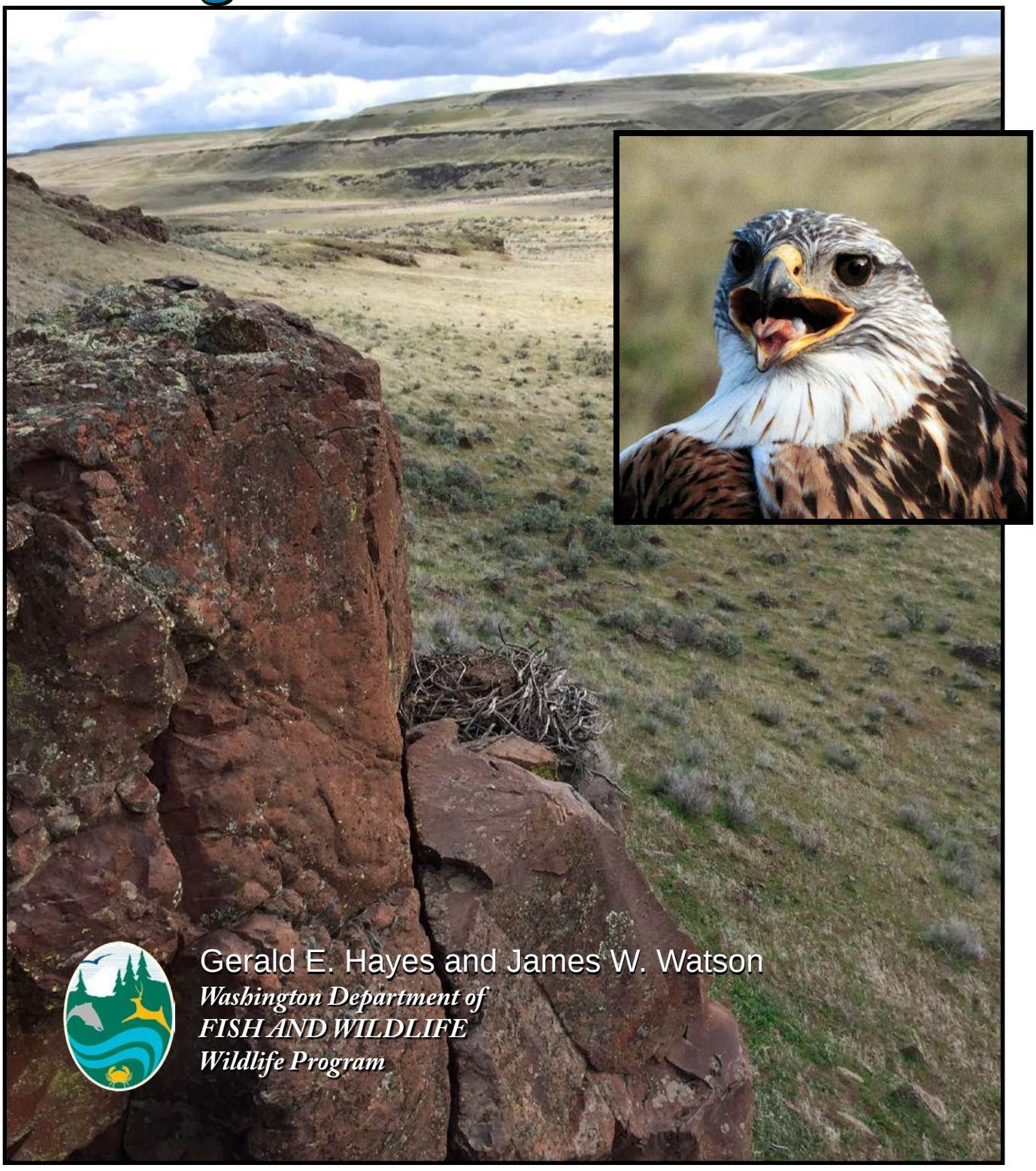
STATE OF WASHINGTON August 2021

Periodic Status Review for the Ferruginous Hawk



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The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 220-610-010 and 220-200-100). In 1990, the Washington Wildlife Commission adopted listing procedures developed by a group of citizens, interest groups, and state and federal agencies (Washington Administrative Code 220-610-110). These procedures include how species listings will be initiated, criteria for listing and delisting, a requirement for public review, the development of recovery or management plans, and the periodic review of listed species.

The Washington Department of Fish and Wildlife is directed to conduct reviews of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing by the Washington Fish and Wildlife Commission. These periodic reviews include an update on the species status to determine whether the species warrants its current listing or deserves reclassification. The agency notifies the general public and specific parties interested in the periodic status review, at least one year prior to the end of the five-year period, so that they may submit new scientific data to be included in the review. The agency notifies the public of its recommendation at least 30 days prior to presenting the findings to the Fish and Wildlife Commission. In addition, if the agency determines that new information suggests that the classification of a species be changed from its present state, the Department prepares documents to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act.

This periodic status review for the Ferruginous Hawk was reviewed by species experts and was available for a 90-day public comment period from 12 January to 12 April 2021. All comments received were considered during the preparation of this final periodic status review. The Department presented the results of this periodic status review to the Fish and Wildlife Commission at a meeting on 6 August 2021, and the Commission voted to uplist the species to endangered on 27 August.

This report should be cited as:

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On the cover: Photos of Ferruginous Hawk and nest by Jim Watson

This work was supported in part by personalized and endangered species license plates

Periodic Status Review for the Ferruginous Hawk in Washington

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TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

EXECUTIVE SUMMARY

The Ferruginous Hawk (*Buteo regalis*), was listed as state threatened by Department of Game policy in 1983, and in 1990 the Washington Wildlife Commission maintained the species on the state list of threatened species. North America's largest buteo, the Ferruginous Hawk, occurs in low numbers in shrubsteppe and grassland regions of several eastern Washington counties, however, early accounts suggest they were once relatively abundant in the state. An average of 55 breeding pairs per year nested in the state between 1992 and 1995. More than 60% of the nesting territories are concentrated in Franklin and Benton counties, which are considered the core breeding range in the state.

The Ferruginous Hawk is largely restricted to grasslands and shrubsteppe. Conversion of native grasslands and arid shrublands to agriculture, urbanization, and the degradation of rangelands have contributed to the loss of nesting and foraging habitat on its breeding range in Washington. Degradation of fall and winter ranges frequented by Washington's hawks in migration and the nonbreeding period has been documented through satellite monitoring. Reductions in prey base on the breeding range and depressed prey populations encountered during migration on fall and winter ranges are likely a significant factor in the decline of Washington's breeding population of Ferruginous Hawks.

The breeding population of Ferruginous Hawks in Washington is in sustained decline. Between 1974 and 2016, there have been significant declines in nesting territory occupancy, nest success, and productivity. Additionally, the percentage of surveyed nesting territories supporting breeding pairs has significantly declined in the core breeding range of the species in Benton and Franklin counties. The distribution of breeding pairs statewide also appears to have contracted since the 1990s. There has been no improvement in habitat conditions or amelioration of primary threats, and therefore the recommendation is to reclassify the Ferruginous Hawk from threatened to endangered status in Washington.

ACKNOWLEDGMENTS

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INTRODUCTION

This document summarizes the historic and current distribution and abundance of the Ferruginous Hawk (*Buteo regalis*) in Washington and describes factors affecting the population and its habitat. It updates the species' status since 1995 (WDFW 1996), as per WAC 220-610-110. This document is intended to review information pertinent to Washington State classification and not serve as a comprehensive literature review for the species.

LEGAL STATUS AND DESCRIPTION

In Washington, the Ferruginous Hawk was listed as state threatened by Department of Game policy in 1983 and in 1990 the Washington Wildlife Commission maintained the Ferruginous Hawk on the state list of threatened species (WAC 220-200-100). It retains the classification of state threatened today. The Ferruginous Hawk was petitioned for listing under the federal Endangered Species Act in 1983 and 1991 and found to be not warranted (USFWS 1992). The Ferruginous Hawk is a Species of Greatest Conservation Need (SGCN) in State Wildlife Action Plans (SWAPs updated 2015) in 14 of 17 states in the U.S. where breeding occurs.

The Ferruginous Hawk is a member of the order Accipitriformes and the family Accipitridae. The genus *Buteo* includes nine species that breed in mainland North America. The species was first described by G. R. Gray in 1844, who named it *Archibuteo regalis* (AOU 1998). No subspecies are recognized (Ng et al. 2017). Common names include Squirrel Hawk and Ferruginous Rough-legged Buzzard (Jewett et al. 1953). The Ferruginous Hawk is the largest North American buteo. Adults measure 56-69 cm from the top of the head to tail tip, have a wingspan of nearly 1.5 m, and a body mass of 977-2,074 g, with females being larger than males (Ng et al. 2017). Both light and dark morph plumages occur with the light morph plumage more characteristic of our Washington birds (Bowles and Decker 1931). Underparts are starkly white at a distance and make the reddish leggings and black "commas" at the wrist of the wing very apparent (Figs. 1, 2). The head is brown with rufous or creamy streaking. From above, the back and upper-wing feathers are rufous, contrasting with the grayish flight feathers and white "window" on the outer primary feathers. The tail is white, rufous, gray, or a mixture of these. Sexes are similar in plumage (Dunne et al. 1988, Ng et al. 2017).

Figure 1-2. Ferruginous Hawk (photos, left to right, by Jim Watson,and Jerry Liguori)

DISTRIBUTION

The Ferruginous Hawk breeds from the Canadian Prairies south through northern Arizona and New Mexico and winters from central Mexico north to California, Colorado, and western Kansas (Ng et al. 2017; Fig. 3). In Washington, Ferruginous Hawks are restricted to the arid shrubsteppe region of southeastern Washington. Most hawks migrate from their breeding ranges in Washington with only a small percentage (6%) overwintering on their breeding territories in the state (Watson et al. 2018*a*). Breeding activity has been confirmed in 11 eastern Washington counties (Fig. 3) with most nesting territories concentrated in Benton and Franklin counties. Most hawks from Washington's breeding population migrate and overwinter in the Central Valley of California (Watson and Pierce 2003, Watson et al. 2018*a*).

Figure 3. Breeding and winter range of Ferruginous Hawks in North America (*left*; source: Ng et al. 2017). Distribution of Ferruginous Hawk nesting territories (first reported 1978−2019) in Washington (*right*; Source: WDFW database).

