COSEWIC
Assessment and Status Report

on the

Peregrine Falcon
Falco peregrinus

pealei subspecies – *Falco peregrinus pealei*
anatum/tundrius – *Falco peregrinus anatum/tundrius*

in Canada

***pealei* subspecies – SPECIAL CONCERN**
***anatum/tundrius* – NOT AT RISK**
2017

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2017. COSEWIC assessment and status report on the Peregrine Falcon *Falco peregrinus* (*pealei* subspecies – *Falco peregrinus pealei* and *anatum/tundrius* – *Falco peregrinus anatum/tundrius*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xviii + 108 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Previous report(s):

COSEWIC 2007. COSEWIC assessment and update status report on the Peregrine Falcon *Falco peregrinus* (*pealei* subspecies - *Falco peregrinus* and *pealei anatum/tundrius* - *Falco peregrinus anatum/tundrius*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 45 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC 2001. COSEWIC assessment and update status report on the Peregrine Falcon *pealei* subspecies *Falco peregrinus pealei* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 21 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC 2000. COSEWIC assessment and update status report on the Peregrine Falcon *anatum* subspecies *Falco peregrinus anatum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 45 pp.

Kirk, D.A., and R.W. Nelson. 1999. COSEWIC update status report on the Peregrine Falcon *pealei* subspecies *Falco peregrinus pealei* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-21 pp.

Jonhstone, R.M. 1999. COSEWIC update status report on the Peregrine Falcon *anatum* subspecies *Falco peregrinus anatum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-45 pp.

Martin, M. 1978. COSEWIC status report on the Peregrine Falcon *anatum* subspecies *Falco peregrinus* (*anatum, tundrius and pealei*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-48 pp. The 1992 assessment was based on 1978 report.

Production note:
COSEWIC would like to acknowledge Ted (Edward R.) Armstrong and Allan Harris for writing the status report on the Peregrine Falcon *anatum/tundrius* and Peregrine Falcon *pealei* subspecies, *Falco peregrinus anatum/tundrius and Falco peregrinus pealei*, in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Marcel Gahbauer, Co-chair of the COSEWIC Birds Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment and Climate Change Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Faucon pèlerin (*Falco peregrinus*) (sous-espèce *pealei* et *anatum/tundrius*) au Canada.

Cover illustration/photo:
Peregrine Falcon — Photo courtesy of Brian Ratcliff.

Catalogue No. CW69-14/516-2018E-PDF
ISBN 978-0-660-26682-4

COSEWIC
Assessment Summary

Assessment Summary – November 2017

Common name
Peregrine Falcon *pealei* subspecies

Scientific name
Falco peregrinus pealei

Status
Special Concern

Reason for designation
This subspecies occurs along much of the British Columbia coastline. Despite a continuing increase in numbers, its population remains small. However, a large portion of the population breeds in protected areas, and there is a high probability of rescue from the United States. Conversely, there remains concern that oil spills or other factors that are capable of reducing seabird populations upon which they prey could result in the subspecies declining.

Occurrence
British Columbia

Status history
The Peregrine Falcon in Canada was originally evaluated by COSEWIC 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*. The Peregrine Falcon *pealei* subspecies was designated Special Concern in April 2007 and November 2017.

Assessment Summary – November 2017

Common name
Peregrine Falcon *anatum/tundrius*

Scientific name
Falco peregrinus anatum/tundrius

Status
Not at Risk

Reason for designation
Following dramatic declines in the mid-20th century, this species has rebounded significantly over the past few decades, with continued moderate to strong increases in many parts of Canada since the last status report in 2007. The initial recovery was a result of reintroductions across much of southern Canada following the ban of organochlorine pesticides (e.g., DDT). Increasingly, the ongoing population growth is a function of healthy productivity and, in the case of urban-nesting pairs, exploitation of previously unoccupied habitat. While pollutants continue to be used on the wintering grounds of some individuals, and can be found in tissue samples, they appear to be at levels that are not affecting reproductive success at the population level. The extent to which populations have recovered relative to historical levels is generally unknown, but the consistent strong growth of the overall population suggests that there are currently no significant threats to the species.

Occurrence
Yukon, Northern Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador

Status history
The Peregrine Falcon in Canada was originally evaluated by COSEWIC 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 designated Special Concern in April 2007. Status re-examined and designated Not at Risk in November 2017.

COSEWIC
Executive Summary

Peregrine Falcon
Falco peregrinus

pealei subspecies – *Falco peregrinus pealei*
anatum/tundrius – Falco peregrinus anatum/tundrius

Wildlife Species Description and Significance

The Peregrine Falcon is a crow-sized raptor with long, pointed wings. Sexes are best distinguished by size, with females being on average 15-20% longer and 40-50% heavier than males. Adults have bluish-grey or darker upperparts, and pale underparts with variable amounts of dark spotting and barring. Immatures have upperparts that vary from pale to slate or chocolate brown, and underparts that are buffy with blackish streaks. A dark malar stripe extends from the eye across the cheek, and is generally wider on adults.

Nineteen subspecies of Peregrine Falcon are recognized globally, three of which occur in North America. The *pealei* subspecies is darker overall and is the largest, on average, in North America. The *anatum* and *tundrius* subspecies cannot be distinguished genetically, and are considered as a single entity for the purpose of this status report. Within the *anatum*/*tundrius* complex, northern birds are typically paler and smaller, while more southern birds tend to have orange to brownish tinges to their underparts.

The Peregrine Falcon became an important symbol of environmental degradation due to its dramatic declines in abundance in the middle of the 20th century, and its recovery has been heralded as a conservation success story. It is one of the more desired falconry species globally.

Distribution

The Peregrine Falcon is one of the world's most widely distributed bird species, occurring on every continent except Antarctica. The *pealei* subspecies is restricted to the western coast of North America, and in Canada it is limited to the marine coasts of British Columbia from northwestern Vancouver Island to the Alaska panhandle, with the majority occurring on Haida Gwaii (formerly known as the Queen Charlotte Islands). The *anatum/tundrius* Peregrine Falcon is widely distributed across Canada, breeding in every jurisdiction except Prince Edward Island, but its distribution in southern Canada is discontinuous. It occurs in southern parts of British Columbia and the Prairie Provinces, and across eastern Canada from the Great Lakes Basin to the Bay of Fundy, but does not breed on the island of Newfoundland. Arctic-nesting Peregrine Falcons breed from the Beaufort Sea coast of the Yukon east to Labrador and north to Baffin Island.

Habitat

The Peregrine Falcon breeds in a wide variety of habitats, including tundra, coastal islands, desert canyons, and major metropolitan centres. Higher densities are often found in Arctic and coastal habitats. Although its diet is flexible, it breeds only where there is access to sufficient food supplies. The most commonly used habitats contain cliffs or buildings for nesting and open landscapes for foraging, with large rivers or lakes typically present nearby. Breeding sites may have a linear distribution, following rivers or coastlines. Nest sites of *pealei* Peregrine Falcons are usually on island cliffs. The *anatum/tundrius* Peregrine Falcons in northern Canada nest primarily on cliffs along large river systems. Urban habitats have become increasingly used by Peregrine Falcons in southern Canada in recent decades, with buildings, bridges and other structures being used as nest sites. The proportion of individuals nesting on cliffs versus urban habitats varies substantially across Canada. Alternate nest sites, which are not used every year, are often located within a nesting territory.

Peregrine Falcons often migrate along coasts, which provide prime hunting habitat because they coincide with the migration routes of preferred prey species, but some migrate through the interior. Peregrine Falcon wintering habitat varies widely, but typically contains aquatic and wetland habitats, and can also include urban areas. Northern-nesting *anatum/tundrius* birds generally migrate the farthest, to Central and South America, while more southern-nesting birds may not migrate as far and some even overwinter on their nesting territories. Many *pealei* Peregrine Falcons winter on or close to their nesting territories.

Biology

Peregrine Falcons maintain a nesting territory, although in areas with abundant prey, nest sites can be close together. Adults typically return to previously used nest sites, and those with high productivity are often occupied throughout successive generations. Breeding typically begins at 2-3 years of age, typically one year younger for females than males. The nest is a simple scrape on a nest ledge, usually a cliff or building, and occasionally in a stick nest of another bird. Peregrine Falcons typically lay 3-4 eggs, and incubation averages 32-35 days. The young usually begin to take flight around 40 days after hatching, with males typically fledging earlier than females. Both adults incubate, with the female usually doing more of the incubation. Nest productivity varies considerably, both annually and regionally, and is heavily influenced by individual condition, severe weather events, and prey availability. Productivity among *pealei* Peregrine Falcons averages 1.9 young fledged per territorial pair. For *anatum/tundrius* Peregrine Falcons in southern Canada it has ranged between 1.5-1.9 young/territorial pair since 1995, while in northern Canada it has consistently remained at or below 1.5. Peregrine Falcons typically prey upon small to medium-sized birds that are hunted in the air, although they can pursue a wide range of prey, including rodents in the Arctic.

Population Sizes and Trends

The Canadian *pealei* Peregrine Falcon nesting population is presently considered to be stable to slightly increasing, with the recent total of 119 occupied nests documented in 2015 being a record high, although the trend may in part reflect increasing survey effort over time. Overall, the population is estimated at 250-1000 mature individuals.

There are 300 known pairs of *anatum/tundrius* Peregrine Falcons in southern Canada, an area with good survey coverage, and the total population for the region is estimated at approximately 1000 mature individuals. In northern Canada, a minimum of 479 known nesting sites[1] have been identified within regularly surveyed study areas, and the population for these surveyed areas is estimated at 1,500 mature individuals. However, the vast majority of the Arctic region is not surveyed and the total population is undoubtedly much larger. The total post-breeding population of northern North America (Canada, Alaska, and Greenland) in 2000, based upon mark-recapture studies of hatching-year birds, was estimated to represent more than 60,000 mature individuals. Based upon this estimate and subsequent rates of population growth, the Peregrine Falcon population in northern Canada is conservatively estimated to be at least 35,000 mature individuals.

Although the historical population size was not well documented, given the remoteness of most nest sites, there was an evident dramatic decline in Peregrine Falcon numbers in the middle of the 20th century because of widespread contamination by DDT (dichlorodiphenyltrichloroethane), which resulted in impaired reproduction through thinning of eggshells. The *pealei* Peregrine Falcon population has been gradually increasing over the past several decades at an estimated rate of almost +2% per year. The most recent estimates of population growth over a 20-year period for southern Canada *anatum/tundrius* subpopulations range from +50% in Saskatchewan to +3233% in Ontario. Although generally increasing, northern-nesting *anatum/tundrius* Peregrine Falcon subpopulations have shown more variability across jurisdictions and years. From 1990-2010, the number of occupied territories in five regularly surveyed areas of northern Canada increased by an average of 1.3% per year, with a range over 20 years from -5% in Labrador to 100% in Nunavut.

Threats and Limiting Factors

The Peregrine Falcon remains potentially vulnerable to threats including toxic chemicals, heavy metal contamination, and severe weather effects associated with climate change. However, climate change may also have some positive effects, such as an extended nesting season for High Arctic subpopulations. Regulated harvest levels for falconry purposes appear to be sufficiently low to avoid population impacts. Overall, no substantial threats are currently apparent for *anatum/tundrius*, as reflected by the steady increase in numbers across most of Canada. Given its reliance on seabirds, the *pealei* subspecies remains vulnerable to oil spills and other pollution that may affect these prey, as well as other natural system modifications that could result in seabird declines.

[1] Based upon the number of observed nesting sites in the 2010 survey, supplemented by higher counts for regions also surveyed in 2015 and the highest recent count for regions not surveyed in 2010.

Protection, Status and Ranks

Peregrine Falcon *anatum/tundrius* was assessed by COSEWIC as Special Concern in April 2007 and reassessed as Not at Risk in November 2017. The *pealei* subspecies was assessed as Special Concern in April 2007 and November 2017.The *anatum/tundrius* and the *pealei* subspecies of the Peregrine Falcon are both listed as Special Concern under Schedule 1 of the federal *Species at Risk Act*. Peregrine Falcon is currently listed under Appendix 1 of the Convention on International Trade in Endangered Species of Flora and Fauna. In addition to the national management plan, a number of provinces and national parks have management plans or recovery strategies for the Peregrine Falcon.

TECHNICAL SUMMARY - Peregrine Falcon *pealei* subspecies

Falco peregrinus pealei

Peregrine Falcon *pealei* subspecies
Faucon pèlerin de la sous-espèce *pealei*
Range of occurrence in Canada: British Columbia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2016) is being used)	6 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No. Population is likely stable or increasing.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	N/A. Population is not declining.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last 3 generations	Observed +37% increase in the number of occupied sites from 1995 to 2015 (3.3 generations), although increased survey effort over time suggests that this projection may be artificially high and a stable or smaller increase in population is more likely.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Population projected to remain stable or gradually increase.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Population thought to have increased in recent years and projected to continue to remain stable or gradually increase.
Are the causes of the decline: a. clearly reversible and b. understood and c. ceased?	 a. Yes, in part. b. Yes. c. Yes, in part. Oil spills, chemical pollutants and climate change remain ongoing concerns.
Are there extreme fluctuations in number of mature individuals?	No.

Extent and Occupancy Information

Estimated extent of occurrence *Calculation is based on the range envelope polygon described by the breeding range in Figure 2. Areas of water were not excluded.*	147,000 km².
Index of area of occupancy (IAO)	Approximately 9,000 km².

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	No.
Number of "locations2*	Estimated at 6-10. Oil spills are the threat most likely to affect a substantial portion of the population.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No.
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No.
Are there extreme fluctuations in number of subpopulations?	No.
Are there extreme fluctuations in number of "locations"?	No.
Are there extreme fluctuations in extent of occurrence?	No.
Are there extreme fluctuations in index of area of occupancy?	No.

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Total population	250-1,000 (BCCDC 2016a).

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 20 years or 5 generations, or 10% within 100 years.	Not conducted.

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on March 9, 2017.

Overall threat impact of low, based on two identified threats:
- Pollution (Category 9), in particular the risk of oil spills with potential for direct effects on Peregrine Falcons and indirect effects through mortality to seabird prey, but also continued persistence and use of organochlorine pesticides.
- Natural system modifications (Category 7), specifically declines in seabird populations, which are a critical prey base.

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Stable in adjacent USA (Washington S2B; Alaska S2S3; NatureServe 2016); the Washington population is not large and there is some uncertainty about the distribution of *pealei* versus *anatum/tundrius* in coastal Washington (Hayes and Buchanan 2002).
Is immigration known or possible?	Yes.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Yes. Additional nest sites appear to be available (BCMOE 2016).
Are conditions deteriorating in Canada? +	No, although there are some concerns about the seabird prey base.
Are conditions for the source population deteriorating?	No.
Is the Canadian population considered to be a sink?	No.
Is rescue from outside populations likely?	Yes.

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The Peregrine Falcon in Canada was originally evaluated by COSEWIC 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*. The Peregrine Falcon *pealei* subspecies was designated Special Concern in April 2007 and November 2017.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Met criterion for Threatened, D1, but designated Special Concern given a continuing increase in numbers, a large part of the population breeding in protected areas, and rescue effect.

Reasons for designation:

This subspecies occurs along much of the British Columbia coastline. Despite a continuing increase in numbers, its population remains small. However, a large portion of the population breeds in protected areas, and there is a high probability of rescue from the United States. Conversely, there remains concern that oil spills or other factors that are capable of reducing seabird populations upon which they prey could result in the subspecies declining.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals):
Not applicable. Subspecies is not declining.

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO are above thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Subspecies is not declining.
Criterion D (Very Small or Restricted Population): Meets Threatened, D1, as the population is less than 1000 mature individuals.
Criterion E (Quantitative Analysis): Not conducted.

TECHNICAL SUMMARY - Peregrine Falcon *anatum/tundrius*

Falco peregrinus anatum/tundrius

Peregrine Falcon *anatum/tundrius*

Faucon pèlerin *anatum/tundrius*

Range of occurrence in Canada: Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador; does not breed on the island of Newfoundland

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2016) is being used)	6 years.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No – population is increasing.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Not applicable – population is not declining.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Observed increase in the number of nesting territories over a 20-year period (3.3 generations) averaging +13.5% (range from -5% to 100%) in northern Canada, and averaging 162% (range +50% to +3233%) in southern Canada.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Subpopulations in southern Canada are projected to continue to increase substantially. However, it is likely that the rate of increase will be somewhat slower than over the past three generations, as the species may be approaching carrying capacity in some areas, especially Saskatchewan and Manitoba. The Mackenzie River (NT) subpopulation is likely to follow a similar increasing trend to that in southern Canada. Subpopulations elsewhere in northern Canada are expected to remain stable or increase slightly, based on trends over the past three generations.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	The breeding population in Canada is conservatively expected to increase by at least 12.6%, based upon past trends in northern Canada as most of the population occurs in the north. However, the southern Canada breeding subpopulation has increased more rapidly than in the north in recent decades, and is projected to continue to do so.

Are the causes of the decline: a. clearly reversible and b. understood and c. ceased?	 a. Yes. b. Yes. c. In part. Chemical pollutants and climate change remain ongoing concerns.
Are there extreme fluctuations in number of mature individuals?	No.

Extent and Occupancy Information

Estimated extent of occurrence *Calculation is based on the range envelope polygon described by the breeding range in Figure 1. Areas of water were not excluded*	12,461,000 km^2 (exceeds area of Canada as convex polygon includes some ocean and USA territory).
Index of area of occupancy (IAO)	Minimum 69,700 km^2.
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	No. Population is not severely fragmented, although it is not continuous across Canada. There is some ecological and behavioural fragmentation as urban and rural birds raised in one habitat type only rarely disperse to the other habitat type to breed.
Number of "locations" (use plausible range to reflect uncertainty if appropriate)	Unknown, but certainly much greater than 10.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No.
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No overall observed decline in breeding habitat, although there has been a decline in foraging habitat due to wetland loss on more developed parts of Canada, and the conversion and simplification of agricultural landscapes in some parts of southern Canada
Are there extreme fluctuations in number of subpopulations?	No.
Are there extreme fluctuations in number of "locations"?	No.
Are there extreme fluctuations in extent of occurrence?	No.

Are there extreme fluctuations in index of area of occupancy?	No.

Number of Mature Individuals (in each subpopulation)

Subpopulations (see Figure 1)	**N Mature Individuals**
Southern Canada	Minimum estimate of 900, based upon a pair at each known breeding site (300) and a surplus non-breeding population comprising an estimated 50% of the breeding population. As this area is surveyed relatively thoroughly, a conservative estimate would be that 10% of the total breeding subpopulation was not surveyed, leading to a conservative subpopulation estimate of approximately 1,000 mature individuals.
Northern Canada	Minimum estimate of 1,500 in regularly surveyed study areas, based upon a pair at each known breeding site (500) and a surplus non-breeding population comprising an estimated 50% of the breeding population[3]. The vast majority of the total breeding subpopulation and range has not been surveyed in Canada. Extrapolated population estimates for North America based upon mark/recapture of hatching year birds suggest a northern Canada population of 35,100 mature individuals or higher.
Total	Range of 36,000-40,000

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not conducted for Canadian populations. A population viability analysis of a recovered population in Sweden suggested that carrying capacity would be reached within 30 years without further manipulation, and the probability of extirpation was 0% (Ebenhard 2000).

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, on March 9, 2017. Overall threat impact was rated as unknown, based largely on pervasive exposure to pollution but uncertainty about the severity of current and future effects. Other threat categories all have negligible exposure and or severity; this is consistent with the widespread increase in numbers indicating that any existing threats are currently not sufficient to be causing declines.

[3] A very conservative estimate, well below other estimates of 100-200% (Newton 1977; White *et al*. 2002; Franke 2016).

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Stable to increasing, although NatureServe (2016) status remains low in most states adjacent to Canada: Washington S2, Idaho S2, Montana S3, North Dakota SNR, Minnesota S2, Michigan S1, Ohio S1, Pennsylvania S1, New York S3, Vermont S3, New Hampshire SNR, Maine S2.
Is immigration known or possible?	Yes, known. There is some variable genealogy in populations adjacent to southern/eastern Canada from Peregrine Falcons released in the USA that were not *anatum/tundrius*.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Yes.
Are conditions deteriorating in Canada?	No.
Are conditions for the source population deteriorating?	No.
Is the Canadian population considered to be a sink?	No.
Is rescue from outside populations likely?	Yes.

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The Peregrine Falcon in Canada was originally evaluated by COSEWIC 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 designated Special Concern in April 2007. Status re-examined and designated Not at Risk in November 2017.

Status and Reasons for Designation:

<table>
<tr><td>Status:
Not at Risk</td><td>Alpha-numeric codes:
Not applicable</td></tr>
<tr><td colspan="2">Reasons for designation:
Following dramatic declines in the mid-20th century, this species has rebounded significantly over the past few decades, with continued moderate to strong increases in many parts of Canada since the last status report in 2007. The initial recovery was a result of reintroductions across much of southern Canada following the ban of organochlorine pesticides (e.g., DDT). Increasingly, the ongoing population growth is a function of healthy productivity and, in the case of urban-nesting pairs, exploitation of previously unoccupied habitat. While pollutants continue to be used on the wintering grounds of some individuals, and can be found in tissue samples, they appear to be at levels that are not affecting reproductive success at the population level. The extent to which populations have recovered relative to historical levels is generally unknown, but the consistent strong growth of the overall population suggests that there are currently no significant threats to the species.</td></tr>
</table>

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Subspecies is not declining.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO and IAO are both very large.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Subspecies is not declining.
Criterion D (Very Small or Restricted Population): Not applicable. Population exceeds all thresholds.
Criterion E (Quantitative Analysis): Not conducted.

PREFACE

The Peregrine Falcon has gained a high profile as an emblematic symbol of species at risk conservation. There has been a great deal of research and monitoring effort directed towards this species globally, more so than for most raptor species (e.g., Kiff *et al.* 2007). This includes considerable additional research in Canada since the 2007 status report was published (e.g., see **Information Sources**), much of which was directed towards the diminishing effects of previous threats and the potential implications of new threats and limiting factors. New genetic research has also clarified and expanded our understanding of taxonomy, especially as it relates to subspecies. There has also been continued monitoring effort directed towards understanding the status of this species. This monitoring has been relatively consistent within jurisdictions, but varies considerably among them. Survey coverage has approached 100% of suitable and historical habitat in southern Canada, but is much more localized in the north, covering a far smaller proportion of suitable habitat. This updated status report thus incorporates the results of a number of recent research initiatives, as well as the continued nationwide monitoring surveys that have traditionally occurred every five years since 1970.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2017)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Peregrine Falcon
Falco peregrinus

pealei subspecies – *Falco peregrinus pealei*
anatum/tundrius – *Falco peregrinus anatum/tundrius*

in Canada

2017

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The most widely accepted common name for *Falco peregrinus* is Peregrine Falcon (AOS 2017). It was formerly also known as Duck Hawk, and is sometimes simply referred to as Peregrine. The French name is Faucon pèlerin. Its taxonomy is as follows:

Class: Aves
Order: Falconiformes
Family: Falconidae
Genus: *Falco*
Species: *Falco peregrinus.*

Current classification follows the American Ornithological Society's checklist of North and Middle American birds (7th edition and supplements) (AOS 2017). Nineteen subspecies of Peregrine Falcon have been recognized, three of which are present in North America – the American Peregrine Falcon (*Falco peregrinus anatum*)*,* the Arctic Peregrine Falcon (*F. p. tundrius*) and Peale's Peregrine Falcon (*F. p. pealei*) (White and Boyce 1988; White *et al.* 2002). However, the *anatum* and *tundrius* subspecies are not genetically distinct (Brown *et al.* 2007; Johnson *et al.* 2010), and are considered jointly in this report as *anatum/tundrius*.

Morphological Description

The Peregrine Falcon is a crow-sized, medium-to-large raptor with long, pointed wings. It is the only falcon whose wing tips reach the tip of the tail when perched (Clark 2007). Sexes are best distinguished by size, with females being 15-20% longer and 40-50% heavier than males. Males range in length from 36-49 cm and weigh 650 g on average (450-1060 g). Females range from 45-58 cm with an average weight of 950 g (800-1600 g). There is little overlap in size between sexes within a given subspecies (White 1968; White *et al.* 2002; Farmer *et al.* 2008).

Adults have bluish-grey or darker upperparts, and pale underparts that are whitish, greyish, or buffy with variable amounts of dark spotting and barring. Immatures have upperparts that vary from pale to slate or chocolate brown, and underparts that are buffy with blackish streaks. A dark malar stripe extends from the eye across the cheek, and is typically broader on adults.

There are plumage and morphological differences among subspecies, but they are clinal. Paler birds occur in dry areas and darker birds in wetter areas; smaller birds occur in the north and larger birds in the south and west. Typically, *tundrius* Peregrine Falcons were reported as paler and smaller, while *anatum* birds were reported to have orange or brownish tinges to underparts; *pealei* Peregrine Falcons are darker overall and are on average the largest Peregrine Falcons in North America (White 1968; White *et al*. 2002; BCMOE 2016). Highly migratory *anatum/tundrius* Peregrine Falcons such as those nesting in the Arctic tend to have longer and narrower wings, compared to resident or typically non-migratory birds such as *pealei* (White and Boyce 1988).

Population Spatial Structure and Variability

<u>Genetic Diversity and Population Structure</u>

The Peregrine Falcon is most closely related to the Prairie Falcon (*Falco mexicanus*; White *et al.* 2002), and may on very rare occasion hybridize with it (Oliphant 1991). The *pealei* subspecies is genetically distinct, but studies have shown that *anatum* and *tundrius* were not historically genetically distinguishable (Brown *et al.* 2007). Currently, there are weak genetic differences between parts of the range traditionally associated with *anatum* and *tundrius,* but these appear to be due mainly to changes in genetic diversity within the *anatum* range related to the reintroduction of birds (in adjacent US states) from a variety of genetic backgrounds (Brown *et al.* 2007; Johnson *et al.* 2010). A similar situation appears to have occurred in southern Scandinavia, where the genetic composition of the Peregrine Falcon population appears to have been altered as a result of introductions from captive breeding stock (Jacobsen *et al.* 2008). Results suggest that there is considerable gene flow between areas traditionally associated with *tundrius* and *anatum* Peregrine Falcon populations across Canada, Alaska, and Greenland (Johnson *et al.* 2010).

<u>Reintroductions and Genetic Heritage</u>

Captive-bred Peregrine Falcons were reintroduced into Canada and the USA following the collapse of eastern North American subpopulations in the 1950s and 1960s. The number of releases in North America peaked in 1990, at over 500 birds that year (Heinrich 2009), although it was not the peak year for releases in Canada. Over 2,000 *anatum* Peregrine Falcons were released in Canada between 1975 and 1996 as part of a recovery program led by Environment Canada (Erickson *et al.* 1988; Holroyd and Bird 2012). Smaller numbers of releases continued beyond that period, and remain ongoing in some provinces, including Alberta (e.g., Court 2015). In the USA, Peregrine Falcon releases were concentrated in northeastern North America. In the northeastern USA, 2,500 Peregrine Falcons of multiple subspecies, including four subspecies not native to North America, were released in 13 states including several adjacent to eastern Canada (e.g., New York, Minnesota, Michigan, Wisconsin, Ohio) (Tordoff and Redig 2001). Overall, 5,000 birds were released in the USA (Heinrich 2009). The majority of birds released in the eastern USA were *tundrius* (46%), *anatum* (18%), and the Mediterranean Peregrine Falcon, *F.p. brookei* (18%), while in the Midwest USA the majority were *anatum* (57%) and *pealei* (27%) (Tordoff and Redig 2001). There was considerable controversy regarding the introduction of subspecies from outside of North America into the USA, with potential concerns being raised regarding the genetic integrity of breeding *anatum* Peregrine Falcons (Tordoff and Redig 2001). The primary rationale for using this range of subspecies in the USA was that the original “Rock Peregrine Falcons” were a larger phenotype of *anatum* that were effectively extirpated from eastern North America and not available for re-introduction, and that this genetic variability would provide ample opportunity for natural selection to take effect (Tordoff and Redig 2001). In Canada, only *anatum* Peregrine Falcons were released through the recovery program (Holroyd and Bird 2012), although there are unsubstantiated reports of the release of some *pealei* falcons by falconers to the Gulf Islands in the 1970s (BCMOE 2016). However, by the early 2000s there were no pure *anatum* pairs known to be breeding in southern Ontario (Gahbauer *et al*. 2015a). In Manitoba, almost all (97%) of the wild-hatched young (1989-2016) had one parent that originated in the Midwest USA (Maconachie pers. comm. 2017). Despite the known mixing of eastern Canadian and USA-reared birds on both sides of the international border, the rate of introgression of microsatellites of other subspecies was low (<1.6%; Brown *et al*. 2007). It appears that USA birds of diverse genetic origin have likely had only a minor effect on the genetic composition of Peregrine Falcons in southern Canada.

Designatable Units

The three subspecies of Peregrine Falcon in Canada were assessed separately by COSEWIC from 1977 to 2001. The *pealei* Peregrine Falcon is clearly distinct genetically, and tends to be larger than other North American subspecies. It also differs in terms of its largely sedentary nature and heavy reliance on seabirds as prey, and is therefore recognized as a distinct designatable unit. However, given studies showing that *anatum* and *tundrius* Peregrine Falcons are not genetically distinguishable (Brown *et al*. 2007), and show a clear continuum in terms of distribution and plumage, the two subspecies were considered as a single designatable unit for the 2007 COSEWIC evaluation, and this report continues that approach.

Special Significance

The Peregrine Falcon became an important environmental symbol during the 1970s, and very large investments towards its recovery were made across North America. The collapse of the North American population of Peregrine Falcons precipitated by DDT (dichlorodiphenyltrichloroethane) contamination helped to galvanize a shift in public attitudes toward better environmental stewardship, and it was one of the primary factors leading to the establishment of endangered species legislation across North America. More recently, the species' recovery across much of its North American and global range has been heralded as a success story of endangered species legislation and many lessons have been learned from its recovery (USFWS 2008a; Heinrich 2009; Lambert *et al.* 2009; Holroyd and Bird 2012).

The Peregrine Falcon continues to globally be a very highly sought-after species for falconry (Weaver 1988; Bowardi 2011; Franke 2016). North America comprises 9% of the global source of exported Peregrine Falcons, and these birds are primarily exported to North Africa and the Middle East (53%), and Asia outside of the Middle East (24%) (Convention on International Trade in Endangered Species 2016a).

As a top predator, Peregrine Falcon has the potential to influence the population status of rare or at-risk species such as Red Knot (*Calidris canutus*), an endangered species that is potentially impacted by Peregrine Falcon predation during staging (Watts 2009, 2016).

Aboriginal Traditional Knowledge is not currently available for this species (Jones pers. comm. 2016).

DISTRIBUTION

Global Range

The Peregrine Falcon is one of the mostly widely distributed birds globally, occurring on all continents except Antarctica (White *et al*. 2013). Peregrine Falcons nest into the extreme High Arctic, although less commonly than elsewhere (Burnham *et al.* 2012).

Falco peregrinus pealei

The *pealei* Peregrine Falcon breeds along the western coast of North America, from southern British Columbia to the Aleutian Islands of Alaska (Hayes and Buchanan 2002; Cooper 2007; BCCDC 2016a). It may also breed in Oregon and Washington, although there is some uncertainty over its status in Washington (Hayes and Buchanan 2002). Its range is not completely contiguous, as the Pacific coast of southern Alaska is apparently inhabited by *anatum/tundrius* Peregrine Falcons rather than *pealei* (Lewis and Kissling 2015). The *pealei* subspecies is also resident on the Commander and Kuril islands of Russia, and possibly Japan (BCCDC 2016a).

Falco peregrinus anatum/tundrius

The a*natum/tundrius* Peregrine Falcon breeds from the interior of Alaska, across northern Canada to Greenland, then south through continental North America to northern Mexico (White *et al*. 2002). It is not found along most of the Pacific coast of British Columbia and Alaska, but does occur on the British Columbia coast in the Lower Mainland, Vancouver Island, and Gulf Islands area, and may also nest in coastal Washington and Oregon (Hayes and Buchanan 2002; White *et al*. 2002). Peregrine Falcons were extirpated from the eastern United States by 1964 (Henny and Elliott 2007), but have returned to much of their former range and colonized new urban habitat.

Canadian Range

Approximately 12% of the global population of *pealei* Peregrine Falcons occurs in British Columbia (BCMOE 2016). The *pealei* Peregrine Falcon is restricted to coastal British Columbia, being uncommon but well distributed from northern and western Vancouver Island to the Alaska panhandle (Figures 1 and 2). The population is centred on Haida Gwaii, which supports over 70% of Canadian breeding pairs (BCCDC 2016a; BCMOE 2016).

Over 60% of the North American range of the *anatum/tundrius* Peregrine Falcon occurs in Canada (Environment Canada 2015). It breeds in all Canadian provinces and territories except Prince Edward Island and the island of Newfoundland, but with a disjunct distribution between southern and northern Canada (see Figure 1). In southern Canada, the *anatum/tundrius* Peregrine Falcon nests from the southwest coast of British Columbia and the lower Fraser River valley, eastward to the Bay of Fundy in the Maritime Provinces (Cooper and Beauchesne 2004; Brown *et al*. 2007; Environment Canada 2015). Range is expanding in British Columbia, where a new nest site on the Interior Plateau extended the breeding range considerably northward in B.C.'s interior (Chutter 2015a). In the southern prairies, the Peregrine Falcon is sparsely distributed and is primarily restricted to urban centres. Peregrine Falcons occur in both southern and northeastern Alberta (Alberta Peregrine Falcon Recovery Team 2005). Peregrine Falcons now nest in several urban sites in southern Saskatchewan, but historically nested in the extreme southwest and northwest parts of the province (Smith 1996). The only documented nesting sites in Manitoba are in southern cities. No formal survey work has been conducted in northern regions of Manitoba where there is some potential for nesting based upon habitat availability, anecdotal reports, breeding season eBird reports and bird atlas records (Franke pers. comm. 2016; Maconachie pers. comm. 2016; Bird Studies Canada 2017; eBird 2017a). The Peregrine Falcon now occurs across much of the Great Lakes watershed and the St. Lawrence River Valley of southern Ontario and southern Quebec, although formerly occupied range in central Ontario east of Georgian Bay (Lake Huron) remains vacant. In Nova Scotia and New Brunswick, nesting is primarily along or adjacent to the Bay of Fundy. Migratory Peregrine Falcons are occasionally seen in Prince Edward Island, but there are no breeding records (Gregory pers. comm. 2016).

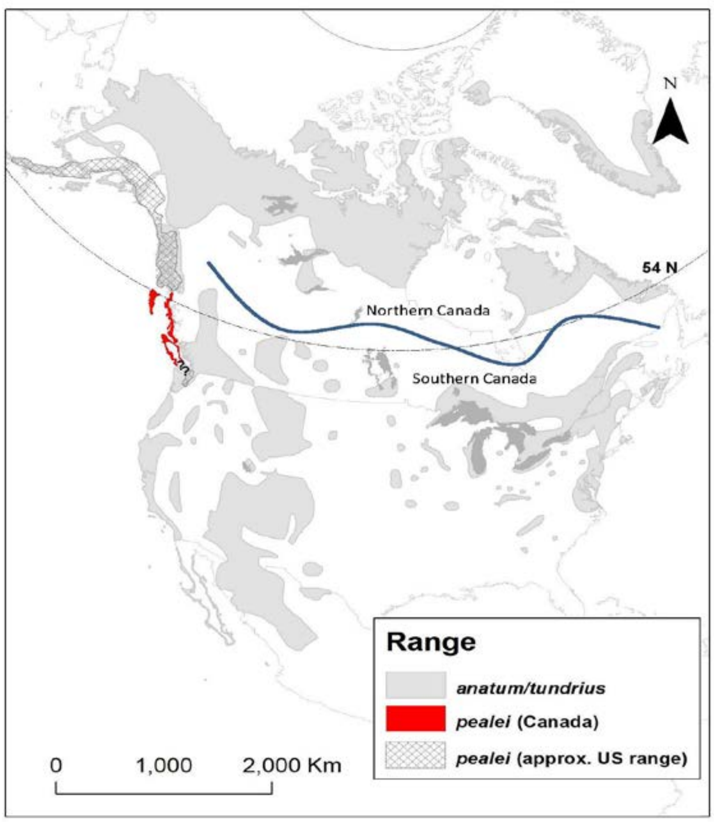


Figure 1. Canadian and North American breeding distribution of the Peregrine Falcon (adapted from Johnsgard 1990; Rowell and Stepnisky 1997; Walton *et al.* 2013; Environment Canada 2015).[4]

[4] Delineation between northern and southern Canada is a very general distinction to recognize broadly separated range

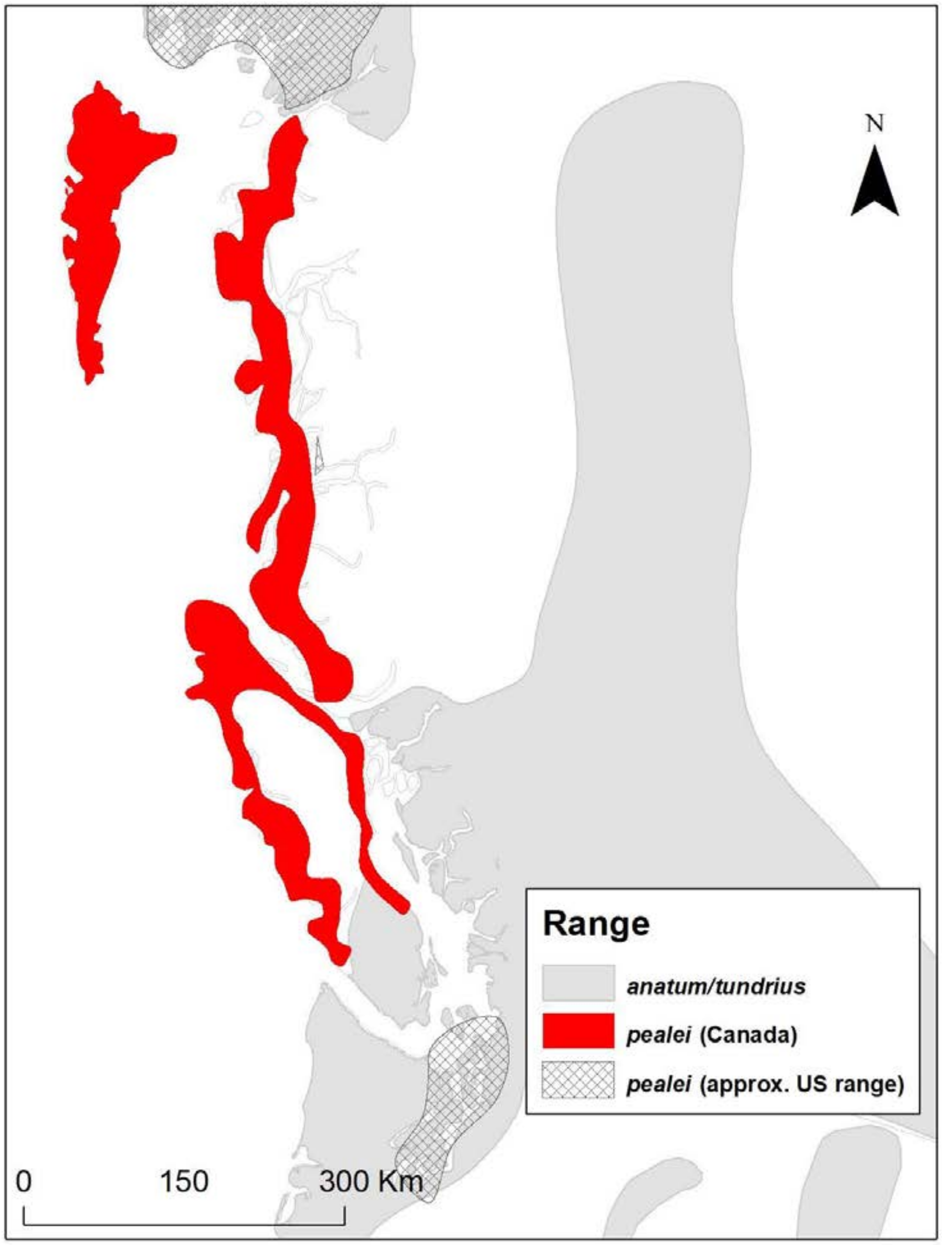


Figure 2. Canadian and North American breeding distribution of the *pealei* Peregrine Falcon (adapted from Johnsgard 1990; Rowell and Stepnisky 1997; Walton *et al.* 2013; B.C. Ministry of Environment. 2016).

