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The State of Knowledge about Grizzly Bears (Kakenokuskwe osow Muskwa (Cree), *Ursus arctos*) in Northern Manitoba

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ABSTRACT. Grizzly bears have been observed with increasing frequency in northern Manitoba, Canada over the last four decades (1980–2020), likely originating from the established population in Nunavut and the Northwest Territories. We summarize and present an interdisciplinary synthesis of documented observations of grizzly bears in northern Manitoba from historical records from the Hudson's Bay Company Archives, published literature, direct observations, remote camera observations, government agency reports, the first author's field notes, volunteered observations, and media and social media reports. A total of 160 observations were recorded, 140 of them since 1980. Spatially, these observations all fall within the Southern Arctic, Hudson Plains, and Taiga Shield ecozones within Manitoba and span from the northern limit of Manitoba at the Nunavut border to the south shore of the Nelson River. Grizzly bears were historically present in northern Manitoba prior to 1980, though in very low numbers, but the frequency of observations has increased significantly since then. Most observations (86%) were less than 1 km from the Hudson Bay coast. Grizzly bears appear to select for open habitats and against forested ones. Reported observations, however, have been largely opportunistic, and the geographical distribution of observer efforts was uneven, so our data likely contain spatial and temporal biases. All confirmed observations were of single bears, suggesting that the present population is likely maintained by dispersal from the population to the north. Understanding grizzly bear ecology, distribution, and demographics north and west of Churchill will be critical for more accurately assessing the status and conservation needs of grizzly bears in the province.

Key words: grizzly bear; Hudson's Bay Company; interdisciplinary; Manitoba; resource selection function; *Ursus arctos*

RÉSUMÉ. Au cours des quatre dernières décennies (1980–2020), de plus en plus de grizzlis ont été observés dans le nord du Manitoba, au Canada, vraisemblablement en provenance de la population établie au Nunavut et dans les Territoires du Nord-Ouest. Nous résumons et présentons une synthèse interdisciplinaire d'observations documentées de grizzlis dans le nord du Manitoba à partir de dossiers historiques des archives de la Compagnie de la Baie d'Hudson, d'ouvrages publiés, d'observations directes, d'observations en provenance de caméras à distance, de rapports d'organismes gouvernementaux, de notes prises sur le terrain par les principaux auteurs, d'observations participatives ainsi que de signalements prélevés dans les médias et les médias sociaux. Dans l'ensemble, 160 observations ont été consignées, dont 140 depuis 1980. Du point de vue géographique, ces observations ont toutes été faites dans les écozones du sud de l'Arctique, des plaines hudsoniennes et de la taïga du Bouclier du Manitoba, allant de la limite nord du Manitoba à la frontière du Nunavut jusqu'à la rive sud du fleuve Nelson. Les grizzlis étaient présents dans le nord du Manitoba avant 1980, bien qu'en très petits nombres, mais la fréquence des observations s'est accrue considérablement depuis cette époque. La plupart des observations (86 %) ont été faites à moins d'un kilomètre de la côte de la baie d'Hudson. Les grizzlis semblent opter pour les habitats ouverts au détriment des habitats forestiers. Cependant, les observations signalées sont largement opportunistes et la répartition géographique des efforts des

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observateurs n'était pas égale, ce qui signifie que nos données sont vraisemblablement empreintes d'un biais spatial et d'un biais temporel. Toutes les observations confirmées se rapportaient à des ours seuls, ce qui suggère que la présente population découle probablement de la dispersion de la population du Nord. La compréhension de l'écologie, de la répartition et de la démographie des grizzlis au nord et à l'ouest de Churchill jouera un rôle critique dans l'évaluation plus précise de l'état des grizzlis et de leurs besoins en conservation au sein de la province.

Mots clés : grizzli; Compagnie de la Baie d'Hudson; interdisciplinaire; Manitoba; fonction de sélection des ressources; *Ursus arctos*

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INTRODUCTION

Grizzly bears (*Ursus arctos*) have a circumpolar distribution and are commonly found in mountain, tundra, and boreal forest environments (Schwartz et al., 2003; McLellan et al., 2017). In the Canadian Arctic their range appears to have increased in recent decades (Doupe et al., 2007; COSEWIC, 2012; Fawcett et al., 2018). While this is popularly described as a recent unidirectional change (e.g., Struzik, 2015), which it may be, the historical distribution of grizzly bears in the Canadian Arctic and sub-Arctic is not well understood and some authors have suggested that it may have expanded and contracted previously (Banfield, 1959; Harington et al., 1962).

In northern Manitoba, grizzly bears have been observed with increasing frequency over the past four decades, particularly within Wapusk National Park (WNP) (Clark, 2000; Dubois and Monson, 2004; Rockwell et al., 2008; Clark et al., 2018; Barnas et al., 2020). Those bears most likely originated from established populations to the northwest in Nunavut and the Northwest Territories since there is no known source population to the south or directly west, and eastward is ocean (Clark, 2000). Little is known about the ecology or population status of this species in northern Manitoba. Indeed, many range maps do not even show this area as historical grizzly bear range (Banfield, 1977; Banci, 1991; Ross, 2002; McLellan et al., 2017), though one exception is the COSEWIC (2012:8) species status assessment. Earlier scientific literature documents their presence only in southern Manitoba before the species' apparent extirpation from the province in the early 1900s (Sutton, 1967). The only known literature mentioning grizzly bears from northern Manitoba indicates absence (Preble, 1902). During his fieldwork in 1900, Preble asked specifically about grizzly bears at Fort Churchill but said the local official in charge of the Fort "knew nothing of such a species" and concluded that "If this animal extends its range to the vicinity of Hudson Bay it must be very rare" (Preble, 1902:64). Dunning (1998:83) includes one trapper's observations of tracking grizzly bears northwest of Churchill and seeing occasional grizzly hides harvested by Inuit, but does not specify when, or whether those observations were in Manitoba or in adjacent Nunavut.

