Changes to the Population Status of Horned Grebes (*Podiceps auritus*) and Red-necked Grebes (*Podiceps grisegena*) in Southwestern Manitoba, Canada

Gord Hammell

P.O. Box 37, Erickson, Manitoba R0J 0P0 Canada; email: gmhammell@gmail.com

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Continental trend data for North America suggest that Horned Grebe (*Podiceps auritus*) breeding populations are declining and Red-necked Grebe (*P. grisegena*) populations are increasing. However, data reliability is low due to lack of survey routes in the northern boreal and taiga ecozones, areas encompassing much of the breeding range of both species. Locally in the southern Manitoba prairie ecozone, reliability of long-term trend data is also considered low and these data suggest that Horned Grebe populations are declining faster than the continental trend and that Red-necked Grebe populations are increasing rapidly. The lack of current quantitative information on population densities of these two species in southern Manitoba prompted me to compare 1970s historical data from two sites to recent data collected at the same locations in 2008–2016. I surveyed 42 (1970–1972) and 38 (2008–2016), and 144 (2009–2015) Class III-V wetlands at Erickson and Minnedosa, Manitoba, respectively. Historical Minnedosa data were available from previous field studies. At both locations, Horned Grebe breeding populations have fallen significantly, and Red-necked Grebe populations have risen significantly since the 1970s. The results of this study corroborate the Breeding Bird Survey's trend data for Horned and Red-necked Grebes in southwestern Manitoba pothole habitat.

Key Words: Horned Grebe; *Podiceps auritus*; Red-necked Grebe; *Podiceps grisegena*; Manitoba prairie-potholes; species at risk; population status

Introduction

Horned Grebes (*Podiceps auritus*) and Red-necked Grebes (*P. grisegena*) are highly-specialized waterbirds that nest over-water in or near emergent vegetation on semi-permanent or permanent ponds. Horned Grebes prefer small (less than 2 ha) open-water wetlands for nest sites in Manitoba, Saskatchewan, and North Dakota (Faaborg 1976; Sugden 1977; Ferguson and Sealy 1983) whereas the larger Red-necked Grebe usually occupy wetlands greater than 2 ha (Riske 1976 as cited in Stout and Nuechterlein 1999; De Smet 1983 as cited in Stout and Nuechterlein 1999; the current study; but see Fournier and Hines 1998). For both species, males and females are similar in appearance and difficult to distinguish in the field. They are intra- and interspecifically territorial. Both species have Holarctic distributions and, in North America, the majority of their populations have a similar breeding range, extending from northwestern Ontario and the northwestern United States to the Northwest Territories and Alaska (Stout and Nuechterlein 1999; Stedman 2000). The Horned Grebe Western population is listed as special concern but the small (less than 15 birds), disjunct Magdalen Island population in the Gulf of St. Lawrence is listed as endangered under the *Species at Risk Act* following their 2009 assessments by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; SARA Registry 2017a,b). Red-necked Grebe was last assessed by COSEWIC in 1982 as 'not at risk' (SARA Registry 2017c). Although the reproduction and behaviour of the species have been studied extensively in Eurasia and North America (Stout and Nuechterlein 1999; Stedman 2000; Klatt 2003; Nuechterlein *et al*. 2003; Klatt *et al.* 2004; Kuczynski *et al.* 2012), accurate information on population trends for breeding and wintering populations in North America is still lacking (Stout and Nuechterlein 1999; Stedman 2000; COSEWIC 2009). Breeding Bird Survey (BBS) data suggest continental declines for Horned Grebe and increases for Red-necked Grebe (yearly % change 1966–2015: Horned Grebe −0.47, Red-necked Grebe +0.65; Sauer *et al*. 2017). But BBS data have limited value, as much of the breeding range of both species lies in the northern boreal and taiga ecozones, areas with few BBS survey routes. Thus, potential data are missing and results are biased towards southern prairie-parkland populations (COSEWIC 2009).

