The Northern Goshawk

On the Southern Blue Mountains and Malheur National Forest: A Technical Review of its Status, Ecology and Management

The Nature Conservancy

Blue Mountains Forest Partners

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Executive Summary

Stakeholders in the southern Blue Mountains have reported a need for a scientific review of the northern goshawk (*Accipiter gentilis atricapillus;* hereafter, goshawk) in relation to dry forest restoration and management activities. Here, we provide a compilation of relevant synthesis papers, existing peer-reviewed research, and goshawk monitoring efforts in the region to assist stakeholder discussions regarding restoration planning and implementation.

The goshawk is not currently considered a species of special conservation status in North America, and as such is afforded the same legal protection as other non-priority forest raptors by regulatory entities (USFWS, CITES, IUCN), including the land management agencies within the southern Blue Mountains region (BLM, USFS). However, starting in the early 1990s, there were multiple petitions to list the goshawk under the Endangered Species Act. In response, the US Forest Service Region 6 implemented interim wildlife standards (Eastside Screens) in 1994, which included specific guidelines for the protection of active goshawk nests on National Forests on the eastside of Oregon and Washington. This was intended to secure protections until further information was available.

A review of scientific literature on the goshawk shows the species nests across a broad gradient of forest types throughout the western US, and in more diverse habitat types (e.g., contiguous hardwood forests, open tundra) throughout North America. The Forest Service proposed nine goshawk bioregions along geographical areas of similar ecological conditions across the continental US. Four of those bioregions occur in Oregon, speaking to the diverse forests the goshawk inhabits in this state alone.

While early research appeared uncertain, a series of long-term, rigorous studies in dry forest systems have now markedly improved our understanding of goshawk ecology. The legacy of contentious litigation should not cloud stakeholder understanding of the species' conservation status. Rather the volume and breadth of published literature helps to clarify the status of the goshawk in the western US and the dry forests of the Blue Mountains.

Recent advances in our understanding of goshawk status and ecology indicate:

1. *Goshawk populations appear stable and/or no decline has been measured.*
2. *The goshawk occupies territories in more diverse forest types than previously understood.*
3. *While foraging and post-fledging habitat is highly variable, the goshawk selects nest sites in mid to late structural stands with high canopy closure.*
4. *Standard survey techniques still in use by most land managers may significantly underestimate goshawk occupancy.*

5. *Breeding goshawks may utilize a higher proportion and diversity of small mammal prey than previously measured.*

Under the current Forest Plan and Eastside Screens, the Malheur National Forest is required to manage for active and historical goshawk nests at specific scales, each with activity restrictions. However, survey techniques currently employed do not effectively detect active goshawk territories and/or nest sites, especially in single year attempts. This underrepresents current goshawk occupancy and reduces the amount of habitat protected. Additionally, due to specific Eastside Screens and seasonal restrictions on management activities, some districts and forests are not surveying for goshawks and are only leaving goshawk habitat when active territories are found. Collectively, this strategy fails to: (1) leave post-fledging areas (for the goshawk and other species) in some management areas; and (2) proactively plan for future goshawk habitat based on site characteristics. As such, a move away from the Eastside Screens could allow mangers to be more strategic in selecting wildlife habitat areas, benefiting the goshawk and other wildlife species.

In the 20 years since the Forest Plan and subsequent amendments were written, the science and research has greatly advanced our understanding of goshawk ecology and status. In light of the new science, we find the Eastside Screens management recommendations do not fit into the current understanding of the goshawk and dry forest restoration. This is in part because the Eastside Screens are based on flawed premises, primarily: (1) the goshawk is a species of conservation concern based on population and distribution; (2) retention of known and active territories offers the best habitat protection; and (3) the goshawk selects old-growth (late, old structure), thus acting as a surrogate for the retention of this habitat.

A new Forest Plan for the Malheur National Forest has been proposed with the goshawk potentially listed as a management indicator species (MIS) or focal species. Different Planning Rules (1982, 2012) address MIS, surrogate species, and focal species in different ways. Scientific debate on the goshawk as an MIS or focal species is part of a larger debate on the surrogate/focal species concept in general. Our review finds the goshawk does not meet the criteria for an MIS nor does it act as a reliable surrogate for other wildlife species and their habitat needs.

We suggest dry forest restoration at the landscape level (such as the focus on the Collaborative Forest Landscape Restoration area on the Malheur National Forest) could include leaving diverse wildlife habitat areas across ponderosa pine, dry mixed conifer, lodgepole pine, and moist mixed conifer, accommodating goshawk populations presently and in the future. Strategically this move away from managing for the goshawk and only protecting stands where it's detected, would allow managers and stakeholders to create wildlife habitat areas even when goshawks are not present. Habitat selection could be based on land characteristics, potential vegetation types, and other biophysical factors to select landscape-specific stands for a diversity of wildlife species. This strategic selection would allow for consideration of the stand's ability to persist during future drought, fire, or other disturbance events.

We recognize that the Eastside Screens have created an expectation that the goshawk will be protected and managed for, and thus PFAs would be retained during restoration and management activities. While that has not been successful in all projects, it is a requirement counted on by some stakeholders. Under our proposed approach, more wildlife habitat would be retained. Still, we understand that mangers and stakeholders will need assurances that this will work to meet their outlined social and ecological goals. Some stakeholders may need assurances of new wildlife habitat areas being required similar to what PFAs were under the old model.

We recommend the creation of new selection criteria for wildlife habitat in the different dry forest types found on the Malheur National Forest. This strategic placement of wildlife habitat areas (for the goshawk and other species) in forest management planning will require close working relationships and trust between each National Forest, stakeholders, and placed-based collaborative groups. We suggest groups of land managers, stakeholders, and trusted scientists work together to develop the new model of wildlife habitat areas within each of the dry forest types.

Key Management Considerations

1) The goshawk is not a species with population viability concerns, and thus prioritizing its specific habitat needs on a multi-spatial scale is not warranted.

2) The goshawk occupies varied forest types and does not appear to reliably indicate species composition, diversity and abundance in forest communities; suggesting it may be an inappropriate focal species intended to guide dry forest restoration.

3) New research demonstrates goshawks may be more tolerant of limited timber harvest (in nest stands and post-fledgling areas) than previously assumed.

4) The seasonal restrictions required by the Eastside Screens need not be based on decades old management guides, and instead could be modified to either match the dates proposed in the new Forest Plan or the research contained within this review.

Potential Applications

1) Modify goshawk management under the Eastside Screens to better suite diverse wildlife habitat needs in associated forest types (ponderosa, dry mixed conifer, lodgepole pine, moist mixed conifer).

2) Alter timber harvest and seasonal restrictions adopted by the Malheur National Forest from Reynolds et al. (1992) to better reflect the current science on such impacts.

3) Consider alternatives to the goshawk for the new Forest Plan that will better meet current and future wildlife habitat needs.

4) Create a working group of managers, stakeholders, and scientists to explore the creation and protection of *wildlife habitat areas* in lieu of goshawk habitat areas.

5) Work with current science to create new models for selecting wildlife habitat areas based on biophysical characteristics such as soil type, overstory structure, ability to persist in future drought and disturbances, and spatial analysis to surrounding protected areas and planned management activities.

Caption: Goshawk nest in pinyon-juniper habitat, southwest Idaho (photo: © Rob Miller). Goshawks were found nesting in pinyon and juniper habitat in Colorado, California, Idaho, Utah, and in Oregon. This adaptability of the goshawk to diverse habitat types that contain appropriate prey base makes it challenging to model for specific forest structure, such as late and old structure or closed canopy.

He sweeps along the margins of the fields, through the woods, and by the edges of the ponds and rivers, with such speed as to enable him to seize his prey by merely deviating a few yards from his course, assisting himself on such occasions by his long tail, which, like a rudder, he throws to the right or left, upwards or downwards, to check his progress, or enable him suddenly to alter his course. At times he passes like a meteor through the underwood, where he secures squirrels and hares with ease. Should a flock of Wild Pigeons pass him when on these predatory excursions, he immediately gives chase, soon overtakes them, and forcing his way into the very centre of the flock, scatters them in confusion, when you may see him emerging with a bird in his talons, and diving toward the depth of the forest to feed upon his victim.

- J.J. Audubon 1832

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Introduction

Introduction

The northern goshawk (*Accipiter gentilis atricapillus;* hereafter, goshawk) is the largest of forest accipiters, or true hawk. It is one of only two diurnal forest-associated raptors with a Holarctic (Eurasia and North America) distribution. This elusive raptor was chosen as an indicator of old-growth forest structure in parts of the western US, and subsequently garnered increased protection status in some US Forest Service regions. During the 1990s and 2000s, long legal battles occurred to list the species (and subspecies) in the western US under the Endangered Species Act (ESA). During this time, scientists and researchers produced a large body of work to better understand the goshawk, its habitat, and its prey base. Much of this information was used in court cases and additionally helped inform management decisions by many agencies, including the Forest Service.

Current land managers and stakeholder groups that are actively working with forest restoration and wildlife habitat in dry forests of the southern Blue Mountains are expressing a need to better understand the current legal status, ecology, habitat, and prey resources of the goshawk. Of note is that the current Forest Plans for the Malheur, Umatilla, and Ochoco National Forests do not list the goshawk as a management indicator species (MIS), while the Wallowa-Whitman National Forest does (USDA Forest Service 1989, 1990a, 1990b, 1990c). Drafts of the new Forest Plans for the region propose the goshawk as an MIS or focal species, offering a management plan to replace the longstanding goshawk management required by the Regional Forester (USDA Forest Service 1995). The scientific research and literature produced in the past 20 years has greatly increased our understanding of the goshawk in the western US, inland Pacific Northwest, and dry forest systems of the Blues Mountains.

This review provides a compilation of relevant goshawk synthesis papers, existing peer-reviewed research, and goshawk monitoring efforts in the region. Numerous scientific documents have synthesized goshawk ecology and its legal and management status in great detail.[1] We used these reviews substantially in the Legal and Conservation Status assessments in this paper, and direct the reader to these sources for more detailed information. For the purposes of discussing the goshawk within dry forest restoration and management in this review, we use a vegetation approach by defining the dry forests of eastern Oregon in four types: ponderosa pine, dry mixed conifer, lodgepole pine, and moist mixed conifer.

How to Use This Document

We created this document for use by natural resource managers, wildlife biologists, silviculturists, and members of stakeholder groups and collaboratives interested in goshawk ecology and status in relation to dry forest restoration. This document is broken into eight sections. While the reader may want to quickly find the area of

[1] These reviews include: Kennedy 1997, USFWS 1998, Anderson et al. 2005, Boyce et al. 2006, Morrison 2006, Squires and Kennedy 2006, Reynolds et al. 2008.

interest, it is important to note that the document builds on itself with many references to earlier sections for more detail.

The Background provides a review of the selection of the goshawk as an indicator species in forest management. The Species Overview section gives the taxonomy and distribution of the goshawk globally, in North America, and the subspecies found in the Blue Mountains. We include a table of goshawk research and monitoring related specifically to the Malheur National Forest and greater Blue Mountain region. The Status section addresses the legal status of the goshawk in the western US and in the southern Blue Mountains. We review the management and conservation status in Oregon and on the Malheur, including the Forest Service management guidelines in the Eastside Screens (USDA Forest Service 1995). That section concludes by specifically reviewing the scientific debate on the goshawk as habitat driven (old-growth obligate) versus prey driven (generalist able to adapt based on food resources). The Survey Methodology section reviews occupancy and prey delivery surveys and detectability biases, leading to habitat, nest site, and prey requirement assumptions and concerns. The Breeding Ecology and Habitat section reviews the diverse habitat and forest types the goshawk is found within the Intermountain West and Blue Mountains. We review the spatial management of the goshawk at the nest stand, post-fledging area, and home range. The Site Occupancy and Habitat Change section addresses management implications and forest restoration activity within goshawk territories and their impacts.

The above six sections provide a technical review of the status and ecology of the goshawk with a synthesis of scientific publications. The review includes detailed information and analysis of goshawk occupancy, habitat, and potential human influence on habitat and nest disturbance. We provide this thorough review and background information so natural resource managers and stakeholders may better understand the reasons why the goshawk is not a species with population viability concerns. As such, the protection the species is afforded under the Eastside Screens is brought into question. The review finds the species is challenging to locate and monitor, questioning its ability to act as an occupancy-based MIS or focal species. Additionally, on the Malheur National Forest and inland Pacific Northwest, the goshawk was found to sometimes nest in small trees (10-15 inches diameter at breast height), young conifer stands, and juniper habitat, confounding modeling that uses late, old structure or large diameter trees as its basis.

In that context, we provide two Management Review and Recommendation sections. In the first, we look at the Current Management Framework outlined in the Eastside Screens (USDA Forest Service 1995). We review whether the goshawk works as an indicator of habitat or a surrogate for other wildlife species based on selection criteria. We propose that natural resource managers use silvicultural activities that facilitate the likelihood of stand persistence under potential future disturbances while remaining within the Eastside Screens framework.

In the second, we conclude by offering Future Management Framework suggestions to move beyond managing for the goshawk and instead creating wildlife habitat areas to: maximize wildlife diversity and abundance, protect wildlife habitat based on spatial

representation, and assure habitat persistence under future climate disruptions and associated disturbances. We propose this be done within each of the dry forest types to better meet the needs of the associated wildlife.

Caption: Immature goshawk in flight. Above: note the short, broad wings and long tail, adapted for bursts of speed and rapid changes when pursuing prey. Below: the large feet of the goshawk allow it to take prey larger than itself, such as the snowshoe hare.

© Keith Thompson

Background

Indicator Species in Forest Management

During the later-half of the 20th century, wildlife scientists became increasingly interested in identifying bio-indicators as tools to assess human-caused environmental change and its effects on sensitive wildlife. The concept of *bio-indicators*, *indicator species* or *surrogates*, was introduced as a species representative of a unique biological community or ecosystem. As a practical monitoring tool, population declines seen in appropriate indicator species could theoretically warn of detrimental environmental change to a broader community or ecosystem (Noss 1990, Niemi et al. 1997, Murphy et al. 2011).