NATURAL HISTORY

Habitat requirements. The Ferruginous Hawk is an open country species that inhabits grasslands, shrubsteppe, and deserts of North America (Ng et al. 2017). Habitat in the breeding range is flat and rolling terrain in grassland or shrubsteppe regions where sparse riparian forests, canyons with rock outcrops, and isolated trees and small groves of trees provide suitable nest sites (Ng et al. 2017). In Washington, breeding habitat is shrubsteppe and juniper savanna where basalt rock outcrops or isolated trees, primarily juniper (*Juniperus occidentalis*), provide suitable nest sites (Bowles and Decker 1931, Bechard et al. 1990, WDFW 1996). In Oregon, breeding habitat occurs in grasslands and shrubsteppe where rock outcrops, trees, and the ground provide nest sites (Lardy 1980, Cottrell 1981, Kolar 2013).

During migration, Ferruginous Hawks use shrubsteppe, grasslands, and agricultural edges as foraging habitat (Ng et al. 2017). Winter habitat is open terrain from grassland to desert (Ng et al. 2017). East of the Rocky Mountains, the hawk primarily uses grasslands, especially where prairie dogs (*Cynomys* spp.) are abundant. West of the Rocky Mountains, grasslands and arid areas are used, especially where ground squirrels (*Urocitellus* spp.), prairie dogs (*Cynomys* spp.), lagomorphs, or pocket gophers (*Thomomys* spp.) are abundant (Ng et al. 2017). Ferruginous Hawks from Washington's breeding population use grasslands, shrubsteppe, pasture, and croplands on summer and fall ranges in the Great Basin, along the

east slope of the Rocky Mountains, and Northern Great Plains, and use grasslands and oak savannah interspersed with croplands on winter range in the Central Valley of California (Watson and Pierce 2003, Watson et al. 2018*a*).

Diet. The Ferruginous Hawk preys primarily on small to medium size mammals, including rabbits (*Sylvilagus* spp.), hares (*Lepus* spp.), ground squirrels, prairie dogs, and pocket gophers (Olendorff 1993, Ng et al. 2017). Primary prey varies by region with ground squirrels and prairie dogs utilized east of the Continental Divide, while jackrabbits and cottontails are mainly utilized west of the Continental Divide (Ng et al. 2017). On the breeding range in shrubsteppe, diet is comprised mostly of jackrabbits in Utah (Smith and Murphy 1978) and southern Idaho (Thurow et al. 1980), with ground squirrels and pocket gophers replacing rabbits as primary prey in Washington (Fitzner et al. 1977), Oregon (Lardy 1980, Cottrell 1981), and southwestern Idaho (Steenhof and Kochert 1985).

Ferruginous Hawks in Washington appear to have undergone a dietary shift since the 1920s. Anecdotal accounts from that time suggest jackrabbits were critical to the state breeding population (Bowles and Decker 1931), but subsequent declines in jackrabbits (Couch 1928, Larrison 1976), Washington ground squirrels (*Urocitellus washingtoni*) (Betts 1990, Betts 1999) and Townsend's ground squirrel (*U. townsendii*) may have contributed to dietary shifts of Ferruginous Hawks to small mammals, snakes, insects, and gulls (*Larus* spp.) (Fitzner et al. 1977, Leary et al. 1996, Richardson et al. 2001). In some parts of the state, Ferruginous Hawks may be nearly dependent on northern pocket gophers, which are small and nocturnal, indicating that their traditional, higher quality prey species may no longer be available (Richardson et al. 2001).

During migration and on their winter range, Ferruginous Hawks prey on lagomorphs, ground squirrels, pocket gophers, and prairie dogs (Jones 1989, Allison et al. 1995, Plumpton and Anderson 1997, Plumpton and Anderson 1998, Watson and Pierce 2003, Smith and Lomolino 2004). After the breeding season has ended, Washington's Ferruginous Hawks migrate to exploit small to medium-sized mammalian prey that includes Richardson's ground squirrels (*U. richardsoni*), California ground squirrels (*U. beecheyi*), prairie dogs, and pocket gophers on late summer, fall and winter ranges (Watson and Pierce 2003, Watson et al. 2018*a*).

Home range and movements. During the breeding season raptor pairs establish a territory overlapping with suitable habitat resources, such as prey and nesting substrates, which they defend from conspecifics (Newton 1979). Raptors demonstrate strong territory fidelity and nest-site fidelity, especially *Buteo* species such as Ferruginous Hawks (Newton 1979, Watson and Pierce 2003, Watson and Keren 2019). Nesting territories typically contain one to multiple nests that are reused for many years (Houston 1995, Ng et al. 2017). Nests act as the loci around which resource use is centered during the breeding season (Bechard et al. 1990). The size of the adult home range and distance from the nest to foraging areas during the breeding season is largely determined by food availability (Newton 1979). Adults may range over small areas where prey is locally abundant or range over larger areas where prey is generally scarce or far away. Breeding hawk pairs that do not reproduce or fail in their nesting attempts may expand their home range or abandon their territory for the remainder of the season (Steenhof and Newton 2007).

In Washington, average home range size (95% minimum convex polygon) for seven radio-marked adult males was 79 km^2 (range 8.9 – 136.4 km^2), and core activity areas (85% adaptive kernel) averaged 30.8 km^2 (Leary et al. 1998). In southwestern Idaho, average home range size (95% minimum convex polygon) for seven radio-marked adult males was 7.6 km^2 (range 4.8 – 14.1 km^2), and core activity areas (50% harmonic mean) averaged 2.2 km^2 (0.46 – 5.5 km^2) (McAnnis 1990). The relatively larger home ranges and core activity areas used by hawks in the Washington study (Leary 1996) was attributed, in

part, to some adult males traveling more than 10 km from their nests to hunt northern pocket gophers in irrigated agricultural fields. This indicated that prey may have been less available in habitats around nest sites and more available in the irrigated agricultural fields. In contrast, prey may have been more abundant near nests in the Idaho study. Core activity areas were centered on the nests and most foraging attempts occurred within one kilometer of the nests site (McAnnis 1990). In a study using GPS telemetry and more advanced analytical methods, home ranges averaged 315.9 km^2 (Browian Bridge 95% isopleths) and 32.3 km^2 (50% isopleths) for seventeen breeding pairs in southcentral Washington and northcentral Oregon from 2007 to 2014 (J. Watson, WDFW, *unpubl. data*).

The majority of Ferruginous Hawks from Washington migrate and are away from breeding territories for two-thirds of the year (Watson and Pierce 2003, Watson et al. 2018*a*). Changes in population sizes of migratory birds can be influenced by conditions on migration and wintering areas, in addition to conditions on breeding areas (Newton 2004, Newton 2006). In general, Washington's adult hawks follow a migration pattern (Fig. 4) of migrating across the Continental Divide to ranges in late summer, then migrate in the fall back across the Continental Divide to winter ranges, and migrate in the spring back to breeding ranges (Watson and Pierce 2003, Watson et al. 2018*a*). Adult hawks from Pacific Northwest breeding populations depart breeding territories in late July and migrate northeast or southeast to summer ranges (occupied in September and October) in the southern Canadian provinces, northwest Montana, and the Northern and Central Plains, then migrate westward to the Central Valley of California where the majority (78%) of their winter ranges (occupied in November through February) are located (Watson et al. 2018*a*). In late February, adult hawks depart winter ranges in California for breeding ranges in Washington. Adult hawks demonstrate high breeding and winter range fidelity but are nomadic in late summer when they migrate to fall ranges (Watson and Keren 2019). While away from breeding ranges, adult hawks from Pacific Northwest breeding populations migrate an average of 2,679 km (Watson et al. 2018*a*). Juveniles migrate independently of their parents. Juvenile hawks hatched in Washington and Oregon migrate northeast in late summer to ranges in the northern grasslands and to winter ranges in California and the Great Plains. During their first year, juveniles travel about three times farther (6,079 km) and twice as long (89 vs. 40 days) as adults during annual migrations (Watson et al. 2019).

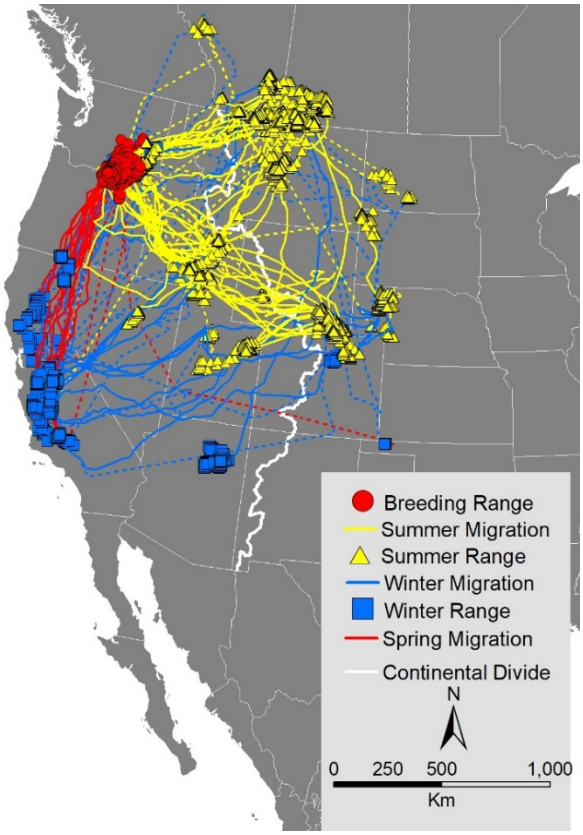

Figure 4. Year-round migration patterns of adult Ferruginous Hawks breeding in shrubsteppe west of the Continental Divide and tracked ≤6yr with satellite telemetry.

Reproduction. Ferruginous Hawks first breed at two to three years of age (Wheeler 2003, Ng et al. 2017). Adults return to nesting territories in Washington during late February and early March (Watson and Pierce 2003, Watson et al 2018*a*) and typically reoccupy the same nesting territories each year (Watson and Pierce 2003, Watson and Keren 2019). Adults engage in display flights and vocalizations, nest building, food transfers, and copulation that aid in establishing and renewing pair bonds (Palmer 1988, Ng et al. 2017). Nests are typically large in diameter (61–107 cm) and constructed of old sagebrush stems. An average clutch of 2–4 eggs is laid in 2-day intervals each and incubated for 32– 33 days, resulting in asynchronous hatching (Ng et al. 2017). Young fledge in 38–50 days (Palmer 1988, Pope 1999, Ng et al. 2017). If the first nesting attempt fails, re-nesting is apparently rare (Palmer 1988). In Washington, on average, incubation begins about mid-April, hatching begins in mid-May, and nestlings begin to fledge by late June (J. Watson, unpublished data) with one to two fledglings being the most common. After leaving the nest, the young continue to depend on the parents for food as they develop flight, hunting and social skills while remaining in the adult home range. The post-fledging dependency period averages 27 days (range = 16–34 days) with a mean departure date from natal ranges of 27 July (Pope 1999, Watson and Keren 2019).

