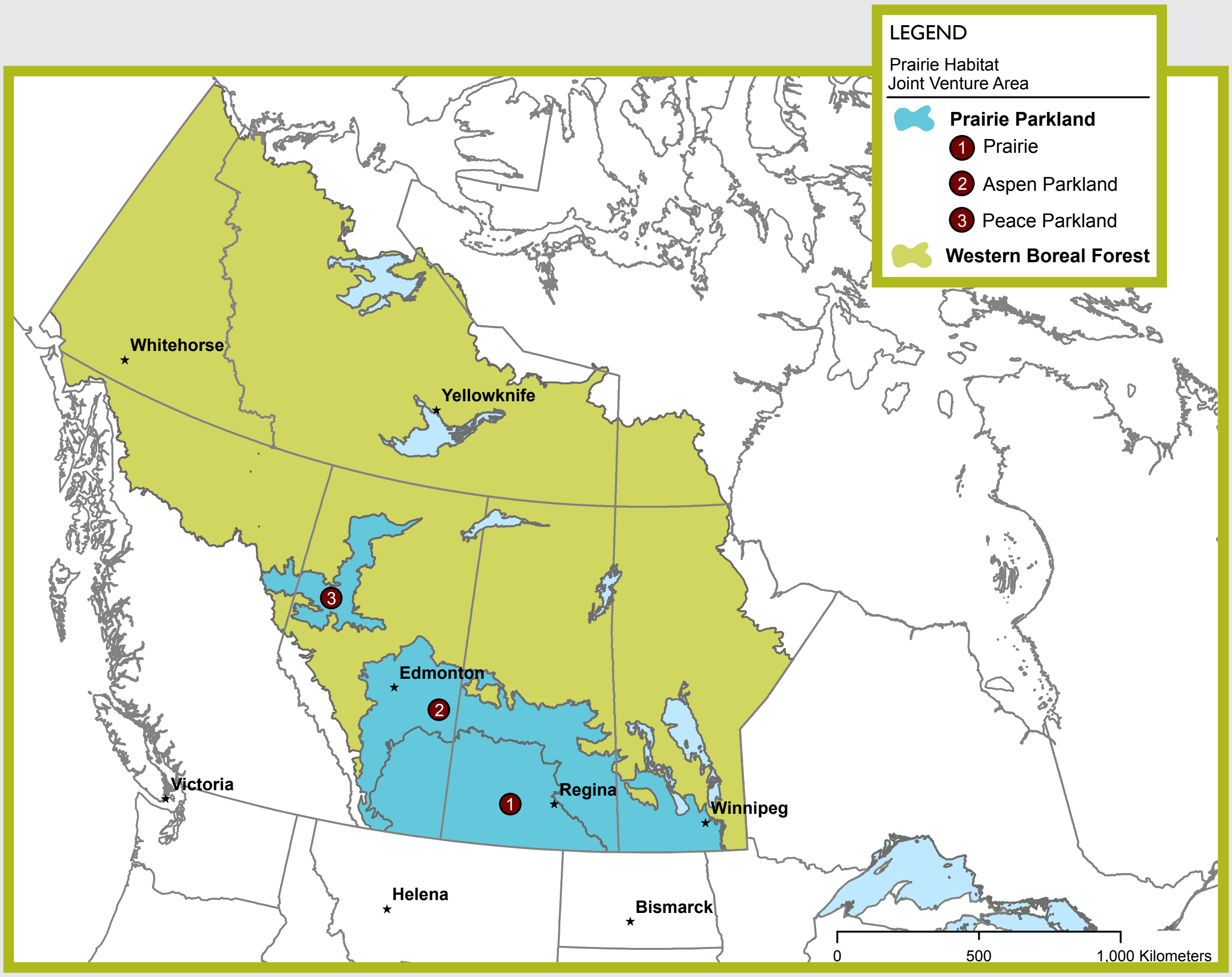
PLANNING FOR THE FUTURE

PRAIRIE HABITAT JOINT VENTURE: THE PRAIRIE PARKLANDS

IMPLEMENTATION PLAN 2013-2020

FIGURE 1

Prairie Habitat Joint Venture area



On the cover:

Large Photo: Mallard Hen with Ducklings/©Ducks Unlimited Canada /Brian Wolitski

Left to Right: Blue-winged Teal Nest/©Ducks Unlimited Canada

Wetland Habitat/©Ducks Unlimited Canada

Blue-winged Teal Drake/©Ducks Unlimited Canada/Tye Gregg

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Area measurements are shown in acres in this Plan; to convert acres to hectares, divide acres by 2.47.

All dollar amounts are shown in Canadian currency (CDN $).

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The PHJV's accomplishments would not be possible without the ongoing commitment of more than 300 partner organizations and 17,000 landowners who have supported wetland-habitat conservation projects across the Canadian Prairies for nearly 30 years.

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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. One of the continent's first NAWMP priority landscapes was the Canadian Prairies where as much as one third of continental waterfowl populations breed. The Prairie Habitat Joint Venture (PHJV) partnership of Alberta, Saskatchewan and Manitoba was formed.

The PHJV has become a leader in developing conservation projects that benefit waterfowl and other migratory birds and the wetland habitats upon which they depend.

Since the inception of NAWMP nearly 30 years ago, the business of conservation has changed considerably. To remain relevant and to 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's planning, implementation and evaluation efforts have always been guided by a series of habitat implementation plans. The plans are modified regularly to reflect current and anticipated landscape conditions, socioeconomic trends, emerging priorities for bird conservation and 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. This *PHJV Habitat Implementation Plan, 2013-2020: The Prairie Parklands* builds on past accomplishments and reinforces an enduring legacy of strong partnerships and science-based information to guide innovative actions for achieving conservation goals.

The remarkable diversity and abundance of bird species across the PHJV area results from the region's highly productive and diverse wetland and upland habitats and the movement of these birds among prairie, parkland and western boreal forest biomes.

This Plan is comprised of two main parts. Part One identifies the Prairie Parkland Region's habitat objectives and related work. Part Two focuses on conservation planning for the Western Boreal Forest (WBF), primarily within the Boreal Plains Ecoregion. The PHJV has developed individual plans for these two high-priority regions due to their distinct land-tenure systems, differing land-use and environmental threats and distinct conservation partners. The remarkable diversity and abundance of bird species across the PHJV area results from the region's highly productive and diverse wetland and upland habitats and the movement of these birds among prairie, parkland and western boreal forest biomes. While many wetland-associated species are boreal specialists that use the prairie biome during migration, others have stronger affinities 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 security of critical wetland and associated upland habitat across the entire Prairie Region in both Canada and the United States.

The PHJV remains firmly committed to maintaining and restoring wetlands and landscapes capable of sustaining healthy waterfowl populations and vibrant rural communities. Yet, PHJV partners have long recognized that improved information and planning tools could help to guide habitat programs beyond waterfowl species to include many shorebird, waterbird and landbird species. For example, the advent of decision-support tools for marshbirds inhabiting the Prairie Parkland Region is transforming this vision in all three Prairie Provinces. The PHJV envisions a future wherein decision-support tools will

help to inform the biological basis for habitat investments for all bird species.

Finally, the *NAWMP 2012: People Conserving Waterfowl and Wetlands* revision, 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. This Plan begins to incorporate these objectives, and presents ways that existing or new information and initiatives could advance these and other NAWMP priorities. It sets out clear wetland and upland habitat objectives for sustaining the PHJV's diversity and abundance of waterfowl and other birds. Achieving these objectives is ambitious, and will be accomplished with strong partnerships, a common vision and a sustained commitment — for waterfowl, the environment and for people.

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Flock of Mallards/©Ducks Unlimited Canada/Tye Gregg

EXECUTIVE SUMMARY

When the North American Waterfowl Management Plan (NAWMP) was launched in 1986, its visionaries recognized that the Canadian Prairie Pothole Region would be critical to its success. Shortly thereafter, the Prairie Habitat Joint Venture (PHJV) began to implement habitat programs across the Prairie Parkland Region in Alberta, Saskatchewan and Manitoba signaling the clear intent to retain, restore and manage the Region's natural wetland and upland habitats needed to sustain healthy waterfowl populations. Strong partnerships among conservation agencies and landowners emerged and remain today.

During the past decade, the PHJV has also assumed responsibility for wetland-waterfowl conservation in the Western Boreal Forest (WBF), a vast, wetland-rich area that attracts waterfowl in numbers only surpassed by the Prairie Parkland Region. There are tight biological linkages between the Prairie Parkland Region and the WBF, with ducks and many other wetland-associated birds moving between these biomes during the Prairie Parkland Region's regular wet-dry cycles.

A separate habitat implementation plan has been developed for the WBF because many factors, including land-tenure systems, conservation challenges and partners, differ between the Prairie Parkland Region and the WBF. This document focuses on the Prairie Parkland Region.

Since its inception, PHJV activities have been guided by a series of habitat implementation plans. They have served as conservation roadmaps and have been adjusted periodically to reflect:

- changing socioeconomic, policy and environmental conditions
- improving knowledge about duck population responses to managed and unmanaged habitats

Prairie Parkland Region Wetlands near Minnedosa, Manitoba./ ©Ducks Unlimited Canada /Jeope Wolfe

- understanding of landowner acceptance of habitat delivery alternatives
- growing interest in identifying ways to enhance all-bird conservation

This Plan once again incorporates lessons learned about program delivery, information about bird ecology and responses to PHJV programs and changes to agricultural and policy landscapes, enabling the PHJV to re-shape its habitat and policy objectives over an 8-year cycle (2013-2020) and beyond, to 2030. As advocated during the NAWMP 2012 revision process, explicit objectives for hunters, viewers and supporters are currently being identified for the first time and will be implemented over the next two to five years within the Prairie Parkland Region.

The long-term capacity of PHJV landscapes to support Prairie Parkland Region duck populations remains a concern due to ongoing wetland loss.

Since 2007 when the PHJV's previous habitat plan was implemented, most duck populations have responded well to improving pond and upland habitat conditions within the Prairie Parkland Region, and by 2014, only northern pintail and American wigeon populations were well below revised NAWMP goals (average of 1955-2014). In 2014, pond counts were 1 million ponds (~30%) above the 10-year average and 19% above the long-term average.

The long-term capacity of PHJV landscapes to support Prairie Parkland Region duck populations remains a concern due to ongoing wetland loss (-3% per decade; including drainage) and degradation as well as market uncertainties regarding demand for cattle (favouring the retention of grassland habitat) versus demand for cereal, oilseed and other crops that favour conversion of grassland to cropland.

Notwithstanding these challenges, the PHJV has had tremendous success delivering on-the-ground habitat conservation in Manitoba, Saskatchewan and Alberta since 2007, with over 1.58 million acres of wetlands and uplands being retained or restored in this period, representing approximately 11% and 9% of respective 25-year target levels established in the previous implementation plan. The total investment over the past 5 years has been an estimated $210 million, with ~84% being allocated directly to habitat-conservation programs. The PHJV has also played an active role in the wetland-policy arena, supporting the development and adoption of Alberta's wetland policy in 2015, and working in Manitoba and Saskatchewan to influence regulations that protect landowners and communities from the costly down-stream impacts of wetland drainage.

The PHJV will achieve success only by implementing programs and policies that maintain and restore the long-term productive capacity of prairie landscapes. In this regard, provincial planning teams used updated quantitative models to forecast duck productivity in the Prairie Parkland Region in 2020 and 2030, and tailored suites of programs aimed at restoring or sustaining the productive capacity of these landscapes. In addition, a new decision-support tool has been developed for marshbirds; the tool will help to guide habitat-program decisions over the next implementation cycle. Similar products are needed for landbirds and shorebirds as these could assist the PHJV in determining program and policy impacts on all birds.

In the Prairie Parkland Region, habitat restoration and retention of existing native grasslands and wetlands remain the top PHJV priorities. Expanding producer- and duck-friendly programs like winter wheat, and adopting effective provincial wetland policies, are also important goals. This Plan assumes that Alberta's wetland policy will be fully implemented during 2015, and that similar policies in Saskatchewan and Manitoba will follow within the next decade. Restoration objectives include 10,500 wetland basins prairie-wide, roughly 1 million acres, and as much as 15-20% of all wheat acres being converted to winter wheat by 2030. Additionally, the PHJV is targeting retention of over 343,000 acres of wetlands and more than 341,000 acres of upland habitat for conservation. An estimated $470 million is required in the Prairie Parkland Region to achieve these ambitious new objectives by 2020. Most expenditures (80%) are for habitat restoration ($107 million) and retention ($273 million) activities, with the balance to support policy (1%), operations and maintenance (6%), research and evaluation (5%), communications and education (1%) and coordination (7%) activities.

Enduring strengths of the PHJV have been the emphasis on program evaluation, including adaptive management, and the willingness to modify, add or eliminate programs in response to new information.

Enduring strengths of the PHJV have been the emphasis on program evaluation, including adaptive management, and the willingness to modify, add or eliminate programs in response to new information. This pattern will continue in the next implementation cycle to ensure that resources are wisely invested and that new knowledge will guide policy and program decisions. Examples include investigating:

- the effectiveness of wetland policies
- causes of and solutions to chronically low northern pintail populations
- development and refinement of decision-support tools for quantifying the ecological goods and services provided by the PHJV's conservation investments
- wetland and native grassland inventories
- anticipated impacts of climate and land-use changes on duck populations
- assessment and analysis of habitat functions and economic benefits to people as a result of the PHJV's program and policy investments

American Wigeon/©Ducks Unlimited Canada /Brian Wolitski

INTRODUCTION

The Prairie Habitat Joint Venture (PHJV; Figure 1) implements the North American Waterfowl Management Plan (NAWMP) in the Prairie Parkland Region and the Western Boreal Forest (WBF) of Canada. Since 1986, NAWMP has addressed the continental needs of waterfowl-habitat conservation through science-based programming and strong commitments from Canada, the United States and Mexico.

North America's Prairie Pothole Region, found largely in Canada, is recognized as the most important breeding area for continental waterfowl and an important region for many other bird species. Long-term systematic surveys of breeding duck populations in North America indicate that the WBF is the second most important breeding area on the continent (Figure 2). Collectively, the PHJV has the responsibility for habitat conservation in a broad region of North America that is unsurpassed in terms of breeding duck populations.

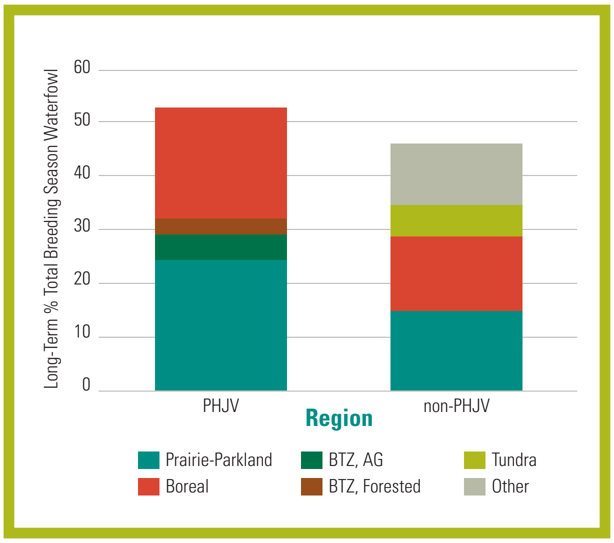
North America's Prairie Pothole Region, found largely in Canada, is recognized as the most important breeding area for continental waterfowl and an important region for many other bird species.

The PHJV was formed in 1986 to direct the conservation of wetlands and associated habitats in Prairie Canada (Prairie Habitat Joint Venture, 1986). Its role expanded in 2004 when administrative responsibility for the WBF was assumed. The PHJV also includes the Peace Parklands Region of British Columbia. The PHJV continues to have active committees to address science, policy, communications and integration issues. Provincial organizations coordinate program details in support of the PHJV within each province. Responsibility for the WBF program lies with the PHJV Advisory Board, with most operational programs delivered by Ducks Unlimited Canada (DUC) and its partners. The PHJV Advisory Board includes representatives from federal and provincial government departments and non-governmental organizations in Alberta, Saskatchewan and Manitoba (Appendix 1). The continental NAWMP community recognizes the leadership of the PHJV Advisory Board, PHJV committees and associated provincial organizations as being outstanding leaders among Joint Ventures.

In 2006, the PHJV implemented a new Strategic Plan designed to re-focus efforts and resources to achieve ambitious targets for wetland and native grassland habitats and the important bird populations that depend on them. Revised waterfowl population objectives have recently been announced by the NAWMP Committee and the PHJV has started to incorporate these new population objectives into planning processes. 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 Prairie Parkland Region (BCR 11). The NAWMP Committee also released new goals for hunters and conservation supporters. The PHJV recognizes the importance of building broad support for conservation programs, and this Plan begins to identify ways to engage hunters and other conservation supporters in PHJV conservation activities.

FIGURE 2

Importance of Prairie Habitat Joint Venture region to North American breeding populations of dabbling and diving ducks.



[Note:] BTZ refers to the boreal transition zone. AG refers to agricultural areas within the BTZ. Long-term breeding waterfowl counts were obtained from the traditional surveys in the mid-continent region and Eastern Canada.

PHJV Vision

Healthy prairie, parkland and boreal landscapes that support sustainable bird populations and provide ecological and economic benefits to society.

PHJV Mission

Provide leadership to achieve healthy and diverse waterfowl and other bird populations through conservation partnerships. These partnerships strive for sustainable and responsible management of the landscape taking into account social, economic and environmental factors.

PHJV Goals

Bird Populations

Duck populations are maintained at average levels recorded during 1955-2014, recognizing that abundance and species composition will fluctuate in response to variable pond and upland habitat conditions. Goals for other bird species are aligned with those specified in Bird Conservation Region Plans and Recovery Plans for Species at Risk.

Habitat

The Prairie Parkland Region and the Western Boreal Forest are capable of sustaining duck populations at levels recorded during 1955-2014, including populations in years of peak abundances, by maintaining the PHJV's carrying capacity (wetlands support breeding pairs; reproductive and survival rates allow population growth). Identify and pursue opportunities to retain and restore key habitats for non-waterfowl species.

People

Programs and policies are delivered and advocated that favour both conservation and the long-term sustainability of rural communities. Enhanced opportunities enable people to hunt and view waterfowl, while building support for wetland conservation among a wider community including the general public. Crop damage, overabundant geese and other socioeconomic concerns created by waterfowl or other birds are addressed.

Collectively, the PHJV has the responsibility for habitat conservation in a broad region of North America that is unsurpassed in terms of breeding duck populations.

These broad PHJV goals are ambitious and aligned with goals recently updated (October 2014) in response to the *NAWMP 2012: People Conserving Waterfowl and Wetlands* revision. Moreover, PHJV programs, partners, land-tenure systems and, hence, conservation actions are unique within and between its two major geographic areas. The following PHJV Plan separates the activities of the Prairie Parkland Region from those in the WBF. Part One focuses on the traditional PHJV areas within the Prairie Parkland Region and Part Two focuses on the WBF.

The Boreal Transition Zone (BTZ) is mentioned in both Part One (Prairie Parkland Region) and Part Two (WBF) because it is the confluence zone between the Prairie Parkland Region and the WBF. It is a region of continentally significant bird diversity wherein widespread conversion of forest to agriculture and ongoing forest loss and fragmentation associated with energy development continue to occur.

Blue-winged Teal/©Ducks Unlimited Canada

PRAIRIE-PARKLAND REGION

A. Status of Bird Populations

1. Status of Waterfowl

The following assessment of Prairie Parkland Region duck populations is based on data from the U.S. Fish and Wildlife Service (USFWS) and the Canadian Wildlife Service (CWS) Waterfowl Breeding Population and Habitat Survey (WBPHS) conducted annually across Prairie Canada (Benning 1976). The review is limited to the 10 most common duck species (7 dabbling duck and 3 diving duck species; common and scientific names are shown in Table 1) and May ponds in the traditional survey area covering the majority of the PHJV area (Figure 3). Visibility-corrected, segment-level data from 1955-2014 were used to calculate long-term average breeding pair populations for the Prairie Parkland Region (also, Prairie Parkland Ecozone; Ecological Stratification Working Group 1995). Because segment-level data are reported for individual species, the first observations were summed within strata, transect, segment and year. Next, density was calculated for each stratum, transect, segment and year, based on segment areas provided by the USFWS. Average density for each species was then calculated for each stratum and multiplied by the area of the Prairie Parkland Region within each stratum. The result was a Prairie Parkland Region population estimate for each stratum, year and species. To smooth annual variation and elucidate trend, counts and trends are also presented and discussed as running 10-year average breeding population sizes.

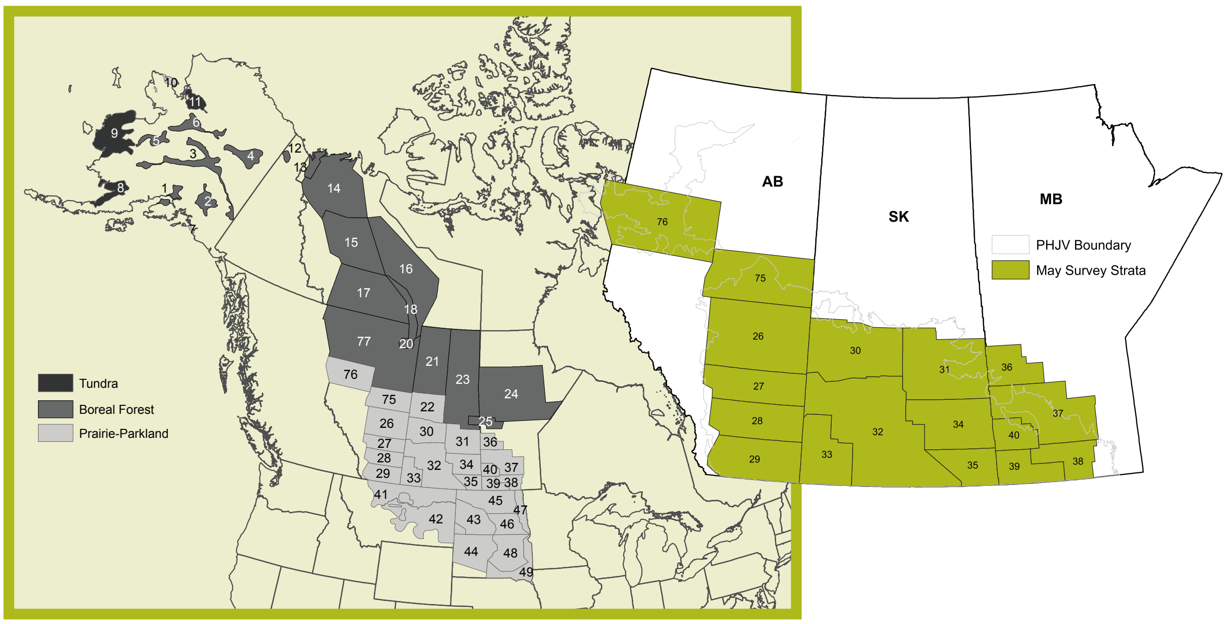
Current waterfowl populations within the Prairie Parkland Region show considerable variation among species relative to long-term average population levels.

Regional Perspective

Current waterfowl populations within the Prairie Parkland Region show considerable variation among species relative to long-term average population levels (Table 1) and in trends over time (Figure 4). Ten-year average northern pintail, American wigeon and lesser scaup populations have shown the greatest declines relative to long-term averages (Table 1); mallard populations are at roughly average levels, despite pond counts being 19% higher than average during the past decade. Northern pintail declines are thought to be due to habitat factors within the PHJV (see Northern Pintail — A Species of Conservation Concern; also, Mattson et al. 2012).

FIGURE 3

Distribution of survey locations for waterfowl in Canada and the United States.



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

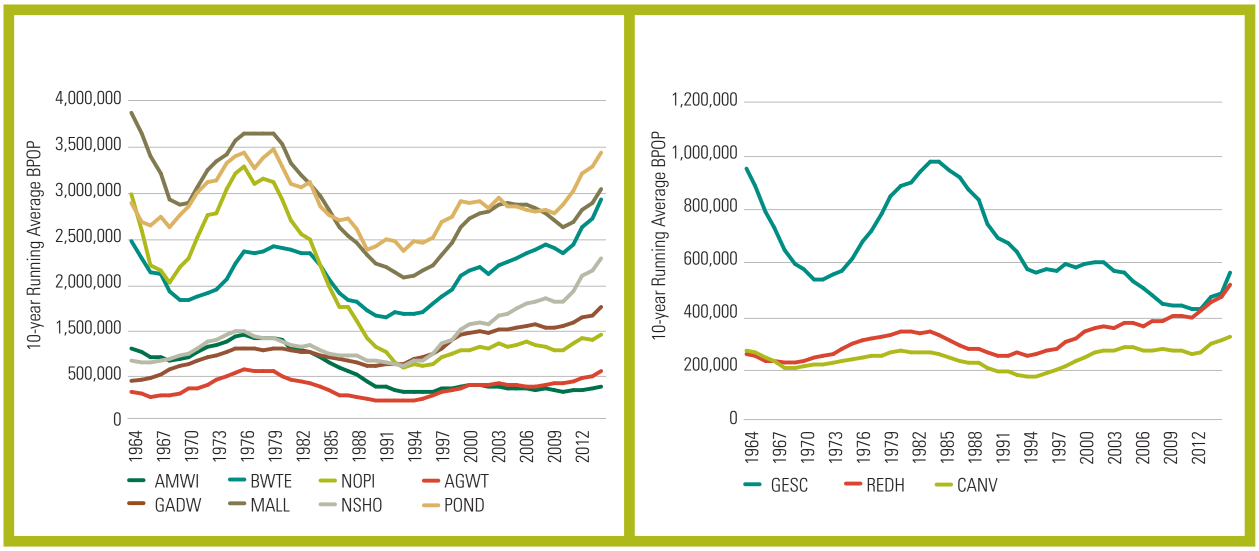
Increased suitability of habitat within the U.S. Prairie Pothole Region, as a result of the Conservation Reserve Program and increased mallard numbers there, may also indicate a shift in population distribution. Causal factors implicated in American wigeon and lesser scaup declines remain less certain.

The remaining species are generally well above long-term averages — blue-winged teal, northern shoveler and gadwall populations have recently shown consistent upward trends (Figure 4). Likewise, canvasback and redhead are above average levels and redhead populations have shown generally strong and consistent increases whereas the canvasback population has been relatively stable in recent years. As a result, the species composition of the PHJV duck community has changed substantially in the past decade. The current summed 10-year average population for the 10 duck species in Table 1 is 15% above the long-term average, owing to increases in northern shoveler, blue-winged teal and gadwall, yet 17% below aspirational NAWMP goals (80th percentile of 1955-2014 counts). Historically, the most dominant species, mallard and northern pintail, are numerically important in the annual duck harvest, and are prized by hunters across the continent, so explanations for recent trends in regional populations of mallard and northern pintail, and appropriate responses, must be addressed.

Pond counts are 19% above the long-term average and have recently trended sharply upward, likely as a result of relatively high winter-spring precipitation and heavy summer rainfall events since 2006. Nonetheless, in the long-term, reduced pond counts are anticipated due partly to climatic factors, but ongoing wetland drainage is also a contributing factor (e.g., Watmough and Schmoll 2007). Pond counts correlate well with increasing counts of northern shoveler, blue-winged teal and gadwall, but contrast with relatively low northern pintail (and American wigeon) counts. Improvements in upland habitat over much of the PHJV area since 1986 (see Status of Habitat) have likely improved reproductive success of many dabbling duck species. As noted above, however, reasons why stronger resurgences in populations of mallard, American wigeon and especially northern pintail have not been observed with improving wetland and upland conditions in the past decade remains a serious concern, warranting further investigation and action.

FIGURE 4

Trends in 10-year running average breeding populations for the seven most common dabbling duck species, 1955-2014 (left panel) and three most common diving duck species (right panel) and ponds from the Waterfowl Breeding Population and Habitat Survey conducted annually across the Prairie Habitat Joint Venture area, 1955-2014.



[Note:] Estimates only include the portions of survey strata that fall within the Prairie Habitat Joint Venture's Prairie Parkland Region.
Species acronyms are American wigeon (AMWI), gadwall (GADW), blue-winged teal (BWTE), mallard (MALL), northern pintail (NOPI), northern shoveler (NSHO), American green-winged teal (AGWT), scaup (GESC; most are lesser scaup), redhead (REDH) and canvasback (CANV). Scientific names are shown in Table 1.

TABLE 1

*Ten-year average duck and pond counts in the PHJV Prairie Parkland Region (2005–2014), revised NAWMP goals for the PHJV, and percent difference between recent average count and both long-term average (1955–2014) and 80th percentile (aspirational NAWMP goal) counts.**

	Prairie Parkland Region		NAWMP Revision Goals — PHJV			
Species	**2014 estimate**	**2014 ten-year average**	**Long-term average (1955-2014)**	**Long-term 80th percentile**	**% difference from LTA**	**% difference from 80th percentile**
Mallard *(Anas platyrhynchos)*	3,873,520	2,845,000	2,850,000	3,476,000	0	-18
Northern Pintail *(Anas acuta)*	1,164,000	1,035,000	1,680,000	2,762,000	-38	-62
Blue-winged Teal *(Anas discors)*	3,914,000	2,704,000	1,957,000	2,635,000	38	3
Northern Shoveler *(Anas clypeata)*	2,590,000	1,976,000	1,093,000	1,343,000	81	47
Gadwall *(Anas strepera)*	1,972,000	1,379,000	879,000	1,210,000	57	14
American Wigeon *(Anas americana)*	442,000	397,000	612,000	1,006,000	-35	-61
Green-winged Teal *(Anas crecca)*	753,000	587,000	412,000	596,000	43	-1
Dabbling ducks	14,709,000	10,923,000	9,483,000	12,584,000	15	-13
Canvasback *(Aythya valisineria)*	377,000	308,000	239,000	319,000	29	-3
Redhead *(Aythya americana)*	716,000	501,000	316,000	415,000	58	21
Scaup *(Aythya affinis)*	10,400,000	547,000	678,000	949,000	-19	-42
Diving ducks	2,132,000	1,356,000	1,233,000	1,543,000	10	-12
All ducks	16,841,000	12,279,000	10,717,000	13,747,000	15	-11
Ponds	3,809,000	3,292,000	2,762,000	3,643,000	19	-10

* *Population estimates for the Prairie Parkland Region and Western Boreal Forest (WBF) strata from the Waterfowl Breeding Population and Habitat Survey were summed separately. In instances where strata contained both the Prairie Parkland Region and WBF biomes, stratum-specific population estimates were partitioned to each biome by multiplying the proportion of area of each biome within the stratum by its respective population estimate. Boreal transition zone population estimates were included in the WBF section of this Plan and are not included in this Table.*

2. Status of Shorebirds, Waterbirds and Landbirds

This Plan focuses on a subset of shorebird, waterbird and landbird species (Appendix 2; includes scientific names) from the priority species list of the recently completed Bird Conservation Strategy for Bird Conservation Region (BCR) 11 Prairie and Northern Region. BCR 11 includes the Prairie Parkland Region but excludes the Peace Lowlands of Alberta and British Columbia and the BTZ (Environment Canada 2013a). "Priority species" in the BCR 11 Plan were identified as those that are vulnerable due to population size, distribution and abundance, population trend and threats, in addition to "stewardship" species and species of management concern (Environment Canada 2013a). The subset of species included in this Plan emphasizes species that use the prairie habitats of BCR 11 and for which BCR 11 represents a considerable portion of the species distribution. Species are broadly characterized into three groups:

1) Prairie breeding species that use wetlands or may frequently occupy uplands in moderate to high-density wetland landscapes
2) Prairie breeding species that are characteristic of moist mixed-grass prairie, mixed-grass prairie and sagebrush shrublands in lower density wetland landscapes
3) Waterbird and shorebird species that breed in the Boreal and Arctic Regions but use wetland habitats in the Prairie Parkland Region during migration (Appendix 2)

The latter group excludes landbirds that breed in the Boreal and Arctic Regions. While many landbirds that breed in these regions pass through the Prairie Parkland Region during spring and fall migration, they do so in a broad front without staging at specific sites.

Shorebirds

Bird Conservation Region 11 provides important breeding and migratory staging habitats for shorebirds. Twenty-three species are the focus of conservation efforts within the PHJV area (Appendix 2) representing 64% of the shorebird species that regularly use BCR 11 during either breeding or migration. Twelve of the 23 priority species breed in boreal or Arctic habitats while the others breed regularly in prairie habitats. Among the 11 breeding species in the Prairie Parkland Region, 8 use wetlands or upland sites near

NORTHERN PINTAIL – A SPECIES OF CONSERVATION CONCERN

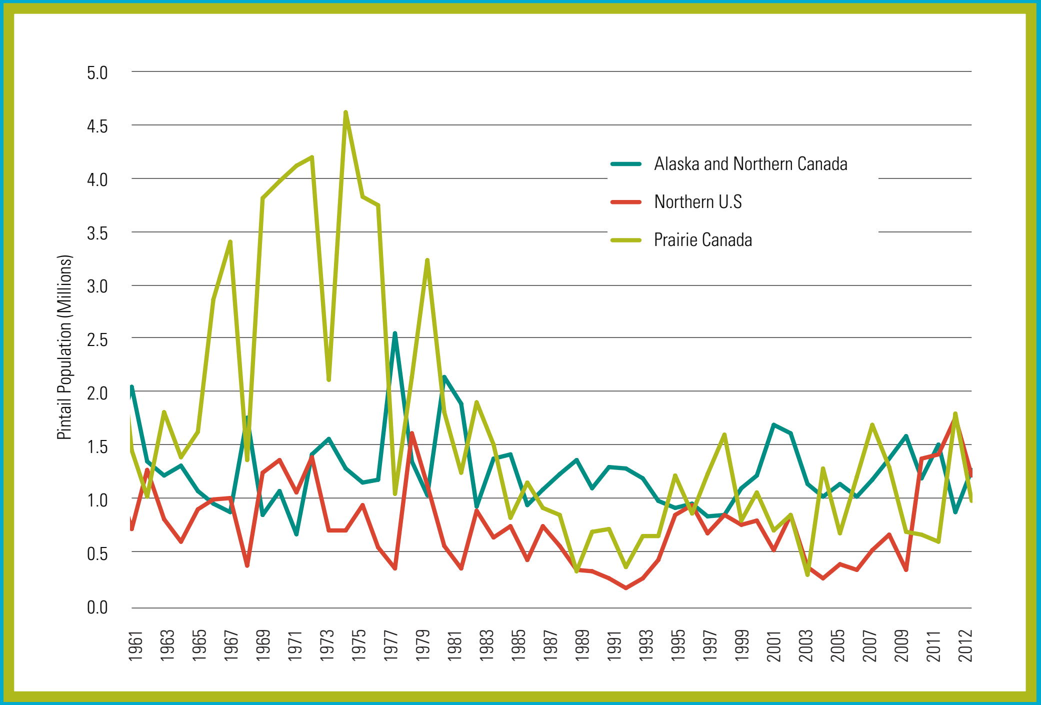
Over the past 3 decades, unlike most other waterfowl species, the northern pintail population in North America has remained well below the revised NAWMP goal of 4 million birds. In 2014, the pintail population in traditional survey areas stood at ~3.5 million birds, 20% below the NAWMP goal (Zimpher et al. 2014). Typically, the numbers of pintail that settled on the prairies had a consistent and positive relationship with numbers of prairie wetlands counted during May surveys. Since the early 1980s, however, the strength of this relationship has weakened greatly (Miller and Duncan 1999), and it was virtually nonexistent in the mid-1990s when water conditions in the Prairie Pothole Region were excellent. Comparison of population trends between the Canadian and U.S. portions of the Prairie Pothole Region indicate clearly that most of the decline has occurred in the southern Canadian portion (Figure 5). A primary causal mechanism in the decline is thought to be the tendency of pintail to nest in croplands prior to seeding and the resulting destruction of nests with the seeding operation. Increases in spring-seeded acreage on the Canadian prairies since the 1970s (primarily as a result of declining summerfallow) are thought to have reduced pintail nesting success (Podruzny et al. 2002, Miller et al. 2003).

The PHJV recognizes the urgency and importance of addressing pintail population concerns, and will continue to identify and implement grassland and agricultural programs to improve pintail productivity and survival.

Northern Pintail Drakes in Flight/©Ducks Unlimited Canada/Brian Wolitski

FIGURE 5

Comparison of northern pintail population trajectories in Alaska/Northern Canada, Northern U.S. states and Prairie Canada, 1961-2012. (source: USFWS/CWS)



Piping Plover/©Ducks Unlimited Canada

wetlands, and 3 primarily use select mixed-grass prairie in areas of more expansive upland habitat. Three of these 11 species are listed under Canada's *Species at Risk Act* (piping plover, mountain plover, long-billed curlew). Piping plover are also listed as at-risk in all three provinces while long-billed curlew and mountain plover are listed in

Bird Conservation Region 11 contains the highest species richness of breeding waterbirds in Canada.

Alberta. Two Arctic migrants, red knot (*rufa* subspecies) and buff-breasted sandpiper, are federally listed as Endangered and Special Concern, respectively.

Waterbirds

Bird Conservation Region 11 contains the highest species richness of breeding waterbirds in Canada; 13 species are the focus of conservation efforts in this Plan (Appendix 2). The group includes a diversity of species such as loons, grebes, bitterns, rails, gulls and terns. These 13 species represent 36% of the total number of waterbird species that regularly occur in BCR 11. Many of the remaining species are colonial breeding gulls, terns, pelicans and cormorants that breed on isolated islands of large lakes. Three of the 13 species in this Plan are listed under *Canada's Species at Risk Act* including whooping crane (endangered), least bittern (threatened) and yellow rail (special concern). The whooping crane is also listed as a Provincial Species at Risk in all three provinces, while the western grebe is listed in Alberta.

Landbirds

Two-hundred and seventeen landbird species occur in BCR 11 (Environment Canada 2013a) and 29 (13%) are the focus of conservation efforts in this Plan (Appendix 2). The much lower percentage for landbirds compared to shorebirds and waterbirds is due to the large fraction of boreal-breeding landbirds that pass through BCR 11 during migration only. The landbirds highlighted in this Plan select a wide range of habitats including wetlands, uplands in landscapes of variable wetland density and expansive areas of drier mixed-grass and sagebrush habitat. Populations of many upland landbirds have declined significantly in the PHJV area, largely due to the loss of native grasslands and, consequently, 14 of the 29 PHJV landbird focus species are protected under Canada's *Species at Risk Act*. These include several iconic species such as greater sage grouse, burrowing owl and ferruginous hawk. Many species that are listed under Canada's *Species at Risk Act* are also protected under similar provincial jurisdiction.

Population Trends

Appendix 2 includes annual population trends with 95% credible intervals for prairie-breeding species that are surveyed by the North American Breeding Bird Survey (BBS, Sauer et al. 2011, and Environment Canada 2013b). The BBS is a road-based survey method using point counts; it is the most commonly used method to estimate change in abundance via a sampling index. Trends were only included for species when trends were considered to be of medium

***Populations of many upland landbirds have declined significantly in the PHJV area, largely due to the loss of native grasslands and, consequently, 14 of the 29 PHJV landbird focus species are protected under Canada's* Species at Risk Act.**

or high reliability as defined by Environment Canada (2013b) and Sauer et al. (2011). Of the 52 priority species that breed in prairie habitats, 41 had sufficient data for BBS trend estimation, while the remaining 11 species are not reliably monitored by the BBS because they are too secretive (e.g., yellow rail), occur at very low densities (e.g., prairie falcon) or have a restricted

Burrowing Owl/©Ducks Unlimited Canada

distribution in Canada that is not conducive to large-scale trend monitoring (e.g., sage thrasher). However, 7 of these latter 11 species are listed under Canada's *Species at Risk Act* and based on trends noted in recovery documents were assigned qualitative trend categories (declining, stable, increasing or unknown, Appendix 2). Five of the 7 species are still considered to be declining, one is increasing and one has an unknown trend in Canada.

Trends for the most seriously declining species tended to be lower in CA-BCR 11 suggesting greater negative impacts in the Canadian portion.

Twenty-two priority species that use wetland or adjacent upland habitats are monitored by the BBS. Of these 22 species, half had negative long-term trend coefficients in the Canadian portion of BCR 11 (1970-2011) but only 3 declines were statistically significant. Twelve species had negative trend coefficients for BCR 11 as a whole. Most species showed similar trends when comparing the Canadian portion of BCR 11 (CA-BCR 11) with the entire BCR 11 Region (~50:50 split of BBS routes on either side of the border). However, notable differences existed for a few species. Short-eared owl, American bittern, black tern and horned grebe all had more strongly negative coefficients for BCR 11 overall suggesting greater negative impacts in the U.S. portion of the BCR. In contrast, trend coefficients were more negative in CA-BCR 11 for northern harrier and killdeer. Significant positive long-term trends were observed in CA-BCR 11 for spotted sandpiper, Wilson's snipe, sedge wren and Nelson's sparrow.

Population trends were more negative for species that inhabit upland habitats. Nine of 19 species showed significant long-term declines and nearly all of these were grassland passerines. Six of the remaining 10 had negative but non-significant trend coefficients while 4 had positive coefficients but none with intervals that did not overlap 0. Declines exceeded 65% for several species (loggerhead shrike, horned lark, Sprague's pipit, Baird's sparrow) and were over 90% for

Of the 52 priority species that breed in prairie habitats, 41 had sufficient data for BBS trend estimation, while the remaining 11 species are not reliably monitored.

chestnut-collared longspur, McCown's longspur and lark bunting. Trends for the most seriously declining species tended to be lower in CA-BCR 11 suggesting greater negative impacts in the Canadian portion.

While PHJV conservation activities result in restoration and protection of habitat, they are but a few of the many influences, both positive and negative, on waterfowl habitat.

B. Status of Waterfowl Habitat

Consistent with original NAWMP planning, the general landscape composition that existed in the 1970s was used as a habitat benchmark under the assumption that habitat conditions at the time would be more than adequate to support waterfowl populations at NAWMP goals (Devries et al. 2004), and corresponding in broad terms with the 80th percentile values of long-term average (1955-2014) duck population sizes identified in the revised NAWMP goals (October 2014). Current information suggests that for the five primary dabbling duck species (mallard, gadwall, northern pintail, northern shoveler, blue-winged teal), reproductive success on prairie-breeding grounds as affected by upland change is one of the primary population limiting factors. Specifically, conversion of perennial cover to cropland restricts available nesting cover and increases nest predation rates. Ongoing loss or degradation of wetlands due to drainage, infilling and climate change reduces the carrying capacity of the Prairie Parkland Region to attract and hold breeding pairs. Landscape change is not uniform, however, and trends in habitat modifications vary with spatial scale. The full effects of habitat loss and habitat degradation on waterfowl productivity depend on the coincident occurrence of wetland and upland habitat changes.

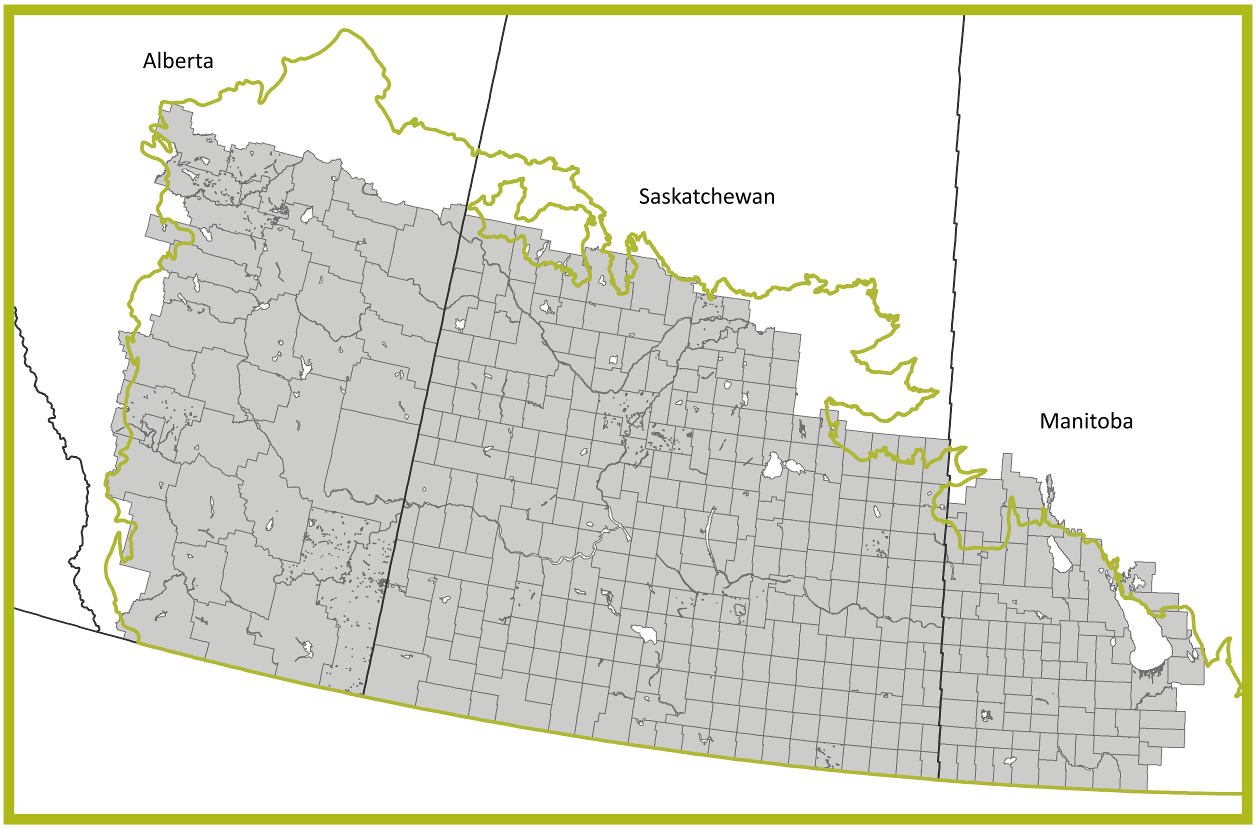
While PHJV conservation activities result in restoration and protection of habitat, they are but a few of the many influences, both positive and negative, on waterfowl habitat. Understanding and accounting for these changes and their potential impact on waterfowl populations requires quantitative estimates of wetland and upland status. Below is a broad synopsis of current upland and wetland habitat status and trends from 1971-2011 as estimated from various sources.

1. Upland Habitat

Native grasslands declined by ~10% within the PHJV from 1985-2001 (Watmough and Schmoll 2007) and have continued to decline at similar rates since 2001 (M. Watmough, CWS, unpubl. data). Despite significant gains in areas of permanent cover since 1986, primarily due to strengthening cattle markets and the need for (tame) pasture and forages, pressure on remaining native grassland areas has increased.

FIGURE 6

Statistics Canada Census of Agriculture CCS units (municipalities) used to characterize landscape change in the PHJV area.



For consistency in reporting over the entire Prairie Parkland Region, Statistics Canada Census of Agriculture (Statistics Canada 2012) data were used to track broad upland changes over time. Some portions of the BTZ along the northern PHJV boundary and the Alberta Peace Lowlands are not considered in the analysis (Figure 6). To obtain general trends in land use from census data, the acreages of spring crops, fall crops, summerfallow and hayland were extracted for each Consolidated Census Subdivision (CCS) (i.e., municipality, or CCS; Figure 6) within the Prairie Parkland Region. The balance of upland area within CCSs was assumed to be other uplands (i.e., lands generally in grassland or woodland pasture and idle habitat remnants). This analysis tracks annually tilled land (crops + summerfallow), hayland and all other uplands. Over time, the sum of these categories equals the total upland area available within CCSs. This categorization recognizes the dominant impact of croplands on the "intactness" of landscapes.

Because large areas of cropland were classified as "too wet to seed" in Saskatchewan and Manitoba and were lumped into a generic "other" category in the 2011 federal census, 2011 cropland acreage was estimated using provincial crop insurance sources. Municipality-specific estimates of cropland and "too wet to seed" acres were obtained from 2006 and 2011 provincial crop insurance agencies under the assumption that total cropland equaled the sum of these categories. Municipality-specific cropland in the 2011 federal census was adjusted relative to the 2006 federal census based on these ratios in provincial crop insurance data.

For the PHJV area as a whole, upland change since 1971 is characterized by an increase in tilled land until ~1986 followed by a decline of ~10 million acres to levels in 2011 below those of 1971 (Figure 7, Table 2). Formerly tilled land has generally been converted to forage lands leading to increases in haylands and other uplands. (Figure 7). Contributing factors to landscape changes include removal of grain transportation subsidies in 1995, federal and

Despite significant gains in areas of permanent cover since 1986, primarily due to strengthening cattle markets and the need for (tame) pasture and forages, pressure on remaining native grassland areas has increased.

TABLE 2

Estimated change in three primary land-use types composing the land base within the majority of the Prairie Habitat Joint Venture area, 1971, 1986, 2001, 2006 and 2011 (source: Statistics Canada Census of Agriculture, Saskatchewan and Manitoba Crop Insurance).

	Acres within the PHJV area [a]				
Land use	**1971**	**1986**	**2001**	**2006**	**2011**
Annual Tillage	60,700,500	68,775,400	62,674,900	57,655,600	57,190,700
Hayland	7,918,900	4,681,400	8,373,700	9,906,600	8,635,500
Other Upland [b]	52,814,700	47,972,000	50,380,300	53,866,600	55,602,600

[a] see Figure 6 for covered portion of the PHJV area.
[b] calculated as the balance of uplands that are not tilled or hayland (includes grazed and ungrazed grassland, woodlands, shrublands, wetland vegetation and all other uplands).

provincial programs encouraging conversion of marginal cropland to permanent cover and NAWMP programs. Furthermore, expansion of the cattle industry has increased the need for pasture and hayland forage. As of 2011, landscape composition of the Prairie Parkland Region was approximately 47% annual tillage, 46% other uplands and 7% haylands (Table 2).

Winter wheat is of specific interest to waterfowl managers given its use for nesting by many species of dabbling ducks, including northern pintail, and high nest survival rates (Devries et al. 2008). The PHJV has been very active in supporting winter-wheat variety development and promoting it as a viable alternative to spring-seeded wheat. Winter wheat has seen strong gains within the PHJV since the early 1990s, most notably in Southeastern Saskatchewan and Manitoba. Since 2006, winter-wheat acres appear to fluctuate between 0.6 and 1.5 million acres in the PHJV area (Figure 8). As additional cold-hardy, disease-resistant strains are developed, winter wheat production has the potential to expand considerably over the next 10-15 years.

Land-use change within the BTZ has been substantial since the early 1970s. Typically, expansion of agriculture into the boreal fringe has resulted in large decreases in forest cover and wetlands; deforestation rates have previously been estimated at approximately 1% per year (Cumming et al. 2001, Hobson et al. 2002). From 1985 to 2001 in the BTZ, cropland decreased by ~11%, tame pasture increased by ~112%, hayland increased by ~116% and treed habitat decreased by ~4% (Watmough and Schmoll 2007).

As of 2011, landscape composition of the Prairie Parkland Region was approximately 47% annual tillage, 46% other uplands and 7% haylands (Table 2).

FIGURE 7

Changes in acres of annual crops, hayland and all other uplands within the Prairie Habitat Joint Venture area, 1971-2011.

