoveler	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from exposure to pesticides	Reduce use of pesticides	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	Bobolink Killdeer Loggerhead Shrike Northern Harrier Sharp-tailed Grouse	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		

Note: Only threats ranked as medium magnitude or higher in herbaceous habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for herbaceous habitat (Table 13) but not listed in the associated threats table (Table 14 above). These priority species either have no known threats in herbaceous habitat or have known threats in herbaceous habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Semipalmated Sandpiper, for example, is associated with herbaceous habitat but does not appear in Table 14 because identified threats for Semipalmated Sandpipers in this habitat were ranked as low (e.g., 12.1 Information lacking). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Lichens/Mosses

Much of the Lichen/Moss habitat in BCR 6 is found in the northern sub-arctic region, where it can be the dominant vegetation within much of the tundra barrens (Fig. 23). There are two shorebirds in particular that extensively use lichen-dominated habitats within BCR 6, the Whimbrel and American Golden-Plover (Table 15). Lichen/Moss habitat may also be utilized by the Least Sandpiper. Lichen- and moss-dominated habitats can also occur within many broad habitat classes within BCR 6. For example, lichen and moss are found in coniferous forests as the dominant forest floor vegetation and in black spruce **peatland** complexes where they have a significant role in hydrological processes. Priority species that utilize or require this habitat are included in the coniferous forest section above.

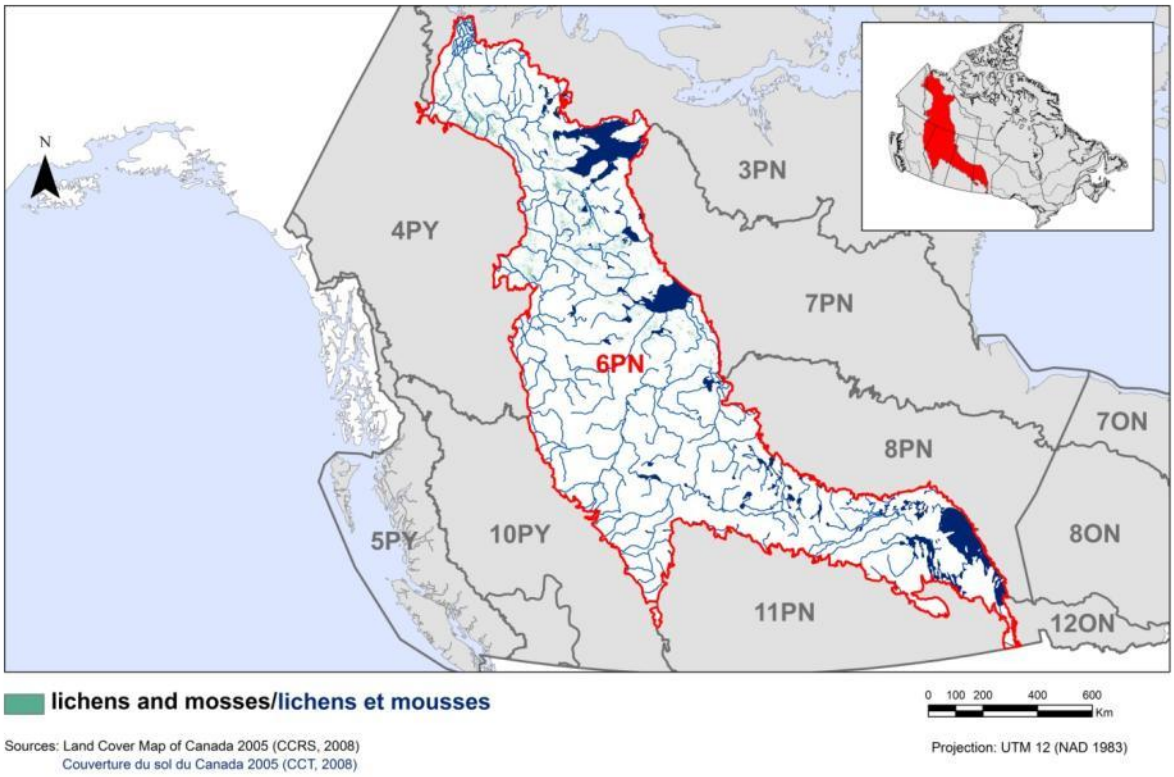


Figure 23. Map of lichen and moss habitat in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

Habitat loss from peat mining is a human threat identified for Whimbrels in lichen/moss habitat. Other low-impact threats to priority species are climate-related changes and disturbance from work or recreational activities (Fig 24). Industrial activity is limited but expanding in the tundra barrens, primarily as a result of mineral mining and exploration. The most important consideration for maintaining this habitat class is limiting the extent of mining and exploration activities coupled with appropriate reclamation work. As all the threats in this habitat are of low magnitude, conservation objectives and recommended actions have not been developed.

Table 15. Priority species that use lichen/moss habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American Golden-Plover	Lichen-covered rocky tundra/barrens		Increase 100%		Y	Y		Y	
Least Sandpiper	Low lichen/moss tundra; mossy bogs	Near water or muddy areas	Increase 100%			Y		Y	
Whimbrel	Lichens		Migrant		Y	Y		Y	Y

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

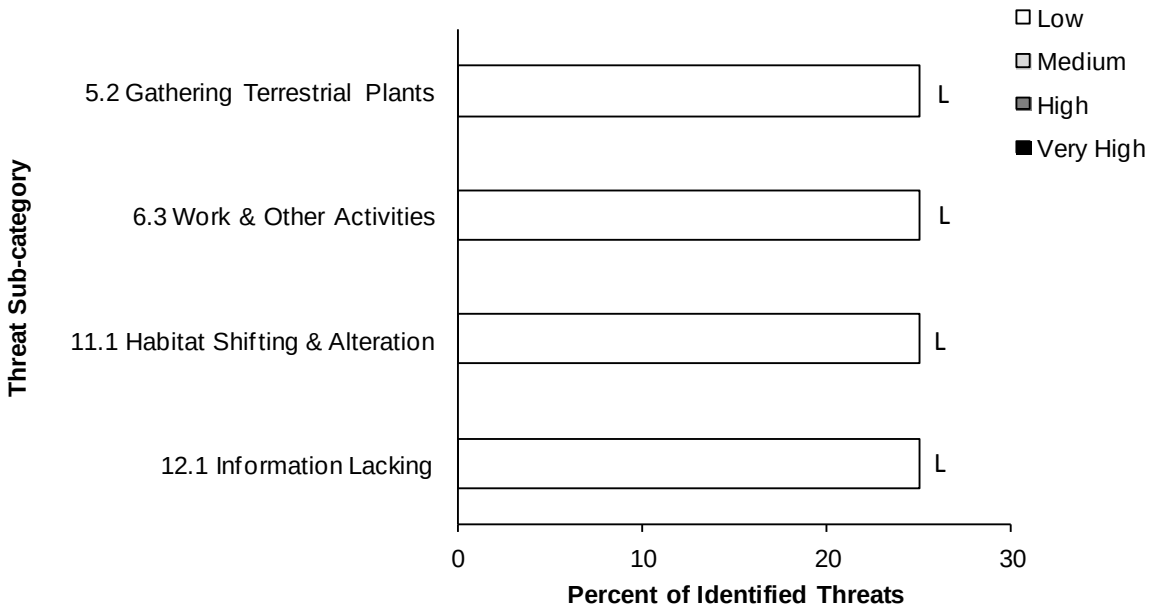


Figure 24. Percent of identified threats to priority species in lichen/moss habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in lichen/moss habitat (for example, if 100 threats were identified in total for all priority species in lichen/moss habitat, and 10 of those threats were in the category 5.2 Gathering terrestrial plants, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitudes of all the sub-threats in lichen/moss habitat are low.

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Cultivated and Managed Areas

Habitats that fall under the designation of cultivated and managed areas are numerous and diverse and can be found in both urban and rural areas. Cultivated areas are regions that have been modified for agricultural use such as plantations, hayfields and plant food production areas. Managed areas incorporate many land-use types including recreation areas (parks and parklands) and lawns (human settlements, golf courses). Large portions of the southern half of the BCR fall into this habitat class (Fig. 25), and some overlap occurs with other broad habitat classes including bare areas, herbaceous and shrub/early successional. Managing areas for human use can affect wildfire intervals, natural grazing patterns and other historical disturbance regimes.

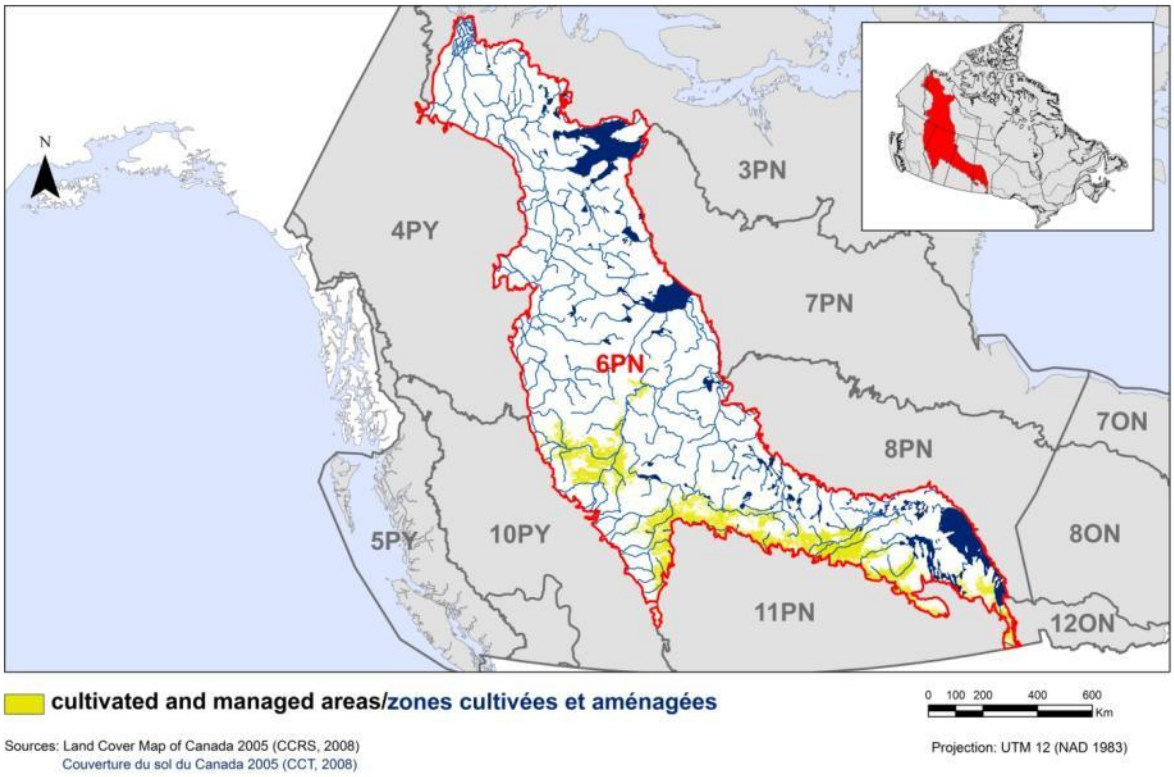


Figure 25. Map of cultivated and managed habitat in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

Forty-eight priority species use this habitat class in BCR 6, which partly reflects the diversity of cultivated and managed habitat types (Table 16). Many of these species use this habitat as an alternative to lost or much reduced natural grassland habitat. Current threats to species within cultivated and managed areas are related to native habitat loss (threat sub-categories 2.1 and 2.3, Fig. 26), which may result in species declines due to the reduced fitness associated with the lower quality of these cultivated and managed habitats (i.e., population sinks). Additionally, agricultural runoff and increased abundance of invasive plants and animals can further modify these regions and affect priority species (Fig. 26).

Some management approaches in cultivated, managed and other human-modified areas involve shifting to lower impact by optimizing sustainable land-use practices (Table 17). Reduction in chemical and fertilizer application and no-**tillage** approaches to farming are also being implemented. Selective harvests of plantations and re-introduction of natural fire regimes will assist in emulating historical disturbance regimes.

Table 16. Priority species that use cultivated and managed habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American Bittern	Crops	Adjacent to wetlands; emergent vegetation	Increase 50%		Y	Y		Y	
American Kestrel	Crops; parklands	Nest trees/perches	Assess/Maintain					Y	
American Wigeon	Crops		Increase 50%		Y	Y			
Baltimore Oriole	Parks		Increase 50%					Y	
Bank Swallow	Crops		Assess/Maintain					Y	
Barn Swallow	Crops	Overhang for nest site (human-made structure); water for mud to build nest	Increase 50%	Y				Y	
Black-billed Cuckoo	Parklands		Increase 100%			Y			
Black-billed Magpie	Parklands		Assess/Maintain				Y		
Black-crowned Night-Heron	Crops		Increase 50%			Y		Y	
Blue-winged Teal	Crops		Maintain Current		Y	Y			
Bobolink	Crops	Large forbs for nest cover	Increase 50%	Y	Y			Y	
Cackling Goose	Lawns; crops		Assess/Maintain		Y	Y			
California Gull	Crops	Islands	Assess/Maintain		Y	Y			
Canvasback	Crops		Maintain Current		Y	Y			
Clay-colored Sparrow	Parklands; crops		Increase 50%				Y		
Common Nighthawk	Crops	Open ground	Recovery Objective	Y	Y			Y	
Eastern Whip-poor-will	Orchards or plantations	Open understory	Recovery Objective	Y	Y			Y	
Gadwall	Crops		Assess/Maintain			Y			
Harris's Sparrow	Orchards or plantations		Assess/Maintain		Y			Y	
Herring Gull	Crops	Islands	Increase 50%		Y	Y			

Table 16 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Killdeer	Lawns; crops		Increase 50%		Y	Y			
Le Conte's Sparrow	Crops		Assess/Maintain				Y	Y	
Lesser Scaup	Crops		Increase 50%		Y	Y		Y	
Lesser Snow Goose (Western Arctic)	Crops		Decrease			Y			
Loggerhead Shrike	Orchards or plantations; crops	Natural or human-made perches and impaling stations	Recovery Objective	Y				Y	
Mallard	Parklands; crops		Maintain Current		Y	Y			
Marbled Godwit	Crops	Prefer native grass to tame	Increase 50%		Y	Y			
Merlin	Parks	Abandoned nests of other species	Assess/Maintain				Y		
Mountain Bluebird	Crops	Open agricultural areas with scattered woodlands; snags or cavities for nesting	Assess/Maintain					Y	
Nelson's Sparrow	Crops		Assess/Maintain		Y		Y		
Northern Flicker	Parks	Snags	Increase 50%				Y		
Northern Harrier	Crops		Increase 100%			Y		Y	
Northern Pintail	Crops		Increase 50%		Y	Y		Y	
Northern Shoveler	Crops		Maintain Current			Y			
Northern Shrike	Orchards or plantations; parklands		Assess/Maintain		Y			Y	
Peregrine Falcon (*anatum/tundrius*)	Parks	Ledges or structures for nesting	Assess/Maintain	Y	Y			Y	
Purple Martin	Parks, orchards/plantations		Assess/Maintain					Y	
Red-headed Woodpecker	Orchards or plantations; parks	Snags	Recovery Objective	Y	Y			Y	
Sedge Wren	Crops	Nomadic	Maintain Current					Y	

Table 16 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Sharp-tailed Grouse	Crops	Mowed areas for lek sites	Assess/Maintain		Y			Y	
Short-eared Owl	Crops; Orchards or plantations	Open areas; prey availability	Increase 100%	Y	Y			Y	
Sora	Crops	Adjacent to wetlands	Assess/Maintain	Y		Y		Y	
Sprague's Pipit	Crops	Grassland patches >150 ha	Recovery Objective	Y	Y	Y		Y	
Trumpeter Swan	Crops		Assess/Maintain	Y	Y	Y		Y	
Tundra Swan (Eastern)	Crops	Wetlands	Assess/Maintain		Y	Y		Y	
Whooping Crane	Crops		Recovery Objective	Y	Y	Y		Y	
Wilson's Phalarope	Crops		Increase 100%		Y	Y			
Yellow Rail	Crops		Increase 50%	Y	Y	Y		Y	

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

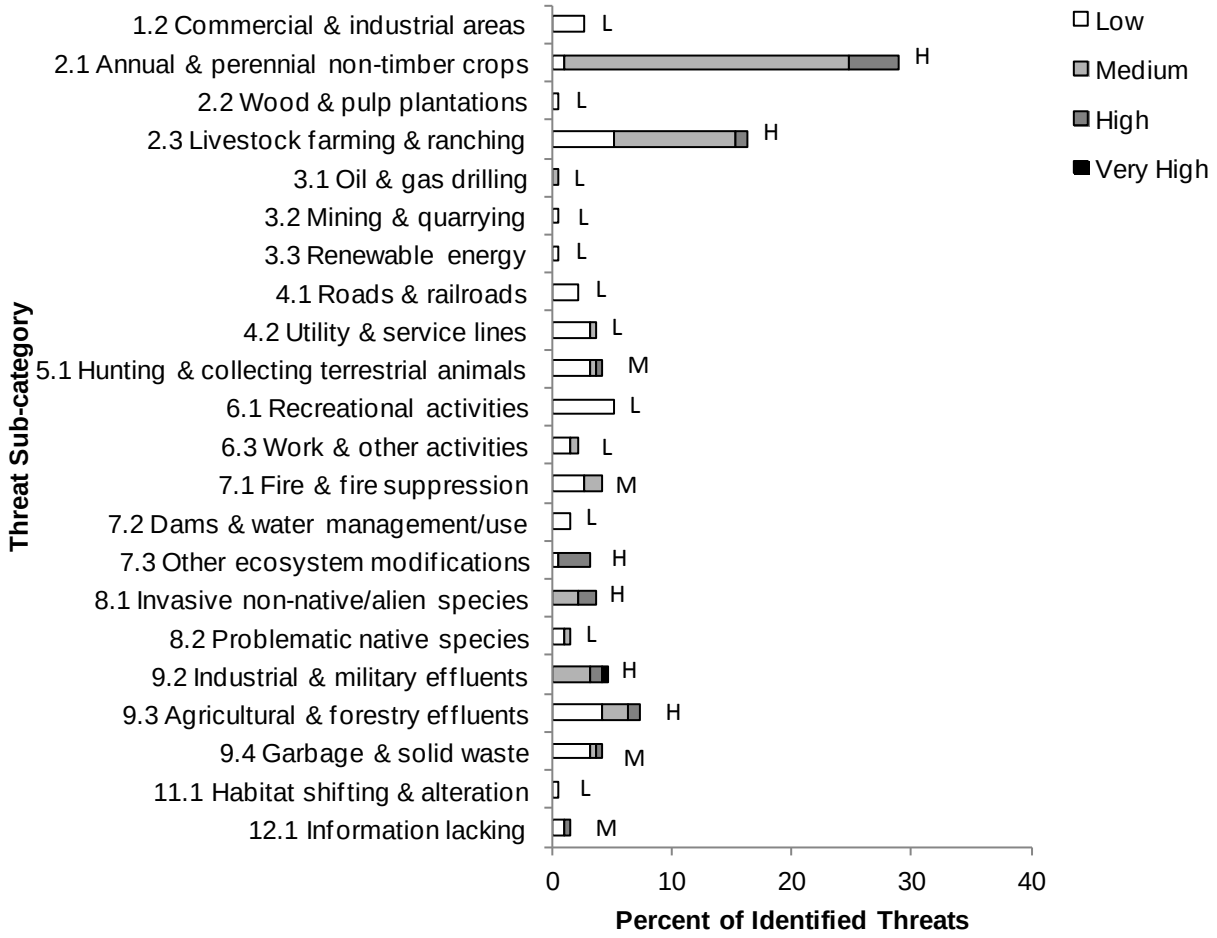


Figure 26. Percent of identified threats to priority species in cultivated and managed habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in cultivated and managed habitat (for example, if 100 threats were identified in total for all priority species in cultivated and managed habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in cultivated and managed habitat is shown at the end of each bar (also presented in Table 4).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 17. Threats addressed, conservation objectives, recommended actions and priority species affected for cultivated and managed habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber Crops	Clearing woody vegetation eliminates roosting, perching, and nesting sites.	1.4 Maintain important habitat features on the landscape	Retain woody vegetation in the form of woodlots, hedgerows, isolated trees, or small tree patches.	1.1 Site/area protection and 1.2 Resource and habitat protection; and 5.2 Policies and regulations	Support the spatially targeted securement of privately owned high value conservation lands through the use of **conservation easement** agreements and **fee simple** purchase by eligible land trusts or governments.	Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. The Conservation Reserve Program in the United states is a useful model for a large-scale land retirement program.	American Kestrel American Wigeon Blue-winged Teal Canvasback Clay-colored Sparrow Eastern Whip-poor-will Gadwall Killdeer Lesser Scaup Loggerhead Shrike Mallard Northern Pintail Northern Shoveler Northern Shrike Red-headed Woodpecker	59 60 61 62 63 64 65 66 67 68 69 70 71
				4.1 Formal education and 4.2 Training	Promote training in **precision agriculture** technology (GPS, remote sensing, yield mapping, profitability mapping) to identify areas in cultivated fields with negative profitability that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		72 73 109
2.1 Annual and Perennial Non-Timber Crops	Insufficient amount and connectivity of intact native grassland.	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Retain functional blocks of intact natural grassland habitat.	1.1 Site/area protection and 1.2 Resource and habitat protection; and 5.2 Policies and regulations	Support the spatially targeted securement of privately owned high value conservation lands through the use of **conservation easement** agreements and **fee simple** purchase by eligible land trusts or governments.	Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. The Conservation Reserve Program in the United states is a useful model for a large-scale land retirement program.	American Bittern Bobolink Killdeer Le Conte's Sparrow Loggerhead Shrike Marbled Godwit Northern Harrier Northern Shrike Sharp-tailed Grouse Short-eared Owl Sprague's Pipit Wilson's Phalarope	59 60 61 62 63 64 65 66 67 68 69 70 71
				4.1 Formal education and 4.2 Training	Promote training in **precision agriculture** technology (GPS, remote sensing, yield mapping, profitability mapping) to identify areas in cultivated fields with negative profitability that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior		109 72 73

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						experience with such technology.		
2.1 Annual and Perennial Non-Timber Crops	Draining and degradation of wetlands for agriculture constitutes habitat loss.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Retain/improve wetland and **riparian** features on cultivated land to ensure proper wetland function.	1.1 Site/area protection; 1.2 Resource and habitat protection; and 5.2 Policies and regulations	Support the spatially targeted securement of privately owned high value conservation lands through the use of **conservation easement** agreements and **fee simple** purchase by eligible land trusts or governments.	Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. The Conservation Reserve Program in the United states is a useful model for a large-scale land retirement program.	American Bittern American Kestrel American Wigeon Black-crowned Night-Heron Blue-winged Teal Bobolink Canvasback Gadwall Killdeer Le Conte's Sparrow Lesser Scaup Mallard Marbled Godwit Nelson's Sparrow Northern Harrier Northern Pintail Northern Shoveler Sedge Wren Short-eared Owl Sora Trumpeter Swan Whooping Crane Wilson's Phalarope Yellow Rail	59 60 61 62 63 64 65 66 67 68 69 70 71
				4.1 Formal education and 4.2 Training	Promote training in **precision agriculture** technology (GPS, remote sensing, yield mapping, profitability mapping) to identify areas in cultivated fields with negative profitability that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		109 72 73
				2.1 Site/area management	Discourage practices that involve spring **tillage** and promote conversion of land to pasture or **perennial forage**.	Delayed **tillage** allows ground-nesting species, e.g., Northern Pintail, to fledge young (nests are otherwise destroyed by tilling). A factor suspected to be important in the decline of Northern Pintail is the move from summer fallow to continuous cropping in the prairies.		104 77 105
					Maintain existing wetlands and restore those that have been degraded on private land.	Wetlands provide many ecological benefits, including improving water quality and water retention; both beneficial to sustainable agricultural production. Restoring wetlands can help restore these beneficial processes.		104 77 105
				5.3 Private sector standards and codes	Discourage practices that involve **tilling** and cropping **riparian** areas of wetlands.	Leaving a natural **riparian buffer** around wetlands will control erosion and help ensure continuation of natural wetland processes.		104 77 105
2.1 Annual and	Mowing can lead to	2.9 Reduce nest	Reduce nest	5.3 Private sector	Defer mowing until after nesting and brood	Late-season mowing following the breeding	Bobolink	50

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
Perennial Non-Timber Crops	nest destruction.	destruction	destruction caused by mowing.	standards and codes	rearing.	season prevents nest destruction, and may provide valuable habitat for some species in subsequent years (e.g., Bobolink).	Northern Harrier Sedge Wren Short-eared Owl	51
2.2 Wood and Pulp Plantations	Failure to maintain natural grassland and shrubland habitats limits habitat for this species.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan wood plantations to maintain native grassland and early successional habitats throughout the region. Represent the size, shape, and spatial and temporal arrangement of early successional forest types and stand age classes at a regional scale.	1.1 Site/Area Protection	Support the spatially targeted securement of privately owned high value conservation lands through the use of **conservation easement** agreements and **fee simple** purchase by eligible land trusts or governments.	Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. Protected areas should represent and include: the size, shape and spatial arrangement of all habitat types including grassland and shrubland habitats.	Sharp-tailed Grouse	15
2.3 Livestock Farming and Ranching	Degradation of wetlands through trampling of **riparian** areas reduces habitat quality and vegetation complexity.	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Retain/improve wetland and **riparian** features on grazed land.	5.3 Private sector standards and codes; 2.3 Habitat and natural process restoration	Protecting riparian areas from excessive grazing or grazing at sensitive times through fencing, off-stream watering sites, and grazing management. Planting native vegetation in **riparian** areas.	Limiting damage by grazing livestock allows **riparian** areas to recover and provide better water quality and complex vegetation structure for nesting, roosting, and foraging birds.	American Wigeon Blue-winged Teal Bobolink Canvasback Gadwall Le Conte's Sparrow Lesser Scaup Mallard Nelson's Sparrow Northern Harrier Northern Pintail Northern Shoveler Sedge Wren Sharp-tailed Grouse Short-eared Owl Trumpeter Swan	57
				4.2 Training, 5.1 legislation and 5.2 policies and regulation, 6.4 Conservation payments	Provide information, training, and financial incentives for ranchers to implement grazing management strategies and associated infrastructure (e.g., fencing, off-stream watering sites).	**Healthy riparian** areas can be economically advantageous for ranchers over several years (through improved water quality and high forage production), but implementation of **riparian** management strategies carries significant up-front costs.		57
				7.3 conservation finance; 7.1 Institutional and civil society development	Develop and/or provide funding and resources for local and community-based groups advocating for the implementation of conservation practices by farmers/ranchers/landowners.	Even with financial incentives or tangible economic benefits, conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members.		55 56
2.3 Livestock Farming and Ranching	Livestock overgrazing reduces structural heterogeneity of vegetation; complex heterogeneous	1.2 Maintain the size, shape and configuration of habitat within the **natural range of**	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned	Bobolink Clay-colored Sparrow Eastern Whip-poor-will Le Conte's Sparrow	52 53 54

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	structure is required for successful reproduction.	**variation**				patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	Loggerhead Shrike Northern Harrier Northern Shrike Red-headed Woodpecker Sharp-tailed Grouse Short-eared Owl Sprague's Pipit	
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		53 55 56
2.3 Livestock Farming and Ranching	Trampling by livestock may reduce nest success.	2.4 Reduce incidental mortality	Reduce mortality caused by livestock trampling.	5.3 Private sector standards and codes	Defer grazing until after the breeding season.	Trampling by livestock may be a significant source of mortality in some grassland-nesting birds, and avoiding grazing during the breeding period would benefit several species.	Northern Harrier	58
5.1 Hunting and Collecting Terrestrial Animals	Sustainable landbird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative harvest rates for legally hunted species using best available information.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	Black-billed Magpie Sharp-tailed Grouse	9
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.			9 10
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area	Conserve and manage habitat of hunted	Purchase of land is warranted for highly		9

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				protection	species. Support the spatially targeted securement of privately owned high value conservation lands through incentives, **conservation easement** agreements, or **fee simple** purchase by eligible land trusts or governments.	ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		90
5.1 Hunting and Collecting Terrestrial Animals	Illegal hunting and collecting of raptors.	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American Kestrel	
5.1 Hunting and Collecting Terrestrial Animals	Waterbirds and shorebirds may be persecuted for various reasons (e.g., considered a pest, mistaken for other species, egging).	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	Black-crowned Night-Heron Herring Gull Killdeer Sora Whooping Crane	
				4.3 Awareness and communications	Promote awareness and education regarding inappropriately persecuted species of birds.			
7.1 Fire and Fire Suppression	Encroaching woody vegetation is reducing habitat quality and availability; homogenous vegetation reduces nesting opportunities for multiple species.	1.3 Ensure the continuation of natural processes that maintain bird habitat	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	Bobolink Le Conte's Sparrow Mountain Bluebird Purple Martin Sprague's Pipit	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential		53 55 56 57

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		
7.1 Fire and Fire Suppression	Repeated burning of tall vegetation reduces nesting cover.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	American Bittern Sedge Wren Yellow Rail	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		53 55 56 57
7.2 Dams and Water Management/Use	Changes in flow regimes in agricultural areas including dams and water drawdowns may reduce water availability, strand or flood nests, or reduce natural variability in water levels.	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Retain/improve wetland and **riparian** features on cultivated land to ensure proper wetland function.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	American Bittern, Herring Gull	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and	Mimic natural season and daily river flows,	Maintenance of natural flows will help		18

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				natural process restoration	as close to hydrologic natural processes as possible (representing natural high and low cycles).	maintain downstream wetland habitat.		
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted		19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
				5.2 Policies and regulations	Implement policy changes that regulate anthropogenic water drawdowns, particularly during timing of nesting and brood rearing.	Anthropogenic water drawdowns cause water to disappear from natural waterbodies and can strand nests of waterbirds, waterfowl and shorebirds.		19
7.3 Other Ecosystem Modifications	Control of insect defoliators (forest tent caterpillar) removes an important food resource.	7.1 Improve population/demographic monitoring	Determine causes of forest tent caterpillar outbreaks.	8.1 Research	Determine what factors influence the initiation of forest tent caterpillar outbreaks.	Predation by birds, particularly orioles, is capable of keeping low-density forest tent caterpillar populations in check, but it is unclear what mechanisms allow density to rise above the level where they can be controlled by predation and thus initiate outbreaks.	Baltimore Oriole	21
				8.2 Monitoring	Support monitoring of both insect outbreaks and bird species at suitable spatial and			

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					temporal scales to improve knowledge of predator-prey population dynamics.			
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	8.1 Research	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Bank Swallow Barn Swallow Common Nighthawk Eastern Whip-poor-will Purple Martin	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.1 Invasive Non-native/Alien Species	Lower densities when exotic plant species are present.	3.5 Prevent and control the spread of invasive and exotic species	Maintain/foster complex, heterogeneous vegetation structure.	2.3 Habitat and natural process restoration; 3.1 Species management	Encourage range management that incorporates a fire-grazing model that emulates the historical disturbance regime resulting from interactions between wildfires and native ungulates (i.e., bison).	A fire-grazing disturbance model in which patches within a pasture are burned on a 3-4-year rotation while being freely grazed by cattle (i.e., cattle are free to graze in any patch, but typically select recently burned patches thereby reducing fuel loads and the likelihood of future fire) fosters heterogeneity of the vegetation community and increased avian biodiversity, without any losses to livestock production.	Sprague's Pipit	52 53 54
				4.2 Training; 7.1 Institutional and civil society development	Provide information, training, and finances to implement a fire-grazing management model. Provide funding and resources for groups advocating sustainable range practices (e.g., similar to Cows and Fish for **riparian** management in Alberta).	While implementing a fire-grazing disturbance regime does not result in reduced livestock production, there are costs and labour associated with it, particularly with **prescribed burns**. Conservation practices are most often adopted by landowners when they are implemented and advocated by influential community members, so this combined with financial incentives would likely be required for the adoption of this fairly novel strategy.		53 55 56 57

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus. Limit population size of invasive species.	8.0 Research and Monitoring	Provide funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	American Kestrel Short-eared Owl	30
8.1 Invasive Non-native/Alien Species	European Starlings and House Sparrows exclude native species from nesting cavities.	3.1 Reduce competition with invasive species	Limit population size of invasive European Starlings and House Sparrows to ensure a sufficient supply of nest cavities for native birds.	8.1 Research	Identify key areas where nest cavities are limiting native birds due to cavities being occupied by European Starlings and House Sparrows. Add nest boxes to increase cavity availability for primary and secondary cavity nesters.	Exclusion of native birds from nest cavities is widespread, but population-level effects are largely unknown.	Mountain Bluebird Northern Flicker Purple Martin	38
				2.2 Invasive/problematic species control	Promote control of European Starlings and House Sparrows in key areas to increase the availability of nesting cavities for native birds.			
8.1 Invasive Non-native/Alien Species	Non-native earthworms may be impacting the Eastern Whip-poor-will by altering their forest floor habitat.	7.4 Improve understanding of causes of population declines	Understand effect to which non-native earthworms affect birds such as the Eastern Whip-poor-will and increase awareness in the spread of invasive earthworms.	8.1 Research	Undertake research to understand the interactions between non-native earthworms and forest and open-country birds. Research the mechanisms of earthworm transmission and dispersal.		Eastern Whip-poor-will	
				4.3 Awareness and communications	Increase awareness on the spread of non-native earthworms; discourage dumping of bait worms on land or water (should be put in garbage), clean vehicle tires before moving between forest sites, freeze compost, etc.	Impacts that non-native earthworms may have on other species are not well understood. Measures to understand these impacts and reduce the dispersal of non-native earthworms should be undertaken.		44
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/ problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Le Conte's Sparrow Nelson's Sparrow Sprague's Pipit	32 33 34
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal,	The breeding behaviour and movement patterns of Brown-headed Cowbirds in		32 33

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		34
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	American Kestrel Black-crowned Night-Heron Blue-winged Teal Cackling Goose Canvasback Mallard Northern Shoveler Peregrine Falcon (*anatum/tundrius*) Trumpeter Swan	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	American Kestrel American Wigeon Baltimore Oriole Black-billed Cuckoo Bobolink Cackling Goose Killdeer Lesser Snow Goose (Western Arctic) Loggerhead Shrike Merlin Northern Harrier Peregrine Falcon (*anatum/tundrius*) Red-headed Woodpecker	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
							Sharp-tailed Grouse	
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is restricted.	Canvasback Lesser Scaup Lesser Snow Goose (Western Arctic) Sora Trumpeter Swan Tundra Swan (Eastern)	38 39
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38
9.4 Garbage and Solid Waste	Ingestion of garbage such as plastic at dumps can cause choking or entanglement.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce gull use of dumps/landfills.	2.1 Site/area management	Employ overhead wires and/or netting to exclude gulls from foraging at waste sites. Frightening devices may also deter gulls.	Overhead wires can exclude the majority of gulls, and netting can exclude all gulls if deployed properly. Gulls may become habituated to frightening devices, so they are likely only a short-term solution. Use of falcons can also be effective, but lethal control can be controversial with the general public, so non-lethal management is preferable.	California Gull Herring Gull	74 75
				5.2 Policies and regulations	Expand composting programs for municipal waste so that anthropogenic food and plastic/garbage are not located at the same site.	Waste disposal facilities that do not contain food/putrescible waste will not attract gulls.		74

Table 17 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
12.1 Information lacking	Lesser Scaup, California Gulls, and Sedge Wrens are in decline but reasons for the decline remain unknown.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of these species in order to undertake conservation action to reverse the decline.	8.1 Research	Continued research throughout the region to understand the reasons for the decline of Lesser Scaup, California Gulls, and Sedge Wrens.		Lesser Scaup California Gull Sedge Wren	
				8.2 Monitoring	Increased monitoring of Lesser Scaup, California Gulls and Sedge Wren populations throughout the boreal forest.			

Note: Only threats ranked as medium magnitude or higher in cultivated and managed habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for cultivated and managed habitat (Table 16 but not listed in the associated threats table (Table 17 above). These priority species either have no known threats in cultivated and managed habitat or have known threats in cultivated and managed habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Harris' Sparrow, for example, is associated with cultivated and managed habitat but does not appear in Table 17 because known threats for Harris' Sparrows in this habitat were ranked as low (e.g., 1.2 Commercial and industrial areas). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Wetlands

The wetlands habitat class includes bogs, fens, marshes, swamps and shallow open water (largely non-vegetated surface, but <2 m deep). A large proportion of BCR 6 is classified as wetland habitat largely due to the occurrence of bogs and fens, which can be herb-, shrub- or tree-dominated (Fig. 27). The northern portion of the BCR also contains a number of small lakes and wetlands. There are more priority species utilizing wetland habitat than any other habitat class in the region, with 79 species or distinct populations from all 4 bird groups (Table 18).

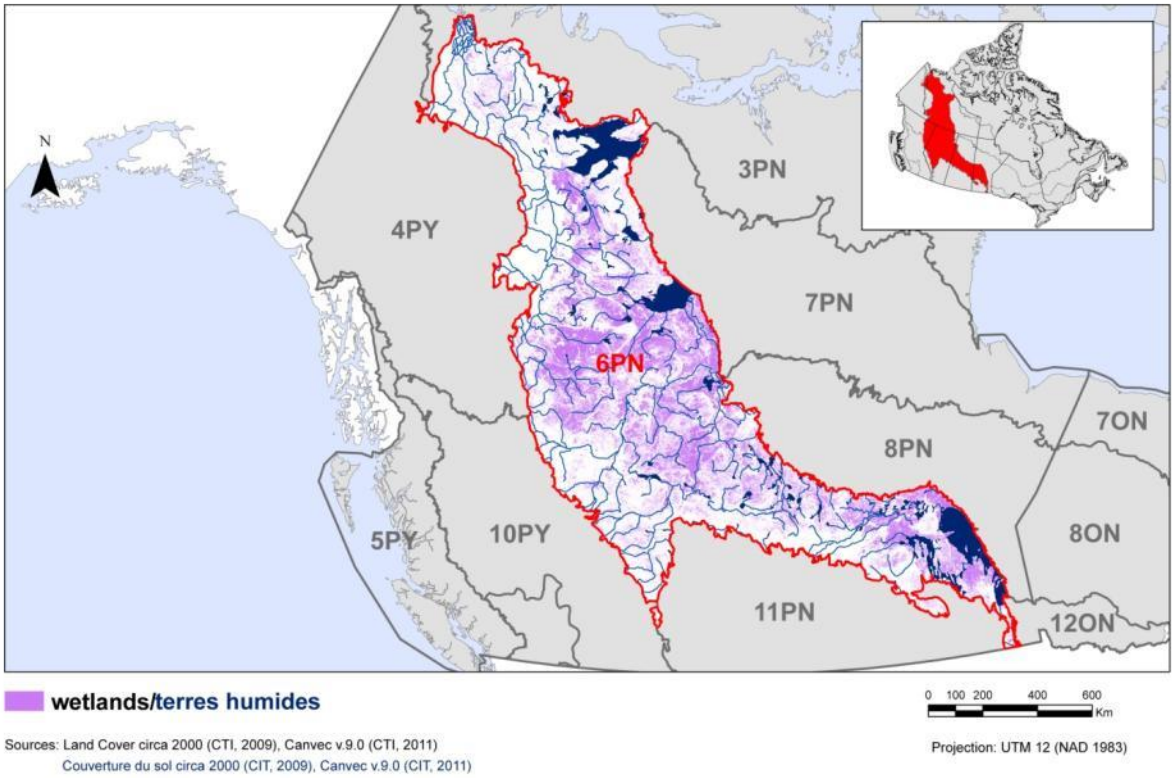


Figure 27. Map of wetland habitat in BCR 6, at 250 m resolution from the Land Cover circa 2000, Centre for Topographic Information.

Species using wetland habitats face a wide variety of threats (Fig. 28). Wetland habitats have been lost in the past to drainage and conversion to agriculture, and these losses continue, though at a lower rate today than historically[76] (threat sub-category 2.1). Currently, heavy livestock grazing (sub-category 2.3) in southern areas removes **riparian** and wetland vegetation, and, along with agricultural runoff (sub-category 9.3), degrades water quality. Water diversion for irrigation or other uses and flood control measures (sub-category 7.2) impair wetland hydrology, and productive wetlands have been lost to reservoir creation. Wetland habitats also face future threats from climate change (sub-category 11.1). Changes in precipitation and increased temperatures are expected to lower water levels, and small or shallow wetlands (which are some of the most productive) may be lost completely. Biological, chemical and thermal characteristics of wetlands are also expected to change (e.g., become ice-free earlier, warmer and eutrophic due to increases in primary productivity). Key actions to address threats

facing priority species in wetland habitats include protection of key wetland habitats; maintenance or restoration of natural hydrologic regimes; encouraging the use of beneficial management practices for biodiversity and bird conservation in ranching and farming, including establishment and maintenance of suitable vegetated buffers to maintain water quality; and supporting efforts to reduce and mitigate the effects of climate change (Table 19).

Table 18. Priority species that use wetland habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Alder Flycatcher	Bog		Increase 50%		Y		Y		
American Bittern	Marsh; Shallow Water	Emergent vegetation	Increase 50%		Y	Y		Y	
American White Pelican	Shallow Water	Remote islands	Assess/Maintain	Y	Y	Y		Y	
American Wigeon	Marsh; Shallow Water	Emergent vegetation	Increase 50%		Y	Y			
Arctic Tern	Marsh	Islands	Increase 50%		Y	Y			
Barrow's Goldeneye	Shallow Water	Nest sites	Maintain Current					Y	
Black Tern	Shallow Water; Marsh	Emergent vegetation	Increase 100%		Y	Y		Y	
Black-crowned Night-Heron	Marsh; Swamp		Increase 50%			Y		Y	
Blue-winged Teal	Shallow Water, Marsh		Maintain Current		Y	Y			
Bobolink	Marsh	Large forbs for nest cover	Increase 50%	Y	Y			Y	
Bonaparte's Gull	Marsh; Bog	Islands; emergent vegetation; open water and coniferous forest nearby	Assess/Maintain		Y	Y			
Bufflehead	Bog		Assess/Maintain			Y			
Cackling Goose	Marsh		Assess/Maintain		Y	Y			
California Gull	Bog	Islands	Assess/Maintain		Y	Y			
Canvasback	Shallow Water; Marsh	Emergent vegetation	Maintain Current		Y	Y			
Caspian Tern	Shallow Water	Islands	Maintain Current					Y	
Common Goldeneye	Bog		Maintain Current			Y			
Common Loon	Marsh	Lakes and wetlands with shallow water (less than 0.5 metres)	Assess/Maintain		Y	Y			
Common Nighthawk	Bog	Open ground	Recovery Objective	Y	Y			Y	
Common Tern	Marsh	Islands	Assess/Maintain		Y	Y			
Common Yellowthroat	Bog		Increase 100%					Y	
Connecticut Warbler	Bog		Assess/Maintain		Y		Y	Y	

Table 18 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Eared Grebe	Marsh; Shallow Water		Assess/Maintain			Y			
Forster's Tern	Marsh		Increase 50%		Y	Y		Y	
Gadwall	Marsh; Shallow Water		Assess/Maintain			Y			
Golden-winged Warbler	Swamp		Recovery Objective	Y	Y			Y	
Great Grey Owl	Bog		Assess/Maintain				Y	Y	
Greater Yellowlegs	Marsh; Bog		Assess/Maintain		Y	Y		Y	
Green-winged Teal	Marsh		Maintain Current			Y		Y	
Harris's Sparrow	Bog		Assess/Maintain		Y			Y	
Horned Grebe	Shallow Water	Emergent vegetation	Increase 50%		Y	Y		Y	
Hudsonian Godwit	Marsh; Bog; Fen		Assess/Maintain		Y	Y		Y	
Killdeer	Marsh; Shallow Water		Increase 50%		Y	Y			
Le Conte's Sparrow	Marsh; Bog		Assess/Maintain				Y	Y	
Least Sandpiper	Bog; Marsh; Wet Sedge Meadows	Boggy or muddy margins; wet meadows or short grasses in close proximity to edge	Increase 100%			Y		Y	
Lesser Scaup	Shallow Water; Marsh		Increase 50%		Y	Y		Y	
Lesser Snow Goose (Western Arctic)	Marsh		Decrease			Y			
Lesser Yellowlegs	Marsh		Increase 100%			Y			
Long-tailed Duck	Shallow Water		Increase 100%		Y	Y		Y	
Mallard	Marsh; Swamp		Maintain Current		Y	Y			
Marbled Godwit	Shallow Water; Marsh	Prefer native grass to tame	Increase 50%		Y	Y			
Nelson's Sparrow	Fen; Marsh		Assess/Maintain		Y		Y		
Northern Harrier	Marsh		Increase 100%			Y		Y	
Northern Hawk Owl	Bog	Natural and secondary cavities; snags	Assess/Maintain					Y	
Northern Pintail	Shallow Water; Marsh		Increase 50%		Y	Y		Y	
Northern Shoveler	Shallow Water; Marsh		Maintain Current			Y			

Table 18 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Olive-sided Flycatcher	Bog	Tall prominent trees or snags	Recovery Objective	Y	Y			Y	
Pacific Loon	Shallow Water; Marsh	Islands	Assess/Maintain		Y	Y		Y	
Peregrine Falcon (*anatum/tundrius*)	All types	Cliffs or ledges or human-made structures for nesting	Assess/Maintain	Y	Y			Y	
Pied-billed Grebe	Marsh		Assess/Maintain					Y	
Purple Martin	Bog		Assess/Maintain					Y	
Redhead	Shallow Water; Marsh		Maintain Current		Y	Y			
Red-necked Grebe	Bog		Assess/Maintain						Y
Red-necked Phalarope	Marsh; Fen		Increase 50%		Y	Y		Y	
Ring-necked Duck	Swamp; Marsh; Shallow water		Assess/Maintain			Y			
Rusty Blackbird	Bog		Increase 100%	Y	Y			Y	
Sedge Wren	Marsh		Maintain Current					Y	
Semipalmated Sandpiper	Fen		Increase 100%		Y	Y		Y	Y
Sharp-tailed Grouse	Marsh		Assess/Maintain		Y			Y	
Short-billed Dowitcher	Marsh; Fen; Bog		Increase 100%		Y	Y		Y	
Short-eared Owl	Bog; Marsh	Open areas; prey availability	Increase 100%	Y	Y			Y	
Smith's Longspur	Marsh; fen		Assess/Maintain		Y			Y	Y
Solitary Sandpiper	Bog		Increase 50%		Y	Y			
Sora	Marsh		Assess/Maintain		Y	Y		Y	
Spruce Grouse	Bog		Assess/Maintain		Y		Y		
Surf Scoter	Bog		Increase 50%		Y	Y		Y	
Trumpeter Swan	Shallow water; Marsh	Nest sites	Assess/Maintain	Y	Y	Y		Y	
Tundra Swan (Eastern)	Marsh		Assess/Maintain			Y		Y	
Upland Sandpiper	Marsh		Increase 100%			Y		Y	
Virginia Rail	Marsh; Shallow Water		Assess/Maintain		Y	Y			
Western Tanager	Bog		Assess/Maintain					Y	
Whimbrel	Bog; fen		Migrant (no		Y	Y		Y	Y

Table 18 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
			population objective)						
White-throated Sparrow	Bog		Increase 50%		Y			Y	
White-winged Crossbill	Bog	Conifer and conifer-dominated forest; Coniferous seed crops	Maintain Current		Y				
White-winged Scoter	Shallow Water	Islands	Increase 50%		Y	Y		Y	
Whooping Crane	Marsh; Shallow Water; Fen		Recovery Objective	Y	Y	Y		Y	
Wilson's Phalarope	Shallow Water; Marsh		Increase 100%		Y	Y			
Wilson's Snipe	Marsh		Increase 100%			Y			
Yellow Rail	Bog; Fen; Marsh		Increase 50%		Y	Y		Y	

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

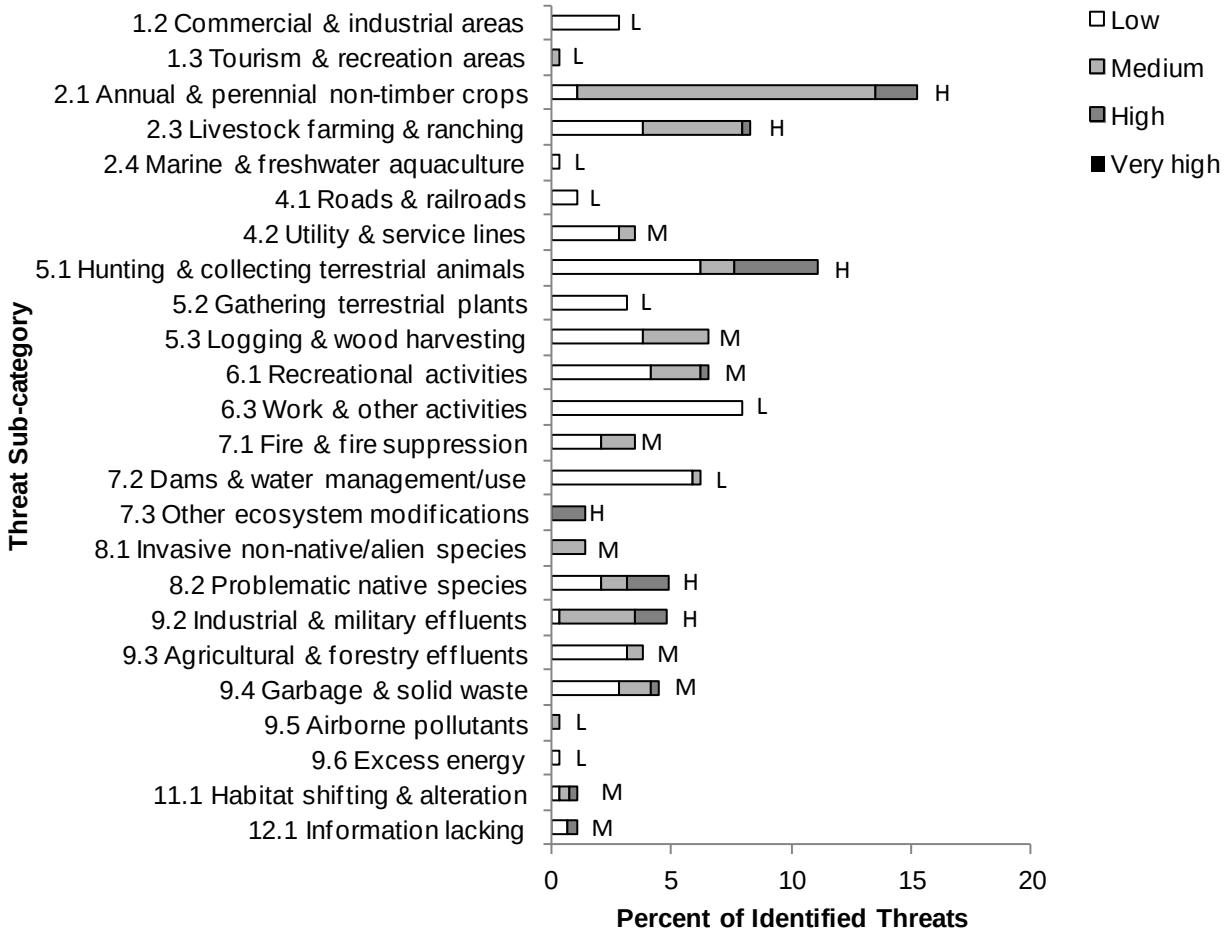


Figure 28. Percent of identified threats to priority species in wetland habitat in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category in wetland habitat (for example, if 100 threats were identified in total for all priority species in wetland habitat, and 10 of those threats were in the category 1.2 Commercial & industrial areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in waterbodies is shown at the end of each bar (also presented in Table 4).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 19. Threats addressed, conservation objectives, recommended actions and priority species affected for wetland habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber crops	Agricultural conversion of wetlands results in destruction and degradation of wetland habitat.	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Plan agriculture to maintain large, contiguous areas of natural wetlands throughout the region, within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).	2.1 Site/area management	Discourage practices that involve spring **tillage** and promote conversion of wetland areas to pasture or **perennial forage**.	Delayed **tillage** allows ground-nesting species, e.g., Northern Pintail, to hatch young (nests are otherwise destroyed by tilling). A factor suspected to be important in the decline of Northern Pintail is the move from summer fallow to continuous cropping in the prairies.	American Bittern American Wigeon Black Tern Black-crowned Night-Heron Blue-winged Teal Bobolink Bonaparte's Gull Canvasback Common Yellowthroat Eared Grebe Forster's Tern Gadwall Golden-winged Warbler Great Gray Owl Greater Yellowlegs Green-winged Teal Horned Grebe Hudsonian Godwit Le Conte's Sparrow Lesser Scaup Lesser Yellowlegs Mallard Marbled Godwit Nelson's Sparrow Northern Harrier Northern Pintail Northern Shoveler Pied-billed Grebe Redhead Ring-necked Duck Rusty Blackbird Sedge Wren Short-billed Dowitcher Short-eared Owl	104 105
					Maintain existing wetlands and restore those that have been degraded.	Wetlands provide many ecological benefits, including improving water quality and water retention; both beneficial to sustainable agricultural production.		77 105
				5.3 Private sector standards and codes	Discourage practices that involve **tilling** and cropping **riparian** areas of wetlands.	Leaving a natural **riparian buffer** around wetlands will control erosion and help ensure continuation of natural wetland processes. The minimum width of the buffer zone should depend on the hydrology of the surrounding landscape, taking into account factors such as wetland type and slope (steeper areas should have wider buffers for erosion control).		105
						GIS/remote sensing- based precision conservation tools can help determine buffer area and extent. This could particularly be useful in landscapes that are a high priority for conservation.		107
				1.1 Site/area protection	Create a system of protected areas that represent the size, shape, and spatial arrangement of all wetland **ecosites** at a regional scale.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas.		15
				1.2 Resource and habitat protection	Create a system of protected areas through **conservation easements** that represent the size, shape, and spatial arrangement of all wetland **ecosites** at a regional scale.	The boreal forest within BCR 6 is rapidly being transformed to agricultural cropland and wetlands are destroyed and degraded in the process; wetlands in the boreal provides nesting habitat to up to 40% of North America's waterfowl. Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. The Conservation Reserve Program and Wetland Reserve Program in the United states is a useful model for a large-scale land retirement program for agricultural land.		4 104 108

