PROPOSED

Species at Risk Act
Management Plan Series

Management Plan for the Horned Grebe (*Podiceps auritus*), Western population, in Canada

Horned Grebe, Western population

2021

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For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: A pair of Horned Grebes © iStock.com/pum_eva

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Horned Grebe, Western population, and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the governments of Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, the Gwich'in Renewable Resources Board, the Sahtu Renewable Resources Board, the Wek'eezhii Renewable Resources Board and the Wildlife Management Advisory Council as per section 66(1) of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada, the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Horned Grebe, Western population, and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

Acknowledgments

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Executive Summary

The Horned Grebe (*Podiceps auritus*) is a waterbird species found in Eurasia and North America. There are two populations in North America: the Western population and a small isolated population in the east (on the Magdalen Islands, Quebec). The Western population, which represents the bulk of the breeding population in Canada and in North America, is the subject of this Management Plan.

The Horned Grebe, Western population, was assessed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2009 and was listed in Schedule 1 of Canada's *Species at Risk Act* in 2017. The IUCN Red List[3] increased the global rank of the Horned Grebe from Least Concern to Vulnerable in 2015 because of ongoing population declines in North America and Europe. In North America, the Horned Grebe is protected in Canada under the *Migratory Birds Convention Act* and in the United States under the *Migratory Bird Treaty Act*.

The Western population of the Horned Grebe is estimated at between 200,000 and 500,000 individuals. Approximately 92% of the North American breeding range of this population is located in Canada. While the COSEWIC status report of this population suggested a long-term decline of the continental population on the wintering grounds, a new analysis of the Christmas Bird Count (CBC) data using a hierchical model[4] now suggests that the population has been relatively stable since the 1970s and might have been increasing in recent years. However, this continental trend masks regional variations between two important wintering areas: while the number of birds wintering along the Pacific coast has been increasing, there was a decline along the Atlantic coast until the mid 2000s. On the breeding grounds, Breeding Bird Survey (BBS) data suggest the species has experienced long-term declines in Canada since 1970, and particularly steep declines in the Canadian Prairies in recent years (2007-2017). Horned Grebe abundance in the Canadian Prairies is positively correlated with the abundance of ponds in spring, which suggest that wet/dry cycles might influence the spatial breeding distribution of the species. However, the BBS has significant drawbacks when it comes to assessing population trends of wetland species, and lacks sufficient coverage in the boreal forest to properly assess population trends over the entire breeding range of the Horned Grebe, Western population. Additional research and monitoring is required to assess breeding population trends and to understand the connectivity between breeding and wintering grounds.

Because the Horned Grebe, Western population has such a widespread distribution, it faces numerous threats. Wetland loss and degradation occurs throughout the breeding range at the hand of various activities, but is particularly problematic in the Canadian Prairies where a large number of small, shallow wetlands are vulnerable to conversion to agriculture and contamination by pesticides. Additionally, droughts in the Prairies (a likely result of climate change) will further reduce the availability of breeding sites and

[3] International Union for the Conservation of Nature Red List of Threatened Species
[4] See Link et al. 2006, Sauer and Link 2011 and Soykan et al. 2016

exacerbate the conversion of wetlands to cropland. As a waterbird, Horned Grebes are vulnerable to fisheries bycatch and oil spills. Additional threats include eutrophication of nesting sites, diseases (Type E botulism) and collisions with power lines and wind turbines.

The management objective for the Horned Grebe, Western population, is to maintain, over the next 30 years (2021-2051), population levels at or above the average population levels of the past 30 years (1987-2017), and to maintain the population's current distribution in Canada.

The broad strategies and conservation measures identified to achieve these objectives are: i) conserving and restoring Horned Grebe breeding habitat in the Prairies through stewardship programs and best-management practices on privately owned land, ii) conserving and restoring Horned Grebe breeding habitat in the boreal forest through wetland conservation policies and best-management guidelines for natural resources industries, iii) addressing key knowledge gaps regarding threats other than habitat loss, particularly the impact of pesticides and the magnitude of mortality associated with fisheries bycatch, oil spills, diseases and collisions with power lines and wind turbines, iv) understanding the connectivity between breeding and wintering grounds, v) establishing a monitoring program suited to this (and other) wetland species.

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1. COSEWIC* Species Assessment Information

Date of Assessment: April 2009

Common Name (population): Horned Grebe – Western population

Scientific Name: *Podiceps auritus*

COSEWIC Status: Special Concern

Reason for Designation: Approximately 92% of the North American breeding range of this species is in Canada and is occupied by this population. It has experienced both long-term and short-term declines and there is no evidence to suggest that this trend will be reversed in the near future. Threats include degradation of wetland breeding habitat, droughts, increasing populations of nest predators (mostly in the Prairies), and oil spills on their wintering grounds in the Pacific and Atlantic Oceans.

Canadian Occurrence: Yukon Territory, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario

COSEWIC Status History: Designated Special Concern in April 2009. Assessment based on a new status report.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

The North American Horned Grebe (*Podiceps auritus cornutus*) population is divided into two distinct populations: the Western population, which comprises the bulk of the individuals across the continent, and a small long-standing breeding population (approximately 15 adults) on the Magdalen Islands in Quebec. The Western population is the subject of this Management Plan.

The Horned Grebe, Western population, is found breeding in Canada from the Yukon to the extreme northwestern part of Ontario, including British Columbia, Alberta, Saskatchewan, Manitoba, the Northwest Territories and the southern part of Nunavut. Approximately 92% of the Western population's breeding range is in Canada, but extends to Alaska, in the northwest, and to Montana and North Dakota, to the south (Stedman 2018).

The Horned Grebe's global conservation status rank is G5 (Secure). It is also considered Secure in Canada (N5B, N5B and N5M; NatureServe 2018). The statuses in each province and territory are presented in Table 1. The IUCN Red List increased the rank of the global Horned Grebe population from Least Concern to Vulnerable in 2015

because of ongoing population declines in North America and Europe (BirdLife International 2018).

Table 1. NatureServe Status[a] for the Horned Grebe and its populations in Canada

Region	Horned Grebe species' status	Magdalen Islands population's Status (Pop. 1)[b]	Western population's Status (Pop. 2)[b]
Global	G5	G5TNR	G5TNR
Canada	N5B, N5N, N5M	NNR	NNR
Alberta	S3B	-	SNR
British Columbia	S4B, SNRN	-	SNR
Labrador	SU	-	-
Manitoba	S3B	-	SNR
New Brunswick	S4N, S4M	-	-
Newfoundland Island	SNA	-	-
Northwest Territories	S3B	-	SNR
Nova Scotia	S4N	-	-
Nunavut	SUB, SUM	-	SNR
Ontario	S1B, S4N	-	SNR
Prince Edward Island	SNA	-	-
Quebec	S1	SNR	-
Saskatchewan	S5B	-	SNR
Yukon Territory	S4B	-	SNR

[a] The NatureServe status (rank) is made up of a letter which reflects the spatial level for which the status has been granted (G = global, N = national and S = provincial, state or territorial level). The numbers which follow it refer to the following statuses: 1- critically imperiled; 2- imperiled; 3-vulnerable to extirpation or disappearance; 4- apparently secure; 5- demonstrably widespread, abundant and secure. A breeding code is used when a breeding population and a non-breeding population are found within the same province or territory: B = breeding, N = non-breeding, M = migratory. Finally, the code NR signifies that the status has not yet been assessed. Two ranking values next to each other (e.g. S4S5N) show a range of uncertainty regarding the status of the species for the region.

[b] NatureServe acknowledges the presence of two distinct populations (Population 1 being the Magdalen Islands population and Population 2 being the Western population), but a complete assessment was only conducted at the species (global) level in Canada.

In Canada, the Western population was designated as Special Concern by COSEWIC and was listed as such under Schedule 1 of the *Species at Risk Act* (S.C. 2002, c.29) in 2017, while the Magdalen Islands population has been listed as Endangered since 2011. The Horned Grebe is also a migratory bird protected in Canada under the *Migratory Birds Convention Act,* 1994 and in the United States under the *Migratory Bird Treaty Act*. It is designated as a priority species in eleven Bird Conservation Regions[5,6]

[5] Bird Conservation Regions or BCR are bird ecoregions developed by the North American Bird Conservation Initiative (NABCI 2019; see Map of BCRs in Appendix A).

[6] Northwestern Interior Forest, Pacific & Yukon Region (BCR 4), Northern Pacific Rainforest (BCR 5), Boreal Taiga Plains, Prairie & Northern Region (BCR 6), Taiga Shield and Hudson Plain, Prairie & Northern Region (BCR 7), Boreal Softwood Shield, Prairie & Northern Region and Ontario subregions (BCR 8-PNR and BCR 8-ON), Great Basin, Pacific & Yukon Region (BCR 9), Northern Rockies, Pacific & Yukon Region (BCR 10), Prairie Potholes (Prairie & Northern Region (BCR 11), Boreal Hardwood Transition, Ontario and Manitoba Region (BCR 12) and Lower Great Lakes/St. Lawrence Plain (BCR 13).

across Canada. Finally, at the national level, it is listed as a Tier 2 species in Canada's Waterbird Conservation Plan (Environment Canada 2003).

At the provincial and territorial levels, the Horned Grebe has been listed as Special Concern in Ontario under the *Endangered Species Act* since 2009, and it is designated as Special Concern in New Brunswick under the *Species at Risk Act* (O.C. 2013-143). In Alberta, it has the general status of Sensitive, but this does not provide legal protection. In British Columbia, the species is listed on the Yellow List (species that are apparently secure and not at risk of extinction), but this listing does not provides no legal protection either.

In Quebec, the Magdalen Islands population is listed as Threatened under the *Loi sur les espèces menacées ou vulnérables* (L.R.Q. c. E-12.01).

3. Species Information

3.1. Species Description

The Horned Grebe is a waterbird weighing between 300 and 570 g (Stedman 2018). Its breeding plumage is characterized by a distinctive patch of bright yellow feathers which extends into tufts behind the eye. Its eyes are red, its neck and flanks are chestnut-red and the back is black. Males and females are similar in colouration. In winter, the plumage is black (back) and white (belly), with the white cheeks contrasting with a black crown.

This species is known as Surilitchiaq in Inuvialuktun and Tagwaatsik by the Teetl'it Gwich'in First Nation (Kaytlin Cooper, Gwich'in Renewable Resources Board, pers. comm. 2019).

3.2. Species Population and Distribution

The Horned Grebe has a holarctic[7] distribution: it is found both in North America and Eurasia and it is represented by a different subspecies in each hemisphere. While the global population is estimated at 239,000–583,000 individuals (Wetlands International, 2012). The Western population of the Horned Grebe is estimated at between 200,000 and 500,000 individuals, while the European subspecies, also known as the Slavonian Grebe (*P. a. auritus*), is estimated at only 12,800-18,400 mature individuals (BirdLife International 2017).

