SPECIES ASSESSMENT FOR NORTHERN GOSHAWK (*ACCIPITER GENTILIS*) IN WYOMING

prepared by

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Introduction

The Northern Goshawk (*Accipiter gentilis*, Linnaeus 1758) is a diurnal raptor (Family Accipitridae) of temperate forests and woodlands. The genus *Accipiter* is representative of closely related hawks noted for long tails and relatively broad wings, well suited for pursuit of prey in dense forests. Once commonly known as "bird hawks", (Craighead and Craighead 1956) the genus is well known for aerial pursuit of avian prey, however, the diet of accipiters is very diverse. Reliant upon explosive acceleration and adept maneuverability, the Northern Goshawk is a predator of birds and small mammals throughout its range. The species has proven to be highly influenced by cyclical abundances of prey species in any season.

The species inhabits temperate, montane and boreal forests of the Holarctic. In the western hemisphere two, possibly three subspecies are extant throughout the range. A smaller recognized supspecies of western Canada (*A.g. laingi*) breeds on Queen Charlotte and Vancouver Islands. Resident birds in the forests of southern Arizona and southwestern New Mexico into the Mexican highlands of the Sierra Madre display clinal variation in size and color that may constitute a third North American subspecies (*A. g. apache*). The Northern Goshawk (*A. g. atricapillus*) is rare, yet widely distributed, from Alaska, throughout Canada, New England, the Great Lakes states, South and West through the Rockies and mountain ranges of the pacific states. The Northern Goshawk, subspecies *atricapillus*, is a resident breeder and short distance migrant in the state of Wyoming, and the focus of this species assessment.

Natural History

Morphological Description

The Northern Goshawk (goshawk) is the largest of the three North American Accipiters. There is size dimorphism in accipiters between females and males, and hence the near overlap in the size of the female Coopers Hawk (*Accipiter cooperii*) and the male goshawk can cause confusion, especially between the very similar plummages of immature birds. The shape of the goshawk in flight is a great aid to identification between accipiters, with experience. The broad chest and heavy body are similar in width to the broad, rounded tail, which can look more like an extension of the body. In powered flight wingtips appear pointed, but are otherwise tapered and broader in the goshawk, making the tail appear relatively shorter. In addition, the head protrudes further from leading edge of the wing in this species, and barring on the underside of the wing and tail is less defined. The ability to correctly identify accipiters in the field is greatly improved with practice.

The definitive field marking of an adult goshawk viewed at medium to close range is the pronounced broad, white superciliary line starting at the yellow cere, extending above the eye, and grading into the darker feathers of the nape. The supercilium bisects the dark cheek and auriculars from the near black crown and top of the head. The back, upper-wing and nape vary from brown-gray to deeper shades of gray; flight feathers tending to be darker than wing coverts and lining. The relatively long and rounded tail is a similar color, intermittently banded with broad, dark bars (3-5); if recently molted a thin, white terminal band will be present. The underparts of the adult goshawk are entirely white, with fine gray horizontal bars, or vermiculation; dark streaks of varying width run vertically on the breast and belly. The wing tips barely reach the mid point of the tale in perched birds. The eye of the goshawk is distinctive, with iris' initially bright yellow, turning orange-red, and ultimately red in mature birds (> 4 y.o.). Mouth lining, tarsi, and toes

yellow, claws bluish black. Females may tend to be slightly browner above, less white below, iris orange-yellow in mature birds (Sibley 2003, Johnsgard 1990, Squires and Reynolds 1997).

Juvenile goshawk plumage (sexes similar) is near completion by the fortieth day from hatching. This plumage is retained throughout the first winter, and is predominantly brown above. Back and upper wing is streaked with white and cinnamon, and mottling occurs in the upper wing coverts. Head has a pale, less distinguishable superciliary line, and tale has much more definitive, uneven brown bars bordered with white. As common to all juvenile accipiters, the underside is predominantly white with varying cinnamon to dark brown streaks from throat to belly, thicker and more buffy in the goshawk than in the Cooper's Hawk (Sibley 2003).

Behavior

The goshawk is reputed to be among the most territorial and aggressive species. Highly defensive adults will react vocally and stoop on intruders if there is perceived threat to an active nest. Nests areas are often located opportunistically due to agitated adults, and there have been reports of interruption of logging operations by territorial goshawks (Bartelt 1977). There are reports of agonistic behavior between females and males returning to the nest area with prey (Schnell 1958, Boal et al. 1994). Dismissal calls and alarm calls tend to accompany this behavior, yet Good et al. (2001) documented a physical talon strike by the brooding female when a male attempted prey delivery to the nest.

Taxonomy and Distribution

The Northern Goshawk species has a broad, Holarctic distribution. An accurate determination of the number of valid subspecies is a current debate, however, there are as many as nine Eurasian (Palearctic) subspecies, or the *gentilis* group, and two, possibly three Nearctic, or North American subspecies of the *atricappillus* group (Kennedy 2003, Johnsgard 1990). The Queen Charlotte

Goshawk, *A. g. laingi* (Taverner), is a resident of the Queen Charlotte and Vancouver Islands, coastal British Columbia, and Southeast Alaska (Squires and Reynolds 2001). Although not currently accepted by the American Ornithologists' Union (1957, 1983) there is scientific support for subspecies classification for *A. g. apache* (van Rossem) a larger, and dorsally near black goshawk of the extreme Southwestern U.S. (AZ, NM) into the mountains of Mexico to Jalisco (Johnsgard 1990). The Northern Goshawk, *A. g. atricapillus* (Wilson) is comprised of all other resident goshawks of North America; from Alaska to Newfoundland, South through New England and into the Appalachian Mountains, the upper Midwest, and the western states from the Black Hills of South Dakota to the Pacific coast, Rocky Mountains and Cascades through the Southern Sierras of California (AOU 1997; Figure 1).

The Northern Goshawk winters locally throughout its range, and south through the northern Gulf coast states although seldom Florida, Texas, Northern Mexico and Southern California (Johnsgard 1990). The goshawk is considered a short distance migrant, and adults may stay loosely tied to breeding territories throughout the winter months. The phenomenon of irruptive southern invasions in roughly ten year cycles due to depressed prey populations is well documented from the northern latitudes. Such a cycle has not been documented in the lower 48 states, however, winter dispersal distance is postulated to be related to prey abundance within home ranges.

In Wyoming bird and mammal distribution is commonly broken up into a matrix of 28 rectangles (latilongs), formed where latitudinal and longitudinal lines cross (Dorn and Dorn 1999). Each area is approximately 70 x 50 miles, forming a grid four units high and 7 units across, covering the state. In the Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming (1999), goshawks are listed as common with observed nests or young dependant upon parental birds in 21

if 28 latilongs. Circumstantial evidence of nesting is reported from two more latilongs, leaving four latilongs (three from eastern and southeastern Wyoming, and one in the northern Big Horn Basin) where goshawks have been observed without evidence of nesting. Only one latilong, south of the Black Hills on the South Dakota border lacks verified goshawk records (Luce et al. 1999). Dorn and Dorn (1999) list the goshawk as "Yearlong resident, uncommon in summer, rare in winter, with migration peaks in March and October". The Dorn and Dorn (1999) distribution map lacks any record of goshawks in the same eastern latilong as Luce et al. (1999), with birds only observed wintering east of the Laramie Mountains in the southeast portion of the state. (*see* Figure 2, Wyoming Goshawk Distribution)

Habitat Requirements

General

The generalization of the Northern Goshawk as an old growth forest obligate is an over-simplification of the habitat requirements of the species. Rangewide a great diversity of habitats are utilized, from dense coniferous taiga, mixed conifer and deciduous forests, to lush riparian forest. Johnsgard (1990) points out that the significance of coniferous forests is increased further south in the breeding distribution, yet habitat specificity decreases outside of the breeding season. There is an abundance of evidence that wintering goshawks will hunt in open habitats, shrub dominated foothills areas, and oak or other savannahs (Johnsgard 1990). In general, goshawk nest areas are unique in structure, with large trees and dense canopies which, towards the southern portion of the species' range, tend to be on north facing slopes (Reynolds et al. 1994).

Stands of young, dense forest are not habitable by goshawk, due primarily to body size and wing span. The goshawk is more limited in maneuverability than the smaller accipiters, and may hence be limited by density of understory growth. The forest understory must be open enough for

efficient foraging for avian and mammalian prey (Reynolds et al. 1992). In addition, nest site requirements necessitate trees of sufficient size to bear a nest and facilitate approach and departure on the wing.

Spring/Summer/Fall (Breeding Season)

Nest stands are generally occupied from early March until late September. There are characteristics of nest stands that are common across much of the goshawk's range. Johnsgard (1990) describes a stand of tall timber with moderately dense canopy in proximity to small, open foraging areas within the forest. Goshawks are generally associated with mature forest types, yet there is variation throughout the range, with particular tolerances within particular cover types. Nest sites generally are found in proximity to a source of water, on moderate slopes with northerly aspects, in stands of generally older and larger timber (Johnsgard 1990). Nest stands appear to provide protection from predators through increased cover, and a mild and stable micro-climate for protection of vulnerable broods (Reynolds et al. 1994). Goshawks will re-use nest stands between years, often using several (range 1-8) alternate nests, either within stands or between stands, over time (Squires and Reynolds 1997). Historic nest areas have been reported in use intermittently over decades (Reynolds 1983).