Similarly, the causes of recent grizzly range expansion across the Arctic are not known. While there may well be a causal linkage with a warming regional climate (e.g., Struzik, 2015), this link has not been established, nor have the proximate mechanisms for such effects been identified. Nonetheless, the establishment of grizzly bear populations in previously (or at least recently) unoccupied areas can have consequences for both northern communities that must coexist and cope with grizzly bears on the land and for wildlife managers who must navigate new situations where community concerns may become acute (Clark and Slocombe, 2011; Fawcett et al., 2018). In 2017, grizzly bears in western and northern Canada, represented as a single designated unit, were listed as a species of "special concern" under the federal *Species at Risk Act* (Government of Canada, 2002) and remain listed as extirpated under Manitoba's *Endangered Species and Ecosystems Act* (Government of Manitoba, 2022) since there is no evidence to date of an established breeding population in the province (Clark et al., 2018).

Given this dynamic situation, there are important pragmatic and scientific reasons for better understanding the state, drivers, and potential future of grizzly bear populations where they are establishing themselves across northern Canada. Our objective here is to contribute to that goal by synthesizing the current state of knowledge on grizzly bears in northern Manitoba. Specifically, we 1) examine historical fur trade data for information on relative abundance and distributions, 2) summarize recent sightings of grizzly bears (since 1980) reported in the primary literature, gray literature, and personal accounts, and 3) present a preliminary analysis on the relationship between geographic habitat features and recent grizzly bear sightings.

METHODS

Study Area

Our 191,000 km^2 study area (referred to here as "northern Manitoba") includes the Hudson Plains, Southern Arctic, and Taiga Shield terrestrial ecozones within the province of Manitoba (Fig. 1). The area represents a broad ecological transition zone from boreal forest to low Arctic tundra (Shilts et al., 1987; Brook, 2001; Jefferies et al., 2003). Hudson Bay has a dramatic effect on the climate and vegetation of the study area, which is characterized by long cold winters and short cool summers. Fire is

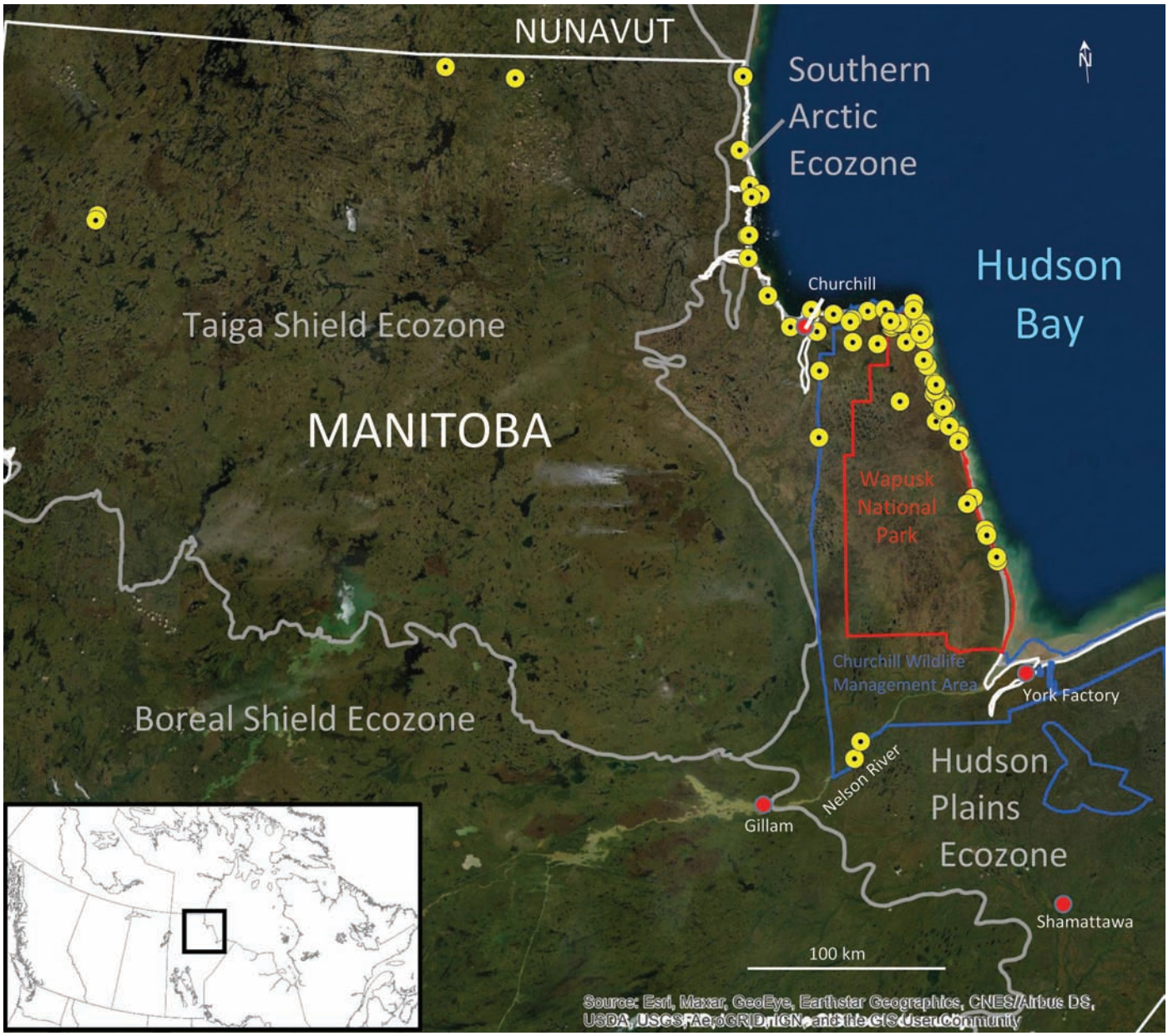

FIG. 1. All confirmed and spatially referenced grizzly bear occurrences in northern Manitoba (1980–2020, n = 133). Blue lines indicate provincial Wildlife Management Area boundaries, red line indicates Wapusk National Park boundary.

common throughout the treed areas (Richardson et al., 2007). Topography is generally flat (0–500 m above sea level), and the area is underlain by extensive continuous and discontinuous permafrost (Dredge and Nixon, 1992). The study area includes WNP and the Churchill Wildlife Management Area (CWMA). Diverse wildlife occupies the study area including the western Hudson Bay population of polar bears (*U. maritimus*) during the ice-free and winter maternity period, resident eastern migratory caribou (*Rangifer tarandus*) of the Cape Churchill and Penn Island populations, the winter range of the migratory Qamanirjuaq caribou herd, wolves (*Canis lupus*), moose (*Alces americanus*), and black bears (*U. americanus*) (Clark et al., 2018). Human density is very low at 0.19 individuals/km^2 in the study area and is concentrated in Gillam (1265 residents), Shamattawa (1019), Churchill (900), and the Fox Lake Cree Nation (500) (Statistics Canada, 2017a, b).

