Draft Species Status Report for Peregrine Falcon

Falco peregrinus (anatum/tundrius complex)

Kilgavik (Inuinnaqtun)
Kijgavik (Siglitun)
Kirgavik (Ummarmiutun)
Tatsəa (Délı̨nę Got'ı̨ne)
Fenısęn (Shúhtaot'ı̨ne)
Fəsęne (K'ashógot'ı̨ne)
Tatsea (Tłı̨chǫ)
Chiniitrành (Gwich'ya Gwich'in)

IN THE NORTHWEST TERRITORIES

NORTHWEST TERRITORIES SPECIES AT RISK COMMITTEE

ASSESSMENT – TO BE DETERMINED

JUNE 2021

Species at Risk Committee status reports are working documents used in assigning the status of species suspected of being at risk in the Northwest Territories (NWT).

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The drafts of this report were prepared by Chris Shank under contract with the Government of the Northwest Territories, and edited by Michele Grabke and Mélanie Routh, NWT Species at Risk Secretariat.

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ABOUT THE SPECIES AT RISK COMMITTEE

The Species at Risk Committee was established under the *Species at Risk (NWT) Act*. It is an independent committee of experts responsible for assessing the biological status of species at risk in the NWT. The Committee uses the assessments to make recommendations on the listing of species at risk. The Committee uses objective biological criteria in its assessments and does not consider socio-economic factors. Assessments are based on species status reports that include the best available Indigenous knowledge, community knowledge, and scientific knowledge of the species. The status report is approved by the Committee before a species is assessed.

ABOUT THIS REPORT

This species status report is a comprehensive report that compiles and analyzes the best available information on the biological status of peregrine Falcon the NWT, as well as existing and potential threats and positive influences. Full guidelines for the preparation of species status reports, including a description of the review process, may be found at www.nwtspeciesatrisk.ca.

Government of Northwest Territories

Environment and Natural Resources, Government of the Northwest Territories, provides full administrative and financial support to the Species at Risk Committee.

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Executive Summary

Scientific Knowledge
About the Species

Taxonomy

Traditionally, there have been three recognized subspecies of Peregrine Falcons (*Falco peregrinus*), in North America. Peale's Peregrine Falcon (*F. p. pealei*) is found only along the coast of the Pacific Northwest. The Tundra Peregrine Falcon (*F. p. tundrius*) is found in tundra ecosystems from Alaska to Greenland. The Anatum, or American, Peregrine Falcon (*F. p. anatum*) includes all Peregrine Falcons in North America south of the tundra, except *pealei*. However, recent genetic investigations conclude that the *anatum* and *tundrius* subspecies are indistinguishable. Consequently, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) considers them as *anatum/tundrius*. The Northwest Territories Species at Risk Committee (SARC) previously considered Northwest Territories (NWT) Peregrine Falcons as *anatum/tundrius,* but have recently referred to them as only *F. peregrinus*. NWT Peregrine Falcons nesting in the taiga and those in the tundra can be considered as different ecotypes. Many ornithological authorities adhere to the original subspecies differentiation.

Description

The Peregrine Falcon is a medium- to large-sized Falcon roughly the size of a crow. Wings are long, narrow and pointed. Females are significantly larger than males with little overlap in size within populations. Adults have bluish-grey upperparts and a bold, black facial stripe extending down from the eye. Underparts are whitish, grey or buffy with variable amounts of striping and barring. Juveniles are dark brown with heavy streaking and blotches on the undersides.

Home Range

Peregrine Falcons vigorously defend an area from all intruders within approximately 200 m or more of the nest. Defense beyond that is less common and vigorous. The home range size during breeding varies widely with prey density. Based on limited data from elsewhere, NWT home ranges are assumed to be approximately 1000 km^2.

Diet

The diet of Peregrine Falcons consists largely of birds with the diversity in prey broadly reflecting availability. Along the Mackenzie River, Peregrine Falcons were found to be eating primarily shorebirds, diving ducks and songbirds.

Mortality and Reproduction

Adult Peregrine Falcons have an annual survival rate of 80-85% while juvenile mortality may be as high as 50%. Maximum lifespan is about 20 years and age at first reproduction (recruitment) in Peregrine Falcons at Rankin Inlet, Nunavut (NU) is 3-4 years. On average, Peregrine Falcons in the NWT lay 3.3 eggs and raise 2.4 young/successful pair.

Place

Distribution

The Peregrine Falcon is among the most widespread birds in the world. It is found on every continent, except Antarctica with a patchy distribution over all of North America. Peregrine Falcons are found throughout the NWT, but concentrated in cliff habitat close to water, particularly major rivers, and sparsely-treed, open landscapes. The home ranges of Peregrine Falcons are estimated to encompass about 13% of the NWT land area. More than 60% of known NWT Peregrine Falcon occurrences are above treeline. All NWT Peregrine Falcons undertake seasonal migrations primarily to Mexico, the Caribbean or Central and South America with the longest known movement being a linear distance of 11,969 km. Peregrine Falcons generally return to their natal area to breed. Peregrine Falcons do not build nests and most commonly lay eggs on ledges located on steep cliffs.

Habitat Preference

Breeding Peregrine Falcons show little or no large-scale habitat preferences and can be found in almost all ecological regions of the NWT. On a finer scale, breeding Peregrine Falcons show preferences for productive, sparsely treed landscapes located near water and south facing cliffs. However, cliff habitat is not an absolute requirement and Peregrine Falcons may nest on grassy ledges or on bare ground.

Population

Abundance

Based on a number of assumptions, the current number of adult Peregrine Falcons in the NWT is approximately 3500 – 7000 individuals.

Trends and Fluctuations

Peregrine Falcon populations worldwide crashed dramatically in the 1950s through the 1970s. By the mid-1960s it became clear that eggshells were thinner than usual leading to egg-breakage and reproductive failure. By 1971 it was established that dichlorodiphenyldichloroethylene (DDE), the metabolite of dichlorodiphenyltrichloroethane (DDT), was the cause of the egg-shell thinning. By the 1970s, Peregrine Falcons were extirpated east of the Rocky Mountains and south of the boreal forest, but declines were not as pronounced in northern populations. There are no reliable population estimates for NWT Peregrine Falcons prior to the DDT-induced decline. However, surveys at the time estimated a decline of 33 – 60%. Use of DDT was banned in the United States in 1972, phased out in Canada in the mid-1970s, and restricted worldwide in 2001. Pesticide levels have now declined to levels that they no longer have population-level consequences.

The proportion of known nest sites seen to be occupied is a common proxy for population abundance and increased dramatically from 1985 to about 2000 and subsequently plateaued.

The recovery of Peregrine Falcons in the NWT is most clearly illustrated by the Mackenzie Valley population which has been frequently surveyed since the mid-1960s. Number of occupied sites increased from nine in 1969 to 141 in 2010. The estimated number of young produced increased from 11 in 1969 to 202 in 2010.

The NWT Peregrine Falcon population currently is considered to be stable, or possibly slowly increasing.

Threats and Limiting Factors

Peregrine Falcons maintain a low population density, have relatively low reproductive rate and are high trophic level predators, all of which are characteristics associated with high extinction risk. However, the recent population growth of NWT Peregrine Falcons and the low likelihood of population-limiting threats suggest there is currently little risk to the species in the NWT.

Specific Threats

The concentrations of pesticides detected are currently not at a level that causes population effects. However, Peregrine Falcons are top predators, and biomagnification of newly developed chemicals may pose a future threat.

Peregrine Falcons are almost entirely predatory on other bird species, particularly shorebirds. Over the past 48 years, North American shorebird numbers declined by 39% while populations of waterfowl have increased by 56%. It is not known how this change in the Peregrine falcon's prey base has affected, or will affect, peregrine populations.

The most significant widespread threats of climate change to NWT Peregrine Falcons are a) its possible effect on prey availability as a result of temporal mismatches, b) on-going changes in habitat structure on the tundra, and c) increase in extreme weather events,

particularly heavy rainfalls causing nestling mortality and nest collapse. Nestling mortality from infestations of black flies and blowflies may be increasing, but the population effects remain uncertain. The human-related threats to NWT Peregrine Falcons (trapping, shooting, egg-collecting, industrial disturbance) are generally not at a scale likely to cause population-level effects.
Positive Influences
The warming climate allows earlier arrival at nest sites which might prove beneficial to NWT Peregrine Falcons since earlier breeding is correlated with high productivity in many birds. As well, climate change will likely provide the opportunity for Peregrine Falcons to extend their range northwards. Genetic diversity in Canadian Peregrine Falcons is currently higher than in historical populations. Broad genetic diversity helps a species adapt to a changing environment. Peregrine Falcons are protected through the Migratory Bird Convention, *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (WAPPRIITA) and are on the Convention on International Trade in Endangered Species (CITES) Appendix I which prohibits all international commercial trade in the species.

Technical Summary

Question	Scientific Knowledge
Population Trends	
Generation Time (average age of parents in the population) (indicate years, months, days, etc.).	At least eight years.
Number of mature individuals in the NWT (or give a range of estimates)	Unknown, but roughly estimated at 3,500 – 7,000.
Percent change in total number of mature individuals over the **last** 10 years or 3 generations (ca. 24 years)	Number of occupied territories in the Mackenzie Valley increased from 40 – 141 (250%) in the 25 years from 1985 – 2010.
Percent change in total number of mature individuals over the **next** 10 years or 3 generations (ca. 24 years)	Unknown, but expected to remain stable or possibly increase marginally.
Percent change in total of mature individuals over any 10 years or 3 generation period that includes **both the past and the future.**	Expected 0% change from 2010 – 2034.
If there is a decline in the number of mature individuals, is the decline likely to continue if nothing is done?	No declines in number of mature individuals over the past 35 years.

If there is a decline are the causes of the decline reversible?	Not applicable.
If there is a decline are the causes of the decline clearly understood?	Not applicable.
If there is a decline, have the causes of the decline been removed?	Not applicable.
If there are fluctuations or declines are they within, or outside of, natural cycles?	Not applicable.
Are there 'extreme fluctuations' (>1 order of magnitude) in number of mature individuals?	Uncertain. The DDT-induced crash of northern populations in the 1950s – 1970s has been estimated at 33 – 60%.
Distribution	
Estimated extent of occurrence in the NWT (in km²).	Approximately 1,122,267 km² for both sightings and nest site locations (= 95% of NWT land area). 1,042,287 km² for nest site locations only (= 88% of NWT land area).
Index of area of occupancy (IAO) in the NWT (in km²; based on 2x2 km grid).	163,780 km² (= 14% of NWT land area).
Number of extant locations[1] in the NWT.	Not applicable. IUCN Red List Guidelines indicate that when there is no serious plausible threat, one approach is not to use number of locations. There are no "serious plausible

[1] Extant location - The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a species is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.

	threats" currently threatening NWT Peregrine Falcons.
Is there a **continuing decline** in area, extent, and/or quality of habitat?	No, although increase in shrub cover in the tundra is changing habitat structure, with unknown consequences to tundra Peregrine Falcon populations.
Is there a **continuing decline** in number of locations, number of populations, extent of occupancy, and/or IAO?	No, numbers and distribution are stable or possibly increasing.
Are there 'extreme fluctuations' (>1 order of magnitude) in number of locations, extent of occupancy, and/or IAO?	No, numbers and distribution are stable or possibly increasing.
Is the total population 'severely fragmented' (most individuals found within small and isolated populations)?	No, Peregrine Falcons highly mobile.
Immigration from populations elsewhere	
Does the species exist elsewhere?	Yes. Peregrine Falcons are found in all Canadian provinces and territories except Prince Edward Island. The species is one of the most widespread birds in the world.
Status of the outside population(s)?	In 2012, the *anatum/tundrius* subspecies of Peregrine Falcon was listed as Special Concern on Schedule 1 of the federal *Species at Risk Act*. The subspecies was last re-assessed by the Committee on the Status of Endangered Wildlife in Canada in 2017 as Not at Risk (COSEWIC 2017). The legal status has not yet been updated.
Is immigration known or possible?	Yes. Peregrine Falcons are highly mobile and source populations are present.

Would immigrants be adapted to survive and reproduce in the NWT?	Yes. Peregrine Falcons have wide ecological amplitude and are adapted to many environments.
Is there enough good habitat for immigrants in the NWT?	Yes, but nest site locations may be limiting.
Is the NWT population self-sustaining or does it depend on immigration for long-term survival?	Yes, the NWT population is self-sustaining.
Threats and limiting factors	
Briefly summarize the threats and limiting factors, and indicate the magnitude and imminence for each.	1. The threat posed to Peregrine Falcons by DDT has largely dissipated at present. However, the development of potentially harmful new classes of chemicals, uncertainty about controls over hazardous substances on the Peregrine falcon's wintering ranges, and the species' demonstrated susceptibility to toxic chemicals all present a significant, if hypothetical, threat over the longer term. 2. The changing composition of the Peregrine falcon's avian prey base has apparently not affected populations to date suggesting NWT Peregrine Falcons may be effectively switching to alternative prey species. However, if avian declines continue, NWT Peregrines populations may be impacted. 3. The most significant widespread threats of climate change to NWT Peregrine Falcons are a) its possible effect on prey availability as a result of temporal mismatches, b) on-going changes in habitat structure (shrubification) in the tundra, c) increase in extreme weather events causing nestling mortality, d) permafrost melt and increased erosion leading to ground nest collapse, e) potential increase in ectoparasitism of nestlings. The population impacts of

	these potential threats are uncertain and are likely to unfold gradually. 4. The few human-related threats to NWT Peregrine Falcons are generally not at a scale likely to cause population level effects.
Positive influences	
Briefly summarize positive influences and indicate the magnitude and imminence for each.	Climate change may lead to more favourable conditions (e.g., longer breeding season) with range expansion and increased populations (potential for small population increases with slow increase in magnitude). Genetic diversity is higher than it was in historical populations and may help the species to adapt to a changing environment. Peregrine Falcons are protected through the Migratory Bird Convention, *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (WAPPRIITA) and are on the Convention on International Trade in Endangered Species (CITES) Appendix I.

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PLACE NAMES

The maps below (Figures 1 and 2) are intended to help provide context to readers who may be unfamiliar with the NWT geographic features and place names referred to in this status report.