Survival. Among raptor species, adult survival tends to increase with body mass and pre-breeders have lower survival than adult breeders (Newton et al. 2016). The population growth rate of many raptor populations is more sensitive to changes in adult survival rates than it is to reproductive parameters (Stahl and Oli 2006, Sergio et al. 2011). Identifying factors and processes that affect age- or life-stage specific survival rates is important for understanding population dynamics and implementation of conservation actions (e.g., Todd et al. 2003, Klaassen et al. 2014). Estimates of age-specific survival rates of Ferruginous Hawks are highly variable (Table 1) and likely reflect spatial and temporal variability in prey abundance and other factors across the species' range. Age- and life-stage specific survival rates for Ferruginous Hawks suggest a mortality bottleneck early in life before reaching sexual maturity. This pattern of survival may be influenced by factors occurring on breeding areas and after dispersal from natal areas as they learn to hunt and make long-distance migratory movements (Schmutz and Fyfe 1987, Harmata et al. 2001, Watson and Pierce 2003, Watson et al. 2019). Maximum potential longevity for Ferruginous Hawks is 20 years (Ng et al. 2017), but most do not survive longer than 6 years (Harmata et al. 2001).

Table 1. Age- and stage-specific survival rates of Ferruginous Hawks.

Period	Survival	*n*	Study type[c]	Location	Source
Hatching to dispersal	0.42[a]	202	VT	Utah	Ward and Conover 2013
Pre-fledge	0.93[a]	54	ST	Range-wide	Watson et al. 2019
Fledge to dispersal	0.62[a]	50	ST	Range-wide	Watson et al. 2019
Fledge to dispersal	0.85[b]	29	VT	Montana	Zelenak 1996
Nestling to 1 yr	0.55[b]	6,6 87	B	Canada	Schmutz et al. 2008
Fledge to 1 yr	0.43[b]	15	ST	Washington	Watson and Pierce 2003
Nestling to 1.5 yr	0.05[a]	233	B and VT	Montana	Harmata et al. 2001
Adult (≥ 1 yr)	0.70[b]	115	B	Canada	Schmutz et al. 2008
Adult	0.76	13	ST	Washington	Watson and Pierce 2003

[a]Relative survival; [b]Estimated survival rate; [c]B = banding; VT=VHF telemetry; ST=satellite telemetry

Causes of Ferruginous Hawk mortality are mostly based on encounters with banded birds and include collisions, shootings, electrocution, and predation (Harmata 1981, Schmutz and Fyfe 1987, Gilmer et al. 1985, Gossett 1993, Harmata et al. 2001, Ng et al. 2017). American crow (*Corvus brachyrhynchos*) and Common Raven (*Corvus corax*) prey on eggs and nestlings. Great Horned Owl (*Bubo virginianus*),

Golden Eagle (*Aquila chrysaetos*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), American badger (*Taxidea taxus*), and foxes (*Vulpes* spp.) are predators of nestlings and fledglings (Zelenak 1996, Keough 2006, Ward and Conover 2013, Nordell et al. 2017, Ng et al. 2017). Golden Eagles may kill adults (Buhler et al. 2000). Sources of direct mortality of wintering Ferruginous Hawks include shooting, electrocution, and collisions with vehicles (Allison et al. 1995, Cartron et al. 2000, Bak et al. 2001, Harmata et al. 2001, Cartron et al. 2006). Indirect sources of mortality likely affect overall health and survival of hawks and include factors such as loss and fragmentation of breeding and wintering habitat and associated loss of prey (Plumpton and Andersen 1998). Ferruginous Hawks are at risk to secondary poisoning from scavenging carcasses of ground squirrels and prairie dogs exposed to rodenticides (Schmutz et al. 1989, Proulx 2011, Vyas et al. 2017) or those shot with lead ammunition (Chesser 1979, Knopper et al. 2006, Pauli and Buskirk 2007, Stephens et al. 2008). Other sources of mortality include electrocution at power lines (Cartron et al. 2000, Harness and Wilson 2001, APLIC 2006, Cartron et al. 2006, Lehman et al. 2010, Kemper et al. 2013, Dwyer et al. 2015) and collisions with wind turbines (Kolar and Bechard 2016, Watson et al. 2018*b*).

POPULATION AND HABITAT STATUS

North America. The estimated population of Ferruginous Hawks in the United States and Canada was 2,921 to 5,665 nesting pairs in 1992 (Olendorff 1993). There are no recent and reliable population estimates for the U.S. population of Ferruginous Hawks. In Canada, the latest population estimates are 865 pairs in Alberta (2015), 278-500 pairs in Saskatchewan (2006), and 42 pairs in Manitoba (2006) (COSEWIC 2008, Redman 2016).

The species is thought to be declining in several areas of its breeding range, but data are largely lacking to quantify percent declines (Ng et al. 2017). The best documentation of earlier declines is from the northern edge of its range in Alberta, Saskatchewan, and Manitoba (Ng et al. 2017). Apparent declines also occurred in the core of its range during the 1980s, as suggested by vacancies of many historic nests (Ng et al. 2017). Between 1979 and 1992, breeding populations were stable in Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, North Dakota, South Dakota, Texas, Washington and Saskatchewan. During this same time period, apparent population increases occurred in Oregon, Wyoming, Alberta and Manitoba, whereas declines were confirmed only in northern Utah and eastern Nevada (Olendorff 1993). Alberta has the largest Ferruginous Hawk population in North America (Olendorf 1993). Long-term population monitoring in Alberta began in 1982 and repeated surveys documented a steep decline between 1992 and 2000. Since 2005 the population has stabilized, but at lower numbers relative to its population peak in the late 1980s and early 1990s (Redman 2016, Ng et al. 2017). The breeding range has contracted by 40% in Alberta and 50% in Canada (Downey 2006, COSEWIC 2008).

Washington: Past. Early accounts suggest that Ferruginous Hawks were once abundant in the state. Decker and Bowles (1926) observed that the hawks must have been formerly "very plentiful" based on the number of old nests they found in the area around Kiona, Benton County. Bowles and Decker (1931) described the center of abundance for this species as shrubsteppe in proximity to the Columbia and Yakima Rivers where they were "not at all rare" during the breeding season.

Fitzner et al. (1977) conducted the first state-wide survey of the species in 1974−1975 over 12 counties in southeastern Washington. They documented at least 15 territorial pairs of hawks and estimated the state population to be about 20 pairs. The Washington Department of Game conducted a statewide survey in 1978 and found 26 territorial pairs (WDG 1978). Friesz and Allen (1981) documented 31 territorial pairs over 10 counties in 1981 and estimated the statewide population to be about 40 pairs.

Studies of reproductive rates in raptors can be useful in decisions to list or reclassify an endangered raptor species (Steenhof and Newton 2007). Territory occupancy, nest success and productivity are indices that may be used to assess the overall health and status of raptor populations (USFWS 2003). A minimum of two visits to each nesting territory during the breeding season is required to determine the number of potential breeders and to count the number of young raised; both are required to calculate reproductive success (Postupalsky 1974). The purpose of the first check of nesting territories is to locate nests and determine whether they are being used by adult birds. The timing of the first nest check (early season survey) occurs when all birds are either incubating or about to lay eggs. The purpose of the second nest check, later in the breeding season (late season survey), is to count the number of young raised. The best time for the second nest check is just prior to the earliest known fledging dates (Postupalsky 1974). The *nesting territory* refers to an area that contains, or historically contained, one or more nests within the home range of a pair of mated birds (Postupalsky 1974). A *nesting territory* can also be described as a confined locality where nests are found, usually in successive years, and where no more than one pair has bred at one time. The territory *occupancy rate* is defined as the percentage of the total known territories where activity patterns indicate the presence of a mated, territorial pair of potential breeders (Postupalsky 1974). *Nest success* is defined as the percentage of occupied territories which produce one or more young to an advanced stage of development (Postupalsky 1974, USFWS 2003, Steenhof and Newton 2007). *Productivity* is another measure of reproductive success and is defined as the number of young (fledging or advanced age of development) per occupied nest (Postupalsky 1974, Steenhof and Newton 2007). In general, WDFW conducted nest surveys at known nesting territories based on a first visit in April and early May to determine occupancy and a visit in June or July to determine productivity.

Coordinated efforts to survey all known nesting territories and to search for new sites were undertaken by WDFW in 1987 and in 1992-1995 (WDFW 1996). By 1995, an average of 55 breeding pairs (1992−1995) nested in the state across 12 Washington counties (WDFW 1996).

Washington: Present. The last statewide surveys conducted in 2016 recorded 47 occupied nests and 32 breeding pairs. As of 2020, WDFW maintains a database of 284 known nesting territories of Ferruginous Hawks. While the number of known nesting territories in the WDFW database has steadily increased over time, most new nesting territories were added to the database during a period of intensive annual surveys for this hawk in the late 1970s, 1980s and 1990s (Fig. 5). Moreover, not all 284 known nesting territories in the WDFW database are based on documented breeding activity (i.e., evidence eggs were laid) at some time in their history. The percentage of known nesting territories with no prior breeding activity observed has increased from 14% in 1990 to 28% in 2016. As of 2016, 216 nesting territories in the WDFW database have had breeding activity (i.e, eggs laid) documented, 16 territories had only been observed occupied by one or more adult hawks with no evidence of breeding activity, and 52 nesting territories have never been observed with an adult in attendance. These data indicate that the trend of an increasing number of nesting territories overtime, and especially since the mid-1990s, is not reflective of an increasing breeding population, but rather the discovery of "old" Ferruginous Hawk nests on the landscape that have long been vacant.

The number of nesting territories surveyed by WDFW and its partners has varied over the years. Greater survey effort (≥70% of nesting territories surveyed) occurred in 1978, 1981, 1986, 1987, 1992−1997, 2002−2003, 2010, and 2016 (Fig. 5, Table 2). Most of these surveys were intended to assess comprehensive, statewide status of all nesting territories systematically, but were <100% due to access limitation, limited staff capacity, weather factors, or other conditions. Nest surveys were not based on a random selection of preselected nesting territories prior to the survey season, due in part to the small size of the population and incomplete knowledge of the distribution of nesting territories as the Department added new nesting territories to its raptor database.