Types of Data

We aggregated and synthesized multiple types of observations from available sources known to all co-authors to quantitatively and qualitatively describe spatial and temporal trends in grizzly bear observations in northern Manitoba.

Historical Occurrence: Fur Trade Records: Fur trade records from northern Manitoba were used in a preliminary assessment of the historical status of grizzly bears in this area. Archival data on the Hudson's Bay Company (HBC) fur trade are available at the HBC Archives (HBCA) at

the Archives of Manitoba in Winnipeg. We compiled records of bear hides listed as "grey" (Elton, 1954) or "grizzle" for the Churchill, Nelson River, York Factory, and Severn posts. Our primary source of information was the District Fur Returns kept and compiled by the HBC's Northern Department headquarters at York Factory. Data on fur acquisitions are recorded by "outfit," which were recorded from 1 June of one year to 31 May of the next (outfit 1821 reported records from 1 June 1821 to 31 May 1822). Fur data was obtained in seven different files for the period from outfit 1821 to 1891, with some overlap in the different records (HBCA, 1842, 1846, 1860, 1869, 1875, 1892a, b). These fur trade records start with outfit 1821 (the year the HBC merged with its biggest rival, the Montreal-based North West Company) and include furs from all the various fur trade districts in the Northern Department, with districts ranging from Alberta to Ontario (Bumsted, 1999). We also compiled data for outfits 1901 to 1909 using fur packing accounts (HBCA, 1909) and fur books (HBCA, 1910) from the Churchill post (with incomplete coverage for all years and all posts; see Results). We are not aware of any archival materials that summarize HBC fur trade returns for outfits 1892 to 1900. The time period we consider in this initial assessment does not cover the entirety of the fur trade history in northern Manitoba, which extended from the late 1600s to the mid-1900s.

Incidental Observations of Grizzly Bears in Manitoba from Primary Sources: More recent grizzly bear observations by researchers and government personnel in northern Manitoba were incidental to other efforts, but nonetheless were often recorded because of their novelty (Clark, 2000; Rockwell et al., 2008). Grizzly bear observations were requested from past and present researchers operating in the area and known to the authors, Manitoba Conservation, the Canadian Wildlife Service's polar bear project, and Parks Canada. Information requested about each observation included data type (e.g., personal observation, camera trap images), date, location (with latitude and longitude coordinates if they were known), bear behaviour, observer, and data ownership. We included all known remote camera photos of grizzly bears from the first authors' own field research, the Hudson Bay Project, and Parks Canada. Following Laforge et al. (2017) and Clark et al. (2018), we considered all photos of a bear taken by any camera at the same site (many sites have more than one camera) within an hour of each other as a single bear observation. We also included observations made during the Hudson Bay Project's standardized waterfowl survey flights since the early 1970s, flown by helicopter at 100 m above ground level approximately 250 m inland from the coastline from Watson Point, east to Cape Churchill, and south to the Owl River. While primarily focussed on monitoring Lesser Snow Geese (*Anser caerulescens caerulescens*), all bear species encountered were typically recorded.

Documented Local Observations, Oral Histories, and Indigenous Knowledge: Although we did not conduct any systematic efforts to record oral histories or Indigenous knowledge, some such information has already been documented (e.g., Clark, 2000; Rockwell et al., 2008). A study of Cree place names (M'Lot, 2002) recorded numerous references to a range of wildlife species, but no references to grizzly bears were identified. However, the first author's field notes, journals, and email correspondence contain a number of first- and secondhand grizzly bear observations that community members voluntarily shared between 1997 and 2019, and these are included here.

Data Management and Analysis: All occurrences were categorized by data type and collated in an Excel spreadsheet. Observations were categorized as confirmed or unconfirmed based on whether any of the distinguishing physiognomic features of grizzly bears could be (or were) identified, including shoulder hump, concave face, or long forefoot claws. This distinction in observation type was made for consistent comparison with Clark (2000) and Rockwell et al. (2008), but oral history and first-hand observations that the recording author judged to be from reliable sources were also classified as confirmed observations. Similarly, locations of observations were categorized based on their precision as unknown, low (described with an imprecise but mappable reference to a known place, estimated to be within 1 km), or high (with geographical coordinates provided or a precise reference to a known place). The temporal trend in grizzly observations was examined using a linear regression with all occurrences pooled and the year they occurred. Maps were produced using ArcGIS Desktop 10.6 and show the confirmed observations with low and high location classes. Similarly, we only performed quantitative analyses on confirmed locations. We did not quantify observer effort, but its potential effect is discussed below.

We conducted a habitat selection analysis for all confirmed observations (1980 – 2020) using resource selection ratios (resource use/resource availability) and comparing used points (locatable grizzly bear observations, n = 133) and available points (locations randomly distributed throughout the study area, n = 500) (Manly et al., 2002) based on the formula:

$$w_i = o_i/\pi_i$$

where o_i is the proportion of the *i*th habitat variable at used sites, and π_i represents the proportion available of the covariate, as determined by randomly generated locations throughout the study area. Selection ratios (SR) for each habitat variable were compared using Bonferroni-corrected confidence intervals for multiple comparisons (Manly et al., 2002). The threshold for selection is 1. If use of resource is greater than it is available (i.e., selection) then the SR is above 1. If the SR is less than 1, the category is used less than available (i.e., avoided), and if the SR = 1, the resource is used at the same proportion as it is available (i.e., neither selected nor avoided). Habitat analysis was based on 13 types defined within the study area in the 2015 land cover

TABLE 1. Records of grizzly ("grey" or "grizzle") bear hides secured by the Hudson's Bay Company (HBC) between 1821 and 1909 at the Nelson River, Churchill, and York Factory posts in northern Manitoba and at Fort Severn in northern Ontario.

