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

IMPLEMENTATION PLAN **2021–2025:**

The Prairie *Parklands*

prairie habitat
joint venture

ON THE COVER:

Large Photo: Pintails / © Ducks Unlimited Canada
Small Photo: Chestnut Collared Longspur / Christian Artuso

RECOMMENDED CITATION:

Prairie Habitat Joint Venture. 2021. ***Prairie Habitat Joint Venture Implementation Plan 2021-2025 : The Prairie Parklands.*** Report of the Prairie Habitat Joint Venture. Environment Canada, Edmonton, AB.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

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 Prairie Parklands* was prepared by the PHJV Science Committee, the PHJV Human Dimension Committee, the PHJV Policy Committee and the PHJV Communications Committee, with substantial contributions from the three provincial implementation committees.

The PHJV Advisory Board would like to express their gratitude to the contributors/writers of this Plan:

PHJV Science Committee: James Devries DUC Chair, Jeff Ball ECCC, Blake Bartzen ECCC, Stephen Carlyle MHHC, Kiel Drake Birds Cda, Ryan Fisher SK, Greg Hale AB NAWMP, Cary Hamel NCC, Glenn Mack AEP, Ann McKellar ECCC, Janet Ng WSA, Barry Robinson ECCC, Howie Singer DUC, Roald Stander MHHC, Stuart Slattery DUC, Mike Watmough ECCC, Corie White SK WSA.

PHJV Human Dimensions Committee: Corie White SK WSA, Chair, Stephen Carlyle MHHC, Ian Cook Birds Cda, Jim Devries DUC, Deanna Dixon PHJV/ECCC, Greg Hale AB NAWMP, Howie Harshaw UAlberta, Dave Kostersky DUC, John Pattison-Williams Policy Committee, Katherine Sainsbury UAlberta, Dean Smith AFWA.

PHJV Policy Committee: Greg Hale AB NAWMP, Chair; John Pattison-Williams Coordinator, Robin Bloom ECCC, Stephen Carlyle MHHC, Jim Fisher DWF, Peter Joyce SK, Tracy Maconachie DUC, Tracy Scott AB-DUC, Corie White SK WSA.

PHJV Communications Committee: Dave Kostersky, Chair, Deanna Dixon PHJV/ECCC

Alberta Implementation Committee: Travis Ripley AEP Chair, Greg Hale AB NAWMP Partnership Coordinator, Bryanne Aylward NCC, Ron Bennett ECCC, Katelyn Ceh NCC, Darwin Chambers DUC, Jim Devries DUC, Thorsten Hebben DUC, Kristen Lorenz AAF, Tom Lynch-Staunton NCC, Glenn Mack AEP, Dave Mussell AEP, Alain Richard DUC, Barry Robinson ECCC, Tracy Scott DUC, Howie Singer DUC, Jamie Wuite AAF.

Saskatchewan Implementation Committee: Corie White SK WSA, Chair, Blake Bartzen ECCC, Bradley Bergen DUC, Kiel Drake Birds Cda, Ron Ely SK MoA, Peter Joyce SK EVN, Janet Ng SK WSA, Trevor Plews DUC, Mafgur Rahman SK WSA, Megan Schaefer SK MoA, Cameron Wood NCC.

Manitoba Implementation Committee: Stephen Carlyle MHHC, Chair, Ron Bazin ECCC, Jim Devries DUC, Jim Fisher DWF, Mark Francis DUC, Cary Hamel NCC, David Hay ARD, Andrea McLean Manitoba Agriculture and Resource Development (ARD), Cameron Meuckon ARD, Gabrielle Miller MHHC, Tim Poole ARD, Sharon Reedyk ECCC, Roald Stander MHHC, Howie Singer DUC, Tony Szumigalski ARD, Lena Vanden Elsen DUC.

Additional Contributors: Jean-Michel DeVink DUC, Sandy Gousseau, Zhong Li ECCC, Tiana Phillips ECCC Summer Student, Samantha Song ECCC, Gillian Turney ECCC.

Special thanks to Dr. James Devries for his significant contributions to this plan and his leadership in bringing it together.

THE PHJV GRATEFULLY ACKNOWLEDGES ALL CANADIAN PARTNERS:

- The Federal Government of Canada
- The Provinces of Alberta, Manitoba, Saskatchewan and British Columbia, and the Northwest Territories and Yukon Territory
- 35 Canadian regional and local governments
- 360 Canadian non-government organizations
- 17,000 landowners

THE PHJV GRATEFULLY ACKNOWLEDGES ALL UNITED STATES PARTNERS:

- Including the many federal, state and non-governmental organizations whose invaluable contributions to the PHJV have shaped the success of the Joint Venture and the entire North American Waterfowl Management Plan partnership.
- The Federal Government of the United States
- 24 U.S. State Governments
- 22 United States non-government organizations

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 critical habitat programs across the Prairie Parklands in Alberta, Saskatchewan and Manitoba. Since the early 2000s, the PHJV has assumed responsibility for wetland and waterfowl conservation in the Western Boreal Forest (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 2020-2025 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 1). 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.

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 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 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

For 35 years, the Prairie Habitat Joint Venture (PHJV) has been implementing critical habitat programs across the Prairie Parklands in Alberta, Saskatchewan and Manitoba. Building on the achievements of the 2013–2020 Implementation Plan, the 2021–2025 Implementation Plan continues to incorporate lessons learned about program delivery, information about bird ecology and responses to PHJV programs and changes to agricultural and policy landscapes, enabling the partnership to reshape its habitat and policy objectives over a five-year cycle and beyond, to 2040. Also, the PHJV strives to integrate new North American Waterfowl Management Plan (NAWMP) direction outlined in the 2012 Revision, 2014 Addendum and 2018 Update.

Our implementation plans have always guided PHJV activities that continue to serve as conservation roadmaps. These plans have been adjusted periodically to reflect:

- changing socioeconomic, policy and environmental conditions
- improving knowledge about duck population responses to managed and unmanaged habitats
- understanding of landowner acceptance of habitat delivery alternatives
- growing interest in identifying ways to enhance all-bird conservation

Despite ongoing and significant investments in conservation action and cooperative stewardship, the long-term capacity of PHJV landscapes to support duck populations in the Prairie Parklands remains a concern due to ongoing loss or degradation of wetlands and grasslands habitat, especially native grasslands. Habitat is also impacted by market uncertainties regarding the demand for cattle (favouring the retention of grassland habitat) versus demand for cereal, oilseed and other crops (favouring conversion of grassland to cropland).

2013–2020 Achievements

The success of the PHJV has been shaped by the invaluable contributions of our partners and supporters in Canada and the US, including federal, provincial/state and municipal governments, Indigenous Peoples, corporations and environmental non-governmental organizations.

This plan focused on identifying combined high-priority areas for both waterfowl and non-game birds for habitat conservation efforts, as the larger area requirements of waterfowl includes wetlands and adjacent uplands that benefits a range of shorebirds, water birds and landbirds. Since the 2013–2020 Plan was implemented, duck populations for all species increased for the 10-year average abundance, except for Northern Pintail. Despite high-sustaining pond numbers of 18% above the long-term average, 10-year average American Wigeon, Northern Pintail and Scaup populations remain below NAWMP conservation goals. Lesser Scaup has exhibited an increasing trend at 6% below the long-term average. Remaining species are generally well above long-term averages. The Mallard population size, which was a concern in the 2013–2020 Plan, has increased 17% above the long-term average objective in 2019. The waterfowl survey did not take place in 2020 or 2021 due to the COVID-19 outbreak.

Across the PHJV area, 23 Shorebirds, 13 Waterbirds and 29 Landbirds were identified from the priority species list of the recently completed Bird Conservation Region (BCR) Strategy for BCR 11 Prairie and Northern Region. Twenty species from this list are protected under Canada's Species At Risk Act (SARA). Populations of many upland landbirds have declined significantly in the PHJV area, largely due to the loss of native grasslands, and ambitious new targets have been set for these bird populations and habitats for 2021–2025.

The 2013–2020 Plan had a strong focus on wetlands and associated upland restoration and retention within Waterfowl Target Landscapes. The PHJV made significant achievements toward these objectives, but had varying degrees of success for habit restoration objectives at the PHJV scale. Habitat restoration and retention efforts overall achieved 42% (433,448 acres) and 96% (791,800 acres) of eight-year objectives, respectively. Wetland restorations achieved 88% (6,900 acres), almost entirely through direct programs. The total investment over the past eight years was $395.5 million with ~ 86% allocated directly to habitat conservation programs.

The PHJV plays an active role in the wetland policy arena and significant changes were made across the prairies and continue to remain a PHJV focus, including:

- The Alberta Wetland Policy, which was approved in 2013, implemented in 2015, and affects approximately 130,000 acres of wetlands.
- In Saskatchewan, new regulations, legislation, and policies have been implemented to support "responsible drainage". Further, an Agricultural Water Management Strategy was initiated in 2015.
- In Manitoba, significant gains were made with the amendment of legislation and associated regulations that protect Class 3, 4 and 5 wetlands, mandate no net loss of wetland benefits and establish the Growing Outcomes in Watersheds (GROW) program to provide incentives for retention of Class 1 and 2 wetlands.

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. As we continue to focus on building broad support for conservation programs, we are identifying ways of strengthening ties and enhancing engagement with our partners.

2021–2025 Implementation Plan

For the 2021–2025 Implementation Plan, targeting effort in waterfowl target landscapes directs conservation resources to areas of highest average duck density, with special consideration for Northern Pintail. The impact of habitat and land use changes, and conservation activities outside of target landscapes is captured in our modeling process as well.

New: Expanding Efforts and Creating Opportunities

The PHJV has developed a new strategic approach to integrate human dimensions (HD) into our conservation actions, programs and a broader inclusive approach to the partnership, including Indigenous Peoples of Canada, as well as the public more broadly. The strategy includes both ecologically- and socially-informed goals associated with engaging priority audiences to create long-lasting partnerships and coalitions based on trust and relevancy. The use of HD tools and research will help the conservation community to better understand 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.

Also, the PHJV has expanded efforts to achieve ambitious targets for wetland and native grassland habitats, as well as the important bird populations supported by these unique habitats. First-time, quantitative targets have been included for grasslands bird habitat conservation throughout the PHJV delivery area. This provides opportunities for our current and new partners to create / include capacity to deliver programs outside of waterfowl landscapes. It will challenge partners to look for alignment of benefits between waterfowl and the other priority birds groups. Achieving these objectives will be heavily influenced by this delivery capacity, the ability to grow existing funding and develop new sources, and through the development of new conservation mechanisms that look beyond our current practices.

Conservation for the Benefit of All Birds

Habitat objectives setting for this Plan was guided by wetland and upland restoration and retention scenarios (direct and policy) that were estimated to achieve the waterfowl hatched nest objective by 2040, and to stop priority landbird population declines by 2035. The PHJV will achieve success only by implementing programs and policies that maintain and restore the long-term productive capacity of prairie landscapes.

For waterfowl conservation planning, primary drivers of PHJV productive capacity are: 1) ongoing loss or degradation of wetlands reducing the ability of the region to attract and hold breeding pairs and 2) changes in land use affecting the availability of safe nest sites.

This Plan focuses on a subset of priority shorebird (22), waterbird (13) and landbird (28) species that use wetland and upland habitats in the PHJV area, and are further classified based on breeding location and habitat associations. Of the 64 priority species, five shorebirds, five waterbirds and 14 landbirds are protected under SARA. Population trend information was based on the North American Breeding Bird Survey (BBS).

In this Plan, the PHJV has:

- set spatially explicit conservation targets for grassland habitat to meet population objectives for grassland songbirds
- estimated amounts of grassland (acres) using species density models and simulations of grassland conversion to cropland
- targeted grasslands that are high priority to grassland birds and at high risk of conversion

Habitat restoration objectives primarily focus on conversion of cropland to perennial grass cover in the form of forage crops for hay or pasture (~500,000 acres). These habitats have greater nest survival than croplands and further improve landscape-level hatching success as well. Wetland restoration objectives (18,100 acres) restore waterfowl pair carrying capacity and, on a per unit area basis, provide a greater contribution to incremental hatched nests however, opportunities for restoration are much more limited.

The PHJV's overarching goals for habitat retention are to stem the loss of wetlands and to retain all remaining native grasslands given their practically irreplaceable nature and critical habitat value for several Species at Risk. The PHJV is targeting habitat retention objectives for waterfowl and landbirds of 302,900 acres of wetlands and ~1.3 million acres upland habitat for conservation.

To meet habitat objectives for the Prairie Parklands by 2025, habitat restoration costs are approximately $100.1 million, and habitat retention costs are $408.5 million. Landbird conservation expenditures add ~$255.6 million to address the conservation of 676,300 acres of grassland retention. Most expenditures are allocated to direct and indirect costs associated with habitat restoration and retention activities (90%). The total estimated expenditure for implementation of

PHJV habitat objectives for waterfowl and landbirds during 2020–2025 is projected at $886.5 million (including 1.5% annual inflation). This estimate reflects a substantial increase in conservation delivery, including the addition of landbird conservation objectives (upland retention) to meet Species At Risk Recovery Plan objectives. PHJV partners recognize that additional strategies and resources will be needed to meet the conservation objectives outlined in this Plan.

Building on the policy achievements of the 2013–2020 Plan, efforts will focus on specific objectives to continue to make progress toward policies that support the maintenance of wetlands and grasslands as part of sustainable agricultural landscapes. Efforts to advance human dimension objectives will focus on two areas: advocating and delivering programs and policies supporting conservation, and the long-term sustainability of agricultural communities; and connecting with the public about the benefits of wetland and waterfowl habitat, in participating wetland-related recreation activities and taking action to support conservation initiatives.

Evaluating and adaptively improving habitat programs in response to new information have been hallmarks of the PHJV. The 2001–2016 change in the trajectory of cultivated acres sends an alarming signal that gains in productive upland habitat seen since 1986 have begun to erode. Understanding if, where and which habitats are being affected by this change, and how they will affect bird populations will continue to be a top priority for research and evaluation.

Priorities include:

- completion of the Canadian Wetland Inventory (CWI) for the Prairie Parklands
- development and completion of a PHJV-wide native grassland inventory
- research on the demographic and population responses of birds to wetland and upland habitat changes within the Prairie Parklands
- further understanding of habitat risk of loss incorporated into spatial layers for use in conservation planning and objective setting
- ongoing research to project the impact of climate change on wetland habitat and potential waterfowl response across the PHJV (similar work on grasslands and grassland birds may be warranted)
- assessment of the impact of recent wetland policy advancements in Alberta and Manitoba on wetland loss
- further quantifying and refining estimates of the impact of wetland and grassland conservation activities on carbon sequestration/storage and biodiversity

1.0 INTRODUCTION THE PRAIRIE PARKLANDS

The Prairie Habitat Joint Venture (PHJV) is one of 22 Migratory Bird Joint Ventures spanning North America (https://partnersinflight.org/partners/mbjvs/) and one of the original Joint Ventures under the North American Waterfowl Management Plan (NAWMP 1986). Conservation delivery under the auspices of the PHJV is achieved through diverse partnerships and delivery initiatives (Appendix 1). The PHJV delivery area covers two distinct biomes in western Canada – the Prairie Parklands and the Western Boreal Forest (WBF) (Figure in Preface) – and together, this region supports approximately 50% of North American breeding waterfowl. The Prairie Parklands delivery area represents the Canadian extent of the vast Prairie Pothole Region encompassing more than 770,000 km^2 of central North America (Doherty et al. 2018). This region is one of the richest, most diverse, and unique wetland-grassland ecosystems in the world, and is named for the millions of depressional wetlands called "prairie potholes" which dot the landscape. These wetlands were formed as subterranean masses of ice melted following the retreat of glaciers at the end of the last ice age. While approximately 40-70% of historic wetland area has been lost to surface drainage, the Prairie Parklands today host approximately 4.96 million ha of wetland area (Watmough et al. 2017). Maintained by snowmelt, rain or groundwater connections, their depth and ecological function is determined by differences in topography, soil type and location within the Prairie Pothole Region. The Prairie Parklands also encompass the northern extent of the North American Great Plains transitioning into the Western Boreal Forest. This includes the remaining remnants of the shortgrass, mixed-grass and tallgrass prairies with increasing tree cover in Parkland and Boreal transition zones along the northern fringe.

Given highly-productive soils throughout the region, the Prairie Parklands are largely under privately-owned agricultural production systems supporting dispersed urban and rural communities. Primary land uses include cropland (predominantly for cereal grain and oil-seed production), and introduced and native grass forage lands (pasture and haylands) for cattle production. Remaining wetlands and grasslands provide vital habitat for a diverse array of plant and animal species, including threatened and endangered mammals, fish, amphibians, and a variety of invertebrates (Peterka 1989, Lehtinen et al. 1999, Clark 2000, Wrubleski and Ross 2011). Most notably, large populations of migratory birds, including waterfowl, shorebirds, waterbirds and landbirds depend on these habitats for food and cover primarily during breeding and migration (Johnson and Grier 1988, Peterjohn and Sauer 1997, Niemuth et al. 2008). In some years, up to 70% of all breeding ducks estimated in traditionally surveyed areas may occur within the US and Canadian Prairie Pothole Region (e.g., Zimpher et al. 2011). Thus, the PHJV represents a unique juxtaposition of vital ecosystem elements embedded within a working agricultural landscape where the sustainability of habitat is heavily influenced by local, regional and global factors driving land management decisions.

While wetlands and grasslands support much of the remaining biodiversity in the PHJV, including pollinator and beneficial insect populations, these habitats also provide other ecosystem services important to society. These services include regulation of surface water quality and flow, groundwater recharge, as well as greenhouse gas sequestration and storage. Thus, while PHJV conservation activities are focused on maintaining and restoring habitats for multiple bird species, the impacts are expected to benefit many other species, rural and urban communities, as well as global efforts to mitigate the effects of climate change.

Declines in bird populations in the PHJV are most commonly attributed to the loss and fragmentation of grassland and wetland habitats through conversion to agricultural uses – now covering approximately 93% of the land area of the Prairie Parklands (Environment Canada 2013). Oil and gas development, urban and industrial development and mining further contribute to native grassland and wetland habitat loss. While cropland can provide important feeding habitat for some species during migration, it is generally poor habitat and several bird species that select cultivated land for nesting (e.g., Northern Pintail, Horned Lark) are subject to nest destruction by agricultural equipment (e.g., Duncan and Devries 2018). In contrast, pastures can provide suitable breeding habitat for a suite of grassland bird species when grazing intensities are well managed. Loss of remaining native grassland and sagebrush habitat is of special concern given many of the bird species of highest conservation concern are endemic to these habitats (Environment Canada 2013). Loss of wetland habitat continues to be a conservation concern in the Prairie Parklands despite ongoing and significant investments in conservation action and cooperative stewardship.

In addition to habitat loss, agriculture and other anthropogenic activities can degrade remaining habitats through water diversion, intensification of mowing, incompatible grazing, invasion of exotic plant species, fire suppression and encroachment of woody vegetation, as well as pollution from systemic pesticides, agricultural effluents and industrial accidents. These activities may directly impact survival of adults, nests, or young, or they may indirectly affect survival and/or reproduction through reducing availability of insect prey, increasing competition and predation, or sublethal toxic impacts on behaviour, physiology or body condition. In Canada, pesticides contribute to an estimated 2.7 million bird mortalities annually (Calvert et al. 2013) and may meet or exceed the current contributions of habitat loss and fragmentation to declining populations of farmland-associated birds (Stanton et al. 2018).

Overarching these persistent threats, climate change is a growing conservation concern. Several grassland birds and shorebirds of high conservation priority are highly vulnerable to climate change (Bateman et al. 2020). Further, habitat loss and fragmentation can exacerbate climate vulnerability because larger patches of native grass have greater capacity to buffer the impacts of higher temperatures and precipitation on avian reproduction and survival (Jarzyna et al. 2016, Zuckerberg et al. 2018). Attempts to address climate warming by expanding solar and wind energy production facilities and associated infrastructure could result in further losses or degradation of habitat and increased collision mortality if not carefully sited (Laranjeiro et al. 2018, Kosciuch et al. 2020). Thus, emerging climate-related threats should play a greater role in conservation planning for the future – highlighting the importance of wetlands and grasslands as important to carbon sequestration and storage, and focusing on areas that are predicted to have suitable climates for priority birds today and in the future (Grand et al. 2019).

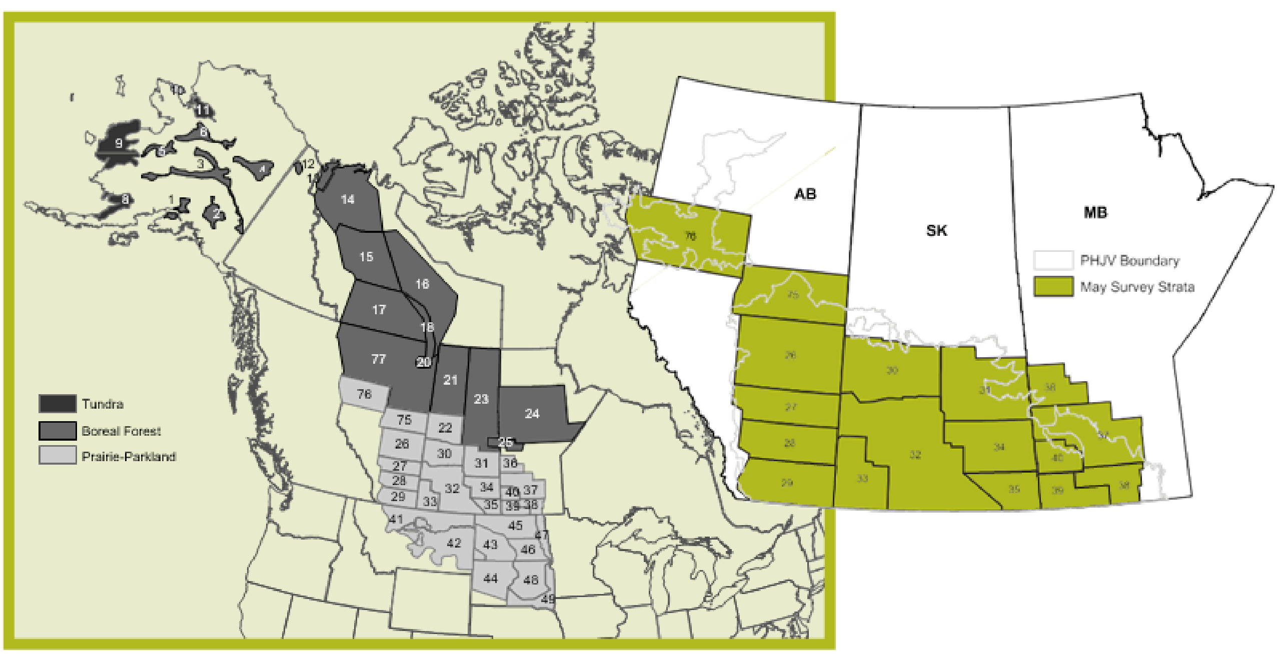
In this Plan, the PHJV strives to integrate new NAWMP direction outlined in the 2012 Revision, 2014 Addendum and 2018 Update. In doing so, we have expanded our efforts to achieve ambitious targets for wetland and native grassland habitats and the important bird populations supported by these unique habitats. Population objectives for non-game bird species have been closely linked to the planning processes for Bird Conservation Regions (BCR) in the WBF (BCR 4, 6, 7, 8) and the Prairie Parklands (BCR 11). This plan represents the first time the PHJV has included quantitative targets for grasslands bird habitat conservation. Building on PHJV achievements, there are opportunities for new and existing partners to create/include capacity to deliver programs within and outside of waterfowl landscapes. The PHJV remains committed to integrating human dimensions by creating a more inclusive plan that includes human dimension objectives and strategies, which are aimed at using social science to inform programming, policies and communication. Further, the PHJV recognizes the importance of building broad support for conservation programs across the entire region. We have started to identify ways of strengthening ties and enhancing engagement with our non-traditional partners, including the Indigenous Peoples of Canada.

2.0
STATUS OF BIRD POPULATIONS

Waterfowl

Duck populations in the Prairie Parklands have been monitored continuously from 1955–2019 as part of the U.S. Fish and Wildlife Service (USFWS) and the Canadian Wildlife Service (CWS) Waterfowl Breeding Population and Habitat Survey (WBPHS) conducted annually in the U.S. and Canada (Benning 1976; Figure 1). Included in the survey is a count of wetlands on survey transects as an index of annual wetland habitat conditions (hereafter, May ponds). Given a focus of PHJV conservation activity on ducks, this review is limited to the 10 most common duck species (seven dabbling duck and three diving duck species; Table 1). Visibility-corrected, survey stratum-level data from 1955–2019 were used to calculate long-term and 10-year average breeding populations for the Prairie Parklands (also, Prairies Ecozone; Ecological Stratification Working Group 1995). Stratum-level abundance for each species and May ponds were multiplied by the area of the Prairie Parklands within each stratum, and then summed to produce a Prairie Parklands population estimate for each year and species. To smooth annual variation, counts and trends are presented and discussed as running 10-year average breeding population sizes. The waterfowl survey did not take place in 2020, due to the COVID-19 outbreak. Consequently, 2019 was the last year of survey reporting used for this report.

Although many duck populations were below the respective long-term average abundances in 2019, likely due to drier conditions, the 10-year averages remained above the long-term average objective for most populations (Table 1). Since the 2013–2020 Implementation Plan, the 10-year average abundance for all species increased, except for Northern Pintail, while the 10-year average abundance of ponds remained relatively stable and was only slightly lower in 2019 (Figure 2). Ten-year average American Wigeon, Scaup and Northern Pintail populations remain below long-term averages, but Lesser Scaup exhibited an increasing trend and were 6 % below the long-term average (Table 1). Causal factors implicated in American Wigeon and Lesser Scaup declines remain uncertain. Changing cropping practices in combination with the Northern Pintail's propensity to nest in early spring crop stubble in the Canadian Prairie Parklands are believed to be the primary factor for the population decline of this species (e.g., Zhao et al. 2019), but the very low estimate in 2019 was likely attributed to dry conditions in the core breeding areas in southern Alberta and Saskatchewan.



[Note:] Surveys in the Prairie Habitat Joint Venture (insert) and U.S. portions of the Prairie Pothole Region have been conducted since 1955.

FIGURE 1. Coverage of the annual Waterfowl Breeding Population and Habitat Survey (WBPHS).

TABLE 1. Current duck and pond counts (2019 and running 10-year average) in the PHJV Prairie Parklands relative to population objectives (long-term average [LTA; 1955–2014]) and 80th percentiles.

	PHJV-PRAIRIE PARKLANDS		NAWMP REVISION GOALS - PHJV			
Species	2019 ESTIMATE	2019 10-YEAR AVERAGE	LONG-TERM AVERAGE (1955-2014)	LONG-TERM 80TH PERCENTILE	% DIFFERENCE FROM LTA	% DIFFERENCE FROM 80TH PERCENTILE
MALLARD	2,554,065	3,329,048	2,849,978	3,476,261	+17	-4
NORTHERN PINTAIL	278,446	854,080	1,679,932	2,762,212	-49	-69
BLUE-WINGED TEAL	1,507,058	3,055,404	1,957,316	2,635,094	+56	+16
NORTHERN SHOVELER	1,403,042	2,029,935	1,093,035	1,343,418	+86	+51
GADWALL	1,599,837	1,646,979	879,401	1,209,964	+87	+36
AMERICAN WIGEON	428,580	415,877	611,779	1,006,139	-32	-59
GREEN-WINGED TEAL	532,518	634,793	411,867	595,915	+54	+7
DABBLING DUCKS	**8,303,546**	**11,966,117**	**9,483,308**	**12,584,014**	**+26**	**-5**
CANVASBACK	283,894	323,791	238,695	319,032	+36	+1
REDHEAD	280,811	557,583	316,273	415,371	+76	+34
SCAUP	641,948	637,946	678,426	948,598	-6	-33
DIVING DUCKS	**1,206,654**	**1,519,320**	**1,233,394**	**1,543,401**	**+23**	**-2**
ALL DUCKS	**9,510,200**	**13,485,436**	**10,716,702**	**13,746,974**	**+26**	**-2**
PONDS	**2,248,685**	**3,255,817**	**2,761,740**	**3,642,987**	**+18**	**-11**

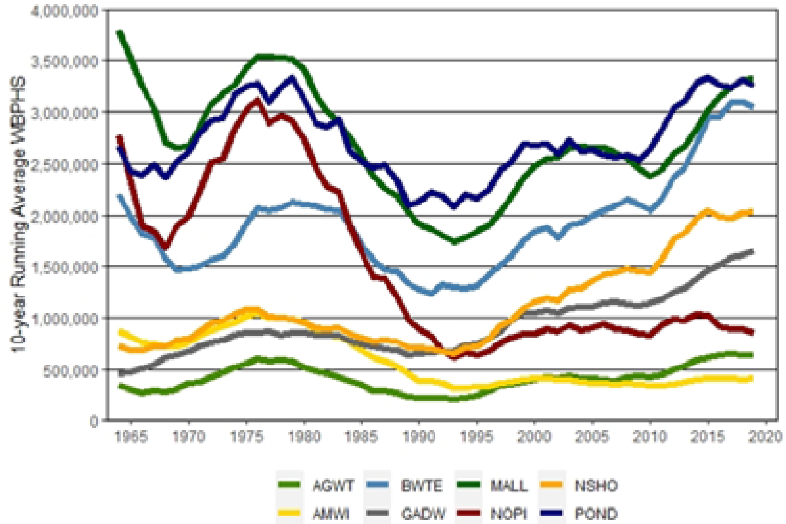
Remaining species are generally well above long-term averages (LTAs; Table 1). Blue-winged Teal, Northern Shoveler and Gadwall populations have recently shown consistent upward trends, although Blue-winged Teal have exhibited signs the population is leveling off (Figure 2). Ten-year average abundance of Green-winged Teal also increased since 2014. Canvasback and Redhead are above the long-term average population objective level and Redhead population continued to increase, while the Canvasback population remained relatively stable. While the size of the Mallard population was of some concern in the 2013–2020 Implementation Plan, their population has continued to increase and was 17% above the long-term average objective in 2019 (Table 1). The 10 year-average for pond counts in 2019 remained similar to 2014 and was 18% above the long-term average. Despite the high sustained pond numbers, American Wigeon and especially Northern Pintail populations have remained persistently low.

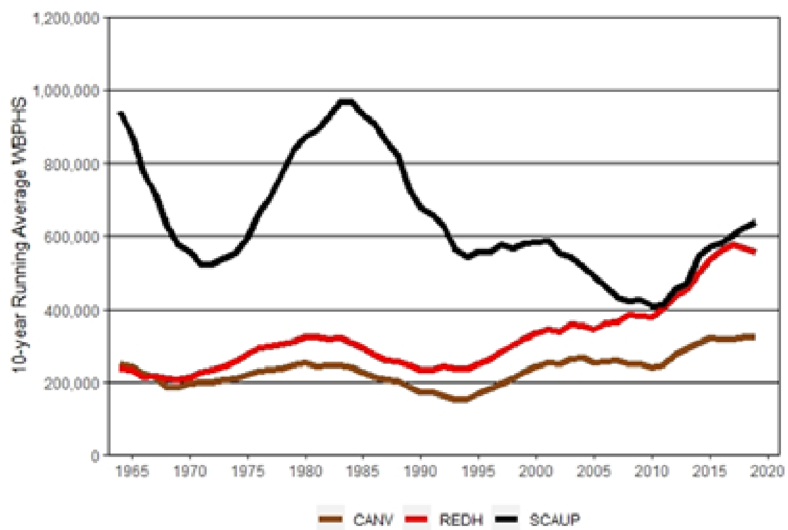
The 2019 summed 10-year average population for the 10 duck species was 26% above the long-term average and just 2% below the 80th percentile of 1955–2014 population estimates. These population levels likely reflect the positive effects of land use change (see Status of Habitat in the next section), PHJV habitat delivery, and an extended wet cycle overriding the impacts of continual wetland habitat loss. Despite the high 10-year averages, some caution is warranted as many of the population were down considerably in 2019 and, although there are no data for 2020, conditions were dry in much of southern prairies, and it is likely that duck populations were low again (B. Bartzen, Canadian Wildlife Service, pers. obs.). Summary of waterfowl population trends at the provincial level are provided in Appendix 2.

Shorebirds, Waterbirds and Landbirds

This Plan focuses on a subset of 64 priority shorebird, waterbird and landbird species (Appendix 3; includes scientific names). This list was selected to emphasize species that use wetland and upland habitats of the Prairie Parklands, and for which this region represents a considerable portion of the species distribution. Population trends (based on the Breeding Bird Survey or International Shorebird Survey; Smith A.C. et al. unpublished, an update of Environment Canada 2017; P.A. Smith and A.C. Smith,

FIGURE 2. Trends in 10-year running average populations of seven most common dabbling duck species and ponds (top) and three most common diving duck species (bottom) from the Waterfowl Breeding Population and Habitat Survey conducted annually across the Prairie Habitat Joint Venture Area, 1955–2019. AGWT –American Green-winged Teal, AMWI – American Wigeon, BWTE – Blue-winged Teal, GADW – Gadwall, MALL – Mallard, NOPI – Northern Pintail, NSHO – Northern Shoveler, CANV – Canvasback, REDH – Redhead, SCAUP – mostly Lesser Scaup.





unpubl. data), listing status under Canada's Species at Risk Act, and regional conservation concern scores (Avian Conservation Assessment Database Conservation Concern Scores for BCR 11; http://pif.birdconservancy.org/) were also considered. Note that shorebird, waterbird and landbird classifications are based mainly on taxonomy.

We further classified species based on breeding location and habitat associations:

- prairie-breeding species that use wetlands;
- prairie-breeding species that make use of both uplands and wetlands, or uplands in moderate to high-density wetland landscapes;
- prairie-breeding species associated with upland habitats in moist mixed-grass prairie.
- grass prairie and sagebrush shrublands in lower density wetland landscapes; and
- waterbird and shorebird species that breed in the Boreal and Arctic Regions, but use wetland habitats in the Prairie Parklands during migration (Appendix 3).

The latter group excludes landbirds that breed in the Boreal and Arctic Regions, because they pass through the Prairie Parklands during annual migrations across a broad front without staging at specific sites.

SHOREBIRDS (22)

The Prairie Parklands provide important breeding and migratory staging habitats for shorebirds. Twenty-two species are the focus of conservation efforts within the PHJV area (Appendix 3); 12 priority species breed in Boreal or Arctic habitats, while the others breed regularly in prairie habitats. Among the 10 species that breed in the Prairie Parklands, eight use wetlands or upland sites near wetlands, and one primarily uses mixed-grass prairie in areas of more expansive upland habitat. Five priority shorebird species are listed under SARA, of which two breed in the Prairie Parklands (Piping Plover, Long-billed Curlew) and three use the region only while migrating (Red Knot, Buff-breasted Sandpiper, Red-necked Phalarope).

WATERBIRDS (13)

The Prairie Parklands contain the highest species richness of breeding waterbirds in Canada; 13 species are the focus of conservation efforts in this plan (Appendix 3). The group includes a diversity of species such as loons, grebes, bitterns, rails, gulls and terns. Twelve of these species breed in the region, with about half nesting solitarily, typically in small marshes or wetlands with emergent vegetation, and the other half nesting colonially, often on larger marshes or lakes. The remaining species, Whooping Crane, is a passage migrant that often makes use of cropland for foraging, and shallow lakes or marshes for roosting. Five priority waterbird species are listed under SARA (Horned Grebe, Western Grebe, Yellow Rail, Least Bittern and Whooping Crane).

LANDBIRDS (28)

Twenty-eight species are the focus of conservation efforts in this Plan (Appendix 3). The landbirds highlighted in this Plan select a wide range of habitats including wetlands (e.g., Sedge Wren and Common Yellowthroat), uplands in landscapes of variable wetland density (Black-billed Cuckoo and Northern Harrier), and expansive areas of drier mixed-grass and sagebrush habitat (e.g., several species of grouse and birds of prey, as well as typical grassland songbirds such as Sprague's Pipit and Western Meadowlark). Populations of many upland landbirds have declined significantly in the PHJV area (see Population Trends below), largely due to the loss of native grasslands and, consequently, 14 priority landbird species are protected under SARA. These include several iconic species, such as Greater Sage-Grouse, Burrowing Owl and Ferruginous Hawk.

POPULATION TRENDS

Population trend information for priority species that breed in the Prairie Parklands was based on the North American Breeding Bird Survey (BBS), which is a road-based survey method using point counts (Appendix 3). Both short-term (2008–2018) and long-term (1970–2018) trends for the Canadian portion of BCR 11 are provided, as well as 95% credible intervals and the overall reliability of the trend. For shorebirds that breed in Boreal or Arctic habitats, a long-term (1974–2016) continental population trend based on migration monitoring via the International Shorebird Survey (ISS) is provided (P.A. Smith and A.C. Smith, unpubl. data). These trends give an indication of population change for the species as a whole and are not specific to the portion of the population passing through the Prairie Parklands. It should be noted that population trend information from the BBS or ISS is not always available for species at risk, due to small population sizes or other factors. One may wish to consult species-specific recovery strategies or status assessments for more information on population trends for these species (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Widespread, long-term population declines have occurred in Boreal and Arctic stopover migrants (Appendix 3). Specifically, all of the 10 priority shorebird species in this group, for which information was available, have negative trends. The remaining two shorebird species, for which trend information was not available from the ISS (Buff-breasted Sandpiper and Red-necked Phalarope), are both listed as Special Concern under SARA due to their perceived vulnerability. The single waterbird species in this group, Whooping Crane, is also listed under SARA as Endangered. Concerns over rapid and widespread declines in North American long-distance migratory shorebird species have also been highlighted recently in other reports and publications (NABCI Canada 2019; Rosenberg et al. 2019).

Declining population trends are particularly notable within the prairie breeding species of upland habitats group (Appendix 3). Of the 22 landbirds in this group, population trends were available for 19, with nine showing both short-term and long-term declines, and four more showing declines in either the short or the long term. Only Upland

Sandpiper showed increasing trends. All species within this group demonstrating significant population declines are strongly associated with native grasslands. Evidence suggests grassland-associated birds are declining precipitously across North America and that these declines are likely driven by widespread conversion of grassland habitats to cropland (NABCI Canada 2019; NABCI 2019; Rosenberg et al. 2019)

Population trends were more variable for prairie breeding species of wetland, or wetland and adjacent upland habitats. Six of 11 waterbirds with available short- and long-term trend data showed increases in both, two showed declines in both, and three showed a difference in direction between short- and long-term trends. Of eight shorebirds with trend data, the four relying primarily on wetlands showed both short- and long-term increases, whereas the four relying on both wetlands and uplands showed decreases. Three landbirds had increasing short- and long-term trends, two had decreasing trends, and two showed a difference in direction between short- and long-term trends.

3.0 STATUS OF HABITAT

Waterfowl and other bird conservation goals in the PHJV generally depend on the maintenance and restoration of wetlands and grasslands. Our challenge is to understand how past and future changes in these habitats impact the ability of species to achieve desired population abundance or trend objectives. In the PHJV, we are fortunate to have several sources of information that allow tracking of habitat trends in addition to the ability of partner organizations to track conservation actions. With the use of biological models linking status of habitat to population parameters, we use this information to set habitat conservation objectives that will achieve the waterfowl and other bird population objectives identified in this Plan.

A primary source of habitat status and trend information is the PHJV Prairie Habitat Monitoring Program (Watmough et al. 2017). This program employs transect-based change detection using high resolution aerial and satellite imagery, 3D heads-up stereo interpretation, and limited on-the-ground field verification. The program was initiated in 1985 with transect resampling in 2001 and 2011. Longer-term (1961–2016), more frequent, but lower resolution trends in land use change are provided by the quinquennial Census of Agriculture (Statistics Canada 2016) reporting at the municipality/county scale. Annual crop mapping (e.g., Agriculture and Agri-food Canada 2016) is a third source of land use change information only available post 2009. Information from all three sources is included in our modeling and setting of habitat objectives for waterfowl and other birds.

For waterfowl conservation planning, primary drivers of PHJV productive capacity are: 1) ongoing loss or degradation of wetlands reducing the ability of the region to attract and hold breeding pairs] and 2) changes in land use affecting the availability of safe nest sites. Together, these influences are thought to be the main population limiting factors for PHJV priority waterfowl species.