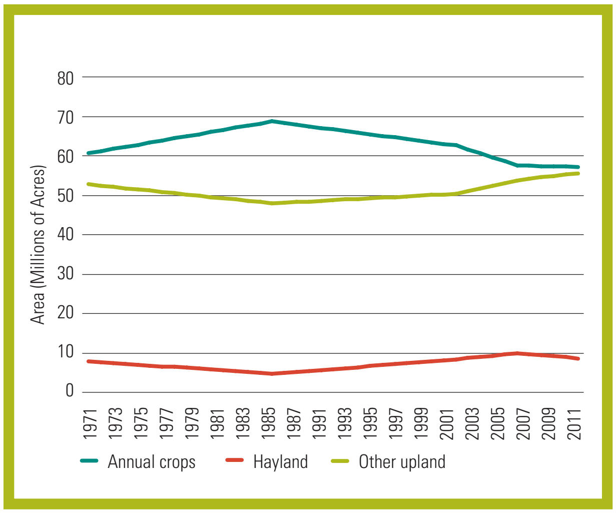
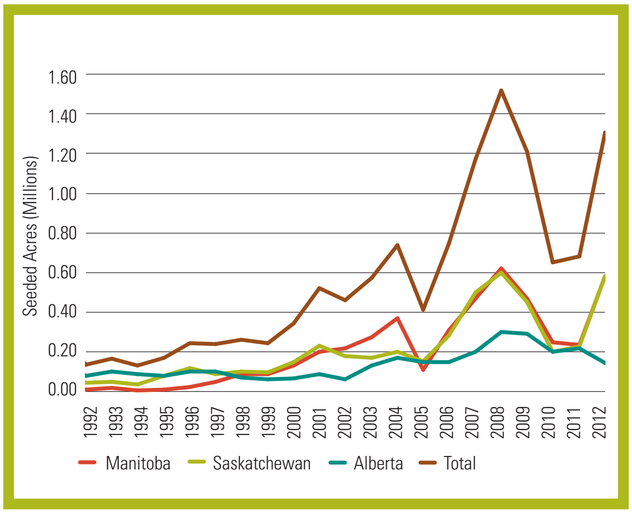


FIGURE 8

Acres sown to winter wheat in prairie Canada, 1992-2012 (source: Statistics Canada).



A restored wetland near Hay Lakes, Alberta/©Ducks Unlimited Canada

Approximately 4.6 million wetland acres, generally consisting of small prairie-pothole wetlands, are located within PHJV Target Landscapes.

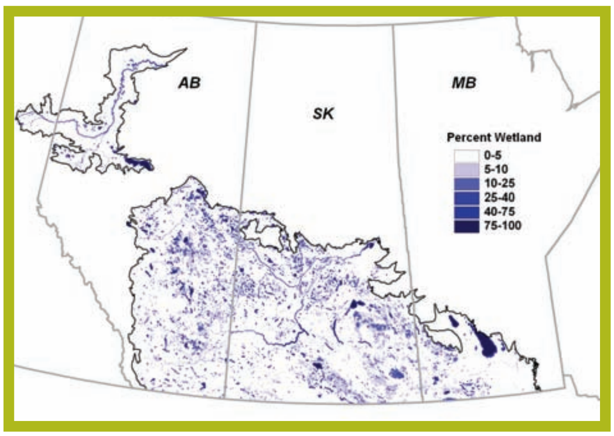
2. Wetland Habitat

Wetland habitat as a percentage of the landscape shows much regional variability across the PHJV area (Fernandes et al. 2001; Figure 9) resulting in landscapes of varying quality as waterfowl habitat.

Excluding large lakes and riverine systems, Watmough and Schmoll (2007) estimated that the PHJV area (excluding the Alberta Peace Lowlands) contained ~11.3 (±1.1) million wetland acres. Generally, wetland habitat becomes more prevalent moving from the grasslands to the parklands and into the BTZ. This occurs in conjunction with a change from small potholes and sloughs to larger lake, marsh and bog systems further north. Approximately 4.6 million wetland acres, generally consisting of small prairie-pothole wetlands, are located within PHJV Target Landscapes (DUC, unpublished data). In general, smaller wetlands, especially temporary and seasonal ponds found in intensively cropped landscapes, are the most vulnerable to transitory and permanent agricultural impacts on pond margins and basins (Bartzen et al. 2010).

FIGURE 9

Percent wetland area by 1 km x 1 km grid cell within the PHJV area (source: Fernandez et al. 2001).



Estimates of wetland loss since settlement are scarce and fraught with methodological issues (e.g., drought influence, scale of measurement) that confound regional generalizations. Watmough and Schmoll (2007) examined wetland loss on 141 transects within the PHJV area and indicated an overall gross loss of -5% (95% CI [CI] = -7% to -4%) of wetland area from 1985-2001 (-0.31%/year). Losses of wetland area varied among transect from 0 to -61% and these estimates are expected to be conservative given the strict definition of wetland loss. Wetland loss also varied among ecoregions (Watmough and Schmoll 2007): BTZ -5% (CI = -8% to -2%), Aspen Parkland -5% (CI = -7% to -4%), Moist Mixed Grassland -4% (CI = -9% to -2%), Mixed Grassland -8% (CI = -13% to -3%), Fescue Grassland -5% (CI = -11% to -2%) and Lake Manitoba Plain -5% (CI = -13% to -2%).

A recent update of habitat conditions on the PHJV's habitat-monitoring transects identified further decreases in wetland area and numbers between 2001 and 2012 (M. Watmough, Environment Canada, Prairie Habitat Monitoring GeoDatabase). In this most recent update, estimated overall wetland area loss on 221 transects within the PHJV area averaged -3% (CI = -4% to -2%), representing an average annual decline of -0.35%/year in wetland area. On average, transects lost -4% (CI = -5% to -3%) of wetland basin numbers, with basin losses varying among transects (range = 0 to -53% loss). As in the previous time period, the magnitude of loss varied considerably amongst transects within the PHJV area, ranging from 0% to -62% of wetland area. Average area lost (as a percentage of total baseline wetland area) on transects also varied across ecoregions: Boreal Transition -3% (CI = -6% to -1%), Aspen Parkland -3% (CI = -5% to -2%), Moist Mixed Grassland -3% (CI = -5% to 0%), Mixed Grassland -2% (CI = -3% to -1%), Fescue Grassland -0.4% (CI = -1% to 0%) and Lake Manitoba Plain -5% (CI = -9% to -1%).

FIGURE 10

Estimated wetland loss rates by municipality, 2001-2011, in the Prairie Habitat Joint Venture area

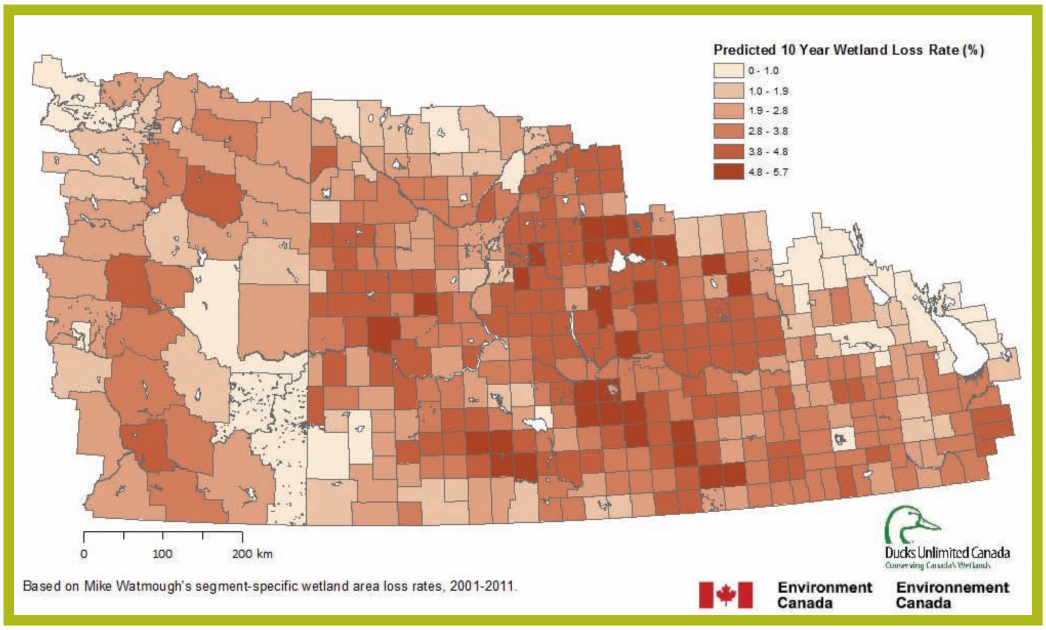


TABLE 3

Estimates of historical wetland area loss, (2001-2011) and remaining wetland areas within Prairie Habitat Joint Venture Target Landscapes of Alberta, Saskatchewan and Manitoba. Estimates were derived by combining municipality-level information for wetland area (Figure 9) and wetland losses (Figure 10).

	PHJV Target Landscape	Estimated Historical Wetland Area	Estimated Wetland Area Loss 2001-2011	Estimated Remaining Wetland Area
Alberta	Arrowwood	38,180	1,002	37,178
	Beaverhill	66,295	2,008	64,287
	Bellshill	77,693	2,604	75,089
	Big Hay/Bittern	115,057	1,754	113,303
	Buffalo Lake	90,307	1,116	89,191
	Calgary East	27,894	550	27,344
	Calgary West	38,587	1,347	37,240
	Clear Lake	15,015	660	14,355
	Cypress	3,114	9	3,105
	Derwent	26,325	868	25,457
	Eastern Plains	238,973	3,581	235,392
	Eastern Irrigation District	52,445	245	52,200
	Jenner Plains	18,307	112	18,195
	Kenilworth	38,938	1,104	37,834
	Milk River Ridge	24,780	362	24,418
	Owlseye	21,811	56	21,755
	Pakowki	37,516	1,126	36,390
	Pine Lake	18,399	341	18,058
	Sullivan Lake	132,010	1,831	130,179
	Vermillion/Viking	118,704	3,244	115,460
	Wintering Hills	76,063	1,728	74,335
Landscape Total		1,354,106	28,252	1,325,854

TABLE 3 CONTINUED

	PHJV Target Landscape	Estimated Historical Wetland Area	Estimated Wetland Area Loss 2001-2011	Estimated Remaining Wetland Area
Saskatchewan	Allan Hills	48,826	2,394	46,432
	Boundary Plateau	76,681	2,701	73,980
	Cactus Lake	143,186	5,591	137,595
	Conjuring Creek	81,565	3,298	78,267
	Coteau Central	190,436	5,904	184,532
	Coteau North	34,124	1,021	33,103
	Coteau South	240,073	8,367	231,706
	Dana Hills	209,561	8,648	200,913
	Fox Valley	21,228	928	20,300
	Hillmond	38,324	1,095	37,229
	Lenore/Ponass	172,663	6,943	165,720
	Lightning	375,054	16,206	358,848
	Pheasant Hills	71,270	3,309	67,961
	Prince Albert	59,432	2,244	57,188
	Quill South	136,640	5,008	131,632
	Regina East	108,427	4,710	103,717
	Thickwood	112,990	3,343	109,647
	Touchwood/Beaver	288,800	12,901	275,899
	Tramping Lake East	159,056	5,100	153,956
	Upper Assiniboine	247,648	10,624	237,024
	Virden Sask	59,231	2,239	56,992
Landscape Total		**2,875,215**	**112,574**	**2,762,641**
Manitoba	Minnedosa/Shoal	188,405	6,139	182,266
	Alexander/Griswold	6,864	256	6,608
	Virden	69,984	2,402	67,582
	Killarney	86,237	2,937	83,300
Landscape Total		**351,490**	**11,734**	**339,756**
PHJV Total		**4,580,811**	**152,560**	**4,428,251**

To describe spatial variation in wetland loss, wetland area loss rates by municipality were estimated for the period 2001-2011 from data gathered during the most recent update of the PHJV Habitat Monitoring Program on 221 transects within the PHJV area (M. Watmough, unpubl. data). Wetland losses across the PHJV area were estimated by constructing statistical models relating wetland loss to specific landscape covariates associated with surveyed transects. This model was applied using Agriculture and Agri-Food Canada's (AAFC) land cover map (AAFC Canada 2008) to generate municipality-specific estimates of wetland loss (Figure 10). Areas of high wetland losses in many cases coincided with areas of high wetland density (Figure 9); indeed, applying these loss rates to estimated wetland area (DUC, unpubl. data) generated an estimated 10-year loss of ~152,000 acres within PHJV Target Landscapes (Table 3). While highly variable across the PHJV area, overall wetland loss rates have shown no sign of abating over the last several decades (Watmough and Schmoll 2007), representing a significant challenge to the PHJV. Fortunately, recent and anticipated changes to wetland regulations in Alberta and Manitoba, respectively, could help to alleviate or offset wetland losses.

C. Accomplishments

1. Waterfowl Habitat and Duck Productivity

Habitat implementation plans within the PHJV area have been guided by a series of decision-support tools designed to model statistically the biological responses of ducks, typically measured in terms of habitat selection and nest success, to landscape modifications resulting from the PHJV's conservation-program delivery. During the past 25 years, these models, assumptions and duck responses to suites of programs have been rigorously tested, leading to model refinements and, importantly, both subtle and pronounced changes to program delivery (e.g., Howerter et al. 2014).

Much was accomplished in terms of program delivery over the last six years.

The *PHJV's 2007-2012 Habitat Implementation Plan* had a strong focus on wetland restoration and specified ambitious objectives to retain and restore wetlands in all provinces (Table 4). The objective was based on stark evidence of the continuing wetland losses described above as well as widespread degradation of pond margins and basins since 1985 (Bartzen et al. 2010). Thus, wetland losses were progressively reducing the capacity of the PHJV landscape to support breeding duck populations (Devries et al. 2004).

Much was accomplished in terms of program delivery over the last six years, with gains in the uptake of winter wheat — owing in large part to the development and promotion of disease- and cold-resistant winter wheat varieties by PHJV partners — and, acceptance of planted cover by landowners (see Appendix 3 for PHJV Program Definitions). Thus, short-term habitat-restoration objectives (i.e., 5-year) were either met (winter wheat) or exceeded (planted cover) in a few instances, whereas those for tame pasture, tame hay and small wetlands were not (Table 4; provincial summaries shown in Appendix 4). In particular, whereas the short-term upland habitat retention objective was achieved, meeting wetland restoration and retention area targets proved difficult to fulfill in many PHJV areas (Table 4). Wetland-restoration objectives were met in Manitoba but retention targets were not; this pattern was reversed in Saskatchewan and neither objective was achieved in Alberta (Appendix 4).

Several key learning experiences emerged from efforts to restore wetlands during 2007-2012. Given high grain prices and land values in recent years, financial incentives were likely insufficient to encourage landowners to opt for wetland restoration. The use of perpetual easements may have created a barrier for some landowners, especially cereal and oil-seed crop producers.

Finally, given the wet conditions that have prevailed across much of the PHJV area since 2010, many rural landowners are concerned about water issues and their ability to drain their land.

Estimating the net impact of PHJV programs on waterfowl productivity was accomplished by formally integrating a wide range of new information about land-use characteristics and duck populations in a series of modeling steps (Figure 11). This new modeling approach represented a substantial revision over methods used in the previous habitat implementation plan, especially with respect to duck densities, distributions and species composition, associations between wetland area and duck breeding pairs and habitat selection and nesting success relationships.

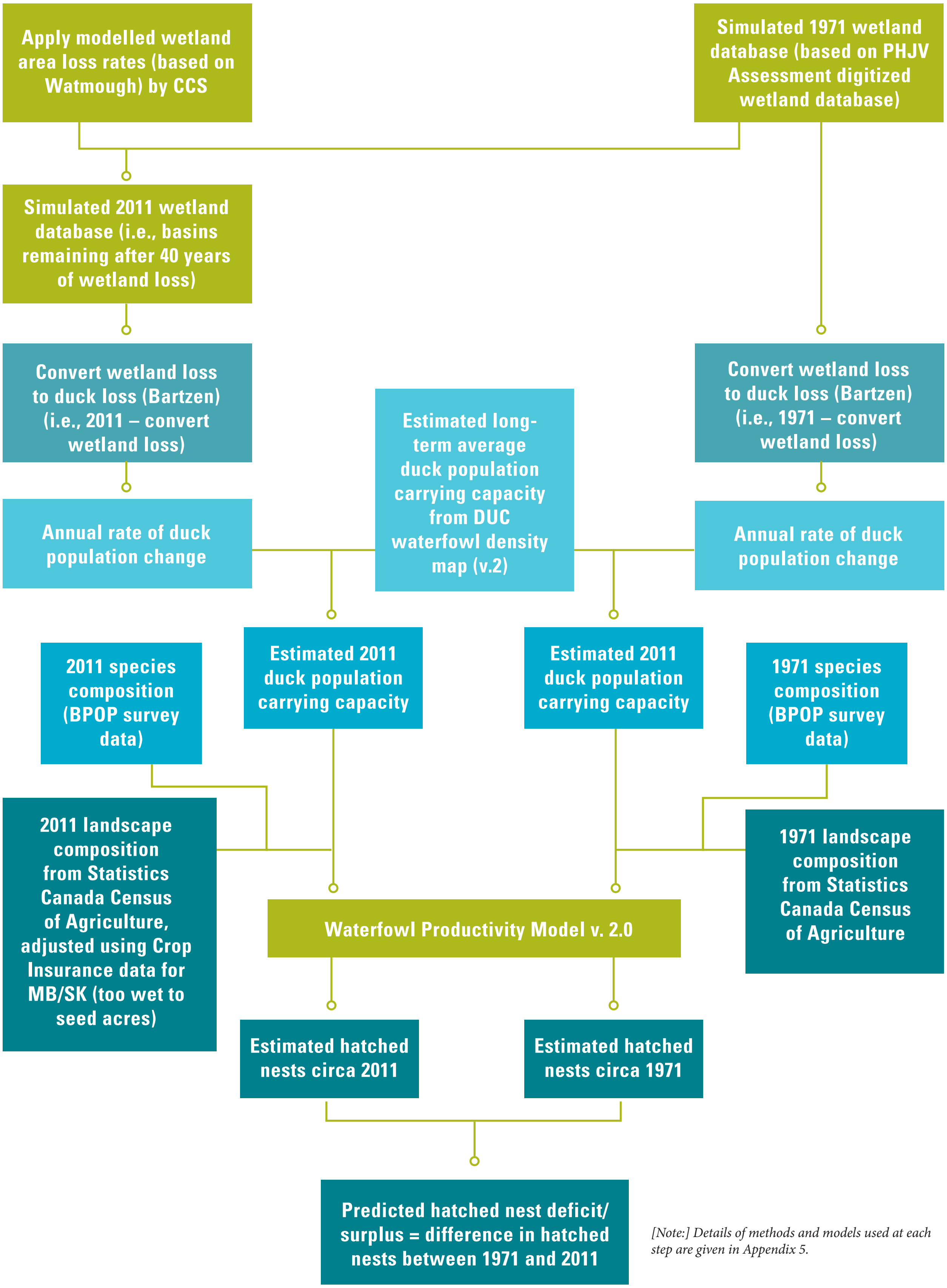
Notwithstanding the challenges associated with delivering specific programs, PHJV investments have been crucial for maintaining the productive capacity of this region for breeding ducks, as indexed by numbers of hatched duck nests (Figure 12). By 2006, deficits in duck productivity were nearly eliminated due to strengthened cattle markets and PHJV program implementation, with all factors contributing to more grassland area. Furthermore, changes to duck species composition had an impact on the hatched nest deficit estimates over the past decade because of greater relative abundances of blue-winged teal, northern shoveler

Given the wet conditions that have prevailed across much of the PHJV area since 2010, many rural landowners are concerned about water issues and their ability to drain their land.

and gadwall, and generally higher nest success associated with these species when compared with mallard and northern pintail (Table 5). While the annual and cumulative impact of PHJV programs remains positive (Figure 12), the recent projected decline in duck productivity is related primarily to ongoing wetland loss in much of the PHJV area (also refer to Figures 17 and 18).

FIGURE 11

Flow chart of steps used to estimate changes in the number of hatched nests of dabbling ducks in the Prairie Habitat Joint Venture area, 1971-2011, as illustrated in Figure 12.



[Note:] Details of methods and models used at each step are given in Appendix 5.

TABLE 4

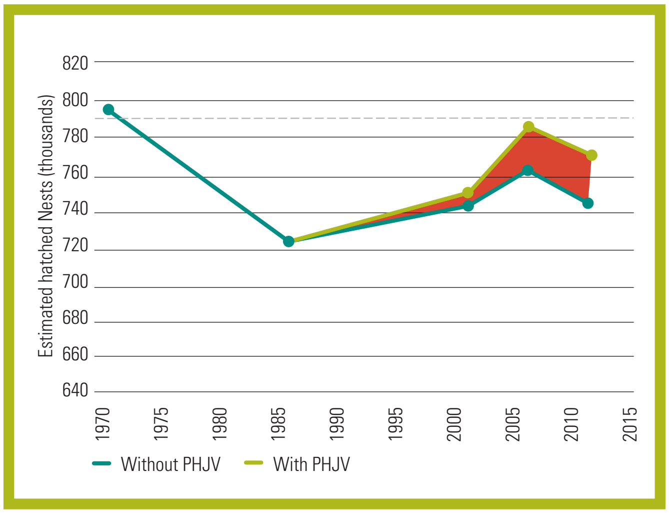
Habitat restoration and retention accomplishments within the Prairie Habitat Joint Venture area, 2007-2012, relative to initial 25-year projections.

	25-Year Habitat Objective Acres	5-Year Accomplishments (Acres)				5-year Habitat Objective	% 5-year Habitat Objective	% 25-year Habitat Objective
		Direct NAWMP	Stewardship NAWMP	Policy NAWMP	Total			
Habitat Restoration								
Winter Wheat	2,759,300	11,857	539,603	–	551,460	596,400	92%	20%
Tame Pasture	4,235,800	121,487	169,631	–	291,118	836,400	35%	7%
Tame Hay	2,824,400	55,412	39,106	–	94,518	575,700	16%	3%
Planted Cover	79,200	16,310	–	–	16,310	8,800	185%	21%
Wetlands **	278,200	5,312	22	–	5,334	10,800	49%	2%
Nesting tunnels (structures)	2,200	825	–	–	825	800	103%	38%
Restoration Sub-total	10,179,100	211,203	743,362	–	959,565	2,028,900	47%	9%
Habitat Retention								
Wetland	2,867,600	113,555	28,183	–	141,738	1,440,300	10%	5%
Upland ***	2,847,200	316,573	152,677	13,860	483,110	423,100	114%	17%
Retention Sub-total	5,714,800	430,128	180,860	13,860	624,848	1,863,400	34%	11%
Grand Total	**15,893,900**	**641,331**	**929,222**	**13,860**	**1,584,413**	**3,892,300**	**41%**	**10%**

** An estimate of change of specific land use types based on current, broad-scale Agricultural Census data.*
*** Assumes small wetland basins are primary restoration target (range, 0.5-1.0 acres; average, 0.75 acres).*
**** May include both tame and native grass acres.*
[Note:] In previous PHJV habitat implementation plans, "stewardship" was referred to as "extension".

FIGURE 12

Numbers (± standard deviation) of hatched nests of 5 dabbling duck species estimated by the Waterfowl Productivity Model (Appendix 5) in 1971, 1986, 2001, 2006 and 2011.



[Note:] The PHJV goal (grey dashed line) is the circa 1971 estimate, the solid light green line connects estimates of hatched nests for each year shown and the solid turquoise line represents estimates assuming no PHJV conservation program delivery.

During the past 25 years, the PHJV's planning models, assumptions and duck responses to suites of programs have been rigorously tested, leading to model refinements and, importantly, both subtle and pronounced changes to program delivery (e.g., Howerter et al. 2014).

TABLE 5

Estimated average annual number of hatched nests (± standard deviation) produced by nesting dabbling ducks in the Prairie Habitat Joint Venture area. Prior to 1988 there was no Prairie Habitat Joint Venture program. For 2001, 2006 and 2011, estimates are shown for each species in response to landscape conditions in the absence of PHJV conservation investments (no PHJV) versus with the PHJV, as depicted for all ducks combined in Figure 12.

Species*	1971	1986	2001 (no PHJV)	2001	2006 (no PHJV)	2006	2011 (no PHJV)	2011
BWTE	177,810 (± 1,000)	189,440 (± 1,220)	211,980 (± 1,070)	212,760 (± 1,060)	232,880 (± 1,070)	238,450 (± 1,040)	224,770 (± 1,050)	231,600 (± 1,020)
GADW	68,970 (± 600)	79,580 (± 710)	95,680 (± 820)	96,600 (± 810)	100,400 (± 770)	104,240 (± 770)	99,640 (± 750)	104,080 (± 750)
MALL	311,710 (± 2,680)	277,820 (± 2,200)	266,020 (± 2,060)	268,770 (± 2,050)	239,060 (± 1,680)	246,750 (± 1,690)	233,420 (± 1,630)	242,530 (± 1,650)
NOPI	151,100 (± 2,420)	86,150 (± 1,480)	52,160 (± 890)	53,340 (± 880)	53,820 (± 920)	56,170 (± 910)	52,710 (± 900)	55,220 (± 900)
NSHO	84,020 (± 710)	88,840 (± 820)	115,530 (± 1,000)	117,260 (± 1,000)	134,720 (± 1,180)	139,170 (± 1,180)	132,290 (± 1,160)	137,160 (± 1,160)

** BWTE, blue-winged teal; GADW, gadwall; MALL, mallard; NOPI, northern pintail; NSHO, northern shoveler.*

TABLE 6

Costs of Prairie Habitat Joint Venture Programs and Operations, 2007-2012 (source: NAWMP National Tracking System).

Program	Expenses	Cumulative Expenses
RETENTION Acquisition	$58,521,612	
Lease	$511,317	
Cooperative Land Use Agreement	$5,503,489	
Conservation Agreement	$5,379,079	
Conservation Easement	$22,822,378	
Common Activities	$3,199,470	
TOTAL RETENTION		**$95,937,345**
STEWARDSHIP	$16,582,433	
TOTAL RETENTION and STEWARDSHIP		**$112,519,778**
Enhancement	$19,899,748	
Management	$37,805,398	
Reconnaissance & Design	$790,963	
Policy Adjustment	$3,042,498	
Continuing Habitat Project Operation	$1,719,158	
Crop Damage Compensation	$216,427	
Crop Damage Prevention	$311,476	
TOTAL LANDSCAPE CONSERVATION		**$176,305,446**
Research & Evaluation	$8,526,214	
Communication & Education	$5,349,549	
Coordination	$19,616,279	
GRAND TOTAL EXPENDITURES		**$209,797,488**

The cost of PHJV program delivery and operations during the previous implementation cycle was $210 million, with nearly 50% invested in habitat retention (Table 6). Acquisition efforts resulted in over 78,000 acres of habitat being secured. Cooperative land-use agreements (323,823 acres), conservation agreements (290,621 acres) and easements (144,370 acres) cumulatively formed most secured acres.

2. Shorebirds, Waterbirds and Landbirds

Quantitative analyses of the influence of landscape-scale wetland and upland changes on Prairie Parkland Region shorebird, waterbird and landbird populations have not been done. However, data exist to develop habitat-abundance models for a wide range of landbird and shorebird species (e.g., McMaster et al. 2005, Skinner and Clark 2008), and pursuing this modeling step would enable assessments of PHJV impacts on relative abundances of diverse non-game species and also facilitate projections regarding the consequences of future land-use and wetland changes on these species. As explained below, this represents a significant research need in support of future habitat-management decisions.

Data exist to develop habitat-abundance models for a wide range of landbird and shorebird species.

D. Setting Habitat Objectives — Biological Foundations

1. Waterfowl Target Landscapes

The PHJV's Target Landscape boundaries were reviewed, and in some cases revised, during the current planning process. Predicted duck densities were derived by modeling relationships between long-term duck counts and landscape characteristics (Appendix 5). The principal criteria were the inclusion of areas with long-term averages of >30 pairs of breeding ducks/mi² of the 7 primary duck species in Prairie Canada (mallard, gadwall, blue-winged teal, northern shoveler, northern pintail, redhead, canvasback) and areas estimated to have ≥6 pairs/mi² of northern pintail.

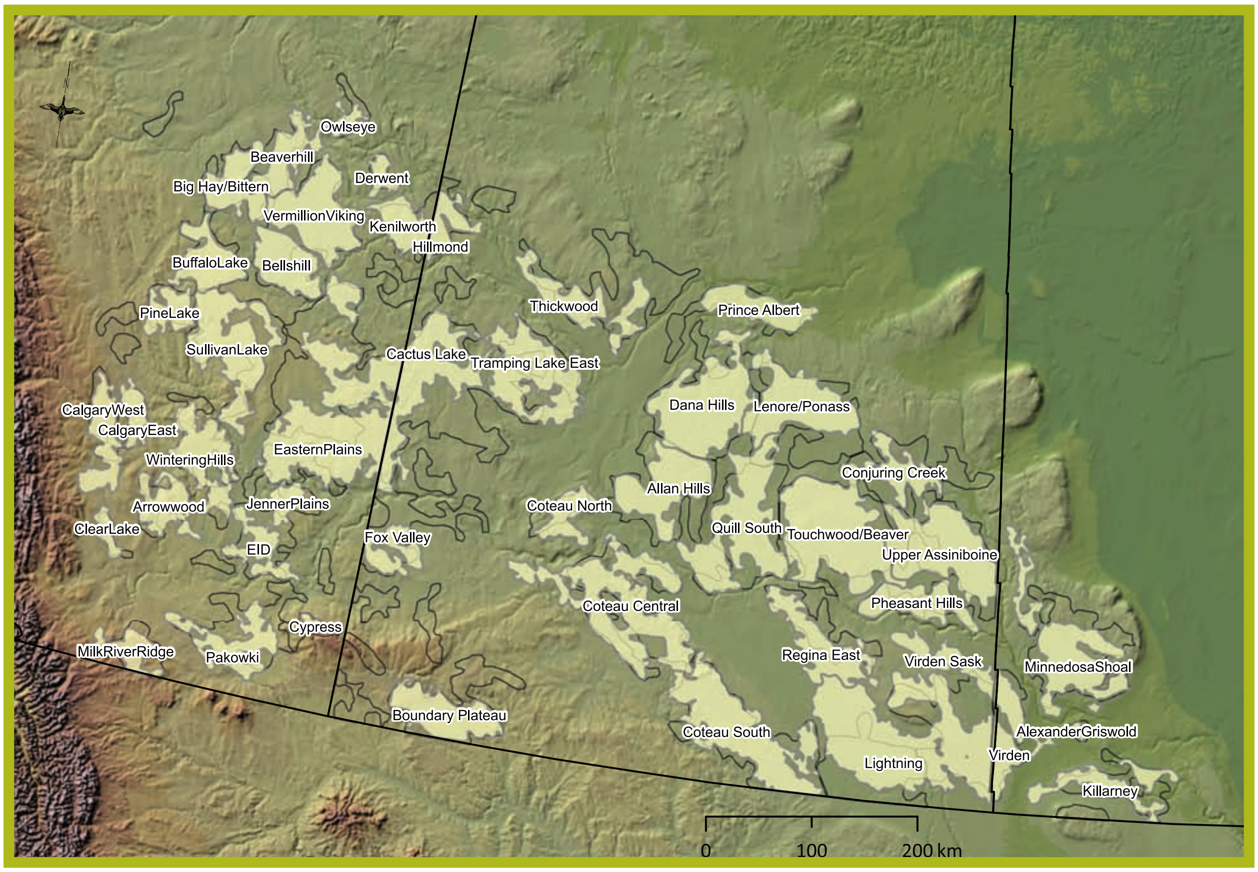
There were slight boundary modifications based on local knowledge and efforts to include areas immediately adjacent to Target Landscapes with high value for non-game species. Targeting efforts in these landscapes directs conservation resources to areas of highest average duck density, with special consideration for northern pintail: 21 Target Landscapes in Alberta, 21 in Saskatchewan and 4 in Manitoba (Figure 13). All habitats outside Target Landscapes but within the PHJV boundary typically have lower average waterfowl densities than within Target Landscapes. Direct program delivery will occasionally occur outside Target Landscapes, whereas stewardship programs are often delivered broadly throughout the PHJV (Figure 13).

2. Waterfowl Habitat Objectives — Updating Process

Since its inception, the PHJV's habitat implementation plans have been guided by quantitative models that use the best available information to predict mallard and other duck responses to habitat initiatives. Furthermore, as part of the PHJV's adaptive management cycle, the predictions, assumptions and uncertainties implicit in each model have been evaluated repeatedly (e.g., Howerter et al. 2014), and models subsequently refined. This process helps to foster continual improvements in the cost-effectiveness of program delivery. The previous Waterfowl Productivity Model has recently been refined to account for new biological information obtained from PHJV directed studies, monitoring programs and other sources (Appendix 5).

FIGURE 13

Revised Prairie Habitat Joint Venture Target Landscapes in Alberta, Saskatchewan and Manitoba for the 2013-2020 Planning Cycle.



3. Shorebird, Waterbird and Landbird Objectives

Population objectives for non-game species have been developed as part of BCR plans for the Prairie Parkland Region and WBF (e.g., BCR 11 in the PPR; BCR 6 and others in the WBF). Objectives for threatened and endangered species are identified in respective recovery plans and are not included here.

Population objectives for non-game species have been developed as part of BCR plans for the Prairie Parkland Region and WBF.

This Plan has identified how habitat requirements of BCR priority species align with broad upland and wetland priorities set by the PHJV to achieve duck population objectives (Appendix 2). New work is needed to determine how landbird and shorebird priority species abundances are related to PHJV habitat accomplishments since 1986, and also to predict the likely impacts of the PHJV's new habitat objectives for the next planning cycle. In this regard, innovative products have been developed and are being refined for a broad suite of marshbird species, as explained later in this Plan; the creation of similar planning tools for other non-game species would be extremely useful.

E. Habitat Objectives

1. Waterfowl Habitat Restoration Scenarios and Objectives

Provincial implementation teams were formed to review progress in achieving habitat objectives during the 2007-2012 cycle, and to adjust programs, as required, for the new implementation period. These teams were guided by new information and revised planning tools (e.g., Appendices 5 and 6). Briefly, the predicted 2030 landscape was developed using a model that quantifies the relationship between agricultural land-use and economic and regional characteristics (Rashford et al. 2013). This was the base landscape for applying scenarios of upland and wetland-restoration efforts, and assuming that proportions of duck species observed during 2001-2011 would remain relatively consistent into the future (Appendix 6). Provincial planning teams considered scenarios that incorporated the impacts of wetland policy, in the absence of further PHJV conservation-program delivery, implemented at different times during the implementation cycle to 2030. A wetland policy now exists for Alberta; however, a fundamental assumption in setting program objectives was that wetland policy implementation would eliminate wetland loss in Manitoba and Saskatchewan prior to 2030.

Nesting tunnels (pictured middle right) have high usage rates, particularly by mallards, and improve nesting success by minimizing predation./©Ducks Unlimited Canada

Provincial implementation teams then developed scenarios of upland and wetland habitat restoration programs for Target Landscapes and the remaining PHJV area to eliminate hatched nest deficits. The planning process began well before the new NAWMP duck population goals had been established, so the benchmark, "average of the 1970s", was retained for guidance during the process. In practical terms, retaining the 1970s average implies that PHJV landscape conditions should sustain periodic population sizes at the 80th percentile of long-term levels specified by new NAWMP duck population goals (Table 1). However, the PHJV will evaluate the habitat program implications of these new population goals in the next two to three years as it considers management approaches for addressing concerns regarding northern pintail and possibly American wigeon, lesser scaup and mallard (see Section H: Research and Evaluation).

Provincial implementation teams were formed to review progress in achieving habitat objectives during the 2007-2012 cycle, and to adjust programs, as required, for the new implementation period.

Objectives set for Manitoba were based on a two-step process. First, an analysis of program delivery over the past 5 years was completed. Based on that step, and incorporating any significant program changes by delivery partners, habitat-restoration objectives were projected to 2020 and 2030. The second step assessed the impact of this work on the waterfowl deficit. In Manitoba, continuing program delivery at the current pace (i.e., previous 5-year window) was deemed sufficient to achieve a zero-deficit situation; therefore, objectives based on recent delivery approaches were retained. The only exception was winter wheat, with a new objective of 20% of all wheat area sown to winter wheat.

TABLE 7

Provincial and Prairie Habitat Joint Venture-level habitat restoration objectives for Target and non-target Landscapes to 2020.

Habitat Restoration Objectives

Province	Winter Wheat*	Tame Pasture (Acres)	Tame Hay (Acres)	Planted Cover Cover (Acres)	Wetland Basins (#)	Nesting Tunnels (#)
Manitoba						
Target Landscapes		15,446	10,298	4,800	1,580	1,360
Remaining Delivery Areas		6,700	4,466	0	882	0
Sub-total	20%	22,146	14,764	4,800	2,463	1,360
Saskatchewan						
Target Landscapes		242,549	68,621	6,078	3,388	0
Remaining Delivery Areas		149,600	25,200	1,360	632	0
Sub-total	15%	392,149	93,821	7,438	4,020	0
Alberta						
Target Landscapes		116,400	230,000	14,200	4,050	0
Remaining Delivery Areas		60,000	60,000	0	0	0
Subtotal	20%	176,400	290,000	14,200	4,050	0
PHJV	**15-20%**	**590,695**	**398,585**	**26,438**	**10,533**	**1,360**

* *Percentage of all wheat acres planted to winter wheat by 2030 (possibly 2020) in each Province; uptake by producers will depend on several factors (see text). Provincial-level details are shown in Appendix 7.*

Objectives developed for Saskatchewan were also based on a two-step process. First, an analysis of program delivery over the past five years was completed. Based on that step, and incorporating any significant program changes by delivery partners, habitat-restoration objectives were projected out to 2020 and 2030. The second step involved an assessment of how this work would reduce waterfowl deficits. In Saskatchewan, the continuation of most program delivery at the current pace would be sufficient to maintain a surplus rather than result in a deficit of hatched duck nests; therefore, objectives based on previous accomplishments were adopted. The only exception was winter wheat where an objective of 15% of all wheat acres was established.

Restoration objectives for Alberta were initially set for the period 2013-2030 and applied an aspirational approach; that is, continue adding landscape-appropriate wetland and upland acres until the deficit was eliminated. The required level of habitat treatments to be implemented over this planning horizon, based on current capacity, was deemed unrealistic. However, this planning approach served the purpose of framing the long-term conservation challenge. Restoration objectives for the medium-term (2013-2020) applied a blend of aspirational and pragmatic approaches. Landscape-appropriate wetland and upland acres were applied ambitiously at levels as close to the ideal of 40% (i.e., to 2020) of all treatments required in the long term (2030) with the exception that 5% of wetland basin objectives would be achieved by 2020. The projected effect of this work by 2020 indicates that only a ~15% reduction in the long-term deficit can be achieved. Seeking innovative means to increase habitat-restoration capacity by partners and others will also be a critical part of the PHJV's conservation work during this period.

To achieve new 2020 targets, wetland-restoration programs will involve higher payments, allow short-term agreements (e.g., 10 years or less) and incentives will be promoted more widely.

Socioeconomic and other challenges identified during the recent program delivery period, several discussed above, will be addressed during the next implementation cycle and program adjustments are anticipated to encourage program participation. Specifically, wetland objectives have been substantially modified (Table 7). To achieve new 2020 targets, wetland-restoration programs will involve higher payments, allow short-term agreements (e.g., 10 years or

Winter wheat (pictured) benefits spring-nesting waterfowl, particularly northern pintails, a species in decline since the late 1970s./©Ducks Unlimited Canada/Tye Gregg

less) and incentives will be promoted more widely. Top-up payments will also be offered for restoration agreements made in-perpetuity.

Provincial teams have identified new winter-wheat targets ranging from 15% of all wheat acres sown in Saskatchewan, to 20% in Manitoba and Alberta, representing substantial increases over current levels (Table 7). As winter-wheat varieties continue to improve and producers gain knowledge and experience, winter-wheat acreage is expected to expand. Furthermore, with changes to the Canadian Wheat Board, there is some expectation that winter-wheat prices will rise, resulting in market incentives to increase crop acreages. The PHJV will closely monitor winter-wheat acreage, promote its use and also remain attuned to new opportunities to improve winter-wheat or other cropping practices that benefit waterfowl and other birds.

The estimated area of remaining tame and native grassland in PHJV Target Landscapes is 4.7 million acres.

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).

Land areas in tame hay, pasture and planted cover are assumed to result from conversions of cropland to these cover types. These improvements in perennial cover and wetlands are set within an agricultural landscape that is expected to change considerably due to climate change impacts on cropping practices, and other factors, and thus the amount of land retained as pasture and hayland.

2. Waterfowl Habitat Retention Objectives

The PHJV's overarching goals are to achieve "no net loss" of wetlands and native grasslands. The premise of this Plan is to reduce deficits in duck productivity (e.g., Figure 12), meaning that retention must be secondary to restoration. Wetland and upland habitat retention activities do not reduce the productivity deficit; instead, they prevent or slow a continuing decline in productivity. Thus, habitat retention will be essential to prevent or slow further loss and degradation of critical waterfowl habitat. The following information and assumptions were used to set retention targets for 2013-2030.

Retention objectives for Alberta applied a strictly practical approach for both medium- (2013-2020) and long-term (2030) planning; an annual retention target was projected forward for both wetlands and uplands based on actual annual accomplishments during the period 2007-2012. Related to a wetland retention target was the key assumption that Alberta's wetland policy would become operational and take effect by 2015.

The estimated area of remaining tame and native grassland in PHJV Target Landscapes is 4.7 million acres (L. Boychuk, DUC, personal communication); the amount and location of high-risk grassland and wetland habitat are unknown but should be determined. Likewise, Target Landscapes contain 4.3 million acres of wetlands. In the last phase of implementation, the PHJV secured about 80,000 acres of wetlands and uplands annually, with a wetland:upland ratio of about 1:5. Retention objectives in the period 2013-2020 were therefore set to the same annual rate and projected forward, subject to influences of major project(s) and/or large policy effects (about 684,000 acres across the PHJV area; Table 8). The PHJV's combined restoration and retention objectives total 351,000 acres of wetlands and 1,357,800 acres of upland habitat during 2013-2020.

3. Projecting Reductions in Hatched Nest Deficits

Achieving PHJV habitat objectives outlined in Tables 8 and 9 is expected to produce gains in the numbers of hatched nests for all species (Table 9; provincial-level details in Appendix 8). For the 5 dabbling duck species combined, the net impact of PHJV programs is an additional ~3,000 hatched nests by 2020, but the remaining deficit (Table 9) would not be eliminated until nearly 2030 (Appendix 8; also refer to Figure 17). The largest gains in hatched nests are driven by the substantial improvements in productivity

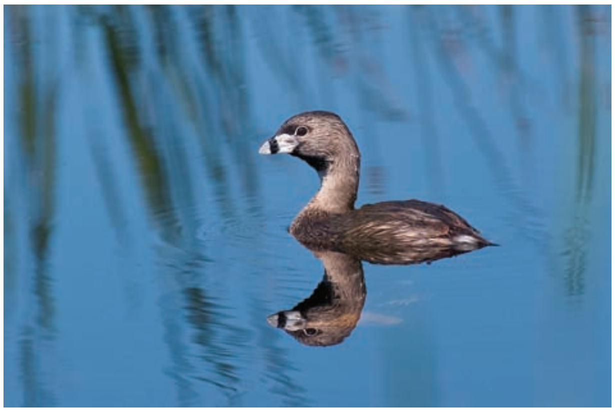
TABLE 8

PHJV wetland and upland habitat retention objectives to 2020 (i.e., 8-year) and 2030 for each province, and overall.

Habitat Retention	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Stewardship NAWMP	Total	
Wetland					
Alberta	97,875	43,500	-	43,500	44%
Saskatchewan	580,155	232,062	-	232,062	40%
Manitoba	169,600	67,840	-	67,840	40%
Sub-total	**847,630**	**343,402**	-	**343,402**	**41%**
Upland					
Alberta	199,125	88,500	-	88,500	44%
Saskatchewan	318,159	127,264	-	127,264	40%
Manitoba	312,400	124,960	-	124,960	40%
Sub-total	**829,684**	**340,724**	-	**340,724**	**41%**
Retention Total	**1,677,314**	**684,126**		**684,126**	**41%**

The information is used to identify species that are significantly declining in the PHJV area and to suggest how different groups of species would benefit from decision-support planning targeted jointly towards waterfowl and all birds.

associated with gadwall, blue-winged teal and shoveler. The 2020 estimates were not model-estimated values; rather, they were calculated *post hoc* by multiplying hatched nests gained by 2030 by 0.40 (i.e., ~8/18 years) and applying them to the deficit values. Impacts on mallard and northern pintail production are expected to be limited, and this anticipated difficulty in improving landscape carrying capacity for these two species will represent a significant conservation challenge for the PHJV in the next decade (see Section H).



Pied-billed Grebe/© Ducks Unlimited Canada

4. Shorebird, Waterbird and Landbird Habitat Objectives

Quantitative habitat objectives are not described for Prairie Parkland Region shorebirds, waterbirds or landbirds. In most cases, limited knowledge exists on species distributions and habitat associations, which hinders the PHJV's ability to estimate population size and to quantify the impact of landscape change on populations. Two exceptions exist: 1) Species at risk, such as greater sage grouse and whooping crane, whose abundances and/or distributions are sufficiently small to enable an accurate estimate of population size, and 2) Colonial waterbirds, where bird concentrations at specific breeding sites often facilitate a reliable survey of the population within a region. Other species that are more uniformly distributed across the landscape require a sample-based approach to estimate relative abundance. While the BBS is a reliable means of assessing trends for these species based on an index of abundance, it does not incorporate ways of estimating species detectability during surveys. Therefore, it is difficult to use the BBS to estimate true abundance, although this is done in some cases (e.g., Rich et al. 2004).

TABLE 9

Estimates of the average annual current (2011) and projected (2020) surpluses or deficits (± standard deviation) in number of hatched nests for five dabbling duck species nesting within the Prairie Habitat Joint Venture Target Landscapes and remaining delivery areas. Predicted hatched nest deficit/surplus in 2011 was estimated from the Waterfowl Productivity Model.

Current (2011) Deficit/Surplus (± SD)

Province	All Dabblers	Mallard	Northern pintail	Gadwall	Blue-winged teal	Northern shoveler
Manitoba:						
Target Landscapes	-640 (± 940)	710 (± 360)	-1,090 (± 200)	1,060 (± 150)	-2,060 (± 610)	730 (± 200)
Remaining Delivery Area	-810 (± 470)	1,930 (± 190)	-2,230 (± 110)	1,560 (± 60)	-3,120 (± 290)	1,050 (± 100)
Sub-total	-1,450 (± 1,050)	2,640 (± 410)	-3,310 (± 230)	2,620 (± 160)	-5,190 (± 670)	1,790 (± 220)
Saskatchewan:						
Target Landscapes	15,790 (± 4,450)	-14,460 (± 1,940)	-19,680 (± 1,960)	11,910 (± 910)	24,820 (± 1,890)	13,200 (± 1,160)
Remaining Delivery Area	990 (± 1,780)	-23,750 (± 1,070)	-25,120 (± 780)	10,270 (± 300)	26,370 (± 490)	13,230 (± 370)
Sub-total	16,780 (± 4,790)	-38,210 (± 2,220)	-44,810 (± 2,110)	22,180 (± 960)	51,190 (± 1,950)	26,430 (± 1,220)
Alberta:						
Target Landscapes	-14,090 (± 2,970)	-14,520 (± 1,700)	-16,920 (± 1,420)	3,250 (± 540)	3,940 (± 660)	10,160 (± 770)
Remaining Delivery Area	-24,220 (± 3,020)	-19,070 (± 1,730)	-30,820 (± 1,430)	7,050 (± 490)	3,860 (± 610)	14,760 (± 750)
Sub-total	-38,310 (± 4,240)	-33,590 (± 2,420)	-47,750 (± 2,010)	10,300 (± 730)	7,790 (± 900)	24,930 (± 1,070)
PHJV Total	**-22,980**	**-69,160**	**-95,870**	**35,100**	**53,790**	**53,150**

Estimated Deficit/Surplus in 2020 After PHJV Action

Province	All Dabblers	Mallard	Northern pintail	Gadwall	Blue-winged teal	Northern shoveler
Manitoba:						
Target Landscapes	240	1,260	-1,070	1,060	-1,790	780
Remaining Delivery Area	-1,620	1,670	-2,250	1,370	-3,310	910
Sub-total	-1,380	2,930	-3,320	2,430	-5,100	1,680
Saskatchewan:						
Target Landscapes	12,610	-15,440	-19,500	10,870	23,910	12,770
Remaining Delivery Area	-7,290	-26,430	-25,390	8,370	24,190	11,980
Sub-total	5,320	-41,880	-44,890	19,240	48,100	24,750
Alberta:						
Target Landscapes	-4,310	-11,760	-15,830	4,430	6,270	12,570
Remaining Delivery Area	-19,260	-17,600	-30,090	7,350	5,080	16,010
Sub-total	-23,570	-29,370	-45,920	11,780	11,360	28,580
PHJV Total	**-19,630**	**-68,320**	**-94,130**	**33,450**	**54,360**	**55,010**

[Note:] 2020 hatched nest estimates are based on a predicted landscape for 2030.

The Missouri Coteau is a narrow band of prairie upland that stretches from Southern Saskatchewan to South Dakota./
©Ducks Unlimited Canada

Because of the uncertainty in generating regional population estimates and habitat objectives for shorebirds, waterbirds and landbirds, this Plan provides information on population trends and habitats selected for breeding or migratory stopovers. The information is used to identify species that are significantly declining in the PHJV area and to suggest how different groups of species would benefit from decision-support planning targeted jointly towards waterfowl and all birds. Decision-support-system (DSS) modeling is an important conservation technique to identify high-priority landscapes for protection and restoration (PHJV 2007). The approach combines information on waterfowl-breeding distribution and productivity with land-cover mapping tools to identify areas where conservation protection will have the highest potential to benefit waterfowl (DUC and the Institute for Wetland and Waterfowl Research 1999, DUC, 2000). The method has yet to be applied solely to non-game species in the PHJV area. However, the large area requirements of waterfowl includes wetlands and adjacent uplands such that habitat protection directed to waterfowl can also benefit a range of shorebirds, waterbirds and landbirds that use these habitats and have smaller area requirements. Thus, the current focus of the PHJV in this respect is to identify combined high-priority areas for waterfowl and non-game birds for habitat-conservation efforts. The remainder of this section first discusses those species with similar requirements to waterfowl and then identifies the potential for protection of non-game species that have habitat requirements that differ from waterfowl.

Within the PHJV area, priority species that are the most likely to benefit from a focus on productive waterfowl habitat include those that are obligate users of small to large semi-permanent to permanent wetlands (Class 3, 4 and 5 wetlands; Stewart and Kantrud 1971) and those that use adjacent upland habitat (Skinner 2004, Skinner and Clark 2008). The species in Appendix 2(a) that fall within this category are non-colonial breeders and include horned grebe, pied-billed grebe, sora, American coot, Wilson's snipe, Wilson's phalarope, common yellowthroat and Nelson's sparrow. First-generation decision-support modeling for this group of marshbirds has been completed (below). Some species in Appendix 2(a), most notably American bittern and black tern, depend on larger scale wetland complexes with heterogeneity in the size and structure of individual wetlands within the complex (Brown and Dinsmore 1986, Naugle et al. 2000). These two species are among the most seriously declining waterbirds on the prairies (Appendix 2(a)), likely due in part to the loss of these large, wetland complexes. Conservation efforts targeting expansive wetland landscapes will benefit these species as well as the many other species that have smaller area requirements.

A small group of species in Appendix 2(a) select ephemeral Class 1-2 wetlands including yellow rail, sedge wren and Le Conte's sparrow. Yellow rail are currently listed as a species of special concern under Canada's *Species at Risk Act* and are the focus of improved monitoring and conservation efforts in Canada. Water depth often varies annually in these habitats and the species that use ephemeral wetlands exhibit a high degree of within and between-year movements to take advantage of this spatial variation in habitat suitability (Herkert et al. 2001). Decision-support system modeling may be more difficult for these species because the ephemeral nature of their habitat makes it difficult to predict where they will occur in space and time. Moreover, Class 2 sedge-meadow wetlands hold lower potential for waterfowl compared to pothole wetlands and small lakes, and are therefore not likely to be targeted by waterfowl habitat-conservation efforts. However, the protection of large wetland landscapes may include these types of habitats and this should be explored in future wetland mapping efforts.

Given the vast diversity of wetland types that are potentially available for stopovers, conserving wetland areas for waterfowl might also protect shorebird staging habitat.