Birds were identified as excellent bio-indicators due to their sensitivity to environmental impacts coupled with their diversity, abundance, and conspicuousness, and thus presented a practical measure of environmental change. The selection of appropriate indicator species continues to fuel debate, with emphasis on establishing and following specific selection guidelines (Landres et al. 1988, Caro and O'Doherty 1999, Carignan and Villard 2002, Niemi and McDonald 2004, Hollamby et al. 2006):

1) **Relevance:** Is the indicator relevant to the assessment question (management concern) and to the ecological resource or function at risk?

2) **Feasibility:** Are the methods for sampling and measuring the environmental variables technically feasible, appropriate, and efficient for use in a monitoring program?

3) **Response Variability:** Are human errors of measurement and natural variability over time and space sufficiently understood and documented?

4) **Interpretation and Utility:** Will the indicator convey information on ecological condition that is meaningful to environmental decision-making? (based on Kurtz et al. 2001 and Niemi and McDonald 2004)

With the passage of the National Forest Management Act in 1976, Land and Resource Management plans were required for each individual National Forest and the concept of forest management indicator species (MIS) was introduced into Forest Service management guidelines.

Raptor species were often selected as bio-indicators due to their large home ranges and vulnerability to environmental contaminants, while also demonstrating sensitivity human nest-site disturbance, habitat loss, and prey species fluctuations (Rodríguez-Estrella et al. 1998, Ozaki et al. 2006, Burgas et al. 2014). Throughout the 1970s and 80s, the ecology and conservation of North American forest landbird communities garnered increasing attention in relation to timber harvest on western public forests. With the passage of the National Forest Management Act (NFMA) in 1976, Land and Resource Management plans were required for each individual National Forest, and

the concept of forest management indicator species (MIS) was introduced into Forest Service management guidelines (Thomas et al. 2006).

As research and monitoring efforts increased, wildlife professionals identified the historical and ongoing loss of mature and old-growth conifer forests as a primary threat to the nesting habitat of indicator species such as the northern spotted owl (*Strix occidentalis caurina*) and the marbled murrelet (*Brachyramphus marmoratus*). Both species were eventually listed under the Endangered Species Act (ESA) in the 1990s. As outlined in the ESA statutes, the decision-making framework requires evidence of significant population declines and/or range contractions and habitat losses documented within a distinct population, subspecies or species (Endangered Species Act 16 U.S.C. Sections 1531-1533).

Caption: Second-year, male northern goshawk (© Abbott Schindler)

Debate about the Goshawk as an Old-Growth Indicator

Research and monitoring in Arizona prompted the Forest Service in the southwest (Region 3) to identify the goshawk as an MIS and a Sensitive Species (see Legal Status for more details). While nesting areas were afforded some protection in the 1980s, a scientifically controversial paper published by Crocker-Bedford (1990) asserted goshawks were an old-growth obligate species that required extensive tracks (1000-2000 ha [2500-5000 acres]) of dense, large trees. Due to historical occupancy estimates, Crocker-Bedford inferred the breeding population on the Kaibab National Forest may have undergone a nearly 80% decline, and the cause of this decline was attributed to over-harvest of mature and old-growth coniferous forest stands (see Conservation Status for more details).

The Crocker-Bedford (1990) paper sparked a lively debate over the fundamental aspects of goshawk ecology and its conservation status. Two petitions to list the species under the ESA soon followed (see Kennedy 2003 for a more detailed legal history). In a detailed critique of the Crocker-Bedford paper, Kennedy (1997, 1998) identified a series of methodological errors in estimating goshawk densities and

concluded that the Crocker-Bedford (1990) estimates of goshawk population change was unjustified. Subsequent status assessments and synthesis papers have concurred with Kennedy's conclusions regarding goshawk population status and trends (USFWS 1998, Anderson et al. 2005, Boyce et al. 2006, Squires and Kennedy 2006, Reynolds et al. 2008).

Throughout the 1990s, a flurry of peer-reviewed research continued to provide valuable insights into population viability concerns and ultimately guided the US Fish and Wildlife Service (USFWS) decision that listing was not warranted under the guidelines set forth in the ESA. In 2012, the British Columbia population of *A. g. laingi* was listed as Threatened under the authority of the Endangered Species Act (USFWS 2012; see Legal Status for more details).

Recent research concluded the goshawk was a poor forest indicator species due to its varying habitat preferences. The goshawk is not an MIS or focal species on the SMB/MNF, though it is being considered in the new Forest Plan.

The Goshawk as a Forest Indicator

Recent research evaluated the goshawk as an indicator of forest species richness, abundance and composition across four taxa in the forests of Japan and concluded that the goshawk "was not effective as an indicator of the species diversity…" (Ozaki et al. 2006). The study also "did not find any difference in species richness, abundance, and species composition between sites predicted as occupied and unoccupied" (Ozaki et al. 2006). Another evaluation in Europe concluded a suite of prey species may perform equally well as indicators of forest species richness (Roth and Weber 2008). In North America, multiple peer-reviewed synthesis papers addressing goshawk management and status concur that the goshawk uses a wide variety of forest habitat types (and non-forest) for nesting and therefore is a forest generalist and not a suitable indicator of old-growth forest and the biological community therein (Kennedy 1997, 1998, USFWS 1998, Boyce et al. 2006, Squires and Kennedy 2006). While goshawks occupy varied forest types and conditions throughout their range and within single territories, the immediate nest site is generally characterized by mid to late structure with relatively closed canopies and sparse understory trees (McGrath et al. 2003, Squires and Kennedy 2006).

Caption: Goshawk nest in pinyon-juniper habitat, southwest Idaho. © Rob Miller

Species Overview

Species Description

The northern goshawk (*Accipiter gentilis; meaning "noble hawk"*), is the world's largest and most widely distributed species in the genus *Accipiter* and one of only two diurnal forest-associated raptor species distributed widely across both Eurasia and North America (Holarctic distribution). In North America, the goshawk is one of three endemic *Accipiter* species, including the Cooper's hawk (*Accipiter cooperi*) and sharp-shinned hawk (*Accipiter striatus*). While all three species appear to overlap in size, and appear very similar in immature plumage, they remain easily separated and do not overlap in standard morphometric measurements such as wing chord and tail length. Of the three, the goshawk is the largest and fastest in flight. Relative to the Cooper's and sharp-shinned, this large hawk seems barrel-chested, with a longer and broader appearance to its wings and tail that often appears *Buteo*-like in flight. Its powerful feet with medium-length toes resemble that of a red-tailed hawk; evidence of its adaptability to small mammal quarry, which it preys upon more frequently than any other *Accipiter* hawk.

Caption: The goshawk (left; © Rob Miller) and the red-tailed hawk (right) showing similar foot morphology.

Although it is nearly identical to the Cooper's and sharp-shinned hawks in immature plumage, the goshawk's adult plumage is strikingly unique, with a blue-gray back and head, finely vermiculated gray breast, a prominent supercilium (*eye-stripe*), and bold under-tail coverts that often appear as a large white, pillowy plume beneath the tail. The European goshawk subspecies all display a yellow-orange eye color as adults, while North American adults eventually display the deep, blood-red eye color typical of North American adult Accipiter hawks.

Caption: Immature male goshawk carrying a leg-mounted radio transmitter.
© Abbott Schindler

True to other accipiters, goshawk wingbeats in casual flight appear as a rhythmic "flap-flap-glide…". In pursuit, smaller accipiter hawks are known for their frenetic short-distance acceleration, but the goshawk also possesses a nearly falcon-like long-distance speed and endurance; often observed in protracted, direct pursuits against powerful avian quarry like pigeons.

> *While scientists debate some subspecies designations in other regions, the goshawk found in the SBM/MNF region is the same subspecies found throughout most of continental North America: Accipiter gentilis atricapillus*

Nomenclature, Taxonomy and Distribution

The general public often interprets taxonomy as a process of almost arbitrary uncertainty, as species and subspecies categories appear in near-perpetual flux. Yet, while several subspecies questions remain, the classification of the northern goshawk, like many other taxa, has benefited from over 250 years of refinement in the fields of taxonomy and cladistics. Originally described in 1758 by Carl Linnaeus, he incorrectly assigned the goshawk to the genus *Falco*.

The goshawk was later moved to the genus *Astur*, while species such as the European sparrowhawk, Cooper's hawk and sharp-shinned hawk were grouped in the *Accipiter* genus *(*Brisson 1760*)*. In the early 20th century, ornithologists split the "Ámerican Goshawk" (*Astur atricapillus,* Wilson 1812) into the "Eastern Goshawk" (*Astur atricapillus atricapillus*) and "Western Goshawk "*Astur atricapillus striatulus* (Baird et al. 1874), due to the more finely vermiculated breast pattern observed in adult specimens from western populations. *(atricapillus* meaning "black head/cap";

while not necessarily distinguishable in the field, the “black cap” is often apparent in the hand, compared to Eurasian specimens). Nelson (1884) described *A. g. henshawi* as a distinct subspecies endemic to southern Oregon and northern California, but this was later abandoned. By the mid-20th century, ornithologists recognized the European and American goshawks were the same species (northern goshawk), and, realizing they were indistinguishable, grouped the previously described “Eastern” and “Western” North American subspecies together as *A. g. atricapillus* (Taverner 1940), the most widespread of the three North American subspecies and the subject of this review.

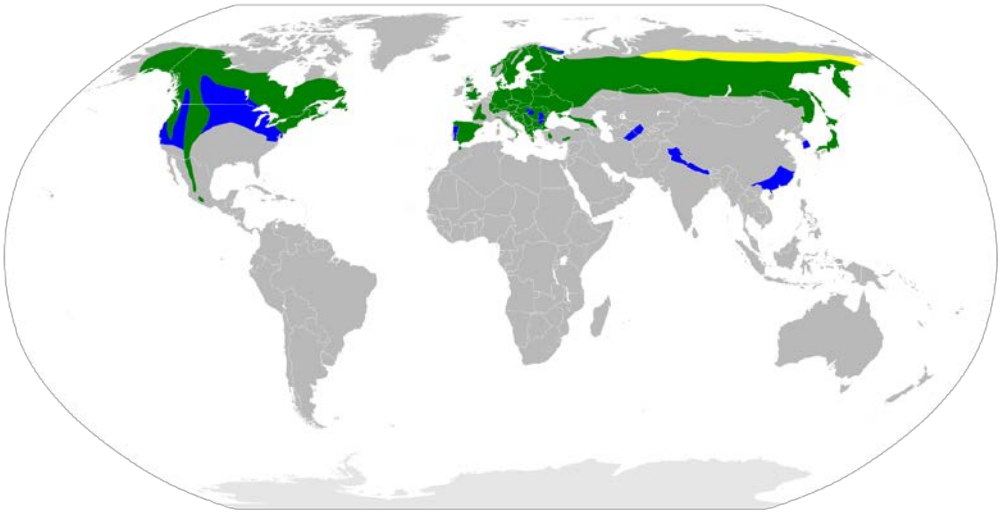
Caption: Adult goshawk (Eurasia); *A. g. gentilis*– note orange eye and grey cap. Photo courtesy S. Garvie

Of the two other subspecies, *A.g. laingi* (Taverner 1940), or Queen Charlotte goshawk, is found along the dense temperate rainforests of coastal southeast Alaska, coastal British Columbia and possibly the Olympic Peninsula of Washington state. Scientific debate continues regarding the accurate distribution of *A. g. laingi*. The third subspecies, *A. g. apache* (van Rossem 1938) is found in the dry forests of northern Mexico, southeast Arizona and New Mexico. Questions remain about whether *A.g. apache* as a distinct subspecies and the USFWS considers the inquiry unresolved in the peer-reviewed literature (for a more detailed overview of taxonomy see USFWS 1998). Results of recent genetic work indicate, “…populations in the extreme American Southwest may have been isolated for some time.” These goshawks sampled in southern Arizona and Mexico exhibited a high frequency of a unique haplotype, possibly supporting *A. g. apache* subspecies status (Volo et al. 2013).

Caption: Adult goshawk (*A. g. atricapillus*) of the subspecies found on the SBM/MNF (above). Biologist examining the plumage of an adult male goshawk in Idaho (below). Photos: © Rob Miller

Holarctic Distribution

The goshawk is distributed throughout the temperate and boreal forests of both North American and Eurasia and the relevance of this unique distribution to goshawk habitat assessments is often overlooked. Along with the merlin *(Falco columbarius*; a forest generalist), the goshawk is the only other diurnal, forest-associated raptor species with a holarctic distribution; signifying an intrinsic adaptability to varied forest types.



Caption: Holarctic distribution of the northern goshawk (*Accipiter gentilis*). Breeding (yellow), resident (green), and wintering (blue) shown. Map by Simon Pierre Barrett.

North American Distribution of *A. g. atricapillus*

The subspecies endemic to the SBM/MNF (*A. g. atricapillus*), is distributed from West Virginia north to northern Newfoundland, west to northern Alaska, south throughout the Pacific and Rocky Mountain regions, extending at elevation south, even into montane forests of western Mexico (the southwest extent of *A*. *g*. *atricapillus* hinges to some degree on the status of *A. g. apache* as a distinct subspecies). Although breeding populations are common in the forested areas of the Great Lakes region, they are absent from much of the remaining upper Midwest, southern central states, and the southeastern US (for more information on historical range see Conservation Status).

Within the range of *A. g. atricapillus*, breeding records have included the broad forest types common to temperate, boreal and sub-arctic forest regions of North America. Breeding records also include non-forested habitats and small, forested patches within a relatively non-forested landscape context:

1. ***Temperate deciduous***
2. ***Temperate mixed deciduous/conifer***
3. ***Temperate conifer (****includes pinyon-juniper)*
4. ***Shrub-steppe*** *(small island stands of aspen)*
5. ***Boreal conifer***
6. ***Non-forested arctic tundra*** *(willow shrublands; likely not common)*

Caption: North American Distribution of the northern goshawk (includes *A. g. atricapillus, A. g. laingi, and A. g. apache*). Map: Squires et al. 1997.

Oregon Distribution

In Oregon, the goshawk (*A. g. atricapillus*) is found breeding throughout montane forests of the west and east slopes of the Cascade, Blue, Ococho, Wallowa, Bly, and Siskiyou Mountains among others, but their presence along the Coast Range is notably infrequent (Reynolds et al. 1982, Thrailkill et al. 2000, DeStefano et al. 2006), and no active territories are known throughout the range's northern extent. While avian prey appears abundant, researchers speculate the dense understory of the Coast Range forest may interfere with successful foraging and may be a limiting factor in goshawk breeding success (Thrailkill et al. 2000, Salafsky et al. 2007). Notably, goshawks in the Klamath Basin were found nesting in juniper trees, outside of those forest types traditionally surveyed; suggesting the true distribution of goshawks in Oregon maybe underestimated (see Goshawk Research and Monitoring).

Historical Distribution on SBM/MNF

Before the 1970s historical information on the goshawk in the SBM/MNF is limited but useful in corroborating historical distribution. Noted ornithologist, Major Charles E. Bendire, described the goshawk as "pretty generally distributed throughout the Blue Mountain region of Oregon and Washington" (Bendire 1892) and noted, "a few pairs breed in the mountains north of Camp Harney" (also called Ft. Harney, presently the southern edge of Malheur National Forest north of Hwy 20).

Caption: Major Charles Bendire US Cavlary. Bendire was one of earliest trained ornithologists to inventory bird species in eastern Oregon. Photo: courtesy of the National Archives

Goshawk Research and Monitoring in Eastern Oregon

Oregon goshawk survey efforts have primarily occurred in ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), and mixed conifer stands (DeStefano et al. 2006). A notable exception were nesting goshawk density surveys conducted in the BLM Klamath Falls Resource Area in the early 1990s. This survey effort utilized a random-systematic grid sampling approach where survey points in all habitat types were visited. The density study subsequently found active goshawk nests in western juniper (*Juniperus occidentalis*), outside of the ponderosa pine forests (Chris Yee, *personal communication,* August 2015). This juniper-dominated habitat

contained some scattered pine trees but was far outside the range of required overstory and vegetation type for classic goshawk habitat. A few years later, another goshawk nest was located in juniper during Chiloquin Ranger District (Fremont-Winema National Forest) goshawk surveys (Chris Yee, *personal communication*). These Oregon nests reaffirm what has been reported in many western states, that goshawks nest in diverse forest types, including pinyon-juniper (Bloom et al. 1985, Johansson et al. 1994, Slater and Smith 2010, Miller et al. 2014).

In eastern Oregon, the majority of known nest sites have been located between 1,300 and 1,800 m (~4,400 to 5800 ft) in ponderosa pine, lodgepole pine, and mixed conifer stands. Dry sites are dominated by ponderosa pine; more moist sites contain mixed stands of ponderosa and fir species; while wetter north slopes often contain lodgepole pine, western larch (*Larix occidentalis*) and grand fir (*Abies grandis;* Reynolds et al. 1982, Daw 1996, Desimone and DeStefano 2005, DeStefano et al. 2006, Rickabaugh and Fremd 2012). Goshawk data collection in eastern Oregon primarily occurred during the 1990s using standard goshawk alarm call broadcast surveys and nest searches (see Table 1; also see Rickabaugh and Fremd 2012 for a more detailed description of eastern Oregon goshawk survey history).

Caption: adult northern goshawk. Note the key identifying markers of the: red eye, blue-gray back and head, finely vermiculated gray breast, a prominent supercilium (*eye-stripe*), and bold under-tail coverts that often appear as a large white, pillowy plume beneath the tail. Photo: © Keith Thompson

Table 1: Goshawk Research and Monitoring Related to SBM/MNF

Authors	Date	Title	Oregon Region
Reynolds and Wright	1978	Distribution, density, and productivity of Accipiter hawks in Oregon.	Statewide
Reynolds et al.	1982	Nesting habitat of coexisting Accipiter in Oregon	Statewide
Moore and Henny	1983	Nest Site Characteristics of Three Coexisting Accipiter Hawks in Northeastern Oregon	Wallowa-Whitman NF
Henny et al.	1985	Breeding Chronology, molt, and measurements of Accipiter hawks in northeastern Oregon	Wallowa-Whitman NF
Bull and Hohman	1994	Breeding Biology of North Goshawks in Northeastern Oregon	Wallowa Valley, Eagle Cap, Hell's Canyon
Haines	1995	Northern goshawk breeding habitat in conifer stands with natural tree mortality in eastern Oregon. (M.S. Thesis)	Eastern Oregon
Cutler	1996	Diets of northern goshawks in Oregon (Unpublished report)	Wallowa-Whitman and Malheur NFs
Daw	1996	Goshawk nest site selection and habitat associations at the post- fledging family area scale in Oregon. (M.S. Thesis)	Wallowa-Whitman and Malheur NFs
Desimone	1997	Occupancy rates and habitat relationships of goshawks in historic nesting areas in Oregon.	Wallowa-Whitman and Malheur NFs
DeStefano and Cutler	1998	Diets of northern goshawks in eastern Oregon (Unpublished report)	Wallowa-Whitman and Malheur NFs
Daw et al.	1998	Does survey method bias the description of northern goshawk nest-site structure?	Wallowa-Whitman and Malheur NFs
Daw and DeStefano	2001	Forest characteristics of northern Goshawk nest stands and post-fledging areas in Oregon	Malheur National Forest
McGrath et al.	2003	Spatially explicit influences on northern goshawk nesting habitat in the interior Pacific Northwest	East Cascades, Blue Mountains and Malheur NF
Desimone and DeStefano	2005	Temporal patterns of northern goshawk nest area occupancy and habitat: A retrospective analysis	Statewide
DeStefano et al.	2006	Ecology and habitat of breeding northern goshawks in the inland PNW: a summary of research	Wallowa-Whitman, Fremont, and Malheur NFs
Rickabaugh and Fremd	2012	Northern goshawks in the Malheur National Forest Eastern OR. 1992-2011 (Unpublished report)	Malheur NF

Status

Legal Status of the Goshawk in the Western US and SBM/MNF

In 1998, the USFWS concludes listing under the ESA not warranted based on three findings:

1. **Western goshawk population distribution has not changed**
2. **No population trend evidence existed**
3. **Goshawks are a habitat generalist**

USFWS (1998) also noted, "…its habitat use is not restricted to old-growth, making it less appropriate for use as an old-growth indicator."

Summary of Legal History

Due to significant harvest of mature and old-growth forests in the southwestern US, a petition was filed in 1991 to list the goshawk as endangered under the provisions of the Endangered Species Act (ESA). This was largely prompted by research suggesting a significant decline in the breeding population throughout the Kaibab Plateau (Crocker-Bedford 1990). The petition sought protection for the goshawk populations within Colorado, Utah, New Mexico and Arizona. A subsequent amendment to the petition asked for protection for goshawks populations west of the 100th meridian (USFWS 1998).

Following a status review in 1992, the USFWS found the petitioner had failed to prove the identified population as distinct from other continental populations (as per ESA listing criteria), citing the population was "virtually continuous from the petitioned region into Canada and Mexico and across Canada to the eastern U.S." Subsequently a suit was filed to overturn the denial (USFWS 1998).

The court determined the USFWS's criteria to deny listing was flawed and ordered the USFWS to review the petition once again. In 1994, the USFWS again determined listing was not warranted as the petition included possibly three subspecies (*A. g. atricapillus, A. g. laingi,* and *A. g. apache*) which taken together, did not represent a "distinct population".

Following more legal challenges, in 1997 the USFWS initiated a full conservation status review of the goshawk. In 1998, the Service concluded that listing was not warranted due to several key findings: (1) western goshawk population distribution has not changed; (2) no evidence exists that populations are declining, stable or increasing; (3) goshawks are a habitat generalist and not entirely dependent upon old-growth forests. Following another lawsuit in 2001, the court ruled in favor of the USFWS, and the goshawk remains not listed under the ESA (Kennedy 2003, Boyce et al. 2006; see Conservation Status).

Current Legal Status: USFWS

In 2012, the British Columbia population of the Queen Charlotte goshawk (*A. g. laingi*) was listed as *Threatened* under the ESA, encompassing USFWS Region 7 - Alaska. Currently the goshawk (*A. g. atricapillus*) is protected under the authority of the Migratory Bird Treaty Act and applicable state wildlife statutes (USFWS 1998; see Table 2).

Current Legal Status: Oregon Department of Fish and Wildlife

The goshawk is listed as Sensitive-Vulnerable under the Oregon Department of Fish and Wildlife's (ODFW) Sensitive Species list (see Management Status) and is protected wildlife under Oregon Administrative Rule (OAR) # 635-044-0130 "Nongame Wildlife Protected" (ODFW 2008, 2012).

Table 2: Legal and Management Status of *A.g. atricapillus* in the Inland Pacific Northwest

Organization	Region	Status	Source
USFWS	Region 1	Species of Concern MBTA Species	www.fws.gov
USFWS Birds of Conservation Concern	BCR 9 and 10	Not listed (listed in Region 5)	www.fws.gov
CITES	Global	Appendix II	http://www.cites.org/
USFS	Region 6	Not listed	http://www.fs.usda.gov/
USFS Sensitive Species	Malheur National Forest	Not listed	http://www.fs.usda.gov/
USFS MIS	Malheur National Forest	Not listed	http://www.fs.usda.gov/
BLM Sensitive Species	Oregon and Washington	Not listed	http://www.blm.gov/or
ODFW Sensitive Species	Oregon	Sensitive-Vulnerable	http://www.dfw.state.or.us/
International Union for the Conservation of Nature	Global	Least Concern	www.iucnredlist.org
The Nature Conservancy	US and Canada	G5,T5,NNR; Globally secure, Subspecies secure; Nationally not ranked	www.natureserve.org

Caption: Goshawk biologist climbing nest to examine and band nestlings. © Rob Miller

Management Status

Forest Service Sensitive Species

In accordance with Forest Service policy, the management of sensitive species "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32). Regional foresters are responsible for identifying sensitive species and coordinating with federal and state agencies to avert the need for Federal or State listing as a result of National Forest management activities.

While the goshawk is listed as a sensitive species in several Forest Service regions, it is not listed in Region 6 (Oregon and Washington, encompassing the Malheur National Forest) and therefore does not require a Biological Evaluation relative to management activities in this region (USDA Forest Service Special Status Species Lists).

Goshawk Status:

- The Forest Service does not currently list the goshawk as an MIS or sensitive species in the SBM/MNF region.
- The USFWS does not list the goshawk as a species of concern in the SBM/MNF region.
- The 1995 Eastside Screens do require managers follow special guidelines for goshawks in the SBM/MNF.

Forest Service Management Indicator Species

The goshawk is listed as an MIS in 37 of 104 National Forests in the US, but is not listed as an MIS on the Malheur National Forest. In their 1998 status review, the USFWS determined the goshawk was not a suitable MIS due to its generalist habitat and prey tendencies (USFWS 1998).

> *"We suggest that the northern goshawk is not an appropriate species for use as a Management Indicator for the Forest Service. The species is difficult to locate through surveys, making it less amenable to monitoring and its habitat use is not restricted to old-growth, making it less appropriate for use as an old-growth indicator." (USFWS 1998)*

Forest Service Region 6 Management Guidelines: Eastside Screens

The Regional Forester amended all Forest Plans on the eastside of Oregon and Washington establishing riparian, ecosystem and wildlife standards (Eastside Screens; USDA Forest Service 1994, 1995). These were originally intended as temporary guidelines, pending completion of a region-wide old-growth conservation strategy, the Interior Columbia Basin Ecosystem Management Project (ICBEMP). The Eastside Screens (USDA Forest Service 1995) amended the land management plans outside of the range of the northern spotted owl in eastern Oregon and Washington, including the southern Blue Mountains and Malheur National Forest, and include the following broad standards:

1) Prohibit timber sales within late and old structural forest stands in biophysical provinces within watersheds that are below a historic range of variability (HRV) for late and old structure stages (LOS)

2) Require that amount of late and old structural forest stands does not fall below HRV

3) Prohibit logging of live trees >53 cm (21 in) diameter at breast height (dbh)

4) Establish connectivity corridor requirements between late and old structural stands

> *The Eastside Screens also specifically address goshawks and set forth several minimum guidelines intended to remain in effect "Until further information is known…"*

Specific to the goshawk, the Eastside Screens proposed two scenarios (A and B) with the difference being the description of allowed harvest in PFAs within Scenario B.

Scenario A

1) Protect all active and historical (active within last 5 years) goshawk nest sites from disturbance

2) No timber harvest in 12 ha (30 acres) of nesting habitat (suitable) surrounding active or historical nests

3) Retain late and old structural stages in a 162 ha (400 acre) Post Fledging Area (PFA) around every active nest site (harvest activities permitted that do not reduce older structural stages)

Scenario B

If LOS are within or above the "historic range of variability" at the watershed scale, then limited timber harvest can occur with conditions; such as maintaining at least 60% late/old structural stands within the PFA.

Harvest activities may occur in the following stand types (in order of priority):

1) Stands other than LOS

2) Smaller isolated LOS stands less than 40.50 ha (100 acres) and/or at the edges of large LOS stands (greater than 40.50 ha [100 acres])

3) Harvest in larger stands of LOS, but only as last priority, within large stands over 40.50 ha (100 acres), harvest is limited to thinning, single-tree selection, salvage, understory removal and other non-regeneration activities.

4) Adhere to prescriptions in Scenario A

(*note*: surveys for goshawks in project areas are not required. For more details see USDA Forest Service 1995)

Eastside Screens, Scenario A for the Goshawk*:*

1. Protect all active and historical (active within last 5 years) goshawk nests from disturbance
2. No timber harvest in 12 ha (30 acres) of nesting habitat (suitable) surrounding active or historical nests
3. Retain late and old structural stages in a 162 ha (400 acre) Post Fledging Area (PFA) around every active nest site (harvest activities permitted)

USFWS Species of Concern

In the southern Blue Mountains and on the Malheur National Forest, the goshawk is not listed as a species of concern by the USFWS. The Fish and Wildlife Conservation Act directs the USFWS to: "…identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973."

As a response, the USFWS produced the Birds of Conservation Concern listing species of concern in 35 distinct ecoregions in the US. The southern Blue Mountains and Malheur National Forest reside in BCR's # 9 and 10 where the goshawk is not listed. The goshawk is listed as in the adjoining BCR 5, encompassing the Oregon Coast Range (USFWS 2008).

BLM Sensitive Species

In coordination with the Forest Service, the Oregon/Washington BLM participates in the Interagency Special Status /Sensitive Species Program (ISSSSP). The goshawk is not listed in the ISSSSP list for the OR/WA region.

ODFW Sensitive Species

The goshawk is listed as "Sensitive-Vulnerable" on the Sensitive Species List for ODFW (2008). This list is primarily a non-regulatory tool, and instead serves as an early warning system for biologists, land managers, policy makers, and the public. According to ODFW (2008), "Vulnerable species are not currently imperiled with extirpation from a specific geographic area or the state but could become so with continued or increased threats to populations and/or habitats."

> *"Conservation biology seeks…to predict how an animal-population-species will react to future/current changes, usually human caused, in its environment/ density/distribution. Most importantly, whether it will survive and what to do to prevent extinction." Soulé 1978*

Conservation Status

Background: Evaluating a Species' Conservation Status

Conservation status assessments rely on the well-established tools of population biology, whereby measuring trends in a population of concern is preferable to other alternatives. Monitoring presence or absence over time is often an effective means to monitor changes in spatial distribution – a cornerstone of conservation assessments. While requiring more effort, monitoring a population's vital rates may provide the most confident assessments. Vital rates refer to the *rates of change* in a population's vital statistics such as: abundance, reproductive output, mortality/survivorship, immigration and emigration. The number of individuals counted in a population and the population's distribution at a point in time, cannot by itself reveal a species'

conservation status. A species may appear abundant at a point in time, yet be in the midst of a dramatic declining trend where reproductive output is high, but survival and recruitment extremely low (Kennedy 1998). Even increasing trends in abundance over time may be driven by immigration not local reproduction, and possibly mask underlying dysfunction such as low reproduction and survival of the local population (Newton 1976, 1998).

Avian biologists strive to incorporate a large population sample size from which they monitor indices such as territory occupancy (proportion of known territories occupied across time), reproductive output (mean number of fledged young per nest), juvenile survival, and adult survival (or mortality rates). This information is commonly gleaned from long-term nest searching/monitoring and mark/recapture studies (banding) in a discrete study area (Martin and Geupel 1993, Ralph et al. 1993). New approaches that do not require mark/recapture may offer a better approach for goshawk population trend estimates (Bruggeman et al. 2015a, 2015b).

However, sparsely distributed, secretive forest raptors such as the goshawk present significant logistical challenges to population monitoring (see Survey Methodology). Monitoring rates of territory occupancy (and occupancy modeling) across large landscapes is more feasible, and may be a valid method of estimating population performance (Woodbridge and Hargis 2006, Martin et al. 2009, Beck et al. 2011, Kennedy et al. 2014, Wallace 2014, Bruggeman et al. 2015a, 2015b). If occupancy data are collected using a probabilistic sampling design, not opportunistically, then occupancy can be used to estimate abundance (MacKenzie et al. 2006, Bruggeman et al. 2015a, 2015b).

If a significant population trend is observed, biologists identify those environmental, food resource, or habitat variables ultimately responsible. If a relationship between specific habitat variables and population performance is identified, predictive habitat models can be generated, allowing biologists a drastically more cost-effective means to predict a population's trajectory over time and space. To date, most goshawk habitat models are correlative and are not built upon a cause/effect relationship between measured habitat variables and measured population performance; however models based on occupancy rates are promising (Woodbridge and Hargis 2006, Beck et al. 2011, Bruggeman et al. 2015a, 2015b).

Experimental Management

One of the most effective methods to detect a cause-effect relationship between a habitat variable and a population's trend is through a controlled experiment whereby a population's vital rates (or occupancy rates) are monitored in a control area with no habitat treatment and a test area with a pre-defined treatment (Bierregaard and Lovejoy 1989, Kennedy 1997, 1998). To date, few studies have attempted to experimentally test the effects of various timber harvest regimes on goshawk occupancy and/or reproduction, and such studies were generally short-term (Penteriani and Faivre 2001, Mahon and Doyle 2005, Moser and Garton 2009, Saga and Selås 2012).

Caption: And example of experimental approach to forest management: The Biological Dynamics of Forest Fragments Project in Brazil is the world's largest ecological experiment, designed to develop a better understanding of how to conserve forest biodiversity. Photo courtesy of Tom Lovejoy.

USFWS Listing Decision – Not Warranted

In their 1998 status review, the USFWS identified the lack of evidence of a population decline and/or range contraction in their decision that listing the goshawk was not warranted. Despite the significant goshawk research and monitoring efforts throughout the 1990s, no data are available identifying a range contraction or population decline in the goshawk (*A. g. atricapillus*) west of the 100th meridian. Secondly, the data indicated the goshawk is not an old-growth forest obligate, but rather a forest generalist using "small patches of mature habitat to meet their nesting requirements within a mosaic of habitats of different age classes…" (USFWS 1998). This rationale was generally corroborated by findings from multiple studies and reviews that looked at large geographic areas, multiple populations, or sample sizes large enough to be scaled to the population level (Kennedy 1997, Anderson et al. 2005, Boyce et al. 2006, Squires and Kennedy 2006, Reynolds et al. 2008).

Migration Counts

The number of hawk migration count stations has increased in the last three decades providing a long-term trend data for numerous North American raptor species. Specifically, these count sites have provided valuable insights into the role of weather

patterns in raptor migration; how climate change may affect migration timing; and may provide an early warning system of dramatic population declines (Bildstein 1998).

Although cost-effective, migration counts present significant problems when used to inform the goshawk's conservation status (Kennedy 1997, Boyce et al. 2006): the natal area (birth place) of goshawks observed is unknown; the relationship between goshawk migration count trend and actual population trend is unknown; the sample size at migration count sites is small; telemetry data indicates most females remain on the breeding home ranges year-round, while most males made short-distance, elevational migrations; and survey effort is highly variable across time.

Caption: Immature goshawk gliding along a mountain ridge in fall migration. Goshawks are not considered an *obligate migrant*. In other words, goshawk movements are highly variable and often effected by prey abundance around their natal area, temperature/precipitation, and competition from other goshawks. For example, a reduction of goshawk numbers counted at migration survey sites may be the result of increased prey populations in their natal region. Photo: © Rob Palmer

Historical Distribution/Evidence of Range Contraction

Documented range contractions may significantly influence the conservation status of species otherwise known to be abundant in their current distribution. In their 1998 status assessment, the USFWS compiled historical records throughout the goshawk's US range and determined northeastern populations likely experienced a significant contraction during aggressive forest clearing throughout the 19th century. However, current records indicate these populations had recolonized (or are currently expanding) with reforestation of the northeast. In the west, historical records indicate the distribution of the goshawk is relatively unchanged (USFWS 1998).

Historical Information on the SBM/MNF

Noted ornithologist, Major Charles E. Bendire, described the goshawk as "… generally distributed throughout the Blue Mountain region of Oregon and Washington" and noted, "a few pairs breed in the mountains north of Camp Harney" (also called Ft. Harney; presently the southern edge of Malheur National Forest north of Hwy 20; Bendire 1892).

Caption: Adult goshawk at nest. Goshawks typically build their nests in the lowest branches, providing easy access for adult delivering prey, and protection from inclement weather and predators from above. Photo: © Keith Thompson.

Addressing the heart of the argument that the goshawk is an old-growth forest obligate and required added protection, Kennedy (1998) stressed that much of the available research only correlated breeding goshawk presence with certain forest habitat conditions but had yet to detect a relationship between those forest structure and goshawk population trends.

Scientific Debate on Goshawk Population and Habitat:

Habitat vs. Population Monitoring

Kennedy (1998) presented one of the most important critiques of the argument that the goshawk is an old-growth forest obligate (see Debate about the Goshawk as an Old-Growth Indicator section for more details). Kennedy underscored that much of the available research only correlated breeding goshawk presence with certain forest habitat conditions. Crocker-Bedford (1990) and Greenwald et al. (2005) identified goshawks as requiring old-growth forests without empirically validating this hypothesis with scientific testing. In other words, researchers did not observe robust trends in

reproduction and survival in forests managed for old-growth forest vs. other forest management; and what trend data existed pointed to inter-annual variability in weather and prey abundance (Kennedy 1997, 1998, Boyce et al. 2006, Reynolds et al. 2008).

The scientific literature provides over 10 years of publications with detailed reviews of goshawk population assessments in the western and continental US (see Kennedy 1997, 1998, USFWS 1998, Anderson et al. 2005, Boyce et al. 2006, Squires and Kennedy 2006, Reynolds et al. 2008) finding that habitat monitoring is not an effective means of monitoring goshawk populations. Multiple techniques are available to assess population status (see Evaluating a Species' Conservation Status).

"…our 17-year study of goshawks on as many as 123 goshawk territories on the Kaibab Plateau…is demonstrating that intern-annual variation in food abundance, high annual fidelity to breeding territories, extensive variation in the breeding life of goshawks, and direct weather effects on reproduction can all act synergistically to produce large variations in total reproduction on and among territories. Each of these factors confounds our search for the true effects of tree harvests on goshawks; unless habitat changes approach a catastrophic level…" (Reynolds et al. 2008)

Limiting Factors: Old-growth Forest Nesting Habitat vs. Prey-based Habitat

In a recent review of published studies on the goshawk, Greenwald et al. (2005) concluded that published research supported the singular importance of old-growth forest structure to goshawk breeding ecology. The authors suggested current management strategies may not afford adequate protections. In response, Reynolds et al. (2008), used a broader compilation of studies and concluded Greenwald et al. (2005):

1) Ignored the goshawk's opportunistic use of habitat (and prey habitat)
2) Failed to understand the role of prey in limiting goshawk populations
3) Ignored multiple studies indicates goshawk are less limited by vegetation structure than by food abundance

For example, Salafsky et al. (2007) determined that prey densities (specifically the combination of only four species) explained 89% of the variation in goshawk reproduction. Evaluating fledging rates across varying habitats, McClaren et al. (2002) found that weather and fluctuating prey populations influenced goshawk productivity more than habitat variables (see Goshawk Reproduction and Prey section for more details). Spring weather and prey abundance are known to influence occupancy and reproductive success in many raptors. Additionally, since the goshawk nests in a variety of forest and habitat types in the western US, not all of them will fit into old-growth categories, such as aspen, pinyon-juniper, and young ponderosa pine stands (see Nest Site Structure and Breeding Habitat and Forest Types sections for more details).

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Survey Methodology

Single visit surveys using historical nest searches, broadcast calls, and transect nest tree search still underestimated occupancy by 36-42% and may require as many as 5 or more visits to achieve confidence in occupancy estimates.

Occupancy Survey Methods

Responding to the need to survey for breeding goshawk territories associated with planned timber harvest, researchers developed a systematic survey method using taped goshawk alarm calls broadcast at stations along pre-defined transects (Kennedy and Stahlecker 1993). The method relies upon territorial goshawks visually and/or vocally responding broadcast calls. A response would indicate a possible occupied territory, where surveyors would conduct subsequent area searches for possible occupied nest sites. Other methods included systematic nest tree transects and dawn listening stations (no taped broadcast calls) where surveyors would record goshawk dawn vocalizations to determine territory occupancy (Dewey et al. 2003, Boyce et al. 2005, 2006).

Detectability Biases and Implications

Over the course of goshawk research and monitoring efforts in the 1990s and beyond, researchers began to evaluate the efficacy of standard survey methods in use by the Forest Service and others. Through experimental research, biases were identified relating to survey effort, goshawk detectability, and estimation of territory occupancy over time (Daw et al. 1998, Dewey et al. 2003, Boyce et al. 2005, Reynolds et al. 2005, Boyce et al. 2006, Woodbridge and Hargis 2006).

Single Visit Surveys

Outside of limited, long-term research efforts, most goshawk surveys are opportunistic and occur in response to planned timber harvest. Survey effort is generally comprised of a single visit, potentially several seasons before logging activities commence. Experimental research found that standard goshawk survey efforts in use by most forest managers strongly bias estimates of occupancy. Single visit surveys using historical nest searches, broadcast calls, and transect nest tree search still underestimated occupancy by 36-42% (Boyce et al. 2005, 2006) and may require as many as 5 or more visits to achieve confidence in occupancy estimates (Boyce et al. 2006). Additionally, surveys with single visits cannot be analyzed with dynamic occupancy models, which account for imperfect detection.

Measuring Occupancy across Time

The response of goshawk pairs to broadcast calls in numerous studies has been highly variable and often strongly correlated to nesting stage, with up to 75% of known breeding pairs changing nest trees to alternate trees (sometimes over 2km away). Many goshawk pairs displayed a decreasing tendency to respond to taped broadcast calls over subsequent years, potentially resulting in an appearance of decreased occupancy and indicating the need to expand searches over much large areas before

classifying a historical territory as “unoccupied” (Boyce et al. 2005, 2006, Woodbridge and Hargis 2006).

In the most thorough, long-term goshawk population study conducted in a dry forest ecosystem in the western US, researchers recommended as many as 8 years of continuous nest searching to accurately detect the breeding population of a given area (Reynolds et al. 2005). These studies direct managers to employ multiple techniques across various stages of a single nesting sequence to achieve confidence in detections (Boyce et al. 2005): (1) Listening stations prior to egg laying (Dewey et al. 2003); (2) Nest-tree searches on parallel transects during incubation and nestling stage; (3) Broadcast calling (wail and food begging) during post-fledging dependency stage (Kennedy and Stahlecker 1993).

Surveys Method Biasing Nest Site Structure

Due to the strong positive relationship between occupancy and surveying effort, concerns remain about survey bias with respect to forest structure. Are ideas of goshawk breeding habitat a function of biased search effort in specific habitat types? Since most goshawks surveys have possibly occurred more often in late-structural forest stands vs. other forest types, is goshawk nest site structure biased toward mature and old-growth characteristics? Addressing this question, research in Oregon (Wallowa-Whitman, Malheur, and Fremont-Winema National Forests) compared opportunistic versus systematic nest searches, and concluded that goshawk territories cover diverse forest types, and the nest-site itself (0.4 ha [1 acre] area around nests) is characterized by large trees and high percent canopy closure regardless of search method (Daw et al. 1998). However, few systematic surveys of goshawk occupancy in alternate forest habitats (e.g., pinyon-juniper) have occurred in Oregon. The goshawk has been found nesting in pinyon and juniper forest types in Idaho (Miller et al. 2014), Utah (Johansson et al. 1994), California (Bloom et al. 1985), and Colorado (Slater and Smith 2010), and Oregon (Chris Yee, personal communication; see Goshawk Research and Monitoring in Eastern Oregon). As such, this habitat should be considered viable for the goshawk and included in Oregon surveys.

Implications to SBM/MNF

1. These and other results not only bring into question previously published estimates of nesting density and occupancy rates but convey significant implications to the ongoing debate over the goshawk’s use as an indicator species and its overall conservation status.

2. From the practical perspective of forest management in the SBM/MNF, accurately detecting and monitoring goshawk occupancy in relation to planned silvicultural treatments is arguably unfeasible or requires increased survey effort within breeding seasons and across multiple years.

3. In the SBM/MNF specifically, historical goshawk field research occurred primarily in the early to mid-1990s using survey techniques, which may underestimate nesting density and occupancy.

Caption: Goshawk nest in pinyon pine (© Rob Miller). The goshawk can nest in large conifers, aspen, or in atypical habitat such as pinyon pine and juniper throughout the Intermountain West and Rocky Mountain regions. The pinyon-juniper is often located in a lower elevational gradient where historically few systematic goshawk surveys have occurred.

Assessing Goshawk Diets: Methodology Issues

Forest management and restoration activities may directly affect goshawk prey abundance and availability; therefore diet assessments may offer valuable insights for forest managers. Historical anecdotes and early research suggested the goshawk relies heavily on avian prey, particularly forest grouse and other medium-sized woodland passerines such as woodpeckers and jays (and other corvids; Eng and Gullion 1962, Bull and Hohman 1994, Cutler et al. 1996). Recent advances in survey methodology suggest the previous estimates of prey composition may be significantly biased in favor of an avian diet. Additionally, mammalian prey may be more important to goshawk breeding ecology in the western dry forest ecosystems in contrast to other regions (Smithers et al. 2005, Reynolds et al. 2008, Miller et al. 2014). Multiple studies across diverse regions found goshawk prey composition estimates can be biased toward avian prey (Boal and Mannan 1994, Younk and Bechard 1994, Cutler et al. 1996, DeStefano et al. 2006, Miller et al. 2014).

Assessing the Diet of an Enigmatic Forest Hawk

While the goshawk is a notably secretive forest predator, assessing the diet of any diurnal forest raptors presents several methodological problems:

1. Recording prey deliveries to nests are challenging due to the visual obstruction of woodlands. Most diurnal raptors partially or completely digest small bones, leaving pellet analysis of limited value.
2. Feathers found in pellets are often quickly identifiable to genus whereas fur identification is more challenging.
3. Avian prey are often plucked at “plucking posts” near the nest site (often easily located and monitored), whereas mammals are usually delivered to the nest directly, and consumed whole.

Prey Delivery Observations from a Blind

Goshawk diet studies were significantly improved when observations from blinds were incorporated into diet survey methods. Although extremely labor-intensive, observations from blinds significantly increased the detectability of prey deliveries such as small mammals. For example, two studies using blind recorded a surprising prey composition relative to earlier assessments. Of the observed deliveries, one study recorded a 3:1 ratio of mammals to birds, with mammals encompassing 94% of the diet by biomass observations (Boal and Mannan 1994, Younk and Bechard 1994).

Remote Camera Monitoring and Seasonal Diet Shifts

Although research within regional dry forest ecosystems underscores the importance of small mammals in the diet of goshawks, several studies using remote cameras recorded a seasonal shift in diet composition away from mammals (Boal and Mannan 1994, Younk and Bechard 1994, Miller et al. 2014). During the later stages of nesting, many ground squirrels estivate, possibly forcing goshawks to rely more heavily upon avian resources. The relative abundance of the red squirrel (*Tamascuirus hudsonicus*), which does not estivate, is likely an important variable influencing dietary shifts across the nesting season (Miller et al. 2014).

Implications to SBM/MNF

1. In the SBM/MNF specifically, historical goshawk diet research occurred primarily in the early to mid-1990s using survey techniques which may under-estimate mammalian prey composition.
2. Recent goshawk diet studies in other western dry forest systems indicate importance of mammals as prey, contradicting the historical data collected on the SBM/MNF.

Caption: Immature goshawk easting a jay, an important prey species in the western US (upper). The Goshawk (Eurasian) capturing a rabbit (lower; © Keith Thompson). Goshawks frequently utilize rabbits and hares when and where available. Snowshoe hare and mountain cottontail (*Sylvilagus nuttallii*) are utilized in the SMB/MNF. Unlike birds that are conspicuously plucked at ritual plucking posts, small mammals are swiftly delivered directly to the nest, making their detection by biologists difficult. Remote cameras at nests have drastically improved prey studies.

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Breeding Ecology and Habitat

Current published data and observations on the Malheur National Forest and in the inland PNW found that goshawks preferred mesic sites in dry pine and dry mixed conifer, though nested in all forest types.

Breeding Habitat and Forest Types

Goshawks nest in diverse forest types around the Intermountain West, leading to a recommendation that monitoring population assessments occur at bioregional scales (Hargis and Woodbridge 2006). The contiguous US was separated into eight different goshawk bioregions (Woodbridge and Hargis 2006). Four of these regions intersect in Oregon, speaking to the diversity of coarse-scale ecological conditions (e.g., soils, climate, topography) found within the state. The SBM/MNF are classified as part of the Northern Rockies/Blue Mountain goshawk bioregion, though it should be noted that the southern Malheur National Forest borders the Intermountain Great Basin goshawk bioregion.

On the Malheur National Forest, research reports goshawks nest sites (1 ha) are primarily comprised of ponderosa and mixed conifer (DeStefano et al. 2006). In general, goshawk literature reports nest stands and surrounding forest by dominant tree type or tree species composition. Forest restoration and vegetation management planning is based on temperature and moisture regime, i.e, Plant Association Groups (PAG) as a mid-scale approach, or plant associations, plant community types, and plant communities, i.e, Potential Vegetation Type (PVT) for a fine scale approach (Powell et al. 2007). Goshawk research in the SMB/MNF region reports on forest types uniformly and instead focuses on forest vegetation structure (Daw et al. 1998, Daw and DeStefano 2001, McGrath et al. 2003, DeStefano et al. 2006).

As noted before, for the purposes of discussing the goshawk within dry forest restoration in this technical guide, we consider dry forest types to include: ponderosa pine, lodgepole pine, dry mixed conifer, and moist mixed conifer (Franklin et al. 2013). Moist mixed conifer in the Blue Mountains can be defined by different criteria (Franklin et al. 2013, Stine et al. 2014), creating some confusion. In this paper, we consider moist mixed conifer to be higher elevation, higher precipitation sites that transition into moist forests of true fir. Unlike the nearby Umatilla and Wallowa Whitman National Forests, the Malheur National Forest has little moist mixed conifer habitat type, primarily on the northern end of the forest boundary. Areas or small stands of mixed conifer on moist microsites (e.g., north slope, other typographic or microsite characteristics) within the dry mixed conifer on the Malheur National Forest are considered part of the dry mixed conifer. Additionally, due to legacy effects of past silvicultural management practices and fire suppression in the southern Blue Mountains, the PAG and PVT may not reflect the current forest overstory (Powell et al. 2007, Franklin et al. 2013, Stine et al. 2014).

Here, we discuss four forest types used by the goshawk on SBM/MNF. These stand types are based on published goshawk literature and dry forest restoration guides. We

separated out lodgepole pine to denote that the goshawk nests in lodgepole pine stands on the Malheur National Forest, even though the stands may not be entirely pure or only cover a small area, and thus be listed as other forest types. In the southern Blue Mountains and Malheur National Forest, goshawk nests are found in four main forest types: ponderosa pine, dry mixed conifer, lodgepole pine, and moist mixed conifer.

The most comprehensive habitat assessment of breeding goshawks in the inland Pacific Northwest (PNW) was by McGrath et al. (2003). This included four study areas within the Blue Mountains, one of which was on the Malheur National Forest. Additional study areas outside the Blue Mountains were the Fremont-Winema National Forest and in the north Cascades of Washington state. The authors compiled the data and results, thus the findings are generalized for the goshawk across the inland PNW.

While renewed techniques have detected diverse forest types in foraging areas, post-fledging areas, and stands; the immediate nest site is consistently comprised of mid to late-structural characteristics.

Defining Goshawk Territories

To address goshawk habitat and forest management in the southwestern U.S, goshawk territories were divided into 3 spatial scales (Reynolds et al. 1992, Youtz et al. 2008):

1) Nest Stand: 12 ha (30 acre) nest area, possibly including several alternate nests within multiple stands.

2) Post-fledging Area: 168 ha (420 acre) post-fledging area surrounding the nest; and area used by adults, and fledglings until independence from adults.

3) Home Range/Landscape: 2,160 ha (5,400 acre) foraging area used by adults to hunt for food. Much smaller home range sizes have been reported in the western US and are likely highly influenced by prey abundance/availability (Hasselblad et al. 2007).

Ponderosa pine is the most common nest tree utilized by goshawks on the SMB/MNF region even in mixed conifer stands.

Nest Trees in SBM/MNF

Long-term goshawk nest monitoring on the Malheur National Forest was published as a white paper (Rickabaugh and Fremd 2012) providing detailed nest tree data specific to the Forest. This report noted the goshawk strongly preferred ponderosa pine for a nest tree. In reporting on 52 nest sites that were monitored from 1992 to 2011, the

project found 56% of goshawk pairs nested exclusively in ponderosa and another 21% alternated equally between ponderosa and Douglas-fir (*Pseudotsuga menziesii*) or western larch within the same territory. Of the remaining territories, 15% used Douglas-fir, 6% used western larch, and 3% used grand fir or lodgepole pine.

The long-term monitoring report (Rickabaugh and Fremd 2012) found nest tree size showed significant variation. The average dbh of ponderosa pine trees containing nests was 75 cm (29.5 in; *n*=132; range = 15 to 43 in dbh). The average nest tree dbh for Douglas-fir was 60 cm (23.5 in; *n*=44; range = 10 to 45 in dbh) and for larch was 63.5 cm (25 in; *n*=28; range = 12 to 33 in). Grand fir trees were only used three times as nest trees with dbh range from 48 cm (19 in) to 68.5 cm (27 in).

McGrath et al. (2003) recorded that goshawk nests across the inland PNW most frequently occurred in three tree species (in order of frequency); Douglas-fir, ponderosa pine, and western larch with lodgepole pine occasionally used. Nest trees throughout the study area showed significant variation in dbh (25-127 cm [10-50 in]) and age (47-345 yr) but were often the dominant tree in the immediate nest stand. Overall, the nest-site forest characteristics tended to be more uniform than surrounding sites.

Caption: Adult female goshawk on nest in lodgepole pine. A leaning snag has provided the structure needed to initiate nest building. While the large limbs of old-growth pine and fir often provide good nest structure, goshawks also utilize mid-aged trees exhibiting a fork in the apical stem or other atypical structures that can support a nest.
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In the inland PNW, goshawk nest stands were not consistent with "old-growth" structure, however they contained larger trees, higher canopy closure, and higher stem density than random sites.

Nest Stands in Southern Blue Mountains

McGrath et al. (2003) found in the Inland PNW that nest stands were often found on north-facing slopes and contained larger trees (dbh), greater stem density, greater canopy closure, and higher basal area than random sites. However most nest stands were not consistent with "old-growth" structure. Canopy closure was ≥50% (mean was

53%) in nest stands (12 to 30 ha [30 to 74 acres]) and “nesting was probably negatively influenced by presence of stand initiation…”. Overall, nest areas contained more mid to late successional forest structure within a more heterogeneous landscape of multiple structural types (McGrath et al. 2003). While most studies agree that canopy closure is an important component of goshawk nest stands, the open understory of the 30 ha (74 acres) scale is emphasized as just as important (Squires and Kennedy 2006). Canopy cover is reported as important for different reasons throughout the goshawk nesting season (Reynolds et al. 1992)**.**

Nest Stand Habitat and Predation Risks

Temperate and northern boreal forests of North America support a myriad of fierce arboreal predators including American marten (*Martes americana*), fisher (*Martes pennant*), black bear (*Ursus americanus*), and cougar (*Puma concolor*). As a result, goshawks display one of the most aggressive nest defense behavior known amongst all raptor species. Toward humans, their nest defense can escalate into aggressive strikes, commonly resulting in lacerations. While this behavior may turn away a tree-climbing predator like a fisher, goshawk nestlings and fledglings are also vulnerable to aerial predators such as the golden eagle (*Aquila chrysaetos*), great-horned owl (*Bubo virginianus*), and red-tailed hawk (*Buteo jamaicensis*). Several authors have suggested goshawk nest stand characteristics such as greater stem density and relatively closed canopy may be important attributes reducing predation risks by aerial predators (Reynolds et al. 1982, Moore and Henny 1983).

PFAs generally contain highly variable forest structure and this variability is likely tied to the importance of diverse prey and ultimately post-fledging foraging success.

Post-fledging Areas in SBM/MNF

McGrath et al. (2003) discovered higher habitat variability at the PFA scale than random sites, while also containing “mid to late successional forest core areas of high canopy closure understory reinitiation and stem exclusion…within 30-60 ha (75-150 acres) surrounding the nest” in the inland PNW. This and other studies in dry forest ecosystems support the conclusion that goshawk PFAs generally contain highly variable forest structure and this variability is likely tied to the importance of diverse prey and ultimately post-fledging foraging success.

Landscape and Foraging Areas in SBM/MNF

Inland PNW research found that goshawk habitat selection is likely most discriminating closer to the nest and more diverse and general at the territory/landscape scale (McGrath et al. 2003). In other words, different goshawk territories within a region and between regions do not demonstrate a clear pattern of forest habitat selection outside of the nest stand or PFA scale.

High prey availability near the nest site and in the post-fledging foraging area are likely important variables reducing nestling mortality and increasing juvenile recruitment into the breeding population.

Prey resources

Determining the prey species composition and frequency in raptor diets provides insights into raptor foraging habitats. Multiple studies suggest forest managers consider how the alteration of forest structure may affect prey abundance and availability and directly influence goshawk populations (Reynolds et al. 1992, Lewis et al. 2006, Salafsky et al. 2007).

Food Supplementation: Nesting Stage

Food supplementation experiments have provided essential insights into the relationship between food resources and goshawk reproductive success and mortality. Results suggest that while goshawk productivity is linked to prey resources, increase food resources (or prey availability) may also alter adult female behavior, and indirectly decrease nestling mortality rates (due to the interaction between starvation probability and predation). Specifically, in a dry forest ecosystem in New Mexico, food supplementation (near the nest site) was utilized by nesting adult females and appeared to indirectly reduce nestling mortality due to increased nest site vigilance (i.e., female food provisioning was easier/faster therefore females were less absent). While increased food availability changed the adult female behavior, male provisioning rates (prey deliveries to nest) were unchanged (Ward and Kennedy 1994, 1996, Dewey and Kennedy 2001). Another experiment in Finland demonstrated food supplementation had no positive effect on nestling survival in prime territories (less impacted by timber harvest) but significantly decreased mortality in low-quality territories (Byholm and Kekkonen 2008).

Caption: Goshawk hunting an open meadow. Goshawks often opportunistically course openings near forested edges at high speed, hoping to surprise prey. Photo: © Abbott Schindler

Food Supplementation: Post-fledging stage

Using radio telemetry Kennedy and Ward (2003) provided supplemental food to juvenile goshawks at their nest site during and 4 months following fledging. Their work demonstrates increase in food availability in goshawk natal areas (nest areas) results in goshawks dispersing shorter distances post-fledging. This suggests food resources influence recruitment into the natal population. Juvenile recruitment into the breeding population is a recognized cornerstone of stable and/or growing raptor populations (Newton 1976, 1998).

Relationship between Goshawk Reproduction and Prey in a Dry Forest Ecosystem

By evaluating the variability observed in habitats utilized by goshawks, more recent research points to the importance of fluctuating prey populations over time on reproductive performance (McClaren et al. 2002, Salafsky et al. 2007). Overall, research in dry forest systems suggests the variation observed in goshawk territories may provide important alternative prey resources that may buffer the effects of specific prey species declines (Boal and Mannan 1994, Younk and Bechard 1994, Salafsky et al. 2007, Miller et al. 2014).

Recently, goshawk researchers on the Kaibab Plateau analyzed the relationship between fluctuating prey populations and goshawk reproduction. This study is significant due to the similar forest composition to SBM/MNF, and the large sample size and duration of monitoring (823 nesting attempts over 8 years; Salafsky et al. 2007). The abundance of four prey species explained 89% of the variation in goshawk reproduction over the course of the study period. More specifically, variation in red squirrel abundance (found in both mixed conifer and ponderosa forest types) accounted for most of the variation in goshawk productivity (followed by Kaibab squirrels, Stellar's jay [*Cyanocitta stelleri*], and northern flicker [*Colaptes auratus*]; Salafsky et al. 2005, 2007).

> *Fluctuations in the abundance of tree squirrels, Steller's jay and northern flickers explained nearly 90% of the variation in goshawk reproduction over an 8-year period in Arizona.*

Prey Species Composition on the SBM/MNF

Prey studies on the SBM/MNF region are limited and consist of one investigation conducted from 1992 to 1996 on the Malheur National Forest and from 1992 to 1993 on the Wallowa-Whitman National Forest (Culter et al. 1996). The largest sample size of prey items occurred on the Malheur (197) vs. the Wallowa-Whitman National Forest (30). Prey composition (frequency of occurrence) on the Malheur National Forest was split evenly between birds and mammal. By species, the American robin, northern flicker, and ground squirrels (*Urocitellus* spp.*; formerly Spermophilus*) dominated the diet (Cutler et al. 1996); however these results may be subject to sampling biases (see Survey Methodology). By biomass, birds accounted for 35% of the diet and mammals 65%. Rabbits (*Sylvilagus* spp.) and hares (*Lepus* spp.) dominated the diet

by biomass although they appeared infrequently. Ground squirrels (*Urocitellus* spp.; 15%) and the northern flicker (14%) also comprised significant percentage of diet by biomass (Cutler et al. 1996, DeStefano and Cutler 1998, DeStefano et al. 2006).

Caption (above): Goshawk nestlings pine tree (photo: © Keith Thompson). Nests on the Malheur National Forest were found in trees of varying sizes (dbh) and species, but goshawks preferred ponderosa pine. (Left): Adult female goshawk at nest (photo: © Rob Palmer). Throughout the early stages of nesting, the adult male conducts nearly all of the hunting and food provisioning for his mate and nestlings. As the nestlings grow and their food demands climb, the adult female often begins hunting. High squirrel abundance near the nest site is likely very important to nest success, as the female spends less time away from nestlings, reducing predation or mortality of nestlings. (Right): Goshawk fledgling. Like all raptors, post-fledging mortality is often very high. Once parental food provisioning ceases in late summer, young raptors have a narrow window to develop hunting skills. Many die of starvation or move away from the natal area in hopes of locating food.

Implications to SBM/MNF

1. Limited diet assessments on the SBM/MNF should be interpreted with caution due to sampling biases.
2. The proportion of small mammals recorded is lower than recent estimates in similar dry forest ecosystems where observations from blinds and/or remote camera survey methods were employed.

Caption: Throughout northern temperate forest systems, the northern flicker (left) is a common avian prey of breeding goshawks. In western dry forest systems, the flicker and the Steller's jay (above) are typical avian prey species. Woodpeckers and jays (and other avian prey) are nutrient rich prey and likely play a key role in goshawk reproduction and survival. Avian prey consistently appear in goshawk diets even when small mammal prey are extremely abundant.

Caption: The American red squirrel (upper left) and the Belding's ground squirrel (*Urocitellus beldingi;* upper right) are both significant goshawk prey species (by prey biomass) throughout much of northern Great Basin and Northern Rockies. Snowshoe hare (lower) can be an important goshawk prey base in mixed conifer habitat on the SMB/MNF.

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Site Occupancy and Habitat Change

Review of Territory Occupancy

Rickenbaugh and Fremd (2012) conducted goshawk nest monitoring on the Malheur National Forest from 1992 to 2011, the longest monitoring project on the forest to date. The occupancy rate ranged from 41% to 83%, with a mean of 60%. Nest re-usage from the previous year averaged 26%. While these estimates are similar to other studies, they may underestimate occupancy rates based on unchecked territories during certain years and in light of detection biases. Forest Service recently developed a standardized Goshawk Bioregional Monitoring Design (GBMD) intended to more accurately estimate occupancy across large landscapes (Woodbridge and Hargis 2006, Beck et al. 2011; see Survey Methodology and Management Recommendations).

Anthropogenic Disturbance

In North America, very few studies have addressed the effects of anthropogenic disturbance to goshawks during breeding periods (March to August). Evidence from Europe suggests European subspecies (*A. g. gentilis*) either may be more tolerant of human development and activities in proximity to active nests, or the Europe data provides a more accurate measure of the species' behavior range-wide. Recent monitoring has documented over 100 breeding pairs within the city limits of Berlin (and other German cities; Rutz 2008).

In contrast, the North American goshawk (*A. g. atricapillus*) may be more sensitive to human activity but the data are sparse and equivocal. In a retrospective analysis of goshawk occupancy relative to human disturbance in the Sierra-Nevada range, researchers concluded that "human disturbance and road and trail development negatively impact goshawk occupancy" and specifically goshawks avoided intensely trafficked roads experienced the year before (Morrison et al. 2011). However, a landscape analysis of goshawks in the inland PNW found goshawk nests were closer to human disturbance (forest roads and timber harvest) than random sites (McGrath et al. 2003). This may be a function of roads, campgrounds, and other forest developments tending to occur in mild gradients (slope and associated forest structure) typical of goshawk nest sites.

Caption: Adult goshawk in Berlin. Northern goshawks in Europe appear more tolerant of urban and exurban environments. Photo © Sam Hobson (used by permission)

Caption: Logging operation. Photo courtesy USFS.

Three independent studies (Idaho, British Columbia, and Norway) found no significant relationship between nest area re-occupancy and timber harvest within nest stands. The availability of closed canopy forest adjacent to harvested areas is likely important to re-occupancy post-harvest.

Timber Harvest in Nesting Habitat

Previous studies indicate the goshawk has strong nest-area fidelity (Reynolds et al. 1982). However information on the effects of timber harvest on breeding goshawks has been limited until recently. Several recent studies have experimentally tested the effect of timber harvest (occurring following post-fledging periods; after August 15th) within goshawk nest stand areas, on goshawk occupancy and nest reuse. Three independent studies (Idaho, British Columbia, and Norway) found no significant relationship between nest area re-occupancy and timber harvest within nest stands (Penteriani and Faivre 2001, Mahon and Doyle 2005, Moser and Garton 2009, Saga and Selås 2012). In Norway, research indicated goshawks nest reuse may decline if the immediate nest stand is reduced to less than 2 ha (5 acres).

Two North American studies also determined nest reuse, distance an active pair moved to alternate nests, and nest success did not differ significantly between harvested and non-harvested control areas (Mahon and Doyle 2005, Moser and Garton 2009) contradicting the findings of Crocker-Bedford (1990) and Patla (2005). However, Moser and Garton (2009) predicted goshawks were more likely to reoccupy territories (post-harvest) if the 170 ha (420 acres) area around the nest contained >39% mature closed canopied forest, though detecting goshawk responses to timber harvest may require longer monitoring periods. Instead of logging disturbance, declines in goshawk occupancy and nesting success were strongly correlated to late winter temperatures and early spring precipitation (Fairhurst and Bechard 2005, Moser and Garton 2009).

Monitoring Goshawks within Restoration Activities

Kennedy (1997, 1998) and DeStefano et al. (2006) underscore the need to design and implement experimental research measuring the response of known goshawk breeding pairs to various forest harvest and/or restoration regimes. In response to differing sampling approaches, sampling biases, and lack of coordination between forests, the Forest Service recently developed a standardized Goshawk Bioregional Monitoring Design (GBMD) intended to estimate the proportion of occupied sampling units across large landscapes (Woodbridge and Hargis 2006, Beck et al. 2011). This approach is built on the accepted premise that occupancy is a valid indicator of population performance (MacKenzie and Royle 2005, MacKenzie et al. 2006). Adapting the GBMD to the SBM/MNF (Woodbridge and Hargis 2006, Beck et al. 2011) and implementing this occupancy monitoring in concert with restoration could provide nearly real-time guidance and fine-tuning of goshawk habitat management on the SBM/MNF.

Caption: Logging truck on Forest Service lands. Photo courtesy Forest Service

Some raptors may acclimate to routine disturbance such as a commonly used forest road, whereas in-frequent vehicle or pedestrian incursions into goshawk nest areas may be impactful.

Road and Pedestrian Disturbance on National Forests

A recent study in Kaibab Plateau (Grubb et al. 1998, 2013) found no evidence of any negative effects of logging truck noise on nesting goshawks. Observed goshawk response was “limited to at most looking in the direction of the hauling road”. Seasonal restriction (1 March to 30 September) from Reynolds et al. (1992) have been included in various Forest Plans and applied as standard in the implementation of goshawk management within the Eastside Screens. The restrictions include a 400 m (¼ mile) radius buffer around active northern goshawk nests, to mitigate anthropogenic disturbances. Grubb et al. (1998, 2013) suggested, “…the broad restriction of hauling and other vehicle travel within a PFA is unnecessary.”

Many raptor species are known to acclimate to routine disturbance, and therefore regular vehicle noise can be benign. However, in-frequent vehicle incursions into goshawk territories may result in disturbance. Anecdotal evidence during a study "strongly indicated pedestrian activities should continue to be restricted within a 400 m (¼ mile) radius of active goshawk nests," relaying important consequences to outdoor recreation planning (Grubb et al. 2013).

While nesting goshawks may display tolerance of human disturbance in some scenarios, observed behavioral responses to disturbance events should be interpreted with caution. Observed escape behavior associated with a disturbance event is often interpreted as a stress response, implying the need for protection such as buffers or designated refuge areas. Conversely, the absence of escape behavior could be interpreted as tolerance or indifference, and could imply the species (or scenario) does not require added protection. However, an observed response to disturbance may be influenced by the availability of alternate refugia, or nuanced behavioral traits of that species or individual. A species may appear at ease behaviorally, but nevertheless suffer reduced reproduction or increased mortality due to decreased foraging and/or increased vigilance (Gill et al. 2001, Strasser and Heath 2013).

Caption: Mountain bikers on Forest Service lands. While much of the debate about human disturbance to wildlife on public lands centers around motorized users, research demonstrates that hikers, trail runners, skiers, and mountain bikers all project a zone of influence to the natural movements and distribution of various sensitive wildlife. In fact, because many non-motorized users produce little sound, they often encroach closer to wildlife before being detected, resulting in panicked flight behavior. Photo courtesy Forest Service.

Implications to SBM/MNF via Eastside Screens

1. Raptor research demonstrates human-caused disturbance to during courtship, nesting and post-fledging stages can be detrimental to nest initiation, nest success, fledgling survival and ultimately re-occupancy of the nest site or territory. However goshawks may respond variably dependent on the activity and timing. Disturbance should be especially avoided during the early courtship and egg laying nesting stages.
2. Appropriate timber harvest (or other construction/development) activities may not interfere with goshawk breeding ecology if initiated after August 15th.
3. Logging trucks and other vehicle disturbance may be permissible within 400 m (¼ mile) of active nest sites.
4. Managers should discern between routine disturbances that goshawks can habituate to versus unusual incursions near nest sites.
5. Outdoor recreation is a significant and growing activity on all western forests, and manager should carefully consider outdoor recreation planning in relations to goshawk territory occupancy.

Caption: Adult goshawk on nest. Photo: © Keith Thompson

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Management Review and Recommendations: Current Framework

Summary

The current management framework for the goshawk on the Malheur National Forest is directed under their existing Land and Resource Management Plan (or Forest Plan; USDA Forest Service 1990a) amended by the Eastside Screens (USDA Forest Service 1995). As reviewed in this document, the Eastside Screens come from a mid-1990s era when there was an active petition to list the goshawk (see Legal Status). As such, they were established to be temporary until ESA listing occurred or more information on the goshawk was known. Science has greatly increased our understanding of goshawk ecology and forest management in the last 20 years. During that same period, the Eastside Screens remained as the basis of goshawk management on the SBM/MNF. This creates a paradox for managers and stakeholders: while the goshawk is not an MIS, not listed, and not considered to have conservation concern, the Forest Service is still required to manage for the species under the Eastside Screens. We propose that during forest management activities, stakeholders and the Forest Service find potential ways to sustain goshawk nest stands and PFAs from future drought, fire, and other stressors. Silvicultural prescriptions within the PFAs and in the surrounding areas should increase nest stand and PFA persistence under future climate-induced stressors and disturbances. We recognize that this recommended approach must still fit within to the required restrictions of the Eastside Screens. To aid stakeholders and land managers in this new approach, we provide the following in this section:

1) A review of the current management framework for the goshawk on the Malheur National Forest.

