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Western Grebe

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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 Western Grebes performing a courtship display © iStock.com/twphotos

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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 Western Grebe and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the Ministry of Environment and Parks of Alberta, the Ministry of Agriculture and Resource Development of Manitoba and the Ministry of Environment of Saskatchewan 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 Western Grebe 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

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Executive Summary

The Western Grebe (*Aechmophorus occidentalis*) is a colonial waterbird species endemic to North America. The core of the Canadian breeding range is located in the Prairie Provinces, with a small number of individuals breeding in the south central interior of British Columbia. In Alberta, most of the major colonies occur in the boreal forest and the parkland in the central part of the province, but there are also colonies throughout southern Alberta. In Saskatchewan and Manitoba, breeding colonies occur mainly in the central and southern parts of the provinces. These areas represent approximately 30% of the species' North American breeding range. The continental population is estimated at 100,000 individuals, of which 31,000 to 34,000 breed in Canada. Breeding colonies are mostly found on medium to large lakes with prey fish and adequate vegetation to support nests. The species winters along the Pacific coast from southern Alaska to Baja California.

The Western Grebe is listed as Special Concern in Schedule 1 of the *Species at Risk Act* and as Threatened under the *Alberta Wildlife Act*. The Western Grebe is protected in Canada under the *Migratory Birds Convention Act, 1994* and in the United States, where most of the population winters, under the *Migratory Bird Treaty Act*.

Christmas Bird Count data show that the continental population of Western Grebe has declined by 74.2% since 1985, while the number of Western Grebes wintering in Canada has declined by 95.8% over the same period. According to the British Columbia Coastal Waterbird Survey, the decline in Canada has been particularly steep in the Salish Sea, while the population appears more stable in other areas along the coast. This decline could be related to changes in prey fish abundance and distribution along the Pacific coast, which have led to an apparent southward shift of the Western Grebe distribution, as well as other factors, such as increased human disturbance in southern British Columbia. On their wintering grounds, Western Grebes are also vulnerable to oil spills, fisheries bycatch and harmful algal blooms.

The Western Grebe faces numerous threats on its breeding grounds in Canada, such as disturbance from boating activities, changes in water levels (as a result of heavy rains, storms or water management), lethal and sub-lethal effects of pesticides and contaminants, and problematic invasive species which modify or destroy its breeding habitat. These threats cause nest failure and decrease productivity sometimes to the point where a colony is abandoned. Western Grebes are also vulnerable to collisions with power lines and wind turbines, and landing in mining tailing ponds and solar farms.

The management objectives for the Western Grebe in Canada are to: 1) maintain a stable wintering population trend (i.e. not decreasing) over the next 10 years, 2) maintain the wintering population's distribution over the next 10 years, 3) maintain the breeding population between 31,000 and 34,000 adults over the next 10 years and 4) maintain the breeding distribution at ~830,000 km^2 over the next 10 years. Broad strategies and conservation measures to achieve these objectives are presented in this document.

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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2014

Common Name (population): Western Grebe

Scientific Name: *Aechmophorus occidentalis*

COSEWIC Status: Special Concern

Reason for Designation:
Although population declines have occurred within this waterbird's Canadian wintering area on the Pacific Coast, this could largely be the result of a southern shift in wintering distribution rather than a true loss in population size. Nevertheless, on a continental scale, wintering populations have undergone a 44% decline from 1995 to 2010 based on Christmas Bird Count data. Some of this decline may also be the result of declines on the Canadian breeding grounds. In addition, this species' propensity to congregate in large groups, both in breeding colonies and on its wintering areas, makes its population susceptible to a variety of threats, including oil spills, water level fluctuations, fisheries bycatch, and declines in prey availability.

Canadian Occurrence:
British Columbia, Alberta, Saskatchewan, Manitoba

COSEWIC Status History:
Designated Special Concern in May 2014.

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

2. Species Status Information

The Western Grebe (*Aechmophorus occidentalis*) is designated as Least Concern on the global IUCN Red List (BirdLife International, 2020) and Globally Secure (G5) by NatureServe (2019). In Canada, the species' breeding population is Apparently Secure (N4B), but the nonbreeding population is considered Vulnerable to Imperiled (N2N3N; NatureServe, 2019). NatureServe provincial and state status are presented in Table 1.

Table 1. National and provincial/state NatureServe statuses for the Western Grebe (NatureServe, 2019).

Global (G) Rank	National (N) Ranks	Sub-national (S) Ranks
G5	Canada N4B,N2N3N,N4M	Alberta (S3B), British Columbia (S1B,S2N), Manitoba (S3S4B), Saskatchewan (S5B)
	United States N5B, N5N	Alaska (S3N), Arizona (S3), Arkansas (SNA), California (SNR), Colorado (S4B), Idaho (S2B), Illinois (SNA), Iowa (S2N), Kansas (S1B), Minnesota (SNRB), Montana (S4B), Navajo Nation (S3B,S4N), Nebraska (S3), Nevada (S4B), New Mexico (S3S4), North Dakota (SNRB), Oklahoma (S1N), Oregon (S3B,S2S3N), South Dakota (S4B), Texas (S3), Utah (S4B,S3N), Washington (S3B,S3N), Wyoming (S4B)

National (N) and Subnational (S) NatureServe alphanumerical ranking: 1 - Critically Imperiled, 2 - Imperiled, 3 - Vulnerable, 4 - Apparently Secure, 5 - Secure, NR - Unranked, NA - Not Applicable. Occurrence definitions: B - Breeding, M - Migrant. For example, the S3S4B rank in Manitoba indicates the range of uncertainty about the status of the species (Vulnerable to Apparently Secure breeder in Manitoba).

In Canada, the Western Grebe has been listed as Special Concern under Schedule 1 of the *Species at Risk Act* (S.C. 2002, c.29) since 2017. As a migratory bird, the Western Grebe is protected in Canada under the *Migratory Birds Convention Act*, 1994 and in the United States under the *Migratory Bird Treaty Act*. This species is considered a Tier 1 priority species in Canada's Waterbird Conservation Plan (Environment Canada, 2003) and it is also designated as a priority species in five Bird Conservation Regions (BCR)[3,4].

In Alberta, the Western Grebe is listed as Threatened under the *Wildlife Act*. It is on the British Columbia provincial Red List, which means it is at risk of being lost, but this designation provides no legal protection. The species is not currently listed by any other province or territory.

[3] 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).
[4] Northern Pacific Rainforest (BCR 5), Boreal Taiga Plains (BCR 6), Great Basin (BCR 9), Northern Rockies (BCR 10) and Prairie Potholes (BCR 11).

3. Species Information

3.1. Species Description

The Western Grebe is one of the largest grebe species and, like all members of the Podicipedidae family, is adapted for an aquatic lifestyle (COSEWIC, 2014). The Western Grebe has a slender profile with its long neck and long, sharply pointed bill which, combined with the spearing mechanism of the neck, is ideal for the pursuit and capture of fish (LaPorte et al., 2020). Adults have a black crown and this black coloration continues down the dorsal side of the neck and over the back (COSEWIC, 2014). Their cheeks, throat, breast and belly are white. Their eye is bright red and the bill yellowish-green. Sexes are similar in appearance, but males are slightly larger and heavier than females. The females can be distinguished from their shorter, thinner bill and the somewhat upturned appearance of their bill (LaPorte et al., 2020). Winter plumage is similar to breeding plumage, but the black coloration of the crown, neck and back is less contrasted with the white body. Newly hatched chicks are precocial[5] and climb on the back of the incubating parent (Nuechterlein, 1981a; Lindvall and Low, 1982; Johnsgard, 1987; Knapton, 1988).

3.2. Species Population and Distribution

The Western Grebe is endemic to North America, where it breeds from the Canadian Prairies to the Mexican Plateau (Figure 1). The subspecies *A. o. occidentalis*, which is the subject of this Management Plan, breeds in southwestern Canada through the western United States into northern Baja California and winters along the Pacific coast. The other subspecies, *A. o. ephemeralis,* is a resident of the Mexican Plateau from Chihuahua to the Valley of Mexico (LaPorte et al., 2020) and does not occur in Canada.

[5] Hatched with eyes open, covered with down and leave the nest within a few days.

Figure 1. Distribution of the Western Grebe in North America.

About 30% of the Western Grebe's breeding range is located in Canada (Figure 1), where the population is estimated at 31,000 to 34,000 individuals (out of a total continental population of approximately 100,000 individuals; COSEWIC, 2014).

Additionally, the Western Grebe and the Clark's Grebe (*Aechmophorus clarkii*) are closely related and were not distinguished as separate species until 1985 (American Ornithologists' Union, 1985). Therefore, early estimates of Western Grebe breeding population size included Clark's Grebes, and this lack of distinction complicates the comparison between historical and recent surveys. However, Clark's Grebes are mostly found in the southern portion of the Western Grebe's range (Eichhorst and Parkin, 1991; Eichhorst, 1992) and its distribution is limited in Canada. Hence, the lack of distinction between the two species until 1985 likely had little impact on historical population estimates in Canada.

Breeding distribution, abundance and trend

In Canada, the extent of occurrence of the Western Grebe is estimated at ~830,000 km^2, but because of its colonial behavior, the actual area of occupancy is estimated at only 440 km^2 (COSEWIC, 2014). There are about 110 breeding colonies in Canada (COSEWIC, 2014). Colonies have an uneven and clustered distribution, and vary greatly in size, from only a few breeding pairs to over 2,500 pairs. Most colonies are located in Alberta, Saskatchewan and Manitoba, with only a few colonies in British Columbia. In Alberta, most of the major colonies occur in the boreal forest and the parkland, but there are also colonies throughout southern Alberta (COSEWIC, 2014). In Saskatchewan and Manitoba, breeding colonies occur mainly in the central and southern parts of the provinces, while they are restricted to the south central interior of British Columbia (COSEWIC, 2014). The largest colonies (>1,000 individuals) are located in Manitoba and Alberta.

Accurately estimating the size of the Western Grebe's breeding population is challenging. Colony size can vary from one year to the next, often in response to changes in water levels (COSEWIC, 2014), making year-to-year comparison difficult. Some colonies can even be abandoned at times when conditions are unsuitable (e.g. floods), only to reappear a few years later when favorable conditions return (La Porte et al., 2013; Wollis and Stratmoen, 2010).

Also, Western Grebe colonies are often located in marshy areas that are difficult to access and where conducting an accurate nest count is difficult, particularly when trying to avoid disturbing nesting adults. Colony size is often extrapolated from shore counts (e.g. data submitted in eBird), but other methods have been used: meandering the shoreline (Hanus et al., 2002a; Hanus et al., 2002b), transect surveys and distance sampling by boat (Found and Hubbs, 2004; Prescott et al., 2018), aerial surveys (Gendron et al., 2001; Found and Hubbs, 2004) and nest counting (and multiplying x2 to estimate adult population size) either by direct observation or using drones (Hanus et al., 2002a; Hanus et al., 2002b; D. Prescott pers. comm., 2020; McKellar et al., 2021).

Although complete counts are possible on some lakes, this is not feasible when colonies are located on large lakes (particularly those with multiple colonies), where counts only cover parts of a lake at any time. For these reasons, counts are generally considered to be conservative estimates. Reliable population trends are also difficult to obtain for the Western Grebe, since very few colonies are visited on a yearly basis or even regularly, and there is no consistent census method to survey breeding colonies. Hence, an accurate breeding population trend is not available at this time.

The breeding population estimate presented in this document was revised using the most recent information from Wilson and Smith (2013) and Prescott et al. (2018), as well as the highest colony counts over a 10-year period from McKellar et al. (2019; Table 2).

To inform the Western Grebe's assessment by COSEWIC, Wilson and Smith (2013) conducted a review of existing information and estimated the Canadian population at 21,000 to 27,000 breeding individuals. However, following the designation of the species as Threatened in Alberta in 2014, Prescott et al. (2018) conducted a review of existing information, as well as additional field surveys, and they concluded that the population estimate in Alberta had been underestimated by Wilson and Smith (2013). Instead of the 10,270-12,289 breeding individuals estimated by Wilson and Smith (2013), the provincial population was estimated at >19,000 breeding adults (Alberta Environment and Parks, 2018). This significantly increases the total population estimate in Canada.

