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Conservation Assessment for the Woodpeckers in the Black Hills National Forest South Dakota and Wyoming

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Conservation Assessment

of

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INTRODUCTION

The Black Hills National Forest Land and Resource Management Plan was revised and approved as revised in 1997 (USDA Forest Service 1997). Several groups then appealed this decision to the Chief of the Forest Service. The Chief's decision in 1999 (USDA Forest Service 1999) stated that "the standards and guidelines established in the Revised Plan for maintaining viability of the Lewis's woodpecker are inadequate" (p. 47) and in addition, "additional evaluation of the sufficiency of the plan in providing for the diversity of plant and animal communities, and species viability, is needed" (p. 2). In response to this decision, the Black Hills National Forest is developing assessment plans for several species of interest in order to ascertain the important conservation issues for these species. This document represents a conservation assessment for woodpeckers.

This document thoroughly describes the biology and management issues related to the black-backed woodpecker, three-toed woodpecker, Lewis's woodpecker, red-headed woodpecker, downy woodpecker, hairy woodpecker, and northern flicker, especially as pertains to the Black Hills National Forest. The assessment draws information from primary scientific literature where possible, but also includes information from government documents, management plans, theses and dissertations, and other reports. The document covers information from the entire range of each species, but focuses especially on regional studies when the information is available. Since very little information is available that is specific to the Black Hills, regional information becomes very important. For the purposes of this report, the region is assumed to include South Dakota, Wyoming, Colorado, Montana and Idaho. On topics where information is not available from regional studies, the author tries to point out the relative holes in knowledge and the weakness of the conclusions.

While unique local variation in woodpecker response to habitat change is possible, enough data have been documented that some generalized conclusions can be drawn. The main assumption of the document is that data from elsewhere in the region is applicable in the Black Hills. For example, many studies have been conducted in forests dominated by species such as Englemann spruce and Douglas fir, which are not present in the Black Hills National Forest, and species such as cottonwood or lodgepole pine, which are rare in the Black Hills. The Black Hills is dominated by ponderosa pine and white spruce, with some areas where aspen, bur oak, and burch are common (Larson and Johnson 1999). The document assumes that the birds' response in similar habitats will be comparable (i.e. the response in white spruce may be similar to response in Englemann spruce). A list of species found in the Black Hills is located at the end of this assessment.

Each species is treated in a separate section covering a wide range of topics. Each section begins by discussing the current management status of the species, and then reviews the range, abundance, habitat use, and general ecology of the species, and concludes with a discussion of how this species responds to disturbance and the various conservation practices that are applicable. A summary follows each species account.

For some of the species, information is sparse or totally missing on a particular topic. For example, although much research has been done on these species, much of it focuses on summer habitat characteristics and very little is known about their dispersal habits or winter habitats.

Lack of information is noted in the appropriate section.

Envirograms (after Andrewartha and Birch 1984) are shown for each species following the text on that species. These diagrams draw from the information included in the report and illustrate a simplified web of interactions (biotic and abiotic) important to that species. It is important to remember these are hypotheses, based on the available information, but are not complete due to information gaps.

Tables 13-15, comparing population trends, habitat requirements, and responses to management activities among the seven species are located following all of the species assessments.

A general section follows that reviews the conservation practices for woodpeckers. This section was combined to avoid repetition within the species sections, since much of the information applies to all of the species mentioned. Most studies making management recommendations were making the recommendations for several woodpecker species as a group, so it would be awkward to break up the recommendations into individual species. Anything only applicable to a specific species is noted. This section includes suggestions for potential conservation measures in the Black Hills, examines existing models for woodpeckers, and discusses the existing surveying and monitoring methods for woodpeckers. The section concludes with a discussion of additional information needs.

A list of scientific names of all species mentioned in the report is included. The intent of this list is to eliminate the need for extensive use of scientific names throughout the text. Scientific names of woodpecker species and subspecies are given as they are needed within the report, but other animals and plant species are noted only by their common name where feasible in the text.

Acknowledgements, literature cited and a glossary of definitions are located at the end of the report.

Most studies of habitat use are based on observation, although there are also some that may be considered experimental studies. The term, observational study, for the purposes of this review, refers to a type of scientific study that does not involve manipulation of the environment. These studies rely on statistical relationships between variables to draw conclusions. In contrast, an experimental study would involve a manipulation of habitat to observe a cause and effect and requires a control group for comparison. Studies of resident bird populations before and after a clear-cut treatment would be experimental. The author does not mean to imply that one type of study is more reliable than another, but rather to point out the different types of studies that are involved in this review. Both kinds of studies require proper statistical design in order for conclusions to be valid.

A third type of article also included in this review is the anecdotal report. These are especially common in early natural history articles, and report on personal observations on topics not previously described. An example would be an article reporting on all the types of trees that the scientist had seen the birds nesting in during a trip to the woods. This is a report of observed data without a particular statistical design. Such articles are often valuable when obtaining basic information on species.

Studies described as reporting a *preference* for a particular habitat (or tree species, stand type, etc.) indicate a statistically significant use of that type of habitat more than random chance would allow based on how much of that habitat is available in the environment. Studies using other types of analyses are explained in more detail.

Finally, some mention should be made here of the boundaries of this document. Liggett and others (2001) "recognize a clear distinction between Conservation Assessments, which compile and synthesize scientific information, and Conservation Strategies and the Reference Models of Sustainability, which integrate information from the assessments." Therefore this assessment is NOT a management decision, and should not be viewed as such, but it does provide essential information to assist those who make the decisions.

BLACK-BACKED WOODPECKER

INTRODUCTION

Black-backed woodpeckers (*Picoides arcticus*), play an important role in the ecosystem, eating many invertebrate species and excavating cavities that can be used by secondary cavity users. They nest in snags and are principally associated with burn areas and mature forest stands.

They utilize 'hard' snags (Raphael and White 1984) and various adaptations allow them to excavate cavities and forage on these trees. For example, leg adaptations allow strong blows to trees (Spring 1965). Black-backs position their three toes in such a way that allows their heel to move in and out so they can deliver a blow (Spring 1965). They also position themselves farther from tree so they can lean back to deliver harder blows (Spring 1965).

Because of their habitat needs, they are at risk from activities such as fire suppression and salvage logging (Dixon and Saab 2000). This section summarizes the ecology and management of the species.

CURRENT MANAGEMENT SITUATION

Management Status

The U.S. Fish and Wildlife Service assigns no special conservation status to black-backed woodpeckers. Black-backed woodpeckers are not included on either the IUCN Red List of Threatened Species (Hilton-Taylor 2000), or the National Audubon Society's Watchlist (Muehter 1998). The Association for Biodiversity Information gives the species a rank of G5, meaning it is secure on most of its range (Association for Biodiversity Information 2001).

Regionally, the story is somewhat different. Of 74 species of montane birds in the Great Basin, black-backed woodpeckers are considered one of the top 10 most vulnerable to extirpation (Reed 1995). The U.S. Forest Service in Region 2 considers the black-backed woodpecker a sensitive species (Welp and others 2000). In the Partners In Flight region that includes the Black Hills, black-backed woodpeckers are considered to be under high regional threat (category IIC) (Panjabi 2001a; Partners In Flight 2001). The Wyoming Natural Heritage Database considers them globally common (category G5), but imperiled in Wyoming (S2) (Welp and others 2000). The Wyoming Game and Fish Department classifies the black-backed woodpecker as a category 4 species of special concern (Luce and others 1999). The Wyoming Bird Conservation Plan considers black-backed woodpeckers a level 2 species where monitoring is the focus (Cerovski and others 2001). South Dakota considers the species in category S3 meaning it is "either very rare and local throughout its range, or found locally … in a restricted range…"(South Dakota Department of Game Fish and Parks 2000).

Existing Management Plans

Forest Service biologists at the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers were available in the region (C. Schultz, personal communication).

Region 1 of the Forest Service (including forests in northern Idaho, northeastern Washington and Montana) does have an interim management plan that addresses black-backed woodpeckers (USDA Forest Service 1992). The recommendations include: maintaining snags and mature/old growth areas, leaving corridors between old growth areas, preventing snags from being cut for firewood (which may mean shutting down roads), delaying logging in black-backed woodpecker areas until July, maintaining snags in clumps, and leaving uncut patches dispersed through burn areas (USDA Forest Service 1992). The plan also specifies the preferred amount of snags for black-backed habitat: 1,692 hard snags (4 times the required number of soft snags) per 80 acres in burn areas and 342 snags, one-third of them hard, per 80 acres in unburned areas (USDA Forest Service 1992). However, it is unclear what these snag recommendations are based on, since they are lower than habitat use data from that region (see habitat characteristics section below).

In the Columbia Basin, where black-backed woodpecker habitat has declined more than 33% from historical levels (Wisdom and others 2000), an Ecosystem Management Project identified some strategies to conserve the species. These strategies include retaining old stands of large old trees (23 cm dbh), retaining the natural fire regime, allowing some beetle outbreaks, and reducing salvage logging (Wisdom and others 2000).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Characteristics of the black-backed woodpecker, *Picoides arcticus*, include an entirely black back, black and white barred sides, a white chest, a very small white stripe behind the eye, a thick white stripe below the eye, and three toes (Short 1982; National Geographic Society 1987). A yellow patch on the top of its head distinguishes the male (Short 1982). The birds are 23 cm (9.06 inches) (Dixon and Saab 2000) to 24 cm (9.5 inches) (National Geographic Society 1987) long with a wing length of 11.9 to 13.2 cm (4.7 to 5.2 inches) (Short 1982; Dixon and Saab 2000). Males are slightly larger and heavier than females with longer bills (Short 1982). Juveniles tend to be more brown than black with more white on the wings, and yellow spots (in females) or a small patch (in males) on the crown (Short 1982).

The black-backed woodpecker is a close relative of the three-toed woodpecker, *Picoides tridactylus,* based on morphology and behavioral interactions (Bock and Bock 1974; Short 1974) and has sometimes been referred to as the black-backed three-toed woodpecker (i.e. Spring 1965). Both of these birds have three toes (other woodpeckers have four) and other physical adaptations that help them excavate beetle larvae from tree trunks (Bock and Bock 1974). However, three-toed woodpeckers have white on their backs and white behind their eyes, and males also have large, streaky yellow patches on the top of their heads instead of the solid yellow of the black-backs (Dixon and Saab 2000). Three-toed woodpeckers also differ in their call and drumming patterns (Dixon and Saab 2000). Even abnormal colorations of other woodpecker species (such as downy woodpeckers) can be distinguished by the absence of barred sides and the yellow patch (Dixon and Saab 2000).

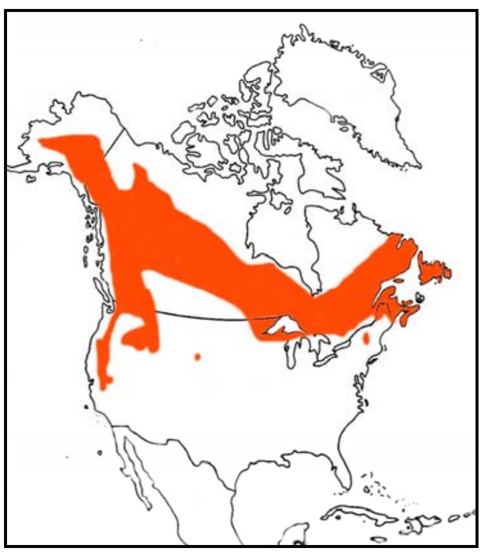
The black-backed woodpecker is not closely related to any of the other woodpeckers based on genetic analyses of mitochondrial DNA by Tennant (1991), which placed *P. arcticus* outside all of the other woodpecker species. However, *P. tridactylus* was not included in the analyses so it is not clear whether that would affect the results. Additional analyses by Weibel and Moore (2002) that includes 27 species still have P. arcticus and P. tridactylus as sister species, although they suggest the Picoides genera may need to be revised.

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

Black-backed woodpeckers are found only in North America (Dixon and Saab 2000). In the summer, black-backed woodpeckers range from central Alaska east across Canada to Newfoundland (Dixon and Saab 2000). In the U.S., their range extends into western Montana, northwest Wyoming, Idaho, portions of Oregon and Washington, northeast and east central California, northern Minnesota, northern Wisconsin, northern Michigan, northern Vermont, northern New Hampshire, and northern Maine (Dixon and Saab 2000). Somewhat disjunct populations exist in northeast New York and the Black Hills of South Dakota and Wyoming (Dixon and Saab 2000).

Figure 1. Distribution of black-backed woodpeckers. Red indicates the normal year-round distribution. Adapted from Dixon and Saab (2000) and National Geographic Society (1987).



The northern edge of their range is limited to where mixed coniferous forest stretches (Bock and Bock 1974). Black-backs are not present in the far northern regions of taiga that have only spruce trees (Bock and Bock 1974). They may be rare in parts of the Rockies due to dominance of spruce/fir forests with little pine (Bock and Bock 1974). Their distribution is slightly more restricted in these areas than three-toed woodpeckers (Bock and Bock 1974). Bock (1974) suggests that the larger size of black-backed woodpeckers may allow them to utilize the larger pine trees while the smaller three-toed woodpeckers can use the spruce.

Although these birds are not generally migratory in the north-south direction, during the non-breeding season their range expands and large numbers migrate as far east as Iowa, central Illinois, Indiana, Ohio, Pennsylvania, West Virginia, New Jersey, and Delaware (Dixon and Saab 2000).

Dixon and Saab (2000) indicate that, as far as is currently known, historical range was basically the same as the current range. Historically they regularly wintered in southeastern Wisconsin, but that is not common currently (Dixon and Saab 2000)

The infrequent irruptions in the northeast and midwest are sometimes tied to insect outbreaks (i.e. after outbreaks of Dutch elm disease) (Dixon and Saab 2000). After large forest fires in southeast Canada and New England, 293 black-backed woodpeckers were observed during the winter (West and Speirs 1959). Some incidents cannot be explained by insects (Yunick 1985). These large-scale irruptions are not to be confused with local incidents where birds may be responding to insect outbreaks in forests that are part of their normal range.

Additional Information (Local Distribution)

Although not common, black-backed woodpeckers are found in the higher areas of the Black Hills (South Dakota Ornithologists Union 1991). Some sources consider the Black Hills to be on the edge of their range (Bock and Bock 1974) or disjunct from the main range (Dixon and Saab 2000).

Estimates Of Local Abundance

Recent records from South Dakota show black-backed woodpeckers present in the fall of 1997 (Palmer 1998a) and the winter of 1998-1999 (Schenck 1999a) and in Christmas counts for the years 1998-1999 and 1999-2000 (South Dakota Bird Notes 1999,2000). The South Dakota Ornithological Society could not confirm black-backed woodpeckers breeding in South Dakota in 1999 or 2000 (Schenck 1999b, 2000).

Breeding Bird Survey's Interactive Map shows zero black-backed woodpeckers per route for both the Sundance Route Group and the Black Fox Group (including Hill City and Custer) (Sauer and others 2001). Preliminary data from the Christmas Bird Counts in the Spearfish area did not show any black-backs from 1996 to 2000 (Cornell Laboratory of Ornithology and National Audubon Society 2001).

During the 2000 field season, 35 black-backed woodpeckers and nine nests were found in a survey of the Black Hills National Forest (Mohren and Anderson 2000). Their 2001 survey found 38 black-backs (Mohren and Anderson 2001). Panjabi (2001b) reported 24 black-backed woodpeckers in the Black Hills. Although these are preliminary results, they do indicate the birds are still breeding in the area.

Population Trends

Neither the Breeding Bird Survey, nor the Christmas Bird Count shows a significant ($p<0.05$) survey-wide population trend for black-backed woodpeckers (Sauer and others 1996; Sauer and others 1999; Sauer and others 2001). There is not a large enough sample size from Breeding Bird Survey Routes to determine trends in the Black Hills region (Patterson 2000).

Movement Patterns

Black-backed woodpeckers do not usually migrate, but occasional population irruptions south of the breeding range do occur (Dixon and Saab 2000). Black-backs tend to be found in larger numbers in areas with insect outbreaks (see discussion below), but it is still not clear how these dynamics work or how the birds disperse following outbreaks. These dynamics and general information on movement patterns in this species are areas where much research is needed (Dixon and Saab 2000). No information is available on dispersal of black-backed young from their birthplace. No information is available on differences in movements between age and sex classes. It is unknown whether there are any links between the Black Hills' population and populations elsewhere.

Habitat Characteristics

General Habitat

Black-backed woodpeckers live in burned and unburned areas of mixed coniferous forests consisting of various tree species in different geographical areas. Tree species used include: spruce, tamarack, pines, firs, or mountain hemlock (Dixon and Saab 2000). Bock and Bock (1974) summarize many observations of black-backs by stating they live in spruce, pine, and other coniferous forests. Ponderosa pine and white spruce are the most common tree species in the Black Hills (USDA Forest Service 1996), so the forest should be able to support these birds.

Black-backed woodpeckers are found at a range of elevations. The elevation varies geographically from sea level to 1280 m (4200 ft) in the eastern part of the range, from 1219 to 3109 m (4000 to 10,200 ft) in California, to over 1371 m (4500 ft) in South Dakota (Short 1982). Usually these birds are found at lower elevations than the closely related three-toed woodpecker (Bock and Bock 1974). In a systematic search for woodpeckers along transects in the Black Hills, black-backed woodpeckers were observed in ponderosa pine stands from 1411 to 1867 m (4629 to 6125 ft) in elevation (Mohren and Anderson 2000).

Very little information is available on patch size requirements. Home range estimates vary from 61 to 328 ha (151 to 811 acres) from limited data in various geographical locations (Dixon and Saab 2000). Haldeman (1980) suggests that 30 ha (75 acres) are required for each pair although the basis for his statement is unclear. In Idaho after a burn, nests were only found in stands larger than 12 ha (29.7 acres), although the birds utilized areas from 30 to 50 ha (74.1 to 123.6 acres) most commonly (Saab and others in press). Further information on territory size and density is discussed under the Demography section. In the Black Hills, the presence of black-backed woodpeckers may not be affected by the size of the stand, based on a study with a small sample size (Rumble and others 2000).

Black-backs are associated with burns, but the number of years post-fire that these birds utilize an area differs in different studies. A meta-analysis of bird studies in various habitats found reports of black-backed woodpeckers are virtually restricted to early-successional burn areas

(Hutto 1995). In a Montana forest after a July burn, 20 black-backs were present in November, but had disappeared by March (Blackford 1955). Black-backed woodpeckers have been discovered nesting successfully within weeks of an intense forest fire in Alberta (Villard and Schieck 1997).

In Alaska, black-backs used burn areas for 2 to 3 years and then decreased (Murphy and Lehnhausen 1998). In Idaho, the birds used burn areas that were two to four years old, although it is not clear whether they subsequently decreased since the study did not continue (Saab and Dudley 1998, Saab and others *in press*). In Wyoming coniferous forests, black-backs were most common in the first few years after fires, and were only present in low numbers in unburned areas (Taylor and Barmore 1980).

Black-backed woodpeckers are not always restricted to burned areas only a few years old. A California study found black-backs breeding in both burned and unburned areas five years after a fire in mixed-conifer forest (Bock and Lynch 1970). Black-backed woodpeckers were significantly more abundant in burned areas than in unburned areas of a lodgepole pine forest in Montana (Caton 1996). Six years after fires in a mixed-conifer forest in California, black-backs nested most commonly in burned areas, but by 21 years post-fire, black-backs were virtually absent (Raphael and others 1987).

Ten of eleven black-backed nests were in burn areas in a study in the Yellowstone area (Hoffman 1997). High levels of nest success (71-100%) are reported from some burn areas (Dixon and Saab 2000). Success in burn areas suggests that burns may be source habitat (after Pulliam 1988; Pulliam and Danielson 1991) where offspring above that needed to replace the local population move to other, lower quality forest patches, called sinks (non-burn areas for this species), where reproductive efforts are not as successful (Hutto 1995). This theory has not been directly tested in these woodpeckers.

A study in a lodgepole pine forest in northwestern Wyoming showed the habitat surrounding the burn may also affect how the woodpeckers use the habitat (Skinner 1989). For example, black-backs in forest bordering riparian areas were found only in the burned habitat and only during the breeding season. However, in forest bordering sagebrush habitat, black-backs were more common in burned areas in both breeding and post-breeding seasons.

In his review of bird habitat in the Black Hills, Haldeman (1980) states that black-backed woodpeckers used mature and old-successional stages of the forest. Panjabi's (2001b) survey found black-backs mostly in burned and late-successsional pine. A study in Newfoundland supports this statement with the finding that black-backed woodpeckers clearly preferred older stands, especially those more than 80 years old, over younger stands (Setterington and others 2000). In black spruce forest in Quebec, black-backed woodpeckers were found only in mature forest and recent burns (Imbeau and others 1999). Saab and others (in press) found that in ponderosa pine forests in southwestern Idaho, black-backed woodpeckers are associated most closely (from multivariate statistical analyses) with unlogged, burned Douglas fir stands from 30 to 50 ha (74.1 to 123.6 acres) with high (>70%) pre-fire crown closure. These Idaho stands had various severity of burns. Logging created patches where remaining snag densities were 43 snags >23 cm dbh and 5 snags >53 cm dbh per ha, compared to unlogged areas of 81 snags >23 cm dbh and 17 snags >53 cm dbh per ha. In an Oregon study, they preferred mature stands from 1326 to 1646 m (4350 to 5400 ft) in elevation, actually avoiding young or logged stands (various logging methods including shelterwood cuts) (Goggans and others 1989). The same study found more nests built in unlogged stands (49%), than in stands with logging of various regimes (26%) or in fuelwood areas (26%).

Preference for older habitats or early-successional burn areas may be related to the presence of large snags (Setterington and others 2000) or to the temporal nature of insect outbreaks (i.e. Blackford 1955). Since wood-boring insects play such an important role in black-backed woodpeckers' diet (see section on Prey Species) and in promoting decay of trees (i.e. Furniss and Carolin 1977; Amman and others 1997), it makes sense that woodpeckers would respond to their presence. Also, snags created by burns may only be useful to a particular species while in a certain decay state (Raphael and White 1984). Therefore, the number of useable snags will often decrease at some point after a fire since no new snags are being created (i.e. see model developed in Raphael and White 1984). For example, in a predominantly ponderosa pine forest in Arizona, snags were followed after prescribed burns (Horton and Mannan 1988). During the first year of the Horton study, there was a 45% decrease in snags, especially in older snags and in snags with medium amounts of decay. The rate of decay likely differs between types of stands and burn intensities, possibly explaining differences between studies in the length of time a stand is used by woodpeckers following fires.

Nesting Habitat

Black-backed woodpeckers have been observed using many different species of live trees or snags for nest trees. These species include aspen, paper birch, Douglas fir, western larch (a.k.a. tamarack), red maple, jack pine, lodgepole pine, ponderosa pine, red pine, black spruce, white spruce, balsam fir, noble fir, red fir, silver fir, and even telephone poles (Bull and others 1986; Goggans and others 1989; Dixon and Saab 2000). In a study in Yellowstone, areas of the forest had been burned, logged, or undisturbed and consisted mainly of lodgepole pine with some aspen, Douglas fir, and subalpine fir (Hoffman 1997). Black-backs did not nest in aspen trees or in logged areas in this study. The Black Hills National Forest has significant numbers of ponderosa pine, white spruce, aspen, and birch (USDA Forest Service 1996), so these are the trees potentially being used locally.

Apparently some heartrot is helpful for these birds to construct cavities. Some sources state that live trees must have some amount of heartrot for black-backs to effectively construct a nest cavity (Goggans and others 1989). Significantly more nests were excavated in areas with more heartrot fungus infection in a Colorado aspen stand (Winternitz and Cahn 1983). After a beetle epidemic in Oregon, nests were found in lodgepole pines with heartrot (Goggans and others 1989). Black-back nests (n=2) were found only in dead pine trees after a northwestern Montana beetle outbreak in a lodgepole pine forest (Lester 1980). Nest trees used by cavity-nesting birds were significantly softer than random trees in aspen stands in Arizona (Schepps and others 1999). The presence of bark was correlated with hardness of aspen trees in Arizona, but it explained a small amount of the variation (Schepps and others 1999).

Burn areas have an abundance of snags and dying trees, which are very important as woodpecker nest sites. In fact, 60% of nests were in dead trees in one Oregon study (Bull and others 1986). In California, 71% of black-backed woodpecker nest sites were snags (Raphael and White 1984).

Several studies have examined specific characteristics of the nest trees used by black-backed woodpeckers (see Table 1). Important attributes of a nest tree listed in the table include: the tree's diameter at breast height (dbh), the height of the nest tree, and the height of the actual nest cavity. Data vary with geographical area and forest type. No data are currently available for black-backed woodpecker nests in the Black Hills (although see Mohren and Anderson 2000). Studies from other western mixed conifer forests are listed in the table and are the closest applicable data available.

Table 1. Summary of Nest-Tree Characteristics of Black-backed Woodpeckers

Tree Species Used	DBH, cm[a]	Tree height, m[a]	Nest height, m[a]	Location	Forest Type	Notes[b]	Citation
Ponderosa pine and Douglas-fir; all snags	39	21.7	9.5	Idaho	Ponderosa pine/ Douglas fir	Burned forest, n=35	(Dixon and Saab 2000)
---	44.5	16.8	2.8	California	Jeffrey pine/ white fir	n=7	(Raphael and White 1984)
---	22	---	---	Montana	---	Burned forest	(Harris 1982)
Mostly ponderosa pine, some lodgepole pine, western larch	37	19	5	Oregon	Ponderosa pine/ lodgepole pine/ western larch	n=15	(Bull and others 1986)
---	25.4	---	---	Montana	Western larch/ Douglas fir	Most birds in old growth, n=2	(McClelland and others 1979)
Mostly western larch, some Douglas fir, all snags	40	28	11	Montana	Lodgepole pine	Burn area, n=11	(Caton 1996)
Douglas fir and western larch	25 (*min* 20)	---	---	Montana	Douglas fir/ western larch	n=2	(McClelland 1977)

[a] Measurements given are means if only one number is stated, minimums if preceded by *min*, or ranges if two numbers are listed.
[b] Sample sizes for studies are listed as "n=".

Although they prefer large snags, Bull and others (1986) found black-backed woodpeckers preferred smaller-diameter nest trees relative to other woodpeckers and speculated the reason was a higher percentage of sapwood in these smaller trees. Among eight cavity-nesting birds in burned forests of Idaho, black-backed woodpeckers selected nest sites with the highest tree densities, smallest diameters, and least-decayed snags (Saab and Dudley 1998, Saab and others *in press*). See Table 14 for a comparison of species habitat requirements.

Nest sites are selected also for nearby foraging areas and multiple potential nest trees (Caton 1996). Therefore, not just the specific nest tree is important, but also the characteristics of the area immediately around the nest tree. As the following studies illustrate, features ranging from basal area to amount of downed wood seem to be important for selection by the black-backs as breeding areas. In a burned Montana lodgepole pine forest, black-backed woodpeckers nested in areas with trees averaging 35cm (13.78 inches) in dbh, basal area of 34 m^2/ha (365 ft^2/2.5 acres) (representing a significant preference over what was randomly available), and live canopy of only 1% (Caton 1996). In burned areas in Montana conifer forests, black-backed woodpeckers preferred areas with larger dbh trees than random for nesting (Hitchcox 1996). Nest sites also had higher tree densities and lower amounts of tall shrub cover than randomly available (Hitchcox 1996). In the Yellowstone area, black-backed nest sites were more likely to be in areas with low amounts of small down wood, but greater amounts of larger, solid debris (Hoffman 1997).

Black-backed woodpecker density in a Newfoundland balsam fir forest increased with more large snags, and decreased as the total number of dead stems increased (Setterington and others 2000). In addition, the size of the snags was more important than the number of snags (Setterington and others 2000).

Arrangement of snags may also be important. In Idaho after a burn, the relatively small-diameter snags surrounding nest trees were not evenly distributed, but were clumped (Saab and Dudley 1998; Saab and others in press).

Foraging Habitat

Black-backed woodpeckers also require suitable foraging areas. This section provides an overview of the type of stands used for foraging, as well as the particular trees frequented by the birds.

Foraging activity was primarily in unlogged areas (88%) in Oregon with 12% in fuelwood areas, but logged stands were avoided (Goggans and others 1989). In Oregon, the woodpeckers foraged predominantly (97% of the time) on ridges (Bull and others 1986). Significantly more of their winter foraging was done in burn areas than in unburned areas in a mixed-conifer forest in Washington (Kreisel and Stein 1999).

Apparently, several different tree species can be used. In Oregon, a study found 93% of foraging areas were lodgepole pine and only 5% mixed-coniferous stands (Goggans and others 1989). However, in Montana, Harris (1982) found the birds had a significant preference for Douglas fir and against larch. In Alaska, spruce was the most commonly selected species for foraging (Murphy and Lehnhausen 1998).

Characteristics of specific forage trees varied. In Montana, foraging trees in two areas had average dbhs of 12 and 25 cm (4.72 and 9.84 inches) (Harris 1982), while in Canada, the dbh ranged from 7.5 to 25 cm (2.95 to 9.84 inches) (Villard 1994). Foraging height in Montana averaged 4 and 5 m (13.12 and 16.40 ft) above ground (Harris 1982). In burn areas, moderately burned trees (less than half to slightly more than half burned) were chosen for foraging in Alaska (Murphy and Lehnhausen 1998). In burned, mixed-coniferous forest of northeastern Washington, black-backs foraged primarily on mid-level and lower trunks of western larch and Douglas-fir (Kreisel and Stein 1999).

Whether snags or live trees are used for foraging apparently depends on what the prey in the area is attacking. Living lodgepole pine was utilized by black-backs 54% of the time in one Oregon study (Bull and others 1986), while snags were preferred in another Oregon study (Goggans and others 1989). In Washington, 99% of foraging occurred on snags (Kreisel and Stein 1999). In California, 61% of foraging occurred on live trees (Raphael and White 1984).

Besides standing trees, downed wood is also important in some forests. In a Canadian study, black-backed woodpeckers spent 41% of their time foraging on downed woody material, always focusing on trunks rather than branches (Villard 1994). Downed wood was also an important source for foraging in a lodgepole forest in Yellowstone National Park (Hoffman 1997).

It is theoretically possible to increase the amount of foraging habitat available to the woodpeckers in a stand. Bergvinson and Borden (1991) found that applying glyphosate (diluted Roundup) increased the efficiency of the woodpeckers' foraging and decreased the time the trees needed to decay enough for cavity excavation. They did not follow the woodpeckers to determine if the glyphosate had any negative effect on the woodpeckers or other species, so caution should be used before considering treatments of large areas.

Roost Habitat

In lodgepole pine forest in Oregon, black-backs preferred mature timber stands for roosting, and their roost trees averaged 27.94 cm (11 inches) dbh (Goggans and others 1989).

Food Habits

Black-backed woodpeckers obtain food by gleaning (visual inspection and removal of food from the tree surface and cracks in the bark), pecking (tapping on the surface to locate insect tunnels or to stimulate insects to move), scaling (pealing or flaking of pieces of bark), and excavating (drilling or probing into the bark or substrate) (Ritchison 1999; Dixon and Saab 2000). The method of choice is not clear, although most likely depends on the type of food available. In Alaska, black-backed woodpeckers foraged mostly by excavation with some time spent utilizing the peck and flake method (Murphy and Lehnhausen 1998), while in Oregon, scaling was the primary method occurring 72% of the time, with pecking and gleaning in lesser amounts (Bull and others 1986). In California, gleaning occurred 32% of the time and drilling (probably a combination of pecking and excavating) occurred 68% of the time (Raphael and White 1984). In a Canadian study, foraging time was split between pecking, scaling, and excavating (Villard 1994). In the winter in a mixed-conifer Washington forest, black-backed woodpeckers used flaking and drilling at low to middle heights on trunks of Douglas fir and western larch (Kreisel and Stein 1999).

Due to potential competition between black-backed and three-toed woodpeckers (see later section on Competitors), some have suggested the two species have developed different foraging strategies (Villard 1994), but this is not always supported by data. Villard (1994) found that three-toed woodpeckers spend more time with slightly different foraging mechanisms, foraged higher on trees, and used scaling more than black-backed woodpeckers (Villard 1994). However, Harris (1982) found no difference in foraging height between the two species.

Prey Species

Studies of stomach contents showed black-backs' diet consists of 89% animal matter (64% wood-boring Coleoptera species larvae, 13% wood-boring caterpillars, 3% other beetles, 6% ants, and a small amount of spiders and other insects) and the remainder cambium and rubbish with a small amount of fruit and mast (Beal 1911). Black-backed woodpeckers in Alaska forage mostly on wood-boring beetle larvae, especially the white spotted sawyer (*Monochamus scutellatus*) (Murphy and Lehnhausen 1998). Wood-boring insects in the Black Hills that are candidates for woodpecker food include: Coleoptera (*Dendroctonus ponderosae, D. valens, D. rufipennis, Ips pini, I. Integer, I. knausi, I. Borealis lanieri, Pityogenes sp., Pityokteines sp., Pityophthorus sp., Melanophila sp., Agrilus sp., Acanthocinus sp., Monochamus sp.,* and *Saperda sp*.) and Hymenoptera (*Trimex sp*.) (J. McMillin, personal communication).

<u>Characteristics Of Prey</u>

Wood-boring beetles are extremely important food sources for black-backed woodpeckers as indicated above. Wood-boring beetles exhibit many differences in host preference and timing of outbreaks among species. For example, in the Black Hills, ponderosa pine is a host for *Dendroconus ponderosae*, *D. valens*, and *Ips pini*, while white spruce is host for *Dendroctonus rufipennis* and *Ips borealis lanieri* (J. McMillin, personal communication). *Agrilus sp.* and *Trimex sp.* utilize various hardwoods and *Saperda sp.* inhabit aspen trees (J. McMillin, personal communication). General characteristics of one common beetle, the mountain pine beetle, are described here. Specifics on other insect species are given elsewhere (i.e. Furniss and Carolin 1977).

Mountain pine beetles usually have a one-year life cycle, which begins as eggs are laid in summer or fall in tunnels that the female makes within the tree (Amman and others 1997). The eggs hatch in about two weeks and the larvae feed on the tree's phloem until the following summer when they pupate and become adults (Amman and others 1997). Adults make an exit hole where they can leave the tree to find a mate and then attack new trees (Amman and others 1997). Trees defend themselves from small numbers of beetles by producing pitch, but large numbers of beetles overwhelm trees (Amman and others 1997). Mountain pine beetles survived best in trees with 10 to 11 inch (25.5 to 27.9 cm) dbh in Montana (Lester 1980).

Adult beetles that have emerged release pheromones, which attract other beetles to the site and may contribute to epidemics when large numbers of susceptible trees are available in a particular area (Furniss and Carolin 1977). Beetles also carry fungi, which infect trees' sapwood, contributing to the death of the tree (Amman and others 1997). Wood-boring beetles are very quick to infect dead trees after a fire (Evans 1966; Villard and Schieck 1997). Drought, windblown or snapped trees, fires, lightning strikes, and other diseases all make trees susceptible to attack (Furniss and Carolin 1977). Cold temperatures and normal amounts of moisture naturally control these insects (Furniss and Carolin 1977; Amman and others 1997).

Woodpeckers kill many insects, either directly by drilling holes or peeling bark and eating the larvae, or indirectly when their holes dry the bark thereby drying up the beetle larvae (Amman and others 1997). Any larvae contained in the flakes of bark removed by woodpeckers are also likely to die either due to cold or dessication (Otvos 1965, 1979; Kroll and Fleet 1979). Thinner bark may also allow more insect parasites to enter and attack the insects (Otvos 1979; Kroll and others 1980). Parasites increased 87% after woodpeckers stripped bark during an eastern Texas outbreak of pine beetles (Kroll and others 1980).

Although woodpeckers do respond behaviorally to the presence of prey species (i.e. by aggregating in outbreak areas), their capacity for numerical response is limited because they feed on other species and have other limiting factors (Otvos 1979). Population trends of woodpeckers and pine beetles did respond to one another during a pine beetle outbreak in eastern Texas (Kroll and others 1980). For example, a large increase in beetles in 1971 and 1972 was followed by an increase in woodpeckers in 1972 to 1973. Beetles subsequently declined in 1972 to 1973, while woodpeckers declined in 1974 to 1975. Both woodpeckers and beetles showed large increases in 1975 and 1976.

How much of the insect population is being consumed by woodpeckers is still being debated. In some areas of a mountain pine beetle outbreak in Montana, 96-97% beetle mortality occurred where woodpeckers were present (Lester 1980). In eastern Texas, southern beetle mortality due to woodpeckers (as a group) was 3.5% (eggs) and 63.5% (emerging adults) (Kroll and others 1980). In a mixed-conifer forest in California, woodpeckers (hairy, downy and flickers) consumed 31.8% of beetles over two beetle generations (Otvos 1965).

After a large outbreak of spruce beetles in Colorado following blowdowns, foraging activity of woodpeckers (three-toed, downy, and hairy woodpeckers were present) was observed from November to June (Hutchison 1951). In plots with 24,000 to 32,000 beetles infesting each tree, woodpeckers were eating 53 to 57% of the beetles. These numbers were calculated from the amount of bark removed from the trees.

Winter mortality of spruce beetles in a Colorado outbreak was due mostly to woodpeckers (three-toed, hairy, and downy woodpeckers were present) (McCambridge and Knight 1972). Woodpeckers were responsible for up to 70% of mortality one winter for a single brood of spruce beetles. Overall mortality (summer and winter mortality combined) showed around 27% of broods were killed by woodpeckers.

Although the woodpeckers are eating many insects, scientists believe they are not actually suppressing beetle epidemics, but may be helpful in preventing outbreaks (Bruns 1960; Beebe 1974; Otvos 1979; Amman and others 1997). Woodpeckers respond to insect outbreaks behaviorally, not by increasing their breeding levels (Beebe 1974). For example, woodpeckers as a group were more common in areas with insect outbreaks during winter in Texas (Kroll and Fleet 1979). Besides increasing in numbers, woodpeckers focus their predation more in outbreak areas. Woodpeckers (three-toed and hairy woodpeckers) had a larger percentage of spruce beetles in their stomachs in outbreak areas than in areas with lower, endemic levels of spruce beetles (Koplin and Baldwin 1970). In endemic situations, woodpeckers ate 19% of available spruce beetle larvae, but in epidemic situations the woodpeckers consumed 83% of available larvae (Koplin 1972). The woodpeckers were more efficent predators at epidemic levels and could increase in density (Koplin 1972). Nest boxes can increase the number of birds of some species, but whether increasing the number of woodpeckers with nest boxes could control insects is not well understood (Franz 1961), although such a labor-intensive method may not be practical over large areas (Otvos 1979). Also, there may be other limitations on the number of woodpeckers in an area, such as territory boundaries, etc (Koplin 1972). In addition, woodpeckers may have more effect on certain life stages of beetles (Koplin and Baldwin 1970; Kroll and Fleet 1979; Kroll and others 1980) or at certain times of the year (Otvos 1979). Clearly more information is needed on how woodpeckers respond to outbreaks and how they could be encouraged to control insects further.

Breeding Biology

Phenology Of Courtship And Breeding

Nest construction occurs from April to May or early June (Short 1982; Dixon and Saab 2000). Black-backs lay their eggs from late April to early June (Dixon and Saab 2000) and the eggs are incubated from 12 to 14 days before hatching (Ehrlich and others 1988). The young fledge at 21 to 25 days after hatching, usually in early June to July (Dixon and Saab 2000). These dates vary, for example in an Oregon study 63% of nests fledged after July 6 (Bull and others 1986). Bull and others (1986) hypothesize this was an attempt to reduce competition from the other woodpecker species in the area. In South Dakota, nesting occurs from May to July, with earliest reports of nest building on April 24 and earliest evidence of young on June 20 (South Dakota Ornithologists Union 1991).

Courtship Characteristics

Call notes in the form of a short click or "kyik" and drumming, a repeated tapping with a particular cadence, characterize the courtship period (Dixon and Saab 2000). Other information about courtship is unknown.

Clutch Initiation, Laying, And Size

Nests usually contain three to four eggs (Short 1982), but may contain two to six eggs (Dixon and Saab 2000). The white eggs average 25.03 mm long and 18.20 mm wide (1 by 0.72 inches) (Dixon and Saab 2000). If the first clutch is lost, a second clutch may be laid (Dixon and Saab 2000).

Parental Care

Both the male and female incubate, brood, and feed young (Dixon and Saab 2000). Females make more frequent feeding trips, but males carry more on each trip, so both contribute substantially to the diet of the nestlings (Kilham 1966; Short 1974). Most prey is obtained less than 1000 m (0.62 miles) from the nest (Kilham 1966). Nestlings are aggressive towards one another (Kilham 1966).

