prairie habitat *joint venture* **(PHJV)**

IMPLEMENTATION PLAN **2021–2025:**

The Western Boreal *Forest*

prairie habitat
joint venture

ON THE COVER:

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The Prairie Habitat Joint Venture acknowledges the Indigenous Peoples who live in the Prairie Parklands and Western Boreal Forest of Canada, and acknowledge the many Inuit, Dene, Métis and First Nations as the original caretakers of this land. The traditional lands, unceded territories and, where applicable, Treaties that form part of this area can be viewed at: www.native-land.ca. As members of the conservation community, we recognize our responsibility towards building and strengthening meaningful and mutually-respectful relations with Indigenous Peoples, as well as raising our own understanding and awareness of local Indigenous Peoples and their history, traditions and cultures.

The Prairie Habitat Joint Venture (PHJV) Implementation Plan 2021—2025: The Western Boreal Forest was produced by Environment and Climate Change Canada (ECCC), Ducks Unlimited Canada (DUC) and members of the PHJV Science Committee. Components of this document were prepared by Ann McKellar, Andrew Crosby, Blake Bartzen, Darrell Kovacz, Jean-Michel DeVink, Jeff Ball, John Conkin, Kevin Smith, Lindsay McBlane, Mark Bidwell, Steven Van Wilgenburg, Stuart Slattery, Teegan Docherty, and Vanessa Harriman. The following reviewers provided valuable contributions: Alain Richard, Beverly Gingras, Glen McMaster, Judith Toms, Raina Mithrush, Samantha Song, Silke Nebel and Trent Hreno. This plan builds on the contributions and content of the previous (2013—2020) plan and acknowledges the important contributions of its authors. The PHJV's achievements would not be possible without the ongoing commitment of the *North American Wetlands Conservation Act* (NAWCA), the International Boreal Conservation Campaign (IBCC), as well as a combined total of 61 First Nations, academic, industrial, government and nongovernmental partners that have supported wetland habitat conservation across the Western Boreal Forest since 2001.

PREFACE

In 1986, the North American Waterfowl Management Plan (NAWMP) partnership was founded with the goal to restore waterfowl populations to 1970s numbers by implementing conservation projects across priority landscapes in Canada and the United States — Mexico joined in 1994. These NAWMP population objectives were later revised to target species abundance at their long-term average (LTA) with an aspirational goal of 80th percentile of their LTA when annual wetland conditions are optimal.

The Prairie Habitat Joint Venture (PHJV) partnership was formed by federal, provincial, and non-governmental organizations to deliver the North American Waterfowl Management Plan in Prairie Canada, and later expanded to include the Western Boreal Forest. It is one of 22 Migratory Bird Joint Ventures spanning North America (https://partnersinflight.org/partners/mbjvs/) and one of the original Joint Ventures under NAWMP. The PHJV delivery area covers two distinct biomes in western Canada —- the Prairie Parklands and the Western Boreal Forest (WBF) — and together, this region supports approximately 50% of North American breeding waterfowl.

For 35 years, the Prairie Habitat Joint Venture partnership has been implementing important habitat programs across the Prairie Parklands in Alberta, Saskatchewan and Manitoba. Since the early 2000s, the PHJV has expanded efforts to include wetland and waterfowl conservation in the WBF, which covers the boreal regions of the prairie provinces, and portions British Columbia, the Yukon and Northwest Territories. This vast, wetland-rich region is an important breeding area attracting waterfowl in numbers only surpassed by the Prairie Parklands. There are tight biological linkages between the Prairie Parklands and the WBF, with ducks and many other wetland-associated birds moving between these biomes during the regular wet-dry cycles of the Prairie Parklands.

The PHJV's planning, implementation and evaluation efforts have always been guided by a series of habitat implementation plans. The two PHJV Implementation Plans: Prairie Parklands and Western Boreal Forest, have been developed as separate documents for 2021—2025 due to distinct land-tenure systems and conservation partners, as well as differing land-uses and conservation challenges. These plans seek to identify habitat objectives needed to support populations at objective levels using the best available science. Plans are generally modified on a five-year cycle to reflect current and anticipated landscape conditions, socioeconomic trends, emerging priorities for waterfowl and other bird conservation, as well as new knowledge about bird populations and their habitats. In short, habitat implementation plans have evolved to meet persistent and new challenges facing the waterfowl conservation community.

The remarkable diversity and abundance of bird species across the entire PHJV area results from the region's highly productive and diverse wetland and upland habitats, as well as the movement of these birds among Prairie, Parklands and WBF biomes. Across the PHJV, there are wetland-associated species that are strongly philopatric to the Prairie Pothole Region or the WBF, while others have an affinity to the prairie biome and seek refuge in boreal wetlands during prairie droughts. Thus, the PHJV understands that long-range planning for multi-species habitat conservation must consider these interactions to ensure the long-term conservation of critical wetland and associated upland habitat across the Prairie Pothole Region and the WBF in both Canada and the United States.

Since the inception of NAWMP, the business of conservation has changed considerably. Conservation delivery under the auspices of the PHJV is achieved through diverse partnerships and delivery initiatives (Appendix A). In order to remain relevant and continue to achieve challenging habitat and population targets, conservation partnerships across North America must be resilient and adapt their programs and policies to ever-changing socioeconomic and environmental conditions.

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The PHJV remains firmly committed to maintaining and restoring wetlands and landscapes capable of sustaining healthy waterfowl and other bird populations, as well as vibrant rural communities. We continue to use valuable information to inform planning, guide habitat programs and maximize return on habitat investment in both regions of the PHJV. For example, the data gathered to identify remaining native grasslands, also ensures that we focus our conservation activities on targeted grasslands that are at a high risk of loss due to conversion to cropland. This will ensure that we can prevent further loss of grasslands, given their practically irreplaceable nature and critical habitat value for several Species at Risk.

Finally, the NAWMP 2012: People Conserving Waterfowl and Wetlands revision and 2018 NAWMP Update, challenged the NAWMP community to broaden its efforts to build support for conservation by focusing investments in places that provide the greatest benefits to birds and to people, by supporting waterfowl hunting traditions and by engaging diverse communities of conservation supporters. Many opportunities exist for engaging different segments of the public in bird habitat conservation based on the wide-ranging benefits to society it provides. This Plan continues to incorporate these objectives, and presents a specific strategy to advance these human dimension objectives and other NAWMP priorities. It sets out clear wetland habitat objectives for sustaining the PHJV's diversity and abundance of waterfowl. Also, this Plan identifies the conservation need and opportunities for expanding conservation partnerships in the Prairie Parklands and WBF for other migratory birds, particularly where those priority areas do not overlap waterfowl priority areas.

Achieving these objectives is ambitious, and will be accomplished with strong partnerships, a common vision and a sustained commitment — for birds, the environment and for people.

EXECUTIVE SUMMARY

Conservation programs for wetlands and waterfowl led under the North American Waterfowl Management Plan (NAWMP) established in 1986, have had enormous successes across North America. Emphasis for waterfowl conservation has always been on the Prairie Parklands, considered the duck factory of North America. During the previous iteration of the Prairie Habitat Joint Venture (PHJV) implementation planning undertaken in 2013, the importance of the Western Boreal Forest (WBF) and its conservation challenges were formally recognized through the development of its own implementation plan (PHJV 2014). The need to expand conservation programs into other bird guilds in the WBF was also recognized at this time.

The WBF is a critical region of the PHJV for breeding birds, including forest birds, waterfowl and other wetland-associated bird species. With more consistent water conditions than the prairies, it also serves as an oasis for prairie populations that settle in the WBF during prairie droughts, or use this area for other important life-cycle events (e.g., moult). Within the PHJV, the WBF accounts for approximately 44% of the breeding duck population, based on the annual May Breeding Waterfowl Survey.

2013—2020 Achievements

During the tenure of the 2013—2020 Plan, the eight duck species with more than 25% of their populations in the WBF have increased in combined 10-year average abundance by 14% from an estimated 10,073,245 to 11,485,018. With exception of Scaup (Lesser and Greater), all species are at or above long-term averages, with many above the 80th percentile of the aspirational NAWMP population objectives. Meanwhile populations of many other avian guilds, including forest-associated and wetland-associated species have experienced dramatic declines in abundance across the WBF.

To advance how we deliver conservation on the landscapes, PHJV partners and other scientists completed studies to address knowledge gaps, some of which were identified in the 2013—2020 Implementation Plan (IP), on the effects of human activities on birds in the WBF. Generally, we learned that forest harvesting activities have an overall limited adverse effect on breeding waterfowl abundance and distribution compared to natural disturbance (i.e., fires), which is nuanced by nesting guild and scale. Linear disturbances (e.g., pipelines, seismic lines and roads) also appear to have limited adverse effects on waterfowl, though this relationship is a function of the density of these features on the landscape. The complicated effects of climate change on waterfowl in the WBF are less well studied, but long-term projections indicate that predicted northward retraction of the southern forest boundary will result in loss of forested uplands and wetlands through agricultural encroachment and natural disturbance. This change in the fundamental habitat type and structure is expected to shift wetland bird communities from forest-associated species to communities dominated by open-land species. Wetland attrition and the associated implications on aquatic invertebrate communities may not result in immediate implications for wetland-associated species, but the potential complete loss of these wetlands will result in habitat loss for these species, including waterfowl. Future studies supported through PHJV partners should seek to elucidate the broader implications of climate change on the hydrology and habitat suitability of the WBF for waterfowl. Filling these and other knowledge gaps will support better conservation planning in the WBF. Alignment of efforts to address the conservation needs of all avian species and societal interests will further improve conservation delivery and outcomes in this region.

The PHJV's WBF activities are primarily habitat retention-based stewardship activities directed towards large area conservation with an ultimate goal of no net loss of habitat function.

The PHJV's WBF activities are primarily habitat retention-based stewardship activities directed towards large area conservation with an ultimate goal of no net loss of habitat function. Strategic partnerships are essential to delivering this conservation program in the WBF; partnerships with conservation delivery organizations that champion the PHJV's objectives and strategic partnerships with governments and organizations responsible for managing the landbase are key. The WBF is principally provincial or territorial crown land with management of the land and its resources vested in trust to provincial and territorial governments, and some areas under management of federal and Indigenous governments. To be effective, conservation efforts must focus on developing strategic partnerships to influence policy and practices related to activities occurring on this land. Among these strategic partnerships will be Indigenous-led conservation initiatives, such as Indigenous Protected and Conserved Area and the Indigenous Guardians program. The PHJV must also focus on identifying and recruiting new conservation delivery partners to champion its expanded all-bird scope. The current plan remains largely waterfowl centric, reflecting current PHJV partner investment. While waterfowl-focused conservation will deliver habitat co-benefits for some species, efforts and investment in other taxa are needed to achieve conservation goals. Engaging new partners and identifying new sources of funds to support non-waterfowl conservation is necessary to set goals and undertake actions for these species. A diverse and collaborative PHJV also presents opportunities to meet non-avian conservation needs, such as caribou, where habitat characteristics overlap.

Of the more than 750 million acres within the PHJV boreal forest boundary, the PHJV has claimed influence on a total of 108 million acres of protected lands and 12 million acres of sustainable land use (SLU) areas from 2001—2021. Conservation activities during the previous implementation planning period (2013—2020) resulted in approximately 69 million acres conserved or influenced, and the objectives for the 2021—2025 Plan are to conserve or influence an additional 75 million acres, which will help secure waterfowl population objectives for the WBF. The anticipated budget for this current planning period will be similar to the 2013—2020 Plan and is set at $43 million to accomplish this objective.

The boreal forest of Canada is one of five forests in the world that remain largely intact and presents a conservation opportunity to secure habitat conditions for myriad breeding migratory birds. This Plan outlines an approach to continue advancing the successful conservation of wetland-associated species in the WBF through waterfowl-focused programs. It also highlights the need and presents an opportunity to expand conservation targetting of all birds by growing the number and diversity of PHJV conservation partners involved in the WBF.

1.0 INTRODUCTION

Within the boundary of the Prairie Habitat Joint Venture (PHJV), there are two distinct planning areas: the Prairie Parklands and the Western Boreal Forest (WBF) (Figure 1). Combined, these are two of the most important breeding areas for waterfowl in North America. The PHJV's Habitat Implementation Plans for these two regions are produced as separate, companion documents because of regional differences in conservation challenges and associated strategies needed to achieve objectives, their unique land-tenure systems and the distinctive governance structures that create unique partnership opportunities.

The PHJV portion of the WBF (green area of Figure 1) extends from the Ontario-Manitoba border to Alaska, and excludes the boreal transition zone of the Boreal Plains. The broader WBF (red boundary in Figure 1), is based on the ecological framework of Canada and includes the portions of Bird Conservation Regions (BCR) 4, 6, 7, 8, and 12 that occur within Manitoba, Saskatchewan, Alberta, British Columbia, Nunavut, Yukon and Northwest Territories. It also includes a very small sliver of BCR 3 along the McKenzie River near Inuvik. The differences between the PHJV portion

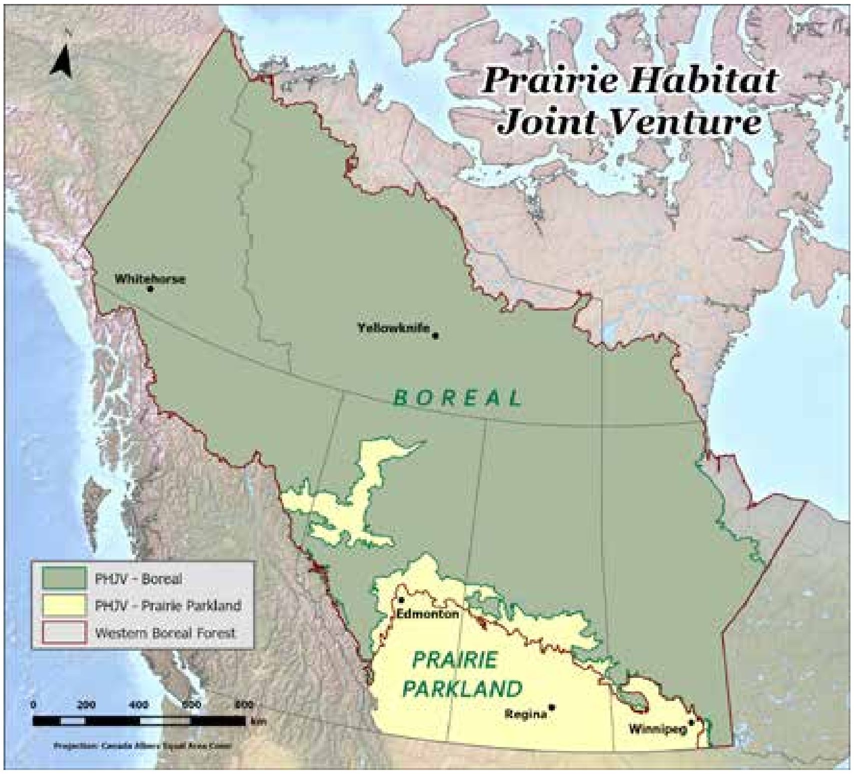


FIGURE 1. The Prairie Habitat Joint Venture planning area including the PHJV Prairie Parkland (Yellow) and PHJV Boreal (Green). The broader Western Boreal Forest (WBF; red boundary) includes the PHJV Boreal, as well as forested portions of the boreal transition zone and the Hudson Bay Lowlands.

of the WBF and the BCR defined WBF is that the BCR definition includes all or portions of several ecoregions in the prairie provinces, including:

- Peace Lowlands of Alberta;
- Boreal transition zones (BTZ) of Alberta, Saskatchewan, British Columbia and Manitoba;
- The southern portion of the Interlake Plains;
- Coastal Hudson Bay Lowlands of Manitoba; and,
- Hudson Bay Lowland ecoregions of Manitoba.

In Canada, the WBF has an average estimated abundance of waterfowl approaching that of the Canadian Prairie Parklands, albeit comprised of different species that are distributed over an area five times larger (Figure 1). The WBF is also considered a "safety net" for prairie populations in periods of drought, with birds moving north when prairie breeding habitat is limited. The WBF is also important to many shorebird, waterbird and landbird species, and the BTZ at the southern fringe of the WBF is considered to have some of the highest avian diversity in Canada (Venier et al. 2014).

At the start of the original North American Waterfowl Management Plan (NAWMP), planners acknowledged the importance of the WBF to waterfowl, and they assumed it to be "intact" and not facing conservation challenges. However, the extent and pace of habitat change in this region have grown rapidly since then; both traditional (e.g., agricultural expansion, forestry or conventional energy) and newly emerging industrial activities (e.g., steam-assisted gravity drainage and resource mining) in this area have potential impacts on water, wetlands and waterfowl. This growth spurred a re-evaluation of the NAMWP assumption, and PHJV partners concluded that WBF was an area requiring additional attention for conservation initiatives. With increasing concerns about the impacts of climate change on the WBF, particularly where northern ecosystems will experience the greatest effects, the challenges facing this ecoregion are growing. In 2001, the PHJV expanded into this region and, since then, has made significant gains in conserving waterfowl and waterfowl habitat with co-benefits for other biodiversity. With this latest iteration of its Implementation Plan (IP), the PHJV looks to address its commitment to all-bird conservation by highlighting opportunities for co-benefits with existing conservation activities, and emphasizing the need for additional partner involvement and conservation targeted at non-waterfowl taxa.

Resource development occurs through a diverse array of industries representing mining, oil and gas, peat harvesting, forestry, hydroelectric and agricultural sectors. The vast area of the WBF is primarily (more than 90%) public land, most of which is under provincial or territorial jurisdiction and the remainder in federal or Indigenous managed lands. Land use decisions are administered through various levels and departments of these governments. Therefore, the main vehicles to achieve conservation are through influencing public land policies and associated practices undertaken by both provincial and territorial governments, and through influence of industry practices to protect priority habitat or ensure it is sustainably developed. Through time, PHJV activities have evolved to include habitat delivery programs focused on habitat retention through protection and sustainable land use (SLU), consistent with the vision and mission of the PHJV. These conservation activities have also become more collaborative through expansion of direct partnerships with Indigenous and other partners who share PHJV goals and objectives.

Within agriculture-dominated portions of the BTZ, there is a mix of private land and land held under crown tenure where commercial resource development (e.g., forestry) activities often occur. These tracts of crown land have not been developed for agricultural purposes (i.e., the private agricultural lands of Canada). As such, they are more similar to those of the broader PHJV WBF and have been included within the 2021—2025 Plan for modelling and conservation planning purposes, as the tools used to conserve these lands are the same as those used in the rest of the PHJV WBF. Note that priority conservation areas identified in this WBF IP that fall within the BTZ do not overlap any of the priority areas identified in the Prairie Parklands Plan.

Activities under the WBF 2013—2020 Plan focused on delivering effective waterfowl habitat conservation through:

- Establishment of new protected areas.
- Advancement of sustainable land use approaches, including:
  - Developing and promoting the use of best management practices and guiding principles around wetlands, water and waterfowl;
  - Developing resource materials for land managers and operators;
  - Expansion of knowledge sharing and transfer (web-based training, webinars and databases); and
  - Stewardship agreements that advance waterfowl conservation through sustainable forest management.
- Continued support for development of waterfowl habitat conservation policies, including a wetland Codes of Practice.

In addition to the direct PHJV activities, partners also supported development of new and innovative conservation mechanisms and approaches (e.g., Indigenous Protected and Conserved Areas [IPCAs], Other Effective Area Based Conservation Measures [OECMs]) to adapt to the ever-changing conservation landscape in the WBF and support achieving conservation goals. This period also saw a significant rise in Indigenous-led conservation, which has become an opportunity for PHJV partners to advance waterfowl habitat conservation goals through reconciliation and other human dimension goals. PHJV partner funding agreements, such as the International Boreal Conservation Campaign (IBCC) provided match to expand the scope and delivery of waterfowl conservation in the WBF. Research during this period led to increased knowledge and understanding of boreal ecosystems and waterfowl, which will guide future conservation delivery in this region. While conservation activities made progress on securing habitat, this period also saw an increase in fire (number and extent), invasive insect damage, and other increasing impacts of climate change and anthropogenic land use changes, which underline the need for conservation actions within the WBF. The purpose of this document is to outline the PHJV's plans for habitat conservation to meet the challenges and leverage the opportunities for conservation in the WBF over the next five-year horizon.

2.0 STATUS OF BIRD POPULATIONS

Status of Waterfowl

The standard survey data used to evaluate breeding waterfowl abundance is the U.S. Fish and Wildlife Service (US FWS)/Canadian Wildlife Service (CWS) Waterfowl Breeding Population and Habitat Survey (WBPHS) conducted annually across the Prairie Pothole Region (PPR) and parts of the WBF. In the WBF, the focus is on eight species that have ≥25% of their traditional survey area population in this region. Population estimates for the PPR and WBF strata from the WBPHS were summed separately due to differences in the estimate calculation methods (i.e., correction factors applied to calculate estimates). In instances where strata contained both the PPR and WBF biomes, stratum-specific population estimates were partitioned to each biome by multiplying the areal proportion of each biome within the stratum by its respective population estimate.

Due to the COVID-19 pandemic, the WBPHS did not take place in 2020 or 2021; therefore, the last year of reporting for this Plan was 2019 (Table 1). With exception of Goldeneye (mostly common) and Canvasback, the 10-year average abundance of species increased from that of 2014 (Table 1). Population increases were most pronounced for Mallard, American Green-winged Teal, American Wigeon, and Ring-necked Duck (Figure 2 and Figure 3). Although abundance of Scaup (both Lesser and Greater) remained below the long-term average (LTA), abundance also increased from 2014 (Figure 3). Abundance of Bufflehead steadily increased over the time series (since 1964) with that trend continuing through to 2019. With exception of Scaup, all waterfowl populations were at or above LTAs in 2019, and, as a result, total ducks were 19 % above the LTA (Table 1). Other waterfowl species found in the WBF are up slightly from the LTA.

The specific cause for the recent increase in abundance of dabbling duck species is unknown, but likely varies between species and is due to high local reproductive success and immigration from other productive areas, such as the Prairie Parklands. For example, Mallard were at or near record levels throughout much of the Traditional Survey Area, and American Green-winged Teal were above the LTA in prairie Canada. However, abundance of American Wigeon in the Parklands was relatively stable and well below the LTA for that region over the same period when the population increased in the WBF. Some species overfly the prairies and settle in the WBF when breeding conditions are less favourable in the prairies, but conditions have generally been favorable in prairie Canada over the same period. Scoters (White-winged, Black and Surf) were species of concern for the WBF in previous implementation plans because of a pronounced population decline through the 1990s and the population remained below the LTA. However, the WBPHS ceased reporting estimates of abundance of Scoters after 2012 out of caution that the survey was not adequately covering the breeding distribution of Scoters, and that estimates of abundance may not be accurate. Experimental surveys were conducted by the CWS and the US FWS from 2017—2019 to assess the feasibility of Scoter surveys, but evaluations are not yet completed. Consequently, the status of Scoters in the WBF is unknown for this reporting period.

TABLE 1. Running 10-year average duck counts in the PHJV-WBF (2010–2019), revised NAWMP goals for the PHJV WBF, and percent difference between recent average count and both long-term average (1955–2019) and 80th percentile (aspirational NAWMP goal) counts. Species included have about 25% or more of their Traditional Survey Area populations in the WBF.

PHJV-WBF			NAWMP REVISION - PHJV			
SPECIES*	2019 ESTIMATE ('000s)	2019 TEN-YEAR AVERAGE ('000s)	LONG-TERM AVERAGE (1955-2014) ('000s)	LONG-TERM 80TH PERCENTILE ('000s)	% DIFFERENCE (10-YR AVG VS. LTA)	% DIFFERENCE (10-YR AVG. VS. 80TH PERCENTILE)
MALLARD (*ANAS PLATYRHYNCHOS*)	2,906	2,987	2,628	3,056	14	-2
GREEN-WINGED TEAL (*ANAS CRECCA*)	1,924	1,936	1,101	1,336	76	45
AMERICAN WIGEON (*ANAS AMERICANA*)	1,532	1,299	1,202	1,507	8	-14
DABBLING DUCKS	**6,361**	**6,222**	**4,930**	**5,534**	**26**	**12**
SCAUP (*AYTHYA SP.*)	2,011	2,495	2,985	3,550	-16	-30
RING-NECKED DUCK (*AYTHYA COLLARIS*)	1,142	1,038	523	675	99	54
BUFFLEHEAD (*BUCEPHALA ALBEOLA*)	834	1,007	628	878	60	15
GOLDENEYE (*BUCEPHALA SP.*)	469	511	381	524	34	-2
CANVASBACK (*AYTHYA VALISINERIA*)	202	211	208	246	2	-14
DIVING DUCKS	**4,658**	**5,263**	**4,724**	**6,101**	**11**	**-14**
ALL WBF DUCKS	**11,019**	**11,485**	**9,655**	**11,635**	**19**	**-1**
OTHER WATERFOWL SPECIES**	3,090	3,194	2,828	3,407	13	-6
ALL DUCKS	**14,109**	**14,679**	**12,483**	**15,178**	**18**	**-3**

* Scoter estimates are no longer included in the May Breeding Waterfowl Population survey due to a mismatch in the timing of surveys and Scoter migration, and are therefore not presented.

** Includes Blue-winged Teal, Northern Pintail, Northern Shoveler, Merganser species, Gadwall, Redhead, Ruddy Duck, and American Black Duck.

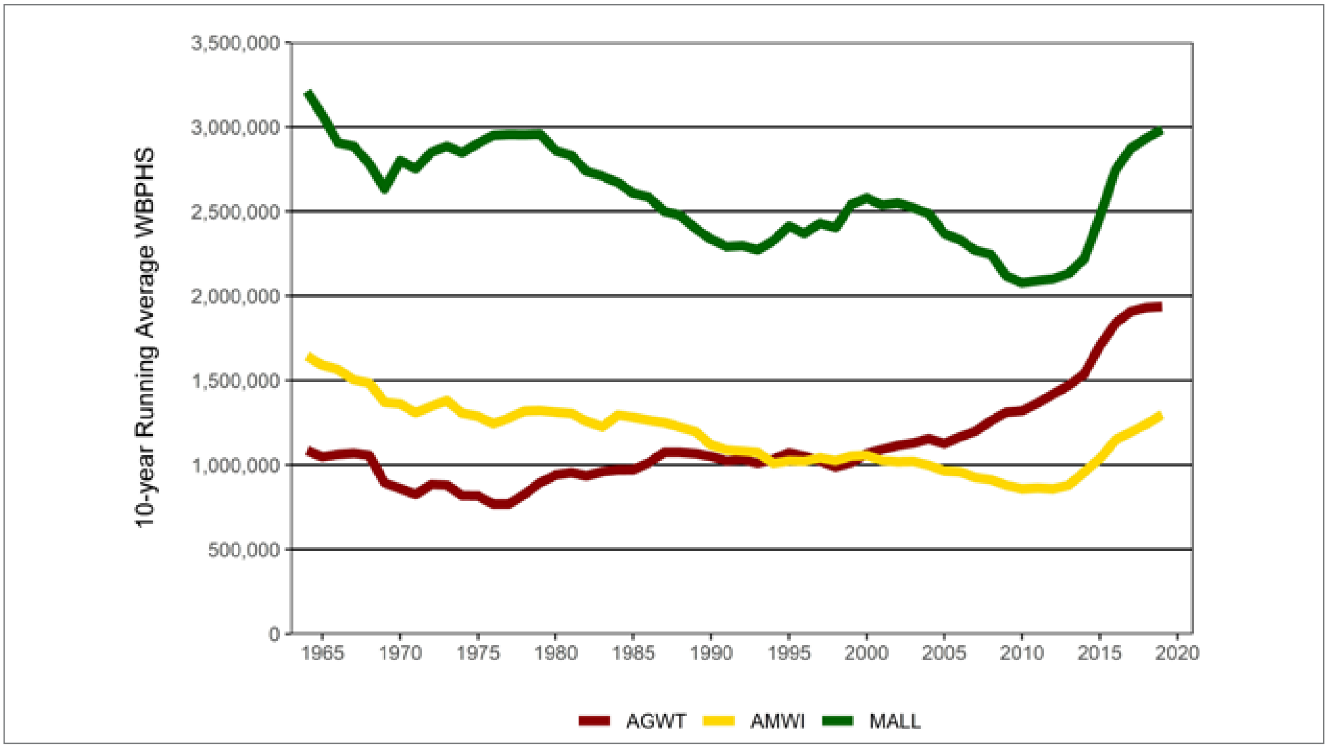


FIGURE 2. Trends in 10-year running average populations of dabbling ducks in the Western Boreal Forest (WBF). All species have at least 25% of their Traditional Survey Area population in the WBF. AGWT- American Green-winged Teal, AMWI- American Wigeon, MALL- Mallard.