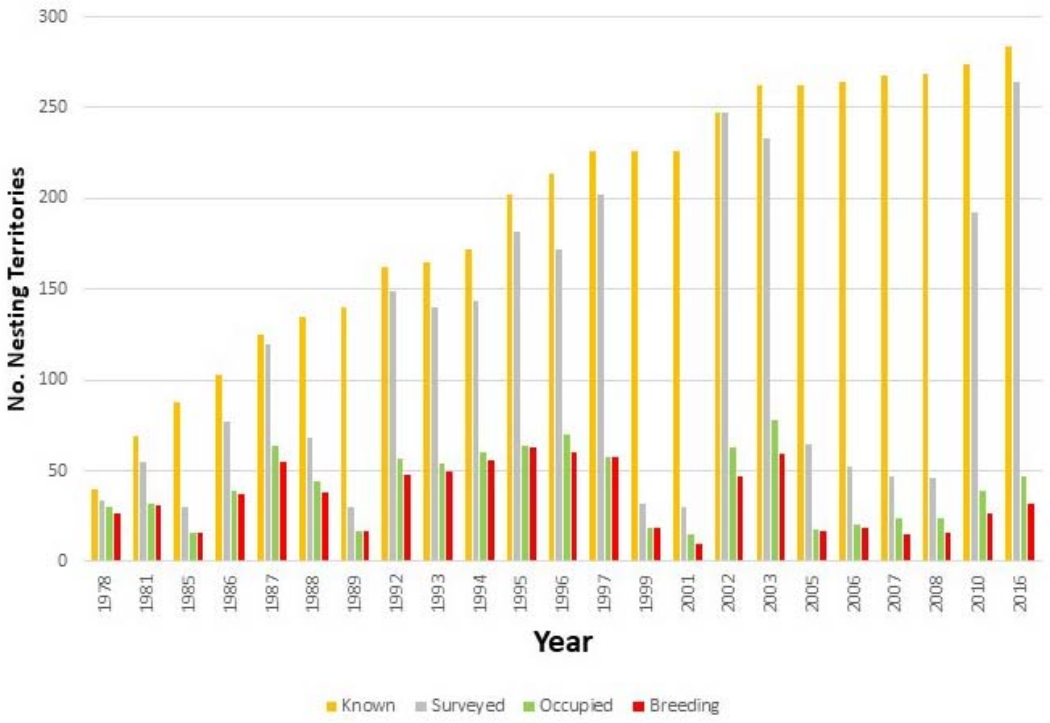

Figure 5. Number of Ferruginous Hawk nesting territories surveyed that were occupied and that supported breeding activity by survey year (1978-2016). Data displayed are only those years when ≥30 nesting territories were surveyed.

Table 2. Occupancy and reproductive success at Ferruginous Hawks nesting territories in Washington, 1978-2016. Data reported are for years when >70% of known nesting territories were surveyed.

	Nesting territories			Nesting Territories Occupied Known Outcome						Number of Young[c] /Occupied	/Successful Nesting Attempt
	Known	Surveyed		Occupied[a]				Successful[b]		Observed	Known
Year	(n)	(n)	%	(n)	%	(n)	%	(n)	%	(n)	Outcome	(brood size)
1978	40	34	85	30	88	18	60	18	100	56	3.11	3.11
1981	69	55	80	32	58	25	78	25	100	70	2.8	2.80
1986	103	75	73	39	52	25	64	22	88	58	2.32	2.64
1987	125	119	95	64	54	49	77	38	78	121	2.47	3.18
1992	162	148	91	57	39	46	82	38	83	88	1.91	2.32
1993	165	140	85	54	39	47	87	42	89	83	1.77	1.98
1994	172	143	83	60	42	48	80	42	88	92	1.92	2.19
1995	202	181	90	64	35	28	44	14	50	22	0.79	1.57
1996	214	173	81	70	40	55	79	45	82	115	2.09	2.56
1997	226	201	89	58	29	48	83	42	88	94	1.96	2.24
2002	247	246	100	63	26	45	71	29	64	56	1.24	1.93
2003	262	230	88	78	34	55	71	39	71	92	1.67	2.36
2010	274	192	70	39	20	18	46	12	67	26	1.44	2.17
2016	284	263	93	47	18	26	55	21	81	53	2.04	2.52

[a] Nest sites (territories) where at least one adult Ferruginous Hawk was observed at or near a nest; one adult was observed sitting low in a nest, presumably incubating; eggs were laid; or young were raised.

[b] Number of occupied nesting territories from which at least one young fledged or at least one young was raised to an advanced stage of development (i.e., near fledging age; 33 days). Estimates are inflated because they are usually based on the number of chicks seen during a single survey, regardless of their age, some of which may not survive to fledging.

[c] Productivity estimates are inflated because they are usually based on the number of chicks seen during a single survey, regardless of their age. Young chicks included in productivity estimates may not survive to fledging.

For survey data collected systematically, we used linear regression to test for trends in occupancy, nest success, and productivity among survey years. To eliminate potential bias associated with incidental survey results we excluded from analysis survey years when <70% of territories were surveyed. Incidental surveys may have favored more easily accessible or active territories. We weighted the number of territories surveyed by the proportion of known territories in each year. There were significant declines in territory occupancy ($P < 0.001$, $F_{(1,12)} = 50.01$, $r^2 = 0.81$), and the fitted regression line showed a decline in occupancy of >40% to the lowest recent levels of about 20% statewide (Fig. 6a). Productivity also declined significantly ($P = 0.023$, $F_{(1,12)} = 6.75$, $r^2 = 0.36$) during the study period (1978-

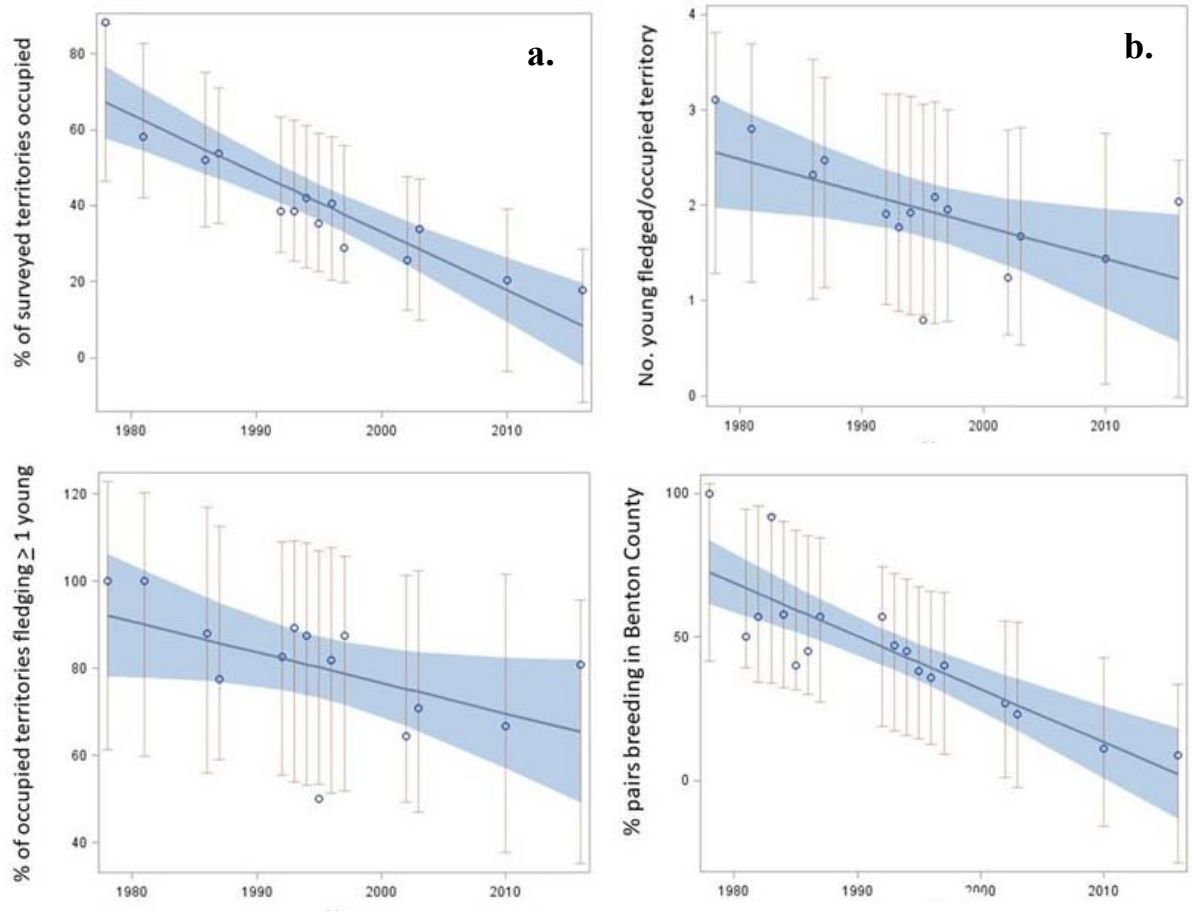

Figure 6 a-d. Productivity of Ferruginous Hawks in Washington, 1978-2016. Blue line is the fitted linear trend and blue band is the 95% confidence interval of the trend (WDFW data). Data are restricted to only those years when ≥70% of all known nesting territories were surveyed and analyses incorporate a weighting factor to account for uneven survey effort among years. a. Proportion of surveyed nesting territories occupied; b. Number of young fledged per occupied nesting territory; c. Proportion of occupied territories that fledged at least one young during the breeding season; d. Percentage of surveyed nesting territories in Benton County where breeding was confirmed.

2016) resulting in reduction of about one young/occupied territory over that time (Fig. 6b). There was a similar, but marginal decline in nest success ($P = 0.052$, $F_{(1,12)} = 4.65$, $r^2 = 0.28$), biologically resulting in

about 20% fewer occupied territories producing young (Fig. 6c). In the core breeding range, there were significant declines in the percentage of surveyed nesting territories supporting breeding pairs in Benton County ($P < 0.001$, $F_{(1, 16)} = 38.66$, $r^2 = 0.69$; Fig. 6d) and Franklin County ($P < 0.001$, $F_{(1, 11)} = 36.12$, $r^2 = 0.75$; Fig. 7) during the same period, and the statewide distribution of breeding pairs showed a corresponding contraction from the north and west since the 1990s (Fig. 8).

