

**COSEWIC**  
**Assessment and Status Report**

on the

**Ferruginous Hawk**  
*Buteo regalis*

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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Schmutz, K. J. 1995. COSEWIC update status report on the Ferruginous Hawk *Buteo regalis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-15 pp.

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Ferruginous Hawk — Photo credit: Beatriz Prieto (with permission).

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## COSEWIC Assessment Summary

### Assessment Summary – April 2021

**Common name**

Ferruginous Hawk

**Scientific name**

*Buteo regalis*

**Status**

Special Concern

**Reason for designation**

This large hawk is the only raptor endemic to North American grasslands. Its Canadian range is largely limited to the southern Prairies of Alberta and Saskatchewan, with a few individuals in southwestern Manitoba. Overall population trends have been stable or slightly increasing over the past three generations, despite ongoing loss of nesting and foraging habitat. The revised status reflects an improvement in population trend since the previous assessment, but recognizes that the species may become Threatened again if threats such as displacement by energy production, increased competition for nesting habitat, disturbance at nest sites, and persecution of prey are not effectively managed.

**Occurrence**

Alberta, Saskatchewan, Manitoba

**Status history**

Designated Threatened in April 1980. Status re-examined and designated Special Concern in April 1995. Status re-examined and designated Threatened in April 2008. Status re-examined and designated Special Concern in May 2021.



## **COSEWIC Executive Summary**

### **Ferruginous Hawk *Buteo regalis***

#### **Wildlife Species Description and Significance**

Ferruginous Hawk is the largest hawk in North America, and the only raptor that is endemic to the grasslands of the continent. Most individuals are pale below with a rusty orange back, but some are dark brown with a contrastingly lighter tail.

#### **Distribution**

Ferruginous Hawk breeds from the prairie provinces to the southwest United States, and winters from the southwest United States to northern Mexico. By 1980, the northern edge of the Canadian range had contracted 150-350 km south from its historical limit, likely influenced by factors including shooting, reduced prey availability, and habitat loss.

#### **Habitat**

Ferruginous Hawk requires open habitat, including grassland, shrub-steppe, or desert, typically nesting on elevated features such as trees or nest platforms. Nesting density and the likelihood of re-using nests between years is higher in landscapes with less than 50% cropland. The availability of preferred nesting and wintering habitat has declined by over 80% historically and continues to decrease.

#### **Biology**

Ferruginous Hawk first breeds at two years, has a clutch of 2-8 eggs, and raises 2-3 young on average each year. Generation time is estimated as nearly 7 years. Compared to other raptors, Ferruginous Hawk has a specialized diet, heavily favouring Richardson's Ground Squirrel as prey, and is more easily disturbed by human activity near nests.

#### **Population Sizes and Trends**

The Canadian population is estimated to be 3000-4000 mature individuals, based on surveys specifically targeting nesting Ferruginous Hawk. Breeding Bird Survey data indicate significant long-term population increases in both Canada and the United States, but only a marginally positive trend overall in both countries for the past three generations (1998-2019), with continued increases in some regions being offset by declines in others. Surveys in Alberta specifically targeting Ferruginous Hawk suggest roughly stable or slightly

increasing numbers over the most recent span available (2000-2015), whereas nest counts in Manitoba have declined substantially over the past three generations. The Saskatchewan population has not been monitored in sufficient detail to derive a provincial trend from targeted surveys.

### **Threats and Limiting Factors**

Threats to Ferruginous Hawk include loss of nesting sites, reduction in prey availability, disturbance from energy production and agriculture, collisions with vehicles and infrastructure, and climate change and severe weather. However, the impact of some of these threats may have been partially offset in recent years by recovery actions.

### **Protection, Status and Ranks**

Ferruginous Hawk is listed as Threatened under Schedule 1 of the federal *Species at Risk Act*, Endangered under the *Alberta Wildlife Act*, and Threatened under the *Manitoba Endangered Species Act*. The species is not listed in Saskatchewan, under *The Wild Species at Risk Regulations*. NatureServe ranks it as Apparently Secure globally (G4), Vulnerable in Canada (N3), and Apparently Secure (N4) in the United States. Within Canada, it is ranked Vulnerable (S3) in Saskatchewan, but Imperilled to Vulnerable (S2S3) in Alberta, and Critically Imperilled (S1) in Manitoba, and Vulnerable or worse in the U.S. border states where it has been ranked.

## TECHNICAL SUMMARY

*Buteo regalis*

Ferruginous Hawk

Buse rouilleuse

Range of occurrence in Canada: Alberta, Saskatchewan, Manitoba

### Demographic Information:

Generation time (usually average age of parents in the population)	6.9 years (Bird <i>et al.</i> 2020).
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No. Population inferred to be stable to increasing, based on Breeding Bird Survey and Alberta survey data.
Estimated percent of continuing decline in total number of mature individuals within 5 years [or 2 generations; whichever is longer up to a maximum of 100 years]	Not applicable. Population is inferred to be stable to increasing.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last 10 years [or 3 generations; whichever is longer up to a maximum of 100 years]	Inferred 16% increase over 21 years (1998-2019), based on Breeding Bird Survey data for Canada.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]	Unknown, although projected to decline based on threats assessment.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any period of 10 years [or 3 generations; whichever is longer, up to a maximum of 100 years], including both the past and future	Unknown.
Are the causes of the decline a. clearly understood? b. understood and c. ceased?	a. Not applicable b. Not applicable c. Not applicable  Overall population not declining.
Are there extreme fluctuations in number of mature individuals	No.

### Extent and Occupancy Information:

Estimated extent of occurrence (EOO)	237,000 km <sup>2</sup> , calculated based on minimum convex polygon around known occurrences in the breeding range.
Index of area of occupancy (IAO), reported as 2x2 km grid value	Not estimated, because distribution at 2x2 km grid scale is uncertain, but almost certainly >2000 km <sup>2</sup> .

Is the population “severely fragmented”, i.e., is >50% of its total area of occupancy in habitat patches that are both (a) smaller than 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” (use plausible range to reflect uncertainty if appropriate)	Unknown, but certainly >10 given the number of sites at which key threats may affect the species.
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Yes, observed decline within past three generations in Manitoba.
Is there an [observed, inferred, or projected] continuing decline in area of occupancy?	Yes, at least in Manitoba, some local losses have been observed over the past three generations.
Is there an [observed, inferred, or projected] continuing decline in number of subpopulations?	Not applicable; no subpopulations recognized in Canada.
Is there an [observed, inferred, or projected] continuing decline in number of “locations”?	No.
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes, observed and projected declines in area, extent, and quality of breeding habitat.
Are there extreme fluctuations in number of subpopulations?	No, only one population recognized in Canada.
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 (by subpopulation):**

Total (no subpopulations recognized)	3000-4000  Sum of provincial estimates.
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**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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**Threats:**

Was a threats calculator completed for this species?  
 Yes (see Appendix A); overall threat impact: high

Key threats were identified as:

- i. IUCN 7, Natural systems modifications (low-medium threat impact)
- ii. IUCN 2, Agriculture and aquaculture (low threat impact)
- iii. IUCN 3, Energy production and mining (low threat impact)
- iv. IUCN 4, Transportation and service corridors (low threat impact)
- v. IUCN 5, Biological resource use (low threat impact)
- vi. IUCN 8, Invasive and other problematic species (low threat impact)
- vii. IUCN 11, Climate change and severe weather (low threat impact)

What other limiting factors are relevant?

- Low reproductive rate and relatively high age at first breeding
- Abundance of rodent prey
- Availability of safe ground or elevated nesting sites

**Rescue Effect (from outside Canada):**

Status of outside population(s) most likely to provide immigrants to Canada.	Stable. United States population has increased 4% over the past three generations, including a change of -27% in Idaho and +43% in Montana, the two states most likely to be a potential source for the Canadian population.
Is immigration known or possible?	Yes.
Would immigrants be adapted to survive in Canada?	Yes.
Is there sufficient habitat for immigrants in Canada?	Yes, although declining in extent and quality.
Are conditions deteriorating in Canada?	Yes, although at a lower rate than historically.
Are conditions for the source (i.e., outside) population deteriorating?	Yes.
Is the Canadian population considered to be a sink?	No.
Is rescue from outside populations likely?	No, although immigration occurs, it is unlikely to be sufficient to rescue the population if conditions continue to decline both within Canada and in adjacent states.

**Data Sensitivity:**

Is this a data sensitive species?	No.
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**Status History:**

COSEWIC Status History  
 Designated Threatened in April 1980. Status re-examined and designated Special Concern in April 1995.  
 Status re-examined and designated Threatened in April 2008. Status re-examined and designated Special Concern in May 2021.



## Status and Reasons for Designation

<b>Status:</b> Special Concern	<b>Alpha-numeric Codes:</b> Not applicable
<b>Reasons for designation</b> This large hawk is the only raptor endemic to North American grasslands. Its Canadian range is largely limited to the southern Prairies of Alberta and Saskatchewan, with a few individuals in southwestern Manitoba. Overall population trends have been stable or slightly increasing over the past three generations, despite ongoing loss of nesting and foraging habitat. The revised status reflects an improvement in population trend since the previous assessment, but recognizes that the species may become Threatened again if threats such as displacement by energy production, increased competition for nesting habitat, disturbance at nest sites, and persecution of prey are not effectively managed.	

## Applicability of Criteria:

Criterion A (Decline in total number of mature individuals) Not applicable. Breeding Bird Survey results indicate that the population has increased 16% over the past three generations (21 years).
Criterion B (Small distribution range and decline or fluctuation) Not applicable. EOO of 237,000 km <sup>2</sup> and IAO of >2000 km <sup>2</sup> both exceed thresholds.
Criterion C (Small declining number of mature individuals) Not applicable. There is no decline in the number of mature individuals.
Criterion D (Very small or restricted population) Not applicable. Estimate of 3000-4000 mature individuals exceeds thresholds for D1, and the population is not vulnerable to rapid and substantial decline.
Criterion E (Quantitative analysis) Not applicable. Analysis not conducted.

## PREFACE

Since the last status report on Ferruginous Hawk (COSEWIC 2008), breeding bird atlas projects and surveys targeting this species have provided new information on population size and trends. Research on many aspects of its biology, notably movements, habitat use, breeding biology, and responses to disturbance has greatly clarified knowledge gaps in the previous status report (e.g., REACT 2016; Nordell *et al.* 2017b; Ng *et al.* submitted). These new surveys and studies considerably revise and extend the information in the previous status report, especially concerning the species' biology, trends and threats. Actions implemented to improve survival and reproductive success of Ferruginous Hawk in Canada include construction of artificial nesting platforms, installation of markers on power lines to reduce collision risk, and implementation of setback guidelines for energy industry activities. Ferruginous Hawk is among the species targeted by the Action Plan for Multiple Species at Risk in Southwestern Saskatchewan: South of the Divide (Environment and Climate Change Canada), and a draft Recovery Strategy is in development.



## 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.



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Canada

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

# **COSEWIC Status Report**

on the

## **Ferruginous Hawk** *Buteo regalis*

**in Canada**

2021

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## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and Classification

Scientific name: *Buteo regalis*  
English name: Ferruginous Hawk  
French name: Buse rouilleuse  
Classification: Class: Aves  
Order: Accipitriformes  
Family: Accipitridae

Classification follows the American Ornithological Society (AOU 1998; Chesser *et al.* 2019). Ferruginous Hawk is the largest of the North American buteos (genus *Buteo*), which are hawks with broad wings specialized for soaring and gliding. Ferruginous Hawk is most closely related to Upland Buzzard (*B. hemilasius*), of central Asia (Ng *et al.* 2017).