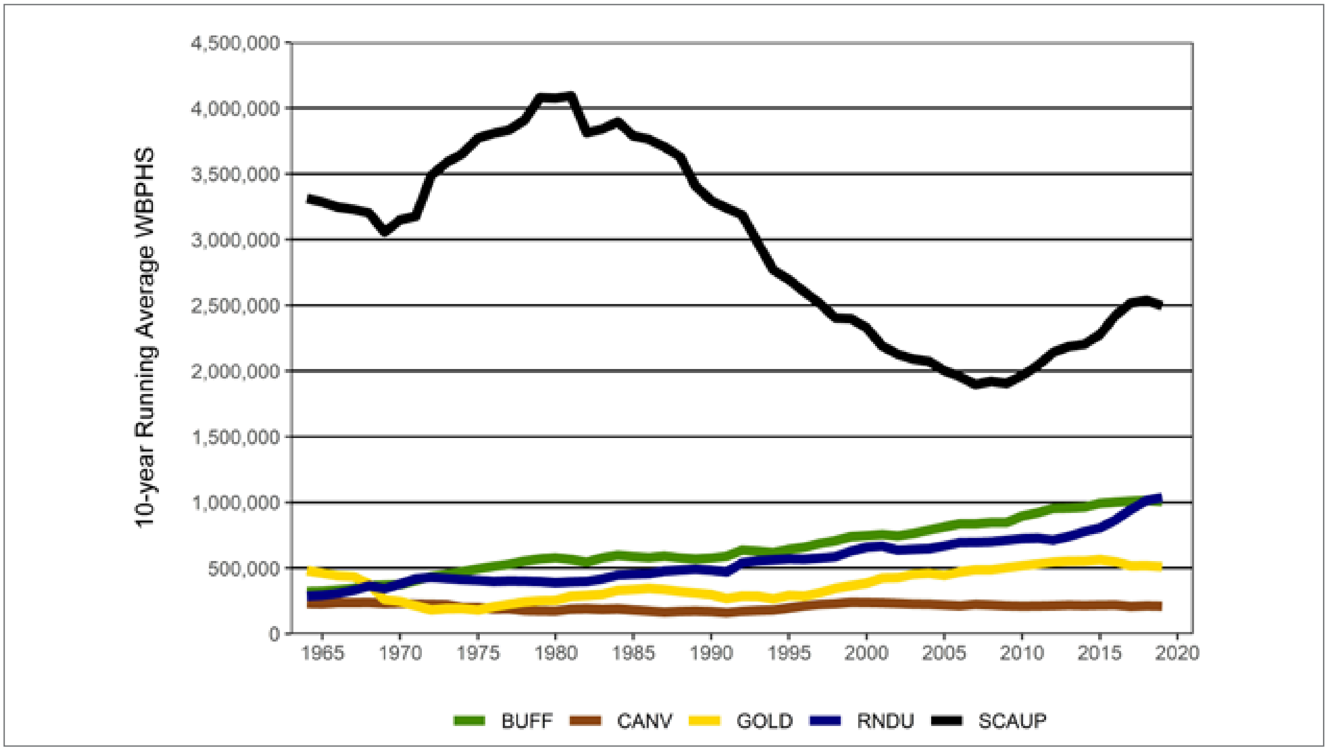


FIGURE 3. Trends in 10-year average populations of diving and sea duck species that have at least 25% of their Traditional Survey Area population in the Western Boreal Forest. BUFF – Bufflehead, CANV – Canvasback, GOLD – Goldeneye spp., RNDU – Ring-necked Duck, SCAUP – Scaup spp.

Status of Shorebirds, Waterbirds and Landbirds

North America has approximately one-third fewer birds today than were present in 1970 (Rosenberg et. al. 2019). Described as a biodiversity crisis, the cumulative loss of nearly three billion birds, which are integral components of ecosystems, threatens the function of ecosystems on which we depend to ameliorate temperatures, filter water, clean the air, as well as provide food and other renewable resources. A significant proportion of the continental decline (17%) has occurred in boreal-nesting birds; approximately half of boreal-nesting species have declined resulting in a net loss of approximately 33% or 0.5 billion individuals since 1970 (Rosenberg et al. 2019). Declines are most prevalent in long-distance migrants, forest crop specialists, and aerial insectivores, whereas species that winter in or near the boreal forest are more likely to be stable or increasing (NABCI 2019).

Patterns observed in the WBF are generally similar to those described above for the boreal forest as a whole: 58% of species have declined since 1970 and 61% of species have declined over the past 10 years (Appendix A). Negative trends are more prevalent in species associated with forests compared to those associated with wetlands, and in landbirds and shorebirds compared to waterbirds, especially over the past 10 years. However, there are no apparent patterns of change across feeding or habitat guilds. For example, among forest crop specialists, Pine and Evening Grosbeaks have experienced substantial long-term declines (76% and 85% since 1970, respectively) whereas Red and White-winged Crossbill have increased 100% to nearly 600%, respectively, over the same period (Smith A.C. et al. unpublished, an update of Smith et al. 2019). A similar lack of pattern exists between trend and habitat associations. For example, among those forest-associated species with the highest conservation ranks (3 and 4; indicating greatest declines), there are several mature and old forest-associates, as well as several species associated with young- and intermediate-aged stands (Appendix A). Rosenberg et al. (2019) similarly found that continental losses were not restricted to rare and threatened species, but included several common, widespread species.

3.0 STATUS OF THE WESTERN BOREAL FOREST

The North American boreal forest remains one of the largest intact forest ecosystems on earth (Wells et al. 2020). Prior to European settlement, large-scale disturbance in the WBF was dominated by insect outbreaks and fire. Since then, anthropogenic influence has slowly spread through the WBF (Hobson et al. 2000c). The largest human influence in this landscape to date has been the conversion of approximately 22% of the Boreal Plains ecozone to agricultural land uses along the southern periphery of the WBF (Hobson et al. 2000c; State of Canada's Forests 2020). Most conversion occurred in the early 20th century and has slowed markedly in recent years, but still occurs primarily in the Boreal Plains ecozone. Other industries such as forestry, mining and oil and gas have become important influences on the amount, distribution and configuration of forested habitats in the boreal forest in recent decades. Despite increased development, the proportion of the landscape directly impacted by anthropogenic activities is still comparatively low relative to other biomes. The extent of anthropogenic influence is largely a function of accessibility and is therefore distributed unequally across the region, with southern areas more prone to development compared to remote northern regions of the WBF (Schneider et al. 2003, Wells et al. 2020). Agriculture and industrial developments, such as forestry, conventional oil and gas, and bitumen (oil sands) extraction, have converted large areas of forest to younger age classes, created numerous vegetated and non-vegetated clearings (Alberta Biodiversity Monitoring Institute 2020), and, in addition to the creation of hundreds of thousands of kilometres of linear disturbance, has increased forest fragmentation (Pattison et al. 2016). Across the WBF there also has been an increase in the number of large fires and lightning-caused fires, particularly in the Lake Athabasca area where the area burned has increased substantially over the last 57 years (Hanes et al. 2019). These changes are attributed to climate change-driven moisture levels, as well as forest pest distribution and abundance, and they interact with harvest and other anthropogenic activities to further change forest composition and age structure.

Of the more than 750 million acres within the PHJV WBF, there are nearly 180 million acres or 24% currently under some form of conservation status

The working forest region does not directly equate to anthropogenic activities on the ground and, while expansion of industrial activity in the WBF is generally considered to be rapid, particularly in Alberta, limited spatial trend information has been compiled on changes to WBF habitat in recent decades. Pasher et al. (2013) identified just over 14 million acres or approximately 2% of the landscape having an anthropogenic footprint. The methods used to assess the anthropogenic activities are based on remote sensing techniques and omit any pre-defined buffers to linear features, as had been used in earlier anthropogenic datasets. Although covering the majority of the WBF, but not all, Pasher et al. (2013) is currently the most commonly used data source across the boreal, and it was developed to assist with caribou recovery strategy planning and various other conservation initiatives. As such, the Pasher et al. (2013) approach and dataset were used in assessing the anthropogenic footprint for the WBF spatial planning.

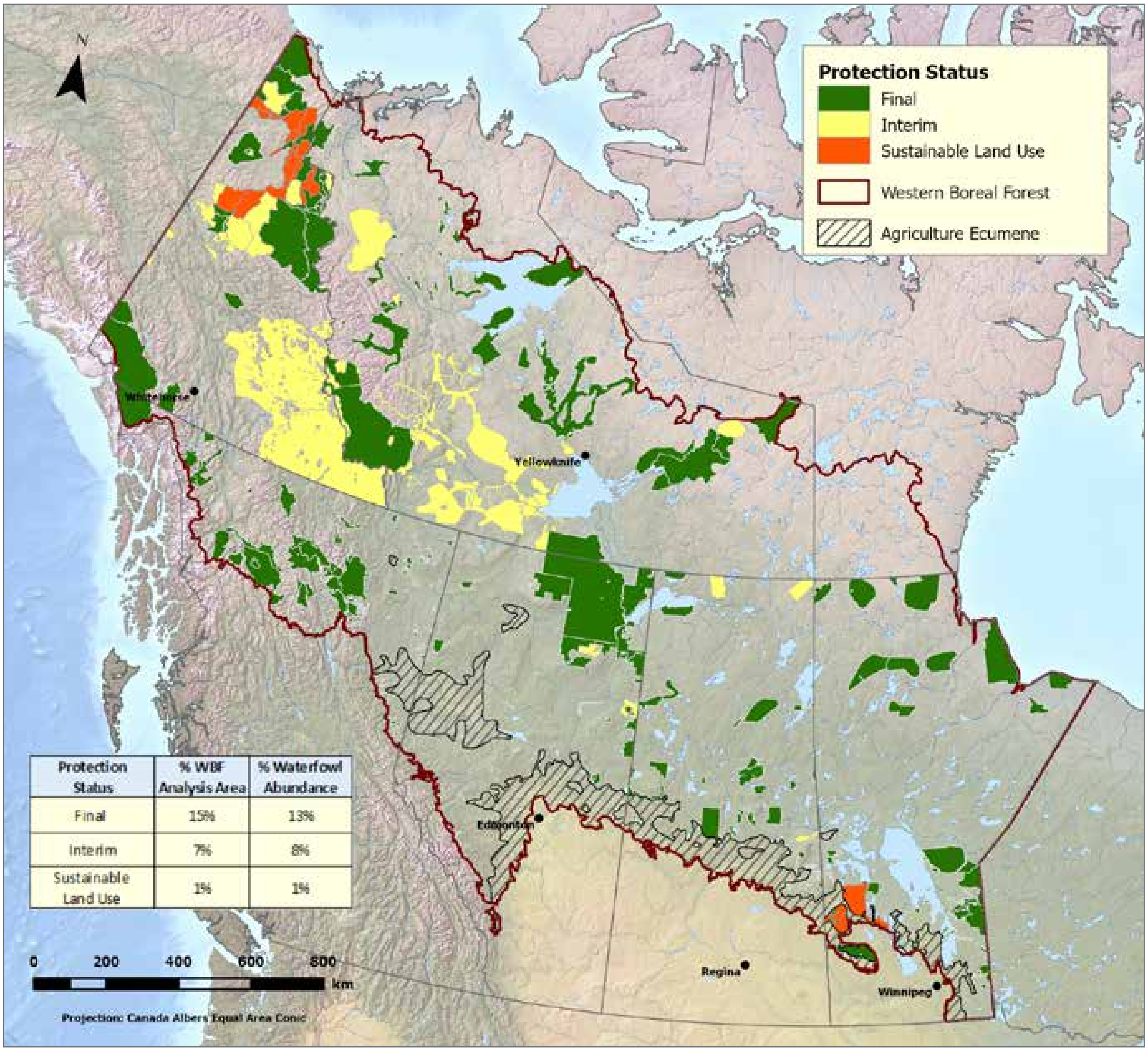


FIGURE 4. Recognized conservation status throughout the Western Boreal Forest for both final and interim protection and sustainable land use. Conservation status based on CPCAD 2020 information with minor edits from regional experts.

TABLE 2. Distribution of estimated acres of anthropogenic activities based on Pasher et al. (2013) within each jurisdiction of the Western Boreal Forest.

JURISDICTION	ESTIMATED AREA IMPACTED ('000s ACRES)	% OF JURISDICTION IMPACTED
ALBERTA	6,800	7.5
BRITISH COLUMBIA *	1,700	2.4
MANITOBA	2,700	2.0
NORTHWEST TERRITORIES *	190	0.1
NUNAVUT	0	0.0
SASKATCHEWAN	2,700	3.1
YUKON *	5	0.0

* Indicates jurisdictions where area outside of Pasher et al. (2013) data extent exceeds 5 million acres.

Of the more than 750 million acres within the PHJV WBF, there are nearly 180 million acres or 24% currently under some form of conservation status (Figure 4). Spatial information for these areas is often incomplete or outdated, due to various reporting process. As such, areas shown in Figure 4 were obtained from the publicly available CPCAD 2020 data release with minor edits from regional experts, and should not be considered an exact representation of all conservation established or occurring currently.

There are several different mechanisms through which habitat protection has occurred in the WBF. Government-led protected-area initiatives commonly have an ultimate end point of protection in perpetuity (typically through an Order In Council) or protection for a term greater than 10 years are termed "long-term protected lands".[1] Land use planning processes can also result in designated conservation zones that are protected lands with limited to no allowable development. Some of land use planning processes result in perpetual protection, or for greater than 10 years, while other areas are subject to renewal when land use plans receive periodic review, typically at five-year intervals. The latter are also often referred to as "short-term protected lands". Prior to that designation, proposed protected areas may be withdrawn from development and placed in interim protection while the establishment process is underway and is renewable if final decisions are not made by the end of the term. Moreover, there has been recent emphasis on establishment of Indigenous Protected and Conserved Areas (IPCAs), which are funded through the Nature Fund process and private foundation funding. These proposed IPCAs, although not shown on the map due to confidentiality, are likely to contribute large areas of long-term protection in this five-year (2021—2025) WBF planning window. This represents a significant opportunity for protection across the WBF.

In addition, there are nearly 12 million acres of land in the WBF that have some form of sustainable land use (SLU) status, called "sustainable land use areas" or "SLU areas" in this plan. Sustainable land use is defined as: The management of landscape resources that maintain economic benefits and social values, while ensuring the conservation of ecosystems services, including sustaining waterfowl populations at goal levels. Generally, SLU areas are created through private land management, conservation/cooperative land use agreements, crown agreements, industrial agreements, stewardship (extension), policy and integrated land use planning (terminology as per NAWMP 2012). The specific criteria for designating SLU status were developed and implemented during the 2013—2020 Plan. SLU areas are primarily located within forestry tenure lands south of 60 under two conditions: 1) interim SLU is claimed when a commitment to sustainable land use planning is being undertaken; 2) permanent SLU is claimed when a long-term wetland and waterfowl stewardship plan and agreement focusing on SLU has been put in place. SLUs are claimed in northern regions (north of 60) where land use plans limit industrial activity. Other considerations for designating SLU status include any overlap between industrial sectors on the landscape, meaning that even if SLU practices are being implemented by one industry, overlapping development on any given parcel of land by other industries may or may not impact the habitat suitability of waterfowl and other birds. Thus, there is a need to ensure SLU practices have a net habitat benefit.

4.0 HABITAT ACHIEVEMENTS 2013—2020

PHJV partners have claimed influence on a total of 108 million acres of protected lands and 12 million acres of SLU areas between 2001—2021. This amounts to approximately 67% of the 180 million acres currently under some form of conservation protection within the WBF. Within the protected and SLU acres influenced by the PHJV, a total of 50 million acres are considered waterfowl habitat.

Conservation programs implemented in the WBF for the 2013—2020 Plan were primarily focused on delivering waterfowl habitat acres, due to the mandate of conservation partners actively working in this landscape. Waterfowl specific acres had been identified based on Ducks Unlimited Canada's Hybrid Wetland Layer (Ducks Unlimited Canada 2010a). This product was derived by merging Canvec and Earth Observation for Sustainable Development earth cover data, and categorizing the landscape into open water, undefined vegetated wetlands and uplands. Waterfowl habitat was subsequently defined as open water and any of the other two habitat classes within 400 metres of the open water boundary. This value contained the maximum value for most species reported in the literature and was deemed reasonable for conservation planning (Ducks Unlimited Canada, 2010b), although it is recognized that waterfowl will nest more than 400 metres from open water. However, the actual conservation achievements better reflect the areas of land where conservation during this period could be achieved and often contains portions of waterfowl-focused projects that are outside of identified waterfowl habitat.

During the 2013—2020 Plan period, the PHJV were involved in the protection of 57 million acres (4.7 million in long-term; 52.5 million in short-term) and influenced almost 12 million acres through SLU in the WBF (Table 3). Protected lands exceeded goals of 30.8 million acres due in part to a large, protected area in the Yukon, which the PHJV partners played a role in establishing. Achievements via SLU fell short of the objective for the IP period, with some notable exceptions in Manitoba (due to a forestry industry-based stewardship agreement, the first of its kind) and the Yukon (land use planning zones that qualify as SLU) (Table 3). However, as

1 For more information on CPCAD, visit: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html#definitions

this was a new conservation delivery tool, there was a lag in the development of a successful approach to implemented it during this past IP period. With the momentum achieved in application of SLU towards the end of the 2013—2020 IP period, we anticipate this shortfall will be achieved in the 2021—2025 IP period through projects underway. It is anticipated that during this current IP, the tools that were developed to achieve SLU will expand significantly through forest stewardship plans and agreements, along with the development of new tools for conservation.

Waterfowl Habitat Conservation Achievements

Overall, the WBF contains about 262.5 million acres of wetlands, or 35% for the total area. For the purposes of conservation planning, waterfowl habitat is defined as open water or wetlands along with their adjacent upland habitat located within 400m. Based on this simplistic definition, 49% of the WBF is considered suitable waterfowl habitat with varying distribution among jurisdictions (Table 4).

Wetlands within the WBF are generally peatland-dominated systems of bogs and fens (National Wetlands Working Group 1997), with about 60% of wetlands as peatland and 40% as open water. In addition to providing wildlife habitat, these wetlands provide ecosystem services including filtration, nutrient transport, water storage and aquifer recharge, regulating climate through carbon capture and storage, hunting, fishing, as well as collectively contribute significantly to the food security and traditional economy of Indigenous communities. It is the hydrologic interconnectedness of these wetland systems that make this landscape sensitive to habitat changes, particularly in the core ecozones for waterfowl (Boreal and Taiga Plains). Wetlands are sensitive to climate change and climate-induced effects on wetlands are already apparent (Riordan et al. 2006). These changes will have important implications on wetland dependent wildlife but also for people and infrastructure. Additionally, uplands are important habitats in the WBF for waterfowl nesting and as nutrient sources to wetlands. Hydrologic flow through uplands within catchment basins provide water recharge areas for water bodies and wetlands.

TABLE 3. Objective and accomplished acres ('000s) claimed as influenced through PHJV activities in the WBF, 2014—2020. Acres claimed from 2001—2013 are found in the previous 2013—2020 report and no acres were claimed prior to 2001. Areas of influence may extend beyond the PHJV WBF boundaries, but do not include any areas fully outside of the PHJV.

JURISDICTION	TOTAL PROTECTED LANDS ('000s ACRES)		TOTAL SUSTAINABLE LAND USE AREAS ('000s ACRES)	
	OBJECTIVE	ACCOMPLISHED	OBJECTIVE	ACCOMPLISHED
ALBERTA	7,500	6,563	26,100	0
BRITISH COLUMBIA	400	0	800	0
MANITOBA	3,300	334	700	6,092
NORTHWEST TERRITORIES	15,600	7,200	16,800	0
SASKATCHEWAN	300	1,706	5,400	0
YUKON	3,800	41,410	4,100	5,605
TOTAL	**30,800**	**57,213**	**53,700**	**11,697**

Of the area in the WBF influenced by the PHJV during the 2013—2020 period, approximately 17 million acres are considered waterfowl habitat (Table 5), which accounts for approximately 9% of the total estimated PHJV boreal waterfowl population. Given that waterfowl habitat achievements in the WBF are achieved primarily through influence of provincial/territorial governments, industry or Indigenous governments, the amounts and areas of waterfowl habitat conserved through protection and sustainable land use varied considerably by area and amount (Table 5). Some jurisdictions, like the Yukon, where several long-term land use planning efforts were completed, exceeded their habitat objectives. Other jurisdictions, however, experienced lower than expected numbers due to either delays in establishing protected areas, or final areas of protection were smaller than the interim areas of protection. Unlike in the Prairie Parklands where conservation projects are smaller, more numerous, and can be spatially targeted more easily, potential projects in the WBF take longer to develop and tend to be much larger, which results in some extending beyond boundaries of target areas.

TABLE 4. Distribution of predicted waterfowl breeding population, waterfowl habitat, and proportion of total WBF area among PHJV jurisdictions.

JURISDICTION	WATERFOWL (% OF WBF TOTAL)	WATERFOWL HABITAT (% OF WBF TOTAL)	AREA (% OF WBF TOTAL)
ALBERTA	10.8	6.7	11.7
BRITISH COLUMBIA	5.3	5.1	9.5
MANITOBA	13.3	20.3	16.5
NORTHWEST TERRITORIES	31.4	42.1	31.5
NUNAVUT	4.6	6.1	3.3
SASKATCHEWAN	11.5	13.8	11.8
YUKON	23.1	5.9	15.6

TABLE 5. 2013-2020 PHJV waterfowl habitat objectives and achievements ('000s acres) for protection and sustainable land use (SLU).

JURISDICTION	WATERFOWL HABITAT PROTECTION ('000s ACRES)		WATERFOWL HABITAT SLU ('000s ACRES)	
	OBJECTIVE	ACHIEVEMENTS	OBJECTIVE	ACHIEVEMENTS
ALBERTA	3,100	2,833	6,600	0
BRITISH COLUMBIA	200	0	200	0
MANITOBA	2,400	120	500	2,656
NORTHWEST TERRITORIES	9,500	4,221	4,900	0
SASKATCHEWAN	100	831	1,700	0
YUKON	1,000	6,222	800	369
TOTAL	**16,300**	**14,227**	**14,700**	**3,026**

Habitat Conservation Achievements for Non-waterfowl

Since the late 1990s, the PHJV has had a stated objective to support all bird conservation planning in both the Prairie Parklands and the WBF. For various reasons, this objective has not been actioned to date and the previous WBF IP did not include conservation objectives for non-waterfowl species. However, given the typically large spatial scale of individual waterfowl conservation projects in the WBF and the overlapping habitat associations between ducks and some species of landbirds, shorebirds and waterbirds, it is reasonable to assume that some non-target species habitat was also conserved. We examined the incidental conservation benefits for three species of high conservation priority with varying degrees of overlap in their habitat associations with waterfowl (Table A-1, General Habitat Descriptions). Our goal was to determine to what extent non-target species may benefited from waterfowl-centric conservation actions, and to highlight the need for additional conservation planning and action targeted at non-waterfowl. Rusty Blackbird (Special Concern) are associated with habitats most similar to waterfowl and are expected to have benefited most from conservation activities directed at waterfowl during 2013—2020. Olive-sided Flycatcher (*Threatened*) are also associated with some wetland types, and with conifer and mixedwood forest near water. In contrast, Canada Warbler (Threatened) are most closely associated with older stands of deciduous and mixedwood forest, often near small, incised streams, and they are expected to benefit less from waterfowl conservation.

Using density models created by the Boreal Avian Modelling project (Appendix C), we calculated the proportion of Canada Warbler, Olive-sided Flycatcher and Rusty Blackbird included within the area influenced by PHJV partners during 2013—2020 relative to the total number predicted to occur in each jurisdiction and in the WBF. Contrary to expectations, Olive-sided Flycatcher benefited most from waterfowl conservation (Table 6). This result can be explained by the concentration of waterfowl acres in the Yukon, which hosts moderate densities of Olive-sided Flycatcher. Canada Warbler density in the Yukon is low, but incidental benefits were realized by PHJV achievements in central and northern Alberta, as well as in the southeastern WBF portion of Saskatchewan. While Rusty Blackbirds were expected to benefit most from waterfowl conservation, their distribution is restricted to the northeastern portion of the WBF where there was little conservation delivery (compare 37.5% of the population conserved in the Yukon to 3.5% in the WBF). The 69 million acres influenced by the PHJV during 2013—2020 represents 9.2% of the total area in the WBF. In this context, conservation of Canada Warbler and Olive-sided Flycatcher habitat, 8.7% and 10.5%, respectively, is roughly equivalent to what would be achieved if conservation was applied randomly to the landscape with respect to the habitat associations of these species and reflects the large scales at which waterfowl conservation occurs. In contrast, 24.6% of the area influenced in 2013—2020 included waterfowl habitat. These results demonstrate that, while non-waterfowl species may benefit from conservation activities focused on waterfowl, targeted conservation planning and action are needed to increase benefits for other species, particularly those with restricted range.

TABLE 6. Percent of Canada Warbler (CAWA), Olive-sided Flycatcher (OSFL) and Rusty Blackbird (RUBL) populations affected by PHJV Western Boreal Forest habitat conservation programs 2013—2020.

JURISDICTION	SPECIES		
	CAWA	OSFL	RUBL
	PERCENT AFFECTED	PERCENT AFFECTED	PERCENT AFFECTED
ALBERTA	3.9%	6.2%	3.6%
BRITISH COLUMBIA	0.0%	0.0%	0.0%
SASKATCHEWAN	1.9%	2.0%	1.3%
MANITOBA	6.0%	1.0%	0.1%
NORTHWEST TERRITORIES	4.0%	3.4%	1.3%
YUKON	41.4%	40.9%	37.5%
NUNAVUT	0.0%	0.0%	0.0%
WBF TOTAL	**8.7%**	**10.5%**	**3.5%**

Conservation Programs Summary 2013—2020

The habitat conservation programs delivered in the WBF during the 2013—2020 implementation period focused on influencing policy and on supporting conservation approaches with industry partners through SLU practices. The following further describes each of these programs and outlines some examples of achievements and the lessons learned to improve future conservation programs.

Policy Support

PHJV partners were involved in several initiatives with an objective of influencing conservation policies across the WBF. The development of wetland policies that recognize the importance of wetlands on the landscape, and provide guidance on restricting or mitigating impacts to these features is atop the list of these initiatives, particularly in jurisdictions where no such policy exists. Examples of achievements and changes in policy approaches within the PHJV during 2013—2020 include:

- PHJV partners were involved in the development of Alberta's wetland policy and several key wetland policy frameworks were advanced towards adoption in the Yukon and Manitoba. There was ongoing progress towards the development of wetland policies in the Northwest Territories, Saskatchewan and British Columbia.
- Wetland inventories were completed across over 150 million acres in multiple jurisdictions that support the implementation of wetland policies, among other uses, including assessing carbon storage and sequestration, and habitat suitability of other wildlife species.
- PHJV partners produced a report outlining all desired key components of a successful wetland policy to guide future policy development. This advanced our ability to track, evaluate and monitor various policies being developed in different jurisdictions and is a key requirement for wetland policies developed by PHJV partners to leverage support for these activities.

Through achieving the successes in conservation policies across the PHJV, there were also lessons learned that will be used to increase our influence on conservation policy. For example, acknowledging that wetland policies need not be single comprehensive documents; rather they can be components aggregated from different policies that together achieve the desired protection. Understanding when to target the development of single comprehensive policies versus inserting components within an array of different policies will be important to advancing conservation policy more quickly. Establishing multi-lateral support for wetland policy among prominent political parties within a jurisdiction provide greater assurance that the policies will be resilient to changes in government.

Protected Area Support

Supporting the establishment of new protected areas and finalization of interim protected areas is another conservation program that PHJV partners implemented during the 2013—2020 period. Examples of the projects where PHJV partners influenced the development of protected areas includes:

- Over 57 million acres in protection were claimed, which included new protected areas and conservation zones in land use plans.
- Indigenous-led conservation grew exponentially between 2013—2020, in part due to the considerable efforts of PHJV partners, along with increasing funding from Canadian federal sources like the Nature Fund. Among the many Indigenous Protected and Conserved Areas (IPCAs) established during this time period include: Thaidene Nëné, Ts'udé Nı̨lı̨́né Tuyeta, and Edéhzhíe.
- PHJV partners were increasingly engaged in protected areas gap analyses using conservation planning tools to help identify potential future IPCAs and protected areas.
- A comprehensive geodatabase was created to track establishment of protected areas across Canada.