Similarly, for grassland birds, the loss and degradation of remaining grasslands, especially native grasslands, is largely responsible for the decline in populations, including Species at Risk, like Sprague's Pipit, Baird's Sparrow, and Thick-billed and Chestnut-collared Longspurs (e.g., Somershoe et al. 2018). Other priority bird species identified in this Plan will be variably affected depending on their reliance on grassland and wetland habitat, but, in general, these species are

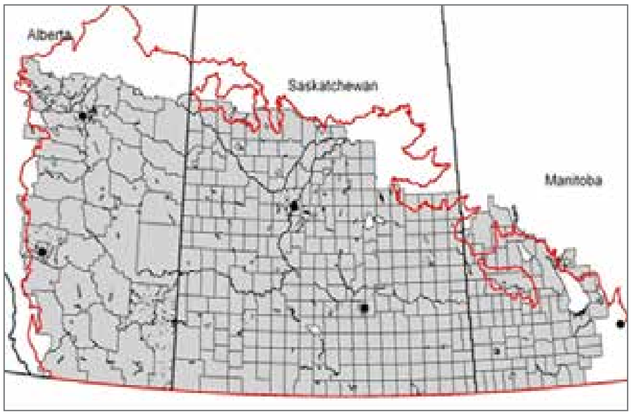


FIGURE 3. Statistics Canada Census of Agriculture CCS units (municipalities) used to characterize land use change in the PHJV planning area (outlined in red), 1961–2016.

assumed to be limited as well by the availability of wetland and grassland habitat. Landscape change is not uniform across the region, and habitat trends will vary in space and with spatial scale. The full effect of habitat change on bird populations depends on the coincident distribution of birds and habitat change. Understanding and accounting for these changes and their potential impact on bird populations requires quantitative estimates of wetland and upland status. Below, is a broad synopsis of current upland and wetland habitat status and trends in the PHJV as estimated from various sources.

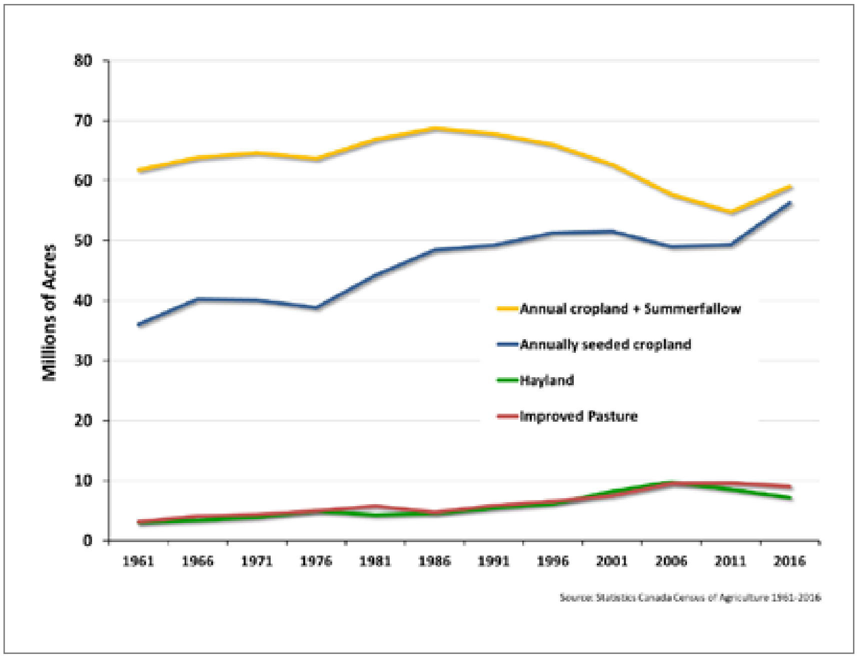


FIGURE 4. Trends in annually tilled lands (annually-seeded cropland + summerfallow), annually-seeded cropland, hayland and improved pasture in the PHJV delivery area, 1961–2016. The area between the top two lines represents acres of summerfallow (source: Statistics Canada Census of Agriculture 1961–2016).

Upland Habitat

To track broad habitat and land use change over time, we rely primarily on Statistics Canada Census of Agriculture data (e.g., Statistics Canada 2016). Primary indicators extracted from the census include acreage of spring-seeded crops, fall-seeded crops, summerfallow (rested cropland), hayland and improved pasture for each Consolidated Census Subdivision (CCS; ~ municipality/county; Figure 3) within the PHJV boundary. Some portions along the northern fringe of the PHJV boundary and the Alberta Peace Lowlands are not considered in this analysis (Figure 3), but much of this area falls outside areas targeted for priority species conservation.

In general, while agricultural lands under tillage (croplands and summerfallow) increased to 1986, tilled land declined by approximately 15 million acres to 2011, typically being replaced with seeded grasslands (haylands and seeded pasture) that provide some benefit to breeding birds. Contributing factors to this trend include the removal of grain transportation subsidies in 1995, federal and provincial programs encouraging conversion of marginal cropland to permanent cover, as well as NAWMP programs. A related expansion of the cattle industry during this period increased the need for pasture and hayland forage. This trend however, reversed around 2011, and cropland agriculture has been on a relatively steep rise through the most recent Census in 2016, while cattle numbers were decreasing (Figure 4). These trends are indicative of an increasing risk to bird habitats in the region. Upland habitat lost to urbanization is not estimated, but is thought to be relatively minor except near major urban centers (Alberta Agriculture and Forestry 2018, Watmough et al 2017).

The PHJV contains an estimated 25 million acres of remaining native grassland (Fields and Barnes 2019) – a habitat critical to many grassland birds, including several species listed under SARA legislation. Native grasslands declined by ~10% within the PHJV from 1985-2001 (Watmough and Schmoll 2007) and by ~4% from 2001–2011 (Watmough et al. 2017). Recent analysis suggests native grassland loss has again accelerated from 2011–2017 (Fields and Barnes 2019). Thus, despite significant gains in area of perennial grassland cover during 1986–2011, loss of remaining areas of native grassland has been continual.

As of 2016, landscape composition of the Prairie Parklands was approximately 49% annual tillage cropland, 29% grasslands (~17.6% native), 11% trees/shrubs, 7% water/wetland, and 4% urban/bare (Table 2). Total cropland area is expected to expand a further 5% by 2040 based on the predicted influence of climate change and economics on land use change in prairie Canada (Rashford et al. 2013; DUC Unpublished Data).

TABLE 2. PHJV Prairie Parklands upland habitat areas (acres; [%]) circa 2016. Area of water/wetland is underestimated given known issues with source data. Grassland is a combination of all types, both native and tame seeded. Cropland includes lands under annual tillage but not necessarily planted to a crop (e.g., summerfallow). Source: AAFC Annual Crop Map 2016.

PROVINCE	URBAN/BARE	WATER/WETLAND	GRASSLAND	CROPLAND	TREES/SHRUBS
ALBERTA	2,152,557 [3.5]	3,348,063 [6.4]	18,943,307 [24.3]	18,987,245 [56.2]	5,903,524 [9.5]
SASKATCHEWAN	2,567,511 [4.4]	4,649,841 [6.8]	17,734,770 [38.4]	40,957,349 [38.5]	6,923,950 [12.0]
MANITOBA	657,715 [3.3]	2,261,077 [11.3]	4,499,798 [22.4]	9,480,067 [47.3]	3,161,694 [15.8]
PHJV TOTAL	**5,377,782 [3.8]**	**10,258,980 [7.2]**	**41,177,874 [29.0]**	**69,424,662 [48.8]**	**15,989,168 [11.2]**

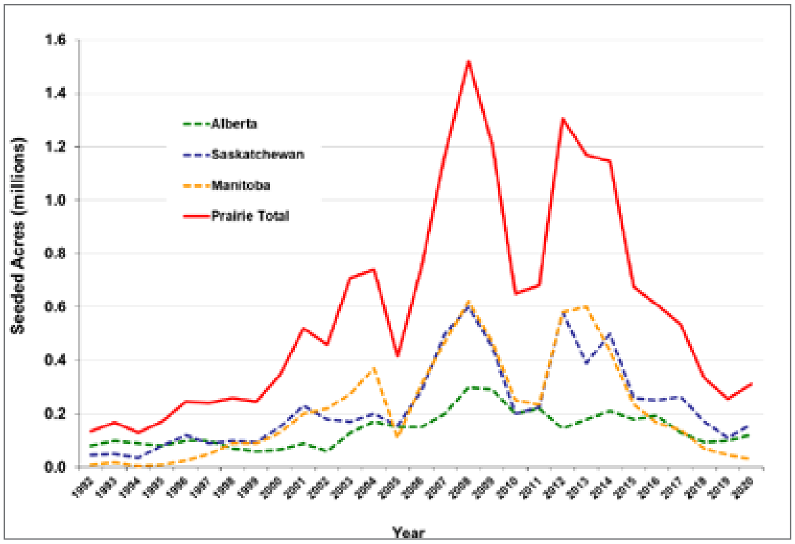


FIGURE 5. Acres sown to winter wheat in prairie Canada, 1992-2020 (source: Statistics Canada; https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3210035901)

Winter wheat is of specific interest to waterfowl managers given its use for nesting by most species of dabbling ducks and high nest survival rates (Devries et al. 2008, Skone et al. 2015). Winter wheat also provides relatively undisturbed cover during the nesting season for many bird species prone to nesting in otherwise risky residual crop stubble (Devries et al. 2010, Davis et al. 2020). Further, winter wheat typically yields 10 to 25% higher than spring sown cereals making it a true win-win land use. PHJV partners have been very active in supporting winter wheat variety development and promoting this crop type as a viable alternative to spring-seeded wheat. While winter wheat saw strong gains in the Prairie Parklands since the early 1990s, most notably in southeastern Saskatchewan and Manitoba, recent trends have been declining in opposition to projections in our 2013–2020 Implementation Plan (Figure 5).

While adapted and high-yielding varieties continue to be developed, climate-related delays in harvest of other crops, and shifts in market demand, have reduced winter wheat acres. Over the 2013–2020 Implementation Plan cycle, winter wheat seeded acres dropped from a peak of 1.3 million seeded acres in fall 2012 to 237,000 acres in fall 2020. Until market demand increases and production systems adapt to facilitate winter wheat seeding more easily, it is expected that acreage will remain relatively low.

In contrast, fall sown rye has been growing as the result of superior varieties and market returns. Rye is the first cereal with hybrid varieties commercially available in Canada. Acreage has steadily grown over the past few years with 345,000 acres seeded in fall 2020. While the aggressive goals PHJV set for winter wheat may not be realized in the near term, there are reasons to continue some level of involvement and investment. Combined winter cereals area sown in the fall of 2020 is approximately 582,000 acres. This is a substantial area of habitat delivered at a very low cost per acre, and is particularly important in those landscapes with wetlands but limited perennial cover.

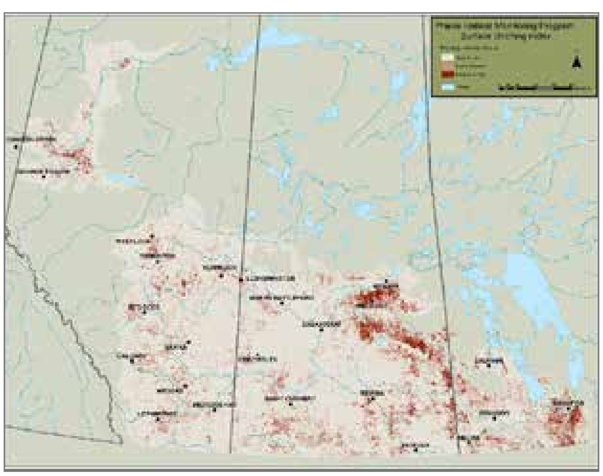


FIGURE 6. Distribution of wetland drainage cumulative ditching intensity across the PHJV. Intensity ranges from low (beige) to high (red). Watmough et al. 2017.

Wetland Habitat

Wetland habitat status and trends measurements within PHJV were measured as part of Environment and Climate Change Canada's Prairie Habitat Monitoring Program (PHMP; Watmough et al. 2017). The PHMP evaluated wetland habitat change using a sampling network of 221 high resolution air photo based transects sampling the PHJV delivery area. Overall, 56,586 wetland basins comprising 30,500 ha of wetland habitat area were evaluated. The most recent periods examined were circa 2001 and 2011.

Extrapolations from the 2011 PHMP transect sample estimated 4,959,000 ha (95% CI [4,543,000; 5,374,000]) of wetland habitat area with average wetland density of 16.0 (95% CI 14.5; 17.5]) basins per km^2 ranging from 0.82 to 64.28 basins per km2. Between 2001 and 2011 wetland area measured on habitat monitoring transects declined by -2.2% (95% CI [-3.2; -1.5]). The number of wetland basins on the transect sample declined by -3.1% (95% CI [-4.0; -2.2]) and by far the majority of these (~95%) were basins ≤ 1 ha in size, which accounted for 67% of the total lost wetland habitat area measured on habitat monitoring transects.

Wetland habitat loss and degradation are often the result of drainage (intermittent seasonal and permanent works) and filling for various purposes, including agriculture, transport, resource extraction, and other anthropogenic land uses. Sampled wetland basins had a median size of 0.1 ha and a mean size of 0.5 ha, and lost wetland basins had a median size of 0.1 ha and mean of 0.3 ha. About 52% of the total wetland area sampled in 2011, which includes ephemeral, temporary and seasonal wetlands, was comprised of grass/sedge marsh cover type. Cultivated wetland basin area accounted for 12% of total wetland area sampled in 2011, and the cultivated wetland basin type made up 57% of absolute sampled wetland area lost between 2001 and 2011. An assessment of the spatial intensity of drainage activity (ditching) within the PHJV is provided in Figure 6. Further detail on habitat changes within the PHJV is provided in Watmough et al. (2017).

The PHJV delivery area also contains multiple large wetlands of national and international importance for breeding and migrating waterfowl, shorebirds and waterbirds. Threats to these special wetlands are often poorly quantified, but include water regulation (e.g., hydro-electric, irrigation), invasive alien species and climate change.

4.0 ACHIEVEMENTS 2013–2020

Habitat Achievements

The PHJV's 2013–2020 Habitat Implementation Plan had a strong focus on wetlands and associated upland restoration and retention within Waterfowl Target Landscapes (see Conservation Planning section below), and we made significant achievements toward these objectives.(Table 3). PHJV habitat objectives over this time period were driven by the conservation needs of waterfowl, as quantitative planning tools have been available for priority waterfowl species (i.e.,

TABLE 3. Habitat restoration and retention achievements within the PHJV delivery area, 2013–2020, relative to eight-year objectives and 2030 horizon objectives in the 2013–2020 Implementation Plan. Provincial-level detailed reporting of Achievements is provided in Appendix 4.

	YEAR 2030 HABITAT OBJECTIVE ACRES	Eight-Year Achievements (Acres)			EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP [a]	TOTAL			
HABITAT RESTORATION							
TAME PASTURE	1,476,738	106,026	55,847	161,874	590,695	27%	11%
TAME HAY	996,461	73,735	163,118	236,853	398,586	59%	24%
PLANTED COVER	66,096	26,696	1,077	27,773	26,439	105%	42%
WETLANDS	77,864	6,675	274	6,948	7,900	88%	9%
SUB-TOTAL	**2,617,159**	**213,132**	**220,317**	**433,448**	**1,023,620**	**42%**	**17%**
HABITAT RETENTION							
WETLANDS	1,195,722	121,997	56,272	178,269	482,639	37%	15%
UPLAND	829,684	275,230	338,301	613,531	340,724	180%	74%
SUB-TOTAL	**2,025,406**	**397,227**	**394,573**	**791,800**	**823,363**	**96%**	**39%**
GRAND TOTAL	**4,642,565**	**610,359**	**614,889**	**1,225,248**	**1,846,983**	**66%**	**26%**
OTHER							
NESTING TUNNELS [b]	3,400	2,432	0	2,432	1,360	179%	72%
WINTER WHEAT (ACRES)	4,000,000	0	630,000 [c]	630,000	4,000,000	16%	16%

a Includes securement of Community Pastures.
b Nest tunnels delivered only in Manitoba.
c Average acreage 2013–2020 (Source: Statistics Canada). Winter wheat acres are claimed given PHJV investment in the development of winter-hardy varieties currently grown in the Prairie Parklands.

allowing comparison of duck productivity estimates versus objective benchmarks). While other wetland-dependent birds, shorebirds and landbirds have benefited from these conservation actions, quantifying these benefits has been hampered by lack of an objective means to do so.

Over the past eight years, habitat restoration objectives set in the 2013–2020 Implementation Plan had varying degrees of success at the PHJV scale. Habitat restoration and retention efforts overall achieved 42% and 96% of eight-year objectives, respectively. Restoration of perennial grassland through tame pasture and hayland achieved approximately 40% of the almost one-million acre, eight-year objective. Delivery of upland restoration through extension activity was especially successful, especially for tame haylands. However, given the interchangeable nature of these acres and similar habitat value for birds, this difference may not be noteworthy. Efforts to restore wetlands were encouraging during 2013–2020, but significant delivery remains a challenge. Nonetheless, wetland restorations achieved 88% of the eight-year objective, almost entirely through direct programs, which is notable, however this only targeted 10% of the 20-year objectives thus leaving much to be accomplished in future years. Likewise, wetland retention only achieved 37% of the eight-year objective, suggesting a need to continue focused efforts on protecting our wetland base. Upland retention efforts were especially successful delivering 180% the eight-year goal with considerable help from extension activity. This achievement was specific to the protection of community pastures totaling 226,000 acres across Saskatchewan. Winter wheat objectives of the 2013–2020 Implementation Plan, which equated to ~4 million acres (15–20% of wheat acres), were expected to be achieved primarily through industry trend, however, only 16% was achieved. Weather-related barriers to timely fall seeding of the crop are thought to be the primary reason for low acres, especially in the last few years (see Status of Habitat Section 3.0 above). Further detail of achievements at the provincial level is provided in Appendix 4.

Policy Achievements

The PHJV seeks to provide policy leadership contributing to conservation enhancement of wetlands and grassland ecosystems across Alberta, Saskatchewan and Manitoba. Explicit policy achievements and strategic collaboration with PHJV partners are integral to the achievement of conservation outcomes, while strongly supporting human dimension and other scientific components of the PHJV Implementation Plan.

An important component of policy development and implementation are metrics to evaluate success (Knill et al. 2011; OECD 2007). The PHJV strives to develop quantifiable metrics, such as policy acres, number of people influenced or participating in projects, as well as other means to measure the effectiveness of policy strategies. Also, the PHJV used qualitative approaches and metrics, (e.g., the existence of a policy as a result of partner influence), increased communication approaches that lead to engagement, and dialogue on the need for policy development (e.g., the number of workshops or webinars held on specific policy related topics). Efforts to work with key subject matter experts on program evaluation and human dimension work assists the PHJV in identifying key metrics that are essential to measure the achievements of policy goals over time. Here, only those efforts by the PHJV and its partners are reported –examples listed are deemed to be largely influenced by the actions of the PHJV and its member organizations.

The 2013–2020 PHJV Implementation Plan had several policy-related goals:

- Stop Wetland Loss and Restore Wetlands
- Provincial policies protecting wetlands
- Consistent mitigation frameworks
- Stop Further Loss of Native Grasslands
- Provincial policies protecting grasslands
- Initiatives to increase the economic viability of perennial cover and native habitats

During 2013–2020, significant changes were made in the realm of wetland policy across the prairies. Highlights include:

The Alberta Wetland Policy was approved in 2013 and implementation has been fully operational since 2015. Effectiveness of policy implementation is currently underway. This policy affects approximately 130,000 acres of wetlands in Alberta.

While no formal wetland policy yet exists in Saskatchewan, new regulations, legislation, and policies have been implemented to support “responsible drainage”. Further, an Agricultural Water Management Strategy was initiated in 2015 with a policy environment based upon “trust, relevancy, and understanding”. Understanding the outcome of these changes will remain a focus for the PHJV.

In Manitoba, the Sustainable Watersheds Act of 2018 mandated no net loss of wetland benefits. The Water Rights Act and Regulation was also amended to require registration of Class 1 (ephemeral) and 2 (temporary) wetland drainage, and requires compensation for loss or alteration of Class 3 (seasonal) wetlands. Additional to the legislation, the province has adopted a policy to prohibit the drainage of Class 4 and 5 wetlands, except in rare circumstances. Complementing these legislative changes, the Growing Outcomes in Watersheds (GROW) initiative was established to provide incentives to retain Class 1 and 2 wetlands. This suite of legislation affects the fate of over 500,000 acres of wetlands in Manitoba.

Despite significant efforts made by stakeholders across the Canadian prairies, no formal grassland policy exists in Alberta, Saskatchewan or Manitoba. In 2018, the PHJV policy committee commissioned a Grassland Situational Analysis (Liebel 2018) and in 2019 commissioned the report Grassland Economics: Conservation and Competing Interests in Prairie Canada (Pattison-Williams 2019).

A highly significant development for both wetland and grassland conservation in Manitoba was the establishment of a $52 million GROW endowment fund

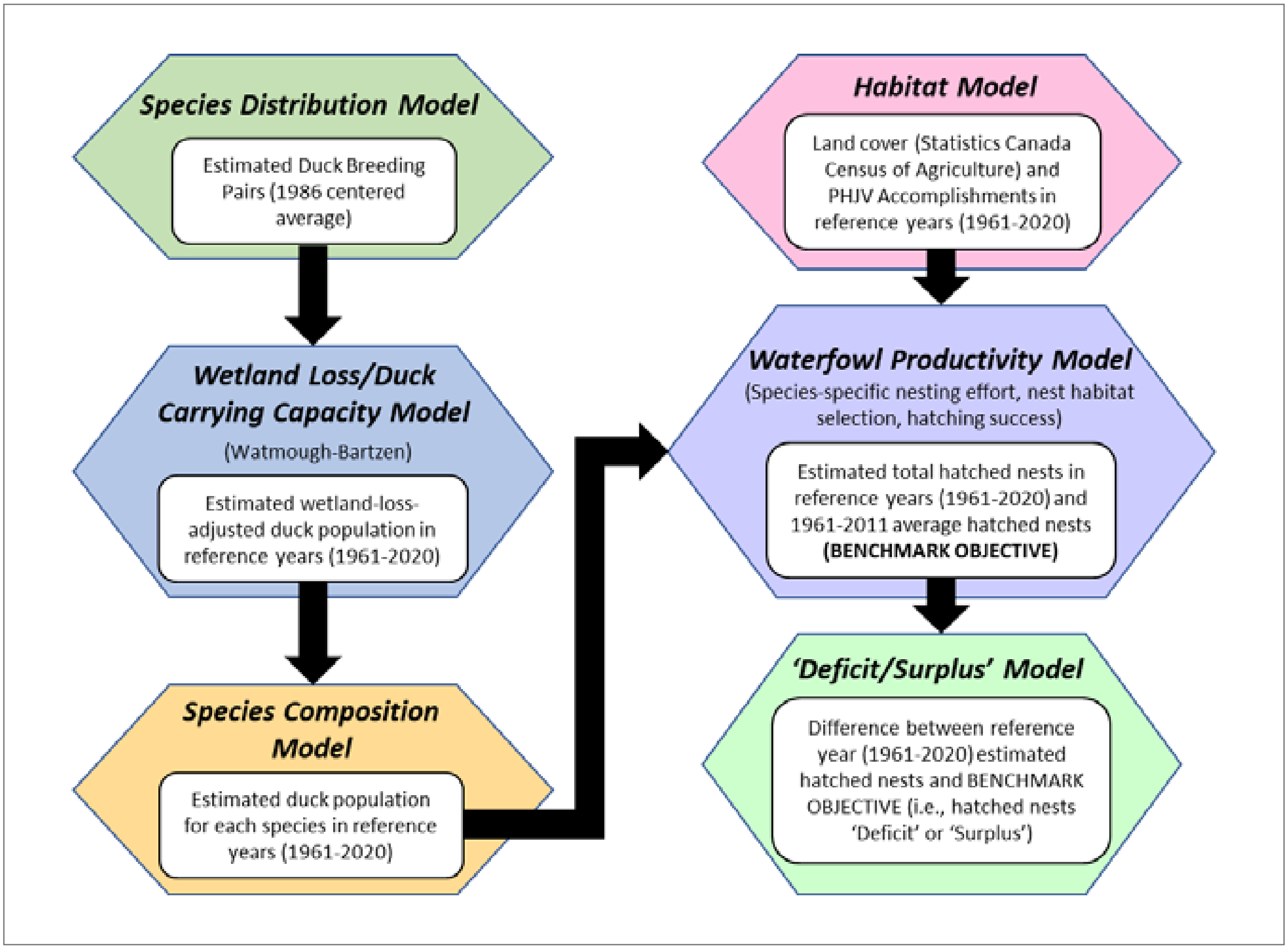


FIGURE 7. Flowchart of steps used to estimate changes in the number of hatched nests of dabbling ducks in the PHJV 1961–2020 as illustrated in Figure 8.

in 2019, providing perpetual support for conservation, restoration and enhancement of at-risk habitats in Manitoba. More detailed information on the policy achievements can be found in Annex A.

Impacts on Duck Productivity

Estimating the net impact of PHJV programs on waterfowl productivity (estimated hatched nests) was accomplished by formally integrating the spatial interaction of land use and wetland changes, PHJV program delivery, and resident duck populations in a series of modeling steps (Figure 7). This modeling approach incorporates estimated spatial variation in habitat change (1961–2020), duck densities and species composition, associations between wetland area and duck breeding pairs, breeding effort, nest habitat selection, and nesting success relationships (Appendix 5). To reflect the PHJV population goals (1955–2014 average), we use the 1961–2011 estimated average annual number of hatched nests as the benchmark goal for waterfowl productivity. Departures below this benchmark are considered productivity 'deficits' while those above are considered productivity 'surpluses'.

Modeling the cumulative impact of PHJV delivery on duck productivity across the PHJV indicates a 5% gain in annual hatched nests attributed to PHJV habitat achievements (i.e., an additional 35,426 hatched nests; Figure 8). However, local gains as high as 46% were observed in some municipalities. These increases result primarily from approximately 3.2 million acres of cropland conversion into hayland, pasture, winter wheat and dense nesting cover (DNC). We did not model expected gains from PHJV agreements that secured existing uplands or wetlands from loss (given low probability of secured parcels being lost during the modeled timeframe; Watmough et al. 2017), and hence our estimate of impact is conservative.

Further, while we suspect potential gains have accrued from PHJV policy and extension activities directed toward cropland conversion and fall cereals, only quantification of fall cereal impacts is currently included. Looking forward, our model indicates that broad-scale efforts that result in increases in forage, such as part of a robust cattle industry, will continue to provide very positive gains in waterfowl production. While modeling indicates that upland changes have generally had positive impacts on duck productivity since 1986, wetland loss has negated some of these impacts by reducing the carrying capacity for waterfowl pairs. The combined impact is such that duck productivity

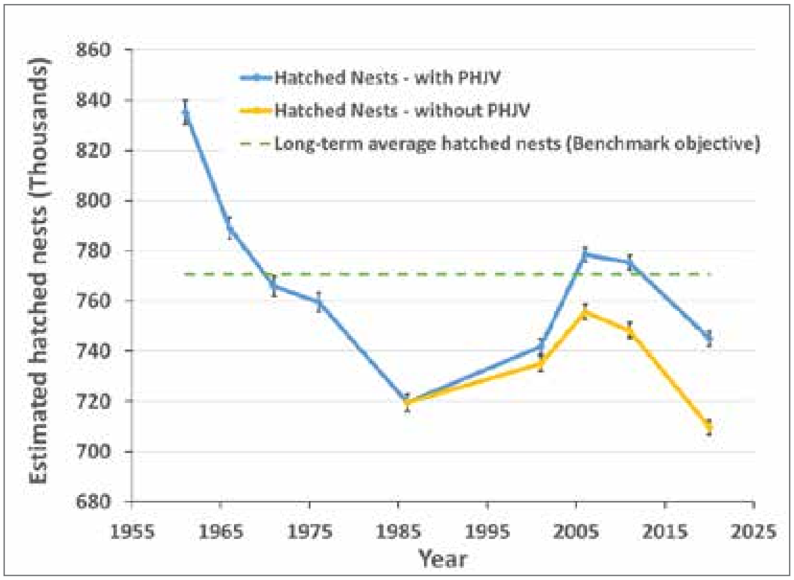


FIGURE 8. Estimated hatched nests (± 1 standard deviation) of the five main dabbling duck species with and without PHJV habitat programs relative to the long-term average estimated hatched nests representing the PHJV population goal (green dashed line). Estimates were derived from the Waterfowl Productivity Model with estimated upland habitat composition including/excluding PHJV habitat and wetland loss impacted breeding pair populations in 1961, 1966, 1971, 1976, 1986, 2001, 2006, 2011 and 2020.

in 2020 is approximately 3.3% below the long-term average objective of 770,580 hatched nests (Figure 8).

Notwithstanding the challenges associated with delivering specific programs, PHJV investments have generally contributed to the maintenance of the productive capacity of this region for breeding ducks, as indexed by estimated numbers of hatched duck nests with and without PHJV contributions (Figure 8). From 2006–2011, deficits in duck productivity relative to the long-term (1961–2011) average were eliminated despite continued loss of wetlands reducing carrying capacity of the landscape for waterfowl pairs. Positive land use trends (noted above) and PHJV program implementation, have contributed to overall maintenance of duck production in the region. However, changes in land use trends apparent post 2011 have had a counteracting effect on waterfowl productivity resulting in a sharp decline in productivity below objective levels. In fact, without PHJV habitat achievements, we estimate waterfowl productivity would currently be lower than estimated in 1986 (Figure 8). While the annual and cumulative impact of PHJV programs will remain positive (Figure 8), duck productivity is projected to decline to 2040 related primarily to continued wetland and upland habitat loss in much of the PHJV area.

Impacts on Other Birds

In order to assess potential benefits of past conservation projects for non-game bird groups funded by the North American Wetlands Conservation Act (NAWCA), we calculated the percentage of projects that occurred within overlapping priority areas defined for upland-associated species, wetland-associated species, and species associated with both uplands and wetlands (mixed species). Details of how priority areas were defined are described below (Conservation Planning – Biological Foundations).

Of 5,922 quarter sections where NAWCA-funded projects occurred from 1989–2019, 13%, 39%, and 7% occurred in priority areas for upland, wetland, and mixed priority species, respectively, while 51% fell outside of non-game priority areas. For comparison, 71% of quarter sections occurred in Waterfowl Target Landscapes. Not surprisingly, NAWCA-funded projects, given their wetland focus, disproportionally benefit waterfowl and wetland-dependent species.
This simple analysis highlights the need for additional conservation funding targeted to priority areas outside of Waterfowl Target Landscapes.

Achievement Expenditures

The overall cost of PHJV program delivery and operations during the previous implementation cycle (2013–2020) was $395.5 million (Table 4). Approximately 42% was invested in habitat retention, 16% invested in habitat restoration, and 5% in conservation extension activities. Management of existing conservation lands comprised 23% of expenditures. Support activities, including conservation planning and evaluation, policy efforts, communication and education, and crop damage compensation comprised 14% of expenditures.

TABLE 4. Costs of Prairie Habitat Joint Venture programs and operations 2013–2020 (Source: NAWMP National Tracking System).

PROGRAM [a]	EXPENSES [b]	CUMULATIVE EXPENSE
RETENTION		
HABITAT RETENTION - PERMANENT	$ 158,339,241	
HABITAT RETENTION - MEDIUM (10–99YRS)	$ 8,756,560	$ 167,095,801
RESTORATION		
WETLAND RESTORATION	$ 34,754,370	
UPLAND RESTORATION	$ 29,690,143	$ 64,444,513
STEWARDSHIP (EXTENSION)		
HABITAT RETENTION–SHORT TERM (<10YRS)	$ 18,921,825	$ 18,921,825
MANAGEMENT		
MANAGEMENT (HABITAT ASSETS)	$ 91,259,389	$ 91,259,389
SCIENCE	$ 10,673,941	$ 10,673,941
LAND & WATER POLICY	$ 5,127,024	$ 5,127,025
OPERATIONS		
CONSERVATION PLANNING	$ 33,258,464	
COMMUNICATION & EDUCATION	$ 3,968,672	
CROP DAMAGE	$ 739,919	$ 37,967,055
GRAND TOTAL EXPENDITURES		**$ 395,489,548**

a PHJV conservation program delivery initiative definitions are provided in Appendix 1.
b Expenditures occurred in Alberta, Saskatchewan, Manitoba, and the Peace Parkland Region of British Columbia

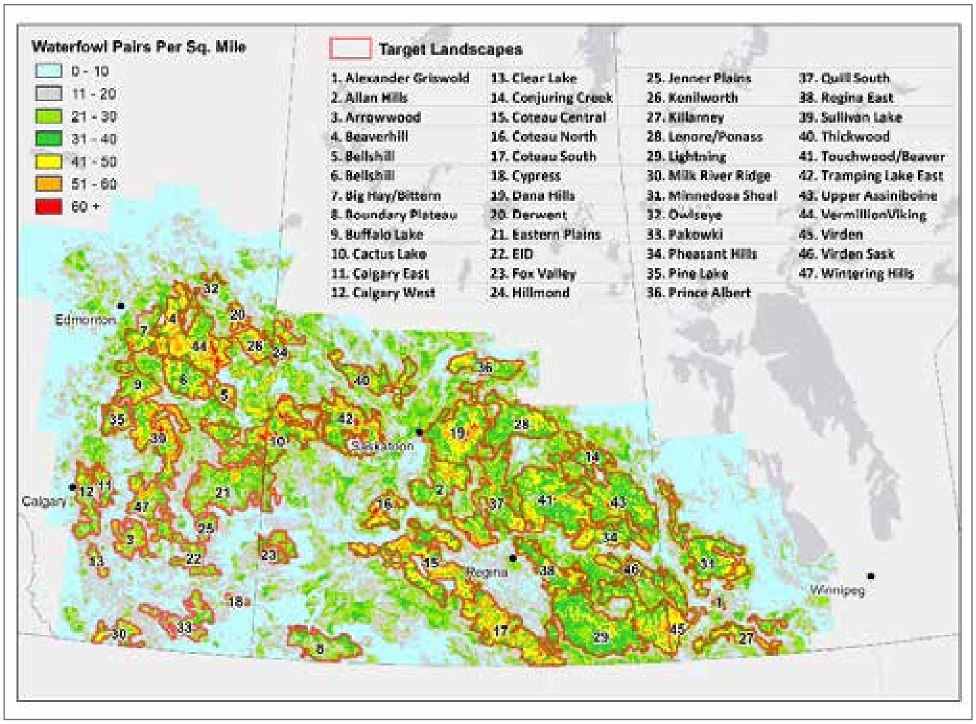


FIGURE 9. Prairie Habitat Joint Venture Waterfowl Target Landscapes defining primary conservation program delivery regions where estimated breeding density of upland nesting ducks is generally >30 pairs/mi2 and density of breeding Northern Pintails, specifically, is ≥6 pairs/mi2.

5.0 CONSERVATION PLANNING – BIOLOGICAL FOUNDATIONS

Spatial Targeting

WATERFOWL

Waterfowl habitat objective setting in the PHJV focuses on Waterfowl Target Landscapes where long-term average predicted breeding duck densities are >30 pairs/mi2 for the seven most abundant duck species in Prairie Canada (Mallard, Gadwall, Blue-winged teal, Northern Shoveler, Northern Pintail, Redhead, Canvasback) and including areas having ≥6 pairs/mi2 for Northern Pintail. These regions were identified based on species distribution models predicting duck density as described in Appendix 5. Slight boundary modifications have been made in some instances based on local knowledge and efforts to include areas immediately adjacent with high value for non-game species (Figure 9; Ducks Unlimited Canada Unpublished Data). Targeting effort in these landscapes directs conservation resources to areas of highest average duck density, with special consideration for Northern Pintail. The impact of habitat and land use changes, and conservation activities outside of Target Landscapes is captured in our modeling process as well.

SHOREBIRDS, WATERBIRDS AND LANDBIRDS

To identify potential co-benefits of waterfowl conservation initiatives for non-game birds, and to facilitate inclusion of all bird planning, priority areas for non-game species have now been identified within the PHJV. Like the PHJV Waterfowl Target Landscapes, species distribution models were used to identify priority areas for non-game birds. Probability of occurrence models for six waterbird and two landbird species previously developed for the 2013–2020 Implementation Plan have been updated. In the new models, a categorical ecoregion variable was replaced with multiple continuous weather covariates in order to remove unrealistic hard edges seen in the previous version (Appendix 6). Spatial density models were also developed for 20 landbird and four shorebird species (Table 5; Sólymos et al. 2013; Appendix 6).

Before defining priority areas, species were categorized based on broad habitat associations (see Status of Shorebirds, Waterbirds and Landbirds Section 2.0): species associated with a) wetlands only; b) both wetlands and uplands (referred to as mixed species); and c) uplands only (Table 5). Grouping species together allowed priority areas to be defined separately for species associated with different habitat types found within the Prairie Parklands. These groupings also allowed us to test the previous assumption that priority areas for wetland-associated species have a high degree of overlap with Waterfowl Target Landscapes.

TABLE 5. List of species used to define priority areas for non-game birds within the PHJV. When defining priority areas, species were grouped together based on habitat rather than taxonomy.

SPECIES	TAXONOMIC GROUP	HABITAT GROUP	MODEL TYPE
Baird's Sparrow	Landbird	Upland	Density
Bobolink	Landbird	Upland	Density
Brewer's Sparrow	Landbird	Upland	Density
Brown-headed Cowbird	Landbird	Upland	Density
Chestnut-collard Longspur	Landbird	Upland	Density
Clay-coloured Sparrow	Landbird	Upland	Density
Grasshopper Sparrow	Landbird	Upland	Density
Horned Lark	Landbird	Upland	Density
Lark Bunting	Landbird	Upland	Density
LeConte's Sparrow	Landbird	Upland	Density
Thick-billed Longspur	Landbird	Upland	Density
Savannah Sparrow	Landbird	Upland	Density
Sprague's Pipit	Landbird	Upland	Density
Vesper Sparrow	Landbird	Upland	Density
Western Meadowlark	Landbird	Upland	Density
Common Yellowthroat	Landbird	Wetland	Density
Red-winged Blackbird	Landbird	Wetland	Density
Sedge Wren	Landbird	Wetland	Density
Wilson's Snipe	Landbird	Wetland	Density
Yellow-headed Blackbird	Landbird	Wetland	Density
Marsh Wren	Landbird	Wetland	Occupancy
Nelson's Sparrow	Landbird	Wetland	Occupancy
American Bittern	Waterbird	Wetland	Occupancy
American Coot	Waterbird	Wetland	Occupancy
Horned Grebe	Waterbird	Wetland	Occupancy
Pied-billed Grebe	Waterbird	Wetland	Occupancy
Red-necked Grebe	Waterbird	Wetland	Occupancy
Sora	Waterbird	Wetland	Occupancy
Long-billed Curlew	Shorebird	Mixed	Density
Marbled Godwit	Shorebird	Mixed	Density
Willet	Shorebird	Mixed	Density
Upland Sandpiper	Shorebird	Upland	Density

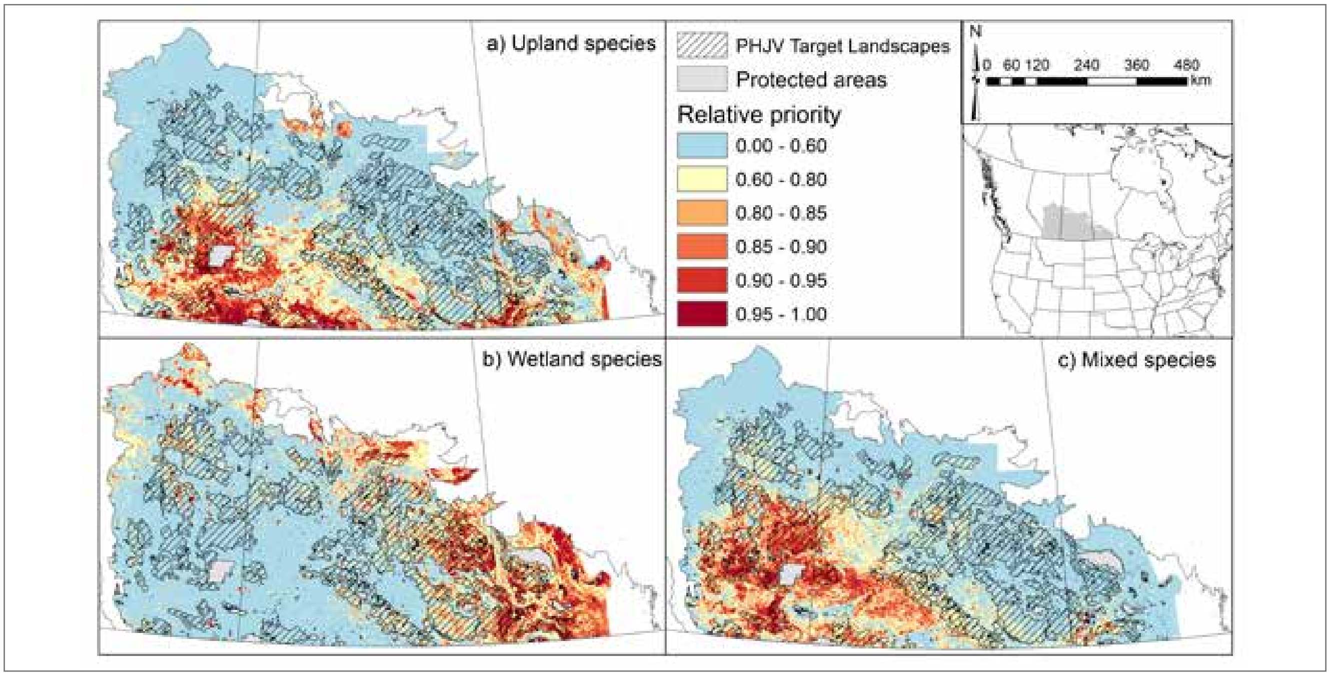


FIGURE 10. Spatial variation in relative priority throughout the Prairie Habitat Joint Venture for three groups of non-waterfowl birds associated with upland (a), wetland (b), and mixed (c) habitats. Values range from 0-1 representing low-high relative priority. Mean relative priority values for each bird group within each Waterfowl Target Landscape are provided in Appendix 5.