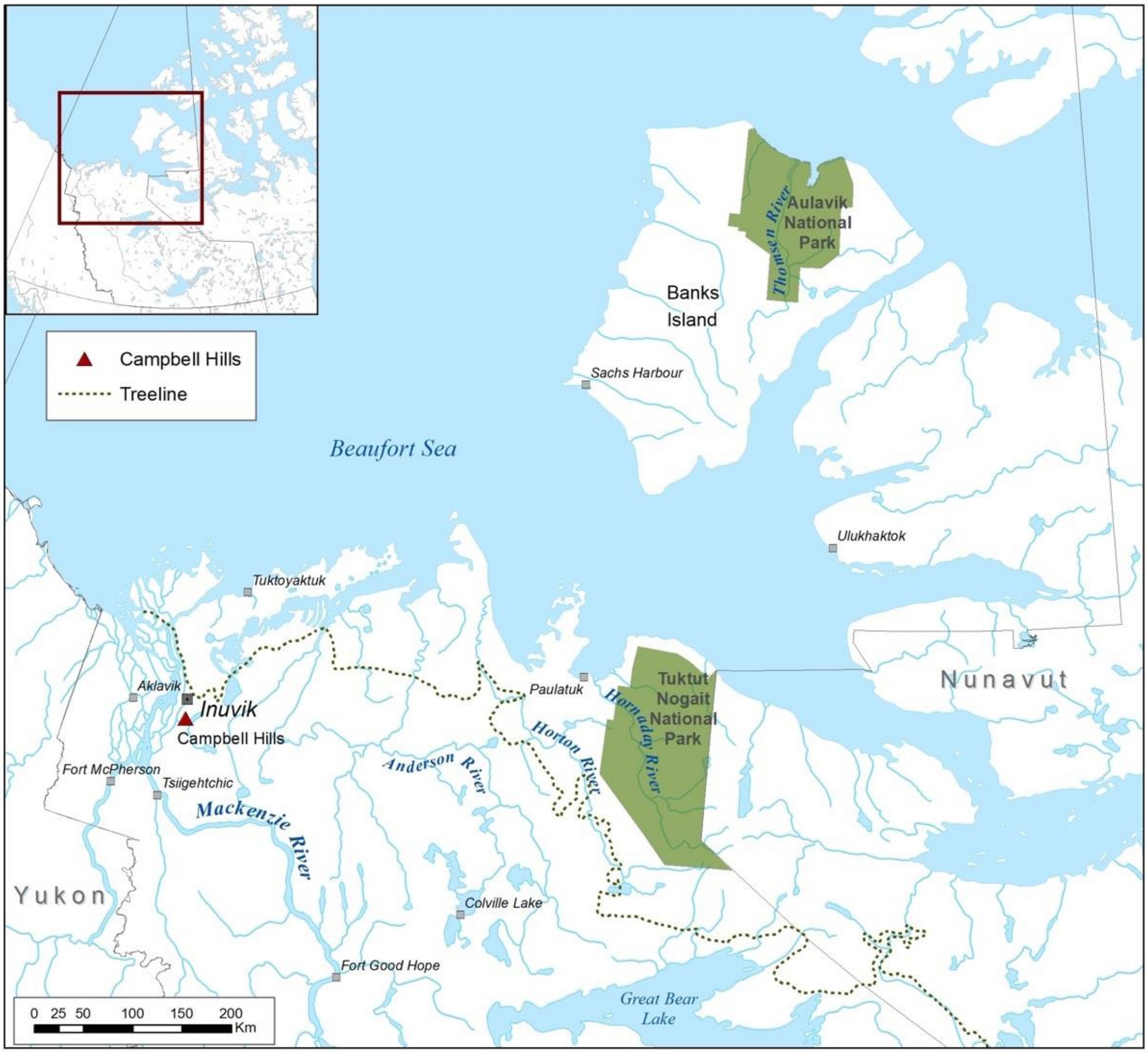

Figure 1. Place names and water bodies referred to in this status report that occur in the northern portion of the NWT. Map courtesy B. Fournier, Environment and Natural Resources (ENR).

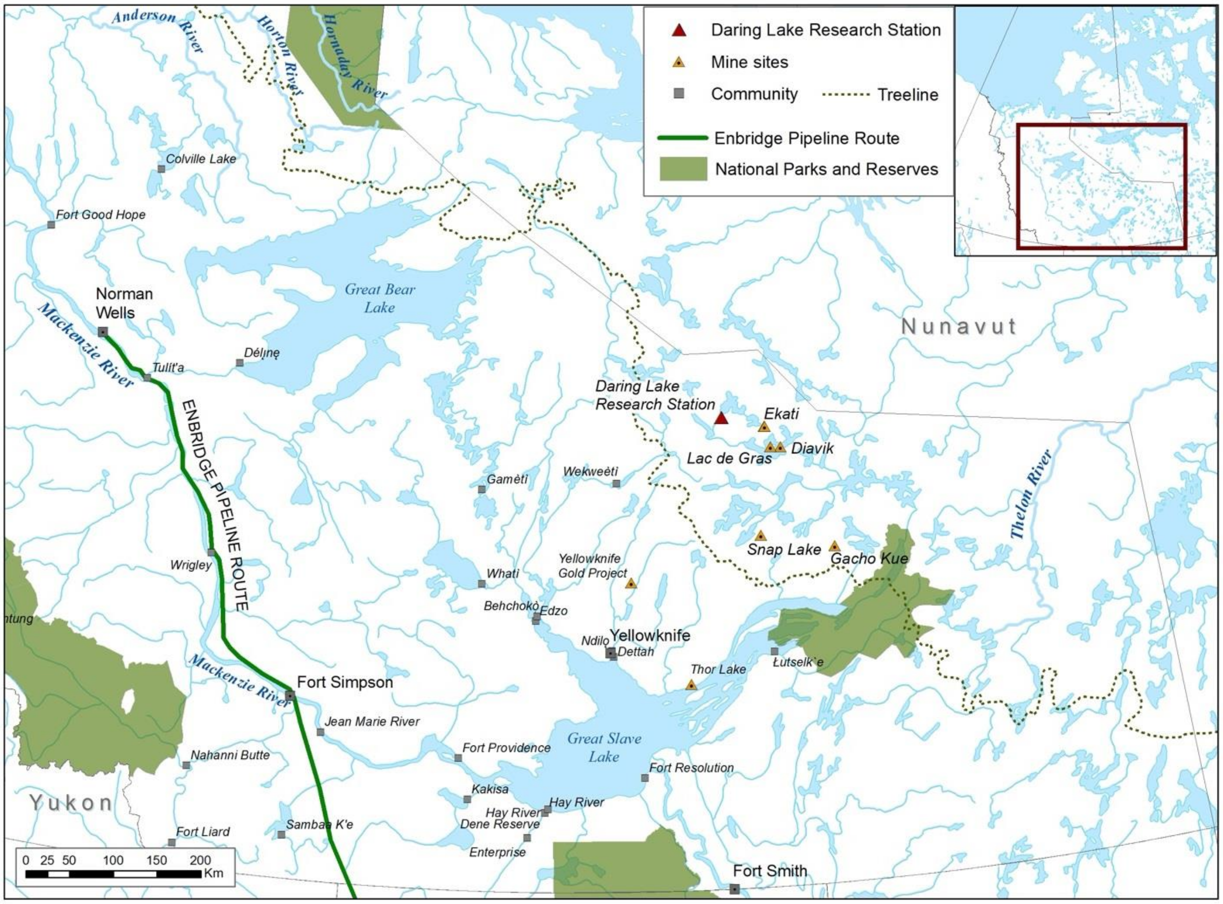

Figure 2. Place names and water bodies referred to in this status report that occur in the northern portion of the NWT. Map courtesy B. Fournier, ENR.

Preface

In the preparation of this report, an effort was made to find sources of Indigenous knowledge, community knowledge, and scientific knowledge. Unfortunately, there is little available documented Indigenous or community knowledge for Peregrine Falcon. Therefore, this report is based almost exclusively on scientific knowledge.

Preamble

Worldwide, Peregrine Falcons experienced a catastrophic decline in numbers in the 1950s through the 1970s as a result of reproductive failure caused by organochlorine pesticides, particularly dichlorodiphenyltrichloroethylene (DDT). Peregrine Falcons became totally or functionally extinct throughout large parts of their global range, although the numerical decline in the NWT was less dramatic than many other parts of North America. Following the ban on DDT, numbers of Peregrine Falcons began to show dramatic increases in the NWT and elsewhere. The recovery of the Peregrine Falcon is widely proclaimed as one of the conservation movement's greatest successes.

This report is intended to review the status of Peregrine Falcons in the NWT and provide the information necessary for SARC to evaluate the species' risk status. Since the 1970s, NWT Peregrine Falcon populations have been regularly monitored for numbers and reproductive status. However, there has been little detailed research on behaviour and ecology in the NWT. The most relevant research has been undertaken at Rankin Inlet, Nunavut and this report makes regular reference to findings made there.

ABOUT THE SPECIES

Names and Classification

Scientific Name:	*Falco peregrinus* (Tunstall, 1771)
Common Name (English):	Peregrine, Peregrine Falcon, Duck Hawk
Common Name (French):	Faucon pèlerin
Local Names:	
Inuinnaqtun:	Kilgavik (Species at Risk Secretariat 2012)
Siglitun:	Kijgavik (Species at Risk Secretariat 2012)
Ummarmiutun:	Kirgavik (Species at Risk Secretariat 2012
Délı̨nę Got'ı̨ne:	Tatsəa (Species at Risk Secretariat 2013)
Shúhtaot'ı̨ne:	Fenısę̨n (Species at Risk Secretariat 2013)
K'ashógot'ı̨ne:	Fəsę̨ne (Species at Risk Secretariat 2013)
Tłı̨chǫ	Tatsea (Tłı̨chǫ Online Dictionary 2006)
Gwich'ya Gwich'in	Chiniitrành (Mitchell-Firth *et al.* 2003)
Population/subpopulations:	Northwest Territories population of *anatum*/*tundrius* peregrines (considered a single population)
Class:	Aves
Order:	Falconiformes
Family:	Falconidae
Life Form:	Diurnal bird of prey, Falcon

Systematic/Taxonomic/Naming Clarifications

Historically, Falcons were included with vultures, hawks, ospreys and eagles in the Order Falconiformes. However, recent genetic evidence shows that Falcons are not closely related to other diurnal birds of prey, but are now considered most closely related to parrots and songbirds (Hackett *et al*. 2008, Suh *et al*. 2011, Jarvis *et al*. 2014). As a result, hawks, eagles, ospreys and vultures were recently reclassified into the new Order Accipitriformes while Falcons and caracaras remain in the Order Falconiformes (Integrated Taxonomic Information System (ITIS) n.d.).

Subspecies are a controversial taxonomic unit for conservation, but are often used as a proxy for evolutionary significant units (Phillimore and Owens 2006). Consequently, subspecies can be listed separately under the Species at Risk (NWT) Act.

Globally, there is only one Peregrine Falcon species, but 16 – 19 currently recognized subspecies (White *et al*. 2013, Integrated Taxonomic Information System (ITIS) n.d.). Of these, three traditionally accepted subspecies of Peregrine Falcon occur in North America. The distribution of the Peale's Peregrine Falcon (*F. p. pealei*) is limited to the west coast of Canada and Alaska, but does not occur in the NWT. The Tundra Peregrine Falcon (*F. p. tundrius*) is found in tundra ecosystems from Alaska to Greenland, including in the NWT. The Anatum, or American, Peregrine Falcon (*F. p. anatum*) includes all Peregrine Falcons in North America south of the tundra, except *pealei*. The subspecies name "*anatum*" is a Latin reference (genitive plural) to a duck, reflecting the species' original common name of "duck hawk" (Glosbe - the multilingual online dictionary n.d.).

Following the near total extinction of the eastern *anatum* Peregrine Falcon (see Section 3.3.1), *anatum* captive-breeding recovery efforts in the United States of America (USA) included at least seven non-native subspecies from around the world, of which at least five contributed genes to the released populations (Tordoff and Redig 2001). However, only native Peregrine Falcons were used in Canadian captive breeding programs (Brown *et al*. 2007) and no captive-bred birds were release in the NWT.

Brown *et al*. (2007) found that anatum and tundrius were genetically indistinguishable in samples taken prior to the population decline. This result was subsequently confirmed by several researchers using a variety of genetic techniques (Johnson *et al*. 2010, White *et al*. 2013, Talbot *et al*. 2017). Consequently, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) currently does not separate the two subspecies and considers them as *anatum/tundrius*. Arguably, *tundrius* should be subsumed into the *anatum* subspecies. Nevertheless, most ornithological authorities still recognize *anatum* and *tundrius* as valid subspecies (e.g. Avibase— the World Bird Database n.d.).

In the NWT, Peregrine Falcons nest in both the taiga and the tundra biomes and would traditionally have been separated by subspecies, but would now be called "ecotypes". However, as Peregrine Falcons have very wide habitat and prey preferences and there are no significant life history or genetic differences between taiga and tundra nesting birds. SARC has considers all NWT Peregrine Falcons as simply *Falco peregrinus* with no sub specific designation.

Description

The Peregrine Falcon is a medium- to large-sized Falcon roughly the size of a crow (Figure 3). Wings are long, narrow and pointed. The tail is long and fairly broad. Females are significantly larger than males with little overlap in size within populations. Data for Peregrine Falcons in the NWT are not available. A study around Rankin Inlet (Nunavut) found that the average weight for female tundra-type peregrines was 920 g $\pm$ 55.3 SD and 607 g $\pm$ 42.4 SD for males (Court *et al*. 1988). Yukon River (Alaska) taiga-type females average 977 g $\pm$ 76.4 SD and males 652 g $\pm$ 52.4 SD. The average wing chord of western birds is 349.8 mm $\pm$ 5.80 SD for females and 306.0 ± 3.90 SD. Tail length is 170.3 ± 6.62 for females and 142.6 ± 6.12 SD for males. Populations are reasonably uniform in colour and size throughout the North American range with some clinal and individual variation; the northern tundra-types are generally paler that the southern taiga-types. Adults have bluish-grey upperparts and a bold, black facial stripe ("malar stripe") of varying width extending down from the eye. Underparts are whitish, grey or buffy with variable amounts of striping and barring. The underwing and under the tail are barred pale grey and black. There are no marked seasonal or sexual differences in feather colour. At hatch, chicks weigh 35-40 g and are covered in off- white, downy feathers which are gradually replaced by darker flight feathers. Juveniles are dark brown with heavy streaking and blotches on the undersides. The cere (waxy structure at base of the bill) and eye ring are yellow to yellow-orange in adults and bluish-white to greenish in juveniles. The feet are yellow in adults and bluish-grey to bluish-green in juveniles. Unless otherwise noted, this description is abstracted from White *et al*. (2020).