Lessons learned during the 2013—2020 period will help improve our protected area support programs in the WBF moving forward. Protected areas, like other conservation approaches in the WBF, take time and substantial effort to establish, which is important to understand in setting conservation objectives and evaluating program progress. Protected areas initiatives also require significant partnerships across multiple stakeholders with varying interests and motivating factors; collaboration is key to advancing protected areas. There is less appetite for new protected areas among many governments using more traditional methods (e.g., parks, wilderness areas, wildlife management areas), but there is increasing interest in IPCAs to advance both conservation and broader reconciliation goals. Therefore, effective, respectful, and lasting/sustained partnerships with Indigenous communities and governments are key to advancing protected areas. Having an awareness about the Indigenous Peoples within a project's region is critical. Indigenous Peoples have strong cultural and personal relationships with land, and a holistic view of the land where all components are interconnected and equally important. Indigenous knowledge systems, when braided with other knowledge systems within an ethical space, are important to both land relationship planning and establishment of IPCAs that can protect key waterfowl habitats and other important areas.

Sustainable Land Use

Conservation objectives can also be achieved through partnerships with land users to increase and maintain the habitat suitability on the landscape. Establishing stewardship agreements with industrial partners working within the WBF have proven to be successful during the 2013—2020 IP where 12 million acres of SLU were established. Examples of SLU initiatives include:

- Establishment of the Canadian Conservation and Land Management (CCLM) system. This is an important national forum for knowledge sharing and transfer around several topics including wetland best practices. It is the culmination of a significant amount of work to assemble waterfowl, bird, water and wetland BMPs, and share them in a unique, innovative and collaborative manner to increase awareness, uptake and use.
- Establishment of the Forest Management Wetland Stewardship Initiative (FMWSI) between Ducks Unlimited Canada (DUC) and several forestry companies, and the Forest Products Association of Canada (FPAC) to advance wetland stewardship within sustainable forest management. Several key products and guides were produced, which influence how forest land managers and operators work in and around wetlands.
- Collaboration with major forestry certification programs (e.g., SFI, CSA) resulted in improving certification standards around water and wetlands, which helps to maintain the overall function of wetlands and water bodies.

A key lesson learned through the development of SLU initiatives is that a multi-scale approach is most effective and includes pan-boreal forest landscape scale through work with national bodies, such as forest certification associations, regional scale initiatives with multiple companies within a sector to develop guiding principles, and at the local scale where SLUs are established with individual companies. Often the work done at the local or regional scale can be scaled up to influence larger areas as opportunities arise to expedite the process. As with other conservation implementation programs in the WBF, accomplishing SLUs is only possible through partnerships and collaboration.

5.0 RESEARCH AND EVALUATION 2013—2020

Research and evaluation programs contributed to better understanding conservation of waterfowl and other species in the WBF. The following is a summary of knowledge gained during the 2013—2020 implementation plan period, and reflects work completed in the WBF that may contribute to improving conservation delivery. It is not intended to be a comprehensive literature review and is not limited to work completed by the PHJV partners.

What We Learned About Waterfowl

A key uncertainty targeted during the 2013—2020 period was the impact of industrial activity on waterfowl distribution and reproduction. The primary industrial activities occurring within the WBF are forest harvesting, in-situ oil and gas exploration and extraction, and mining for various resources. Associated with these activities are development of linear features (e.g., roads, seismic lines, pipelines), point features (e.g., well pads) and larger polygons (e.g., forest cut blocks, mining areas). The effect of these disturbances is likely not equal through time because some of these activities leave the disturbed areas in a vegetated land cover (e.g., revegetated forest cut blocks), while others result in permanent land cover change (e.g., forest to road or forest to crop fields). Recent conservation activities within the WBF focused on preventing industrial activities from adversely impacting waterfowl carrying capacity by reducing or avoiding assumed effects on predator communities and hydrologic connectivity (PHJV 2014). Over the 2013—2020 period, investigations were targeted at evaluating our assumptions on how industrial development affects duck distribution and abundance. Investigations leveraged existing population survey data to explore correlations between development and pair abundance; study-specific aerial surveys to identify the effects of forestry and oil and gas development on pair and brood abundance; and a ground-based nesting study to improve our understanding of basic boreal waterfowl ecology and evaluate evidence for predation effects.

Forestry has the largest anthropogenic footprint in the WBF (Schneider et al. 2003). Forest harvest appears to emulate natural disturbance (i.e., fire) for breeding waterfowl at 10- to 20-year timescales in the boreal forest (Borger and Nudds 2014). This study also reported that land cover type and proportion of disturbance from fire and forestry had a greater predictive effect on waterfowl species occupancy (including ducks; Mallard, American Black Duck, Green-winged Teal, Ring-necked Duck, Mergansers, Common Goldeneye and Bufflehead) than roads, settlements or mines. Ongoing research in the WBF is exploring the effects of fire, live (green tree) and salvage logging practices on pair abundance and productivity based on helicopter survey data (M. Bidwell, unpublished data). Initial analysis suggest that responses varied by nesting guild and harvest type, with a negative relationship observed between salvage harvest and ground nesting duck pair abundance (M. Bidwell, unpublished data). The footprint of salvage harvest is small, though may grow if disturbance, including insect outbreaks and fire frequency or severity, increases due to climate change (Wang et al. 2021). These results are relevant because work by Lewis et al. (2014) found that Alaskan boreal wetland ecosystems were resilient to the effects of fire across multiple trophic levels that included duck broods. Lewis et al. (2016), concluded that waterfowl populations in the WBF have been resilient to historic wildfire (1955—2014). That is, if forestry emulates fire under historic climate regimes, then we might not expect any negative population level impacts on ducks. In Atlantic Canada, McLean (2020) did not observe any effect of forest harvesting on nest success or brood distribution, consistent with observations of Lemelin et al. (2007) from Quebec who found a positive or no detectable response of forestry on breeding waterfowl. However, neither of these studies compared forestry to fire. Collectively, whether these relationships hold under changing climatic conditions, with increase fire frequency and intensity (Wang et al. 2021), is unknown.

Linear features (e.g., roads, pipelines, and seismic lines) are the next most prevalent industrial footprint by area in the WBF. Within the Boreal Plains ecozone (i.e., southern WBF), exploratory analyses of relationships between linear features and duck population trends between 1960 to 2007 found some indication of negative correlations (Singer et al. 2020). However, results varied in direction and magnitude depending on the nesting guild, disturbance type and presence of agriculture (Singer et al. 2020). Seismic lines and pipelines had the greatest number and magnitude of negative relationships with population trajectory across guilds, potentially because these features may serve as predator movement corridors (Singer et al. 2020). Comparatively, the response to roads varied across nesting guilds where ground nesting ducks had a weak positive response, overwater nesters had a negative response, and cavity nesters had a strong positive response. Witherly (2018) also used breeding population data but included time varying indices of industrial activity and found a generally-positive relationship between number of duck breeding pairs and industrial activity (i.e., pipelines, well pads and other industrial dispositions). However, she found a small negative relationship with the total area of industrial development. Finally, Slattery et al. (in prep) examined relationships between linear features, and both settling and productivity in the boreal forest of Alberta. In general, they observed some support for both top-down and bottom-up hypotheses for negative impacts of linear features, albeit somewhat limited. Results were complicated and negative effects when observed were dependent on spatial scale, feature type, nesting guild and density of natural linear features, with few consistent patterns. For the latter, relationships with anthropogenic linear features tended to be more negative where natural linear features densities were low. Overall conclusion from this work is that, while there is evidence for negative relationships with linear features, no single feature emerged as a focal point for conservation, and there was equal or greater evidence for resilience of ducks to current levels of development.

Recent work by Dyson (2020) found that ducks prefer nesting in areas with lower densities of pipelines and seismic lines, despite no observed negative effects of these features on nest success, albeit with a limited sample size. It is uncertain whether this apparent avoidance of pipelines and seismic lines resulted from perceived increased predation risk associated with these features (Dyson 2020; Fisher et al. 2021) or was an artefact of where these features are constructed relative to nesting habitat. In some cases, seismic and pipeline placement avoids wetlands. Interestingly, duck nest success and brood survival have been shown to increase with proximity to roads and pipelines in the WBF (Roy 2018, Dyson 2020). Roads may be ecological sinks for nest predators through direct mortality from vehicle collisions and indirect mortality due to increased access by humans, and associated hunting and trapping. Similarly, these linear features may serve as movement corridors for large, non-human predators such as coyotes, wolves and bears (Dyson et al. 2020), which may lead to displacement of or predation on smaller mesocarnivores that eat duck hens and nests (e.g., mustelids, foxes, skunks and raccoons). Another component of this work found that industrial development did not negatively affect second order (i.e., home range) habitat selection of female Mallards (Johnstone 2021). At the third order (i.e., hen locations within home range), female Mallards selected marsh, graminoid fen and shrub swamp, and selected industrial features including well pads, borrow pits, and used habitat closer to roads and pipelines (Johnstone 2021).

Land conversion to agriculture is a disturbance that results in deforestation within the WBF. Singer et al. (2020) found no negative relationships between duck pair population trajectory and distance to agriculture. However, as the landscape composition shifts from forest and associated wetlands to cultivated or grassland-dominated cover, often with drained wetlands, wetland bird communities have been observed to shift from those dominated by forest species to ones dominated by species found in open-country ecoregions (Morissette et al. 2019). This land conversion is likely to be exacerbated by the effects of climate change, allowing northward expansion of agriculture, and so may have implications for forest wetland bird communities more generally.

Unlike physical disturbances, such as forestry or linear features that result in sudden changes in habitat conditions, many of the effects of climate change are protracted over time, such as longer growing seasons. The implications of climate change on waterfowl in the WBF remain uncertain, but are anticipated to be a significant modifier of WBF habitat and industrial practices over time. Warming trends in the WBF will likely lead to a northward contraction of the forest biome, but specific implications for precipitation, evapotranspiration, and hence waterfowl habitat conditions are unclear (Ireson et al. 2015). Holopainen et al. (2015)

reviewed 98 studies of waterfowl ecology in boreal ecoregions and they suggest that there is little evidence that water characteristics (e.g., chemistry, turbidity, organic matter) in this ecoregion affect duck habitat use or survival. While warming and more frequent droughts are contributing to increased wildfire occurrence and extent, Lewis et al. (2016) did not find a relationship between wildfire and waterfowl abundance in the WBF between 1955 and 2014. We do not know if this resilience to historic fire patterns can be expected under more severe fire regimes. Meanwhile, evidence suggests that terrestrialization of wetlands is occurring in boreal regions of Alaska, which will reduce the amount of waterfowl habitat (Roach et al 2011). Roach and Griffith (2015) identified that reduced lake size attributed to climate change in the boreal regions of Alaska was associated with a decline in waterfowl species richness, possibly due to reduced nesting habitat diversity. Increases in habitat diversity associated with lake changes did not offset the loss of habitat on waterfowl species richness within these systems. The degree and extent of terrestrialization in the WBF of Canada are unknown. Waterfowl population models accounting for predicted climate change effects suggest that the Boreal and Taiga Plains ecozones will have greater wetland loss compared to the prairie region (Zhao et al. 2016, 2018), but the impacts to waterfowl abundance may be lower than in the prairie regions due to a lower density-dependent effect on waterfowl populations. This may be related to climate change effects that appear to increase the productivity of these wetlands through the release of nutrients into aquatic systems (DeColibus et al. 2017). Overall, better understanding the spatial patterns of climate change and cumulative effects of anthropogenic disturbance will contribute to improving our knowledge of the boreal ducks over the 2021—2025 Plan. This knowledge may lead to refined spatial planning of conservation activities or improvements to best management practices in the WBF.

Implications for Waterfowl Conservation

The WBF, despite its importance to breeding waterfowl in North America, remains an understudied region compared to the Prairie Parklands. Research conducted during the 2013—2020 Plan has greatly improved our knowledge and allowed critical assessment of many of our management assumptions. Multiple lines of evidence appear to support the theory that boreal ducks are resilient to current levels of disturbance in the WBF with support for specific top-down and bottom-up hypotheses remaining equivocal. This new knowledge of the complex relationships between boreal ducks and changes to their habitat will help guide future conservation planning and delivery in the region. Available evidence suggests that forest harvesting and linear feature effects on waterfowl in the WBF is variable at the landscape scale, but shows no clear pattern of adverse effects on ducks. These results indicate that the presence of linear features on the landscape should not exclude areas with linear features from being included in conservation projects. However, implications of linear features on other avian species and Species at Risk, such as caribou, may lead to reduced co-benefits of conservation activities in areas with greater density of linear features.

The overall effects of climate change on waterfowl in the WBF remain uncertain, but indications suggest that the effects mechanisms may be related to wetland functional or physical loss through altered hydrological processes. Climate modelling projections coupled with knowledge of waterfowl habitat suitability developed for eastern Canada suggest that landscape changes by the end of the century may benefit seven of 12 waterfowl species, while being detrimental to five (Adde et al. 2020). Other questions remain about how the broader WBF wildlife communities might be affected by climate change, which include the potential introduction of novel waterfowl nest predators and changes in the distribution and abundance of existing nest predators. Better understanding the implications of climate change on waterfowl would allow for refining best management practices (BMPs) in the WBF to help mitigate against these effects (e.g., focused protection of some wetland types).

Conservation partners working within the WBF should also consider how changes outside the WBF will influence the value of boreal wetlands as refugia for waterfowl and other species (Stralberg et al. 2020). Changes in habitat suitability or availability, whether due to land use change, climate change or other factors, outside the WBF may result in a shift in the proportion of waterfowl using the boreal for breeding and molting (Zhao et al. 2019). These potential shifts may require adjustment to conservation practices within the WBF to mitigate against effects in other areas.

Overall, ducks in the WBF appear to be more or less resilient to industrial activities in the WBF occurring adjacent to wetlands. As such, waterfowl conservation programs within the WBF should focus primarily on reducing or avoiding direct wetland loss, and less on mitigating perceived habitat degradation due to industrial activities.

Priority Knowledge Gaps for Waterfowl

Current approaches and analyses have focussed on guild level grouping of species (i.e., ground, cavity, overwater) to identify broad trends to focus on immediate conservation objectives. There is a need for more species-specific studies given the need to understand changes in community structure (i.e., species composition and abundance) and differing species population trajectories in the WBF, even within guilds.

While the state of knowledge about waterfowl in the WBF has advanced significantly in recent decades, there are several key topics where WBF information gaps will be the priority for future boreal waterfowl studies over the 2021—2025 IP period. These topics include, in no order of priority:

- Gaps in waterfowl population abundance and distribution estimates throughout the WBF lead to uncertainty in spatial modelling efforts for conservation priority area delineation, particularly in areas like the Yukon. As this challenge is unlikely to be addressed through expansion of the

current May Breeding Waterfowl Survey program, novel approaches to either supplementing these surveys or modelling extrapolations should be explored.
- The effects of industrial activities on waterfowl distribution and productivity throughout the WBF have advanced during the 2013—2020 IP period; however, there remains uncertainties about the cumulative effects from industry occurs on the landscape. Continued evaluation of this topic to identify mitigation measures, where possible, will benefit conservation planning in the WBF.
- Monitoring and evaluation of current BMPs and mitigation measures should continue through adaptive management programs of evaluating the effectiveness of conservation policies and practices. Knowledge obtained would help refine future policy direction.
- The suite of climate change implications within the WBF remains uncertain. Greater certainty in the direction and magnitude of the effects of climate change on this ecoregion will allow for improved modeling of future wildlife distribution and abundance, and will allow for proactive planning for shifts within this system. Moreover, understanding how climate change effects may lead to shifts in waterfowl species composition and relative abundance will be important to plan for habitat conservation.

What We Learned About Other Avian Species

Early studies on WBF bird communities focused on how species responded to forest composition and stand age, with an emphasis on predicting potential community responses to forest harvesting. In general, early research suggested that historic forest management practices based on principles of maximum sustained yield and replanting forests to monocultures would result in a reduction in the abundance of old forest species (Hobson and Bayne 2000a, Cumming and Diamond 2002), and a reduction in avian richness and diversity due to reduced stand species diversity (Hobson and Bayne 2000b). As forestry moved toward approaches using natural disturbance emulation (NDE), the focus of bird community research switched to testing the efficacy of NDE forestry for conservation (Hobson and Schieck 1999; Schieck and Song 2006). These studies generally concluded that NDE forestry improved upon "traditional" forestry practices in that it resulted in bird communities in post-harvest stands that were more similar (yet still substantially different) to communities in post-fire stands (Hobson and Schieck 1999; Schieck and Song 2006). While similarity improved as stands aged, recovering the pre-disturbance bird communities and thereby maintaining avian diversity requires harvest rotations be extended beyond 80 years to ensure enough older forest age classes are available across the WBF to support old forest bird communities, which are unique (Hobson and Schieck 1999, Schieck and Song 2006). The avian community similarity to post-fire sites could be optimized, including benefits to priority species such as the Canada Warbler (Cardellina canadensis), by retaining 5–19% of the disturbance area as live residual patches and at least 50% of harvests should have ≥9% of the area in residuals (Van Wilgenburg and Hobson 2008; Ball et al. 2016; Hunt et al. 2017). Work on nest webs also highlights the importance of retaining large patches of mature and old forest to provide nesting habitat for species of cavity nesters that are associated with old forest stands, such as Pileated Woodpecker (Dryocopus pileatus), and species that are reliant on the cavities they provide, such as Common Goldeneye (Cooke and Hannon 2011). Characteristics of the nest cavities across multiple species suggest that retaining large (>35 cm diameter at breast height) aspen with conks within harvest residual patches ≥5ha, and having planned retention patches (≥5ha) composed of 33–67% mature (or older) aspen or mixedwood stands helps to promote cavity nesting within harvests (Cooke and Hannon 2012). Leave areas along riparian corridors has been a standard forestry practice, but studies suggest there are no adverse effects of harvesting these areas on riparian birds (Kardynal et al. 2009). Varying the level of forest harvesting within riparian buffers resulted in reduced abundance and diversity of upland and interior forest nesting species, a positive response by shrub nesting and generalist species, but little response by riparian species (Kardynal et al. 2011). Foresters have also experimented with the use of understory protection harvesting to protect sapling conifers and potentially shorten the duration for forest stands to return to pre-harvest conditions. Recent work suggests that some species associated with mature to old, unharvested stands (e.g., Magnolia Warbler, Setophaga magnolia) can be encouraged to use early post-harvest sites using understory protection harvesting (Charchuk and Bayne 2018).

While much of the historic research focus has been on bird responses to forest harvesting, one of the predominant anthropogenic influences on avian communities in the WBF has been agricultural conversion. Many species of boreal forest birds are virtually absent from forest fragments in the agricultural matrix of the southern WBF (Hobson and Bayne 2000c). Similarly, Morissette et al. (2019) found that agricultural conversion tended to favour open country species and negatively impact species for which loss of forest cover was a direct loss of habitat. In areas where there is co-occurrence of multiple industries working on the land base there may be effects that are harder to predict for forest birds. Simulation models of the WBF 100 years into the future suggested that plausible future landscape conditions are likely to result in projected population declines for boreal forest birds, particularly for old forest species (Mahon et al. 2014). The results of Mahon et al. (2014) highlight the need for careful land use planning, understanding of cumulative effects, and emphasize that collaboration between multiple industrial sectors using the same land base could be used to avoid unintentional impacts on bird populations.

Recent work examining how avian abundance was affected by well pads, pipelines and seismic lines found that on average, species abundance was likely to increase (relative to forest interior) near energy sector disturbances if the species was not associated with old forests (Bayne et al. 2016). When examining the additive and interactive effects of multiple disturbances on the bird community, Mahon et al (2019) found that species associated with deciduous forest and open habitats tended to benefit from disturbance whereas species associated with coniferous forest were more likely to have reduced abundance. Species' responses to multiple disturbances on the landscape were a complex mixture of synergistic and antagonistic interactions for 39% of species, suggesting that landscape management in the face of multiple overlapping land uses will be difficult (Mahon et al. 2019).

Within the Athabasca Oilsands Region (AOR) studies have focused on whether ongoing reclamation efforts are providing effective habitat for boreal forest songbirds. Community similarity and avian abundance in reclaimed oil sands mine areas has not yet converged with mature (>70 years old) reference sites, and reclaimed sites may serve as ecological sinks for some species (Foster et al. 2017; Hawkes et al. 2021). Ongoing efforts to reclaim well sites within the WBF have also met with mixed success, with 16/35 species assessed only being found within mature forest reference sites (Wilson and Bayne 2019). Key uncertainties associated with reclamation efforts relate to how well forests and their associated biota may respond as more difficult to reclaim disturbances and areas are reclaimed. Because reclamation of linear features to aid in the recovery of woodland caribou (Rangifer tarandus caribou) is a priority in the WBF (Bentham and Coupal 2015, Finnegan et al 2018), understanding when and where to undertake these efforts would optimize the opportunity to help conserve boreal bird populations as well (Lankau et al. 2013).

At larger spatial and temporal scales, we have also learned that climate plays a crucial role in determining species distribution of WBF birds (Cumming et al 2014). The strong dependence of species distribution on climatic drivers has important ramifications given projected climate warming, with projected songbird distributions predicted to decrease by up to 169% under realistic climate change scenarios (Stralberg et al. 2015). Vegetation time lags in response to climate change are likely to result in significant reductions in core area habitat for boreal landbirds, particularly for mixedwood associated species (e.g., Canada Warbler; Stralberg et al. 2015). Further, many species are projected to decline due to an inability to colonize new sites beyond their range (Ralston et al. 2017). Boreal refugia for birds are projected to occur in coastal and high-elevation areas, as well as transition zones between biomes (Stralberg et al. 2015). While generalist and early successional species may be able to adapt their distributions more rapidly in response to climatic change, refugia are predicted to be important for mature forest-associated species that will remain in these areas (Stralberg et al. 2015). This emphasizes the need for conservation planning that includes long-term monitoring, identification of priority areas (including refugia) and adaptive strategies (Stralberg et al. 2015).

Climate change adds significant uncertainty to future population sizes and distribution of birds in the WBF as projected northward shifts of species ranges (Stralberg et al. 2015, Micheletti et al. in press), and projected changes in the amount and distribution of habitat through wildfire mediated habitat change (Stralberg et al. 2018) seem probable. Habitat conditions within Alaska are predicted to bear greater resemblance to the mixed deciduous-conifer forests of southern Canada in future (Mann et al., 2012). More recently, Cadieux et al. (2020) project major shifts in avian composition and abundance in southern portions of the WBF owing to combined effects of forest harvest and wildfire causing projected shifts of conifer and mixedwood stands to greater deciduous cover. In northern regions of the WBF, permafrost melt is also likely to alter tree demography (Dearborn et al. 2021), forest loss (Carpino et al. 2018), may cause wetlands to dry (Haynes et al 2018) and may decrease the areal extent of wetlands (Avis et al. 2011). A key shortcoming of current models attempting to forecast the projected impacts of climatic change on boreal forest bird communities is an inability to incorporate the influence of permafrost melt on avian habitat abundance, distribution or quality (Micheletti et al. in press), and to anticipate the impact of human activity in response to changing habitat.

Challenges associated with monitoring and estimating populations of landbirds, shorebirds and waterbirds throughout the WBF have historically led to biases in environmental conditions sampled and uncertainty in spatial modelling efforts to support conservation planning (Van Wilgenburg et al. 2015; Sólymos et al. 2020). Combining Breeding Bird Survey (BBS) data from multiple Bird Conservation Regions improves the reliability of long-term trends (87% of species have long-term trends of medium or high reliability), but more than half of short-term trends have low reliability, including trends of several species of high conservation priority (Appendix A). These challenges are currently being addressed by a strategy to develop WBF bird monitoring programs that balance cost constraints, as well as habitat stratification and spatial representation across the boreal region (Van Wilgenburg et al. 2020). Additional sampling and integrated modeling of available data sources to improve population estimation will support bird conservation across the WBF (Sólymos et al. 2020).

Implications for Conservation of Other Avian Species

Forest and wetland loss within the WBF is less prevalent than during the 20th century, but it still occurs along the southern periphery of the WBF and thereby impacts forest- and wetland-associated bird communities (Hobson and Bayne 2000c; Morissette et al. 2019).

As the spatial extent of forest harvesting is generally larger and the data surrounding land cover types and planned disturbances are well managed, this presents a potential multi-pronged approach to conservation. First, land use (and/or forest management) planning in which there is cross-sectoral collaboration (e.g., oil and gas) could help avoid unintended cumulative effects (Mahon et al. 2014). Second, existing research points to several "best management practices" based on NDE forestry that encourage species communities that are more similar to post-fire stands and thus should be widely used and expanded where possible. Third, species associated with old forests tend to be the most vulnerable to impacts from anthropogenic disturbances regardless of the disturbance type/sector (Bayne et al. 2016; Cumming and Diamond 2002; Hobson and Bayne 2000a,c; Mahon et al. 2014). Working with conservation partners to ensure sufficient habitat persists beyond the typical forest rotation ages and follows stand age distributions expected under natural disturbance regimes would be an important step toward avoiding declines in old forest associated species. Where old forest retention is difficult or where the associated species are still difficult to maintain on the land base, working with partners to ensure understory protection harvesting is used to encourage old forest characteristics earlier in succession would benefit several species (Charchuk and Bayne 2018). In addition, working with conservation partners to ensure widespread use of best management practices such as within harvest residual retention (Schieck and Song 2006), skipped or extended rotations to maintain old forest communities (Schieck and Song 2006), employing low impact seismic exploration (Bayne et al 2005), and reducing energy sector noise (Bayne et al. 2008; Habib et al. 2007) would benefit species conservation.

While cutblocks are reforested after harvest through natural regeneration, planting or a combination of both to achieve full restocking of stands, disturbances left by other sectors may not have the same treatment. As a result, some disturbed areas may take longer to return to their pre-disturbance conditions if not actively reclaimed, which presents an opportunity for conservation partners in the WBF. For example, reclamation of seismic lines and well pads could benefit some forest birds (Wilson and Bayne 2019) and other biota (Tattersal et al. 2020). Given there are complex interacting effects on forest birds where multiple disturbances co-occur (Mahon et al. 2019), coordinating forest cutting (for harvest and clearing) and replanting efforts across sectors could help to better manage landscapes planned for harvesting to more closely match NDE (D. Andison, personal communication). Indeed, compared to baseline harvesting scenarios, Leston et al. (2020) recently found in a simulation study that the addition of seismic line restoration would benefit populations of Black-throated Green Warbler, Brown Creeper, Canada Warbler, and Western Tanager. However, some ecosites such as treed peatlands and fens tend to be more difficult to restore (Filicetti et al. 2019), and avian response is therefore hard to predict.

Priority Knowledge Gaps for Other Avian Species

Despite the importance of the WBF as a breeding habitat for non-game birds, knowledge gaps remain for this region. Critical knowledge gaps that are not currently being addressed to support the conservation of WBF birds include, in no order of priority:

- While forest landbird monitoring is currently being addressed by other programs, raptors, owls, waterbirds and shorebirds continue to lack sufficient monitoring using current methods and, as a result, are data deficient. Coordinated monitoring is needed to adequately describe distribution and trend, and to support conservation planning.
- Plans and experiments are underway to restore seismic lines and other disturbances within woodland caribou ranges. However, it is unclear how well these restoration efforts may be for encouraging vegetation growth (Filicetti et al. 2019) and whether forest birds will respond to restoration efforts. Predicting locations and habitat types where restoration for caribou would produce co-benefits for avian species of concern should be a component of this process.
- Develop landscape-scale restoration strategies where legacy disturbances exist (e.g., Alberta Oil Sands Region) by determining whether aggregated harvest and/or fire followed by replanting efforts can be used to "remove" or reduce cumulative effects by restoring landscape configuration and plant communities, and thereby benefit forest bird communities.
- Evaluate mitigation measures, including habitat mitigation, implemented by industry, should continue in the WBF, to confirm effectiveness or to identify new mitigation strategies to support avian conservation planning.
- Evaluate alternate harvest rotation strategies aimed at retaining amounts and spatial distributions of forest age classes in the WBF needed to support population objectives for birds, particularly old forest-associates.
- Continued research is needed, not only to understand relative effects of individual industrial disturbances on birds, but also to understand cumulative and interactive effects of climate change and anthropogenic disturbances on boreal bird populations, particularly those species inhabiting older age class forests. This knowledge should be included in future conservation planning efforts to support population objectives.
- Understanding the full range of potential effects of climate change on individual boreal bird species will require an improved understanding of a species' climate exposure and vulnerability, along with a species' vulnerability to other forms of disturbance in the region. Gaining a better understanding of how climate influences wildfire regimes and how these may interact with forest management (Cadieux et al. 2020) will be crucial to both understanding the long-term sustainability of forestry in the face of climatic change and the conservation challenges these interactions may present.
- An improved understanding of how permafrost thaw will change forest growth, forest

composition, as well as wetland areal extent and succession is needed to predict changes in avian community composition, distribution and population sustainability due to climate change (Micheletti et al. 2021).