Additionally, a database of existing information on known colonies was also compiled by McKellar et al. (2019). Although this database did not include all of Prescott et al. (2018) data from Alberta, it did suggest that population estimates in Saskatchewan had also been underestimated by Wilson and Smith (2013). Based on this new information, the total Canadian population is estimated to be closer to 31,000 to 34,000 individuals (Table 2).

Table 2. Western Grebe population estimates in Canada.

Province	Wilson and Smith, 2013	McKellar et al., 2019[1]	Alberta Environment and Parks, 2018	Latest population estimate
British Columbia	<400	N/A	N/A	<400
Alberta	10,270-12,289	9,250-15,103	19,000	19,000
Saskatchewan	1,794-2,421	2,957-3,274	N/A	2,957-3,274
Manitoba	8,453-11,203	9,338-11,192	N/A	9,338-11,192
Canada (total)	**20,917-26,313**	**21,545-29,569**	**N/A**	**31,695-33,866**

[1]The lower end of the range was calculated by adding the average count at confirmed breeding colonies over a 10-year period, while the higher end of the range was obtained by adding the highest count obtained at the same colonies over the same 10-year period. The 10-year period was 2007-2017 in Saskatchewan and Manitoba and 2006-2016 in Alberta.

British Columbia

The breeding distribution of the Western Grebe in British Columbia is limited to a few sites, mainly Shuswap Lake (Salmon Arm Bay), Duck/Leach's Lakes complex (within the Creston Valley Wildlife Management Area) and Okanagan Lake. Two former colonies on Swan Lake and Williams Lake no longer exist. Burger (1997) estimated British Columbia's Western Grebe population at 190 pairs (90 pairs at Shuswap Lake, 60 pairs at Duck/Leach's Lakes and 40 pairs at Okanagan Lake). During the surveys for the Atlas of the breeding birds of British Columbia (Davidson et al., 2015), breeding was confirmed only on Shuswap Lake (high count: 150 individuals) and Duck/Leach's Lakes (high count: 11 individuals), while breeding was suspected, but not confirmed, at Okanagan Lake (Howie, 2015). Howie (2015) also states that the Shuswap Lake colony is consistently the largest and appears to have increased, while the Duck/Leach's Lakes complex and Okanagan Lake colonies have decreased. The population of Western Grebes at the Duck/Leach's Lakes complex has significantly decreased after a flood in 2012 and there are probably less than 20 breeding pairs now (M.-A. Beaucher, pers. comm. 2020). Overall, the breeding population of Western Grebes in British Columbia appears to be less than 200 breeding pairs (<400 individuals).

Alberta

Alberta supports the largest number of Western Grebes in Canada. Prescott et al. (2018) did an extensive review of existing literature and conducted surveys in 2015 and 2016 to update the population status of the species. They concluded that there were >19,000 breeding adults in Alberta which is higher than previous estimates (Wilson and Smith, 2013; AESRD and ACA, 2013).

In Alberta, 318 lakes are known to have historically supported Western Grebes during the breeding season and breeding was confirmed on 67 of those lakes. A list of the 48 priority lakes identified in Alberta's draft Western Grebe Recovery Plan (Alberta Environment and Parks, 2018), all of which have supported at least 100 individuals during the breeding season (1 May to 31 August) in the past, is presented in Appendix B with information on historical high counts, high counts since 2000 and most recent counts at each site.

Colony size varies greatly among sites and years. For example, Lesser Slave Lake formerly supported a large number of breeding pairs, but in 2007 water levels increased and the spring ice scoured vegetation where the colony had been located (COSEWIC, 2014), resulting in the near disappearance of that colony in the following years, until it was re-established in 2011 (ASRD and ACA, 2013). Another 10 lakes have seen their habitat change (Beaverhill, Buck, Conn, Frog, Garner, Lac Sante, Muriel, Reita, Thunder and Wolf) to the point where they are currently incapable of supporting a major breeding colony (Prescott et al., 2018). Yet, in their report, Prescott et al. (2018) also identified 15 lakes that have supported >100 individuals that were unknown previously. They concluded that "this, along with the discovery of many smaller waterbodies that support small numbers of Western Grebes (often breeding) suggests a highly dynamic system of lake occupancy by Western Grebes in Alberta, and the possibility that provincial populations are higher than previously thought".

Saskatchewan

Saskatchewan supports the fewest number of Western Grebes in the prairie provinces. In their 2013 report, Wilson and Smith (2013) estimated the population at 1,794-2,412 individuals, but subsequent data gathered by McKellar et al. (2019) suggested it was closer to 3,000-3,300 individuals. Colonies in Saskatchewan are also smaller than those in Alberta and Manitoba; none exceed 1,000 individuals.

Since 2000, breeding has been confirmed on 18 lakes in Saskatchewan with an additional 19 locations where Western Grebes were reported during the breeding season (May 1 to August 31), but where breeding was not confirmed. A list of these sites, including historical high counts, high counts since 2000 and most recent counts at each site, is presented in Appendix C. The largest colonies (>100 individuals) are located on Mud Lake (highest count since 2000: 516 individuals), Jackfish Lake (480), Last Mountain Lake (400), Pelican Lake (400), Waterhen Lake (348), Lac des Iles (330), Good Spirit Lake (300), Buffalo Pound Lake (250), Dore Lake (240), Big Quill Lake (226), McLean Lake (150) and Valeport Marsh (150).

Manitoba

Manitoba has fewer Western Grebe colonies than either Alberta or Saskatchewan but they tend to be larger. In fact, Manitoba hosted the largest colony at Marshy Point on Lake Manitoba, which accounted for nearly 20% of the Canadian population in 2011 (5,798 individuals; COSEWIC, 2014). The largest colonies in recent years were located on Lake Manitoba (Delta Marsh, Sandy Bay and Marshy Point), Lake Winnipegosis (Long Island and Long Island Bay IBA), Lake Winnipeg (Netley-Libau Marsh) and Whitewater Lake.

However, many colonies have declined and some have even disappeared since intensive research on the species was conducted in the 1970s and 1980s (Nuechterlein, 1975; Nuechterlein, 1981a; Nuechterlein, 1981b; Nuechterlein, 1981c; Nuechterlein and Storer, 1982; Nuechterlein and Buitron, 1989). For example, the large colony located at Marshy Point formerly hosted almost 20% of all Western Grebes breeding in Canada, but appears to have declined in recent years. The Netley-Libau Marsh colony also appears to have declined recently as a result of habitat degradation due to artificially high water levels (T. Poole, pers. comm. 2020). The colony at Gimli Marsh formerly hosted 400 individuals but declined to less than 100 in the 2000s and probably no longer exists. Large groups of >200 Western Grebes were also reported in the 1970s and 1980s in several areas on Lake Winnipegosis, on Swan Lake and on Inland Lake, but there are no recent sightings (2010-2020) of the species on these lakes in eBirds, with the exception of a flock of approximately 200 individuals at the mouth of the Red Dear River in June 2020 (eBird, 2020). In other cases, colony size has varied greatly over the years. For example, the Shoal Lakes colony decreased from 800 individuals in 1995 to 117 in 2017. However, in August 2018, a estimated 900 individuals (including both adults and well grown young) were present on those lakes (T. Poole, pers. comm. 2020). Similarly, the Whitewater Lake colony decreased in the 1980s due to changes in water levels, subsequently increased in the 2000s (C. Artuso, pers. comm. 2020) and appears to have declined again recently (T. Poole, pers. comm. 2020).

A list of all known sites where >50 breeding adults have been observed in Manitoba during the breeding season, including historical high counts, high counts since 2000 and most recent counts at each site is presented in Appendix D.

Population estimates from McKellar et al. (2019) are consistent with those obtained by Wilson and Smith (2013; Appendix D). The most recent population estimate for Manitoba is 9,300-11,200 individuals.

Wintering distribution, abundance and trend

Western Grebes winter along the Pacific coast of North America from southern Alaska to Baja California (LaPorte et al., 2020). Based on Christmas Bird Count (CBC) data, approximately 3% of the North American population winter along the coast of Alaska, 10% in British Columbia, 14% in Washington, 10% in Oregon and 64% in California (National Audubon Society, 2020).

Intra-winter movement of Western Grebes is minimal and some individuals may return to the same sites in subsequent winters (Eichhorst, 1992). However, Western Grebes are not constrained to specific wintering sites and will respond to spatial and temporal variations in the abundance of their prey (Therriault et al., 2009; Wilson et al., 2013; Vilchis et al., 2015).

In Canada, Western Grebes winter along the entire British Columbia coast, but their precise distribution is unknown. Western Grebes winter in large numbers in the Salish Sea (Strait of Georgia, Strait of Juan de Fuca and Puget Sound), but their numbers have been declining since the 1970s. Also, an unknown portion of Canadian breeding birds winter outside the country (COSEWIC, 2014).

The CBC and the British Columbia Coastal Waterbird Survey (BCCWS) are useful to assess long-term wintering population trends at the continental level and in British Columbia. However, both of these land-based surveys are not particularly efficient to survey Western Grebes, because their coverage is limited to accessible near-shore areas and Western Grebes flocks will often forage well beyond the line-of-sight of land-based observers (i.e. >500m) or in remote areas (A. Breault, pers. comm. 2020; S. Boyd, pers. comm. 2020). Additionally, the CBC data present aggregated data for Clark’s and Western Grebes, since these were considered to be part of the same species until 1985 by the American Onithologists’ Union. After 1985, Western and Clark’s grebes were identified to species when possible, with Western Grebes comprising 98% of observations, indicating that trends can be attributed primarily to Western rather than Clark’s grebes (COSEWIC, 2014). This is particularly true for northern regions, where Clark’s Grebes were rarely documented (COSEWIC, 2014).

At the continental scale, CBC data show a significant long-term decline of *Aechmophorus* grebes since 1966 (Figure 2).

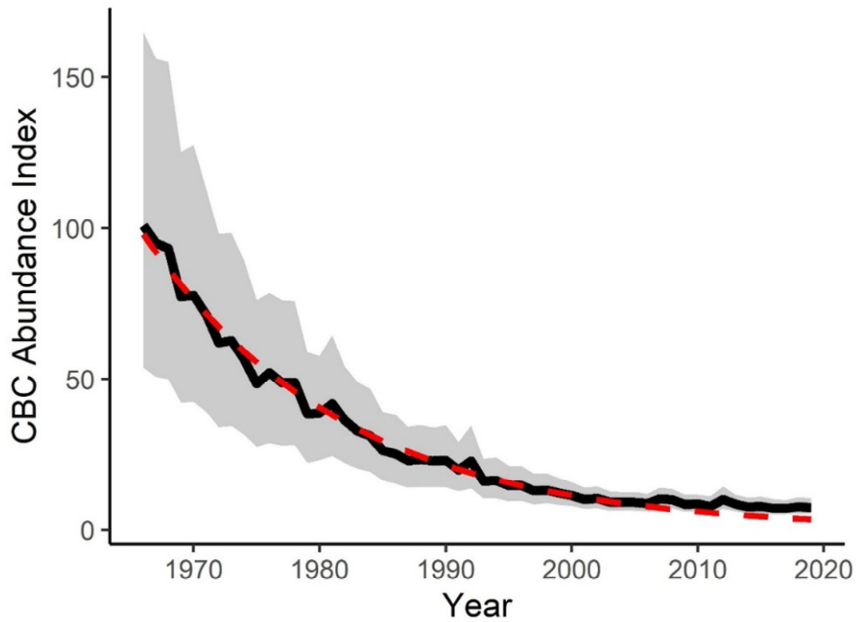

Figure 2. Continental annual index of *Aechmophorus* grebes from Christmas Bird Counts (1966–2017; National Audubon Society 2020); solid black lines represent the mean CBC index, shaded areas represent the 95% credible intervals, and dashed red lines represent the log-transformed regression of CBC indices (1966-2017).

The CBC data suggest the Western Grebe continental population has declined by 74.2% since 1985, and by 95.8% over the same period in Canada (Table 3). In the past 15 years alone, the Western Grebe continental population has declined by 25.7%, and by 63.2% in Canada. The steeper decline in Canada is also reflected in the annual rates of decline (Table 3).