Site And Mate Fidelity

Black-backed woodpeckers excavate a new nest cavity each year (Dixon and Saab 2000). Limited data suggest that at least some birds re-nest in the same area in following years (Dixon and Saab 2000). No information is available on mate fidelity.

Demography

Life History Characteristics

No information is available on the age of first reproduction, the proportion of the population that is breeding, or other life history characteristics.

Survival And Reproduction

No information is available on longevity or overall survivorship for black-backed woodpeckers. Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995).

Nest success can be quite high. Dixon and Saab (2000) report nesting success in burned areas of 87% (n=35) in Idaho and 100% (n=14) in Wyoming. In a study in a partially logged Oregon lodgepole pine forest, overall nesting success was 63% (n=35) (Goggans and others 1989).

Social Pattern For Spacing

Breeding territories are defended by both sexes (Dixon and Saab 2000). The defense behavior is especially aggressive towards other black-backs during the nesting period (Short 1974).

Very little information is available on spacing. One study reported 1.5 km (0.93 miles) between pairs during the breeding season (Lisi 1988 as cited in Dixon and Saab 2000). Haldeman (1980) stated 30.4 ha (75 acres) are needed for each pair. A review of the limited data from various studies showed home ranges from 61 to 328 ha (150.7 to 810.5 acres) in various locations (Dixon and Saab 2000). In Oregon, home range varied from 72 to 327.8 ha (178 to 810 acres) and was related to the proportion of unlogged and mature forest within the home range (i.e. less mature forest = bigger home range) (Goggans and others 1989).

Density estimates vary with location and quality of habitat. The maximum density recorded in an Oregon study was 1.31 black-backed woodpeckers per 100 ha (247.1 acres) (Bate 1995). Higher densities are known from burn areas (Dixon and Saab 2000). For example, the maximum density was 0.25 birds per ha (2.5 acres) in an Alaska burn area (Murphy and Lehnhausen 1998). After a fire in Idaho, nest density was 0.4 nests per 40 ha (98.8 acres) (unpublished data cited in Dixon and Saab 2000). In a Newfoundland study, the calculated black-backed density ranged from 0.1 to 0.2 presumed pairs per second-growth stand to 0.43 presumed pairs in unlogged areas (Setterington and others 2000). These were listed as presumed because any evidence of active nest was counted as a pair. The stands in that study varied in size, but were part of continuous forest of at least 3 ha (0.7 acres) (Setterington and others 2000).

Local Density Estimates

Regional density estimates available are from two studies. A Montana study estimated up to 15 individuals per 40 ha (98.8 acres) in a burn area (Harris 1982). Maximum densities of 3.9 pairs per 40 ha (98.8 acres) were found in burned spruce-fir habitat in Yellowstone National Park (Pfister 1980). No regional density data are available for unburned areas. No information is currently available for densities in the Black Hills National Forest.

Limiting Factors

Some disagreement exists in the literature over the exact limiting factor for black-backed woodpeckers. Suitable nest habitat has been assumed to be the limiting factor and this is supported by several studies and reports outlined here. The conclusion of a literature review by Beebe (1974) was that the limiting factor is the cavity, roost-site, or nest-building substrate. The amount of standing dead timber available for nesting sites is explained as the limiting factor for insectivorous birds in a Wyoming study (Davis 1976). Authors of a theoretical study investigating correlations between clutch size and the ability of a species to utilize existing holes explained their results also supported the hypothesis that nest sites are limiting factors (Martin 1993).

Several studies emphasize factors other than nest sites as limiting factors. Authors of a study in northwestern Montana larch/fir forest explained their results with the hypothesis that woodpeckers are limited by food, not nest site (McClelland and others 1979). Observed differences between burned and unburned habitat were more prominent during the non-breeding season in Montana, suggesting foraging may be more important than nest-cavity limitations (Caton 1996). Another study reported that limiting factors may be winter food sources for residents or territoriality for migrants, but do not seem to be nest sites (McClelland 1977). However, even though appropriate nest sites are not limiting, the nest tree is still important because these woodpeckers cannot nest in the open where no snags or decaying trees are present, with the possible exception of flickers (McClelland 1977).

Patterns Of Dispersal

No information is available on dispersal of young birds or yearly movement patterns. However, black-backed woodpeckers are apparently able to colonize areas, especially after burns (Villard and Schieck 1997; Murphy and Lehnhausen 1998). In the winter, they are often observed to irrupt in various locations, apparently in response to food resources (Yunick 1985).

Community Ecology

Predators

Probable predators include Cooper's hawks, northern goshawks, great horned owls, flying squirrels, and tree squirrels (Goggans 1989a; Dixon and Saab 2000). Most of this information comes from individual anecdotes and it is not known the overall impact predation has on populations.

Competitors

Black-backed woodpeckers display aggression at nesting sites with mountain bluebirds (*Sialia currucoides*), western bluebirds (*Sialia mexicana*), white-headed woodpeckers (*Picoides albolarvatus*), and tree swallows (*Tachycineta bicolor*) (Dixon and Saab 2000). Aggressive encounters between black-backs and hairy woodpeckers, three-toed woodpeckers, flickers, and sapsuckers have been observed (Short 1982), which may also be nest defense or competition over nest sites or breeding territory.

Dominance over other species in these interactions seems to vary with the particular situation. Dixon and Saab (2000) reported observations of both subordination and displacement of hairy woodpeckers. Observations of interactions with flickers, show black-backed woodpeckers are usually dominant (Short 1974). Interactions with tree swallows are mixed (Short 1974) and the tree swallows may drive off black-backed woodpeckers (Short 1982).

In interactions with three-toed woodpeckers, black-backed woodpeckers are usually dominant (Short 1974,1982; Dixon and Saab 2000). In a study in Manitoba where both black-backs and three-toed woodpeckers were present, three-toed woodpeckers showed slightly different foraging mechanisms and used higher portions of trees than black-backed woodpeckers, which may reflect past natural selection to limit competition between the two species (Villard 1994).

Short (1982) suggests the black-backed woodpeckers' tendency towards aggressive behavior may be an adaptation derived from defending exposed nest sites (snags in the open are fairly visible). Raphael and White (1984) suggest that these interactions do not represent true competition because cavity-nesting birds have enough differences in their niches. Conner and Adkisson

(1977) reiterate the idea that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited.

Maintaining an abundance of nest sites (i.e. snags of suitable size) will probably minimize potential competition.

Data on intraspecific competition are sparse. However, nestlings are quite aggressive towards each other (Kilham 1966), presumably over food.

Parasites, Disease, Mutualistic Interactions

No information is available.

Other Complex Interactions

Black-backed woodpeckers' association with burn areas also leads to other complex interactions that benefit the birds. For example, mammal predators may avoid large burns, thereby increasing nest success of woodpeckers (Dixon and Saab 2000).

Primary cavity-nesters such as woodpeckers construct cavities that may be used by other animals. Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin (1995) also discusses the importance of primary cavity nests as nest sites for secondary cavity-nesters. Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

However, Gutzwiller and Anderson (1988) dispute the importance of these cavities for secondary nesters. Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). For example, snag density may not accurately determine the habitat availability for secondary cavity-nesters. This is further supported by a study in California oak/pine forest where blocking cavities did not change the bird densities (Waters and others 1990).

The author of this review suggests that the dependence on primary cavities probably depends on the particular stand in question.

Risk Factors

Practices that limit habitat and food resources are the major risk factors. Villard and Schieck (1997) state eliminating events that leave large groups of standing snags likely impact black-backed woodpeckers. Fire suppression, salvage logging, and the practice of replacing overmature stands with young stands are all considered detrimental for black-backed woodpecker populations (Goggans 1989a; Goggans and others 1989; USDA Forest Service 1992; Villard and Schieck 1997; Saab and Dudley 1998; Dixon and Saab 2000). All of these factors apply to the Black Hills National Forest, where changes in habitat due to timber management, fire and insect suppression may have affected woodpecker populations (Parrish and others 1996).

Many studies link black-backed woodpeckers to fire areas (for more details see Habitat

Characteristics section above). Black-backs are predicted to have a negative response in areas where fire has been excluded (Saab and Dudley 1998). Many other studies have also indicated the negative effect of fire suppression for these birds (Hutto 1995; Murphy and Lehnhausen 1998; Dixon and Saab 2000). Intensity of the fire also matters, as stand-replacement fires are essential habitat for black-backed woodpeckers and should not be eliminated (Hutto 1995).

Fire suppression is a major risk factor for black-backed woodpeckers in the Black Hills. Because of fire suppression, fires have become less frequent in Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed in the area (Parrish and others 1996). Historically, many fires were low intensity, but there were areas with high intensity burns and insect infestations (Parrish and others 1996).

Salvage logging is also a factor. Black-backed woodpeckers had significantly lower densities in the salvaged areas than in the unsalvaged areas after a burn in a Montana mixed conifer forest (Douglas fir, western larch, and ponderosa pine, with some aspen) (Hitchcox 1996). Salvage cutting of timber after fires usually takes snags, which would be ideal habitat for black-backed woodpeckers (Hutto 1995). Better options might be salvage cutting in only part of the burn (although how much of a burn can be safely salvage cut while still providing for woodpecker habitat is unknown), or not taking trees in size classes preferred by the birds (Hutto 1995). Saab and Dudley (1998) concluded black-backed woodpeckers react to post-fire habitat structure, preferring areas not salvage-logged. Although their sample sizes were too small to evaluate actual nest success between different treatments, they did find black-backs nesting in areas where tree density still remained high.

Replacing mature stands with young stands through timber harvesting on a landscape scale can eliminate decaying trees and reduce insect infestations. Black-backs may decrease in numbers because mature stands are converted into young stands, so Goggans (1989a) suggests leaving large (387 ha, 956 acres), unlogged areas for woodpecker management.

Response To Habitat Changes

Management Activities

For a general summary of the effects of various management practices on black-backed woodpeckers see Table 15.

Timber Harvest

Timber harvesting has an immediate effect if active nest trees are removed. However, the effect on a landscape scale is more important to the population as a whole. Black-backs may decrease in numbers because mature stands are converted into young stands through timber harvesting, so Goggans and others (1989) suggest leaving large (387 ha, 956 acres), contiguous, unlogged areas in each sale area for woodpecker management per pair of birds. The maximum density of black-backed woodpeckers was found in ponderosa pine stands with the lowest amount of harvesting (Bate 1995). Cavity-nesting birds as a group fed more often in uncut stands than in cut stands in Montana larch/fir forest (McClelland 1980). These effects are likely due to the elimination of decaying trees and snags, which reduce insect infestations and food availability.

Different cutting strategies differ in their severity of impact, due to the differences in how much they affect these decaying trees and snags. The Final Environmental Impact Statement for the Black Hills National Forest (USDA Forest Service 1996) lists clear-cutting, group selection, and thinning as having negative effects on black-backed woodpeckers, while the impact from shelterwood harvesting is unclear (due to the fact that large trees may be left at one stage of the cut and removed later). Thinning is detrimental since snags are removed during the process (Beebe 1974; Cline and others 1980).

Clear-cutting would have the most severe impact, especially if snags of sufficient size and density are not left in the stand. Clear-cutting treatments and treatments that removed all trees larger than 2.54 cm (1 inch) dbh, and leaving all residue had negative effects on feeding activity of woodpeckers (McClelland 1980). When hardwood snags were retained in clear-cuts in eastern Texas, some of the negative effects on cavity-nesters were mitigated (Dickson and others 1983). However, a controlled, unlogged plot was not available for comparison in that study.

Thomas and others (1979) suggested black-backs require 145 snags per 100 ha (247.1 acres) in order to maintain 100% of the maximum black-backed population in mixed conifer forest in Washington and Oregon (Suggestions for ponderosa pine were not given). However, these suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Goggans and others (1989) found black-backed woodpeckers preferred (positively selected for) mature timber areas for nesting, foraging, and roosting. Single-story areas (i.e. stands with relatively uniform age and size trees) were selected against for nesting; and immature stands, multi-story stands, and cut areas were selected against for foraging. Large numbers of stands that are the same age limit the diversity of tree species and sizes (Beebe 1974). Beebe's (1974) review found that the reduction of stand rotation age reduces the number of large snags.

Interestingly, although there were fewer nests in logged areas (6 versus 13) of an Oregon lodgepole pine forest, the nest success rate was not affected by logging activity (83% success in logged areas versus 54% in unlogged areas) (Goggans and others 1989). It is not clear from the report exactly what type of treatment occurred in those particular stands with nests. Also the beetle infestation rate was quite high in the area, so the abundance of prey may have had a mitigating effect.

Although these results are from forest consisting mainly of lodgepole pine, which is not present in the Black Hills National Forest, this author assumes the Black Hills birds would also respond similarly to the same type of habitat structure.

Salvage sales after fires or blowdowns have the most potential for detrimental effect because they often remove the snags in the size classes preferred by black-backs, plus they reduce insect outbreaks in these areas, which are prime food sources. Saab and Dudley (1998) demonstrated that black-backs preferred areas that were not salvage-logged. Following salvage activities, black-backed woodpeckers had significantly lower densities in the salvaged areas than in the unsalvaged areas after a burn in a Montana mixed conifer forest (Douglas fir, western larch, and Ponderosa pine, with some aspen) (Hitchcox 1996). Some of the negative effects might be mitigated by not taking trees in size classes preferred by the birds, or salvage cutting in only part of the burn (although the acceptable amount of salvage cutting has not been determined) (Hutto 1995). It is important to note that if portions of the burn are salvage cut, those areas would not then be considered potential black-back habitat, since no evidence exists that any level of salvage cutting is acceptable to the birds.

Recreation

In other geographical areas, black-backed woodpeckers are not usually bothered by the mere presence of humans (Dixon and Saab 2000), so recreational use probably has a minimal effect. However, in the Black Hills, the large numbers of roads means the birds have very few refuges. "[T]he number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b).

There may also be detrimental impacts if recreational users looking for wood for campfires cut down snags. Wisdom and others (2000) stated that black-back habitat is reduced near roads due to snag reduction and the direct edge effect of the road.

Livestock Grazing

No information is available on the effect of grazing on black-backed woodpeckers. Although the study did not include black-backs, a review of livestock grazing effects on neotropical migrants of western Northa America, Saab and others (1995) found that cavity-nesting birds were relatively unaffected by cattle grazing, at least in the short-term, compared to open-nesting species. It is the opinion of this author that grazing probably has a limited impact on black-backs as well, since they are foraging mostly on wood-boring insects, which would not usually be affected by the presence of other vegetation.

Mining

Mining activity may be detrimental if preferred habitat is lost or if recreational use of mining roads reduces snag densities in areas near roads due to firewood cutting (USDA Forest Service 1996).

Fire Suppression

Many studies link black-backed woodpeckers to fire areas (for more details see Habitat Characteristics section above). Black-backs are predicted to have a negative response to fire-suppressed areas (Saab and Dudley 1998). Many others have also indicated the negative effect of fire suppression for these birds (Hutto 1995; Murphy and Lehnhausen 1998; Dixon and Saab 2000). Severity of the fire also matters, as stand-replacement fires are essential habitat for black-backed woodpeckers and should not be eliminated (Hutto 1995).

Fire suppression is a major risk factor for black-backed woodpeckers in the Black Hills. Fires have become less frequent in Black Hills than they were historically due to fire suppression (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed historically in the area (Parrish and others 1996). Many fires were low intensity, but there were areas with high intensity burns and insect infestations (Parrish and others 1996).

Prescribed Fire

Prescribed fires would likely be beneficial if they create new snags for nesting and foraging habitat. However, studies linking high woodpecker presence to burn areas describe high-intensity stand replacement burns, so it is unknown whether low-intensity burns will have the same benefit for woodpeckers, or whether they will actually decrease woodpecker habitat due to the destruction of available snags. Saab and Dudley (1998) predict prescribed fires will have a neutral effect on these birds. The ideal size of prescribed burns is also unknown. Horton and Mannan (1988) recommend protecting large snags during intense prescribed burns, especially if there are not many large snags in the landscape.

Non-Native Plant Establishment And Control

In this author's opinion, non-native plants probably do not have much effect on black-backed woodpeckers. Control methods may affect these birds if chemical sprays also impact insect populations on which the woodpeckers depend. Goggans *and others* (1989) recommend against pest treatment because eliminating the heartrot (carried by some insects) in trees may decrease the woodpecker species.

Fuelwood Harvest

Fuelwood harvesting will affect black-backed woodpeckers if snags used for nest trees are located in easily accessible areas (i.e. near roads) (USDA Forest Service 1992, 1996). Due to the large number of roads in the Black Hills National Forest (see glossary for discussion of road density), this is likely to be a factor. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags of ponderosa pine per 40.5 ha (100 acres) (>25.4 cm, 10 inches dbh) (USDA Forest Service 1996). A separate study found an average of 3.6 snags/0.4 ha (1 acre) (>25.4 cm, 10 inches dbh) on the Black Hills National Forest in stands not actively managed for 20 to 30 years (Lentile and others 2000). These numbers mean that many stands have much lower than the number of snags recommended by many sources (Scott 1978; Scott and Oldemeyer 1983a; Raphael and White 1984; Zarnowitz 1985; Goggans 1989a; USDA Forest Service 1992; Bate 1995; also see Table 14), so it is important to conserve as many snags as possible.

Insect Pest Control

Pesticides may impact woodpecker prey populations because the chemicals kill insect prey (Beebe 1974).

Natural Disturbance

Insect Epidemics

Wood-boring insects are beneficial for black-backed woodpeckers because they serve as prey items and speed tree decay. The frequency of natural insect outbreaks in the Black Hills is unknown, but they can be very intense and last several years, as the mountain pine beetle outbreak from 1894 to 1908 that consumed 1 to 2 billion mbf (Furniss and Carolin 1977). Since black-backed woodpeckers feed on wood-boring beetles and their larvae, they can be important natural control mechanisms for insect outbreaks (although see discussion under Characteristics of Prey above).

Wildfire

Saab and Dudley (1998) concluded black-backed woodpeckers are associated with post-fire forests (for more details see Habitat Characteristics section above). They are present in early successional burn areas, anywhere from days after the fire (Villard and Schieck 1997) to the first year following the event (Harris 1982; Murphy and Lehnhausen 1998). They were still nesting five years after a fire in Idaho (Saab and others in press). In general, their populations in the burn area decrease as succession continues. They were totally absent by the fourth winter after a burn in Alaska (Murphy and Lehnhausen 1998). Their decrease after the third year in Montana was associated with a decline in the insect population (Harris 1982). Hutto (1995) suggests that burn areas serve as source areas (after Pulliam 1988; Pulliam and Danielson 1991), supplying the remaining forest (sink areas) with woodpeckers, although this has not been proven. Regardless, burn areas are preferred habitat for the woodpeckers and very important to their survival. Fires have become less frequent in Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996). Decreased amount of burn areas for source habitat, may decrease the overall population. Large wildfires in the Black Hills during 2000 and 2001 may provide more habitat for these birds and should be investigated.

Wind Events

Blowdowns may increase insect infestations (Furniss and Carolin 1977), which may benefit woodpeckers. White spruce in the Black Hills National Forest are susceptible to blowdown events (USDA Forest Service 1996). Large amounts of blowdowns in the Black Hills from 2000 and 2001 may benefit woodpeckers.

SUMMARY

Black-backed woodpeckers play an important role in the ecosystem, eating many wood-boring insects and excavating cavities that can be used by secondary cavity users. For an envirogram showing the important ecological interactions for this species, see Figure 1. These are North American birds that range from Alaska to central California and east to Maine. The Black Hills represents a disjunct portion of their breeding range. Black-backed woodpeckers have shown fairly stable population trends across North America, although point transect methods may not be adequately recording trends in these birds that appear sporadically. Little is known about the population trends in the Black Hills, but they do breed in some of the higher elevation areas of the forest.

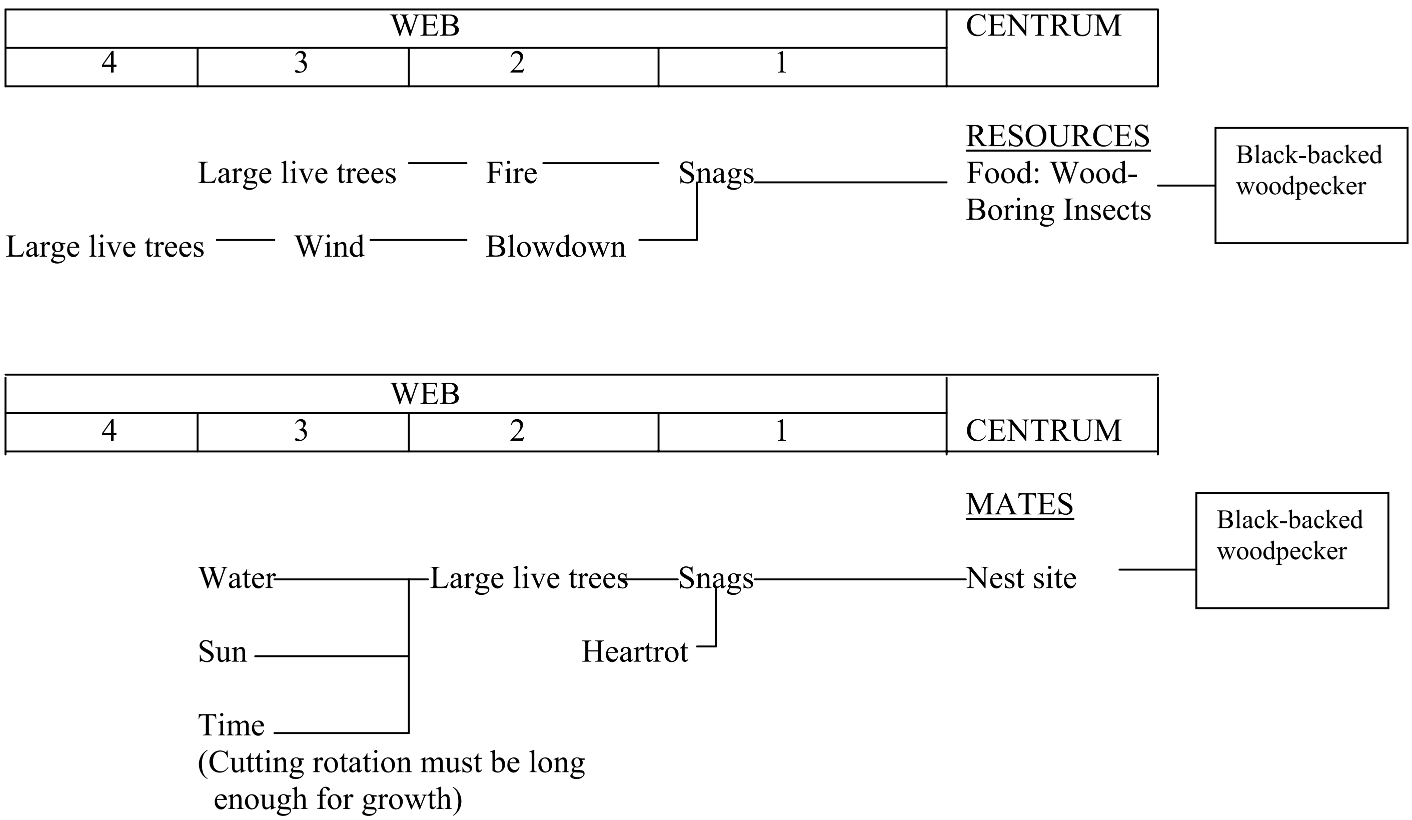
Black-backed woodpeckers reside in older stands and burned areas with snags. In the Black Hills, they most likely utilize ponderosa pine and white spruce for nest trees. They nest in snags or decaying portions of live trees and lay one clutch of about 3 or 4 eggs during the spring. Nest trees vary in size with type of forest; averages have been noted from 22 cm (8.66 inches) in a burned forest in Montana to 44.5 cm (17.52 inches) in California forests. Nesting areas also have large trees and low amounts of tall shrub cover. Home range estimates are from 61 to 328 ha (150.7 to 810.5 acres).

They feed mainly on wood-boring insects. In fact, this species' populations can irrupt in areas with large beetle outbreaks, such as burns.

They are principally associated with burn areas and mature forest stands. Burn areas used are usually early-successional habitat in the first few years after a fire. Presumably, they then move on to other areas with substantial food sources, although this needs further study. Fires have become less frequent in Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996). Decreased amount of burn areas that may function as source habitat, may decrease the overall population. Large wildfires in the Black Hills during 2000 and 2001 may provide more habitat for these birds and should be investigated. Because of their habitat needs, they are negatively affected by activities such as fire suppression and timber cutting because these activities reduce the number of snags present in the landscape.

Salvage sales after fires are especially detrimental on the woodpeckers if they remove much potential habitat in the form of large snags. Recreation may have a negative effect if the birds are disturbed at their nest sites or if snags are removed for campfires. The effect of grazing is likely neutral. Prescribed fire will likely benefit these birds. Chemicals used to control plants or insects may affect these birds if they decrease the woodpeckers' insect prey. Fuelwood harvest negatively affects these birds by removing snags that could be used for nesting and foraging. Management efforts that retain snags and plan for long-term recruitment of snags will benefit these birds.

Figure 2. Envirogram of the black-backed woodpecker in the Black Hills National Forest. Competition and predation are not understood well enough to represent.



THREE-TOED WOODPECKER

INTRODUCTION

Three-toed woodpeckers (*Picoides tridactylus*) play an important role in the ecosystem, eating many invertebrates and excavating cavities that can be used by secondary cavity users. They nest in snags and are principally associated with burn areas and mature forest stands. Because of their habitat needs, they are threatened by activities such as fire suppression and silvicultural practices. Three-toed woodpeckers are fairly secretive, so less information is available about the species than for some other more prominent woodpeckers. This document summarizes the available information on the ecology and management of the species.

CURRENT MANAGEMENT SITUATION

Management Status

No special status is assigned to the three-toed woodpecker by the U.S. Fish and Wildlife Service (Welp and others 2000). Three-toed woodpeckers are not included on either the IUCN Red List (Hilton-Taylor 2000) or the National Audubon Society's Watchlist (Muehter 1998) and are not considered a priority species in the region by Partners In Flight (Panjabi 2001a; Partners In Flight 2001). However, both Region 2 and Region 4 of the U.S. Forest Service classify the species as sensitive (Welp and others 2000). Several western states (Idaho, Utah, Washington, and Oregon) consider the species as either sensitive or a species of concern (Leonard 2001). South Dakota considers these birds a category S2 species, meaning that in South Dakota it is "imperiled because of rarity … making it very vulnerable to extinction…" (South Dakota Department of Game Fish and Parks 2000). The Wyoming Natural Heritage Database classifies the species as globally secure (G5) but rare (S3) statewide (Welp and others 2000). The Wyoming Bird Conservation Plan classifies three-toed woodpeckers as a level 2 species, meaning the primary focus is monitoring (Cerovski and others 2001).

Existing Management Plans

Forest Service Biologists at both the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers were available in the region (C. Schultz, personal communication).

In the Columbia Basin an ecosystem management plan has been developed that addresses conservation issues of the three-toed woodpecker (Wisdom and others 2000). This plan identifies the decline of snags and beetles as significant problems and suggests several conservation strategies: retaining some bark beetle areas, retaining old trees, and allowing some burn areas with no salvage logging.

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Picoides tridactylus is a three-toed woodpecker averaging 22 cm (8.75 inches) in length (National Geographic Society 1987) with a wing length of 10.7 to 13.3 cm (4.21 to 5.24 inches) (Short 1982). It is characterized by a white chest, black and white barred sides, predominantly black wings and head except for white stripes behind and below the eyes, and a patch on the back which varies from solid white to densely barred (National Geographic Society 1987). The sexes differ slightly, with males slightly larger and having yellow on the top of the head, whereas the female is slightly smaller with some barring on the top of the head (Hogstad 1978; National Geographic Society 1987).

Three races are recognized by some sources (National Geographic Society 1987). *P. t. fasciatus* is found in the northwest and has black and white bars across its back. *P. t. bacatus* is found in the eastern part of the North American range and has very dense, almost solid, barring on its back. *P. t. dorsalis* is the form found in the Black Hills region and has very little barring on its back, appearing to have a white patch instead. *P. t. dorsalis* is the largest of the subspecies in North America (Leonard 2001). The North American birds are sometimes referred to as American three-toed woodpeckers (Bent 1939).

Other sources recognize up to eight races/subspecies: *P. t. tridactylus*, *P. t. crissoleucus*, *P. t. albidior*, *P. t. funebris*, *P. t.* alpinus (all non-North American groups), plus the three listed above (Bent 1939; Short 1982). Limited genetic data (DNA taken from four of the eight races) shows distinct genetic differences between Old World and New World races (Zink and others 1995).

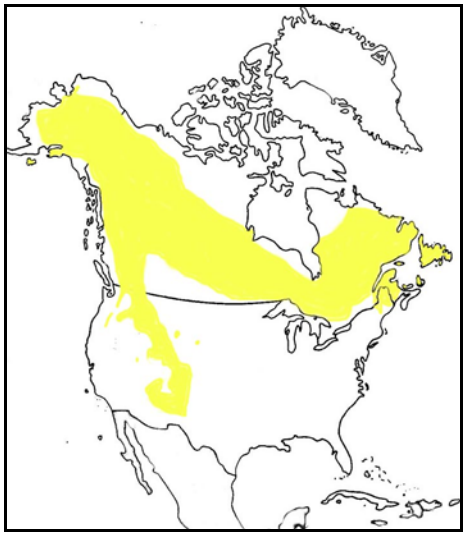
The three-toed woodpecker is very closely related to the black-backed woodpecker (Bock and Bock 1974; Short 1982). Both species have three toes (instead of the four found on other woodpeckers) and other physical adaptations, which help them to excavate beetle larvae from tree trunks (Bock and Bock 1974). However, three-toed woodpeckers are slightly smaller and have white backs and white behind their eyes, while black-backs have solid black backs and no white stripe behind the eye (Dixon and Saab 2000; Leonard 2001). Slight differentiation in habitat use also distinguish between these two species: three-toed woodpeckers use spruce forests and eat mainly bark beetles (Scolytidae) in contrast to the black-backs, which utilize a wide variety of coniferous forests and eat mainly Cerambycidae beetles that reside deeper in the tree (Leonard 2001).

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

The three-toed woodpecker has virtually a worldwide nearctic distribution including: Scandinavia, the Moscow region, portions of Siberia, Mongolia, Manchuria, and northern Korea, and somewhat disjunct mountainous populations in the Alps, the Balkans, Japan, and China (Short 1982). The North American distribution stretches from the northern tree line south to Oregon and Idaho in the northwest, in the Rocky Mountain region south to northern New Mexico and Arizona, and in the midwest and east south to Minnesota, New York, and northern New England (Short 1982).

Figure 3. Distribution of three-toed woodpeckers. Solid yellow indicates the normal year-round distribution of three-toed woodpeckers. Adapted from Leonard (2001) and National Geographic Society (1987).



Occasional irruptions in the northeast and midwest occur, some of which are tied to insect outbreaks (such as the insect outbreaks after Dutch elm disease). For example, after extensive forest fires in southeast Canada and New England in 1955, 59 three-toed woodpeckers were observed in the winter of 1956-1957 (West and Speirs 1959). Some incidents cannot be explained by insects (Yunick 1985). These incidents are not necessarily the same outbreaks as those that result in black-back irruptions, since the species have somewhat different diets (Leonard 2001).

This distribution is closely aligned with the distribution of spruce trees (Bock and Bock 1974). The three-toed woodpecker extends further north than the black-backed woodpecker, because it can utilize spruce and smaller diameter coniferous trees than the black-back (Bock and Bock 1974).

Additional Information (Local Distribution)

In Wyoming, the species is considered uncommon, although breeding observations are known from much of the western part of the state (Luce and others 1999). In South Dakota, they are only noted from the Black Hills (South Dakota Ornithologists Union 1991). Three-toed woodpeckers are considered rare in South Dakota (South Dakota Ornithologists Union 1991).

Estimates Of Local Abundance

In South Dakota, recent confirmed breeding reports are known for 1997 (Palmer 1997) and 1998 (Palmer 1998b), but reports on these birds have been missing during the last two seasons (Schenck 1999b, 2000). In a survey of the Black Hills National Forest in the summer of 2000, 11 three-toed woodpeckers were found (Mohren and Anderson 2000). The subsequent year, 12 individuals were found (Mohren and Anderson 2001). Panjabi (2001b) also reported 12 individuals. Although this information is based on only a few seasons, it does indicate these birds are still present in the area.

Population Trends

Information from national surveys does not show clear population trends for three-toed woodpeckers. Christmas Bird Counts from 1959 to 1988 show no significant trends survey wide (Sauer and others 1996). No significant trends are seen survey wide in Breeding Bird Surveys either (Sauer and others 2001). Not enough samples of three-toed woodpeckers are available on the regional Breeding Bird Surveys to determine trends for the Black Hills (Patterson 2000). The BBS Interactive Map shows no three-toed woodpeckers on either the Sundance Group routes or the Black Fox Group routes, which includes Hill City and Custer (Sauer and others 2001).

Of 74 species in the Great Basin, three-toed woodpeckers are considered one of the top 10 montane birds most vulnerable to extirpation (Reed 1995).

Movement Patterns

Information on movement is limited, although Black Hills birds may move to lower elevations in the winter (South Dakota Ornithologists Union 1991).

Habitat Characteristics

General Habitat

Three-toed woodpeckers use somewhat different tree species in different parts of their range. In Poland, they mainly utilize swampy ash-alder forest stands, although they are also found in oak-hornbeam stands, and coniferous stands (Wesolowski and Tomialoje 1986). Wesolowski and Tomialoje (1986) go on to suggest this preference for wet areas may be due to intense logging in drier areas that pushed the woodpeckers into swampy stands. Other studies have also found the birds in moist forest (Leonard 2001). In the Black Hills, they have been found in ponderosa pine and aspen stands (Mohren and Anderson 2000). Panjabi (2001b) found these birds most commonly in white spruce habitat in the Black Hills.

Haldeman (1980) reports these birds like old-growth stages. This statement is supported by the results of at least one study. In an Oregon study, three-toed woodpeckers preferred mature stands, while avoiding younger, logged areas (Goggans and others 1989).

Three-toed woodpeckers are associated with burns and insect outbreaks. In a study of burned and unburned sections of lodgepole pine forests, more individual three-toed woodpeckers and more nests were found in burned sections than in unburned sections (Caton 1996). Blackford (1955) found several three-toed woodpeckers after an insect outbreak in a burned area in Montana. Three-toed woodpeckers had higher breeding densities in burned than in unburned

Jeffrey pine-white fir habitat in California eight years following a fire (Bock and others 1978). In Wyoming coniferous forests, three-toed woodpeckers were most common in the first few years after fires, and were only present in low numbers in unburned areas (Taylor and Barmore 1980). In a study in the Yellowstone area, three-toed woodpeckers did not nest in logged areas or in aspen trees, but mostly in burned areas (Hoffman 1997). In that study, areas of the forest had been burned, logged, or left undisturbed and consisted mainly of lodgepole pine with some aspen, Douglas fir, and subalpine fir. A separate study in Yellowstone burn areas, found three-toed woodpeckers in burn or edge habitat in spruce stands (Pfister 1980). In black spruce forest in Quebec, three-toed woodpeckers were found only in mature forest and recent burns (Imbeau and others 1999). In lodgepole pine stands, the birds' response to the burn varied from year to year, with the birds found almost exclusively in burned areas in one year and equally between burned and unburned habitat the following year (Pfister 1980).

They are present in early-successional burn areas, appearing the first year following the event (Harris 1982), and are most common 1.5 years after the fire (Murphy and Lehnhausen 1998). Their populations in the burn area decrease as succession continues. They were quite rare 3.5 years after a burn in Alaska (Murphy and Lehnhausen 1998). Their decrease after the third year in Montana was associated with a decline in the insect population (Harris 1982).

A study in a lodgepole pine forest in northwestern Wyoming showed the habitat surrounding the burn may also affect how the woodpeckers use the habitat (Skinner 1989). For example, three-toed woodpeckers were found in forest bordered by riparian areas only during post-breeding season and then only in burned areas. In forest bordering sagebrush, three-toed woodpeckers were found in burned areas only in the breeding season, however in post-breeding season, they were found only in the unburned areas.

Preference for older habitats or early-successional burn areas may be related to the presence of large snags (Setterington and others 2000) or to the temporal nature of insect outbreaks (Blackford 1955). Since wood-boring insects play such an important role in three-toed woodpeckers' diet (see section on Prey Species) and in promoting decay of trees (i.e. Furniss and Carolin 1977; Amman and others 1997), it makes sense that woodpeckers would respond to their presence. Also, snags created by burns may only be useful to a particular species while in a certain decay state (Raphael and White 1984). Therefore, the number of useable snags will often decrease at some point after a fire since no new snags are being created (i.e. see model developed in Raphael and White 1984). For example, in a predominantly ponderosa pine forest in Arizona, snags were followed after prescribed burns (Horton and Mannan 1988). During the first year of the Horton study, there was a 45% decrease in snags, especially snags with medium amounts of decay and older snags. The rate of decay likely differs between types of stands and burn intensities, possibly explaining different findings among studies in the length of time a stand is used by woodpeckers following fires.

A summary of North American records shows the birds between 450 and 2743 m (1,476 and 9,000 ft), in dense forests including white pine, lodgepole pine, alpine fir, Englemann spruce, larch, yellow pine, and even one sighting in aspen (Bent 1939; Short 1982). Bent (1939) reports the birds from 1981 to 2743 m (6,500 to 9,000 ft), and Short (1982) indicates they range up to 2743 m (9,000 ft) in the Rockies. In British Columbia, three-toes are found in coniferous forests from 450 to 2100 m (1,476 to 6,890 ft) in elevation (British Columbia Ministry of Forests 1997). After a beetle outbreak in Oregon, the birds used lodgepole pine trees with heartrot at elevations ranging from 1372 to 1707 m (4500 to 5600 ft) (Goggans and others 1989). In the Black Hills they have been found from 1373 to 2042 m (4,505 to 6,699 ft) in elevation (Mohren and Anderson 2000).

Home range estimates are discussed in the Demography section.

Nesting Habitat

Again, the tree species used varies by geographical location. Nest trees in Poland were usually dead or dying spruce (Wesolowski and Tomialoje 1986). Short (1982) reviewed reports of three-toed woodpeckers nesting in dead or live spruce, larch, pine, balsam, cedar, and aspen. The Black Hills has large numbers of ponderosa pine, spruce, and aspen (USDA Forest Service 1996), so these are the trees potentially being used locally.

These birds utilize trees with some heartrot (Goggans 1989b; Goggans and others 1989), which softens the tree for excavation. In an insect outbreak area in a mixed conifer forest in Montana, nine of eleven nests were in dead pine trees, while the others were in aspen and cottonwood (Lester 1980). These results were not significant due to the small sample size. Only 3% of nests were in intact live trees in a Montana study (Caton 1996). Nest trees used by cavity-nesting birds as a group were significantly softer than random trees in aspen stands in Arizona (Schepps and others 1999). The presence of bark was correlated with hardness of aspen trees in Arizona, but it explained a small amount of the variation (Schepps and others 1999).

Several studies have examined specific characteristics of the nest trees used by three-toed woodpeckers (see Table 2). Important attributes of a nest tree listed in the table include: the diameter at breast height (dbh), the height of the nest tree, and the height of the actual nest cavity. Data varies with geographical area and forest type. No data is currently available for three-toed woodpecker nests in the Black Hills. Studies from other western mixed conifer forests are listed in the table and are the closest applicable data available.