Northern-nesting Peregrine Falcons breed from the Beaufort Sea coast of the Yukon Territory east across the low Arctic islands of Nunavut, Hudson Bay, Ungava, and Labrador. They occur as far north as Banks Island and northern Baffin Island. Peregrine Falcons are widely distributed in the Northwest Territories and Nunavut, and there are undoubtedly many more sites where they nest but no nest searches have been conducted (Carrière pers. comm. 2016). The Ungava Peninsula supports a substantial Peregrine Falcon subpopulation (Bird and Weaver 1988), and a 2016 survey found many new nest sites (Fradette 2016). Peregrine Falcons occur along the Atlantic coast from northern Quebec to Labrador well south of 54°N. Recent bird atlas effort has substantially increased information on the distribution of Peregrine Falcons breeding in northern Quebec (Appendix 1). Despite historical reports that Peregrine Falcons nest in the Hudson Bay lowlands of northern Ontario (Fyfe 1969), this report has never been substantiated and appears to be erroneous (Peck 1972; Sutherland pers. comm. 2016), although there are a number of breeding season (June-July) observations in the area (eBird 2017a), presumably floaters taking advantage of abundant shorebird prey.

The geographic boundary between *pealei* and *anatum/tundrius* subspecies in Canada is not precisely defined. Within British Columbia, some individuals from the Strait of Georgia and all birds sampled from the lower Fraser River valley of coastal British Columbia appear to be *anatum/tundrius*, whereas all birds sampled from the outer British Columbia coast are *pealei* (Cooper 2007). There is a zone of overlap between *pealei* and *anatum/tundrius* birds on southeast Vancouver Island and the Gulf Islands (BCMOE 2016). Both subspecies are present, and hybridization is known to occur (BCMOE 2016). The degree of overlap in distribution between *pealei* and *anatum/tundrius* Peregrine Falcons in adjacent Washington may be similar with some degree of intergradation, with the outer coast representing *pealei* Peregrine Falcons and the San Juan Islands representing *anatum/tundrius* and/or intergrades between the two (Hayes and Buchanan 2002).

Extent of Occurrence and Area of Occupancy

The calculated extent of occurrence (EOO) is 147,000 km^2 for *pealei* and over 12 million km^2 for *anatum/tundrius*, as measured by a minimum convex polygon based on distribution shown in Figures 1 and 2. The latter estimate is exceptionally large because the species occurs in every Canadian jurisdiction except PEI, and while disjunct, the distribution across Canada is quite extensive. These estimates also include some open ocean and, in the case of *anatum/tundrius*, some USA territory.

The index of area of occupancy (IAO) cannot be calculated precisely based upon 2 km x 2 km grids intersecting known areas of occupancy because of the species' very large distribution and incomplete information on the distribution of all breeding sites, particularly in the north. However, it is clearly much greater than the COSEWIC minimum threshold of 2,000 km^2 for both subspecies groupings. An approximation of the IAO for *pealei*, based upon an average home range size of 78 km^2 (using the estimated 5 km foraging radius reported in Nelson [1990]) for 119 occupied sites in 2015), yields an estimate of over 9,000 km^2. For *anatum/tundrius* Peregrine Falcons, an average home range size between 100 km^2 (L'Hérault *et al*. 2013; Sokolov *et al.* 2014; Franke pers. comm. 2016) and 500 km^2 (White *et al.* 2002) and minimum of 697 nesting sites documented in the 2010 survey (a small proportion of the total breeding population), yields an estimate of 69,700-348,500 km^2.

HABITAT

Habitat Requirements

Breeding Habitat

The Peregrine Falcon breeds in a wide variety of habitats, including Arctic tundra, coastal islands, desert canyons, and major metropolitan centres (Cade 1982); greater densities tend to be found in tundra and coastal habitats (White *et al*. 2002). Although its diet is flexible, it breeds only in suitable habitat with access to sufficient prey. The most commonly occupied habitats feature cliffs for nesting, open areas for foraging, and nearby water (White *et al*. 2002). Large tracts of dense, closed forests appear to be one of the few habitat types where Peregrine Falcons do not occur, as they require open or partially open conditions to hunt for prey (Ratcliffe 1988).

The presence of large waterbodies is typically very important (Dennhardt and Wakamiya 2013). Nesting of *pealei* Peregrine Falcons occurs near the marine coastline, usually on island cliffs, and no nesting records are known from inland sites (BCMOE 2016). In the Arctic, nests are primarily on riparian cliffs along large river systems (Ritchie *et al.* 2004; Carrière and Matthews 2013; Mossop 2015). In the Ungava Bay region of northern Quebec, cliffs used for nesting are typically found in close association with water (Bird and Weaver 1988). Nesting sites in Labrador are mostly along coastal cliffs, with inland sites being on steep cliffs alongside rivers and lakes (Rodrigues 2010). In Ontario, 96% of historically documented nesting sites were adjacent to water (Peck and James 1987). This pattern appears to be changing somewhat with the expansion of urban subpopulations. Of 52 urban/quarry nest sites examined in northeastern North America, 30 (57%) were within 1 km of waterbodies, but 18 (35%) were 1-5 km from water and 4 (8%) were 5-20 km from water (Gahbauer *et al.* 2015b). Manitoba's urban-nesting Peregrine Falcons spend much of their time at wetlands in southern Manitoba during the breeding season, based upon prey remains, satellite telemetry data, sightings, and mortality reports (Maconachie pers. comm. 2017).

Home ranges for *pealei* Peregrine Falcons average 78 km^2 based upon the estimated 5 km foraging radius reported in Nelson (1990). Estimates of average home range size for *anatum/tundrius* Peregrine Falcons vary from 100 km^2 (L'Hérault *et al*. 2013; Sokolov *et al.* 2014) to 500 km^2 (White *et al.* 2002), although home ranges up to 1,500 km^2 have been reported (Enderson and Craig 1997). In an agricultural landscape of southern Quebec, nesting home ranges for female Peregrine Falcons averaged 83.9 km^2 (range of 0.3-392.5 km^2), increasing to 201.9 km^2 (range of 100-811.1 km^2) in the month after fledging (Lapointe *et al.* 2013).

Nesting Habitat

Peregrine Falcon nest site characteristics are remarkably similar worldwide, and may be the most important factor in determining breeding habitat (CITES 2016). Preferred nesting sites are typically ledges on high cliffs with wide lateral extent affording wide fields of view; these sites provide good conditions for hunting and territory defence, security from interference, and multiple perching and nesting options (Ratcliffe 1962; Newton 1988a). Habitat characteristics that best predicted nest occupancy of Peregrine Falcons in Greenland were inaccessibility to predators, ledges with bare ground, higher cliff height, lower height of terrain opposite the nest, and less overhead exposure (Wightman and Fuller 2005). Ratcliffe (1993) viewed cliff-nesting as an adaptation against nest predation, with the value of the nest site being related to its inaccessibility, requiring steep rock walls above and below. Other advantages include better views of potential competitors, nearby prey and foraging habitat, and conditions that allow resident birds to quickly attain high velocities (Bruggeman *et al.* 2016). Cliffs ranging from 50-200 m in height are generally preferred, although smaller cliffs are sometimes selected (Cade 1960; White and Cade 1971; Newton 1988a). There is a tendency for smaller and more marginal cliffs to be used as population density increases (Ratcliffe 1988,1993; Barnes *et al*. 2015). In Ontario, nesting Peregrine Falcons have begun to use more cliffs of lower height and shorter linear extent of cliff face, and lower buildings for nesting, a trend which is anticipated to continue (Armstrong and Ratcliff 2010). A similar trend towards the use of lower quality nesting sites as the population recovered may also have occurred in a very different ecosystem among Arctic-nesting Peregrine Falcons, with increasing use of lake cliffs as opposed to the more traditionally used river systems (Ritchie *et al*. 2004). Nests of *pealei* Peregrine Falcons have been found on cliffs as high as 366 m (BCMOE 2016). In Alaska, Peregrine Falcon abundance at cliffs is positively associated with cliff height (Bruggeman *et al.* 2015). Habitat in urban environments appears to be selected based primarily upon the availability of suitable buildings and shelter (i.e., ledges and overhead cover) (Gahbauer *et al.* 2015b).

As nesting density increases, broad areas of occupied habitat are being infilled by Peregrine Falcons. For example, the nearest-neighbour distance between occupied nests along the Mackenzie River in the Northwest Territories has decreased linearly by 2.3 km/decade ($p=0.002$) (Carrière and Mathews 2013). A similar pattern was found in Alaska, where nearest-neighbour distances declined by 0.44 km/year ($p<0.001$; equating to 4.4 km/decade) from 1995-2003 (Ritchie and Shook 2011).

Where natural landscapes lack suitable cliff habitat, such as parts of the Prairie Provinces and southwestern Ontario, the availability of artificial urban cliff habitat in the form of tall buildings, bridges and similar structures for nesting sites combined with ample avian prey has allowed for colonization of formerly unoccupied regions. However, such sites are primarily used by Peregrine Falcons raised in similar habitat, as there is little crossover from cliff-reared birds, or vice versa (Holroyd and Banasch 1990; Katzner *et al.* 2012; Faccio *et al.* 2013).

Eggs are laid in a scrape, a depression in the substrate (e.g., rotting wood chips, old pellets, dust, sand, or gravel) where eggs are deposited; this is a typical nesting behaviour of birds of prey that do not construct nests such as falcons and owls (Steenhof and Newton 2007). Although rare, there are some records of Peregrine Falcons nesting on the ground (Pagel *et al.* 2010) or in trees (only for *pealei*). In particular, when cliff habitat is limited, *pealei* Peregrine Falcons nest in former tree stick nests of Bald Eagle (*Haliaeetus leucocephalus*), cormorants (*Phalacrocorax* spp.), Common Ravens (*Corvus corax*) and Ospreys (*Pandion haliaetus*), as well as natural cavities or snags of very large trees (Campbell *et al.* 1977; Buchanan *et al*. 2014; BCMOE 2016). Cliff ledges are very rare along a 500 km stretch of the northern B.C. mainland coast, and all known *pealei* nesting sites in this area are in trees or snags (BCMOE 2016). Peregrine Falcons in the Northwest Territories used the cliff stick nests of Rough-legged Hawks (*Buteo lagopus*), Golden Eagles (*Aquila chrysaetos*) or Common Ravens in 14% of nesting attempts (Carrière and Matthews 2013). In southern Quebec, Peregrine Falcon nests in rock quarries or on natural cliffs were in Common Raven stick nests 32% and 37% of the time, respectively (Savignac and Bélisle 2015). In some urban settings, nesting success has been improved by the placement of nest boxes or trays on buildings, bridges, smokestacks or other structures (Martell *et al.* 2000; Altwegg *et al*. 2014; Gahbauer *et al.* 2015b).

Peregrine Falcons often nest on alternate ledges of the same or adjacent cliff faces in different years (e.g., Bird and Weaver 1988; Carrière and Matthews 2013; Zuberogoitia *et al.* 2015). Along the Lake Mead reservoir of the Colorado River, nesting Peregrine Falcons used alternate nest sites following 58% of all nesting attempts (Barnes *et al.* 2015). Although some nest sites are used repeatedly (often because of limited availability of alternate sites), lifetime productivity often increases where a number of alternate sites are available and used (Zuberogoitia *et al.* 2015). As a result, the percentage of known nest sites active in a given area can be far less than 100% even for thriving subpopulations.

The degree of selection for cliff or urban habitats varies considerably across southern Canada. In British Columbia, *anatum/tundrius* Peregrine Falcon nests are typically on cliffs along lake shores, rivers, or at confluences of major valleys which provide easy access to prey (e.g., Cannings *et al*. 1987). In southern Alberta, most nests are on human-made structures, while elsewhere in the province most are natural nest sites confined to the banks of rivers, or on cliffs overlooking lakes in the Canadian Shield region (Alberta Peregrine Falcon Recovery Team 2005). Nests in southern Manitoba and Saskatchewan occur only in cities. In Ontario, most northern nest sites are on cliffs, while in southern Ontario most nests are on buildings or other anthropogenic structures; overall in Ontario, 68% of nests are on cliffs, 22% on buildings, 5% on bridges, 4% in open pit mines, and 1% on smokestacks (Armstrong and Ratcliff 2010). Similarly, in southern Quebec nests are on cliffs (59%), quarries (19%), bridges (11%), and buildings (11%) (Tremblay *et al*. 2012). In a review of Peregrine Falcon nesting in northeastern North America (Ontario, Quebec, and three USA states), 35 (40.2%) of 87 urban nest sites used between 1980 and 2006 were on bridges (Gahbauer *et al.* 2015b). In the Midwest USA. adjacent to Ontario, 80% of Peregrine Falcons nest on artificial structures and only 20% are on cliffs (Tordoff and Redig 1997). Peregrine Falcons nesting in the Bay of Fundy nest solely on cliffs in Nova Scotia (Rowell *et al.* 2003; Nova Scotia Department of Natural Resources 2016), while in New Brunswick all nests are on cliff sites except for one on a building (Sabine pers. comm. 2016).

Historical nest records of Arctic-nesting Peregrine Falcons were primarily on cliffs (82%), but also on cutbanks (16%), boulders (1%) and low hummocks (1%) (Fyfe 1969). In Labrador, all nest sites are on cliffs (Brazil pers. comm. 2006), while along the Mackenzie River they are on rocky or grassy cliffs (73%), cliff stick nests (14%), and atypical structures such as the eroding banks of waterbodies (13%) (Carrière and Matthews 2013). In Tuktut Nogait National Park in Nunavut, most nests were on steep river bank slopes and cliff ledges, and two were in stick nests (Holroyd and Frandsen 2015). In Rankin Inlet, Nunavut, most nests were on south- or southwest-facing vertical coastal cliffs or rocky bluffs in inland tundra areas (Court *et al*. 1988a, b).

Some nest sites appear to be preferred, especially those with large cliffs, and are consistently occupied despite disturbance or other impacts (Ratcliffe 1993). In Ontario, 27 sites, both cliff and urban, were occupied continuously since the first nesting attempt subsequent to population recovery (Gahbauer *et al*. 2015a). Of nine occupied territories known in Quebec prior to 1980, 67% were still occupied in 2010 (Tremblay *et al*. 2012). Older and more established nest sites are more likely to be used and are more consistently used than more recently established nest sites (Coulton *et al*. 2013).

Roosting sites are an important component of breeding habitat. These are often used repeatedly over time, and are often located on small rock ledges or projections on rock faces, often under overhangs (Ratcliffe 1993). Alternate sites are often used for perching, hunting, and roosting when not being used for nesting (Carrière and Matthews 2013). Peregrine Falcons often cache surplus prey, especially during the breeding season (White *et al*. 2002). These cache sites are usually near the nest ledge, but may take a wide variety of forms.

<u>Migratory Habitat</u>

Peregrine Falcons migrate along both coastal and interior routes in North America (White *et al.* 2002; Farmer *et al.* 2008). Many concentrate along shorebird migration routes, particularly in the spring, when they often forage at open tidal mud flats where prey are present in large numbers (Hunt and Ward 1988; Lank *et al.* 2003). Migratory habitat is widespread in Canada, including areas where the birds do not breed.

<u>Wintering Habitat</u>

Wintering habitat for Peregrine Falcons that breed in Canada is highly varied, including open areas, urban environments, wetlands, major river valleys, pristine and harvested tropical moist and dry broadleaf forests, mangroves, desert shrub lands, tropical grasslands, and pastures (White *et al*. 2002; Prostor *et al.* 2013). Wintering habitat in the Neotropics is largely coastal or inland wetlands (Bildstein 2004), not dissimilar from foraging habitat during the breeding season. Habitat for wintering *pealei* Peregrine Falcons typically consists of areas where seabirds concentrate, and wetlands and estuaries where waterbirds concentrate (BCMOE 2016).

Urban-nesting and urban-reared birds favour urban wintering habitats, while individuals from rural nest or release sites mostly use natural wintering habitats (Gahbauer 2008). A satellite telemetry study found that birds wintering in the United States or Canada tended to remain within 15 km of major bodies of water, although the same pattern does not appear to hold for birds wintering in Central or South America (Gahbauer 2008). Many *pealei* adults and some urban-dwelling Peregrine Falcon adults in Ontario and Quebec remain on the breeding territory year-round.

Habitat Trends

This discussion of habitat trends focuses on breeding habitat because there are few data on trends in migratory and wintering habitat. There is little doubt that Peregrine Falcons have used some cliff ledges for centuries or even millennia (e.g., Ferguson-Lees 1957), and there is a Canadian record of a nest site in Newfoundland and Labrador that has been active for 145 years (Newfoundland and Labrador Department of Environment and Conservation 2016). Habitat loss or degradation was not considered to be a significant factor in the Peregrine Falcon's decline (Holroyd and Bird 2012). Natural nesting habitat appears not to have changed much since eastern subpopulations collapsed and is still mostly available for reoccupancy, while the expansion of the species into urban centres has allowed the species to settle in areas that were previously not suitable. Foraging habitat has been degraded in some highly developed anthropogenic landscapes such as southern British Columbia, Ontario and Quebec.

Falco peregrinus pealei

There are few direct threats to the habitat of *pealei* Peregrine Falcons, which nest on and forage from remote, rugged coastal cliffs (BCMOE 2016). The population has the potential to increase further based upon the available breeding habitat, as only about one-half of known historical breeding sites are currently occupied (BCMOE 2016). Seabird populations, which provide the primary prey, are strongly influenced by variable ocean productivity as a result of a number of factors including global warming and El Niño events.

Falco peregrinus anatum/tundrius

Habitat for Peregrine Falcons in Alberta is considered abundant (Alberta Peregrine Falcon Recovery Team 2005), although there are concerns related to habitat degradation resulting from the erosion and slumping of riverside cliffs and the loss of wetland foraging habitat (Rowell and Stepnisky 1997). In the Northwest Territories, some nest loss has similarly occurred due to slumping and erosion of riverbanks, as well as the loss of stick nests from forest fires (Carrière *et al*. 2003). More than one quarter of known Rough-legged Hawk nests on Bylot Island in Nunavut were lost due to geomorphological processes related to increased temperatures and precipitation over the course of an eight year study, and more than 50% were at moderate to high risk of loss (Beardsell *et al.* 2017).

Although not used in Canada, in the mid-Atlantic USA coastal nesting towers which helped to expand Peregrine Falcon numbers and range (Watts *et al.* 2015) are being dismantled over concerns for predation impacts on shorebird species of conservation concern (Watts 2009, 2016).

The availability of unoccupied historical and potential cliff breeding habitat in Ontario suggests that there is still suitable habitat for Peregrine Falcons to expand into new territories (OMNRF 2015). Peregrine Falcons are continuing to become more numerous in urban habitats, using tall buildings, bridges, and smokestacks as nest sites. Many pairs in southern Canada nest on human-made structures, leading Holroyd and Bird (2012) to suggest that the conservation of natural habitat is less important for Peregrine Falcon recovery than for other species. The provision and/or availability of suitable nest sites appear to be critical to the increase of Peregrine Falcon in urban environments (Altwegg *et al*. 2014), and such nesting opportunities are likely to continue to increase over time in southern Canada.

Foraging areas can be impacted by agricultural, industrial and recreational land uses (Holroyd and Bird 2012). The long-term loss of wetland habitat across southern Canada has likely affected the availability of foraging habitat for migratory, wintering and breeding birds, especially in the most heavily human populated areas of southern Ontario, southern Quebec, and southern British Columbia (e.g., BCCDC 2016b), although the impact may be less important for urban-breeding birds. Wetlands in southern Ontario were reduced by 72% from pre-settlement times to 2002, and the loss was most dramatic in southwestern Ontario and north of the lower Great Lakes, where over 85% of wetlands have been converted to other uses (Ducks Unlimited 2010). Similarly, in southwestern British Columbia including Vancouver Island, 50-70% of the original wetland habitat has been lost, while in the Okanagan Valley 85% of wetland habitat has been lost (BCMOE 2017). Agricultural landscapes can also provide important foraging habitat. In southern Quebec, perennial crops such as pasture and hayfields were largely converted to cash crops such as Corn (*Zea mays*) and Soybeans (*Glycine max*) between 1965 and 1997, resulting in a more homogenous agricultural landscape less attractive to foraging Peregrine Falcons (Jobin *et al*. 2014). Nesting female Peregrine Falcons make less use of these crop types for foraging than other crop categories, and the expansion in Corn and Soybeans may contribute to a decline in foraging habitat quality (Lapointe *et al.* 2013).

BIOLOGY

There has been extensive research on the biology and life history of the Peregrine Falcon, both in North America and globally. Despite its cosmopolitan distribution and the existence of 19 subspecies, the life history and habitat requirements of this species are remarkably similar around the world.

Life Cycle and Reproduction

Number of Broods Annually

Only one brood is raised annually. Re-nesting may occur if the nest fails early in the laying or incubation periods (Beebe 1974). This occurs rarely in the Arctic due to the more restricted nesting season, although some instances have been observed (Anctil pers. comm. 2017).

Clutch Size

Clutch size is typically 3-4 eggs (Ratcliffe 1993), with smaller clutches (mean of 2.9) in Arctic regions and larger clutches (mean of 3.7) in mid-latitudes (Hickey 1969; Palmer 1988). Clutch size varies with laying date; in Arctic Canada the probability of a four-egg clutch decreases with advancing lay date (Lamarre *et al.* 2017). Court *et al*. (1988a) reported a remarkably consistent mean clutch size for Rankin Inlet, ranging from 3.4-3.7, and averaging 3.6, over six years in the 1980s. In a more recent Nunavut study of three nesting areas from 2008-2013, clutch size (n=288) ranged from 1-5, with 2.4% and 0.7% being one- and five-egg clutches respectively (Jaffré *et al.* 2015). In British Columbia, clutch sizes for both *pealei* and *anatum/tundrius* Peregrine Falcons ranged from 1-5, with 3-4 being most common (Campbell *et al*. 1990). In Alberta, five-egg clutches were reported on only three occasions (Alberta Peregrine Falcon Recovery Team 2005). Five-egg clutches may be the result of two females laying eggs in the same nest (Franke pers. comm. 2017). In Ontario, historical mean clutch size was 3.4 eggs (n = 35, range 2-5; Peck and James 1987).

Incubation and Fledging

Incubation typically begins following the laying of the penultimate (often third or fourth) egg, and lasts 32-35 days, averaging 33.5 (Burnham 1983; Campbell *et al*. 1990; Ratcliffe 1993; Baicich and Harrison 1997; White *et al*. 2002). Eggs typically hatch within a 24-48 hour period for a clutch of four (White *et al.* 2002), but can span up to six days, especially in the Arctic, and often resulting in death of the last-hatched young (Court *et al*. 1988a). In a recent Nunavut study, median incubation times ranged from a low of 33 +/- 1.5 days for four-egg clutches to a high of 36 +/- 1.8 days for one-egg clutches (Jaffré *et al.* 2015).

The female does most of the incubation while the male provides food, although experienced males may share a significant portion of the incubation duties (Enderson *et al*. 1972). The female typically takes the prey provided by the male to a nearby perch to feed, while the male incubates the clutch (Ratcliffe 1993). Males incubated the nest about 33% of the time in Alaska (Enderson *et al*. 1972). On Langara Island, B.C. *pealei* males incubated 30-50% of the time during mid-incubation during the day (Nelson 1970). Nestlings typically leave the nest 40-46 days after hatching, with males typically fledging 3-5 days earlier than females. Young continue to be fed by adults and may remain near the nest site for 3-6 weeks after fledging until onset of migration (Beebe 1974; White *et al.* 2002). The period of parental feeding may be extended in non-migratory Peregrine Falcons (White *et al.* 2002).

.

Age of First Breeding

Age of first breeding is skewed toward earlier ages in subpopulations that are depleted and recovering, and in areas with abundant unoccupied habitat (Newton and Mearns 1988; White *et al*. 2002). Peregrine Falcons typically begin breeding at 2-3 years of age, although there are records of breeding in one-year-old birds, particularly females (Tordoff and Redig 1997). Females tend to begin breeding on average one year earlier than males (Cade and Fyfe 1978; Ratcliffe 1993). In southern Ontario only eight records of breeding by second-year birds were noted (Gahbauer *et al*. 2015a). In an increasing subpopulation in Rankin Inlet, mean recruitment age was four years (range 2–8) for males and three years (range 3–5) for females (Johnstone 1998).

Age of first breeding is influenced by population density and the presence of floater breeding adults of both sexes in the population (Johnstone 1998). Even in most recovering populations there is a surplus of non-territorial adults, and missing or killed adults on territory are quickly replaced by another adult, often within hours (Newton 1988a; Tordoff and Redig 1997; Johnstone 1998).

Nest Occupancy and Territoriality

While nest sites are typically used from year to year and through successive generations, and occupancy is typically high, not all nesting sites are occupied every year, especially where pairs alternate use of nest site within their territories. Estimates of the average proportion of known or monitored sites in northern Canada that were occupied annually include:

- 63% (range of 62-68%) along the Mackenzie River, Northwest Territories (1995-2010) (Carrière and Matthews 2013);
- 79.2% at Rankin Inlet (1982-2009) (Franke *et al*. 2010);
- 81.7% from the Lac de Gras area, Northwest Territories (2000-2010) (Coulton *et al*. 2013); and
- >92% annually near Igloolik, Nunavut (2010-2012) (L'Hérault *et al.* 2013).

When discussing recovery, the occupancy of currently occupied nesting sites can be compared to historically documented nesting sites which were used prior to the DDT-era (i.e., typically prior to the mid-20th century), although even in southern Canada it is clear that only a small proportion of historical nesting sites were known and documented. Only 30% of historical nesting sites in Labrador were occupied in 2010, similar to 2005 (Rodrigues 2010; Holroyd and Banasch 2012). In southern Canada, 84.6% of previously known sites were occupied in Quebec in 2005 (Holroyd and Banasch 2012). In 2010, 37% of southern Alberta historical nesting sites and 54% of northern Alberta sites were occupied (Court pers. comm. 2016). Similarly, in British Columbia, where there are about 232 known historical *pealei* Peregrine Falcon nest sites (Cooper 2007), roughly half are occupied.

There are a considerable number of historical nesting sites in southern Ontario that have not been recolonized (Holroyd and Banasch 2012). In the 2010 survey only 3 (6.3%) of 48 documented historical sites in Ontario were reoccupied (Chikoski and Nyman 2011), and one additional historical nesting territory, which had not been occupied since the 1920s, was reoccupied in 2016 (Sutherland pers. comm. 2016). However, these results do not reflect the large number of newly occupied sites that were not previously recorded, and therefore may in some cases represent a shift in distribution more than a difference in regional occupancy.

Peregrine Falcons are solitary breeders and are highly territorial towards other Peregrine Falcons, although relatively high densities may occur in areas of high prey abundance (White *et al.* 2002). Territory defence decreases with increasing distance from the nest site, and only the inner 200 m may be consistently defended (White *et al.* 2002). Density is often best expressed as the number of territories or pairs per linear distance rather than by area, where breeding distribution follows linear water features (White *et al.* 2002). Several pairs of *pealei* Peregrine Falcons nested as close as 400 m apart on Langara Island (Beebe 1960). In high density areas with abundant food sources, *pealei* territories can average approximately one territory per 4-10 km of shoreline (White *et al.* 2002). Elsewhere, territory density for *anatum/tundrius* Peregrine Falcons ranged from one territory per 3.2-9.8 km in high density Arctic regions, to 5.8-31.3 km in taiga regions (White *et al.* 2002).

Productivity

Productivity is estimated primarily as the number of young produced per occupied territory/territorial pair, although a secondary measure is the number of young produced per pair that successfully fledged young. These measures have been used for comparative purposes for all of the national surveys, and both measures provide information on annual reproductive performance. The number of young produced per territorial pair is more relevant when discussing population-level implications of productivity, as it is possible to have a high number of young produced per successful pair and still have a low proportion of successfully breeding pairs.

It is important to understand that reproductive data collected during the five-year surveys provide only an approximation of the actual fledging rate, as productivity estimates are typically calculated around the time that young are of banding age (approximately 3-4 weeks), rather than the age at which young actually fledge from the nest. This is consistent with Steenhof and Newton’s (2007) summation that raptor pairs are generally considered to be successful when well-grown young are observed in the nest prior to fledging. Although survival at this age is generally good, some additional mortality may occasionally occur after 3-4 weeks but prior to the young fledging.

Conversely, if only one visit is conducted during the survey, which is often the case for remote areas or surveys covering a large area, nests that were established but failed early in the breeding cycle will be not be enumerated and included in the productivity statistics, as nest failure lowers the probability of a given pair being counted. Study areas that are the subject of more intensive research, such as the Rankin Inlet subpopulation, may have lower but more accurate estimated fledging rates, because multiple visits will identify sites that were active early in the nesting cycle but failed prior to the time when most general surveys are initiated (Franke pers. comm. 2016).

The productivity of Peregrine Falcons in North America varied greatly by region and year between the 1970s and 1990s as the species recovered from the effects of pesticides on reproduction. Before the 1980s, declining populations generally suffered depressed annual productivity rates of 0.5 - 1.0 fledglings per territorial pair or lower (Cade *et al*. 1989; Ratcliffe 1993). After 1984, in association with reintroductions and population recovery, annual productivity generally increased (Mesta 1999). Models suggest that >1.7 fledglings/territorial pair are required for population growth (Court 1994; Stepnisky 1998; Craig and Enderson 2004). Johnstone (1998) similarly concluded that territories producing 1.7 or more young annually are reproductive sources, while those with lower productivity are sinks.

Productivity of 1-2 young fledged/territorial pair is considered average (White *et al*. 2002), but it can vary greatly from year to year, often by as much as 2-4 fold (Newton and Mearns 1988; Bradley *et al*. 1997). Productivity rates in northern subpopulations in particular appear to vary widely in response to environmental conditions. Long-term monitoring (1971-2000) of a Peregrine Falcon subpopulation in northern Alberta revealed a wide range in annual productivity between 0.0-3.0 (Corrigan 2001). Along the Mackenzie River, annual productivity varied from 0.8-2.1 young/occupied nest (Carrière and Matthews 2013). The Rankin Inlet subpopulation experienced almost total reproductive failure in 2005 in response to heavy rain events, following a year of record high productivity in 2004 (Holroyd and Banasch 2012).

A number of factors influence annual productivity, including:

- egg and chick mortality resulting from cold, wet, and late spring weather (White and Cade 1971; Court *et al*. 1988a; Mearns and Newton 1988; Ratcliffe 1993; Bradley *et al*. 1997; Anctil *et al.* 2014.);
- local annual variation in prey abundance (Court *et al*. 1988a; Bradley and Oliphant 1991; Robinson *et al.* 2017);
- regional differences in overall prey availability (Ratcliffe 1993);
- clutch initiation date, with the number of young fledging increasing with earlier clutch initiation (Dawson *et al.* 2011);
- predation and disease have not been quantified for any population but can be locally significant (Cade *et al*. 1989; Tordoff and Redig 1997);
- urban versus rural environments, with Peregrine Falcons nesting in urban habitats having a higher fecundity rate (Kauffman *et al.* 2003); and
- nest site quality (Zuberogoitia *et al*. 2015).

There is considerable variation in breeding success at the individual pair level. At Langara Island, half of all *pealei* fledglings were produced across years by 21% of known nesting pairs, and one-quarter of nestlings were produced by just 9% (Nelson 1990). At regularly occupied high-quality nest sites of Arctic-nesting Peregrine Falcons at Rankin Inlet, productivity over 14 years averaged 1.4 young/pair, while at infrequently occupied poorer quality sites, the average was 0.8 (Johnstone 1998). Cliff sites with higher productivity for Arctic-nesting Peregrine Falcons were occupied more frequently and had lower local extinction probabilities (Bruggeman *et al.* 2016). Peregrine Falcons nesting on inland sites at Rankin Inlet were more productive than those nesting on islands, raising almost 0.5 more young annually on average (L'Hérault *et al.* 2013).

Falco peregrinus pealei

Most studies of *pealei* Peregrine Falcons report productivity of 1-2 young/territorial pair, and up to 3.0 young in some years (Cooper 2007). A large proportion of the Canadian *pealei* productivity records are from Langara Island. During the 1980s, productivity at 5-7 nests on Langara Island annually ranged between 1.6-3.3 young per territorial pair, although it was lower than 2.0 during only three seasons and exceeded 3.0 in only one year (Nelson 1990). Productivity per successful pair in Canada has remained high in recent years (Table 1, Figure 3). Since 1970, the unweighted productivity for all sites and all years averaged 2.4 fledged young/successful pair and 1.8 fledged young/territorial pair.

Table 1. Productivity of *pealei* Peregrine Falcons in Canada from 1970-2015, measured as average number of young fledged[5]/successful pair (average number of young fledged/territorial pair); sample sizes based on productivity surveys presented in Table 3 (Rowell *et al.* 2003; Holroyd and Banasch 2012; Chutter 2016) (nd = no data).

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Langara Island [6]	2.2 (2.2)	2.4 (2.0)	2.2 (2.2)	2.0 (1.6)	2.8 (2.0)	2.0 (1.7)	1.8 (1.3)	2.8 (2.8)	3.0 (1.7)	3.0 (3.0)
Haida Gwaii	2.5 (nd)	3.2 (nd)	2.5 (2.1)	nd	nd	nd	nd	nd	nd	4.0 (2.7)
N. Vancouver Island	nd	nd	nd	nd	nd	nd	nd	nd	2.3 (2.0)	1.7 (1.3)
Triangle Island	nd	nd	nd	nd	nd	nd	nd	nd	1.5 (1.5)	nd
SE Vancouver Island/Gulf Islands	nd	nd	nd	nd	nd	nd	nd	2.2 (1.0)	nd	nd
Unweighted survey average	**2.4 (2.2)**	**2.8 (2.0)**	**2.4 (2.2)**	**2.0 (1.6)**	**2.8 (2.0)**	**2.0 (1.7)**	**1.8 (1.3)**	**2.5 (1.4)**	**2.3 (1.7)**	**2.9 (2.3)**
Unweighted average for all surveys										**2.4 (1.8)**

[5] In many cases fledging is inferred based upon young of banding age (e.g., 21-28 days) or for hatched chicks (15-20 d) in the nest, rather than actual observed fledging. Data were also collected opportunistically, e.g., 2015 data represent only seven nests, including only two nests for Langara Island (Chutter 2016).

[6] Langara Island is part of Haida Gwaii, but is reported separately

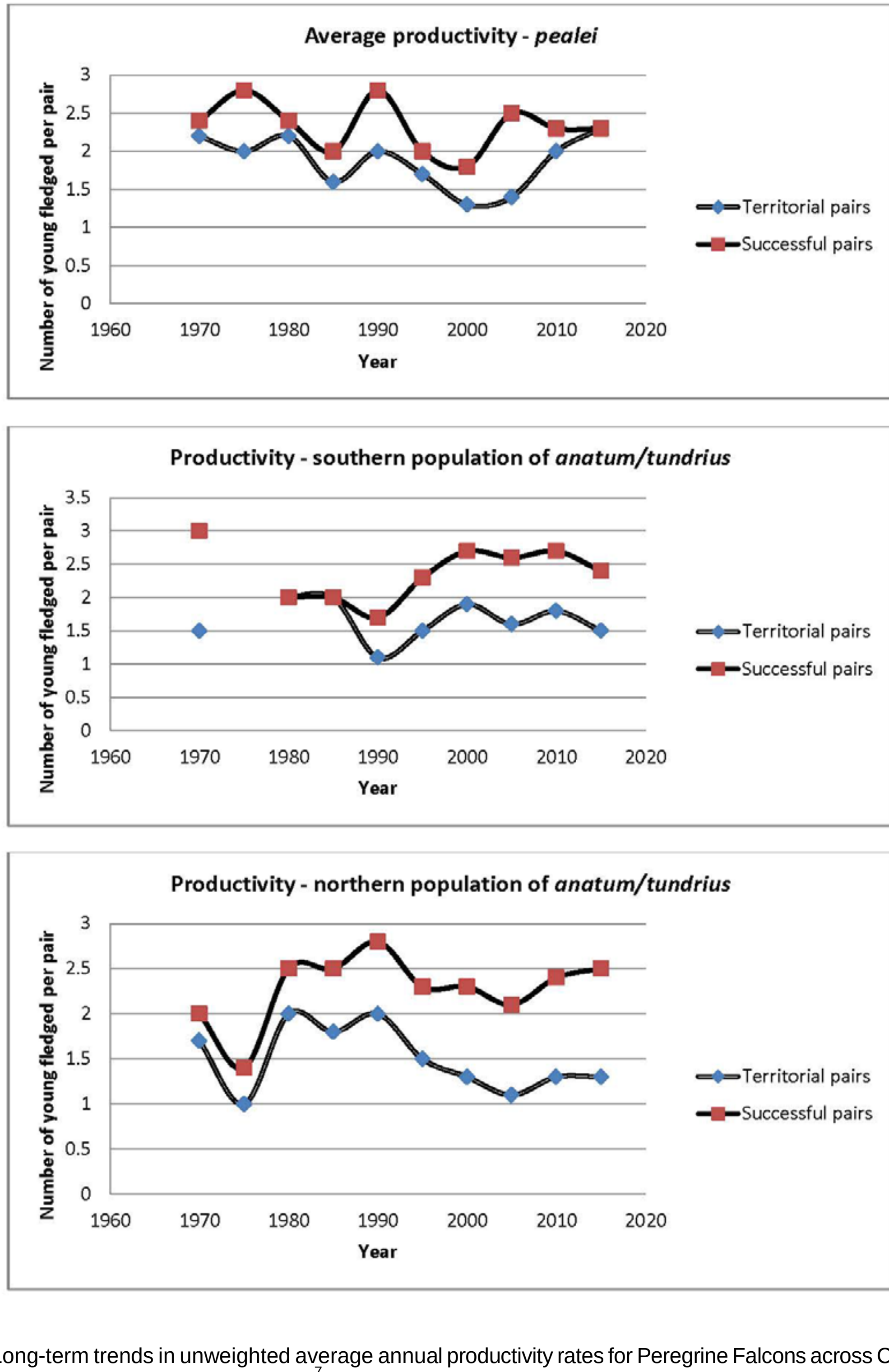


Figure 3. Long-term trends in unweighted average annual productivity rates for Peregrine Falcons across Canada based upon quinquennial survey results.[7]

[7] Note that *pealei* trends are based upon very small sample sizes and sometimes include nestlings that were not yet close to fledging age

Falco peregrinus anatum/tundrius

Nest productivity has varied considerably across Canada since the initiation of nation-wide surveys in 1970, although productivity measures for territorial pairs and successful pairs are generally synchronous (e.g., Figure 3). Average annual productivity, based upon unweighted average number of young fledged per territorial pair for all jurisdictions, has generally been higher for *anatum/tundrius* Peregrine Falcons nesting in southern Canada in comparison with northern Canada (Table 2, Figure 3). Weighted means cannot be calculated because individual nest data are not available for all years. Average productivity in southern Canada has ranged between 1.5-1.9 young/territorial pair since 1995, while productivity per successful pair has consistently been between 2.3-2.7. Comparable ranges for northern Canada for the same period were 1.1-1.5 and 2.1-2.5, respectively. The unweighted average productivity for northern-nesting birds has been consistently less than 1.5 young/territorial pair since 1995, and productivity estimates from a number of Arctic studies averaged 1.4 young/territorial pair (Franke 2016). In the Yukon Territory in particular, there has been a long-term declining trend since the early 1990s in the proportion of nest sites successfully producing young, with only 27% being successful in 2015 (Mossop 2015). However, the ongoing gradual increase in the size of northern subpopulations suggests that the modelled threshold for population growth of 1.7 fledged young/territorial pair may be conservative. These broad trends of course obscure very distinct differences at the annual and regional/jurisdictional level in both northern and southern Canada.