Post	Outfits with data[1]	Grizzly bear records	Details
Severn	1821–91, 1900, 1904, 1908 (n = 74 outfits)	None	None available.
Nelson River	1821–45 (n = 25 outfits)	None	No longer recorded on ledgers post-1845.
Churchill	1821–91, 1902–08 (n = 78 outfits)	12 hides	One hide in outfit 1838, another ("grizzle large") in outfit 1839 (HBCA, 1840, 1842, 1846). Ten "grey bear" hides recorded in 1908, no further information available (HBCA, 1909).
York Factory	1821–91, 1901, 1904, 1909 (n = 74 outfits)	One hide	One "large grizzle" hide in outfit 1836 (HBCA, 1842, 1846).

[1] An outfit is the time period around which the HBC structured its trade (https://www.gov.mb.ca/chc/archives/hbca/glossaries.html). Outfits ran from 1 June of one calendar year to 31 May of the next (e.g., outfit 1821 ran from 1 June 1821 to 31 May 1822) (Archives of Manitoba).

map of Canada (Latifovic, 2019) that were reclassified to nine classes to remove extremely rare classes and aggregate others that were similar in nature.

RESULTS

Historical Occurrence: Fur Trade Records

The available fur trade record for the period 1821 to 1909 includes 13 "grey" or "grizzle" bear hides from the Churchill and York Factory posts, with almost all (n = 12) from Churchill. The HBC District Fur Returns (HBCA, 1842, 1846, 1860, 1869, 1875, 1892a, b) include data on grizzly bear hides secured for the period 1821 to 1891 for fur trade posts and districts from Alberta to northern Ontario. Data from northern Manitoba are available in return data for the Nelson River, Churchill, and York Factory posts, and we also examined data from Fort Severn in northern Ontario. The Churchill packing account for outfits 1901–09 (HBCA, 1909) and fur book for 1903–10 (but the record ends in 1909) (HBCA, 1910) provide some additional data for Severn, Churchill, and York Factory, with variable coverage for the different posts (Table 1).

Data for the Severn post were available for outfits 1821–91, 1900, 1904, and 1908 (n = 74 outfits), with no "grey" or "grizzle" bear hides recorded. Similarly, no such bears were recorded from Nelson River for the outfits 1821 to 1845 (n = 25) (no data recorded in the ledgers for subsequent outfits). Churchill data were available for outfits 1821–91 and 1902–08 (n = 78 outfits), and coverage for York Factory included outfits 1821–91, 1901, 1904, and 1909 (n = 74 outfits) (Table 1). Three grizzly bear hides were secured by the HBC in Churchill and York Factory in the mid- to late 1830s: one "large grizzle" at York Factory in outfit 1836, and one each in outfits 1838 and 1839 at Churchill (HBCA, 1842, 1846). The outfit 1839 Churchill record (a "grizzle large") was also included in the Churchill general account book for outfit 1839 (HBCA, 1840) (no account book is available for outfit 1838). No other details are available. These three grizzly bear hides were secured in a four-year period from outfit 1836 (1 June 1836–31 May 1837) to outfit 1839 (1 June 1839–31 May 1840). No other grizzly bear hides were recorded in the District Fur Returns for these posts, despite a continuous record spanning a further 50+ years for Churchill and York Factory. There is a gap in the available fur trade record following the end of the District Fur Returns series (HBCA, 1842, 1846, 1860, 1869, 1875, 1892a, b) in outfit 1891. Some limited data for the trading posts of interest are reported in Churchill fur account files from the early 1900s (HBCA, 1909, 1910). These records show 10 "grey bear" hides procured at Churchill in outfit 1908 (HBCA, 1909). No additional details were reported, so these hides might have been procured outside northern Manitoba.

Observations since 1980

A total of 160 observations of grizzly bears were documented since 1980 and these occurrences increased significantly between 1980 and 2020 ($R^2 = 0.60$, df = 40, $p < 0.001$). These include 149 confirmed observations and 11 unconfirmed (mostly secondhand), with 133 (89.3%) of the confirmed observations having precise dates (Tables 2 and 3). The low number of observations in 2020 was due to a reduction in fieldwork because of COVID-19. Only one observation was of a female with cubs; otherwise, there have been no recently documented observations of grizzly bears breeding in northern Manitoba. That observation is considered unconfirmed because the presence of breeding within the province would trigger a review of the species' status (Clark et al., 2018) so confirming such observations requires the highest standards of proof. Although the observer was unquestionably experienced, this observation lacked important details, and no photos were taken. Two grizzly bears have been documented as shot, and two have been relocated by Manitoba Conservation to ameliorate conflicts with people; all four of these bears were adult males.

Grizzly bears have primarily been observed in the Hudson Plains and Southern Arctic ecozones, while no observations in the Boreal Shield zone were recorded (Fig. 1). Observations of grizzly bears have increased rapidly across northern Manitoba since 1980, with significant geographic spread south and west from the locations of the earliest observations. Most observations have been within

TABLE 2. Summary of grizzly bear observations in northern Manitoba from 1980 to 2020, by type. Some observations were categorized as more than one type, so the column numbers sum to greater than the total number of observations.

Observation type	Number
1. Documented direct observations (with photos or field notes by the observer)	77
2. Remote camera observations (may be > 1 photo)	50
3. Bear observation and incident reports from Parks Canada or Manitoba Conservation[1]	4
4. Local observations voluntarily shared with the first author and described in dated field notes	25
5. Local observations recalled and voluntarily shared during preparation of this report	3
6. Media reports and social media	3
7. Observations published in peer-reviewed and grey literature	2
8. Archival sources	13

[1] Only confirmed observations were provided by these agencies.

TABLE 3. Distribution of all confirmed and locatable grizzly bear occurrences temporally by decade (1980–2020) and spatially by ecozone.

Decade	Southern Arctic	Taiga Shield	Hudson Plains	Boreal Shield	Total
1980–89	1	0	1	0	2
1990–99	2	0	3	0	5
2000–09	4	1	13	0	18
2010–19	3	3	97	0	103
2020	2	1	2	0	5
Total	12	5	116	0	133

1 km of the Hudson Bay coast, with a mean distance from the coast of 11 km, minimum of 0 km, modal distance of 0 km, and maximum of 352 km. The increase in frequency of observations in the Hudson Plains ecozone by decade is revealing, with observations more than doubling every decade since the 1980s (Table 3). That trend holds even when subtracting the 49 remote camera observations from the most recent decade's total, which make up 50% of observations. All confirmed observations took place between 13 April and 16 September. Grizzly bears were observed each month between April and September, with the greatest proportion of observations occurring in June (54/117, 46%), July (31/117, 26%), and August (18/117, 15%) (Table 4). Limitations and potential biases of these observations may influence our interpretations, discussed below.