[7] of, relating to, or being the biogeographic region including the northern parts of the Old and the New Worlds and comprising the Nearctic and Palearctic regions or subregions (Merriam-Webster, 2019)

3.2.1 Breeding distribution, abundance and trends

Horned Grebes of the Western population breed south of the treeline from Alaska through the Northwest Territories, and from eastern British Columbia to the northern Unites States and east to the Ontario border (Sinclair et al. 2003, Stedman 2018). Approximately 92% of the Horned Grebe, Western population's breeding range is in Canada (COSEWIC 2009, Figure 1).

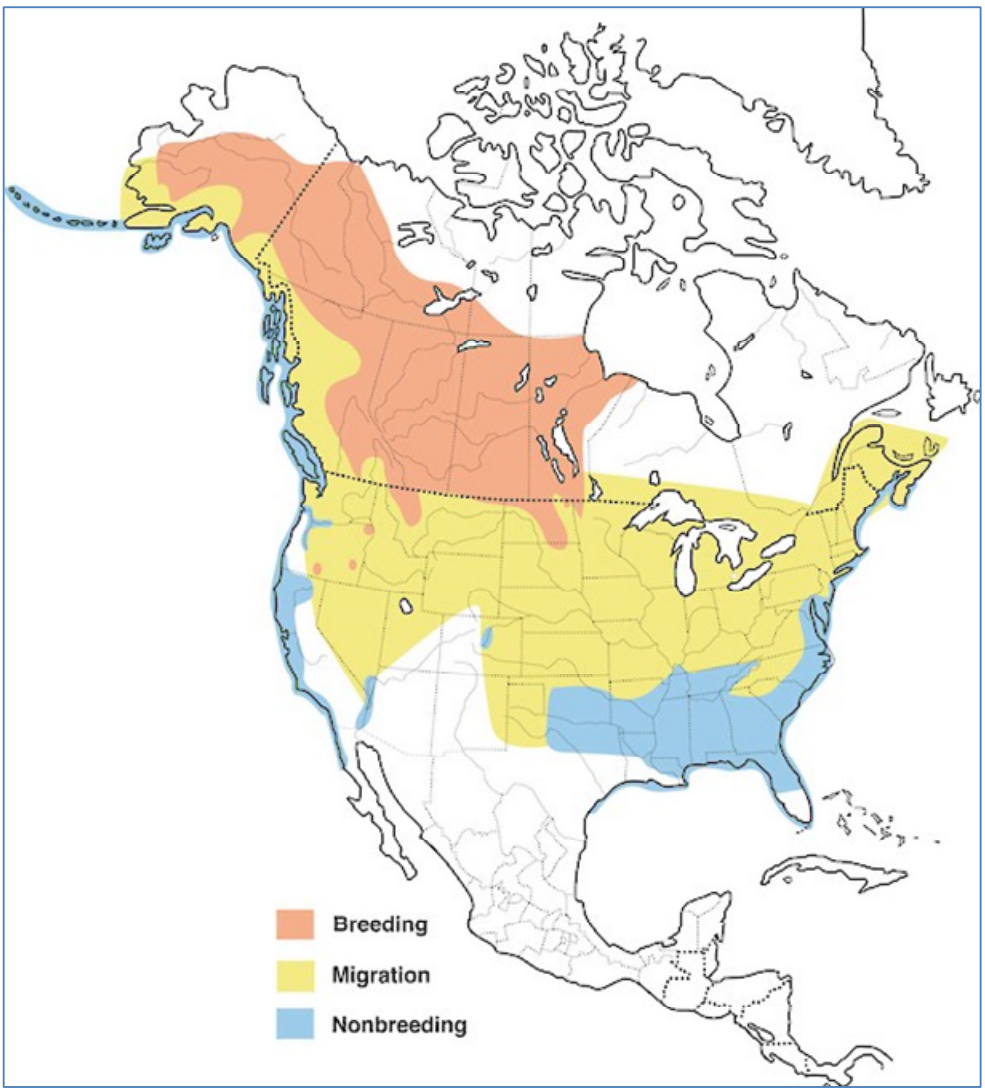

Figure 1. Distribution of the Horned Grebe in North America (from Cornell Lab - Birds of North America's Website, Stedman 2018). Note: the distribution of the Horned Grebe in the Northwest Territories extends futher north and east than what is illustrated on the map (C. Wood pers. comm. 2020).

In Canada, Horned Grebes breed at different densities across their range. The highest densities are found in the wetlands of the Prairies, where densities of 1.5 to 3.3 pairs per km^2 have been observed (Sugden 1977, COSEWIC 2009). The relative abundance map derived from BBS surveys indicate that the core breeding area coincides with the Prairie Parkland Region (as defined by PHJV 2014a and 2014b) of Alberta, Saskatchewan and Manitoba (Figure 2). Although data for the northern portion of the species' range is lacking in Figure 2, Horned Grebes are widespread, but less common, more localized and breed at lower densities in the boreal forest than in the Prairie Parkland Region (Semenchuk 2007, COSEWIC 2009, Mitchell 2018), which is supported by data from the Breeding Bird Atlases of Alberta, Saskatchewan[8] and Manitoba (Semenchuk 2007, Mitchell 2018, K. Drake pers. comm. 2019).

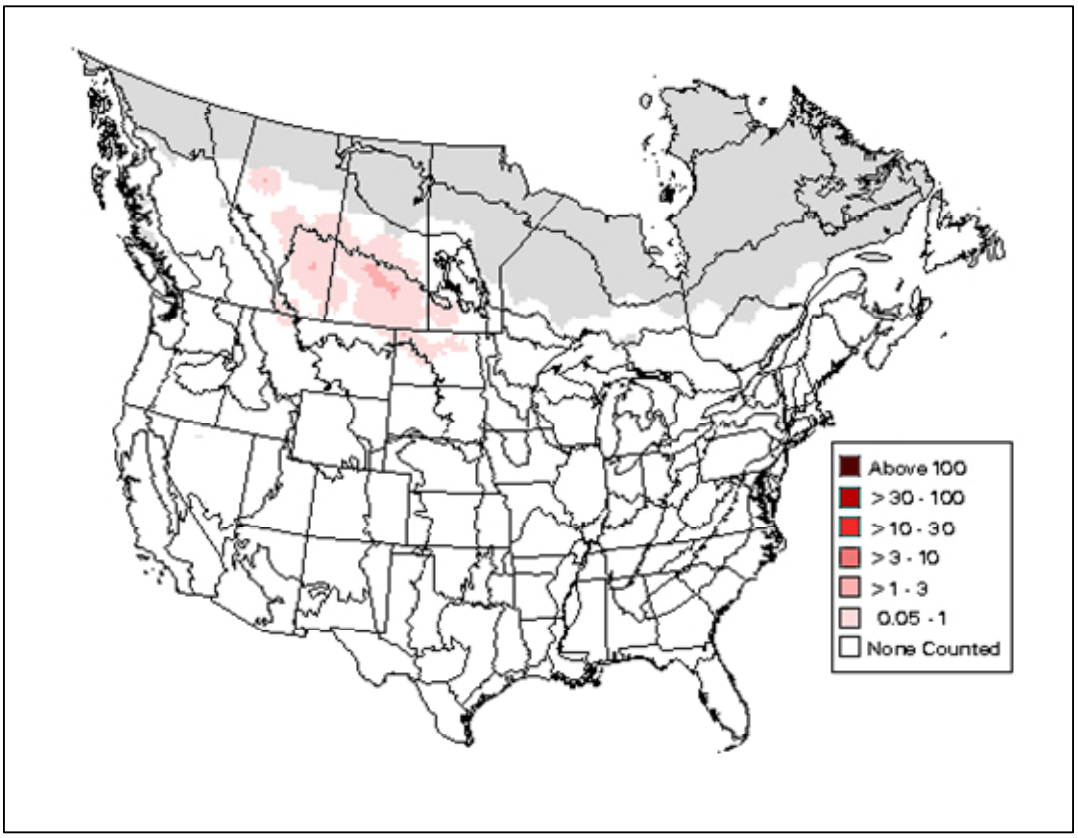

Figure 2. Relative abundance of the Horned Grebe in North America based on the Breeding Bird Survey from 2011 to 2015 (limited to southern parts of the range; areas in grey are areas where not enough data were available; Sauer et al. 2017)

In Alberta, Horned Grebes were most often found in the Grassland and Parkland Natural Region and were only found occasionally in the Boreal Forest, Foothills and Rocky Mountain Natural Regions (Semenchuk 2007). The second Atlas of the Breeding

[8] The Breeding Bird Atlas of Saskatchewan is an ongoing five-year project and only preliminary results from the first three field seasons (2017, 2018, 2019) are available. Yet, these results suggest that the species if more common and abundant in the south of the province than in the northern boreal forest. https://www.birdscanada.org/birdmon/skatlas/atlas_maps.jsp

Birds of Alberta suggests there has been a range contraction in the northwestern part of the province (Semenchuk 2007).

In Saskatchewan, the Horned Grebe is a common breeder in the Prairie Parkland Region, but less common and localized in the boreal and subarctic regions (Smith 1996, K. Drake pers. comm. 2019).

In Manitoba, the number of detection and probability of observation were the highest in the Prairie Pothole Region, especially south and west of Riding Mountain National Park (Mitchell 2018). Detections within the boreal biome were few and far between, with the exception of a cluster of sites around The Pas and around Churchill and Nueltin Lake (Mitchell 2018).

They are considered common in the southern Yukon Territory (Sinclair et al. 2003) and widespread in the Northwest Territories, where their known range actually extends futher east that what is illustrated in Figure 1 (C. Wood pers. comm. 2020). Although relatively high breeding densities were recorded near Yellowknife (2.2 pairs/km^2), this is probably not representative of the rest of the Northwest Territories, where breeding density is probably less than 0.1 bird/km^2 overall (Stotts 1988, Fournier and Hines 1999). They breed in small numbers in northern Manitoba up to the border with Nunavut (Mitchell 2018), which suggest that breeding in the southernmost portions of Nunavut is possible.

In British Columbia, the species breeds in sparse clusters east of the Coast Mountains, with the largest clusters located in the Peace River lowlands, the Cariboo plateau, and the Thompson-Nicola plateau (Howie 2015).

In Ontario, the Horned Grebe is an irregular, even rare breeder in the extreme northwestern parts of the province, near the border with Manitoba. During the surveys for the second Atlas of the Breeding Birds of Ontario, breeding evidence was reported in three locations (Opasquia Provincial Park, Pikangikum Lake and the Rainy River sewage lagoons) (Hoar 2007).

3.2.1.1 Breeding Bird Survey (BBS)

The BBS provides long-term breeding bird population trends in Canada, but its coverage is limited in the northern parts of the Horned Grebe's range. Additionally, the BBS is not well-suited for wetland species, such as the Horned Grebe: BBS routes may in general under-sample wetlands, and they are conducted in June, a time of the year when Horned Grebes are less visible and less active vocally (e.g. during incubation; Stedman 2018).

However, the BBS is the only dataset available to estimate long-term breeding population trends. Hence, according to BBS data, the Horned Grebe population has declined significantly in Canada since 1970, while the most important short-term

(2007-2017) declines occurred in BCR-11[9], also known as the Prairie Potholes Region (Table 2).