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				6.4 Conservation payments	Implement an incentive program that discourages draining, filling and/or planting wetlands on agricultural land.	The boreal forest within BCR 6 is rapidly being transformed to agricultural cropland and wetlands are destroyed and degraded in the process; wetlands in the boreal provides nesting habitat to up to 40% of North America's waterfowl.	Solitary Sandpiper Sora Spruce Grouse Trumpeter Swan Upland Sandpiper Virginia Rail White-throated Sparrow Whooping Crane Wilson's Phalarope Yellow Rail	19
				8.1 Research	Continued research in **precision agriculture** technology and precision conservation to identify agricultural **riparian** and wetland areas with low yields/negative profitability/high conservation value that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields/excess irrigation and use of fertilizer; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		109
				4.2 Training	Promote training in **precision agriculture** technology (GPS, remote sensing, yield mapping, profitability mapping) to identify areas in cultivated fields with negative profitability that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields/excess irrigation and use of fertilizer; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		109
				8.2 Monitoring; 4.2 Training; 4.3 Awareness and communications;	Design and promote a regional and national wetland and waterbody volunteer monitoring program for birds associated with these habitat types, particularly focusing on waterbirds.	Relatively few data are available for birds that use wetlands and waterbodies in parts of Canada, particularly in the boreal forest. Involvement of the public in a monitoring program similar to Bird Studies Canada's Marsh Monitoring Program or NatureWatch's FrogWatch program will aid in data collection as well as in fostering public awareness, involvement, and environmental stewardship. Bird Studies Canada and Environment Canada have developed the Marsh Monitoring Program (beginning in 1994). This marsh survey program is run by citizen scientist volunteers, and spans the Great Lakes basin. This program could be expanded and developed to encompass western Canada.		78 79

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
2.3 Livestock Farming and Ranching	Clearing of **riparian** areas for agriculture and excessive grazing by livestock results in decreased wetland habitat availability and can result in trampling of nests of ground-nesting birds	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Maintain intact wetland habitat, including **riparian**, emergent, and open water areas.	1.1 Site/area protection	Create a system of protected areas that represent the size, shape, and spatial arrangement of all wetland **ecosites** at a regional scale.	Conservation of wetlands will ensure varied habitat for birds that are intolerant to livestock grazing and negative habitat impacts associated with cattle-grazing in wetlands (e.g., trampling of vegetation required for nest construction and shelter).	American Wigeon Blue-winged Teal Bobolink Canvasback Gadwall Golden-winged Warbler Great Gray Owl Green-winged Teal Le Conte's Sparrow Lesser Scaup Mallard Nelson's Sparrow Northern Harrier Northern Pintail Northern Shoveler Redhead Ring-necked Duck Rusty Blackbird Sedge Wren Sharp-tailed Grouse Short-eared Owl Solitary Sandpiper Spruce Grouse Trumpeter Swan	110
				5.3 Private sector standards and codes	Defer grazing around wetlands until after nesting and brood rearing.	Excessive grazing by cattle can result in trampling of nests of ground-nesting birds and elimination of specialized habitat (e.g., tall grasses in **riparian** areas are the preferred habitat of Le Conte's Sparrow).		110
					Manage grazing in wetlands such that it mimics a **natural disturbance regime** (frequency, severity, size); avoid overgrazing and limit grazing of **riparian** areas.	Careful management and policy/regulation implementation are important because grazing in wetlands can have variable effects relating to birds. Overgrazing can have negative effects on vegetation biomass and diversity and introduce excess nutrients to the water, however sustainable grazing practices can allow for increased habitat for wildlife species and restoration and conservation of **riparian** and wetland habitat.		57 111
				5.2 Policies and regulations	Implement policy changes that regulate management of livestock grazing on private land.			
				4.2 Training	Training for ranchers in beneficial management practices related to grazing in and around wetlands.	Ongoing education for practitioners will ensure that knowledge on beneficial management practices is current and can be put into practice.		57
2.4 Marine and Freshwater Aquaculture	Persecution of birds nesting and/or foraging at aquaculture facilities results in disturbance, injury, or direct mortality.	2.8 Reduce mortality from legal or illegal hunting, and persecution	Reduce disturbance, injury, and mortality of birds by decreasing accessibility to fish at aquaculture facilities.	5.3 Private sector standards and codes	Preferentially use exclusion and barriers over removal and culling to reduce encounters with birds by reducing accessibility to aquaculture facilities.	Use of exclusions, barriers and deterrents will impede birds from foraging at aquaculture facilities and from establishing colonies nearby. If methods other than total exclusion are used (particularly for waterbodies > 2 ha), a combination of non-lethal methods should be used. Non-lethal exclusion methods include fencing, netting and overhead wires, while deterrents include acoustic devices, removal of perches, etc.).	American White Pelican	113 114
				4.2 Training	Seek opportunities for training and education of managers and staff of aquaculture facilities on bird conservation issues.	Education will allow for the implementation of conservation actions.		
4.1 Roads and Railroads	The presence of roads through or	2.7 Reduce incidental mortality from	Minimize injury and mortality as a result	2.1 Site/Area Management	Limit road construction through or near wetlands.	Roads are a large source of direct mortality to wildlife and both directly and indirectly degrade wetland	Common Nighthawk White-winged	80

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	near wetlands results in direct mortality of avian species both directly through collision and indirectly through consumption of de-icing salts.	collisions	of road placement through and near wetlands.			habitat. Avoiding road construction near wetlands will help to mitigate these effects.	Crossbill Whooping Crane	
					Reduce/limit new roads in areas that have not been previously developed; place new roads along existing right-of-ways.	Meta-analysis revealed a decline of 28-36% in birds within 2.6 km of human infrastructure. Attempts should be made to promote integration of activities among land use operators to minimize the construction of new roads. Relatively undeveloped areas such as the boreal should be left intact as much as possible as construction and operation of infrastructure such as roads in these areas results in species declines.		81
				5.2 Policies and regulations	Implement policy changes to deter use of salt on roadways. Promote alternatives to salt.	Road salt is consumed by some avian species, e.g., White-winged Crossbill, and has many other noted negative effects.		80
				6.2 Substitution	Eliminate use of salt on roads. Alternatives to salt should be used (e.g., calcium magnesium acetate, potassium acetate for de-icing, sand for traction).	Road salt is consumed by some avian species, e.g., White-winged Crossbill, and has many other noted negative effects.		80
4.2 Utility and Service Lines	Utility lines near wetlands present a risk to birds, both through collision and electrocution.	2.7 Reduce incidental mortality from collisions	Minimize injury and mortality as a result of utility line placement through and near wetlands.	2.1 Site/Area Management	Limit installing new lines across wetlands and reclaim lines that are no longer in use.	Birds are commonly injured and killed by collisions with utility lines when lines cross wetlands.	American Wigeon Caspian Tern Connecticut Warbler Harris's Sparrow Marbled Godwit Sora Trumpeter Swan Tundra Swan (Eastern) Virginia Rail Whooping Crane	82
					Use the best available knowledge and technology when designing and installing new utility lines to minimize injury to birds.			83
					Use deterrents to prevent contact with dangerous lines/parts (e.g., jumper wires and conductors) and discourage perching. Ensure lines are adequately spaced (e.g., 60 inch horizontal and 48 inch vertical spacing allows safe passage for an eagle).			83
				1.2 Resource and habitat protection	Limit installing new lines in areas that have not been previously developed; place new lines along existing right-of-ways.	Meta-analysis revealed a decline of 28-36% in birds within 2.6 km of human infrastructure. Relatively undeveloped areas such as the boreal should be left intact as much as possible as construction and operation of infrastructure such as power lines in these areas results in species declines.		81
				4.2 Training	Training in best available knowledge and technology regarding utility lines is essential for			82

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					those designing and installing lines. Understand what birds in the region are at risk and implement species-specific changes to the technology.			
5.1 Hunting and Collecting Terrestrial Animals	Sustainable landbird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative harvest rates for legally hunted species using best available information.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	Sharp-tailed Grouse Spruce Grouse	9
					Implement hunting restrictions/limits in areas where populations are vulnerable to local extirpation.			9 10
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			110
				1.1 Site/area protection	Conserve and manage habitat of hunted species. Maintain a system of static habitat reserves on crown lands to ensure protection of wetlands and to function as ecological benchmark areas.	Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	Waterbirds and shorebirds may be persecuted for various reasons (e.g., considered a pest, mistaken for other species, egging).	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American Bittern American White Pelican	
				4.3 Awareness and communications	Promote awareness and education regarding inappropriately persecuted species of birds.		Arctic Tern Black-crowned Night-Heron Caspian Tern Common Tern Sora Virginia Rail Whooping Crane	
5.1 Hunting and Collecting Terrestrial Animals	Sustainable waterfowl hunting within legal limits can aid in species and habitat	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative limits on legally hunted species using best available science.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of	American Wigeon Barrow's Goldeneye Blue-winged Teal Bufflehead Cackling Goose Canvasback	9 10 110

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.					individuals taken should be verified by survey.	Common Goldeneye Gadwall Green-winged Teal Lesser Scaup Mallard Northern Pintail Northern Shoveler Redhead Ring-necked Duck Surf Scoter White-winged Scoter	
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			
				1.1 Site/area protection	Conserve and manage species habitat in areas where hunting occurs.	Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	Sustainable shorebird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative limits on legally hunted species using best available science.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	Wilson's Snipe	9 10 110
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			
				1.1 Site/area protection	Conserve and manage species habitat in areas where hunting occurs.	Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	These species are taken by Aboriginal people for subsistence hunting.	7.2 Improve harvest monitoring	Increase monitoring of species taken for subsistence hunting.	8.2 Monitoring	Collect information on what species are taken for subsistence hunting as well as how many individuals of each species.	Birds in the boreal are important for subsistence hunting purposes, however there is little information available on numbers of species that are taken. Increased data gathered through monitoring will help in the management of these species. E.g., there are very few data on numbers and species of geese and ducks taken in northern Canada and Alaska by subsistence hunters, making it difficult to obtain accurate harvest estimates for population management.	Arctic Tern Long-tailed Duck Pacific Loon	90 84

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
5.2 Gathering Terrestrial Plants	Peat mining results in habitat loss and degradation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Maintain intact **peatland** habitat within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).	1.1 Site/area protection	Protect large complexes of bogs and fens so that the size, shape and spatial arrangement of these habitats are represented at a regional scale, through **fee simple** purchase, **conservation easements**, or creation of parks/protected areas.	Conservation of large intact **peatlands** will ensure that there is habitat available for **peatland** nesting bird species.	Bonaparte's Gull Greater Yellowlegs Hudsonian Godwit Rusty Blackbird Short-billed Dowitcher Solitary Sandpiper Whimbrel Yellow Rail	11
				2.1 Site/Area Management	Management for peat mining should favour leaving large intact islands of **peatland** and clustering residual patches (patches free of mining activity) together.	Zoning areas (to designate mine and no-mine areas) will decrease edge effects and will increase habitat value to birds and other wildlife.		12
				8.1 Research	Continued research of more sustainable mining techniques as well as restoration techniques for **peatlands** that have been previously mined.	There are relatively few published studies on effects of peat mining on wildlife including ways to mitigate negative impacts. Increased research effort will allow for better practices in the industry.		
				4.3 Awareness and communications	Promote awareness of detrimental and irreparable effects of peat mining on the environment.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives will increase awareness of impacts by consumers.		
				6.2 Substitution	Promote use of alternatives to peat moss in gardening such as compost and mulch.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives will increase awareness of impacts by consumers.		
5.3 Logging and Wood Harvesting	Removal of trees around wetlands results in habitat loss for tree-nesting species, water level drawdowns and wetland habitat degradation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan forestry to maintain large, contiguous areas of natural wetlands surrounded by intact forest throughout the region, within the **natural range of variation** (size, shape, spatial	1.1 Site/area protection	Create a system of protected areas that represent the size, shape, and spatial arrangement of all wetland **ecosites** at a regional scale.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. The boreal landscape should consist of a heterogeneous mix of wetlands and large areas of natural forest distributed throughout the region.	Black Tern Bonaparte's Gull Bufflehead Common Goldeneye Great Gray Owl Greater Yellowlegs Killdeer	15 85
				5.1 Legislation	Legislate requirements to leave forested **riparian** areas intact along all wetlands.	The width of the **riparian buffer** zone should depend on the sensitivity and hydrology of the surrounding landscape, taking into account factors such as wetland type and slope (steeper areas should have wider	Lesser Yellowlegs Northern Hawk Owl Olive-sided Flycatcher Pied-billed Grebe	106

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
			arrangement of all habitat types).			buffers for erosion control). **Riparian** areas span the transition area between aquatic and terrestrial vegetation and are important in stabilizing banks, filtering nutrients, buffering against fluctuating water levels, and provide habitat for many different species.	Short-billed Dowitcher Solitary Sandpiper Sora Spruce Grouse Upland Sandpiper Western Tanager White-throated Sparrow White-winged Crossbill	
				2.1 Site/Area Management	Preferentially avoid harvesting near wetlands wherever possible and retain forested **riparian buffer** zones along all wetlands, regardless of wetland permanency.	The width of the **riparian buffer** zone should depend on the sensitivity and hydrology of the surrounding landscape, taking into account factors such as wetland type and slope (steeper areas should have wider buffers for erosion control). GIS/remote sensing- based precision conservation tools can help determine buffer area and extent. This could particularly be useful in landscapes that are a high priority for conservation.		106 107 115
				5.3 Private sector standards and codes	Manage forests surrounding wetlands to emulate natural disturbance processes that influence wetlands (e.g., fire, flooding, drought).	The Sustainable Forest Management Network provides recommendations on managing **riparian** areas with respect to harvesting.		116
					Avoid clear cutting in favour of selection harvesting practices to mimic patterns of natural disturbance (e.g., fire, insect outbreaks) and maintain forested habitat adjacent to wetlands.			116 115
					Avoid harvesting activities during nesting and brood rearing periods.	This will allow for broods to fledge prior to commencement of harvesting activities and mitigation of direct bird mortality.		115
					Ensure regeneration of original stand characteristics of harvested trees. Re-vegetate forested land with a variety of species representative of natural forest types for the area that will not require irrigation.	It is important that wetland-associated tree species (e.g., black spruce) are regenerated when harvested and are not replaced by more easily replaceable forest types in order to preserve wetland-associated vegetation. Establishment of forest monoculture plantations involves irrigation which can drain wetlands.		19
					Harvesting **peatlands** should seek to minimize compaction of peat.	Harvesting **peatlands** causes compaction of hummock features which results in a change in the regenerating plant community; harvesting during the winter while ground is frozen should lessen these long term effects.		117

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				4.2 Training	Training for forestry practitioners in sustainable methods of forestry.			110
6.1 Recreational Activities	Recreational Activities such as boating, fishing and visiting colonies of colonial waterbirds can cause flooding and/or abandonment of nests and young as well as disruption of activities during migration.	4.1 Reduce disturbance from human recreation	Limit disturbance to aquatic birds, particularly during key periods of their breeding cycle (courtship, incubation, nestling, migration).	2.1 Site/area management	Monitor effects of fishing activity during nesting and migrating periods for waterbirds and waterfowl. Restrict fishing in areas with sensitive species.	Reaction to human disturbance is species-specific. Disturbance on Oklahoma migration lakes caused increased alertness and altered feeding strategies.	American Bittern American White Pelican American Wigeon Arctic Tern Black Tern Blue-winged Teal Caspian Tern Common Loon Common Tern Forster's Tern Gadwall Green-winged Teal Mallard Northern Pintail Northern Shoveler Pied-billed Grebe Trumpeter Swan	86
					Access to bird breeding colonies should be restricted during the breeding season, both by land and water.	Colonial birds are highly sensitive to disturbance; large numbers of visitors can have great impacts.		3
					Limit recreational boating on lakes with important breeding colonies.	Recreational disturbance through boating can cause disruption and flooding of nests due to waves in the short term and colony abandonment in the long term (e.g., Western Grebes in Alberta).		87
				1.1 Land/water protection	Establish protected areas surrounding significant staging areas for waterbirds and waterfowl as well as surrounding breeding colonies of colonial waterbirds with limited human access via land or water.	Limiting human access during important times in species life cycles will limit negative effects on these species due to human disturbance.		
6.1 Recreational Activities	Terrestrial-based recreational activities such as bird watching, hiking and rock climbing can result in nest abandonment and disturbance of landbirds.	4.1 Reduce disturbance from human recreation	Limit disturbance to landbirds, particularly during key periods of their breeding cycle (courtship, incubation, and nestling).	2.1 Site/area management	Creation of well-defined trails in recreation areas will encourage visitors to stay on paths.		Northern Harrier Sharp-tailed Grouse	88
					Access to important breeding areas for these species should be limited during the breeding season.	Limiting human access during important times in species life cycles will limit negative effects on these species due to human disturbance.		
6.3 Work and Other Activities	Non-recreational activities near nesting and brood-rearing avian species can result in nest desertion, premature	4.2 Reduce disturbance from industrial or work activity	Limit disturbance to birds, particularly during key periods of their breeding cycle.	2.1 Site/area management	Limit conducting research related work during the breeding season or minimize impact to active breeding areas/colonies.		American White Pelican Arctic Tern Barrow's Goldeneye Black Tern Bonaparte's Gull California Gull Caspian Tern	
					Limit unnecessary disturbance when conducting avian research related work during the breeding season. Avoid and mitigate disturbance to non-target species.	The government of British Columbia provides guidelines for surveying and handling birds for research purposes. Similar guidelines should be created for boreal jurisdictions.		89
				4.2 Training	Training for anyone working in and near areas			

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	fledging, among other negative effects.				with sensitive species. Training should outline methods and best practices to limit disturbance to these species.		Common Loon Common Tern Common Yellowthroat Eared Grebe Forster's Tern Golden-winged Warbler Northern Harrier Pacific Loon Red-necked Phalarope Sedge Wren Sharp-tailed Grouse Short-billed Dowitcher Trumpeter Swan Virginia Rail Whimbrel White-throated Sparrow	
7.1 Fire and Fire Suppression	Burning of wetlands destroys specialist habitat of some avian species.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Maintain large, contiguous areas of natural wetlands throughout the region, within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).	2.3 Habitat and natural process restoration	Utilize **prescribed burns** in wetland and upland areas to emulate a **natural disturbance regime**. Re-seed burned fields with native perennial grasses that can compete with invasive plant species.	Years of fire suppression can result in encroachment of woody vegetation and a buildup of fuel for potential fire that would not build up naturally; selectively and carefully burning certain areas can help to maintain natural wetland habitat.		90 116
					Avoid burns during nesting and brood-rearing periods.		American Bittern Sedge Wren Sora Virginia Rail Yellow Rail	90
				4.2 Training	Train forest managers in **prescribed burn** implementation and management.			
				8.1 Research	Continue research on effects of fire in wetlands and best practices regarding using **prescribed burns** in emulating natural disturbance patterns in boreal Canada; focus research on response of boreal birds to forest management practices.			
				8.2 Monitoring	Conduct monitoring to provide status and trend data for wetland-associated species.			
7.1 Fire and Fire Suppression	Widespread fire suppression in the boreal results in change in	1.3 Ensure the continuation of natural processes that maintain bird habitat	Maintain large, contiguous areas of natural wetlands throughout the	2.3 Habitat and natural process restoration	Consider the use of **prescribed burns** in wetland and upland areas to emulate a **natural disturbance regime** that resulted from interactions between wildfires and native	The Sustainable Forest Management Network provides recommendations on planning and best practices regarding **riparian** areas.	Bobolink Le Conte's Sparrow Northern Hawk Owl Olive-sided Flycatcher	91 116

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	species composition and encroachment of woody vegetation in wetlands.		region, within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).		ungulates (i.e., bison). Re-seed burned fields with native perennial grasses that can compete with invasive plant species.		Purple Martin	
					Avoid burns during nesting and brood-rearing periods.			90
				4.2 Training	Train forest managers in **prescribed burn** implementation and management.			
				8.1 Research	Continue research on effects of fire in wetlands and best practices regarding using **prescribed burns** in emulating natural disturbance patterns in boreal Canada.			
				8.2 Monitoring	Conduct monitoring to provide status and trend data for wetland-associated species.			
7.2 Dams and Water management/use	Changes in flow regimes including dams and water drawdowns may reduce water availability, strand or flood nests, or reduce natural variability in water levels	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	American Bittern American White Pelican Black-crowned Night-Heron California Gull Caspian Tern Eared Grebe Forster's Tern Greater Yellowlegs Horned Grebe Hudsonian Godwit Pied-billed Grebe Red-necked Grebe Short-billed Dowitcher Sora Virginia Rail Whooping Crane Yellow Rail	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted		19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
				5.2 Policies and regulations	Implement policy changes that regulate anthropogenic water drawdowns, particularly during timing of nesting and brood rearing.	Anthropogenic water drawdowns cause water to disappear from natural waterbodies and can strand nests of waterbirds, waterfowl and shorebirds.		
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	8.1 Research	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Alder Flycatcher Common Nighthawk Olive-sided Flycatcher Purple Martin	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring needs	Support increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.1 Invasive Non-native/Alien Species	Mortality from West Nile virus.	7.4 Improve understanding of causes of population declines	Determine population-level impacts of West Nile virus.	8.0 Research and Monitoring	Promote funding for **trend monitoring** efforts to determine the prevalence of West Nile virus in raptors and owls, and for modeling efforts to determine the population-level impacts.	West Nile virus can be a significant cause of mortality in owls and raptors, although the population-level effects are unknown.	Great Gray Owl Short-eared Owl	30
8.1 Invasive Non-native/Alien Species	Purple Loosestrife/other invasive plants may alter native vegetation communities and decrease habitat suitability.	7.1 Improve population/demographic monitoring	Determine population-level impacts of purple loosestrife/other invasive plants.	8.0 Research and Monitoring	Provide funding for researchers to conduct properly designed studies to measure the impact, if any, of invasive plant species on bird populations.	Impacts of invasive plants on native bird species are unclear, and the validity of much research claiming negative impacts of non-native plant invasions has been called into question due to biases or faulty methods. For example, purple loosestrife is commonly claimed to be unsuitable as nesting habitat; however, Whitt et al. (1999)[94] found ten avian species breeding in loosestrife-dominated habitat, with densities being	Black Tern Pied-billed Grebe	92 93 94

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						higher for some species and lower for others compared to other vegetation types.		
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/predation	Reduce rates of brood parasitism.	2.2 Invasive/problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Golden-winged Warbler Le Conte's Sparrow Nelson's Sparrow	32 33 34
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
8.2 Problematic Native Species	Increased nest predation by generalist predators may limit populations.	2.5 Reduce parasitism/predation	Improve nesting/fledgling success by limiting nest predation by generalist predators.	8.1 Research	Determine causes of increased nest predation and/or abundance of generalist nest predators (e.g., human development, edge effects, linear features, increased rodent density due to agriculture).	Landscape impacts on nest predation rates may be complex and operate at multiple spatial scales, and are therefore difficult to measure and quantify.	Horned Grebe	34
8.2 Problematic Native Species	Overabundant Lesser Snow Geese (Western Arctic population) denude vegetation, destroy habitat, and are a reservoir for avian cholera.	3.2 Reduce competition with problematic native species	Reduce abundance of Lesser Snow Geese populations breeding in BCR 6 (Western Arctic).	2.2 Invasive/problematic species control	Breeding ground impacts of Lesser Snow Goose (Western Arctic) have been documented although impact of grazing at stopover sites is unknown. Intensive management will be required to reduce density of this Lesser Snow Goose population.	Decreasing Snow goose density will require large-scale, intensive management efforts possibly during breeding since recent evidence suggests that increased bag limits and extended hunting seasons (e.g., spring hunting) are not effective.	Lesser Snow Goose (Western Arctic)	95 96

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
8.2 Problematic Native Species	Avian botulism can be a major source of mortality and appear episodically in lakes where it is endemic.	2.6 Reduce the spread of disease	Prevent or limit the scope of botulism outbreaks in lakes where they occur commonly.	8.2 Monitoring; and 2.2 Invasive/problematic species control	Implement monitoring programs in lakes where avian botulism occurs frequently to identify lakes with a high density of bird/vertebrate carcasses that could provide an initial substrate for *Clostridium botulinum*, the causative agent of botulism.	*C. botulinum* develops in maggot-infested vertebrate carcasses in lakes. The initial substrate is often unknown, but can likely be any suitable supply of carcasses; once an epidemic takes hold and botulism-killed carcasses are present to propagate *C. botulinum*, carcass removal is ineffective at mitigating epidemics. Identification and removal of the primary substrate is therefore required.	American White Pelican Common Loon Eared Grebe Greater Yellowlegs Marbled Godwit	97
8.2 Problematic Native Species	Competition with and nest predation by gulls.	3.2 Reduce competition with problematic native species	Reduce gull populations at sensitive sites such as tern colonies.	2.2 Invasive/problematic species control	Consider implementing culling programs for target gull species at sensitive tern colonies to reduce the number of predatory gulls.	Culling predatory gulls can drastically limit or eliminate nest predation of terns, but culls must be repeated annually.	Arctic Tern Caspian Tern Common Tern	98
8.2 Problematic Native Species	Domination of wetlands and waterbodies by cattails reduces habitat suitability.	1.3 Ensure continuation of natural processes that maintain bird habitat	Promote avian diversity by restoring cattail-dominated emergent areas to a mixture of open water and emergent vegetation.	2.2 Invasive/problematic species control; 2.3 habitat and natural process restoration	Implement cattail control programs using removal methods, grazing, or **prescribed burning** to selectively remove patches of cattails.	Clearing cattails from wetlands to restore a mixture of emergent vegetation and open water led to increases in Black Tern abundance.	Black Tern	99
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Black-crowned Night-Heron Blue-winged Teal Bufflehead Cackling Goose Canvasback Caspian Tern Common Tern Mallard Northern Shoveler Peregrine Falcon (*anatum/tundrius*) Red-necked Grebe Surf Scoter Trumpeter Swan White-winged Scoter	

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides that may affect wetlands directly or through runoff.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	American Wigeon Bobolink Cackling Goose Common Yellowthroat Lesser Yellowlegs Northern Harrier Peregrine Falcon (*anatum/tundrius*) Red-necked Grebe Sharp-tailed Grouse	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
9.3 Agricultural and Forestry Effluents	Pesticides used to control forest pests may have direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Decrease chemical pesticide use to limit potential toxic effects and maintain insect prey populations.	6.2 Substitution	Replace chemical insecticides with microbial agents (e.g., *Bacillus thuringiensis*, or *Bt*) or lepidopteran-specific insecticides (e.g., tebufenozide, also known as MIMIC) that have low toxicity to vertebrates.	Tennessee Warblers were not significantly affected by application of the lepidopteran-specific pesticides *Bt* or MIMIC.	White-throated Sparrow	37
				8.1 Research	Continue researching factors that promote the initiation of insect pest (e.g., spruce budworm) outbreaks and the functional and numerical responses of avian predators to changes in insect abundance.	Control of spruce budworm has been linked to declining abundance of avian predators, but it is unclear whether spruce budworm abundance can be controlled by avian predators when below outbreak densities.		22
					Continue researching the non-target effects of pesticides on non-target species.			
9.3 Agricultural and Forestry Effluents	Eutrophication decreases water quality.	1.5 Reduce habitat degradation from contaminants	Reduce runoff of fertilizers from agricultural areas.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field require fertilizer, and apply fertilizer at a variable rate to minimize excess fertilizer and runoff.	Spatially variable application of fertilizer is capable of reducing **nitrate leaching** and nutrient runoff while increasing yields, but carries additional costs in the form of soil sampling, imagery, and data analysis.	Horned Grebe	100 101
				2.1 Site/area management	Maintain existing wetlands and restore those that have been degraded on private land.	Healthy **riparian** areas and wetlands filter and store nutrients and improve water quality.		77
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing	Canvasback Common Loon Lesser Scaup Lesser Snow Goose (Western Arctic) Long-tailed Duck Northern Harrier Pacific Loon	38 39

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
						ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is restricted.	Ring-necked Duck Sora Trumpeter Swan Tundra Swan (Eastern) White-throated Sparrow	
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38
9.4 Garbage and Solid Waste	Ingestion of garbage such as plastic at dumps can cause choking or entanglement.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce gull use of dumps/landfills.	2.1 Site/area management	Employ overhead wires and/or netting to exclude gulls from foraging at waste sites. Frightening devices may also deter gulls.	Overhead wires can exclude the majority of gulls, and netting can exclude all gulls if deployed properly. Gulls may become habituated to frightening devices, so they are likely only a short-term solution. Use of falcons can also be effective, but lethal control can be controversial with the general public, so non-lethal management is preferable.	California Gull	74 75
				5.2 Policies and regulations	Expand composting programs for municipal waste so that anthropogenic food and plastic/garbage are not located at the same site.	Waste disposal facilities that do not contain food/putrescible waste will not attract gulls.		74
9.5 Air-borne pollutants	Acid precipitation degrades habitat quality.	1.5 Reduce habitat degradation from contaminants	Reduce emissions of air-borne pollutants.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
				5.3 Private sector standards and codes	Encourage industries to employ spatial and climatic modeling in order to minimize emissions during times or at locations when pollution would be most damaging.	For example, emissions from a coal-fired power plant could be minimized when wind patterns would carry pollution to more sensitive areas, either by delaying activity or reallocating energy production to other facilities. Altering the spatial and temporal distribution of emissions could have economic benefits for polluters (i.e., if the tax on emissions is lower in/at less-damaging locations/times). This is an improvement on a cap-and-trade system, which may be capable of lowering total emissions, but is unable to minimize the damage caused for a given level of emissions.	Rusty Blackbird	40
9.6 Excess Energy	Lower density observed in areas affected by noise from compressor stations on pipelines.	4.2 Reduce disturbance from industrial or work activity	Reduce noise levels at industrial sites.	5.3 Private sector standards and codes	Beneficial management practices for construction of new compressor stations should include noise suppression technology, and existing stations should be retrofitted with noise-suppressing technology.	Retrofitting existing compressor stations to reduce the decibel level mitigates noise impacts on forest songbirds.	White-throated Sparrow	41

Table 19 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
11.1 Habitat shifing and alteration					See Climate Change in Widespread Issues for Priority Species in BCR 6 (Table 28)		Arctic Tern, Bonaparte's Gull Smith's Longspur	
12.1 Information lacking	Some species are in decline throughout the region but reasons for the decline remain unknown.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of these species in order to undertake conservation action to reverse the decline.	8.1 Research	Continued research throughout the region to understand the reasons for the decline of Lesser Scaup, Least Sandpipers and Semipalmated Sandpipers.		Least Sandpiper Lesser Scaup Semipalmated Sandpiper	
				8.2 Monitoring	Increased **trend monitoring** of Lesser Scaup, Least Sandpiper and Semipalmated Sandpiper populations throughout the boreal.			

Bare Areas

Bare areas (areas devoid of vegetation) are habitats that occur across BCR 6 in the form of bare rock, mudflats, upland sand dunes, and coarse soils and rock adjacent to water bodies (shoreline, beach) (Fig. 29). A large majority of bare-area habitats in BCR 6 consist of rocky outcrops and sand/gravel substrates, which are often associated with rivers and lakes. There are 13 species that utilize bare areas, 4 of which are federally or provincially protected under species at risk legislation (Table 20). These birds use bare ground primarily for nesting and accessing food sources in close proximity to aquatic ecosystems. Several of these birds are at risk of decline, although the causes are not well understood. Threats to these species are complex (Fig. 30) but are likely due to changes in the abundance of food resources (threat sub-category 7.3; potentially impacted by pollution, sub-category 9.2), invasive species (sub-category 8.2), human disturbance (sub-categories 6.1 and 6.3) and direct mortality (sub-category 5.1). Key conservation actions to manage species using bare-area habitat include both the establishment of well-defined recreational areas and the protection of significant staging or breeding areas for priority species; programs to target problematic invasive species; and increased monitoring and regulatory actions that will enhance understanding of risks and impacts of human activities within bare-area habitats (Table 21).

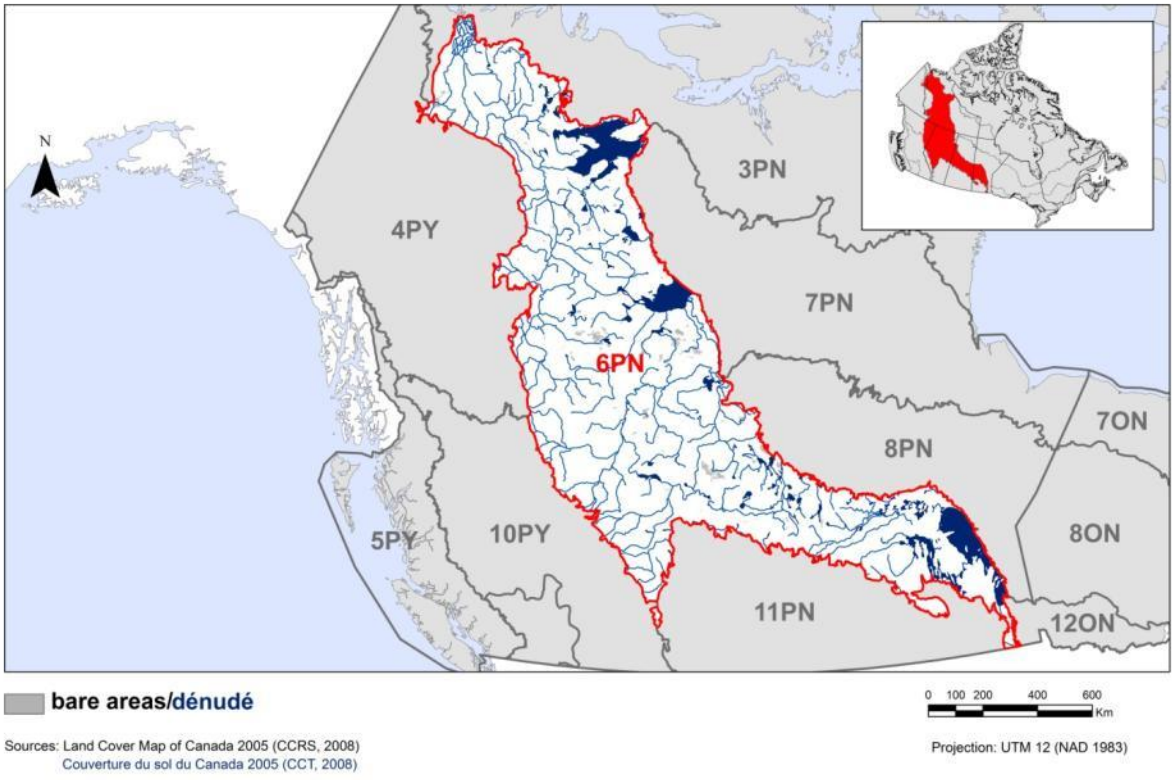


Figure 29. Map of bare area habitat in BCR 6 at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing.

Table 20. Priority species that use bare area habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American White Pelican	Bare soil, sand or rock	Islands	Assess/Maintain	Y	Y	Y		Y	
Arctic Tern	Rocky islands; barrier beaches; sand or gravel	Islands	Increase 50%		Y	Y			
Bank Swallow	Banks of streams, rivers, or lakes	Vertical stream banks (human-made or natural)	Assess/Maintain					Y	
Black-crowned Night-Heron	All types	Ledges or protected sites for nesting on islands or over water	Increase 50%					Y	
Caspian Tern	Rocky islands, beaches, and sandy shores	Islands	Maintain Current		Y	Y		Y	
Common Nighthawk	Dunes, rocky outcrops, barrens, burned over and logged areas	Open ground	Recovery Objective	Y	Y			Y	
Common Tern	Sand, gravel, shell or cobble substrates	Islands	Assess/Maintain		Y	Y			
Eastern Phoebe	Natural niches, rocky outcrops	Overhang for nest site (natural or human-made structure)	Increase 100%					Y	
Eastern Whip-poor-will	Barrens with scattered pine and oak	Open understory	Recovery Objective	Y	Y			Y	
Herring Gull	Rock, sand, beaches	Islands	Increase 50%		Y	Y			
Killdeer	Gravel, sand, mudflats		Increase 50%		Y	Y			
Peregrine Falcon (*anatum/tundrius*)	All types	Cliffs or ledges or human-made structures for nesting	Assess/Maintain	Y	Y			Y	
Semipalmated Sandpiper	Rock and sand		Increase 100%		Y	Y		Y	Y

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

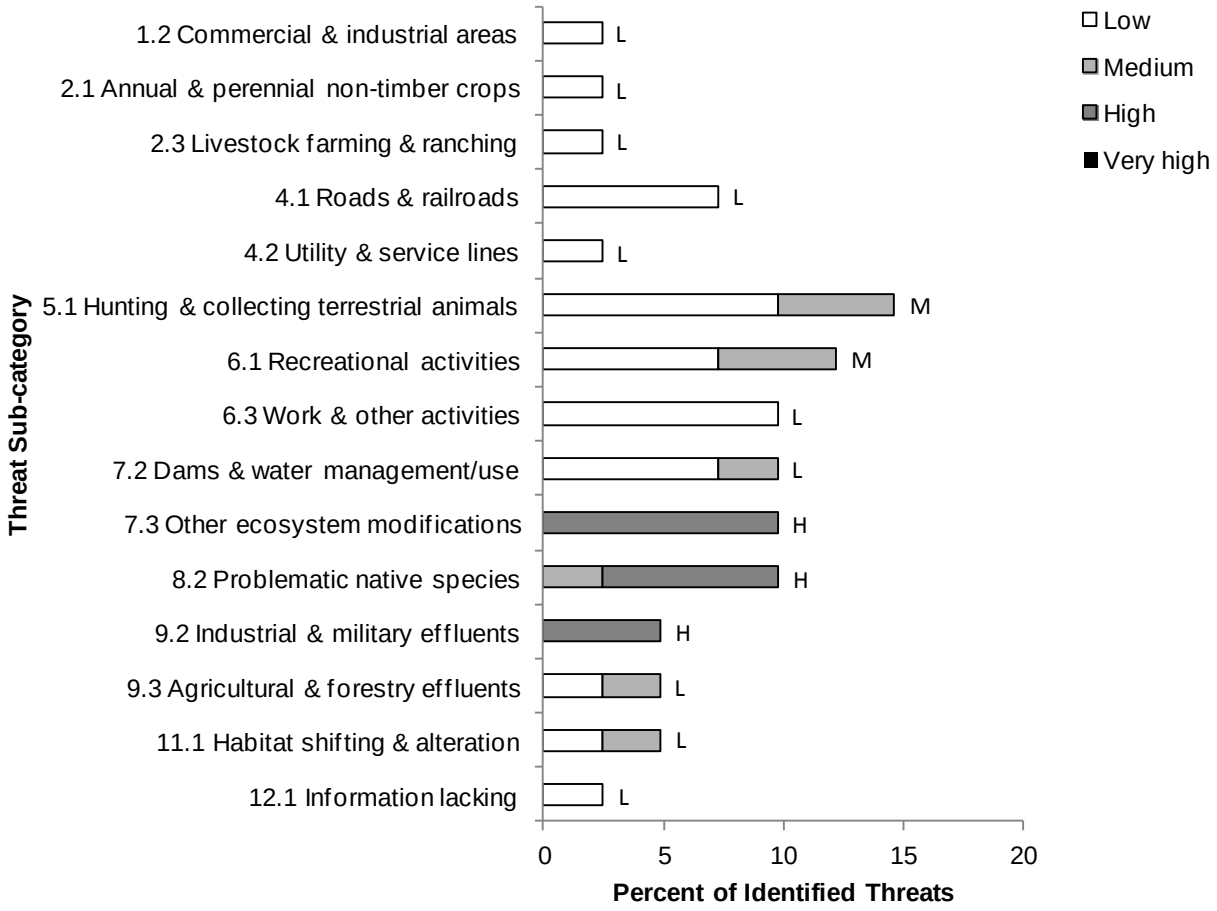


Figure 30. Percent of identified threats to priority species in bare habitat in each threat sub-category. Each bar represents the percent of the total number of threats identified in each threat sub-category in bare habitat (for example, if 100 threats were identified in total for all priority species in bare habitat, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in bare habitat is shown at the end of each bar (also presented in Table 4). **Note:** Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 21. Threats addressed, conservation objectives, recommended actions and priority species affected for bare area habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
5.1 Hunting and Collecting Terrestrial Animals	Waterbirds and shorebirds may be persecuted for various reasons (e.g., considered a pest, mistaken for other species, egging).	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	Arctic Tern Caspian Tern Common Tern Herring Gull Killdeer	
				4.3 Awareness and communications	Promote awareness and education regarding inappropriately persecuted species of birds.			
5.1 Hunting and Collecting Terrestrial Animals	These species are taken by Aboriginal people for subsistence hunting.	7.2 Improve harvest monitoring	Increase monitoring of species taken for subsistence hunting.	8.2 Monitoring	Collect information on what species are taken for subsistence hunting as well as how many individuals of each species.	Birds in the boreal forest are important for subsistence hunting purposes, however there is little information available on numbers of species that are taken. Increased data gathered through monitoring will help in the management of these species. E.g., there are very few data on numbers and species of geese and ducks taken in northern Canada and Alaska by subsistence hunters, making it difficult to obtain accurate harvest estimates for population management.	Arctic Tern	90 84
6.1 Recreational Activities	Recreational activities such as boating, fishing and visiting colonies of colonial waterbirds can cause flooding and/or abandonment of nests and young as well as disruption of activities during migration.	4.1 Reduce disturbance from human recreation	Limit disturbance to aquatic birds, particularly during key periods of their breeding cycle (courtship, incubation, nestling, migration).	2.1 Site/area management	Monitor effects of fishing activity during nesting and migrating periods for waterbirds and waterfowl. Restrict fishing in areas with sensitive species.	Reaction to human disturbance species-specific. Disturbance on Oklahoma migration lakes caused increased alertness and altered feeding strategies.	American White Pelican Arctic Tern Caspian Tern Common Tern	86
					Access to bird breeding colonies should be restricted during the breeding season, both by land and water.	Colonial birds are highly sensitive to disturbance; large numbers of visitors can have great impacts.		3
					Limit recreational boating on lakes with important breeding colonies.	Recreational disturbance through boating can cause disruption and flooding of nests due to waves in the short term and colony abandonment in the long term (e.g., Western Grebes in Alberta).		87
				1.1 Land/water protection	Establish protected areas surrounding significant staging areas for waterbirds and waterfowl as well as surrounding breeding colonies of waterbirds with limited human access via land or water.	Limiting human access during important times in species life cycles will limit negative effects on these species due to human disturbance.		
6.1 Recreational Activities	Terrestrial-based recreational	4.1 Reduce disturbance from	Limit disturbance to	2.1 Site/area management	Creation of well-defined trails in recreation areas will encourage visitors to stay on paths.		Peregrine Falcon (*anatum/tundrius*)	88

Table 21 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
	activities such as bird watching, hiking and rock climbing can result in nest abandonment and disturbance of landbirds.	human recreation	landbirds, particularly during key periods of their breeding cycle (courtship, incubation, and nestling).		Access to important breeding areas for these species should be limited during the breeding season.	Limiting human access during important times in species life cycles will limit negative effects on these species due to human disturbance.		
6.3 Work and Other Activities	Non-recreational activities near nesting and brood-rearing avian species can result in nest desertion, premature fledging, among other negative effects.	4.1 Reduce disturbance from human recreation	Limit disturbance to birds, particularly during key periods of their breeding cycle.	2.1 Site/area management	Limit conducting research related work during the breeding season or minimize impact to active breeding areas/colonies.		American White Pelican Arctic Tern Caspian Tern Common Tern	
					Limit unnecessary disturbance when conducting avian research related work during the breeding season. Avoid and mitigate disturbance to non-target species.	The government of British Columbia provides guidelines for surveying and handling birds for research purposes. Similar guidelines should be created for boreal jurisdictions.		89
				4.2 Training	Training for anyone working in and near areas with sensitive species. Training should outline methods and best practices to limit disturbance to these species.			
7.2 Dams and Water Management/Use	Changes in flow regimes may reduce water availability, strand or flood nests, or reduce natural variability in water levels.	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	American White Pelican Bank Swallow Black-crowned Night Heron Caspian Tern	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20

Table 21 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	9.0 Research needs and/or science needs	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.		28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.		Bank Swallow Common Nighthawk Eastern Phoebe Eastern Whip-poor-will	
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Support increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.2 Problematic Native Species	Brood parasitism by Brown-headed Cowbirds reduces reproductive output.	3.3 Reduce parasitism/preda-tion	Reduce rates of brood parasitism.	2.2 Invasive/problematic species control	Promote programs to control Brown-headed Cowbirds. Importance should be placed on areas where the cowbird range overlaps with the range for species at risk (SAR) and areas at the edge of the cowbird range; this species continues to expand from agricultural to forest habitats where it can take advantage of naive hosts.	Brown-headed Cowbird management and control is a proven and effective management tool in the conservation of species at risk or priority songbirds. Trapping of Brown-headed Cowbirds for relocation from areas occupied by species at risk can be a cost-effective management strategy.	Eastern Phoebe	32 33 34

Table 21 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
				8.1 Research	Conduct research to investigate range expansion mechanisms, seasonal dispersal, daily movement patterns, and host-detection behaviour of Brown-headed Cowbirds in the boreal forest.	The breeding behaviour and movement patterns of Brown-headed Cowbirds in forest habitats differ from traditional habitats associated with this species (e.g., agriculture, rangeland/grassland, urban/rural areas). Is the perforation of the boreal forest by linear features (roads, pipelines, seismic lines) and natural resource activities (forest harvesting, energy exploration and development) resulting in increased access to movement corridors and exposure to naive native hosts for Brown-headed Cowbirds?		32 33 34
8.2 Problematic Native Species	Competition with and nest predation by gulls.	3.2 Reduce competition with problematic native species	Reduce gull populations at sensitive sites such as tern colonies.	2.2 Invasive/problematic species control	Consider implementing culling programs for target gull species at sensitive tern colonies to reduce the number of predatory gulls.	Culling predatory gulls can drastically limit or eliminate nest predation of terns, but culls must be repeated annually.	Arctic Tern Caspian Tern Common Tern	98
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Common Tern Peregrine Falcon (*anatum/tundrius*)	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	Killdeer Peregrine Falcon (*anatum/tundrius*)	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		

Note: Only threats ranked as medium magnitude or higher in bare areas were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for bare areas (Table 20) but not listed in the associated threats table (Table 21 above). These priority species either have no known threats in bare areas or have known threats in bare areas that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Semipalmated Sandpiper, for example, is associated with bare areas but does not appear inTable 21 because identified threats for Semipalmated Sandpipers in this habitat were ranked as low (e.g., 12.1 Information lacking). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Artificial Surfaces

Artificial surfaces make up a small proportion of the BCR, and include buildings, parking lots, garbage dumps, and other human-made sites and structures typically associated with urban areas (Fig. 31). Nine priority species in BCR 6 use this habitat class by utilizing available artificial surfaces (parking lot, landing strip/pad) or human-made structures (buildings, bridges) that provide substitute habitats for naturally-occurring but rare habitats or habitat features (Table 22). Aerial insectivores (e.g., Chimney Swift, Barn Swallow, Bank Swallow) are common inhabitants of artificial surfaces. These species are thought to be in decline due to decreases in aerial insect populations (sub-category 7.3), but research initiatives to increase understanding of declines are needed to develop specific conservation actions. Many of the management issues in these human-associated habitats involve exposure to contaminants (sub-categories 9.2, 9.3, 9.4). Restricting use of these habitats for nesting or foraging may protect these species from exposure (e.g., Chimney Swifts in chimneys, gulls at garbage dumps). Within urban habitats, one threat facing Barn Swallows is the active removal of their nests from buildings (threat sub-category 6.3, Fig. 32). The primary action to address this threat is to increase public awareness of the species and reduce persecution (Table 23).

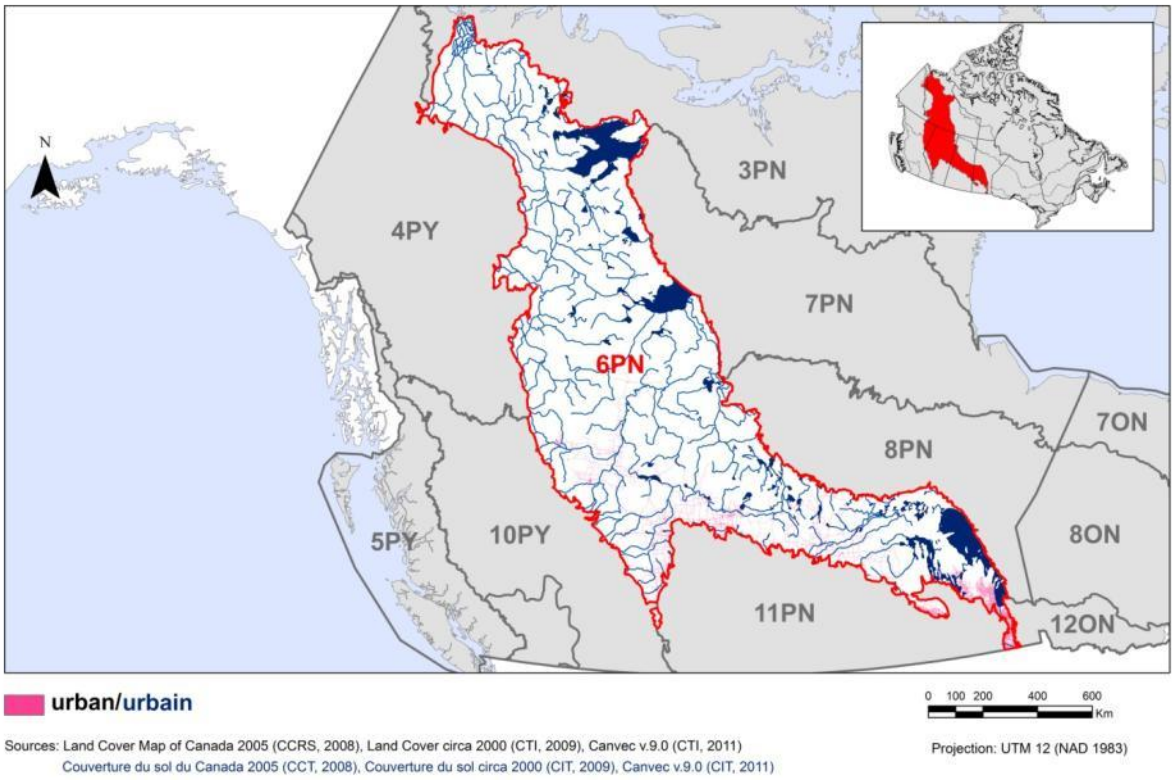


Figure 31. Map of artificial surfaces (urban habitat) in BCR 6, at 250 m resolution from the Land Cover of Canada 2005, Canadian Centre for Remote Sensing and Land Cover circa 2000, Centre for Topographic Information.

Table 22. Priority species that use artificial surface habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Bank Swallow	Human-made vertical banks (gravel pits, quarries)	Vertical stream banks (human-made or natural)	Assess/Maintain					Y	
Barn Swallow	Human-made structures	Overhang for nest site (human-made structure); water for mud to build nest	Increase 50%	Y				Y	
California Gull	Dumps; feed lots		Assess/Maintain		Y	Y			
Chimney Swift	Human-made structures	Chimneys/cavities for nest sites and communal roosts	Recovery Objective	Y	Y			Y	
Common Nighthawk	Gravel roofs; airports; mines	Open ground	Recovery Objective	Y	Y			Y	
Eastern Phoebe	Bridges, culverts, outbuildings	Overhang for nest site (natural or human-made structure)	Increase 100%					Y	
Herring Gull	Dumps; fish-processing plants; parking lots; fields; airports; roof tops		Increase 50%		Y	Y			
Killdeer	Construction sites; road shoulders; gravel roads and driveways; graveled rooftops; parking lots		Increase 50%		Y	Y			
Peregrine Falcon (*anatum/ tundrius*)	Quarries and buildings	Cliffs or ledges or human-made structures for nesting	Assess/Maintain	Y	Y			Y	

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

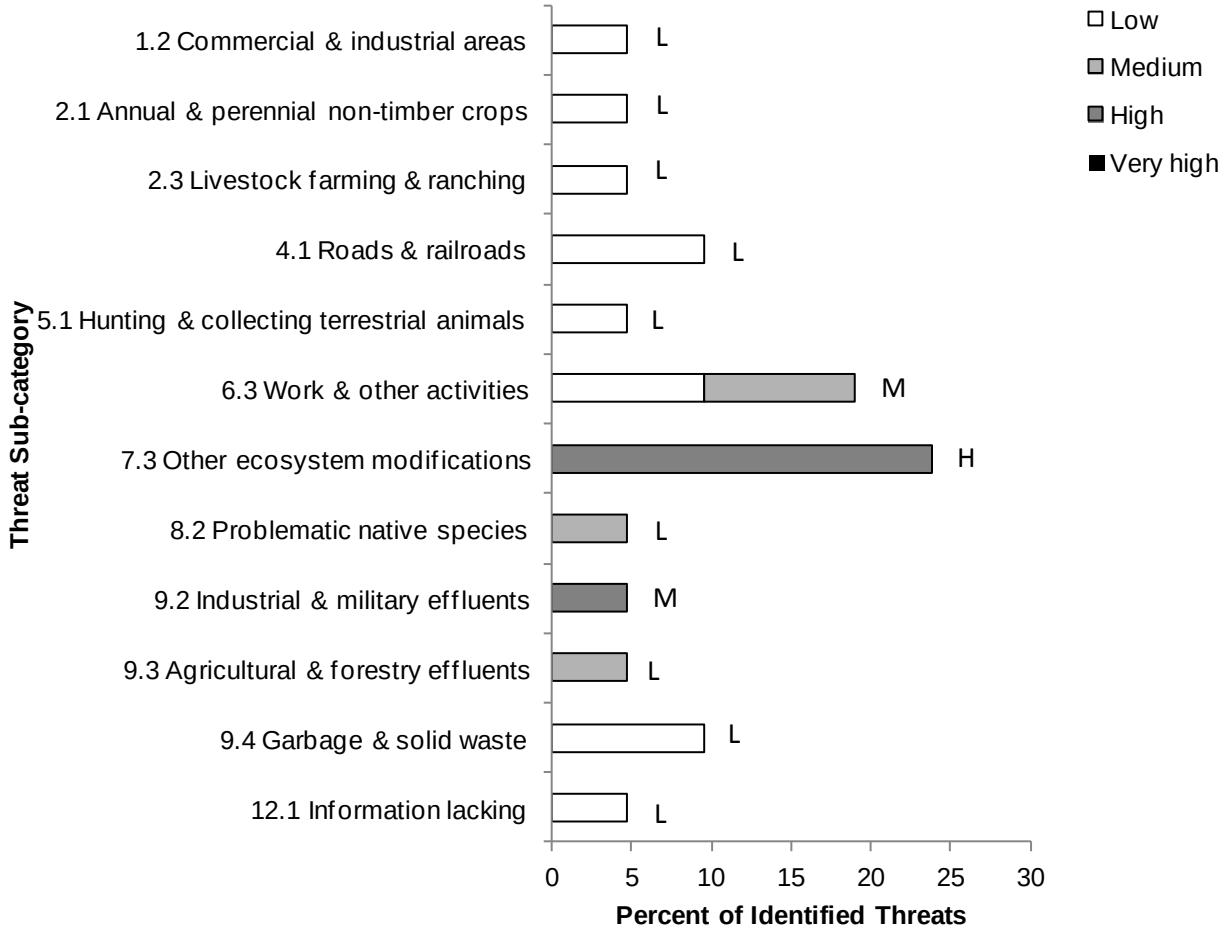


Figure 32. Percent of identified threats to priority species using artificial surfaces in each threat sub-category.