The species in Appendix 2(b) are those that inhabit more expansive upland areas, most often in moist-mixed grass prairie, mixed-grass prairie and sagebrush habitats. Grassland birds have displayed some of the strongest population declines of any bird group in North America (Vickery and Herkert 2001, Sauer et al. 2011, Environment Canada 2013b) due to a combination of factors such as habitat loss on breeding and wintering grounds (Brennan and Kuvlesky Jr. 2005, Askins et al. 2007), pesticide poisoning (Mineau and Whiteside 2013) and oil and gas development (Naugle et al. 2011). The priority areas for grassland birds and waterfowl have some potential for overlap, but several species of priority grassland birds depend on total area of native grassland and not wetland density or crop cover (Skinner and Clark 2008). Grassland birds that show the greatest potential for overlap often select wetter habitats even if they also use drier upland sites (e.g., Le Conte's sparrow; Skinner 2004). Conservation planning for species of arid upland habitats in landscapes with low wetland density (e.g., Sprague's pipit, chestnut-collared longspur, lark bunting) needs to target this group rather than attempt to use waterfowl as a surrogate (Koper and Schmiegelow 2006, Skinner and Clark 2008).

The Prairie Parkland Region provides important migratory staging habitat for many shorebirds, as well as the endangered whooping crane, that breed in Boreal and Arctic Regions (Appendix 2c). Migratory shorebirds are well known to concentrate at particular staging areas such as the Chaplin/Old Wives/Reed Lake complex in Southern Saskatchewan (Beyersbergen and Duncan 2007). However, given the vast diversity of wetland types that are potentially available for stopovers, conserving wetland areas for waterfowl might also protect shorebird staging habitat. Preliminary surveys in 2013 by CWS and Bird Studies Canada revealed differences among species in their propensity to use specific staging areas, such as Chaplin Lake, versus the many smaller wetlands across the landscape. Species, such as sanderling, white-rumped sandpiper, stilt sandpiper and semipalmated sandpiper, predominantly used Chaplin Lake and a few other large lakes in Southern Saskatchewan (CWS, unpublished data). For these species, retention and restoration of small wetlands may have little impact and conservation efforts need to ensure protection of the main staging sites like Chaplin Lake. However, a number of other migratory shorebirds were more variable in their habitat preferences and spread out to use a variety of wetlands across the landscape as long as suitable shoreline habitat (shallow water with little vegetation or mudflats) was available. This group included most boreal-breeding migrant shorebirds (e.g., lesser yellowlegs, solitary sandpiper, least sandpiper, short-billed dowitcher) and some arctic breeders (e.g., long-billed dowitcher, pectoral sandpiper). Further study is needed but these preliminary findings suggest that priority areas for waterfowl and other bird groups that breed in wetland habitats may also benefit certain Boreal and Arctic-breeding shorebirds during migration.

The result of these efforts is the production of first-generation species-habitat models that link species distributions to landscape features for 10 species, including bitterns, coots, grebes, rails, snipe and Nelson's sparrow.

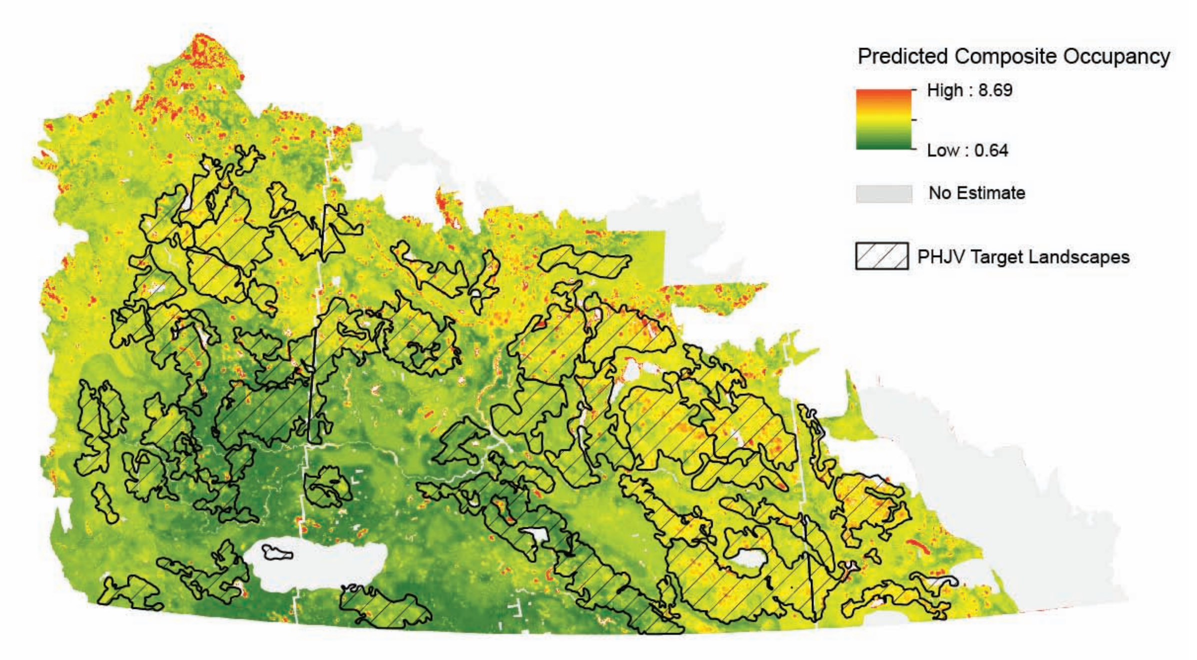
Decision-Support Tools for Marsh Birds

The biological foundation of PHJV conservation activities is based on linkages between bird populations and landscape/habitat features. These relationships are relatively well-established for waterfowl and have led to the identification of Target Landscapes and the focusing of conservation resources in areas with the highest waterfowl breeding pair and nesting densities. Information about landscape influences on waterfowl productivity has led to the development of waterfowl productivity models which enable forecasting of gains or losses to duck populations resulting from different land-use changes and conservation scenarios. As described above, these models help to inform the setting of habitat objectives and the spatial allocation of conservation resources to meet PHJV waterfowl population objectives. At the time of release of the *PHJV's 2007-2012 Habitat Implementation Plan*, a lack of information on species distributions and habitat associations impeded the development of similar biological models for other bird groups.

During 2007-2012, work was undertaken to develop linkages between bird populations and landscape/habitat features for other wetland-associated species. The result of these efforts is the production of first-generation species-habitat models that link species distributions to landscape features for 10 species, including bitterns, coots, grebes, rails, snipe and Nelson's sparrow. This group of species was selected because it represents a diverse assemblage of wetland-obligate birds that inhabit emergent marsh and hemi-marsh habitats, as well as those that are associated with a gradation zone from emergent vegetation to the wet prairie and/or wet meadow zones that are often found near the margins of wetlands. For a given wetland-associated bird species, these models predict either occurrence or abundance based on factors such as ecoregion, agricultural intensity, average moisture conditions and amounts of wetland and natural upland land-cover classes. Development of such spatially explicit planning tools can facilitate an assessment of the degree of overlap between PHJV waterfowl Target Landscapes and measurements of diversity or abundance of other wetland-associated birds.

FIGURE 14

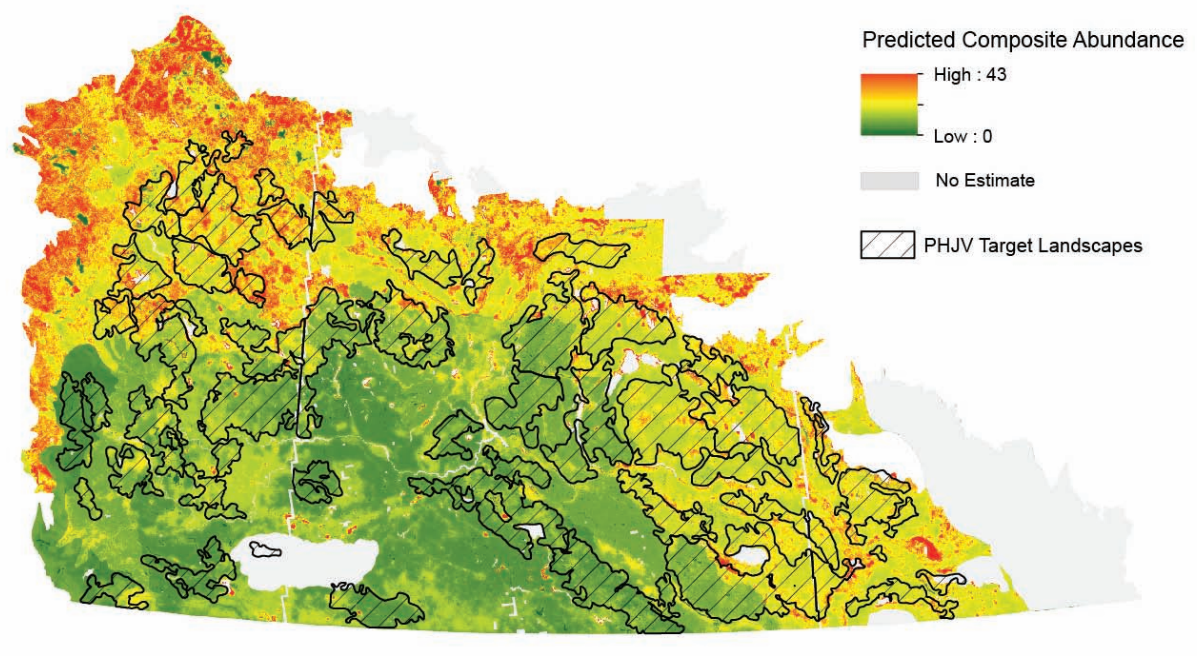
Predicted composite occupancy for 10 species of wetland-associated birds (refer to colour-codes in legend) and the Prairie Habitat Joint Venture Waterfowl Target Landscapes (outlined in black).



[Note:] Predicted composite occupancy includes the following species: American bittern, American coot, eared grebe, horned grebe, pied-billed grebe, red-necked grebe, Nelson's sparrow, sora, Virginia rail and Wilson's snipe.

FIGURE 15

Predicted composite abundance of four species of wetland-associated birds (American bittern, Nelson's sparrow, sora, and Virginia rail) and the Prairie Habitat Joint Venture Target Landscapes (outlined in black).



[Note:] Refer to the legend for colour-codes representing abundances.

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 waterfowl.

Figure 14 shows the predicted occupancy for 10 species within the PHJV area, identifying biodiversity "hotspots" for wetland-associated birds and their proximity to the waterfowl target areas.

It is often more challenging to model the abundance of species in relation to landscape and habitat characteristics, but for some species such models are possible. Figure 15 shows the predicted abundance of four species within the PHJV area identifying likely hotspots of abundance of these species and their proximity to the waterfowl Target Landscapes. Areas within the Prairie Parkland Region and BTZ tend to have a high occurrence and abundance of these marshbird species. Methods used to generate composite maps of occurrences and abundances are described in Appendix 9, where maps for individual species are also shown.

5. Special Wetlands and Large Marsh Acquisitions

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 waterfowl. 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 may also provide crucial spawning and nursery areas for fish and deliver other important ecological services such as nutrient retention and carbon sequestration. 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 prioritized list of important wetlands in the Prairie Parkland Region and adjacent BTZ (Appendix 10). These wetlands have remarkable attributes that merit their retention and, where possible, the restoration of their productive potential.

The Prairie Parkland Region offers numerous recreational opportunities, including photography, hiking, birding and canoeing./ David Johns

Threats to these special wetlands are often poorly quantified, but include changes to water regimes for hydro-electric or flood-control purposes, invasive alien species and climate change. For instance, coastal marshes like Delta and Netley-Libau on Manitoba's "great" lakes 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 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
- pursue opportunities to secure and protect designated wetlands, such as those owned by the Provincial Crown

F. Developing New Objectives for People: Building Support for Conservation

1. Human Dimensions

The *NAWMP 2012: People Conserving Waterfowl and Wetlands* revision incorporated an explicit human dimensions goal and, in 2014, the NAWMP Committee added a specific objective for waterfowl supporters.

***NAWMP Goal for Waterfowl Supporters:* Growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation.**

The Addendum to the *NAWMP 2012: People Conserving Waterfowl and Wetlands revision* (September 2014) states that traditional (waterfowl-hunter conservationists) and non-traditional (waterfowl conservationists who do not hunt) supporters will be essential to sustaining the system of waterfowl conservation. The PHJV Advisory Board and partner organizations acknowledge that this is particularly true in Canadian prairie landscapes. Integrating management actions that balance objectives for waterfowl populations with those for waterfowl supporters from various groups, such as urban residents, represents a key challenge for waterfowl managers. Concerns about the shift from rural to urban living, the high turnover rate among waterfowl-user segments and an aging support base are important considerations for the waterfowl management community. Region-specific strategies within the PHJV area and other areas across the continent will be needed to address unique demographics, hunting traditions, perspectives about wetlands and waterfowl and other social characteristics.

In terms of the broader groups of conservation supporters, communicating the value of the ecological goods and services provided by landscapes used by waterfowl presents an opportunity to further advance waterfowl and wetland conservation.

A significant body of information exists (due to earlier work by the Flyway Councils) on the draft *Waterfowl Hunter Recruitment and Retention Strategy* (2008) which provides a strong social-science basis for developing supporter objectives. The relevance of the Strategy to hunter recruitment and retention in Canada has not been evaluated. The NAWMP Committee established the Human Dimensions Working Group (HDWG) and the Public Engagement Team (PET) to advance efforts to achieve NAWMP's waterfowl support goal. Rigorous social-science surveys are under development for use in Canada and the United States by the HDWG and the results will be central to informing and revising future NAWMP objectives and to guiding specific regional strategies for increasing the number of hunters and other supporters. The PET is developing a public-engagement strategy that will provide a framework for building waterfowl-conservation support.

The Addendum to the *NAWMP 2012: People Conserving Waterfowl and Wetlands* revision (September 2014) suggests that achieving the NAWMP goal to increase the number of waterfowl supporters will occur through a combination of engagement strategies that will differ for each of Canada, the United States and Mexico. The strategies should be developed and implemented at smaller scales such as regional and Joint Venture levels. It is important to recognize that landowners and local residents are critical partners in habitat management on both private and public lands. The strategic engagement of landowners and other groups will have significant benefits. In terms of the broader groups of conservation supporters, communicating the value of the ecological goods and services provided by landscapes used by waterfowl presents an opportunity to further advance waterfowl and wetland conservation.

Integrating management actions that balance objectives for waterfowl populations with those for waterfowl supporters from various groups, such as urban residents, represents a key challenge for waterfowl managers.

Contributing to the Hunter/Supporter Goal

The PHJV has extensive experience working with landowners to conserve habitat and increase waterfowl populations. Partner organizations have been responding to stakeholder values and needs. For example, partners inherently know that ranchers are more likely to accept wetland restoration as compared to landowners with predominantly cultivated lands. Recently, DUC has developed new ways of communicating to distinct audiences about landscape conditions within a watershed (e.g., Broughton's Creek) and how these conditions affect water quality, surface-water runoff, etc., and motivating these audiences to support changes in conservation policies.

In the past, the PHJV assumed that habitat and waterfowl-population objectives would also meet hunter needs and expectations over the long-term. This may not be correct given that most waterfowl populations are currently at record levels, while the number of waterfowl hunters is not

NAWMP Objective:

NAWMP Objective: Increase waterfowl conservation support among various constituencies to at least the levels experienced during the last two decades.

- Increase support for waterfowl conservation through involvement in the hunting tradition
- Increase support from North American citizenry who value and understand waterfowl-wetland conservation and take action to demonstrate active support
- Increase numbers of landowners participating in habitat-conservation programs

Hunters contribute millions of dollars annually to Canada's habitat-conservation efforts./©Dean Davenport

The current challenge for the PHJV is to identify what role it should play in including diverse groups of stakeholders in discussions regarding wetland and waterfowl conservation, participation in conservation programs and waterfowl hunting.

increasing. During the next planning cycle, the PHJV must improve its understanding of stakeholder values and make wetland conservation more relevant to a broader range of stakeholders. The PHJV also should motivate people to participate in waterfowl hunting, viewing and/or support for habitat-conservation programs for beneficial watershed-management purposes such as flood attenuation and surface-water-quality enhancement.

Within the PHJV area, there is a long history and considerable experience in what works for, and resonates with, landowners and land managers for conservation program delivery, however, the Joint Venture's knowledge of other stakeholders is limited and fragmented.

The PHJV Advisory Board and partner organization staff will begin the transition to incorporating human dimensions into the PHJV's overall strategic/implementation planning and program delivery. The current challenge for the PHJV is to identify what role it should play in including diverse groups of stakeholders in discussions regarding wetland and waterfowl conservation, participation in conservation programs and waterfowl hunting.

Questions include:

- How should the PHJV identify and engage various stakeholders and support their values? For example, which groups are most interested in flood attenuation and water quality and what are the key characteristics of these groups?
- Which social science techniques, marketing, communications, consultation or other approaches are needed to engage landowners, waterfowl professionals, hunters, birders, industry and the general public? How are these groups most effectively informed and engaged?
- Should the PHJV begin to develop a formal system for gathering and incorporating social-science information into its strategic-planning process, information that is needed to better understand tradeoffs or to optimize the combination of social values and biological knowledge?

Information that is gathered could be incorporated into a human dimensions information layer within decision-support systems used to identify Target Landscapes, while also informing PHJV partners about who and how to involve other stakeholders in the waterfowl conservation community. For example, if urban residents tend to be most interested in wetland values within a given distance of where they live, a proximity analysis could help to identify and target landscapes for their water-quality or wildlife-viewing values. Within the PHJV area, there is a long history and considerable experience in what works for, and resonates with, landowners and land managers for conservation program delivery, however, the Joint Venture's knowledge of other stakeholders is limited and fragmented.

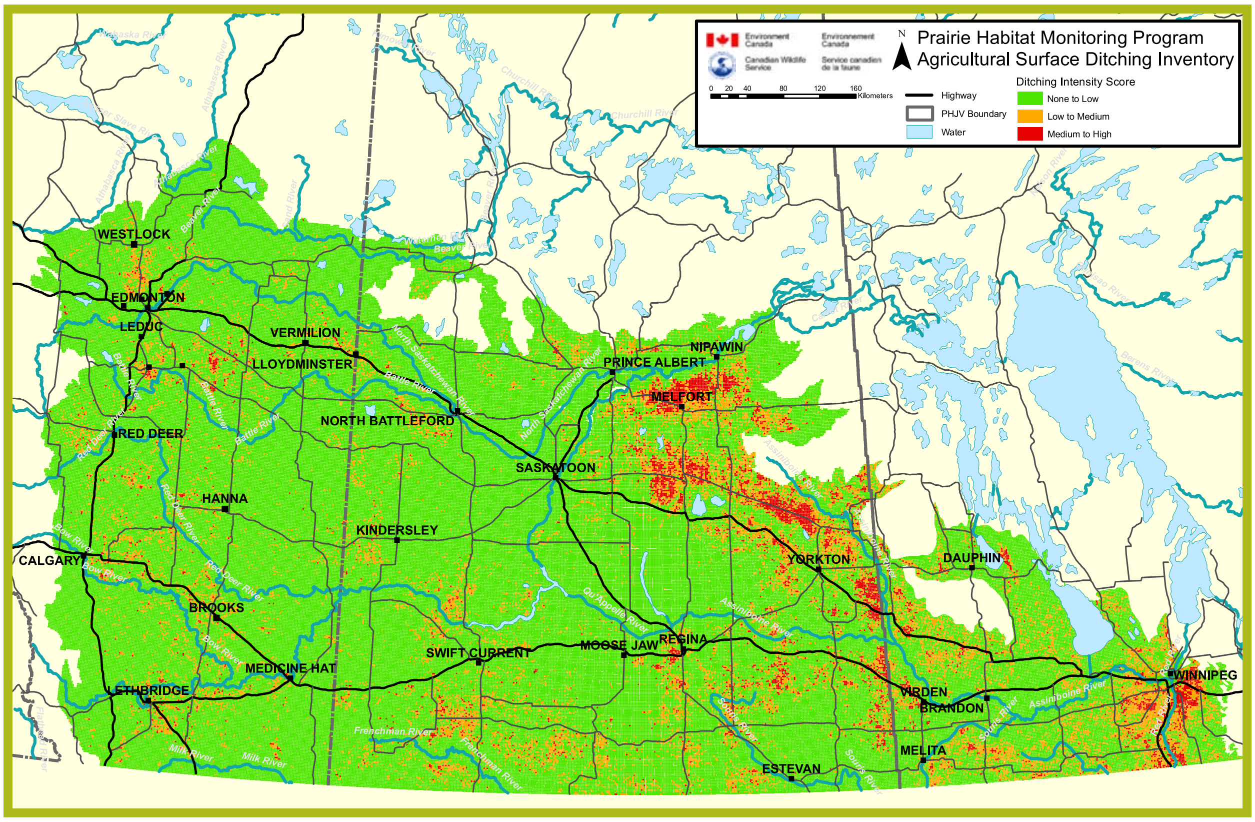
The Canadian Prairies are comprised of predominantly privately owned agricultural land, and there is significant rural sociology research that goes back to the agricultural extension models and soil-conservation programs, circa 1980 to 2000. This knowledge, and perhaps newer social-science research, could help the PHJV to begin testing what motivates landowner decision-making processes regarding conservation. This existing social science and extension information — and similarly other information about hunters and viewers — could help the PHJV to focus on action items such as (i) waterfowl hunter recruitment and retention, (ii) wildlife viewer engagement and (iii) conservation delivery.

2. Ecological Goods and Services: Case-studies of the Socioeconomic Benefits of Conservation Programs

Over the past 10 years, the PHJV has invested in program and policy research aimed at improving the understanding of factors influencing land-use decisions by agricultural

FIGURE 16

Cumulative ditching intensity for the Prairie Habitat Joint Venture in relation to provincial boundaries.



[Note:] Intensity ranges from low (green) to medium-high (red) as indicated by the relative numbers of ditches evident in aerial photography and satellite images. Methods used to determine ditching intensity are described in Appendix 11.

producers, the broad socio-economic consequences of those decisions and the benefits accruing from PHJV conservation investments. Some of the main findings and future information needs are outlined below.

Recent PHJV inventory and assessment work reveals that the distribution and intensity of ditching across the PPR (Figure 16; Appendix 11) has likely been common in Southern Manitoba for decades. In the past 20 years, it has become more widespread in portions of Northeastern Saskatchewan's Prairie Parkland Region and when combined with extreme precipitation events recorded over the past decade, ditching likely contributed to downstream effects on communities in Saskatchewan and Southwestern Manitoba (see Duck Habitat and People — Making the Connections with Canadians). The ditching inventory illustrates an enormous conservation challenge for the PHJV and also demonstrates clearly where restoration efforts could be directed to restore watershed function and potentially generate substantial societal benefits.

Fortunately, the PHJV has been active in building a constituency of supporters for wetland conservation based on concerns about flooding and water quality. Many of these constituents are not rural landowners, hunters or nature enthusiasts, yet they are fundamental to advancing wetland policy. Given the heightened awareness of wetland values to watersheds, there are significant opportunities to advance wetland-conservation goals now and in the near future.

Aerial of conserved wetland with ditch plugs/©Ducks Unlimited Canada/Jeope Wolfe

DUCK HABITAT AND PEOPLE – MAKING THE CONNECTIONS WITH CANADIANS

By establishing the goal to: ***Grow numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation, the*** **NAWMP 2012: People Conserving Waterfowl and Wetlands** *revision formally recognized the importance of broad public engagement in waterfowl-conservation planning. To encourage support, waterfowl-habitat conservation must be relevant to more people from all segments of society.*

Landowner management agreements include the installation of water-control structures, like this one near Patricia, Alberta./©Ducks Unlimited Canada

In addition to providing habitat for waterfowl, wetlands contribute significantly to Canada's social, economic and ecological well-being and prosperity by:

- *providing recreational opportunities*
- *supporting tourism*
- *creating jobs through conservation work*
- *sequestering atmospheric carbon*
- *supporting nutrient cycling*
- *filtering sediments and chemicals from surface waters*
- *regulating water supply by moderating effects of flooding and drought*
- *recharging groundwater*
- *providing critical habitat for wildlife, including numerous species at risk*

In combination, these benefits are commonly referred to as ecological goods and services or EGS.

When wetlands are lost, natural support systems are crippled and society may incur higher costs in the form of lost revenue (e.g., fewer recreation and tourism dollars), new demands for infrastructure to compensate for lost function and disaster-relief management and repair in the case of flooding and drought, creating significant risk and liability for Canadians.

The PHJV has been actively working for several years to increase awareness of the benefits that waterfowl habitats confer to society. For example, in the Broughton's Creek watershed in Southwestern Manitoba, 69% of existing wetlands were lost or degraded between 1958 and 2005 (Yang et al. 2008). These changes resulted in a 62% increase in total stream flows, a 37% increase in peak flows, a 32% increase in phosphorous loading, a 57% rise in nitrogen loading, an 81% increase in sediment export and an estimated 28% decrease in waterfowl production. Loss of these wetlands also released the equivalent of approximately 125,000 tonnes of carbon dioxide, equal to the annual emissions of >23,000 cars. A similar study in East-central Saskatchewan determined that water discharge from the Smith Creek watershed is extremely sensitive to wetland drainage (Pomeroy et al. 2014). Both annual and peak flow rates were estimated to increase by more than 40% as the result of wetland drainage that occurred between 1958 and 2008.

Loss of wetland-ecosystem services has had substantial impacts on local economies. An analysis of the impacts of wetland loss within the Lake Winnipeg watershed estimated that ecosystem services have been reduced by 36-80% when compared to pre-settlement landscapes. This loss of services was valued at $0.11-1.4 billion/year (Voora and Venema 2008).

Quantifying the range of benefits waterfowl habitats confer to society will help to ensure that a broad range of stakeholders continue to support wetland and waterfowl conservation.

G. Conservation Programs and Partnerships

The PHJV will advance its restoration and retention habitat objectives through a broad mix of conservation actions. As explained above, the methods will include direct program interventions, stewardship and policy change and associated support programs. Over the last planning cycle, the PHJV launched significant improvements to its data tracking systems which facilitated the reporting of accomplishments toward this Plan's goals. However, further refinements are anticipated over the next planning cycle to make the system even more user-friendly and capture additional information of value to the PHJV and to the NAWMP community.

1. Direct Programs

The delivery of direct habitat programs involves personal contact with landowners to secure high-quality, at-risk, wetland and upland habitats on private and Crown lands and/or to facilitate wetland and upland habitat restoration (enhancement) or retention. Generally, long-term (≥10 years) agreements are used to secure habitat including fee simple purchase, land donation, Crown-land transfer, Crown-land designation, conservation easements, conservation agreements and cooperative land-use agreements. Some stewardship programs are delivered directly to landowners but do not involve land agreements of 10 years or more. These programs (e.g., winter wheat, grazing systems, wetland retention) are intended to lead to long-term habitat securement. Direct habitat programs are focused primarily within Target Landscapes.

Wetland restoration, achieved only through direct programs, seeks 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), the same types that have endured the greatest losses primarily through agricultural development. Wetland restoration normally involves minor earth-fill 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 reduce duck nest-success deficits.

Direct program activities for upland restoration include 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. 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.

A total of 1.068 million acres of direct restoration and retention programs are presented in this 8-year plan: approximately 384,000 acres are restoration-based and 684,000 are retention-based (Table 10). Detailed accounts of direct programs in each province are provided in Appendix 7.

2. Stewardship Programs

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 favorable land-management practices, an idea that warrants investigation. 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

Conservation Easement/©Ducks Unlimited Canada

The delivery of direct habitat programs involves personal contact with landowners to secure high-quality, at-risk, wetland and upland habitats on private and Crown lands and/or to facilitate wetland and upland habitat restoration (enhancement) or retention.

comparison with direct-program activities which tend to target smaller areas.

Ultimately, stewardship activities are intended to create long-term opportunities to secure habitat, such as small wetland restoration, in conjunction with cropland conversion to perennial cover. Stewardship activities do not typically employ agreements, or if so, they are <10 years duration. 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 Parkland Region but whenever possible are focused within the PHJV's Target Landscapes.

3. Policy Initiatives — Agriculture, Wetlands and Native Grasslands

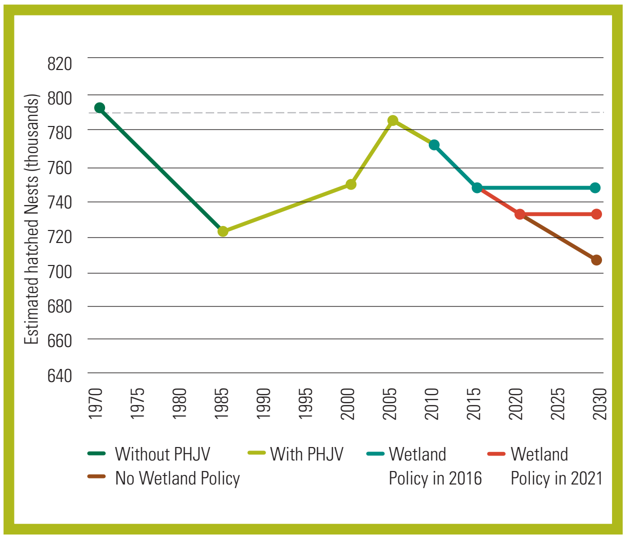
In the context of this Plan, policy initiatives are activities undertaken by partners with the purpose of supporting government legislation, policies and programs that benefit wetland and upland waterfowl habitat. Agricultural land-use changes and wetland drainage are major issues of current policy concern to the PHJV and are common to all three Prairie Provinces. To achieve its goals, the PHJV must consider existing and new policies and associated regulations pertaining to wetlands, land use and watersheds and also provide a foundation for inter-provincial policy coordination and support.

The Alberta government implemented a new Wetland Policy in 2015, creating optimism in the conservation community due to its potential to protect wetlands and mitigate losses. The PHJV fully recognizes that wetland protection across the region will remain a challenge requiring strong and ongoing policy efforts. *[Note: In Manitoba, a recently proposed water policy could help to reduce wetland drainage.]* Wetland policies have the potential to arrest wetland loss and, furthermore, failure to achieve wetland restoration and retention objectives could seriously undermine PHJV efforts to maintain or enhance the productive capacity of the Prairie Parkland Region landscape for ducks and other wetland-associated species (Figure 17).

Similarly, the delivery of complementary programs to retain and restore both wetland and upland habitat is essential to ensure the long-term capacity of PHJV landscapes to support resilient duck populations, as predicted in 2030 (Figure 18).

FIGURE 17

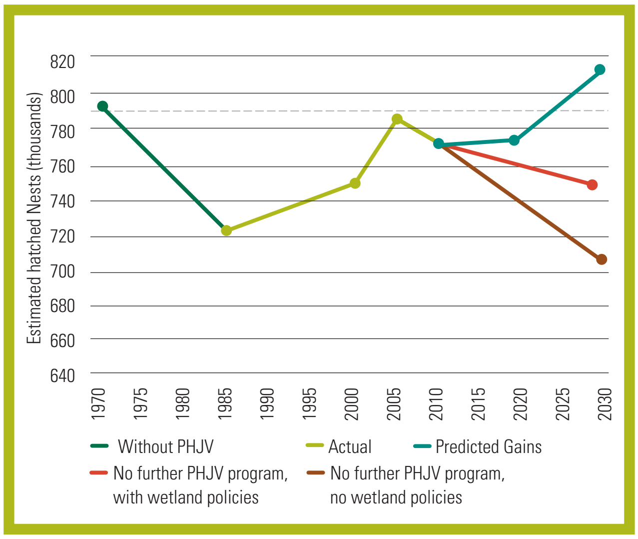
Predicted numbers of hatched nests of five dabbling duck species derived from the Waterfowl Productivity Model (Appendices 5 and 6) in response to wetland policy scenarios within the Prairie Habitat Joint Venture, 2011-2030.



[Note:] Implementation of wetland policies could help to reduce or possibly reverse wetland losses (orange and turquoise lines), improving the capacity of landscapes to support breeding pairs of ducks and other wetland-associated species. A lack of wetland policy (brown line) could lead to further loss of wetland habitat, and reduce duck breeding populations in the PHJV.

FIGURE 18

Predicted numbers of hatched nests of five dabbling duck species in the Prairie Habitat Joint Venture estimated by the Waterfowl Productivity Model (Appendices 5 and 6) in 1971, 1986, 2001, 2006 and 2011, and in response to upland and wetland habitat objectives and wetland policy scenarios, 2011-2030.



The goal (grey dashed line) is the circa 1971 estimate, the solid light green line connects estimates of hatched nests between 1986 and 2011 and the solid turquoise line connects estimates of hatched nests in 2020 and 2030. The orange line depicts the hatched nest estimate for 2030 in the absence of PHJV programs but with wetland policies in effect and the brown line depicts the hatched nest estimate for 2030 in the absence of both PHJV programs and wetland policies.

Partnerships with ranchers are essential to implementing conservation projects across the Prairie Parkland Region./©Ducks Unlimited Canada

The PHJV Policy Committee has begun to adopt a sharper focus on grazing and forage lands and will seek to build stronger relationships with representatives of the forage and livestock industry over the upcoming 8-year implementation period.

The PHJV's capacity to meet its habitat-retention and habitat-restoration objectives is determined primarily by the willingness of agricultural producers to participate in programs, commodity prices and agricultural policy in Canada and world-wide. A strong cattle market during much of the 2000s was responsible for expansion of perennial cover across most of the Region, but there are indications now that the conversion of grassland to cropland is well underway in some areas of the PHJV (e.g., in Manitoba). Market conditions that favour non-cereal crops (and reduce the uptake of winter wheat) will also have a strong bearing on the PHJV's success. Notwithstanding these uncertainties, the medium-range projections (i.e., 2013 to 2023) by AAFC of agricultural trends indicate the following important highlights:

- Global growth in the demand for cereals is expected to act as a counterbalance to oilseed expansion, which is driven by higher vegetable oil and protein meal prices. Canola production is expected to increase to accommodate a larger Canadian crushing industry, as well as rising export demand.
- In Canada, both biodiesel and ethanol production are expected to increase over the outlook; however, imports will likely be necessary to meet federal-consumption mandates (i.e., 5% of renewable content in gasoline and 2% in diesel). The proportion of (livestock) feed grain imports from the United States has declined over the last decade as domestic production has been relatively strong apart from the droughts of 2001 and 2002 and the decline in the size of the livestock herd.
- Although (livestock) feed prices have declined from U.S. drought-induced highs, they are expected to remain relatively strong and continue to be the most significant cost component for the livestock sector.
- Steer prices are still high as supply remains tight in the United States. Slow reconstruction of the U.S. breeding herd will continue to support high prices moving forward.
- After a decline in 2012, Canadian beef net exports are expected to return to a higher level over the medium term.

The PHJV recognizes that agricultural expansion and intensification driven by rising commodity prices and associated land valuations are major factors affecting wetland and permanent cover retention in prairie Canada. Policy changes to reverse trends in wetland and upland habitat loss on highly productive agricultural lands are considered very unlikely. However, there is a close correspondence between the strategic interests of the

The role of wetlands and permanent cover in mitigating concerns about the water quality and quantity impacts of agricultural practices and flooding is another matter of current public concern that could provide a valuable context within which to frame the PHJV's policy initiatives.

prairie wetland and permanent-cover retention community and the livestock industry on lands with lower annual crop-production capability. The PHJV Policy Committee has begun to adopt a sharper focus on grazing and forage lands and will seek to build stronger relationships with representatives of the forage and livestock industry over the upcoming 8-year implementation period.

The role of wetlands and permanent cover in mitigating concerns about the water quality and quantity impacts of agricultural practices and flooding is another matter of current public concern that could provide a valuable context within which to frame the PHJV's policy initiatives. Thus, the Policy Committee will work to share experiences between the three Prairie Provinces and build a regional capacity to support wetland-policy development, specifically in the area of wetland mitigation. This will serve the dual interests of enabling better surface-water management on agricultural lands and sustaining wetland function within watersheds that are subject to drainage pressures. The PHJV also sees considerable value in creating a consolidated and standardized inventory of wetland and permanent cover across the prairies and establishing a system for monitoring and reporting regional trends in this inventory. Such a system could strengthen evidence-based policy making related to wetland retention and encourage greater consistency in wetland mitigation schemes across the PHJV area.

The Policy Committee will support provincial policy development by standardizing and sharing information related to wetland and permanent cover and supporting networking between provinces.

Maintaining agriculture's "social license" through certification is another area that offers substantial promise for promoting wetland and permanent cover-friendly practices. The Policy Committee will work with the livestock and forage industry, government and other collaborators to support ongoing efforts to develop a certification standard and system for environmentally responsible beef production.

Despite consistency in current policy concerns across the three Prairie Provinces, the PHJV recognizes that the key determinants affecting wetlands and upland waterfowl habitat on the Canadian prairies relate to water management, land-use and resource-development policies. These fall largely within the jurisdictional authorities of the provincial governments of Manitoba, Saskatchewan and Alberta. While the issues of wetland loss, agricultural land-use change and water management may be common to these provinces, the status of public-policy development and approaches to dealing with these issues are unique to each jurisdiction. Furthermore, because the economic, social and political circumstances are different in each province, the opportunities and approaches to influencing provincial policies are also different.

The Policy Committee will support provincial policy development by standardizing and sharing information related to wetland and permanent cover and supporting networking between provinces. Providing a forum to promote networking to share information and experiences in wetland and permanent-cover retention-policy development among provinces will be a primary role for the Policy Committee. Over the next implementation cycle, to 2020, the Policy Committee will concentrate on fostering mutual awareness of and learning from the ongoing policy development experiences of the three Prairie Provinces. A policy coordinator will facilitate this through regular contact with the NAWMP implementation teams in each province and by organizing periodic meetings on policy topics of immediate concern across the PHJV area. The Policy Committee and coordinator will also provide more specific support to help build provincial PHJV policy capacity in Manitoba and Saskatchewan, aiming to capture benefits similar to those realized in Alberta where a provincial NAWMP coordinator has been active for the past 20 years. In this regard, the Policy Committee will establish more significant awareness of past PHJV accomplishments and promote active engagement among senior and elected officials with authority for provincial land- and water-management agencies.

Landowners participate in educational tours to learn about how they can implement wildlife-friendly practises on their properties./ ©Ducks Unlimited Canada

The PHJV manages and monitors approximately 11 million wetland- and upland-habitat acres.

4. Management

The PHJV manages and monitors approximately 11 million 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. 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.

5. Communications and Education

The PHJV Communications Committee provides leadership on communications activities on behalf of the PHJV. Its 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. Communications priorities for the PHJV are focused on three primary areas:

1. Long-term protection of wetland and grassland habitats through provincial and federal policies is a clear priority for the PHJV and requires directed communications with target audiences in all three Prairie Provinces. For example:
   - Informative communication to funding supporters in both the pre- and post-conservation efforts are needed to ensure partners continue to support the PHJV goals and priorities.
2. Frequent communications is needed among conservation partners who control the land base on which the waterfowl resource relies to ensure they understand PHJV efforts, successes and the broad societal benefits that result from their participation in PHJV programs.
3. Human dimension activities undertaken by the PHJV, including waterfowl-hunter recruitment and retention and the promotion of ecological goods and services benefits associated with the PHJV's habitat investments, could be used to build support for conservation.

The PHJV works in partnership with waterfowl conservation supporters, like the Oran Richard family from Louisiana, to conserve wetlands and migratory bird populations across the Canadian Prairies./©Ducks Unlimited Canada

6. Coordination

Coordination ensures the continuity, consistency and momentum among PHJV partnership agency representatives and maximizes opportunities to integrate resources. 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 the *North American Wetlands Conservation Act*.

7. Partnerships

The PHJV has become a continental leader in developing and sustaining long-lasting, diverse and successful partnerships to implement waterfowl and wetland conservation programs and activities across the Canadian prairies. The PHJV Advisory Board includes representation from federal and provincial governments and environmental non-governmental organizations. As such, diverse perspectives are brought to the PHJV. Responsibilities of individual partners are defined by the strengths and mandates of each agency, and include habitat-program planning, habitat-program delivery, government policy, research and evaluation, coordination and communications.

The broad scope of the PHJV includes landowners, industry, federal, provincial and municipal governments, First Nations, corporations and environmental non-governmental organizations. The PHJV has over 300 contributing partners and 17,000 landowners which demonstrates broad support for the partnership.

The PHJV gratefully acknowledges all U.S. 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.

H. Research and Evaluation — Biological Foundations, Policy and Human Dimensions

Research and evaluation support PHJV partner decision making and 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 (e.g., decision-support systems), inform conservation planning priorities and actions (e.g., Waterfowl Productivity Model, northern pintail and scaup research and studies of other wetland-dependent species) and enhance the ability of partners to measure progress toward population objectives for waterfowl and priority species identified in BCR plans. Substantial new work will also be required to support the development and implementation of a PHJV human-dimensions strategy, monitor its success in meeting objectives and refine approaches as new information is gained.

The habitat objectives identified in this Plan depend on several models that incorporate the best information presently available regarding current and anticipated landscape conditions and waterfowl production capacity. Assumptions are necessary and clearly stating them provides a basis for future testing and refinement of the models and updating management plans within an adaptive management framework.

Evaluating and adaptively improving habitat programs in response to new information have been hallmarks of the PHJV. The latest round of planning reflects continued adaptation with program shifts towards increased focus on winter wheat, wetland restoration and policy initiatives to retain and restore habitat. The assumption that upland improvements (observed since 1971) would continue was made prior to recent and dramatic changes in commodity prices and must be monitored closely under these new circumstances. In accordance with these modifications, there will be new needs for monitoring and evaluation.

Blue-winged Teal Nest/©Ducks Unlimited Canada

Science-based Planning, Program and Policy Implementation

- **Completion of a Prairie Parkland Region wetland inventory** would significantly advance efforts to track wetland changes and PHJV progress, support policy development and enable improved modelling of the abundance and distribution of waterfowl and other wetland-dependent species. PHJV partners anticipate that an inventory of wetlands within its target landscapes will be completed by 2020.
- **Improved understanding of demographic and community-level responses** of ducks to wetland and upland habitat changes within the entire Prairie Parkland Region and WBF (e.g., northern pintail, mallard, lesser scaup, American wigeon; duck community composition). This information would be used to inform habitat delivery.
- **Decision-support models** (assumptions, uncertainties, refinements) and other quantitative tools, enable the PHJV to evaluate the success of its programs and pinpoint necessary adjustments, while advancing objectives in maturing and nascent program areas such as for duck species of conservation concern, risk assessments for native habitats and non-game species habitat planning. These include:
  - a) Habitat: assessment of risks of conversion or degradation of native grasslands and wetlands; further refinement of existing waterfowl productivity models; assessment of habitat-retention impacts on landscape-carrying capacity for waterfowl
  - b) Marshbirds and other non-game species
- **Ecological goods and services (EGS)** model (and decision support tools) to be developed and tested to support habitat conservation initiatives, especially for native grasslands and wetlands. The PHJV has invested in first-generation models to determine (i) carbon stocks in wetland sediments and (ii) downstream impacts of water and nutrient flows from drained wetlands. Further work is needed to validate and refine these models, and incorporate results into policy initiatives for achieving the PHJV's wetland and native grassland objectives.
- **Effectiveness of wetland policy initiatives** will be assessed as policy implementation progresses (e.g., in Alberta). It will be important for the PHJV to determine the subsequent impacts on wetland habitat and associated

The habitat objectives identified in this Plan depend on several models that incorporate the best information presently available regarding current and anticipated landscape conditions and waterfowl production capacity.

Gadwall/©Ducks Unlimited Canada/Michel Blachas & Carole Piché

wildlife species, and, as needed, recommend adjustments to improve effectiveness.

- **Additional policy-based research and knowledge sharing** (e.g., enhancing wetland mitigation approaches, developing a rapid assessment tool for EGS) will be needed by the PHJV to shape decision-making and to develop strategies for engaging key agricultural sectors (e.g., cattle producers).
- **Acoustic monitoring of target species and bird communities** in support of the focus on all-bird conservation which has become a central theme in the planning and evaluation framework of North America's habitat Joint Ventures and Mexico's regional partnerships, but data deficiencies currently impede achieving this goal for many species. Field-based sampling at large spatial scales is costly because it usually requires large work crews and substantial logistical support; thus, it is common for such efforts to endeavor to record information on many species during a single site visit. Since species differ in their breeding habits and the seasonal timing of these activities, they are not all available to be detected by sampling efforts at the same time of day or within the same seasonal period. Furthermore, some species exhibit cryptic behaviors (e.g., several marshbird species), while other species are primarily active at night (e.g., yellow rail, common nighthawk), a time when virtually no avian surveys occur. Recent advances in technology have made it logistically feasible to collect survey information for the entire avian community using autonomous recording units (ARU) but additional work is needed to verify for which species ARUs will provide suitable count data.
- **The impact of targeted programs on participation and support for conservation among landowners, hunters and the public.**

The PHJV requires new information about how to engage people in specific conservation programs and practices, including the types of messages that could influence adoption of, or support for, conservation.; how best to connect different environmental, social and economic messages to increase support for conservation, and; how best to increase participation in waterfowl hunting. This will require targeted social-science studies, perhaps aimed at different segments of society. The PHJV could consider the following information needs:

- refine geospatial tools to prioritize habitat retention or restoration in areas most accessible to hunters/bird watchers and other recreationalists
- identify and explicitly incorporate human dimension needs and values into biologically based (i.e., bird) habitat values, to quantitatively inform the trade-offs involved in multiple-objective management situations
- identify ways to increase public awareness and use of land restored or enhanced by the PHJV
- develop metrics for evaluating PHJV program success in terms of meeting human-dimension objectives

I. Expenditure Forecast

The total estimated *PHJV Habitat Implementation Plan, 2013-2020* costs for the 8-year period, is projected at $470 million (Table 10). Most expenditures are allocated to direct and indirect costs of habitat-restoration and habitat-retention activities (80%), with the balance to support policy (1%), operations and maintenance (6%), research and evaluation (5%), communications and education (1%) and coordination (7%) activities.

Cost estimates for habitat restoration objectives are approximately $104 million, and those for habitat retention are ~$273 million (Table 10).

When compared with the previous implementation plan (2007-2012), higher total cost estimates reflect an 8-year (rather than 5-year) implementation cycle. Furthermore, land acquisition and operating costs have increased over the last 5 years; for example, land prices have increased an estimated 3-4% annually during this period.

Expenditure forecasts provided in this Plan were not 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 a representative agency (DUC was the only agency with readily available data). Inflation costs were included based on 3% per annum. Data were sourced from the NAWMP National Tracking System and individual agency records, as applicable.

TABLE 10

Prairie Habitat Joint Venture habitat objectives summary by major program areas, and expenditure forecast, 2013-2020, relative to 2030 objectives.

Habitat Restoration	Year 2030 Habitat Objective (Acres)	By 2020, 8-Year Objectives (Acres)			% of 2030 Habitat Objective	Total 8-Year Expenditure
		Direct NAWMP	Stewardship NAWMP	Total		
Winter Wheat						
Alberta	20%	-	-	20%		$ -
Saskatchewan	15%	-	-	15%		$ -
Manitoba	20%	-	-	20%		$ -
Sub-total	15-20% of all wheat acres	-	-	15-20% of all wheat acres		$ 17,600,000
Tame Pasture						
Alberta	441,000	0	176,400	176,400	40%	$ 1,234,800
Saskatchewan	980,373	254,899	137,250	392,149	40%	$ 15,235,094
Manitoba	55,365	19,266	2,880	22,146	40%	$ 1,099,056
Sub-total	**1,476,738**	**274,165**	**316,530**	**590,695**	**40%**	**$ 17,568,950**
Tame Hay						
Alberta	725,000	0	290,000	290,000	40%	$ 2,030,000
Saskatchewan	234,551	60,984	32,838	93,822	40%	$ 3,644,970
Manitoba	36,910	12,844	1,920	14,764	40%	$ 732,704
Sub-total	**996,461**	**73,828**	**324,758**	**398,586**	**40%**	**$ 6,407,674**
Planted Cover						
Alberta	35,500	14,200	-	14,200	40%	$ 25,375,400
Saskatchewan	18,596	7,439	-	7,439	40%	$ 13,293,493
Manitoba	12,000	4,800	-	4,800	40%	$ 8,577,600
Sub-total	**66,096**	**26,439**	**-**	**26,439**	**40%**	**$ 47,246,493**
Wetlands						
Alberta	65,708	3,038	-	3,038	5%	$ 5,428,906
Saskatchewan	7,538	3,015	-	3,015	40%	$ 5,387,805
Manitoba	4,618	1,847	-	1,847	40%	$ 3,300,589
Sub-total	**77,864**	**7,900**	**-**	**7,900**	**10%**	**$ 14,117,300**
Nesting Tunnels (structures)						
Alberta	-	-	-	-	-	$ -
Saskatchewan	-	-	-	-	-	$ -
Manitoba	3,400	1,360	-	1,360	40%	$ 710,875
Sub-total	**3,400**	**1,360**	**-**	**1,360**	**40%**	**$ 710,875**
Restoration Sub-total	**2,620,559**	**383,692**	**641,288**	**1,024,980**	**39%**	**$ 103,651,292**

Habitat Retention	Year 2030 Habitat Objective (Acres)	8-Year Accomplishments (Acres) Direct NAWMP	Stewardship NAWMP	Total	% of 2030 Habitat Objective	Total 8-Year Expenditure Forecast
Wetland						
Alberta	97,875	43,500	-	43,500	44%	$ 10,875,000
Saskatchewan	580,155	232,062	-	232,062	40%	$ 58,015,434
Manitoba	169,600	67,840	-	67,840	40%	$ 16,960,000
Sub-total	847,630	343,402	-	343,402	41%	$ 85,850,434
Upland						
Alberta	199,125	88,500	-	88,500	44%	$ 48,675,000
Saskatchewan	318,159	127,264	-	127,264	40%	$ 69,994,956
Manitoba	312,400	124,960	-	124,960	40%	$ 68,728,000
Sub-total	829,684	340,724	-	340,724	41%	$ 187,397,956
Retention Sub-total	**1,677,314**	**684,126**	**-**	**684,126**	**41%**	**$ 273,248,390**
Policy						$ 4,000,000
Operation and Maintenance Sub-Total						$ 27,120,000
Research and Evaluation Sub-Total						$ 22,000,000
Communication Sub-Total						$ 5,400,000
Coordination Sub-Total						$ 34,920,000
Sub-total						$ 93,440,000
Grand Total	**4,297,873**	**1,067,818**	**641,288**	**1,709,106**	**40%**	**$ 470,339,682**

Note: In previous PHJV habitat implementation plans, "stewardship" was referred to as "extension".

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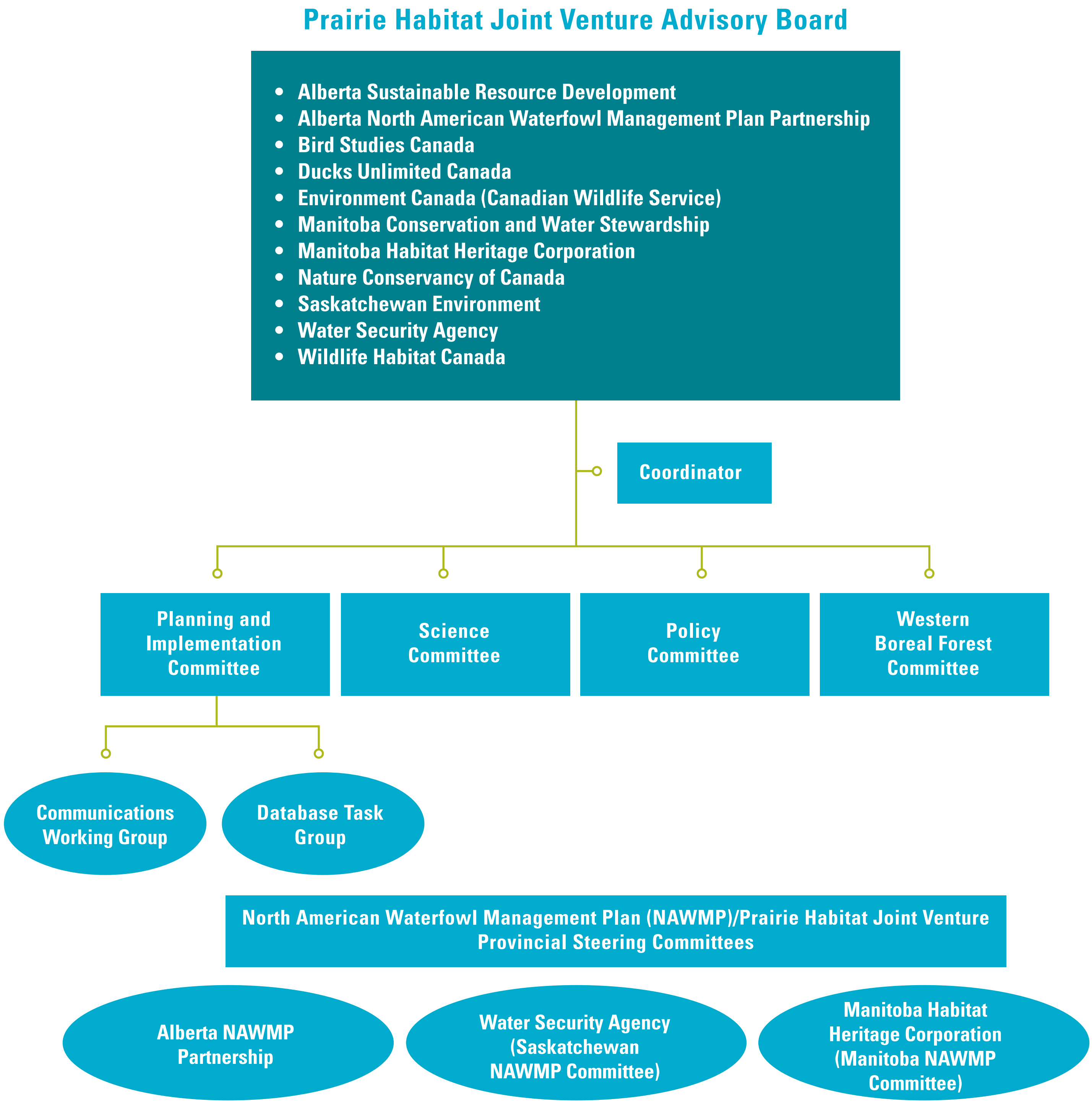
APPENDICES

APPENDIX 1:
Prairie Habitat Joint Venture Organizational Structure.