Figure 3. Adult male Peregrine Falcon representative of NWT boreal forest peregrines. Photo taken on the North Saskatchewan River, Alberta. Photo courtesy of Gordon Court.

Life Cycle and Reproduction

Number of Broods Annually

Peregrine Falcons breed only once per year, but may re-nest if the breeding attempt fails early in the reproductive cycle. However, Anctil *in* COSEWIC (2017) indicates that re-nesting rarely happens in Arctic Peregrine Falcons because of the restricted breeding season.

Eggs and Clutch Size

Eggs weigh about 50 g (Burnham *et al*. 2003) and are usually a cream-colour with warm brown blotches. The sex ratio of eggs is 1:1 (Burnham *et al*. 2003). Mean clutch sizes vary between years, but are generally between 3.0 and 3.8 eggs, often with fewer in the north. In captivity, if eggs are removed, a single female may lay as many as 16 – 20 eggs (White *et al*. 2020).

Incubation and Fledging

The average incubation period is 34 days with both males and females incubating (Shank and Poole 2016). Following hatch, nestlings remain at the nest for 38 days on average (Shank and Poole 2016). Recently fledged birds remain in the nest site vicinity and continue to be fed by the adults for 5 – 6 weeks before undertaking their first migration.

Breeding Period

All NWT Peregrine Falcons are migratory arriving in the NWT in April or May, depending on latitude. Males typically arrive at the nest site first. Egg-laying typically begins in the second week of May in southern NWT and the second week of June at high latitudes. Hatching typically varies from the third week of June at low latitudes to the third week of July in the mid-Arctic. Fledging occurs between the fourth week of July to the end of August (Shank and Poole 2016).

Productivity

Productivity is defined as the mean number of young fledged, or reaching an advanced nestling stage, per occupied[2] territory. However, there is methodological difficulty in establishing number of productive territories. Single surveys undertaken early in the breeding season will include occupied sites that fail later in the season. Single surveys during the late nestling period will record almost all occupied sites observed as successful. Hence, the denominator in productivity estimates is uncertain when survey effort and timing differ. A less ambiguous proxy for reproductive success is young per successful territory or mean brood size.

The average number of young is reported as 1 – 2 per territorial pair, but this varies widely from year to year from 0.0 to 3.0 (COSEWIC 2017). Females with elevated fattening rate in the

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[2] "Occupied" means a nest site at which at least one adult bird was seen.

pre-reproduction period initiate egg-laying earlier (Lamarre *et al*. 2017). At Rankin Inlet (Nunavut), nestlings that hatched later in the season had lower survival (Anctil *et al*. 2014) suggesting a clear advantage to earlier nesting.

Many factors influence number of young produced including egg and nestling mortality from inclement weather, differences in prey abundance, date of clutch initiation, predation, and nest site quality. In Arctic populations, breeding success is highly variable between years and appears to be dependent largely upon juvenile mortality caused by external events, such as heavy and/or extended rainfall, extreme low temperatures and black fly outbreaks (Bradley *et al*. 1997, Anctil *et al*. 2014, Carlzon *et al*. 2018, Lamarre *et al*. 2018). These factors can increase nestling mortality by as much as 50% (Anctil *et al*. 2014, Lamarre *et al*. 2018).

Age at First Breeding

Peregrine Falcons typically begin breeding at 2 - 3 years of age, although females often begin earlier than males (review in COSEWIC 2017). The most relevant data for NWT Peregrine Falcons is likely from Rankin Inlet (Nunavut) where the mean recruitment age (age at first breeding) was four years (range 2 – 8) for males and three years (range 3 – 5) for females (Johnstone 1998).

Life Span and Survivorship

Annual survival rates of adults likely fall in the range of 80 – 85% for migrant individuals. First year survival is generally assumed to be in the range of 40 – 50%. Maximum recorded longevity for wild Peregrine Falcons is at least 20 years (White *et al*. 2020). At Rankin Inlet (Nunavut), annual survivorship was 81% for females and 85% for males (Court *et al*. 1988). Apparent survival of adult Peregrine Falcons at Rankin Inlet (Nunavut) was negatively affected by climatic conditions during the fall southward migration (Franke *et al*. 2011). White *et al*. (2020) indicates that territorial defense may result in mortalities, particularly when there is intense competition for nest sites and mates.

Generation Length

The estimated generation length for Canadian Peregrine Falcons calculated by COSEWIC (2017) is at least 6 years based on a minimum of 80% adult survival, age of first reproduction of 1, and the IUCN formula of 1/(adult mortality) + age at first reproduction (IUCN 2019). However, if age at first reproduction for NWT Peregrine Falcons is considered to be three years (Section 1.3.6), then generation length should be at least eight years.

Physiology and Adaptability

Peregrine Falcons are found in a vast array of ecosystems worldwide highlighting their ability to adapt to a wide variety of local conditions. They may be one of the world's most adaptable avian species.

During the breeding season, Peregrine Falcons typically vigorously defend a territory against any intruders within approximately 200 m of the nest. A larger perimeter may be defended depending upon local conditions of prey abundance. Nest sites tend to be spaced out with inter-nest distances related to prey and nest site availability (White *et al*. 2020).

In literature, Peregrine Falcon home ranges are reported with an exceedingly wide range of values due to methodological and statistical differences. These values are also likely due, in part, to intrinsic variability (e.g., prey and breeding density). Early reports for Peregrine Falcon home range size consisted of estimates based on linear distance of observations from the nest. The review by Enderson and Craig (1997) indicate these distances as being 18 km or less. White and Nelson (1991) followed a male Peregrine Falcon by helicopter in Alaska and calculated a home range of 319 km^2 and a maximum straight-line distance from the nest of 14.6 km.

Later estimates of home range size have been based primarily on radio- and satellite-telemetry. Using radio-tracking, Enderson and Craig (1997) found home range sizes of 308 – 1508 km^2 in Colorado, while in South Africa, home ranges were only 90 – 192 km^2 in size (Jenkins and Benn 1998). Using satellite telemetry, Burnham *et al*. (2012) found summer home ranges in Greenland to vary between 23 km^2 and 3,021 km^2 depending on accuracy of locations and analysis technique. In northern Russian, average home ranges were reported using satellite data as only 98 km^2 in one study (Sokolov *et al*. 2014) and in another as much as 1175 km^2 (Ganusevich *et al*. 2004). However, the latter is likely an overestimate resulting from using less precise satellite locations (Sokolov *et al*. 2014). DeSorbo *et al*. (2018) filtered out low quality satellite-telemetry locations from female Peregrine Falcons in New Hampshire and found 50% of occurrences within an area of 597 -1036 km^2 and 95% within 8,626 - 12,670 km^2. Burnham *et al*. (2012) conclude that satellite telemetry is better suited to migration studies than to home range area analysis.

Interactions

Nest Sites

Peregrine Falcons usually lay their eggs directly on rocky ledges, grass or dirt. When possible, they create a small depression in the substrate called a "scrape". They may also use stick nests built by Rough-legged Hawks (*Buteo lagopus*), Golden Eagles (*Aquila chrysaetos*), Bald Eagles (*Haliaeetus leucocephalus*) or Common Ravens (*Corvus corax*), but do not build their own stick nests. Only about 14% of occupied peregrine nests recorded along the Mackenzie River in the NWT were stick nests (Carríère and Matthews 2013).

Interactions with Prey Species

Peregrine Falcon diet consists almost entirely of a wide variety of birds representative of the local avian species diversity, although mammals, insects and reptiles (south of the NWT) are occasionally taken. A review by White *et al*. (2020) indicates diets containing a minimum of 47 species in Alaska, 28 at Rankin Inlet (Nunavut), 11 in Greenland, and 60 in the Alaskan taiga. Hodson (2018) collected 507 prey remains from Mackenzie River nest sites. There were 55 species in the 307 samples that could be identified to species. Shorebirds comprised 37% of the samples, diving ducks 25% and passerines 21%. Other bird groups made up the remainder. The most commonly taken species were Lesser Scaup (*Aytha affinus*) (13.8%), Lesser Yellowlegs (*Tringa flavipes*) (11.5%) and Northern Flicker (*Colaptes auratus*) (5.8%). The only local birds missing from the diet were ones too large for Peregrine Falcons to handle. Hodson (2018) recorded only one mammal in the sample. Rodents comprise a significant proportion of the diet during peak lemming years at Rankin Inlet (Nunavut) (Court *et al*. 1988, Bradley and Oliphant 1991).

Interactions with Parasites

White *et al*. (2020) lists numerous organisms parasitizing Peregrine Falcons. Wong *et al*. (1990) lists two species of nematodes found in Peregrine Falcons, neither of which have been found in the NWT. Wheeler and Threlfall (*in* White *et al*. 2020) list four species of Phthiraptera (chewing lice), Siphonaptera (fleas), and several dipterans (flies) as ectoparasites of Peregrine Falcons. The population effects of these species are not clear.

At Rankin Inlet (Nunavut), adult black flies (Diptera: Simuliidae) were seen as a major source of nestling mortality (30- 50%) during outbreak years linked to warm spells and higher than normal precipitation (Franke *et al*. 2016, Lamarre *et al*. 2018). It is suggested that climate change may exacerbate black fly induced nestling mortality. The effect of black flies on NWT Peregrine Falcons has not been investigated.

Hodson (2018) noted unidentified maggots infesting the ears of Mackenzie Valley Peregrine Falcon, a condition termed "myiasis". A gaping hole was left in the ear canal following their maturation and departure from the nest. Effects on mortality are unclear. Based on repeated surveys Hodson concludes the problem has become worse since about 2000 (Hodson pers. comm. 2020). The description is similar to infestations by larvae of the bird blowfly *Protocalliphora avium* (Diptera: Calliphoridae) on nestling Gyrfalcons (*Falco rusticolus*) in the Central Canadian Arctic reported by Poole and Bromley (1988).

Interactions with Predators

There is very little predation on adult Peregrine Falcons. However, Great Horned Owls (*Bubo virginianus*) and Golden Eagles sometimes take Peregrine Falcons, particularly juveniles and nestlings. Paradoxically, both species occasionally nest in close proximity to Peregrine Falcon nests (White *et al*. 2020). Ground nests are particularly susceptible to predation by mammals such as foxes (*Vulpes vulpes*, *V. lagopus*) and bears (*Ursus americanus*, *U. arctos*) and wolverines (*Gulo gulo*).

Ecological Function

By examining ecosystems in which predators have been removed, Estes *et al*. (2011) documented the key role that apex predators play in shaping local ecologies through trophic cascades. There was no research undertaken describing the ecology of NWT Peregrine Falcon breeding areas during the DDT-induced declines that could be compared with the current situation following population recovery. Nevertheless, NWT Peregrine Falcons are clearly preying upon many birds and can be assumed to be having a significant, but currently unknown, effect on local food chains and the health of local ecosystems.

PLACE

Distribution

World and North American Distribution

The Peregrine Falcon is among the most widespread of the world's wild birds (Figure 4). It is found on every continent, except Antarctica, and in all terrestrial biomes, although they may be rare or absent in deserts, dry shrub lands and tropical forests.

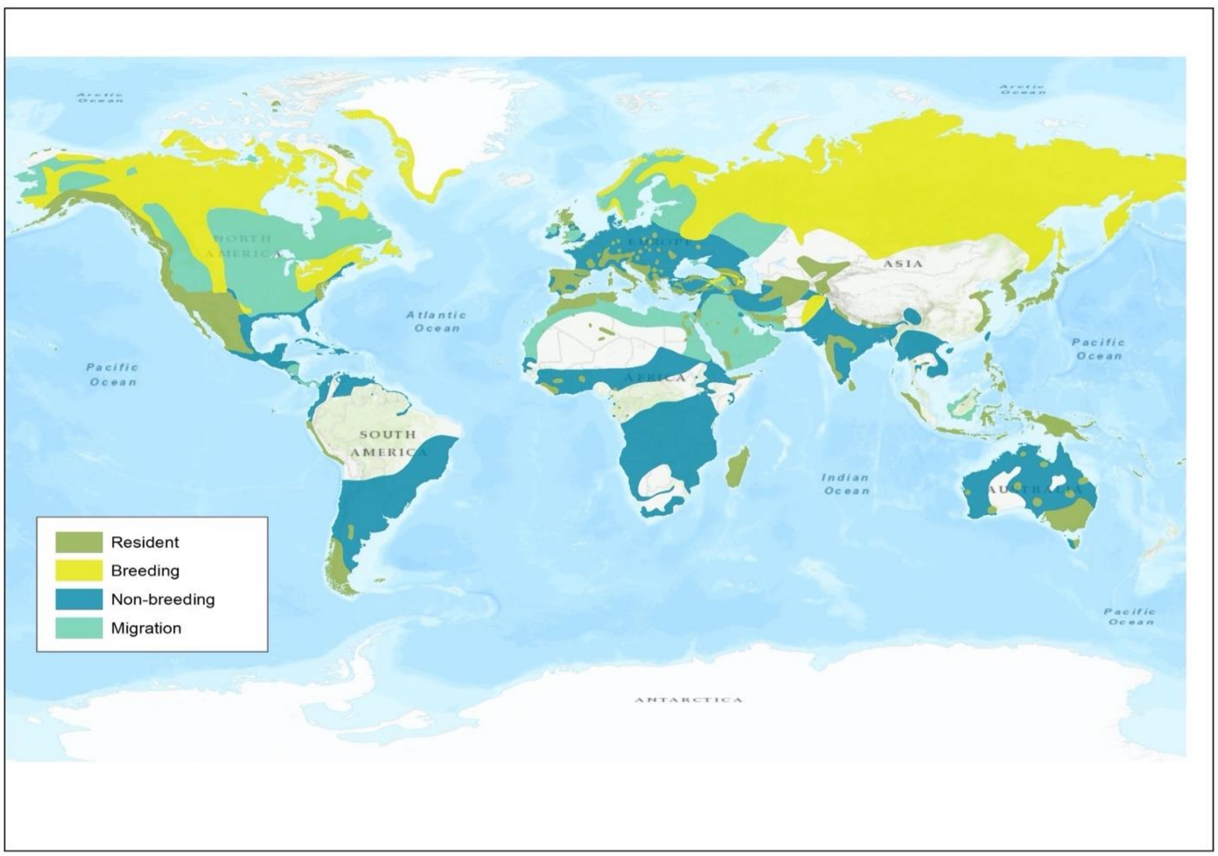

Figure 4. Global distribution of Peregrine Falcon. Geospatial data courtesy of BirdLife International and Handbook of Birds of the World 2019. Map courtesy B. Fournier, ENR.

