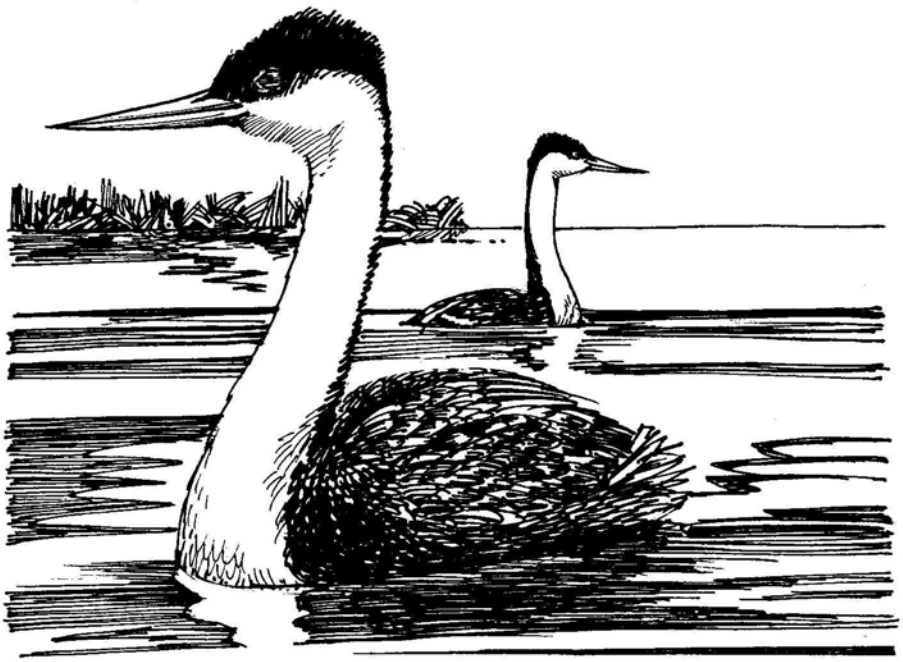
Fish & Wildlife Division

RESOURCE DATA AND SPECIES AT RISK SECTION

Status of the Western Grebe (*Aechmophorus occidentalis*) in Alberta



Alberta Wildlife Status Report No. 60

Alberta Conservation Association

Alberta

Status of the Western Grebe (*Aechmophorus occidentalis*) in Alberta

Prepared for:
Alberta Sustainable Resource Development (SRD)
Alberta Conservation Association (ACA)

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PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the general status of wildlife species in Alberta. These overviews, which have been conducted in 1991 (*The Status of Alberta Wildlife*), 1996 (*The Status of Alberta Wildlife*) and 2000 (*The General Status of Alberta Wild Species 2000*), assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A key objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general status exercise, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are *At Risk* or *May Be At Risk* in the province, that are of uncertain status (*Undetermined*), or that are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information that will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information that will assist Alberta's Endangered Species Conservation Committee in identifying species that may be formally designated as *Endangered* or *Threatened* under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The western grebe (*Aechmophorus occidentalis*) is a colonial waterbird that winters on the Pacific coast and migrates inland to breed at the shallow margins of medium to large lakes and wetlands. The species is local and uncommon in Alberta and exists only in North America, with a distribution that is widespread across the west and central parts of the continent. Historical data regarding colony locations and population sizes in Alberta are typically unavailable or are not comparable to recent studies as a result of different objectives and sampling techniques between surveys. Thus, population trends over the long term are difficult to assess. The western grebe is currently ranked as *Sensitive* in *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001) based on the lack of data, the species' sensitivity to human disturbance, and habitat degradation. Several other provincial and state agencies in North America have recognized the western grebe as a species of special management concern for the above reasons, as well as moderate to severe declines in breeding and wintering populations.

In 2000, systematic surveys were initiated by the Fish and Wildlife Division in central, northeastern and northwestern Alberta to fill in the knowledge gaps and create a foundation of comparable studies. Nesting sites are confined to only a handful of lakes in the province, and survey results suggest significant population declines and low reproductive success, primarily in the central and northeastern regions. A number of lakes that previously supported nationally important populations of western grebes (> 500 breeding pairs) now support only regionally important populations (between 100 and 500 breeding pairs). It is likely that the western grebe is more vulnerable than previously considered, and the species' status in Alberta may be threatened in the long term.

The greatest threats to the western grebe include habitat degradation and human disturbance, oil spills, pollution, and reduction of its prey base. Management for the western grebe in Alberta should include habitat protection and restoration, protection from human disturbance, continued and expanded research and monitoring, the establishment of legislated protected areas, implementation of special agricultural and industrial practices, and public education.

ACKNOWLEDGEMENTS

I am very grateful to the following people and organizations that made this report possible: Sue Peters (Alberta Conservation Association [ACA]) provided guidance, and Hugh Wollis (Fish and Wildlife Division [FWD], a division of Alberta Sustainable Resource Development, Spruce Grove), Christine Found (FWD, Lac La Biche), Robin Gutsell (FWD, Spruce Grove), Wayne Nordstrom (Alberta Community Development), Tom Maccagno (Lac La Biche Birding Society), Lisa Priestley (Beaverhill Lake Bird Observatory), Amy Wotton (Lesser Slave Lake Bird Observatory), Ted Hindmarch (Beaver River Naturalists Society, Cold Lake), George Newton (Federation of Alberta Naturalists, Cold Lake), Marsha Hayward (Cold Lake), CN Environment and Gavin Berg (FWD, Spruce Grove) provided information on the western grebe in Alberta. Garry Bogdan (Canadian Wildlife Service, Wildlife Enforcement Branch) provided information on the Migratory Birds Convention Act, John Elliot (Canadian Wildlife Service) provided information on the western grebe in British Columbia, and David Nysewander (Washington Department of Fish and Wildlife, Puget Sound Ambient Monitoring Program) and John Bower (Western Washington University) provided information on coastal western grebe populations. Mark Heckbert (FWD, High Prairie) and Frank Fraser (Parks and Protected Areas Division, Alberta Community Development) assisted in tracking down data. Hugh Wollis, Morley Riske (Professor Emeritus, Augustana Faculty, University of Alberta), Sue Peters, Lisa Matthias (FWD, Edmonton) and Robin Gutsell reviewed this report and provided additional information. I would like to acknowledge the individuals and organizations that have directed efforts to western grebe research in Alberta, including Stephen Hanus (FWD, Spruce Grove; ACA), Lisa Wilkinson (FWD, Edson), Matt Hanneman (FWD, High Prairie), Mark Heckbert, Anne Hubbs (FWD, Athabasca), Hugh Wollis, Christine Found and Gavin Berg; Fish and Wildlife Division and the Lesser Slave Lake Bird Observatory.

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INTRODUCTION

The western grebe (*Aechmophorus occidentalis*) is a member of the Podicipedidae family, an ancient lineage of piscivorous (fish-eating) diving specialists. It is a colonial nesting waterbird that breeds on medium to large lakes and wetlands and builds floating nests anchored to emergent or floating vegetation. Western grebes are local and uncommon in Alberta and their distribution is wide across western and central North America (Hanus et al. 2002a, Berg et al. 2004). Declines in some of Alberta's western grebe populations were noticed in the 1970s as a result of habitat loss, boating disturbances and the bioaccumulation effects of pesticides (Hanus et al. 2002a). According to *The General Status of Alberta Wild Species 2000*, the western grebe is listed as *Sensitive** in Alberta (Alberta Sustainable Resource Development 2001) because there is little species information available, the species is highly sensitive to human activity and development, and critical nesting habitat is disappearing (Fish and Wildlife Division 2005).

The western grebe has received little research and monitoring attention throughout its range, and the majority of historical information in Alberta comes from incidental observations and waterbird surveys. The nature of these early data prevents accurate comparison with more recent systematic surveys, making assessment of the western grebe problematic (Hanus 2002). This report summarizes historical and current information on the western grebe in Alberta as a step in reviewing its status in the province.

SPECIES INFORMATION

The western grebe was split taxonomically in 1985 into the dark-phase western grebe (*Aechmophorus occidentalis*) and the pale-phase Clark's grebe (*Aechmophorus clarkii*) (Semenchuk 1992, Burger 1997). The ranges of the two species across North America overlap, but are not well known (Semenchuk 1992, Stokes 1996). In Alberta, Clark's grebe breeds only in the extreme south of the province at sites such as Crow Indian Lake, Pakowki Lake and Verdigris Lake (Semenchuk 1992, Fisher and Acorn 1998). A geographically distinct subspecies of the western grebe, *Aechmophorus occidentalis ephemeralis*, exists in Mexico as a permanent resident with limited range (O'Donnel and Fjeldså 1997, NatureServe 2005).

HABITAT

Western grebes breed on large inland lakes and wetlands across eastern and central North America and migrate to the Pacific Coast to winter.

1. Alberta

1.1 Breeding Sites - Breeding western grebes have six basic habitat requirements (Forbes 1984):

1. A sufficiently long ice-free period to permit the growth of emergent vegetation and allow time for all phases of nesting.
2. Protection of nests from wind.
3. Sufficient water depth at the nest site for diving (minimum 25 cm).
4. Stable water levels while nesting.
5. Access to open, weed (aquatic vegetation)-free water with sufficient fish populations.
6. Freedom from human disturbance.