APPENDIX 2:
Prairie Habitat Joint Venture priority landbird, shorebird and waterbird species, along with annual trends and general descriptions of breeding habitat.

Annual trends are based on changes in the Breeding Bird Survey index (Sauer et al. 2011) from 1970 to 2011 for both regions and include the best estimate of annual change (95% credible intervals in parentheses). Canada-BCR 11 refers to trends in the Canadian portion of BCR 11 while BCR 11 trends include both Canada and the United States. Numerical trends are only included for species with medium to high reliability (Sauer et al. 2011, Environment Canada 2013b), and for others a status of declining or increasing may be noted for Canada-BCR 11 if specified in Species at Risk documents. Groups include landbirds (L), shorebirds (S) and waterbirds (W). Species with an asterisk are listed as Species at Risk in Canada.

Species	Group	Annual Trend — Canada BCR 11	Annal Trend — BCR 11	General Habitat Description in the PHJV Region
a) Prairie Breeding Species of Wetland and adjacent Upland Habitats:				
Horned Grebe* *(Podiceps auritus)*	W	-0.67 (-2.74, 1.71)	-0.95 (-2.86, 1.26)	Perennial ponds and small wetlands with emergent vegetation
Eared Grebe *(Podiceps nigricollis)*	W	-0.44 (-3.39, 2.50)	1.01 (-1.82, 3.63)	Perennial ponds or temporarily flooded marshland, colonial breeder
Pied-billed Grebe *(Podilymbus podiceps)*	W	1.83 (-0.20, 3.98)	2.20 (0.68, 3.69)	Perennial ponds or temporarily flooded marshland
Western Grebe *(Aechmophorus occidentalis)*	W	unknown	unknown	Large lakes and wetlands with emergent vegetation along periphery, colonial breeder
American Bittern *(Botaurus lentiginosus)*	W	0.19 (-1.74, 2.27)	0.42 (-0.99, 1.86)	Large wetlands with tall, emergent vegetation and expansive graminoid cover
Northern Harrier *(Circus cyaneus)*	L	-1.54 (-2.34, -0.74)	-0.65 (-1.31, -0.01)	Upland grasslands, marshy meadows and wetland edge
Virginia Rail *(Rallus limicola)*	W	unknown	unknown	Marshes and small wetlands with emergent vegetation
Sora *(Porzana carolina)*	W	0.86 (-0.45, 2.23)	1.54 (0.42, 2.68)	Small to moderate sized wetlands with emergent vegetation
Yellow Rail* *(Coturnicops noveboracensis)*	W	unknown	unknown	Ephemeral sedge marshes
Piping Plover* *(Charadrius melodus)*	S	declining	unknown	Pebbly or sandy shores of large prairie lakes
Killdeer *(Charadrius vociferus)*	S	-1.51 (-2.02, -0.98)	-0.39 (-0.76, -0.01)	Open habitats with short vegetation in native, urban and agricultural areas, often near water
American Avocet *(Recurvirostra americana)*	S	0.35 (-1.60, 2.18)	0.15 (-1.62, 1.73)	Shallow prairie wetlands
Willet *(Tringa semipalmata)*	S	-0.56 (-1.28, 0.22)	-0.57 (-1.25, 1.16)	Shallow wetlands mixed with sparse upland habitats
Spotted Sandpiper *(Actitis macularius)*	S	1.79 (0.17, 3.50)	1.98 (0.65, 3.32)	Wetland or riparian edge mixed with drier habitat for nesting
Marbled Godwit *(Limosa fedoa)*	S	-1.55 (-2.26, -0.84)	-0.55 (-1.21, 0.16)	Open areas with a mix of wetlands and upland grasses
Wilson's Snipe *(Tringa semipalmata)*	S	3.75 (2.66, 4.89)	4.08 (3.06, 5.10)	Marshy wetland edge in open or forested habitats
Wilson's Phalarope *(Phalaropus tricolor)*	S	0.22 (-1.72, 2.23)	-0.03 (-1.43, 1.34)	Wet prairie meadows and wetland edge
Franklin's Gull *(Leucophaeus pipixcan)*	W	-0.27(-2.85, 2.24)	-1.27 (-3.74, 0.99)	Large prairie marshes amidst agricultural fields and grasslands, colonial breeder

Species	Group	Annual Trend — Canada BCR 11	Annal Trend — BCR 11	General Habitat Description in the PHJV Region
Forster's Tern *(Sterna forsteri)*	W	unknown	1.01 (-2.47, 4.57)	Prairie ponds and lakes with extensive marshy vegetation along periphery, colonial breeder
Black Tern (Chlidonias niger)	W	-1.90 (-4.00, 0.29)	-1.10 (-2.67, 0.50)	Extensive wetlands with emergent vegetation, semi-colonial breeder
Short-eared Owl* *(Asio flammeus)*	L	0.93 (-2.45, 4.29)	0.08 (-2.81, 2.88)	Open country consisting of grasslands and marshes
Black-billed Cuckoo *(Coccyzus erythropthalmus)*	L	-2.37 (-4.60, 0.09)	-2.65(-3.99, -1.24)	Deciduous groves and thickets often associated with water
Sedge Wren *(Cistothorus platensis)*	L	3.38 (1.13, 5.58)	4.59 (3.10, 6.00)	Ephemeral sedge marshes
Common Yellowthroat *(Geothlypis trichas)*	L	0.61 (-0.20, 1.42)	-0.27 (-0.63, 0.09)	Dense thickets, often along wetland edges, but also shrub habitat in uplands
Le Conte's Sparrow *(Ammodramus leconteii)*	L	0.25 (-1.24, 1.88)	0.84 (-0.62, 2.40)	Tall, wet grasslands and marshes
Nelson's Sparrow *(Ammodramus nelsoni)*	L	3.84 (1.79, 6.11)	4.05 (2.13, 5.06)	Wet meadows, marshes and wetland edge
Bobolink* *(Dolichonyx oryzivorus)*	L	-0.20 (-1.14, 0.79)	0.11 (-0.41, 0.61)	Medium to tall grasslands and wet meadows with dense vegetation
b) Prairie Breeding Species of Upland Habitats:				
Greater Sage-Grouse* *(Centrocercus urophasianus)*	L	declining	unknown	Sagebrush shrublands
Sharp-tailed Grouse *(Tympanuchus phasianellus)*	L	-0.56 (-2.93, 1.59)	0.44 (-1.47, 2.06)	Grasslands of short to medium height mixed with shrubs
Ferruginous Hawk* *(Buteo regalis)*	L	1.21 (-1.58, 3.61)	1,54 (-0.28, 3.20)	Open grassland with occasional trees for nesting
Swainson's Hawk *(Buteo swainsoni)*	L	0.15 (-0.63, 0.96)	0.04 (-0.63, 0.77)	Open grass or sparse shrublands with occasional trees
Prairie Falcon *(Falco mexicanus)*	L	unknown	unknown	Open grasslands with cliff sites for nesting
Mountain Plover* *(Charadrius montanus)*	S	unknown	unknown	Arid grasslands with sparse vegetation
Upland Sandpiper *(Bartramia longicauda)*	S	1.12 (-0.40, 2.79)	0.45 (-0.22, 1.12)	Grasslands of short to medium height
Long-billed Curlew* *(Numenius americanus)*	S	-1.09 (-2.37, 1.54)	-0.37 (-1.74, 1.01)	Open, short grasslands
Burrowing Owl* *(Athene cunicularia)*	L	declining	unknown	Open, short grasslands
Common Nighthawk* *(Chordeiles minor)*	L	0.45 (-2.18, 3.47)	-0.56 (-1.99, 0.93)	Open habitats with variable levels of forest cover
Northern Flicker *(Colaptes auratus)*	L	-2.06 (-2.93, -1.19)	-2.61(-3.07, -2.13)	Forest edge and open woodlands
Loggerhead Shrike* *(Lanius ludovicianus)*	L	-2.80 (-4.84, -1.22)	-2.78 (-3.84, -1.71)	Open grasslands with patches of shrubs or small trees
Black-billed Magpie *(Pica hudsonia)*	L	-0.16 (-0.74, 0.40)	-0.31 (-0.91, 0.28)	Open or shrubby areas with deciduous groves and riparian woodland
Horned Lark *(Eremophila alpestris)*	L	-4.09 (-4.82, -3.33)	-3.54 (-4.16, -2.90)	Open, sparsely vegetated grasslands and cultivated areas
Brown Thrasher *(Toxostoma rufum)*	L	-1.00 (-2.12, 0.05)	-1.22 (-1.70, -0.75)	Dense, shrubby habitats within a landscape ranging from open to deciduous woodlands
Sage Thrasher* *(Oreoscoptes montanus)*	L	declining		Sagebrush shrublands
Sprague's Pipit* *(Anthus spragueii)*	L	-3.58 (-4.98, -2.18)	-3.24 (-4.65, -1.87)	Mixed-grass and fescue prairie
Baird's Sparrow* *(Ammodramus bairdii)*	L	-2.63 (-7.00, -0.50)	-2.98 (-4.50, -1.44)	Mixed-grass and fescue prairie
Grasshopper Sparrow *(Ammodramus savannarum)*	L	-1.94 (-4.57, 0.78)	-2.86 (-3.88, -1.76)	Short to medium tall grasslands
Clay-colored Sparrow *(Spizella pallida)*	L	-0.36 (-0.81, 0.10)	-0.51(-0.93, -0.07)	Shrubby or early successional habitats amidst open grasslands or agricultural areas
Chestnut-collared Longspur* *(Calcarius ornatus)*	L	-5.73 (-7.73, -3.57)	-4.55 (-5.70, -3.32)	Open, short grasslands
McCown's Longspur* *(Rhynchophanes mccownii)*	L	-9.68 (-14.10, -6.14)	-7.45 (-11.3, -4.6)	Sparse and arid shortgrass prairie
Lark Bunting *(Calamospiza melanocorys)*	L	-10.50 (-15.0, -6.36)	-5.99 (-8.88, -3.10)	Shortgrass prairie and sagebrush shrublands
Western Meadowlark *(Sturnella neglecta)*	L	-1.77(-2.27, -1.23)	-2.20(-2.62, -1.78)	Grasslands and agricultural areas with taller cover

Species	Group	Annual Trend — Canada BCR 11	Annal Trend — BCR 11	General Habitat Description in the PHJV Region
c) Arctic and Boreal stopover migrants				
Whooping Crane* *(Grus americana)*	W	increasing	NA	Often forages in cropland during stopover, alternating with shallow lakes and marshy wetlands for roosting
Black-bellied Plover *(Pluvialis squatarola)*	S	NA	NA	Edges of prairie lakes, marshes and flooded fields
American Golden-Plover *(Pluvialis dominica)*	S	NA	NA	Upland sites with short vegetation and wetland edge (e.g., shores)
Hudsonian Godwit *(Limosa haemastica)*	S	NA	NA	Edges of prairie lakes, marshes and flooded fields
Ruddy Turnstone *(Arenaria interpres)*	S	NA	NA	Shorelines of large lakes
Red Knot* *(Calidris canutus)*	S	NA	NA	Edges of prairie lakes, marshes and flooded fields
Sanderling *(Calidris alba)*	S	NA	NA	Edges of alkaline, saline and freshwater lakes
Semipalmated Sandpiper *(Calidris pusilla)*	S	NA	NA	Edges of prairie ponds and lakes
Stilt Sandpiper *(Calidris himantopus)*	S	NA	NA	Ponds, marshes and flooded fields
Short-billed Dowitcher *(Limnodromus griseus)*	S	NA	NA	Shallow wetlands, mudflats and flooded fields
Long-billed Dowitcher *(Limnodromus scolopaceus)*	S	NA	NA	Shallow wetlands, mudflats and flooded fields
Buff-breasted Sandpiper* *(Tryngites subruficollis)*	S	NA	NA	Short grasslands and marshes or wetland edge
Red-necked Phalarope *(Phalaropus lobatus)*	S	NA	NA	Large lakes and wetlands

APPENDIX 3:
Program Definitions for *Prairie Habitat Joint Venture Habitat Implementation Plan 2013-2020.*

Winter Wheat

Fall-seeded, annual crop provides nesting cover for breeding waterfowl and other bird species. Delivery of this program is by direct means (e.g., core growers provided modest incentives) and/or adopted by producers through extension activities (e.g., general promotion, research). Acres claimed are deemed additive or incremental to industry trends in the absence of these activities. Acres are calculated as cumulative annual totals over the period 2007-12.

Tame Pasture

Perennial tame (or native) grasses seeded in annual cropland and used as forage for cattle through grazing and also provide nesting cover for breeding waterfowl and other bird species. Delivery of this program is by direct means (e.g., 10 year+ producer agreements) and/or adopted by producers through extension activities (e.g., general promotion, seed discount). Acres claimed are deemed additive or incremental to industry trends in the absence of these activities. Acres are calculated as the cumulative annual totals over the period 2007-12.

Tame Hay

Perennial tame (or native) grasses seeded in annual cropland used as forage for cattle upon mechanical harvest and also provide nesting cover for breeding waterfowl and other bird species. Delivery of this program is by direct means (e.g., 10 year+ producer agreements) and/or adopted by producers through extension activities (e.g., general promotion, seed discount). Acres claimed are deemed additive or incremental to industry trends in the absence of these activities. Acres are calculated as the cumulative annual totals over the period 2007-12.

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 periodic management to maintain stand health). Delivery of this program is by direct means (e.g., 10 year+ producer agreements, conservation easements, acquisition). Acres claimed are deemed additive or incremental to industry trends. Acres are calculated as the cumulative annual totals over the period 2007-12.

Wetland Restoration

Replacement of natural hydrology of previously drained, naturally occurring wetland basins through installation of earthen dams serving as pair and brood habitat for breeding waterfowl and other bird species. Delivery of this program is by direct means (e.g., 10 year+ producer agreements) or policy (e.g., wetland mitigation framework). Acres claimed are deemed additive or incremental to industry trends. Acres are calculated as the cumulative annual totals over the period 2007-12.

Objectives for wetland restoration were initially set by number of basins. This was then converted to acres based on an assumption that the average restored basin size would be 0.75 acres. Numbers reported in the accomplishment report are acres, not basins.

Nesting Tunnels

Installation of artificial structures as nesting habitat for breeding waterfowl, mainly mallard. Delivery of this program is by direct means (e.g., 10 year+ producer agreements). Acres of associated wetland(s), to where structure was installed, are claimed at a ratio of 1 acre per structure, and are deemed additive or incremental to industry trends. Acres are calculated as the cumulative annual totals over the period 2007-12.

Wetland Retention

Protection of wetlands as pair and brood habitat for breeding waterfowl and other bird species. Management may include agricultural use or not. Delivery of this program is by direct means (e.g., 10 year+ producer agreements, conservation easements, acquisition), through extension activities (e.g., general promotion, grazing clubs, rangeland management) and policy (i.e., adoption of wetland policy/regulations/dedicated areas under plans). Acres claimed under extension are deemed additive or incremental to ambient trends in the absence of these activities. Acres are calculated as the cumulative annual totals over the period 2007-12.

Upland Retention

Protection of grasslands (tame or native) as nesting cover for breeding waterfowl and other bird species. Management may include agricultural use or not. Delivery of this program is by direct means (e.g., 10 year+ producer agreements, conservation easements, acquisition), through extension activities (e.g., general promotion, grazing clubs, rangeland management) and policy (i.e., adoption of wetland policy/regulations/dedicated areas under plans). Acres claimed under extension are deemed additive or incremental to ambient trends in the absence of these activities. Acres are calculated as the cumulative annual totals over the period 2007-12.

Program Delivery Methods

Direct

Activities and costs (e.g., securement/enhancement/management, supplies, directly associated staff time and costs) related to specific wetland or associated upland conservation projects.

Stewardship

Activities (with committed tenures of less than 10 years) that promote or directly result in the sustainable use of land for the purpose of supporting breeding waterfowl and other bird species. *Note: Actions that benefit land-use do not qualify.*

Policy (or Government Relations)

Activities, specific to non-governmental partners, that develop new or make changes to existing governmental (including federal, provincial/territorial and municipal) legislation, policies and/or programs that affect wetland and associated upland outcomes. Policy also includes activities to maintain existing beneficial legislation, policies and programs.

General Definitions

Target Landscapes and Remaining Delivery Areas

Target Landscapes are waterfowl productivity model-derived polygons (i.e., landscapes) within the prairie and aspen parkland ecoregions of the PHJV supporting waterfowl breeding pair densities of 30+ pairs/all species and/or 6+ pairs of northern pintail. All areas excluded by Target Landscapes but within the prairie and aspen parkland ecoregions of the PHJV are referred to as "remaining delivery areas."

Management

Wetland and upland management involves the ongoing control and manipulation of these habitats to achieve North American Waterfowl Management Plan objectives and habitat function goals.

Cost examples include:

- Control structure operation and repair
- Project reconstruction
- Access permissions and controls
- Land taxes (purchased lands)
- Management activities
  - Fencing
  - Sign repair
  - Weed control

Communications

Costs associated with the general communications of wetland and upland habitat benefits as well as North American Waterfowl Management Plan programming. These would typically include:

- Communications contracting costs
- Website management
- Advertising costs to maintain JV status
- Awareness campaigns
- Dissemination of relevant research results

Coordination

Coordination supports the administration and organization of PHJV partner-based habitat programs, organizational structures, meetings, conferences, field trips and other activities. A significant portion of the coordination costs stem from allocation of a portion of PHJV partner head office indirect costs to this activity based on a formula defined by the *North American Wetlands Conservation Act* (i.e., the Negotiated Indirect Cost Rate Agreement).

Research and Evaluation

Research and Evaluation refers to work that supports the PHJV's commitments to adaptive management, provides planning support and facilitates the tracking of progress towards population goals. Further, this category includes research that will support the implementation or development of policy consistent with PHJV goals.

Cost examples include:

- Wetland and grassland inventories and monitoring
- Decision-support system development
- Waterfowl population and productivity modelling
- Evaluation of program or policy impacts on waterfowl or species of conservation concern
- Carbon sequestration research
- Ecological goods and services valuation

APPENDIX 4:
Prairie Habitat Joint Venture Habitat Accomplishments, 2007-2012, Alberta.

	25-Year Habitat Objective Acres	5-Year Accomplishments (Acres)				5-year Habitat Objective	% 5-year Habitat Objective	% 25-year Habitat Objective
		Direct NAWMP	Extension NAWMP	Policy NAWMP	Total			
Habitat Restoration								
Winter Wheat								
Target Areas	320,790	278	49,019	-	49,297		-	15%
Remaining Delivery Area	551,307	11,579	125,257	-	136,836		-	25%
Sub-total	872,097	11,857	174,276	-	186,133	174,400	107%	21%
Tame Pasture								
Target Areas	504,070	4,822	-	-	4,822	17,270	28%	1%
Remaining Delivery Area	928,927	810	-	-	810	31,730	3%	0%
Sub-total	1,432,997	5,632	-	-	5,632	49,000	11%	0%
Tame Hay							-	-
Target Areas	336,267	1,951	80	-	2,031	17,150	12%	1%
Remaining Delivery Area	619,332	157	-	-	157	31,850	0%	0%
Sub-total	955,599	2,108	80	-	2,188	49,000	4%	0%
Planted Cover								
Target Areas	7,661	3,410	-	-	3,410	1,500	227%	45%
Remaining Delivery Area	-	-	-	-	-	-	-	-
Sub-total	7,661	3,410	-	-	3,410	1,500	227%	45%
*Wetlands **								
Target Areas	165,055	1,220	-	-	1,220	5,300	23%	1%
Remaining Delivery Area	63,844	935	-	-	935	-	-	1%
Sub-total	228,899	2,155	-	-	2,155	5,300	41%	1%
*Nesting Tunnels (structures)***								
Target Areas	–	-	-	-	-	-	-	-
Remaining Delivery Area	-	-	-	-	-	-	-	-
Sub-total	-	-	-	-	-	-	-	-
Restoration Sub-total	3,497,253	25,162	174,356	-	199,518	279,200	71%	6%
Habitat Retention								
Wetland								
Target Areas	689,250	21,354	-	-	21,354	689,250	3%	3%
Remaining Delivery Area	689,250	5,613	-	-	5,613	689,250	1%	1%
Sub-total	1,378,500	26,967	-	-	26,967	1,378,500	2%	2%
*Upland****								
Target Areas	59,670	35,485	-	-	35,485	16,250	218%	59%
Remaining Delivery Area	32,130	20,004	-	-	20,004	8,750	229%	62%
Sub-total	91,800	55,489	-	-	55,489	25,000	222%	60%
Retention Sub-total	1,470,300	82,456	-	-	82,456	1,403,500	6%	6%
Grand Total	**14,894,998**	**107,618**	**174,356**	**-**	**281,974**	**1,682,700**	**17%**	**2%**

** Assumes small basins are primary restoration target (range 0.5-1.0 acres, average 0.75 acres)*
*** No nesting tunnels deployed by PHJV in Alberta   *** May include both tame and native-grass acres*

Prairie Habitat Joint Venture Habitat Accomplishments, 2007-2012, Saskatchewan.

	25-Year Habitat Objective Acres	5-Year Accomplishments (Acres)				5-year Habitat Objective	% 5-year Habitat Objective	% 25-year Habitat Objective
		Direct NAWMP	Extension NAWMP	Policy NAWMP	Total			
Habitat Restoration								
Winter Wheat								
Target Landscape	708,930				-	141,792	0%	0%
Remaining Delivery Area	1,025,710				-	205,143	0%	0%
Sub-total	1,734,640	-	345,000	-	345,000	346,935	99%	20%
Tame Pasture							-	-
Target Landscape	867,900	74,623	110,190	-	184,813	173,582	106%	21%
Remaining Delivery Area	1,611,000	37,976	55,621	-	93,597	322,201	29%	6%
Sub-total	2,478,900	112,599	165,811	-	278,410	495,783	56%	11%
Tame Hay							-	-
Target Landscape	578,880	33,115	10,707	-	43,822	115,770	38%	8%
Remaining Delivery Area	1,074,000	15,819	26	-	15,845	214,801	7%	1%
Sub-total	1,652,880	48,934	10,733	-	59,667	330,571	18%	4%
Planted Cover							-	-
Target Landscape	57,180	8,229			8,229	6,400	129%	14%
Remaining Delivery Area	-	845			845	-	-	-
Sub-total	57,180	9,074	-	-	9,074	6,400	142%	16%
*Wetlands **							-	-
Target Landscape	42,200	1,502	-		1,502	4,900	31%	4%
Remaining Delivery Area	-	296	22		318		-	-
Sub-total	42,200	1,798	22	-	1,820	4,900	37%	4%
*Nesting Tunnels (structures)***							-	-
Target Landscape	-				-	-	-	-
Remaining Delivery Area	-				-	-	-	-
Sub-total	-	-	-	-	-	-	-	-
Restoration Sub-total	5,965,800	172,405	521,566	-	693,971	1,184,589	59%	12%
Habitat Retention								
Wetland								
Target Landscapes	914,100	51,573	17,281		68,854	37,300	185%	8%
Remaining Delivery Area	-	7,229	582		7,811		-	-
Sub-total	914,100	58,802	17,863	-	76,665	37,300	206%	8%
*Upland ****							-	-
Target Landscapes	1,605,400	158,882	110,737		269,619	321,600	84%	17%
Remaining Delivery Area	-	32,476	8,844		41,320	-	-	-
Sub-total	1,605,400	191,358	119,581	-	310,939	321,600	97%	19%
Retention Sub-total	2,519,500	250,160	137,444	-	387,604	358,900	108%	15%
Grand Total	**8,485,300**	**422,565**	**659,010**	**-**	**1,081,575**	**1,543,489**	**70%**	**13%**

** Assumes small basins are primary restoration target (range 0.5-1.0 acres, average 0.75 acres)*
*** No nesting tunnels deployed by PHJV in Saskatchewan *** May include both tame and native-grass acres - for SK this included only native grasslands*

Prairie Habitat Joint Venture Habitat Accomplishments, 2007-2012, Manitoba.

	25-Year Habitat Objective Acres	5-Year Accomplishments (Acres)				5-year Habitat Objective	% 5-year Habitat Objective	% 25-year Habitat Objective
		Direct NAWMP	Extension NAWMP	Policy NAWMP	Total			
Habitat Restoration								
Winter Wheat								
Target Landscapes	55,900	-	18,690	-	18,690	11,356	165%	33%
Remaining Delivery Area	96,700	-	1,637	-	1,637	19,644	8%	2%
Sub-total	152,600	-	20,327	-	20,327	31,000	66%	13%
Tame Pasture								
Target Landscapes	132,330	3,008	2,640	-	5,648	22,069	26%	4%
Remaining Delivery Area	191,470	248	1,180	-	1,428	31,931	4%	1%
Sub-total	323,800	3,256	3,820	-	7,076	54,000	13%	2%
Tame Hay								
Target Landscapes	88,250	3,982	5,000	-	8,982	22,073	41%	10%
Remaining Delivery Area	127,650	388	23,293	-	23,681	31,927	74%	19%
Sub-total	215,900	4,370	28,293	-	32,663	54,000	60%	15%
Planted Cover								
Target Landscapes	14,300	2,295	-	-	2,295	900	255%	16%
Remaining Delivery Area	-	1,531	-	-	1,531	-	n/a	n/a
Sub-total	14,300	3,826	-	-	3,826	900	425%	27%
*Wetlands **								
Target Landscapes	10,800	756	-	-	756	600	126%	7%
Remaining Delivery Area	-	603	-	-	603	-	n/a	n/a
Sub-total	10,800	1,359	-	-	1,359	600	227%	13%
Nesting Tunnels (structures)								
Target Landscapes	2,200	825	-	-	825	800	103%	38%
Remaining Delivery Area	-	-	-	-	-	-	n/a	n/a
Sub-total	2,200	825	-	-	825	800	103%	38%
Restoration Sub-total	719,600	13,636	52,440	-	66,076	141,300	47%	9%

	25-Year Habitat Objective Acres	5-Year Accomplishments (Acres)				5-year Habitat Objective	% 5-year Habitat Objective	% 25-year Habitat Objective
		Direct NAWMP	Extension NAWMP	Policy NAWMP	Total			
Habitat Retention								
Wetland								
Target Landscapes	575,000	21,522	7,980	-	29,502	24,500	120%	5%
Remaining Delivery Area	-	6,264	2,340	-	8,604	-	n/a	n/a
Sub-total	575,000	27,786	10,320	-	38,106	24,500	156%	7%
*Upland ** *								
Target Landscapes	1,150,000	33,059	17,000	-	50,059	76,500	65%	4%
Remaining Delivery Area	-	36,667	16,096	13,860	66,623	-	n/a	n/a
Sub-total	1,150,000	69,726	33,096	13,860	116,682	76,500	153%	10%
Retention Sub-total	1,725,000	97,512	43,416	13,860	154,788	101,000	153%	9%
Grand Total	**2,444,600**	**111,148**	**95,856**	**13,860**	**220,864**	**242,300**	**91%**	**9%**

** Assumes small basins are primary restoration target (range 0.5-1.0 acres, average 0.75 acres)*
*** May include both tame and native-grass acres*

APPENDIX 5:
General description of habitat models used to estimate the influence of habitat change on waterfowl production.

Introduction

The following describes in detail the statistical models developed by Ducks Unlimited Canada (DUC) to estimate waterfowl production in response to habitat characteristics and change within the agricultural landscapes of Prairie Canada. Specifically, models estimate the distribution of waterfowl as a function of wetland and landscape characteristics, and estimate reproductive success as function of nesting effort, nest habitat selection, habitat availability and habitat-specific influences on nest survival. Thus, changes in wetland area and upland habitat composition and availability over time can be translated into changes in the waterfowl production potential of Canadian prairie landscapes.

Part 1: Modeling spatial variation in the long-term distribution of waterfowl in Prairie Canada

Methods:

Study area and scope

We used several spatial and temporal datasets to model variation in waterfowl density across Prairie Canada during the time period 1961-2009. Specifically, we used long-term waterfowl count data collected during 1961-2009 along 546 systematically located surveytransects (Figure A5-1) and related these to landscape variables extracted or estimated along each transect. We selected landscape variables that were available across the entire region because our intent was to extrapolate model estimates to the entire region. We limited investigation to the time period 1961-2009 because population estimates were corrected for visibility only from 1961 onward (Bowden 1973).

Waterfowl data

We used waterfowl counts collected during the annual May Breeding Waterfowl Population and Habitat Survey (MBWPHS; Benning 1976) conducted across the primary breeding grounds of North America by the U.S. Fish and Wildlife Service (USFWS) and the Canadian Wildlife Service (CWS). Counts are conducted in May along permanent transects within survey strata, of which are 14 are included within the Canadian prairies (strata 26-35 and 37-40) (Figure A5-1). Survey transects are systematically spaced within strata and each transect consisted of 2-11 segments, each ~29 kilometres (km) in length and 0.4 km in width (11.6 km^2 in area) to which data are coded. Procedures for conducting surveys and evaluations of their efficacy were described in detail by Bowden (1973), Benning (1976) and Anonymous (1987). The survey segment is the experimental unit in our analysis.

In practice, survey biologists record the numbers of all waterfowl and ponds seen from a fixed-wing aircraft on each segment along survey transects. Concurrent with aerial waterfowl counts, biologists conduct simultaneous ground surveys on a sample of transect segments to establish visibility correction factors which are applied to aerial counts at the stratum level (hereafter, visibility-corrected counts). We restricted our analysis to the 7 most common species of waterfowl occurring in Prairie Canada; mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*), blue-winged teal (*Anas discors*), northern shoveler (*Anas clypeata*), northern pintail (*Anas acuta*), canvasback (*Aythya valisineria*) and redhead (*Aythya americana*). We used the mean aggregate 7-species sum of indicated breeding duck pairs (i.e., observed pairs + lone males) as the response variable in the analysis.

Wetland covariates

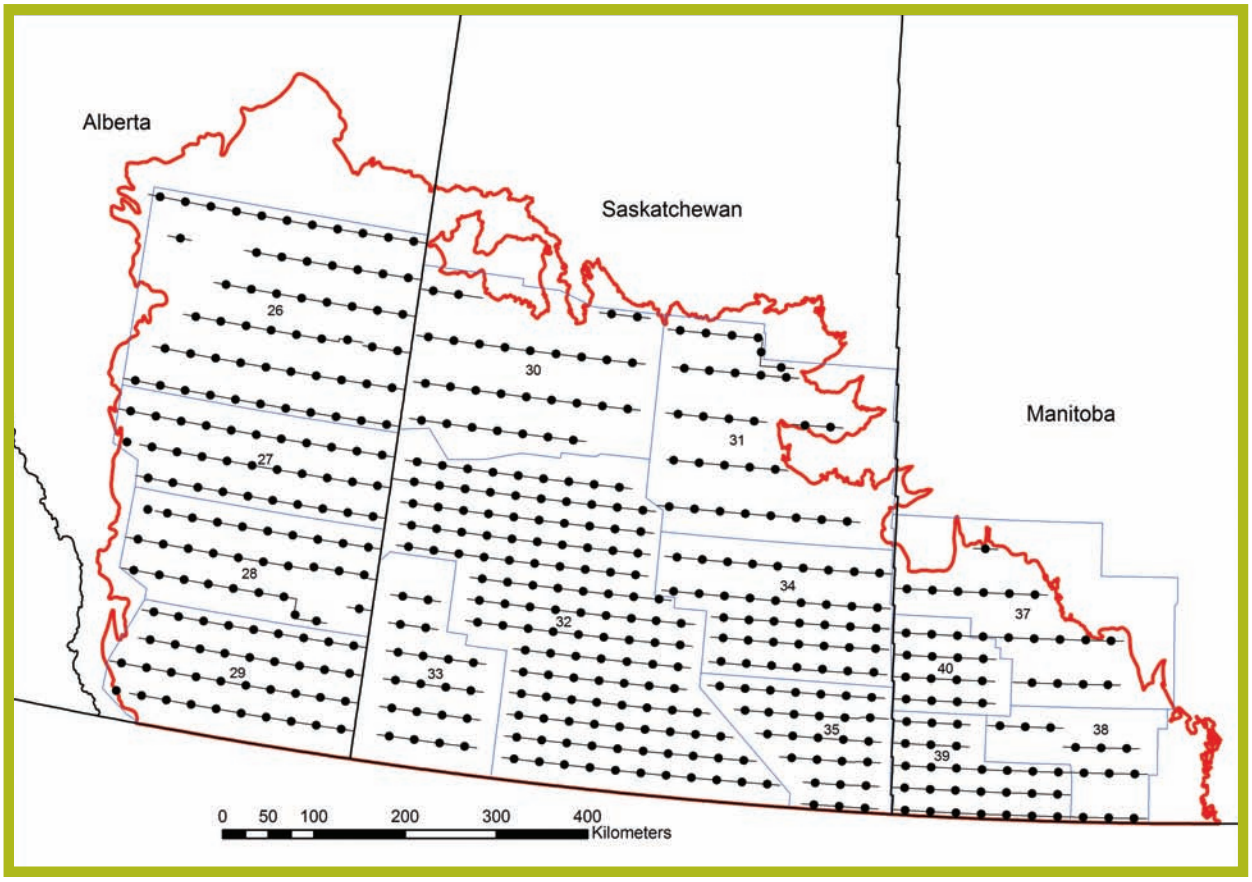
Because waterfowl are wetland-obligate species, we included estimated wetland area (in hectares; WETAREA) and wetland count (# of wetland basins; WETCNT) contained within survey segment boundaries in ArcMap 9.3 (ESRI, Redlands, CA). Wetland area and count information was sourced from hydrography and saturated soils features in the CanVec database (Natural Resources Canada 2011). Because CanVec hydrography is known to vary in wetland capture (e.g., missing small wetland basins), we compared CanVec and DUC high-resolution wetland inventory at 1,349–41 km^2 sites in Prairie Canada and constructed separate wetland area and count adjustment models (DUC unpublished data). Hence, we used the adjusted wetland area and wetland-count estimates as our wetland covariates. Because large open water provides relatively poor waterfowl pair habitat, we first removed open-water areas greater than 100 metres (m) from shorelines on large wetland basins.

Canada Land Inventory (CLI) Waterfowl Capability

CLI waterfowl capability is a map-based product for portions of Canada that classifies landscape units by degree of limitation to waterfowl production (Natural Resources Canada 2002). Classification was conducted by

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.



Canadian Wildlife Service staff 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. We used the focal mean CLI value among grids within a survey segment boundary for the CLI covariate.

Landcover covariates

Because landcover 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 an explanatory variable. 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).

Other spatial covariates

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 MIXED). We used 546 segments with complete covariate data. We used a natural-log link function where all compositional (AAFC Landcover), count-based (Wetland Count), and areal covariates (Wetland Acres) were natural-log transformed. 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 Generalized Additive Models, quadratic covariate effects were included for all quantitative covariates (LAT, LONG, CLI, PCTGRASS, PCTTREE, PCTCROP, WETAREA, WETCNT). A backward elimination procedure was used to sequentially simplify the models. At each step, the least-predictive covariate (i.e., the smallest F-ratio or "signal-to-noise ratio") was removed, providing that model hierarchy was preserved. We used Akaike's Information Criterion (AIC) adjusted for small samples (AICc, Burnham and Anderson 2002) to assess model fit. 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.

As a validation procedure, the measures of goodness-of-fit were adjusted 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.

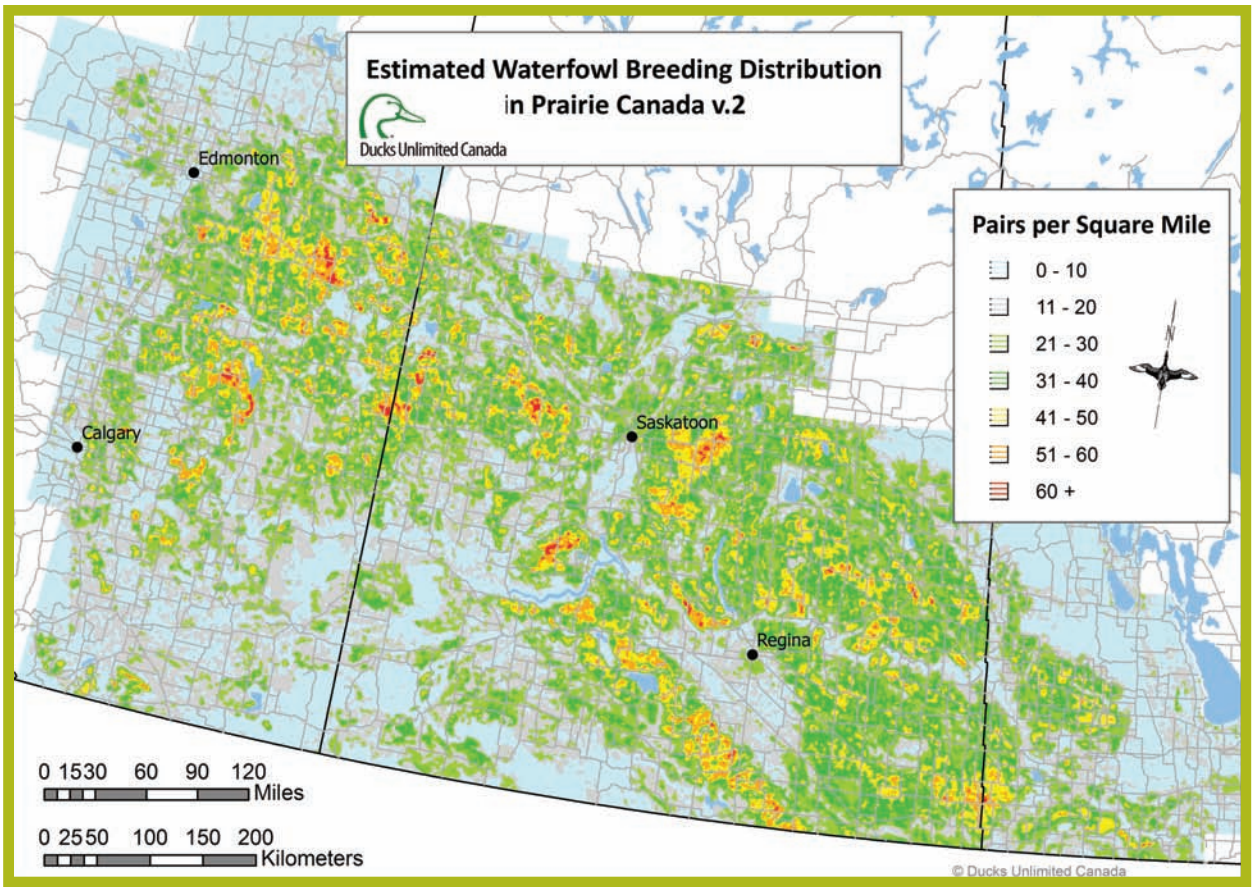
Results:

The best approximating model included the effects of LAT, LAT2, CLI, CLI2, PCTGRASS, PCTGRASS2, PCTCROP, PCTTREE, PCTTREE2, WETAREA and WETCNT. Model fit as measured by Spearman's correlation (Rho adjusted for optimism) between observed and predicted counts was 0.82.

To create the waterfowl distribution (pair density) surface for Prairie Canada, we applied the best approximating model using the Raster Calculator in ArcMap's Spatial Analyst. Specifically, parameter values were extracted from respective GIS layers within an 11.6 km^2 neighborhood (equal to the surveyed segment area), input into the model equation, and the estimated pair number assigned to the reference 400 m pixel. Pair values in the final surface were recalculated to represent estimated waterfowl pairs/mi^2 (Figure A5-2).

FIGURE A5-2

Estimated long-term average distribution of the seven most common dabbling and diving duck species breeding in Prairie Canada.



Part 2: Estimating waterfowl nest distribution and success among habitats within prairie Canada.

Methods:

Study area and scope

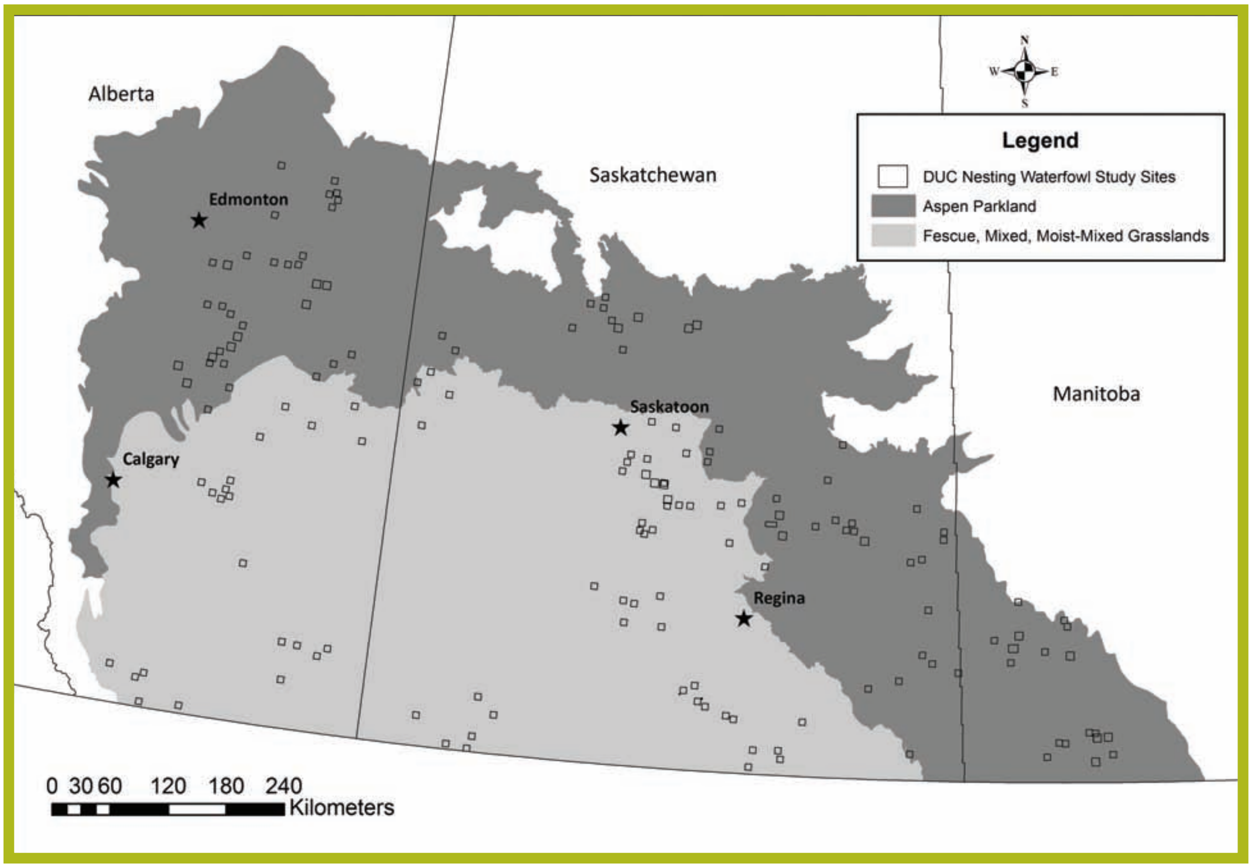
We used data from three multi-year nesting studies conducted in Prairie Canada by DUC (PHJV Assessment Study, 1993-2000; Pintail Study, 2005-2007; and Spatial/Temporal Variability Study [SPATS] 2001–2011) to model breeding duck nest habitat selection. PHJV Assessment Study areas were single sites, 64 km^2 in size, examined for 1 year only. Pintail Study and SPATS designs include clusters (hereafter, site clusters) of 6-41 km^2 study areas stratified by percent grassland composition, including 2 replicates each of low (< 30%), moderate (30-60%), and high (>60%) grassland area; each site cluster was examined for 1 or 2 years. In total, 163 study areas (1993–2011) were included in grassland and parkland ecoregion (FigureA5-3).

Study areas were characterized by flat to hummocky or kettle topography formed by lacustrine deposits and deposition of glacial till (Ecological Stratification Working Group 1995). Because these studies were focused on finding waterfowl nests, study area 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, DUC unpublished data). Among study areas, wetland habitat averaged 14.5% (range: 4-51%) of the area within study-area 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

FIGURE A5-3

Location of DUC waterfowl nesting study areas (PHJV Assessment, Pintail, SPATS) within Grassland and Aspen Parkland Ecozones of Prairie Canada, 1993-2011.



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 areas in September of the year prior to research activities. Location of fall-seeded crops within the study-area 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. 2008). 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).

Traditional nest searches

Among studies, 3 or 4 nest searches were conducted at 3-week intervals from late April through mid-July following the procedures of Klett et al. (1986). Nests were located by dragging a 30 m cable-chain assembly or a 2.5 cm x 75 m rope between 2 all-terrain vehicles (ATV; Higgins et al. 1977) through habitats being searched. The ATV rope drag was typically used in growing crop 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 tended by a female when found (Klett et al. 1986). Nest searches were conducted 6 days per week between 0700 and 1300 hr 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 growing crops (unless permission was obtained), trees and flooded wetland vegetation.

Radio-telemetry of mallard females

At PHJV-assessment sites, radio-transmitters were attached to a sample of mallard hens at the beginning of the nesting season to attain additional information on nest-site selection. We captured 111 and 123 female mallards at our first 2 study areas in 1993 and 135-137 females at each subsequent study area (1994-2000) using decoy traps baited with game-farm mallard females (Sharp and Lokemoen 1987, Ringelman 1990). Birds were captured from 4 April to 5 May, immediately before or concurrent with the earliest recorded nesting attempts. Captured females were marked with Telonics model IMP/150 22-g abdominally implanted radio-transmitters (Telonics, Mesa, AZ; Olsen et al. 1992, Rotella et al. 1993). In 1993, every second female was fitted with a unique set of nylon nasal discs (Lokemoen and Sharp 1985). A subsequent analysis of reproductive performance on nasal-marked birds suggested that birds with markers showed a slight delay in initiating their first nest attempt (2-6 days; Howerter et al. 1997). We retained these birds in analyses, although nasal marking birds was suspended for the remainder of the study.

We used vehicle-mounted, null array antenna systems and triangulation from locations identifiable on aerial photographs, typically along established grid roads, to locate radio-marked females (Kenward 1987). We generally located birds at least twice daily from the morning following marking until mid-July to identify nesting attempts and monitor female survival. Birds were tracked between 0600 and 1300 hr when laying females were most likely to be attending nests (Gloutney et al. 1993, Loos and Rohwer 2004). Females suspected of nesting were tracked with a hand-held receiving antenna and were either flushed from their nests (prior to June 1994), or we attempted to estimate nest locations without flushing the female (June 1994 onwards, Thorn et al. [2005]). Nests where females were not flushed were located later, usually the same day, when the female was absent from the nest area.

We conducted weekly fixed-wing aircraft and road-based vehicle searches on and in the vicinity of study areas (within ~4 km of study area boundaries) to locate females not found during regular daily radio-tracking. Tracking ceased when females were observed unpaired and flocked on at least 2 different days, or after 2 weeks had elapsed since the last known nest initiation on each study area.

Nest data

When a nest was discovered, we recorded habitat patch type, duck species, number of eggs and incubation status by field candling (Weller 1956). Nest location was determined using GPS for later analyses in ArcMap and nests were marked with a flagged willow stake placed 4 m north of the nest to facilitate relocation. Nest-searched nests were revisited at 7-10 day intervals until nest fate (successful/failed) was determined. If the scheduled revisit was within 2 days of estimated hatch, we revisited the nest 2-3 days after the estimated hatch date to avoid separating the female from recently hatched ducklings. Nests of radio-marked females were monitored via telemetry until a female's absence from the nest for 2 consecutive location periods prompted a visit to determine the nest's status. Otherwise, nests were visited only once prior to hatch to determine final clutch size. 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. Where nests were determined to be 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. Clutch initiation date was estimated by subtracting the age of the nest when found (i.e., number of eggs + days of incubation) from the date of discovery (Klett et al. 1986).

Habitat classification and digitizing

We used an 11-class habitat definition scheme incorporating habitats and land use (Table A5-1). We digitized habitat types in ArcMap from several imagery sources among studies. During the PHJV-assessment study, we used 1:5,000 black-and-white infrared aerial photos taken in July or August of the year of investigation. On pintail-study sites we used 2.5 m panchromatic SPOT imagery (SPOT Image Corporation, Chantilly, VA) taken in May or June of the year previous to investigation. On SPATS study areas we used 1:10,000 color or black-and-white infrared aerial photos taken in June-August of the year of investigation. We ground-truthed all habitats within study area boundaries in June and July of the year of investigation.

Nest survival analysis

We used a general likelihood specification in PROC NLMIXED to examine the influence of covariates on nest survival probability (Emery et al. 2005) 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 on the basis of previous research and plausible hypotheses. We constructed sets of *a priori* model suites containing covariates of potential importance at nest, habitat patch, and landscape scales. Full models included additive covariate main effects and selected within- and between-scale interactions that seemed plausible or tested specific hypotheses. We used Akaike's Information Criterion (AIC) adjusted for overdispersion ($\hat{c}$= Pearson $\chi 2$ / df, McCullagh and Nelder 1989; QAIC, Burnham and Anderson 2002) to assess model fit. Prior to full model construction, all continuous covariates were run singly and in their quadratic form, and the best fitting form (lowest QAIC) was used in full models.

We sequentially reduced full models using backward elimination of least predictive covariates. Top models from each scale were combined to create a full multi-scale model which in turn was reduced by backward elimination to arrive at a final best-fitting model. In all backward elimination procedures, we identified best-approximating models when elimination of additional covariates achieved no further reduction in QAIC (Burnham and Anderson 2002).
We began with models for each species examining the

TABLE A5-1

General description of habitat models used to estimate the influence of habitat change on waterfowl production.