Each bar represents the percent of the total number of threats identified in each threat sub-category for artificial surfaces (for example, if 100 threats were identified in total for all priority species using artificial surfaces, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat affecting artificial surfaces is shown at the end of each bar (also presented in Table 4).

Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 23. Threats addressed, conservation objectives, recommended actions and priority species affected for artificial surface habitat in BCR 6.

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
6.3 Work and Other Activities	Loss of artificial nesting sites	1.4 Maintain important habitat features on the landscape	Provide sufficient nesting and roosting sites	2.1 Site/area Management	Maintain nesting/roosting sites in older human structures, and create new artificial nesting and roosting sites.	Programs to build artificial nests such as artificial chimneys have helped populations of these species.	Barn Swallow Chimney Swift Common Nighthawk Eastern Phoebe	102
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in populations of aerial insects.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of aerial insectivores in order to undertake conservation action to reverse the decline.	9.0 Research needs and/or science needs	Increase research efforts to examine 1) causes for decline in aerial insects, and 2) methods to reverse the decline.	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be done to conserve these species.	Bank Swallow Barn Swallow Chimney Swift Common Nighthawk Eastern Phoebe	28 29
					Increase research efforts examining non-target effects of pesticides and herbicides used widely in Canada.			
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Peregrine Falcon (*anatum/tundrius*)	
9.3 Agricultural and Forestry Effluents	Agricultural pesticide use has direct (toxic) and indirect (e.g., decreased prey abundance) effects.	2.1 Reduce mortality and/or sub-lethal effects from pesticide use	Reduce use of pesticides.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field are infested so that pesticide use can be restricted to these areas that require it.	Variable pesticide application can reduce pesticide use by 66-80%.	Peregrine Falcon (*anatum/tundrius*)	35 36
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		

Table 23 continued

Threats addressed	Brief description	Objective category	Objectives	Action category	Recommended actions	Justification	Priority species affected	Refs
9.4 Garbage and Solid Waste	Ingestion of garbage at dumps such as plastic can cause choking or entanglement.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce gull use of dumps/landfills.	2.1 Site/area management	Employ overhead wires and/or netting to exclude gulls from foraging at waste sites. Frightening devices may also deter gulls.	Overhead wires can exclude the majority of gulls, and netting can exclude all gulls if deployed properly. Gulls may become habituated to frightening devices, so they are likely only a short-term solution. Use of falcons can also be effective, but lethal control can be controversial with the general public, so non-lethal management is preferable.	California Gull Herring Gull	74 75
				5.2 Policies and regulations	Expand composting programs for municipal waste so that anthropogenic food and plastic/garbage are not located at the same site.	Waste disposal facilities that do not contain food/putrescible waste will not attract gulls.		74

Note: Only threats ranked as medium magnitude or higher in artificial surfaces habitat were included as threats addressed in the table above (see Table 4 for threat categories of medium or higher magnitude). Therefore, some priority species may be included in the priority species list for artificial surfaces habitat (Table 22) but not listed in the associated threats table (Table 23 above). These priority species either have no known threats in artificial surfaces habitat or have known threats in artificial surfaces habitat that were ranked with a low magnitude. Some of these priority species are, however, associated with medium or higher magnitude threats in other habitats. The Killdeer, for example, is associated with bare areas but does not appear in Table 23 because identified threats for Killdeers in this habitat were ranked as low (e.g., 1.2 Commercial and industrial areas). See Appendix B for further details on methodologies for selecting habitat associations and threats addressed.

Waterbodies

The waterbodies habitat class in BCR 6 includes standing and flowing freshwater habitats such as lakes and ponds (>2 m deep), rivers, streams and reservoirs (Fig. 33). The non-vegetated state of these habitats distinguishes them from wetland habitats. They cover a relatively small but important portion of the BCR, and are more abundant and cover a greater area in the northern Taiga Plains ecozone than in the southern Boreal Plains ecozone.

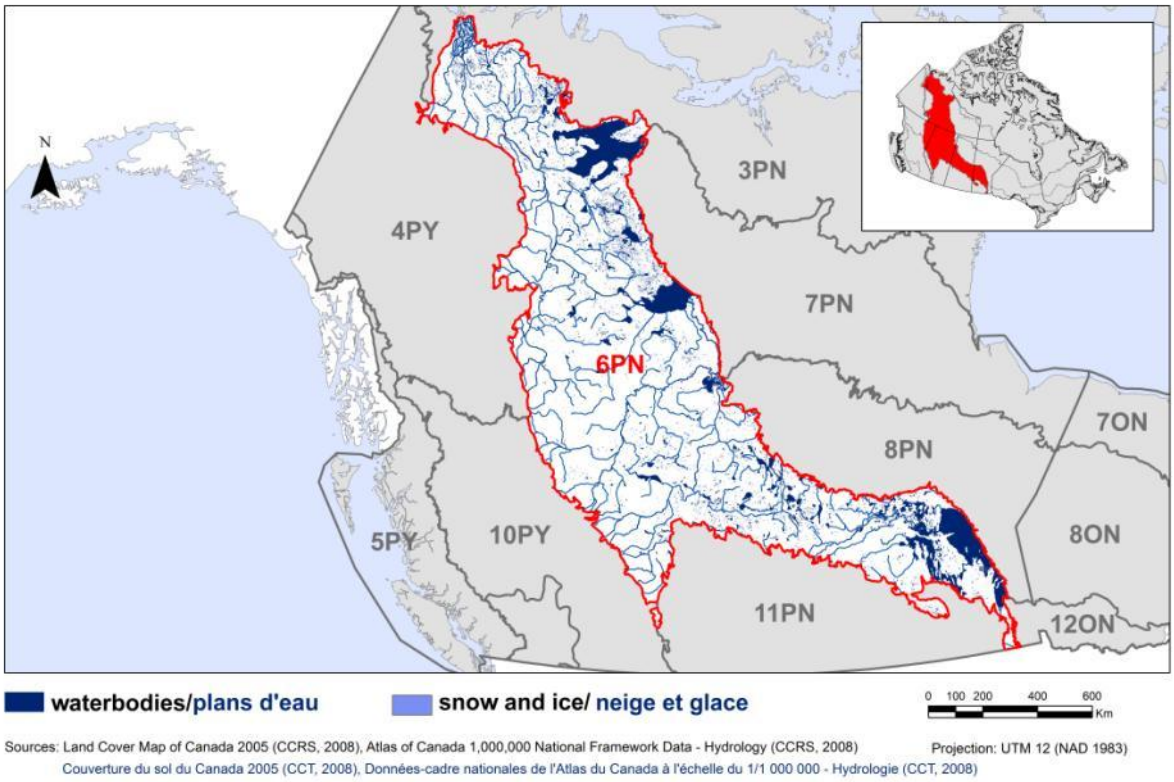


Figure 33. Map of waterbodies in BCR 6, at 250 m resolution from the Land Cover of Canada 2005.

The 50 priority species that use these habitats face a number of threats (Table 24). Over-hunting (sub-category 5.1) and conversion to agriculture (sub-category 2.1) are the main threats facing many waterbirds, shorebirds and waterfowl using waterbody habitats. Priority species are threatened by decreases in water quality due to agricultural and industrial runoff (threat sub-categories 9.3 and 9.2, Fig. 34) and overgrazing in **riparian** areas (sub-category 2.3). Many priority species, particularly colonial breeders, are also sensitive to human disturbance while breeding (sub-category 6.1). Climate change is expected to alter precipitation patterns, resulting in earlier and more intense spring floods, while reducing summer and fall flows[76, 103] (sub-category 11.1). Changes to water levels and hydrology patterns due to water management or climate change (e.g., dams, flood control measures, human water use) threaten priority species by altering the quality and availability of foraging and nesting habitat (sub-category 7.2). Key actions (Table 25) to address threats facing priority species in this habitat class include protecting water quality, promoting awareness for hunting regulations, maintaining or restoring

natural hydrological cycles, and supporting efforts to reduce and mitigate the effects of climate change. Increasing public awareness of the needs of breeding waterbirds and waterfowl is also beneficial.

Table 24. Priority species that use waterbodies habitat, regional habitat sub-class, important habitat features, population objectives and reason for priority status.

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
American White Pelican	Perennial river or large lake; artificial waterbody	Islands	Assess/Maintain	Y	Y	Y		Y	
American Wigeon	Pond/small lake		Increase 50%		Y	Y			
Arctic Tern	Perennial stream and river	Islands	Increase 50%		Y	Y			
Bank Swallow	Perennial stream		Assess/Maintain					Y	
Barrow's Goldeneye	Perennial pond/small lake	Nest sites	Maintain Current					Y	
Black-crowned Night-Heron	All types		Increase 50%					Y	
Black Tern	Perennial pond/small lake		Increase 100%		Y	Y		Y	
Blue-winged Teal	Artificial waterbody		Maintain Current		Y	Y			
Bonaparte's Gull	All types	Islands	Assess/Maintain		Y	Y			
Bufflehead	Perennial pond/small lake	Secondary cavities (Abandoned NOFL nests)	Assess/Maintain			Y			
Cackling Goose	Perennial pond/small lake; artificial waterbody		Assess/Maintain		Y	Y			
California Gull	Perennial river or large lake	Islands	Assess/Maintain		Y	Y			
Canvasback	Perennial pond/small lake		Maintain Current		Y	Y			
Caspian Tern	Perennial large lake	Islands	Maintain Current					Y	
Chimney Swift	Perennial pond/small lake	Chimneys/cavities for nest sites and communal roosts	Recovery Objective	Y	Y			Y	
Common Goldeneye	Perennial river or pond/lake		Maintain Current		Y	Y			
Common Loon	Perennial large lake		Assess/Maintain		Y	Y			
Common Tern	Perennial pond/small lake	Islands	Assess/Maintain		Y	Y			
Eared Grebe	Perennial pond/small lake; Artificial waterbody		Assess/Maintain		Y	Y			
Forster's Tern	Perennial pond/small lake		Increase 50%		Y	Y		Y	

Table 24 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Gadwall	Perennial pond/small lake		Assess/Maintain			Y			
Greater Yellowlegs	Perennial pond/small lake		Assess/Maintain		Y	Y		Y	
Green-winged Teal	Non-perennial pond/small lake		Maintain Current			Y		Y	
Herring Gull	Perennial large lake	Islands	Increase 50%		Y	Y			
Horned Grebe	Artificial waterbody; Perennial pond/small lake		Increase 50%	Y	Y	Y		Y	
Hudsonian Godwit	Perennial large lake; mudflat/saltmarsh		Assess/Maintain		Y	Y		Y	
Least Sandpiper	Perennial pond/small lake		Increase 100%			Y		Y	
Lesser Scaup	Perennial large lake; Non-perennial pond/small lake		Increase 50%		Y	Y		Y	
Lesser Snow Goose (Western Arctic)	Large rivers; lakes		Decrease			Y			
Long-tailed Duck	Perennial stream		Increase 100%		Y	Y		Y	
Mallard	Non-perennial pond/small lake		Maintain Current		Y	Y			
Nelson's Sparrow	Perennial pond/small lake		Assess/Maintain		Y		Y		
Northern Pintail	Perennial pond/small lake		Increase 50%		Y	Y		Y	
Northern Shoveler	Non-perennial pond/small lake; Artificial waterbody		Maintain Current			Y			
Pacific Loon	Perennial stream or large lake	Islands	Assess/Maintain		Y	Y		Y	
Pied-billed Grebe	Perennial or non-perennial pond/small lake	Emergent vegetation	Assess/Maintain					Y	
Redhead	Non-perennial pond/small lake; perennial large lake; artificial waterbody		Maintain Current		Y	Y			
Red-necked Grebe	Perennial large lake		Assess/Maintain						Y
Red-necked Phalarope	Perennial pond/lake		Increase 50%		Y	Y		Y	
Ring-necked Duck	Perennial pond/small lake		Assess/Maintain			Y			
Semipalmated Sandpiper	Perennial pond/small lake		Increase 100%			Y		Y	Y
Solitary Sandpiper	Perennial pond/small lake	Near coniferous forest	Increase 50%		Y	Y			

Table 24 continued

Priority species	Regional habitat sub-class	Important habitat features	Population objective	Reason for priority status					
				At Risk	CO	RC	RS	GS	EX
Sora	Non-perennial pond/small lake		Assess/Maintain		Y	Y		Y	
Surf Scoter	Perennial large lake		Increase 50%		Y	Y		Y	
Trumpeter Swan	Perennial pond/lake	Nest sites	Assess/Maintain	Y	Y	Y		Y	
Tundra Swan (Eastern)	Perennial pond/lake		Assess/Maintain			Y		Y	
Virginia Rail	Non-perennial pond/small lake		Assess/Maintain		Y	Y			
Western Grebe	Perennial large lake		Increase 50%	Y	Y	Y		Y	
White-winged Scoter	Perennial large lake	Islands	Increase 50%		Y	Y		Y	
Wilson's Snipe	Perennial pond/small lake		Increase 100%			Y			

Note: Reasons for inclusion in the priority species list are as follows. At Risk: the species is listed as Special Concern, Threatened or Endangered by the federal SARA, by COSEWIC, or provincially listed (AB, SK, MB, BC, YT, NT); CO: the species meets national/continental conservation criteria for its bird group (continental concern or continental stewardship based on the bird group protocols using continental conservation plans ([1, 2, 3, 4]); RC: the species meets regional conservation concern criteria for its bird group. RS: the species meets regional stewardship criteria (landbirds only); GS: the species has a provincial General Status rank of At Risk, May be At Risk, or Sensitive; EX: included due to expert opinion.

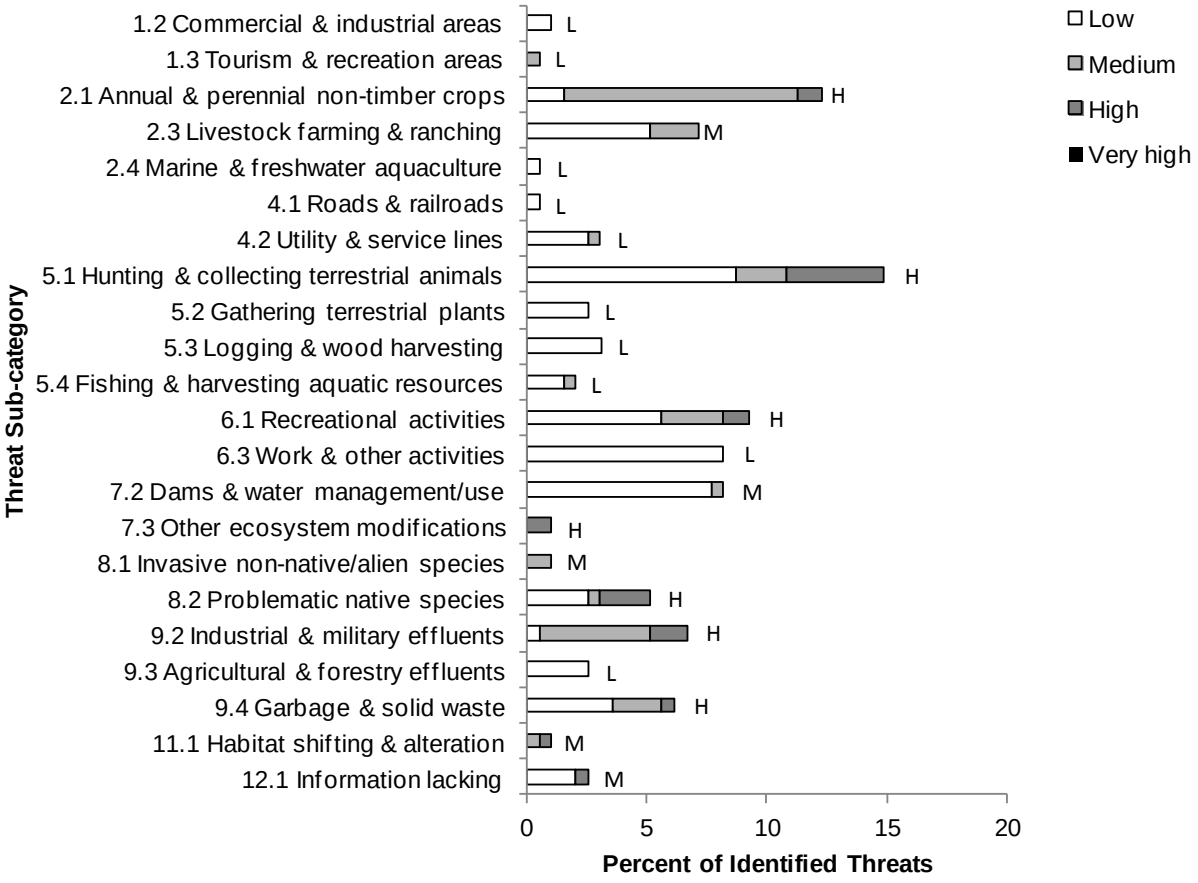


Figure 34. Percent of identified threats to priority species in waterbodies in each threat sub-category.
Each bar represents the percent of the total number of threats identified in each threat sub-category in waterbodies (for example, if 100 threats were identified in total for all priority species in waterbodies, and 10 of those threats were in the category 1.2 Commercial & industrial areas, the bar on the graph would represent this as 10%). The bars are divided to show the distribution of Low (L), Medium (M), High (H) and Very High (VH) rankings of individual threats within each threat sub-category. For example, the same threat may have been ranked H for one species and L for another; the shading illustrates the proportion of L, M, H and VH rankings in the sub-category. The overall magnitude of the sub-threat in waterbodies is shown at the end of each bar (also presented in Table 4).
Note: Threats of all magnitudes are included; however, low-ranked threats were not assigned conservation objectives or recommended actions unless the overall impact of the threat category was considered of medium or higher threat magnitude within the habitat (see Table 4 for threat categories of medium or higher magnitude).

Table 25. Threats addressed, conservation objectives, recommended actions and priority species affected for waterbody habitat in BCR 6.

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
2.1 Annual and Perennial Non-Timber crops	Agricultural conversion of surrounding waterbodies results in destruction and degradation of **riparian** habitat.	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Plan agriculture to maintain large, contiguous areas of natural waterbodies throughout the region, within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).	2.1 Site/area management	Discourage practices that involve spring **tillage** and promote conversion of land to pasture or **perennial forage**.	Delayed **tillage** allows ground-nesting species, e.g., Northern Pintail, to fledge young (nests are otherwise destroyed by **tilling**). A factor suspected to be important in the decline of Northern Pintail is the move from summer fallow to continuous cropping in the prairies.	American Wigeon Black Tern Black-crowned Night-Heron Blue-winged Teal Bonaparte's Gull Eared Grebe Forster's Tern Gadwall Greater Yellowlegs Horned Grebe Hudsonian Godwit Mallard Nelson's Sparrow Northern Pintail Pied-billed Grebe Ring-necked Duck Solitary Sandpiper Sora Virginia Rail White-winged Scoter	104 105
					Maintain existing waterbodies and their **riparian** areas and restore those that have been degraded on private land.	Natural waterbodies provide many ecological benefits, including improving water quality and water retention; both beneficial to sustainable agricultural production.		105
				5.3 Private sector standards and codes	Discourage practices that involve **tilling** and cropping **riparian** areas of waterbodies.	Leaving a natural **riparian buffer** around waterbodies will control erosion and help ensure continuation of natural processes. The minimum width of the buffer zone should depend on the hydrology of the surrounding landscape, taking into account factors such as waterbody type, size and slope (steeper areas should have wider buffers for erosion control).		106
						GIS/remote sensing-based precision conservation tools can help determine buffer area and extent. This could particularly be useful in landscapes that are a high priority for conservation.		107
				1.1 Site/area protection	Create a system of protected areas that represent the size, shape, and spatial arrangement of all waterbody **ecosites** at a regional scale.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas.		13
				1.2 Resource and habitat protection	Create a system of protected areas through **conservation easements** that represent the size, shape, and spatial arrangement of all waterbody **ecosites** at a regional scale.	The boreal forest within BCR 6 is rapidly being transformed to agricultural cropland and waterbodies are degraded in the process. Purchase of land is warranted for highly ecologically significant areas. **Conservation easements** are adequate protection for less significant areas and for highly significant areas that cannot be purchased. The Conservation Reserve Program and Wetland Reserve Program in the United states is a useful model for a large-scale land retirement program for agricultural land.		104 108
				8.1 Research	Continued research in **precision agriculture** technology and precision conservation can identify agricultural **riparian** areas next to waterbodies with low yields/negative profitability that can be returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields/excess irrigation and use of fertilizer; use of spatial technology to identify such areas can result in increased profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS		109

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
						applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		
				4.2 Training	Promote training in **precision agriculture** technology (GPS, remote sensing, yield mapping, profitability mapping) to identify areas in cultivated fields with negative profitability that may be set aside and returned to native vegetation.	Many areas of fields may actually lose money due to poor crop yields/excess irrigation and use of fertilizer; use of spatial technology to identify such areas can increase profits for farmers while also working toward conservation goals. Computers and technology have been rapidly adopted for farm management in Canada, but adoption of GIS applications using multivariate spatial data has been slow, largely due to a lack of prior experience with such technology.		109
2.3 Livestock Farming and Ranching	Clearing of riparian areas for agriculture and excessive grazing by livestock results in decreased **riparian** habitat availability and can result in disturbance of ground-nesting birds.	1.1 Ensure land and resource-use policies and practices maintain or improve bird habitat	Maintain intact **riparian** and emergent habitat of lakes and ponds.	1.1 Site/area protection	Create a system of protected areas that represent the size, shape, and spatial arrangement of all waterbody **ecosites** at a regional scale.	Conservation of lakes and ponds will ensure varied habitat for birds that are intolerant to livestock grazing (e.g., trampling of vegetation required for nest construction and shelter).	American Wigeon Blue-winged Teal Gadwall Lesser Scaup Mallard Nelson's Sparrow Northern Pintail Ring-necked Duck Solitary Sandpiper	13 110
				5.3 Private sector standards and codes	Defer grazing around waterbodies until after nesting and brood rearing.	Excessive grazing by cattle can result in trampling of nests of ground-nesting birds.		110
					Manage grazing surrounding waterbodies such that it mimics a **natural disturbance** regime (frequency, severity, size); avoid overgrazing and limit grazing of **riparian** areas.	Careful management and policy/regulation implementation are important because grazing in wetlands can have variable effects relating to birds. Overgrazing can have negative effects on vegetation biomass and diversity and introduce excess nutrients to the water, however sustainable grazing practices can allow for increased habitat for wildlife species and restoration and conservation of **riparian** and wetland habitat.		111 112
				5.2 Policies and regulations	Implement policy changes that regulate management of livestock grazing on private land.			
				4.2 Training	Training for ranchers in beneficial management practices related to grazing in and around waterbodies.	Ongoing education for practitioners will ensure that knowledge on beneficial management practices is current and can be put into practice.		
2.4 Marine and Freshwater Aquaculture	Persecution of birds nesting and/or foraging at aquaculture facilities results in disturbance, injury, or direct mortality.	2.8 Reduce mortality from legal or illegal hunting, and persecution	Reduce disturbance, injury, and mortality of birds through decreasing accessibility to fish at aquaculture	5.3 Private sector standards and codes	Preferentially use exclusion and barriers over removal and culling to reduce encounters with birds by reducing accessibility to aquaculture facilities.	Use of exclusions, barriers and deterrents will impede birds from foraging at aquaculture facilities and from establishing colonies nearby. If methods other than total exclusion are used (particularly for waterbodies > 2 ha), a combination of non-lethal methods should be used. Non-lethal exclusion methods include fencing, netting and overhead wires, while deterrents include acoustic devices, removal of perches, etc.)	American White Pelican	113 114
				4.2 Training	Opportunities for training and education of managers and staff of aquaculture facilities.	Education will allow for the implementation of management actions and will keep current on techniques and concerns.		

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
			facilities.					
5.1 Hunting and Collecting Terrestrial Animals	Waterbirds and shorebirds may be persecuted for various reasons (e.g., considered a pest, mistaken for other species, egging).	2.8 Reduce mortality from legal or illegal hunting, and persecution	Support compliance with hunting and other regulations that govern take of birds.	5.4 Compliance and enforcement	Support compliance with regulations that govern take of birds through compliance promotion and enforcement.	Ensuring that people are aware that regulations exist and are enforced will decrease the persistence of this threat.	American White Pelican Arctic Tern Black-crowned Night-Heron Caspian Tern Common Tern Herring Gull Sora Virginia Rail	
				4.3 Awareness and communications	Promote awareness and education regarding inappropriately persecuted species of birds.			
5.1 Hunting and Collecting Terrestrial Animals	Sustainable waterfowl hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag limits can have detrimental effects on both species populations and habitats.	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative limits on legally hunted species using best available science.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	American Wigeon Barrow's Goldeneye Blue-winged Teal Bufflehead Cackling Goose Canvasback Common Goldeneye Gadwall Green-winged Teal Lesser Scaup Mallard Northern Pintail Northern Shoveler Redhead Ring-necked Duck Surf Scoter White-winged Scoter	9 10 110
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			
				1.1 Site/area protection	Conserve and manage species habitat in areas where hunting occurs.	Ensuring that there is structurally diverse habitat for the hunted species will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	Sustainable shorebird hunting within legal limits can aid in species and habitat conservation, however illegal hunting and unsustainable bag	7.2 Improve harvest monitoring	Maintain sustainable populations of legally hunted species.	3.1 Species management	Set conservative limits on legally hunted species using best available science.	Careful management of hunted populations is important to ensure hunting is not affecting sustainability of population and that hunting can persist into the future. Harvest rates should consider individual species' population numbers and trends as well as aspects of a species' life history. Number of individuals taken should be verified by survey.	Wilson's Snipe	9 10 110
				8.2 Monitoring	Long-term monitoring of hunted species across the region to help determine trends and set limits.			

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
	limits can have detrimental effects on both species populations and habitats.			1.1 Site/area protection	Conserve and manage species habitat in areas where hunting occurs.	Ensuring that there is structurally diverse habitat for the hunted species (size, shape, spatial arrangement of forest habitat types; import key attributes associated with forest habitat types include: forest composition, forest structure, coarse woody debris, standing dead wood, soil organic layer) will help maintain population numbers, allowing for a sustainable level of hunting to take place.		9 90
5.1 Hunting and Collecting Terrestrial Animals	These species are taken by Aboriginal people for subsistence hunting.	7.2 Improve harvest monitoring	Increase monitoring of species taken for subsistence hunting.	8.2 Monitoring	Collect information on what species are taken for subsistence hunting as well as how many individuals of each species.	Birds in the boreal are important for subsistence hunting purposes, however there is little information available on numbers of species that are taken. Increased data gathered through monitoring will help in the management of these species. E.g., there are very few data on numbers and species of geese and ducks taken in northern Canada and Alaska by subsistence hunters, making it difficult to obtain accurate harvest estimates for population management.	Arctic Tern Long-tailed Duck Pacific Loon	90 84
5.2 Gathering Terrestrial Plants	Peat mining results in habitat loss and degradation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Maintain intact **peatland** habitat which includes mosaic of ponds and lakes contained within **peatlands** within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).	1.1 Site/area protection	Protect large complexes of bogs and fens so that the size, shape and spatial arrangement of these habitats are represented at a regional scale, through **fee simple** purchase, **conservation easements**, or creation of parks/protected areas.	Conservation of large intact **peatlands** will ensure that there is habitat available for **peatland** nesting bird species.	Bonaparte's Gull Common Loon Greater Yellowlegs Hudsonian Godwit Solitary Sandpiper	13
				2.1 Site/Area Management	Management should favour leaving large intact areas of **peatland** containing a mosaic of ponds and lakes representing the size, shape and spatial arrangement of these waterbody **ecosites** at a regional scale.	Zoning areas (to designate mine and no-mine areas) will decrease edge effects and will increase habitat value to birds and other wildlife.		11
				8.1 Research	Continued research of more sustainable mining techniques as well as restoration techniques for **peatlands** that have been previously mined.	There are relatively few published studies on effects of peat mining on wildlife in western Canada, including ways to mitigate negative impacts. Increased research effort will allow for better practices in the industry.		12
				4.3 Awareness and communications	Promote awareness of detrimental and irreparable effects of peat mining on the environment.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives will slow down the expansion of this industry.		
				6.2 Substitution	Promote use of alternatives to peat moss in gardening such as compost and mulch.	Peat mining is a destructive practice for obtaining a non-renewable resource for which there are multiple sustainable		

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
						options for substitution. Education on effects of peat mining on habitat of birds and other wildlife and promotion of use of renewable alternatives will slow down the expansion of this industry.		
5.3 Logging and Wood Harvesting	Removal of trees around waterbodies results in habitat loss for tree-nesting species, water level drawdowns and habitat degradation.	1.2 Maintain the size, shape and configuration of habitat within the **natural range of variation**	Plan forestry to maintain large, contiguous areas of waterbodies surrounded by intact forest throughout the region, within the **natural range of variation** (size, shape, spatial arrangement of all habitat types).	1.1 Site/area protection	Create a system of protected areas that represent the size, shape, and spatial arrangement of all waterbody **ecosites** at a regional scale.	The high proportion of crown land within the BCR and the limited total area dedicated to parks containing representative habitats warrants the establishment of additional protected areas. Protected areas should represent and include: 1) the size, shape, and spatial arrangement of all forest types; 2) the important attributes of forest types (e.g., forest composition, forest structure, coarse woody debris, standing dead trees, soil organic layer).	Bonaparte's Gull Greater Yellowlegs Pied-billed Grebe Solitary Sandpiper Sora Western Grebe	13
				2.1 Site/Area Management	Retain forested **riparian buffer** zones along all waterbodies.	The minimum width of the buffer zone should depend on the hydrology of the surrounding landscape, taking into account factors such as waterbody type and slope (steeper areas should have wider buffers for erosion control). GIS/remote sensing- based precision conservation tools can help determine buffer area and extent. This could particularly be useful in landscapes that are a high priority for conservation. **Riparian** areas span the transition area between aquatic and terrestrial vegetation and are important in stabilizing banks, filtering nutrients, buffering against fluctuating water levels, and provide habitat for many different species.		106 107 115
				5.3 Private sector standards and codes	Manage forests surrounding waterbodies to emulate natural disturbance processes that influence waterbodies (e.g., fire, flooding, drought).	The Sustainable Forest Management Network provides recommendations on managing **riparian** areas with respect to harvesting.		116
					Ensure regeneration of original stand characteristics of harvested trees. Re-vegetate forested land with a variety of species representative of natural forest types for the area that will not require irrigation.	It is important that wetland-associated tree species (e.g., black spruce) are regenerated when harvested and are not replaced by more easily replaceable forest types in order to preserve wetland-associated vegetation. Establishment of forest monoculture plantations involves irrigation which can drain wetlands.		19
					Avoid harvesting activities during nesting and brood rearing periods.	This will allow for broods to fledge prior to commencement of harvesting activities and mitigation of direct bird mortality.		115
					Avoid clear cutting in favour of more selective harvesting practices to mimic patterns of natural disturbance (e.g., fire,			115

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
					insect outbreaks) and maintain forested habitat adjacent to waterbodies.			
					Harvesting **peatlands** should seek to minimize compaction of peat.	Harvesting **peatlands** causes compaction of hummock features which results in a change in the regenerating plant community; harvesting during the winter while ground is frozen should lessen these long term effects.		117
				4.2 Training	Training for forestry practitioners in sustainable methods of forestry.			110
5.4 Fishing and Harvesting Aquatic Resources	These species can get caught in fishing nets and drown.	2.4 Reduce incidental mortality	Decrease the number of waterbirds killed as bycatch in fishing nets.	8.2 Monitoring	Continue monitoring bycatch and use data to help identify specific problems to be further researched (alternative fishing methods, timing of bycatch, location of bycatch).	Bycatch of waterbirds can be an important source of mortality, even in inland freshwater waterbodies. Monitoring, legislation, and mitigation are needed to reduce magnitude of this threat.	Common Loon Horned Grebe Pacific Loon Pied-billed Grebe	118
				5.2 Policies and regulations	Legally require application of best available technology for mitigating waterbird bycatch in gillnets and other fishing devices.			118
				4.3 Awareness and communications	Promote awareness of waterbird bycatch in fishing operations. Educate and promote awareness on not abandoning or disposing of nets in the water.			118
6.1 Recreational Activities	Recreational activities such as boating, fishing and visiting colonies of waterbirds can cause flooding and/or abandonment of nests and young as well as disruption of activities during migration.	4.1 Reduce disturbance from human recreation	Limit disturbance to aquatic birds, particularly during key periods of their breeding cycle (courtship, incubation, nestling, migration).	2.1 Site/area management	Monitor effects of fishing activity during nesting and migrating periods for waterbirds and waterfowl. Restrict fishing in areas with sensitive species.	Reaction to human disturbance species-specific. Disturbance on Oklahoma migration lakes caused increased alertness and altered feeding strategies.	American White Pelican American Wigeon Arctic Tern Black Tern Blue-winged Teal Caspian Tern Common Loon Common Tern Forster's Tern Gadwall Green-winged Teal Mallard Northern Pintail Northern Shoveler Pied-billed Grebe Trumpeter Swan	86
					Access to breeding colonies of birds should be restricted during the breeding season, both by land and water.	Colonial birds are highly sensitive to disturbance; large numbers of visitors can have great impacts.		3
					Limit recreational boating on lakes with important breeding colonies.	Recreational disturbance through boating can cause disruption and flooding of nests due to waves in the short term and colony abandonment in the long term (e.g., Western Grebes in Alberta).		87
				1.1 Land/water protection	Establish protected areas surrounding significant staging areas for waterbirds and waterfowl as well as surrounding breeding colonies of colonial waterbirds with limited human access via land or water.	Limiting human access during important times in species life cycles will limit negative effects on these species due to human disturbance.		

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
							Western Grebe White-winged Scoter	
6.3 Work and Other Activities	Non-recreational activities near nesting and brood-rearing avian species can result in nest desertion, premature fledging, among other negative effects.	4.2 Reduce disturbance from industrial or work activity	Limit disturbance to birds, particularly during key periods of their breeding cycle.	2.1 Site/area management	Limit conducting research-related work during the breeding season or minimize impact to active breeding areas/colonies.		American White Pelican Arctic Tern Barrow's Goldeneye Black Tern Bonaparte's Gull California Gull Caspian Tern Common Loon Common Tern Eared Grebe Forster's Tern Pacific Loon Red-necked Phalarope Trumpeter Swan Virginia Rail Western Grebe	
					Limit unnecessary disturbance when conducting avian research-related work during the breeding season. Avoid and mitigate disturbance to non-target species.	The government of British Columbia provides guidelines for surveying and handling birds for research purposes. Similar guidelines should be created for boreal jurisdictions.		89
				4.2 Training	Training for anyone working in and near areas with sensitive species. Training should outline methods and best practices to limit disturbance to these species.			
7.2 Dams and Water management/use	Changes in flow regimes including dams and water drawdowns may reduce water availability, strand or flood nests, or reduce natural variability in water levels.	1.1. Ensure land and resource-use policies and practices maintain or improve bird habitat	Minimize the loss of important breeding habitat through improved design and management of new dams.	5.2 Policies and regulations	Design new dams using best possible environmental practices. Develop high standards for environmental impact assessment. Retain highly trained environmental staff through all stages of planning, construction, and **baseline** and **trend monitoring**.	Proper design, placement and management of a new dam can help mitigate environmental effects.	American White Pelican Black-crowned Night Heron California Gull Caspian Tern Common Loon Eared Grebe Forster's Tern Greater Yellowlegs Herring Gull Horned Grebe Hudsonian Godwit Pied-billed Grebe Red-necked Grebe Sora	18
					Use careful placement of new dams; avoid sensitive areas or areas of high biodiversity, take into account **cumulative effects** of multiple dams within a watershed.			18
				2.3 Habitat and natural process restoration	Mimic natural season and daily river flows, as close to hydrologic natural processes as possible (representing natural high and low cycles).	Maintenance of natural flows will help maintain downstream wetland habitat.		18

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
				4.2 Training	Ensure sufficient training in best available knowledge/technology regarding culvert design and placement.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.	Virginia Rail Western Grebe	19 20
				8.2 Monitoring	Conduct **baseline monitoring** before dam construction and establish a **trend monitoring** program that runs throughout the operation of the dam, e.g., monitor up and downstream water quality and species affected.	**Baseline** followed by **trend monitoring** coupled with **adaptive management** will ensure early detection and mitigation of effects.		18
				8.1 Research	Ensure ongoing research into mitigating effects of hydroelectric projects of all types.			
					Investigate environmental effects of run-of-river hydroelectric projects, both generally and region-specific, including **cumulative effects** of multiple run-of-river projects within the same watershed, including effects of all associated infrastructure.			
					Ensure sufficient research into culvert design and placement is conducted prior to construction.	Proper culvert design and placement will ensure proper connectivity of waterways such that fish (prey for waterbird species) migration routes are not interrupted.		19 20
				5.2 Policies and regulations	Implement policy changes that regulate anthropogenic water drawdowns, particularly during timing of nesting and brood rearing.	Anthropogenic water drawdowns cause water to disappear from natural waterbodies and can strand nests of waterbirds, waterfowl and shorebirds.		
7.3 Other Ecosystem Modifications	Apparent decline in these species as a result of decline in prey abundance.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of prey abundance (fish) of these lake-nesting species in order to undertake conservation action to reverse the decline.	8.1 Research	Undertake research to understand reasons for the decline in prey abundance of these lake-nesting species.		Herring Gull Western Grebe	
7.3 Other Ecosystem Modifications	Aerial insectivores may be declining due to changes in	7.4 Improve understanding of causes of	Understand reasons for decline of aerial	8.1 Research	Increase research efforts studying reasons for decline in aerial insects, and ways to reverse the decline. Increase research efforts	There are dramatic declines in populations of aerial insectivores in Canada. More research is needed to ultimately determine the cause of this decline, as well as what can be	Bank Swallow Chimney Swift	28 29

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
	populations of aerial insects.	population declines	insectivores in order to undertake conservation action to reverse the decline.		examining non-target effects of pesticides and herbicides used widely in Canada.	done to conserve these species.		
				4.3 Awareness and communications	Increase awareness and understanding among the general population about non-target effects of pesticides and herbicides.			
				8.2 Monitoring	Increased **trend monitoring** and **cause-effect monitoring** of populations of aerial insectivores throughout their range.			
8.1 Invasive Non-native/Alien Species	Purple Loosestrife/other invasive plants may alter native vegetation communities and decrease habitat suitability.	7.3 Improve habitat monitoring	Determine population-level impacts of purple loosestrife or other invasive plants.	8.0 Research and Monitoring	Provide funding for researchers to conduct properly designed studies to measure the impact, if any, of invasive plant species on bird populations.	Impacts of invasive plants on native bird species are unclear, and the validity of much research claiming negative impacts of non-native plant invasions has been called into question due to biases or faulty methods. For example, purple loosestrife is commonly claimed to be unsuitable as nesting habitat; however, Whitt et al. (1999)[94] found ten avian species breeding in loosestrife-dominated habitat, with densities being higher for some species and lower for others compared to other vegetation types.	Black Tern Pied-billed Grebe	92 93 94
8.2 Problematic Native Species	Increased nest predation by generalist predators may limit populations.	2.5 Reduce parasitism/predation	Improve nesting/fledgling success by limiting nest predation by generalist predators.	8.1 Research	Determine causes of increased nest predation and/or abundance of generalist nest predators (e.g., human development, edge effects, linear features, increased rodent density due to agriculture).	Landscape impacts on nest predation rates may be complex and operate at multiple spatial scales, and are therefore difficult to measure and quantify.	Horned Grebe	34
8.2 Problematic Native Species	Overabundant Lesser Snow Geese (Western Arctic population) denude vegetation, destroy habitat, and are a reservoir for avian cholera.	3.2 Reduce competition with problematic native species	Reduce abundance of Lesser Snow Geese populations breeding in BCR 6 (Western Arctic).	2.2 Invasive/problematic species control	Breeding ground impacts of Lesser Snow Goose (Western Arctic) have been documented although impact of grazing at stopover sites is unknown. Intensive management will be required to reduce density of this Lesser Snow Goose population.	Decreasing Snow Goose density will require large-scale, intensive management efforts possibly during breeding since recent evidence suggests that increased bag limits and extended hunting seasons (e.g., spring hunting) are not effective.	Lesser Snow Goose (Western Arctic)	95 96
8.2 Problematic Native Species	Avian botulism can be a major source of mortality and appear	2.6 Reduce the spread of disease	Prevent or limit the scope of botulism outbreaks in lakes	8.2 Monitoring; and 2.2 Invasive/problematic species	Implement monitoring programs in lakes where avian botulism occurs frequently to identify lakes with a high density of bird/vertebrate carcasses that could provide	*C. botulinum* develops in maggot-infested vertebrate carcasses in lakes. The initial substrate is often unknown, but can likely be any suitable supply of carcasses; once an epidemic takes hold and botulism-killed carcasses are present to propagate *C.*	American White Pelican Common Loon Eared Grebe	97

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
	episodically in lakes where it is endemic.		where they occur commonly.	control	an initial substrate for *Clostridium botulinum*, the causative agent of botulism.	*botulinum*, carcass removal is ineffective at mitigating epidemics. Identification and removal of the primary substrate is therefore required.	Greater Yellowlegs	
8.2 Problematic Native Species	Competition with and nest predation by gulls.	3.2 Reduce competition with problematic native species	Reduce gull populations at sensitive sites such as tern colonies.	2.2 Invasive/problematic species control	Implement culling programs at sensitive tern colonies to reduce the number of predatory gulls.	Culling predatory gulls can drastically limit or eliminate nest predation of terns, but culls must be repeated annually.	Arctic Tern Caspian Tern Common Tern	98
8.2 Problematic Native Species	Domination of wetlands and waterbodies by cattails reduces habitat suitability.	1.3 Ensure continuation of natural processes that maintain bird habitat	Promote avian diversity by restoring cattail-dominated emergent areas to a mixture of open water and emergent vegetation.	2.2 Invasive/problematic species control; 2.3 habitat and natural process restoration	Implement cattail control programs using removal methods, grazing, or **prescribed burning** to selectively remove patches of cattails.	Clearing cattails from wetlands to restore a mixture of emergent vegetation and open water led to increases in Black Tern abundance.	Black Tern	99
9.2 Industrial and Military Effluents	Lethal and sub-lethal toxic effects of industrial contaminants.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce emissions of pollutants from industry.	5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.	Black-crowned Night-Heron Blue-winged Teal Bufflehead Cackling Goose Canvasback Caspian Tern Common Tern Mallard Northern Shoveler Peregrine Falcon (*anatum/tundrius*) Red-necked Grebe Surf Scoter Trumpeter Swan White-winged Scoter	
				6.3 Market forces	Develop national standards for no-spray certification for labeling food products.			
				5.1 Legislation; 5.2 Policy and regulations	Consider regulatory /policy options to 1) evaluate risk to species and 2) reduce or eliminate harmful emissions.	Stricter emissions policies and upgrading to new technologies will reduce/eliminate harmful emissions.		
9.3 Agricultural and Forestry Effluents	Eutrophication decreases water quality.	1.5 Reduce habitat degradation from contaminants	Reduce runoff of fertilizers from agricultural areas.	4.2 Training	Encourage adoption of **precision agriculture** techniques including training in GIS and remote sensing to determine what parts of a field require fertilizer, and apply fertilizer at a variable rate to minimize excess fertilizer and runoff.	Spatially variable application of fertilizer is capable of reducing **nitrate leaching** and nutrient runoff while increasing yields, but carries additional costs in the form of soil sampling, imagery, and data analysis.	Horned Grebe	100 101

Table 25 continued

Threats addressed	Brief description	Objective category	Brief description	Action category	Recommended actions	Justification	Priority species affected	Refs
				2.1 Site/area management	Maintain existing wetlands and restore those that have been degraded on private land.	Healthy **riparian** areas and wetlands filter and store nutrients and improve water quality.		77
9.4 Garbage and Solid Waste	Ingestion of lead shot, bullets or bullet fragments, and/or fishing tackle can lead to poisoning.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce or eliminate deposition of lead into the environment through hunting and fishing.	5.1 Legislation	Limit the sale and use of lead shot, lead fishing tackle (jigs, lead weights/sinkers), and lead bullets for all hunting, fishing, and non-hunting (e.g., firing ranges) activities.	Current restrictions on lead use are limited; hunting migratory birds with lead shot and fishing with lead tackle in National Parks and National Wildlife Areas are prohibited. However, use of lead for hunting upland game birds or fishing outside of these federal lands is still permitted, and deposits ~1560 tonnes of lead into the environment. Bullet and/or bullet fragments left in the environment from large game hunting and firing ranges can result in significant lead contamination that can affect terrestrial birds, but neither use of lead is restricted.	Canvasback Common Loon Lesser Scaup Lesser Snow Goose (Western Arctic) Long-tailed Duck Pacific Loon Ring-necked Duck Sora Trumpeter Swan Tundra Swan (Eastern)	38 39
				6.3 Market forces	Provide rebates or tax incentives on non-toxic shot/tackle/bullets for trading in previously purchased lead shot/tackle/bullets.	Monitor and enforce lead use by hunters and anglers; economic incentives may encourage individuals who currently possess lead shot/tackle/bullets to switch to non-toxic alternatives.		38
9.4 Garbage and Solid Waste	Ingestion of garbage at dumps such as plastic can cause choking or entanglement.	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants	Reduce gull use of dumps/landfills.	2.1 Site/area management	Employ overhead wires and/or netting to exclude gulls from foraging at waste sites. Frightening devices may also deter gulls.	Overhead wires can exclude the majority of gulls, and netting can exclude all gulls if deployed properly. Gulls may become habituated to frightening devices, so they are likely only a short-term solution. Use of falcons can also be effective, but lethal control can be controversial with the general public, so non-lethal management is preferable.	California Gull Herring Gull	74 75
				5.2 Policies and regulations	Expand composting programs for municipal waste so that anthropogenic food and plastic/garbage are not located at the same site.	Waste disposal facilities that do not contain food/putrescible waste will not attract gulls.		74
11.1 Habitat shifing and alteration					See Climate Change in Widespread Issues for Priority Species in BCR 6 (Table 28)		Arctic Tern Bonaparte's Gull	
12.1 Information Lacking	Some species are in decline throughout the region but reasons for the decline remain unknown.	7.4 Improve understanding of causes of population declines	Understand reasons for decline of these species in order to undertake conservation action to reverse the decline.	8.1 Research	Continued research throughout the region to understand the reasons for the decline of Lesser Scaup, Least Sandpipers and Semipalmated Sandpipers.		Least Sandpiper Lesser Scaup Semipalmated Sandpiper	
				8.2 Monitoring	Increased **trend monitoring** of Lesser Scaup, Least Sandpiper and Semipalmated Sandpiper populations throughout the boreal.			

Section 3: Additional Issues

Widespread Issues

Some well-known conservation issues may not be identified in the literature as significant threats to populations of an individual priority species and therefore may not be captured in the threat assessment. However, these issues, while they may or may not be limiting factors for any individual species or population, contribute to avian mortality or decreases in fecundity across many species and thus warrant conservation attention. Usually these issues transcend habitat types and are considered "widespread". Examples of these issues include:

- Collisions with human-made structures (buildings, cars, utility/telecommunication towers and lines, etc.)
- Predation by domestic cats
- Pollution/pesticides/oil spills
- Roads
- Climate change

Because the widespread issues do not fit into the standard presentation format used in the BCR strategies, they are presented separately here. The mortality estimates included here are largely based on draft reports that were available within Environment Canada when this strategy was produced; the numbers may change as the final scientific papers are peer-reviewed and published. Human-related avian mortality across all sectors was standardized and compared in Calvert *et al*. 2013[125].

Collisions

In BCR 6, bird mortality related to buildings, wind turbines, towers and vehicles is likely limited to the southern portion of BCR 6 where large urban areas exist (Boreal Plains ecozone).

Buildings

Collisions with glass windows or reflective panels on buildings are believed to be a significant source of bird mortality in Canada. Estimates of mortality from collisions with houses in Canada (including birds using feeders) range from approximately 15.8 – 30.5 million birds per year[119]. Mortality from collisions with buildings of fewer than 12 storeys is estimated at approximately 0.3–11.4 million birds/year, and for all cities in Canada with tall buildings in an urban core the estimate is 13 000–256 000 birds/year[119]. The total estimate of mortality from collisions with buildings in Canada is therefore between 16.1 and 42.2 million birds/year[119].

Data from Canada and the northeastern United States reveal that 163 species of birds of 32 families are known to have been killed by buildings. Some families and species of birds are disproportionately affected by collisions with buildings. *Parulidae* (warblers), *Fringillidae* (sparrows and allies) and *Regulidae* (kinglets) account for 70% of all bird deaths; the species most frequently killed are White-throated Sparrows (13.5% of all reported deaths), Golden-crowned Kinglets (10.2%), Dark-eyed Juncos (6.1%), Ovenbirds (5.3%) and Ruby-crowned

Kinglets (5.3%). The population-level effects of bird mortality from building strikes are unknown. See Table 26 for conservation objectives and actions.

Wind Turbines

The 2 955 wind turbines in Canada in 2011 have drawn considerable attention for their potential to cause mortality to birds and other species (notably bats). Two sources of mortality are typically associated with wind turbines: collisions with the turbines themselves, and the destruction of nests by turbine construction activities during the breeding season. On average, 5.9 birds are killed per turbine per year. Scaling up to a national level, an estimated 16 700 birds (range 13 300 – 21 600) die from collisions with wind turbines each year[120].

Some species are particularly vulnerable to collisions with wind turbines, for example, raptors flying along a land/water interface. For smaller, more common passerine species (warblers, thrushes, kinglets, etc.), the relatively small number of birds affected does not appear to pose a population-level threat. However, the anticipated proliferation of wind turbines means we should continue to ensure that turbines are sited to avoid important bird habitats and migration corridors.

At the 43 wind farms in Canada for which data are available, total habitat loss per turbine is 1.23 ha on average. Based on this average, the predicted total habitat loss for wind farms nationwide is 3 635 ha. Using published estimates of nest densities, the total number of affected nests, not accounting for construction that might occur outside the breeding season, is approximately 5 700[120] . See Table 26 for conservation objectives and actions.

Communication Towers

There are currently almost 8 000 communication towers in Canada >60m high[121], each of which can pose a hazard to birds during migration. Birds are attracted to the lights of communication towers and are killed when they collide with the structures and guy wires. Mortality increases exponentially with tower height, in part because the use of guy wires also increases with tower height. Poor weather also plays a significant role in increasing migrant fatality; foggy and cloudy conditions increase the lit area around towers and block celestial clues used by migrating birds. The result is that birds circle to exhaustion in the halo of artificial light, or collide with each other, the tower or its guy wires[122].

Avian mortality at towers is unequally distributed among species and regions, but estimates suggest that over 220 000 birds are killed in Canada each year[121].

Neotropical migrants in the families *Parulidae* (wood-warblers) and *Vireonidae* (vireos) are the species most commonly killed by communication towers. These families include threatened species and many that are of conservation concern in Canada and/or the United States. When considered in concert with mortality at towers in the United States (which is 20 times higher due to the larger number and greater height of towers in the United States), and the mortality from other stationary structures, mortality from collisions with communication towers may

negatively affect the population trends of some birds. See Table 26 for conservation objectives and actions.

Power Lines

Birds may be killed by colliding with power lines, or they may be electrocuted. Species with high wing-loading and thus low maneuverability, such as waterfowl, appear particularly at risk for collisions[123]. Electrocutions are most likely for large birds such as raptors and herons, whose bodies are large enough to span the distances between wires and create a short-circuit. Raptors' habit of using power poles as perches further increases their risk. However, estimates of total mortality due to collisions and electrocutions can vary widely[124] and population-level impacts are difficult to determine. Canadian estimates are that 161 000 – 802 000 birds are killed annually by electrocution and another 5.3–20.6 million birds are killed each year by colliding with electrical transmission lines[125]. See Table 26 for conservation objectives and actions.