The western grebe nests in large colonies (a group of nests spaced relatively close together within a given area), often consisting of thousands of birds, at the shallow margins of medium to large lakes and marshes. Floating nests are constructed of plant material anchored to emergent vegetation such as cattails (*Typha*), rushes (*Scirpus*) or willows (*Salix*). Good

* See Appendix 1 for definitions of selected status designations.

breeding sites are characterized by dense stands of this vegetation or, less favourably, thick mats of floating aquatic plants (Ehrlich et al. 1992; Semenchuk 1992; Stokes 1996; Burger 1997; Hanus et al. 2002a, 2002b). Nesting locations must be protected from wind and wave action to prevent flooding of nests—a major cause of nest failure as a result of storms or boat wakes (Storer and Nuechterlein 1992)—and they must be near enough to deep water to allow adults to dive for cover if threatened (Nuechterlein 1975 in Kristensen and Nordstrom 1979). Relatively stable lake water levels during all periods of nesting are also required. During episodes of high water, emergent plants may not extend far enough out of the water to be useful for nesting, and during low water levels, shoreline plant growth may become too dense to accommodate the birds, or nests may be subject to tipping, breakage and stranding (Burger 1997, Blood and Backhouse 1999).

Once the young are ready to leave the nest, the birds spend the majority of their time foraging in open water. Western grebes select lakes that support adequate prey fish populations and provide access to deep, open and generally weed (aquatic vegetation)-free water for diving (Semenchuk 1992; Burger 1997; Blood and Backhouse 1999; Hanus et al. 2002a, 2002b). Lakes in Alberta that have historically sustained, or presently sustain, large colonies of more than 500 grebes (see Table 1 in *Distribution* section) range from 7.5 km^2 to 1160 km^2 in area, and have average depths ranging from 1.7 m to 49.9 m (Mitchell and Prepas 1990, Hanus 2002).

The breeding distribution of the western grebe is limited by the availability of suitable lake and wetland habitats, and further restricted by human activity. Western grebes depend on large lakes for nesting and feeding requirements, and these lakes are often the most coveted by humans for recreation and cottage development (Hanus et al. 2003, Berg et al. 2004). In Alberta, trends toward increased tourism and agricultural, forestry, and oil and gas development (Schneider et al. 2003, Alberta Economic Development 2005) have resulted in negative effects on waterbirds, including habitat alteration, fragmentation and loss, as well as increased access and human-caused disturbances mainly from boating, water-skiing, jet-skiing and cottage development (Brechtel 1981, Koonz and Rakowski 1985, Korschgen and Dahlgren 1992, Burger 1997, Schneider et al. 2003, Found and Hubbs 2004). Colonial waterbirds are highly vulnerable to these site-specific disturbances and habitat changes (Jurick 1985), and may adapt by colonizing in other areas (Poston et al. 1990). However, dispersal to other sites may be a problem for the western grebe if suitable habitat is not available as a result of land-use changes, habitat loss or human disturbance (H. Wollis pers. comm.). It appears that the species returns each year to historical breeding sites, thereby making it especially vulnerable (Berg et al. 2004).

There are lakes in the province that appear to have suitable nesting habitat but are not currently being used by the species. These include Lac La Nonne and Thunder Lake in central Alberta, and Lac Sante and Ethel, Frog, Garner, Hastings, Muriel, North Buck, Reita and Wolf lakes in the northeastern part of the province. Each of these lakes supported breeding populations of western grebes in the past (Hanus et al. 2002a, Found and Hubbs 2004).

1.2 Wintering Sites - In Alberta, observations of western grebes overwintering at Wabamun Lake, Waterton Lakes and Lethbridge have been recorded (Semenchuk 1992). A portion of Wabamun Lake remains open during the winter as a result of the heat produced from the TransAlta Utilities Corporation Wabamun Generating Plant, built in 1956 near the village of Wabamun. The plant uses lake water for cooling and returns heated effluent to the lake via a canal. This prevents a large portion of Kapasiwin Bay from icing over. Two other power-generating plants also located on the lake—the Sundance and Keephills plants—

currently direct their cooling water to holding ponds (Schindler et al. 2004).

2. Other Areas

2.1 Migratory Staging Grounds - Western grebes migrate in a loosely formed flock and typically use large, deep lakes as staging grounds, often remaining for days to feed and rest (Cannings et al. 1987, Campbell et al. 1990, Fisher and Acorn 1998). In British Columbia, though the birds generally avoid areas of human activity, it does not appear that human disturbance or habitat alterations are negatively affecting the use of these sites for staging purposes (Burger 1997).

2.2 Wintering Grounds - In winter, western grebes reside on the Pacific coast in areas that provide sufficient fish populations for food, such as sheltered coastal bays and lagoons, and, uncommonly, some inland freshwater lakes (American Ornithologists' Union 1983 in NatureServe 2005, Godfrey 1986, Semenchuk 1992, Stokes 1996).

CONSERVATION BIOLOGY

The western grebe is a member of the Podicipedidae (grebe) family, an ancient lineage that spans 80 million years and is not closely related to any other birds (Llimona and del Hoyo 1992). Of the 22 recognized species of grebes worldwide, two are extinct and nearly a quarter are considered threatened by extinction (O'Donnel and Fjeldså 1997, Hanus et al. 2002a). The western grebe is North America's largest and most gregarious (living or moving in flocks or groups) grebe species. It measures approximately 64 cm in length and weighs up to 1.8 kg. The species is best distinguished by its long, curved neck, contrasting black and white coloration, red eyes and thin, sharp bill (Fisher and Acorn 1998, Blood and Backhouse 1999).

Western grebes feed on fish, which constitute up to 80% to 100% of their diet, as well as molluscs, crustaceans and aquatic insects (Stokes 1996, Blood and Backhouse 1999). Their adaptations for diving—lobed toes and legs set far back on their body—facilitate their ability to obtain food underwater; these adaptations also make movement on land difficult (Godfrey 1986, Semenchuk 1992). They spend nearly all of their time in the water and flight is limited beyond migration, which occurs nocturnally in loose flocks. They breed in colonies and pairs become very aggressive when defending the small territory around their nest, which results in a fairly uniform distribution of nests (Nuechterlein 1975 in Burger 1997).

Courtship begins shortly after arrival inland in late April and early May (Pease 2001). The spectacular courtship behaviour of the western grebe is a very complex and elegant dance consisting of a variety of calls, gestures and synchronized rushes (Fisher and Acorn 1998). Breeding generally occurs annually, but may be deferred during periods of unsuitable conditions (Nuechterlein 1975 in Burger 1997). Nesting generally peaks in June, but varies according to geographical location and seasonal factors such as the timing of ice-melt and water levels (Kristensen and Nordstrom 1979; Hanus et al. 2002a, 2003; Found and Hubbs 2004). Both sexes participate in nest building, incubation (approximately 23 days) and chick rearing. Young leave the nest once their down is dry, usually within hours after hatching, and are raised in deeper, open water on their parents' backs, making it nearly impossible to study the growth and survivorship of individual broods. Fledging occurs at 49 to 51 days (Semenchuk 1992) and juveniles reach independence at 63 to 77 days (Palmer 1962, Storer and Nuechterlein 1992). The average lifespan is unknown, but potential longevity is estimated at 14 years (Environment Canada 2002). Banded birds aged 9 to 16 years have been recovered (Eichhorst 1992).

The reproductive biology of the western grebe in Alberta is poorly understood (Berg et al.

The age of first breeding is not known, but may be one year (Storer and Nuechterlein 1992). Western grebes are single-brooded with clutch (a complete set of eggs laid for one brood) sizes that vary among colonies (Semenchuk 1992). Recent studies in Alberta show that mean clutch sizes range from 1 to 4 eggs per nest (Hanus et al. 2002a, 2002b; Found and Hubbs 2004), and though this is within the range of results reported in other studies conducted in Canada and the northwestern United States (Riske 1976, Kristensen and Nordstrom 1979, Hanus et al. 2002a), many colonies lie at the lower end of the spectrum. Relatively low mean clutch sizes have been observed at Wabamun Lake (1.8 eggs/nest; Hanus et al. 2002a), Lac Ste. Anne (2.3 eggs/nest; Hanus et al. 2002a), Lac La Biche (1.2-2.4 eggs/nest; Found and Hubbs 2004), and Cold Lake (2.11 eggs/nest; Found and Hubbs 2004). Historically, clutch sizes at Lac Ste. Anne were generally of 3 to 4 eggs per nest (Riske 1976) and 3 to 5 eggs per nest at Cold Lake (Kristensen and Nordstrom 1979). A high proportion of empty nests and high rates of nest abandonment, likely indications of failed nesting attempts caused by disturbance, have been observed at Wabamun Lake and Lac Ste. Anne (Hanus et al. 2002a). Additionally, western grebes have low recruitment rates (the number of offspring entering the population each year), thus reducing the potential for population growth and recovery from decline (Hanus et al. 2002b). For example, the average number of young per adult at Lac Ste. Anne is most commonly between 0.60 and 0.73 (Hanus et al. 2002a), and in British Columbia, 0.79 (Forbes 1988). The combination of the above factors suggests low reproductive success at many colonies in Alberta.