Figure 5. Breeding range of Peregrine Falcons in North America. This map accurately reflects the full extent of the Peregrine falcons' breeding range in southern NWT and northern Alberta where the species is known to be present (see Figure 6). Geospatial data courtesy of Environment and Climate Change Canada (ECCC). Map courtesy B. Fournier, ENR.

North American Peregrine Falcons formerly bred throughout much of Canada and the US, but the range was significantly reduced during the population crash of the 1950s – 1970s (Section 3.3.1). This resulted in the near-complete loss of Peregrine Falcons in central and southern Canada and in the mid-western and eastern United States. Peregrine Falcons are now distributed widely throughout the western United States and are becoming increasingly common in the northeastern and midwestern United States, particularly in urban areas (Figure 5). Over 60% of the *anatum/tundrius* breeding range in North America is in Canada (Environment Canada 2015).

NWT Distribution

Peregrine Falcons are widely distributed across the NWT during the breeding and migratory seasons (Figure 6), although densities differ geographically and many areas have been insufficiently surveyed. Local nesting densities are determined primarily by suitable nest site locations and prey availability. A total of 61% of Peregrine Falcon known nest sites and 64% of eBird sightings (eBird n.d., GBIF n.d.) are located above tree line (Figure 6). The NWT population is contiguous with those of Nunavut, Yukon and Alberta.

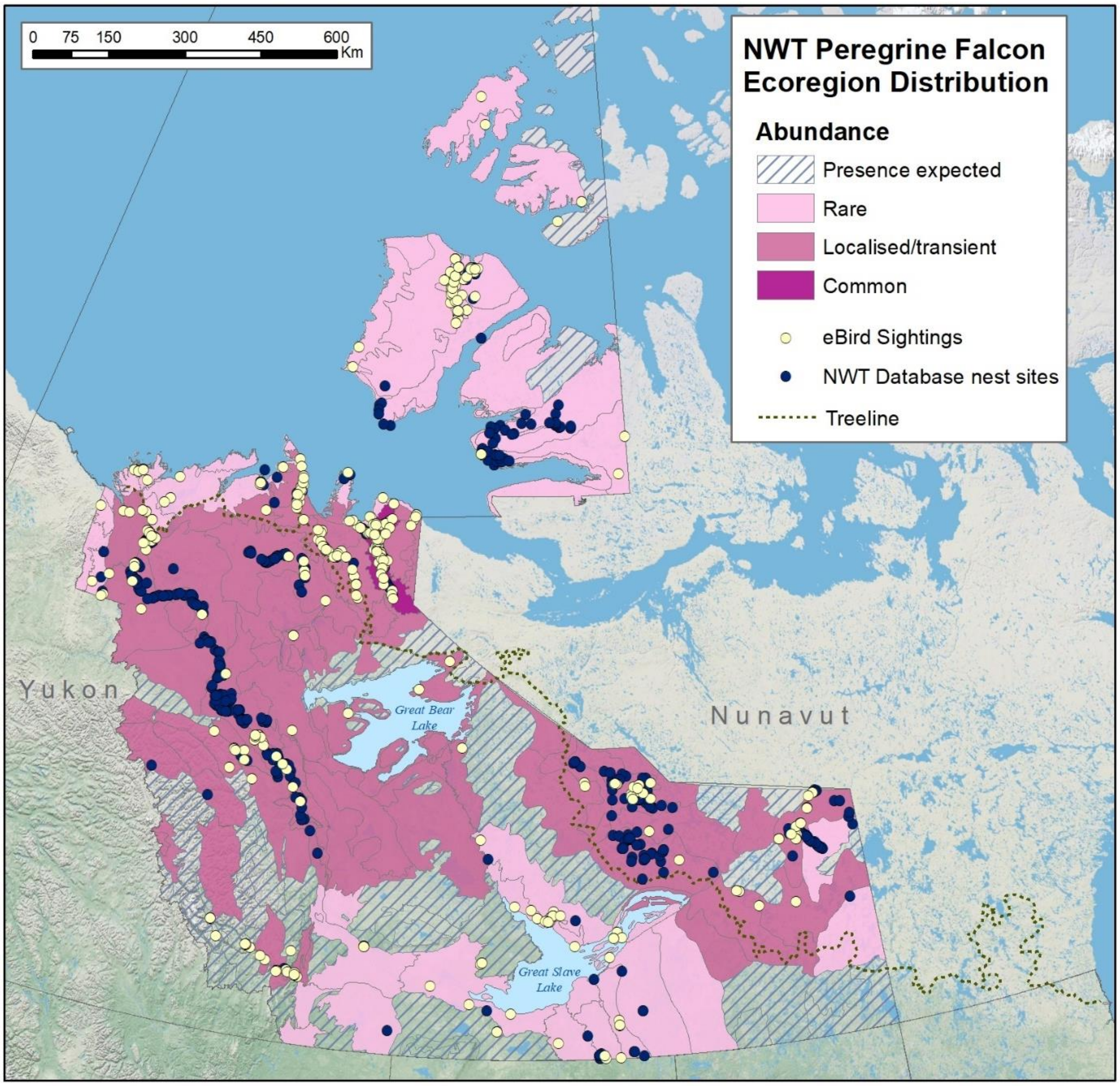

Figure 6. Location of peregrine Falcon nests in the NWT. Yellow dots represent eBird sightings (GBIF n.d.) where people have searched for nests but not the entirety of all nests, and navy-blue dots represent NU/NWT Raptor Database nest site locations. Estimated Peregrine Falcon density is shown in Level II ecoregions (Chowns n.d.). Map courtesy B. Fournier, ENR.

The Species at Risk Committee (SARC) defines the 'extent of occurrence' (EO) as 'the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a species (SARC 2020). The extent of occurrence for Peregrine Falcon in the NWT (the minimum convex hull less the areas of the Beaufort Sea and major lakes) is about 1,122,267 km² (= 95% of NWT land area) for sightings and nest sites together and 1,042,287 km² (=88% of NWT land area) for nest sites only.

The "index of area of occupancy" (IAO) is a measure that aims to provide an estimate of area of occupancy that is not dependent on scale. The IAO is measured as the surface area of 2 x 2 km grid cells that intersect the actual area occupied by the wildlife species (i.e., the biological area of occupancy). The IAO for Peregrine Falcons in the NWT is about 163,780 km² (=14% of NWT land area). Peregrine Falcons are widespread throughout the NWT, but sparsely distributed. It also reflects that much of the NWT has been poorly surveyed for Peregrine Falcons.

Locations

SARC defines 'location' as 'a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a species is affected by more than one threatening event, location should be defined by considering the most serious plausible threat (SARC 2015).

Peregrine Falcon locations are either nest sites that are currently occupied or have previously been occupied. Locations are discovered in formal surveys by foot, boat or aircraft. The NU/NWT Raptor Database records nest locations and visit histories for Peregrine Falcons along with other raptors (Peck *et al.* 2012). eBird sightings are opportunistic observations of Peregrine Falcons which may or may not be associated with a nest site location and they are not included in the NU/NWT Raptor Database. There is no information on surveys in areas where no locations were determined (i.e., negative location data).

Currently, there are 613 unique Peregrine Falcon locations in the database not counting alternative nest sites (Appendix B). A total of 346 sites are above tree line and 267 locations are below tree line. Most of these location records are along rivers (e.g., Thelon, Anderson, Horton, Hornaday, Thomsen, Mackenzie) (Figure 6). The distribution map is somewhat biased since surveys are targeted in areas of high nest density. Large areas in the central and southeastern parts of the NWT have not been adequately surveyed, but are expected to have low density of Peregrine Falcon nests.

Search Effort

Data on Peregrine Falcons locations in the NWT are from eBird and dedicated raptor surveys. eBird sightings are usually opportunistic sightings made by recreationalists and are often not at nest sites. Dedicated surveys of nesting raptors are by fixed-wing aircraft, helicopter, boat and on foot (Table 2). Attempts are made to check all known sites in the locality as well as likely-looking unknown sites. Nest site records kept by the Nunavut and NWT governments are recorded in the NU/NWT Raptor Database (Peck *et al*. 2012) and contain information on the location of the nest site, species present, status (e.g., occupied, unoccupied, number of adults, eggs or nestlings), observers, and explanatory notes. Unoccupied sites represent absence of breeding birds. Each observation at a nest site is considered as a "nest visit". Because of the diverse survey methods employed and variation in reporting, it is not possible to provide an estimate of survey effort in terms of hours spent or kilometers surveyed. Emphasis has been on establishing trend by repeating surveys in areas of known raptor breeding concentrations. Consequently, much of the NWT has not been systematically surveyed.

The NU/NWT Raptor Database contains a total of 3,289 nest visits at 613 NWT Peregrine Falcon nest locations (not counting alternatives). The visit period covers sporadic samples prior to the 1970s to more systematic samples until 2020 (inclusive) (Table 1). Repeated visits to the same site in a single year are not compiled in Table 1. The single greatest effort in one year was 322 nest visits in 2010. The most consistently surveyed area has been the Mackenzie Valley, which has been surveyed in 22 years between 1966 and 2020 (Table 3).

Table 1. Number of NWT nest visits by decade. Data from NU/NWT Raptor Database.

Decade	Nest Visits
Prior to 1970	77
1970 -1979	332
1980 - 1989	608
1990 - 1999	531
2000 – 2009	809
2010 – 2020 (11 years)	933

Figure 7 illustrates the cumulative number of nest visits since the 1960s. Nearly 39% of nest locations had only one visit for the entire period covered in the database, and 76% had seven (7) visits or fewer. This suggests limitations in establishing trends for individual nest sites (see section on trends).

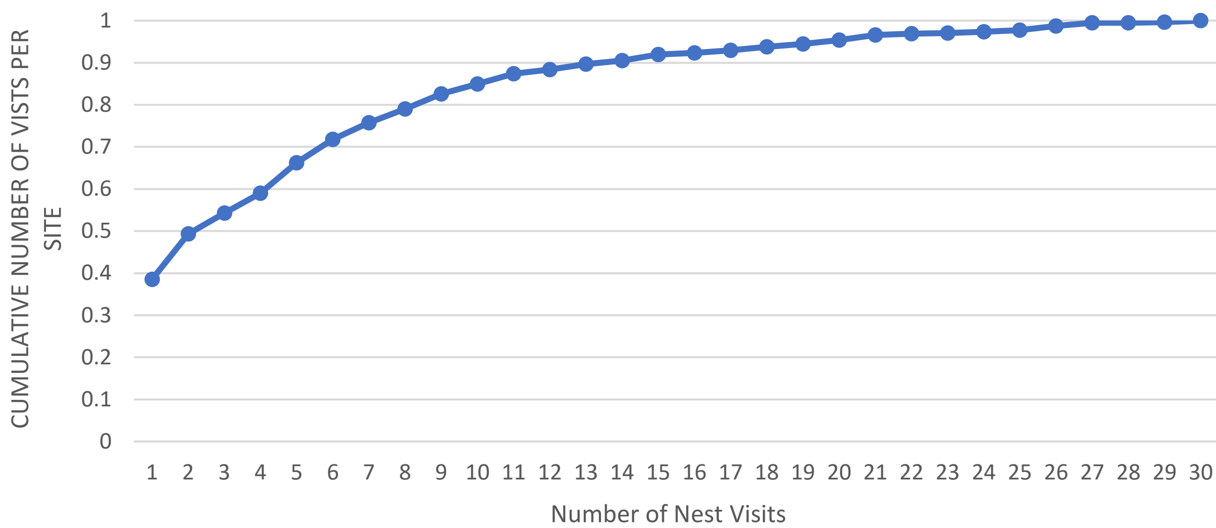

Figure 7. Cumulative number of visits to individual sites. Data from NU/NWT Raptor Database.

Distribution Trends

The population decline in Peregrine Falcons from the 1950s to the 1970s (Section 3.3.1) is not known to have caused significant contractions in the range of NWT Peregrine Falcons, but data are lacking. Conversely, subsequent population increases may not have been associated with significant range expansions in the NWT.

Movements

Peregrinus means "foreigner" in Latin (Glosbe - the multilingual online dictionary n.d.), reflecting that Peregrine Falcons are a mobile species with many populations undertaking long seasonal migrations. Whereas Peregrine Falcons in temperate climates may be resident year-round, all NWT Peregrine Falcons migrate south during the non-breeding season (roughly October – April).

Figure 8. Capture (green dots, northern end) and recapture (red squares, southern end) locations of Peregrine Falcons banded in the NWT between 1969 and 1977 (Dunn *et al*. 2009). The line between the points does not indicate path of migration. Data courtesy Environment and Climate Change Canada (ECCC). Map courtesy B. Fournier, ENR.

Peregrine Falcon migration can be monitored by band returns or telemetry. Peregrine Falcons from the NWT typically spend the winter in Texas, Mexico, the Caribbean or in Central and South America. Figure 8 shows the banding and winter recapture locations of the only five NWT-banded birds to have been recaptured until 1977. No later data is available because there has been little banding of Peregrine Falcons in the NWT in recent years. The maximum linear distance recorded for an NWT Peregrine Falcon was from an individual banded near the Anderson River in the NWT that wintered 11,969 km south in Argentina (encounter record #8 in Dunn *et al*. 2009). Average southward migration of Peregrine Falcons fitted with satellite transmitters at a number of North American locations was a straight-line distance of 8,624 km at a rate of 172 km/day (Fuller *et al*. 1998). Peregrine Falcons satellite tagged on wintering grounds on the Gulf of Mexico moved north to NWT and NU with migration distances between 4,580 and 5,840 km over an average of 30 days (McGrady *et al*. 2002).

Characteristically, Peregrine Falcons return to their general natal area. Of 12 Peregrine Falcons banded as nestlings and encountered three or more years later during the breeding season, half were within 50 km of their natal site. The maximum distance was a bird banded in northern Yukon which moved 757 km from the natal site to its breeding site (Dunn *et al*. 2009). Alberta Parks and Environment (2019) indicates that breeding dispersal may be as great as 1,800 km for Alberta Peregrine Falcons. This suggests that Peregrine Falcons have considerable dispersal capability if nesting opportunities are not available in their natal area.