Table 3. Annual rates of decline for the Western Grebe according to Christmas Bird Count data as calculated from the log-transformed regression (National Aubudon Society, 2020).

Geography	Since 1966*	Since 1985	Last 15 years (2005-2019)
Canada	-1.9%	-8.9%	-6.5%
United States	-2.2%	-2.7%	-1.3%
North America	-2.2%	-3.9%	-2.0%

* Data before 1985 includes both Clark's and Western Grebe data, since these two species were considered part of the same species until 1985.

The decline in Canada is likely linked with the steep decline observed in the Salish Sea since the late 1980s (Bower, 2009; Crewe et al., 2012; Wilson et al., 2013; Ethier et al., 2020). According to the BCCWS, the portion of the population wintering in the Salish Sea has shown a significant decline of -12.7%/year over 20 years (1999-2019; Ethier et al., 2020).

The reasons for this decline are unclear, but, as noted earlier, Western Grebes are a mobile species that respond to spatial and temporal variations in the abundance of their prey (Therriault et al., 2009; Wilson et al., 2013; Vilchis et al., 2015). Using CBC data, Wilson et al. (2013) measured a 95% decline between 1975 and 2011 in the number of Western Grebes wintering in the Salish Sea, but, in parallel, noted a 300% increase along the coast of California resulting in a southward shift in the mean centre of the distribution by approximately 900 km.

The redistribution and the population declines of wintering Western Grebes and other diving piscivores in the Salish Sea are hypothesized to be associated with a decrease in the abundance and quality (i.e. weight-at-age) of prey fish (Therriault et al., 2009; Wilson et al., 2013; Vilchis et al., 2015). Other suspected causes of this decline include an increase of disturbance by boat traffic and shellfish aquaculture activities and predation threat from increasing numbers of overwintering Bald Eagles on the coast (Wilson et al., 2013; COSEWIC, 2014; S. Boyd, pers. comm. 2020). However, evaluating population trends throughout the species wintering range in Canada is limited by the lack of information on the wintering distribution and abundance of Western Grebe in areas not well captured by the CBC or the BCCWS.

Migration

Fall migration generally occurs between early September and early November, while spring migration to the breeding grounds occurs from late April to early May (LaPorte et al., 2020). During migration, which occurs at night, Western Grebes will stop on large freshwater lakes (LaPorte et al., 2020).

Based on band recoveries of Western Grebes breeding in Canada, some birds migrate westward to British Columbia, while others migrate southwest, particularly to California, although a few band recoveries also suggest that some birds winter inland (Eichhorst, 1992; Dunn et al., 2009; Figure 3).

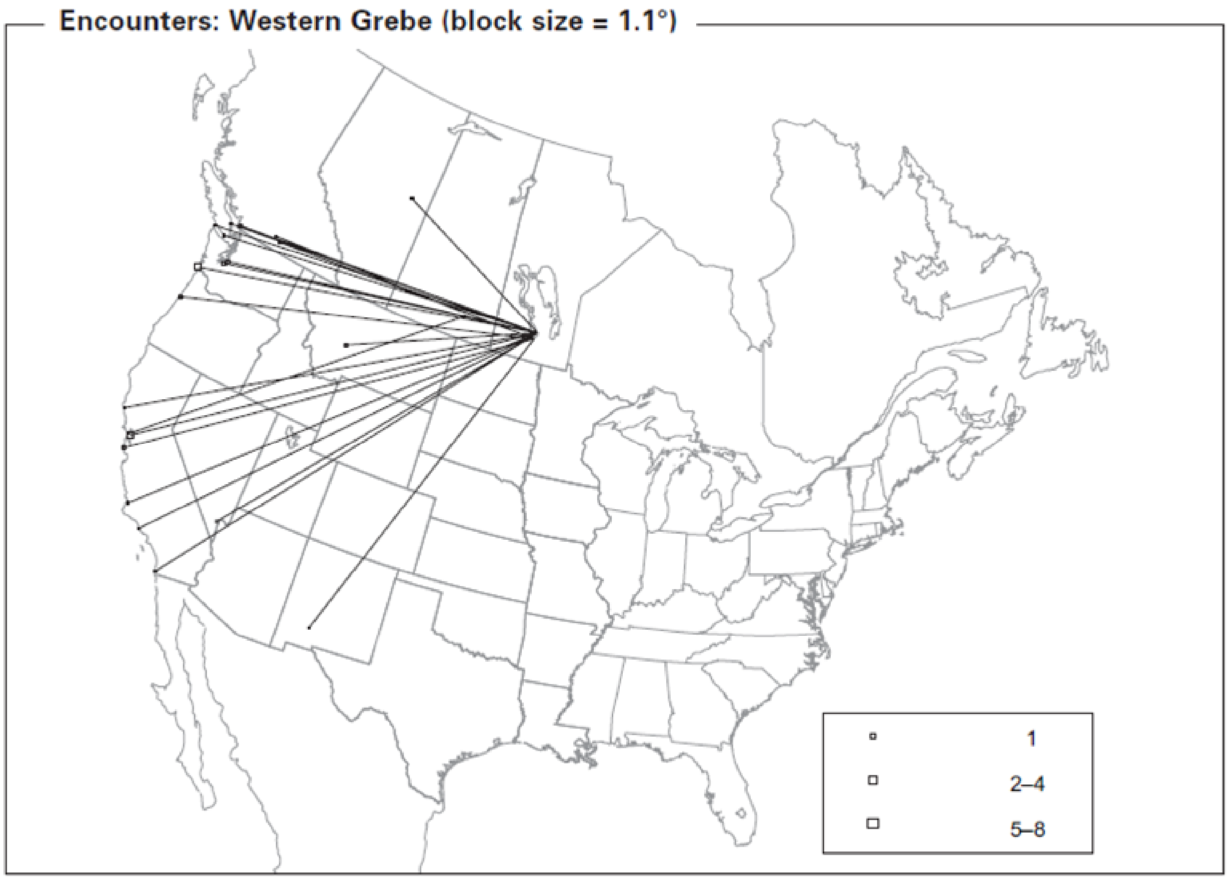

Figure 3. Western Grebe banding and band recovery locations. Squares represent band recovery locations and the size of the square represents the number of bands recovered at each location. Source: Dunn et al., 2009.

3.3. Needs of the Western Grebe

Breeding season

Western Grebes breed across a range of ecoregions, but their breeding site requirements are quite specific and potential colony sites are limited (COSEWIC, 2014). Western Grebes are obligate colonial breeders, thus single colonies can hold large proportions of the breeding population, as evidenced by the Marshy Point, Lake Manitoba colony which supported up to 20% of all Western Grebes in Canada in 2011.

Western Grebe colonies are mostly found on freshwater lakes (and rarely on tidewater marshes) with stable water levels, extensive open water bordered by emergent vegetation and sufficient prey fish abundance (LaPorte et al., 2020). Nests are located in sheltered marshes of adequate depth (>25 cm) with emergent vegetation which provides an anchor for nests and protection from wave action and predation. Emergent vegetation used for nesting includes *Scirpus sp.*, *Phragmites ssp.* and *Typha spp.*, while submergent beds of Water Milfoil (*Myriophyllum spp.*) and Sago Pondweed (*Potamogeton pectinatus*) are sometimes used (LaPorte et al., 2020).

Natal philopatry[6] and adult site fidelity are poorly studied. Although Western Grebes have established large colonies at the same locations for multiple years, they are known to relocate due to changes in habitat conditions (Calvert, 2009; Wollis and Stratmoen, 2010; COSEWIC, 2014). In early May, nest locations are selected based on attributes including water level and emergent vegetation. If these conditions change dramatically, Western Grebes will abandon these sites and return when favorable habitat conditions return. Human disturbance has also been identified as a reason for colony abandonment (Burger, 1997; Wollis and Stratmoen, 2010; Erickson, 2010). Floods and wave action caused by storms can expose a high proportion of the colony to nesting failure (Allen et al., 2008).

During the first few days after hatching, the young are particularly dependent on adults for protection and feeding, making them vulnerable to disturbance by boating activities. They often climb on the backs of their adult parents until 2 to 4 weeks of age (LaPorte et al., 2014). Also, some adults start molting flight feathers on their breeding grounds, which limits their ability to relocate between lakes to avoid human disturbance or predation (LaPorte et al., 2020; COSEWIC, 2014).

Western Grebes specialize on fish (>81 % of diet) of 80-100 mm in size, but are opportunistic and utilize other prey such as crustaceans, polychaete worms, aquatic insects and molluscs (LaPorte et al., 2020). This diet specialization appears to restrict breeding colonies to lakes with sufficient fish prey abundance. Winter kills of prey fish are naturally occurring events that can reduce prey fish abundance and limit potential nesting habitat, regardless of the availability of emergent vegetation (Wollis and Stratmoen, 2010).

Wintering season and migration

Post-breeding, most Western Grebes move to large freshwater lakes and coastal locations to molt before proceeding to wintering areas, although some birds molt on the breeding grounds (Stout and Cooke, 2003; LaPorte et al., 2020).

On the wintering grounds, Western Grebes mostly occupy sheltered near-shore, marine habitat where they pursue Pacific Herring (*Clupea pallasii*), Pacific Sardine (*Sardinops sagax*), Pacific Sand Lance (*Ammodytes hexapterus*), Northern Anchovy (*Engraulis mordax*), and Eulachon (*Thaleichthys pacificus*; Therriault et al., 2009; Wilson et al., 2013). Less frequently, they will winter on freshwater lakes and occasionally rivers (LaPorte et al., 2020). They can congregate in flocks of several thousand birds, exposing large proportions of the wintering population to local events such as oil spills or harmful algal blooms (Humple et al., 2011; COSEWIC, 2014).

Western Grebes are not constrained to specific wintering sites and will respond to spatial and temporal variations in the abundance of their prey (Therriault et al., 2009; Wilson et al., 2013; Vilchis et al., 2015).

[6] Tendancy of an individual to return to the area of its birth.

4. Threats

4.1. Threat Assessment

The Western Grebe threat assessment is based on the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats 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 the Description of Threats section.

Table 4. Threat assessment summary.

	Threat	Impact[a]	Scope[b] (next 10 Yrs)	Severity[c] (10 Yrs or 3 Gen.)	Timing[d]
1	**Residential & commercial development**	**Low**	**Small (1-10%)**	**Extreme (71-100%)**	**High (Continuing)**
1.1	Housing & urban areas	Medium	Restricted (11%-30%)	Serious - Extreme (31-100%)	High (Continuing)
1.3	Tourism & recreation areas	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)
2	**Agriculture & aquaculture**	**Negligible**	**Negligible (<1%)**	**Extreme (71-100%)**	**High (Continuing)**
2.1	Annual & perennial non-timber crops	Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)
2.3	Livestock farming & ranching	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)
3	**Energy production & mining**	**Unknown**	**Unknown**	**Serious - Extreme (31-100%)**	**High (Continuing)**
3.1	Oil & gas drilling	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)
3.3	Renewable energy	Unknown	Unknown	Serious - Extreme (31-100%)	High (Continuing)
4	**Transportation & service corridors**	**Unknown**	**Unknown**	**Serious - Extreme (31-100%)**	**High (Continuing)**
4.2	Utility & service lines	Unknown	Unknown	Serious - Extreme (31-100%)	High (Continuing)
5	**Biological resource use**	**Low**	**Pervasive (71-100%)**	**Slight (1-10%)**	**High (Continuing)**
5.4	Fishing & harvesting aquatic resources	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)
6	**Human intrusions & disturbance**	**Medium**	**Large (31-70%)**	**Moderate (11-30%)**	**High (Continuing)**
6.1	Recreational activities	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)
6.3	Work & other activities	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
7	**Natural system modifications**	**Medium**	**Pervasive (71-100%)**	**Moderate (11-30%)**	**High (Continuing)**
7.1	Fire & fire suppression	Unknown	Unknown	Unknown	High (Continuing)
7.2	Dams & water management/use	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)

Threat		Impact[a]	Scope [b] (next 10 Yrs)	Severity [c] (10 Yrs or 3 Gen.)	Timing[d]
7.3	Other ecosystem modifications	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)
8	**Invasive & problematic species, pathogens & genes**	**Low**	**Large (31-70%)**	**Slight (1-10%)**	**High (Continuing)**
8.1	Invasive non-native/alien plants and animals	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)
8.2	Problematic native plants and animals	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)
8.4	Pathogens & microbes	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)
9	**Pollution**	**Low - High**	**Small - Large (1-70%)**	**Serious - Extreme (31-100%)**	**Moderate - High**
9.2	Industrial & military effluents	Low - High	Small - Large (1-70%)	Serious - Extreme (31-100%)	Moderate - High
9.3	Agricultural & forestry effluents	Low - Medium	Large (31-70%)	Slight - Moderate (1-30%)	High (Continuing)
11	**Climate change**	**Low - Medium**	**Small - Restricted (1-30%)**	**Serious - Extreme (31-100%)**	**High (Continuing)**
11.3	Changes in temperature regimes	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)
11.4	Changes in precipitation & hydrological regimes	Unknown	Unknown	Unknown	High (Continuing)
11.5	Severe / Extreme Weather Events	Low - Medium	Small - Restricted (1-30%)	Serious - Extreme (31%-100%)	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 Western Grebe faces numerous threats on its breeding grounds in Canada, such as anthropogenic disturbance from boating activities, changes in water levels (as a result of heavy rains, storms or water management), lethal and sub-lethal effects of pesticides and contaminants, and problematic invasive species which modify or destroy its breeding habitat.