Vehicles

There are over 1.4 million km of roads and hundreds of airports in Canada[126] that are often bordered by fences and vegetation that provide convenient places for birds to perch, forage and nest. The paved surfaces can attract birds through the heat they emit, the puddles that form beside roads, and the salt and grit used for de-icing. Current estimates for one- and two-lane paved roads outside of major urban centres in Canada are that between 4.65 and 13.8 million birds are killed annually[127].

Bird collisions with cars are influenced by the location of the road, proximity of vegetation and vehicle speed. Raptors and owls that hunt and forage near roads are particularly vulnerable, but many species that forage for grit and road salt or are otherwise attracted to roads have a high likelihood of being hit by vehicles. The population-level effects of this source of mortality are not known. See Table 26 for conservation objectives and actions.

Predation by Domestic Cats

Based on the number of pet cats in Canada and published kill rates by cats elsewhere, roughly 204 million birds (range 105–348 million) are killed by domestic and feral cats in Canada each year[128]. The broad range on this estimate reflects imprecise information on the average number of bird kills per cat, especially for rural and feral cats, and a lack of information on the number of feral cats (versus owned or pet cats) in Canada.

The birds most susceptible to cat predation are those that nest or forage on or near the ground, or spend substantial time in human-dominated landscapes (both rural and urban) where cats are abundant. The proportion of Canada's birds killed by cats would be higher if additional cat predation when migrating through, or wintering in, the U.S. is factored in.

Without detailed study of the individual species affected, it is difficult to assess whether mortality caused by cat predation impacts population trends of birds in Canada. Nevertheless, it is likely that bird populations are depressed or extirpated locally in areas with very high cat

populations; areas with high densities of cats may function as population sinks. See Table 26 for conservation objectives and actions.

Pollution

Pollution caused by industrial chemicals, pesticides and heavy metals can have both direct and indirect effects on survival and reproduction in birds. Sometimes the effects of exposure to pollutants are unexpected and do not result in immediate, measurable impacts on bird populations[110,129,130,131]. However, persistent exposure can result in sharp declines in bird populations, as happened with Peregrine Falcons in eastern Canada prior to the ban of DDT. See Table 26 for conservation objectives and actions.

Pesticides

The most recent estimate suggests that 0.96–4.4 million birds are killed by pesticides annually in Canada[131]. Provinces such as Saskatchewan, which have a large agricultural land base, account for the majority of the estimated kill, and pesticides are thought to be an important contributor to the decline in grassland bird species in Canada[131]. Pesticides can kill birds rapidly following contact or may have sub-lethal impacts such as suppressed immune function and reduced stress response. There may also be indirect effects of pesticides such as reduction in prey and changes in vegetation that reduce habitat quality. While the use of the many toxic pesticides has been eliminated in Canada, migratory birds are still exposed while on wintering grounds in countries where their use is still permitted[131]. See Table 26 for conservation objectives and actions.

Toxic Chemicals and Heavy Metals

Toxic organic chemicals and heavy metals released into the environment can also negatively impact bird populations. While some industrial chemicals such as PCBs are regulated, there is concern about new chemicals such as flame retardants (PBDE) that are used in computers, car parts and upholstery, and whose effects on wildlife are largely unknown[132]. Scavengers experience toxic effects when they ingest lead shotgun pellets or bullet fragments embedded in carcasses of game animals, and loons and other waterbirds are exposed to lead from shotgun pellets, sinkers and jigs that they ingest either while collecting grit for their gizzards or by eating bait fish with line and sinker still attached[133,134]. In some areas, lead poisoning from sinkers and jigs can account for approximately half of the mortality of adult Common Loons on their breeding grounds[133]. Birds are also susceptible to bioaccumulation of other toxic metals such as methylmercury, selenium and others when they consume prey that has been exposed to these substances. See Table 26 for conservation objectives and actions.

Oil Pollution

Oil may enter the environment either accidentally, through deliberate dumping, or in contained tailings ponds. It may be a single large event, as occurred in the Gulf of Mexico in 2010, or numerous smaller events. Annual estimates are that between 217 800 and 458 600 birds are killed by ship-source oil spills annually[125]. Typically, diving birds are most at risk of oiling; however, any birds that come into contact with oil are vulnerable. In Northeast Alberta (Boreal Plains ecozone within BCR 6–Boreal Taiga Plains), oil enters the environment in the form of

tailings ponds. Bitumen extracted from open pit mines is separated from sand and the tails (process-affected water, residual hydrocarbons, brine, silts and clays, and metals) are discharged into tailings ponds. Open water tailings ponds present potential resting, roosting, foraging and nesting sites for birds[135]. Tailings ponds can result in direct bird mortality when the birds land in the ponds and become oiled. Waterfowl, waterbirds, shorebirds and some landbirds have died due to exposure to tailings ponds[136]. Reliable estimates of bird contacts and mortalities in tailings ponds as well as risk factors (time of day or year, environmental conditions) are currently unavailable. A robust, systematic and standardized monitoring program of tailings ponds to provide estimates of bird contacts and mortalities relative to bird activity levels across ponds, sites, seasons and years is currently in development[137]. Throughout the Boreal Plains, oil can also enter the environment as a result of pipeline spills. Pipeline spills occur as a result of an aging and weakened pipeline infrastructure (active and inactive pipelines), improper maintenance of active pipelines, and human-associated error at active pipelines.

Typically, diving birds are most at risk of oiling; however, any birds that come into contact with oil are vulnerable. Oil can impact birds through direct effects such as hypothermia (resulting from lost waterproofing of feathers following oil contamination), toxicity (from ingesting oil as they preen or by inhaling volatile organic compounds) and indirect effects, such as reduced prey availability and decreased quality of habitat. While techniques exist to clean and rehabilitate oiled birds, many birds die before, during and after rescue attempts, or their productivity is greatly reduced[138]. See Table 26 for summary and objectives.

Roads

Roads (highways, primary, secondary) required for the transport of goods and people are a source of human stressors within BCR 6[147], and road coverage is slowly intensifying to support economic development within this region. Roads have both direct and indirect impacts on birds and other wildlife, including: mortality from vehicle strikes (See Vehicles section, above); individual species disruption (noise, dust); habitat loss, subdivision and degradation (loss of suitable nest sites, destruction of nest sites, decline of prey species); indirect mortality (from increased predator/prey contact, including human hunters); and increased exposure to invasive species[147]. Physical impacts include accelerating erosion from road surfaces, alteration of surface water flows and the timing of peak flows, erosion during flood events, increased landslides, and loss of soil productivity. For aquatic habitat, roads may introduce barriers to fish (prey) migration, cause changes in water temperature and alter stream flow regimes[139].

Several approaches can be used to mitigate the impacts of expanding road networks. Restricting or limiting road access in key areas during critical times of year (e.g., breeding/lekking) can reduce disturbances during the most important periods. **Access management** outside of hunting seasons will likely be met with less public opposition and may be easier to implement[140], although attempts should be made to restrict road access during seasons associated with specific life requisites (courtship/mating, reproducing, staging and migrating). New road networks should be designed in conjunction with other land-use

activities (Integrated Landscape Management approaches) to maximize coordination and emulate/simulate the region's **natural disturbance regime**[141]. Finally, decommissioning of roads that are no longer required can restore habitat and prevent erosion. Road removal techniques include **road ripping** (de-compacting road surface, addition of soil and revegetation), which decreases soil compaction; **restoration of stream crossings**, which allows for natural water flow across roads; and **full recontours**, which re-grades the land around the road and completely removes any trace of the road[142]. More-expensive, **full recontours** are warranted for high-priority road closures (e.g., those with significant watershed impacts or roads that increase the risk of landslides). Less-expensive techniques such as road deactivation (e.g., cross-ditches, water bars) and road-ripping may suffice where long-term stability is not an issue (e.g., lower-grade roads).

Table 26. Conservation objectives and actions associated with bird mortality from collisions, cats and contaminants.

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
Collision mortality						
Collisions with buildings cause bird mortality.	1.1 Housing and urban areas 1.2 Commercial and industrial areas	Reduce incidental mortality from collisions with windows/ buildings	2.7 Reduce incidental mortality from collisions	Follow beneficial management practices for bird-friendly buildings including using bird-friendly glass, reducing reflection from windows, providing visual markers to enable birds to perceive windows, and reducing light pollution.	2.1 Site/area management 5.3 Private sector standards and codes	All species
Collisions with wind turbines cause bird mortality.	3.3 Renewable energy	Reduce incidental mortality from collisions with wind turbines	2.7 Reduce incidental mortality from collisions.	Follow beneficial management practices for reducing bird mortality when designing and locating wind turbines. Ensure that offshore wind energy developments will not present significant migration barriers. Locate offshore wind energy developments away from seabird breeding colonies and important waterbird foraging areas. Utilize techniques such as radar monitoring to determine pre-construction	2.1 Site/area management 5.3 Private sector standards and codes 1.2 Resource and habitat protection 8.2 Monitoring	All species

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
				flight paths and assess the degree to which wind farms present migration barriers, and infrared camera systems to quantify strike rates.		
Collisions with communications towers cause bird mortality, particularly during migration.	1.2 Commercial and industrial areas	Reduce incidental mortality from collisions with human-made structures	2.7 Reduce incidental mortality from collisions.	Follow beneficial management practices for reducing mortality to birds when constructing new communications towers. Switch off solid lights on existing towers and ensure that remaining lights have a synchronized, complete dark phase. Take steps to ensure that new towers avoid guy wires and minimize height, and avoid topographic locations where migrating birds are likely to be found in abundance. Retrofit existing towers to adhere to as many guidelines as possible.	2.1 Site/area management 5.3 Private sector standards and codes	All species

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
Collisions with power lines and accidental electrocution cause bird mortality.	4.2 Utility and service lines	Reduce mortality from collisions with utility lines/ transmission towers	2.7 Reduce incidental mortality from collisions.	In high-risk areas, retrofit power lines so that the risk of electrocution of raptors is minimized. In new developments, locate transmission lines underground. Use markers or paint to increase visibility of power lines in high-strike areas. Avoid siting lines over or near wetlands.	2.1 Site/area management	Waterfowl, herons, raptors
Collisions with vehicles cause bird mortality.	4.1 Roads and railroads	Reduce mortality from collisions with vehicles	2.7 Reduce incidental mortality from collisions.	Erect road signs or speed bumps to lower vehicle speeds where bird activity is frequent. Remove plants that attract birds from roadsides and medians. Landscape along roads using taller trees and bushes to cause birds to fly higher. Encourage the use of salt management plans to avoid unnecessary use of particulate salt (a bird attractant) on roads.	2.1 Site/area management 1.1 Site/area protection	Bald Eagle, Barn Swallow, Common Nighthawk, Cooper's Hawk, Short-eared Owl

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
				Avoid locating roads in valuable bird habitat.		
Population effects of collisions are unknown.	12.1 Information lacking	Improve understanding of population effects of mortality from collisions	7.4 Improve understanding of causes of population declines.	Assess the biological importance of bird kills from all sources of collisions.	8.1 Research	All species
Predation by domestic cats						
Predation by domestic and feral cats.	8.1 Invasive non-native/ alien species	Reduce mortality from domestic and feral cats	2.4 Reduce incidental mortality.	Implement a "Cats Indoors!" Campaign following the guidelines of the American Bird Conservancy (http://www.abcbirds.org/abcprograms/policy/cats/index.html). Work to reduce feral cat overpopulation through cat control regulations.	5.3 Private sector standards and codes 5.2 Policies and regulations	Ground nesting or ground foraging species; species attracted to feeders; species inhabiting suburban or urban areas
Population effects of cat predation are unknown.	12.1 Information lacking	Improve understanding of population effects of cat predation	7.4 Improve understanding of causes of population declines.	Evaluate which species are most vulnerable to cat predation. Investigate the population-level effects of cat predation through better monitoring of kill rates and the number of feral cats. Continue to monitor bird	8.1 Research 8.2 Monitoring	Ground nesting or ground foraging species; species attracted to feeders; species inhabiting suburban or urban areas

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
				populations so changes in numbers and distributions can be identified and management of cats can be altered to reflect these changes. Conduct effectiveness monitoring to evaluate if mitigation activities are achieving the desired results.		
Environmental Contaminants						
Mortality, sub-lethal effects, reductions in prey populations and habitat alteration caused by exposure to/use of pesticides.	9.3 Agricultural & forestry effluents	Reduce mortality and sub-lethal effects of pesticides on birds Reduce the effects of pesticides on prey species	2.1 Reduce mortality and/or sub-lethal effects from pesticide use. 5.1 Maintain natural food webs and prey sources.	Substantially reduce the use of pesticides/rodenticides/ herbicides in Canada. Where elimination is not possible, they should be used as part of an integrated pest management system. Improve regulation of pesticides/rodenticides/herbicides in Canada to reduce bird mortality.	5.2 Policies and regulations 5.3 Private sector standards and codes	**Direct or indirect poisoning by pesticides:** American Wigeon, Bald Eagle, Black-crowned Night Heron, Common Tern, Northern Harrier, Peregrine Falcon (*anatum/tundrius*) **Reductions in prey due to pesticide use:** Barn Swallow, Black Tern, Common Nighthawk, Northern Harrier
Mortality from ingestion of lead shot or tackle.	5.1 Hunting & collecting terrestrial animals 5.4 Fishing & harvesting aquatic	Reduce mortality and sub-lethal effects of lead shot and fishing tackle on birds	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants.	Work with hunters, anglers and industry to eliminate the exposure of birds to shot, sinkers and jigs made of lead. Enforce the use of non-toxic shot in waterfowl hunting, and encourage adoption of	4.3 Awareness and communications 5.4 Compliance and enforcement	American Wigeon, Bald Eagle, Blue-winged Teal, Cackling Goose, Canvasback, Common Loon, Green-winged Teal, Lesser Scaup, Lesser Snow Goose (Western Arctic),

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
	resources			non-toxic alternatives in target shooting, upland game bird hunting, and fishing.		Mallard, Northern Pintail, Northern Shoveler, Trumpeter Swan, Tundra Swan
Mortality from heavy metals and other contaminants.	9.2 Industrial & military effluents	Reduce mortality from heavy metals and other contaminants	2.2 Reduce mortality and/or sub-lethal effects from exposure to contaminants.	Work with industry and policy makers to reduce the quantity of heavy metals and other contaminants released into the environment.	5.3 Private sector standards and codes 5.2 Policies and regulations	**Heavy metals:** Barrow's Goldeneye, Common Goldeneye, Common Loon, Northern Harrier, Surf Scoter **PCBs:** Barrow's Goldeneye, Common Goldeneye, Caspian Tern, Common Tern **Other contaminants:** Horned Grebe, Peregrine Falcon (*anatum/tundrius*)
Mortality of waterbirds from oil pollution.	9. Pollution	Reduce mortality from oil pollution	2.3 Reduce mortality and/or sub lethal effects of oil pollution. 5.1 Maintain natural food webs and prey sources.	Improve monitoring and enforcement capacity to reduce chronic oil pollution from illegal dumping of bilge waste and cleaning of oil tanks. Improve education/outreach to make sure that the oil industry and its regulators are aware of the potential impacts on birds and take measures to prevent exposure of birds to oil.	5.4 Compliance and enforcement 4.3 Awareness and communications	**Lethal and sub lethal effect of oil exposure:** American Golden-Plover, Bald Eagle, Barrow's Goldeneye, Bufflehead, Cackling Goose, Common Goldeneye, Common Loon, Horned Grebe, Lesser Scaup, Red-necked Phalarope, Short-billed Dowitcher, Surf Scoter, Whimbrel, White-winged Scoter

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
Population effects of pollution are unknown.	12.1 information lacking	Improve understanding of population effects of pollution	7.4 Improve understanding of causes of population declines.	Evaluate the effects of PBDEs and other chemicals on vital rates in birds. Evaluate the extent to which pesticides are reducing prey availability for aerial insectivores. Improve the ability to monitor and understand the effects of contaminant concentrations in birds. Continue to acquire information on oiling of waterbirds through programs like Birds Oiled at Sea.	8.1 Research 8.2 Monitoring	All species
Roads						
Habitat loss, subdivision and degradation (loss of suitable nest sites, declines of prey)	4.1 Roads and railroads	Reduce impact of roads on bird habitat	1.1 Ensure that land and resource-use policies and practices maintain or improve bird habitat	Design new road networks in conjunction with other land-use activities to maximize coordination and emulate the regions natural disturbance regime. Decommissioning of roads that are no longer required.	5.2 Policies and regulations 2.1 Site/area management	All species.
Indirect mortality (increased	4.1 Roads and railroads	Reduce mortality from indirect road impacts	2.4 Reduce incidental mortality	Restricting or limiting road access in key areas during critical times of year.	2.1 Site/area management	All species.

Table 26 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended actions	Action category	Example priority species affected
predator/prey contact, invasive species exposure, physical impacts of roads, species disruption)						
Population effects of roads are unknown	12.1 Information lacking	Improve understanding of population effects of roads	7.4 Improve understanding of causes of population declines.	Evaluate the biological importance of mortalities from all sources of road effects.	8.1 Research	All species.

Climate Change

The effects of climate change are already measurable in many bird habitats and have resulted in range shifts and changes in the timing of migration and breeding in some species[143,110]. Birds in all habitats will be affected by climate change. The most vulnerable are predicted to be those that are dependent on oceanic ecosystems and those found in coastal, island, grassland, arctic and alpine habitats[144]. Changing climate may also facilitate the spread of disease, the introduction of new predators and the invasion of non-native species that alter habitat structure and community composition[110,145]. See Tables 27 and 28 for a summary of impacts of climate change and conservation objectives.

In a recent study[146], shifts in the distribution and abundance of 102 boreal bird species were modelled and mapped under climate change scenarios for three 30-year windows between the years 2011 and 2100. Detailed bioclimatic niche models for each species were built using the best-available interpolated climate data and bird data from structured surveys in >125 000 locations across boreal North America. Projected shifts in the climatic conditions that currently characterize species' niches resulted in declines in abundance by 2100 for 36 species while increases were expected for 66 species. The largest percent decreases were projected for American Tree Sparrow, White-crowned Sparrow and Common Redpoll. Large percent increases in abundance were expected for Red-winged Blackbird, Black-capped Chickadee and Townsend's Warbler. Projected shifts in density for 40 northerly species (those that currently breed in boreal Alaska) were provided in individual maps. Refugia were identified as areas within a species' range that had a higher-than-average density within both the current and a future time period. On average, only 36% of these species' ranges remained in refugia by 2100 according to the model. Multi-species refugia for this group of species were largely restricted to western Alaska, the northern Rocky Mountains and northeastern Labrador. Such refugia will be particularly important to the persistence of many species if, as expected, vegetation changes cannot keep pace with climate change. These refugia could be evaluated as potential conservation targets.

Some of the major predicted impacts of climate change in BCR 6 are associated with changes in the frequency and spatial extent of natural disturbances such as fire[147,148]. Alterations to the fire regime result in changes to the spatial and temporal distribution of seral stages across all forest types within the boreal forest[149]. Warmer winter temperatures may also result in habitat change by allowing forest insects such as the mountain pine beetle to increase in abundance and distribution, leading to significant losses of specific tree species and forest types[150]. Increased variability in weather may also lead to a greater number of annual freeze-thaw cycles, increased precipitation (including freezing rain and deep snow) and hotter summer temperatures[151]. Late-nesting species including the Long-tailed Duck, scoters and Lesser Scaup may be particularly impacted by climate change[152,153].

To maintain healthy bird populations in the face of a changing climate, conservation must be carefully planned and must be implemented so as to buffer birds from the negative impacts of climate change wherever possible[145].

Table 27. Examples of the current and anticipated effects of climate change on bird populations in Canada and some affected bird species.

Note: The species shown here do not represent an exhaustive list; rather, they provide examples of species for which the effects of climate change have been suggested or documented.

Potential and Realized Effects of Climate Change	Examples of Species Affected
Mismatch between peak hatch and peak food abundance	Lesser Scaup, Long-tailed Duck, Swallows
Extended breeding season	All migratory species
Habitat loss as a result of ecosystem changes (e.g. advances in treeline)	American Golden-plover, Hudsonian Godwit, Smith's Longspur
Increase in severe weather events	All species
Introduction of new predators and competitors	
Range shifts to the north and from coastal to inland sites	Ring-necked Duck
Thawing of permafrost and increased evaporation will result in vegetation shifts and loss of wetlands in arctic habitat	Hudsonian Godwit, Ring-necked Duck, Rusty Blackbird, Yellow Rail

Table 28. Proposed conservation objectives and actions to address climate change.

Threats addressed	Threat sub-category	Objective	Objective category	Recommended Actions	Action category	Priority species affected
Climate change impacts habitat and negatively affects survival and productivity of birds	11.1 Habitat shifting and alteration	Reduce greenhouse gas emissions	6.1 Support efforts to reduce greenhouse gas emissions	Support efforts to reduce greenhouse gas emissions.	5.2 Policies and regulations	All
		Mitigate the effects of climate change on bird habitat	6.2 Manage for habitat resilience as climate changes	Manage for habitat resilience to allow ecosystems to adapt despite disturbances and changing conditions.	1.1 Site/area protection	
				Minimize anthropogenic stressors (such as development or pollution) to help maintain resilience.		
				Manage buffer areas and the matrix between protected areas to enhance movement of species across the landscape.	2.1 Site/area management	
				Manage ecosystems to maximize carbon storage and sequestration while simultaneously enhancing bird habitat.		
				Incorporate predicted shifts in habitat into landscape level plans (e.g., when	5.2 Policies and regulations	

Table 28 continued

Threats addressed	Threat sub-category	Objective	Objective category	Recommended Actions	Action category	Priority species affected
				establishing protected areas ensure the maintenance of north-south corridors to facilitate northward range shifts of bird species).		
Population-level effects of climate change are unknown	12.1 Information lacking	Improve understanding of climate change on birds and their habitats	7.5 Improve understanding of potential effects of climate change	Evaluate which species are most vulnerable to climate change. Investigate the **cumulative effects** of climate change. Investigate behavioural responses to climate change (such as range shifts, changes in demographic rates, and changes in timing of breeding and migration) through long-term studies. Continue to monitor bird populations so changes in numbers and distributions can be identified. Undertake monitoring to evaluate the effectiveness of mitigation activities.	8.1 Research 8.2 Monitoring	All

Research and Population Monitoring Needs

Population Monitoring

An estimate of population trend for each species is necessary for the development of elements 1 and 3 (Species Assessment and Population Objectives). However, there are many species for which we are currently unable to estimate a population trend (PT) score. These species were typically assigned a population objective of "assess/maintain." The inability to estimate a PT score may be the result of a lack of monitoring data for the BCR as a whole or may be because certain species are not well captured by common monitoring techniques. To be able to effectively evaluate species believed to be of conservation concern, and to track those not yet of concern for future changes in status, we require more comprehensive monitoring that enables us to generate population trends for all species of birds in Canada.

Although we present population objectives for most species in BCR 6, many species are not adequately monitored due to: the incomplete coverage of existing monitoring programs in northern boreal regions and the absence of new group, or species-specific monitoring programs that effectively monitor all priority species. In Table 29 below, we address the absence of suitable monitoring initiatives for all bird groups. Furthermore, a recent Environment Canada review[154] of avian monitoring programs in Canada made the following recommendations for each of the four bird groups:

Landbirds

- Develop options for on-the-ground monitoring across boreal Canada;
- Evaluate the ability of migration monitoring and checklist surveys to contribute to Environment Canada's monitoring needs; and
- Evaluate the feasibility and cost-effectiveness of improving demographic monitoring to help understand causes of population change.

Shorebirds

- Develop more reliable sampling methods for counting shorebirds in migration to address concerns about bias; and
- Increase Latin American involvement in monitoring shorebirds on the wintering grounds, including Red Knot.

Waterbirds

- Evaluate alternative strategies for filling gaps in coverage for both colonial waterbirds and marsh birds;
- Consider both costs and potential reduction in risks; and
- Carry out any necessary pilot work to evaluate options.

Waterfowl

- Review the information needs and expenditures for duck banding programs;
- Realign resources for eider and scoter monitoring to a more efficient suite of surveys.

Table 29. Monitoring recommendations to develop landbird, shorebird, waterbird and waterfowl programs that adequately survey all bird species within BCR 6.

Actions	Justification	Refs
All bird groups		
General Action: Develop large-scale, long-term coordinated monitoring programs that assess population status, identify causal factors, set population targets, evaluate conservation actions (management approaches), and document recovery at the regional and continental scale.	Monitoring programs are needed to assess population status and trend, identify causal factors in population change, set population targets, and evaluate the success of conservation actions. Current monitoring programs for all bird groups (landbirds, shorebirds, waterbirds, and waterfowl) do not meet these objectives.	
Landbirds		
General Action: Increase monitoring effort for landbirds, specifically species with poor trend data (Mo2 – low precision of Breeding Bird Survey (BBS) trends – SE of 20 yr trend >0.02 or trends based on Christmas Bird Count trend graphs); species with inadequate northern coverage (Mo3-> one third of range in boreal and arctic regions north of BBS coverage area); and species that are inadequately monitored by BBS.	Many landbird species groups and species are not adequately monitored using existing landbird monitoring programs. This is a key data gap. New landbird monitoring programs should target the following: 1) species with poor trend data (PIF Mo2); 2) species with inadequate northern coverage (PIF Mo3); 3) species that are not adequately monitored or not monitored using existing monitoring programs (e.g., irruptive species, nomadic species, woodpeckers, grouse, diurnal raptors); and 4) species at risk (federal, provincial/territorial).	1
General Action: Develop and implement a boreal landbird monitoring strategy within PNR with the goal of monitoring the health of native landbird populations (distribution; abundance; population trends) and understanding the effects of human activities on birds (habitat relationships; trends in habitat). Monitoring could focus on species with >50% of their breeding range within the boreal forest.	New monitoring plans should be in clear concordance with the results of the Avian Monitoring Review (assess the current and potential contribution of existing monitoring programs). Existing monitoring programs include: Breeding Bird Survey (BBS), Christmas Bird Count (CBC), Forest Bird Monitoring Program (FBMP), Marsh Monitoring Program (MMP), Canadian Migration Monitoring Network (CMMN), Hawk Migration Association of North America, National Nocturnal Owl Survey Programs, and Project FeederWatch.	155

Table 29 continued

Actions	Justification	Refs
Specific Action: Increase the number of Breeding Bird Survey (BBS) routes and route participation throughout BCR 6 (note-limited by the presence of roads).	Education and awareness programs may be needed in remote areas to encourage volunteers to take on the long-term commitment of conducting BBS routes. See recommendations in Bart et al. 2004[156] for sample sizes of BBS routes within BC and AB to achieve the monitoring goal for most of the 300 species that can be monitored with BBS. Note that additional landbird surveys will be required to address the habitat and location bias associated with BBS routes in BCR 6 (see below).	1
Specific Action: For BBS data and all other landbird monitoring data: 1) estimate and correct for potential bias (region-wide and roadside population trends; changes in observer detection rates; analytic methods), and 2) meet precision targets for 80% of landbirds currently sampled by these surveys.	Reliable estimates of trends in population size are critical to effective management of landbirds. Use a standard measure to determine whether landbird populations are adequately monitored: 80% power to detect a 50% decline occurring within 20 years, using a 2-tailed test and a significance level of 0.10, and incorporating effects of potential bias; also requires 2/3 coverage of the target region by the monitoring program. Note: currently only 42% of species considered suitable for monitoring with BBS and similar programs are adequately monitored using these standards--the proposed target would adequately monitor 80% of all species.	1 156
Specific Action: Design and implement a boreal landbird monitoring program to address gaps in BBS program (coverage, route location bias, habitat bias, specific species and species groups).	Key requirements include: determine target species, develop program objectives, develop detailed design elements (study design, sampling design, sampling protocols) and implementation strategies, and determine partnerships. New monitoring programs and the expansion of existing monitoring programs will monitor species groups and species that cannot be adequately surveyed using the Breeding Bird Survey (BBS). BBS is a road-based survey that captures avian species that vocalize during June. The BBS may not provide adequate coverage for species associated with contiguous or poorly represented habitats or species with large portions of their breeding range outside of areas with road access. The BBS does not provide good coverage for many species and species groups including: irruptive species (e.g., Snowy Owl), nomadic species (e.g., Bohemian Waxwing), woodpeckers (e.g., Black-backed Woodpecker), grouse (e.g., Spruce Grouse), diurnal raptors (e.g., Northern Goshawk), nocturnal raptors (e.g., Eastern Screech Owl) and wetland-associated landbirds. New programs must have well-developed	1 155

Table 29 continued

Actions	Justification	Refs
	objectives and sampling plans (e.g., random or stratified random sampling to enable extrapolation to larger regions). Target species could include species with >50% of their range within the boreal forest or species with >33% of their range within northern boreal regions.	
Specific Action: Design supplementary monitoring programs to target species at risk and rare species.	Species with narrow geographic distributions and high habitat specificity (rare species) may require additional monitoring effort in order to assess distribution, abundance, status, and population trends.	157
Specific Action: Improve quality of data for northern species that can be most easily monitored on temperate wintering grounds by conducting additional winter surveys (e.g., Christmas Bird Count).	Research is needed on analytical methods and precision estimation. Analysis and reporting should be conducted annually. More than 1/3 of the ranges of 167 landbird species are within the northern boreal regions. These species cannot be monitored solely with temperate breeding season surveys but may be monitored with temperate wintering ground surveys.	1
Specific Action: Continue to expand and improve migration monitoring for raptors by supporting RPI (Raptor Population Index) (http://rpi-project.org/).	RPI is a continent-wide long-term monitoring program of diurnal raptor migration. Research is needed on analytical methods and precision estimation. Analysis and reporting should be conducted annually.	1
Specific Action: Continue to expand and improve migration monitoring for neotropical migrants that are inaccessible for monitoring both in the breeding and wintering seasons. Expand the number of boreal species monitored and the number of stations in Canada's western boreal forest (NWT, AB, SK).	Research is needed on design, analytical methods, precision estimation, and ability to inform trend estimation. Analysis and reporting should be conducted annually. More than 1/3 of the ranges of 167 landbird species are within the northern boreal regions. These species cannot be monitored solely with temperate breeding season surveys. Currently The Canadian Migration Monitoring Network (CMMN) monitors 150 species of landbirds (80 of which breed in Canada's boreal and other northern forests and are not well monitored by established surveys) at 20 stations across Canada. Species include: Swainson's Thrush, Alder and Yellow-bellied Flycatchers, Blackpoll, Cape May, Connecticut, Wilson's, and Tennessee Warblers.	1 158
Specific Action: Continue to expand and promote the National Nocturnal Owl Survey Program.	This is a Canadian volunteer-based nocturnal roadside survey for breeding owls. Research is needed on analytical methods and precision estimation. Analysis and reporting should be conducted annually. Education and awareness programs may be needed in remote areas to encourage volunteers to take on the long-term commitment of conducting nocturnal owl surveys.	

Table 29 continued

Actions	Justification	Refs
Waterbirds		
General Action: Increase monitoring effort for waterbirds, specifically species with poor trend data (e.g., PT score=3); species with inadequate northern coverage (> one third of range in boreal and arctic regions north of BBS coverage area); and species that are inadequately monitored by BBS.	All species of colonial and non-colonial waterbirds have poor trend data in boreal BCRs due to the absence of a national waterbird monitoring program in Canada. This is a key data gap. Large-scale population monitoring is needed to document the severity and geographic extent of population declines.	
General Action: Develop and implement a boreal waterbird monitoring strategy within BCR 6 with the goal of: monitoring the status and trends of native waterbird populations (distribution; abundance; population trends); understanding the effects of human activities on birds (habitat relationships; trends in habitat); and understanding regional population dynamics in relation to habitat (upland, water, wetland).	New monitoring plans should be in clear concordance with the results of the Avian Monitoring Review (assess the current and potential contribution of existing monitoring programs). Existing monitoring programs include: Breeding Bird Survey (BBS), Christmas Bird Count (CBC), Forest Bird Monitoring Program (FBMP), Marsh Monitoring Program (MMP), Canadian Migration Monitoring Network (CMMN), Hawk Migration Association of North America, National Nocturnal Owl Survey Programs, Project FeederWatch. Note that currently a regional or national waterbird monitoring program does not exist.	
Specific Action: Design and implement a boreal waterbird monitoring program.	Key requirements include: determine target species, develop program objectives, develop detailed design elements (sampling design and sampling protocols) and implementation strategies, and determine partnerships. New monitoring programs and the expansion of existing monitoring programs will need to be designed to monitor both colonial and non-colonial waterbird species.	
Specific Action: Develop a sampling design framework for both colonial species (e.g., Eared Grebe, American White Pelican, Forster's Tern) and non-colonial species (e.g., Whooping Crane, Least Bittern, Yellow Rail, Common Loon, Pied-billed Grebe).	The sampling design for waterbirds should address the following criteria: 1) probability sampling (i.e. random) to provide a rigorous basis for inference; 2) hierarchical structure to permit nesting of sub-regions within larger geographic areas; 3) spatial balance to improve precision of estimates and to ensure the sample is spatially well-distributed; 4) spatial clustering of sample locations to reduce costs; 5) adaptable; 6) survey-wide consistency. The sampling unit should be the entire wetland (small, discrete wetlands ≤3 ha) or portions of wetlands (large, extensive wetlands >3 ha). Consult species-specific monitoring plans where appropriate.	159 160

Table 29 continued

Actions	Justification	Refs
Specific Action: Develop a specific sampling protocol for monitoring breeding colonial waterbirds in the boreal.	The sampling protocol for colonial waterbirds should consider: specific objectives (distribution or presence, density, population trend); diverse life history strategies of colonial waterbirds; breeding asynchrony in both single and multi-species colonies; number of surveys; timing of surveys; type of census procedure (direct ground, boat/ground visual, air); count bias associated with each census procedure; bias associated with spatial variability, temporal variability, and detection probability.	161 162
Specific Action: Develop a specific sampling protocol for monitoring breeding non-colonial waterbirds in the boreal.	The sampling protocol for non-colonial waterbirds (includes secretive marshbirds) should consider: specific objectives (distribution or presence, density, population trend); diverse life history strategies of non-colonial waterbirds; secretive behaviour of many species; breeding asynchrony among species; number of surveys; timing of surveys; type of census procedure (ground, passive, call-playback, combination of passive and call-playback); call-playback procedure (species included, order of species calls); count bias associated with each census procedure; bias associated with spatial variability, temporal variability, and detection probability.	163 164
Specific Action: For all waterbird monitoring data: 1) estimate and correct for potential bias (spatial variability; temporal variability; detection probability), and 2) meet precision targets for 80% of waterbirds sampled by surveys.	Reliable estimates of trends in population size are critical to effective management of waterbirds. Use a standard measure to determine whether waterbird populations are adequately monitored. See standards outlined for landbirds: 80% power to detect a 50% decline occurring within 20 years, using a 2-tailed test and a significance level of 0.10, and incorporating effects of potential bias; also requires 2/3 coverage of the target region by the monitoring program.	156
Shorebirds		
General Action: Increase monitoring effort for shorebirds, specifically species with poor trend data (e.g., PT score=3); species with inadequate northern coverage (> one third of range in boreal and arctic regions north of BBS coverage area); and species that are inadequately monitored by BBS.	All species of shorebird species have poor trend data in boreal BCRs due to the absence of a boreal shorebird monitoring program in Canada. This is a key data gap. Large-scale population monitoring throughout the boreal is needed to document the severity and geographic extent of population declines.	165

Table 29 continued

Actions	Justification	Refs
General Action: Develop and implement a boreal shorebird monitoring strategy within PNR with the goal of: monitoring the health of native shorebird populations (distribution; abundance; population trends); understanding the effects of human activities on birds (habitat relationships; trends in habitat); and understanding regional population dynamics in relation to habitat (upland, water, wetland).	New monitoring plans should be in clear concordance with the results of the Avian Monitoring Review (assess the current and potential contribution of existing monitoring programs). Existing monitoring programs include: Breeding Bird Survey (BBS), Christmas Bird Count (CBC), Marsh Monitoring Program (MMP), Canadian Migration Monitoring Network (CMMN), Hawk Migration Association of North America, National Nocturnal Owl Survey Programs, Project FeederWatch.	165
General Action: Boreal shorebird monitoring should meet the general program goals of PRISM (Program for Regional and International Shorebird Monitoring).	The goals of PRISM are to: 1) estimate the size of breeding populations; 2) describe the distribution, abundance and habitat relationships; 3) monitor trends in population size; 4) monitor numbers at stopover locations; and 5) assist local managers in meeting conservation goals. PRISM uses a 3-part approach to estimate trends: a) breeding surveys in the arctic, boreal, and temperate regions; b) migration surveys; and c) wintering surveys.	165
Specific Action: Design and implement a boreal shorebird monitoring program.	Key requirements include: determine target species, develop program objectives, develop detailed design elements (sampling design and sampling protocols) and implementation strategies, and determine partnerships. New monitoring programs and the expansion/modification of existing monitoring programs will need to be designed to monitor the 19 species of shorebirds that breed extensively in the boreal. For specific details see Section 6-Recommendations in Sinclair et al. (2004)[185].	166
Specific Action: Coordinate with existing monitoring programs (landbird, waterfowl) in order to maximize impact of effort and funds for shorebird surveys in the boreal region.	The BBS (landbird survey during breeding season) could be utilized to effectively monitor Killdeer, Marbled Godwit, Wilson's Snipe, Wilson's Phalarope, Spotted Sandpiper, Lesser Yellowlegs, Solitary Sandpiper, and Upland Sandpiper primarily in southern portions of BCR 6 (with existing road networks) with the following recommendations: increased coverage (assess current and potential coverage for each species), increased consistency of coverage, training of observers, recruitment of observers, paid observers, conducting off-road/near-road counts, and assessing seasonal changes in detectability. In northern portions of BCR 6, additional off-road surveys could be used to monitor these species.	167 168 166

Table 29 continued

Actions	Justification	Refs
Specific Action: Develop protocols (aerial and/or ground surveys) to monitor migrating shorebirds at boreal stopover sites.	For some shorebird species, counts at boreal stopover sites provide the best opportunity for population monitoring (e.g., Surfbird, Hudsonian Godwit). In BCR 6, key stopover sites are Quill Lakes, Burke/Porter/Buffer Lakes, Blaine Lakes, and Lac Lenore/Basin Lake. Note that there are few significant concentrated sites for migrating shorebirds in the boreal region. Efforts to identify additional boreal region stopover sites throughout BCR 6 should be initiated (stopover sites may be spatially dispersed in the boreal region).	166
Specific Action: Investigate the need for species-specific shorebird surveys.	Both Hudsonian Godwit and Short-billed Dowitcher have very limited breeding ranges and may require targeted surveys for population monitoring.	166
Specific Action: For all shorebird monitoring data: 1) estimate and correct for potential bias (spatial variability; temporal variability; detection probability), and 2) meet precision targets for 80% of shorebirds sampled by surveys.	Reliable estimates of trends in population size are critical to effective management of shorebirds. Use a standard measure to determine whether shorebird populations are adequately monitored. The goal of PRISM is to achieve 80% power to detect a 50% decline occurring within 20 years, using a 2-tailed test with a significance level of 0.15, and acknowledging the effects of potential bias.	165
Waterfowl		
General Action: Increase monitoring effort for waterfowl, specifically species with poor trend data (e.g., PT score=3) or species not monitored by U.S. Fish and Wildlife Service (FWS) and Canadian Wildlife Service (CWS).	Aerial breeding waterfowl surveys are conducted across boreal BCRs (USFWS, CWS) annually but only widely-distributed and abundant species are surveyed: American Black Duck, Mallard, Gadwall, American Wigeon, Green-winged Teal, Blue-winged Teal, Northern Shoveler, Northern Pintail, Redhead, Canvasback, Bufflehead, Ring-necked Duck, Canada Geese, Brant, Snow Geese, Ross' Geese, Emperor Geese, White-fronted Geese, and Tundra Swans. Scoters, goldeneyes, and scaup are monitored as groups, not individual species. Mergansers, eiders, Long-tailed Ducks, and Wood Ducks are not monitored. Additional monitoring effort is required to adequately survey diving ducks (e.g., scaup) and cavity-nesting ducks (e.g., mergansers) in the boreal region. Scaup show a dramatic long-term decline (significant over the past 10-15 years but not the past 5 years). Cavity-nesting ducks may be at risk due to changes in land use patterns and loss of old forest habitat across the boreal region.	169 170

Research

The focus of this section is to outline the main areas where a lack of information hindered our ability to understand conservation needs and make conservation recommendations. Research objectives presented here are bigger picture questions, and not necessarily a schedule of studies, that are needed to determine the needs of individual species. Undertaking research will allow us to improve future iterations of BCR strategies and to focus future implementation, and will also enable the development of new tools for conservation.

For BCR 6 we have developed a series of general research and monitoring needs (Table 30 below). The information in this table addresses key data gaps identified while summarizing data and information for Elements 1–4. Research needs focus on two key areas: 1) causes of population declines; and 2) methods/procedures, data products, tools, and partnerships to develop habitat-based population objectives within BCR 6.

Table 30. General research and monitoring needs identified in BCR 6.

Brief Description	Objective	Actions	Justification	Refs
Developing solutions for scientists, managers, and policy makers to accomplish avian conservation goals.	To develop an approach that combines research results, management activities, and monitoring into an operational framework for advancing avian conservation science and management.	Continue to support NABCI (North American Bird Conservation Initiative) and the four guiding principles: 1) integration of management needs across species; 2) standardized ecological framework for planning, implementation, and evaluation; 3) use the best available scientific information; 4) use an adaptive approach to bird conservation.	NABCI offers a vehicle for scientific organizations to direct activities, in collaboration with management organizations, toward meeting avian conservation goals.	171
Identifying priority research areas that work towards integrated solutions for scientists, managers, and policy makers.	To organize research and monitoring efforts in the context of 5 priority areas: 1) avian life history-increase basic ecological knowledge for many species; 2) habitat and environment-understand role of habitat quantity, quality, and distribution of bird populations; 3) integration of information- develop and use models like habitat, population, habitat-population dynamics, and land use to support bird conservation; 4) bird conservation planning-support development and implementation of BCR plans; 5) communication-maximize the value of data, models, and other information by using effective communication.	Support basic research into avian life history and bird-habitat relationships at appropriate spatial scales (e.g., regional or sub-regional). Support collaborative partnerships to develop and use models that support bird conservation. Support implementation of Canadian BCR plans.	These 5 priority areas represent the general needs of scientists, managers, and policy makers for meeting avian conservation objectives. Recommendations are based on outcomes from U. S. Geological Survey (USGS) workshop-Science for Avian Conservation: Understanding, Modelling, and Applying Ecological Relationships in 2000.	171

Table 30 continued

Brief Description	Objective	Actions	Justification	Refs
Identifying a framework for the interface between research and management.	To develop a framework for communicating scientific information to decision-makers and incorporating this information into natural resource policy.	Support the use of ARM (Adaptive Resource Management) by scientists, managers, and policy makers. ARM is resource management under uncertainty, with a focus on the reduction of uncertainty (management strategies are adjusted based on increases in knowledge).	ARM is used to facilitate the development, testing, and use of predictive models; guide management actions; and improve scientific knowledge about various systems. ARM links data and decisions by integrating monitoring, assessment, and decision-making into a coherent framework.	171
Key research, monitoring, and science needs should focus on: A) assessing causes of population declines, and B) establishing methods/ procedures, data products, tools, and partnerships to achieve population objectives within BCRs.	To conduct research and monitoring that examines causes of population declines within BCRs focusing on: 1) habitat-related factors, 2) disturbance factors (land uses, **cumulative effects**), and 3) non-habitat factors.	General Action: To establish cause and effect in bird population declines, research and monitoring projects require: knowledge of natural history; effective monitoring at useful spatial scales; and approaches that can directly link cause and effect relationships to population response.	Research projects should be: long-term studies (>2 yrs); large-scale (e.g., landscape, regional); and replicated (e.g., spatially and temporally).	172
		General Action: Link data from breeding and wintering areas including specific migratory routes.	Linking breeding, wintering, and migratory data would allow an assessment of habitat conditions across the annual cycle of a species and may identify the location of bottlenecks. Conservation actions need to be directed to the correct location if identifying and addressing population declines are the ultimate goals. This is a key research gap.	172

Table 30 continued

Brief Description	Objective	Actions	Justification	Refs
		General Action: Identify primary drivers of population decline (e.g., habitat related or non-habitat related) and identify key questions.	One of the key steps in assessing drivers of population decline is to determine the role of habitat versus non-habitat related drivers. The best habitat management policies will not accomplish population objectives if climate change, pollution, or disease is the primary driver of declines. Declines of aerial insectivores offer a good example of this issue. First steps should involve testing multiple broad hypotheses (e.g., habitat loss and nest site loss, decline of insects, and direct mortality possibly using existing data sources and meta-analysis techniques) to narrow the research focus and direct research resources appropriately. This is a key research gap.	172
		General Action: Identify habitat-related drivers of population decline for each priority species.	Collecting and summarizing data and developing bird-habitat relationships using qualitative and quantitative habitat models (e.g., describe the relationship between habitat variables and bird occurrence or abundance) are key requirements.	
		Specific Action: Identify high-quality habitats that promote high reproduction and survival for each priority species.	Critical or essential habitats are those habitats that support the survival or recovery of a species during breeding, wintering, and for migration. Habitat quality should be linked or indexed to demographic measures like reproductive success, productivity, juvenile and adult survival.	

Table 30 continued

Brief Description	Objective	Actions	Justification	Refs
		General Action: Identify the impacts of disturbance-specifically land use practices (agriculture, ranching, forestry, conventional and non-conventional oil and gas development, mining) and **cumulative effects** on boreal birds.	Requires specific data, data products, and specialized tools. Requires collaboration among various scientists – wildlife biologists, climatologists, geologists, land use planners. Also requires collaborative partnerships between scientists, managers, and industry.	
		Specific Action: Promote using a hierarchical approach to modelling suitable or essential habitat availability or population density.	A hierarchical approach involves using the best available data sources. At the lowest level in the hierarchy is WHRS models (Wildlife Habitat Rating Standard); the next level is HSI models (Habitat Suitability Index); the next level is empirical or data-driven habitat models; the final level is an integrated habitat-population model. Models at each level require external, independent evaluation using field-based validation or verification methods.	
		General Action: Identify non-habitat related drivers of population declines.	Examine the effects of abiotic factors – climate change, pollutants, acid precipitation, or disease on bird population declines. This is a key research gap. These issues have received little attention in the past and may become more severe in the future.	
Key research and science needs should focus on: A) assessing risks to populations and causes of population	To design, facilitate, collaborate, and conduct projects that establish methods/procedures to achieve population objectives within BCRs.	General Action: Develop the specific data products and tools necessary to develop habitat-based conservation objectives.	Ideally population objectives for priority species should reflect the population levels necessary to maintain long-term species persistence and evolutionary potential. Habitat objectives should reflect the amount of habitat necessary to support population levels of priority species outlined in the population objectives.	

Table 30 continued

Brief Description	Objective	Actions	Justification	Refs
declines, and B) establishing methods/ procedures, data products, tools, and partnerships to achieve population objectives within BCRs.	To develop habitat objectives that reflect the amount of habitat necessary to support proposed population levels (stated population objectives) of priority species.	Continue to investigate methods to account for detectability in surveys of diverse assemblages of birds over extensive areas.	Although many procedures exist to account for detectability there is disagreement over the utility of the multiple approaches developed to overcome imperfect detectability.	173 174
		Develop a common habitat and landcover mapping system to produce maps and geospatial products.	A common habitat and landcover mapping system would allow all partners, stakeholders, agencies (federal, provincial) working on data products for all bird groups to develop and apply products (e.g., bird-habitat models) to one consistent habitat layer.	
		Develop guidelines for the development of consistent habitat mapping across all landscapes using a variety of modelling methods: WHRS models (Wildlife Habitat Rating Standard); HSI models (Habitat Suitability Index); empirical or data-driven habitat models developed using common mapping system attributes (e.g., forest resource inventory data, Land Cover Classification of Canada).	A set of guidelines for large-scale landscape conservation planning should include the development of multiple methods for producing consistent, standardized, and comprehensive habitat mapping. A hierarchy of modelling methods are needed due to differences in data availability, capacity, expertise, and resources in different management units within a BCR. A model could be Landscape Conservation Cooperative (LCC) Planning in the United States.	
		Develop methods to assess historical habitat condition.	What is historical estimated habitat supply? What is estimated population size for each priority bird species under historical condition? Since qualitative and quantitative population objectives for priority species within each bird group are based on returning to 1970s levels, it is necessary to recreate the historical habitat	

Table 30 continued

Brief Description	Objective	Actions	Justification	Refs
			condition during this time period. This may require the use of historical natural disturbance records (e.g., fire, insect, flood, wind, disease) or Statistics Canada land cover/agriculture census records.	
		Develop various land and resource management scenarios to determine whether changes in land and resource activities can return the landscape to historical condition (or approximate historical condition) and therefore historical population objectives.	If NABCI population objectives are based on 1970s levels, it is imperative to determine under what conditions the current landscape could support 1970s or historical bird population objectives. This requires the development and comparison of multiple resource management scenarios: avian conservation scenario; forest harvest reduction scenario; agriculture reduction and rehabilitation scenario; conventional and non-conventional oil and gas development reduction and rehabilitation scenario.	
		Investigate methods and tools (e.g., bird-habitat models, landscape accounting tools, landscape simulation models) needed to assess risk to bird populations.	Programs to anticipate and predict the impact of current and alternative land and resource management on bird populations are needed to assess risk to populations. A combination of bird-habitat models and landscape simulation models can be used to quantify expected changes in population size in response to land use change. Scenario analyses (both current and alternative) examine how various resource activities (e.g., forestry, oil and gas exploration and development, mining, agriculture, ranching, transportation, human activity) influence habitat supply within a landscape. These can be used to track habitat amount (either spatially or aspatially) over simulated time. There are	

Table 30 continued

Brief Description	Objective	Actions	Justification	Refs
			various landscape accounting tools available to accomplish this task: ALCES (A Landscape Cumulative Effects Simulator), SELES (Spatially Explicit Landscape Effects Simulator), LSL (Landscape Scripting Language), LANDIS.	

Threats Outside Canada

Many bird species found in Canada spend a large portion of their life cycle outside of the country (Figure 35). These species face threats while they are outside Canada; in fact, threats to some migratory species may be most severe outside of the breeding season[175]. Of the 120 priority species in BCR 6, 104 (87%) are migratory and spend part of their annual cycle—up to half the year or more—outside Canada.

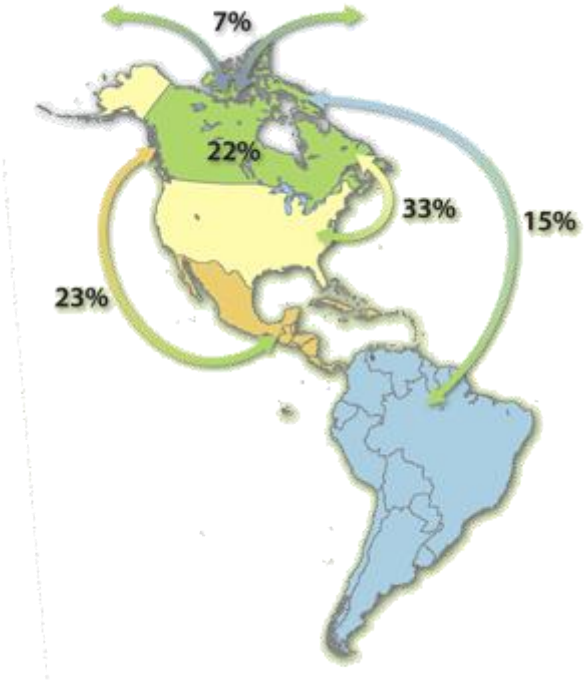


Figure 35. Percent of Canadian breeding birds that migrate to regions outside of Canada for part of their life cycle[176].

Similar to the assessment of threats facing priority species within Canada, we conducted a literature review to identify threats facing priority species while they are outside Canada. A lack of data was a pervasive issue for this exercise. For many species, little is known about threats they face during migration or while on their wintering grounds. Indeed, for some species, their wintering ranges and habitat use are only poorly known, if at all. There is also little information linking specific wintering areas to particular breeding populations, making it difficult to connect declines in breeding populations to potential problems on the wintering grounds. In addition, what data exist on wintering migrant species are heavily biased towards work done in the United States and little research is available from Mexico, Central and South America. While many of the threats identified in the United States likely affect species throughout their range, unique issues outside of the United States may have been missed. An absence of threats in a region may reflect that the necessary research has not yet been conducted (or may not be published in English). Because information on bird distributions during the non-breeding season is limited, we were unable to assess the scope and severity of threats to priority species while they are outside of Canada.

Despite this, some information is available to inform conservation work outside Canada (Fig. 36). Priority birds from BCR 6 face the loss or degradation of key migration and wintering habitats. The primary sources of habitat loss, subdivision, and degradation include: the conversion of grasslands and wetlands for agricultural use (threat sub-category 2.1); logging and wood harvesting (threat sub-category 5.3); water diversion and wetland draining for construction; water management and insect control (threat sub-category 7.2); and residential development (threat sub-category 1.1). The threat of loss, subdivision and degradation of stopover or overwinter habitat is greater for species that have relatively small and concentrated wintering ranges. Semipalmated Sandpiper, Least Sandpiper, Short-billed Dowitcher and other shorebird species are particularly vulnerable as large numbers of these species concentrate at just a handful of key migratory stopover sites; loss or degradation of these sites could have devastating impacts on the species.

In addition to habitat loss, other significant threats encountered by priority birds from BCR 6 are the lethal and sub-lethal impacts of exposure to industrial and agricultural contaminants (threat sub-categories 9.2 and 9.3). Oil pollution, heavy metals and pesticides cause mortality during migration and on the wintering grounds either directly by poisoning, or indirectly through reductions in prey. Other large sources of mortality for priority species outside of Canada are related to legal and illegal hunting activities (threat sub-category 5.1) and collisions with buildings and towers (threat sub-category 1.2).