To define priority areas, species distribution models were input into a spatial conservation prioritization software called Zonation (Lehtomäki and Moilanen 2013), which produced a raster-based relative priority map for each bird group (Figure 10). A more detailed description of the Zonation analysis is provided in Appendix 6.

Relative priority maps for each species group were then used to define priority areas based on primary habitat association. All pixels within the 80th percentile of relative priority values (i.e., top 20%) were defined as priority areas (Figure 11). Landbird species, such as Baird's Sparrow, Chestnut-collared Longspur and Sprague's Pipit, have a lower probabilty of occurrence in small, isolated patches of suitable habitat (Davis 2004), so any polygons < 1600 ha were removed. Priority areas for upland-associated species were generally associated with large, contiguous areas of grassland, which tend to be found mainly in southern Alberta and Saskatchewan (Figure 11a). However, priority areas also encompassed regions with smaller patches of grassland surrounded by a matrix of cropland, such as those found in southwestern Manitoba. Priority areas for species that use both upland and wetland habitats (mixed species) were somewhat linked to large tracts of grassland as well, but only those grasslands that were in close proximity to or contained a relatively high number of wetlands (Figure 11b). For example, the dry and relatively high elevation grasslands surrounding Cypress Hills Interprovincial Park were not included, nor were the dry grasslands in southern Saskatchewan along the border with Montana. Also, mixed species tended to have an affinity for regions with smaller patches of grassland within a matrix of cropland. Priority areas for wetland-associated species were concentrated in eastern and northern portions of the PHJV, which receive more rainfall and contain larger, more permanent wetlands (Figure 11c). Large, isolated water bodies throughout Saskatchewan and Alberta were included as well.

After quantifying relative priority and defining priority areas throughout the PHJV, the average value of each Waterfowl Target Landscape for non-game bird species was assessed. Mean relative priority values of pixels for each non-game bird group within each Waterfowl Target Landscape are provided in Appendix 7. Using a mean relative priority threshold of 0.8 (same threshold used to define priority areas polygons for non-game species), 16 Waterfowl Target Landscapes contained a significant amount of high priority habitat for at least one non-game bird group: four contained high priority habitat for upland-associated species; seven for wetland-associated species; and eight for species associated with both uplands and wetlands (Table 6; Appendix 7). Alberta contains the most Waterfowl Target Landscapes that are a high priority for non-game species (seven), particularly for those species with mixed habitat preferences. Saskatchewan contains five Waterfowl Target Landscapes that are a high priority for non-game species and all four of Manitoba's Waterfowl Target Landscapes are a high priority for wetland-associated species (Table 6).

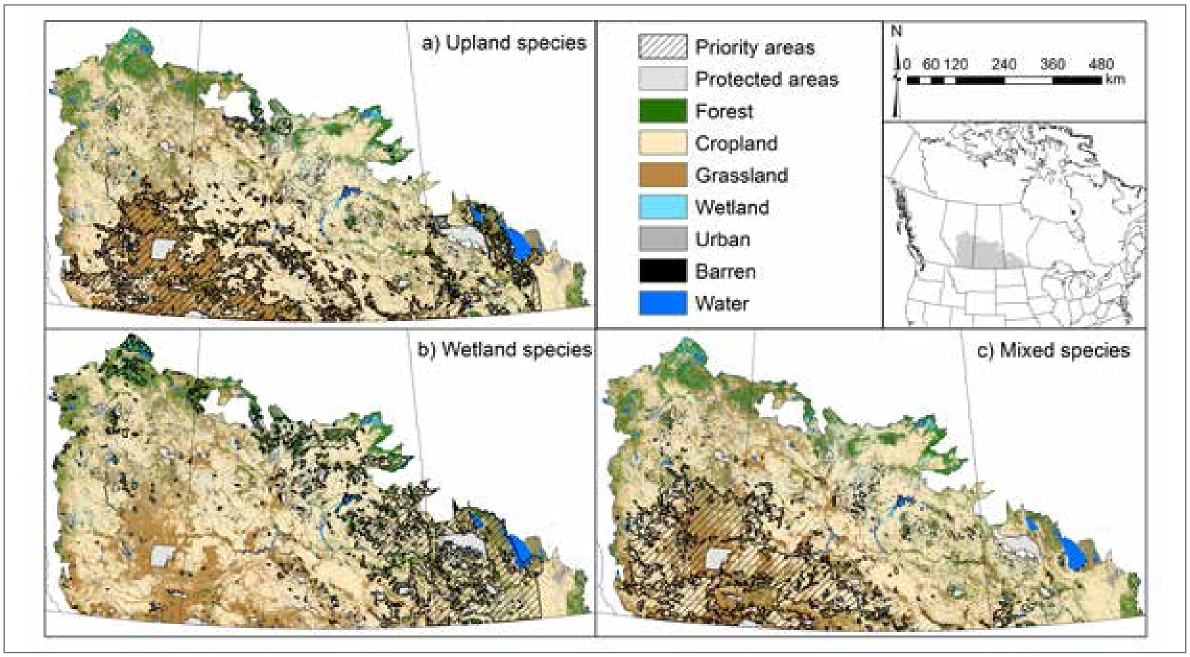


FIGURE 11. Priority areas define for three groups of non-game birds associated with upland (a), wetland (b), and mixed (c) habitats. Priority areas were defined as areas with a relative priority value ≥ 0.8 (Figure 10).

TABLE 6. Waterfowl Target Landscapes with mean relative priority value > 0.80 (**bold**) for at least one priority non-game bird group.

BIRD PRIORITY GROUP				
PROVINCE	WATERFOWL TARGET LANDSCAPE	UPLAND	WETLAND	MIXED
ALBERTA	Arrowwood	0.78	0.21	**0.89**
ALBERTA	Clear Lake	0.62	0.35	**0.83**
ALBERTA	Eastern Plains	0.69	0.24	**0.83**
ALBERTA	EID (Eastern Irrigation District)	**0.90**	0.18	**0.89**
ALBERTA	Jenner Plains	**0.88**	0.26	**0.90**
ALBERTA	Pakowki	**0.84**	0.25	**0.88**
ALBERTA	Wintering Hills	0.63	0.26	**0.84**
SASKATCHEWAN	Boundary Plateau	**0.83**	0.30	**0.81**
SASKATCHEWAN	Fox Valley	0.68	0.29	**0.90**
SASKATCHEWAN	Pheasant Hills	0.32	**0.85**	0.34
SASKATCHEWAN	Prince Albert	0.32	**0.82**	0.43
SASKATCHEWAN	Upper Assiniboine	0.30	**0.86**	0.37
MANITOBA	Alexander Griswold	0.63	**0.95**	0.67
MANITOBA	Killarney	0.70	**0.90**	0.58
MANITOBA	Minnedosa Shoal Lake	0.43	**0.82**	0.28
MANITOBA	Virden	0.73	**0.91**	0.54

Defining priority areas for non-game species has demonstrated that there are opportunities for other birds to benefit from waterfowl-based conservation activities carried out by PHJV partners in Waterfowl Target Landscapes. Any work that conserves or restores grasslands or wetlands in Waterfowl Target Landscapes identified in Table 6 will likely benefit non-waterfowl species.

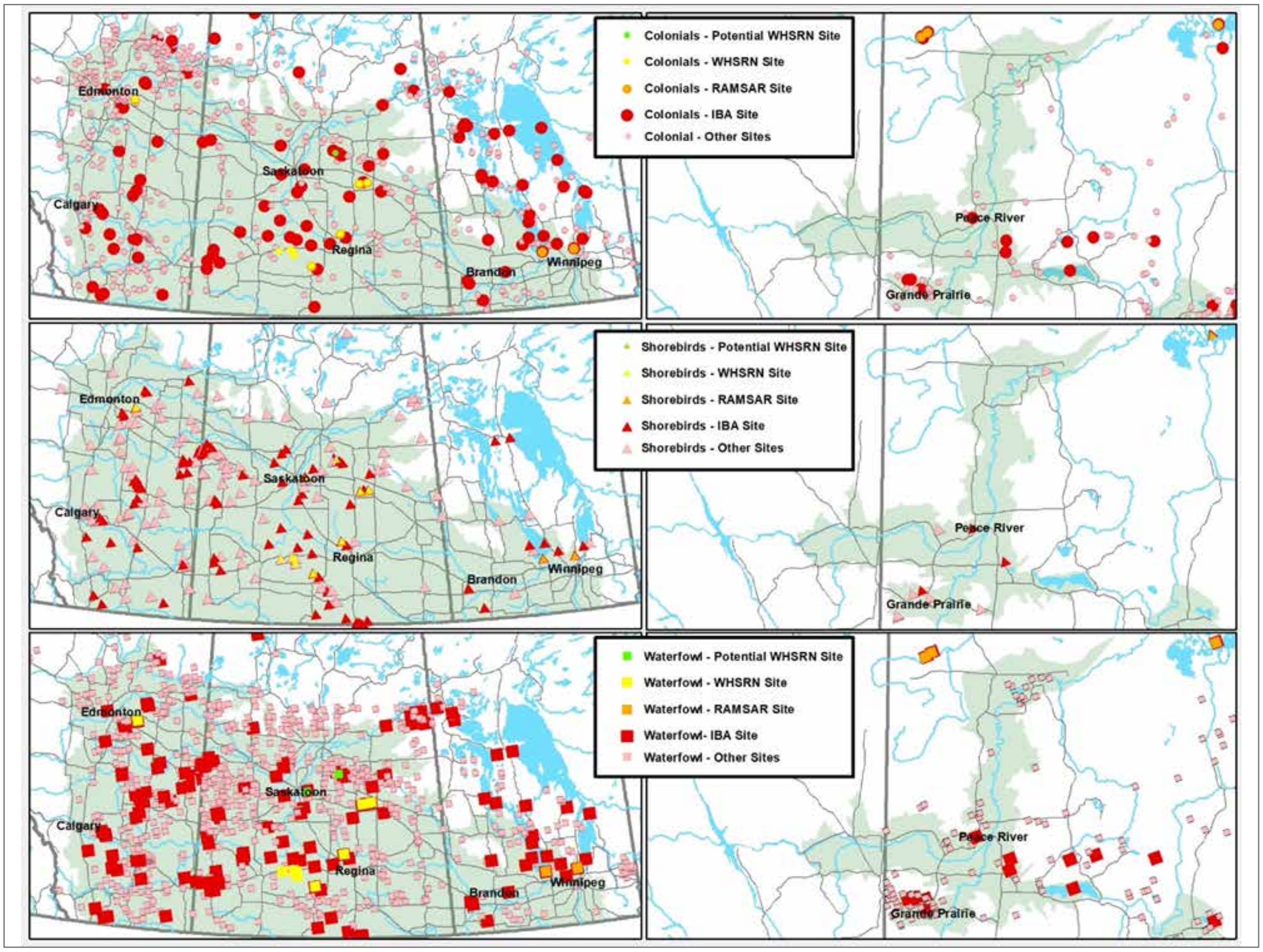


FIGURE 12. Location of wetland sites of significant importance to wetland-associated birds (colonial nesters, shorebirds, waterfowl) in Alberta, Saskatchewan and Manitoba including those within the PHJV Prairie Parklands.

Important Wetland Sites

This Plan strongly emphasizes the retention and restoration of high value and threatened breeding habitats (primarily small wetlands and associated uplands), but recognizes that other wetland areas are also important to the life cycle needs of many bird species within the PHJV. Many large wetlands and wetland complexes are critical molting and staging habitat for waterfowl, and provide key habitat for many shorebirds, waterbirds and landbirds. They also provide crucial spawning and nursery areas for fish, and deliver other important ecological services, such as nutrient retention and carbon sequestration/storage. Some of these marshes may provide spectacular birding, or exceptional diving duck and goose hunting opportunities.

The PHJV's provincial partners have routinely reviewed available literature and canvassed expert opinion to develop a list of priority wetlands in the Prairie Parklands Region and adjacent Boreal Transition Zone.

NEW TO THIS PLAN

The database has been updated to include:

1. Canadian Important Bird and Biodiversity Areas (ibacanada.com) not already included in the previous database;
2. all Western Hemisphere Shorebird Reserve Network (WHSRN) sites (https://whsrn.org), as well as sites that meet criteria for inclusion in the network but have not yet been designated (from McKellar et al. 2020);
3. priority wetlands for colonial marsh-nesting terns, gulls, grebes, and herons (from McKellar et al. 2019); and
4. priority wetlands identified in the Priority Migratory Bird Habitats of Canada's Prairie Provinces (Poston et al. 1990).

Currently the database contains records for 1,386 important wetland sites in the prairie provinces, of which 938 occur within the PHJV Prairie Parklands boundary (Figure 12; hereafter PHJV Important Wetlands database). These wetlands have remarkable attributes that merit their retention and, where needed, the restoration of their productive potential. Threats to these special wetlands are often poorly quantified, but include changes to water regimes for hydroelectric or flood-control purposes, invasive alien species, and climate change. For instance, coastal marshes like Delta and Netley-Libau on the large lakes of southern Manitoba have been impacted by changes to water regimes, while extensive flooding, caused by the Grand Rapids Dam, has severely degraded the Saskatchewan River Delta, the continent's largest inland river delta. Substantial investments are currently being made to restore Delta Marsh. While this Plan does not include objectives or direct expenditures for large marsh restoration activities, the PHJV intends to:

- examine opportunities to pursue restoration activities in a cost-effective manner;
- highlight the need to protect the diversity and productivity of large wetlands if threats arise; and
- pursue opportunities to secure and protect designated wetlands, such as IBA and WHSRN sites.

The new spatial database will be available to all PHJV partners to aid in conservation planning and identification of opportunities to secure and protect these important resources.

Setting Habitat Objectives — Benchmark and Updating Process

WATERFOWL

Congruent with the revised long-term average NAWMP population objectives (NAWMP 2014), the PHJV has adopted the long-term average population objectives across the Canadian Prairie Pothole Region as identified above (Table 1). In setting habitat objectives, the PHJV Science Committee has adopted the rationale that habitat sufficient to support the long-term average number of hatched nests for the five most common upland nesting ducks (Mallard, Gadwall, Blue-winged Teal, Northern Shoveler, Northern Pintail) will serve as the benchmark for setting habitat objectives. This is based on the reasoning that wetland and upland habitats available determine the carrying capacity for breeding pairs and their reproductive success, and is supported by many years of research on prairie breeding waterfowl. Also, this reasoning allows for losses in carrying capacity (e.g., due to wetland loss) to somewhat be compensated for by improved breeding success resulting from improvements in upland habitat. Thus, we have used the Waterfowl Productivity Model (Appendix 5) in conjunction with data on land use change from 1961–2011, and wetland loss (Watmough et al. 2007, 2017; Bartzen et al. 2017) to estimate the benchmark long-term average number of hatched nests across the PHJV planning region (i.e., 770,580 hatched nests; Figure 8 and associated text). Habitat objectives estimate the amount of wetland and upland habitat (relative to current) needed to achieve the LTA benchmark number of hatched nests (i.e., hatched nest 'deficits').

In order to facilitate a longer-term projection of habitat objectives, we include estimates of future land use trends and future landscape projections incorporating the interplay of economic drivers and climate change (e.g., Rashford et al. 2016). While published estimates using this method exist for the US Prairie Pothole Region, we have applied the same methodology to the Canadian Prairie Pothole Region to estimate habitat composition at the municipality/county scale circa 2040 (Ben Rashford, unpublished data; DUC 2013). We further project loss in waterfowl carrying capacity over the same time period, by modeling the impact of wetland loss rates, and wetland size classes most at risk on associated waterfowl pair density (Bartzen et al. 2017; described in Appendix 5).

Thus, the elimination of the future estimated 'deficit' through conservation actions provides the basis for setting waterfowl habitat objectives. More specifically, objectives are established that achieve:

reduction or cessation of further wetland loss;

- restoration of lost wetlands, especially small basins;
- maintenance or increase in perennial grasslands; and
- improved habitat function on cultivated lands (e.g., reduced disturbance during seeding).
- In practice, the Waterfowl Productivity Model is used in consultation with provincial PHJV conservation partners to explore various combinations of these actions in varying amounts at Target Landscape and provincial scales to establish habitat objectives that eliminate projected provincial deficits.

LANDBIRDS

In order to set habitat objectives to meet population objectives, models that link species abundance to habitat are required. The density models created for 24 non-waterfowl species provide this link (Appendix 6). To establish habitat objectives for non-waterfowl species, we focused on four landbirds listed under Canada's Species at Risk Act: Baird's Sparrow (Special Concern), Chestnut-collared Longspur (Threatened), Thick-billed Longspur (Threatened), and Sprague's Pipit (Threatened). Environment and Climate Change Canada has developed recovery documents for each of these species (either Management Plans or Recovery Strategies, depending on their designation), which specify population objectives. All four species have 30-year population objectives to increase the population to some benchmark. Chestnut-collared Longspur was the only species that also had a short-term objective of stabilizing population trends to 0 within 15 years. Because most of these species are currently declining (other than Baird's Sparrow, which was stable or increasing slightly over the last 10 years as of 2019), we assumed that population declines must be stopped before working toward the long-term objective of increasing populations. Therefore, we applied the same 15-year population objective to all four species: stop declines and stabilize the 10-year trend (i.e., after 15 years, the mean annual trend over 10 years = 0%/year).

To meet this 15-year objective, current rates of population decline must slow over the next five years, then remain

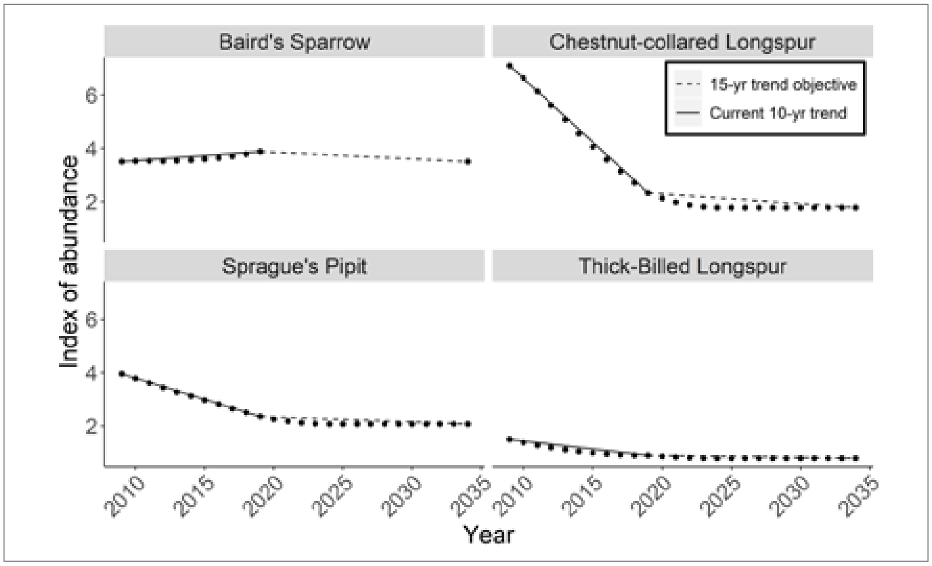


FIGURE 13. Current 10-year trends (solid lines) and 15-year trend objectives (dashed lines) for four species of grassland bird Species at Risk in the Canadian portion of the Prairie Pothole Region. Current trends and indices of abundance were obtained from the 2019 analysis of North American Breeding Bird Survey data.

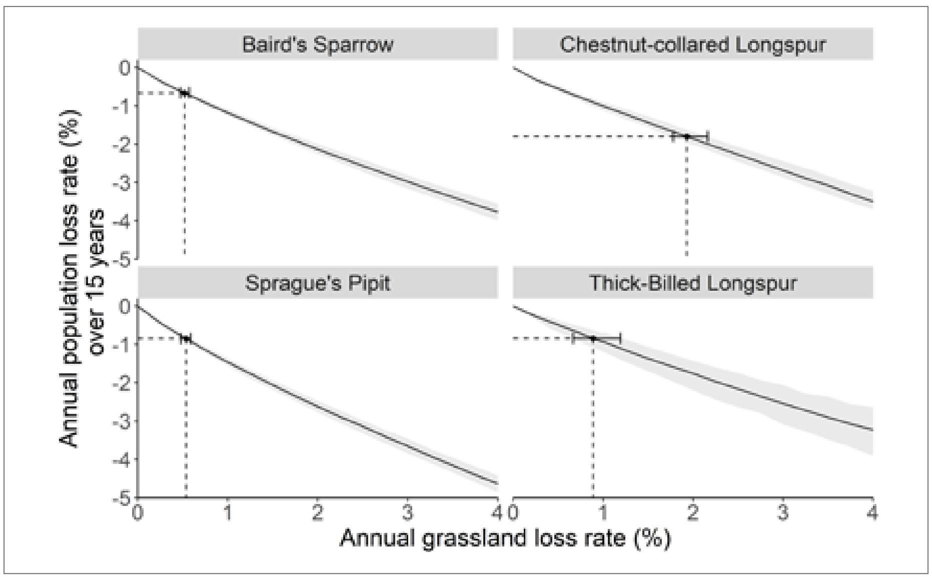


FIGURE 14. Mean annual population loss (%) over 15 years as a function of annual grassland loss (solid line; shading represents 95% confidence intervals) for four grassland bird Species at Risk. Dotted lines show the population objective for each species and the maximum grassland loss rates that would still allow this objective to be met.

stable for the following 10 years. Using the most recent 10-year trend estimate (2019) from the BBS for each species, we calculated the annual change in trend needed to slow population declines to 0 in five years. Then, we applied these changes in trend starting with the 2019 annual index of abundance from the BBS to forecast the resulting index of abundance in 2024. Since populations need to be stable for the next 10 years, the index of abundance should remain the same in 2034. The 15-year trend objective needed to achieve a stable 10-year trend by 2034 was calculated based on the projected change in the annual index of abundance from 2019 to 2034 (Figure 13). Note that Baird's Sparrow had a slightly positive 10-year trend in 2019, so we used a modified approach for this species. We assumed the Baird's Sparrow population should not decline below the lowest index of abundance observed over the last 10 years, and set the 15-year objectives accordingly (Figure 13).

To translate these population objectives into habitat objectives, we took advantage of the link provided by species density models between amount of habitat across the landscape and population size. Once density models are extrapolated across the PHJV, population size can be estimated by multiplying the density estimate of each pixel by pixel area, then summing the values of these products across all pixels. Because density models are based on various spatial covariates, including land cover, population size of each species can be estimated as a function of the amount of grassland and cropland throughout the PHJV. By simulating grassland conversion to cropland at various rates over time and extrapolating our species density models at each time step of the simulation, we quantified population decline rates as a function of grassland loss rates (Figure 14). We used this relationship to determine the maximum grassland loss rates that would still allows us to meet the

TABLE 7. Annual allowable grassland loss rates, actual grassland loss rates, and number of acres of grassland that need to be protected throughout the PHJV in order to meet population objectives for four grassland birds defined under Canada's Species at Risk Act (SARA). Total grassland acres after 15 years are based on the annual objective for Baird's Sparrow, which has the highest annual objective.

SPECIES	ALLOWABLE LOSS RATE (%/YEAR)	ACTUAL LOSS RATE 2011–16 (%/YEAR)	PROTECTION RATE NEEDED (%/YEAR)	ANNUAL GRASSLAND OBJECTIVE (ACRES)
BAIRD'S SPARROW	0.52	1.32	0.80	309,700
CHESTNUT-COLLARED LONGSPUR	1.93	1.32	0.00	0
THICK-BILLED LONGSPUR	0.89	1.32	0.43	166,500
SPRAGUE'S PIPIT	0.54	1.32	0.78	302,000
TOTAL AFTER 15 YEARS				**4,407,000**

15-year trend objectives described above. By comparing maximum allowable grassland loss rates for each species to actual grassland loss rates, we determined the amount of grassland that needs to be conserved annually (i.e., the amount of grassland loss that needs to be prevented) in order to meet population objectives.

To estimate current grassland loss rates, we used the most recent Agriculture Census data from Statistics Canada (Figure 4) and assumed any increases in cropland were at the expense of grasslands (i.e., acres of grassland loss = acres of cropland increase). Then, we calculated the total amount of grassland that would need to be conserved over 15 years in order to meet the 15-year trend objectives (Table 7). Results indicate that Baird's Sparrow requires the highest annual grassland protection rate in order to meet the 15-year population objective, so we used this species to define acre objectives for grassland conservation.

To make these habitat objectives spatially explicit and recommend which specific acres of grassland to conserve, we took advantage of an existing model that predicts the probability of grassland conversion to cropland based on soils, climate, and topography (Olimb and Robinson 2019). By targeting grasslands that are at a high risk of conversion, we will ensure that conservation activities prevent further loss of grasslands, which is critical for stabilizing population declines. However, it is also important that grasslands targeted for conservation have a relatively high abundance of the focal grassland bird species used in this analysis. Therefore, we set spatially explicit grassland conservation targets based on pixels that were both at high risk of conversion and a high priority for the four focal species. Once spatially explicit habitat objectives were defined, we overlapped these pixels with the Waterfowl Target Landscapes to define grassland retention acre objectives within and outside of each Waterfowl Target Landscapes. A more detailed description of the analytical methods used to set habitat objectives is provided in Appendix 6.

SHOREBIRDS AND WATERBIRDS

Similar to landbird prioritization, models that link species to habitat were used to establish priority areas for shorebird and waterbird conservation efforts, based on six waterbird and four shorebird species with available data (Table 5, Figure 11). However, while the general habitat associations for waterbirds and shorebirds in the PHJV are well understood, density models are not available for most, largely due to incomplete information on the quantity of wetland basins (i.e., wetland inventory), and the innumerate dynamic fluctuations in the amount of wetland habitat (i.e., basins with water) that results from spatial and temporal variability in hydrologic cycles. Despite the lack of abundance-based models for many wetland- and water-associated species, we strongly recommend that conservation of wetlands of all types be considered a top priority for maintaining much of the region's capacity to harbour biodiversity. While populations of many wetland-associated species appear to be doing well within the PHJV region (see Status of Shorebirds, Waterbirds and Landbirds Section 2.0), the amount and quality of wetland habitat continue to diminish with concomitant efforts to manage water to intensify the agricultural footprint. These impacts are seen most strongly in species that use small (<1 ha) shallow marshes (e.g., Horned Grebe) or ephemeral marsh and meadowlands (e.g., Yellow Rail) for breeding habitat; but the less evident impacts are manifest in population declines of many species of arctic-breeding shorebirds that use wet areas across the region as critical staging habitat. Some of these migrant species are known to congregate at predictable staging sites, making targeted conservation localized, whereas other species are more dispersed requiring a network of wet habitat on the landscape.

6.0
HABITAT OBJECTIVES 2021–2025, 2040

Setting of habitat objectives for this iteration of implementation planning was guided by wetland and upland restoration and retention scenarios (direct and policy) that were estimated to achieve the waterfowl hatched nest objective by 2040, and to stop priority landbird population declines by 2035. These objectives account, in part, for projected background changes in land use to 2040, and hence estimate habitat objectives to that date (as described above). Objectives were then scaled back in delivery to the timeframe of this Implementation Plan, 2021–2025. In setting habitat objectives, provincial teams drew on previous experience and achievements, and considered future capacity to arrive at the objectives presented below.

Objectives were first set at the provincial scale before being rolled up to the PHJV-wide objectives reported below (see Appendix 8 for provincial scale objectives). Working at a provincial scale is justified given that many key PHJV partners operate only within their respective provinces. Currently, habitat objectives for landbirds are focused only

TABLE 8. Five-year (to 2025) and 20-year (to 2040) Habitat Restoration Objectives within and outside Waterfowl Target Landscapes in each province.

Habitat Restoration Objectives					
PROVINCE/REGION	WINTER WHEAT (ACRES)	TAME HAY/ PASTURE (ACRES)	PLANTED COVER (ACRES)	WETLAND (ACRES)	NESTING TUNNELS (#)
ALBERTA (2040 OBJECTIVE)	308,000	291,800	0	48,100	0
WITHIN TARGET LANDSCAPES (5-YEAR)	91,000	61,400	0	10,300	0
REMAINING DELIVERY AREA (5-YEAR)	217,000	11,500	0	1,700	0
SUB-TOTAL	308,000	72,900	0	12,000	0
% OF 2040 OBJECTIVE	100%	25%		25%	
SASKATCHEWAN (2040 OBJECTIVE)	561,000	1,536,900	20,500	16,500	0
WITHIN TARGET LANDSCAPES (5-YEAR)	211,000	252,000	4,900	3,500	0
REMAINING DELIVERY AREA (5-YEAR)	350,000	132,200	200	600	0
SUB-TOTAL	561,000	384,200	5,100	4,100	0
% OF 2040 OBJECTIVE	100%	25%	25%	25%	
MANITOBA (2040 OBJECTIVE)	238,000	178,300	0	9,200	5,000
WITHIN TARGET LANDSCAPES (5-YEAR)	62,000	23,000	0	800	1,200
REMAINING DELIVERY AREA (5-YEAR)	176,000	14,500	0	1,200	100
SUB-TOTAL	238,000	37,500	0	2,000	1,300
% OF 2040 OBJECTIVE	100%	21%		22%	26%
PHJV RESTORATION TOTAL (2040)	1,107,000	2,007,000	20,500	73,800	5,000
PHJV RESTORATION TOTAL (2021–2025)	1,107,000	494,700	5,100	18,100	1,300
% OF 2040 OBJECTIVE	100%	25%	25%	24%	26%

The deployment of nest tunnels is proposed for delivery in Manitoba. Due to their high use and success rates, nesting tunnels are expected to enhance Mallard production in most program areas (i.e., ~60% tunnel occupancy and ~70% nest success).

on retention of remaining grasslands throughout the PHJV delivery area. This includes objectives both within and outside current Waterfowl Landscapes targeting 15% of the 20-year objectives for this five-year Implementation Plan.

Habitat Restoration Objectives – Waterfowl

Habitat restoration objectives are presented in Table 8. These objectives primarily focus on conversion of cropland to perennial grass cover in the form of forage crops for hay or pasture. These habitats have greater nest survival than croplands and further improve landscape-level hatching success as well (e.g., Stephens et al. 2005, Howerter et al 2014). Wetland restoration objectives restore waterfowl pair carrying capacity and, on a per unit area basis, provide a greater contribution to incremental hatched nests however, opportunities for restoration are much more limited. Winter wheat objectives represent the estimated adoption of this crop type in prairie Canada in the absence of further incentives – somewhat reduced from expectations in our 2013–2020 Implementation Plan given recent acreage trajectories. Regardless, the PHJV will closely monitor winter wheat acreage, promote its use and remain attuned to new opportunities to improve winter wheat or other cropping practices that benefit waterfowl and other birds.

Habitat Retention Objectives – Waterfowl and Landbirds

Habitat retention objectives are presented in Table 9 for the estimated needs of both waterfowl and landbirds. The

TABLE 9. Five-year (to 2025) and 20-year (to 2040) Habitat Retention Objectives for waterfowl and landbirds. Distribution of acre objectives among Waterfowl Target Landscapes is provided in Table 10 and Appendix 8.

Habitat Retention	2040 HABITAT OBJECTIVE (ACRES)	FIVE-YEAR HABITAT OBJECTIVE (ACRES)			% 2040 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	
WETLAND					
ALBERTA	798,100	11,900	187,600	199,500	25%
SASKATCHEWAN	286,300	71,600	0	71,600	25%
MANITOBA	142,700	31,800	0	31,800	22%
SUB-TOTAL	**1,227,100**	**115,300**	**187,600**	**302,900**	**24%**
UPLAND-WATERFOWL					
ALBERTA	511,500	45,900	82,000	127,900	25%
SASKATCHEWAN	1,840,000	410,000	50,000	460,000	25%
MANITOBA	252,200	53,000	10,000	63,000	25%
SUB-TOTAL	**2,603,700**	**508,900**	**142,000**	**650,900**	**25%**
UPLAND-LANDBIRDS [a]					
ALBERTA	1,768,700	199,000	66,300	265,300	15%[b]
SASKATCHEWAN	2,484,800	279,500	93,200	372,700	15%[b]
MANITOBA	153,300	28,800	9,500	38,300	25%
SUB-TOTAL	**4,406,800**	**507,300**	**169,000**	**676,300**	**15%**

a Upland objectives for landbirds are not additive to upland objectives for waterfowl – delivered acres will be targeted to serve both landbird and waterfowl objectives to the degree possible.
b 5-year habitat objectives projected at 15% for Alberta and Saskatchewan are considered aspirational to demonstrate the importance and need for grassland birds. However, with current resource and programming levels, a 5% objective for Upland-LANDBIRDS is more realistic.

PHJV's overarching goals for habitat retention are to stem the loss of wetlands and to retain all remaining native grasslands given their practically irreplaceable nature and critical habitat value for several Species at Risk.

In order to meet the population objectives set in recovery documents for Baird's Sparrow, Chestnut-collared Longspur, Thick-billed Longspur, and Sprague's Pipit, it is estimated that 4.4 million acres of grassland needs to be conserved over the next 15 years (Table 7). Defining this objective spatially, based on which grasslands are both at a high risk of conversion and contain a relatively high abundance of these species (Figure 15), allowed us to identify grassland conservation targets for each province and Waterfowl Target Landscape (Table 10 and Appendix 8).

Although most target grasslands fall outside of Waterfowl Target Landscapes, ~1.4 million acres are within (Table 10), and many individual Waterfowl Target Landscapes contain a considerable number of acres. For example, Coteau Central in Saskatchewan contains ~173,000 acres of target grasslands, Pakowki in Alberta contains ~100,000 acres, and the majority of remaining grassland habitat in the Clear Lake Target Landscape in southern Alberta are included (Appendix 8, Figure 15).

The habitat retention objectives identified here are estimated to achieve the dual population objectives for waterfowl and landbirds as described above. Wetland retention objectives outlined in Table 9 will continue to be pursued within PHJV Target Landscapes are targeted, to the degree possible, to regions of high risk for wetland loss. New strategies, however, are called for in targeting grassland habitat retention objectives given the inclusion of landbirds in this Plan.

The upland habitat retention objectives provided in Table 9 and 10 will be, to the degree possible, targeted to remaining grassland parcels deemed at high risk of loss as described above (see Setting Habitat Objectives above, Figure 15). Within PHJV Waterfowl Target Landscapes, effort and resources will be focused on retention in these defined areas. However, grassland conservation within Waterfowl Target Landscapes alone will not allow population objectives for these focal grassland birds to be met. Outside of Waterfowl Target Landscapes, additional strategies, efforts and resources will be needed to engage landowners in the conservation of identified parcels.

The PHJV's combined restoration and retention objectives for waterfowl total 321,000 acres of wetlands and 1,150,700 acres of upland habitat during 2021–2025 (Tables 8 and 9). Grassland retention objectives for landbirds during 2021–2025 are 15% of the 20-year objectives. Although this is a lower objective in the first five years, it recognizes the importance of identifying new financial resources, expanding the PHJV partnership, and developing mechanisms for this large challenge. This objective totals 676,300 acres of which approximately 25% may be achieved through waterfowl-targeted programs (Table 9).

Habitat Objectives for Shorebirds and Waterbirds

While specific habitat objectives linked to population objectives have not been developed for PHJV priority shorebirds and waterbirds, we believe current wetland and upland habitat objectives will benefit many of these species. Newly developed distribution models (Appendix 6) and important wetland site information (PHJV Important Wetlands database) provide valuable tools for targeting conservation resources to maximize value for multiple species groups both within and outside Target Landscapes. While this Plan does not include direct expenditures for large marsh restoration activities, the PHJV intends to pursue opportunities to secure and protect important wetland sites where current conservation measures are not in place.

For those species that congregate at known sites, such as Western Hemisphere Shorebird Reserve Network (WHSRN) sites, or sites that have been identified as qualifying under WHSRN (identified in PHJV Important Wetlands database), site-based protection of these key wetlands would have clear conservation benefits. The WHSRN program involves voluntary agreements to help shorebirds and their habitat through a network of key sites across the Americas, but provides no legal protection. Similarly, colonial waterbirds, such as some gulls, terns and grebes, tend to concentrate during both breeding and staging at known sites that are amenable to targeted conservation, such as Important Bird

TABLE 10. Grassland-specific retention objectives (acres) within and outside of Waterfowl Target Landscapes for each Prairie Province to meet landbird conservation objectives by 2035.

PROVINCE	WITHIN TARGET LANDSCAPES	OUTSIDE TARGET LANDSCAPES	TOTAL
ALBERTA	584,700	1,184,000	1,768,700
SASKATCHEWAN	804,800	1,680,000	2,484,800
MANITOBA	35,100	118,000	153,000
TOTAL	**1,424,600**	**2,982,000**	**4,406,600**

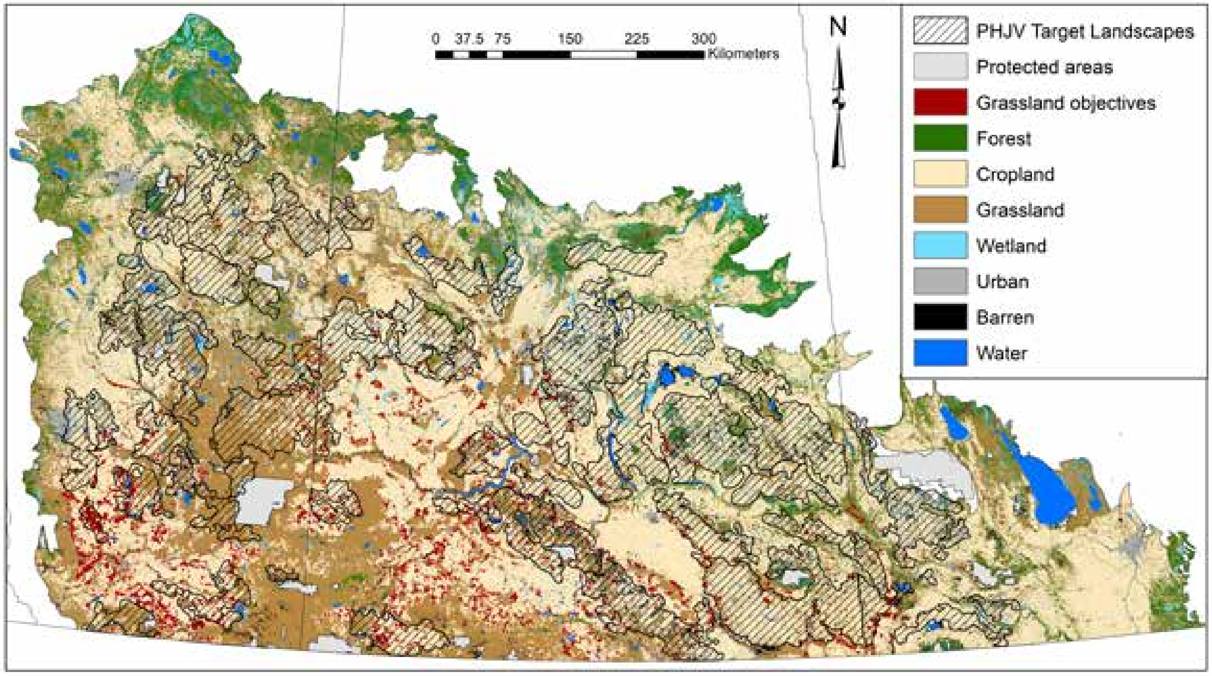


FIGURE 15. Spatially-explicit grassland retention objectives (red pixels) for four grassland bird Species at Risk. Target grassland pixels represent ~4.4 million acres that are a relatively high priority for these species and at a high risk of conversion to cropland.