Table 2. National and regional annual percent population change (including 95% Confidence Intervals [CI]) for the Horned Grebe (Western Population) in Canada over the long-term and most recent 10 years, based on Breeding Bird Survey results.

Geographic area	Long-term trend (1970-2017)[a]				Most recent 10-years trend (2007-2017)			
	%/year	Lower CI	Upper CI	Overall reliability	**%/year**	Lower CI	Upper CI	Overall reliability
Canada	**-1.8***	-3.34	-0.495	Medium	**-3.22**	-8.46	2.02	Low
BCR-4 (Northwestern Interior Forest)	**-1.27**	-3.9	1.87	Low	**-1.17**	-8.25	7.62	Low
BCR-6 (Boreal Taiga Plains)	**-1.31**	-3.09	0.58	Low	**-1.27**	-7.99	3.62	Low
BCR-7 (Taiga Shield and Hudson Plains)	**-2.21**	-7.63	1.51	Low	**-2.04**	-12.3	8.58	Low
BCR-10 (Northern Rockies)	**-4.92***	-13.6	-0.411	Low	**-2.49**	-26.7	33.1	Low
BCR-11 (Prairie Potholes)	**-1.74**	-3.56	0.015	Medium	**-7.36***	-14.5	-0.807	Low

[a] Long-term trends range from 1970 to 2017, except for the Northwest Territories (1989-2017) and Yukon (1973-2017); *Significant trends
Source: Environment and Climate Change Canada (2017)

In the Prairie Potholes Region, Horned Grebe abundance (i.e. the BBS Annual Index) is positively correlated with the number of ponds in May (i.e. the WBPHS Pond Index[10]; Figure 3). This suggests that wet/dry cycles in the Prairie Potholes Region influence the availability of breeding ponds, which could influences the abundance of Horned Grebes in the region. For example, in during dry years, Horned Grebes may not be as abundant because of limited nesting sites because shallow ponds dry out. During these dry years, it is possible that Horned Grebes "flyover" the less suitable Prairie Potholes Region to nest in other areas, presumably further north; such a strategy is adopted by some waterfowl species using similar breeding habitat (Roy et al. unpublished 2018). However, there is insufficient data from the northern parts of the Horned Grebe's breeding range to capture the extent of this potential flyover. Hence, the population trend observed in the Prairie Potholes Region might not reflect a true population decline, but could be related to individuals moving north due to the limited number of suitable wetlands available for breeding.

[9] A map of BCRs is provided in Appendix A
[10] The Waterfowl Breeding Population Habitat Survey (WBPHS) Pond Index (or "May ponds") refers to the the number of wetlands detected in May during aerial surveys of the WBPHS.

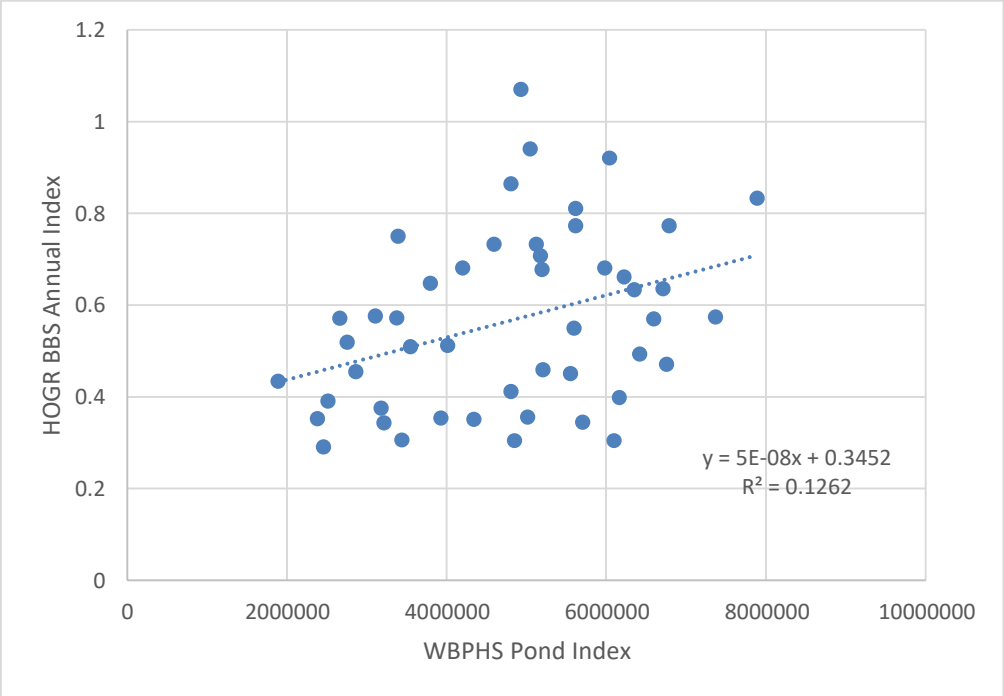

Figure 3. Correlation between the Horned Grebe's Breeding Bird Survey Annual Index and the number of ponds in May (WBPHS Pond Index) in BCR-11 (Prairie Potholes Region).

Given that there is possibly a relation between Horned Grebe abundance and wet/dry cycles, it is helpful to look at the BBS 10-year rolling trends to understand the long-term population trends for this species (Figure 4). The 10-year period trends are negative for most 10-year periods until the mid 2000s, with a few exceptions for periods ending in 1983, 1998 and 1999. However, after 2005, there are a number of positive 10-year period trends, such as in 2007 and between 2011 and 2015. This suggests that in recent years, the Horned Grebe population has been increasing, and this could be related to the return of favorable breeding conditions in the Prairie Potholes Region, after the worst recorded drought in 100 years in the Prairies occurred between autumn 1999 and spring 2004 (Drought Research Initiative 2011).

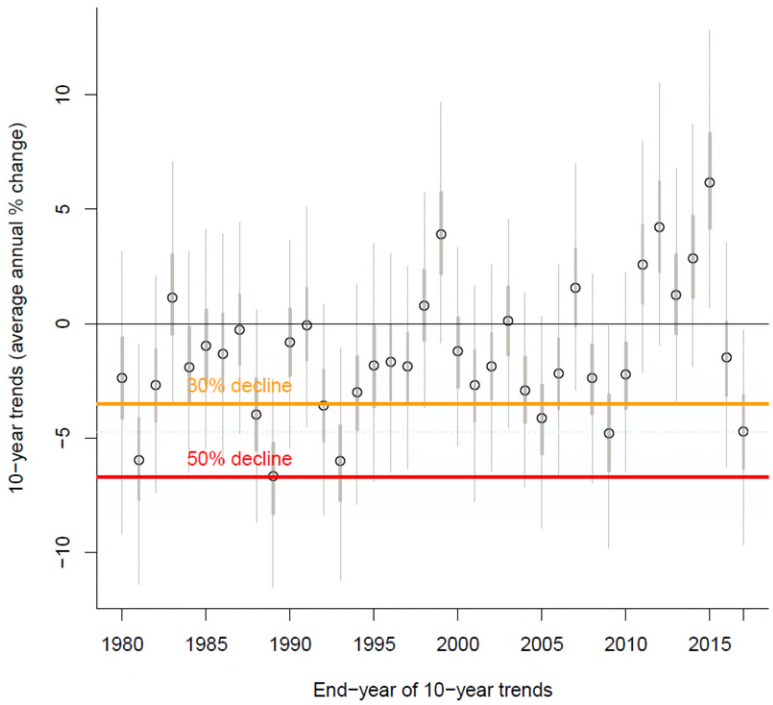

Figure 4. Rolling 10-year period trends for the Horned Grebe in Canada according to Breeding Bird Survey data (Environment and Climate Change Canada 2017).

3.2.2 Wintering distribution, abundance and trends

The Horned Grebe, Western population, winters mostly along the Pacific and Atlantic coasts. Based on the last ten years (2008–2017) of the Audubon's Christmas Bird Counts (CBC), an average of 48% of Horned Grebes winter on the west coast of the continent, while 35% winter on the east coast (including Florida). Twelve percent (12%) of birds counted were reported in states located on the Gulf of Mexico, and 5% on inland waterbodies of south and southeastern states (e.g. northeastern Texas through as far north as central Maryland, including: Arkansas, Tennessee, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana and Florida; National Audubon Society, 2019). In Texas, more Horned Grebes are found inland than on the coast (A. Wormington, pers. comm. 2014 *in* Kirk 2014).

In Canada, the Horned Grebe winters on the coast and in the southern interior of British Columbia, on the coasts of Prince Edward Island, Nova Scotia and New Brunswick and occasionally on the lower Great Lakes (Godfrey 1986).

3.2.2.1 Christmas Bird Count

At the continental scale (results from Canada and the USA combined; Figure 5), the CBC population trend has been relatively stable since 1966 (+0.54%/year). In Canada, CBC data indicate that the number of Horned Grebes wintering in British Columbia (- 1.49%/year) and Nova Scotia (-2.38%/year) has been declining since 1966 (National Audubon Society, 2019). It is not clear if this is due to an overall decline or a shift in wintering distribution.

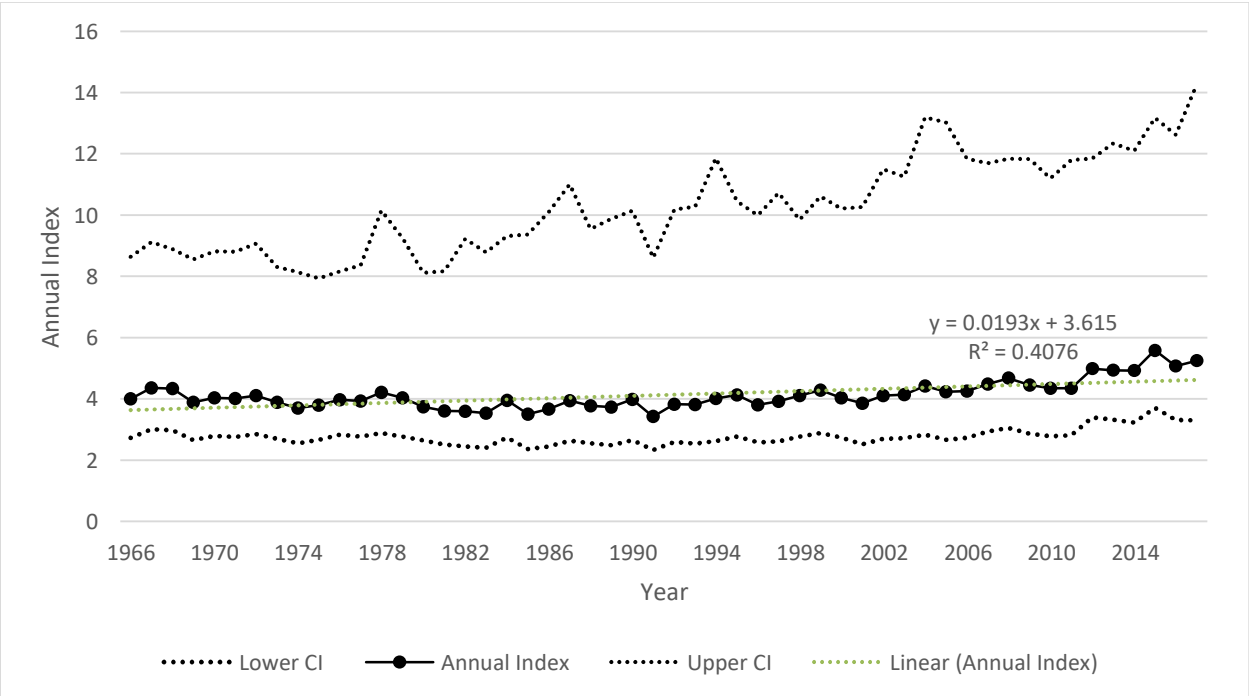

Figure 5. Long-term continental annual index of Horned Grebes from the Christmas Bird Count (1966–2017).