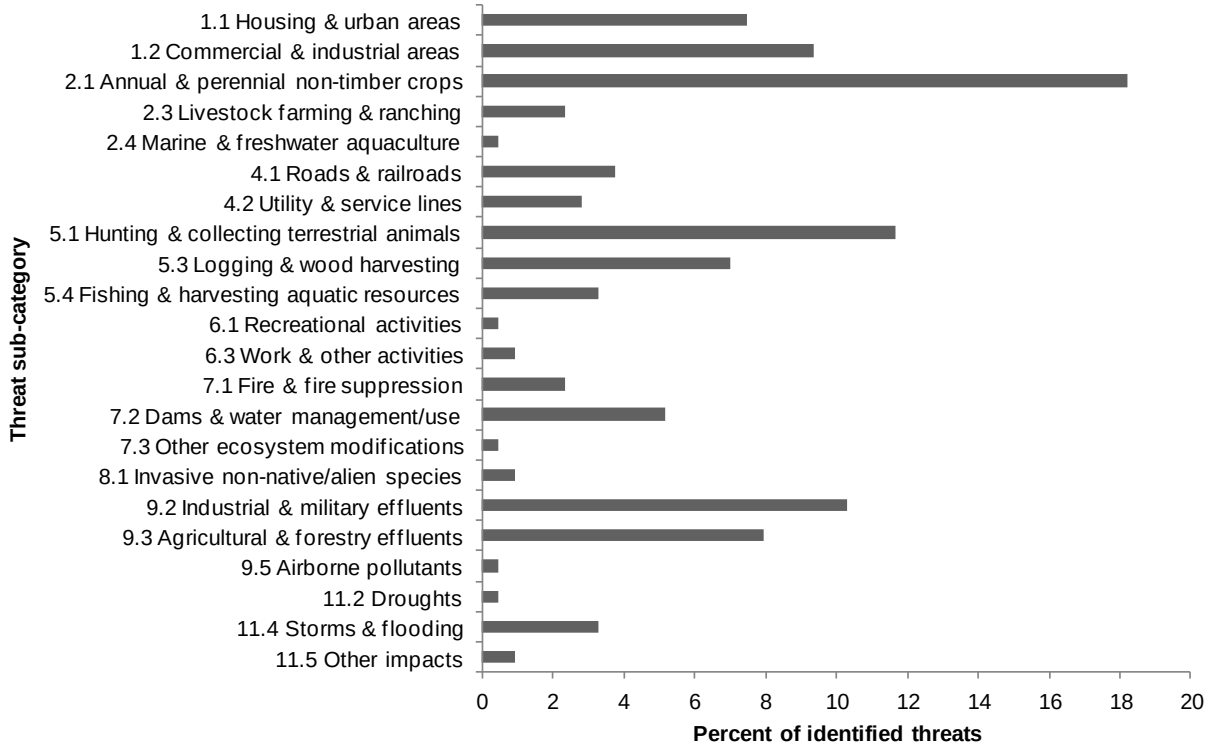


Figure 36. Percent of identified threats to priority species (by threat sub-category) from BCR 6 when they are outside Canada.

Note: Magnitudes could not be assigned for threats outside Canada due to lack of information on scope and severity.

Next Steps

The primary aims of BCR strategies are to present Environment Canada's priorities with respect to migratory bird conservation, and to provide a comprehensive overview of the conservation needs of bird populations to practitioners who may then undertake activities that promote bird conservation in Canada and internationally. Users from all levels of government, Aboriginal communities, the private sector, academia, NGOs and citizens will benefit from the information. BCR strategies can be used in many different ways depending on the needs of the user, who may focus on one or more of the elements of the strategy to guide their conservation projects.

BCR strategies will be updated periodically. Errors, omissions and additional sources of information may be provided to Environment Canada at any time for inclusion in subsequent versions.

Appendix A

List of All Bird Species in BCR 6

Table A1. Complete list of species in BCR 6, when they are in the BCR (breeding, migrant, winter) and their priority status.

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Landbirds					
Empidonax alnorum	Alder Flycatcher		Landbird	Breeding	Yes
Corvus brachyrhynchos	American Crow		Landbird	Breeding	
Spinus tristis	American Goldfinch		Landbird	Breeding	
Falco sparverius	American Kestrel		Landbird	Breeding	Yes
Anthus rubescens	American Pipit		Landbird	Breeding	
Setophaga ruticilla	American Redstart		Landbird	Breeding	
Turdus migratorius	American Robin		Landbird	Breeding	
Picoides dorsalis	American Three-toed Woodpecker		Landbird	Breeding	Yes
Spizella arborea	American Tree Sparrow		Landbird	Breeding	
Ammodramus bairdii	Baird's Sparrow		Landbird	Breeding	
Haliaeetus leucocephalus	Bald Eagle		Landbird	Breeding	
Icterus galbula	Baltimore Oriole		Landbird	Breeding	Yes
Riparia riparia	Bank Swallow		Landbird	Breeding	Yes
Hirundo rustica	Barn Swallow		Landbird	Breeding	Yes
Strix varia	Barred Owl		Landbird	Breeding	Yes
Setophaga castanea	Bay-breasted Warbler		Landbird	Breeding	Yes
Megaceryle alcyon	Belted Kingfisher		Landbird	Breeding	
Mniotilta varia	Black-and-white Warbler		Landbird	Breeding	
Picoides arcticus	Black-backed Woodpecker		Landbird	Breeding	Yes
Coccyzus erythropthalmus	Black-billed Cuckoo		Landbird	Breeding	Yes
Pica hudsonia	Black-billed Magpie		Landbird	Breeding	Yes
Setophaga fusca	Blackburnian Warbler		Landbird	Breeding	Yes
Poecile atricapillus	Black-capped Chickadee		Landbird	Breeding	
Setophaga striata	Blackpoll Warbler		Landbird	Breeding	Yes
Setophaga caerulescens	Black-throated Blue Warbler		Landbird	Breeding	
Setophaga virens	Black-throated Green Warbler		Landbird	Breeding	Yes
Cyanocitta cristata	Blue Jay		Landbird	Breeding	
Vireo solitarius	Blue-headed Vireo		Landbird	Breeding	
Dolichonyx oryzivorus	Bobolink		Landbird	Breeding	Yes
Bombycilla garrulus	Bohemian Waxwing		Landbird	Breeding	Yes
Poecile hudsonicus	Boreal Chickadee		Landbird	Breeding	Yes

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Aegolius funereus	Boreal Owl		Landbird	Breeding	Yes
Euphagus cyanocephalus	Brewer's Blackbird		Landbird	Breeding	
Spizella breweri	Brewer's Sparrow		Landbird	Breeding	
Buteo platypterus	Broad-winged Hawk		Landbird	Breeding	Yes
Certhia americana	Brown Creeper		Landbird	Breeding	Yes
Toxostoma rufum	Brown Thrasher		Landbird	Breeding	
Molothrus ater	Brown-headed Cowbird		Landbird	Breeding	
Selasphorus calliope	Calliope Hummingbird		Landbird	Breeding	
Cardellina canadensis	Canada Warbler		Landbird	Breeding	Yes
Setophaga tigrina	Cape May Warbler		Landbird	Breeding	Yes
Vireo cassinii	Cassin's Vireo		Landbird	Breeding	
Bombycilla cedrorum	Cedar Waxwing		Landbird	Breeding	
Setophaga pensylvanica	Chestnut-sided Warbler		Landbird	Breeding	
Chaetura pelagica	Chimney Swift		Landbird	Breeding	Yes
Spizella passerina	Chipping Sparrow		Landbird	Breeding	
Spizella pallida	Clay-colored Sparrow		Landbird	Breeding	Yes
Petrochelidon pyrrhonota	Cliff Swallow		Landbird	Breeding	
Quiscalus quiscula	Common Grackle		Landbird	Breeding	
Chordeiles minor	Common Nighthawk		Landbird	Breeding	Yes
Corvus corax	Common Raven		Landbird	Breeding	
Acanthis flammea	Common Redpoll		Landbird	Breeding	
Geothlypis trichas	Common Yellowthroat		Landbird	Breeding	Yes
Oporornis agilis	Connecticut Warbler		Landbird	Breeding	Yes
Accipiter cooperii	Cooper's Hawk		Landbird	Breeding	
Junco hyemalis	Dark-eyed Junco		Landbird	Breeding	
Picoides pubescens	Downy Woodpecker		Landbird	Breeding	
Empidonax oberholseri	Dusky Flycatcher		Landbird	Breeding	
Dendragapus obscurus	Dusky Grouse		Landbird	Breeding	
Sialia sialis	Eastern Bluebird		Landbird	Breeding	
Tyrannus tyrannus	Eastern Kingbird		Landbird	Breeding	
Sturnella magna	Eastern Meadowlark		Landbird	Breeding	
Sayornis phoebe	Eastern Phoebe		Landbird	Breeding	Yes
Pipilo erythrophthalmus	Eastern Towhee		Landbird	Breeding	
Antrostomus vociferus	Eastern Whip-poor-will		Landbird	Breeding	Yes
Contopus virens	Eastern Wood-Pewee		Landbird	Breeding	
Sturnus vulgaris	European Starling		Landbird	Breeding	
Coccothraustes vespertinus	Evening Grosbeak		Landbird	Breeding	
Passerella iliaca	Fox Sparrow		Landbird	Breeding	
Aquila chrysaetos	Golden Eagle		Landbird	Breeding	

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Regulus satrapa	Golden-crowned Kinglet		Landbird	Breeding	
Zonotrichia atricapilla	Golden-crowned Sparrow		Landbird	Breeding	
Vermivora chrysoptera	Golden-winged Warbler		Landbird	Breeding	Yes
Ammodramus savannarum	Grasshopper Sparrow		Landbird	Breeding	
Dumetella carolinensis	Gray Catbird		Landbird	Breeding	
Perisoreus canadensis	Gray Jay		Landbird	Breeding	
Perdix perdix	Gray Partridge		Landbird	Breeding	
Catharus minimus	Gray-cheeked Thrush		Landbird	Breeding	
Poecile cinctus	Gray-headed Chickadee		Landbird	Breeding	Yes
Myiarchus crinitus	Great Crested Flycatcher		Landbird	Breeding	
Strix nebulosa	Great Gray Owl		Landbird	Breeding	Yes
Bubo virginianus	Great Horned Owl		Landbird	Breeding	
Tympanuchus cupido	Greater Prairie-Chicken		Landbird		
Picoides villosus	Hairy Woodpecker		Landbird	Breeding	
Empidonax hammondii	Hammond's Flycatcher		Landbird	Breeding	
Zonotrichia querula	Harris's Sparrow		Landbird	Breeding	Yes
Catharus guttatus	Hermit Thrush		Landbird	Breeding	
Acanthis hornemanni	Hoary Redpoll		Landbird	Breeding	
Eremophila alpestris	Horned Lark		Landbird	Breeding	
Haemorhous mexicanus	House Finch		Landbird	Breeding	
Passer domesticus	House Sparrow		Landbird	Breeding	
Troglodytes aedon	House Wren		Landbird	Breeding	
Passerina cyanea	Indigo Bunting		Landbird	Breeding	
Calcarius lapponicus	Lapland Longspur		Landbird	Breeding	
Chondestes grammacus	Lark Sparrow		Landbird	Breeding	
Ammodramus leconteii	Le Conte's Sparrow		Landbird	Breeding	Yes
Empidonax minimus	Least Flycatcher		Landbird	Breeding	Yes
Melospiza lincolnii	Lincoln's Sparrow		Landbird	Breeding	
Lanius ludovicianus	Loggerhead Shrike		Landbird	Breeding	Yes
Asio otus	Long-eared Owl		Landbird	Breeding	
Geothlypis tolmiei	MacGillivray's Warbler		Landbird	Breeding	
Setophaga magnolia	Magnolia Warbler		Landbird	Breeding	
Cistothorus palustris	Marsh Wren		Landbird	Breeding	
Falco columbarius	Merlin		Landbird	Breeding	Yes
Sialia currucoides	Mountain Bluebird		Landbird	Breeding	Yes
Zenaida macroura	Mourning Dove		Landbird	Breeding	
Geothlypis philadelphia	Mourning Warbler		Landbird	Breeding	Yes
Oreothlypis ruficapilla	Nashville Warbler		Landbird	Breeding	
Ammodramus nelsoni	Nelson's Sparrow		Landbird	Breeding	Yes
Cardinalis cardinalis	Northern Cardinal		Landbird	Breeding	

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Colaptes auratus	Northern Flicker		Landbird	Breeding	Yes
Accipiter gentilis	Northern Goshawk		Landbird	Breeding	Yes
Circus cyaneus	Northern Harrier		Landbird	Breeding	Yes
Surnia ulula	Northern Hawk Owl		Landbird	Breeding	Yes
Mimus polyglottos	Northern Mockingbird		Landbird	Breeding	
Setophaga americana	Northern Parula		Landbird	Breeding	
Glaucidium gnoma	Northern Pygmy-Owl		Landbird	Breeding	
Stelgidopteryx serripennis	Northern Rough-winged Swallow		Landbird	Breeding	
Aegolius acadicus	Northern Saw-whet Owl		Landbird	Breeding	
Lanius excubitor	Northern Shrike		Landbird	Breeding	Yes
Parkesia noveboracensis	Northern Waterthrush		Landbird	Breeding	
Oenanthe oenanthe	Northern Wheatear		Landbird	Breeding	
Contopus cooperi	Olive-sided Flycatcher		Landbird	Breeding	Yes
Oreothylpis celata	Orange-crowned Warbler		Landbird	Breeding	
Icterus spurius	Orchard Oriole		Landbird	Breeding	
Pandion haliaetus	Osprey		Landbird	Breeding	
Seiurus aurocapilla	Ovenbird		Landbird	Breeding	
Empidonax difficilis	Pacific-slope Flycatcher		Landbird	Breeding	
Setophaga palmarum	Palm Warbler		Landbird	Breeding	
Falco peregrinus anatum/tundrius	Peregrine Falcon *anatum/tundrius*		Landbird	Breeding	Yes
Vireo philadelphicus	Philadelphia Vireo		Landbird	Breeding	
Dryocopus pileatus	Pileated Woodpecker		Landbird	Breeding	Yes
Pinicola enucleator	Pine Grosbeak		Landbird	Breeding	
Spinus pinus	Pine Siskin		Landbird	Breeding	
Setophaga pinus	Pine Warbler		Landbird	Breeding	
Haemorhous purpureus	Purple Finch		Landbird	Breeding	
Progne subis	Purple Martin		Landbird	Breeding	Yes
Loxia curvirostra	Red Crossbill		Landbird	Breeding	
Sitta canadensis	Red-breasted Nuthatch		Landbird	Breeding	
Sphyrapicus ruber	Red-breasted Sapsucker		Landbird	Breeding	
Vireo olivaceus	Red-eyed Vireo		Landbird	Breeding	
Melanerpes erythrocephalus	Red-headed Woodpecker		Landbird	Breeding	Yes
Buteo lineatus	Red-shouldered Hawk		Landbird	Breeding	
Buteo jamaicensis	Red-tailed Hawk		Landbird	Breeding	
Agelaius phoeniceus	Red-winged Blackbird		Landbird	Breeding	
Phasianus colchicus	Ring-necked Pheasant		Landbird	Breeding	
Columba livia	Rock Pigeon		Landbird	Breeding	
Lagopus muta	Rock Ptarmigan		Landbird	Breeding	
Pheucticus ludovicianus	Rose-breasted Grosbeak		Landbird	Breeding	
Buteo lagopus	Rough-legged Hawk		Landbird	Breeding	

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Regulus calendula	Ruby-crowned Kinglet		Landbird	Breeding	
Archilochus colubris	Ruby-throated Hummingbird		Landbird	Breeding	
Bonasa umbellus	Ruffed Grouse		Landbird	Breeding	
Selasphorus rufus	Rufous Hummingbird		Landbird	Breeding	
Euphagus carolinus	Rusty Blackbird		Landbird	Breeding	Yes
Passerculus sandwichensis	Savannah Sparrow		Landbird	Breeding	
Sayornis saya	Say's Phoebe		Landbird	Breeding	
Piranga olivacea	Scarlet Tanager		Landbird	Breeding	
Cistothorus platensis	Sedge Wren		Landbird	Breeding	Yes
Accipiter striatus	Sharp-shinned Hawk		Landbird	Breeding	
Tympanuchus phasianellus	Sharp-tailed Grouse		Landbird	Breeding	Yes
Asio flammeus	Short-eared Owl		Landbird	Breeding	Yes
Calcarius pictus	Smith's Longspur		Landbird	Breeding	Yes
Plectrophenax nivalis	Snow Bunting		Landbird	Breeding	
Bubo scandiacus	Snowy Owl		Landbird	Wintering	
Melospiza melodia	Song Sparrow		Landbird	Breeding	
Pipilo maculatus	Spotted Towhee		Landbird	Breeding	
Anthus spragueii	Sprague's Pipit		Landbird	Breeding	Yes
Falcipennis canadensis	Spruce Grouse		Landbird	Breeding	Yes
Cyanocitta stelleri	Steller's Jay		Landbird	Resident	
Buteo swainsoni	Swainson's Hawk		Landbird	Breeding	
Catharus ustulatus	Swainson's Thrush		Landbird	Breeding	
Melospiza georgiana	Swamp Sparrow		Landbird	Breeding	
Oreothlypis peregrina	Tennessee Warbler		Landbird	Breeding	
Myadestes townsendi	Townsend's Solitaire		Landbird	Breeding	
Setophaga townsendi	Townsend's Warbler		Landbird	Breeding	
Tachycineta bicolor	Tree Swallow		Landbird	Breeding	
Cathartes aura	Turkey Vulture		Landbird	Breeding	
Ixoreus naevius	Varied Thrush		Landbird	Breeding	
Catharus fuscescens	Veery		Landbird	Breeding	
Pooecetes gramineus	Vesper Sparrow		Landbird	Breeding	
Tachycineta thalassina	Violet-green Swallow		Landbird	Breeding	
Vireo gilvus	Warbling Vireo		Landbird	Breeding	
Tyrannus verticalis	Western Kingbird		Landbird	Breeding	
Sturnella neglecta	Western Meadowlark		Landbird	Breeding	
Piranga ludoviciana	Western Tanager		Landbird	Breeding	Yes
Contopus sordidulus	Western Wood-Pewee		Landbird	Breeding	Yes
Sitta carolinensis	White-breasted Nuthatch		Landbird	Breeding	
Zonotrichia leucophrys	White-crowned Sparrow		Landbird	Breeding	
Lagopus leucurus	White-tailed Ptarmigan		Landbird	Breeding	
Zonotrichia albicollis	White-throated Sparrow		Landbird	Breeding	Yes

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Loxia leucoptera	White-winged Crossbill		Landbird	Breeding	Yes
Empidonax traillii	Willow Flycatcher		Landbird	Breeding	
Lagopus lagopus	Willow Ptarmigan		Landbird	Breeding	
Cardellina pusilla	Wilson's Warbler		Landbird	Breeding	
Troglodytes hiemalis	Winter Wren		Landbird	Breeding	
Hylocichla mustelina	Wood Thrush		Landbird	Breeding	
Setophaga petechia	Yellow Warbler		Landbird	Breeding	
Empidonax flaviventris	Yellow-bellied Flycatcher		Landbird	Breeding	
Sphyrapicus varius	Yellow-bellied Sapsucker		Landbird	Breeding	Yes
Coccyzus americanus	Yellow-billed Cuckoo		Landbird	Breeding	
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		Landbird	Breeding	
Setaphaga coronata	Yellow-rumped Warbler		Landbird	Breeding	
Vireo flavifrons	Yellow-throated Vireo		Landbird	Breeding	
Shorebirds					
Pluvialis dominica	American Golden-Plover		Shorebird	Breeding	Yes
Tringa melanoleuca	Greater Yellowlegs		Shorebird	Breeding	Yes
Limosa haemastica	Hudsonian Godwit		Shorebird	Breeding	Yes
Charadrius vociferus	Killdeer		Shorebird	Breeding	Yes
Calidris minutilla	Least Sandpiper		Shorebird	Breeding	Yes
Tringa flavipes	Lesser Yellowlegs		Shorebird	Breeding	Yes
Limosa fedoa	Marbled Godwit		Shorebird	Breeding	Yes
Phalaropus lobatus	Red-necked Phalarope		Shorebird	Breeding	Yes
Charadrius semipalmatus	Semipalmated Plover		Shorebird	Breeding	
Calidris pulsilla	Semipalmated Sandpiper		Shorebird	Breeding	Yes
Limnodromus griseus	Short-billed Dowitcher		Shorebird	Breeding	Yes
Tringa solitaria	Solitary Sandpiper		Shorebird	Breeding	Yes
Actitis macularius	Spotted Sandpiper		Shorebird	Breeding	
Bartramia longicauda	Upland Sandpiper		Shorebird	Breeding	Yes
Numenius phaeopus	Whimbrel		Shorebird	Migrant	Yes
Phalaropus tricolor	Wilson's Phalarope		Shorebird	Breeding	Yes
Gallinago delicata	Wilson's Snipe		Shorebird	Breeding	Yes
Waterbirds					
Botaurus lentiginosus	American Bittern		Waterbird	Breeding	Yes
Fulica americana	American Coot		Waterbird	Breeding	
Pelecanus erythrorhynchos	American White Pelican		Waterbird	Breeding	Yes
Sterna paradisaea	Arctic Tern		Waterbird	Breeding	Yes
Chlidonias niger	Black Tern		Waterbird	Breeding	Yes
Nycticorax nycticorax	Black-crowned Night-Heron		Waterbird	Breeding	Yes
Chroicocephalus philadelphia	Bonaparte's Gull		Waterbird	Breeding	Yes

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Larus californicus	California Gull		Waterbird	Breeding	Yes
Hydroprogne caspia	Caspian Tern		Waterbird	Breeding	Yes
Gavia immer	Common Loon		Waterbird	Breeding	Yes
Sterna hirundo	Common Tern		Waterbird	Breeding	Yes
Phalacrocorax auritus	Double-crested Cormorant		Waterbird	Breeding	
Podiceps nigricollis	Eared Grebe		Waterbird	Breeding	Yes
Sterna forsteri	Forster's Tern		Waterbird	Breeding	Yes
Leucophaeus pipixcan	Franklin's Gull		Waterbird	Breeding	
Ardea herodias	Great Blue Heron		Waterbird	Breeding	
Larus argentatus	Herring Gull		Waterbird	Breeding	Yes
Podiceps auritus	Horned Grebe		Waterbird	Breeding	Yes
Stercorarius longicaudus	Long-tailed Jaeger		Waterbird	Breeding	
Larus canus	Mew Gull		Waterbird	Breeding	
Gavia pacifica	Pacific Loon		Waterbird	Breeding	Yes
Stercorarius parasiticus	Parasitic Jaeger		Waterbird	Breeding	
Podilymbus podiceps	Pied-billed Grebe		Waterbird	Breeding	Yes
Podiceps grisegena	Red-necked Grebe		Waterbird	Breeding	Yes
Gavia stellata	Red-throated Loon		Waterbird	Breeding	
Larus delawarensis	Ring-billed Gull		Waterbird	Breeding	
Grus canadensis	Sandhill Crane		Waterbird	Breeding	
Porzana carolina	Sora		Waterbird	Breeding	Yes
Rallus limicola	Virginia Rail		Waterbird	Breeding	Yes
Aechmophorus occidentalis	Western Grebe		Waterbird	Breeding	Yes
Grus americana	Whooping Crane		Waterbird	Breeding	Yes
Coturnicops noveboracensis	Yellow Rail		Waterbird	Breeding	Yes
Gavia adamsii	Yellow-billed Loon		Waterbird	Breeding	
Waterfowl					
Anas americana	American Wigeon		Waterfowl	Breeding	Yes
Bucephala islandica	Barrow's Goldeneye	Western	Waterfowl	Breeding	Yes
Melanitta americana	Black Scoter		Waterfowl	Breeding	
Anas discors	Blue-winged Teal		Waterfowl	Breeding	Yes
Bucephala albeola	Bufflehead		Waterfowl	Breeding	Yes
Branta hutchinsii	Cackling Goose	Shortgrass Prairie	Waterfowl	Breeding	Yes
Branta canadensis	Canada Goose	Eastern Prairie	Waterfowl	Breeding	
Branta canadensis	Canada Goose	Rocky Mountain	Waterfowl	Breeding	
Aythya valisineria	Canvasback		Waterfowl	Breeding	Yes
Anas cyanoptera	Cinnamon Teal		Waterfowl	Breeding	
Somateria mollissima	Common Eider		Waterfowl	Breeding	
Bucephala clangula	Common Goldeneye		Waterfowl	Breeding	Yes
Mergus merganser	Common Merganser		Waterfowl	Breeding	

Table A1 continued

Scientific Name	Common Name	Population	Bird group	Residency	Priority
Anas strepera	Gadwall		Waterfowl	Breeding	Yes
Aythya marila	Greater Scaup		Waterfowl	Breeding	
Anser albifrons	Greater White-fronted Goose		Waterfowl	Breeding	
Anas crecca	Green-winged Teal		Waterfowl	Breeding	Yes
Lophodytes cucullatus	Hooded Merganser		Waterfowl	Breeding	
Aythya affinis	Lesser Scaup		Waterfowl	Breeding	Yes
Chen caerulescens caerulescens	Lesser Snow Goose	Western Arctic	Waterfowl	Breeding	Yes
Chen caerulescens caerulescens	Lesser Snow Goose	Western Central Flyway	Waterfowl	Migrant	
Chen caerulescens caerulescens	Lesser Snow Goose	Wrangel Island	Waterfowl	Migrant	
Clangula hyemalis	Long-tailed Duck		Waterfowl	Breeding	Yes
Anas platyrhynchos	Mallard		Waterfowl	Breeding	Yes
Anas acuta	Northern Pintail		Waterfowl	Breeding	Yes
Anas clypeata	Northern Shoveler		Waterfowl	Breeding	Yes
Mergus serrator	Red-breasted Merganser		Waterfowl	Breeding	
Aythya americana	Redhead		Waterfowl	Breeding	Yes
Aythya collaris	Ring-necked Duck		Waterfowl	Breeding	Yes
Chen rossii	Ross's Goose		Waterfowl	Migrant	
Oxyura jamaicensis	Ruddy Duck		Waterfowl	Breeding	
Melanitta perspicillata	Surf Scoter		Waterfowl	Breeding	Yes
Cygnus buccinator	Trumpeter Swan	Rocky Mountain	Waterfowl	Breeding	Yes
Cygnus columbianus	Tundra Swan	Eastern	Waterfowl	Breeding	Yes
Cygnus columbianus	Tundra Swan	Western	Waterfowl	Migrant	
Melanitta fusca	White-winged Scoter		Waterfowl	Breeding	Yes
Aix sponsa	Wood Duck		Waterfowl	Breeding	

Table A2. Species removed from priority list by the expert review process.

Species	Priority Criteria	Reason for Removal
American Tree Sparrow	GS Rank[1]	Removed based on expert opinion of species status within BCR 6
Bald Eagle	GS Rank	GS Rank in AB/SK/YT qualifies for inclusion but species does not meet additional criteria for significant breeding density and portion of global breeding population within BCR 6.
Eastern Meadowlark	COSEWIC[2]	Threatened COSEWIC status qualifies for inclusion but Eastern Meadowlark is a grassland species; range is peripheral to BCR 6.
Evening Grosbeak	GS Rank	GS rank in MB qualifies for inclusion but only a small portion of Evening Grosbeak range in BCR 6 overlaps with MB; does not meet criteria for significant breeding density and portion of global breeding population within BCR 6.
Golden Eagle	GS Rank	GS Rank in AB/SK/YT qualifies for inclusion but does not meet additional criteria for breeding density and significant portion of global breeding population within BCR 6.
Great Blue Heron	GS Rank	GS Rank in AB/SK qualifies for inclusion but species does not meet additional criteria for significant breeding density and portion of global breeding population within BCR 6.
Greater Prairie-Chicken	COSEWIC	Extirpated COSEWIC status qualifies for inclusion but there is currently no Recovery Strategy for this species. Further assessment is needed to determine whether recovery of the Greater Prairie-Chicken is technically and biologically feasible.
Horned Lark	GS Rank	GS rank in MB qualifies for inclusion but Horned Lark is a grassland species; range is peripheral in BCR 6.
Lesser Yellowlegs	GS Rank	GS Rank in YT qualifies for inclusion but does not meet additional criteria for significant breeding density and portion of global breeding population within BCR 6.
Nelson's Sparrow	GS Rank	GS rank in BC qualifies for inclusion but only a small portion of Nelson's Sparrow range within BCR 6 overlaps with BC
Osprey	GS Rank	GS rank in YT/AB qualifies for inclusion but species does not meet additional criteria for significant breeding density and portion of global breeding population within BCR 6.
Pine Grosbeak	GS Rank	GS rank in SK qualifies for inclusion but species does not meet additional criteria for significant breeding density and portion of global breeding population within BCR 6.
Red Crossbill	GS Rank	GS rank in MB qualifies for inclusion but only a small portion of species range in BCR 6 is within MB.
Sandhill Crane	GS Rank	Removed based on expert opinion of species status;
Swainson's Hawk	GS Rank	GS rank in various jurisdictions qualifies for inclusion but species is peripheral in BCR 6. Only northern tip of breeding range overlaps with BCR 6.
Turkey Vulture	GS Rank	GS rank in SK qualifies for inclusion but species is peripheral in BCR 6. Only northern tip of breeding range overlaps with BCR 6.

Note: AB=Alberta; BC=British Columbia; SK=Saskatchewan; MB=Manitoba; YT= Yukon Territory.
[1] General Status Rank (www.wildspecies.ca/) must be ≤3 (At Risk, May be at Risk, or Sensitive) in any province or territory overlapping with the BCR and satisfy additional criteria to warrant inclusion when GS rank listing(s) do not encompass the species range within BCR 6. See Appendix 2 for more detail.
[2] Assessed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as Special Concern status or higher.

Appendix B

General Methodology for Compiling the Six Standard Elements

Each strategy includes six required elements to conform to the national standard. An extensive manual[5] provides methods and other guidance for completing each element. The six elements provide an objective means of moving towards multi-species conservation efforts that are targeted to species and issues of highest priority. The six elements are:

1) identifying priority species – to focus conservation attention on species of conservation concern and those most representative of the region
2) attributing priority species to habitat classes – a tool for identifying habitats of conservation interest and a means of organizing and presenting information
3) setting population objectives for priority species – an assessment of current population status compared to the desired status, and a means of measuring conservation success
4) assessing and ranking threats – identifies the relative importance of issues affecting populations of priority species within the planning area as well as outside Canada (i.e., throughout their life cycle)
5) setting conservation objectives – outlines the overall conservation goals in response to identified threats and information needs; also a means of measuring accomplishments
6) proposing recommended actions – strategies to begin on-the-ground conservation to help achieve conservation objectives

The first four elements apply to individual priority species and together comprise an assessment of the status of priority species and the threats they face. The last two elements integrate information across species to create a vision for conservation implementation both within Canada and in countries that host priority species during migration and the non-breeding season.

Element 1: Species Assessment to Identify Priority Species

The Bird Conservation Strategies identify "priority species" from all regularly occurring bird species in each subregion. The priority species approach allows management attention and limited resources to focus on those species with particular conservation importance, ecological significance and/or management need. The species assessment processes used are derived from standard assessment protocols developed by the four major bird conservation initiatives[i].

The species assessment process applies quantitative rule sets to biological data for factors such as:

- population size,
- breeding and non-breeding distribution,
- population trend,

[i] Partners in Flight (landbirds), Wings Over Water (waterbirds), Canadian Shorebird Conservation Plan (shorebirds), North American Waterfowl Management Plan (waterfowl).

- breeding and non-breeding threats, and
- regional density and abundance.

The assessment is applied to individual bird species and ranks each species in terms of its biological vulnerability and population status. The assessments can be used to assign sub-regional (i.e. provincial section of a BCR), regional (BCR) and continental conservation needs among birds.

In BCR 6, priority species are identified using the following data sources. For landbirds, BCR-specific assessment data are obtained from the Rocky Mountain Bird Observatory[177] and priority and stewardship species are identified following Partners In Flight (PIF) guidelines[178]. For waterfowl, waterfowl conservation region (WCR)-specific assessment data are obtained from the NAWMP Implementation Framework[4]. For shorebirds and waterbirds, only national assessment data and information are used[2,3]. For shorebirds specifically, new information evaluated since the production of national conservation plans is also included[179].

Additional species have been added to the priority species list based on two assessments at the regional level: 1) provincial/territorial General Status ranks and 2) expert opinion.

General Status (GS) Ranks

This is a numerical rank (0.1, 1–8) assigned for a species that represents its status in a specific province or territory where it occurs. GS ranks are reassessed every 5 years: GS ranks from 2010 were used to assess additional PNR species. To be included as a priority species (P-PNR), a species' GS rank had to be ≤3 ("At Risk," "May be at Risk" or "Sensitive") in a province or territory that overlaps the species' range within BCR 6. See www.wildspecies.ca/wildspecies2005/index.cfm?lang=e for more information on GS ranks. As GS rank designations can differ between provincial/territorial jurisdictions, if the rankings of a species were not ≤3 throughout its range in BCR 6, additional assessment criteria were used to determine if listing the species as a priority was warranted. Criteria included whether the listing jurisdiction(s) covered a significant proportion of the species' range within BCR 6, as well as the relative density and proportion of the global breeding population of the species within BCR 6. See Table B1 for a complete list of General Status ranks and definitions.

Expert Review

Avian and habitat conservation experts associated with each of the four bird groups reviewed data and information summarized for the species assessment process for BCR 6. Some species have been added or removed from the priority list based on expert opinion. Species removed from the priority species list have been retained on the candidate species list (regularly occurring species in the BCR including breeding, residents and migrants).

For a complete list of all candidate species in BCR 6 including residency status and priority status, see Appendix A, Table A1.

Table B1. Descriptions of General Status rank categories.
Species categorized as 3 or lower were considered for listing as priority species.

Rank	General Status	Description
0.2	Extinct	Species that are extirpated worldwide (i.e., they no longer exist anywhere).
0.1	Extirpated	Species that are no longer present in a given geographic area, but occur in other areas
1	At Risk	Species for which a formal, detailed risk assessment (COSEWIC status assessment or provincial or territorial equivalent) has been completed and that have been determined to be at risk of extirpation or extinction (i.e., Endangered or Threatened). A COSEWIC designation of Endangered or Threatened automatically results in a Canada General Status Rank (Canada rank) of At Risk. Where a provincial or territorial formal risk assessment finds a species to be Endangered or Threatened in that particular region, then, under the general status program, the species automatically receives a provincial or territorial general status rank of At Risk.
2	May Be At Risk	Species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment by COSEWIC, or provincial or territorial equivalents.
3	Sensitive	Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.
4	Secure	Species that are not believed to belong in the categories Extinct, Extirpated, At Risk, May Be At Risk, Sensitive, Accidental or Exotic. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant.
5	Undetermined	Species for which insufficient data, information, or knowledge is available with which to reliably evaluate their general status
6	Not Assessed	Species that are known or believed to be present regularly in the geographic area in Canada to which the rank applies, but have not yet been assessed by the general status program.
7	Exotic	Species that have been moved beyond their natural range as a result of human activity. In this report, Exotic species have been purposefully excluded from all other categories.
8	Accidental	Species occurring infrequently and unpredictably, outside their usual range.

Element 2: Habitats Important to Priority Species

Identifying the broad habitat requirements for each priority species in the breeding and non-breeding season allows species with shared habitat-based conservation issues or actions to be grouped. If many priority species associated with the same habitat class face similar conservation issues, then conservation action in that habitat class may support populations of several priority species. In most cases, all habitat associations identified in the literature are listed for individual species. Habitat associations do not indicate relative use, suitability ratings or rankings, nor selection or avoidance; this could be a useful exercise to undertake in the future.

In order to link with other national and international land classification schemes and to capture the range of habitat types across Canada, habitat classes for all priority species are based, at the coarsest level, on the hierarchical approach of the international Land Cover Classification System (LCCS) developed by the United Nations Food and Agriculture Organization[7]. Some modifications were made to the LCCS scheme to reflect habitat types that are important to birds that are not included in the classification (e.g., marine habitats). Species often are assigned to more than one of these coarse habitat classes. To retain the link to regional spatial data (e.g., provincial forest inventories), or to group species into regionally relevant habitat classes, individual BCR strategies may identify finer-scale habitat classes. Finer-scale habitat attributes and the surrounding landscape context were also captured when possible to better guide the development of specific conservation objectives and actions.

For BCR 6, all primary habitat associations are identified for each priority species using species accounts and life history accounts. A maximum of five habitat associations are listed for each priority species. Although additional habitat types may be used by priority species, primary habitat associations represent the broad habitat classes typically associated with the species during the identified residency period (breeding, wintering, migrant). Habitat associations should not be interpreted as ranked measures of habitat use, habitat ratings or habitat preference.

Table B2. Habitat associations for priority species in BCR 6.

Common Name	Coniferous	Deciduous	Mixed	Shrubs/Early Successional	Herbaceous	Lichens/ Mosses	Cultivated and Managed Areas	Wetlands	Bare Area	Artificial Surfaces	Waterbodies
Landbirds											
Alder Flycatcher		Y		Y				Y			
American Kestrel		Y	Y	Y			Y				
American Three-toed Woodpecker	Y		Y	Y							
Baltimore Oriole		Y					Y				
Bank Swallow							Y		Y	Y	Y
Barn Swallow					Y		Y			Y	
Barred Owl		Y	Y								
Bay-breasted Warbler	Y	Y	Y								
Black-backed Woodpecker	Y		Y	Y							
Black-billed Cuckoo		Y		Y			Y				
Black-billed Magpie				Y	Y		Y				
Blackburnian Warbler	Y		Y								
Blackpoll Warbler	Y	Y	Y	Y							
Black-throated Green Warbler	Y	Y	Y								

Table B2 continued

Common Name	Coniferous	Deciduous	Mixed	Shrubs/Early Successional	Herbaceous	Lichens/ Mosses	Cultivated and Managed Areas	Wetlands	Bare Area	Artificial Surfaces	Waterbodies
Bobolink					Y		Y	Y			
Bohemian Waxwing	Y	Y	Y	Y							
Boreal Chickadee	Y		Y								
Boreal Owl	Y	Y	Y								
Broad-winged Hawk		Y	Y								
Brown Creeper	Y	Y	Y								
Canada Warbler		Y	Y								
Cape May Warbler	Y		Y	Y							
Chimney Swift		Y								Y	Y
Clay-colored Sparrow		Y		Y			Y				
Common Nighthawk			Y	Y			Y	Y	Y	Y	
Common Yellowthroat		Y	Y	Y				Y			
Connecticut Warbler		Y	Y					Y			
Eastern Phoebe		Y		Y					Y	Y	
Eastern Whip-poor-will		Y	Y				Y		Y		
Golden-winged Warbler		Y		Y				Y			
Gray-Headed Chickadee	Y		Y								
Great Gray Owl	Y	Y	Y					Y			
Harris's Sparrow	Y	Y		Y			Y	Y			
Le Conte's Sparrow				Y	Y		Y	Y			
Least Flycatcher		Y	Y	Y							
Loggerhead Shrike				Y	Y		Y				
Merlin			Y				Y				
Mountain Bluebird	Y	Y	Y		Y		Y				
Mourning Warbler		Y	Y	Y							
Nelson's Sparrow							Y	Y			Y
Northern Flicker		Y	Y	Y			Y				
Northern Goshawk		Y	Y	Y							
Northern Harrier				Y	Y		Y	Y			
Northern Hawk Owl	Y			Y				Y			
Northern Shrike	Y			Y			Y				
Olive-sided Flycatcher	Y		Y	Y				Y			
Peregrine Falcon (*anatum/tundrius*)							Y	Y	Y	Y	
Pileated Woodpecker	Y	Y	Y								
Purple Martin		Y		Y			Y	Y			
Red-headed Woodpecker		Y					Y				
Rusty Blackbird	Y		Y	Y				Y			

Table B2 continued

Common Name	Coniferous	Deciduous	Mixed	Shrubs/Early Successional	Herbaceous	Lichens/ Mosses	Cultivated and Managed Areas	Wetlands	Bare Area	Artificial Surfaces	Waterbodies
Sedge Wren							Y	Y			
Sharp-tailed Grouse		Y		Y	Y		Y	Y			
Short-eared Owl				Y	Y		Y	Y			
Smith's Longspur			Y	Y				Y			
Sprague's Pipit					Y		Y				
Spruce Grouse	Y		Y					Y			
Western Tanager	Y		Y	Y				Y			
Western Wood-Pewee	Y	Y	Y	Y							
White-throated Sparrow	Y	Y	Y	Y				Y			
White-winged Crossbill	Y		Y					Y			
Yellow-bellied Sapsucker	Y	Y	Y	Y							
Shorebirds											
American Golden-Plover				Y	Y	Y					
Greater Yellowlegs	Y	Y		Y				Y			Y
Hudsonian Godwit				Y				Y			Y
Killdeer					Y		Y	Y	Y	Y	
Least Sandpiper						Y		Y			Y
Lesser Yellowlegs	Y	Y	Y					Y			
Marbled Godwit					Y		Y	Y			
Red-necked Phalarope								Y			Y
Semipalmated Sandpiper				Y	Y			Y	Y		Y
Short-billed Dowitcher	Y			Y				Y			
Solitary Sandpiper	Y			Y				Y			Y
Upland Sandpiper				Y				Y			
Whimbrel						Y		Y			
Wilson's Phalarope					Y		Y	Y			
Wilson's Snipe				Y				Y			Y
Waterbirds											
American Bittern					Y		Y	Y			
American White Pelican								Y	Y		Y
Arctic Tern								Y	Y		Y
Black Tern								Y			Y
Black-crowned Night-Heron							Y	Y	Y		Y
Bonaparte's Gull	Y							Y			Y
California Gull							Y	Y		Y	Y
Caspian Tern								Y	Y		Y
Common Loon								Y			Y

Table B2 continued

Common Name	Coniferous	Deciduous	Mixed	Shrubs/Early Successional	Herbaceous	Lichens/ Mosses	Cultivated and Managed Areas	Wetlands	Bare Area	Artificial Surfaces	Waterbodies
Common Tern								Y	Y		Y
Eared Grebe								Y			Y
Forster's Tern								Y			Y
Herring Gull					Y		Y		Y	Y	Y
Horned Grebe								Y			Y
Pacific Loon								Y			Y
Pied-billed Grebe								Y			Y
Red-necked Grebe								Y			Y
Sora							Y	Y			Y
Virginia Rail								Y			Y
Western Grebe											Y
Whooping Crane							Y	Y			
Yellow Rail							Y	Y			
Waterfowl											
American Wigeon				Y			Y	Y			Y
Barrow's Goldeneye		Y						Y			Y
Blue-winged Teal					Y		Y	Y			Y
Bufflehead		Y						Y			Y
Cackling Goose							Y	Y			Y
Canvasback		Y					Y	Y			Y
Common Goldeneye		Y						Y			Y
Gadwall				Y	Y		Y	Y			Y
Green-winged Teal		Y		Y	Y			Y			Y
Lesser Scaup							Y	Y			Y
Lesser Snow Goose (Western Arctic)				Y			Y	Y			Y
Long-tailed Duck				Y				Y			Y
Mallard		Y		Y	Y		Y	Y			Y
Northern Pintail				Y			Y	Y			Y
Northern Shoveler				Y	Y		Y	Y			Y
Redhead								Y			Y
Ring-necked Duck								Y			Y
Surf Scoter				Y				Y			Y
Trumpeter Swan							Y	Y			Y
Tundra Swan (Eastern)							Y	Y			Y
White-winged Scoter				Y				Y			Y

Element 3: Population Objectives for Priority Species

A central component of effective conservation planning is setting clear objectives that can be measured and evaluated. Bird Conservation Strategies set objectives based upon the conservation philosophies of national and continental bird initiatives, including the North American Bird Conservation Initiative (NABCI), that support conserving the distribution, diversity and abundance of birds throughout their historical ranges. The baselines for population objectives used in this planning exercise (those existing during the late 1960s, 1970s and 1990s for eastern waterfowl) reflect population levels prior to widespread declines. Most of the four bird conservation initiatives under the umbrella of NABCI have adopted the same baselines at the continental and national scale (waterfowl, shorebirds and landbirds; national and continental waterbird plans have not yet set population objectives). Some regions in the current planning effort have adjusted baselines to reflect the start of systematic monitoring. The ultimate measure of conservation success will be the extent to which population objectives have been reached. Progress towards population objectives will be regularly assessed as part of an **adaptive management** approach.

Population objectives for all bird groups are based on a quantitative or qualitative assessment of species' population trends. If the population trend for a species is unknown, the objective is usually "assess and maintain", and a monitoring objective is set. Harvested waterfowl and stewardship species that are already at desired population levels are given an objective of "maintain". For any species listed under SARA or under provincial/territorial endangered species legislation, Bird Conservation Strategies defer to population objectives in available Recovery Strategies and Management Plans. If recovery documents are not available, objectives are set using the same approach as for other species within that bird group. Once recovery objectives are available, they will replace interim objectives.

Population objective categories are based on population trend scores (summarized for priority species within each bird group). The table below (Table B3) describes the link between population trend[7] and categorical population objectives. The overall population objective is to return declining populations to approximate population sizes of the late 1960s[1]. Categorical population objectives are qualitative and do not represent numerical population targets that reflect population estimates of the actual numbers of birds in the late 1960s.

Table B3. Population trend score descriptions and final population objectives.

Population Trend and Description	Final Population Objective
1=Large population increase	Assess/Maintain
2=Possible population increase/population stable	Maintain Current
3=Uncertain population trend	Assess/Maintain
4=Possible population decrease	Increase 50%
5=Large population decrease	Increase 100%
Federal/provincial/ territorial listed species at risk	Recovery Objective
Over-abundant species	Decrease
Migrant species	Migrant (No Population Objective)

Simple quantitative population objectives for a subset of landbirds (with declining population trends and available data) have been developed using Breeding Bird Survey (BBS) Annual Index data in BCR 6 (see Table B4). These simplified population objectives use BBS Annual Index data to: 1) determine a baseline year or period (late 1960s or early 1970s); 2) determine a trend pattern (e.g., population trend-BCR 6); and 3) calculate the level of increase required to reach the baseline population (e.g., population multiplier-BCR 6). These methods provide a simple quantitative measure of the level of increase required to return the current population to the baseline population.

Approaches to step forward BCR scale population objectives into biologically-based, spatially explicit, landscape-oriented habitat objectives as proposed by Partners In Flight (PIF) are known as the Five Elements Process[180] and include the following steps: 1) landscape characterization and assessment; 2) bird population response modelling; 3) conservation opportunities assessment; 4) optimal landscape design; and 5) monitoring and evaluation. Habitat-based population objectives identify the type, amount and location of habitats required to meet the BCR conservation target of reversing population declines for priority bird species observed over the past 40 years[1]. Although a number of projects have developed methods to assess habitats and produce bird-habitat models to predict bird abundance or density across habitat types[181,182,183,184] , few approaches have been identified to evaluate how future land use (expected future habitat conditions) will contribute to meeting proposed population objectives for priority species at regional or local scales over the next 30–40 years.

Population trend scores and associated categorical population objectives for all priority species in BCR 6 are presented below (Table B4). The final population trend represents the highest population trend score when multiple population trend scores (national, regional) were available. Where specific data were available (subset of landbirds only), baseline year, population trend-BCR 6, and population multiplier-BCR 6 are also presented.

For a subset of landbirds with available data, Breeding Bird Survey (BBS) Annual Index data for BCR 6 was used to: 1) determine a baseline year or period (late 1960s or early 1970s depending on available data); 2) determine a trend pattern (trend pattern presented in the data; Decreasing, Increasing, No Trend); and 3) calculate a population multiplier (level of increase

required to reach the baseline population). The trend pattern was assessed using scatterplots to identify linearity, non-linearity, outliers and the direction of the relationship (positive, negative). Trend pattern must be represented by > 3 data points. The population multiplier was calculated only for species with a negative population trend in BCR 6 (i.e., = Decreasing) and was calculated as the average BBS population index over the first 10 years of data divided by the average BBS index over the last 10 years of data.

This Appendix also contains the BBS Annual Index data for BCR 6 (subset of landbirds only) used to determine the population trend-BCR 6 and the population multiplier-BCR 6.

Table B4. Population trends and population objectives for priority species in BCR 6.
Population Trend Scores: 1 = large increase, 2 = possible increase/stable, 3 = uncertain trend, 4 = possible decrease, 5 = large decrease, IL = Information Lacking. Population Trend Data Limited identifies limitations in BBS data for landbird species inadequately surveyed by BBS (BBS may not provide suitable trend data for these species due to limitations of the sampling design and survey protocol). Baseline Year is year from late 1960s to early 1970s. Population Trend-BCR 6 is trend pattern presented in BBS Annual Index data. Population Multiplier-BCR 6 is level of increase required to return current population to baseline population.