DISTRIBUTION

1. Alberta - Western grebes are local and uncommon (< 1000 breeding occurrences) in Alberta from April to October (Alberta Sustainable Resource Development 1996, Fisher and Acorn 1998), and inhabit all natural regions in the province with the exception of the Canadian Shield (Alberta Environmental Protection 1994, Hanus 2002). Breeding Bird Atlas surveys between 1987 and 1991 reported western grebes in 8% of surveyed squares in the Boreal Forest and Parkland natural regions, 6% in the Grassland, and 2% in the Foothills (Semenchuk 1992). Breeding occurs primarily in the Boreal Forest, Parkland and Grassland natural regions south of latitude 56º N (Figure 1; Kristensen and Nordstrom 1979, Semenchuk 1992, Hanus 2002). The species' requirement for a sufficiently long ice-free period for nesting possibly prevents its expansion to more northerly areas. Based on their Alberta distribution (Figure 1), the extent of occurrence for western grebes in the province is approximately 380 700 km^2, which represents 39% of their range in Canada (Fraser 2000) and approximately 11% of their breeding range in North America. The latter is an estimate based on the area of distribution (Figure 2) and is not formally documented in the literature. Based on a conservative overestimate of 1 km^2 for each breeding colony, the minimum area required by the species for breeding is less than 18 km^2 (breeding grebes have been recently documented at 18 discrete locations; see Appendices 2 and 3 for details). The minimum requirement for associated foraging habitat is unknown, but is probably approximately 409 km^2 based on the area of the smallest lake that has supported a persistent colony (Lake Isle: 22.7 km^2) multiplied by 18 breeding sites.

Semenchuk (1992) reports 53 confirmed and 51 probable breeding sites in Alberta. Relatively few lakes in the province support large colonies (500 to 999 birds) or very large colonies (1000+ birds). Excluding Beaverhill Lake, which is located in the Parkland Natural Region, all major colonies greater than 500 birds (Table 1) are located in the Boreal Forest Natural Region, and include Lac La Biche and Lac Ste. Anne, and Angling, Cold, Frog, Lesser Slave, Saskatoon, Utikuma, Wabamun and Wolf lakes (Hanus 2002). Several sub-colonies

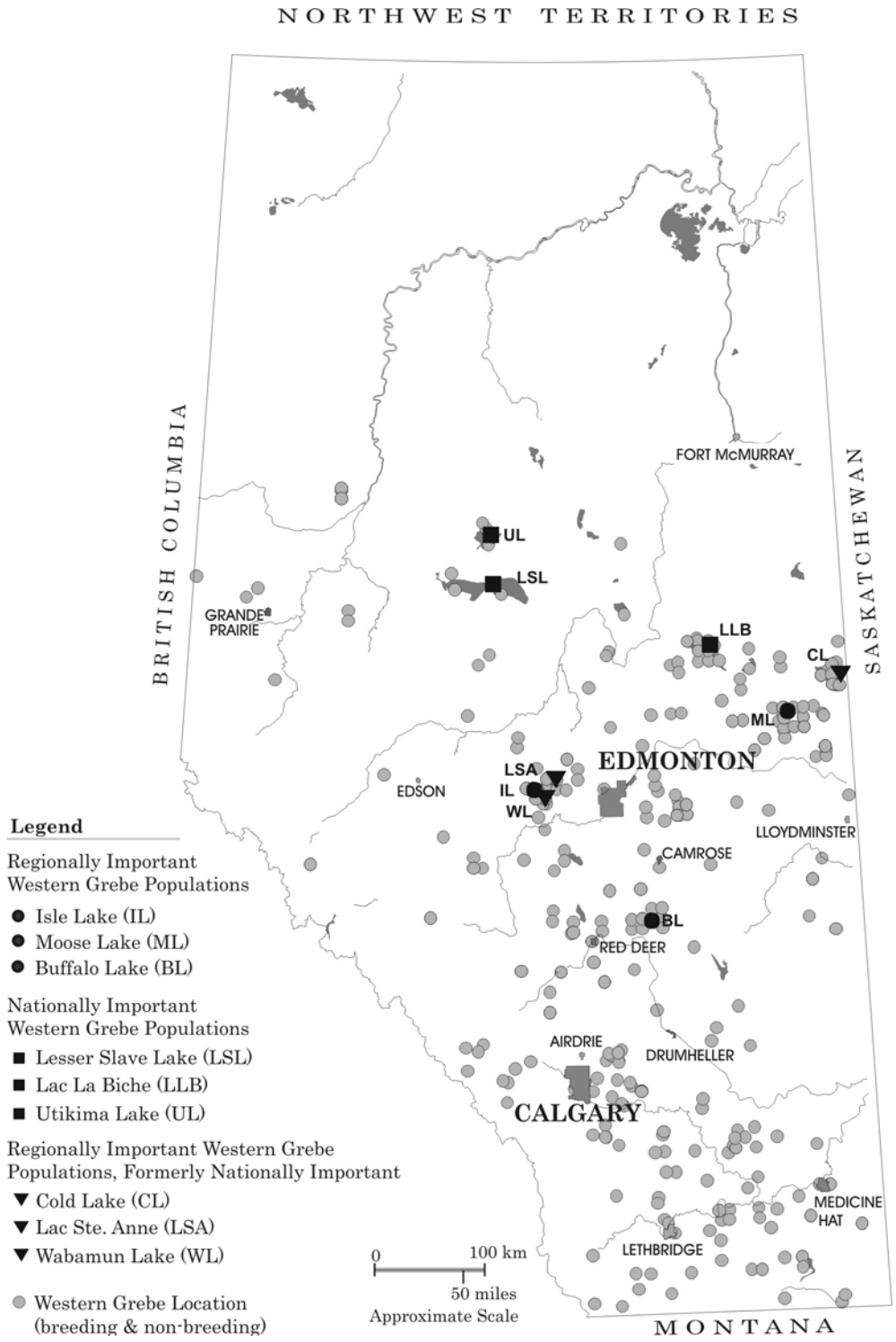

Figure 1 Alberta distribution of western grebe.

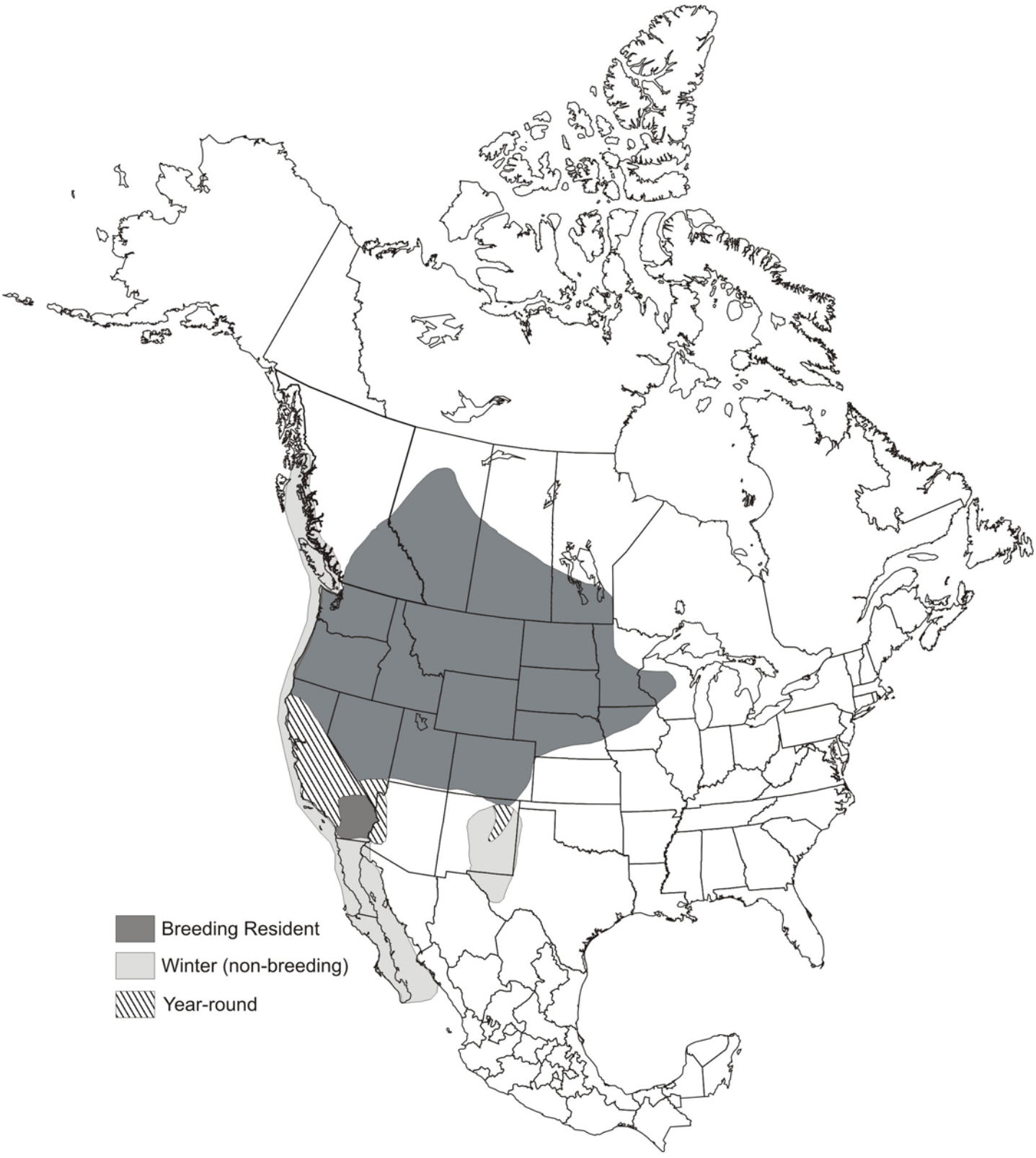

Figure 2 North American distribution of western grebe.