Locally in the parklands of southern Manitoba, the reliability of BBS data for Horned Grebe and Red-necked Grebe are considered low due to small sample sizes but the data suggest that Horned Grebe populations are decreasing and Red-necked Grebe populations are increasing (Manitoba Prairie-potholes long-term trend 1970–2015 yearly % change: Horned Grebe −2.94; Red-necked Grebe +10.7; Environment and Climate Change Canada 2017). No corroborative, multi-year studies of reproduction have been conducted in this area in over 30 years (Ferguson and Sealy 1983;

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De Smet 1987). Intensive monitoring at a local scale can provide additional trend information, and in conjunction with landscape data (e.g., BBS), may allow more accurate decisions regarding the need for possible intervention (e.g., small wetland construction for Horned Grebe; Kuczynski *et al.* 2012). Accordingly, personal anecdotal evidence suggesting changes in grebe populations in southwestern Manitoba and the lack of current quantitative information prompted me to examine the extent of any change. I took advantage of historical data from two locations in southwestern Manitoba (Erickson and Minnedosa) and compared these data to those collected in 2008–2016 at the same locations.

Study Area

The study areas are in the parkland pothole region of southwestern Manitoba (Figure 1). The topography of the region is rolling hills with numerous ponds and lakes; the uplands are a mixture of cereal and oilseed crops, hay, pasture, and native woodland (mainly poplars, *Populus* spp.). The Erickson study area (50.470351°N, 99.895847°W) consists of a 6.8 km^2 area established by the author in 1970, and contained 12 seasonal (Class III: 0.4 ± 0.3 ha, 0.1–1.3 [average ± SD, range]), seven semi-permanent (Class IV: 0.5 ± 0.3 ha, 0.2–0.9), and 23 permanent (Class V: 2.0 ± 2.3 ha, 0.1–8.7 [18 natural, five constructed dugouts]) wetlands during 1970–1972 (~ 6 wetlands/km^2; classification according to Stewart and Kantrud [1971]). In 2008–2016, two Class III and two small Class V wetlands (dugouts) had been lost due to draining or filling. The 7.1 km^2 Minnedosa study area (50.125001°N, 99.844663°W), established in 2009 by the author, is about 27 km south of the Erickson site and is a 17.7 km × 0.4 km roadside transect (0.2 km either side) and