### Morphological Description

Ferruginous Hawk is approximately 60 cm in length (beak to tail), 150 cm in wingspan, and 1.5 kg in weight. It is distinguished from other buteos by its larger size and longer wings (which are often held slightly raised during flight), mostly white underparts and tail, and rusty orange shoulders and back. Some individuals have dark brown feathers with rusty-edges feathers overall, but with a characteristically pale tail. Females are larger than males, by about 50% in weight and 5-15% in other measurements (Ng *et al.* 2017).

### Population Spatial Structure and Variability

Previous work suggested that the Rocky Mountains might block dispersal (COSEWIC 2008). However, recent tracking studies show that individuals regularly cross the Rockies, and there is insufficient evidence to delineate subpopulations (Watson *et al.* 2018). No subspecies have been described (Ng *et al.* 2017).

### Designatable Units

Only one designatable unit is recognized, based on lack of evidence for any distinct subpopulations, as in previous status reports (e.g., COSEWIC 2008).

### Special Significance

Ferruginous Hawk is the largest species of buteo in North America, and globally only the Upland Buzzard may be larger. It is the only raptor that is endemic to the grasslands of North America. There is no species-specific Aboriginal Traditional Knowledge in this report. However, Ferruginous Hawk, like all species, is important to Indigenous peoples who recognize the interrelationships of all species within the ecosystem.



## DISTRIBUTION

### Global Range

Ferruginous Hawk is endemic to interior western North America. Its breeding range extends through the northern Great Plains, from southern Canada to the southwest U.S. and through interior basins and mountain ranges from Washington to Arizona. Between these eastern and western portions, the breeding range is interrupted by the Rocky Mountains. The winter range extends from California to Nebraska, south into Baja and north-central Mexico (Figure 1).

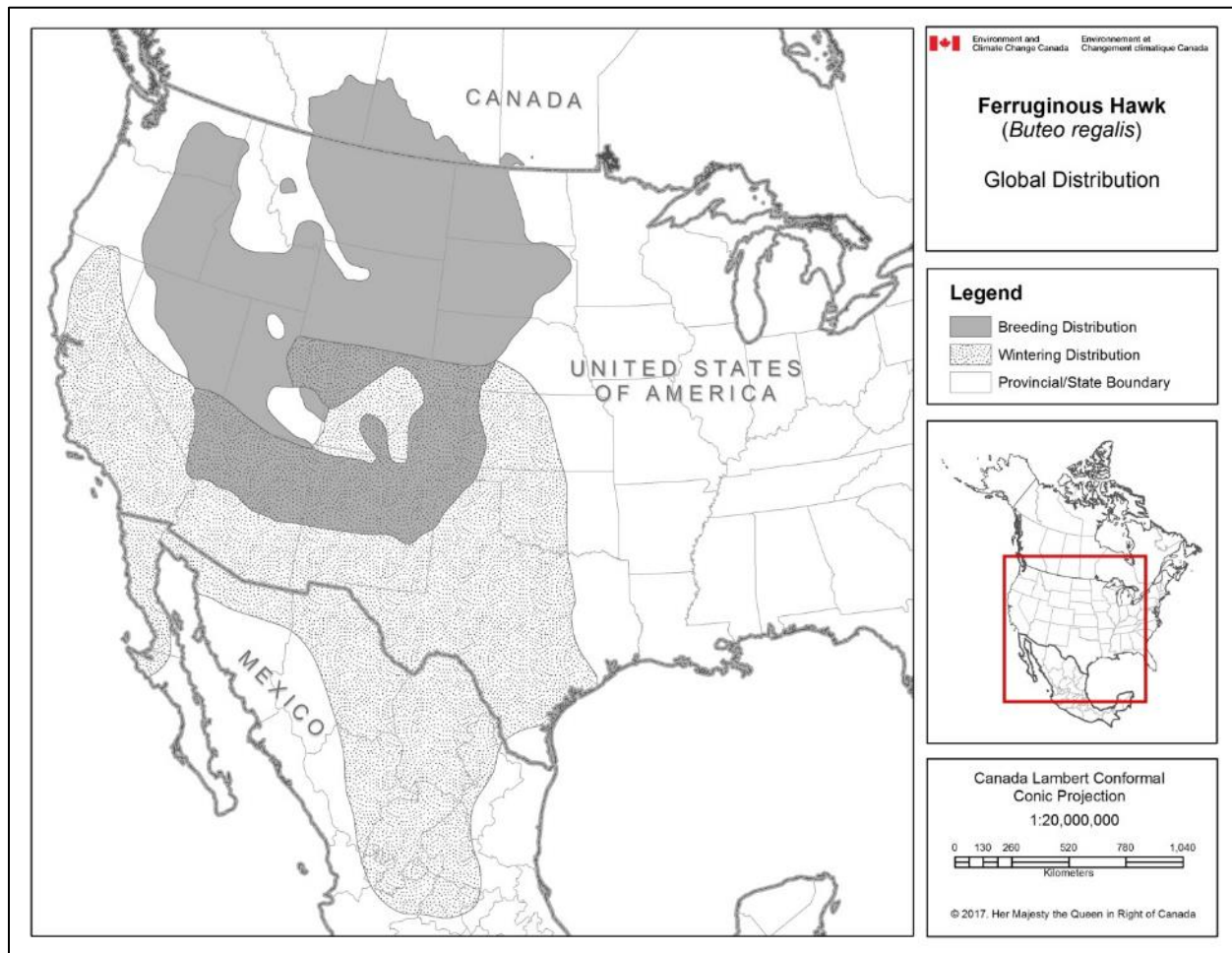


Figure 1. Breeding and wintering range of Ferruginous Hawk (map prepared by L. Burns).

## Canadian Range

Canada comprises about 10% of Ferruginous Hawk's breeding range. The species breeds in southeastern Alberta, southern Saskatchewan, and extreme southwestern Manitoba (Figure 2). British Columbia has two confirmed breeding records, from 1968 and 1978 (Campbell *et al.* 1990), and at least five other suspected breeding records since then. However, most individuals sighted in that province are thought to have wandered out of their normal range (BC Conservation Data Centre 2015; Di Corrado 2015).

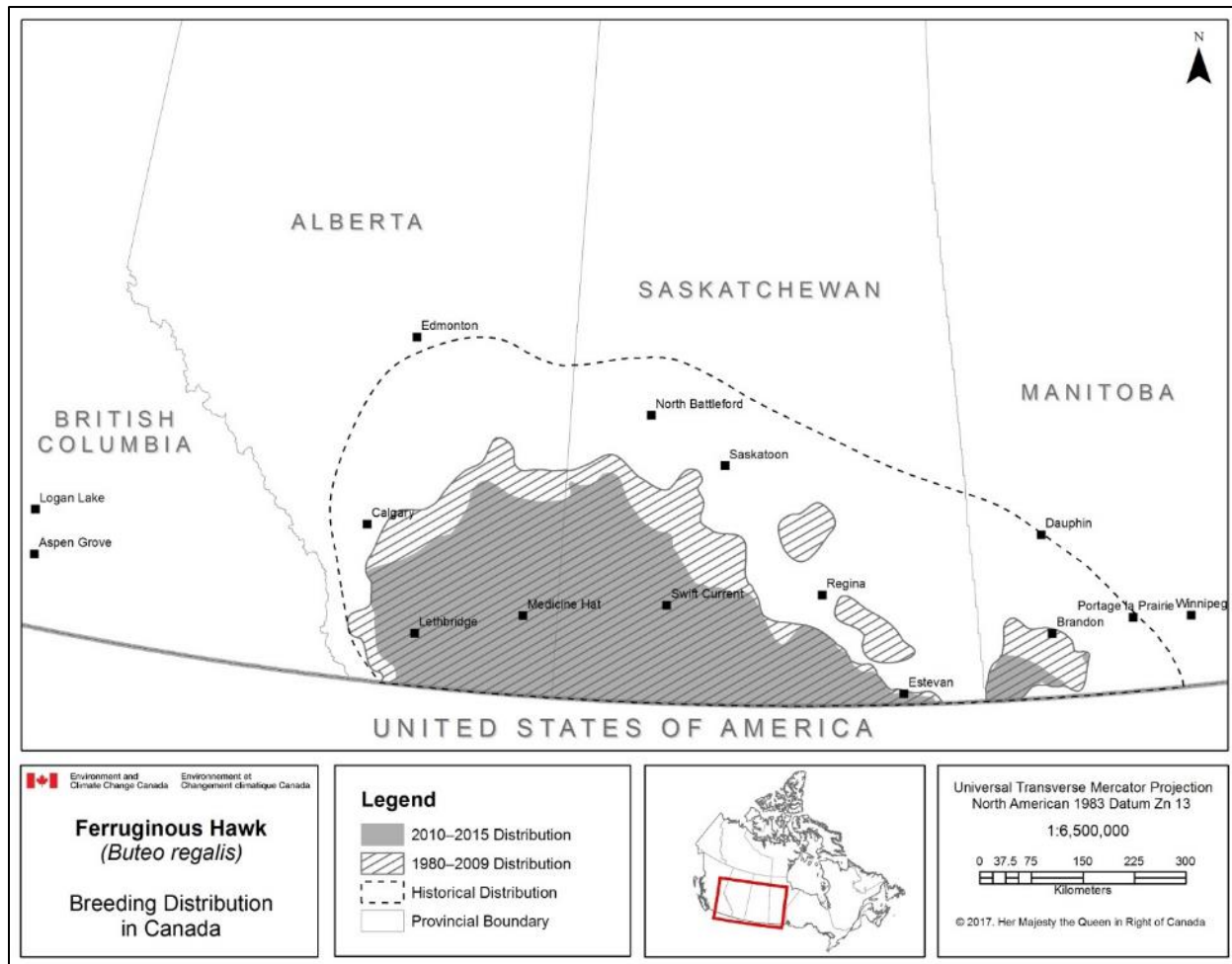


Figure 2. Ferruginous Hawk breeding distribution in Canada (map prepared by L. Burns). Historical distribution is adapted from Schmutz and Schmutz (1980) and COSEWIC (2008). 1980–2009 and 2010–2015 distributions were compiled by the University of Alberta Raptor Ecology and Conservation Team (REACT) from nesting records in a range of sources. Points in British Columbia indicate the only two breeding records in that province.

The northern limit of the current (2010-2015) range is 150-350 kilometres south of the known historical range extent (Figure 2). In Saskatchewan, Houston and Bechard (1984) attributed the early contractions in range to shooting, reduced prey populations, and habitat loss, including both conversion of grasslands to agriculture, and encroachment by Trembling Aspen (*Populus tremuloides*) in response to fire suppression. The apparent further contraction of the extent of occurrence in 2010-2015 compared to 1980-2009 (Figure 2) may be misleading, as the earlier range of dates spans three decades, and may include areas that were only occupied during the population peak in the late 1980s and early 1990s. The current range is considered to be largely unchanged over the past decade (Alberta Environment and Parks 2018), except in Manitoba, where it has been reduced 60% since 2010 (De Smet pers. comm. 2019).

## Extent of Occurrence and Area of Occupancy

Extent of occurrence (EOO) is estimated to be 237,000 km<sup>2</sup> within Canada, based on a minimum convex polygon around the current breeding range (Figure 2). The same method yields an EOO of 470,000 km<sup>2</sup> for the historical range, and 290,000 km<sup>2</sup> for breeding records between 1980 and 2009. Thus, EOO has declined by 50% from its original value, but most of the change occurred over 40 years ago (Figure 2; Soares pers. comm. 2018).

Index of area of occupancy (IAO) is difficult to calculate for this species. However, given the population estimate of at least 3000 breeding birds (see **Abundance**, below), and the average size of individual home ranges in Canada of 31.8 km<sup>2</sup> (REACT, unpubl. data), it is highly unlikely that many 2 x 2 km squares would be occupied by more than one pair, and the IAO is therefore almost certainly >2,000 km<sup>2</sup>.

## Search Effort

Ferruginous Hawk is easily identified, and of particular interest to naturalists by virtue of its relative rarity, so its distribution is well represented by sources such as eBird (2018) and provincial breeding bird atlases (see **Sampling Effort and Methods**, below). More detailed information on distribution and abundance is available from systematic surveys that focus on the species in all three provinces where it breeds. In 2013, the University of Alberta Raptor Ecology and Conservation Team (REACT), searched the species' range in Alberta and Saskatchewan for nesting pairs, then used a model relating relative nest abundance to habitat to estimate the total population. In Alberta, Alberta Environment and Parks conducts surveys to estimate the number of breeding pairs every five years (Redman 2016). A program similar to REACT's Alberta survey started in Saskatchewan in 2018 (Government of Saskatchewan 2018). In Manitoba, Manitoba Sustainable Development conducts yearly surveys for Ferruginous Hawk, which are thought to reliably measure the population, because few birds nest in a small area there (De Smet pers. comm. 2019).

## HABITAT

### Habitat Requirements

#### Breeding habitat

Throughout the year, Ferruginous Hawk uses open grassland, shrub-steppe, and desert (Ng *et al.* 2017). In Canada, it breeds in prairie landscapes that are predominantly grassland, especially those with a balanced mix of cropland and grassland (Ng 2019). Nesting densities and nesting success are higher in landscapes with low to moderate edge density (< 80 km within circles 2.5 km in radius), such as where grassland borders cropland or is intersected by roads (REACT 2016; Ng 2019). Some studies report that moderate levels of cropland (10-30%) may be preferred because Richardson's Ground Squirrel (*Urocitellus richardsonii*), the hawk's main prey, is more abundant there (Schmutz and Hungle 1989; Zelenak and Rotella 1997). Nonetheless, rate of prey delivery to nestlings at 83 Alberta nests was unrelated to landscape features (Ng 2019). An increase in the proportion of cropland, even beyond 50%, does not appear to affect nesting success (De Smet and Conrad 1991; REACT 2016; Ng 2019), but might reduce re-use of particular nests, though perhaps not re-use of territories, between years (REACT 2016).

Ferruginous Hawks defend territories around the nest that vary widely in size, from 3 to 136 km<sup>2</sup> (REACT 2016), perhaps in relation to prey availability (Leary *et al.* 1998). Nest sites are typically re-occupied in consecutive years, especially if prey are abundant (Wallace *et al.* 2016a) and if previous nesting resulted in the fledging of young (White and Thurow 1985; REACT 2016).

Nests range widely in size, and are made of dead and dry sticks, bones, and other debris, often lined with finer material, such as dung, sod, or bark (Ng *et al.* 2017). Nests are built on a wide variety of substrates, but almost all are features that are raised above the surrounding open, relatively level landscape. Over half of nest sites are trees or shrubs, but they also include cliffs, slopes, knolls, ridge crests and other outcrops, utility poles and towers, haystacks, and artificial nest platforms (Ng *et al.* 2017). Nest sites are generally lower than those of other large raptors in the species' range and can be on the ground when no raised sites are available.

#### Migration and winter habitat

During migration and winter, Ferruginous Hawk occurs in desert, shrub-steppe, and grassland, often concentrating where ground squirrels (Family Sciuridae, Subfamily Xerinae), Black-tailed Prairie Dog (*Cynomys ludovicianus*), or pocket gophers (Family Geomyidae) are abundant (Ng *et al.* 2017).

## Habitat Trends

Since European settlement, over 87% of native grassland on Canadian prairies has been lost (Samson *et al.* 2004), with substantial reductions in the distribution of Ferruginous Hawk as early as the 1930s (Smith *et al.* 2019). Habitat loss has slowed recently, but continues across the Great Plains at a rate of 1-5% per year (Gage *et al.* 2016).

Suitability of grassland habitat for Ferruginous Hawk depends on particular features of habitat, notably nesting sites and prey availability, as discussed under **Threats and Limiting Factors**, below.

## BIOLOGY

Most of this section is based on Ng *et al.* (2017) and recent research on the species in Alberta and Saskatchewan by REACT.

### Life Cycle and Reproduction

Ferruginous Hawk can live 20 years or more, and begin breeding at two years old (Ng *et al.* 2017). Generation time is estimated to be 6.86 years by BirdLife International (Bird *et al.* 2020).

In Canada, nests contain eggs in April or May and nestlings starting in May. Average clutch size is 2-4 eggs (range 1-8), and 2-3 nestlings are typically raised to fledging (Ng *et al.* 2017). Young fledge 38-50 days after hatching, remaining on the natal territory for up to 3 weeks after fledging (Ng *et al.* 2017).

Post-fledging survival varies across studies and sites from 30% to 70%. Among nests monitored in Alberta and Saskatchewan over three decades (n=6,687), first-year apparent survival (from return rates) of hatch-year hawks was 0.55 (standard error 0.147) and annual adult survival was 0.708 (standard error 0.024, n=115; Schmutz *et al.* 2008). In one Utah study with a much smaller sample size (n=13), survival over the first year of life was lower and survival thereafter slightly higher (34% and 75%, respectively; Woffinden and Murphy 1989).

High winds account for 20-40% of nest failures (Gilmer and Stewart 1983; Laux *et al.* 2016), and predation for another 20%, likely most often involving Great Horned Owl (*Bubo virginianus*; REACT, unpubl. data). Known causes of adult mortality include collisions, electrocution, shooting, and pesticide use. However, birds that die in these ways may be more likely to be recovered and reported, which biases the relative frequency of these causes of mortality.

## Physiology and Adaptability

Perhaps more so than in other raptors, repeated or intense disturbance from humans early in the nesting period may cause Ferruginous Hawk nest abandonment (White and Thurow 1985). After young are at least 10 days old and thus able to thermoregulate, human activity within 500 m may still cause adults or older nestlings to flush prematurely from the nest, but abandonment is less likely (Keeley and Bechard 2011; REACT 2016; Nordell *et al.* 2017b).

Heat stress has been observed to result in nestling mortality in areas without shade, particularly on hot surfaces like rock or cliff sides where heat reflects (Ng pers. comm. 2019).

## Dispersal and Migration

From the north of their range, including Canada, Ferruginous Hawks migrate to more southerly wintering areas. Young birds depart first, starting in late August, and adults leave as late as early October, with breeding-age adults returning in March or April (Ng *et al.* 2017). Stopovers of 3-6 weeks during fall migration are known from satellite-tagged breeders from Washington (which initially dispersed to the northeast, stopping over in Alberta, Saskatchewan, and Montana), and from breeders from Alberta and Saskatchewan (which stopped over in states from North Dakota to Nebraska; Ng *et al.* 2017). Juveniles may range widely (over thousands of kilometres) in winter, but adults generally return to the same wintering sites every year (Watson and Pierce 2003).

## Interspecific Interactions

### Diet

In Canada and the United States east of the Rocky Mountains, Ferruginous Hawk mainly eats ground squirrels (*Ictidomys*, *Poliocitellus*, and *Urocitellus* spp.), Black-tailed Prairie Dog, and pocket gophers (*Geomys* and *Thomomys* spp.). Ground squirrels and pocket gophers are also the primary prey in Washington, Oregon, and southwest Idaho, but in shrub-steppe habitats west of the Rocky Mountains, jackrabbits (*Lepus* spp.) and cottontail rabbits (*Sylvilagus* spp.) are preferred. In both regions and on the wintering grounds, other small to medium-sized vertebrates are also taken (Ng *et al.* 2017).

In Canada, up to 85-95% of the diet consists of Richardson's Ground Squirrel, as is true elsewhere in this ground squirrel's range (Ng *et al.* 2017). Pair density, fledging success, and nest re-use are positively associated with squirrel abundance (Schmutz and Hungle 1989). Reliance on other prey (such as birds, pocket gophers, jackrabbits, and smaller mammals) might increase when squirrels are scarcer (De Smet 2003).

### Nest and adult predation

Predators of eggs, nestlings, or fledglings include Great Horned Owl, American Crow (*Corvus brachyrhynchos*), Common Raven (*Corvus corax*), Common Raccoon (*Procyon lotor*), American Badger (*Taxidea taxus*), Bobcat (*Lynx rufus*), foxes (*Vulpes* spp.), and Coyote (*Canis latrans*; Ng *et al.* 2017). A pair of Golden Eagles (*Aquila chrysaetos*) was observed killing an adult Ferruginous Hawk (Buhler *et al.* 2000), but otherwise predation on adults has not been reported (Ng *et al.* 2017). Nonetheless, adult females are likely vulnerable to death or injury from Great Horned Owls, on nests at night, during incubation or brooding periods (Wellicome, pers. comm. 2019).

### Non-predatory interspecific interactions

Up to 5% of nests occupied in previous years may be occupied in subsequent years by other species, including Swainson's Hawk (*Buteo swainsoni*), Red-tailed Hawk (*Buteo jamaicensis*), Great Horned Owl, American Crow, Common Raven, and Canada Goose (*Branta canadensis*; Schmutz *et al.* 1980; Schmutz *et al.* 1988).

Aggressive interactions with other raptors occur, and Ferruginous Hawk may be displaced from nests on occasion by Swainson's Hawk (Ng *et al.* 2017). There is no interspecific territoriality (Ng *et al.* 2017), although reproductive success may be lower when competing species, such as Swainson's or Red-tailed Hawk, nest nearby (Schmutz *et al.* 1980). Often Ferruginous Hawks are seen perched next to nests that are occupied by Canada Geese but were occupied by Ferruginous Hawks the previous year (Wellicome pers. comm. 2019).

## **POPULATION SIZES AND TRENDS**

### **Sampling Effort and Methods**

The main source for abundance and population trends of many landbird species is the Breeding Bird Survey (BBS), in which volunteers count all species detected at 50 points evenly spaced along 39.2-km roadside routes once during each breeding season (Downes *et al.* 2016). Trends over time in Canada are analyzed using a hierarchical generalized additive model.

Most raptors are sparsely distributed, with limited detections and relatively high variability in the data (Farmer *et al.* 2007; Johnson *et al.* 2019). In the case of Ferruginous Hawk, the BBS (and eBird; see below) undersamples landscapes of contiguous grassland and few roads, where a high proportion of the species occurs. Surveys start in early morning before the hawks tend to become active, the species is more likely to perch on the ground than other buteos, and females are incubating when surveys occur, usually in trees where leaves occlude the nest and its occupants (Wellicome pers. comm. 2019). However, these limitations are consistent over time and the BBS provides a large annual sample of sites that can provide useful trend estimates for most raptors (Farmer *et al.* 2007). For

Ferruginous Hawk, the statistical reliability of BBS trend estimates (a combination of geographic coverage, precision, and influence of subsets of data points) is considered medium to high for Ferruginous Hawk in most regions (Smith *et al.* 2014; see **Fluctuations and Trends**, below).

Focused searches for breeding adults and nests within bounded areas, stratified by habitat and conducted before leaf out, have been undertaken in all three prairie provinces. In Alberta, 80-146 quadrats, each measuring 6.4 x 6.4 km, were searched for nests every 5 years, in 1982-1992 and 2000-2015 (Redman 2016). The quadrats were systematically chosen to represent landscapes with high and low amounts of cropland, so that the amount of each cropland type throughout the breeding range could be used to convert raw counts into a population estimate (Redman 2016). A similar scheme was started in Saskatchewan in 2018 (Government of Saskatchewan 2018), but is not comparable to the previous comprehensive search for breeding pairs conducted in 2013 (see **Search Effort**, above). It has only been conducted once to date, so trends cannot yet be estimated (Prieto pers. comm. 2019). All Ferruginous Hawk nests in Manitoba occur in a small region monitored by Sustainable Development. These provincial surveys circumvent many of the challenges faced by the BBS and likely provide more accurate estimates of population size. However, because the Alberta surveys have only been undertaken every five to eight years, they offer more limited insight into trends, especially considering annual variability in population numbers.

Provincial breeding bird atlases can also provide information on trends when they are repeated. During each 5-year atlas period, volunteers search for all breeding species within 10 x 10 km squares covering an entire province. Not all squares are searched, and search effort varies even within those squares that are searched, so data analyses must account for such variation. Within the breeding range of Ferruginous Hawk in Canada, search effort has been relatively thorough and consistent, and analyses of atlas data have taken effort into account. However, only the Alberta breeding bird atlas (covering about half the Canadian population) has been repeated, in 1987-1991 and 2000-2005 (Federation of Alberta Naturalists 2007).

Other monitoring programs survey birds that breed in the United States, as well as an unknown proportion of birds that breed in Canada, but migrate through or winter in the United States. The Raptor Population Index is a synthesis of hawk migration counts conducted regularly at sites across North America where migrating hawks concentrate (Crewe *et al.* 2016). Sampling is generally consistent, but can be strongly biased at the site level, owing to changes in observer participation or raptor flight paths (Nolte *et al.* 2016), and at the regional level, owing to changes in the timing and likelihood of migration (Farmer *et al.* 2007; Paprocki *et al.* 2017). Moreover, Ferruginous Hawks follow ridges and other narrow flight paths less than other raptors, and only a few count sites detect enough Ferruginous Hawks to estimate trends.



The Christmas Bird Count (CBC) is conducted yearly between December 14 and January 5. Volunteers count all birds encountered within a 24 km radius of points, throughout North America (Dunn *et al.* 2005). Neither the selection of points nor the survey methods are systematic, and detections of Ferruginous Hawk are scant, but sample sizes are sufficiently large, and sampling across years sufficiently consistent, to yield trend estimates when combined across the wintering range. It is not possible to differentiate trends for the Canadian population from the overall results.

## **Abundance**

Partners in Flight estimated a Canadian population of 22,000 mature individuals, based on global population size and extent of range (Will *et al.* 2018). However, Partners in Flight itself warns that these estimates are coarse in various respects, and that sources targeting particular species are preferable, where available (Stanton *et al.* 2019).

More accurate population estimates are available for Ferruginous Hawk from targeted provincial surveys. The latest results from Alberta (2015), Saskatchewan (2012-2013), and Manitoba (2018) estimate a total of 2960 breeding individuals in Canada, as follows:

Alberta: 865 (95% CI  $\pm$  201) pairs (Redman 2016)  
Saskatchewan: 604 pairs (REACT, unpubl. data)  
Manitoba: 11 pairs (De Smet pers. comm. 2019).

Within a given year, 5-40% of pairs may not breed (Ng *et al.* 2017) and may be undercounted on surveys. Additionally, many raptor populations include non-breeding 'floaters' (Newton 1998), though Schmutz *et al.* (2008) found no evidence of Ferruginous Hawk floaters in western Canada. Assuming that the targeted surveys did not have complete detection, and that non-breeders were relatively scarce, the number of mature individuals in Canada is likely at least 3000, but probably no more than 4000.

## **Fluctuations and Trends**

Ferruginous Hawk breeding density, reproductive output, and nest re-occupancy rates are positively correlated with abundance of prey, which in Canada is overwhelmingly Richardson's Ground Squirrel (e.g., Schmutz and Hungle 1989; Schmutz *et al.* 2008; Ward and Conover 2013; Wallace *et al.* 2016a). Fluctuations in response to changes in prey availability may add noise to long-term trend data, especially if they derive primarily from a few repeatedly sampled areas (Johnson *et al.* 2019). In particular, higher populations in the late 1980s and early 1990s in Alberta and Manitoba may be attributable to unusually elevated ground squirrel populations in those years (De Smet 2003).

## Trends in Canada

The BBS results for Ferruginous Hawk in Canada show a substantial long-term growth of 2.23% per year (95% credible interval [CI] = 0.53%, 3.87%), amounting to a 195% increase (95% CI = 29%, 543%) between 1970 and 2019 (Table 1; Figure 3). However, the trend has decelerated over time, with an average annual increase of 0.71% per year (95% CI = -1.39, 2.85) over the past three generations (1998-2019), amounting to a cumulative change of 16% (95% CI = -26%, 80%; Table 1). Rolling three-generation (21-year) trends show that they have remained positive, though since 2011 the lower end of the 50% CI has been slightly below zero (Figure 4).

**Table 1. Short-term (three-generation, 1998-2019) and long-term (1970-2019) population trends for Ferruginous Hawk in Canada, states bordering Canada, and the United States overall, based on generalized additive modeling of Breeding Bird Survey data; bolded trends have 95% credible intervals that do not cross zero and are highly likely to represent a substantial rate of change (A. Smith, unpubl. data).**

Region	Annual % Rate of Change (95% Lower/Upper CI)	Cumulative % Change (95% Lower/Upper CI)	Probability of decline >30%	# routes	Reliability
<b>Short-term</b>					
Alberta	-0.16 (-2.43, 2.06)	-3.3 (-40.4, 53.6)	0.094	50	Medium
Saskatchewan	1.73 (-1.92, 5.36)	43.3 (-33.5, 199.5)	0.034	26	Medium
Manitoba	-3.02 (-8.34, 2.03)	-47.4 (-83.9, 52.4)	0.689	7	Low
Canada	0.71 (-1.40, 2.85)	16.0 (-25.6, 80.3)	0.012	83	Medium
Washington	-2.78 (-8.59, 2.61)	-44.7 (-84.8, 71.8)	0.845	7	Low
Idaho	-1.47 (-61.5, 2.92)	-26.8 (-73.6, 82.9)	0.751	18	Low
Montana	1.70 (-0.42, 3.92)	42.6 (-8.4, 124.4)	0.061	48	Medium
North Dakota	<b>-3.43 (-6.06, -0.64)</b>	<b>-51.9 (-73.1, -12.6)</b>	0.991	34	Medium
United States	0.19 (-0.94, 1.34)	4.01 (-17.9, 32.4)	0.001	421	Medium
<b>Long-term</b>					
Alberta	<b>2.37 (0.60, 4.16)</b>	<b>214.6 (33.9, 638.3)</b>	0	51	High
Saskatchewan	2.21 (-0.38, 4.98)	192.4 (-16.9, 979.8)	0.012	29	Medium
Manitoba	1.49 (-1.87, 5.12)	105.9 (-60.3, 1057.3)	0.097	7	Low
Canada	<b>2.23 (0.52, 3.87)</b>	<b>194.7 (29.5, 542.7)</b>	0.008	87	High
Washington	0.69 (-3.06, 3.95)	36.7 (-78.1, 567.0)	0.218	9	Low
Idaho	2.01 (-0.81, 4.96)	164.9 (-32.9, 969.6)	0.082	18	Medium
Montana	<b>3.99 (2.34, 5.68)</b>	<b>579.0 (211.8, 1396.0)</b>	0	48	High
North Dakota	0.48 (-1.21, 2.25)	26.3 (-44.8, 198.1)	0.290	35	High
United States	<b>1.93 (1.11, 2.82)</b>	<b>155.0 (71.7, 290.3)</b>	0	448	High

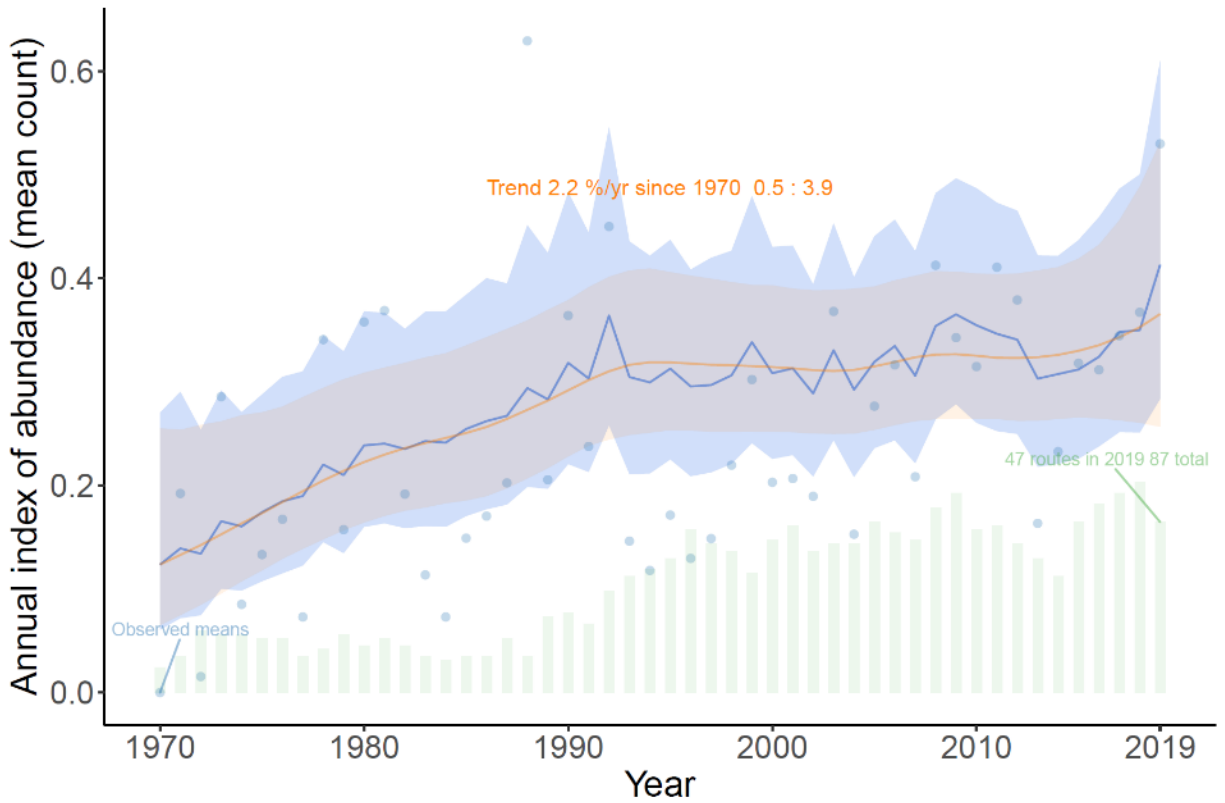


Figure 3. Annual index of population abundance for Ferruginous Hawk in Canada, based on Breeding Bird Survey data from 1970-2019 (n=87 routes), with observed means shown with blue dots. The GAM (generalized additive model) trend in orange represents the best curvilinear fit of data, whereas the slope trend in blue incorporates effects of annual variation. Orange (appearing grey 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 in Canada with Ferruginous Hawk detections (A. Smith, unpubl. data).

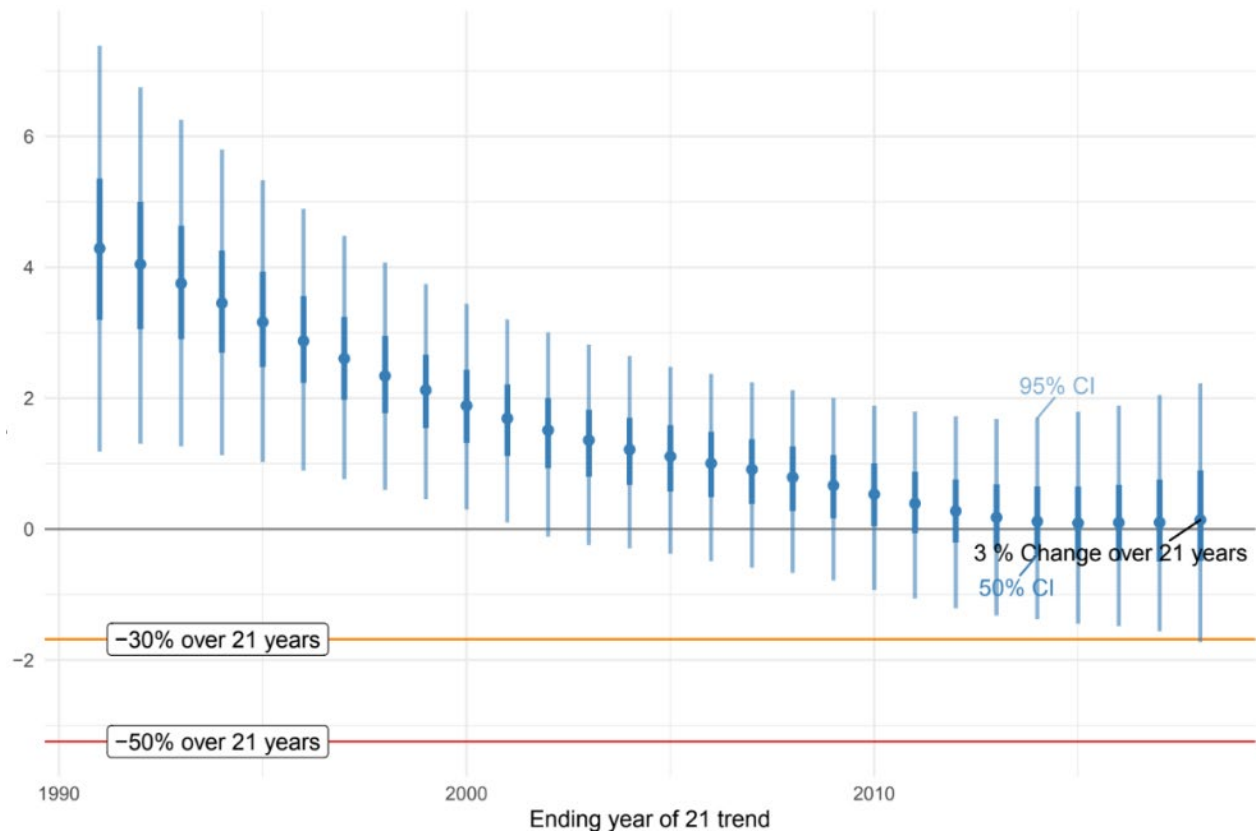


Figure 4. Rolling 21-year (three-generation) trends for Ferruginous Hawk population change in Canada, based on Breeding Bird Survey data from 1970 to 2019 (A. Smith, unpubl. data). The vertical axis represents the average annual percent change in population size over a three-generation period. The horizontal axis represents the last year of the 21-year rolling trend (e.g., 2019 is the trend for 1998-2019). Orange and red horizontal lines depict 30% and 50% cumulative three-generation decline rates, which represent COSEWIC thresholds for assessing a species as Threatened and Endangered, respectively. Vertical bars depict 50% (broad, dark blue) and 95% (narrow, light blue) credible intervals.

### Trends in provinces

At a provincial scale, the long-term BBS trend estimate is positive in all three provinces, whereas the three-generation trend estimate is positive in Saskatchewan, but weakly negative in Alberta, and more strongly negative in Manitoba (Table 1). Route-level BBS analysis shows a mix of increasing and decreasing three-generation trends in Alberta (n=50), primarily increasing trends in Saskatchewan (n=26), and entirely decreasing trends in Manitoba (n=7; Figure 5).

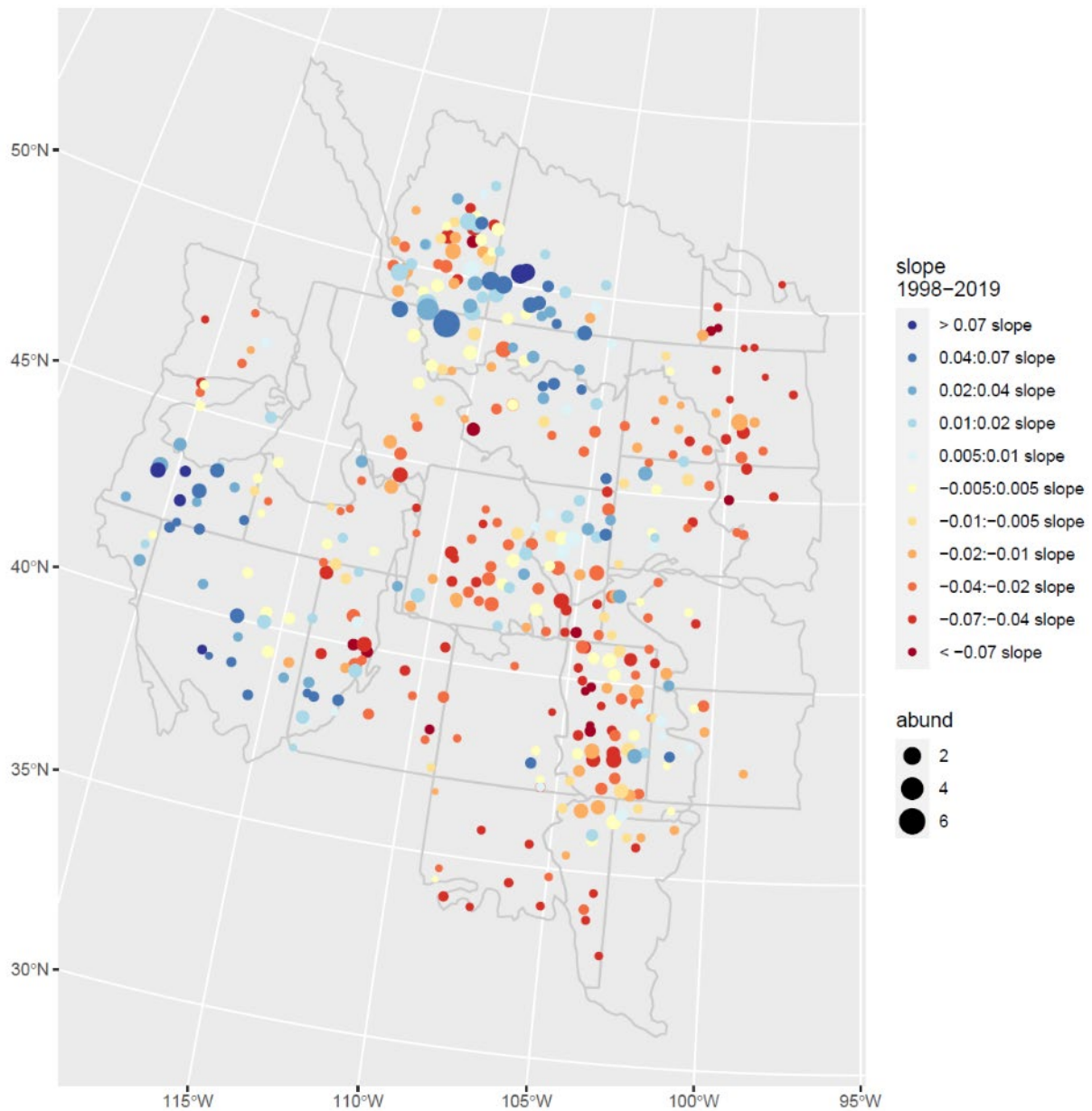


Figure 5 Breeding Bird Survey route-level trends over the most recent three-generation period (1998-2019; A. Smith, unpubl. data). The four polygons north of the 49<sup>th</sup> parallel delineate (from left to right) Bird Conservation Region (BCR) 10 within Alberta, and BCR 11 within Alberta, Saskatchewan, and Manitoba.

The Alberta breeding bird atlas, the only atlas project in the prairie provinces that currently offers information on changes in abundance, reports the probability of detection of Ferruginous Hawk as “increasing” between atlas projects (1987-1991 versus 2000-2005). Conversely, standardized searches for Ferruginous Hawk conducted in Alberta every five years yielded an estimate of 1702-1791 pairs in 1987 and 1992, but only 618-731 pairs in 2000 and 2005 (Redman 2016), an average decrease of 61% between the two periods. However, there is a slight increasing trend over the period most closely aligned with the past three generations (2000-2015; Redman 2016, Figure 6).

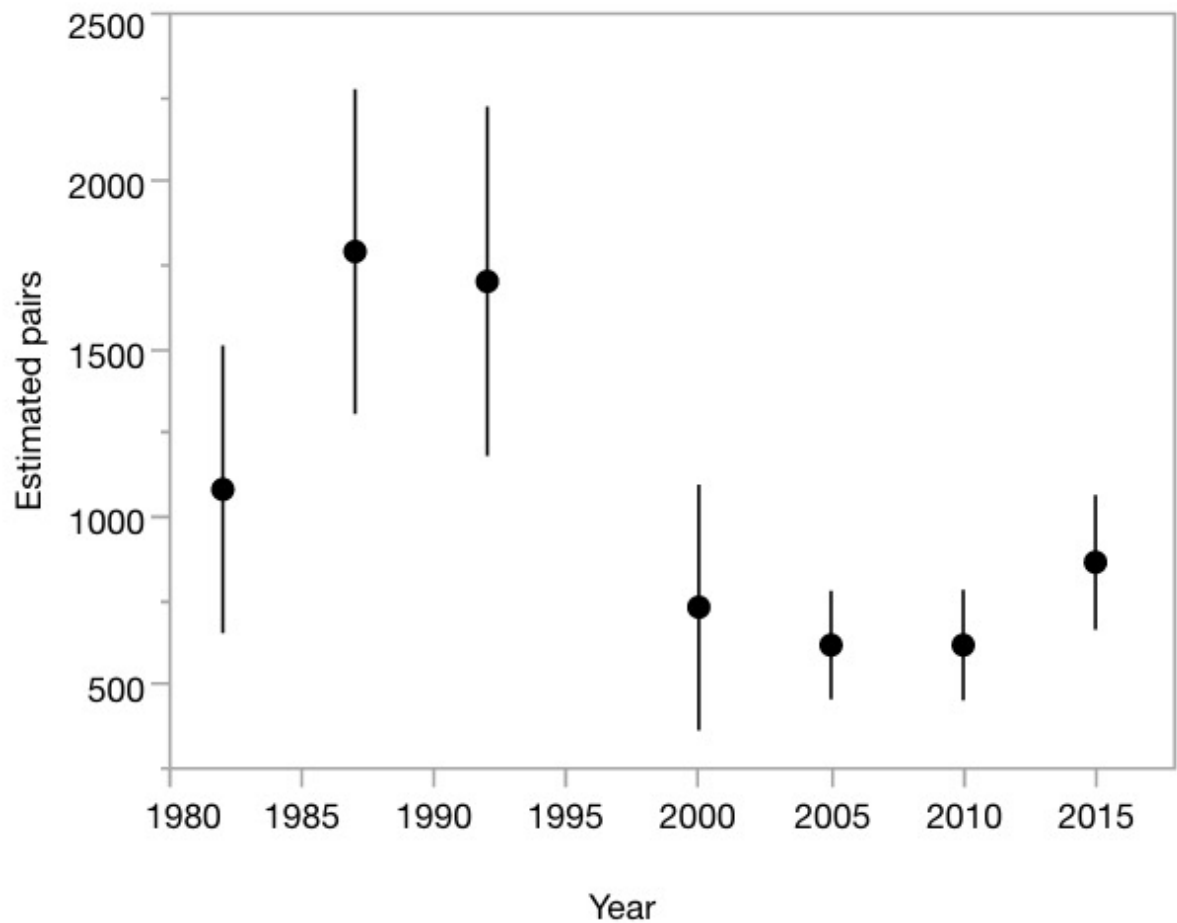


Figure 6. Estimated number of pairs (with 95% confidence intervals) of Ferruginous Hawk breeding in Alberta, 1982-2015 (from Redman 2016).

Manitoba surveys show a precipitous decline (annual trend -6%) in the number of nests over the last 20 years (Figure 7). Precipitation levels in Manitoba that were well above average, since at least 1997, have reduced ground squirrel numbers and may account for the decrease (De Smet 2003; Artuso pers. comm. 2019).

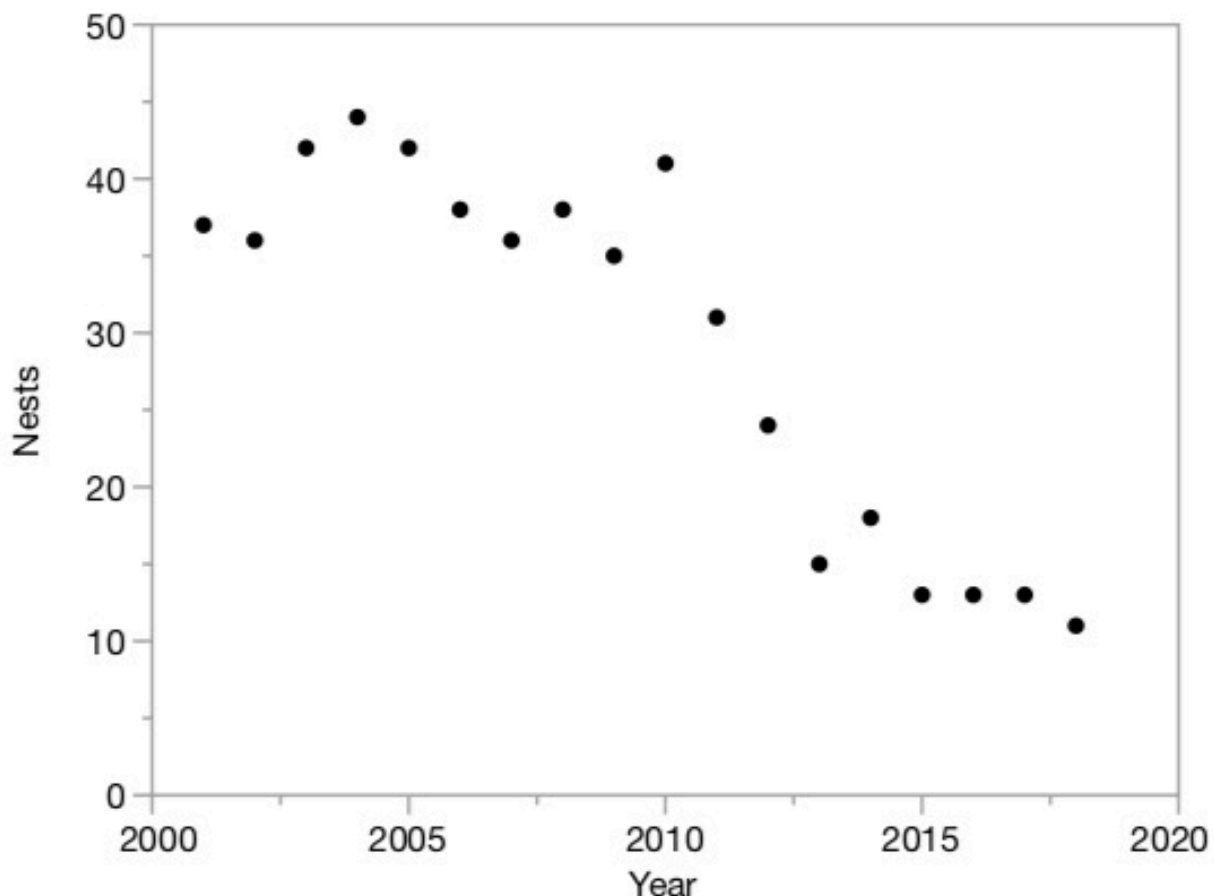


Figure 7. Number of active Ferruginous Hawk nests in Manitoba, 2001-2018 (Artuso pers. comm. 2019). The latest 15-year trend (2003-2018) is -2.49 nests/year (95% CI: -3.01, -1.98).

### Trends outside Canada

BBS data from the United States show a long-term increase similar to that in Canada, with an average annual trend of 1.93% (95% CI = 1.11%, 2.82%) amounting to a 155% increase between 1970 and 2019. The short-term trend has slowed to nearly stable, with an average annual trend of 0.19% (95% CI = -0.94%, 1.34%) and cumulative change of 4.0% (95% CI = -17.9%, 32.4%) from 1998 to 2019 (Table 1). At a continental scale, route-level BBS analysis shows that increases are concentrated in the southwest (Oregon, Nevada) and north-central (southeastern Alberta, Saskatchewan, northern Montana) parts of the breeding range, contrasting with declines through much of the eastern one-third of the range, especially in the northeast (Manitoba, North Dakota) and southeast (New Mexico, Texas, and Oklahoma).

CBC data indicate slightly to moderately increasing trends of Ferruginous Hawk over both the long term (0.78%/year, 1970-2019; 95% CI = -0.11%, 1.42%), and short term (1.41%/year, 2009-2019; 95% CI = -0.39%, 2.91%; Figure 8; Meehan *et al.* 2020).

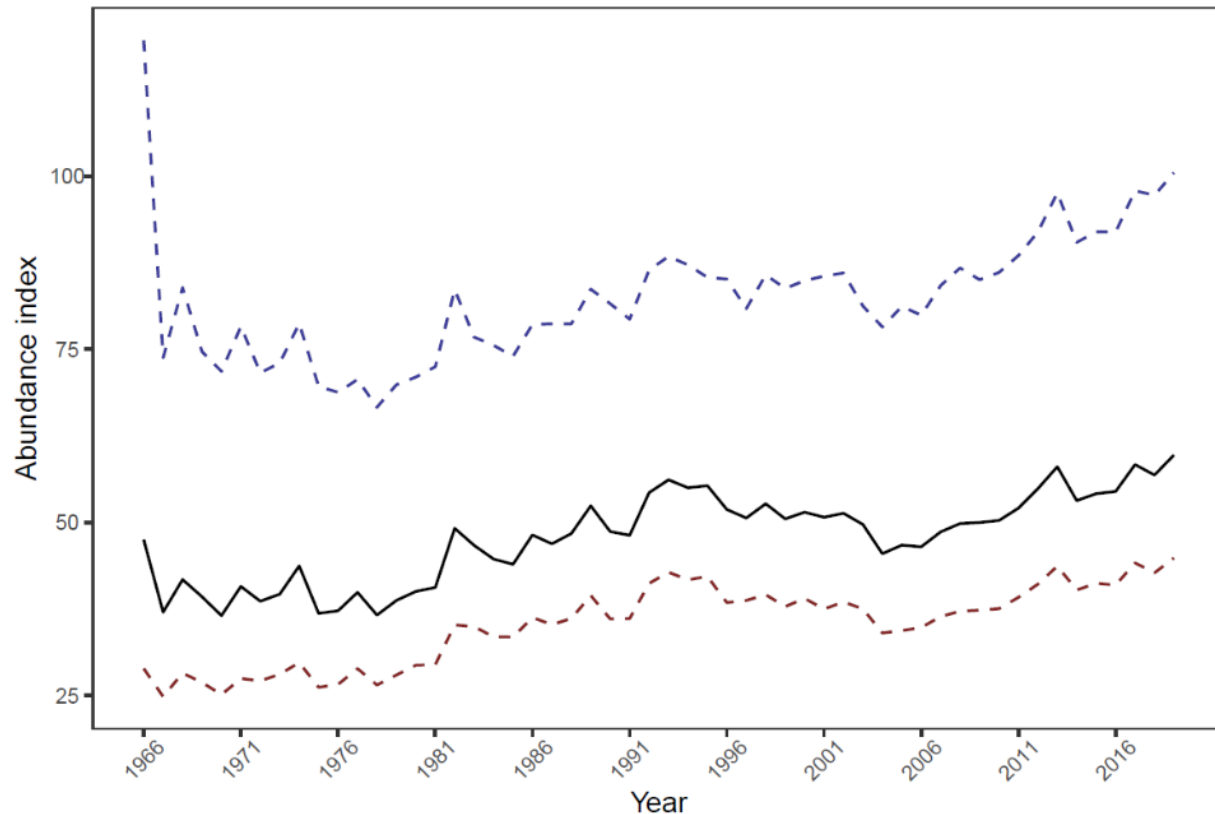


Figure 8. Mean abundance per hours of observation of Ferruginous Hawk in the United States between 1966 and 2019, as recorded on the Christmas Bird Count (Meehan *et al.* 2020). Blue and red dashed lines represent upper and lower 95% credible intervals, respectively.

Only three hawk migration sites detect enough Ferruginous Hawks to estimate recent trends (2006-2016). Migrants decreased at one site (fall migrants at Dinosaur Ridge, Colorado: trend = -18.5%/year, 95% CI = -24.2% to -12.4%); increased at another (spring migrants at Goshute Mountains, Nevada: 7.1%/year, 95% CI = -5.4% to 17.7%), and remained stable at a third (Manzano Mountains, New Mexico: -3.6%/year, 95% CI: -10.0% to 3.2%).

### Summary of trends

The BBS and CBC both show substantial long-term population growth, but differ somewhat over the past three generations, with BBS data suggesting that the rate of increase is tapering off, whereas CBC data indicate it is accelerating. The targeted Ferruginous Hawk survey in Alberta produces much more precise population estimates, but that advantage is offset by having data points only every 5-7 years, most recently in 2015. However, the trend of the Alberta counts from 2000 to 2015 is quite similar to the rate of increase estimated from the BBS. The stable to increasing numbers in Alberta and Saskatchewan contrast sharply with the steep declines in Manitoba, but such a small part of the Canadian population occurs there that these losses have limited influence on the



national trend. Overall, the positive long-term and short-term trends provide evidence that Ferruginous Hawk appears to have capacity to cope with at least some of the concerns identified in the **Threats section**, although the gradually decreasing rate of increase shown by BBS data suggests the possibility of a future decline.

## **Rescue Effect**

Immigration of birds originating in the United States Great Plains is likely, and there is currently habitat available for immigrants. However, although immigration occurs, it is unlikely to be sufficient to rescue the Canadian population if availability of suitable habitat continues to decline on both sides of the border.

## **THREATS AND LIMITING FACTORS**

### **Threats**

Ferruginous Hawk is vulnerable to the cumulative effects of various threats throughout its annual cycle. These factors are categorized below and in Appendix 1, following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system (based on Salafsky *et al.* 2008). The evaluation assesses impacts for each of 11 main categories of threats and their subcategories, based on the scope (proportion of population exposed to the threat over the next 10-year period), severity (predicted population decline among those exposed to the threat during the next 10 years or 3 generations, whichever is longer), and timing of each threat. The overall threat impact is calculated by taking into account the separate impacts of all threat categories and can be adjusted by the species experts participating in the evaluation.