6.0 OBJECTIVES FOR THE 2021–2025 WBF IP

The objectives of the PHJV drive the development and implementation of programs and activities in the WBF. These objectives fall under several themes, including: populations, habitat and people that represent the three "stool legs" identified in the 2018 NAWMP update. Conservation efforts of PHJV partners within the WBF to date, and outlined above in this IP, have focused primarily on waterfowl population and habitat objectives, largely due to the active partners in this region. The conservation outcomes to date have had modest co-benefits for non-waterfowl species, as described in the Habitat Conservation Achievements section above. However, the absence of focused programs directed at these other species risks failing to deliver on their conservation needs.

The improvement of demographic information and development of habitat models for non-waterfowl species, as well as a clear demonstration of conservation needs (i.e., population declines of some species) within the WBF, highlight an opportunity for conservation delivery partners to increase their activity and support positive population and habitat outcomes for the diverse avian community of the WBF. Until there is greater investment among PHJV partners, the objectives within the WBF will remain waterfowl focused.

The following objectives were developed based on current spatial information layers and advances in the state of knowledge in waterfowl and non-waterfowl ecology. The human dimensions objectives, while separate from the habitat objectives to achieve population goals, are ultimately drivers of those habitat and population objectives on the landscape.

Habitat Objectives

Waterfowl Target Landscapes

Identifying waterfowl target landscapes provides guidance and decision support for conservation planning and assists with directing conservation delivery efforts across a broad land base. Waterfowl are not evenly distributed across the WBF landscape, and waterfowl-focused conservation should ideally reflect their pattern of distribution. Given limited resources and variation in where conservation opportunities exist, spatial targeting can help increase the return on investment by providing decision support for where and how much investment is placed in different waterfowl conservation opportunities.

Identifying target areas helps direct efforts towards those key areas, which will see the greatest gains for waterfowl populations by reducing the risk of habitat loss or degradation or contributing to conserving refugia areas for climate change. This means guiding staff in selecting future projects and areas, determining the most relevant compliment of conservation tool delivery mechanisms, and implementing partnerships with the best return on investment. While the target areas are primarily used to guide waterfowl conservation delivery, it is important to note that there are other considerations to help inform decisions around conservation program direction and engagement in various projects throughout various jurisdictions of the WBF. Other considerations may include:

- The opportunities for total potential acre outcomes both in terms of established protected areas and for sustainable land use;
- Development of new and existing partnerships that can leverage larger conservation gains over time;
- The overall probability of success from the opportunity;
- Opportunities to further the innovation of conservation tools and services, which lead to new conservation gains;
- The level of risk due to anthropogenic disturbances, future development and natural disturbance; and,
- The potential to leverage other co-benefits, such as all-bird conservation, caribou habitat protection or carbon sequestration and storage, to advance waterfowl conservation goals.

While direct investments of time and resources into stewardship of the highest priority waterfowl acres is the primary consideration, these other considerations can also be achieved through large-area influence mechanisms like policies, best management practices, and leveraging other ongoing conservation efforts.

Target areas, although static regions on maps, are dynamic through time. As information increases, methods change and new ideas are brought forward and tested, spatial targeting will be adjusted and adapted. As a matter of practice, and for the purposes of the PHJV, these target areas will continue to be re-evaluated with each future implementation planning cycle, as data inputs, modeling approaches and knowledge gaps are closed. As such, the target landscapes derived for this IP represent the best available information and science to date. Further, these target areas are used to prioritize and direct program staff and resources to the highest value waterfowl areas within the WBF. Detailed methods on the waterfowl modelling approach can be found in Appendix B, with a summary as follows.

With generally the same number of ducks as the Prairie Parklands, but five times the land mass, WBF duck populations are distributed at much lower densities on average. However, pan-Canada modeling efforts (Barker et al. 2014a, 2014b; Adde 2020) suggest that boreal duck pairs may be sufficiently aggregated for effective spatial planning. Within the 17 waterfowl species or groupings modelled in Barker et al. (2014a), a subset of eight boreal forest-associated species were selected for modelling: American Green-winged Teal, American Wigeon, Mallard, generic Scoter, Bufflehead, generic Goldeneye, Ring-necked Duck, and generic Scaup. The decision-support tool, Zonation, was used to evaluate the WBF region minus the agricultural portion of the BTZ for the purpose of identifying priority areas for conservation. As presented in the Introduction, the broader boundary of the WBF, minus the agricultural areas (the agricultural ecumene), was used for target area modelling. This area was used because it represents the boundaries of the overlapping BCRs, because conservation efforts within the PHJV WBF extend by virtue of geopolitical boundaries into these additional ecoregions that are predominantly crown lands, and because they are increasingly under Indigenous government management or co-management.

The WBF analysis was used to highlight the highest priority areas in the WBF (Figure 5). The priority areas identified consist of the top 40% of the waterfowl habitat (Appendix B). This corresponded to approximately 56% of the total estimated waterfowl population of the WBF (Table 7). The focus of PHJV waterfowl conservation efforts will be within these priority areas. However, due to the large landscape scale influence approaches used to deliver conservation in the WBF, some of the other waterfowl habitat areas will need to be conserved to meet the overall waterfowl targets for the WBF.

Within WBF waterfowl priority areas for waterfowl conservation (see Setting Habitat Objectives section), nearly six million acres or approximately 2% of the priority areas land base is impacted by anthropogenic activities. The distribution of anthropogenic activities is not consistent

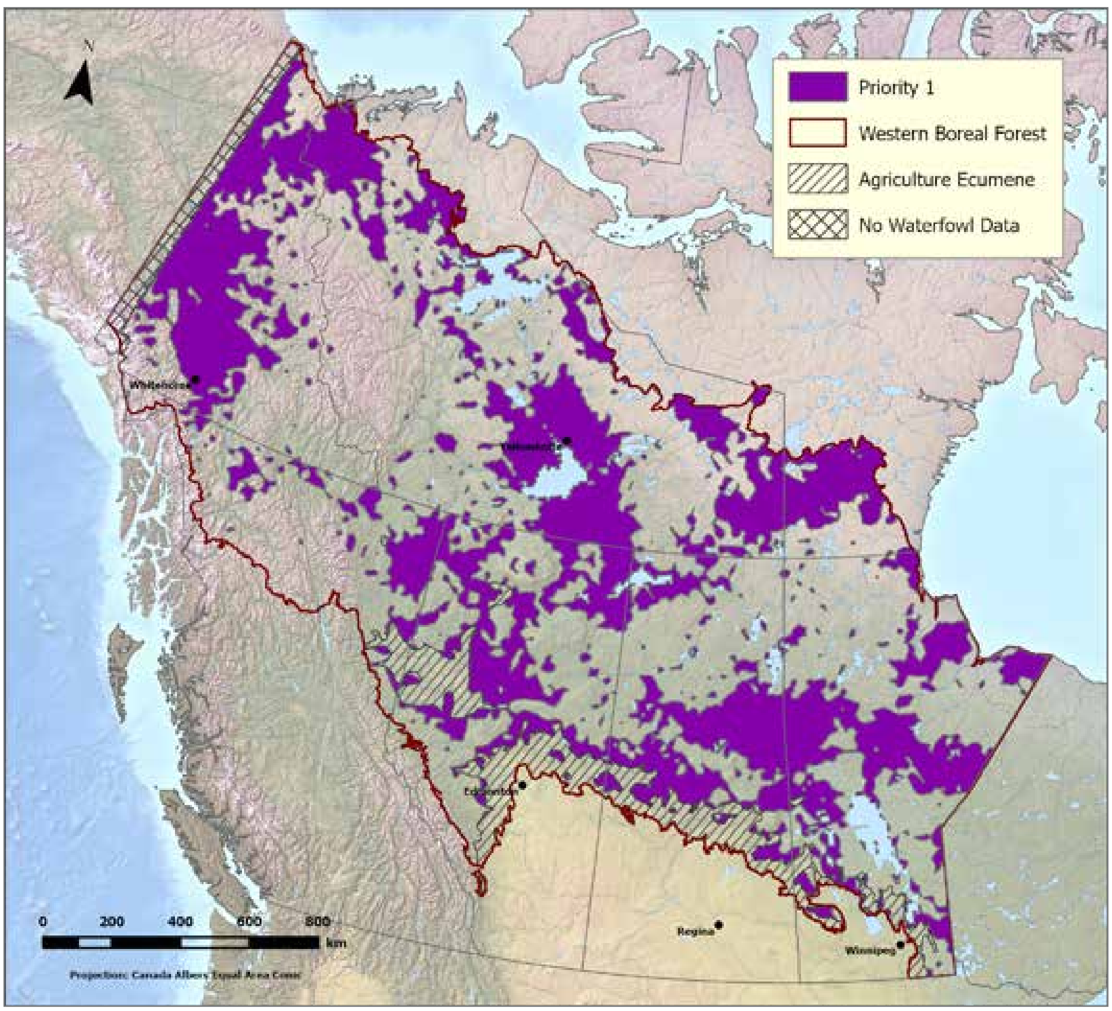


FIGURE 5. Western Boreal Forest waterfowl priority areas.

across the provincial/territorial jurisdictions with the highest rate of impacts in Alberta, and moderate impacts in British Columbia, Saskatchewan and Manitoba (Table 2). Uncertainty remains around the approach to address cumulative impacts of anthropogenic disturbances, specifically around the severity of those impacts as it relates to permanence (permanent vs. non-permanent) and restoration opportunities.

Waterfowl Habitat Objectives

The PHJV's primarily undertakes habitat retention-based stewardship activities in the WBF directed towards large area conservation with an ultimate goal of no net loss of habitat function. This involves adopting the first principles of the mitigation framework which are to avoid, minimize, and offset and counter both degradation and loss of habitat. The long-term PHJV habitat objective for the WBF equates to the amount of duck habitat required to support 75% of the duck population predicted within potentially at-risk habitat (i.e., outside of existing long-term protected lands). To accomplish this goal, an estimated 390 million acres of conservation would be needed. As of 2021 there are over 180 million acres in conservation (169 million in protection, 12 million in SLU) and the PHJV has influenced approximately 50 million acres of waterfowl habitat in the WBF. The PHJV's five-year (2021—2025) habitat objective for the WBF is to conserve through influencing protection and SLU that ultimately conserve about 75 million acres, of which 40 million acres is projected to be waterfowl habitat and just over 28 million acres would be within Priority Areas (Table 8).

TABLE 7. Distribution, as percent of total pairs of waterfowl in the Western Boreal Forest, by provinces or territories within and outside waterfowl priority areas.

PROVINCE / TERRITORY	WBF WATERFOWL PAIRS (% OF TOTAL)	
	PRIORITY AREAS	OUTSIDE
ALBERTA	7.9	4.2
BRITISH COLUMBIA	1.6	3.6
MANITOBA	7.0	7.5
NORTHWEST TERRITORIES	15.5	14.6
NUNAVUT	2.9	1.6
SASKATCHEWAN	6.6	5.0
YUKON	14.4	7.7
TOTAL	**55.9**	**44.2**

TABLE 8. Five-year (2021—2025) total and waterfowl habitat objectives ('000s acres) within the WBF for protection and sustainable land use (SLU). Note that not all protection and SLU goals overlap with Priority Areas due to land use tenure. Details about the spatial distribution of habitat goals is provided at (insert website link of the online Boreal IP).

PROVINCE/TERRITORY	PRIORITY AREA GOALS		OUTSIDE PRIORITY AREA GOALS	
	PROTECTION & SLU ('000s ACRES)		PROTECTION & SLU ('000s ACRES)	
	TOTAL AREA	WATERFOWL HABITAT	TOTAL AREA	WATERFOWL HABITAT
ALBERTA	4,000	1,000	8,400	1,100
BRITISH COLUMBIA	500	200	6,100	1,800
MANITOBA	15,300	15,250	17,700	15,500
NORTHWEST TERRITORIES	1,500	1,000	8,500	2,000
NUNAVUT	0	0	0	0
SASKATCHEWAN	3,000	500	3,000	1,000
YUKON	3,800	650	3,200	0
TOTAL	**28,100**	**18,600**	**46,900**	**21,400**

These five-year habitat objectives were determined using a combination of decision support tools within an adaptive management approach including:

- Updated spatial targeting – detailed maps showing important areas for waterfowl, which delineate Priority Areas as the most important areas for waterfowl in the WBF, along with other waterfowl habitat areas;
- Current and future conservation opportunity – scan of up-to-date knowledge of current and future conservation opportunities from conservation staff and partners;
- Current understanding of threats to waterfowl in the WBF – integrated adaptive management of recent waterfowl research results; and
- Other ongoing conservation efforts – potential opportunities that can be leveraged to advance waterfowl conservation.

The primary goal of this process is to focus as much conservation effort towards the Priority Areas as possible, because, on average, conservation of one acre of priority habitat is estimated to yield twice the return for waterfowl as other areas across the WBF, based on the modeled breeding waterfowl population estimates. However, given the overall PHJV goal for waterfowl (maintain habitat function to support 75% of the waterfowl population) – conservation of other waterfowl habitat will also be needed. With the large-scale conservation approaches (e.g., policy, SLU, protection) some consideration was given to these other waterfowl habitat areas if the conservation opportunity was likely to result in acres of waterfowl habitat conservation.

As several ecozones within the WBF extend slightly beyond PHJV boundaries, development of PHJV habitat objectives for the WBF was integrated within a larger, WBF waterfowl planning effort. Specific habitat objectives were developed based on the duck distribution patterns predicted by the pair-distribution models (Barker et al. 2014a, 2014b) and identification of waterfowl habitat (process discussed in Appendix B). The WBF is comprised of approximately 49% waterfowl habitat and the waterfowl priority areas assist with identification of that key habitat distributed amongst the jurisdictions (Table 8). With the focus on Priority Areas, conserving them will provide some form of protection for 56% of the estimated waterfowl population as well as for 44% of the WBF total estimated waterfowl habitat (Table 7). Priority areas would also provide protection for 44% of wetland habitats and 33% of upland habitats used by waterfowl as primary or supporting habitat and would also benefit some other avian species. By incorporating other waterfowl habitat areas, an additional 44% of WBF waterfowl habitats could be targeted for conservation efforts with an additional 42% of the wetland habitats and 43% of the upland habitats.

Opportunities for Shorebird, Waterbird and Landbird Conservation

This iteration of the 2021–2025 WBF IP advances the PHJV's commitment to all bird conservation by demonstrating the opportunities for co-benefits with waterfowl-focused conservation programs, and highlighting the need for targeted conservation planning and action. Similar to the PHJV IP for the Prairie Parklands, the WBF IP identified areas of high conservation value within the WBF for seven wetland-associated species and 92 forest-associated species (as defined by Rosenberg et al. 2019; Table A-1) using spatial density models (Boreal Avian Modelling Project, 2020) and the Zonation software package, which is a widely-used conservation planning tool (version 4.0; Moilanen 2007). The forest-associated group included 32 species whose primary breeding habitat is the boreal forest (Rosenberg et al. 2019). During the Zonation process, species were weighted according to their conservation status to reflect their priority for conservation action (Table A-1). Details about the priority area identification methods are found in Appendix C.

We arbitrarily selected the top 20% of cells from the Zonation prioritization to highlight the areas of highest priority for wetland- and forest-associated species (Figure 6). Within the WBF, the Northwest Territories captured most of the high priority areas for wetland-associated species, which were concentrated in the Taiga Shield ecozone (Figure 7). Alberta had the greatest proportion of high priority areas for forest-associated species, which were primarily located along the southern edge of the PHJV in both the Boreal Cordillera ecozone in British Columbia and the Boreal Plains ecozone from Alberta to Manitoba. Overlap in the highest priority areas for wetland- and forest-associated species occurred in the Taiga Shield ecozone in northern Manitoba and southeastern regions of the Northwest Territories (Figure 7).

To identify areas with potential co-benefits of habitat conservation for waterfowl and land birds, the priority areas for non-game species were mapped with the waterfowl priority areas (Figure 8). The average relative conservation value of cells for wetland- and forest-associated birds was calculated within the waterfowl priority areas for each jurisdiction to identify where waterfowl conservation could result in the greatest co-benefits to other bird species (Table 9; Figure 8). On average, the relative conservation value of waterfowl priority areas for wetland-associated species was highest in Nunavut and the Northwest Territories, and for forest birds it was highest in Alberta, British Columbia, Saskatchewan and Manitoba (Table 9).

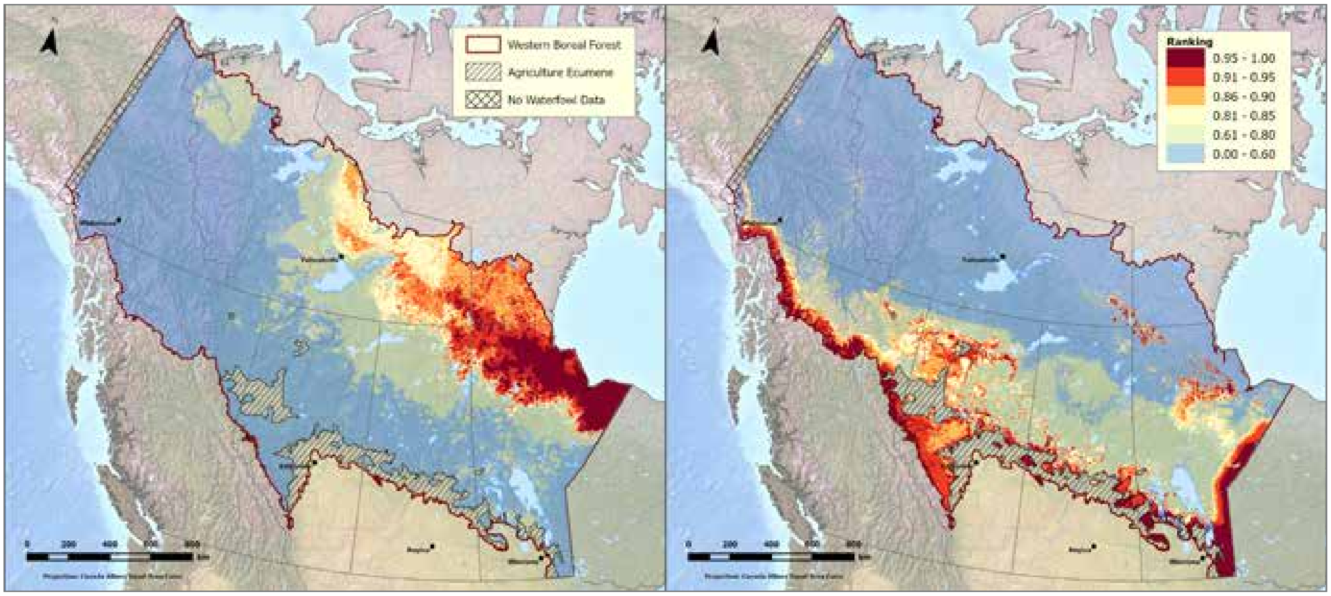


FIGURE 6. Conservation priority ranked areas for landbirds and shorebirds outside of existing protected areas (grey) across the Western Boreal Forest, Canada. Landbird and shorebird ranking is based on avian density and generated using the software package Zonation across a suite of seven wetland-associated species and 92 forest-associated species. The highest ranks are in red; lowest ranks are in blue. The highest priority areas (i.e., top 20%) are in orange and red

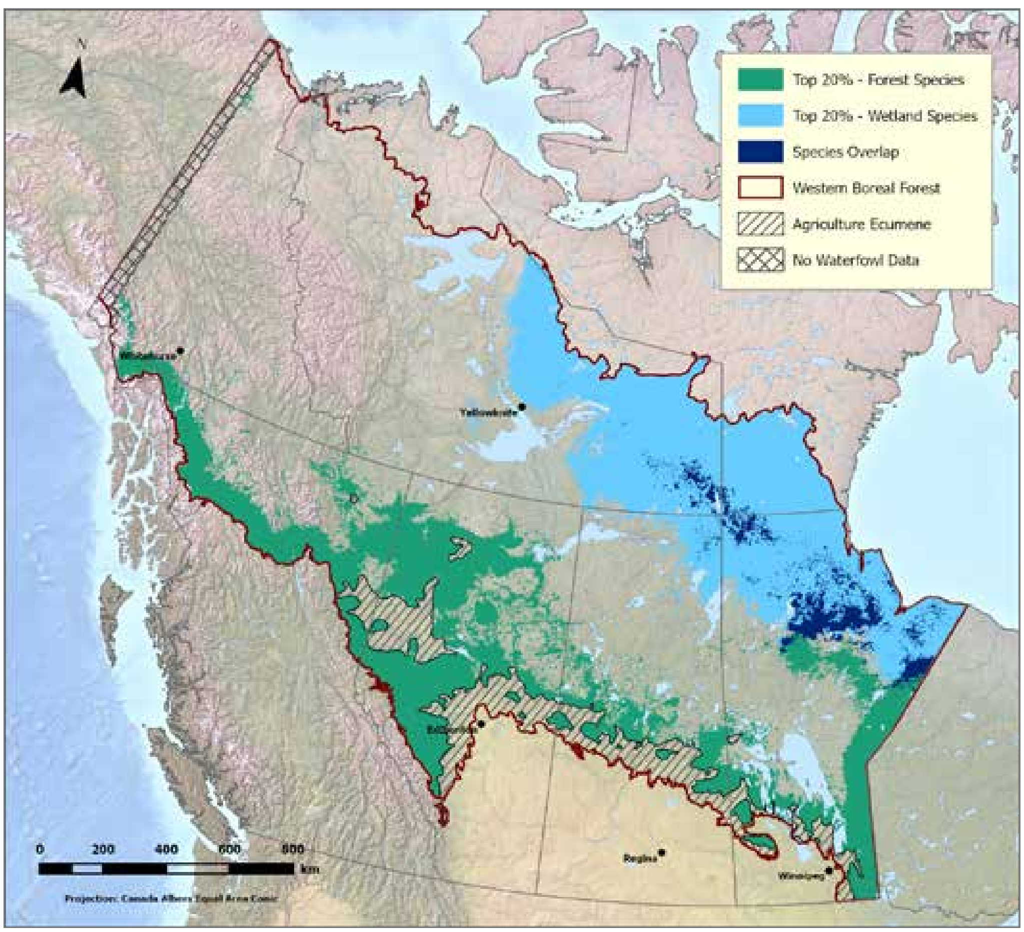


FIGURE 7. Locations of the top 20% priority areas for conservation for (a) wetland-associated species (light blue), (b) forest-associated species (green) and (c) their overlap (dark blue) across the Western Boreal Forest, Canada.

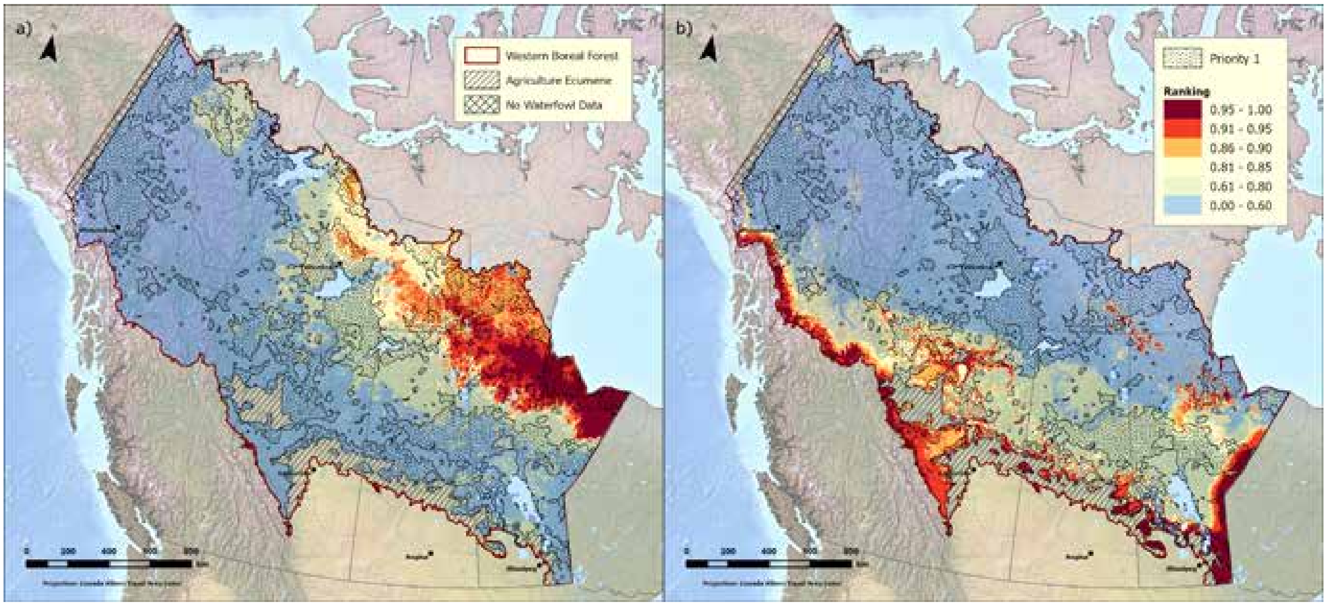


FIGURE 8. Spatial conservation priority ranking for wetland-associated species (a) and forest-associated species (b) across the Western Boreal Forest, Canada. Ranking is based on avian density and generated using the software package Zonation across a suite of seven wetland-associated species and 92 forest-associated species. The highest ranks are in red; lowest ranks are in blue. The highest priority areas (i.e., top 20%) are in orange and red.

TABLE 9. The mean (±SD) relative conservation value of cells for wetland- and forest-associated non-game birds within the waterfowl Priority areas across the Western Boreal Forest, Canada. Values were stratified by province and territory. Priority areas with a mean relative priority value ≥ 0.80 for at least one non-game bird group are **bolded**.

JURISDICTION	WETLAND BIRDS	FOREST BIRDS
	MEAN (±SD)	MEAN (±SD)
ALBERTA	0.44 (±0.20)	0.78 (±0.16)
BRITISH COLUMBIA	0.31 (±0.19)	0.74 (±0.14)
MANITOBA	0.60 (±0.26)	0.68 (±0.25)
NORTHWEST TERRITORIES	0.71 (±0.15)	0.21 (±0.15)
NUNAVUT	**0.88 (±0.14)**	0.06 (±0.07)
SASKATCHEWAN	0.50 (±0.17)	0.71 (±0.16)
YUKON	0.21 (±0.10)	0.45 (±0.10)

Across the WBF, the waterfowl priority areas capture 28% and 35% of the WBF population size for wetland- and forest-associated species respectively. In some jurisdictions, the waterfowl priority areas captured a significant proportion of that jurisdiction's populations of wetland- and forest-associates. For example, waterfowl priority areas in Nunavut included 53.9% of the estimated population of wetland-associated birds and 52.5% of the estimated population of forest-associated birds in Nunavut (Table 10). However, Nunavut contains a small proportion of the total population of these taxa in the WBF. By comparison, the waterfowl priority areas in Northwest Territories have the potential to make the biggest contribution to populations of wetland- and forest-associated birds in the WBF as a whole (Table 10).

These results demonstrate that there are opportunities for co-benefits from conservation programs targeting waterfowl, and some of this work is underway. For example, in Manitoba the Seal River Watershed Alliance is working to develop an IPCA, and in the Northwest Territories, the Akaitcho land use planning is in progress. These areas both include opportunities for meaningful co-benefits between waterfowl and wetland-associated non-waterfowl species. Nunavut, on the other hand, is an area where PHJV partners have not been as active; the potential for co-benefits may provide future opportunities to advance conservation planning in that region. Many of the regions that have the greatest potential for co-benefits for forest-associated species also have various opportunities for conservation from land use planning initiatives to IPCAs and OECMs to sustainable land use practices. The Whooping Crane species profile below provides an additional opportunity to achieve co-benefits for this high-profile Endangered species. Leveraging the opportunities to benefit both waterfowl and forest landbirds will assist the PHJV partners to move forward with large landscape-scale planning initiatives and foster collaborative partnerships with mutually beneficial objectives.

