Management Recommendations for Washington's Priority Species:

Ferruginous Hawk

Washington Department of FISH & WILDLIFE

January 29, 2024

Management Recommendations for Washington's Priority Species:

Ferruginous Hawk

Buteo regalis

January 29, 2024

Written By James W. Watson and Jeffrey M. Azerrad

Suggested citation:

Watson, J. W., and J. M. Azerrad. 2024. Management Recommendations for Washington's Priority Species: Ferruginous Hawk. Washington Department of Fish and Wildlife, Olympia, Washington.

Cover photo by Jesse Watson, HawkWatch International.

Acknowledgements

The authors would like to thank the numerous individuals who contributed their time and expertise to help develop the Management Recommendations for Washington's Priority Species: Ferruginous Hawk. We are particularly grateful to our many reviewers: Chuck Stambaugh-Bowey (WDFW), Scott Downes (WDFW), Jason Fidorra (WDFW), Keith Folkerts (WDFW), Gerry Hayes (WDFW), Jason Lowe (Bureau of Land Management), Julia Michalak (WDFW), Mike Ritter (WDFW), Matthew Stuber (U.S. Fish and Wildlife Service), Elizabeth Torrey (WDFW), Grant Traynor (Walla Walla County Conservation District), Mark Vekasy (WDFW), and Zach Wallace (Wyoming Game and Fish Department). We are also grateful to Sean Williams for his work writing the guidance for ferruginous hawk management in areas used for agricultural and rangeland practices.

Contents

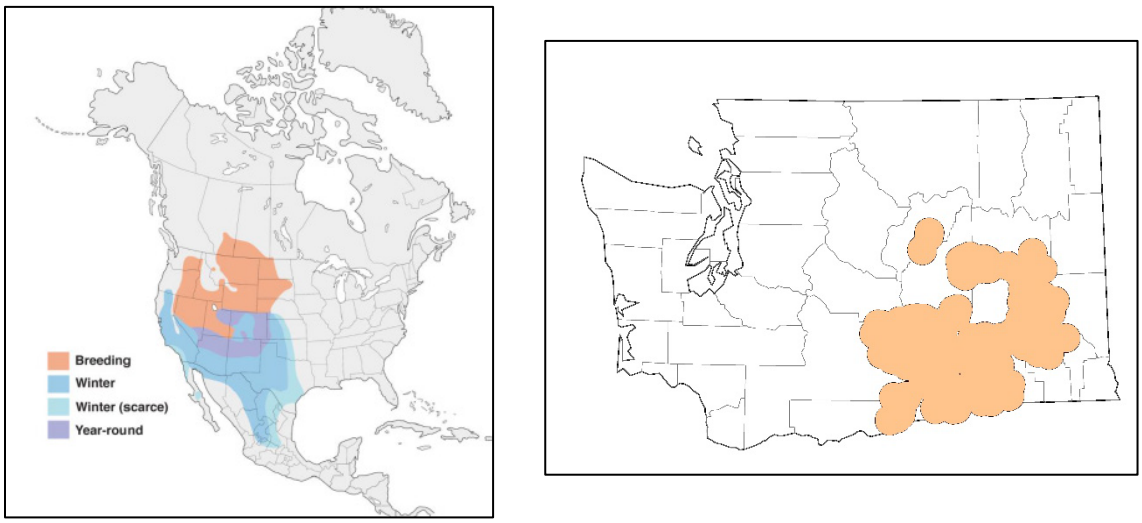
List of Figures

List of Tables

General range and regional distribution

The ferruginous hawk (*Buteo regalis*) occupies western North America from Canada through central Mexico (Ng et al. 2020). Washington is at the western limit of the species' breeding range, which extends eastward to extreme southwestern Manitoba, and south to northern Texas (Figure 1). This species' historic breeding distribution has remained unchanged, except for a contraction of their range in Alberta, Saskatchewan, and Manitoba in the 1900s caused by agricultural conversion and aspen (*Populus* spp.) invasion (Ng et al. 2020).

Figure 1. Distribution of ferruginous hawks in North America



Left map from allaboutbirds.org and Washington map from WDSM Data System, WDFW.

Throughout their range, most (98%) adult ferruginous hawks migrate from breeding territories after nesting (Watson et al. 2018*a*). Juvenile hawks migrate a few weeks after fledging (Watson et al. 2019). Migration begins in late summer for regional breeding populations, except those in Canadian grasslands, with hawks migrating eastward and northward to the northern grasslands and Great Plains (Watson et al. 2018*a*). Hawks migrate again in fall to winter ranges. Hawks from Washington winter in central to southern California, and other populations winter eastward through the southern grasslands (Figure 1).

Because most ferruginous hawks that nest in Washington are migratory, management recommendations in this document are directed to the land-use impacts affecting breeding populations. However, many of the same threats and management recommendations presented here are also relevant to Washington's hawks on their non-breeding ranges in other regions.

Rationale

Range-wide population estimates of ferruginous hawks in the early 1990s were between 2,921 and 5,665 nesting pairs (Olendorff 1993). Trend analysis of Breeding Bird Surveys indicates several states and regions have experienced downward trends since 1993 (Sauer et al. 2019). In the United States, the species was petitioned for federal listing under the Endangered Species Act in 1983 and 1991 (USFWS 1992). No federal listing resulted from either of these petitions. The species was federally listed in Canada as threatened in 1980, downlisted to special concern in 1995, and relisted to threatened in 2008 (COSEWIC 2008). In Alberta, a breeding stronghold of the species range-wide, the species was designated as endangered in 2006. The ferruginous hawk in 2005 was designated as a Species of Greatest Conservation Need in 17 U.S. states and is a listed species in several states (Ng et al. 2020). In Washington it was listed as threatened in 1983. Due to continued declines it was reclassified as endangered in Washington in 2021 (Hayes and Watson 2021).

Resource requirements

The ferruginous hawk is an open-country raptor that inhabits grasslands, shrubsteppe, and deserts of North America (Ng et al. 2020). These habitats provide the critical resources that ferruginous hawks require for successful nesting: medium-sized mammalian prey, low substrate suitable for nest placement, and space that isolates it from disturbance. Their breeding habitat in Washington most often occurs in shrubsteppe and juniper savanna. These areas are especially important as ferruginous hawk habitat when occupied by native mammalian prey and when there are basalt rock outcrops or isolated trees, primarily juniper, to provide suitable substrate for supporting nests (Bowles and Decker 1931, Bechard et al. 1990, WDFW 1996). Degradation or conversion of shrubsteppe and grassland often results in reduction or removal of the critical resources required for ferruginous hawk nesting. Recent attempts at habitat restoration for ferruginous hawks in southeast Washington through the Conservation Reserve Program have been effective in re-establishing hawks in degraded habitats.

Prey

Ferruginous hawks are dietary specialists that thrive on mammalian prey (Olendorff 1993), including ground squirrels (*Urocitellus* spp.) and jackrabbits (*Lepus* spp.), often supplemented by pocket gophers (Figure 2). Ferruginous hawk nesting populations and breeding performance fluctuate in synchrony with populations of these prey. Hawks can lay more eggs per nesting attempt when their prey populations are high (Ng et al. 2020). As many as six young can fledge from a nest in a year when prey populations are productive (Clarke and Houston 2008).

Figure 2. Washington ground squirrel

Washington ground squirrels like this one are preferred by ferruginous hawks as prey. Photo by Rich Finger.

Ferruginous hawk diets in Washington are diverse compared to elsewhere in their range. This is likely a consequence of declines in their preferred prey of ground squirrels and jackrabbits in Washington. Jackrabbits now contribute less in terms of prey frequency, which is a major dietary shift noted since the 1920s. More recently, a greater proportion of their diets have consisted of insects (51%) and mammals (49%). This shift in diet was based on the findings of a study of 67 nests between 1992 to 1995 in Washington (Richardson et al. 2001). In that study, Mormon crickets (*Anabrus simplex*) were the main insect prey (92% of insects in their diet), and northern pocket gophers (*Thomomys talpoides)* were the main mammalian prey (72% of mammals in their diet). A negligible portion of their total diet consisted of ground squirrels (1%) and jackrabbits (<1%; Richardson et al. 2001). Other studies in Washington have reported diets consisting of pocket gophers, Columbia Plateau pocket mice (*Perognathus parvus*), reptiles, and even gulls (Fitzner et al. 1977, Mazaika and Cadwell 1994, Leary et al. 1996). These dietary shifts are not without consequences as they can reduce nestling survival and can lead to declining raptor populations (Preston et al. 2017, Heath et al. 2021).

Nests

Ferruginous hawks build their nests on natural and artificial objects that are often short structures, or they build their nests on the ground (Ng et al. 2020). In Washington, ferruginous hawks construct nests away from human activity, in contrast to Swainson's (*Buteo swainsoni*) or red-tailed hawks (*Buteo jamaicensis*; Bechard et al. 1990). In some places, artificial structures have improved suitability as ferruginous hawk nest structures and reduce access to hawks by ground-based predators (Neal et al. 2010, Wallace et al. 2015). A range-wide summary of nest substrate in the 1970s and 1980s found that 49% of nests were in trees (Figure 3), 21% on cliffs, 12% on utility structures, 10% on dirt outcrops, and only 6% on the ground (Olendorff 1993).

Figure 3. Ferruginous hawk nest

Ferruginous hawk nest in crook of a lone tree in grassland habitat. Photo by Jim Watson.

Ferruginous hawks in Washington have been observed nesting primarily on cliffs (62%), trees (34%), and artificial substrates (4%; Bechard et al. 1990). In recent years, nest platforms installed in southeast Washington have been successfully used by nesting ferruginous hawks (M. Vekasy, unpublished data). Early research in southeastern Washington found nests constructed with greasewood branches (*Sarcobatus vermiculatus*; Bowles and Decker 1931). Later research found nests constructed mainly of sagebrush (*Artemesia* spp.) and rabbitbrush sticks of at least 5 centimeters (2 inches) in diameter and lined with bunchgrass and peeled sagebrush bark (Fitzner et al. 1977).