Areas, which may not have any existing legal protection. For example, significant numbers of Franklin's Gulls, Western Grebes, and Black Terns have been observed staging or breeding at the Blackstrap Coulee IBA, about 50 km south of Saskatoon, Saskatchewan, a site that has no legal protection apart from a small section that is part of Blackstrap Provincial Park.

It is important to note that, while all of the habitat objectives described above were developed to eliminate deficits for waterfowl or stop declines/stabilize populations for landbirds, making meaningful progress on these objectives will be strongly influenced by the availability of funds to invest in habitat programs. Given the importance of the available financial resources, we thought it would be helpful to provide context on the current scale of investment of PHJV partners during FY22 (April 1, 2021 – March 31, 2022). The estimated Total Planned Investment for FY22 is $82,000,000.

Given the current level of investment, we will need to grow existing funding and seize new partner opportunities. It is clear that for the waterfowl objectives to be met we will rely on the continued and valued support of existing PHJV partners, while pursuing opportunities with new partners to grow critical funding for habitat work within waterfowl target landscapes. Also, securing significant new funding sources and delivery partners is essential to toward making meaningful progress with landbird objectives. We acknowledge that most PHJV partners work within their jurisdiction of responsibility and are focused on delivering very limited acres of habitat programs outside of the existing waterfowl target landscapes. Thus, achieving these objectives will be heavily influenced by the ability to grow existing funding sources and develop new sources, along with partner delivery capacity outside of existing Waterfowl Target Landscapes.

7.0 HUMAN DIMENSIONS AND POLICY 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. As such, the PHJV has developed a new strategic approach to integrate HD into our conservation actions, programs and a broader inclusive approach to the partnership, including Indigenous Peoples of Canada.

Recently, there have been fundamental shifts in applied ecology, natural resource management and conservation towards managing integrated social – ecological systems (Cumming and Allen 2017). This has broadened the scope from single species focus to a recognition that conservation problems often encompass a wide variety of disciplines, systems and solutions involving inextricably connected ecosystems and social systems (Cumming et al. 2011). This understanding was reflected in the 2012 NAWMP revision, which highlighted the importance of people to the success of waterfowl conservation by including a third goal for the engagement of people (i.e., the "human dimension"; NAWMP 2012). This goal was to "grow the number of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetland conservation". This specifically recognizes the conservation challenges presented by shifting public values, urbanization, and increasing demands for water, energy and food, which directly influence land use decisions, and hence, habitat (see Status of Habitat above).

While borne out of a concern over the decline in waterfowl hunters and their support for conservation (NAWMP 2012), the need to address the HD challenge applies to bird conservation in general – we can only succeed if bird conservation is relevant to society. To impact bird habitat conservation positively, it's important that we not only better understand how people connect with bird habitat conservation, but also how to apply that knowledge in ways that more readily engage the public in active support of conservation programs. Fortunately, bird habitat provides wide-ranging benefits to society, from recreation, to health, to climate resilience and the economy. Thus, there are multiple opportunities to engage different segments of the public regarding the benefits that are most relevant to them.

Across the Prairie Parklands, the sustainability of prairie landscapes is influenced by the people who manage, use and conserve the land. In many cases, their livelihoods depend on the use and management of the land – a true working landscape. Additionally, the prairie landscape carries cultural value and significance for many indigenous peoples. Conservation is challenging in this landscape, where change in land use is highly responsive to real and perceived socio-economic imperatives.

Integrating HD in conservation requires a recognition that conservation is linked to culture, community, trust, credibility and the ability to bridge diverse perspectives in a way that scales up to create an impact over time and space. Integration will require understanding people's thoughts and actions relative to conservation, incorporating that into decisions regarding conservation policies and programs, and evaluating responses in human behaviour relative to conservation targets (Dayer et al. 2019). Inclusion of HD in this Implementation Plan advances the PHJV in considering and understanding the ecological and social threats together as part of a social-ecological system and the integration allows for the development of socially and ecologically informed goals (Sexton et al. 2013).

Social Foundation and Target Audiences

Following NAWMP 2012 guidance, the PHJV has recognized the need for prioritized efforts towards target audiences as a key first step in developing the strategic direction. Identification of priority audiences was based on considering which audiences are most critical for supporting and achieving the PHJV conservation outcomes. These goals recognize that in the PHJV context, our success hinges on the engagement of the agricultural community and industry, government, as well as the general public more

The PHJV Definition of Human Dimensions

There are a variety of definitions for Human Dimensions, which range from broad definition to a very narrow scope of work. For the PHJV, it was important to identify what we considered Human Dimensions within the scope of work necessary to influence the transformative change required on the landscape. This was an important step in developing the Strategy.

For the PHJV, the definition of Human Dimensions refers to "everything in conservation that is not about wildlife and habitats" (adapted from Decker, Riley, & Siemer 2012). This includes the cultural, legal, political, economic and social constraints and opportunities that influence both the status of wildlife populations, and the feasibility and success of conservation efforts. Human Dimensions theory and research incorporate many other disciplines and often combine these social sciences with insights from the biological sciences (Dayer et al. 2019).

broadly. This represents a shift from the more traditional social foundations of NAWMP that focus on the retention and recruitment of hunters and recreational users. However, this broader social foundation reflects similar successful strategies adopted by several other Joint Ventures (e.g., Playa Lakes, Intermountain West JVs). Further, our HD Strategy places intentional focus on both short- and long-term goals associated with engaging priority audiences to create long-lasting partnerships and coalitions based on trust and relevancy.

Recognizing the pivotal role land managers, governments and the general public play in achieving conservation outcomes in the PHJV, we have prioritized audiences as follows:

1. PRIMARY TARGET GROUPS:

a) Agricultural Community: including private landowners, land managers and agricultural industry. The PHJV recognizes the opportunities of working with these groups toward sustainable agricultural and land use decisions.

b) Government: including federal, provincial and municipal. The PHJV recognizes the need to build broader relationships with policy- and decision-makers.

c) General public: including urban and rural residents within the Prairie Parklands, as well as all residents of Canada who benefit from a healthy environment. The PHJV recognizes the need to focus strategies and tactics to include an expanded Human Dimensions component and engage with non-traditional partners, including exploring opportunities to work with Indigenous Peoples of Canada.

2. SECONDARY TARGET GROUP:

a) Recreational Users: including hunters, wildlife viewers and other recreational users of wetland- and grassland-associated habitat. The PHJV recognizes that these audiences contribute to increasing the level of active public support regarding the value of wetlands, grasslands and associated biodiversity.

Human Dimensions Goals, Outcomes and Objectives

Our HD Strategy defines two overarching goals to guide our activities and five associated Key Outcomes that provide benchmarks of success in integrating HD into our conservation plans:

Goal: Programs and policies are delivered and advocated that favour both conservation and the long-term sustainability of agricultural communities.

OUTCOMES:

- Build Social Science Capacity: The PHJV delivery partners have the social science capacity required to support a human-centric approach to decision-making and conservation support.
- Trust & Relevancy with the Agricultural Community: The agricultural community in the prairie provinces, which includes producers, Indigenous communities and industry, are aware of the delivery partners and the PHJV partnership, and view them as trusted, relevant partners in supporting the sustainability of the rural communities and sustainable agriculture in the prairie provinces.
- Participating in PHJV Programs: Farmers, ranchers and other land managers in the prairie provinces recognize the importance of and actively participate in landscape-level initiatives to conserve wetland and grassland habitats.
- Building support for effective policies: Policy makers understand the importance of maintaining wetland and grassland habitats as a key part of sustainable agriculture.

Goal: Citizens understand and value the benefits of wetland and waterfowl habitat, participate in wetland-related recreation activities, and act to support conservation initiatives.

OUTCOME:

- Creating pathways to build active support for conservation.
- Residents of the prairie provinces have positive attitudes, change behaviours, and take actions that result in the conservation of wetland and grassland habitats.
- The PHJV (delivery partners) create opportunities for constituents of the public to access or experience PHJV programs and spaces.

To address adequately the ecological impacts at the scale and magnitude required in the Prairie Parklands, the PHJV recognized the need to consider underlying social drivers throughout the planning, implementation, and evaluation cycle (Dayer et al. 2019). To achieve the outcomes, we have developed long-term objectives, five-year milestones, and measurement metrics for each objective (Table 11). The HD goals and outcomes included in this Plan reflect an integration into the planning cycle and the need to balance the urgency of the conservation threats with the deliberate efforts to build social support. These deliberate efforts to build trust, social license and political willingness is pivotal however, these actions can be resource and time intensive. This can result in challenges, such as mismatched scales of governance and conflicting management trade-offs (Cumming et al. 2006, Cavender-Bares et al. 2015). As such, this Plan includes the identification of strategies and key actions that reflect short-term activities, which build towards creating the social capital and relationships required to deliver programs, influence policy, or engage with citizens (Cumming and Allen 2017). This Plan strives to help reimagine conservation as an opportunity to support both social and ecological thriving (Epstein et al 2021).

TABLE 11. Prairie Habitat Joint Venture Human Dimensions outcomes, objectives, milestones and metrics guiding integration and implementation through the 2021-2025 PHJV Implementation Plan.

OUTCOME: SOCIAL SCIENCE CAPACITY WITHIN THE PHJV			
HD OUTCOME	LONG-TERM HD OBJECTIVES (20 YR.)	FIVE-YEAR MILESTONES FOR THE 2020–2025 IP	METRICS
The PHJV and delivery partners have the social science capacity required to support a human-centric approach to decision-making and conservation support.	Human Dimensions tools are used to support PHJV work.	By 2025, the PHJV has the necessary infrastructure and processes in place for integrating and disseminating HD information.	Number of PHJV programs decisions made using HD information.

OUTCOME: TRUST & RELEVANCY IN THE AGRICULTURAL COMMUNITY			
HD OUTCOME	LONG-TERM HD OBJECTIVES (20 YR.)	FIVE-YEAR MILESTONES FOR THE 2020–2025 IP	METRICS
The agricultural community in the prairie provinces, including producers, Indigenous communities and industry are aware of the delivery partners and the PHJV partnership, and view them as trusted relevant partners in supporting the sustainability of the rural communities and sustainable agriculture in the prairie provinces.	By 2040, increase the percentage of agricultural community, including producers, Indigenous communities and industry that are aware of and trust PHJV partners by 50%.	By 2025, the PHJV understands the levels of awareness, trust, and outcomes of PHJV efforts. By 2025, the PHJV has developed a monitoring framework.	Proportion of producers, Indigenous communities and industry that are 1) aware of and 2) trust the delivery partners and/or the PHJV.

OUTCOME: PARTICIPATION IN PHJV PROGRAMS			
HD OUTCOME	**LONG-TERM HD OBJECTIVES (20 YR.)**	**FIVE-YEAR MILESTONES FOR THE 2020–2025 IP**	**METRICS**
Farmers, ranchers and other land managers in the prairie provinces recognize the importance of and actively participate in landscape-level initiatives to conserve wetland and grassland habitats.	Participation: Maximize the number of farmers, ranchers and other land managers who proactively seek out wetland/upland restoration programs: By 2040, increase the number of farmers, ranchers and other land managers who proactively seek out wetland retention and restoration programs by 25%. By 2040, increase the number of individuals who proactively seek out opportunities to protect native grasslands by 25%. By 2040, increase the number of individuals who proactively seek out opportunities to restore grassland (permanent cover) by a 25% above-industry trend.	By 2025, the PHJV understands the level of proactive engagement by farmers, ranchers and other land managers and the outcome of PHJV efforts. By 2025, the PHJV works with ag industry partners to create consistent messaging regarding sustainable agriculture. By 2025, identify and engage in strategic partnerships, including Indigenous communities, to promote sustainable agriculture.	PHJV program uptake rates. Number of individuals who proactively seek out partner programs: For wetland retention and restoration. To protect native grasslands. To restore grasslands.
Farmers, ranchers and other land managers in the prairie provinces recognize the importance of and actively participate in landscape level initiatives to conserve wetland and grassland habitats.	Attitudes: Increase positive attitudes of farmers, ranchers, and other land managers. By 2040, increase the percentage of farmers, ranchers and other land managers who have supportive attitudes towards agricultural practices that conserve wetland and grasslands by 25% by 2040.	By 2025, the PHJV understands the attitudes that farmers, ranchers, and other land managers have toward wetlands and grasslands. By 2025, develop a monitoring framework to track attitudes.	The attitudes of farmers, ranchers and other land managers in the Prairie Provinces related towards wetland and grasslands by survey monitoring efforts.

OUTCOME: SUPPORT FOR EFFECTIVE POLICIES			
HD OUTCOME	**LONG-TERM HD OBJECTIVES (20 YR.)**	**FIVE-YEAR MILESTONES FOR THE 2020–2025 IP**	**METRICS**
Policy makers understand the importance of maintaining wetland and grassland habitats as key part of sustainable agriculture.	Maximize the effectiveness of government policies: By 2040, each Prairie Province has policies in place that significantly slow or stop the loss of wetlands. By 2030, each Prairie Province has policies in place to protect priority native grassland habitats. (Note: The aggressive timeline included for this objective reflects the urgency and impact of the threats.)	A benchmark to evaluate the effectiveness of wetland and grassland policies. Create a comparative framework to inventory wetland and grassland policies by 2025.	Number of effective policies in place that support positive wetland and grassland outcomes Extent of wetland and grassland policy expansion or dismantling. Number of policy barriers in each province.

OUTCOME: CREATING PATHWAYS TO BUILD ACTIVE SUPPORT FOR CONSERVATION			
HD OUTCOME	**LONG-TERM HD OBJECTIVES (20 YR.)**	**FIVE-YEAR MILESTONES FOR THE 2020–2025 IP**	**METRICS**
Residents of the prairie provinces have positive attitudes, change behaviours, and take actions that result in the conservation of wetland and grassland habitats.	Maximize nature-based recreation participation, recruitment and retention. Maintain high levels of overall participation in nature-based recreation by the public through to 2040. By 2040, increase the number of resident waterfowl hunters by 25%. Maintain current increasing trends of birders.	Maintain high levels of nature-based recreation. By 2025, increase the number of resident waterfowl hunters by 5% Maintain the increasing trend of birders	Participation levels in nature-based recreation as reported by Canadian Nature Survey. Number of waterfowl hunters Number/trend of birders
	By 2040, increase the percentage of citizens that have positive attitudes towards conservation of wetlands and grasslands by 25%.	By 2025, the PHJV understands the attitudes that residents in the Prairie Provinces have towards wetlands and grasslands. By 2025, the PHJV has a monitoring framework to track attitudes.	Number of citizens that have positive attitudes towards conservation of wetlands and grasslands.
	Maximize pro-conservation action taken by residents of the Prairie Provinces. By 2040, increase the number of waterfowl hunters, birders and other stakeholders in the prairie provinces that are engaged in pro-conservation behaviours by 50%.	By 2025, increase the number of waterfowl hunters, birders and other stakeholders in the prairie provinces that are engaged in pro-conservation behaviour by 10%.	Number of individuals that participate in pro-conservation behaviours as reported in the NAWMP Surveys and the Canadian Nature.
The PHJV (delivery partners) create opportunities for constituents of the public to access or experience PHJV programs and spaces.	By 2040, increase the percentage of individuals who interact with PHJV partner programs, projects, or spaces by 25%.	By 2025, the PHJV understands how many individuals visit PHJV spaces or participate in PHJV Programs. By 2025, the PHJV understands the characteristics and attributes of individuals who interact/ engage with partner programs, projects or spaces. By 2025, the PHJV coordinates partners information and develops a monitoring framework.	Degree of interactions measured through participant hours. Number of properties that are used as birding locations. Satisfaction rates of participants.

TABLE 12. Priority policy objectives for 2021–2025.

POLICY OBJECTIVE	DESIRED OUTCOME
Development, adoption and implementation of wetland policies.	Provinces have effective wetland policies in place Provinces effectively implement wetland policies
Implementation of natural infrastructure programs / removal of barriers and creation of a dedicated program	Revision of current agreements to remove application and funding barriers Creation of a federal/provincial stand-alone natural infrastructure fund
Development and use of watershed models that can monetize and analyze BMPs for ES&G on prairie landscapes	The application of watershed models providing ES from wetland and upland retention and restoration
Improved accounting for wetland and upland carbon losses and sequestration in provincial and federal carbon strategies	The inclusion of land use, land use change and forestry (LULUCF) in provincial and federal carbon accounting, including the Net Zero Emissions Framework
Prevention of conversion or sale of crown land for cultivation	Appropriate crown land policies for the conservation of wetlands and uplands Establish avoided conversion of grassland protocols and implement a carbon-based offset compensation program. Develop and put in place Grassland Policy for Alberta. Understand the effectiveness of the existing AWP and implement solutions to the barriers and challenges.

Policy Objectives

The multiple achievements made in the 2013–2020 Implementation Plan provide excellent building blocks for policy strategies during 2021–2025 (Annex A). In order to make progress toward policies that support the maintenance of wetlands and grasslands as part of sustainable agricultural landscapes, efforts during this Implementation Plan cycle will focus on policy objectives identified in Table 12.

8.0 RESEARCH AND EVALUATION

Research and evaluation support PHJV partner decision-making, commitments to adaptive management, and continual program and policy improvements. The PHJV will continue to undertake evaluations with prairie-wide implications that inform geographic priorities, inform conservation planning priorities and actions, and enhance the ability of partners to measure progress toward population objectives for priority species (e.g., species distribution and habitat/demographic models). Also, substantial new work will be required to support the development and implementation of our HD strategy, monitor its success in meeting objectives and refine approaches as new information is gained.

Fundamentally, habitat JVs operate on the assumption that bird populations are limited, to a large degree, by the availability of important or critical habitats and/or their condition (as opposed to acute threats; e.g., pesticides – unless pesticides degrade habitat condition). Thus, research and evaluation priorities are directly or indirectly related to improving our ability to retain and restore habitat for birds. The habitat objectives identified in this Plan depend on several models that incorporate the best information presently available regarding the linkage between landscape conditions and bird responses (e.g., waterfowl production capacity, grassland bird presence). Examining the assumptions, validity and performance of these models is an ongoing need as part of an adaptive management framework to test and refine the models, and update management plans. Where appropriate, the PHJV may pursue research needs identified for all birds by ongoing collaborative reviews (e.g., Grassland Roadmap Summit, Smoking Guns Workshop, etc.), especially if there are linkages to the Prairie Parklands habitat.

Evaluating and adaptively improving habitat programs in response to new information have been hallmarks of the PHJV. The 2001–2016 change in the trajectory of cultivated acres (see Status of Habitat Section 3.0 above) sends an alarming signal that gains in productive upland habitat seen since 1986 have begun to erode. Understanding if, where and which habitats are being affected by this change, and how they will affect bird populations will continue to be a top priority for research and evaluation during this Implementation Plan cycle.

Biological and Conservation-Specific Information, Research and Evaluation Needs

- Completion of the Canadian Wetland Inventory (CWI) for the Prairie Parklands remains a priority that would significantly advance efforts to track wetland changes (e.g., automated change detection) and PHJV progress, support policy development and enable improved modelling of the abundance and distribution of waterfowl and other wetland-dependent species, and various wetland-dependent ecosystem services. Current projections for completion of PHJV-wide CWI coverage of Waterfowl Target Landscapes is circa 2022. Further refinement to identify wetland permanency class within the CWI would add biological value to the CWI in the Prairie Parklands.
- Development and completion of a PHJV-wide native grassland inventory is a growing priority need. This layer is a critical need for grassland bird conservation planning and modelling, modelling associated ecosystem services (e.g., carbon storage), and monitoring native grassland loss into the future. While the JV8 effort to map undisturbed grasslands (i.e., putative 'native') for the Central Grasslands of North America has provided an interim product for use, more refined regional methods to inventory remaining native grasslands are needed.
- Research regarding the demographic and population responses of birds to wetland and upland habitat changes within the Prairie Parklands is an ongoing priority. This can include simple quantification of habitat associations for species distribution models, to more complex studies of habitat influence on reproductive success and survival – ideally both are optimal. This information is fundamental to conservation planning and should be informed by current knowledge of expected or hypothesized limiting factors. The scale of PHJV habitat conservation delivery provides unique opportunities for working with landowners or partner-owned properties, on large-scale experiments with land use or habitat manipulation. Focusing on key species of concern (e.g., Sprague's Pipit, Northern Pintail) is warranted.
- Further understanding of habitat risk of loss incorporated into spatial layers for use in conservation planning and objective setting. Current PHJV models exist for loss of grassland (Olimb and Robinson 2019) and wetlands (DUC/ECCC unpublished), however, further spatial refinements should be explored, especially for wetland loss which is currently driven solely by cropping intensity. Further, recent upward trends in cropland acreage suggest the grassland risk profile may be changing. These layers are integral to estimating the conservation benefit of habitat retention activity and projecting future bird population carrying capacity/productivity.
- Longitudinal change in habitats through various mechanisms, including climate change and habitat succession, may alter habitat availability or quality. Research to project the impact of climate change on wetland habitat and potential waterfowl response across the PHJV is ongoing. Similar work on grasslands and grassland birds may be warranted. Successional change in shrub or aspen communities surrounding wetlands also may be impacting bird use.
- Assessment of the impact of recent wetland policy advancements in Alberta and Manitoba on wetland loss (e.g., implementation, compliance) in these provinces is a high priority policy research need. Further, the Manitoba policy does not afford protection to ephemeral or temporary wetlands (Stewart and Kantrud 1971 Class I and II). Further research is warranted regarding the value of these often-cultivated wetland classes to waterfowl and other birds (e.g., waders), especially during early spring.
- Further quantifying and refining estimates of the impact of wetland and grassland conservation activities on carbon sequestration/storage and biodiversity.

Human Dimensions-Specific Information, Research and Evaluation Needs

- Ecosystem service models (and decision-support tools) to estimate the contribution of existing and restored habitats, especially grasslands (native and tame) and wetlands to a variety of ecosystem services, including carbon sequestration and storage, nutrient export and retention, water quality and flow attenuation, and biodiversity potential. Where existing information is inadequate to inform a modelling exercise, field research is warranted to gather the needed information. This information is critical for facilitating, informing and engaging HD and policy initiatives to achieve habitat objectives.
- Additional research is needed regarding how PHJV programs and/or agricultural practices can be adjusted to achieve the dual objectives of 1) economically viable (sustainable) rural communities, and 2) maintenance of remaining wetland and upland habitat. Further understanding of regenerative farming practices, sustainability criteria, market forces, and agricultural industry value and supply chains may be useful in advancing Key HD Outcomes identified above.
- Review current partner activities and additional opportunities to measure the benefits of engaging the general public in citizen science activities on PHJV project lands as a means of awareness

building. This could include engagement through school educational curriculums, naturalist or birding societies, or other outdoor-based groups. The use of popular citizen science platforms like iNaturalist (https://www.inaturalist.org/) and eBird (https://ebird.org/home) can facilitate engagement and data collection.

Broadly, engage social science analytic methods to:

5. Examine the current participation rates, barriers and opportunities related to PHJV program uptake by Prairie Parklands farmers, ranchers and other land managers.
6. Understand attitudes, decision-making processes, and engagement of Prairie Parklands farmers, ranchers, other land managers and the general public toward wetlands and grasslands and their conservation.
7. Quantify participation of key audiences in nature-based recreation within the PHJV region and their attitudes toward grasslands and wetlands.
8. Determine the proportion of key stakeholders including agricultural producers and industry that are aware of and trust the delivery partners and/or the PHJV.
9. Identify ways to increase public awareness and use of land restored or enhanced by the PHJV, and assess the response and willingness to support the PHJV resulting from this engagement.

9.0 EXPENDITURE FORECAST

The total estimated expenditure for implementation of PHJV habitat objectives for waterfowl and landbirds during 2020–2025 is projected at $886,480,000 (Table 13). Most expenditures are allocated to direct and indirect costs associated with habitat restoration and retention activities (89%), with the balance supporting management of habitat assets (7%), conservation planning (2.5%), JV science (0.9%), land and water policy (0.4%), and communications and education (0.35%). To meet habitat objectives, habitat restoration costs are approximately $100 million, and habitat retention costs are ~$664 million (Table 13).

When compared with the previous Implementation Plan (2013–2020), higher total cost estimates reflect a substantial increase in conservation delivery, including the addition of landbird conservation objectives (upland retention) to meet Species At Risk Recovery Plan objectives. Furthermore, land values and annual operating costs have increased over the last eight years. Land values alone have increased an estimated 50 to 100% in many parts of the PHJV delivery area during this period.

Landbird conservation expenditures add $255,551,000 to address the conservation of 676,350 acres of grassland retention. These acres are 15% of the 2040 upland retention objective falling outside of Waterfowl Target Landscapes, plus grassland retention objectives within Waterfowl Target Landscapes above those which are required to meet waterfowl objectives. To estimate expenditures, we assumed costs associated with conservation easements as the primary tool for perpetual grassland protection.

Expenditure forecasts provided in this Plan reflect the estimated investment needed to meet the population-based habitat objectives identified and have not been verified against projected PHJV-dedicated partner budgets. Expenditure forecasts were based on estimates of agency specific direct and stewardship program costs plus indirect costs based on representative partner agencies with readily available data (i.e., DUC, MHHC and NCC). Inflation costs were included based on 1.5% per annum. Data were sourced from the NAWMP National Tracking System and individual agency records, as applicable. While the projected expenditure represents a significant increase over previous implementation cycles, it provides a real cost to tangible efforts contributing to the future of waterfowl, landbirds and all other migratory birds that rely on the Prairie Pothole Region of Canada as breeding habitat.

There is wide recognition among PHJV partners that additional strategies and resources will be needed to meet the conservation objectives outlined in this Plan. For example, PHJV membership on the JV8 Grassland Conservation Initiative will serve to raise the international profile of grassland conservation for landbirds and may enable access to additional funding sources. Efforts to increase public awareness of the plight of prairie grasslands and grassland birds, in addition to wetland-dependent species, will further raise the provincial and national profile for conservation needs. PHJV partners are committed to seeking increased support for the important conservation objectives outlined in this Plan.

TABLE 13. Estimated Prairie Habitat Joint Venture expenditure forecast to meet the five-year habitat conservation objectives set for waterfowl and landbirds, 2021–2025.

HABITAT CATEGORIES	2040 OBJECTIVES (ACRES)	FIVE - YEAR HABITAT OBJECTIVES (ACRES)			% OF 2040 OBJECTIVES	TOTAL 5-YEAR EXPENDITURES
		DIRECT	EXTENSION	TOTAL		
Habitat Restoration						
WINTER WHEAT (FALL CEREALS) [a]						
ALBERTA	308,000	-	308,000	308,000	100%	$ 550,000
SASKATCHEWAN	561,000	-	561,000	561,000	100%	$ 875,000
MANITOBA	238,000	-	238,000	238,000	100%	$ 700,000
SUB-TOTAL	**1,107,000**	**0**	**1,107,000**	**1,107,000**		**$ 2,125,000**
TAME GRASS						
ALBERTA	221,800	72,900	0	72,900	25%	$ 8,019,000
SASKATCHEWAN	1,536,900	249,800	134,400	384,200	25%	$ 20,609,000
MANITOBA	178,300	37,500	0	37,500	21%	$ 4,125,000
SUB-TOTAL	**1,937,000**	**360,200**	**134,400**	**494,600**		**$ 32,753,000**
PLANTED NESTING COVER						
ALBERTA	-	-	-	-		$ 0
SASKATCHEWAN	20,500	5,100	0	5,100	25%	$ 792,000
MANITOBA	-	-	-	-		$ 0
SUB-TOTAL	**20,500**	**5,100**		**5,100**		**$ 792,000**
WETLAND RESTORATION						
ALBERTA	35,800	12,000	3,800	15,800	25%	$ 50,400,000
SASKATCHEWAN	16,500	4,100	0	4,100	25%	$ 7,380,000
MANITOBA	9,200	2,000	0	2,000	22%	$ 6,000,000
SUB-TOTAL	**61,500**	**18,100**	**3,800**	**21,900**		**$ 63,780,000**
NESTING TUNNELS (# STRUCTURES)						
ALBERTA	-	-	-	-		$ 0
SASKATCHEWAN	-	-	-	-		$ 0
MANITOBA	5,000	1,300	0	1,300	26	$ 650,000
SUB-TOTAL	**5,000**	**1,300**		**1,300**		**$ 650,000**
RESTORATION SUB-TOTAL	**3,126,000**	**383,400**	**1,245,200**	**1,628,600**		**$ 100,100,000**

HABITAT CATEGORIES	2040 OBJECTIVES (ACRES)	FIVE - YEAR HABITAT OBJECTIVES (ACRES) DIRECT	EXTENSION	TOTAL	% OF 2040 OBJECTIVES	TOTAL 5-YEAR EXPENDITURES
Habitat Retention						
WETLAND						
ALBERTA	798,100	11,900	187,600	199,500	25	$ 6,779,000
SASKATCHEWAN	286,300	71,600	0	71,600	25	$ 37,288,000
MANITOBA	142,700	31,800	0	31,800	22	$ 19,406,000
SUB-TOTAL	**1,227,100**	**115,300**	**187,600**	**302,900**		**$ 63,473,000**
UPLAND - WATERFOWL FOCUS						
ALBERTA	511,500	45,900	82,000	127,900	25	$ 43,434,000
SASKATCHEWAN	1,840,000	410,000	50,000	460,000	25	$ 263,424,000
MANITOBA	252,200	53,000	10,000	63,000	25	$ 38,178,000
SUB-TOTAL	**2,603,700**	**508,900**	**142,000**	**650,900**		**$ 345,036,000**
UPLAND - LANDBIRD FOCUS [b]						
ALBERTA	1,768,700	199,000	66,300	265,300	15	$ 157,524,000
SASKATCHEWAN	2,484,800	279,500	93,200	372,700	15	$ 85,800,000
MANITOBA	153,300	28,800	9,500	38,300	25	$ 12,227,000
SUB-TOTAL	**4,406,800**	**507,300**	**169,000**	**676,300**		**$ 255,551,000**
RETENTION SUB-TOTAL	**8,237,600**	**1,131,500**	**498,600**	**1,630,100**		**$ 664,060,000**
MANAGEMENT						**$ 60,000,000**
SCIENCE						**$ 8,000,000**
LAND AND WATER POLICY						**$ 3,500,000**
CONSERVATION PLANNING						**$ 22,000,000**
COMMUNICATION AND EDUCATION						**$ 3,000,000**
OPERATIONS SUB-TOTAL						**$ 96,500,000**
ESTIMATED GRAND TOTAL						**$ 860,660,000**
					+INFLATION	**$ 886,480,000**

a Winter wheat expenditure estimated based on overall program costs relative to variety development (plant breeding), market development and communications, and targeted incentive program costs.

b Upland retention acres used in expenditure forecast represent 25% of the 2040 upland retention objective for landbirds falling outside of Waterfowl Target Landscapes, plus grassland retention objectives within Waterfowl Target Landscapes above those which are required to meet waterfowl objectives.

10.0 LITERATURE CITED

Alberta Agriculture and Forestry. 2018. Fragmentation and conversion of agricultural land in Alberta – Land use framework reporting: Background and methodology. Policy, Strategy and Intergovernmental Affairs Branch, Policy Coordination and Research Section, Alberta Agriculture and Forestry, Edmonton, Alberta, Canada.

Agriculture and Agri-food Canada. 2016. Annual Space-Based Crop Inventory for Canada, 2016. Centre for Agroclimate, Geomatics and Earth Observation, Science and Technology Branch, Agriculture and Agri-Food Canada, Ottawa, Canada.

Bartzen, B., K.W. Dufour, M.T. Bidwell, M.D. Watmough, and R.G. Clark. 2017. Relationships between abundances of breeding ducks and attributes of Canadian prairie wetlands. Wildlife Society Bulletin 41:416–423.

Bateman, B.L., C. Wilsey, L. Taylor, J. Wu, G.S. LeBaron, and G. Langham. 2020. North American birds require mitigation and adaptation to reduce vulnerability to climate change. Conservation Science and Practice 2:e242 https://doi.org/10.1111/csp2.242

Benning, D. S. 1976. Standard procedures for waterfowl population and habitat surveys: operating manual. U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, MD, USA.

Calvert, A.M., C.A. Bishop, R.D. Elliot, E.A. Krebs, T.M. Kydd, C.S. Machtans, and G.J. Robertson. 2013. A synthesis of human-related avian mortality in Canada. Avian Conservation and Ecology 8(2):11. http://dx.doi.org/10.5751/ACE-00581-080211

Clark W.R. 2000. Ecology of muskrats in prairie wetlands. Pages 287-313 In: H.R. Murkin, A. van der Vals, and W.R. Clark, editors. Prairie wetland ecology: the contribution of the Marsh Ecology Research Program. Iowa State University Press, Ames Iowa, USA.

Cumming G.S. 2011. Spatial resilience: integrating landscape ecology, resilience and sustainability. Landscape Ecology 26:899-909.

Cumming, G. S. and C.R. Allen. 2017. Protected Areas as social-ecological systems: perspectives from resilience and social-ecological systems theory. Ecological Applications 27:1709-1717. https://doi.org/10.1002/eap.1584

Davis, S.K. 2004. Area sensitivity in grassland passerines: effects of patch size, patch shape, and vegetation structure on bird abundance and occurrence in southern Saskatchewan. The Auk, 121:1130-1145.

Davis, S.K., D.A. Kirk, L.M. Armstrong, J.H. Devries, and R.J. Fisher. 2020. Shifting from spring wheat to winter wheat: A potential conservation strategy for grassland songbirds in cultivated landscapes? Biological Conservation 245:108530.

Dayer A., A. Gramza and J. Barnes. 2019. Incorporating Human Dimensions into the Joint Venture Implementation Plans. Report provided to North American Bird Conservation Initiative. 12 pp.

Devries, J.H., L.M. Armstrong, R.J. MacFarlane, L. Moats, and P.T. Thoroughgood. 2008. Waterfowl nesting in fall-seeded and spring-seeded cropland in Saskatchewan. Journal of Wildlife Management 72:1790-1797.

Devries, J.H., S.O. Rimer, and E.M. Walsh. 2010. Cropland nesting by long-billed curlews (Numenius americanus) in southern Alberta. Prairie Naturalist 42:123-129.

Doherty, K. E., D. W. Howerter, J. H. Devries, and J. Walker. 2017. The prairie pothole region. Pages 1-10 in C. M. Finlayson, G. R. Milton, R. C. Prentice, and N. C. Davidson, editors. The wetland book II: Distribution, description and conservation. Springer, Dordrecht, Netherlands.

Duncan, D., and J.H. Devries. 2018. Agricultural destruction of northern pintail nests on cropland in prairie Canada. Avian Conservation and Ecology 13. https://doi.org/10.5751/ACE-01243-130206

Ecological Stratification Working Group. 1995. A national ecological framework for Canada. Agriculture and Agri-Food Canada, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull, Canada.

Environment Canada, 2017. North American Breeding Bird Survey - Canadian Trends Website, Data-version 2015. Environment Canada, Gatineau, Quebec, K1A 0H3.

Environment Canada. 2013. Bird Conservation Strategy for Bird Conservation Region 11 in the Prairie and Northern Region CWS region: Prairie Potholes. Canadian Wildlife Service, Environment Canada. Saskatoon, Saskatchewan.

Fields, S., and K. Barnes. 2019. Grassland Assessment of North American Great Plains Migratory Bird Joint Ventures. Unpublished Report. Prairie Pothole Joint Venture. Great Falls MT, USA.

Grand, J., C. Wilsey, J.X. Wu, and N.L. Michel. 2019. The future of North American grassland birds: Incorporating persistent and emergent threats into full annual cycle conservation priorities. Conservation Science and Practice 1:e20 https://doi.org/10.1111/csp2.20

Howerter, D.W., M.G. Anderson, J.H. Devries, B.L. Joynt, L.M. Armstrong, R.B. Emery, and T.W. Arnold. 2014. Variation in mallard vital rates in Canada Aspen Parklands: The Prairie Habitat Joint Venture assessment. Wildlife Monographs 188.

Jarzyna, M.A., B. Zuckerberg, A.O. Finley, and W.F. Porter. 2016. Synergistic effects of climate and land cover: grassland birds are more vulnerable to climate change. Landscape Ecology 31: 2275–2290.

Johnson D.H., and J.W. Grier. 1988. Determinants of breeding distributions of ducks. Wildlife Monographs 100.

Knill, C., K. Schulze, and J. Tosun. 2011. Measuring environmental policy change: Conceptual alternatives and research implications. Political Science Series 125. Institute for Advanced Sciences https://irihs.ihs.ac.at/id/eprint/2092/1/pw_125.pdf

Kosciuch K., D. Riser-Espinoza, M. Gerringer, and W. Erickson. 2020. A summary of bird mortality at photovoltaic utility scale solar facilities in the Southwestern U.S. PLoS ONE 15(4):e0232034. https://doi.org/10.1371/journal.pone.0232034

Laranjeiro, T., R. May, and F. Verones. 2018. Impacts of onshore wind energy production on birds and bats: recommendations for future life cycle impact assessment developments. International Journal of Life Cycle Assessment 23:2007–2023. https://doi.org/10.1007/s11367-017-1434-4

Lehtinen R.M., S.M. Galatowitsch, and J.R. Tester. 1999. Consequences of habitat loss and fragmentation for wetland amphibian assemblages. Wetlands 19:1–12.

Lehtomäki, J., and A. Moilanen. 2013. Methods and workflow for spatial conservation prioritization using Zonation. Environmental Modelling & Software 47:128-37.

Leibel, C. 2018. Grassland Situational Analysis - Final Report. Prepared for the Prairie Habitat Joint Venture (PHJV) Policy Committee.

Manfredo, M.J., D.J Decker, and M.D. Duda. 1998. What is the future for human dimensions of wildlife? Transactions of the North American Wildlife and Natural Resources Conference 64:278–292.

McKellar, A.E., L.A. Nych, and M.T. Bidwell. 2019. Distribution and abundance of marsh-nesting colonial waterbirds in Prairie Canada. Wilson Journal of Ornithology 131:583-597.

McKellar, A.E., Y. Aubry, M.C. Drever, C.A. Friis, C.L. Gratto-Trevor, J. Paquet, C. Pekarik, and P.A. Smith. 2020. Potential Western Hemisphere Shorebird Reserve Network sites in Canada: 2020 update. Wader Study 127:102-112.

Niemuth N.D., J.W. Solberg, and T.L. Shaffer. 2008. Influence of moisture on density and distribution of grassland birds in North Dakota. Condor 110:211–22.

North American Bird Conservation Initiative. 2019. State of the Birds 2019. Cornell University. www.stateofthebirds.org/2019

North American Bird Conservation Initiative Canada. 2019. The State of Canada's Birds, 2019. Environment and Climate Change Canada, Ottawa, Canada. 12 pages. www.stateofcanadasbirds.org

North American Waterfowl Management Plan. 1986. North American Waterfowl Management Plan: a strategy for cooperation. U.S. Fish and Wildlife Service, Washington, D.C., USA, and Canadian Wildlife Service, Ottawa, ON, Canada.

North American Waterfowl Management Plan. 2012. North American Waterfowl Management Plan: People Conserving Waterfowl and Wetlands. http://nawmprevision.org/.

North American Waterfowl Management Plan. 2014. Revised Objectives: An addendum to the 2012 North American Waterfowl Management Plan. http://nawmprevision.org/.

Olimb, S.K., and B. Robinson. 2019. Grass to grain: Probabilistic modeling of agricultural conversion in the North American Great Plains. Ecological Indicators 102:237-245.

Organization for Economic Co-operation and Development (OECD). 2007. Assessing Environmental Policies. Policy Brief Series www.oecd.org/publications/Policybriefs.

Pattison-Williams, J.K. 2019. Grassland Economics: Conservation and Competing Interests in Prairie Canada. A research report produced for the Prairie Habitat Joint Venture by Pattison Resource Consulting Ltd., Alberta, Canada.

Peterjohn B.G., and J.R. Sauer. 1997. Population trends of black terns from the North American breeding bird survey, 1966–1996. Colonial Waterbirds 20:566–73.

Peterka J.J. 1989. Fishes in northern prairie wetlands. Pages 302-315 In: van der Valk A, editor. Northern prairie wetlands. Iowa State University Press, Ames, Iowa, USA.

Poston, B., D.M. Ealey, P.S. Taylor, and G.B. McKeating. 1990. Priority Migratory Bird Habitats of Canada's Prairie Provinces. Environment Canada, Canadian Wildlife Service, Edmonton, Alberta. 107pp.