On their wintering grounds, the main threats are changes in prey fish abundance and distribution, oil spills, harmful algal blooms and bycatch in fishing gear. Collisions with power lines and wind turbines as well as landing in mining tailing ponds and solar farms are problematic during migration.

1. Residential & commercial development

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

Many lakes where colonies are located are relatively large and deep, and contain fish species of interest for recreational anglers, which also makes them desirable for development (Erickson et al., 2014; Prescott et al., 2018). The persistence of Western Grebe colonies in Alberta is directly related to the extent of shoreline bulrush (Erickson et al., 2014). Habitat loss due to residential development occurs when developments overlap with breeding habitat and emergent vegetation is removed, particularly to clear the shoreline or make space for docks. According to Alberta’s draft Western Grebe Recovery Plan (Alberta Environment and Parks, 2018), “the continuing loss or degradation of emergent vegetation for cottages and dock or marina development reduces or fragments viable nesting Western Grebe habitat and has been described as a key reason for population concerns in Alberta”. Residential developments along the shores of lakes used by Western Grebes will increase in the future and unless steps are taken to prevent future developments from infringing on the species’ habitat, this threat will continue to increase. Hence this threat was scored as “medium”.

Additionally, residential development on lakeshores will generally cause an increase in recreational activities on a lake (e.g. recreational boating, sport fishing). Disturbance by boaters also has significant impact on Western Grebes and colony persistence (see 6.1 Recreational activities).

<u>1.3 Tourism & recreation areas (low)</u>

As is the case for 1.1 Residential development, lakes used for tourism and recreation and those selected for breeding by Western Grebes have similar characteristics (e.g. large and deep, and contain species of fish of interest for recreational anglers). Although the construction of lakeside recreational areas, such as campgrounds, marinas and boat launches, could displace or even cause the abandonment of colonies (Prescott et al., 2018; Burger, 1997), it is the disturbance by boaters that has the most impact (Erickson et al., 2014; Prescott et al., 2018; Alberta Environment and Parks, 2018). Such disturbance is discussed under 6.1 Recreational activities. Hence, the impact of tourism and recreation areas' footprint in Western Grebe habitat was scored as "low".

2. Agriculture & aquaculture

2.1 Annual & perennial non-timber crops (negligible)

Although some lakes with breeding colonies are located in an agricultural landscape, they are generally larger and deeper, which somewhat protects them from conversion to agriculture. As such, this threat was considered to have a negligible impact on the Western Grebe.

2.3 Livestock farming & ranching (negligible)

Livestock can impact wetlands in a number of ways. They use wetlands as a source of drinking water and in the process they defecate (input nutrients to the wetland, possibly resulting in eutrophication; see section 7.3 Other ecosystem modifications) and trample the marsh vegetation. In some cases, shoreline vegetation is removed to facilitate livestock access to water. However, the overlap between livestock ranching activities and Western Grebe habitat is limited on the breeding grounds, so this was generally considered to have a negligible impact on the species.

3. Energy production & mining

3.1 Oil & gas drilling (negligible)

In Canada, oil & gas development projects greatly overlap with the breeding range of Western Grebes. Their infrastructure, however, are usually built on land and the habitat loss due to oil & gas drilling was considered "negligible" overall. The most likely direct impact of the industry on Western Grebe habitat is modification of hydrology, which is discussed under 7.2 Dams & water management/use and 7.3 Other ecosystem modifications.

On the wintering grounds, however, the development of offshore facilities might pose a threat to Western Grebes. Excluding the threat of oil spills (which are discussed under 9.2 Industrial & military effluents), offshore oil developments could overlap with the Western Grebe's wintering range. These projects can displace grebes and their food source, which is discussed under 7.3 Other ecosystem modifications. However, more data is required to assess the extent of this threat of wintering habitat loss and for the moment, it is considered negligible.

3.3 Renewable energy (unknown)

Grebes migrate at night, at relatively low altitudes, and they have low manoeuvrability, which makes them vulnerable to collisions with structures such as wind turbines and power lines (Bevanger, 1998; Garthe and Huppop, 2004; Furness et al., 2013). In Alberta, Western Grebes represented 1.4% of mortality (n=4) at three inland wind farms (120 turbines total) from 2007-2016 (Bird Studies Canada, Canadian Wind Energy Association, Environment and Climate Change Canada and Ontario Ministry of Natural Resources and Forestry, 2018). In Canada <0.2% of the population of any bird species is currently affected by mortality or displacement from wind turbine development, so population level impacts are unlikely (Zimmerling et al., 2013). However, the estimated mortality of any species is likely underestimated, because not all carcasses are found or identifiable at the species' level.

Another potential impact of wind development is related to displacement of Western Grebes on the wintering grounds. Western Grebes tend to avoid the areas surrounding wind energy infrastructure (Kelsey et al., 2014). Offshore development is currently limited along the Pacific coast of North America, but there are at least three calls for offshore projects in the United States (Bureau of Ocean Energy Management, 2020), so these could pose additional threats in the future.

Additionally, grebes can mistake solar farms for water bodies and land (Kagan et al., 2004). This is termed "dry landing". It is difficult for grebes to take flight from land so, once stranded, they die from starvation or predation (Kagan et al., 2004). At least 9 mortalities of Western Grebe have been reported in southern California, but the number of dead birds are likely underrepresented (Kagan et al., 2014).

Grebes are, in general, vulnerable to collisions with wind turbines and dry landing in solar farms, but a precise estimate of this mortality is not available, since there is no nation wide monitoring program. Also, this threat will likely increase in the future if new projects are launched. Hence, this threat was scored as "unknown" overall, but this assessment should be revised once additional information is available.

4. Transportation & service corridors

<u>4.2 Utility & service lines (unknown)</u>

Grebes are one of the most vulnerable bird groups to collisions with power lines (Bevanger, 1998; APLIC, 2012; Rioux et al., 2013). 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 grebe mortality due to collisions with a power line near a wetland in Montana. No Western Grebes were reported, but Eared Grebes represented 29% of the 3,218 dead birds detected. However, the estimated mortality of any species is likely underestimated, because not all carcasses are found or identifiable at the species' level.

Grebes are, in general, vulnerable to collisions with power lines, but a precise estimate of this mortality is not available, since there is no nation wide monitoring program. Also, this threat will likely increase in the future as new projects are launched. Hence, this threat was scored as “unknown” overall, but this assessment should be revised once additional information is available.

5. Biological resource use

5.4 Fishing & harvesting aquatic resources (low)

Western Grebes forage by diving, so they are susceptible to getting caught in gill nets and derelict/ghost nets and drown. Annual mortality of Western Grebe from this threat is unknown, but it likely affects the species both on the breeding and wintering grounds and during migration. Nets which are set up near colonies during the breeding season are particularly problematic since birds will usually forage nearby.

Large number of Western Grebes caught in fishing nets have been reported. Bartonek (1965) mentions up to 3,000 loons and grebes caught in Lake Winnipegosis (unspecified species) and the COSEWIC status report (2014) also documents a few cases involving Western Grebes (Table 5). Additionally, Hamel et al. (2009) report that Western Grebes also get caught in fishing nets in the Salish Sea. This threat is likely more widespread than what has been reported, since derelict/ghost net mortality might go undetected. Grebes can also become entangled in discarded fishing line (Hanus et al., 2002a; Berg et al., 2004; Ivey, 2004).

Table 5. Bycatch mortality of Western Grebe reported in the COSEWIC report (2014).

Number of mortalities	Location	Date	Source
~100	Lake Winnipegosis, Manitoba	1970s	Nuechterlein, pers. comm. *in* O’Donnel and Fjeldsa, 1997)
64	Delta Marsh, Manitoba	2009-2010	LaPorte, 2012
80	Lac La Biche, Alberta	May/June 2006	Miller, pers. comm. *in* Kemper et al., 2008
100-150	Lac La Biche, Alberta	Yearly	Davis, pers. comm. *in* ASRD and ACA, 2013

Based on the available information, this threat does not appear to have significant population level effects and was scored as “low”, but requires further attention, since mortality in fishing nets is likely under-reported.

6. Human intrusion & disturbance

6.1 Recreational activities (medium)

Lakes used by Western Grebes for breeding are deep and contain fish species which makes them desirable for recreation (e.g. for fishing and boating). Disturbance by recreational boaters (e.g. power boats, motorcrafts, jet-skis and, to a lesser extent, canoes and kayaks) can scare adults away from their nest or chicks, leaving them vulnerable to predation. Although disturbance from boaters can occur early in the breeding season (e.g. fishing derbies during incubation), boat traffic generally increases throughout the summer months. This coincides with the period when Western Grebes are brooding their young. Western Grebe chicks are particularly vulnerable in the first few weeks after hatching, a period when they are highly dependent on their parents (COSEWIC, 2014; Erickson et al., 2014; Alberta Environment and Parks, 2018). In some cases, human disturbance has been suspected as the primary reason for colony abandonment at Gimli Marsh and Pelican Lake in Manitoba and Swan, Williams and Duck Lakes in British Columbia (Burger, 1997; COSEWIC, 2014; Mitchell and Artuso, 2018; S. Boyd, pers. comm. 2020), making this an important threat to the species on the breeding grounds. Additionally, waves created by boats can sometimes flood nests (Erickson et al., 2014).

Disturbance by recreational boaters can also occur on the non-breeding grounds, particularly in areas of higher boat traffic near the coast, but adult Western Grebes are generally more mobile then. Yet, this is one of the major threats to the species and was scored as “medium”.

<u>6.3 Work & other activities (negligible)</u>

Pilot trials on Western Grebe movements using intracoelomic transmitters showed that individuals had low survival rates and died within days of the surgery (Gaydos et al., 2011). Although the technique was refined and survival rate improved in subsequent attempts (Gaydos et al., 2011; Mills et al., 2016), grebes do not generally fare well with transmitters or implants with external antennas (S. Boyd, pers. comm. 2020). New methods for tracking Western Grebes movement, including light level geolocators and stable isotopes should be explored. Currently, there are very few studies on Western Grebe movement and such research would only involve a very small number of birds and would not have population level effects. Hence, this threat was considered negligible.

7. Natural system modifications

<u>7.1 Fire & fire suppression (unknown)</u>

Forest fires occur every year in the boreal forest of western Canada and have a profound impact on ecosystems (e.g. changes in vegetation, run-offs of sediments, changes in nutrient cycles and hydrological processes). Although specific impacts of forest fires on the Western Grebe have not been studied, they are likely to have a negative impact if they occur near colonies. Since forest fire frequency and severity are expected to increase with climate change (Amiro et al., 2003), this threat might increase in the future.