Habitat Requirements

North American Peregrine Falcons can be found in almost all ecological regions (White *et al*. 2020) and can be found in almost all ecological regions. At smaller scales, breeding Peregrine Falcons show specific preferences. Although Peregrine Falcons prefer cliffs for nesting, cliff habitat is not an absolute requirement. Carríère and Matthews (2013) found 76% of Mackenzie River nest sites were on cliffs 15 – 50 m in height with the remainder nesting in stick nests or on flatter areas. Most nests (63%) were on rocky ledges, 10% on grassy ledges, 14% stick nests and 13% on the ground. They found most (63%) nest sites to be south, south-east or south-west facing. Bruggeman *et al*. (2016) found that sites along the Colville River, Alaska with higher productivity were associated with south-facing cliffs having early snowmelt located high above the river and surrounded by adequate prey habitat. Galipeau *et al*. (2019) built a habitat selection model for northern Baffin Island and found that steep, rugged terrain, located close to water, having southern aspects and adjacency to productive habitat explained nest site selection at three spatial scales (landscape, territory, nest site). Many other studies have arrived at essentially the same conclusions; see Galipeau *et al*. (2019) for a recent review. Those nest sites that are consistently used year after year are associated with higher and more regular productivity indicating higher quality (Wightman and Fuller 2006).

Little is known about habitat preferences during migration and on the wintering grounds in Latin America, other than they utilize a wide array of habitats (White *et al*. 2020). Using only higher accuracy satellite-transmitter locations, McGrady *et al*. (2002) found wintering home ranges along the Gulf of Mexico averaging 169 km^2 (90% minimum convex polygon). The habitat was mostly sandy and grass covered beaches with large numbers of shorebirds. Burnham *et al*. (2012) found larger winter home ranges, but there were not enough high-quality satellite-transmitter locations to establish winter home range size with any certainty. All of the locations were in open areas of human disturbance.

Habitat Availability

Habitat availability for Peregrine Falcons in the NWT has not been quantified. At this time, habitat availability is not thought to be a limiting factor.

Habitat Trends

It is unlikely that NWT Peregrine Falcon habitat in the taiga has changed substantially in the last few decades, or that it is likely to change in the foreseeable future. However, climate change is resulting in changes in spring weather, riverbank or cliff slumping, and expansion of shrubs in Arctic and alpine tundra (See Threat section, e.g., Myers-Smith *et al*. 2011). These may reduce availability of cliff nesting and open hunting habitat that Peregrine Falcons prefer.

Habitat Fragmentation

Peregrine Falcons are highly mobile, so habitat fragmentation is unlikely to affect NWT Peregrine Falcons.

POPULATION

Abundance

Peregrine Falcons show strong nest site fidelity and are generally quite visible while territorial during the nesting period, so number of occupied nest sites or occupancy (proportion of known nests occupied) are often used as proxies for abundance. However, counting occupied sites or determining occupancy can be biased by absence of multiple annual surveys, differences in survey type and effort, and detection error, which are often not adequately described in written survey results. Franke *et al*. (2020) offer suggestions for international standardization of survey methods and reporting. The list of all known NWT Peregrine Falcon surveys is provided in Table 2, based on information recorded in the NU/NWT Raptor Database.

Table 2. Known surveys of Peregrine Falcons in the Northwest Territories, 1966 - 2019. The methods reflect search methodology and not whether the nest sites were visited on foot.

Year	Area	Method	Citations
1966	Mackenzie River	Not specified	Cade and Fyfe (1970)
1966 - 2018	Mackenzie River	Boat and helicopter	Hodson (2018)
1968	Horton River	Not specified (possibly Fixed-wing, boat)	Fyfe *et al*. (1976)
1969	Mackenzie River	Not specified	Cade and Fyfe (1970)
1970	Mackenzie River	Not specified	Cade and Fyfe (1970)
1971	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1972	Campbell Hills	Not specified	Beebe (1974) in (Fyfe *et al*. 1976)
1973	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1973	Horton River	Not specified	Fyfe *et al*. (1976), Fyfe and Olendorff (1976)

1974	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1975	Mackenzie River	Aircraft. ground	Fyfe *et al*. (1976)
1975	Banks Island	Fixed-wing, ground, helicopter	Fyfe *et al*. (1976)
1975	Horton River	Fixed-wing, boat	Fyfe *et al*. (1976)
1977	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1978	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1979	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1980	Mackenzie River	Not specified	White *et al*. (1990)
1980	Anderson/Horton	Not specified	White *et al*. (1990)
1980 - 1988	Enbridge Norman Wells Pipeline	Ground, fixed-wing, helicopter	Matthews (1989)
1981	Mackenzie River	Not specified	Referenced in Bromley and Matthews (1985)
1983	Mackenzie River	Helicopter	Referenced in Bromley and Matthews (1985)
1984	Mackenzie River	Helicopter	Referenced in Bromley and Matthews (1985)
1985-1986	Mackenzie River	Helicopter	Murphy (1990)
1988 & 1990	Tuktut Nogait National Park	Ground	Obst (2003)
1990	Mackenzie River	Boat and helicopter	Holroyd and Banasch (1996)
1994 - 2017	Daring Lake	Ground	Unpublished Excel spreadsheet compiled by Joachim Obst and on file with NWT ENR
1995	Mackenzie River	Helicopter, boat, ground	Shank (2004)
1998 - 2010	Diavik and Ekati Mine sites	Helicopter	Coulton *et al*. (2013)
2000	Mackenzie River	Boat and helicopter	Rowell *et al*. (2003b)
2000	Hornaday River, Tuktut Nogait National Park	Boat and ground	Obst (2003)
2005	Mackenzie River	Boat and helicopter	Holroyd and Banasch (2012)
2010	Mackenzie River	Boat and helicopter	Carrière and Matthews (2013)
2010	Hornaday River, Tuktut Nogait	Helicopter	Holroyd (2010)

	National Park		
2015	Hornaday River, Tuktut Nogait National Park	Helicopter	Holroyd and Frandsen (2015)
2010 & 2020	Ekati/Diavik/Daring Lake	Helicopter and ground	Unpublished Excel spreadsheets on file with NWT ENR
2016 - 2019	Mackenzie Valley	Boat	Unpublished data from K. Hodson on file with NWT ENR

The most consistent trend data is from repeated surveys of the Mackenzie Valley for the 45 years between 1966 and 2019.

Using a mark-recapture model for banded hatch-year Peregrine Falcons and based on a number of assumptions, Franke (2016) estimated the total number of breeding age Peregrine Falcons north of 54° (US, Canada and Greenland) at 60,000 in 2000. Based on Franke's (2016) assessment, COSEWIC estimated 35,100 mature Peregrine Falcons for all of Canada in 2017.

The number of Peregrine Falcons in the NWT can only be roughly estimated. The NU/NWT Raptor Database currently records 613 unique nest sites. Assuming an occupancy rate of 71% (Section 3.3.2), this suggests that known sites are currently occupied by about 435 pairs in any given year. If one-quarter to one-half of the Peregrine Falcon nesting sites in the NWT are known and the non-breeding, non-territorial (floater) population equals the number of breeders (Franke 2016, White *et al*. 2020), a conservative estimate would be 3,500 – 7,000 adult Peregrine Falcons in the NWT.

Population Dynamics

Clutch Size in NWT

The NU/NWT Raptor Database records 242 Peregrine Falcon nest visits in which eggs were counted with mean clutch size of 2.6 (± 0.9 SD). A clutch size of four was most common (Figure 9).

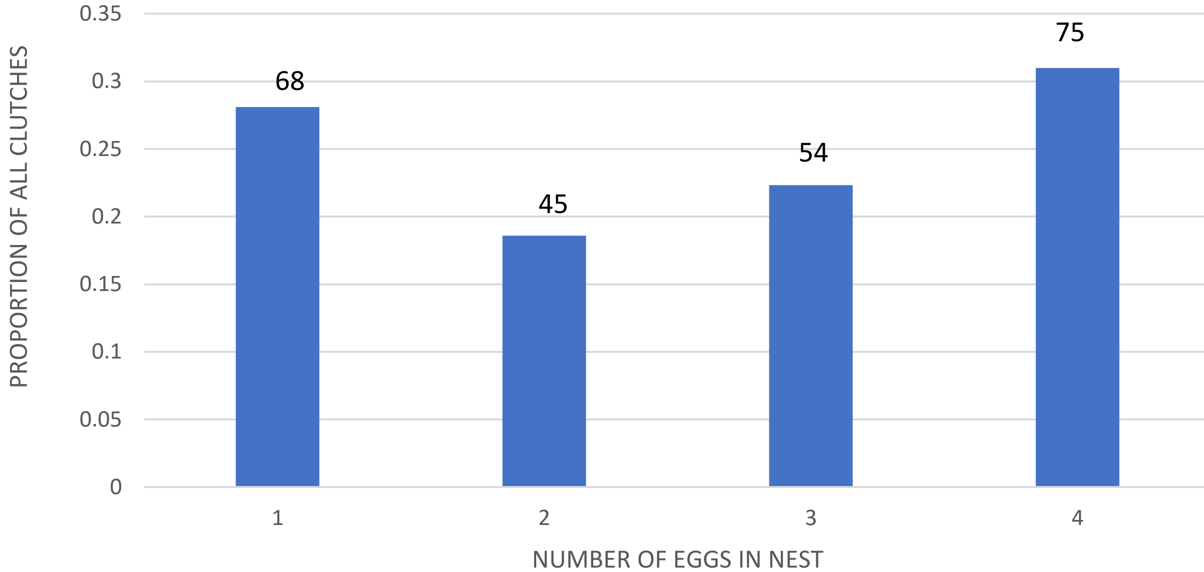

Figure 9. Frequency of clutch sizes in NWT Peregrine Falcon nests in which eggs were recorded. The number above the bar is number of observations. Data from NU/NWT Raptor Database.

Brood Size

The NU/NWT Raptor Database records 1,195 nest site visits in which young were counted with an average brood size of 2.4 (± 0.9 SD) (Figure 10).

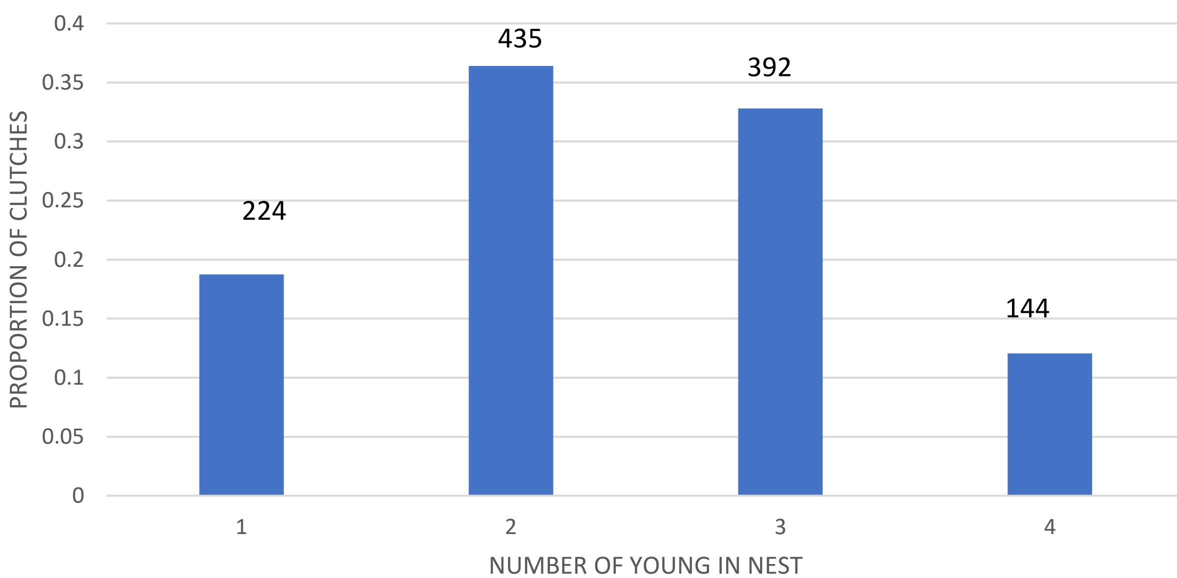

Figure 10. Frequency of brood sizes seen in 1,195 nest visits in which young were recorded. The number above the bar is number of observations. Data from NWT/NU Raptor Database.

There was no apparent trend in brood size in the 1,195 productive nest sites in which young could be counted over the 55 years between 1965 and 2019 (Figure 11).

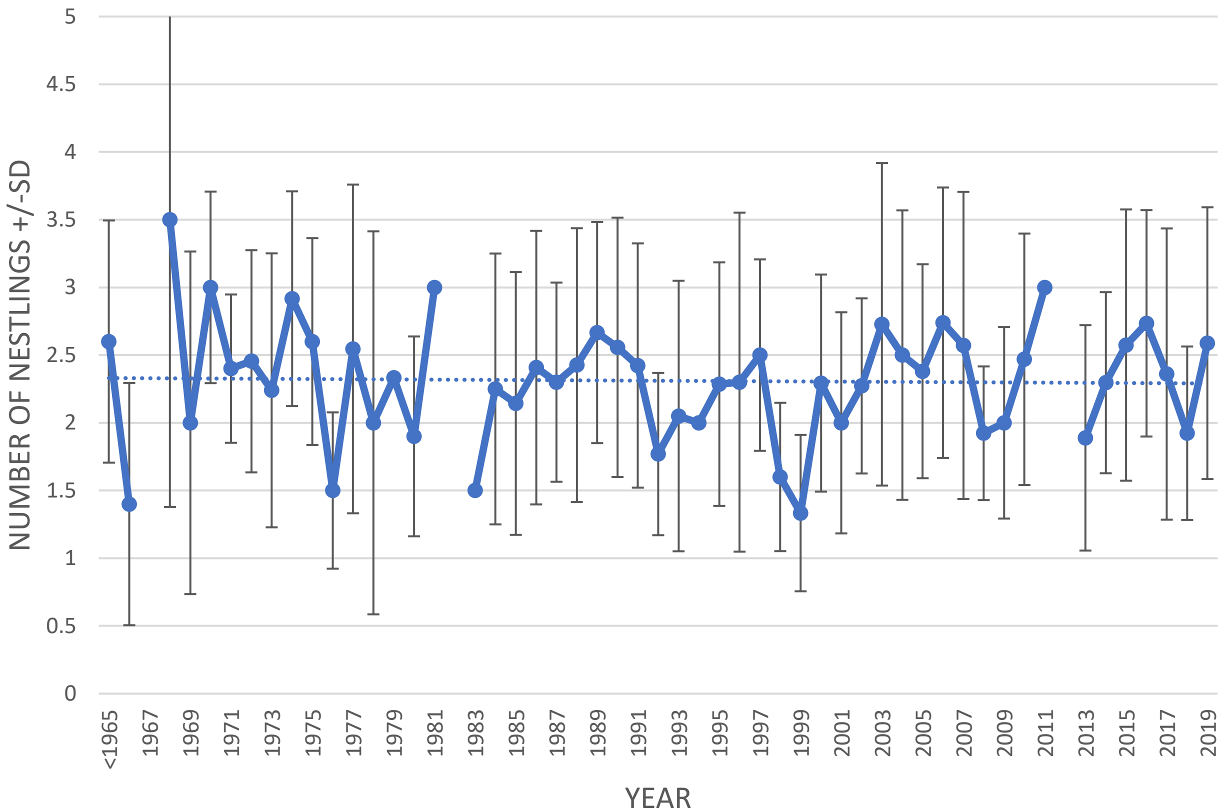

Figure 11. Mean (± SD) brood size at 1,195 productive sites from 1965 to 2015. Data from NU/NWT Raptor Database.