Rashford, B.S., M.A. Amin and C.T. Bastian. 2013. Integrating economics and ecology to model land-use impacts on waterfowl habitat in Prairie Canada. Report to DU Canada, Institute for Wetland and Waterfowl Research. 42 pp.

Rashford, B.S., R.M. Adams, J. Wu, R.A. Voldseth, G.R. Guntenspergen, B. Werner, and W.C. Johnson. 2016. Impacts of climate change on land-use and wetland productivity in the Prairie Pothole Region of North America. Regional Environmental Change 16:515-526.

Rosenberg, K.V., A.M. Dokter, P.J. Blancher, J.R. Sauer, A.C. Smith, P.A. Smith, J.C. Stanton, A. Panjabi, L. Helft, M. Parr, and P.P. Marra. 2019. Decline of the North American avifauna. Science 366:120–124 (2019).

Sexton, N., K. Leong, B. Milley, M. Clarke, T. Teel, M. Chase, and A. Dietsch. 2013. The State of Human Dimensions Capacity for Natural Resource Management: Needs, Knowledge, and Resources. The George Wright Forum, 30:142-153. http://www.jstor.org/stable/43598996

Skone, B.R., J.J. Rotella, and J. Walker. 2015. Waterfowl production from winter wheat fields in North and South Dakota. Journal of Wildlife Management 80:127–137.

Sólymos, P., S.M. Matsuoka, E.M. Bayne, S.R. Lele, P. Fontaine, S.G. Cumming, D. Stralberg, F.K.A. Schmiegelow, S.J. Song, and R.B. O'Hara. 2013. Calibrating indices of avian density from non-standardized survey data: making the most of a messy situation. Methods in Ecology and Evolution 4:1047-58.

Somershoe, S. G. (editor). 2018. A Full Annual-Cycle Conservation Strategy for Sprague's Pipit, Chestnut-collared and McCown's Longspurs, and Baird's Sparrow. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., USA

Stanton, R.L., C.A. Morrissey, and R.G. Clark. 2018. Analysis of trends and agricultural drivers of farmland bird declines in North America: A review. Agriculture, Ecosystems and Environment 254:244-254.

Statistics Canada. 2016. 2016 Census of Agriculture. Ottawa, Canada.

Stephens, S. E., J. J. Rotella, M. S. Lindberg, M. L. Taper, and J. K. Ringelman. 2005. Duck nest survival in the Missouri Coteau of North Dakota: landscape effects at multiple spatial scales. Ecological Applications 15:2137–2149.

Stewart, R. E., and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. U.S. Fish and Wildlife Service, Resource Publication 92.

Watmough, M. D., and M. J. Schmoll. 2007. Environment Canada's Prairie & Northern Habitat Monitoring Program Phase II: Recent habitat trends in the PHJV. Technical Report Series 493. Environment Canada, Canadian Wildlife Service, Edmonton, AB, Canada.

Watmough, M.D., Z. Li, and E.M. Beck. 2017. Prairie Habitat Monitoring Program Canadian Prairie Wetland and Upland Status and Trends 2001–2011 in the Prairie Habitat Joint Venture Delivery Area. Canadian Wildlife Service, Edmonton, Alberta, Canada.

Wrubleski, D.A., and L.C.M. Ross. 2011. Aquatic invertebrates of prairie wetlands: community composition, ecological roles, and impacts of agriculture. Pages 91-116 In: K.D. Floate, editor. Arthropods of Canadian grasslands, vol. 2. Biological Survey of Canada, Ottawa, Canada.

Zhao, Q., T.W. Arnold, J.H. Devries, D.W. Howerter, R.G. Clark, and M.D. Weegman. 2019. Land use change increases climatic vulnerability of migratory birds: insights from integrated population modelling. Journal of Animal Ecology 88:1625–1637.

Zimpher N.L., W.E. Rhodes, E.D. Silverman, G.S. Zimmerman, and K.D. Richkus. 2011. Trends in duck breeding populations, 1955–2011. U.S. Fish & Wildlife Service, Division of Migratory Bird Management, Laurel MD, USA.

Zuckerberg, B., C.A. Ribic, and L.A. McCauley. 2018. Effects of temperature and precipitation on grassland bird nesting success as mediated by patch size. Conservation Biology 32:872-882. https://doi.org/10.1111/cobi.13089

11.0 APPENDICES & ANNEXES

APPENDIX 1: PHJV Conservation Program Delivery Initiatives - Definitions

APPENDIX 2: Summary of Waterfowl Population Trends – Provincial Summaries

APPENDIX 3: Priority Non-game Bird Species – Status and Trends

APPENDIX 4: PHJV Habitat Achievements 2013-2020 – Provincial Summaries

APPENDIX 5: Waterfowl Conservation Planning Models Used in Habitat Objective Setting

APPENDIX 6: Priority Non-game Conservation Planning Models Used in Habitat Objective Setting

APPENDIX 7: Mean Relative Priority Values of Waterfowl Target Landscapes for Each Non-game Bird Group

APPENDIX 8: Habitat Objectives by Waterfowl Target Landscape - Provincial Detail (Waterfowl and Landbirds)

ANNEX A: A Review of PHJV Policy Achievements 2013–2020 and Policy Objectives, 2021–2025

APPENDIX 1: CONSERVATION PROGRAM DELIVERY INITIATIVES (DEFINITIONS):

Successful delivery on Prairie Habit Joint Venture (PHJV) objectives can only be achieved through its large and diverse partnership.

For more information on the partnership aspect of PHJV delivery, please see phjv.ca – PHJV Partners, Committees and Board.

PHJV program delivery initiatives align with all Canadian North American Waterfowl Management Plan (NAWMP) Habitat Joint Ventures, and have been cross-walked with North American Wetlands Conservation Act (NAWCA) definitions.

The PHJV will advance its IP 2021–2025 objectives through a broad mix of conservation initiatives described below. Delivery will take place in PHJV Target Landscapes, plus a small portion in remaining delivery areas.

Retention – Permanent and Medium Term (10–99 years)

The delivery of direct habitat programs involves personal contact with landowners to conserve high-quality, at-risk, wetland and upland (grassland) habitats. Wetland and Upland Retention include both Permanent (e.g., fee simple, conservation easement, land donation, Crown land designation or transfer); and Medium Term 10–99 years (e.g., agreements, cooperative land use agreements).

Retention – Short Term (<10 years) and Stewardship Activities

Short Term Retention supports stewardship activities which are intended to create long-term opportunities to secure habitat, such as small wetland restoration, in conjunction with cropland conversion to perennial cover. Retention under stewardship is through agreements of less than 10 years duration.

Stewardship programs are intended to motivate voluntary adoption or maintenance of preferred land use practices through the provision of information. Greater emphasis on the exchange of technical information could produce behavioral changes that would promote adoption of favourable land management practices. Because stewardship is often targeted toward a broad audience (e.g., agricultural community) over large areas, it has the potential to affect large acreages in comparison with direct-program activities which tend to target smaller areas.

Stewardship programs support forage conversion (upland restoration), winter cereals adoption (upland restoration) and biodiversity initiatives (wetland and upland retention). Stewardship programs are delivered throughout the Prairie Parklands but, whenever possible, are focused within the PHJV's Target Landscapes.

Extension programs support wetland and upland retention. Information is provided to individual land managers to reduce the risk of loss of wetlands and/or uplands. Activities involved in this program generally result in <5 year agreements or no signed agreements.

Restoration – Wetlands

Following Retention, wetland restoration activities are carried out to return historic hydrological and ecological functions to drained wetland basins. The primary targets are small, temporary or seasonal wetlands (range from 0.5 to 1.0 acre, average of 0.75 acres), which are the same types that have endured the greatest losses primarily through agricultural development. Wetland restoration normally involves minor earthfill construction applying "ditch plugs" to outlets of drained basins. Wetland restoration focuses on Target Landscapes with adequate upland nesting cover to maximize their potential to increase duck productivity and co-benefits for other migratory birds. Other benefits may include carbon sequestration, nutrient capture and native pollinator habitat.

Wetland restoration also includes installation of Nesting Tunnels – artificial structures as nesting habitat for breeding waterfowl, mainly mallards.

Restoration – Uplands

Following Retention, upland restoration includes cropland conversion to perennial nesting cover (hayland, pasture, planted nesting cover). Most cropland conversion is to pasture or hayland with unrestricted agricultural use, but may involve deferring haying or grazing until after the nesting season. This deferred haying or grazing is achieved through prescribed actions or agronomic drivers. Also included is planted nesting cover, which is intensively managed as waterfowl nesting cover on small areas of the highest quality, permanently secured lands. Periodic management maintains cover quality (e.g., haying, grazing, burning). When winter wheat is promoted directly with a landowner, it is also considered an upland restoration direct program. In this case, the conversion is to a more environmentally-friendly annual cropping practice that restores much of the upland nesting cover function for species like the Northern Pintail.

- Winter Wheat: Fall seeded, annual crop provides nesting cover for breeding waterfowl and other bird species.
- Tame Pasture and Tame Hay: Perennial tame (or native) grasses seeded in annual cropland

and used as forage for cattle through grazing (pasture) / upon mechanical harvest (hay), and also provide nesting cover for breeding waterfowl and other bird species.
- Planted Cover: Perennial tame (or native) grasses seeded in annual cropland and reserved exclusively as nesting cover for breeding waterfowl and other bird species (i.e., not used for agricultural purposes except for period management to maintain stand health.

Management (Habitat Assets)

The PHJV manages and monitors millions of wetland and upland habitat acres. The PHJV's operating paradigm is to balance between minimizing management costs, while achieving habitat function and meeting other standards. Wetland management involves a wide range of management intensity and frequency on wetlands of varying sizes. Water level manipulation (e.g., stop log removal and placement, pump operation) is conducted on some projects. Major repairs and rebuilds to wetland projects are included in management actions and are the responsibility of the respective PHJV partner. Similarly, upland management involves a range of cover types (e.g., native grasslands, tame grasses), and management intensity and frequency. Some projects are managed more frequently but at a low intensity to maintain a healthy equilibrium most beneficial to nesting species. Activities range from regular compliance monitoring to periodic, intensive management due to deficiencies in cover quality, or need for weed control, fencing and signage repair. Payment of land taxes on purchased lands is also a management cost.

Science

PHJV Science includes:

- Habitat Program Evaluation for example the PHJV Assessment project, Spatial and Temporal Variation in Nesting Success (SpATS), and winter wheat evaluation;
- Physical Science including water quality, carbon sequestration, climate ensemble models, etc.;
- Habitat/Landscape Inventory, such as Canadian Wetland Inventory;
- Waterfowl/Wildlife Science including Northern Pintail nesting, shorebird nesting, marshbird monitoring, etc.;
- Economic Science to understand economic values of wetlands and associated habitats; and
- Social Science which includes human dimension-studies.

For more information on PHJV Science, go to phjv.ca – Prairie Parklands Science and Planning.

The PHJV Human Dimensions Committee is leading social science initiatives. For more information, go to phjv.ca

Land and Water Policy

Land and Water Policy initiatives include:

- Agriculture Policy – to influence the development and implementation of agricultural programs;
- Wetland Policy – working with government to increase levels of protection on wetlands;
- Integrated Land Use Planning – to protect habitat within development plans on private and public lands, for example through Integrated Watershed Management; and
- Government and Industry Relations – to build relationships with key stakeholders in government and industry.

In addition to partner-based initiatives, the PHJV Policy Committee provides leadership, coordination, information sharing and support for broad PHJV policy initiatives. For more information, go to phjv.ca – Policy.

Communications and Education

Communication and Education includes promotion of wetland and upland values, primarily to the general public through PHJV partner-based programs. In addition, the PHJV Communications Committee provides leadership on communications activities on behalf of the PHJV. The committee's membership represents all PHJV partner agencies, and activities are described in the PHJV Communications Plan and approved by the PHJV Advisory Board. Activities are coordinated with provincial PHJV communications actions.

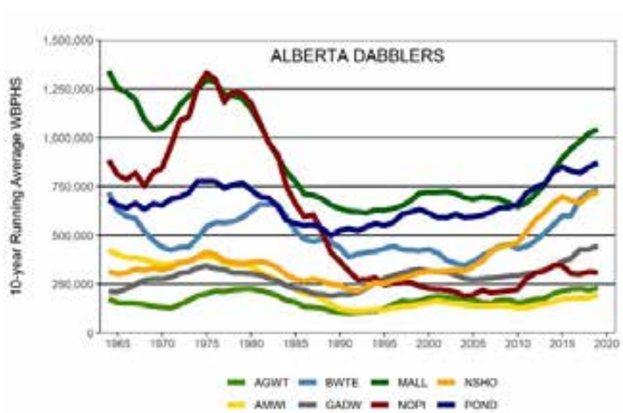
Conservation Planning

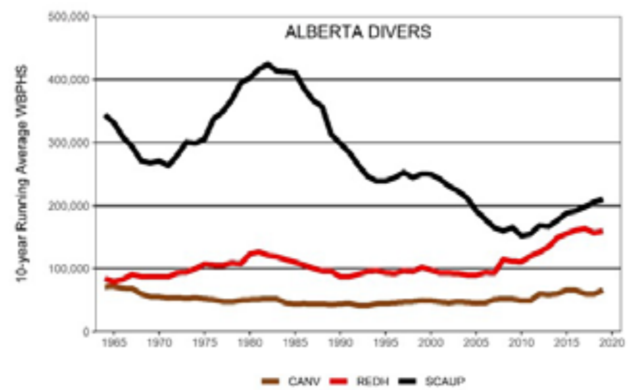
Conservation Planning includes both Planning Tools and Program Coordination:

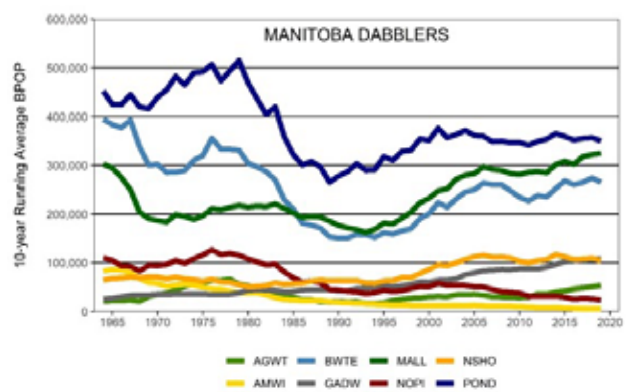
- Planning Tools include the PHJV's foundational tools, such as the Waterfowl Productivity Model, Decision Support System, and Economic Efficiency Models.
- Program Coordination supports the administration and organization of PHJV partner-based programs. It ensures the continuity, consistency and momentum among PHJV partnership agency representatives, and maximizes opportunities to integrate resources. Also, it supports administration and organization of PHJV partner-based habitat programs, organizational structures, meetings, conferences, field trips and other activities. A significant portion of coordination costs stem from allocating a portion of PHJV delivery partner head office indirect costs to this activity based on a formula defined by NAWCA.

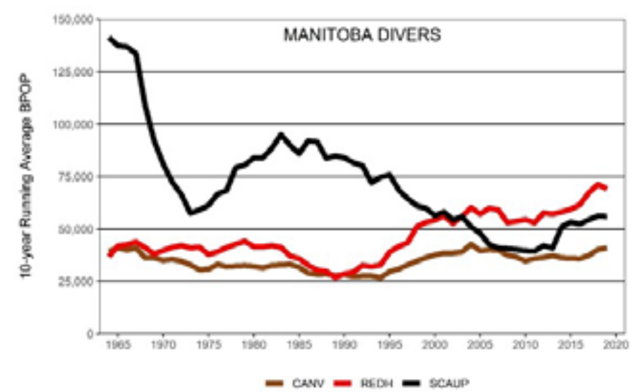
APPENDIX 2.
TRENDS IN 10-YEAR RUNNING AVERAGE POPULATIONS OF DUCKS FROM THE PRAIRIE PORTION OF THE PRAIRIE HABITAT AND JOINT VENTURE AREA 1955–2019.

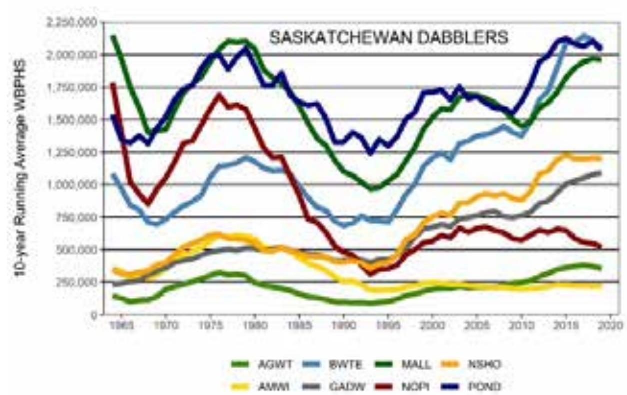
Averages of the seven most common dabbling duck species and ponds (top) and three most common diving duck species (bottom) for each prairie province are derived from the annual Waterfowl Breeding Population and Habitat Survey. AGWT – American Green-winged Teal, AMWI – American Wigeon, BWTE – Blue-winged Teal, GADW – Gadwall, MALL – Mallard, NOPI – Northern Pintail, NSHO – Northern Shoveler, CANV – Canvasback, REDH – Redhead, SCAUP – mostly Lesser Scaup.

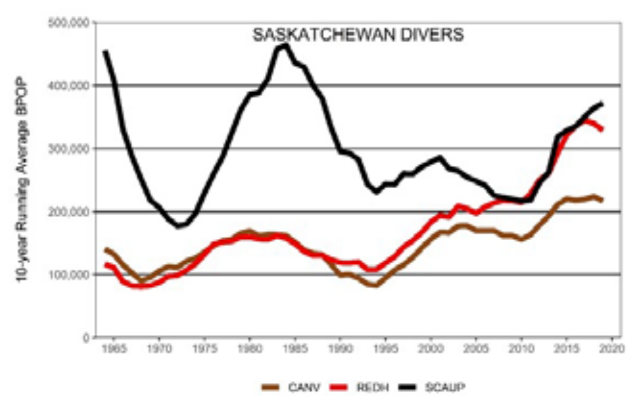












APPENDIX 3:
PRAIRIE HABITAT JOINT VENTURE PRIORITY SHOREBIRD, WATERBIRD AND LANDBIRD SPECIES, ALONG WITH ANNUAL TRENDS AND GENERAL DESCRIPTIONS OF BREEDING HABITAT.

Annual trends for breeding species (% change per year with 95% credible intervals in parentheses) are based on Breeding Bird Survey data from 2008 to 2018 (short-term; ST) and 1970 to 2018 (long-term; LT) for the Canadian portion of BCR 11 (Smith A.C. et al. unpublished, an update of Environment Canada 2017). The reliability of the trend (H = High, M = Medium, L = Low) is also provided, which takes into account three measures of reliability: precision, geographic coverage and local data weight. For species that do not breed in BCR 11 (i.e., migratory shorebirds), long-term (1974 to 2016) continental trends based on migration monitoring data from the International Shorebird Survey (ISS) are shown (P.A. Smith and A.C. Smith, unpubl. data). Species are broadly categorized into three habitat groupings based on their habitat preferences (see below), and are listed in taxonomic order within these groupings. Bird groups include shorebirds (S), waterbirds (W) and landbirds (L). Species with a superscript are listed as Species at Risk in Canada. Provincial-level conservation concern scores are not shown, but can be accessed at https://www.wildspecies.ca/.

SPECIES	BIRD GROUP	BCR11-CANADA ST TREND	BCR11-CANADA LT TREND	CONTINENTAL ISS LT TREND	GENERAL HABITAT DESCRIPTION
PIED-BILLED GREBE (PODILYMBUS PODICEPS)	W	5.12 (0.45, 10.73) L	1.55 (0.03, 3.06) H	-	Perennial ponds or temporarily flooded marshland
HORNED GREBES (PODICEPS AURITUS)	W	-0.18 (-4.98, 4.65) L	-1.69 (-3.04, -0.33) H	-	Perennial ponds and small wetlands with emergent vegetation
EARED GREBE (PODICEPS NIGRICOLLIS)	W	6.11 (0.45, 13.22) L	3.42 (1.5, 5.74) M	-	Perennial ponds or temporarily flooded marshland, colonial breeder
WESTERN GREBES (AECHMOPHORUS OCCIDENTALIS)	W	3.81 (-9.06, 20.52) L	-	-	Large lakes and wetlands with emergent vegetation along periphery, colonial breeder
YELLOW RAILS (COTURNICOPS NOVEBORACENSIS)	W	-2.69 (-14.94, 3.99) L	0.47 (-2.15, 4.38) L	-	Shallow sedge marshes
VIRGINIA RAIL (RALLUS LIMICOLA)	W	4.64 (-2.94, 13.84) L	2.08 (-0.73, 5.55) L	-	Marshes and small wetlands with emergent vegetation and other vertical structure
SORA (PORZANA CAROLINA)	W	1.72 (-0.99, 4.99) M	0.6 (-0.32, 1.56) H	-	Small to moderate sized wetlands with emergent vegetation
AMERICAN COOT (FULICA AMERICANA)	W	10.22 (3.85, 16.27) L	2.19 (0.36, 3.94) M	-	Marshes and small wetlands with emergent vegetation
AMERICAN AVOCET (RECURVIROSTRA AMERICANA)	S	6.12 (1.14, 11.85)	2.32 (0.61, 4.08) H	-	Shallow prairie wetlands, often with gradual sloping and open shorelines
PIPING PLOVERE (CHARADRIUS MELODUS)	S	-	-	-	Pebbly or sandy shores of large prairie lakes; often alkali wetlands
WILSON'S SNIPE (GALLINAGO DELICATA)	S	6.47 (3.75, 9.46) M	3.99 (3.19, 4.88) H	-	Wet pasture or marshy wetland edge in open or forested habitats

SPECIES	BIRD GROUP	BCR11-CANADA ST TREND	BCR11-CANADA LT TREND	CONTINENTAL ISS LT TREND	GENERAL HABITAT DESCRIPTION
SPOTTED SANDPIPER (ACTITIS MACULARIUS)	S	5.69 (2.81, 9.03) M	2.29 (1.14, 3.44) H	-	Wetland or riparian edge mixed with drier habitat for nesting; also along shorelines of rivers
WILSON'S PHALAROPE (PHALAROPUS TRICOLOR)	S	5.97 (1.21, 11.86) L	1.4 (-0.26, 2.97) H	-	Wet prairie meadows and wetland edge
FRANKLIN'S GULL (LEUCOPHAEUS PIPIXCAN)	W	11.37 (1, 19.99) L	-0.31 (-2.74, 2.07) M	-	Large prairie marshes amidst agricultural fields and grasslands; colonial breeder
BLACK TERN (CHLIDONIAS NIGER)	W	-0.34 (-5.03, 5.6) L	-2.2 (-3.56, -0.5) H	-	Wetlands with emergent vegetation, within high-density wetland complexes; semi-colonial breeder
FORSTER'S TERN (STERNA FORSTERI)	W	-4.75 (-19.37, 11.73) L	1.66 (-4.18, 8.43) L	-	Prairie ponds and lakes with extensive marshy vegetation along periphery; colonial breeder
LEAST BITTERNT (IXOBRYCHUS EXILIS)	W	-	-	-	Freshwater and brackish marshes with tall aquatic vegetation, especially interspersed with patches of open water and small stands of woody vegetation
SEDGE WREN (CISTOTHORUS PLATENSIS)	L	2.26 (-2.82, 7.21) M	3.12 (1.43, 4.88) H	-	Ephemeral sedge marshes or wet open pasture with some vertical nesting structure
MARSH WREN	L	7.37 (3.41, 11.52) M	4.29 (2.38, 5.94) M	-	Wetlands with emergent vegetation such as bulrush and cattail
LECONTE'S SPARROW (AMMOSPIZA LECONTEII)	L	-4.67 (-9.12, -0.43) L	-0.64 (-1.84, 0.65) H	-	Tall, wet grasslands and marshes
NELSON'S SPARROW (AMMOSPIZA NELSONI)	L	-2.38 (-7.01, 2.88) L	2.14 (0.53, 4.02) H	-	Wet meadows, marshes and wetland edge
COMMON YELLOWTHROAT (GEOTHLYPIS TRICHAS)	L	3.09 (1.52, 4.66) H	1.34 (0.81, 1.97) H	-	Ephemeral sedge marshes or other wetlands with vertical nesting structure
BLACK-BILLED CUCKOO (COCCYZUS ERYTHROPTHALMUS)	L	0.66 (-3.72, 5.93) L	-1.4 (-2.75, 0.04) H	-	Deciduous groves and thickets often associated with water
KILLDEER (CHARADRIUS VOCIFERUS)	S	-0.31 (-1.73, 1.24) H	-0.84 (-1.28, -0.41) H	-	Open habitats with short vegetation in native, urban and agricultural areas, often near water
LONG-BILLED CURLEWS (NUMENIUS AMERICANUS)	S	-6.86 (-9.66, -3.75) M	-1.57 (-2.74, -0.24) H	-	Open, short grasslands with moderate density of wetlands for foraging
MARBLED GODWIT (LIMOSA FEDOA)	S	-7 (-8.78, -4.95) M	-2.03 (-2.75, -1.28) H	-	Expanses of upland grass with a mix of wetlands
WILLET (TRINGA SEMIPALMATA)	S	-0.48 (-2.36, 1.46) H	-0.77 (-1.38, -0.13) H	-	Shallow wetlands mixed with sparse upland habitats

SPECIES	BIRD GROUP	BCR11-CANADA ST TREND	BCR11-CANADA LT TREND	CONTINENTAL ISS LT TREND	GENERAL HABITAT DESCRIPTION
NORTHERN HARRIER (CIRCUS HUDSONIUS)	L	-2.42 (-4.64, 0.11) H	-1.99 (-2.67, -1.2) H	-	Upland grasslands, marshy meadows and wetland edge
GREATER SAGE-GROUSEE (CENTROCERCUS UROPHASIANUS)	L	-	-	-	Sagebrush shrublands
SHARP-TAILED GROUSE (TYMPANUCHUS PHASIANELLUS)	L	6.4 (1.76, 11.44) L	0.67 (-0.88, 2.24) H	-	Grasslands of short to medium height mixed with shrubs; emergent wetland vegetation important in winter for this year-round resident
COMMON NIGHTHAWKT (CHORDEILES MINOR)	L	8.84 (3.58, 14.77) L	2.03 (0.35, 3.78) H	-	Open habitats, sometimes with variable levels of forest cover
UPLAND SANDPIPER (BARTRAMIA LONGICAUDA)	S	4.44 (1.42, 7.37) H	2.69 (1.58, 3.87) H	-	Grasslands of short to medium height
SWAINSON'S HAWK (BUTEO SWAINSONI)	L	1.97 (0.01, 4.04) H	0.91 (0.19, 1.67) H	-	Open grass or sparse shrublands with occasional trees
FERRUGINOUS HAWKT (BUTEO REGALIS)	L	0.38 (-3, 3.82) M	2.05 (0.48, 3.63) H		Open grassland with occasional trees for nesting; highly depending on native grassland
BURROWING OWLE (ATHENE CUNICULARIA)	L	-	-	-	Open, short grasslands
SHORT-EARED OWLS (ASIO FLAMMEUS)	L	-1.92 (-6.8, 3.35) L	-2.24 (-3.99, -0.64) H	-	Open country consisting of grasslands and marshes
NORTHERN FLICKER (COLAPTES AURATUS)	L	-	-	-	Forest edge and open woodlands
PRAIRIE FALCON (FALCO MEXICANUS)	L	-0.59 (-5.6, 4.09) L	1.43 (-0.44, 3.48) M	-	Open grasslands with cliff sites for nesting
LOGGERHEAD SHRIKET (LANIUS LUDOVICIANUS)	L	0.38 (-3.1, 3.84) M	-2.96 (-4.09, -1.83) H	-	Open grasslands with patches of shrubs or small trees
BLACK-BILLED MAGPIE (PICA HUDSONIA)	L	-0.23 (-1.75, 1.31) H	-0.58 (-1.11, -0.08) H	-	Open or shrubby areas with deciduous groves and riparian woodland
HORNED LARK (EREMOPHILA ALPESTRIS)	L	-8.65 (-10.05, -7.29) H	-4.31 (-4.81, -3.86) H	-	Open, sparsely vegetated grasslands and cultivated areas
BROWN THRASHER (TOXOSTOMA RUFUM)	L	-0.4 (-2.65, 2.03) H	-0.76 (-1.44, -0.07) H	-	Dense, shrubby habitats within a landscape ranging from open to deciduous woodlands
SPRAGUE'S PIPITT (ANTHUS SPRAGUEII)	L	-6.11 (-9.94, -2.48) L	-4.17 (-5.38, -3.11) H	-	Mixed-grass and fescue prairie
CHESTNUT-COLLARED LONGSPURT (CALCARIUS ORNATUS)	L	-10.03 (-14.31, -5.91) M	-4.77 (-6.03, -3.56) H	-	Open, short grasslands; highly dependent on native grassland

SPECIES	BIRD GROUP	BCR11-CANADA ST TREND	BCR11-CANADA LT TREND	CONTINENTAL ISS LT TREND	GENERAL HABITAT DESCRIPTION
THICK-BILLED LONGSPURT (RHYNCHOPHANES MCCOWNII)	L	-7.24 (-14.44, 1.16) L	-7.16 (-9.68, -4.02) H	-	Sparse and arid shortgrass prairie with minimal vegetation cover
CLAY-COLORED SPARROW (SPIZELLA PALLIDA)	L	-0.5 (-1.48, 0.54) H	-0.47 (-0.79, -0.13) H	-	Shrubby or early successional habitats amidst open grasslands or agricultural areas
LARK BUNTINGT (CALAMOSPIZA MELANOCORYS)	L	-1.11 (-12.55, 11.68) L	-5.31 (-8.98, -1.7) L	-	Shortgrass prairie and sagebrush shrublands
GRASSHOPPER SPARROW (AMMODRAMUS SAVANNARUM)	L	6.09 (1.38, 11.5) M	1.15 (-0.6, 2.82) H	-	Short to medium tall grasslands
BAIRD'S SPARROWS (CENTRONYX BAIRDII)	L	1.15 (-3.04, 5.56) L	-1.38 (-2.96, 0.3) H	-	Mixed-grass and fescue prairie
BOBOLINKT (DOLICHONYX ORYZIVORUS)	L	2.36 (-0.4, 5.28) H	0.95 (0.02, 1.86) H	-	Medium to tall grasslands, moist meadows with dense vegetation, or emergent vegetation in dry wetland basins
WESTERN MEADOWLARK (STURNELLA NEGLECTA)	L	1.31 (0.45, 2.17) H	-1.33 (-1.66, -0.99) H	-	Grasslands and agricultural areas with taller cover
WHOOPING CRANEE (GRUS AMERICANA)	W	-	-	-	Often forages in cropland during stopover, alternating with shallow lakes and marshy wetlands for roosting
BLACK-BELLIED PLOVER (PLUVIALIS SQUATAROLA)	S	-	-	-1.6 (-3.7, 0.7)	Edges of prairie lakes, marshes and flooded fields
AMERICAN GOLDEN-PLOVER (PLUVIALIS DOMINICA)	S	-	-	-1.9 (-4, 0.9)	Upland sites with short vegetation and wetland edge (e.g., shores)
HUDSONIAN GODWIT (LIMOSA HAEMASTICA)	S	-	-	-3.4 (-10.9, 5.8)	Edges of prairie lakes, marshes and flooded fields
RUDDY TURNSTONE (ARENARIA INTERPRES)	S	-	-	-4.7 (-8.2, -1.2)	Shorelines of large lakes
RED KNOTE (CALIDRIS CANUTUS)	S	-	-	-5.7 (-10.2, -0.6)	Edges of prairie lakes, marshes and flooded fields
STILT SANDPIPER (CALIDRIS HIMANTOPUS)	S	-	-	-1.5 (-5, 2.8)	Ponds, marshes and flooded fields
SANDERLING (CALIDRIS ALBA)	S	-	-	-3.3 (-4.7, -1.7)	Edges of alkaline, saline and freshwater lakes
BUFF-BREASTED SANDPIPERS (CALIDRIS SUBRUFICOLLIS)	S	-	-	-	Short grasslands and marshes or wetland edge

SPECIES	BIRD GROUP	BCR11-CANADA ST TREND	BCR11-CANADA LT TREND	CONTINENTAL ISS LT TREND	GENERAL HABITAT DESCRIPTION
SEMIPALMATED SANDPIPER (CALIDRIS PUSILLA)	S	-	-	-3.1 (-6.9, 1.6)	Edges of prairie ponds and lakes
SHORT-BILLED DOWITCHER (LIMNODROMUS GRISEUS)	S	-	-	-2.9 (-8.4, 3.4)	Shallow wetlands, mudflats and flooded fields
LONG-BILLED DOWITCHER (LIMNODROMUS SCOLOPACEUS)	S	-	-	-0.3 (-5.5, 5.2)	Shallow wetlands, mudflats and flooded fields
RED-NECKED PHALAROPES (PHALAROPUS LOBATUS)	S	-	-		Large lakes and wetlands

S Special Concern
T Threatened
E Endangered

APPENDIX 4:
PHJV HABITAT ACHIEVEMENTS 2013–2020 PROVINCIAL SUMMARIES

ALBERTA

	YEAR 2030 HABITAT OBJECTIVE ACRES	EIGHT-YEAR ACHIEVEMENTS (ACRES)	EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE		
Habitat Restoration		DIRECT NAWMP	EXTENSION NAWMP	TOTAL			
TAME PASTURE							
TARGET LANDSCAPES	291,000	18,255	2,439	20,694	116,400	18%	7%
REMAINING DELIVERY AREA	150,000	7,429	7,418	14,847	60,000	25%	10%
SUB-TOTAL	**441,000**	**25,684**	**9,857**	**35,541**	**176,400**	**20%**	**8%**
TAME HAY							
TARGET LANDSCAPES	575,000	15,892	2,841	18,733	230,000	8%	3%
REMAINING DELIVERY AREA	150,000	18,102	2,751	20,852	60,000	35%	14%
SUB-TOTAL	725,000	33,994	5,591	39,585	290,000	14%	5%
PLANTED COVER							
TARGET LANDSCAPES	35,500	3,579	384	3,964	14,200	28%	11%
REMAINING DELIVERY AREA	-	1,028	545	1,573	-	-	-
SUB-TOTAL	**35,500**	**4,608**	**929**	**5,537**	**14,200**	**39%**	**16%**
WETLANDS							
TARGET LANDSCAPES	32,708	2,635	228	2,862	3,038	94%	9%
REMAINING DELIVERY AREA	33,000	290	46	336	-	-	1%
SUB-TOTAL	**65,708**	**2,925**	**274**	**3,198**	**3,038**	**105%**	**5%**
RESTORATION TOTAL	**1,267,208**	**67,210**	**16,652**	**83,861**	**483,638**	**17%**	**7%**

Habitat Retention

	YEAR 2030 HABITAT OBJECTIVE ACRES	EIGHT-YEAR ACHIEVEMENTS (ACRES)	EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE		
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL			
WETLANDS							
TARGET LANDSCAPES	97,875	7,809	278	8,087	43,500	19%	8%
REMAINING DELIVERY AREA	-	2,575	497	3,072	-	-	-
SUB-TOTAL	**97,875**	**10,384**	**775**	**11,159**	**43,500**	**26%**	**11%**
UPLAND							
TARGET LANDSCAPES	199,125	40,213	-	40,213	88,500	45%	20%
REMAINING DELIVERY AREA	-	59,487	-	59,487	-	-	-
SUB-TOTAL	**199,125**	**99,700**	**-**	**99,700**	**88,500**	**113%**	**50%**
RETENTION TOTAL	297,000	110,084	775	110,859	132,000	84%	37%
GRAND TOTAL	**1,564,208**	**177,294**	**17,426**	**194,720**	**615,638**	**32%**	**12%**

SASKATCHEWAN

Habitat Restoration

	YEAR 2030 HABITAT OBJECTIVE ACRES	EIGHT-YEAR ACHIEVEMENTS (ACRES)			EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL			
TAME PASTURE							
TARGET LANDSCAPES	606,373	63,925	16,520	80,445	242,549	33%	13%
REMAINING DELIVERY AREA	374,000	1,110	7,870	8,980	149,600	6%	2%
SUB-TOTAL	**980,373**	**65,035**	**24,390**	**89,425**	**392,149**	**23%**	**9%**
TAME HAY							
TARGET LANDSCAPES	71,551	23,250	134,206	157,456	68,622	229%	92%
REMAINING DELIVERY AREA	63,000	2,035	8,921	10,956	25,200	43%	17%
SUB-TOTAL	**234,551**	**25,285**	**143,127**	**168,412**	**93,822**	**180%**	**72%**
PLANTED COVER							
TARGET LANDSCAPES	15,196	20,157	148	20,305	6,079	334%	134%
REMAINING DELIVERY AREA	3,400	641	-	641	1,360	47%	19%
SUB-TOTAL	**18,596**	**20,798**	**148**	**20,946**	**7,439**	**282%**	**113%**
WETLANDS							
TARGET LANDSCAPES	6,353	2,085	-	2,085	2,541	82%	33%
REMAINING DELIVERY AREA	1,185	194	-	194	474	41%	16%
SUB-TOTAL	**7,538**	**2,279**	**-**	**2,279**	**3,015**	**76%**	**30%**
RESTORATION TOTAL	**1,241,058**	**150,293**	**179,491**	**329,784**	**496,425**	**66%**	**27%**

Habitat Retention	YEAR 2030 HABITAT OBJECTIVE ACRES	EIGHT-YEAR ACHIEVEMENTS (ACRES)	EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE		
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL			
WETLANDS							
TARGET LANDSCAPES	580,155	43,055	33,869	76,924	232,062	33%	13%
REMAINING DELIVERY AREA	348,092	2,508	17,199	19,707	139,237	14%	6%
SUB-TOTAL	**928,247**	**45,563**	**51,068**	**96,631**	**371,299**	**26%**	**10%**
UPLAND							
TARGET LANDSCAPES	318,159	74,440	72,957	147,397	127,264	116%	46%
REMAINING DELIVERY AREA	-	17,884	228,344	246,228	-	-	-
SUB-TOTAL	**318,159**	**92,324**	**301,301**	**393,625**	**127,264**	**309%**	**124%**
RETENTION TOTAL	**1,246,406**	**137,887**	**352,369**	**490,256**	**498,563**	**98%**	**39%**
GRAND TOTAL	**2,487,464**	**288,180**	**531,860**	**820,040**	**994,988**	**82%**	**33%**

MANITOBA

Habitat Restoration

	YEAR 2030 HABITAT OBJECTIVE ACRES	EIGHT-YEAR ACHIEVEMENTS (ACRES)			EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL			
TAME PASTURE							
TARGET LANDSCAPES	38,616	10,836	3,037	13,873	15,446	90%	36%
REMAINING DELIVERY AREA	16,749	4,471	18,563	23,034	6,700	344%	138%
SUB-TOTAL	**55,365**	**15,308**	**21,600**	**36,908**	**22,146**	**167%**	**67%**
TAME HAY							
TARGET LANDSCAPES	25,744	8,857	2,025	10,882	10,298	106%	42%
REMAINING DELIVERY AREA	11,166	5,599	12,375	17,974	4,466	402%	161%
SUB-TOTAL	**36,910**	**14,456**	**14,400**	**28,856**	**14,764**	**195%**	**78%**
PLANTED COVER							
TARGET LANDSCAPES	12,000	773	-	773	4,800	16%	6%
REMAINING DELIVERY AREA	-	517	-	517	-	0%	0%
SUB-TOTAL	**12,000**	**1,290**	**-**	**1,290**	**4,800**	**27%**	**11%**
WETLANDS							
TARGET LANDSCAPES	2,963	856	-	856	1,185	72%	29%
REMAINING DELIVERY AREA	1,655	615	-	615	662	93%	37%
SUB-TOTAL	**4,618**	**1,471**	**-**	**1,471**	**1,847**	**80%**	**32%**
NESTING TUNNELS (STRUCTURES)							
TARGET LANDSCAPES	3,400	2,349	-	2,349	1,360	173%	69%
REMAINING DELIVERY AREA	-	83	-	83	-	0%	0%
SUB-TOTAL	**3,400**	**2,432**	**-**	**2,432**	**1,360**	**179%**	**72%**
RESTORATION TOTAL	**112,293**	**34,957**	**36,000**	**70,957**	**44,917**	**158%**	**63%**

Habitat Retention

	YEAR 2030 HABITAT OBJECTIVE ACRES	EIGHT-YEAR ACHIEVEMENTS (ACRES)			EIGHT-YEAR HABITAT OBJECTIVE	% EIGHT-YEAR HABITAT OBJECTIVE	% YEAR 2030 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL			
WETLANDS							
TARGET LANDSCAPES	33,600	24,104	1,828	25,932	13,440	193%	77%
REMAINING DELIVERY AREA	136,000	41,947	2,601	44,548	54,400	82%	33%
SUB-TOTAL	**169,600**	**66,050**	**4,429**	**70,479**	**67,840**	**104%**	**42%**
UPLAND							
TARGET LANDSCAPES	77,000	32,931	5,202	38,133	30,800	124%	50%
REMAINING DELIVERY AREA	235,400	50,275	31,798	82,073	94,160	87%	35%
SUB-TOTAL	**312,400**	**83,206**	**37,000**	**120,206**	**124,960**	**96%**	**38%**
RETENTION TOTAL	**482,000**	**149,256**	**41,429**	**190,685**	**192,800**	**99%**	**40%**
GRAND TOTAL	**594,293**	**184,213**	**77,429**	**261,642**	**237,717**	**110%**	**44%**

APPENDIX 5: PHJV WATERFOWL CONSERVATION PLANNING MODELS USED IN HABITAT OBJECTIVE SETTING AND MEASURING CONSERVATION IMPACT

To achieve our long-term average population objectives, the PHJV has adopted a strategy to maintain overall duck productivity (estimated hatched nests) at long-term average levels. Thus, our planning benchmark requires the foundational ability to link duck populations and their productive capacity to habitat conditions that change in response to ongoing land use trends, as well as conservation activity. To do so, the PHJV has developed a series of biostatistical models which, in combination with spatially explicit historic and current land use information, allows us to estimate the impact of wetland and upland habitat changes on duck productivity. These models account for changes in population carrying capacity due to wetland loss over time, and the impact of local and regional upland habitat changes on reproductive success (i.e., nest survival).