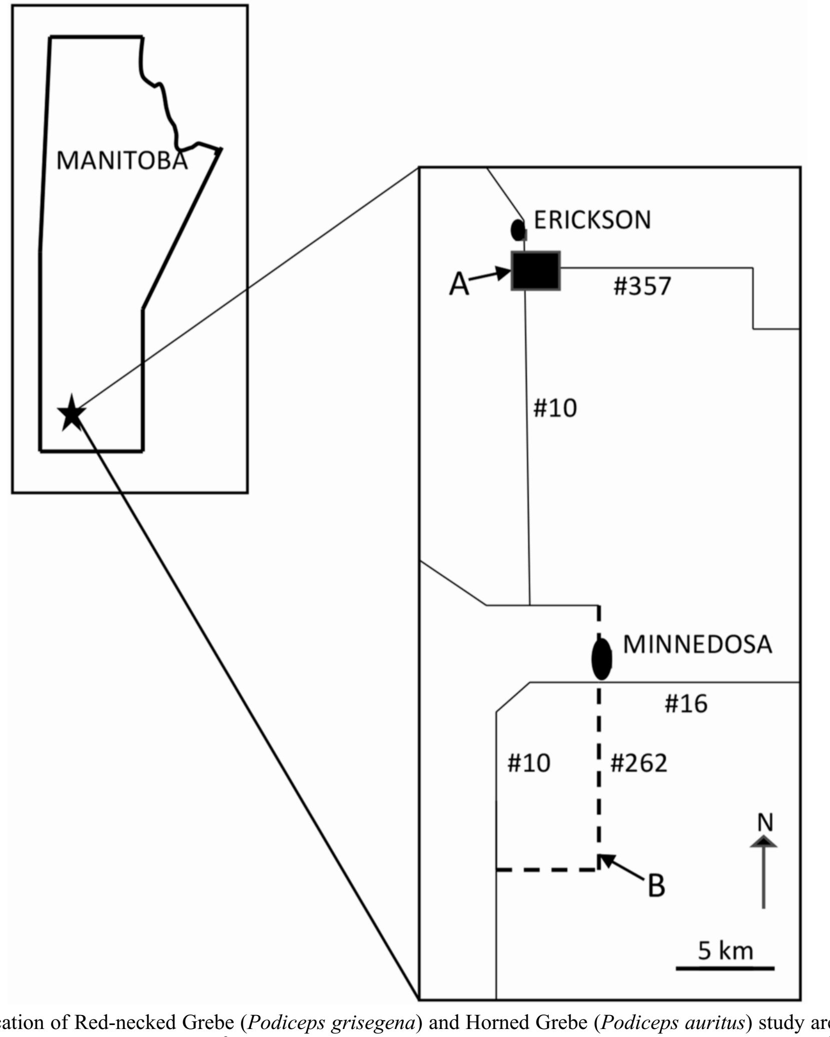

FIGURE 1. Location of Red-necked Grebe (*Podiceps grisegena*) and Horned Grebe (*Podiceps auritus*) study areas in southwest Manitoba, Canada: 6.8 km^2 Erickson site (black square A: 1970–1972, 2008–2016), and 7.1 km^2 Minnedosa transect (dashed line B: 2009–2015).

contained ten Class III (0.1 ± 0.07 ha, 0.02 – 0.22), 118 Class IV (0.9 ± 0.9 ha, 0.03–4.0), and 16 Class V (1.6 ± 1.1 ha, 0.06–3.6 [nine natural; seven {five flooded} dugouts]) wetlands (~ 20 wetlands/km^2). The latter study site is part of a larger site intensively studied for Horned Grebe in 1974–1975 (Ferguson 1977). Using 1964 and 2011 aerial photos of the Minnedosa transect (Aerial Data Survey Base, Natural Resources Canada and Google Earth, respectively), I estimated about a 2% loss (four Class IV lost, one dugout added) of Class IV and V wetlands between 1964 and 2011. Because Horned Grebes and Red-necked Grebes occupy Class IV and V wetlands almost exclusively during the breeding season, both study sites have experienced little grebe habitat loss between the 1970s and 2000s.

At Erickson, wetland water levels were high in the springs of 1970–1972 and in all years in the 2000s except 2012 (unpublished data). At Minnedosa, wetlands were wet in spring 1974–1975 (Ferguson 1977) and in all years 2009–2015 except 2012, and 2013 when the north section of the transect was dry (personal observation). Mean total yearly precipitation (*Precip*), 1981–2010, for Wasagaming, Manitoba ~21 km north of the Erickson site and for Brandon, Manitoba ~23 km south of the Minnedosa transect was 488 mm and 474 mm, respectively (Environment Canada Historical Climate Data 2016). Both early and recent study period *Precip* was greater than long-term averages (Erickson [Wasagaming] *Precip* 1970–1972 and 2009–2015 was 514 mm and 592 mm, respectively; Minnedosa [Brandon] *Precip* 1974–1975 and 2009–2015 was 529 mm and 506 mm, respectively). At Erickson, most wetlands were wetter (and some were larger) during 2008–2016 than during 1970–1972. Good wetland conditions are necessary to attract grebes to settle on territories (Stout and Nuechterlein 1999; Stedman 2000).