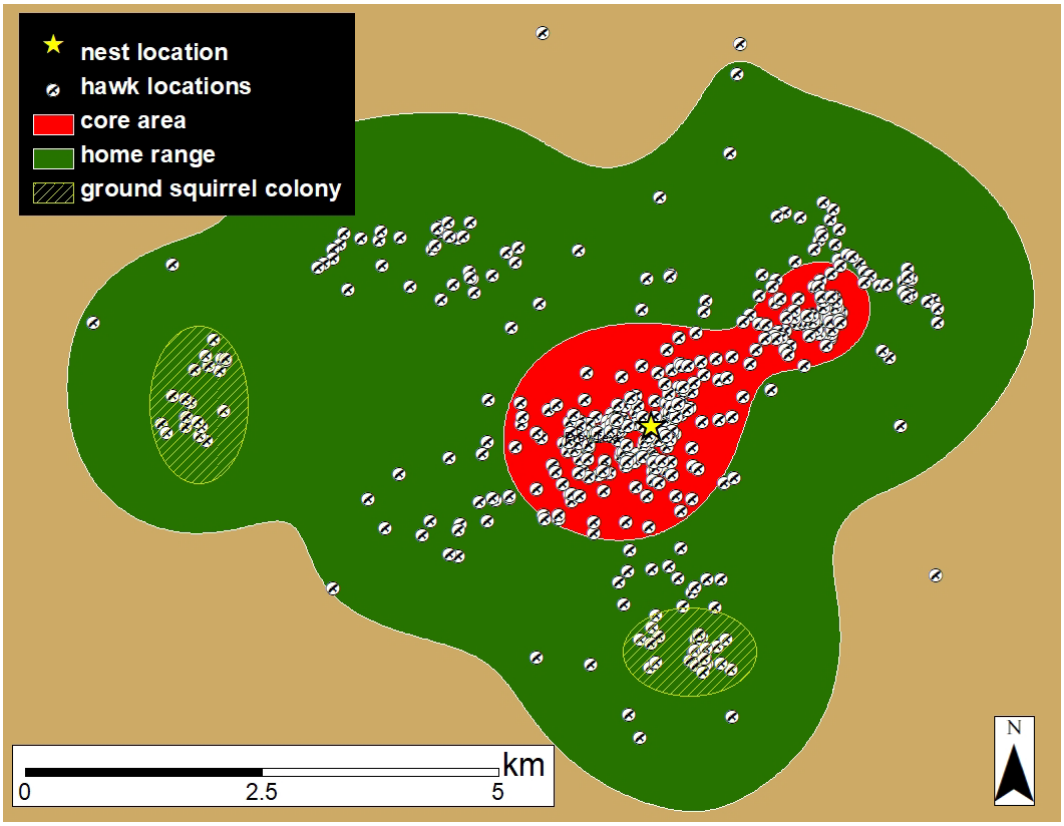
Ferruginous hawk nests and nest substrate may be lost to natural and human-caused disturbances. This can include fire, inclement weather, and abrasion from cattle rubbing (Houston 1982, Datta 2016, Parayko 2021). The resulting loss of nests can reduce ferruginous hawk nesting opportunities and increase competition for nest substrates with other raptors, as well as with common ravens (*Corvus corax*) and great-horned owls (*Bubo virginianus*).

Space

Breeding home ranges of raptors encompass the area within which all resources for successful nesting occur (Figure 4; Newton 1979). Home ranges of nesting ferruginous hawks are most often in arid, open landscapes that typically have low levels of human activity. Due to their dietary specialization, the location and size of breeding home ranges of ferruginous hawk are affected by the distribution and abundance of preferred prey (Leary 1996, Watson 2020). The distribution of elevated nest substrates and perches also influence characteristics of breeding home ranges of ferruginous hawk (Wiggins et al. 2014, Watson 2020, Watson et al. 2023). The core areas of breeding home ranges encompass the most

intense areas of use (Figure 4; Wilson et al. 2010). Core areas typically include nests and key foraging habitats (Watson 2020, Watson et al. 2023).

Figure 4. Stylized ferruginous hawk home range and core area.



A study of seven hawks tracked with ground-based telemetry in Washington found that their breeding home ranges (95% minimum convex polygons) were 10 times larger (78.6 kilometers^2) than those in other regions (Leary 1996). Large home ranges were attributed to distant irrigated agricultural fields (i.e., >15 kilometers [km] from nests) where hawks foraged. These fields were harvested several times a year and thus had low canopy cover that likely enhanced the foraging opportunities for hawks.

More recent use of precise satellite telemetry found even larger ferruginous hawk home ranges in southern Washington and north-central Oregon (Watson et al. 2023). This study of 17 hawks monitored for an average of 100 days and 1588 fixes revealed an average breeding home range size (95% isopleths, Brownian Bridge Model) of 378 km^2. Core areas (50% isopleths, Brownian Bridge Model) averaged 39.8 km^2. The comparatively large home ranges found in this study were attributed to the scattered distribution of prey in this region. These relatively large home ranges are an indicator of overall low prey abundance. Ferruginous hawks must in turn travel farther from their nests in search of prey, which ultimately increases the size of their home range.

Adult ferruginous hawks in the Pacific Northwest occupy their home ranges between 27 December and 17 October (Table 1; Watson et al. 2018a). The December arrival date is due to the small percentage of adult male hawks (6%) that return to winter on their breeding ranges after late-summer migration. Most hawks arrive in early March. Although earlier studies suggest ferruginous hawks moved nomadically during prey declines (Schmutz and Hungle 1989, Woffinden and Murphy 1989), more recent evidence based on satellite telemetry (Watson and Keren 2019) found that ferruginous hawks have a high fidelity to their breeding home ranges throughout their breeding distribution, with most birds returning to the same ranges year after year. In this study using satellite telemetry, 83% of hawks returned to the same breeding range. Fledgling ferruginous hawks typically migrate before, and independently from, adults (Watson et al. 2019).

Table 1. Chronology of ferruginous hawk nesting in the Pacific Northwest*

Behavior	Date		
	Begin	**Average**	**End**
Arrival of adults on home ranges	27 December	2 March	22 March
Incubation initiated	1 April	13 April	30 April
First eggs hatch	3 May	15 May	31 May
First young fledge	11 June	24 June	11 July
Late summer departure of adults from ranges	5 June	21 July	17 October

* Derived from 20 radio-monitored adults studied for 33 combined years, J. Watson, unpublished data.

Limiting factors

Human-caused or natural changes in ferruginous hawk habitat may reduce breeding rates and productivity when these changes impact the prey, nest substrates, and space that hawks require for nesting. A population viability analysis concluded the most important factors affecting ferruginous hawk population trends were adult survival and their ability to produce offspring (Collins and Reynolds 2005). Adult mortality from anthropogenic sources like wind power is likely additive (Dwyer et al. 2018, Diffendorfer et al. 2021), effectively meaning there is no surplus of adults to replace those lost to cumulative sources. Disturbance of nesting hawks may alter their behavior and potentially impact their reproductive success, health, and survival of young. Disturbance of nesting raptors may result in nest desertion; injury to eggs and young by startled adults; loss of eggs or death of young from exposure; premature fledging of young; or avian and mammalian predation (Rosenfield et al. 2007). Disturbances may not only reduce ferruginous hawk productivity but can cause hawks to desert their territories (White and Thurow 1985).

Development

Direct mortality and disturbance of hawks from development, including that for residential, recreational, and industrial purposes (e.g., renewable energy, surface mining, and road construction), may limit breeding population sizes. These disturbances associated with development can disrupt natural behaviors in ways that may be subtle (e.g., flushing; Keely and Bechard 2011, Nordell et al. 2017) or less obvious (e.g., displacement). These behavioral changes can ultimately reduce reproduction and population sizes (Kolar and Bechard 2016). Development can indirectly impact hawks that may avoid or completely abandon a developed area due to the associated disturbances (Dwyer et al. 2018). Hawks

that continue nesting near development may be adversely impacted by construction (e.g., machinery) and post construction (e.g., pedestrians) disturbances. Development may also directly eliminate prey and nesting habitat.

Mortality

Several factors cause direct, accidental mortality of ferruginous hawks. Mortality is often the result of vehicle collisions. Other sources of mortality include power line electrocutions (Harness and Wilson 2001, APLIC 2006) and collisions with wind turbines (Smallwood and Thelander 2008). Recreational development and road construction that increase off-road vehicle access can increase disturbances and mortality, including the illegal shooting of ferruginous hawks. Shooting was historically the highest cause of mortality (15.8%) for ferruginous hawks banded and recovered between 1916 and 1992 (Gossett 1993). Programs to control or eliminate populations of burrowing mammals through shooting or poisoning may result in lead toxicosis or sub-lethal hemorrhage of hawks that consume affected mammal carcasses (Chesser 1979, Knopper et al. 2006, Vyas et al. 2012, Murray 2017).

Prey and prey availability

Disturbances affecting ferruginous hawk prey can indirectly impact nesting hawks (Coates et al. 2014, Wiggins et al. 2014). Habitat disturbances that alter shrubsteppe and grasslands favored by native prey species can then indirectly affect nesting hawks. This can include adverse influences on prey resulting from the conversion of grasslands and shrubsteppe to agriculture as well as invasions by exotic annuals caused by overgrazing or altered fire regimes (Fleischner 1994, Vander Haegen et al. 2000, Knick et al. 2003, Wick et al. 2016, Heath et al. 2021). Because ferruginous hawks cannot hunt in dense forests, encroachment of aspen or juniper into grasslands and shrublands may inhibit their nesting (Woffinden and Murphy 1983, Bartuszevige et al. 2012, Kennedy et al. 2014).

Cultivation and grazing

Effects of cultivation on ferruginous hawk nesting have been studied extensively in grassland habitats in Alberta where ground squirrels were the primary prey (Schmutz 1999). In that study, hawk densities were greatest on random survey plots where ≤10% of the land was in cultivation. Hawk densities declined in areas where cultivated lands exceeded 30% (Schmutz 1999). Overgrazing and overstocking cattle in pastures can also affect ferruginous hawks by damaging and trampling nest trees (Houston 1982).