Also, these models allow us to estimate the net impact of PHJV programs on waterfowl productivity by integrating the spatial interaction of land use and wetland changes, PHJV program delivery, and resident duck populations in a series of modeling steps (see Implementation Plan Section 4.0 Figure 7). This modeling approach incorporates spatial variation in habitat change (1961–2020), duck densities and species composition, associations between wetland area and duck breeding pairs, and species-specific differences in breeding effort, nest habitat selection and nesting success. Details on the models, their structure and use is provided below.

A. Modeling the Distribution of Priority Duck Species

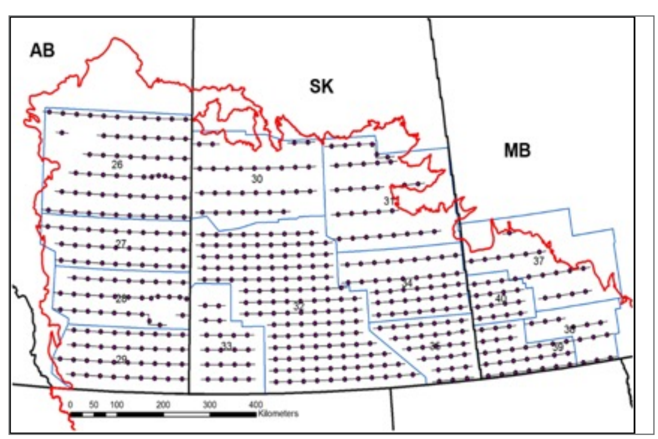
To estimate the spatial distribution of waterfowl breeding pair density across the PHJV, we related long-term waterfowl count data to multiple landscape-scale habitat covariates. We limited investigation to the time period 1961–2009 because visibility-corrected waterfowl counts (below) were available only from 1961 onward (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987). Thus, the model produces a long-term average representation of the spatial distribution and abundance of breeding duck pairs across the geography. Also, this layer has been used to define the Waterfowl Target Landscapes referenced throughout the PHJV Prairie Parklands Implementation Plan.

WATERFOWL COUNTS

We used waterfowl count data collected as part of the Waterfowl Breeding Population and Habitat Survey (WBPHS; Smith 1995) conducted annually in May along 546 systematically-located, permanent transect segments within 16 survey strata (strata 26–40, 75) covering much of the Canadian PPR (Figure A5-1). Transects are systematically spaced within strata, and each transect consisted of 2–11 survey segments, each ~29 km long and 0.4 km wide (11.6 km^2 in area).

Survey biologists record the numbers of all waterfowl seen from a fixed-wing aircraft flying ~160 km/h at 30–46 m AGL along survey transects. Species are counted as pairs (male and female in close association), lone males, grouped males <5, and groups (mixed-sex groupings in close association, and ≥ 5 males in a group). Concurrent with aerial waterfowl counts, biologists conduct complete ground surveys on a sub-sample of survey segments (~50) to establish visibility-correction factors, which are applied to aerial counts at the stratum level (hereafter, visibility-corrected counts). Survey segment-level count data used in this analysis were downloaded from the U.S. Fish and Wildlife Service (USFWS) Office of Migratory Bird Management online data portal (https://migbirdapps.fws.gov/). We restricted our analysis to the seven most common species of waterfowl occurring in prairie Canada; Mallard *(Anas platyrhynchos)*, Northern Pintail *(Anas acuta)*, Blue-winged Teal *(Spatula discors)*, Northern Shoveler *(Spatula clypeata)*, Gadwall *(Mareca strepera)*, Canvasback *(Aythya valisineria)*, and Redhead *(Aythya americana)*. We used the mean aggregate seven-species sum of indicated breeding duck pairs (i.e., visibility-corrected observed pairs + lone males + grouped males <5; Dzubin 1969a, Hammond 1969) as the response variable in the analysis. We used mean values under the rationale that conservation actions are focused on the long-term number of waterfowl exposed to the action rather than the number exposed in any given year.

FIGURE A5-1. Extent and location of 546 MBWPHS survey transect segments (centroid points) within survey Strata 26-35, 37-40 used to model waterfowl distribution within prairie Canada.



SPATIAL COVARIATES

We selected covariates that were available across the Prairie Parklands because our intent was to understand factors associated with the distribution of breeding waterfowl across the entire region, and also to extrapolate model estimates to the spatial extents of the Prairie Parklands. Covariates were generally extracted in ArcMap (ArcGIS; ESRI, Redlands, CA) from within, or associated with, the boundary of the surveyed area of each survey segment.

Because ducks are wetland obligate species, we included the best available data for the spatial distribution of wetland numbers (count) and area (ha) for the Prairie Parklands. Wetland count and area were derived from digital hydrography and saturated soils features in the CanVec database (Edition 1.2.2; Natural Resources Canada 2011). However, because CanVec hydrography fails to detect small wetland basins, we used overlapping CanVec and Canadian Wetland Inventory (CWI, incomplete coverage; Canadian Wetland Inventory Technical Committee 2016) high-resolution wetland inventories for 1,371 – 41.4 km^2 blocks, and constructed separate wetland area and count adjustment models (i.e., CWI/CanVec; Ducks Unlimited Canada [DUC] unpublished data). Overlapping blocks covered the extent of CWI coverage in Alberta, Saskatchewan and Manitoba circa 2011. Adjustment models included the effects of province, soil landscape variables (Canadian Soil Information System 2011; drainage, surface form, water holding capacity), and number and area of small CanVec basins (i.e., small = <0.5 ha) under the rationale that more basins are missed where CanVec detects more small wetland basins. The best-approximating adjustment models were then applied in ArcGIS to covariates extracted from approximately 14,000 - 41.4 km^2 blocks covering the Prairie Parklands within prairie Canada. An adjusted wetland area and count surface was created by multiplying raw CanVec wetland area and count by spatially coincident adjustment factors. Finally, estimated wetland area (WETHA) and count (WETCNT) were extracted from these adjusted wetland surfaces as the mean of pixel values within survey segment boundaries. Because large areas of open water provide relatively poor waterfowl pair habitat, we first removed open water areas greater than 100 m from shorelines on large wetland basins.

Additionally, we used a spatial dataset of Canada Land Inventory (CLI) Waterfowl Capability ratings for portions of Canada that classifies landscape units by degree of limitation to waterfowl production (Solman 1970, Environment Canada 1981). Classification was conducted by personnel of the Canadian Wildlife Service during the mid-late 1960s. Capability classes range from 1 (no significant limitation to waterfowl production) to 7 (extreme limitation to waterfowl production). This polygon-based map product was first converted to a 400 m resolution raster grid in ArcMap, and we used the focal mean CLI value within a survey segment boundary as a continuous covariate.

Because land cover may affect the suitability of landscapes for waterfowl (e.g., the availability of nesting cover), we included broad land cover composition within survey segments as explanatory variables. We extracted land cover covariates in ArcMap from Agriculture and Agri-food Canada's thematic map of the agricultural regions of Canada, circa 2000 (AAFC 2008). Specifically, we included the proportion of the survey segment in native grass, perennial crops (e.g., haylands), and pasture together as 'grassland'(PCTGRASS), coniferous, deciduous, and mixed trees together as 'trees'(PCTTREE), and annual croplands as 'cropland' (PCTCROP). Finally, to account for other regionally varying spatial factors that may affect waterfowl abundance, we included latitude (LAT) and longitude (LONG) of the survey segment centroid, province (PROV), and ecoregion (ECOR).

MODELING APPROACH AND ANALYSIS

We modeled average pair count as a function of covariates using negative binomial regression in SAS (SAS Institute; PROC GENMOD). The negative binomial model explicitly estimates a dispersion parameter to accommodate unaccounted spatial covariance and other possible sources of overdispersion (White and Bennetts 1996). We used counts from 546 segments with complete covariate data. We used a natural-log link function and correspondingly all compositional (AAFC land cover), count-based (WETCNT), and areal covariates (WETHA) were natural-log transformed, since we expected proportional changes in a predictor to yield similar effects on pair counts (i.e., the effect of doubling the number of wetlands is similar whether there are few or many wetlands). To facilitate calculation of the log transform when values were 0, a small constant (e.g., 0.01) was added to each variable prior to transformation. Based on preliminary single predictor Generalized Additive Models, quadratic covariate effects were included for all quantitative covariates (LAT, LONG, CLI, PCTGRASS, PCTTREE, PCTCROP, WETHA, WETCNT).

Given the observational nature of the data used in this analysis, we used information-theoretic techniques to select among competing models fit to the data (Johnson and Omland 2004). We began with a full model containing main effects and plausible interactions between linear forms of covariates. We simplified models by sequentially removing the least-predictive covariate (i.e., the smallest likelihood ratio statistic). Interaction terms and quadratics were always removed before associated main effects. We used Akaike's Information Criterion (AIC) adjusted for small samples (AICc, Burnham and Anderson 2002) to assess model fit. The model with the lowest AICc was identified as the best-approximating model. As this model was being developed as a predictive tool, we only considered the best-approximating model for estimating pair densities. Examination of the model revealed spatially-clustered underprediction in Stratum 40 (Southwest MB). As a remedial measure, LONG was subsequently excluded from the best model. The final model used for prediction of pair density included effects of LAT, LAT^2, CLI, CLI^2, PCTGRASS, PCTGRASS^2, PCTCROP, PCTTREE, PCTTREE^2, WETHA< and WETCNT.

As a goodness-of-fit measure, we calculated the Spearman correlation between the observed and predicted data for the best-approximating model. As a validation procedure, we adjusted the measures of goodness-of-fit for optimism (Harrell, Jr., 2001). Typical measures of goodness-of-fit are thought to be optimistic, since the same data are used to both develop and assess the model. This model validation procedure entails re-estimating model parameters and estimates of model fit from bootstrap re-samples of the data (see Harrell, Jr., 2001 for more details), and estimating the amount of inflation (or optimism) present in the estimates of goodness-of-fit. The average optimisms are then subtracted from the measures of goodness-of-fit estimated from the original data.

MAPPING BREEDING DUCK DENSITY

To create the waterfowl pair distribution surface (pair density; Figure A5-2), we applied the best-approximating model using Raster Calculator in ArcMap's Spatial Analyst. Specifically, covariate values were extracted from respective GIS layers within an 11.6 km^2neighborhood (equal to the surveyed segment area), input into the model equation, and estimated pair population assigned to a reference 400 m x 400 m pixel. Model fit as measured by Spearman's correlation (Rho adjusted for optimism) between observed and predicted counts was 0.82.

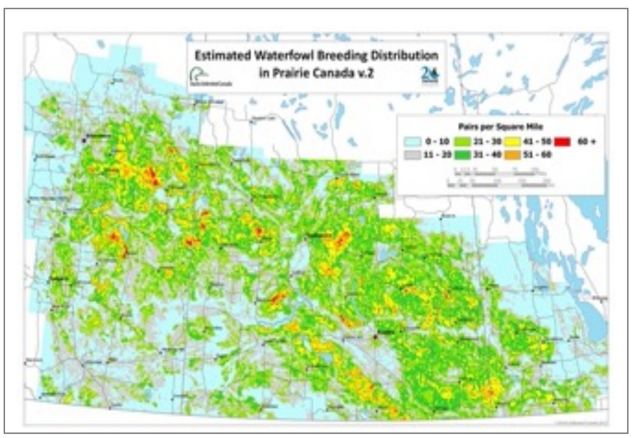


FIGURE A5-2. Estimated long-term average breeding pair density of the seven most common waterfowl species in prairie Canada.

B. Modeling the Impact of Wetland Loss on Prairie Breeding Duck Populations

We used wetland loss data provided from the PHJV Habitat Monitoring Program (Watmough and Scmoll 2007, Watmough et al. 2017) to estimate lost waterfowl carrying capacity as a function of the area and size class distribution of lost wetlands. First, we used province/ecoregion specific models developed by Bartzen et al. (2017; and unpublished data) to estimate the number of duck species pairs on each wetland basin in a large dataset of wetland inventory basins from the Prairie Parklands (Canadian Wetland Inventory;

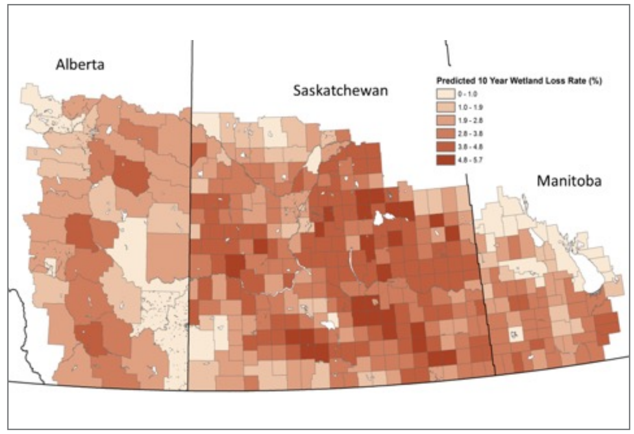


FIGURE A5-3. Estimated municipality-specific 10-year wetland loss rates. Loss rates were estimated as a function of the amount of cropland in the surrounding landscape.

https://www.ducks.ca/initiatives/canadian-wetland-inventory/). Then we simulated the impact of various wetland loss rates (i.e., estimated annual change in wetland area), matching the size class distribution of lost basins (mean, median, max; Watmough et al. 2017), on the in-silico duck population supported. In this way, we derived province/ecoregion-specific regression estimates allowing us to convert wetland loss rates into breeding pair loss rates.

To better account for spatial variability in wetland loss rates, we used data gathered during the most recent update of the PHJV Habitat Monitoring Program on 250 transects covering the Prairie Parklands (Watmough et al. 2017). We constructed statistical models relating wetland loss to various landscape covariates associated with surveyed transects. The best fitting statistical model of wetland loss included only a positive nonlinear relationship with the amount of cropland in the surrounding landscape. Thus, we applied this model using cropland area from Agriculture and Agri-Food Canada's (AAFC) landcover map to generate municipality-specific estimates of wetland loss rate (Figure A5-3). We assumed these loss rates have been relatively constant through time based on analyses reported in Watmough and Schmoll (2007) and Watmough et al. (2017).

To estimate the impact of lost breeding pair capacity over time, we assumed our estimated breeding density (above) represented the long-term average during the period we modeled (i.e., 1961–2009). Assuming the impacts of wetland loss were present throughout the modeled time period, we projected annual breeding pair loss rates backward and forward from the median year (1986) using province/ecoregion-specific, simulation-based conversion of wetland loss rate to duck pair loss rates. This allowed us to generate landscape-level estimates of duck pairs for specific time periods from 1961 to present accounting for spatial variation in wetland loss rates. For example, the 1971 and 2016 estimated duck pair population in an Alberta Parkland municipality with an estimated long-term average population of 20,000 pairs, and annual duck pair loss rate of 0.37%, would be:

1971 Pairs (15 years prior to 1986) = 20,000 / (1.0 - 0.0037)15 = 20,945

2016 Pairs (30 years after 1986) = 20,000 * (1.0 - 0.0037)30 = 17,895

Adjusted population estimates for each municipality were used as inputs into our waterfowl production model (below) for scenario runs representing historic and future time periods.

We recognize several assumptions have been made in this process. Most notably, we are assuming wetland loss results in permanent loss of the ability of ducks to settle in a region (i.e., density does not increase on remaining wetlands). This assumption currently remains untested.

C. Modeling the Impact of Habitat Change on Duck Productivity

To generate estimates of agricultural land use change and conservation activity on duck productivity (estimated hatched nests), the PHJV has used extensive field studies of waterfowl nesting patterns and success to understand key nest, habitat, landscape and regional-scale factors influencing the hatching success of ducks. As described below, this information informs predictive models of how species composition, habitat availability, species-specific nest habitat preference, species/habitat-specific nest survival, and spatial variation in these factors affect the number of successfully hatched nests in geographically defined planning landscapes.

FIELD STUDIES USED TO MODEL DUCK NESTING PATTERNS AND SUCCESS

Models of duck nesting patterns and success were developed from data provided by three multi-year nesting studies conducted in prairie Canada between 1993 and 2009 (PHJV Assessment Study, 1993–2000 [Howerter et al. 2014]; Pintail Study, 2005–2007 [Devries et al. 2018]; and Spatial/Temporal Variability Study 2001–2009 [Bortolotti et al. 2021]). This data was used to model variation in breeding waterfowl nest survival and nest site preference among common nesting habitats across the region. PHJV Assessment Study sites were single sites, 64 km^2 in size, examined for one year only (n=25). Pintail Study (n=16) and SPATS (n=104) included clusters (hereafter, site clusters) of 6 – 41 km^2 sites stratified by percent grassland composition, including two replicates each of low (< 30%), moderate (30-60%), and high (>60%) grassland area; each site cluster was examined for one or two years. In total, 145 study sites (1993–2009) were included from across the Prairie Parklands (Figure A5-4).

Because these studies were focused on finding waterfowl nests, study site locations generally were randomly selected within regions that contained moderate to high amounts of wetland habitat in the form of ponds and shallow lakes (Stewart and Kantrud 1971, Prairie Habitat Joint Venture 2014). Among study sites, wetland habitat averaged 14.5% (range: 4–51%) of the area within study site boundaries.

Primary land uses across sites included cropland (predominantly for cereal grain and oil-seed production), and introduced and native grass forage lands (pasture and haylands) for cattle production. Native pasture and areas not in agricultural production were dominated by native grasses and shrubs with few trees (Ecological Stratification Working Group 1995). Approximately 99% and 92% of native and tame grasslands, respectively, were used as pasture and generally provided sparse cover throughout the nesting season. Haylands provided sparse cover early in the season, but dense cover by early June (e.g., McMaster et al. 2005). Ungrazed and unhayed native and tame grasslands generally provided dense cover throughout the nesting season. Croplands included standing stubble of cereal crops (e.g., wheat, barley) and canola or bare dirt (previous year's fallow land). Because winter cereal crops (fall rye, winter wheat) were of specific interest during the Pintail Study, these crops were seeded by DUC on study sites in September of the year prior to research activities. Location of fall-seeded crops within the study site boundaries was constrained by the willingness of producers to be involved in the study. All croplands provided sparse nesting cover early in the nesting season although winter cereal crops included germinated seedlings in stubble in April and became relatively tall and dense by early June (Devries et al. 2008a). Research protocols among study sites were similar except that not all habitat types are represented in all studies (e.g., fall-seeded crops primarily examined in the Pintail Study).

LOCATING AND MONITORING

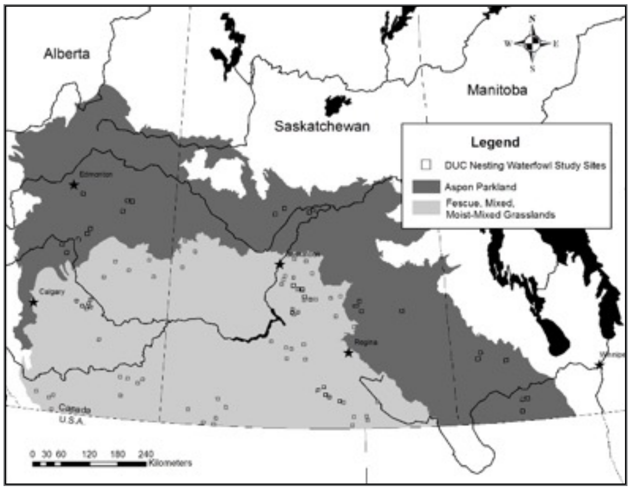


FIGURE A5-4. Location of DUC waterfowl nesting study areas (PHJV Assessment, Pintail, SPATS) within Grassland and Aspen Parkland Ecozones of prairie Canada, 1993-2009.

WATERFOWL NESTS

Among studies, three or four nest searches were conducted at three-week intervals from late April through mid-July following the procedures of Klett et al. (1986). Nests were found by dragging a 30 m cable-chain assembly, or a 2.5 cm x 75 m rope, between two all-terrain vehicles (ATV) through habitats being searched (Higgins et al. 1977). The ATV rope drag was typically used in growing crops to minimize crop damage. Where ATV use was not practical, a 1 cm x 30 m rope was dragged between observers on foot, or lone observers walked and struck vegetation with willow switches to flush female ducks from nests. A nest was defined as a nest bowl with ≥ 1 egg attended by a female when found (Klett et al. 1986). Nest searches were conducted six days per week between 0700 and 1300 hours when most laying and incubating females are expected to be tending nests (Gloutney et al. 1993). Searches were suspended during heavy rain. All habitat types were searched except trees and flooded wetland vegetation. All areas searched were recorded on aerial photographs and later digitized in ArcGIS (ESRI, Redlands, CA).

At PHJV Assessment Sites, an additional sample of nests were discovered based on tracking radio-marked female Mallards throughout the nesting season. In total, 3,214 Mallard females were trapped between 4 April to 5 May using decoy traps and marked with Telonics model IMP/150 22-g abdominally-implanted radio-transmitters (Telonics, Mesa, AZ; Olsen et al. 1992, Rotella et al. 1993). Radio-marked individuals were tracked daily using vehicle-mounted antenna and were visited on foot to confirm nesting attempts (Howerter et al. 2014).

When a nest was discovered, the nest habitat, duck species, and number of eggs were recorded, and incubation status was determined by field candling (Weller 1956). Nest location was recorded using GPS for later analyses in ArcGIS and nests were marked with a flagged willow stake placed 4 m north of the nest to facilitate relocation. Nests were revisited at seven to10-day intervals until nest fate (successful, failed, or abandoned) was determined. A successful nest was defined as hatching ≥ 1 egg as indicated by the presence of shell membranes (Klett et al. 1986) or ducklings in the nest bowl. Failed nests were indicated by evidence of abandonment or predation. When nests were abandoned on the first revisit following discovery (i.e., hen absent and no change in number of eggs or incubation), abandonment was attributed to investigator activity. Because we did not search overwater nest habitats, our productivity modeling focused on the five main upland-nesting ducks in the Prairie Parklands (hereafter, focal species), Mallard, Gadwall, Blue-winged Teal, Northern Shoveler (hereafter, Shoveler), and Northern Pintail (hereafter, Pintail), which comprised 94% of our nest sample.

Overall, nest searches were conducted on a total of 72,473 ha of habitat (among study site range: 59 – 2,036 ha). Nests of focal species comprised 25,393 of 26,979 nests found; 21,762 and 21,114 nests were used in nest survival and habitat selection analyses, respectively (below).

HABITAT CLASSIFICATION AND DIGITIZING

We used an 11-class habitat definition scheme to describe a combination of vegetative and land-use characteristics (Table A5-1). Habitat types were digitized in ArcMap from several imagery sources including 1:5,000 or 1:10,000 color or black-and-white infrared aerial photos and 2.5 m panchromatic SPOT images (SPOT Image Corporation, Chantilly, VA). All imagery was taken in May to August of the year of investigation (aerial photos), or May or June of the previous year (SPOT). All habitats within study site boundaries were ground truthed in June and July of the year of investigation. We used ArcGIS to extract from the digitized habitat layers various nest, patch and landscape habitat covariates for use in analyses.

TABLE A5-1. Habitat category definitions used in modeling waterfowl nest distribution in prairie Canada.

HABITAT	DEFINITION
SPRING-SEEDED CROPLAND	Areas that are tilled and planted to grain or row crops, or that are plowed and left fallow or contain crop residue.
FALL-SEEDED CROPLAND	Croplands that are seeded in the fall (e.g., winter wheat, fall rye).
HAYLAND	Areas that have been seeded to grasses and/or legumes for forage production and that are hayed annually.
DELAYED HAYLAND	Hayland where the hay cut is delayed until after July 15 each year and is restricted to one cut per season.
DENSE NESTING COVER (DNC)	Former cropland seeded to medium height and/or tall native or introduced grasses and/or forbs and idled.
NATURAL-IDLE	All grassland/shrubland/wetland vegetation that was not under an annual grazing regime.
NATURAL-RESTED	All grassland/shrubland/wetland vegetation that is annually grazed but was not grazed during the nesting season under study.
NATURAL-USED	All grassland/shrubland/wetland vegetation that was grazed at some point during the waterfowl nesting season under study.
OTHER	Includes all habitats that don't fit into any of the other habitat types listed (e.g., roads, farmsites, developed lands).
TREES-IDLE	Areas of idled woody plants (trees or tall shrubs) > 6m in height having an aerial cover > 30%.
TREES-USED	Areas of grazed woody plants (trees or tall shrubs) > 6m in height having an aerial cover > 30%.

MODELING WATERFOWL NEST SURVIVAL

We used a general likelihood specification in PROC NLMIXED (SAS Institute) to examine the influence of covariates on nest survival probability and used a logistic link function to model daily survival rate (DSR) as a transformably linear function of covariates (Dinsmore et al. 2002).

First, we assembled covariates that potentially explained variation in nest survival, selected based on previous research and plausible hypotheses. Also, Covariates were selected that could reasonably be obtained, estimated or assumed in a conservation planning context. These included nest-level covariates of nest age (NAGE) and categorical variables for clutch initiation date (IDATE; early, mid, and late), nest habitat (NHAB), and focal species (SPEC) given evidence from previous research (e.g., Higgins 1977, Klett et al. 1988, Emery et al., 2005).

Landscape-level covariates (i.e., at the scale of our study sites; 41–64 km2) included several measures of total duck pair density (PDEN). Among studies, we conducted ground-based walking surveys (Dzubin 1969a) or roadside surveys (Sauder et al. 1971) at least twice to estimate breeding pair densities for both early- and late-arriving species. Early surveys occurred during late April to early May (for Mallard and Pintail), and late surveys occurred in late May (for other duck species). While both walking and roadside pair counts were conducted among studies, both methods are expected to provide comparable results (Pagano and Arnold 2010).

Because annual climatic variation can impact nest survival over several years (e.g., Walker et al. 2013), we included competing annual wetness indices (including one- and two-year lags) for each site-year: 1) the inverse distance weighted median absolute deviation in 1961–2011 May pond counts from nearest WBPHS survey segments (MADPOND); and 2) the Normalized Difference Vegetation Index (NDVI) anomaly in May. To account for landscape composition effects (e.g., Reynolds et al. 2001, Stephens et al. 2008), we included the proportional coverage of cropland (PCROP), herbaceous cover (i.e., grass/forb/wetland vegetation; PHERB), all perennial cover (i.e., grass/forb/wetland vegetation/trees; PPER), and trees alone (PTREE). To account for broad regional gradients in nest survival (e.g., Reynolds et al. 2001, Arnold et al. 2007), we included latitude and longitude (LAT, LONG) of study site centroids. Where covariates measured related phenomenon (e.g., landscape percent cropland, percent herbaceous cover), or where covariates were correlated ($r > 0.5$), we included them separately in competing models. Throughout, we included within- and between-scale interactions that were supported by previous research or seemed biologically plausible.

We adopted a step-based approach to modeling that addressed: 1) collinearity among wetness indices, pair density metrics, and habitat compositions; and 2) sparse data for some combinations of species/initiation date category/nest habitat components inhibiting model convergence. We used Akaike's Information Criterion (AIC) to determine the best-approximating model (Burnham and Anderson 2002). The best-approximating model demonstrated that variation in nest survival was influenced by interacting effects of SPEC, NHAB, IDATE, MADPOND, PHERB, PTREE, LAT and LONG.

MODELING WATERFOWL NEST HABITAT SELECTION

We used resource selection functions (RSFs; Johnson et al. 2006; McLoughlin et al. 2006, 2010) to examine the influence of covariates affecting nest survival on waterfowl habitat use versus availability. We used logistic regression (PROC GLIMMIX, SAS Institute; e.g. Gillies et al. 2006) to compare the observed distribution of nest sites among habitats at a study site year (coded as 1's) with a sample of random points (coded as 0's), generated at a rate of 3:1 to the number of nests per SPEC*IDATE category combination. Other than nests of radio-tagged Mallards, only nests found in areas consistently searched three or more times by traditional nest search methods were included in the analysis (i.e., incidentally found nests were excluded). We used a multinomial distribution to attribute study habitats to the random points, with pi proportional to the area of nest-searched habitats for nests found by traditional methods, and proportional to study site habitat availabilities for radio-tagged Mallards (i.e., assuming all habitats available). Thus, radio-tagged Mallards were essentially treated as a separate species at this stage of the analysis. Site- and year-specific covariates were assigned to respective random points.

Because differences in nest survival rates among habitats can affect the observed number of nests detected (e.g., Peron et al. 2014), we estimated the effects of differing DSR among SPEC*NHAB*IDATE (from above) on the proportion of nests found given our three-week nest search interval, and the species-specific laying and incubation period (32–35 days). The probability of finding a nest given it was active during a search and not previously discovered, was held constant at 0.5 in all habitats. Nest inclusion probabilities were estimated as the likelihood of discovering nests at any age prior to nest destruction or successful hatch. Thus, we mitigated the effect of DSR on nest detection for each SPEC*NHAB*IDATE by weighting observed nests by the inverse of the estimated probability of their inclusion in our sample. For random points, weights were set at a constant value of 1. To account for the clustered data structure, we specified random intercepts at the study-site level.

Preferences for habitats with < 10 nests/species across all sites were set to 0 and these nests excluded from modeling. Specifically, this included Other and Tree habitats during all IDATE categories for all species except Mallard, and Fall-seeded Cropland during the Early IDATE category for Gadwall. We began with models examining the impact of covariates on selection ratios, including MADPOND, LAT, LONG, PHERB (quadratic effect), PTREE, and PDEN. Model complexity was restricted to two-way interactions with NHAB – querying whether covariates influence selection among habitats. Additional habitats were excluded from these covariate models when models failed to converge due to relatively small numbers and patchy nest distributions across study sites. Models were reduced to identify best-approximating covariate models.

We estimated selection ratios for the excluded habitats from species-specific models, including only the effects of NHAB*IDATE. To account for weightings of three random points per nest and nest inclusion probabilities, we scaled our model-estimated odds ratios by dividing them by (3*nest inclusion probability) so that a value of 1 represents use as available for a given habitat. Generally, best-approximating models for each species indicated nest habitat preference varied with IDATE, MADPOND, PHERB, PTREE, LAT and LONG.

Post-analysis, we combined habitat selection estimates for non-radioed and radio-tagged mallards. Specifically, selection ratios for Spring-seeded Cropland, Dense Nesting Cover, Hayland, Natural-Idle, Natural-Grazed, Other, Tree-Idle, and Tree-Grazed were derived from the covariate model for radio-tagged Mallards. Selection ratios for Delayed-Hayland and Natural-Rested were derived from the covariate model for non-radioed Mallards, and the selection ratio for Fall-seeded Cropland was derived from the non-radioed Mallard NHAB*IDATE model.

WATERFOWL HATCHING SUCCESS MODEL

We combined the best-approximating models of nest survival and nest habitat selection generated above, estimates of habitat availability, estimates of breeding propensity and renesting rates (from literature and expert opinion), and estimates of uncertainty to develop a stochastic predictive model of waterfowl hatching success in Prairie Parklands landscapes.

We first estimate a population of nests generated by the population of females using species-specific female breeding and renesting propensity and setting the maximum number of nests initiations attempted based on data and expert opinion. The number of first nest initiations (Init1j) during the jth seasonal nesting period (Early, Mid, or Late) is defined by the equation:

$$Init_{1,j} = N * p_{nest} * q_{1j}, \ \ j = 1, 2, 3 \qquad (1)$$

where N denotes the size of the population of nesting females for the planning geography, P_{nest} denotes the proportion of females that initiate at least one nest (i.e., breeding propensity), and q_{1j} denotes the proportion of the females that initiate their first nest in the jth seasonal period, given that females initiate at least one nest ($\sum_j q_{ij} = 1$). Because breeding propensity has not been estimated for most species, we used the average propensity observed for radio-tagged Mallards in the Prairie Parklands (0.90; Devries et al. 2008b). The proportion of females nesting in early, mid, and late periods was set to attain a nest initiation distribution among seasonal periods matching observed data while accounting for female mortality and nest survival effects on nest production (below).

Subsequent nest initiations (i.e., renests; i = 2…, k) by seasonal period are defined by the equations:

$$Init_{i,1} = Init_{i-1,1} * (1 - NS_1) * r_1 * q_{i1} \quad (2)$$

$$Init_{i,2} = \left[Init_{i-1,1} * (1 - NS_1) * r_1 * q_{i2}\right] + \left[Init_{i-1,2} * (1 - NS_2) * r_2 * \left(\frac{q_{i2}}{q_{i2}+q_{i3}}\right)\right] \quad (3)$$

$$Init_{i,3} = \left[Init_{i-1,1} * (1 - NS_1) * r_1 * q_{i3}\right] + \left[Init_{i-1,2} * (1 - NS_2) * r_2 * \left(\frac{q_{i3}}{q_{i2}+q_{i3}}\right)\right] + \left[Init_{i-1,3} * (1 - NS_3) * r_3\right] \quad (4)$$

where NS_j denotes the expected usage-weighted average nest survival over habitats during the jth seasonal period, and denotes the probability that an unsuccessful female initiates a renest in the j^{th} seasonal period. We assumed an average renesting probability of 0.7 based on observed rates in mallards (Arnold et al. 2010). We set i=5 for Mallards (Arnold et al. 2010), i=3 for Pintail and Gadwall (Gates 1962, Duncan 1987, Grand and Flint 1996, Guyn and Clark 2000). Estimates of renesting for s\Shoveler and Blue-winged Teal are lacking in the published literature and are assumed to be intermediate (i=4). Finally, to account for the effect of female mortality through the nesting season on nest production, we multiplied the sum of estimated nest initiations in each seasonal period by an estimate of the proportion of females that survive to the midpoint of each seasonal period (0.967, 0.865, and 0.780, respectively, using Devries et al.'s [2003] results for Mallards).

The sum of nests initiated by surviving females within each seasonal period above (, are subsequently distributed among habitats within a seasonal period based on the equation:

$$Nests_{hj} = \left(\frac{P_{hj} * A_h}{\sum_h^k P_{hj} * A_h}\right) * Nests_j \quad (5)$$

where $Nests_{hj}$ denotes the number of nests initiated in habitat *h* in the j^{th} seasonal period, P_{hj} denotes the relative preference for habitat *h* in the j^{th} seasonal period based on selection ratios from the best-approximating model of habitat selection, and A_h denotes the proportional availability of habitat *h* within a planning geography (constant for a given site among seasonal periods).

Hence, hatched nests in each habitat and seasonal period are provided by the equation:

$$Hatched_{hj} = Nests_{hj} * NS_{hj} \quad (6)$$

where NS_{hj} represents nest survival rate for each habitat and seasonal period using model estimating equations from the best-approximating model of DSR. Unless otherwise of interest, hatched nests are generally summed across habitats and seasonal periods for a planning geography.

UNCERTAINTY IN HATCHED NEST ESTIMATES

We used Monte Carlo simulation for estimating uncertainty associated with estimates of hatched nests. For each of the best-approximating model forms for nest survival and nest habitat selection, we initially populated a matrix Z_{r*k} (where *r* = number of simulation replicates, *k* = number of model parameters) with realizations of a standard normal distribution (i.e., $Z_{ij} \sim N(0, 1)$). We post-multiplied this matrix by the upper-triangular Cholesky decomposition of the estimated parameter correlation matrix to affect the same correlation structure among these Monte Carlo runs (Lurie and Goldberg 1998). Each column of the matrix was subsequently "unstandardized" (i.e., $X_j = (Z_j$*standard error of $\beta_j) + \beta j$) so that each row represented a realization of the *k* simulated model parameters. For each simulation replicate *i*, we calculated the number of nests initiated and hatched (see equations 5 and 6) and estimate productivity as the averages across the replicates. Parameter or second-order uncertainty (Briggs et al. 2012) is reported as the standard deviation across replicates.

D. The Waterfowl Productivity Model (WPM)

The WPM combines the waterfowl distribution and productivity models described above. In application, we first extract the estimated breeding pairs from the distribution model within a planning landscape (typically 41-km^2 in size) using ArcGIS. To extract focal species breeding populations from the seven species density model, we apportion species abundance by their mean inverse distance weighted proportions from the four nearest WBPHS survey segments observed in the 1961–2009 data. Habitat availability at this scale is extracted from available land cover mapping sources in ArcGIS (e.g., Agriculture and Agri-Food Canada's [AAFC] annual 30-m resolution crop inventory digital layer; https://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9) in combination with finer-level habitat or land use attribution derived from locally acquired data (e.g., our study sites) or expert opinion (e.g., proportion of grassland hayed, grazed, grazed-rested, or ungrazed during the nesting season).

In operation, the WPM inputs breeding pairs by species, habitat availability and other landscape-specific covariates (e.g., LAT, LONG) to generate a population of nests which are apportioned among habitats within seasonal periods, and

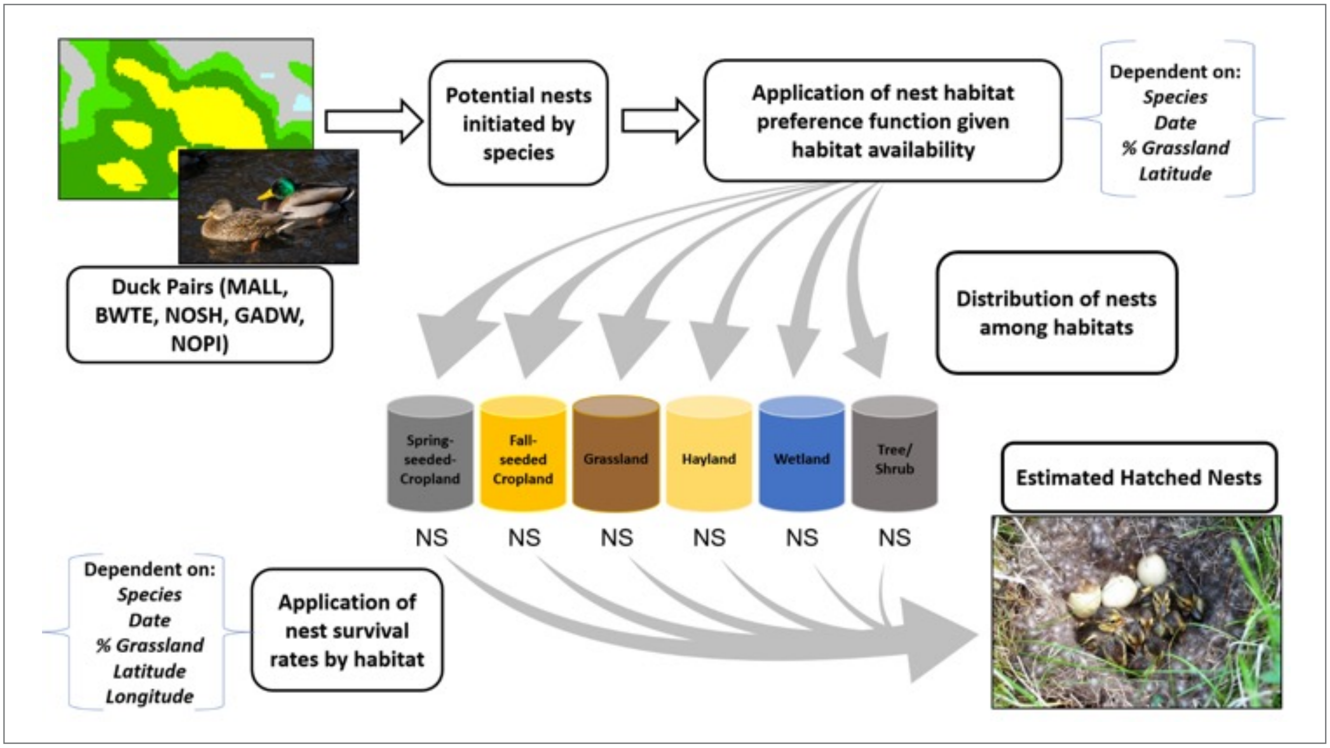


FIGURE A5-5. Graphical representation of the Waterfowl Productivity Model (WPM). Beginning in the upper left: 1) estimated waterfowl pairs are extracted from the waterfowl density layer for a planning geography and parsed into individual species estimates based on proportions in regional waterfowl survey data; 2) total nests initiated for each species are estimated based on species-specific breeding and renesting propensity; 3) nests are distributed among potential nest habitats based on covariate-dependent nest habitat preference and habitat availability; and 4) covariate-dependent nest survival (NS) rates applied by habitat to produce total estimated hatched nests.

exposed to habitat- and season-specific nest survival rates (Figure A5-5). Final model output is estimated hatched nests by species, habitat and seasonal period with associated variation. Thus, in a conservation planning context, the model can estimate the impact of various habitat changes, whether background or conservation-related, affecting the number or species composition of waterfowl pairs present (e.g., wetland loss or restoration), or the distribution and survival of nests (e.g., grassland loss or restoration, increased acreage of winter wheat, etc.).