Documented Oral Histories and Indigenous Knowledge

There is a Swampy Cree name for grizzly bears, taught to the first author in York Landing, Manitoba: "Kakenokuskwe osow Muskwa" ("brown bear with long claws," underlining in original notes to denote syllable emphasis; D. Clark field notes, 15 September 1998). A York Landing resident shared that his mother-in-law remembered her elders talking about grizzly bears, called "humpbacked bear", which were found to the north (D. Clark field notes, 15 September 1998). One lifelong Churchill resident said her "mother-in-law said they used to see & shoot grizzly bears in the '50s & '60s - FN [First Nation] people said, 'nothing new when we started seeing them, thought it was a lot of fuss about nothing.'" (D. Clark field notes, 5 October 2015, underlining in original notes). In other words, recent observations of grizzly bears by wildlife managers and scientists are in agreement with what Indigenous people already knew.

Habitat Use

Habitat selection associated with the mapped grizzly bear locations (n = 133) in the study area indicated that the bears primarily selected for unvegetated habitats (primarily the Hudson Bay intra- and supra-tidal zone; SR = 7.6), barren lands (relict gravel and sand beach ridges, SR = 2.5), lichen moss tundra (SR = 1.9), water (SR = 1.7) although we believe this is an artifact rather than active selection, and coastal wetlands (SR = 1.3) (Fig. 2). These observations indicate selection against three habitats, all with trees of various types and densities, including forest-tundra (SR = 0.6), mixed forest (SR = 0.4), and spruce forest (SR = 0.08), though data limitations and potential biases may influence these interpretations and are discussed further below. Only one habitat was neither selected nor avoided: deciduous shrub (SR = 1.3).

DISCUSSION

Fur trade records and shared local and Indigenous knowledge corroborate one another and make a strong case for the historical presence of grizzly bears in the region. Based on observations to date, grizzly bears appear to have been historically present in very low numbers in northern Manitoba but have been observed markedly more often in the same three ecozones since the 1990s, especially near the Hudson Bay coast. It is possible that some grizzly bear

TABLE 4. Monthly frequency of confirmed and locatable grizzly bear observations where month was known, 1980–2020.

Month	Southern Arctic	Taiga Shield	Hudson Plains	Boreal Shield	Total
April	0	0	3	0	3
May	0	0	9	0	9
June	5	2	47	0	54
July	3	1	27	0	31
August	0	0	18	0	18
September	1	1	0	0	2
Total	9	4	104	0	117

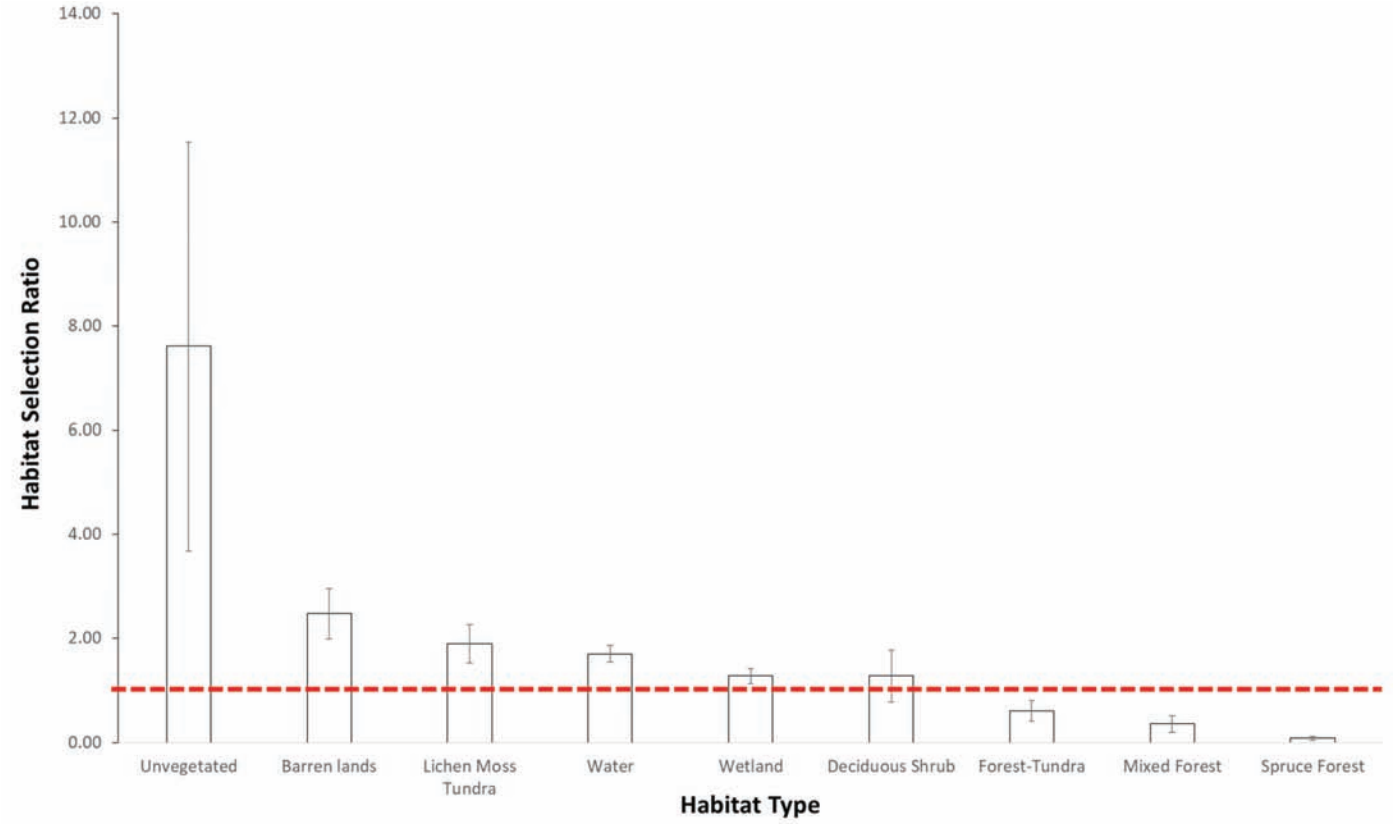

FIG. 2. Habitat selection associated with spring, summer, and fall pooled grizzly bear occurrences in northern Manitoba (1980–2020, n = 133) based on selection ratios (SR) and 95% Bonferroni-corrected confidence intervals. The red line represents an SR of 1. An SR − CI > 1 indicates that each habitat type is selected for. When SR ± CI overlaps with 1, the habitat type is neither selected for or against, and when the SR + CI < 1, the habitat type is used less than available, i.e., avoided.

hides received by the HBC may have been recorded as "brown" or "black" bears, so while these records of "grey" and "grizzle" bear hides indicate presence, they represent only the minimum number of grizzly bears incorporated into trade records.