Methods

As both species require wetlands with open water for breeding (Stout and Nuechterlein 1999; Stedman 2000), I restricted my observations to ponds equal to or greater than Class III (some Class III wetlands have open water, cover type 3 and 4; Stewart and Kantrud 1971). Both species are thought to attain full nuptial plumage at 1-year old, but some adults may not breed until greater than 1-year old (Stout and Nuechterlein 1999; Stedman 2000). The number of non-breeding Red-necked Grebes and Horned Grebes observed on the breeding ponds is assumed to be low (Riske 1976 as cited in Stout and Nuechterlein 1999; Fjeldså 1973 as cited in Stedman 2000). Thus, I assumed that all birds observed represented members of breeding pairs. At Erickson, one or two observers walked a fixed route at approximately weekly intervals from early May to late June 1970–1972 and from mid-May to mid-June 2008–2016. All wetlands were scanned with binoculars and spotting scopes from one or more elevated locations between 0600 and 1400 hours. At the Minnedosa transect, late May was the optimal census period to observe the greatest number of Horned Grebes when only one survey was conducted (Arnold 1994). One observer conducted one late-May survey beginning at ~ 0600 hours (1100 hours in 2009) at the southwest end and proceeded east, then north (6–10 hrs to complete) in all years except 2014 (June 5th). Each wetland within 200 m of the road was approached by vehicle or on foot and quickly scanned in its entirety then rescanned for 1 min or more, according to Arnold (1994). If the transect line bisected a large wetland (*n* = 3), I included only those grebes in the analysis observed within the transect. Horned Grebes were recorded as single birds or pairs (two birds in close proximity, not displaying aggressive behaviour) and a single bird on a wetland was assumed to represent a pair on that wetland (but see below for differing analysis of Minnedosa Horned Grebe data). Rarely does more than one pair of Horned Grebe occupy a given wetland at the Minnedosa site (Ferguson 1977) but at Erickson, larger wetlands allow for more pairs, and greater scrutiny was necessary. Similarly, for Red-necked Grebes, territory establishment and initial egg-laying occurs in May in Manitoba (egg-laying peaked in late May; De Smet 1987), and counts taken during mid to late May would best represent the breeding population (Stout and Nuechterlein 1999; personal observation). Red-necked Grebes were recorded as pairs or single birds (representing a probable pair). Many pairs could occupy larger lakes (especially at Erickson after 1999) so long observation times (to 0.5 hr) were necessary to estimate numbers. Repeated total counts from several elevated viewpoints combined with field maps of bird locations (to determine territories) aided estimation. At Minnedosa, the relatively smaller Class IV and V wetlands generally precluded the occurrence of more than one pair of Red-necked Grebe at a site.

For 2009 and 2010, time constraints allowed only a partial census of the Minnedosa transect (40% of total Class III wetlands, 66% of Class IV and V combined). Consequently, to estimate the number of pairs on the entire transect for those years, I developed a correction factor using 2011–2015 data (see method in Hammell 2016). This analysis indicated that the number of Horned Grebe and Red-necked Grebe pairs recorded in 2009 and 2010 on the partially surveyed transect represented 80% and 89%, respectively, of total pairs that would have been seen on the entire transect and this adjustment was applied to the 2009 and 2010 raw data.

Horned and Red-necked Grebes differ in their willingness to remain visible at disturbance. At the sight of the observer, Horned Grebes generally dive underwater, sometimes swimming into emergent vegetation to hide (Arnold 1994; personal observation). At Erickson, repeated wetland visits over the season increased the accuracy of Horned Grebe pair estimates and data presented for this site are considered reasonable estimates. However, at Minnedosa, because only one survey was conducted, lowered observability necessitated the application of a correction factor using my total adult bird numbers (i.e., estimating density using single birds and assumed pairs as described above for Erickson might bias breeding pair results downward for Minnedosa). Arnold (1994) estimated Horned Grebe visual detection of total adults for a single survey at Minnedosa as 62% based on known nesting populations determined from repeated nest searches. Therefore, an estimate of the number of initial nests (and the presumed breeding population) can be calculated using visible adults and the correction factor (Horned Grebe adults recorded/0.62 = estimate of total adults/2 = number of initial nests or breeding pairs; T. Arnold, personal communication). In contrast, Red-necked Grebes generally remain in open water on the surface. If they are not obvious at arrival, usually one or both pair members swim out from emergent vegetative cover after a short wait (personal observation). Therefore, recorded pair estimates are considered reasonably accurate, and no correction factor has been applied to Red-necked Grebe raw numbers.