2) A review of the selection of the goshawk as a focal/surrogate species.

3) Propose management recommendations of silvicultural prescriptions in and around nest stands and PFAs in relation to more recent peer reviewed research.

4) Propose an alternate framework for dry forest restoration addressing breeding goshawks and other wildlife diversity goals within the Eastside Screens.

Forest Plan and Eastside Screen

Evaluation of Current Forest Plans

The National Forest plans for the Malheur (USDA Forest Service 1990a), Ochoco (USDA Forest Service 1989), and Umatilla (USDA Forest Service 1990b) provides forest-wide standards for wildlife and habitat. In the forest plans for these National Forests, the goshawk is not listed as an MIS, raptor, or wildlife species to be considered during management. The goshawk is listed as an MIS in the Forest Plan for the nearby Wallowa-Whitman National Forest (USDA Forest Service 1990c). As outlined above (see Management Status), the Forest Service Region 6 Eastside Screens amended Forest Plans to provide specific provisions for protection of active goshawk nest stands in central and eastern Oregon.

Goshawks and Other MIS under Malheur National Forest Plan

The current Malheur Forest Plan does list 12 woodpecker species as MIS (USDA Forest Service 1990a). These include prey items considered as important for goshawks, such as the northern flicker. The Forest Plan lists the pileated woodpecker as an MIS for old-growth forests. Similar to the goshawk, the pileated prefers >60% canopy closure. However, the species' primary habitat type in northeast Oregon is stands dominated by grand fir (75%) with ponderosa pine being an indicator of poor habitat (Bull and Holthausen 1993). This is in contrast to broad habitat types selected by the goshawk. Similar to the goshawk, the pileated is known to vary its diet across forest types and can persist in habitat seemingly contrary to outlined requirements (e.g., stands with no canopy closure >60% due to extensive overstory loss from insect kill; Bull et al. 2007).

The Malheur and nearby National Forests in the Blue Mountains are in the process of proposing new Forest Plans (USDA Forest Service 2014). For complex legal and management reasons, the new Malheur Forest Plan will be developed using the 1982 Planning Rule procedures (USDA Forest Service 1982) even though interim procedures and a new Planning Rule exist. The 1982 rule uses an MIS framework with population trend monitoring in relation to habitat changes. The consideration to list the goshawk as an MIS, surrogate, or focal species in the proposed Forest Plan (USDA Forest Service 2014) faces many hurdles. The most challenging could be that the Forest Service itself states, "The concept of MIS as a surrogate for the status of other species is not supported by current science, and population trends are difficult and sometimes impossible to determine within the lifespan of a plan." (USDA Forest Service 2012).

> *"As the scale of consideration increases, the diversity of habitats used by goshawks provides a broader understanding of the adaptability of goshawks at regional and continental scales."*
> *(Boyce et al. 2006)*

Goshawks as a Focal Species: Is It a Surrogate of a Forest Mosaic?

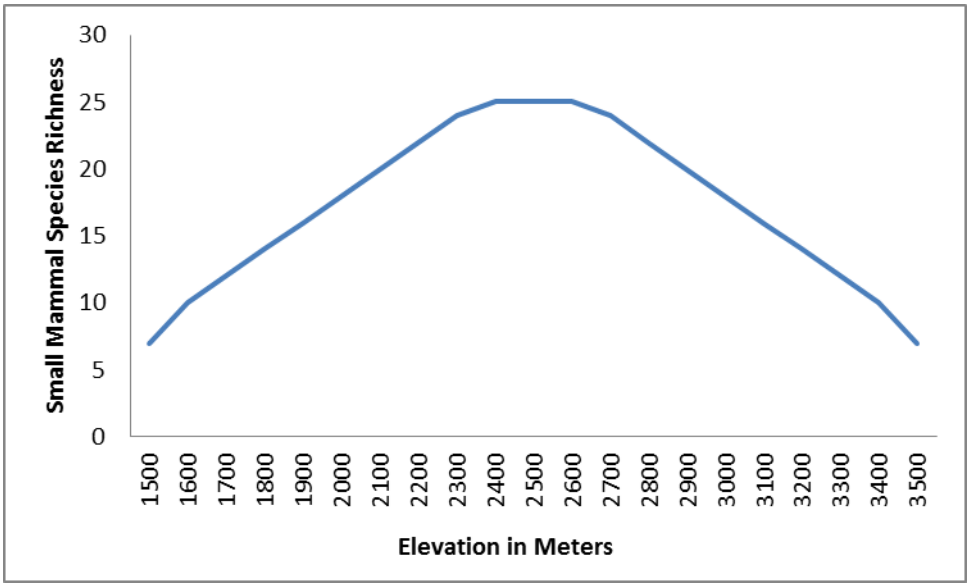
Currently, Forest Service managers are considering the goshawk as a focal species in the Blue Mountains, representing a forest mosaic (complex mosaic of landscape conditions defined as PVT, tree size, canopy layers, and canopy cover by USDA Forest Service 2014). The goshawk is also being considered to act as a surrogate for a heterogeneous forest (Wisdom et al. 2000, Suring et al. 2011, USDA Forest Service 2014). The literature from the interior west describes goshawks in variable forest types, but does not necessarily support the conclusion that goshawks require forest mosaics to support a stable population; rather goshawks appear highly adaptable and "are not restricted to one forest environment" (Boyce et al. 2006). While the goshawk is known to use variable forest types (and non-forest habitat) in the interior west, it is also known to occupy homogenous forest types throughout the range of *A g. atricapillus*.

To better evaluate the use of the goshawk as a surrogate, its use of patchy, forest mosaics in the SBM/MNF should be considered in the context of biogeography and prey. The northern taiga forests of Canada and the mixed deciduous/coniferous forests of the northeast are comprised of large expanses of lowland forest with relatively mild topography. As a result, forest structure and species composition is often homogenous and forest stands are contiguous across large areas. Bird and mammal diversity may be lower; often comprised of forest-interior adapted species like red squirrels, snowshoe hare (*Lepus americanus*) and others (Block et al. 1994, Ranta et al. 2003, Handel et al. 2009, Marini et al. 2011). Similar forest conditions occur in the interior west at local scales and support goshawks (e.g., large homogenous stands of lodgepole pine).

Elevational gradients produce a dynamic mosaic of forested types interspersed with non-forested areas, directly influencing the diversity, abundance and composition of prey species on the SBM/MNF.

Elevational Gradient and Prey Species

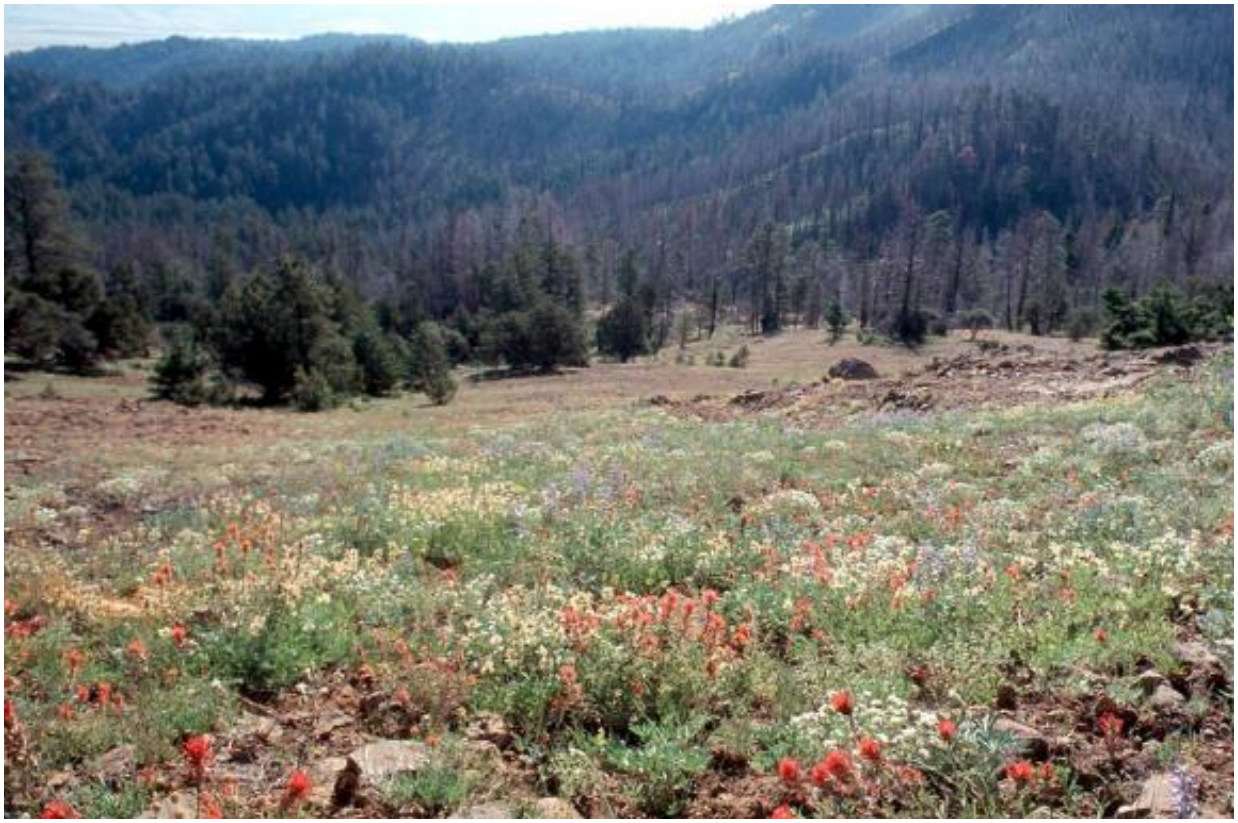
In contrast, the elevational gradients of the interior west produce a dynamic mosaic of forested types frequently interspersed with meadows and shrublands, with the forests themselves in flux due to disturbance such as fire. Elevational gradients and resulting habitat diversity found throughout SBM/MNF shape goshawk prey composition and availability. Notably, western North America is home to largest number (67) of sciurid species (ground squirrels, tree squirrels, chipmunks, marmots, prairie dogs, and flying squirrels) of any region in the world, followed by East Asia with 20, then eastern North America with 11 (Mönkkönen and Viro 1997, McCain 2005).



Caption: Small mammal species richness as a function of elevation; horizontal axis is elevation in meters (based on McCain 2004, 2005).

Forest regions like the Blue Mountains have maintained connectivity (post-Pleistocene) to the northern Rockies, and therefore generally support higher small mammal species richness than remote mountain islands separated by an ocean of sage-steppe (Rickart 2001). Following the principles of island biogeography, desert lowlands may prohibit the recolonization of arboreal small mammals after extinction events (MacArthur and Wilson 1967). The red squirrel, a significant prey species of the goshawk, is absent from many isolated mountain regions of the Great Basin, where the goshawk may nest in isolated aspen stands, and instead utilize fossorial small mammal prey in non-forest habitat (Younk and Bechard 1994, Miller et al. 2014; see Prey Resources).

In a recent evaluation of raptors as indicators of species richness (birds, insects, plants), Roth and Weber (2008) stress ecological relationship between top predators and species richness may be too complex and varied across spatial scales. Evaluating the goshawk alongside several other raptor and passerine species, they suggest prey species may be more effective indicators of species richness.



Caption: Live conifer forest, beetle-killed forest, and meadows near Logan Valley, Malheur National Forest, Oregon. Elevation gradients in dry forest systems often produce a mosaic of forested and non-forested habitat types in close proximity. Photo courtesy of the Forest Service.

Caption (above): The American red squirrel. This squirrel is a key prey species throughout the range of the goshawk in North America. Caption (right): The golden-mantled ground squirrel (*Callospermophilus lateralis*). This squirrel is a common prey species of goshawks in dry forest systems throughout the interior west. Caption (left): The Belding's ground squirrel .This open grassland squirrel is a noteworthy prey species for breeding goshawks in the Great Basin, including the Malheur National Forest. Ground squirrels likely provide an important prey base for goshawks breeding in naturally fragmented forest systems within a larger landscape dominated by shrub-steppe habitats.

> *"…conservation biologists need to define precisely how they are using these terms or they will lose meaning. Better still, we should abandon them altogether and define precisely what we are talking about instead of using insider jargon." (Caro 2002)*

Indicator/Surrogate/Focal Species in Forest Restoration

The use of indicator species has been widely criticized in conservation planning due to the often ill-defined cause-effect relationship between indicator species and the ecological conditions in question (Landres et al. 1988, Caro and O'Doherty 1999, Lindenmayer et al. 2002, Roth and Weber 2008, Murphy et al. 2011), prompting the Forest Service to shift away from the use of MIS (and the related monitoring requirements). Yet with limited resources to conserve imperiled species and habitats, Forest Service managers must employ efficient, powerful tools to identify and prioritize vulnerable species and their habitats (Wiens et al. 2008). As a result, Forest Service managers are moving to a *focal species framework* (Wisdom et al. 2000, Suring et al. 2011, USDA Forest Service 2012), although its distinction from the MIS concept is vague:

- *Focal Species Approach*: identify a suite of focal species at risk, and identify and conserve their habitat to function as surrogates; the management/conservation of surrogates protects other vulnerable species, communities, and their habitats. (Wisdom et al. 2000, Suring et al. 2011).
- *MIS Approach*: among other criteria: select species whose populations may be at risk (or of special interest), or their measured population changes "…are believed to indicate the effects of management activities on other species of selected major biological communities or on water quality". Then assess management through population monitoring of MIS and possibly mitigate effects (NFMA 1976, USDA Forest Service 1982).

Ideally, a landscape managed to meet the needs of appropriately chosen focal species will encompass the needs of many other species and their habitats (1999) and this broad multi-taxa selection approach may be preferable to singe indicator species. Still, the focal species model is often defined as equivalent to indicator or surrogate. Questions about their selection and performance remain (Landres et al. 1988, Caro and O'Doherty 1999, Lindenmayer et al. 2002, Roth and Weber 2008), with an emphasis on selecting species whose response to the ecological processes of concern has been empirically validated and/or can be effectively monitored (Chase and Geupel 2005, Murphy et al. 2011).