Additionally, fire retardants, which are used to prevent and extinguish fires, are a diverse group of chemicals that can impact birds’ behavior and reproduction (Guigueno and Fernie, 2017) and contaminate water (Angeler and Moreno, 2011). At Duck Lake, British Columbia, water bombers filling their tanks caused disturbance to nesting and brooding Western Grebes (M.A. Beaucher, pers. comm. 2020).

Since there is not enough evidence to score the impact of fires and fire suppression products on the Western Grebe, this threat was scored as “unknown”.

7.2 Dams & water management/use (low)

Because Western Grebes build their nests on vegetation only a few centimetres above the water surface, they are vulnerable to changes in water levels. Maintaining stable water levels within a breeding season (i.e. when adults are incubating) and between breeding seasons is crucial for the species. If water levels decrease significantly during the breeding season, the emergent vegetation supporting nests can collapse (Wollis and Stratmoen, 2010; Ivey, 2004) or make them more vulnerable to predators. On the other hand, when water levels rise, nests can be flooded (Ivey, 2004). On Lake Winnipeg, the Netley-Libau Marsh colony has been considerably degraded by artificially high water levels (T. Poole, pers. comm. 2020). High water levels are particularly problematic in heavy rainfall years (see 11.5 Sever/extreme weather events).

Variable water levels between breeding seasons can also destroy the emergent vegetation (Calvert, 2009; Ivey, 2004). For example, in 2007 water levels increased in spring on Lesser Slave Lake (Alberta), ice scoured the vegetation, and the large colony that was present there previously (>3000 individuals) was greatly reduced in size (Wollis and Stratmoen, 2010). Low winter water levels, coupled with eutrophication, can also cause winterkill of prey fish (Wollis and Stratmoen, 2010).

Many lakes supporting Western Grebe colonies are dammed in British Columbia, Alberta and Manitoba, including those hosting the largest colonies. In some cases, stabilized natural lakes and reservoirs have even created habitat for the Western Grebe (D. Prescott, pers. comm., 2020). However, it is the combination of artificially high water levels combined *with* heavy rainfall that seems to be particularly problematic, causing nest destruction. Hence, the threat of dams and water management/use itself was scored as “low” (for the artificially high water levels), while the impact of flooding and storms was assessed separately (see 11.5 Severe/extreme weather events).

7.3 Other ecosystems modifications (medium)

There are several ecosystem modifications that can affect the Western Grebe, including changes in prey fish distribution and abundance, eutrophication and invasive species.

The steep declines observed in the Salish Sea are suspected to be related to changes in the abundance and distribution of prey fish, such as Pacific Sardine, Pacific Herring and Northern Anchovy (Therriault et al., 2009; Wilson et al., 2013; Vilchis et al., 2015). The causes of these changes in prey fish are unclear, but could include climate change, ocean acidification, habitat loss, fishing pressure, pollution and aquaculture (Enticknap et al., 2011; PEW Ocean Science, 2013).

A number of factors will increase nutrient loading (e.g. removal of riparian vegetation), which in turn will increase eutrophication. This, combined with low water levels, can lead to prey fish winterkill (Wollis and Stratmoen, 2010). Eutrophication will also favor invasive species such as the Water Milfoil which can form dense clusters that will decrease the extent of open water available for foraging (Burger, 1997). The impact of this invasive plant remains uncertain and requires further study (COSEWIC, 2014).

Other invasive species, such as the hybrid cattail (*Typha x glauca*) and the Flowering Rush (*Butomus umbellatus*) are replacing native shoreline vegetation and are unsuitable to support nests (LaPorte, 2012; COSEWIC, 2014; Alberta Environment and Parks, 2018). Hybrid cattails can create dense stands of emerging vegetation, forcing grebes to nest closer to the water edge, where they are more vulnerable to wave action (LaPorte, 2012; LaPorte, 2014). These invasive species were included in the assessment of this threat, rather than in 8.1 Invasive non-native/alien plants & animals, because they have an indirect impact on Western Grebes (i.e. modification of nesting habitat).

Introduced fish species, particularly those coveted by anglers, can compete with Western Grebes for prey fish (Hanus et al., 2002a).

Estimating the overall impact of all these threats is complex, but changes in prey fish distribution and abundance along the Pacific coast could be an important reason for the decline of Western Grebe wintering in southern British Columbia. Additionally, most Western Grebes, are affected by at least one of the threats discussed in this section, so the overall threat of ecosystem modifications was scored as “medium”.

8. Invasive & problematic species, pathogens & genes

8.1 Invasive non-native/alien plants & animals (low)

The Common Carp (*Cyprinus carpio*) is an introduced, invasive species present in many lakes throughout the southern Prairies and southern British Columbia, many of which host Western Grebe colonies. When spawning and foraging in shallow areas, Common Carps will uproot vegetation supporting Western Grebe nests, leading to nest failure (Goldsborough and Wrubleski, 2001; LaPorte, 2014). By turning up lake sediments, they also increase water turbidity. At Delta Marsh, Common Carp were observed thrashing numerous Western Grebe nests (LaPorte, 2014; LaPorte et al., 2020).

A few invasive plant species have an indirect impact on Western Grebe (i.e. through habitat modification), but are covered under 7.3 Other ecosystem modifications.

Because the Common Carp is present in several lakes where Western Grebes nest, some hosting large colonies in Manitoba, this impact was scored overall as “low”.

8.2 Problematic native plants & animals (negligible)

Several predators will take eggs, young or adult Western Grebes. Predation of eggs and young is exacerbated by human disturbance (e.g. boat traffic; see threat 6.1

Recreational activities). However, under this threat category, and following the IUCN-CMP methodology, only species that are outside their natural range of variation directly or indirectly due to human activities are considered as a threat.

Eggs are particularly vulnerable to avian predators, including American Coots (*Fulica americana*), California Gulls (*Larus californicus*), Ring-billed Gulls (*Larus delawarensis*), Forster's Terns (*Sterna forsteri*), American Crows (*Corvus brachyrhynchos*), Common Ravens (*C. corax*) and White-faced Ibis (*Plagedis chihi*). Common Ravens also thrive in human developed landscapes, which provide additional nesting or roosting structures and additional sources of food and water, including roadkills (Boarman and Heinrich, 2020). Once Common Ravens have saturated high-quality habitat near human settlements, they may begin to colonize more natural habitats in the surroundings (Kristan and Boarman, 2007). Western Grebe egg predation by Common Raven has been observed at Duck Lake (M.-A. Beaucher, pers. comm. 2020) and at Buffalo Lake (D. Prescott, pers. comm. 2020).

Raccoons are also known to take Western Grebe eggs (*Procyon lotor*; COSEWIC, 2014; LaPorte et al., 2020). Raccons have greatly expanded their range northwards over the course of the last century, possibly due to an increase in food availability related to the expansion of agriculture (Larivière, 2004). They are now widespread in the Canadian Prairies and even in the boreal forest (Larivière, 2004; Latham, 2008) and their distribution overlaps that of Western Grebe.

Predators of young Western Grebes include California Gulls, Ring-billed Gulls, Herring Gulls (*Larus argentatus*), Great Blue Herons (*Ardea herodias*), bass (*Micropterus spp.*) and pike (*Esox spp.*), while predators of adults include Raccoons, American Mink (*Neovison vison*), and River Otters (*Lontra canadensis*) as well as Bald Eagles (*Haliaeetus leucocephalus)* and Sea Otters (*Enhydra lutris*) (COSEWIC, 2014). Bald Eagles benefitted from the ban on shooting and DDT[7] and their abundance has increased significantly in North America since the 1970s (Buehler, 2020). Bald Eagles could also have an impact on Western Grebe distribution along the coast of British Columbia, since they can deter Western Grebes from near-shore areas (S. Boyd, pers. comm. 2020).

Hence, it is possible that Western Grebes are facing an increased predation rate from a few predatory species which are now more abundant than before due to human activities and climate change. However, these predators have a negligible effect at the population level and this threat was considered "negligible" overall.

8.4 Pathogens & microbes (low)

Mass mortality caused by harmful algal blooms have been reported on the Pacific coast. These events are caused by dinoflagellates (e.g. *Akashiwo sanguinea*) that produce a slimy material which, once coated on the bird's feathers, reduces their waterproofing function and induces hypothermia (Jessup et al., 2009). These events are sporadic and

[7] Dichlorodiphenyltrichloroethane is a chemical compound originally developed as an insecticide.

localized, but one episode in 2007 affected at least 200 Western Grebes (Humple et al., 2011), and another in 2009 affected 86 individuals (Phillips et al., 2011). Harmful algal bloom occurrences have been linked to warmer ocean temperatures (Hallegraeff, 2010; McKibben et al., 2015) and the occurrence and intensity of these events is likely to increase in the future (EPA, 2013).

Although grebe species are susceptible to avian botulism and avian cholera (Ivey, 2004), the Canadian Wildlife Health Cooperative's database (2019) contained only one record of avian botulism in Western Grebe. Overall, this threat was scored as "low".

9. Pollution

9.2 Industrial & military effluents (low to high)

Western Grebes' gregarious[8] behavior and their inability to fly when they are molting make them particularly vulnerable to oil spills (AESRD and ACA, 2013). Western Grebes are often reported as casualities in oil spill events. Between 1971 and 2007, oil spills (some chronic) along the Pacific coast caused the death of at least 9,700 Western Grebes (COSEWIC, 2014; see Table 6). The number of Western Grebes dying as a result of oil spills is likely underestimated, since not all carcasses can be found or identified at the species level and broader mortality estimates are not available for all events (D. Humple, pers. comm. 2020). Additionally, several relatively small spills affect Western Grebes locally every year. For example, at least 44 oil spills affecting >10 birds were recorded between 1969 and 2001 in California alone (Carter, 2003). Additionally, at least one incident occurred on the breeding grounds at Wabamun Lake in Alberta in 2005 when a Canadian National Railway train derailed, causing the death of 69% (n=333) of the breeding population (ASRD and ACA, 2006). This previously important breeding colony has since all but disappeared (see Appendix B).

[8] Tendency to live in groups.

Table 6. Non-exhaustive list of oil spills that have affected Western Grebes since 1971.

Event	Year of event	# of individuals affected (observed alive or dead or estimated)	Source
Ventura	2005 (& chronic)	2,500	Humple et al., 2011
Cosco Busan	2007	1,071	Mills et al., 2016
San Francisco Bay	1971	2,055	Smail et al., 1972
Luckenbach	1997 (& chronic)	348	Hampton et al., 2003
Wabamun Lake	2005	333	ASRD and ACA, 2006
Mobiloil	1984	227	Speich and Thompson, 1987
Kure	1997	75*	Humple et al., 2011
Unknown vessel, Puget Sound	1984	>17	Speich and Thompson, 1987

* Includes both Clark's and Western Grebes

As high-level predators, Western Grebes are possibly at risk of bioaccumulation and biomagnification of toxins (COSEWIC, 2014), such as mercury contained in their prey fish (Ackerman et al., 2016; Jackson et al., 2016). As a water bird, they could be exposed to a number of contaminants, such as mercury, arsenic, chlordanes, etc. (Henny et al., 1990; Burger and Eichhorst, 2005). The long-term, cumulative and sub-lethal effects on Western Grebes are unknown, but they could cause a reduction in productivity (e.g. Feerer and Garett, 1977).

Western Grebes can also land in tailings ponds, but only one mortality has been reported between 2011 and 2018 as part of the Oil Sand Bird Contact Monitoring Program (Hatfield Consultants, 2018). Another oil-contaminated bird was brought to the Northern Alberta Wildlife Rescue and Rehabilitation Center in Edmonton in 2019 and was rehabilitated (K. Bloome, pers. comm. 2020).

Overall, this threat was scored as "low to high" due to uncertainty regarding the timing and location of future major oil spills on the wintering grounds. It is considered to be one of the greatest threat to the species, particularly due to their gregarious nature.