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Landbirds									
Alder Flycatcher	Breeding	2	4	4	Increase 50%		1972	Decreasing	1.82
American Kestrel	Breeding	2	3	3	Assess/Maintain	Uncertain Diurnal Raptor	1972	No Trend	
American Three-toed Woodpecker	Breeding	2	3	3	Assess/Maintain	Uncertain Cavity Nester	1972	No Trend	
Baltimore Oriole	Breeding	4	3	4	Increase 50%		1972	Decreasing	4.18
Bank Swallow	Breeding	3	3	3	Assess/Maintain		1972	No Trend	
Barn Swallow	Breeding	4	4	4	Increase 50%		1972	Decreasing	3.34
Barred Owl	Breeding	1	3	3	Assess/Maintain	Uncertain Nocturnal Raptor			
Bay-breasted Warbler	Breeding	4	3	4	Increase 50%		1978	Decreasing	5.39
Black-backed Woodpecker	Breeding	3	3	3	Assess/Maintain	Uncertain Cavity Nester			
Black-billed Cuckoo	Breeding	4	5	5	Increase 100%	Uncertain Landbird	1972	Decreasing	29.15
Black-billed Magpie	Breeding		3	3	Assess/Maintain		1972	Decreasing	1.39
Blackburnian	Breeding	2	3	3	Assess/Maintain		1972	No Trend	

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Warbler									
Blackpoll Warbler	Breeding	3	3	3	Assess/Maintain		1972	No Trend	
Black-throated Green Warbler	Breeding	3	4	4	Increase 50%		1972	Increasing	
Bobolink	Breeding	4	4	4	Increase 50%		1972	Decreasing	7.76
Bohemian Waxwing	Breeding	2	3	3	Assess/Maintain				
Boreal Chickadee	Breeding	5	1	5	Increase 100%	Uncertain Cavity Nester	1972	Increasing	
Boreal Owl	Breeding	3	3	3	Assess/Maintain	Uncertain Nocturnal Raptor			
Broad-winged Hawk	Breeding	2	3	3	Assess/Maintain	Uncertain Diurnal Raptor			
Brown Creeper	Breeding	3	3	3	Assess/Maintain	Uncertain Cavity Nester	1972	Increasing	
Canada Warbler	Breeding	4	3	4	Recovery Objective		1972	No Trend	
Cape May Warbler	Breeding	2	3	3	Assess/Maintain		1972	Increasing	
Chimney Swift	Breeding	4	IL	4	Recovery Objective	Uncertain Landbird			
Clay-colored Sparrow	Breeding	4	4	4	Increase 50%		1972	Decreasing	1.8
Common Nighthawk	Breeding	4	5	5	Recovery Objective	Uncertain Landbird	1972	Decreasing	198.35

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Common Yellowthroat	Breeding	2	5	5	Increase 100%		1972	Decreasing	2.51
Connecticut Warbler	Breeding		3	3	Assess/Maintain		1972	No Trend	
Eastern Phoebe	Breeding	2	5	5	Increase 100%		1972	Decreasing	4.98
Eastern Whip-poor-will	Breeding	4	IL	4	Recovery Objective	Uncertain Landbird			
Golden-winged Warbler	Breeding (irreg.)	5	IL	5	Recovery Objective	Uncertain Landbird			
Gray-headed Chickadee	Breeding		3	3	Assess/Maintain				
Great Gray Owl	Breeding	3	3	3	Assess/Maintain	Uncertain Nocturnal Raptor			
Harris's Sparrow	Breeding		3	3	Assess/Maintain				
Le Conte's Sparrow	Breeding	3	3	3	Assess/Maintain	Uncertain Marshbird	1972	No Trend	
Least Flycatcher	Breeding	4	4	4	Increase 50%		1972	Decreasing	1.43
Loggerhead Shrike	Breeding (irreg.)	5	IL	5	Recovery Objective	Uncertain Landbird			
Merlin	Breeding	1	3	3	Assess/Maintain	Uncertain Diurnal Raptor	1972	No Trend	
Mountain Bluebird	Breeding	3	1	3	Assess/Maintain		1973	Decreasing	2..58
Mourning Warbler	Breeding		5	5	Increase 100%		1972	Decreasing	2.57
Nelson's Sparrow	Breeding	2	3	3	Assess/Maintain	Uncertain Marshbird	1972	No Trend	

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Northern Flicker	Breeding	4	4	4	Increase 50%	Uncertain Cavity Nester	1972	Decreasing	1.45
Northern Goshawk	Breeding	3	3	3	Assess/Maintain	Uncertain Diurnal Raptor			
Northern Harrier	Breeding	4	5	5	Increase 100%	Uncertain Diurnal Raptor	1972	Decreasing	4.44
Northern Hawk Owl	Breeding	2	3	3	Assess/Maintain	Uncertain Nocturnal Raptor			
Northern Shrike	Breeding	2	3	3	Assess/Maintain				
Olive-sided Flycatcher	Breeding	5	3	5	Recovery Objective		1972	No Trend	
Peregrine Falcon (*anatum/ tundrius*)	Breeding	1	3	3	Assess/Maintain	Uncertain Diurnal Raptor			
Pileated Woodpecker	Breeding	1	2	2	Maintain Current	Uncertain Cavity Nester	1972	Increasing	
Purple Martin	Breeding	2	3	3	Assess/Maintain		1972	No Trend	
Red-headed Woodpecker	Breeding (irreg.)		3	3	Recovery Objective	Uncertain Cavity Nester			
Rusty Blackbird	Breeding	5	3	5	Increase 100%		1975	Decreasing	139.47
Sedge Wren	Breeding	1	2	2	Maintain Current	Uncertain Marshbird	1972	No Trend	
Sharp-tailed	Breeding	3	3	3	Assess/Maintain	Uncertain	1972	No Trend	

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Grouse						Grouse			
Short-eared Owl	Breeding	5	3	5	Increase 100%	Uncertain Diurnal Raptor	1972	Decreasing	21.16
Smith's Longspur	Breeding		3	3	Assess/Maintain	Uncertain Landbird			
Sprague's Pipit	Breeding		5	5	Recovery Objective		1972	No Trend	
Spruce Grouse	Breeding	1	3	3	Assess/Maintain	Uncertain Grouse			
Western Tanager	Breeding		3	3	Assess/Maintain		1972	No Trend	
Western Wood-Pewee	Breeding		4	4	Increase 50%		1972	No Trend	
White-throated Sparrow	Breeding	4	3	4	Increase 50%		1972	No Trend	
White-winged Crossbill	Breeding	2	2	2	Maintain Current		1972	Increasing	
Yellow-bellied Sapsucker	Breeding	3	3	3	Assess/Maintain	Uncertain Cavity Nester	1972	Decreasing	1.44
Shorebirds									
American Golden-Plover	Breeding	4	5	5	Increase 100%				
Greater Yellowlegs	Breeding	3	3	3	Assess/Maintain				
Hudsonian Godwit	Breeding (irreg.)	3	3	3	Assess/Maintain				
Killdeer	Breeding	5	4	4	Increase 100%				
Least Sandpiper	Breeding	5	5	5	Increase 100%				

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Lesser Yellowlegs	Breeding	3	5	5	Increase 100%				
Marbled Godwit	Breeding	4	4	4	Increase 50%				
Red-necked Phalarope	Breeding	4	4	4	Increase 50%				
Semipalmated Sandpiper	Breeding	5	5	5	Increase 100%				
Short-billed Dowitcher	Breeding	5	5	5	Increase 100%				
Solitary Sandpiper	Breeding	3	4	4	Increase 50%				
Upland Sandpiper	Breeding	2	5	5	Increase 100%				
Whimbrel	Migrant	5	4		Migrant (no population objective)				
Wilson's Phalarope	Breeding	4	5	5	Increase 100%				
Wilson's Snipe	Breeding		5	5	Increase 100%				
Waterbirds									
American Bittern	Breeding	4	4	4	Increase 50%				
American White Pelican	Breeding		3	3	Assess/Maintain				
Arctic Tern	Breeding	4	4	4	Increase 50%				
Black Tern	Breeding	4	5	5	Increase 100%				
Black-crowned Night-Heron	Breeding	3	4	4	Increase 50%				
Bonaparte's Gull	Breeding	3		3	Assess/Maintain				
California Gull	Breeding		3	3	Assess/Maintain				

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Caspian Tern	Breeding	1	2	2	Maintain Current				
Common Loon	Breeding	1	3	3	Assess/Maintain				
Common Tern	Breeding	5	3	3	Assess/Maintain				
Eared Grebe	Breeding		3	3	Assess/Maintain				
Forster's Tern	Breeding		4	4	Increase 50%				
Herring Gull	Breeding	5	4	4	Increase 50%				
Horned Grebe	Breeding	5	4	4	Increase 50%				
Pacific Loon	Breeding	2		2	Maintain Current				
Pied-billed Grebe	Breeding	2		2	Maintain Current				
Red-necked Grebe	Breeding	2	1	1	Assess/Maintain				
Sora	Breeding	3		3	Assess/Maintain				
Virginia Rail	Breeding	1		1	Assess/Maintain				
Western Grebe	Breeding		4	4	Increase 50%				
Whooping Crane	Breeding		1	1	Recovery Objective				
Yellow Rail	Breeding	4		4	Increase 50%				
Waterfowl									
American Wigeon	Breeding	Stable	4	4	Increase 50%				
Barrow's Goldeneye	Breeding	Stable	IL	2	Maintain Current				

Table B4 continued

Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Blue-winged Teal	Breeding	Stable	2	2	Maintain Current				
Bufflehead	Breeding	Increasing	1	1	Assess/Maintain				
Cackling Goose	Breeding	Unknown	IL	3	Assess/Maintain				
Canvasback	Breeding	Stable	2	2	Maintain Current				
Common Goldeneye	Breeding	Stable	IL	2	Maintain Current				
Gadwall	Breeding	Increasing	1	1	Assess/Maintain				
Green-winged Teal	Breeding	Increasing	2	2	Maintain Current				
Lesser Scaup	Breeding	Decreasing	4	4	Increase 50%				
Lesser Snow Goose (Western Arctic)	Breeding (irreg.)	Increasing	IL	1	Decrease				
Long-tailed Duck	Breeding (irreg.)	Decreasing	5	5	Increase 100%				
Mallard	Breeding	Stable	2	2	Maintain Current				
Northern Pintail	Breeding	Decreasing	4	4	Increase 50%				
Northern Shoveler	Breeding	Increasing	2	2	Maintain Current				
Redhead	Breeding	Increasing	2	2	Maintain Current				
Ring-necked Duck	Breeding	Increasing	1	1	Assess/Maintain				

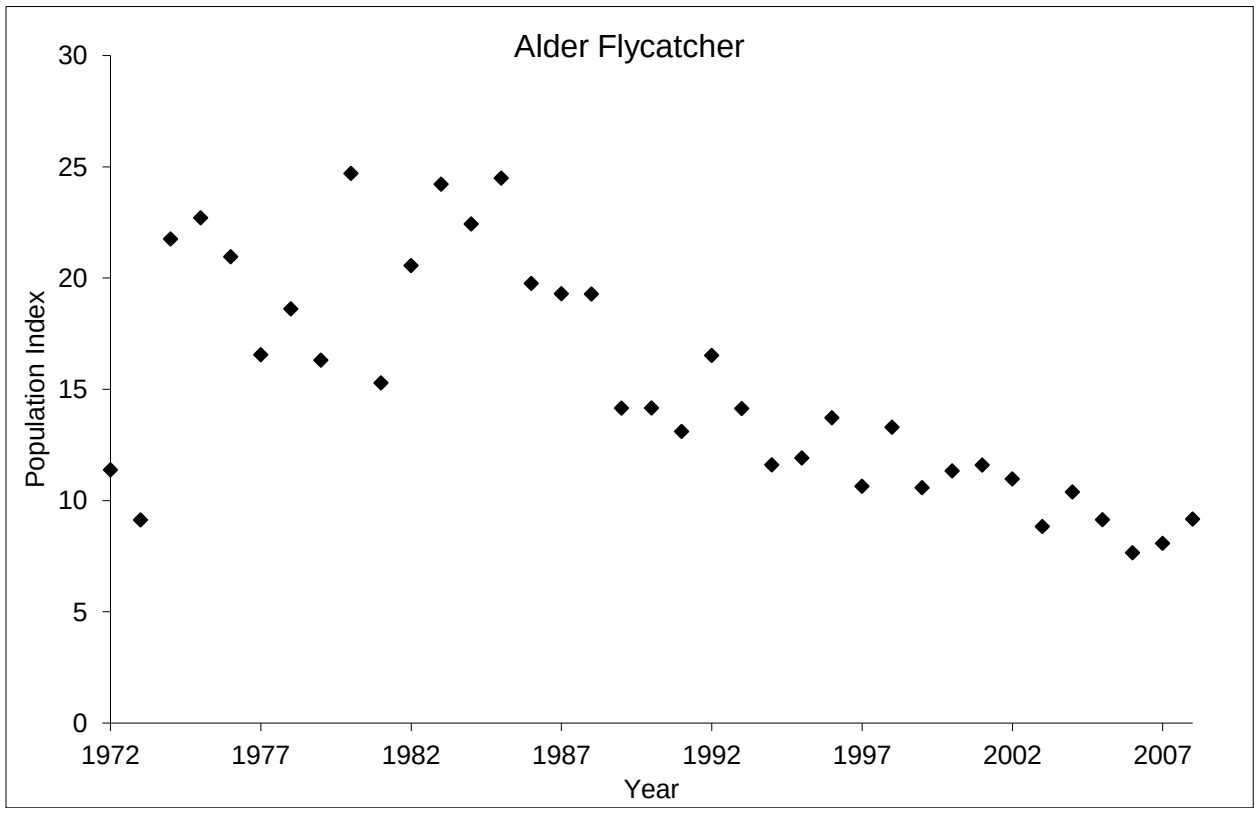
Table B4 continued

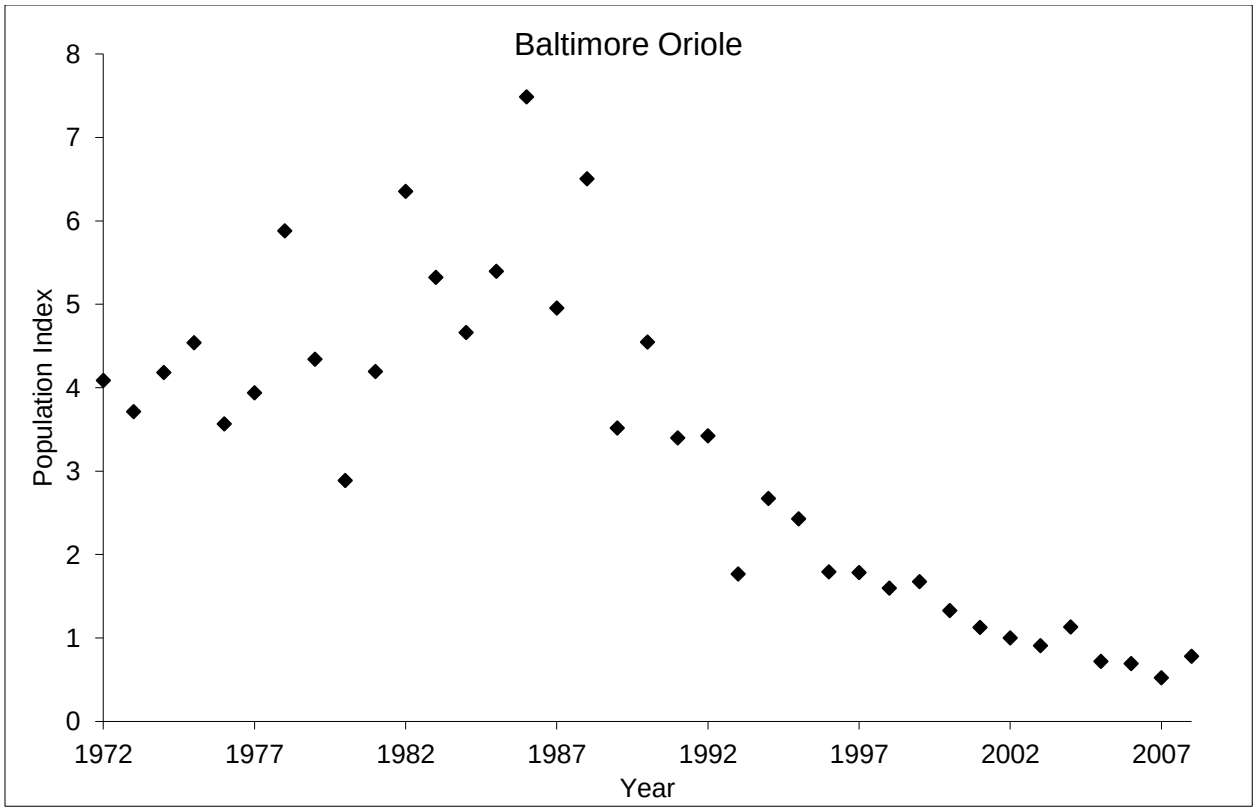
Common Name	Residency Status	Continental Population Trend	BCR Population Trend	Final Population Trend	Population Objective	Population Trend Data Limited	Baseline Year	Population Trend-BCR 6	Population Multiplier-BCR 6
Surf Scoter	Breeding	Decreasing	IL	4	Increase 50%				
Trumpeter Swan	Breeding	Increasing	IL	1	Assess/Maintain				
Tundra Swan (Eastern)	Breeding (irreg.)	Stable	IL	2	Assess/Maintain				
White-winged Scoter	Breeding	Decreasing	4	4	Increase 50%				

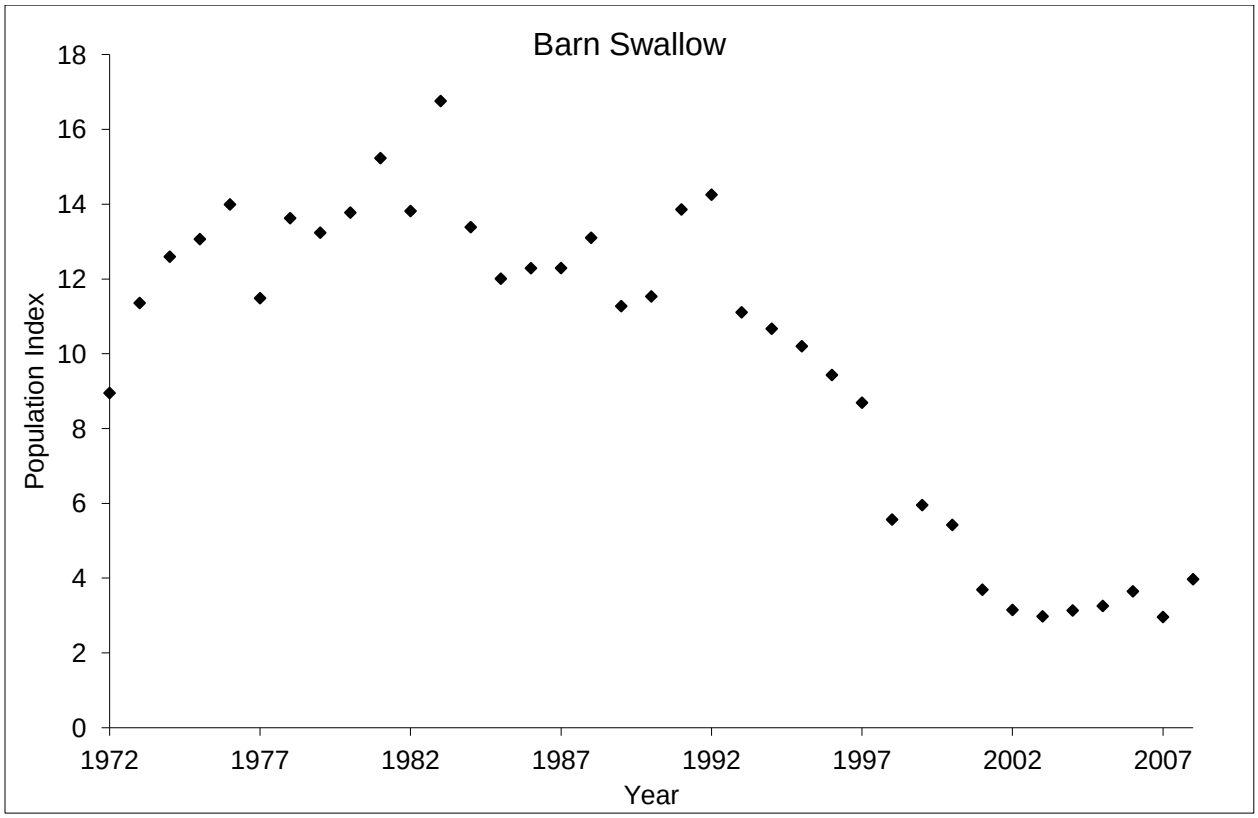
Note: Where multiple population trend scores were available (e.g., continental, regional), we report the highest score for the Final Population Trend. For waterbirds and shorebirds there are no reliable sources of long-term survey data within the BCR. Instead, wide scale trend data was used to derive the BCR 6 Population Trend score. For shorebirds, U.S. Shorebird Conservation Plan 2004[179] listings were used for BCR 6 Population Trend scores as these additions are considered the most current. BCR Population Trend scores were therefore used as Final Population Trend Scores where these values differed from Continental trend scores. For waterbirds, regional updates to Wings Over Water BCR 6 Population Trend values were based on the Rocky Mountain Bird Observatory species assessment scores for non-landbirds[185]. Regional trends for waterbirds were used as final population trends, as these trends were considered more current.

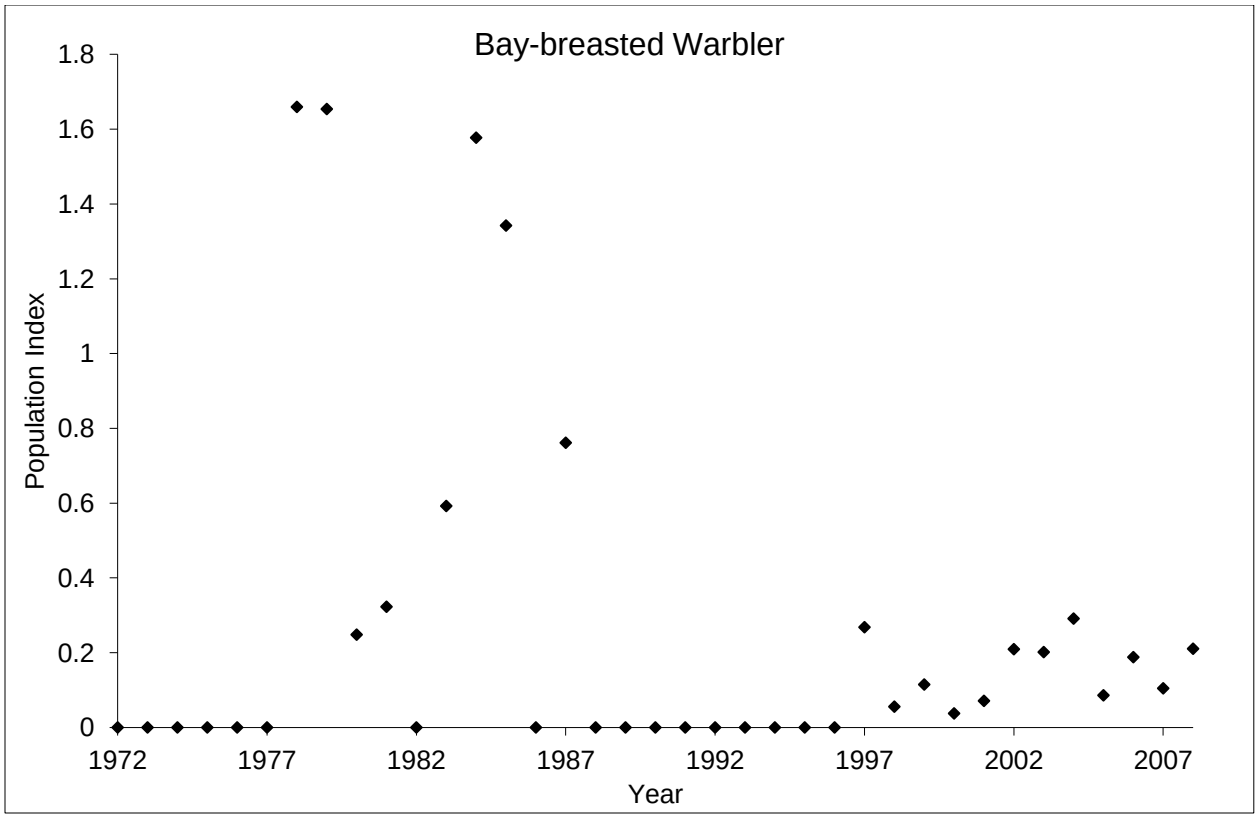
Population Trend-BCR 6 Data

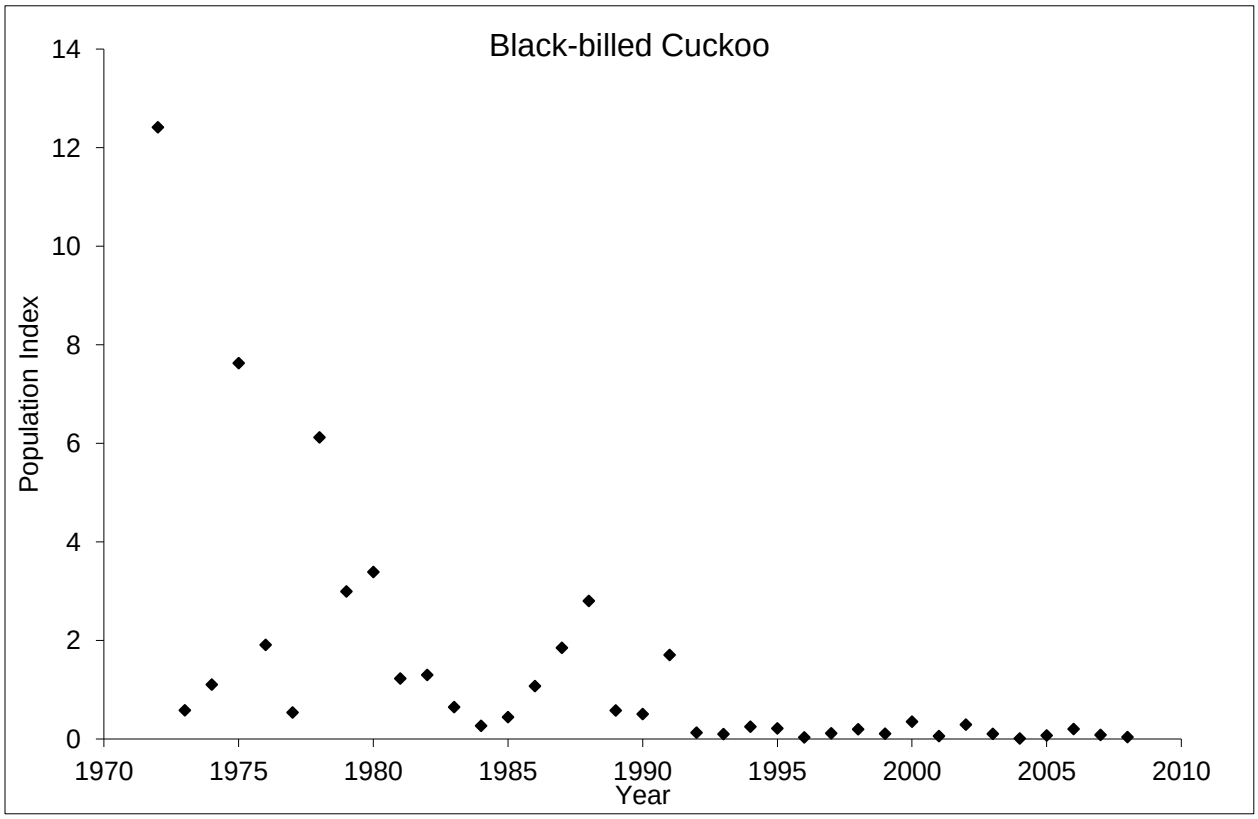
Plots use BBS annual index data over the entire period of BBS coverage within BCR 6. Note that plots are only presented for species with declining population trends and available data (Population Trend-BCR 6 = Decreasing; Table B4).

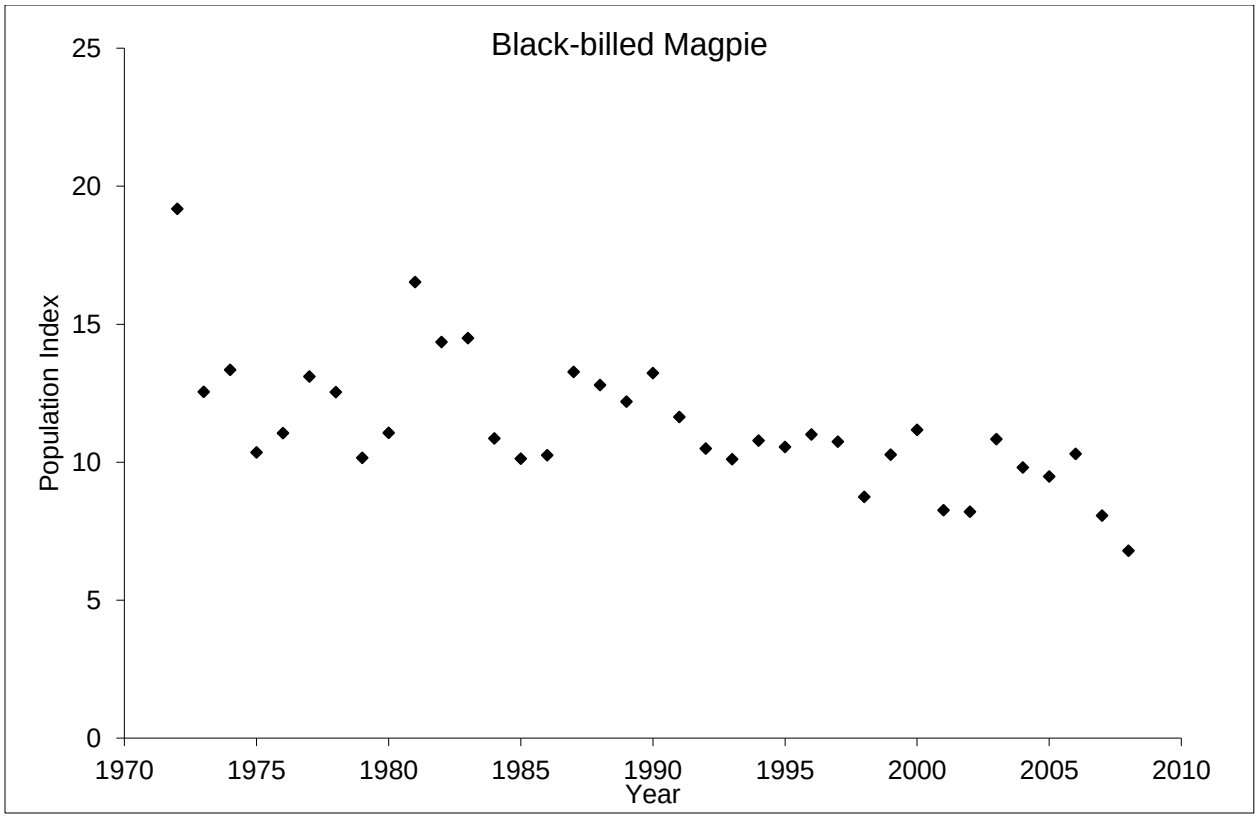


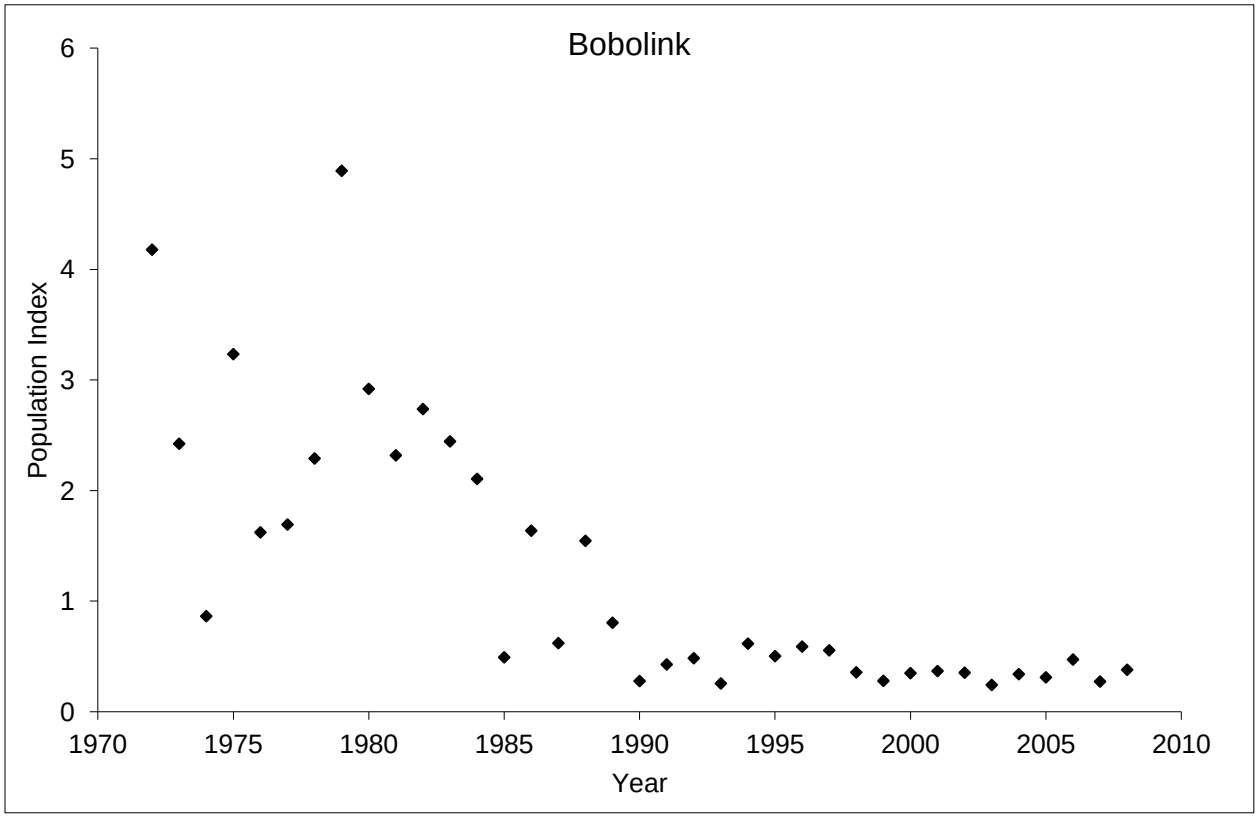

Baltimore Oriole
Population Index
Year
0
1
2
3
4
5
6
7
8
1972
1977
1982
1987
1992
1997
2002
2007

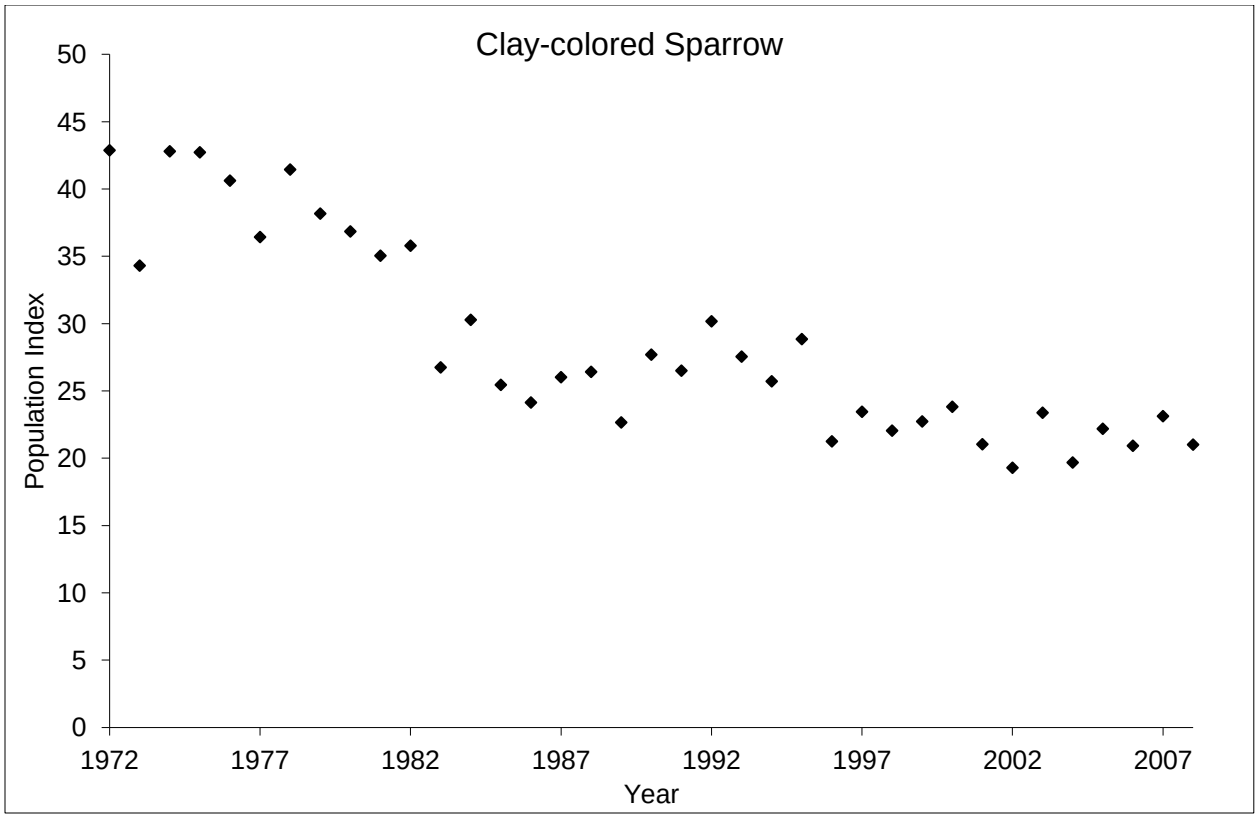

Barn Swallow
Population Index
Year
0
2
4
6
8
10
12
14
16
18
1972
1977
1982
1987
1992
1997
2002
2007

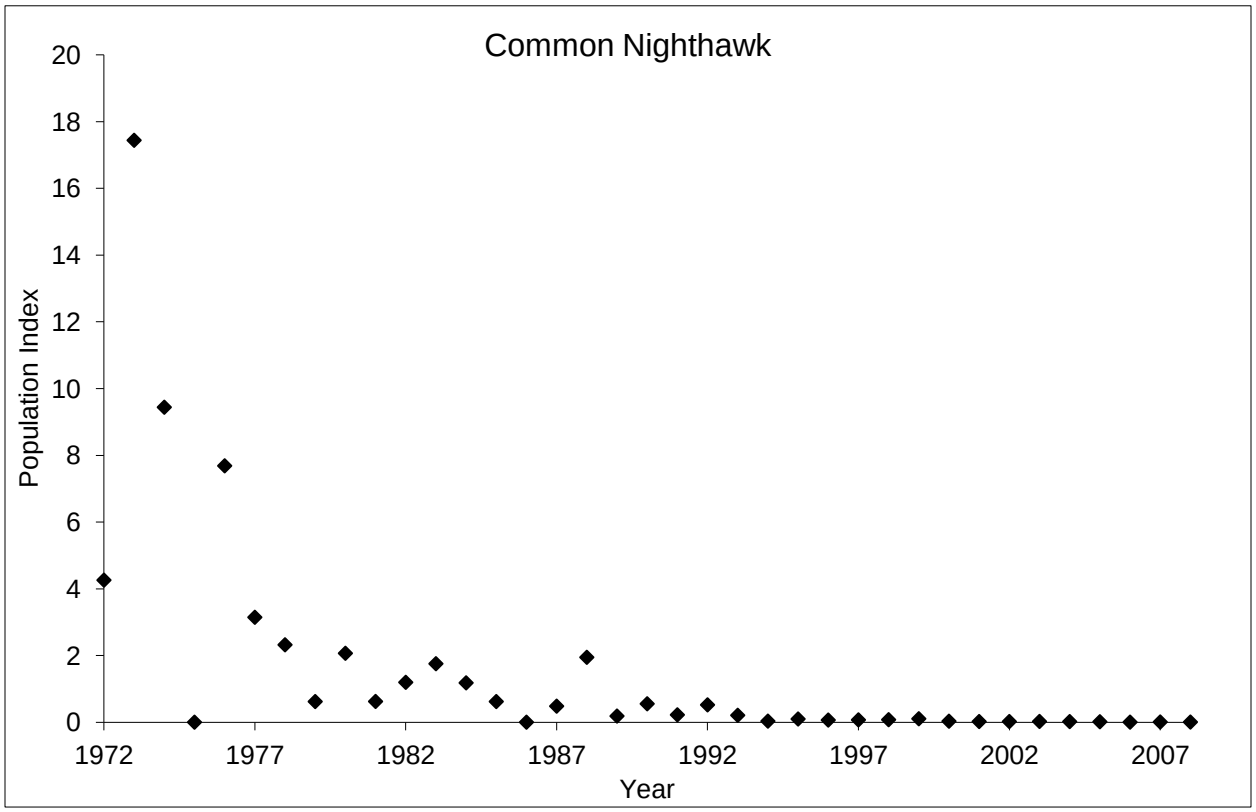

Bay-breasted Warbler
Population Index
Year
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
1972
1977
1982
1987
1992
1997
2002
2007

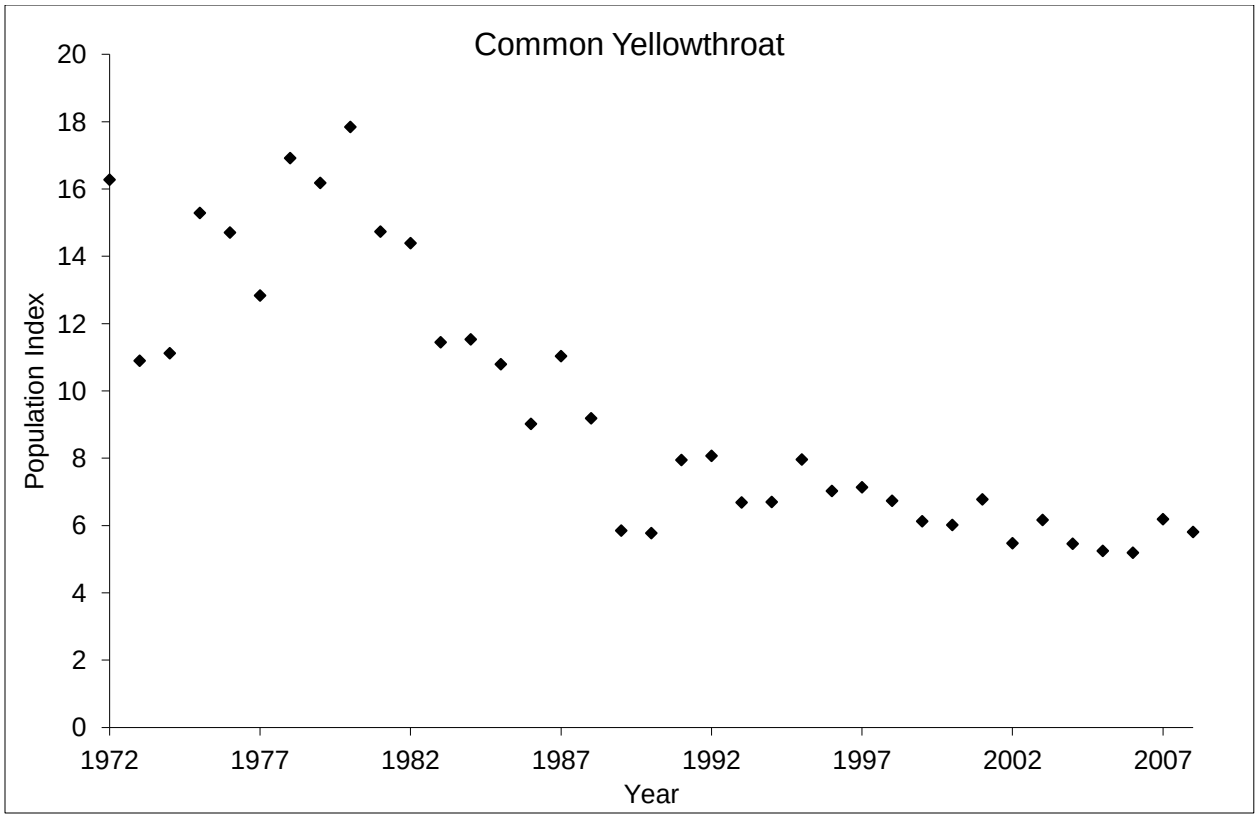

Black-billed Cuckoo
Population Index
Year
0
2
4
6
8
10
12
14
1970
1975
1980
1985
1990
1995
2000
2005
2010

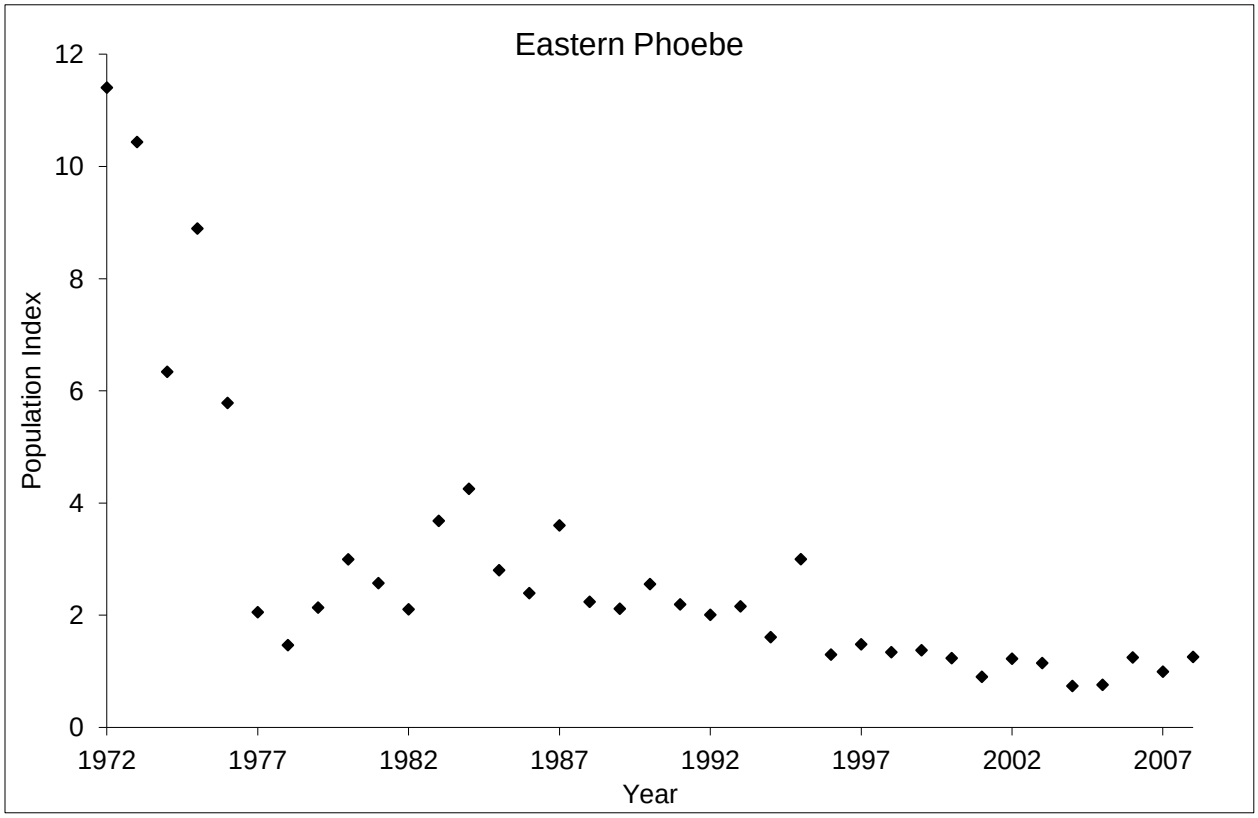

Black-billed Magpie
Population Index
Year
0
5
10
15
20
25
1970
1975
1980
1985
1990
1995
2000
2005
2010

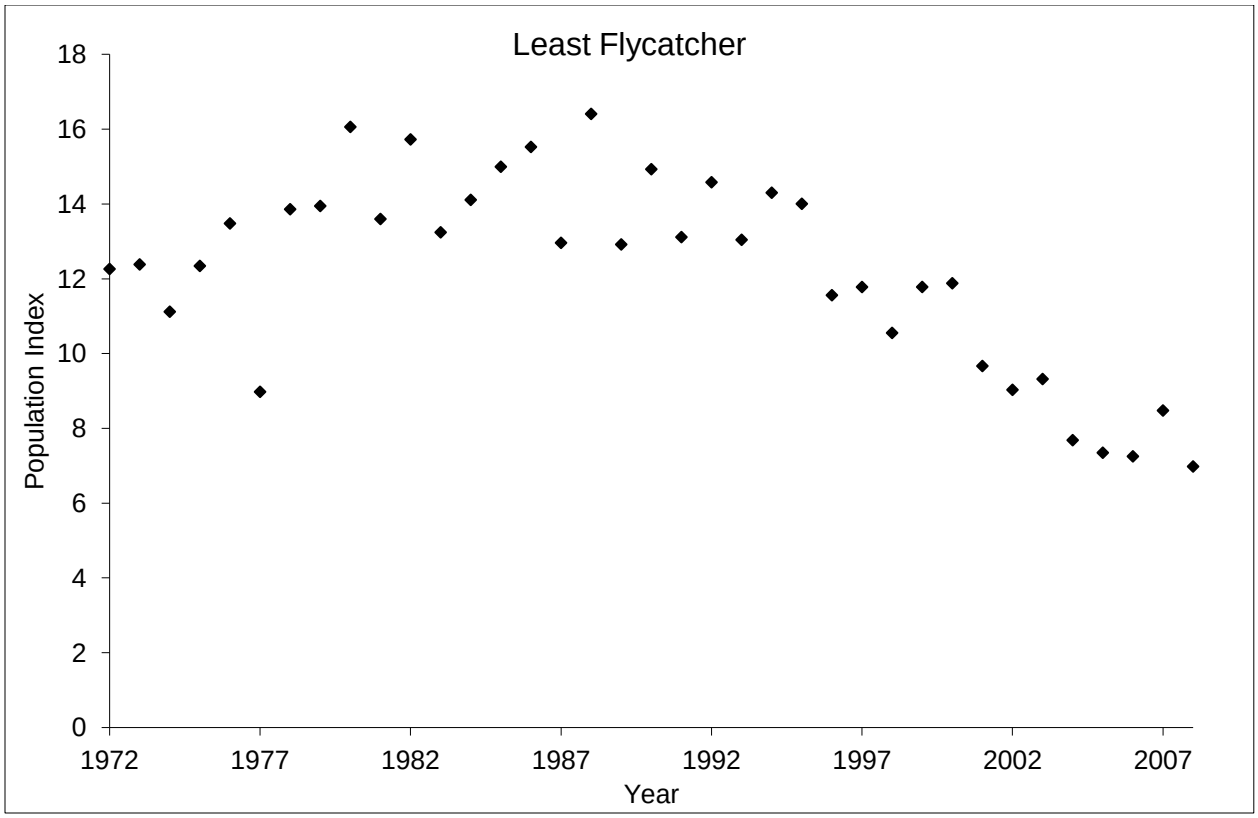

Bobolink
Population Index
Year
0
1
2
3
4
5
6
1970
1975
1980
1985
1990
1995
2000
2005
2010

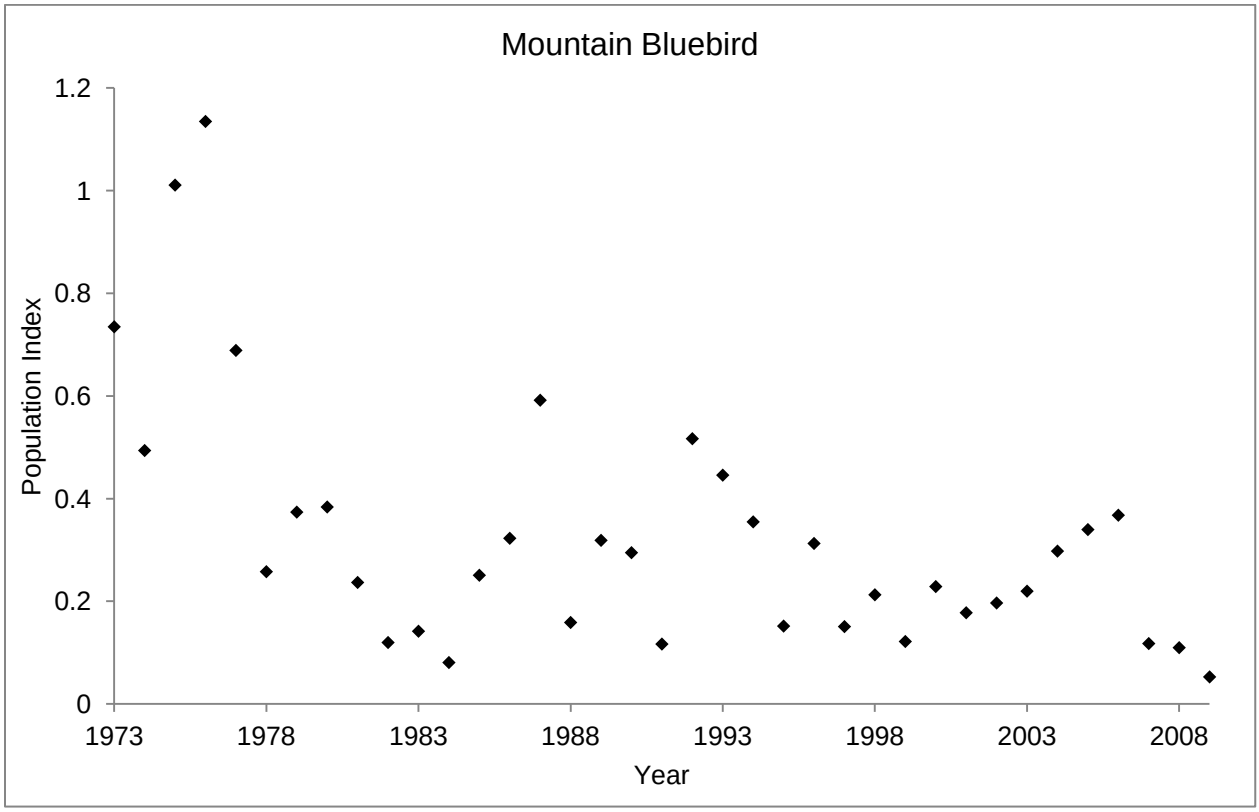

Clay-colored Sparrow
Population Index
Year
0
5
10
15
20
25
30
35
40
45
50
1972
1977
1982
1987
1992
1997
2002
2007

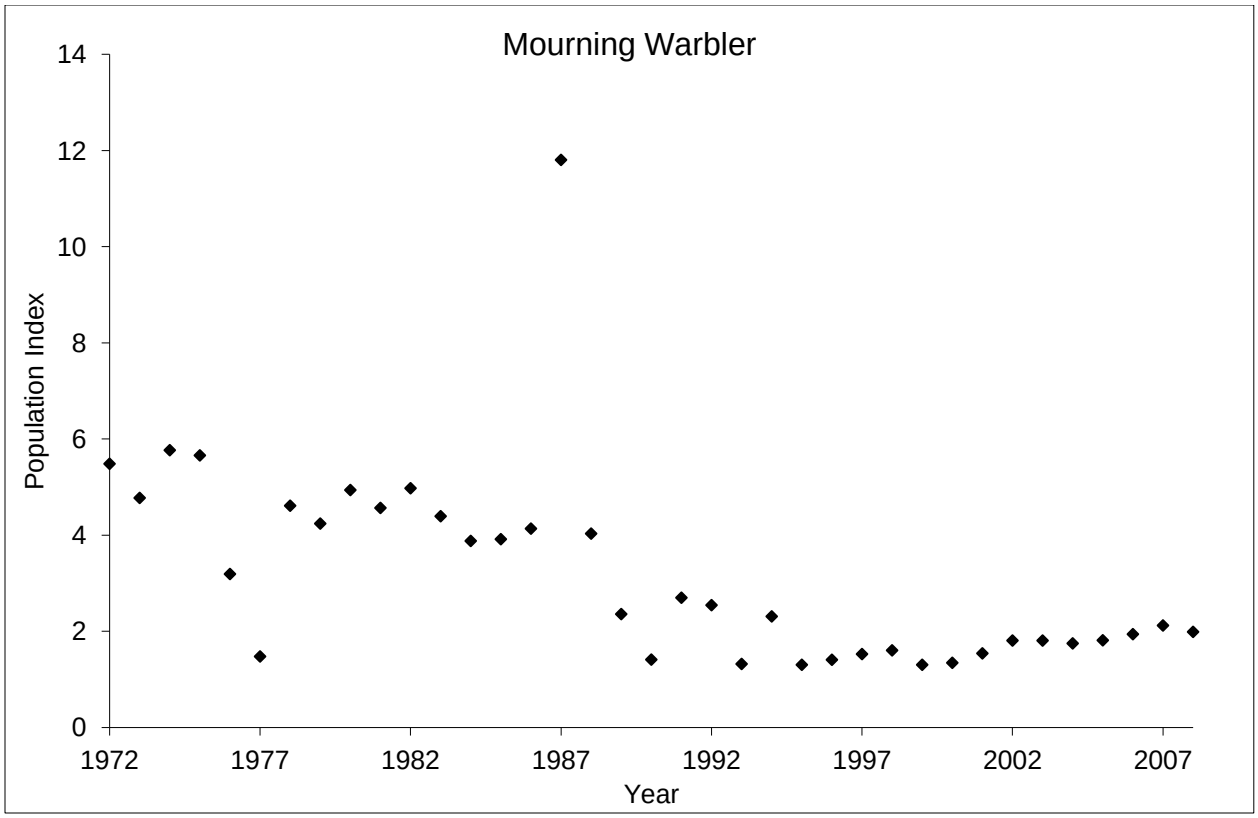

Common Nighthawk
Population Index
Year
0
2
4
6
8
10
12
14
16
18
20
1972
1977
1982
1987
1992
1997
2002
2007