Habitat Model	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 first hay cut is delayed until after July 15th each year and is restricted to one cut per season
Dense Nesting Cover (DNC)	Former cropland seeded to medium height and/or tall native native or introduced grasses and/or forbs and then 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%.
Unmanaged	Covertypes not managed and/or protected for duck nesting cover under the Prairie Habitat Joint Venture of the North American Waterfowl Management Plan

Species*Habitat*Idate interaction. The best fitting model for each species was taken forward with the addition of each covariate. Covariates retained in the final model included:

- Annual wetness (Pondindex): a standardized index created from the MBWPHS May pond counts at the segment level and interpolated across prairie Canada for the years of study
- Longitude: Longitude of the study area centroid
- Latitude: Latitude of the study area centroid
- Percent Herbaceous (PctHerb): Proportion of the study area comprised of herbaceous cover (i.e., the sum of grasslands, low shrub, and haylands)
- Percent Tree (PctTree): Proportion of the study area comprised of tree cover
- Pair Density per Wetland Edge (Pair density): Total waterfowl pairs counted in pair surveys divided by total edge of all surveyed wetlands on the study area

Habitat selection analysis

We used resource selection functions (RSFs; Manly et al. 2002, McLoughlin et al. 2006, 2010) to examine the influence of covariates on waterfowl nest habitat use versus availability. RSFs are useful for inferring selection based on departures from random use while considering covariate effects that can provide insight into underlying ecological processes (McLoughlin et al. 2010). We used conditional logistic regression in SAS (PROC GLIMMIX; e.g., Gillies et al. 2006) to compare the distribution of used versus random locations among habitats at the scale of the study area. Nests found outside of areas that had been searched at least 3 times (for nests searched nests) and nests found outside of study area boundaries (for radioed mallard nests) were excluded from analysis (i.e., initiated outside areas defined as "available").

Specifically, we compared the observed distribution of nest sites among habitats (coded as 1) with a sample of random

TABLE A5-2

Model-based estimates of relative nest habitat selection probability, and nest survival, for the five most common dabbling duck species nesting in Prairie Canada during early, mid and late nesting season at average covariate.

		Mallard			Blue-winged Teal		
	Habitat	Early	Mid	Late	Early	Mid	Late
Habitat Preference	Spring-seeded Cropland	0.16	0.15	0.52	0.86	0.83	3.52
	Fall-seeded Cropland	4.67	8.11	11.79	10.66	10.72	11.65
	Dense Nesting Cover	10.75	12.83	14.32	28.28	24.25	22.32
	Delayed Hayland	0.61	3.25	8.72	10.96	17.25	20.23
	Hayland	0.46	3.17	7.68	8.56	11.21	8.06
	Natural-Idle	14.17	15.18	15.33	17.98	15.44	14.85
	Natural-Rested	6.14	4.82	5.30	12.99	12.65	11.11
	Natural-Used	4.77	5.31	6.12	9.72	7.65	8.26
	Other	0.79	0.72	0.52	0.00	0.00	0.00
	Trees-Idle	38.19	31.99	19.41	0.00	0.00	0.00
	Trees-Used	19.27	14.49	10.30	0.00	0.00	0.00
Nest Survival	Spring-seeded Cropland	0.03	0.04	0.16	0.10	0.12	0.25
	Fall-seeded Cropland	0.02	0.20	0.16	0.17	0.19	0.11
	Dense Nesting Cover	0.21	0.18	0.13	0.16	0.14	0.13
	Delayed Hayland	0.43	0.37	0.10	0.14	0.40	0.16
	Hayland	0.13	0.15	0.10	0.19	0.21	0.18
	Natural-Idle	0.11	0.11	0.13	0.11	0.16	0.15
	Natural-Rested	0.08	0.14	0.18	0.13	0.20	0.19
	Natural-Used	0.09	0.09	0.15	0.13	0.12	0.14
	Other	0.12	0.09	0.14	0.05	0.03	0.04
	Trees-Idle	0.08	0.12	0.11	0.19	0.24	0.19
	Trees-Used	0.08	0.10	0.11	0.09	0.10	0.08

** BWTE, blue-winged teal; GADW, gadwall; MALL, mallard; NOPI, northern pintail; NSHO, northern shoveler.*

Northern Shoveler			Gadwall			Northern Pintail		
Early	Mid	Late	Early	Mid	Late	Early	Mid	Late
2.00	1.93	3.26	0.00	0.37	1.67	8.60	6.05	3.43
9.86	15.23	14.59	0.00	7.15	10.78	7.56	13.26	20.57
37.12	30.64	30.57	30.82	33.78	27.04	28.78	19.52	21.97
3.46	6.85	7.04	12.78	9.97	18.31	5.78	18.59	20.62
11.00	10.77	11.55	19.61	17.42	16.09	14.75	15.92	15.27
14.96	14.11	13.43	19.89	18.55	13.27	13.33	10.98	7.21
13.28	11.94	11.49	7.69	5.58	7.29	11.21	9.01	6.84
8.31	8.52	8.07	9.22	7.19	5.55	9.99	6.69	4.08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.05	0.04	0.14	0.02	0.08	0.14	0.02	0.03	0.10
0.16	0.16	0.14	0.14	0.20	0.10	0.09	0.15	0.13
0.18	0.18	0.09	0.03	0.18	0.11	0.32	0.26	0.10
0.25	0.34	0.15	0.18	0.23	0.13	0.64	0.21	0.22
0.17	0.18	0.04	0.19	0.10	0.06	0.12	0.19	0.04
0.09	0.12	0.17	0.10	0.15	0.15	0.08	0.07	0.10
0.10	0.13	0.14	0.09	0.27	0.20	0.03	0.07	0.07
0.09	0.06	0.09	0.07	0.15	0.13	0.06	0.05	0.07
0.06	0.03	0.04	0.27	0.37	0.32	0.25	0.22	0.23
0.14	0.15	0.12	0.02	0.11	0.04	0.06	0.09	0.06
0.33	0.31	0.29	0.16	0.31	0.21	0.01	0.02	0.01

points (coded as 0) generated at a rate of 3:1 to the number of nests per study site*species*initiation date category combination. We converted nest initiation date (Idate) to a categorical variable for nests and assigned early, mid and late nest initiations based on 33rd percentiles. For all nests except those of radioed mallards, both nests and random points were constrained to include only those in habitat patches where at least three complete nest searches had been conducted. Within each study area, the covariates associated with the random points were identical to the nests, save for study habitat. A multinomial distribution was used for attributing study habitats to the random points, with p_i proportional to the area of nest-searched habitats for nests found by nest dragging and proportional to study-site habitat availabilities for nests found for radio-tagged mallards.

We began with models for each species examining the habitat*Idate interaction. The best fitting model for each species was taken forward with the addition of the same covariates identified above in the nest survival analysis.

Results:

We used data from 21,215 waterfowl nests comprised of mallards (n=3,976 nests from traditional nest searching; n=4,246 nests from radio-tagged females), blue-winged teal (n=6,137 nests), northern shoveler (n=2,860 nests), gadwall (n=2,884 nests), and northern pintail (n=1,112 nests). The best-approximating models provided nest survival and relative selection probability estimates for each habitat*initiation date category assuming equal habitat availability (Table A5-2). Due to a lack of nests for species other than mallards in Tree-idle and Tree-used, and field experience, selection probability of these habitats was set to 0 for all species except mallards. Given a lack of gadwall nests in croplands early in the nesting season, selection probability for spring-seeded cropland and fall-seeded cropland were set to 0 for early season gadwall.

Synthesis: Estimation of waterfowl nest distribution among habitats in Prairie Canada.

To estimate waterfowl nest distribution across Prairie Canada and among the 11 habitats defined in this analysis, we first extracted the estimated breeding pair numbers in each rural municipality/county (i.e., Census of Agriculture Census Consolidated Subdivision [CCS]) from the long-term average pair density map outline in Part 1 above. We used data from the Census of Agriculture (Statistics Canada) at the CCS level to provide estimates of habitat availability in years of interest. Challenges with these data included estimating some habitat categories including Treed and Natural, estimating grazed lands, and data suppression by Statistics Canada at the CCS level (for further detail, see Devries et al. 2004).

We used DUC's Waterfowl Productivity Model (WPM; DUC unpublished data), which incorporates the estimates from Table A5-2, to generate the number, distribution and success of waterfowl nests among habitats available in each CCS. Specifically, for each species, the WPM combines estimates of the average nesting population within a planning area (as described in Part 1 above), estimates of average nesting and renesting propensity (set at 0.9 and 0.7, respectively for all species) and the maximum number of nesting attempts for each species (mallard, 6; blue-winged teal and northern shoveler, 5; gadwall and northern pintail, 4; DUC unpublished data), to generate a population of nests for each species. Nests are subsequently distributed among habitats based on species-specific estimates of nest habitat selection probability and habitat availability within each CCS. Hatched nests for each habitat are estimated by applying habitat-specific and initiation-date specific nest survival rates. Covariates for Pond index and Pair density were held at average values. All other covariates affecting habitat selection and nest survival were allowed to vary with the location and characteristics of the CCS (e.g., Latitude, Longitude).

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APPENDIX 6:
Waterfowl Habitat Objectives Updating Process.

Previously, Devries et al. (2004) described a process for updating Prairie Habitat Joint Venture (PHJV) habitat objectives that estimated the influence of wetland and upland changes on waterfowl productivity in Prairie Canada from 1971-2001 (Appendix C in Devries et al. 2004). This process was revised in 2012 to estimate changes in waterfowl productivity from 1971-2011 (Appendix 5). Inclusion of habitats delivered under the North American Waterfowl Management Plan (NAWMP) since 1986 were incorporated and included estimates of suppressed acres and unreported habitats (e.g., woodlands; Appendix D in Devries et al. 2004). Changes in waterfowl-pair population-carrying capacity were estimated using simulation models that converted wetland loss estimates at the municipality scale into change in population carrying capacity from 1971-2011, using models developed by Bartzen (2010; Appendix E in Devries et al. 2004). This approach recognizes that duck productivity from the Region is affected by both the amount of wetland habitat present (i.e., carrying capacity for duck pairs) and the types and areas of upland habitat available for use by nesting female ducks. Given measurements of wetland and upland changes over the 1971-2011 time period, corresponding changes in estimated hatched nests at the municipality scale were calculated using the Waterfowl Productivity Model v2.0 (WPM; Appendix 5). Changes in hatched nests at the municipality scale were recorded as either a 'deficits' or 'surpluses' (Figure 11). Deficits and surpluses at the municipality scale were then attributed to Target Landscapes or the NAWMP Delivery Area relative to the proportion of the local waterfowl population falling within and outside of PHJV Target Landscapes.

Scenario Modeling Process

To develop scenarios for setting objectives, we used Rashford's predicted 2030 landscape produced from the B1 Scenario (Rashford et al. 2013). The predicted 2030 landscape was developed using a model that quantifies the relationship between agricultural land use and economic and regional characteristics. We adjusted the landscape to include the habitats used in the Waterfowl Productivity Model and to incorporate areas of dense nesting cover and delayed haying on the ground as of 2011. Winter wheat was removed from the landscape to reflect a 'no further PHJV action' landscape (because PHJV claims all winter wheat acres). This was the base landscape onto which we applied various scenarios of upland and wetland restoration efforts. For all planning scenarios, we used the species' proportions from 2001-2011, under the assumption that these proportions will remain relatively consistent into the future.

First, provincial planning teams considered scenarios that incorporated the impacts of wetland policy, in the absence of further PHJV conservation program delivery, undertaken at different times during the implementation cycle, 2013-2030. We converted wetland losses to duck losses (Bartzen 2010) to estimate populations of five dabbling duck species in 2016, 2021 and 2030. We used these as population inputs for each wetland policy scenario. This process removes pairs from the population that would have settled had these wetlands not been lost due to continued wetland loss.

We considered the following three wetland policy scenarios:

1. Wetland Policy in 2016 = 5 years of continued wetland loss (at 2011 rates) followed by no further loss of wetlands to 2030, uses estimated 5-dabbler population in 2016
2. Wetland Policy in 2021 = 10 years of continued wetland loss (at 2011 rates) followed by no further loss of wetlands 2030, uses estimated 5-dabbler population in 2021
3. No Wetland Policy = continued wetland loss to 2030, uses estimated 5-dabbler population in 2030

Next, provincial implementation teams developed scenarios for upland- and wetland habitat restoration programs for Target Landscapes and the remaining PHJV delivery area to eliminate hatched nest deficits. Each provincial team selected a wetland policy scenario they felt was optimistic for their province (e.g., wetland policy in 2016 for AB, wetland policy in 2021 for MB/SK). We ran the 2030 base landscape described above through the WPM and compared the predicted number of hatched nests in 2030 to the predicted number of hatched nests in 1971 to determine the 'Predicted Deficit/Surplus in 2030 without PHJV Action'. Habitat-restoration scenarios were generally based on previous accomplishments and available budgets. The predicted number of hatched nests in 2030 after adjusting for PHJV program activities was compared to the predicted number of hatched nests in 1971 to calculate a 'Predicted Deficit/Surplus in 2030 after PHJV Action'. This was compared to the 'Predicted Deficit in 2030 without PHJV Action' to determine if the deficit was overcome (see Figures 17 and 18).

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APPENDIX 7:
PHJV habitat restoration and retention objectives (2013-2020 and 2030), Alberta.

PHJV wetland and upland habitat retention objectives to 2020 (i.e., 8-year) and 2030 for each province, and overall.

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Extension NAWMP	Total	
Habitat Restoration					
Winter Wheat					
All Target Landscapes	20%		20%	0	100%
Remaining Delivery Area	20%		20%	0	100%
Sub-total					
Tame Pasture					
Arrowwood	20,000	-	8,000	8,000	40%
Beaverhill	-	-	-	-	-
Bellshill	30,000	-	12,000	12,000	40%
Big Hay/Bittern	30,000	-	12,000	12,000	40%
Buffalo Lake	-	-	-	-	-
Calgary East	30,000	-	12,000	12,000	40%
Calgary West	-	-	-	-	-
ClearLake	10,000	-	4,000	4,000	40%
Cypress	10,000	-	4,000	4,000	40%
Derwent	1,000	-	400	400	40%
Eastern Plains	-	-	-	-	-
Eastern Irrigation District	10,000	-	4,000	4,000	40%
Jenner Plains	-	-	-	-	-
Kenilworth	30,000	-	12,000	12,000	40%
Milk River Ridge	10,000	-	4,000	4,000	40%
Pakowki	20,000	-	8,000	8,000	40%
PineLake	20,000	-	8,000	8,000	40%
Sullivan Lake	-	-	-	-	-
Vermillion/Viking	40,000	-	16,000	16,000	40%
Wintering Hills	30,000	-	12,000	12,000	40%
Remaining Delivery Area	150,000	-	60,000	60,000	40%
Sub-total	**441,000**	**-**	**176,400**	**176,400**	**40%**
Tame Hay					-
Arrowwood	45,000	-	18,000	18,000	40%
Beaverhill	-	-	-	-	-
Bellshill	35,000	-	14,000	14,000	40%
Big Hay/Bittern	50,000	-	20,000	20,000	40%
Buffalo Lake	-	-	-	-	-
Calgary East	40,000	-	16,000	16,000	40%
Calgary West	50,000	-	20,000	20,000	40%
Clear Lake	25,000	-	10,000	10,000	40%
Cypress	-	-	-	-	-

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Extension NAWMP	Total	
Derwent	-	-	-	-	-
Eastern Plains	15,000	-	6,000	6,000	40%
Eastern Irrigation District	-	-	-	-	-
Jenner Plains	-	-	-	-	-
Kenilworth	30,000	-	12,000	12,000	40%
Milk River Ridge	25,000	-	10,000	10,000	40%
Pakowki	150,000	-	60,000	60,000	40%
Pine Lake	20,000	-	8,000	8,000	40%
Sullivan Lake	20,000	-	8,000	8,000	40%
Vermillion/Viking	50,000	-	20,000	20,000	40%
Wintering Hills	20,000	-	8,000	8,000	40%
Remaining Delivery Area	150,000	-	60,000	60,000	40%
Sub-total	**725,000**	**-**	**290,000**	**290,000**	**40%**
Planted Cover					
Arrowwood	2,000	800	-	800	40%
Beaverhill	2,500	1,000	-	1,000	40%
Bellshill	1,500	600	-	600	40%
Big Hay/Bittern	2,500	1,000	-	1,000	40%
Buffalo Lake	2,000	800	-	800	40%
Calgary East	-	-	-	-	-
Calgary West	-	-	-	-	-
Clear Lake	-	-	-	-	-
Cypress	-	-	-	-	-
Derwent	2,000	800	-	800	40%
Eastern Plains	5,000	2,000	-	2,000	40%
Eastern Irrigation District	-	-	-	-	-
Jenner Plains	-	-	-	-	-
Kenilworth	5,000	2,000	-	2,000	40%
Milk River Ridge	-	-	-	-	-
Pakowki	-	-	-	-	-
Pine Lake	2,000	800	-	800	40%
Sullivan Lake	2,000	800	-	800	40%
Vermillion/Viking	5,000	2,000	-	2,000	40%
Wintering Hills	4,000	1,600	-	1,600	40%
Remaining Delivery Area	-	-	-	-	-
Sub-total	**35,500**	**14,200**	**-**	**14,200**	**40%**
Wetlands **					
Arrowwood	975	225	-	225	23%
Beaverhill	3,000	75	-	75	3%
Bellshill	5,813	150	-	150	3%
Big Hay/Bittern	3,750	300	-	300	8%
Buffalo Lake	4,575	38	-	38	1%
Calgary East	75	38	-	38	50%
Calgary West	338	225	-	225	67%
Clear Lake	45	38	-	38	83%
Cypress	-	-	-	-	-

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres) Direct NAWMP	Extension NAWMP	Total	% of 2030 Habitat Objective
Derwent	1,500	38	-	38	3%
Eastern Plains	750	300	-	300	40%
Eastern Irrigation District	150	150	-	150	100%
Jenner Plains	-	-	-	-	-
Kenilworth	3,375	300	-	300	9%
Milk River Ridge	75	75	-	75	100%
Pakowki	263	38	-	38	14%
Pine Lake	2,025	75	-	75	4%
Sullivan Lake	2,025	375	-	375	19%
Vermillion/Viking	3,750	375	-	375	10%
Wintering Hills	225	225	-	225	100%
Remaining Delivery Area	33,000	-	-	-	0%
Sub-total	65,708	3,038	-	3,038	5%
Nesting Tunnels (structures)					
Target Areas	-	-	-	-	-
Remaining Delivery Area	-	-	-	-	-
Sub-total	-	-	-	-	-
AB Restoration Sub-total	**1,267,208**	**17,238**	**466,400**	**483,638**	**38%**

	Year 2030 Habitat Objective Acres	8-Year Objectives (Acres) Direct NAWMP	Extension NAWMP	Total	% of 2030 Habitat Objective	8-Year Direct Expenditure	8-Year Indirect Expenditure	Total 8-Year Expenditure
Habitat Retention								
Wetland								
All Target Landscapes	-	-	-	-	-	$ 0	$ 0	$ 0
Remaining Delivery Area	97,875	43,500	-	43,500	44%	$ 8,700,000	$ 2,175,000	$ 10,875,000
Sub-total	97,875	43,500	-	43,500	44%	$ 8,700,000	$ 2,175,000	$ 10,875,000
*Upland ****								
All Target Landscapes	-	-	-	-	-	$ 0	$ 0	$ 0
Remaining Delivery Area	199,125	88,500	-	88,500	44%	$ 39,825,000	$ 8,850,000	$ 48,675,000
Sub-total	199,125	88,500	-	88,500	44%	$ 39,825,000	$ 8,850,000	$ 48,675,000
AB Retention Sub-total	**297,000**	**132,000**	**-**	**132,000**	**44%**	**$ 48,525,000**	**$ 11,025,000**	**$ 59,550,000**
AB Grand Total	**1,564,208**	**149,238**	**466,400**	**615,638**	**41%**			

PHJV habitat restoration and retention objectives (2013-2020 and 2030), Manitoba.

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Extension NAWMP	Total	
Habitat Restoration					
Winter Wheat					
All Target Landscapes	20%	-	20%	0	100%
Remaining Delivery Area	20%	-	20%	0	100%
Sub-total					
Tame Pasture					-
Alexander/Griswold	3,720	1,200	288	1,488	40%
Killarney	6,000	1,968	432	2,400	40%
Minnedosa/Shoal	10,148	3,339	720	4,059	40%
Virden	18,748	6,059	1,440	7,499	40%
Remaining Delivery Area	16,749	6,700	-	6,700	40%
Sub-total	**55,365**	**19,266**	**2,880**	**22,146**	**40%**
Tame Hay					-
Alexander/Griswold	2,480	800	192	992	40%
Killarney	4,000	1,312	288	1,600	40%
Minnedosa/Shoal	6,766	2,226	480	2,706	40%
Virden	12,498	4,039	960	4,999	40%
Remaining Delivery Area	11,166	4,466	-	4,466	40%
Sub-total	**36,910**	**12,844**	**1,920**	**14,764**	**40%**
Planted Cover					-
Alexander/Griswold	2,000	800	-	800	40%
Killarney	2,000	800	-	800	40%
Minnedosa/Shoal	4,000	1,600	-	1,600	40%
Virden	4,000	1,600	-	1,600	40%
Remaining Delivery Area	-	-	-	-	-
Sub-total	**12,000**	**4,800**	**-**	**4,800**	**40%**
*Wetlands ** *					-
Alexander/Griswold	225	90	-	90	40%
Killarney	495	198	-	198	40%
Minnedosa/Shoal	1,095	438	-	438	40%
Virden	1,148	459	-	459	40%
Remaining Delivery Area	1,655	662	-	662	40%
Sub-total	**4,618**	**1,847**	**-**	**1,847**	**40%**
Nesting Tunnels (structures)					-
Alexander/Griswold	200	80	-	80	40%
Killarney	-	-	-	-	-
Minnedosa/Shoal	2,800	1,120	-	1,120	40%
Virden	400	160	-	160	40%
Remaining Delivery Area	-	-	-	-	-
Sub-total	**3,400**	**1,360**	**-**	**1,360**	**40%**
MB Restoration Sub-total	**112,293**	**40,117**	**4,800**	**44,917**	**40%**

	Year 2030 Habitat Objective Acres	8-Year Objectives (Acres)			% of 2030 Habitat Objective	8-Year Direct Expenditure	8-Year Indirect Expenditure	Total 8-Year Expenditure
		Direct NAWMP	Extension NAWMP	Total				
Habitat Retention								
Wetland								
Alexander/Griswold	500	200	-	200	40%	$ 40,000	$ 10,000	$ 50,000
Killarney	2,800	1,120	-	1,120	40%	$ 224,000	$ 56,000	$ 280,000
Minnedosa/Shoal	14,100	5,640	-	5,640	40%	$ 1,128,000	$ 282,000	$ 1,410,000
Virden	16,200	6,480	-	6,480	40%	$ 1,296,000	$ 324,000	$ 1,620,000
Remaining Delivery Area	136,000	54,400	-	54,400	40%	$ 10,880,000	$ 2,720,000	$ 13,600,000
Sub-total	169,600	67,840	-	67,840	40%	$ 13,568,000	$ 3,392,000	$ 16,960,000
*Upland ****					-			
Alexander/Griswold	500	200	-	200	40%	$ 90,000	$ 20,000	$ 110,000
Killarney	6,300	2,520	-	2,520	40%	$ 1,134,000	$ 252,000	$ 1,386,000
Minnedosa/Shoal	30,100	12,040	-	12,040	40%	$ 5,418,000	$ 1,204,000	$ 6,622,000
Virden	40,100	16,040	-	16,040	40%	$ 7,218,000	$ 1,604,000	$ 8,822,000
Remaining Delivery Area	235,400	94,160	-	94,160	40%	$ 42,372,000	$ 9,416,000	$ 51,788,000
Sub-total	312,400	124,960	-	124,960	40%	$ 56,232,000	$ 12,496,000	$ 68,728,000
MB Retention Sub-total	**482,000**	**192,800**	**-**	**192,800**	**40%**	**$ 69,800,000**	**$ 15,888,000**	**$ 85,688,000**
MB Grand Total	**594,293**	**232,917**	**4,800**	**237,717**	**40%**			

PHJV habitat restoration and retention objectives (2013-2020 and 2030), Saskatchewan.

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Extension NAWMP	Total	
Habitat Restoration					
Winter Wheat					
All Target Landscapes	15%		15%	0	100%
Remaining Delivery Area	15%		15%	0	100%
Sub-total					
Tame Pasture					
Allan Hills	56,876	14,788	7,962	22,750	40%
Boundary Plateau	24,000	6,240	3,360	9,600	40%
Cactus Lake	11,227	2,919	1,572	4491	40%
Conjuring Creek	14,872	3,867	2,082	5,949	40%
Coteau Central	55,610	14,459	7,785	22,244	40%
Coteau North	9,904	2,575	1,387	3,962	40%
Coteau South	49,904	12,975	6,986	19,961	40%
Dana Hills	20,134	5,235	2,819	8,054	40%
Fox Valley	3,184	828	446	1,274	40%
Hillmond	-	-	-	-	-
Lenore/Ponass	3,658	951	512	1,463	40%
Lightning	110,000	28,600	15,400	44,000	40%
Pheasant Hills	28,330	7,366	3,966	11,332	40%

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Extension NAWMP	Total	
Prince Albert	1,213	315	170	485	40%
Quill South	15,468	4,022	2,165	6,187	40%
Regina East	9,809	2,551	1,373	3,924	40%
Thickwood	16,250	4,225	2,275	6,500	40%
Touchwood/Beaver	64,196	16,691	8,987	25,678	40%
Tramping Lake East	38,485	10,006	5,388	15,394	40%
Upper Assiniboine	55,553	14,444	7,777	22,221	40%
Virden Sask	17,700	4,602	2,478	7,080	40%
Remaining Delivery Area	374,000	97,240	52,360	149,600	40%
Sub-total	**980,373**	**254,899**	**137,250**	**392,149**	**40%**
Tame Hay					
Allan Hills	24,512	6,373	3,432	9,805	40%
Boundary Plateau	16,000	4,160	2,240	6,400	40%
Cactus Lake	2,042	530	286	816	40%
Conjuring Creek	1,216	316	170	486	40%
Coteau Central	21,430	5,572	3,000	8,572	40%
Coteau North	119	31	17	48	40%
Coteau South	11,407	2,966	1,597	4,563	40%
Dana Hills	2,051	533	287	820	40%
Fox Valley	452	118	63	181	40%
Hillmond	-	-	-	-	-
Lenore/Ponass	774	202	108	310	40%
Lightning	36,826	9,575	5,156	14,731	40%
Pheasant Hills	3,842	999	538	1,537	40%
Prince Albert	182	47	26	73	40%
Quill South	1,544	402	216	618	40%
Regina East	1,055	274	148	422	40%
Thickwood	4,600	1,196	644	1,840	40%
Touchwood/Beaver	11,325	2,945	1,585	4,530	40%
Tramping Lake East	11,904	3,095	1,667	4,762	40%
Upper Assiniboine	13,271	3,450	1,858	5,308	40%
Virden Sask	7,000	1,820	980	2,800	40%
Remaining Delivery Area	63,000	16,380	8,820	25,200	40%
Sub-total	**234,551**	**60,984**	**32,838**	**93,822**	**40%**
Planted Cover					
Allan Hills	2,608	1,043	-	1,043	40%
Boundary Plateau	-	-	-	-	-
Cactus Lake	-	-	-	-	-
Conjuring Creek	1,608	643	-	643	40%
Coteau Central	2,120	848	-	848	40%
Coteau North	-	-	-	-	-
Coteau South	2,428	971	-	971	40%
Dana Hills	504	202	-	202	40%
Fox Valley	-	-	-	-	-

	Year 2030 Habitat Objective (Acres)	8-Year Objectives (Acres)			% of 2030 Habitat Objective
		Direct NAWMP	Extension NAWMP	Total	
Hillmond	-	-	-	-	-
Lenore/Ponass	-	-	-	-	-
Lightning	-	-	-	-	-
Pheasant Hills	1,272	509	-	509	40%
Prince Albert	-	-	-	-	-
Quill South	464	186	-	186	40%
Regina East	-	-	-	-	-
Thickwood	660	264	-	264	40%
Touchwood/Beaver	1,000	400	-	400	40%
Tramping Lake East	1,532	613	-	613	40%
Upper Assiniboine	1,000	400	-	400	40%
Virden Sask	-	-	-	-	-
Remaining Delivery Area	3,400	1,360	-	1,360	40%
Sub-total	18,596	7,439	-	7,439	40%
*Wetlands ***					
Allan Hills	394	158	-	158	40%
Boundary Plateau	-	-	-	-	-
Cactus Lake	-	-	-	-	-
Conjuring Creek	964	386	-	386	40%
Coteau Central	-	-	-	-	-
Coteau North	-	-	-	-	-
Coteau South	250	100	-	100	40%
Dana Hills	165	66	-	66	40%
Fox Valley	-	-	-	-	-
Hillmond	-	-	-	-	-
Lenore/Ponass	-	-	-	-	-
Lightning	825	330	-	330	40%
Pheasant Hills	43	17	-	17	40%
Prince Albert	-	-	-	-	-
Quill South	158	63	-	63	40%
Regina East	150	60	-	60	40%
Thickwood	323	129	-	129	40%
Touchwood/Beaver	836	334	-	334	40%
Tramping Lake East	162	65	-	65	40%
Upper Assiniboine	1,933	773	-	773	40%
Virden Sask	150	60	-	60	40%
Remaining Delivery Area	1,185	474	-	474	40%
Sub-total	7,538	3,015	-	3,015	40%
Nesting Tunnels (structures)					
Target Areas	-	-	-	-	-
Remaining Delivery Area	-	-	-	-	-
Sub-total	-	-	-	-	-
SK Restoration Sub-total	**1,241,059**	**326,337**	**170,088**	**496,425**	**40%**

Year 2030 Habitat Objective Acres	8-Year Objectives (Acres)			% of 2030 Habitat Objective	8-Year Direct Expenditure	8-Year Indirect Expenditure	Total 8-Year Expenditure
		Direct NAWMP	Extension NAWMP	Total				
Habitat Retention								
Wetland								
Allan Hills	9,751	3,900	-	3,900	40%	$ 780,058	$ 195,014	$ 975,072
Boundary Plateau	15,536	6,214	-	6,214	40%	$ 1,242,864	$ 310,716	$ 1,553,580
Cactus Lake	28,895	11,558	-	11,558	40%	$ 2,311,596	$ 577,899	$ 2,889,495
Conjuring Creek	16,436	6,574	-	6,574	40%	$ 1,314,886	$ 328,721	$ 1,643,607
Coteau Central	38,752	15,501	-	15,501	40%	$ 3,100,138	$ 775,034	$ 3,875,172
Coteau North	6,952	2,781	-	2,781	40%	$ 556,130	$ 139,033	$ 695,163
Coteau South	48,658	19,463	-	19,463	40%	$ 3,892,661	$ 973,165	$ 4,865,826
Dana Hills	42,192	16,877	-	16,877	40%	$ 3,375,338	$ 843,835	$ 4,219,173
Fox Valley	4,263	1,705	-	1,705	40%	$ 341,040	$ 85,260	$ 426,300
Hillmond	7,818	3,127	-	3,127	40%	$ 625,447	$ 156,362	$ 781,809
Lenore/Ponass	34,801	13,920	-	13,920	40%	$ 2,784,096	$ 696,024	$ 3,480,120
Lightning	75,358	30,143	-	30,143	40%	$ 6,028,646	$ 1,507,162	$ 7,535,808
Pheasant Hills	14,272	5,709	-	5,709	40%	$ 1,141,745	$ 285,436	$ 1,427,181
Prince Albert	12,009	4,804	-	4,804	40%	$ 960,758	$ 240,190	$ 1,200,948
Quill South	27,643	11,057	-	11,057	40%	$ 2,211,418	$ 552,854	$ 2,764,272
Regina East	21,781	8,712	-	8,712	40%	$ 1,742,446	$ 435,611	$ 2,178,057
Thickwood	23,026	9,210	-	9,210	40%	$ 1,842,070	$ 460,517	$ 2,302,587
Touchwood/Beaver	57,939	23,176	-	23,176	40%	$ 4,635,103	$ 1,158,776	$ 5,793,879
Tramping Lake East	32,331	12,932	-	12,932	40%	$ 2,586,461	$ 646,615	$ 3,233,076
Upper Assiniboine	49,775	19,910	-	19,910	40%	$ 3,982,003	$ 995,501	$ 4,977,504
Virden Sask	11,968	4,787	-	4,787	40%	$ 957,466	$ 239,366	$ 1,196,832
Remaining Delivery Area	348,092	139,237	-	139,237	40%	$ 27,847,400	$ 6,961,850	$ 34,809,250
Sub-total	**928,247**	**371,299**	**-**	**371,299**	**40%**	**$ 74,259,769**	**$ 18,564,942**	**$ 92,824,711**
*Upland ****								
Allan Hills	12,823	5,129	-	5,129	40%	$ 2,308,109	$ 512,913	$ 2,821,023
Boundary Plateau	41,375	16,550	-	16,550	40%	$ 7,447,536	$ 1,655,008	$ 9,102,544
Cactus Lake	51,003	20,401	-	20,401	40%	$ 9,180,484	$ 2,040,108	$ 11,220,592
Conjuring Creek	8,078	3,231	-	3,231	40%	$ 1,454,062	$ 323,125	$ 1,777,186
Coteau Central	7,365	2,946	-	2,946	40%	$ 1,325,698	$ 294,600	$ 1,620,298
Coteau North	7,261	2,904	-	2,904	40%	$ 1,306,940	$ 290,431	$ 1,597,372
Coteau South	28,145	11,258	-	11,258	40%	$ 5,066,062	$ 1,125,792	$ 6,191,854
Dana Hills	11,820	4,728	-	4,728	40%	$ 2,127,643	$ 472,810	$ 2,600,453
Fox Valley	3,972	1,589	-	1,589	40%	$ 714,994	$ 158,888	$ 873,882
Hillmond	1,731	692	-	692	40%	$ 311,492	$ 69,220	$ 380,712
Lenore/Ponass	12,142	4,857	-	4,857	40%	$ 2,185,565	$ 485,681	$ 2,671,247
Lightning	21,890	8,756	-	8,756	40%	$ 3,940,268	$ 875,615	$ 4,815,884
Pheasant Hills	3,431	1,373	-	1,373	40%	$ 617,639	$ 137,253	$ 754,893
Prince Albert	8	3	-	3	40%	$ 1,400	$ 311	$ 1,712
Quill South	9,281	3,712	-	3,712	40%	$ 1,670,621	$ 371,249	$ 2,041,871
Regina East	12,763	5,105	-	5,105	40%	$ 2,297,326	$ 510,517	$ 2,807,842
Thickwood	3,654	1,461	-	1,461	40%	$ 657,652	$ 146,145	$ 803,796
Touchwood/Beaver	26,404	10,562	-	10,562	40%	$ 4,752,743	$ 1,056,165	$ 5,808,909
Tramping Lake East	43,560	17,424	-	17,424	40%	$ 7,840,800	$ 1,742,400	$ 9,583,200

	Year 2030 Habitat Objective Acres	8-Year Objectives (Acres)			% of 2030 Habitat Objective	8-Year Direct Expenditure	8-Year Indirect Expenditure	Total 8-Year Expenditure
		Direct NAWMP	Extension NAWMP	Total				
Upper Assiniboine	10,317	4,127	-	4,127	40%	$ 1,857,028	$ 412,673	$ 2,269,700
Virden Sask	1,136	455	-	455	40%	$ 204,536	$ 45,452	$ 249,988
Remaining Delivery Area			-	-	-	$ -	$ -	$ -
Sub-total	318,159	127,264	-	127,264	40%	$ 57,268,600	$ 12,726,356	$ 69,994,956
SK Retention Sub-total	**1,246,406**	**498,562**	**-**	**498,562**	**40%**	**$ 131,528,369**	**$ 31,291,298**	**$162,819,667**
SK Grand Total	**2,487,464**	**824,899**	**170,088**	**994,988**	**40%**			

** An estimate of change of specific land-use types based on current, broad-scale Ag Census data*
*** Assumes small basins are primary restoration target (range 0.5-1.0 acres, average 0.75 acres)*
**** May include both tame and native grass acres. For SK this included only Native Grasslands*

Assumptions:
- *Winter wheat acres will be 15% (SK) or 20% (AB, MB) of total wheat acres prior to 2030*
- *Conversions to planted cover, hay and pasture come from cropland*
- *61% occupancy of nest tunnels and 71% nest success of occupied tunnels*
- *Projected upland habitats predicted by Ben Rashford and adjusted to incorporate 20% Winter Wheat and to include PHJV program as of 2011*
- *Wetland loss assumed to continue at 2011 rates until 2016 (AB) or 2021 (MB, SK), followed by no further wetland loss*

APPENDIX 8:
Average annual estimates of surpluses or deficits in numbers of hatched nests by province in 2020 and in 2030, with and without Prairie Habitat Joint Venture Program implementation.

Manitoba

Current Deficit/Surplus (2011)						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Alexander/Griswold	-10 (± 20)	10 (± 10)	-20 (± 10)	10 (± 10)	-20 (± 10)	10 (± 10)
Killarney	-100 (± 400)	420 (± 120)	-210 (± 90)	240 (± 60)	-760 (± 270)	220 (± 80)
Minnedosa/Shoal	80 (± 730)	-20 (± 310)	-520 (± 150)	460 (± 120)	-30 (± 450)	190 (± 140)
Virden	-620 (± 440)	300 (± 140)	-340 (± 100)	360 (± 70)	-1,250 (± 300)	320 (± 110)
Target Landscape Total	-640 (± 940)	710 (± 360)	-1,090 (± 200)	1,060 (± 150)	-2,060 (± 610)	730 (± 200)
MB Remaining Delivery Area	-810 (± 470)	1,930 (± 190)	-2,230 (± 110)	1,560 (± 60)	-3,120 (± 290)	1,050 (± 100)
Provincial Total	**-1,450 (± 1,050)**	**2,640 (± 410)**	**-3,310 (± 230)**	**2,620 (± 160)**	**-5,190 (± 670)**	**1,790 (± 220)**

Predicted Deficit/Surplus in 2030 without PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Alexander/Griswold	-10 (± 20)	10 (± 10)	-20 (± 10)	10 (± 10)	-20 (± 10)	10 (± 10)
Killarney	-590 (± 390)	240 (± 120)	-230 (± 90)	150 (± 50)	-890 (± 270)	140 (± 80)
Minnedosa/Shoal	490 (± 670)	110 (± 290)	-510 (± 150)	500 (± 110)	140 (± 420)	250 (± 140)
Virden	-940 (± 430)	180 (± 140)	-350 (± 100)	300 (± 60)	-1,300 (± 300)	250 (± 110)
Target Landscape Total	-1,050 (± 880)	530 (± 340)	-1,110 (± 200)	960 (± 140)	-2,070 (± 580)	640 (± 190)
MB Remaining Delivery Area	-2,100 (± 460)	1,470 (± 180)	-2,290 (± 110)	1,320 (± 60)	-3,400 (± 290)	800 (± 100)
Provincial Total	**-3,150 (± 1,000)**	**2,000 (± 380)**	**-3,390 (± 230)**	**2,270 (± 150)**	**-5,470 (± 650)**	**1,440 (± 210)**

Predicted Deficit/Surplus in 2030 After PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Alexander/Griswold	190 (± 20)	130 (± 10)	-10 (± 10)	20 (± 10)	20 (± 10)	30 (± 10)
Killarney	-230 (± 410)	360 (± 130)	-210 (± 90)	200 (± 50)	-780 (± 270)	200 (± 90)
Minnedosa/Shoal	2,040 (± 660)	1,260 (± 290)	-490 (± 150)	580 (± 120)	350 (± 410)	340 (± 140)
Virden	170 (± 440)	610 (± 150)	-310 (± 100)	420 (± 70)	-970 (± 310)	420 (± 110)
Target Landscape Total	2,170 (± 900)	2,350 (± 360)	-1,020 (± 200)	1,220 (± 150)	-1,380 (± 580)	990 (± 200)
MB Remaining Delivery Area	-900 (± 490)	1,960 (± 190)	-2,200 (± 110)	1,440 (± 60)	-3,160 (± 290)	1,060 (± 100)
Provincial Total	**1,270 (± 1,020)**	**4,320 (± 410)**	**-3,220 (± 230)**	**2,670 (± 160)**	**-4,540 (± 650)**	**2,040 (± 230)**

Assumptions:
- *Conversions to planted cover, hay and pasture come from cropland*
- *61% occupancy of nest tunnels and 71% nest success of occupied tunnels*
- *Projected upland habitats predicted by Ben Rashford and adjusted to incorporate 20% winter wheat and to include PHJV program as of 2011*
- *Wetland loss assumed to continue at 2011 rates until 2021, followed by no further wetland loss*
- *No winter wheat in the landscape used to create predicted deficit in 2030 without PHJV action*

Saskatchewan

Current Deficit/Surplus (2011)						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Allan Hills	1,610 (± 690)	-560 (± 270)	-610 (± 330)	410 (± 130)	1,830 (± 320)	550 (± 200)
Boundary Plateau	-400 (± 550)	-310 (± 190)	-550 (± 320)	110 (± 70)	-40 (± 120)	380 (± 100)
Cactus Lake	-1,620 (± 1,060)	-2,020 (± 480)	-1,780 (± 610)	20 (± 260)	1,290 (± 250)	870 (± 280)
Conjuring Creek	-200 (± 280)	-270 (± 150)	-300 (± 80)	80 (± 40)	300 (± 110)	-10 (± 60)
Coteau Central	3,060 (± 1,380)	-1,820 (± 530)	-2,230 (± 730)	1,270 (± 380)	3,820 (± 440)	2,020 (± 430)
Coteau North	-1,730 (± 250)	-1,250 (± 120)	-700 (± 140)	20 (± 60)	170 (± 70)	30 (± 70)
Coteau South	4,430 (± 1,520)	-260 (± 490)	-1,600 (± 760)	920 (± 450)	3,480 (± 520)	1,890 (± 460)
Dana Hills	2,760 (± 1,300)	-1,030 (± 650)	-760 (± 430)	1,060 (± 270)	2,750 (± 490)	750 (± 300)
Fox Valley	-170 (± 200)	-230 (± 70)	-420 (± 120)	20 (± 40)	350 (± 50)	120 (± 60)
Hillmond	-400 (± 390)	-1,150 (± 330)	-90 (± 70)	190 (± 80)	330 (± 80)	330 (± 70)
Lenore/Ponass	1,120 (± 860)	80 (± 500)	-460 (± 220)	340 (± 110)	990 (± 330)	160 (± 170)
Lightning	4,320 (± 2,470)	1,880 (± 850)	-2,710 (± 1,030)	2,200 (± 370)	790 (± 1,240)	2,160 (± 620)
Pheasant Hills	700 (± 350)	-40 (± 180)	-330 (± 90)	450 (± 60)	290 (± 210)	330 (± 90)
Prince Albert	-1,340 (± 720)	-950 (± 520)	-370 (± 190)	60 (± 60)	-120 (± 180)	50 (± 100)
Quill South	3,420 (± 900)	-920 (± 430)	-1,100 (± 430)	1,190 (± 190)	3,040 (± 370)	1,200 (± 270)
Regina East	-320 (± 540)	-340 (± 230)	-910 (± 260)	390 (± 90)	350 (± 260)	190 (± 130)
Thickwood	680 (± 600)	-750 (± 450)	-410 (± 180)	490 (± 120)	910 (± 140)	440 (± 110)
Touchwood/Beaver	-550 (± 1,080)	-2,290 (± 500)	-1,520 (± 400)	1,290 (± 220)	1,360 (± 600)	620 (± 280)
Tramping Lake East	150 (± 960)	-1,580 (± 480)	-1,650 (± 500)	590 (± 210)	2,260 (± 340)	540 (± 270)
Upper Assiniboine	-490 (± 780)	-730 (± 360)	-1,030 (± 250)	460 (± 110)	480 (± 450)	330 (± 200)
Virden Sask	740 (± 190)	90 (± 100)	-170 (± 50)	350 (± 40)	200 (± 120)	270 (± 50)
Target Landscape Total	15,790 (± 4,450)	-14,460 (± 1,940)	-19,680 (± 1,960)	11,910 (± 910)	24,820 (± 1,890)	13,200 (± 1,160)
SK Remaining Delivery Area	990 (± 1,780)	-23,750 (± 1,070)	-25,120 (± 780)	10,270 (± 300)	26,370 (± 490)	13,230 (± 370)
Provincial Total	**16,780 (± 4,790)**	**-38,210 (± 2,220)**	**-44,810 (± 2,110)**	**22,180 (± 960)**	**51,190 (± 1,950)**	**26,430 (± 1,220)**

Predicted Deficit/Surplus in 2030 without PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Allan Hills	2,070 (± 620)	-420 (± 260)	-540 (± 320)	420 (± 120)	1,960 (± 290)	650 (± 180)
Boundary Plateau	-230 (± 490)	-280 (± 170)	-510 (± 310)	160 (± 60)	0 (± 100)	390 (± 90)
Cactus Lake	-1,520 (± 1,020)	-1,980 (± 460)	-1,780 (± 600)	100 (± 240)	1,280 (± 230)	870 (± 260)
Conjuring Creek	-270 (± 260)	-290 (± 140)	-300 (± 80)	80 (± 40)	260 (± 100)	-20 (± 60)
Coteau Central	3,440 (± 1,330)	-1,610 (± 490)	-2,090 (± 720)	1,180 (± 340)	3,930 (± 380)	2,040 (± 400)
Coteau North	-1,930 (± 250)	-1,320 (± 120)	-700 (± 140)	-50 (± 50)	140 (± 70)	0 (± 70)
Coteau South	2,060 (± 1,550)	-840 (± 500)	-1,820 (± 760)	370 (± 460)	2,970 (± 530)	1,380 (± 470)
Dana Hills	1,980 (± 1,210)	-1,160 (± 620)	-820 (± 430)	880 (± 250)	2,510 (± 470)	570 (± 290)
Fox Valley	-110 (± 190)	-200 (± 60)	-430 (± 120)	30 (± 40)	350 (± 40)	130 (± 60)
Hillmond	-230 (± 390)	-1,100 (± 330)	-90 (± 70)	210 (± 80)	400 (± 80)	350 (± 70)
Lenore/Ponass	620 (± 830)	-150 (± 470)	-460 (± 220)	240 (± 100)	890 (± 330)	100 (± 160)
Lightning	-530 (± 2,390)	220 (± 800)	-3,000 (± 1,010)	1,440 (± 350)	-540 (± 1,270)	1,360 (± 590)
Pheasant Hills	380 (± 340)	-150 (± 170)	-330 (± 90)	380 (± 50)	190 (± 200)	280 (± 80)
Prince Albert	-1,820 (± 720)	-1,140 (± 510)	-390 (± 190)	-10 (± 60)	-230 (± 180)	-50 (± 100)
Quill South	2,240 (± 870)	-1,240 (± 420)	-1,170 (± 420)	930 (± 170)	2,760 (± 370)	960 (± 270)
Regina East	-1,220 (± 540)	-660 (± 230)	-950 (± 260)	240 (± 80)	100 (± 270)	60 (± 140)
Thickwood	580 (± 560)	-800 (± 440)	-400 (± 180)	420 (± 100)	930 (± 140)	430 (± 110)

Predicted Deficit/Surplus in 2030 without PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Touchwood/Beaver	90 (± 950)	-2,030 (± 470)	-1,490 (± 390)	1,420 (± 190)	1,440 (± 520)	750 (± 240)
Tramping Lake East	290 (± 870)	-1,600 (± 440)	-1,640 (± 490)	620 (± 180)	2,330 (± 310)	580 (± 250)
Upper Assiniboine	440 (± 690)	-270 (± 330)	-1,020 (± 250)	580 (± 100)	680 (± 390)	470 (± 180)
Virden Sask	220 (± 190)	-100 (± 90)	-190 (± 50)	270 (± 30)	40 (± 120)	200 (± 40)
Target Landscape Total	6,550 (± 4,260)	-17,140 (± 1,850)	-20,100 (± 1,940)	9,900 (± 870)	22,370 (± 1,830)	11,520 (± 1,120)
SK Remaining Delivery Area	-11,760 (± 1,760)	-27,710 (± 1,060)	-26,040 (± 770)	7,730 (± 300)	23,280 (± 490)	10,970 (± 360)
Provincial Total	**-5,210 (± 4,610)**	**-44,840 (± 2,140)**	**-46,140 (± 2,090)**	**17,630 (± 910)**	**45,650 (± 1,900)**	**22,490 (± 1,170)**

Predicted Deficit/Surplus in 2030 After PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Allan Hills	3,620 (± 610)	-40 (± 260)	-380 (± 320)	650 (± 110)	2,430 (± 250)	960 (± 180)
Boundary Plateau	310 (± 490)	-130 (± 180)	-330 (± 320)	210 (± 60)	70 (± 90)	480 (± 90)
Cactus Lake	-1,240 (± 1,030)	-1,950 (± 450)	-1,710 (± 600)	140 (± 240)	1,290 (± 220)	990 (± 270)
Conjuring Creek	80 (± 260)	-170 (± 140)	-290 (± 80)	120 (± 40)	380 (± 100)	30 (± 60)
Coteau Central	4,740 (± 1,330)	-1,290 (± 500)	-1,890 (± 720)	1,420 (± 300)	4,120 (± 380)	2,380 (± 450)
Coteau North	-1,810 (± 250)	-1,280 (± 120)	-680 (± 140)	-20 (± 50)	140 (± 60)	30 (± 70)
Coteau South	3,830 (± 1,610)	-480 (± 530)	-1,600 (± 740)	700 (± 490)	3,410 (± 520)	1,790 (± 460)
Dana Hills	2,660 (± 1,240)	-1,010 (± 620)	-760 (± 430)	1,030 (± 260)	2,700 (± 480)	710 (± 270)
Fox Valley	-20 (± 190)	-180 (± 60)	-400 (± 110)	40 (± 40)	360 (± 40)	160 (± 60)
Hillmond	-220 (± 380)	-1,110 (± 320)	-90 (± 70)	210 (± 70)	400 (± 80)	370 (± 70)
Lenore/Ponass	780 (± 860)	-90 (± 480)	-450 (± 220)	290 (± 110)	890 (± 320)	130 (± 160)
Lightning	2,400 (± 2,410)	1,140 (± 800)	-2,750 (± 1,020)	1,800 (± 340)	350 (± 1,230)	1,870 (± 560)
Pheasant Hills	860 (± 330)	40 (± 170)	-310 (± 90)	450 (± 50)	330 (± 200)	350 (± 80)
Prince Albert	-1,790 (± 720)	-1,150 (± 510)	-380 (± 190)	0 (± 60)	-230 (± 180)	-40 (± 110)
Quill South	2,920 (± 870)	-1,110 (± 430)	-1,110 (± 420)	1,040 (± 180)	2,940 (± 400)	1,160 (± 250)
Regina East	-920 (± 530)	-570 (± 240)	-930 (± 260)	280 (± 90)	190 (± 250)	110 (± 140)
Thickwood	890 (± 570)	-680 (± 430)	-380 (± 180)	480 (± 110)	980 (± 130)	500 (± 120)
Touchwood/Beaver	1,360 (± 980)	-1,650 (± 470)	-1,450 (± 390)	1,670 (± 180)	1,850 (± 500)	940 (± 250)
Tramping Lake East	1,130 (± 850)	-1,380 (± 440)	-1,560 (± 490)	780 (± 170)	2,500 (± 260)	790 (± 250)
Upper Assiniboine	1,590 (± 680)	170 (± 340)	-980 (± 250)	740 (± 100)	1,010 (± 370)	660 (± 170)
Virden Sask	520 (± 200)	20 (± 90)	-180 (± 50)	320 (± 30)	120 (± 120)	240 (± 40)
Target Landscape Total	21,690 (± 4,310)	-12,900 (± 1,860)	-18,600 (± 1,930)	12,330 (± 860)	26,230 (± 1,780)	14,630 (± 1,110)
SK Remaining Delivery Area	-580 (± 1,770)	-24,530 (± 1,070)	-24,430 (± 770)	9,330 (± 300)	25,550 (± 490)	13,490 (± 370)
Provincial Total	**21,110 (± 4,660)**	**-37,430 (± 2,150)**	**-43,020 (± 2,080)**	**21,660 (± 910)**	**51,780 (± 1,850)**	**28,120 (± 1,170)**

Assumptions:
- *Conversions to planted cover, hay and pasture come from cropland*
- *Projected upland habitats predicted by Ben Rashford and adjusted to incorporate 15% winter wheat and to include PHJV program as of 2011*
- *Wetland loss assumed to continue at 2011 rates until 2021, followed by no further wetland loss*
- *No winter wheat in the landscape used to create 'predicted deficit in 2030 without PHJV action'*