9.3 Agricultural & forestry effluents (low to medium)

The large-scale use of pesticides in agriculture and forestry activities has been reported to negatively impacts birds, surface and ground water, and the food chain (Mineau and Palmer, 2013; Anderson et al., 2015; Morrissey et al., 2015). Long-term studies on the direct impact of pesticides on Western Grebes is lacking, but there are examples of pesticides accumulating in eggs and affecting the species. For example, DDE[9] and PCB[10] were found in egg shells in Manitoba (Forsyth et al., 1994) and the use of DDD[11] and parathion was linked to a decrease in productivity at Clear Lake, California (Feerer and Garrett, 1977). There are growing concerns that other pesticides used in

[9] DDE: dichlorodiphenyldichloroethylene
[10] PCB: Polychlorinated biphenyls
[11] DDD: dichlorodiphenyldichloroethane

agriculture, such as atrazine, glyphosate and neonicotinoids, might have harmful impacts on wildlife, but additional research is required to specifically assess their impacts on the Western Grebe (Mineau and Palmer 2013).

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 Canadian Prairies, and might contribute to a reduction of invertebrates and a decrease in reproductive output in birds (Main et al. 2014; Li et al. 2020). Given that pesticides have been documented to enter and persist in water systems, but that documenting this long-term impacts takes time, the impact of this threat was scored as “low to medium” to reflect the uncertainty about the actual direct and indirect effects of pesticides on Western Grebes.

11. Climate change

<u>11.3 Changes in temperature regimes (unknown)</u>

Rising ocean temperatures are one of the expected consequences of climate change. This can lead to an increase of frequency and severity of lethal harmful algal bloom events (see 8.4 Pathogens & microbes) as well as changes in prey fish abundance and distribution, particularly on the wintering grounds. For example, a powerful marine heat wave in the North Pacific observed between summer 2015 and spring 2016 caused mass mortality of fish-eating birds (Piatt et al., 2020). The impact of this threat is currently unknown due to lack of information and studies specifically on the Western Grebe.

<u>11.4 Changes in precipitation & hydrological regimes (unknown)</u>

As mentioned under threat 7.2 Dams & water management/use, changes in water levels can drastically impact breeding sites, making them unsuitable for nesting. Although there is still much uncertainty regarding the impact of climate change in the Canadian Prairies, it appears that it will lead to an overall warmer and drier climate, which will increase evaporation and could decrease water levels (Gregory et al., 1997; Cubasch et al., 2001). Declining water levels have already been observed in the region (van der Kamp and Keir, 2005; van der Kamp et al., 2006), but the impacts are spatially heterogenous (Roy, 2015), with the western prairies becoming drier and the eastern prairies wetter (Millett et al., 2009; Werner et al., 2013). The hydrology in the Canadian Prairies is also shaped by cyclical wet and dry periods (Millett et al., 2009). In recent years, pond counts in the Canadian Prairies were higher than the long-term average, indicating a relatively wet period (PHJV, 2014a), so it is possible that the prairies experience drier years in the future.

Water levels at some lakes where Western Grebes breed are already managed, which might help to mitigate this threat. However, changes in precipitation levels could also modify water management practices. Overall this threat was scored as “unknown” due to the uncertainty and variability of climate change throughout the breeding range of the species.

11.5 Severe/extreme weather events (low - medium)

Western Grebe nests are vulnerable to changes in water levels, including rapid changes caused by storms which create waves and/or high water levels that will flood nests. For example, floods at a few sites in Manitoba (e.g. Sandy Bay Marshes and Marshy Point) are suspected to have significantly altered the emergent vegetation, considerably reducing the availability of nesting habitat (T. Poole, pers. comm. 2020). In other cases, wind storms created waves which exposed a high proportion of the colony to nesting failure (Allen et al., 2008). Such events were recently observed at Duck Lake, British Columbia in July 2015 (M.-A. Beaucher, pers. comm. 2020) and on the south side of North Shoal Lake, Manitoba in June 2019 (T. Poole, pers. comm. 2020). Also, thousands of aquatic birds were killed at Big Lake Wildlife Management Area in Montana in August 2019 due to a hail storm (CNN 2019; although none were Western Grebes). Storms might also force birds to land on dry land or frozen lakes, leaving them stranded and vulnerable to predation (COSEWIC, 2014).

Extreme weather events such as floods and storms are hard to predict, but their magnitude and frequency are expected to increase as a result of climate change. Considering this uncertainty, but also that these extreme weather events have had significant impacts at specific Western Grebe colonies, this threat is considered as “low - medium”.

5. Management Objective

The management objectives for the Western Grebe in Canada are:

Wintering population:

1- To maintain a stable wintering population trend (i.e. not decreasing) over the next 10 years.
2- To maintain the wintering population’s distribution over the next 10 years.

Breeding population:

3- To maintain the breeding population between 31,000 and 34,000 adults over the next 10 years.
4- To maintain the breeding distribution at ~830,000 km^2 over the next 10 years.

Rationale for management objective

The Western Grebe was designated as Special Concern because of large wintering population declines in Canada and in North America. The decline in Canada has been particularly steep in the Salish Sea area.

However, there are knowledge gaps on the size and distribution of the portion of the Western Grebe population wintering in British Columbia, because current data is acquired through land-based surveys, while many flocks are suspected to forage offshore, beyond the line-of-sight of observers, and in remote areas along the coast. Acquiring data on Western Grebe abundance and distribution in offshore and remote areas along the Pacific coast of British Columbia is relevant to properly assess the species' population size and status in Canada.

The Canadian breeding population in this report is estimated at 31,000-34,000 breeding adults (i.e. higher than the population estimate in the COSEWIC Status report), and was re-assessed based on different sources and recent data from various non-coordinated surveys. It is unclear if the declines observed on the wintering grounds could be related to declines in the breeding population, so distinct population objectives for the wintering and breeding populations were developed.

Western Grebes breed across a range of ecoregions, but their breeding site requirements are quite specific and potential colony sites are limited. Although there is no recent evidence that the breeding range for this species is contracting in Canada, colony size can vary greatly between years, and in some cases, some colonies can disappear if conditions are severely modified (e.g. disturbance or habitat modification). Hence, the breeding distribution objective is to maintain the current species' distribution over the next 10 years.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

- The continental Western Grebe population is monitored by the CBC, which was used to assess winter distribution shifts in the Salish Sea (Wilson et al., 2013). However, this survey does not cover remote areas along the coast or deeper, offshore zones.
- The portion of the population wintering in British Columbia is monitored through the ongoing BCCWS that has provided data to assess wintering population trends (Crewe et al., 2012; Ethier et al., 2020). However, like the CBC, this survey does not cover remote areas along the coast or deeper, offshore zones.
- As part of Marine Ecosystem Analysis Puget Sound Project (MESA), surveys were conducted in the Puget Sound in 1978-1979 using a variety of survey methodologies: shore-based counts, transect counts from ferries and small boats and aerial transects (Wahl et al., 1981).

- Between 1992 and 1999, 54 of the MESA aerial transects were flown under the Puget Sound Ambient Monitoring Program (PSAMP; Nysewander et al., 2005; Bower, 2009) and in 2003-2005, Western Washington University researchers replicated shoreline and ferry transect surveys from the MESA study (Bower, 2009).
- Important Bird Areas (IBA Canada, 2020) have been established where major Western Grebe colonies occur, particularly Delta Marsh (MB001), Eagle, Namaka and Stobart Lakes (AB0878), Frank Lake (AB079), Lac La Biche (AB097), Lesser Slave Lake Provincial Park (AB003), Marshy Point (MB087), Sandy Bay Marshes (MB093), Utikuma and Utikumasis Lakes (AB054) and Whitewater Lake (MB015).
- Important Bird Areas (IBA Canada, 2020) have been established where Western Grebes winter or migrate through (or used to, because in some cases the information is outdated), particularly Barkley Sound (BC075), Baynes Sound (BC057), Boundary Bay – Roberts Bank – Sturgeon Bank (BC017), Comox Valley (BC014), English Bay, Burrard Inlet & Howe Sound (BC020), K'omoks (BC027), Lambert Channel/Hornby Island Waters (BC061), Little Qualicum Estuary to Nanoose Bay (BC056) and Skidegate Inlet (BC145).
- In 2009, the Government of Manitoba established a Provincial Wetlands Working Group focused on the restoration of Netley-Libau and Delta Marsh, two locations hosting nationally significant Western Grebe colonies. To date, work has occurred primarily on Delta Marsh where, in 2012, structures were built in all the channels connecting the marsh to Lake Manitoba as a means of controlling entry to the marsh by large fish, primarily Common Carp, that are destructive to marsh habitat (Goldsborough, 2015).
- 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 Western Grebe refer to the documents published for the species on the Species at Risk Public Registry.
- A 2010 report to Parks Canada on the status and distribution of birds and mammals in the Southern Gulf Islands identified the Western Grebe as a priority species for monitoring in the area (Davidson et al., 2010).
- The Multi-species Action Plan for Gulf Islands National Park Reserve of Canada includes the Western Grebe.
- ECCC has conducted breeding colony surveys primarily in Saskatchewan and Manitoba from 2008 through 2012 in order to address knowledge gaps in breeding population and colony sizes in these provinces.
- ECCC has conducted drone surveys of waterbird colonies in Saskatchewan including some Western Grebe colonies (McKellar et al. 2021)
- ECCC has conducted winter surveys of waterbirds associated with Herring and Eulachon spawning areas between 2014 and 2019 which have identified additional Western Grebe wintering areas along the coast of British Columbia (A. Breault, pers. comm. 2020).
- M.Sc. thesis by N. LaPorte (2012) on Western Grebe population changes between 1973/1974 and 2009/2010 at Delta Marsh, Manitoba. The primary threat

to nesting success was destruction of nests from wave action, followed by spawning Common Carp and depredation by River Otters.
- Alberta Environment and Parks will soon finalize the *Alberta Western Grebe Recovery Plan*, reviewed the population estimate in Alberta, and is continuing to conduct surveys on major Western Grebe lakes.
- The Prairie Habitat Joint Venture developed habitat objectives, and conservation programs and partnerships for the Prairie Parklands (PHJV, 2014a) and the Western Boreal Forest (PHJV, 2014b). These plans establish programs and partnerships that address the threat of habitat loss and degradation facing waterfowl species, which could also benefit the Western Grebe across its Canadian breeding range.
- The initiative Clean Your Gear (https://clearyourgear.ca/) in Manitoba is designed to encourage and enable anglers to dispose of unused and broken line safely in order that the line might be recycled.
- The Canadian Wildlife Health Cooperative monitors avian influenza mortality in a wide range of bird species including the Western Grebe.

6.2. Broad Strategies

- Habitat conservation and stewardship
- Reduce direct anthropogenic mortality
- Population monitoring and surveys
- Research

6.3. Conservation Measures

Table 7. Conservation Measures and Implementation Schedule

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
1) Broad Strategy: Habitat conservation and stewardship			
1a) Support conservation efforts in Important Bird Areas hosting colonies and 48 priority lakes in Alberta identified by Alberta Environment and Parks (e.g. minimizing disturbance and shoreline development and degradation).	High	1.1 Residential development 1.3 Tourism & recreation areas 6.1 Recreational activities 7.2 Dams & water management/use	2022-2032
1b) Develop and distribute educational material to limit disturbance on lakes supporting breeding colonies.	High	6.1 Recreational activities	Ongoing
1c) Establish no-disturbance buffer zones around colonies, including erecting signage at access points and near colonies to limit speed and disturbance by boat traffic.	High	6.1 Recreational activities	2022-2032
1d) Conserve key marine prey fish and their habitat along the Pacific coast.	High	7.3 Other ecosystems modifications	