The overall threat impact for Ferruginous Hawk is considered to be high, corresponding to an anticipated decline of 10-70% over the next three generations (Master *et al.* 2012; see **Appendix 1** for details). This contrasts with evidence of a stable to increasing population, suggesting that certain activities may be limiting growth rather than causing declines, and that there may be some capacity of the population to cope with existing threats, supported at least in part by recovery efforts such as installation of nest platforms, reduction of collision risk through attachment of markers to power lines near nests, and implementation of setback recommendations for industry activities. However, the projected impact reflects concerns that the scope or severity of some threats is anticipated to rise. Threats are discussed below, in order of decreasing severity of impact.

### IUCN 7, Natural Systems Modifications (low-medium threat impact)

#### *IUCN 7.3, Other Ecosystem Modifications (low-medium threat impact)*

Removal or senescence of homestead trees and shelterbelts (Bellet 2013) reduces the number of available nest sites (Houston and Bechard 1984), although this has been

offset to some extent by erection of nesting platforms and expansion of the utility line network. The abundance of Richardson's Ground Squirrel (and, in the United States, Black-tailed Prairie Dog) is positively related to hawk abundance and nest success (see **Physiology and Adaptability**, above), but these key prey species are controlled locally by humans as pests (Marsh 1982; Proulx 2010), and may also affect suitability of migrating and wintering areas for Ferruginous Hawk. Outbreaks of sylvatic plague, an introduced disease caused by a bacterium (*Yersinia pestis*) and carried by fleas (Order Siphonaptera), can decimate Black-tailed Prairie Dog populations, which may in turn affect hawks migrating or wintering in the United States (Jones 1989; Cully 1991; Seery and Matiatos 2000). However, the primary prey species, Richardson's Ground Squirrel, remains generally common, and locally abundant (Downey *et al.* 2006; Proulx 2010; Proulx *et al.* 2012).

#### *IUCN 7.1, Fire & Fire Suppression (low threat impact)*

Fire suppression partially accounts for the encroachment of trees into grassland areas (Fent and Richard 1999; Schneider 2013), especially in the northern parts of Ferruginous Hawk's breeding range (Schmutz 1984). Isolated, large diameter trees offer nesting sites, but most tree encroachment reduces open grassland foraging habitat with dense, small trees that are unsuitable to Ferruginous Hawk for nesting or foraging (Houston and Bechard 1984; Shank and Bayne 2015), but may facilitate increased abundance of predators and nest competitors. This threat may partly account for the southward retraction of the range by the early 1980s (Houston and Bechard 1984).

#### IUCN 2, Agriculture & Aquaculture (low threat impact)

##### *IUCN 2.1, Annual & Perennial Non-Timber Crops (low threat impact)*

Conversion to cropland has accounted for most of the loss of native grassland in Canada (Samson *et al.* 2004) and is continuing (Statistics Canada 2017; see **Habitat Trends**, above). Ferruginous Hawk is two to four times less likely to occur in landscapes with less than 50% grassland (i.e. more than 50% cropland; Schmutz 1989; Redman *et al.* 2016), and nests with less grassland (within 2.5 km are less likely to be reoccupied (by about 1% for every 10% decrease in grassland cover; REACT 2016). Ongoing grassland conversion is reducing edges and gaps between areas of existing agriculture, and expanding into heterogeneous habitat.

#### IUCN 3, Energy Production & Mining (low threat impact)

##### *IUCN 3.1, Oil & Gas Development (low threat impact)*

Although oil and gas development in western Canada has slowed considerably overall since 2004 (National Energy Board 2017), there have been localized increases (e.g., the Bakken Shale in North Dakota; Wiggins *et al.* 2017). The associated infrastructure displaces nesting and foraging habitat in each project's footprint and may reduce occupancy or nesting success at a landscape level. Nests near oil wells produced fewer

young in a Utah study (Keough *et al.* 2015), nest re-occupancy (but not productivity) has slightly declined with the density of petroleum access roads (Wallace *et al.* 2016a,b), and across a small sample of nests (n=18), nest re-occupancy was lower in areas with more extraction (Wiggins *et al.* 2017). However, no such effects were found in one intensive study in Canada (REACT 2016).

### *IUCN 3.3, Renewable Energy (low threat impact)*

Wind energy development is expanding rapidly in the prairie provinces, especially in southern Alberta and Saskatchewan (Natural Resources Canada 2016), with currently proposed projects expected to increase the number of turbines by a factor of five. Wind farms can reduce both availability and suitability of habitat. Reduced productivity near turbines is suggested by an Oregon study, one of the only wind energy studies involving Ferruginous Hawk. Specifically, nestlings were more likely to starve or be depredated, and adults appeared more likely to avoid foraging habitat, as the number of wind turbines within 3.2 km of nests increased (Kolar and Bechard 2016). Collisions with turbines are also a risk, and may be more likely for Ferruginous Hawk than other hawks, because of its tendency to fly at heights swept by rotor blades (Wulff *et al.* 2016).

### IUCN 4, Transportation & Service Corridors (low threat impact)

#### *IUCN 4.1, Roads & Railroads (low threat impact)*

Roads and railroads remove habitat and introduce the risk of collisions. In a tracking study, 4% of adult Ferruginous Hawks (N = 50) and 3% of juveniles (N = 103) died from vehicle collisions (Bayne *et al.* 2016). Fledglings often perch along roads, and road kills are occasionally reported. Nest re-occupancy in Wyoming was negatively correlated with the density of nearby oil and gas field roads (Wallace *et al.* 2016a). Conversely, roads and roadside fences may increase the availability of prey (REACT, unpubl. data).

#### *IUCN 4.2, Utility & Service Lines (low threat impact)*

The poles and towers that support utility lines can offer perches and nesting sites (Lokemoen and Duebbert 1976; Gilmer and Stewart 1983), but the lines themselves can result in collisions or electrocution. Electrocuted birds account for at least 2% of mortalities in several studies of Ferruginous Hawk (Schmutz and Fyfe 1987; Harmata *et al.* 2001; REACT 2016), and 0.1% of individuals banded in North America (Gossett 1993; see also Kemper *et al.* 2013).

### IUCN 5, Biological Resource Use (low threat impact)

#### *IUCN 5.1, Hunting & Collecting Terrestrial Animals (low threat impact)*

Shooting raptors is now illegal in Canada and the United States, but historically it reduced Ferruginous Hawk populations, and may have influenced the reduction in the species' historical range (Ellis *et al.* 1969; Houston and Bechard 1984). As late as the

1980s, 16-19% of band recoveries were birds that had been shot (Schmutz and Fyfe 1987; Gossett 1993), although there is a positive bias to recovery of such birds. Recent satellite tracking has revealed that Ferruginous Hawks that breed in Canada are still occasionally shot during winter season south of the border (J.L. Watson, unpubl. data).

Poisoning from lead shot in prey occurs but is unlikely to be lethal (Stephens *et al.* 2005; Knopper *et al.* 2006). Nonetheless, Ferruginous Hawk is sometimes poisoned from eating prey that contains pesticides (Mineau *et al.* 1999; Fleischli *et al.* 2004) or anticoagulant rodenticides (Vyas *et al.* 2012; Proulx 2014; George 2015). However, sufficiently few birds are affected by poisoning to likely have any population-level effects (George 2015).

#### IUCN 8, Invasive & Other Problematic Species & Genes (low threat impact)

##### *IUCN 8.2, Problematic Native Species (low threat impact)*

Great Horned Owl, Coyote, and Common Raccoon are predators of Ferruginous Hawk that are increasing in the Canadian breeding range (Lariviere 2004; Nordell *et al.* 2017a). Great Horned Owl may also compete for previously used nests, preventing use by Ferruginous Hawk, as the owl's nesting season begins earlier (Kamer *et al.* 2005; Environment and Climate Change Canada 2014).

##### *IUCN 8.1, Invasive Non-Native/Alien Species (unknown threat impact)*

West Nile Virus (*Flavivirus* spp.) has been found in dead Ferruginous Hawks (Nemeth *et al.* 2006; Datta *et al.* 2015), but its impact on populations is unknown.

#### IUCN 11, Climate Change & Severe Weather (low threat impact)

##### *IUCN 11.4, Storms & Flooding (low threat impact)*

The frequency of extreme weather events is projected to increase with climate change (Easterling *et al.* 2000). In Alberta, average precipitation and wind speed may not increase over the next few decades, but more precipitation will fall during extreme events, and extreme wind events will be more frequent (Shank and Bayne 2015). Severe storms reduce nesting and fledging success (Wallace *et al.* 2016b), rainfall and wind reduce foraging opportunities (Laux *et al.* 2016), and up to 8% of 1017 monitored nests in Canada failed because of high winds (Shank and Bayne 2015). Mortality from lightning strikes may be increasing as frequency of severe storms during the breeding season rises.

##### *IUCN 11.1, Habitat Shifting & Alteration (unknown threat impact)*

The abiotic conditions for grassland habitats currently occupied by Ferruginous Hawk are projected to shift northward with climate change (Thorpe 2011; Schneider 2013), and changes in winter snow cover or extreme snowfalls may strongly affect spring or summer availability of ground squirrels (T. Wellicome pers. comm. 2019). Population models

comparing the effects of climate change to land use change suggest the latter will have a far stronger impact (Ng 2019), but the ultimate effect of climate change on the species' population is unknown at this time (Shank and Bayne 2015).

## Limiting Factors

Like most other raptors, Ferruginous Hawk is ecologically limited by its low reproductive rate. Moreover, it is particularly dependent on populations of ground-dwelling rodents (see **Physiology and Adaptability**, above) and the need for safe ground or elevated nesting sites in grassland landscapes (see **Life Cycle and Reproduction**, above).

## Number of Locations

The number of locations is difficult to estimate for Ferruginous Hawk. However, given the extent of its range and the number of threats with potential to affect the species at a local scale, the number of locations is likely much greater than 10. Even single threats with large geographical scopes, such as climate change, are likely to vary regionally in their severity.

# PROTECTION, STATUS AND RANKS

## Legal Protection and Status

Ferruginous Hawk is listed as Threatened under Schedule 1 of Canada's *Species at Risk Act* (Government of Canada 2019), Endangered under Alberta's *Wildlife Act* (Province of Alberta 2018), and Threatened under Manitoba's *Endangered Species and Ecosystems Act* (Province of Manitoba 2018). Like other raptors, it is not protected by the *Migratory Birds Convention Act* of Canada, instead falling under provincial laws and regulations against hunting and disturbance (Government of Canada 2017). In the United States, however, it is protected under the *Migratory Bird Treaty Act* (USFWS 2017) in addition to state legislation.

Ferruginous Hawk is also protected under the *Canada National Parks Act* and is one of the species listed in a multi-species action plan for Grasslands National Park (Parks Canada 2016), as well as being expected to benefit from the conservation actions outlined in the South of the Divide Action Plan (Environment and Climate Change Canada 2016).

## Non-Legal Status and Ranks

The NatureServe conservation ranking of Ferruginous Hawk is Vulnerable (N3) in Canada; at the provincial scale it is Vulnerable (S3) in Saskatchewan, but Imperilled to Vulnerable (S2S3) in Alberta, and Critically Imperilled (S1) in Manitoba (Table 2). It is ranked as Apparently Secure both globally (G4) and in the United States (N4), but in states bordering Canada it is Critically Imperilled (S2) or Vulnerable (S3) (Table 2).