These results also demonstrate that co-benefits of waterfowl conservation activities in the WBF alone will not achieve the conservation objectives for the majority of non-waterfowl species. Indeed, the greater proportion of the populations of several species of highest conservation priority in the WBF are found outside the waterfowl priority areas (Table 11). These and other species will require alternative conservation planning and action to ensure sufficient upland and other habitat is conserved to support population goals.

TABLE 10. Representation of the wetland- and forest-associated non-game bird populations within the waterfowl priority areas across the Western Boreal Forest (WBF), Canada. Non-game bird representation is estimated as the percentage of the total a) province or territory population size (% Prov/Terr) and b) WBF population size (% WBF) that is captured by the waterfowl priority areas within a jurisdiction.

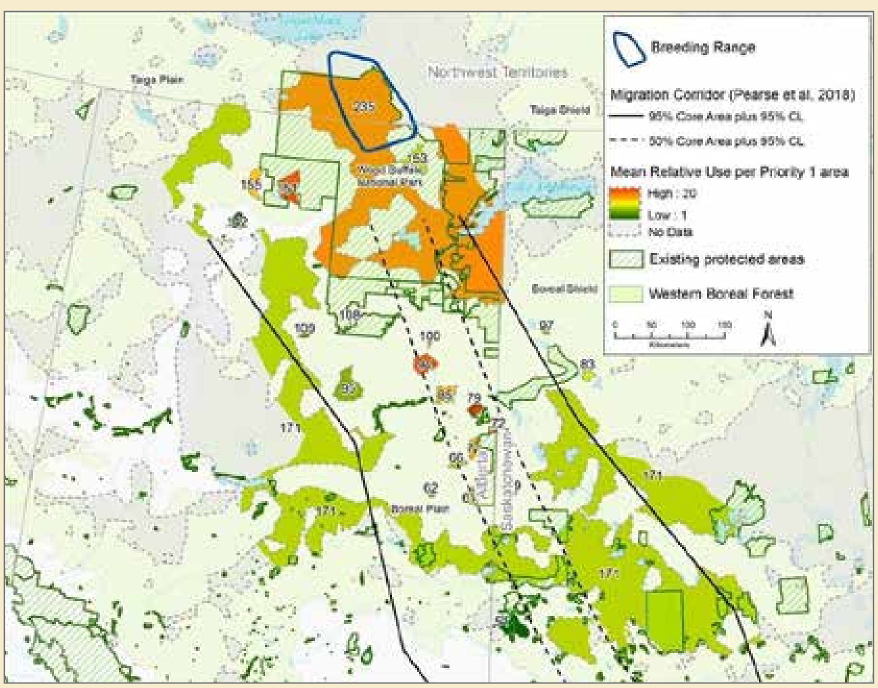
PROVINCE OR TERRITORY	WETLAND BIRDS		FOREST BIRDS	
	% PROV/TERR	%WBF	% PROV/TERR	%WBF
ALBERTA	42.1	5	38.9	5.2
BRITISH COLUMBIA	25.4	1.4	18.4	2.1
MANITOBA	32.3	8.5	34.1	5.7
NORTHWEST TERRITORIES	36.2	10.8	31.6	8.8
NUNAVUT	53.9	2.5	52.5	1.2
SASKATCHEWAN	36.5	5.2	39.8	4.4
YUKON	40.9	3.2	41.6	7.2

Whooping Crane: opportunities for co-benefits from waterfowl conservation

Whooping Crane (Grus americana) is one of North America's rarest bird species and the subject of intense public interest. Once numbering in the thousands, Whooping Cranes occupied a broad region in the central grasslands and northern forests of North America (Austin et al., 2019). By the 1940s, habitat loss and persecution had reduced the species to a single population consisting of 14 individuals. This population, referred to as the Aransas Wood Buffalo Population (AWBP), summers in the WBF in and around Wood Buffalo National Park and winters on the Gulf Coast of Texas in and around the Aransas National Wildlife refuge.

Today, Whooping Crane are listed as Endangered in both Canada and the United States, and it is protected by this and other legislation in both countries. The AWBP has approximately 500 individuals and continues to grow. This recovery is the result of legal protection and the collaborative research and conservation efforts of government agencies and conservation organizations in both countries. One such collaboration is a satellite tracking program to quantify habitat use and movement patterns of cranes, and identify threats to recovery and opportunities for conservation (Appendix E). To date, 97% of the recorded migrations included one or more landings in the WBF, typically lasting one to two days (range 1-17), and 60% of these landings and 80% of the migration corridor in the WBF occurred in unprotected areas, much of which is used for resource extraction and includes areas with the highest levels of anthropogenic disturbance in the WBF (Pasher et al., 2013). Almost 30% of the breeding range lies to the east and north of Wood Buffalo National Park in areas that also are unprotected.

When migrating through the WBF, Whooping Cranes select most strongly for landing sites containing emergent and meadow marshes and graminoid and shrubby fens, and select against uplands. These habitat preferences provide clear opportunities for deriving conservation co-benefits for cranes from activities targeted at waterfowl. Of 22 priority areas for waterfowl conservation contained within the migratory corridor, 16 have above median values of predicted relative use by Whooping Cranes; one area contains ~93% of the breeding range. Whooping Cranes would benefit most from activities focused on conserving the quality and quantity of preferred wetlands in the migratory corridor and breeding range. **By protecting these habitats and mitigating risk within them, PHJV can play an important role in supporting the ongoing recovery of this high-profile species.**



Predicted relative use of waterfowl priority areas by Whooping Crane within their migratory corridor in the WBF.

TABLE 11. Distribution, as percent of a species' population in the Western Boreal Forest (based on BAM density models; Appendix C), of priority non-game birds (as per Table A-1) within waterfowl priority areas as well as outside of boreal waterfowl priority areas.

SPECIES	% POPULATION IN WBF	
	WATERFOWL PRIORITY AREA	OUTSIDE
CANADA WARBLER	40	58
EASTERN WOOD-PEWEE	40	58
EVENING GROSBEAK	32	65
GOLDEN-WINGED WARBLER	41	57
LESSER YELLOWLEGS	35	63
OLIVE-SIDED FLYCATCHER	32	66
RUSTY BLACKBIRD	33	65

Human Dimensions Objectives

There is increasing recognition that resource management is part of a complex system involving social, economic and ecological dynamics (Cumming and Allen 2017). Many of the challenges facing conservation managers, including engagement and support from a wide range of stakeholders, requires insight into the human dimensions of conservation. Manfredo et al. (1998) defines the concept of "human dimensions" (hereafter, HD) in wildlife conservation as the assessment and application of social information in fish and wildlife decision-making. Use of HD tools and research can offer the conservation community a better understanding of the driving forces behind conservation behaviours, and the management strategies required to address different perceptions and behaviours relative to habitat conservation (Dayer et al. 2019). The solutions to these challenges involve motivating a broad set of constituents to engage in habitat conservation. Doing so will require a better understanding of how people connect with bird habitat conservation, and how to apply that knowledge in ways that more readily engage the public in active support of conservation programs.

Building on the PHJV's growing WBF achievements that support people and wildlife through conservation of natural places and the ecological goods and services they provide, HD will continue to gain importance in the planning process for conservation in the WBF. The consideration of traditional knowledge and practices about the ecological goods and services (e.g., traditional food gathering locations, wildlife wintering areas, traditional hunting locations) provided by wetlands and other natural features will support conservation planning. Engaging Indigenous communities to improve this HD strategy will be important to its success.

Conservation objectives, such as protecting natural land cover and maintaining sustainable populations of wildlife, are fundamentally based on the value, whether intrinsic or utilitarian, that humans place on functional ecosystems. Achievements towards these objectives, though, are often measured in terms of ecosystem-based metrics (e.g., hectares conserved, species population size). These metrics have historically been assumed to align with the human values and uses of these natural resources; however, defining explicit objectives and metrics of success that are directly based on the values of stakeholders will create better alignment of HD in conservation planning.

The PHJV held a workshop with the science advisory committee to develop a Human Dimensions Strategic Plan with explicit objectives. Each objective identified an HD outcome, long-term (20-year) objective, five-year milestone, metrics for evaluation of success, and a strategy to achieve these objectives. The objectives identified during the workshop largely focused on the PHJV Prairie Parklands, which differs substantially from the WBF, as previously described. While the general objectives and approaches of the PHJV Prairie Parklands HD strategy aligned with the needs of the WBF, a modified Boreal HD strategy was created to focus on the needs of this region. The Boreal HD strategy is provided in Appendix D, and the objectives will focus on the following:

- Increasing social science capacity within the PHJV WBF;
- Improving trust and relevancy among all stakeholders;
- Enhancing stakeholder participation in PHJV programs;
- Increasing awareness of policy makers of the importance of wetlands, including as waterfowl habitat, and encouraging improvements to wetland protection policy; and
- Improving attitudes and participation among the general public of PHJV WBF programs.

As human dimensions of conservation continue to gain focus within the habitat joint ventures, evaluating the proposed boreal forest HD strategy among partner groups and stakeholders will be important to adapting the strategy for conservation work within the WBF. There are unique cultural and historical uses and values of wetlands by WBF residents, particularly those of Indigenous Peoples and their communities of the boreal region, and ensuring that the strategy is appropriate for these groups will be key. As such, refining the HD strategy should include the ability to incorporate traditional knowledge and Indigenous interests into conservation planning within an ethical space.

7.0 CONSERVATION PROGRAMS 2021–2025

The suite of conservation programs, including delivery, research and evaluation, communication and education, and partnerships and coordination are developed to achieve the specific conservation objectives of the PHJV in the WBF and are tailored to this unique landscape. Conservation delivery programs target the protection of or sustainable use of lands throughout the boreal forest, through working with partners in this broad landscape. To date, these delivery programs have occurred in areas that support waterfowl population and habitat objectives, as they have primarily been delivered by Ducks Unlimited Canada. However, these programs would be equally effective at delivering habitat conservation for other species as well.

All PHJV conservation programs employ Strategic Habitat Conservation (SHC) as an adaptive, science-based approach to conservation (Figure 9). Through this adaptive management framework, research and evaluation programs are essential to inform biological planning, adapt conservation delivery programs, and test working hypotheses in order to refine future plans and actions.

Continuous evaluation and research to improve conservation will help deliver the greatest return on investment throughout the PHJV region. Communication and education programs are also important to conservation delivery because of the size of the region, and the number and diversity of stakeholders and land managers. Engaging stakeholders through communication and providing educational resources about boreal forest conservation to foster participation are key in this region. Finally, the partnerships and coordination programs are fundamental to conservation implementation in the WBF. Given the nature of the land tenure in this region (primarily public land) and the diverse values (e.g., birds, caribou, climate change mitigation), conservation programs outside of partnerships would have limited success.

FIGURE 9. Flow process of strategic habitat conservation applied in the WBF.

The anticipated expenditures and projections of these conservation programs are presented in the Expenditures and Projections section below. These expenditures are approximate and developed from the perspective of what would be needed to deliver these programs in the absence of additional effort targeting non-waterfowl conservation. They also reflect past experience of potential funding available for waterfowl-focused conservation in the WBF.

Conservation Delivery

With more than 90% of the WBF as public land, and bird abundance varying by species and by area across the WBF, the most successful conservation approaches with the highest return on investment are those that result in landscape-level influence. Although waterfowl habitat will continue to be the focus reflecting the current PHJV partners active in conservation across the WBF, most of the conservation programs outlined here will also deliver some co-benefits of conserving key habitat areas for non-waterfowl migratory bird species. Experience has shown that it is more cost effective in the WBF to invest in landscape level (>100,000 acres) activities that promote or protect healthy and functional landscapes than activities that influence smaller areas.

While the scale of influence is key to successful conservation delivery, several other factors are also critical to successful implementation of conservation goals in the WBF (Figure 10).

Experience has shown that it is more cost effective in the WBF to invest in landscape level (>100,000 acres) activities that promote or protect healthy and functional landscapes

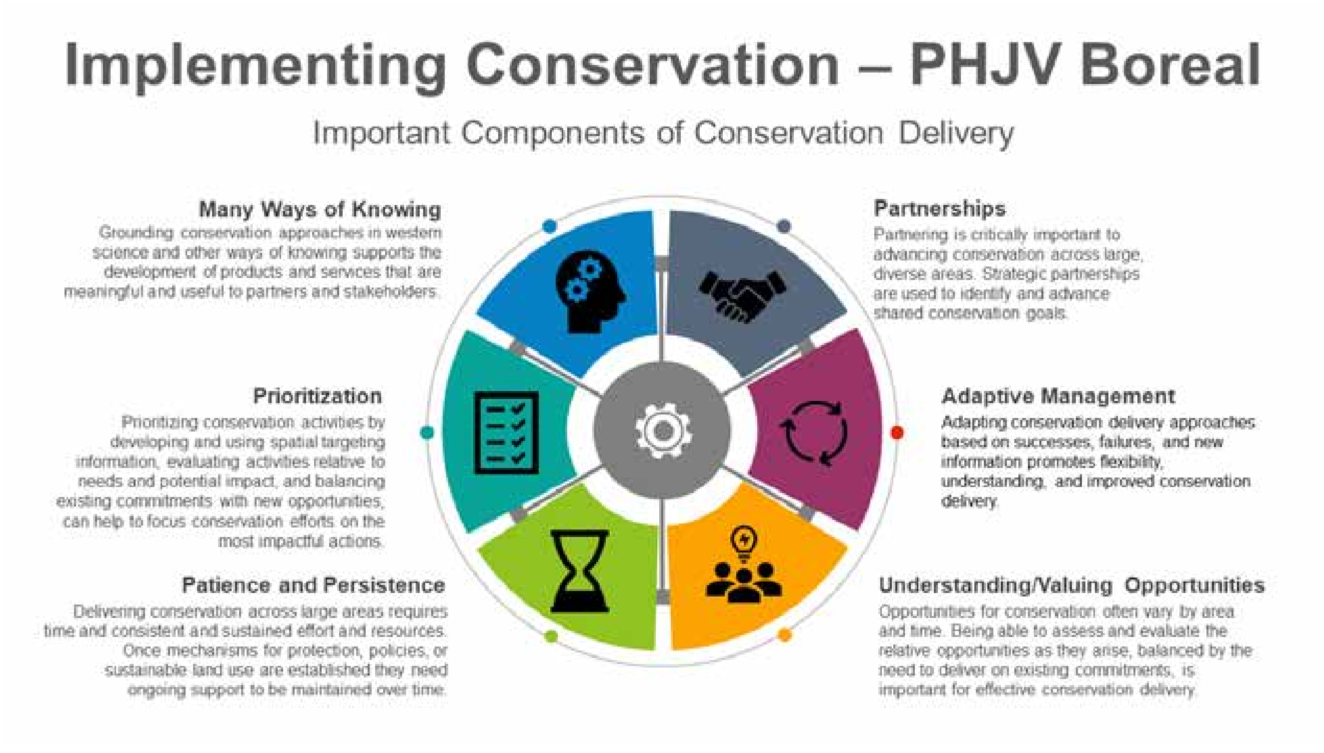


FIGURE 10. Important components to successful conservation delivery in the WBF.

Previous PHJV IPs for the WBF established that the primary conservation delivery mechanisms to advance waterfowl conservation in the boreal forest were through the establishment of protected areas, promoting sustainable land use practices with land managers, and working with governments and industries to advance policies that result in habitat conservation. These tactics are typically achieved by working within collaborative, partnership-based processes associated with government policies and regulations, green certification protocols, industry associations, corporate policies and practices, Indigenous communities, and other stakeholders. The overall approach to PHJV WBF conservation delivery is shown in Figure 11. The following sections highlight the main conservation approaches and how they can influence conservation delivery going forward to achieve WBF habitat objectives. Note that the approaches currently focus largely on waterfowl habitat conservation, but will be revised as additional conservation delivery partners focused on all-bird conservation become engaged in the PHJV WBF.

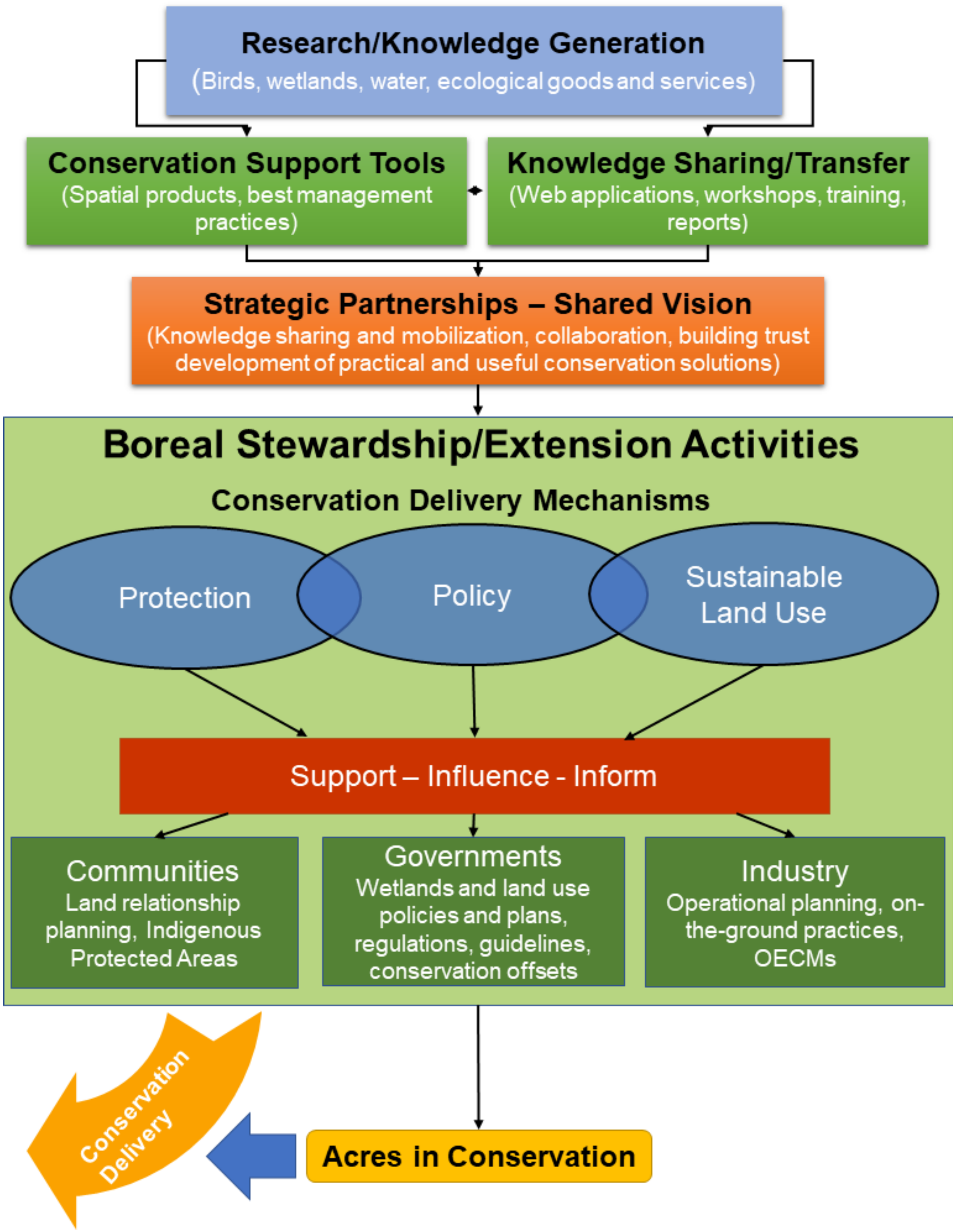


FIGURE 11. Flowchart of approach to conservation delivery in the Western Boreal Forest.

Research, Knowledge Generation and Evaluation

The PHJV's success in the WBF will depend on its relevance to external policy-based processes and stakeholders. Given the relatively limited knowledge about wetlands and waterfowl in the WBF compared to other regions, and the great value of that information for creating conservation opportunities, a long-term role for the PHJV will be to continue bringing key scientific information to internal and external WBF conservation planning and implementation processes, and to support prioritization and adaptive management of conservation program delivery.

The science support for PHJV policy efforts will be strengthened by continuing to formulate and evaluate hypotheses that relate land use change and PHJV programs to waterfowl abundance and productivity (see Research and Evaluation 2013—2020 section). Further, this science support will help guide conservation programs to address the landscape- and climate-based changes that cause significant demographic limitation to waterfowl (e.g., guide the development and/or evaluation of SLU practices and other conservation programs related to waterfowl habitat conservation programs and stewardship activities).

Finally, the WBF has and will continue to be impacted by climate change. A core long-term objective is to evaluate how climate change a) interacts with industrial landscape changes and may limit waterfowl and other birds; b) alters the value of PHJV investments; and c) influences the locations and types of future PHJV conservation in the WBF. This information will form the basis of the PHJV's climate change adaptation strategy and the development of nature-based climate solutions.

Conservation Planning and Support Tools

Another important component of PHJV success in the WBF is the generation of timely, relevant, and useful conservation planning and support tools. These tools create a defensible and objective framework to guide PHJV decision-making and are regularly refined with the input of new knowledge. For waterfowl-focused programs these include waterfowl distribution mapping, ongoing improvement and updating of spatial targeting of conservation programs, spatial assessments of habitat risk, and scenario models connecting current and potential habitat conditions to waterfowl abundance and indices of productivity. Such tools will be critical to evaluating the successes of conservation programs, refining habitat objectives, developing future budget scenarios, and measuring PHJV success beyond acres conserved, including evaluation of provincial wetland policies. Some similar tools exist for non-waterfowl species and their ongoing development will benefit the integration of conservation programs designed for all birds. In addition, the case for waterfowl and other bird conservation will be strengthened by continued development of conservation support tools that link habitat of waterfowl and other bird species to other ecosystem services that may have greater relevance to society, (e.g., caribou and other Species at Risk, carbon sequestration).

Conservation support tools are also important to provide timely and relevant information on wetlands, birds, water, waterfowl habitat and other topics to assist land managers and decision makers with decisions that ultimately result in conservation acres on the ground (e.g., land use plans). One key information layer identified by PHJV partners is a Canada-wide detailed wetland inventory. Unfortunately, no completed wetland inventories exist that extend across all WBF jurisdictions with sufficient spatial resolution, coverage, or other defined standards to facilitate a full implementation or a large-scale evaluation of potential wetland policies. Therefore, the PHJV must continue to play a role in ensuring the tools required to implement wetland policies are developed. Currently, work continues to advance wetland inventories, with over 250 million acres mapped by Ducks Unlimited Canada, along with new funding commitments from the federal government towards advancing wetland inventories.

Communications and Education — Knowledge Sharing and Transfer

Communications and education aspects of conservation delivery, while primarily funded via sources external to NAWCA funding, are important to PHJV WBF conservation efforts. They increase awareness of the need, opportunity, and importance of conservation, and support more broadly the PHJV human dimension goals (Appendix D). During the next five years, additional funding sources will be needed to support knowledge mobilization (through knowledge sharing and transfer) to accomplish the overall PHJV goals.

During the last IP, several successful knowledge sharing and transfer approaches targeting waterfowl and wetlands were implemented, including, among many other approaches:

- establishment of a Wetland Centre that provides on-the-ground, immersive learning around best management practices in wetlands;
- the launch of the Canadian Conservation Land Management system (www.cclmportal.ca), a comprehensive, online resource for sharing best management practices around water, wetlands, waterfowl and other birds); and
- a series of detailed field guides to minimize impacts on wetlands.

Currently, the PHJV will continue to deliver communications and education programs that promote wetland conservation in the WBF through stewardship/extension-based support tools and products that help partners advance PHJV goals to a wide range of groups including Indigenous Peoples, governments, and industry and public stakeholders. Implementation plans, reports, fact sheets and related documentation, plus hosting workshops, are a few examples of how the PHJV increases wetland- and waterfowl-conservation awareness and provide guidance to government, industry, environmental non-governmental organizations (ENGOs) and the public. Similar programs are needed to foster learning and engagement in conservation efforts for all birds.

PHJV communications and education efforts will also continue to evolve and adapt to new approaches, technologies and audiences. Continued innovation such as the creation of internet-based wetland training modules, webinars, 360-degree virtual wetland tours, support in the development of wetland field guides and BMP portals, and hands-on wetland best management practice learning centres will continue to advance PHJV goals while generating increased awareness and interest in WBF wetland and waterfowl conservation.

There are over 600 First Nations communities in the boreal forest, and federal funding for Indigenous Protected Conserved Areas and Guardians programs has increased capacity within Indigenous communities to advance conservation.

Strategic Partnerships and Coordination

Because conservation in the WBF is largely achieved through large-area influence, strategic and engaged partnerships are critical to the overall success of PHJV efforts. Coordination of PHJV partner activities in the WBF occurs largely through Ducks Unlimited Canada in Manitoba, Saskatchewan, Alberta, northern British Columbia, Northwest Territories, and the Yukon. In Alberta, Alberta NAWMP Partnership also plays a key role in coordinating and facilitating WBF research, evaluation, policy development, communication and education. Government partners (Indigenous, federal, provincial or territorial) hold the land use decision power, and these governments must balance the range of social needs (e.g., employment and resource needs, environmental, cultural) when making land use decisions. Indigenous Peoples are a major government influence on land management decisions. There are over 600 First Nations communities in the boreal forest, and federal funding for Indigenous Protected Conserved Areas and Guardians programs has increased capacity within Indigenous communities to advance conservation.

Much like the prairies, there are also numerous stakeholders within the boreal forest, and each has their own priority interests. PHJV interests may at times be secondary to the multitude of other interests that land managers and decision makers must address. Because of this complexity, conservation success in the boreal forest often takes considerable time to achieve, though the returns on investment can be substantial. For example, the Sahtu Land Use Plan (NWT) took over 15 years to establish through an Order In Council, but it resulted in over 40 million acres of protection and sustainable development. Thus, success of PHJV programs in the WBF will be proportional to our ability to form long-term, strategic partnerships with other ENGOs, Indigenous communities and organizations, industries, governments, and the private sector to guide goals of these diverse partners towards our waterfowl and other bird habitat objectives. Leveraging partner interests, the like federal government's interests around regulating the *Species at Risk Act* and the *Migratory Bird Conservation Act*, provide resources and funding to support conservation of many different species, that ultimately provide co-benefits to birds and their habitat as well.

PHJV Stewardship / Extension Activities

During the next five years, it is anticipated that over $25 million dollars are to be spent by PHJV partners on stewardship and extension activities in the WBF (see Expenditures and Projections below), highlighting the importance of these activities to deliver influenced acres. PHJV partners employ three main conservation delivery mechanisms (protection, policy, sustainable land use) to inform, influence and support land managers and decision makers throughout the WBF, and ultimately result in influenced priority habitat acres on the ground, as detailed in the following sections.

Conservation Delivery Mechanism — Policy Influence

The goal of the Policy Influence programs is to support effective provincial/territorial, Indigenous, national, and other government policies that conserve the identified habitat required to achieve the population objectives for species. In the case of waterfowl, this is through effective wetland policies to prevent further loss and leverage an increase in wetland abundance. The experience gained during the 2013—2020 implementation period and lessons learned have been used to refine the primary approaches used to influence conservation policies. The approach to policy influence in the 2021—2025 Plan has a current focus on waterfowl habitat conservation due to the absence of PHJV partners that are driving conservation for other species. As such, the policy influence approach will:

- Inform and influence government-led policies, legislation and regulations that have significant impacts on waterfowl habitat within and outside target areas (e.g., the Yukon Wetland Policy; review of the Alberta Green Zone wetland policy; update and modernization to various Acts and Regulations related to wetlands in the Northwest Territories).
- Engage in government-led programs that flow out of existing legislation and regulations, which will result in land use decisions that align with PHJV waterfowl and other bird habitat conservation objectives (e.g., land use planning, climate change

mitigation programs and crown land designation programs).
- Inform and influence specific government-led industry operating guidelines, codes of practices and standards (e.g., the Manitoba Boreal Wetland Codes of Practice; the Saskatchewan Boreal Wetland Codes of Practice).
- Work collaboratively with all levels of government to ensure effective implementation and monitoring of all policies and ensure that adaptive management policies and practices for sustainable development of natural resources objectives are in place.