However, the continental trend (Figure 5) masks the fact that populations wintering in different areas are fluctuating at different rates and directions. Based on the CBC, the number of birds wintering along the Pacific coast is increasing, while the number of individuals wintering in the Gulf of Mexico is declining. Also, the number of Horned Grebes wintering along the Atlantic coast declined until the late 2000s, but this trend has reversed in recent years. The number of Horned Grebes wintering along the Atlantic coast now reaches levels similar to what they were in the 1980s (Figure 6). The reasons for this decline and subsequent increase along the Atlantic coast are unknown.

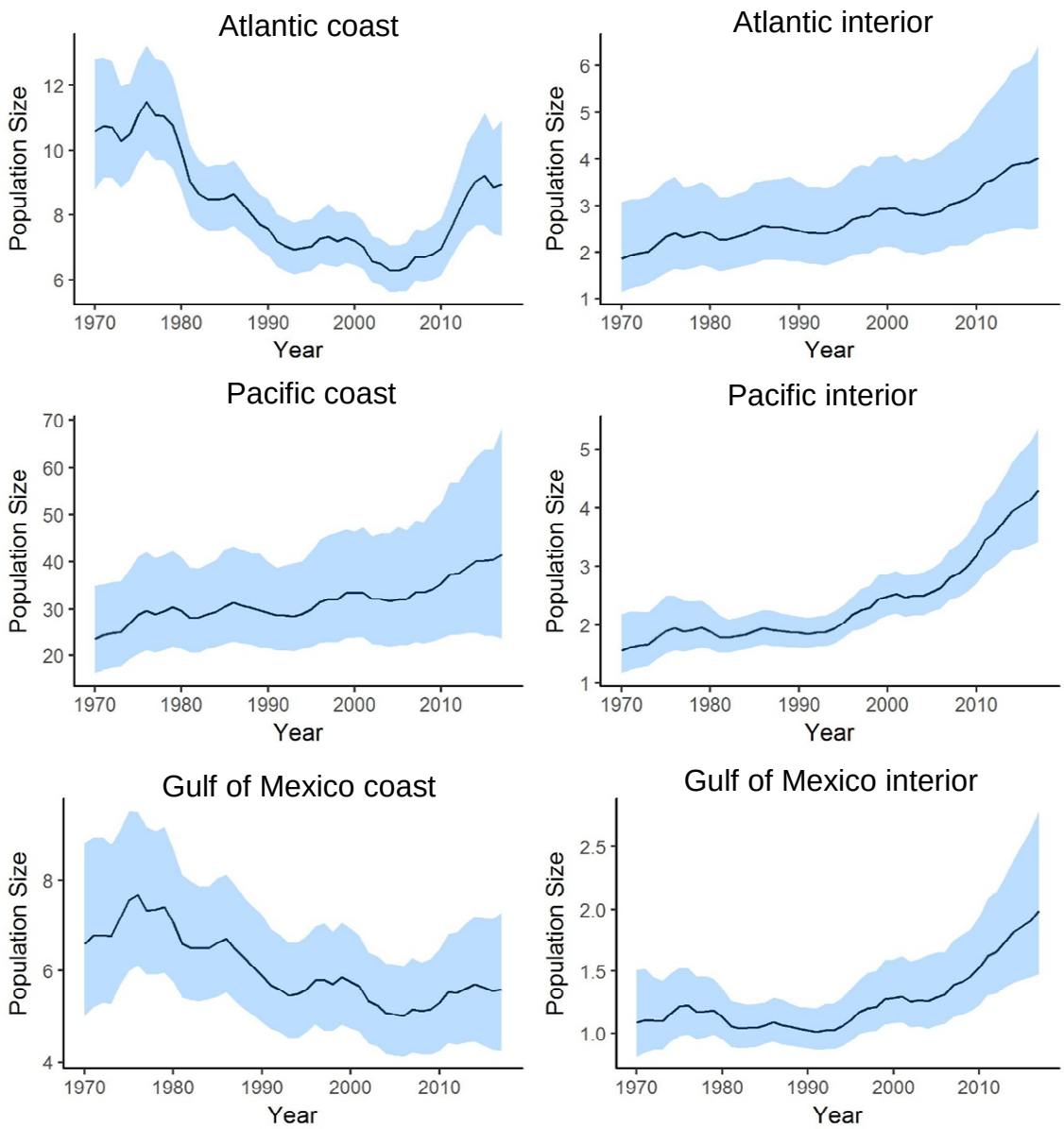

Figure 6. Predicted trends in the Horned Grebe Christmas Bird Count population index between 1970 and 2018 by regions. The original data (Soykan et al. 2018) have been smoothed with a state-space autoregressive population model that includes the effects major climatic drivers and the numbers of ponds in the Prairies potholes (C. Roy, CWS, unpublished data 2019). The "interior" regions refer to the non coastal areas of each main wintering area.

3.2.3 Migration

After breeding, Horned Grebes move to larger lakes to undergo molt (Stout and Cooke 2003). Adult Horned Grebes molt wing-feathers simultaneously, which results in a flightless period of a few weeks, usually between July and October (Stedman 2018). Molting locations are largely unknown. Most birds molt away from breeding areas (Stout and Cooke 2003), but a few adults will molt on the breeding grounds (André Breault, CWS-Pacific Region pers. comm.).

During migration, Horned Grebes stop on large lakes, rivers and wetlands. In Ontario, large numbers of birds can be observed on the Great Lakes, with peaks around mid-October and mid-April (highest count in April: 3,000) (Kirk 2014).

More research connecting breeding and wintering grounds is required and very few bands have been recovered for this species (Figure 7).

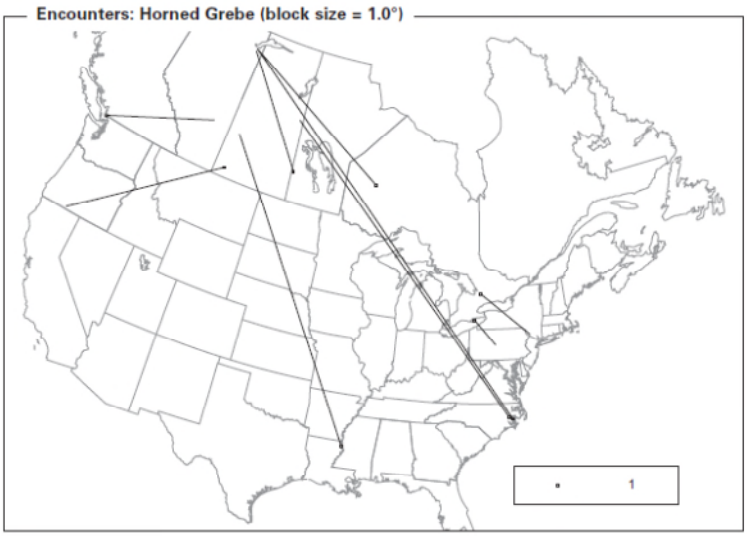

Figure 7. Horned Grebe banding and band recovery locations (from Dunn et al. 2009). Squares represent band recovery locations for each individual.

3.3. Needs of the Horned Grebe, Western Population

3.3.1 Breeding season

The Horned Grebe breeds in small (generally 0.5 to 2 ha, but ranging from 0.24 to 18.2 ha), shallow (at least 20 cm deep, but on average 40 cm), and usually fishless, perennial wetlands, but they can also nest on larger lakes with shallow edges and sufficient emergent vegetation. Breeding sites usually contain at least 40% open water with beds of emergent vegetation, such as sedges (*Carex* spp.), rushes (*Juncus* spp.) and cattails (*Typha* spp.) (Faaborg 1976, Kuczynski et al. 2012, Routhier 2012, Stedman 2018).

Horned Grebes are territorial and are usually solitary nesters (Palmer 1962), but occasionally, more than one pair and even loose colonies will occur on larger waterbodies with highly productive habitats (Fjeldså 1973, Sugden 1977, Stedman 2018). Horned Grebes are also opportunistic in their selection of a breeding site and will readily nest in human-created habitat (Fournier and Hines 1999, Hoar 2007, Kuczynski et al. 2012).

Horned Grebes generally breed in their first year and the generation time[11] is 4 years (COSEWIC 2009). During the breeding season, Horned Grebes will feed mainly on aquatic and some airborne arthropods (Stedman 2018). The chicks are semi-precocial[12]. They leave the nest hours after hatching and are looked after by the adults, which feed and carry them on their back up to 14 days after hatching (Stedman 2018).

3.3.2 Migration and wintering periods

Horned Grebes migrate mostly at night (Stedman 2018) and will stop on large lakes, rivers and wetlands. During severe winters or storms, Horned Grebes might become stranded and be forced to dry land. They can also land in areas they mistakenly believe to be water bodies (e.g. mining tailing ponds, solar farms).

In winter, they are mostly found at sea, near coastlines and in bays along the Atlantic, Pacific and Gulf of Mexico coasts (del Hoyo et al. 1992, Stedman 2018), generally south of 38° N, where average January temperature is warmer than -1° C (Kirk 2014). They will sometimes winter on lakes (Godfrey 1986). On their wintering grounds, diet shifts to fish, crustaceans (especially amphipods and crayfish – at least in North America) and polychaetes[13] (Stedman 2018).

[11] Average age of parents in the population
[12] Hatched with eyes open, covered with down, and capable of leaving the nest soon after hatching (they can walk and often swim), but stay at the nest and are fed by parents (Ehrlich et al. 1988)
[13] A class of annelid worms, generally marine.

4. Threats

4.1. Threat Assessment

The Horned Grebe, Western population's threat assessment uses the IUCN-CMP (International Union for the Conservation of Nature –Conservation Measures Partnership) unified threat classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in detail in section 4.2 Description of Threats.