Table 2. Nest-tree Characteristics for Three-Toed Woodpeckers

Tree Species	DBH [a], cm	Tree Height [a], m	Nest Height [a], m	Location	Forest Type	Notes[b]	Citation
Lodgepole pine	27.94	22.86	7.62	Oregon	Lodgepole pine	Birds selected against logged and immature areas	(Goggans and others 1989)
---	>30.5	---	---	British Columbia	---	---	(British Columbia Ministry of Forests 1997)
Red cedar	---	---	---	Montana	Western larch/ Douglas fir	Cut areas, n=2	(McClelland 1980)
---	---	---	---	Montana	Western larch/ Douglas fir	Old growth had most birds, n=4	(McClelland and others 1979)
Aspen, Englemann spruce, western larch	31	22.7	7	Montana	Lodgepole pine	Some habitat was burned, 3% of nests were in intact live trees	(Caton 1996)
---	43.18	16.46 (11.28-21.34)	10.06 (9.14-10.67)	---	Various stand types	---	(Scott and others 1980)
Pine, spruce, fir, cedar, aspen, poplar, birch, alder	---	---	5.60	----	Various	N=36, 84% in snags	(Leonard 2001)
---	---	---	---	Idaho and Montana	Mixed conifer	1-6 years after fires, 84% nests in unlogged plots, n=61	(Hejl and McFadzen unpublished data cited in Leonard 2001)
Hemlock, lodgepole pine, telephone pole	24 (min18)	---	---	Montana	Western larch/ Douglas fir	Older forest, n=4	(McClelland 1977)

[a] **Measurements given are means if only one number is stated, minimums if preceded by *min*, or ranges if two numbers are listed.**
[b] **Sample sizes for studies are listed as "n=".**

Characteristics of the habitat surrounding the nest are important as well. As the following studies illustrate, features ranging from basal area to the tree condition were important for selection by the three-toed woodpeckers as breeding areas. In the Yellowstone area, three-toed woodpecker nest sites were likely to have large amounts of rotten downed wood in the area (Hoffman 1997). In a Montana lodgepole pine forest, areas surrounding nests had average dbh of 29 cm, average basal area of 26 m2/ha (279.8 ft^2/2.5 acres) (significantly larger than that randomly available), and 4% live canopy cover (Caton 1996). A multiple logistic regression model correctly classified 74% of nests using basal area, tree species, tree condition, and average dbh (Caton 1996). After a burn in a Montana mixed-conifer forest, three-toed woodpeckers preferred taller western larch with larger dbh for nest trees in areas that were less-severely burned (Hitchcox 1996).

Thomas (1979) stated 145 snags were needed per 100 ha (247.1 acres) in lodgepole pine forest to maintain 100% of the maximum population of the three-toed woodpeckers. However, these suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Foraging Habitat

Three-toed woodpeckers in a Montana study showed a significant preference for foraging on Douglas fir and larch trees, but not ponderosa pine (Harris 1982). In Alaska, they foraged mostly on spruce trees (Murphy and Lehnhausen 1998), while in Oregon the most common species used for foraging was lodgepole pine, although some Engelmann spruce trees were used also (Goggans and others 1989). In a study in south-central Wyoming, they foraged preferentially in spruce/fir habitat over pine or aspen habitats (Loose and Anderson 1995). In a mixed-coniferous Washington forest, three-toed woodpeckers foraged on the middle of the trunks of Douglas fir, western larch, ponderosa pine, and lodgepole pine (Kreisel and Stein 1999). They foraged significantly more in burn areas than in unburned areas (Kreisel and Stein 1999).

Condition of preferred foraging trees varies with the particular study (Table 3). Villard (1994) found three-toed woodpeckers foraging on standing trees (95%) and on dead trees or logs (95%). Standing tree foraging is also noted in a study in Oregon where 90% of the foraging activity was done on standing tree trunks while only 7% was done on logs (Goggans and others 1989). Dead trees outnumber living trees (88% of observations) as forage material in Oregon (Goggans and others 1989). Lightly burned trees were favored in an Alaskan burn area (Murphy and Lehnhausen 1998). In burned Colorado subalpine forest, three-toed woodpeckers foraged 81% on Englemann spruce, 97% on fire-killed trees, usually (93%) on the trunks (Koplin 1969).

Table 3. Characteristics of Foraging Trees Used by Three-Toed Woodpeckers

Tree Species	DBH, cm	Tree Status	Part of Tree	Forest Type	Location	Notes	Citation
Lodgepole pine	24 (n=58)	78% recently dead	19 m high	---	Oregon	86 minutes of observation	Bull and others 1986
Englemann spruce	---	Fire-killed trees	Trunks	Englemann spruce/ subalpine fir/ lodgepole pine	Colorado	Burn area with many insects	(Koplin 1969)
Lodgepole pine and spruce	37.2 (n=429)	Dead	Standing trees and logs	Lodgepole pine	Oregon	Birds selected against cut areas and saplings	(Goggans and others 1989)
Preferred Douglas fir	13-20	---	---	Douglas fir, larch, ponderosa pine	Montana	Burn areas	(Harris 1982)
Douglas fir, lodgepole pine, ponderosa pine, and subalpine fir	---	94% on snags	---	Mixed conifer	Montana and Idaho	---	(Hejl and McFadzen, unpublished data reported in Leonard 2001)
---	7.5-15	95% dead	Trees and logs	---	Canada	---	(Villard 1994)

Roost Habitat

In Oregon, three-toed woodpeckers preferentially selected roosting sites in mature timber and specifically mountain hemlock (Goggans and others 1989).

Winter Habitat

No information is available on winter habitat for three-toed woodpeckers.

Food Habits

Three-toed woodpeckers most commonly forage using the pecking method, although scaling and excavating methods are also used (Villard 1994; Murphy and Lehnhausen 1998). On rare occasions, these birds also lick sap on trees, though very little time is spent sap-licking when compared to European three-toed woodpeckers (Villard 1994). In a mixed-coniferous Washington forest, three-toed woodpeckers used flaking and drilling to obtain forage (Kreisel and Stein 1999).

The small gape and structure of particular cranial muscles allows hard blows for foraging or constructing cavities (Spring 1965).

Due to competition between three-toed and black-backed woodpeckers (see later section on Competitors), some have suggested the two species have developed different foraging strategies (Villard 1994) but this is not always supported by data. Villard (1994) found that three-toed woodpeckers spend more time with slightly different foraging mechanisms, forage higher on trees, and used scaling more than black-backed woodpeckers. However, Harris (1982) found no difference between black-backed woodpeckers and three-toed woodpeckers in foraging height.

Male three-toed woodpeckers forage on larger diameter trees than females, black-backed woodpeckers, or hairy woodpeckers (Murphy and Lehnhausen 1998). Some evidence exists that when females are present, males may somewhat dominate the more productive higher areas, as well (Hogstad 1978,1991). In the winter, these birds may forage with a mate or individually (Hogstad 1991).

Prey Species

Three-toed woodpeckers control insects that are harmful to forests and are especially important during insect outbreaks (Short 1982). Prey includes mostly bark beetles (scolytids) (Murphy and Lehnhausen 1998) and other wood-boring insects and larvae, but also other insects including caterpillars and ants (British Columbia Ministry of Forests 1997). A study of stomach contents revealed three-toed woodpeckers eat mostly animal material (94%) including wood-boring Coleoptera larvae (61%), wood-boring caterpillars (14%), other beetles (10%), ants (8%), and a small amount of other insects and spiders (Beal 1911). Wood-boring insects in the Black Hills that are candidates for woodpecker food include Coleoptera (*Dendroctonus ponderosae, D. valens, D. rufipennis, Ips pini, I. Integer, I. knausi, I. Borealis lanieri, Pityogenes sp., Pityokteines sp., Pityophthorus sp., Melanophila sp., Agrilus sp., Acanthocinus sp., Monochamus sp.,* and *Saperda sp.*) and Hymenoptera (*Trimex sp.*) (J. McMillin, personal communication). Leonard (2001) emphasized three-toed woodpeckers may be focusing on bark beetles (Scolytidae) in some areas, in contrast to the black-backed woodpeckers that prefer wood-boring beetles (Cerambycidae), although certainly enough evidence exists that three-toed woodpeckers eat both types in certain circumstances.

Characteristics Of Prey

Wood-boring and bark beetles beetles are extremely important food sources for three-toed woodpeckers as indicated above. Leonard (2001) suggested that three-toed woodpeckers may be utilizing the wood-boring beetles early in their life cycle when they live close to the surface of the tree. Beetles exhibit many differences in host preference and timing of outbreaks among species. For example, in the Black Hills, ponderosa pine is a host for *Dendroconus ponderosae*, *D. valens*, and *Ips pini*, while white spruce is host for *Dendroctonus rufipennis* and *Ips borealis lanieri* (J. McMillin, personal communication). *Agrilus sp.* and *Trimex sp.* utilize various hardwoods and *Saperda sp.* inhabit aspen trees (J. McMillin, personal communication). General characteristics of one common wood-boring beetle, the mountain pine beetle, are described here. Specifics on other insect species are given elsewhere (i.e. Furniss and Carolin 1977).

Mountain pine beetles usually have a one-year life cycle, which begins as eggs are laid in summer or fall in tunnels that the female makes within the tree (Amman and others 1997). The eggs hatch in about two weeks and the larvae feed on the tree's phloem until the following summer when they pupate and become adults (Amman and others 1997). Adults make an exit hole where they can leave the tree to find a mate and then attack new trees (Amman and others 1997). Trees defend themselves from small numbers of beetles by producing pitch, but large numbers of beetles overwhelm trees (Amman and others 1997). Mountain pine beetles survived best in trees with 10 to 11 inch (25.5 to 27.9 cm) dbh in Montana (Lester 1980).

Adult beetles that have emerged release pheromones, which attract other beetles to the site and may contribute to epidemics when large numbers of susceptible trees are available in a particular area (Furniss and Carolin 1977). Beetles also carry fungi, which infect trees' sapwood contributing to the death of the tree (Amman and others 1997). Wood-boring beetles are very quick to infect dead trees after a fire (Evans 1966; Villard and Schieck 1997). Drought, windblown or snapped trees, fires, lightning strikes, and other diseases all make trees susceptible to attack (Furniss and Carolin 1977). Cold temperatures and normal amounts of moisture naturally control these insects (Furniss and Carolin 1977; Amman and others 1997).

Woodpeckers kill many insects, either directly by drilling holes or peeling bark and eating the larvae, or indirectly when their holes dry the bark thereby drying up the beetle larvae (Amman and others 1997). Any larvae contained in the flakes of bark removed by woodpeckers are also likely to die either due to cold or dessication (Otvos 1965, 1979; Kroll and Fleet 1979). Thinner bark may also allow more insect parasites to enter and attack the beetles (Otvos 1979; Kroll and others 1980). Parasites increased 87% after woodpeckers stripped bark during an eastern Texas outbreak of pine beetles (Kroll and others 1980).

Although woodpeckers do respond behaviorally to the presence of prey species (i.e. by aggregating in outbreak areas), their capacity for numerical response is limited because they feed on other species and have other limiting factors (Otvos 1979). Population trends of woodpeckers and pine beetles did respond to one another during a pine beetle outbreak in eastern Texas (Kroll and others 1980). For example, a large increase in beetles in 1971 and 1972 was followed by an increase in woodpeckers in 1972 to 1973. Beetles subsequently declined in 1972 to 1973, while woodpeckers declined in 1974 to 1975. Both woodpeckers and beetles showed large increases in 1975 and 1976.

How much of the insect population is being consumed by woodpeckers is still being debated. In some areas of a mountain pine beetle outbreak in Montana, 96-97% beetle mortality occurred where woodpeckers were present (Lester 1980). In eastern Texas, southern beetle mortality due to woodpeckers (as a group) was 3.5% (eggs) and 63.5% (emerging adults) (Kroll and others 1980). In a mixed-conifer forest in California, woodpeckers (hairy, downy, and flickers) consumed 31.8% of beetles over two beetle generations (Otvos 1965).). Baldwin (1968) found hairy and three-toed woodpeckers preyed on spruce beetles in downed logs in a blowdown area, resulting in 70 to 79% mortality of the beetle brood.

After a large outbreak of spruce beetles in Colorado following blowdowns, foraging activity of woodpeckers (three-toed, downy, and hairy woodpeckers were present) was observed from November to June (Hutchison 1951). In plots with 24,000 to 32,000 beetles infesting each tree, woodpeckers were eating 53 to 57% of the beetles. These numbers were calculated from the amount of bark removed from the trees.

Winter mortality of spruce beetles in a Colorado outbreak was due mostly to woodpeckers (three-toed, hairy, and downy woodpeckers were present) (McCambridge and Knight 1972). Woodpeckers were responsible for up to 70% of mortality one winter for a single brood. Overall mortality (summer and winter mortality combined) showed around 27% of broods were killed by woodpeckers.

Although the woodpeckers are eating many insects, scientists believe they are not actually suppressing beetle epidemics, but may be helpful in preventing outbreaks (Bruns 1960; Beebe 1974; Otvos 1979; Amman and others 1997). Woodpeckers respond to insect outbreaks behaviorally, not by increasing their breeding levels (Beebe 1974). For example, woodpeckers as a group were more common in areas with insect outbreaks during winter in Texas (Kroll and Fleet 1979). Besides increasing in numbers, woodpeckers focus their predation more in outbreak areas. Woodpeckers (three-toed and hairy woodpeckers) had a larger percentage of spruce beetles in their stomachs in outbreak areas than in areas with lower, endemic levels of spruce beetles (Koplin and Baldwin 1970). In endemic situations, woodpeckers ate 19% of available spruce beetle larvae, but in epidemic situations the woodpeckers consumed 83% of available larvae (Koplin 1972). Three-toed woodpeckers were more efficent predators at epidemic levels and increased in density in the epidemic situations (Koplin 1972). Nest boxes can increase the number of birds of some species, but whether increasing the number of woodpeckers with nest boxes is possible and whether the method could be used to control insects is not well understood (Franz 1961). Even if it worked, the nest-box method may not be practical over large areas (Otvos 1979). Also, there may be other limitations on the number of woodpeckers in an area, such as territory boundaries, etc (Koplin 1972). In addition, woodpeckers may have more effect on certain life stages of beetles (Koplin and Baldwin 1970; Kroll and Fleet 1979; Kroll and others 1980) or at certain times of the year (Otvos 1979). Clearly more information is needed on how woodpeckers respond to outbreaks and how they could be encouraged to control insects further.

Breeding Biology

Phenology

The breeding season for three-toed woodpeckers begins in May or June (Short 1982). After eggs are laid, they are incubated for 12 to 14 days (Short 1982). Fledging occurs 22 to 26 days after hatching, although the juveniles stay with the parents for up to two months longer (Short 1982). In South Dakota, these birds are known to nest from May to July (South Dakota Ornithologists Union 1991).

Courtship Characteristics

Three-toed woodpeckers utilize two different types of drumming (Short 1974). Faster drumming defines territories, and is used inter- and intra-specifically. Slower drumming is used between mates during courtship. Several vocalizations are known, including the common 'pik' call, but it is unclear how three-toed woodpeckers use these calls during courtship (Short 1974). Other information on courtship is unknown.

Clutch Initiation, Laying, And Size

Five or fewer eggs are laid (Bent 1939). The exact number apparently varies by geographical area, but the amount expected in the Black Hills is unknown. Short (1982) reports 3 to 4 eggs per clutch in Europe. Reports of North American clutch size differ from 4 or 5 eggs per clutch (Short 1982) to 3 or 4 eggs per clutch (British Columbia Ministry of Forests 1997). Eggs average 24.52 mm (0.97 inches) long by 17.52 mm (0.69 inches) broad (Bent 1939). The females will lay only one clutch per year even if a clutch is lost (Short 1982).

Parental Care

Nest-building, incubation, and brooding duties are shared by both sexes, although males do the brooding at night (Short 1982).

Site And Mate Fidelity

No information is available on site fidelity. A new nest is constructed every year (Short 1982). Pair-bonds longer than one year are known (Leonard 2001), but not enough information is available to determine if living pairs always remain together. No evidence of non-monogamous mating exists (Leonard 2001).

Demography

Life History Characteristics

No information is available on the age of first reproduction or the proportion of the population that is breeding.

Survival And Reproduction

One record exists of a bird living to 6 years old (Leonard 2001). Limited information is available on nest success. Nest success was 53% in an Oregon study (Goggans and others 1989). Nest success in Montana and Idaho was measured at 79.2% (n=60) (Leonard 2001). Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995).

Social Pattern For Spacing

Home range estimates vary widely. A European study reviewed in Short (1982) showed a home range of 100 ha (247 acres), with a breeding territory of 2.3 ha (0.6 acres). Haldeman (1980) states pairs need a minimum of 42.9 ha (106 acres). In an Oregon study, radiotagged individuals were monitored to determine their home range (Goggans and others 1989). The home ranges in that study varied from 53 to 304 ha (131 to 751 acres) per individual. Goggans *and others* (1989) also note that the home range of pairs were larger than that of individuals, but they could not determine the exact acreage because none of their radiotagged individuals were paired together.

Density estimates are hard to compare because of differing habitats. In the Bialowieza National Park in Poland, scientists estimated density at 1 pair per km (0.62 miles) in excellent habitat and much lower in less preferred habitat (Wesolowski and Tomialoje 1986). The maximum density in an Alaska burn area was approximately 0.22 birds per ha (2.5 acres) (Murphy and Lehnhausen 1998). The three-toed density in a Newfoundland study ranged from 0 to 0.3 presumed pairs per stand where stands varied in size but were part of continuous forest (Setterington and others 2000). (Note that presumed pairs is listed in the Setterington study because they counted any evidence of an active nest or breeding activity as a presumed pair.)

Local Density Estimates

The available density estimates in the region come from a Montana study where density reached 10 birds per 40 ha (98.8 acres) (Harris 1982). Density of woodpeckers in a Colorado burn area of spruce-fir-lodgepole pine forest was 50% higher than outside of a burn area (Koplin 1969). In Yellowstone National Park, maximum densities of 8.9 pairs per 40 ha (98.8 acres) were found in spruce burned areas and the edge of spruce-fir habitat (Pfister 1980). In lodgepole pine habitat in Yellowstone, the maximum density was 6.7 pairs per 40 ha (98.8 acres) (Pfister 1980). No regional density estimates are available for unburned areas. No density estimates are available for the Black Hills.

Limiting Factors

Some disagreement exists in the literature over the exact limiting factor for three-toed woodpeckers. Suitable nest habitat has been assumed to be the limiting factor and this is supported by several studies and reports outlined here. The conclusion of a literature review by Beebe (1974) was that the limiting factor is the cavity, roost-site, or nest-building substrate. The amount of standing dead timber available for nesting sites is explained as the limiting factor for insectivorous birds in a Wyoming study (Davis 1976). Authors of a theoretical study investigating correlations between clutch size and the ability of a species to utilize existing holes explained their results support the hypothesis that nest sites are limiting factors (Martin 1993).

Several studies emphasize factors other than nest sites as limiting factors. Authors of a study in northwestern Montana larch/fir forest explained their results with the hypothesis that woodpeckers are limited by food, not nest site (McClelland and others 1979). Another study reported that limiting factors may be winter food sources for residents or territoriality for migrants, but does not seem to be nest sites (McClelland 1977). However, even though appropriate nest sites are not limiting, the nest tree is still important because these woodpeckers cannot nest in the open where no snags or decaying trees are present, with the possible exception of flickers (McClelland 1977). Observed differences between burned and unburned habitat were more prominent during the non-breeding season in Montana, suggesting foraging may be more important than nest-cavity limitations (Caton 1996).

Patterns Of Dispersal

Very little information is available on natal dispersal patterns. A one-year-old was found breeding 250 m from its birthplace (as cited in Leonard 2001).

Community Ecology

Predators

Leonard (2001) lists northern goshawks, black bears, and mice as predators. Goggans (1989b) includes the following as predators of three-toed woodpeckers: goshawks, great horned owls, and probably tree squirrels. Most of this information comes from anecdotal observations and it is not known what impact predation has on populations.

Competitors

Black-backed woodpeckers usually dominate encounters with three-toed woodpeckers (Short 1982). Perhaps in response to these encounters, three-toed woodpeckers partition resources with black-backed woodpeckers by foraging higher on trees and foraging primarily by scaling, not excavating (Villard 1994). Three-toed woodpeckers also compete with tree swallows over nest sites and have some unclear interactions with tree squirrels (Short 1982). Conner and Adkisson (1977) suggest that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited.

Parasites, Disease, Mutualistic Interactions

No information is available for three-toed woodpeckers although it is likely that have similar parasites to other woodpecker species.

Other Complex Interactions

In the winter males seem to be dominating certain foraging niches (Hogstad 1978). How this affects female survival is unknown.

Primary cavity-nesters such as woodpeckers construct cavities that may be used by other animals. Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin and others (1995) also discuss the importance of primary cavity nests as nest sites for secondary cavity-nesters. Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

However, others dispute the importance of these cavities for secondary nesters (Gutzwiller and Anderson 1988). Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). For example, snag density may not accurately determine the habitat availability for secondary cavity-nesters. This is further supported by a study in California oak/pine forest where blocking cavities did not change the bird densities (Waters and others 1990).

The author of this review suggests that the dependence on primary cavities probably depends on the particular stand in question.

Risk Factors

Practices that limit habitat and food resources are the major risk factors for three-toed woodpeckers. Few studies directly address risk factors in this species. However, due to the similarity in habitats between black-backed woodpeckers and three-toed woodpeckers, it is likely that risk factors are similar, including fire suppression, salvage logging, and elimination of large mature stands.

Three-toed woodpeckers are associated with burn areas so fire suppression is most likely detrimental. Fire suppression is a major risk factor in the Black Hills. Fires have become less frequent in the Black Hills due to fire suppression (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed historically in the area (Parrish and others 1996). Many fires were low intensity, but there were occasional areas with high intensity burns and insect infestations (Parrish and others 1996). Changes in habitat due to timber management, fire and insect suppression may have affected woodpecker populations (Parrish and others 1996).

Replacing mature stands with young stands through timber practices can eliminate decaying trees and reduce insect prey for the woodpeckers. Goggans and others (1989) suggest leaving large, unlogged areas as woodpecker management areas.

Salvage logging is also detrimental to these woodpeckers if snags that would be ideal habitat for the woodpeckers are removed (Hutto 1995). Hutto (1995) suggests salvage cutting only part of burn areas, or not taking trees in size classes preferred by the birds.

Response To Habitat Changes

Management Activities

For a general summary of the effects of various management practices on three-toed woodpeckers see Table 15.

Timber Harvest

Timber harvesting has an immediate effect if active nest trees are removed. However, the effect on a landscape scale is more important to the whole population. Replacing mature stands with young stands through timber harvesting can eliminate decaying trees and reduce insect infestations, which will reduce the woodpecker population. Goggans (1989b) states three-toed woodpeckers are vulnerable to logging if enough snags are not left intact. Cavity-nesting birds fed more often in uncut units than in cut stands in Montana larch/fir forest (McClelland 1980). An Oregon study also found that success was higher in unlogged areas (58% versus 33%) (Goggans and others 1989). Loose (1993) found no relationship between the number of snags retained and the amount of woodpecker foraging activity. However, this result was probably due to the small dbh of the available snags and the fact that many of the snags originally available in the stands fell due to exposure. Generally logging has a negative effect on three-toed woodpeckers and Goggans *and others* (1989) suggests leaving large, unlogged areas for woodpecker management areas.

Different cutting strategies differ in the severity of their impact. Clear-cutting would have the most severe impact, especially if snags of sufficient size and density are not left in the stand. Clear-cutting treatments and treatments that removed all trees larger than one inch dbh and left all residue had negative effects on feeding activity (McClelland 1980). Loose (1993) found the woodpeckers were still foraging in clear-cuts in Wyoming, even those without snag retention policies, but they were not using the snags for nesting because they were too small. Three-toed woodpeckers are most likely negatively affected by clear-cuts or group selection treatments in the Black Hills (USDA Forest Service 1996).

Other practices would most likely have less severe effects since snag maintenance is more likely under other treatments. However, three-toed woodpeckers may be more sensitive to treatments than other woodpeckers. Although shelterwood cutting in a Maine study did not significantly affect other woodpecker species' abundance, three-toed woodpeckers were only found in unmanaged (i.e. untreated) softwood areas (Gunn and Hagann 2000). Thinning is detrimental since snags are often removed during the process (Beebe 1974; Cline and others 1980). Thinning and regular shelterwood cutting in the Black Hills is likely to have a negative effect on three-toed woodpeckers because few large diameter trees are left (USDA Forest Service 1996).

Salvage sales after fires or blowdowns likely have the most detrimental effect because they remove the snags in the size classes preferred by three-toed woodpeckers, plus they reduce potential insect outbreaks in these areas, which are prime food sources. Saab and Dudley (1998) demonstrated that black-backed woodpeckers preferred areas that were not salvage-logged, and it is likely that three-toed woodpeckers' reaction is similar. Following salvage activities, three-toed woodpeckers had significantly lower densities in the salvaged areas than in the unsalvaged areas after a burn in a Montana mixed conifer forest (Douglas fir, western larch, and Ponderosa pine, with some aspen) (Hitchcox 1996). Some of the negative effects of salvage logging might be mitigated by not taking trees in size classes preferred by the birds or salvage cutting in only part of the burn (although the acceptable amount of salvage cutting has not been determined) (Hutto 1995).

Reduction of stand rotation age reduces the number of large snags (Beebe 1974). Thomas and others (1979) stated that in order to support 100% of the three-toed woodpeckers, mixed conifer forest must contain 145 snags per 100 ha (247.1 acres) with a minimum of 30.5 cm (12.01 inches). Recommendations for ponderosa pine forest are not given for three-toed woodpeckers. However, these suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Recreation

Some three-toed woodpeckers are found near human activity (Mohren and Anderson 2000), but this does not necessarily indicate optimal habitat. Leonard (2001) also indicates human activity does not greatly impact three-toed woodpeckers. In the Black Hills, the large numbers of roads (see glossary for discussion of road density) means the birds have very few refuges. "The number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b). In addition, there may be detrimental impacts if users looking for wood for campfires cut down snags (see fuelwood harvest below). Wisdom and others (2000) stated that habitat is reduced near roads due to snag reduction and the direct edge effect of the road.

Livestock Grazing

No information is available on the effect of grazing on three-toed woodpeckers. It is the opinion of this author that grazing probably has limited impact on these woodpeckers since most of their prey items are wood-boring and bark-dwelling insects, which would not be affected by the presence of ground vegetation.

Mining

Mining activity may be detrimental if preferred habitat is lost or if recreational use of mining roads reduces snag densities in areas near roads due to firewood cutting (USDA Forest Service 1996).

Fire Suppression

Fire suppression likely has a negative effect on these birds. Three-toed woodpeckers use burn areas for nesting and foraging so suppressing fires reduces habitat for these birds. Fire suppression is a major risk factor in the Black Hills. Fires have become less frequent in Black Hills due to fire suppression (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed historically in the area (Parrish and others 1996). Many fires were low intensity, but there were occasional areas with high intensity burns and insect infestations (Parrish and others 1996).

Prescribed Fire

The potential effect of prescribed burns is unclear. Prescribed fires would likely be beneficial if they create new snags for nest habitat. However, studies linking high woodpecker presence to burn areas describe high intensity stand replacement burns (at least for black-backed woodpeckers), so it is unknown whether low intensity burns will have the same benefit for woodpeckers, or whether they will actually decrease woodpecker habitat. Horton and Mannan (1988) recommend protecting large snags during intense prescribed burns, especially if there are not many large snags in the landscape, as is the case in the Black Hills (USDA Forest Service 1996). The ideal size of prescribed burns is unknown.

Non-Native Plant Establishment And Control

It is the opinion of this author that non-native plants probably do not have much effect on three-toed woodpeckers. Control methods may affect these birds if chemical sprays also impact insect populations on which the woodpeckers depend.

Fuelwood Harvest

Fuelwood harvesting will negatively affect three-toed woodpeckers overall if snags used for nest trees are located in easily accessible areas (i.e. near roads) (USDA Forest Service 1996). Due to the large number of roads in the Black Hills National Forest (see glossary for discussion of road density), this is likely to be a factor. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags of ponderosa pine per 100 acres (40.5 ha) greater than 25.4 cm (10 inches) dbh (USDA Forest Service 1996). A separate study found an average of 3.6 snags greater than 25.4 cm (10 inches) dbh per 0.4 ha (1 acre) in stands not actively managed for 20 to 30 years on the Black Hills National Forest (Lentile and others 2000). These numbers mean that many stands have much lower than the number of snags recommended by many sources (Scott 1978; Scott and Oldemeyer 1983a; Raphael and White 1984; Zarnowitz 1985; Goggans 1989a; Bate 1995; see Table 17), so it is important to conserve as many snags as possible.

Insect Pest Control

Pesticides may impact woodpecker populations because the chemicals kill insect prey (Beebe

1974). Goggans and others (1989) recommend against pest treatment because eliminating the heartrot (carried by some insects) in trees can decrease the woodpeckers.

Natural Disturbance

Insect Epidemics

Insects are beneficial for three-toed woodpeckers because they serve as prey items and help trees decay. Since three-toed woodpeckers feed on wood-boring beetles and their larvae, they are important natural control mechanisms for insect outbreaks.

Wildfire

Saab and Dudley (1998) conclude three-toed woodpeckers are responsive to fire activities. They are present in early successional burn areas, appearing the first year following the event (Harris 1982) and most common 1.5 years after the fire (Murphy and Lehnhausen 1998). Their populations in the burn area decrease as succession continues. They were quite rare 3.5 years after a burn in Alaska (Murphy and Lehnhausen 1998). Their decrease after the third year in Montana was associated with a decline in the insect population (Harris 1982). Hutto (1995) suggests that burn areas serve as source areas (after Pulliam 1988; Pulliam and Danielson 1991) for black-backed woodpeckers, supplying the remaining forest (sink areas) with woodpeckers, although this has not been proven. The same pattern may hold for three-toed woodpeckers. Regardless, burn areas are preferred habitat for the woodpeckers and very important to their survival.

Fires have become less frequent in Black Hills than they were historically due to fire suppression (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed historically in the area (Parrish and others 1996). Many fires were low intensity, but there were occasional areas with high intensity burns and insect infestations (Parrish and others 1996). Decreased amount of burn areas for source habitat may decrease the overall population. Large wildfires in the Black Hills during 2000 and 2001 may provide more habitat for these birds and should be investigated.

Wind Events

Blowdowns may increase insect infestations (Furniss and Carolin 1977), which may benefit woodpeckers. For example, in a 50-100 km^2 blowdown area in Lapland with 30 to 40% of the trees down, density of three-toed woodpeckers was 1.2 pairs/km^2 in the blowdown area and 0.1 pair/km^2 in virgin forest (Virkkala and others 1991). Large amounts of blowdowns in the Black Hills from 2000 and 2001 may benefit woodpeckers.

SUMMARY

Three-toed woodpeckers play an important role in the ecosystem, eating many wood-boring insects and excavating cavities that can be used by secondary cavity-nesters. They are more secretive than the similar black-backed woodpecker, so fewer studies are available. Little is known about their population in the Black Hills. See the envirogram in Figure 4 for an illustration of the ecological interactions of this species.

Three-toed woodpeckers are distributed around the globe in northern latitudes. In North

America they stretch from the tree line south to Arizona in the west, and in the east to Minnesota, New York, and New England. They do not usually migrate. They are considered rare in South Dakota, but there is not enough information from the Black Hills area to determine population trends.

They are slightly smaller than black-backed woodpeckers, but similar in that both have three toes and similar excavation and food habits. These birds are principally associated with early-successional burn habitat and areas with insect outbreaks. The dynamics between outbreaks are unclear and should be investigated further.

They nest mainly in snags and decaying trees. In the Black Hills they most likely utilize ponderosa pine, spruce, and aspen for nest trees. They lay one clutch of three to five eggs. Nest trees vary in size with the type of forest; averages have been noted from 24 cm to 31 cm in Montana. Nesting areas also have large basal areas surrounding the nest tree.

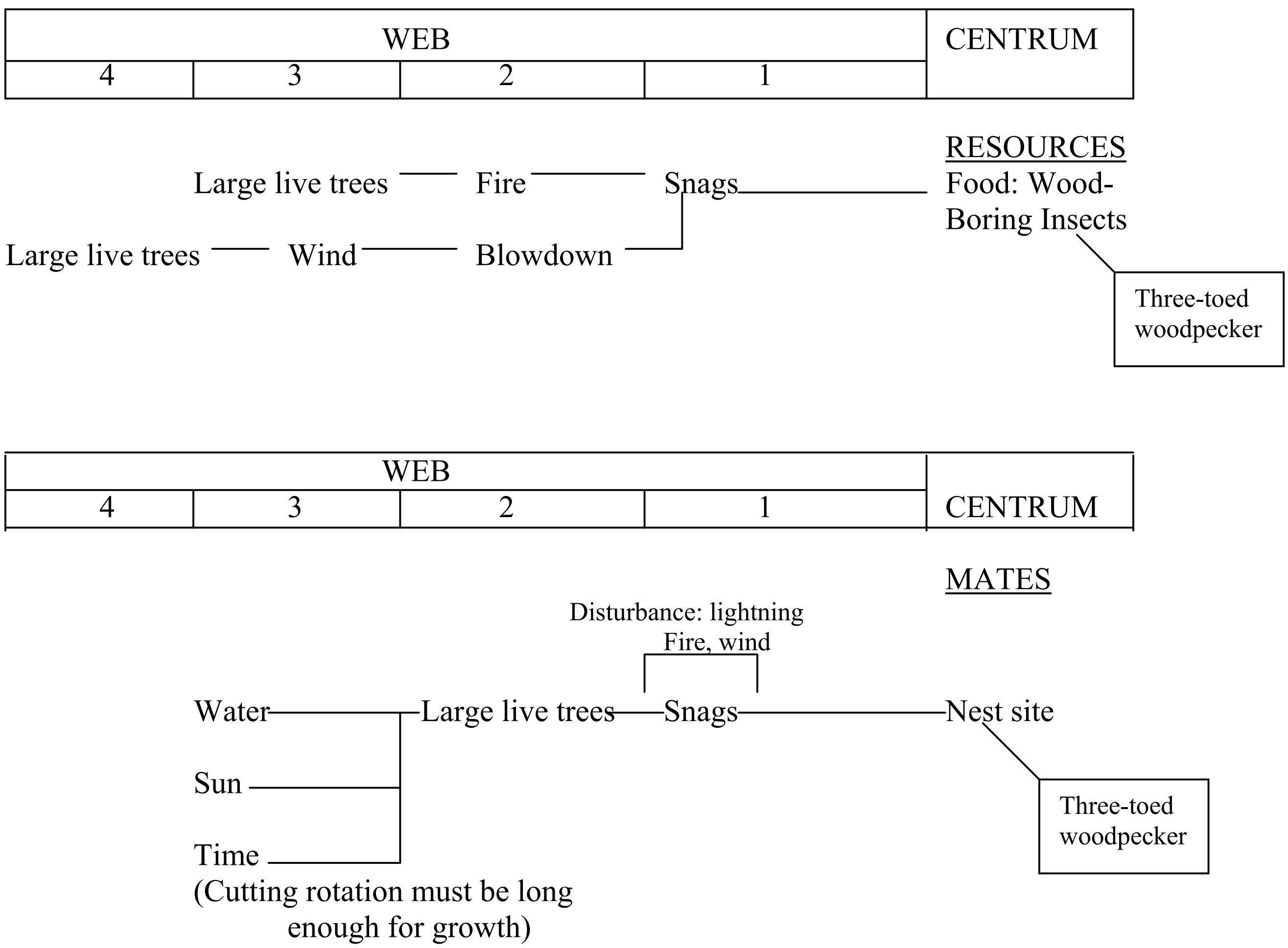
They feed mainly on wood-boring beetle larvae and bark beetles. These beetles are subject to outbreaks, partially explaining birds' presence in some areas.

Fires have become less frequent in the Black Hills than they were historically and this may be affecting these woodpeckers. Decreased amounts of burn areas for source habitat, may decrease the overall population. Large wildfires in the Black Hills during 2000 and 2001 may provide more habitat for these birds.

Because of their habitat needs, they are negatively affected by activities such as fire suppression and timber cutting if these activities reduce the number of snags present in the landscape. Salvage sales after fires are especially detrimental on the woodpeckers as they remove much potential habitat. Recreation may have a negative effect if the birds are disturbed at their nest sites or if snags are removed for campfires. The effect of grazing is likely neutral. Prescribed fires will likely benefit these birds. Chemicals used to control plants or insects may affect these birds if they decrease the woodpeckers' insect prey. Fuelwood harvest negatively affects these birds by removing snags that could be used as nests.

Management efforts that retain snags and plan for long-term recruitment of snags will benefit these birds.

Figure 4. Envirogram of the Three-toed woodpecker in the Black Hills National Forest. The effects of competition and predation are not understood well enough to represent, so the Malentities section is not included.



LEWIS'S WOODPECKER

INTRODUCTION

The colorful Lewis's woodpecker (*Melanerpes lewis*) is undergoing a nationwide population decline. The ranges of red-headed and Lewis's woodpeckers are almost mutually exclusive, with only small areas of overlap, including the Black Hills (Tobalske 1997). This document summarizes the ecology and life history of the species and discusses management and conservation issues related to maintaining viable populations of these woodpeckers.

CURRENT MANAGEMENT SITUATION

Management Status

No special status is awarded to the Lewis's woodpecker by the U.S. Fish and Wildlife Service (Welp and others 2000). The species is not included on the IUCN Red List (Hilton-Taylor 2000). However, the National Audubon Society ranks the Lewis's woodpecker as having moderate conservation priority (Muehter 1998). The species is included on the Blue List in British Columbia (Beardmore 2001). The U.S. Forest Service in Region 2 considers Lewis's woodpeckers to be a sensitive species (Welp and others 2000). The Partners In Flight database for the region including the Black Hills considers Lewis's woodpecker to be of high overall priority (class I) for conservation concern (Panjabi 2001a; Partners In Flight 2001). South Dakota classifies the species as S3, meaning it is "either very rare and local throughout its range, or found locally … in a restricted range…" (South Dakota Department of Game Fish and Parks 2000). The Wyoming Natural Heritage Database considers the species to be globally secure, but rare in the state during the breeding season only (S2B, SZN) (Welp and others 2000). The Wyoming Game and Fish Department classifies Lewis's woodpeckers as a category 3 species of special concern (Luce and others 1999). The Wyoming Bird Conservation Plan lists the species as a level 2 species where the primary focus is monitoring (Cerovski and others 2001).

Existing Management Plans

Forest Service Biologists at both the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers were available in the region (C. Schultz, personal communication).

In the Columbia Basin, where Lewis's woodpecker habitat has declined more than 83% from historical levels, an ecosystem management plan was developed to define conservation issues important to the species (Wisdom and others 2000). The plan identified several issues of concern, including: the loss of shrubs (as a source of arthropods), decline in older forests, loss of large snags, and the impact of pesticides (Wisdom and others 2000).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Lewis's woodpeckers are relatively large for local woodpeckers at 27 cm (10.75 inches) long and are described as having a "greenish-black head and back, with a gray collar and breast; dark red face, pinkish belly" (National Geographic Society 1987). Until the first winter, juvenile plumage lacks the gray collar and the head is brown (sometimes with some red mixed in) with brown or steel blue barring under the wings and partially down the sides (Bent 1939; National Geographic Society 1987). With this distinctive coloration, this species is not easily confused with other woodpecker species. These birds have a very interesting flight pattern--a slow, gliding flight more like crows than other woodpeckers (Bent 1939), presenting the potential for misidentification as a crow or jay (Tobalske 1997).

Melanerpes lewis is named after Meriwether Lewis who described the species on the famous Lewis and Clark expedition (Tobalske 1997). Lewis's woodpeckers were previously classified in genus *Asyndesmus*, so some sources refer to this species as *Asyndesmus lewis* (i.e. Hadow 1973; Constantz 1974).

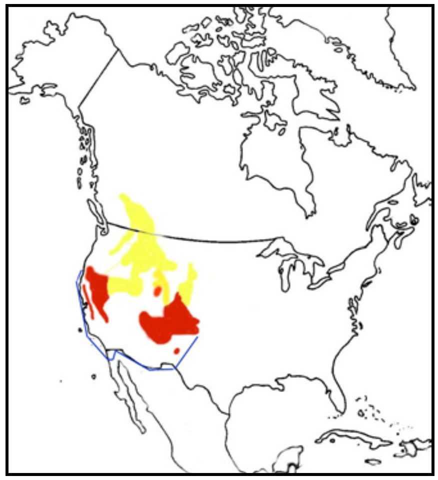
No official subspecies are recognized. Lewis's woodpecker is closely related to the red-headed woodpecker, *Melanerpes erythrocephalus* (Tobalske 1997).

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

In the summer, Lewis's woodpeckers' range extends from British Columbia and Montana south to New Mexico and Arizona; California, Oregon, Washington and east to Wyoming, Colorado, and western South Dakota (Bent 1939; Short 1982). Since 1900, the breeding range has been extending eastward, into the plains of Colorado along the Platte and Arkansas rivers due to cottonwoods maintained near ranches and corn crops providing mast (Hadow 1973).