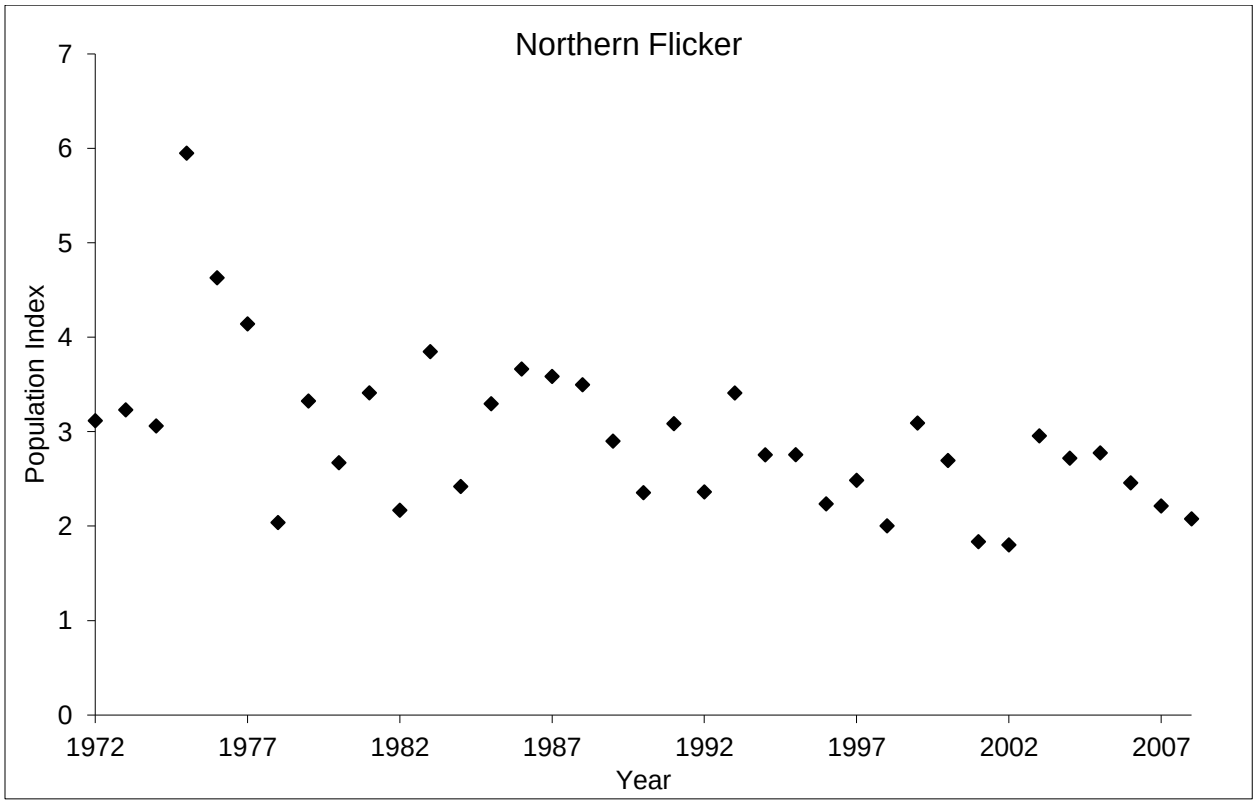

Common Yellowthroat
Population Index
Year
0
2
4
6
8
10
12
14
16
18
20
1972
1977
1982
1987
1992
1997
2002
2007

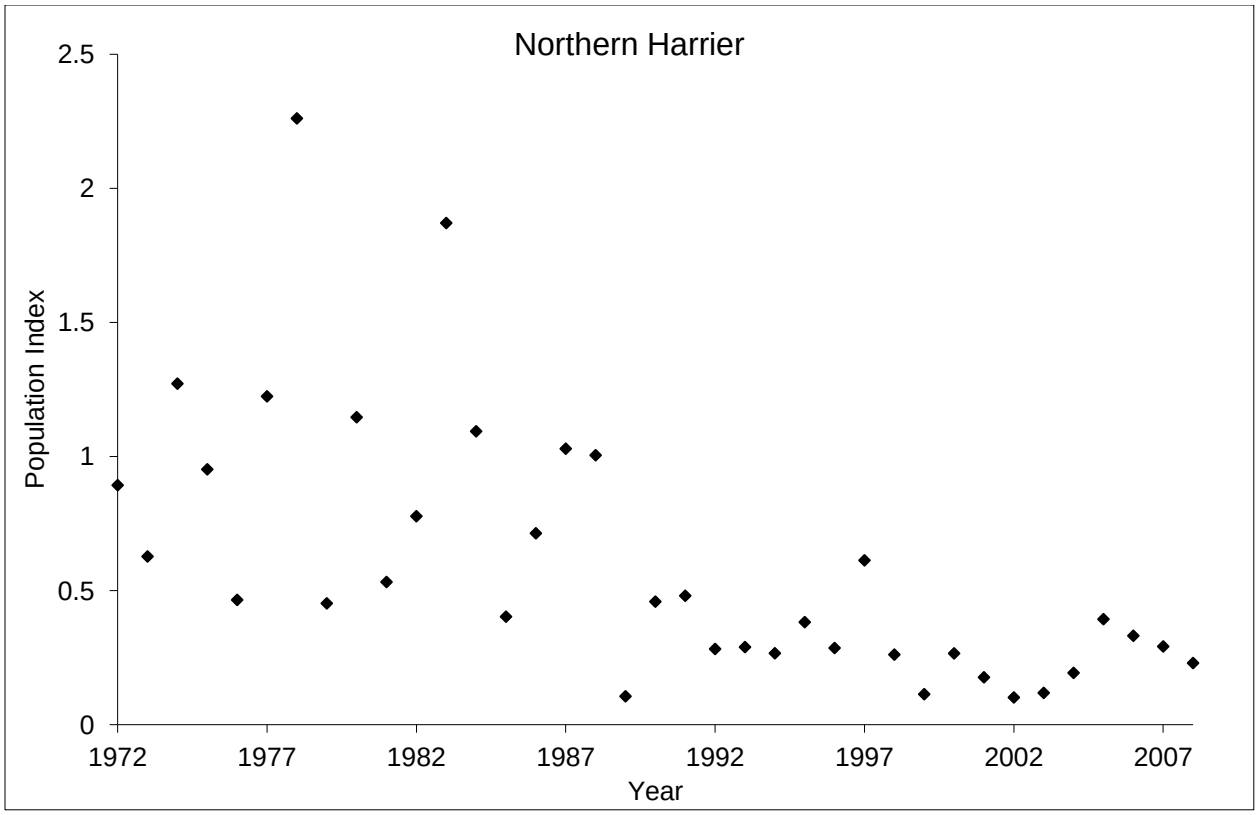

Eastern Phoebe
Population Index
Year
0
2
4
6
8
10
12
1972
1977
1982
1987
1992
1997
2002
2007

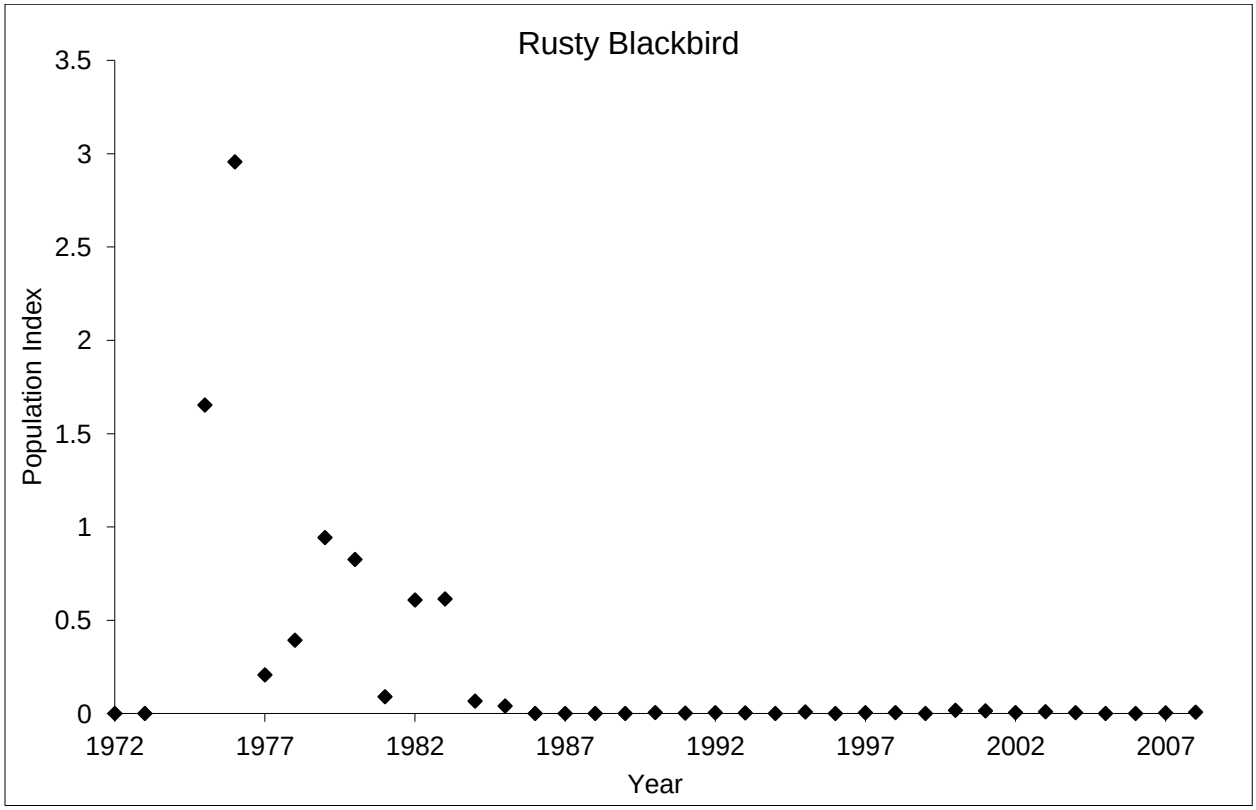

Least Flycatcher
Population Index
Year
0
2
4
6
8
10
12
14
16
18
1972
1977
1982
1987
1992
1997
2002
2007

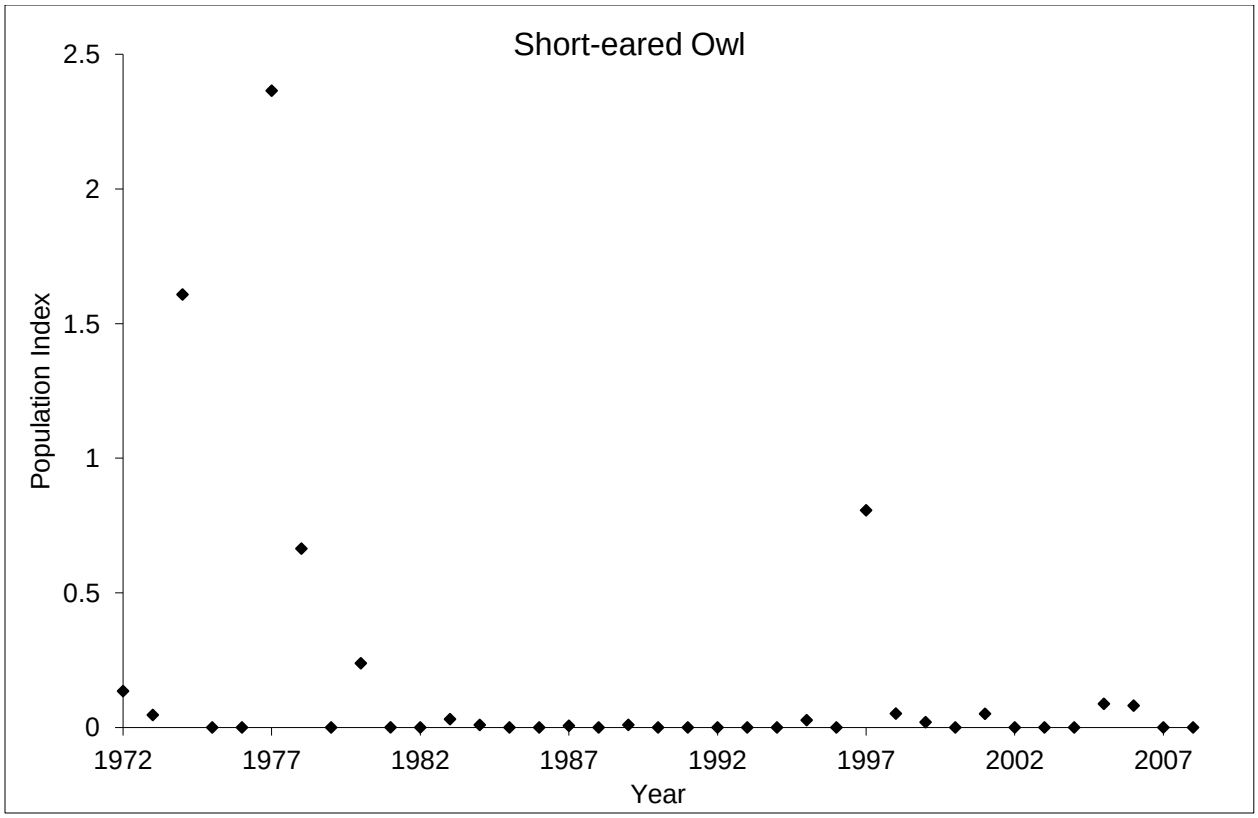

Mountain Bluebird
Population Index
Year
0
0.2
0.4
0.6
0.8
1
1.2
1973
1978
1983
1988
1993
1998
2003
2008

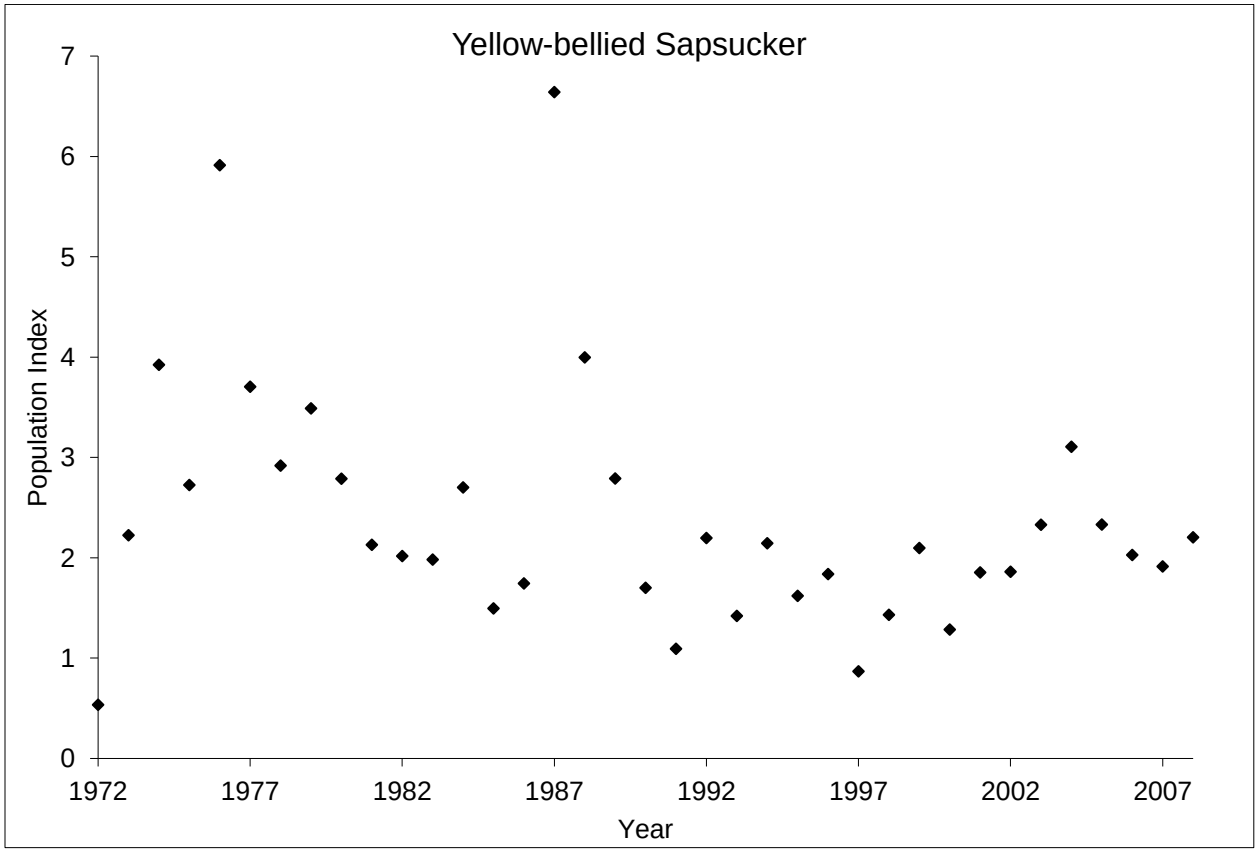

Mourning Warbler
Population Index
Year
0
2
4
6
8
10
12
14
1972
1977
1982
1987
1992
1997
2002
2007


Northern Flicker
Population Index
Year
0
1
2
3
4
5
6
7
1972
1977
1982
1987
1992
1997
2002
2007


Northern Harrier
Population Index
Year
0
0.5
1
1.5
2
2.5
1972
1977
1982
1987
1992
1997
2002
2007


Rusty Blackbird
Population Index
Year
0
0.5
1
1.5
2
2.5
3
3.5
1972
1977
1982
1987
1992
1997
2002
2007


Short-eared Owl
Population Index
Year
2.5
2
1.5
1
0.5
0
1972
1977
1982
1987
1992
1997
2002
2007


Yellow-bellied Sapsucker
Population Index
Year
7
6
5
4
3
2
1
0
1972
1977
1982
1987
1992
1997
2002
2007

Element 4: Threat Assessment for Priority Species

Bird population trends are driven by factors that affect reproduction and/or survival during any point in the annual cycle. Threats that can reduce survival include, for example, reduced food availability at migratory stopovers or exposure to toxic compounds. Examples of threats that can reduce reproductive success may include high levels of nest predation or reduced quality or quantity of breeding habitat.

The threats assessment exercise included three main steps:

1. Conducting a literature review to Itemize past, current and future threats for each priority species and classifying the threats following a standardized classification scheme[186].
2. Ranking the magnitude of threats for priority species following a standardized protocol[5].
3. Preparing a set of threat profiles for the BCR subregion, for broad habitat categories.

Each threat was categorized following the IUCN-CMP threat classification scheme[186] with the addition of categories to capture species for which we lack information. Only threats stemming from human activity were included in the threats assessment because they can be mitigated; natural processes that prevent populations from expanding beyond a given level were considered and noted, but no actions beyond research and/or monitoring were developed. Threats were ranked by assessing the scope (the proportion of the species' range within the subregion that is affected by the threat) and severity (the relative impact that the threat poses to the viability of the species' populations) of the threat. The scores for scope and severity were combined to determine an overall magnitude of low, medium, high or very high. These magnitudes were then rolled-up by threat categories and sub-categories across habitat types5. The threats roll-up allows for comparison of the relative magnitude of the threats among threat categories and habitat types. The scoring and ranking of threats not only helps to determine which threats contribute most to population declines in individual species, but also allows us to focus attention on the threats with the greatest effects on suites of species or in broad habitat classes.

In BCR 6, threats for individual priority species are identified using a variety of sources, including peer-reviewed literature, national and regional conservation plans, and government reports and internal documents. We describe dominant and low-intensity threats to priority species in BCR 6 in Section 2. A systematic review process[187,188,189] is used to document the hierarchy of evidence (the value of the literature or data used to document the threats with respect to scientific rigour) and the heterogeneity of evidence (variability in the types of studies that document threats) for all threats associated with individual priority species. We assess the quality of information for each threat using the following hierarchy of evidence: Study Type (the type of scientific study), Ecological Scale (the ecological or biological scale to which the information or study applies) and Location (area to which the information or study applies during the season in which the species is present in the BCR). We use this information to determine the weight of evidence associated with each threat.

This section contains a detailed explanation of the methods used to summarize threats for individual priority species and an example of the type of data summarized during the threats assessment for representative species from each bird group (landbirds, shorebirds, waterbirds, waterfowl) in BCR 6 (Table B5). We also include a table of IUCN threats (category and sub-category) and threat definitions (Table B6).

In BCR 6, widespread threats and issues affecting many priority species are identified using a variety of sources that characterize threats within habitats and ecological regions (ecozones) within BCR 6. These widespread threats likely apply to a large number of priority species but are not identified for individual species in the current literature (as described above) and therefore may be overlooked in the species-specific threats assessment process. These threats and issues are not included in the summary of the species-specific threats assessment below in Section 1. These widespread threats are discussed in the section on Widespread Issues for Priority Species in BCR 6 in Section 2.

Below (Table B5) is a list of documented threats for representative species from each bird group (landbirds, shorebirds, waterbirds, and waterfowl) in BCR 6. This table is meant to demonstrate to readers how threat information was compiled and summarized for each species by providing examples (for representative species within the BCR) from the larger threat assessment database. Note that in Table B5, only the strongest source or reference was presented despite the documentation of many threats in several references.

We developed and conducted a systematic review process[187,188,189] to document the hierarchy and the heterogeneity of evidence. We assessed the quality of information for each threat using the following hierarchy of evidence (see the list below): Study Type, Ecological Scale, and Location. We used this information to determine the weight of evidence associated with each threat. We determined the highest rank of information associated with each threat using the ranking system identified below.

Study Type - the type of scientific study
(Highest weight, hierarchy E>Q>O>P>N)

E = Experimental/Manipulative Study
Q = Quasi-Experimental Study (takes advantage of prior manipulation that was not part of a designed study, such as logged vs. unlogged habitat)
O = Observational/Mensurative Study
P = Planning Document (based on expert opinion and existing studies, although no direct references of these documents were consulted)
N = No Study

Ecological Scale - the ecological scale to which the information or study applies
(Second Highest weight, hierarchy S>PPG>PG>G)

S = Species (group of individuals that have major characteristics in common and can only breed with each other)

PPG = Portion of the bird Pillar Group (group of individuals to which the threat applies indicating that not all species in the bird group are affected. The PPG is not defined).
PG = bird Pillar Group (bird pillar group – landbirds, waterbirds, shorebirds, waterfowl)
G = General (any scale above the level of the bird pillar group such as ecosystems, wildlife, landscapes, or broad groupings of birds)

Location – area to which the information or study applies during the season in which the species is present in the BCR/Sub-BCR
(Lowest weight, hierarchy LI>R>LO>C)

LI = Local Inside (study area located within the BCR)
R Regional=Bird Conservation Regions (BCRs) as defined by NABCI
WB = Western Boreal Forest (e.g., west of the Ontario-Manitoba border)
B = Boreal Forest, including eastern and western portions
LO = Local Outside (study area located outside the planning unit (PNR) portion of the BCR, but relevant to species within the BCR)
C = Continental=North America (Canada, U.S., Mexico)

Table B5. Species-specific threats and associated mechanisms identified for representative priority species in BCR 6, with selected references included.

Common Name	Threat	Habitat Loss	Habitat Degradation	Direct Mortality	Reduced Reproduction	Evidence	Threat Magnitude	Refs
Black-throated Green Warbler	2.1 Annual & Perennial Non-timber Crops	Y	Y			Agricultural expansion implicated in the northward contraction of species' range (O-LI-S)	M	190
Black-throated Green Warbler	2.3 Livestock Farming & Ranching	Y	Y			Agricultural expansion implicated in the northward contraction of species' range (O-LI-S)	M	190
Black-throated Green Warbler	3.1 Oil & Gas Drilling		Y		Y	Results in loss of habitat and increased forest **subdivision** (O-LI-PPG); evidence of increased red squirrel predation rates along linear seismic lines (E-LI-PPG)	M	190
Black-throated Green Warbler	5.3 Logging & Wood Harvesting	Y	Y			Species declined by ~50% in forest fragments only 5 years following harvest despite large amounts of remaining (not harvested) forest in the surrounding landscape (E-LI-S); recent allocation of deciduous and mixed wood forests at northern limit of range reduces habitat	M	190
Black-throated Green Warbler	6.3Stable Work & Other Activities				Y	One female would not incubate eggs or brood and feed young when an observer was near, but implications of this unclear (N-C-S)	L	191
Black-throated Green Warbler	8.2 Problematic Native Species			Y	Y	Known to suffer negatively from BHCO nest parasitism (O-LO-S), and potential nest predation by corvids and red squirrels (O-LI-PPG)	L	190
Black-throated Green Warbler	9.3 Agricultural & Forestry Effluents			Y	Y	Deaths associated with application of DDT to control Dutch elm disease (O-C-S); population decrease observed in association with application of fenitrothion to control spruce budworm (O-C-S)	L	191
Northern Goshawk	5.Logging & Wood Harvesting	Y	Y		Y	Timber harvest is a primary threat to nesting populations; each year nests are destroyed by logging operations, although impacts to nesting populations are unknown (O-C-S)	M	192
Northern Goshawk	6.1 Recreational Activities		Y		Y	Humans camping near nests has been documented as a cause of nest failures (O-C-S)	L	192
Northern Goshawk	6.3 Stable Work & Other Activities		Y		Y	Timbering activities near nests can cause nest failure, especially during incubation (O-C-S); research impacts are usually of short duration having little impact (O-LO-S)	L	192
Northern Goshawk	9.2 Industrial & military effluents		Y	Y		PCBs and heavy metals occur in levels that negatively affect body condition (O-LO-S)	M	192
Olive-sided Flycatcher	5.3 Logging & wood harvesting	Y	Y		Y	Recently logged areas may be ecological traps. Birds preferentially nest in these areas due to higher insect forage abundance compared to burned areas, but experience higher nest predation due to higher abundances of nest predators such as red squirrels and Gray Jays in logged vs. burned habitats. In one study, nest success was Stable 0% in logged vs. 61% in burned habitat (Q-LO-S)	M	193

Table B5 continued

Common Name	Threat	Habitat Loss	Habitat Degradation	Direct Mortality	Reduced Reproduction	Evidence	Threat Magnitude	Refs
Olive-sided Flycatcher	7.4 Fire suppression	Y	Y		Y	Reliant on recently disturbed habitat such as post-fire clearings; fire suppression reduces the amount of this habitat (P-C-S)	H	194
Olive-sided Flycatcher	7.3 Other ecosystem modifications		Y			Declines of aerial insects reduce forage and may lead to mortality and declining reproduction. Insect declines may be due to land use change (forestry, agriculture, wetland drainage, etc.), pesticide use in agricultural or other areas, other pollution sources, increases of non-native insects, climate change, or light pollution (P-C-PPG; N-C-PPG)	M	28 28
Greater Yellowlegs	2.1 Annual & Perennial Non-Timber Crops	Y	Y			The expansion of agriculture into cleared lands is often accompanied by drying of the land and direct drainage of bogs, muskeg, and other wetland areas (P-WB-PG)	M	195
Greater Yellowlegs	5.2 Gathering Terrestrial Plants	Y	Y			Greater Yellowlegs nest in **peatlands**; wetlands in the boreal forest may be threatened by loss due to peat mining (P-WB-PPG)	L	196
Greater Yellowlegs	5.3 Logging & Wood Harvesting	Y	Y			The growth of the logging and pulp and paper industries in the boreal region and resultant cutting could represent a threat to breeding habitats for shorebirds such as yellowlegs (P-WB-PPG); clearing of forested lands can also cause surface drying that may lead to direct wetland loss	L	195
Greater Yellowlegs	7.2 Dams & Water Management/Use	Y	Y			Different factors are likely affecting shorebird populations such as wetland drainage (P-C-PG); massive wetland losses have already occurred throughout North America (P-C-PG)	L	2
Greater Yellowlegs	8.2 Problematic native species			Y		Sensitive to outbreaks of avian botulism (N-S-C)	M	197
Killdeer	1.2 Commercial & Industrial Areas			Y	Y	Chicks hatched from rooftop nests often die due to overheating, starvation and falls during fledging (N-S-C); Killdeer nests were found on 4% of sampled rooftops throughout their breeding range in Canada O-S-LO	L	198
Killdeer	1.2 Commercial & industrial areas			Y		Killed more frequently than other birds through collision with lighted towers (N-S-C)	L	199
Killdeer	2.1 Annual & Perennial Non-Timber Crops	Y	Y			The western boreal forest is undergoing far-reaching development by agricultural expansion, which may cause loss of ecosystem function resulting in reduced habitat quality and quantity (P-WB-G); expansion of agriculture into the Boreal Transition Ecoregion has resulted in large decreases in forest cover and wetland abundance in these areas (P-WB-G)	M	59
Killdeer	5.1 Hunting and Collecting Terrestrial Animals			Y		Accidentally killed by hunters because mistaken for Mourning Doves (N-S-C)	L	199

Table B5 continued

Common Name	Threat	Habitat Loss	Habitat Degradation	Direct Mortality	Reduced Reproduction	Evidence	Threat Magnitude	Refs
Killdeer	5.3 Logging & Wood Harvesting	Y	Y			Have been pushed out of much native wetland habitat and into human-dominated landscapes due to habitat destruction through logging (N-S-C)	L	199
Killdeer	8.2 Problematic native species			Y		Susceptible to avian botulism (N-S-C)	M	199
Killdeer	9. 3 Agricultural & Forestry Effluents		Y	Y		Killdeer were less abundant where granular insecticide (to control flea beetles in canola) is used in Alberta, Saskatchewan, and Manitoba (O-S-LI)	L	200
Horned Grebe	2.1 Annual & Perennial Non-Timber Crops	Y	Y			Horned Grebe population decline is primarily due to wetland habitat degradation (P-S-C)	M	201
Horned Grebe	5.4 Fishing & Harvesting Aquatic Resources			Y		Occasional mortality when caught in fishing nets (N-S-C)	L	202
Horned Grebe	7.2 Dams & water management/use	Y	Y		Y	Wetland drainage and subsequent loss and degradation of wetland habitat; water manipulation (timing of drawdown, release of water) can affect nesting and feeding sites, particularly for island- and shoreline-nesting species through direct flooding of nests or destroying the island's integrity by joining it to the mainland, thus increasing the risk of nest predation; drying of basins for flood storage; reduced water-level fluctuations in native marshes can influence structure and composition of emergent vegetation or lead to encroachment of vegetation; use of surface water for oil and gas production affects water tables at drilling sites; loss and degradation of habitat through hydroelectric development (P-LI-PG)	L	90
Horned Grebe	8.2 Problematic native species			Y	Y	Declines in part as a result of increasing predation in breeding areas (P-S-C)	L	201
Horned Grebe	9. 3 Agricultural & Forestry Effluents	Y	Y			Eutrophication contributes to degradation of wetland habitat in agricultural areas (N-S-C)	L	202
Sora	1.2 Commercial & industrial areas			Y		Commonly killed at tall lighted towers (N-S-C)	L	203
Sora	2.1 Annual & Perennial Non-Timber Crops	Y	Y			Loss and degradation of habitat through agricultural practices (P-LI-PG); conversion of grassland and wetland habitat to cropland (P-LI-PPG); sedimentation from agricultural practices has resulted in loss of available nesting and foraging habitat for rails (P-LI-S); timing of haying has important implications for rails during the breeding season (P-LI-S)	L	90
Sora	4.2 Utility & service lines			Y		Commonly killed at power lines utility wires (N-S-C)	L	203
Sora	5.1 5.1 Hunting and Collecting Terrestrial			Y		Hunted in 31 US states and 2 Canadian provinces (Manitoba and Ontario) (N-S-C)	M	203

Table B5 continued

Common Name	Threat	Habitat Loss	Habitat Degradation	Direct Mortality	Reduced Reproduction	Evidence	Threat Magnitude	Refs
	Animals							
Sora	5. 3 Logging & Wood Harvesting	Y	Y			Destruction of nesting habitat through forestry practices (P-C-PG); forestry impacts in the north are causing habitat degradation (P-C-PG)	L	204
Sora	7.1 Fire	Y	Y		Y	Repeated annual spring burning can cause a significant loss of waterbird production due to a decrease in nesting cover quality and quantity (P-LI-PPG); timing of **prescribed burns** has important implications for rails (P-LI-S); burning may negatively impact soil quality resulting in poor moisture retention and erosion (P-LI-PG); excessive burning might encourage the growth of invasive weeds (P-LI-PG)	L	90
Sora	7.2 Dams & water management/use	Y	Y		Y	Sora abundance was correlated with water level of Great Lakes marshes (O-S-LO)	L	205
Sora	9.4 Garbage & solid waste		Y	Y		7.4% of Soras sampled in Maryland had ingested lead shot (O-S-LO)	M	206
Bufflehead	5.1 5.1 Hunting and Collecting Terrestrial Animals			Y		Hunting is a significant cause of mortality but is unlikely to limit populations (N-S-C)	L	207
Bufflehead	5. 3 Logging & wood harvesting	Y	Y			Nest in cavities excavated by northern flickers; logging changes forest age-structure and removes mature trees suitable for cavity nests (N-S-C)	M	207
Bufflehead	9.2 Industrial & military effluents			Y	Y	Accumulate heavy metals and other contaminants, likely on wintering grounds. Selenium (Se) found at high levels in 90% of birds in one study, which may cause health or reproductive effects (O-S-LO); however, another study found lower levels of Se in the Canadian arctic that would be unlikely to have negative effects (O-S-LO).	M	208 209
Lesser Scaup	2.1 Annual & perennial non-timber crops	Y	Y			Wetland draining for agriculture represents a leading cause of habitat loss for waterfowl in western Canada, and is a principal cause of declines in waterfowl abundance in recent decades (O-PPG-R)	M	210
Lesser Scaup	2. 3 Livestock farming & ranching	Y	Y			Wetland draining for ranching/degradation by livestock use represents a leading cause of habitat loss for waterfowl in western Canada, and is a principal cause of declines in waterfowl abundance in recent decades (O-PPG-R)	L	210
Lesser Scaup	5.1 5.1 Hunting and Collecting Terrestrial Animals			Y		Hunting occurs, but the number of scaup harvested has decreased in recent decades as population sizes have decreased; hunting regulations have become more restrictive, and are likely not a major source of mortality (N-S-C)	L	211
Lesser Scaup	9.4 Garbage & solid waste			Y		Lead shot may be ingested, but number of ducks with lead shot decreased dramatically following the banning of lead shot for hunting waterfowl (O-S-LO)	L	212

Table B5 continued

Common Name	Threat	Habitat Loss	Habitat Degradation	Direct Mortality	Reduced Reproduction	Evidence	Threat Magnitude	Refs
Lesser Scaup	12.9 Unknown			Y	Y	Populations are declining for unknown reasons, but are most sensitive to decreased adult female survivorship, and to a lesser extent reduced production (O-S-C). Both of these vital rates appear to have decreased in the last several decades (O-S-WB). Several hypotheses explaining declines have been postulated (including reduced forage abundance, declining water quality, declining water levels, contamination from heavy metals and other chemicals; N-S-C), but to date none are well-supported.	H	213 214 215

Table B6. World Conservation Union — Conservation Measures Partnership (IUCN—CMP) classification of direct threats to biodiversity (version 1.1) from Salafsky et al. 2008[186].

Table B6 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
1. Residential and commercial development	human settlements or nonagricultural land uses with substantial footprint	1.1 housing and urban areas	human cities, towns, and settlements including nonhousing development typically integrated with housing	*urban areas, suburbs, villages, vacation homes, shopping areas, offices, schools, hospitals*
		1.2 commercial and industrial areas	factories and other commercial centres	*manufacturing plants, shopping centres, office parks, military bases, power plants, train and ship yards, airports*
		1.3 tourism and recreation areas	tourism and recreation sites with a substantial footprint	*ski areas, golf courses, beach resorts, cricket fields, county parks, campgrounds*
2. Agriculture and aquaculture	threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture	2.1 annual and perennial nontimber crops	crops planted for food, fodder, fiber, fuel, or other uses	*farms, plantations, orchards, vineyards, mixed agroforestry systems*
		2.2 wood and pulp plantations	stands of trees planted for timber or fiber outside of natural forests, often with non-native species	*teak or eucalyptus plantations, silviculture, Christmas tree farms*
		2.3 livestock farming and ranching	domestic terrestrial animals raised in one location on farmed or nonlocal resources (farming); also domestic or semidomesticated animals allowed to roam in the wild and supported by natural habitats (ranching)	*cattle feed lots, dairy farms, cattle ranching, chicken farms, goat, camel, or yak herding*
		2.4 marine and freshwater aquaculture	aquatic animals raised in one location on farmed or nonlocal resources; also hatchery fish allowed to roam in the wild	*shrimp or fin fish aquaculture, fish ponds on farms, hatchery salmon, seeded shellfish beds, artificial algal beds*
3. Energy production and mining	threats from production of nonbiological resources	3.1 oil and gas drilling	exploring for, developing, and producing petroleum and other liquid hydrocarbons	*oil wells, deep sea natural gas drilling*
		3.2 mining and quarrying	exploring for, developing, and producing minerals and rocks	*coal mines, alluvial gold panning, gold mines, rock quarries, coral mining, deep sea nodules, guano harvesting*
		3.3 renewable energy	exploring, developing, and producing renewable energy	*geothermal power production, solar farms, wind farms (including birds flying into windmills), tidal farms*

Table B6 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
4. Transportation and service corridors	threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality	4.1 roads and railroads	exploring for, developing, and producing petroleum and other liquid hydrocarbons	*oil wells, deep sea natural gas drilling*
		4.2 utility and service lines	exploring for, developing, and producing minerals and rocks	*coal mines, alluvial gold panning, gold mines, rock quarries, coral mining, deep sea nodules, guano harvesting*
		4.3 shipping lanes	transport on and in freshwater and ocean waterways	*dredging, canals, shipping lanes, ships running into whales, wakes from cargo ships*
		4.4 flight paths	air and space transport	*flight paths, jets impacting birds*
5. Biological resource use	threats from consumptive use of "wild" biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species	5.1 hunting and collecting terrestrial animals	killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch	*bushmeat hunting, trophy hunting, fur trapping, insect collecting, honey or bird nest hunting, predator control, pest control, persecution*
		5.2 gathering terrestrial plants	harvesting plants, fungi, and other nontimber/nonanimal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons	*wild mushrooms, forage for stall fed animals, orchids, rattan, control of host plants to combat timber diseases*
		5.3 logging and wood harvesting	harvesting trees and other woody vegetation for timber, fiber, or fuel	*clear cutting of hardwoods, selective commercial logging of ironwood, pulp operations, fuel wood collection, charcoal production*
		5.4 fishing and harvesting aquatic resources	harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch	*trawling, blast fishing, spear fishing, shellfish harvesting, whaling, seal hunting, turtle egg collection, live coral collection, seaweed collection*
6. Human intrusions and disturbance	threats from human activities that alter, destroy and disturb habitats and species associated with nonconsumptive uses of biological resources	6.1 recreational activities	people spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons	*off-road vehicles, motorboats, jet-skis, snowmobiles, ultralight planes, dive boats, whale watching, mountain bikes, hikers, birdwatchers, skiers, pets in recreation areas, temporary campsites, caving, rock-climbing*

Table B6 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
		6.2 war, civil unrest and military exercises	actions by formal or paramilitary forces without a permanent footprint	*armed conflict, mine fields, tanks and other military vehicles, training exercises and ranges, defoliation, munitions testing*
		6.3 work and other activities	people spending time in or traveling in natural environments for reasons other than recreation or military activities	*law enforcement, drug smugglers, illegal immigrants, species research, vandalism*
7. Natural system modifications	threats from actions that convert or degrade habitat in service of "managing" natural or seminatural systems, often to improve human welfare	7.1 fire and fire suppression	suppression or increase in fire frequency and/or intensity outside of its **natural range of variation**	*fire suppression to protect homes, inappropriate fire management, escaped agricultural fires, arson, campfires, fires for hunting*
		7.2 dams and water management/use	changing water flow patterns from their **natural range of variation** either deliberately or as a result of other activities	*dam construction, dam operations, sediment control, change in salt regime, wetland filling for mosquito control, levees and dikes, surface water diversion, groundwater pumping, channelization, artificial lakes*
		7.3 other ecosystem modifications	other actions that convert or degrade habitat in service of "managing" natural systems to improve human welfare	*land reclamation projects, abandonment of managed lands, rip-rap along shoreline, mowing grass, tree thinning in parks, beach construction, removal of snags from streams*
8. Invasive and other problematic species and genes	threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance	8.1 invasive non-native/alien species	harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities	*feral cattle, household pets, zebra mussels, Dutch elm disease or chestnut blight, Miconia tree, introduction of species for biocontrol, Chytrid fungus affecting amphibians outside of Africa*
		8.2 problematic native species	harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become "out of balance" or "released" directly or indirectly due to human activities	*overabundant native deer, overabundant algae due to loss of native grazing fish, native plants that hybridize with other plants, plague affecting rodents*
		8.3 introduced genetic material	Human-altered or transported organisms or genes	*pesticide resistant crops, hatchery salmon, restoration projects using nonlocal seed stock, genetically modified insects for biocontrol, genetically modified trees, genetically modified salmon*

Table B6 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
9. Pollution	threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources	9.1 household sewage and urban waste water	water-borne sewage and nonpoint runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments	*discharge from municipal waste treatment plants, leaking septic systems, untreated sewage, outhouses, oil or sediment from roads, fertilizers and pesticides from lawns and golf-courses, road salt*
		9.2 industrial and military effluents	water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments	*toxic chemicals from factories, illegal dumping of chemicals, mine tailings, arsenic from gold mining, leakage from fuel tanks, PCBs in river sediments*
		9.3 agricultural and forestry effluents	water-borne pollutants from agricultural, silivicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied	*nutrient loading from fertilizer runoff, herbicide runoff, manure from feedlots, nutrients from aquaculture, soil erosion*
		9.4 garbage and solid waste	rubbish and other solid materials including those that entangle wildlife	*municipal waste, litter from cars, flotsam and jetsam from recreational boats, waste that entangles wildlife, construction debris*
		9.5 air-borne pollutants	atmospheric pollutants from point and nonpoint sources	*acid precipitation, smog from vehicle emissions, excess nitrogen deposition, radioactive fallout, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves*
		9.6 excess energy	inputs of heat, sound, or light that disturb wildlife or ecosystems	*noise from highways or airplanes, sonar from submarines that disturbs whales, heated water from power plants, lamps attracting insects, beach lights disorienting turtles, atmospheric radiation from ozone holes*
10. Geological events	threats from catastrophic geological events	10.1 volcanoes	volcanic events	*eruptions, emissions of volcanic gasses*
		10.2 earthquakes/tsunamis	earthquakes and associated events	*earthquakes, tsunamis*
		10.3 avalanches/landslides	avalanches or landslides	*avalanches, landslides, mudslides*
11. Climate change and severe weather	long-term climatic changes that may be linked to global	11.1 habitat shifting and alteration	major changes in habitat composition and location	*sea-level rise, desertification, tundra thawing, coral bleaching*

Table B6 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
	warming and other severe climatic or weather events outside the **natural range of variation** that could wipe out a vulnerable species or habitat	11.2 droughts	periods in which rainfall falls below the normal range of variation	*severe lack of rain, loss of surface water sources*
		11.3 temperature extremes	periods in which temperatures exceed or go below the normal range of variation	*heat waves, cold spells, oceanic temperature changes, disappearance of glaciers/sea ice*
		11.4 storms and flooding	extreme precipitation and/or wind events or major shifts in seasonality of storms	*thunderstorms, tropical storms, hurricanes, cyclones, tornados, hailstorms, ice storms or blizzards, dust storms, erosion of beaches during storms*
12. Other direct threats	unknown threats or threats from additional activities	12.1 Information lacking	species decline or vulnerability to a threat factor is apparent, but causes of decline are unknown	*unknown threats*

Note: The IUCN-CMP classification system is composed of 3 levels of direct threats. While the first and second levels are designed to be comprehensive, consistent and exclusive, the third level contains only some illustrative examples. Action category *12. Other direct threats* is not an IUCN category from Salafasky et al. 2008[186]. It is category used in the BCR 6 plan to include additional threats that do not fit IUCN categories.

Element 5: Conservation Objectives

Overall, conservation objectives represent the desired conditions, within the subregion that will collectively contribute to achieving population objectives. Objectives may also outline the research or monitoring needed to improve the understanding of species declines and how to best take action.

Currently, most conservation objectives are measurable using qualitative categories (e.g., decrease, maintain, increase) that will allow an evaluation of implementation progress but they are not linked quantitatively to population objectives. Implementation that incorporates an active **adaptive management** process is an underlying principle of this conservation effort and will allow for future evaluation of whether or not reaching conservation objectives contributed to achieving population objectives.

Whenever possible, conservation objectives benefit multiple species and/or respond to more than one threat. However, where necessary, they focus on the specific requirements of a single species.

Conservation objectives generally fall into one of two broad categories:

- habitat objectives within the BCR subregion (the quantity, quality and configuration of priority habitats)
- non-habitat objectives within the BCR subregion (minimizing mortality by reducing predation, conducting education and outreach to reduce human disturbance, etc.)

Table B7. Complete list of conservation objective broad category descriptions.

Broad Category	Description
1	Ensure adequate habitat
2	Reduce mortality/increase productivity
3	Manage individual species
4	Reduce disturbance
5	Ensure adequate food supplies
6	Manage for climate change
7	Improve understanding

Ideally, habitat objectives would reflect the type, amount and location of habitat necessary to support population levels of priority species outlined in the population objectives. Currently, there is a lack of data and tools at the BCR scale to develop these specific quantitative objectives. Threats-based objectives present the direction of change required to move toward the population objectives using the best available information and our knowledge of **ecosystem management** strategies within broad habitat types.

Element 6: Recommended Actions

Recommended conservation actions are the strategies required to achieve conservation objectives. Recommended actions are usually made at the strategic level rather than being highly detailed and prescriptive. Actions were classified following the IUCN-CMP classification of conservation actions[186] with the addition of categories to address research and monitoring needs. When possible, more detailed recommendations can be included, for example if beneficial management practices, ecosystem plans or multiple recovery documents are available for a subregion. However, actions should be detailed enough to provide initial guidance for implementation.

The objectives for research, monitoring and widespread issues may not have actions associated with them. These issues are often so multi-faceted that actions are best designed in consultation with partners and subject-matter experts. Implementation teams will be better positioned to address these complex issues, drawing input from various stakeholders.

Recommended actions defer to or support those provided in recovery documents for species at risk at the federal, provincial or territorial level, but because these strategies are directed at multiple species, actions are usually more general than those developed for individual species. For more detailed recommendations for species at risk, readers should consult recovery documents.

Within PNR, we attempted to define an ecological context for each BCR to provide consistent guidance regarding the types of conservation actions developed to address primary threats to priority species. Within BCR 6, the ecological context was conservation and land management using an **ecosystem management** approach. This approach provides a useful framework for all-bird conservation plans because **ecosystem management** integrates scientific knowledge of ecological relationships within a complex socio-political and values framework toward the general goal of protecting native ecosystem integrity over the long term[216,217]. The natural disturbance management model (NDM) emulates patterns of variability created by natural disturbances[218,219] and forms the template for an **ecosystem management** approach. The goal of NDM is to: 1) maintain native species that evolved under the natural disturbance patterns that operated prior to human alteration of the landscape; and 2) maintain the full range of similar conditions or those that existed within the natural range of variability (NROV) including native species, populations, ecosystems, and landscapes[220]. In BCR 6, natural disturbance patterns include fire, insect outbreaks (woody tissue feeders and defoliators), windthrow and disease. Using information about the size, frequency, configuration and severity of various natural disturbances can guide the planning and operational activities associated with human-caused threats.

Table B8. World Conservation Union—Conservation Measures Partnership (IUCN—CMP) classification of conservation actions (version 1.1) from Salafsky et al. 2008[186] plus additional conservation action categories.

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
1. Land/water protection	actions to identify, establish or expand parks and other legally protected areas, and to protect resource rights	1.1 site/area protection	establishing or expanding public or private parks, reserves, and other protected areas	*national parks, wildlife sanctuaries, private reserves, tribally owned hunting grounds*
		1.2 resource and habitat protection	establishing protection or easements of some specific aspect of the resource on public or private lands	*easements, development rights, water rights, instream flow rights, wild and scenic river designation, securing resource rights*
2. Land/water management	actions directed at conserving or restoring sites, habitats and the wider environment	2.1 site/area management	management of protected areas and other resource lands for conservation	*site design, demarcating borders, putting up fences, training park staff, control of poachers*
		2.2 invasive/problematic species control	eradicating, controlling and/or preventing invasive and/or other problematic plants, animals, and pathogens	*cutting vines off trees, preventing ballast water discharge*
		2.3 habitat and natural process restoration	enhancing degraded or restoring missing habitats and ecosystem functions	*creating forest corridors, prairie re-creation,* ***riparian*** *tree plantings,* ***prescribed burns,*** *breaching levees, dam removal, fish ladders, liming acid lakes, cleaning up oil spills*
3. Species management	actions directed at managing or restoring species, focused on the species of concern itself	3.1 species management	managing specific plant and animal populations of concern	*harvest management of wild mushrooms, culling buffalo to keep population size within park carrying capacity, controlling fishing effort*
		3.2 species recovery	manipulating, enhancing or restoring specific plant and animal populations, vaccination programs	*manual pollination of trees, artificial nesting boxes, clutch manipulation, supplementary feeding, disease/parasite management*
		3.3 species reintroduction	reintroducing species to places where they formally occurred or benign introductions	*reintroduction of wolves*
		3.4 *ex situ* conservation	protecting biodiversity out of its native habitats	*captive breeding, artificial propagation, gene banking*
4. Education and awareness	actions directed at people to improve understanding and skills, and influence behavior	4.1 formal education	enhancing knowledge and skills of students in a formal degree program	*public schools, colleges and universities, continuing education*
		4.2 training	enhancing knowledge and skills of students in a formal degree program	*monitoring workshops or training courses in reserve design for park managers, learning networks or writing how-to manuals for project managers,*

Table B8 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
				stakeholder education on specific issues
		4.3 awareness and communications	raising environmental awareness and providing information through various media or through civil disobedience	*Radio soap operas, environmental publishing, Web blogs, puppet shows, door-to-door canvassing, tree sitting, protest marches*
5. Law and policy	actions to develop, change, influence, and help implement formal legislation, regulations, and voluntary standards	5.1 legislation	making, implementing, changing, influencing, or providing input into formal government sector legislation or policies at all levels: international, national, state/provincial, local, tribal	*Global: promoting conventions on biodiversity, wildlife trade laws like CITES; National: work for or against government laws such as the* Species At Risk Act*, influencing legislative appropriation; Provincial/Territorial: ballot initiatives, providing data to policy makers, developing pollution permitting systems, dams relicensing; Local: developing zoning regulations, countryside laws, species protection laws, hunting bans; Tribal: creating tribal laws*
		5.2 policies and regulations	making, implementing, changing, influencing, or providing input into policies and regulations affecting the implementation of laws at all levels: international, national, state/provincial, local/community, tribal	*input into agency plans regulating certain species or resources, working with local governments or communities to implement zoning regulations, promoting sustainable harvest on state forest lands*
		5.3 private sector standards and codes	setting, implementing, changing, influencing, or providing input into voluntary standards and professional codes that govern private sector practice	*Marine and Forest Stewardship Councils, corporate adoption of forestry beneficial management practices, sustainable grazing by a rancher*
		5.4 compliance and enforcement	monitoring and enforcing compliance with laws, policies and regulations, and standards and codes at all levels	*water quality standard monitoring, initiating criminal and civil litigation*
6. Livelihood, economic and other	actions to use economic and other incentives to influence	6.1 linked enterprises and livelihood alternatives	developing enterprises that directly depend on the maintenance of natural resources or	*ecotourism, nontimber forest product harvesting, harvesting wild salmon to*

Table B8 continued

First Level of Classification	Definition	Second Level of Classification	Definition	Third Level of Classification: Examples
initiatives	behavior		provide substitute livelihoods as a means of changing behaviours and attitudes	*create value for wild populations*
		6.2 substitution	promoting alternative products and services that substitute for environmentally damaging ones	*farmed salmon as a replacement for pressure on wild populations, promoting recycling and use of recycled materials*
		6.3 market forces	using market mechanisms to change behaviours and attitudes	*certification, positive incentives, boycotts, negative incentives, grass and forest banking, valuation of ecosystem services such as flood control*
		6.4 conservation payments	using direct or indirect payments to change behaviours and attitudes	*quid-pro-quo performance payments, resource tenure incentives*
		6.5 nonmonetary values	using intangible values to change behaviours and attitudes	*spiritual, cultural links to human health*
7. External capacity building	actions to build the infrastructure to do better conservation	7.1 institutional and civil society development	creating or providing nonfinancial support and capacity building for nonprofits, government agencies, communities, and for-profits	*creating new local land stewardship trusts, providing circuit riders to help develop organizational capacity*
		7.2 alliance and partnership development	forming and facilitating partnerships, alliances, and networks of organizations	*Joint Ventures; Partners In Flight (PIF); North American Bird Conservation Initiative (NABCI)*
		7.3 conservation finance	raising and providing funds for conservation work	*private foundations, debt-for-nature swaps*
8. Research and monitoring	actions to improve knowledge of a species, associated threats, and subsequently fill information gaps needed to determine beneficial conservation objectives or actions for priority species	8.1 Research	address gaps in knowledge regarding species biology and/or associated factors influencing species decline (threats)	*investigate potential mitigation techniques, understanding threat scope or severity, determining factors influencing decline*
		8.2 Monitoring	address gaps in knowledge regarding population trends of priority species	*expanding current monitoring programs, creating new monitoring programs, revising monitoring techniques for more targeted sampling*

Note: Action category *8. Research and/or science needs* is not an IUCN category from Salafasky et al. 2008[186]. It is an additional category used in the BCR 6 plan to indicate where additional information is needed to address threats and determine conservation objectives or actions.