Table 2. Productivity of *anatum/tundrius* Peregrine Falcons in Canada from 1970-2015, measured as average number of young fledged[8]/successful pair (average number of young fledged/territorial pair); sample sizes based on productivity surveys presented in Table 4 (Rowell *et al*. 2003; Holroyd and Banasch 2012; other sources as footnoted in Table 4) (see Figure 1 for delineation of northern and southern Canada).

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Southern Canada										
Bay of Fundy (NS,NB)	0	0	0	0	2.0 (1.2)	2.4 (2.0)	2.0 (1.8)	1.3 (0.9)	nd	nd
Southern Quebec	0	nd	2.0 (2.0)	0	1.9 (1.4)	2.6 (2.0)	2.3 (1.6)	2.3 (1.6)	nd[9]	nd
Ontario	0	0	0	0	2.0 (1.3)	1.5 (1.1)	2.6 (1.6)	2.7 (2.3)	2.8 (2.0)	2.1[10] (1.3)
Manitoba	nd	nd	0	0	2.0 (1.0)	3.0 (1.5)	4.0 (2.0)	3.5 (2.3)	3.0 (1.8)	2.6 (1.6)
Saskatchewan	0	nd	0	0	1.0 (0.5)	1.5 (1.5)	2.5 (1.7)	0 (0)	nd	2.5[11] (2.5)
Alberta south of 58°N	3.0 (1.5)	0	0	2.0 (2.0)	1.5 (1.0)	3.0 (0.8)	3.0 (2.5)	2.7 (2.1)	2.5 (1.7)	3.2[12] (1.6)

[8] In many cases fledging was inferred based upon young of banding age (e.g., 21-28 days) in the nest, rather than actual observed fledging

[9] 2010 survey was conducted, but not designed to collect productivity data

[10] Province-wide survey not conducted; data represent Lake Superior basin only (Ratcliff 2015)

[11] Thompson (2015); does not include 3 hacked young at a third site

[12] Survey was conducted in 2016

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
South Interior BC	nd	nd	nd	nd	nd	nd	nd	2.5 (2.0)	3.0 (1.7)	2.7 (1.1)
Lower Mainland BC	nd	nd	nd	nd	nd	nd	nd	4.0 (0.6)	2.3+ (1.8)	2.5+ (2.1+)
Gulf Islands/SE Vancouver Island, BC	nd	nd	nd	nd	nd	nd	nd	2.0 (0.8)	2.8+ (1.7+)	1.8 (0.6)
Unweighted regional average	**3.0 (1.5)**	**NA**	**2.0 (2.0)**	**2.0 (2.0)**	**1.7 (1.1)**	**2.3 (1.5)**	**2.7 (1.9)**	**2.6 (1.6)**	**2.7 (1.8)**	**2.5 (1.5)**
<u>Northern Canada</u>										
Labrador, Newfoundland	2.0 (2.0)	0	nd	3.0 (1.5)	3.3 (2.6)	2.2 (1.0)	2.4 (1.6)	2.2 (1.0)	2.1 (1.4)	nd
Ungava Bay, Quebec	1.7 (1.3)	1.8 (1.8)	2.7 (2.7)	3.2 (2.7)	3.1 (2.9)	nd	nd	3.2[13] (2.7)	nd	nd
Alberta north of 58°N	0	0	3.2 (2.1)	0	2.6 (1.4)	2.8 (2.2)	2.6 (0.7)	0.9 (0.9)	nd	nd[14]
Porcupine River, Yukon	nd	nd	1.7 (1.2)	2.6 (2.0)	2.8 (1.7)	2.3 (1.3)	2.1 (1.3)	2.1 (0.9)	2.3 (1.1)	1.0 (0.4)
Peel River, Yukon	nd	nd	0	2.3 (1.9)	3.2 (2.4)	2.1 (0.9)	1.2 (0.6)	1.2 (0.6)	2.0 (1.4)	2.7 (1.7)
Yukon River, Yukon	2.0 (2.0)	1.0 (0.4)	2.2 (1.3)	2.8 (2.2)	2.4 (1.7)	2.7 (1.6)	3.1 (1.5)	1.4 (1.0)	2.1 (1.3)	1.7 (0.9)
Southern Lakes, Yukon	nd	nd	nd	nd	nd	3.0 (3.0)	nd	nd	nd	nd
Mackenzie Valley, NT	2.3 (1.4)	1.3 (0.9)	2.0 (1.5)	2.1 (1.7)	2.6 (2.1)	2.6 (1.8)	2.2 (1.0)	2.4 (1.6)	2.4 (1.4)	2.5 (1.8)
Tuktut Nogait NP, NT	nd	nd	nd	nd	nd	nd	2.6 (1.0)	nd	2.5 (2.1)	2.9[15] (2.5)
North Slope, Yukon	nd	nd	0	0	0	2.3 (1.8)	2.1 (1.7)	2.6 (1.8)	2.8 (1.3)	3.5 (1.1)
Daring Lake NT[16]	nd	nd	nd	nd	nd	1.0 (0.3)	3.0 (1.7)	3.0 (0.6)	2.3 (1.4)	2.0 (0.8)
Lac de Gras NT[17]	nd	nd	Nd	nd	nd	nd	1.7 (1.4)	0.0 (0.0)	3.3 (1.0)	3.7 (0.7)
Rankin Inlet, Nunavut	nd	nd	3.3 (2.9)	1.8 (0.6)	2.5 (0.8)	2.1 (0.7)	2.3 (1.7)	? (0.1)	2.1 (1.0)	2.3 (1.0)[18]
Unweighted regional average	**2.0 (1.7)**	**1.4 (1.0)**	**2.5 (2.0)**	**2.5 (1.8)**	**2.8 (2.0)**	**2.3 (1.5)**	**2.3 (1.3)**	**2.1 (1.1)**	**2.4 (1.3)**	**2.5 (1.2)**
Unweighted average for all Canadian surveys	**2.2 (1.6)**	**1.4 (1.0)**	**2.4 (2.0)**	**2.5 (1.8)**	**2.4 (1.6)**	**2.3 (1.5)**	**2.5 (1.5)**	**2.4 (1.3)**	**2.5 (1.5)**	**2.4 (1.3)**

[13] 2007 data (Bird and Chabot 2009)

[14] 2010 survey was conducted, but time and resources did not allow calculation of productivity (Court pers. comm. 2016).

[15] Holroyd and Frandsen (2015)

[16] Northwest Territories Environment and Natural Resources (2016a)

[17] Dominion Diamond Corp and Northwest Territories Environment and Natural Resources (2016b)

[18] Rankin Inlet productivity data were obtained as a result of more intensive surveys with multiple nest checks, leading to lower estimated productivity rates than for sites assessed by only one visit later in nesting season (Franke pers. comm. 2016)

Nest-site Fidelity

Adult Peregrine Falcons typically show territorial fidelity, returning annually after migration to the same breeding territory or nesting area (Peck *et al*. 2012). The rate of adults returning to the same nesting territory in subsequent years can be as high as 90-98% (Bruggeman *et al.* 2015*).* Genetic studies of relatedness amongst chicks at multiple Scandinavian nest sites over multiple breeding seasons has confirmed a high degree of nest-site fidelity (Nesje *et al.* 2000).

Diet and Foraging Behaviour

Peregrine Falcons typically hunt on the wing and feed extensively on birds, although they show considerable versatility. Because of this aerial hunting strategy, Peregrine Falcons require an ample supply of prey species of suitable size, in areas that facilitate aerial hunting (Beebe 1974). Globally the Peregrine Falcon diet includes at least 429 species of birds, 10 bat species and 13 other mammal species, principally rodents (White *et al*. 2002). Important prey species for all subspecies include colonial seabirds, shorebirds, waterfowl and other waterbirds, columbids (doves and pigeons) and passerines (songbirds). Prey remains from 86 different species of birds and bats have been found at nesting sites of Peregrine Falcons within the Lake Superior Basin in Ontario (Ratcliff 2015). Along the Atlantic coast, shorebirds can comprise up to 70% of the prey during the breeding season, and Peregrine Falcons can potentially impact populations of species of conservation concern such as Red Knot (Watts 2009, 2016).

While Peregrine Falcons prey upon many species of birds, some subpopulations appear to specialize on a few primary targets. The *pealei* Peregrine Falcons of the Pacific coast prey primarily on a few very abundant marine bird species (White *et al*. 2002). They usually nest near a seabird colony, with auklets, murrelets and storm-petrels comprising a high percentage of their diet (Nelson and Myres 1976). Rhinoceros Auklet (*Cerorhinca monocerata)* and Cassin's Auklet (*Ptychoramphus aleuticus*) are the primary prey species at Triangle Island, where they are the most abundant seabirds (Blight pers. comm. 2017), while Ancient Murrelet (*Synthliboramphus antiquus)* is the most important prey species at sites where that species nests (Nelson and Myres 1976). On the Atlantic coast of Labrador, nesting *anatum/tundrius* Peregrine Falcons similarly feed primarily upon Black Guillemot (*Cepphus grylle*), a locally abundant colonial seabird (Holroyd and Banasch 2012).

Peregrine Falcons that nest on the tundra take ptarmigan (*Lagopus* spp.), shorebirds, small songbirds such as longspurs (*Calcarius* spp.) and Snow Bunting (*Plectrophenax nivalis*), gulls, terns, and jaegers (Laridae, Sternidae and Stercorariidae), Black Guillemot, and ducks (White *et al.* 2002; Robinson *et al.* 2017, 2018). Some specialize on insectivorous birds (songbirds and shorebirds), which are disproportionately selected for, regardless of abundance (Robinson *et al.* 2017). Lapland Longspur (*C. lapponicus*) is the principal prey species of Peregrine Falcons in western Greenland (Rosenfield *et al.* 1995). Resident birds such as ptarmigan and early migrants such as Snow Buntings can be especially important, representing the only available avian prey species when migrating Peregrine Falcons first return to the breeding territory in the spring (Court *et al*. 1988a).

Terrestrial prey (songbirds and small mammals) are important to the diet of nesting Peregrine Falcons in the tundra regardless of where the nest site is located in the terrestrial-marine landscape (L'Hérault *et al.* 2013). While marine resources were important to those pairs with access to them, even pairs nesting in the marine environment derived up to 90% of their diet from terrestrial sources (L'Hérault *et al.* 2013).

Small mammals such as lemmings and juvenile Arctic Ground Squirrels (*Spermophilus parryii*) can comprise a major portion of the diet of Arctic-nesting Peregrine Falcons in some parts of the range (Court *et al*. 1988b; Bradley and Oliphant 1991). Peregrine Falcons nesting inland in Labrador also rely more heavily upon small mammals (Rodrigues 2010). Lemmings are apparently preyed upon opportunistically, particularly when they are abundant, and their use is low relative to their proportional availability (Robinson 2015).

While Peregrine Falcons prey upon birds in a wide range of sizes, most prey weigh 50-500 g (Ratcliffe 1993; Farmer *et al.* 2008), likely reflecting optimal size relative to aerodynamics and the striking/grasping capabilities of Peregrine Falcons (White *et al*. 2002). Interior-nesting Peregrine Falcons in the Yukon Territory select medium-sized prey (50-1000 g) such as shorebirds, jays, thrushes and waterbirds significantly more than expected by abundance, relative to larger and smaller prey (Dawson *et al*. 2011). Larger prey such as waterfowl generally do not appear in the diet of nestlings until the females begin foraging as they mature (Rosenfield *et al*. 1995). Despite this apparent size specialization, the utilization of prey of all biomass sizes to some extent suggests that Peregrine Falcons can be flexible when foraging (Dawson *et al*. 2011).

Columbids, especially Rock Pigeon (*Columba livia*), comprise important prey species for many Peregrine Falcons globally, often being the most frequent prey item and the most important by biomass in temperate, continental latitudes (Ratcliffe 1962; Cade and Bird 1990; White *et al*. 2002; Drewitt and Dixon 2008; Sutton 2015). A study of pesticide levels in Rock Pigeons and Mourning Doves (*Zenaida macroura*) in southern British Columbia found that these columbids had levels of DDE (dichlorodiphenyldichloroethylene), a breakdown product of DDT, several-fold lower than other common Peregrine Falcon prey (Elliott *et al. 2*005). This was thought to have important implications for future recovery potential. While there is little historical documentation, there is strong speculation that Peregrine Falcons historically preyed heavily upon the now-extinct Passenger Pigeon (*Ectopistes migratorius*), and there may have been a strong ecological linkage between the two species in eastern North America (Beebe 1969; Greenberg 2014).

During the breeding season in Colorado, most foraging flights (60%) took place within 8 km of the nest site (Enderson and Craig 1997). However, 20% of foraging flights were greater than 23 km from the nest site, with a maximum distance of 79 km travelled (Enderson and Craig 1997). In the agricultural landscapes of southern Quebec, 95% of female foraging flights were within 8.7 km of the nest, and the maximum distance travelled during the nestling period was 25.2 km (Lapointe *et al.* 2013). Foraging flight distances increased after fledging (Lapointe *et al.* 2013).

Life Span and Survivorship

The maximum longevity records for banded birds in North America is 20 years, but the bird was released alive and thus could have exceeded 20 years (USGS 2015). In captivity, few live beyond 20 years, although a maximum age of 25 years has been recorded (White *et al*. 2002). Banded Peregrine Falcons in Alberta have been known to return for at least 11-12 years (Rowell and Stepnisky 1997). One male Peregrine Falcon was recorded in Toronto, Ontario over a span of 16 years (Gahbauer pers. comm. 2016).

Survivorship in adult Peregrine Falcons appears to be density-dependent, with a negative correlation between apparent survival and abundance at breeding sites (Bruggeman *et al.* 2015). Considering known population growth and productivity rates in the context of population models, White *et al*. (2002) calculated that actual adult survival rates likely fall in the ranges of 80-85% and 85-90% for migrant and resident Peregrine Falcons respectively. Annual survival for breeding *pealei* Peregrine Falcons based upon observed turnover rates is estimated to be a minimum of 63% and 74% for females and males respectively (Nelson 1988b, 1990). In Rankin Inlet, survivorship estimates for Arctic-nesting adult Peregrine Falcons range from 81% for females to 85% for males, based upon turnover rates in a marked population (Court *et al*. 1989). Detailed survivorship estimates for the Rankin Inlet subpopulation conducted by Johnstone (1998) were 69% for females and 73% for males based upon turnover data, and 70% and 77%, respectively, based upon Jolly-Seber capture-recapture methodology. Generation time is estimated to be at least 6 years, based on a minimum 80% adult survival (White *et al.* 2002) and the guidance of IUCN (2016) for generation time being 1/(adult mortality) + age of first reproduction, using an age of 1 for those that begin reproducing between 12 and 24 months.

First-year survival is not well known but is generally assumed to be 40-50% (White *et al.* 2002). Tordoff and Redig (1997) estimated a minimum of 23% fledgling survival in *anatum/tundrius* Peregrine Falcons in the Midwest USA. In California, urban first-year Peregrine Falcons have a much higher survival rate than birds raised in rural environments (65 versus 28% respectively) (Kauffman *et al.* 2003). Beebe (1960) suggested that survival among yearling *pealei* Peregrine Falcons was low due to their harsh maritime environment.

Physiology and Adaptability

The Peregrine Falcon is an extremely versatile and plastic species, adapting to a wide range of habitats and ecological conditions around the globe. Tordoff and Redig (2001) recognized that "probably few species match the Peregrine Falcon in adaptability". Traits leading to the global adaptability of this species include versatility in the use of nest sites, the use of ubiquitous avian prey, the ability to persist in the face of heavy human persecution, and diverse genetic backgrounds that allow the species to thrive upon introduction to vacant habitats (Tordoff and Redig 2001).

Although Peregrine Falcons forage primarily on diurnal birds caught on the wing, and often specialize on just a few species, individual falcons can show considerable flexibility and adaptability in response to novel food sources. This includes hunting migrating songbirds near urban light sources at night (Rejt 2004; DeCandido and Allen 2006; Drewitt and Dixon 2008; Sutton 2015), hunting from moving ships (Whittington 2014), hunting fish (Hetzler 2013), exploiting high local populations of small mammals (Bradley and Oliphant 1991), pirating prey from Merlins (*Falco columbarius*) (Dekker 2003), and feeding on carrion (Holland 1989).

Although primarily cliff nesters, Peregrine Falcons also show adaptability in breeding habitat selection. In recent decades, many Peregrine Falcons in southern Canada and the USA, as well as many areas of Europe, have established territories in urban habitats where there are abundant food sources and they use buildings, towers or bridges as surrogates to cliff nest sites (Cade *et al*. 1996). This adaptability has proven to be a key to the recovery of Peregrine Falcons in eastern North America, and may ultimately allow Peregrine Falcons to exceed their known historical abundance (Cade *et al*. 1996). Some Peregrine Falcons in southern Canada have nested in inactive mine sites and quarries (Armstrong and Ratcliff 2010; Tremblay *et al*. 2012), an adaptation that has allowed them to expand into breeding areas that otherwise lacked suitable habitat, as previously reported in Great Britain (Ratcliffe 1993). The increased use of old stick nests of other large birds of prey, ravens and cormorants, particularly when cliff sites are lacking, is another example of adaptability in nest site selection (Campbell *et al*. 1990; Cooper 2007).

Dispersal, Migration and Wintering

Dispersal

Falco peregrinus pealei

Young *pealei* Peregrine Falcons tend to disperse relatively large distances. On Langara Island only 4% of 140 banded *pealei* nestlings have returned to natal sites to breed, with others known to have settled up to 300 km away (BCCDC 2016a).

Falco peregrinus anatum/tundrius

Some young *anatum/tundrius* birds are known to disperse widely to new breeding areas. In Ontario, 49% of 43 known-origin breeding birds (1993-2006) originated from outside of the province (Gahbauer *et al*. 2015a), although the actual proportion may be lower, given that many young hatched in Canada are not banded (Holroyd pers. comm. 2017). In Manitoba, 39% of breeding individuals (1981-2017) were from outside of the province, and Manitoba-released birds have emigrated to breed in Alberta, Saskatchewan, Manitoba, North Dakota, Minnesota and Nebraska (Maconachie pers. comm. 2017). Females generally disperse farther than males, with mean natal dispersal distances approximately 50% greater for female Peregrine Falcons from the midwestern and northeastern USA (Katzner *et al*. 2012; Dennhardt and Wakamiya 2013; Gahbauer *et al*. 2015a); for example, mean dispersal distances in the Midwest USA were 226 ± 16.7 km for females (n=101), and 108 ± 9.47 km (n=90) for males (Dennhardt and Wakamiya 2013). There are records of Alberta birds dispersing as much as 1800 km from their natal site (Alberta Peregrine Falcon Recovery Team 2005). Natal dispersal distances in Ontario are mostly less than 700 km, with the exception of two birds nesting in northern Ontario – a female that moved 1540 km west from Quebec and a male from Nova Scotia that moved 1600 km (Gahbauer *et al*. 2015a). Young from Manitoba have dispersed as much as 1200 km (both males and females) to jurisdictions outside of the province (Maconachie pers. comm. 2017). In southern Canada, immature captive-raised and released Peregrine Falcons returned an average of 130 km from their natal site, with females averaging 263 km and males 52 km (Holroyd and Banasch 1990). Breeding adults in Alaska nested an average of 121 km (range 2-370) from natal sites for females, and 69 km (range 4-206) for males (Ambrose and Riddle 1988).

In contrast to this tendency for some Peregrine Falcon young to disperse to new breeding areas, some also show a moderate tendency to return to natal nesting sites. Of 12 birds banded in Canada as nestlings and encountered at least three years later, 50% were within 50 km of the natal site during the breeding season, and returned on average 188 km from the natal site (Dunn *et al*. 2009). In Ontario, three individuals have been recorded returning to nest at their natal or release site (Gahbauer *et al*. 2015a). At Rankin Inlet, 37 (5.5%) of 668 nestling *anatum*/*tundrius* Peregrine Falcons banded from 1981 through to 2003 have returned to the study area to breed, but none has been found breeding elsewhere (Setterington pers. comm. 2006).

Migration

The Peregrine Falcon is considered a long-distance migrant and a trans-equatorial migrant capable of long water crossings (Bildstein 2004). They typically migrate in a “leap-frog” fashion, with northernmost birds tending to migrate the farthest south and mid-latitude birds migrating to a lesser extent (Schmutz *et al*. 1991; McGrady *et al*. 2002). Migration behaviour of Peregrine Falcons is directly related to their prey, explaining why those breeding at high latitudes have the longest migratory movements; where their primary prey is sedentary year-round, Peregrine Falcons are much less migratory (Ratcliffe 1993).

Some Arctic-nesting birds in North America may migrate up to 25,000 km annually (White *et al*. 2002). Across North America, Peregrine Falcons have average southward and northward migrations of over 8,000 km annually (Fuller *et al*. 1998), migrating on average 165-198 km daily (Fuller *et al*. 1998; Gahbauer 2008). Migration tends to be more rapid and direct with fewer stopovers in the spring than in the fall (Watts *et al*. 2007; Gahbauer 2008). Adult Peregrine Falcons generally migrate at a much faster rate than juveniles (Gahbauer 2008).

Migration occurs across broad fronts, but with some clearly defined routes where the species concentrates (Farmer *et al.* 2008). Major southward migration routes include Atlantic and Pacific coasts, the Gulf of Mexico coastline, the Great Lakes shoreline, and the eastern front of the Rocky Mountains (Yates *et al*. 1988; White *et al.* 2002). Migrant Peregrine Falcons appear to show fidelity to the same flyway in subsequent southern migrations (Yates *et al*. 1988), although there is some evidence of flexibility. As an example, a male Peregrine Falcon released in southern Ontario shifted fall migration pathways substantially from year to year (Gahbauer 2008). Southward migrating Peregrine Falcons frequently cross the Gulf of Mexico and the Caribbean Sea, while Peregrine Falcons migrating north from South and Central America tend to remain inland until the Texas coast and rarely cross large bodies of water (Fuller *et al*. 1998). Arctic-nesting birds banded on the Gulf of Mexico in winter typically migrate northward through the centre of North America (McGrady *et al.* 2002). Coastlines and mountain ranges appear to influence migration routes, with landscape features such as the Appalachian Mountains determining whether migrants fly along the coast or west of the mountains (Fuller *et al*. 1998). The western coast of Hudson Bay appears to be a transition zone between migration paths to the west and the east of the Gulf of Mexico (Dunn *et al*. 2009). Natal site also appears to affect migratory pathways and destinations. As an example, in Virginia only birds fledged on the coast migrated to and wintered in the tropics, while birds fledged inland remained in the mid-Atlantic region or migrated relatively short distances (Watts *et al*. 2007).

During fall migration, banded Peregrine Falcons from the Yukon Territory are primarily concentrated in central USA states, Texas and Mexico, while those banded in Ontario, northern Quebec and Labrador are mainly encountered in the eastern United States (Dunn *et al*. 2009). The largest known migratory concentration of Peregrine Falcons in North America occurs in the Florida Keys (Lott 2006). The shape of North America tends to naturally concentrate and funnel migrant raptors as they move southward (Lank *et al.* 2003). The Mesoamerican Land Corridor stretching from southern Texas to Panama is considered “the most numerically important raptor migration flyway” in the Neotropics, and the Peregrine Falcon is considered a “numerically significant migrant” with an estimated 5,000 birds using this corridor in the early 2000s (Bildstein 2004). During spring migration, the largest concentrations of northward migrating Peregrine Falcons occur along the west coast of the Gulf of Mexico (Yates *et al.* 1988; Gahbauer 2008).

Peregrine Falcons also appear to have a strong influence on the migration patterns of their prey, creating a “predator landscape” affecting their spatial and temporal distribution (Lank *et al.* 2003). As an example, Peregrine Falcons time their northward spring migration in synchrony with sandpiper migrations, while during the southward fall migration Western Sandpipers (*Calidris mauri*) depart south almost one month before Peregrine Falcons have completed their nesting cycle, in an apparent adaptive response to avoid predation pressure (Lank *et al*. 2003).

Recently fledged birds in eastern North America show a wide range of dispersal patterns, with many remaining in the natal territory until migration, while others move short distances to a separate staging area prior to migration (Gahbauer 2008). Elsewhere, recently fledged birds move widely during the post-fledging period. Fledged birds from Virginia dispersed to 23 states throughout the eastern United States (Watts *et al*. 2007). Inland movements appeared to be limited and bounded by major water systems such as the Great Lakes to the north and the Mississippi River to the west (Watts *et al*. 2007).

Wintering

Peregrine Falcons banded in northern Canada and Alaska tend to migrate the farthest south and winter in Central and South America, from Mexico to Argentina, Chile and Brazil (White *et al*. 2002; Dunn *et al*. 2009). Three satellite-tagged birds from Rankin Inlet migrated to coastal southern Brazil in 1994; bands have also been returned from Peru, Uruguay and Argentina (Court *et al*. 1988b; Setterington pers. comm. 2007; Seegar *et al*. 2015). Band returns have been reported from most of South America with the exception of the central Amazon and southern Argentina (Figure 4) (Dunn *et al.* 2009). Individuals with satellite transmitters on wintering grounds in coastal Mexico and Central America subsequently bred in the Canadian Arctic and Greenland (McGrady *et al*. 2002). One Peregrine Falcon nestling banded in the Thelon River area of Nunavut was recovered 14,500 km south in Argentina four months after fledging (Kuyt 1967). There is considerable overlap in the winter range of Arctic and boreal-nesting Peregrine Falcons (formerly considered *tundrius* and *anatum,* respectively) (White *et al*. 2002). Two-thirds of banded birds from eastern Canada wintered within the United States, and most went no farther south than Guyana (Dunn *et al*. 2009). Among a sample of banded Peregrine Falcons from Greenland, males tended to winter farther south (in South America) than females, and only one of 16 females satellite-tagged in Greenland wintered as far south as South America (Mattox and Restani 2014). Arctic-nesting birds tend to show fidelity to wintering areas but not have specific winter home ranges (McGrady *et al.* 2002; Falk and Moller 2015). However, in one study all 11 migrant Peregrine Falcons from southern Ontario had distinct winter territories in which they spent the majority of their time for at least three months (Gahbauer 2008).

Some coastal *pealei* Peregrine Falcon pairs and some southern *anatum/tundrius* pairs are resident and remain on breeding territories year-round where food supplies are adequate (White *et al*. 2002). This is particularly true for *pealei* Peregrine Falcons, which can be quite sedentary (Schmutz *et al*. 1991). White *et al*. (2002) noted that mated *pealei* pairs could be seen on snow-covered ledges in the Aleutian Islands in January. Some *pealei* falcons from Langara Island migrate as far south as the Pacific coast of southern Washington (Varland *et al.* 2012). Of six banded *pealei* Peregrine Falcons encountered between Haida Gwaii and Washington, five showed an average movement of 150 km, although one bird wintered in California (Dunn *et al*. 2009). While adult *pealei* Peregrine Falcons generally remain on territory year-round, immatures apparently migrate south and spend the winter between the Fraser River estuary (near Vancouver, B.C.) and California (Nelson pers. comm. 2006).

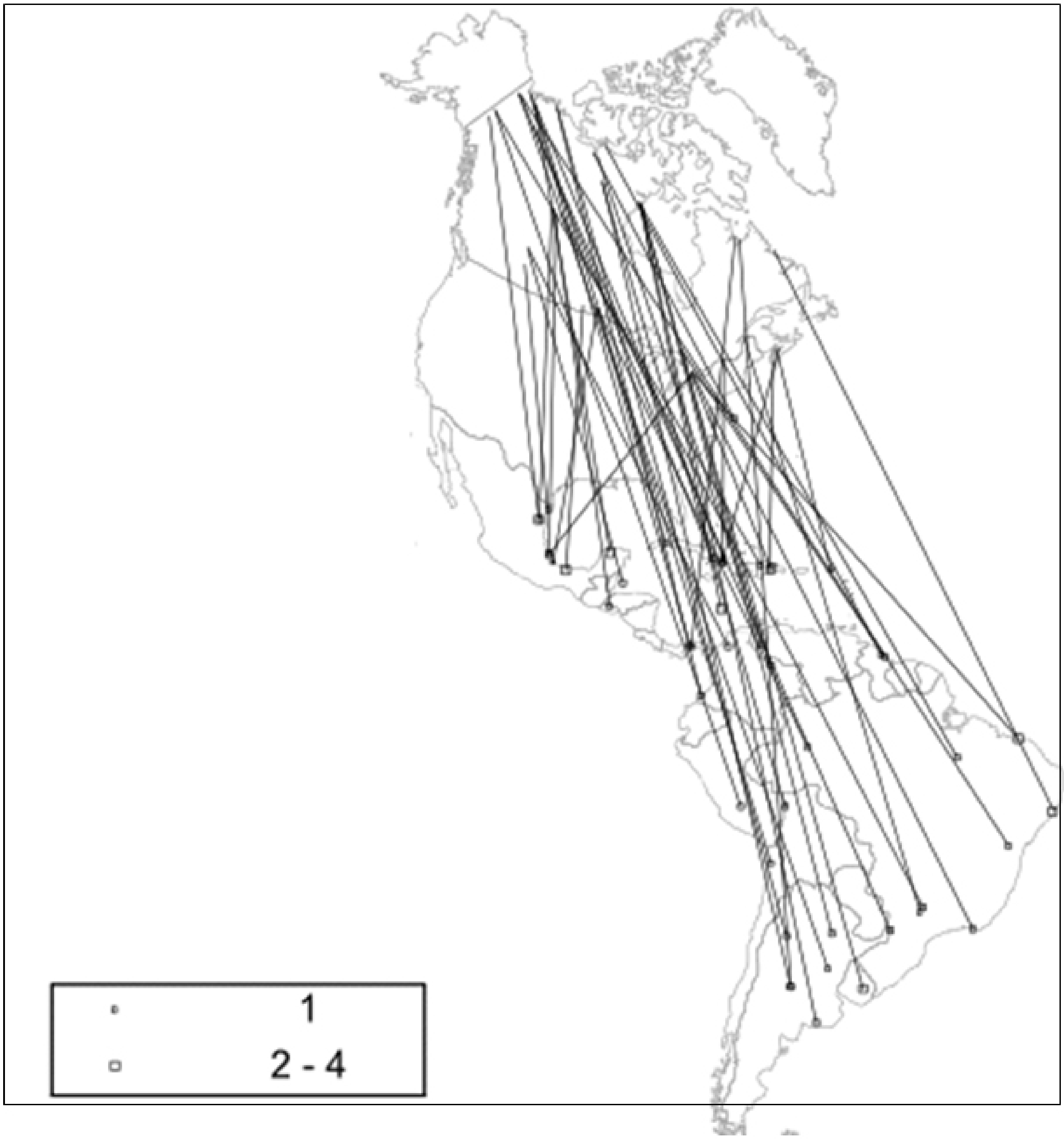


Figure 4. Southern band returns for Peregrine Falcons banded in Canada (locations <200 km excluded) (from Dunn *et al*. 2009).

Winter range in eastern North America appears to have shifted northward with population recovery (White *et al*. 2002). Urban-dwelling Peregrine Falcon pairs in Ontario and Quebec often remain on territory year-round. In contrast, only once was a bird documented on territory throughout the entire winter in Alberta (Alberta Peregrine Falcon Recovery Team 2005). Individual Peregrine Falcons generally do not change behaviour over time, either migrating or not migrating consistently from year to year (Watts *et al*. 2007). However, Gahbauer (2008) observed an instance of a male Peregrine Falcon in southern Ontario that migrated as a juvenile and young adult, but eventually ceased migrating and stayed at its breeding territory year-round. Wintering Peregrine Falcons have been recorded at least once since 1950 on Christmas Bird Counts (CBC) in all jurisdictions across Canada except for Nunavut and Yukon; however, most observations are from southern Canada, primarily British Columbia, Ontario and Quebec (Audubon 2016). Over the past 10 years (2007-2017), there have been winter (December-February) eBird reports from all provinces except Saskatchewan and Manitoba, with none from the northern territories (eBird 2017b) (Figure 5); while helpful, these reports are limited by the distribution of birders who voluntarily report their sightings.

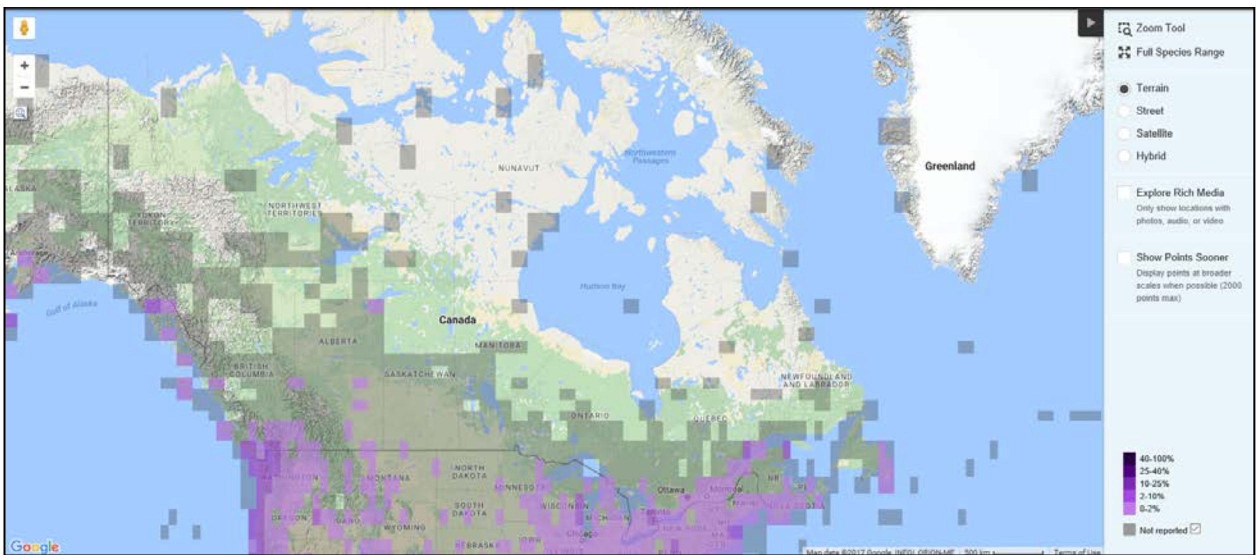


Figure 5. Reported winter sightings of Peregrine Falcons in Canada during winter (December-February) over the most recent 10 years (2007-2017) (eBird 2017b). Purple squares indicate a Peregrine Falcon sighting, grey squares indicate a square where volunteer observers reported bird sightings but Peregrine Falcons were not observed.

POPULATION SIZE AND TRENDS

Sampling Effort and Methods

In Canada, the Peregrine Falcon is widely distributed, with many subpopulations occurring in remote areas. Subpopulations of both *pealei* and *anatum/tundrius* Peregrine Falcons have been surveyed regularly at the jurisdictional level (i.e., provinces, territories, and states) every five years across much of southern Canada and elsewhere in North America as part of a nationally coordinated survey protocol (Kiff 1988; Holroyd and Banasch 2012). These quinquennial surveys have been conducted since 1970, using standardized protocols (Cade and Fyfe 1970; Fyfe *et al.* 1976; Murphy 1990; White *et al*. 1990; Holroyd and Banasch 1996; Rowell *et al*. 2003; Banasch and Holroyd 2004; Holroyd and Banasch 2012). Methods were largely consistent across jurisdictions and over time to allow for comparison, although search effort may have increased in some circumstances, e.g., efforts for *pealei* has encompassed more area over time (BCMOE 2016), whereas some other jurisdictions were not surveyed during certain periods or were covered less intensively owing to logistical or financial constraints. For example, surveys are also conducted every five years in Labrador, but take place over two consecutive years because of cost and time requirements (Rodrigues 2010). In many jurisdictions, surveys are only conducted at specific study sites, e.g., urban Saskatchewan subpopulations are studied annually, no formal province-wide survey has been conducted over the past 20 years (Thompson pers. comm. 2016), and similarly only known urban subpopulations are surveyed in Manitoba (Maconachie pers. comm. 2016). Overall, many additional breeding pairs exist, especially for Arctic-nesting *anatum/tundrius* Peregrine Falcons that breed across a vast, sparsely populated landscape. The national quinquennial surveys are therefore generally much more comprehensive for southern than northern *anatum/tundrius* Peregrine Falcons in many jurisdictions, and for *pealei* Peregrine Falcons, which are considered to be generally well-surveyed. Data from the 2010 and 2015 surveys have not yet been published elsewhere but are summarized in this report. The national surveys, which are designed to collect population and productivity trend information, do not provide a breeding population estimate as they do not cover the entire breeding range, particularly in northern Canada. With the improving status of Peregrine Falcons in Canada and the discontinuation of the national Peregrine Falcon Recovery Team, there is less coordination of the national five-year surveys and the effort has become less consistent. Not all jurisdictions participated in the 2015 survey, although some conducted a subsequent survey in 2016.