Population Dynamics

Our data suggest an increase in grizzly use across our study area in recent years, though further research would be needed to confirm such an increase. Only one unconfirmed observation suggested breeding may be occurring. Consequently, inferences about population dynamics are limited since all recent confirmed observations of grizzly bears in Manitoba have been of lone animals, though certainly more than one over time. The maximum assumed life expectancy for barren-ground grizzly bears is 30 years (McLoughlin et al., 2002), so even though some individual bears have been observed more than once (Clark et al., 2018; Barnas et al., 2020), clearly not all observations here could have been of the same animal. Indeed, three publications document observations of more than one grizzly in the same year. Rockwell et al. (2008) saw two different and distinguishable bears in 2008. Clark et al.'s (2018) remote camera data clearly show a large mature male and a smaller-framed bear of undetermined sex (Fig. 3a, b, c). Barnas et al. (2020) observed two different grizzly bears in 2016, distinguishable by a pronounced facial scar on one. In 2018, when photos were exchanged with provincial conservation officers in Churchill, it was determined that a grizzly they had recently caught at Goose Creek was not one that had been seen on the remote cameras (D. Clark, pers. comm.

FIG. 3. Grizzly bear photographs taken in northern Manitoba: a–c) Grizzly bears traveling near permanent fenced camps in Wapusk National Park (photos: Douglas Clark); d) Grizzly at an observation tower, Wapusk National Park (photo: Parks Canada); e) A grizzly predating a Lesser Snow Goose nest, La Perouse Bay (photo: Andrew Barnas); f) A polar bear successfully defending a marine mammal carcass from an approaching grizzly bear, Kiask Island, 2013 (photo: Robert Rockwell).

2018). The muzzle scars on the captured bear did not match those in the photos of the bear with the prominent rostral scar noted in Barnas et al. (2020) either.

The population of grizzly bears in northern Manitoba has probably been established and maintained by the immigration of individual animals. Many observations

from in and around WNP are of mature males as well as smaller bears (which may be either subadults or adult females), consistent with an immigration-driven grizzly population. Given the very large home range of barren-ground grizzly bears in the central Canadian Arctic (> 6000 km^2, McLoughlin et al., 1999; Gau et al., 2004), the grizzly bears observed in northern Manitoba are very likely part of a larger continuous regional population whose boundaries are not known. McLellan and Hovey (2001) observed that grizzly bear emigration is typically driven by dispersal of subadult male bears, which typically disperse twice as far as females, and it is a multiyear process, not a single event. Since the likely direction of immigration is southeast out of Nunavut, understanding grizzly bear demographics northwest of Churchill, where there are currently very few observations and relatively little observer effort, will be critical for accurately understanding the status, trends, and population dynamics of grizzly bears in the province.

Grizzly bear population density in Manitoba cannot be estimated from our data, nor do the data yield insights into the proximate mechanisms driving apparent immigration from adjacent Nunavut. Efford et al. (2018) conducted a genetic mark-recapture density estimation for grizzly bears in the Kivalliq region, Nunavut, immediately north of the Manitoba border. They estimated 3.51 bears/1000 km^2, extrapolated to a population of 662 bears (95% CI 385 – 1135 bears). Their entire study area was within two of the ecozones, Taiga Shield and Southern Arctic, that extend into Manitoba and are occupied by grizzly bears. However, it is not known whether the same densities might be found in northern Manitoba and this question deserves further research.

Grizzly Bear Ecology

Seasonality and environmental fluctuation determine life history traits in grizzly bears (Ferguson and McLoughlin, 2000). Therefore, in the highly seasonal, variable, and generally low-productivity environment of northern Manitoba, it would be surprising if grizzly bears inhabiting it weren't efficient at locating the highest-quality food sources and denning sites across the large area in which they have been observed. The grizzly bears observed usually appeared in good shape physically, though body condition was not quantified or assessed systematically. Only two observed or reported bears appeared to be in poor condition: the adult male relocated from Churchill in 2018 and the apparent subadult seen associated with a den within WNP near Carey Lake in 2013, which appeared lean to the two experienced local observers. That sighting is the only direct evidence of denning that has been observed in Manitoba. The two observations in mid-April are considerably earlier than the average date of den emergence in the central Canadian Arctic, which is typically late April for males and early May for females (McLoughlin et al., 2002). McLoughlin et al. (2002) also found that grizzly bears in their study area typically entered dens in the second half of October. Nagy et al. (1983) observed similar emergence dates in the western Arctic but den entry in early October. Selection for denning habitat could influence grizzly bear distribution in autumn, but this cannot be assessed without knowing more about what habitats and site attributes they actually use for dens in this region. The one apparent den observation was in an area underlain by peat, which is abundant in the Hudson Plains ecozone. Nagy et al. (1983) documented grizzly bears denning in a peat bank and even using snow dens in the western Arctic, similar to what pregnant female polar bears do in our study area (Clark et al., 1997; Scott and Stirling, 2002; Richardson et al., 2005). However, McLoughlin et al. (2002) found that grizzly bears sought out well-drained esker, heath tundra, and spruce forest habitats for denning. These habitats are also abundant in northern Manitoba but especially inland, west of the Hudson Bay Railway (Dredge and Nixon, 1992).

Since none of the observations in our study are after mid-September, there is likely at least a month's time when grizzly bears remain active but have not been recorded in Manitoba. This lack of observations should not be taken to indicate that they are not present in Manitoba during that time or do not den in the province, although some may not. It is notable that the Canadian Wildlife Service's polar bear biologists confirmed that they have not yet seen a grizzly bear during their extensive helicopter-based fieldwork throughout WNP and the CWMA from late August through September, which occurred annually since the 1970s. The grizzly bear observation that occurred latest in the year from that specific area was 25 August. Consequently, although this particular lack of observations doesn't prove that grizzly bears were absent from that area in autumn, it is suggestive and also consistent with remote camera data, which are collected year-round (Clark et al., 2018).