Nests from the central Rocky Mountains have been described in lodgepole pine (*Pinus contorta*) dominated, conifer, mixed conifer, and quaking aspen (*Populus tremuloides*) forests (Squires and Ruggiero 1996). The more arid climates of the interior Rocky Mountains result in goshawk habitat selection defined by often single-story stands of large trees, dense canopy cover the result of higher tree densities, and a less complex understory with less ground debris (Shuster 1980, Hayward and Escano 1989). On the Targhee National Forest (NF) all goshawk nests have been found in the montane zone, dominated by Douglas fir (*Pseudotsuga menziesii* var. *glauca*)

and lodgepole pine (*P. c.* var. *latifoia*) which occur in pure stands or in mixed conifer forests with Engelmann spruce (*Picea engelmanii*), subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*) or limber pine (*Pinus flexilis*). Aspen stands are found along the lower elevation edges of the montane zone, or mixed within predominantly conifer forests at higher elevations (Patla 1997).

The Black Hills NF is located primarily in South Dakota with 175,000 acres of the forest extending across the northeast border of Wyoming. The Black Hills are dominated by ponderosa pine (*Pinus ponderosa*) stands, yet high quality nesting habitat occurs between 1500-2000 m in pine forests mixed with white spruce (*Picea glauca*) and aspen (Bartelt 1977). It is unclear whether this population is isolated from Canadian or Rocky Mountain populations, however, most birds sighted in extreme north eastern Wyoming outside of irruption years are likely to have originated from the Black Hills.

The breeding season home range of a goshawk is a function of nest area, foraging area, and post fledging family area (Graham et al. 1994). Recognition of this multi-scale habitat use pattern is an essential component of management for this species.

Nest Tree

Deciduous and coniferous trees provide adequate structure for goshawk nests. Squires and Ruggiero (1996) found that aspen and lodgepole pine boles were utilized in proportion to their availability in southern Wyoming. There was no apparent preference for deciduous or conifer trees, however, it appeared that goshawks avoided nesting in sub-alpine fir. Structurally, trees with fewer limbs below the canopy were desirable (Squires and Ruggiero 1996). Patla (1997) found the number of Douglas fir nest trees (38) to outnumber lodgepole pine (9), aspen (1), and Engelmann spruce (1) combined. In this study nest trees were located on the middle and lower

portions of slopes (92%), in large, older trees with dense canopy cover. Over 25% of nests were built on limb deformities resulting from mistletoe infestations (Patla 1997). Nests of the central rockies (Colorado) were found on gentle slopes ($\bar{x}$=12.5%), with a north to east aspect. In this region it appeared that sites were located on benches or basins, surrounded by steeper slopes (Shuster 1980). Nest sites may be more characteristically placed on north slopes, if vegetation density and canopy cover provide a more ideal micro-climate (Reynolds et al. 1992).

Nest Area

Given the degree of range wide variation among breeding habitats, there is a surprising similarity in vegetation structure common to goshawk nest stands (Reynolds and Joy 1998, Graham et al. 1994). Differences in nest stand characteristics are often attributed to changes in available habitat, not necessarily in behavior (Hayward and Escano 1989). Nest sites tend to be located in stands of relatively large timber with an open understory and high canopy cover. Large openings are often reported in close proximity to nest sites, potentially expanding the range of foraging habitats available.

Goshawks commonly use from two to four alternate nests within one or more stands of timber, over time (Reynolds et al. 1992).There is variation in both number and separation distance of alternate nests. In successive years re-use of the same nest appears to be relatively low. Of 46 instances of nest area re-use in successive years by goshawks on the Targhee NF, only twice did pairs use the same nest tree. Over the course of the six year study, there was an 8% incidence of nest re-use (n=18; Patla 1997).

In the Sierra Madre Mountains and the Medicine Bow Mountains of south central Wyoming Squires and Ruggiero (1996) studied nest site preference of Northern Goshawks. In lodgepole pine and mixed lodgepole pine and aspen forests goshawks preferred the largest trees available at the

nest-tree area or within nests stands. Nest-tree area canopy cover was high ($\bar{x}$ = 66.7%, SE = 2.0), but did not differ significantly from random sites. Nest stand results also suggest that goshawks nesting in lodgepole pine forests selected stands lower in overall tree density, but higher in density of trees in the large size class. These nests stands were composed of fewer small-diameter trees than randomly selected stands. In addition, nests were usually in single-storied forests with high lower canopy heights. The spruce fir forest type was uncommon in the study area, but further research is needed to determine overall usage of spruce/fir habitat by goshawks in south central Wyoming (Squires and Ruggiero 1996).

A comparison of goshawk nest site characteristics on two sides of the continental divide characterizes the variation in stand selection, when regional conditions are favorable. Habitats in the Idaho panhandle influenced by the pacific maritime climate are in multi-storied stands, with higher canopy closure, and overall lower tree density. Forests sampled from western Montana were predominantly Douglas fir with grama-needlegrass-wheatgrass associations. Though relatively even-aged, small diameter forests were utilized in the drier climate east of the continental divide, there was uniformity between the general habitats in canopy closure, basal area, and availability of at least one large forest opening within .5-1 km of all nesting areas (Hayward and Escano 1989). During this same study 11 Forest Service biologists indicated that all known goshawk nest areas were found in mature to overmature or oldgrowth forests.

Post-fledging Family Area

The area around the nest used by fledglings until they are no longer dependant upon parental care is called the post-fledging family area (PFA) (Reynolds et al. 1992, Graham et al. 1994). Activities critical to the success of fledglings, including foraging, parental care, and roost sites, occur on the PFA level (Kennedy et al. 1994). Graham et al. (1994) describe the PFA as a mean

area of 170 ha. (range = 120-240 ha) including a mosaic of large trees and snags, an herbaceous understory, large, downed logs, interspersed with small openings. The PFA may also represent the area around the nest defended by territorial adults (Reynolds et al. 1992).

Foraging Areas

The area defined by a nesting raptor's home range minus the nest area represents the foraging area (Kennedy et al. 1994). The foraging area is 2200 ha (range = 2000-2400 ha) area, similar in structure to the PFA, which provides the prey base for nesting goshawks (Graham et al. 1994). Foraging area size is large enough to provide for habitat for small to medium size mammals and birds, as well as providing perches and spacing to facilitate the goshawk's foraging strategy. (see Table 1)

The wide variety of suitable nesting habitat utilized by Northern Goshawks supports the hypothesis that prey availability is as critical if not more than forest structure or composition alone (Graham et al. 1994). However, there is evidence that prey abundance alone is not a determining factor in goshawk distribution. Beier and Drennan (1997) conducted one of the first habitat preference studies based on prey abundance. In the ponderosa pine forests of the Coconino NF and Kaibab NF of northern Arizona, differences in prey abundance between sites did not appear to influence where goshawks foraged during the breeding season. Hence, stand structural characteristics conducive to goshawk foraging strategies will determine habitat use above very low prey abundance levels. Whether forest structure or prey availability and abundance determines territory establishment and inhabitation is an aspect of goshawk biology that requires further research in Wyoming.

Late Fall/Winter

In the Uinta Mountains of northern Utah goshawk populations exhibit short-distance migratory movement, wherein winter range did not include the nest stand of the previous breeding season (Stephens 2001). Fall migration was initiated from late October through late December, and the average time adult birds spent away from territories was approximately 83 days. Several characteristics of the winter movements described in this study (n=14) were short average maximum distance traveled from nest area ($\bar{x}$ = 55 km), higher percentage of female migration (M=40%; F=90%), and a general down slope trend to winter movement (Stephens 2001). In addition to a higher percentage of females migrating, females tended to disperse further than males. Higher nest area fidelity in males through winter could be due to greater experience in the foraging area, higher likelihood of retaining a territory into the next breeding season, and lower energetic costs due to smaller body size. Winter elevation shifts enable foraging goshawks to access new habitats, such as pinyon/juniper woodland, and hunt from a wider prey base. In this study, winter prey shifted from red squirrels at high elevations (~2130-2895 m) to cottontails and black-tailed jackrabbits at lower elevations (~1370-2130 m; Stephens 2001).

A small sample of birds (n=4; 2M,2F) from the Sierra Madre Mountains of south central Wyoming migrated during moderate weather conditions in mid-September (Squires and Ruggiero 1994). One female traveled 185 km south to winter in mixed conifer and aspen forests at higher elevations than her nest area. Although an elevation trend was not discernable, the females traveled at least twice the distance from nest areas as did the males. The period spent away from nest areas appeared longer in Wyoming, as birds departed by mid-September, and returned between mid-March to early April.

A study in Sweden by Kenward and Widen (1989) demonstrated prey distribution was a significant factor in goshawk winter habitat selection. Woodland edge habitats were the preferred foraging area when pheasants (*Phasianus* spp.) and brown hares were the prey of choice. In boreal forest squirrels (*Sciurus vulgarus*) were the primary prey, and goshawk hunted more in large patches of mature forest.