In addition to the broad-scale national surveys every five years, some jurisdictions, non-governmental organizations and academic institutions conduct their own surveys more frequently in selected study areas. A number of volunteers and stewardship organizations also play a role in Peregrine Falcon monitoring, particularly in urban centres, and a number of local or regional voluntary monitoring programs have been established across the country. Examples include the Manitoba Peregrine Falcon Recovery Program (2016), the Thunder Bay Field Naturalists' Project Peregrine for the Lake Superior Basin (Ratcliff 2015), and the Canadian Peregrine Foundation, which monitors and reports on a number of nest sites in southern Canada (Canadian Peregrine Foundation 2016).

Survey results for numbers of breeding birds and nest productivity are separated by southern and northern Canada. This division recognizes two relatively separate distributions within Canada (see Figure 1), as well as differences in survey coverage and population density and, except for the southern Labrador coast, approximates the area of northern Canada, north of latitude 54°N, as identified by Franke (2016) and USFWS (2008b). Survey coverage of breeding subpopulations is much higher for the area identified as southern Canada, while a much smaller proportion of the far larger northern Canada subpopulation is generally surveyed.

By standardizing breeding measures such as the number of occupied territories, territorial pairs, and the number of young fledged per nest, inferences can be made on national and regional trends. Efforts are made to distinguish territories held by single birds from those held by territorial pairs. It is difficult to standardize survey methods across Canada given the diverse nature of habitat, terrain, accessibility, nesting sites and breeding densities, and there may be limitations on the extrapolation of these data to broader areas, especially for northern Canada (Oliphant in prep.). In some cases, helicopters or boats are used, while some urban sites can be viewed with relative ease. Helicopters can typically survey a larger number of sites and provide greater survey coverage, while boats can yield higher detection rates in some settings (Carrière and Matthews 2013). Complete population estimates are difficult to determine for all of Canada, given the remoteness of much of the species' range in the Arctic. Population estimates based solely on quinquennial national survey information would substantially underestimate the total Peregrine Falcon population, as only select areas are surveyed. Population surveys in southern Canada are generally more comprehensive given easier access and the species' more limited range and smaller population size. There is potential to comprehensively survey the *pealei* Peregrine Falcon population because it is geographically restricted, although limited access is still a factor.

Broad-scale migration monitoring may become more important for this species as focused breeding surveys are scaled back (Farmer *et al.* 2008). Breeding bird atlases are an increasingly common and useful source of information, particularly for distribution and breeding status. A number of Canadian jurisdictions have now completed or are undertaking breeding bird atlas projects, and several have repeated a second atlas approximately 20 years after the first (i.e., Alberta, Maritime Provinces, Ontario, and Quebec) (Appendix 1). These repeat surveys provide useful information on changes in breeding distribution within jurisdictions. The North American Breeding Bird Survey is not well-suited to detecting Peregrine Falcons, and Environment Canada (2014a) considers BBS data insufficient to estimate trends for this species. Christmas Bird Count data are also not appropriate for determining detailed population trends for a relatively uncommon top-level predator such as the Peregrine Falcon, because of limited spatial and temporal coverage. However, they can still be useful for determining general trends in population changes and winter distribution.

Abundance

There is a considerable range in the estimates of the size of the global and North American Peregrine Falcon populations. There were no comprehensive surveys in North America prior to the population declines of the mid-20th century, making it difficult to estimate the overall size of the historical population, although selected records exist for some regions, and based on these and concurrent declines elsewhere in the world, the reduction in numbers in Canada is believed to have been severe. Peregrine Falcon populations have clearly increased substantially since that time, with an estimated 4800-6000 pairs of *anatum/tundrius* and 850-1000 pairs of *pealei* Peregrine Falcons thought to be breeding in North America by the late 1990s, part of an overall population of 40,000 to 50,000 individuals, including immature birds and other surplus non-breeders or floaters (White *et al.* 2002).

One of the key factors in estimating the total number of mature individuals in the Peregrine Falcon population is the number of surplus non-breeders. The occurrence of such individuals is generally associated with more stable breeding populations (Penteriani *et al.* 2011). While the number or proportion of surplus non-breeding birds in the Peregrine Falcon population is difficult to estimate, it is clearly substantial. At Rankin Inlet, experimentally created vacancies of Arctic-breeding adults were rapidly replaced in 11 of 14 territories (Johnstone 1998). This suggests that, at a minimum, floaters accounted for 39% of the breeding population for this area. Given that this estimate was based upon replacement of adults at a nest site within 24 hours, this likely substantially underestimates the total floater population and supports Nelson's (1977) estimate that the surplus non-breeding population comprises at least 50% of the breeding population. In estimating the size of the post-breeding North American population, Franke (2016) assumed an equal number of breeding and non-breeding birds, while White *et al.* (2002) noted that floater-to-breeder ratios are commonly between 1:1 and 2:1. An estimate that the number of floaters in a population is equal to half of the breeding population is thus considered a conservative estimate.

Falco peregrinus pealei

The highest densities of Peregrine Falcons in Canada are found amongst *pealei* Peregrine Falcons on the Pacific coast, apparently due to the high concentration of seabirds at colonies (Cooper 2007). Densities are much higher on the offshore islands than along the mainland coastline (Cooper 2007). Although there are approximately 200 current and historical nesting sites (BCCDC 2016a), the Canadian *pealei* Peregrine Falcon nesting population has typically been around 100 occupied territories in recent decades. A total of 119 territories was documented in 2015, the highest recorded since current surveys began in 1970, although survey methods have been variable and effort has been highest in recent surveys (Table 3, Figure 6) (BCMOE 2016; Chutter 2016). This suggests a minimum population estimate of 357 mature individuals, given 119 breeding pairs plus 50% surplus non-breeders, based on studies by Nelson (1977).

Table 3. Number of nesting territories occupied by *pealei* Peregrine Falcons in selected areas surveyed in Canada 1970-2015. Numbers in parentheses indicate number of sites occupied by territorial pairs, while the first number includes sites with both pairs and single birds. Data from Rowell *et al*. (2003) and Chutter (2016)[19].

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Langara Island	6 (5)	6 (6)	6 (6)	6 (5)	7 (7)	7 (5)	9 (7)	10 (8)	8 (7)	7 (5)
Haida Gwaii	56 (46)	60 (51)	73 (58)	50 (ND)	64 (53)	62 (45)	60 (44)	74 (46)	75 (37)	78 (43)[20]
N. Vancouver Island	nd	nd	nd	6(5)	10 (5)	10 (6)	20 (12)	17 (13)	19 (12)	24(8)
Triangle Island	nd	nd	nd	nd	nd	8(8)	7(6)	7(nd)	7(4)	10(3)
Total for all surveys	**62 (51)**	**66 (57)**	**79 (64)**	**62 (10)**	**81 (65)**	**87 (64)**	**96 (69)**	**109 (67)**	**109 (60)**	**119 (59)**

[19] The Gulf Islands/SE Vancouver Island area is considered a hybrid zone between *pealei* and *anatum/tundrius* subspecies. Survey results for this area are included in Table 4 to avoid duplication of results

[20] Incomplete count due to weather - extrapolation for missed area would add more occupied territories (Chutter 2016)

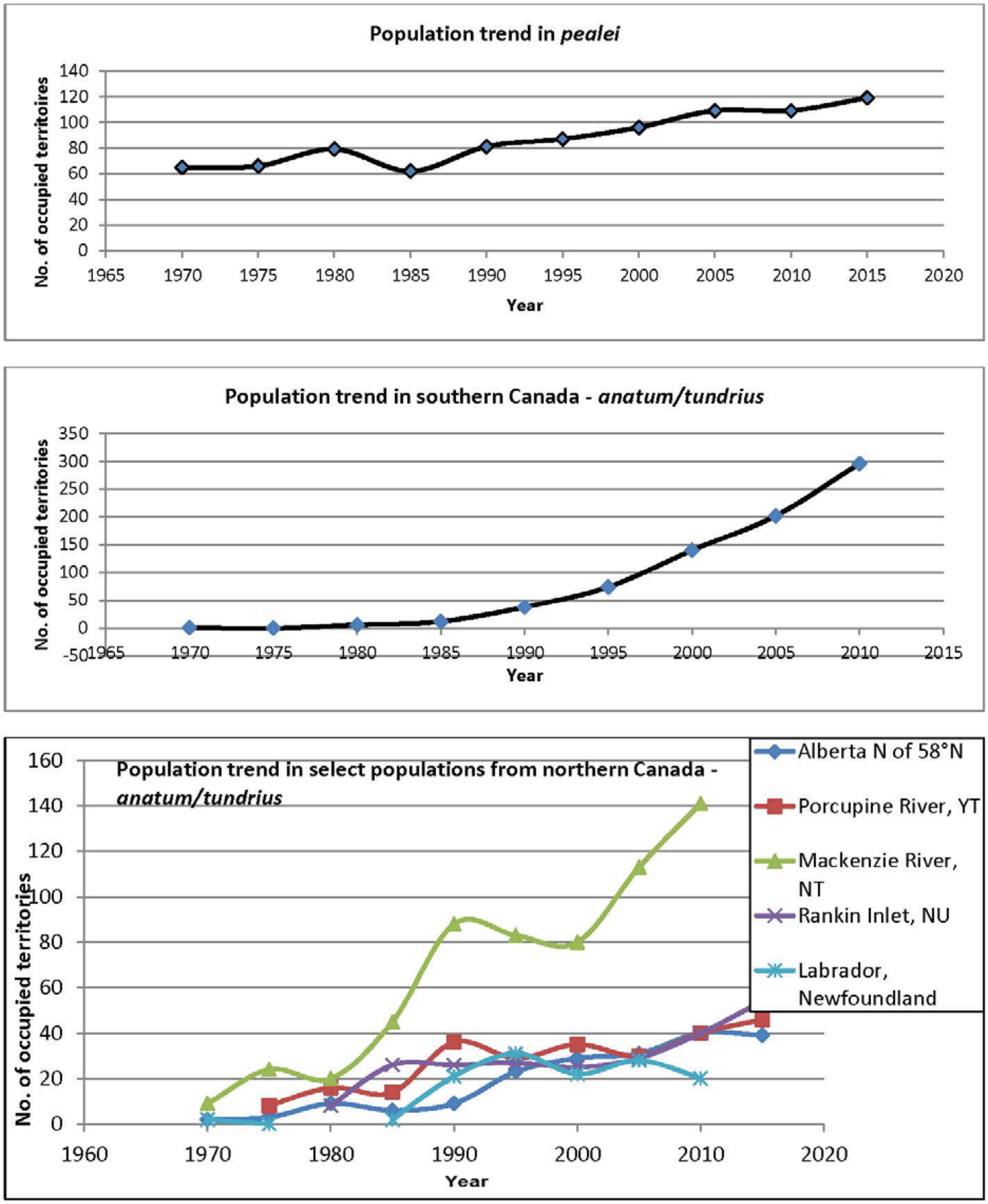


Figure 6. Trends in Peregrine Falcon numbers at study areas across Canada, based upon results of nation-wide five-year surveys.

Falco peregrinus anatum/tundrius

The 2010 national survey results indicated a minimum of nearly 300 breeding pairs, or 600 mature adults, in southern Canada (Table 4). Given an estimated 50% surplus non-breeding adults, and a conservative estimate of 10% of nesting sites not surveyed, a conservative estimate for the region is 1,000 mature individuals. While there was only minimal historical documentation of breeding sites and few estimates of the Peregrine Falcon breeding population prior to its collapse in the mid-20th century, several southern Canada jurisdictions have noted that current populations exceed known documented historical levels (Holroyd and Banasch 2012).

The northern Canada *anatum/tundrius* Peregrine Falcon subpopulation is much larger, but obtaining population estimates is far more difficult. Breeding habitat quality and nesting density is not uniform across the north. Fyfe (1969) estimate 252,061 km^2 of optimum nesting habitat and another 331,945 km^2 of more limited nesting habitat across northern Canada. A number of study areas have been surveyed regularly as part of the five-year surveys, but these represent only a small portion of the northern subpopulation. In northern Canada, there is a minimum of 479 known nesting sites[21] within regularly surveyed study areas, representing a minimum of 958 mature individuals. Considering the observed increases seen in breeding populations that have been more recently surveyed (Table 4, Figure 6), it is certain that the regularly surveyed study areas of northern Canada now support over 500 breeding pairs. With consideration of floaters, the population for these regularly surveyed areas of northern Canada is estimated at 1,500 mature individuals.

Table 4. Number of nesting territories occupied by *anatum/tundrius* Peregrine Falcons in selected areas surveyed in Canada 1970-2015. Numbers indicate occupied sites with pairs or single birds (sites occupied by territorial pairs) (Rowell *et al.* 2003; Holroyd and Banasch 2012; and other sources as footnoted).

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Southern Canada										
Bay of Fundy (NS,NB)[22]	0	0	0	1 (1)	7 (5)	6 (6)	11 (11)	20 (16)	nd	nd
New Brunswick	nd	nd	nd	nd	nd	nd	nd	nd	13 (12)	17 (14)[23]
Nova Scotia	nd	nd	nd	nd	nd	nd	nd	nd	nd	9 (9)[24]
Southern Quebec	0	nd	1 (1)	1 (1)	15 (12)	15 (13)	28(25)	58 (53)	114 (98)	139 (116)[25]

[21] Based upon the number of observed nesting sites in the 2010 survey, supplemented by higher counts for regions also surveyed in 2015 and the highest recent count for regions not surveyed in 2010 (Table 4 data).

[22] Surveys have been conducted by individual jurisdictions since 2010

[23] Includes one additional occupied territory (territorial pair) that was newly located in 2014 but not surveyed in 2015 because not reported in time

[24] Survey not completed but 9 territories known to be active; plan to undertake survey of known sites in 2016 (Elderkin pers. comm. 2016)

[25] Survey completed in 2016 (Fradette 2016)

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Ontario	0	0	0	1 (0)	3 (2)	15 (14)	53 (42)	76 (67)	100 (119)	48 (36)[26]
Manitoba	nd	nd	0	1 (1)	2 (1)	4 (4)	3 (2)	3 (2)	5 (3)[25]	8 (5)[27]
Saskatchewan	0	nd	0	2 (1)	2 (1)	2 (2)	4(3)	1(0)	nd	3 (2)[28]
Alberta south of 58°N	1 (1)	0	0	2 (2)	3 (3)	13 (12)	23 (23)	21 (17)	28 (26)	28 (27)[29]
South Interior BC	nd	nd	nd	nd	nd	2 (2)	1 (1)	4 (2)	11 (11)	17 (15)
Lower Mainland BC	nd	nd	nd	nd	nd	8 (8)	6 (5)	7 (5)[30]	6 (4)	11 (7)
Gulf Islands/SE Vancouver Island, BC[31]	nd	nd	5 (4)[32]	4 (2)	6 (3)[33]	9 (7)	11 (9)	12 (9)	19 (14)	12 (11)
Regional totals	**1(1)**	**0**	**6 (5)**	**12 (8)**	**38 (27)**	**74 (68)**	**140 (121)**	**202 (171)**	**296 (287)**	**292 (242)[34]**
<u>Northern Canada</u>										
Labrador, Newfoundland	2 (2)	0	nd	2 (2)	21 (21)	31 (31)	22 (15)	28 (18)	20 (14)[35]	nd
Ungava Bay, Quebec.	12 (9)	11 (9)	10 (10)	23 (23)	33 (38)[36]	nd	nd	13 (12)[37]	nd[38]	nd
Alberta North of 58°N	2 (1)	3 (3)	9(9)	6 (5)	9 (9)	23 (23)	29 (29)	31 (31)	40 (40)[39]	39 (39)[40]
Porcupine River, Yukon	nd	8 (8)	16 (13)	14 (11)	36 (nd)	29 (29)	35 (35)	30 (30)	40 (40)	46 (46)
Peel River, Yukon	nd	nd	18 (12)	12(10)	14 (nd)	37 (37)	22 (22)[41]	22 (22)[42]	20 (20)	15 (15)[43]

[26] Province-wide survey not conducted; data represent smaller regionally based studies in Lake Superior Basin (Ratcliff 2015) and cannot be directly compared with previous years

[27] Maconachie (2016)

[28] Two confirmed pairs/nesting attempts; adults seen at third site during migration but no nesting; young were subsequently hacked at the site (Thompson 2015)

[29] 2016 survey (Court pers. comm. 2016)

[30] South Interior, Lower Mainland, Gulf Islands and SE Vancouver Island combined

[31] Noted as a hybrid zone between *pealei* and *anatum/tundrius* subspecies

[32] Gulf Islands only

[33] Data collected in 1991

[34] Cannot be directly compared with previous years because of incomplete data for Ontario

[35] Two year survey (2009-10) (Rodrigues 2010)

[36] Bird and Chabot (2009)

[37] 2007 data; only 28 (39) of 72 known sites surveyed (Bird and Chabot 2009)

[38] Since the 1990 survey, 35 of 43 visited territories have been confirmed as active in a 2011 database (Tremblay *et al.* 2012)

[39] Court pers. comm. (2016)

[40] 2016 survey data (Court and Holroyd 2016). A large number of nesting sites had apparently failed at the time of the 2016 survey due to heavy rainfall events, and the actual population may have been closer to 50-55 pairs (Court pers. comm. 2016).

[41] A smaller section of the Peel was surveyed in 2000 compared to 1995

[42] A smaller section of the Peel was surveyed in 2005 compared to 1995

Area	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Yukon River, Yukon	6(5)	6(5)	12 (10)	22 (18)	33 (nd)	46 (46)	46 (46)	77 (77)	42 (42)	22 (22)[44]
Southern Lakes, Yukon	nd	nd	nd	nd	nd	1 (1)	1 (1)	1 (1)	2 (2)	1 (1)
North Slope, Yukon	nd	5 (5)	2 (0)	0	1 (0)	5 (5)	9 (9)	20 (20))	18 (18)	20 (20)
Mackenzie Valley, NT[45]	9 (6)	24 (21)	20 (15)	45 (nd)	88 (77)	83 (83)	80 (80)	113 (113)	141 (141)	65[46]
Tuktut Nogait NP, NT	nd	nd	nd	nd	19 (19) [47]	nd	19 (18)	24 (24)[48]	20 (20)	23 (20)[49]
Daring Lake NT [50],[51]	nd	nd	nd	nd	nd	4 (4)	7 (7)	5 (5) (8)	5 (5)	8 (8)
Lac de Gras NT [52],[53]	nd	nd	nd	nd	nd	2 (2)	7 (7)	9 (9)	13 (13)	15 (15)
Rankin Inlet, Nunavut	nd	nd	8(8)[54]	26 (nd)	26 (26)	27 (27)	25 (22)	29 (27)	40 (40)[55],[56]	54 (54)
Regional totals	**30 (24)**	**57 (46)**	**101 (82)**	**157 (74)**	**318 (218)**	**324 (318)**	**374 (348)**	**402 (389)**	**401 (375)**	**269 (223)**
National totals for all surveys	**31 (25)**	**57 (46)**	**107 (87)**	**169 (82)**	**356 (245)**	**398 (386)**	**514 (469)**	**604 (560)**	**697 (662)**	**422 (349)**

[43] Considered 29% of breeding population (20 of 70 known sites were visited), potentially equating to 52 territories

[44] Considered 45% of breeding population (42 of 94 known sites were visited), potentially equating to 45 territories

[45] NT Environment and Natural Resources (2016a)

[46] Boat survey only, previous years combined helicopter and boat survey data

[47] Data based on surveys in 1988 and 1990

[48] 2006 data

[49] Holroyd and Frandsen (2015)

[50] NT Environment and Natural Resources (2016b)

[51] "occupied sites" not distinguished by territorial pairs versus single birds

[52] Dominion Diamond Corp and NT Environment and Natural Resources (2016)

[53] "occupied sites" not distinguished by territorial pairs versus single birds

[54] Only a partial survey was conducted in 1980

[55] From Jaffré *et al.* (2015)

[56] Franke, pers. comm. (2016)

Franke (2016) estimated that there was a population of over 21,000 migratory hatching-year Peregrine Falcons (i.e., 16,035 ± 2,040 in western North America and 5,245 ± 500 in the east) originating from northern North America (i.e., Canada, Alaska, and Greenland). This estimate was calculated from a Lincoln-Petersen mark-and-recapture analysis of banding and recapture data, i.e., the number of young banded in northern North America (north of 54°N in Canada), and the number of banded birds recaptured on migration for all years between 1970-2010 when the number of both banded and recaptured birds exceeded 100. Considering the average productivity of a number of Arctic subpopulations (1.4 young/territorial pair) and assuming an equal number of breeding and non-breeding adults, this equated to an estimated total population of mature individuals (breeding pairs plus non-breeders) at the end of the 2000 breeding season of 60,000 mature individuals. Franke (2016) acknowledged that he was unable to account for an unknown portion of the northern subpopulation migrating through the Mississippi Flyway, as there was no suitable banding/trapping program within that flyway. A 1997 estimate suggested that 17% of northern breeding pairs were in Alaska, 66% in Canada, and 17% in Greenland (White *et al.* 2002). Considering these proportions, it is conservative to suggest that at least 50% of the population estimated by Franke (2016) occurs in Canada, which would represent an estimated 30,000 mature individuals in 2000. The total number of known nesting sites observed in northern Canada increased by 17% between the 2000 and 2010 surveys (the 2015 data are too incomplete for this comparison), suggesting a current Canadian population extrapolated from these figures of 35,100 mature individuals, and potentially higher. This estimate lies within the landbird population range category of 5,000-50,000 adult Peregrine Falcons in all of Canada (*pealei* and *anatum/tundrius*) reported by the Status of Birds in Canada (Environment Canada 2014b).

Fluctuations and Trends

Peregrine Falcon populations are generally quite stable in the absence of pesticides or other human impacts, typically fluctuating by less than 8% annually; this pattern has been historically observed in Great Britain, continental Europe and North America, presumably reflecting a steady supply of nesting sites and prey (Newton and Mearns 1988).

For much of Canada, historical nesting sites were poorly documented prior to the population collapse in the mid-20th century, making it very difficult to compare current versus historical population levels. Peregrine Falcon populations across much of North America and much of the global range declined precipitously as a result of eggshell thinning caused by the widespread use of DDT (Kiff 1988; Peakall and Kiff 1988; White *et al*. 2002). Peregrine Falcon populations with greater than 15 ppm DDE in eggs invariably declined (Kiff 1988). Population declines associated with eggshell thinning and levels of DDE were demonstrated in at least 36 countries by 1985 (Peakall and Kiff 1988). Populations in eastern North America were particularly impacted; the species was nearly extirpated in eastern Canada and the United States east of the Mississippi River by the mid-1960s and only one-third of all known sites in the Rocky Mountains were still occupied (Kiff 1988). Only one Peregrine Falcon nest was found in Canada east of the Rocky Mountains and south of 67°N latitude by 1970 (Fyfe 1988). Some of the last documented breeding occurrences prior to population collapse in a number of southern Canada jurisdictions included:

- Alberta – only one active nesting site was found during the first province-wide survey in 1970 (Alberta Peregrine Falcon Recovery Team 2005);
- Ontario – last breeding record in 1963 (Peck and James 1987);
- Southern Quebec – the few remaining nesting sites that were occupied in the early 1960s were abandoned by 1970 (Comité de rétablissement du faucon pèlerin au Québec 2002);
- New Brunswick – last report of nesting activity in 1948 (Kiff 1988);
- Nova Scotia – last documented nesting pair in 1955 (Amirault 2003).

After the 1975 continent-wide surveys, scientists concluded that Peregrine Falcons were essentially extirpated in (south-) eastern Canada, declining in the prairie provinces, Northwest Territories and the Yukon, and of unknown status in interior British Columbia; Arctic-nesting subpopulations also appeared to be declining at an accelerating rate (Fyfe *et al*. 1976; Kiff 1988).

The Canadian recovery program was initiated in the 1970s, and consisted of DDT restrictions, regular monitoring, captive breeding and releases, pesticide monitoring and enforcement (Fyfe 1988; Erickson *et al*. 1988). Peregrine Falcon populations across North America and Europe have recovered substantially since the 1970s with restrictions on the use of DDT, and the associated increase in natural productivity (Kiff 1988; Newton 1988b; Enderson *et al.* 1995; Millsap *et al*. 1998). Migration monitoring data show dramatic increases in Peregrine Falcons in eastern North America since 1974, with more recent moderation and a trend towards stabilization (Farmer *et al.* 2008). Subpopulations in western North America have increased at a more moderate rate. Current population levels are sustained by natural reproduction. As of 2005, only one captive-reared Peregrine Falcon was observed across Canada during the nationwide surveys (Holroyd and Banasch 2012).

Falco peregrinus pealei

Peregrine Falcon subpopulations along the western coast of North America, including British Columbia and Alaska, did not experience DDT-related declines to the same degree as other subspecies, apparently related to their more remote range, primarily non-migratory habits, and their reliance on seabirds that were less exposed to DDT (Kiff 1988; BCMOE 2016). DDE was present in falcon eggs, but at levels below the threshold that caused reproductive effects (Nelson 1990). The historical Canadian population may have comprised 150–200 breeding pairs (BCMOE 2016). The *pealei* subspecies is currently thought to be stable or possibly slightly increasing (BCCDC 2016a), although the population remains smaller than prior to the DDT-era. The Langara Island subpopulation, which contained approximately 20 territorial pairs in the 1950s (Nelson and Myres 1976) and as many as 40 pairs in the 1920s and 1930s (BCCDC 2016a), had seven pairs in the most recent (2015) survey and has never approached more than 50% of the historical level in recent decades. For BC as a whole, the number of documented occupied *pealei* territories has increased gradually over the past four national surveys from 87 in 1995 to an all-time high of 119 in 2015, (Table 3), albeit with increasing or inconsistent search effort over time (B.C.MOE 2016). There has been a continual gradual population increase since 1990, with a 36.8% increase in the number of occupied sites during the 20-year period (~3.3 generations) from 1995 to 2015, or almost 2% per year (Figure 6).

The subpopulation in the zone of overlap and hybridization between *pealei* and *anatum/tundrius* birds on southeastern Vancouver Island and the Gulf Islands has increased over time, with growth tapering off over the past two decades (Table 4).

Falco peregrinus anatum/tundrius

Subpopulations of *anatum/tundrius* Peregrine Falcons are generally stable or increasing across southern Canada. Most areas with ongoing survey coverage have shown a substantial increase since 1970 (Table 4, Figure 6), with tremendous increases between 2000 and 2005 in some areas (e.g., 43% increase in occupied sites in southern Ontario, 112% in southern Quebec) (Holroyd and Banasch 2012). Peregrine Falcon *anatum/tundrius* subpopulations in southern Canada have continued to increase as reflected by the 2010 and 2015 surveys, although there is some suggestion that the rate of increase is slowing. The Bay of Fundy subpopulation showed a rapid increase until 2005, the last time period it was surveyed as a unit. Combined counts in New Brunswick and Nova Scotia in 2015 were the highest recorded to date. Breeding records from the Maritimes tripled between the first and second breeding bird atlases (Stewart *et al.* 2015). In the 25-year period between the first and second breeding bird atlases in Quebec, the proportion of squares occupied by Peregrine Falcons similarly increased by 300% (Coughlan and Duquette 2015). There was a 991% increase in the total number of bird atlas squares in Quebec with evidence of breeding (possible, probable or confirmed breeding) between the two atlas periods (Québec Breeding Bird Atlas 2017). The rate of growth in southern Quebec slowed in 2010 from earlier in the decade, although still showing a 5-year rate of increase of 85%, and there was a subsequent lower increase of 18% between 2010 and 2016 (Fradette 2016). Ontario's breeding subpopulation increased rapidly once recovery was initiated, with a statistically significant annual rate of increase of 0.6 nesting attempts per year in southern Ontario (1995-2006, $p<0.001$) and 2.0 nesting attempts per year in northern Ontario (1991-2006, $p<0.001$) (Gahbauer *et al*. 2015a). Ontario's subpopulation almost doubled between 2000 and 2010. Ontario did not participate in the 2015 nationwide survey, but an additional 37 territories have been documented since the 2010 survey, a 31% increase (OMNRF 2015). In the Prairie Provinces, Manitoba has a small but increasing subpopulation, with the highest recorded count in the most recent 2015 survey, while Saskatchewan has a very small but relatively stable subpopulation. The southern Alberta subpopulation is gradually increasing, with the highest recorded count in the most recent two surveys (2010 and 2015). The British Columbia subpopulation continues to increase, with further expansion in the range and abundance documented during the 2015 survey (Chutter pers. comm. 2016), although the lack of recovery in the Okanagan Valley continues to be a concern (BCCDC 2016b). In both southern interior B.C. and lower mainland B.C., the highest recorded counts to date occurred in the most recent 2015 survey. On the Gulf Islands and southeastern Vancouver Island *anatum/tundrius* subpopulations have shown an initial increase from early surveys in the 1980s, and are now variable but relatively stable.

Summary results from recent five-year surveys (i.e., 2005, 2010) reveal that in recent years the southern Canada *anatum/tundrius* subpopulation is increasing by an average of approximately 45% between five-year surveys, or 9% annually (Figure 7). Trends in population growth over a 20-year period (approximating three generations) were summarized for all jurisdictions for either 1990-2010 or 1995-2015, based upon the availability of data (Table 5). The number of known nesting territories increased in all jurisdictions across southern Canada, despite the noted variability in productivity. The lowest 20-year rate of increase was observed in Saskatchewan (+50%), and the highest rate of increase in Ontario (+3233%).

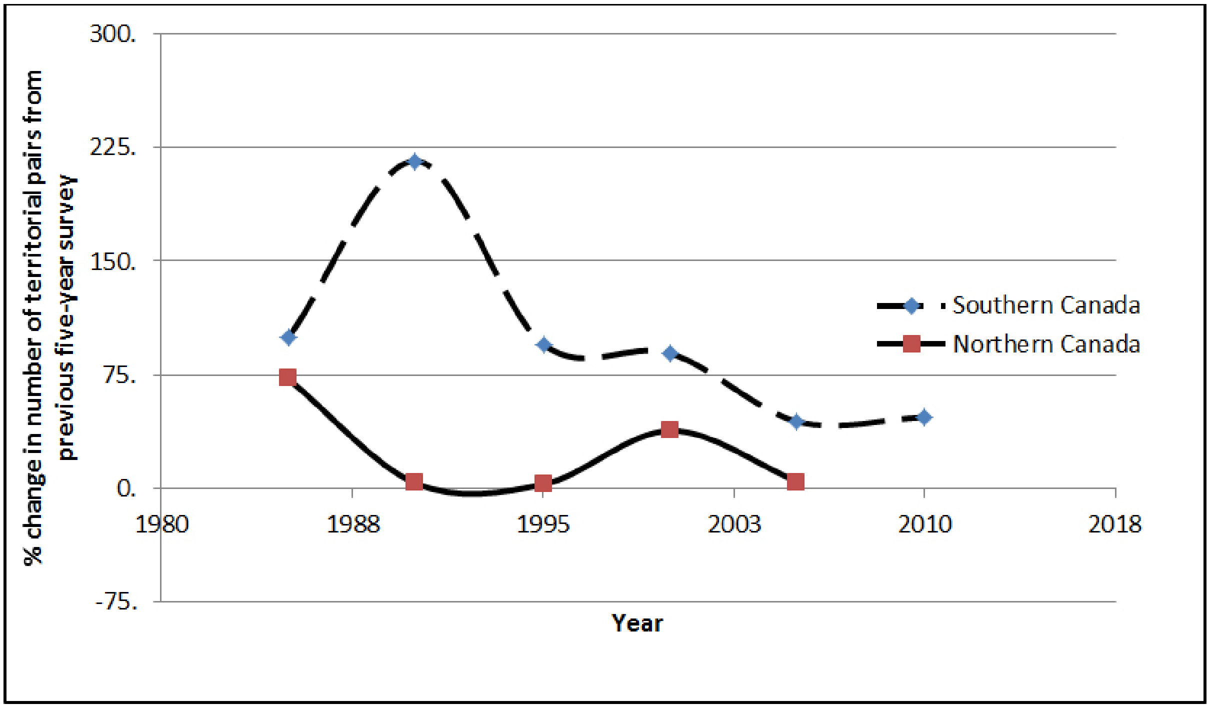


Figure 7. Trends in the percentage change in the number of territorial pairs from the previous quinquennial survey for southern and northern Canada (the latter including the Porcupine River, Yukon River and North Slope, all in the Yukon Territory, Mackenzie River in the NWT and Rankin Inlet in Nunavut).

Table 5. Trends in the number of occupied nesting territories for *anatum/tundrius* Peregrine Falcons by jurisdiction, over the most recently available 20-year survey period.

Location	Jurisdiction	Most recent 20-year survey period[57]	Change in number of documented territories[58]
Southern Canada	British Columbia	1995-2015	+110%
	Southern Alberta	1990-2010	+833%
	Saskatchewan	1995-2015	+50%

[57] A number of jurisdictions were not surveyed in 2015 to the same degree as in previous surveys

[58] As reported in jurisdictional five-year survey reports

Location	Jurisdiction	Most recent 20-year survey period[57]	Change in number of documented territories[58]
	Manitoba	1995-2015	+100%
	Ontario	1990-2010	+3233%
	Southern Quebec	1995-2016	+775%
	Bay of Fundy (New Brunswick, Nova Scotia)[59]	1995-2015	+333%
Northern Canada	Labrador	1990-2010	-5%
	Northern Alberta	1995-2015	+70%[60]
	Yukon Territory	1995-2015	+40%[61]
	Northwest Territories	1990-2010 (2 study areas) 1995-2015 (2 study areas)	+58%
	Nunavut	1995-2015	+100%

Trends in northern Canada were not as consistent across all jurisdictions or years, although most subpopulations have shown an increase over the past several decades (Figure 6). Territories of northern-nesting *anatum/tundrius* subpopulations have not increased as dramatically as in the south, although all jurisdictions except Labrador showed increases of 40-100% over the most recent 20-year period (Table 5). The trend in population change between five-year surveys was plotted for five study areas in northern Canada where subpopulations were surveyed in each survey period between 1980 and 2010 (Figure 7). In three of the last four survey periods, the percentage change in the number of territorial pairs from the previous survey was less than 5% and averaged 3.4%, or 0.7% per year, for those three survey periods. Over the twenty-year period from 1990-2010, the number of occupied territories in surveyed areas of northern Canada increased by 26.1%. In part, the comparatively smaller rates of increase reflect a larger initial population than in the south, where numbers in many regions were so small that growth rates were unsustainably high.

The Mackenzie River subpopulation has shown the most dramatic increase, and most closely parallels rates observed in southern Canada. The Ungava Peninsula in northern Quebec has not been surveyed frequently enough to provide a trend. The northern Alberta subpopulation continued to increase gradually, up until the last reported survey in 2010. The number of productive nesting sites along the Mackenzie River increased significantly by 1.9 sites/year from 1970-2010 ($p<0.01$), with the highest number ever recorded in 2010 (Carrière and Matthews 2013). The number of breeding pairs in the Arctic-nesting subpopulation of Peregrine Falcons in Tuktut Nogait National Park, Nunavut has remained relatively stable from 1988 through 2015 (Holroyd and Frandsen 2015). Two other subpopulations surveyed in recent decades have shown variable trends – the Daring Lake subpopulation has been relatively stable while the Lac de Gras subpopulation has shown a gradual increase. The Rankin Inlet subpopulation has also shown a continued gradual increase. Labrador showed a slight decrease of -5%, although the trend could perhaps be

[59] Similar to but may not be completely comparable; Bay of Fundy data in 1995, individual jurisdictional data in 2015

[60] Percentage increase could potentially have been much higher, as it appeared that many nesting sites failed due to severe rain events prior to the 2016 survey (Court and Holroyd 2016)

[61] Includes two sites that were not completely surveyed in 2015 but results were extrapolated proportionately according to the % area covered

better described as fluctuating (see Table 4). The Tadoussac Bird Observatory in Quebec has observed a variable but gradually increasing number of fall migrant Peregrine Falcons, presumably representing an increasing population in northern Quebec, between 1994 and 2014 (Côté 2015).

Some subpopulations of northern-nesting *anatum/tundrius* Peregrine Falcon have recently shown signs of reduced productivity. Some Yukon subpopulations have shown signs of reduced performance beginning as early as 2000 (Mossop 2003, 2015), with only 27% of nests producing young in 2015 (a 20% decline from 2010) and 0.54 young fledged/territory, well below what is required to sustain a population (Mossop 2015). The Yukon River subpopulation appears to have declined since 2005, after accounting for the proportion of the breeding population surveyed (i.e., 77 occupied sites in 2005, 42 in 2010, 49 in 2015), although the two most recent results are consistent with the count of 46 sites in 1995 and 2000, suggesting that the 2005 results may have been an exceptional peak. However, the Porcupine River subpopulation has shown a gradual increase, with the highest recorded count in the most recent survey in 2015 (Mossop 2015). At Rankin Inlet in Northwest Territories, the number of breeding pairs has increased steadily and was at its highest number in the most recent survey in 2015, but the total number of young produced annually has declined over the past three decades (Jaffré *et al.* 2015).

Christmas Bird Count data reveal that the number of wintering birds seen per party hour in southern/western Canada, primarily reflecting numbers in southern British Columbia, remained relatively stable from the 1950s through the 1990s, and has increased slowly since then (Figure 8a; Audubon 2016). There was an unusual peak in the mid-1960s which appears to reflect an anomalously high number of birds seen during one winter (1961). CBC data indicate a different trend in southern/eastern Canada, where the number of birds seen per party hour was relatively stable until the mid-1990s, after which it increased rapidly (Figure 8b). While this could simply reflect an increasing proportion of wintering birds and a northward shifting of winter range, it is more likely at least partially reflective of an increasing population.

With the recovery and recolonization of former habitat, the distribution of the *anatum/tundrius* Peregrine Falcon has increased across much of Canada. Repeated Breeding Bird Atlases are one useful means of comparing distribution through time, as are standard monitoring surveys of the same area over time. The distribution and number of confirmed breeding records of Peregrine Falcons have expanded significantly over the past two decades in many jurisdictions of southern Canada, including Alberta, the Maritime Provinces, Ontario, and Quebec (Appendix 1). While not a breeding bird atlas, surveys over a similar time period for the Mackenzie River Valley in the Northwest Territories showed a similar pattern (Appendix 1).