Table 1. Summary of lakes in Alberta supporting western grebe colonies of over 500 breeding birds (adapted from Hanus 2002).

Natural Region	Lakes with 1000+ Birds (Date)	Lakes with 500 to 999 Birds (Date)
Boreal	Angling Lake (Unknown) Cold Lake (1970/78/89/2003) Lac La Biche (1980/88/2003/05) Lac Ste. Anne (1971/85/89/2001/03) Lesser Slave Lake (1979/2002) Utikuma Lake (2000) Wabamun Lake (2002/03)	Cold Lake (1980/81/83/85/2004/05) Frog Lake (1990/91) Lac Ste. Anne (1972/73/75/76/77/79/81/82/83/84/86/87/88/91//92/2002) Lesser Slave Lake (1970s/2000) Reita Lake (1981) Saskatoon Lake (1992) Wolf Lake (1985/88/89) Wabamun Lake (2001/04)
Foothills	N/A	N/A
Grassland	N/A	N/A
Parkland	N/A	Beaverhill Lake (1960)
Rocky Mountain	N/A	N/A

may be formed on one lake, and their locations may vary depending on conditions (Burger 1997, Hanneman and Heckbert 2001, Hanus et al. 2002a, Found and Hubbs 2004).

Several lakes in Alberta appear to have been important migratory staging grounds for western grebes in the past. These include Frank Lake near High River, where 2200 western grebes were reported during fall migration in 1977, and Eagle, Namaka and Stobart lakes near Strathmore, where 1500 individuals were reported during spring migration in 1985 (IBA Canada 2004a, 2004b). No recent surveys directed at the western grebe have occurred to reflect recent use of the lakes as staging grounds.

2. Other Areas - The western grebe is found only in North America (Blood and Backhouse 1999). Its distribution is wide across the western and central parts of the continent, but is not well known (Figure 2; Stokes 1996, Berg et al. 2004). Western grebes breed from south-central British Columbia east through central Alberta, central Saskatchewan and southwestern Manitoba, central Minnesota and Wisconsin, and south through the western United States to northwest Texas and west to California (Palmer 1962, Godfrey 1986, Storer and Nuechterlein 1992, Environment Canada 2002, Ivey 2004, NatureServe 2005). Western grebes migrate nocturnally to the Pacific coast to winter from southeastern Alaska and British Columbia south to central Mexico (Burger 1997, British Columbia Resources Inventory Branch 1998, NatureServe 2005). In addition, some grebes winter at inland lakes and reservoirs that do not freeze, from California east to Texas (Storer and Neuchterlein 1992), and are year-round residents at some of these lakes (Ivey 2004). Fall migration occurs from late August through mid-October, and spring migration inland occurs from late April through May (Cannings et al. 1987, Campbell et al. 1990, Semenchuk 1992, NatureServe 2005). Little is known about western grebe migration routes (Campbell et al. 1990).

POPULATION SIZE AND TRENDS

At the turn of the 20th century, tens of thousands of western grebes were killed for their feathers (Ehrlich et al. 1988, Storer and Nuechterlein 1992). With protection from some of North America's first conservation laws, the species appeared to rebound (Bower 2003), but declines were noticed again in the late 1950s when the prolific use of pesticides began to negatively affect food chains (Center for Ecological Health Research 1998).

Western grebes have received little research and monitoring attention throughout their range in North America (Hanus et al. 2002a). This has been attributed to the following three factors: the species is not a game bird, its behaviour precludes traditional air and ground-based surveys, and populations have typically been unassessed or considered secure (Hanus et al. 2002a).

1. Alberta - In Alberta, populations showed signs of decline as early as the 1970s as a result of habitat loss, boating disturbances and the bioaccumulation effects of pesticides (Riske 1976, Hanus et al. 2002a). Population data for the province are limited, and the majority of historical information comes from waterbird surveys (Purdy et al. 1983) and incidental observations collected after 1970 (Riske 1976), with an intensification beginning in 1990 (Hanus 2002). A synthesis of provincial data up to 2002 can be found in Hanus (2002). The nature of much of these historical data prevents them from being easily compared to recent observations. Although the data provide insight into which Alberta lakes have supported grebe colonies in the past, estimates of lake population sizes and colony locations are typically unavailable. Thus, obtaining accurate population assessments and trends for the western grebe is problematic (Hanus 2002).

Recently, efforts have been made to locate western grebe colonies in Alberta, quantify their populations and investigate reproductive success. Since 2000, a number of monitoring projects have begun, and surveys have focused primarily on central Alberta, as well as the northeastern and northwestern parts of the province. This report will address population trends within these regions and focus on recent studies because of the inability to generate trends with historical data. Where possible, historical data will be presented to reflect western grebe population changes in the areas studied since 2000 (see subsections, below).

The most recently published data (2000-2004) indicate that Alberta is home to over 13 000 breeding western grebes (Table 2): at least 13% of the total North American population (estimated at 70 000 to 100 000; B. Eichhorst pers. comm. in O'Donnel and Fjeldså 1997). In 1990, Poston et al. (1990) defined sites with western grebe colonies of over 500 nests or breeding pairs as nationally important, and sites with 100-500 as regionally important. In Alberta, major breeding sites are confined

Table 2. Summary of the most recently published western grebe population data for the province of Alberta.

Study Area	Year	Lake	Number of Western Grebes	Source
Northwest Alberta	2000	Cardinal	30	Hanneman and Heckbert 2001
	2002	Lesser Slave	3742	Eadie 2002
	2000	Utikuma	1700+	Hanneman and Heckbert 2001
Northeast Alberta	2003	Angling	30	Found and Hubbs 2004
	2003	Cold	1982	Found and Hubbs 2004
	2003	Hastings	10	Found and Hubbs 2004
	2003	Lac La Biche	4612	Found and Hubbs 2004
	2003	Wolf	40	Found and Hubbs 2004
Central Alberta	2004	Isle	228	Berg et al. 2004
	2004	Lac Ste. Anne	308	Berg et al. 2004
	2004	Wabamun	634	Berg et al. 2004
		Total	**13 316**	

to only a handful of lakes, and according to the most recent surveys (2000-2005), these include three sites of national importance (Lac La Biche, Lesser Slave Lake, Utikuma Lake) and six sites of regional importance (Buffalo Lake, Cold Lake, Isle Lake, Lac Ste. Anne, Moose Lake, Wabamun Lake). The Cold Lake, Lac Ste. Anne and Wabamun Lake populations have declined in size from nationally important to regionally important since 2003.

Throughout this report, the term local population refers to a group of western grebes within a single lake, population refers to a group of western grebes within a given area (e.g., lake or study area), the individuals of which may or may not include non-breeders, and regional population refers to the total number of western grebes within a region (e.g., central, northeast, specific study area).

1.1. Central Alberta - A series of comprehensive surveys was initiated by the Fish and Wildlife Division in 2001 to provide a foundation for monitoring western grebe populations in central Alberta. The study commenced in the Stony Plain study area (52 lakes initially, 11 592.6 km^2, Boreal Forest Natural Region, northwest of Edmonton), and expanded in 2004 to include the Parkland study area (11 lakes, Parkland Natural Region, southwest of Edmonton). Descriptions and locations of the study areas are detailed in Hanus et al. (2002a) and Berg et al. (2004). The Stony Plain project was the first of its kind in Alberta and has served as a model for surveys throughout the province (Hanus et al. 2002a).

1.1a Stony Plain Study Area (Boreal Forest Natural Region) - The total population in the Stony Plain study area has ranged from 760 to 2554 grebes since 2001, with marked drops in 2004 and 2005 (Figure 3; Berg et al. 2004, H. Wollis unpubl. data 2005). The population decreased in 2004 by approximately 54% from 2003 (Hanus et al. 2003), 52% from 2002 (Hanus et al. 2002b) and 33% from 2001 (Hanus et al. 2002a). Unpublished data from 2005 suggest the lowest figures yet (H. Wollis unpubl. data 2005).