Migration

The Northern Goshawk is defined as a partial migrant, yet there is variation both within and between populations. Short distance fall migration is reported in the interior Rocky Mountains, and often includes down-slope movement out of characteristic breeding habitat (Stephens 2001). Observation of raptors during migration could reflect one of at least six possible movement types: partial or complete migration, natal dispersal, or irruptive "invasions", nomadic or local movements (Kerlinger 1989). Thus, fall and early spring observations cannot be simply defined, as movements within flyways can be multi-directional and representative of a variety of behaviors (Hoffman et al. 2002).

There are areas of the North American range where goshawks are year-round residents. In the ponderosa pine forests of northern Arizona most birds remain year round (Beier and Drennan 1997). Similarly, in the Lake Tahoe region of Northern California, Keane and Morrison (1994) determined adult goshawks were non-migratory through radio-telemetry. There is also evidence from radio telemetry studies in northern New Mexico that goshawks remain on or near nesting home ranges through the winter (Reynolds et al. 1994).

Twenty years of recapture/encounter data from Hawkwatch International, Inc. have helped to define three distinct regional flyways in the West; Rocky Mountain, Intermountain, and Pacific Coast. There are instances of flyway crossover, however, there is high within flyway fidelity, and

counts along each route can be attributed to largely distinct subpopulations, barring irruption events (Hoffman et al. 2002). Northern Goshawks are the least seldom captured accipiter, yet recapture data supports the hypothesis that they are typically observed during dispersal or short-distance migrations (Hoffman et al. 2002, Squires and Reynolds 1997). Migration counts of goshawk are often of localized movement, and Hoffman et al. (2002) speculate that counts of hatch-year birds on distinct flyways could serve as an index of regional annual productivity. Migratory goshawks originating from western Wyoming will principally utilize the Rocky Mountain flyway. Limited research on migrating raptors in south central Wyoming did not reveal a common concentration point for short-distance adult migration or juvenile dispersal, yet, southward fall movement of >150 km from nest areas has been documented (Squires and Ruggiero 1994).

Commissary Ridge migration counts over two years in southwestern Wyoming have begun to shed light on goshawk migratory patterns. Median passage dates varied by age class, with 50% of immature and subadult migration complete by 23-September (2002), whereas the median passage date for adults was 10-October (2002). In the same year bulk passage dates, during which 80% of all migrants passed the lookout, were 19-September through 20 October. Immature to adult ratio was 2.0 in 2001 and 0.8 in 2002, possibly displaying a decline in productivity between years (Smith 2003).

Area Requirements

Home Range

Various measurements of goshawk home range indicate that goshawks occupy an exceptionally large area during the nesting season. In an early study (1947) a Moose, WY goshawk summer home range was estimated, using plots of sight records, at 212 ha (Craighead and Craighead 1956). In this same region Patla (1997) calculated a mean home range size of

approximately 4418 ha using nearest neighbor distances. Radio telemetry studies have improved the accuracy of earlier estimates, and the Craighead's (1956) value is quite low in comparison to several more recent studies. Bright-Smith and Mannan (1994) estimated summer home range size of males (n=11) at 1758 ha (SD=500, range 896-2528) on the Kaibab plateau of northern Arizona. In the arid forests of the eastern Sierra, goshawks in Jeffrey pine (*Pinus jeffreyi*), lodgepole pine, aspen, and red fir (*Abies magnifica*) inhabited large home ranges, often influenced by movement between nest sites and permanent water sources (Hargis et al. 1994). Breeding season males (n=2) utilized an estimated 2,400 ha home range, during the same period home range size for females (n=7) was 1,340 ha. Home ranges on this study area at least doubled in size for females and tripled for males after fledging, supporting the theory that post fledging and foraging habitat requirements vary from those of nesting habitat (Hargis et al. 1994).

Movement and Activity Patterns

Broad-scale Movement Patterns

Seasonal home range size and migration/dispersal behavior remains to be fully understood. These variables show variation by region, by sex, and by age class. Consistency within each class may be violated as well. In the Lake Tahoe region of Northern California, adult goshawks remained on territory throughout the year. This one-year radio tracking study of five pairs (Keane and Morrison 1994) described a non-migratory population. Home range sizes generally grew between the breeding and non-breeding season, with one male outlier removed; however, females had a tendency to continue to return to and center winter movements around the territory center (Keane and Morrison 1994).

Reproduction and Survivorship

Breeding Behavior

Males are the primary provider of prey throughout the breeding cycle. The male will seldom bring prey to the nest while the female is present. Males will perch at a distance from the nest and give a single, low-pitched contact call. Females respond with high pitched calls, and retrieve prey from the male for delivery to the nest (Patla 1997). Goshawks are extremely aggressive when defending active nests, and are territorial against raptors as well as other goshawks (Squires and Reynolds 1997). Goshawks are uncharacteristically shy during the incubation phase of nesting, aggression escalates to a peak during the early nestling phase, and declines by the time of fledging.

An observed territorial display of goshawks is high soaring above nesting areas, most regularly during the incubation phase of reproduction. Males from adjacent territories can display simultaneously through mid-to-late morning without aggression, approaching each other in flight close to territorial boundaries. Breeding adults are solitary outside of the breeding season (Squires and Reynolds 1997).

Breeding Phenology

A radio telemetry study in Wyoming documented migratory adults returning to nest areas between 23 March and 12 April (Squires and Ruggiero 1995). Patla (1997) observed goshawks returning to nesting areas between late March and early April on the Targhee NF, generally corresponding with the emergence from hibernation of Unita ground squirrels (*Spermophilus armatus*). Based on data from 37 successful nesting pairs from the Targhee NF (1989-1994) mean date for onset of incubation was May 5 (range April 20-May 20) and mean hatch date was June 6 (range May 22-June 21; Patla 1997) Nestlings are reliant upon adults during development in the nest for 36-42 days from hatching to fledging (Boal 1994). A provisioning period of approximately 25 days follows, during which fledglings remain within 300-400m of the nest, and

continue to receive prey items from both parents. Self feeding begins as early as 20 days after fledging and young increasingly feed themselves from 26-27 days on. Reduced adult provisioning continued in south central Wyoming up to 62 days post-hatch (Good et al 2001).

Fecundity and Survivorship

In Wyoming the largest dataset providing nest productivity information is from the northwestern corner of the state, and extends into eastern Idaho (Targhee NF). Over six years (1989-1994) goshawks were successful in 61 out of 68 nesting attempts (91%). Annual fecundity varied from 1.45 young fledged per nest to 2.63 (Patla 1997). In the year of lowest productivity (1993) nearly half of the nests produced only one young, whereas in a very productive year (1994) 63% of active nests fledged three young. Spring precipitation indices (March/April and May) were negatively correlated with productivity, and combined temperatures across April and May were positively correlated with productivity (Patla 1997). Cold, wet spring weather may impact foraging success during the early nesting phase, as well as causing direct mortality at the nest.

Localized areas experience high variation in annual rates of nest productivity. Years of high or low productivity are not consistent range-wide, suggesting sensitivity to regional climate and prey availability (McClaren et al. 2002). Warm spring temperatures without excessive precipitation are climatic correlates to high fecundity in goshawks (Patla 1997). In years of foraging stress, or cold, wet conditions during the brooding phase, goshawks may fledge as few as .4 fledglings per active nest. A comparative study of three areas (British Columbia, Utah, and New Mexico) saw annual extremes in fledglings per active nest of .7-2.4 (B.C.), .5-2.1 (NM), and .4-2.3 (UT) (McClaren et al. 2002). The quality of nest areas does not explain this variation, as across study locations there was little within year difference in the number of young fledged between nest areas. Although nest

area was not significant in explaining nest success in the McClaren study (2002) there was a small number of outlier nests in each area that tended to consistently fledge more young than others.

There are no clear data supporting a relationship between parental age and fecundity in goshawks, however, it has been documented that older individuals in long-lived species often fledge more young, regardless of habitat quality (Newton 1991, 1998). In raptors, the mature breeders also tend to occupy higher quality habitat (Newton 1991). Given the similarity of productivity between goshawk nest areas as described by McClaren (2002) it appears that climate and foraging success outweigh such factors as adult experience and nest area alone in sites where pairs experience at least moderate nest success. [McClaren et al. (2002) selected nest areas for analysis which were active at least three years out of the study period. Nests that were active only one or two years were excluded, and may have eliminated nests were breeding conditions were less favorable.]

In a multi-year analysis of the correlation between total prey abundance and goshawk productivity in northern Arizona, Salafsky et al. (in review) found that density of prey species was positively correlated with goshawk productivity. In northern latitudes, survivorship appears to be driven by abundance of cyclic prey populations of snowshoe hare (*Lepus americanus*) and Ruffed Grouse (*Bonasa umbellus*). The broad suite of documented prey species in northern Arizona displayed synchronous annual variation in abundance. Cumulative prey density had a proximal effect on mean number of offspring per territory, yet the synchronous variation of prey species suggests a greater direct effect of climate may drive the relationship.