Table 3. Threat Assessment Calculator Summary

Threat #	Threat description	Impact[a]	Scope[b] (next 10 Yrs)	Severity[c] (10 Yrs or 3 Gen.)	Timing[d]
1	**Residential & commercial development**	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)
1.1	Housing & urban areas	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)
2	**Agriculture & aquaculture**	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)
2.1	Annual & perennial non-timber crops	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)
2.3	Livestock farming & ranching	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
3	**Energy production & mining**	Low	Pervasive – Large (31%-100%)	Slight (1-10%)	High (Continuing)
3.1	Oil & gas drilling	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)
3.2	Mining & quarrying	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
3.3	Renewable energy	Low	Pervasive – Large (31%-100%)	Slight (1-10%)	High (Continuing)

Threat #	Threat description	Impact[a]	Scope[b] (next 10 Yrs)	Severity[c] (10 Yrs or 3 Gen.)	Timing[d]
4	**Transportation & service corridors**	Low	Pervasive – Large (31%-100%)	Slight (1-10%)	High (Continuing)
4.1	Roads & railroads	Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)
4.2	Utility & service lines	Low	Pervasive – Large (31%-100%)	Slight (1-10%)	High (Continuing)
5	**Biological resource use**	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)
5.3	Logging & wood harvesting	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
5.4	Fishing & harvesting aquatic resources	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)
6	**Human intrusions & disturbance**	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)
6.1	Recreational activities	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)
7	**Natural system modifications**	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)
7.1	Fire & fire suppression	Unknown	Unknown	Unknown	High (Continuing)
7.3	Other ecosystem modifications	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)
8	**Invasive & problematic species, pathogens & genes**	Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)
8.2	Problematic native plants and animals	Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)
8.4	Pathogens & microbes	Negligible	Small (1-10%)	Negligible (<1%)	Moderate (Possibly in the short term < 10 yrs)

Threat #	Threat description	Impact[a]	Scope[b] (next 10 Yrs)	Severity[c] (10 Yrs or 3 Gen.)	Timing[d]
9	**Pollution**	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)
9.2	Industrial & military effluents	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)
9.3	Agricultural & forestry effluents	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)
11	**Climate change**	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)
11.4	Changes in precipitation & hydrological regimes	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term < 10 yrs)
11.5	Severe / Extreme Weather Events	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g. if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2. Description of Threats

The Horned Grebe, Western population has a widespread distribution in North America, so it is vulnerable to numerous threats. Wetlands in the Prairies have been severely impacted by the conversion of grassland to cropland and wetland drainage, which has resulted in the permanent loss of small wetlands used for breeding. This habitat loss is further exacerbated in the short-term and medium-term due to potential droughts. In agricultural landscapes, there are also concerns that pesticides might affect small wetlands by contaminating their food chains. In the boreal forest, natural resources industries (oil & gas, mining and forestry) can have negative impacts on wetlands, such as removal of riparian vegetation, changes in water flows and changes in nutrient dynamic.

Direct causes of mortality include diseases (i.e. avian botulism), fisheries bycatch, dry landings, collisions with power lines and wind turbines. On the wintering grounds, oil spills can affect large numbers of grebes.

Considering all these threats, the overall threat impact for the Horned Grebe was scored as “High” (see Master et al. 2012 for a detailed explanation of the methodology).

<u>1.1 Housing & urban areas (negligible)</u>

New residential developments near and around lakes can negatively impact grebes nesting habitat causing permanent habitat loss, habitat modification (e.g. removal of vegetation) and disturbance. In the Canadian prairies, new developments (including new roads, farm infrastructures, housing development and extraction activities) represented a small fraction (<6%) of the total area of wetlands lost between 1985 and 2001 (Watmough and Schmoll 2007). Most ponds where this species breeds are not usually the preferred waterbodies for housing development due to their size and depth, so this threat was considered negligible. Also, a large portion of the Horned Grebe’s breeding distribution is located in areas of relatively low human density, so this threat does not appear as a major driver of habitat loss compared to other activites. However, during dry years in the Praires, ponds dry up and are at risk of encroachment, particularly near settlements.

In Europe, Horned Grebes will abandon lakes with many summer houses and continuous human activity on the water during summer (Summers et al. 2009, J. Fjeldså, pers. communication *in* Stedman 2018). Kuczynski et al. (2012) also observed that Horned Grebes avoided ponds with human structures located inside ponds (e.g. docks, machinery) in Alberta.

<u>2.1 Annual & perennial non-timber crops (medium)</u>

In the Prairies, wetlands have been impacted severely by conversion of grassland to cropland and wetland drainage (Sugden and Beyersbergen 1984, COSEWIC 2009). The conversion of wetlands to agricultural land is deeply rooted in the landscape of the

Prairies: up to 70% of the wetlands have disappeared in some areas since European settlement (Canadian Wetland Inventory 2008). Currently, more than 90% of wetlands show signs of alteration while the number of remaining unaltered wetlands in the landscape is decreasing (Bartzen et al. 2010). Kuczynski et al. (2012) suggested that small pothole-type wetlands might have disappeared faster from the Prairie landscape than larger, natural wetlands, which might be too large to support Horned Grebes.

Between 1985 and 2001, wetland area in the Prairie Habitat Joint Venture (PHJV) decreased by 5% (228,500 ha of wetlands lost). 77% of wetlands lost were <0.25 ha in area. Wetland basin of >0.26 ha and <1 ha in size accounted for 19% of all complete losses, whereas basins >1 ha accounted for 4% of losses (Watmough and Schmoll 2007). During this period, the most common cover types replacing lost wetland area were annual cultivation crops (62%) and perennial grass (21%; Watmough and Schmoll 2007).

Despite ongoing habitat conservation and restoration efforts, it is estimated that approximately 152,000 acres of wetlands will be lost over the next 10 years in the PHJV area (PHJV 2014a) and temporary and seasonal ponds are the most vulnerable to conversion to agriculture (Bartzen et al. 2010).

Considering the high relative abundance of Horned Grebes in the Prairie Potholes Region and their preference for small (generally <2 ha), shallow wetlands, the threat of habitat loss and modification through agriculture is considered one of the major threats to Horned Grebes.

2.3 Livestock farming & ranching (negligible)

Livestock can impact wetlands in a number of ways. They use wetlands as a source of drinking water, defecating or trampling the surrounding vegetation. Horned Grebes require ponds with emergent and riparian vegetation for nesting (Kuczynski et al. 2012), so by trampling vegetation, livestock might make small ponds unsuitable for the species. Also, by removing riparian vegetation, livestock might increase nutrient and sediment loading into small wetlands (see section 7.3 Other ecosystem modifications).

Although ill-managed livestock can have a negative impact on Horned Grebe habitat, proper and environmentally sound livestock management offers potential benefits for this species. Good practices include, for example, fencing wetlands and maintaining riparian vegetation (Cox and Cullington 2009). Once these practices are adopted, the small ponds used by Horned Grebes are more likely to be retained and protected. Additionally, dugouts and farm ponds are often created to maintain a steady supply of water. The Horned Grebe will readily adopt human-made ponds (Fournier and Hines 1999, Kuczynski et al. 2012), and so dugouts and farm ponds, if properly vegetated and naturalized, can also become potential habitat.

For these reasons, livestock management was scored as negligible and could even become beneficial if environmentally sound livestock management practices and best management practices for dugouts and farm ponds are adopted.

3.1 Oil & gas drilling (low)

Oil & gas development is widespread across the western boreal forest and involves the construction of roads, pipelines, seismic lines, well pads and other infrastructures, all of which can lead to modification and disappearance of wetlands. The degree of overlap between wetlands and these activities is unknown, but is assumed to be considerable given the extent of area affected by anthropogenic activities and the abundance of wetlands in the western boreal forest (PHJV 2014b). Most of the western boreal forest is publicly owned, so industry best-management practices and wetland protection policies should provide a minimal degree of protection to wetlands, although small, shallow and fishless ponds, might, by their nature, be overlooked. Overall, this threat was scored as low given the geographic scale at which it occurs, the population size of the Horned Grebe and the existence of best management practices and wetland conservation policies meant to protect wetlands against destruction by development projects. However, the cumulative effect of industries (forestry, oil & gas, mining & quarrying, transportation corridors, etc.) in the western boreal forest might have a higher global impact on habitat loss (Webster et al. 2015).

3.2 Mining & quarrying (negligible)

Similarly to oil & gas and forestry operations, mining and quarrying activities can lead to habitat loss in the boreal zone (Webster et al. 2015). The modification and drainage of small wetlands can be particularly problematic for the Horned Grebe. Mining and quarrying activities are, however, more localized and not as widespread as other industrial activities and as such was scored as negligible. However, the cumulative effect of industries (forestry, oil & gas, mining & quarrying, transportation corridors, etc.) in the western boreal forest might have a higher global impact on habitat loss (Webster et al. 2015).

3.3 Renewable energy (low)

Grebes in general are vulnerable to collisions with wind turbines due to their low manoeuvrability and low flight altitude (Furness et al. 2013). In Canada, there has been at least one report of a Horned Grebe killed by collision with a wind turbine in Alberta (Bird Studies Canada, Canadian Wind Energy Association, Environment and Climate Change Canada and Ontario Ministry of Natural Resources and Forestry 2018).

Offshore wind turbines can also affect bird populations in other ways than collisions. In Europe, many species, including the Slavonian Grebe, avoid areas with offshore wind turbines (Furness et al. 2013). However, offshore wind turbine development is limited in North America at the moment.

Grebes can also land in solar farms, which they mistake for water bodies (Kagan et al. 2004). This is called “dry landing”, since grebes are unable to easily take flight from land. Once stranded, they die from starvation or predation (Kagan et al. 2004). There is not enough information to assess the magnitude of this impact on Horned Grebe. Because grebes are vulnerable to collisions with wind turbines and dry landing in solar farms and the number of Horned Grebes killed each year is likely underestimated (i.e. not all carcasses are found or identifiable at the species’ level), this threat was scored as “low”.

4.1 Roads & railroads (not a threat)

Transportation corridors, which include roads and railroads, are generally considered as a source of habitat loss and fragmentation. Road building combined with other natural resources developments (e.g. oil & gas, mining and logging) can have a large cumulative impact on wetlands in the boreal region (Webster et al. 2015).

However, the Horned Grebe is known to colonize and successfully raise broods on borrow pits created from soil removal in road construction (Fournier and Hines 1999, Kuczynski et al. 2012). In a study conducted in Alberta (Kuczynski et al. 2012), Horned Grebes occupied 36% of constructed ponds and 74.5%-81.3% of these produced chicks. The borrow pits that were occupied were usually 0.6 ha to 2 ha with more emergent (73%) and riparian vegetation (80%) covering the pond periphery and exempt of beavers. Hence, initial habitat loss during construction might be partially or completely compensated by the creation of new habitat which meets their needs.

For this reason, roads are considered to have a neutral or potentially beneficial impact if proper borrow pit restoration guidelines are adopted. These guidelines should focus on creating ponds that are large and deep enough for Horned Grebes (even during drought years), and include a revegetation program.