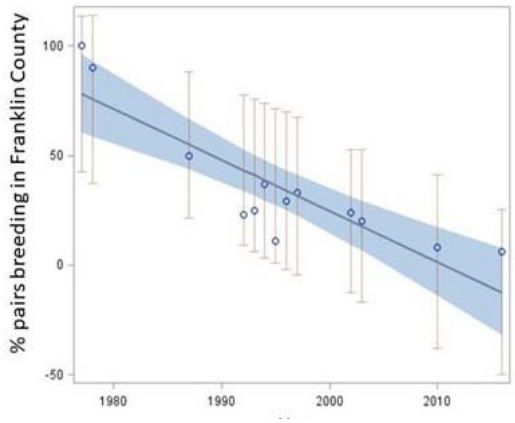

Figure 7. Percentage of surveyed nesting territories in Franklin County, Washington where Ferruginous Hawk breeding was

Figure 8. Ferruginous Hawk nesting territories in eastern Washington where breeding activity has been confirmed: a) 1992-1997, b) 2002-2003, c) 2010, and d) 2016. Data include only those survey years since 1992 (last status update; WDFW 1996) when >70% of nesting territories were surveyed.

Habitat status - breeding range. Breeding habitat of the Ferruginous Hawk occurs in shrubsteppe and grasslands in Washington and Oregon (Bowles and Decker 1931, Fitzner et a. 1977, Lardy 1980, Cottrell 1981, Bechard et al. 1990). Much of eastern Washington is a large arid to semi-arid region of shrublands and grasslands dominated by shrubs and herbaceous (grasses and forbs) vegetation (Franklin and Dyrness 1988, Vander Haegen et al. 2001). The majority of grasslands occurred on the Palouse Prairie in southeastern Washington. Much of the native vegetation in these shrubland and grassland habitats has been converted to cropland (Dobler et al. 1996, Quigley and Arbelbide 1997, McDonald and Reese 1998). Prior to European settlement an estimated 4.2 million ha (10.4 million acres) of shrubsteppe existed in eastern Washington (Dobler et al. 1996) and by 1986 over half of Washington's original shrubsteppe habitat was converted to agricultural lands resulting in high fragmentation of extant habitat (Dobler et al. 1996, Vander Haegen et al. 2001) and disproportionate loss of deep-soil shrubsteppe communities (Vander Haegen et al. 2000). Remaining shrublands are influenced by a legacy of excessive livestock grazing that facilitated invasion by exotic vegetation, especially cheatgrass (*Bromus tectorum*) (Mack 1981). Invasion of exotic annuals has changed both the fire regime and successional patterns in sagebrush resulting in more frequent fires and conversion of shrublands to exotic annual grasslands (D'Antonio and Vitousek 1992, Vander Haegen et al. 2001).

Impacts of wildfires on nesting raptors are not well studied, particularly in shrubsteppe and low elevation sagebrush habitats. Indirect effects of wildfire on nesting raptors include short- and long-term loss of prey (Groves and Steenhof 1988, Yensen et al. 1992), potentially leading to longer-term dietary shifts (Heath and Kochert 2016) and reduced nest success (Kochert et al. 1999). Loss of shrubsteppe and invasion of cheatgrass and other exotic grasses after hot, expansive wildfires, and the population changes in ground squirrels and other small mammals is a current topic of intense research because of the difficulty of regenerating native grasses and shrubs (Knick et al. 2003, Holbrook et al. 2016, Holmes and Robinson 2016). Spatial extent of wildfires in eastern Washington since 1995 (earliest year of fire perimeter data) have overlapped nest locations of Ferruginous Hawks based on an analysis of fire boundary layers (National Interagency Fire Center, https://data-nifc.opendata.arcgis.com/) and nest locations from the Wildlife Program data base (WDFW). Shrubsteppe in west Benton and Yakima counties has been particularly impacted by wildfires and where fire perimeters overlap many nesting territories (Appendix A). Many of these large, hot fires have burned in the past 20 years resulting in conversion to monocultures of cheatgrass. Since 1995, wildfires affected 15 nesting territories in 2010, 7 in 2015, and 5 in 2020.

Agriculture, urbanization, infrastructure placement (e.g., power lines, roads) and energy development have fragmented sagebrush ecosystems (Leu et al. 2008) and provide resource subsidies (e.g. food, perch sites) to the Common Raven, a generalist avian predator (Coates et al. 2014, Howe et al. 2014). Human activities provide ravens access to beneficial resource subsidies (e.g., food, perch sites) that have been associated with agriculture and anthropogenic development. Additive effects of anthropogenic structures and fragmentation of sagebrush ecosystems have led to a dramatic expansion and abundance of the Common Raven into sagebrush ecosystems (Coates et al. 2014, 2020; Howe et al. 2014). In the early 1990s observers conducting nest surveys of the Ferruginous Hawk in Juniper Dunes reported Common Ravens as "uncommon" but they are now much more abundant in this area (J, Lowe, BLM, personal communication). Similarly, on the Hanford Site, the number of Common Raven nests has increased from 9-11 in the 1970s to a peak of 70 nests in 2014, with most nests located on transmission towers or utility poles (Nugent 2016). Common Ravens are known to prey on eggs and nestlings of Ferruginous Hawks (Ng et al. 2017) and may compete with hawks for nest sites (J, Lowe, BLM, personal communication).

Despite the widespread loss of Ferruginous Hawk nesting habitat, agricultural lands enrolled in the USDA's Conservation Reserve Program (CRP) have the potential to provide nesting and foraging habitat for Ferruginous Hawks. The State Acres for Wildlife Enhancement (SAFE) program is an initiative under the Conservation Reserve Program (CRP) that started under the Farm Bill nationwide in January 2008. The program is a partnership between the U.S. Department of Agriculture (USDA) and state fish and wildlife agencies to develop quality wildlife habitat with an emphasis on restoration of native vegetation and associated wildlife benefits. The Ferruginous Hawk SAFE is available to agricultural producers in portions of Adams, Benton, Franklin, and Walla Walla counties. The goal of this initiative is to enhance foraging habitat around Ferruginous Hawk nests by establishing shrubs, grasses and broadleaf forbs on cropland. Therefore, this initiative is restricted to lands near recently occupied nest sites. There are 415 Ferruginous Hawk nests associated with 171 nesting territories within the program boundary (Fig. 9) where agreements may be negotiated. However, enrolled acres may not occur within the home ranges of the hawks and are not permanent. As of November 2019, there were 14,647 acres enrolled out of 20,000 acres allocated to the FEHA SAFE program in Washington (Mike Kuttel, Jr., WDFW, personal communication).

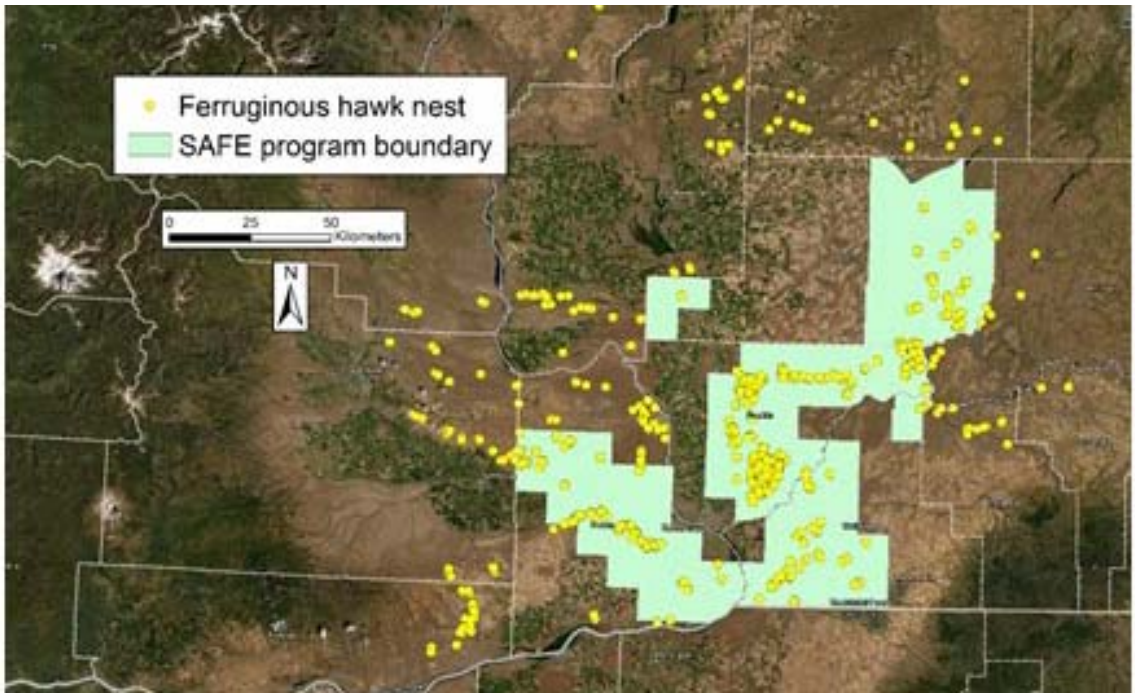

Figure 9. Boundaries of State Acres for Wildlife Enhancement (SAFE) program for Ferruginous Hawk in Adams, Benton, Franklin, and Walla Walla counties, Washington. Boundaries as of June 2020.

Habitat status - nonbreeding range. Winter habitat of the Ferruginous Hawk includes shrubsteppe, grasslands, desert, and edges of agricultural areas that support an abundance of pocket gophers and prairie dogs (Ng et al. 2017). Washington's migratory Ferruginous Hawks spend most of the year (63%) on nonbreeding ranges, most importantly the Great Plains region, from late summer through fall, and the Central Valley of California during winter (Watson et al. 2018*a*). Sagebrush and grasslands are among the most imperiled ecosystems in North America (Samson and Knopf 1994, Noss et al. 1995, White et al.

2000, Wisdom and Rowland 2007). Although the sagebrush ecosystem remains large, it has been substantially reduced in area and quality. Approximately 50-60% of remaining native sagebrush steppe now has either exotic annual grasses in the understory or has been converted completely to non-native annual grasslands (West 2000). Land-use practices that have caused the loss, degradation, and fragmentation of sagebrush ecosystems include historically excessive livestock grazing, agriculture and urbanization, and energy development (Knick et al. 2003, Connelly et al. 2004, Knick et al. 2011). Invasion of exotic annuals has changed both the fire regime and successional patterns in sagebrush resulting in more frequent fires and conversion of shrublands to exotic annual grasslands (D'Antonio and Vitousek 1992). In the Great Plains, the tall-grass prairie has decreased by nearly 98%, mixed-grass prairie has declined by 64% and the short-grass prairie decreased by nearly 66% (Mac et al. 1998, White et al. 2000). Land-use practices that have caused the loss, degradation, and fragmentation of central North American grasslands include agriculture, urbanization, desertification, fire, grazing of domestic livestock, and introduction of non-native plant species (White et al. 2000, Gauthier et al. 2003). Reduced prey and quality of nonbreeding habitats experienced by Washington's hawks on wintering areas and during migration could adversely affect Washington's breeding population (Newton 2006, Watson et al. 2018*a*). Specifically, because the nonbreeding season is the period during which hawks restore body condition diminished during nesting, reduced prey abundance or quality on winter ranges potentially impacts survival and subsequent breeding performance. Although these effects are difficult to quantify, the exposure of Washington's migratory Ferruginous Hawk population to documented loss of habitat and prey on nonbreeding ranges, as well as documented, substantial mortality during the nonbreeding period (J. Watson, unpublished data), suggest these factors are contributing to reduced breeding performance of the population (e.g., nest occupancy).

FACTORS AFFECTING CONTINUED EXISTENCE

Federal regulatory protection. The Ferruginous Hawk was petitioned for listing under the Endangered Species Act in 1983 and 1991 but listing was determined to be unwarranted (USFWS 1992). In Canada, the species is listed as threatened under the federal Species at Risk Act (COSEWIC 2008). The Migratory Bird Treaty Act currently protects the species.

State regulatory protection. The Ferruginous Hawk is protected from 'take' as a threatened species by Washington state law (RCW 77.12.020, RCW 77.15.130). On non-federal lands, the Growth Management Act (GMA) is Washington's primary regulatory tool to protect rare and threatened species from development impacts (WAC 365-190-130). Consistent with provisions of GMA, many counties use the federal and state lists of endangered, threatened, and sensitive species, and require review and mitigation before issuing permits for projects that would impact habitat. WDFW provides Priority Habitat and Species (PHS) information to counties, local jurisdictions, agencies, landowners, and consultants for land use planning and permit evaluation purposes; this includes maps and management recommendations (https://wdfw.wa.gov/species-habitats/at-risk/phs Richardson et al. 1999, Azerrad et al. 2011). County critical area ordinances provide some protection of its habitat through environmental review and habitat management plans for development proposals that affect state-listed species. Although the nature of protections varies, the counties of Adams, Asotin, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Spokane, Walla Walla, Whitman, and Yakima include Ferruginous Hawk in their critical area ordinances.

Habitat loss, degradation, and fragmentation. Conversion of native grasslands and shrublands to crops and urbanization is usually permanent and results in direct loss and fragmentation of breeding and

wintering habitat. Conversion of native habitats to cultivated croplands and urban development eliminates nest sites, removes or reduces prey species, and increases human disturbance and potential predators. In Washington, over half of the original shrubsteppe habitat has been converted to croplands resulting in high fragmentation of extant habitat (Dobler et al. 1996, Vander Haegen et al. 2001) and disproportionate loss of deep-soil shrubsteppe communities (Vander Haegen et al. 2000) that are important habitat for prey species, such as ground squirrels (Vander Haegen et al. 2001).

Compared to agriculture and urbanization that eliminate and often fragment habitat, rangelands can provide nesting and foraging habitat for Ferruginous Hawks, but over-grazing practices may negatively affect populations through habitat degradation. Grazing can affect raptors by 1) altering nest site availability; 2) changing prey diversity, abundance and composition; and 3) influencing prey vulnerability (Kochert 1989). In Washington, historical overgrazing has degraded remaining shrubsteppe communities. Native perennial grasses in shrubsteppe are not adapted to grazing by large herds of large ungulates (Mack and Thompson 1982), several of the major shrub species are fire sensitive and can be eliminated from the site by burning, and exotic annual grasses are well-adapted to invade and increase under excessive grazing pressure (Daubenmire 1988, Franklin and Dyrness 1988). Sagebrush systems used for grazing livestock were historically overgrazed or cleared of sagebrush to increase production of grasses and forbs as forage for livestock (Franklin and Dyrness 1988, Harris 1991). These grazing practices often led to loss of perennial native grasses and forbs and contributed to invasions of annual grasses, such as cheatgrass (Franklin and Dyrness 1988, Harris 1991, Knick et al. 2003, Knick et al. 2011) that adversely impact prey species of Ferruginous Hawks (*see below Reductions in prey base*).

Invasions of annual grasses, particularly cheatgrass, provide fine fuels that facilitate fire spread and result in more frequent fires in cheatgrass-dominated sagebrush communities (Miller et al. 2011). Moreover, big sagebrush is easily killed by fire, and when it occurs at increased frequency, big sagebrush can be eliminated from the vegetation assemblage (Daubenmire 1988, Franklin and Dyrness 1988, Miller et al. 2011). Cheatgrass invasion has altered fire regimes resulting in shorter fire return intervals, larger burned areas, and increased probability of fire (Miller et al. 2011, Balch et al. 2013). Invasion by cheatgrass has led to a grass-fire cycle in which increasing cheatgrass promotes larger fires that allow cheatgrass to increase further, thereby eroding and fragmenting remaining stands of sagebrush and converting native sagebrush to exotic annual grasslands (Whisenant 1990, Knick and Rotenberry 1997, Knick 1999). Degradation of sagebrush systems due to a legacy of historical overgrazing and associated habitat alterations are widespread across the Intermountain West (Young 1999, Knick et al. 2003) and likely reduce foraging habitat of Washington's migratory Ferruginous Hawks encountered on nonbreeding ranges (Watson et al. 2018*a*). Washington's Ferruginous Hawks depend on grasslands in the Great Plains and in the Central Valley of California as critical foraging habitat during the nonbreeding period (Watson et al. 2018*a*).

Reductions in prey base. The Ferruginous Hawk is stenophagus (Ng et al. 2017), a dietary specialist that targets specific small mammal prey. Primary historical prey species of the Ferruginous Hawk that nest in Washington, namely ground squirrels and jackrabbits (Ng et al. 2017), have become scarce in Washington and greatly reduced in numbers and distribution in other parts of their range that are frequented by Washington's hawks during the nonbreeding period. In Washington, the Townsend's ground squirrel, Washington ground squirrel, white-tailed jackrabbit, and black-tailed jackrabbit are state candidate species. In Oregon, the Washington ground squirrel is state endangered. At the federal level, the Washington ground squirrel was petitioned for listing under the Endangered Species Act but found to be not warranted (USFWS 2016). Washington's breeding population of Ferruginous Hawks prey on ground squirrels and rabbits, as well as prairie dogs when they are away from their breeding ranges for up

to two-thirds of the year (Watson et al. 2018*a*). In North America, many prey species of ground squirrels, especially those associated with shrubsteppe, are of conservation concern (Hafner et al. 1998, Yensen and Sherman 2003). Additionally, all five species of prairie dog: black-tailed (*C. ludovicianus*), Gunnison's (*C. gunnisoni*), Mexican (*C. mexicanus*), Utah (*C. parvidans*), and white-tailed (*C. leucurus*) are now rare (Hoogland 2006). The Utah prairie dog is federally listed as threatened under the Endangered Species Act (USFWS 2012) and the Mexican prairie dog is federally listed as endangered (Hoogland 2003). The black-tailed, Gunnison's, and white-tailed prairie dogs were petitioned for listing under the federal Endangered Species Act and found not warranted (USFWS 2004, USFWS 2006, USFWS 2010). The black-tailed prairie dog currently occupies <2% of its former range (Miller et al. 2000).

Distribution and abundance of ground squirrels, prairie dogs, and jackrabbits have sharply declined across their range as a result of habitat loss, degradation and fragmentation of native shrublands and grasslands, as well as decades of persecution from shooting and poisoning, and disease (Flinders and Chapman 2003, Hoogland 2003, Yensen and Sherman 2003, Simes et al. 2015). In Washington, expansion of irrigation into sagebrush areas for agriculture, overgrazing of bunchgrasses in sagebrush and bunchgrass areas by livestock, and conversion of bunchgrass areas to dry-land wheat farming are likely major factors that resulted in the reduction and current rarity of white-tailed jackrabbits (Dice 1916, Couch 1927a, Svihla and Svihla 1940, Dalquest 1948). Livestock grazing, cultivation, and fire in the shrubsteppe have reduced the area and distribution of native vegetation to small, isolated remnant patches (Vander Haegen et al. 2000, Vander Haegen et al. 2001), thereby reducing the protective cover and food plants that are important components of habitat to black-tailed jackrabbits (Uresk 1978, Johnson and Anderson 1984, Anderson and Shumar 1986, Nydegger and Smith 1986, Knick and Dyer 1997, Simes et al. 2015) and ground squirrels (Rogers and Gano 1980, Nydegger and Smith 1986, Betts 1990, Yensen and Quinney 1992, Yensen et al. 1992, Van Horne et al. 1997, Van Horne et al. 1998, Lohr et al. 2013).

Often perceived as "pests" by ranchers and farmers, prairie dogs, ground squirrels, and jackrabbits have been the targets of intensive eradication programs across their range and controlled by trapping, shooting and poisoning (Flinders and Chapman 2003, Hoogland 2003, Yensen and Sherman 2003, Forrest and Luchsinger 2006). Extensive poisoning and shooting of prairie dogs in North America during the past century are largely responsible for the 98% decline in their populations (Miller et al. 1994, Hoogland 2006). Recreational shooting of prairie dogs is estimated to kill nearly 2 million prairie dogs per year (Reeve and Vosburgh 2006). As a result of poisoning programs, prairie dog colonies are now scattered and more isolated. Colonies of prairie dogs that have become isolated due to habitat fragmentation are more susceptible to extirpation due to genetic effects, demographic and environmental stochastic events, and disease, especially sylvatic plague (Miller et al. 1994, Miller and Reading 2012). In Washington, ground squirrels were poisoned because of damage to agricultural crops (Foster 1911, Shaw 1916, Couch 1927*b*). Efforts to eradicate primary prey species of Ferruginous Hawks also increase risk to these hawks due to lead toxicosis from recreational shooting of prairie dogs and ground squirrels (Herring et al. 2016) and exposure to rodenticides (Vyas et al. 2017).

Plague is a disease relevant to Ferruginous Hawk populations because of its effect on its prey base. Plague is a flea-borne zoonotic disease caused by the bacterium *Yersinia pestis* that is maintained in the wild through transmission between blood-feeding adult fleas and certain rodent hosts, and occasionally lagomorphs (Gage and Kosoy 2005). Plague was likely introduced to North America via ship-borne rats and their fleas early in the 20th century and gained its initial foothold in California around 1900 (Link 1955, Gage and Kosoy 2006). Afterward, plague spread rapidly eastward in the 1930s and 1940s in several rodent species, including ground squirrels and prairie dogs, (Svihla 1939, Cully and Williams 2001). Dramatic reductions in numbers and distribution of ground squirrels attributed to plague occurred

in Washington and Utah beginning in 1936 and shortly thereafter in Nevada (Svihla 1939, Hansen 1955). By 1950 the current distribution of plague was established near its current range limit that comprises 17 western states (Cully and Williams 2001, Gage and Kosoy 2006). In Washington, evidence suggests incidents of epizootic plague have occurred among ground squirrel populations in eastern Washington as early as 1896 and "die-offs" among ground squirrels were reported from 1914 through 1938 in seven counties (Klickitat, Benton, Garfield, Columbia, Adams, Lincoln and Spokane) (Svilha 1939, WDOH 2009). All four species of prairie dogs in the U.S. are highly susceptible to plague with high mortality reported during epizootics (Biggins and Kosoy 2001*a*, Biggins and Kosoy 2001*b*, Cully and Williams 2001).

Changes in the abundance, distribution, and composition of available prey species influence breeding populations of Ferruginous Hawks. In areas where jackrabbits are its primary prey, the number of hawks occupying nesting territories and laying eggs and the number of young produced is positively correlated with the abundance of jackrabbits (Howard and Wolfe 1976, Smith and Murphy 1978, Thurow et al. 1980, Smith et al. 1981, Woffinden and Murphy 1989). The response of hawk populations to changes in jackrabbit abundance suggest that jackrabbits as food are a potentially limiting factor to hawk reproduction (Smith et al. 1981). When jackrabbits are abundant, the breeding population and reproductive success of hawks increases, whereas pairs appear to refrain from breeding or have lower reproductive success when jackrabbits are scarce (Smith and Murphy 1978, Smith et al. 1981). A similar relationship has been reported between occupancy of nesting territories and reproductive success of Ferruginous Hawks and ground squirrel abundance (Steenhof and Kochert 1985, Schmutz and Hungle 1989, Houston and Zazelenchuk 2005, Schmutz et al. 2008, Wallace et al. 2016). Some Ferruginous Hawk breeding populations that experienced a decline following a crash in their primary prey failed to increase as their primary prey subsequently increased. This is cause for concern and perhaps is due to low production and increased mortality rates of hawks (Woffinden and Murphy 1989) or other factors that influence recruitment. Given that both nesting populations and productivity of Ferruginous Hawks are known to be negatively affected by declines in abundance of primary prey, it is likely that the apparent drastic reductions in jackrabbits and ground squirrels in Washington have played a role in reducing the nesting population of Ferruginous Hawks in the state.

Wind turbines. Wind energy is one of the fastest growing renewable energy sources in the U.S. (USDOE 2017), and there are concerns for potential direct and indirect impacts of wind energy facilities on wildlife populations, particularly raptors (Watson et al. 2018*c*). Direct impacts are primarily collision fatalities and indirect impacts include habitat loss, fragmentation, and behavioral changes that result in avoidance (Arnett et al. 2007, Kuvlesky et al. 2007). Ferruginous Hawks have been considered at risk of collision with wind turbines based on observed diurnal flight heights within the rotor swept zone at planned wind facilities (Wulff et al. 2016, Watson et al. 2018*b*). While the Golden Eagle has been the focus of much concern about wind energy development, a recent analysis identified both Ferruginous Hawk and Golden Eagle at equally high risk of experiencing population declines from wind energy in the U.S. (Beston et al. 2016).

In Washington, wind turbines occur in proximity to Ferruginous Hawk nesting territories in Klickitat, Benton, Walla Walla, and Columbia Counties. Five Ferruginous Hawk fatalities, due to turbine strikes, have been documented along the Columbia River in Oregon and Washington between 2003 and 2012 (J. Watson, unpublished data.) and likely underestimate the potential impact from this source of mortality since post-construction fatality monitoring is only required up to two years after projects are completed. In north-central Oregon, greater wind turbine densities were related to decreased nest success and lower post-fledging survival of Ferruginous Hawks (Kolar and Bechard 2016). While the specific mechanisms

for these relationships were unclear, the researchers speculated that a combination of breeding adults being killed from turbine collisions and disturbance or displacement from portions of their home range by activities associated with wind energy development in the area were likely responsible (Kolar and Bechard 2016). However, Watson et al. (2018*b*) found no evidence of behavioral displacement of adult hawks by turbines in the same study area, although recent research has documented long-term declines in Ferruginous Hawk nesting on or near wind turbine projects (J. Watson, unpublished data).

Climate change. During the past century temperatures have been increasing across the Great Basin and Columbia Plateau, both annually and seasonally, but changes in precipitation have been minor with no clear trends (Kunkel et al. 2013, Snyder et al. 2019). The Great Basin and Columbia Plateau are becoming more arid and this trend will likely continue resulting in more frequent droughts that last longer, expanded occurrence of invasive annual grasses, and increased duration and severity of wildfire seasons (Snyder et al. 2019). Climate projections for 2020-2050, indicate that temperatures will continue to increase but precipitation estimates are more uncertain (Snyder et al. 2019). More frequent droughts and expansion of invasive annual grass/fire cycles may result in continued conversion of native shrubsteppe to exotic annual grasslands that lead to an increasingly unstable prey base for Ferruginous Hawks (Smith and Johnson 1985, Yensen and Quinney 1992, Yensen et al. 1992, Van Horne et al. 1997, Van Horne et al. 1998). Increased frequency of droughts due to climate change may increase the frequency of widespread epizootics of plague among primary prey species, including prairie dogs in the grasslands of western North America (Eads and Hoogland 2016, Eads et al. 2016, Eads and Hoogland 2017) and ground squirrels. While predicting how Ferruginous Hawks will respond to these conditions is uncertain, the implications of changing climate to Ferruginous Hawks may result in changes in disease incidence, breeding asynchrony with respect to availability of fossorial prey, increased nestling mortality from exposure and nest collapse, and changes in prey numbers and hunting success (Shank and Bayne 2015).

MANAGEMENT ACTIVITIES

Surveys. Coordinated efforts to survey all known Ferruginous Hawk nesting territories and to search for new territories have been undertaken periodically by WDFW and its partners (e.g., USFWS, BLM, YTC, DOE Hanford) to determine the number of territorial pairs and their reproductive status (WDFW data, Nugent 2016). A minimum of two visits are made to each nesting territory with a first visit in April and early May to determine occupancy and a second visit in June or July to determine productivity. Surveys for Washington ground squirrel have been conducted by WDFW and its partners to determine their status (Finger et al. 2007, Cranna and Nugent 2015) and population trend (WDFW data).

Artificial nest platforms. New or replacement nesting opportunities can be provided by constructing artificial nest platforms. Twelve pole platforms were installed in the Juniper Forest Management Area (Franklin County) in 1987 and 1988 and 42 were built and installed in Walla Walla County in 1993. Two additional platforms were constructed in Benton County in 1993. In 2019, WSDOT funded the design and construction of 29 nest platforms that WDFW installed in Benton (7), Franklin (1), Columbia (6), and Walla Walla (15) counties (M. Vekasy, WDFW). WDFW coordinated the placement of 15 platforms in southwest Walla Walla County in the area surrounding the planned Highway 12 re-alignment, an area that overlaps the core breeding range of the Ferruginous Hawk in the county. Although monitoring of nest platforms has been limited due to COVID-19 restrictions, all 29 platforms were monitored to some extent and successful nesting attempts were documented at two new platforms.

Habitat restoration and enhancement. The State Acres for Wildlife Enhancement (SAFE) program is an initiative under the Conservation Reserve Program (CRP) that started under the Farm Bill nationwide in January 2008. The program is a partnership between the U.S. Department of Agriculture (USDA) and state fish and wildlife agencies to develop quality wildlife habitat with an emphasis on restoration of native vegetation and associated wildlife benefits. The Ferruginous Hawk SAFE is available to agricultural producers in portions of Adams, Benton, Franklin, and Walla Walla counties. The goal of this initiative is to enhance foraging habitat and provide buffers around Ferruginous Hawk nests by establishing shrubs, grasses and broadleaf forbs on cropland and expanding upon remnant shrubsteppe and grassland habitat near nests. SAFE has the potential to increase the amount of foraging and nesting habitat available for breeding hawks, but WDFW has not evaluated the effectiveness of the program for this hawk and its primary prey species. Ferruginous Hawks may benefit from other SAFE programs in shrubsteppe.

Conservation planning. A state recovery plan for Ferruginous Hawk was completed in 1996 (WDFW 1996), with the goal of maintaining a breeding population throughout much of the species' historical range in Washington. An assessment of connectivity patterns for jackrabbits and ground squirrels in the Columbia Plateau was completed in 2012 (Ferguson and Atamian 2012*a,b*; Sato 2012*a,b*); the analysis modelled habitat areas and movement corridors. Jackrabbits and ground squirrels are focal species of conservation in the Arid Lands Initiative (Arid Lands Initiative 2014). On the Hanford Site, the Conservation Habitat Assessment and Mitigation Prioritization (CHAMP) takes a landscape approach to evaluate habitat quality of shrubsteppe and grasslands on DOE-managed lands to determine areas for conserving, restoring, mitigating, and connecting habitats. Results from this analysis will direct recovery efforts for black-tailed jackrabbits and Townsend's ground squirrels on DOE-managed lands (MSA 2019).