Population Demographics

The Northern Goshawk in the northern extremities of the species' range demonstrates gradual population increases and rapid declines (Dunne et al. 1988). The population is limited by the availability of snowshoe hare and Ruffed Grouse and has been documented shifting far southward

during fall and winter in years of prey scarcity. These "invasions" have been documented in roughly 10 year cycles, and has resulted in higher numbers of adult birds wintering in southern latitudes. These patterns complicate population trend analysis from migration count stations. Migration observations of adult Northern Goshawks across six western count localities increased in 1983-1984 and 1992-1993, in correspondence with known irruption years (Hoffman and Smith 2003). A great influx of after hatch year goshawks in migratory corridors may reflect a regional low in prey further north and not necessarily an increase in overall population.

Metapopulation Dynamics

The authors are not aware of any current literature suggesting metapopulation dynamics are observed in goshawk populations. Given the life history of this species, there is little evidence that such patterns exist.

Genetic Concerns

There is no published literature on population genetics of the Northern Goshawk. Evidence reviewed by Kennedy (2003, pp. 78-79) suggests that the populations of the intermountain west are probably not genetically isolated from other western populations. The population of goshawks in the Black Hills is the most isolated from other populations (Bartelt 1977), and a population in which gene pool bottleneck is feasible if this population declines below a certain unknown threshold.

Food Habits

Food Items

Increasingly, food preference and availability is understood to be a major determining factor in habitat suitability for Northern Goshawk. Throughout the extensive North American range the species' distribution is uneven, and large tracts of montane forest apparently go unoccupied. Low

abundance of preferred prey or structural impediments to foraging can effectively exclude goshawks from seemingly acceptable habitat. Food habits during the breeding season have been described through prey delivery studies and pellet analysis (Good et al. 2001, Squires 2000). According to regurgitated pellet analysis, nesting goshawks in south central Wyoming consumed at least 33 species of prey, 14 mammalian and 19 avian (Squires 2000). The study characterized prey which occurred in stands of predominantly lodgepole pine, subalpine fir, and Engelmann spruce (Marston and Clarendon 1988 *in* Squires 2000). Dominant prey species based on percent occurrence in pellets included (percentages in parenthesis): red squirrel (*Tamiasciurus hudconicus*; 50), Northern Flicker (*Colaptes auratus*; 34), American Robin (*Turdus migratorius*; 30), golden-mantled ground squirrel (*Spermophilus lateralis;* 27), and Uinta or least chipmunk (*Tamias* spp.; 10). Woodpeckers, including: Northern Flicker, Red-naped Sapsucker (*Sphyrapicus nuchalis*), Hairy Woodpecker (*Picoides villosus*), Three-toed Woodpecker (*Picoides tridactylus*) and an unknown Picicdae, were present in 52 percent of pellets (Squires 2000).

In a prey delivery study in south central Wyoming, during the provisioning of young, both at the nest and during the fledgling stage, prey items were identified to class (n=38). Observers determined that 78.9 percent of identifiable prey items were mammals, and 21.1 percent were birds (Good et al. 2001). This study provides the most current benchmark of known prey items utilized during the rearing of chicks in habitats of southern Wyoming. In order of decreasing frequency (percentages in parenthesis), prey delivered to the nest or recently fledged young were: red squirrel (31.5), unknown mammal (31.5), unknown bird (13.1), ground squirrel or chipmunk (10.5), American Robin (5.2), Northern Flicker (2.6), least chipmunk (*Tamias minimus*) (2.6), and lagamorph (2.6).

Prey analysis in western Wyoming suggests that avian prey makes up a greater percentage of the daily diet of goshawks in this region as compared to central Wyoming. Mammalian prey, adjusted for weight, accounted for 59% of the goshawk diet, and birds 41% (Patla 1997). Grouse species may account for this difference, as of the known prey biomass in western Wyoming, Ruffed Grouse, Blue Grouse (*Dendragapus obscurus*) and unknown grouse species account for 28%, whereas grouse are not indicated as principle prey in southern Wyoming by either Squires (2000) or Good et al. (2001).

Occasional carrion use has been documented in South Dakota (Bartelt 1977), Wyoming and Montana (Squires 1995). Four reports over three consecutive years described goshawks feeding from carrion. On three occasions single goshawks fed from gut piles of mule deer (*Odocoileus hemionus*) on the Medicine Bow NF. The fourth report was of an adult goshawk feeding from a bison skull near Lewistown, Montana (Squires 1995). Discerning carrion from live prey in pellet analysis is subjective, yet the presence of mule deer and American marten (*Martes americana*) in pellets confirmed that both species were either preyed upon or scavenged (Squires 2000). That reports of carrion use were made from the same locale in three consecutive years supports the theory that goshawks use carrion opportunistically, not as alternate food during years of low prey availability.

Foraging Strategy

The goshawk is overall an opportunist, and will kill mammals, avian prey, and occasionally reptiles and insects. Most notably the goshawk utilizes astonishing speed and agility in pursuing prey through forested habitat. The goshawk relies primarily on two distinct foraging tactics. It is characterized as a short duration sit-and-watch predator (Johnsgard 1990, Squires and Ruggiero 1997). Foraging birds utilize elevated hunting perches, often remaining still for many minutes,

punctuated by brief inter-perch flights; averaging 84 s for males and 96 s for females in Sweden (Widen 1984) and 3.5 minutes for males and females in New Mexico (Kennedy 1991). A secondary foraging tactic, is the fast searching flight, which may be most common along forest edges and openings (Johsgard 1990). In areas of heavier vegetation the goshawk will employ a fast, low stoop utilizing cover for concealment; or a silent, descending glide towards prey can be utilized in open areas. Patla (1997) reports of adult goshawks utilizing low short flights and runs across the ground to reposition while foraging for ground squirrels in sage (*Artemesia* sp.) meadows. Stalking and exhaustive pursuit of prey on the wing are both characteristics of this determined predator (Squires Ruggiero 1997).

Foraging Variation

There is variation in prey selection between male and female accipiters. In a North American study Storer (1966 *in* Johnsgard 1990) illustrated that this is the most pronounced in goshawks, with male birds taking prey of an average weight of 397 g as opposed to female average prey size of 522 g. During the brood rearing phase of nesting males provision the nest with greater frequency. Average male foraging area during this period in northern New Mexico were 2090 ha, compared to mean female foraging area of 560 ha (Kennedy et al. 1994). Females were rarely observed foraging while young remained at the nest, and in the early stages of fledgling independence the males remained the principle provider of prey (Kennedy 1991). In south central Wyoming male goshawks provided 71% of prey delivered to young as nestlings or as fledglings, whereas females accounted for 29% of such prey deliveries (Good et al. 2001).

Community Ecology

Predators and Competitors

Predation does not appear to be a limiting factor on goshawk populations in any part of the range, although specific studies have not been done on this topic. A broad suite of predators are reported by Reynolds et al. (1994) including: other goshawks, Great-Horned Owls (*Bubo virginianus*), Red-tailed Hawks (*Buteo jamaicensis*), coyotes, bobcats, raccoons, and humans. Avian and mammalian nest predators have been reported including wolverines, Great Horned Owls, and fishers. Martens and Great-horned Owls were reported to depredate adult goshawks (Squires and Reynolds 1997). Instances of Bald Eagle (*Haliaeetus leucocephalus*) predation on wintering goshawks (Squires and Ruggiero 1995) have also been reported.

Nest area and nest structures are valuable resources susceptible to inter- and intra-specific competition. There is overlap in nest habitat utilized by Great Gray Owls (*Strix nebulosa*) and goshawks. Great Gray Owls were observed nesting within active goshawk territories on 13 different occasions on the Targhee NF by Patla (1997), and all but one of the owl nests were located in alternate goshawk nests. Great Horned Owls and Spotted Owls (*Strix occidentalis*) will also nest in structures built by goshawks (Kennedy 2003).

Inter-specific competition for nest areas may be more prevalent in fragmented habitats, where other raptors may be better adapted to utilize open forests (Crocker-Bedford 1990, Patla 1997). Historic nest stands were visited following timber harvest. In the resulting fragmented stands where goshawks were no longer active, Red-tailed Hawk, Cooper's Hawk, Great Gray Owl, and Raven (*Corvus corax*) were observed nesting (Patla 1997).

Each case of inter-specific competition; predation, nest site, and nest area, a secondary confounding factor is competition for prey base. Because the goshawk is a generalist predator,

many of the species competing for nest site and territory, simultaneously compete with goshawks for prey. The Great Horned Owl, a powerful predator which preys on large birds and mammals, is distributed widely throughout the goshawk's range. There is little information on the impact of inter-specific competition and the role of forest fragmentation in providing greater access to habitat generalists (Kennedy 2003).

Siblicide

Goshawk siblicide occurs in some circumstances, generally associated with periods of food stress (Squires and Reynolds 1997, Kennedy 2003). Reports of such instances suggest older nestlings may strike or talon younger siblings in the nest. Siblicide interactions favor the females, which are already larger early in development (Squires and Reynolds 1997). During a food supplementation experiment Estes et al. (1999 *in* Kennedy 2003) were able to support the hypothesis of siblicide as a mechanism for brood reduction, in which siblicide occurred at control nests.