4.2 Utility & service lines (low)

Grebes are one of the most vulnerable bird groups to collisions with power lines (Bevanger 1998, APLIC 2012, Rioux et al. 2013), but there is no estimate of Horned Grebe mortality due to these collisions in Canada. Bevanger (1998) conducted a review of literature of 16 investigations of bird collisions with power lines (1972-1993) and reported a total 303 casualties of unspecified grebe species. In the early 1980s, Malcolm (1982) reported important grebe mortality due to collisions with a power line near a wetland in Montana. No Horned Grebe was reported, but Eared Grebes represented 29% of the 3,218 bird mortality detected. However, Horned Grebes have been found dead under powerlines (C. Kemper pers. comm. 2020) and the estimated mortality is likely underestimated (i.e. not all carcasses are found or identifiable at the species’ level).

Because grebes are vulnerable to collisions with power lines and the number of Horned Grebes killed each year is likely underestimated (i.e. not all carcasses are found or identifiable at the species' level), this threat was scored as "low".

5.3 Logging & wood harvesting (negligible)

Similarly to oil & gas and mining operations, forestry operations are widespread across the western boreal forest and overlap greatly with the Horned Grebe's distribution. Forestry operations, which involves building roads, can cause the modification or destruction of wetlands. Most of the western boreal forest is publicly owned, so industry best-management practices and wetland protection policies should provide a minimal degree of protection to wetlands, although small, shallow and fishless ponds, might, by their nature, be overlooked. Although this threat can lead to habitat loss, it was scored as negligible given the geographic scale at which it occurs, the population size of the Horned Grebe in the western boreal forest and the existence of best management practices and wetland conservation policies meant to protect wetlands against destruction by the industry. However, the cumulative effect of industries (forestry, oil & gas, mining & quarrying, transportation corridors, etc.) in the western boreal forest might have a higher global impact on habitat loss (Webster et al. 2015).

5.4 Fishing & harvesting aquatic resources (low)

Because of their diet specialization during migration and on their wintering grounds (i.e. fish), grebes are vulnerable to getting caught and drowning in fishing nets (Riske 1976, Piersma 1988, Ulfvens 1989, Harrison and Robins 1992). The COSEWIC report (2009) mentions that grebes are killed annually on the Great Lakes during both spring and fall migration and that grebe species are caught in gillnet fisheries in California (Mills et al. 2005). Bartonek (1965) estimated that 3,000 grebes (not identified at the species level) and loons were netted annually on the southern part of Lake Winnipegosis, Manitoba. In Europe, the order of magnitude of Slavonian Grebes reported as bycatch[14] in the Baltic and North Seas was in the "tens" of individuals (Zydelis et al. 2009). This represents the mortality of approximately 1% (total wintering population of approximately 1,850), so the number of birds potentially affected in North America could be much higher than what has been reported in Europe, but evidence is lacking because bycatch mortality is not systematically reported.

On the Pacific coast, it is estimated that gill-net fishing is responsible for an annual bycatch of 12,085 (range 1,129–24,002) seabirds, but Horned Grebes were not reported as being taken (Smith and Morgan 2005, Ellis et al. 2013).

Additionally, fishery regulations and reduced fishing efforts have resulted in an overall decline of bycatch mortality of seabirds on the eastern (Regular et al. 2013) and western coasts of North America (Zydelis et al. 2013), which most likely reduced the impact of this threat on Horned Grebe. Although detailed data on Horned Grebe bycatch

[14] Caught accidentally

are lacking, this impact was scored as “low” because there is evidence that the species is vulnerable and individuals likely get caught on a yearly basis.

6.1 Recreational activities (negligible)

In Europe, watercraft disturbance on grebes (including Slavonian/Horned Grebes) has been documented to impact reproductive success either by flushing birds from their nest or causing nest destruction through wave action (Ruddock and Whitfield 2007). This threat is probably limited on their Canadian breeding grounds due to the nature of their preferred habitat (i.e. fishless, small, shallow wetlands) which do not present a lot of interest to recreational boaters or anglers. Disturbance by watercraft is more likely to occur on their staging and wintering areas, particularly after the breeding season when they are molting and are flightless (Stedman 2018). Specific information on the intensity of this disturbance in North America is lacking, but this threat is generally considered marginal and was scored as “negligible”.

7.1 Fire & fire suppression (unknown)

Forest fires can have a profound impact on the boreal forest (e.g. habitat destruction, changes in vegetation, run-offs of sediments, changes in nutrient cycles and hydrological processes). With climate change, frequency and intensity of forest fires is predicted to increase (Amiro et al. 2003). Specific impacts of forest fires on Horned Grebes have not been studied, but the effects are likely cumulative, causing habitat loss and a decrease of the reproductive success. Additional research should provide insight on forest fire’s impact on waterbirds and wetlands (particularly small, shallow wetlands). For this reason, this threat was scored as unknown.

7.3 Other ecosystem modifications (low)

Horned Grebes are exclusively aquatic birds and rely heavily on waterbodies to feed, breed and molt. Any activity that could potentially affect water quality is likely to impact the Horned Grebe. Such activities include agriculture (e.g. fertilizer run-offs), livestock farming and ranching, oil & gas, mining & quarrying, logging & wood harvesting, and the construction of related infrastructure, such as roads, camps, pipelines, well pads, and cut lines. These activities are widespread throughout much of the Horned Grebe’s distribution, and although their cumulative impact is unknown, they can increase nutrient loading (Bayley et al. 2012) by removing riparian vegetation, changing water flows and changing nutrient dynamic.

Horned Grebes use primarily eutrophic environments, so nutrient loading can be beneficial to a certain point by making small ponds more productive and increasing the abundance of macroinvertebrates which grebes eat. However, excessive eutrophication can be detrimental by decreasing water quality (Sánchez-Carrillo et al. 1999, Scheffer et al. 2001). An increase of water turbidity and aquatic plant growth could reduce Horned Grebes’ ability to forage and a decrease the amount of open water, making small ponds unsuitable for breeding.

Because Horned Grebes use small ponds and marshes for breeding, these are generally considered vulnerable to alteration of hydrologic regime and sediment loading due to their shallow depth (Scheffer et al. 2001, Bayley et al. 2012). The scope of this threat was estimated to be large because many activities might impact breeding ponds throughout the species' range, but the severity over the next 3 generations was considered small overall. Hence, this threat was scored as low.

8.2 Problematic native plants & animals (negligible)

Raccoons (*Procyon lotor*) are known nest predators and have greatly expanded their range northwards over the course of the last century. They are now widespread in the Canadian Prairies and in parts of the boreal forest (Larivière 2004, Latham 2008). Changes to habitat, such as conversion to cropland, is a contributing factor to a reduced nest success due to predation (Sovada et al. 2001, Watmough and Schmoll 2007), so it is possible that Horned Grebes are facing an increased predation rate from raccoons.

8.4 Pathogens & Microbes (negligible)

Avian botulism is the most significant pathogens threat to waterfowl and shorebirds (Rocke and Bollinger 2007). Horned Grebes are particularly vulnerable to Type E botulism, which mostly affects fish-eating birds in the Great Lakes in Canada. Type E botulism outbreaks in the Great Lakes were documented for the first time in the United States in 1963 (Rocke and Bollinger 2007) and in Ontario in 1998 (Campbell and Barker 1999, CWHC 2000). During some outbreaks, more than 10,000 fatalities have been reported, with Horned Grebe sometimes in the top 5 species affected (Chipault et al. 2015). Kirk (2014) also reports that "between 2004 and 2013, the USGS National Wildlife Health Center received reports of 660 known (2,304 estimated) dead Horned Grebes recovered on Great Lakes shores and associated with confirmed or suspected botulism type E mortality events in Wisconsin, Michigan, Pennsylvania, New York, and Ontario (J. Chipault, pers. comm. 2014)".

The species could also be vulnerable to Type C avian botulism (Smith 1977 *cited in* Rocke and Bollinger 2007), but to a lesser extent than Type E. In Canada, Type C mostly affects waterfowl in the Prairies (CWHC 2000). In the database maintained by the Canadian Wildlife Health Cooperative (2019), there are 9 records of botulism Type E in Horned Grebe and 4 records of an "unknown" botulism strain, which could be either Type C or E.

Invasive non-native species which could be intermediate hosts are a contributing factor to mortality associated with avian botulism. Zebra mussels (*Dreissena polymorpha*) and round gobies (*Gobius sp.*) are contributing factors to outbreaks of Type E botulism in Great Lakes fish-eating and mussel-eating birds (CWHC 2000).

Overall, the impact of pathogens & microbes on the Horned Grebe is considered negligible.

9.2 Industrial & military effluents (low)

The increase of natural resources extraction activities leads to a higher risk of contaminant spills occurring in the environment, which could impact Horned Grebes. However, such incidents are likely to affect a small number of birds, since they are usually solitary nesters.

Tailings ponds[15] are located across internationally important migratory corridors and pose a significant mortality risk for birds, including mass mortality events (Timoney and Ronconi 2010). In 2008, approximately 1,600 ducks were found dead after landing on tailing ponds located on Syncrude Canada's Aurora North tar sands mine (R. v. Syncrude Canada Ltd. 2010). In 2011, a standardized monitoring program called the Oil Sands Bird Contact Monitoring Program (OSBCMP) was created to estimate the number of birds landing in tailing ponds of oil sands mines in Alberta (Ronconi 2011). Horned Grebes were reported as one of the species affected by tailing ponds and the number of Horned Grebes that landed on tailing ponds varied between year (2011-2018) from one to 263 (145 on average). However, the overall number of Horned Grebes that were oiled and died was relatively low. It varied from one individual to a high of nine individuals in 2015 (St. Clair et al. 2012, St. Clair et al. 2013, Owl Moon Environmental Inc 2015, Owl Moon Environmental Inc 2016, Owl Moon Environmental Inc 2017, Hatfield Consultants 2018, Canadian Natural Resources Limited, Canadian Natural Albian Sands, Fort Hills Energy Corporation, Imperial Oil Canada Ltd., Suncor Energy Inc. and Syncrude Canada Ltd. 2019). However, data regarding the non-lethal effects on birds that survive after leaving tailing ponds are lacking.

Because of their higher trophic position in the food chain, grebes are vulnerable to bioaccumulation of contaminants. DDE (dichlorodiphenyldichloroethylene) and PCB (polychlorinated biphenyl) have been reported in Horned Grebe egg shells in Manitoba (Forsyth et al. 1994) and high levels of dioxins and furans were detected in Horned Grebe livers downstream of a pulp and paper plant in British Columbia (Vermeer et al. 1993).

Horned Grebes are also vulnerable to oil pollution on their wintering grounds and have been reported as casualties in many incidents. In the southern USA, 12.3% of 34,717 oiled birds killed in eight oil spills were Horned Grebes (del Hoyo et al. 1992). In 1976, an oil spill in Chesapeake Bay was responsible for the death of more than 4,000 Horned Grebes (Roland et al. 1977). On the Pacific coast, Horned Grebes are also regularly affected by oil spills: 78 oiled Horned Grebes were collected (both alive and dead) in California after the Cosco Busan oil spill (California Department of Fish and Game, 2008), 12 were collected after the Selendang Ayu oil spill in Alaska (Industrial Economics Inc. 2015) and 16 were collected during an oiling episode in the winter of 1997-98 in central California (Hampton *et al*. 2003). Following the Deepwater Horizon

[15] In mining facilities, tailings are stored in artificial ponds. Tailings are a mixture of water and other byproducts of the extraction processes.