The breeding population is currently confined to only three lakes of the 52 initially surveyed: Wabamun Lake, Lac Ste. Anne and Isle Lake, which are the largest lakes in the study area (Appendix 2, Figure 3). These colonies have been present for over 20 years at Wabamun and Isle lakes, and over 30 years at Lac Ste. Anne (Hanus et al. 2002a). Local populations at each lake have shown considerable fluctuations in size over the years. In 2004, colonies at Wabamun Lake and Lac Ste. Anne were the largest in the study area and represented 54% and 26% of the population, respectively. Both showed significant declines in 2004 and 2005 (Wabamun: 53% and 23%; Lac Ste. Anne: 72% and 76%) and, as a result, have decreased from sites of national importance to sites of regional importance (Berg et al. 2004). Monitoring over a longer time frame will show whether these declines are the result of real population reduction in central Alberta, natural population fluctuations or stochastic events at wintering grounds.

On 3 August 2005, a CN train derailment near the summer village of Whitewood Sands Beach on Wabamun Lake dumped over 700 000 L of bunker fuel and pole-treating oil into the lake. Final numbers show that 368 western grebes, approximately 76% of Wabamun's 2005 population, were affected by the spill (very few juveniles were found—almost all of the birds found were adults). Of these, 333 birds were found dead or were euthanized (69% of the 2005 population), and 35 were cleaned and released elsewhere (CN Environment pers. comm., G. Berg pers. comm.). Additional birds may have been killed and not found. Although future studies will begin to reveal the extent of the damage caused by the spill, the event will likely make it more difficult to identify other factors affecting the local population.

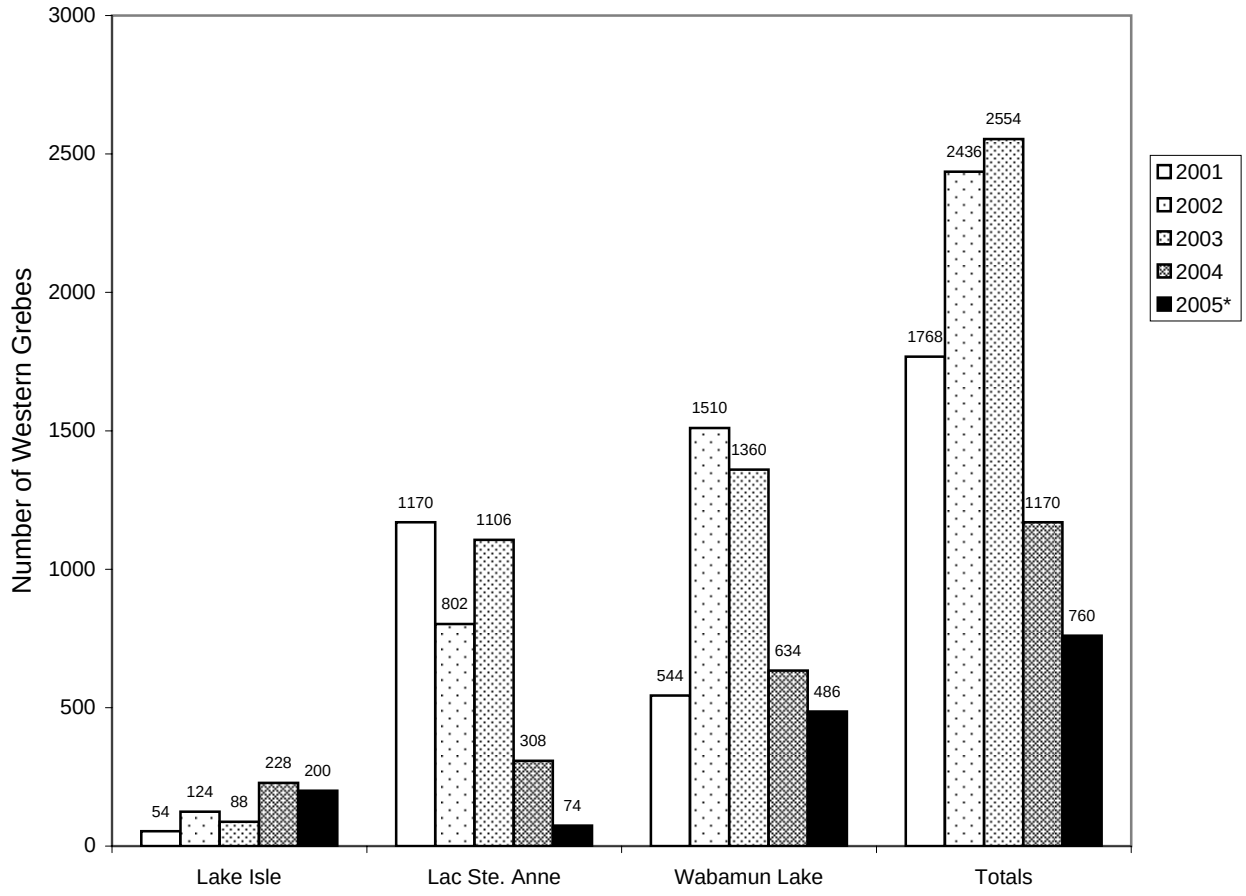

Figure 3. Estimated total number of western grebes (nests x 2) in the Stony Plain study area, central Alberta, 2001-2005. (* H. Wollis unpubl. data).

The Isle Lake colony is the only one in the Stony Plain study area that has grown in size, doubling from 2003 to 2004 (Figure 3; Berg et al. 2004). Throughout the Stony Plain study area, no new colonies have been established since surveys in the 1970s, and no known historical populations have gone extinct, with the possible exception of Big Lake. It is unclear whether the three adults noted at Big Lake in 1982 (Purdy et al.1983) were remnants of a former colony or transient non-breeders. Individuals observed on Lac La Nonne and Thunder Lake on recent surveys may also represent remnants of historically documented breeding populations; both lakes provide suitable nesting habitat, yet few individuals have been found and breeding has not been confirmed (Hanus et al. 2002a).

1.1b Parkland Study Area (Parkland Natural Region) - Recent surveys in the Parkland study area were initiated in 2004. Results showed that 9 of the 11 lakes surveyed supported a total of 711 western grebes, but breeding was not confirmed (Appendix 2). The greatest numbers of birds were observed at Gull and Buffalo lakes, which supported 45% and 43% of the population, respectively. A survey in 2005 found two breeding colonies at Buffalo Lake, but no count of nests was made (H. Wollis pers. comm.). Several lakes in the study area appear to provide suitable nesting habitat, and future surveys will concentrate on attempting to identify and confirm breeding colonies to determine the extent of the breeding population in the Parkland area (Berg et al. 2004).

Historical information suggests that Beaverhill Lake supported over 600 western grebes in 1960. Although Beaverhill Lake was not included in the Parkland study area, it is known that the lake no longer supports the birds, except during migration, as it has been virtually dry for three years (L. Priestley pers. comm.).

1.2 Northeast Alberta (Boreal Forest Natural Region) - In 2000, the Fish and Wildlife Division began a long-term monitoring program to measure the relative abundance and occurrence of colonial nesting species, waterfowl and other waterbirds in the Lac La Biche/Athabasca area, and to assess lakeshore habitat and shoreline development. Surveys for the productivity and nesting success of western grebes, consistent with those initiated in central Alberta, were later integrated into the program (Found 2004).

Survey results suggest a trend toward an overall decline in the regional western grebe population (Appendix 3). In 2003, western grebes were observed on 12 of the 69 lakes surveyed, but only five lakes supported breeding colonies: Lac La Biche and Angling, Cold, Hastings and Wolf lakes. The regional population was estimated at 6674 breeding adults, with Lac La Biche and Cold Lake as the dominant colonies, accommodating 69% and 30% of the total population, respectively (Found and Hubbs 2004). Both lakes supported nationally important populations (> 500 nests or breeding pairs) in 2003 (Found and Hubbs 2004). The Cold Lake population declined by 50% from 2003 to 2004, decreasing from national importance to regional importance (100-500 nests or breeding pairs), and in 2005 the population dropped again, by 54% from 2004. Breeding colonies were found on only four lakes in the region in both 2004 and 2005: Lac La Biche and Angling, Cold and Moose lakes. No nests were found on Wolf or Hastings lakes in 2004 or 2005, though a small number of nests was present in 2003. The Moose Lake population observed in 2004 and 2005 was surveyed in 2003 but breeding was not confirmed. It appears that many lakes in the region that historically supported populations no longer do so. These include former colonies on Lac Sante and Ethel, Frog, Garner, Hastings, Muriel, North Buck and Wolf lakes (Found 2004, Found and Hubbs 2004, Found unpubl. data 2005).

1.3 Northwest Alberta (Boreal Forest Natural Region) - The most extensive studies in the northwest portion of the Boreal Forest Natural Region include a 36-lake survey conducted in 2000 by the Fish and Wildlife Division (Hanneman and Heckbert 2001), and periodic surveys of Lesser Slave Lake over the last 30 years (Fraser 2000, Eadie 2002). In 2001, the Lesser Slave Lake Bird Observatory initiated western grebe surveys to locate colonies, estimate the number of breeding adults on the lake, identify possible threats and begin assessing lakeshore nesting habitat suitable for western grebes. Survey methods were expanded and standardized in 2002 (Eadie 2002).