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
1e) Prevent rapid changes of water levels on lakes hosting colonies during the nesting season (May 1 to July 31) and prevent drainage.	Medium	7.2 Dams & water management/use	Ongoing
1f) Implement a buffer zone around colonies to protect riparian vegetation from modification and destruction by development.	Medium	1.1 Residential development 1.3 Tourism & recreation areas 7.2 Dams & water management/use	Ongoing
1g) Assess importance of aquatic-invasive species on lakes supporting colonies and control/remove it.	Low	7.3 Other ecosystems modifications 8.1 Invasive non-native/alien plants and animals	Ongoing
1h) Support enforcement of regulations to prevent the spread of invasive species.	Low	8.1 Invasive non-native/alien plants and animals	Ongoing
2) Broad Strategy: Reduce direct anthropogenic mortality			
2a) Work with provincial and state departments to enforce regulations against dumping of oily ship wastes and improve oil spill response programs and beach surveys on the Pacific coast.	High	9.2 Industrial & military effluents	Ongoing
2b) Create/implement and enforce best practices and regulations to minimize fisheries bycatch.	Medium	5.4 Fishing & harvesting aquatic resources	Ongoing
2c) Establish a continent-wide reporting program that compiles incidents, species and number of individuals affected by fisheries bycatch.	Medium	5.4 Fishing & harvesting aquatic resources	2022-ongoing
2d) Establish a continent-wide reporting program that compiles incidents, species and number of individuals affected by oil spills.	Medium	9.2 Industrial & military effluents	2022-ongoing
2e) Establish a continent-wide reporting program that compiles incidents, species and number of individuals affected by diseases, dry landings and collisions with power lines and wind turbines.	Low	3.3 Renewable energy 4.2 Utility & service lines 8.4 Pathogens & microbes	2022-ongoing
3) Broad Strategy: Population monitoring and surveys			
3a) Implement a coordinated nationwide monitoring program of inland waterbirds, including Western Grebe colonies, using a standardized methodology.	High	All	2022–2032
3b) Implement a range-wide, offshore monitoring program of wintering distribution and abundance.	High	All	2022-2032
3c) Continue to monitor winter population trends and potential shifts in distribution using available data (e.g. CBC and BCCWS).	Medium	All	2022–ongoing

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
3d) Continue to compile information from available sources on past occupancy, current suitability and threats on lakes occupied during the breeding season.	Low	All	2022–ongoing
4) Broad Strategy: Research			
4a) Conduct research to understand connectivity (i.e. telemetry or stable isotopes) between breeding, molting, staging and wintering grounds.	High	All	2022-2032
4b) Continue to investigate causes of Western Grebe wintering distribution shifts including underlying causes of prey fish changes in distribution and abundance.	High	7.3 Other ecosystems modifications 11.3 Changes in temperature regimes	2022–ongoing
4c) Conduct research on the long-term, cumulative and sub-lethal effects of pesticides on freshwater ecosystems.	Medium	9.3 Agricultural & forestry effluents	2022-2032
4d) Conduct research on the impact of climate change on breeding habitat.	Low	11.3 Changes in temperature regimes 11.4 Changes in precipitation & hydrological regimes 11.5 Severe/Extreme Weather Events	Ongoing
4e) Conduct research to address the unknown effects of forest fires on inland waterbird species.	Low	7.1 Fires and fire suppression	2022-ongoing

[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 Western Grebe were developed to address gaps in knowledge to attain the Management Objectives, and all threats that scored at least "low".

Current winter surveys (such as the CBC and BCCWS), can generally inform on long-term wintering population trends, and will continue to do so, but they fail to capture birds wintering well offshore or in remote areas along the coast. Hence, information on Western Grebe wintering distribution and abundance outside the areas covered by these land-based surveys is lacking and an offshore monitoring program of wintering Western Grebe is required. Since shifts in prey fish distribution and abundance have been hypothesized to explain shifts in Western Grebe wintering distribution, this monitoring program should focus on key areas for prey fish, such as their spawning grounds. Because Western Grebes often forage offshore, beyond the line-of-sight of land-based observers, a different type of survey method is required, such as boats, drones, or aerial surveying methods.

Additionally, conservation measures on the wintering grounds should focus on conserving key marine prey fish species (Pacific Herring, Pacific Sardine, Pacific Sand Lance, Northern Anchovy and Eulachon) and their habitat. The Central Pacific Coast and Fraser River populations of Eulachon have been assessed as Endangered by the COSEWIC, while the Nass/Skeena Rivers population has been assessed by the COSEWIC as Special Concern. All three populations are under consideration for addition to Schedule 1 of the *Species at Risk Act*. Other key prey species are either not at risk or have not been assessed by the COSEWIC, but are vulnerable to several threats. The threats to prey fish along the Pacific coast include climate change, ocean acidification, habitat loss, fishing pressure, pollution and aquaculture. Research on the causes for prey fish changes in abundance and distribution would support the conservation and understanding of the Western Grebe's (and other marine birds) status in Canada and the United States. Monitoring and research projects should be developed in collaboration with the United States Fish and Wildlife Service and academic partners.

On the breeding grounds, Western Grebes, like many other inland waterbird species, are not currently monitored through a robust survey, which poses significant challenges in assessing population trends. Although current Western Grebe surveys are useful to assess breeding population size and trends and should continue, it is necessary to implement a coordinated nationwide survey and monitoring program of inland waterbirds, including Western Grebe colonies, to evaluate changes in population size and distribution. There are many existing methods for surveying inland waterbird species (see Section 3.2 Species distribution and population), and recent efforts using drones and thermal imagery have proven successful at surveying colonial breeders such as the Western Grebe and estimating the number of active nests while minimizing disturbance to nesting birds.

It is unclear if the declines observed on the wintering grounds could be linked to declines on the Canadian breeding grounds. Since there is little information on the connectivity between wintering and breeding areas, research on Western Grebe movement would inform on this. Movement and connectivity research could be conducted using the latest available technology that does not negatively affect survival and behavior, especially the bird's ability to dive, such as light level geolocators or stable isotopes.

Several important colonies are located within designated Important Bird Areas. These are Delta Marsh (MB001), Eagle, Namaka and Stobart Lakes (AB0878), Frank Lake (AB079), Lac La Biche (AB097), Lesser Slave Lake Provincial Park (AB003), Marshy Point (MB087), Sandy Bay Marshes (MB093), Utikuma and Utikumasis Lakes (AB054) and Whitewater Lake (MB015). Additionally, Alberta Environment and Parks has identified 48 priority lakes for Western Grebe conservation in Alberta (Appendix B), but this excercice has not been conducted in Saskatchewan or Manitoba yet. Together, these sites host the majority of Western Grebes breeding in Canada, so supporting conservation efforts (e.g. minimizing disturbance by boats and shoreline development and degradation) should focus on these sites.

Breeding Western Grebes are easily disturbed by recreational boaters. The fact that young grebes are dependent on their parents for up to 4 weeks after hatching make them particularly vulnerable to boat activity on breeding lakes. Such disturbance has led to a decrease in productivity, the decline and even the abandonment of some colonies in North America. However, because of their colonial nature, it is relatively easy to identify sites where conflicts between boaters and Western Grebes can arise. Several conservation measures in this management plan aim to raise awareness and reduce disturbance by boaters, particularly when young still rely heavily on adults. These include developing and distributing educational material to limit disturbance on lakes supporting breeding colonies and erecting signage at access points and near colonies to limit speed and disturbance by boat traffic. Shoreline vegetation should also be protected from modification and destruction due to development projects by implementing buffer zone around colonies. These actions should be implemented in the most problematic areas and in Important Bird Areas and priority lakes in each province where the species is breeding with the collaboration of Indigenous governments and communities, provincial agencies, conservation organizations, municipalities and shoreline house owners.

Because of their colonial nature, Western Grebes are vulnerable to threats that can significantly modify their habitat, particularly the vegetation required to support nests. Drastic changes in local water levels during and between breeding seasons can destroy nests, the vegetation supporting the nests or both. On breeding lakes where it is applicable, water levels should be managed to minimize damage to Western Grebe habitat (i.e. avoid flooding or ice scouring which destroys emergent vegetation), particularly in years with heavy rainfall or to allow the vegetation to grow back where it was destroyed. This should be coordinated with various stakeholders (e.g. municipalities, dam operators, users, etc.).

Many introduced and invasive species, such as Water Milfoil, Flowering Bulrush, Hydrid Cattail and Common Carp can drastically affect the vegetation required to support nests and the ability of birds to forage. These species are considered problematic for several reasons, so their control and even removal will benefit natural ecosystems in general, as well as Western Grebes. Control and removal programs and regulations to limit the spread of invasive species often already exist at the local and regional level and should be supported and coordinated between conservation agencies and organizations and municipalities.

As a mostly aquatic species, and because of their diving behavior to forage for fish, Western Grebes are particularly vulnerable to fisheries bycatch and contamination by oil. These threats are a concern for a number of species, so conservation measures to reduce bycatch and improve oil spill response, particularly in the Pacific Ocean will largely benefit Western Grebes. This includes implementing a bycatch and oil spill impact monitoring program (both live debilitated and dead birds), coordinating oil spill response programs and implementing best-practices or regulations regarding the use of problematic fishing gear.

In addition to fisheries bycatch and oil contamination, Western Grebes are also vulnerable to collisions with wind turbines and power lines and dry landing. A continent-wide coordinated reporting program should be implemented with the various industry, natural resources management agencies, scientific groups and wildlife rehabilitation centers to assess to which degree the Western Grebe, and other species, are impacted by each of these threats. Although some industries and wildlife rehabilitation centers collect this kind of information, there is no centralized database where this information can be easily searched, which makes a precise threat assessment difficult. This would also facilitate the identification of geographic areas and industrial sectors where anthropogenic activities are the most problematic.

There is little information on the impact of pesticides on freshwater lakes used by Western Grebes, although some data suggest that they are vulnerable to bioaccumulation of contaminants and toxins, such as mercury, DDE, DDT and PCB. Additional research is required to measure the impact of these and new pesticides (e.g. neonicotinoids) on Western Grebes, particularly if they have sub-lethal effects (e.g. contamination of the food chain leading to a decrease in productivity). Additional research on the impact of climate change, in particular changes in precipitation, impact on hydrology and changes in ocean temperatures will be useful to assess the impact of this threat in the future.

7. Measuring Progress

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

Wintering population:

- By 2032, the trend of the Western Grebe population wintering in the Salish Sea over a 10-year period is stable (not decreasing).
- By 2032, an accurate population estimate of the Western Grebe population wintering in Canada is available.
- By 2032, an accurate distribution of the Western Grebe population wintering in Canada is available.

Breeding population:

- By 2032, the population estimate of the Western Grebe population breeding in Canada is maintained between 31,000 and 34,000 individuals.
- By 2032, the extent of occurrence of the Western Grebe breeding distribution in Canada is maintained at ~830,000 km^2.

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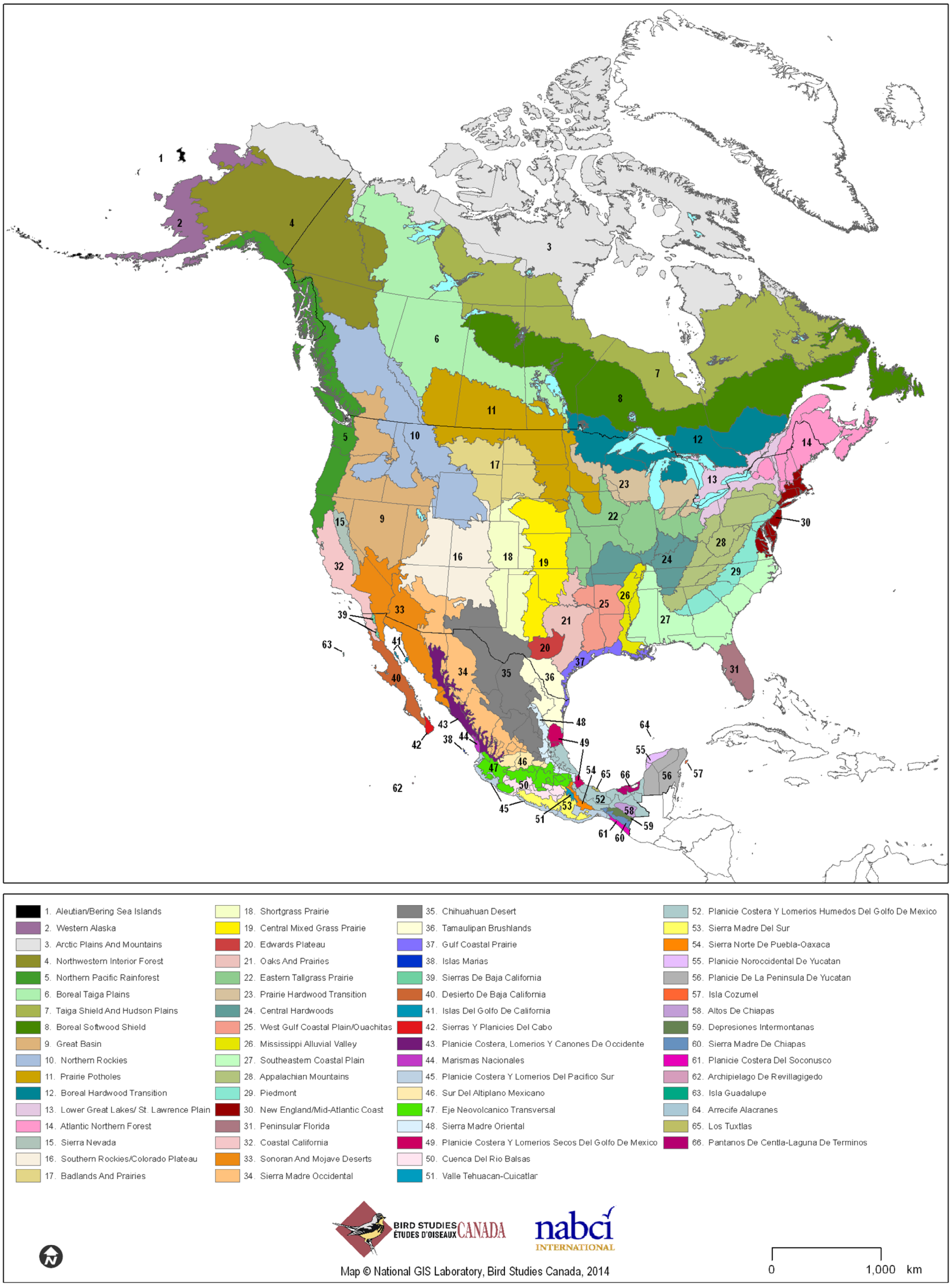
Appendix A: Map of Bird Conservation Regions