E. Literature Cited

AAFC (Agriculture and Agri-food Canada). 2008. Land cover for agricultural regions of Canada, circa 2000. Agriculture and Agri-food Canada, Ottawa, Ontario, Canada.

Arnold, T. W., J. H. Devries, and D. W. Howerter. 2010. Factors that affect renesting in mallards (Anas platyrhynchos). Auk 127:212-221.

Arnold, T. W., L. M. Armstrong, D. W. Howerter, J. H. Devries, B. L. Joynt, R. B. Emery, and M. G. Anderson. 2007. Waterfowl use of dense nesting cover in the Canadian parklands. Journal of Wildlife Management 71:2542-2549.

Bartzen, B., K. W. Dufour, M. T. Bidwell, M. D. Watmough, and R. G. Clark. 2017. Relationships between abundances of breeding ducks and attributes of Canadian prairie wetlands. Wildlife Society Bulletin 41:416-423.

Bortolotti, L., R. Emery, L. Armstrong, and D. Howerter. 2021. Landscape composition, climate variability, and their interaction drive waterfowl nest survival in the Canadian Prairies. Ecosphere 12: In Press.

Briggs, A. H., M. C. Weinstein, E. A. Fenwick, J. Karnon, M. J. Sculpher, and A. D. Paltiel. 2012. Model parameter estimation and uncertainty analysis: a report of the ISPOR-SMDM Modeling Good Research Practices Task Force Working Group–6. Medical Decision Making 32:722-732.

Burnham, K. P., and D. R. Anderson. 2002. Model Selection and Multi-model Inference: A Practical Information-theoretic Approach. 2nd edition. Springer-Verlag, New York, New York, USA.

Canadian Soil Information System. 2011. Soil landscapes of Canada, Version 3.2. Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada

Canadian Wetland Inventory Technical Committee. 2016. Canadian Wetland Inventory (Data Model V.7.0). URL: https://www.ducks.ca/initiatives/canadian-wetland-inventory/

Devries, J. H., J. J. Citta, M. S. Lindberg, D. W. Howerter, and M. G. Anderson. 2003. Breeding-season survival of mallard females in the Prairie Pothole Region of Canada. Journal of Wildlife Management 67:551-563.

Devries, J. H., L. M. Armstrong, R. J. MacFarlane, L. Moats, and P. T. Thoroughgood. 2008a. Waterfowl nesting in fall-seeded and spring-seeded cropland in Saskatchewan. Journal of Wildlife Management 72:1790-1797.

Devries, J. H., R. W. Brook, D. W. Howerter, and M. G. Anderson. 2008b. Effects of spring body condition and age on reproduction in mallards (Anas platyrhynchos). Auk 125:618-628.

Devries, J., R. Clark, and L. Armstrong. 2018. Dynamics of habitat selection in birds: adaptive response to nest predation depends on multiple factors. Oecologia 187:305-318.

Dinsmore, S. J., G. C. White, and F. L. Knopf. 2002. Advanced techniques for modeling avian nest survival. Ecology 83:3476-3488.

Duncan, D. C. 1987. Nest-site distribution and overland brood movements of northern pintails in Alberta. Journal of Wildlife Management 51:716-723.

Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. Pages 178–230 in Saskatoon wetlands seminar. Canadian Wildlife Service Report Series 6, Department of Indian Affairs and Northern Development, Ottawa, Ontario, Canada.

Ecological Stratification Working Group. 1995. A national ecological framework for Canada. Centre for Land and Biological Resources Research, State of the Environment Directorate, Hull, Quebec, Canada.

Emery, R. B., D. W. Howerter, L. M. Armstrong, M. G. Anderson, J. H. Devries, and B. L. Joynt. 2005. Seasonal variation in waterfowl nesting success and its relation to cover management in the Canadian prairies. Journal of Wildlife Management 69:1181-1193.

Environment Canada. 1981. Canada Land Inventory: Land Capability Classification for Wildlife - Waterfowl. The Canada Land Inventory, Report 16. Environment Canada, Ottawa, Ontario, Canada.

Gates, J. M. 1962. Breeding biology of the gadwall in northern Utah. The Wilson Bulletin:43-67.

Gillies, C. S., M. Hebblewhite, S. E. Nielsen, M. A. Krawchuk, C. L. Aldridge, J. L. Frair, D. J. Saher, C. E. Stevens, and C. L. Jerde. 2006. Application of random effects to the study of resource selection by animals. Journal of Animal Ecology 75:887-898.

Gloutney, M. L., R. G. Clark, A. D. Afton, and G. J. Huff. 1993. Timing of nest searches for upland nesting waterfowl. Journal of Wildlife Management 57:597-601.

Grand, J. B., and P. L. Flint. 1996. Renesting ecology of northern pintails on the Yukon-Kuskokwim Delta, Alaska. Condor 98:820-824.

Guyn, K. L., and R. G. Clark. 2000. Nesting effort of northern pintails in Alberta. Condor 102:619-628.

Hammond, M. C. 1969. Notes on conducting waterfowl breeding population surveys in the north central states. Pages 345–352 in Saskatoon wetlands seminar. Canadian Wildlife Service Report Series 6, Department of Indian Affairs and Northern Development, Ottawa, Ontario, Canada.

Higgins, K. F. 1977. Duck nesting in intensively farmed areas of North Dakota. Journal of Wildlife Management 41:232-242.

Higgins, K. F., L. M. Kirsch, H. F. Duebbert, A. T. Klett, J. T. Lokemoen, H. W. Miller, and A. D. Kruse. 1977. Construction and operation of a cable-chain drag for nest searches. Wildlife Leaflet 512, US Fish and Wildlife Service, Washington, D.C., USA.

Howerter, D. W., M. G. Anderson, J. H. Devries, B. L. Joynt, L. M. Armstrong, R. B. Emery, and T. W. Arnold. 2014. Variation in mallard vital rates in Canadian Aspen Parklands: The Prairie Habitat Joint Venture assessment. Wildlife Monographs 188.

Johnson, C. J., S. E. Nielsen, E. H. Merrill, T. L. McDonald, and M. S. Boyce. 2006. Resource selection functions based on use-availability data: theoretical motivation and evaluation methods. Journal of Wildlife Management 70:347-357.

Johnson, J. B., and K. S. Omland. 2004. Model selection in ecology and evolution. Trends in Ecology and Evolution 19:101-108.

Klett, A. T., H. F. Duebbert, C. A. Faanes, and K. F. Higgins. 1986. Techniques for studying nest Success of ducks in upland habitats in the Prairie Pothole Region. U.S. Fish and Wildlife Service Resource Publication 158, Washington, D.C., USA.

Klett, A. T., T. L. Shaffer, and D. H. Johnson. 1988. Duck nest success in the Prairie Pothole Region. Journal of Wildlife Management 52:431-440.

Lurie, P. M., and M. S. Goldberg. 1998. An approximate method for sampling correlated random variables from partially-specified distributions. Management Science 44:203-218.

McLoughlin, P. D., M. S. Boyce, T. Coulson, and T. Clutton-Brock. 2006. Lifetime reproductive success and density-dependent, multi-variable resource selection. Proceedings of the Royal Society B: Biological Sciences 273:1449-1454.

McLoughlin, P. D., D. W. Morris, D. Fortin, E. Vander Wal, and A. L. Contasti. 2010. Considering ecological dynamics in resource selection functions. Journal of Animal Ecology 79:4-12.

McMaster, D. G., J. H. Devries, and S. K. Davis. 2005. Grassland birds nesting in haylands of southern Saskatchewan: Landscape influences and conservation priorities. Journal of Wildlife Management 69:211-221.

Natural Resources Canada. 2011. CanVec feature catalogue. Edition 1.1.2. Natural Resources Canada, Centre for Topographic Information, Sherbrooke, Quebec, Canada.

Olsen, G. H., F. J. Dein, G. M. Haramis, and D. G. Jorde. 1992. Implanting radio transmitters in wintering canvasbacks. Journal of Wildlife Management 56:325-328.

Pagano, A. M., and T. W. Arnold. 2010. Detection probabilities for ground-based breeding waterfowl surveys. Journal of Wildlife Management 73:392-398.

Péron, G., J. Walker, J. Rotella, J. E. Hines, and J. D. Nichols. 2014. Estimating nest abundance while accounting for time-to-event processes and imperfect detection. Ecology 95:2548-2557.

Prairie Habitat Joint Venture. 2014. Prairie Habitat Joint Venture Implementation Plan 2013–2020: The Prairie Parklands. Environment Canada, Edmonton, AB, Canada.

Reynolds, R. E., T. L. Shaffer, R. W. Renner, W. E. Newton, and B. D. J. Batt. 2001. Impact of the Conservation Reserve Program on duck recruitment in the U.S. Prairie Pothole Region. Journal of Wildlife Management 65:765-780.

Rotella, J. J., D. W. Howerter, T. P. Sankowski, and J. H. Devries. 1993. Nesting effort by wild mallards with 3 types of radio transmitters. Journal of Wildlife Management 57:690-695.

Sauder, D. W., R. L. Linder, R. B. Dahlgren, and W. L. Tucker. 1971. An evaluation of the roadside technique for censusing breeding waterfowl. Journal of Wildlife Management 35:538-543.

Smith, G. W. 1995. A critical review of the aerial and ground surveys of breeding waterfowl in North America. U.S. Department of the Interior, National Biological Service, Biological Science Report 5, Washington, D.C., USA.

Solman, V. 1970. Canada land inventory wildlife capability maps. Biological Conservation 2:305.

Stephens, S. E., J. A. Walker, D. R. Blunck, A. Jayaraman, D. E. Naugle, J. K. Ringelman, and A. J. Smith. 2008. Predicting risk of habitat conversion in native temperate grasslands. Conservation Biology 22:1320-1330.

Stewart, R. E., and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. U.S. Fish and Wildlife Service Resource Publication 99.

U.S. Fish and Wildlife Service and Canadian Wildlife Service. 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys in North America. U.S. Fish and Wildlife Service, Washington D.C., USA, and Canadian Wildlife Service, Ottawa, Ontario, Canada.

Walker, J., J. J. Rotella, S. E. Stephens, M. S. Lindberg, J. K. Ringelman, C. Hunter, and A. J. Smith. 2013. Time-lagged variation in pond density and primary productivity affects duck nest survival in the Prairie Pothole Region. Ecological Applications 23:1061-1074.

Watmough, M., and M. J. Schmoll. 2007. Environment Canada's Prairie & Northern Region Habitat Monitoring Program Phase II: Recent habitat trends in the Prairie Habitat Joint Venture. Canadian Wildlife Service, Edmonton, Alberta, Canada.

Watmough, M., Z. Li, and E. Beck. 2017. Prairie Habitat Monitoring Program: Canadian prairie wetland and upland status and trends 2001-2011 in the Prairie Habitat Joint Venture delivery area. Prairie Habitat Joint Venture, Environment Canada, Edmonton, Alberta, Canada.

Weller, M. W. 1956. A simple candler for waterfowl eggs. Journal of Wildlife Management 20:111-113.

White, G. C., and R. E. Bennetts. 1996. Analysis of frequency count data using the negative binomial distribution. Ecology 77:2549-2557.

APPENDIX 6: PRIORITY NON-GAME CONSERVATION PLANNING MODELS USED IN HABITAT OBJECTIVE SETTING

Probability of Occurrence Models

UPDATING THE FIRST GENERATION MODELS

Probability of occurrence models for six waterbird and two landbird species (Table 5) from the 2013-2020 Implementation Plan were updated. Appendix 9 of the 2013-2020 PHJV Implementation Plan described first-generation species habitat models for select waterbird and wetland-associated landbirds used in conjunction with GIS to project thunderstorm maps of species occurrence or abundance in relation to land cover characteristics. These earlier analyses used habitat covariates that derived from the thematic land cover classification Land Cover for Agricultural Regions of Canada circa 2000 published by Agriculture and Agri-food Canada, as they were the best available data at the time to quantify landscape-level habitat variables for the entire PHJV region. Here, we provide a synopsis of a reanalysis of the 2008-2012 waterbird data, which was done to update the first-generation models when the land cover classification was updated to the 2010 Land Cover of Canada (Agriculture and Agri-Food Canada 2010), a product that corresponded more closely with the timing of when the waterbird data were collected.

Like earlier analyses, we considered physiographic and land cover variables at both local landscape and regional levels. GIS and the 2010 thematic land cover classification data were used to quantify local landscape-level habitat variables and extract covariate values for use in models of marshbird occurrence. For these we calculated the amount of emergent wetland, crop, grass, treed area and open water surrounding each survey site at three spatial scales: the quarter section; the section; and the 16 mile2 study site. We selected these levels of scaling because they represent nested working units for land managers in the region; the quarter section being the lowest common denominator and the typical division whereby land is bought, sold and managed.

Changed from the earlier analysis, at the regional scale, we substituted the categorical ecoregion variable with two continuous variables that are primarily responsible for ecoregion transition: mean temperature and mean precipitation. For this we used 30 years of weather data obtained from Daymet (Thornton et al. 2020b) for the breeding season (May – July) and created a raster for each variable across the entire study region for use in the predictive mapping. Also at the regional scale, we considered variables related to ponds (wetland count and basin area) and the Canada Land Inventory (CLI) — Land Capability for Waterfowl (Natural Resources Canada 2002; hereafter CLI Waterfowl). The adjusted wetland count and wetland area used for the duck density model (Appendix 5) were also used for the waterbird models.

Regional scale variables were seen to represent the underlying ecological potential of the landscape. CLI Waterfowl Classes are assigned based on known or extrapolated information on parent material, soil profile, depth, moisture, fertility, landform, climate, as well as vegetation cover generated from field surveys and interpretation of aerial photography. Also ponds are requisite habitat for wetland-associated birds; where there are more wetlands there would appear to be more potential to support populations of wetland-associated birds.

HYPOTHESIS AND MODEL EVALUATION

Prior to examining relationships between occupancy (Ψ) and habitat variables, we examined model fit of different parameterizations of detection probability, and then maintained the best-supported parameterization of detection in subsequent model evaluations of habitat variables. Because of the large number of variables in the analysis, a hierarchical process of model evaluation was used that began with assessing support for variables at the largest spatial scale, and ending with variables at the smallest spatial scale.

When assessing covariates known to influence detection probability, we held the occupancy process constant. We considered linear and quadratic effects of date and time until dark to account for seasonal and diurnal variation in vocalization. Since we conducted surveys both in the morning and in the evening, we also tested a categorical time-of-day parameterization, AM or PM, covariate influence detection probability. We assessed models, including a null model using Akaike Information Criterion (AIC) and then included the top ranked model in the detection process for the subsequent evaluation of occupancy covariates.

In the second step, we assessed habitat associations at three different spatial scales (Quarter Section, Section and 16 mile^2). Univariate models for each habitat type scale were compared with a null model to select the spatial scale with the most support. If the null model was ranked $\Delta AIC \leq 2$, no covariate from that habitat type was carried forward. Finally, we considered additive subsets of the influential covariates from the previous step, as well as covariates known to influence the occurrence of marsh birds that were sampled at only one spatial scale, such as climate and adjusted Ducks Unlimited Canada wetland area and count.

Density Models

POINT COUNT DATA

Spatial density models were newly developed for 20 landbird and four shorebird species. These models were derived from data collected during ~70,000 controlled-effort point count surveys from 2009-2018 at ~28,000 unique locations. Data was obtained from a variety of sources (Table 1) that used a diversity of survey protocols. Survey protocol (point count duration, survey radius) and other survey-specific parameters, such as date and time, influence probability of detection making it problematic to directly compare counts from disparate datasets. We employed the QPAD method developed by Sólymos et al. (2013) that uses distance and removal sampling to estimate species- and survey-specific probabilities of detection. Variation in detection probability across surveys was then accounted for with an offset in the count model.

TABLE 1. Point count data sources used to develop species density models with Boosted Regression Trees

DATASET	YEARS	NUMBER SURVEYS	DATA SOURCE/CONTACT
NORTH AMERICAN BREEDING BIRD SURVEY	2009-2018	47,703	US Geological Survey (https://www.pwrc.usgs.gov/bbs/)
GRASSLAND BIRD MONITORING PROGRAM	2017-2018	697	Environment and Climate Change Canada/Barry Robinson (barry.robinons@ec.gc.ca)
GRASSLANDS NATIONAL PARK	2009-2015	287	Parks Canada/ Stefano Liccioli (stefano.liccioli@pc.gc.ca)
MANITOBA BREEDING BIRD ATLAS	2010-2014	9,346	Birds Canada/Nature Counts (https://www.birdscanada.org/naturecounts/default/searchquery.jsp)
MANITOBA COMMUNITY PASTURE MONITORING	2016-2018	212	Birds Canada/Christian Artuso (christian.artuso@ec.gc.ca)
MANITOBA SARPAL BIRD MONITORING	2017-2018	590	Birds Canada/Christian Artuso (christian.artuso@ec.gc.ca)
MANITOBA TALL GRASS PRAIRIE MONITORING	2007-2008, 2010-2011, 2014	236	University of Manitoba /David Bruinsma, Dr. Nicola Koper
GRASSLAND BIRD MONITORING IN ALBERTA SPECIAL AREAS	2011	1507	University of Regina/Nathan Clements, Dr. Stephen Davis
MONITORING OF BIODIVERSITY OF GRAZING MANAGEMENT AT GRASSLANDS NATIONAL PARK	2006-2014	756	University of Manitoba/Samantha Fischer, Tonya Lwiwski, Kelsey Molloy, Dr. Nicola Koper
GRASSLAND BIRD MONITORING IN SUFFIELD MILITARY TRAINING AREA	2012-2014	834	University of Calgary/Ben McWilliams, Dr. Darren Bender
GRASSLAND BIRD MONITORING IN SOUTHEASTERN ALBERTA	2010-2011	561	University of Manitoba, Jennifer Rodgers, Dr. Nicola Koper
GRASSLAND BIRD MONITORING IN FEDERAL, PROVINCIAL AND PRIVATE PASTURES	2016-2017	1544	University of Regina, Philip Rose, Dr. Stephen Davis
GRASSLAND BIRD MONITORING IN THE MILK RIVER REGION	2009-2010	889	University of Saskatchewan, Dr. Allison Henderson, Dr. Stephen Davis
SASKATCHEWAN BREEDING BIRD ATLAS	2017-2018	2770	Birds Canada/Nature Counts (https://www.birdscanada.org/naturecounts/default/searchquery.jsp)
GRASSLAND BIRD MONITORING IN SOUTH OF THE DIVIDE, SK	2008-2009	776	Environment and Climate Change Canada/Dr. Stephen Davis (stephen.davis@ec.gc.ca)
GRASSLAND BIRD MONITORING IN SUFFIELD NATIONAL WILDLIFE AREA	2009, 2015-2017	996	Environment and Climate Change Canada/Barry Robinson (barry.robinons@ec.gc.ca)
GRASSLAND BIRD MONITORING IN SOUTHERN SASKATCHEWAN	2013-2014	370	University of Regina, Jason Unruh, Dr. Stephen Davis

ACCOUNTING FOR VARIATION IN SURVEY PROTOCOL AND DETECTION PROBABILITIES

Using those surveys that recorded time of first detection for each individual, we developed species-specific removal models (Farnsworth et al. 2002) predicting the average rate at which individuals give a visual or auditory cue during the survey ([illegible]). For each species, we tested a suite of removal models with different combinations of survey-specific parameters, including time-since-local-sunrise (TSSR) and ordinal day (OD; Table 2), and used Bayesian Information Criteria (BIC; Schwarz 1978) to choose the most appropriate model. Removal models were parameterized using the cmulti function from the detect package (Sólymos et al. 2020) in the R statistical environment (R Core Team 2021). For each point count survey, the overall average that an individual of a given species provided a cue during the survey (p) was estimated as: $p = 1 - e^{-t[illegible]}$, where *t* is the total point count duration in minutes (see Sólymos et al. 2013 for equation derivation).

TABLE 2. Variables used in candidate removal models, predicting the rate at which individuals provide a cue during point count surveys.

MODEL #	VARIABLES
1	Null
2	TSSR
3	OD
4	TSSR + OD
5	TSSR × OD
6	TSSR2

Using those surveys that recorded distance of each individual from the observer (either continuous or discrete), we estimated species-specific detection functions (Buckland et al. 2001), which include a parameter that can be considered the effective detection radius of the point count survey (τ). We used a half-normal detection function parameterized with the cmulti function from the detect package in the *r*. For all point count surveys, we then estimated the average probability that an individual of a given species randomly located within the point count radius was detected by an observer if a cue was provided (*q*) as:

$$q = \frac{\tau^2\left(1 - e^{\frac{-r^2}{\tau^2}}\right)}{r^2}$$

where *r* is the point count radius in meters (see Sólymos et al. 2013 for equation derivation). For unlimited distance point counts, we fixed $q = 1$.

In order to model true density, as opposed to relative abundance, variation in area surveyed across different point count protocols also needed to be accounted for in the offset (Sólymos et al. 2013). For fixed-radius point count surveys, area surveyed was calculated as $A = \pi r^2$; for unlimited distance point counts, *r* was set as the effective detection radius (τ). The overall species-specific offsets were calculated for each point count survey as log(*Apq*).

SPATIAL COVARIATES

We modelled species-specific counts as a function of various spatial covariates including land cover, multi-spectral satellite imagery, topography and weather. All covariates were derived from existing raster datasets and were resampled to 800-m resolution, clipped to the same extent, snapped to the same origin, and projected to the same projection using the raster package (Hijmans 2021) in *r*. We used the nearest neighbour method to resample categorical covariates and bilinear interpolation for continuous covariates.

For land cover, we used the 30-m resolution Annual Crop Inventory (Agriculture and Agri-Food Canada 2020) and combined categories into broad land cover classes: forest, shrubland, grassland, and cropland. Note that the grassland category included native grasslands and non-native pastures, and hay fields. For each landcover class j, we developed three raster layers: a binomial raster where the value of each pixel was 1 if it was classified as *j* and 0 for any other class; and two continuous rasters where the value of each pixel represented the number of pixels classified as *j* within either a 3×3- or 5×5-pixel window (2400×2400- or 4000×4000-m, respectively) surrounding the pixel. We developed these three rasters separately for each habitat type and year from 2009-2018. To quantify the amount of wetlands around point count locations, we used the same basin count and basin area covariates used for the duck and waterbird models (see Appendix 5), but resampled to 800-m resolution. We also created four additional layers where each pixel represented either mean basin counts or mean basin area within either a 3×3- or 5×5-pixel window.

To account for temporal and spatial variation in the amount of photosynthetic activity, a proxy for green vegetation biomass, over the growing season, we obtained 250-m resolution rasters where the value of each pixel represents weekly maximum Normalized Difference Vegetation Index (NDVI). Weekly maximum NDVI was derived from daily Moderate Resolution Imaging Spectroradiometer (MODIS) L2-G reflectance data products (Agriculture and Agri-Food Canada 2021). Within-season NDVI time series can be used to distinguish between native and non-native grasslands in the Northern Great Plains because there are differences in the temporal patterns of NDVI between the two classes, particularly during green up (McInnes et al. 2015, Olimb et al. 2017). For each year, we obtained a time series of weekly Maximum NDVI rasters consisting of early, mid and late periods of the growing season (18 May, 10 June and 4 July, respectively). To fill in gaps of missing data due to cloud cover, we used the genSmoothingIMA function from the RGISTools package in R (Militino et al. 2019). For each time period, we also created two additional rasters where each pixel represented mean NDVI values within either a 3×3- or 5×5-pixel window surrounding the pixel.

To quantify topographic variation, we used a 200-m resolution digital elevation model (DEM) for Canada (Natural Resources Canada 2015). In addition to the raw DEM raster resampled to 800-m resolution, we created four new rasters with pixel values representing the mean or standard deviation of elevation in the surrounding 3×3- or 5×5-pixel window.

We included seven weather covariates (Table 3) all calculated from daily minimum and maximum temperature (td_{min} and td_{max}), total monthly precipitation (*pm*), or mean monthly minimum and maximum temperature (tm_{min} and tm_{max}) rasters obtained from Daymet, which provides 1-km resolution products that spans all of North America from 1980-present (Thornton et al. 2020a, b). Each weather covariate was calculated separately for each year from 2009-2018, so that avian counts could be linked with weather conditions specific to the year of surveys. Weather covariates included total summer precipitation ($TSP = \sum_{i=5}^{9} pm_i$, mm), total annual precipitation ($TAP = \sum_{i=1}^{12} pm_i$, mm), mean temperature of the warmest month ($MTWM = \max_{1 \le i \le 12} [(tm_{\min i} + tm_{\max i})/2]$, °C), summer heat moisture index (*SHM=MTWM/(TSP/1000)*), number of frost-free days (FFD, number of days in a calendar year where $(td_{\min i} + td_{\max i})/2 > 0$ °C), degree days above 5°C (DD_5, see equation below), and degree days below 0°C (DD_0, see equation below).

$$DD_5 = \sum_{i=1}^{365} \begin{cases} \dfrac{td_{\min i} + td_{\max i}}{2} - 5, & \dfrac{td_{\min i} + td_{\max i}}{2} \ge 5 \\ 0, & \dfrac{td_{\min i} + td_{\max i}}{2} < 5 \end{cases}$$

$$DD_0 = \sum_{i=1}^{365} \begin{cases} 0 - \dfrac{td_{\min i} + td_{\max i}}{2}, & \dfrac{td_{\min i} + td_{\max i}}{2} \le 0 \\ 0, & \dfrac{td_{\min i} + td_{\max i}}{2} > 0 \end{cases}$$

DENSITY MODEL DEVELOPMENT

Species-specific counts from point count surveys were modelled using Boosted Regression Trees (BRT), a form of machine learning with superior predictive performance than most traditional statistical models (Elith et al. 2008). We modeled counts as a Poisson distribution using the covariates described above and the QPAD offset term to account for variation in detection probability and survey protocol. To account for the non-random distribution of point count surveys across the landscape, we weighted each point count survey by the inverse of the number of point counts conducted in the same year within a 24.8×24.8-km square around each point count locations.

Boosted Regression Tree (BRT) models have four hyperparameters that need to be tuned in order to find the optimal settings that maximize predictive performance for a given dataset: learning rate (*lr*), tree complexity (*tc*), bag fraction (*bf*) and number of trees (*nt*). To tune the hyperparameters, we selected a range of candidate values for *lr* (0.05, 0.01, 0.005, and 0.001), *tc* (2, 3, 4, and 5) and *bf* (0.50 and 0.75), and developed models for each species using every combination of these values (for a total of 32 models per species). BRT models were fit using the gbm.step function in the dismo package (Hijmans et al. 2021) in R, which uses cross-validation statistics to determine the optimal value of the final hyperparameter, *nt*, for each combination of the other hyperparameters (see Elith et al. 2008 for a detailed description of the cross-validation process). Hyperparameters associated with the model that had the lowest predictive deviance (i.e., highest predictive performance) were used to develop all subsequent models.

To develop final density models for each species, we took 100 bootstrap samples of the count data stratified by year and fit BRT models to each sample. We extrapolated each bootstrap model using covariate values from 2018, then for each pixel calculated the median, 5% and 95% quantiles across Bootstrap model predictions. Median values were used for the final density models, and 5% and 95% quantiles were used to define the 90% confidence interval around density estimates. Final models were expressed as males/ha.

LITERATURE CITED

Agriculture and Agri-Food Canada. 2010. Land Cover of Canada. Agroclimate, Geomatics and Earth Observation Division, Science and Technology Branch. https://open.canada.ca/data/en/dataset/c688b87f-e85f-4842-b0e1-a8f79ebf1133

Agriculture and Agri-Food Canada. 2020. Annual space-based crop inventory for Canada, 2009-2020. Agroclimate, Geomatics and Earth Observation Division, Science and Technology Branch. https://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9

Agriculture and Agri-Food Canada. 2021. Canadian ag-land monitoring system. Agroclimate, Geomatics and Earth Observation Division, Science and Technology Branch. https://open.canada.ca/data/en/dataset/20b8aafa-dec3-4db2-84c1-f2f96797ef3f

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, UK.

Elith, J., J. R. Leathwick, and T. Hastie. 2008. A working guide to boosted regression trees. Journal of Animal Ecology 77:802-813.

Farnsworth, G. L., K. H. Pollock, J. D. Nichols, T. R. Simons, J. E. Hines, J. R. Sauer, and J. Brawn. 2002. A removal model for estimating detection probabilities from point-count surveys. The Auk 119:414-425.

Hijmans, R. J. 2021. raster: Geographic data analysis and modeling. R package version 3.5-2, https://CRAN.R-project.org/package=raster.

Hijmans, R. J., S. Phillips, J. R. Leathwick, and J. Elith. 2021. dismo: Species Distribution Modeling. R package version 1.3-5, https://CRAN.R-project.org/package=dismo.

McInnes, W. S., B. Smith, and G. J. McDermid. 2015. Discriminating Native and Nonnative Grasses in the Dry Mixedgrass Prairie With MODIS NDVI Time Series. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 8:1395-1403.

Militino, A. F., M. D. Ugarte, U. Pérez-Goya, and M. G. Genton. 2019. Interpolation of the Mean Anomalies for Cloud Filling in Land Surface Temperature and Normalized Difference Vegetation Index. IEEE Transactions on Geoscience and Remote Sensing 57:6068-6078.

Natural Resources Canada. 2002. Canada Land Inventory - Land capabiltiy for waterfowl. Centre for Topographic Information, Sherbrooke, QC, Canada.

Natural Resources Canada. 2015. Canadian digital elevation model. https://open.canada.ca/data/en/dataset/7f245e4d-76c2-4caa-951a-45d1d2051333

Olimb, S. K., A. P. Dixon, E. Dolfi, R. Engstrom, and K. Anderson. 2017. Prairie or planted? Using time-series NDVI to determine grassland characteristics in Montana. GeoJournal.

R Core Team. 2021. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Schwarz, G. 1978. Estimating the dimension of a model. The Annals of Statistics 6:461-464, 464.

Sólymos, P., S. M. Matsuoka, E. M. Bayne, S. R. Lele, P. Fontaine, S. G. Cumming, D. Stralberg, F. K. A. Schmiegelow, S. J. Song, and R. B. O'Hara. 2013. Calibrating indices of avian density from non-standardized survey data: making the most of a messy situation. Methods in Ecology and Evolution 4:1047-1058.

Sólymos, P., M. Moreno, and S. R. Lele. 2020. detect: Analyzing Wildlife Data with Detection Error. R package version 0.4-4. https://CRAN.R-project.org/package=detect.

Thornton, M. M., R. Shrestha, Y. Wei, P. E. Thornton, S. Kao, and B. E. Wilson. 2020a. Daymet: Daily Surface Weather Data on a 1-km Grid for North America, Version 4. ORNL Distributed Active Archive Center, Oak Ridge, Tennessee, USA. https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1840

Thornton, M. M., R. Shrestha, Y. Wei, P. E. Thornton, S. Kao, and B. E. Wilson. 2020b. Daymet: Monthly Climate Summaries on a 1-km Grid for North America, Version 4. ORNL Distributed Active Archive Center, Oak Ridge, Tennessee, USA. https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1855

APPENDIX 7: MEAN RELATIVE PRIORITY VALUES OF WATERFOWL TARGET LANDSCAPES FOR EACH NON-GAME BIRD GROUP

Mean relative priority values of pixels within each waterfowl target landscape for each non-game bird group. Target Landscapes with a mean relative priority value > 0.80 for at least one non-game bird group are in **bold**.

LANDSCAPE	PROVINCE	UPLAND	WETLAND	MIXED
ARROWWOOD	Alberta	0.78	0.21	**0.89**
BEAVERHILL	Alberta	0.20	0.56	0.46
BELLSHILL	Alberta	0.29	0.48	0.56
BIG HAY / BITTERN	Alberta	0.27	0.70	0.47
BUFFALO LAKE	Alberta	0.30	0.59	0.53
CALGARY EAST	Alberta	0.40	0.36	0.72
CALGARY WEST	Alberta	0.42	0.46	0.79
CLEAR LAKE	Alberta	0.62	0.35	**0.83**
CYPRESS	Alberta	0.70	0.29	0.61
DERWENT	Alberta	0.25	0.57	0.35
EASTERN PLAINS	Alberta	0.69	0.24	**0.83**
EID (EASTERN IRRIGATION DISTRICT)	Alberta	**0.90**	0.18	**0.89**
JENNER PLAINS	Alberta	**0.88**	0.26	**0.90**
KENILWORTH	Alberta	0.29	0.44	0.38
MILK RIVER RIDGE	Alberta	0.60	0.42	0.71
OWLSEYE	Alberta	0.15	0.49	0.22
PAKOWKI	Alberta	**0.84**	0.25	**0.88**
PINE LAKE	Alberta	0.28	0.36	0.37
SULLIVAN LAKE	Alberta	0.53	0.47	0.66
VERMILLION VIKING	Alberta	0.29	0.55	0.47
WINTERING HILLS	Alberta	0.63	0.26	**0.84**
ALLAN HILLS	Saskatchewan	0.44	0.47	0.55
BOUNDARY PLATEAU	Saskatchewan	**0.83**	0.30	**0.81**
CACTUS LAKE	Saskatchewan	0.40	0.37	0.69

LANDSCAPE	PROVINCE	UPLAND	WETLAND	MIXED
CONJURING CREEK	Saskatchewan	0.25	0.77	0.34
COTEAU CENTRAL	Saskatchewan	0.66	0.48	0.7
COTEAU NORTH	Saskatchewan	0.63	0.37	0.66
COTEAU SOUTH	Saskatchewan	0.63	0.61	0.66
DANA HILLS	Saskatchewan	0.26	0.65	0.50
FOX VALLEY	Saskatchewan	0.68	0.29	**0.90**
HILLMOND	Saskatchewan	0.28	0.44	0.42
LENORE / PONASS	Saskatchewan	0.20	0.64	0.35
LIGHTNING	Saskatchewan	0.53	0.74	0.48
PHEASANT HILLS	Saskatchewan	0.32	**0.85**	0.34
PRINCE ALBERT	Saskatchewan	0.32	**0.82**	0.43
QUILL SOUTH	Saskatchewan	0.44	0.61	0.51
REGINA EAST	Saskatchewan	0.39	0.68	0.42
THICKWOOD	Saskatchewan	0.22	0.59	0.38
TOUCHWOOD/BEAVER	Saskatchewan	0.33	0.76	0.30
TRAMPING LAKE EAST	Saskatchewan	0.28	0.47	0.54
UPPER ASSINIBOINE	Saskatchewan	0.30	**0.86**	0.37
VIRDEN SASK	Saskatchewan	0.36	0.78	0.28
ALEXANDER GRISWOLD	Manitoba	0.63	**0.95**	0.67
KILLARNEY	Manitoba	0.70	**0.90**	0.58
MINNEDOSA SHOAL	Manitoba	0.43	**0.82**	0.28
VIRDEN	Manitoba	0.73	**0.91**	0.54

APPENDIX 8. HABITAT OBJECTIVES BY WATERFOWL TARGET LANDSCAPE - PROVINCIAL DETAIL (WATERFOWL AND LANDBIRDS)

Alberta Habitat Objectives Narrative:

Habitat restoration and retention objectives for Alberta were based on a review of past habitat accomplishments by each delivery partner during the last PHJV IP period of 2013--2020 PHJV Implementation Planand, as well as analysis of current program delivery success within each respective PHJV target area, including other key areas in the province. Habitat objective projections for the next five years (2025) are based on anticipated delivery, while objectives out to 2040 include framing "what is required" to meet waterfowl deficit modeling results. Though aspirational, these longer-term objectives provide insight into the level of programming and resources needed, to fully achieve restoration and retention objectives, above existing program delivery accomplishmentsachievements. Alberta delivery partners feel that increased support to the Alberta's existing Alberta Wetland Policy (AWP) will be key to meeting longer-term, 20-year habitat objectives by reducing wetland loss rates across the province. Projections include program efforts to enhance awareness and understanding of the Wetland Policy across sectors, with a focus on agriculture. In addition, Alberta delivery partners have aligned grassland bird objectives with current upland targets for waterfowl and no additional projections were incorporated at this time. However, current grassland bird habitat deficits and priority areas for restoration and retention have been identified, including a focus on native grassland retention, and need for policy support;- delivery partners will be incorporating this need into annual work planning.