Data from surveys in 2000-2002 indicate a regional western grebe population of 5474, concentrated at three lakes: Lesser Slave, Utikuma and Cardinal (Table 3). Lesser Slave and Utikuma lakes have the largest colonies, representing 68% and 31% of the total population, respectively, and both currently support nationally important western grebe populations (> 500 nests or breeding pairs). The increase in the Lesser Slave Lake population from 700 individuals in 2000 to 3742 in 2002 may be attributed to the refinement of survey methods used by the Lesser Slave Lake Bird Observatory in 2002. The population at Utikuma Lake appears to be growing, perhaps related to the fairly remote location of the lake (Hanneman and Heckbert 2001, Eadie 2002).

1.4 Provincial Summary – Major breeding sites for the western grebe in Alberta are confined to only a handful of lakes. Recent surveys suggest significant population declines in

Table 3. Summary of historical and current information on breeding populations of western grebes on lakes in northwestern Alberta.

Lake	Year	Number of Western Grebes*	Source
Cardinal Lake	1995	Present	Kerr 2002 unpubl. data in Hanus 2002
	2000	30	Hanneman and Heckbert 2001
Lesser Slave Lake	1970s	800	Hanneman and Heckbert 2001
	1979	1300+	Ealey 1979 in Hanus 2002
	2000	700	Hanneman and Heckbert 2001
	2002	3742	Eadie 2002
Utikuma Lake	1990s	206	Hanneman and Heckbert 2001
	2000	1700+	Hanneman and Heckbert 2001

* Number of western grebes determined by multiplying nests counted by 2

central and northeastern parts of the province. Local populations appear to be increasing in northwestern Alberta at Lesser Slave and Utikuma lakes. Cold Lake, Lac Ste. Anne and Wabamun Lake have decreased from sites of national importance for the western grebe to sites of regional importance since 2003. It appears that many lakes in the northeastern region that historically supported populations no longer do so. These include former colonies on Lac Sante and Ethel, Frog, Garner, Hastings, Muriel, North Buck and Wolf lakes (Found 2004, Found and Hubbs 2004, Found unpubl. data 2005). These findings indicate that the western grebe in Alberta may be more vulnerable than previously thought, and it may be threatened in the long term.

2. Other Areas - The lack of comparable population data over time for the western grebe in Alberta mirrors the situation across the species' range. However, there are many indications that western grebe populations are declining in several locations throughout Canada and the United States (Koonz and Rakowski 1985, Burger 1997, Bower 2003, Ivey 2004, Puget Sound Action Team 2004, Nysewander et al. 2005, Sauer et al. 2005).

2.1 Breeding Sites - In British Columbia, two of the five primary western grebe nesting sites in the province have been abandoned, and the small breeding population that remains is threatened by human disturbance (Burger 1997). Declines in breeding populations are also noted in southern Manitoba (Koonz and Rakowski 1985), Washington (-14.6%; Sauer et al. 2005) and many important sites in northern California (Ivey 2004).

2.2 Wintering Grounds - The southern Strait of Georgia, B.C. and adjacent Puget Sound, Washington are believed to support the greatest winter densities of western grebes in the species' range (Burger 1997, Bower 2003). The most comprehensive historical marine bird census of this area was the Marine Ecosystems Analysis Puget Sound Project (MESA), conducted during 1978-79. The study used a wide variety of survey techniques to assess hundreds of sites and transects in 13 regions off the mouth of the Strait of Juan de Fuca, the Washington mainland, the Canadian Gulf Islands, and Port Townsend (Wahl et al. 1981 in Bower 2003).

More recent studies designed to be compared with the historical MESA data have commenced in the same areas. These studies include the Puget Sound Ambient Monitoring Program—an extensive research project that initiated marine bird surveys in 1992—and surveys conducted by researchers from Western Washington

University. When compared to MESA results, these studies showed declines ranging from 80% to 95% in western grebe wintering populations over the last 25 years and suggested that this trend is consistent all along the Pacific coast of the U.S. and Canada, except for a small area near Los Angeles where populations may be increasing slightly (Bower 2003, Puget Sound Action Team 2004, Nysewander et al. 2005).

Christmas Bird Count data also show considerable declines in western grebe wintering populations in British Columbia and the western states, with the exception of California (National Audubon Society 2002). For the whole coastal region from 1984-2003, counts indicate an annual population decrease of 5.3%: in BC, 12%; Washington, 5.5%; and Oregon, 4.5% (Ivey 2004). It is important to note that although Christmas Bird Counts provide data over long periods of time, they are no substitute for larger systematic surveys. These counts do not account for birds using pelagic areas (referring to the open sea), and several factors may lead to overestimations in recent counts, including an increased number of observers over time, increased effort over time, and the incorporation of boats in more recent surveys (Bower 2003).

LIMITING FACTORS

Limiting factors are those that can affect habitat quality and availability, reproductive success, and survival of the western grebe, thereby making the species more susceptible to population decline. Some natural limiting factors include fluctuating water levels during nesting, storms with high wind, egg depredation and disease (Burger 1997, Hanus et al. 2002b, Berg et al. 2004). Though these factors can have significant consequences for the species, this section will focus on anthropogenic (of human origin) factors.

The colonial behaviour of western grebes exposes them to single and localized events that can have serious implications for entire populations. It is likely that site-specific conditions are contributing to the declines observed at breeding sites in Alberta, and that cumulative effects of the following factors are negatively affecting the species locally, regionally and throughout its range (Jurick 1985, Hanneman and Heckbert 2001, Hanus et al. 2002a, Berg et al. 2004, Nysewander et al. 2005).

1. Habitat Degradation - Habitat degradation was identified as a major threat to Alberta's western grebes nearly 30 years ago (Riske 1976). The ongoing draining of wetlands and small water bodies for residential, industrial or agricultural expansion may have hydrological effects on the watersheds used by western grebes (H. Wollis pers. comm.). The clearing of emergent vegetation for housing, cottage and dock or marina development reduces and fragments viable nesting habitat at many Alberta lakes. At Wabamun Lake, a distinct line of cleared and uncleared emergent vegetation is obvious along the shores, with western grebes nesting in the most intact portions. At Lac Ste. Anne, where nesting occurs in the last intact section of bulrush remaining (Hanus et al. 2002b, Berg et al. 2004), a large condominium and marina development is planned adjacent to the western grebe colony (H. Wollis pers. comm.). Shoreline development was a major factor in the extirpation of western grebes at some lakes in British Columbia (Burger 1997).

Cattle grazing, power boating and snowmobile activity can also damage breeding habitat. Grazing of shoreline vegetation and boating can reduce the extent of emergent vegetation and pose a threat to the colonies of Lesser Slave Lake (Eadie 2002). Snowmobiles that drive over reed beds in the winter result in reeds being broken and submerged the following spring. This occurred at Isle Lake in 2002, and forced the western grebe colony to relocate to an area of sparser vegetation, increasing the colony's exposure to wind, avian predators and

competition from other nesting birds (Berg et al. 2004). In addition, intentional manipulation of lake water levels (either by raising or lowering), or the introduction of invasive wetland plants, can cause changes in habitat composition and lead to a significant decrease in reproductive success (British Columbia Resources Inventory Branch 1998, Hanus et al. 2002b). Natural fluctuations in water levels can provide opportunities for grebe nesting habitat to develop, as has occurred at Lake Isle. Here, dropping water levels have allowed expansion of reed beds and the western grebe colony (H. Wollis pers. comm.).

2. Human Disturbance - The sensitivity of western grebes to human disturbance has been well established. Development and recreational activities, including boating, water-skiing and personal watercraft use, cause wave, audio and visual disturbances that can threaten nests and degrade the viability of the colony sites. The number of boats, size of motors, and types of water sports have increased dramatically on Alberta's lakes, exacerbating these negative effects (Hanus et al. 2002a, Berg et al. 2004, Found 2004). The long-term impact of recreational disturbance may be evident at Lac La Nonne and Thunder Lake: both lakes provide apparently suitable nesting habitat that is not being utilized (Hanus et al. 2002a). Lac La Nonne is a highly developed popular recreation lake (Mitchell and Prepas 1990). Declines at Thunder Lake began after the establishment of Thunder Lake Provincial Park, development of boating access, and a general increase in human presence (J. Kinnaird pers. comm. in Hanus et al. 2002a). Jack Kinnaird, a birding enthusiast and long-time resident of the Barrhead area, regularly visited a western grebe colony on Thunder Lake in the early 1960s. Subsequent to his observations, the lake was developed for boating recreation with boat ramps and docks. The site no longer has an active colony of western grebes (H. Wollis pers. comm.).

Additionally, two historical colony sites at Lac Ste. Anne (Purdy et al. 1983) are no longer active in areas that now maintain high boat traffic, which likely caused the colonies to relocate (Hanus et al. 2002a). Boating disturbance was a primary factor of western grebe extirpation at some lakes in British Columbia (Burger 1997).