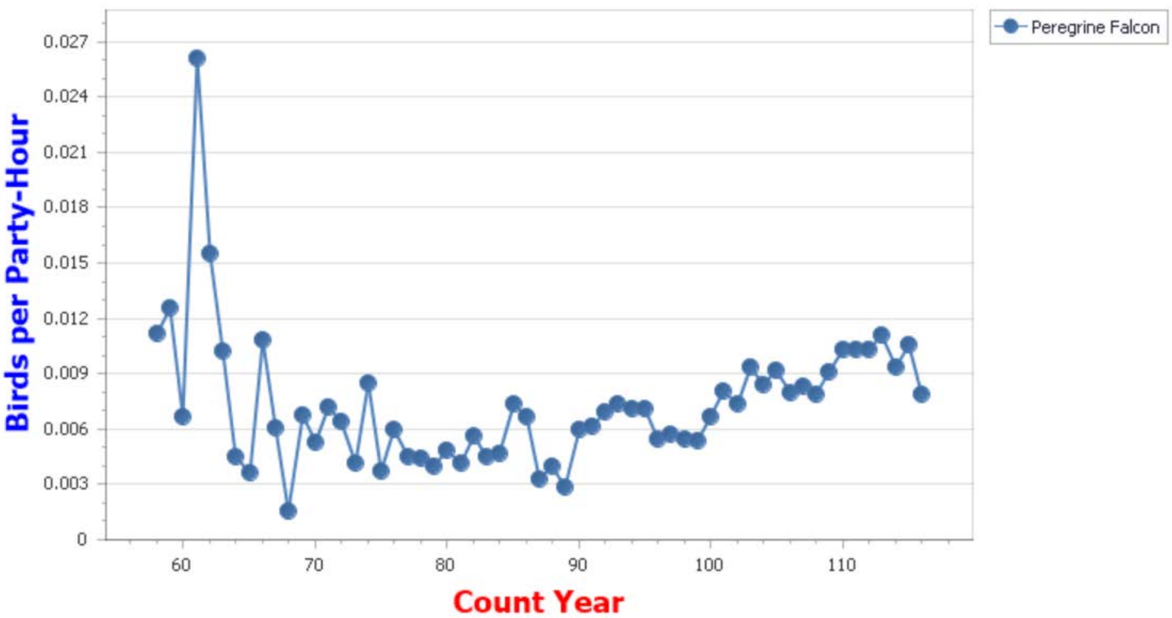


Figure 8a. Trends in the number of Peregrine Falcons seen per party-hour in all Christmas Bird Counts across southern/western Canada (British Columbia to Manitoba), 1950-2015 (from Audubon 2016)[62].

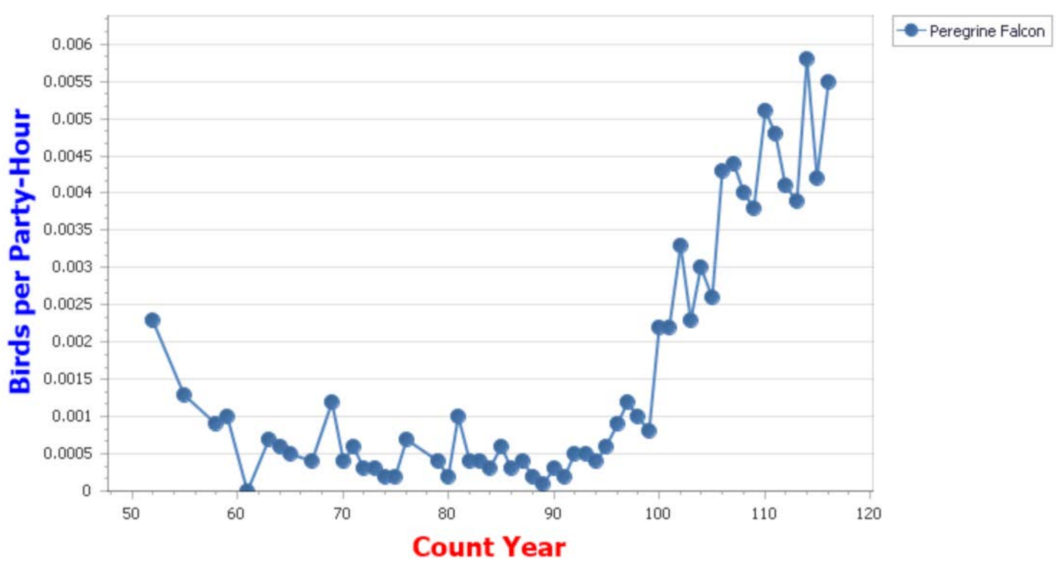


Figure 8b. Trends in the number of Peregrine Falcons seen per party-hour in all Christmas Bird Counts across eastern Canada (Ontario to Newfoundland and Labrador), 1950-2015 (from Audubon 2016).

[62] Count year and Calendar year are offset by one year, e.g.., 1950 = count year 51

Rescue Effect

The potential for rescue effect from immigration is high for both *pealei and anatum/tundrius* Peregrine Falcons, a conclusion reinforced by documented movement of individuals from re-introduction programs involving the release of captive-reared birds.

Falco peregrinus pealei

The Alaskan subpopulation of *pealei* Peregrine Falcons is considered stable, with an estimated 600 pairs, plus a floater population (Walton *et al*. 2013), although still classified as S3 (vulnerable) by NatureServe (2016). Smaller subpopulations occur in Washington (S2) and Oregon (S1), but some of these birds may not be *pealei* (Wilson *et al*. 2000; White *et al*. 2002; NatureServe 2016).

Falco peregrinus anatum/tundrius

Populations in adjacent states are generally healthy and increasing, particularly in the eastern USA, although the NatureServe (2016) breeding status for most states adjacent to Canada remains low (Washington S2, Idaho S2, Montana S3, North Dakota SNR, Minnesota S2, Michigan S1, Ohio S1, Pennsylvania S1, New York S3, Vermont S3, New Hampshire SNR, Maine S2). There is considerable evidence of immigration from the USA into Canada, particularly from Manitoba eastward. Between 1991 and 2006, at least one adult of USA origin was involved in 59% of all nesting attempts in southern Ontario, and pairings between American immigrants accounted for 21% of all nesting attempts (Gahbauer *et al.* 2015a). Arctic-nesting *anatum/tundrius* Peregrine Falcons from Greenland and Alaska are known to migrate through Canada and could also provide rescue effect.

THREATS AND LIMITING FACTORS

Threats are described below and summarized in Appendices 2 (*pealei*) and 3 (*anatum/tundrius*) based on a modified version of the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Salafsky *et al.* 2008; COSEWIC 2014), which resulted in an overall threat impact of low to high for *pealei* and unknown for *anatum/tundrius*. Threats are presented in decreasing order of importance to Peregrine Falcons, rather than in numerical sequence.

Category 9: Pollution (high to low threat impact for *pealei*; unknown threat for *anatum/tundrius*)

Oil Spills

Oil spills are one of the greatest threats potentially affecting *pealei* Peregrine Falcons. Oil spill modelling demonstrates that a single event could potentially affect a large portion of Haida Gwaii and other coastal islands (Living Oceans 2013; Fine and Masson 2015). This could affect Peregrine Falcons directly, or indirectly through reduced availability of seabird prey. The development of oil spill response plans is ongoing (BCMOE 2016).

Toxic Chemicals, Heavy Metals and Organochlorine Pesticides

Peregrine Falcons have proven highly susceptible to chemical contamination, as shown by the widespread reproductive failure, particularly in *anatum* Peregrine Falcons, from uptake of organochlorine pesticides. Widespread use of organochlorine pesticides from the late 1940s until the 1970s, most notably DDT, was the primary factor in the dramatic decline of Peregrine Falcon populations in North America and elsewhere, exacerbated by the subsequent bioaccumulation and biomagnification of DDE within the food chain (White *et al*. 2002). With the prohibition on DDT use in North America in the 1970s, DDT levels in the environment began to decline, and reproductive success started to improve. DDE residues in migrant Peregrine Falcons from South Padre Island in Texas, representing Arctic-nesting birds from northern Canada, Alaska, and Greenland, decreased significantly from 1978 to 1994 (Henny *et al*. 1996). Eggs from Alaskan *anatum/tundrius* Peregrine Falcons showed declines in several organochlorine contaminants, including DDE, between 1979-84 and 1991-95 (Ambrose *et al*. 2000). In Alberta, DDE concentrations in eggs have declined steadily since the mid-1970s, and are now, on average, nearly an order of magnitude less than 40 years ago (Alberta Fish and Wildlife Division 2010; Court and Holroyd 2016). Similarly, there has been a general downward trend in DDE levels in serum samples of adult Rankin Inlet birds collected since 1981; although contaminant loads of some individual Peregrine Falcons still exceed safe thresholds, population-level loads are well below those known to cause reproductive failure (Franke *et al.* 2010). However, two of 15 Peregrine Falcons from southeast Vancouver Island and the Gulf Islands between 2001 and 2004 had very elevated levels of DDE, and measurable levels were found in others (BCMOE 2016). Similarly, residual contamination levels in some prey species remain high enough to affect reproduction and re-establishment of Peregrine Falcons in specific regions of Canada, such as the Okanagan Valley of British Columbia (Elliott *et al.* 2005, 2015). Polychlorinated biphenyls (PCBs) have been found in high concentrations in Peregrine Falcons and are a potential concern, although a clear relationship between high levels and reproductive effects has not been established (Henny and Elliott 2007).

DDT was banned in Canada and the United States in the early 1970s and in Mexico in 2000 (Holroyd and Bird 2012), but is still used in other parts of the world, potentially including parts of the winter range of some *anatum/tundrius* Peregrine Falcons in South and Central America (White *et al*. 2002). DDT usage has declined there, being primarily used for spot treatments within homes rather than being widely used in agriculture (Roberts *et al.* 1997). However, DDT contamination can occur in soil and water even from this residual or spot spraying, as has been demonstrated in Brazil (van den Berg 2009). DDT use was phased out in Ecuador, Venezuela and Mexico in 2000, and there is no current reported use of DDT to control disease vectors in the Americas (van den Berg 2009). The continued controlled use of DDT for the control of malaria has been recognized as legitimate by both the World Health Organization and the United Nations Environment Programme (Environmental Protection Agency 2016), although there are current joint initiatives by both organizations to phase out the use of DDT completely by the early 2020s (United Nations News Center 2009). Ambrose *et al*. (2000) cautioned that organochlorine chemicals remain contaminants of concern because of their persistence, toxicity and continued use in some areas.

Recently identified threats include emerging long-lasting chemicals such as brominated flame retardants, polybrominated diphenyl ethers (PBDEs; Fernie and Letcher 2010; Braune 2011). High concentrations of PBDEs have been found in the eggs of Peregrine Falcons in northern Sweden and have been shown to bioaccumulate, raising concerns for potential reproductive impacts (Lindberg *et al*. 2004; Park *et al.* 2009). Such impacts have not been confirmed in Peregrine Falcons, but comparable concentrations have been found to cause reproductive effects in American Kestrels (*F. sparverius*; Fernie *et al.* 2009). There was a significantly increasing trend in the concentrations of PBDEs in the eggs of Peregrine Falcons from southern Greenland between 1986 and 2003 (Vorkamp *et al*. 2005). Concentrations of BDE-209, which is the major PBDE produced worldwide, increased over time in the northeastern USA, doubling in a 5-year period (Chen *et al.* 2008). BDE-209 was found in the plasma of all young (34 nests) tested from the Canadian Great Lakes basin, including both urban and cliff sites (Fernie and Letcher 2010). One of 15 Peregrine Falcon samples from southeast Vancouver Island and the Gulf Islands (2001-2004) had an elevated level of PBDEs. Additional Peregrine Falcon samples from north-central Vancouver Island and the Lower Mainland contained elevated concentrations of PBDEs that exceeded the minimum avian reproductive effects threshold suggested by Harris and Elliott (2011) (Elliott *et al.* 2015). Some limits on the manufacture and use of PBDEs have been in place in Canada since 2009 (Government of Canada 2016).

Chemical bird control agents such as 4-amino-pyridine (avitrol), strychnine and fenthion can pose hazards to non-target species, through both direct and secondary poisoning (Mineau *et al.* 1999). Organophosphorus fenthion, commonly used as an avicide to control European Starlings (*Sturnus vulgaris*) and other pest birds, has been implicated in the deaths of several Peregrine Falcons in North America (Mineau *et al*. 1999; Faccio *et al.* 2013). This and other organophosphorus compounds are used widely in North America (Hayes and Buchanan 2002). In a sample of 19 Peregrine Falcons examined by the Canadian Cooperative Wildlife Health Centre Ontario Region in the early 2000s, two had trace amounts of avitrol while quantifiable amounts were found in five additional birds that died of traumatic injuries (Campbell 2006). While these birds did not contain lethal amounts, researchers speculated that any disorientation could be fatal to raptors flying at high speeds (Campbell 2006). Ontario has voluntary pesticide control guidelines in place to limit the use of chemical bird control agents near 34 known urban nesting sites (Government of Ontario 2013).

Heavy metals such as lead continue to pose a level of risk to Peregrine Falcons, and there have been recent cases of lead poisoning (McBride *et al*. 2004). Lead levels are significantly higher ($p<0.01$) in urban Rock Pigeons than rural birds (DeMent *et al.* 1986). Peregrine Falcons with lethally elevated lead levels in Great Britain are believed to have ingested avian prey species with lead gunshot in their flesh (Pain *et al*. 1995). Mercury is a contaminant of concern because of its toxicity, bioavailability and increasing concentrations over time (Ambrose *et al*. 2000). Aquatic prey are typically more contaminated than terrestrial prey. In Nevada, the most contaminated guild contained aquatic invertebrate feeders such as the Eared Grebe (*Podiceps nigricollis*) (Barnes and Gerstenberger 2015). Mercury was present in Peregrine Falcon blood samples in Quebec at levels considerably lower than those for fish-eating birds of prey such as Osprey and Bald Eagle during the latter half of the 20^{th} century (1931 to 2002), although small sample size precluded any analysis of temporal trends (Champoux *et al*. 2015). Estimated mercury threshold levels were exceeded for 30% of Alaskan Peregrine Falcon eggs in 1991-95 (Ambrose *et al*. 2000). While mercury occurs naturally in the environment, anthropogenic sources and long-range transport may contribute significantly to the occurrence of mercury in Arctic ecosystems, resulting in increasing mercury concentrations in a variety of Arctic biota (Braune 2011).

Overall, nearly all *anatum/tundrius* Peregrine Falcons likely are exposed to multiple toxic chemicals, heavy metals, and organochlorine pesticides, and there is potential for negative consequences. However, evidence largely shows a reduction in exposure compared to previous decades, and Peregrine Falcon numbers continue to increase in most regions despite the lingering threats of pollution. Therefore, the severity and impact of pollution are considered unknown. For *pealei* Peregrine Falcons, the greatest pollution-related risk is oil spills, the scope of which is considered large to small, and the severity serious to slight, for a threat impact of high to low.

Category 7: Natural System Modifications (medium to low threat impact for *pealei*; negligible threat for *anatum/tundrius*)

Most of the *pealei* population is highly dependent on seabirds for food. Changes to this prey base could affect a small to large portion of the population depending on the scope of seabird reductions, with the severity of effects on Peregrine Falcons likely slight to moderate, resulting in a medium to low threat. Given that the *anatum*/*tundrius* population has a much broader prey base, this is considered a negligible threat for it.

Category 8: Invasive and Other Problematic Species (unknown threat impact for *pealei* and *anatum/tundrius*)

Invasive Non-native/alien species/diseases

Peregrine Falcons are known to be infected by West Nile Virus, although they appear to be less affected by the disease than many raptor species (Nemeth *et al.* 2006; Centers for Disease Control and Prevention 2017). Among a sample of 14 Peregrine Falcons submitted to the Wildlife Center of Virginia from 1993-2003, West Nile Virus was the most frequent infectious disease (Harris and Sleeman 2007).

Problematic Native Species/Diseases

There is evidence to suggest that climate change is allowing for the northward range expansion of ornithophilic black flies (Diptera: Simuliidae), which is posing a risk to Peregrine Falcons in northern Canada, especially on Arctic islands (Franke *et al.* 2016b). Observed outbreaks of ornithophilic black flies may reflect a climate-related range shift in response to increasing summer temperatures and increased frequency of heavy rainfall events, but this link is still considered hypothetical, and more research is needed to determine if the severity of this threat is increasing and if it is having a population impact. At this point it still seems to be a rare occurrence.

Introduced Genetic Material

Only identified *anatum* Peregrine Falcons were re-introduced into southern Canada (Holroyd and Bird 2012), and possibly some *pealei* falcons into the Gulf Islands (BCMOE 2016). However, some introduced birds in the USA were of different subspecies than those native to Canada (Tordoff and Redig 2001), and the genetic composition of the population in southern Canada (Ontario and Quebec) has been somewhat influenced by these birds (Gahbauer *et al*. 2015a; see **Reintroductions and Genetic Heritage** for more details). However, genetic introgression is considered to be minor and changes in genetic composition are not considered a significant threat to the population.

Problematic Species/Diseases of Unknown Origin

The parasitic disease Trichomoniasis (*Trichomoniasis gallinae*) is transmitted to Peregrine Falcons by ingesting infected prey such as Rock Pigeons (Samour and Naldo 2003). Trichomoniasis has been found in young Peregrine Falcons in southern Ontario (Ontario Peregrine Falcon Recovery Team 2010), and may be a threat to some southern urban populations. However, it is considered a negligible threat to the overall Canadian population.

Overall, invasive and other problematic species may affect a small to restricted portion of both *pealei* and *anatum*/*tundrius* Peregrine Falcons in Canada, but the severity of effects and impact to the population are both unknown at this time.

Category 11: Climate Change and Severe Weather (negligible threat impact for *pealei* and *anatum/tundrius*)

Owing to their tendency to nest on open cliffs and similar sites, Peregrine Falcons appear to be vulnerable to extreme weather events associated with changes in weather patterns. Some climate-related changes are likely to be greatest in northern regions, including warming temperatures over land (Intergovernmental Panel on Climate Change 2007). As this area has the majority of Canada's *anatum/tundrius* Peregrine Falcons, there are potential population implications. Heavy rainfall events (i.e., >8 mm/day) which have increased in recent decades were responsible for 38% of the deaths of nestlings in an

Arctic-nesting Peregrine Falcon subpopulation, while nestlings which were sheltered by a nest box had significantly higher survival rates (Anctil *et al.* 2014). In Rankin Inlet, there was a linear relationship between mean chick survival and the amount of precipitation during rainstorms of three or more days (Bradley *et al*. 1997), and more frequent summer heavy rain events appear to be having a negative effect on this subpopulation (Jaffré *et al.* 2015). In Scotland, there was a significant negative relationship between the amount of rainfall in May (during the late incubation-early hatch period) and the proportion of clutches that successfully fledged young (Newton and Mearns 1988). The frequency of heavy rain events has a much greater influence on nestling survival and overall productivity than the amount of rainfall (Anctil *et al.* 2014). Unusually cold wet weather during incubation and hatching also appears to significantly affect nest productivity in the Midwest USA, particularly along the north shore of Lake Superior (Fallon 2011). Heavy late spring snowfalls can cause the abandonment of nests being incubated, as well as higher chick mortality if the young are not yet able to thermoregulate (Court *et al*. 1988a; Bradley *et al*. 1997). The effect of severe weather in Arctic regions can be exacerbated because of the much narrower window for successfully breeding.

Observations from the northwestern USA in the 1930s (prior to the DDT-mediated population decline) revealed that Peregrine Falcons flourished during periods of wet weather, but declined precipitously during drought years with limited water availability, coinciding with reduced nesting populations of shorebirds (Nelson 1969). Increased drying or drought conditions can reduce available wetland habitat, in turn reducing available shorebird populations for foraging Peregrine Falcons (Kiff 1988).

Increasing summer temperatures may have an impact on Arctic cliff-nesting Peregrine Falcons through dehydration and hyperthermia. Nestlings in nests exposed to direct sunlight can be stressed by thermal- and water-balance issues, and heat-induced deaths of Peregrine Falcon nestlings have been documented (Rosenfield *et al.* 2007). Recent observations of mortality among Arctic-nesting incubating Brünnich's Guillemots (*Uria lomvia*) appeared to result from a combination of high daily maximum temperatures, nest exposure to insolation, and high numbers of mosquitoes (Culicidae) due to weather-related earlier emergence (Gaston *et al.* 2002).

Changes in climate may also have indirect effects on Peregrine Falcons. Heavy rain events can have indirect effects on Arctic-nesting Peregrine Falcons by reducing prey abundance/availability (Robinson *et al.* 2017). Weather-mediated changes in lemming populations may influence avian prey abundance, as Arctic Fox (*Vulpes lagopus*) prey more upon bird eggs when lemmings decline, subsequently affecting the avian prey base (Robinson *et al.* 2014).

Another more localized impact of climate change in Arctic Canada may be the collapsing of nest sites on soil cliffs with the melting of the underlying permafrost (Gauthier *et al*. 2011). Nesting sites on Arctic slopes are susceptible to loss due to bank slumping and mass movement as a result of increased summer temperature and summer precipitation (e.g., Beardsell *et al.* 2017).

There may also be positive effects of generally warming temperatures, including access to snow-free nest sites sooner for early-arriving birds (Bruggeman *et al.* 2015), allowing for earlier initiation of breeding and hatching in Arctic-nesting subpopulations. Earlier snowmelt may result in increased availability of nest sites and longer nesting seasons (Bruggeman *et al.* 2015). Hatching dates for Peregrine Falcons nesting along the Mackenzie River advanced by 1.5-3.6 days/decade from 1985-2010, dependent on latitude (Carrière and Matthews 2013). The advancement of hatching dates may have reached a limit based upon arrival dates, and has now apparently stabilized around June 25 (Carrière and Matthews 2013). First date of hatching in southern Greenland has similarly advanced an average of 6 days over the past 35 years (July 4 versus June 29 respectively) (Falk and Moller 2015). At Rankin Inlet, clutch initiation is negatively correlated with average temperature in May ($p<0.05$), with an increase of 1ºC leading to an average advancement of egg laying by 0.76 days (Jaffré *et al.* 2015). Earlier hatching is an advantage for Arctic-nesting birds, giving the young additional rearing time to learn how to successfully catch prey prior to fall migration (Carrière and Matthews 2013). Amelioration of weather during the breeding season, including earlier and warmer springs and warmer autumns that have led to a longer breeding window, may have facilitated the recent breeding range expansion of Peregrine Falcons into the High Arctic in northern Greenland, potentially representing the most northerly breeding sites in the world (Burnham *et al.* 2012).

Climate change and severe weather are not ranked as a threat for *pealei* Peregrine Falcons. For *anatum/tundrius* this threat is considered likely to affect a small portion of the population over the next decade, but severity is expected to be negligible overall, as is impact.

Category 1: Residential and Commercial Development (negligible threat impact for *pealei*; neutral or positive impact for *anatum/tundrius*)

Hazards leading to mortality include collisions with transmission lines, towers and high-rise buildings, particularly for recently fledged birds (Cade and Bird 1990; Watts *et al.* 2007). The fast speed of the Peregrine Falcon puts it at risk of colliding with transmission lines (SAIC 2000). A literature review revealed 24 records of Peregrine Falcon collisions with utility or transmission lines, primarily young of the year (SAIC 2000). Window-strikes and vehicle collisions were the leading causes of mortality for both adult and immature urban Peregrine Falcons, representing 17% and 11%, respectively, of the known sources of mortality (n=455) (Hager 2009). Collisions from all sources were responsible for 61% of the known mortalities in a study of urban-nesting Peregrine Falcons in northeastern North America (Gahbauer *et al.* 2015b). Collisions with buildings were the greatest source (64%) of known mortality among Pennsylvania's predominantly urban Peregrine Falcons (Katzner *et al*. 2012). Among 186 Peregrine Falcons submitted to UQROP between 1986 and 2013, at least 15 (8%) were victims of a collision. Fitzgerald 2015). Collisions with transmission line corridors are one of the major industrial sources of mortality for birds in general (Calvert *et al.* 2013). Of 372 Peregrine Falcon returns between 1995-2017 for birds banded in Canada, 6 (1.6%) were reported as being the result of collisions with wires or towers, and an additional 15 (4.0%) were reported as being the result of collisions other than wires or towers (Canadian Wildlife Service 2017)[63]. Conversely, buildings provide safe and productive nesting locations for many Peregrine Falcons, allowing for population growth in areas otherwise not suitable for the species. Therefore, while collisions clearly kill some Peregrine Falcons annually, the continued growth of urban Peregrine Falcon subpopulations suggests that residential, and commercial development has an overall neutral or positive effect for *anatum*/*tundrius;* the scope of this effect is minimal for *pealei*, and severity is unknown.

<u>Category 5: Biological Resource Use (negligible threat impact for both *pealei* and *anatum/tundrius*)</u>

Persecution

Persecution was historically a concern, with shooting of individuals and destruction of nests, especially where birds of prey were seen as threats to wildlife and domestic poultry (Bent 1938). This has reduced over time in North America, but remains a significant factor in some parts of the species' global range such as the United Kingdom (Amar *et al.* 2011). Most studies of Peregrine Falcon mortality still show some level of shooting mortality (Desmarchelier *et al.* 2010; Faccio *et al.* 2013). Nine of the 99 Peregrine Falcon specimens submitted to the Université de Montréal's Faculty of Veterinarian Medicine between 1986 and 2007 had been shot (Desmarchelier *et al.* 2010), although the proportion of raptors killed by shooting declined from 13.4% to 2.2% during that period. While shooting is much scarcer in Canada in recent decades, it is still a minor threat for migrating and wintering birds. Returns of banded Canadian Peregrine Falcons (1921-1995) indicate that the proportion of birds that had been shot dropped from 38% prior to 1952 to 12% in later years (Dunn *et al.* 2009). More recently, only 2 (0.5%) of 372 Peregrine Falcon returns between 1995 and 2017 for birds banded in Canada were reported as being shot (Canadian Wildlife Service 2017).

Harvest of Birds for Falconry

A legal harvest of Peregrine Falcons in the United States was reinstated in 2009; Franke *et al.* (2016a) concluded that 840 migrant hatching-year *anatum/tundrius* birds could be taken annually without affecting the breeding population, but the total quota established is only 152, including up to 116 nestling and post-fledging first-year Peregrine Falcons from the nesting period through 31 August west of 100°W (including Alaska), and up to 36 first-year migrant Peregrine Falcons between 20 September and 20 October from anywhere in the USA east of 100°W (USFWS 2008b; Franke *et al.* 2016a). Two "populations of conservation concern" were a factor in developing these rules – southern Alberta and the Great Lakes region (Franke *et al.* 2016a). The majority (78%) of migrating Peregrine Falcons taken by falconers in the USA between 2009 and 2011 originated from northern natal areas (i.e., north of 54°N) (Franke *et al.* 2016a), suggesting that 22% may have originated from more southern populations. A small harvest of Arctic-nesting Peregrine Falcons, targeted on the nesting range, has been allowed in Alaska since 1996 (Wright and Bente 1999). An unknown number of Peregrine Falcons are also harvested in

[63] These band returns do not represent only mortalities, as many returns are from living birds

Mexico, which could include some Canadian-origin birds. The take of western Peregrine Falcons has not approached the established Pacific Flyway Council limits, with an average authorized harvest of 70 birds and an average actual take of 21 from nine states, and an additional authorized take of 41 birds and an actual take of two annually in Alaska (Pacific Flyway Council 2017). All three eastern flyway councils (Atlantic, Mississippi, and Central) have passed resolutions recommending that the USFWS increase the allowable take of fall migrant Peregrine Falcons to 144 (48 per council) in fall 2017.

Concurrent with the recovery of the Peregrine Falcon across Canada, several Canadian jurisdictions have recently liberalized their falconry regulations. Ten of the 13 Canadian jurisdictions now allow falconry, seven allow a limited take of raptors from the wild, and five specifically allow a regulated and very limited take of wild Peregrine Falcons (Table 6). A limited and highly regulated harvest of *pealei* Peregrine Falcons is considered biologically feasible (Cooper 2007); as of 2016 up to a maximum of six permits have been issued annually for young-of-the-year migrating *pealei* birds, but no birds have been taken (B.C. Ministry of Environment 2016).

Table 6. Status of falconry in Canadian jurisdictions as of June 2015 (Canadian Wildlife Directors' Committee 2015).

Jurisdiction	Is Falconry Allowed?	Is Take of Wild Peregrine Falcons Allowed?	Is Take of Other Raptors Allowed?
Alberta	Yes	No	Yes
British Columbia	Yes	Yes (*pealei* only)	Yes
Manitoba	Yes	Yes	Yes
Newfoundland and Labrador	No	No	No
New Brunswick	No	No	No
Northwest Territories	Yes	Yes	Yes
Nova Scotia	Yes	No	No
Nunavut	Yes	Yes	Yes
Ontario	Yes	No	Yes
Prince Edward Island	Yes	No	No
Québec	Yes	No	No
Saskatchewan	Yes	Yes	Yes
Yukon	No	No	No

Poaching

Poaching of Peregrine Falcon eggs or nestlings for falconry purposes may occur very rarely, but is not thought to be a significant current threat (Cooper 2007; CITES 2016a). Outside of North America, there is an acknowledged illegal and unquantified harvest of Peregrine Falcons for falconry purposes, although most of these birds are thought to be sourced from Asia (Dixon *et al.* 2011).

Other Threat Categories

The remaining IUCN threat categories are considered to have a negligible impact or be not applicable for both *pealei* and *anatum/tundrius*; notes on these are included in Appendices 2 and 3, respectively.

Limiting Factors

Peregrine Falcon populations are traditionally considered to be limited by the availability of nest sites and/or the availability of prey (Newton 1988a). Interspecific interactions and predation can also be limiting factors in some situations.

Habitat Availability

Although Peregrine Falcons are widespread, they do have very specific breeding habitat requirements. Ratcliffe (1962) believed that availability of suitable cliffs for nesting limits Peregrine Falcon densities, and Temple (1988) predicted that population size will eventually be limited by the number of suitable nest sites near adequate prey sources. The growing availability of anthropogenic nesting habitat in southern Canada mitigates this limitation to some extent, while for northern subpopulations the availability of nesting sites is not considered to be a limiting factor. Populations such as those in the Mackenzie River Valley continue to expand with every quinquennial survey, and the average proportion of known or monitored sites in northern Canada that were occupied annually has ranged between 63-92% across northern study areas in recent years (see **Nest Occupancy and Territoriality**).

Prey Availability and Selection

For the *pealei* Peregrine Falcon, the abundance and distribution of colonial-nesting seabird prey is considered the primary limiting factor, and if seabird colonies decline the resident Peregrine Falcons are likely also to be affected (BCMOE 2016). In Labrador, coastal nesting *anatum/tundrius* Peregrine Falcons seem to be similarly strongly associated with Black Guillemots (Rodrigues 2010), and are rare in otherwise suitable nesting areas when guillemots are absent. Seabirds, in turn, are susceptible to predation from introduced mammalian predators and are strongly influenced by ocean productivity, which can be affected by such diverse factors as global warming, El Niño events, over-fishing, and oil spills (Cooper 2007; BCMOE 2016). Reduced breeding success of seabird colonies can lead to depressed populations, which can have a resultant impact on *pealei* Peregrine Falcon populations. Peregrine Falcons are thought to have been more numerous on Haida Gwaii in the past and may have declined due to reduced seabird populations, potentially due to changing oceanographic conditions and reduced availability of fish prey (Nelson and Myres 1976). The impact of introduced mammalian predators on seabird colonies can be significant (Taylor *et al*. 2000), and this has been linked to local declines of nesting *pealei* Peregrine Falcon populations (Kirk and Nelson 1999). Shorebirds can be important prey for wintering *pealei* Peregrine Falcons. Many shorebird species in North America are declining (22 of 51 species; Thomas *et al.* 2006). However, the effect on *pealei* Peregrine Falcons may be limited at present, as the declines are most notable among shorebird species that migrate across continental North America, whereas most species that are coastal or oceanic migrants have stable populations (Thomas *et al.* 2006).

Interspecific Interactions

Peregrine Falcons often select nesting sites similar to those of several other raptor species, and may come into conflict with them. While Bird and Weaver (1988) reported that Peregrine Falcons seldom nest on a cliff with a successful Common Raven pair, there are several records from Rankin Inlet of both species nesting on the same cliff every year (Franke pers. comm. 2017). In the Italian Alps, Peregrine Falcons appeared to select nesting sites closer to Common Raven nests, and productivity increased with decreasing distance to a raven nest (Sergio *et al.* 2004). The presence of a Golden Eagle nest typically precludes Peregrine Falcons from nesting on that cliff face, with nests being at least 1 km apart and often much farther (Ratcliffe 1962, 1993; Sergio *et al.* 2004). Bald Eagles and Peregrine Falcons also have an antagonistic relationship in some situations, often clashing on Langara Island off the British Columbia coast (Beebe 1960). Kleptoparasitism by Bald Eagles has been shown to affect the distribution of wintering Peregrine Falcons by potentially displacing them from winter foraging areas (Dekker 2003; Dekker and Drever 2015). Peregrine Falcons sometimes share cliffs with Gyrfalcons (*Falco rusticolus*; Bird and Weaver 1988), although there is usually some competition for nest sites and the Gyrfalcon is typically dominant (Cade 1960). Peregrine Falcon and Rough-legged Hawks often nest in close proximity, and Rough-legged Hawks often use the alternate nest site of a Peregrine Falcon (Peck *et al*. 2012). A cliff several hundred metres in length in Ungava Bay in northern Quebec simultaneously supported successful nests of Peregrine Falcons, Rough-legged Hawks and Common Ravens (Bird and Weaver 1988).

Nesting Peregrine Falcons have a close and complex relationship with Prairie Falcons. They are typically more aggressive than Prairie Falcons and tend to take over nest sites when both are present (White *et al*. 2002; Dekker and Corrigan 2006). However, Porter and White (1973) noted that outcomes of territorial disputes varied, that the two species sometimes nest much closer together than pairs of the same species, and that they sometimes use the alternate nest site of the other species. Rather than directly competing with Peregrine Falcons for nest sites, Prairie Falcons appear to have taken over Peregrine Falcon nests that were abandoned owing to environmental changes in western North America in the mid-20th century (Kiff 1988; Nelson 1988a). As Peregrine Falcons recovered and increased in recent decades, they appear to have in turn taken over and replaced Prairie Falcons at some historical nest sites in Alberta and British Columbia (Dekker and Corrigan 2006; Chutter 2015b), leading to increased concerns over the status of the Prairie Falcon.

Predation

While predation is not generally considered to be an important limiting factor for adult Peregrine Falcons, it can be significant for nestlings and immature birds (White *et al.* 2002). For example, predation accounted for 46% of mortalities amongst 24 monitored first-year Peregrine Falcons in Vermont, comprising both wild-reared and hacked birds (Watts *et al.* 2007). Of 455 Peregrine Falcon fatalities in the mid-west USA, only 15 (3.3%) were known to be caused by predators (Tordoff *et al*. 2000); however, owls caused more than 25% of total Peregrine Falcon mortality in the northeastern USA during the early part of the population recovery (Barclay and Cade 1983). Great Horned Owl (*Bubo virginianus*), Northern Goshawk (*Accipiter gentilis*), and Red Fox (*Vulpes vulpes*) are the main known predators of wild Peregrine Falcons (Rowell 2002; Watts *et al.* 2007). Cliff-nesting Great Horned Owls are known to harass and kill Peregrine Falcons at some sites (Tordoff and Redig 1997; Tordoff *et al*. 2000), but at other sites both species nest in close proximity. For many decades Great Horned Owl predation was seen as one of the primary reasons why the re-establishment of breeding Peregrine Falcons at historical cliff-nesting habitat along the Mississippi River had been so difficult (Cade *et al.* 1989); owl control measures were implemented during the initial recovery program for the Midwest USA to facilitate Peregrine Falcon reintroduction programs (Redig and Tordoff 1988). Several mammalian predators depredate ground nests, including bears (*Ursus* spp.), wolves (*Canis* spp.), foxes, Wolverines (*Gulo gulo*) and cats (*Felis* spp.) (White *et al.* 2002).

Number of Locations

Falco peregrinus pealei

Oil spills are considered the threat most likely to affect a large portion of the population. The majority of the population is on Haida Gwaii (including Langara Island), and three other island populations are regularly studied (i.e., North Vancouver Island, Triangle Island, and Southeast Vancouver Island/Gulf Islands). However, spills can affect opposite sides of large island complexes independently, and the population is also distributed more sparsely along the British Columbia coastline from Vancouver Island to Alaska (Figure 2). Projections of oil spill trajectories indicate that there are more than five locations (e.g., Living Oceans 2013). However, given the semi-colonial nesting nature of this subspecies, the relatively small population size and restricted distribution, and the sensitivity of the entire population to both oil spills and fluctuations or reductions in the seabird population prey base, which is in turn related to oceanographic and climatic conditions, there are considered to be a limited number of locations in Canada, likely no more than ten.

Falco peregrinus anatum/tundrius

The number of locations is difficult to determine for a wide-ranging and versatile subspecies such as the *anatum/tundrius* Peregrine Falcon. Some of the highest probability threats, such as toxic chemicals and heavy metals, organochlorine pesticides, and climate change and severe weather can potentially affect a very large component of the population in breeding, migratory and wintering areas. Arctic-nesting subpopulations appear to be most susceptible to the effects of climate change and severe weather (see **Threats** section, “Climate Change and Severe Weather”). Peregrine Falcons in southern Canada face very different habitat conditions. Urban and cliff-nesting birds also face very different threats during the nesting season.

Given the diverse nature of Canada’s breeding populations, there are undoubtedly far more than 10 locations across Canada.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Peregrine Falcon *anatum/tundrius* was assessed by COSEWIC as Special Concern in April 2007 and reassessed as Not at Risk in November 2017. The *pealei* subspecies was assessed as Special Concern in April 2007 and November 2017. The *pealei* and *anatum/tundrius* subspecies of Peregrine Falcon are both listed under Schedule 1 of Canada’s *Species at Risk Act* (SARA) as Special Concern (SARA Registry 2016), based on updated status recommendations by COSEWIC in April 2007. Like other raptors, Peregrine Falcons are not protected under the federal *Migratory Birds Convention Act*.

The Peregrine Falcon is listed under Appendix 1 of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) as a species threatened with extinction, and international import and export is not permitted (Dixon *et al.* 2011; CITES 2016b). A proposal to transfer the Peregrine Falcon (*Falco peregrinus*) from Appendix I to Appendix II of CITES in 2016 was not supported at the 17th Conference of Parties to CITES (CITES 2016c). Appendix II includes “species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival” (CITES 2016b).

In the USA, the *tundrius* Peregrine Falcon subspecies was delisted from the list of endangered species in 1994, and the *anatum* Peregrine Falcon followed in 1999 (Franke 2016). It is now managed under control of the Office of Migratory Bird Management (Federal Register 1999), and this legislation pertains to Canadian Peregrine Falcons while on migration or wintering in the USA. The harvesting of Peregrine Falcons for falconry purposes in the lower 48 states of the USA was enabled under an Environmental Assessment approved in 2008 (USFWS 2008b). Harvest of nestling Peregrine Falcons is administered by individual states, and the harvest of migrating birds is agreed upon and allocated by the Atlantic, Central, and Mississippi Flyway councils (Franke *et al.* 2016a). Canadian jurisdictions are represented on flyway councils as follows:

- Atlantic – Nunavut, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island and Quebec;
- Central – Alberta, Saskatchewan, Northwest Territories;
- Mississippi – Manitoba, Ontario, Saskatchewan (USFWS 2015).

The Peregrine Falcon is also protected under all provincial and territorial wildlife acts but the details of such protection vary among provinces and territories. A number of provincial wildlife acts protect raptors, nests and eggs. Status designations at the provincial and territorial levels vary across the country with those designations having various legal and/or conservation meanings (Table 7).

Table 7. Status of the Peregrine Falcon in Canadian jurisdictions.

Jurisdiction	At-risk designations
Alberta	Threatened (*Falco peregrinus*)
British Columbia	Red List[64] (*F. p. anatum*) Blue List[65] (*F. p. pealei, F.p. tundrius)*
Manitoba	Endangered (*F. peregrinus)*
New Brunswick	Endangered
Newfoundland and Labrador	Vulnerable (*F. p. anatum/tundrius*)
Northwest Territories	No status
Nova Scotia	Vulnerable (*F. p. anatum*)
Nunavut	No status
Ontario	Special Concern (*F. peregrinus*)
Prince Edward Island	No status
Québec	Vulnerable (*F. p. anatum*) Likely to become Vulnerable or Endangered (*F. p. tundrius*) Considering listing *F. p. anatum/tundrius* complex as Vulnerable
Saskatchewan	No status
Yukon	Specially protected wildlife

Non-Legal Status and Ranks

Conservation rankings for Peregrine Falcon vary across Canada. The General Status of Species in Canada gives the Peregrine Falcon an overall rank of N3N4, or Vulnerable to Apparently Secure, in Canada (CESCC 2016). This report considered Peregrine Falcon to be Critically Imperiled (S1) in Alberta, Saskatchewan, Manitoba, New Brunswick, and Nova Scotia; Imperiled (S2) in Newfoundland and Labrador; Vulnerable (S3) in Yukon, Northwest Territories, British Columbia, Ontario, and Quebec; and Apparently Secure (S4) in Nunavut.

[64] Candidate for Threatened or Endangered status

[65] Equivalent to Special Concern

In addition to the proposed national management plans for the *pealei* Peregrine Falcon (Environment and Climate Change Canada 2017) and the *anatum/tundrius* Peregrine Falcon (Environment Canada 2015), a number of jurisdictions in southern Canada have management plans or recovery strategies for the Peregrine Falcon. These include:

- Alberta – Alberta Peregrine Falcon Recovery Plan 2004-2010 (Alberta Peregrine Falcon Recovery Team 2005);
- British Columbia – Management Plan for the Peregrine Falcon, *pealei* Subspecies (*Falco peregrinus pealei*) in British Columbia (BCMOE 2016);
- Manitoba – A Recovery Plan and Strategy for the Peregrine Falcon in Manitoba (Wheeldon 2003);
- Ontario – Recovery Strategy for the Peregrine Falcon (*Falco peregrinus*) in Ontario (Ontario Peregrine Falcon Recovery Team 2010); Peregrine Falcon Ontario Government Response Statement (OMNR 2010); and
- Québec – Plan d’action pour le Rétablissement du Faucon Pèlerin *anatum* (*Falco peregrinus anatum*) au Québec (Comité de Rétablissement du Faucon pèlerin au Québec 2002) (a revised plan is anticipated but is not yet available).

The Peregrine Falcon is also addressed under several national park management plans, including:

- Multi-species Action Plan for Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site (Proposed) (Parks Canada 2016a).

Habitat Protection and Ownership

F. p. pealei

Most *pealei* nest sites and seabird colonies are protected within B.C. provincial parks and ecological reserves, or National Park Reserves (Fraser *et al*. 1999; BCCDC 2016a). On Haida Gwaii, approximately one-half of the occupied nest sites are located within the Gwaii Haanas National Park Reserve and Haida Heritage Site, and additional sites are expected to be protected by coastal conservancies and provincial parks (BCMOE 2016). Other nesting habitat is protected in Naikoon Provincial Park, Anne Vallee (Triangle Island) Ecological Reserve, and Lanz and Cox Islands Provincial Park (BCMOE 2016). The seabird colonies that are the main prey base for *pealei* Peregrine Falcons are also largely protected (Hipfner *et al*. 2002).

F. p. anatum/tundrius

Ownership of nesting and foraging habitat is a mix of private and public lands (Rowell 2002). A minor proportion of *anatum/tundrius* nesting sites are protected within provincial or national parks or are on Crown land, with many also on private land. At least one nesting site in British Columbia is protected within a provincial park (BCCDC 2016b). Peregrine Falcon nests in Ontario are protected within at least eight provincial parks. Of 35 *anatum/tundrius* nesting sites on public land in Quebec, 46% are on some form of protected area, such as parks, nature reserves, or protected habitats (Comité de Rétablissement du Faucon pèlerin au Québec 2002). Of 23 Peregrine Falcon nesting sites along the Bay of Fundy, New Brunswick, with known land ownership, 3 (13%) are on conservation lands (i.e., Nature Conservancy, NB Nature Trust, NB Tourism). Most urban nest sites are on privately owned properties.

Of 447 known nests of Arctic-nesting Peregrine Falcon nest sites in Nunavut, 15% are on conservation lands (e.g., National Parks, Migratory Bird Sanctuaries, National Wildlife Areas, Caribou Protection Areas, Wildlife Sanctuaries), and 5% are on conservation lands within Inuit-owned lands (IOL)[66] (GNWT/GNDoE data, Setterington pers. comm. 2006). Regional Inuit Associations own 17.7% of surface lands in Nunavut (Nunavut Tunngavik Incorporated 2000). High value Peregrine Falcon nesting habitat has been included within identified Wildlife Areas of Special Interest to support land use planning in Nunavut (Beckett *et al.* 2012); many of the areas under consideration for land use planning in Nunavut have identified Peregrine Falcon habitat values (Nunavut Planning Commission 2016). Recently established parks in Nunavik in northern Quebec may offer protection to the species over considerably large territories, although the parks (Nunavik Parks 2017) do not appear to overlap much with known Peregrine Falcon nesting habitats (Appendix 1). The exception is the newest park, Ulittaniujalik National Park, established in 2016 and containing known Peregrine Falcon habitat (Nunavik Parks 2016). Of 223 known nests of Arctic-nesting Peregrine Falcons in the Northwest Territories, 14% are within protected areas (GNWT/GNDoE data, Carrière pers. comm. 2006). Some high density Peregrine Falcon breeding areas are being investigated for possible future protection under the Northwest Territories Protected Areas Strategy (Government of the Northwest Territories 2015).

A large number of national parks have documented Peregrine Falcon breeding territories within their boundaries, although not necessarily nests. These include: Aulavik, Auyuittuq, Fundy, Gulf Islands (may be *pealei, anatum/tundrius* or an intergradation), Ivvavik, Kluane, La Mauricie, Pukaskwa, Saguenay-St. Lawrence, Sirmilik, Thousand Islands, Torngat Mountains, Tuktuk Nogait, Ukkusiksalik, Vuntut, Wood Buffalo, and Yoho (one record from 1994, although not considered a breeding site) (Parks Canada 2016b, Nantel pers. comm. 2016).

Other nest sites are located on provincial or federal Crown land, private lands, or Aboriginal-controlled lands. A large proportion of northern Peregrine Falcon nests are within lands subject to present or future management by Aboriginal governments.

[66] Under the Nunavut Land Claims Agreement, some IOLs were located within designated Conservation Areas. The future management status of these lands is unknown, and may be withdrawn from the conservation areas.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The assistance of a great many individuals and organizations in the preparation of this status report is recognized. These include the many organizational and jurisdictional contacts including the following: Diane Amirault-Langlais (Parks Canada and Fisheries and Oceans Canada), Alexandre Anctil (Ministère des Forêts, de la Faune et des Parcs du Quebec), Bird Studies Canada, Bruce Bennett (Yukon Department of Environment), Andrea Benville (Saskatchewan NHIC), Sherman Boates (Nova Scotia Department of Natural Resources), Joe Brazil (Newfoundland and Labrador Department of Environment and Conservation), Suzanne Carrière (Northwest Territories Department of Natural Resources and Environment), Jennifer Chikoski (Ontario Ministry of Natural Resources and Forestry), Myke Chutter (British Columbia Ministry of Environment), Gordon Court (Alberta Department of Sustainable Resource Development), Ken De Smet (Manitoba Department of Conservation and Water Stewardship), Mark Elderkin (Nova Scotia Department of Natural Resources), Kim Fernie (Canadian Wildlife Service), Jan Franden (Parks Canada), Alistair Franke (University of Alberta), David Fraser (British Columbia Ministry of Environment), Marcel Gahbauer (Migration Research Foundation), Isabelle Gauthier (Ministère des Forêts, de la Faune et des Parcs du Quebec), Gary Gregory (Prince Edward Island Department of the Environment), Geoff Holroyd (Canadian Wildlife Service-retired), Jessica Humber (Newfoundland and Labrador Department of Environment and Conservation), Neil Jones (Canadian Wildlife Service), Joe Kennedy (New Brunswick Department of Natural Resources), Nicholas Larter (Northwest Territories Department of Natural Resources and Environment), Louise Laurin (Bird Banding Office, Canadian Wildlife Service), Tracy Maconachie (Manitoba Peregrine Falcon Recovery Project), Erin Moffat (Canadian Wildlife Health Cooperative), David Mossop (Yukon College), Randi Mulder (Yukon Department of Environment), Patrick Nantel (Parks Canada), R.W. Nelson (University of Calgary), Lynn Oliphant (University of Saskatchewan), Lynda Orman (Nunavut Department of Environment), Shelley Pardy (Newfoundland and Labrador Department of Environment and Conservation), Brian Ratcliff (Thunder Bay Field Naturalists), Chris Risley (Ontario Ministry of Natural Resources and Forestry), Mary Sabine (New Brunswick Department of Natural Resources), Antoine St-Louis (Ministère des Resources naturelles et de la Faune du Quebec), Sonia Schnobb (Canadian Wildlife Service), Mike Setterington (Northwest Territories Department of Natural Resources and Environment), François Shaffer (Canadian Wildlife Service), Donald Sutherland (Ontario NHIC), Paddy Thompson (Saskatchewan), and Richard Weir (B.C. Ministry of Environment). The jurisdictional reviewers and the COSEWIC Birds SSC reviewers (Paul Allen Smith, RIG (Guy) Morrison, Louise Blight) are thanked for their constructive input. The previous (2007) status report was written by John M. Cooper and Suzanne M. Beauchesne. Assistance with the procurement of materials was provided by the Lakehead University Library, Thunder Bay Public Library, and The Peregrine Fund. Report writers also acknowledge the many helpful review comments provided by jurisdictional and renewal resource board contacts. The contributions of the many volunteers who contributed data to nest monitoring programs, breeding bird atlases, Christmas Bird Counts, and other citizen science initiatives is acknowledged with thanks. The encouragement, assistance and advice of the late Bud Tordoff is recognized, as is the dedication and commitment over the years of many colleagues on the National Recovery Team and Ontario Peregrine Falcon recovery initiatives.

INFORMATION SOURCES

Alberta Fish and Wildlife Division. 2010. Peregrine Tissues Cleaner Every Year. Unpublished report. Alberta Fish and Wildlife Division, Edmonton, Alberta. 2 pp.

Alberta Peregrine Falcon Recovery Team. 2005. Alberta Peregrine Falcon Recovery Plan 2004-2010. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Recovery Plan No. 3. Edmonton, Alberta. 16 pp.

Altwegg, R., A. Jenkins, and F. Abadi. 2014. Nestboxes and immigration drive the growth of an urban Peregrine Falcon *Falco peregrinus* population. Ibis 156:107-115.

Amar, A., I.R. Court, M. Davison, S. Downing, T. Grimshaw, T. Pickford, and D. Raw. 2011. Linking nest histories, remotely sensed land use data and wildlife crime records to explore the impact of grouse moor management on Peregrine Falcon populations. Biological Conservation 145:86-94.

Ambrose, R.E., and K.R. Riddle. 1988. Population dispersal, turnover, and migration of Alaskan Peregrines. Pages 677-684 *in* T.J. Cade, J.H. Enderson, C.G. Thelander and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Ambrose, R.E., A. Matz, T. Swem, and P. Bente. 2000. Environmental contaminants in American and Arctic Peregrine Falcon eggs in Alaska, 1979-95. U.S. Fish and Wildlife Service Technical Report NAES –TR-00-02. U.S. Fish and Wildlife Service. Fairbanks, Alaska. 67 pp.

AOS (American Ornithological Society). 2017. AOS checklist of North and Middle American birds (7th edition and supplements). Web site: http://checklist.aou.org/taxa/ [accessed October 2017].

Amirault, D.L. 2003. An overview of recovery and trends in Bay of Fundy Peregrine Falcons. Bird Trends 9 (winter):63-65.

Anctil, A. pers. comm. 2017. *Email correspondence to M. Gahbauer*. 2017. Ministère des Forêts, de la Faune et des Parcs du Québec.

Anctil, A., A. Franke, and J. Bêty, 2014. Heavy rainfall increases nestling mortality of an Arctic top predator: experimental evidence and long-term trend in Peregrine Falcons. Oecologia 174:1033-1043

Armstrong, T. 2007. Peregrine Falcon. pp. 194-195 *in* M.D. Cadman, D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier (eds.). Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources and Ontario Nature, Toronto, Ontario. 706 pp.

Armstrong, T. (E.R.) and B. Ratcliff. 2010. Ontario's recovering Peregrine Falcon population: results of the 2005 survey. Ontario Birds 28:32-42.

Audubon. 2016. Audubon Christmas Bird Count. Web site: http://netapp.audubon.org/CBCObservation/Historical/ResultsBySpecies.aspx?1. [accessed May 2017].

Baicich, P.J., and C.J.O. Harrison. 1997. A Guide to the Nests, Eggs, and Nestlings of North American Birds. 2nd edition. Academic Press, San Diego, California. 347 pp.

Banasch, U., and G.L. Holroyd. 2004. The 1995 Canadian Peregrine Falcon survey. Occasional Paper No. 110. Canadian Wildlife Service, Edmonton, Alberta. 43 pp.

Barclay, J.H. 1996. Management guidelines for specific types of eyries. Pages 64-79 *in* T.J. Cade and J.H. Enderson (eds). Guide to Management of Peregrine Falcons at the Eyrie. The Peregrine Fund, Boise, Idaho. 97 pp.

Barclay, J.H., and T.J. Cade. 1983. Restoration of the Peregrine Falcon in the eastern United States. Bird Conservation 1:3-40.

Barnes, J.G, R.D. Haley, D.B. Thompson, and J.R. Jaeger. 2015. Attributes of a breeding population of Peregrine Falcons associated with reservoirs on the Colorado River. Journal of Raptor Research 49:269-280.

Barnes, J.G., and S.L. Gerstenberger. 2015. Using feathers to determine mercury contamination in Peregrine Falcons and their prey. Journal of Raptor Research 49:43-58.

BCCDC (British Columbia Conservation Data Centre). 2016a. Conservation status report: *Falco peregrinus pealei*. B.C. Ministry of Environment, Victoria, British Columbia. Web site: http://a100.gov.bc.ca/pub/eswp/esr.do;jsessionid=20d8668f733adba221a72b49fadac25de3ebd9cf22388d822c743fa0b6f03da1.e3uMah8KbhmLe34PahiPc3yMbxr0n6jAmljGr5XDqQLvpAe?id=19818 [accessed January 2016].

BCCDC. 2016b. Conservation status report: *Falco peregrinus anatum*. B.C. Ministry of Environment, Victoria, British Columbia. Web site: http://a100.gov.bc.ca/pub/eswp/esr.do;jsessionid=b8a4a67e3f5c0601c81257e483b8dd96798fa566abe78a89b22c3fcdbd34ee75.e3uMah8KbhmLe34PahiPc3yMbxr0n6jAmljGr5XDqQLvpAe?id=18798 [accessed January 2016].

BCMOE (British Columbia Ministry of Environment). 2016. Management plan for the Peregrine Falcon, *pealei* subspecies (*Falco peregrinus pealei*) in British Columbia. B.C. Ministry of Environment, Victoria, British Columbia. 33 pp.

BCMOE. 2017. Wetlands in B.C. Web site: http://www.env.gov.bc.ca/wld/wetlands.html [accessed April 2017].

Beardsell, A., G. Gauthier, D. Fortier, J.F. Therrien, and J. Bêty. 2017. Vulnerability to geomorphological hazards of an Arctic cliff-nesting raptor, the Rough-legged Hawk. Arctic Science 3:203-219.

Beckett, J., M. Marcotte, D, Chiperzak, B. Wheeler, R. Jefferies, D. Ebner, and M. Setterington. 2012. Nunavut wildlife resource and habitat values. Amendment. Prepared for the Nunavut Planning Commission by Nunami Stantec, Burnaby, British Columbia. 10 pp.

Beebe, F.L. 1960. The marine Peregrines of the northwest Pacific coast. Condor 62:154-189.

Beebe, F.L. 1969. Passenger Pigeons and Peregrine biology. pp. 399-402 *in* J.J. Hickey, (ed.). Peregrine Falcon Populations. Their Biology and Decline. University of Wisconsin Press, Madison, Wisconsin. 596 pp.

Beebe, F.L. 1974. Field studies of the Falconiformes of British Columbia. Vultures, hawks, falcons, eagles. Occasional Paper Series No. 17, B.C. Provincial Museum, Victoria, British Columbia.

Bent, A.C. 1938. Life histories of North American Birds of Prey (Part 2): Orders Falconiformes and Strigiformes. U.S. National Museum Bulletin 170. United States Government Printing Office, Washington DC.

Bildstein, K.L. 2004. Raptor migration in the Neotropics: patterns, processes, and consequences. Ornitologia Neotropical 15(Supp.):83-99.

Bird, D.M., and D. Chabot. 2009. The 2007 Ungava Bay (QC) Peregrine Falcon (*Falco peregrinus*) survey. Canadian Wildlife Service report, Ottawa, Ontario. 10 pp.

Bird, D.M., and J.D. Weaver. 1988. Peregrine Falcon populations in Ungava Bay, Quebec, 1980-1985. pp. 45-49 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Bird Studies Canada. 2016. Second atlas of the breeding birds of the Maritime Provinces. Bird Studies Canada, Sackville New Brunswick. Web site: http://www.mba-aom.ca/jsp/map.jsp. [accessed July 2016].

Bird Studies Canada. 2017. Species and effort maps. Manitoba Breeding Bird Atlas. Web site: http://www.birdatlas.mb.ca/mbdata/maps.jsp?lang=en [accessed May 2017].

Blight, L.K. pers. comm. 2017. *E-mail correspondence to M. Gahbauer*. 2017. British Columbia Ministry of the Environment, Victoria, British Columbia.

Bowardi, M.A. 2011. The role of the Gyrfalcon in Arabian falconry. pp. 21-26 *in* Watson, R.T., T.J. Cade. M. Fuller, G. Hunt, and E. Potapov (eds.). Gyrfalcons and Ptarmigan in a Changing World – Conference Proceedings. The Peregrine Fund, Boise, Idaho. 398 pp.

Bradley, M., R. Johnstone, G. Court, and T. Duncan. 1997. Influence of weather on breeding success of Peregrine Falcons in the Arctic. Auk 114:786-791.

Bradley, M., and L.W. Oliphant. 1991. The diet of Peregrine Falcons in Rankin Inlet, Northwest Territories: an unusually high proportion of mammalian prey. Condor 93:93-96.

Braune, B. 2011. Chemical contaminants in the Arctic environment–are they a concern for wildlife. pp.133-145 *in* R.T. Watson, T.J. Cade, M. Fuller, G. Hunt and E. Potapov (eds.). Gyrfalcons and Ptarmigan in a Changing World – Conference proceedings. The Peregrine Fund, Boise, Idaho. 398 pp.

Brazil, J., pers. comm. 2006. *Communication with John Cooper*. 2006. Species at Risk Biologist, Newfoundland and Labrador Department of Environment and Conservation, St. John's, Newfoundland and Labrador.

Brown, J.W., P.J. Van Coeverden de Groot, T.P. Birt, G. Seutin, P.T. Boag, and V.L. Friesen. 2007. Appraisal of the consequences of the DDT-induced bottleneck on the level and geographic distribution of neutral genetic variation in Canadian Peregrine Falcons, *Falco peregrinus.* Molecular Ecology 16:327-343.

Bruggeman, J.E., T. Swem, D.E. Anderson, P.L. Kennedy, and D. Nigor. 2015. Dynamics of a recovering Arctic bird population: the importance of climate, density dependence, and site quality. Ecological Applications 25:1932-1943.

Bruggeman, J.E., T. Swem, D.E. Anderson, P.L. Kennedy, and D. Nigor. 2016. Multi-season occupancy models identify biotic and abiotic factors influencing a recovering Arctic Peregrine Falcon *Falco peregrinus tundrius* population. Ibis 158:61-74.

Buchanan, J.B., K.A. Hamm, L.J Salzer, L. V. Diller, and S.J. Chinnici. 2014. Tree-nesting by Peregrine Falcons in North America: historical and additional records. Journal of Raptor Research 48:61-67.

Burnham, K.K., W.A. Burnham, I. Newton, J.A. Johnson, and A.G. Gosler. 2012. The history and range expansion of Peregrine Falcons in the Thule area, Northwest Greenland. Monographs on Greenland Vol. 352. Museum Tusculanum Press, Denmark. 106 pp.

Burnham, W. 1983. Artificial incubation of falcon eggs. Journal of Wildlife Management 47:158-168.

Cade, T.J. 1960. Ecology of the Peregrine and Gyrfalcon populations in Alaska. University of California Publications in Zoology 63:151-290.

Cade, T.J. 1982. The Falcons of the World. Cornell University Press, Ithaca, New York. 188 pp.

Cade, T.J., and D.M. Bird. 1990. Peregrine Falcons, *Falco peregrinus*, nesting in an urban environment: A review. Canadian Field-Naturalist 104:209-218.

Cade, T.J., J.H. Enderson, and J. Linthicum. 1996. Guide to Management of Peregrine Falcons at the Eyrie. The Peregrine Fund, Boise, Idaho. 97 pp.

Cade, T.J., and R.W. Fyfe. 1970. The North American Peregrine Falcon survey, 1970. Canadian Field-Naturalist 84:231-245.

Cade, T.J., and R.W. Fyfe. 1978. What makes Peregrine Falcons breed in captivity? Pages 251–262 *in* S.A. Temple (ed.). Endangered Birds, Management Techniques for Preserving Threatened Species. University of Wisconsin Press, Madison, Wisconsin. 468 pp.

Cade, T.J., P.T. Redig, and H.B. Tordoff. 1989. Peregrine Falcon restoration: expectation vs. reality. Loon 61:160–162.

Calvert, A., C. Bishop, R. Elliot, E. Krebs, T. Kydd, C. Machtans, and G. Robertson., 2013. A synthesis of human-related avian mortality in Canada. Avian Conservation and Ecology 8(2):11.

Campbell, D. 2006. Common toxicological problems of Ontario wildlife. Wildlife Health Centre Newsletter 12(1):10-11.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia, Volume 2: Nonpasserines, Diurnal birds of prey through woodpeckers. Royal British Columbia Museum and Canadian Wildlife Service. 636 pp.

Campbell, R.W., M.P. Paul, M.S. Rodway, and H.S. Carter. 1977. Tree-nesting Peregrine Falcons in British Columbia. Condor 79:500-501.

Canadian Peregrine Foundation. 2016. Nest site directory. The Canadian Peregrine Foundation. Web site: http://www.peregrine-foundation.ca/sightings.html [accessed May 2016].

Canadian Wildlife Directors Committee. 2015. Provincial and territorial regulations regarding Peregrine Falcon. Current as of June 25 2015. Unpublished report. Canadian Wildlife Directors' Committee, Ottawa, Ontario. 3 pp.

Canadian Wildlife Service. 2017. Peregrine Falcon banding return data, 1995-2017. Bird Banding Office, Canadian Wildlife Service, Carlton University, Ottawa, Ontario.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal British Columbia Museum, Victoria, British Columbia. xix + 420 pp.

Carrière, S., pers. comm. 2006. *Email correspondence to J. Cooper.* 2006. Wildlife Biologist, Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, Northwest Territories.

Carrière, S., pers. comm. 2016. *Email correspondence to T. Armstrong.* March-April 2016. Wildlife Biologist, Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, Northwest Territories.

Carrière, S., D. Abernethy, M. Bradley, R.G. Bromley, S.B. Matthews, J. Obst, and M. Setterington. 2003. Raptor trends in the Northwest Territories and Nunavut: a Peregrine Falcon case study. Bird Trends 9 (winter):57-60.

Carrière, S., and S. Matthews. 2013. Peregrine Falcon surveys along the Mackenzie River, Northwest Territories, Canada. Government of the Northwest Territories Environment and Natural Resources File Report no. 140. Government of the Northwest Territories, Yellowknife, Northwest Territories. 55 pp.

Centers for Disease Control and Prevention. 2017. Species of dead birds in which West Nile virus has been detected, United States, 1999-2012. Centers for Disease Control and Prevention, Atlanta, Georgia. Web site: https://www.cdc.gov/westnile/resources/pdfs/birdspecies1999-2012.pdf [accessed May 2017].

CESCC (Canadian Endangered Species Conservation Council). 2016. Wild Species 2015: The general status of species in Canada. National General Status Working Group, Ottawa, Ontario.

Champoux, L., J. Rodrigue, G. Fitzgerald, and F. Bilodeau. 2015. Évolution temporelle des concentrations de mercure dans les plumes d'oiseaux de proie au Québec. Le Naturaliste Canadien 139:65-73.

Chen, D., M.J. La Guardia, E. Harvey, M. Amaral, K. Wohlfort, and R.C. Hale. 2008. Polybriminated diphenyl ethers in Peregrine Falcon (*Falco peregrinus*) eggs from the northeastern U.S. Environmental Science and Technology 42:7594-7600.

Chikoski, J., and L. Nyman. 2011. The 2010 Ontario Peregrine Falcon survey – a summary report. Unpublished report. Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 36 pp.

Chutter, M. 2015a. Peregrine Falcon *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). The Atlas of the Breeding Birds of British Columbia, 2008-2012. Bird Studies Canada. Delta, British Columbia. Web site: http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=PEFA&lang=en [accessed May 2016].

Chutter, M. 2015b. Prairie Falcon *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). The Atlas of the Breeding Birds of British Columbia, 2008-2012. Bird Studies Canada. Delta, British Columbia. Web site: http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=PRFA&lang=en [accessed May 2016].

Chutter, M.J. 2016. 2015 British Columbia summary report for the national Peregrine Falcon survey. Provincial summary report. B.C. Ministry of Forests, Land and Natural Resource Operations, Wildlife Branch, Victoria, British Columbia. iv + 14 pp.

Chutter, M.J., pers. comm. 2016. *Email correspondence to T. Armstrong.* February, April, and November 2016. Bird Specialist, British Columbia Ministry of Environment, Victoria, British Columbia.

CITES (Convention on International Trade in Endangered Species). 2016a. Seventeenth meeting of the Conference of the Parties Johannesburg (South Africa), 24 September–5 October 2016. Consideration of proposals for amendment of appendices I and II. CoP17 Prop. 17. Convention on International Trade in Endangered Species of Wild Flora and Fauna, Geneva, Switzerland. Web site: https://cites.org/eng/cop/17/prop/index.php [accessed May 2017].

CITES. 2016b. How CITES works. Convention on International Trade in Endangered Species of Wild Flora and Fauna, Geneva, Switzerland. Web site: https://cites.org/eng/disc/how.php [accessed February 2016].

CITES. 2016c. Final decisions made at CoP17 on the proposals to amend CITES Appendices. Convention on International Trade in Endangered Species of Wild Flora and Fauna, Geneva, Switzerland. Web site: https://cites.org/sites/default/files/eng/cop/17/Decisions-on-amendment-proposals.pdf [accessed May 2017].

Clark, W.S. 2007. Raptor identification, ageing, and sexing. pp. 47-55 *in* D.M. Bird and K.L. Bidstein (eds.). Raptor Research and Management Techniques. Hancock House Publishers Ltd., Surrey, British Columbia. 463 pp.

Comité de rétablissement du faucon pèlerin au Québec. 2002. Plan d'action pour le rétablissement du faucon pèlerin *anatum* (*Falco peregrinus anatum*) au Québec. Société de la Faune et des Parcs du Québec, Québec, Québec. ix + 28 pp.

Cooper, J.M. 2007. Management plan for Peale's Peregrine Falcon (*Falco peregrinus pealei*) in British Columbia. B.C. Ministry of the Environment, Victoria, British Columbia. British Columbia Wildlife Bulletin no. B-124. 35 pp.

Cooper, J.M., and S.M. Beauchesne. 2004. Status of the Peregrine Falcon in British Columbia (*Falco peregrinus*) in British Columbia. B.C. Ministry of Water, Land and Air Protection, Biodiversity Branch, Victoria, British Columbia. Wildlife Bulletin no. B-115.

Cordes, F. 2000. How to share the cliffs with Peregrine Falcons. Gripped August/ September 2000:18-19.

Corrigan, R. 2001. Survey of the Peregrine Falcon (*Falco peregrinus*) in Alberta. Alberta Species at Risk Report no. 2. Alberta Sustainable Resource Development, Fish and Wildlife Service, Edmonton, Alberta. 17 pp.

COSEWIC. 2014. Guidance for completing the Threats Classification and Assessment Calculator and Determining the number of 'Locations'. Committee on the Status of Endangered Wildlife in Canada. April 2012, edited April 2014, Version 1.2, Ottawa, Ontario. 20 pp.

Côté, P. 2015. Rapport d'activité 2014. Observatoire d'oiseaux de Tadoussac, Explos-Nature, Les Bergeronnes, Québec. 35 pp.

Coughlan, A., and G. Duquette. 2015. Quebec breeding bird atlas: emerging trends. BirdWatch Canada 73:4-5.

Coulton, D.W., J.A. Virgl, and C, English. 2013. Falcon nest occupancy and hatch success near two diamond mines in the southern Arctic, Northwest Territories. Avian Conservation and Ecology 8(2). 15 pp.

Court, G. 2015. Re-introduction of Peregrine Falcons (*Falco peregrinus anatum*) at priority historical nesting sites in Alberta. Interim Report to Claire Serdula, Nexen Balzac Gas Plant, Balzac, Alberta January 5, 2015. Alberta Environment and Sustainable Resource Development, Edmonton, Alberta. 9 pp.

Court, G., and G. Holroyd. 2016. Survey of the northern Alberta Peregrine Falcon (*Falco peregrinus anatum*) population – 2016. Unpublished report. Alberta Environment and Parks, Edmonton, Alberta. 16 pp.

Court, G., pers. comm. 2016. *Email correspondence to T. Armstrong.* February, March, May, June, and October 2016. Provincial Wildlife Status Biologist, Alberta Department of Sustainable Resource Development, Edmonton, Alberta.

Court, G.S. 1994. Population dynamics of American Peregrine Falcons (*Falco peregrinus anatum*) breeding in northeastern Alberta, Canada - 1971 to 1993: an evaluation of the need for continued management. Occasional Paper No.14. Department of Environmental Protection, Fish and Wildlife Division, Government of Alberta. 25 pp.

Court, G S., D.M. Bradley, C.C. Gates, and D.A. Boag. 1988a. The population biology of Peregrine Falcons in the Keewatin District of the Northwest Territories, Canada. Pages. 729–739 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Court, G S., D.M. Bradley, C.C. Gates, and D.A. Boag. 1989. Turnover and recruitment in a tundra Peregrine Falcon *Falco peregrinus* population. Ibis 131:487-496.

Court, G.S., C.G. Gates, and D.A. Boag. 1988b. Natural history of the Peregrine Falcon in the Keewatin District of the Northwest Territories. Arctic 41:17-30.

Craig G.R., and J. Enderson. 2004. Peregrine Falcon biology and management in Colorado, 1973-2001. S. Cochran (ed.). Technical Publication no. 43. Colorado Division of Wildlife. 80 pp.

Davidson, S., T. Duck, P. Jodice, and S. Moser. 2000. Climbing and natural resources management. An annotated bibliography. The Access Fund, Boulder, Colorado. 56 pp.

Dawson, R.D., D.H. Mossop, and B. Boukal. 2011. Prey use and selection in relation to reproduction by Peregrine Falcons breeding along the Yukon River, Canada. Journal of Raptor Research 45:27-37.

DeCandido, R., and D. Allen. 2006. Nocturnal hunting by Peregrine Falcons at the Empire State Building, New York City. The Wilson Journal of Ornithology 118:53-58.

Dekker, D. 2003. Peregrine Falcon predation on Dunlins and ducks and kleptoparasitic interference from Bald Eagles wintering at Boundary Bay, British Columbia. Journal of Raptor Research 37:91-97.

Dekker, D, and R. Corrigan. 2006. Population fluctuations and agonistic interaction of Peregrine and Prairie Falcons in central Alberta, 1960-2006. Journal of Raptor Research 40:255-263.

Dekker, D., and M.C. Drever. 2015. Kleptoparasitism by Bald Eagles (*Haliaeetus leucocephalus*) as a factor in reducing Peregrine Falcon (*Falco peregrinus*) predation on Dunlin (*Calidris alpine*) wintering in British Columbia. Canadian Field-Naturalist 129:159-164.

DeMent, S.H., J.J.Chisolm Jr., J.C. Barber, and J.D. Strandberg. 1986. Lead exposure in an “urban” Peregrine Falcon and its avian prey. Journal of Wildlife Diseases 22:238-244.

Dennhardt, A.J., and S.M. Wakamiya. 2013. Effective dispersal of Peregrine Falcons (*Falco peregrinus*) in the Midwest, USA. Journal of Raptor Research 47:262-270.

Desmarchelier, M., A. Santamaria-Bouvier, G. Fitzgerald, and S. Lair. 2010. Mortality and morbidity associated with gunshot in raptorial birds from the province of Quebec: 1986 to 2007. Canadian Veterinary Journal 51:70-74.

Dixon, A., N. Batbayar, G. Purev-Ochir, and N. Fox. 2011. Developing a sustainable harvest of Saker Falcons (*Falco cherrug*) for falconry in Mongolia. pp.363-372 *in* R.T. Watson, T.J. Cade, M. Fuller, G. Hunt, and E. Potapov (eds.). Gyrfalcons and Ptarmigan in a Changing World – Conference proceedings. The Peregrine Fund, Boise, Idaho. 398 pp.

Dominion Diamond Corp and Northwest Territories Environment and Natural Resources 2016. Updated summary data on Peregrine Falcons nesting in the Lac de Gras Study area NWT. Unpublished data. Environment and Natural Resources, Yellowknife, Northwest Territories.

Drewitt, E.J., and N. Dixon. 2008. Diet and prey selection of urban-dwelling Peregrine Falcons in southwest England. British Birds 101:58-67.

Ducks Unlimited Canada. 2010. Southern Ontario Wetland Conversion Analysis (Final Report). Ducks Unlimited Canada, Barrie, Ontario. 51 pp.

Dunn, E.H., A.D. Brewer, A.W. Diamond, E.J. Woodsworth, and B.T. Collins. 2009. Canadian Atlas of Bird Banding, Volume 3: Raptors and Waterbirds, 1921-1995. Canadian Wildlife Service Special Publication. Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. Web site: http://www.ec.gc.ca/aobc-cabb/index.aspx?lang=En&nav=overview_survol3 [accessed February 2016].

Ebenhard, T. 2000. Population viability analyses in endangered species management: the Wolf, Otter and Peregrine Falcon in Sweden. Ecological Bulletins 48:143-163.

eBird. 2017a. Peregrine Falcon, June-July all years. Web site: http://ebird.org/ebird/map/perfal?neg=true&env.minX=-94.42712177851558&env.minY=58.66751047487227&env.maxX=-93.80914082148433&env.maxY=58.82870543516807&zh=true&gp=false&ev=Z&mr=6-7&bmo=6&emo=7&yr=all&byr=1900&eyr=2017 [accessed May 2017].

eBird. 2017b. Peregrine Falcon, December-February, past 10 years. Web site: http://ebird.org/ebird/map/perfal?neg=true&env.minX=-149.0859375&env.minY=48.36529539249224&env.maxX=-36.5859375&env.maxY=69.85188364011266&zh=true&gp=false&ev=Z&mr=12-2&bmo=12&emo=2&yr=last10&byr=2007&eyr=2017 [accessed April 2017].

Elderkin, M., pers. comm. 2016. *Communication with T. Armstrong.* January 2016. Species at Risk Biologist, Nova Scotia Department of Natural Resources, Halifax Nova Scotia.

Elliott, J.E., J. Brogan, S.L. Lee, K.G. Drouillard, and K.H. Elliott. 2015. PBDEs and other POPs in urban birds of prey partly explained by trophic level and carbon source. Science of the Total Environment 524:157-165.

Elliott, J.E., M.J. Miller, and L.K. Wilson. 2005. Assessing breeding potential of Peregrine Falcons based on chlorinated hydrocarbon concentrations in prey. Environmental Pollution 134:353-361.

Enderson, J.A., S.A. Temple, and L.A. Swartz. 1972. Time-lapse photographic records of nesting Peregrine Falcons. Living Bird 11:113-128.

Enderson, J.H., W. Heinrich, L. Kiff, and C.M. White. 1995. Population changes in North American Peregrines. Transactions of the North American Wildlife and Natural Resources Conference 60:142-161.

Enderson, J.H., and G.R. Craig. 1997. Wide ranging by nesting Peregrine Falcons (*Falco peregrinus*) determined by radiotelemetry. Journal of Raptor Research 31:333-338.

Environment Canada. 2009. Petroleum industry activity guidelines for wildlife species at risk in the Prairie and Northern Region. Canadian Wildlife Service, Environment Canada, Prairie and Northern Region, Edmonton Alberta. 64p.

Environment Canada. 2014a. Breeding Bird Survey results. Trend results for Peregrine Falcon. Environment Canada, Ottawa, Ontario. Web site: http://ec.gc.ca/ron-bbs/P004/A001/?lang=e&m=s&r=PEFA&p=L [accessed December 2016].

Environment Canada. 2014b. Peregrine Falcon (*Falco peregrinus*). Status of Birds in Canada. Environment Canada, Ottawa, Ontario. Web site: https://wildlife-species.canada.ca/bird-status/oiseau-bird-eng.aspx?sY=2014&sL=e&sM=a&sB=PEFA [accessed October 2017].