**Table 2. Conservation status of Ferruginous Hawk in Canada, the United States, and states bordering Canada (from NatureServe 2020).**

<b>Jurisdiction</b>	<b>Status Rank</b>
Global	G4
Canada	N3B,N3N,NUM
British Columbia	SU
Alberta	S2S3B
Saskatchewan	S3B
Manitoba	S1B
United States	N4B,N4N
Washington	S2B
Idaho	S3B
Montana	S3B
North Dakota	SU
Minnesota	SNA

\*N (at start of rank) = National; S = Subnational; B = Breeding; M = Migratory; N (at end of rank) = Non-breeding. 1 = Critically Imperilled; 2 = Imperilled; 3 = Vulnerable; 4 = Apparently Secure; 5 = Secure; NA = Not Applicable; NR = Not Ranked; U = Unrankable (due to lack of information or conflicting information)

Ferruginous Hawk is not on the Partners in Flight Watch List, but the U.S. Fish and Wildlife Service lists it as a Species of Management Concern, and it is a Species of Conservation Concern in several states. Moreover, it is listed as a Species of Greatest Need (or Concern, Priority, or similar designation) in 14 states, a Type 2 Sensitive Species by the U.S. Bureau of Land Management in several states, and Subject to Special Protection in Mexico (Ng *et al.* 2017).

## **Habitat Protection and Ownership**

Over one-third of Canada's Prairie Ecozone is privately owned, and only 3.5% is in protected areas: 2% in Alberta, 9% in Saskatchewan, and 1% in Manitoba, even when marginally protected areas, such as former Prairie Farm Rehabilitation Administration and provincial community pastures, are included (Gauthier and Wiken 2003; Woodley *et al.* 2008). Notably large protected areas within the range of Ferruginous Hawk include Suffield National Wildlife Area, Onefour and Twin River Heritage Rangeland Natural Areas in Alberta, and Grasslands National Park, Govenlock-Nashlyn-Battle Creek Grasslands, and Old Man on His Back Heritage Conservation Area in Saskatchewan (Canadian Council on Ecological Areas 2019). Important Bird Areas that were designated partly because of high concentrations of breeding Ferruginous Hawk include Mantario Hills and Maple Creek

Grasslands in Saskatchewan, and Southwestern Manitoba Mixed-Grass Prairie in Manitoba (Bird Studies Canada 2019).

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Andrew Gregg Horn is a behavioural ecologist with a Ph.D. in Zoology, which he earned studying Western Meadowlarks (*Sturnella neglecta*) in agricultural landscapes in Manitoba. Since then, he has conducted a wide range of avian monitoring and assessment projects and authored several status reports and recovery plans, including an updated COSEWIC status report for the grassland-dwelling Baird's Sparrow (*Ammodramus bairdii*) and Thick-billed (formerly McCown's) Longspur (*Rhynchophanes mccownii*). He is currently a Research Adjunct (Faculty of Graduate Studies) and Assistant Professor (Biology and Psychology & Neuroscience) at Dalhousie University, where his teaching and research focus on animal behaviour, especially acoustic communication in birds.

## **COLLECTIONS EXAMINED**

No museum specimens were examined for the preparation of this report.

## Appendix 1. Threat calculator results for Ferruginous Hawk.

<b>Species or Ecosystem Scientific Name</b>		Ferruginous Hawk - <i>Buteo regalis</i>	
<b>Element ID</b>		<b>Elcode</b>	
<b>Date</b>	2019-05-30		
<b>Assessor(s):</b>	Andy Horn (writer), Marcel Gahbauer (co-chair), Dave Fraser (facilitator), Marie-France Noel (COSEWIC secretariat); Ruben Boles, Brandy Downey, Janet Ng, Liana Zanette		
<b>References:</b>	Adapted from previous version prepared for the SARA Recovery Strategy by Troy Wellicome, David Bruinsma, and Ryan Fisher		
<b>Overall Threat Impact Calculation Help:</b>		<b>Level 1 Threat Impact Counts</b>	
<b>Threat Impact</b>		<b>high range</b>	<b>low range</b>
A	Very High	0	0
B	High	0	0
C	Medium	1	0
D	Low	6	7
<b>Calculated Overall Threat Impact:</b>		High	High
<b>Assigned Overall Threat Impact:</b>		B = High	
<b>Impact Adjustment Reasons:</b>		Population has been stable or increasing, suggesting that threats may be overstated. However, an overall impact of high may be plausible, because the severity of several threats is uncertain, the scope and/or severity of some threats may be increasing, and the effect of current threats may have been offset to some degree by recovery actions.	
<b>Overall Threat Comments:</b>		Generation time assumed to be 6.86 years.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Urban development is reducing and fragmenting habitat for Ferruginous Hawk in parts of its range (Roch and Jaeger 2014; Keeley <i>et al.</i> 2016), although scope is likely negligible in Canada. It generally avoids urban areas in winter (Berry <i>et al.</i> 1998; Plumptre and Andersen 1998), rarely nests near occupied buildings (Schmutz 1984; Gaines 1985), and has lower reproductive success within 2.5 km of residences (Gaines 1985), but may winter in suburban areas (Ng pers. comm. 2019).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Some development of warehouses and malls may occur on urban fringes used by Ferruginous Hawk, but scope is almost certainly negligible.
1.3	Tourism & recreation areas						Not applicable
2	Agriculture & aquaculture	D	Low	Restricted (11-30%)	Slight to Moderate (1-30%)	High (Continuing)	
2.1	Annual & perennial non-timber crops	D	Low	Restricted (11-30%)	Slight to moderate (1-30%)	High (Continuing)	Some conversion of grassland to cropland continues (especially in Saskatchewan); considering the large home ranges of Ferruginous Hawk, a restricted portion of the population is likely exposed to some extent. Severity is likely slight to moderate, given frequent use by Ferruginous Hawk of mixed grassland-crop landscapes, but potential for local displacement if the grassland component becomes too scarce.
2.2	Wood & pulp plantations						Not applicable
2.3	Livestock farming & ranching		Not a Threat	Pervasive (71-100%)	Neutral or Potential Benefit	High (Continuing)	Grazing on pastures is generally beneficial, as it maintains open grassland for foraging (Bylo <i>et al.</i> 2014), especially the short vegetation preferred by Richardson's Ground Squirrel (Downey <i>et al.</i> 2006; Proulx <i>et al.</i> 2012). Deleterious effects of ranching may occasionally include severe overgrazing (because resulting short vegetation or bare ground is avoided by that ground squirrels), damage of potential nesting trees by livestock, and collision with barbed wire fencing, which is used extensively in pastureland (Fleischner 1994). Almost all Ferruginous Hawks are exposed to grazing. Although ranching causes some mortality, its positive effects outweigh these losses, so it is not considered a threat.
2.4	Marine & freshwater aquaculture						Not applicable
3	Energy production & mining	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
3.1	Oil & gas drilling	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	At present, the scope of oil and gas drilling may extent into the range of restricted, but as wells are increasingly abandoned, it may drop back to small. Given inconsistent results of research to date, severity of effects may range from slight to moderate.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)	Clay, potash, sodium sulfate, bentonite, coal, and gravel mines may cause local loss of habitat, mainly in Saskatchewan. Although the overall footprint of these industries is expanding, it likely only affects <1% of Ferruginous Hawks.
3.3	Renewable energy	D	Low	Pervasive - Large (31-100%)	Slight (1-10%)	High (Continuing)	Most of the Canadian population will likely encounter turbines at some point. The severity of effects has been poorly documented to date. The most serious consequence, mortality, is likely also the least frequent, and may not have more than a negligible impact on the population. Reduced nesting success may become a somewhat greater concern, though evidence to date does not suggest severity will be more than slight.
4	Transportation & service corridors	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Most individuals are exposed to roads at some point, but based on documented mortality rates, severity if believed to be slight.
4.2	Utility & service lines	D	Low	Pervasive - Large (31-100%)	Slight (1-10%)	High (Continuing)	At least a large proportion of the population is exposed to utility and service lines, and exposure is likely to increase as wind energy development expands. However, severity is likely toward the lower end of the range for slight, considering documented mortality rates and some offsetting benefits of poles and towers.
4.3	Shipping lanes						Not applicable
4.4	Flight paths						Not applicable
5	Biological resource use	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Although shooting of raptors is now illegal in both Canada and the United States, some still occurs. Consumption of poisoned prey is likely a more frequent concern, with exposure believed to be restricted. Effects are poorly understood, but most likely slight.
5.2	Gathering terrestrial plants						Not applicable
5.3	Logging & wood harvesting						Not applicable
5.4	Fishing & harvesting aquatic resources						Not applicable
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Off-road vehicles (ATV, trucks), birdwatchers, and photographers may cause disturbance. Repeated or intense disturbance from humans early in the nesting period (e.g., walking or driving toward the nest more than six times) may cause nest abandonment (White and Thurow 1985). Abandonment is less likely after young are at least 10 days old, but human activity within 500 m may still cause adults or older nestlings to flush (Keeley and Bechard 2011; REACT 2016; Nordell <i>et al.</i> 2017b).
6.2	War, civil unrest & military exercises		Negligible	Negligible (<1%)	Moderate - Slight (1-30%)	High (Continuing)	Disturbance from military vehicles, artillery/explosives, and training exercises during critical time periods can cause nest abandonment and potentially lower nest re-occupancy rates. At a military training area in Idaho, 3 of 4 Ferruginous Hawk nests failed after a tank training exercise, without being directly damaged, presumably due to disturbance (Lehman <i>et al.</i> 1999). One of 75 nests at Canadian Forces Base Suffield in Alberta, may have been abandoned due to military activities (Smith <i>et al.</i> 2013).
6.3	Work & other activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Disturbance from construction, maintenance, and other work at oil and gas facilities, wind farms, and agriculture operations during critical time periods can cause nest abandonment and lower nest re-occupancy rates. These threats refer specifically to human presence associated with such projects.
7	Natural system modifications	CD	Medium - Low	Restricted (11-30%)	Serious - Moderate (11-70%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	Fire suppression is a concern, but change is likely slow to occur in most of the range of Ferruginous Hawk, with scope unlikely to exceed small over the short term. Where it does occur, however, severity may range from moderate to serious.
7.2	Dams & water management/use						Not applicable
7.3	Other ecosystem modifications	CD	Medium - Low	Restricted (11-30%)	Serious - Moderate (11-70%)	High (Continuing)	A restricted part of the population is likely affected by removal of suitable nesting structures, or reduced prey availability at some point in the annual cycle. Depending on availability of alternate resources, severity may be locally serious, but overall perhaps more likely moderate.
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	West Nile Virus is a potential threat throughout most of the Canadian breeding range. Severity remains poorly understood, though is likely no more than slight.
8.2	Problematic native species	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Growing abundance of nest competitors and predators is pervasive through the Canadian breeding range of Ferruginous Hawk. However, effects are likely slightly at most, given that the hawk population has remained stable or increasing as these other species have expanded in recent decades.
8.3	Introduced genetic material						Not applicable
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Although specific concerns have not been identified for Ferruginous Hawk, it is highly likely that almost all individuals are exposed to some form of pollution, most likely agricultural effluents and airborne pollutants
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						Not applicable
10.2	Earthquakes/tsunamis						Not applicable
10.3	Avalanches/landslides						Not applicable
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Climate change could alter prey abundance, availability, and distribution throughout the Canadian breeding range. However, these effects may be gradual, and at this point their severity cannot be predicted.
11.2	Droughts			Unknown	Unknown	High (Continuing)	
11.3	Temperature extremes			Unknown	Unknown	High (Continuing)	



Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	All individuals in the Canadian population are potentially vulnerable to storms and flooding. However, individuals are most vulnerable while young are in the nest, and on average, severity in the near future is likely to remain slight.