For the policy influence approaches to be most effective at conserving the desired habitat, addressing key knowledge gaps will be essential. Knowledge gaps often delay the establishment or limit the implementation of provincial/territorial policies in certain areas. More research is needed to support the justification of wetland policies as well as the avoidance, minimization and offset steps of wetland policy. Accurate wetland inventories are also needed across all jurisdictions to effectively implement and monitor wetland policies.

Conservation Delivery Mechanism — Protected Areas Influence

The protected areas influence approach to conservation implementation has similarities to the policy influence approach through working with Indigenous communities, governments and private stakeholders, but differs in the focus of that influence. The goal of influencing protected areas is to maintain existing and continue expanding protected areas throughout the WBF that contribute to the habitat conservation objectives. The key initiatives under this approach include:

- Support the renewal of interim protected areas when reviewed or the transition into permanent protection when proposed under government protected areas processes, and the establishment of adequate management plans and monitoring programs.
- Promote the development of new protected areas that contribute to achieving habitat objectives, particularly where there is a greater potential for habitat loss. Leveraging the current federal protected area targets (i.e., 30% by 2030).
- Support Indigenous-led conservation through the establishment to IPCAs and Indigenous Land Use/Relationship Plans; and continue to explore new mechanisms (e.g., OECMs) for influencing the stewardship of priority habitat.

The greatest challenge with advancing protected area establishment throughout the WBF is the political will. Despite international commitments to achieve benchmarks of land area protected (e.g., 30% by 2030), provinces and territories have final jurisdiction over much of the land base in the WBF, and are balancing often competing economic and social priorities as well. Therefore, continuing to leverage multiple conservation priorities (e.g., Species at Risk - caribou, carbon) may provide some of the best opportunities to achieve waterfowl and other bird habitat conservation objectives. There also remain some gaps in data on the regional distribution and abundance of some species, which is beneficial to the process of determining protected area boundaries.

Conservation Delivery Mechanism: Sustainable Land Use Influence

The goal of sustainable land use as a conservation tool in the WBF is to work with industry partners in advancing PHJV conservation objectives in non-protected working landscapes. The development of sustainable land use policies, practices and guidelines is done at a scale-appropriate level (i.e., national, regional, local) for their application. Initiatives used in the sustainable land use approach include:

- Develop new and review existing codes of practice for the opportunity to recommend changes to improve their overall effectiveness in delivering habitat aligned with the IP objectives.
- Develop, collate, monitor, and evaluate novel sustainable land use practices and best management practices that sustain waterfowl and other bird habitats, which may be above regulatory requirements.
- Ensure environmental certification associations incorporate adequate wetland and other key habitat (e.g., old-growth forest) conservation standards into their respective certification processes.
- Develop and implement knowledge sharing and transfer platforms.
- Address information needs of industry partners to help sustain bird habitat.
- Develop and sign Stewardship Agreements with leading industrial companies committing to further development and implementation of sustainable land use practices (planning and operations), with a commitment to adaptive management and continuous improvement.

One of the biggest barriers to development and implementation of SLU for conservation in the WBF is the relative lack of information and tools. Therefore, focus should be on leveraging new research to identify tools and techniques that can be developed into BMPs, advancing knowledge sharing and transfer of these approaches, and delivering other extension activities to increase the awareness of sustainable land use.

8.0
EXPENDITURES AND PROJECTIONS

Expenditures to deliver habitat conservation as well as other PHJV WBF programs during the 2013—2020 IP period were similar to the forecasted expenditures with some notable exceptions (Table 12). Because most of the waterfowl conservation delivery mechanisms in the WBF are focused on supporting partner initiatives (e.g., policy, stewardship), the PHJV did not have many expenditures on activities such as enhancement, management, and reconnaissance and design. These are activities primarily associated with conservation applied in the prairies where habitat conservation is directed at private lands. Also, during this period, the PHJV changed protected areas from a securement activity (implies purchase/ownership of title) to a stewardship activity, which are reflected in the reported expenditures for securement and stewardship and the discrepancy in 2013—2020 forecast and expenditures in both categories (Table 12). Other PHJV activities (i.e., communication and education, coordination, evaluation, policy support) had expenditures similar to the original forecasted number.

For the 2020—2025 planning period, the forecasted budget is anticipated to be similar to the expenditures of the previous (2013—2020) period with a continued emphasis on stewardship, policy support, evaluation, coordination, and communication and education (Table 12). These estimates were based on a review of expenditures from the 2013—2020 period, the suite of conservation program initiatives anticipated in 2021—2025, and the anticipated expenses required to achieve the habitat objectives for this period.

TABLE 12. Summary of the 2013—2020 forecast and actual expenditures with 2020—2025 expenditure forecast.

ACTIVITY	2013-2020 FORECAST	2013-2020 EXPENDITURES	2021-2025 FORECAST (ANTICIPATED)
COMMUNICATION AND EDUCATION	$3,000,000	$4,634,976	$4,000,000
COORDINATION	$2,880,000	$3,706,306	$3,500,000
ENHANCEMENT	$0	$0	$0
EVALUATION	$7,024,000	$6,263,281	$7,000,000
MANAGEMENT	$5,528,000	$2,275	$0
POLICY SUPPORT	$4,328,000	$2,773,942	$3,000,000
RECONNAISSANCE AND DESIGN	$640,000	$0	$0
SECUREMENT	$12,000,000	$3,726,671	$500,000
STEWARDSHIP	$12,000,000	$24,683,366	$25,000,000
TOTAL	**$47,400,000**	**$45,790,817**	**$43,000,000**

9.0
CONCLUSIONS AND FUTURE OPPORTUNITIES

Since 2001, PHJV conservation actions have influenced conservation of 120 million acres through both protection and SLU in the WBF and the delivery programs targeting policy and practices of government (Indigenous, federal, provincial, territorial and municipal), industry partners, and other stakeholders. Of this total, more than half (58%) was delivered in the last implementation period (2013—2020). Between 2013 and 2019, waterfowl populations within the WBF increased substantially with all but Scaup at or above their LTA abundance in the region, and some species well above their 80th percentile of the LTA. In addition to these habitat successes, relationship building efforts with Indigenous groups created strong partnerships that will continue and help achieve future waterfowl habitat conservation goals recognizing the value of these areas to traditional cultural activities.

The success of this program will only happen through conservation initiatives that are founded in collaborative partnerships with Indigenous communities, resource development industries, and government agencies to ensure the sustainability of this important waterfowl breeding, staging and moulting area.

While waterfowl and most other avian species within the WBF are not at risk of extirpation, several species have declined substantially in numbers and 15 are listed on Schedule 1 of the *Species at Risk Act*, including the most at-risk bird species, the Whooping Crane (Venier et al. 2014). Pursuing opportunities for conservation co-benefits between waterfowl and these key species, as well as achieving co-benefits for other species of conservation concern, will be increasingly important for habitat conservation in the WBF, and the future sustainability of their populations.

The WBF, particularly throughout its southern portion, continues to change because of direct human activities, such as resource development and agricultural expansion. These activities coupled with the shifts resulting from climate change will continue to pose challenges to the conservation of waterfowl and biodiversity in this region, and the ecological goods and services it provides. Research conducted as part of our adaptive management programs over the 2013—2020 period provided greater clarity on the scope and scale of the effects of changes in the WBF, though there remain several key knowledge gaps that should be addressed to improve our understanding of this ecosystem and how to manage its sustainably. Advancing our understanding of the cumulative effects of agricultural conversion, industrial activities and climate change on habitat changes and demography of waterfowl and other bird species is a particularly important challenge to refine best management practices and policies that help shape activities in the WBF. Also, fundamental to understanding effects of these activities and changes is the gap in monitoring information for waterfowl and other avian species in some regions of the WBF, which affects the ability to develop accurate spatial targets for conservation delivery. More broadly, understanding and leveraging human dimensions in the WBF will be essential to the success of conservation that balances multiple stakeholders' perspectives and values associated with this biome. Overcoming these challenges will better position the PHJV in delivering conservation that is effective and recognizes that much of the WBF is and will remain a working landscape.

The 2013—2020 WBF IP set ambitious goals for conservation within the WBF and there are equally ambitious goals set in this 2020—2025 Plan. Achieving the goal of conserving 75 million acres, of which 40 million acres are projected to be core waterfowl habitat, will be achieved through leveraging a projected budget of $43 Million. Beyond waterfowl habitat goals, this plan also identifies the extent to which these priority areas will benefit non-waterfowl avian species; it identifies the need for additional conservation planning and action targeted at non-waterfowl species; it highlights opportunities to make progress towards achieving conservation goals for these species; and it sets a strategy for the understanding and implementation of HD in PHJV WBF conservation planning. The success of this program will only happen through conservation initiatives that are founded in collaborative partnerships with Indigenous communities, resource development industries, and government agencies to ensure the sustainability of this important waterfowl breeding, staging and moulting area.

10.0 LITERATURE CITED

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APPENDICES

APPENDIX A:
LONG- AND SHORT-TERM TRENDS, CONSERVATION RANKS AND BREEDING HABITAT DESCRIPTIONS OF SHOREBIRDS, WATERBIRDS AND LANDBIRDS IN THE BOREAL FOREST PORTION OF THE PRAIRIE HABITAT JOINT VENTURE.

Non-waterfowl avian species were classed as wetland- or forest-associated shorebirds, waterbirds and landbirds (based on Rosenberg et al. 2019) in the Western Boreal Forest. Species marked with an asterisk (*) had sufficient data to model habitat associations and identify areas of conservation opportunity for multiple species. The status of those species included on Schedule 1 of the *Species at Risk Act* (SARA) is indicated in parentheses (TH = Threatened; SC = Species Concern). Conservation ranks were assigned to species in decreasing order of conservation priority based on their inclusion on Schedule 1 of SARA (4), a large decrease in population size (3; Partners in Flight Population Trend continental score (PT-c) of 5 (https://pif.birdconservancy.org)), a moderate decrease in population size (2; PT-c = 4), and all others (1). Annual trends (% change per year with 95% credible intervals in parentheses) are based on Breeding Bird Survey (BBS) data from 2009 to 2019 (short-term) and 1970 to 2019 (long-term) for the Boreal PHJV portions of Bird Conservation Region (BCR) 4, 6 and 8 combined (BCR 7 was excluded due to insufficient data for a sub-regional analysis; Smith A.C. et al. unpublished, an update of Smith et al. 2019). The reliability of the amalgamated trend estimates (H = High, M = Medium, L = Low) considers precision and local data weight, but does not include geographic coverage. General habitat descriptions are from ABMI and BAM (2020) with supplementation from Poole (2020).

TABLE A-1. Conservation rank, trend and habitat descriptions of landbird, waterbird and shorebird species in the boreal forest portion of the PHJV.

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
ALDER FLYCATCHER*	Landbird	2	-0.33 (-2.47, 1.94) M	-0.81 (-2.48, 0.24) H	Shrub thickets and young deciduous stands near water
AMERICAN GOLDFINCH*	Landbird	1	-1.15 (-3.33, 1.09) M	-1.18 (-1.94, -0.45) H	Open meadows and grassy fields; less common in mature, open deciduous and mixedwood stands
AMERICAN REDSTART*	Landbird	1	-0.48 (-2.61, 1.89) M	-0.06 (-2.70, 1.66) M	Young deciduous stands with dense shrub understory, often near water
AMERICAN ROBIN*	Landbird	1	0.55 (-0.59, 1.72) H	0.54 (-0.57, 1.30) H	Habitat generalist with preference for young pine and black spruce stands, and proximity to disturbed areas
AMERICAN THREE-TOED WOODPECKER*	Landbird	1	6.68 (1.51, 12.45) L	3.94 (1.36, 6.73) M	Mature coniferous forests
BALTIMORE ORIOLE*	Landbird	2	-1.97 (-4.83, 0.86) M	-3.03 (-3.89, -2.22) H	Open deciduous forests and edge habitats, including riparian areas

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
BAY-BREASTED WARBLER*	Landbird	1	8.40 (-1.41, 20.67) L	2.67 (-1.04, 6.26) L	Mainly white spruce and mixedwood stands, deciduous stands to a lesser degree; abundance increases with stand age
BLACK-AND-WHITE WARBLER*	Landbird	2	-0.81 (-3.34, 2.27) M	0.90 (-1.30, 2.73) M	Immature deciduous, white spruce and mixedwood stands, and shrubby and treed swamp
BLACK-BACKED WOODPECKER*	Landbird	1	1.18 (-5.87, 8.93) L	2.88 (-0.38, 6.24) M	Recently burned stands, especially pine and black spruce
BLACK-BILLED CUCKOO*	Landbird	3	0.61 (-4.97, 6.31) L	-1.80 (-3.70, 0.00) M	Open deciduous and mixed forests, and brushy habitats
BLACKBURNIAN WARBLER*	Landbird	1	-3.86 (-8.10, 1.46) L	-1.13 (-3.10, 0.88) M	Mature and old deciduous, black spruce and mixedwood stands
BLACK-CAPPED CHICKADEE*	Landbird	1	-1.55 (-3.79, 0.73) M	0.51 (-0.36, 1.37) H	Generally common across upland forest types with abundance higher in intermediate-aged deciduous and mixedwood stands
BLACKPOLL WARBLER*	Landbird	3	2.38 (-5.72, 13.28) L	-2.47 (-6.61, 0.90) L	Wet coniferous forest, primarily spruce and stands with an expansive coniferous mid-story, and spruce-shrub thickets
BLACK-THROATED BLUE WARBLER*	Landbird	1	-	-	Mature deciduous and mixedwood stands
BLACK-THROATED GREEN WARBLER*	Landbird	1	-5.25 (-10.68, 3.28) L	-2.69 (-5.32, -0.10) M	Mature and old mixedwood, deciduous, and white spruce stands
BLUE JAY*	Landbird	2	0.68 (-1.28, 2.69) M	1.08 (0.10, 1.96) H	Habitat generalist that is equally uncommon in all forest types and ages; strong positive association with urban and industrial sites
BLUE-HEADED VIREO*	Landbird	1	-1.17 (-4.12, 1.95) M	2.11 (0.41, 3.60) H	Intermediate to mature mixedwood, white spruce and deciduous stands
BOHEMIAN WAXWING*	Landbird	3	-4.55 (-9.53, 1.18) L	-2.85 (-5.07, -0.33) M	Open coniferous or mixedwood stands, and open fields
BOREAL CHICKADEE*	Landbird	1	0.85 (-2.48, 4.23) M	-0.25 (-1.70, 1.21) H	Old-growth coniferous forest, and old mixedwood forest to a lesser degree
BROWN CREEPER*	Landbird	1	-0.95 (-6.37, 5.49) L	1.53 (-0.82, 3.82) M	Large tracts of old coniferous, mixedwood and deciduous forest

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
BROWN THRASHER*	Landbird	2	-5.77 (-10.15, -1.16) L	-3.11 (-4.60, -1.51) H	Dense shrubby habitats, including riparian areas
CANADA JAY*	Landbird	1	-1.87 (-3.92, 0.28) M	-0.43 (-1.35, 0.49) H	Habitat generalist with preference for intermediate-aged stands of pine, white spruce, and mixedwoods; also common in treed swamps and treed fens
CANADA WARBLER (TH)*	Landbird	4	2.73 (-1.76, 9.19) L	-1.11 (-3.05, 0.96) M	Old-growth deciduous and mixedwood forests with a dense shrub understory, particularly near incised streams
CAPE MAY WARBLER*	Landbird	2	5.57 (-2.14, 14.78) L	1.56 (-2.53, 5.46) L	Old-growth stands of white spruce-dominated coniferous and mixedwoods forests; also common in treed swamp
CEDAR WAXWING*	Landbird	1	2.81 (-1.34, 7.29) L	-0.14 (-2.82, 1.65) M	Open forests, old fields and riparian areas
CHESTNUT-SIDED WARBLER*	Landbird	2	0.45 (-3.08, 4.91) L	1.22 (-0.44, 2.86) H	Intermediate-aged deciduous stands with shrubby understory
CHIPPING SPARROW*	Landbird	2	-2.24 (-3.94, -0.53) H	-1.27 (-3.77, 0.02) M	Habitat generalist with preference for mature and old coniferous stands, as well as treed and shrubby fens, swamps and bogs; attracted to natural and anthropogenic edges
COMMON NIGHTHAWK (TH)	Landbird	4	-0.69 (-5.64, 5.02) L	-2.93 (-4.86, -1.04) M	Open and semi-open habitat in coniferous forests, also fields and bogs
CONNECTICUT WARBLER*	Landbird	3	-2.16 (-6.15, 2.25) L	-0.77 (-2.85, 1.15) M	Intermediate-aged deciduous stands with a shrubby understory; white spruce and deciduous-dominated mixedwood stands to a lesser degree
DARK-EYED JUNCO*	Landbird	2	-3.31 (-4.93, -1.57) H	-1.44 (-3.18, -0.15) H	Intermediate-aged coniferous stands, especially pine and black spruce stands and treed fen
DOWNY WOODPECKER*	Landbird	1	-0.88 (-3.02, 1.36) M	0.31 (-0.44, 1.09) H	Deciduous, mixedwood and white spruce forests
DUSKY FLYCATCHER*	Landbird	2	1.01 (-8.04, 12.28) L	1.84 (-2.64, 6.37) L	Open coniferous forests; brushy habitats in montane regions
EASTERN BLUEBIRD*	Landbird	1	1.23 (-5.60, 8.65) L	2.65 (-0.49, 6.20) M	Open forests with grassy understory or adjacent to old fields

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
EASTERN PHOEBE*	Landbird	1	-2.84 (-5.01, -0.61) M	-2.00 (-2.85, -1.16) H	Open deciduous forests near lakes or streams; often nest on anthropogenic structures
EASTERN TOWHEE*	Landbird	2	8.34 (0.62, 17.07) L	-0.37 (-2.99, 2.36) M	Shrublands or open forest with shrubby understory
EASTERN WOOD-PEWEE (SC)*	Landbird	4	-4.59 (-8.8, -0.05) L	-4.14 (-6.38, -2.12) M	Mature deciduous stands, particularly near edges
EVENING GROSBEAK (SC)*	Landbird	4	-7.07 (-16.59, 5.30) L	-3.83 (-9.96, 1.02) L	Mature and old-growth stands of mixedwood, deciduous and white spruce forest
FIELD SPARROW*	Landbird	3	-	-	Open brushy woodlands, natural or anthropogenic clearings and overgrown fields
FOX SPARROW*	Landbird	2	-3.37 (-8.03, 0.80) L	0.45 (-5.20, 4.76) L	Immature mixedwood and pine stands, and dense shrubby areas
GOLDEN-CROWNED KINGLET*	Landbird	2	-0.16 (-5.33, 6.57) L	0.34 (-2.76, 2.99) M	Mature upland conifer and mixedwood stands
GOLDEN-WINGED WARBLER (TH)*	Landbird	4	5.96 (-5.85, 19.56) L	3.84 (-2.08, 11.17) L	Early successional and other habitats that support extensive shrub growth (e.g., forest edges and openings, marshes and bogs)
GRAY CATBIRD*	Landbird	1	1.81 (-0.52, 4.10) M	-0.20 -1.14, 0.75) H	Dense shrubs and thickets often near disturbed areas, forest edges and wetlands
GRAY-CHEEKED THRUSH*	Landbird	1	5.01 (-3.11, 16.41) L	-0.43 (-5.26, 4.26) L	Wet coniferous forests and bogs, and open old-growth forest with a dense shrub understory
GREAT CRESTED FLYCATCHER*	Landbird	1	-0.86 (-3.60, 1.84) M	-0.75 (-1.75, 0.25) H	Open mature deciduous and mixedwood forests
HAIRY WOODPECKER*	Landbird	1	1.11 (-0.86, 2.99) M	1.13 (0.23, 1.95) H	Young deciduous, mixedwood and white spruce stands with a supply of large living or standing dead trees for foraging and excavating cavities
HAMMOND'S FLYCATCHER*	Landbird	1	1.99 (-3.03, 7.76) L	5.15 (1.81, 8.94) L	Mature conifer and conifer-dominated mixedwood forests

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FOREST HABITAT GROUP					
HERMIT THRUSH*	Landbird	1	-3.82 (-5.73, -1.77) M	-0.36 (-3.04, 1.30) M	Immature age classes of conifer and mixedwood forests, and less commonly in deciduous forests; also shrub and shrubby bog habitats
HOUSE WREN*	Landbird	1	0.68 (-1.16, 2.55) M	0.03 (-0.51, 0.60) H	Old fields, meadows, marshes and open old-growth deciduous stands
INDIGO BUNTING*	Landbird	2	-9.97 (-19.12, -1.12) L	-1.49 (-4.95, 2.10) L	Brushy habitats adjacent to deciduous woodlands
LEAST FLYCATCHER*	Landbird	3	-3.49 (-5.01, -1.81) H	-1.62 (-3.31, -0.75) H	Intermediate-aged deciduous stands, early seral mixedwood and white spruce forests, meadows, and treed and shrubby swamps
LINCOLN'S SPARROW*	Landbird	1	1.62 (-0.97, 4.23) M	1.46 (-1.95, 3.54) M	Graminoid fens, treed and shrubby fens, bogs and swamps, and clearings in young black spruce stands
MAGNOLIA WARBLER*	Landbird	1	-3.22 (-6.49, 0.48) L	-0.05 (-1.99, 1.57) M	Young, dense stands of mixedwood, deciduous and conifer forest
MOUNTAIN BLUEBIRD*	Landbird	2	-7.51 (-13.02, -1.85) L	-3.37 (-5.66, -1.37) M	Open woodlands in close proximity to meadows
MOURNING WARBLER*	Landbird	2	-0.68 (-3.02, 2.00) M	-0.51 (-1.67, 0.57) H	Old-growth age classes of deciduous, mixedwood and white spruce forests, and early seral stands resulting from anthropogenic disturbance
NASHVILLE WARBLER*	Landbird	1	-2.45 (-5.62, 1.24) L	-0.38 (-2.27, 1.54) M	Early seral conifer and conifer-dominated mixedwood forests, shrubby forest gaps, and treed bogs and swamps
NORTHERN CARDINAL*	Landbird	1	-	-	Brushy understory, forest edges, shrubby swamps and riparian thickets
NORTHERN FLICKER*	Landbird	2	-0.30 (-2.08, 1.62) M	-1.28 (-2.35, -0.46) H	Younger age classes of all forest, wetland and other vegetation types with a preference for moderately open habitats that permit ground foraging
NORTHERN PARULA*	Landbird	1	-8.79 (-13.89, -3.61) L	-1.11 (-3.84, 1.64) M	Older age classes of moist conifer or conifer-dominated mixedwood forest
NORTHERN WATERTHRUSH*	Landbird	1	-0.24 (-3.69, 3.45) L	0.45 (-2.45, 2.52) M	Treed and shrubby swamps, and woodland and riparian edges along standing or slow-moving water

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
OLIVE-SIDED FLYCATCHER (TH)*	Landbird	4	-1.88 (-5.00, 1.80) M	-2.57 (-4.16, -1.13) H	Coniferous and mixedwood forests, often near water and in areas that have been naturally disturbed; also common in shrub and treed fen habitats
ORANGE-CROWNED WARBLER*	Landbird	2	-1.74 (-4.97, 1.56) M	1.16 (-3.76, 4.18) L	Intermediate age classes of all forest types with a dense shrub understory, particularly pine, white spruce and mixedwood stands; also treed swamps and fens
OVENBIRD*	Landbird	1	0.99 (-0.55, 2.63) H	0.58 (-0.69, 1.61) H	Intermediate age classes of deciduous, mixedwood and white spruce forests
PALM WARBLER*	Landbird	1	6.76 (-0.30, 14.76) L	1.86 (-1.68, 5.16) L	Immature age classes of open conifer stands, particularly pine and black spruce, and treed fens and shrubby bogs with a dense understory and proximity to water
PHILADELPHIA VIREO*	Landbird	1	-4.31 (-8.61, 0.48) L	-0.19 (-2.27, 1.84) M	Treed swamps and intermediate age classes of deciduous forests, particularly shrubby forest edge habitats
PILEATED WOODPECKER*	Landbird	1	3.34 (0.70, 6.35) M	3.28 (1.90, 4.61) H	Prevalent in all forest types, particularly white spruce, deciduous and mixedwoods, with abundance increasing with stand age
PINE GROSBEAK*	Landbird	2	-4.11 (-10.36, 2.60) L	-2.88 (-5.90, -0.14) M	Open coniferous forest and less commonly mixedwood forest and forest edges
PINE SISKIN*	Landbird	3	-3.74 (-7.53, 1.10) L	-2.08 (-3.57, -0.41) H	Old-growth pine and white spruce stands
PINE WARBLER*	Landbird	1	-	-	Pine forests
PURPLE FINCH*	Landbird	2	-1.89 (-5.11, 1.15) M	-0.33 (-1.72, 0.94) H	Open conifer and mixedwood forests
RED CROSSBILL*	Landbird	1	-0.80 (-5.65, 4.87) L	1.42 (-0.47, 3.36) M	Mature conifer forests
RED-BREASTED NUTHATCH*	Landbird	1	-1.06 (-3.63, 1.76) M	1.85 (0.74, 3.05) H	Mature mixedwood, white spruce, deciduous and pine stands

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FOREST HABITAT GROUP					
RED-EYED VIREO*	Landbird	1	0.61 (-0.42, 1.75) H	0.37 (-0.93, 1.10) H	Intermediate age classes of deciduous, mixedwood and white spruce forests with a dense shrub understory, and treed swamps
ROSE-BREASTED GROSBEAK*	Landbird	2	-1.51 (-3.65, 0.61) M	0.52 (-0.61, 1.45) H	Edge habitats in intermediate age classes of deciduous, mixedwood and white spruce forests
RUBY-CROWNED KINGLET*	Landbird	1	-0.92 (-3.47, 1.58) M	2.47 (0.04, 4.14) M	Mature age classes of conifer and mixedwood forest, and treed fens and swamps
RUBY-THROATED HUMMINGBIRD*	Landbird	1	-1.34 (-4.77, 2.54) L	1.16 (-0.23, 2.62) H	Intermediate-aged deciduous forest
RUFFED GROUSE*	Landbird	1	1.52 (-1.64, 5.04) M	-0.36 (-1.59, 0.82) H	Intermediate age classes of deciduous, mixedwood and white spruce; also treed swamp and open habitats
RUSTY BLACKBIRD (SC)*	Landbird	4	1.72 (-4.43, 8.73) L	-3.31 (-5.53, -0.84) M	Young mixedwood, treed swamp and fens; near open standing water
SCARLET TANAGER*	Landbird	1	-6.39 (-12.13, -0.41) L	-3.52 (-6.12, -1.06) M	Mature deciduous forest
SOOTY GROUSE*	Landbird	2	-	-	Open coniferous and mixed forests
SWAINSON'S THRUSH*	Landbird	2	-0.83 (-2.12, 0.57) H	-0.34 (-1.58, 0.75) H	Mature age classes of all forest types, especially white spruce and mixedwoods closed-canopy forests, and treed swamp
TENNESSEE WARBLER*	Landbird	2	1.78 (-4.03, 8.64) L	-0.18 (-7.52, 3.97) L	Mature and old-growth stands of mixedwood, deciduous and white spruce forest, and treed swamp; associated with edges and forest gaps
TOWNSEND'S SOLITAIRE*	Landbird	1	-4.00 (-8.86, 1.03) L	1.04 (-1.24, 3.29) M	Open coniferous forests
TOWNSEND'S WARBLER*	Landbird	2	5.35 (-0.27, 11.73) L	1.88 (-1.43, 5.35) M	Mature conifer forests
VARIED THRUSH*	Landbird	3	1.42 (-1.56, 4.87) M	2.18 (0.29, 4.48) M	Old-growth pine and white spruce forests
VEERY*	Landbird	2	0.77 (-1.83, 3.26) M	-1.62 (-2.76, -0.56) H	Moist deciduous forest with dense shrub understory and shrub swamps