Appendix C

Glossary

Term	Meaning	Ref
Access Management	Closing roads to restrict human access during certain times of year.	
Adaptive Management	An iterative decision making process where results from the previous decision(s) are used to make the next. Requires ongoing monitoring, analysis and incorporation of current knowledge and technology into decision making and management.	221
Baseline Monitoring	An assessment of pre-development/exploitation conditions, used as a point of reference to determine the amount of change since development and a condition for which restoration goals are often set.	222
Cause-Effect Monitoring	Monitoring for cause-effect relationships. Cause-effect monitoring is hypothesis-driven and allows for the attribution of cause and effect between stressors and targets.	223
Conservation Easement	A voluntary agreement between a landowner and a government or qualified conservation organization that restricts certain land uses for conservation purposes, either in perpetuity (even if land ownership changes) or for a period of time specified in the easement contract.	
Cumulative Effects	The combined effects of past, present, and foreseeable future individual human activities on the environment. Effects can combine to be additive, antagonistic or synergistic and can change with changing spatial and temporal scale.	221
Ecosite	A level of Canada's Ecosystem Classification System (seven levels total) that refers to areas with similar soil, bedrock, vegetation and hydrology.	221
Ecosystem Management	A holistic approach to land, natural resource and species management with the goal of restoring and maintaining ecological integrity while providing for sustainable resource development. The cornerstone of ecosystem management is the use of a natural disturbance regime.	216
Fee Simple	A type of land title in which ownership is essentially complete, limited only by the basic government powers of taxation, expropriation, police power, and escheat (transferral of property to the state in the absence of an owner, e.g., following the death of an owner with no heir).	
Free-to-grow	When a regenerated tree stand exhibits growth that meets the following standards: 1) it meets the minimum stocking levels; 2) it has the desired species composition; 3) it meets a minimum height requirement; and 4) it is free from vegetative competition that would hinder growth.	221
Full Recontours	Complete road removal including returning the road bed to its original slope and restoration of stream crossings.	142
Habitat Subdivision	The break-up of native habitat into pieces (islands) by various types of land-use such as roads, agricultural conversion and forestry activities.	
Mixed wood Management	Method of forest management for managing for both coniferous and deciduous species; involves selective harvesting of deciduous species (leaving 12–15% standing) to free up nutrients. Coniferous species grow more quickly but	

Glossary continued

Term	Meaning	Ref
	remain protected from blowdown. This method provides a trade-off between protection and growth response.	
Natural Disturbance Regime	The concept that natural ecosystems are shaped by thousands of years of natural disturbances (such as fire, drought, flood, grazing, insect outbreaks) that determine species assemblages. A current land management practice involves gaining an understanding of the natural disturbance history of a region (type, frequency and severity), and attempting to re-establishing temporally and spatially relevant processes of natural disturbance (e.g., prescribed fire) in order to best restore and manage species habitat, and thus species in human-altered landscapes.	224
Natural Range of Variation	Defines the range of ecological conditions in a particular ecosystem and their spatial and temporal variability, with respect to processes such as natural disturbances (e.g., drought cycles, flood pulses, fire return intervals) or states, such as distribution of specific habitat types and sizes across a landscape. An understanding of the natural range of variation allows for implementation of a natural disturbance regime.	220 221
Nitrate Leaching	The process of soil nitrates being moved with water out of the root zone and into groundwater, freshwater, and/or marine systems. Increased nitrate concentrations in these systems have a number of negative effects, including altered nutrient balances, eutrophication, and toxic effects on humans, livestock, and wildlife. It is also a significant economic loss to farmers.	225
Peatland	Peatlands are organic wetlands that contain more than 40 centimeters of peat accumulation on which organic soils develop. Peat is defined as partly decomposed vegetation matter that has accumulated in a waterlogged environment.	226 221
Perennial Forage	A land management practice, used in areas that transition from upland to wetland, where flood tolerant perennial plants are cultivated for use as livestock feed. For example, perennial forage may be used in areas susceptible to moderate flooding.	105
Precision Agriculture	Agriculture that incorporates analysis of technologically based spatial and temporal data into management practices. Spatial technologies such as remote sensing, global positioning system (GPS), and geographic information system (GIS) can be used to identify target areas with high profitability and decreased soil erosion properties. This can include identifying areas that require fertilizers/pesticides, tracking costs (seeding, fertilizer, etc.) and yields generated by patches within a single field in order to maximize profit. In general, precision agriculture leads to more efficient land use, and can be useful for conservation as well as being economically advantageous to farmers.	109
Prescribed Burn	Controlled fire used as a management tool in order to meet certain objectives such as reduction of woody vegetation or approximating a natural disturbance regime.	26 221
Restoration of Stream Crossings	Restoring the natural flow of water in an area disturbed by roads by removing culverts, recontouring stream banks, and stabilizing banks via installation of structures and re-vegetation.	142
Riparian	A transition zone between aquatic and terrestrial vegetation and processes,	227

Glossary continued

Term	Meaning	Ref
	characterized by periodic flooding from the adjacent wetland or waterbody and hydrophytic vegetation.	
Riparian Buffer	A pre-defined setback distance between a wetland or waterbody and upland land use to remain in a natural condition in order to provide beneficial wetland processes such as filtration, buffering from extreme weather and wildlife habitat.	
Riparian health	The ability of riparian areas to provide beneficial wetland-associated functions, encompassing soil, water and wildlife habitat. Riparian health assessment protocols have been developed for the Canadian prairies and evaluate important functions of riparian areas, such as trapping and storing sediment, building and maintaining banks and shores, storing water and energy, recharging aquifers, filtering and buffering water, reducing and dissipating energy created by the water body (example: stream flow and lake waves), maintaining biodiversity and creating primary productivity like forage and browse. The assessment process ranks riparian areas into Healthy, Healthy with Problems or Unhealthy on a scale of 1–100.	
Road Ripping	De-compacting the soil of a road bed, typically accomplished with a bulldozer and a specialized plow.	142
Salvage Harvest	The removal of dead or dying trees for economic gain.	26
Steam-Assisted Gravity Drainage (SAGD)	A method of heavy oil extraction where steam is injected underground via a horizontal well which softens oil enough to enter a lower well for extraction via a pump.	
Tillage	The process of ploughing soil to remove some of the previous seasons' crop residue and loosen the soil to prepare the field for planting.	
Trend Monitoring	Ongoing assessment of a particular population, community, ecosystem or process to determine amount and direction of change over a period of time. Trend monitoring programs are developed with specific objectives and endpoints in mind.	222

References

[1] Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Iñigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, T.C. Will. 2004. *Partners in Flight North American Landbird Conservation Plan*. Cornell Lab of Ornithology. Ithaca, NY.

[2] Donaldson, G. M., C. Hyslop, R. I. G. Morrison, H. L. Dickson, and I. Davidson (editors). 2000. *Canadian Shorebird Conservation Plan.* Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. 27pp.

[3] Milko, R., L. Dickson, R. Elliot, and G. Donaldson. 2003. Wings *Over Water: Canada's Waterbird Conservation Plan*. Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. 28pp.

[4] North American Waterfowl Management Plan, Plan Committee. 2004. *North American Waterfowl Management Plan 2004. Implementation Framework: Strengthening the Biological Foundation.* Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales, 106pp. www.nawmp.ca/pdf/impfr-en-k.pdf

[5] Kennedy, J.A., E.A. Krebs and A.F. Camfield. 2012. *A Manual for Completing All-bird Conservation Plans in Canada*, April 2012 version. Canadian Wildlife Service, Environment Canada. Ottawa, ON

[6] Burton, P. J., M-A. Parisien, J. A. Hicke, R. J. Hall, and J. R. Freeburn. 2008. *Large fires as agents of ecological diversity in the North American boreal forest.* International Journal of Wildland Fire 17:754-767.

[7] Food and Agriculture Organization (FAO). 2000. *Land cover classification system*. United Nations Food and Agriculture Organization, Rome. www.fao.org/docrep/003/x0596e/x0596e00.htm

[8] Leroux, S. J., F. K. A. Schmiegelow, S. G. Cumming, R. B. Lessard, and J. Nagy. 2007. *Accounting for system dynamics in reserve design.* Ecological Applications 17:1954-1966.

[9] Rolland, V., J. A. Hostetler, T. C. Hines, H. F. Percival and M. K. Oli. 2010. *Impact of harvest on survival of a heavily hunted game bird population.* Wildlife Research 37:392-400.

[10] Government of British Columbia. 1996. *Wildlife harvest strategy: improving British Columbia's wildlife harvest regulations.* Ministry of Environment, Lands and Parks.

[11] Desrochers, A., L. Rochefort and J. P. Savard. 1998. *Avian recolonization of eastern Canadian bogs after peat mining.* Canadian Journal of Zoology 76:989-997.

[12] Delage, V., M. J. Fortin, and A. Desrochers. 2000. *Effects of peripheral and isolated locations of songbird habitats in mined bogs.* Ecoscience 7:149-156.

[13] Schmiegelow, F. K. A, S. G. Cumming, S. Harrison, S. Leroux, K. Lisgo, R. Noss, and B. Olsen. 2006. *Conservation beyond crisis management: A reverse-matrix model*. BEACONs Discussion Paper, No. 1

[14] Cumming S. G., P. J. Burton, and B. Klinkenberg. 1996. *Boreal mixedwood forests may have no "representative" areas: some implications for reserve design.* Ecography 19:162-180;

[15] Schmiegelow, F. K. A., D. P. Stepnisky, C. A. Stambaugh, and M. Koivula. 2006. *Reconciling salvage logging of boreal forests with a natural-disturbance management model.* 20:971-983.

[16] Shinneman, D. J., M. W. Cornett, and B. J. Balik. 2010. *Simulating restoration strategies for a southern boreal forest landscape with complex ownership patterns.* Forest Ecology and Management 259:446-458.

[17] Sturtevant, B. R., B. R. Miranda, J. Yang, H. S. He, E. J. Gustafson, and R. M. Scheller. 2009. *Studying fire mitigation strategies in multi-ownership landscapes: Balancing the management of fire-dependent ecosystems and fire risk.* Ecosystems 12:445-461.

[18] McAllister, D. E., J. F. Craig, N. Davidson, S. Delany and M. Seddon. 2000. *Biodiversity impacts of large dams.* Prepared on behalf of IUCN. 1-66.

[19] Foote, L. and N. Krogman. *Wetlands in Canada's western boreal forest: agents of change.* The Forestry Chronicle 82:825-833.

[20] Turcotte, I., L. Venier and D. Kirk. *Boreal shield ecozone^{Plus} status and trends report draft #3.2*. Environment Canada, Unpublished Report.

[21] Parry, D., J. R. Spence, and W. J. A. Volney. 1997. *Responses of natural enemies to experimentally increased populations of the forest tent caterpillar,* Malacosoma disstria. Ecological Entomology 22:97-108.

[22] Sleep, D. J. H., M. C. Drever, and K. J. Szuba. 2009. *Potential role of spruce budworm in range-wide decline of Canada Warbler.* Journal of Wildlife Management 73:546-555.

[23] Bonnot, T. W., J. J. Millspaugh, and M. Rumble. 2009. *Multi-scale nest-site selection by black-backed woodpeckers in outbreaks of mountain pine beetles.* Forest Ecology and Management 259:220-228.
[24] Fayt, P., M. M. Machmer, and C. Steeger. 2005. *Regulation of spruce bark beetles by woodpeckers - a literature review.* Forest Ecology and Management 206:1-14.
[25] Martin, K., A. Norris, and M. Drever. 2006. *Effects of bark beetle outbreaks on avian biodiversity in the British Columbia interior:Implications for critical habitat management*. BC Journal of Ecosystems and Management 7:10-24.
[26] Lindenmayer, D.B., P.J. Burton and J.F. Franklin. 2008. *Salvage logging and its ecological consequences.* Island Press, Washington DC, USA.
[27] Eveleigh, E. S., K. S. McCann, P. C. McCarthy, S. J. Pollock, C. J. Lucarotti, B. Morin, G. A. McDougall, D. B. Strongman, J. T. Huber, J. Umbanhowar, and L. D. B. Faria. 2007. *Fluctuations in density of an outbreak species drive diversity cascades in food webs.* Proceedings of the National Academy of Sciences of the United States of America 104:16976-16981.
[28] Knapton, R. 2009. *Conservation Issues for Declining Aerial Insectivores in Canada (Draft 1.0).* Environment Canada (Canadian Wildlife Service and Science and Technology Branch) and Bird Studies Canada.
[29] McCracken, J. 2008. *Are aerial insectivores being 'bugged out'?* Birdwatch Canada 42:4-7.
[30] Saito, E. K., L. Sileo, D. E. Green, C. U. Meteyer, G. S. McLaughlin, K. A. Converse, and D. E. Docherty. 2007. *Raptor mortality due to West Nile virus in the United States, 2002.* Journal of Wildlife Diseases 43:206-213.
[31] Fisher, R. J., and K. L. Wiebe. 2006. *Nest site attributes and temporal patterns of Northern Flicker nest loss: effects of predation and competition.* Oecologia 147:744-753.
[32] Smith, J. N. M., M. J. Taitt, and L. Zanette. 2002. *Removing Brown-headed Cowbirds increases seasonal fecundity and population growth in Song Sparrows.* Ecology 83:3037-3047.
[33] Summers, S. G., R. M. Kostecke, and G. L. Norman. 2006. *Efficacy of trapping and shooting in removing breeding Brown-headed Cowbirds.* Wildlife Society Bulletin 34:1107-1112.
[34] Tewksbury, J. J., L. Garner, S. Garner, J. D. Lloyd, V. Saab, and T. E. Martin. 2006. *Tests of landscape influence: Nest predation and brood parasitism in fragmented ecosystems.* Ecology 87:759-768.
[35] Smith, L. A., and S. J. Thomson. 2003. *United States Department of Agriculture - Agricultural Research Service research in application technology for pest management*. Pest Management Science 59:699-707.
[36] Giles, D. K., and D. C. Slaughter. 1997. *Precision band spraying with machine-vision guidance and adjustable yaw nozzles.* Transactions of the ASAE 40:29-36.
[37] Holmes, S. B. 1998. *Reproduction and nest behaviour of Tennessee Warblers* Vermivora peregrina *in forests treated with Lepidoptera-specific insecticides.* Journal of Applied Ecology 35:185-194.
[38] Fisher, I. J., D. J. Pain, and V. G. Thomas. 2006. *A review of lead poisoning from ammunition sources in terrestrial birds.* Biological Conservation 131:421-432.
[39] Environment Canada. 1998. *Hunting with lead shot - wildlife and human health concerns.* Proceedings: Society of Environmental Toxicology and Chemistry 19th Annual Meeting, The Natural Connection: Environmental Integrity and Human Health. Charlotte, NC: November 15-19, 1998.
[40] Mauzerall, D. L., B. Sultan, N. Kim, and D. F. Bradford. 2005. *NOx emissions from large point sources: variability in ozone production, resulting health damages and economic costs.* Atmospheric Environment 39:2851-2866.
[41] Bayne, E. M., L. Habib, and S. Boutin. 2008. *Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest.* Conservation Biology 22:1186-1193.
[42] Stuart, S. N., J. S. Chanson, N. A. Cox, B. E. Young, A. S. L. Rodrigues, D. L. Fischman, and R. W. Waller. 2004. *Status and trends of amphibian declines and extinctions worldwide.* Science 306:1783-1786.
[43] Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2009. *Assessment and Status Report on the Whip-poor-will* Caprimulgus vociferus. Ottawa. vi + 28 pp.
[44] Alberta Worm Invasion Project. 2010. http://worms.biology.ualberta.ca/how-to-help/
[45] Hobson, K.A. and E. Bayne. 2000. *Breeding bird communities in boreal forest of western Canada: Consequences of "unmixing" the mixedwoods.* Condor 102:759-769.
[46] Lieffers, V. J., G. W. Armstrong, K. J. Stadt, and E. H. Marenholtz. 2008. *Forest regeneration standards: are they limiting management options for Alberta's boreal mixedwoods?* Forestry Chronicle 84:76-82.

[47] Grover, G., and W. Fast. 2007. *Alberta making strides in mixedwood management.* Forestry Chronicle 83:714-718.
[48] Alberta Sustainable Rescource Development. 2009. *Recommended grazing best management practices in coniferous and deciduous cutblocks in Alberta.* Approximation 1, Lands Division, Edmonton, AB.
[49] Thomson, I. D., J. A. Baker, and M. Ter-Mikaelian. 2003. *A review of long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada*. Forest Ecology and Management 177:441-469.
[50] Bollinger, E. K., P. B. Bollinger, and T. A. Gavin. 1990. *Effects of hay-cropping on eastern populations of the Bobolink.* Wildlife Society Bulletin 18:142-150.
[51] Warren, K. A., and J. T. Anderson. 2005. *Grassland songbird nest-site selection and response to mowing in West Virginia.* Wildlife Society Bulletin 33:285-292.
[52] Fuhlendorf, S. D., and D. M. Engle. 2001. *Restoring heterogeneity on rangelands: Ecosystem management based on evolutionary grazing patterns.* Bioscience 51:625-632.
[53] Fuhlendorf, S. D., and D. M. Engle. 2004. *Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie.* Journal of Applied Ecology 41:604-614.
[54] Fuhlendorf, S. D., W. C. Harrell, D. M. Engle, R. G. Hamilton, C. A. Davis, and D. M. Leslie. 2006. *Should heterogeneity be the basis for conservation?* Grassland bird response to fire and grazing. Ecological Applications 16:1706-1716.
[55] Brodt, S., K. Klonsky, L. Jackson, S. B. Brush, and S. Smukler. 2009. *Factors affecting adoption of hedgerows and other biodiversity-enhancing features on farms in California, USA.* Agroforestry Systems 76:195-206.
[56] Risgaard, M. L., P. Frederiksen, and P. Kaltoft. 2007. *Socio-cultural processes behind the differential distribution of organic farming in Denmark: a case study.* Agriculture and Human Values 24:445-459.
[57] Fitch, L. and B.W. Williams. 1998. *Can cows and fish coexist?* Canadian Journal of Plant Science 78:191-198.
[58] Fondell, T. F., and I. J. Ball. 2004. *Density and success of bird nests relative to grazing on western Montana grasslands.* Biological Conservation 117:203-213.
[59] Prairie Habitat Joint Venture. 2008. *Prairie Habitat Joint Venture Implementation Plan 2007 – 2012.* Report of the Prairie Habitat Joint Venture. Environment Canada, Edmonton, 34 pp.
[60] Riley, J.L., Green, S.E., Brodribb, K.E. 2007. *A Conservation Blueprint for Canada's Prairies and Parklands.* Nature Conservancy of Canada, Toronto, 226 pp.
[61] Smith - Fargey, K. (ed). 2004. *Shared Prairie - Shared Vision: The Northern Mixed Grass Transboundary Conservation Initiative.* Conservation Site Planning Workshop Proceedings and Digital Atlas. Environment Canada, Regina.
[62] Good, K., Michalsky, S.2008. *Summary of Canadian Experience with Conservation Easements and their Potential Application to Agri-Environmental Policy.* Agriculture & Agri-food Canada
[63] Cuddington, A.D.2008. *Bio-economic Considerations for Wetland Policy on an Agricultural Landscape*. MSc Thesis, University of Saskatchewan, Saskatoon, 136 pp.
[64] North American Grouse Partnership. 2004. *The North American Grouse Management Plan: a prospectus.* North American Grouse Partnership, Williamsport, MD, 39 pp.
[65] Vickery, P.D., Blanco, D.E., López-Lanús, B. 2008. *Conservation Plan for the Upland Sandpiper* (Bartramia Longicauda). Western Hemisphere Shorebird Reserve Network, Manomet, Massachusetts, 55 pp.
[66] Prairie Habitat Joint Venture. 2000. *Prairie Canada Shorebird Conservation Plan.* Prairie Habitat Joint Venture, 248 pp.
[67] Canadian Prairie Partners in Flight. 2004. *Landbird Conservation Plan for Prairie Pothole Bird Conservation Region 11 in Canada.* Canadian Wildlife Service, Edmonton, AB.
[68] Environment Canada. 2006. *Recovery Strategy for the Mountain Plover* (Charadrius montanus) *in Canada.* Environment Canada, Ottawa, 24 pp.
[69] Environment Canada. 2008. *Recovery Strategy for the Sprague's Pipit* (Anthus spragueii) *in Canada*. Environment Canada, Ottawa, 38 pp.
[70] Environment Canada. 2010. *Recovery Strategy for the Burrowing Owl* (Athene cunicularia) *in Canada (Revised version)*. Environment Canada, Ottawa, 45 pp.

[71] Lewandrowski, J., and K. Ingram. 1999. *Policy considerations for increasing compatibilities between agriculture and wildlife.* Natural Resources Journal 39:229-269.
[72] Kitchen, N. R., K. A. Sudduth, D. B. Myers, R. E. Massey, E. J. Sadler, R. N. Lerch, J. W. Hummel, and H. L. Palm. 2005. *Development of a conservation-oriented precision agriculture system: Crop production assessment and plan implementation.* Journal of Soil and Water Conservation 60:421-430.
[73] Goddard, T. W. 2005. *An overview of precision conservation in Canada.* Journal of Soil and Water Conservation 60:456-461.
[74] Belant, J. L. 1997. *Gulls in urban environments: landscape-level management to reduce conflict.* Landscape and Urban Planning 38:245-258.
[75] Cook, A., S. Rushton, J. Allan, and A. Baxter. 2008. *An evaluation of techniques to control problem bird species on landfill sites.* Environmental Management 41:834-843.
[76] CIJV Technical Committee. August 2010. *Canadian Intermountain Joint Venture implementation plan: Wetlands and associated species [draft]*. viii+ 64pp.
[77] Zedler, J. B. 2003. *Wetlands at your service: reducing impacts of agriculture at the watershed scale.* Frontiers in Ecology and the Environment 1:65-72.
[78] NatureWatch. 2002. *FrogWatch*. www.naturewatch.ca/english/select_province.html.
[79] Bird Studies Canada. *Marsh Monitoring Program*. www.bsc-eoc.org/volunteer/glmmp/index.jsp?targetpg=index&lang=EN.
[80] Trombulak, S. C. and C. A. Frissell. 2000. *Review of ecological effects of roads on terrestrial and aquatic communities.* Conservation Biology 14:18-30
[81] Benítez-López, A., R. Alkemade and P. A. Verweij. 2010. *The impacts of roads and other infrastructure on mammal and bird populations: a meta-analysis.* Biological Conservation 143:1307-1316.
[82] Sundararajan, R. and R. Gorur. 2005. *When birds and power lines collide.* Transmission and Distribution World. Available online: http://tdworld.com/overhead_transmission/power_birds_power_lines/index.html
[83] Edison Electric Institute's Avian Power Line Interaction Committee and U.S. Fish and Wildlife Service. 2005. *Avian protection plan (APP) Guidelines.* 88pp.
[84] Arctic Goose Joint Venture Technical Committee. 2008. *Arctic Goose Joint Venture strategic plan: 2008-2012*. Unpublished report. C/o AGJV coordination office, Canadian Wildlife Service, Edmonton, Alberta. 112pp.
[85] Houlahan, J. E. and C. S. Findlay. 2004. *Estimating the 'critical' distance at which adjacent land-use degrades wetland water and sediment quality.* Landscape Ecology 19:677-690.
[86] Schummer, M. L. and W. R. Eddleman. 2003. *Effects of disturbance on activity and energy budgets of migrating waterbirds in south-central Oklahoma.* The Journal of Wildlife Management 67:789-795.
[87] Alberta Sustainable Resource Development and Alberta Conservation Association. 2006. *Status of the Western Grebe (Aechmophorus occidentalis) in Alberta.* Alberta wildlife status report no. 60, Edmonton, AB. 29 pp.
[88] Finney, S. K., J. W. Pearce-Higgins and D. W. Yalden. 2005. *The effect of recreational disturbance on an upland breeding bird, the golden plover,* Pluvialis apricaria. Biological Conservation 121:53-63.
[89] Government of British Columbia. 1997. *Live animal capture and handling guidelines for wild mammals, birds, amphibians and reptiles: 3. Birds*. http://archive.ilmb.gov.bc.ca/risc/pubs/tebiodiv/live-animal/index.htm#a.
[90] Beyersbergen, G.W., N. D. Niemuth, and M.R. Norton, coordinators. 2004. *Northern Prairie & Parkland Waterbird Conservation Plan.* A plan associated with the Waterbird Conservation for the Americas initiative. Published by the Prairie Pothole Joint Venture, Denver, Colorado. 183pp.
[91] Morissette, J. and M. Donnelly. 2010. *Riparian areas: challenges and opportunities for conservation and sustainable forest management.* Sustainable Forest Management Network, Edmonton, Alberta 56 pp.
[92] Lavoie, C. 2010. *Should we care about purple loosestrife?* The history of an invasive plant in North America. Biological Invasions 12:1967-1999.
[93] Farnsworth, E. J., and D. R. Ellis. 2001. *Is purple loosestrife* (Lythrum salicaria) *an invasive threat to freshwater wetlands?* Conflicting evidence from several ecological metrics. Wetlands 21:199-209.
[94] Whitt, M. B., H. H. Prince, and R. R. Cox. 1999. *Avian use of purple loosestrife dominated habitat relative to other vegetation types in a Lake Huron wetland complex.* Wilson Bulletin 111:105-114.
[95] Samuel, M. D., D. J. Shadduck, D. R. Goldberg, and W. P. Johnson. 2005. *Avian cholera in waterfowl: The role of Lesser Snow and Ross's Geese as disease carriers in the Playa Lakes Region.* Journal of Wildlife Diseases 41:48-57.

[96] Calvert, A. M., and G. Gauthier. 2005. *Effects of exceptional conservation measures on survival and seasonal hunting mortality in Greater Snow Geese.* Journal of Applied Ecology 42:442-452.
[97] Soos, C., and G. Wobeser. 2006. *Identification of primary substrate in the initiation of avian botulism outbreaks.* Journal of Wildlife Management 70:43-53.
[98] Guillemette, M., and P. Brousseau. 2001. *Does culling predatory gulls enhance the productivity of breeding Common Terns?* Journal of Applied Ecology 38:1-8.
[99] Linz, G. M., and D. C. Blixt. 1997. *Black Terns benefit from cattail management in the northern Great Plains.* Colonial Waterbirds 20:617-621.
[100] Delgado, J. A., R. Khosla, W. C. Bausch, D. G. Westfall, and D. J. Inman. 2005. *Nitrogen fertilizer management based on site-specific management zones reduces potential for nitrate leaching.* Journal of Soil and Water Conservation 60:402-410.
[101] Yang, C., J. H. Everitt, and J. M. Bradford. 2001. *Comparisons of uniform and variable rate nitrogen and phosphorus fertilizer applications for grain sorghum.* Transactions of the ASAE 44:201-209.
[102] Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2007. *COSEWIC Assessment and Status Report on the Chimney Swift in Canada.*
[103] Harding, L. 2009. *Montane Cordillera Ecozone^{Plus} Status and Trends Assessment [draft June 2009].* Prepared by SciWrite Environmental Sciences Ltd. Coquitlam, B.C.
[104] Podruzny, K. M., J. H. Devries, L. M. Armstrong and J. J. Rotella. 2002. *Long-term response of Northern Pintails to changes in wetlands and agriculture in the Canadian prairie pothole region.* The Journal of Wildlife Management 66:993-1010
[105] Haak, D. 2008. *Sustainable agricultural land management around wetlands on the Canadian prairies. Agriculture and Agri-Food Canada*. www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1231514224747&lang=eng. Accessed: August 23 2010
[106] Creed, I. F. and K. J. Devito. 2004. *Predicting the potential susceptibility of surface waters to changes in the boreal forest: towards adaptive forest management strategies*. Sustainable Forest Management Network Project Reports2003/2004.
[107] Berry, J. K., J. A. Delgado, F. J. Pierce and R. Khosla. 2005. Applying spatial analysis for precision conservation across the landscape. Journal of Soil and Water Conservation 60:363-370.
[108] Ferris, J. and J. Siikamäki. 2009. *Conservation Reserve Program and Wetland Reserve Program: primary land retirement programs for promoting farmland conservation*. Resources for the future. Available online: www.rff.org.
[109] Berry, J. K., J. A. Delgado, R. Khosla, and F. J. Pierce. 2003. *Precision conservation for environmental sustainability*. Journal of Soil and Water Conservation 58:332-339.
[110] North American Bird Conservation Initiative, U.S. Committee, 2009. *The State of the Birds, United States of America, 2009*. U.S. Department of Interior: Washington, DC. 36 pages.
[111] Davis, C. A. and J. R. Bidwell. 2008. *Response of aquatic invertebrates to vegetation management and agriculture*. Wetlands 28:793-805.
[112] Stavne, R. B. 2005. *Effects of cattle grazing on breeding wetland birds in the Aspen Parkland of Alberta*. M.Sc. Thesis, University of Alberta, Edmonton, Alberta, Canada.
[113] Bevan, D. J., K. P. Chandroo and R. D. Moccia. 2002. *Predator control in commercial aquaculture in Canada*. www.aps.uoguelph.ca/~aquacentre/files/misc-factsheets/Predator%20Control%20in%20Commercial%20Aquaculture%20in%20Canada.pdf. Accessed: August 19, 2010. AEC Order No. 02-001
[114] Falker, S. T. and M. C. Brittingham. 1998. *Controlling birds at aquaculture facilities*. Pennsylvania State University. Wildlife damage control 12
[115] Welsch, D. J., D. L. Smart, J. N. Boyer, P. Minkin, H. C. Smith and T. L. McCandless. 1995. *Forested wetlands: functions, benefits and the use of beneficial management practices*. USDA Forest Service. NA-PR-01-95.
[116] Sibley, P. K. and A. M. Gordon. 2010. *Managing riparian forests: a decision support system*. Sustainable Forest Management Network, Edmonton, Alberta 42 pp.
[117] Locky, D. A. and S. E. Bayley. 2007. *Effects of logging in the southern boreal peatlands of Manitoba, Canada*. Canadian Journal of Forest Research 37:649-661.

[118] Manville, A. M. 2005. *Seabird and waterbird bycatch in fishing gear: next steps in dealing with a problem*. USDA Forest Service General Technical Report PSW-GTR-191.2005.

[119] Machtans, C. S., C. H. R Wedeles, and E. M Bayne. 2013. *A First Estimate for Canada of the Number of Birds Killed By Colliding with Buildings.* Avian Conservation and Ecology - Écologie et conservation des oiseaux 8(2):6. http://www.ace-eco.org/vol8/iss2/art6/.

[120] Zimmerling, J.R., A. Pomeroy, M.V. d'Entremont and C.M. Francis. 2013. *Canadian Estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine developments.* Avian Conservation and Ecology - Écologie et conservation des oiseaux 8(2):10. http://www.ace-eco.org/vol8/iss2/art10/.

[121] Longcore, T., C. Rich, P. Mineau, B. MacDonald, D.G. Bert, L.M. Sullivan, E. Mutrie, S.A. Gauthreaux Jr, M.L. Avery, R.L. Crawford, A.M. Manville II, E.R. Travis, D. Drake. 2012. *An Estimate of Avian Mortality at Communication Towers in the United States and Canada*. PLoS ONE 7(4): e34025. doi:10.1371/journal.pone.0034025

[122] American Bird Conservancy. 2012. *Bird Collisions at Communication Towers*. www.abcbirds.org/abcprograms/policy/collisions/towers.html. Accessed 19 March 2012.

[123] Bevanger, K. 1998. *Biological and conservation aspects of bird mortality caused by electricity power lines: a review*. Biological Conservation. 86:67-76

[124] Manville, A.M., II. (2005). "Bird strikes and electrocutions at power lines, communication towers, and wind turbines: state of the art and slate of the science — next steps toward mitigation.". In C.J. Ralph and T. D. Rich. *Bird Conservation Implementation in the Americas: Proceedings 3rd International Partners in Flight Conference 2002*. U.S.D.A. Forest Service. GTR-PSW-191, Albany. CA.

[125] Calvert, A.M., C.A. Bishop, R.D. Elliot, E.A. Krebs, T.M. Kydd, C.S. Machtans, and G.J. Robertson. 2013. *A synthesis of human-related avian mortality in Canada.* Avian Conservation and Ecology - Écologie et conservation des oiseaux 8(2):11. www.ace-eco.org/vol8/iss2/art11/.

[126] World Bank Indicators. 2012. *Roads; paved (% of total roads) in Canada*. World Bank www.tradingeconomics.com/canada/roads-paved-percent-of-total-roads-wb-data.html. Accessed 5 April 2012.

[127] Bishop, C.A., and J.M. Brogan. 2013. *Estimates of avian mortality due to vehicle collisions on the Canadian road network.* Avian Conservation and Ecology - Écologie et conservation des oiseaux 8(2):2. http://www.ace-eco.org/vol8/iss2/art2/.

[128] Blancher, P. J. 2013. *Estimated number of birds killed by house cats* (Felis catus) *in Canada*. Avian Conservation and Ecology - Écologie et conservation des oiseaux 8(2):3. http://www.ace-eco.org/vol8/iss2/art3/.

[129] Eeva, T. and Lehikoinen, E. 2000. *Recovery of breeding success in wild birds*. Nature 403: 851-852.

[130] Franceschini, M.D., Custer, C.M., Custer, T.W., Reed, J.M., and Romero, L.M. 2008. *Corticosterone stress response in tree swallows nesting near polychlorinated biphenyl- and dioxin-contaminated rivers*. Environmental Toxicology and Chemistry 27: 2326–2331.

[131] Mineau, P. 2010. *Avian mortality from pesticides used in agriculture in Canada*. Wildlife and Landscape Science Directorate unpublished report. Environment Canada Science and Technology Branch.

[132] Environment Canada. 2003. *Great Lakes Fact Sheet. Fish and wildlife health effects in the Canadian Great Lakes areas of concern*. ISBN 0-662-34076-0. www.ec.gc.ca/Publications/A793CA48-2A8C-4F38-8B1C-B3AEBEAE2342%5CFishAndWildlifeHealthEffectsInTheCanadianGreatLakesareasofconcern.pdf

[133] Scheuhammer, A. M., and S. L. Norris. 1996. *The ecotoxicology of lead shot and lead fishing weights.* Ecotoxicology 5: 279-295.

[134] Scheuhammer, A.M., S. L. Money, D. A. Kirk, and G. Donaldson. 2003. *Lead fishing sinkers and jigs in Canada: Review of their use patterns and toxic impacts on wildlife*. Occasional Paper no. 108. Canadian Wildlife Service.

[135] Ronconi, R. A. 2006. *Predicting bird oiling events at oil sands tailings ponds and assessing the importance of alternate waterbodies for waterfowl: a preliminary assessment*. Canadian Field Naturalist 120:1-9.

[136] Timoney, K. P. and R. A. Ronconi. 2010. *Annual bird mortality in the bitumen tailings ponds in northeastern Alberta, Canada*. The Wilson Journal of Ornithology 122: 569-576.

[137] Ronconi, R. A. 2011. *Alberta oil sands bird contact monitoring plan for 2011 [Draft 11 March 2011].* 35 pp.

[138] Brown, R.G. B. Revision: A. R. Lock. 2003. *Oil pollution and birds*. Hinterland Who's Who. Minister of the Environment, Environment Canada. www.hww.ca/en/issues-and-topics/oil-pollution-and-birds.html. Accessed 4 April 2012.

[139] Global Forest Watch 2000. *Canada's Forests at a Crossroads: An Assessment in the Year 2000*.
[140] Gratson, M. W., and C. Whitman. 2000. *Characteristics of Idaho elk hunters relative to road access on public lands.* Wildlife Society Bulletin 28:1016-1022.
[141] Miller, J. R., L. A. Joyce, R. L. Knight, and R. M. King. 1996. *Forest roads and landscape structure in the southern Rocky Mountains*. Landscape Ecology 11:115-127.
[142] Switalski, T. A., J. A. Bissonette, T. H. DeLuca, C. H. Luce, and M. A. Madej. 2004. *Benefits and impacts of road removal.* Frontiers in Ecology and the Environment 2:21-28.
[143] National Audubon Society. 2009. *Birds and climate change - Ecological disruption in motion*. 16 pages.
[144] North American Bird Conservation Initiative, U.S. Committee, 2010. *The State of the Birds 2010 Report on Climate Change, United States of America*. U.S. Department of the Interior: Washington, DC.
[145] Faaborg, J., R.T. Holmes, A.D. Anders, K.L. Bildstein, K.M. Dugger, S.A. Gauthreaux, P. Heglund, K.A. Hobson, A.E. Jahn, D.H. Johnson, S.C. Latta, D.J. Levey, P.P. Marra, C.L. Merkord, E. Nol, S.I. Rothstein, T.W.Sherry, T.S. Sillett, F.R. Thompson, N. Warnock. 2010. *Conserving migratory land birds in the New World: Do we know enough?* Ecological Applications 20(2): 398-418.
[146] Stralberg, D., S. M. Matsuoka, P. Sólymos, E. M. Bayne, F. K. A. Schmiegelow, S. G. Cumming, S. J. Song, T. C. Fontaine, and C. M. Handel. 2013. Modeling avifaunal responses to climate change across North America's boreal-arctic transition zone. Final Report to the Arctic Landscape Conservation Cooperative from the Boreal Avian Modeling Project, Edmonton, AB., www.borealbirds.ca.
[147] Gunn , A. 2009. *Taiga Plains ecozone^{Plus} status and trends assessment (Draft 2.0).* Environment Canada, Unpublished Draft Report. 122 pp.
[148] Field, C. B., L. D. Mortsch, M. Brklacich, D. L. Forbes, P. Kovacs, J. A. Patz, S. W. Running, and M. J. Scott. 2007. "North America." In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, Eds., Cambridge University Press, Cambridge, UK pp 617-652.
[149] Weber, M.G. & Flannigan, M.D. 1997. *Canadian boreal forest ecosystem structure and function in a changing climate: Impact on fire regimes.* Environmental Review 5: 145-166.
[150] Environment Canada. 2007. *Recovery Strategy for the Woodland Caribou* (Rangifer tarandus caribou)*, Boreal Population, in Canada*. Unpublished work.
[151] Thomas, D.C. and Gray, D.R. 2002. *Update COSEWIC Status Report on the Woodland Caribou* Rangifer Tarandus *Caribou in Canada*. COSEWIC assessment and update status report on the woodland caribou Rangifer tarandus caribou in Canada. Committee on the Status of Endangered Wildlife in Canada. 98 pp.
[152] DeVink, J.-M.A., R.G.Clark, S.M.Slattery and D.L.Trauger (2008) *Are Late-spring Boreal Lesser Scaup* (Aythya affinis) *in poor body condition? Auk*, 125, 297-298.
[153] Bergengren, J. C., D. E. Waliser, and Y. L. Yung. 2011. *Ecological sensitivity: a biospheric view of climate change*. Climate Change 107: 433-457.
[154] Avian Monitoring Review Steering Committee. 2012. *Environment Canada Avian Monitoring Review – Final Report.* Environment Canada, Ottawa ON, xii + 170 pages + 3 appendices.
[155] Norton, M. and C. Machtans. 2007. *The National Boreal Bird Monitoring Program*. Canadian Wildlife Service, Environment Canada.
[156] Bart, J., K. P Burnham, E. H. Dunn, C. M. Francis, and C. J. Ralph. 2004. *Goals and strategies for estimating trends in landbird abundance*. Journal of Wildlife Management 68:611-626.
[157] Hannon, S. J., S. E. Cotterill, and F. K. A. Schmiegelow. 2004. *Identifying rare species of songbirds in managed forests: application of an ecoregional template to a boreal mixedwood system*. Forest Ecology and Management 191:157-170.
[158] Crewe, T. L., J. D. McCracken, P. D. Taylor, D. Lepage, and A. E. Heagy. 2008. *The Canadian Migration Monitoring Network: Ten-year Report on Monitoring Landbird Population Change*. CMMN-RCSM Scientific Technical Report #1. Produced by Bird Studies Canada, Port Rowan, Ontario. 69 pp.
[159] Johnson, D. H., J. P. Gibbs, M. Herzog, S. Lor, N. D. Niemuth, C. A. Ribic, M. Seamans, T. L. Shaffer, W. G. Shriver, S. V. Stehman, and W. L. Thompson. 2009. *A sampling design framework for monitoring secretive marshbirds*. Waterbirds 32(2):203-215.

[160] Morris, R. D. 2006. *Techniques for monitoring colonial waterbirds in the boreal forest*. Unpublished Report. 36 pp.
[161] Steinkamp, M. B. Peterjohn, V. Byrd, H. Carter, and R. Lowe. 2003. *Breeding season survey techniques for seabirds and colonial waterbirds through North America*. Unpublished Draft Report. 81 pp.
[162] Conway, C. J. 2008. *Standardized North American marsh bird monitoring protocols*. Wildlife Research Report #2008-01. U. S. Geological Survey, Arizona Fish and Wildlife Research Unit, Tucson, AZ. 36 pp.
[163] Conway, C. J. and J. P. Gibbs. 2005. *Effectiveness of call-broadcast surveys for monitoring marsh birds*. Auk 122(1):26-35.
[164] Nadeau, C. P., C. J. Conway, B. S. Smith, and T. E. Lewis. 2008. *Maximizing detection probability of wetland-dependent birds during point-count surveys in Northwestern Florida*. Wilson Journal of Ornithology 120(3):513-518.
[165] Skagen, S. K., J. Bart, B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, S. L. Jones, and R. I. G. Morrison. 2003. *Monitoring the shorebirds of North America: towards a unified approach*. Wader Study Group Bulletin 100:102-104.
[166] Sinclair, P. Y. Aubry, J. Bart, V. Johnston, R. Lanctot, B. McCaffrey, K. Ross, P. Smith, and L. Tibbitts. 2004. *Boreal Shorebirds: An Assessment of Conservation Status and Potential for Population Monitoring*. Unpublished Report. 41 pp.
[167] Elliot, K. H., P. A. Smith, and V. H. Johnston. Submitted. *Aerial surveys do not reliably census boreal shorebirds*.
[168] Elliot, K., V. Johnston, T. Marsh, A. Miller, J. Rausch, P. Smith, S. Smith, and C. Wood. 2009. *Boreal shorebirds in Northwest Territories: Breeding biology and survey techniques*.
[169] Canadian Wildlife Service Waterfowl Committee. 2009. *Population Status of Migratory Game Birds in Canada, 2009*. CWS Migratory Birds Regulatory Report Number 28. 99 pp.
[170] U.S. Fish and Wildlife Service. 2009. *Waterfowl population status, 2009*. U. S. Department of the Interior, Washington, D. C. USA. 79 pp.
[171] Ruth, J. M., D. R. Petit, J. R. Sauer, M. D. Samuel, F. A Johnson, M. D. Fornwall, C. E. Korschgen, and J. P. Bennett. 2003. *Science for avian conservation: Priorities for the new millennium*. Auk 120(1):204-211.
[172] Donovan, T. M., C. J. Beardmore, D. N. Bonter, J. D. Brawn, R. J. Cooper, J. A. Fitzgerald, R. Ford, S. A. Gauthreaux, T. L. George, W. C. Hunter, T. E. Martin, J. Price, K. V. Rosenberg, P. D. Vickery, and T. Bently Wigley. 2002. *Priority research needs for the conservation of Neotropical migrant landbirds*. Journal of Field Ornithology 73(4):329-450.
[173] Johnson, D. H. 2008. *In defense of indices: The case of bird surveys*. Journal of Wildlife Management 72(4):857-868.
[174] Thompson, F. R. and F. A. La Sorte. 2008. *Comparison of methods for estimating bird abundance and trends from historical count data.* Journal of Wildlife Management 72(8):1674-1682.
[175] Calvert, A. M., S. J. Walde and P. D. Taylor 2009. *Non-breeding drivers of population dynamics in seasonal migrants: conservation parallels across taxa*. Avian Conservation and Ecology - Écologie et conservation des oiseaux 4(2): 5. www.ace-eco.org/vol4/iss2/art5/
[176] North American Bird Conservation Initiative (NABCI). 2012. *The State of Canada's Birds, 2012*. Environment Canada, Ottawa, Canada. 36 pp.
[177] Rocky Mountain Bird Observatory. 2005. *Partners in Flight Species Assessment database (online)*. Available at: www.rmbo.org/pif/pifdb.html
[178] Panjabi, A. O., E. H. Dunn, P. J. Blancher, W. C. Hunter, B. Altman, J. Bart, H. Berlanga, G. S. Butcher, S. K. Davis, D. W. Demarest, R. Dettmers, W. Easton, H. G. de Silva Garza, E. E. Inigo-Elias, D. N. Pashley, C. J. Ralph, T. D. Rich, K. V. Rosenberg, C. M. Rustay, J. M. Ruth, J. S. Wendt, and T. C. Will. 2005. *The Partners in Flight Handbook on Species Assessment.* Partners in Flight Science Committee, Technical Series No. 3, 30 pp.
[179] Morrison, R. I. G., B. J. McCaffery, R. E. Gill, S. K. Skagen, S. L. Jones, G. W. Page, C. L. Gratto-Trevor, and B. A. Andres. 2006. *Population estimates of North American Shorebirds, 2006*. Wader Study Group Bull. 111:67–85.
[180] Will, T. C., J. M. Ruth, K. V. Rosenberg, D. Krueper, D. Hahn, J. Fitzgerald, R. Dettmers, and C. J. Beardmore. 2005. *The Five Elements Process: Designing Optimal Landscapes to Meet Bird Conservation Objectives*. Partners in Flight Science Committee, Technical Series No. 1, 8 pp.

[181] Rosenberg, K. V. and P. J. Blancher. 2005. *Setting Numerical Population Objectives for Priority Landbird Species*. USDA Forest Service General Technical Report PSW-GTR-191. 2005.
[182] Thogmartin, W. E. and M. G. Knutson. 2007. *Scaling local species-habitat relations to the larger landscape with a hierarchical spatial count model*. Landscape Ecology 22:61-75.
[183] Fitzgerald, J. A., W. E. Thogmartin, R. Dettmers, T. Jones, C. Rustay, J. M. Ruth, F. R. Thompson, III, and T. Will. 2009. "Application of Models to Conservation Planning for Terrestrial Birds in North America." In J. J. Millspaugh and F. R. Thompson, III, eds., *Models for Planning Wildlife Conservation in Large Landscapes*, Academic Press, Burlington, USA pp 593-624.
[184] Jones-Farrand, D. T., T. M. Fearer, W. E. Thogmartin, F. R. Thompson, III, M. D. Nelson, and J. M. Tirpak. 2011. *Comparison of statistical and theoretical habitat models for conservation planning: the benefit of ensemble prediction*. Ecological Applications 21: 2269-2282.
[185] Rocky Mountain Bird Observatory. *BCR-specific list of PIF species assessment scores for shorebirds, waterbirds, and waterfowl.* Unpublished data supplied by Arvind Panjabi.
[186] Salafsky, N., D. Salzer, A. J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S. H. Butchart, B. Collen, N. Cox, L. L. Master, S. O'Connor, and D. Wilkie. 2008. *A standard lexicon for biodiversity conservation: unified classifications of threats and actions.* Conservation Biology 22:897-911.
[187] Pullin, A. S. and T. M. Knight. 2001. *Effectiveness in conservation practice: Pointers from medicine and public health*. Conservation Biology 15:50-54.
[188] Pullin, A. S. and T. M. Knight. 2003. *Support for decision making in conservation practice: An evidence-based approach*. Journal for Nature Conservation 11:83-90.
[189] Pullin, A. S., T. M. Knight, D. A. Stone, and K. Charman. 2004. *Do conservation managers use scientific evidence to support their decision-making?* Biological Conservation 119:245-252.
[190] Alberta Sustainable Resource Development (ASRD) 2000. *Alberta Wildlife Status Report No. 23*
[191] Birds of North America (BNA). 2005. http://bna.birds.cornell.edu/bna No. 055
[192] Birds of North America (BNA). 1997. http://bna.birds.cornell.edu/bna No. 298
[193] Robertson, B. A. and R. L. Hutto. 2007. *Is selectively harvested forest and ecological trap for Olive-sided Flycatchers?* The Condor 109(1):109-121.
[194] Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2007. *COSEWIC Assessment and Update Status Report on the Olive-sided Flycatcher in Canada.*
[195] Gratto-Trevor, C., G. Beyersbergen, L. Dickson, P. Erikson, B. MacFarlane2001. *Prairie Canada Shorebird Conservation Plan*. Prairie Habitat Joint Venture. Environment Canada, Edmonton, AB. 245 pp.
[196] Environment Canada. 2005. *Western Boreal Conservation Initiative: Key Conservation Issues for the Western Boreal Conservation Initiative*. http://205.189.8.19/nature/ecosystems/wbci-icbo/di00s05.en.html
[197] Birds of North America (BNA). 1998. http://bna.birds.cornell.edu/bna No.355
[198] Ankney, C. D. and J. Hopkins. 1985. *Habitat selection by roof-nesting Killdeer*. Journal of Field Ornithology 56(3):284-286.
[199] Birds of North America (BNA). 2000. http://bna.birds.cornell.edu/bna No.517
[200] Mineau , P., C. M. Downes, D. A. Kirk, E. Bayne, M. Csizy. 2005. *Patterns of bird species abundance in relation to granular insecticide use in the Canadian prairies*. Ecoscience 12(2) :267-278.
[201] Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2009. *COSEWIC Assessment and Status Report on the Horned Grebe* Podiceps auritus *in Canada*.
[202] Birds of North America (BNA). 2000. http://bna.birds.cornell.edu/bna No. 505
[203] Birds of North America (BNA). 1996. http://bna.birds.cornell.edu/bna No.250
[204] Kushlan, J. A. and M. J. Steinkamp. 2002. *Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1*. Waterbird Conservation for the Americas, Washington, DC. 78 pp.
[205] Timmermans, S. T., A.A. Badzinski, and J. W. Ingram. 2008. *Associations between marsh bird abundances and great lakes hydrology*. International Assoc Great Lakes Research, Journal of Great Lakes Research 34:351-364.
[206] Stendell , R. C., J. W. Artmann, and E. Martin. 1980. *Dietary exposure of Kestrels to lead*. Journal of Wildlife Management 44:525-527
[207] Birds of North America (BNA). 1993. http://bna.birds.cornell.edu/bna No. 67.

[208] Custer, C. M. and T. W. Custer. 2000. *Organochlorine and trace element contamination in wintering and migrating diving ducks in the southern great lakes, USA, since the zebra mussel invasion*. Environmental Toxicology and Chemistry 19:2821-2829.
[209] Braune, B. M. and B. J. Malone. 2006. *Mercury and selenium in livers of waterfowl harvested in northern Canada*. Archives of Environmental Contamination and Toxicology 50(2):284-289.
[210] Bethke, R. W. and T. D. Nudds. 1995. *Effects of climate change and land use on duck abundance in Canadian prairie-parklands*. Ecological Applications 5:588-600.
[211] Birds of North America (BNA). 1998. http://bna.birds.cornell.edu/bna No. 338.
[212] Demendi , M. and S. A. Petrie. 2006. *Diets of lesser and greater scaup during autumn and spring on the lower Great Lakes*. Wildlife Society Bulletin 34(3):664-674.
[213] Koons, D. N., J. J. Rotella, D. W. Willey, <M. Taper, R.G. Clark, S. Slattery, R.W. Brook, R. M Corcoran, and J. R. Lovvorn. 2006. Lesser Scaup population dynamics: what can be learned from available data? Avian Conservation and Ecology 1(3):6.
[214] Afton, A. D. and M. G. Anderson. 2001. *Declining scaup populations: a restrospective analysis of long-term population and harvest survey data*. Journal of Wildlife Management 65:781-796.
[215] Austin, J. E., A. D. Afton, M.G. Anderson, R. G. Clark, C. M. Custer, J. S. Lawrence, J. B. Pollard, and J. K. Ringelman. 2000. *Declining scaup populations: issues, hypotheses, and research directions*. Wildlife Society Bulletin 28(1):254-263.
[216] Grumbine, R. E. 1994. *What is ecosystem management?* Conservation Biology 8:27-38.
[217] Grumbine, R. E. 1997. *Reflections on "What is Ecosystem Management?"* Conservation Biology 11:41-47.
[218] Hunter, M. L., Jr. 1990. *Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity*. Prentice-Hall, Englewood Cliffs, N.J.
[219] Seymour, R. S., and Hunter, M. L., Jr. 1999. "Principles of ecolgical forestry. *In Maintaining biodiversity in forest ecosystems*. Edited by M.L. Hunter, Jr. Cambridge University Press, Cambridge, U.K. pp. 22–61.
[220] Landers, P.B., P. Morgan and F.J. Swanson. 1999. *Overview of the use of natural variability concepts in managing ecological systems.* Ecological Applications 9:1179-1188.
[221] Dunster, J. and K. Dunster. 1996. *Dictionary of natural resource management*. UBC Press, Vancouver, Canada. CEAA. 2010. Reference guide: addressing cumulative environmental effects. www.ceaa-acee.gc.ca/default.asp?lang=En&n=9742C481-1&offset=1&toc=show
[222] Yarnell, P. and D.V. Gayton. 2003. *Community-based ecosystem monitoring in British Columbia: a survey and recommendations for extension.* Forrex Series 13.
[223]Environment Canada. 2011. *Integrated Monitoring Plan for the Oil Sands: Terrestrial Biodiversity Component. Environment Canada*. 66pp. En14-48/2011E-PDF. www.ec.gc.ca/pollution/EACB8951-1ED0-4CBB-A6C9-84EE3467B211/Biodiversity%20Monitoring%20Plan_low_e.pdf
[224] Government of British Columbia and Forest Renewal BC. *Ecological Restoration Guidelines for British Columbia*. www.env.gov.bc.ca/fia/documents/TERP_eco_rest_guidelines/documents/RestorationGuidelines.pdf
[225] Riley, W. J., I. Ortiz-Monasterio, and P. A. Matson. 2001. *Nitrogen leaching and soil nitrate, nitrite, and ammonium levels under irrigated wheat in Northern Mexico*. Nutrient Cycling in Agroecosystems 61:223-236.
[226] National Wetlands Working Group. 1997. *The Canadian wetland classification system*. Wetlands Research Center, University of Waterloo, Waterloo, Ontario. 68 pp.
[227] Mitsch, W.J. and J.G. Gosselink. 2000. *Wetlands*. John Wiley & Sons, New York, USA.

www.**ec.gc.ca**

Additional information can be obtained at:
Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca