

COSEWIC
Assessment and Status Report

on the

Band-tailed Pigeon
Patagioenas fasciata

in Canada



SPECIAL CONCERN
2021

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:

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COSEWIC Assessment Summary

Assessment Summary – April 2021

Common name

Band-tailed Pigeon

Scientific name

Patagioenas fasciata

Status

Special Concern

Reason for designation

This large, fruit-eating pigeon breeds in woodlands of western North and Central America, but in Canada nests only in southwestern British Columbia. Forest harvesting and encroaching urbanization have reduced the quality and extent of its breeding habitat. Most individuals overwinter in the western United States, where they are exposed to habitat loss and hunting and are threatened by an epizootic disease caused by the parasite *Trichomonas gallinae*. This pigeon's normal one-egg clutch limits its annual reproductive output. Aggregation at communal foraging areas, and at sites where minerals are ingested to offset dietary imbalances, increases its vulnerability to disturbance and disease. The Breeding Bird Survey has documented continuing long-term population declines in Canada, with an 11.5% decline over the last three generations. However, species-specific surveys at mineral sites suggest localized declines of about 40% over three generations, and this species may become Threatened if threats related to habitat loss throughout the year, and disease on US wintering grounds, cannot be managed effectively.

Occurrence

British Columbia

Status history

Designated Special Concern in November 2008. Status re-examined and confirmed in May 2021.



COSEWIC Executive Summary

Band-tailed Pigeon *Patagioenas fasciata*

Wildlife Species Description and Significance

Band-tailed Pigeon (*Patagioenas fasciata*) is a large pigeon with an average weight of 400 g and an average length of 37 cm. It is distinguished by a purple-grey head, and distinctive white crescent bordering a large bronze iridescent patch on the nape of the neck. The grey tail has a broad light grey tip, with a charcoal band across the middle. The bill is yellow with a black tip, and the feet and legs are yellow.

Band-tailed Pigeon occurs in Canada only in southwestern British Columbia, where it plays an ecological role as a seed consumer and disperser. It is also a legally hunted game bird in British Columbia, six US states, Mexico, and much of Latin America. Band-tailed Pigeon has special significance as the closest living relative of the extinct Passenger Pigeon (*Ectopistes migratorius*).

Distribution

Band-tailed Pigeon is distributed along the west coast and interior of southwestern British Columbia and the United States, and southward to northern Argentina. The Pacific Coast race, *P. f. monilis*, the only one of six subspecies that occurs in Canada, is also found also in Oregon, Washington, and California. Most Band-tailed Pigeons that breed in Canada migrate southward to overwinter in Oregon and California, although a small and variable number remain in British Columbia during the winter.

Habitat

In British Columbia, Band-tailed Pigeon breeds primarily in coniferous and mixed deciduous forests at low elevations (<1000 m), although it also occurs in coastal montane forests. Band-tailed Pigeon forages in the open, and in areas with trees and shrubs that produce flowers, berries, and nuts. Mineral sites that play an essential role in offsetting dietary imbalances are likely important in influencing its distribution.

Biology

Band-tailed Pigeon is long-lived with a generation time estimated at 4.4 years. It has relatively low reproductive potential, with clutches usually containing only one egg, although

2-3 clutches may be laid in years with high food availability. Band-tailed Pigeon is a monogamous solitary nester, and most begin breeding in the second year. It is frugivorous and granivorous, and has a tendency to forage exclusively on a single crop, leading to sodium imbalances that are compensated by mineral consumption. Nest sites are typically found within about 10 km of mineral sites.

Population Sizes and Trends

The Canadian population size is estimated to be 43,000-300,000 mature individuals, with the range reflecting uncertainty in the number of birds nesting in British Columbia and challenges in extrapolating estimates from Breeding Bird Survey (BBS) data.

BBS results show a significant long-term decline in the Canadian Band-tailed Pigeon population of -82.8% (95% CI: -93.7%, -61.8%) over 49 years, most of which occurred prior to 1990. The Canadian annual BBS trend estimate over the most recent 3-generation period (2006-2019) is -0.93%/year (95% CI: -5.06, 3.60), equivalent to a cumulative decline of -11.5% (95% CI: -49.1, 58.3). However, analysis of surveys of Band-tailed Pigeons using mineral sites in British Columbia suggests localized declines of up to -43.5% (95% CI: -69.4%, 10.9%) over three generations. A reduction of about 80% over three generations in the small numbers detected by the Christmas Bird Count in Canada may largely reflect a shift in wintering areas south into the United States, rather than a population decline.

Threats and Limiting Factors

Main threats include the epizootic disease caused by the parasite *Trichomonas gallinae* and the loss and degradation of breeding and foraging habitat by forest harvesting and urban development, together with the loss of critical mineral sites. *T. gallinae* is endemic in California and thought to be a particular threat to migrants wintering in the western United States, including those coming from British Columbia. Band-tailed Pigeon is particularly vulnerable to reductions in adult survival rate, due to its low annual productivity and relatively long generation time.

Overhunting in fall and on the US wintering grounds was previously considered to be an important threat to the Canadian population of Band-tailed Pigeon, but harvest rates declined appreciably in the 1990s, with the imposition of restrictive regulations in Canada and the United States.

Protection, Status and Ranks

Band-tailed Pigeon is classified as a migratory game bird in Canada under the *Migratory Birds Convention Act* (1994), and in the United States under the *Migratory Bird Treaty Act* (1918). It can be hunted in areas with open seasons subject to a daily bag limit, and is protected outside legal hunting seasons. It is listed as a species of Special Concern under the Canadian *Species at Risk Act* (2002), is included on the British Columbia Blue List, and is protected under the British Columbia *Wildlife Act*.

In the United States, Band-tailed Pigeon is listed as a species of concern in Oregon, but is not listed in Washington or California. The Partners in Flight 2016 Landbird Conservation Plan recognizes Band-tailed Pigeon as a “D” Yellow Watch List species.

TECHNICAL SUMMARY

Patagioenas fasciata

Band-tailed Pigeon

Pigeon à queue barrée

Range of occurrence in Canada: British Columbia

Demographic Information

Generation time (average age of parents in the population)	Approximately 4.4 years (Bird <i>et al.</i> 2020).
Is there a [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred continuing decline.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Estimated decline over last 2 generations (9-year trend) of 8.1% (95% CI: -37.3, 37.5) based on interpolation of Canadian BBS data from 2006-2019, and up to -32.7% (95% CI: -55.9, 7.4) extrapolated from the Mineral Site Survey.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Estimated 11.5% (95% CI: -49.1, 58.3) reduction over last 3 generations (13-year trend) based on Canadian BBS from 2006-2019, and up to 43.5% reduction (95% CI: -69.4%, 10.9%) extrapolated from the Mineral Site Survey.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown.
[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.	Unknown.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No. b. Partly. c. No.
Are there extreme fluctuations in number of mature individuals?	No.

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	235,845 km ² ; calculated using a minimum convex polygon around Canadian breeding range.
Index of area of occupancy (IAO)	Unknown, but likely far exceeds 2000 km ² .

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?	a. No. b. No.
Number of “locations”	Unknown, but likely far exceeds 10 locations.
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, observed decline, with disappearance from most sites in interior British Columbia over past two decades.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred decline, with disappearance from most sites in interior British Columbia over past two decades.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No; no defined subpopulations.
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Unknown.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed decline in extent and quality of habitat in the Georgia Depression ecoprovince.
Are there extreme fluctuations in number of subpopulations?	No; no defined subpopulations.
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 (no subpopulations)	N Mature Individuals
Total	43,000-300,000.

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown; analysis not conducted.
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* See Definitions and Abbreviations on [COSEWIC web site](#) and [IUCN](#) (Feb 2014) for more information on this term

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

Was a threats calculator completed for this species?

Yes, on 17 April 2019 (see Appendix 1 for participants).

The assigned overall threat impact is **High-Medium**, and the following contributing threats were identified, listed in decreasing order of impact:

- 8.1 Invasive non-native/alien species (disease) (High-Medium)
- 5.3 Logging and wood harvesting (Medium)
- 1.1 Housing and urban areas (Low)
- 5.1 Hunting and collecting terrestrial animals (Low)
- 6.1 Recreational activities (Unknown)
- 7.1 Fire and fire suppression (Unknown)
- 9.2 Industrial and military effluents (Unknown)
- 9.3 Agricultural and forestry effluents (Unknown)
- 11 Climate change and severe weather (Unknown)

Key limiting factors for Band-tailed Pigeon are related to its low annual reproductive potential, which is limited by the species' normal 1-egg clutch, with only 1-2 clutches usually produced per year. During the breeding season and fall migration, Band-tailed Pigeon distribution may be limited by access to mineral sites that provide sodium and other minerals missing from their specialized diet. Relatively few mineral sites are used in southwestern British Columbia, and pigeons often travel long distances to reach them.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	The most likely source of immigrants is Washington state, where breeding numbers have declined slightly over the long term (1970-2019) at -0.46% per year (95% CI: -1.96, 1.16), but increased recently (2006-2019) at 2.29% per year (95% CI: -1.42, 6.09).
Is immigration known or possible?	Yes, possible.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Unknown.
Are conditions deteriorating in Canada ^{†*} ?	Likely.
Are conditions for the source (i.e., outside) population deteriorating [*] ?	Unknown.
Is the Canadian population considered to be a sink [*] ?	Unknown.
Is rescue from outside populations likely?	Unlikely, as declining habitat quality and quantity may already be limiting breeding numbers in much of the Canadian breeding range.

* + See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect)

Data Sensitive Species

Is this a data sensitive species?	No, although Band-tailed Pigeon is susceptible to disturbance at the few known mineral sites, where increased public activity can be detrimental, as evidenced by past disturbance.
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Status History

COSEWIC Status History:

Designated Special Concern in November 2008. Status re-examined and confirmed in May 2021.

Status and Reasons for Designation

Status: Special Concern	Alpha-numeric codes: Not applicable
Reasons for designation: This large, fruit-eating pigeon breeds in woodlands of western North and Central America, but in Canada nests only in southwestern British Columbia. Forest harvesting and encroaching urbanization have reduced the quality and extent of its breeding habitat. Most individuals overwinter in the western United States, where they are exposed to habitat loss and hunting and are threatened by an epizootic disease caused by the parasite <i>Trichomonas gallinae</i> . This pigeon's normal one-egg clutch limits its annual reproductive output. Aggregation at communal foraging areas, and at sites where minerals are ingested to offset dietary imbalances, increases its vulnerability to disturbance and disease. The Breeding Bird Survey has documented continuing long-term population declines in Canada, with an 11.5% decline over the last three generations. However, species-specific surveys at mineral sites suggest localized declines of about 40% over three generations, and this species may become Threatened if threats related to habitat loss throughout the year, and disease on US wintering grounds, cannot be managed effectively.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Estimated 11.5% decline in number of mature individuals over the past three generations (13 years), based on the Breeding Bird Survey, does not meet thresholds.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO of 235,845 km ² and IAO of >2000 km ² are both higher than threshold levels.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population estimate of 43,000-300,000 mature individuals is higher than threshold levels.
Criterion D (Very Small or Restricted Population): Not applicable. Population estimate of 43,000-300,000 mature individuals is higher than thresholds, IAO exceeds 20 km ² , and number of locations likely far exceeds ten.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

Band-tailed Pigeon was first assessed by COSEWIC in 2008 (COSEWIC 2008), and designated as a species of Special Concern under the *Species at Risk Act* in 2010. Since the previous status report (COSEWIC 2008), the British Columbia Breeding Bird Atlas has provided updated information on the breeding distribution of Band-tailed Pigeon in Canada (Davidson 2015). The emergence of eBird, a citizen science checklist program, continues to improve our understanding of Band-tailed Pigeon distribution (eBird 2018). New analyses of updated data from the Breeding Bird Survey, Christmas Bird Count, and Mineral Site Survey reveal that the long-term decline of Canadian Band-tailed Pigeon numbers has continued. The primary threats to Canadian Band-tailed Pigeons remain uncertain, but new research has provided strong evidence that the epizootic disease caused by *Trichomonas gallinae* infection poses considerable threats to Band-tailed Pigeons, overtaking overharvest as the primary threat on the US wintering grounds (Stromberg *et al.* 2008; Rogers *et al.* 2016; Seamans 2018). A proposed Species at Risk Management Plan for Band-tailed Pigeon was developed in 2016 (Environment and Climate Change Canada 2016).



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 (2021)

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
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Canada

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

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Band-tailed Pigeon *Patagioenas fasciata*

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2021

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name:	<i>Patagioenas fasciata</i>
English name:	Band-tailed Pigeon
French name:	Pigeon à queue barrée
Aboriginal name:	Akoigh homin – Chinook (lower Columbia River, Washington)
Classification:	Class: Aves Order: Columbiformes Family: Columbidae

Classification follows the American Ornithological Society's 58th checklist (Chesser *et al.* 2017). Band-tailed Pigeon was first described in 1823 as *Columba fasciata* (Say), with the genus changed to *Patagioenas* in 2003 (Banks *et al.* 2003). The six subspecies of Band-tailed Pigeon are treated as two separate groups, the North American *fasciata* group (*Patagioenas fasciata monilis*, *P. f. fasciata*, and *P. f. vioscae*), and the Central and South American *albilinea* group (*P. f. crissalis*, *P. f. albilinea* and *P. f. roraimae*). Only the *P. f. monilis* Vigors 1839, also referred to as the 'Pacific Coast' subspecies, occurs in Canada. It is distinguished from other subspecies by its slightly larger size, and darker and more intense plumage colouration (Keppie and Braun 2000, Gibson and Kessel 1997). Band-tailed Pigeon is also referred to as the 'Blue Rock' due to a similarity in size to Rock Pigeon (*Columba livia*) (Keppie and Braun 2000).

Morphological Description

Band-tailed Pigeon (cover photo) is the largest native North American pigeon, with an average length of 33-40 cm (Keppie and Braun 2000). Adults have a purple-grey head and distinctive white collar with a patch of iridescent green-bronze on the nape of the neck. The dorsal wing surface is greyish with contrasting dark grey primaries. The proximal half of the tail is dark grey, with a dark band midway along the shaft, and lighter grey at the tip of the tail. Underparts are lighter grey with the colouration transitioning from purplish to rosy-buff to purplish-grey on the chest and head. There is a narrow, dark pink orbital ring. In the *fasciata* group, the bill is yellow with a black tip, and in the *albilinea* group, the bill is entirely yellow. The feet and legs are yellow (Keppie and Braun 2000). Females are about 7% smaller than males, and have slightly duller colouration (Keppie and Braun 2000). Juvenile plumage is more uniformly grey, lacking the rosy-buff chest, white collar, and iridescent nape patch (Sibley 2003).

Although the Pacific Coast subspecies, *P. f. monilis*, tends to have darker plumage, it is difficult to identify based on plumage alone (Braun 1994), but it is generally heavier (>400 g) than the Interior subspecies, *P. f. fasciata* (rarely >400 g), the other subspecies found in the United States (Braun 1994).

Population Spatial Structure and Variability

The six recognized subspecies show geographical variation in size, colouration, and migratory tendencies. To date, there have been no studies on the geographical population genetic structure of Band-tailed Pigeon, although it has been included in several phylogenetic analyses and whole genome sequencing projects, resulting in the availability of abundant sequence data. Using next-generation shotgun sequencing of the nuclear genome of four Band-tailed Pigeon samples, Murray *et al.* (2017) reported a ratio of the effective population size to census size (N_e/N_c) of 0.2, which falls within the average range for an avian species of between 0.05 - 0.8 (Frankham 2007).

Designatable Units

Only the Pacific Coast subspecies of Band-tailed Pigeon (*P. f. monilis*) occurs in Canada, where it is restricted to southwestern British Columbia. As there is no evidence of discrete genetic or morphological differences within this subspecies in Canada, Band-tailed Pigeon is treated here as one designatable unit, as in the previous status report (COSEWIC 2008).

Special Significance

Band-tailed Pigeon is legally hunted as a game bird across its range in British Columbia, United States, and Latin America. Past population declines and concerns of overharvesting have led to more restrictive harvest regulations in British Columbia and in the United States, and harvest in Canada is now negligible.

Band-tailed Pigeon has a special significance in being the closest living relative to the extinct Passenger Pigeon (*Ectopistes migratorius*). It has been used as a model to reconstruct Passenger Pigeon ecology and has been suggested to have a role in 'de-extinction' efforts for Passenger Pigeon (Oehler *et al.* 2018). A louse species, *Columbicola extinctus*, previously thought to have gone extinct with its host, the Passenger Pigeon, was rediscovered on Band-tailed Pigeon (Clayton and Price 1999).

Band-tailed Pigeon serves as prey for a variety of medium to large raptors, especially Peregrine Falcon (*Falco peregrinus*; Keppie and Braun 2000). Recent experimental studies suggest that Band-tailed Pigeon could play a role in seed dispersal dynamics of certain coniferous and deciduous tree species (Novak *et al.* 2018). Band-tailed Pigeon has been proposed as an important indicator of the condition of Californian Black Oak (*Quercus kelloggii*) in California and western Oregon, due to its strong association with those trees for roosting and foraging (Bottorff 2009).

No publicly available Aboriginal Traditional Knowledge was identified for this report. However, like all species, Band-tailed Pigeon is important to Indigenous peoples, who recognize the interrelationships of all species within the ecosystem.

DISTRIBUTION

Global Range

Band-tailed Pigeon has a distribution extending from western British Columbia to Argentina (Keppie and Braun 2000; Figure 1). Within North America, the Pacific Coast subspecies (*P. f. monilis*) breeds near the coast from southwestern British Columbia through Washington and Oregon to California. It reaches the northern limit of its range in extreme southern southeast Alaska (Kessel and Gibson 1978), where it is a rare to uncommon summer visitor and probable breeder (Heinl and Piston 2009). The Interior subspecies (*P. f. fasciata*) does not occur in Canada, but breeds across the southwestern US states of Colorado, Utah, Arizona, and New Mexico, south through Mexico to north-central Argentina.

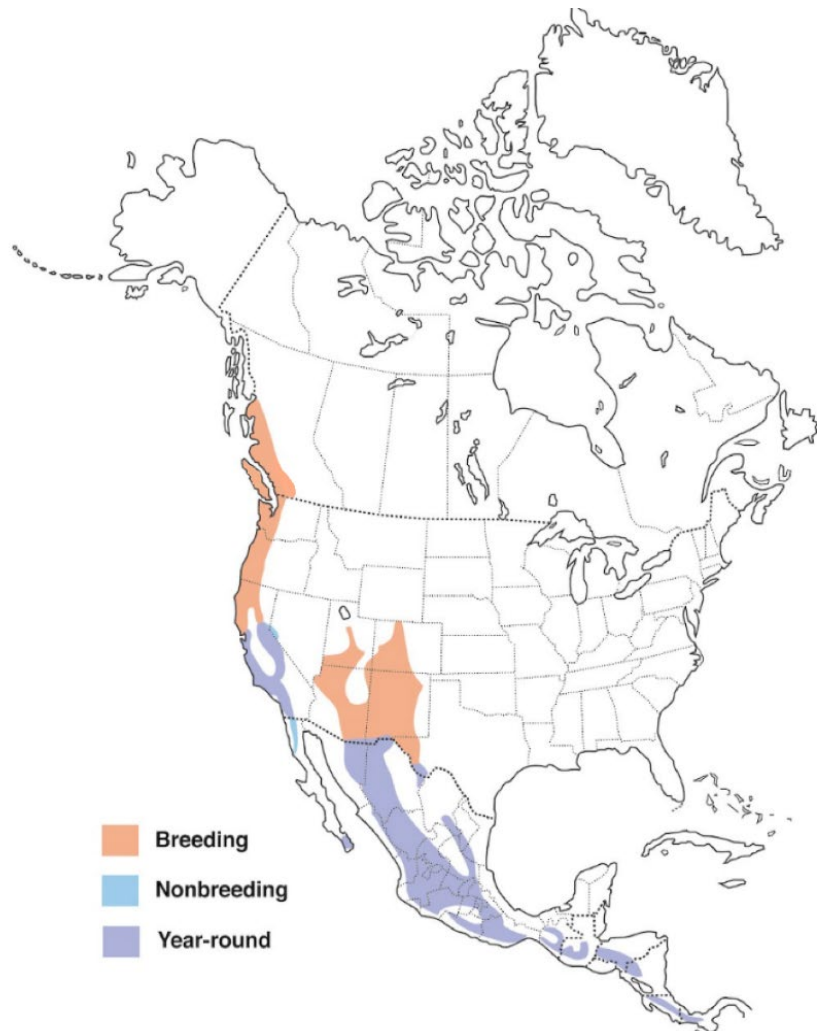


Figure 1. Breeding, nonbreeding, and year-round range of Band-tailed Pigeon in North America, based on the Birds of North America Band-tailed Pigeon species account (Keppie and Braun 2000, used with permission), and modified to reflect breeding evidence records from the Atlas of the Breeding Birds of British Columbia (Davidson 2015, see Figure 2). Note that some Band-tailed Pigeons also overwinter in parts of the breeding range, including extreme southwestern British Columbia.

Canadian Range

The breeding range of Band-tailed Pigeon in Canada is restricted to British Columbia (Godfrey 1986; Campbell *et al.* 1990), although incidental observations of the species have been reported in most Canadian provinces (eBird 2018). Within British Columbia, Band-tailed Pigeon is distributed along coastal lowland and upland areas. Breeding records and related breeding evidence indicate that the Georgia Depression, southern Coast, and Mountain ecoprovinces likely represent the core breeding area for Band-tailed Pigeon in Canada, although survey effort has been relatively low along the coast (Figure 2; Davidson 2015). It breeds in the Central and North Coast range, with low breeding densities observed in the southern and central interior (eBird 2018; Davidson 2015), and most breeding bird atlas records were in areas west of the Fraser River and western Cascade Mountains (Davidson 2015).

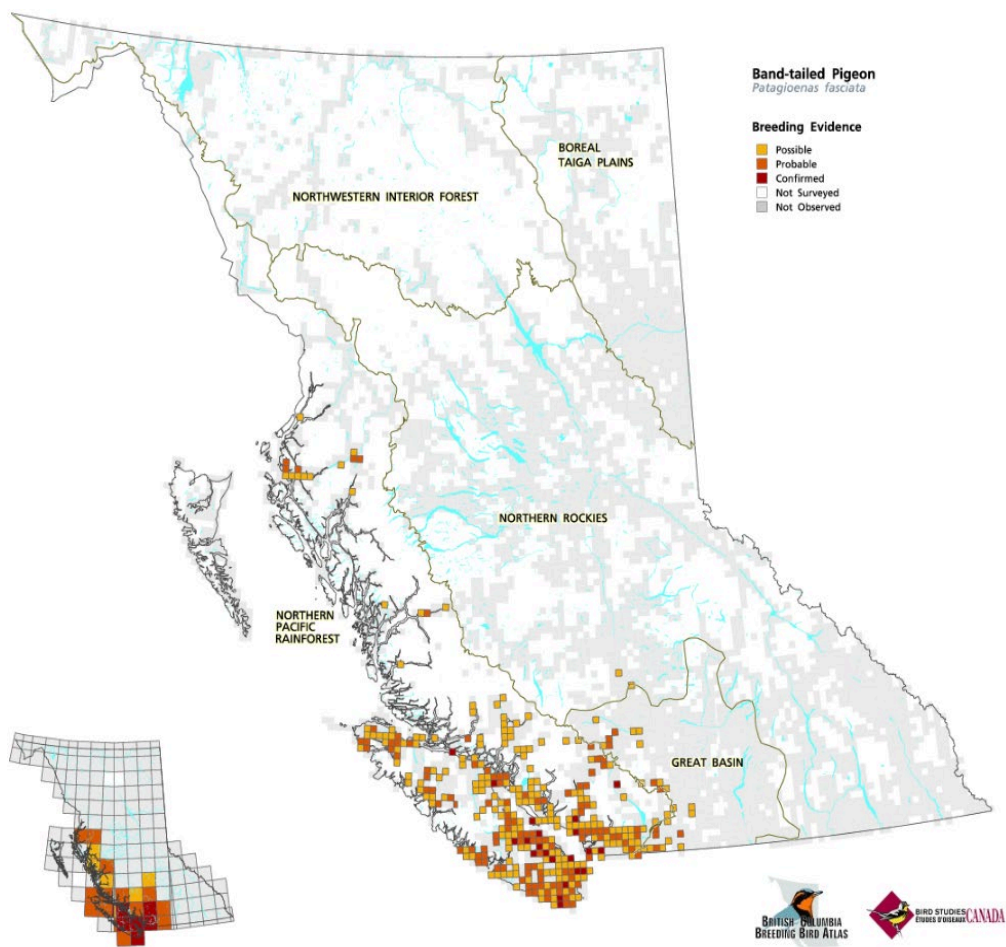


Figure 2. Band-tailed Pigeon breeding distribution in British Columbia during 2008-2012, from the Atlas of the Breeding Birds of British Columbia (Davidson 2015).

Most birds from the Canadian population of Band-tailed Pigeon overwinter along the Pacific Coast, especially in northern and central California (Campbell *et al.* 1990; Brewer *et al.* 2000). However, Band-tailed Pigeon is now considered to be a partial migrant, as some birds overwinter in the relatively mild southwestern corner of British Columbia (Keppie and Braun 2000; eBird 2018). Small numbers winter regularly in local areas of the Georgia Depression, mainly in rural areas near agriculture or where stands of Garry Oak (*Q. garryana*) and Arbutus (*Arbutus menziesii* = Pacific Madrone) occur (Campbell *et al.* 1990).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) in Canada is 235,845 km², based on a minimum convex polygon around Band-tailed Pigeon breeding records from the Atlas of the Breeding Birds of British Columbia, using the centroid of the grid square as the site of occurrence (Davidson 2015; Figure 3). The EOO reported in the previous COSEWIC (2008) report was 95,000 km², but cannot be compared directly with the current EOO estimate, due to differences in calculation method and search effort. Nonetheless, the species' EOO appears to be decreasing, at least over the longer term, and the eastward expansion into the interior reported by Campbell *et al.* (1990) seems to have stopped, although some northward expansion may still be occurring (Davidson 2015).

The index of area of occupancy (IAO) for Band-tailed Pigeon is unknown. Given the possible range of population estimates from 43,000-300,000 mature individuals, or 21,500-150,000 pairs (see **Abundance**), the IAO for Band-tailed Pigeon is likely to far exceed the threshold value of 2000 km² for Threatened status designation based on small range. The IAO of Band-tailed Pigeon appears to be decreasing in Canada, with the disappearance of nesting birds from most sites in interior British Columbia over the past two decades (Davidson 2015).

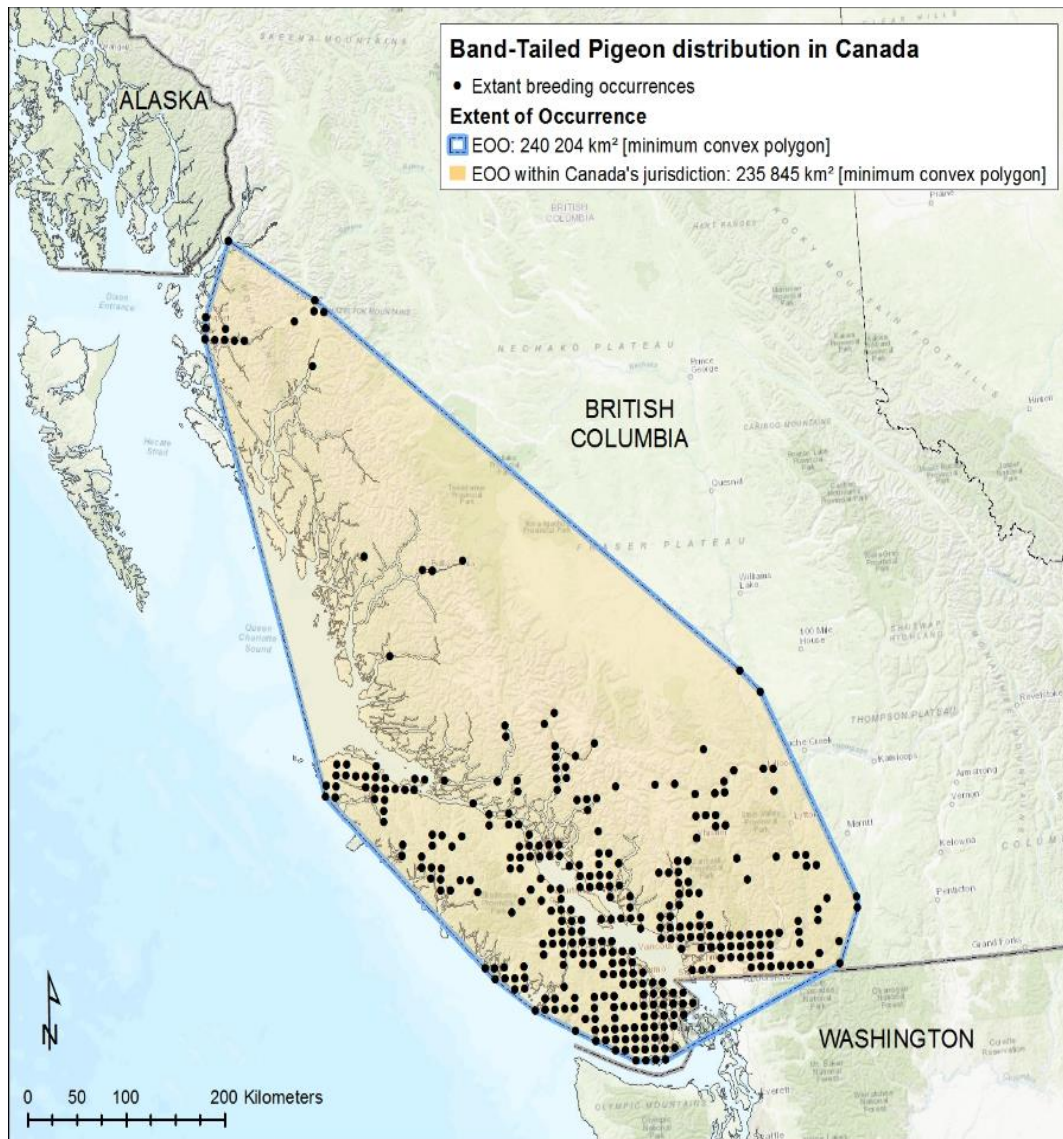


Figure 3. Extent of occurrence (EOO) for Band-tailed Pigeon in Canada, based on records of breeding evidence from the Atlas of the Breeding Birds of British Columbia (Davidson 2015; map prepared by R. Soares).

Search Effort

Information on the Canadian distribution of Band-tailed Pigeon was obtained primarily from the Breeding Bird Survey, British Columbia Breeding Bird Atlas, and e-Bird databases. However, the methods used in these surveys may underestimate the current range of Band-tailed Pigeon, because detectability of breeding birds is often low and much of the area inhabited by Band-tailed Pigeon is not well-covered by these surveys (Casazza *et al.* 2005; Figure 3).

HABITAT

Habitat Requirements

Breeding Habitat

Band-tailed Pigeon occurs in coniferous and mixed deciduous forests, often with an understorey of fruiting shrubs, including suburban and agricultural environments with adequate tree cover, where grains and exotic fruiting shrubs may supplement natural food sources (Davidson 2015). The breeding habitat of *P. f. monilis* occurs predominantly in temperate, coniferous rainforest from sea level to 1000 m elevation, although generally below 300 m (Leonard 1998; Keppie and Braun 2000; Davidson 2015). Various forest types and structural stages may be used, but stands of mature Douglas-fir (*Pseudotsuga menziesii*) are preferred (Carey *et al.* 1991; Manuwal 1991), and most nests are in Douglas-fir trees (Leonard 1998). Other common tree species in breeding habitat include Sitka Spruce (*Picea sitchensis*), Western Redcedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), Lodgepole Pine (*Pinus contorta*), Red Alder (*Alnus rubra*), Arbutus, and oak (*Quercus* spp.), including Garry Oak (Jeffery 1989; Braun 1994; Keppie and Braun 2000).

More specifically, in southern Washington, mature Douglas-fir stands (95-190 years old) were preferred to wet old-growth (250-700 years) or younger stands (55-80 years old) (Manuwal 1991). In southern Oregon, Band-tailed Pigeon was more abundant in mature (80-120 years old) and old-growth (200-525 years old) Douglas-fir forests, than in younger forests (40-72 years old) (Carey *et al.* 1991). In Oregon, nests were in closed-canopied, conifer forests (69%); sapling or pole-sized stands (55%); in stands with 150-500 trees/ha (71%); 16-32 cm diameter at breast height (DBH) (69%); and on mid-slopes (59%) (Leonard 1998). Within British Columbia, Band-tailed Pigeon is most frequently encountered in Coastal Western Hemlock and Coastal Douglas-fir biogeoclimatic zones (Davidson 2015). Band-tailed Pigeon also occurs in montane forests in interior British Columbia, although preferred nesting habitat there is poorly characterized (Campbell *et al.* 1990).

Winter Habitat

Band-tailed Pigeon from British Columbia winter mainly in pine-oak woodlands and coastal chaparral of Washington, Oregon, and northern and central California (Braun 1994; Brewer *et al.* 2000), where they favour open woods and edges. Very small numbers overwinter in Canada along the south coast of British Columbia, overlapping with the distribution of Arbutus and Garry Oak, which provide important winter food (Campbell *et al.* 1990; eBird 2018). Wintering birds also use backyard bird feeders in British Columbia, with over 1100 Project Feeder Watch records, and may occur in flocks containing as many as 39 individuals (Project FeederWatch 2018).

Migratory Habitat

Migratory habitat is thought to be similar to that used during the breeding season (Keppie and Braun 2000). During fall migration, Band-tailed Pigeon commonly occurs in open conifer areas adjacent to farmland, regenerating clear-cuts, shoreline areas where mineral sites occur, riparian areas, and suburban and residential areas, where they frequent bird feeders and feed on acorns, fruit, and berries (COSEWIC 2008). Areas with spilled grain and newly sown crops are also used (Campbell *et al.* 1990).

Mineral Site Use

Mineral sites represent important foraging habitats for *P. f. monilis* during the breeding season and fall migration (Jarvis and Passmore 1992; Keppie and Braun 2000). Mineral sites are localized areas with concentrated levels of minerals such as calcium, potassium, magnesium, sulfur, and particularly sodium. Mineral sites may be exposed dry deposits, mineralized springs, estuaries, ocean bays, salt wells, or pulp mill wastewater sites (Sanders and Jarvis 2000). In a Californian radio-transmitter study, 65% of nesting sites used by pigeons were located within 5 km of mineral sites, and 90% were within 9 km (Casazza and Overton 2006). Flocks visit mineral sites frequently during the breeding season, with the same sites being used over many years (Leonard 1998; Sanders and Jarvis 2000).

The importance of these sites was initially attributed to the birds' need for calcium supplementation, reflecting increased metabolic demands during egg development and crop milk provisioning to squabs (nestlings) (March and Sadleir 1972; Jarvis and Passmore 1992; Braun 1994). However, experimental studies have shown that Band-tailed Pigeon use these sites to supplement sodium deficiencies that arise from a narrow frugivorous diet (Sanders and Jarvis 2000; Sanders and Koch 2018). From June to September, some birds reportedly feed exclusively on Red Elderberry (*Sambucus racemosa*), Blue Elderberry (*S. cerulea*), and Cascara (*Rhamnus purshiana*) berries (March 1971; Jarvis and Passmore 1992), which although abundant, and nutrient- and energy-rich, are relatively low in sodium and high in potassium (Sanders and Jarvis 2000).

Breeding individuals in British Columbia and Oregon visit mineral sites as frequently as every 7-12 days (Passmore 1977; Leonard 1998; Sanders and Koch 2018). Pigeons may travel up to 27 km/trip to reach these sites, and typically use the mineral site closest to their nest (Leonard 1998). Maintaining connectivity of wooded areas between mineral sites and breeding areas is important (Breault pers. comm. 2019). The Interior subspecies *P. f. fasciata* does not use mineral sites to the same extent, possibly due to a broader diet or more frequent use of grit (Braun 1994).

Band-tailed Pigeon shows considerable site fidelity to mineral sites (Passmore 1977), with some sites in Oregon having a history of over 43 years of use (Jarvis and Passmore 1992; Sanders and Jarvis 2000). Newly developed sites may quickly become exploited, as a result of conspecific attraction to birds using the sites (Morse 1957). The attraction of particular mineral sites is thought to be related to the presence of perches, overhanging

vegetation, degree of anthropogenic disturbance and predator abundance (Sanders and Jarvis 2000; Breault pers. comm. 2019), proximity to nesting areas (Leonard 1998), specific mineral composition, and availability of adjacent deciduous forest cover (Overton *et al.* 2010).

Mineral sites may occur at low densities in some parts of the range; for example, in western Oregon there was only one known site in an area of about 3,800 km² (Overton 2003). In British Columbia, it is believed that mineral sites are generally not limiting (Breault pers. comm. 2019), and there are ten known mineral sites located in the areas of Cowichan, Ladysmith, Nanaimo, Comox, Port Moody, Squamish, Chilliwack, and Hatzic, although others likely exist (Breault pers. comm. 2018). Due to challenges in locating birds using inland mineral sites, these sites are likely more difficult to identify than those along estuaries.

Habitat Trends

Although the substantial conversion of low-elevation forests to agricultural, urban, and industrial environments in coastal British Columbia over the last several decades has likely removed considerable amounts of nesting habitat, there are limited data on how these changes in land-use practices have affected Band-tailed Pigeon (Keppie and Braun 2000). The Moist Maritime Coastal Douglas-fir Biogeoclimatic subzone (CDFmm/01; informally known as the Douglas-fir and Dull Oregon-grape (*Mahonia nervosa*) ecological community) has been severely impacted, with the small fragments remaining consisting largely of young stands (B.C. Conservation Data Centre 2018). Compared to the situation prior to European settlement, only 17.2% of the remaining Douglas-fir community is ranked as having good or excellent integrity (143.4 km² compared to the pre-European settlement area of 1323 km²), with only one patch exceeding 25 km² (B.C. Conservation Data Centre 2018). Private ownership of 80% of the land within this community impedes coordinated protection and restoration (B.C. Conservation Data Centre 2018). Almost half of this ecological community has been converted to industrial, agricultural, or urban land use, which is expected to continue. Invasive plant species, fire suppression, and overgrazing from deer are also ongoing threats to habitat (B.C. Conservation Data Centre 2018).

Band-tailed Pigeon can be conspicuous in British Columbia when aggregated at preferred feeding areas from spring through fall, or in relatively large flocks during the fall migration. Birds typically concentrate in agricultural fields (e.g., Fraser River valley, Saanich Peninsula, Sidney Island, Metchosin) or in clear-cuts with abundant deciduous fruit-bearing shrubs (e.g., Nimpkish Valley, Brem Bay; Campbell *et al.* 1990). Habitat loss along migratory routes and on wintering grounds has likely impacted Band-tailed Pigeon, but the paucity of information on specific routes and wintering areas used by birds from Canada precludes any conclusions and highlights the need for more research.

BIOLOGY

The biology of Band-tailed Pigeon is summarized in the Birds of North America account (Keppie and Braun 2000). Certain aspects have been well-studied, such as breeding ecology, demography, mineral site use, and emerging diseases.

Life Cycle and Reproduction

Survivorship

Band-tailed Pigeon is relatively long-lived, with records of individuals surviving over 20 years in the wild (Jarvis and Passmore 1992). Early studies based on band-recovery data for *P. f. monilis* reported annual survival estimates from across California, Oregon and Washington of 0.648 (Silovsky 1969) with a range of 0.57 (California; Smith 1968) to 0.709 (Oregon; Wight *et al.* 1967). Females and males did not differ in survival or band recovery rates (Kautz and Braun 1981; Seamans and Braun 2016). However, Seamans and Braun (2016) caution that demographic rates estimated from historical data may not reflect contemporary demographic rates, due to changes in the severity of threats to populations. More recently, annual survival of *P. f. monilis* in California tagged with electronic PTTs (Platform Transmitter Terminals) was estimated at 0.66 ± 0.092 (95% CI: 0.466–0.813 (Casazza *et al.* 2015)). Casazza *et al.* (2015) reported that weekly survival rates of Californian populations of Band-tailed Pigeon were lowest during the spring (0.989) and autumn (0.990) migratory periods, and highest during the breeding (0.994) and overwintering (0.993) period.

Generation Time

The generation time of Band-tailed Pigeon has previously been estimated at approximately 6 years (COSEWIC 2008), although calculations from survival estimates and age-of-first-breeding gave an estimated generation time of 5 years (Casazza *et al.* 2015; Seamans and Braun 2016). Bird *et al.* (2020) recently estimated generation time to be 4.4 years, modelled on the basis of an annual survival rate of 0.70, age at first breeding of 1.48 years, and maximum longevity of 22 years. The latter generation time estimate is used for trend estimation in this report, with a 3-generation period of 13.2 years.

Nesting Ecology

Band-tailed Pigeon is monogamous (Braun 1994), with pair formation occurring upon arrival on the breeding grounds, although some courtship behaviour has been reported on wintering grounds (Braun 1994) and during migration (Peeters 1962). It is assumed that Band-tailed Pigeon defends breeding territories, due to the relatively dispersed distribution of nests (Curtis and Braun 1983). The average home range size was 50 km² in California (Casazza *et al.* 2001) and 110 km² in Oregon (Leonard 1998). Some radio-tagged individuals in Oregon travelled over 50 km from their nesting area to feeding areas, with an average daily foraging distance of about 5 km (Leonard 1998).

The age of first successful breeding of Band-tailed Pigeon is typically two years, although some yearlings are capable of reproduction (March 1971; Gutierrez *et al.* 1975). Yearlings are much less likely to nest, with nesting attempts later in the season than older birds (Keppie and Braun 2000). The onset and duration of nesting is associated with food availability (March and Sadleir 1972; Gutierrez *et al.* 1975; Leonard 1998), although timing is often relatively consistent across years (Jarvis and Passmore 1992; Leonard 1998). In British Columbia, nesting may start as early as March, but field studies report that about half of the nests are initiated in May, and nestlings may be found as late as 7 September (Campbell *et al.* 1990). Nests are constructed primarily by the female, and are loosely arranged, flat to saucer-shaped twig platforms, typically located near the base of a horizontal branch about 3-15 m from the ground (Campbell *et al.* 1990; Braun 1994; Leonard 1998). New nests are constructed each year, although individual trees may be re-used (Braun 1994; Leonard 1998).

Approximately 89-95% of clutches consist of a single egg, with the remainder containing two eggs (Campbell *et al.* 1990; Keppie and Braun 2000), although 2-3 broods per season are possible when food is abundant (Baicich and Harrison 1997; Keppie and Braun 2000). In western Oregon, radio-tagged birds initiated an average of 1.69 nests per year, and only birds at least two years old raised more than one brood (Leonard 1998). The distance between successive nests of radio-tagged individuals was an average of 657 m (Leonard 1998). Similar data are not available for Canada.

Both sexes incubate, with an incubation period of 16-22 days (Baicich and Harrison 1997; Keppie and Braun 2000). During the breeding season, glands in the lining of the crop in Columbiformes produce a milky secretion that contains proteins, anti-oxidants, and essential fatty acids (Keppie and Braun 2000). Both adults feed this crop milk to the young squabs over the 22-30 day nestling period (Beams and Meyer 1931; Baicich and Harrison 1997; Keppie and Braun 2000). Males may continue to provision fledged young, enabling females to re-nest and thus allowing for multiple broods (Braun 1994).

Limited data are available on nest success, due in part to the difficulty in finding and monitoring nests. In western Oregon, nest survival was estimated at 0.689 (SE: 0.004), with annual reproductive success estimated to be 1.26 young per pair (Leonard 1998). After-second-year birds have about 70% higher productivity than second-year birds (Jarvis and Passmore 1992).

Potential for Hybridization

Hybrids have been produced from matings between Band-tailed and Rock Pigeons in captivity (Miller 1956), but no hybrids have been reported in the wild (McCarthy 2006).

Population Age Structure

The most recent analysis of US harvest data (1994-2012) indicates that the proportion of juveniles in the harvested population ranged from 13.2-33.5% and 8.3-50.5% in the Pacific Coast and Interior populations, respectively (Sanders and Braun 2014). No data are available on age structure of the Canadian population.

Physiology and Adaptability

Band-tailed Pigeon is frugivorous and granivorous, consuming berries, grain seeds, acorns, pine nuts, inflorescences, and fresh buds of a range of tree and shrub species (Neff 1947; March 1971; Jarvis and Passmore 1992; Keppie and Braun 2000). It forages on the ground, in open areas such as agricultural lands, and in trees in sparse to closed-canopied stands in fruit and nut-bearing areas (e.g., natural forests, orchards, and semi-urban areas; Keppie and Braun 2000).

Band-tailed Pigeon appears to prefer natural food sources, but opportunistically forages on scattered unsprouted agricultural grains, grain spillage areas in rail yards, and cultivated crops, particularly during non-breeding periods (Braun 1994). Once breeding commences and wild berries are available, Band-tailed Pigeon diet becomes predominantly frugivorous, including fruit of *Rubus* spp., *Prunus* spp., Cascara, Arbutus, and elderberries (*Sambucus* spp.; March and Sadleir 1972; Keppie and Braun 2000). Locally, Band-tailed Pigeons often consume a single food source until it is depleted, and then move on to feed on a new food type or in a new area (Neff 1947; Braun 1994; Keppie and Braun 2000).

Dispersal and Migration

Most Band-tailed Pigeons that breed in Canada are migratory. They typically return to Canadian breeding grounds from March to May, and depart for wintering grounds from late August to October (Keppie and Braun 2000). Most birds from British Columbia are thought to overwinter in the Pacific coastal region of the United States, especially in northern and central California (Campbell *et al.* 1990; Brewer *et al.* 2000). Low and variable numbers overwinter in southwestern British Columbia (Campbell *et al.* 1990; Braun 1994; Brewer *et al.* 2000; eBird 2018).

Precise migration routes and stopover sites are unknown. In fall, flocks of up to 50 pigeons have been observed migrating over coastal subalpine areas of Vancouver Island (Martin and Ogle 1998). Vancouver Island pigeons seem to concentrate southward in September near Victoria before crossing the Strait of Juan de Fuca. Daily counts at Rocky Point Bird Observatory, just west of Victoria, show peak southbound movements in September (Bartels 2017). Fall migrant flocks of 20-200 birds have been seen daily at this site in September (COSEWIC 2008), although they have historically sometimes been much larger (e.g., at least 1200 birds on 10 September 1960; eBird 2018).

From 1955 to 2016, there were 58 records of individual Band-tailed Pigeon banded in winter or spring in California (n=19), Oregon (n=22), and Washington (n=17), and subsequently recovered in British Columbia (Laurin pers. comm. 2018). Banding records also provide evidence of some pigeons moving northward into British Columbia after breeding in California (Brewer *et al.* 2000). There is some evidence of limited dispersal of the Interior Band-tailed Pigeon *P. f. fasciata* into the breeding range of *P. f. monilis* (Schroeder and Braun 1993).

Breeding site fidelity was about 0.858 (95% CI: 0.791-0.906) in Colorado Band-tailed Pigeons, with some inter-annual variation (Seamans and Braun 2016). In Colorado, 87.6% of birds that were recaptured in successive breeding seasons were within 50 km of initial banding sites (Schroeder and Braun 1993). Strong fidelity to breeding and natal areas was also found in Oregon (Jarvis and Passmore 1992; Leonard 1998). No studies have examined breeding site fidelity or home range size in Canada.

Interspecific Interactions

Raptors are considered to be the primary predators of Band-tailed Pigeon. Adult birds are taken by Sharp-shinned Hawk (*Accipiter striatus*), Cooper's Hawk (*A. cooperii*), Northern Goshawk (*A. gentilis*), Peregrine Falcon, Prairie Falcon (*Falco mexicanus*), and Great Horned Owl (*Bubo virginianus*; Keppie and Braun 2000). Common Raven (*Corvus corax*), Steller's Jay (*Cyanocitta stelleri*), and tree squirrels (*Sciurus* and *Tamiasciurus* spp.) are likely the main predators of eggs and nestlings, although Cooper's Hawk and Great-Horned Owl have also been reported to depredate nests during the nestling stage (Peeters 1962).

Parasites that have been recovered from Band-tailed Pigeon, but with unknown health significance, include a nasal mite (*Tinaminyssus juxtamelloi*; Pence and Canaris 1976), cestodes (*Hymenolepsis armata*, *Railletina* sp.), nematodes (*Ascaridia columbae*, *Splendidofilaria columbensis*, *S. hiebleri*, and *Chandlerella robinsoni*; Olsen and Braun 1980), and haemoparasites *Leucocytozoon marchouxi* (Stabler *et al.* 1977).

A parasitic disease of significant consequence to Band-tailed Pigeon is caused by *Trichomonas gallinae*, a single-celled flagellated protozoan parasite (Cole 1999; Forrester and Foster 2009). One of its primary hosts is Rock Dove (Stabler 1954), which may develop the disease, but often serves as an asymptomatic carrier, acting as a reservoir for the disease (Stabler 1954; Bon Durant and Honigberg 1994). *T. gallinae* is thought to have arrived in North America from Europe with the introduction of infected Rock Doves in the 17th century (Stabler 1954). Although trichomonosis is most commonly associated with doves and pigeons, it may affect other avian species, including raptors and songbirds. There are multiple strains of *T. gallinae*, which vary in their pathogenicity among individuals, populations, and species.

T. gallinae generally infects the upper digestive tract, causing large proliferative caseous (cheese-like) lesions that block food passage, leading to starvation (Kocan and Herman 1970). Depending on the strain and host species, *T. gallinae* may also invade other sites such as the respiratory tract or liver, leading to organ failure (Kocan 1969; Kocan and Herman 1971). Death may occur within 4-14 days after infection, depending on the strain (Forrester and Foster 2009). Alternatively, some infected Band-tailed Pigeon individuals may show no clinical signs, apart from very minimal damage in the oral cavity (Stabler 1951).

Infection occurs when susceptible birds ingest even a single organism in contaminated food, crop milk, or water (Stabler and Kihara 1954). Flocking species such as Band-tailed Pigeon that congregate at communal water or seed sources have a high risk of infection (Forrester and Foster 2009). Research on the environmental persistence of *T. gallinae* has shown that strains may be viable for up to 48 hours in organic debris or water (Gerhold *et al.* 2013; McBurney *et al.* 2017). Immunity to virulent strains has been demonstrated in Rock Pigeon (Stabler 1948) and Mourning Dove (*Zenaida macroura*) that originate from areas where epidemics of *T. gallinae* have occurred (Kocan and Amend 1972).

Epidemics of *T. gallinae* in Band-tailed Pigeon tend to occur in winter, and in years that are warmer or drier than average, and are often associated with large crops of acorns (Rogers *et al.* 2016). Water bodies may be smaller and more stagnant in years with low precipitation, which in turn increases the environmental persistence of *T. gallinae* (Gerhold *et al.* 2013). In warmer, drier years, Coast Live Oak (*Q. agrifolia*) retains acorns longer (Koenig *et al.* 2014), which may further concentrate pigeons at particular foraging sites in Oregon and California, and increase infection rates (Rogers *et al.* 2016). Band-tailed Pigeon may be particularly susceptible to disease outbreaks due to its gregarious behaviour when flocking at mineral sites, and during migration and overwintering (Stabler and Braun 1979; Rogers *et al.* 2016).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The Breeding Bird Survey

The Breeding Bird Survey (BBS) is a North America-wide citizen science program that monitors population trends for birds in North America (Hudson *et al.* 2017; Sauer *et al.* 2017). Skilled volunteers are assigned to a roadside route 39.2 km long, composed of fifty 3-minute point counts located at 0.8-km intervals. All birds heard or seen within 400 m are recorded at each stop (Hudson *et al.* 2017). In Canada, Band-tailed Pigeon is regularly recorded on 42 BBS routes in southwestern British Columbia, with a long-term (1970-2019) trend precision of 'medium' (able to detect an annual change of <3%/year). Canadian survey coverage for the full BBS time series meets reliability standards of the United States Geological Survey (USGS) for coverage (>14 BBS surveys per region), moderate precision

(able to detect an annual change of <3%/year), and moderate abundance (>1 bird per route year on average; Sauer *et al.* 2017).

The Christmas Bird Count

The Christmas Bird Count (CBC) is an annual survey of winter bird populations in North America (Sauer *et al.* 1996) that takes place between 14 December and 5 January, in which volunteers record all birds seen or heard within a 24-km diameter count circle (Sauer *et al.* 1996). Although summaries of count data are available from 1900 to 2017, most trend analyses cover the period 1967-2017. Trends are corrected for search effort using a hierarchical approach that estimates an effort function relating the expected number of individuals observed to the number of survey hours (Link and Sauer 2007). As most Canadian Band-tailed Pigeons over-winter in the United States, relatively few are recorded by the CBC in Canada. On average, Band-tailed Pigeon was recorded on eight CBC circles/year in British Columbia between 1967 and 2017 (range: 2-14) with an average total of 173 individuals detected/year (range: 2-637). CBC survey coverage of Band-tailed Pigeon is greater in the US, with an average of 64 circles recording the species annually (range: 21-120) and an average of 10,095 individuals detected/year (range: 1,941-45,425).

British Columbia Breeding Bird Atlas

Canada's National Breeding Bird Atlas Program is a large-scale citizen science project that documents the distribution and relative abundance of breeding birds at provincial or regional scales. Surveys are volunteer-based, with skilled birders recording evidence of breeding (possible, probable, or confirmed) for all bird species within each atlas square sampling unit of 100 km². Each atlas is composed of a contiguous grid of atlas squares. Atlas participants strive for a minimum of 20 survey hours per square, but because the number of survey hours varies across the grid, presence/absence data are more robust than abundance data. The British Columbia Breeding Bird Atlas (BCBBA) is based on five years of surveys from 2008-2012 (Davidson *et al.* 2015). The methods used in this atlas may not be particularly well-suited to detecting Band-tailed Pigeon, due to observer bias and possible detection bias among habitats (Keppie *et al.* 1971). In addition, BCBBA coverage of the southern central coast of British Columbia was relatively sparse (Davidson 2015).

Mineral Site Survey

Surveys of the number of pigeons using mineral sites can be used to estimate recent short-term population trends for Band-tailed Pigeon (Seamans 2018). The Mineral Site Survey (MSS) protocol was initiated in 2001 on a trial basis and was fully implemented in 2004. Mineral site use varies with season and weather, necessitating the use of a standardized protocol that accounts for these factors (Overton *et al.* 2005, 2010; Sanders and Koch 2017). The standardized protocol MSS uses fixed-point counts at 52 mineral sites across California (n=12), Washington (n=14), Oregon (n=21), and British Columbia (n=5) (Seamans 2018). This species-specific survey should prove more useful in future years, when more sites have been surveyed over longer periods, but its use is currently somewhat limited by its inability to effectively account for site abandonment.

Trends from Migratory Game Bird Harvest Data

As Band-tailed Pigeon is a hunted species, harvest statistics can be used to estimate long-term trends in abundance, provided that changes in hunting effort are adequately accounted for (Seamans and Braun 2016). Most demographic information and population abundance indices for Band-tailed Pigeon were derived from harvest data collected during the 1960s, with the only detailed British Columbia demographic data coming from the early 1960s (March 1971). In Colorado, band recovery rates ranged from about 1.1% for after-hatch-year birds to 1.5% for hatch-year, with marked inter-annual variation (Kautz and Braun 1981; Seamans and Braun 2016). Decreasing harvest rates have led to a continuing reduction in recovery rates, which impeded the use of harvest statistics to infer demographic trends (Seamans and Braun 2016). As a consequence, Band-tailed Pigeon population abundance and trends are best estimated from the larger data sets with broader geographic coverage.

Summary

Although the results of all surveys are considered here, the BBS is preferred for assessing trends in the Canadian Band-tailed Pigeon population. BBS data can be used to calculate trend estimates for the Canadian population alone, while the CBC only provides reliable trend estimates for the North American population, as few individuals remain in Canada year-round. The BBS also has a greater geographic coverage in British Columbia than the MSS, which presently only surveys five sites, in comparison to the 42 BBS routes used to estimate the Canadian trend. Within British Columbia, the abandonment of mineral sites may be a source of bias, particularly if birds move to other un-surveyed sites (Breault pers. comm. 2019).

Abundance

The global Band-tailed Pigeon population was recently estimated to be 6.1 million mature individuals, with a North American (Canada and United States) population of about 1,500,000 mature individuals (95% CI: 1,000,000-2,000,000), and a Canadian population of about 300,000 mature individuals (95% CI: 130,000-580,000; Partners in Flight 2019). These estimates are markedly higher than the 2013 estimates from Partners in Flight (2017) (global estimate: 2.0 million mature individuals; North American estimate: 940,000 mature individuals; Canadian estimate: 160,000 mature individuals). Abundance was estimated as a product of the BBS density data and the area of the range in 2013 (Partners in Flight 2017), and as a product of the BBS density data and occupied area as indicated by eBird records in 2019 (Partners in Flight 2019). The most recent PIFSC estimate for Canada is higher than that provided by R.J. Cannings (pers. comm. in COSEWIC 2008; 43,000-170,000 mature individuals) and the range in COSEWIC (2008; 20,000-170,000 mature individuals), despite indications of a continuing decline in British Columbia (see **Fluctuations and Trends** below).

Seamans (2018) noted that caution should be used in interpreting abundance estimates of Band-tailed Pigeon from BBS results, as sample sizes (number of routes) and pigeon counts per route are often low, variances may be high, and coverage of appropriate habitat by BBS routes may be poor. The 2019 abundance estimates are not used directly here, as expert opinion is more in line with the lower 2013 Canadian abundance estimate (e.g., Breault pers. comm. 2019), and it is unlikely that the declining Canadian population could represent 20% of the North American population. Instead, a broad range of 43,000-300,000 mature individuals is used here, precluding a comparison with previous abundance estimates.

Fluctuations and Trends

Historical Trends

Band-tailed Pigeon numbers have been declining in many parts of the North American range since the BBS started in the 1960s (Keppie and Braun 2000). There were three major periods of apparent large declines in North American populations during the 20th century: the early 1900s, mid-1900s, and the 1970s (Campbell *et al.* 1990). Although quantitative data are lacking, there are many written accounts of concerns expressed by US biologists. The causes of widespread population declines are uncertain (Braun 1994), although overharvesting by hunters in the early and mid-1900s seems to have had profound effects on numbers of Band-tailed Pigeon. This species was heavily harvested before 1916-1918, especially in years when population numbers were higher as a result of large acorn crops. Overharvesting led to observable declines in California in 1912 (Chambers 1912, 1916; Grinnell 1913), triggering the closure of hunting seasons from about 1913 to 1931. In the late 1940s (Pearse 1940; Neff 1947; McMillan 1949; Morse 1950; Einarsen 1953), and in the 1970s (Mathewson 2005), locally abundant pigeons were again subject to excessively heavy harvests. The peak harvest in the United States occurred in 1972, when about 724,000 individuals, or approximately half of the estimated population of *P. f. monilis*, were killed in Washington, Oregon, and California (Jarvis and Passmore 1992). This noticeably reduced its abundance thereafter in many parts of its range (Mathewson 2005).

Trends from the Breeding Bird Survey

BBS data analyzed using a hierarchical generalized additive model show a statistically significant long-term annual rate of decline between 1970 and 2019 of -3.53% per year (95% CI: -5.26, -1.70) for Band-tailed Pigeon in Canada, equivalent to a cumulative decline over that 49-year period of -82.8% (95% CI: -92.9, -56.9); most of the decline occurred prior to 1990 (Figure 4). The Canadian BBS trend estimate for the most recent 13-year period (2006-2019) is -0.93% per year (95% CI: -5.06, 3.60), or -11.5% (95% CI: -49.1, 58.3) over three generations (A. Smith unpubl. data). The decline in British Columbia over the past three generations contrasts with an increasing trend in Washington, Oregon, and northern California (Figure 5). The rolling 13-year trends from 1983 to 2019 based on BBS data show that the rate of decline in Canada was greatest in the early to mid-1990s, peaked with slight increases from 2009 to 2014, and more recently has since decreased again slightly (Figure 6).

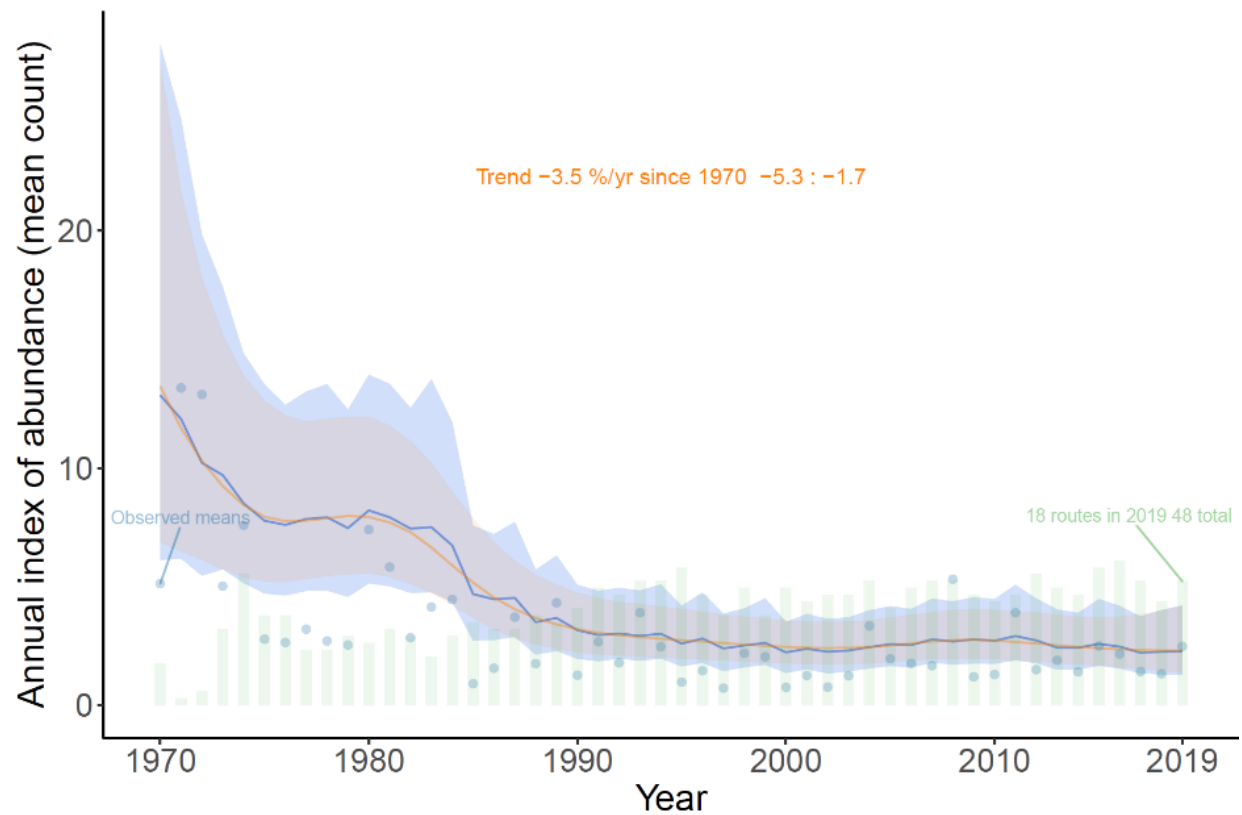


Figure 4. Annual index of population abundance for Band-tailed Pigeon in Canada, based on Breeding Bird Survey data from 1970 to 2019 ($n=48$ routes), with observed means shown with blue dots. The GAM (generalized additive model) trend in orange represents the best curvilinear fit of data, whereas the slope trend in blue incorporates effects of annual variation. Orange (appearing gray in areas of overlap) and blue shading, respectively, show 95% credible intervals for the GAM and slope trends. Green bars indicate the number of survey routes on which Band-tailed Pigeon was detected each year in Canada (A. Smith unpubl. data).

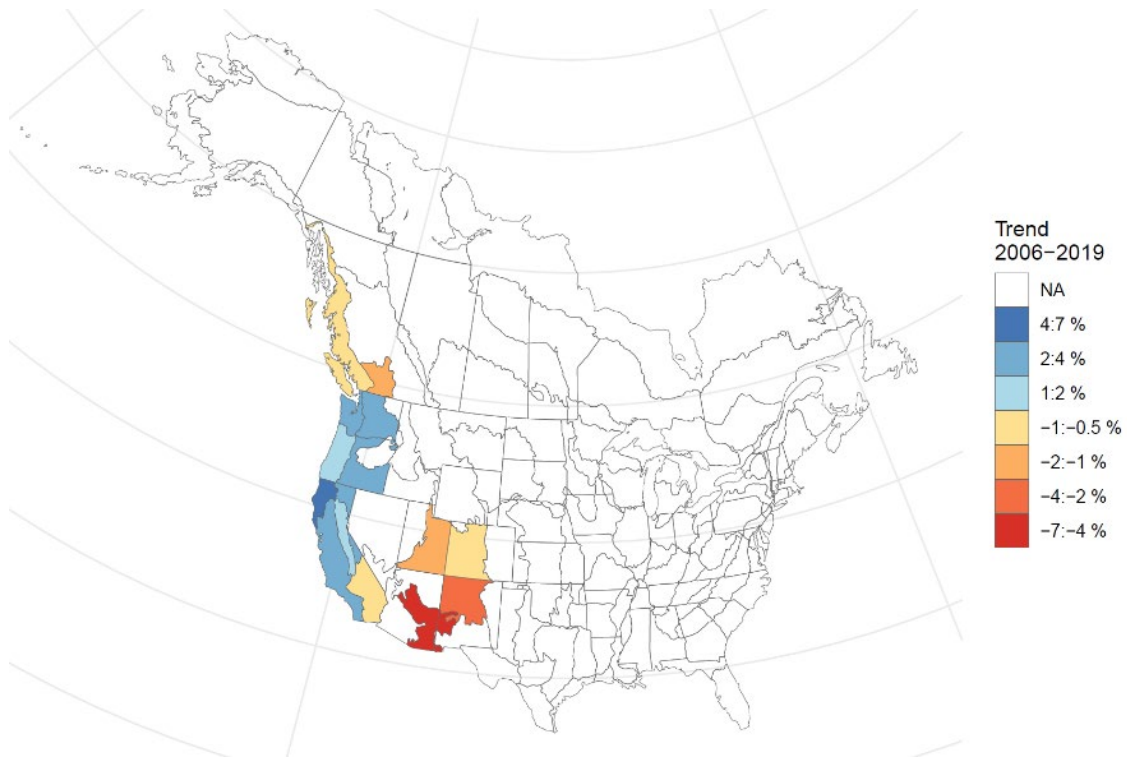


Figure 5. Annual rates of population change for Band-tailed Pigeon over three generations (2006-2019) estimated from Breeding Bird Survey data, for those Bird Conservation Regions within provinces and states with sufficient data to estimate trends for this species (A. Smith unpubl. data).

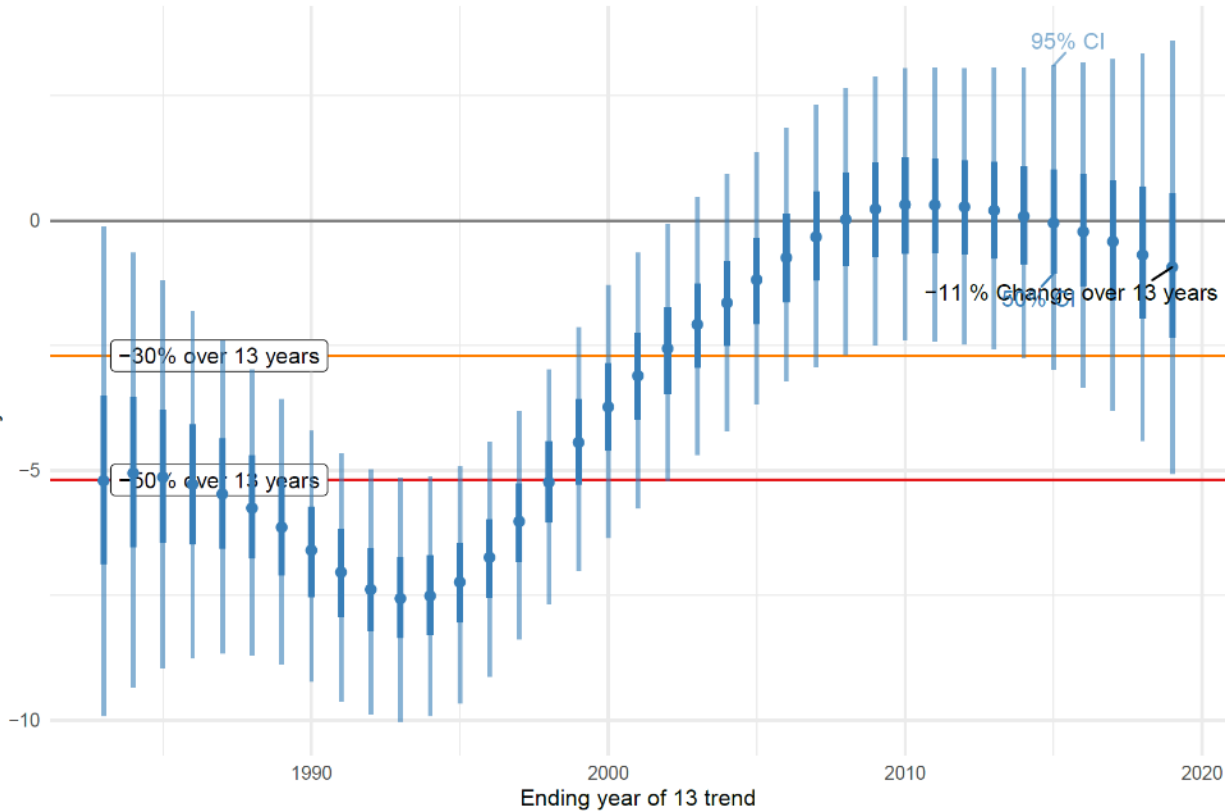


Figure 6. Rolling 13-year (three-generation) trends of Band-tailed Pigeon population change in Canada, based on Breeding Bird Survey data from 1970 to 2019 (A. Smith unpubl. data). The vertical axis represents the average annual percent change in population size over a three-generation period. The horizontal axis represents the last year of the 13-year rolling trend (e.g., 2019 is the trend for 2006-2019). Orange and red horizontal lines depict 30% and 50% cumulative short-term decline rates, which represent COSEWIC thresholds for assessing a species as Threatened and Endangered, respectively. Vertical bars represent the 50% (broad, dark blue) and 95% (narrow, light blue) credible intervals.

Trends from Christmas Bird Counts

Abundance indices for Band-tailed Pigeon from the CBC show long-term overall stability at the continental scale, with a trend of -0.02% per year (95% CI: -1.00, 1.23) between 1970 and 2019 (Meehan *et al.* 2020), which corresponds to a cumulative estimated change of -0.99% (95% CI: -38.9, 82.0). Trends specific to the most recent 3-generation (13-year) period are not available, but over the 10-year period 2009-2019, the continental trend shows an annual increase of 4.37% (95% CI: -1.25, 16.67), amounting to a cumulative change of 53.4% (95% CI: -11.8, 367.3). However, trends vary geographically, with declines in the northern part of the wintering range offset by increases in the south (Figure 7). The long-term CBC trend for Canada is strongly negative, with an average annual change of -3.52% (95% CI: -4.97, -1.99), corresponding to a cumulative decline of -82.7% (95% CI: -91.8, -62.3) between 1970 and 2019. Recent declines are steeper, with an average annual trend of -14.94% (95% CI: -24.61, -5.25) between 2009 and 2019, amounting to a cumulative change of -80.2% (95% CI: -94.1, -41.7) over that period. However, trends in Canada are based on a small sample size, averaging about eight CBC

circles per year, and the proportion of Canadian breeding birds that overwinter in British Columbia likely varies among years. The decline in number of Band-tailed Pigeon recorded in Canada by the CBC may reflect, in part, a shift towards a greater proportion of Canadian birds wintering in the United States.



Figure 7. Percent change in Christmas Bird Count abundance index (mean count adjusted for survey effort) for Band-tailed Pigeon in North American Bird Conservation Regions from 2009 to 2019 (Meehan *et al.* 2020).

Trends from Mineral Site Surveys

Population indices developed from annual counts at mineral sites show promise as useful indicators of Band-tailed Pigeon population trends (Casazza *et al.* 2005), but even this method has potential bias (Keppie and Braun 2000; Overton *et al.* 2005, 2010). The annual trend from MSS data in British Columbia over 15-years (2004-2018) was -4.3% (95% CI: -8.7, 0.8). This rate of decline corresponds to -32.7% (95% CI: -55.9, 7.4) over two generations (9 years). The 3-generation (13-year; 2005-2018) trend estimated by extrapolating from 15 years of data produces an estimate of -43.5% (95% CI: -69.4%, 10.9%; S. Wilson pers. comm. 2019).

Trends from the British Columbia Breeding Bird Atlas

Although only one Breeding Bird Atlas has been conducted in British Columbia (2008-2012), comparison of BCBBA distribution records with those in Campbell *et al.* (1990) shows Band-tailed Pigeon to be more sparsely distributed in the interior of the province, with BCBBA records restricted to the western slope of the Cascade Mountains and areas west of the Fraser River (Davidson 2015).

Summary

The BBS has documented significant long-term declines in Band-tailed Pigeon in Canada (Figure 4), with a decline over the past three generations of about 11.5%. Most Canadian Band-tailed Pigeon overwinter in the United States, and the continental CBC trend shows relative stability over the long term, with an increase over the past decade. The extent to which the reduction of about 80% over three generations in the small numbers detected by the CBC in Canada reflects a population decline, or a southward shift in wintering areas, is uncertain. Species-specific surveys at mineral sites suggest a localized decline of up to 43.5% over three generations, although small sample sizes and the inability of the survey to account for site abandonment means this estimate must be considered as a maximum. Overall, the weight of evidence from these three surveys, together with range reduction indicated by the BCBBA, indicates an ongoing population decline of Band-tailed Pigeon in Canada.

Rescue Effect

The bulk of the Pacific Coast Band-tailed Pigeon population breeds in the western United States, and two cases of apparent post-breeding northward dispersal into Canada have been documented (Brewer *et al.* 2000). Based on the ecological requirements of Band-tailed Pigeon in Oregon (Leonard 1998), it is reasonable to assume that immigrants from the northwestern United States could survive and breed successfully in British Columbia, if breeding sites were available.

BBS annual trend estimates from adjacent Washington state, the most likely source of immigrants, were slightly negative at -0.46% per year (95% CI: -1.96, 1.16) from 1970 to 2019, but positive from 2006 to 2019 at 2.29% per year (95% CI: -1.42, 6.09), with an 89% probability of population increase (Smith unpubl. data). It is therefore possible that immigrants from Washington could bolster declining numbers in British Columbia. However, as declines in both nesting habitat quality and quantity in British Columbia are already likely limiting breeding numbers in key portions of the Canadian range, it is unlikely that northward dispersal of individuals from the United States would supplement declining numbers in Canada. Rescue is therefore considered relatively unlikely.

THREATS AND LIMITING FACTORS

Threats

The threats to Band-tailed Pigeon reviewed below are categorized following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system, based on the standard lexicon for biodiversity conservation of Salafsky *et al.* (2008). The following assessment focuses on threats in the Band-tailed Pigeon's range in Canada, but also considers threats on migration and on the wintering grounds, where information exists and where it is known or strongly suspected that migrants or overwintering birds are of Canadian origin. Threats are presented in decreasing order of severity of impact, ending with those for which scope or severity is unknown. The overall threat impact is considered to be Medium to High, corresponding to an anticipated further decline of between 3 and 70% over the next ten years (Master *et al.* 2012). See **Appendix 1** for further details, including threats considered to have negligible impact.

IUCN 8. Invasive and Other Problematic Species and Genes

8.1 Invasive Non-Native/Alien Species (High Medium threat impact)

Band-tailed Pigeon is highly susceptible to avian trichomonosis, which is the leading cause of mortality for Band-tailed Pigeon presenting to the California Department of Fish and Wildlife's Wildlife Investigations Laboratory (Rogers pers. comm. 2019). This disease is caused by the introduced protozoan parasite *T. gallinae*, and its biology is summarized in **Interspecific Interactions**.

From 1945 to 2017, *T. gallinae* was implicated in over 60 epidemic events in overwintering populations of *P. f. monilis*, each killing thousands to tens of thousands of birds (Rogers *et al.* 2016, 2018; Table 1). The largest recorded epidemic was in Carmel Valley, California, in January to March 2007, where over 43,000 Band-tailed Pigeons were estimated to have died, and Stromberg *et al.* (2008) speculated that total mortality may have been several-fold higher over a larger geographic area. Rogers *et al.* (2018) reported that a trichomonas epidemic from November 2014 to June 2015 was more geographically widespread and persisted for longer than recorded previously, with an estimated mortality of over 18,000 birds. Epidemics in California were correlated with decreases in BBS and CBC abundance indices in subsequent years (Rogers *et al.* 2016). Girard *et al.* (2014) reported that adult birds were disproportionately affected by *T. gallinae*, which would have population-level consequences, as birds older than one year produce most offspring (Jarvis and Passmore 1992).

Table 1. Dates of recorded *Trichomonas* outbreaks in Band-tailed Pigeon in California and Washington from 1988-2017, and the number of Band-tailed Pigeon estimated to have been killed, as reported by the WHISPers database (WHISPers 2020). See text for detailed description of outbreaks not included in this table.

Dates	Estimated number killed	Locations of outbreak (Counties, State)
8 Jan. - 28 Feb. 2017	300	San Diego, California
10 Dec. 2015 - 20 May 2016	3000	El Dorado, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, California
15 Dec. 2014 - 1 May 2015	15,000	Contra Costa, Santa Barbara, San Mateo, Santa Clara, San Luis Obispo, San Bernardino, Marin, Los Angeles, Placer, San Diego, Santa Cruz, Yuba, Alameda, Butte, El Dorado, Mendocino, Nevada, Sacramento, Sonoma, Tehama, Ventura, California
10-30 Aug. 2014	12	King, Washington
9 Jan. - 12 Feb. 2014	200	San Diego, California
4-10 Feb. 2012	30	Nevada, California
1-20 Feb. 2012	10	Amador, California
11 Jan. - 18 Mar. 2012	400	Monterey, California
10 Jan. 2012 - 9 Mar. 2012	400	Madera, California
1-28 Apr. 2006	300	Shasta, California
4-9 Mar. 2004	40	Tehama, California
13 Feb. - 25 Mar. 2004	2000	Monterey, California
21 Jan. - 2 Mar. 1995	2000	San Luis Obispo, Mendocino, Monterey, El Dorado, California
21 Feb. 1988 -7 Mar. 1988	15,000	Lake Sierra, Mendocino, Monterey, Sonoma, California

Migratory Band-tailed Pigeons, such as those breeding in British Columbia, may be more susceptible to *T. gallinae* in California than resident birds, which are likely more continually exposed to the disease (Rogers *et al.* 2016). More information is needed on the proportions of pigeons from British Columbia affected by epidemics on US wintering grounds. Trichomonosis is rarely reported in Canada, with only two cases of Band-tailed Pigeon with gross lesions consistent with *Trichomonas* submitted to the British Columbia Ministry of Agriculture since 2010 (McGregor pers. comm. 2018), and no follow-up field survey data are available.

The frequency of trichomonosis epidemics is increasing in the United States (Rogers *et al.* 2016, 2018), and given high Band-tailed Pigeon mortality rates, could contribute to major population declines (Rogers *et al.* 2018). Population-level impacts due to *T. gallinae* mortality have been demonstrated in Northern Goshawk in Scotland (Cooper and Petty 1988), Greenfinch (*Carduelis chloris*), and Chaffinch (*Fringilla coelebs*) in the United Kingdom (Robinson *et al.* 2010) and Mauritian Pink Pigeons (*Nesoenas mayeri*) (Swinnerton *et al.* 2005; Bunbury *et al.* 2008). It has been suggested that *T. gallinae* may also have contributed to the extinction of Passenger Pigeon (Stabler 1954).

Introduced Rock Dove and Eurasian Collared Dove (*Streptopelia decaocto*) pose an indirect risk to Band-tailed Pigeon as primary hosts of *Trichomonas* (Forrester and Foster 2009; Evans pers. comm. 2019).

Introduced predators pose a serious conservation threat to Band-tailed Pigeon, with mortalities reported from domestic cats (Jessup 2004). WILD-ONe North American wildlife rehabilitation centres database indicates that domestic cats accounted for 7% of Band-tailed Pigeon deaths in the database due to a known cause (WILD-ONe 2018). Other non-native mammals that could serve as invasive nest predators of Band-tailed Pigeon include rats (*Rattus* spp.) and eastern Gray Squirrel (*S. carolinensis*; Keppie and Braun 2000).

IUCN 5. Biological Resource Use

5.1 Hunting and Collecting Terrestrial Animals (Low threat impact)

Hunting pressure was historically considered to be a major contributor to declines of Band-tailed Pigeon numbers. However, harvests in the United States and British Columbia are now strictly regulated, and overall hunting interest and harvest has declined markedly.

From 1976-1990, harvest limits in British Columbia were 10 birds/day with a 20-bird possession limit, which was reduced to 5/day with a 10-bird possession limit in 1991. The Band-tailed Pigeon hunting season was closed completely in Canada from 1994 to 2001, inclusive (Gendron pers. comm. 2018; Figure 8). The current hunting season in British Columbia extends from 15-30 September, with a daily limit of five pigeons and a possession limit of 15 birds (Pacific Flyway Council 2010). Harvest is now very low In British Columbia, with a total estimated harvest of 568 individuals over the past 5 years (average of about 114 birds/year; Gendron pers. comm. 2018; Figure 8). About 66-87% of these were likely mature individuals, assuming the same age structure of harvested birds as was reported in the United States by Sanders and Braun (2014).

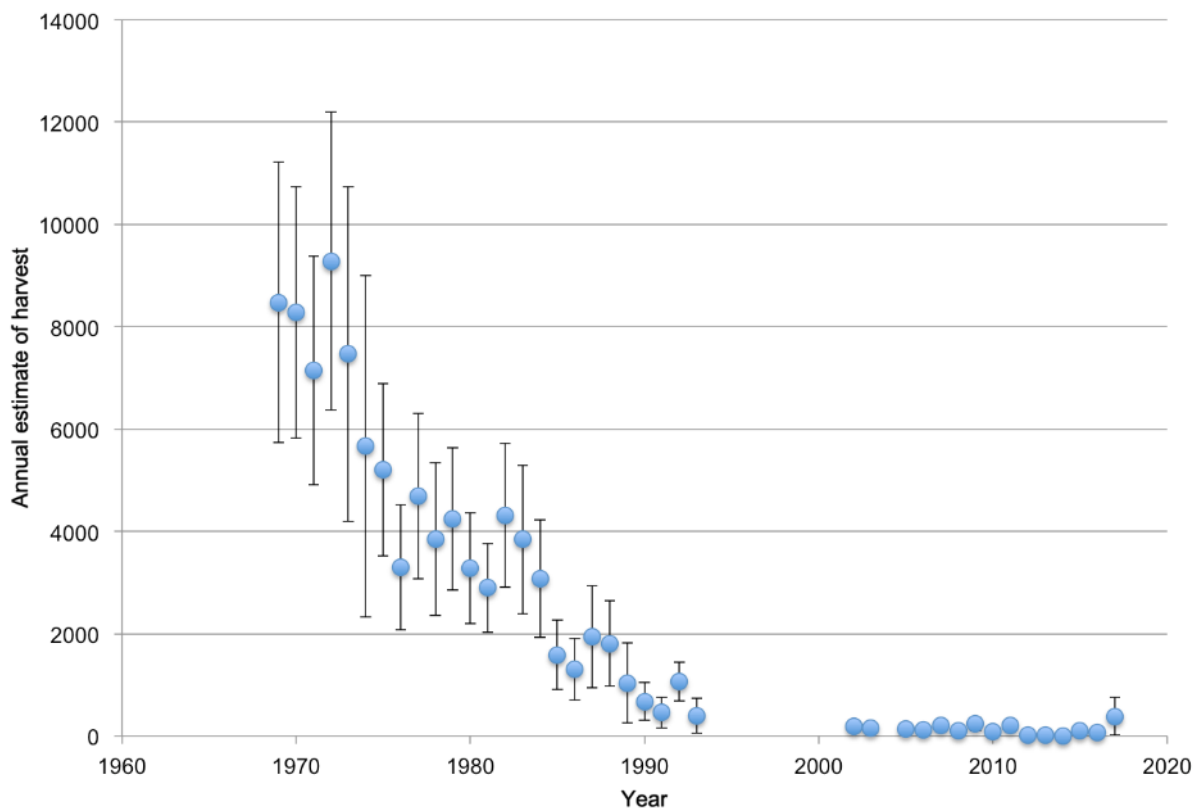


Figure 8. Estimated number of Band-tailed Pigeon harvested annually in British Columbia, 1969-2017 (with standard errors; Environment and Climate Change Canada in preparation; Gendron pers. comm. 2018). Note the closure of the legal harvest in Canada from 1994-2001, inclusive, and imposition of a reduced bag limit in 2002 (Environment and Climate Change Canada 2016).

Based on the timing and duration of US hunting seasons, the Canadian population of Pacific Coast Band-tailed Pigeon may also be exposed to some hunting pressure in, and en route to, overwintering areas in California, although harvest in the United States is likely to be very low. In 2018, the 9-day hunting season extended from 15-23 September in Washington, Oregon, and northern California, and from 15-23 December in southern California, with daily bag limits varying from 2-10 birds and a possession limit of three times the daily bag limit (Seamans 2018). The average annual harvest level in California, Oregon, and Washington was about 8200 total individuals over the recent period 2012-2016, or about 6200 mature individuals (Seamans 2018). Impacts of crippling loss and illegal hunting on Band-tailed Pigeon in the United States are unknown but may be locally important (Braun pers. comm. 2019), although additional impact on birds from Canada is likely negligible.

5.3 Logging and wood harvesting (Medium threat impact)

Habitat degradation and loss is an ongoing threat to Band-tailed Pigeon in Canada and throughout its range. In British Columbia, ongoing forest harvesting activities in second growth, mixed forests in the Fraser River valley and southeast Vancouver Island have reduced the quality and extent of breeding habitat in recent decades (e.g., Cooper 2002). Recent population declines of *P. f. monilis*, particularly in the United States, may be related to widespread habitat alteration due to forestry practices in the late 20th century, especially the replacement of structurally variable old-growth forests by even-aged stands, although this needs more empirical study (Hansen *et al.* 1991; Braun 1994; Sanders and Jarvis 2003).

Forestry practices that promote the expansion of coniferous species and the reduction of fruit-bearing deciduous shrubs likely contribute to habitat and population declines, although some forestry practices may be beneficial in increasing availability of food tree and shrub species (Braun 1994; Mathewson 2005; Overton *et al.* 2010). Alteration of treed habitat surrounding mineral sites may reduce the availability of perches and forest cover, causing those sites to become less suitable for Band-tailed Pigeon (Overton *et al.* 2006).

IUCN 1. Residential & commercial development

1.1 Housing and Urban Areas (Low threat impact)

The Georgia Depression ecoprovince has been a major nesting area for Band-tailed Pigeon, but is the most populous area in British Columbia and subject to ongoing urban development (Campbell *et al.* 1990; Davidson 2015). Continued conversion of forested nesting habitats and areas adjacent to mineral sites for housing and urban development represents a significant risk factor in the southwestern part of the province. Some aspects of urbanization may provide limited benefits, such as ornamental fruit trees used for foraging, but this may be offset by increased numbers of residential window strikes (Machtans *et al.* 2013), predation by free-roaming cats (Blancher 2013), and *Trichomonas* infection risk at urban bird feeders (McBurney *et al.* 2017).

IUCN 6. Human Intrusions and Disturbance

6.1 Recreational Activities (Unknown threat impact)

Human disturbance at mineral sites is a concern, as Band-tailed Pigeon has abandoned about 20% of traditionally used mineral sites in Oregon due to human disturbance (Overton *et al.* 2006). Biologists surveying pigeons at mineral sites in British Columbia in the 2000s recorded repeated disturbance at some sites, by sources including road-paving, industrial activity, road traffic, and the presence of joggers and photographers (COSEWIC 2008). This disturbance will likely continue to increase with the projected human population growth in coastal British Columbia (Breault pers. comm. 2019).

Hot springs used as mineral sites by Band-tailed Pigeon are especially vulnerable due to their increasing use by humans. Anecdotal reports from hot spring users and landowners reported to Overton *et al.* (2006) indicated a general decline in their use by Band-tailed Pigeon over a period of several decades, during which all hot spring sites in Oregon were abandoned. Some hot spring mineral sites used by humans in British Columbia were found to have low concurrent use by Band-tailed Pigeon (Overton 2003).

IUCN 7. Natural System modification

7.1 Fire and Fire Suppression (Unknown threat impact)

Wildfires in California have potential to impact habitat used by overwintering Band-tailed Pigeons, due to the intensity of these fires and the large areas burned in recent years (Seamans pers. comm. 2019). California state wildfire statistics report that over 650,000 ha burned in 2018, compared to a 5-year average of about 93,000 ha (California Department of Forestry and Fire Protection 2019). These fires can lead to loss of oaks (*Quercus* spp.), which are an important winter food source for Band-tailed Pigeon. Mature oak trees can be relatively tolerant of low intensity burns, although high severity fires that occur in rapid succession may impact oak regeneration (Hammett *et al.* 2017), and long-term declines in Black Oak in the western United States have been attributed to wildfire (Long *et al.* 2018).

IUCN 9. Pollution

9.2 Industrial and Military Effluents (Unknown threat impact)

Industrial activities have polluted some areas of the Pacific coastal and estuarine environment of southern British Columbia, including some mineral sites. For example, the Pigeon Cove mineral site in Port Moody Arm was found to be contaminated with cadmium, chromium, copper, lead, and zinc, as well as oil and grease hydrocarbons and polycyclic aromatic hydrocarbons originating from petroleum facilities (COSEWIC 2008). Polychlorinated biphenyls (PCBs), which have been banned since the mid-1970s, persisted in low concentrations throughout Port Moody Arm (COSEWIC 2008).

9.3 Agricultural and Forestry Effluents (Unknown threat impact)

Band-tailed Pigeon is likely exposed to a range of chemical contaminants due to its use of agricultural areas for foraging. The only information on contaminants was provided by Braun *et al.* (1977) who measured mercury levels in individuals sampled in Colorado in 1969; 30% had mercury levels equal to or exceeding 0.50 ppm, presumably due to exposure to fungicides. Although these levels were insufficient to cause clinical signs (Braun *et al.* 1977), this study highlights the potential for bioaccumulation and the importance of sampling at mineral sites in British Columbia.

IUCN 11. Climate Change and Severe Weather (Unknown)

11.1 Habitat Shifting and Alteration (Not scored)

Climate change could benefit Band-tailed Pigeon in Canada, as models specific to British Columbia predict an increase in conditions favoured by Douglas-fir (Hamann and Wang 2006), with longer and warmer summers, so that coastal forests could develop higher densities of fruiting shrubs used as food source plants (COSEWIC 2008). However, overall effects are difficult to predict, as increases in the frequency and severity of droughts could reduce seasonal food availability. As Band-tailed Pigeon often feeds almost exclusively on a single plant species at certain times, it is vulnerable to changes in plant phenology that may lead to a mismatch between timing of breeding activity and the availability of specific forage plant species.

11.2 Droughts (Not scored)

Climate change is already likely increasing the impact of *T. gallinae* on Band-tailed Pigeon numbers (see **8.1 Invasive Non-Native/Alien Species** above), as the frequency and severity of epidemics are increasing with warmer and drier summers in California and Oregon; these likely lead to higher transmission and infection rates (Stromberg *et al.* 2008; Rogers *et al.* 2016). Warmer and drier conditions in US wintering areas could increase the frequency and impact of fires in contributing to habitat loss (see **7.1 Fire and Fire Suppression** above).

Limiting Factors

Potential for recovery of depleted numbers to former levels is hampered by the Band-tailed Pigeon's low annual reproductive potential, which is limited by the species' 1-egg clutch, with only 1-2 clutches laid per year (Keppie and Braun 2000). Band-tailed Pigeon also requires access to mineral sites during the breeding season and fall migration (Jarvis and Passmore 1992; Keppie and Braun 2000). These provide minerals such as calcium, potassium, magnesium, sulfur, and particularly sodium, which are often missing from diets when pigeons feed almost exclusively on elderberry or Cascara berries (March 1971; Sanders and Jarvis 2000; Sanders and Koch 2018). Only ten known mineral sites are used in southwestern British Columbia, although others likely exist (Breault pers. comm. 2018), and pigeons often travel long distances to use them.

Number of Locations

Among the most important threats to Band-tailed Pigeon in Canada are those associated with land-use activities that have the potential to impact both the quantity and quality of nesting and foraging habitat at a large scale (Environment and Climate Change Canada 2016). As most activities that impact habitat, such as logging and wood harvesting, agriculture, and residential and commercial development, operate differently at many local levels, the number of locations for Band-tailed Pigeon in Canada is not known, but is likely much greater than ten. It is unknown whether the number of locations may be declining, although it is unlikely that the number of locations fluctuates.

Trichomonas gallinae epidemics on US wintering grounds have led to large mortality events in Pacific Coast Band-tailed Pigeon populations, likely impacting individuals from the Canadian breeding population. In many years, trichomonosis may represent the most serious plausible threat to Canadian birds, although this impact would be sporadic and geographically localized on the Canadian Band-tailed Pigeon's winter distribution. In such cases, the above threat of habitat loss from land-use changes would be used to define and count locations in areas not affected by trichomonosis, and the combined number of locations would again likely to be much greater than ten.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Under the *Migratory Birds Convention Act 1994* (Government of Canada 2017), Band-tailed Pigeon individuals, their nests and eggs are protected from harm and disturbance in Canada, except during the open hunting season, when it is subject to the federal Migratory Game Bird hunting regulations. Band-tailed Pigeon was listed as a Species of Special Concern in 2011, under Schedule I of the *Species at Risk Act 2002* (Government of Canada 2019), and was thus considered a species that may become threatened or endangered due to limiting factors and threats. Band-tailed Pigeon is included on the British Columbia Blue List, and is protected in that province under the British Columbia *Wildlife Act*.

In the United States, Band-tailed Pigeon is protected under the *Migratory Bird Treaty Act* (USFWS 2017), but is not listed under the Federal *Endangered Species Act*. The Pacific Coast Band-tailed Pigeon is listed as a species of concern in Oregon, but not in Washington or California.

Non-Legal Status and Ranks

The provincial status rank of Band-tailed Pigeon in British Columbia was changed from S3S4B to S3S4 in 2015 (NatureServe 2020). This ranking conveys a range between Vulnerable (S3) and Apparently Secure (S4). The previous ranking included a 'B' designation associated with breeding occurrence; this reflects a change in the ranking process as the species breeds and occurs in winter in British Columbia. The British Columbia Conservation Data Centre identifies Band-tailed Pigeon as Blue-listed, equivalent to Special Concern (B.C. Conservation Data Centre 2010). The Bird Conservation Region 5 Conservation Strategy lists Band-tailed Pigeon as a Priority Species (ECCC 2013).

The status of Band-tailed Pigeon is nationally ranked by NatureServe as N3N4 (Vulnerable/Apparently Secure) in Canada, and N4B, N4N (both breeding and non-breeding populations Apparently Secure) in the United States (NatureServe 2020). It is listed globally by NatureServe as G4 (Apparently Secure; NatureServe 2020) and by the IUCN as LC (Least Concern: BirdLife International 2016).

Partners In Flight has listed Band-tailed Pigeon as a “D” Yellow Watch List species, which recognizes it as a species with population declines and moderate to high threats (Rosenberg *et al.* 2016). On a five point scale of low (1) to high (5) the threats to global population size, threats to breeding, and threats to non-breeding were all scored at 3/5; the breeding, non-breeding distributions were scored at 2/5, and the population trend was scored as 5/5 (Partners in Flight 2019).

Habitat Protection/Ownership

Band-tailed Pigeon nests as individual pairs scattered across suitable habitat, with no known significant breeding aggregations. Within its Canadian breeding range, potential habitat is protected for 36.9% (16,807 km²) of the northern central coast, 13% (8,096 km²) on the southern coast, and 13% (4,386 km²) on Vancouver Island, with the majority of these areas under provincial park protection (Environmental Reporting BC 2016), although only portions of these protected areas provide suitable habitat for Band-tailed Pigeon.

The proportion of extant coastal Douglas-fir forest that has been protected increased from about 2.5% in 1991 to 6-7% in 2008 (Environmental Reporting BC 2016). About 6-12% of forested areas of eastern Vancouver Island is now protected, compared to less than 6% protected in the vicinity of the Broughton archipelago (Environmental Reporting BC 2016). Protected areas now make up an average of 12% or more of the northern parts of the central British Columbia coast (Environmental Reporting BC 2016), although this is not a core portion of Band-tailed Pigeon range.

Four of the mineral sites described in British Columbia were on marine mud flats under control of the federal government, although adjacent perch trees were either on private land (two sites) or land under the control of municipal governments (two sites; Overton 2003). Four mineral sites were entirely on private land, two were on British Columbia provincial Crown land and one was within a provincial park (Overton 2003). Most mineral sites within British Columbia are located in intertidal areas of estuaries, with relatively low risk of disturbance. Mineral sites that are on Crown land or private land could be subject to forestry and recreational activities.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Dr. Amy Wilson completed a B.Sc. at the University of Calgary, an M.Sc. and Ph.D. at the University of British Columbia, and a Doctorate of Veterinary Medicine at the University of Saskatchewan. Over the past 20 years, Amy has had extensive involvement in avian conservation research, and is currently a practising veterinarian in British Columbia involved in wildlife conservation medicine and research.

COLLECTIONS EXAMINED

No museum collections were examined as part of the preparation of this report.

Appendix 1. Threats Calculation Table for Band-tailed Pigeon.

Species or Ecosystem Scientific Name	Band-tailed Pigeon (<i>Patagioenas fasciata</i>)		
Element ID		Elcode	
Date::	2019-04-12		
Assessor(s):	Amy Wilson (report writer), Richard Elliot (co-chair), Dwayne Lepitzki (facilitator), Marie-France Noel (COSEWIC Secretariat), Louise Blight, Clait Braun, Marcel Gahbauer, Krysta Rogers, Jean-Pierre Savard, Mark Seamans, Liana Zanette		
References:	Draft threats calculator, draft Band-tailed Pigeon status report		
Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
		Threat Impact	high range
		low range	
	A	Very High	0
	B	High	0
	C	Medium	2
	D	Low	1
Calculated Overall Threat Impact:		High	Medium
Assigned Overall Threat Impact:		B = High-Medium	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation time is about 4.4 years, so three-generation timeframe for considering severity and timing is 13 years.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	Local impacts of continued conversion of forested nesting habitats and areas adjacent to mineral sites for housing and urban development, especially in the Georgia Depression, are likely to continue to reduce availability of Band-tailed Pigeon breeding habitat. Scope may be at high end of range of 1-10%. Note that some aspects of urbanization (e.g. bird feeders, planting ornamental fruit trees) may be beneficial.
1.2	Commercial & industrial areas						Potential for habitat loss due to industrial activities at mineral sites, and effects of disturbance and traffic, are considered below in 6.3 and 9.6, respectively.
1.3	Tourism & recreation areas						Some mineral sites may be further developed as commercial hot springs.
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Band-tailed Pigeon uses open agricultural areas and orchards for foraging, especially outside the breeding season. Changes in agricultural practice may have positive effects through provision of new food sources, or negative effects through loss of foraging opportunity with conversion of agricultural fields to unusable habitat such as green houses. Little change anticipated within 10 years.
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						Grain used to feed livestock may be beneficial as a supplementary food source.
2.4	Marine & freshwater aquaculture						
3	Energy production & mining		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
3.1	Oil & gas drilling						Past threat in some US wintering areas.
3.2	Mining & quarrying						Possible future threat in wintering areas in northern California, although little information available.
3.3	Renewable energy		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Increasing numbers of wind turbines in areas used on migration and in winter present a slight mortality risk from striking turbine structures, although there are no known records of Band-tailed Pigeon documented in studies of bird strikes (Braun pers. comm. 2019).
4	Transportation & service corridors		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Roadways may serve as source areas for grit, which could be associated with increased risk of roadkill of pigeons consuming grit from roadsides (Rogers pers. comm. 2019).
4.2	Utility & service lines		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Power lines are frequently used by Band-tailed Pigeon as perches, with a slight risk of mortality from striking wires or electrocution (Rogers pers. comm. 2019).
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.1	Hunting & collecting terrestrial animals	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Hunting pressure during open gamebird seasons was a significant factor through the 1990s in Canada, and US wintering grounds, but recent restrictive regulations have markedly reduced the harvest of Canadian Band-tailed Pigeon almost to zero. Most US hunting seasons are closed when Canadian birds are present. Impacts of crippling loss and illegal hunting on Band-tailed Pigeon in US are unknown but may be locally important, although additional impact on birds from Canada is likely low.
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	Logging practices that change stand structure continue to affect the availability of nesting trees in southern British Columbia, and changes in forest edge composition and harvesting practices reduce deciduous cover, especially of seasonally-important food plants. Some effects may be beneficial in increasing availability of food tree and shrub species.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Unknown	Small (1-10%)	Unknown	High (Continuing)	
6.1	Recreational activities		Unknown	Small (1-10%)	Unknown	High (Continuing)	Certain mineral sites may be disturbed by individuals involved in recreational activities.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Negligible (<1%)	Unknown	High (Continuing)	There are limited research activities in Canada involving Band-tailed Pigeon, with no active banding or scientific collection programs, so the risk of negative effects on birds is almost non-existent.
7	Natural system modifications		Unknown	Large - Restricted (11-70%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression		Unknown	Large - Restricted (11-70%)	Unknown	High (Continuing)	Increased incidence and intensity of fires in northern California wintering grounds in recent ten-year period is expected to continue, with potential negative impacts on food availability through loss of ground seed bank and reduced regeneration of oaks which are important food source and potential for impact on winter habitat of Canadian Band-tailed Pigeon.
7.2	Dams & water management/use						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes	BC	High - Medium	Large - Restricted (11-70%)	Serious (31-70%)	High (Continuing)	
8.1	Invasive non-native /alien species	BC	High - Medium	Large - Restricted (11-70%)	Serious (31-70%)	High (Continuing)	Band-tailed Pigeon numbers are threatened by the introduced parasite <i>Trichomonas gallinae</i> , with Rock Pigeon and Eurasian Collared Dove as reservoir hosts, particularly on US wintering grounds. Trichomonosis has caused large sporadic mortality events (up to 20-30,000 birds estimated killed) in Oregon and California in eight of past 10 years. Events are most frequent in hot dry years when pigeons concentrate at slow-moving water sources, such as irrigation canals. Migrants, including Canadian birds, are likely more susceptible than resident birds, and up to 90% of second-year birds present may be killed in mortality events. Rock Dove and Eurasian Collared Dove pose an indirect risk as the primary hosts of <i>Trichomonas</i> . Band-tailed Pigeon is sometimes predated by domestic cats, and introduced rats and Grey Squirrels may serve as nest predators, although impacts are likely relatively small.
8.2	Problematic native species						
8.3	Introduced genetic material						
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Those Band-tailed Pigeons that use mineral sites in industrial areas are susceptible to exposure to industrial heavy metal pollutants and other contaminants, although contaminant levels in the single Canadian study at Port Moody, British Columbia, were not near lethal levels.
9.3	Agricultural & forestry effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Band-tailed Pigeon forages in agricultural field and so is susceptible to exposure to agricultural pesticides, herbicides and other contaminants, although there is no evidence of impacts in recent years.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	All subcategories for Threat category 11 likely apply to Band-tailed Pigeon. There is evidence of the effects of climate change throughout its range, although net overall impacts at population levels are uncertain, and may extend beyond the 3-generation timeframe.
11.1	Habitat shifting & alteration						With predicted longer and warmer summers, coastal forests could develop higher densities of fruiting shrubs used as food sources, but other changes could reduce seasonal food availability or lead to mismatches in timing between peak fruit availability and dependence by Band-tailed Pigeon.
11.2	Droughts						Predicted increasing incidence of droughts may affect seasonal food availability, and may promote concentration of Band-tailed Pigeon and Rock Pigeon at water sources and in wintering areas, increasing rates of <i>Trichomonas gallinae</i> transmission and infection.
11.3	Temperature extremes						
11.4	Storms & flooding						
Classification of Threats adopted from IUCN-CMP, Salafsky <i>et al.</i> (2008).							