Alberta

Current Deficit/Surplus (2011)						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Arrowwood	-870 (± 240)	-120 (± 80)	-1,250 (± 160)	50 (± 30)	170 (± 30)	270 (± 70)
Beaverhill	-880 (± 750)	-1,150 (± 580)	-660 (± 260)	310 (± 110)	200 (± 180)	410 (± 110)
Bellshill	-2,620 (± 840)	-2,640 (± 470)	-1,350 (± 450)	200 (± 180)	330 (± 220)	830 (± 210)
Big Hay/Bittern	-2,060 (± 670)	-1,470 (± 460)	-910 (± 280)	60 (± 110)	50 (± 170)	210 (± 110)
Buffalo Lake	-1,600 (± 430)	-1,100 (± 260)	-700 (± 180)	140 (± 90)	-230 (± 110)	290 (± 100)
Calgary East	-180 (± 170)	110 (± 60)	-620 (± 100)	60 (± 30)	130 (± 30)	140 (± 50)
Calgary West	-510 (± 260)	160 (± 90)	-1,160 (± 160)	80 (± 40)	220 (± 30)	190 (± 70)
Clear Lake	-90 (± 60)	20 (± 30)	-280 (± 40)	40 (± 10)	40 (± 10)	90 (± 20)
Cypress	20 (± 40)	-20 (± 20)	-60 (± 20)	20 (± 10)	30 (± 10)	60 (± 20)
Derwent	-370 (± 200)	-460 (± 160)	-130 (± 60)	90 (± 40)	-10 (± 40)	140 (± 40)
Eastern Plains	1,660 (± 1,740)	-380 (± 640)	-2,270 (± 930)	200 (± 320)	1,260 (± 350)	2,860 (± 560)
Eastern Irrigation District	110 (± 230)	-100 (± 90)	-450 (± 140)	100 (± 40)	210 (± 30)	350 (± 80)
Jenner Plains	70 (± 130)	-40 (± 50)	-150 (± 60)	40 (± 30)	70 (± 20)	150 (± 50)
Kenilworth	-980 (± 490)	-1,370 (± 400)	-280 (± 140)	170 (± 100)	110 (± 110)	380 (± 80)
Milk River Ridge	30 (± 240)	-150 (± 90)	-700 (± 150)	300 (± 30)	190 (± 20)	390 (± 60)
Owlseye						
Pakowki	-300 (± 390)	-330 (± 120)	-910 (± 270)	330 (± 50)	110 (± 30)	500 (± 80)
Pine Lake	-1,430 (± 190)	-590 (± 110)	-490 (± 90)	-80 (± 40)	-210 (± 50)	-50 (± 50)
Sullivan Lake	-2,050 (± 960)	-1,720 (± 460)	-1,610 (± 410)	420 (± 210)	-220 (± 250)	1,080 (± 300)
Vermillion/Viking	-1,990 (± 1,400)	-3,220 (± 1,070)	-1,500 (± 550)	530 (± 240)	1,030 (± 330)	1,160 (± 240)
Wintering Hills	-60 (± 530)	40 (± 190)	-1,460 (± 320)	200 (± 90)	460 (± 90)	710 (± 180)
Target Landscape Total	-14,090 (± 2,970)	-14,520 (± 1,700)	-16,920 (± 1,420)	3,250 (± 540)	3,940 (± 660)	10,160 (± 770)
Remaining Delivery Area	-24,220 (± 3,020)	-19,070 (± 1,730)	-30,820 (± 1,430)	7,050 (± 490)	3,860 (± 610)	14,760 (± 750)
Provincial Total	**-38,310 (± 4,240)**	**-33,590 (± 2,420)**	**-47,750 (± 2,010)**	**10,300 (± 730)**	**7,790 (± 900)**	**24,930 (± 1,070)**

Predicted Deficit/Surplus in 2030 without PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Arrowwood	-1,080 (± 240)	-200 (± 80)	-1,270 (± 160)	20 (± 30)	140 (± 30)	220 (± 70)
Beaverhill	-860 (± 740)	-1,130 (± 570)	-660 (± 260)	320 (± 110)	190 (± 170)	420 (± 110)
Bellshill	-2,350 (± 840)	-2,550 (± 490)	-1,320 (± 450)	220 (± 180)	430 (± 220)	870 (± 200)
Big Hay/Bittern	-1,890 (± 670)	-1,400 (± 460)	-900 (± 280)	70 (± 110)	110 (± 160)	240 (± 110)
Buffalo Lake	-1,520 (± 430)	-1,070 (± 270)	-690 (± 180)	130 (± 90)	-190 (± 110)	300 (± 100)
Calgary East	-260 (± 160)	80 (± 60)	-620 (± 100)	40 (± 30)	120 (± 30)	130 (± 50)
Calgary West	-430 (± 270)	160 (± 90)	-1,150 (± 160)	80 (± 40)	250 (± 30)	210 (± 70)
Clear Lake	-110 (± 60)	10 (± 20)	-280 (± 40)	40 (± 10)	40 (± 10)	90 (± 20)
Cypress	50 (± 40)	-10 (± 10)	-50 (± 20)	20 (± 10)	40 (± 0)	60 (± 10)
Derwent	-420 (± 190)	-480 (± 160)	-130 (± 60)	90 (± 40)	-30 (± 40)	130 (± 40)
Eastern Plains	4,620 (± 1,600)	320 (± 590)	-1,880 (± 920)	520 (± 300)	2,010 (± 310)	3,650 (± 540)
Eastern Irrigation District	150 (± 220)	-90 (± 90)	-450 (± 140)	90 (± 40)	220 (± 30)	380 (± 70)
Jenner Plains	270 (± 110)	10 (± 40)	-130 (± 60)	60 (± 20)	110 (± 20)	220 (± 40)
Kenilworth	-1,080 (± 480)	-1,440 (± 390)	-280 (± 130)	150 (± 90)	110 (± 110)	380 (± 80)
Milk River Ridge	-110 (± 240)	-210 (± 90)	-700 (± 150)	280 (± 30)	170 (± 20)	350 (± 60)
Owlseye						
Pakowki	-590 (± 400)	-420 (± 120)	-960 (± 270)	280 (± 60)	90 (± 30)	420 (± 90)

Predicted Deficit/Surplus in 2030 without PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Pine Lake	-1,420 (± 190)	-580 (± 100)	-490 (± 90)	-90 (± 40)	-210 (± 50)	-40 (± 50)
Sullivan Lake	-1,330 (± 900)	-1,540 (± 440)	-1,500 (± 420)	510 (± 190)	-40 (± 230)	1,240 (± 280)
Vermillion/Viking	-2,170 (± 1,370)	-3,310 (± 1,040)	-1,510 (± 550)	490 (± 240)	1,020 (± 320)	1,140 (± 250)
Wintering Hills	110 (± 510)	120 (± 180)	-1,430 (± 320)	200 (± 80)	470 (± 80)	760 (± 150)
Target Landscape Total	**-10,320 (± 2,850)**	**-13,700 (± 1,660)**	**-16,410 (± 1,420)**	**3,530 (± 510)**	**5,060 (± 620)**	**11,200 (± 750)**
Remaining Delivery Area	-26,790 (± 2,950)	-20,140 (± 1,710)	-30,940 (± 1,420)	6,310 (± 470)	3,770 (± 590)	14,210 (± 710)
Provincial Total	**-37,110 (± 4,100)**	**-33,840 (± 2,380)**	**-47,360 (± 2,000)**	**9,840 (± 700)**	**8,820 (± 860)**	**25,410 (± 1,030)**

Predicted Deficit/Surplus in 2030 After PHJV Action						
Target Landscape	**All Dabbler**	**MALL**	**NOPI**	**GADW**	**BWTE**	**NSHO**
Arrowwood	80 (± 260)	210 (± 90)	-1,120 (± 160)	150 (± 40)	310 (± 30)	530 (± 80)
Beaverhill	30 (± 770)	-830 (± 610)	-620 (± 260)	460 (± 120)	440 (± 170)	580 (± 120)
Bellshill	-230 (± 910)	-1,920 (± 510)	-1,180 (± 450)	570 (± 200)	940 (± 210)	1,360 (± 250)
Big Hay/Bittern	-470 (± 730)	-910 (± 490)	-830 (± 280)	290 (± 130)	500 (± 170)	480 (± 130)
Buffalo Lake	40 (± 460)	-520 (± 280)	-610 (± 180)	360 (± 90)	180 (± 130)	630 (± 130)
Calgary East	-60 (± 160)	150 (± 60)	-610 (± 100)	90 (± 30)	140 (± 30)	190 (± 50)
Calgary West	-20 (± 280)	310 (± 100)	-1,110 (± 160)	130 (± 40)	320 (± 40)	320 (± 80)
Clear Lake	0 (± 60)	50 (± 30)	-280 (± 40)	60 (± 10)	50 (± 10)	120 (± 20)
Cypress	60 (± 40)	-10 (± 20)	-60 (± 20)	20 (± 10)	40 (± 10)	70 (± 20)
Derwent	10 (± 200)	-350 (± 170)	-110 (± 60)	170 (± 40)	80 (± 50)	220 (± 40)
Eastern Plains	5,290 (± 1,630)	450 (± 610)	-1,690 (± 920)	590 (± 300)	2,070 (± 320)	3,860 (± 520)
Eastern Irrigation District	260 (± 230)	-50 (± 90)	-440 (± 140)	110 (± 40)	240 (± 40)	400 (± 70)
Jenner Plains	280 (± 110)	20 (± 40)	-130 (± 60)	60 (± 20)	110 (± 20)	230 (± 40)
Kenilworth	-480 (± 530)	-1,280 (± 410)	-240 (± 140)	280 (± 100)	260 (± 120)	510 (± 110)
Milk River Ridge	250 (± 240)	-90 (± 90)	-650 (± 150)	330 (± 30)	210 (± 20)	450 (± 60)
Owlseye						
Pakowki	870 (± 390)	-20 (± 120)	-560 (± 280)	460 (± 50)	210 (± 30)	780 (± 90)
Pine Lake	-80 (± 210)	-20 (± 120)	-450 (± 90)	80 (± 40)	130 (± 60)	180 (± 60)
Sullivan Lake	-220 (± 910)	-1,240 (± 430)	-1,410 (± 420)	680 (± 200)	180 (± 220)	1,560 (± 310)
Vermillion/Viking	-1,150 (± 1,460)	-2,980 (± 1,070)	-1,440 (± 550)	670 (± 250)	1,230 (± 340)	1,370 (± 270)
Wintering Hills	250 (± 520)	170 (± 190)	-1,430 (± 320)	240 (± 80)	470 (± 90)	810 (± 160)
Target Landscape Total	**4,700 (± 2,970)**	**-8,870 (± 1,720)**	**-14,950 (± 1,430)**	**5,790 (± 540)**	**8,100 (± 650)**	**14,630 (± 780)**
Remaining Delivery Area	-7,960 (± 3,060)	-13,800 (± 1,770)	-28,820 (± 1,450)	8,890 (± 500)	7,060 (± 620)	18,710 (± 780)
Provincial Total	**-3,260 (± 4,270)**	**-22,670 (± 2,470)**	**-43,770 (± 2,030)**	**14,680 (± 730)**	**15,150 (± 900)**	**33,340 (± 1,100)**

Assumptions:
- *Conversions to planted cover, hay and pasture come from cropland*
- *Projected upland habitats predicted by Ben Rashford and adjusted to incorporate 20% winter wheat and to include PHJV program as of 2011*
- *Wetland loss assumed to continue at 2011 rates until 2016, followed by no further wetland loss*
- *No winter wheat in the landscape used to create 'predicted deficit in 2030 without PHJV action'*

APPENDIX 9:
First generation decision support tool for informing marshbird conservation within the Prairie Habitat Joint Venture area.

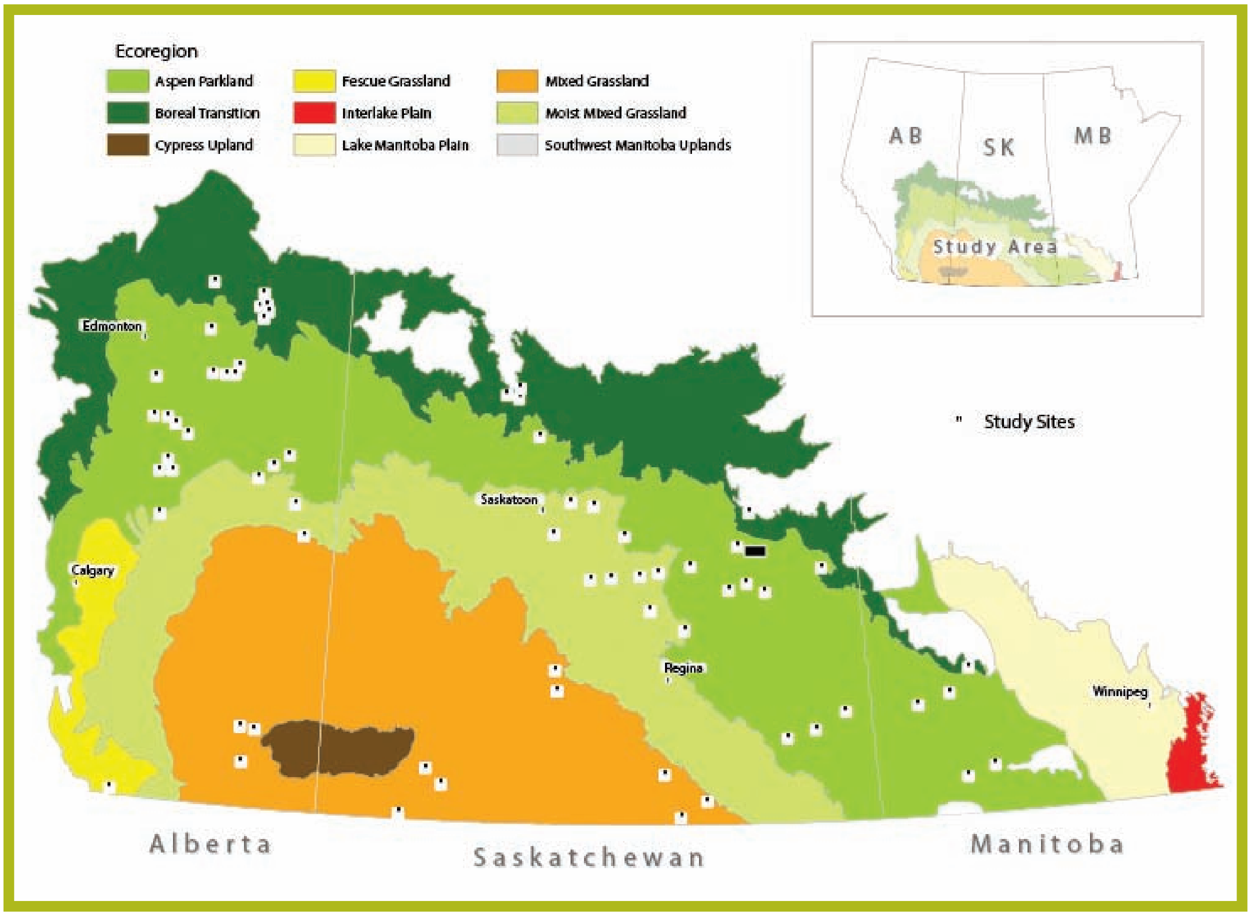
Development of waterbird models

During 2008-2012, a large-scale project was conducted within the Prairie Habitat Joint Venture (PHJV) area to link the occurrence/abundance of wetland-associated migratory birds to habitat characteristics at different spatial scales. Spatially indexed resource inventories of birds and habitats are needed for assessing the value of current conservation programs to other bird groups and, going forward, to advance the biological foundation from which to base all-bird landscape-conservation planning. These first-generation species-habitat models were used in conjunction with geographic information system (GIS) software to produce species-specific 'thunderstorm' maps showing the predicted occurrence or abundance of selected waterbird species in relation to land-cover attributes.

To garner the information needed to model species-habitat relationships for wetland-associated birds, sampling occurred within the 5 largest ecoregions at 1,115 wetlands within 67 study sites located throughout the PHJV delivery area (Figure A9-1). Sampling was further stratified by upland perennial cover categories (e.g., annual crop, hayland, natural cover and planted nesting cover) and wetlands were randomly selected for targeted sampling. Approximately half of all study sites and wetland stations were located in the aspen parkland ecoregion, while the remainder were split almost equally between boreal transition, moist-mixed grassland and mixed grassland. Only one study area was located in fescue grassland, a small ecoregion along the western edge of the prairie and

FIGURE A9-1

Map of the Prairie Habitat Joint Venture delivery area showing ecoregion boundaries and study site locations where sampling for wetland-associated birds occurred during 2008-2012.



parkland area. We sampled 1,430 survey stations that were located at the marsh-upland interface along 1,115 wetlands, conducting ~7,700 point counts in efforts to detect wetland-associated birds. All survey stations were visited 3-7 times throughout the breeding season.

Quantification of landscape-level habitat variables was accomplished using GIS and the thematic land-cover classification *Land Cover for Agricultural Regions of Canada, circa 2000* (hereafter, AAFC Land Cover), published by Agriculture and Agri-Food Canada; this served as the primary source for extraction of covariate values that were used to model marshbird occurrence and abundance in the PHJV area. This product is derived from Landsat 5 Thematic Mapper and Landsat 7 Enhanced Thematic Mapper multi-spectral imagery by inputting imagery and ground-reference training data into a decision tree or supervised image classification process. The AAFC Land Cover incorporates imagery dating from 1996 to 2005, however, 80% of this comes from imagery 1999 to 2001. While the AAFC Land Cover product is published and compiled by AAFC, it also integrates products mapped by other provincial and federal agencies. Integrated products relevant to our work include *The Earth Observation for Sustainable Development of Forests (EOSD) Land Cover, circa 2000* published by Natural Resources Canada, Canadian Forest Service and *LANDSAT-based Land Use/Land Cover for the Agro-region of Manitoba* published by the Manitoba Remote Sensing Centre (Agriculture and Agri-Food Canada).

AAFC Land Cover data were downloaded from the Government of Canada's Open Data Portal [http://data.gc.ca/data] for UTM Zones 11-14. These separate raster datasets were mosaicked to create a single raster for subsequent processing. Following review of the classification scheme of the AAFC Land Cover, we decided to merge certain classes prior to further processing or analysis. Classification schemes of the original and merged products are given in Table A9-1.

TABLE A9-1

Land-cover types and descriptions of the Land Cover for Agricultural Regions of Canada, circa 2000 classification (AAFC Land Cover).

Land Cover Class	Description	Merged[1] Land Cover Class
Water	Water bodies (lakes, reservoirs, rivers, streams, salt water)	Water
Wetland	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes (semi-permanent or permanent wetland vegetation, including fens, bogs, swamps, sloughs, marshes)	Wetland
Exposed Land	Predominately non-vegetated and non-developed, includes exposed lands, bare soil, snow, glacier, rock, sediments, burned areas, rubble, mines, other naturally occurring non-vegetated surfaces	Non-vegetated
Built-up	Land predominantly built-up or developed including vegetation associated with these cover conditions, may include road surfaces, railway surfaces, buildings and paved surfaces, urban areas, parks, industrial sites, mine structures, farmsteads and may also include golf courses	
Cultivated Agricultural Land	Annually cultivated cropland and woody perennial crops, includes annual field crops, vegetables, summer fallow, orchards and vineyards	Cropland
Annual Cropland	Fall seeded crops such as winter wheat may be erroneously identified in this class (grasslandsand shrublands may be delineated within in this class)	
Grassland, Native	Predominantly native grasses and other herbaceous vegetation, may include some shrubland cover, also land used for range or native unimproved pasture may appear in this class	Grassland/Pasture
Perennial Cropland and Pasture	Periodically cultivated cropland includes tame grasses and other perennial crops such as alfalfa and clover grown alone or as mixtures for hay, pasture or seed	
Shrubland	Predominantly woody vegetation of relatively low height (generally +/-2 meters) and may include grass or grassland wetlands with woody vegetation, regenerating forest	Woodland
Coniferous Forest	Predominantly coniferous forests or treed areas, may include mixed forests and shrubland areas	
Deciduous Forest	Predominantly broadleaf/deciduous forests or treed areas, may include mixed forests and shrubland areas	
Mixed Forest Description	Mixed coniferous and broadleaf/deciduous forests or treed areas	

[1] *Merged classes are those considered in models to describe the distribution and abundance of marsh bird species in the PHJV delivery area*

Landscape habitat variables were considered at three spatial scales: regional scale, local scale (i.e. 4x4 mile study site) and quarter-section scale. At the regional scale we considered ecoregion, variables related to ponds (e.g., wetland basins/km^2, total wetland area, average wetland size) and the Canada Land Inventory — Land Capability for Waterfowl (Natural Resources Canada 2002; hereafter CLI Waterfowl). Regional scale variables were seen to represent the underlying ecological potential of the landscape. Ecoregions cover relatively large areas of land and contain characteristic assemblages of natural communities and species; CLI Waterfowl Classes are assigned based on known or extrapolated information on parent material, soil profile, depth, moisture, fertility, landform, climate and vegetation cover generated from field surveys and interpretation of aerial photography; and 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.

The pond count covariate was derived from the Waterfowl Breeding Population and Habitat Survey. Pond count data were downloaded from the U.S. Fish and Wildlife Service's Migratory Bird Data Center for years 1961 (when annual ground work began to provide a correction factor for aerial counts) through 2012 for survey strata that intersect the PHJV Delivery Area. Pond data (count per year per survey strata segment) were compiled and organized in a Microsoft Access Database. In addition to compilation of yearly pond counts per strata segment, we calculated a standardized pond count for each year in which sampling occurred (2008-2012) for each segment. Standardized pond count was calculated as the pond count in year i minus the median value of counts for segment g for years 1961-2012. The standardized pond count serves as a relative wetness measure accounting for the differences in the range of pond counts among segments and permitting a comparison of wetness that is adjusted and relative to the potential (i.e., number of basins) for a given segment. Standardized pond count values were assigned to a GIS shapefile layer of centroids of each strata segment. Universal Kriging was used to fit a spatially dependent model to the standardized pond count centroid layer for each year to create a predictive year-specific standardized count raster surface. During the Kriging process, the Optimize Model option was selected; here a cross validation method is used to adjust the Bandwidth and Searching Neighborhood to find the model structure with the best fit. For all years, an exponential kernel function provided the optimal goodness of fit.

Adjusted wetland count and adjusted wetland area were also explored as covariates in decision-support system models. Spatial GIS layers for these variables were provided by Ducks Unlimited Canada's (DUC) Institute for Wetland and Waterfowl Research (IWWR)). The Adjusted wetland count and wetland area data originate from CanVec digital topographic dataset according to the National Topographic System (Natural Resources Canada, 2012), but have been adjusted to account for inaccurate precision and accuracy of wetland data in the original CanVec product. To achieve the adjusted wetland count and area, wetland data from CanVec and selected DUC projects were modeled against slope gradient, [soil] available water holding capacity, soil drainage class and number of small basins to calculate province-specific wetland count and area adjustment factors. Adjustment factors were then applied to CanVec wetland layers across the region to create the adjustment wetland count and area surfaces. In addition to adjusted wetland count and area, we calculated a third wetland variable from the adjusted wetland database: average wetland size. Average wetland size was calculated as the adjusted wetland area divided by the adjusted wetland count; the digital version of this variable was produced using the adjustment wetland variables in the *Raster Calculator* using the same formula.

At a more local landscape scale (i.e., 4x4-mile study site) we considered total crop area and total grass/pasture area. Agriculture is predominant throughout much of the PHJV area and lands that are in annual crop generally do not serve as habitat for most species of marshbirds. Areas that are not in annual crop typically have remnant natural habitat, or other forms of perennial cover (e.g., hayland, pasture) that are more apt to serve as habitat. As such, we predicted a negative to neutral relationship between total crop area and bird abundance, and we predicted that abundance would increase with total wetland area.

At the quarter-section scale we considered quantifiable attributes that characterized major differences in the amount and structure of natural land cover; this included total area in emergent vegetation, open water, grass, woody vegetation and crop. Grass and woodland provide a measure of the openness and vertical structure, respectively, of habitats adjacent to wetlands, and emergent vegetation and open water provide detail about the amount and type of wetland habitat.

Hypotheses and model evaluation

Prior to examining relationships between abundance (λ), or 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.

Ecoregions differ in their plant assemblages and geography, which influence key features such as land cover and overall amount of wetland habitat. It was anticipated for abundance of all species to vary by ecoregion, so ecoregion and moisture variables were considered at the largest spatial scale. The overall amount of wetland habitat varies by ecoregions, but there is also substantial spatial variation in wetland habitat within ecoregions, particularly related to longitude with higher pond counts in the eastern portion of the PHJV area. As such, landscape-level variation in moisture was considered in models as variables such as pond count per square kilometer, amount of wetland area, average wetland size, and an annual wetness index as potential factors influencing species occurrence or abundance.

At the intermediate study-site level the amount of area in crop and grassland/pasture were variables that were tested. Wetland draining for agriculture is thought to be a primary factor behind earlier declines in abundance for waterbirds and waterfowl in the Prairie Region. Therefore, crop cover and grass/pasture cover at the site level were included to reflect variation in the intensity of agriculture; it was predicted that all species would show a negative relationship with crop cover due to less plant diversity and a general loss of wetlands in areas of higher agriculture, and a positive relationship with grass/pasture cover because of greater diversity in plant cover and an overall less-modified landscape.

Variables at the quarter-section scale were used to test relationships with wetland cover type (open water and emergent vegetation) and the surrounding upland cover. Although several habitat variables were measured at this scale, we focused on relationships with the cover of emergent vegetation, open water, grasslands (including hay and tame pasture), woody vegetation and crop. Considered together, these variables describe preferences for wetland type (shallow marshy wetlands with high emergent vegetation cover versus open deeper wetlands) and the type of upland habitat in which the wetlands were embedded (open habitats versus shrub or wooded areas). While it was expected that species would be similar in their habitat associations at landscape and site scales, we anticipated different relationships to emerge at the quarter and pond scales depending on the behavior and life history characteristics of each species.

Mapping species occupancy and abundance model results

Equations for occurrence and abundance models for each focal species were implemented into the GIS by combining model coefficients (Tables A9-2 and A9-4) with appropriate land cover and other spatial raster layers to solve for the dependent variable in each map pixel using the *Raster Calculator*. For occurrence models, the inverse logistic transformation, $exp(y) / (1+exp(y))$, was then applied to obtain a probability of encounter of that species for each pixel.

During review of abundance maps, we noticed extreme predicted abundance values for several species. Through examination of these values and consultation with PHJV partners, it became evident that high abundances were a result of extreme values of underlying spatial layers that were included in the model; in particular, wetland count, wetland area and average wetland size covariates. Because the extreme values were unrealistic and the wide range in abundances in the maps made it impossible to see the variation in abundance at lower (and reasonable) values, the upper abundance values for some species were capped to more realistic values. We used the following criteria to cap abundances: 1) the maximum abundance predicted at sample stations plus one standard deviation (applied to models for American bittern, Nelson's sparrow, sora, Virginia rail and Wilson's snipe), or 2) the mean abundance predicted at sample stations plus one standard deviation (applied to models for American coot, eared grebe, horned grebe, pied-billed grebe and red-necked grebe).

Mapping multispecies occurrence and abundance maps

Multispecies probability of occupancy and abundance maps were created to develop visual tools to highlight areas where probability of occurrence or abundance of wetland-associated birds was predicted to be particularly high. Multispecies layers were created by summing probability of occupancy or abundance raster layers for each species using the *Raster Calculator*. Because several species still displayed very high and unrealistic predicted abundance (even after capping upper values), it was decided to only include four species in the multispecies abundance map: American bittern, sora, Virginia rail and Nelson's sparrow.

Results

Abundance models

Landscape variables at two or three spatial scales were supported as important predictors of bird abundance. All species differed in abundance by ecoregion (Table A9-2). Most species showed similar association at the larger spatial scale and had weak relationships with wetland-related variables. CLI Waterfowl was only supported as a predictor variable within the model structure for the American bittern, and the relationship was negative.

At the intermediate study site scale, five species showed a selection for habitat characteristics. Abundances of American bitterns and sora were positively related to study site grass/pasture, whereas abundances of American coot, eared grebe and horned grebe were positively related to the amount of crop. Eared grebe abundance was positively related to open water but negatively related to grass/pasture; eared grebe is a difficult species for which to infer generalizations regarding distribution in relation to habitat preferences because this species is a colonial nester with an ephemeral distribution and site selection may also be determined by sociality.

For most species habitat associations were more distinct at the quarter section (Table A9-3), suggesting that habitat characteristic at the quarter-section level were more influential than at the study site level. Quarter sections with grass/pasture and wetlands having a mixture of emergent vegetation and open water appear to support more diverse communities of wetland-associated birds as abundance was associated with these landscape features for seven species. Abundances of Nelson's sparrow and Wilson's snipe were greater in areas with shallow wetlands having emergent vegetation, as inferred from the positive relationship with wetland areas and the negative relationship with open water areas. Abundances of American coot and pied-billed grebe were negatively associated with woodland areas, which indicates that abundance declines with encroachment by woody vegetation.

Occupancy models

Similar to results from abundance models, species occupancy varied by ecoregion (Table A9-4). Most species showed similar associations and had weak relationships with wetland-related variables at the larger spatial scale. Similar to abundance models, CLI Waterfowl was not a good predictor variable for waterbird occupancy.

Six species showed an association with grassland/pasture or crop at the intermediate scale (Table A9-5). Occupancy probability of American bittern, Nelson's sparrow and Virginia rail was positively related to grass/pasture at the study site scale; whereas, occupancy probability of American coot, horned grebe and Wilson's Snipe was positively related to crop. Eared crebe occupancy was negatively related to grass/pasture at the study-site scale, but this result should be viewed with caution because eared grebes nest in colonies that may not occur at specific locations every year.

For most species the relationship between occupancy probability and habitat characteristics were more distinct at the quarter section scale, a result that is consistent with results from abundance models. From a conservation-delivery perspective this is an encouraging result because land is typically purchased and managed/used at the quarter-section scale. Occupancy probability of five species was positively related to the amount of wetland habitat, and only the red-necked grebe was negatively related to amount of wetland habitat (i.e., shallow marsh with emergent vegetation) as this species showed a strong preference for larger, permanent wetlands with open water. Occupancy probabilities of American coot, pied-billed grebe and Virginia rail were negatively associated with the amount of woody vegetation.

Maps of predicted abundances and wetland occupancy by marsh birds

As explained above, coefficients obtained by modeling abundances or occupancy against landscape and habitat variables were linked to land-cover maps to predict the abundance of occurrences of marshbird species. These map products are shown below, after Table A9-5.

References

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TABLE A9-2

Parameter estimates (standard error) of variables in the best-approximating habitat-abundance association model for several marshbird species.

	AMBI	AMCO	EAGR	HOGR	NESP	PBGR	RNGR	SORA	VIRA	WISN
Aspen Parkland	0.35(1.00)	1.19(0.23)	-4.67(0.75)	0.58(0.62)	0.97(0.49)	-0.59(0.50)	-1.86(0.40)	1.46(0.24)	-2.21(0.87)	2.95(0.20)
Boreal Transition	-0.39(0.28)	0.05(0.14)	-1.19(0.58)	-0.38(0.37)	0.28(0.22)	0.21(0.20)	0.68(0.27)	0.16(0.10)	-0.27(0.40)	-0.45(0.13)
Fescue Grassland	-12.78(251)	0.29(0.35)	-0.71(1.15)	-0.49(0.83)	-2.02(1.09)	-1.29(0.69)	-1.79(1.16)	-0.68(0.28)	-8.60(44.7)	1.27(0.26)
Mixed Grassland	-1.19(0.44)	-0.05(0.16)	2.04(0.54)	0.44(0.38)	-1.25(0.33)	-0.89(0.27)	-3.86(0.93)	-0.67(0.13)	-1.34(0.56)	-0.97(0.18)
Moist Mixed Grassland	-2.86(0.65)	0.46(0.16)	0.01(0.63)	0.94(0.46)	-0.58(0.31)	0.03(0.23)	-0.04(0.33)	-0.35(0.12)	-0.93(0.53)	-1.15(0.18)
Wetness	0.02(0.01)	0.00(0.00)	-0.01(0.01)	-0.02(0.01)	0.01(0.00)	0.00(0.00)	0.02(0.00)	0.01(0.00)	0.02(0.01)	0.00(0.00)
Adjusted Wetland Count	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
Total Wetland Area	0.00(0.01)	0.01(0.01)	0.07(0.03)	-0.01(0.02)	0.02(0.01)	0.02(0.01)	0.03(0.02)	0.00(0.01)	0.03(0.03)	0.02(0.01)
Avg. Wetland Size	0.01(0.01)	0.02(0.01)	0.00(0.03)	0.02(0.02)	0.00(0.01)	0.03(0.02)	0.00(0.02)	0.00(0.00)	-0.04(0.04)	0.00(0.00)
Waterfowl Capability	-0.22(0.10)									
Sec Crop		0.03(0.01)	0.13(0.03)	0.03(0.02)						
Sec Grassland/Pasture	0.07(0.02)							0.02(0.01)		
Qrt Wetland			17.29(5.01)		5.03(1.84)					3.14(1.23)
Qrt Open Water			16.45(6.24)		-5.76(2.54)		27.04(3.82)	-7.21(1.20)		-8.32(1.51)
Qrt Wood		-3.12(0.76)				-2.07(1.12)				
Qrt Grassland/Pasture				-2.06 (1.11)	2.70 (0.67)				3.14(1.14)	
Qrt Crop										

TABLE A9-3

Habitat-abundance associations for several marshbird species: (+) or (-) indicates a weak effect, with 95% CIs that overlap zero, (++) or (--) indicates an effect with 95% CIs that do not overlap zero.

	AMBI	AMCO	EAGR	HOGR	NESP	PBGR	RNGR	SORA	VIRA	WISN
Ecoregion	+	+	+	+	+	+	+	+	+	+
Wetness	+	+	-	-	++	+	++	++	+	+
Pond Count	+	+	+	+	+	+	+	+	+	+
Total Wetland Area	+	+	++	-	+	+	+	+	+	+
Avg. Wetland Size	+	+	+	+	+	+	+	+	-	+
Waterfowl Capability	--									
Sec Crop		++	++	+						
Sec Grassland/Pasture	++							+		
Qrt Wetland			++		++					++
Qrt Open Water			++		--		++	--		--
Qrt Wood		--				-				
Qrt Grassland/Pasture				-	++				++	
Qrt Crop										

TABLE A9-4

Parameter estimates (standard error) of variables in the best-approximating habitat-occupancy association model for several marshbird species. A positive sign for ecoregion indicates an effect of this parameter on occupancy.

	AMBI	AMCO	EAGR	HOGR	NESP	PBGR	RNGR	SORA	VIRA	WISN
Aspen Parkland	-1.83(0.61)	-1.52(0.23)	-2.27(0.43)	-2.97(0.38)	-1.37(0.34)	-2.32(0.23)	-4.05(0.38)	-0.14(0.17)	-2.55(0.55)	0.68(0.28)
Boreal Transition	-0.25(0.32)	-0.13(0.17)	-1.60(0.55)	-0.44(0.32)	0.23(0.25)	-0.02(0.21)	0.34(0.28)	0.46(0.18)	0.02(0.38)	-0.32(0.21)
Fescue Grassland	-7.83(22.0)	-0.21(0.39)	1.04(0.68)	-0.43(0.75)	-1.78(1.04)	-2.29(1.03)	-1.13(1.06)	-0.39(0.39)	-6.21(13.1)	6.52(12.5)
Mixed Grassland	-2.58(0.66)	-0.56(0.19)	1.58(0.36)	0.38(0.28)	-1.70(0.40)	-1.17(0.30)	-4.16(1.15)	-0.63(0.18)	-1.68(0.57)	-1.35(0.26)
Moist Mixed Grassland	-3.63(0.80)	-0.04(0.19)	0.16(0.46)	0.90(0.29)	-0.91(0.35)	0.07(0.24)	0.41(0.37)	0.10(0.22)	-1.40(0.53)	-1.70(0.30)
Wetness	0.03(0.01)	0.01(0.00)	-0.01(0.01)	-0.01(0.00)	0.01(0.00)	0.00(0.00)	0.02(0.01)	0.02(0.00)	0.02(0.01)	0.00(0.00)
Pond Count	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	-0.01(0.00)
Total Wetland Area	-0.02(0.02)	0.02(0.01)	0.03(0.02)	0.01(0.02)	0.02(0.01)	0.02(0.01)	0.06(0.02)	0.02(0.01)	0.03(0.02)	0.05(0.01)
Avg. Wetland Size	0.03(0.02)	0.01(0.01)	-0.04(0.03)	-0.01(0.02)	0.00(0.01)	0.02(0.01)	-0.02(0.02)	0.00(0.01)	-0.04(0.03)	0.00(0.02)
Waterfowl Capability	-0.16(0.12)		0.00(0.00)					-0.01(0.00)		
Sec Crop		0.05(0.01)		0.06(0.02)						0.03(0.01)
Sec Grassland/Pasture	0.09(0.02)		-0.09(0.03)		0.06(0.02)				0.05(0.03)	
Qrt Wetland	6.97(3.17)		11.24(3.76)	4.13(1.75)	7.66(2.61)		-11.50(4.36)			12.27(6.69)
Qrt Water			13.36(3.04)		-7.72(2.80)		24.94(3.31)	-11.37(1.90)		-15.40(2.59)
Qrt Wood		-4.46(0.94)				-2.52(1.19)			-9.02(2.94)	
Qrt Grassland/Pasture										
Qrt Crop										

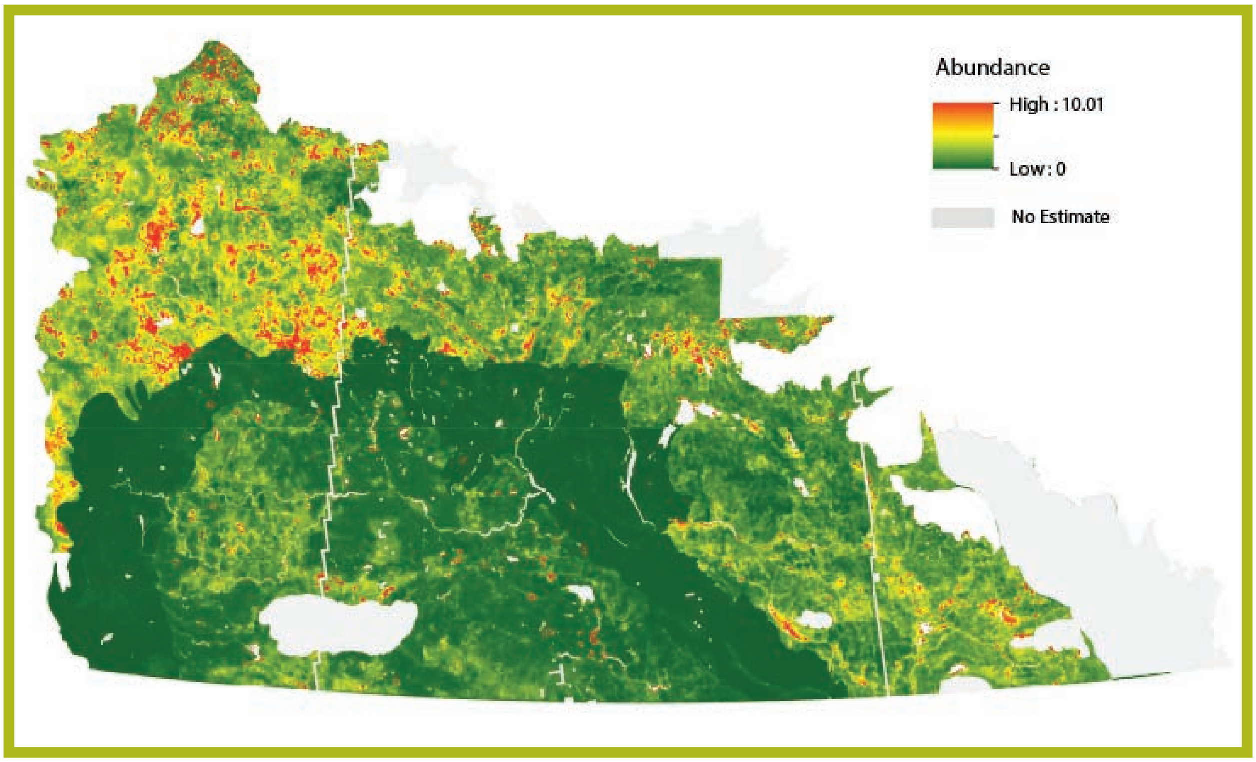
TABLE A9-5

Habitat-abundance associations for several marshbird species: (+) or (-) indicates a weak effect, with 95% CIs that overlap zero, (++) or (--) indicates an effect with 95% CIs that do not overlap zero.

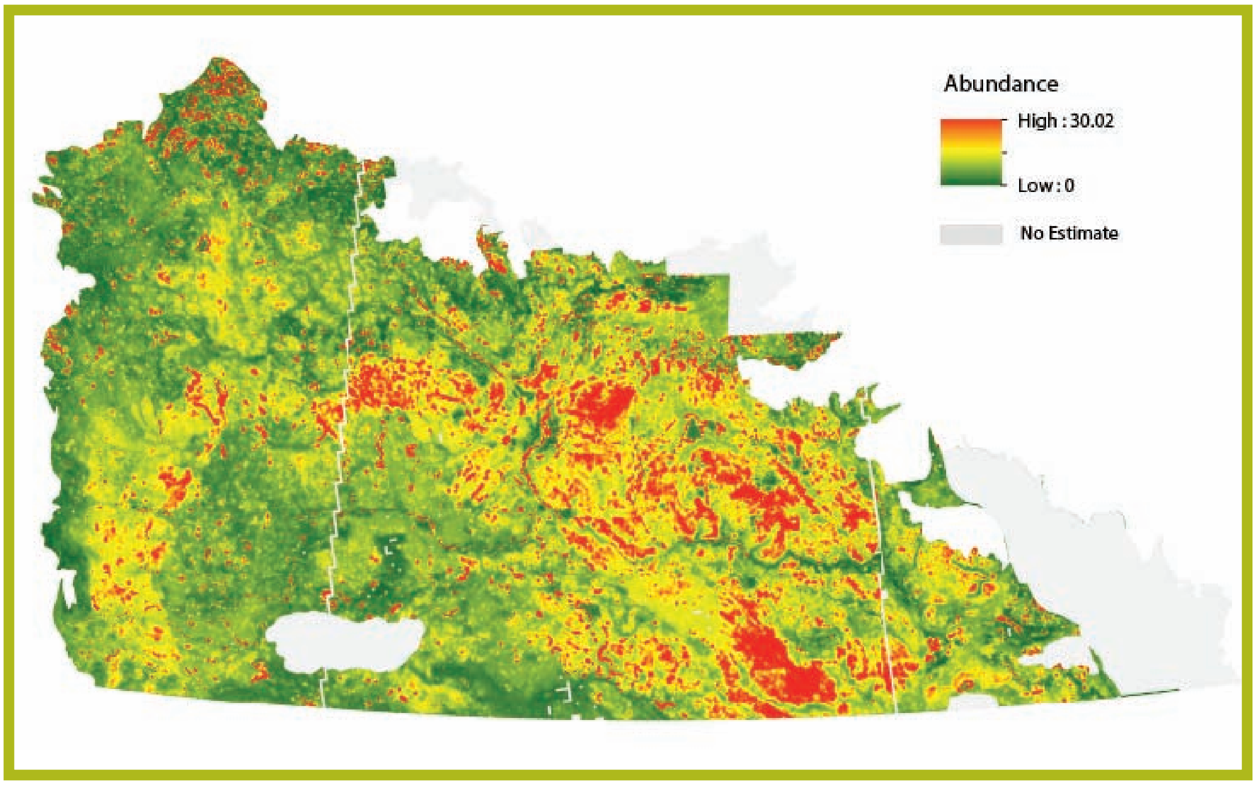
	AMBI	AMCO	EAGR	HOGR	NESP	PBGR	RNGR	SORA	VIRA	WISN
Ecoregion	+	+	+	+	+	+	+	+	+	+
Wetness	++	++	-	--	++	+	+	++	+	+
Pond Count	+	+	+	+	+	+	+	+	+	--
Total Wetland Area	-	+	+	+	+	+	++	+	+	++
Avg. Wetland Size	+	+	-	-	+	+	-	+	-	+
Waterfowl Capability	-		+					--		
Sec Crop		++		++						++
Sec Grassland/Pasture	++		--		++				+	
Qrt Wetland	++		++	++	++		--			+
Qrt Open Water			++		--		++	--		--
Qrt Wood		--				--			--	
Qrt Grassland/Pasture										
Qrt Crop										

Abundance Maps

American Bittern

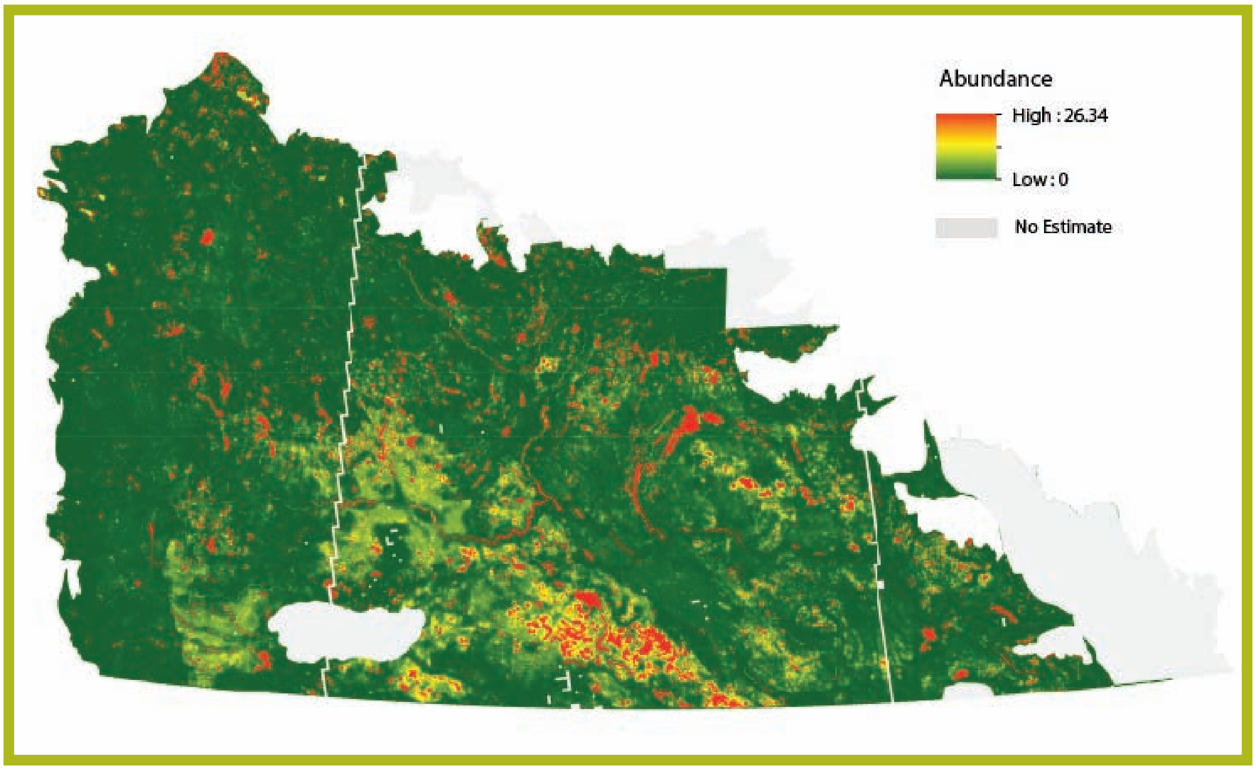


American Coot

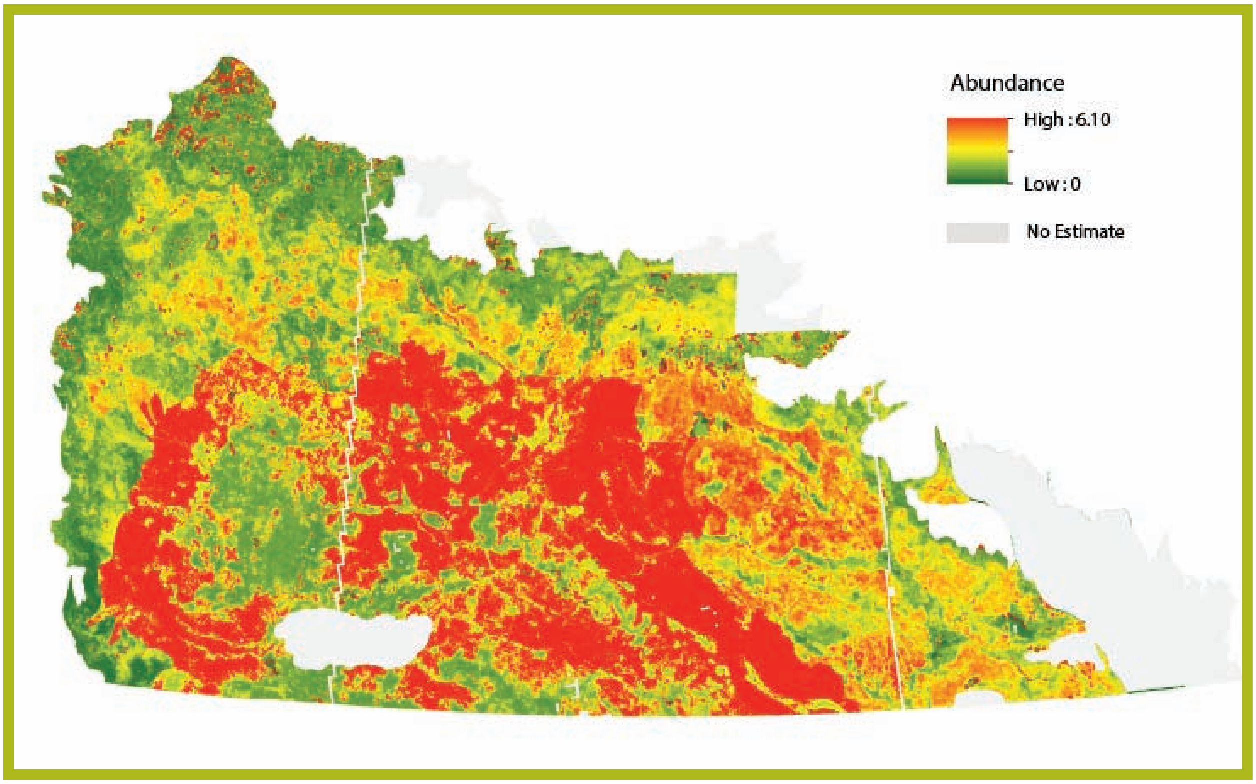


Abundance Maps (cont'd)