Management recommendations

Because of the *endangered* status of ferruginous hawks, the Washington Department of Fish and Wildlife (WDFW) recommends land-use managers protect all areas associated with their breeding and nesting habitat. A status of *endangered* means that the species is "seriously threatened with extinction throughout all or a significant portion of its range within the state" (see WAC 220-610-110). For this reason, WDFW recommends broad protective measures with respect to (a) the extent of the area that should be protected, and (b) the degree to which areas are protected (e.g., strong emphasis on avoidance of harm). We recommend protecting unoccupied nesting territories because ferruginous

hawks have been observed re-occupying territories after an absence of at least 20 years (Romin and Muck 2002; M. Vekasy, pers. comm.; J. Fidorra, pers. comm.). We recommend strictly avoiding places that provide key breeding and foraging opportunities because this is the lowest-risk option for this seriously at-risk species. Recovery of the species will ultimately require restoration of currently degraded habitat (WDFW 1996).

Proposals to develop in areas associated with ferruginous hawk breeding should be assessed for impacts on nesting habitat. This can be accomplished by devising a plan to avoid (strongly preferred) or minimize and provide compensatory mitigation for unavoidable impacts to important nesting habitat resources. The following steps are provided to help assess the potential impacts of a proposed development to ferruginous hawks and to avoid, minimize, and provide compensatory mitigation to offset all unavoidable impacts.

Identification of ferruginous hawk breeding habitat

Ferruginous hawk nests are the focal point of breeding. From 1978 to 2020, WDFW identified and mapped 672 ferruginous hawk nest locations on 287 home ranges (WDFW Wildlife Survey Management Database). Nest locations were used to identify areas associated with ferruginous hawk breeding habitat. Occupancy and productivity surveys at historical ferruginous hawk territories and searches to document new territories are ongoing and conducted statewide by WDFW every five years.

Areas "associated with" ferruginous hawk breeding habitat are lands that provide the ecosystem services of space and prey needed for ferruginous hawks to successfully reproduce ("breeding habitat"). Breeding habitat consists of natural vegetation or agricultural cover types listed in Table 2 provided the land is either (a) within 10 km of a ferruginous hawk **nest site** that has been identified at any time since September 1, 1991[1], or (b) within 20 km of a nest site that has been used by ferruginous hawks within the past five years (Figure 5).

[1] Since September 1, 1991, the Growth Management Act has required that local jurisdictions designate and protect critical areas. The GMA requires that local governments provide for no net loss of ecosystem functions and values for fish and wildlife habitat conservation areas (See WAC 365-196-830(4)). Our recommendations use the same no net loss standard and date.

Table 2. Natural vegetation and agricultural cover types associated with ferruginous hawk breeding habitat.

Natural vegetation types [1]
Columbia Plateau Scabland Shrubland
Inter-Mountain Basins Big Sagebrush Shrubland
Columbia Plateau Steppe and Grassland
Inter-Mountain Basins Big Sagebrush Steppe
Inter-Mountain Basins Semi-Desert Shrub-Steppe
Columbia Basin Foothill and Canyon Dry Grassland
Columbia Basin Palouse Prairie
Inter-Mountain Basins Active and Stabilized Dune
Inter-Mountain Basins Cliff and Canyon
Agricultural cover types [2]
Pasture
Other [3]

The 10-km distance approximates the radius of a circular breeding home range of a ferruginous hawk (378 km^2) in the Columbia Basin (Watson et al. 2023). This distance is doubled to define the 10-20 km zone for suitable habitat, which also approximates the maximum nearest-neighbor distance for nesting ferruginous hawks (i.e., 7.2 km) in studies reviewed by Olendorff (1993). Because of their tendency to reoccupy a site, a "nest site" does not require a nest or even nesting material at the time a land-use proposal is in review. The presence of a nest site only requires a recent or historically reliable documentation of a nest, such as those recorded in WDFW's Priority Habitats and Species (PHS) data or observed nesting ferruginous hawks that have not yet been recorded[4].

Breeding ferruginous hawks may nest in agricultural lands, including pastures, and hunt along edges of irrigated fields. Guidance for managing agricultural practices in cover types "associated with" ferruginous hawk breeding habitat is found in the *Guidance for Agriculture and Rangelands* section of this publication.

Local governments should flag development proposals whenever the activity is within an area associated with ferruginous hawk breeding habitat (Figure 5). This step is carried out by overlaying the location of the proposed activity with WDFW's PHS data. The PHS data shows the locations of areas associated with ferruginous hawk breeding habitat. The appropriate management strategies to avoid, minimize, and provide compensatory mitigation to offset all unavoidable impacts will depend on the proximity of a given development proposal to the nearest ferruginous hawk nest site (Table 3)[5].

[1] Vegetation types associated with ferruginous hawk breeding areas according to the Washington State Wildlife Action Plan (WDFW 2015).

[2] Below are the two primary "crop group" where breeding ferruginous hawks may nest or hunt. Source: Washington Department of Agriculture Crop Database

[3] "Other" is a crop group that includes fallow irrigated cropland edges, which has value to breeding ferruginous hawks.

[4] Report locations of any nesting ferruginous hawks if they are not already in our PHS data to the local district wildlife biologist.

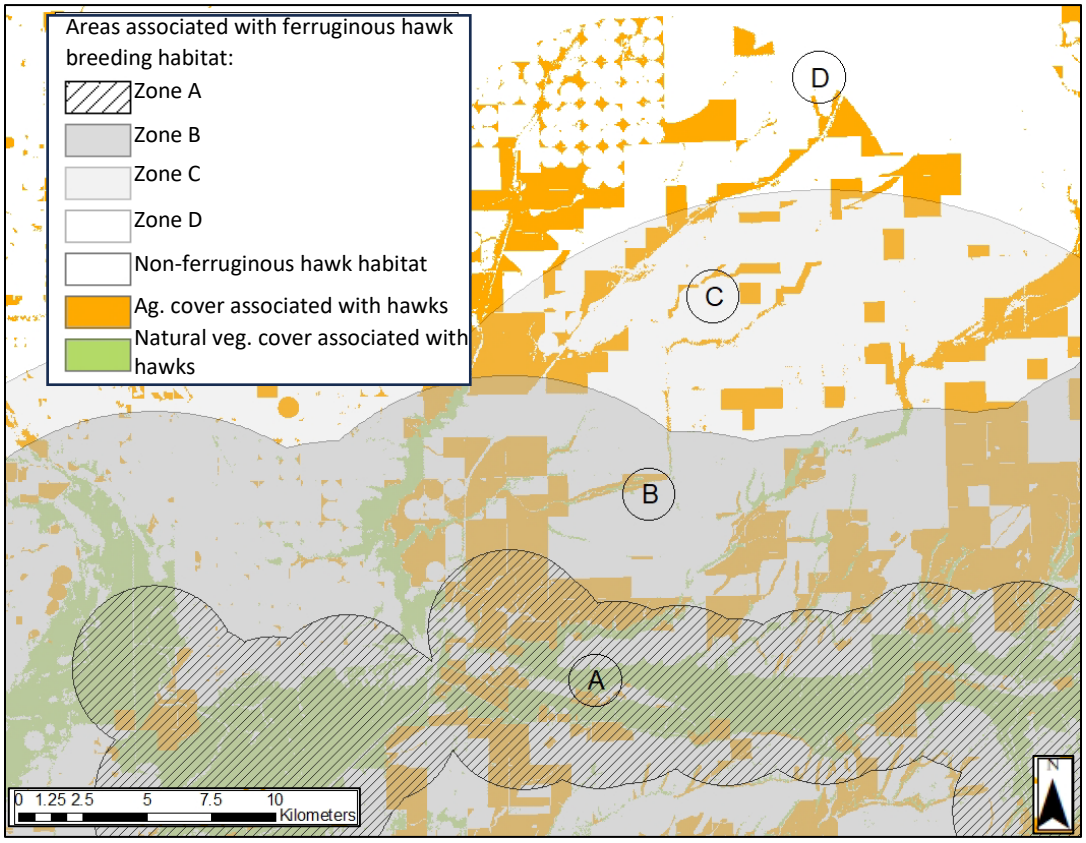
[5] Disclosing the specific location of ferruginous hawk nest sites is restricted under the state's Public Records Act (RCW 42.56.430(2)) and WDFW policy. However, WDFW allows local governments to disclose to a landowner that their proposal is within a core area (Zone A), home range (Zone B), or outer priority management zone (Zone C) for a ferruginous hawk.

Strategies for management will also depend on the ecosystem functions provided by the site (e.g., breeding, foraging) as well as the nature of the disturbance.

Site assessment

WDFW recommends local governments take strong measures to strictly avoid any disturbance within **Zone A** (Table 3). A *survey assessment* should be required when any proposal to develop or otherwise cause a disturbance in lands in Zone A cannot be completely avoided. A survey assessment should also be required in **Zone B** when the project or disturbance cannot be avoided. The protocol for conducting a survey assessment is described in Appendix 1. The survey assessment is necessary for gathering information to develop a Habitat Management Plan.

Figure 5. Ferruginous hawk management zones



Ferruginous hawk management zones A to D (see Table 3) and cover types associated with breeding habitat (see Table 2). The outer edge of Zone B represents a 10 km buffer around nests where no nesting has been documented in the last five years. The outer edge of Zone C represents a 20 km buffer around nests used by ferruginous hawks in the past five years. A land use proposal anywhere in Zone A should be flagged for a site assessment for potential mitigation. Only land use proposals that fall within a green or orange area in zones B and C should be flagged for a site assessment for potential mitigation. No site assessment or mitigation is needed for any land use proposals set entirely within Zone D. The most current version of this ferruginous hawk data is available in WDFW's Priority Habitats and Species Database. Table 3 outlines the type of mitigation recommended for land use proposals in each of these management zones.

We recommend a *rapid assessment* whenever a land-use activity is proposed in **Zone C**. The protocol for conducting a rapid assessment is in Appendix 2. The rapid assessment does not require collecting any detailed measurements. Rather, it is a brief survey of the site to determine if further action is necessary. If the rapid assessment demonstrates a need for further action, then proceed with a more detailed survey assessment. No action is required for ferruginous hawks when the proposed activity is in **Zone D**.

Table 3. Management zones within the areas "associated with" ferruginous hawk breeding habitat.

Zone	Nearest nest (km)	Area	Survey and management strategies for land use proposals
A	<3.2 km (Core area)	All lands within 3.2 km of a ferruginous hawk nest site. Prevent hawk mortality, avoid nesting disturbance, and avoid habitat alteration in this zone including protection of nest support structures and foraging habitat.	***Survey Assessment*** **-** Require ***Habitat Management Plan*** ✓ Avoidance strongly recommended in this zone. ✓ Minimization measures require no-net-loss of function. ✓ Compensatory mitigation strongly discouraged.
B	3.2 to 10 km (Home range)	Lands between 3.2 to 10 km of a ferruginous hawk nest site when lands are composed of the natural vegetation and agricultural cover types listed in Table 2.	***Survey Assessment*** **-** Require ***Habitat Management Plan*** ✓ If possible, avoid disturbances in areas associated with ferruginous hawk. If strict avoidance is not possible, minimize disturbance, and provide compensatory mitigation for unavoidable disturbance. ✓ Take extraordinary measures to strictly avoid disturbance of any ground squirrel colony.
C	10 to 20 km	Lands between 10 to 20 km of a nest site used by ferruginous hawks in the past five years and when these lands are composed of vegetation types listed in Table 2.	***Rapid Assessment*** **–** Require ***Survey Assessment*** – Dependent on rapid assessment results. ***Habitat Management Plan*** **–** Prepare habitat management plan if a ferruginous hawk nest or ground squirrel colony is observed during rapid or survey assessment.
D	>20 km	All lands where the closest ferruginous hawk nest site is >20 km away.	No action necessary

Mitigation

The Growth Management Act (GMA) uses the same definition for "mitigation" as the State Environmental Policy Act (RCW 43.21C). Local government's use of this framework is required for many development proposals (see RCW 43.21C.240). The GMA defines "mitigation" and describes the prescribed order of steps (i.e., mitigation sequence) to implement in order to reduce the impacts of activities on critical areas in WAC 360-196-210(23). It is imperative that mitigation be followed in the prescribed order. Specific to projects that affect ferruginous hawks, here are strategies to consider when applying the standard mitigation sequence:

Avoid the impact altogether by not taking a certain action or parts of an action. Especially in Zone A, avoidance must be pursued to the maximum extent possible for this endangered species. Strong measures to avoid disturbance should also be taken for Zone B. All options to avoid harm or disturbance should receive genuine and serious consideration. Minimization should be sought only after all options to avoid impacts have been exhausted and deemed not feasible. Parcels almost entirely comprised of higher-value breeding habitat or where options to minimize impacts are limited should be strong candidates for taking a strategy of avoiding impacts.

Minimize (includes rectifying and reducing over time) impacts by reducing the degree or magnitude of the effects exerted on the site's ecosystem functions for ferruginous hawks (e.g., breeding, foraging). Common strategies to minimize impacts include:

- Reducing a project's footprint and intensity (e.g., the smallest possible building envelope, precluding otherwise acceptable uses such as off-road vehicle use, burying electric lines).
- Siting a project further away from areas of high ecosystem function for breeding ferruginous hawks (e.g., nests, ground squirrel colonies).
- Creating or restoring habitat and breeding ecosystem functions.
- Using low impact development practices.
- Timing actions to avoid breeding periods.

Although actions to minimize can reduce a significant amount of a project's potential to disturb ferruginous hawk breeding habitat, minimization will still result in some degree of unavoidable losses of ecosystem function. These losses must then be offset to achieve GMA's No Net Loss (NNL) standard. However, given the species' endangered status, ferruginous hawk recovery will likely require increasing the total amount of habitat statewide (i.e., net-ecological-gain) to successfully reverse population decline.

Offsetting unavoidable disturbances should focus on improving nest productivity and occupancy as well as richness and density of available prey species within the home range. Actions to both minimize and offset unavoidable disturbances should be guided by a Habitat Management Plan, which should take advantage of site-specific opportunities to benefit the species. This should include setting aside and permanently protecting areas of higher value habitat for breeding ferruginous hawks. Although it is preferable to offset harm to ferruginous hawks through on-site measures, when on-site measures fall short of achieving NNL, then additional measures to mitigate must be taken off-site.

Often there will be more opportunities to minimize negative impacts on ferruginous hawk on-site when the parcel being developed is either relatively large or when it consists of varying levels of ecosystem function. This is because larger parcels with more varied habitat can often have a combination of lesser quality areas where development can be sited while also containing areas that are of higher value for breeding ferruginous hawks that should be set aside and permanently protected. Parcels almost entirely comprised of higher value breeding habitat or where options to minimize impacts are limited should be strong candidates for taking a strategy of avoiding impacts.

Compensate unavoidable development-related impacts that cannot be adequately offset with actions on-site by replacing or providing substitute resources or environments. Compensating through off-site mitigation occurs at a location ("receiving site") that has been secured for the express purpose of recouping lost habitat functions on-site ("sending site"). It provides a substitute for the habitat functions that have been lost or degraded by the land use activity. Receiving sites must provide an ecological "lift". Mitigation ratios reflect the level of risk from the loss of a given species' habitat, with greater mitigation ratios reserved for more vulnerable species.

Off-site compensatory mitigation guidance:

- If not adjacent, the receiving site should be as close as possible to the sending site – within 10 km if possible to remain in the same home range.
- Sending and receiving sites should undergo a survey assessment to quantify the amount of ecosystem function harm at the sending site and "lift" at the receiving site.
- Receiving site should be of equal or greater habitat and ecosystem quality than that of the sending site as determined through survey assessments of both sites.
- At a minimum, a receiving site should be three times the area of the sending site (3:1 mitigation ratio).
- When the sending and receiving sites are greater than 10 km apart, the mitigation ratio should be at least 5:1.
- A receiving site should be well connected to other areas of natural or semi-natural habitat with few or no artificial impervious surfaces.
- Receiving sites adjacent to other conserved properties are preferred.
- A receiving site should not require long-term maintenance to sustain ferruginous hawk breeding habitat functions.
- Known historical ferruginous hawk nesting sites or sites with a documented prey base should be prioritized as receiving sites.
- A receiving site should be permanently protected (e.g., with an enforceable conservation easement that precludes harm but not restoration activities) prior to harm occurring at the sending site.
- Permit approval and occupancy should be conditioned upon successful completion of all off-site mitigation requirements (e.g., Habitat Management Plan completion, land purchase, conservation easement execution, completion of receiving site restoration activities). A performance bond should guarantee performance of actions not yet taken.

Fee-in-lieu programs are sometimes arranged for off-site mitigation. Whenever fee-in-lieu is used to mitigate losses of ferruginous hawk breeding habitat, the result of any such arrangement will need to meet the mitigation standards (e.g., mitigation ratios) described in this section.

Local governments and landowners should consult with WDFW's area habitat and district wildlife biologists or another neutral qualified expert for technical assistance with off-site mitigation.

Habitat management plan

Local governments should require a Habitat Management Plan (HMP) that identifies and quantifies the ecosystem functions for ferruginous hawks provided by the site. It also will need to describe the actions that will be taken to avoid and minimize harm. The HMP should describe and quantify unavoidable impacts and how those impacts will be offset on-site or, if necessary, off-site to achieve NNL. Attributes that can be used in the HMP to quantify and evaluate ecosystem function include nest productivity and occupancy as well as the species richness and density of available prey species within the project site. These measures will preferably need to be evaluated beyond the project site (e.g., on adjacent parcels and throughout the home range).

A three-part template for developing the HMP is provided in Appendix 3:

- **Part 1** gathers basic information about the applicant, their representatives, the site, and the proposed project.
- **Part 2** provides a description and map of the site features of significant value to ferruginous hawks. This information provided in Part 2 will be informed by the results of a survey assessment.
- **Part 3** provides a detailed explanation of the on-site and off-site actions. It includes a detailed description and quantification of ecosystem losses and gains and necessary future monitoring.

Appendix 4 provides standard actions that may be included as mitigation in the HMP. These activities, which address the loss of ferruginous hawk breeding habitat function, are categorized by development and disturbance types. The HMP should also describe any restrictions on the time of year when various activities should not take place. Any activities associated with site preparation or development should generally be avoided during the breeding season, which occurs in Washington between April 1 (earliest time of incubation) through September 5 (when most adults have departed).

The HMP should include a certification by a qualified biologist that the HMP will result in NNL and should be reviewed by an unbiased qualified expert prior to its approval and implementation. A WDFW area habitat and district wildlife biologist or some other neutral qualified expert should provide such a review.

Additional guidance

Guidance for community and long-range planning

Local governments play an important role in helping conserve ferruginous hawks and their breeding habitat. The following recommendations are intended to help local governments review, develop, and implement regulatory tools and incentives to protect ecosystem functions necessary to support ferruginous hawks.

Critical Areas Ordinance:

- Designate as Fish and Wildlife Habitat Conservation Areas in critical areas ordinances (CAO) all areas associated with ferruginous hawk breeding habitat.
- Incorporate by reference in CAO the current PHS map and require use of PHS maps showing ferruginous hawk breeding habitat. The PHS program publishes maps for this purpose that are considered Best Available Science (RCW 36.70A.172). Use these maps to flag projects and proposals (see the *Identification of Ferruginous Hawk Breeding Habitat* section above).
- Require that a qualified expert conducts a site assessment to determine if a proposed project is in ferruginous hawk breeding habitat after a project or proposal has been flagged (see *Site Assessment* section above).
- Require that a qualified expert prepare the HMP to inform mitigation actions to achieve NNL, while also requiring review of the HMP by a WDFW area habitat or district wildlife biologist or some other neutral qualified expert.
- Require that the permit approval be conditioned on the successful implementation of protections specified in the HMP.
- Evaluate success at achieving the NNL at the full jurisdictional scale. Local WDFW district wildlife biologists can assist with this, for example through the information they gather during on-going surveys of nesting ferruginous hawks statewide. These surveys will be done at 5-year intervals to measure productivity and occupancy (WDFW 1996). Review and amend local GMA protections for ferruginous hawks if NNL is not being achieved.

Long-range planning and zoning:

- Carefully consider the potential impacts of rezoning sites with ferruginous hawk breeding habitat to more intensive land use designations. We recommend avoiding the expansion of Urban Growth Areas or creating more intense land use designations in areas associated with ferruginous hawk breeding habitat. Such changes in land use designations create greater expectations for development that then may be difficult to mitigate.
- To curb conversions of agricultural lands to higher intensity uses, apply zoning policies, such as zoning for long-term agricultural significance.
- In places where land use designations are already set at levels likely to result in impacts, other tools should be made available to landowners to minimize potential impacts to ferruginous hawk breeding habitat such as:
    - Cluster development with the possibility of a slight bonus density as an incentive for setting aside areas in proposed parcels where there is breeding habitat.
    - Create a transfer of development rights (TDR) program that allows landowners to sell their development rights to other less sensitive areas. Many counties in Washington, mainly Puget Sound counties, have their own TDR programs.