Figure 5. Distribution of Lewis's woodpeckers. Adapted from Tobalske (1997). Solid yellow represents breeding range and red represents year-round range. Yellow lines represent the extent of the irregular breeding areas. The solid blue line represents the extent of the irregular winter range.



In winter some migration occurs and their distribution contracts, pulling south (Bent 1939). In the west, the winter range stretches from California to the Columbia River, although they occasionally remain as far north as British Columbia (Bent 1939). Inland the winter range stretches from northern Colorado south to Texas, New Mexico, and Arizona (Bent 1939).

Additional Information (Local Distribution)

Lewis's woodpeckers' breeding range covers most of Wyoming and western South Dakota (Tobalske 1997). In Wyoming, this species is considered an uncommon summer resident, although breeding records exist from much of the state (Luce and others 1999). Records of breeding populations exist for Yellowstone and Medicine Bow National Forest in Wyoming (Welp and others 2000). In South Dakota, breeding activity has been recorded in Meade County, McVey Burn, Pennington County, Sturgis, Fall River County, Lawrence County, and Deadwood (South Dakota Ornithologists Union 1991). Lewis's woodpeckers are considered rare in the Black Hills (South Dakota Ornithologists Union 1991).

Some historical records (pre-1960) show winter residents in the Black Hills (South Dakota Ornithologists Union 1991). Recently, these birds have been sighted during Christmas Bird Counts in South Dakota in 1997-1998, 1998-1999, and 1999-2000 (South Dakota Bird Notes 1998,1999,2000) and have been confirmed to be wintering in 1998 (Schenck 1999a).

Estimates Of Local Abundance

Historically, Lewis's woodpeckers were not considered common in the Black Hills, but they were present (Ludlow 1875). In the Christmas Bird Count at Spearfish, 3 Lewis's woodpeckers were recorded in 1997, but none have been recorded in the counts since then (Cornell Laboratory of Ornithology and National Audubon Society 2001). Summer sightings in South Dakota are documented from 1997 (Palmer 1997) and 1998 (Palmer 1998b), but Schenck (2000) notes that records are missing for the 2000 season. The Breeding Bird Surveys in the Sundance Route Group average .01 birds per route, but the Black Fox Group (including Hill City and Custer) averages .00 birds (Sauer and others 2001). In the summer of 2000, one Lewis's woodpecker was observed, none were found the following year, during a preliminary study of woodpeckers in the Black Hills National Forest (Mohren and Anderson 2000, 2001). Although this is preliminary data, it does indicate that Lewis's woodpeckers can occasionally be found in the area. Panjabi (2001b) located three birds in the BHNF in 2001 with density estimates of 1 per 100km in burned areas and 2 per 100 km in ponderosa pine.

Population Trends

It is difficult to obtain population trends for this species over a short time period. Population sizes seem to fluctuate, even disappearing from some regions for a time, then reappearing (Tobalske 1997). Still, most information available indicates declines for this species. In the western region of the Breeding Bird Survey, Lewis's woodpeckers show a significant negative trend from 1966 to 1998 (Sauer and others 1999). Utah studies also show evidence of declines (see Sorenson 1986 as cited in Vierling, 1997). Although trend analysis of Christmas Bird Count data from 1959 to 1988 shows no significant trends (Sauer and others 1996), combined CBC and BBS data showed declines of 60% overall (Tashiro-Vierling 1994 as cited in Tobalske, 1997). Not enough observations were recorded on local Breeding Bird Survey Routes to determine statistically significant trends in the Black Hills (Patterson 2000).

Movement Patterns

Lewis's woodpeckers are partially migratory. In general, these birds migrate out of the northern ends of their range during the fall/winter (Bent 1939). However, migration appears to vary from year to year, some areas outside of the breeding range have birds in the winter some years, but not other years (Tobalske 1997). In addition, some groups move up in elevation in the later summer, perhaps following food resources, then migrate south in the fall (Tobalske 1997). No information is available on individual routes or distances of migration (Tobalske 1997). In eastern Colorado, some birds migrate to the foothills, while others remain on the plains for the winter (Hadow 1973).

Lewis's woodpeckers reportedly arrive in Wyoming in April or May and leave in September or October (Bent 1939). Connections between the Black Hills' population and other areas are unknown.

Habitat Characteristics

General Habitat (Summer)

Lewis's woodpeckers' summer habitats vary considerably, and include: farmland areas, woodlands along creeks, sagebrush areas, mixed forest, and open pine forest (Bent 1939).

Although the birds have been found in many types of habitat, Tobalske (1997) classifies their breeding habitat into three main types: open ponderosa pine forest, open forest along drainages especially those with a large cottonwood component, and logged or burned pine forest with snags. In general, for nest areas they need areas with open-canopy forest, snags, sufficient ground cover, and insect prey (Tobalske 1997). The Black Hills National Forest contains much ponderosa pine (USDA Forest Service 1996), so the forest should be able to support these birds. Panjabi (2001b) located two birds in ponderosa pine stands and one bird in burned areas. None of these birds were located in riparian areas on the Black Hills National Forest.

In Colorado, they breed in both the foothills and the plains (Vierling 1997). In the foothills, they preferred areas with nearby grazed or mowed areas, and avoided dense tree stands and areas with bare ground, presumably because insect levels were higher or maneuverability easier in the former (Vierling 1997). In the plains areas, the birds preferred areas near cornfields and avoided areas adjacent to fallow fields, mowed or grazed fields, and heavily forested areas (Vierling 1997).

Burned areas vary in suitability over time for Lewis's woodpeckers (Tobalske 1997). After a fire in California, the birds used burned habitat preferentially over non-burned during nesting but then showed no preference later in July (Block and Brennan 1987). Burn areas were also preferred in a Wyoming study (Linder and Anderson 1998). Burns 7 to 8 years old were preferred for nesting over burns 20 years old (Linder and Anderson 1998).

Patch size requirements are unknown. See Spacing section under Demography for more information on home ranges and territory size.

Nesting Habitat

Bent (1992) describes various studies, which show the birds nesting in several different decaying tree species including: cottonwoods, pines, sycamores, oaks, junipers, willows, larch, and yellow pine. These birds usually nest in snags; choosing snags 100% of the time in California (Raphael and White 1984). These snags used by Lewis's woodpeckers are classified as 'soft snags', meaning they are somewhat decayed and have been dead more than 6 years (Raphael and White 1984). The Black Hills contains much ponderosa pine (USDA Forest Service 1996) so this is the tree species potentially being used locally by Lewis's woodpeckers.

Cottonwood trees may be preferred in some areas because the softer wood and many natural crevices make it easier for Lewis's woodpeckers who might have difficulty constructing cavities in trees with harder wood (Vierling 1997). Vierling (1997) suggests that Lewis's woodpeckers may currently avoid breeding in ponderosa pine in Colorado because the stands are too dense for them to maneuver efficiently enough to catch insects.

Several studies have examined specific characteristics of the nest trees used by Lewis's woodpeckers (see Table 4). Important attributes of nest trees listed in the table include: the diameter at breast height (dbh), the height of the nest tree, and the height of the actual nest cavity. Data varies with geographical area and forest type. In Oregon, it was predicted Lewis's woodpeckers could be supported at 100% of its maximum population if 249 snags (>30.5 cm, 12.01 inches dbh) per 100 ha (247.1 acres) are maintained in ponderosa pine forest (Thomas and others 1979). However, these suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002). No data is currently available for

Lewis's woodpecker nests in the Black Hills.

Table 4. Characteristics of Nest Trees Used by Lewis's Woodpeckers

Tree Species	DBH, cm[a]	Tree Height, m	Nest Height, m	Forest Type	Location	Notes[b]	Tree Decay Status	Citation
Fir and pine	66.5 Min 56	11.4	7.3	Jeffrey Pine/ white fir	California	Used snags, burned, n=37	Soft, 59% bark cover	(Raphael and White 1984)
Cottonwood	112.6	---	---	---	Colorado	Used dead and decaying trees, n=47	---	(Vierling 1997)
---	47.8	---	7.5	---	Wyoming	Burn area, n=35	82% bark cover	(Linder 1994; Linder and Anderson 1998)
---	76.20	---	---	Western larch/ Douglas fir	Montana	Birds found mostly in open/semi-open habitat; n=2	---	(McClelland and others 1979)
---	78	22	25.3	Lodgepole pine	Montana	Burned and unburned areas, n=2	---	(Caton 1996)
Black cottonwood and paper birch	69	---	---	Western larch/ Douglas fir	Montana	Cut area, n=2	Broken top snags	(McClelland 1977,1980)
---	44.7	---	---	Ponderosa pine/ Douglas-fir	Idaho	Burned forest, n=208	Ave. decay class 2.3 (light to medium decay)	(Saab and Dudley 1998)[c]
---	46.7 (burn); 112.6 (not burned)	---	---	Ponderosa pine (burn in Idaho); Cotton-wood (unburned, riparian in Colorado)	Idaho and Colorado	Burned area, mostly snags n=256; Unburned riparian area n=47	---	(Saab and Vierling 2001)[c]

[a]Numbers preceded by "Min" are minimums, other numbers are averages.
[b]Sample size is indicated by n=#.
[c]These two studies utlize many of the same nest data from the Idaho sites.

Areas around nest trees may be important also, if Lewis's respond similarly to other woodpeckers. The following studies indicate canopy cover, basal area, and ground cover are important factors in choosing a nest site. In a Montana study Lewis's woodpeckers used sites with average dbh of 35 cm, basal area of 18 m2/ha, and 0% live canopy (Caton 1996).

Presumably these were snags, since 96% of all nest trees (for all species studied) were in snags, although specific information was not given for nests of Lewis's woodpeckers. Sample sizes (n=2) were too small to be able to test for preferences. Snag densities around nests in burned and logged areas in Idaho were 100 snags (>23 cm dbh)/ha (n=260) and around nests in unlogged areas were 198.1 snags (>23 cm dbh)/ha (n=27) (Saab and others *in press*). In Wyoming, nesting sites had greater canopy cover or obstruction of sky, were clumped (although this may be due to burn dynamics), and contained more litter cover than non-nesting sites (Linder and Anderson 1998).

Landscape characteristics around Lewis's woodpecker nests (n=305) and non-nest random points (n=49) were modeled to predict nest occurrence in logged units of an Idaho burn (Saab and others in press). Size (mean =6.63 ha) of ponderosa pine/Douglas-fir moderate (40-70% pre-fire) crown closure stands was the most important variable in predicting nest occurrence. Closely distributed (mean nearest neighbor = 61.9 m) and large-sized (mean = 15.82 ha) stands of ponderosa pine high crown closure were also significant landscape variables in predicting nest occurrence.

Basal area around nest trees was an important predictor in a California study (Raphael and White 1984). Basal area was zero around two Lewis's woodpecker nests in Montana (McClelland 1977). They apparently like open areas to catch insects (McClelland 1977).

Ground cover is important also, probably due to the insects that depend on those plants. The density and height of ground cover preferred by Lewis's woodpeckers is disputed, however. The Fish and Wildlife Habitat Suitability Index model indicates Lewis's woodpeckers prefer extremely dense shrub cover of over 50% (Sousa 1983). Other studies support a lesser amount of shrub cover. Block and Brennan (1987) found lesser shrub covers in both burned (26.5%) and unburned (13.4%) areas occupied by the woodpeckers. Linder and Anderson (1998) found 16.14% shrub cover in occupied habitat in a Wyoming study.

Foraging Habitat

The particular "foraging tree" is not important for Lewis's woodpeckers, because it serves only as a perch to catch flying insects (Raphael and White 1984). Hardwoods, however are important as mast sources (Tobalske 1997). Large dead or decaying trees were also chosen as sites to store mast (Vierling 1997).

Winter Habitat

In the winter, Lewis's woodpeckers in Colorado avoided areas with ungrazed fields, structures, or bare ground, while preferring areas near oaks. In the plains areas, they avoided plowed, grazed, and fallow fields, but did prefer corn fields (Vierling 1997). These preferences reflect a difference in the type of mast (acorns vs. corn) available in the different habitat types (Vierling 1997).

In an Arizona ponderosa pine forest, part of which had burned and been cut, Lewis's woodpeckers were found only in clear cut, unburned areas in the fall and winter (Blake 1982). The birds were not found in the spring.

Winter habitat information is lacking for the few Lewis's woodpeckers that remain in the Black Hills year-round.

Food Habits

Lewis's woodpeckers catch insects on the fly, glean them from branches, or forage on the ground (Tobalske 1997). Raphael and White (1984) report 76% of foraging activity was flycatching with 22% gleaning. These birds watch from a perch and then catch flying insects similar to the methods of flycatchers (Bent 1939). They also hunt by flying back and forth over the ground (Bent 1939). Wing shape and muscle fibers in the wings may make them uniquely adapted among woodpeckers to their hunting style (Tobalske 1996). Lewis's woodpecker has the largest gape of the common woodpeckers and this is associated with consuming flying prey (Spring 1965).

In addition to catching live insects, Lewis's woodpeckers stash food, including: acorns, corn, and sometimes insects (Bent 1939; Tobalske 1997). The mast is broken into pieces and stored in crevices in trees (Tobalske 1997). These birds also eat fruit and can seriously damage fruit crops (Bent 1939).

Foraging strategies varied between parts of the season and between years in a Wyoming study, possibly due to different types of insects available (Linder 1994). During the winter, Lewis's woodpeckers eat mainly stored foods, although they will still catch insects when available (Short 1982).

Prey Species

Insect prey includes: grasshoppers, crickets, ants, beetles, wasps, flies, mayflies, and various larvae (Bent 1939; Tobalske 1997). Studies of stomach contents reveal woodpeckers eat 37% animal material including: 7% predacious beetles (Carabidae and Coccinellidae), 12% ants, 12% other hymenoptera, and small amounts of hemiptera, grasshoppers, and spiders (Beal 1911). Lewis's woodpeckers do not consume wood-boring insects like most other woodpeckers (Beal 1911).

Non-insect food includes: wild strawberries, wild raspberries, serviceberries, salmon berries, acorns, corn, pine seeds, hawthorn, dogwood, elderberry, juniper berries, grit, and cultivated fruits such as almonds, pears, apples, cherries, peaches, and pomegranates (Bent 1939; Tobalske 1997). Beal (1911) found 15% fruit (mostly wild), 34% mast (mostly acorns), and some seeds and corn in Lewis's woodpecker stomachs. No information is available on the specific species consumed in the Black Hills.

Characteristics Of Prey

Along water ways, massive hatches of insects may draw the birds to the area (Tobalske 1997).

Breeding Biology

Phenology

Timing of breeding events varies with latitude and elevation (Tobalske 1997). The birds' arrival at breeding grounds occurs from May to June and they build their nests from April to May (Tobalske 1997). After eggs are laid, incubation lasts 13 to 16 days and occurs from mid-April to June (Tobalske 1997). The young begin to leave the nest from 28 to 34 days after hatching, placing fledging in June or July (Tobalske 1997).

In the Black Hills, most nesting activity occurs in June and July, with copulation as early as April 19 and hatched young as early as June 9 (South Dakota Ornithologists Union 1991). Fall migration starts in August or September, although occasionally birds will remain in the area (South Dakota Ornithologists Union 1991).

Courtship Characteristics

Various calls, drumming, and flying displays characterize courtship (Tobalske 1997). Males tend to use 'churr' and 'chatter' calls to defend territory (Tobalske 1997). A special rolling type of drumming occurs only during the breeding season (Tobalske 1997). Males also use particular displays during courtship where the maximum amount of coloration is displayed while perching or gliding around the nest (Tobalske 1997). Other courtship information is unknown.

Clutch Initiation, Laying, And Size

Lewis's woodpeckers lay 5 to 9 white eggs, which average 26.22 mm long by 19.99 mm wide (Bent 1939). Clutch size is correlated with latitude (Koenig 1986). Each pair lays one clutch per year (Tobalske 1997).

Parental Care

Males select the nest site, which may be the male's wintering site in some areas (Short 1982). Both sexes construct the nest, either creating a new hole or reusing previous nests of Lewis's woodpecker, northern flicker, or hairy woodpecker or using a natural hole (Tobalske 1997).

Both sexes incubate eggs and brood the young (Tobalske 1997), although males usually take the night shifts (Short 1982). As expected, adults spend significantly more time foraging while nestlings/fledglings are present, in order to keep the young fed (Linder 1994).

Site And Mate Fidelity

Tobalske (1997) discussed some evidence of mate fidelity, but since the pairs do not necessarily winter together, this could reflect site fidelity. Bent (1939) reported on nest sites being used in subsequent years, although it is unknown whether the same pairs were being observed. A Wyoming study showed birds reused 36.7% of nests sites in the second year of the study, but it was unknown if they were the same pairs using the sites (Linder 1994).

Demography

Life History Characteristics

No information is available on age of first breeding, but Tobalske (1997) assumes the birds are sexually mature the year following their birth. No information is available on life span or non-breeders or other aspects of life history.

Survival And Reproduction

Estimates of nest success range from 29.4% to 85% (Tobalske 1997). Reproductive success of Lewis's woodpecker was 46% (n=65) in cottonwood riparian areas of Colorado and 78% (n=283) in burned pine forests of Idaho (Saab and Vierling 2001). Predation was the major cause of nest failure in both study areas, although significantly higher predation was noted in in the cottonwood areas (34% vs. 16%). Cottonwood riparian areas were surrounded primarily by an agricultural landscape where the nest predator assemblage was probably very different from a large-scale burn in a relatively natural landscape (Saab and Vierling 2001).

The only longer-term survivorship data available for this species indicates a high over-winter survivorship of 88% (see Tashiro-Vierling 1994 as cited in Tobalske, 1997). Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995).

Social Pattern For Spacing

Very little information is available on this topic. Lewis's woodpeckers apparently defend territories around their nest in summer (male) and around their stash of nuts in winter (male and female), although individuals' harvesting areas can overlap (Tobalske 1997). However, territories must be somewhat flexible since occasionally multiple nests are observed within one tree (Vierling 1997).

Local Density Estimates

In Montana, densities ranged up to three birds per 40 ha (98.8 acres) (Harris 1982). No density estimates are available for the Black Hills.

Limiting Factors

Some disagreement exists in the literature over the exact limiting factor for woodpeckers. Beebe (1974) reviewed many studies and concluded that the limiting factor is the cavity, roost-site, or nest-building substrate. In Wyoming, one study concludes that standing dead timber is limiting since fewer woodpeckers overall were found in the same habitat type with less standing timber (Davis 1976).

Several studies emphasize factors other than nest sites as limiting factors. In Montana, observed differences in abundance between burned and unburned habitat were more prominent during the non-breeding season, suggesting foraging may be more important than nest-cavity limitations (Caton 1996). For the Lewis’s woodpeckers this would be the presence of abundant mast, fruit, and/or appropriate insect prey species (see section on Food Habits).

It is the opinion of this author that limiting factors for Lewis’s woodpeckers in the Black Hills are most likely nesting habitat (i.e. soft snags) in open forests with abundant food sources.

Patterns Of Dispersal

No information is available on natal dispersal.

Community Ecology

Predators

Recognized predators include: red-tailed hawk, American kestrel, and possibly Cooper's and sharp-shinned hawks (Tobalske 1997). Most of this information comes from anecdotal evidence and it is not known what impact predation has on populations. Black bears, weasels, and chipmunks are potential nest predators that have been seen in or near nest cavities of Lewis's woodpeckers (Saab and Vierling 2001). Human predators may take a toll in some areas. Some hunting pressure exists on the Zuni reservation in New Mexico (Taylor and Albert 1999). However, hunting pressure is unlikely to be a problem in the Black Hills.

Competitors

Lewis's woodpeckers defend their territory from American kestrels, Northern flickers, red-headed woodpeckers, and downy woodpeckers (Linder 1994). Tobalske (1997) reports aggressive encounters with many species including: acorn woodpecker, northern flicker, red-headed woodpecker, sapsuckers, Nuttall's woodpecker, downy woodpecker, hairy woodpecker, American kestrel, plain titmouse, European starling, Steller's jay, and American crow.

What effect these competitors have on Lewis's woodpeckers is largely unknown. Crows do rob Lewis's woodpeckers' caches of food (Constantz 1974). Conner and Adkisson (1977) discuss the idea that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited.

Despite widespread concern about starlings' impact on the species (see Tobalske 1997), Lewis's woodpeckers may not lose many nests to starlings. For example, in Colorado only 1 of 59 nests were lost to starlings, and Lewis's woodpeckers were dominant over starlings in 92% of interactions (Vierling 1998). Vierling (1998) states that starlings are not responsible for declines in Lewis's woodpeckers. In a separate study, competition from starlings did not affect breeding of secondary cavity-nesters in Arizona, but the authors suggest there could be problems in areas with limited available cavities (Brush 1983). Some sources state that Lewis's woodpeckers may be restricting red-headed woodpeckers' range (Hadow 1973).

Parasites, Disease, Mutualistic Interactions

Lewis's woodpeckers probably suffer similar parasite infections to other woodpeckers, but little information is available on this topic. Only body lice are listed as parasites by Tobalske (1997). No information is available about diseases or mutualistic interactions.

Other Complex Interactions

Territorial activity varies over the season. Defense of territory against other Lewis's woodpeckers is most common during pre-nesting and nestling periods, perhaps due to lower numbers of insects at this time and competition for nest sites being higher as nests and territories are being set up (Linder 1994).

Primary cavity-nesters such as woodpeckers construct cavities that may be used by other animals. Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin and others (1995) also discus the importance of primary cavity nests as nest sites for secondary cavity-nesters. Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

Gutzwiller and Anderson (1988) dispute the importance of these cavities for secondary nesters and this is supported in other studies. In a California oak/pine forest blocking cavities did not change the bird densities (Waters and others 1990). Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). For example, snag density may not accurately determine the habitat availability for secondary cavity-nesters.

Risk Factors

Risk factors for Lewis's woodpeckers include pesticides, degradation or disappearance of habitat, and human disturbance (Tobalske 1997). Fire suppression is also a risk factor (Saab and Dudley 1998). The Ecosystem Management Project for the Columbia Basin identified several issues of concern for Lewis's woodpeckers, including: the loss of shrubs (as a source of arthropods), decline in older forests, loss of large snags, and the impact of pesticides (Wisdom and others 2000). Pesticide risk would be greatest in areas with large orchards (Tobalske 1997), so this probably is not much of a factor in the Black Hills, except perhaps in non-native plant control areas.

The importance of shrubs for insect prey habitat (Wisdom and others 2000) is contrary to other literature which states "understory vegetation may not be an important part of the food chain" for arthropods (Hanula and others 2000). Hanula and others (2000) found no relationship between the number or biomass of arthropods and the herbaceous diversity or percent ground cover in a longleaf pine forest. Herbivorous insects were only a small amount of the total biomass on the forest floor in longleaf pine stands in South Carolina (Hanula and Franzreb 1998). Red-cockaded woodpeckers will actually abandon territories where hardwood midstory encroaches in loblolly and shortleaf pine stands in Texas (Conner and others 2001). However, the observations that dense ground cover (litter and forbs) is associated with Lewis's nesting habitat in some areas (Linder and Anderson 1998) and bare ground is avoided (Vierling 1997) means that ground cover of some type can be important to Lewis's woodpeckers. Not all studies of Lewis's woodpeckers show large shrub components (Block and Brennan 1987). It is not clear whether herbaceous layer is important rather than shrubs, or whether the habitat and insect preferences of the Lewis's are different enough from the red-cockaded woodpecker that the same relationships with the shrub layer do not exist. It seems evident to this author that in many areas some component of shrub and/or herbaceous layer is important for the Lewis's woodpecker. For Lewis's that winter in the Black Hills, the hardwood mast sources available are usually shrubs or mid-story, so these also may influence the habitat needs.

The effect of direct human disturbance is mixed. Linder and Anderson (1998) found birds still placed nests near human disturbances. Other sources indicate some abandonment of nests if overly stressed (Tobalske 1997). Fuelwood harvesting will negatively affect three-toed woodpeckers overall if snags used for nest trees are located in easily accessible areas (i.e. near roads) (USDA Forest Service 1996). Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor.

Habitat loss/degredation probably has the greatest effect in the Black Hills. Open forest habitats with adequate snags and shrub cover are essential for Lewis's woodpeckers. Any practices that interfere with the availability of such habitat will be detrimental to these birds. Wisdom and others (2000) suggests maintaining cottonwood riparian areas, thinning and using fire to develop shrubs, retaining all snags over 53 cm (21 in) dbh in clumps of varying decay classes, allowing for and/or creating broken-top snags, closing roads and/or restricting fuelwood cutting.

Fire suppression also is detrimental to these birds. Evidence suggsts that large-scale burned forests may play a critical role in creating ephemeral habitats for Lewis's woodpeckers because burns create favorable habitat aspects including: snags, open space for foraging maneuvers, ground cover and associated arthropod prey, and reduced numbers of nest predators (Saab and Vierling 2001). They do not seem to be affected by salvage logging where at least 50% of the snags (>23 cm dbh) are retained (Saab and Dudley 1998).

Fire suppression is a major factor in the Black Hills. Fires have become less frequent in the Black Hills due to fire suppression (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed historically in the area (Parrish and others 1996). Many fires were low intensity, but occasionally there were areas with high intensity burns and insect infestations (Parrish and others 1996). Changes in habitat due to timber management, fire and insect suppression may have affected woodpecker populations (Parrish and others 1996).

Response To Habitat Changes

Management Activities

For a summary of species' responses to habitat changes, see Table 15.

Timber Harvest

Timber harvesting can have an immediate negative effect if active nest trees are removed. However, the effect on a landscape scale is more important to the whole population. Replacing mature stands with young stands through timber harvest can eliminate decaying trees that will reduce the woodpecker population. Reduction of stand rotation age reduces the number of large snags (Beebe 1974). Maintaining an adequate supply of mature stands and snags on the landscape is desired. Thomas and others (1979) state that 249 snags (>30.5 cm, 12.01 inches) per 100 ha (247.1 acres) are required to maintain 100% of the potential Lewis's woodpecker habitat in ponderosa pine forest. However, Thomas and others (1979) suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Different cutting strategies differ in their severity of impact. Negative effects are likely from clear-cutting, irregular shelterwood cutting, and group selection (nesting areas would decrease although foraging habitat might increase) (USDA Forest Service 1996). A mixed effect is expected from shelterwood cutting because different stages of the process have different suitability as habitat (USDA Forest Service 1996). Cavity-nesting birds as a group, including Lewis's woodpeckers, fed more often in uncut units than in cut stands in Montana larch/fir forest (McClelland 1980). Clear-cutting treatments and treatments that removed all trees larger than one inch dbh, leaving all residue had negative effects on feeding activity (McClelland 1980).

Thinning may be beneficial to these birds, as long as snags are retained. Wisdom and others (2000) suggests thinning to develop shrubs. Presumably, the ground cover serve as sources for mast and berries and potential habitat for insect prey, and the open habitat helps Lewis's woodpeckers in their flycatching activities. (However, see discussion of shrubs under 'Risk Factors')

Salvage sales may not be as detrimental to Lewis's woodpeckers as to some other species, as long as some snags remain. Saab and Dudley (1998) found Lewis's woodpeckers favored partially salvage-logged units over unlogged units for nesting sites, although nest success was higher in unlogged areas than salvaged areas. In Montana, Hitchcox (1996) also found no significant difference between densities of Lewis's woodpeckers in salvage logged versus unlogged stands, although very few Lewis's woodpeckers were observed.

Recreation

Some conflicting information exists on Lewis's woodpeckers' response to human activity. Linder and Anderson (1998) found birds still placed nests near human disturbances, although their study did not measure success rates of those nests. Other sources indicate some abandonment of nests if overly stressed (Tobalske 1997). In the Black Hills, the large numbers of roads (see glossary for discussion of road density) means the birds have very few refuges. "[T]he number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b). Lewis's woodpeckers may be subject to similar stresses.

Impact may be severe if users looking for wood for campfires cut down snags. Wisdom and others (2000) implied that Lewis's woodpeckers are negatively affected by roads due to snag reduction along the roads. Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. (See Fuelwood Cutting section below.)

Livestock Grazing

Grazing may have a negative effect on Lewis's woodpeckers if browse vegetation used by woodpeckers is overgrazed (USDA Forest Service 1996). Wisdom and others (2000) identified loss of shrubs as a concern for this species. Many insects, including grasshoppers, leafhoppers, froghoppers, and larvae of butterflies and moths, feed on leafy vegetation (Borror and others 1992), so herbaceous groundcover is certainly a concern (see Risk Factors section for discussion of relationships between arthropods, shrubs, and Lewis's woodpeckers).

Under moderate grazing regimes and in years with adequate insect populations and mast crops, the impact of grazing is probably minimal. In a review of livestock grazing effects on Neotropical migrants of western North America, Saab and others (1995) found that cavity-nesting birds were relatively unaffected by cattle grazing, at least in the short-term, compared to open-nesting species. Lewis's woodpeckers did not have a significant response to grazing in riparian habitats (Saab and others 1995). No studies were available on the effects of grazing in montane coniferous forests, but Saab and others (1995) suggest Lewis's woodpeckers may be affected if vegetation is impacted because they prefer "open savannahs" unlike other species which utilize "closed canopy forests".

Mining

Mining may negatively impact woodpecker populations through loss of habitat or increased human activity (USDA Forest Service 1996; Tobalske 1997). Koehler (1981) suggested that noise, blasting tremors, and dust may also negatively impact these birds. Suggested mitigation measures in coal mining areas include: surveying for the birds and potential habitat, monitoring of water quality, placing buffer zones between mining activity and breeding areas, and reclamation including establishing snags or other perches as well as shrub cover (Koehler 1981). Although, there is currently no coal mining in the Black Hills National Forest, similar mitigation measures might be used for other types of mining.

Fire Suppression

Fire suppression likely has a negative effect on Lewis's woodpeckers (Saab and Dudley 1998). Snags and relatively open forest habitats are preferred by this species and are created by fires. Fires have become less frequent in the Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996), so fire suppression can become a severe limiting factor for these birds.

Prescribed Fire

Lewis's woodpeckers would most likely benefit from prescribed burns that produce additional snags and open forest habitat (Saab and Dudley 1998). Wisdom and others (2000) suggests using fire to develop shrubs (see Risk Factors section for a discussion of the relationships between shrubs, arthropods, and Lewis's woodpeckers).

Non-Native Plant Establishment And Control

Non-native plants probably do not have much effect on Lewis's woodpeckers in the Black Hills, in the opinion of the author. Potential negative effects may occur if non-native species out-compete herbaceous vegetation that provides habitat for arthropods consumed by the woodpeckers. Control efforts may affect the birds if herbicides kill preferred plant foods.

Fuelwood Harvest

Fuelwood harvesting will affect Lewis's woodpeckers if snags used for nest trees are located in easily accessible areas (i.e. near roads) (USDA Forest Service 1996). Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags of ponderosa pine per 40.5 ha (100 acres) greater than 25.4cm (10 inches) dbh (USDA Forest Service 1996). These numbers mean that many stands have much lower than the 615 snags/100 acres recommended by Thomas and others (1979), so it is important to retain as many snags as possible. However, the suggestions by Thomas and others (1979) are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002). A separate study found an average of 3.6 snags/0.4 ha (1 acre) greater than 25.4 cm (10 inches) dbh in stands not actively managed for 20 to 30 years on the Black Hills National Forest (Lentile and others 2000). This would indicate that many areas have abundant snags for Lewis's woodpeckers, however 60% of these snags did not last 10 years (Lentile and others 2000), so it is unclear whether these snag numbers are appropriate over the long-term.

Insect Pest Control

Pesticides may impact woodpecker populations by killing their insect prey (Beebe 1974).

Natural Disturbance

Insect Epidemics

Free-living insects are important prey items for Lewis's woodpeckers. Therefore, insect epidemics may benefit these woodpeckers.

Wildfire

Lewis's woodpeckers are sometimes characterized as a "burn specialist" because they are often found nesting in burned pine forests (Tobalske 1997). Although they are not as restricted to burn areas as some other woodpeckers (i.e. black-backed and three-toed), fires probably have a positive effect on Lewis's woodpecker populations because they provide more snags for nesting (Saab and Dudley 1998). In the Black Hills National Forest, cottonwood riparian zones are rare, so burn areas are probably essential to Lewis's woodpeckers.

Wind Events

Effects of wind events on Lewis's woodpeckers is mixed. Blowdowns may increase insect infestations (Furniss and Carolin 1977), which may benefit woodpeckers (see Insect Epidemics section above). However, Lewis's woodpeckers forage by flycatching, so blowdowns would have a negative effect if they create dense situations where maneuverability is reduced.

SUMMARY

Like other woodpeckers, Lewis's woodpeckers play an important role in the ecosystem by consuming large numbers of insects. Unlike other woodpeckers, however, they prey on flying insects using a flycatcher style of gliding. However, a large portion of their diet consists of mast and fruit, including cultivated fruits, and this trait has led to conflicts with fruit growers in some portions of the country. Lewis's woodpeckers cache mast and insects. See Figure 6 for an envirogram of the ecological relationships of this species.

These birds are found in the western half of the United States. Their summer range is from southern Canada to Arizona, east to South Dakota. Northern birds typically migrate south for winter, although this varies from year to year.

These woodpeckers prefer open forest habitats, riparian woodlands, and burn areas. The open areas allow them to utilize their flycatching foraging style. However, the presence of oaks or other mast sources and shrubs that produce berries are also important.

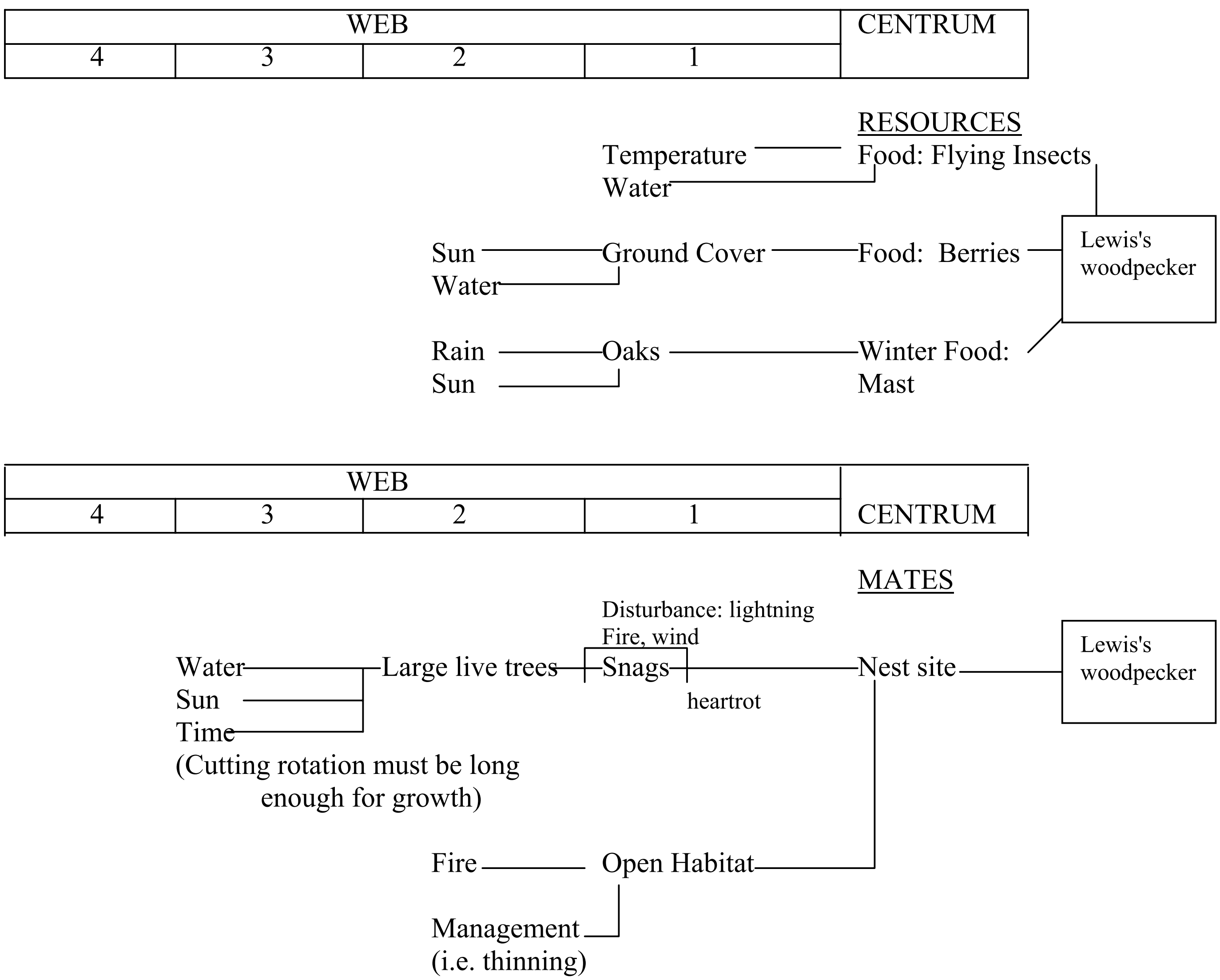
Snags are used for nesting and sufficient ground cover is necessary to maintain insect populations. In the Black Hills, they are most likely nesting in ponderosa pine. Large trees are used, from 30.5 cm to 112.6 cm. They lay one clutch of 5 to 9 eggs.

Lewis's woodpeckers are undergoing a nationwide population decline. Reasons for the decline are not clear. Loss of their preferred habitat is likely a major cause. Population trends in the Black Hills are unknown.

Fire suppression is detrimental to these birds because fires open up forests for flycatching, create new snags, and promote ground cover growth. Fuelwood cutting and grazing are also detrimental if they are too extensive. These birds probably benefit from thinning if large snags remain. They do not seem to be as affected by salvage sales as other woodpecker species.

Management that preserves snags and promotes shrub growth will benefit these birds.

Figure 6. Envirogram of the Lewis's woodpecker in the Black Hills National Forest. Predation and competition are not well enough understood to represent for these birds, so the malentities section is omitted.



RED-HEADED WOODPECKER

INTRODUCTION

A bright red head characterizes red-headed woodpeckers (*Melanerpes erythrocephalus*) as their name implies. They are a generalist species feeding on mast, a wide variety of berries, as well as insects and other birds' young. They often appear in areas with insect outbreaks, so they are important natural predators. They use more open and edge forest habitats than some other woodpeckers, but are still dependent on snags and decaying trees. Populations of red-headed woodpeckers show evidence of declines in North America. This document summarizes the ecology and life history of red-headed woodpeckers and discusses some management and conservation issues related to maintaining the species.

CURRENT MANAGEMENT SITUATION

Management Status

No federal status is given to red-headed woodpeckers, nor do they have any special status in Wyoming (Luce and others 1999) or South Dakota (South Dakota Department of Game Fish and Parks 2000). They are not included on the IUCN Red List (Hilton-Taylor 2000). However, the National Audubon Society considers them of moderate conservation priority on their Watch List (Muehter 1998). The Partners In Flight database for the region that includes the Black Hills considers red-headed woodpeckers to be under high regional threat (tier IIC) (Panjabi 2001a; Partners In Flight 2001). The Wyoming Bird Conservation Plan includes the species in the level 3 category where local interest may exist (Cerovski and others 2001).

Existing Management Plans

Forest Service Biologists at both the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers were available in the region (C. Schultz, personal communication).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Adult red-headed woodpeckers, have a white chest, rump and inner wing patches; otherwise they are blue-black except for red covering the head and extending down the neck (National Geographic Society 1987). The colorful pattern prevents confusion with other woodpecker species in its range (Smith and others 2000). Juveniles have a brown head and neck, a dull white chest, and a white rump and inner wing patches (National Geographic Society 1987). This juvenile plumage may extend into fall and winter; wing barring may even extend into May of following year (Short 1982). The adults are 19.4 to 23.5 cm (7.6 to 9.25 inches) long with a wing length from 12.7 to 15.0 cm (5 to 5.9 inches) (Short 1982; Smith and others 2000). Males and females are very similar in size, but no information is available on mass differences (Smith and others 2000)

Some taxonomists choose to identify a northwestern (including the Black Hills region) subspecies, *M. e. caurinus*, characterized by slightly longer wings and perhaps more ventral-side yellow, but this designation is disputed (Short 1982). Albino plumages are also known, and those birds were able to raise normal young in Alabama (Rogers and others 1979).

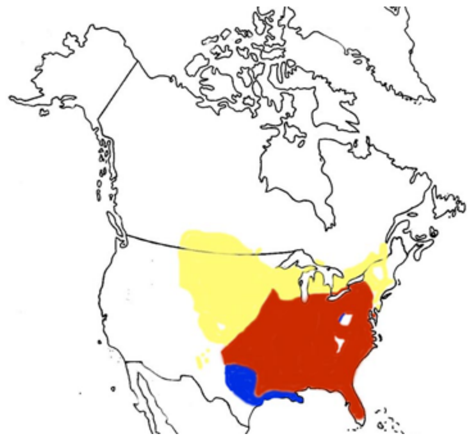
Comparing *Melanerpes* species as defined by Short (1982) to other woodpecker groups supports *Melanerpes* as a unified, monophyletic group using genetic allozyme data (Tennant 1991). Scientists from the 1800s sometimes included both the red-headed and the red-bellied woodpecker when referring to red-headed woodpeckers (Smith and others 2000). Red-headed woodpeckers are closely related to Lewis's woodpeckers (Tobalske 1997).

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

The overall range of the red-headed woodpecker covers a large block of territory bordered on the west by Rocky Mountains, on the east by the Atlantic Ocean, on the south by the Gulf coast, and in the north reaches southern Canada (Bent 1939). Normally these birds do not reach New England (Bent 1939). In the 1700s and 1800s they were much more common in New England due to the presence of the American Beech tree, which formerly formed forests in much of the area (Smith and others 2000). The exact winter distribution varies with the amount and distribution of mast in a given year (Smith and others 2000). The ranges of red-headed and Lewis's woodpeckers are almost mutually exclusive, with only small areas of overlap, including the Black Hills (Tobalske 1997).

Figure 7. Distribution of red-headed woodpeckers. Yellow represents breeding range only, red represents year-round range, and blue represents winter only range. Adapted from Smith and others (2000).



Additional Information (Local Distribution)

In Wyoming, red-headed woodpeckers are considered an uncommon summer resident and breeding records are known from much of the northern and eastern portion of the state (Luce and others 1999). In South Dakota, red-headed woodpeckers range across the state (South Dakota Ornithologists Union 1991). Historically, these birds were considered abundant in the forests of the Black Hills (Ludlow 1875). The Black Hills are near the western edge of the normal distribution and they have not been recorded in South Dakota in recent Christmas Bird Counts (South Dakota Bird Notes 1998,1999,2000).

Estimates Of Local Abundance

South Dakota considers red-headed woodpeckers to be common in the summer (South Dakota Ornithologists Union 1991). Recent confirmed breeding records in South Dakota exist since at least 1997 (Palmer 1997,1998b; Schenck 1999b, 2000). No individuals were found in preliminary surveys of the Black Hills in 2000, but three individuals were found in 2001 (Mohren and Anderson 2000, 2001). Panjabi (2001b) reported 25 individuals during 2001 surveys.

Population Trends

The Breeding Bird Survey shows decreasing trends from 1966 to 1998 surveywide (Sauer and others 1999; Sauer and others 2001). The Breeding Bird Survey's Interactive Map Data shows no red-headed woodpeckers on either the Sundance Route Group or the Black Fox Group (including Hill City and Custer) (Sauer and others 2001). Christmas Bird Count data from 1959 to 1988 show no significant trend overall (Sauer and others 1996). Sample sizes are too small from the Black Hills routes in the Breeding Bird Survey to determine trends (Sauer and others 1999; Patterson 2000).

Movement Patterns

Red-headed woodpeckers in the north usually migrate for witner, but they may stay if a large amount of food is available (Bent 1939). Migration varies with mast crops, southern birds may even move north to find mast (Smith and others 2000). The local birds follow this same pattern and are sometimes migratory (South Dakota Ornithologists Union 1991).

When the birds do migrate, they fly south in small groups between September and November (Bent 1939). These flights are usually diurnal (Smith and others 2000). In the spring, they return to their breeding areas from February to May (Bent 1939).

Habitat Characteristics

General Habitat

Red-headed woodpeckers use a wide variety of open forest or edge habitats including: riparian strips, forest edge habitats, farmlands, meadows, agricultural pastures, golf courses, river bottoms, burn or flood areas, isolated small forests, ponds, reservoirs, reclaimed strip-mines, and orchards (Short 1982; Smith and others 2000). These birds need habitat with snags or dead limbs, but can utilize many different forest types from cottonwood-willow, to aspen, longleaf-pine, or pine-oak (Smith and others 2000). Red-headed woodpeckers also frequent disease areas--such as elms with Dutch elm disease (Smith and others 2000). Breeding habitat for these birds has different characteristics than their winter habitat, so the two are treated separately below.

In Panjabi's (2001b) survey, 24 individuals were located in burned habitat in the Black Hills and one individual was located in riparian habitat. No information is available on minimum required patch sizes. See section on spacing under Demography for information on home range and territory size.

Nesting Habitat

Red-headed woodpeckers make nests in snags or some dead portion of living trees of various species: pine, maple, birch, oak, cottonwood, elm, willow, box elder, shagbark hickory, white ash, or American sycamore, and even utility poles or nest boxes (Smith and others 2000). If trees are scarce, they may build their nest in the side of buildings (Short 1982). In northeastern Colorado along the South Platte River, red-headed woodpeckers nest in cottonwoods, especially in areas with many dead limbs (Sedgwick and Knopf 1990). In the Black Hills National Forest, these birds may be utilizing pine, birch, or oak trees.

Snags and decaying trees are important for nest sites. Nest trees used by cavity-nesting birds as a group were significantly softer than random trees in aspen stands in Arizona (Schepps and others 1999). A Texas study found red-headed woodpeckers to be more prevalent in stands with snags (2.1 birds per 40 ha [98.8 acres]) than those without (averaging 0 birds per 40 ha [98.8 acres])

(Dickson and others 1983). These stands were clear-cut stands replanted with loblolly pine with some hardwood snags remaining in some of the stands. In Manitoba, Canada, nests were observed in partly dead poplar snags (Bancroft 1983). In Illinois hardwood forests, 10 of 10 red-head nests were in dead trees (Reller 1972). However, live trees are also used--62.3% of nests were in live trees in a Virginia study (Conner 1976).

Specific traits of nest trees have been examined by several studies and are summarized in Table 5. Nest tree height and dbh varies by location as illustrated by studies in the following states: Arkansas (height 14.8 +/- 3.3 m [48.56 ft], dbh 33.4 +/- 7.0 cm [13.15 inches]) (Smith and others 2000), Virginia (height 29.5 +/- 12.8 m [96.78 ft], dbh 95.0 +/-25.2 cm [37.4 inches]) (Conner 1976), and Colorado (height 15.4 m [50.52 ft], dbh 66.8 cm [26.30 inches]) (Sedgwick and Knopf 1990). In Kansas, 88% of nest trees were dead, average diameter of limb with nest was 21.8 cm (8.58 inches), and the average tree height was 10.9 m (35.8 ft) (Jackson 1976). In a Wyoming study, nest trees measured 59.2 +/- 4.3 cm [23.31 inches] dbh (Gutzwiller and Anderson 1987).

Table 5. Characteristics of Nest Trees Used by Red-headed Woodpeckers

Tree Species	DBH, cm	Tree Status	Tree Height, m	Nest Height, m	Forest Type	Location	Notes	Citation
Cottonwood	---	---	---	---	Riparian area	Colorado	---	(Sedgwick and Knopf 1990)
Poplar species	---	Partly-dead Snags	---	2.4 to 3[a]	---	Manitoba	---	(Bancroft 1983)
Mostly American elm, also cottonwood, willow, oak, utility pole	Nest limb 21.8 (13-36, n=10)	88% of nest trees dead	10.9 (4-24, n=10)	7.0 (3-15, n=34)	Various	Kansas	---	(Jackson 1976)
---	---	All dead	---	Range 7 to 20	Hardwood	Illinois	n=10	(Reller 1972)
White oak, hickory, red oak	95.0	62.3% live	29.5	17.5	Mature oak-hickory	Virginia	n=14, ave. age 228.1 yrs	(Conner 1976)
---	---	---	0.9 to 19.8	---	---	---	Summary	(Short 1982)
---	30.6 to 95.0[b]	---	10.9 to 29.5[b]	---	Various	Various	Summary	(Smith and others 2000)
---	59.2	---	---	10.0	Cotton-wood	Wyoming	Floodplain habitat	(Gutzwiller and Anderson 1987)

[a]Bancroft reported on two different trees.
[b]These numbers reflect the range of means reported in the studies summarized by Smith and others

Habitat characteristics of the area around the nest are important as well. Using principal component analysis, scientists found that in a Virginia forest red-headed woodpeckers nested in areas with high basal area containing trees with large dbh, tall canopy, low stem density, near clearings (Conner and Adkisson 1977). No shrubs were present, grass and forbs are the ground cover around nest trees (Conner 1976). In the nest area in Virginia, live trees' basal area averaged 25.5 m2/ha, 67.3 stems/ha (all stems greater than 7 cm and no stems less than 20 cm dbh within 1/20 ha of nest itself), and 31.6 m average canopy height (Conner 1976). These birds avoided nesting in areas with dense undergrowth (Conner 1976). Red-headed woodpeckers in Kansas preferentially selected nest trees with more than 30 m (98.4 ft) of open space surrounding it (Jackson 1976).

Foraging Habitat

Specific information is lacking on foraging habitat separate from breeding habitat or winter habitat. In Virginia, the birds foraged in open areas nearby their nest patch (Conner 1976). In Illinois hardwood forests, red-headed woodpeckers preferred maples and hickories for foraging, although they also commonly used oaks (Reller 1972). In central Texas, foraging during breeding season took place in cottonwoods nearby the cottonwood snag being used as the nest tree (Selander and Giller 1956).

In a Virginia study, oak-hickory stands were used more commonly by red-headed woodpeckers than pine-oak stands or pasture for foraging (Conner 1980). Mature stands were used most often by red-headed woodpeckers in that study, although they also used open areas with low ground cover. Oak trees were the most common tree foraged on by the red-headed woodpeckers. These foraging sites were characterized by high canopy height (28.4 m), low tree density (5.8 stems >6 cm dbh per 1/25 ha), and high basal area (19.8 m^2/ha) (Conner 1980). Sites used during the breeding season had lower basal areas than those sites used during postbreeding (Conner 1980).

Winter Habitat

For the winter, red-headed woodpeckers move where the mast is, including: oak, oak-hickory, maple, ash, or beech woods with snags (Smith and others 2000). In Missouri hardwood forests, mast production was compared with Christmas Bird Count data and the presence of oak mast and red-headed woodpeckers had more positive correlations than expected by chance (Smith and Scarlett 1987). Most counties showed a positive correlation between oak mast and red-head numbers (Smith and Scarlett 1987).

In Maryland, twelve red-headed woodpeckers spent September through May in oaks along creeks where they set up and defended small territories (Kilham 1958). Elms and locust trees were used for storage (Kilham 1958). Red-headed woodpeckers in Louisiana defended only their roost and storage sites during December and January (MacRoberts 1975).

During winter in a Texas study, the birds preferentially used bottomland hardwood forest (oak, sweet gum, and gum) especially in areas with large logs (Shackelford and Conner 1997).

Roost Sites

Snags are also used by red-headed woodpeckers for roost sites and perches (Conner 1978).

Food Habits

Red-headed woodpeckers forage mainly by flycatching or swooping down from a perch (especially in the summer), but also take food by gleaning or tapping (Short 1982; Smith and others 2000). Observations of foraging behavior in Kansas showed these birds utilize flycatching, ground foraging, fruit and seed eating, and less than five percent gleaning, pecking, and excavating (Jackson 1976). Red-headed woodpeckers store food for winter in cavities, and may even cover their stash with bark in winter (Bent 1939; Smith and others 2000). In Ohio, beechnuts were stored on trunks, limbs, and branches (Doherty and others 1996). Whether these stores are "sealed in" (i.e. hammering mast into small hole) tightly apparently varies depending on the type and quality of the habitat (MacRoberts 1985).

Prey Species

Red-headed woodpeckers' diet includes a wide variety of foods from insects to berries to other bird chicks. Invertebrate prey includes: ants, wasps, beetles, bugs, grasshoppers, crickets, moths, caterpillars, spiders, myriapods, weevils, flying insects, grubs, and earthworms (Bent 1939; Short 1982; Smith and others 2000). Vertebrate prey includes mice, lizards, dead fish, and eggs and/or chicks of small birds including: cliff swallows, nuthatches, chickadees, bluebirds, flickers, robins, and mourning doves (Bent 1939; Short 1982; Smith and others 2000). Studies of stomach contents reveal 34% animal matter including: 19% beetles (including 7% predacious ground beetles, tiger beetles, and ladybird beetles), 5% ants, and, in smaller amounts, other hymenoptera, hemiptera, grasshoppers, caterpillars, dragonflies, spiders, millipedes, crayfish, eggshells, and rodent hair and bone (Beal 1911). The specific species taken in the Black Hills are unknown.

Red-headed woodpeckers also eat fruits and seeds of corn, dogwood, huckleberry, strawberry, blackberry, raspberry, mulberry, poison ivy, elderberry, wild black cherry, choke cherry, cultivated cherry, wild grape, apple, pear, acorns, beechnuts, and pecans (Bent 1939; Smith and others 2000). Sixty-six percent of the diet is vegetable matter including: 4% grain, 3% cultivated fruit, 23% mast, 18% cambium and seeds, and small amounts of other fruit (Beal 1911). These proportions vary throughout the year, presumably as they become available. For example, grain and cultivated fruit increase in late summer to 20% and 17% respectively (Beal 1911). Bark, sap, and grit is also consumed (Short 1982; Smith and others 2000).

Nestlings in Kansas were fed mostly mullberries, grasshoppers, and beetles (larvae and adult), with less than five percent katydids, spiders, earthworms, and other unidentified vegetable matter (Jackson 1976).

Mast makes up most of its food in the winter (96%), while many more insects are taken in the summer (Short 1982; Smith and others 2000).

<u>**Characteristics Of Prey**</u>

Red-headed woodpeckers prey on many insect species subject to irruptions, such as cicadas or midges (Smith and others 2000). One common western grasshopper now believed to be extinct (Rocky Mountain grasshopper) formerly made up a good portion of its diet (Smith and others 2000).

Breeding Biology

Phenology

Red-headed woodpeckers may take considerable time to construct their nest. Short (1982) reports they take about 2 weeks to construct the nest hole and Smith and others (2000) report most nests are finished in 12 to 17 days, but excavation can last from 2 to 50 days depending on the type of tree. Eggs are laid later in the season than other woodpeckers (at least in the south) and in the local area egg-laying occurs from May to June (Smith and others 2000). Incubation lasts 12 to 14 days (Short 1982; Smith and others 2000). Fledging takes place 24 to 31 days after hatching, but the juveniles hang around their parents for some time afterwards (Smith and others 2000). Due to second clutches, fledging may occur as late as September (Smith and others 2000).

In South Dakota, birds migrate into the area in early May, although records are known from as early as March 19 (South Dakota Ornithologists Union 1991). Nesting occurs in June and the beginning of July (South Dakota Ornithologists Union 1991). The birds leave at the beginning of September, although some have been known to remain in South Dakota for the winter (South Dakota Ornithologists Union 1991).

Courtship Characteristics

Drumming, mutual tapping, and 'chatter' and 'kweer' calls characterize courtship (Short 1982). These activities usually take place near the nest cavity, or even on the nest limb (Smith and others 2000). A 'chatter' call emphasizes copulation (Short 1982). Other information on courtship is unknown.

Clutch Initiation, Laying, And Size

Clutches consist of 4 to 7 or 10 eggs (Short 1982; Bent 1939). Clutches of 3 to 5 eggs were found in Kansas (Jackson 1976). The eggs measure on average 25.14 mm (0.99 inches) long by 19.17 mm (0.75 inches) wide (Bent 1939). Eggs are laid one per day, but incubation begins before the end of the laying period, so some chicks are much smaller than others in the clutch when they hatch and they may die (Short 1982). Additional eggs are laid if eggs are removed (Bent 1939).

Varying reports exist on how many clutches are laid. Bent (1939) reports red-headed woodpeckers will lay an additional clutch if their first clutch is lost. Two broods were observed in Mississippi even when the first brood was successful (Ingold 1987). Short (1982) reports two clutches, one from April to June, and the second from July to August. Three of fifteen pairs in Illinois second-nested even with successful fledglings from their first attempt (Reller 1972).

Parental Care

The male does most of the work carving out the nest cavity (Smith and others 2000). Both parents incubate, brood, and feed the chicks, though the male does most of the night work (Bent 1939; Short 1982; Smith and others 2000). In the late nestling stage (after the twelfth day), the female does most of the feeding (Jackson 1976; Smith and others 2000). After fledging, the youngsters remain near their parents even though they can flycatch insects on their own, until eventually the parents chase them off (Smith and others 2000).

Site And Mate Fidelity

Pairs may breed again together the following year and may even use the same nest cavity (Smith and others 2000).

Demography

Life History Characteristics

Red-headed woodpeckers can begin to breed after 1 year (Smith and others 2000). No information is available on non-breeding individuals.

Survival And Reproduction

Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995). Results from nest success studies range from 48.4% to 80% (as cited in Smith and others 2000). The oldest red-headed woodpecker known was 9 years old (as cited in Smith and others 2000). Annual adult survival is 62% (as cited in Smith and others 2000). Winter mortality (November through March) in Ohio was 7% (1 juvenile died) (Doherty and others 1996).

Social Pattern For Spacing

Densities vary with geographical area and habitat from 2.3 pairs per 40 ha (98.8 acres) in the southeast, under 1 to 7 pairs per 40 ha (98.8 acres) in Oklahoma, to 27 pairs per 40 ha (98.8 acres) in second growth forest in Illinois, where the density increased greatly after elm tree deaths from dutch elm disease (Smith and others 2000). Two pairs were found within 60 m (196.85 ft) in Canada (Bancroft 1983). No density data is reported for the western United States. Haldeman (1980) states the home range size ranges from 1.2 to 2.4 ha (3 to 6 acres).

Each individual defends its' own winter territory. Neither sex has an advantage with individual territories because of the evolution of their monochromatic plumage (Kilham 1978). Winter territories of 0.05 ha to 1 ha (0.1 to 2.5 acres) (including roost sites and storage site) are defended (Smith and others 2000). Winter territories in hardwood woodlots in Ohio averaged 0.04 ha (Doherty and others 1996).

Local Density Estimates

In cottonwood riparian areas in Colorado, red-headed woodpeckers were found to have an average density of 7.9 pairs per 100 ha (247.1 acres) (Sedgwick and Knopf 1992). No density estimates are available for the Black Hills population.

Limiting Factors

Red-headed woodpeckers are most likely limited by habitat availability and the availability of mast in the winter. Food is likely limiting in the winter since the winter range is closely associated with mast (Smith and others 2000). In the summer, the limiting factors could include the availability of suitable nest trees or food resources. The precise limiting factors for red-headed woodpeckers in the Black Hills is unknown.

Patterns Of Dispersal

Many first year breeders return to areas nearby their natal territory (Smith and others 2000). No other information is available on juvenile dispersal.

Community Ecology

Predators

Reported predators include: black rat snakes, raccoons, flying squirrels, Cooper's hawks, peregrine falcon, eastern screech owl, and red foxes (Bent 1939; Meng 1959; Smith and others 2000). Other tree-climbing snakes are probably nest predators also. Most of this information comes from individual observations and it is not known what impact predation has on populations. Humans are also predators, as historically, the birds were hunted as sporting game or pest species (Smith and others 2000), but hunting is not currently a major issue.

Competitors

Red-headed woodpeckers aggressively defend food resources from blue jays, starlings, red-bellied and downy woodpeckers, white-breasted nuthatches, and tufted titmice (Bent 1939; Short 1982). In winter, red-headed woodpeckers are aggressive towards mixed flock species (including downy woodpeckers) to maintain control of their feeding areas (Smith and others 2000). Reller (1972) noted a 90% decrease in intraspecific encounters during the non-breeding season.

Red-headed woodpeckers are very aggressive, and some suggest the aggressiveness of interactions are due to female red-headed woodpeckers having more red on their head and participating in aggressive behavior more so than females of other species (Nichols and Jackson 1987). Red-headed woodpeckers attack nests and/or eggs of flickers, tree swallows, Baltimore orioles, eastern phoebes, eastern kingbirds, great crested flycatchers, and ducks (Smith and others 2000). In Illinois, agresseive encounters were observed mostly against other red-headed woodpeckers, but also against hairy woodpeckers, flickers, blue jays, red-bellied woodpeckers, and eastern bluebirds (Reller 1972). Bancroft (1983) observed red-headed woodpeckers attacking an Eastern kingbird nest, destroying the nest and the eggs.

Other interactions have mixed results. An observer reported red-headed woodpeckers chased a red-bellied pair from and took over their nest, only to be later usurped by starlings (Nichols and Jackson 1987). Smith and others (2000) also discuss records of lost nests due to red-bellied interactions, but mention other cases where both species ignored each other in close proximity.

In some situations evidence of niche overlap between red-headed woodpeckers and other woodpecker species exists. For example, red-bellied woodpeckers and red-headed woodpeckers overlap in foraging tree type and height (Reller 1972). Others note differences between red-headed and red-bellied woodpeckers in foraging habitat (Selander and Giller 1956), foraging behavior, nesting habitat around the tree, and breeding phenology (Jackson 1976). Conner and Adkisson (1977) reiterate the idea that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited. Regardless, red-bellied woodpeckers do not occur in the Black Hills, so the potential competition with this species is not an issue.

Starlings may or may not be detrimental to red-headed woodpeckers as speculated by various authors. Starlings may usurp red-headed woodpeckers, but many red-headed woodpeckers then successfully make new nests (Smith and others 2000). Also red-headed woodpeckers have a later breeding season than starlings, which would seem to minimize interactions (Smith and others 2000). Only 7% of red-headed woodpeckers had cavities taken over by starlings in late May in Mississippi, wheras 52% of red-bellied woodpeckers, which nest earlier, had cavities taken over by starlings (Ingold 1989). Red-headed woodpeckers may have only been competing against those starlings attempting second broods (Ingold 1989). Gutzwiller and Anderson (1986) suggest that less aggression is evident between northern flickers and other species when there is an abundance of available nest cavities, and this may be the case for red-headed woodpeckers as well. Red-headed woodpeckers may also compete with starlings for roost sites, even to the point of physically fighting for the site (Kilham 1958).

Parasites, Disease, Mutualistic Interactions

Various studies cited in Smith *and others* (2000) list known parasites including: bacteria (*Aeromonas hydrophila*), chiggers (*Trombicula irritans*), biting lice (*Philopterus jugans*, *P. evagens*, *Degeeriella* marginatula), nematodes (*Oxyspirura pusillae*, *Sygamus trachea*, *Dispharynx nasuta*), trematodes (*Mosesia chordeilesia*, *Parabascus imanensis*), cestodes (*Dilepis undula*), hematozoa (*Haemoproteus*). Some observers have speculated that cowbirds act as brood parasites (Smith and others 2000).

Other Complex Interactions

Since 1900, the eastward extension of the breeding range of Lewis's woodpeckers, into the plains of Colorado along the Platte and Arkansas rivers may be restricting red-headed woodpeckers' range (Hadow 1973).

Primary cavity-nesters such as woodpeckers construct cavities that may be used by other animals. Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin (1995) also discusses the importance of primary cavity nests as nest sites for secondary cavity-nesters. Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

Gutzwiller and Anderson (1988) dispute the importance of these cavities for secondary nesters and this is supported in other studies. In a California oak/pine forest blocking cavities did not change the bird densities (Waters and others 1990). Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). For example, snag density may not accurately determine the habitat availability for secondary cavity-nesters.

Risk Factors

The reasons for population declines in the red-headed woodpecker are unclear. Several potential risk factors are discussed below.

Several authors indicate that red-headed woodpeckers commonly fly across roads and are often killed by vehicle collisions (Bent 1939; Bancroft 1983; Smith and others 2000). Whether this has an effect on Black Hills populations is unknown.

Changes and/or reductions in preferred habitat are probably the main risk factors. Removal of dead trees and the elimination of small orchards has probably affected populations in some areas (Smith and others 2000).

Since populations are tied to mast (at least in winter), practices which eliminate mast-producing trees pose a major risk for these birds. In the Black Hills, timber treatments that reduce the numbers of large, quality oaks may be a risk.

Populations also respond to insect outbreaks, so insect control practices may put these birds at risk. Insect control that leads to the extinction of a prey species (such as the Rocky Mountain grasshopper) is especially detrimental.

Fire suppression also may be a risk factor in the Black Hills. Red-headed woodpeckers have been found in burn areas, but their dependence on these areas is unclear. Fires have become less frequent in Black Hills than they were historically due to fire suppression (Progulske 1974; Brown and Sieg 1996). Also, different fire intensities existed historically in the area (Parrish and others 1996). Many fires were low intensity, but occasionally there were areas with high intensity burns and insect infestations (Parrish and others 1996). Changes in habitat due to timber management, fire and insect suppression may have affected woodpecker populations (Parrish and others 1996).

Response To Habitat Changes

Management Activities

Timber Harvest

Timber harvesting may have an immediate impact if active nest trees are removed. However, the effect on a landscape scale is more important to the whole population.

Reducing the amount of mature forest stands with their snag component may negatively affect these birds. However, treatments that increase the hardwood component may be beneficial to red-headed woodpeckers due to their association with mast production. Very little data is available on the response of red-headed woodpeckers to different treatments. Thinning is detrimental if snags are removed (Beebe 1974).

It is the opinion of this author that negative effects of treatments may be mitigated for this species if large snags remain. For example, a Texas study found red-headed woodpeckers to be more prevalent in stands with snags (2.1 birds per 40 ha [98.8 acres]) than those without (averaging 0 birds per 40 ha [98.8 acres]) (Dickson and others 1983). These stands were cleared stands replanted with loblolly pine with some hardwood snags remaining in some of the stands. However, the benefit of leaving snags lasts only as long as the snags themselves, which can be a short time period. Eighty of the snags created in a Texas pine-hardwood forest were followed for 16 years, and most (75%) snags were gone by by the eighth year of the study (Dickson and others 1995).

Recreation

Tolerance of human disturbance at nest sites in unclear (Smith and others 2000). In the Black Hills, the large numbers of roads means the birds have very few refuges away from activity. "The number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b). Red-headed woodpeckers may respond similarly. Red-headed woodpeckers nesting in Kansas were stressed enough to get off their eggs and look out the nest hole for these activities: vehicles and horseback riders on a road 7 m away and an airplane more than 1 km away (Jackson 1976).

Impact may be severe if users looking for wood for campfires cut down snags. Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. (See Fuelwood Cutting section below.)

Several authors indicate that red-headed woodpeckers commonly fly across roads and are often killed by vehicle collisions (Bent 1939; Bancroft 1983; Smith and others 2000). Whether this has an effect on Black Hills populations is unknown, but the large number of roads in the Black Hills could make this a large negative impact for these birds.

Livestock Grazing

It is the opinion of this author that a low level of grazing probably has a limited impact on these woodpeckers. Grazing in Virginia oak-hickory forest kept the understory open so flycatching was possible, and, in fact, the birds avoided nesting in areas with dense undergrowth (Conner 1976). However, Conner (1976) cautions that if no tree saplings survive grazing, the woodpecker habitat will eventually run out.

Mining

The direct effect of mining activity is unknown. Koehler (1981) suggested that noise, blasting tremors, and dust may negatively impact Lewis's woodpeckers, and the response of red-headed woodpeckers may be the same. Suggested mitigation measures in coal mining areas include: surveying for the birds and potential habitat, monitoring of water quality, placing buffer zones between mining activity and breeding areas, and reclamation including establishing snags or other perches as well as shrub cover (Koehler 1981). Although these mitigation measures are for coal mining, similar measures may be appropriate for the mining that occurs in the Black Hills National Forest.

Fire Suppression

Fire suppression is likely detrimental to red-headed woodpeckers in this author's opinion. Snags and relatively open forest habitats are preferred by this species and are created by fires. Fires have become less frequent in the Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996), so fire suppression can become a severe limiting factor for these birds.

Prescribed Fire

In the opinion of the author, prescribed fire could potentially benefit these woodpeckers if by providing open habitat as long as snags and mast-producing trees or shrubs are not eliminated. Burn areas provide snags, which red-headed woodpeckers might utilize. Prescribed burns can also destroy current snags, which would be detrimental (Smith and others 2000), but usually more snags are created than are destroyed.

Non-Native Plant Establishment And Control

Non-native plants probably have little effect on red-headed woodpeckers unless the plants block vegetation supplying the birds' food directly or indirectly as insect habitat. Control programs might negatively affect these birds if herbicides result in the reduction of their prey base.

Fuelwood Harvest

Fuelwood harvesting will affect these woodpeckers if large numbers of snags are easily accessible (i.e. near roads). Due to the large number of roads in the Black Hills National Forest (see glossary for discussion of road density), this is likely to be a factor. Exact recommendations of snag numbers for red-headed woodpeckers in ponderosa pine/oak habitat are unknown.

Insect Pest Control

Pesticides may impact woodpecker populations, because they reduce insects used as prey (Beebe 1974).

Natural Disturbance

Insect Epidemic

Insect outbreaks have a positive effect on these woodpeckers. They are reported to increase in areas affected by chestnut blight and Dutch elm disease (Smith and others 2000).

Wildfire

Wildfire is likely beneficial to red-headed woodpeckers. Snags and relatively open forest habitats are preferred by this species and are created by fires. Fires have become less frequent in the Black Hills than they were historically due to suppression (Progulske 1974; Brown and Sieg 1996), so the existing burn areas may become even more important.

Wind Events

Blowdowns may benefit red-headed woodpeckers if they are accompanied by insect outbreaks of species that decay snags to the point these woodpeckers can utilize them.

Flooding

Flooding may result in insect outbreaks of species that these woodpeckers prey upon, and may therefore benefit these woodpeckers (Smith and others 2000).

SUMMARY

Red-headed woodpeckers play an important role in the ecosystem, eating many insects. Their populations nationwide are declining for unknown reasons. Little is known about populations in the Black Hills. See Figure 8 for an envirogram illustrating the ecological interactions important to this species.

These birds range from the Rockies east to the Atlantic Ocean and from southern Canada south to the Gulf of Mexico. Red-headed woodpeckers and Lewis's woodpeckers ranges are almost mutually exclusive, with only small areas of overlap, including the Black Hills. Some authors speculate that Lewis's woodpeckers are expanding in range, inhibiting the red-headed woodpeckers.

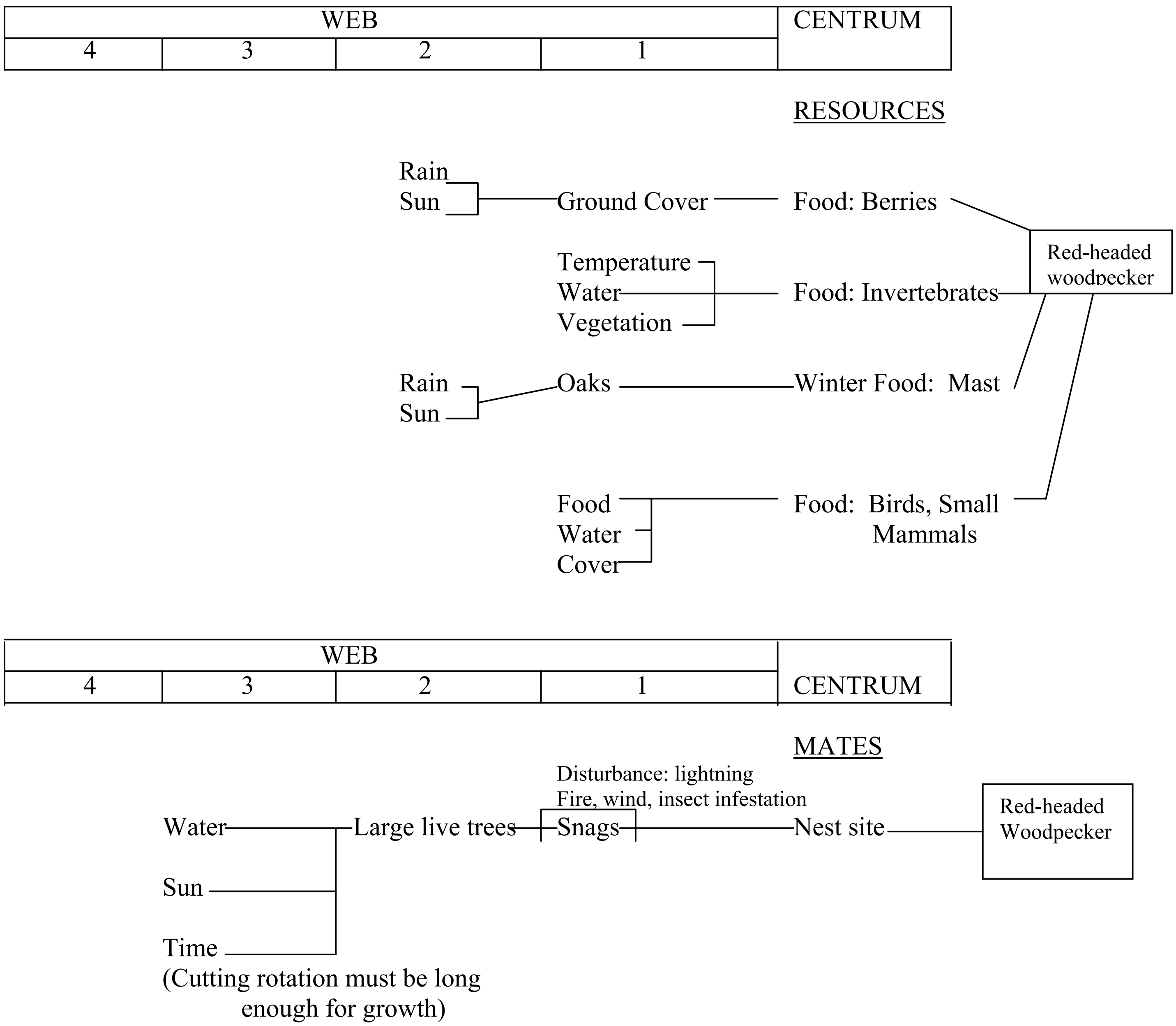
They reside in open forest habitats, even forest edges and agricultural woodlots, of a variety of tree species, but still need snags and decaying trees for nesting. In the spring they are likely to be found in open areas with snags or dead portions of large trees and open understory so they can forage on the groun. In the winter, they need mature forest stands with abundant mast for foraging. In the Black Hills, they are most likely nesting in ponderosa pine, birch, and oak. The average size of snags used ranges from 30.6 to 95.0 cm (12.1 to 37.4 inches) dbh. They lay 4 to 10 eggs per clutch, and they may renest.

They are generalist feeders, consuming everything from mast to flying insects to young of other bird species. However, they do not feed on wood-boring insects. Their distribution seems to be tied to mast distribution, especially in the winter, but their distribution varies each year, so the exact relationship is difficult to determine.

Because of their habitat needs, they are threatened by activities such as insect control, fire suppression, and some types of logging. Car collisions are also noted as a risk factor. Mining, and recreation may have negative effects in certain situations.

Management strategies that maintain snags and recruit new snags should benefit these birds.

Figure 8. Envirogram of the Red-headed woodpecker in the Black Hills National Forest. Predators and Competitors are not well enough understood to represent.



DOWNY WOODPECKER

INTRODUCTION

Downy woodpeckers (*Picoides pubescens*) are the smallest woodpeckers in North America. They are relatively common and provide an important role in the ecosystem by eating insects and constructing cavities used by other cavity-nesting birds. This document reviews the ecology and life history of downy woodpeckers and discusses issues related to management and conservation of this species.

CURRENT MANAGEMENT SITUATION

Management Status

Downy woodpeckers do not have any federal status, nor do they have any special status in Wyoming (Luce and others 1999) or South Dakota (South Dakota Department of Game Fish and Parks 2000). They are not included on the IUCN Red List (Hilton-Taylor 2000), the Audubon Society's Watch List (Muehter 1998). Downy woodpeckers are not among those species prioritized by Partners In Flight for the region encompassing the Black Hills (Partners In Flight 2001).

Existing Management Plans

Forest Service Biologists at both the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers were available in the region (C. Schultz, personal communication).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Downy woodpeckers, *Picoides pubescens*, are characterized by a white to pale gray back and chest, a small bill, black and white barred wings, barred outer tail feathers, a black head with a white stripe above, behind and below the eye (National Geographic Society 1987). The adults' eyes are reddish brown (Short 1982). Juveniles are brownish, with pale gray eyes, and streaking on the back, sides, and sometimes the breast (Short 1982).

The male has a small red patch on the back of his head (National Geographic Society 1987). The brightness of this patch varies among males. Extrapolating from physiological studies of other bird species, Ritchison (1999) suggests the brightness of the patch is linked to the amount of carotenoids ingested (i.e. the quality of diet), and could be used by females choosing mates as a direct measure of male quality. This theory has not been tested, however.

Downy woodpeckers are the smallest woodpecker species in the United States, measuring 14 to 17 cm (5.5 to 6.7 inches) long (National Geographic Society 1987; Ritchison 1999) with a wing length of 8.3 to 10.5 cm (3.3 to 4.1 inches) (Short 1982). These birds are very similar in appearance to the larger hairy woodpeckers, differentiated in the field only by body size and length of the bill (downys' bills are shorter).

Various regional races have been named, including: *pubescens* in southeastern U.S., *medianus* in midwestern and northeastern U.S. and much of Canada, *leucurus* along the entire range of the Rockies, *glacialis* along the Alaskan coast, *gairdneri* in coastal British Columbia south to the northwestern coast of California, and *turati* in inland regions of Washington, Oregon, and inland and southern California (Short 1982). The local form is *medianus* (Bent 1939), although *leucurus* may occasionally occur since it has been known to appear as far east as Nebraska (Bent 1939). Taxonomists previously listed downy woodpeckers in the genera *Dryobates* and *Dendrocopos* (Ritchison 1999).

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

Downy woodpeckers range from southern Alaska south across southern Canada and including most of the U.S. from sea level to a maximum 2743 m (9000 ft) elevation (Short 1982).

Figure 9. Distribution of downy woodpeckers. Solid blue represents the year-round range of downy woodpeckers.

Additional Information (Local Distribution)

The downy woodpecker is a common resident in Wyoming, with breeding records known from most areas of the state (Luce and others 1999). The species is perhaps less abundant in the Black Hills region than elsewhere in South Dakota (South Dakota Ornithologists Union 1991).

Estimates Of Local Abundance

Historically, records of the downy woodpecker in the Black Hills date all the way back to 1875, when William Ludlow, traveling with General Custer noted a single downy woodpecker in his time in the area (Ludlow 1875). More recently, breeding records are known for this species in South Dakota every summer since at least 1997 (Palmer 1997,1998b; Schenck 1999b,2000). Christmas Bird Counts in South Dakota have recorded downy woodpeckers every year as well (South Dakota Bird Notes 1998,1999,2000). Christmas Bird Counts at Spearfish from 1996 to1999 ranged from 5 to 9 birds (Cornell Laboratory of Ornithology and National Audubon Society 2001). Breeding Bird Survey routes from 1966 to 2000 averaged 0.01 birds per route in both the Sundance Route Group and the Black Fox Group, which includes Hill City and Custer (Sauer and others 2001).

A woodpecker survey of the Black Hills during the 2000 summer field season found 33 downy woodpeckers (Mohren and Anderson 2000). The following year they found 11 individuals (Mohren and Anderson 2001). However, this data is preliminary and the study was not designed to focus on this species so these numbers may not necessarily reflect abundance accurately (Mohren and Anderson 2000). Panjabi's (2001b) survey located 18 individuals on the forest.

Population Trends

Breeding bird surveys across North America show no significant trends from 1966 to 1999 (Sauer and others 1999; Sauer and others 2001). Christmas Bird Count data show a significant increase in downy woodpeckers for the overall survey area from 1959 to 1988 (Sauer and others 1996).

Downy Woodpeckers have shown a decline in the Black Hills from 1966-1999 according to annual breeding bird surveys, although in the 1990s, the numbers have fluctuated in the region (Sauer and others 1999; Patterson 2000). Numbers rebounded enough in 2000, that the trend is no longer significant (Sauer and others 2001).

Movement Patterns

Downy woodpeckers are not generally migratory (Bent 1939,1992), however northern and mountainous birds do migrate (Short 1982). Higher elevation birds in the west tend to move to lower elevations (Bent 1939). In Ontario, 81% of downy woodpeckers migrated and a few remained year-round, although the migratory status of a particular individual did not always remain the same from year to year (Lawrence 1967). In the Black Hills, local birds usually remain for winter, but a few may migrate in from elsewhere (South Dakota Ornithologists Union 1991).