Western grebes exhibit strong avoidance behaviour in the presence of humans (Burger 1997, Hanus et al. 2002a). When nesting sites are approached, the adults leave the nest and move into open water until the threat is gone. As the birds often do this hastily, eggs do not get covered with vegetation to protect them from extreme temperatures and predators, eggs may be knocked into the water, or hatchlings left in nests may be permanently separated from their parents (Kristensen and Nordstrom 1979, Berg et al. 2004). This can have severe impacts on the overall productivity of the colony, and areas subject to frequent disturbance have high rates of nest abandonment and low reproductive success (Riske 1976, Kristensen and Nordstrom 1979, Hanus et al. 2002b, Berg et al. 2004). It is likely that the population declines and low reproductive success observed at Lac Ste. Anne and Wabamun Lake are largely the result of corvid nest predation during nest abandonment—a problem noted at several lakes—in combination with other human disturbance factors (Kristensen and Nordstrom 1979, Berg et al. 2004, Found 2004). At Wabamun Lake, for example, there is a large population of crow nests near the traditional western grebe colony. It may be that the degradation of western grebe nesting habitat at that lake has prevented the western grebes from changing their nesting area to avoid the crows (H. Wollis pers. comm.).

3. Oil Spills - The gregarious behaviour of western grebes makes them highly vulnerable to oiling mortality. Oil spills in coastal regions can span vast areas and kill thousands of birds (Curtis 2005, NatureServe 2005). The spill at Wabamun Lake in August of 2005 occurred after

the nesting period and the oil was prevented from entering the primary nesting habitat. However, the event negatively affected at least 76% of the lake's western grebe population (through birds either dying or being captured, cleaned and released) and may affect future generations (H. Wollis pers. comm.).

4. Pollution - Western grebes, like many piscivorous waterbirds, are subject to elevated levels of chlorinated hydrocarbons and heavy metals magnified in the food chain. These chemicals accumulate in their bodies and can affect immunological and neurological processes, reduce eggshell thickness and reproductive success, and cause high adult mortality rates. The effects of pollution on the western grebe were noticed as early as the 1950s in the United States, and though some recovery occurred after the ban of DDT in the 1970s, recent studies show that pollution from agricultural and industrial applications is still a problem (Herman et al. 1969, Kraft 1983 in Burger 1997, Forsyth et al. 1994, Elliot and Martin 1998, Elbert and Anderson 1998, Hanus et al. 2002a). In Alberta, exposure to pollution may result from the runoff of fertilizers, pesticides and herbicides into lakes and marshes (Priestley 2002). Industrial activities including power generation, transportation and petroleum production add to pollution, as do cottage use and other recreational activities (Wollis pers. comm.).

5. Reduction of Prey Base - Changes in forage fish populations caused by commercial fisheries (C. Davis pers. comm. in Found and Hubbs 2004), pollutants, alteration of spawning habitat, introduction of sport or invasive fish species, and climate change likely affect western grebe populations (Bower 2003, Puget Sound Action Team 2004). Fishing at lakes inhabited by western grebes also has the side effects of disturbing birds and potentially causing problems when waste fishing line is discarded into the water. Grebes tangled in line and unable to fly have been observed on Alberta lakes, and are likely indicative of a widespread problem. Thus, it is important to teach anglers about proper disposal of waste line (Berg et al. 2004).

STATUS DESIGNATIONS*

1. Alberta - According to *The General Status of Alberta Wild Species 2000*, the western grebe is considered *Sensitive* in Alberta (Alberta Sustainable Resource Development 2001). It is ranked as such because there is little species information available, the species is sensitive to human activity and development, and critical nesting habitat is disappearing (Fish and Wildlife Division 2005). The species is monitored by the Alberta Natural Heritage Information Centre's Watch List system as S3 (Alberta Natural Heritage Information Network 2004a).

2. Other Areas - The status of the western grebe has not been assessed by COSEWIC (2005). According to *Wild Species 2000: The General Status of Species in Canada*, the species is considered *Secure* in Canada, *At Risk* in British Columbia and *Secure* in Saskatchewan and Manitoba (Canadian Endangered Species Conservation Council 2001). The western grebe has been assigned to the Red List of species being considered for legal designation as *Endangered* or *Threatened* in British Columbia as a result of population declines, few active breeding sites, and the vulnerability of those sites to habitat degradation and human disturbance. It is protected under the British Columbia *Wildlife Act* (Burger 1997).

The global heritage rank of the western grebe is G5, with the last global review occurring in 1996 (NatureServe 2005), and the species is included in the IUCN Red List Category of Least Concern (O'Donnel and Fjeldså 1997). Federal conservation status for the species in

* See Appendix 1 for definitions of selected status designations.

Canada is N3 for the non-breeding population and N5 for the breeding population. Federal conservation status for the species in the United States is N5 for both breeding and non-breeding populations, though state rankings (primarily for breeding populations) range from S1 (Kansas), to S3 (Arizona, Nebraska, New Mexico, Oregon, Texas, Washington), to S4 (Colorado, Idaho, Montana, Nevada, South Dakota, Utah, Wyoming). The species is currently Not Ranked/Under Review in the three states of California, North Dakota and Minnesota (NatureServe 2005). The western grebe is a candidate species for listing as *Sensitive*, *Threatened* or *Endangered* in Washington State (Washington Natural Heritage Program 2005). The species is protected federally under the *Migratory Birds Convention Act, 1994*, which protects migratory birds and their nests from "take," defined as possession, sale, purchase, barter, transport, import and export. Ivey (2004) proposed that in the United States abandonment of nests caused by anthropogenic factors can also be considered as take. In Canada, there has never been a case that has dealt with the specific issue of "take" and human disturbance (G. Bogdan pers. comm.).

The western grebe was on the North American Blue List each year from 1973 to 1986. By 1982 the population appeared to be stabilizing at a "reduced level," and in 1986, the species was delisted to a species of "special concern" (Tate 1986 in Semenchuk 1992). Though not a legal designation, the Blue List was designed to identify patterns of impending or ongoing serious losses in regional bird populations (National Audubon Society 2004).

RECENT MANAGEMENT IN ALBERTA

Recent management for the western grebe in the province has been concentrated in central Alberta. This includes public education through the establishment of public awareness signs (a total of 11 signs at five lakes within the Stony Plain study area), presentations and newsletter articles (for further details see Hanus et al. 2002b). Protective notations (i.e., PNTs; Colonial Nester Habitat Protection Areas) have been applied for, or established, at all of the western grebe colonies in central and northwestern Alberta, and progress is being made in this matter in the northeastern region (Hanneman and Heckbert 2001, Hanus et al. 2002b, Found 2004). Several breeding sites have been listed as Important Bird Areas (IBA) in part because of the western grebe colonies they support (Lac La Biche and Cardinal, Lesser Slave and Utikuma lakes), and IBA Conservation Plans have been created for Lac La Biche and Lesser Slave Lake, which outline site-specific needs for education, habitat protection and enhancement, enforcement, research, and monitoring (Fraser 2000, Gammon 2000). Cold Lake was somehow missed during the initial Alberta IBA screening in 1999, but efforts are being made to rectify this (G. Newton pers. comm.). Lac La Biche is recognized as a Provincial Bird Sanctuary and regulations prohibit disturbance (except in cases where access is required) or hunting of birds found on the lake surface or its islands (Gammon 2000). Regions in central and southern Alberta are within the boundaries of the international *Northern Prairie and Parkland Waterbird Conservation Plan* area, which recognizes the western grebe as a species of high concern (Beyersbergen et al. 2004). The plan provides an overview of the status and current knowledge of waterbirds and waterbird habitat in the region, and outlines strategies and priorities for monitoring, research and management.

SYNTHESIS

The western grebe is highly sensitive to human disturbance, and recent studies suggest significant population declines in central and northeastern Alberta, with trends toward low reproductive success and occurrence on fewer lakes. Important breeding sites are limited to a handful of lakes in the province and several have shown alarming rates of population decline.

The western grebe may be more vulnerable than previously believed and its status in Alberta may be threatened in the long term. Management for this species in Alberta clearly requires continued monitoring at principal sites already identified, as well as investigation into other areas of the province (e.g., Parkland Natural Region, where surveys have recently been initiated) to gain more accurate population estimates for future assessments. Research is needed on clutch sizes, brood survival, natural and human-related causes of breeding failure, and habitat use (Burger 1997, Hanus et al. 2002b, Berg et al. 2004).

Protection from habitat degradation and human disturbance at identified sites requires immediate attention. The clearing of emergent shoreline vegetation must be prevented and habitat restoration projects should commence in areas already cleared. Shoreline development should be strictly controlled and surface access near colonies should restrict all watercraft within 1000 m and air access below 650 m, particularly during the breeding season (Brechtel 1981). Access for people and pets near breeding colonies should also be restricted, where possible. Human manipulation of lake water levels should be prevented at lakes supporting breeding colonies. Special agricultural and industrial techniques must be applied in riparian areas to prevent habitat loss and the leaching of pollution. Such practices may include the exclusion of cattle from shoreline areas (Burger 1997) and the use of vegetation buffers between shorelines and cropland, grazing areas and industrial facilities. Public education and signage focusing on local groups, landowners and land managers, should continue to be used in central Alberta and expanded throughout the province (Hanus et al. 2002b, Berg et al. 2004, Found and Hubbs 2004).