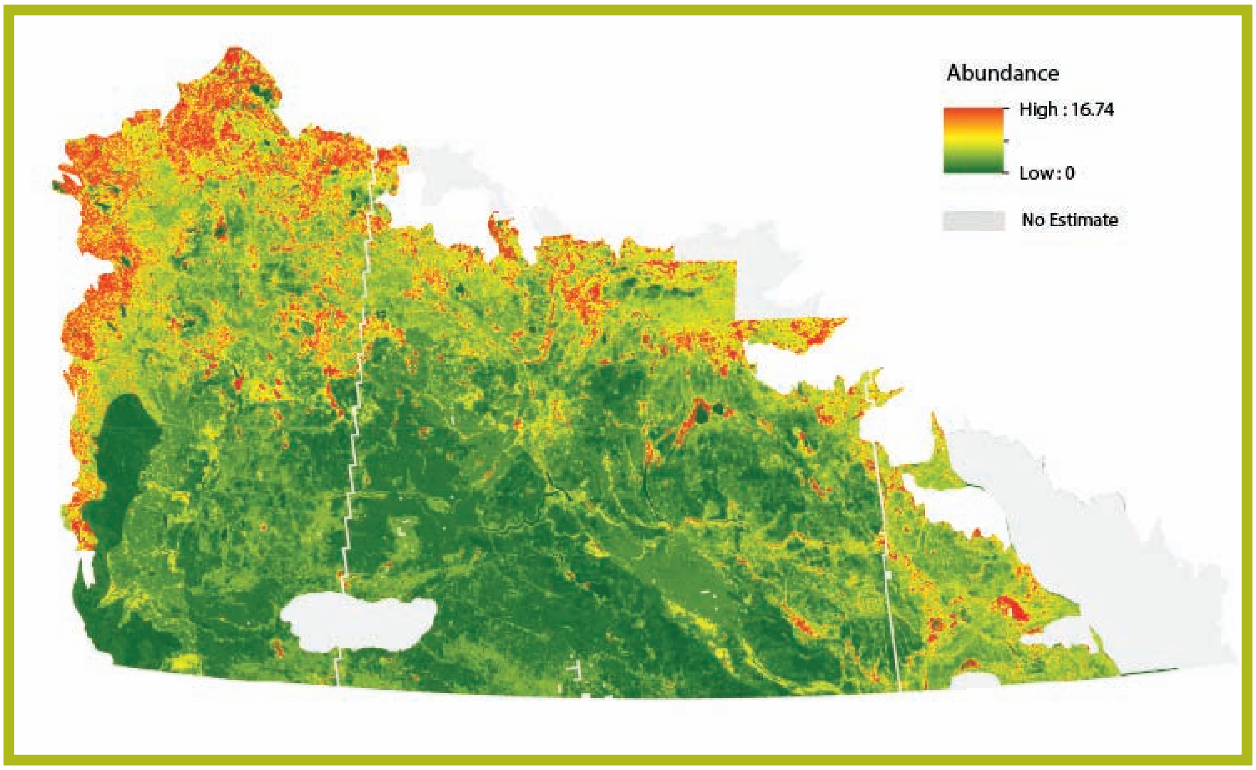
Eared Grebe



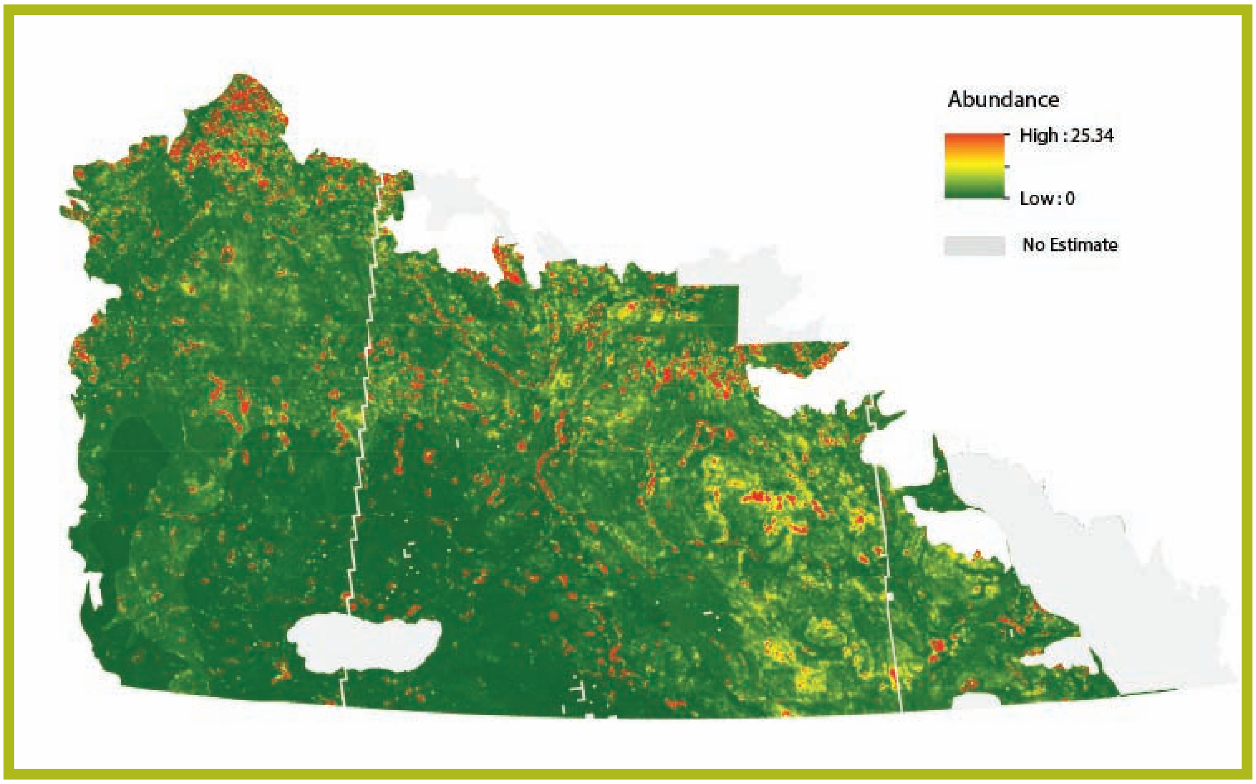
Horned Grebe



Nelson's Sparrow

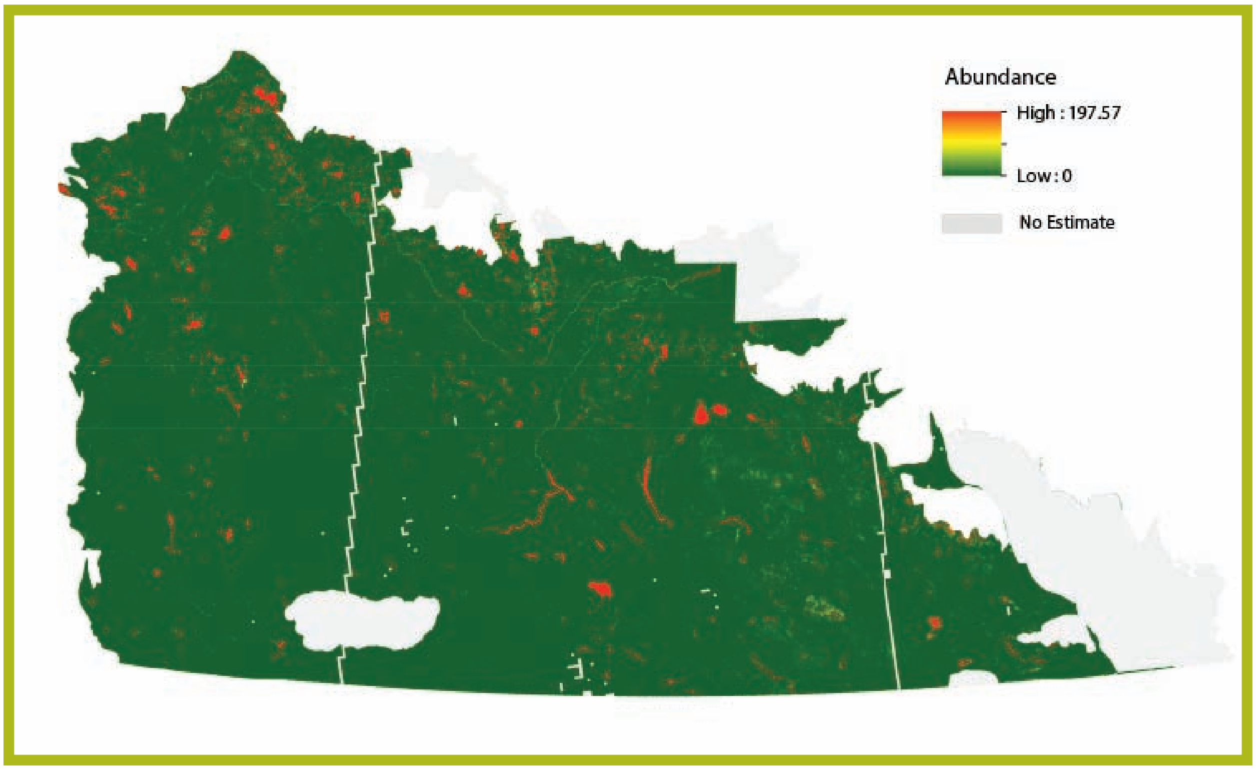


Pied-billed Grebe

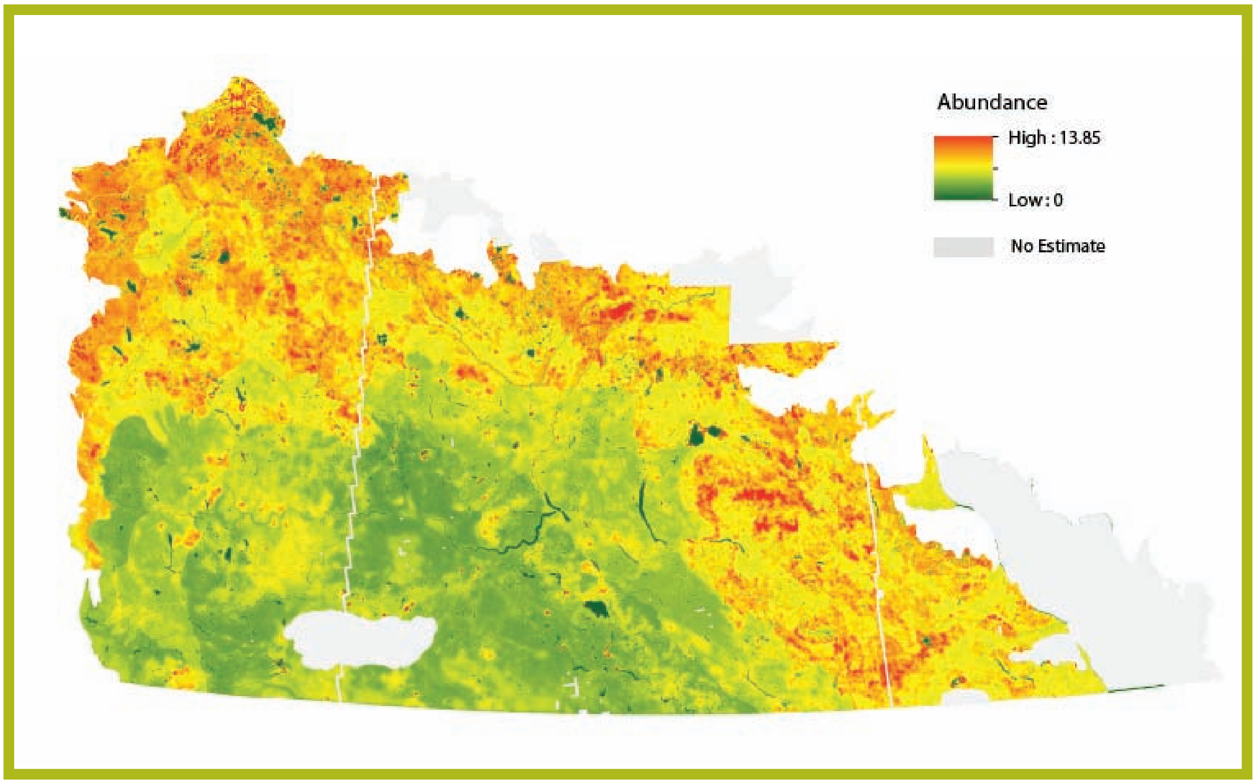


Abundance Maps (cont'd)

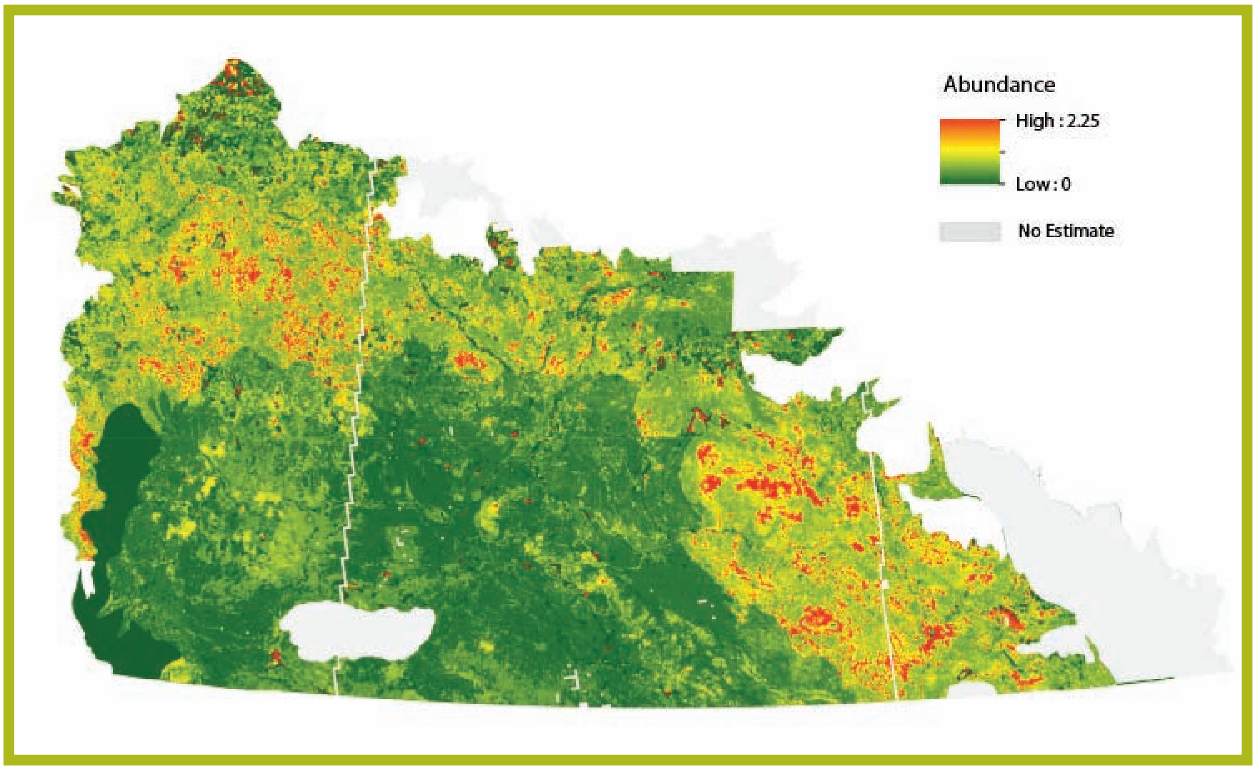
Red-necked Grebe



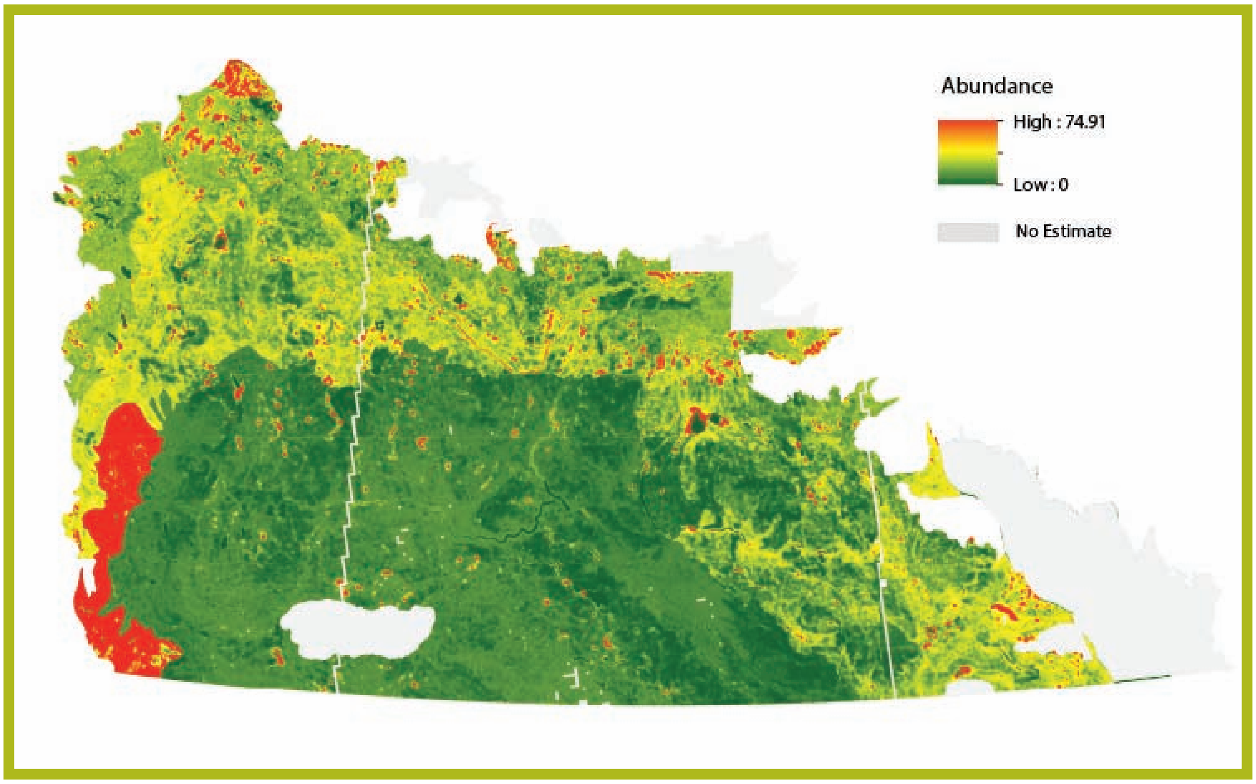
Sora



Virginia Rail

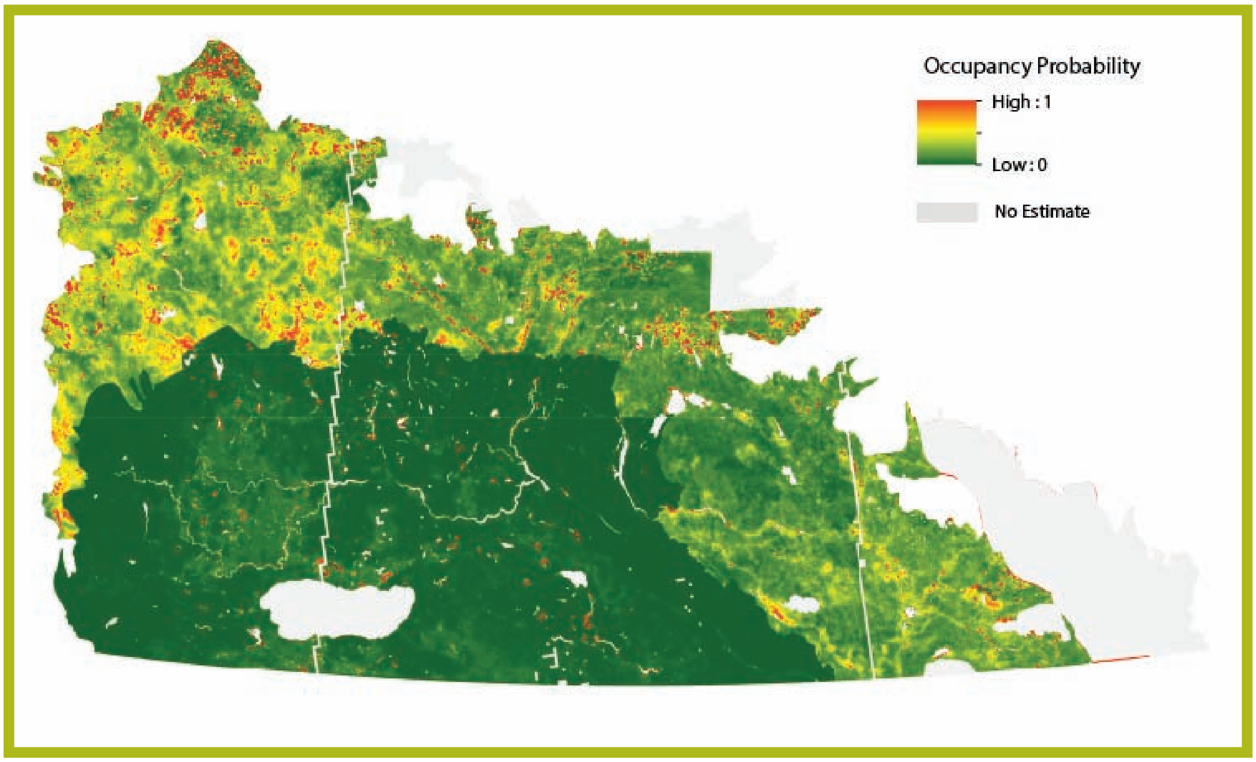


Wilson's Snipe

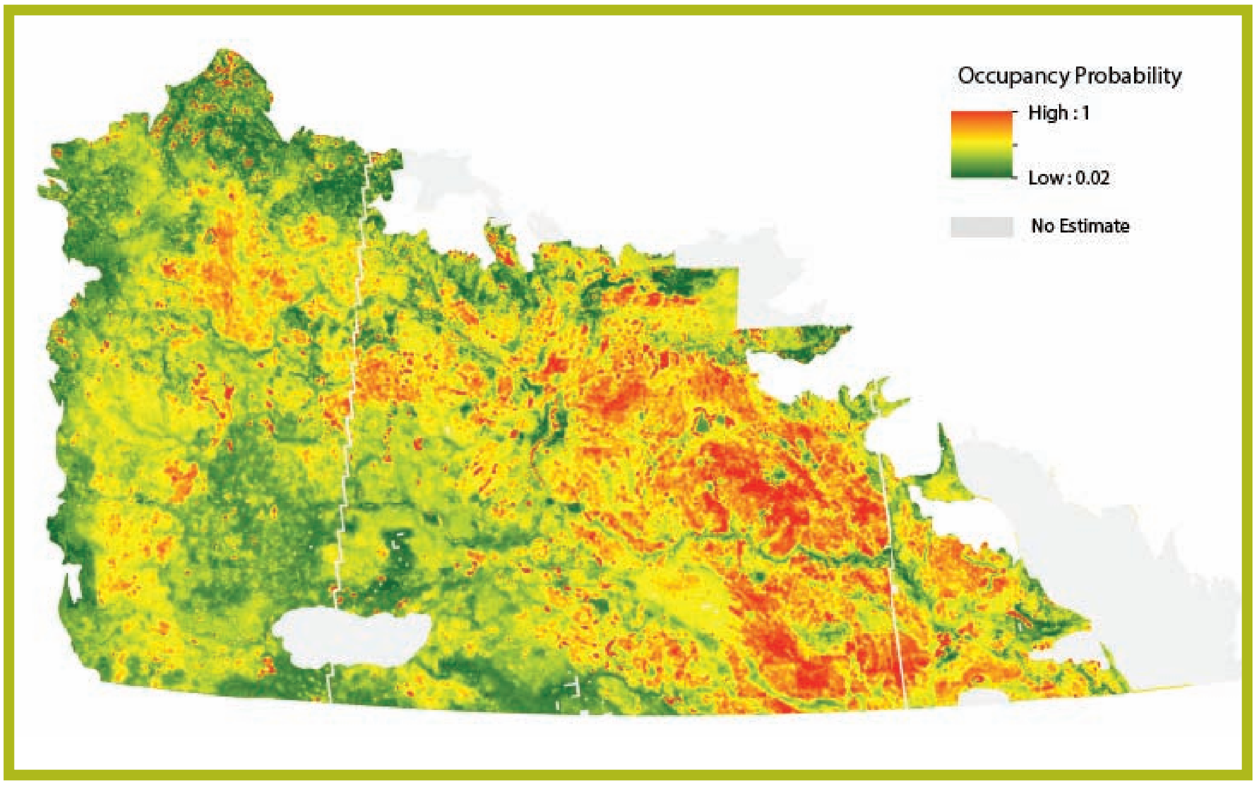


Occupancy Maps

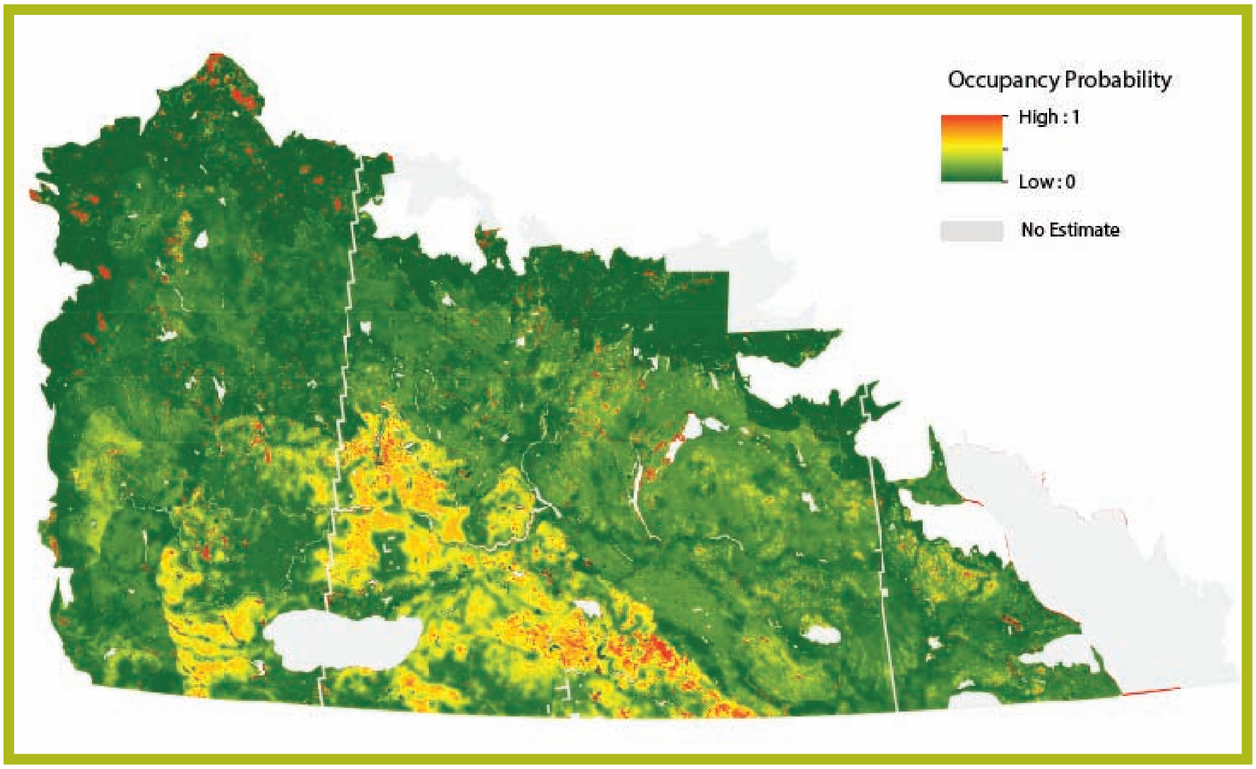
American Bittern



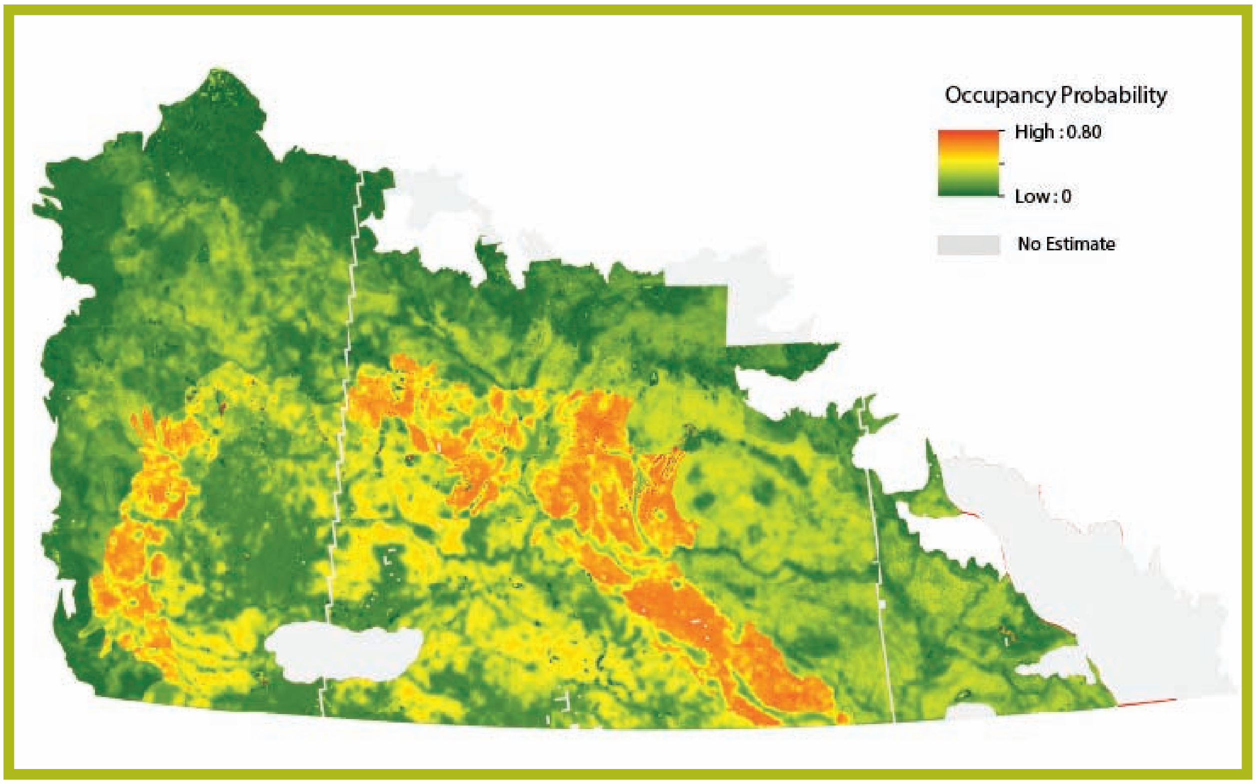
American Coot



Eared Grebe

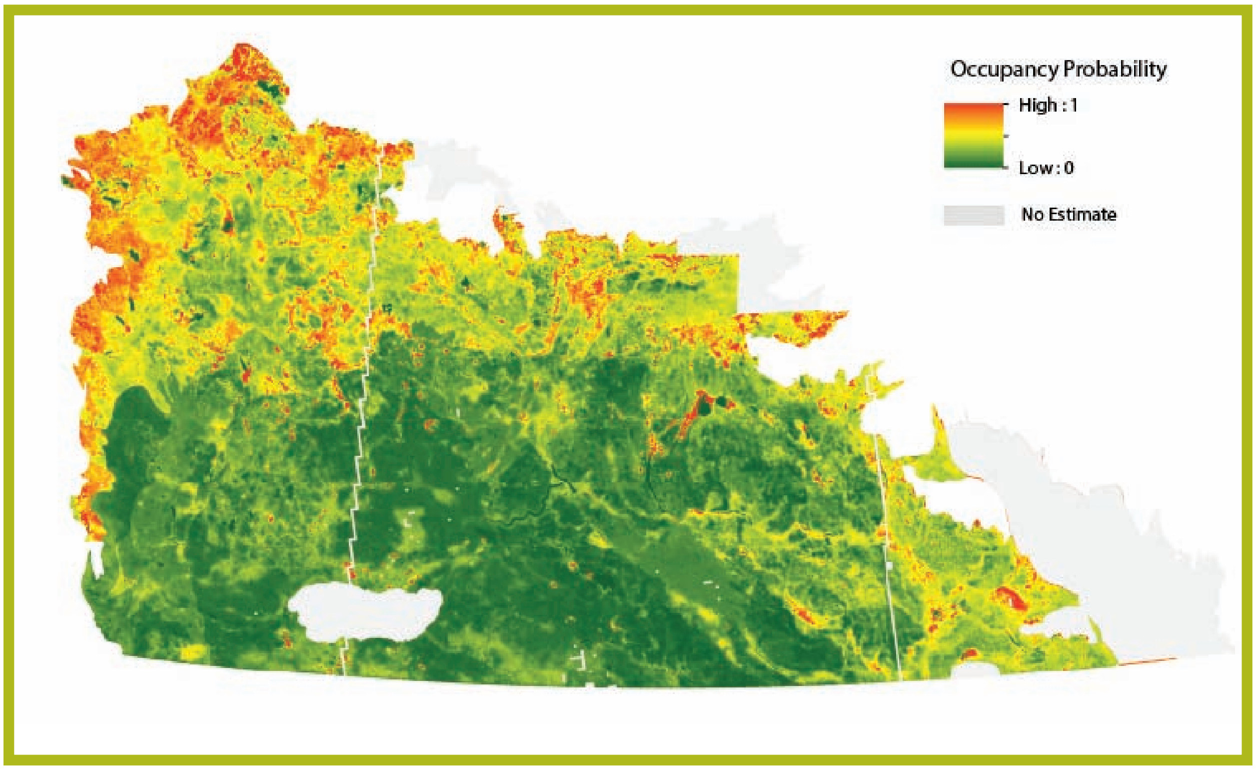


Horned Grebe

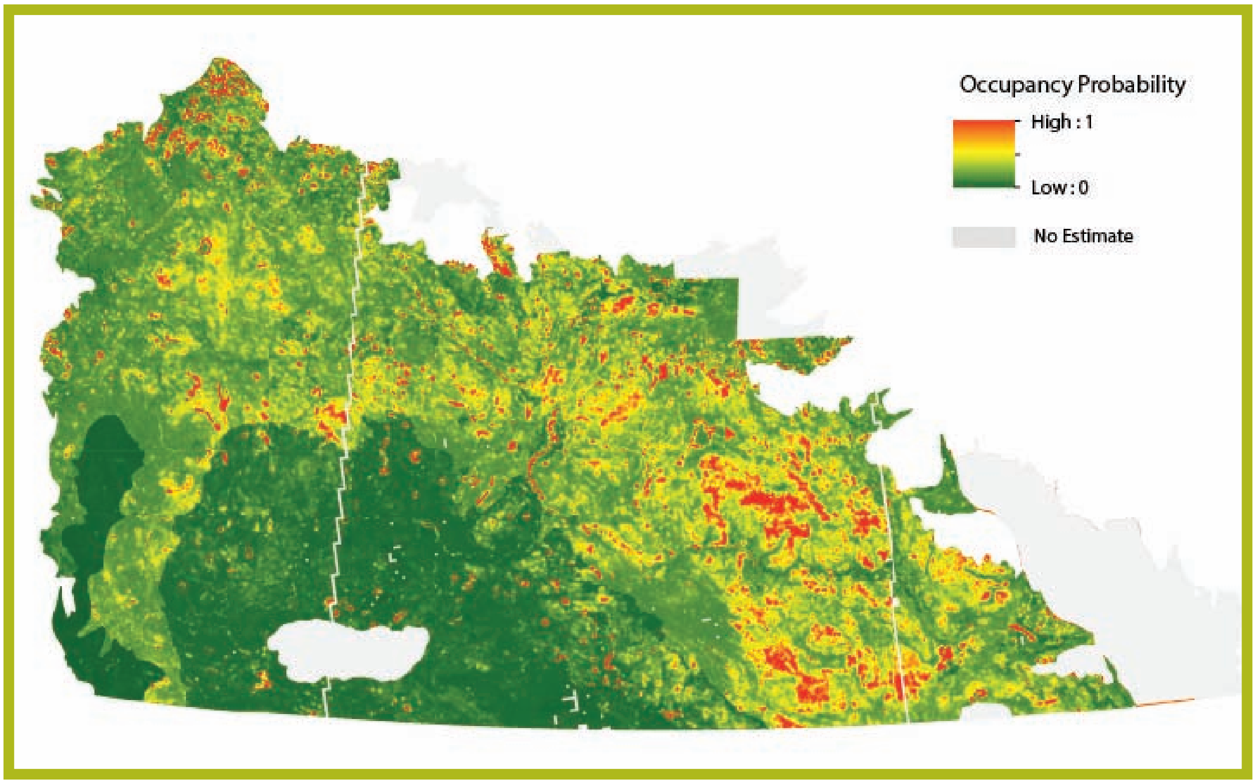


Occupancy Maps (cont'd)

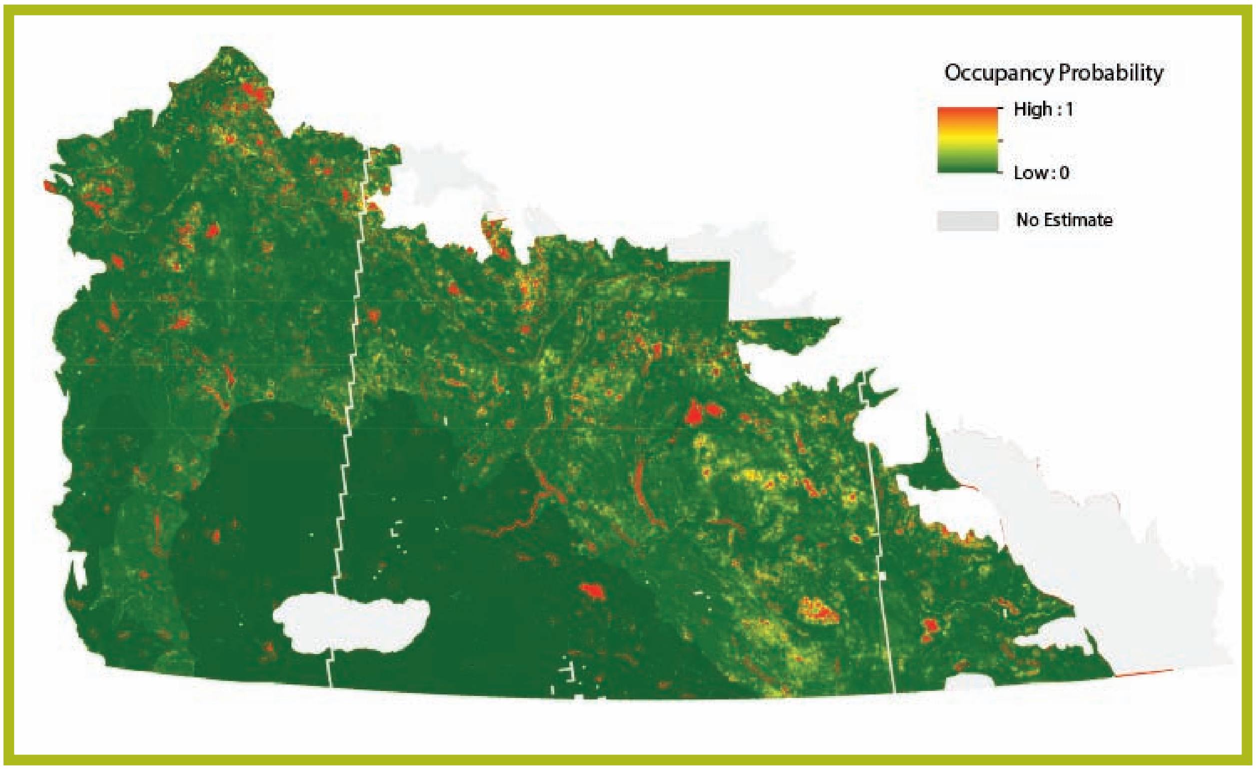
Nelson's Sparrow



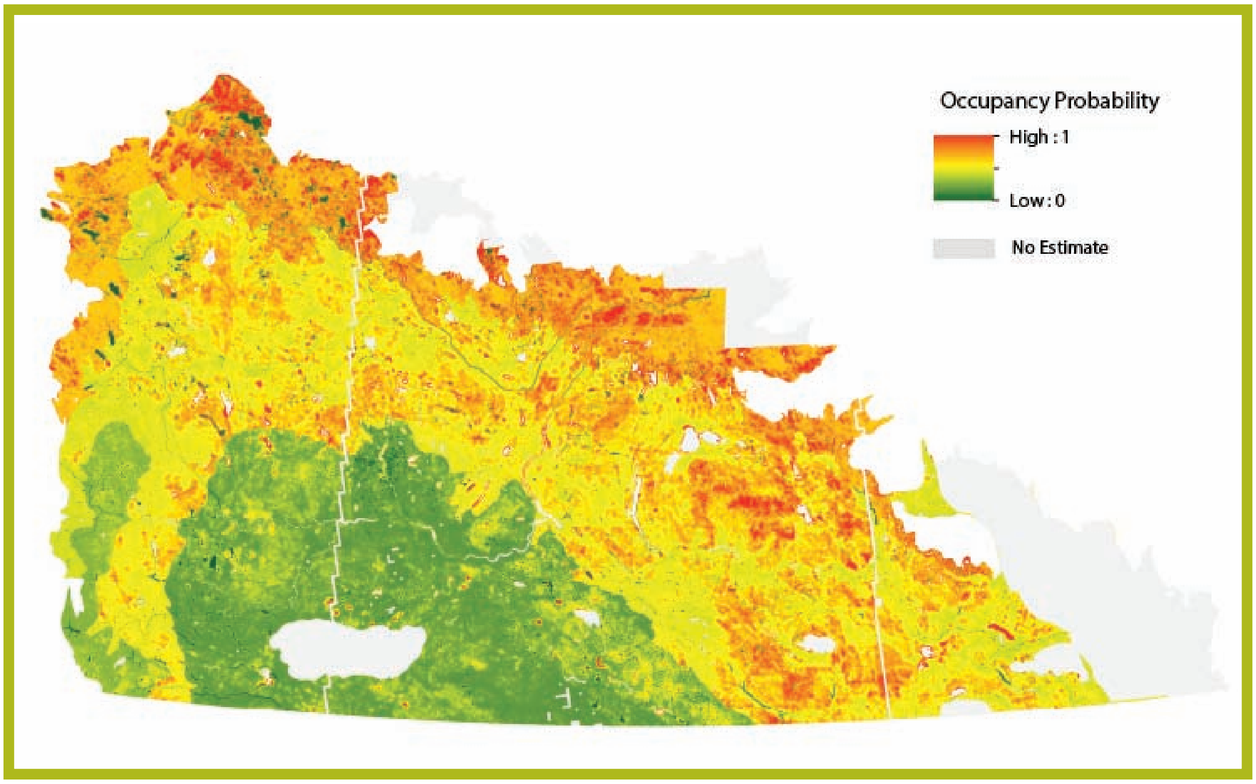
Pied-billed Grebe



Red-necked Grebe

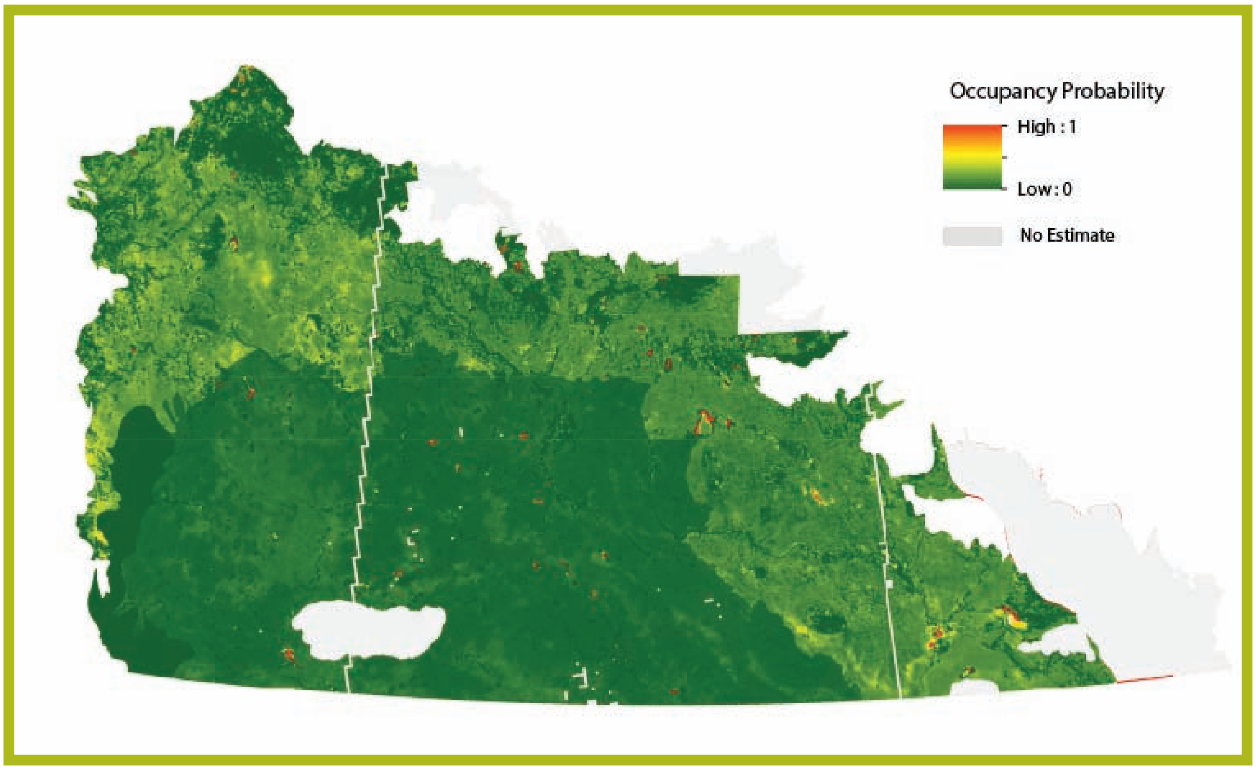


Sora

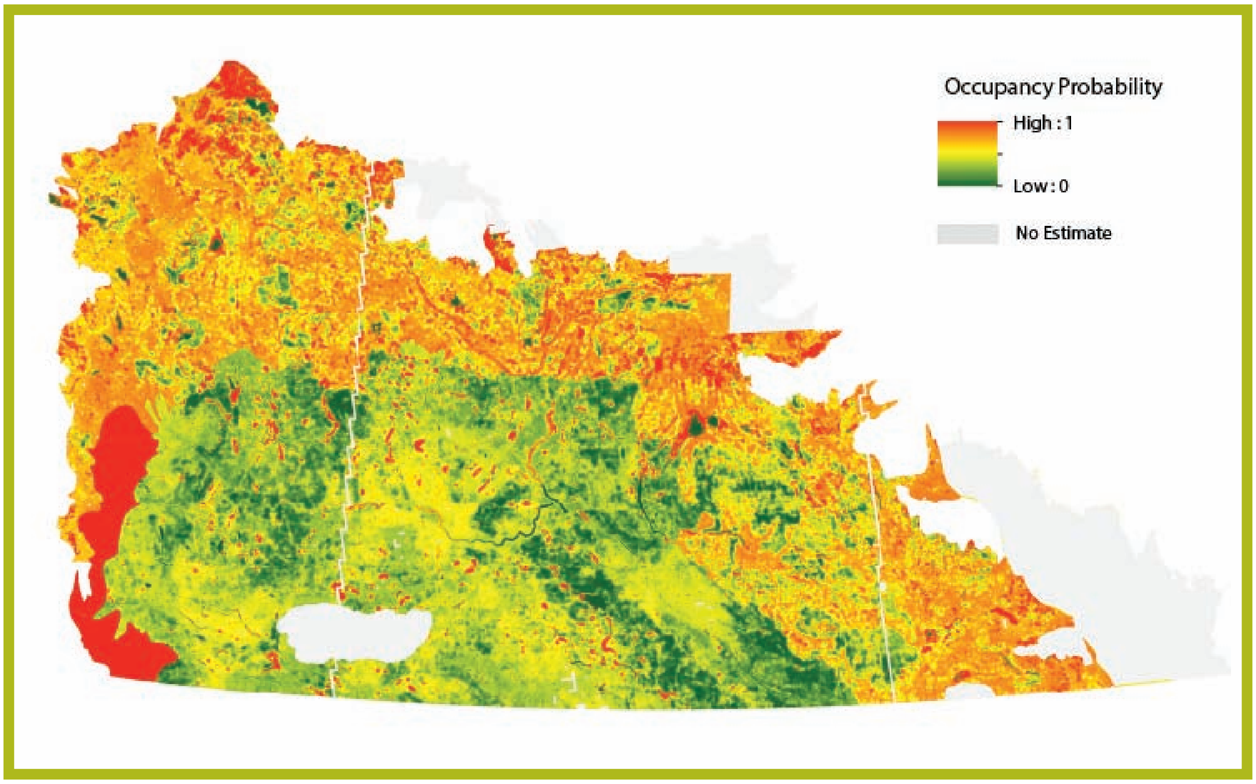


Occupancy Maps (cont'd)

Virginia Rail



Wilson's Snipe



APPENDIX 10:
Important large marshes used by moulting and staging waterfowl and other waterbirds by province.