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
WARBLING VIREO*	Landbird	1	-1.10 (-2.96, 0.75) M	-0.71 (-1.75, 0.26) H	Intermediate age classes of pine, white spruce and mixedwoods, old growth deciduous forest, and treed swamp
WESTERN TANAGER*	Landbird	1	0.36 (-3.27, 4.58) L	0.56 (-1.64, 2.36) M	Open, old-growth mixedwood, white spruce and deciduous forests
WESTERN WOOD-PEWEE*	Landbird	3	-4.72 (-7.33, -1.80) M	-2.77 (-4.17, -1.49) H	Young, open stands of white spruce, mixedwood and pine; often near forest edges and riparian areas
WHITE-BREASTED NUTHATCH*	Landbird	1	1.32 (-2.85, 6.19) L	3.65 (1.79, 5.67) M	Intermediate age classes of mixedwood and deciduous forest
WHITE-THROATED SPARROW*	Landbird	2	-1.14 (-2.43, 0.17) H	-0.78 (-3.14, 0.46) M	younger age classes of all forest types, especially deciduous and mixedwoods with dense shrub understory; also shrubby forest openings, and shrubby and treed swamps
WHITE-WINGED CROSSBILL*	Landbird	1	5.38 (-0.38, 14.31) L	4.04 (1.79, 6.74) M	Mature and old conifer and mixedwood stands, and shrubby bog and fen habitats
WILSON'S WARBLER*	Landbird	3	0.64 (-2.21, 3.56) M	0.28 (-1.51, 2.07) M	Wet shrublands and intermediate age classes of conifer, particularly with dense shrubby edges or understory
WINTER WREN*	Landbird	1	-1.22 (-4.50, 3.14) L	-0.25 (-1.81, 1.26) H	Old growth mixedwood, white spruce and deciduous stands with a dense understory, often near open water
WOOD THRUSH (TH)*	Landbird	4	-	-	Mature deciduous forest with closed canopy and moist understory
YELLOW WARBLER*	Landbird	2	-0.65 (-3.02, 2.11) M	-0.19 (-1.66, 0.71) H	Older deciduous forest in proximity to riparian areas and water, treed swamp, marsh, and wet meadows
YELLOW-BELLIED FLYCATCHER*	Landbird	1	4.69 (0.21, 9.81) L	0.76 (-2.90, 3.81) M	Moist shrubby areas and immature stands of pine, deciduous and mixedwoods
YELLOW-BELLIED SAPSUCKER*	Landbird	1	-0.88 (-3.91, 2.63) M	-0.48 (-2.59, 1.12) M	Early seral stages of all forest types, particularly pine and deciduous

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
YELLOW-RUMPED WARBLER*	Landbird	1	-1.75 (-3.40, -0.09) H	1.01 (-1.24, 2.58) M	Mature conifer and mixedwood stands, and deciduous, treed swamp and treed fen habitats to a lesser amount
YELLOW-THROATED VIREO*	Landbird	1	4.63 (-3.04, 12.55) L	2.14 (-0.75, 5.23) M	Mature deciduous forest, often near edges with well-developed understory
WETLAND HABITAT GROUP					
AMERICAN BITTERN	Waterbird	2	2.85 (-2.42, 9.84) L	-1.48 (-3.15, 0.29) H	Large marshes and shallow water with tall emergent vegetation
BLACK TERN	Waterbird	3	7.39 (-3.01, 21.20) L	-2.89 (-5.68, 0.03) M	Marshes and shallow water with emergent vegetation
BLACK-CROWNED NIGHT-HERON	Waterbird	2	-0.63 (-15.32, 15.75) L	-0.79 (-6.62, 5.15) L	Wetland generalist with preference for shallow wetlands and marshes
BONAPARTE'S GULL	Waterbird	1	-3.90 (-9.64, 1.70) L	-1.24 (-3.91, 0.78) M	Open coniferous forests adjacent to bogs, marshes and lakes
CASPIAN TERN	Waterbird	1	-7.97 (-19.03, 0.67) L	0.38 (-4.04, 3.87) L	Sparsely vegetated islands or shorelines of sand, mud or pebbles on larger lakes
COMMON LOON	Waterbird	1	-0.53 (-3.03, 2.05) M	1.05 (-0.13, 2.18) H	Generally clear fish-bearing lakes with numerous bays and inlets
COMMON TERN	Waterbird	3	1.43 (-5.81, 9.66) L	-1.42 (-4.01, 1.42) M	Bare or sparsely vegetated sand or gravel islands and sandpits in marshes, ponds or small lakes
COMMON YELLOWTHROAT	Landbird	2	2.81 (1.46, 4.28) H	0.14 (-0.71, 0.77) H	Dense shrubs in or near wetlands
EARED GREBE	Waterbird	1	6.51 (-1.24, 15.33) L	3.32 (0.99, 5.77) M	Shallow marshes, ponds and lakes with emergent vegetation
FORSTER'S TERN	Waterbird	2	-7.96 (-18.47, 7.62) L	-1.96 (-6.57, 2.62) L	Marshes containing or adjacent to deeper, open water
GREATER YELLOWLEGS*	Shorebird	1	0.62 (-2.35, 4.28) M	0.68 (-0.63, 2.58) H	Muskeg, bogs and sparsely wooded coniferous forests
HORNED GREBE (SC)	Waterbird	4	0.75 (-4.47, 7.20) L	-0.83 (-2.87, 1.57) M	Small to moderate-sized shallow marshes and ponds with emergent vegetation and substantial open water
KILLDEER	Shorebird	2	-1.22 (-3.58, 1.57) M	-3.74 (-4.51, -2.99) H	Open areas with sparse vegetation, especially sandbars, mudflats and gravel shorelines adjacent to shallow water

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
LEAST SANDPIPER	Shorebird	1	-1.85 (-11.52, 4.92) L	-0.98 (-6.13, 1.89) L	Sedge, mossy and grassy bogs near water and muddy areas at or above treeline
LECONTE'S SPARROW	Landbird	3	-0.72 (-5.46, 6.03) L	-0.57 (-2.28, 1.29) M	Sedge meadows and grassy or shrubby perimeter of bogs and marshes
LESSER YELLOWLEGS*	Shorebird	3	-1.47 (-6.00, 3.20) L	-2.08 (-5.25, 0.67) M	Shallow ponds, bogs and marshes within open coniferous forests
MARBLED GODWIT	Shorebird	2	-0.15 (-3.93, 3.64) L	2.02 (0.45, 3.75) H	Shallow marshes with emergent sedges and scattered willows
SHORT-BILLED GULL	Waterbird	3	-3.94 (-9.81, 1.39) L	-1.88 (-4.55, 0.33) M	Wetland generalist including marsh, ponds, lakes, streams, rivers and tundra
NELSON'S SPARROW*	Landbird	1	-9.19 (-14.90, -3.68) L	-0.27 (-2.46, 1.79) M	Wetland with emergent vegetation and tall grasses within coniferous and deciduous forests
NORTHERN HARRIER	Landbird	2	-1.68 (-4.66, 1.62) M	-1.95 (-2.99, -0.93) H	Open meadows, marsh meadows, tundra
PACIFIC LOON	Waterbird	1	2.11 (-3.82, 14.37) L	0.5 (-2.11, 4.26) M	Lakes and larger ponds
PEREGRINE FALCON (SC)	Landbird	4	8.63 (0.41, 19.04) L	6.70 (3.23, 11.00) L	Cliffs adjacent to open areas (tundra, meadows, untreed wetlands) suitable for foraging
PIED-BILLED GREBE	Waterbird	1	5.05 (0.21, 10.56) L	0.86 (-0.93, 2.59) H	Seasonal or permanent wetlands with dense aquatic or emergent vegetation with nearby open water
PURPLE MARTIN	Landbird	2	1.31 (-5.56, 10.25) L	-0.19 (-2.46, 2.19) M	Habitats supporting dead standing trees including bogs, beaver ponds, burns and logged areas
RED-NECKED GREBE	Waterbird	1	6.54 (0.02, 14.83) L	1.45 (-0.55, 3.63) M	Typically uses shallow lakes, secluded bays or marshes with some emergent vegetation, but will use other shallow, protected waters
RED-NECKED PHALAROPE (SC)	Shorebird	4	-8.21 (-22.72, 6.46) L	-6.75 (-12.14, -0.91) L	Freshwater lakes, pools, bogs and marshes with emergent vegetation
RED-THROATED LOON	Waterbird	1	0.60 (-4.64, 7.75) L	0.24 (-2.07, 3.85) M	Small ponds and larger lakes
SEDGE WREN	Landbird	1	3.80 (-0.42, 8.60) L	1.07 (-0.60, 2.75) H	Wet meadows, ponds, marshes or bogs with dense stands of tall sedges or grasses

SPECIES	TAXONOMIC GROUP	CONSERVATION RANK	SHORT-TERM TREND	LONG-TERM TREND	GENERAL HABITAT DESCRIPTION
FOREST HABITAT GROUP					
SHARP-TAILED GROUSE	Landbird	1	3.23 (-3.43, 12.18) L	0.14 (-2.27, 2.57) M	Breeding habitat includes grasses, forbs and dense shrubs. Leks in open areas included muskeg, disturbed or elevated areas. Winters in deciduous stands with dense shrubs
SHORT-EARED OWL (SC)	Landbird	4	-3.22 (-7.85, 1.83) L	-2.21 (-4.04, -0.52) H	Large patches of open meadow, marsh or tundra
SOLITARY SANDPIPER*	Shorebird	1	1.46 (-2.37, 6.49) L	0.67 (-1.08, 2.88) M	Wetlands in or near coniferous forests preferred
SORA	Waterbird	1	3.88 (0.35, 7.98) L	0.86 (-0.37, 2.09) H	Marshes with shallow to intermediate water depths and emergent cattail, sedge and/or bulrush
SPOTTED SANDPIPER*	Shorebird	2	-0.44 (-3.29, 2.64) M	-1.80 (-3.08, -0.60) H	Wetlands adjacent to upland forested habitats
SWAMP SPARROW*	Landbird	1	3.30 (0.42, 6.46) M	2.47 (-0.45, 4.46) M	Wetlands in forested areas, particularly young black spruce stands
VIRGINIA RAIL	Waterbird	1	0.30 (-6.04, 8.15) L	0.73 (-1.65, 3.79) M	Robust emergent vegetation (e.g., cattails and bulrush) within or adjacent to marshes, ponds or lakes
WESTERN GREBE (SC)	Waterbird	4	-4.90 (-19.97, 10.27) L	-1.41 (-9.09, 6.17) L	Medium to large marshes or lakes with extensive open water bordered by emergent vegetation
WILSON'S PHALAROPE	Shorebird	1	-6.67 (-15.52, 4.49) L	-3.21 (-6.65, 0.16) L	Marshes
WILSON'S SNIPE*	Shorebird	1	2.33 (-0.70, 5.41) M	1.08 (-1.71, 2.47) M	Sedge bogs, fens, swamps, and pond and river edges
YELLOW RAIL (SC)	Waterbird	4	-2.10 (-11.86, 3.59) L	0.94 (-1.12, 3.99) M	Shallow sedges marshes or fens

APPENDIX B:
WATERFOWL SPATIAL TARGETING METHODS

Prioritization of conservation programs and actions in the Western Boreal Forest (WBF) based on waterfowl densities can be challenging given the size of the region as well as the relative uniformity in distribution of waterfowl populations across the landscape. Although the densities at any given location may be lower than their Prairie Parkland counterparts, the collective densities found within the WBF contribute greatly to continental waterfowl populations. To identify WBF priority areas for waterfowl, Ducks Unlimited Canada (DUC) used the decision-support tool Zonation and opted to evaluate key high-density areas selected most frequently across a range of scenarios. This appendix covers the technical details of the overall modelling process.

The analysis focused on the WBF region with the agricultural portions of the boreal transition zones (BTZ) (i.e., the agricultural ecumene; Statistics Canada, 2017) removed. This area differs slightly from the PHJV WBF region (see Figure 2 in report). The main data source was predicted waterfowl densities modelled by Barker et al. (2014a, 2014b). This is comprised of 17 waterfowl species of which eight are boreal forest-specific species and account for approximately 80% of waterfowl abundance in the WBF (Table B-1 and Figure B-1).

TABLE B-1. Waterfowl species with modelled predicted densities classified by biome.

CODE	COMMON NAME	BIOME
ABDU	American Black Duck	-
AGWT	American Green-Winged Teal	Boreal
AMWI	American Wigeon	Boreal
BWTE	Blue-Winged Teal	Prairie
GADW	Gadwall	Prairie
MALL	Mallard	Prairie/Boreal
NOPI	Northern Pintail	Prairie
NSHO	Northern Shoveler	Prairie
GSCO	Scoter Spp.	Boreal
BUFF	Bufflehead	Boreal
GGOL	Goldeneye Spp.	Boreal
GMER	Merganser Spp.	-
CANV	Canvasback	Prairie
REDH	Redhead	Prairie
RNDU	Ring-necked Duck	Boreal
RUDU	Ruddy Duck	-
GSCA	Scaup Spp.	Boreal

Within the Zonation modelling, the Additive Benefit Function (ABF) was employed to concentrate the analysis on species richness and high diversity components. Zonation may also use the Core Area Zonation (CAZ) algorithm to emphasize species representation and uniqueness but given the overall objectives of the modelling process to highlight abundance, richness, and diversity, the ABF was preferred. Modelling parameters included assigning a value of 0 for edge removal following work done in the prairies by Carlson (2019) and a warp value of 1000, which in the number of cells removed in each iteration. This value allowed for many scenarios to be run with a lower processing time while maintaining an accurate result.

Uncertainty in the waterfowl modelling was an important factor to consider given that much of the WBF falls outside of the traditional survey areas (Figure B-2). The assumption that high uncertainty should equate with higher discounting of an area may not necessarily be true, as these areas may contain important waterfowl habitats. In order to work through evaluating uncertainty and to create a robust final result, various parameters were considered throughout the Zonation scenarios, Table B-2, by incorporating geographical stratification (WBF, provincial and territorial jurisdictions, and ecoregions), species distributions (treated as individual species or total waterfowl), species composition (eight boreal waterfowl species or 17 waterfowl species), species densities adjusted by positive or negative standard deviation, and distribution discounting with alpha values of 0.2, 0.4, 0.6, 0.8, and 1.0.

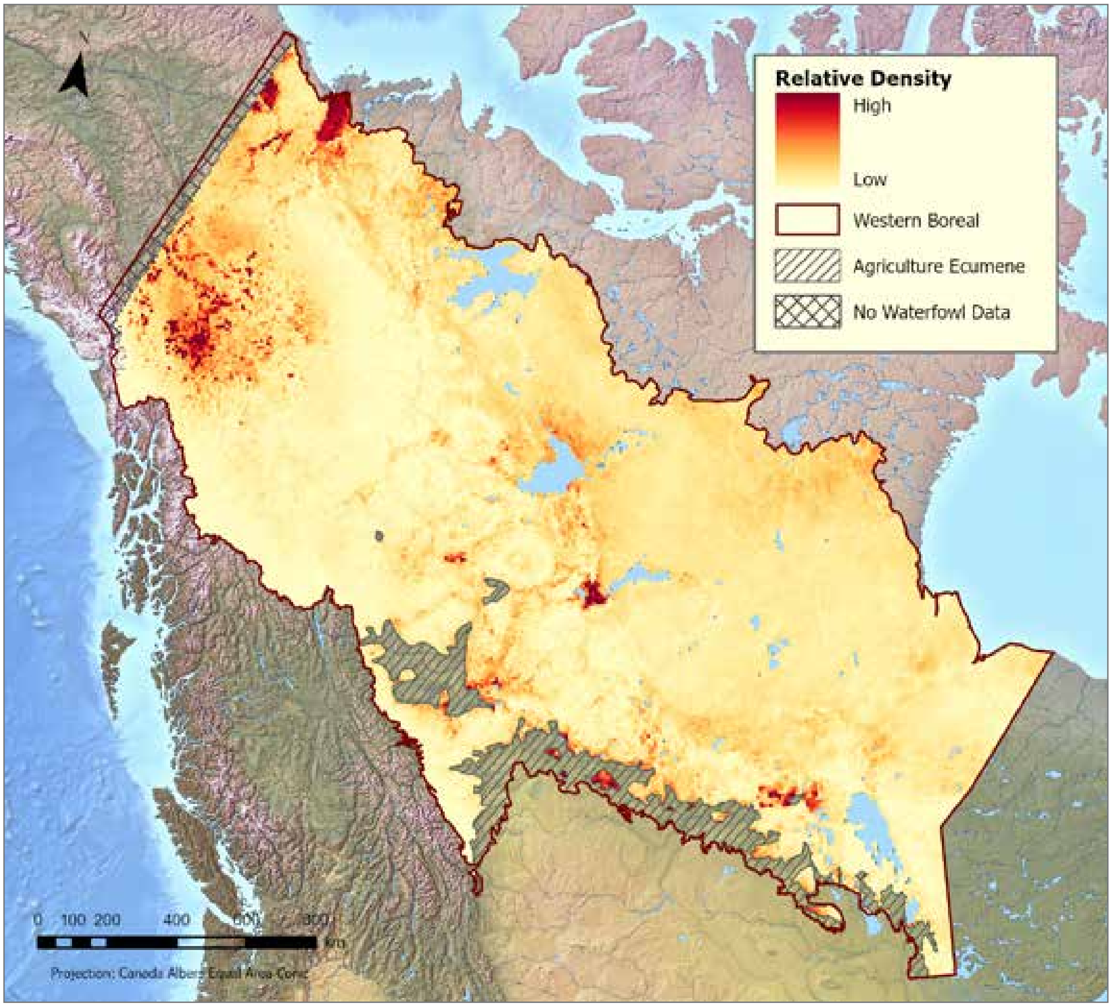

FIGURE B-1. Total Waterfowl Relative Density (Barker et al. 2014)

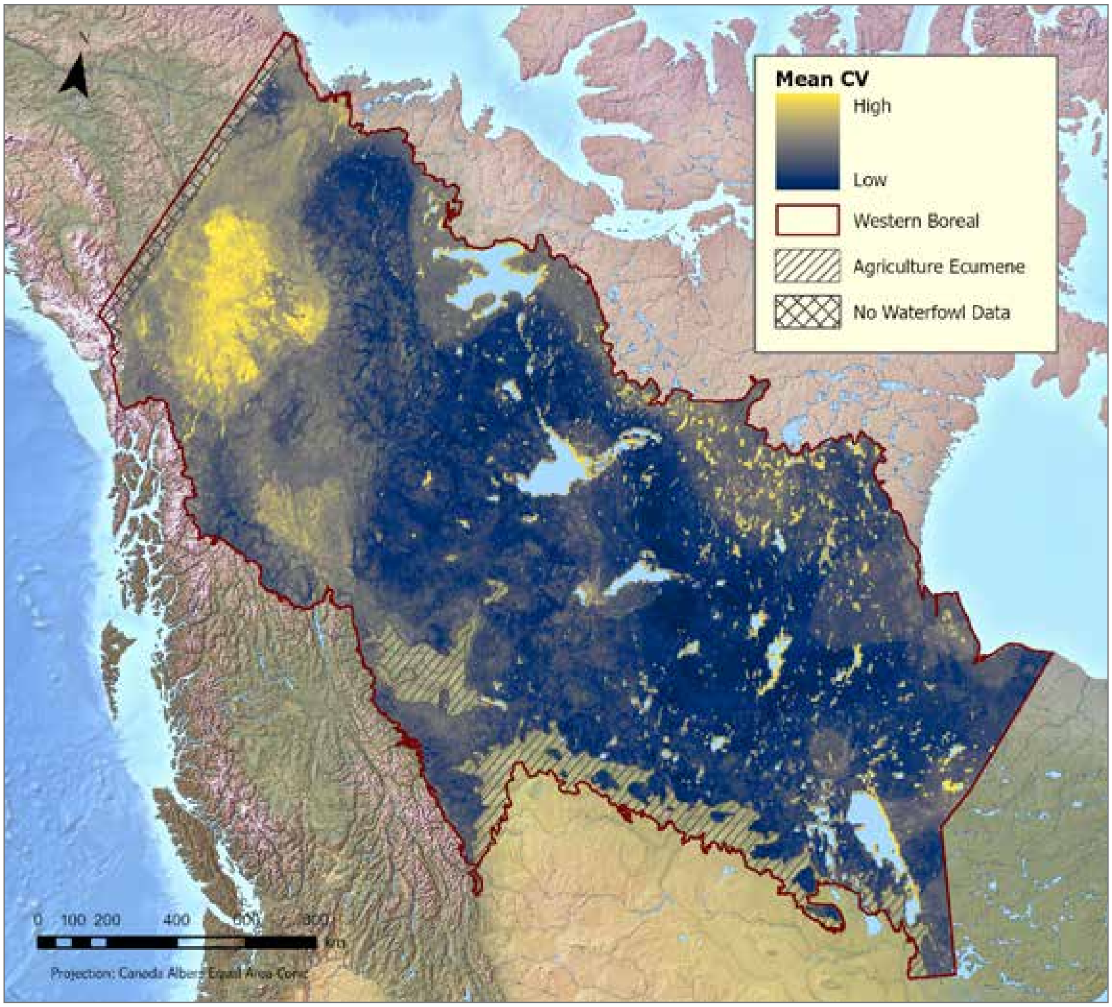

FIGURE B-2: Mean Waterfowl Uncertainty Presented as the Coefficient of Variation (CV) in Waterfowl Abundance.

TABLE B-2. Zonation modelling parameter options used within the various scenarios to assist with the frequency selection of highest priority areas.

MODELLING FACTOR	SCENARIO PARAMETERS
ZONATION METHOD	Additive Benefit Function (ABF)
GEOGRAPHIC EXTENT	Western Boreal Forest minus Agricultural Ecumene
GEOGRAPHIC STRATIFICATION	None / Provincial / Ecoregion
SPECIES	17 Waterfowl Species / 8 Boreal Specific Species
SPECIES GROUPING	Total / Individual
SPECIES WEIGHTS	None / Boreal Species weighted 2:1
UNCERTAINTY	None / Positive SD / Negative SD
DISTRIBUTION DISCOUNTING	None / 0.2 /0.4 / 0.6 / 0.8 / 1.0

Upon running the 43 different zonation scenarios, the areas identified most frequently among all the scenarios were selected as the priority areas which highlight species diversity. This was calculated by summing the results of all scenarios and averaging the ranking. The final averaged ranked results are presented in Figure B-3; the results smoothed using Bayesian Kriging are displayed in Figure B-4. To generate the final priority areas, the top 40% of the area selected were deemed priority and encompass approximately 56% of the waterfowl population (Figure B-5).

Although there is strong confidence in the robustness of these identified WBF priority areas, it does highlight some key topics to be addressed over the coming years to further strengthen and refine the spatial targeting efforts in the boreal forest. These include but are not limited to, (1) considering models and associated covariates at various scales including the WBF, national, jurisdictional, biomes, ecoregions; (2) exploring whether other waterfowl density data exists for areas outside traditional survey regions potentially gathered using different data collection methods; and (3) evaluating and modelling with more detailed covariates, such as using high resolution wetland information where available, or using data collected outside of Canada to assist with modelling predictions, such as Alaskan survey data.

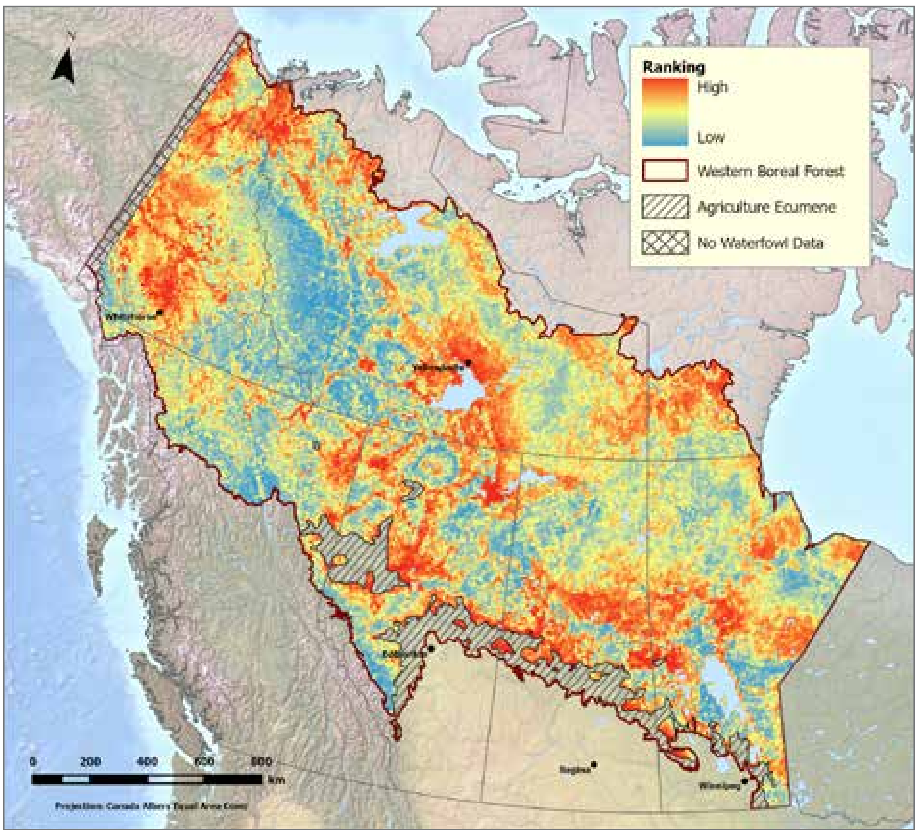

FIGURE B-3. Zonation final averaged ranked result for boreal waterfowl.

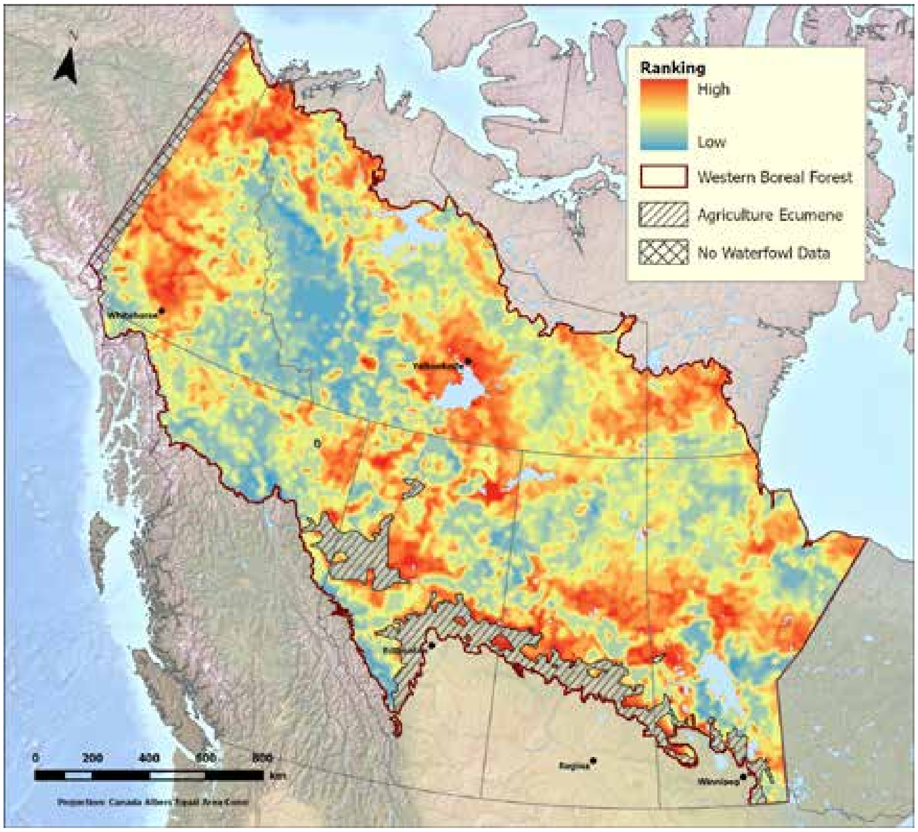

FIGURE B-4. Bayesian Kriging smoothed zonation final averaged ranked result for boreal waterfowl.