	2040 HABITAT OBJECTIVE ACRES	5FIVE-YEAR HABITAT OBJECTIVES (ACRES)			% 2040 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	
Habitat Restoration					
WINTER WHEAT	308,000		308,000	308,000	100%
TAME PASTURE					
ARROWWOOD	2,000	500	-	500	25%
BEAVERHILL	3,000	750	-	750	25%
BELLSHILL	2,500	625	-	625	25%
BIG HAY / BITTERN	3,000	750	-	750	25%
BUFFALO LAKE	2,000	500	-	500	25%
CALGARY EAST	2,500	625	-	625	25%
CALGARY WEST	2,000	500	-	500	25%
CLEAR LAKE	2,000	500	-	500	25%
CYPRESS	1,500	375	-	375	25%
DERWENT	2,000	500	-	500	25%
EASTERN PLAINS	6,000	1,500	-	1,500	25%
EASTERN IRRIGATION DISTRICT	2,000	500	-	500	25%
JENNER PLAINS	2,000	500	-	500	25%

TAME PASTURE					
KENILWORTH	2,000	500	-	500	25%
MILK RIVER RIDGE	3,000	750	-	750	25%
OWLSEYE	1,500	375	-	375	25%
PAKOWKI	2,000	500	-	500	25%
PINE LAKE	2,000	500	-	500	25%
SULLIVAN LAKE	6,000	1,500	-	1,500	25%
VERMILLION / VIKING	5,000	1,250	-	1,250	25%
WINTERING HILLS	1,500	375	-	375	25%
REMAINING DELIVERY AREA	11,167	2,792	-	2,792	25%
SUB-TOTAL	**66,667**	**16,667**	**-**	**16,667**	**25%**
TAME HAY					
ARROWWOOD	6,550	1,112	525	1,637	25%
BEAVERHILL	10,500	1,837	788	2,625	25%
BELLSHILL	8,975	1,587	656	2,244	25%
BIG HAY / BITTERN	11,400	2,062	788	2,850	25%
BUFFALO LAKE	7,000	1,225	525	1,750	25%
CALGARY EAST	7,850	1,306	656	1,962	25%
CALGARY WEST	6,325	1,056	525	1,581	25%
CLEAR LAKE	6,550	1,112	525	1,637	25%
CYPRESS	4,800	806	394	1,200	25%
DERWENT	6,550	1,112	525	1,637	25%
EASTERN PLAINS	20,550	3,562	1,575	5,137	25%
EASTERN IRRIGATION DISTRICT	7,000	1,225	525	1,750	25%
JENNER PLAINS	6,775	1,169	525	1,694	25%
KENILWORTH	7,000	1,225	525	1,750	25%
MILK RIVER RIDGE	10,050	1,725	788	2,512	25%
OWLSEYE	5,025	862	394	1,256	25%
PAKOWKI	6,550	1,112	525	1,637	25%
PINE LAKE	7,000	1,225	525	1,750	25%
SULLIVAN LAKE	20,550	3,562	1,575	5,137	25%

TAME HAY					
VERMILLION / VIKING	17,275	3,006	1,313	4,319	25%
WINTERING HILLS	5,925	1,087	394	1,481	25%
REMAINING DELIVERY AREA	34,958	5,808	2,931	8,740	25%
SUB-TOTAL	**225,158**	**38,790**	**17,500**	**56,290**	**25%**
WETLANDS					
ARROWWOOD	1,452	138	225	363	25%
BEAVERHILL	2,957	288	452	739	25%
BELLSHILL	2,994	163	586	748	25%
BIG HAY / BITTERN	3,829	563	395	957	25%
BUFFALO LAKE	1,604	150	251	401	25%
CALGARY EAST	1,270	194	124	318	25%
CALGARY WEST	1,737	131	303	434	25%
CLEAR LAKE	1,144	138	149	286	25%
CYPRESS	283	69	2	71	25%
DERWENT	1,081	75	195	270	25%
EASTERN PLAINS	5,623	600	806	1,406	25%
EASTERN IRRIGATION DISTRICT	1,321	275	55	330	25%
JENNER PLAINS	1,176	269	25	294	25%
KENILWORTH	1,594	150	248	398	25%
MILK RIVER RIDGE	926	150	81	231	25%
OWLSEYE	600	138	13	150	25%
PAKOWKI	1,163	38	253	291	25%
PINE LAKE	907	150	77	227	25%
SULLIVAN LAKE	3,398	438	412	849	25%
VERMILLION / VIKING	3,645	181	730	911	25%
WINTERING HILLS	2,705	288	389	676	25%
REMAINING DELIVERY AREA	6,717	525	1,154	1,679	25%
SUB-TOTAL	**48,125**	**5,106**	**6,925**	**12,031**	**25%**
RESTORATION TOTAL	**429,950**	**60,562**	**114,425**	**174,987**	**41%**

Habitat Retention

WETLAND					
ARROWWOOD	20,589	500	4,647	5,147	25%
BEAVERHILL	33,894	438	8,036	8,473	25%
BELLSHILL	39,020	369	9,386	9,755	25%
BIG HAY / BITTERN	58,852	550	14,163	14,713	25%
BUFFALO LAKE	46,096	375	11,149	11,524	25%
CALGARY EAST	15,572	475	3,418	3,893	25%
CALGARY WEST	20,420	450	4,655	5,105	25%
CLEAR LAKE	8,953	444	1,794	2,238	25%
CYPRESS	2,453	225	388	613	25%
DERWENT	13,754	256	3,182	3,438	25%
EASTERN PLAINS	122,361	1,166	29,424	30,590	25%
EASTERN IRRIGATION DISTRICT	27,300	300	6,525	6,825	25%
JENNER PLAINS	10,248	288	2,274	2,562	25%
KENILWORTH	20,142	306	4,729	5,036	25%
MILK RIVER RIDGE	15,534	831	3,052	3,884	25%
OWLSEYE	11,628	188	2,719	2,907	25%
PAKOWKI	20,005	453	4,549	5,001	25%
PINE LAKE	10,379	338	2,257	2,595	25%
SULLIVAN LAKE	68,940	963	16,272	17,235	25%
VERMILLION / VIKING	61,130	850	14,433	15,283	25%
WINTERING HILLS	39,718	638	9,292	9,929	25%
REMAINING DELIVERY AREA	131,127	1,513	31,269	32,782	25%
SUB-TOTAL	**798,109**	**11,913**	**187,615**	**199,527**	**25%**
UPLAND					
ARROWWOOD	18,997	1,438	3,312	4,749	25%
BEAVERHILL	22,745	2,113	3,574	5,686	25%
BELLSHILL	30,175	1,644	5,900	7,544	25%
BIG HAY / BITTERN	27,524	3,025	3,856	6,881	25%
BUFFALO LAKE	21,128	1,538	3,744	5,282	25%
CALGARY EAST	12,326	1,306	1,775	3,082	25%

UPLAND					
CALGARY WEST	18,903	1,175	3,551	4,726	25%
CLEAR LAKE	8,514	1,119	1,010	2,128	25%
CYPRESS	6,393	1,044	554	1,598	25%
DERWENT	8,874	1,100	1,119	2,219	25%
EASTERN PLAINS	86,608	5,688	15,964	21,652	25%
EASTERN IRRIGATION DISTRICT	17,681	1,575	2,845	4,420	25%
JENNER PLAINS	11,559	1,525	1,365	2,890	25%
KENILWORTH	17,065	1,431	2,835	4,266	25%
MILK RIVER RIDGE	18,340	2,081	2,504	4,585	25%
OWLSEYE	3,920	900	80	980	25%
PAKOWKI	22,311	1,025	4,553	5,578	25%
PINE LAKE	14,761	1,325	2,365	3,690	25%
SULLIVAN LAKE	50,550	4,300	8,337	12,637	25%
VERMILLION / VIKING	43,767	3,525	7,417	10,942	25%
WINTERING HILLS	31,151	2,413	5,375	7,788	25%
REMAINING DELIVERY AREA	18,250	4,563	-	4,563	25%
SUB-TOTAL	**511,542**	**45,850**	**82,035**	**127,885**	**25%**
RETENTION TOTAL	**1,309,651**	**57,263**	**265,003**	**322,265**	**25%**
GRAND TOTAL	**1,739,600**	**118,325**	**384,075**	**502,400**	

Grassland Birds

Habitat Retention

	2035 HABITAT OBJECTIVE ACRES	5-YEAR ACCOMPLISHMENTS (ACRES)			% 2035 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	
UPLAND					
ARROWWOOD	93,939	3,050	3,312	6,362	7%
BEAVERHILL	1,740	4,700	3,574	8,274	476%
BELLSHILL	8,224	3,856	5,900	9,756	119%
BIG HAY / BITTERN	5,377	5,887	3,856	9,743	181%
BUFFALO LAKE	4,270	3,337	3,744	7,082	166%

UPLAND					
CALGARY EAST	24,197	3,237	1,775	5,013	21%
CALGARY WEST	33,053	2,731	3,551	6,282	19%
CLEAR LAKE	93,149	2,731	1,010	3,741	4%
CYPRESS	1,581	2,225	554	2,779	176%
DERWENT	316	2,712	1,119	3,831	1211%
EASTERN PLAINS	82,711	10,750	15,964	26,714	32%
EASTERN IRRIGATION DISTRICT	7,117	3,300	2,845	6,145	86%
JENNER PLAINS	-	3,194	1,365	4,559	0%
KENILWORTH	11,387	3,156	2,835	5,991	53%
MILK RIVER RIDGE	9,805	4,654	2,504	7,158	73%
OWLSEYE	-	2,137	80	2,218	0%
PAKOWKI	99,791	2,662	4,553	7,215	7%
PINE LAKE	633	3,050	2,365	5,415	856%
SULLIVAN LAKE	13,284	9,865	8,337	18,202	137%
VERMILLION / VIKING	18,029	7,781	7,417	15,198	84%
WINTERING HILLS	63,417	3,875	5,375	9,250	15%
REMAINING DELIVERY AREA	1,158,903	50,662	-	50,662	4%
GRASSLANDS TOTAL	**1,636,982**	**139,556**	**82,035**	**221,592**	**14%**

Saskatchewan Habitat Objectives Narrative:

Saskatchewan applied a stepwise approach to setting habitat objectives. The objective setting approach applied a blend of aspirational and pragmatic approaches. The aspirational approach was needed to frame the long-term conservation challenges presented by the projected hatched nest deficit in Saskatchewan. The Saskatchewan NAWMP committee ensured a balance between the aspirational approach to highlight the need and urgency of conservation action with partner insight on delivery capacity. Habitat retention and restoration objectives set for Saskatchewan were developed through a stepwise process, examining program benefits and program delivery capacity relative to the waterfowl deficit at each step. First, an analysis of program delivery over the past eight years by program type was completed and future delivery projections were based on restoration and retention achievements. Program delivery based on 2012--2020 accomplishments were projected to 2040 and the program contributions to reduce the waterfowl deficit was modelled. The initial modeling results predicted continued wetland loss to 2040; therefore, the Saskatchewan delivery partners decided a more aggressive approach was necessary to minimize the waterfowl deficit. Increases to objectives varied by partner, but typically involved continued program delivery at levels equivalent to what was delivered in the past eight years. Significant increases in upland restoration objectives were added for landscape areas with considerable upland bird potential. The five-year objectives are based on achieving 25%per cent of the long term 2040 objectives. Grassland birds were integrated into the waterfowl objectives for each Target Landscape and the remaining delivery area. The grassland bird objectives for each Target Landscape were compared to upland habitat retention objectives and upland restoration objectives (50%per cent of restoration objectives), and additional acres were added where waterfowl-only objectives fell short of the required habitat to support grassland birds.

	2040 HABITAT OBJECTIVE ACRES	5FIVE-YEAR HABITAT OBJECTIVES (ACRES)	% 2040 HABITAT OBJECTIVE		
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	
Habitat Restoration					
WINTER WHEAT	561,000		561,000	561,000	100%
TAME PASTURE					
ALLAN HILLS	59,300	9,636	5,189	14,825	25%
BOUNDARY PLATEAU	43,600	7,079	3,812	10,890	25%
CACTUS LAKE	8,000	1,294	697	1,990	25%
CONJURING CREEK	9,500	1,544	831	2,375	25%
COTEAU CENTRAL	100,300	16,293	8,773	25,066	25%
COTEAU NORTH	14,500	2,360	1,271	3,630	25%
COTEAU SOUTH	44,800	7,275	3,917	11,193	25%
DANA HILLS	13,500	2,194	1,181	3,375	25%
FOX VALLEY	7,000	1,138	613	1,750	25%
HILLMOND	0	0	0	-	0%
LENORE / PONASS	2,500	406	219	625	25%
LIGHTNING	88,000	14,300	7,700	22,000	25%
PHEASANT HILLS	40,000	6,500	3,500	10,000	25%
PRINCE ALBERT	1,000	163	88	250	25%
QUILL SOUTH	12,100	1,966	1,059	3,025	25%
REGINA EAST	14,000	2,275	1,225	3,500	25%
THICKWOOD	12,500	2,033	1,095	3,128	25%
TOUCHWOOD / BEAVER	45,000	7,313	3,938	11,250	25%
TRAMPING LAKE EAST	36,300	5,899	3,176	9,075	25%
UPPER ASSINIBOINE	60,000	9,750	5,250	15,000	25%
VIRDEN SASK	15,000	2,438	1,313	3,750	25%
REMAINING DELIVERY AREA	452,500	73,538	39,597	113,135	25%
SUB-TOTAL	**1,079,400**	**175,391**	**94,441**	**269,832**	**25%**

TAME HAY					
ALLAN HILLS	39,900	6,489	3,494	9,983	25%
BOUNDARY PLATEAU	29,000	4,719	2,541	7,260	25%
CACTUS LAKE	5,000	813	438	1,250	25%
CONJURING CREEK	6,500	1,056	569	1,625	25%
COTEAU CENTRAL	37,500	6,095	3,282	9,378	25%
COTEAU NORTH	9,700	1,573	847	2,420	25%
COTEAU SOUTH	29,700	4,822	2,597	7,419	25%
DANA HILLS	9,000	1,463	788	2,250	25%
FOX VALLEY	1,800	286	154	440	24%
HILLMOND	0	0	0	-	0%
LENORE / PONASS	2,000	325	175	500	25%
LIGHTNING	59,000	9,588	5,163	14,750	25%
PHEASANT HILLS	26,000	4,225	2,275	6,500	25%
PRINCE ALBERT	500	81	44	125	25%
QUILL SOUTH	8,500	1,376	741	2,118	25%
REGINA EAST	4,500	731	394	1,125	25%
THICKWOOD	8,500	1,381	744	2,125	25%
TOUCHWOOD / BEAVER	30,000	4,875	2,625	7,500	25%
TRAMPING LAKE EAST	24,200	3,933	2,118	6,050	25%
UPPER ASSINIBOINE	40,000	6,500	3,500	10,000	25%
VIRDEN SASK	10,000	1,625	875	2,500	25%
REMAINING DELIVERY AREA	76,200	12,387	6,670	19,058	25%
SUB-TOTAL	**457,500**	**74,343**	**40,031**	**114,374**	**25%**
PLANTED COVER					
ALLAN HILLS	2,600	650	-	650	25%
BOUNDARY PLATEAU	1,000	250	-	250	25%
CACTUS LAKE	1,000	250	-	250	25%
CONJURING CREEK	1,600	400	-	400	25%
COTEAU CENTRAL	2,100	525	-	525	25%
COTEAU NORTH	100	25	-	25	25%
COTEAU SOUTH	2,400	600	-	600	25%

PLANTED COVER					
DANA HILLS	500	125	-	125	25%
FOX VALLEY	0	0	-	-	0%
HILLMOND	0	0	-	-	0%
LENORE / PONASS	0	0	-	-	0%
LIGHTNING	1,800	450	-	450	25%
PHEASANT HILLS	1,300	325	-	325	25%
PRINCE ALBERT	0	0	-	-	0%
QUILL SOUTH	500	125	-	125	25%
REGINA EAST	0	0	-	-	0%
THICKWOOD	700	175	-	175	25%
TOUCHWOOD / BEAVER	1,000	250	-	250	25%
TRAMPING LAKE EAST	1,500	375	-	375	25%
UPPER ASSINIBOINE	1,000	250	-	250	25%
VIRDEN SASK	500	125	-	125	25%
REMAINING DELIVERY AREA	900	225	-	225	25%
SUB-TOTAL	**20,500**	**5,125**	**-**	**5,125**	**25%**
WETLANDS					
ALLAN HILLS	788	197	-	197	25%
BOUNDARY PLATEAU	638	159	-	159	25%
CACTUS LAKE	38	9	-	9	25%
CONJURING CREEK	1,950	488	-	488	25%
COTEAU CENTRAL	300	75	-	75	25%
COTEAU NORTH	38	9	-	9	25%
COTEAU SOUTH	525	131	-	131	25%
DANA HILLS	330	83	-	83	25%
FOX VALLEY	38	9	-	9	25%
HILLMOND	38	9	-	9	25%
LENORE / PONASS	300	75	-	75	25%
LIGHTNING	1,650	413	-	413	25%
PHEASANT HILLS	90	23	-	23	25%
PRINCE ALBERT	38	9	-	9	25%

WETLANDS					
QUILL SOUTH	315	79	-	79	25%
REGINA EAST	300	75	-	75	25%
THICKWOOD	645	161	-	161	25%
TOUCHWOOD / BEAVER	1,665	416	-	416	25%
TRAMPING LAKE EAST	323	81	-	81	25%
UPPER ASSINIBOINE	3,866	967	-	967	25%
VIRDEN SASK	300	75	-	75	25%
REMAINING DELIVERY AREA	2,378	594	-	594	25%
SUB-TOTAL	**16,549**	**4,137**	**-**	**4,137**	**25%**
RESTORATION TOTAL	**1,573,949**	**258,996**	**134,472**	**393,468**	**25%**

Habitat Retention

WETLAND					
ALLAN HILLS	20,000	5,000	-	5,000	25%
BOUNDARY PLATEAU	6,000	1,500	-	1,500	25%
CACTUS LAKE	10,000	2,500	-	2,500	25%
CONJURING CREEK	5,000	1,250	-	1,250	25%
COTEAU CENTRAL	10,000	2,500	-	2,500	25%
COTEAU NORTH	4,000	1,000	-	1,000	25%
COTEAU SOUTH	25,000	6,250	-	6,250	25%
DANA HILLS	15,500	3,875	-	3,875	25%
FOX VALLEY	200	50	-	50	25%
HILLMOND	500	125	-	125	25%
LENORE / PONASS	2,000	500	-	500	25%
LIGHTNING	25,000	6,250	-	6,250	25%
PHEASANT HILLS	3,500	875	-	875	25%
PRINCE ALBERT	1,900	475	-	475	25%
QUILL SOUTH	29,800	7,450	-	7,450	25%
REGINA EAST	2,000	500	-	500	25%
THICKWOOD	2,200	550	-	550	25%
TOUCHWOOD / BEAVER	21,700	5,425	-	5,425	25%

WETLAND					
TRAMPING LAKE EAST	10,000	2,500	-	2,500	25%
UPPER ASSINIBOINE	17,000	4,250	-	4,250	25%
VIRDEN SASK	5,000	1,250	-	1,250	25%
REMAINING DELIVERY AREA	70,000	17,500	-	17,500	25%
SUB-TOTAL	**286,300**	**71,575**	**-**	**71,575**	**25%**
UPLAND					
ALLAN HILLS	40,000	10,000	-	10,000	25%
BOUNDARY PLATEAU	87,000	21,750	-	21,750	25%
CACTUS LAKE	50,000	12,500	-	12,500	25%
CONJURING CREEK	7,500	1,875	-	1,875	25%
COTEAU CENTRAL	100,000	25,000	-	25,000	25%
COTEAU NORTH	32,000	8,000	-	8,000	25%
COTEAU SOUTH	106,000	26,500	-	26,500	25%
DANA HILLS	7,000	1,750	-	1,750	25%
FOX VALLEY	30,000	7,500	-	7,500	25%
HILLMOND	3,300	825	-	825	25%
LENORE / PONASS	4,200	1,050	-	1,050	25%
LIGHTNING	37,500	9,375	-	9,375	25%
PHEASANT HILLS	1,800	450	-	450	25%
PRINCE ALBERT	100	25	-	25	25%
QUILL SOUTH	25,000	6,250	-	6,250	25%
REGINA EAST	20,000	5,000	-	5,000	25%
THICKWOOD	3,800	950	-	950	25%
TOUCHWOOD / BEAVER	6,000	1,500	-	1,500	25%
TRAMPING LAKE EAST	50,000	12,500	-	12,500	25%
UPPER ASSINIBOINE	6,000	1,500	-	1,500	25%
VIRDEN SASK	6,000	1,500	-	1,500	25%
REMAINING DELIVERY AREA	1,400,000	350,000	-	350,000	25%
SUB-TOTAL	**2,023,200**	**505,800**	**-**	**505,800**	**25%**
RETENTION TOTAL	**2,309,500**	**577,375**	**-**	**577,375**	**25%**
GRAND TOTAL	**3,883,449**	**836,371**	**134,472**	**970,843**	**25%**

Grassland Birds

Habitat Retention

	2035 HABITAT OBJECTIVE ACRES	FIVE5-YEAR HABITAT OBJECTIVE (ACRES)			% 2035 HABITAT OBJECTIVE
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	
UPLAND					
ALLAN HILLS	41,435	-	-	-	0%
BOUNDARY PLATEAU	108,647	-	-	-	0%
CACTUS LAKE	45,230	-	-	-	0%
CONJURING CREEK	316	-	-	-	0%
COTEAU CENTRAL	170,641	-	-	-	0%
COTEAU NORTH	39,221	-	-	-	0%
COTEAU SOUTH	116,871	-	-	-	0%
DANA HILLS	8,540	-	-	-	0%
FOX VALLEY	65,315	-	-	-	0%
HILLMOND	3,321	-	-	-	0%
LENORE / PONASS	-	-	-	-	0%
LIGHTNING	69,268	-	-	-	0%
PHEASANT HILLS	-	-	-	-	0%
PRINCE ALBERT	-	-	-	-	0%
QUILL SOUTH	30,048	-	-	-	0%
REGINA EAST	26,885	-	-	-	0%
THICKWOOD	158	-	-	-	0%
TOUCHWOOD / BEAVER	19,768	-	-	-	0%
TRAMPING LAKE EAST	27,834	-	-	-	0%
UPPER ASSINIBOINE	3,479	-	-	-	0%
VIRDEN SASK	8,698	-	-	-	0%
REMAINING DELIVERY AREA	1,648,685	-	-	-	0%
GRASSLAND TOTALS	**2,434,360**	**-**	**-**	**-**	**0%**

Manitoba Habitat Objectives Narrative:

Habitat retention and restoration objectives set for Manitoba were developed through a two-step process, examining program benefits relative to the waterfowl deficit at each step. First, an analysis of program delivery over the past 8 eight years by each delivery partner was completed, and future delivery projections were based on average restoration and retention achievements. These results were projected to 2025 and 2040, and their impact on the waterfowl deficit was modelled. At the second step, recent changes to wetland drainage policy in Manitoba were incorporated into the 2040 waterfowl deficit modelling, assuming wetland loss ceasing in 2025. Based on initial model results, the Manitoba delivery partners decided a more aggressive approach was necessary to minimize the waterfowl deficit. Increases to objectives varied by partner, but typically involved continuing program delivery at 2020 levels, with minor increases for future years. Incremental nests realized through nest structure installations were counted separately from nests gained through habitat objectives and are considered additional to the deficit / surplus achieved through habitat programming. Grassland bird objectives were compared to upland habitat retention objectives established for waterfowl benefits. Delivery partners identified that the co-delivery benefits exceeded grassland bird specific objectives and therefore, no additional programming objectives were established.

	2040 HABITAT OBJECTIVE ACRES	5FIVE-YEAR HABITAT OBJECTIVES (ACRES)	% 2040 HABITAT OBJECTIVE		
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	
Habitat Restoration					
WINTER WHEAT	238,000		238,000	238,000	100%
TAME PASTURE					
ALEXANDER / GRISWOLD	1,150	290	-	290	25%
KILLARNEY	13,060	3,270	-	3,270	25%
MINNEDOSA / SHOAL	28,820	7,220	-	7,220	25%
VIRDEN	12,030	3,010	-	3,010	25%
REMAINING DELIVERY AREA	51,930	7,540	-	7,540	15%
SUB-TOTAL	106,990	21,330	-	21,330	20%
TAME HAY					
ALEXANDER / GRISWOLD	770	200	-	200	26%
KILLARNEY	8,710	2,180	-	2,180	25%
MINNEDOSA / SHOAL	19,220	4,810	-	4,810	25%
VIRDEN	8,020	2,010	-	2,010	25%
REMAINING DELIVERY AREA	34,620	7,010	-	7,010	20%
SUB-TOTAL	**71,340**	**16,210**	**-**	**16,210**	**23%**
PLANTED COVER					
ALEXANDER / GRISWOLD	-	-	-	-	0%
KILLARNEY	-	-	-	-	0%
MINNEDOSA / SHOAL	100	30	-	30	30%

PLANTED COVER					
VIRDEN	-	-	-	-	0%
REMAINING DELIVERY AREA	-	-	-	-	0%
SUB-TOTAL	**100**	**30**	**-**	**30**	**30%**
WETLANDS					
ALEXANDER / GRISWOLD	-	-	-	-	0%
KILLARNEY	1,610	410	-	410	25%
MINNEDOSA / SHOAL	1,250	320	-	320	26%
VIRDEN	230	60	-	60	26%
REMAINING DELIVERY AREA	6,070	1,190	-	1,190	20%
SUB-TOTAL	**9,160**	**1,980**	**-**	**1,980**	**22%**
NESTING TUNNELS (STRUCTURES)					
ALEXANDER / GRISWOLD	-	-	-	-	0%
KILLARNEY	-	-	-	-	0%
MINNEDOSA / SHOAL	4,200	1,050	-	1,050	25%
VIRDEN	400	100	-	100	25%
REMAINING DELIVERY AREA	400	100	-	100	25%
SUB-TOTAL	**5,000**	**1,250**	**-**	**1,250**	**25%**
DELAYED HAY					
ALEXANDER / GRISWOLD	-	-	-	-	0%
KILLARNEY	-	-	-	-	0%
MINNEDOSA / SHOAL	3,130	790	-	790	25%
VIRDEN	1,640	410	-	410	25%
REMAINING DELIVERY AREA	7,970	2,000	-	2,000	25%
SUB-TOTAL	**12,740**	**3,200**	**-**	**3,200**	**25%**
RESTORATION TOTAL	**205,330**	**44,000**	**-**	**44,000**	**21%**

Habitat Retention

		WETLAND			
ALEXANDER / GRISWOLD	1,760	440	-	440	25%
KILLARNEY	21,710	5,300	-	5,300	24%
MINNEDOSA / SHOAL	38,090	9,290	-	9,290	24%
VIRDEN	18,650	4,500	-	4,500	24%
REMAINING DELIVERY AREA	62,490	12,300	-	12,300	20%
SUB-TOTAL	**142,700**	**31,830**	**-**	**31,830**	**22%**
		UPLAND			
ALEXANDER / GRISWOLD	2,540	640	-	640	25%
KILLARNEY	18,400	4,580	-	4,580	25%
MINNEDOSA / SHOAL	24,390	6,080	-	6,080	25%
VIRDEN	38,560	9,620	-	9,620	25%
REMAINING DELIVERY AREA	168,260	41,560	-	41,560	25%
SUB-TOTAL	**252,150**	**62,480**	**-**	**62,480**	**25%**
RETENTION TOTAL	**394,850**	**94,310**	**-**	**94,310**	**24%**
GRAND TOTAL	**600,180**	**138,310**	**-**	**138,310**	**23%**

Grassland Birds

	2035 HABITAT OBJECTIVE ACRES	FIVE5-YEAR HABITAT OBJECTIVE (ACRES)	% 2035 HABITAT OBJECTIVE		
		DIRECT NAWMP	EXTENSION NAWMP	TOTAL	

Habitat Retention

		UPLAND			
ALEXANDER / GRISWOLD	-	640	-	640	0%
KILLARNEY	1,107	4,580	-	4,580	414%
MINNEDOSA / SHOAL	2,372	6,080	-	6,080	256%
VIRDEN	30,839	9,620	-	9,620	31%
REMAINING DELIVERY AREA	115,922	41,560	-	41,560	36%
GRASSLANDS TOTAL	**150,240**	**62,480**	**-**	**62,480**	**42%**

ANNEX A:
A REVIEW OF PHJV POLICY ACHIEVEMENTS 2013–2020 AND POLICY OBJECTIVES, 2021–2025

Policy Committee worked under an eight-year work plan (2015–2020) that focused on five objectives. These objectives, their status and Policy Committee accomplishments are described in Table A1 below.

TABLE A1. PHJV policy objectives and accomplishments (2013–2020)

	OBJECTIVE	ACCOMPLISHMENT
1	Supporting government legislation, policies and programs that benefit wetland and upland waterfowl habitat.	Prairie Wetland Policy Leads Meeting (Regina 2019) (Active engagement from provincial policy leads)
2	Fostering mutual awareness of and learning from the ongoing policy development experience of the three prairie provinces.	2016 Workshop and Report Wetland Policies, Regulations and Science in Prairie Canada: An Assessment of Mutual Needs and Future Directions 2018 Workshop and Report Finding Common Ground Between the Agriculture Industry and Wetland Policy (Edmonton 2018) PHJV Policy Webinar Series (Thematic approach to conservation issues, averaging 30 attendees per webinar and 42 YouTube channel views afterwards) PHJV Policy Newsletter (Distribution to 230 policy practitioners and influences in Canada and the USA)
3	Build a regional capacity to support wetland policy development specifically around wetland mitigation.	Research funding for: Sustainability Standards, Market Access and Prairie Wetland Conservation (2018) ($10,000) AB Wetland Classification project (2019) ($10,000) MB Wetland classification to support policy delivery (2019) ($10,000) WSA Agriculture producer focus groups on barriers and motivators for drainage compliance (2019) ($10,000) Review of MB boreal wetland codes of practice for application in SK (2020) ($10,000)
4	Support provincial policy development by standardizing and sharing information related to wetland and permanent cover programs.	Scan of agriculture, wetland and wildlife management agencies in Manitoba, Saskatchewan and Alberta: Conservation Policy Needs and Roles for PHJV Policy Committee (2014)
5	Supporting networking between provinces by providing a forum to share information and experiences in wetland and permanent cover retention policy.	2016 Workshop and Report Wetland Policies, Regulations and Science in Prairie Canada: An Assessment of Mutual Needs and Future Directions 2018 Workshop and Report Finding Common Ground Between the Agriculture Industry and Wetland Policy (Edmonton 2018) Prairie Wetland Policy Leads Meeting (Regina 2019) (Active engagement from provincial policy leads rather than passive observation)
6	Adopt a sharper focus on grazing and forage lands.	Grassland Situational Analysis (2018) Grassland Economics: Conservation and Competing Interests in Prairie Canada (2019)

Within the duration of the 2013–2020 IP, significant advances were made in the realm of wetland policy across the prairies. These advances are captured under the labels of "direct" (formal legislative policy) and "indirect" (associated programs and initiatives under the umbrella of legislation) for both wetland and grassland habitat across Alberta, Saskatchewan and Manitoba.

TABLE A2. BACKCASTING: Partner and provincial policy accomplishments (2013–2020)

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION	DATE
		Federal	AAFC and ECCC stewardship funding	Agricultural Climate Solutions; Nature Smart Climate Solutions and Nature Legacy funding programs.	2020
DIRECT REGULATORY POLICY	Wetland	AB	Wetland Policy	Policy drafted and passed with estimated 131,000 acres (in addition to direct delivery by partners) influenced by the policy.	2013
			Wetland Policy Implementation	Policy regulatory requirements and mitigation system implemented.	2016
			Wetland Replacement Program	Ministerial Order in force, financial and contracting controls developed and operationalized, program in effect to deliver wetland replacement under outcome 3 of AWP.	2020
			Wetland Policy Review	Evaluate current effectiveness of policy.	2020
			Wetland Code of Practice	Regulate activities through approvals enabled by the Water Act.	2020
		SK	Water Security Agency Regulations revised	Regulate drainage activities under the WSA Act and Regulations. Revisions to the regulations completed, WSA Regulations empower the direction of the Ag Water management strategy and supporting policies.	2015
			SK AWMS Policies	Development of associated policies.	2013–2020
			Drainage Approvals	Approved 4,469 quarter sections that include some mitigation conditions, but these do not include considerations for wetlands currently in the mitigation conditions. There are considerations for flow controls, sediment and erosion control etc.	2020

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION	DATE
		MB	Sustainable Watersheds Act (amended)	Manitoba's Watershed-based Policy Framework was proposed in 2017 and proposed changes included: 1. Modernization of Manitoba's Conservation Districts Program; 2. Watershed-Based Drainage and Water Resource Management; and 3. Growing Outcomes in Watersheds (GROW). The Sustainable Watershed Bill amended four pieces of legislation including The Conservation Districts Act, The Water Rights Act, The Water Protection Act, and The Manitoba Habitat Heritage Corporation Act. This brought changes to water-based governance in Manitoba, new regulatory regimes to water management and provisions to allow for the establishment of GROW.	2018
			Water Rights Act and Regulations (amended)	Through the Sustainable Watersheds Bill, The Water Rights Act was amended to further enhance the protection of more permanent wetlands through a goal of no net loss of wetland benefits.	2019
			Water Rights Regulation (amended 130/2019)	Class 4 and 5 wetlands have been protected since late 1980s. The amendment was a recommitment of Class 4 and 5 wetland protection and strengthening of Class 3 wetland protection through a new requirement to compensate for the loss or alteration of a Class 3 wetland. In addition, a new requirement for registration of Class 1 and 2 drainage, with continued policy of no drainage of Class 4 and 5 in general. Estimated protection of 500,000 acres of Class 4 and 5 wetlands enhanced to include Class 3 compensation.	2019
			Peatlands Stewardship Act (and related amendments)	The Act requires peat harvest licence holders to submit comprehensive Peatland Management and Recovery Plans. The Act also establishes restrictions for future commercial peat developments in provincial parks and wildlife management areas, as well as gives the Provincial Government the ability to designate and protect provincially significant peatlands.	2020
			Climate and Green Plan (2018–2022)	Provincial Government is continuing to explore carbon offsets, carbon sequestration and the value of carbon in wetlands (including GROW).	2017
			Hunting Policy Changes	New spring conservation Canada Goose season for the month of March in Manitoba; a new Sandhill Crane season in Alberta; a lowering in the age requirement for Alberta to 10; new areas opened to hunting in Alberta; and the liberalization of pintail limits in both Alberta and Saskatchewan.	2019

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION	DATE
	Grassland	AB	Avoided Conversion of Grassland Protocols	Under development including several research projects to support the science behind the protocols - specific focus on carbon in wetland and grassland ecosystems.	2018
			Alberta Grassland Policy Roadmap	Review of existing legislation, regulation, and policies for public and private grasslands, with native grassland focus.	2020
		SK	Agriculture Crown Land Policy revised	No to clear / break / drain on native grassland.	2018
			Southern Conservation Land Management Strategy	Instituted to conserve ecological values through continued Crown ownership or through Crown conservation easements on 3.0M acres of Wildlife Habitat Protection Act designated land (Ministries of Agriculture and Environment).	2016
			Climate and Green Plan (2018–2022)	Provincial government is continuing to explore carbon offsets, carbon sequestration and the value of carbon in wetlands and grasslands.	2017
			Crown Lands Modernization	In November 2018, the Manitoba Government passed The Crown Lands Amendment Act (Improved Management of Community Pastures and Agricultural Crown Lands). This piece of legislation provides for the ability to protect Community Pastures through special designation, while also enabling a public auction mechanism for the allocation of agricultural leases and permits. As well aspects of the leasing program have been modernized to improve predictability, transparency and efficiency in program administration.	2018
ENABLED STEWARDSHIP POLICY	Wetland	AB	Tools and Directives	1. Four Alberta Wetland Rapid Evaluation Tools (ABWRET) and associated guides for all regions of Alberta; 2. Alberta Identification and Delineation Directive, Alberta Wetland Classification System, Alberta Wetland Assessment and Impact Report and Form, Alberta Wetland Mitigation Directive, Directive for Permittee-responsible Wetland Construction, Professional Responsibilities in Completion and Assurance of Wetland Science, Design, and Engineering Work in Alberta, Alberta Merged Wetland Inventory, and Alberta Wetland Mapping Standards and Guidelines: Mapping Wetland at an Inventory Scale; 3. Alberta's Wetlands: A Law and Policy Guide, 4. Municipal Wetland Guide; and 5. Education and outreach (Human Dimensions) on policy issues through forums, webinars and piloting of Alberta's Wetland Education Network (WEN). Projects noted are just highlights, not full list.	2015–2020

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION	DATE
		SK	Draft Operational Guidelines for Offsetting Development Impacts on Prairie wetlands	Pilot testing of offset prototype at six non-agriculture industry projects resulting in wetland restoration.	2015–2020
			Wetland Inventory	Wetland mapping inventory commenced.	2020
			Prairie Resilience: A made in SK Climate Change Strategy	Plan is focused on addressing impacts of climate change by building capacity in five key resilience areas.	
		MB	Wetland Inventory	Ducks Unlimited Canada (DUC) and the Manitoba Habit Heritage Corporation (MHHC), with the support of Manitoba and others mapped wetlands >0.1 ha in southern Manitoba and >1ha in the Boreal Forest of eastern Manitoba. DUC has also undertaken wetland mapping within the Boreal Plains Ecozone of Manitoba. Ongoing work by PHJV partners to classify this data with potential use in association with GROW and drainage legislation.	2019
			GROW Trust	Program and funding source to provide private landowners with annual incentives to conserve, restore and enhance at-risk habitats in Manitoba. $52M endowed to provide perpetual incentives.	2019
			Wetlands GROW Trust	Program and funding source to provide private landowners with incentives to conserve Class 1 and 2 wetlands. $50M endowed to provide perpetual incentives.	2019
			Conservation Trust	Grant program that includes significant funding for wetlands conservation and enhancement incentives. Significant grasslands and perennial cover incentives are also delivered. $102M endowment provides perpetual revenues.	
			Mitigation – Hydro/MI	Wetland mitigation is required for project impacts (e.g., Bipole III).	2017
			Manitoba Wetland Assessment Method	Manitoba Wetland Assessment Method (MB WAM). Initiated.	2018
	Grassland	AB	Grassland Roadmap	Ongoing research.	2019
		SK	Grassland Offsets piloted	K+S Potash Canada project (NCC, Ministry of Environment with K+S Potash Canada).	2019

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION	DATE
			Prairie Landscape Inventory project	Completed for mixed grassland ecoregion (Ministry of Environment).	2019
		MB	Grassland Inventory	Agriculture and Resource Development is working with consultants and academia to develop a grassland inventory for Manitoba. Field sampling being planned for 2021 and in the future as necessary.	2020-21
			Grassland Compensation	Compensation agreement established for grassland impacts resulting from Birtle hydro line development.	2020-21

Note: it is a priority of the Policy Committee during the 2021–-2025 IP to explore approaches to measurement and metrics for policy initiatives.

Table A3. FORECASTING: Partner and provincial policy anticipated objectives (2021-2025)

The multiple accomplishments made in the previous IP provide an excellent building block for the strategies moving forward into 2021–2025. Expected direct and indirect policy actions for the next IP are described below.

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION
		Federal	Next agriculture policy framework	Guelph Statement 2021: New Canadian Agriculture Partnership vision to 2028 has explicit considerations for improving biodiversity and protecting sensitive habitats in agricultural landscapes.
			AAFC and ECCC stewardship funding	Agricultural Climate Solutions; Nature Smart Climate Solutions and Nature Legacy funding programs.
DIRECT REGULATORY POLICY	Wetland	AB	Monitor, evaluate and report on policy outcomes	Develop Performance Measures.
			Annual reporting	Develop annual reports on policy effectiveness and evaluation.
		SK	Ongoing development of wetland related policies	Ongoing work on wetlands and mitigation.
		MB	Climate and Green Plan (2023–2027)	Provincial Government is continuing to explore carbon offsets, carbon sequestration and the value of carbon in wetlands and grasslands.
			Manitoba Water Strategy	Watershed Planning: expert advisory council released recommendations to Minister with links to watershed and water/land planning; discussion paper under development.
	Grassland	AB	Grassland Conservation Tools	Ongoing development

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION
			Alberta Grassland Policy Roadmap	Ongoing development
		SK	Prairie Resilience	Carbon offset market (retaining Saskatchewan's Grasslands)
		MB	Climate and Green Plan (2023–2027)	Provincial Government is continuing to explore carbon offsets, carbon sequestration and the value of carbon in grasslands.
			Manitoba Water Strategy	Land planning / discussion paper under development
			Sustainable Protein Strategy / Framework	Promote sustainable growth in cattle industry, reducing carbon footprint and increasing productivity of pastures.
ENABLED STEWARDSHIP POLICY	Wetland	AB	Alberta Wetland Rapid Evaluation Tool (ABWRET) upgrade	Update the standardized method for rapidly assessing some of the important natural functions of all types of wetlands present in Alberta.
			Alberta Wetland Classification System update	Update the existing classification system.
			Alberta Wetland Identification and Delineation Directive update	Update the existing directive.
		SK	Habitat Management Plan	Initiated development of a 20-year adaptive management plan to support conservation of priority habitat for fish and wildlife.
			Protected and Conserved Areas Roadmap	The Protected and Conserved Areas Roadmap identifies goals, objectives and actions to protect 12% of terrestrial and aquatic environments in Saskatchewan over the 2021–2025 period.
		MB	Wetland Classification Tool	Classifying Class 1-5 wetlands; intent to assist in licensing, incentives, and enforcement.
			Boreal Wetland Mapping	Ongoing mapping and classifying of boreal wetlands. Implications for Forestry and Peatlands branch for codes of practice and peat harvest sites / locations
			Price Discovery for Payments for ES / Easements	Future research project.
			Integrated Watershed Planning	Plan renewed every 10 years
			No Net Loss of Wetland Monitoring Plan	Required under the Sustainable Watershed Act
			Wetland Classification Course	Advocate for a course offered by partnership between government / PHJV partners.

	HABITAT	JURISDICTION	INITIATIVE	DESCRIPTION
	Grassland	AB	Carbon Sequestration Initiatives including offset pilots	Various options are ongoing and under development.
			Grassland Roadmap	Ongoing work
		SK	Prairie Landscape Initiative (PLI)	Completion of mapping initiative
			Habitat Management Plan	Ongoing development and implementation for habitat conservation
			Protected and Conserved Areas Roadmap	The Protected and Conserved Areas Roadmap identifies goals, objectives and actions to protect 12% of terrestrial and aquatic environments in Saskatchewan over the 2021–2025 period.
		MB	Grassland Mapping / Inventory	Ongoing research efforts to map grasslands
			Carbon Storage	
			Regenerative Agriculture Initiatives	Multiple initiatives under development within which would fit under "enabled" policy, such as Regenerative Agriculture Initiatives and Manitoba Livestock Initiative (sustainable cattle productions).
			Species at Risk Initiative and MB Beef Producers	Incentive program to implement BMPs that benefits pasture management and ultimately, Species at Risk habitat ensuring the continued use of land as cattle production.
			Environmental Farm-Plan (Provincial / Federal)	Ongoing online development

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