Appendix B: Information on Western Grebe population size in Alberta

Lake Name	Historical high count		High count since 2000		Most recent count	
	# of individuals	Year	# of individuals	Year	# of individuals	Year
Angling Lake*+	1680	1981	200	2004	1	2016
Bear Lake*+	>150	1994	219	2015	219	2015
Beaverhill Lake	600	1960	10	2000	0	2016
Buck Lake*+	69	1990	32	2008	5	2016
Buffalo Lake*+	2086	2016	2086	2016	2086	2016
Cardinal Lake *	219	2006	219	2006	0	2016
Cold Lake *+	2000	1979	1876	2006	585	2016
Conn Lake	300	1993	0	2016	0	2016
Crow Indian Lake *+	140	2007	140	2007	4	2015
Fork Lake*+	200	2015	200	2015	200	2015
Frank Lake*+	2200	1977	150	2015	60	2016
Frog Lake+	600	1991	>50	2015	4	2016
Garner Lake+	102	1985	6	2016	6	2016
Glenmore Reservoir+	300	1990	80	2014	4	2016
Gull Lake*+	3230	2016	3230	2016	3230	2016
Hastings Lake*+	440	2006	440	2006	>25	2016
Irricana Sloughs*+	121	1983	25	2016	25	2016
Isle Lake*+	234	2007	234	2007	>40	2016
Kinosiu Lake*+	104	2004	102	2004	>30	2016
Lac La Biche*+	4612	2003	4612	2003	25	2016
Lac Sante+	150	1993	6	2016	6	2016
Lac Ste. Anne*+	1500	1985	1268	2001	20	2016
Lake Newell*+	600	1999	140	2014	60	2016
Lesser Slave Lake*+	3742	2002	3742	2002	30	2016
Little Fish Lake*+	247	2016	247	2016	247	2016
Logan Lake*	100	2007	100	2007	100	2007
Marguerite Lake*	120	1982	N/A	N/A	120	1982
McGregor Lake*+	30	1983	11	2016	11	2016
Miquelon Lake	1000	1963	2	2014	0	2016
Missawawi Lake	284	2005	284	2005	0	2016
Moose Lake*+	649	2008	649	2008	230	2016
Muriel Lake	>760	2003	>760	2003	0	2016
Murray Lake+	107	2009	107	2009	6	2016
Namaka Lake*+	100	1984	33	2007	6	2016
North Buck Lake*+	124	1991	>30	2015	>30	2015
Pakowki Lake+	100	2014	100	2014	30	2016

Lake Name	Historical high count		High count since 2000		Most recent count	
	# of individuals	Year	# of individuals	Year	# of individuals	Year
Pigeon Lake	100	1971	20	2004	0	2016
Pine Lake+	257	1983	10	2009	4	2015
Reita Lake*	532	1981	0	2008	0	2008
Sandy Lake+	150	2002	150	2002	3	2015
Saskatoon Lake*+	200	1996	51	2015	51	2015
Shanks Lake*+	140	2004	140	2004	20	2016
Sturgeon Lake*+	179	2005	179	2015	179	2005
Thunder Lake*+	273	1981	>80	2016	>80	2016
Tilley B Reservoir*	<100	2010	<100	2010	0	2016
Utikima Lake*+	4568	2000	4568	2000	present	2015
Wabamun Lake*+	1510	2002	1510	2002	2	2016
Wolf Lake*	732	1988	100	2000	1	2011

Bold font indicates that breeding was confirmed on the lake in 2015-16; an asterisk (*) denotes potential habitat available during surveys in 2015-16; and a plus (+) indicate lake was occupied by Western Grebes in 2015-16. Source: Prescott et al., 2018 and Alberta Environment and Parks, 2018.

Appendix C: Information on Western Grebe population size in Saskatchewan

Lake Name	Historical high count		High count since 2000		Most recent count	
	# of individuals	Year	# of individuals	Year	# of individuals	Year
Big Quill Lake	**226**	**2019**	**226**	**2019**	**226**	**2019**
Buffalo Pound Lake	**250**	**2011**	**250**	**2011**	**16**	**2017**
Chaplin Lake	35	2011	35	2011	32	2015
Crooked Lake	150	1989	46	2017	46	2017
Cypress Lake	50	2002	50	2002	45	2015
Deep Lake	34	2011	34	2011	34	2011
Dore Lake*	**240**	**2008**	**240**	**2008**	**240**	**2008**
Duck Lake	40	2017	40	2017	40	2017
Echo Lake	95	2008	95	2008	18	2014
Fife Lake	850	2016	850	2016	850	2016
Fishing Lake	**76**	**2009**	**76**	**2009**	**76**	**2009**
Good Spirit Lake	**300**	**2004**	**300**	**2004**	**40**	**2009**
Grass Lake	**100**	**2009**	**100**	**2009**	**100**	**2009**
Highfield Reservoir	**60**	**2011**	**60**	**2011**	**30**	**2017**
Jackfish Lake	**480**	**2019**	**480**	**2019**	**480**	**2019**
Katepwa Lake	74	2009	74	2009	12	2011
Lac des Iles	**330**	**2009**	**330**	**2009**	**100**	**2011**
Last Mountain Lake	**400**	**2008**	**400**	**2008**	**10**	**2017**
Little Arm Bay	300	2013	300	2013	36	2016
McLean Lake	**150**	**2004**	**150**	**2004**	**150**	**2004**
Mission Lake	53	2009	53	2009	53	2009
Mud Lake	**516**	**2016**	**516**	**2016**	**516**	**2016**
Murray Lake	**20**	**2006**	**20**	**2006**	**13**	**2007**
Old Wives Lake	**600**	**1928**	**100**	**2006**	**65**	**2007**
Pasqua Lake	300	1985	250	2004	250	2004
Paysen Lake	**86**	**2009**	**86**	**2009**	**86**	**2009**
Pelican Lake	**400**	**2016**	**400**	**2016**	**12**	**2017**
Radisson Lake	40	2017	40	2017	40	2017
Rafferty Reservoir	40	2017	40	2017	40	2017
Reed Lake	102	2012	102	2012	80	2017
Round Lake	52	2017	52	2017	52	2017
Saskatchewan Landing Provincial Park	100	2007	100	2007	14	2017
Saskatoon Area	277	1970	40	2013	40	2013
Turtle Lake	**50**	**1988**	**100**	**2011**	**100**	**2011**

Lake Name	Historical high count		High count since 2000		Most recent count	
	# of individuals	Year	# of individuals	Year	# of individuals	Year
Valeport Marsh	**200**	**1989**	**150**	**2015**	**3**	**2017**
Waterhen Lake	**348**	**2008**	**348**	**2008**	**133**	**2009**
Willow Bunch IBA	74	2015	74	2015	74	2015
Woodley and St. Lukes	**13**	**2015**	**13**	**2015**	**13**	**2015**

Bold font denotes that breeding has been confirmed on the lake; *Wilson and Smith (2013) report a high count of 800 individuals between 1991 and 2011, but there is no indication if this was observed before or after 2000. Source: McKellar et al., 2019 and McKellar et al., 2021.

Appendix D: Information on Western Grebe population size in Manitoba

Lake name (and colony name for large lakes where multiple colonies occur)	Historical high count		High count since 2000		Most recent count	
	# of individuals	Year	# of individuals	Year	# of individuals	Year
Lake Manitoba						
Delta Marsh IBA	1854	2010	1854	2010	350	2017
Sandy Bay IBA	1500	1986	522	2017	522	2017
Marshy Point IBA	5798	2011	5798	2011	62	2017
Mouth of Ebb and Flow Lake	62	1979	N/A	N/A	N/A	1986
Lake Winnipegosis						
Bachelor Island	300	1979	N/A	N/A	30	1987
Marsh NW of Duck Bay	400	1986	N/A	N/A	400	1986
NW of Channel Islands	700	1972	N/A	N/A	400	1986
Meadow Portage town (near)	60	1986	N/A	N/A	60	1986
Long Island and Long Island Bay IBA[1]	800	1979	594	2011	594	2011
Red Deer River[2]	205	2020	205	2020	205	2020
Lake Winnipeg						
Netley-Libau Marsh IBA	1200	2004	1200	2004	3	2017
Gimli Marsh	400	1979	47	2015	3	2017
North, West and East Shoal Lakes IBA	900	2018	900	2018	900	2018
Pelican and Ninette Lakes	250	2001	250	2001	6	2016
Whitewater Lake[3]	4098	2017	4098	2017	4098	2017
Dog Lake IBA	300	2012	300	2012	25	2017
Inland Lake	400	1986	N/A	N/A	400	1986
Swan Lake[4]	200	1979	N/A	N/A	200	1979

[1]Called “Waterhen” by Wilson and Smith (2013). Source: McKellar et al., 2019.
[2]Recent observation from eBird (https://ebird.org/checklist/S70137250)
[3] In 2020, the highest count was 82 individuals (https://ebird.org/canada/checklist/S69534269)
[4] No birds were observed there between 1991 and 2011 (Wilson and Smith, 2013)

Appendix E: 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*[12]. 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[13] (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 Western Grebe is a colonial waterbird species nesting in wetlands and lakes of the prairie and boreal ecoregions upon which many other species depend for nesting and feeding. Conservation measures of this management plan are expected to benefit the Least Bittern (*Ixobrychus exilis*), the Horned Grebe (*Podiceps auritus*), Western Tiger Salamander (*Ambystoma mavortium*), Western Toad (*Anaxyrus boreas*), Northern Leopard Frog (*Lithobates pipiens*), Great Plains Toad (*Anaxyrus cognatus*), non-inclusively. Water level fluctuations are effective at removing vegetation from beaches, which is beneficial to the the Piping Plover, circumcinctus subspecies (*Charadrius melodus circumcinctus*). At some locations, this might be problematic, since the Western Grebe requires stable water levels during breeding. On wintering grounds, mitigating stresses related to fisheries bycatch and contamination is expected to benefit marine species such as the Ancient Murrelet (*Synthliboramphus antiquus*), Marbled Murrelet (*Brachyramphus marmoratus*), Cassin's Auklet (*Ptychoramphus aleuticus*) the Pink-footed Shearwater (*Puffinus creatopus*), the Short-tailed Albatross (*Phoebastria albatrus*), the Grey Whale (*Eschrichtius robustus*), the Killer Whale (*Orcinus orca*), the Harbour Porpoise (*Phocoena phocoena vomerina*), the Sea Otter (*Enhydra lutris*) and the Steller Sea Lion (*Eumetopias jubatus*).

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.

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