Trends and Fluctuations

Historical Population Decline

Peregrine Falcon populations worldwide crashed dramatically in the 1950s through the late 1970s (Hickey 1969). Peakall (1993) provides a comprehensive historical summary of the linkage of organochlorine pesticides to the worldwide declines. During the 1950s, an abnormal number of broken eggs were being found in British Peregrine Falcon nests (Ratcliffe 1967). By the mid-1960s it became clear that egg-shell thinning was the cause of the breakage and thinning greater than 17 – 18% resulted in Peregrine Falcon population declines. The first signs of egg-shell thinning occurred as early as 1947. By 1971 a negative correlation was established between concentration of DDE (the metabolite of DDT) in egg contents and the thickness of the shell. Experimental work on American Kestrels (*Falco sparverius*) determined the causal relationship beyond doubt. Because of biomagnification of contaminants, raptors are known to be particularly sensitive (González-Rubio *et al*. 2020), whereas avian species lower on the food chain were much less susceptible.

By the 1970s, Peregrine Falcons were extirpated in the United States east of the Mississippi River (Fyfe *et al*. 1976). The decline of Peregrine Falcons was not as pronounced in northern populations (review in Franke *et al*. 2020). There are no population estimates for NWT Peregrine Falcons prior to the DDT-induced decline. Based on occupancy of historically known sites relative to 1975, Fyfe *et al*. (1976) generalized a continuing decline in the Canadian Arctic of approximately 60%, a decline of 33% along the Mackenzie River and a 50% decline in other western boreal populations. Surveys suggest that the NWT population was at its lowest in the mid-1980s (Section 3.3.2).

Population Recovery

Use of DDT was banned in the United States in 1972 and phased out in Canada in the mid-1970s (Environment Canada n.d.). Agricultural use worldwide was prohibited in 2001 by the Stockholm Convention on Persistent Organic Pollutants, although use for disease vector control is still permitted in exceptional cases (UNEP 2017). van den Berg (2008) reported that in 2008 there was no use of DDT reported in the Americas, with the possible exception of the Dominican Republic. However, Venezuela notified the Convention's DDT Register in 2009 that they reserved the right to use, but not produce, DDT for disease control. Most use now is in India and Sub-Saharan Africa with global production of 4,550 tonnes.

There are no data on DDE residues in NWT Peregrine Falcons, but following the ban on DDT, DDE residues in Peregrine Falcon eggs collected in Alberta plummeted by nearly 80% (Alberta Environment and Parks 2019, Figure 12) and declined in eggs and blood plasma at Rankin Inlet (Nunavut) (Court *et al*. 1990, Johnstone *et al*. 1996, Franke *et al*. 2010). Remaining levels of DDE are likely due to its long-term persistence in the environment rather than accumulation from new sources. However, eggshell thicknesses have not shown such a robust response. There was no apparent increase in thickness at Rankin Inlet between the early 1980s (Court *et al*. 1990) and the late 1990s (Johnstone *et al*. 1996). In Greenland, Peregrine Falcon eggshell thickness has been steadily increasing, but it is not expected to reach pre-DDT levels until about 2034 (Falk *et al*. 2018). It is expected that these trends apply broadly to NWT Peregrine Falcons.

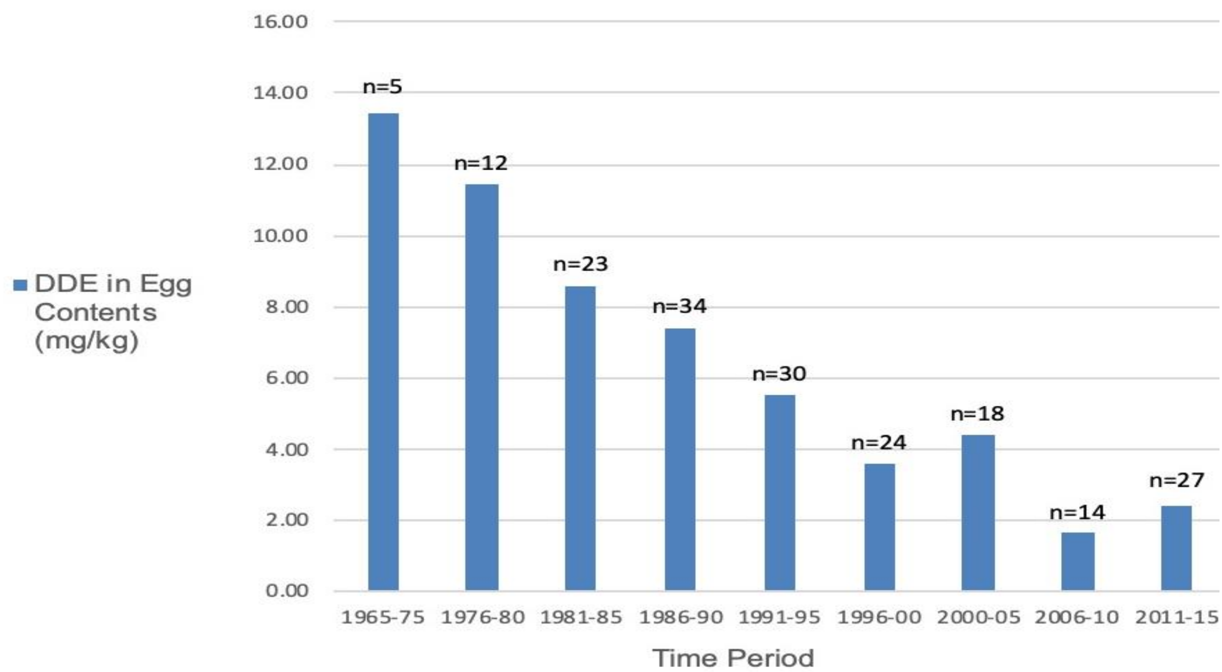

Figure 12. Decline in DDE residues in Peregrine Falcon eggs collected in Alberta (Alberta Environment and Parks 2019). Figure courtesy of Government of Alberta. (Reproduced with permission).

The decline in pollutants, together with captive breeding and reintroduction efforts, gradually resulted in increasing Peregrine Falcon abundance across North America (Cade and Burnham 2003). Simultaneously, populations of other raptors (e.g., Bald Eagles, Ospreys (*Pandion haliaetus*)) also began to rebound. Trends at both eastern and western US migration monitoring stations (hawk watches) showed statistically significant increases in number of Peregrine Falcon sightings up until the early 2000s (Hoffman and Smith 2003, Farmer *et al*. 2007). The Breeding Bird Survey indicates an annual increase in Canadian Peregrine Falcons of 11.4% (95% CI = -20.5 to 54.4) from 2005 – 2015 (USGS n.d.). Ambrose *et al*. (2016) document an increase number of territories and reproductive metrics in Alaskan Peregrine Falcons during the 1970s and 1980s with a gradual stabilization in the 2000s. Franke *et al*. (2020) conclude that northern Peregrine Falcon populations worldwide are now generally stable.

Trend in proportion of Peregrine Falcon nest sites seen to be occupied can be considered as a rough proxy for population performance (i.e., a combination population size and breeding success). Figure 13 shows trend in proportion of sites occupied from 1965 – 2020 based on 3,289 nest visits recorded in the NU/NWT Raptor Database. The 5-year moving average suggests that occupancy fell through the 1960s, 1970s and early 1980s, reaching a low point in 1983 with a rapid increase until 1998 and then a plateau to 2020. The mean nest occupancy over the 55 years is 71%. Proportions in the 1960s are biased upwards because nearly all sightings were new records of occupied nests.

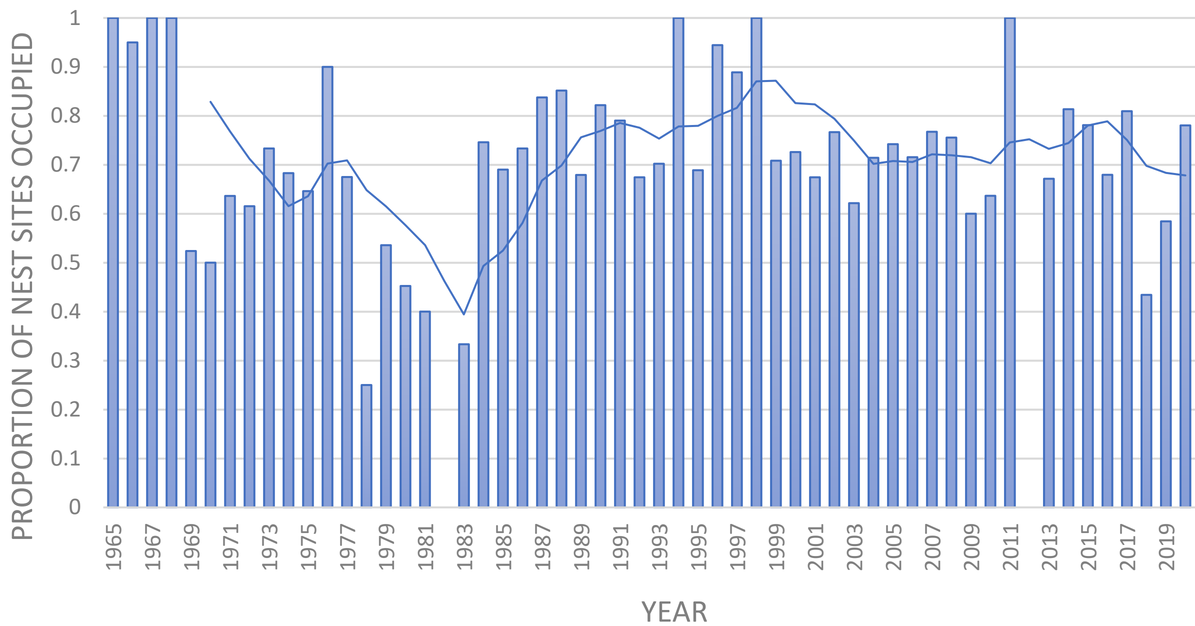

Figure 13. Proportion of nest sites occupied 1965 – 2020. The trend-line is the 5-year moving average. Data from NWT/NU Raptor Database.

The most consistent survey data in the NWT are from the Mackenzie Valley. Helicopter and boat surveys were summarized by Carrière and Matthews (2013). The boat component of the surveys is described in more details by Hodson (2018) (Table 3). Both helicopter and boat datasets show that the number of occupied and productive sites in the Mackenzie Valley increased from dramatically from the late 1960s until 2010 and essentially plateaued until 2020. The percentage of productive sites varied between years, but showed no clear trend. The increasing number productive sites has resulted in a marked increase in production since the mid-1980s (Figure 14).

Table 3. Occupied and productive Peregrine Falcon sites in the Mackenzie Valley 1966 – 2018. The surveys reported by Carrière and Matthews (2013) were done by helicopter and by boat. The surveys reported by Hodson were all done by boat except for 1975, 1980 and 1985 which were done by helicopter.

Year	Hodson (2018)			Carrière and Matthews (2013)		
	Occupied	Productive	% Productive	Occupied	Productive	% Productive
1966	12	12	100			
1969	8	8	100			
1970	9	3	33	9	2	22

1971	8	5	63			
1972	7	7	100			
1975	23			24	16	67
1980	19			20	10	50
1985	45			45	36	80
1990	37	34	92	88	70	80
1995	35	28	80	83	58	70
2000	28	21	75	80	37	46
2005	65	60	92	112	76	68
2010	75	65	87	141	81	57
2011	60	51	85			
2013	52	37	71			
2014	48	33	69			
2015	68	52	76			
2016	61	54	89			
2017	54	46	85			
2018	40	29	73			

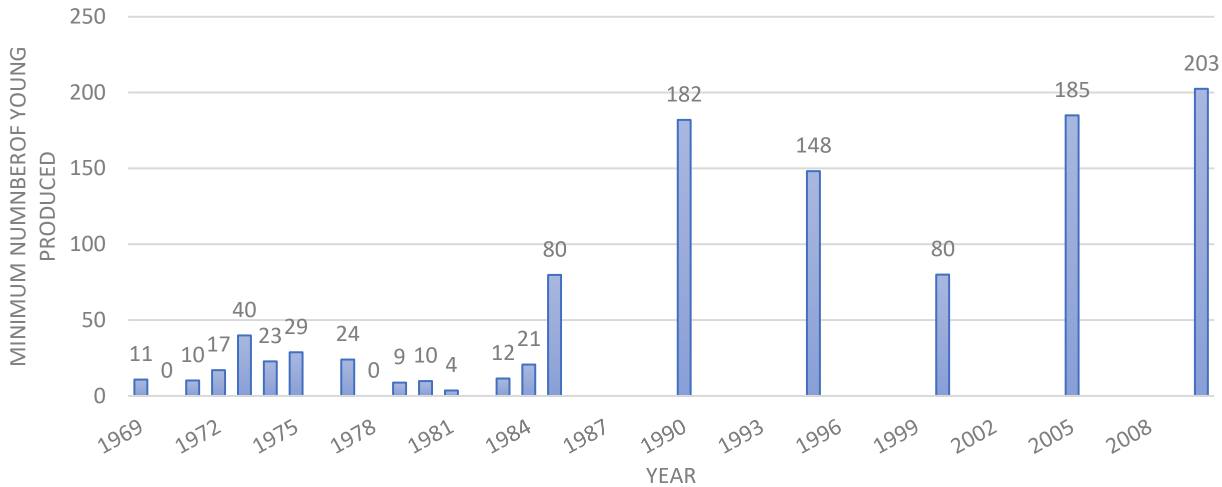

Figure 14. Estimated minimum number of young produced along the Mackenzie River 1969 – 2010. The 1969 data are from Bromley and Matthews (1985) and the remainder from Carríère and Matthews (2013).