Recent estimates of pairs/km² after 1999 were compared to estimates from my historical data at Erickson, and for Minnedosa, to estimates calculated from data in Ferguson (1977) and Stoudt (1982). Ferguson (1977: 36) found 34 and 36 initial nests in 1974 and 1975, respectively, on his 34.4 km² (29.2 km² roadside transect + 5.2 km² adjacent block) study area. I used these data to calculate Horned Grebe breeding pair densities for those years. Red-necked Grebes were not included in species lists nor discussion for two waterbird studies at Minnedosa during 1961–1972 (Stoudt 1982) and 1974–1975 (Ferguson 1977). So, I assumed them not to be present or in very low densities prior to 1980 and used the number, 0 pairs / km², to represent density for that period. Densities were still very low in the mid-1980s (T. Arnold, personal communication; K. De Smet, personal communication). I compared historical and recent data with non-parametric Wilcoxon rank-sum test via *t*-test on rank transformed data (data analysis using Microsoft Excel, Redmond, Washington, USA), and considered differences significant at $P \leq 0.05$, because the distribution of variables was unknown and sample sizes were small. Means are expressed as ± SD, range (McDonald 2014). Areas were determined by dot grid overlay or Acme Planimeter (http://acme.com/planimeter).

Results

Horned Grebes

At Erickson, Horned Grebes used some of the same wetlands in the 2000s as in the 1970s (1970s: 2.8 ± 2.8 ha, 0.6–8.7, $n = 14$; 2000s: 6.3 ha, 1.2–11.3, $n = 2$). In 2016, one pair occupied a large Class V wetland (11.3 ha) with four pairs of Red-necked Grebes. At Minnedosa, Horned Grebes in the 2000s used semi-permanent and permanent wetlands similar in size to those used in the 1970s (1974–1975: 1.2 ± 1.3 ha, 0.1–8.4, $n = 65$; Ferguson and Sealy 1983; 2009–2015: 1.3 ± 0.9 ha, 0.2–3.1, $n = 10$) and were not recorded on a wetland occupied by a Red-necked Grebe.

Horned Grebe pairs/km² changed significantly from historical to recent times (Table 1). At Erickson, Horned Grebe density fell from 1.8 pairs/km² in 1970 (mean = 1.3, 1970–1972) to 0 pairs/km² for most years in the 2000s (mean = 0.0; $t = -4.37$, $P = 0.001$). Similarly, at Minnedosa, Horned Grebe density fell from 1.0 pairs/

TABLE 1. Estimated breeding pairs per km² (total pairs in parentheses) of Horned Grebes (*Podiceps auritus*; HOGR) and Red-necked Grebes (*Podiceps grisegena*; RNGR), Erickson and Minnedosa, Manitoba study sites. Period-specific estimates: Hammell (1970–1972), Ferguson (1974–1975), Stoudt (1961–1972), and Hammell (2008–2016).

	Study Site			
	Erickson (6.8 km²)		Minnedosa (7.1 km²)	
Year	HOGR	RNGR	HOGR	RNGR
1970	1.8 (12.0)	0.0 (0.0)	no data	0.0 (0.0)
1971	1.2 (8.0)	0.1 (1.0)	no data	0.0 (0.0)
1972	0.9 (6.0)	0.0 (0.0)	no data	0.0 (0.0)
Mean	1.3 (8.7)	0.0 (0.3)	no data	0.0 (0.0)
1974	no data	no data	1.0 (34.0)	0.0 (0.0)
1975	no data	no data	1.0 (36.0)	0.0 (0.0)
Mean	no data	no data	1.0 (35.0)	0.0 (0.0)
2008	0.1 (1.0)	2.6 (18.0)	no data	no data
2009	0.1 (1.0)	2.5 (17.0)	0.4 (3.0)	1.0 (7.0)
2010	0.0 (0.0)	2.6 (18.0)	0.6 (4.0)	2.0 (14.0)
2011	0.0 (0.0)	2.8 (19.0)	0.0 (0.0)	2.7 (19.0)
2012	0.0 (0.0)	2.6 (18.0)	0.4 (3.0)	2.8 (20.0)
2013	0.0 (0.0)	2.6 (18.0)	0.0 (0.0)	2.2 (16.0)
2014	0.0 (0.0)	3.1 (21.0)	0.4 (3.0)	2.5 (18.0)
2015	0.0 (0.0)	2.9 (20.0)	0.1 (1.0)	2.5 (18.0)
2016	0.1 (1.0)	2.9 (20.0)	no data	no data
Mean	0.0 (0.3)	2.7 (19.0)	0.3 (2.0)	2.2 (16.0)

km^2 in both 1974 and 1975 (mean = 1.0) to a range of 0 to 0.6 pairs/km^2 during the 2000s (mean = 0.3; t = −2.94, P = 0.021).