Habitat Characteristics

General Habitat

In general, downy woodpeckers are found in riparian forests or moist aspen and willow areas of coniferous forests (Short 1982). In the eastern part of its range, this species uses many types of forest including oak-hickory and beech-maple-hemlock forest, but mainly deciduous forest (Short 1982). In a Texas study, downy woodpeckers preferentially used bottomland forest

(*Quercus*, *Liquidambar*, and *Nyssa* species) in both summer and winter (Shackelford and Conner 1997).

In the Black Hills, downys tend to inhabit forested areas along waterways (South Dakota Ornithologists Union 1991). They have been observed in white spruce, aspen, and ponderosa pine from 1,415 to 2,152 m (4,642 to 7,060 ft) in elevation in the Black Hills (Mohren and Anderson 2000). In the Black Hills, no significant preference is known for ponderosa pine stands over aspen/birch stands (Mills and others 2000). Panjabi (2001b) located five individuals in aspen stands, seven in pine stands, and six in riparian areas.

Downys may have a preference for older stands. Haldeman (1980) states they prefer stands with trees more than 40 years old. In another study, downy woodpeckers were significantly related to the amount of forest over 70 years old (Penhollow and Stauffer 2000). In Newfoundland the birds are not restricted to old growth or logged areas there (Setterington and others 2000), perhaps because there were sufficient snags present.

Preference for older stands may be connected with the tendency of these stands to have more snags. A Texas study found downy woodpeckers to be more prevalent in stands with snags (1.2 birds per 40 ha [98.8 acres]) than those without (averaging 0 birds per 40 ha [98.8 acres]) (Dickson and others 1983). These stands were cleared stands replanted with loblolly pine with some hardwood snags remaining in some of the stands. In Newfoundland, downys were associated with the presence of birch snags (Setterington and others 2000). Four or five snags per acre are desired with each being at least 1.83 m (6 ft) tall and 15.24 to 30.48 cm (6 to 12 inches) dbh (Ritchison 1999). Downy woodpeckers with 741 snags per 40.5 ha (100 acres) of aspen forest will be supported at 100% of their maximum population (Thomas and others 1979). However, Thomas and others' (1979) suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

These birds do not seem as closely associated with burned habitats as some other woodpeckers. In Montana, burned areas had more birds and more nests than unburned areas, but not significantly so due to small sample sizes (Caton 1996). In a Washington study, downys were not present significantly more in burned areas than unburned areas (Kreisel and Stein 1999). Cavity-nesters as a group did not show a difference in abundance in the first year after a fire in a coniferous forest in Oregon (Sallabanks 1995).

Villard and others (1999) were unable to relate the presence of downys with either landscape variables (edge, fragmentation, etc.) or amount of cover, so something else is influencing their presence. These results could indicate the scale of analysis was not able to pick up the appropriate variable or an unmeasured microhabitat variable could be important to the presence of the downys.

No information is available regarding minimum patch size, but see the spacing section under Demography for information on density and home range.

Nesting Habitat

Downy woodpeckers use snags or decaying trees, dead branches, or even a post or pole to house their nests (Bent 1939; Short 1982; Ritchison 1999). In Ontairo, 100% of nests were in dead trees (Lawrence 1967). Nest trees include aspen, cottonwood, willow, elm, oak, and ash (Ritchison 1999). In Vermont, downys used deciduous trees (aspen and maple) for nesting

(Runde and Capen 1987). The specific trees used for nesting in the Black Hills are unknown, but aspen and oak are available (USDA Forest Service 1996).

Several studies have examined specific characteristics of the nest trees used by downy woodpeckers (see Table 6). Important attributes of a nest tree listed in the table include: the diameter at breast height (dbh), the height of the nest tree, and the height of the actual nest cavity. Conner (1978) reviewed the literature and estimated optimal conditions for a downy woodpecker nest are from 2 to 11 m (19.69 to 36.90 ft) high in a dead tree 17 to 60 cm (6.69 to 23.62 inches) diameter and 60 to 70 years old. Data varies with geographical area and forest type. No data are currently available for downy woodpeckers in the Black Hills. Studies from other western forests are listed in the table and are the most applicable data available.

Table 6. Characteristics of Nest Trees Used by Downy Woodpeckers[a]

Tree Species	DBH, cm	Tree Status	Tree Height, m	Nest Height, m	Tree Age	Location	Forest Type	Notes	Citation
---	17 to 60	Dead	---	2 to 11	60 to 70	---	---	Review of other studies; these are given as "optimal values"	(Conner 1978)
---	25.4 to 38.1	---	6.1 to 10.7	4.6 to 6.1	---	---	---	Summary of other studies	(Ritchison 1999)
---	---	---	---	1.5 to 18.3		Various	Various	Summary	(Short 1982; Bent 1939)
---	25.4	---	---	---	---	Montana	Western larch/ Douglas fir	Most birds in oldgrowth , n=3	(McClelland and others 1979)
Aspen	---	---	---	---	---	Montana	Western larch/ Douglas fir	Cut areas	(McClelland 1980)
---	43.18 (40.64 to 45.72)	---	13.72 (12.19 to 15.24)	7.32 (6.4 to 8.23)	---	Colorado	Various types	---	(Scott and others 1980)
Only aspen	29	All snags	21.4	9	---	Montana	Lodgepole pine	Burned areas	(Caton 1996)
---	31.8 min 15	---	8.3	4.7	---	Virginia	Oak-hickory, some pitch pine	Forest, n=15	(Conner and others 1975)
---	27.2 min 15	---	5.8	4.9	---	Virginia	Oak-hickory, some pitch pine	Woodlots, n=4	(Conner and others 1975)
100% poplars	26 (21-30, n=4)	100% snags	---	8.9 (3.7-13.7)	---	Ontario	Mixed coniferous, some birch and poplars	n=11, 45% in trees previously used	(Lawrence 1967)
Aspen	25 min 18	---	---	---	---	Montana	Western larch/ Douglas fir	Older forest, n=10	(McClelland 1977)
Aspen	---	---	---	14.9	---	Arizona	---	---	(Schepps and others 1999)
---	20	---	---	2	---	Washington	Mixed conifer	Various aged stands, n=1	(Zarnowitz 1985)

[a]Dimensions listed represent means if one number is listed, minimums if preceded by min, and ranges if two numbers are listed (i.e. 21 to 27). Ritchison's summary gives numbers that represent the ranges of means given in other studies.

Apparently some heartrot is necessary for woodpeckers to excavate holes (Conner 1978). In a southwestern Virginia oak-hickory forest, *Spongipellis pachyodon*, *Polyporus versicolor*, *Phellinus igniarius*, and three Basidiomycetes infected nest trees used by downys (Conner and others 1976). Downy woodpeckers use nest trees that are significantly softer than those randomly available (Schepps and others 1999).

Habitat around nest trees is also important. Nests are located in areas with good foraging, but also other suitable nest trees (Caton 1996). Tree density and the number of birch snags are important habitat variables for downy woodpeckers in Newfoundland (Setterington and others 2000). Thomas and others (1979) state 741 snags per 40.5 ha (100 acres) are needed to fully support these birds in aspen forest. However, Thomas and others' (1979) suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

The following studies illustrate the importance of basal area and canopy cover to these birds. Downy woodpeckers in a Montana lodgepole pine forest nested in areas with an average dbh of 26 cm (10.24 inches), 3% live canopy, and a basal area of 23 m^2 per ha (247.5 ft2 per 2.5 acres) (Caton 1996). The basal area represents a significant preference over habitat that was randomly available. Downy woodpeckers (n=3) in Montana preferred nest sites with larger basal areas 9.8 m^2 per 0.4 ha (105 ft^2 per acre) than random sites 4.9 m^2 (53 ft^2 per acre) (McClelland 1977).

The preferred basal area appears to be higher in the western forests than in eastern forests. In a Virginia hardwood forest, downys nested in areas with lower basal area, lower canopy area, and a high density of stems (Conner and Adkisson 1976,1977). The variables measured for downys were: 10.1 m^2/ha (108.7 ft^2 per 2.5 acres) average stand basal area, 361.8 stems/ha (2.5 acres) (trees > 4cm [1.57 inches] dbh), and 16.3 m (53.48 ft) average canopy to crown distance (Conner and Adkisson 1976). Another study in Virginia found average basal areas of 11.9 m2/ha (128 ft^2/2.5 acres) and average stem densities (>7 cm [2.76 inches] dbh) of 113.9 stems per ha (2.5 acres) around downy nests (Conner and others 1975).

In the Black Hills, the birds show a trend towards canopy covers of less than 70%, but the trend is not significant (Mills and others 2000).

Burned areas had more birds and more nests than unburned areas, but not significantly so due to small sample sizes (Caton 1996). A study in a lodgepole pine forest in northwestern Wyoming showed the habitat surrounding the burn may also affect how the woodpeckers use the habitat (Skinner 1989). For example, downy woodpeckers in forest habitat bordering riparian areas used both burn and unburned areas, while in forest habitat bordering sagebrush, they were more common in burned areas during the breeding season and in unburned areas during postbreeding season.

Foraging Habitat

Downy woodpeckers use trunks as well as branches of trees, reeds, poison sumac, milkweed, etc. for foraging for insects (Short 1982). They also use downed wood for foraging (Schroeder 1983). Downys in a post-burn area of a subalpine forest in Colorado mostly foraged on twigs on fire-killed Englemann spruce (Koplin 1969). However, the presence of downys in those stands was apparently linked to an outbreak of bark beetles, as the insects declined, the downys disappeared (Koplin 1969). In Kansas, the birds preferentially used dead American elm trees for foraging (Jackson 1970). In New Hampshire, downys foraged mostly on birch trees (Kilham 1970). In New York mixed hardwood forests, downys foraged on live trees significantly more than on dead trees (Kisiel 1972). Live trees were also used more often (70% of foraging observations were on live trees) in Virginia (Conner 1980,1993).

Mature stands were used more often than cut stands in Virginia (Conner 1980). Oak-hickory stands were the most commonly-used stands for downy woodpeckers in an area of southwestern Viriginia that included mixed hardwood stands, pine-oak stands, and pasture with woodlots (Conner 1980). Stands with high canopy (18.5 m) were used in mixed hardwood stands in southwestern Virignia (Conner 1980).

Downy woodpeckers' foraging habitat preferences vary by season. Live trees were used significantly more in late spring and summer than in winter in Kansas (Jackson 1970). Tree species preferences changed significantly between summer and winter in Pennsylvania mixed hardwood forest (Travis 1977). Areas with lower basal area were used during the breeding season than in winter or the postbreeding season in Virginia (Conner 1980). In the postbreeding season, downys reduced their foraging niche (Table 7, Conner 1981). Travis (1977) suggests the seasonal changes in foraging may be due to changes in invertebrate location, since invertebrates are unlikely to survive winter in smooth-barked areas of trees which offer little protection.

Table 7. Foraging Characteristics of Downy Woodpeckers by Season (from Conner 1981)

	Breeding Season	Postbreeding Season	Winter
Basal area (m^2/ha)	11.3	21.4	17.3
Stem density (stems > 6cm dbh per 1/25 ha plot)	35.1	37.0	38.5
Canopy height, m	17.0	18.5	19.9
Height of woodpecker while foraging, m	9.2	6.7	11.2
Stem diameter being foraged, cm	15.9	10.3	12.0
Tree height, m	16.0	13.7	17.4
Tree DBH, cm	45.9	31.8	48.7
% of foraging trees that were white oak	14	51	25
%Red oak	10	16	6
%Hickory	59	--	15
% Pine	3	5	23
% Other species	14	28	31

Male and female downy woodpeckers utilize slightly different foraging habitats. In New York mixed hardwood areas both sexes foraged on elmsand twigs, but males used more branches and twigs of aspen and sumac trees, while females used more branches and trunks of pines (Kisiel

1972). Male downys foraged on significantly smaller diameter stems and branches and on significantly taller tree than females in mixed hardwood forests in Virginia (Conner 1993). However, the actual foraging height did not differ between the sexes in that study. In Kansas hardwood forests dominated by American elm trees, no significant difference existed between the sexes' foraging height or tree height, but males used significantly smaller limb diameter than females (Jackson 1970). The male of the pair dominated the upper parts of tree trunks, limbs, and branches, while the female foraged on the smoother, trunk and lower parts of birch trees in New Hampshire (Kilham 1970). Kilham also observed the female moving lower on the trunk when the male landed nearby. Kilham suggests that both sexes were apparently getting enough food and it may be that the higher position is preferred for dominance reasons, not necessarily the food found at those positions.

Roosting Habitat

Roost cavities are needed year-round. These cavities are constructed in snags or dead limbs of trees from 15.2 to 30.5 cm (6 to 12 inches) in diameter (Ritchison 1999).

Food Habits

Downy woodpeckers obtain prey by scanning, gleaning, probing or excavating (even into galls), tapping, or flycatching (Bent 1939; Short 1982; Ritchison 1999). They do not usually cache food (Ritchison 1999). In a mixed conifer forest in Washington, downys foraged by pecking on branches of ponderosa pine trees (Kreisel and Stein 1999). Gleaning and pecking were the most common methods in Virginia hardwood forest (Conner 1993). Downys have also observed peeling bark (scaling) off infected trees to feed on beetles (Kilham 1961).

In the winter, foraging methods change slightly. The birds spend more time on excavation and they have to penetrate deeper to find invertebrates (Ritchison 1999). Rough bark trees are used more for winter foraging, because these types of trees with thicker bark insulate invertebrates, so more woodpecker food is available there (Ritchison 1999). In Kansas hardwoods, males foraged by gleaning more in the summer (peaking in July) and females glean throughout the year (peaking in August) (Jackson 1970). Downys in Virginia used gleaning more during the breeding season, pecking more in the non-breeding season, and excavating behaviors were added during winter (Conner 1979a)

The male dominates females during foraging, utilizing the preferred small limbs over trunks (Ritchison 1999). In a New York study, males foraged more by drilling while females used more gleaning (Kisiel 1972).

Foraging models show that downys are not as efficient foragers as they could be if they were able to precisely count the prey available at a site, but they are using a complex foraging strategy that is able to nearly maximize energy in variable habitats (Lima 1984). Lima speculates that the birds may be able to somehow estimate the time spent to find food at a certain site.

Prey Species

Invertebrate prey includes: beetles (both wood-boring and non-wood-boring), larvae, weevils, ants, caterpillars, gall insects, flying insects, plant lice, butterfly and moth pupae, scale insects, aphids, crickets, katydids, cockroaches, spiders, millipedes, sow bugs, and snails (Bent 1939;

Short 1982; Ritchison 1999). Stomach contents revealed 22% beetles (wood-boring larvae, weevils, and other beetles), 21% ants, 9% hemiptera (scales and aphids), 17% caterpillars (especially wood-boring species), and small amounts of orthoptera (grasshoppers), other hymenoptera, neuroptera (dopson), spiders, millipedes, pseudoscorpions, sowbugs, and snails (Beal 1911).

Vegetable matter makes up 24% of the diet, including: 6% fruit, seeds 6% (especially *Rhus sp.*), 2% grain, 8% mast, and 2% cambrium and rubbish (Beal 1911). Fruit and seeds are consumed from various plants including: poison ivy, poison oak, poison sumac, elderberry, dogwood, cherry, blackberry, raspberry, acorns, beechnuts, hazelnuts, corn, and sunflower seeds (Bent 1939; Short 1982; Ritchison 1999). A few other unusual food habits have been reported including stealing sap and insects from sapsucker holes (Short 1982) and eating fat from animal carcasses (Ritchison 1999).

Characteristics Of Prey

Downys are not reported to be as dependent on insect outbreaks as other woodpeckers. They will take advantage of a situation however. Downy woodpeckers in a post-burn area of a subalpine forest in Colorado was apparently linked to an outbreak of bark beetles, and as the insects declined, the downys disappeared (Koplin 1969). Downys also eat the Scolytus beetles that spread Dutch elm disease fungus (Kilham 1961). The response to insects may depend on the type of stand. For example, in Texas forest stands infected with southern pine beetle outbreaks, downy woodpeckers were found more often in pine stands (88%) than in infected hardwoods (12%), while in unaffected stands they were less common in pine stands (41%) than hardwood stands (59%) (Kroll and others 1980).

Woodpeckers kill many insects, either directly by drilling holes or peeling bark and eating the larvae, or indirectly when their holes dry the bark thereby drying up the beetle larvae (Amman and others 1997). How much of the insect population is being consumed by woodpeckers is still being debated. In some areas of a mountain pine beetle outbreak in Montana, 96-97% beetle mortality occurred where woodpeckers were present (Lester 1980). In eastern Texas, southern beetle mortality due to woodpeckers (as a group) was 3.5% (eggs) and 63.5% (emerging adults) (Kroll and others 1980). In a mixed-conifer forest in California, woodpeckers (hairy, downy and flickers) consumed 31.8% of beetles over two beetle generations (Otvos 1965).

After a large outbreak of spruce beetles in Colorado following blowdowns, foraging activity of woodpeckers (three-toed, downy, and hairy woodpeckers were present) was observed from November to June (Hutchison 1951). In plots with 24,000 to 32,000 beetles infesting each tree, woodpeckers were eating 53 to 57% of the beetles. These numbers were calculated from the amount of bark removed from the trees.

Winter mortality of spruce beetles in a Colorado outbreak was due mostly to woodpeckers (three-toed, hairy, and downy woodpeckers were present) (McCambridge and Knight 1972). Woodpeckers were responsible for up to 70% of mortality one winter for a single brood. Overall mortality (summer and winter mortality combined) showed around 27% of broods were killed by woodpeckers.

Although the woodpeckers are eating many insects, scientists believe they are not actually suppressing beetle epidemics, but may be helpful in preventing outbreaks (Bruns 1960; Beebe

1974; Amman and others 1997). Population trends of woodpeckers and pine beetles did respond to one another during a pine beetle outbreak in eastern Texas (Kroll and others 1980). For example, a large increase in beetles in 1971 and 1972 was followed by an increase in woodpeckers in 1972 to 1973. Beetles subsequently declined in 1972 to 1973, while woodpeckers declined in 1974 to 1975. Both woodpeckers and beetles showed large increases in 1975 and 1976.

Woodpeckers respond to insect outbreaks behaviorally, not by increasing their breeding levels (Beebe 1974). However, nest boxes can increase the number of birds of some species, but whether increasing the number of woodpeckers with nest boxes could control insects is not well understood (Franz 1961), although such a labor-intensive method may not be practical over large areas (Otvos 1979). Clearly more information is needed on how woodpeckers respond to outbreaks and how they could be encouraged to control insects further.

Breeding Biology

Phenology

Pair-formation may start in the fall and breeding initiation dates vary with geographic location (Short 1982). First, males establish territories, then females choose a mate in conjunction with the territory (Ritchison 1999). Pairing in resident birds occurs earlier than in migratory birds (Lawrence 1967). Both sexes may select the nest site and make the nest (although see Bent 1939; 1992 for a discussion of reports of only females excavating nests). Lawrence (1967) reports males in Ontario did most of the excavation. Nestbuilding takes from 2 days to 2 weeks (Short 1982). Nests are usually built in April (Ritchison 1999). South Dakota Ornithologists Union (1991) states that courtship drumming starts as early as January and nesting occurs from May to July in the local region.

Eggs are laid between April and June (Short 1982) and are incubated for 12 days (Bent 1939; Short 1982). Fledging takes place after 20 to 25 days (Short 1982; Ritchison 1999).

Courtship Characteristics

Courtship behavior includes drumming as well as vocal calls, displays, chases, and some fighting (Lawrence 1967; Ritchison 1999). Drumming is used to establish territory, attract mates, and communicate between pairs (Ritchison 1999). Calls during courtship include the 'chirr' call and the 'kweek' call (Ritchison 1999).

Clutch Initiation, Laying, And Size

Downy woodpeckers lay anywhere from 3 to 8 eggs (although usually just 4 or 5) (Bent 1939; Short 1982). Clutch size is correlated to latitude (Koenig 1986). The eggs average 19.35 mm (0.76 inches) long by 15.05 mm (0.59 inches) wide (Bent 1939).

Parental Care

Both parents incubate eggs and feed the hatchlings, although males tend to do most of the night work (Lawrence 1967; Short 1982; Ritchison 1999). After fledging, the young remain near the nest awhile, still getting food from their parents (Ritchison 1999). The youngsters start to follow the parents, until they can forage on their own, becoming independent about 2 to 3 weeks later (Ritchison 1999). Short (1982), however, observed that fledglings still follow adults around until even July, but do roost independently by fall. They remain on the nest range for four to six weeks before leaving the area (Lawrence 1967).

Site And Mate Fidelity

Downys occasionally keep the same mate in subsequent years, but regardless of mate, they always make a new nest cavity (Ritchison 1999). Lawrence (1967) reported that ranges were sometimes inhabited in subsequent years, sometimes by the same pair, and nests were made 45% of the time in trees previously used.

Demography

Life History Characteristics

No information is available on age of first reproduction or non-breeders.

Survival And Reproduction

Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995). Downy woodpeckers have high levels of nest success, even 100% success has been reported in Arizona (Li and Martin 1991). However, there is high fledgling/juvenile mortality (perhaps as high as 70 to 80%) due to predation and the poor foraging ability of the young (Ritchison 1999). Even adults have 40% mortality, so the normal lifespan is 2 to 5 years (Ritchison 1999). Lawrence (1967) reported one individual lived 6 years.

Social Pattern For Spacing

Territories differ in size among seasons. During the breeding season, a territory may be from 2 to 10 hectares (4.9 to 24.7 acres) (Ritchison 1999). In Ontario, ranges for downy woodpeckers extended beyond the nest territory, from 2 to 3.2 ha (5 to 8 acres), and were used for foraging, roosting, and pairing (Lawrence 1967). Some Downy woodpeckers defend individual territories in winter due to limited resources in that season (Bent 1939). Non-breeding territories average 4 to 6.1 ha (10 to 15 acres) (Ritchison 1999).

In a Newfoundland study, average density of presumed pairs ranged from 0.25 and 0.43 per stand in second growth stands to 0.53 pairs in old unlogged stands (Setterington and others 2000). The density was reported as 'presumed' pairs because any nesting activity was counted as evidence that a pair was present. In this study, stand size was not uniform because stands were chosen for tree age, but each stand consisted of a set of five survey points 200 m apart within contiguous forest blocks of at least 3 km^2.

Local Density Estimates

Harris (1982) estimated the density at 2 birds per 40 ha (98.8 acres) in her Montana study. A study of a 20 ha (49.4 acres) grid in an aspen stand found 1.2 pairs of downys per year (Winternitz and Cahn 1983). Average densities in cottonwood riparian areas in Colorado were

8.0 pairs per 100 ha (247.1 acres) (Sedgwick and Knopf 1992). No information is available on downy woodpecker density in the Black Hills.

Limiting Factors

Downy woodpecker populations may be limited by available habitat or food sources. In Wyoming, one study concludes that standing dead timber is limiting since fewer woodpeckers overall were found in the same habitat type with less standing timber (Davis 1976). Caton (1996) found that bird abundance differed between burned and unburned habitats, but this was more prominent in the non-breeding season, which she suggests indicates foraging may be more important than nest cavity limitations. It is the opinion of this author that in the Black Hills downy woodpeckers are probably limited by a combination of habitat more so than food, since they are fairly generalist feeders.

Patterns Of Dispersal

Juveniles usually disperse a short distance, but some travel over 100 miles (Ritchison 1999). Some adults disperse to new breeding areas also, with females generally dispersing farther than males (Ritchison 1999).

Community Ecology

Predators

Predators include: goshawks, foxes, squirrels, snakes, raccoons, and opossums (Bent 1939; Ritchison 1999). Most of this information comes from anecdotal evidence and it is not known what impact predation has on the overall population. Human predators provide some hunting pressure on the Zuni reservation in New Mexico (Taylor and Albert 1999), but hunting is unlikely a major factor in the Black Hills.

Competitors

Downy woodpeckers are not very aggressive and are sometimes driven off by red-headed woodpeckers, hairy woodpeckers, and Nutthall's woodpeckers (Short 1982). They may even hybridize with the latter (Short 1982). Downys compete with house wrens for nest space (Bent 1939). However, they avoid competition with starlings because of the very small entrance holes (3.18 cm [1.25 inch] diameter) of their nests (Short 1982). Competition from starlings did not affecting breeding of secondary cavity-nesters in Arizona, but the authors suggest there could be problems in areas with limited available cavities (Brush 1983). Conner and Adkisson (1977) discuss the idea that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited. Gutzwiller and Anderson (1986) do suggest that less aggression between downy woodpeckers and other species is evident when there is an abundance of available nest cavities. Downy woodpeckers also display when disturbed by chipmunks or humans (Short 1982).

Parasites, Disease, Mutualistic Interactions

Known parasites include: bird flies (*Ornithoica confluenta* and *Ornithomyia anchineuria)* (Bent 1939), chewing lice, and louse flies (Ritchison 1999).

Other Complex Interactions

In the winter, downy woodpeckers sometimes form flocks with other species: chickadees, tufted titmice, ruby or golden-crowned kinglets, brown creepers, and hairy woodpeckers (Ritchison 1999). These species all forage together giving individuals the advantage of the protection of the flock so they can focus more energy on feeding. (Ritchison 1999).

Primary cavity-nesters such as woodpeckers construct cavities that may be used by other animals. Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin (1995) also discusses the importance of primary cavity nests as nest sites for secondary cavity-nesters. Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

Gutzwiller and Anderson (1988) dispute the importance of these cavities for secondary nesters and this is supported in other studies. In a California oak/pine forest blocking cavities did not change the bird densities (Waters and others 1990). Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). For example, snag density may not accurately determine the habitat availability for secondary cavity-nesters.

Risk Factors

Practices which limit habitat and food resources are the major risk factors. Parrish and others (1996) recognize that changes in habitat due to timber management, fire and insect suppression may have affected woodpecker populations in the Black Hills.

Logging probably has some effect on downy woodpeckers, but some disagreement exists in the literature on this matter. Setterington and others (2000) found downy woodpeckers showed no preference for old-growth stands. However, other studies indicate that they are associated with older stands (Penhollow and Stauffer 2000). Slash from recent clear-cuts was used commonly for prey sources by downy woodpeckers in Virginia, but as slash aged and clear-cuts filled with dense stems, few downys were seen (Conner and Crawford 1974).

It is the opinion of this author that fire suppression likely decreases downy populations because fires create snags and dead limbs and promotes growth of shrubs that the downy woodpecker uses for foraging. However, Saab and Dudley (1998) predict that fire suppression does not affect these birds. Fires have become less frequent in the Black Hills than they were historically due to suppression (Progulske 1974; Brown and Sieg 1996), so burned habitat can be relatively rare. However, the large fires in the Black Hills in 2000 and 2001 should mitigate this for awhile.

Clear-cutting apparently does not necessarily mimic burns as far as downy woodpeckers are concerned (Schulte and Niemi 1998). Salvage logging can also be detrimental to these birds (Hitchcox 1996).

Insect control programs also put downy woodpeckers at risk because they decrease the woodpeckers' food base.

Response To Habitat Changes

Management Activities

Timber Harvest

Timber harvesting may have an immediate effect on downy woodpeckers if active nest trees are removed. However, the effect on a landscape scale is more important to the whole population. Replacing mature stands with young stands can eliminate decaying trees and reduce insect infestations, which will reduce the woodpecker population. Maintaining stands with snags is desired.

Even so, downy woodpeckers are probably less affected by timber activity than some other woodpecker species in the Black Hills because they utilize slightly smaller diameter trees and can also use aspens in addition to ponderosa pine. Aspen stands must be of sufficient diameter, however, which is not always the case on the Black Hills Forest. It is the opinion of this author that aspen regeneration would benefit these birds in the long run once aspen stands attain diameters (around 15cm [5.91 inches], see Habitat section) that the birds are able to utilize as nest trees.

Negative effects of logging on downy woodpeckers can be at least partially mitigated by retaining snags and leaving slash. Cavity-nesting birds as a group (including downy woodpeckers) fed more often in uncut units than in cut stands in Montana larch/fir forest (McClelland 1980). Clear-cutting treatments and treatments that removed all trees larger than one inch dbh, but left all residue had negative effects on feeding activity (McClelland 1980). Removing all snags is likely to have negative effects on downy woodpeckers (Conner and others 1975). Slash left in clear-cuts was used as sources for prey by downys in hardwood forest in Virginia (Conner and Crawford 1974). Shackelford and Conner (1997) call for maintaining some mature forest with snags and logs of a range of sizes.

Gunn and Hagan (2000) studied the effects of shelterwood cutting in hardwood stands in Maine and determined that downy abundance was not affected (no difference in abundance between managed and unmanged stands). These birds were not keying on a specific number of snags, although Gunn and Hagan (2000) could not rule out that both types of stands were over some threshold level for the required number of snags. They do not address the diameter of those snags.

Thinning apparently did not affect downy woodpeckers in a Virginia hardwood forest since they utilized a wide range of stem densities (Conner and others 1975). These results may differ in western forests where the downys seem to be utilizing areas with higher basal areas (see Habitat section).

Downy woodpeckers had significantly lower densities in salvaged areas than in the unsalvaged areas after a burn in a Montana mixed conifer forest (Douglas fir, western larch, and Ponderosa pine, with some aspen) (Hitchcox 1996). These results are most likely because salvage cutting generally reduces the number of available snags (Beebe 1974).

In a small sample from mixed conifer/hardwood Minnesota forest found more birds in burned than logged areas but not significantly so when logged (clear-cut with some patches remaining) areas were compared to burned areas (Schulte and Niemi 1998).

Recreation

The effect of recreation is difficult to assess. Downys are common at feeders (Ritchison 1999) so they are probably not disturbed by the presence of humans. At nest sites disturbances may have a different effect. In the Black Hills, the large numbers of roads (see glossary for discussion of road density) means the birds have very few refuges away from activity. "The number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b). Downys may react similarly.

Impact may be severe if users looking for wood for campfires cut down snags. Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. (See Fuelwood Cutting section below.)

Livestock Grazing

Low levels of grazing probably have little impact on downy woodpeckers, in this author's opinion, since downy woodpeckers are mainly bark foragers. Hanula and others (2000) found no relationship between the number or biomass of arthropods and the herbaceous diversity or percent ground cover in a longleaf pine forest.

Mining

Mining activity may be detrimental if preferred habitat is lost or if mining roads reduces snag densities in areas near roads due to firewood cutting (USDA Forest Service 1996).

Fire Suppression

Saab and Dudley (1998) predict that fire suppression does not affect these birds. However, it is the opinion of this author that fire suppression in the Black Hills may be detrimental to these birds because it reduces the number of available snags and decaying limbs that downy woodpeckers need. Fires have become less frequent in the Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996), so fire suppression can become a limiting factor for these birds.

Prescribed Fire

Prescribed fires would likely be beneficial if they create new snags for nest habitat (Saab and Dudley 1998). Fires should be scheduled so they do not decrease the available ground cover these birds use for forage during winter. Fires have become less frequent in the Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996), so prescribed fires may help these birds.

Non-Native Plant Establishment And Control

Non-native plants probably do not have much effect on downy woodpeckers. Control methods may be detrimental if they reduce ground cover these birds use for forage. Chemical control may be detrimental to insects, which the downy uses for forage (Beebe 1974).

Fuelwood Harvest

Fuelwood harvesting will affect these woodpeckers if large numbers of snags are easily accessible (i.e. near roads). Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags (>25.4 cm [10 inches] dbh) of ponderosa pine per 40.5 ha (100 acres) (USDA Forest Service 1996). These numbers are lower than the amount of snags recommended for downy woodpeckers--741 snags per 40.5 ha (100 acres) of aspen forest will be support 100 % of their maximum population (Thomas and others 1979). However, these recommendations are disputed by some since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002). A separate study found an average of 3.6 snags/0.4 ha (1 acre) (>25.4 cm [10 inches] dbh) in stands not actively managed for 20 to 30 years on the Black Hills National Forest (Lentile and others 2000). This would indicate that many areas have abundant snags for downy woodpeckers, however 60% of these snags did not last 10 years (Lentile and others 2000), so it is unclear whether long-term snag needs are being met.

Insect Pest Control

Pesticides may impact woodpecker populations because they kill insects on which the woodpeckers feed (Beebe 1974).

Natural Disturbance

Insect Epidemics

Insects are beneficial for downy woodpeckers because they serve as prey items.

Wildfire

Downy woodpeckers are not as closely tied to burn areas as some other woodpecker species. Downy woodpeckers are found in burn areas, but their preference for them is unclear (Schulte and Niemi 1998). However, fires are an important source for snags and dead branches on which the birds depend. High-intensity fires likely have a negative effect on downy woodpeckers since they reduce the amount of available forage material (Saab and Dudley 1998). Fires have become less frequent in the Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996), so fire suppression can become a limiting factor for these birds.

Wind Events

Blowdowns likely increase forage material for downy woodpeckers, at least in the short term.

SUMMARY

Downy woodpeckers are small, common woodpeckers that serve an important role in the ecosystem by consuming numerous insect species and excavating cavities later used by other cavity-nesters. These birds eat a variety of insects and fruits, but do not cache food for the winter. Usually 4 or 5 eggs are laid in May or June in the region. See Figure 10 for an envirogram illustrating the ecological interactions important to this species.

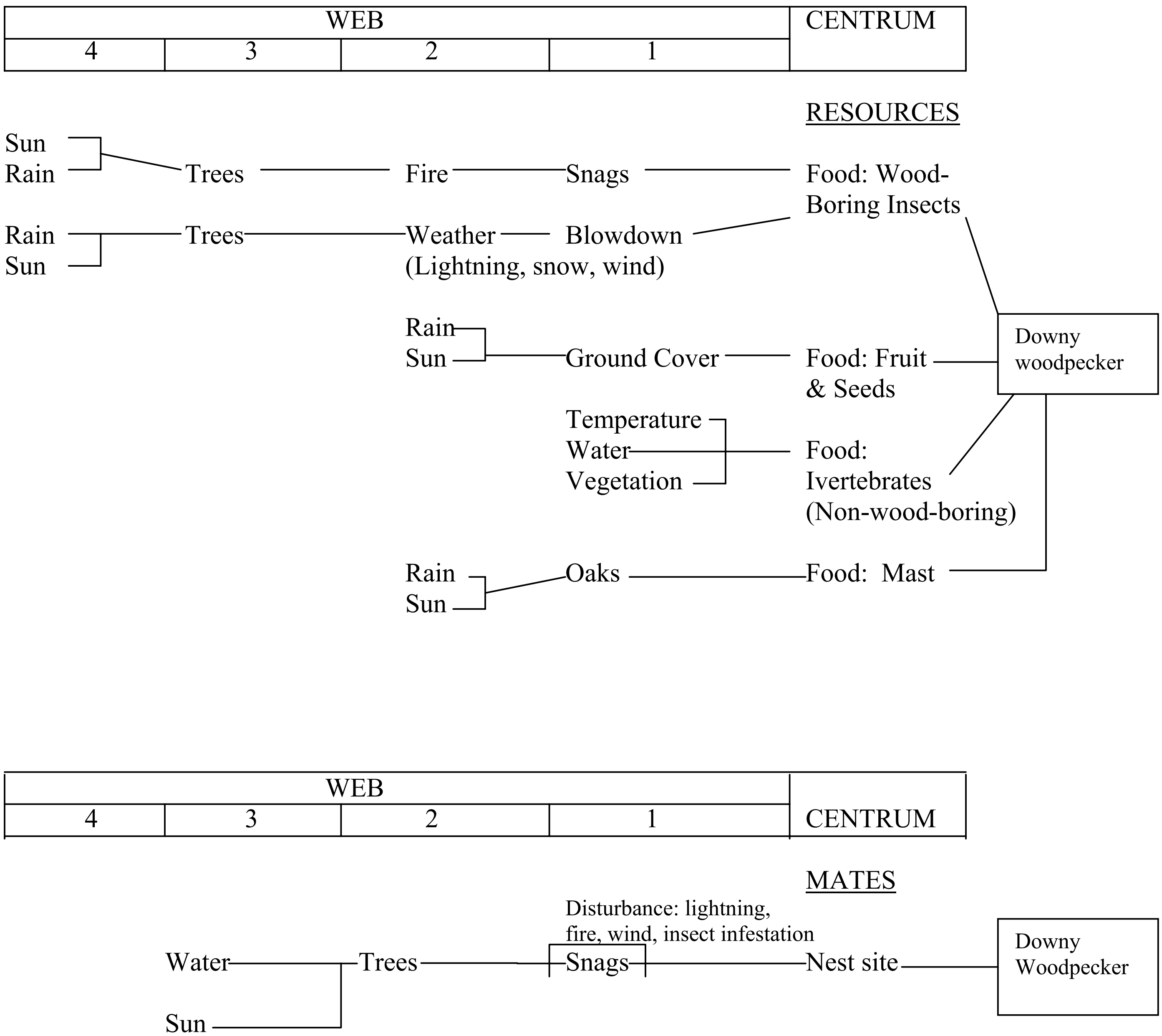
These birds range from Alaska down across most of the United States. They do not usually migrate for winter. Populations of downy woodpeckers are somewhat stable range-wide and in the local area.

Downy woodpeckers utilize snags and dead branches for nests, but the other habitat characteristics they are keying on are unclear. In other regions of the country, they utilize moist forest areas and deciduous stands, but in the Black Hills, no clear trend has been shown for the use of aspen over ponderosa pine stands. They do tend to inhabit riparian areas in the Black Hills. "Optimal" nest tree diameter is said to be between 17 and 60 cm (6.7 and 23.6 inches). Downys use higher basal area sites in the west than in the east part of their range.

They are loosely associated with burn areas. Conflicting information also exists on whether they prefer unlogged areas. Information is needed to determine the habitat features these birds are keying on locally in order to better predict their response to timber practices. They are probably less affected than other woodpeckers.

They are negatively impacted by salvage logging. Overgrazing, insect control, fire suppression, and fuelwood harvesting may have negative effects in certain conditions. Some types of timber harvesting may be a factor, but it is difficult to predict the exact effects without a clear indication of what aspect of the habitat the birds are keying on.

Figure 10. Envirogram of the downy woodpecker in the Black Hills National Forest. The impacts of competitors and preditors are not well understood, so these are not modelled.



HAIRY WOODPECKER

INTRODUCTION

Hairy woodpeckers (*Picoides villosus*) hold an important place in the ecosystem by consuming insects and carving out cavities that can later be used by other cavity-nesting species. These birds closely resemble the common downy woodpecker, but are slightly larger. The following is a review of the ecology and life history of hairy woodpeckers and discusses issues related to the management and conservation of this species.

CURRENT MANAGEMENT SITUATION

Management Status

Hairy woodpeckers have no special conservation status at the federal level or in Wyoming (Luce and others 1999) or South Dakota (South Dakota Department of Game Fish and Parks 2000). The species is not included on the IUCN Red List (Hilton-Taylor 2000) or the National Audubon Society's Watchlist (Muehter 1998). Nor are they among those species prioritized by Partners In Flight for the region encompassing the Black Hills (Partners In Flight 2001).

Existing Management Plans

Forest Service Biologists at both the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers are available in the region (C. Schultz, personal communication).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Hairy woodpeckers are characterized by a long, white to pale gray back and chest, a long bill, black and white barring (of various densities) on their wings, solid white outer tail feather, and a white stripe behind the eye and on the cheek (National Geographic Society 1987). Adult males have a small red patch on the back of the head and juvenile males have light red-orange streaking on the head (National Geographic Society, 1987). They measure 24 cm (9.25 inches) long with a wing length 9.8 to 13.9 cm (3.9 to 5.5 inches) (Short 1982; National Geographic Society 1987). Hairy woodpeckers are very similar in appearance to downy woodpeckers, but hairy woodpeckers are larger with a much longer bill (National Geographic Society 1987).

Short (1982) summarized the many subspecies and races described based mainly on geography and differing slightly in degree of coloration and size. *P. v. piger* and *P. v. maynardi* are found in the Bahamas and *P. v. sanctorum* resides in Central America. *P. v. audubonii* is found in the southeastern United States, *P. v. villosus* in the northeast and midwest, and *P. v. teraenovae* in Newfoundland. *P. v. septentrionalis* ranges from Alaska, across most of Canada and the western U.S.. *P. v. septentrionalis* is sometimes further separated into a Rocky Mountain variant *P. v.*

monticola though Short does not agree with this division. Northwestern races include *P.v. picoideus*, *P. v. sitkensis*, and *P. v. harrisi*. *P. v. orius* ranges from British Columbia down to New Mexico and over to Texas. *P.v. hyloscopus* resides in California and *P.v. jardinii* resides in western Mexico. Short also disagrees with the subdivision of *P. v. leucothorectis* which some recognize as residing in New Mexico and Arizona. The local form in the Rocky Mountains, South Dakota, and Nebraska is *D. v. monticola* (Bent 1939), although Short would consider the local form *P. v. septentrionalis*.