Most observations took place in spring and summer, on or very near the Hudson Bay coast (Fig. 1). Coasts provide a diversity of food resources, both observed and potential. Grizzly bears are generalist omnivores (Coogan et al., 2014) but observations of specific food resources being consumed by grizzly bears in northern Manitoba are limited. The most comprehensive are Barnas et al.'s (2020) 24 observations of Lesser Snow Goose and Common Eider (*Somateria mollissima*) nest predation in WNP (Fig. 2e). In years when both grizzly and polar bears were detected feeding on nests in waterfowl colonies, grizzly bears were detected earlier in the year than polar bears. This finding indicates that grizzly bears are making use of waterfowl eggs as a food resource in coastal Manitoba and may have implications for the use of terrestrial resources by polar bears. Two observations were of grizzly bears feeding on subadult polar bears but in those cases neither observer could conclusively determine whether the grizzly bears had killed them, though the details of one case strongly suggested so. Grizzly bears are known to have killed and consumed polar bears on the sea ice in the western Arctic (Taylor, 1995) and typically dominate polar bears when they interact on shore in Alaska (Miller et al., 2015). These two observations

contrast though with Rockwell's 2013 observation of an adult male polar bear successfully deterring an approaching grizzly that appeared attracted to an unidentifiable marine mammal carcass the polar bear was standing on (Fig. 2f). One observation was made of a grizzly eating a beluga whale (*Delphinapteras leucas*) carcass. Ballard et al. (1993) mentioned beluga carcass–scavenging in Kotzebue Sound, Alaska, but did not provide any details. Similarly, Edwards et al. (2011) speculated about the potential for marine mammal use by grizzly bears in the Mackenzie Delta but found no evidence of it.

As noted by Rockwell et al. (2008) and Barnas et al. (2020), potential food sources for grizzly bears in northern Manitoba include caribou, moose, marine mammal carcasses, black bears, berries such as *Vaccinium uliginosum* (Clark, 2018) and *V. vitis-idaea*, *Hedysarum* sp. (Johnson et al., 1987), and beaver (*Castor canadensis*). Other potential foods include Arctic ground squirrels (*Spermophilus parryi*) north of the Seal River (Wrigley, 1974), ringed seals (*Pusa hispida*), as documented in the Western Arctic (Ross, 2002), or even harbour seals (*Phoca vitulina*), which may be even more accessible in the ice-free period since they have increased in abundance in the study area (Florko et al., 2018). Fish are present in creeks near where grizzly bears have been observed (Rockwell et al., 2008) but have not been observed being eaten by grizzly bears. They are unlikely to be eaten unless caught opportunistically in shallow water; for example, as with polar bears eating pike (*Esox lucius*) (Gormezano, 2017). Spawning Arctic char (*Salvelinus alpinus*) or sea-run brook trout (*S. fontinalis*) are also possible food sources in coastal Manitoba.

Rockwell et al. (2008) cited a traditional knowledge interview conducted with York Factory Cree Nation Elder Flora Beardy who identified Thompson Point as an area traditionally used for berry picking. Productive berry crops could explain the preponderance of grizzly observations at Thompson Point, but the extended timing of bear observations (June–August) does not suggest a seasonal focus on berries. However, these observations (from goose-banding flights, wildlife surveys, and remote cameras placed seasonally for studying nest predation) were likely not optimal for observing bears during "peak" berry season from August through September (D. Clark, unpubl. observ.) so any such focus by grizzly bears may not have been clear. Clark (1996) quantified berry production in the CWMA (including what is now WNP) and concluded it was much lower than areas where berry crops support bear populations. However, berry productivity may have increased in the 28 years since those measurements were recorded and should be reexamined (Clark, 2018).

Range and Habitat Use

Based on these observations, the range of grizzly bears in northern Manitoba appears to extend from the Nunavut border southward to the Nelson River and westward nearly to Saskatchewan. Most observations have been in the Hudson Plains and Southern Arctic ecozones, although it's not known whether the entire portions of the ecozones where grizzly bears have been observed are inhabited or even habitable by grizzly bears. If significant portions of those ecozones are occupied by grizzly bears, and assuming no significant changes in such availability or suitability due to human activity or climate warming, then grizzly bears could eventually inhabit a large area of the province and even northeastern Saskatchewan (COSEWIC, 2012). Similarly, establishment throughout the Hudson Plains ecozone could permit immigration into northern Ontario, though that ecozone narrows to a band along the coast and is therefore vulnerable to blockage by development or environmental change, potentially preventing immigration southeastward.

Most observations took place in spring and early summer, mainly in open habitat types, with the majority occurring along the Hudson Bay coast. Curiously though, grizzly bears have rarely been observed past August in this region (Table 4), even on remote cameras, which operate year-round at the three fenced camps in WNP that are no busier with people at that time of year. There are notably few observations from forested areas; even bears spotted in this habitat were seen in openings such as the Hudson Bay Railway or Nelson River. Since grizzly bears are commonly associated with open habitats (Herrero, 1985) and not typically with the non-mountainous boreal forest east of the Rocky Mountain foothills (Nielsen, 1975), it is not clear whether this absence is an artifact of biased observer effort, decreased grizzly sightability or detection associated with increasing canopy cover, or a real biological phenomenon.

Since barren-ground grizzly bears are highly mobile (Edwards et al., 2009), the observations we document may represent only part of a seasonal "round" between known food sources that peak at different times in different places—a strategy known for this species elsewhere (Munro et al., 2006; Nielsen et al., 2010). Speculatively, caribou, gut piles, and any wounded animals from hunters northwest of Churchill could be such a resource in autumn and this provisional hypothesis would be straightforward to test through telemetry-based research. Both September observations were in the area where caribou hunting occurs. Grizzly bear scavenging of hunter kills has been documented elsewhere and has implications for managing human-bear conflicts (Ruth et al., 2003; Haroldson et al., 2004). Grizzly bears in autumn may also be seeking denning locations outside the poorly drained habitats that dominate the Hudson Plains ecozone, though as noted above, those habitats are used for denning elsewhere so this potential explanation remains hypothetical.