Red-necked Grebes

At Erickson, Red-necked Grebes occupied natural Class V (or former Class IV adjacent to and included in Class V wetlands due to flooded conditions) wetlands exclusively and consistently (5.1 ± 3.4 ha, 0.9–11.3, n = 11). Eight of the 11 (73%) wetlands contained pairs all nine years of the study and total pair count on the study area was similar every year (Table 1). At Minnedosa, of the 35 wetlands (34 natural, one flooded dugout) with a recorded pair in 2009–2015 (2.1 ± 0.9 ha, 0.5–4.0, n = 35), Red-necked Grebes occupied 26 Class IV (74%) and nine Class V (26%) wetlands but were less consistent than at Erickson. None of 35 wetlands were occupied all seven years but 16 of 35 (46%) were occupied equal to or greater than four years. Total pair count was similar each year after 2010.

Red-necked Grebe pairs/km^2 also changed significantly from historical to recent times (Table 1). At Erickson, Red-necked Grebe density increased dramatically from very low values of 0.1 or 0 pairs/km^2 in the 1970s (mean = 0.0, 1970–1972) to values of greater than 2 pairs/km^2 in all years in the 2000s (mean = 2.7; t = 3.59, P = 0.005). Similarly, at Minnedosa, Red-necked Grebe density increased from 0 pairs/km^2 during 1974 and 1975 to values of greater than 2 pairs/km^2 in all but one year (1.0 in 2009) in the 2000s (mean = 2.2; t = 2.87, P = 0.028).

Discussion

The results of this study corroborate the BBS trend data for Horned Grebes and Red-necked Grebes in southwestern Manitoba pothole habitat. At Erickson and Minnedosa sites in the 2000s, the density of Horned Grebe breeding pairs has fallen to less than one third of the mean level in the 1970s and the density of Red-necked Grebe breeding pairs has risen dramatically from nil or essentially nil in the 1970s to densities in the 2000s of greater than or equal to 2.0 pairs/km^2. Red-necked Grebes nest in colonial groups in some areas (Nuechterlein *et al.* 2003) but not on my study sites, and for solitary-nesting pairs, my Red-necked Grebe densities are higher than any reported in North America by Stout and Nuechterlein (1999). Although sample sizes (i.e., number of years) were small in the early period, pair density differences were statistically significant. Lack of breeding Horned Grebe pairs at the Erickson site in 2010–2015 does not suggest absence of breeding in the greater Erickson area during those years but may be the result of the small size of the study area. Horned Grebes were indeed noted on a few lakes just outside the Erickson study area but at densities incomparable to the past because of the lack of local historical data. In a broader Canadian context, BBS trend data for Saskatchewan pothole habitat shows a large positive change for Red-necked Grebes and a small positive trend for Horned Grebes for 1970–2015, and negative trends for both species in Alberta potholes (Environment and Climate Change Canada 2017). The Alberta data are corroborated by a long-term study in east-central Alberta pothole habitat that also shows negative changes in numbers of breeding Horned Grebes and Red-necked Grebes in 1989–2004 (Corrigan 2007). But these declines may have been influenced by long-term drought (C. Paszkowski, personal communication).

Several potential biases could affect my results. Across southern Manitoba, wetland type and number have changed over time due to agricultural draining and filling and such change may have affected numbers of pairs settling in the recent period. However, at the Erickson and Minnedosa sites, wetland loss between the 1970s and 2000s has been minimal and most of the ponds lost have been small, temporary, and not usually used by grebes. Thus, wetland loss on my study areas was not considered to be a significant factor explaining grebe population change. Moreover, macrohabitat conditions in almost all years, across the two study periods, appeared favourable for breeding grebes (i.e., wet). Microhabitat conditions (e.g., emergent vegetation configuration and width) may have changed, but such analysis is beyond the scope of this study and was not done. However, Horned Grebes at both sites were recorded on the same size and class of wetland as in the past suggesting that habitat conditions still may be adequate for this species. At Minnedosa, differences between observers and methodologies could have confounded the comparison. I have attempted to reduce biases there by duplicating study area and observational techniques, and applying correction factors where necessary.