Environment Canada. 2015. Management plan for the Peregrine Falcon *anatum/tundrius* (*Falco peregrinus anatum/tundrius*) in Canada (proposed). *Species at Risk Act* Management Plan series. Environment Canada, Ottawa, Ontario. iv + 27 pp.

Environment and Climate Change Canada. 2017. Management Plan for the Peregrine Falcon *pealei* subspecies (*Falco peregrinus pealei*) in Canada [Proposed]. Species at Risk Act Management Plan Series. Environment and Climate Change Canada, Ottawa. 2 parts, 4 pp. + 33 pp.

Environmental Protection Agency. 2016. DDT – a brief history and status. United States Environmental Protection Agency, Washington DC. Web site: https://www.epa.gov/ingredients-used-pesticide-products/ddt-brief-history-and-status [accessed March 2016].

Erickson, G.L., R. Fyfe, R. Bromley, G. Holroyd, D. Mossop, B. Munro, R. Nero, C. Shank, and T. Weins. 1988. Anatum Peregrine Falcon recovery plan. Canadian Wildlife Service, Ottawa, Ontario. 52 pp.

Faccio, S.D., M. Amaral, C.J. Martin, J.D. Lloyd, T.W. French, and A. Tur. 2013. Movement patterns, natal dispersal, and survival of Peregrine Falcons banded in New England. Journal of Raptor Research 47:246-261.

Falk, K., and S. Moller. 2015. Monitoring of the Peregrine Falcon population in South Greenland. Field report 2015. Web site: http://vandrefalk.dk/feltrap/rap2015.pdf [accessed May 2016].

Fallon, J.M. 2011. 2011 annual Peregrine Falcon report. Midwest Peregrine Society, Duluth, Minnesota. 30 pp.

Farmer, C.J., L.J. Goodrich, E.R. Inzunza, and J.P. Smith. 2008. Conservation status of North America's birds of prey. State of North America's birds of prey. Series in Ornithology 3:303-420.

Federal Register. 1999. Final rule to remove the American Peregrine Falcon from the Federal List of Endangered and Threatened Wildlife. Federal Register Vol. 64, No. 164:46542-46558.

Federation of Alberta Naturalists. 2007. The Atlas of Breeding Birds of Alberta: A Second Look. Federation of Alberta Naturalists. Edmonton, Alberta. 626 pp.

Ferguson-Lees, I.J. 1957. The rare birds of prey. Their present status in the British Isles. Peregrine. British Birds 50:149-155.

Fernie, K.J., and R.J. Letcher. 2010. Historical contaminants, flame retardants and halogenated phenolic compounds in Peregrine Falcon (*Falco peregrinus*) nestlings in the Canadian Great Lakes Basin. Environmental Science and Technology 44:3520-3526.

Fernie, K.J., J.L. Shutt, R. Letcher, I.J. Ritchie, and D.M. Bird. 2 009. Environmentally relevant concentrations of DE-71 and HBCD alter eggshell thickness and reproductive success of American Kestrels. Environmental Science and Technology 43:2124-2130.

Fine, I., and D. Masson. 2015. Oil spill trajectory on the northern British Columbia coast: results from a series of numerical simulations. Fisheries and Oceans Canada, North Saanich, BC. Canadian Technical Report of Hydrography and Ocean Sciences 306. 27 pp.

Fitzgerald, G. 2015. Programme de réhabilitation des oiseaux de proie au Québec: bilan 1986-2013. Le Naturaliste canadien 139:74-81

Fradette, P. 2016. Inventaire 2016 de la population de Faucon pèlerin du Québec méridional, rapport de mission et compilation des résultats. Rapport préparé par le Regroupement QuébecOiseaux et présenté au MFFP. 12 pp + 2 annexes.

Franke, A. 2016. Population estimates for northern juvenile Peregrine Falcons with implications for harvest levels in North America. Journal of Fish and Wildlife Management 7:36-45.

Franke, A., pers. comm. 2016. *Email correspondence to T. Armstrong.* April-September 2016. Arctic Raptors Project, University of Alberta, Edmonton, Alberta.

Franke, A., pers. comm. 2017. *Email correspondence to T. Armstrong.* April 2017. Arctic Raptors Project, University of Alberta, Edmonton, Alberta.

Franke, A., G.S. Court, M. Bradley, R. Johnstone, M. Setterington, and D. Abernethy. 2005. Survivorship of adult male and female Peregrine falcons (*F. p. tundrius*) at Rankin Inlet, Nunavut. Talk presented at the Raptor Research Foundation conference in Green Bay, Wisconsin. October 13, 2005.

Franke, A., J. Duxbury, H. Qi, T.B. Coplen, G. Holroyd, and B.A. Millsap. 2016a. U.S. Fish and Wildlife Service draft report: Hydrogen stable isotope analysis of Peregrine Falcons in the United States. Prepared for the North American Flyway councils. 26 pp.

Franke, A., V. Lamarre, and E. Hedlin. 2016b. Rapid nestling mortality in Arctic Peregrine Falcons due to the biting effects of black flies. Arctic 69:281-285.

Franke, A., M. Setterington, G. Court, and D. Birkholz. 2010. Long-term trends of persistent organochlorine pollutants, occupancy and reproductive success in Peregrine Falcons (*Falco peregrinus tundrius*) breeding near Rankin Inlet, Nunavut, Canada. Arctic 63:442-450.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. Wildlife Branch and Resource Inventory Branch, Ministry of Environment, Lands and Parks, Victoria, British Columbia. 244 pp.

Fuller, M.R., W.S. Seegar, and L.S. Schueck. 1998. Routes and travel rates of migrating Peregrine Falcons *Falco peregrinus* and Swainson's Hawks *Buteo swainsoni* in the Western Hemisphere. Journal of Avian Biology 29:433-440.

Fyfe, R.W. 1969. The Peregrine Falcon in the Canadian Arctic and eastern North America. pp. 101-114 *in* J.J. Hickey (Ed.). Peregrine Falcon Populations. Their Biology and Decline. University of Wisconsin Press, Madison, Wisconsin. 596 pp.

Fyfe, R.W. 1988. The Canadian Peregrine Falcon recovery program, 1967-1985. pp. 773-778 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Fyfe, R.W., and R.R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Canadian Wildlife Service Occasional Paper 23, Edmonton, Alberta. 17 pp.

Fyfe, R.W., S.A. Temple, and T.J. Cade. 1976. The 1975 North American Peregrine Falcon survey. Canadian Field-Naturalist 90:228-273.

Gahbauer, M.A. 2008. Breeding, dispersal, and migration of urban Peregrine Falcons in eastern North America. Ph.D. thesis. McGill University, Montreal, Quebec. 188 pp.

Gahbauer, M.A. pers. comm. 2016. *Email correspondence to T. Armstrong.* November 2016. Migration Research Foundation, Ste-Anne-de-Bellevue, Quebec.

Gahbauer, M.A., D.M. Bird, and T. (E.R.) Armstrong. 2015a. Origin, growth, and composition of the recovering Peregrine Falcon population in Ontario. Journal of Raptor Research 49:281-293.

Gahbauer, M.A., D.M. Bird, K.E. Clark, T. French, D.W. Brauning, and F.A. McMorris. 2015b. Productivity, mortality, and management of urban Peregrine Falcons in northeastern North America. Journal of Wildlife Management 79:10-19.

Gauthier, G., F.I. Doyle, O. Gilg, I.E. Menyushina, R.I.G. Morrison, N. Ovsyanikov *et al*. 2011. Birds of prey. Pp 63-74. *in* G. Gauthier and D. Berteaux (eds.). ArcticWOLVES: Arctic Wildlife Observatories Linking Vulnerable Ecosystems. Final synthesis report. Centre d'études nordiques, Université Laval, Quebec City, Quebec.

Gaston, A.J., J.M. Hipfner, and D. Campbell. 2002. Heat and mosquitoes cause breeding failures and adult mortality in an Arctic-nesting seabird. Ibis 144:185-191.

Government of Canada. 2016. Polybrominated Diphenyl Ethers Regulations. Consolidation. SOR/2008-18. Current to May 24 2016. Ministry of Justice, Ottawa, Ontario. 7 pp. Web site: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2008-218/ [accessed June 2016].

Government of the Northwest Territories. 2015. Status of Peregrine Falcons in a less contaminated world. Section 16.4 *in* State of the environment report. Government of the Northwest Territories, Environment and Natural Resources, Yellowknife, Northwest Territories. 5 pp. Last updated November 2015. Web site: http://www.enr.gov.nt.ca/state-environment/164-status-peregrine-falcons-less-contaminated-world [accessed May 2017]

Government of Ontario. 2013. Pest bird control and the Peregrine Falcon recovery program in Ontario. Pesticides Memorandum – Revised May, 2013. Ontario Ministry of the Environment and Climate Change, Toronto, Ontario. 4 pp. Web site: https://www.ontario.ca/document/pest-bird-control-and-peregrine-falcon-recover-program-ontario [accessed April 2016].

Greenberg, J. 2014. A Feathered River across the Sky: The Passenger Pigeon's Flight to Extinction. Bloomsbury, New York. 289 pp.

Gregory, G., pers. comm. 2016. *Email correspondence to T. Armstrong.* February 2016. Wildlife Management Biologist, Prince Edward Island Department of Communities, Land, and Environment, Charlottetown, Prince Edward Island.

Hager, S.B. 2009. Human-related threats to urban raptors. Journal of Raptor Research 43:210-226.

Harris, M.C., and J.M. Sleeman. 2007. Morbidity and mortality of Bald Eagles (*Haliaeetus leucocephalus*) and Peregrine Falcons (*Falco peregrinus*) admitted to the Wildlife Center of Virginia, 1993–2003. Journal of Zoo and Wildlife Medicine 38:62-66.

Harris, M.L., and J.E. Elliott. 2011. Polychlorinated biphenyls, dibenzo-p-dioxins and dibenzofurans and polybrominated diphenyl ethers in birds. pp. 471–522 *in* Beyer,W.N., and J. Meador (eds.), Environmental Contaminants in Wildlife — Interpreting Tissue Concentrations. Second edition. CRC press, New York, New York. 768 pp.

Hayes, G.E., and J.B. Buchanan. 2002. Washington State status report for the Peregrine Falcon. Washington Department of Fish and Wildlife, Olympia, Washington. 77 pp.

Heinrich, W. 2009. Peregrine Falcon recovery in the continental United States, 1974-1999, with notes on related programs of The Peregrine Fund. pp. 431-444 *in* J. Sielicki and T. Mizera (eds.). Peregrine Falcon Populations: Status and Perspectives in the 21st Century. Tural/Poznan University of Life Sciences Press, Warsaw, Poland. 800 pp.

Henny, C.J., and J.E. Elliott. 2007. Toxicology. pp. 329-350 *in* D.M. Bird and K.L. Bildstein (eds.). Raptor Research and Management Techniques. Hancock House Publishers Ltd., Surrey, British Columbia. 463 pp.

Henny, C.J., W.S. Seegar, and T.L. Maechtle. 1996. DDE decreases in plasma of spring migrant Peregrine Falcons, 1978-94. Journal of Wildlife Management 60:342-349.

Hetzler, B.C. 2013. Female Peregrine Falcon (*Falco peregrinus*) exploits fish as prey. Western North American Naturalist 73:107-109.

Hickey, J.J. 1969. Peregrine Falcon Populations: Their Biology and Decline. University of Wisconsin Press, Madison, Wisconsin. 596 pp.

Hipfner, J.M., D.F. Bertram, and K.H. Morgan. 2002. Pacific and Yukon regional seabird conservation plan. Canadian Wildlife Service, Delta, British Columbia.

Hipfner, J.M., K.W. Morrison, and R. Darvill. 2011. Peregrine Falcons enable two species of colonial seabirds to breed successfully by excluding other aerial predators. Waterbirds 34:82-88.

Holland, D.C. 1989. An instance of carrion-feeding by the Peregrine Falcon (*Falco peregrinus*). Journal of Raptor Research 23:184.

Holroyd, G.L. pers. comm. 2017. *E-mail correspondence to M. Gahbauer.* 2017. Formerly with Environment Canada, Edmonton, Alberta.

Holroyd, G.L., and U. Banasch. 1990. The reintroduction of the Peregrine Falcon, *Falco peregrinus anatum*, into southern Canada. Canadian Field-Naturalist 104:203-208.

Holroyd, G.L., and U. Banasch. 1996. The 1990 Canadian Peregrine Falcon (*Falco peregrinus*) survey. Journal of Raptor Research 30:145-156.

Holroyd, G.L., and U. Banasch. 2012. The 2005 Canadian Peregrine Falcon survey. Canadian Wildlife Biology and Management 1:30-45.

Holroyd, G.L., and D.M. Bird. 2012. Lessons learned during the recovery of the Peregrine Falcon in Canada. Canadian Wildlife Biology and Management 1:3-20.

Holroyd, G.L., and J. Frandsen. 2015. The 2015 survey of Peregrine Falcons and other raptors in Tuktuk Nogait National Park. Parks Canada, Western Arctic Field Unit, Inuvik, Nunavut. 19 pp.

Hornaday, W.T. 1914. Wild Life Conservation in Theory and Practice. Yale University Press, New Haven, Connecticut. 294 pp.

Hunt, W.G., and F.P. Ward. 1988. Habitat selection by spring migrant Peregrines at Padre Island, Texas. pp. 527–535 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. An assessment of the Intergovernmental Panel on Climate Change, Valencia Spain. 73 pp.

IUCN Standards and Petitions Subcommittee. 2016. Guidelines for using the IUCN red list categories and criteria. Version 12. Prepared by the Standards and Petitions Subcommittee. Web site: http://www.iucnredlist.org/documents/RedListGuidelines.pdf [accessed May 2016].

Jacobsen, F., M. Nesje, L. Bachmann, and J.T. Lifjeld. 2008. Significant genetic admixture after reintroduction of Peregrine Falcon (*Falco peregrinus*) in southern Scandinavia. Conservation Genetics 9:581-591.

Jaffré, M., A. Franke, A. Anctil, P. Galipeau, E. Hedlin, V. Lamarre, V. L'Hérault, L. Nikolaiczuk, K. Peck, B. Robinson, and J. Bêty. 2015. Écologie de la reproduction du faucon pèlerin au Nunavut. Le Naturaliste canadien 139:54-64.

Jobin, B., C. Latendresse, A. Baril, C. Maisonneuve, C. Boutin, and D. Côté. 2014. A half-century analysis of landscape dynamics in southern Quebec, Canada. Environmental Monitoring and Assessment 186:2215-2229.

Johnsgard, P.A. 1990. Hawks, Eagles, and Falcons of North America. Smithsonian Institution Press, Washington, DC. 403 pp.

Johnson, J.A., S.L. Talbot, G.K. Sage, K.K. Burnham, J.W. Brown, T.L. Maechtle, W.S. Seegar, M.A Yates, B. Anderson, and D.P., Mindell. 2010. The use of genetics for the management of a recovering population: temporal assessment of migratory Peregrine Falcons in North America. PLoS One 5(11), p.e14042. 15 pp.

Johnson, T.H. 1988. Responses of breeding Peregrine Falcons to human stimuli. Pp 301-305 *in* Glinski, R.L. *et al.* (eds.), Proceedings of the Southwest Raptor Management Symposium and Workshop. National Wildlife Federation Scientific and Technical Series No. 11. National Wildlife Federation, Washington, DC.

Johnstone, R.M. 1998. Aspects of the population biology of tundra Peregrine Falcons (*Falco peregrinus tundrius*). Ph.D. thesis. Department of Veterinary Anatomy, University of Saskatchewan, Saskatoon, Saskatchewan. xiii + 130 pp.

Jones, N., pers. comm. 2016. *Email correspondence to T. Armstrong.* April 2016. Scientific Project Officer and ATK Coordinator, Environment and Climate Change Canada, Gatineau, Quebec.

Katzner, T., J.D. Winton, F.A. McMorris, and D. Brauning. 2012. Dispersal, band encounters, and causes of death in a reintroduced and rapidly growing population of Peregrine Falcons. Journal of Raptor Research 46:75-83.

Kauffman, M.J., W.F. Frick, and J. Linthicum. 2003. Destination of habitat-specific demography and population growth for Peregrine Falcons in California. Ecological Applications 13:1802-1816.

Kiff, L.F. 1988. Changes in the status of the Peregrine in North America: an overview. pp. 123–139 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Kiff, L., R.G. Bijlsma, L.L. Severinghaus, and J. Shergalin. 2007. The raptor literature. pp. 11-46 *in* D.M. Bird and K.L. Bidstein (eds.). Raptor Research and Management Techniques. Hancock House Publishers Ltd., Surrey, British Columbia. 463 pp.

Kirk, D.A., and R.W. Nelson. 1999. COSEWIC status report on Peale's Peregrine Falcon, *Falco peregrinus pealei*. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. viii + 18 pp.

Kuvlesky, W.P., A.B. Leonard, M.L. Michael, K.K. Boydston, B.M. Ballard, and F.C. Bryant. 2007. Wind energy development and wildlife conservation: challenges and opportunities. Journal of Wildlife Management 71:2478-2498.

Kuyt, E. 1967. Two banding returns for Golden Eagle and Peregrine Falcon. Bird-Banding 38:78-79.

Lamarre, V., A. Franke, O.P. Love, P. Legagneux, J. and Bêty. 2017. Linking pre-laying energy allocation and timing of breeding in a migratory arctic raptor. Oecologia 183:653-666.

Lambert, J.D., T.P. Hodgman, E.J. Laurent, G.L. Brewer, M.J. Iliff, and R. Dettmers. 2009. The Northeast Bird Monitoring Handbook. American Bird Conservancy, The Plains, Virginia. 32 pp.

Lank, D.B., R.W. Butler, J. Ireland, and R.C. Ydenberg. 2003. Effects of predation danger on migration strategies of sandpipers. Oikos 103:303-319.

Lapointe, J., L. Imbeau, J.A. Tremblay, C. Maisonneuve, and M.J. Mazerolle. 2013. Habitat use by female Peregrine Falcons (*Falco peregrinus*) in an agricultural landscape. Auk 130:381-391.

Lewis, S.B., and M.L. Kissling. 2015. Clarifying subspecies of Peregrine Falcons along the Lost Coast of Alaska. Journal of Raptor Research 49:367-375.

L'Hérault, V., A. Franke, N. Lecomte, A. Alogut, and J. Bêty. 2013. Landscape heterogeneity drives intra-population niche variation and reproduction in an Arctic top predator. Ecology and Evolution 3:2867-2879.

Lindberg, P., U. Sellström, L. Häggberg, and C.A. de Wit. 2004. Higher brominated diphenyl ethers and hexabromocyclododecane found in eggs of Peregrine Falcons (*Falco peregrinus*) breeding in Sweden. Environmental Science and Technology 38:93-96.

Living Oceans. 2013. Oil spill model. Living Oceans Society, Sointula and Vancouver, BC. Web site: http://www.livingoceans.org/maps/oil-spill-model [accessed April 2017].

Lott, C,A. 2006. A new raptor migration monitoring site in the Florida Keys: Counts from 1999-2004. Journal of Raptor Research 40:200-209.

Maconachie, T. 2016. Manitoba Peregrine Falcon recovery project. Provincial summaries - 2010 and 2015. MS report. Manitoba Peregrine Falcon Recovery Project, Winnipeg, Manitoba. 1 p.

Maconachie, T., pers. comm. 2016. *Email correspondence to T. Armstrong.* March, April, and May 2016. Project Coordinator, Manitoba Peregrine Falcon Recovery Project, Winnipeg, Manitoba.

Maconachie, T., pers. comm. 2017. *Email correspondence to T. Armstrong.* April 2017. Project Coordinator, Manitoba Peregrine Falcon Recovery Project, Winnipeg, Manitoba.

Manitoba Peregrine Falcon Recovery Program. 2016. Peregrine Falcon Recovery Program (Manitoba). Web site: http://www.species-at-risk.mb.ca/pefa/index.html [accessed May 2016].

Martell, M.S., J.L. McNicoll, and P.T. Redig. 2000. Probable effect of delisting of the Peregrine Falcon on availability of urban nest sites. Journal of Raptor Research 34:126-132.

Mattox, W.G., and M. Restani. 2014. Migratory Movements and Mortality of Peregrine Falcons banded in Greenland, 1972–97. Arctic:433-440.

McBride, T.J., J.P. Smith, H.P. Gross, and M.J. Hooper. 2004. Blood-lead and ALAD activity levels of Cooper's Hawks (*Accipiter cooperii*) migrating through the southern Rocky Mountains. Journal of Raptor Research 38:118-124.

McGrady, M.J., T.L. Maechtle, J.J. Vargas, W.S. Seegar, and M.C. Porras Peña. 2002. Migration and ranging of Peregrine Falcons wintering on the Gulf of Mexico coast, Tamaulipas, Mexico. Condor 104:39-48.

Mearns, R., and I. Newton. 1988. Factors affecting breeding success of Peregrines in south Scotland. Journal of Animal Ecology 57:903-916.

Mesta, R. 1999. Endangered and threatened wildlife and plants; final rule to remove the American Peregrine Falcon from the federal list of endangered and threatened wildlife, and to remove the similarity of appearance provision for free-flying Peregrines in the coterminous United States. Federal Register 64(164):4654246558.

Millsap, B.A., P.L. Kennedy, M.A. Byrd, G. Court, J.H. Enderson, and R.N. Rosenfeld. 1998. Review of the proposal to de-list the American Peregrine Falcon. Wildlife Society Bulletin 26:522-538.

Mineau, P., M.R. Fletcher, L.C. Glaser, N.J. Thomas, C. Brassard, L.K. Wilson, J.E. Elliott, L.A. Lyon, C.J. Henny, T. Bollinger, and S.L. Porter. 1999. Poisoning of raptors with organophosphorus and carbamate pesticides with emphasis on Canada, U.S. and U.K. Journal of Raptor Research 33:1-37.

Mossop, D. 2003. Are northern raptor populations signaling a new collapse? Bird Trends 9 (Winter):62-63.

Mossop, D.H. 2015. 2015 population status of the Peregrine Falcon in the Yukon Territory. MS report, Yukon Research Centre, Yukon College, Whitehorse, Yukon. 11 pp.

Mossop, D.H., pers. comm. 2017. Threats calculator conference call, March 9 2017. Yukon Research Centre, Yukon College, Whitehorse, Yukon.

Murphy, J.E. 1990. The 1985–1986 Canadian Peregrine Falcon, *Falco peregrinus*, survey. Canadian Field-Naturalist 104:182-192.

Nantel, P., pers. comm. 2016. *Email correspondence to T. Armstrong.* June 2016. Office of the Chief Ecosystem Scientist, Parks Canada, Gatineau, Quebec

NatureServe. 2016. Peregrine Falcon. NatureServe Explorer. Web site: http://explorer.natureserve.org/servlet/NatureServe?searchSciOrCommonName=peregrine+falcon&x=0&y=0 [accessed June 2016].

Nelson, M.W. 1969. The status of the Peregrine Falcon in the northwest. pp. 61-72 *in* J.J. Hickey (ed.). Peregrine Falcon Populations: Their Biology and Decline. University of Wisconsin Press, Madison, Wisconsin. 596 pp.

Nelson, M.W. 1988a. Continuing climatic changes affecting Peregrines and humanity. pp. 21-24 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Nelson, R.W. 1970. Some aspects of the breeding behaviour of Peregrine Falcons on Langara Island, B.C. M.Sc. thesis, University of Calgary, Calgary, Alberta. 306 pp.

Nelson, R.W. 1977. Behavioural ecology of coastal peregrines (*Falco peregrinus pealei*). Ph.D. Thesis, University of Calgary, Calgary, Alberta. 490 pp.

Nelson, R.W. 1988b. Do large natural broods increase mortality of parent Peregrine Falcons? pp. 719-728 *in* T.J. Cade, J.H. Enderson, C.G. Thelander and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Nelson, R.W. 1990. Status of the Peregrine Falcon, *Falco peregrinus pealei*, on Langara Island, Queen Charlotte Islands, British Columbia. Canadian Field-Naturalist 104:193-199.

Nelson, R.W., pers. comm. 2006. *Communication with J. Cooper*. 2006. University of Calgary, Calgary, Alberta.

Nelson, R.W. and T.M. Myres. 1976. Declines in populations of Peregrine Falcons and their seabird prey at Langara Island, British Columbia. Condor 78:281-293.

Nemeth, N., D. Gould, R. Bowen, and N. Komar. 2006. Natural and experimental West Nile virus infection in five raptor species. Journal of Wildlife Diseases 42:1-13.

Nesje, M., K.H. Røed, J.T. Lifjeld, P. Lindberg, and O.F. Steen. 2000. Genetic relationships in the Peregrine Falcon (*Falco peregrinus*) analysed by microsatellite DNA markers. Molecular Ecology 9:53-60.

Newfoundland and Labrador Department of Environment and Conservation. 2016. Peregrine Falcon (*Falco peregrinus anatum/tundrius*). Newfoundland and Labrador Species at Risk, Department of Environment and Conservation, St. John's, Newfoundland and Labrador. Web site: www.env.gov.nl.ca/env/wildlife/endangeredspecies/perigrine_falcon.pdf [accessed June 2016].

Newton, I. 1988a. Population regulation in Peregrines: an overview. pp. 761-770 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Newton, I. 1988b. Changes in the status of the Peregrine Falcon in Europe: an overview. pp. 227-234 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Newton, I., and R. Mearns. 1988. Population ecology of Peregrines in south Scotland. pp. 651-665 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Northwest Territories Environment and Natural Resources. 2016a. Updated summary data on Peregrine Falcons nesting in the Daring Lake Study area NWT. Unpublished data. Environment and Natural Resources, Yellowknife, Northwest Territories.

Northwest Territories Environment and Natural Resources. 2016b. Updated summary data on Peregrine Falcons nesting along the Mackenzie River, NWT. Unpublished data. Environment and Natural Resources, Yellowknife, Northwest Territories.

Nova Scotia Department of Natural Resources. 2016. Peregrine Falcon *Falco peregrinus anatum*. Nova Scotia Department of Nova Scotia. Web site: www.speciesatrisk.ca/SARGuide/download/Peregrine%20Falcon.pdf [accessed November 2016].

Nunavik Parks. 2016. National Park Ulittaniujalik: The Nunavik Parks Family is Growing! Web site: www.parcsnunavik.ca/en/news/10-14/2016/national-park-ulittaniujalik-the-nunavik-parks-family-is-growing [accessed December 2017].

Nunavik Parks. 2017. Discover our parks. Web site: http://www.nunavikparks.ca/en/parks [accessed May 2017].

Nunavut Planning Commission. 2016. Draft Nunavut Land Use Plan Options and Recommendations. Draft – 2016. Nunavut Planning Commission, Iqaluit, Nunavut. Web site: http://www.nunavut.ca/files/2016DNLUP/Options%20%20Recommendations%20for%20the%20NLUP%202016 [accessed May 2017].

Nunavut Tunngavik Incorporated. 2000, Inuit owned lands in Nunavut. Nunavut Tunngavik Incorporated. Web site: qia.ca/wp-content/uploads/2017/02/nunavut-map-iol.pdf [accessed May 2017].

Oliphant, L.W. 1991. Hybridization between a Peregrine Falcon and a Prairie Falcon in the wild. Journal of Raptor Research 25:36-39.

Oliphant, L. In prep. Evaluating the size of the northern population of Peregrine Falcons (*Falco peregrinus*) in North America – a discussion paper. Unpublished report. University of Saskatchewan, Saskatoon, Saskatchewan. 22 pp.

OMNR (Ontario Ministry of Natural Resources). 2010. Peregrine Falcon. Ontario Government Response Statement. Ontario Ministry of Natural Resources, Species at Risk Branch, Peterborough, Ontario. 5 pp.

OMNRF (Ontario Ministry of Natural Resources and Forestry). 2015. Five-year review of progress towards the protection and recovery of species at risk. Ontario Ministry of Natural Resources and Forestry, Species Conservation Policy Branch, Peterborough, Ontario. 215 pp.

Ontario Peregrine Falcon Recovery Team. 2010. Recovery strategy for the Peregrine Falcon (*Falco peregrinus*) in Ontario. Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 36 pp.

Pacific Flyway Council. 2017. Informational Note 11 - Take allocation of Peregrine Falcons for falconry purposes in the United States west of 100° Longitude. Pg 68 *in* Pacific Flyway Council Recommendations, Informational Notes and Subcommittee Reports, March 2017. Web site: www.pacificflyway.gov/Documents/Recs_sep.pdf [accessed May 2017].

Pagel J.E., R.T. Patton, and B. Latta. 2010. Ground nesting of Peregrine Falcons (*Falco peregrinus*) near San Diego, California. Journal of Raptor Research 44:323-325.

Pain, D.J., J. Sears and I. Newton. 1995. Lead concentrations in birds of prey in Britain. Environmental Pollution 87:173-180.

Palmer, R.S. 1988. pp. 324–380 *in* Handbook of North American birds. Vol. 5: diurnal raptors. Part 2. Yale University Press, New Haven, Connecticut. 448 pp.

Park, J.S., A. Holden,V. Chu, M. Kim, A, Rhee, P. Patel, Y. Shi, J. Linthicum, B.J. Walton, K. Mckeown, and N.P. Jewell. 2009. Time-trends and congener profiles of PBDEs and PCBs in California Peregrine Falcons (*Falco peregrinus).* Environmental Science and Technology 43:8744-8751.

Parks Canada. 2016a. Multi-species action plan for Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site. *Species at Risk Act* Action Plan Series. Parks Canada, Ottawa, Ontario. vi + 25 pp. Web site: http://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=2911 [accessed August 2016].

Parks Canada. 2016b. Managed area element status assessment for Peregrine Falcon. Unpublished report, Parks Canada, Gatineau. Quebec. 136 pp.

Peakall, D.B., and L.F. Kiff. 1988. DDE contamination in Peregrines and American Kestrels and its effect on reproduction. pp. 337-350 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Peck, G.K., 1972. Birds of the Cape Henrietta Maria region, Ontario. Canadian Field-Naturalist 86:333-348.

Peck, G.K., and R.D. James.1987. Breeding birds of Ontario: nidiology and distribution. Volume 1: Nonpasserines. Life Sciences Miscellaneous Publication. Royal Ontario Museum, Toronto, Ontario. 321 pp.

Peck, K., S. Carrière, and N. Lecomte. 2012. The Nunavut and Northwest Territories raptor database: User's manual. Department of Environment, Igloolik NU and Department of Environment and Natural Resources, Yellowknife, Northwest Territories. 19 pp.

Penteriani, V., M. Ferrer and M.M. Delgado. 2011. Floater strategies and dynamics in birds, and their importance in conservation biology: towards an understanding of nonbreeders in avian populations. Animal Conservation 14:233-241.

Porter, R.D., and C.M. White. 1973. The Peregrine Falcon in Utah, emphasizing ecology and competition with the Prairie Falcon. Brigham Young University Science Bulletin Biological Series vol. XVIII (1). 74 pp.

Prostor, M., B.G. Robinson, O. Beingolea, M. Jaffré, A.E. Derocher, and A. Franke. 2013. From the Arctic to the Neotropics: Migration Routes and Wintering Grounds of the Arctic Peregrine Falcon. Poster presentation, Raptor Research Foundation Conference, Bariloche, Argentina.

Pyke, K. 1997. Raptors and climbers: Guidance for managing technical climbing to protect raptor nests. Access Fund, Boulder, Colorado. 27 pp.

Québec Breeding Bird Atlas. 2016. Quebec Breeding Bird Atlas. Web site: http://www.atlas-oiseaux.qc.ca/donneesqc/cartes.jsp?lang=en [accessed July 2016].

Québec Breeding Bird Atlas. 2017. Quebec Breeding Bird Atlas. Atlas results. Web site: http://www.atlas-oiseaux.qc.ca/donneesqc/datasummaries.jsp?lang=en [accessed September 2017].

Ratcliff, B. 2015. Project Peregrine. Results of the 2015 field season. MS report, Thunder Bay Field Naturalists, Thunder Bay, Ontario. 24 pp.

Ratcliffe, D.A. 1962. Breeding density in the Peregrine Falcon *Falco peregrinus* and Raven *Corvus corax*. Ibis 104:13-39.

Ratcliffe, D.A., 1969. Population trends of the Peregrine Falcon in Great Britain. pp. 239-269 *in* J.J. Hickey (ed.). Peregrine Falcon Populations: Their Biology and Decline. University of Wisconsin Press, Madison, Wisconsin. 596 pp.

Ratcliffe, D. 1988. The peregrine population of Great Britain and Ireland, 1965-1985. pp. 147-157 *in* T.J. Cade, J.H. Enderson, C.G. Thelander and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise ID. 949 pp.

Ratcliffe, D. 1993. The Peregrine Falcon. Second edition, T & AD Poyser, London England. 454 pp.

Redig, P.T., and H.B. Tordoff. 1988. Peregrine Falcon reintroduction in the upper Mississippi Valley and western Great Lakes region. pp.559-563 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Rejt, L., 2004. Nocturnal behaviour of adult Peregrines at the nest during nestling period. Vestnit zoologii 38: 87-90.

Ritchie, R.J., and J.E. Shook. 2011. Recovery and trends of Peregrine Falcons breeding in the Yukon-Tanana Uplands, east-central Alaska, 1995-2003. Journal of Raptor Research 45:150-159.

Ritchie, R.J., A.M. Wildman, and C.M. White. 2004. Peregrine Falcons nesting on lake bluffs on the Arctic Coastal Plain of northern Alaska. Journal of Raptor Research 38:158-160.

Roberts, D.R., L.L. Laughlin, P. Hshei, and L.J. Legters. 1997. DDT, global strategies, and a malaria control crisis in South America. Emerging Infectious Diseases *3*: 295-302.

Robinson, B.G. 2015. Foraging ecology of the Arctic Peregrine Falcon (*Falco peregrinus tundrius*). Ph. D. thesis. University of Alberta, Edmonton, Alberta. xviii + 180 pp.

Robinson, B.G., A. Franke, and A.E. Derocher. 2014. The influence of weather and lemmings on spatiotemporal variation in the abundance of multiple avian guilds in the Arctic. PLoS One 9(7), p.e101495. 11 pp.

Robinson, B.G., A. Franke, and A.E. Derocher. 2017. Weather-mediated decline in prey delivery rates causes food-limitation in a top avian predator. Journal of Avian Biology 48: 748-758.

Robinson, B.G., A. Franke, and A.E. Derocher. 2018. Stable isotope mixing models fail to estimate the diet of an avian predator. The Auk: Ornithological Advances 135:60-70.

Rodrigues, B. 2010. Summary of the 2009-10 nest survey for Peregrine Falcons in Labrador. Report for the Nunatsiavut Government. Government of Newfoundland and Labrador, Department of Environment and Conservation, St. John, Newfoundland and Labrador. 7 pp.

Rosenfield, R.N., J.W. Schneider, J.M. Papp, and W. Seegar. 1995. Prey of Peregrine Falcons breeding in west Greenland. Condor 97:763-770.

Rosenfield, R.N., J.W. Grier, and R.W. Fyfe. 2007. Reducing management and research disturbance. pp. 351–364 *in* D. M. Bird and K. L. Bildstein (eds.) Raptor Research and Management Techniques. Hancock House: Surrey, British Columbia.

Rowell, P. 2002. COSEWIC status report on Anatum Peregrine Falcon *Falco peregrinus anatum*. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 29 pp.

Rowell, P., G.L. Holroyd, and U. Banasch. 2003. The 2000 Canadian Peregrine Falcon survey. Journal of Raptor Research 37:98-116.

Rowell, P., and D. Stepnisky. 1997. Status of the Peregrine Falcon *(Falco peregrinus anatum)* in Alberta. Alberta Status Report Number 8. Government of Alberta, Wildlife Management Division, Edmonton, Aberta. 24 pp.

Sabine, M., pers. comm. 2016. *Email correspondence to T. Armstrong.* December 2016. Species at Risk Biologist, New Brunswick Department of Natural Resources, Fredericktown, New Brunswick.

SAIC (Science Applications International Corporation). 2000. Avian collision at transmission lines associated with the Hells Canyon complex. Technical Report Appendix E.3.2-20. Science Applications International Corporation, Boise, Idaho. 116 pp.

Savard, J-P.L., and S. Rioux. 2013. Bird casualty related to electrocution on distribution power lines, maintenance of transmission power lines and hydro-power reservoirs in Canada. Unpublished report. Environment Canada, Quebec, Quebec.

Savignac, C., and M. Bélisle. 2015. Habitat de nidification du faucon pèlerin dans le sud du Québec : comparaison entre les carrières industrielles et les parois naturelles. Le Naturaliste canadien 139:44-53.

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22: 897-911.

Samour, J.H., and J.L. Naldo., 2003. Diagnosis and therapeutic management of trichomoniasis in falcons in Saudi Arabia. Journal of Avian Medicine and Surgery 17:136-143.

SARA Registry. 2016. Schedule 1 (Subsections 2(1), 42(2) and 68(2)). List of wildlife species at risk. Part 4. Special Concern species. Species at Risk Public Registry, Environment Canada, Gatineau, Quebec. Web site: http://www.registrelep-sararegistry.gc.ca/species/schedules_e.cfm?id=1 [accessed March 2016].

Schmutz, J.K., R.W. Fyfe, U. Banasch, and H. Armbruster. 1991. Routes and timing of migration of falcons banded in Canada. Wilson Bulletin 103:44-58.

Seegar, W.S., T.L. Maechtle, M.A., and G.E. Doney. 2015. 2015 Peregrine Falcon migration studies at South Padre Island, Texas, in cooperation with The Peregrine Fund. MS report. Earthspan. Web site: www.earthspan.org/wp.../01/Padre-Report-2015-FINAL-20151228.pdf [accessed May 2017].

Sergio, F., F. Rizzolli, L. Marchesi, and P. Pedrini. 2004. The importance of interspecific interactions for breeding-site selection: Peregrine Falcons seek proximity to raven nests. Ecography 27:818-826.

Setterington, M., pers. comm. 2006 and 2007. *Communication with J. Cooper.*

Smith, A.R. 1996. Atlas of Saskatchewan Birds. Special Publication no. 22. Saskatchewan Natural History Society, Regina SK. 456 pp.

Sokolov, V., N. Lecomte, and A. Sokolov, 2014. Site fidelity and home range variation during the breeding season of Peregrine Falcons (*Falco peregrinus*) in Yamal, Russia. Polar Biology 37:1621–1631.

Steenhof, K., and I. Newton. 2007. Assessing nesting success and productivity. pp. 181-192 *in* D.M. Bird and K.L. Bidstein (eds.). Raptor Research and Management Techniques. Hancock House Publishers Ltd., Surrey, British Columbia. 463 pp.

Stepnisky, D.P. 1998. Demographic features of a recovering Peregrine Falcon *(Falco peregrinus anatum)* population in southern Alberta: 1980-1997. Alberta Environmental Protection, Wildlife Management Division, Occasional Report Series, No. 15. 27 pp.