Province	Wetland name	Latitude	Longitude	Target group
AB	Algar Lake	56.31190	-112.29191	Waterfowl
AB	Anderson Lake	55.33932	-119.24603	Waterfowl
AB	Antelope Lake	51.67137	-111.24870	Waterfowl
AB	Antelope Lakes	51.29000	-112.25353	Waterfowl
AB	Antelope Lakes	51.28660	-112.23653	Waterfowl
AB	Antelope Lakes	51.28491	-112.22979	Waterbirds
AB	Antelope Lakes	51.28397	-112.22441	Waterfowl
AB	Antoine Lake	54.77000	-112.08000	Waterfowl
AB	Audet Lake	57.64488	-110.91416	Waterfowl
AB	Badger Lake	50.38157	-112.46386	Waterfowl
AB	Bantry 1 & 2	50.36170	-111.59320	Waterfowl
AB	Barbara Lake	54.52818	-110.86120	Shorebirds
AB	Bartman Reservoir	51.11394	-111.45533	Waterfowl
AB	Baxter Lake	52.92000	-110.73000	Waterfowl
AB	Bear Lake	55.25150	-118.99578	Waterfowl
AB	Bear Lake	54.22463	-114.87242	Waterfowl
AB	Bear Lake	54.01699	-110.22256	Waterfowl
AB	Bearhills Lake	52.93927	-113.61038	Waterfowl
AB	Beaver Ranch	58.43482	-115.67125	Waterfowl, Waterbirds, Shorebirds
AB	Beaverhill "A" Lake	53.37780	-112.50100	Waterfowl
AB	Beaverhill Lake	53.45887	-112.53605	Waterfowl
AB	Bellshill Lake	52.60358	-111.56238	Waterfowl
AB	Bens Lake	53.66784	-111.86341	Waterfowl
AB	Berry Lakes	51.08862	-111.50425	Waterfowl
AB	Bethel Lake	55.60789	-119.96047	Waterfowl
AB	Big Hay Lake	53.16661	-113.17583	Waterfowl
AB	Big Lake	53.60101	-113.67919	Waterfowl
AB	Bisbing Lake	55.25840	-119.64111	Waterfowl
AB	Bittern Lake	53.05255	-113.07078	Waterfowl
AB	Bittern Lake North	53.07230	-113.04280	Waterfowl
AB	Black Duck Lake	56.18342	-118.45555	Waterfowl
AB	Black Lake			Waterfowl
AB	Blood Indian Creek Reservoir	51.25592	-111.20706	Waterfowl
AB	Bowman Lake	55.09091	-119.33532	Waterfowl
AB	Brosten Reservoir	51.36434	-111.07149	Waterfowl
AB	Bruce Lake	51.20155	-113.54790	Waterfowl
AB	Buffalo Bay/Horse Lakes	55.55800	-116.18300	Waterfowl, Waterbirds
AB	Buffalo Lake	55.37978	-118.97573	Waterfowl
AB	Buffalo Lake	52.47335	-112.92872	Waterfowl
AB	Bunder Lake	54.28884	-111.70024	Waterfowl
AB	Cadotte Lake	56.44976	-116.39267	Waterfowl, Waterbirds
AB	Calumet Lake	57.41712	-111.76678	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Cardinal Lake	56.23587	-117.72369	Waterfowl
AB	Carroll Lakes	54.11836	-111.66034	Waterfowl
AB	Cemetery Lake	55.32348	-118.83349	Waterfowl
AB	Center Slough	52.01413	-113.86038	Waterfowl, Shorebirds
AB	Cessford Reservoir	51.02821	-111.45772	Waterfowl, Shorebirds
AB	Chain Lakes	51.86452	-112.21986	Waterfowl, Shorebirds
AB	Chain Lakes	51.85080	-112.20275	Waterfowl, Shorebirds
AB	Chain Lakes	51.83682	-112.18298	Waterfowl, Shorebirds
AB	Chain Lakes	51.81995	-112.17429	Waterfowl, Shorebirds
AB	Chain Lakes	51.83145	-112.16671	Waterfowl, Shorebirds
AB	Chain Lakes	51.80604	-112.15710	Waterfowl, Shorebirds
AB	Chain Lakes	51.79094	-112.12284	Waterfowl, Shorebirds
AB	Chain Lakes	51.76861	-112.11405	Waterfowl, Shorebirds
AB	Chain Lakes	51.77741	-112.11329	Waterfowl, Shorebirds
AB	Chain Lakes	51.75816	-112.09286	Waterfowl, Shorebirds
AB	Chain Lakes	51.76164	-112.08309	Waterfowl
AB	Chappice Lake	50.16537	-110.36880	Waterfowl
AB	Charlotte Lake	54.25512	-110.63313	Waterfowl
AB	Chin Lakes	49.74293	-112.46461	Waterfowl
AB	Chin Lakes	49.69555	-112.39216	Waterfowl, Waterbirds
AB	Chin Lakes	49.63437	-112.25027	Shorebirds
AB	Chip Lake	53.65883	-115.37434	Waterfowl
AB	Cipher Lake	52.68000	-110.08000	Waterfowl
AB	Clairmont Lake	55.25593	-118.76205	Waterfowl
AB	Clear Lake	50.14720	-113.41732	Waterfowl
AB	Coal Lake	53.07073	-113.26144	Waterfowl
AB	Coaldale Lake	49.83300	-112.60000	Waterfowl
AB	Coleman Lake	51.44093	-111.87092	Waterfowl
AB	Conrad Flats	49.36540	-111.83730	Waterbirds
AB	Contracosta Lake	51.68300	-111.58300	Waterfowl
AB	Cooking Lake	53.42000	-113.04000	Waterfowl
AB	Cowoki Lake	50.58534	-111.69043	Waterfowl
AB	Craig Lake	51.93780	-111.57800	Waterfowl
AB	Crawling Valley Reservoir	50.92214	-112.36317	Waterfowl
AB	Crestomere Lake	52.67469	-113.91951	Waterfowl
AB	Cutbank Lake	55.71888	-119.76119	Waterfowl
AB	Cutbank Lake	55.25885	-119.12468	Waterfowl
AB	Cutbank Lake	52.05800	-112.31700	Waterfowl
AB	Cygnet Lake	52.28162	-114.01516	Waterbirds
AB	Cygnet Lake	52.27718	-113.97851	Waterfowl
AB	Dalemead Lake	50.92000	-113.62000	Waterfowl
AB	Dapp Lake	54.34129	-113.60725	Waterfowl
AB	Deadhorse Lake	51.06494	-112.66584	Waterfowl
AB	Deadwood Lake	56.71465	-117.58876	Waterfowl
AB	Deep Lake	55.24845	-119.08009	Waterfowl
AB	Deep Lake	56.70281	-119.02229	Waterfowl
AB	Demay Lake	53.12348	-112.69763	Waterfowl
AB	Devil Lake	58.37338	-116.78576	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Dishpan Lake	50.59172	-110.54547	Waterfowl, Shorebirds
AB	Dolcy Lake	52.64912	-110.46995	Waterfowl
AB	Dowling Lake	51.73406	-112.02722	Waterfowl
AB	Driedmeat Lake	52.83947	-112.74009	Waterfowl, Waterbirds
AB	Dusty Lake	53.13022	-112.48176	Waterfowl
AB	Eagle Lake	51.00081	-113.32511	Waterfowl
AB	East Mustus Lake	58.17357	-116.47350	Waterfowl
AB	Edberg Slough	52.77378	-112.86137	Waterfowl
AB	Egg Lake	56.07001	-111.40557	Waterfowl
AB	Elhardt Lake			Waterfowl
AB	Elvestad Lake	55.43973	-119.34625	Waterfowl
AB	Erskine Lake	52.30823	-112.88269	Waterfowl
AB	Farrell Lake	51.87191	-112.33203	Waterfowl
AB	Ferguson Lake	55.26837	-118.81764	Waterfowl
AB	Field and Stream Project	50.86100	-112.06560	Waterfowl
AB	Fincastle Reservoir	49.83300	-111.98300	Waterfowl
AB	Fitzgerald Lake	51.80114	-111.06586	Waterfowl
AB	Flat Lake	54.65354	-112.90542	Waterfowl
AB	Fleischman Lake	50.88200	-112.13150	Waterfowl
AB	Flood Lake	56.49826	-117.81477	Waterfowl
AB	Flyingshot Lake	55.13937	-118.86605	Waterfowl
AB	Forster Reservoir	50.99281	-111.77062	Waterfowl, Waterbirds, Shorebirds
AB	Forty Mile Coulee	49.59230	-114.48840	Waterfowl
AB	Frank Lake	50.54748	-113.70957	Waterfowl
AB	Fresno-Honens	51.27830	-113.48750	Waterfowl
AB	George Lake	56.22650	-118.56911	Shorebirds
AB	George Lake	54.53478	-113.48094	Waterfowl
AB	Gillespie Lake	52.33000	-110.18000	Waterfowl, Shorebirds
AB	Goodfare Lake	55.27291	-119.68993	Waterfowl
AB	Gooseberry Lake	52.11700	-110.71700	Waterfowl
AB	Gopher Lake	51.71995	-111.35000	Waterfowl
AB	Gordon Lake	56.51507	-110.45089	Waterfowl
AB	Gough Lake	51.99325	-112.47012	Waterfowl
AB	Grantham Lake	50.91700	-111.93300	Waterfowl
AB	Grassy Island Lake	54.24312	-111.37368	Waterfowl
AB	Grassy Island Lake	51.82655	-110.31329	Waterfowl
AB	Gull Lake	58.43397	-116.13229	Waterfowl
AB	Gummer Lake	55.36725	-118.99628	Waterfowl, Shorebirds
AB	Hackmatack Lake	55.18603	-119.66636	Waterbirds
AB	Handhills Lake	51.49252	-112.13157	Waterfowl
AB	Hastings Lake	53.42000	-112.92000	Waterfowl
AB	Hay Lake	58.83658	-118.82505	Waterfowl
AB	Hay Lakes	49.20000	-111.63300	Waterfowl
AB	Hays Reservoir	50.05877	-111.82976	Waterfowl
AB	Helen Lake	56.54319	-117.82782	Waterfowl
AB	Henderson Lake	55.34404	-119.09988	Waterfowl
AB	Hermit Lake	55.20586	-118.96442	Waterfowl
AB	Horse Lake	55.33642	-119.71530	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Horse Lake	56.83856	-113.60733	Waterfowl
AB	Horse Lake	54.87462	-112.35264	Waterfowl
AB	Horse Lake	56.14218	-111.94715	Waterfowl
AB	Horse Lake	56.30430	-110.93416	Waterfowl
AB	Horsefly Lake Reservoir	49.73354	-112.10116	Waterfowl
AB	Horseshoe Lake	54.61509	-114.25113	Waterfowl
AB	Horseshoe Lake	54.49013	-113.78802	Waterfowl
AB	Horseshoe Lake	56.65676	-110.99269	Waterfowl
AB	Houcher Lake	52.40766	-110.82934	Waterfowl
AB	Hughes Lake	55.19843	-118.91416	Waterfowl
AB	Hume Creek	55.28100	-119.93325	Waterfowl
AB	Huppie Lake	54.55349	-111.81685	Waterfowl
AB	Intermittent Lake	55.34287	-118.93538	Waterfowl
AB	Jamieson Lake	50.60947	-111.88271	Waterfowl, Waterbirds
AB	Jenson Reservoir	49.31492	-112.89790	Waterfowl
AB	Jessie Lake	54.25246	-110.73381	Waterfowl
AB	John Lake	53.73391	-110.03640	Waterfowl
AB	Johnson Reservoir	50.37127	-111.84558	Waterfowl
AB	Jones Lake	55.39110	-119.00497	Waterfowl
AB	Kakut Lake	55.62882	-118.52849	Waterfowl
AB	Kamisak 6	55.13460	-119.80793	Waterfowl
AB	Kamisak E Lake	55.16364	-119.73089	Waterfowl
AB	Kamisak Lake	55.16301	-119.75615	Waterfowl
AB	Kamisak SW Lake	55.14912	-119.75615	Waterfowl
AB	Kearl Lake	57.29025	-111.23634	Waterfowl
AB	Keeping Lake	55.46131	-119.93601	Waterfowl
AB	Keho Lake	49.94792	-113.00471	Shorebirds
AB	Kenilworth Lake	53.32820	-110.51827	Waterfowl, Waterbirds, Shorebirds
AB	Killarney lake	52.61000	-110.15000	Waterfowl
AB	Kimiwan Lake	55.75324	-116.91361	Waterfowl
AB	Kings Lake	49.35760	-111.65820	Waterfowl
AB	Kininvie Flat	50.37200	-111.50200	Waterfowl, Waterbirds
AB	Kirkpatrick Lake	51.87941	-111.31546	Waterfowl
AB	Kitsim Reservoir	50.45000	-112.05000	Waterfowl
AB	Kleskun Lake	55.35243	-118.57703	Waterfowl
AB	La Glace East Lake	55.38418	-119.24247	Waterfowl
AB	La Glace West Lake	55.38102	-119.32048	Waterfowl
AB	Lac Des Jones	54.24734	-113.73845	Waterbirds
AB	Lac Emilien	53.54437	-111.11732	Waterfowl
AB	Lac La Biche	54.84000	-111.97000	Waterbirds
AB	Lac Magloire	55.86675	-117.17799	Waterfowl
AB	Lac Ste. Anne	53.70000	-114.40000	Waterfowl, Waterbirds
AB	Lacrete Lake	58.19534	-116.44598	Waterfowl
AB	Lake Newell (reservoir)	50.44063	-111.94594	Waterfowl
AB	Lanes Lake	52.20800	-111.98300	Waterfowl
AB	Langdon Reservoir	50.91429	-113.47895	Shorebirds
AB	Lathom Lake	50.71211	-112.29634	Waterbirds
AB	Leane Lake	52.57000	-110.07000	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Lesser Slave Lake	55.46000	-115.35000	Waterfowl
AB	Linton Lake	58.17103	-116.48559	Waterfowl
AB	Little Beave Lake	54.59402	-112.35400	Waterfowl
AB	Little Beaver Lake	52.77127	-112.97597	Waterfowl, Shorebirds
AB	Little Bow Lake (Res.)	50.19310	-112.67558	Waterfowl
AB	Little Fish Lake	51.37710	-112.23263	Waterfowl
AB	Little Lake	55.19992	-119.08371	Waterfowl
AB	Little McClelland Lake	57.45296	-111.29017	Waterfowl
AB	Little Red Deer Marsh	52.75475	-113.14149	Waterfowl
AB	Little Utikuma Lake	55.90769	-114.74854	Waterfowl
AB	Lost Lake	56.24008	-118.01351	Waterfowl
AB	Lost Lake	50.14299	-112.30483	Waterfowl
AB	Lost Lemon Lake	50.35400	-112.28800	Waterfowl
AB	Louisiana Lakes	50.55672	-111.64204	Waterfowl
AB	Louisiana Lakes	50.53626	-111.63984	Waterfowl
AB	Louisiana Lakes	50.53855	-111.63217	Waterfowl
AB	Louisiana Lakes	50.54383	-111.60797	Waterfowl
AB	Louisiana Lakes	50.51988	-111.59223	Waterfowl
AB	Louisiana Lakes	50.50040	-111.58398	Waterfowl
AB	Louisiana Lakes	50.52305	-111.56081	Waterfowl
AB	Louisiana Lakes	50.46399	-111.52046	Waterfowl
AB	Louisiana Lakes	50.48857	-111.51617	Waterfowl
AB	Lowden Lakes	52.14626	-112.68557	Waterfowl
AB	Lowe Lake	55.32670	-119.17927	Waterfowl
AB	Majors Lake	51.13008	-111.17108	Waterfowl
AB	Manatokan Lake	54.46425	-110.94469	Waterfowl
AB	Manawan Lake	53.89569	-113.69212	Waterfowl
AB	Many Island Lake	50.12346	-110.04474	Waterfowl
AB	Marion Lake	52.18300	-112.43300	Waterfowl
AB	Martin Lake	55.44286	-119.56411	Waterbirds
AB	Mattoyekiu Lake	51.12818	-112.44536	Waterfowl
AB	McGregor Lake	50.49000	-112.87000	Waterfowl
AB	McNaught Lake	55.14652	-119.44920	Waterfowl
AB	McNeil Lake	59.54406	-112.40575	Waterfowl
AB	Meadowville One	55.32315	-119.21784	Shorebirds
AB	Metheral	49.40330	-111.49610	Waterfowl, Waterbirds
AB	Metiskow Lake	52.44000	-110.65000	Waterfowl
AB	Milk River Ridge Reservoir	49.37112	-112.56848	Waterbirds
AB	Ministik Lake	53.43598	-113.01033	Waterbirds
AB	Miquelon Lake	53.25000	-112.93000	Waterfowl
AB	Moose Lake	54.25000	-110.91000	Waterfowl
AB	Mud Lake	49.75374	-113.53997	Waterbirds
AB	Mulligan Lake	55.37099	-119.12488	Waterfowl
AB	Muriel Lake	54.15000	-110.69000	Waterfowl
AB	Murray Lake	49.80352	-110.95563	Waterfowl, Waterbirds
AB	Mustus Lake	58.14835	-116.39450	Waterfowl
AB	Namaka Lake	50.93360	-113.21841	Waterfowl
AB	North Cache Lake	54.40920	-112.99370	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Oakland Lake	51.39088	-111.83802	Waterfowl
AB	Oldman Lake	53.87585	-114.54017	Waterfowl
AB	Oldman Lake	51.70709	-111.37828	Waterfowl, Shorebirds
AB	Onetree Reservoir	50.60747	-111.82608	Waterfowl
AB	Pakowki Lake	49.30368	-110.90081	Waterfowl
AB	Peace Athabasca Delta	58.73267	-111.10787	Waterfowl
AB	Peace River (Ft. Vermillion Bridge-Beaver Ranch I.R.)	58.45000	-115.88300	Waterfowl
AB	Peace River (Moose Island-Prairie Point)	58.21700	-116.58300	Waterfowl
AB	Peace River (Prairie Point-Ft. Vermillion Bridge)	58.33000	-116.31700	Waterfowl
AB	Pemukan Lake	51.95800	-110.45800	Waterfowl
AB	Picture Butte Reservoir	49.88560	-112.77884	Waterfowl
AB	Plover Lake	51.49307	-111.38208	Waterfowl
AB	Pluvius Lake	56.57334	-117.60683	Waterbirds
AB	Ponita Lake	55.50858	-119.84175	Waterfowl
AB	Portage Lake	54.96000	-112.05000	Waterfowl
AB	Powell Lake	55.37931	-119.81054	Waterfowl
AB	Preston Lake	55.36738	-119.91806	Waterfowl
AB	Prouty Lake	50.25090	-112.43770	Waterfowl
AB	Rail Lake	56.51563	-117.63099	Waterfowl
AB	Railroad Lake	51.27718	-113.48606	Waterfowl
AB	Rat Lake	54.44059	-118.78190	Waterfowl
AB	Rat Lake	59.87388	-117.00274	Waterfowl
AB	Ray Lake	55.43233	-119.88203	Waterfowl
AB	Ray Lake	56.66085	-119.12629	Waterfowl
AB	Red Deer Lake	52.71271	-113.04448	Waterfowl
AB	Red Deer Lake	50.28497	-110.38229	Shorebirds
AB	Reed Lake	49.17156	-112.80998	Waterfowl
AB	Reflex Lake (Salt Lake)	52.67000	-110.00000	Waterfowl
AB	Ribstone Creek Irrigation System	52.76512	-110.64980	Waterfowl
AB	Ribstone Lake	52.76512	-110.64980	Waterfowl
AB	Robb Lake	51.97029	-111.35583	Waterfowl
AB	Rock Lake	50.69024	-112.01751	Waterfowl
AB	Rolling Hills Lake	50.35887	-111.89885	Waterfowl
AB	Ronald Lake	57.97148	-111.67036	Waterfowl
AB	Roreigh	56.18171	-118.46197	Waterfowl
AB	Rush Lake	53.81919	-112.20333	Waterfowl
AB	Rushmere Lake	51.83097	-111.13185	Waterfowl
AB	Saline Lake	57.07849	-111.52222	Waterfowl
AB	Sampson Lake	52.74778	-113.23771	Waterfowl
AB	San Francisco Lake	50.59401	-112.11867	Waterfowl
AB	San Joaquin	50.91427	-113.33096	Waterfowl
AB	Sandy Lake	53.78833	-114.04062	Waterfowl, Waterbirds
AB	Saskatoon Lake	55.21925	-119.09369	Waterfowl
AB	Scope Reservoir	50.06700	-111.81700	Waterfowl
AB	Shanks Lake	49.06897	-112.72576	Waterfowl
AB	Sherborne Lake	49.76387	-111.81486	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Shoal Lake	54.25020	-114.43210	Waterfowl
AB	Shooting Lake	52.18300	-112.35000	Waterfowl
AB	Sieu Lake	51.14864	-112.40247	Waterfowl
AB	Sinclair Lake	54.72594	-110.65838	Waterfowl
AB	Smoky Lake	54.15039	-112.63874	Waterfowl
AB	Snake Lake	51.94726	-112.76022	Waterfowl
AB	Snipe Lake	55.12704	-116.78641	Waterfowl
AB	Snow Lake	52.71641	-113.79522	Waterfowl
AB	Sounding Creek	51.58300	-110.36700	Shorebirds
AB	Sounding Creek Reservoir	51.57647	-110.70192	Waterfowl
AB	Sounding lake	52.16000	-110.47000	Waterfowl
AB	South Mustus Lake	58.15889	-116.36270	Waterfowl
AB	Spotted Lake	52.49096	-113.13258	Waterfowl
AB	Square Lake	59.05968	-112.47197	Waterfowl, Waterbirds
AB	Square Lake	54.91020	-111.83712	Waterfowl
AB	St. Mary Reservoir	49.30972	-113.22672	Waterfowl, Waterbirds
AB	Stirling Lake	49.52799	-112.55502	Waterfowl
AB	Stobart Lake	50.90598	-113.18708	Waterfowl
AB	Sturgeon Lake	55.10446	-117.56894	Waterfowl, Shorebirds
AB	Sucker Lake	56.41968	-110.86348	Waterfowl
AB	Sullivan Lake	51.94036	-111.96551	Waterfowl
AB	Sunrise	56.15241	-118.50953	Waterfowl
AB	Surette Lake	58.34491	-116.68617	Waterfowl, Waterbirds
AB	Taber Lake	49.80296	-112.09291	Waterfowl
AB	Texas Irricana Lake	51.27735	-113.64061	Waterbirds
AB	Texas Salt Lake	51.30160	-113.55440	Waterfowl
AB	Therien Lakes	53.96000	-111.33000	Waterfowl
AB	Tilley A Reservoir	50.49470	-111.61320	Waterfowl
AB	Tilley B Reservoir	50.55030	-111.63650	Waterfowl
AB	Tilley Slough	50.45128	-111.61720	Waterfowl
AB	Timko Lake (bantry Reser	50.47650	-111.73284	Waterfowl
AB	Travers Reservoir	50.22086	-112.84315	Waterfowl
AB	Twelve Mile Coulee	50.18300	-111.60000	Waterfowl
AB	Twin Lakes	55.01282	-119.60127	Waterfowl
AB	Twin Lakes	55.00172	-119.58948	Waterfowl
AB	Tyrrell Lake	49.38639	-112.27172	Waterfowl
AB	Updike Lake	55.44119	-119.80392	Waterfowl
AB	Utikuma Lake	55.86409	-115.39199	Waterfowl
AB	Valhalla Lake	55.37623	-119.45271	Waterfowl
AB	Verdigris Lake	49.25193	-112.05535	Waterfowl
AB	Verdigris Slough	49.15670	-111.83790	Waterfowl
AB	Vermillion Lakes	53.69194	-111.65582	Waterfowl
AB	Vermillion Lakes	53.68817	-111.60542	Waterfowl
AB	Vermillion Lakes	53.67201	-111.54730	Waterfowl
AB	Vermillion Lakes	53.65376	-111.49545	Waterfowl
AB	Vernon Project	49.42640	-111.35160	Waterfowl
AB	Wakomao Lake	54.16142	-113.55612	Waterfowl
AB	Waterton Reservoir	49.29838	-113.68448	Waterfowl

Province	Wetland name	Latitude	Longitude	Target group
AB	Watt Lake	53.71051	-111.93174	Waterfowl
AB	Wavy Lake	52.87776	-112.06957	Waterfowl
AB	Wembley Lake	55.14894	-119.14034	Waterfowl
AB	West Arm Reservoir	49.36079	-111.02734	Waterfowl
AB	West Buffalo Lake	55.38144	-119.01298	Waterfowl
AB	West Muskeg Lake	56.90083	-112.49799	Waterfowl
AB	Weston Lake	49.33426	-112.18086	Waterfowl, Shorebirds
AB	Whitehorse Lake	50.66471	-110.48858	Waterfowl
AB	Whitford Lake	53.85791	-112.26368	Waterfowl
AB	Wilkin Lake	55.27922	-119.34625	Waterfowl, Waterbirds
AB	Wilson Prairie Lake	58.18756	-116.05924	Waterfowl
AB	Winagami Lake	55.62863	-116.75644	Waterfowl
AB	Wolf Lake	58.09958	-116.47341	Waterfowl
AB	Wolfe Lake	55.43106	-119.19190	Waterfowl
AB	Wood Lake	55.15382	-118.72582	Waterfowl
AB	Yellow Lake	49.73538	-111.50040	Waterfowl
AB	Yoke Lake	55.22038	-119.67923	
AB	Zama Lake	58.77425	-118.99262	

Province	Name	Waterfowl Value	Other Bird Value	Threat
MB	Plum Marsh	5	5	4
MB	Hunter - Maple	5	5	4
MB	Big Grass Marsh	5	5	3
MB	Alexander - Griswold	5	5	3
MB	Whitewater Lake	5	5	2
MB	Marshy Point	4	4	4
MB	Lake Francis	4	5	3
MB	Netley - Libau	4	4	4
MB	Shoal Lakes (Interlake)	4	4	4
MB	Glenboro Marsh	4	5	3
MB	Delta Marsh	3	5	4
MB	Oak Hammock	5	5	1
MB	Lidcliff Marshes	5	3	3
MB	Saskeram Marshes	5	4	2
MB	Summerberry Marshes	5	4	2
MB	Tom Lamb WMA	5	4	2
MB	Dog Lake (Interlake)	4	5	2
MB	Big Point (Lk. Man.)	4	5	2
MB	Sagemace Bay (Lk. Wpgosis.)	4	5	2
MB	Long Island Bay (Lk. Wpgosis.)	5	4	1
MB	Reader - Root Lakes	5	4	1
MB	Proven Lake	4	4	2
MB	Hecla Island Marshes	4	5	1
MB	Kaleida - Snowflake Marshes	4	3	3
MB	Bluewing Country (NW Riding Mtn.)	4	4	2
MB	Pinemuta - Lake St. Martin	3	3	4
MB	Lizard Lake	3	5	2
MB	Douglas Marsh	3	5	2

Province	Name	Waterfowl Value	Other Bird Value	Threat
MB	Central Interlake Marshes	3	4	3
MB	Dennis Lake	3	3	4
MB	Bone Lake	4	4	1
MB	Swan/Grassy Lakes/Floral WMA	4	4	1
MB	Lorne/Louise Lakes	3	3	1
MB	Pelican Lake	3	3	1
MB	Rock Lake	3	3	1
MB	Peonan Point	4	4	1
MB	Kawinaw Lake (N. of Waterhen)	4	4	1
MB	Chitek Lake (N. of Waterhen)	4	4	1
MB	Oak Lake Marsh (SW. MB)	4	4	1
MB	Turtle River	3	4	2
MB	Reykjavik Marshes (Lk. Man.)	3	4	2
MB	Chain Lakes (SW. Man.)	4	3	1
MB	Waterhen Lake	4	3	1
MB	Saint Lakes (N. Interlake)	4	3	1
MB	Beaver Dam Lake (Westlake)	3	3	2
MB	Portia Marshes (Westlake)	3	3	2
MB	Dauphin Lake Marshes	3	3	2
MB	Lonely Lake (Westlake)	3	3	2
MB	Pelican Lake (Swan River Valley)	3	4	1
MB	Swan Lake (Swan River Valley)	3	4	1
MB	Rat River Swamp	2	5	1
MB	Grants Lake	4	2	1
MB	Riverton/Washow Bay Marshes	3	3	1
MB	Spence Lake (Westlake)	3	3	1
MB	Moosehorn Lakes (Interlake)	3	3	1

Province	Wetland name	Latitude	Longitude
SK	Akerlund Lake	52.50000	-109.28000
SK	Amyot Lake	53.70000	-106.64000
SK	Anglin Lake	53.73000	-105.93000
SK	Antelope Lake	50.27000	-108.39000
SK	Aroma Lake	52.28000	-108.56000
SK	Ashe Lake	52.87000	-106.88000
SK	Aurthur Lake	52.57000	-105.44000
SK	Bad Lake	51.38000	-108.44000
SK	Bainbridge Lake	53.59000	-101.98000
SK	Baird Lake	53.95000	-103.83300
SK	Bank Lake	51.58000	-105.13000
SK	Bankside Lake	53.24000	-102.41000
SK	Barber Lake (3N Wiseton)	51.37000	-107.66000
SK	Barnes Lake	53.55000	-107.76000
SK	Barrier Lake	52.52000	-103.79000
SK	Basin Lake	52.61000	-105.28000
SK	Beaton Lake	53.80000	-102.18000
SK	Beaufield Lake	51.78000	-109.09000

Province	Wetland name	Latitude	Longitude
SK	Belanger Lake	53.91700	-102.01000
SK	Bell Lake	53.55000	-106.10000
SK	Berube Lake	53.48000	-106.95000
SK	Big Lake	53.86000	-102.25000
SK	Big Muddy Lake	49.14000	-104.88000
SK	Big Quill Lake	51.88000	-104.36000
SK	Big Sucker Lake	53.42500	-106.40000
SK	Big Valley Lake	52.40000	-103.01000
SK	Bigstick Lake	50.26000	-109.32000
SK	Binns Lake (1)	53.58000	-102.55000
SK	Binns Lake (2)	0.00000	0.00000
SK	Birch Lake	53.46000	-108.18000
SK	Birchbark Lake	53.63000	-102.32000
SK	Birchbark Lake (4N, 12 W Smeaton)	53.55000	-105.10000
SK	Birling Lake	53.03000	-109.09000
SK	Bitter Lake	50.09000	-109.79000
SK	Bittern Lake	53.94000	-105.75000
SK	Bjork Lake	52.73000	-103.52000
SK	Blackstrap Reservoir	51.82000	-106.40000
SK	Blaine Lake	52.79000	-107.01000
SK	Bland Lake	53.50000	-107.27000
SK	Bliss Lake	49.78000	-105.51000
SK	Bloodsucker Lake	53.86000	-102.55000
SK	Bog Lake (10S 2E Cumberland)	53.76000	-102.18000
SK	Boggy Lake	50.57000	-108.47000
SK	Boucher Lake	52.45000	-105.67000
SK	Boulder Lake	51.60000	-105.24000
SK	Bourassa Lake	53.63000	-102.90000
SK	Braddock Reservoir	50.09000	-107.36000
SK	Bronson Lake	53.86000	-109.70000
SK	Buffalo Lake	51.77000	-105.87000
SK	Buffalo Pound Lake	50.60000	-105.41000
SK	Buffalohead Lake	53.50000	-102.73000
SK	Buffer Lake (3N & 2E Vonda)	52.38000	-106.02000
SK	Bulrush Lake	51.38000	-105.40000
SK	Cabri Lake	51.11000	-109.73000
SK	Cactus Lake	52.15000	-109.88000
SK	Candle Lake	53.81000	-105.25000
SK	Carps Lake	52.47000	-103.90000
SK	Carrot Lake	53.70000	-101.90000
SK	Castlewood Lake	52.09000	-108.09000
SK	Channel Lake	49.53000	-105.24000
SK	Chaplin Lake	50.31000	-106.59000
SK	Chaplin Lake	50.44000	-106.71000
SK	Chaplin Lake	50.41000	-106.60000
SK	Charron Lake	52.40000	-104.32000
SK	Cheviot Lake	52.03000	-106.33000
SK	Chitek Lake	53.74000	-107.79000

Province	Wetland name	Latitude	Longitude
SK	Christopher Lake	53.57000	-105.83000
SK	Clarke Marsh	49.93000	-106.03000
SK	Clearsand Lake	53.83000	-105.57000
SK	Coldspring Lake	52.34000	-108.59000
SK	Crabtree Lake	0.00000	0.00000
SK	Crane Lake	50.10000	-109.08000
SK	Crescent Lake	51.02000	-102.49000
SK	Crooked Lake	50.60000	-102.75000
SK	Cross Lake	53.99000	-102.07000
SK	Culdesac Lake	53.62000	-101.77000
SK	Cut Beaver Lake	53.78000	-102.65000
SK	Cutbank Lake (8N 1E Morse)	50.53000	-107.00000
SK	Cypress Lake	49.47000	-109.48000
SK	Dana Salt Lake	52.24200	-105.70800
SK	Deadmoose Lake	52.29000	-105.14000
SK	Deep Lake (7S Indian Head)	50.42000	-103.68000
SK	Deep Lake (8S 12W Cumberland)	53.84000	-102.55000
SK	Delaronde Lake	53.93000	-106.95000
SK	Dewar Lake	51.61000	-109.62000
SK	Dickson Lake	52.83300	-105.30000
SK	Downie Lake	49.80000	-109.68000
SK	Drake Lake	52.44000	-109.93000
SK	Duck Lake	52.80000	-106.27000
SK	Ear Lake	52.29000	-109.21000
SK	East Coteau Lake	49.04000	-104.40000
SK	Echo Lake (1 N Fort Qu?Appelle)	50.79000	-103.84000
SK	Edward Lake	53.66000	-107.74000
SK	Egg Lake (10 E Edenwold)	50.63000	-104.00000
SK	Egg Lake (4S 2W Cumberland)	53.88000	-102.32000
SK	Eins Lake	52.05000	-108.52000
SK	Ekapo Lake	50.29000	-102.55000
SK	Elm Lake	53.74000	-101.89000
SK	Emma Lake	53.58000	-105.89000
SK	End Lake	52.36000	-109.20000
SK	Englishman Lake	53.40000	-109.19000
SK	Eyebrow Lake	50.96000	-106.18000
SK	Fife Lake	49.22000	-105.87000
SK	Fire Lake	52.45000	-109.40000
SK	Fishing Lake	51.83000	-103.52000
SK	Forgan Flats	51.28000	-107.73000
SK	Frederick Lake	50.03000	-105.79000
SK	Freshwater Lake	52.61000	-109.98000
SK	Fulton Lake	51.75000	-102.42000
SK	Galletly Lake	53.92000	-109.63000
SK	George Williams Lake	52.45000	-103.93000
SK	Gillies Lake	52.83000	-106.85000
SK	Good Spirit Lake	51.54000	-102.66000
SK	Goose Lake (2S 2E Tessier)	51.75000	-107.38000

Province	Wetland name	Latitude	Longitude
SK	Goose Lake (25S 8W Cumberland)	53.61000	-102.50000
SK	Goose Lake (7E &7N Landis)	52.31000	-108.30000
SK	Gordon Lake	52.89000	-107.37000
SK	Greenstreet Lake	53.47000	-109.82000
SK	Greenwater Lake	52.52000	-103.50000
SK	Grill Lake	52.20000	-109.12000
SK	Halkett Lake	53.65000	-106.10000
SK	Hanging Heart Lake	53.98000	-106.21700
SK	Harper Lake	53.58000	-104.92000
SK	Hay Bay Lake	53.92000	-106.99000
SK	Hay Lake	49.94000	-109.37000
SK	Helene Lake	53.53000	-108.21000
SK	Helldiver Lake	53.59000	-101.93000
SK	Heritage Lake	0.00000	0.00000
SK	Hewitt Lake	49.76000	-102.34000
SK	Highbank Lake	53.87000	-102.44000
SK	Highfield Reservoir	50.30000	-107.39000
SK	Hill Island Lake	53.96000	-103.03300
SK	Hines Lake	53.41000	-106.97000
SK	Horsehide Lake	52.75000	-103.40000
SK	Horseshoe Lake	51.48000	-102.61000
SK	Houghton Lake	52.37000	-105.14000
SK	Humboldt Lake	52.15000	-105.12000
SK	Hunting Lake	53.97000	-108.27000
SK	Ibsen Lake	49.79000	-104.25000
SK	Indi Lake	51.69000	-106.52000
SK	Ingebright Lake	50.36000	-109.32000
SK	Iroquois Lake	53.17000	-107.02000
SK	Island Lake	53.97000	-107.73000
SK	Ispuchaw Lake	54.00000	-104.70000
SK	Jackfish Lake	53.07000	-108.40000
SK	Jansen Lake	51.91000	-104.76000
SK	Jim Creek Lake	49.08000	-104.63000
SK	Jumping Lake	52.86000	-105.46000
SK	Junction Reservoir	49.94000	-109.50000
SK	Keg Lake	53.62000	-107.03000
SK	Kennedy Lake	53.60000	-102.94000
SK	Kenosee Lake	49.82000	-102.30000
SK	Keppel Lake	52.40000	-108.34000
SK	Ketchamonia Lake	51.75000	-101.68000
SK	Kettlehut Lake	50.66000	-106.51000
SK	Killsquaw Lake	52.40000	-109.09000
SK	Kimoff Lake	52.26000	-108.19000
SK	Kipabiskau Lake	52.57000	-104.18000
SK	Kitako Lake	52.46000	-104.21000
SK	Kiyiu Lake	51.60000	-108.90000
SK	Klogei Lake	52.31000	-103.32000
SK	Lac Huard Lake	53.76000	-107.61000

Province	Wetland name	Latitude	Longitude
SK	Lac Pelletier	49.98000	-107.93000
SK	Ladder Lake	53.82000	-106.98000
SK	Lake of the Prairies	51.29000	-101.57000
SK	Lake of the Rivers	49.81000	-105.73000
SK	Landis Lake	52.19000	-108.51000
SK	Last Mountain Lake	50.80000	-105.01000
SK	Leaf Lake	53.02000	-102.14000
SK	Leech Lake	51.07000	-102.48000
SK	Lenore Lake	52.50000	-104.98000
SK	Little Egg Lake	53.90000	-102.27000
SK	Little Fishing Lake	53.86000	-109.55000
SK	Little Manitou Lake	52.62000	-109.63000
SK	Little Manitou Lake	51.73000	-105.48000
SK	Little Nut Lake	52.32000	-103.51000
SK	Little Pelican Lake	53.76700	-107.75000
SK	Little Quill Lake	51.91000	-104.06000
SK	Little Whitefish Lake	53.58000	-107.11000
SK	Lobstick Lake	53.66000	-102.12000
SK	Loch Lomond	51.98000	-102.74000
SK	Lonetree Lake	50.49000	-106.94000
SK	Luck Lake	51.07000	-107.10000
SK	MacDonnell Lake	54.00000	-105.25000
SK	MacLeod Lake	53.41000	-108.27000
SK	Maiden Lake	53.44000	-108.45000
SK	Maidstone Lake	53.02000	-109.29000
SK	Manitou Lake	52.74000	-109.67000
SK	Mann Lake	52.28000	-102.74000
SK	Many Island Lake	50.11000	-109.99000
SK	Marean Lake	52.52000	-103.58000
SK	Marshall Lake	0.00000	0.00000
SK	Maskwa Lake	52.96000	-109.19000
SK	McAurthur Lake	52.56700	-104.40000
SK	McBride Lake	52.45000	-102.41000
SK	McConechy Lake	53.79000	-105.67000
SK	McIntyre Lake	52.54000	-105.34000
SK	McLean Lake	0.00000	0.00000
SK	Meadow Lake	54.11000	-108.34000
SK	Meeting Lake	53.19000	-107.67000
SK	Middle Creek Reservoir	49.40000	-110.00000
SK	Midnight Lake	53.51000	-108.32000
SK	Mikinak Lake	53.72000	-108.54000
SK	Miller Lake	53.49000	-108.97000
SK	Ministikwan Lake	54.01000	-109.65000
SK	Mistawasis Lake	53.09000	-107.24000
SK	Mizhashk Lake	52.51000	-104.17000
SK	Montague Lake	49.48000	-105.82000
SK	Moose Mountain Lake	49.91000	-103.08000
SK	Moosomin Lake	50.08000	-101.71000

Province	Wetland name	Latitude	Longitude
SK	Morin Lake	53.50000	-107.06700
SK	Mud Lake	51.92000	-104.21000
SK	Muddy Lake	52.32000	-109.12000
SK	Muskiki Lake	52.34000	-105.72000
SK	Namekus Lake	53.83000	-106.02000
SK	Neely Lake	52.72000	-102.81000
SK	Nesslin Lake	53.95000	-106.78000
SK	Newton Lake	49.32000	-107.83000
SK	Nikik Lake	52.66700	-104.33300
SK	Niska Lake	53.56000	-101.88000
SK	No Name	51.23000	-105.40000
SK	No Name	52.02000	-106.23000
SK	No Name	51.42000	-108.09000
SK	No Name	51.81000	-108.77000
SK	No Name	52.51000	-104.50000
SK	No Name	50.87000	-109.40000
SK	No Name	51.40000	-108.03000
SK	No Name	52.09000	-105.75000
SK	No Name	51.62000	-109.49000
SK	No Name	52.90000	-106.82000
SK	No Name	52.93000	-106.83000
SK	No Name	53.92000	-109.76000
SK	No Name	52.55000	-105.07000
SK	No Name	53.67000	-106.84000
SK	No Name	49.78000	-105.87000
SK	No Name	49.92000	-106.78000
SK	No Name	49.21000	-108.99000
SK	No Name	51.94000	-102.26000
SK	No Name	50.22000	-108.94000
SK	No Name	51.59000	-108.64000
SK	No Name	51.05000	-102.44000
SK	No Name	49.67000	-106.56000
SK	No Name	51.49000	-105.29000
SK	No Name	51.95000	-109.46000
SK	No Name	49.88000	-106.18000
SK	No Name	53.94000	-109.97000
SK	No Name	53.61700	-102.04000
SK	No Name	51.21000	-109.46000
SK	No Name	51.85000	-107.22000
SK	No Name	51.36000	-107.94000
SK	No Name	51.49000	-108.78000
SK	No Name	52.67000	-104.27000
SK	No Name	51.74000	-109.35000
SK	No Name	50.30000	-109.89000
SK	No Name	52.48000	-109.18000
SK	No Name	52.26000	-104.56000
SK	No Name	50.02000	-102.19000
SK	No Name	52.38000	-108.67000

Province	Wetland name	Latitude	Longitude
SK	No Name	49.65000	-106.33000
SK	No Name	53.96000	-109.45000
SK	No Name	53.99000	-109.28000
SK	No Name	53.71000	-107.20000
SK	No Name	50.06000	-109.46000
SK	No Name	51.57000	-106.84000
SK	No Name	50.89000	-109.29000
SK	No Name	52.16000	-108.49000
SK	No Name	51.82000	-109.59000
SK	No Name	50.35000	-108.45000
SK	No Name	51.77000	-103.35000
SK	No Name	50.06000	-108.91000
SK	No Name	51.17000	-105.35000
SK	No Name	51.55000	-109.84000
SK	No Name	49.64000	-105.03000
SK	No Name	51.34000	-109.87000
SK	No Name	53.64000	-109.92000
SK	No Name	52.28000	-106.25000
SK	No Name	49.30000	-109.20000
SK	No Name	50.17000	-109.52000
SK	No Name	51.20000	-109.62000
SK	No Name	52.27000	-109.81000
SK	No Name	49.14000	-108.74000
SK	No Name	51.46000	-109.86000
SK	No Name	52.08000	-109.28000
SK	No Name	51.63000	-108.19000
SK	No Name	50.71000	-108.44000
SK	No Name	49.59000	-106.02000
SK	No Name	52.30000	-104.20000
SK	No Name	52.21000	-103.83000
SK	No Name	49.75000	-103.00000
SK	No Name	52.03000	-107.84000
SK	No Name	49.50000	-105.18000
SK	No Name	52.15000	-107.65000
SK	No Name	50.80000	-109.61000
SK	No Name	51.83000	-109.34000
SK	No Name	49.68000	-106.41000
SK	No Name	52.58000	-105.55000
SK	No Name	53.86700	-102.16700
SK	No Name	52.03000	-105.58000
SK	No Name	51.99000	-109.97000
SK	No Name	52.27000	-104.13000
SK	No Name	51.34000	-108.54000
SK	No Name	49.76000	-102.97000
SK	No Name	51.38000	-109.19000
SK	No Name	52.23000	-109.93000
SK	No Name	52.27000	-104.16000
SK	No Name	52.63000	-105.89000

Province	Wetland name	Latitude	Longitude
SK	No Name	52.57000	-104.68000
SK	No Name	52.66000	-105.89000
SK	No Name	49.79000	-107.14000
SK	No Name	52.73000	-107.86000
SK	No Name	53.51000	-109.27000
SK	No Name	51.34000	-109.22000
SK	No Name	51.27000	-109.87000
SK	No Name	52.69000	-107.77000
SK	No Name	51.19000	-104.95000
SK	No Name	52.17000	-109.95000
SK	Nut Lake	52.36000	-103.71000
SK	Okemasis Lake	52.90000	-106.28000
SK	Old Wives Lake	50.10000	-105.98000
SK	Onion Lake	53.71000	-109.89000
SK	Opuntia Lake	51.80000	-108.57000
SK	Oscar Lake	53.62000	-105.85000
SK	Osimisk Lake	53.97000	-106.85000
SK	Overflow Lake	53.16000	-102.49000
SK	Paddling Lake (5W 1S Leask)	53.00000	-106.89000
SK	Paddling Lake (9N 1W Blaine Lake)	52.96000	-106.91700
SK	Patience Lake	52.13000	-106.33000
SK	Patoto Lake	53.69000	-102.11000
SK	Paysen Lake	50.71000	-106.74000
SK	Peck Lake	53.89000	-109.59000
SK	Pelican Lake (1E Domremy)	52.78000	-105.70000
SK	Pelican Lake (7N Mortlach)	50.54000	-106.01000
SK	Petabec Lake	53.71700	-102.20800
SK	Pike Lake	51.89000	-106.80000
SK	Piwei Lake	52.49000	-103.47000
SK	Ponass Lake	52.27000	-104.01000
SK	Porter Lake	52.19000	-106.29000
SK	Proctor Lake	51.71000	-106.64000
SK	Rabbit Lake	52.61000	-107.00000
SK	Radisson Lake	52.49000	-107.41000
SK	Ranch Lake	52.49000	-104.77000
SK	Rat Lake	53.73300	-102.23300
SK	Raven Lake	52.21000	-103.27000
SK	Redberry Lake	52.69000	-107.16000
SK	Redearth Lake	53.52000	-102.88000
SK	Reed Lake	50.40000	-107.09000
SK	Reflex Lakes	52.68000	-109.95000
SK	Reid Lake Reservoir	50.03000	-108.12000
SK	Rice Lake	52.07000	-107.11000
SK	Round Lake (14N 4W Whitewood)	50.54000	-102.39000
SK	Round Lake (2S 2E Kinlach)	52.36000	-103.40000
SK	Rousay Lake	52.16700	-102.55000
SK	Royal Lake	53.08000	-106.88000
SK	Ruby Lake	52.97000	-102.35000

Province	Wetland name	Latitude	Longitude
SK	Rush Lake	53.07000	-109.07000
SK	Russell Lake	53.23000	-108.21000
SK	Sakwasew Lake	51.86000	-103.39000
SK	Saline Lake	51.79000	-103.20000
SK	Salt Lake	49.28000	-104.70000
SK	Scentgrass Lake	52.96000	-108.18000
SK	Seagram Lakes	52.61000	-109.40000
SK	Seagram Lakes	52.59000	-109.33000
SK	Shallow Lake (6S 6E Assiniboia)	49.52000	-105.83000
SK	Shallow Lake (6W 3N Kerrobert)	51.99000	-109.29000
SK	Shell Lake	53.22000	-107.16000
SK	Shoal Lake	53.48000	-102.71700
SK	Shoe Lake	49.73000	-105.35000
SK	Sidney Lake	53.77000	-109.61000
SK	Silver Lake	51.68000	-103.23000
SK	Snakehole Lake	50.51000	-108.47000
SK	Snipe Lake	51.23000	-108.86000
SK	Soda Lake	53.00000	-109.32000
SK	Spence Lake	0.00000	0.00000
SK	Spruce Lake	53.56000	-109.09000
SK	Stink Lake	51.05000	-107.36000
SK	Stinking Lake	52.44000	-104.66700
SK	Stockwell Lake	51.36000	-107.17000
SK	Stone Wall Lake	51.78000	-103.15000
SK	Stony Lake	53.48000	-108.54000
SK	Strawberry Lake (5N 1E Odessa)	50.36000	-103.77000
SK	Strawberry Lakes (5N 3E Odessa)	50.35000	-103.70000
SK	Street Lake	51.86000	-109.36000
SK	Sturgeon Lake	53.42000	-106.04000
SK	Sylvander Lake	53.46000	-107.67000
SK	Taits Lake	49.16000	-108.76000
SK	Tatagwa Lake	49.62000	-104.01000
SK	Tenaille Lake	50.10800	-109.50000
SK	Teo Lakes	51.59000	-109.41000
SK	Teo Lakes	51.54000	-109.34000
SK	Teo Lakes	51.59000	-109.38000
SK	Teo Lakes	51.62000	-109.43000
SK	Thackeray Lake	52.54000	-108.69000
SK	Thomson Lake	49.77000	-106.60000
SK	Tobin Lake	53.59000	-103.47000
SK	Tramping Lake	52.00000	-108.79000
SK	Trappers Lake	53.79200	-106.03300
SK	Turnberry Lake	53.60000	-101.77000
SK	Twelve Mile Lake	49.48000	-106.22000
SK	Usinneskaw Lake	51.79000	-103.36000
SK	Vanscoy Lake	52.08000	-107.55000
SK	Wakaw Lake	52.67000	-105.60000
SK	Waldsea Lake	52.28000	-105.20000

Province	Wetland name	Latitude	Longitude
SK	Waskesiu Lake	53.94000	-106.16000
SK	Waterhen Marsh	52.84000	-105.04000
SK	Wells Lake	52.82000	-109.85000
SK	West Coteau Lake	49.04000	-104.53000
SK	White Gull Lake	53.92000	-105.08000
SK	White Heron Lake	51.90000	-109.06000
SK	Whitebear Lake (5S Elrose)	51.06000	-108.08000
SK	Whitebear Lake (9N Carlyle)	49.78000	-102.26000
SK	Williams Lake	0.00000	0.00000
SK	Willow Bunch Lake	49.44000	-105.44000
SK	Windy Lake	52.31000	-103.11000
SK	Winniford Lake	52.69000	-108.38000
SK	Winter Lake	53.71000	-106.89000
SK	Witchekan Lake	53.43000	-107.58000
SK	Wolverine Lake	52.01000	-105.23000
SK	Worthington Lake	53.95000	-109.61000
SK	York Lake	51.16000	-102.49000
SK	Zella Lake	51.97000	-109.23000
SK	Zelma Reservoir	51.83000	-105.84000
SK	Zoller Lake	52.35000	-109.61000

APPENDIX 11:
Prairie habitat monitoring program agricultural surface ditching inventory.

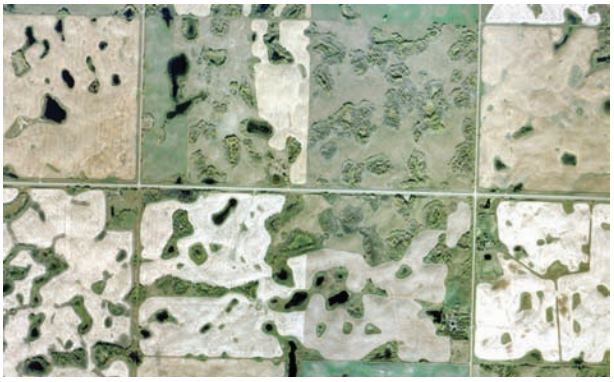
Background:

The Prairie Habitat Monitoring Program Agricultural Surface Ditching Inventory was developed to better understand the geographic distribution of land-use activities related to wetland loss and degradation. The mapping product is the result of a land section-based classification process that measures the intensity of agricultural surface ditching in relation to wetlands across the Prairie Habitat Joint Venture (PHJV) area. The intent of this mapping product is to (i) aid in the identification of areas that have or continue to be subject to wetland loss or degradation and (ii) identify areas with high potential for restoration activities. The mapping product was designed to provide a geographic distribution map of identifiable agricultural ditching intensity from a wetland conservation perspective (Figure 16).

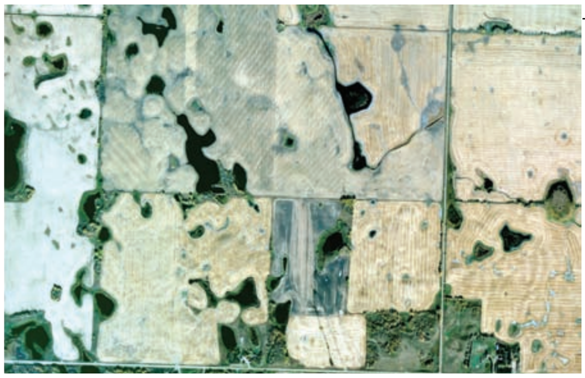
Methods:

Agricultural surface drains (ditches, canals and to some degree contour type drainage works) can be readily detected through aerial photography and high-resolution satellite imagery. The interaction of these surface ditches with wetland basins can also often be detected.

Aerial photography and high resolution satellite imagery of varying dates (image date ranges used by province AB 2004-2012, SK 2010-2012, MB 2010-2012) were used as the base of assessment for the map. Image resolution varied from 2.5 m to 0.5 m, and images were snow free. Images were evaluated through a "heads up process of interpretation" at an average viewing scale of 1:7000. Every section of land within the PHJV delivery area was manually photo interpreted and classified according to the intensity of agricultural-surface ditching present. The sections were classified into three classes of ditching intensity:



Class 1: None to Low ditching intensity is reserved for sections in which there is minimal evidence of anthropogenic drainage and/or natural drainage alteration. Class 1 areas show no direct evidence of wetland drainage, but may show indications of limited natural drainage disturbance impacts.



Class 2 Low to Medium ditching intensity is reserved for sections in which strong evidence exists that there is currently or has been definable ditching activities with some evidence of wetland drainage (ditches intersecting wetland basins). These sections often have permanent ditching works in place or significant natural drainage pattern alterations. In Class 2 sections there may often be definable drained basins and supporting drainage infrastructure.

Class 3 Medium to High is reserved for sections in which extensive ditching and related drainage works are present or sections with evidence of large wetland area impacted by ditching. Multiple drained/impacted basins are very apparent throughout the section. Extensive ditching webs/networks are apparent and there is evidence of ditches in wetland basins.

Limitations:

Ditching classifications presented here should be interpreted with caution and interpreted with consideration of local land use practices. This product is not a direct representation of wetland loss rather a measurement of ditching intensity that in some areas can be directly related to wetland drainage and/or degradation. Historical drainage that shows little remaining evidence of wetland basin or related ditching works would likely not have been identified through this manually interpreted mapping process. All ditching works were considered for classification purposes thus ditches related to irrigation would also have been included as part of the classification process. Common sources of error include misclassification due to confusion between natural drainage patterns and anthropogenic ditching, linear land workings similar in appearance to ditch construction and issues related to season of image capture.

Inside back cover:

Large Wetland in Native Prairie Grassland/©Ducks Unlimited Canada

On the back cover:

Left to Right:

Bullshead Conservation Area Project Tour/©Ducks Unlimited Canada
Flock of Mallards/©Ducks Unlimited Canada/Tye Gregg
IWWR's Sustainable Landscape Change Study/©Ducks Unlimited Canada/Chris Benson
Prairie Landowners/©Ducks Unlimited Canada

CONNECTING PEOPLE

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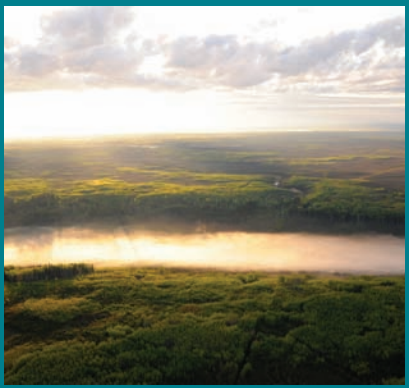
LANDSCAPE LEVEL

using a

PARTNERSHIP APPROACH



prairie habitat
joint venture