The proportion of sites occupied sites is similar for tundra (74%, n = 1,066) and boreal (70%, n = 2,223) nest sites. But the correlation coefficient is low (0.23) between those years in which there are both above and below tree line observations. This very tentatively suggests differences between the tundra and boreal ecotypes in environmental effects on breeding success.

Possibility of Rescue

There is always a large number of local, non-territorial ("floater") birds capable of rapidly occupying any suitable nest sites, as illustrated by removal experiments at Rankin Inlet (Nunavut) (Johnstone 1998). Peregrine Falcons are highly mobile and if populations in Yukon, Nunavut and Alberta remain healthy, any population decline in the NWT population would likely result in rapid recolonization.

THREATS AND LIMITING FACTORS

Peregrine Falcons maintain a low population density, have relatively a low reproductive rate and are high trophic-level predators, all of which are characteristics associated with high extinction risk (Brown *et al*. 2007).

Pollutants

Because Peregrine Falcons are predators at the top of the food chain, some chemicals will tend to bioaccumulate to levels causing damaging physiological responses. Data collected in Alberta and Rankin Inlet (Nunavut) indicate the DDE in Peregrine Falcon eggs and blood plasma have declined to levels at which there are no population consequences (Section 3.3.2). However, Falk *et al*. (2018) reported that Peregrine Falcon egg-shell thickness in Greenland is increasing, but is not yet back to normal pre-DDT thicknesses, although the thinning is not enough to cause reproductive failure. They suggest that Peregrine Falcons may still be picking up DDE on the wintering grounds in Latin America.

There are a number of emerging and, as yet, poorly understood threats to Peregrine Falcons from bioaccumulation of chemical contaminants. Barnes *et al*. (2019) monitored mercury concentration in feathers of migrating northern Peregrine Falcons. Mobilization of mercury from melting permafrost may pose a future risk. Flame retardants, most notably polybrominated diphenyl ether (PBDE) congeners, are increasing in Greenland (Vorkamp *et al*. 2005). PBDE concentrations were found to be lower in Peregrine Falcon nestlings from the eastern Canadian Arctic than in more southerly urban and rural areas (Fernie *et al*. 2017). There appears to be no consensus whether PBDEs have toxic effects on Peregrine Falcons, although thyroid hormone disruption, estrogen effects, and neurotoxicity are mentioned as a potential concern for other species (Wei *et. al* 2021). Perfloroalkyl substances (PFASs), polychlorinated napthlalenes (PCNs), polycholinated bipheyls (PCBs) also contributed to the "chemical cocktail" detected in Greenland peregrines (Vorkamp *et al*. 2019), most of which are likely to have been picked up in wintering areas in Latin America. There is evidence that mammalian wildlife in the Dehcho region have picked up these contaminants (Larter *et al.* 2017). Polycyclic aromatic hydrocarbons (PAHs) are another chemical contaminant of concern. However, PAHs rapidly metabolize (Seegar *et al*. 2015). Following the April 2010 Deepwater Horizon oil spill in the Gulf of Mexico, migrating Tundra Peregrine Falcons, mostly from northern Canada, were captured on the South Padre Islands (Texas) and found to have elevated blood levels of polycyclic aromatic hydrocarbons (PAHs). The PAHs rapidly metabolized and fell to basal levels in 2011 (Seegar *et al.* 2015).

Decline of Prey Species

Many North American bird populations are declining—in some cases dramatically. Indigenous and community knowledge holders in the Mackenzie Delta have observed declines in shorebirds including: Red-necked Phalarope (*Phalaropus lobatus*), Horned Grebe (*Podiceps auritus*), Hudsonian Godwit (*Limosa haemastica*), Eurasian Whimbrel (Yeezhah, Eehzha) (*Numenius phaeopus*) and Common Snipe (Teekheets'il [dooh]) (*Gallinago gallinago*) (Cooper pers. comm. 2021; Salomons 2002; Mitchell-Firth *et al.* 2003).

Trends in North American bird species are being studied using radar detection of nocturnal migrants. Rosenberg *et al*. (2019) analyzed trend in numbers of 529 North American bird species over 48 years. They found a 29% overall decline in numbers for all species representing a loss of 2.7 – 3.1 billion birds. Abundance of boreal forest birds declined by 33% and Arctic tundra birds by 23%. Continent-wide, shorebirds declined in number by 37% and waterfowl numbers increased by 56%. Drawing on published and unpublished population estimates, Smith *et al*. (2020) concluded that approximately half of North American shorebird species of the Arctic tundra are declining in number while more than half of waterfowl species are increasing. The State of Canadian Birds report indicated that shorebird populations have declined by 40% since 1970, while waterfowl have increased by +50% and forest birds by +7% (Nabci Canada 2019).

Hodson (2018) found that shorebirds, diving ducks and passerines together made up 83% of Peregrine Falcon prey items collected along the Mackenzie River. The three most common species found Hodson's (2018) prey samples were Lesser Yellowlegs, Lesser Scaup, and Northern Flicker (Section 1.5.2).

In 2020, COSEWIC assessed the Lesser Yellowlegs as Threatened in Canada based on a -30% decline over three generations (2006-2018) inferred from Breeding Bird Surveys data (COSEWIC 2020, see also Nabci 2019). The NWT portion of the Breeding Bird Surveys (13 routes) show a -25% decline during the same period (2006-2018) (COSEWIC 2020). However, the reliability of the NWT trends is low (95% lower and upper Credible Intervals: -61% to +57%), with about 43% probability that the observed NWT decline rate is steeper than -30% in the last three generations (the rate required to meet the COSEWIC decline criterion for Threatened) (COSEWIC 2020).

For Northern Flickers, the Breeding Bird Surveys data (Smith et al. 2020) indicate a stable population in 2009- 2019, (NWT routes, n=10, trend +12%, with 40% probability the trend is stable, low reliability). For Lesser Scaup, the aerial waterfowl population surveys conducted by the USFW in Alaska and western Canada, including in the NWT, indicate a long-term decline in population since the 1980s (US Interior. 2019).

Although large-scale trends in bird populations are cause for concern, trends or information specific to declining prey populations in the NWT are considered a knowledge gap. The Gwich'in Renewable Resources Board have identified the population status of shorebirds as a research interest (Cooper pers. comm. 2021). Peregrine Falcons are generalist avian predators and if key populations were to decline, Peregrine Falcons might be able to shift their reliance to different species or species groups. To date, the large declines reported in some surveys do not seem to have affected Peregrine Falcon populations in the NWT.

Climate Change

Extreme rainfalls have become more common worldwide in recent years and are expected to increase in frequency with climate change (Easterling *et al*. 2000). Heavy rainfall events at Rankin Inlet (Nunavut) (Bradley *et al*. 1997, Franke *et al*. 2010, Anctil *et al*. 2014) and in Greenland (Carlzon *et al*. 2018) have resulted in significant Peregrine Falcon nestling mortality, an observation that extends to other avian species (Fisher *et al*. 2015). Lamarre *et al*. (2018) suggests that climate change will result in increased black fly outbreaks and more extreme rainfall events, both of which cause increased nestling mortality at Rankin Inlet (Nunavut).

Carríère and Matthews (2013) report slumping along the Mackenzie River banks, where high water levels or heavy rainfall events have washed away nest sites located on unstable slopes.

Franke *et al*. (2011) found occurrence of climatic indices related to the North Atlantic Oscillation (NAO) during the autumn migration to be correlated with a decrease in adult survivorship of Rankin Inlet (Nunavut) Peregrine Falcons the following autumn. The causal relationships remain uncertain but suggest that weather affects fall migration.

Climate change is expected to increase the incidence and size of wildfires in the NWT (e.g., Kochtubadja *et al*. 2006). The direct effects of wildfires on Peregrine Falcons are likely limited to damage to nest sites, nestling mortality and disturbance due to firefighting activities and are generally considered to be minimal (review in Luensmann 2010). Indirect effects of fire on prey abundance are likely to be more important, primarily by maintaining open habitat and affecting local bird populations.

Carríère and Matthews (2013) found Peregrine Falcon breeding along the Mackenzie River to have advanced 1.5 – 3.6 days per decade from 1985 – 2010, presumably as a result of climate change. Filippi-Codaccioni *et al*. (2010) found that European raptor species with the longest migrations advanced their migration dates the most. Phenological changes may lead to biotic mismatches which are most prevalent at higher trophic levels (Ockendon *et al*. 2014) and particularly in the Arctic (Renner and Zohner 2018). For example, Tulp and Schekkerman (2008) found that peaks in arthropod abundance are occurring earlier in the Arctic. This means that the bird species that Peregrine Falcons prey upon need to also advance their arrival and breeding dates to keep up and match their own prey abundance. Currently, there is no data on how prey species in the NWT are adapting and there are no studies on possible mismatches between timing of Peregrine Falcon nesting and the availability of their prey.

As the climate warms, tundra areas worldwide are experiencing an increase in shrub cover (Section 2.6). Peregrine Falcons prefer to hunt in open country. The extent to which this change in habitat structure will affect tundra Peregrine Falcon populations is unknown.

Human-related Threats

Historically, Peregrine Falcons were captured on migration by falconers and eggs and chicks were taken from nests. Egg-collecting is now illegal and widely denounced while poaching is considered to be rare (COSEWIC 2017). Captive-bred Peregrine Falcons are legally available to falconers holding a valid permit for CAN $1,000-$1,500. This meets much of the demand from the falconry community and takes pressure off wild populations. In 2008, the US allowed an annual capture of 152 wild peregrine nestlings or first-year migratory (passage) birds (US Department of Interior, Fish and Wildlife Service 2008). In 2017, the U.S. Fish and Wildlife Service increased the allowable take to 260 birds based largely on Franke's (2016) population estimate (Section 3.1) (US Department of Interior, Fish and Wildlife Service 2017). Deuterium level analysis indicated that 75% of captures in the US were Peregrine Falcons hatched north of 54° (US Department of Interior, Fish and Wildlife Service 2017), i.e., roughly north of Edmonton. It is not possible to determine the hatch location of the captured birds, but it seems likely that some originate in the NWT.

NWT legislation does not explicitly address capture, possession or handling of Peregrine Falcons for purposes of falconry, but there are permitting mechanisms in place under the *Wildlife Act* to allow for the activity. Any person wanting to capture and possess a Peregrine Falcon must apply for a License to Capture Wildlife and a Wildlife Handling Permit.

There are a number of large developments in the NWT having the potential to effect Peregrine Falcon populations. Three operating diamond mines are currently operating in the NWT (Diavik, Ekati, Gahcho Kué) and one is non-operational (Snap Lake). There are numerous inactive gold mines and one rare earth mine (Thor Lake) proposed to begin production in 2021 (Schmidt 2020). The NWT has recently proposed a number of ambitious infrastructure projects (Government of the NWT, 2020). The Mackenzie Valley Highway Extension Project, an all-weather road to the Arctic Coast, was first proposed in 1958, but continues to face delays and uncertainties (CBC 2019). Work is currently set to begin on a 321 km segment running from Wrigley to Norman Wells leaving the nearly 500 km section from Norman Wells to Tsiigehtchic for future phases. Planning is underway for a 413 km road into the Slave Geological Province as far as the Nunavut border. And the Taltson Hydroelectric Project is expected to be expanded to provide energy to the Slave Geological Province resource sector and connect to the Canada-wide grid. These projects are all in their initial phases of planning and/or development

Peregrine Falcons are quite variable in their response to human disturbance depending on individual differences, stages in the breeding cycle, and the general level of ambient disturbance (Cade 1960 in White *et al*. 2020). Coulton *et al*. (2013) found no reduction in nest occupancy (Peregrine Falcons and Gyrfalcons combined) related to diamond mines in the Diavik and Ekati mines and weak or no association with hatch success. The Enbridge Norman Wells pipeline had no effect on nest occupancy or reproductive success between 1980 and 1988 (Matthews 1989). Peregrine Falcons often thrive in urban environments subject to significant levels of disturbance (e.g., Gahbauer *et al*. 2015). A study in Great Britain found that Peregrines in urban environments were more successful than those in rural environments in terms of number of fledglings and nesting success (Kettel *et al.* 2019). Peregrine Falcons appear to be capable of accepting human disturbance if basic precautions are taken.

Considering the small scale of the projects relative to the size of the NWT, uncertainties in implementation and the apparent resilience of Peregrine Falcons to disturbance, the potential impacts on Peregrine Falcons populations are unlikely to be significant within the near-future if impact assessments are undertaken prior to construction and if best management practices are followed.

The primary threats to raptors living in urban environments are electrocutions and collisions with vehicles and windows (Hager 2009). Considering the low levels of human settlement in the NWT, these mortality sources are not likely to be significant.

Parasites and Diseases

West Nile Virus (WNV) is a mosquito-borne disease most commonly found in corvids (crows, ravens, jays, etc.) although it also infects a wide variety of animals, including humans. It is sometimes fatal to Peregrine Falcons (Chambers and Monath 2003), but they are apparently less affected than other raptor species (COSEWIC 2017). Mosquito monitoring efforts between 2004 and 2018 indicated presence of *Culex tarsalis*, a new species for the NWT and a known vector for WNV (Stuart 2020). There are no known cases of WNV in NWT birds (Stuart 2020). However, WNV might become a human and avian health issue in the NWT as the climate warms (Reisen *et al*. 2006).

As noted in Section 1.5.3., Peregrine Falcon nestlings have been observed to be parasitized by adult black flies and by blowfly larvae. Black flies have caused significant nestling mortality at Rankin Inlet during wetter years, but this has not been observed in the NWT. Anecdotal observations suggest that maggot infestations of nestlings are increasing along the Mackenzie River, but the extent of associated mortality remains unclear.