Suggested reasons for the continental and local declines of Horned Grebe populations include pesticide contamination, oiling on marine wintering areas, ingestion of plastics, and breeding habitat degradation; but there are no definitive answers (Stedman 2000). In southwestern Manitoba, the arrival of Raccoon (*Procyon lotor*) at Minnedosa and Erickson in the mid-1950s and 1960s, respectively (Stoudt 1982; Hammell 2011), may have had negative effects on Horned Grebe reproduction but Raccoons are significant predators of Red-necked Grebe nests as well (Ferguson and Sealy 1983; De Smet 1987). Red-necked Grebes are larger than Horned Grebes (males: red-necked 1330.9 ± 192.9 g, n = 15; horned range 320–515 g, n = 13; Stout and Nuechterlein 1999; Stedman 2000) and exhibit interspecific aggression towards most waterbirds entering their territory (Stout and Nuechterlein 1999; personal observation). Accordingly, the increase in Red-necked Grebe populations may have restricted Horned Grebe breeding pairs from preferred habitat, forcing settlement elsewhere. I have little evidence of direct aggression to Horned Grebes because the two species were rarely seen together and when they were, Horned Grebes kept their distance from Red-necked Grebes. I did however observe Red-necked Grebes continually chasing a Horned Grebe pair on one study lake in late spring; the Horned Grebe pair had left by next survey.

At Erickson, Red-necked Grebes demonstrated strong annual fidelity to wetlands, and 57% of 14 ponds with Horned Grebe pairs for at least one year (present for two or more counts) during 1970–1972 are now occupied most or every year by Red-necked Grebes (5.66 ± 3.02 ha, 2.2–9.4, *n* = 8). At Minnedosa, 47% of 35 ponds with a recorded Red-necked Grebe pair for at least one of the years during 2009–2015 are within the Horned Grebe preferred size of less than 2 ha (1.38 ± 0.48 ha, 0.5–1.9, *n* = 17). Red-necked Grebe wetland fidelity was lower at Minnedosa than at Erickson and may have reflected the use of smaller wetlands at Minnedosa (mean 5.1 versus 2.1 ha, respectively) which may not provide adequate resources to attract this species every year. Red-necked Grebes usually occupy wetlands greater than 2 ha in the southern part of their range (Riske 1976 as cited in Stout and Nuechterlein 1999; De Smet 1983 as cited in Stout and Nuechterlein 1999) but Fournier and Hines (1998) reported that, although median pond size used by Red-necked Grebes in Northwest Territories was 2.4 ha (3.7 ± 0.2 ha SE, 0.1–18.2, *n* = 110), a few pairs did occupy very small wetlands when surrounded by adjacent wetlands (seven of 110 ponds used were less than 0.3 ha). Similarly, in high wetland-dense Minnedosa habitat, Red-necked Grebes are occupying small wetlands and possibly excluding Horned Grebes. Horned Grebes are never found on smaller wetlands occupied by Red-necked Grebes, but they can occur together on larger ones (greater than 11 ha; personal observation; M. Fournier, personal communication).

In addition, Pied-billed Grebes (*Podilymbus podiceps*) are territorial and very aggressive and may be increasing in southern Manitoba (Manitoba prairie-potholes long-term trend 1970–2015 yearly % change: +1.91, BBS data; Environment and Climate Change Canada 2017). Average annual Pied-billed Grebe abundance on BBS routes in southern Manitoba during 2000–2015 is almost double that from 1970–1979 (1.13 ± 0.19 versus 0.64 ± 0.07, respectively; unpublished analysis from Environment and Climate Change Canada 2017). Although similar in size to Horned Grebes (mass: 474.0 ± 60.6 g, 321–568, *n* = 36; Muller and Storer 1999), Pied-billed Grebes are known to replace Horned Grebes on breeding ponds and may contribute to a reduced local breeding population as well (Faaborg 1976; Osnas 2003). Horned Grebes arriving on a local pond in the spring will stay and raise a brood if not disturbed but are often attacked continually by Pied-billed Grebes; the Pied-bill Grebe pair then nests after the Horned Grebes abandon the pond (H. Proven, personnel communication).