Other conservation programs:

- Consider developing the following land conservation incentive programs:
    - A Public Benefit Rating Systems program to provide property tax breaks to landowners who enroll lands with ferruginous hawk breeding habitat.

- A conservation futures program that uses funds levied to acquire ferruginous hawk breeding habitat, and particularly habitat in Zone A that is at high risk of development.

Other considerations:

Develop a process to ensure that all departments involved in permitting any part of a project proposal (e.g., building, clearing, grading, utilities) on a site flagged for ferruginous hawk breeding habitat coordinate and are aware of any related conditions or regulations in the local CAO.

Guidance for agriculture and rangelands

Grazing and other types of agriculture are the most prevalent land uses within the range of ferruginous hawks. Unlike more intensive land uses such as energy development, rangeland and other agricultural uses can coexist with important ecosystem functions to support ferruginous hawk foraging, nesting, and breeding while also supporting the state's agricultural economy. Conservation of these lands can provide a valuable contribution to ferruginous hawk recovery. Common uses of these lands include livestock grazing, cultivating irrigated crops, and dryland agriculture, which together create a mosaic of seminatural and cultivated lands within the range of ferruginous hawk. Several federal and state programs fund voluntary and incentive-based conservation practices on these types of lands to support species' recovery. This section provides guidance on the use of these types of programs to conserve this species on rangeland and other agricultural lands.

Voluntary stewardship guidelines presented here focus on protecting and restoring shrubsteppe and grassland habitats to support ferruginous hawk recovery. Rangelands used for livestock grazing are often composed of native shrubs and grasses. These features can provide important nesting and foraging habitat for ferruginous hawks. To protect and restore important habitat, conservation tools should be applied to limit the conversion of agricultural and rangelands to more intensive uses. Converting rangelands to cultivated croplands and other more intensive uses may impact the species' long-term survival by fragmenting the natural landscape. To curb conversions of agricultural lands to higher intensity uses, we recommend the application of zoning policies, such as zoning for long-term agricultural significance, and by using conservation easements to permanently protect lands for their agricultural and conservation values.

At the state level, counties enrolled in the Voluntary Stewardship Program (VSP) are eligible for state funding to protect and enhance environmentally sensitive areas, referred to as critical areas, on agricultural lands. The ferruginous hawk, which is listed as a Priority Species by WDFW, is considered a focal species for recovery under VSP. Counties enrolled in VSP receive funding to work with agricultural producers to voluntarily implement best management practices (BMPs) on agricultural lands to protect and enhance critical areas. Within the ferruginous hawk's geographic range, WDFW recommends using BMPs to support the species recovery (see the *Restoration / grazing and agriculture* section in Appendix 4). These BMPs can be implemented through a variety of federal, state, and local programs to support voluntary conservation outcomes.

Conservation Districts (CD), local governments, private landowners, and other entities can use voluntary and incentive-based conservation tools to improve recovery outcomes for ferruginous hawks. CD staff are particularly skilled at helping agricultural producers get financial support and technical assistance. Farm plans are a resource tool developed jointly between a landowner and a CD to identify voluntary actions landowners can take to improve farm productivity and protect natural resources. Conservation

Districts and local entities can also help producers apply for federal and state cost-share programs to implement voluntary actions identified in their farm plans.

To restore valuable habitat, federal and state programs fund conservation actions on private lands. The federal Farm Bill offers several conservation programs that agricultural landowners can use to receive financial support. This includes the Ferruginous Hawk State Acres for Wildlife Enhancement Program, which provides targeted funding to restore habitat conditions for the species. Agricultural landowners in eligible counties in Washington can apply for this program. Other applicable federal programs that are not specifically designed for ferruginous hawk but can help to buffer nesting habitat from human disturbances include the Conservation Reserve Enhancement Program, Environmental Quality Incentives Program, and Conservation Stewardship Program.

Literature cited

Anderson, A. M., C. B. Jardin, J. R. Zimmerling, E. F. Baerwald, C. M. Davy. 2022. Effects of turbine height and cut-in speed on bat and swallow fatalities at wind energy facilities. Facets 7:1281-1297.

Avian Power Line Interaction Committee (APLIC). 2006. Suggested practices for avian protection on power lines: the state of the art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, California.

Bartuszevige, A. M., P. L. Kennedy, and R. V. Taylor. 2012. Sixty-seven years of landscape change in the last, large remnant of the Pacific Northwest bunchgrass prairie. Natural Areas Journal 32:166-170.

Bechard, M. J., R. L. Knight, D. G. Smith, and R. E. Fitzner. 1990. Nest sites and habitats of sympatric hawks (Buteo spp.) in Washington. Journal of Field Ornithology 61:159-170.

Benson, J. E., R.T. Tveten, M. G. Asher and P.W. Dunwiddie. 2011. Shrub-Steppe and Grassland Restoration Manual for the Columbia River Basin. Washington Department of Fish and Wildlife. Olympia, WA.

Bohm, R. T. 1977. Artificial nest platforms for raptors. Raptor Research 11:97-99.

Bowles, J. H., and F. R. Decker. 1931. The ferruginous rough-leg in Washington. Murrelet 12:65-70.

Chesser, R. K. 1979. Opportunistic feeding on man-killed prey by ferruginous hawks. The Wilson Bulletin 91:330-331.

Clarke, J. B., and C. S. Houston. 2008. Ferruginous hawks successfully fledge six chicks. Journal of Raptor Research 42:152-153.

Clements, C. D., D. N. Harmon, R. R. Blank, and M. Weltz. 2017. Improving seeding success on cheatgrass-infested rangelands in northern Nevada. Rangelands 39:174-181.

Coates, P. S., K. B. Howe, M. L. Casazza, and D. J. Delehanty. 2014. Landscape alterations influence differential habitat use of nesting buteos and ravens within sagebrush ecosystem: Implications for transmission line development. The Condor 116:341-356.

Collins, C. P., and T. D. Reynolds. 2005. Ferruginous hawk (*Buteo regalis*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region, Species Conservation Project. fs.fed.us/r2/projects/scp/assessments/ferruginoushawk.pdf.

COSEWIC. 2008. COSEWIC assessment and update status report on the ferruginous hawk *Buteo regalis* in Canada. Committee on the status of endangered wildlife in Canada, Ottawa.

Cottrell, M. J. 1981. Resource partitioning and reproductive success of three species of hawks (*Buteo* spp.) in an Oregon prairie. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Craig, G. R., and W. C. Anderson. 1979. Ferruginous Hawk nesting studies. Colorado Division of Wildlife, Game Research Report, Denver, Colorado.

Datta, S. 2016. Raptors in temperate grassland: ecology of ferruginous hawk, golden eagle, and northern harrier in the northern great plains. PhD Dissertation, South Dakota State University, Brookings, South Dakota.

Diffendorfer, J. E., J. C. Stanton, J. A. Beston, W. E. Thogmartin, S. R. Loss, T. E. Katzner, D. H. Johnson, R. A. Erickson, M. D. Merrill, and M. D. Corum. 2021. Demographi and potential biological removal models identify raptor species sensitive to current and future wind energy. Ecosphere 23:e03531

Dwyer, J. F., M. A. Landon, and E. K. Mojica. 2018. Impact of renewable energy sources on birds of prey. Pages 303-321 *in* J. H. Sarasola, J. M. Grande and J. J. Negro, editors. Birds of prey: biology and conservation in the XXI century. Springer International Publishing, Cham, Switzerland.

Finger, R., G. J. Wiles, J. Tabor, and E. Cummins. 2007. Washington ground squirrel surveys in Adams, Douglas, and Grant Counties, Washington, 2004. Final Report. Olympia, Washington.

Fitzner, R. E., D. Berry, L. L. Boyd, and C. A. Rieck. 1977. Nesting of ferruginous hawks (*Buteo regalis*) in Washington 1974-75. Condor 79:245-249.

Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8:629-644.

Gossett, D. N. 1993. Studies of ferruginous hawk biology: I. Recoveries of banded ferruginous hawks from presumed eastern and western subpopulations. II. Morphological and genetic differences of presumed subpopulations of Ferruginous Hawks. II. Sex determination of nestling ferruginous hawks. M.S. Thesis, Boise State University, Boise, Idaho.

Harness, R. E., and K. R. Wilson. 2001. Electric-utility structures associated with raptor electrocutions in rural areas. Wildlife Society Bulletin 29:612-623

Hayes, G. E., and J. W. Watson. 2021. Periodic status review for the ferruginous hawk. Washington Department of Fish and Wildlife, Olympia, Washington

Heath, J. A., M. N. Kochert, and K. Steenhof. 2021. Golden eagle dietary shifts following wildfire and shrub loss have negative consequences for nestling survivorship. Ornithological Applications 123:1-14.

Holmes, A. L., and W. D. Robinson. 2016. Small mammal abundance in mountain big sagebrush communities after fire and vegetation recovery. Western North American Naturalist 76:326-338.

Houston, C.S. 1982. Artificial nesting platforms for ferruginous hawks. Blue Jay 40:208-213.

Howard, R. P., and M. A. Hilliard. 1980. Artificial nest structures and grassland raptors. Raptor Research 14:41-45.

Keeley, W. H. and M. J. Bechard. 2011. Flushing distance of ferruginous hawks nesting in rural and exurban New Mexico. The Journal of Wildlife Management 75:1034-1039.

Kemper, C. M., T. I. Wellicome, D. G. Andre, B. E. McWilliams, and C. J. Nordell. 2020. The use of mobile nesting platforms to reduce electrocution risk to ferruginous hawks. Journal of Raptor Research 54:177-185.

Kennedy, P. L., A. M. Bartuszevige, M. Houle, A. B. Humphrey, K. M. Dugger, and J. Williams. 2014. Stable occupancy by breeding hawks (Buteo spp.) over 25 years on a privately managed bunchgrass prairie in northeastern Oregon, USA. The Condor 116:435-445.

Knick, S. T., D. S. Dobkin, J. T. Rotenberry, M. A. Schroeder, W. M. Vander Haegen, and C.v. Riper III. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. The Condor 105:611-634.

Knopper, L. D., P. Mineau, M. S. Anton, D. E. Bond, and D.T. McKinnon. 2006. Carcasses of shot Richardson's ground squirrels may pose lead hazards to scavenging hawks. The Journal of Wildlife Management 70:295-299.

Kolar, P.S., and M. J. Bechard. 2016. Wind energy, nest success, and post-fledging survival of Buteo hawks. The Journal of Wildlife Management 80:1242-1255.

Leary, A. W. 1996. Home ranges, core use areas, and dietary habits of ferruginous hawks in southcentral Washington. M.S. Thesis, Boise State University, Idaho.

Leary, A. W., A. L. Jerman, and R. Mazaika. 1996. Gulls (Larus spp.) in the diet of ferruginous hawks. Journal of Raptor Research 30:105.

Martin, C. J., C. J. Nordell, J. W. Ng, and E. M. Bayne. 2015. Extreme temperatures induce heat stress but do not influence shade selection behaviour in Ferruginous Hawk (Buteo regalis) nestlings. Department of Biological Sciences, University of Alberta.

Mazaika, R., and L. L. Cadwell. 1994. Ferruginous hawks on the Yakima Training Center. Pacific Northwest Lab., Richland, Washington.

McClure, C. J. W., B. W. Rolek, L. Dunn, J. D. McCabe, L. Martinson, and T. Katzner. 2021. Eagle fatalities are reduced by automated curtailment of wind turbines. Journal of Applied Ecology 58:446-452.

Migaj, A., C. Kemper, and C. Downey. 2011. Ferruginous hawk artificial nest poles: inventory and construction protocol. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 140. Edmonton, Alberta.

Murray, M. 2017. Ante-mortem and post-mortem signs of anticoagulant rodenticide toxicosis in birds of prey. Pages 109-134 in N. W. van den Brink, J. E. Elliott, R. F. Shore, and B. A. Rattner, editors, anticoagulant rodenticides and wildlife. Springer International Publishing, Cham, Switzerland.

Neal, M. C. 2007. Dynamics associated with ferruginous hawk (Buteo regalis) nest-site utilization in south-central Wyoming. M.S. Thesis, University of Wyoming. Laramie, Wyoming.

Neal, M. C., J. P. Smith, and S. J. Slater. 2010. Artificial nest structures as mitigation for natural-gas development impacts to ferruginous hawks (Buteo regalis) in south-central Wyoming. BLM Technical Note 434. U.S. DOI BLM, Salt Lake City, Utah.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, South Dakota.

Ng, J., M. D. Giovanni, M. J. Bechard, J. K. Schmutz, and P. Pyle. 2020. Ferruginous hawk (Buteo regalis), version 2.0. in P.G. Rodewald, editor, the birds of North America. Cornell Lab of Ornithology, Ithaca, New York.

Nordell, C. J., T. I. Wellicome, and E. M. Bayne. 2017. Flight initiation by ferruginous hawks depends on disturbance type, experience, and the anthropogenic landscape. Plos one 12:e0177584.

Olendorff, R. R. 1993. Status, biology, and management of ferruginous hawks: a review. Raptor Research and Technical Assistance Center, Special Report. U.S. Department of Interior, Bureau of Land Management, Boise, Idaho.

Parayko, N. W. 2021. Ferruginous hawk (Buteo regalis) response to energy development and inclement weather in southern Alberta. M.S. Thesis, University of Alberta, Edmonton, Alberta.

Pearce D., J. Strittholt, T. Watt, and E. N. Elkind. 2016. A path forward: identifying least-conflict solar PV development in California's San Joaquin Valley. University of California, Center for Law, Energy, and the Environment and Conservation Biology Institute. law.berkeley.edu/wp-content/.

Preston, C. R., R. E. Jones, and N.S. Horton. 2017. Golden eagle diet breadth and reproduction in relation to fluctuations in primary prey abundance in Wyoming's Bighorn Basin. Journal of Raptor Research 51:334-346.

Richardson, S. A., A. Potter, K. L. Lehmkuhl, R. Mazaika, and R. Estes. 2001. Prey of ferruginous hawks breeding in Washington. Northwestern Naturalist 82:58-64.

Romin, L. A., and J. A. Muck. 2002. Utah field office guidelines for raptor protection from human and land use disturbances. U.S. Fish and Wildlife Service, Utah Field Office. Salt Lake City, Utah.

Rosenfield, R. N., J. W. Grier, and R. W. Fyfe. 2007. Reducing management and research disturbance. Pages 351-364 in D.M. Bird and K.L. Bildstein, editors, Raptor Research and Management Techniques. Hancock House Publishers, LTD., Blaine, Washington.

Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski Jr., K. L. Pardieck, J. E. Fallon, and W. A. Link. 2019. The North American breeding bird survey, results, and analysis 1966–2019. Version 2.07.2017. USGS Patuxent Wildlife Research Center, Laurel, Maryland. usgs.gov/tools/north-american-breeding-bird-survey-results-and-analysis

Schmutz, J. K., R. W. Fyfe, D. A. Moore, and A. R. Smith. 1984. Artificial nests for ferruginous and Swainson's hawks. The Journal of Wildlife Management 48:1009-1013.

Schmutz, J. K., and D. J. Hungle. 1989. Populations of ferruginous and Swainson's Hawks increase in synchrony with ground squirrels. Canadian Journal of Zoology 67:2596-2601.

Schmutz, J. K. 1999. Status of the Ferruginous Hawk (Buteo regalis) in Alberta. Alberta Wildlife Status Report No. 18. Alberta Environmental Protection, Edmonton, Alberta.

Shank, C. C., and E. M. Bayne. 2015. Ferruginous hawk climate change adaptation plan for Alberta. Alberta Biodiversity Monitoring Institute, Edmonton, Alberta.

Skeen, J. 1990. Grassland raptor nesting platforms. Oklahoma Department of Wildlife Conservation. Oklahoma, City, Oklahoma.

Slater, S. J., D. M. Maloney, and J. M. Taylor. 2022. Golden eagle use of winter roadkill and response to vehicles in the western United States. The Journal of Wildlife Management e22246. https://DOI: 10.1002/jwmg.22246

Smallwood, K. S., and Thelander, C. 2008. Bird mortality in the Altamont Pass wind resource area, California. The Journal of Wildlife Management, 72:215-223.

Smith, G. W., and N. C. Nydegger. 1985. A spotlight, line-transect method for surveying jack rabbits. Journal of Wildlife Management 49:699-702.

Tigner, J. R., M. W. Call, and M. N. Kochert. 1996. Effectiveness of artificial nesting structures for ferruginous hawks in Wyoming. Pages 137-144 in D. M. Bird, D. E. Varland, and J. J. Negro, editors, raptors in human landscapes: adaptations to built and cultivated environments. Academic Press, Inc., San Diego, California.

U.S. Fish and Wildlife Service (USFWS). 1992. Endangered and threatened wildlife and plants; notice of finding on petition to list the ferruginous hawk. Federal Register 57:37507-37513.

Vander Haegen, W. M., F. C. Dobler, and D. J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, U.S.A. Conservation Biology 14:1145-1160.

Vyas, N. B., C. S. Hulse, and C. P. Rice. 2012. Chlorophacinone residues in mammalian prey at a black-tailed prairie dog colony. Environmental Toxicology and Chemistry 31:2513-2516.

Wallace, Z. P., P. L. Kennedy, J. R. Squires, L. E. Olson, and R. J. Oakleaf. 2015. Human-made structures, vegetation, and weather influence ferruginous hawk breeding performance. The Journal of Wildlife Management 80:78-90.

Washington Department of Fish and Wildlife (WDFW). 1996. Washington state recovery plan for the Ferruginous Hawk. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 2015. Washington State Wildlife Action Plan. Olympia, Washington.

Watson, J. L. 2020. Ferruginous hawk (Buteo regalis) home range and resource use on northern grasslands in Canada. M.S. Thesis, University of Alberta, Edmonton, Alberta.

Watson, J. W., R. W. Davies, and P.S. Kolar. 2023. Contrasting home range characteristics and prey of sympatric hawks (Buteo spp.) nesting in the upper Columbia River Basin. Northwestern Naturalist 104:37-47.

Watson, J. W., U. Banasch, T. Byer, D. N. Svingen, R. McCready, M. A. Cruz, D. Hanni, A. Lafon, and R. Gerhardt. 2018a. Migration patterns, timing, and seasonal destinations of adult ferruginous hawks (Buteo regalis). Journal of Raptor Research 52:267-281.

Watson, J. W., I. N. Keren, and R. W. Davies. 2018b. Behavioral accommodation of nesting hawks to wind turbines. Journal of Wildlife Management 82:1784-1793.

Watson, J. W., U. Banasch, T. Byer, D. N. Svingen, R. McCready, D. Hanni, and R. Gerhardt. 2019. First-year migration and natal region fidelity of immature Ferruginous Hawks. Journal of Raptor Research 53:266-275.

Watson, J. W., and I. N. Keren. 2019. Repeatability in migration of Ferruginous Hawks (Buteo regalis) and implications for nomadism. Wilson Journal of Ornithology 131:561-570.

White, C. M., and T. L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. The Condor 87:14-22.

Wick, A. F., B. A. Geaumont, K. K. Sedivec, and J. R. Hendrickson. 2016. Grassland degradation. Pages 257-276 in J. F. Shroder, and R. Sivanpillai, editors, biological and environmental hazards, risks, and disasters. Academic Press, Boston, Massachusetts.

Wiggins, D. A., G. D. Schnell, and D. J. Augustine. 2014. Distribution and nesting success of ferruginous hawks and Swainson's hawks on an agricultural landscape in the Great Plains. The Southwestern Naturalist 59:356-363.

Wilson, R. R., M. B. Hooten, B. N. Strobel, and J. A. Shivik. 2010. Accounting for Individuals, Uncertainty, and Multiscale Clustering in Core Area Estimation. The Journal of Wildlife Management 74:1343-1352.

Woffinden, N. D., and J. R. Murphy. 1983. Ferruginous hawk nest site selection. The Journal of Wildlife Management 47:216-219.

Woffinden, N. D., and J. R. Murphy. 1989. Decline of a ferruginous hawk population: a 20-year summary. Journal of Wildlife Management 53:1127-1132.

Personal Communications

Jason Fidorra
Washington Department of Fish and Wildlife
District Wildlife Biologist
Pasco, Washington

Mark Vekasy
Washington Department of Fish and Wildlife
Assistant District Wildlife Biologist
Walla Walla, Washington

Appendices

Appendix 1. Ferruginous hawk survey assessment protocol

A *survey assessment* should be required for all proposals to develop any location in **Zone A** or when a proposal is in **Zone B** and flagged as occurring on lands consisting of the natural vegetation and agricultural cover types listed in Table 2. A survey assessment is required in **Zone C** when the result of a rapid assessment shows that it is needed (see Appendix 2). The survey assessment is used to document ferruginous hawks, nests, prey, and habitat within the proposed project boundary.

A qualified professional consultant should be contracted to conduct the survey assessment. The consultant should be skilled in identifying and mapping vegetation as well as surveying raptors and small mammals. These skills are important for anyone carrying out the survey assessment because this survey assessment will be used to generate the data necessary for writing the HMP. Prior to collecting data for this survey assessment, please carefully read Appendix 3 to become familiar with the type of data that will be necessary to write the HMP.

The local government overseeing the project should use information from the survey assessment when determining how permitting for the project will proceed.

Nest and raptor documentation

Surveys for nests and raptors will be used to provide the information required for subsection 2a in the HMP (see Appendix 3). Locations of individual raptors sighted during surveys may help to locate undiscovered nests.

- Search for any raptor nests between 15 March and 15 May. Use optics at a distance and do not approach nests to avoid disturbance. Search for nests that are on the parcel(s) where the development activity is being proposed. From as close and accessible a vantage as possible, also search adjacent properties for nests. Identify, record, and map the location of any observed nesting raptors to species. Suspected raptor or raven nests should also be mapped even when birds are not observed. Identify, document, map, and describe locations where there are elevated structures suitable for raptor nesting.
- Search elevated structures for nests including trees and artificial structures like utility towers and windmills. Search cliffs, talus slopes, and rock outcrops.
- Use photo documentation and/or field identification guides to identify species.
- Identify and record all raptors and ravens observed during the survey. Note which species of raptors were observed. Search for nests whenever a ferruginous hawk is seen.

Prey documentation

Conduct ground surveys for prey and prey habitat on the entire parcel(s) where development is being proposed. This data will provide the information required for subsection 2b in the HMP (see Appendix 3).

- Between 15 March and 15 June, conduct ground surveys to look for potential prey or the sign of prey (e.g., ground squirrel burrows).

- Surveys for ground squirrels and jackrabbits are labor-intensive because animals are timid; use signs of activity to determine animal presence (scat for both ground squirrels and jackrabbits, and vocalizations and active burrows for ground squirrels). Ground squirrels may reside in disturbed habitats (e.g., roadsides, edges of orchards) and some species, like California ground squirrels (*Otospermophilus beecheyi*), may reside in rocky outcrops. These areas should be surveyed by direct inspection. More open and level habitats should be systematically searched by walking and listening and looking for signs along geo-located transects for complete coverage of the survey area (see "Suggested Survey Protocol" *in* Finger et al. 2007). Spotlighting at night may enhance searches for jackrabbits (Smith and Nydegger 1985).

- The presence of pocket gophers is often evident by mounds of excavated soil in ground squirrel colonies or along edges of agricultural land.

- When jackrabbits, ground squirrels, and pocket gophers or signs of these species are located, map the location where these mammals (or their sign) were observed during the survey.

Habitat documentation

Survey and map lands proposed for development that are composed of any of the natural vegetation or agricultural cover types listed in Table 2. This data will provide the information required for subsection 2c in the HMP (see Appendix 3).

- Survey and map areas composed of the natural vegetation or agricultural cover types listed in Table 2 along with a description of their state of quality or level of degradation.

- The protocol in Appendix 9 in *Management Recommendations for Washington's Priority Habitats: Shrubsteppe* can be used to map natural vegetation types and describe their condition using a procedure known as an Ecological Integrity Assessment.

Record of survey assessment

The local government should review the results of the survey assessment and include them in the project file.

Appendix 2. Ferruginous hawk rapid assessment protocol

A rapid assessment involves an on-the-ground evaluation of the entire parcel(s) in Zone C (between 10 km and 20 km from a nest used by ferruginous hawks within the past five years) where a land development activity is proposed (Figure 5).

Within such parcels:

- Document ferruginous hawk nests and ferruginous hawks.
- Document evidence of ground squirrel colonies.

If either ferruginous hawks, ferruginous hawk nests, or ground squirrel colonies are identified, a survey assessment should then be required (Appendix 1). If ferruginous hawks, ferruginous hawk nests, or ground squirrel colonies are not identified on the parcel(s), then no further action is necessary.

The local government should review the results of the rapid assessment and include them in the project file.

Appendix 3. Habitat management plan template[1]

PART 1

1a. Applicant's Full Name	1b. Applicant's mailing address:
1c. Plan prepared by: (Full name and company affiliation)	1d. Date submitted:
1e. County	1f. Parcel ID number(s) of proposed development site.
1g. Detailed description of the proposed project:	

PART 2

2a. Location of nests and raptors

In the space provided below, please briefly describe any nests found on or adjacent to the parcel(s) where the development activity is being proposed. This data is gathered as part of the survey assessment described in this report. Label on a map each nest with a unique nest ID (e.g., nest #1, nest #2). Include attribute information for each mapped nest by identifying which, if any, are occupied, by what species, and size and condition of each nest, and features supporting each nest (e.g., juniper, rock outcrop, telephone pole, ground). Also, Identify, document, map, and describe locations where there are elevated structures suitable for raptor nesting as well as any ferruginous hawk nests mapped in WDFW's PHS database. Document and record any ravens and raptors observed during the survey, identifying all raptors to species whenever possible.

Attachment:

Map of site to scale clearly showing location of nests with their ID numbers, elevated structures suitable for raptor nesting, as well as the location(s) of the proposed development along with any disturbances.[2]

[1] Attach supplemental pages if space in template is insufficient. Indicate in template when content for a section is continued on a separate page and indicate on the sheet the section(s) where the content is continuing from (e.g., continued from 2a).

[2] Attach a single map (rather than 3 separate maps) clearly showing all information required in sections 2a, 2b, and 2c.

2b. Prey

Describe below any signs of prey species (e.g., burrows, scat, animal observations) on the parcel. This data is gathered as part of the survey assessment described in this report. Also, describe below any verified prey locations on site that are mapped in a WDFW database (e.g., PHS on the Web) or that are observed during the survey assessment. In the description, identify the species if known.

Attachment:

- Map of site to scale with locations along with legend clearly depicting species and type of sign.

2c. Space

Describe below the physical and ecological features that occur on the site. This includes the types of natural vegetation or agricultural cover types (Table 2), recent disturbances, location of waterbodies including creeks, as well as any physical features that ferruginous hawks might use for nesting. These include trees, rock outcrops and cliffs, as well as any elevated artificial features such as buildings or telephone poles. Natural vegetation types on site should be identified using Ecological Systems of Washington State.

Attachment:

- Map of site to scale showing locations of all physical and ecological features. Natural vegetation or agricultural cover types (Table 2) should be shown on map as areas. Other features can be displayed with lines (e.g., creeks) or points (e.g., a single tree).

PART 3

3a. Mitigation sequencing

Describe below in detail the reasonable efforts made to apply mitigation sequencing to avoid to the greatest extent possible, minimize to the greatest extent possible, and provide restoration actions (on-site or off-site) that offset impacts resulting in (at a minimum) no net loss of ecosystem function.

3b Mitigation

On a separate sheet (attached to HMP) describe the actions you intend to implement to ensure No Net Loss of ecosystem functions important to ferruginous hawk (see Appendix 4 for examples of mitigation measures). The description must include adequate detail so that any reader will clearly understand the steps that will be taken, their precise mapped locations on the parcel, and their timing. Describe how these steps will ensure that NNL of ecosystem function is achieved, i.e., how the measures will fully offset the loss of function that may be caused by the land use activity.

Also, include a description of the process to monitor the conservation and restoration actions to ensure their success over the long-term. The process for monitoring should include observable benchmarks of successful mitigation, a timeline for measuring those benchmarks, and a description of follow-up actions if benchmarks are not met. Benchmarks can include nest productivity and occupancy as well as the species richness and density of available prey species within the home range.

3c. Financial guarantees

Please describe in detail the financial guarantees (i.e., performance bonds) that will be held to ensure compliance with the measures described in the mitigation section. Include a detailed justification of the proposed dollar amount, terms in which claims can be made against the bond, as well as the period that the bond will be in effect.

Appendix 4. Sample mitigation measures

Restoration / grazing and agriculture

- Nest Substrate: Maintain agricultural fence posts, lone trees or small groves, and other structures that provide perch and nesting habitat. Limit disturbance at nest sites during breeding season (1 April through 5 September) and protect (e.g., fence) and reinforce nest trees from cattle rubbing. Where nest substrates are limited, install artificial nest substrates after consultation with a WDFW district wildlife biologist (see Appendix 5).

- Prey Abundance: Implement agricultural practices that provide habitat for native prey populations, including ground squirrels, jackrabbits, and pocket gophers. Do not use rodenticides or shooting to control ground squirrels or small mammals on or adjacent to agricultural lands. Restore and protect edge of field habitats and hedgerows, especially on irrigated alfalfa fields. Do not burn or plow edges of fields except to promote native grass regeneration and to remove noxious weeds. Mow grain crops and other vegetation periodically to improve access to prey. After mowing or harvesting, maintain brush piles to provide cover for prey.

- Range Restoration: Rehabilitate pastures and range land through cheatgrass control and restoration of native grasses and shrubs. Leave lone or peripheral trees for potential nest substrates. See Shrub-Steppe and Grassland Restoration Manual for the Columbia River Basin (Benson et al. 2011) for guidance on conducting restoration activities.

- Managed Grazing: Implement a grazing management plan that maintains a diversity of native grasses and forbs needed by ferruginous hawk prey species.

Industrial development – wind energy

- Build turbine strings and infrastructure outside of ferruginous hawk core use areas and home ranges to avoid nests, prey concentrations, and disturbance and collision impacts.

- Maximize proposed construction in areas that are already disturbed (e.g., lands in use for more intensive agricultural practices) and reduce the project footprint to the minimum area necessary to meet project needs.