POSITIVE INFLUENCES

Climate Change

Earlier arrival on the breeding grounds as a result of a warming climate might prove to be beneficial to Peregrine Falcons since earlier breeding tends to result in higher productivity (review in Morrison *et al*. 2019). Warming temperatures may also allow range expansion. As the climate warms, Peregrine Falcons are moving north in Greenland and may be aggressively displacing Gyrfalcons (*Falco rusticolus*) at nest site locations (Burnham *et al*. 2017). Peregrine Falcons have all the attributes favourable to successful establishment of climate-induced range shifts (large body size, broad latitudinal range, good dispersal ability and diet generalism) (Monaco *et al*. 2020). Increased incidence of wildfire may maintain open habitat which is generally preferred by Peregrine Falcons (review in Luensmann 2010).

Genetic Diversity

The population bottleneck resulting from the DDT-induced decline of North American Peregrine Falcons might be expected to have caused a severe reduction in genetic diversity. However, genetic diversity in Canadian Peregrine Falcons is currently higher than in historical populations, possibly as a result of widespread genetic mixing during captive breeding recovery efforts, despite only pure *anatum* birds being bred and released in Canada (Brown *et al*. 2007). Broad genetic diversity helps a species adapt to a changing environment.

National and International Protection

The Migratory Bird Convention between the US and Canada is implemented in the US by the *Migratory Birds Treaty Act of 1918*, which offers Peregrine Falcons protection in the US (US Fish and Wildlife Service), but not in Canada. However, Peregrine Falcons are protected in Canada under the *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (WAPPRIITA) which limits trade and export of the species listed by the Convention on International Trade in Endangered Species (CITES) (Government of Canada 2018). Peregrine Falcons are on CITES Appendix I (CITES 2020) which prohibits all international commercial trade in the species, except in exceptional circumstances.

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The Species Specialists indicated in the Authorities Contacted section provided helpful comments on various aspects of the draft report.

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Christopher Shank was the NWT Raptor Biologist from 1986 – 1997. He first visited the North in the early 1970s on long distance ski trips (Ellesmere, Keewatin) and then undertook early studies on muskox/caribou competition on Banks Island. His post-graduate research was on mountain ungulates. He was Chair of COSEWIC from 1992 – 1997. From 1997 – 2006 he was the Provincial Biodiversity Specialist for the Government of Alberta where he helped to design the Alberta Biodiversity Monitoring Institute. Subsequently, he has worked for IUCN in Pakistan and with the United Nations Environment Programme and the Wildlife Conservation Society in Afghanistan.

STATUS AND RANKS

Region	**Coarse Filter (Ranks)**[1] To prioritize	**Fine Filter (Status)** To provide advice	**Legal Listings (Status)** To protect under species at risk legislation
Global	G4 – Apparently Secure (NatureServe 2016)[1]	Least Concern (IUCN Red List 2020)	
Canada	N3N4B,N2N,N3N4M (NatureServe 2016)[2]	Not at Risk (COSEWIC – 2017)[2]	Special Concern (*Species at Risk Act* – 2012)[3]
Northwest Territories	**Sensitive (NWT General Status Ranking Program 2021) S3B –Vulnerable [breeding] (NatureServe 2016)**	**To be determined**	**No Status**
Adjacent Jurisdictions			
Alberta	S2S3B – Vulnerable to Imperiled [breeding] (NatureServe 2016)		
British Columbia	S3 – Vulnerable (NatureServe 2016)		
Saskatchewan	S1B,SNRM – Possibly Extirpated [breeding] & Unranked [migrant] (NatureServe 2016)		
Nunavut	S4B – Apparently Secure [breeding] (NatureServe 2016)		
Yukon	S3B – Vulnerable [breeding] (NatureServe 2016)		

[1] All NatureServe codes are as defined in Definitions of NatureServe Conservation Status Ranks: http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm#NatureSe_2

[2] NatureServe Explorer (nd) (last reviewed 2020) gives a global rank of G4, which means the species, is apparently secure. In Canada, N3N4B,N2N,N3N4M means the national rank for the breeding portion of

the population is vulnerable to apparently secure, the wintering portion is imperiled, and the migratory portion is vulnerable to apparently secure. In the NWT, the status ranks is sensitive, with the equivalent sub-national rank of S3B, or breeding population is vulnerable) (WGGSNS 2016, updated in 2020).

[3] Originally, COSEWIC assessed Canadian Peregrine Falcons as three separate subspecies: anatum subspecies (Endangered in April 1978, Threatened in April 1999 and in May 2000); tundrius subspecies (Threatened in April 1978 and Special Concern in April 1992) and pealei subspecies (Special Concern in April 1978, April 1999 and November 2001). In April 2007, the Peregrine Falcon in Canada was assessed as two separate units: pealei subspecies and anatum/tundrius. Peregrine Falcon anatum/tundrius was assessed as Special Concern in April 2007 (Environment Canada 2015). Then in 2017, COSEWIC assessed anatum/tundrius as Not At Risk and pealei as Special Concern (Government of Canada n.d.). However, it has not yet been removed from Schedule 1. In 1994, tundrius Peregrine Falcons were removed from the United States Endangered Species Act and anatum Peregrine Falcons were removed in 1999 (Brown 2007).

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APPENDIX A – ADDITIONAL INFORMATION

Threats Assessment[1] [SARC to complete assessment]

Threats have been classified for Peregrine Falcon as a whole, insofar as those threats may be relevant to the status of the population in the NWT. The threats assessment is based on whether threats are considered to be of concern for the sustainability of the species over approximately the next 10 years.

This threats assessment was completed collaboratively by members of the NWT Species at Risk Committee, at a meeting on June 18, 2021. The threats assessment will be reviewed and revised as required when the status report is reviewed, in 10 years or at the request of a Management Authority or the Conference of Management Authorities. Parameters used to assess threats are listed in Table 4.

Table 4. Parameters used in threats assessment.

Parameter	Description	Categories
LIKELIHOOD		
Timing (i.e., immediacy)	Indicates if the threat is presently happening, expected in the short term (<10 years), expected in the long term (>10 years), or not expected to happen.	Happening now Short-term future Long-term future Not expected
Probability of event within 10 years	Indicates the likelihood of the threat to occur over the next 10 years.	High Medium Low
CAUSAL CERTAINTY		
Certainty	Indicates the confidence that the threat will have an impact on the population.	High Medium Low

[1] This approach to threats assessment represents a modification of the International Union for the Conservation of Nature's (IUCN) traditional threats calculator. It was originally modified for use in the Inuvialuit Settlement Region Polar Bear Joint Management Plan (Joint Secretariat 2017). This modified threats assessment approach was adopted as the standard threats assessment method by the Species at Risk Committee and Conference of Management Authorities in 2019.

MAGNITUDE		
Extent (scope)	Indicates the spatial extent of the threat (based on percentage of population area affected)	Widespread (>50%) Localized (<50%)
Severity of population-level effect	Indicates how severe the impact of the threat would be at a population level if it occurred.	High Medium Low Unknown
Temporality	Indicates the frequency with which the threat occurs.	Seasonal Continuous
Overall level of concern	**Indicates the overall threat to the population (considering the above).**	**High** **Medium** **Low**

Overall Level of Concern

The overall level of concern for threats to Peregrine Falcon are noted below. Please note that combinations of individual threats could result in cumulative impacts to peregrine in the NWT. Details be found in the *Detailed Threats Assessment*.

Overall level of concern:

- **Threat 1 – Bioaccumulation of pollutants and contaminants** **Low-Medium**
- **Threat 2 – Population decline of prey species** **Low-Medium**
- **Threat 3 – Climate change** **Low-Medium**
- **Threat 4 – Parasites and diseases** **Low**
- **Threat 5 – Human disturbance** **Low**

Detailed Threats Assessment

Threat #1. Bioaccumulation of pollutants and contaminants	
Specific threat	Dichlorodiphenyldichloroethylene (DDE) in Peregrine Falcon eggs and blood plasma has declined to safe levels in Alberta and Rankin Inlet (Nunavut), while eggshell thickness has increased in Greenland but has not reached normal pre-DDT thickness. Yet, there are several other pollutants and contaminants present in the NWT or elsewhere in the species range that can bioaccumulate to levels causing physiological damage. Flame retardants (i.e., polybrominated diphenyl ether [PBDE] congeners), perfloroalkyl substances (PFASs), polychlorinated napthlalenes (PCNs), and polycholinated bipheyls (PCBs) have been detected in Peregrine Falcons in Greenland. These pollutants and contaminants are suspected to have been picked up in wintering areas in Latin America, of note mammalian wildlife in the Dehcho have picked up these contaminants. Both the mobilization of mercury (from melting permafrost) and polycyclic aromatic hydrocarbons (PAHs) may pose a future risk to Peregrine Falcons. However, PAHs are rapidly metabolized and fall back to basal levels within a year after exposure. Bioaccumulation of pollutants and chemical contaminants in Peregrine Falcons is still a poorly understood threat despite recent advances in this research topic.
Stress	PBDE concentrations are lower in Peregrine Falcon nestlings from the eastern Canadian Arctic in comparison to more southerly urban and rural areas. Thyroid hormone disruption, estrogen effects, and neurotoxicity have been mentioned as potential stress for other species, but there is no consensus whether PBDE has toxic effects on Peregrine Falcons.
Extent	Widespread (>50%)
Severity	Unknown (for non-DDE pollutants and contaminants)
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low (Information on non-DDEs is considered a knowledge gap)
Overall level of concern	**Low-Medium**

Threat #2. Population decline of prey species	
Specific threat	Recent estimates suggest that 29% of North American bird populations have declined over the last 48 years. The State of Canadian Birds Report indicates a 40% decline in shorebird populations of the Arctic tundra but a 50% increase in waterfowl populations. Shorebirds, diving ducks, and passerines make up 83% of Peregrine Falcon's diet along the Mackenzie River. Lesser Yellowlegs (*Tringa flavipes*), lesser scaup (*Aythya affinis*), and northern flicker (*Colaptes auratus*) are the most common prey species. Surveys indicate that Lesser Yellowlegs are declining (-30%), Lesser Scaup indicate a long-term decline, and Northern Flickers may be stable.
Stress	Large-scale population declines in boreal forest birds, Arctic tundra birds, and shorebirds across North America, may suggest that populations of prey are changing in the NWT. If populations of key prey species (i.e., lesser yellowlegs, lesser scaup, and northern flicker) were to decline further in the NWT, Peregrine Falcons may shift their reliance to different prey species. However, those species may also be in decline.
Extent	Widespread (>50%)
Severity	Unknown (Information on Peregrine Falcon shifting to other prey species is considered a knowledge gap)
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low-Medium**

Threat #3. Climate change	
Specific threat	In recent years, extreme rainfall events and wildfires are becoming more common worldwide and are expected to increase in frequency and severity with climate change. Black fly outbreaks are expected to increase with higher extreme rainfall events. These events have increase nestling mortality in Rankin Inlet. Climate change may lead to biotic mismatches, which is most prevalent at higher trophic levels and in the Arctic. For example, earlier peaks in arthropod abundance in the Arctic have resulted in bird species having to advance their

	arrival and breeding dates to match their prey abundance.
Stress	Heavy rainfall events have resulted in significant nestling mortality of Peregrine Falcons at Rankin Inlet and in Greenland, and have washed away nest sites located on unstable slopes along the Mackenzie River banks. Climatic indices associated with the North Atlantic Oscillation (NAO) during the autumn migration have been found to be correlated with a decrease in adult survivorship in Peregrine Falcons located in Rankin Inlet in the following autumn. Direct and indirect effects of wildfires on Peregrine Falcons remain largely unknown. However, wildfires could directly damage nest sites, increase nestling mortality, and cause disturbance due to firefighting activities, while indirectly affecting prey abundance. Peregrine Falcons have advanced their breeding dates by 1.5 – 3.6 days/decade from 1985 – 2010 as a result of climate change. There is currently no data suggesting a possible mismatch between the timing of Peregrine Falcon nesting dates and prey availability. Importantly, the negative effects of climate change could be offset by the species favourable attributes to successful establishment (i.e., large body size, broad latitudinal range, good dispersal ability and diet generalism). In fact, a warmer climate in Greenland has allowed Peregrine Falcons to extend their range northwards into gyrfalcons (*Falco rusticolos*) nest site locations.
Extent	Widespread (>50%)
Severity	Unknown
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low-Medium**

Threat #4. Parasites and diseases	
Specific threat	The presence of *Culex tarsalis*, a known vector for West Nile Virus (WNV), has been detected in the NWT from mosquito monitoring efforts between 2004 and 2018. There are no cases of WNV in the NWT, but this disease infects a wide variety of birds, including the Peregrine Falcon, although it seems to be less affected than other raptor species. With a projected warmer climate, this

	disease might cause both human and avian health issues in the NWT. Peregrine Falcon nests can be parasitized by adult black flies and blowfly larvae. Anecdotal observations also suggest that maggot infestations of nestlings are increasing along the Mackenzie River.
Stress	The direct and indirect consequences of these parasites and diseases remain unclear for Peregrine Falcons in the NWT. Current information suggests that Peregrine Falcon nestlings in Rankin Inlet parasitized by adult black flies experienced higher nestling mortality during wet years; the latter has yet been observed in the NWT.
Extent	Localized (<50%)
Severity	Unknown
Temporality	Seasonal
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**

Threat #5. Human disturbance	
Specific threat	Large developments in the NWT have the potential to effect Peregrine Falcon populations. Notably, the three operating diamond mines (i.e., Diavik, Ekati, and Gahcho Kué), the proposed rare earth mine (i.e., Thor Lake), the proposed Mackenzie Valley Highway, the proposed highway from the Slave Geological Province to the Nunavut border, and the expansion of the Taltson Hydroelectric Project.
Stress	Both the Diavik and Ekati mines do not reduce nest occupancy for Peregrine Falcons nor significantly reduce hatch success. Also, the Enbridge Norman Wells pipeline does not affect nest occupancy or reproductive success. Note that Peregrine Falcons are known to thrive in urban environments subject to significant levels of disturbance. Impacts of human disturbances on Peregrine Falcon populations are unlikely to be significant in the NWT, particularly if impact assessments are undertaken prior to construction and best management practices are followed.
Extent	Localized (<50%)

Severity	Low
Temporality	Seasonal
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**

APPENDIX B – SENSITIVE INFORMATION

Coordinates for NWT Peregrine Falcon nests are provided upon request and permission by NWT ENR.