Data Limitations

Taken together, our different data sources provide a consistent picture but individually they all possess limitations. First, there is a gap in the available fur trade

record following the end of the Northern Fur Returns series in outfit 1891 (HBCA, 1842, 1846, 1860, 1869, 1875, 1892a, b). Some limited data for the trading posts of interest are reported in Churchill fur account files from the early 1900s (HBCA, 1909, 1910). These records show 10 "grey bear" hides procured at Churchill in outfit 1908 (HBCA, 1909). No additional details were reported, and these hides may have been secured elsewhere (e.g., Inuit harvests from farther north). We note that these data, while a primary source of fur return information for this period, are only a subset of the overall archival material available for the time frame under consideration. Further archival research is needed, including of post journals and other fur trade accounting records. Missing, unaggregated, and uncatalogued data will pose challenges for such work, as will the lack of spatial resolution in some sources such as district reports that include parts of both Manitoba and Nunavut.

Second, observer and sampling efforts are spatially uneven across northern Manitoba since so much scientific research takes place in WNP and the CWMA, concentrating researchers and helicopter flights along the Hudson Bay coast during the summer. This heterogeneity very likely introduces some bias into the apparent spatial distribution of grizzly bear observations in the province, the implications of which we discuss further below.

Third, it is difficult to know how much of the increased frequency of observation is due to changes in observer effort over time, but it is probably much less of a data limitation than spatial bias. Clark (2000) and Rockwell et al. (2008) both noted that intensive helicopter-based field research in the WNP area began in the 1970s, predating most recent grizzly observations, and has continued since. Those authors judged it unlikely that grizzly bears would have been present in any significant number but not observed. Indeed, since those publications, in-person researcher effort has changed little. The introduction of remote cameras for wildlife research in WNP in 2010 has certainly yielded many more grizzly bear observations that would not have been made without them, but the other categories of observations still show an accelerating increase over time. Also, the trends in observations recorded here far outweigh any apparent trends in park visitation. Helicopter flights are common during the summer tourism season (June to September) and fall polar bear viewing season (October to November) for wildlife observation.

Fourth, recent observations of grizzly bears across all data types have generally been unambiguous and easily confirmable (e.g., high-quality photographs). Only 16.8% of observations were considered unconfirmed (27/160) and these tended to be secondhand reports or, more recently, situations where damage to cabins was ascribed to grizzly bears but the bear itself was not seen. Confusion between grizzly bears and brown-phase black bears is unlikely to have been significant, especially for earlier observations. Although Clark (2000) observed that brown-phase black bears were uncommon in northern Manitoba, they have since been documented on remote cameras at Owl River (Clark et al., 2018) and have appeared at the Churchill cottage community of Goose Creek annually since 2017 (M. Webb, unpubl. observ.). The first author has had many conversations about grizzly bears over several decades with experienced hunters, trappers, elders, pilots, park staff, guides, and researchers, and none have ever had or suggested any difficulty telling grizzly bears from brown-phase black bears. In open (mostly tundra) habitats where most observations have been made, the physiognomic differences are usually easy to observe. Moreover, a substantial number of those observers have prior experience identifying grizzly bears in other regions.

Research Needs and Recommendations

Significant gaps remain in our understanding of grizzly bear ecology in this region. From a species management and conservation perspective, the most important information needs about grizzly bears in northern Manitoba are 1) whether grizzly bears are breeding within the province, which would trigger a reassessment of the species' "extirpated" status under provincial legislation; 2) grizzly bear distribution and demographics, particularly inland from the Hudson Bay coast; 3) where grizzly bears are located between late August and when they enter dens; 4) what grizzly bears are feeding on and what habitats they select or avoid, especially in late summer and autumn when they are hyperphagic and preparing for hibernation; and 5) the specific denning habitats and site attributes that grizzly bears choose, as well as any broader landscape-scale patterns of den distribution.

Because grizzly bear populations have typically been studied where they are declining or stable, the factors that aid colonization and population establishment into largely new habitats—as opposed to just facilitating dispersal—are not well understood. Consequently, we recommend a multifaceted regional effort to fill these knowledge gaps that starts with a base of local and traditional knowledge, builds in mechanisms for local input and guidance, and employs multiple methods, especially non-invasive research techniques such as genetic sampling, remote cameras, and track transects (e.g., Service et al., 2014, 2020). Those methods lend themselves particularly well to community-based monitoring efforts since many local residents already have the requisite field skills. Oral history research should be a priority since it would provide greater detail and broader context than the field notes presented here. Such research would enable a fuller discussion of traditional and local knowledge about grizzly bears in a responsible and culturally appropriate manner (e.g., Battiste, 2008; Wilson, 2008; Chilisa, 2012). It would also be useful to learn more about hunting guides' observations from inland areas. That local knowledge can be systematically collected and validated through methods such as interviews, focus groups, and workshops (Clark et al., 2014), and would be a valuable complement to Indigenous and non-Indigenous oral history research.

Greater coordination between existing research efforts would also be beneficial. Specifically, this cooperation would involve coordinating and expanding existing remote camera deployments; expanding ongoing goose, polar bear, and caribou surveys; and systematically recording the coordinates of flight paths for all research flights, perhaps even incorporating tourism or industrial flight observations as well. More detailed habitat analysis would be beneficial, especially once more is learned about the species' occupancy of the ecozones in which it has been observed. If grizzly bears in northern Manitoba do have a seasonal round between habitats or jurisdictions, there may be transient grizzly bears in Manitoba as well as bears that den within the province. Studying the movements and reproductive status of individual bears—either with an extensive remote camera and DNA-sampling grid, telemetry, or multiple approaches—will be needed to determine whether this is the case. That information gap is probably the most urgent one to fill for foreseeable conservation and management decisions about grizzly bears in northern Manitoba.

CONCLUSIONS

The documented quantity of observations clearly shows that grizzly bears, while not commonplace, have become regular residents of northern Manitoba over a span of roughly four decades. Moreover, we were able to document the species' historical occurrence in Manitoba from multiple sources. While our diverse data contain spatial and temporal biases that must be borne in mind, they describe a coherent picture of increasing grizzly bear use of largely coastal habitats in northern Manitoba and suggest clear questions for further research in order to more fully understand this dynamic biological situation.

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