Stewart, R.L.M., K.A. Bredin, A.R. Courturier, A.G. Horn, D. Lepage, S. Makepeace, P.D. Taylor, M-A. Villard, and R.M. Whittam (eds.). 2015. Second Atlas of the Breeding Birds of the Maritime Provinces. Birds Studies Canada, Environment Canada, Natural History Society of Prince Edward Island, Nature New Brunswick, New Brunswick Department of Natural Resources, Nova Scotia Bird Society, Nova Scotia Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry, Sackville, Nova Scotia. 528 + xxviii pp.

Sutherland, D., pers. comm. 2016. *Email correspondence to T. Armstrong.* September 2016. Zoologist, Natural Heritage Information Centre, Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario.

Sutton, L.J. 2015. Prey spectrum and foraging behaviour of coastal Peregrine Falcons *Falco peregrinus* breeding in South Devon. Devon Birds 68(2):3-12.

Taylor, R.H., G.W. Kaiser, and M.C. Drever. 2000. Eradication of Norway Rats for recovery of seabird habitat on Langara Island, British Columbia. Restoration Ecology 8:151-160.

Temple, S.A. 1988. Future goals and needs for the management and conservation of the Peregrine Falcon. pp. 843-848 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Thomas, G.H., R.B., Lanctot, and T. Székely. 2006. Population declines in North American shorebirds: ecology, life-history and sexual selection. pp. 207-208 *in* G.C. Boere, C.A. Galbraith and D.A. Stroud (eds). Waterbirds around the World. The Stationery Office, Edinburgh, UK.

Thompson, W.J.P. 2015. Saskatchewan Peregrine Activity 2015. Unpublished report. Saskatoon, Saskatchewan.

Thompson, W.J.P., pers. comm. 2016. *Email correspondence to T. Armstrong.* May 2016. Saskatoon, Saskatchewan.

Tordoff, H.B., M.S. Martell, P.T. Redig, and M.J. Solensky. 2000. Midwest Peregrine Falcon restoration 2000 report. Bell Museum of Natural History and The Raptor Center, University of Minnesota, St. Paul, Minnesota.

Tordoff, H.B., and P.T. Redig. 1997. Midwest Peregrine Falcon demography, 19821995. Journal of Raptor Research 31:339–346.

Tordoff, H.B., and P.T. Redig. 2001. Role of genetic background in the success of reintroduced Peregrine Falcons. Journal of the Society for Conservation Biology 15:528-532.

Tremblay, J.A., P. Fradette, F. Shaffer, and I. Gauthier. 2012. Inventaire quinquennal 2010 du Faucon Pèlerin au Québec méridional: état de la population québécoise. Le Naturaliste canadien 136:88-93.

United Nations News Center. 2009. UN agencies launch DDT-free anti-malaria initiative. United Nations News Service. Web site: http://www.un.org/apps/news/story.asp?NewsID=30713#resources [accessed November 2016].

USFWS (United States Fish and Wildlife Service). 2004. Final revised environmental assessment, management plan, and implementation guidance: take of nestling American Peregrine Falcons in the contiguous United States and Alaska for use in falconry. United States Fish and Wildlife Service, Division of Migratory Bird Management Washington DC. v + 63 pp. Web site: https://www.fws.gov/southwest/es/arizona/Documents/SpeciesDocs/AmericanPeregrineFalcon/Final_EA_Peregrine.pdf [accessed August 2016].

USFWS. 2008a. Peregrine Falcon (*Falco peregrinus*). United States Fish and Wildlife Service, Washington DC. 2 pp. Web site: https://www.fws.gov/endangered/esa-library/pdf/Peregrinefactsheet.pdf [accessed March 2016].

USFWS. 2008b. Take of migrant Peregrine Falcons in the United States for use in falconry. Federal Registry 73(236): 74508-74509. Web site: https://www.federalregister.gov/articles/2008/12/08/E8-29011/take-of-migrant-peregrine-falcons-in-the-united-states-for-use-in-falconry [accessed February 2016].

USFWS. 2015. Waterfowl hunting management in North America. Flyways.USA collaborative effort of waterfowl managers across the continent. United States Fish and Wildlife Service, Washington DC. Web site: flyways.us [accessed August 2016].

USGS (United States Geological Survey). 2015. Longevity records of North American Birds (current through September 2015). United States Department of the Interior, U.S. Geological Survey. Web site: https://www.pwrc.usgs.gov/BBL/longevity/longevity_main.cfm [accessed February 2016].

van den Berg, H. 2009. Global status of DDT and Its alternatives for use in vector control to prevent disease. Environmental Health Perspectives 117: 1656–1663.

Varland, D.E., J.B. Buchanan, T.L. Fleming, M.K. Kenney, and T.M. Loughin. 2012. Peregrine Falcons on coastal beaches of Washington: fifteen years of banding and surveys. Journal of Raptor Research 46:57-74.

Vorkamp, K., M. Thomsen, K. Falk, H. Leslie, S. Mølle, and P.B. Sørensen. 2005. Temporal development of brominated flame retardants in Peregrine Falcon (*Falco peregrinus*) eggs from South Greenland (1986-2003). Environmental Science and Technology 39:8199-8206.

Walton, K., T. Gotthardt, and T. Fields. 2013. Peregrine Falcon, Peale's *Falco peregrinus pealei*. Alaska Species Ranking System Summary Report – Peregrine Falcon, Peale's. Alaska Natural Heritage Program, University of Alaska, Anchorage, Alaska. Web site: aknhp.uaa.alaska.edu/species_summary_reports/pdfs/214.pdf [accessed May 2016].

Watts, B. 2009. Conservation in conflict: Peregrines vs. Red Knots. The Center for Conservation Biology, Williamsburg, Virginia. Web site: http://www.ccbbirds.org/2009/09/01/conservation-in-conflict-peregrines-vs-red-knots/ [accessed May 2017].

Watts, B. 2016. Conservation in conflict: Peregrines and shorebirds in the mid-Atlantic. The Center for Conservation Biology, Williamsburg, Virginia. Web site: http://www.ccbbirds.org/2016/07/06/conservation-in-conflict-peregrines-and-shorebirds-in-the-mid-atlantic/ [accessed May 2017].

Watts, B. D., K. E. Clark, C. A. Koppie, G. D. Therres, M. A. Byrd, and K. A. Bennett. 2015. Establishment and growth of the Peregrine Falcon breeding population within the mid-Atlantic Coastal Plain. Journal of Raptor Research 49:359-366.

Watts, B.D., S.M. Padgett, E.K. Mojica, and B.J. Paxton. 2007. FALCONTRAK: Final report. Center for Conservation Biology Technical Report Series. CBCTR 11-07. College of William and Mary, Williamsburg, Virginia. 33 pp.

Weaver, J.D. 1988. The Peregrine Falcon in relation to contemporary falconry. pp. 821–824 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Wheeldon, R. 2003. A recovery plan and strategy for the Peregrine Falcon in Manitoba. A Parkland Mews-Manitoba Conservation Partnership Project. Parkland Mews, Winnipeg, Manitoba. 19 pp.

White, C.M. 1968. Diagnosis and relationships of the North American tundra-inhabiting Peregrine Falcon. Auk 85:179–191.

White, C.M., and D.A. Boyce, Jr. 1988. An overview of Peregrine Falcon subspecies. pp. 789–810 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

White, C.M., and T.J. Cade. 1971. Cliff-nesting raptors and ravens along the Colville River in Arctic Alaska. Living Bird 10:107-150.

White, C.M., T.J. Cade, and J.H. Enderson. 2013. Peregrine Falcons of the World. Lynx Edicions. 379 pp.

White, C.M., N.J. Clum, T.J. Cade, and W.G. Hunt. 2002. Peregrine Falcon (*Falco* peregrinus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America. Web site: http://bna.birds.cornell.edu/bna/species/660 [accessed July 2016].

White, C.M., R. Fyfe, and D.B. Lemmon. 1990. The 1980 North American Peregrine Falcon, *Falco peregrinus*, survey. Canadian Field-Naturalist 104: 174–181.

Whittington, B. 2014. Peregrine Falcon hunting from cruise ships. British Columbia Birds 24:6-8.

Wightman, C.S., and M.R. Fuller. 2005. Spacing and physical habitat selection patterns of Peregrine Falcons in central west Greenland. Wilson Bulletin 117:226-236.

Wilson, U.W., A. McMillan, and F.C. Dobler. 2000. Nesting, population trend and breeding success of Peregrine Falcons on the Washington outer coast, 1980-98. Journal of Raptor Research 34:67-74.

Wright, J.M., and P.J. Bente. 1999. Documentation of active Peregrine Falcon nest sites, 1 Oct. 1994-31 March 1998. Final Research Report, Endangered Species Conservation Fund, Federal Aid Studies SE-2-9, 10 and 11. Alaska Department of Fish and Game, Juneau, Alaska. 15 pp.

Yates, M.A., K.E. Riddle, and F.P. Ward. 1988. Recoveries of Peregrine Falcons migrating through the eastern and central United States, 1955-1985. pp. 471-483 ***in*** T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho. 949 pp.

Zimmerling, J., A. Pomeroy., M. d'Entremont, and C. Francis. 2013. Canadian estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine developments. Avian Conservation and Ecology 8(2): 10.

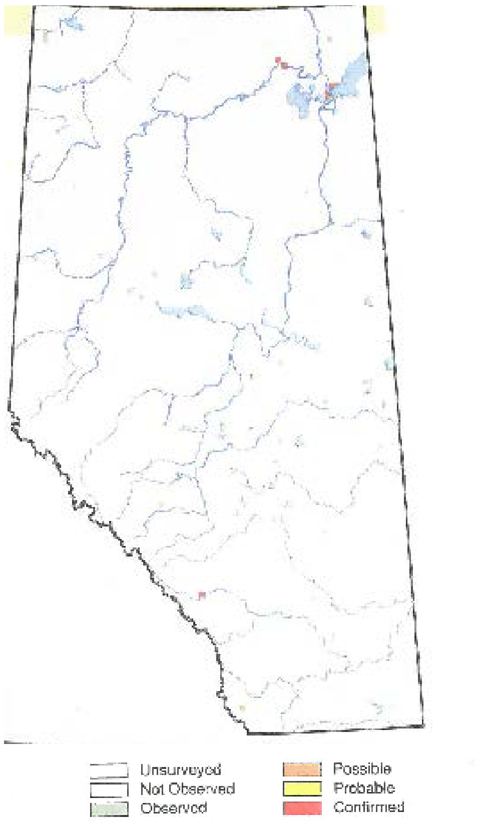
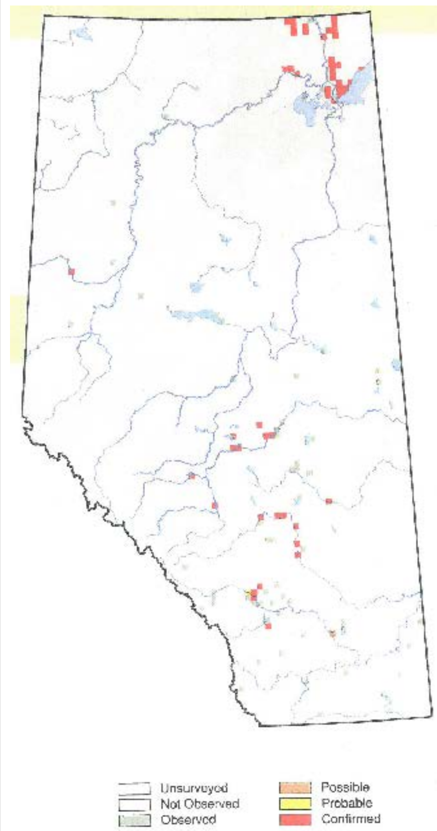
Zuberogoitia, I., J. Zabala, J.E. Martínez, and J. Olsen. 2015. Alternative eyrie use in Peregrine Falcons: is it a female choice? Journal of Zoology 296:6-14.

BIOGRAPHICAL SUMMARY OF REPORT WRITERS

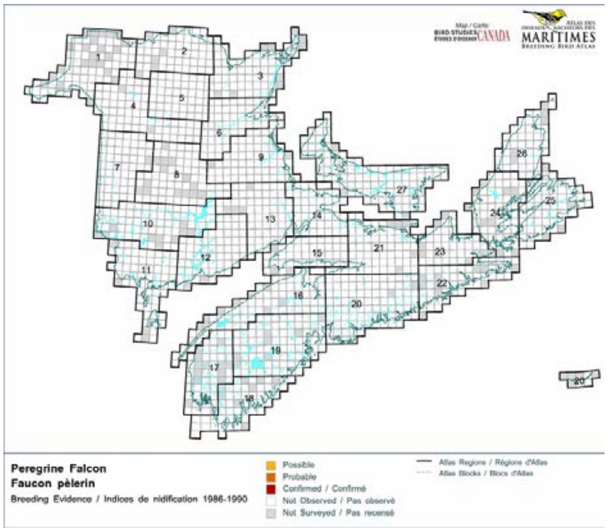
Ted (Edward R.) Armstrong is a wildlife biologist who has worked on wildlife management and species at risk conservation across Ontario, working for the Ontario Ministry of Natural Resources in the Muskoka-Haliburton Region, Cochrane, Wawa and northwestern Ontario. He has a B.Sc. in Fisheries and Wildlife Biology from the University of Guelph, and an M.Sc. in Wildlife Ecology from the University of Guelph. Ted was the provincial lead for Ontario's Peregrine Falcon recovery program and Ontario's representative on the National *anatum* Peregrine Falcon Recovery Team for approximately 15 years in the 1990s and 2000s, and later was a member on Ontario's Peregrine Falcon Recovery Team and helped co-author the Ontario Peregrine Falcon Recovery Strategy. He co-authored Ontario's status report on the Bald Eagle. Ted also worked extensively on both regional and provincial Woodland Caribou conservation initiatives, co-authoring the Ontario Woodland Caribou Recovery Strategy, and leading development of Ontario's Caribou Conservation Plan. As a consulting wildlife biologist, Ted continues to be involved in species at risk conservation, including having authored Ontario management plans for Beluga and Bald Eagle.

Allan Harris is a biologist with over 25 years' experience in northern Ontario. He has a B.Sc. in Wildlife Biology from the University of Guelph and an M.Sc. in Biology from Lakehead University. After spending seven years as a biologist with the Ontario Ministry of Natural Resources, he co-founded Northern Bioscience, an ecological consulting company based in Thunder Bay, Ontario. Al has authored or co-authored dozens of scientific papers, technical reports, and popular articles, including COSEWIC status reports for Riverine Clubtail, Laura's Clubtail, Rapids Clubtail, Gibson's Big Sand Tiger Beetle, Northern Barrens Tiger Beetle, Powesheik Skipperling, Mormon Metalmark, Weidemeyer's Admiral, Bogbean Buckmouth, Hop-tree Borer, Georgia Basin Bog Spider, Broad-banded Forestsnail, Nahanni Aster, Crooked-stem Aster, Bluehearts, Drooping Trillium and Small-flowered Lipocarpha. Al also authored the Ontario provincial status report for Woodland Caribou, and has authored or co-authored national and provincial recovery strategies for vascular plants and birds.

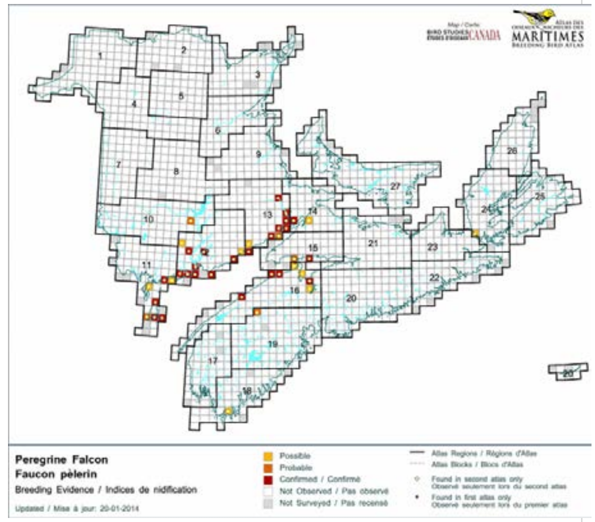
Appendix 1. Changes in the distribution of Peregrine Falcons over time in parts of Canada, based upon Breeding Bird Atlases (Armstrong 2007; Federation of Alberta Naturalists 2007; Bird Studies Canada 2016; Quebec Breeding Bird Atlas 2016), and other surveys (Carrière and Matthews 2013).

Alberta 1987-92	Alberta 2000-05
	

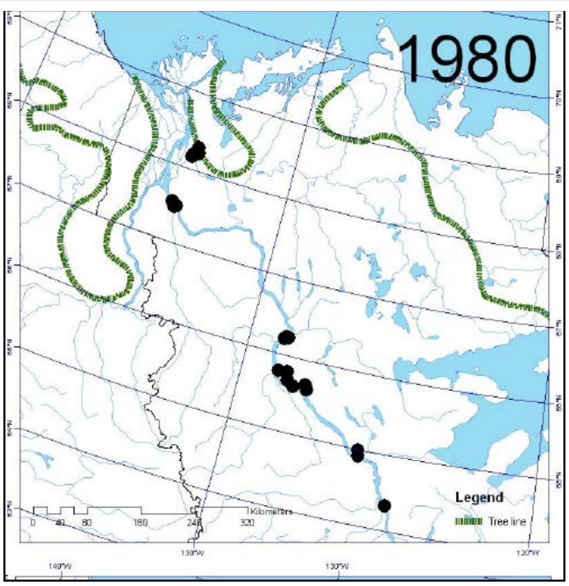
Maritime provinces, 1986-90



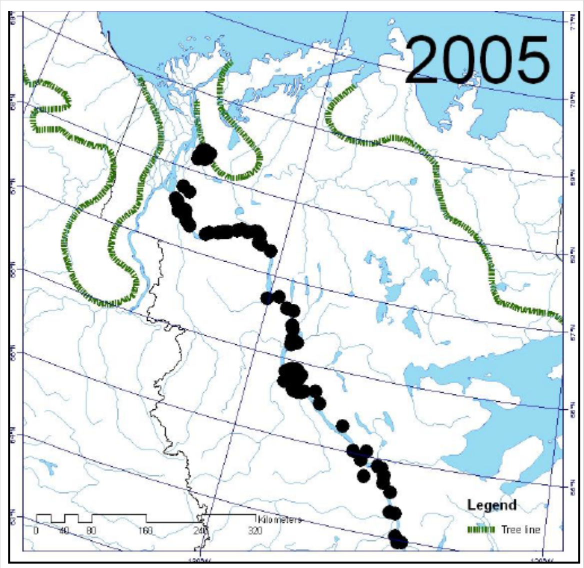
Maritime provinces, 2006-10



Mackenzie River, Northwest Territories, 1980 [67]

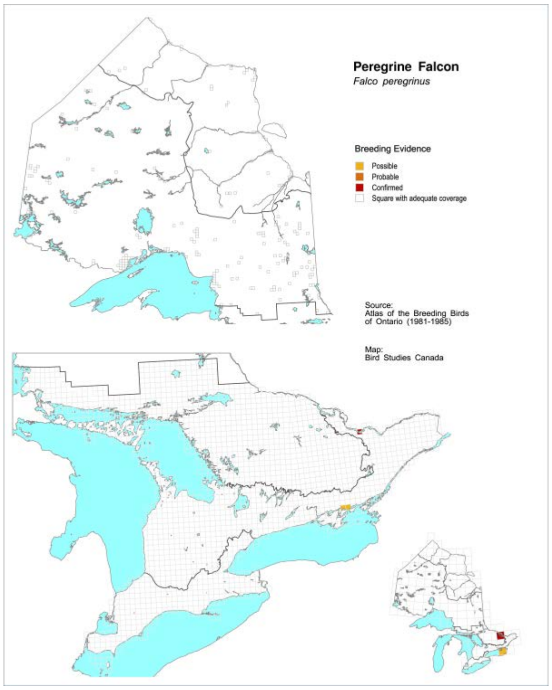


Mackenzie River, Northwest Territories, 2005

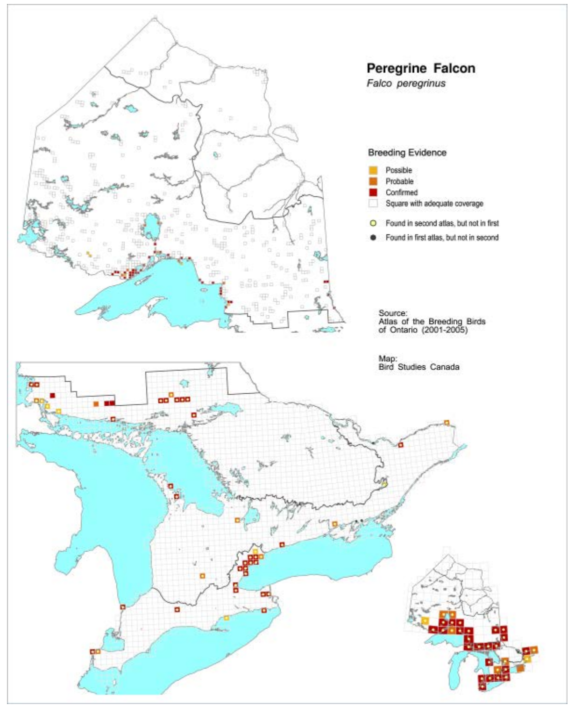


[67] Not a breeding bird atlas, but included for comparative purposes because used similar timeframes

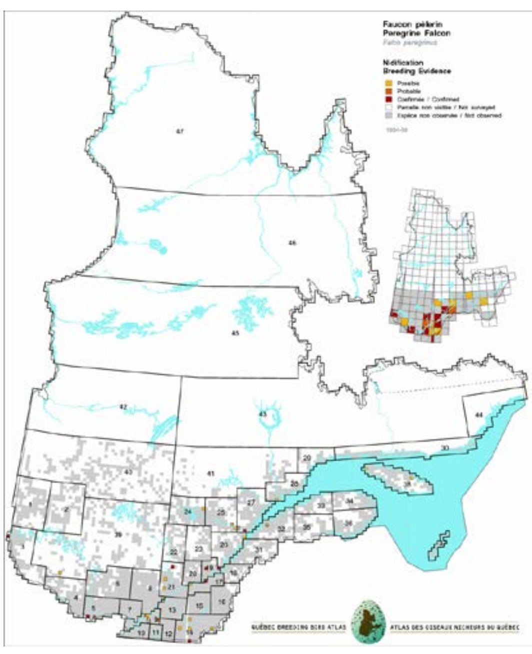
Ontario 1981-85



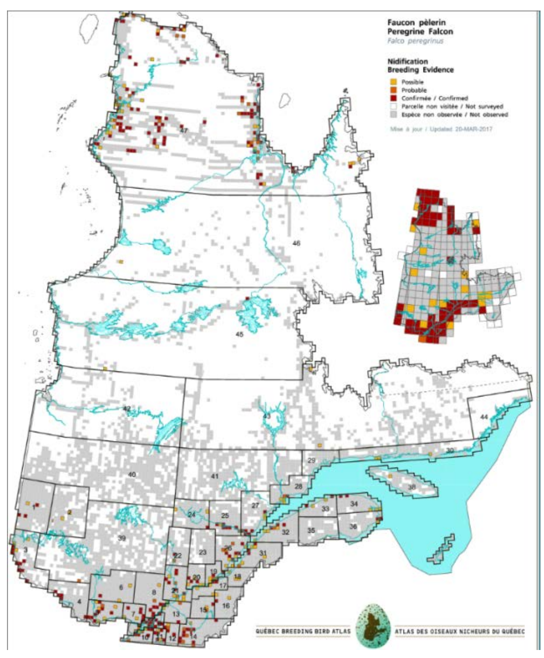
Ontario 2001-05



Québec 1984-89



Québec 2010-16



Appendix 2. Threats Calculator for Peregrine Falcon *pealei* subspecies.

Species or Ecosystem Scientific Name	*Falco peregrinus pealei*, Peregrine Falcon *pealei* subspecies			
Element ID			**Elcode**	
Date (Ctrl + ";" for today's date):	30/07/2015			
Assessor(s):	Original by Don Doyle, Myke Chutter, Dave Fraser Modified June 22 2016 by Dave Fraser and Louise Blight Reviewed and accepted by COSEWIC threats calculator call on March 9 2017: Marcel Gahbauer (Birds SSC co-chair), Ted (E.R.) Armstrong, Allan Harris and Robert Foster; Dave Fraser (facilitator and BC rep); Mary Sabine (NB); Jessica Humber and Shelley Garland (NL); Syd Cannings and Mieke Hagesteijn (CWS); Kaytlin Cooper (GRRB); Guy Morrison, Pam Sinclair, and Liana Zanette (Birds SSC); Alastair Franke (U of Alberta); Geoff Holroyd; David Bird (McGill U); Marie-Andree Carriere (CWS-Recovery); Eric Gross (CWS - Pacific); Tracy Maconachie (MB); Michelle Vala; Alexandre Anctil; Greg Mitchell, Joanna James (COSEWIC Secretariat)			
References:				

Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	1	0
	C	Medium	1	0
	D	Low	0	2
	Calculated Overall Threat Impact:		High	Low
	Assigned Overall Threat Impact:		**High to low**	
	Impact Adjustment Reasons:			
	Overall Threat Comments		Generation time estimated to be 4-6 years.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Likely limited to Gulf Islands.
1.2	Commercial & industrial areas		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	Moderate (Possibly in the short term, < 10 yrs/3 gen)	No known cases of *pealei* using bridges or buildings.
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						Possibly an indirect threat through impacts on prey base (see 7.3)
3	Energy production & mining		Negligible	Small (1-10%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3.1	Oil & gas drilling		Not Calculated (outside assessment timeframe)			Low (Possibly in the long term, >10 yrs/3 gen)	Currently a moratorium for oil and gas drilling off the coast of BC
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Gravel pit operations are a possible future impact
3.3	Renewable energy		Not Calculated (outside assessment timeframe)	Small (1-10%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs/3 gen)	Windfarms have been proposed in the marine environment, but none have been developed yet, and are unlikely to be started within the next ten years.
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Potential for some pairs exposed to low-level flight paths to be disturbed, but impact is likely negligible.
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Anticipated to be negligible, given current access to harvesting; the US permits a small harvest of passage birds which could include *pealei*. There have been reports of illegal shooting of Peregrine Falcons in Washington State.
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Disturbance from logging is a potential threat if it takes place during the breeding season. Effects on seabirds scored under 7.3.
5.4	Fishing & harvesting aquatic resources						Impacts on seabirds scored under 7.3.
6	Human intrusions & disturbance		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Climbers are a potential threat, but few *pealei* sites are accessed. Climbers are known on Mount Prevost and potentially others. Landowners can be advocates for the species on their lands.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Nest surveys done every 5 years, visiting almost all known sites. Timing is chosen to minimize disturbance, and the surveys are not thought to cause declines in the population.
7	Natural system modifications	CD	Medium - Low	Large - Small (1-70%)	Moderate - Slight (1-30%)	High (Continuing)	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	CD	Medium - Low	Large - Small (1-70%)	Moderate - Slight (1-30%)	High (Continuing)	Haida Gwaii and northern Vancouver Island birds are very dependent on seabird numbers for food; changes in this prey base could have a noticeable effect on a small to large portion of the population, depending on the extent and nature of modifications occurring.
8	Invasive & other problematic species & genes		Unknown	Restricted (11-30%)	Unknown		
8.1	Invasive non-native/alien species/diseases						
8.2	Problematic native species/diseases						
8.3	Introduced genetic material		Unknown	Restricted (11-30%)	Unknown	Unknown	There is potential for breeding with released falconry birds, especially in the Gulf Islands or San Juan area, but it is unclear whether this is ongoing or what the effects would be.
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution	BD	High - Low	Large - Small (1-70%)	Serious - Slight (1-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents	BD	High - Low	Large - Small (1-70%)	Serious - Slight (1-70%)	High (Continuing)	Almost all pulp mills on the coast have closed. Only one bird in the 20 Peregrine Falcons (both subspecies) sampled from Gulf Islands in 2003-2004 had elevated dioxin levels, but productivity was not impaired. As *pealei* consume seabirds almost exclusively, oil spill events could have direct long- and short-term impacts on birds via their consumption of or other contact with oiled seabird prey. The effects of oil spills on the seabird prey base are scored in 7.3.
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Almost all individuals are likely to be exposed to airborne pollutants, but it is unknown whether they are affected by them.
9.6	Excess energy						
10	Geological events		Negligible	Restricted - Small (1-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis		Negligible	Restricted - Small (1-30%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	The risk is likely limited to those at low elevations on the coast (<30 m).
10.3	Avalanches/landslides						
11	Climate change & severe weather						
11.1	Habitat shifting & alteration						Effects on the ocean environment that may cause changes to seabird colony populations are considered under 7.3
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).

Appendix 3. Threats Calculator for Peregrine Falcon *anatum/tundrius.*

Species or Ecosystem Scientific Name	*Falco peregrinus anatum/tundrius,* Peregrine Falcon *anatum/tundrius*		
Element ID	ELEMENT_GLOBAL.2.104097, ELEMENT_GLOBAL.2.105102	**Elcode**	ABNKD06074, ABNKD06071
Date (Ctrl + ";" for today's date):	09/03/2017		
Assessor(s):	Marcel Gahbauer (Birds SSC co-chair), Ted (E.R.) Armstrong, Allan Harris and Robert Foster ; Dave Fraser (facilitator and BC rep); Mary Sabine (NB); Jessica Humber and Shelley Garland (NL); Syd Cannings and Mieke Hagesteijn (CWS); Kaytlin Cooper (GRRB); Guy Morrison, Pam Sinclair, and Liana Zanette (Birds SSC); Alastair Franke (U of Alberta); Geoff Holroyd; David Bird (McGill U); Marie-Andree Carriere (CWS-Recovery); Eric Gross (CWS - Pacific); Tracy Maconachie (MB); Michelle Vala; Alexandre Anctil; Greg Mitchell, Joanna James (COSEWIC Secretariat)		
References:			
Overall Threat Impact Calculation Help:			

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	0	0
	Calculated Overall Threat Impact:		

Assigned Overall Threat Impact:	**U = Unknown**
Impact Adjustment Reasons:	
Overall Threat Comments	Generation time estimated to be 6 years. Although potential threats exist under multiple categories, they currently appear to all be negligible or with an unknown impact, consistent with the rapid growth of the population.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	
1.1	Housing & urban areas		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Hazards leading to mortality include collisions with high-rise buildings, particularly for inexperienced recently fledged birds. On the other hand, buildings and other structures in urban areas are providing nesting habitat for this species and the urban population is increasing, rather than declining, especially in eastern Canada. Mortality from collisions with buildings is not limiting the Canadian Peregrine Falcon population.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.2	Commercial & industrial areas		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Commercial and industrial buildings pose a collision similar threat to housing and urban areas. Peregrine Falcons are also known to nest on commercial and industrial buildings, including smokestacks.
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Agricultural intensification is most notable in the Prairie Provinces, which support less than 1% of the Canadian Peregrine Falcon population. Agricultural intensification could create more monoculture crops and, more importantly, is likely to cause a decrease in the number of wetlands, which are foraging sites for this species. Wetland loss is also a lesser concern in BC, ON and QC. Migratory Peregrine Falcons passing through these regions may also be affected, but to a lesser degree.
2.2	Wood & pulp plantations		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	While forestry operations near cliff sites may disturb nesting birds, they also create early successional forest that provides open-country foraging habitat; habitat quality may decline as the new forest matures
2.3	Livestock farming & ranching		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Potential positive impact through fostering of habitat for open-country birds
2.4	Marine & freshwater aquaculture						
3	Energy production & mining		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There is some risk of disturbance from oil and gas drilling, but the impact is low. Timing and setback guidelines are available to prevent disturbance to Peregrine Falcons (see Environment Canada 2009).
3.2	Mining & quarrying		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Mining and quarrying can disturb birds nesting in abandoned quarries and mine sites, but can also provide new nesting habitat.
3.3	Renewable energy		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Wind farms situated in high density nesting or migration habitat pose some level of mortality threat, although there is anecdotal evidence to suggest that Peregrine Falcons largely avoid wind farms. Relatively few nesting sites are near wind farms, and overall mortality levels are likely low.
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Occasional vehicle collisions, but infrequent. Recently fledged individuals from bridge nests are most at risk from vehicle collisions or drowning. Impact is more likely to dampen population growth than lead to a decline. Bridge nest sites typically have lower nest success rates than other anthropogenic sites.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Electrocution is a concern for some raptors, but less so for Peregrine Falcons (Savard and Rioux 2013), although electrocution was the second greatest source of known mortality (27%) among Pennsylvania's predominantly urban Peregrine Falcon population (Katzner *et al.* 2012). Collisions with transmission lines and towers can be a risk, particularly for inexperienced recently fledged birds. Overall though, few individuals are likely to encounter utility and service lines with any frequency, and most interactions are likely brief and insignificant.
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Persecution has declined greatly over time, with the most recent statistics showing that <1% of Peregrine Falcon band recoveries were through shooting (Canadian Wildlife Service 2017). A legal harvest of Peregrine Falcons has been reinstated, but only small numbers have been taken to date, far below thresholds that might affect the population (Franke *et al.* 2016a) Poaching of eggs or nestlings is not considered to be a significant current threat (Cooper 2007; CITES 2016a).
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Forestry activities could cause disturbance to nests, although some jurisdictions have timing and setback guidelines to prevent this.
5.4	Fishing & harvesting aquatic resources		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	There is potential for disturbance from recreational fishing near some cliff nests.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Nesting Peregrine Falcons can be disturbed by recreational activities near the nest site, particularly rock-climbing but also hiking, off-road vehicle use, recreational boating and birders intent on viewing a Peregrine Falcon nest site (Environment Canada 2015). Recreational rock climbing is a localized source of disturbance to some cliff-nesting pairs, although they can coexist well with climbers at larger cliffs (Ratcliffe 1993). In areas with lower or broken cliffs, human disturbance can negatively influence both nest establishment and nest success (Ratcliffe 1969). Recreational disturbance is typically limited to sites close to areas of human populations (Environment Canada 2015). Duck hunting can disturb some birds and lead to some incidental and intentional mortality in some parts of the Yukon, but vast areas have no people or recreation.
6.2	War, civil unrest & military exercises					
6.3	Work & other activities	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Some ongoing research, but of limited concern overall (Rosenfield *et al.* 2007). Some examples of paleontological disturbance in Yukon that led to the loss of nesting pairs, although the problem was more prevalent in the past (Mossop pers. comm. 2017). Urban nesting birds appear to be quite tolerant of roof and window maintenance activities. Birds nesting in remote areas are less tolerant of disturbance at the nest site than urban nesting birds.
7	Natural system modifications	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
7.1	Fire & fire suppression					
7.2	Dams & water management/use	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Hydroelectric developments in some regions may change habitat and suitability for Peregrine Falcons. While water level manipulation can lead to wetland drying, reservoirs can provide novel staging areas for waterfowl, potentially increasing prey availability for Peregrine Falcons. For example, the Peace/Athabasca subpopulation has grown dramatically since dam development.
7.3	Other ecosystem modifications	Unknown	Unknown	Unknown	High (Continuing)	The decline of shorebird populations in the Arctic is not thought to be a significant factor in Peregrine Falcon productivity, given the availability of many other suitable prey.
8	Invasive & other problematic species & genes	Unknown	Small (1-10%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	Negligible	Negligible (<1%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	West Nile Virus has been found in Peregrine Falcons, but they appear less vulnerable than other raptors.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species/diseases	Unknown	Small (1-10%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is evidence to suggest that climate change is allowing for the northward range expansion of ornithophilic black flies and botflies, which could pose a risk to Peregrine Falcons in Northern Canada, especially on Arctic islands. However more research is needed to determine whether the severity of this threat is increasing and whether it is having a population impact. At this point it still seems to be a rare occurrence. There may be increasing competition between Peregrine Falcons and Common Ravens in Labrador. Raven populations are also increasing in the Northwest Territories but there is no evidence of an effect.
8.3	Introduced genetic material	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Some introduced birds in USA were of a different subspecies than those native to Canada. Genetic composition of birds in southern Canada (Ontario & Quebec) has been somewhat influenced by these birds, however genetic composition is not considered a significant threat to the population.
8.4	Problematic species/diseases of unknown origin	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	The parasitic disease Trichomoniasis occurs in Rock Pigeons, a major prey species for urban Peregrine Falcons, and may affect some southern urban populations. However it is not considered a significant threat to the overall Canadian population.
8.5	Viral/prion-induced diseases					
8.6	Diseases of unknown cause					
9	Pollution	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.1	Domestic & urban waste water					
9.2	Industrial & military effluents	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	High concentrations of the fire retardant Polybrominated Diphenyl Ether (PBDEs) have been found in the eggs and blood plasma of Peregrine Falcons and have been shown to bioaccumulate, raising concerns for potential reproductive impacts. Chemical bird control agents such as 4-amino-pyridine (avitrol), strychnine and fenthion can pose hazards to non-target species, through both direct and secondary poisoning. Peregrine Falcons also continue to be exposed to heavy metals such as lead and mercury. The effects of these chemicals on the population are unknown.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural & forestry effluents	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Residual DDT contamination levels remain high enough to affect reproduction and re-establishment of Peregrine Falcons in specific regions of Canada. There is the potential for pressure to increase use of DDT, especially in response to Zika virus and other diseases in Central and South America, which may pose an increased risk to those birds migrating and wintering in the south.
9.4	Garbage & solid waste					
9.5	Air-borne pollutants					See 9.2
9.6	Excess energy					
10	Geological events					
10.1	Volcanoes					
10.2	Earthquakes/tsunamis					
10.3	Avalanches/landslides					
11	Climate change & severe weather	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
11.1	Habitat shifting & alteration	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Climate-mediated changes in lemming populations may influence avian prey abundance because Arctic Fox prey more upon bird eggs when lemmings decline, subsequently affecting the avian prey base. A more localized impact of climate change in Arctic Canada may be the collapsing of nest sites on soil cliffs with the melting of the underlying permafrost, although pairs appear to be able to respond by shifting to alternate nesting sites. There may be some positive effects to generally warming temperatures, including access to more snow-free nest sites, earlier initiation of breeding and earlier hatching in Arctic-nesting populations.
11.2	Droughts	Negligible	Negligible (<1%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs/3 gen)	Increased drying or drought conditions can reduce available wetland habitat, in turn reducing available shorebird populations for foraging Peregrine Falcons. However there is no evidence that Peregrine populations are decreasing as a result.
11.3	Temperature extremes	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	No evidence of population decline due to high temperatures, although monitoring should continue. Elsewhere in their range Peregrine Falcons successfully nest in areas with harsher high temperatures than those found in Canada.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding		Unknown	Unknown	Unknown	High (Continuing)	Increased heavy rain events and late snow events during the nesting season can significantly affect productivity, especially for exposed nests without overhang protection. Northern birds may be more negatively affected due to the colder temperatures. Late winter storms are known to influence productivity in Labrador. It is difficult to predict the impact of changing weather patterns brought on by climate change.
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).