Lakes with colonies warranting special consideration should be designated as legislated wildlife sanctuaries, ecological reserves and/or important bird areas, and, where the backshore is public land, the land should be secured with protective notations at colonies not already addressed by this system (Hanus et al. 2002a, Berg et al. 2004, Found and Hubbs 2004). Colonies that have shown declines from national to regional importance (i.e., Cold Lake, Lac Ste. Anne, Wabamun Lake) demand the highest priority and should receive the maximum level of protection to ensure they are sustained over the long term.

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Appendix 1. Definitions of selected legal and protective designations.

A. The General Status of Alberta Wild Species 2000 (after Alberta Sustainable Resource Development 2001)

2000 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be *At Risk* after formal detailed status assessment and designation as *Endangered* or *Threatened* in Alberta.
May Be At Risk	Blue	Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
Sensitive	Yellow	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Secure	Green	Any species that is not *At Risk*, *May Be At Risk* or *Sensitive*.
Undetermined	Status Undetermined	Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.
Not Assessed	n/a	Any species known or believed to be present but which has not yet been evaluated.
Exotic/Alien	n/a	Any species that has been introduced as a result of human activities.
Extirpated/Extinct	n/a	Any species no longer thought to be present in Alberta (*Extirpated*) or no longer believed to be present anywhere in the world (*Extinct*).
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.

B. Alberta Wildlife Act/Regulation

Species designated as Endangered under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation.

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade.
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed.

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2005)

Extinct	A species that no longer exists.
Extirpated	A species that no longer exists in the wild in Canada, but occurs elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if limiting factors are not reversed.
Special Concern	A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Not at Risk	A species that has been evaluated and found to be not at risk given current circumstances.
Data Deficient	A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.

Appendix 1 continued.

D. Heritage Status Ranks: Global (G), National (N), Sub-National (S) (after Alberta Natural Heritage Information Centre 2004b, NatureServe 2005)

G1/N1/S1	5 or fewer occurrences or only a few remaining individuals. May be especially vulnerable to extirpation because of some factor of its biology.
G2/N2/S2	6 to 20 or fewer occurrences or with many individuals in fewer locations. May be especially vulnerable to extirpation because of some factor of its biology.
G3/N3/S3	21 to 100 occurrences, may be rare and local throughout its range, or in a restricted range (may be abundant in some locations). May be susceptible to extirpation because of large-scale disturbances.
G4/N4/S4	Typically > 100 occurrences. Apparently secure.
G5/N5/S5	Typically > 100 occurrences. Demonstrably secure.
GX/NX/SX	Believed to be extinct or extirpated, historical records only.
GH/NH/SH	Historically known, may be relocated in the future.
GNR/NNR/SNR	Unranked—conservation status not yet assessed.

E. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Appendix 2. Summary of historical and current information on populations of western grebes on lakes in central Alberta.

Lake (S = Stony Plain Study Area, P = Parkland Study Area)	**Year***	**Number of Western Grebes****	**Breeding Confirmed** (Y = yes, N= no)	**Source*****
Big Lake (S)	1982	3	N	Purdy et al. 1983 in Hanus 2002
	2001	0	N	Hanus et al. 2002b
Buck Lake (P)	1970	63	N	Riske 1976 in Hanus 2002
	2004	16	N	Berg et al. 2004
Buffalo Lake (P)	1992	Present	Y	Gray et al. 1992 in Hanus 2002
	2004	309	N	Berg et al. 2004
	2005	>200	Y	H. Wollis pers. comm.
Coal Lake (P)	2004	6	N	Berg et al. 2004
Driedmeat Resevoir (P)	1973	3	N	Kelsall et al. 1973 in Hanus 2002
	2004	5	N	Berg et al. 2004
Glennifer Lake (P)	2004	10	N	Berg et al. 2004
Gull Lake (P)	2000	25	N	Bjorge and Potter 2000 unpubl. data
	2004	320	N	Berg et al. 2004
Isle Lake (S)	1982	96	Y	Purdy et al. 1983 in Hanus 2002
	1990	138	Y	Folinsbee 1990 unpubl. data
	2001	154	Y	Hanus et al. 2002b
	2002	124	Y	Hanus et al. 2002a
	2003	88	Y	Hanus et al. 2003
	2004	228	Y	Berg et al. 2004
Lac La Nonne (S)	1971	13	N	Riske 1976 in Hanus 2002
	1982	2	N	Riske 2002 unpubl. data
	1992	40	N	Riske 2002 unpubl. data
	2001	25	N	Hanus et al. 2002b
Lac Ste. Anne (S)	1971	1000+	Y	Riske 1976 in Hanus 2002
	1981	629	Y	Riske 2002 unpubl. data
	1991	647	Y	Riske 2002 unpubl. data
	2001	1268	Y	Hanus et al. 2002b
	2002	802	Y	Hanus et al. 2002a
	2003	1106	Y	Hanus et al. 2003
	2004	308	Y	Berg et al. 2004
Pine Lake (P)	1976	6	N	Riske 2002 unpubl. data
	1981	5	N	Riske 2002 unpubl. data
	1990	2	N	Riske 2002 unpubl. data
	2004	3	N	Berg et al. 2004
Pigeon Lake (P)	1971	100	N	Riske 1976 in Hanus 2002
	2004	20	N	Berg et al. 2004
Sandy Lake (S)	2002	150+	N	Hanus et al. 2002a
	2003	0	N	Hanus et al. 2003
Sylvan Lake (P)	1993	3	N	Hanus 2002
	2004	22	N	Berg et al. 2004
Thunder Lake (S)	1968	100+	Y	J. Kinnaird pers. comm. in Hanus 2002
	1980	251	N	Riske 2002 unpubl. data
	1990	1	N	Riske 2002 unpubl. data
	2001	3	N	Hanus et al. 2002b

Appendix 2 continued.

Lake (S = Stony Plain Study Area, P = Parkland Study Area)	**Year***	**Number of Western Grebes****	**Breeding Confirmed** (Y = yes, N= no)	**Source*****
Wabamun Lake (S)	1982	184	Y	Purdy et al. 1983 in Hanus 2002
	1989	80+	Y	Folinsbee 1989 in Hanus 2002
	2001	544	Y	Hanus et al. 2002b
	2002	1510	Y	Hanus et al. 2002a
	2003	1360	Y	Hanus et al. 2003
	2004	634	Y	Berg et al. 2004

* For specific dates of surveys, see the original reference.

** Number of western grebes determined by multiplying nests counted by 2.

*** All unpublished data taken from Hanus (2002).

Appendix 3. Summary of historical and current information on breeding populations of western grebes on lakes in northeastern Alberta (adapted from Found and Hubbs 2004).

Lake	Year*	Number of Western Grebes**	Source***
Angling Lake	Unknown	1680	Gunderson 1981 unpubl. data
	2003	30	Found and Hubbs 2004
	2004	8	Found 2004
	2005	30	Found 2005 unpubl. data
Cold Lake	1978	2012	Kristensen and Nordstrom 1979
	1985	508	Alberta Environment 1993 unpubl. data
	2003	1982	Found and Hubbs 2004
	2004	970	Found 2004
	2005	528	Found 2005 unpubl. data
Ethel Lake	1981	84	Gunderson 1981 unpubl. data
	1989	80	Anonymous 1995 unpubl. data
	2003	No Colony	Found and Hubbs 2004
Frog Lake	1957	200	Hampson 1957 unpubl. data
	1965	150	Riske 1965 unpubl. data
	1991	600	Hanus 2002
	2003	No Colony	Found and Hubbs 2004
Garner Lake	1985	102	Anonymous 1995 unpubl. data
	2003	0	Found and Hubbs 2004
Hastings Lake	1990	225	Moore 1990 unpubl. data
	2003	10	Found and Hubbs 2004
	2004	0	Found 2004
	2005	0	Found 2005 unpubl. data
Lac La Biche	1980	3124	Anonymous 1980 unpubl. data
	1988	3000	Alberta Environment 1993 unpubl. data
	2003	4612	Found and Hubbs 2004
	2005	1392****	Found 2005 unpubl. data
Moose Lake	1990	400	Found and Hubbs 2004
	2004	304	Found 2004
	2005	258	Found 2005 unpubl. data
Muriel Lake	1991	400-600	Hanus 2002
	2003	Unknown	Found and Hubbs 2004
	2004	0	Found 2004
North Buck Lake	1991	124	Moore 1991 unpubl. data
	2003	0	Found and Hubbs 2004
Reita Lake	1981	532	Gunderson 1981 unpubl. data
	2003	0	Found and Hubbs 2004
Lac Sante	1987	50	Hanus 2002
	2003	0	Found and Hubbs 2004
Wolf Lake	1980	346	Alberta Environment 1993 unpubl. data
	1985	720	Alberta Environment 1993 unpubl. data
	1989	540	Alberta Environment 1993 unpubl. data
	2003	40	Found and Hubbs 2004
	2004	0	Found 2004
	2005	0	Found 2005 unpubl. data

* For specific dates of surveys, see the original reference.
** Number of western grebes determined by multiplying nests counted by 2.
*** All unpublished data taken from Hanus (2002) with the exception of Found unpublished data 2005.
**** Partial nest survey only. Colony of approximately 200 western grebe nests NE of Current Island existed; nest count not completed.

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