Some of these subspecies may be supported by genetic work. Tennant (1991) found that *P. villosus* is not a monophyletic group using allozyme data. However, her study was not set up to test for geographic structure of species or the validity of subspecies, so future work is needed to answer those questions.

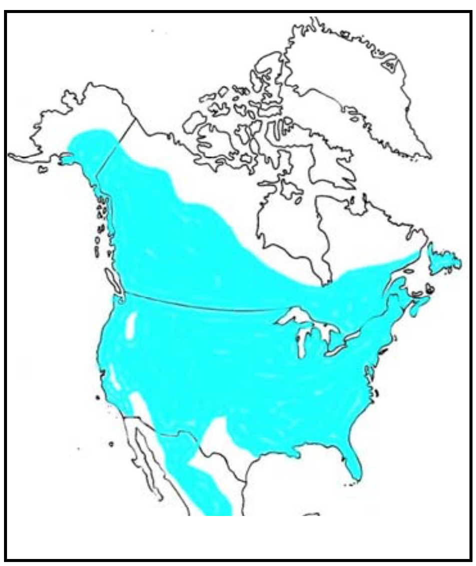
Hairy woodpeckers have sometimes been placed in a separate group, *Dryobates,* so the species may appear in older references as *Dryobates villosus* (Bent 1939).

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

Hairy woodpeckers range from the Canadian tree-line south through most of the U.S. and at higher elevations in Mexico down through Costa Rica and Panama, including the Bahamas (Short 1982). This distribution is shown in Figure 11.

Figure 11. Distribution of hairy woodpeckers. Blue represents the year-round distribution of hairy woodpeckers in North America. Adapted from National Geographic Society (1987).



Additional Information (Local Distribution)

Breeding records are known from almost all counties in Wyoming (Luce and others 1999). Records are also known from across South Dakota, although they are more common in the Black Hills (South Dakota Ornithologists Union 1991). Recent breeding records in South Dakota are documented for 1997 (Palmer 1997), 1999 (Schenck 1999b), and 2000 (Schenck 2000). Recent Christmas Bird Counts in South Dakota have also included hairys (South Dakota Bird Notes 1998,1999,2000).

Estimates Of Local Abundance

They are considered an uncommon resident in Wyoming (Luce and others 1999). Christmas Bird Counts in Spearfish recorded between two and nine birds from 1996 to 1999 (Cornell Laboratory of Ornithology and National Audubon Society 2001). Breeding Bird Survey routes from 1966 to 2000 averaged 0.01 birds on the Sundance Route Group and 0.02 birds on the Black Fox Group, which includes Hill City and Custer (Sauer and others 2001). Panjabi (2001b) found hairy woodpeckers distributed throughout the forest. In a preliminary woodpecker survey of the Black Hills 109 hairy woodpeckers were observed during the summer of 2000 (Mohren and Anderson 2000) and 151 individuals were observed in 2001 (Mohren and Anderson 2001). Although this is preliminary data, it does reiterate that these birds can be seen in the region.

Population Trends

Breeding Bird Surveys survey-wide and for the western region show significant increasing trends from 1966 to 1998 (Sauer and others 1999). When 2000 data are added, no significant trends are noted for the region or for Wyoming or South Dakota (Sauer and others 2001). Christmas Bird Count data from 1959 to 1988 show no significant trend survey-wide, although South Dakota shows a significant positive trend (Sauer and others 1996).

For the Black Hills, Breeding Bird Surveys show a slight decline in regional occurrences, although these trends are based on small sample sizes (Patterson 2000).

Movement Patterns

Some northern birds may migrate, while others only move to lower elevations (Short 1982). Bent (1939) states, “hairy woodpeckers are generally nonmigratory”, although some “wandering” occurs. In central Ontario mixed conifer forest, 89% of hairys remained on their ranges year-round (Lawrence 1967). First-year birds were mainly the birds moving (Lawrence 1967). No information is available on exact flight patterns or movements within the Black Hills.

Habitat Characteristics

General Habitat

Hairy woodpeckers use a range of habitats including: open juniper forest, coniferous forest, riparian forests, and mixed deciduous/coniferous forests (Short 1982). In Newfoundland, they are correlated with areas with more birch snags (Setterington and others 2000). In the eastern U.S., they show a preference for stands with less than 10% pine, but that is apparently not the case in the west (Sousa 1987). In the Black Hills, no significant difference in preference for ponderosa pine versus aspen/birch stands was observed (Mills and others 2000). Highest densities were located in pine stands in the northern hills (Panjabi 2001b), but birds were also found in white spruce, aspen, late-successional pine stands, riparian areas, shrubland, and even mixed-grass habitat.

Elevation limits vary geographically but stretch from sea level to timberline and even up to 3353m (11,000 feet) in Costa Rica (Short 1982). In the Black Hills they have been found in ponderosa pine stands from 1,617 to 1,875 m (5,305 to 6,152 ft) in elevation (Mohren and Anderson 2000).

Haldeman (1980) reports they use mature stands 80 to 159 years old. However, they also used disturbed areas (disturbance ranged from insect outbreaks to thinning activity) in Texas (Shackelford and Conner 1997). In the upper Rocky Mountain region, hairy woodpeckers did not show a clear preference for old growth or secondary growth stands (Hejl and others 1995). Hairy woodpeckers show a preference for relatively open stands with little downed wood material (Bull and others 1986), although this may depend on how old the downed material is (Conner and Crawford 1974). In the Black Hills, they did show a trend towards canopy cover less than 70%, but the trend was not significant (Mills and others 2000).

Hairy woodpeckers are associated with burn areas. In a lodgepole pine forest in Montana, Caton (1996) found significantly more hairy woodpeckers in burned areas than unburned areas. Nest abundance was also higher in the burned areas. Hairys were found in coniferous stands 1 to 43 years after severe fires and 1 to 3 years after moderate fires in western Wyoming (Taylor and Barmore 1980). Hairy woodpeckers were found in both burned and unburned areas of spruce habitat in Yellowstone National Park (Pfister 1980). In lodgepole pine habitat, the few hairys that were found were seen in burned and edge habitat (Pfister 1980). In a mixed-conifer forest in California, hairys more commonly nested on burned plots, although overall presence did not vary between burned and unburned areas (Raphael and others 1987).

The number of years post-fire that these birds utilize an area differs in different studies. A California study found hairys breeding in both burned and unburned areas five years after a fire in mixed conifer forest (Bock and Lynch 1970). Hairys showed no difference in breeding densities between burned and unburned Jeffrey pine-white fir habitat in California eight years following a fire, but had declined in the unburned area 15 years post-fire (Bock and others 1978). Overall the two plots became less similar in species composition as brush increased in the burned area. Cavity-nesters as a group did not show a difference in abundance in the first year after a fire in a coniferous forest in Oregon (Sallabanks 1995).

Hairy woodpeckers attraction to burns and the temporal variation in their usefulness may be a response to insect outbreaks. Blackford (1955) found several hairy woodpeckers in November after an insect outbreak in a burned area in Montana, but all woodpeckers were gone by March.

A study in a lodgepole pine forest in northwestern Wyoming showed the habitat surrounding the burn may also affect how some woodpeckers use the habitat (Skinner 1989). Hairy woodpeckers were not as affected as they used burned areas more frequently in both breeding and post-breeding seasons in both types of habitat (forest bordering riparian areas and forest bordering sagebrush).

Most hairy woodpeckers were found in burned plots in a study comparing clear-cutting and burning in Wyoming (Davis 1976). This may depend on what is left on the ground since new slash in clear-cuts can be used as a prey source (Conner and Crawford 1974).

Sousa (1987) indicates that the minimum patch size required by hairy woodpeckers is 4 ha (9.9 acres). Thomas and others (1979) report others measure territory sizes of 2.4 to 3.6 ha (6 to 9 acres), but they assume the territory is 10.1 ha (25 acres). Thomas and others (1979) assumptions are disputed by some since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002). For more information on density and territory size see the section on spacing under Demography. The presence of hairy woodpeckers was not related to size of the stand in a Black Hills study (Rumble and others 2000).

Nesting Habitat

Hairy woodpeckers nest in aspen or dead pine trees (Bent 1939). In Vermont, hairy woodpeckers used deciduous trees (aspen, maple, and birch) for nesting (Runde and Capen 1987). In an insect outbreak area in a mixed conifer forest in Montana, seven nests were found in live aspen or birch trees, while one nest was found in a beetle-killed lodgepole pine tree (Lester 1980). Poplar trees were used for nesting in Ontario (Lawrence 1967). Short (1982) noted that these woodpeckers usually nest in coniferous trees in the western part of their range and deciduous trees in the eastern part of their range. In the Black Hills, they may be using pine, aspen or birch.

Apparently some heartrot is necessary for woodpeckers to excavate holes (Conner and others 1975; Conner 1978). A study of hairy woodpecker nest trees in an oak-hickory forest in Virginia found they were mostly infected with *Spongipellis pachyodon* (Conner and others 1976). Hairy woodpeckers use nest trees that are significantly harder than downy woodpeckers, although this is not consistent with what is expected from morphological studies (Schepps and others 1999). Raphael and White (1984) classify hairy woodpeckers as soft snag users. Nest trees used by cavity-nesting birds were significantly softer than random trees in aspen stands in Arizona (Schepps and others 1999). Hairy woodpeckers in a California study nested in snags 84% of the time (Raphael and White 1984). In an Oregon study, 93% of nests were in snags (Bull and others 1986). Loose (1993) found nests not in snags, but rather in live aspen. In that study, only a small number of snags were available with large enough dbhs (Loose and Anderson 1995).

Many studies have examined specific characteristics of the nest trees used by hairy woodpeckers (see Table 8). For comparison of nest tree characteristics of various woodpecker species, see Table 12.

Table 8. Characteristics of Nest Trees Used by Hairy Woodpeckers

Tree Species	DBH, cm	Tree Status	Tree Height, m	Nest Height, m	Tree Age	Location	Forest Type	Notes	Citation
---	22 to 60	Dead and live	---	3 to 17	85 to 95	---	---	Review of other studies, these values are given as 'optimal'	(Conner 1978)
---	Preferred 25 to 50	Snags	---	---	---	Oregon	Mixed conifer	Unburned	(Bull and others 1986)
Jeffrey and lodgepole pine, white and red fir	43.8 Min 38	84% Snags	13.7	4.8	---	California	Jack pine/ white fir	Unburned	(Raphael and White 1984)
---	28	---	---	---	---	Montana	Douglas fir/ Ponderosa pine/ western larch	Burned	(Harris 1982)
Poplar trees	28.2 (25.4-34.8; n=7)	91% live	---	10.6 (4.6-13.7; n=11)	---	Central Ontario	Mixed conifer, some birch and poplar	---	(Lawrence 1967)
---	28 to 92	---	---	---	---	---	---	Summary of other articles	(Sousa 1987)
Aspen	32.3	Live	---	---	---	Wyoming	---	---	(Loose 1993; Loose and Anderson 1995)
Preferred larch	35.56	---	---	---	---	Montana	Western larch/ Douglas fir	Old growth had most birds	(McClelland and others 1979; McClelland 1980)
---	38.1 (25.4 to 58.42)	---	17.98 (10.67 to 21.34)	10.06 (6.71 to 15.24)	---	Colorado	Several types	---	(Scott and others 1980)
Mostly aspen	35	Snags	23.4	10	---	Montana	Lodgepole pine	Burned area	(Caton 1996)
---	40.6 min20	---	13.0	8.8	---	Virginia	Oak-hickory, some pitch pine	---	(Conner and others 1975)
---	92	More decayed	18.2	---	<10 and >110	Oregon	Douglas fir, n=7	---	(Mannan and others 1980)
Western larch, aspen, paper birch, subalpine fir, Englemann spruce	37 (min 23)	---	22	11	---	Montana	Western larch/ Douglas fir, n=10	Older forest	(McClelland 1977)
Aspen	---	---	---	17.1	---	Arizona	---	---	(Schepps and others 1999)
---	58	---	---	13	---	Washington	Mixed conifer	Various aged stands, n=16	(Zarnowitz 1985)

Note: Numbers preceded by "Min" are minimums. Single numbers are averages. When two numbers are listed (i.e. 10 to 20) they represent a range.

Hairy woodpeckers preferred taller trees and intact snags with larger dbh and less bark than random trees in areas with higher tree densities (Hitchcox 1996). Conner (1978) reviewed the literature and estimated optimal conditions for a hairy woodpecker nest are from 3 to 17 m (9.84 to 55.77 ft) high in a dead or live tree 22 to 60 cm (8.66 to 23.62 inches) diameter and 85 to 95 years old. A multiple regression model for abundance of hairy woodpeckers in ponderosa pine, showed a positive relationship with trees larger than 50.8 cm (20.0 inches) dbh (Bate 1995). Thomas and others (1979) stated hairy woodpeckers used snags with a minimum dbh of 25 cm (9.84 inches) and at least 4.6 m (15.09 ft) tall [However, these suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002)]. Sousa (1987) reviewed studies from the 1960s to 1970s showing average nest tree dbhs of 28 cm (11.02 inches) in New Hampshire, 40.6 cm (15.98 inches) in Virginia, and 92 cm (36.22 inches) in Oregon. Nest tree characteristics in the Black Hills are unknown. Studies from other western forests are listed in the table and are the closest data available. In a Wyoming study, nest trees averaged 32.3 cm (12.72 inches) in diameter, which was larger than nest trees for other woodpeckers in the study (Loose and Anderson 1995).

Nests were located in areas with good foraging and multiple nest sites (Caton 1996). Therefore, not just the specific nest tree is important, but also the characteristics of the area immediately around the nest tree. As the following studies illustrate, features ranging from tree diameter to canopy cover seem to be important for selection by hairy woodpeckers as breeding areas. Bull and others (1986) also found hairy woodpeckers preferred to nest in areas with open canopies and little downed woody material. In a Montana lodgepole pine forest, habitat around nests showed hairys had a preference for areas where the trees were larger than average dbh (29 cm [11.42 inches]) (Caton 1996). The basal area of nest sites was 19 m^2 per ha (204.4 ft^2 per 2.5 acres) with 4% live canopy, although neither of these variables were significantly preferred (Caton 1996). Yellowstone nest sites had large amounts of small debris, but not much solid downed wood (Hoffman 1997). In Virginia hardwood forests, hairys preferred to nest in areas with high stem densities, intermediate basal areas, and intermediate differences between canopy and crown heights (Conner and Adkisson 1977). Averages for hairys showed they were nesting in areas with a basal area of 17.2 m^2/ha (185.1 ft^2/2.5 acres), canopy to crown distance of 17.8 m (58.4 ft), and stem densities of 401.3 stems >4cm dbh/ha (>1.57 inches/2.5 acres) (Conner and Adkisson 1976). Another Virginia study found hairys used areas with basal area of 19.7 m^2/ha (212 ft^2/2.5 acres) and stem density of 117.3 stems (>7 cm [2.76 inches] dbh) per ha (2.5 acres) (Conner and others 1975).

The presence of snags is essential for these birds. A Texas study found hairy woodpeckers to be more prevalent in stands with snags (0.8 birds per 40 ha) than those without (averaging 0 birds per 40 ha) (Dickson and others 1983). These stands were cleared stands replanted with loblolly pine with some hardwood snags remaining in some of the stands. Hairy woodpeckers can be maintained at 100% of the maximum population potential in ponderosa pine or mixed conifer stands with 446 snags per 100 ha (Thomas and others 1979). However, these suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

A study in the Yellowstone area looked for nests in plots of lodgepole pine forest that had been either logged, burned, or undisturbed (Hoffman 1997). Hairy woodpecker nests were found mostly in aspen and mostly in burned areas, although 10-14% were in undisturbed sites, and one nest was in a logged area (Hoffman 1997).

Foraging Habitat

Hairy woodpeckers use dead and dying trees for foraging and are not restricted by tree species (Short 1982). In Oregon, they feed in living lodgepole pine, western larch, and ponderosa pines (Bull and others 1986). They foraged mostly on spruce in an Alaska burn area, mostly on the most heavily burned trees (half to more than half burned trees) (Murphy and Lehnhausen 1998). In a burned and salvage-logged Oregon forest consisting mainly of Douglas fir, hairy woodpeckers used snags and live trees for foraging (Weikel and Hayes 1999). The live trees they chose were deciduous trees with large dbh (Weikel and Hayes 1999). Living trees were used significantly more in mixed hardwood areas in New York (Kisiel 1972). Fifty-six percent of forage trees were live in Virginia hardwood forests (Conner 1981). Hairys foraged most commonly on oak trees in Virginia (Conner 1980).

In south-central Wyoming they preferred aspen stands over spruce/fir or pine forest habitats for foraging (Loose and Anderson 1995). Oak-hickory stands were used more often than pine-oak stands in Virginia (Conner 1980).

Characteristics of foraging trees are shown in Table 9. The characteristics varied by geographical area. Trees used for foraging averaged 15 and 18 cm (5.91 and 7.09 inches) dbh in Montana (Harris 1982), but over 25 cm (9.84 inches) in Oregon (Bull and others 1986). Significantly more hairy woodpeckers were found foraging in burned than unburned areas in a Washington forest (Kreisel and Stein 1999). The presence of the hairys is associated with the presence of insects (Koplin 1969). In a burned area of subalpine forest in Colorado, hairys foraged on fresh-killed and older snags, on both trunks (81%) and branches (11%) (Koplin 1969). Hairy woodpeckers foraged on all heights of the trunk, and also used stumps and roots (Lawrence 1967).

Table 9. Characteristics of Foraging Trees Used by Hairy Woodpeckers

Tree Species	DBH, cm	Tree Status	Part of Tree	Tree Height, m	Forest Type	Location	Notes	Citation
Englemann spruce, subalpine fir, lodgepole pine	---	Snags and live	Trunks and branches	---	Subalpine fir	Colorado	Burn area with insects	(Koplin 1969)
---	---	---	---	---	Mixed conifer	California	Foraged in burned and unburned patches	(Bock and Lynch 1970)
Preferred live western larch and lodgepole pine, dead ponderosa pine	Min 25	Live trees and snags	---	15	Mixed conifer	Oregon	Unburned	(Bull and others 1986)
Mainly oaks and hickories	---	56% live trees	---	---	Mixed hardwood/ pine	Virginia	Unburned	(Conner 1980)
---	15 and 18[a]	---	8 and 3[a]	---	Mixed conifer	Montana	Burned	(Harris 1982)
---	62	---	---	20.3	Douglas fir	Oregon	---	(Mannan and others 1980)
Jeffrey pine, lodgepole pine, red fir, white fir					Jeffrey pine/ white fir	California	Unburned	(Raphael and White 1984)

[a]The Harris study gave results divided into two different areas. The first numbers refer to Pattee Canyon which was clear-cut and thinned following the fire, with uncut areas averaging 1043 trees/ha. The second numbers refer to Mill Creek which was salvage logged following the fire leaving densities of 855 trees/ha within the cut area and 970 trees/ha outside the cut area.

In Virginia, mature stands were used more often than cut stands (Conner 1980). Hairys used areas with canopy height of 16.7 m, basal area of 18.5 m^2/ha, and stem density of 39.5 stems >6 cm dbh per 1/25 ha (Conner 1980). New clear-cuts were utilized when fresh slash is available for foraging (Conner and Crawford 1974).

Foraging habitat differs between the sexes. Male hairy woodpeckers in Virginia mixed hardwood forests foraged on significantly shorter trees with smaller diameters than females (Conner 1993). The males focused their foraging efforts on the trunks and limbs of the trees, while the females utilized limbs and branches (Conner 1993). In New York mixed hardwood forest, males utilized mostly dead aspen branches, while females foraged on living white oak and birch trees on stems or limbs greater than 6 inches in diameter (Kisiel 1972). Grubb and Woodrey (1990) suggest that differences among studies showing one sex or another in different parts or position on the tree may be due to differences in the most "productive" part of that particular habitat, with the male dominating the most productive areas.

Foraging habitat varies with season as well (Table 10). Hairy woodpeckers have a wider foraging niche in the postbreeding season than in the breeding season (Conner 1981). Hairys used oaks more often in postbreeding and winter seasons than during the breeding season (Conner 1980). Also during the winter, hairys used areas with more dead trees for foraging (Conner 1980). Sites with higher basal areas were used in the postbreeding season than during the remainder of the year (Conner 1980).

Table 10. Hairy Woodpecker Foraging Habitat by Season (from Conner 1981)

	Breeding Season	**Postbreeding Season**	**Winter**
Basal area, m^2/ha	13.7	23.0	15.2
Density of stem, stems >6cm per 1/25 ha	33.2	46.2	33.6
Canopy height, m	15.5	18.0	15.7
Foraging height, m	7.9	12.4	10.5
Stem diameter, cm	11.9	11.8	13.0
Tree height, m	12.1	19.7	17.2
Tree DBH, cm	22.5	46.8	33.6
% of foraging trees that were white oak	9	71	37
% Red oak	9	14	29
% Hickory	27	0	20
% Pine	37	3	11

Using slightly different habitat types in the fall is presumably due to the availability of food. In a ponderosa pine forest in Arizona that had been burned and cut, hairy woodpeckers were found in burned areas of various cutting intensities, but not in the unburned clear-cut (Blake 1982). In the fall, they were found mostly in unlogged and partly logged areas of the burn, with lesser amounts in clear-cut sections of the burn as well as cut sections that were not burned (Blake 1982). This contrasted with spring, when they were found mostly in unlogged burned areas, with only a few sightings in moderately logged burn areas and unburned areas (Blake 1982). In a Texas study, hairy woodpeckers preferred mixed pine-hardwood forest stands (including loblolly and shortleaf pines, oaks, sweet gum, and gum trees) over bottomland hardwood or longleaf pine-savannah habitats in the fall, especially in areas with sawmill-sized (>32 cm, 12.6 inches diameter) snags or logs (Shackelford and Conner 1997).

Roost Habitat

These birds, like all bark-foraging birds, need some sort of cover, such as a cavity, for roosting (Grubb and Woodrey 1990). Roost trees in a Montana Douglas fir/western larch forest included western red cedar and black cottonwood (McClelland 1977).

Food Habits

Hairy woodpeckers use a variety of foraging methods. They forage at all heights including at ground-level (Short 1982). Seventy-five percent of hairy woodpeckers' foraging time is spent scaling in Oregon, although they also use pecking, seed harvesting, and gleaning methods (Bull and others 1986). In a mixed conifer forest in Washington, hairy woodpeckers used flaking and drilling to obtain forage on the lower trunks of Douglas fir, western larch, and ponderosa pine (Kreisel and Stein 1999). In a pine/fir forest in California, hairys foraged by gleaning 77% of the time and drilling 23% (Raphael and White 1984). In a Montana study, hairys foraged mostly by pecking (Harris 1982). These birds forage on trunks and large branches, flitting to many trees (Spring 1965).

Foraging method varies with the season and by sex. Males and females forage differently with males obtaining prey from deeper into the tree (Kilham 1973). In oak/hickory/pine forest in Virginia, pecking was the most common method in all seasons, but scaling and excavating increased during the winter (Conner 1979a).

Prey Species

The diet of these woodpeckers includes 78% animal matter: beetles (especially cerambycid, buprestid, curculionid, scolytid, and carabid beetles), ants (up to 27% in January), caterpillars (10%), hemiptera (2%, scales, aphids), and small amounts of orthoptera, spiders, other hymenoptera, diptera, and millipedes (Beal 1911). Lawrence (1967) observed hairy woodpeckers foraging on grubs, larvae, tent caterpillars, and ants, but no flying insects. Wood-boring insects in the Black Hills that are candidates for woodpecker food include: Coleoptera (*Dendroctonus ponderosae, D. valens, D. rufipennis, Ips pini, I. Integer, I. knausi, I. Borealis lanieri, Pityogenes sp., Pityokteines sp., Pityophthorus sp., Melanophila sp., Agrilus sp., Acanthocinus sp., Monochamus sp.,* and *Saperda sp*.) and Hymenoptera (*Trimex sp*.) (J. McMillin, personal communication).

Vegetative material includes fruit and seeds from: foxtail grass, bayberry, mulberry, sassafras, spice berry, pigweed, pokeberry, vervain, blueberry, elderberry, sour gum, dogwood, Juneberry, chokeberry, strawberry, chokecherry, black cherry, woodbine, frost grape, sumac, poison sumac, poison ivy, black mustard, barberry, and magnolia (Beal 1911). Corn, acorns, hazelnuts, and beechnuts are also eaten (Beal 1911). The birds will occasionally consume sugar cane, sap, and suet from bird feeders (Bent 1939; Short 1982).

Characteristics Of Prey

Some insect species are subject to outbreaks, which may attract these woodpeckers. For a description of the life-cycle of one such insect, the mountain pine beetle, see the Characteristics of Prey portion of the Black-backed woodpeckers' section above. The relationship between woodpeckers, their prey, and their habitat is quite complex. For example, hairy woodpeckers are known to eat Scolytus beetles, which spread Dutch elm disease fungus, and the trees killed by Dutch elm disease are used for nests (Kilham 1961).

The response to insects may depend on the type of stand. For example, in Texas forest stands infected with southern pine beetle outbreaks, hairy woodpeckers were found more often in pine stands (98%) than in hardwoods (2%), while in unaffected stands they showed less preference for pine stands (72%) over hardwood stands (28%) (Kroll and others 1980).

Woodpeckers kill many insects, either directly by drilling holes or peeling bark and eating the larvae, or indirectly when their holes dry the bark thereby drying up the beetle larvae (Amman and others 1997). How much of the insect population is being consumed by woodpeckers is still being debated. In some areas of a mountain pine beetle outbreak in Montana, 96-97% beetle mortality occurred where woodpeckers were present (Lester 1980). In eastern Texas, southern beetle mortality due to woodpeckers (as agroup) was 3.5% (eggs) and 63.5% (emerging adults) (Kroll and others 1980). In a mixed-conifer forest in California, woodpeckers (hairy, downy and flickers0 consumed 31.8% of beetles over two beetle generations (Otvos 1965). Baldwin (1968) found hairy and three-toed woodpeckers preyed on spruce beetles in downed logs in a blowdown area, resulting in 70 to 79% mortality of the beetle brood.

After a large outbreak of spruce beetles in Colorado following blowdowns, foraging activity of woodpeckers (three-toed, downy, and hairy woodpeckers were present) was observed from November to June (Hutchison 1951). In plots with 24,000 to 32,000 beetles infesting each tree, woodpeckers were eating 53 to 57% of the beetles. These numbers were calculated from the amount of bark removed from the trees.

Winter mortality of spruce beetles in a Colorado outbreak was due mostly to woodpeckers (three-toed, hairy, and downy woodpeckers were present) (McCambridge and Knight 1972). Woodpeckers were responsible for up to 70% of mortality one winter for a single brood. Overall mortality (summer and winter mortality combined) showed around 27% of broods were killed by woodpeckers.

Although the woodpeckers are eating many insects, scientists believe they are not actually suppressing beetle epidemics, but may be helpful in preventing outbreaks (Bruns 1960; Beebe 1974; Amman and others 1997). Lawrence (1967) suggested that hairy woodpeckers were not capable of making an impact on a tent caterpillar outbreak in Ontario. Populateion trends of woodpeckers and pine beetles did respond to one another during a pine beetle outbreak in eastern Texas (Kroll and others 1980). Woodpeckers respond to insect outbreaks behaviorally, not by increasing their breeding levels (Beebe 1974). However, nest boxes can increase the number of birds of some species, but whether it is possible to increase the number of woodpeckers with nest boxes in order to control insects is not well understood(Franz 1961). A nest-box method may not be practical over large areas (Otvos 1979). Clearly more information is needed on how woodpeckers respond to outbreaks and how they could be encouraged to control insects further.

Breeding Biology

Phenology

Hairy woodpeckers actually pair in winter and breed from February to June, depending on how far north they are located (Short 1982). In central Ontario, pairing activities begin in November (Lawrence 1967). The pair may establish a breeding territory on the female's winter territory (Short 1982), although other sources observed the male choosing the territory (Lawrence 1967). Nest building takes 1 to 3 weeks, and they always do some remodeling even if they are using a previous nest cavity (Short 1982). In a Maryland study, a female made a nest at the end of April (Kilham 1960).

Eggs are incubated for 14 to 15 days, and fledging occurs 28 to 30 days later (Short 1982). Occasionally hairy woodpeckers fledge earlier. For example, in Oregon 47% fledged during the week of June 22 (Bull and others 1986). In Ontario, fledglings could feed themselves independently of their parents 11 to 14 days after emerging from the nest. Bull and others (1986) hypothesized this might be to reduce competition from the other woodpecker species present.

In South Dakota, nesting occurs from the very end of May to the beginning of July, with earliest records of young present May 24 (South Dakota Ornithologists Union 1991).

Courtship Characteristics

Courtship is characterized by drumming, joint foraging, and male aerial displays (Kilham 1960; Short 1982). The female sets up a winter territory and drums to get the attention of the male, who spends his winter in a separate territory (Kilham 1960). In November and December the drumming increases, and the male spends more time in the female's territory as spring begins (Kilham 1960). The female initiates copulation with aerial fluttering and 'kweek' calls (Short 1982). During nesting, calls and preening activity varies among pairs (Kilham 1968).

Clutch Initiation, Laying, And Size

A clutch consists of 3 to 6 eggs, normally 4 (Short 1982). Clutch size is correlated with latitude (Koenig 1986). In New Hampshire, incubation begins in early to mid-May (Kilham 1968).

Parental Care

Both sexes construct the nest, incubate, and feed the young (Short 1982). However, the distribution of labor varies somewhat between the sexes. Males did most of the excavation in an Ontario study (Lawrence 1967). The females forage nearby the nest, making many more trips to feed the young with smaller prey (Kilham 1968). The males forage further from the nest for larger prey (Kilham 1968). The male is responsible for keeping the nest clean and stays in the nest at night (Lawrence 1967; Kilham 1968). Males are able to defend the nest by filling the opening with their head and using their beak as a weapon through the cavity opening (Kilham 1968). Nestlings may be aggressive or peaceful towards one another (Kilham 1968). After fledging, each youngster follows one parent for a few more weeks (Kilham 1968; Short 1982). Young will leave the parents' home range unless there is a large food supply (Lawrence 1967).

Site And Mate Fidelity

Short (1982) suggests that pairs may mate together in subsequent years. Some ranges are inhabitated in subsequent years, even sometimes by the same pair (Lawrence 1967).

Demography

Life History Characteristics

No information is available on non-breeding individuals or on age at first reproduction.

Survival And Reproduction

Short (1982) suggests only two chicks can survive from any clutch, although this has not been demonstrated. Nest success in Arizona mixed conifer/aspen forest was 75.5% (Li and Martin 1991). Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995). Lawrence (1967) noted one hairy woodpecker in his study lived more than 11 years.

Social Pattern For Spacing

Female winter territories may be only 250 m by 250 m (820 ft by 820 ft) (Short 1982). The territory of a female in a Maryland study was about 411.5 m (1350 ft) in length (Kilham 1960). Breeding ranges, which extended beyond just the nest territory, were 2.4 to 3.2 ha (6 to 8 acres; n=2) in Ontario (Lawrence 1967).

Breeding densities vary with location. The maximum density in Alaska burn area was 0.18 birds per ha (2.5 acres) (Murphy and Lehnhausen 1998). Bate (1995) found a maximum density of 22.3 +/- 12.2 per 100 ha (247.1 acres) (90% confidence interval) in moderately harvested stands (Bate 1995). In a Newfoundland study, density averaged 0.1 and 0.05 presumed pairs per stand in second growth stands, which varied in size but were in continuous forest habitat of at least 3 ha (7.4 acres) (Setterington and others 2000).

Local Density Estimates

In a Montana study, the density reached 19 birds per 40 ha (Harris 1982). In Washington and Oregon mixed conifer or ponderosa pine forests have a maximum density calculated to be 9.9 pairs per 100 ha (4 pairs per 100 acres) (Thomas and others 1979). [However, Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002)]. The maximum density of hairy woodpeckers in a study in Yellowstone National Park was found on the edge of lodgepole pine habitat and was 6.4 pairs per 40 ha (98.8 acres) (Pfister 1980). In spruce habitat, maximum density was 4.4 pairs per 40 ha (98.8 acres) in both burned and unburned areas (Pfister 1980). In the Black Hills National Forest, densities reached 6.3 individuals per km^2 in pine stands in the north and 5.1 individuals per km^2 in white spruce stands (Panjabi 2001b).

Limiting Factors

Some disagreement exists in the literature over the exact limiting factor for woodpeckers. Beebe (1974) reviewed many studies and concluded that the limiting factor is the cavity, roost-site, or nest-building substrate. In Wyoming, one study concludes that standing dead timber is limiting since fewer woodpeckers overall were found in the same habitat type with less standing timber (Davis 1976).

Several studies emphasize factors other than nest sites as limiting factors. In Montana, observed differences in abundance between burned and unburned habitat were more prominent during the non-breeding season, suggesting foraging may be more important than nest-cavity limitations (Caton 1996). For hairy woodpeckers this would be the presence of appropriate insect prey species and the appropriate shrub or ground cover to support these species and/or the presence of abundant fruit or nuts (see section on Food Habits).

It is the opinion of this author that hairy woodpeckers in the Black Hills are limited by a combination of habitat and food resources.

Patterns Of Dispersal

No information is available on natal dispersal.

Community Ecology

Predators

The only recorded predator species is the Cooper's hawk (Meng 1959), although some species which prey on other woodpeckers are also likely predators (see predator sections for other species). The severity of predation pressure is unknown. Human predators exist in some areas. Some hunting pressure exists on the Zuni reservation in New Mexico (Taylor and Albert 1999), although this is not likely an issue in the Black Hills.

Competitors

Nest defense and aggressive displays have been observed against flying squirrels, starlings, flickers, and yellow-bellied sapsuckers (Kilham 1968; Short 1982). Results of encounters with downy woodpeckers are mixed, with sometimes hairys and other times downys being driven off (Short 1982). Lawrence (1967) observed hairys dominating downys. Hairys have been observed to lose nest sites to sparrows and starlings (Bent 1939). Raphael and White (1984) suggest that these interactions do not represent true competition because cavity-nesting birds have enough differences in their niches. Conner and Adkisson (1977) reiterate the idea that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited. Gutzwiller and Anderson (1986) suggest that less aggression between hairy woodpeckers and other species is evident when there is an abundance of available nest cavities.

Parasites, Disease, Mutualistic Interactions

A cestoda, *Liga punctata*, was found in a hairy woodpecker in Oregon (Weatherly and Canaris 1961). Other parasites are unknown, although similar species to those that infect other woodpeckers are possible.

Other Complex Interactions

Primary cavity-nesters such as woodpeckers construct cavities that may be used by other animals. Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin (1995) also discusses the importance of primary cavity nests as nest sites for secondary cavity-nesters.

Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

Gutzwiller and Anderson (1988) dispute the importance of these cavities for secondary nesters and this is supported in other studies. In a California oak/pine forest blocking cavities did not change the bird densities (Waters and others 1990). Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). In other words, snag density may not accurately determine the habitat availability for secondary cavity-nesters.

Risk Factors

Risks include any practices that reduce habitat and/or food resources. In the Black Hills, changes in habitat due to timber management, fire and insect suppression may have affected woodpecker populations (Parrish and others 1996).

Replacing mature stands with young stands can eliminate decaying trees. Increased fragmentation can also be a problem as hairy woodpeckers avoid edge areas (Penhollow and Stauffer 2000). Studies provide conflicting information on the effects of various timber treatments (Bate 1995; Saab and Dudley 1998; Gunn and Hagann 2000). Timber treatments that reduce snags or result in only small diameter trees will affect the population.

Many studies associate hairy woodpeckers with burned areas (Bock and others 1978; Pfister 1980; Taylor and Barmore 1980; Raphael and others 1987; Caton 1996; Kreisel and Stein 1999). Fires were more common historically in the Black Hills (Progulske 1974; Brown and Sieg 1996). Fire suppression puts woodpeckers at risk because it reduces the amount of available snags and insect prey.

Salvage cutting is also a factor. Hairy woodpeckers in post-fire salvage logged stands had lower nest success than those in unlogged stands in Idaho (Saab and Dudley 1998).

Response To Habitat Changes

Management Activities

For a general summary of the effects of various management practices on hairy woodpeckers see Table 15.

Timber Harvest

Timber harvesting has an immediate effect if active nest and roost trees are removed. However, the effect on a landscape scale is more important to the whole population. Replacing mature stands with young stands can eliminate decaying trees and reduce insect infestations, which will reduce the woodpecker population. Increased fragmentation can also be a problem as hairy woodpeckers avoid edge areas (Penhollow and Stauffer 2000). This is not to imply that all logging disturbs these birds. In fact, Bate (1995) found the maximum density of hairy woodpeckers in moderately harvested stands. Hairy woodpeckers are able to use new clear-cut areas as long as fresh slash is available for foraging, but the usefulness of the clear-cut declines by year five (Conner and Crawford 1974). Maintaining an adequate supply of mature stands and snags on the landscape is desired, as the impacts of logging increases as more snags are removed

(McClelland 1977). Thomas and others (1979) reported 446 snags (>25.4 cm [10 inches]) per 100 ha are required to maintain 100% of the maximum potential population of hairy woodpeckers in ponderosa pine forests. However, Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Different cutting strategies differ in their severity of impact. Cavity-nesting birds as a group fed more often in uncut units than in cut stands in Montana larch/fir forest (McClelland 1980). Clear-cutting treatments and treatments that removed all trees larger than one inch dbh, and left all residue had negative effects on feeding activity (McClelland 1980). Loose (1993) found woodpeckers still foraged in clear-cuts even those without snag-retention policies. This result was probably due to the small dbh of the available snags and the fact that many of the snags originally available in clear-cuts fell due to exposure (Loose 1993).

Gunn and Hagan (2000) studied the effects of shelterwood cutting in hardwood stands in Maine and determined that hairy abundance was not affected (i.e. there was no difference in abundance between managed and unmanaged stands). Hairy woodpeckers were not keying on the total number of snags, perhaps because both habitat types were above some threshold of required snags (Gunn and Hagann 2000). Clear-cutting to imitate the effects of burns does not seem to help hairy woodpeckers. A comparison of logged areas which were clear-cut with some patches of trees remaining versus burned areas in a mixed conifer/hardwood forest in Minnesota found more birds in the burned areas but not significantly so (Schulte and Niemi 1998). However, Schulte and Niemi's study (1998) had small sample sizes that provided little power for the test.

Thinning apparently did not affect hairy woodpeckers in Virginia hardwood forests as evidenced by the range of stem densities that they used (Conner and others 1975).

A study in mixed-conifer forest in Washington points out the importance of the retention of snags in managed forests (Zarnowitz 1985). Woodpeckers were observed in stands of several different ages. "Clean plots" with very few snags were compared to "snag plots" that had significantly more snags with larger dbh. Hairy woodpeckers were more dense in plots with snags, even if they were clear cut or 25-50 years old. In Clean plots, they were more dense in old-growth forest.

Salvage logging after fires has a more direct impact. Usually these treatments remove snags in the size classes preferred by many species of woodpeckers (Hutto 1995). Post-fire salvage logged stands had lower nest success than unlogged stands for hairy woodpeckers in Idaho (Saab and Dudley 1998). Salvage logging may affect nesting differently than abundance. In Montana mixed-conifer forest, density of hairy woodpeckers was not significantly different ($p=0.07$) between salvage logged and unlogged areas after a burn (Hitchcox 1996).

Recreation

Hairy woodpeckers' response to direct human disturbance is unknown. In the Black Hills, the large numbers of roads (see glossary for discussion of road density) means the birds have very few refuges away from activity. "[T]he number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b). The impact on hairys may be similar.

Impact may be severe if users looking for wood for campfires cut down snags. Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. (See Fuelwood Cutting section below.)

Livestock Grazing

No information is available on the effect of grazing on hairy woodpeckers. Low-level grazing probably has limited impact on these woodpeckers. However, it is the opinion of this author that overgrazing may negatively affect these birds by reducing ground vegetation on which the birds feed (see Foraging section). Reducing vegetation on which the woodpeckers' insect prey depends may be a factor, although Hanula and others (2000) state "understory vegetation may not be an important part of the food chain" for arthropods.

Mining

As with other woodpecker species, mining activity may be detrimental if preferred habitat is lost or if mining roads encourage additional firewood cutting in snag areas (USDA Forest Service 1996).