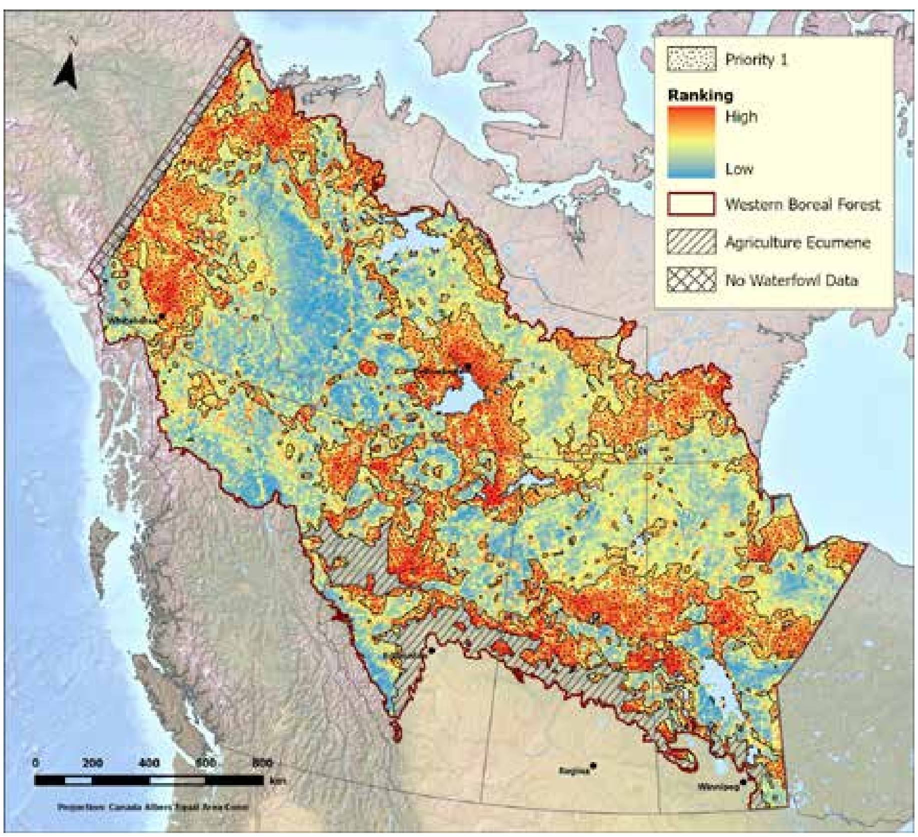

FIGURE B-5. Boreal waterfowl priority areas.

APPENDIX C: NON-WATERFOWL SPATIAL TARGETING METHODS AND PRIORITY LANDSCAPES

Spatial Targeting

Avian data for the density models came from the BAM avian dataset (v. 4; data collected between 1991 and 2018) and was supplemented with automated recording unit (ARU) data from the WildTrax acoustic database. Differences in sampling protocol and covariate effects on detectability were accounted for using statistical offsets (Sólymos et al. 2013). For the models, separate boosted regression tree models were used to predict densities at a 1-km resolution across geographic sub-regions (bird conservation regions intersected by jurisdiction boundaries) based on covariates such as forest age, tree species biomass (local and landscape scale), topography, land use and climate. More information about these models and the underlying data can be found at https://borealbirds.github.io.

Prior to identifying priority areas, species were assigned to two groups based on their association with a primary breeding habitat (as defined by Rosenberg et al. 2019) and were either (a) 93 forest-associated species or (b) seven wetland-associated species (see Appendix A; Table A-1). Species were ranked according to their conservation status weight (see Appendix A; Table A-1). Specifically, we assigned a weight of 4 to species listed on Schedule 1 of the Canadian *Species at Risk Act* (SARA); 3 to species with a Partners in Flight (PIF) population trend score of 5, which have declined by more than 50% since 1970; 2 to species with a PIF population trend score of 4, which have declined by more than 15% since 1970 (Rosenberg et al. 2016); 1 to all other species (see Appendix A; Table A-1).

The Zonation software is designed for the analysis of biological data and supports objectives related to spatial conservation decision-making. Zonation is well suited for multi-species planning and for using large grids of spatial input data (i.e., biodiversity data). The output of Zonation is a relative priority map of the conservation value of a landscape. The relative priority is assigned by iteratively identifying and removing cells (10 at a time) that cause the least marginal loss of conservation value. This process continues until all pixels are removed, with the pixels removed last having the highest relative priority. Analyses were conducted using the additive benefit function cell removal rule that accounts for all weighted features (here species density), and thus, favours diverse cells and prioritizes areas that benefit multiple species. This process produced a pixel-based map of relative priority for each non-game bird group.

APPENDIX D:
PHJV BOREAL HUMAN DIMENSIONS STRATEGY

This Human Dimensions strategy for the PHJV Western Boreal Forest (WBF) identifies the broad topics that the PHJV will work in, the desired outcome, long-term objectives, milestones to achieve within this planning period and the metrics by which success will be measured. For each Human Dimensions topic, strategies to achieve the five-year milestones are also identified.

SOCIAL SCIENCE CAPACITY WITHIN THE PHJV			
HD OUTCOME	LONG-TERM HD OBJECTIVES (20 YR.)	FIVE-YEAR MILESTONES FOR THE 2021–2025 IP	METRIC
The PHJV and delivery partners have the social science capacity required to support a human centric approach to decision-making and conservation support within an ethical space.	Human Dimension tools and information are used to support PHJV activities.	By 2025 the PHJV will have formulated academic partnerships and increased the internal organizational capacity to conduct social sciences related to Human Dimensions of conservation delivery in the PHJV.	Number of PHJV program decision-making processes that incorporate Human Dimensions information.

Strategies:

1. **Increase and enhance social science capacity within the PHJV Partnership.**
   Key Action: *Identify and create opportunities to advance social science throughout the PHJV.*
2. **Emphasize the importance of social science to advance all components of the PHJV's work.**
   Key Action: *Develop consistent key messaging about the importance of integrating social science into various aspects of PHJV programs and decision-making.*

TRUST & RELEVANCY WITH ALL STAKEHOLDER GROUPS			
HD OUTCOME	LONG-TERM HD OBJECTIVES (20 YR.)	FIVE-YEAR MILESTONES FOR THE 2021–2025 IP	METRIC
Ensure all relevant stakeholders in the WBF are aware of the PHJV partnership organizations, and views them as trusted relevant participants in supporting the sustainability of the rural communities and sustainable land use in the PHJV. In the boreal region, this will target industry associations and stakeholders, Indigenous governments and communities, and other jurisdictional governments.	Increase the percentage of stakeholder organizations and industrial companies that are aware of and trust PHJV partners (scientists, government, conservation groups) to 50% by 2040.	By 2025, the PHJV understands the levels of awareness, trust and outcomes of PHJV efforts, and continues to diversify and expand the active PHJV partner base. By 2025, the PHJV has developed a monitoring framework to track awareness and perception of PHJV partners.	Proportion of producers, key stakeholders and industry that are 1) aware of; and 2) trust the delivery partners and/or the PHJV.

Strategies

1. **Inform the advancement of prioritized, focused actions to increase awareness, trust and relevancy of the PHJV and partner agencies.**
   Key action: *Strategic research and monitoring initiatives.*
2. **Strategic partnerships to work with relevant stakeholders to advance sustainable land use practices that have positive conservation outcomes.**
   Key action: *Create opportunities and engage in partnerships and alliances to advance sustainable land use.*
3. **Promote and advocate for sustainable land use through direct Industry engagement (forestry, mining and oil/gas industry sectors in particular), support for Indigenous-led land relationship planning, and other activities that advance SLU.**
   Key Action: *Create and disseminate meaningful consistent messaging regarding sustainable land use.*
   Key Action: *Provide meaningful and relevant technical materials, data, information/knowledge, and training to stakeholders to help advance SLU using effective knowledge transfer mechanisms.*

PARTICIPATION IN PHJV PROGRAMS			
HD OUTCOME	HD OUTCOME	HD OUTCOME	HD OUTCOME
All stakeholders in the PHJV delivery area recognize the importance of and actively participate in landscape-level initiatives to conserve boreal forest habitats.	All stakeholders in the PHJV recognize the importance of and actively participate in landscape-level initiatives to conserve boreal forest habitats.	All stakeholders in the PHJV recognize the importance of and actively participate in landscape-level initiatives to conserve boreal forest habitats.	All stakeholders in the PHJV recognize the importance of and actively participate in landscape-level initiatives to conserve boreal forest habitats.

Strategies:

1. **Influence proactive PHJV program uptake.**
   Key Action: *Examine the current participation rates, barriers and opportunities related to program uptake.*
   Key Action: *Integrate social science information into the development of innovative new approaches or refinements to current programs, products, or management practices (new programs, new pathways for conservation delivery)*
2. **Increase awareness about how the PHJV, partners, and programs support sustainable land use through consistent messaging.**
   Key Action: *Create and distribute coordinated, strategic, relevant, and consistent messaging about PHJV programs and sustainable land use practices.*

POLICY			
HD OUTCOME	**LONG-TERM HD OBJECTIVES (20 YR.)**	**FIVE-YEAR MILESTONES FOR THE 2021–2025 IP**	**MEASUREMENTS (LINKS TO THE LONG-TERM OBJECTIVE)**
Policy makers understand the importance of all ecosystem benefits (e.g., traditional foods, ecosystem goods and services, recreation) in their review of proposed developments and land use planning within the WBF.	Maximize the effectiveness of government policies: by 2040, each PHJV provincial or territorial government has policies in place that recognize and incorporate Human Dimensions in land use planning and development proposal reviews to minimize future impacts on wetlands and waterfowl habitat.	Prepare a document that summarizes all land use planning policies and regulations within each PHJV province/territory and identify gaps in Human Dimensions considerations. Prepare a policy implications document that can identify where gaps in provincial/territorial policies and regulations would benefit from inclusion of Human Dimensions considerations.	Number of provincial/territorial policies and regulations related to land use planning and conservation that consider all Human Dimensions (e.g., traditional harvesting opportunities, nature-based recreational opportunities) outcomes.

Strategies:

1. **Engage governments (at all levels) to advance policies that have positive wetland and associated waterfowl habitat outcomes.**
   Key Action: *Identify opportunities and participate in partnerships to advance policy that have positive outcomes.*
2. **Strategic research to inform the advancement of prioritized, focuses actions to advance wetland policies.**
   Key Action: *Engage in the research required to support policy development in all boreal forest jurisdictions.*
3. **Influence policy makers (at the government and stakeholder levels) to promote positive wetland outcomes.**
   Key Action: *Employ a communications plan targeted to policy makers to promote policies with positive wetland and grassland policy outcomes.*
   Key Action: *Identify provincial level policy opportunities to influence provincial level policy initiatives.*
4. **Policy development processes are informed by relevant Human Dimensions recommendations, outcomes, research.**
   Key Action: *Identify and create opportunities that support policy makers in building social science capacity.*
5. **Partnership strategically functions as a collective (rather than as members) as it relates to wetland policy development.**
   Key Action: *Examine the opportunities to bring together the things that partners are doing.*

GENERAL PUBLIC TARGET AUDIENCES (ATTITUDES AND ACTION)			
HD OUTCOME	**LONG-TERM HD OBJECTIVES (20 YR.)**	**FIVE-YEAR MILESTONES FOR THE 2021–2025 IP**	**MEASUREMENTS (LINKS TO THE LONG-TERM OBJECTIVE)**
Residents of the WBF have positive attitudes towards sustainable land use and engage in activities that promote conservation and sustainable land use.	Promote programs and policies that create opportunities for nature-based recreational activities within the WBF.	Evaluate the barriers to nature-based recreational opportunities in the WBF and understand the barriers to those activities (e.g., low species abundance restricts wildlife harvest, forest management plans reduce abundance of traditional food types).	Participation levels in nature-based recreation as reported by Canadian Nature Survey. Attitudes towards nature-based recreational activities.

Strategies:

1. ***Inform focused actions to support public engagement in nature-based recreation activities that result in pro-conservation actions.***
   Key Action: *Engage in research and monitoring activities required to inform or advance recreation that results in conservation actions.*
2. **Strategic partnerships and alliances to support monitoring and enhance opportunities to support nature-based activities and pro-conservation actions.**
   Key Action:*Identify opportunities and engage in partnerships that advance the opportunities for engagement of residents throughout the WBF.*
3. **Consistent messaging around sustainable working landscapes for the public as a target audience.**
   Key Action:*Develop consistent messaging with provincial partner agencies and disseminate to the public using an effective suite of communication tactics.*
   These may include messaging arounds sustainable practices or standards, labelling, develop messaging that is supported by the resource development industry and stakeholder groups. Role of the PHJV here is the development of the messaging with provincial/territorial agencies. This requires engagement with the provincial level committees.

GENERAL PUBLIC TARGET AUDIENCES (PARTICIPATION)			
HD OUTCOME	**LONG-TERM HD OBJECTIVES (20 YR.)**	**FIVE-YEAR MILESTONES FOR THE 2021–2025 IP**	**MEASUREMENTS (LINKS TO THE LONG-TERM OBJECTIVE)**
The PHJV (delivery partners) create opportunities for constituents of the public to access or experience PHJV WBF programs and projects.	Increase by 25% the number of individuals who interact with PHJV partner programs, projects or spaces by 2040.	By 2025, the PHJV understands how many individuals visit PJHV WBF projects or participate in PHJV Programs. By 2025, the PHJV understands the characteristics and attributes of individual who interact/ engage with WBF partner programs, projects or spaces. By 2025, the PHJV coordinates WBF partners information and develops a monitoring framework.	Degree of interactions – participant hours (partners could calculate on their own and roll up to the PHJV level). This metric and monitoring efforts will need to be developed. Number of properties that are used as birding locations (intersection between eBird observations and partner properties).

Strategies: (Strategies may include citizen science, extension activities, access to partner lands for hunting or hiking etc.)

1. **Gauge the participation and satisfaction levels from individuals who participate in PHJV partner spaces and programs.**
   Key Action: *Develop a monitoring and tracking system using existing data sources and possibly novel data collection tools to create an inventory of current and future partner programming.*
2. **Communicate to the public to increase awareness of opportunities to engage in partner programs or spaces.**
   Key Action: *Develop a communication plan that increases awareness of partner projects and spaces where nature-based recreational opportunities and traditional activities may be practiced.*
3. **Communication about the investment or engagement of the efforts of the organizations that provide this habitat or the space.**
   Key Action: *As part of the communication strategy identified above, include information about the PHJV programs and achievements in WBF conservation that have incorporated human dimensions as part of the project planning.*

APPENDIX E:
WHOOPING CRANE: OPPORTUNITIES FOR CO-BENEFITS FROM WATERFOWL CONSERVATION

Whooping Crane (Grus americana) is one of North America's rarest bird species and the subject of intense public interest in Canada and the United States. Whooping Cranes once numbered in the thousands and occupied a broad region in the central grasslands and northern forests of North America (Austin et al., 2019). By the 1940s, habitat loss and persecution had pushed the species to the brink of extinction with 14 individuals remaining in a single population. This population, referred to as the Aransas Wood Buffalo Population (AWBP), summers in Canada's Western Boreal Forest (WBF) in and around Wood Buffalo National Park, and winters on the Gulf Coast of Texas in and around the Aransas National Wildlife refuge.

Today, the AWBP is widely considered a conservation success story with approximately 500 individuals and growing, and it is still the only wild and self-sustaining population of this species in existence. This success is due in large part to the conservation efforts of numerous partners in Canada and the United States. The species is listed as Endangered under both Canada's *Species at Risk Act* and the United States *Endangered Species Act*, and it is protected by this and other legislation in both countries.

Both governments and several partners have also collaborated on a number of research and conservation activities. One such collaboration between Canadian Wildlife Service, Parks Canada, U.S. Fish and Wildlife Service, U.S. Geological Survey, Crane Trust, International Crane Foundation, Gulf Coast Bird Observatory, and Platte River Recovery Implementation Program tracked 97 Whooping Cranes with satellite transmitters during 364 individual migrations through the WBF between 2010 and 2020. Of those migrations, 97% involved at least one landing in the WBF, typically lasting one to two days (range 1-17).

More than 80% of the boreal forest portion of the Whooping Crane migratory corridor is unprotected and approximately 60% of landings occurred in unprotected areas. Much of this unprotected area is used for resource extraction such as forestry, mining and oil and gas production, and includes areas with the highest levels of anthropogenic disturbance in the WBF (Pasher et al., 2013). While not part of the present analyses, almost 30% of the breeding range lies to the east and north of Wood Buffalo National Park in areas that also are unprotected. Preliminary results of habitat selection modeling based on satellite telemetry data in a used-available design (M. Bidwell and A. Crosby, unpublished analyses) show that when choosing stopover sites during migration, Whooping Cranes select most strongly for areas containing marshes and untreed fens, and select against uplands (Figure E-1). While stopover sites usually contain other wetland types, results showed that marshes and fens are also used most heavily within stopover sites.

Development in these unprotected areas may threaten the quality and quantity of preferred wetland habitats (Volik et al., 2020), or create collision hazards for low-flying cranes.

Fortunately, the association between migratory cranes and certain wetland types provides clear opportunities for deriving conservation co-benefits for cranes from activities targeted at waterfowl (Figure E-2). Of 22 priority areas for waterfowl conservation (Figure E-3), four have very high values (top quartile) and 12 have high values (above median) of predicted relative use by Whooping Crane (Table E-1); one area contains ~93% of the breeding range. Whooping Cranes would benefit most from activities focused on conserving the quality and quantity of preferred wetlands in the migratory corridor and breeding range, especially emergent and meadow marshes and graminoid and shrubby fens. This can be achieved by minimizing disturbance and development in areas used for breeding north of Wood Buffalo National Park, avoiding wetland disturbance in the migratory corridor, and not placing infrastructure near habitats with a high probability of use or modify the infrastructure to reduce collision risk. By protecting these habitats and mitigating risk within them, PHJV can play an important role in supporting the ongoing recovery of this high-profile species.

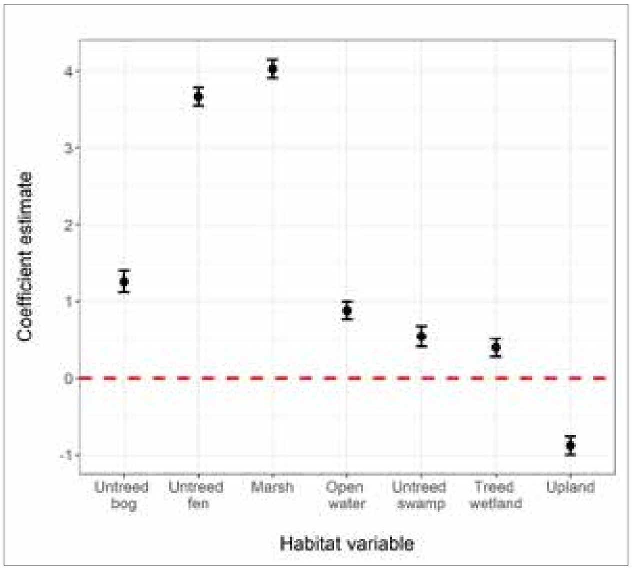

FIGURE E-1. Estimated selection coefficients and 95% confidence intervals of habitat types during stopover site selection by migrating Whooping Cranes (Grus americana) in Canada's Western Boreal Forest, based on a used-available study design. Values > 0 (above red line) represent positive selection and those < 0 represent negative selection.

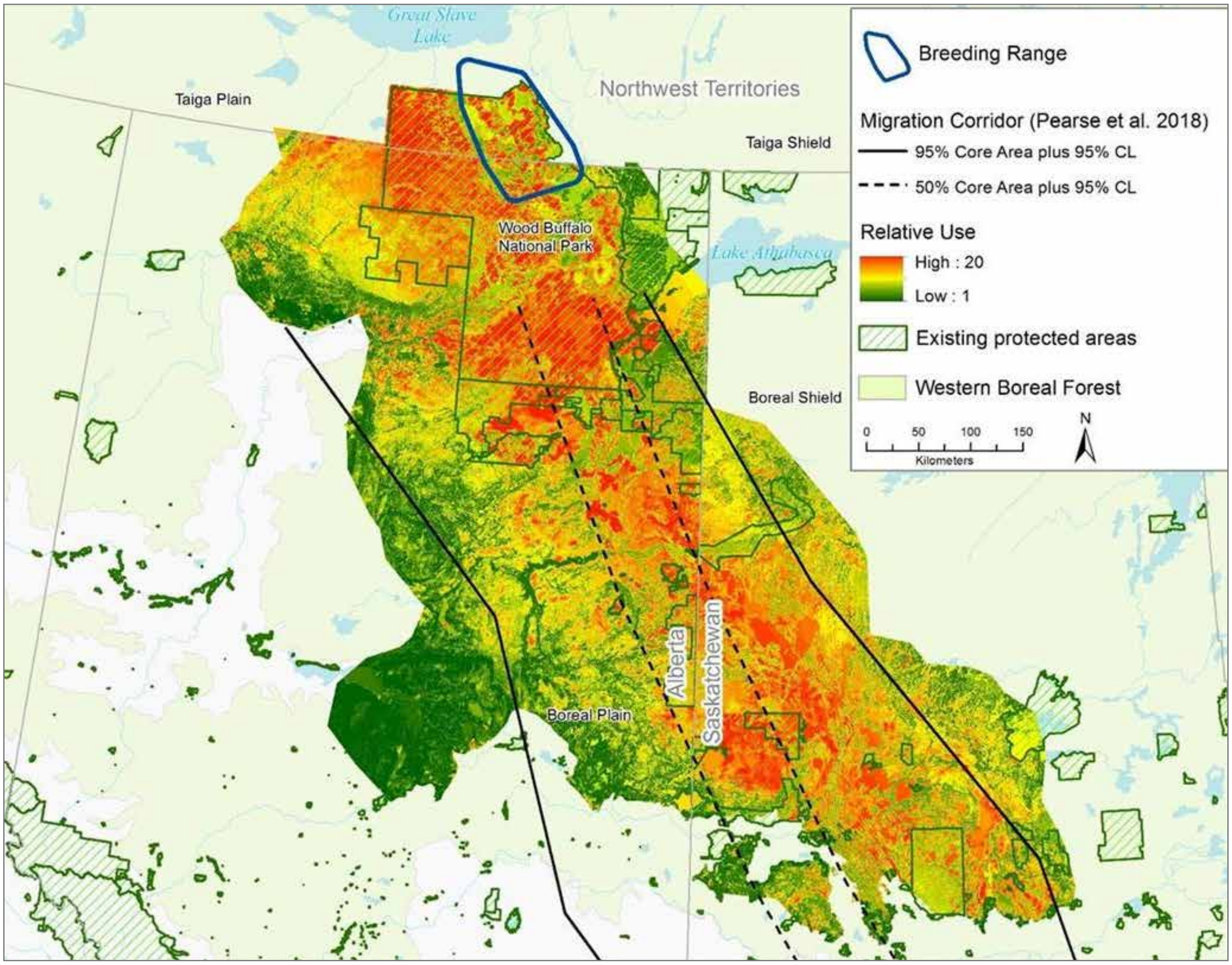

FIGURE E-2. Predicted Whooping Crane (Grus americana) relative use, in relation to the Whooping Crane breeding range, migration corridor, and existing protected areas in Canada's Western Boreal Forest.

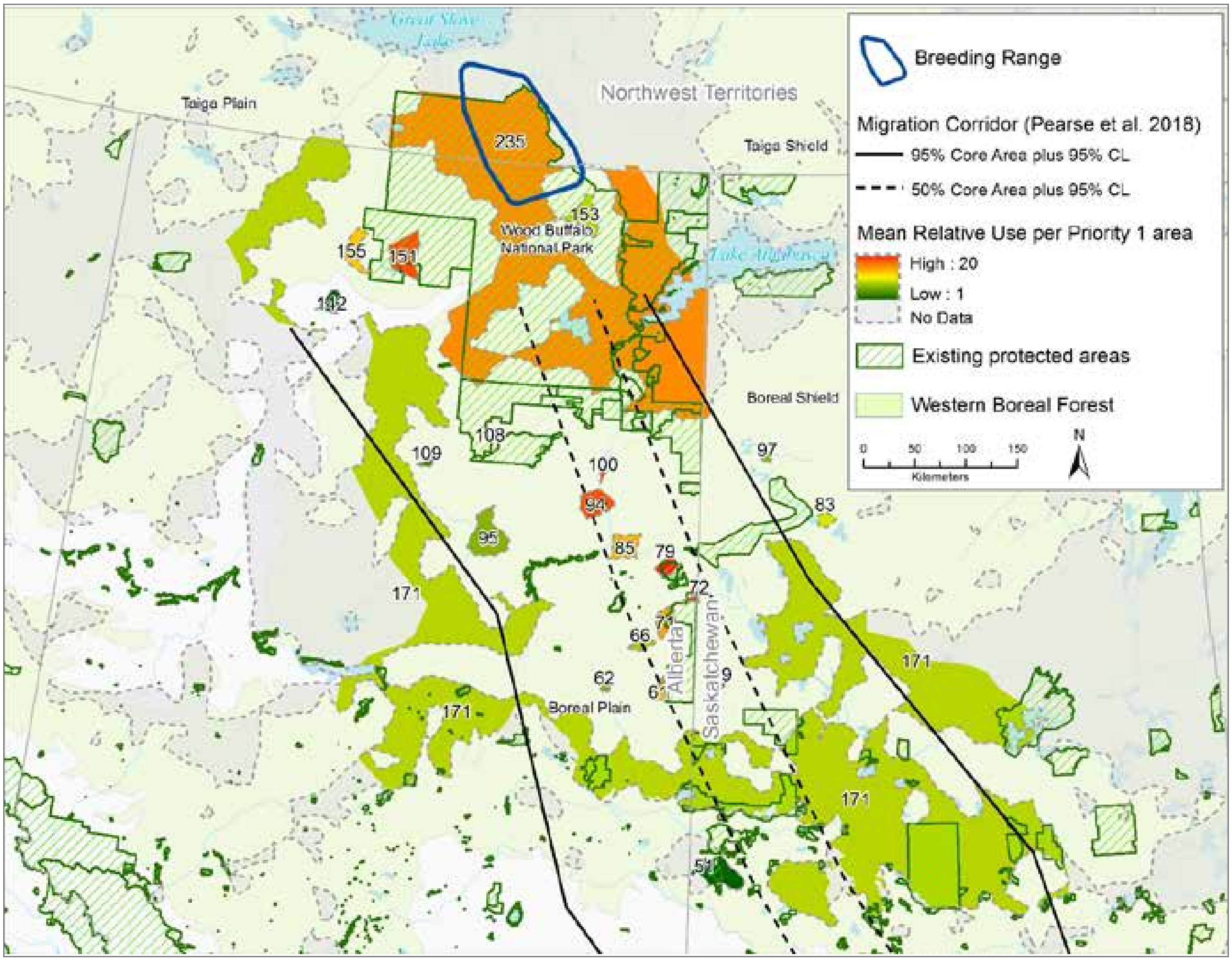

FIGURE E-3. Areas prioritized for waterfowl conservation (priority areas) under the Prairie Habitat Joint Venture's Boreal Implementation Plan classified by their mean values of predicted Whooping Crane (Grus americana) relative use, in relation to the Whooping Crane breeding range, migration corridor and existing protected areas in Canada's Western Boreal Forest.

TABLE 13. ID and size of 22 areas prioritized for waterfowl conservation (priority 1 areas) under the Prairie Habitat Joint Venture's Boreal Implementation Plan in Canada's Western Boreal Forest, with their mean and standard deviation (SD) values of predicted Whooping Crane relative use (RU; range 1-20). Also shown is the coverage (%) of each priority area by the RU layer and the season in which each area is primarily used by Whooping Cranes (M=migration; B=breeding).

ID	SIZE (KM2)	RU (MEAN)	RU (SD)	COVERAGE (%)	SEASON
108	3.3	19.77	0.57	100.0	M
72	50.5	15.50	4.29	100.0	M
79	270.7	15.49	4.15	100.0	M
100	65.0	15.11	5.31	100.0	M
151	928.6	14.30	2.07	100.0	M
94	648.8	14.24	5.11	100.0	M
59	16.0	14.19	2.11	100.0	M
235	181,557.9	12.89	5.90	22.2	B
71	399.1	12.42	4.94	100.0	M
85	561.2	11.99	4.45	100.0	M
61	169.5	11.75	3.52	100.0	M
155	498.4	11.49	2.37	100.0	M
83	182.8	9.51	4.17	100.0	M
153	640.9	9.05	4.54	100.0	M
171	351,150.5	8.95	5.59	25.4	M
66	188.2	8.76	4.73	100.0	M
97	71.1	8.20	4.05	100.0	M
95	1,175.5	7.93	4.01	100.0	M
62	50.5	7.82	3.51	100.0	M
109	69.1	6.71	2.67	100.0	M
51	2,755.6	4.24	3.37	30.5	M
142	281.3	3.66	3.02	100.0	M

**A Shared Vision:
Canada's NAWMP
Habitat Joint Ventures**

Connecting people through sound science at the landscape level using a partnership approach for long term conservation impact.

prairie habitat
joint venture