Research. Research on this species has been directed primarily at understanding movements by Washington's Ferruginous Hawks during the nonbreeding period, food habits, and some focus on assessing risk at wind energy sites. WDFW has led research studies to identify migration patterns, destinations and chronology (Watson and Pierce 2003, Watson et al. 2018*a*, Watson et al. 2019), estimate survival rates and associated sources of mortality (Watson and Pierce 2003), and investigated site fidelity by adults to breeding and nonbreeding (Watson and Pierce 2003, Watson and Keren 2019). Studies of food habits suggest that Washington's breeding population of Ferruginous Hawks has undergone a dietary shift since the early 1900s and appears to have lost a high quality prey component, namely jackrabbits (Richardson et al. 2001). Other research has assessed potential direct and indirect effects of wind energy development on nesting Ferruginous Hawks in the Columbia Basin in Washington and Oregon (Watson et al. 2018*b*). Researchers on the Hanford Site developed a survey method using remote cameras to document the presence and distribution of black-tailed jackrabbits (Grzyb et al. 2016).

CONCLUSIONS AND RECOMMENDATION

Early accounts suggest Ferruginous Hawks were once common in the early 1900s. Ferruginous Hawk populations likely declined concurrent with the conversion of grassland and shrubsteppe to agriculture, degradation of rangelands, and increasing fire frequency that adversely affect both nesting and foraging habitat and their primary prey. In addition to loss and degradation of habitat for primary prey species, such as jackrabbits and ground squirrels, these species were perceived as pests and were targets for eradication in the state by trapping, shooting, and poisoning. Further, sylvatic plague was confirmed in ground squirrels in 1937 in eastern Washington and likely was a significant factor in the decline of

Washington and Townsend's ground squirrel populations statewide. Loss of foraging habitat and sharp declines in abundance and distribution of ground squirrels, jackrabbits and prairie dogs throughout arid shrublands and grasslands of the western U.S. and Great Plains likely adversely affect survival, mortality, and carry-over effects on Washington's Ferruginous Hawk breeding population during the nonbreeding period when they are away from Washington for nearly two-thirds of the annual cycle.

The breeding population of Ferruginous Hawks in Washington is in sustained decline. Between 1974 and 2016, there has been significant declines in nesting territory occupancy, nest success, and productivity. Additionally, the percentage of surveyed nesting territories supporting breeding pairs has significantly declined in the core breeding range of the species in Benton and Franklin counties. The distribution of breeding pairs statewide also appears to have contracted since the early 1990s. There has been no improvement in habitat conditions or amelioration of primary threats, and therefore the recommendation is to reclassify the Ferruginous Hawk from threatened to endangered status in Washington.

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The references cited in the *Periodic Status Review for the Ferruginous Hawk* are categorized for their level of peer review pursuant to section 34.05.271 RCW, which is the codification of Substitute House Bill 2661 that passed the Washington Legislature in 2014. A key to the review categories under section 34.05.271 RCW is provided in Table A. References were categorized by the primary author in April 2021.

Individual papers cited cover a number of topics discussed in the report, including information on: 1) the species' description, taxonomy, distribution, and biology; 2) habitat requirements; 3) population status and trends; 4) conservation status and protections; 5) research, monitoring, and restoration activities; and 6) factors affecting the continued existence of the species.

Table A. Key to 34.05.271 RCW Categories:

34.05.271(1)(c) RCW	Category Code
(i) Independent peer review: review is overseen by an independent third party.	i
(ii) Internal peer review: review by staff internal to the department of fish and wildlife.	ii
(iii) External peer review: review by persons that are external to and selected by the department of fish and wildlife.	iii
(iv) Open review: documented open public review process that is not limited to invited organizations or individuals.	iv
(v) Legal and policy document: documents related to the legal framework for the significant agency action including but not limited to: (A) federal and state statutes; (B) court and hearings board decisions; (C) federal and state administrative rules and regulations; and (D) policy and regulatory documents adopted by local governments.	v
(vi) Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under the processes described in (c)(i), (ii), (iii), and (iv) of this subsection.	vi
(vii) Records of the best professional judgment of department of fish and wildlife employees or other individuals.	vii
(viii) Other: Sources of information that do not fit into one of the categories identified in this subsection (1)(c).	viii

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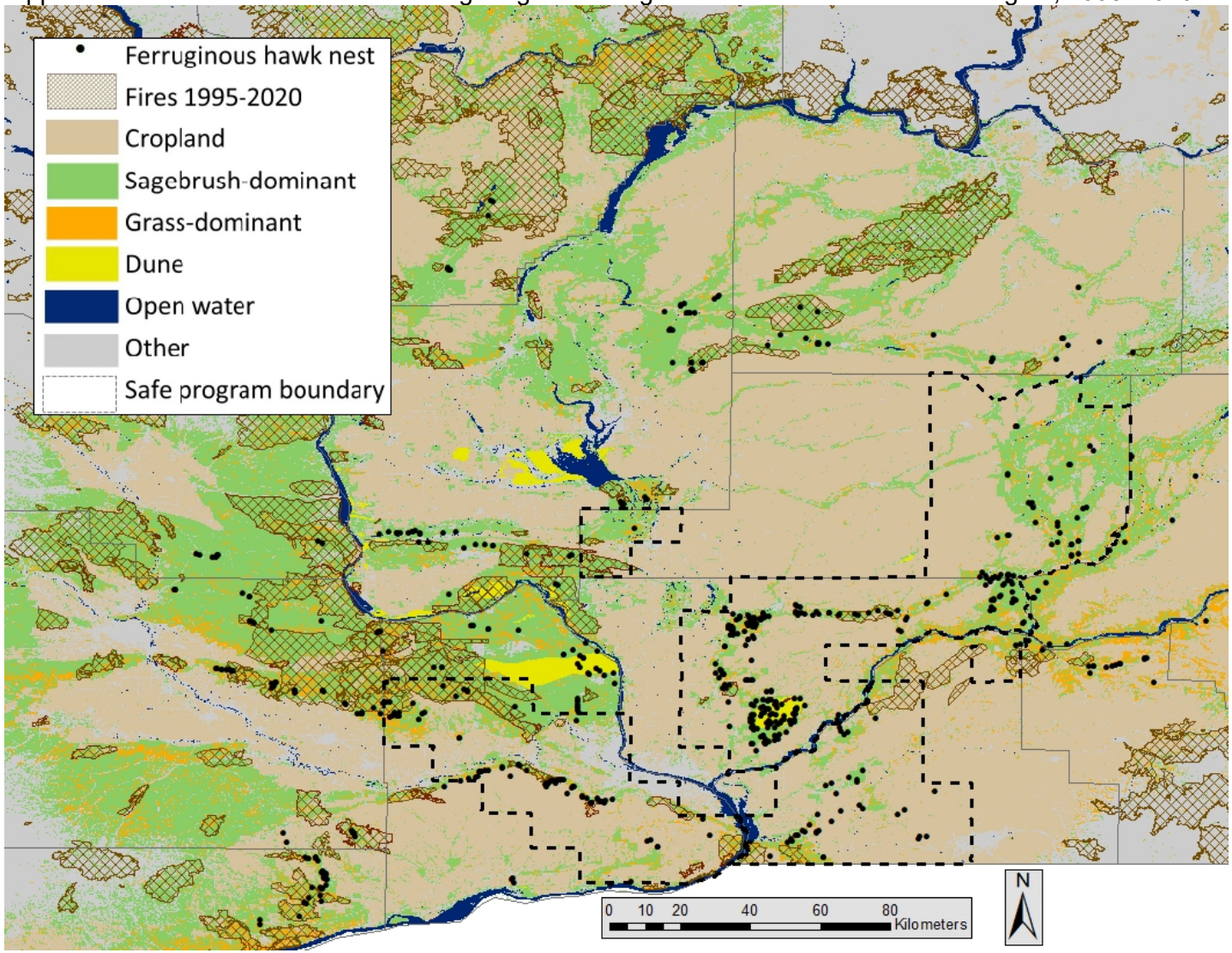
Appendix A. Wildfires within the breeding range of Ferruginous Hawks in eastern Washington, 1995−2020.



APPENDIX B. PUBLIC COMMENTS.

WDFW received public comments during the 90-day public comment period for the draft *Periodic Status Review for the Ferruginous Hawk*. WDFW received 13 individual comment letters from citizens and four comment letters from organizations; 11 of the 13 response letters from citizens and three of the four response letters from organizations indicated support for WDFW's status recommendation to reclassify the Ferruginous Hawk from threatened to endangered in Washington. One response letter from an organization and one response letter from a citizen did not comment on the recommended reclassification to endangered status. One response letter from a citizen did not support reclassification to endangered status.

Washington State Status Reports, Periodic Status Reviews, Recovery Plans, and Conservation Plans

Periodic Status Reviews

2021 Gray Whale
2021 Humpback Whale
2021 Greater Sage-grouse
2020 Mazama Pocket Gopher
2019 Tufted Puffin
2019 Oregon Silverspot
2018 Grizzly Bear
2018 Sea Otter
2018 Pygmy Rabbit
2017 Fisher
2017 Blue, Fin, Sei, North Pacific Right, and Sperm Whales
2017 Woodland Caribou
2017 Sandhill Crane
2017 Western Pond Turtle
2017 Green and Loggerhead Sea Turtles
2017 Leatherback Sea Turtle
2016 American White Pelican
2016 Canada Lynx
2016 Marbled Murrelet
2016 Peregrine Falcon
2016 Bald Eagle
2016 Taylor's Checkerspot
2016 Columbian White-tailed Deer
2016 Streaked Horned Lark
2016 Killer Whale
2016 Western Gray Squirrel
2016 Northern Spotted Owl
2016 Greater Sage-grouse
2016 Snowy Plover
2015 Steller Sea Lion

Conservation Plans

2013 Bats

Recent Status Reports

2019 Pinto Abalone
2017 Yellow-billed Cuckoo
2015 Tufted Puffin
2007 Bald Eagle
2005 Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot
2005 Aleutian Canada Goose
1999 Northern Leopard Frog
1999 Mardon Skipper
1999 Olympic Mudminnow
1998 Margined Sculpin
1998 Pygmy Whitefish
1997 Gray Whale
1997 Olive Ridley Sea Turtle
1997 Oregon Spotted Frog

Recovery Plans

2020 Mazama Pocket Gopher
2019 Tufted Puffin
2012 Columbian Sharp-tailed Grouse
2011 Gray Wolf
2011 Pygmy Rabbit: Addendum
2007 Western Gray Squirrel
2006 Fisher
2004 Sea Otter
2004 Greater Sage-Grouse
2003 Pygmy Rabbit: Addendum
2002 Sandhill Crane
2001 Lynx
1999 Western Pond Turtle
1996 Ferruginous Hawk
1995 Pygmy Rabbit
1995 Snowy Plover

Status reports and plans are available on the WDFW website at:
http://wdfw.wa.gov/publications/search.php