Spill along the Gulf Coast, a total of 4 unidentified grebes (2 oiled and 2 not visibly oiled) died (USFWS, 2011).

Overall, the number of Horned Grebe impacted by the oil spills described above is likely underestimated, as individuals may die offshore and may not be recovered. Even birds that do come ashore can die outside the search areas, are difficult to capture until they are dead, and once dead can easily be missed or misidentified by searchers (Ford et al. 2009). The above figure only reflects the direct, short-term impact of the oil spills and does not take into account long term and cumulative effects. For example, the Horned Grebe wintering population had not recovered from the Exxon Valdez spills in Alsaka even years after the event (Day et al. 1997, McKnight et al. 2008).

The large wintering area of this species in North America partially protects this population from catastrophic losses due to isolated, localized oil spills (Stedman 2018). For these reasons, the overall impact of Industrial & military effluents was scored as "low", but mortality from oil spill incidents requires additional and continent-wide monitoring.

9.3 Agricultural & forestry effluents (medium-low)

There are two major types of run-offs that can impact Horned Grebes: fertilizers and pesticides. The former is covered under section 7.3 Other ecosystem modifications. Pesticides have been documented to have a negative impact on invertebrates (Stehle and Schulz 2015) which can eventually impact grebes' productivity.

In an agricultural landscape, pesticides are likely to contaminate some wetlands (through surface runoffs, leaching, spray-drift and wind erosion). The presence of pesticides, such as atrazine and glyphosate (two herbicides), has been documented in Prairie Pothole wetlands (Donald et al. 2001, Anderson et al. 2012, McMurry et al. 2016, Evelsier and Skopec 2018). Although the impact of these herbicides on the Horned Grebe requires further research, they are generally considered as a threat to biodiversity, including birds (Mineau and Palmer 2013).

Among different pesticides used in agriculture, neonicotinoids have received more attention in recent years. First introduced in the 1990s, neonicotinoids are now the most widely used insecticide in the world (Douglas and Tooker 2015). Neonicotinoids are persistent insecticides that have the propensity to integrate water systems and can have negative impacts on aquatic invertebrates (Mineau and Palmer 2013, Anderson et al. 2015, Morrissey et al. 2015). This class of pesticide is widely used in the Prairies (Main et al. 2014), and although its impact on Horned Grebe has not been studied yet, it might contribute to a reduction of invertebrate prey availability, as well as contributing to sub-lethal effects on the species, such as a decrease in reproductive output (Main et al. 2014). Since information regarding how Horned Grebe are affected by pesticides is lacking, there is some uncertainty regarding the overall impact of this threat and it was scored as "low to medium".

11.4 Changes in precipitation & hydrological regimes (medium-low)

Climate change is a complex phenomenon that is generally expected to lead to a warmer climate and changes in precipitation patterns. A climate change scenario where the combined effects of changes in temperature and precipitation lead to higher evapotranspiration would reduce the persistence of shallow wetlands in the Prairie Potholes Region (Millett et al. 2005, Werner et al. 2010), thus posing a significant threat to Horned Grebes. In fact, Horned Grebes already respond to wet/dry cycles in the Prairie Potholes Region, where the May pond index is positively correlated with the BBS Annual Index (Figure 4).

There is still considerable uncertainty regarding impacts of climate change on wetlands in western Canada, but some cumulative impacts are foreseeable. A warmer and drier climate could increase the frequency and intensity of forest fires, cause the melting of the permafrost and the dessication of wetlands (Cheskey et al. 2011). Additionally, droughts are a contributing factor to shallow wetlands conversion to cropland (Bartzen et al. 2010). This impact was scored as “low to medium” because of the uncertainty about the climate trend over the next 10 years, but recognizing that it can have a significant impact on habitat.

11.5 Severe / Extreme Weather Events (negligible)

Severe weather conditions can force Horned Grebes to land in areas where they are not able to take off again (e.g. dry landing). Stranded birds are frequently reported during migration and severe winters, but some “mass” dry landing episodes can occur following particularly severe storms, as shown in three documented cases in which 68, 75 and 124 individuals were forced to dry land (Hodgdon 1979, Bell 1980, Eaton 1983). Storms will also create waves that can flood nests or kill adults (i.e. hail). Storm frequency (e.g. episodes of hail and tornadoes) are predicted to increase, although information is lacking to predict if this will have a significant impact on the population. Based on current information, this threat was considered to be negligible.

5. Management Objective

The management objective for the Horned Grebe, Western population, is to maintain, over the next 30 years (2021-2051), population levels at or above the average population levels of the past 30 years (1987-2017), and to maintain the population’s current distribution in Canada.

The Horned Grebe, Western population, was designated as Special Concern because of population declines and the many threats it faces, particularly habitat loss and degradation. However, the latest CBC analysis suggests a relatively stable population trend at the continental scale since the 1970s. Nonetheless, this global trend masks the fact that populations wintering in different areas are fluctuating at different rates and directions: while the abundance of birds wintering along the West Coast has increased over the years, it declined along the East Coast until the mid-2000s and increased

subsequently. The combined net effect is a relatively stable trend, with a slight increase in recent years.

On the breeding grounds, BBS data suggest that the Canada-wide decline is ongoing, and that it is steeper in the Prairie Potholes Region. However, this decline might be related to wet/dry cycles, which might reduce the number of small, shallow ponds available for breeding in dry years (or increase their availibility in wet years). Also, BBS has, by its design, significant limitations to evaluate population trends of wetland species. This is particularly true in the northern parts of the Horned Grebe's breeding range where where BBS coverage is limited.

Considering i) that the CBC continental trend masks different regional trends, such as the decline and subsequent increased that occurred along the East coast, and ii) that Horned Grebe abundance in the Prairie Potholes Region is affected by climate conditions and the availability of ponds; the population objective was established using population level over the past 30 years to provide a more robust baseline (i.e. which encompasses potential cycles) against which to assess progress. At the moment, and considering the significant limitations of the BBS to establish trends for the species in the boreal forest, the CBC appears to be the most reliable source of information available against which to assess progress.

Although the CBC data suggests a stable long-term continental trend, the species remains vulnerable to a number of threats, such as habitat loss and degradation, contamination of wetland food chains by pesticides, mortality by fisheries bycatch, oil spills and collisions with power lines and wind turbines. Habitat loss is mostly due to conversion to agriculture in the Prairie Potholes Region and, to a lesser extent, to natural resources development in the boreal forest. Climate change could exacerbate habitat loss, particularly in the Prairies where, in dry years, semi-permanent wetlands are more vulnerable to being converted to agricultural lands. Additional monitoring is required to assess population trends in the boreal forest, and additional reseach is required to understand links between breeding and wintering grounds.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

- A recovery strategy (2013) and an action plan (2015) were developed for the Horned Grebe, Magdalen Islands population. One of the action plan's approach is to support actions targeting the maintenance of the Western population to help ensure it remains abundant and thereby increases the probability of exchanges with the Magdalen Islands population.
- The Horned Grebe, Western population, is surveyed by the major monitoring programs in North America such as the BBS, the CBC and the WBPHS. Although these programs provide long-term trends, they are not specifically designed for secretive marsh birds. Routhier et al. 2012 suggested that

playbacks could be used in the WBPHS ground survey component to increase grebe detection.

- Between 1998 and 2000, 144 adults and 51 young Horned Grebes were banded in the Yellowknife area as part of a Master's thesis by Bonnie Stout (see Stout and Cook 2003).
- The British Columbia Coastal Waterbird Survey has been conducted since 1999 and provides information on trends and abundance of wintering Horned Grebe along British Columbia's coastline.
- In 2007 and 2008, the Canadian Wildlife Service – Northern Region proceeded to the banding of Horned Grebes in the Yellowknife area. 55 adults and 18 young were captured and all banded with a uniquely numbered metal band. Some were also banded with leg color bands (C. Wood, pers. comm. 2020). In 2017, an additional 4 adults were banded (metal band only).
- The Prairie Marsh Monitoring Program, which ran from 2008 to 2012, is a survey dedicated to marsh birds and employs playback call (although the Horned Grebe call was not used; Bird Studies Canada 2018).
- A 2010 report to Parks Canada on the status and distribution of birds and mammals in the Southern Gulf Islands identified Horned Grebe as a priority species for monitoring in the area (Davidson 2010).
- In 2014, the Ontario government released a provincial management plan for the Horned Grebe that identified threats, population objectives and conservation measures for the species (Kirk 2014).
- In 2015, the Ontario government released a Governement response statement on the Horned Grebe Management Plan.
- The Horned Grebe, including both Western and Magdalen Island populations, has been identified as a priority species in 11 BCR strategies which established population objectives and conservation measures.
- The Prairie Habitat Joint Venture developed habitat objectives, and conservation programs and partnerships for the Prairies Parklands (PHJV 2014a) and the Western Boreal Forest Regions (PHJV 2014b). These plans establish programs and partnerships that address the threat of habitat loss and degradation for waterfowl species, which will also benefit the Horned Grebe, Western population, across its Canadian breeding range.
- Parks Canada multi-species action plans identify recovery measures specific to species at risk in Parks Canada places. For a list of current multi-species action plans including Horned Grebe, Western population, refer to the documents published for the species on the Species at Risk Public Registry.
- The Canadian Wildlife Health Cooperative actively monitors mortality by diseases in a wide range of bird species including the Horned Grebe.
- Research on habitat use and selection has been conducted at the University of Alberta and data have been gathered in the Aspen Parkland (Moenting et al. unpublished 2009) and the Peace River Parkland (Kuczinski et al. 2009).
- Bird landings and mortality on liquid impoundment facilities in the oil sand region of Alberta are monitored since 2011 through the Canada-Alberta oil sands environmental monitoring and the Oil Sands Bird Contact Monitoring Program.