Additionally, critics argue the widespread usage of terms *focal*, *indicator*, *surrogate*, and *umbrella* are often used synonymously and this recent spread of loosely defined terms has clouded conservation planning goals and processes (Caro 2000, Armstrong and Caro 2002). In reviewing the use of avian focal species, Chase and Geupel (2005) provide a concise definition: "…any species chosen for special attention in a

multi-species planning effort". The authors go on to define *flagship*, *keystone*, *special status*, *indicator*, and *umbrella* as different classes of focal species. While acknowledging the limitations, the authors propose focal species selection strategies in the context of restoration, suggesting common species may prove most useful, and emphasize monitoring:

> "*The most useful indicators are those which also have populations large enough to be easily monitored and to provide sufficient samples sizes for statistical analysis across sites and/or regions. Another pragmatic reason for including relatively common, 'unlisted' focal species in conservation planning is that some landowners and managers maybe more interested in undertaking restoration or management activities for these species*." (Chase and Geupel 2005)

Focal Species

1. In discussions with Forest Service biologists and managers, stakeholders should consider the goshawk's selection as focal species in the context of litigation, and the risks associated with possibly excluding them in conservation planning. In other words, the litigious nature of forest management may encourage biologists and managers to include species of interest to environmental groups, which may otherwise be ecologically inappropriate to the management question or ecological processes at hand.
2. This risk-averse dynamic underscores the importance of trust building in collaborative restoration. We encourage Forest Service managers and stakeholders to communicate openly and collaboratively to precisely define these terms and to evaluate and clarify species selection guidelines and the ecological conditions they represent.

Evaluating the Goshawk as an Indicator/Surrogate

Here we evaluate the goshawk as an indicator/surrogate species based on selection guidelines in the peer-reviewed literature (Caro and O'Doherty 1999, Committee of Scientists 1999, Kurtz et al. 2001, Carignan and Villard 2002, Niemi and McDonald 2004, Soulé et al. 2005, Schultz et al. 2013).

1) **Relevance**: Is the goshawk relevant to the assessment question (management concern) and to the ecological resource or function at risk?

   Answer: *As a forest raptor, and charismatic top avian predator, the goshawk is relevant to the management and restoration of forest ecosystems*

generally. However its broad use of varied forest types suggest it may be less relevant to dry forest restoration.

2) **Feasibility**: Are the methods for sampling and measuring goshawk occupancy and/or nesting status or other goshawk habitat variables technically feasible, appropriate, and efficient for use in a monitoring program?

   Answer: *Monitoring goshawks may be infeasible for many forest managers due to the effort and cost required to achieve accurate estimates of occupancy and nesting status. Additionally, the relationship between goshawk populations and anthropogenic disturbance to forest habitat is not confidently identified.*

3) **Response Variability**: Are human errors of measurement and natural variability over time and space sufficiently understood and documented for the goshawk?

   Answer: *Peer reviewed research has markedly improved our understanding of sampling errors and breeding habitat variability since initial management framework was implemented. Also, research has documented goshawk use of varied forest habitats. However, such advancements are not consistently accepted and/or implemented by various National Forests.*

4) **Interpretation and Utility**: Will the goshawk convey information on an ecological condition that is meaningful to environmental decision-making?

   Answer: *Best science indicates the goshawk is a forest generalist with respect to forest types selected and prey composition. Due to the high variability observed, the goshawk may not strongly represent a specific ecological condition with respect to dry forest restoration. Also, detecting a relationship between goshawk populations and forest restoration prescriptions will be challenging given the goshawk's low occurrence and low detectability (relative to prey species), and will require resource-intensive, long-term demographic and/or occupancy data. Measuring and modeling goshawk habitat variables (correlated to nest sites, stands, PFAs, etc.) may be of limited value as these correlations have not been linked to trends in population performance (not derived from experimental research), and may simply reflect local forest/prey conditions vs. goshawk habitat requirements needed to support stable populations.*

Caption: (above) Goshawk nestlings in an aspen tree; (below) immature goshawk perched on sagebrush. This species nests in many forest types in the Intermountain West and in the southern Blue Mountains. Some goshawks on the Malheur National Forest were found to forage in shrub-steppe habitats in breeding and non-breeding periods. Photos: © Rob Palmer.

Management Recommendations: Silvicultural Prescriptions in and around Nest Stands and PFAs

Current goshawk management for the Malheur National Forest is directed by the Eastside Screens (USDA Forest Service 1995). Under these guidelines, goshawks are to be protected when found, and some forest management activities are allowed to occur in the nest stand and PFAs when late and old structural stages (LOS) standards are met (see Eastside Screens section for more details). Here we offer management guidelines based on the published goshawk literature to increase the persistence of goshawk nest stands through treatment within and around the nest stand and PFAs. We recognize that the greater landscape around the PFAs are more likely to drive drought, insect, fire and other stressors on the goshawk habitat rather than the treatment within the stand. Strategically, managers should prescribe silvicultural treatments around the goshawk nest stands and PFAs based on the local landscape and desired effects of: increased moisture, decreased stress on LOS trees, and decreased chances of fire carrying into the PFAs. Strategic treatment within the nest area and PFA could help LOS persist by decreasing conifer competition while maintaining or increasing suitability for the goshawk.

Reynolds et al. (1992) provided goshawk management recommendations for the southwestern US at three spatial scales (see Goshawk Territories). These guidelines have been adopted for goshawk management for Forest Service lands in most of the western US. Debate continues over the applicability of these guidelines, especially outside of the southwest region (Beier et al. 2008, Reynolds et al. 2012). DeStefano et al. (2006) support the basic premise of the guidelines for use the inland PNW, though recommend modifications based on local data and to focus on: goshawk nest stands, habitat for prey species, and mixed vegetation structural stages.

While the goshawk management recommendations (Reynolds et al. 1992) have held across time with regional modifications such as these (also see Scientific Debate), the management of dry forests has changed dramatically during the same era (Hessburg et al. 2005, Franklin et al. 2013). As the Malheur National Forest works to restore fire-adapted forest ecosystems within the Collaborative Forest Landscape Restoration (CFLR) project area, management of nest stands and PFAs should be put in this new context.

Different from vegetation management, goshawk research in the SMB/MNF region reports on forest types uniformly and instead focuses on forest vegetation structure (Daw et al. 1998, Daw and DeStefano 2001, McGrath et al. 2003, DeStefano et al. 2006). To effectively retain goshawk nest areas and PFAs, the Forest Service should distinguish specific guidelines for the different dry forest types (e.g., ponderosa pine, dry and moist mixed conifer). One researcher studying goshawks in southern Idaho found the majority of occupied goshawk nests in lodgepole pine are located in stands that have been thinned in the past 30 years (R. Miller, *personal communication*, July 2015). While the Eastside Screens restrict timber harvest within 12 ha (30 acres) of the nest stand, research shows the open understory of the 30 ha (75 acres) scale is just as important as closed canopy (Squires and Kennedy 2006). It follows that

treatment of nest stand areas might include controlled fire and removal of small diameter trees when warranted, as too many small trees may increase midstory cover past a threshold suitable for nesting goshawks (Reynolds et al. 1992, Youtz et al. 2008) and increase the chance of competition for resources between the LOS trees and younger conifers (Hessburg et al. 2005, Franklin et al. 2013).

We recommend that silvicultural activities within and around goshawk nest areas and PFAs should facilitate an increased likelihood of stand persistence under future drought, insect, fire and other disturbances while maintaining or increasing suitability for the goshawk. The matrix within the PFA (around the nest area), and that of the greater landscape (around the PFA), are the most likely predictors of future fire entering the stands. The soil type and depth (available water storage) within the nest area and PFA are the most likely predictors of drought-induced tree and overstory death. With this in mind, managers should consider the geographical and biophysical factors (not just existing overstory) when selecting the PFA, and when prescribing silvicultural activities in the nest stand, PFA, and surrounding areas.

Caption: Mature stand of ponderosa pine near Whitney, Oregon, ca. 1900. Photo courtesy Baker City Library.

Management Review and Recommendations: Future Framework(s)

Summary

We recognize that Eastside Screens have created an expectation among Forest Service managers and stakeholders that the goshawk will be managed for in Oregon's eastside dry forests. However, such an approach is not supported by the species' legal status, conservation status, or ability to effectively act as an MIS or focal species. This approach also fails to effectively meet stated collaborative and management goals. We offer that another model could better serve wildlife species and their habitat needs while still supporting the goshawk. Above we outlined options to manage for the goshawk, and stand persistence under current management guidelines (Eastside Screens). Here we offer a new model and approach for a post-Eastside Screens era, most likely under a new Forest Plan. We propose to shift away from managing specifically for the goshawk or using it as a focal species. Regional synthesis papers such as this one, among much more thorough and broad reviews (Kennedy 1997, USFWS 1998, Squires and Kennedy 2006), provide ample evidence for managers to recognize the lack of support over goshawk population viability concerns, and its ill-advised role as a focal or indicator species in dry forest systems.

The insight into why the move away from goshawk management should occur is offered in the Eastside Screens themselves. The goshawk subsection specifically states, "Habitat uses, nesting stand characteristics, and key habitat structural components in eastern Oregon/Washington are currently being studied. Until further information is known and management plans approved to insure species viability, the following standards are to be met as a minimum." (USDA Forest Service 1995). Since that time, science has learned a great deal about the goshawk; it has not been listed under the ESA, and species/subspecies viability has been addressed at the national level (see Legal Status). Indeed the goshawk is not afforded any special status or more protection than any other forest raptor (e.g., sharp-shinned hawk, Cooper's hawk) in the region outside of the 1995 interim management guidelines. Additionally, the goshawk was found to be a poor indicator species (see Goshawk as a Focal Species, Indicator/Surrogate/Focal Species in Forest Restoration, and Evaluating the Goshawk as an Indicator/Surrogate sections above).

Beyond the Existing Framework

With the increasing attention on climate change, extreme fire events, and insect damage, forest managers are progressively shifting emphases from single species management to a more holistic strategy targeting forest resiliency. In order to restore ecological resiliency to significant areas of the Blue Mountains and Malheur National Forest, and to ensure socio-economic viability of eastside communities, managers and stakeholders generally agree on the need to accelerate the pace and scale of restoration (USDA Forest Service 2007, 2010a, 2010b). While concerns remain over the effects of these aggressive treatments on forest-dependent species like the northern goshawk (Greenwald et al. 2005, Boyce et al. 2006), a single-species management framework may limit desirable wildlife diversity benchmarks. How should stakeholders balance the momentum of accelerated restoration with conservation imperatives?

The best available science suggests the current framework (Eastside Screens) as severely flawed in that it does not adequately protect occupied goshawk territories nor address future goshawk habitat concerns:

- Current surveying techniques employed by forest managers on the SBM/MNF most likely significantly underestimate goshawk occupancy and/or nesting status.
- Some districts and forests are only leaving goshawk habitat when it is found as active, and avoid the restrictions and requirements otherwise.
- This bi-modal approach avoids planning for future goshawk habitat or strategic placement of stands based on site characteristics and ability to persist under future stressors.

Additionally, as stated above, the goshawk is not a species of conservation concern and does not perform effectively as an MIS or focal species.

New Framework

We recommend a new framework, whereby the Forest Service and other land managers in the southern Blue Mountains no longer use the designation of active goshawk nests as protected goshawk habitat areas (nest area and PFA), and instead strategically select *wildlife habitat areas* within each of the forest types (e.g., ponderosa, dry and moist mixed conifer).

We recommend managers:

1) Identify wildlife habitat attributes to maximize diversity and abundance of selected species (or guilds)
2) Select wildlife habitat to be protected based on its representation in the project, district, and forest-level
3) Select a diverse group of focal species within each forest type based on established selection criteria and/conservation need
4) Prioritize habitat areas presenting higher persistence potential under climate disruptions and other disturbance

We offer this as a much more effective approach to meeting wildlife habitat needs than the current models of: *Eastside Screens*: protect only goshawk nests that are found or have been active in the last 5 years and their associated PFAs; and *Proposed New Forest Plan*: use the goshawk as an MIS, surrogate, or focal species.

It should be noted that our proposal is to create wildlife habitat areas instead of goshawk habitat areas. This proposal is not intended to replace the many other wildlife habitat and species components of land management and dry forest restoration (e.g. riparian corridors, designated old-growth, species of special status).

To be strategic, managers should use the existing habitat areas such as riparian and old-growth areas (among others) as part of a spatial analysis when considering selection of the wildlife habitat areas in each project. This framework presents a higher likelihood that wildlife habitat will be conserved across time and space in the dynamic dry forest ecosystem. The literature offers diverse models and drivers that could be considered when selecting habitat in each forest type. We caution against using modeling alone, as even with LiDAR modeling may not capture site-specific details. Ground truthing and the input of local biologists could greatly increase the effectiveness of modeling. Many Forest Service district staff shared their intimate knowledge of planning areas and wildlife needs within them. When moving from a goshawk habitat approach to a wildlife habitat approach, land managers should consider the following:

1) Select wildlife habitat with the soil capacity (available water storage) to carry OG/LOS stands through predicted future drought.

2) Protect selected wildlife habitat areas from fire risk by treating a matrix around the stands and strategically placing the stands where fire models show they are least likely to be lost during future fire events.

3) Use research on species richness and abundance, appropriate focal species, and other biodiversity or conservation indices to select which habitat stands to protect.

4) Forest restoration planning should consider the following focal species selection criteria:
    a) Abundant and easily monitored
    b) Relationship to specific habitat type is strongly established in the peer-reviewed literature
    c) Peer-reviewed literature suggests a reliable response to habitat changes

5) When selecting areas at the project level, emphasize biophysical characteristics to protect wildlife habitat areas that would enhance wildlife diversity, especially in context of the surrounding protected areas (e.g., riparian corridors, dedicated old-growth, replacement old-growth) and planned forest management activities (e.g., thinning, prescribed burning, skips and gaps).

6) Consider future stressors and perturbations (e.g., climate, drought, fire, insects, diseases) and how the surrounding forest management activities might interact with them when selecting wildlife habitat stands to increase the chances of the nest stand and wildlife habitat area persisting during these disturbances.

7) Educate stakeholders to build confidence and trust in a holistic framework whereby managing for diversity in different forest types works for more wildlife, including goshawks.

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