Parasites and Disease

Presently, there are no forms of parasite or disease which are of immediate management concern or threaten wild populations of Northern Goshawks (USFWS 1998b, Kennedy 2003). However, disease ecology and pathology are poorly understood for this species. Of greatest concern in recent years has been the potential for a west Nile virus epizootic. In North America over 150 species of birds have been exposed to this mosquito borne virus, and according to the CDC, Northern Goshawk has been documented as infected (http://www.cdc.gov/ncidod/dvbid/westnile/index.htm). There is no information available at the present time regarding the potential impacts of west Nile virus. Given the status of this new disease, it is absolutely critical that dead birds, of any species, but in this case goshawks, are collected. Please contact Dr. Walt Cook [(307) 742-6638] of the Wyoming Game and Fish

Department, for exact instructions on handling and preservation of dead specimens for lab analysis.

An extensive treatment of the diseases and parasites of the Northern Goshawk is available in Squires and Reynolds (1997) Birds of North America account. The following is a brief summary.

Diseases

Populations with depressed fitness levels from food stress or disturbance may be more susceptible to certain diseases. Aspergillosus (genus *Aspergillus*) was highly prevalent in a possible irruption year at Hawk Ridge in Minnesota. Southward invasions of goshawks are tied to cyclic declines in prey abundance, and this population was likely stressed by greater migration distance, inter-specific harassment, and food stress. This fungal disease can cause granulomas throughout the lungs and air sacs. Bacterial diseases tuberculosis (*Mycobacterium avium* infection) and erysipelas (*Erisipelas insidiosa* infection) are reported. *Chlamydia tsittaci* and *E. coli* are both capable of causing fatality in goshawks.

Parasites

Ecotoparasites infestations are commonly observed on weakened birds, such as lice (*Degeeriella nisus vagrans*) which occur in the plumage. Cestodes and trematodes are common internal parasites, as well as coccidian and a variety of blood borne parasites including microfilariae and haemosporidians (*Leucocytozoon, Haemoproteus*, and *Trypanosoma*). Trichomoniasis (*Trichomonas gallinae* infection) can be transmitted through predation of infected birds, usually columbids (pigeons and doves, and is also prevalent among falconry birds (Kennedy 2003).

Symbiotic and Mutualistic Interactions

The authors are not aware of any published accounts of symbiotic or mutualistic interactions involving the Northern Goshawk.

Conservation

Conservation Status

Federal Endangered Species Act

On June 22, 1998 the U. S. Fish and Wildlife Service announced a 12-month petition finding that listing of the Northern Goshawk, in the contiguous United States west of the 100th meridian, as endangered or threatened under the Endangered Species Act, was not warranted. The best available information does not indicate that this *A.g. atricapillus* sub-population is in danger of extinction or likely to become so in the foreseeable future (USFWS 1998a). The service contends that although the species does require mature forests or older trees for nesting habitat, there is no evidence of decline in the overall matrix of habitats utilized by goshawks. The service found the species to continue to be widely distributed throughout the western range. Because an estimated 80% of goshawk habitat exists on federal land, the court cited a curtailment of timber harvest and fire exclusion on federal lands as positive for goshawk viability. The service found that forest conditions on federal lands are no longer declining as they had in the past two decades, and in many cases management schemes are improving habitats. The decision also cited insufficient evidence of a population decline, allowing that such decline may be occurring but the current science has not detected such trends. On June 28, 2001 this ruling was upheld in federal court by United States District Court Judge Frye (Kennedy 2003).

Bureau of Land Management

Six Bureau of Land Management (BLM) state offices (ID, CO, NV, NM, OR/WA, and WY) have listed the Northern Goshawk as a Sensitive Species *per* BLM Washington Office Instruction Memorandum IM 97-118 Guidance on Special Status Species Management (6840 Manual; Kennedy 2003). The BLM developed the list to "ensure that any actions on public lands consider the overall welfare of these sensitive species and do not contribute to their decline." Wyoming

listed the goshawk at the list's inception in 2001, granting the species the following four tier policy of protection:

- Maintain vulnerable species and habitat components in functional BLM ecosystems.
- Ensure sensitive species are considered in land management decisions.
- Prevent a need for species listing under the Endangered Species Act.
- Prioritize needed conservation work with an emphasis on habitat.

(BLM Wyoming 2001)

Forest Service

In 2001 the Northern Goshawk was listed as "sensitive species" by all of the Forest Service Regions (Kennedy 2003). Proposed forest management actions must submit to biological evaluations to consider potential impacts to sensitive species. Regions, and districts within regions, have approached implementation of sensitive species management differently, and lack a comprehensive region-wide management plan. Many national forests have identified the goshawk as a management indicator species as well, as abandonment of historic range may indicate detrimental habitat change (Squires and Reynolds 1997).

Presently, Forest Service implementation of forest management in goshawk habitat has reached a much more litigious level in the southwest (Region 3). Forest Plans for timber harvest in goshawk habitat were widely criticized by USFWS, game and fish agencies, and Forest Service biologists. Lawsuits were brought by conservation organizations, and on November 18, 2003 won a stay on plans to log timber on eight million acres of federal forest in Arizona and New Mexico. The proposed plan was cited to continue logging of mature forest, and reduce forest canopy cover below thresholds required by goshawks.

Identifying mature and old-growth timber stands as determined by standard scorecard methodology for preservation of will not successfully preserve goshawk nesting habitat in lodgepole pine forests. The common nesting forest type in lodgepole dominated stands lacks

structural heterogeneity, multi-storied canopy, tree size and canopy closure that indicates mature or old-growth forest. Goshawk nest area stand characteristics in lodgepole pine (see above) will need to be identified, and managed for independently. Squires and Ruggiero (1996) report that the Medicine Bow NF generally thins lodgepole pine stands to a 3.1- x 3.1-m spacing that yields an approximate density of 1,077 trees/ha. This thinning policy would need to be amended for management of goshawk nest areas, as the resulting tree density is well below the 95% confidence interval for nesting goshawks (Squires and Ruggiero 1996).

State Wildlife Agencies

The Wyoming Game and Fish Department Nongame Program of the Biological Services Section maintains a current list of nongame species of special concern, ranked through the native species status matrices. The Northern Goshawk is a non-game bird species of special concern with a rank of NSS4; "Species is widely distributed, population status or trends are unknown but are suspected to be stable; habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance" (Cerovski 2003).

Heritage Ranks and WYNDDs Wyoming Significance Rank

Wyoming Natural Diversity Database (WYNDD) uses a standardized ranking protocol developed by The Nature Conservancy and a nationwide network of natural heritage programs. The network of natural heritage programs and systematic biological inventory protocol is now coordinated by NatureServe [Arlington, VA.]. Global, state, breeding, and non-breeding status are monitored and updated in accordance with current scientific standards. The Northern Goshawk has a global rank (G-rank) of G5 on a scale of 1-5, which indicates the species is demonstrably secure throughout the majority of its range. Breeding goshawks are rare throughout the state, and limited in their distribution, and hence has a state rank (S-rank) of S3, on scale of 1-5. At present there is

no state ranking for migratory goshawks or goshawks present in the state outside of the breeding season (Keinath and Beauvais 2003b).

The significance of the extant state population as a contributor to the range-wide persistence of the species is indicated by the Wyoming Contribution Rank. This ranking system is a decision ranking tree developed by WYNDD (Keinath and Beauvais 2003a). The goshawk has the lowest rank out of four possible rankings (Low, Medium, High, Very High) as only small percentages of the range-wide population and available habitat occur in the state; in addition the security of Wyoming populations is uncertain relative to other areas (Keinath and Beauvais 2003a).

Biological Conservation Issues

Abundance

There are few references in the literature to overall abundance of Northern Goshawks. In Wyoming, Dorn and Dorn (1999) describe goshawks as uncommon in summer and rare in winter. Abundance in the breeding season is limited by breeding density of the species, which is low in comparison to many other avian species (USFWS 1998b). Factors limiting density are poorly understood, yet area requirements for a top-level carnivore are relatively large, and prey base may be a limiting factor (Squires and Reynolds 1997). Goshawks are highly mobile, and exploit a wide diversity of prey in many habitats, home ranges are thus inclusive of diverse landscape characteristics, and significance of any single variable is difficult to determine. Kennedy (1997) reports that breeding densities of goshawks vary from one to 11 pairs per 100 km^2. Nesting density of goshawks in lodgepole pine forests of Colorado (Shuster 1976) were 5.8 per km^2. Densities reported from ponderosa pine habitat in Oregon were slightly lower, 3.6 per km^2 (DeStefano et al. 1994). The other reported density of nesting pair relevant to the state of Wyoming was from work done by Bartelt in the seventies (1977), this figure from ponderosa pine forests of the northern

Black Hills (north of Rapid City) was 2.9 pairs per km^2. Given that two of these three breeding densities were calculated in the mid-seventies, there is a likelihood of change.

Trends

The only research in the region within or immediately adjacent to Wyoming where population trend data has been reported is the goshawk monitoring project on the Targhee NF (Patla 2003). In a comparison of mean occupancy rate between two five year periods (1990-1994 and 1998-2002), goshawk occupancy is down by greater than half (from 64% to 31%). Nest success (nest producing at least one fledgling) at monitored territories also declined from 56% to 19%. Occupancy rates and success rates during the later period were higher in undisturbed territories than those located in timber harvest areas (Patla 2003). This is a study limited in area; however, as the only trend data from the immediate region, and one which contradicts the population status findings of the USFWS (1998a), it should be understood that a monitored population of goshawks in Wyoming is in alarming decline.