- Several wetland policies and guidance documents have been published or are underway at the provincial and territorial levels, which might contribute to protecting Horned Grebe habitat:
    - Alberta wetland policy (Alberta Government 2013) https://open.alberta.ca/publications/9781460112878
    - Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia (Cox and Cullington 2009) https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-planning-strategies/wetlands-in-bc
    - Managing Saskatchewan Wetlands, A Landowner's Guide (Huel 2000) http://www.saskh2o.ca/PDF/managingsaskatchewanwetlands.pdf
    - The Manitoba Water Strategy (Manitoba Conservation 2003) https://www.gov.mb.ca/sd/waterstewardship/waterstrategy/pdf/water-strategy.pdf
    - The Yukon Territory is developing a wetland policy (2018-2019) https://online.engageyukon.ca/project/yukon-wetlands

6.2. Broad Strategies

The broad strategies of this management plan are as follows:

- Habitat conservation and stewardship
- Population monitoring and surveys
- Research

6.3. Conservation Measures

Table 4. Conservation Measures and Implementation Schedule

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
6.3.1 Broad Strategy: Habitat conservation and stewardship			
a) Empower private landowners, through stewardship programs, to conserve and restore seasonal and semi-permanent wetlands, particularly in the Prairie Potholes Region.	High	IUCN Threat 2.1	2021-2031
b) Adopt environmentally responsible best practice guidelines for crop and livestock management that integrate conservation of seasonal and semi-permanent wetlands.	Medium	IUCN Threat 2.1 and 2.3 and 9.3	2021-2026
c) Support the adoption, implementation and enforcement of best-management practices and wetland conservation policies, particularly for industries (e.g. oil & gas, mining and forestry) in the western boreal forest.	High	IUCN Threat 2.1 and 9.3	2021-2031
d) Develop and adopt breeding habitat restoration guidelines (e.g. borrow pits, farm dugouts and stock ponds), particularly drought resilient habitat.	High	IUCN Threat 3.1 and 4.1	2021-2026
6.3.2 Broad Strategy: Population monitoring and surveys			
a) Establish a long-term monitoring program of wetland bird species to track abundance and habitat use throughout the Horned Grebe's range.	High	All	2021-2026
b) Establish a reporting program that compiles incidents, species and number of individuals affected by oil spills, fisheries bycatch, diseases, dry landing and collisions with power lines and wind turbines.	Low	IUCN Threat 3.3, 4.2, 5.4, 8.4, 9.2 and 11.5	2021-2031
6.3.3 Broad Strategy: Research			
a) Conduct research to understand connectivity between breeding, molting, staging and wintering grounds.	High	All	2021-2031
b) Conduct research to understand impacts of pesticides on wetland bird species.	Medium	IUCN Threat 9.3	2021-2031

[e] *"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.*

6.4. Narrative to Support Conservation Measures and Implementation Schedule

The conservation measures for the Horned Grebe, Western population, were developed to address all threats this species is facing, while putting more emphasis on the most important threats and addressing important knowledge gaps.

The Prairie Potholes Region has been identified as a focal region for conservation measures because it is an area of relatively high breeding densities where the most important threats occur (i.e. conversion of breeding habitat to agriculture, vulnerability of breeding habitat due to drier climate and pollution by pesticides).

The most imminent threat to Horned Grebe in the Prairie Potholes Region is the degradation and conversion of wetlands on privately owned lands. Small, shallow wetlands are particularly vulnerable to conversion to agriculture, especially during dry years. The involvement of private land owners is thus crucial to implementing this management plan. Outreach and education regarding the importance of seasonal and semi-permanent wetlands as well as stewardship programs will support and empower private landowners to conserve, restore and create wetlands on their property. Farm dugout and water stock ponds can be used as nesting ponds if they are properly managed. Horned Grebes will readily breed in human-created habitats, such as borrow pits, farm dugout and water stock ponds. Restoration guidelines promoting habitat features preferred by the Horned Grebe (and other aquatic animals), such as maintenance of riparian and emergent vegetation, should be adopted. Also, best management practices for livestock management will also support the protection of small wetlands by maintaining riparian vegetation and limiting disturbance and destruction by livestock. Examples of best management practices for wetlands are listed in section 6.1 *Actions already completed or currently underway*.

Habitat loss is also driven by natural resource development projects in the western boreal forest, where industrial activities (e.g. oil & gas, mining and forestry) largely overlap with the Horned Grebe's distribution. Wetland conservation on the public lands should be guided by larger frameworks which are typically of provincial jurisdiction. Wetland policies should be implemented in collaboration with relevant policy makers and include guidelines and best management practices regarding the conservation and the restoration of wetlands. Examples of best management practices for wetlands are listed in section 6.1 *Actions already completed or currently underway*.

Information about connectivity between breeding and wintering grounds is essential to adopt more targeted conservation measures since populations wintering in different areas are fluctuating at different rates and directions. For example, the reasons behind the decline and subsequent increase of Horned Grebes wintering along the East Coast remain largely unknown. Understanding where these individuals breed would help reduce threats throughout their life cycle.

Because the BBS has significant shortcomings as a tool to assess breeding population size and trends in Horned Grebes, a monitoring program targeting Horned Grebes and other marsh-bird species is recommended to properly assess population trends. This program should be implemented to cover, as much as possible, the entire breeding range of the species.

Finally, a number of secondary threats affecting waterbirds (e.g. oil spills, fisheries bycatch, diseases, collisions with power lines and wind turbines, and dry landing) have been identified, but in all these cases, data are currently collected on a case-by-case basis and seldom compiled at national or continental scales. Hence, the overall understanding of the impact of these threats is incomplete and potentially underestimated. Concerted and integrated monitoring programs are required to monitor these threats in the future.

7. Measuring Progress

The performance indicators presented below provide a way to measure progress towards achieving the management objective and monitoring the implementation of the management plan.

- The indicator of progress for a population that is equal or above the average population level of the past 30 years (1987-2017) is the population trend and abundance index:
    - The population trend and abundance index of Horned Grebes will be inferred using a combination of available data sources, particularly the CBC, but also the BBS, the WBPHS and other surveys targeting wetland species once they are developed. The population objective was established using population level over the past 30 years to provide a more robust baseline (i.e. one which encompasses potential cycles) against which to assess progress. At the moment, and considering the significant limitations of the BBS to establish trends for the species, the CBC appears to be the most reliable source of information available against which to assess progress. However, a breeding ground monitoring program and more information on connectivity between breeding and wintering grounds are required to better understand the different trends observed on the wintering grounds.
- The indicator of progress for maintaining of the current distribution of the species in Canada (based on 2007-2017 records) is the population’s distribution:
    - The distribution of Horned Grebes in Canada will be measured using a combination of available data sources, including the eBird database, provincial breeding bird atlases, the BBS and other surveys targeting wetland species once they are developed.

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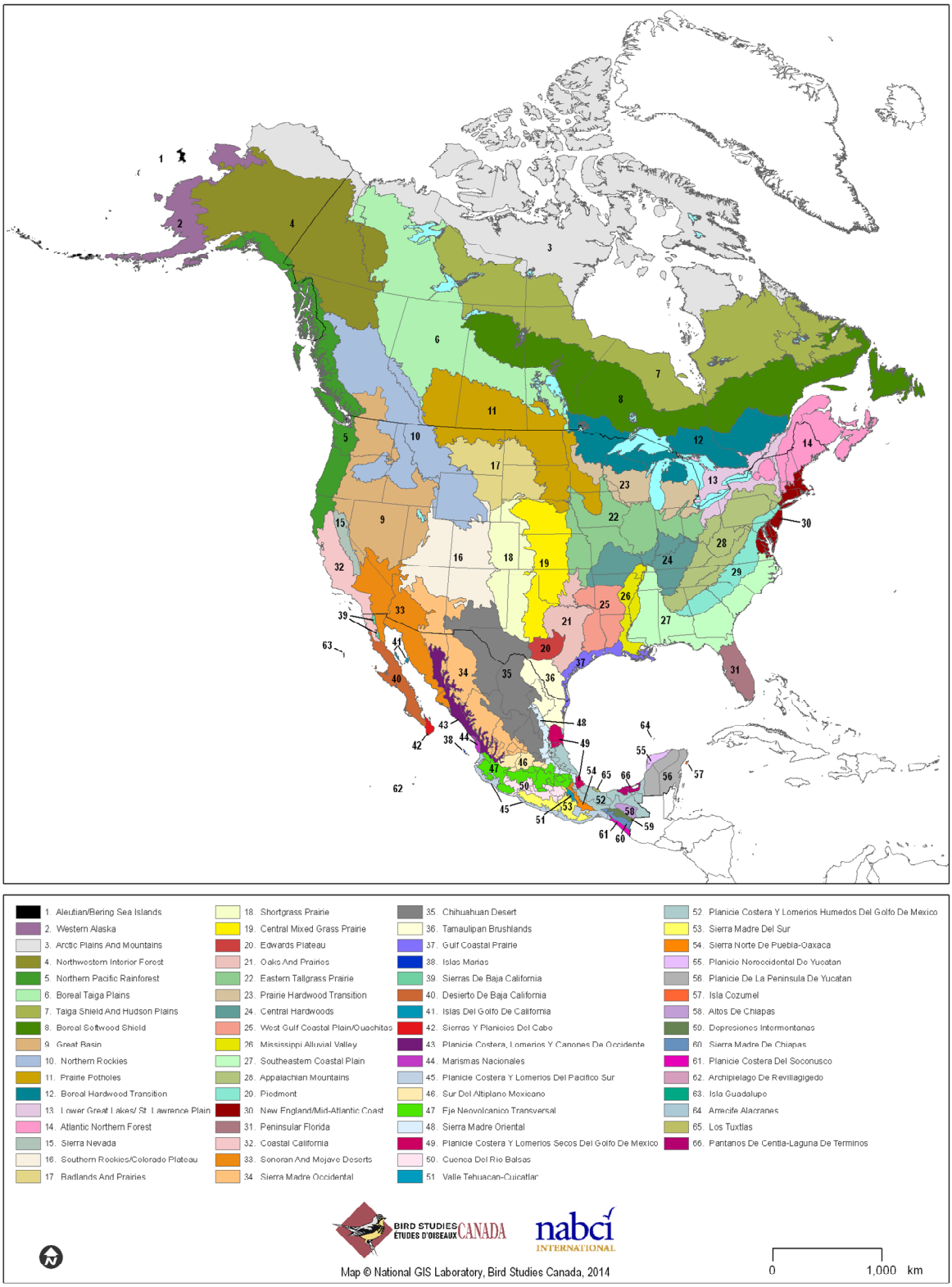
Appendix A: Map of Bird Conservation Regions



Appendix B: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[16]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[17] (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself, but are also summarized below in this statement.

The Horned Grebe is a waterbird species nesting on small ponds and wetlands of the prairie and boreal ecoregions upon which many other species depend for nesting and feeding. Conservation measures aimed at conserving and restoring ecosystems are expected to alleviate threats for other SARA-listed wetlands species, such as the Olive-sided Flycatcher (*Contopus cooperi*), the Rusty Blackbird (*Euphagus carolinus*) and the Yellow Rail (*Coturnicops noveboracensis*), Western Tiger Salamander (*Ambystoma mavortium*), Western Toad (*Anaxyrus boreas*), Northern Leopard Frog (*Lithobates pipiens*), Great Plains Toad (*Anaxyrus cognatus*), non-inclusively. On western wintering grounds, mitigating stresses related to fisheries bycatch and contamination is expected to benefit seabird species such as the Marbled Murrelet (*Brachyramphus marmoratus*), the Pink-footed Shearwater (*Puffinus creatopus*) and the Short-tailed Albatross (*Phoebastria albatrus*).

Although it is possible that this management plan may negatively influence other species, it is concluded that it is unlikely to produce significant negative effects, given the non-intrusive nature of the proposed actions and the abundant populations of potentially affected species.

[16] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[17] www.fsds-sfdd.ca/index.html#/en/goals/