A comparison of the number of estimated pairs of Pied-billed Grebe on the Erickson site in the 1970s and 2000s also suggests an increase in the recent period; this increase was most notably on three smaller wetlands (0.7 ± 0.15 ha, 0.6–0.7) not used by Red-necked Grebes that were regularly used by Horned Grebes during 1970–1972 (unpublished data). However, sample sizes are very small and Pied-billed Grebes are extremely furtive and difficult to observe on larger wetlands resulting in some unknown degree of pair underestimation. Thus, my Pied-billed Grebe data for the Erickson site has low reliability and should be viewed with caution.

Nonetheless, all of the above suggests that Horned Grebes may be facing increased competition and territorial aggression from Red-necked Grebes and Pied-billed Grebes. Reduced Horned Grebe recruitment over many years resulting from Horned Grebe exclusion from larger and smaller wetlands by Red-necked Grebes and Pied-billed Grebes, respectively, could produce low breeding pair return rates that might explain the low density of Horned Grebes at Erickson now. Obviously, other factors occurring on or off the breeding grounds may be responsible for the decline.

Reasons for the marked increase in Red-necked Grebes in southwestern Manitoba are unclear, but change in environmental contaminant uptake may be important. Red-necked Grebes, positioned near the top of the aquatic food chain, ingest large amounts of contaminants (organochlorides, mercury, and other heavy metals) that are often found in adults, eggs, and young (Stout and Nuechterlein 1999). These contaminants are thought to have caused eggshell-thinning, unviable eggs, and high mortality at hatch leading to reduced productivity (southwest Manitoba, 1980–1981: De Smet 1987; central Alberta, 1970–1976: Riske 1976 as cited in Stout and Nuechterlein 1999). Reduction in the release of these toxins into the environment began in the mid-1970s (e.g., DDT banned in 1972 in Canada; Forsyth *et al.* 1994) and Red-necked Grebe eggs collected during 1982–1986 in Manitoba and Saskatchewan, showed a slight decline in mean organochloride residues compared to those from Manitoba collected in 1981 and Wisconsin collected in 1970 (De Smet 1987; Forsyth *et al.* 1994). To my knowledge, more recent Red-necked Grebe data have not been published. Red-necked Grebes from Manitoba are thought to winter primarily along the eastern coast of North America and accumulate contaminants during this period of their life cycle (Forsyth *et al.* 1994). Recent studies of avian species that inhabit the same marine habitats as Red-necked Grebes for some or all of their yearly cycle have shown thicker eggshells (Common Murre [*Uria aalge*]), reduced contaminant levels (Northern Gannet [*Morus bassanus*], Double-crested Cormorant [*Phalacrocorax auritus*], Atlantic Puffin [*Fratercula arctica*], Leach's Storm Petrel [*Oceanodroma leucorhoa*]), and improved reproductive performance (Northern Gannet) compared to historical observations (Pearce *et al.* 1989; Rail *et al.* 2013; Pirie-Hay and Bond 2014). These results are consistent with a reduction of contaminants in the marine environment and reduced uptake by birds, including Red-necked Grebes. If Red-necked Grebe breeding success was low due to ingested contaminants during the period prior to the 1980s, and success improved more recently due to a reduction of the contaminant load in their environment, then the resultant increase in juvenile recruitment and need for additional breeding habitat might produce the observed increases in breeding pairs noted at Erickson and Minnedosa.

In conclusion, this study indicates that a change in Horned Grebe and Red-necked Grebe breeding populations has occurred in southwestern Manitoba over the last four decades. Reasons for these observed changes are unresolved. More current data on contaminant levels in grebes in southwestern Manitoba, and changes in population and contaminant levels in other prairie-parkland areas where historical data exist should prove valuable (Riske 1976 as cited in Stout and Nuechterlein 1999; Sugden 1977; Forsyth *et al*. 1994; Corrigan 2007). For example, current contaminant levels could be compared with levels from carcasses and egg shells from museum specimens. Other priorities include the need for surveys at the provincial, national, and continental levels to determine breeding and wintering population trends (Stout and Nuechterlein 1999; Stedman 2000).

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