The inability to determine overall population trend was the pivotal point over which listing of the goshawk as threatened or endangered, under the Endangered Species Act, was denied (DeStefano 1998). Kennedy (1997) investigated demographic variables from datasets collected in New Mexico and Utah. To support the claim of population decline the rate of population change (λ) would have to be less than neutral (< 1.0), reflecting decreased density, range contraction, or declines in fecundity or survival (DeStefano 1998). Demographic variables did not reflect overall population decline, however, DeStefano (1998) points out that the failure to detect population decline could be the result of a Type II statistical error, the failure to detect a trend that is there. Annual rate of population change (λ) was not computed for the Kaibab goshawk population, one of the longest studied populations in the country. Juvenile (age-specific) survival rates and

fecundity rates were unobtainable, due to low recapture rate subsequent to juvenile banding (Reynolds and Joy 1998). Critics of Kennedy (1997) argue that extensive and precise demographic studies have been unable to accurately estimate λ, and cost and logistics of long term studies (> 10 yrs.) are prohibitive (Crocker-Bedford 1998). Crocker-Bedford supports habitat-based status review in which:

> "…for each North American region and forest type, goshawk habitat requirements should be estimated at three scales: the amounts of important habitats necessary to support a productive breeding pair; the composition within a landscape for a stable or increasing local population, and the composition within a region for a stable or increasing regional population."

Less intensive goshawk monitoring would be used to validate habitat-based goshawk management through presence and absence, but would not be addressing population trend as approached by Kennedy (1997).

Analysis of standardized long-term migration counts has provided population trend information for raptors in the western United States (Hoffman and Smith 2003). Eighteen years of data from the Wellsville Mountains (UT) raptor count site suggests highly significant decline of immature goshawks through comparison of mean annual passage rates from 1977-79 against 1987-2001 (T-test, p value < 0.01). Age ratios of juvenile to adult goshawks declined steadily in the Wellsvilles through the 90s, suggesting a drop in productivity across "significant portions" of northern Utah, eastern Idaho and western Montana during the 1980's (Hoffman and Smith 2003). There remains to be evidence that this region has recovered from this population depression (Hoffman and Smith 2003). The recent establishment of a Commissary Ridge, WY count site will now provide important insight on the biology of the goshawks from western Wyoming, as well as potential trend information in future years.

Range Context

The Northern Goshawk has a Wyoming Contribution Rank of Low (see Heritage Ranks and WYNDD's Wyoming Significance Rank) because only small percentages of the range-wide population and available habitat occur in the state. There are no additional protective measures utilized across the Wyoming range of the species to suggest security of these populations is any greater relative to other areas (Keinath and Beauvais 2003a). However, population indices statewide, should be monitored closely. As a higher order predator in a complex ecological food web, goshawks remain an excellent indicator of overall system health (Crocker-Bedford 1998).

Extrinsic Threats

Raptor populations have been shown to regulate based on resource availability (e.g., physical nest site, prey base, habitat) and/or human impacts (e.g., environmental contamination, disturbance, mortality from persecution) (Newton 1979 *in* Keane and Morrison 1994). There is no evidence that toxins or pervasive human disturbance have had a major impact on the goshawk populations as a whole. Johnsgard (1990) indicates that there is apparently a low pesticide burden in the species. Removal or excessive fragmentation of mature forests in habitat suitable for nesting and foraging is a considerable extrinsic threat to Northern Goshawks (Keane and Morrison 1994). Grazing pressure may contribute to a loss of habitat complexity and decline of prey base in certain habitats, such as aspen stands and riparian vegetative communities(Reynolds et al. 1992).

Falconry

Wyoming Game and Fish Department issues permits for resident and nonresident falconry takes. Falconers are not required to list the species desired or region of capture in obtaining a permit. Northern Goshawk is a highly desirable species for falconry, but the number of annual permits, and successful takes remains too low to be of concern, unless a localized area experiences regular collection. In the last four years 21 goshawks (6, 6, 5, 4) were collected from the wild in

Wyoming (Cerovski 2000, 2001, 2002, 2003). Range-wide, the impact of falconry takes on wild populations is unknown, yet apparently minimal (Squires and Reynolds 1997).

Intrinsic Vulnerability

Low reproductive rate and delayed maturity are two life history traits that impact goshawk populations, and could potentially contribute to a decline in long term population viability. As reported from other long-lived raptor species, conditions resulting in an increase in adult mortality would in turn have the greatest impact on population growth (Noon and Biles 1990 *in* Kennedy 2003). Goshawks are presently susceptible to declines in available prey, therefore, management practices negatively impacting prey abundance would have a detrimental impact on goshawks, and increase effects of stochastic events (i.e. prolonged drought or cold, damp during the early nesting period). Increased forest fragmentation will likely increase competition and predation on goshawk populations (see Predators and Competitors above). Habitat generalists and species better adapted to more open woodlands such as corvids and other raptors (hawks and owls) can displace goshawks, compete for nesting structures, deplete the prey base, and depredate nests and adults.

Goshawks have intrinsic habitat needs, at several scales. Nest area, post-fledging family area, and foraging area make up the breeding home ranges of goshawks. Fire suppression and intensive forestry practices across the west led to the decline in forests with habitats available at all three scales within home ranges, on the level of several thousands of hectares. A great burden of this responsibility lies on federal land managers, as approximately 80% of the remaining goshawk habitat occurs on federal lands (ESFWS 1998a).

Protected Areas

Prior to Reynolds (1992) Management Recommendations for the Northern Goshawk in the Southwestern United States, goshawk habitat was managed at the nest stand level. Management

guidelines recommended a nest buffer of uncut, mature timber remain around nest sites. Buffer sizes varied, ranging from 8 to at least 42 ha, based on different studies (Hargis et al. 1994). Current standards for protecting or managing habitat for breeding goshawks dictate that nest area, post-fledging family area, and foraging area be addressed. Prescriptions for stand attributes (i.e. canopy cover, dbh, basal area, tree density, distance to water, distance to nearest clearing) are not continuous across the species' range, yet, the theory of multi-scale forest management for goshawks is applicable to the habitats in Wyoming.

Population Viability Analyses (PVAs)

Prediction of extinction risk, or projected population growth based on habitat condition, or population viability analysis (PVA), has not been published to the knowledge of the authors. Much of the debate surrounding trend estimates, and accurate calculation of demographic parameters (i.e. immigration, emigration, and age class specific fecundity and survival) are applicable to critics of PVAs. Given the logistical challenges of accurate PVA, Ruggiero et al. 1994) recommend the following guidelines summarized from the conservation literature in guiding population viability estimates in relation to management actions or implementation of conservation plans:

(1) connected habitats are better than disjointed habitats;

(2) suitable habitats in close proximity to one another are better than widely separated habitats;

(3) late stages of forest development are often better than younger stages;

(4) larger habitat areas are better than smaller areas;

(5) populations with higher reproductive rates are more secure than those with lower reproductive rates; and,

(6) environmental conditions that reduce carrying capacity or increase variance in the growth rates of populations decrease persistence probabilities.

The authors also point out that response to localized management actions are much more reliably evaluated for populations, as opposed extrapolating the effects to the species level (Ruggiero et al. 1994).

Conservation Action

Existing or Future Conservation Plans

There are presently no existing or future conservation plans for the Northern Goshawk. For over a decade "conservation" of this species has been driven by a collective will to amend forest management strategies, and ultimately prevent the need to list the species as threatened or endangered under the ESA. The backbone of goshawk management in the western United States is a document prepared by the Goshawk Scientific Committee, formed in 1990, for sustaining goshawks in the southwestern United States. The resulting document GTR RM-217, Management recommendations for the Northern Goshawk in the Southwestern United States, provided a state-of-the-science prescription for goshawk management on public lands. Cover types extant in Region 3 are the basis for this document, yet biological and behavioral similarities range-wide have enabled managers across the west to modify and apply these techniques to forest types not addressed by Reynolds et al. (1992). This document has withstood much controversy, including a soundly discredited petition to correct information disseminated by the USDA Forest Service (Olsen et al. 2003), and continues to inform goshawk management in the west.

Existing Regulatory Mechanisms

The Northern Goshawk is protected under the Migratory Bird Treaty Act. The Migratory Bird Treaty Act protects all migratory birds and their parts (including eggs, nests, and feathers) from illegal harvest, and commercial trade in birds and feathers. The revised candidate system under the Endangered Species Act resulted in the abolishment of the Category 2 (C2) standing. The

goshawk was a C2 species, and removal of this federal status may have reduced institutional willingness to expend resources on goshawk conservation, without a sense of close scrutiny by the USFWS. Therefore, on the ground regulatory mechanisms are somewhat absent for this species, except where forest plan guidance (USDA NFS), or federal agency status (USDA NFS Sensitive Species, Management Indicator Species or USDI BLM Sensitive Species) would apply.

There is an institutional awareness of the need for goshawk conservation, in part due to the extensive history of federal and state litigation. The National Forest Management Act (NFMA), is broad federal act which decrees that vertebrate species occurring entirely or largely on national forest lands be assured viable populations to the extent that species would not require ESA protection (Kennedy 2003). There are no extant monitoring or habitat management tools administered by the Wyoming State Game and Fish department at this time.

Existing Management Plans

Reynolds et al. (1997) provides a food web based prescription for conserving or rehabilitating goshawk habitat and the propagation of important prey species. An important underlying premise for this plan is that goshawk ecology varies spatially and temporally through the breeding season; hence management of nest area, post-fledging family area (PFA), and foraging area is prescribed. This report is not a "cookbook" for range-wide goshawk management, yet outside of the southwest (Region 3), GTR RM-217 has been influential in state or National Forest goshawk management planning in Alaska-Tongass NF, Utah, South Dakota/Wyoming-Black Hills NF, and the state of Utah. In the body of the USFWS 12-month finding on the petition to list the Northern Goshawk as threatened or endangered, confidence in revised forest management, and techniques which were derived from GTR RM-217, was a proximal basis for a ruling of "not warranted":

> "While timber management has been demonstrated to affect goshawks at least at local levels (Reynolds 1989, Crocker-Bedford 1990, Bright-Smith and Mannon

> 1994, Woodbridge and Detrich 1994, Beier and Drennan 1997, Desimone 1997), forest management practices, such as the use of controlled fire and selective thinning, also may make habitats more suitable to goshawks by opening up dense understory vegetation, creating snags, down logs, and woody debris, and creating other conditions conducive to goshawks and their prey (Reynolds et al. 1992, Graham et al. 1997)." (USFWS 1998a)

Existing Conservation Strategies

Habitat based analysis of goshawk distribution and productivity is essential for conservation strategy design in Wyoming. The following paragraph from Kennedy (2003) represents the habitat parameters for Region 2, which should be established as goals for landscape conservation:

> "The limited data on goshawk breeding season nest sites and foraging habitat suggests that old or mature forest stands with open understories, relatively high canopy closure, large trees and high stem densities are selected. The limited regional data suggest that foraging areas are more likely to occur in mature forests on gentler slopes (6-60%), with open understories and greater densities of large conifers (23.0-37.5 cm dbh; range = 0-11 stems/0.04 ha). Evidence for use of openings for foraging is also available but limited. Older forests with more open or uniform understories would probably support goshawks more than older forests with complex or very complex forest structure."

These parameters can be the underpinnings of landscape level planning for goshawk conservation, as addressed in Reynolds et al. (1992), with habitat allowances at the three critical spatial components of a goshawk's nesting home range (i.e. Nest Area, Post-fledging Family Area – PFA, and Foraging Area). Forest management for goshawks, were possible, should follow a design that mimics "regional natural disturbance regimes", as large even aged stands, monoculture, or predominantly early seral stage forests will not be conducive to goshawk habitation (Kennedy 2003).

Conservation Elements

Inventory and Monitoring

The inherent difficulty of conducting accurate breeding season monitoring programs is due to the biology of goshawks, in general, including large territory size, relative secrecy-especially during the incubation stage of reproduction, and low breeding densities. Migration surveys along flyway concentration points, have been developed to contribute to population trend estimates and further understanding of raptor migration behavior (Hoffman et al. 2002). In Wyoming, research has indicated that the Salt River Range and Commisary Ridge are both concentration points along north-south, leading line migratory corridors. Following a pilot study, the southern end of Commissary Ridge (southwestern tip of South Fork Mountain) approximately 37 km north of Kemmerer, Wyoming was selected for a long-term raptor migration research area (Smith 2003). Logistical support for this study was provided by the BLM – Kemmerer Field Office. Development of this research area will contribute to further understanding the dynamics of the Rocky Mountain flyway, and may prove beneficial in monitoring trends in goshawk populations, through population age-structure, overall abundance, and current research such as stable isotope analysis to further understand population demographics (Meehan et al. 2001)

Habitat Preservation and Restoration

The authors know of no specific Goshawk habitat restoration programs, yet implementation of Reynolds et al. (1992) in various forms across the west could be regarded as goshawk reserves. Testing of the efficacy of such measures has not yet been published.

Captive Propagation and Reintroduction

There are no reports of captive rearing of goshawks. Over the last five years goshawks were consistently the second or third most popular falconry bird taken from the wild in Wyoming (Cerovski 1999, 2000, 2001, 2002). As the history of falconry with goshawks goes back (literally)

to Attila the Hun (Squires and Reynolds 1997), survivability of captive held birds and rearing of fertilized eggs has certainly been successful in the past. The authors have not read of experimentation with introduction to the wild of birds reared in captivity.

Information Needs

Time and resource limitations may hinder the ability of land managers to perform broad, unbiased surveys for Northern Goshawk. Selecting survey habitat a priori can skew landscape use results to mature and old-growth habitats, those areas where survey efforts are focused. Randomness must be built into survey protocols to assure managers of the full range of habitat use within a particular resource area.

There is a critical need for further research into the effects of habitat alteration, fire suppression, and silviculture on goshawk reproductive success. Understanding the relationship between demographic rates (fecundity, mortality, and dispersal) and habitat quality in the principal cover types used by goshawks is essential, both in Wyoming and range-wide. Such rates measure individual fitness within a population, and may reflect causal mechanisms population change and indicate areas of concern or potential decline in goshawk habitation. Newton (1989b) was able to illustrate in a long term study of sparrowhawks that territory quality was correlated with lifetime reproductive success. A better regional understanding of the range in demographic rates, will enable managers to emulate forestry practices in areas where goshawk fitness is greatest.

Detailed diet analysis by cover type will also enable managers to monitor prey availability across various landscape treatments. More research is needed on the relative influence of prey distribution and abundance on habitat selection by goshawks in Wyoming, and population trends.

Tables and Figures

Table 1. Prey Items Taken by Northern Goshawks from Regional Studies

South Dakota/Wyoming – Black Hills NF

Barltelt (1977)

Mammals	**Birds**
Common	*Common*
Red Squirrel (*Tamiasciurus hudsonicus*)	Ruffed Grouse (*Bonasa umbellus*)
Least Chipmunk (*Tamia minimus*)	Wild Turkey (*Meleagris gallopavo*)
White-tailed Jackrabbit (*Lepus townsendii*)	American Robin (*Turdus migratorius*)
Mountain Cottontail (*Sylvilagus nuttallii*)	Gray Jay (*Perisoreus canadensis*)
Less Common	Dark-eyed Junco (*Junco hyemalis*)
Masked Shrew (*Sorex cinereus*)	*Less Common*
Thirteen-lined Ground Squirrel (*Spermophilus tridecemlineatus*)	--
Northern Flying Squirrel (G*laucomus sabrinus*)	
Woodrat (*Neotoma cinerea*)	
Northern Pocket Gopher (*Thomomys taploides*)	
House Mouse (*Mus musculus*)	
Norway Rat (R*attus norvegicus*)	

Wyoming – Medicine Bow-Routt NF

Squires (2000)

Mammals	***Birds***
Common	*Common*
Red Squirrel (*Tamiasciurus hudsonicus*)	American Kestrel (*Falco sparverius*)
Golden-mantled Ground Squirrel (*Spermophilus lateralis*)	Northern Flicker (*Colaptes auratus*)
Uinta or Least Chipmunk (*Tamias* spp.)	Steller's Jay (*Cyanocitta stelleri*)
Deer Mouse (*Peromyscus maniculatus*)	American Robin (*Turdus migratorius*)
Red-backed Vole (*Clethrionomys gapperi*)	Black-headed Grosbeak (*Pheucticus melanocephalus*)
Less Common	*Less Common*
Montane Vole (*Microtus montanus*)	Red-naped Sapsucker (*Sphyrapicus nuchalis*)
Snowshoe Hare (*Lepus americanus*)	Pine Siskin (*Carduelis pinus*)
American Marten (*Martes americana*)	Townsend's Solitaire (*Myadestes townsendi*)
Long-tailed Vole (*Microtus longicaudius*)	Dark-eyed Junco (*Junco hyemalis*)
Mule Deer (*Odocoileus hemionus*)	Evening Grosbeak (*Coccothraustes vespertinus*)
Western Jumping Mouse (*Zapus princeps*)	Hairy Woodpecker (*Picoides villosus*)
Ermine (*Mustela erminea*)	Pine Grosbeak (*Pinicola enucleator*)
Richardson's Ground Squirrel (*Spermophilus richardsonii*)	Ruffed Grouse (*Bonasa umbellus*)
	Western Tanager (*Piranga ludoviciana*)
	Gray Jay (*Perisoreus canadensis*)
	Mountain Bluebird (*Sialia currucoides*)
	Red Crossbill (*Loxia curvirostra*)
	Three-toed Woodpecker (*Picoides tridactylus*)
	Black-billed Magpie (*Pica pica*)

Good et al. (2001)

Mammals

Common
- Red Squirrel (*Tamiasciurus hudsonicus)*
- Ground Squirrel or Chipmunk, sp.
- Least Chipmunk (*Tamias minimus)*
- Lagomorph, sp.