- Arrange turbines to avoid slope and rim edges and concentrate industrial development on unproductive agricultural land (Pearce et al. 2016).

- Erect fewer turbines.

- Reduce risk of turbines proposed inside home ranges by stopping turbine motion when hawks are present using “Identiflight” or similar technology or seasonal diurnal curtailment (Watson et al. 2018*b*, McClure et al. 2021). These systems are currently in development and would require identification algorithms trained to identify flying ferruginous hawks. Increasing “cut-in” speeds at which turbines activate has reduced probability of collision for some species (Anderson et al. 2022).

- Address impacts of related infrastructure, including access roads and transmission lines (see Industrial development – Transmission Lines).

- Require notification to WDFW district wildlife biologist for all documented ferruginous hawk mortalities on wind energy project sites no matter the cause of death.
- Require long-term nest surveys for at least 10-years post construction to look at changes in the presence of nesting ferruginous hawks as well as changes in nesting productivity and occupancy. This is in addition to post-construction fatality surveys and reporting of incidental raptor fatalities required on most projects.
- If the result of post-construction surveys finds that there has been any reduction in the presence of nesting ferruginous hawks or reduced nesting productivity or occupancy, then adaptive management measures should be taken to address declines.

Industrial development – solar energy

- Build solar farms and infrastructure outside of ferruginous hawk core use areas and home ranges to avoid nests, prey concentrations, disturbance, and collision impacts.
- Review the Washington Columbia Plateau Least-Conflict Solar Siting Gateway wsuenergy.databasin.org for more information on potential environmental resource conflicts and to identify locations with a lower likelihood of environmental resource conflicts.
- Maximize proposed construction in areas that are already disturbed and reduce the project footprint to minimum area necessary to meet project needs.
- Concentrate panels to cultivated areas to reduce impacts to raptors (Pearce et al. 2016).
- Set panels back from ridgelines to avoid potential impacts to ridge soaring, thermals, and hunting habitats.
- Address impacts of related infrastructure, including access roads and transmission lines (see Industrial development – Transmission Lines).
- For projects that use collection towers, spread aim points of mirrors to reduce temperatures and burn risk when facilities are in stand-by mode (Dwyer et al. 2018).
- Require notification to WDFW district wildlife biologist for all documented ferruginous hawk mortalities on solar energy project sites no matter the cause of death.
- Require long-term nest surveys for at least 10-years post construction to look at changes in the presence of nesting ferruginous hawks as well as changes in nesting productivity and occupancy. This is in addition to post-construction fatality surveys and reporting of incidental raptor fatalities required on most projects.
- If the result of post-construction surveys finds that there has been any reduction in the presence of nesting ferruginous hawks or reduced nesting productivity or occupancy, then adaptive management measures should be taken to address declines.

Industrial development – transmission lines

- Establish new distribution lines outside of hawk home ranges.

- Bury lines where possible.
- Develop raven monitoring and nest management (e.g., removal) plan for new transmission lines built within industrial developments.
- Apply state-of-the-art methods to prevent electrocutions and collisions (e.g., perch diverters, supplemental perches, wire-markers to improve visibility of lines).
- Report pole numbers and electrocution incidents to local utility companies and WDFW district wildlife biologist as soon as possible for remedial actions.

Industrial development – surface mining, gravel pit construction, and road construction

- Develop surface mines, gravel pits, and new roads outside of ferruginous hawk core use areas and home ranges to avoid nests, prey concentrations, and disturbance and collision impacts.
- Maximize line-of-site to hawk nests for projects located in coulees and narrow draws.
- Limit the number of access roads to minimize recreational use.
- Gate permanent roads to reduce access and post as “no-shooting”.
- Reclaim abandoned mines as soon as possible after completion of operation or construction.
- Leave remnant rockpiles in strategic locations to provide raptor perches and prey habitat.
- Improve ledges and crevices on solid banks to provide potential nest substrate.
- Implement program to remove road-killed carrion away from highways to prevent hawk collisions (Slater et al. 2022).

Residential development

- Cluster development away from key breeding and foraging habitat; set aside and permanently conserve areas with features important to breeding ferruginous hawks.
- Use open space/Public Benefit Rating System tax breaks or other incentives to maintain prey habitats within Zones A and B.

Mammal control and toxins

- Control small mammals if necessary for damage control rather than complete eradication.
- Do not use rodenticides to control ground squirrels or small mammals on or adjacent to agricultural lands.
- Prohibit recreational shooting at ground squirrel colonies.
- Do not use lead bullets. Only use non-toxic ammunition. If encountered, bury animal carcasses shot with lead (e.g., ground squirrels, coyotes, livestock).

Fire control, erosion, and climate change resiliency

Note: All proposed projects, whether they contribute to these impacts or not, should consider how to minimize effects of increased fire, cheatgrass invasion, and nest loss.

- Create and maintain firebreaks and develop fire control plans for pasture/grassland interface. Use controlled fire to mimic natural fires to improve small mammal communities in sagebrush habitats (Holmes and Robinson 2016).
- Remove cheatgrass and restore perennial grasses in pastures and native habitats (e.g., Clements et al. 2017).
- Reinforce and stabilize existing nests, nest trees, and cliff ledges to withstand extreme weather and provide protection from wind, sun, and rain (Shank and Bayne 2015, Migaj et al. 2011). See Appendix 5 for information on artificial nest structures.

Appendix 5. Artificial nest structures

Artificial nest structures (ANS) can be placed strategically to provide nest substrates on established ferruginous hawk territories or on vacant habitat that is otherwise limited by an absence of nest structures. For example, ANS may provide a substitute for nest trees lost to inclement weather, tree decadence, or cattle rubbing. They can also be used to create new potential nesting opportunities for ferruginous hawks, but only after consultation with a WDFW district wildlife biologist.

We advise against the placement of ANS to enhance ferruginous hawk nesting or as standard mitigation in areas being developed. This is because in more developed areas ANS may attract ravens and other raptors (e.g., red-tailed hawks, Swainson's hawks, and great horned owls) that are more tolerant than ferruginous hawks to anthropogenic activities such as development. These are species that can compete with or predate on ferruginous hawks. Artificial nest structures should also not be used, other than in exceptional cases (e.g., moving a nest from a hot distribution pole or from farm equipment), to permit or mitigate for the removal of ferruginous hawk nests or for translocating ferruginous hawks. Ferruginous hawk nests on distribution poles that pose a risk should be removed only after the nesting season, and then should be replaced with perch deterrents. Artificial nest structures should then be installed 250-500 meters (820-1,640 feet) away from distribution poles where hawks were removed. Any movement of a nest in use should be done in the following stages (Kemper et al. 2020):

1. First, move the nest to a mobile artificial nest platform 25 meters (82 feet) away.
2. Second, move the nest to a permanent platform following the nesting season.

Before considering the use of an ANS, prioritize management and maintenance of existing trees. For long-term sustainability of nest substrates, trees can be planted within a fence near existing nest trees. Bases of nests in trees can be reinforced with wire netting where limbs are failing, and predator access to the nest can be reduced with tin sheathing placed around the base of trees (Craig and Anderson 1979). Groves of trees can be thinned as necessary to provide nest structure in individual trees or in scattered stands (Olendorff 1993). If an ANS is erected, plant trees nearby. The ANS can later be removed when planted trees reach maturity.

New ANS placement is recommended only after an authorized wildlife biologist identifies the right conditions for locating and erecting an ANS. These conditions include open habitats where there are no existing nest structures, an availability of prey populations, and where the nearest-neighbor distance (i.e., to the nearest nesting ferruginous hawk) is greater than 2.7 km (1.7 miles) – less than 2.7 km is okay in some situations, such as in high quality habitat. This is the distance that Cottrell (1981) found ferruginous hawk nests were spaced on adjacent territories in Oregon.

Neal et al. 2010 provides the following recommendations for ANS placement:

- Occupancy of ANS is highest when hawks are already habituated to disturbance or are known to use artificial substrates.
- ANS should be constructed where there is an extensive prey base.
- ANS should be constructed no greater than 1,000 meters (3,280 feet) and in the line-of sight of the nest when translocating nestlings or eggs to an ANS.

- Placement of ANS should consider the potential for attracting other species.
- Secure resources prior to installation for long-term monitoring, repair, and replacement of ANS.
- Consider whether habitat quality is too poor before siting an ANS, especially in areas already developed. An ANS sited in a poor location may attract hawks to sites prone to nest failure.
- Consider avoiding ANS installation where hawks might pose a threat of predation on other sensitive species such as sage grouse or burrowing owls.

Platform and pole designs for ANS are described elsewhere (Bohm 1977, Howard and Hilliard 1980, Schmutz et al. 1984, Olendorff 1993, Tigner et al. 1996, Skeen 1990, Neal 2007, Migaj et al. 2011). We recommend the use of sticks of the type and size used by ferruginous hawks on nest platforms (see description under the ***Nests*** subsection of the ***Resource Requirements*** section above). Most current evidence suggests shading of platforms is unnecessary or even detrimental to nesting ferruginous hawks. Howard and Hilliard (1980) recommended against "shade structure" based on two of three pairs of ferruginous hawks that preferred non-shaded structure. Red-tailed hawks preferred nesting on platforms with shade structures in Washington (M. Vekasy, pers. obs.). In contrast, Schmutz et al. (1984) found shaded nest platforms were used by ferruginous hawks twice as often as those that were unshaded. Woffinden and Murphy (1983) found hawks tree nests used over repeated years that had branches above them but that were otherwise unshaded. Panting behavior and an unusually wide gape are adaptations of ferruginous hawks to extreme temperatures and may help nestlings avoid the need to seek shade on exposed nests (Martin et al. 2015). Increasing summer temperatures from climate change, especially catastrophic heat episodes that have resulted in large-scale mortality of raptor nestlings, may increase future consideration for platform shading.

Glossary

Breeding Habitat – Habitat used by a mated pair of birds during the breeding season.

Breeding Season – Synonym for nesting season, the period of courtship through dispersal of young.

Core Area – Portion of the home range of a breeding pair of birds that is used most intensively during the breeding season and typically encompasses nests and frequented foraging areas.

Home Range – Area used by a breeding pair of birds that provides the elements for nesting including used and unused nests, prey, and isolation from disturbance.

Nest Site – Historical or current location of a nest.