Birds

Common
- American Robin (*Turdus migratorius)*
- Northern Flicker (*Colaptes auratus*)

Wyoming/Idaho - Targhee NF

Patla (1997)

Mammals

Common
- Snowshoe Hare (*Lepus americanus*)
- Unita Ground Squirrel (*Spermophilus armatus*)
- Red Squirrel (*Tamiasciurus hudsonicus*)
- Marmot (*Marmota caligata*)
- Nuttall's Cottontail (*Sylvilagus nuttallii*)

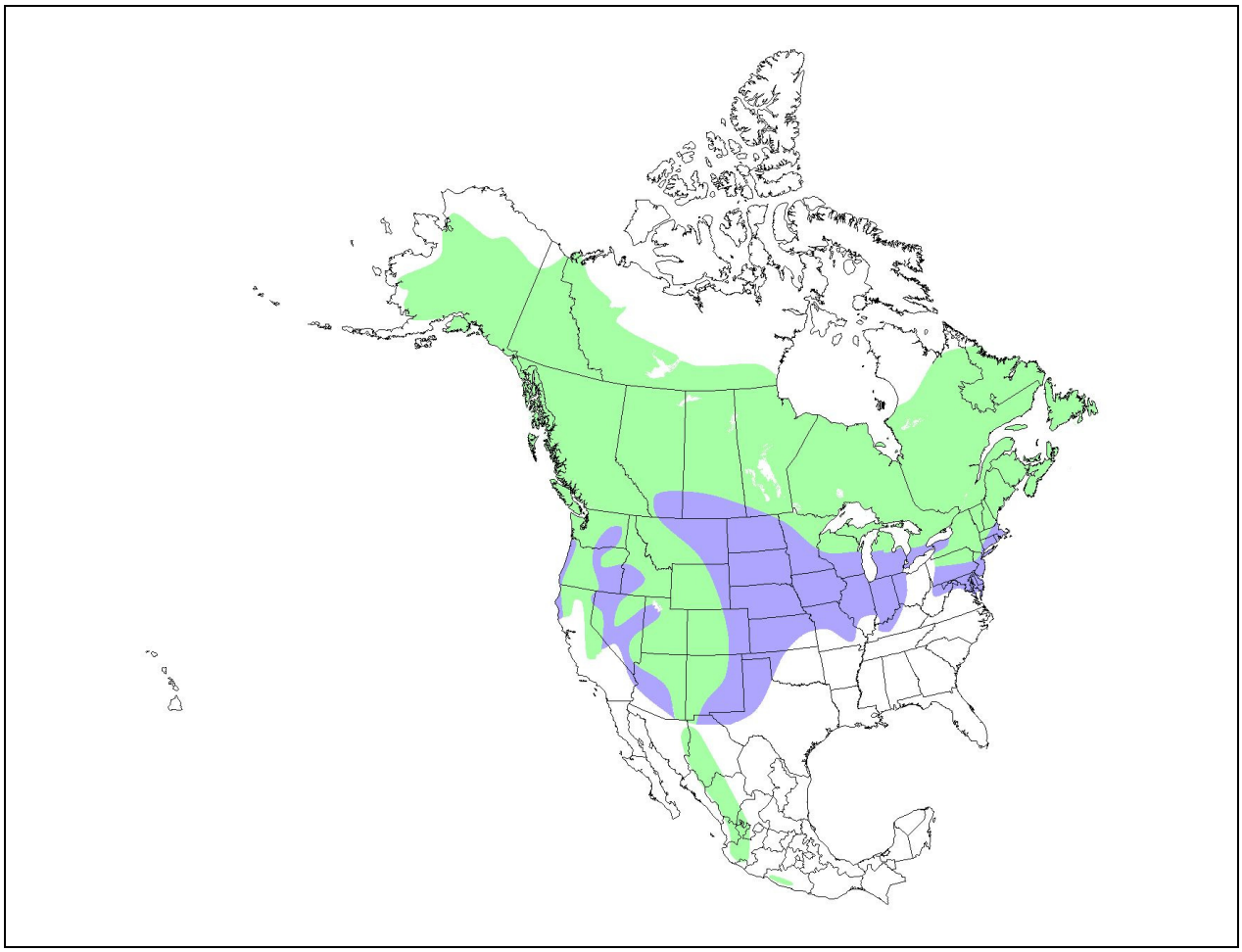
Less Common
- Pocket Gopher (*Thomomys bottae*)
- Long-tailed Weasel (*Mustela frenata*)
- Vole, sp.
- Northern Flying Squirrel (G*laucomus sabrinus*)
- Yellow Pine Chipmunk (*Tamias amoenus*)

Birds

Common
- Ruffed Grouse (*Bonasa umbellus*)
- Blue Grouse (*Dendragapus obscurus*)
- Grouse, sp.
- Common Raven (*Corvus corax*)
- Northern Flicker (*Colaptes auratus*)

Less Common
- Cooper's Hawk (*Accipiter cooperii*)
- Long-eared Owl (*Asio otus*)
- Boreal Owl (*Aegolius funereus*)
- American Robin (*Turdus migratorius*)
- Clark's Nutcracker (*Nucifraga columbiana*)
- Duckling spp.
- Steller's Jay (*Cyanocitta stelleri*)
- Gray Jay (*Perisoreus canadensis*)
- Woodpecker, sp.
- Red-naped Sapsucker (*Sphyrapicus nuchalis*)
- Townsend's Solitaire (*Myadestes townsendi*)
- Williamson's Sapsucker (*Sphyrapicus thyroideus*)

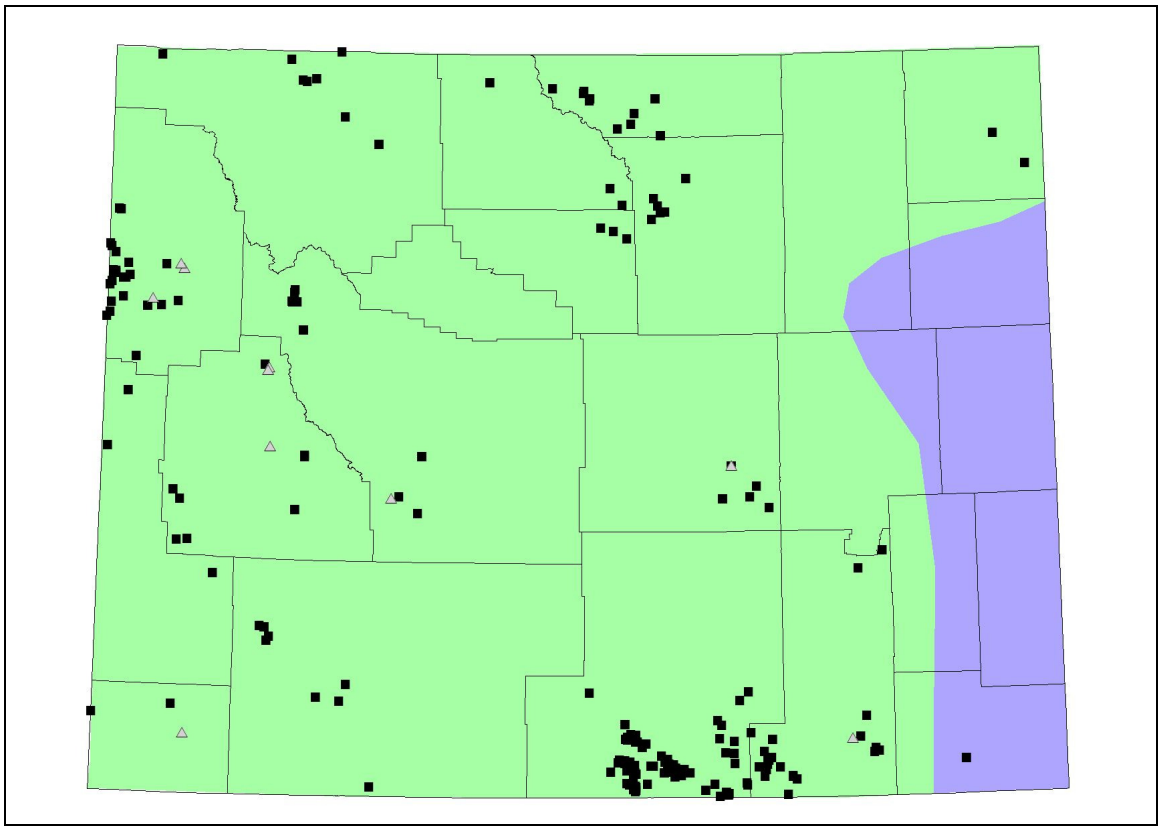
Figure 1. Northern Goshawk (*Accipiter gentilis*), North American Distribution
(Ridgely et al. 2003)



Year-round resident

Winter range

Figure 2. Northern Goshawk (*Accipiter gentilis*), Wyoming Distribution
(WYNDD 2003)



Northern Goshawk observations, after 1950.

Northern Goshawk observations, prior to 1950.

Year-round resident

Winter range

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Additional References

The compendium of literature for the Northern Goshawk (*Accipiter gentilis*) and subspecies is extensive, and would take up many pages here. Two documents which cite nearly all of the relevant literature are:

1. Squires, J. R., and R. T. Reynolds. 1997. Northern Goshawk (*Accipiter gentilis*). *In* The Birds of North America, No. 298 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.
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Either of these complete Literature Cited sections are available from the authors upon request.