Fire Suppression

Fire suppression likely has a negative effect because fewer snags are created. Hairy woodpeckers use burn areas (Saab and Dudley 1998; Schulte and Niemi 1998). Saab and Dudley (1998) predict fire suppression would have a neutral effect. However, since fire frequency in the Black Hills is much reduced from historical levels due to suppression (Progulske 1974; Brown and Sieg 1996), the author of this report suggests that fire suppression does have a negative effect on these birds.

Prescribed Fire

Prescribed fire likely has a positive effect on hairy woodpeckers because new snags are created (Saab and Dudley 1998). Hairy woodpeckers are associated with burn areas (see above). Since fire frequency in the Black Hills is much reduced from historical levels (Progulske 1974; Brown and Sieg 1996), prescribed fire would likely be beneficial for hairy woodpeckers in the Black Hills. However, with the recent large natural fires in the area, this may not be a priority in the near future.

Non-Native Plant Establishment And Control

Non-native plants probably do not have much direct effect on hairy woodpeckers. Chemical control methods may have a negative effect if they also impact plants or insects on which the woodpeckers feed.

Fuelwood Harvest

Fuelwood harvesting will affect these woodpeckers if large numbers of snags are easily accessible (i.e. near roads). Due to the large number of roads (see glossary section for discussion of road density) in the Black Hills National Forest, this is likely to be a factor. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags (>25.4 cm [10 inches] dbh) of ponderosa pine per 100 acres (USDA Forest Service 1996). These numbers are lower than the amount of snags recommended for hairy woodpeckers--446 snags per 40.5 ha (100 acres) of ponderosa forest will support 100 % of their maximum population (Thomas and others 1979). However, Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002). A separate study found an average of 3.6 snags/0.4 ha (1 acre) (>25.4 cm [10 inches] dbh) in stands not actively managed for 20 to 30 years on the Black Hills National Forest (Lentile and others 2000). This study would indicate that many areas have abundant snags for hairy woodpeckers, however 60% of these snags did not last 10 years (Lentile and others 2000), so it is unclear whether these snag numbers are appropriate in the long-term.

Insect Pest Control

Pesticides or other control methods may impact woodpecker populations because chemicals kill their insect prey (Beebe 1974).

Natural Disturbance

Insect Outbreaks

Insects are beneficial for hairy woodpeckers because insects serve as prey items and help trees decay. Insect outbreaks likely have a positive effect for these woodpeckers.

Wildfire

Hairy woodpeckers utilize burn areas, even high-intensity burned stands, therefore wildfires are likely beneficial to these birds (Saab and Dudley 1998). Several studies show hairys have an association with burn areas (Pfister 1980; Harris 1982; Raphael and White 1984; Caton 1996).

Wind Events

The effect of wind events is unclear. Blowdowns may increase overall insect numbers (Furniss and Carolin 1977), which would be beneficial for hairy woodpeckers.

SUMMARY

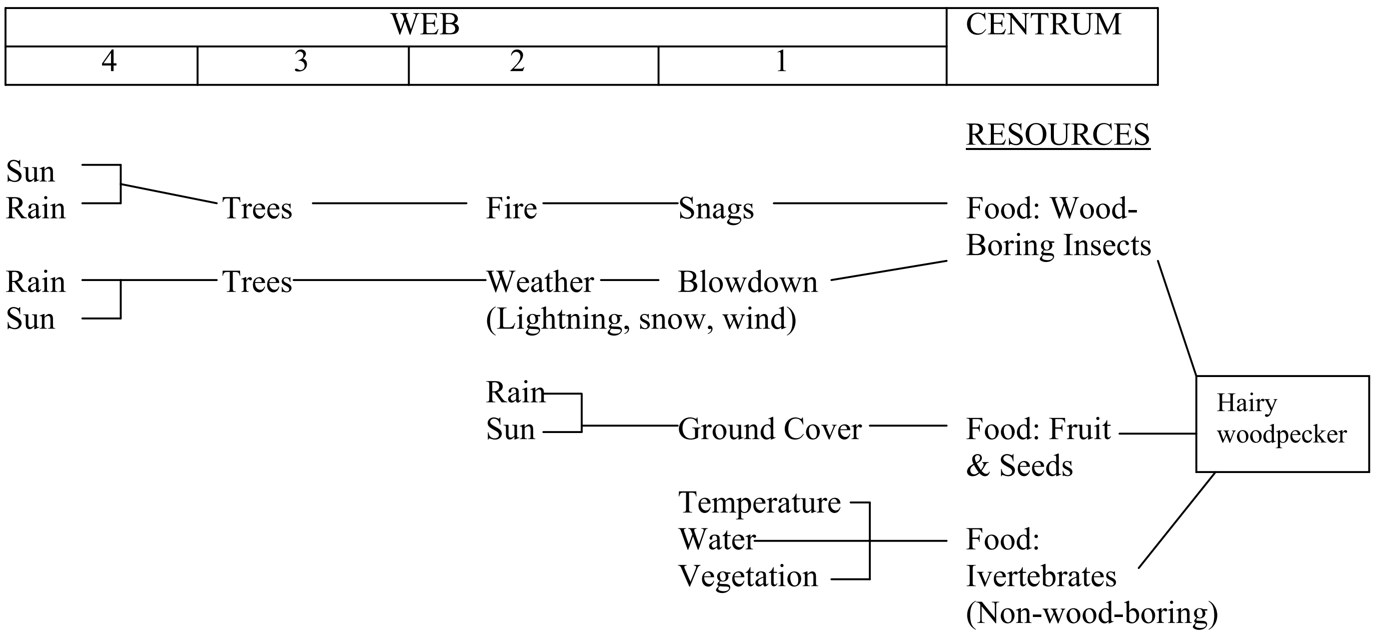
Hairy woodpeckers play an important role in the ecosystem, eating many insect pest species and excavating cavities that can be used by secondary cavity users. Hairys are slightly larger than the very similar downy woodpecker. Hairy woodpeckers' range includes most of North America and high elevation areas in Central America. They are generally non-migratory, but they do move around a bit in the winter. This widespread species shows stable population trends nationwide, although Black Hills population trends are uncertain.

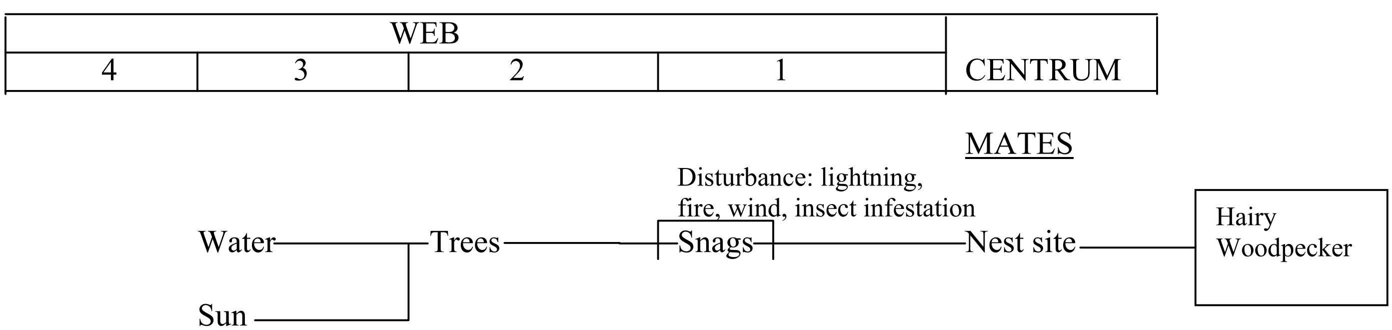
Each pair normally lays a clutch of 4 eggs per year. Hairy woodpeckers nest in snags or live trees of large diameters in coniferous or deciduous forests. "Optimal" nest trees are said to range from 22 to 60 cm in diameter. In the Black Hills, their nest trees are probably pine, aspen, or birch. See Figure 12 for an envirogram illustrating the ecological interactions important to this species.

They are associated with burn areas, due to the presence of snags and insects. They feed on a variety of insects, including wood-boring insects. Some of these insects are subject to outbreaks, so the hairy's presence may be related to that. They are probably limited by appropriate habitat and food sources.

Due to their habitat requirements they are susceptible to fire suppression, insect control, recreation, and fuelwood cutting. They are not as affected by some types of logging as other woodpecker species, but salvage logging and clear-cutting likely decrease the population.

Figure 12. Envirogram of the hairy Woodpecker in the Black Hills National Forest. Effects from competitors and preditors are not well understood, so they are not represented here.





NORTHERN FLICKER

INTRODUCTION

Northern flickers (*Colaptes auratus*) hold a very important position in the forest ecosystem because they hollow out cavities that many other species use and they eat tremendous amounts of ants and other invertebrates (Moore 1995). The following is a review of the ecology and life history of the northern flicker and discusses issues related to the management and conservation of this species.

CURRENT MANAGEMENT SITUATION

Management Status

Flickers do not have any special conservation status either federally or in Wyoming (Luce and others 1999) or South Dakota (South Dakota Department of Game Fish and Parks 2000). They are not included on the IUCN Red List (Hilton-Taylor 2000) or the National Audubon Society's Watchlist (Muehter 1998). Nor are they among those species prioritized by Partners In Flight for the region encompassing the Black Hills (Partners In Flight 2001).

Existing Management Plans

Forest Service Biologists at both the Rocky Mountain and Intermountain Regional Offices stated no conservation plans or management plans directed specifically at woodpeckers are available in the region (C. Schultz, personal communication).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

Northern flickers are characterized by brown and black barring on the back and wings, a spotted chest, and a white rump (National Geographic Society 1987). Adult males have a red or black mustache (National Geographic Society 1987). Immature plumage consists of paler yellow or pink shafts, some barring on top of the head, a barred chest, and a red crown (even on females) (Short 1982). Northern flickers are 28 to 31 cm (11 to 12 inches) long with a wing span of 12.2 to 17.6 cm (4.8 to 6.9 inches) (Short 1982; Moore 1995).

People have many common names for northern flickers such as: yellow-shafted, red-shafted, gilded, yellowhammer, and golden-winged woodpecker (Short 1982). Three forms were formerly recognized as separate species: the yellow-shafted flicker east of the Rocky Mountains which has a yellow tinge on the underside of the wings and a red stripe on the back of the head and a black mustache, the red-shafted flicker west of the Rockies which has a red tinge to the underside of the wings and a red mustache (no stripe on the back of the head), and the gilded flicker in the southwest which has a yellow tinge to the underside of the wings and a red mustache (National Geographic Society 1987).

Five subspecies are currently recognized, which are further divided into races or regional groups (Short 1982; Moore 1995). The yellow-shafted subgroup in the northern and eastern portions of North America is subdivided along a size gradient from the larger northern *C. a. leuteus* to the smaller southern *C. a. auratus*. The red-shafted group, *C. a. cafer*, of western United States and Mexico includes the proper *C. a. cafer* found along the coast, *C. a. collaris* of California and inland areas (which is sometimes further subdivided into *C. a. canescens, C. a. chihuahuae, C. a. martirensis*, and *C. a. sedentarius*), the extinct Guadalupe form *C. a. rufipileus*, and Mexican forms *C. a. mexicanus* and *C. a. nanus*. The gilded flicker, *C. a. chrysoides*, of the Sonoran desert region *includes C. a. mearnsi* and *C. a. chrysoides* (also sometimes subdivided into *C. a. chrysoides* and *C. a. brunnescens* or *C. a. martirensis*). The Cuban flicker, *C. a. chrysocaulosus*, is sometimes divided into *C. a. chrysocaulosus* from the island of Cuba and *C. a. gundlachi* on the Grand Cayman Islands. The Guatemalan flicker, *C. a. mexicanoides*, of the mountainous areas of southern Mexico south to Nicaragua, is also called *C. a. pinicolus*.

Hybridization occurs between some of the subgroups, presumably reinforced by sexual selection (Moore 1995). However, in the hybrid zone between yellow-shafted and red-shafted groups, no preferential mating was found in Colorado populations (Bock 1971). The Black Hills are located entirely within the yellow-shafted/red-shafted hybrid zone (Moore 1995).

Northern flickers are in the same genus as several other flickers, but are not similar to them (Short 1982). In addition, the phylogenetic relationship between the flickers and other woodpecker groups is uncertain; genetic studies could not determine if they were more closely related to Melanerpes or Picoides (Tennant 1991).

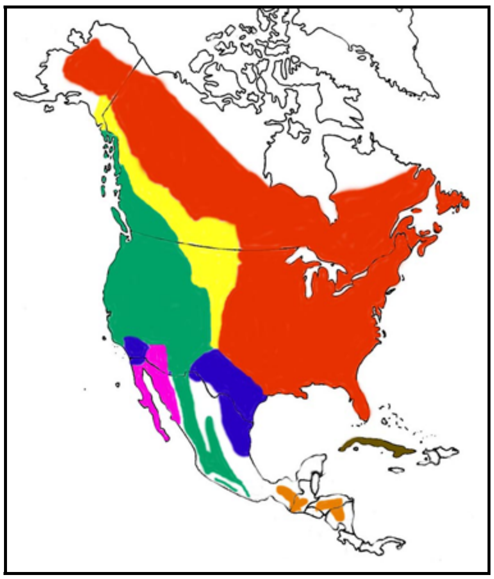
The exact relationships among the various subspecies is not well understood (Moore 1995). Genetic studies have done little to clarify matters. Fletcher and Moore (1992) used allozyme methods to examine nuclear variation among subspecies of northern flickers across North America. Their results did not support the geographical structure of the three subspecies and in fact, found little variation at all. Moore *and others* (1991) used restriction fragments of mitochondrial DNA to examine the birds and found some geographical structure suggesting that the northern and eastern birds are different or at least have a different history from the southwestern birds. None of these samples were taken from the Black Hills region, and no genetic data is available for birds in the Black Hills. However, since the Black Hills are within the suggested hybrid zone (Moore 1995), it is likely that these birds would not show significant genetic differences from birds from other parts of the country.

Distribution And Abundance

Distribution Recognized In Primary Literature (Overall Range)

During the breeding season, northern flickers range from the tree line in Alaska and Canada south to the Gulf of Mexico and Baja California (Short 1982). Their range includes Cuba, the Florida Keys, and mountainous regions in Mexico down through Nicaragua (Short 1982). Northern birds migrate south to winter areas (Moore 1995). The winter range includes the southern United States and Mexico (Short 1982), although some records of indicate they may winter in South Dakota occasionally (South Dakota Bird Notes 1998, 1999, 2000; Schenck 1999a).

Figure 13. Distribution of northern flickers and North American subspecies. Adapted from Moore (1995). Purple represents winter areas only. From the southern portion of Canada south, flickers are year-round residents. The subspecies' distribution is shown as follows: C. a. aurates (red), C. a. cafer (green), aurates/cafer hybrids (yellow), C. a. chrysoides (pink), C. a. mexicanoides (orange), and C. a. chrysocaulosus (brown).



Additional Information (Local Distribution)

Breeding observations are known from all Wyoming counties (Luce and others 1999). South Dakota Ornithologists Union (1991) considers the northern flicker to be a "very common summer resident" across the entire state, and a few birds even remain all winter. Confirmed breeding has been documented each summer in recent years (since at least 1997) in South Dakota (Palmer 1997,1998b; Schenck 1999b, 2000).

Estimates Of Local Abundance

Northern flickers are considered to be a common resident in Wyoming (Luce and others 1999). Panjabi (2001b) considers the birds to be low to moderately abundant in the Black Hills. Christmas Counts in Spearfish ranged from 2 birds to 15 birds from 1996 to 1999 (Cornell Laboratory of Ornithology and National Audubon Society 2001). Breeding Bird Survey's Interactive Data Map shows an average of 0.03 birds per route on the Sundance Route Group and 0.05 birds per route on the Black Fox Group, which includes Hill City and Custer (Sauer and others 2001). In the summer of 2000, 43 birds were observed during a woodpecker survey of the Black Hills (Mohren and Anderson 2000). In the summer of 2001, 24 individuals were found (Mohren and Anderson 2001). Although these are preliminary results, they do provide evidence that the birds are still frequenting the area.

Population Trends

Moore's (1995) analysis shows U.S. populations of flickers are declining overall, since the 1960s, with yellow shafted flickers declining 52% and red-shafted flickers declining 19%, although gilded flickers may be stable or increasing. Breeding Bird Surveys show a significant decline survey-wide in northern flickers from 1966 to 2000 (Sauer and others 2001). Christmas Bird Counts from 1959 to 1988 show a significant decline survey wide (Sauer and others 1996).

Population trends in the Black Hills region are contradictory. Trend analysis from the annual Breeding Bird Survey shows a slight decline in regional Northern Flicker occurrences over the last decade, although the trends are based on small sample sizes (Patterson 2000). Christmas Bird Count analysis for Wyoming shows no significant trend and for South Dakota a significant increasing trend (Sauer and others 1996).

Movement Patterns

Flickers are "true migrants" according to Lawrence (1967). Northern birds fly south from August to November (Bent 1939, Short 1982). Moore (1995) concludes from banding records that yellow-shafted flickers are more migratory (traveling to the southeastern U.S.) than red-shafted (some moving only lower in elevation, with general movement towards the south/southwest). Other subspecies are mostly non-migratory (Moore 1995).

Migration occurs in loose groups mainly at night, but with some morning flights (Bent 1939; Short 1982; Moore 1995). The migration patterns of the Black Hills population are unknown.

Habitat Characteristics

General Habitat

Northern flickers use many habitats including: shrub desert, riparian areas, mountainous forests, pastures, fields, farms, orchards, towns with suitable open habitat, city parks, burned areas, clear-cuts (with snags available), and swamps (Bent 1939; Short, 1982; Moore 1995). They range from sea level to the tree line (Short 1982). Haldeman (1980) reports flickers use open, mature stands rather than old stands. Tree species include: fir, pine, spruce, oak, juniper, and aspen, although structure appears more important than the exact tree species (Moore 1995). In a 2001 survey, the highest densities of flickers were found in white spruce stands, but were also found in other habitats (Panjabi 2001b).

Multiple regression models for flicker abundance show a positive relationship with the number of layers of canopy and the number of snags larger than 20.3 cm (8.0 inches) (Bate 1995). In a Black Hills study, flickers preferred aspen/birch over ponderosa pine stands, and tended towards stands with <70% canopy cover (Mills and others 2000).

Flicker presence was not related to stand size in a separate Black Hills study (Rumble and others 2000). Minimum required patch sizes are not known for northern flickers. See the section on spacing under Demography for information on density and home range.

Several studies show that flickers are associated with burned areas. Flickers were restricted to burn areas 8 years after a fire in lodgepole pine forest in Colorado (Roppe 1974). Flickers had higher breeding densities in burned than in unburned Jeffrey pine-white fir habitat in California eight years following a fire (Bock and others 1978). A California study found flickers (*C. cafer*) breeding in both burned and unburned areas five years after a fire in mixed conifer forest, although they foraged only in the burn area using the ground brush (Bock and Lynch 1970). In Montana, flickers were more often observed in burned areas than unburned areas, although not significantly so due to small numbers (Caton 1996). Nest abundances were also higher in burned areas than unburned areas. In a study of burned and unburned areas in Yellowstone, flickers were found mostly in the burn areas and the edge of both spruce-fir stands and lodgepole pine stands (Pfister 1980).

The severity of the fire and the amount of time since the fire affect how the flickers use the habitat. In coniferous forests in western Wyoming, flickers were present 3 to 7 years after severe fires, but were not present in stands after moderate fires (Taylor and Barmore 1980). After a fire in a mixed-conifer forest in California, flickers nested most commonly on burned portions of the forest 6 years after the fire, but by 21 years post-fire flickers were found equally in both burned and unburned plots (Raphael and others 1987). Cavity-nesters as a group did not show a difference in abundance in the first year after a fire in a coniferous forest in Oregon (Sallabanks 1995).

A study in a lodgepole pine forest in northwestern Wyoming investigated how the habitat surrounding the burn might also affect how the woodpeckers use the habitat (Skinner 1989). However, flickers did not seem to be affected as they used both burned and unburned areas in breeding and post-breeding seasons in both habitat types (forest bordering riparian areas and forest bordering sagebrush).

Nesting Habitat

Tree species used include: apple, poplar, sycamore, oak, butternut, cherry, elm, chestnut, maple, beech, ash, pine, hickory, elm, walnut, cottonwood, and rarely red cedar, hemlock, spruce (data mainly from Midwest sources) (Bent 1939). In Oregon, they nest usually in ponderosa pine larger than 50 cm in diameter (Bull and others 1986). In northeastern Colorado along the South Platte River, they nest in cottonwoods, especially preferring large diameter trees with intermediate amounts of dead limbs (Sedgwick and Knopf 1990). In Arizona, they nest in saguaro cactus at least 5 meters above ground (Kerpez and Smith 1990). In a Montana study in western larch/Douglas fir forest they nested mostly in western larch and paper birch (McClelland and Frissell 1975). In the Black Hills, they are likely using aspen, pine and birch trees.

In a sagebrush area that contained pockets of aspen in Oregon, flickers nested in aspen riparian areas, especially if larger snags were available (Dobkin and others 1995). Flickers preferentially nested in snags at the edge of the riparian areas in order to forage in the open sagebrush areas outside of the riparian zone (Dobkin and others 1995).

Some heartrot is necessary for woodpeckers to excavate a hole in a tree (Conner 1978). A study of flicker nest trees in Virginia oak-hickory forest showed these trees to be infected with *Spongipellis pachyodon*, *Basidiomycetes sp*., imperfect fungi, and bacteria (Conner and others

1976). Nest trees used by cavity-nesting birds were significantly softer than random trees in aspen stands in Arizona (Schepps and others 1999).

Bull and others (1986) states flickers nest mostly in snags (95%). Live trees are also used, especially in the open areas of the Great Plains (Moore 1995). All of the nest trees in a Montana study had broken tops (McClelland and Frissell 1975). However, a review by Moore (1995) indicates that the percentage of nests in dead trees varies with area (and perhaps with snag availability) ranging from 92% in Wisconsin to 78% in California to 27% in eastern Colorado. In Wyoming riparian areas, they use 74% dead and 26% live trees (Gutzwiller and Anderson 1987). Flickers can be supported at 100% of their maximum population with 93 snags (>30.5 cm [12.01 inches] dbh) per 100 ha (247.1 acres) in ponderosa pine or mixed conifer forest in Washington and Oregon (Thomas and others 1979). However, Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Other popular nest sites include buildings, fence posts, telephone poles, or nest boxes and occasionally even the ground (Bent 1939; Short 1982; Moore 1995). Flickers are even known to nest in urban areas such as Detroit (Moore 1995). After a fire in Montana, trees selected for nest trees had only 48% of their bark, which was significantly different from random trees (Caton 1996). Only 4% of nests were in intact live trees.

Northern flickers use larger diameter nest trees (34 cm [13.39 inches] dbh average) than hairy, black-backed or three-toed woodpeckers (Harris 1982). A review of literature estimated the optimal nesting conditions for flickers would be a cavity 3 to 18 m (9.84 to 59.06 ft) high in a 60 to 300 year-old dead tree from 30 to 120 cm (11.81 to 47.24 inches) in diameter (Conner 1978). Flickers preferred shorter deciduous trees or snags with larger dbh and less bark in areas with less burn severity in Montana mixed-conifer forests (Hitchcox 1996). Table 11 summarizes the characteristics of nest trees as reported by various studies. No data is available for nest trees in the Black Hills. Studies from other western mixed coniferous or ponderosa pine forests are the closest applicable data available.

Table 11. Characteristics of Nest Trees Used by Northern Flickers

Tree Species	DBH, cm	Tree Status	Tree Height, m	Nest Height, m	Stand Age	Forest Type	Location	Notes	Citation
Aspen	44.9	Snags	16.3	---	---	Mixed conifer and aspen	Arizona	---	(Li and Martin 1991)
---	30 to 120	Dead	---	3 to 18	60 to 300	---	---	Summary of other studies, these are ‘optimal values’	(Conner 1978)
---	34	---	---	---	---	---	Montana	---	(Harris 1982)
Cottonwood	---	---	---	---	---	---	Colorado	---	(Sedgwick and Knopf 1990)
Saquaro cactus	---	---	---	Minimum 5	---	---	Arizona	---	(Kerpez and Smith 1990)
Jeffrey pine, lodgepole pine, white fir, red fir	60.9	78% snags--soft	12.7	7.7	---	Jeffrey pine/ white fir	California	Unburned	(Raphael and White 1984)
Mostly poplar	27.4 (21.6-33.5; n=2)	76% snags	---	7.0 (2.4-13.7; n=25)	---	Mixed conifer, some birch and poplar	Central Ontario	---	(Lawrence 1967)
Western larch	53.34	---	---	---	---	Western larch/ Douglas fir	Montana	Most in open or semi-open habitat, preferred cut treatments	(McClelland and others 1979; McClelland 1980)
Ponderosa pine, aspen, spruce, fir	40.64 (25.4 to 76.2)	---	19.51 (7.32 to 27.74)	10.97 (3.05 to 20.42)	---	Several types	Colorado	---	(Scott and others 1980)
Mostly aspen	41	96% snags	21.6	12	---	Lodgepole pine	Montana	Some burned areas, n=81	(Caton 1996)
---	36.8 (min 23)	---	12.4	8.5	92.7	Oak-hickory, some pitch pine	Virginia	Forest habitat, n=6	(Conner and others 1975)
---	87.9 (min 23)	---	22.5	13.7	---	---	Virginia	Woodlots, n=16	(Conner and others 1975)
---	61	More decay	11.4	---	<10 and >110	Douglas fir	Oregon	n=8	(Mannan and others 1980)
Mostly Douglas fir	54 (min 25)	---	16	12	---	Douglas fir/ western larch	Montana	Older forest, n=21	(McClelland 1977)

Most numbers listed in the table represent averages. Numbers preceeded by "Min" represent minimums. When two numbers are listed (i.e. 10 to 20) this represents the range.

Characteristics of the areas around the nest are important as well. The following studies indicate features ranging from canopy closure to basal area were important for slection as flicker breeding areas. Nesting areas in Oregon are characterized by large amounts of ground cover (59%) and open canopy (35% canopy closure) (Bull and others 1986). Multiple logistic regression showed both tree and site variables are important to where flickers nest (Caton 1996). A model that was able to correctly classify 94% of nests included basal area, tree lean, percent canopy, live canopy, dbh, burn severity, tree species, and tree condition. Flicker nest sitesaveraged basal area of 18 m^2 per ha (193.7 ft^2 per 2.5 acres), 1% live canopy (significantly different from random), and area trees with a dbh of 26 cm (10.24 inches) (Caton 1996). Flickers in a Montana western larch/Douglas fir forest used nest sites with smaller mean basalareas than other woodpecker species in the area, and eleven nests had zero basal area (McClelland 1977). Height of canopy was important for flickers in British Columbia (Peterson and Gauthier 1985).

Flickers will occasionally nest in a tree with other active cavities (either other flicker nests or other species) in the same tree (Salt 1985).

Flickers in Virginia hardwood forests nested in clear-cuts or near clearings in areas with low stem densities, intermediate canopy height, and intermediate basal areas (Conner and Adkisson 1976,1977). Nesting habitat had an average basal area of 1.5 m^2/ha (16.1 ft^2/2.5 acres), average stem density of 49.3 stems per ha (2.5 acres), and a canopy to crown difference of 2.1 m (6.89 ft) (Conner and Adkisson 1976). Nest trees averaged 92.7 years old (Conner and Adkisson 1976).

In a Ponderosa pine forest in Arizona, flickers were found in partly-logged burn areas and clear-cut unburned areas, but not in other logged and burned combinations (Blake 1982).

Foraging Habitat

Characteristics of trees used by flickers for foraging are given in Table 12 below.

Table 12. Characteristics of Trees Used for Foraging by Northern Flickers

DBH, cm	Tree Status	Tree Height, m	Forest Type	Location	Notes	Citation
---	---	---	Mixed conifer	California	Foraged in burn area only	(Bock and Lynch 1970)
---	14% live tree, 10% dead tree, 70% not on tree (6% other includes stumps, fallen logs)	---	Mixed hardwood and pine-oak, also pasture with some woodlots	Virginia	Used clear-cuts and edge areas	(Conner 1980)
95	Low to mid decay	23.2	Douglas fir	Oregon	N=27	(Mannan and others 1980)

In Virginia, flickers foraged in clear-cut areas and edge areas with the lowest density of understory (Conner 1980). The characteristics of this open habitat included low basal area (2.6 m^2/ha), low stem density (3.1 stems per 1/25 ha), and low canopy height (5.9 m). In a mixed-oak forest with clear-cuts of various ages, flickers were most common in clear-cuts of five years old, but disappeared during the winter (Conner and Crawford 1974). No flickers were present in mature, uncut stands.

In a Texas study, flickers preferred bottomland hardwood forest of oak, sweet gum, and gum trees over either longleaf pine savannah or mixed pine-hardwood forest in fall and winter (Shackelford and Conner 1997). They especially preferred areas with sapling snags. Flickers are not year-round residents in that area so it is unknown how this habitat differs from breeding territory.

Roost Sites

Some flickers roost in holes in buildings during the winter (Bent 1939).

Food Habits

Flickers spend the majority of their foraging time (65%) ground probing, but they also excavate, peck, glean, flycatch, and seed harvest on trees (Bent 1939; Bull and others 1986). In Ontaraio, flickers were usually observed on the ground feeding (Lawrence 1967).

Prey Species

Prey species include mostly ants, but also beetles, wasps, grasshoppers, crickets, mole crickets, cinch bugs, wood lice, caterpillars, grubs, termites, scarab beetles, and aphids, and molluscs (Beal 1911; Bent 1939; Short 1982; Moore 1995). In Utah, a stomach contents study showed mostly insects: Hymenoptera (pupae, adults, larvae; especially *Formica neorufibarbis*, *Pogonomyrmex occidentalis*, *Camponotus sp*.), weevils, Thysanura, grasshopper, crickets, Isoptera, Hemiptera, Homoptera (aphid *Clavigerus bicolor*), coleoptera, spiders, seeds, gravel, and plant parts (Knowlton and Stains 1943). These results closely mirror stomach contents analyzed by Beal (1911). Flickers can be very efficient in attacks on tiger beetle larvae on ground (up to 100%) (Mury-Meyer 1981). Flickers will occasionally take ground-nesting bird chicks (Bent 1939).

Plants in the diet include: berries from dogwood, Virginia creeper, hackberry, blueberry, huckleberry, pokeberry, serviceberry, gooseberry, choke cherry, cultivated cherry, elderberry, barberry, mulberry, blackberry, wild grapes, wild black cherry, black alder, sour gum, greenbrier, spicebush, red cedar, hawthorn, mountain ash, woodbine, viburnum, Virginia creeper, wild strawberry, dewberry, raspberry, wild plum, cacti, oranges, avocados, and seeds of poison ivy, poison sumac, sumac, clover, grasses, pigweed, mullein, ragweed, magnolia, knotweed, acorns, beechnuts, corn, oats, wheat, rye, pigweed, purslane, bur clover, filaree, pepper berry, sunflower, star thistle, and bur thistle (Beal 1911; Bent 1939; Short 1982; Moore 1995). In clear-cut areas in Virginia, dogwood fruit was a very important food source (Conner and Crawford 1974).

The percentage of animal versus vegetable in the diet changes by season, with more vegetable matter in winter (Moore 1995). This pattern is even more evident with the yellow-shafted group (Moore 1995).

Characteristics Of Prey
Some of the insect prey are subject to outbreaks, which may attract the birds.

Breeding Biology

Phenology
Breeding begins from April to June in this region (Short 1982). Eggs are laid one per day in early May and incubation begins before the last egg is laid (Moore 1995). Reported incubation times vary from 11 to 16 days (Bent 1939; Moore 1995). Fledging occurs from 24 to 28 days after hatching (Bent 1939; Moore 1995). In South Dakota, birds arrive at the end of March and begin nest-building as early as April 24, although normally nesting lasts from the end of May to the middle of July (South Dakota Ornithologists Union 1991). In the fall, most birds migrate in October, but some remain in the winter in South Dakota (South Dakota Ornithologists Union 1991).

Courtship Characteristics
Courtship is characterized by the 'wik-a' call and a dancing display sometimes termed a 'wicka dance' (Moore 1995). Studies of behavior show that communication between sexes helps the pair decide on a nest site (Kilham 1959).

Clutch Initiation, Laying, And Size
Normally flickers lay between 6 and 8 eggs, but they can range from 3 to 19 (Bent 1939; Short 1982). Females will lay replacement eggs if one is removed or if the clutch is lost (Bent 1939; Short 1982). Clutch size is correlated with latitude (Koenig 1986). Egg size also varies with region; Bent (1939) reports eggs average 2.69 cm long by 2.06 cm wide, while Moore (1995) reports eggs average 2.8 by 2.2 cm.

Parental Care
Males stake out the breeding territory and then the females choose males with the associated territory (Short 1982). Both sexes do at least some of the nest construction (Bent 1939; Moore 1995). Both parents incubate, brood, and feed the young, although the male does the majority of the night work (Bent 1939; Short 1982; Moore 1995). The nestlings remain in the nest for four weeks, then continue to follow their parents around while learning to fend for themselves (Short 1982).

Site And Mate Fidelity
Data from a small number of individuals indicate that mates are not retained between seasons, but most return to the same area, and some even use the same tree (Moore 1995).

Demography

Life History Characteristics
Moore (1995) speculates that flickers most likely breed at one year, and probably breed each

subsequent year.

Survival And Reproduction

Species vary in fecundity and survival due to their nest site selection and nest predation, with excavators as a group having the highest adult survival and fecundity (Martin 1995). Seventy-eight percent of young flickers survive from the egg to hatchling stage and 86% of those hatchlings survived to late hatchling (near the fledgling stage) (Moore 1995). Normal brood size is about 1 less than the total number of eggs laid (Moore 1995). In a mixed conifer/aspen forest in Arizona, northern flickers had 100% nest success, and failed nests tended to be lower in height with more cover and more large conifers in the area (Li and Martin 1991).

Social Pattern For Spacing

Nest areas are separate from feeding areas (Short 1982). The area actually defended around the nest is small, but the birds need a larger foraging area (Moore 1995). Lawrence (1967) found the flickers range up to 0.8 km (0.5 mile). Nest territories are located as close as 50 m (164.04 ft) from the next territory (Short 1982). Nest distances vary with the type of habitat and geographical area as illustrated by these examples from Moore's (1995) review: a Nebraska riparian zone with many snags had nests averaging 102.7 m (336.94 ft) apart for yellow-shafted flickers and 129.5 m (424.87 ft) for hybrids; in Ontario, nests averaged 252.4 m (828.08 ft) apart; and a New Hampshire pond had 3 nests at distances of 16, 70, and over 70 m (52.49, 229.66, and >229.66 ft). Density in ponderosa pine stands in Oregon reached a maximum of 7.1 +/- 1.7 birds per 100 ha (247.1 acres) (90% confidence interval) (Bate 1995). Reported density of red-shafted flickers is 10 birds per 40 ha (98.8 acres) (Moore 1995). A study by Raphael and White (1984), reported densities of 6 pairs per 40 ha in burn areas versus 0.2 pairs per 40 ha (98.8 acres) in unburned areas.

Although Moore (1995) reports winter range defense is unknown, at least some pairs remain together and defend a joint territory in winter (Kilham 1959). Moore (1995) lists winter home range as 48 to 101 ha (118.6 to 249.6 acres).

Local Density Estimates

In Montana, flicker densities reached up to 15 birds per 40 ha (98.8 acres) in burned areas, and up to 7 birds per 40 ha (98.8 acres) in unburned area (Harris 1982). In a Colorado aspen stand, 2 pairs per year were present on a 20 ha (49.4 acre) grid (Winternitz and Cahn 1983). Maximum densities in burned areas in Yellowstone were 3.2 pairs per 40 ha (98.8 acres) in spruce habitat and 4.4 pairs per 40 ha (98.8 acres) in lodgepole pine habitat (Pfister 1980). In cottonwood riparian areas in Colorado, northern flickers had average densities of 8.7 pairs per 100 ha (247.1 acres) (Sedgwick and Knopf 1992). Based on a 2001 survey, flickers density is 5.9 individuals per km^2 (0.2 acres) in white spruce stands, 1 individual per km^2 (0.2 acres) in burn habitat, and less than 1 individual per km^2 (0.2 acres) in other habitats (Panjabi 2001b).

Limiting Factors

Some disagreement exists in the literature over the exact limiting factor for woodpeckers. Suitable nest habitat has usually been assumed to be the limiting factor as is supported by several authors. The conclusion of a literature review by Beebe (1974) was that the limiting factor is the cavity, roost-site, or nest-building substrate. A separate review of Northern flicker studies have shown that areas where snags were removed have much fewer birds than nearby areas (Moore 1995). In Wyoming, one study concludes that standing dead timber is limiting since fewer woodpeckers overall were found in the same habitat type with less standing timber (Davis 1976).

Several other studies emphasize factors other than nest sites as limiting for woodpeckers as a group. Observed differences between burned and unburned habitat were more prominent during the non-breeding season, suggesting foraging may be more important than nest-cavity limitations (Caton 1996). Limiting factors may be winter food sources for residents or territoriality for migrants, but do not seem to be nest sites according to McClelland (1977).

It is the opinion of this author that northern flickers in the Black Hills are limited by some combination of these factors.

Patterns Of Dispersal

Flickers have high levels of natal dispersal, with an average of 191 km (118.68 miles) between the birth site and the first breeding site (Moore 1995).

Community Ecology

Predators

Flickers display little defense against predators so they have many aggressors including: golden eagle, sharp-shinned hawk, Cooper's hawk, Broad-winged hawk, red-shouldered hawk, northern harrier, raccoon, red squirrel, flying squirrel, weasel, red-headed woodpecker, American crow, Fish Crow, Blue Jay, blacksnake, bull snake, owls, squirrels, and mice (Bent 1939; Short 1982; Moore 1995). A common raven was observed killing a female flicker after pulling her from her nest (Eells 1980). They are a favorite food of Cooper's hawks; 134 of 853 prey items in New York study were flickers (Meng 1959). Most of this information comes from individual observations and it is not known what impact predation has on overall populations.

Historically hunters placed tremendous pressure (even earlier in 1900s) on these birds, but hunting flickers is not legal today in most areas (Moore 1995). A large amount of hunting pressure (>11,000 flickers per year) still exists on the Zuni reservation in New Mexico (Taylor and Albert 1999). However, it is unlikely that hunting plays much of a role in the Black Hills.

Competitors

Flickers are not very aggressive so most records are of other species initiating aggression towards flickers, including: red-headed woodpeckers, Lewis woodpeckers, ash-throated flycatcher, starlings, and screech owls (Short 1982). However, occasionally flickers will attack American kestrel eggs and force kestrels from the cavity (Moore 1995). Also, they may harass other birds as in one account of aggression towards a red-shouldered hawk (Bent 1939). Usually northern flickers are non-aggressive, and one observation exists of a flicker nest in the same tree as a red-headed woodpecker nest (Moore 1995). Raphael and White (1984) suggest that most cavity-nester interactions do not represent true competitive situations because the different species have different niches. Conner and Adkisson (1977) reiterate the idea that overlap of habitat does not equal competition, and that true competition between species occurs only if a required resource is limited. Gutzwiller and Anderson (1986) do suggest that less aggression between northern flickers and other species is evident when there is an abundance of available nest cavities.

Major competition does apparently occur with European starlings. The presence of northern flickers is correlated with the presence of starlings suggesting abundant opportunities for interactions (Gutzwiller and Anderson 1988). Starlings are often successful in competing for food and nesting sites (Bent 1939). Flickers that are displaced from their nests by starlings re-nest, but the later start date of second nest is likely to result in lower productivity (Ingold 1996). Also, starling competition is not mediated by adding nest boxes (Ingold 1998). Peterson (1985) stated that many cavity characteristics overlap between flickers and starlings, but could not determine whether starlings were actually competing for a limited supply of a resource and he did not measure an effect on the flickers.

Competition from starlings did not affect breeding of secondary cavity-nesters in Arizona, but the authors suggest there could be problems in areas with limited available cavities (Brush 1983).

The most conclusive evidence for starling competition is perhaps from a study conducted in a small (70m by 50m [229.66 by 164.04 ft]) plot in a canyon in Nevada (Weitzel 1988). Ten years of nesting data showed that flickers initially nested in the area, but after being harassed by starlings the flickers no longer nested there after the starlings began nesting. After 5 years, the starlings were forcibly removed and the flickers resumed annual nesting. Since this was a small area, nest sites were probably limited, so these findings may not translate to areas with an abundance of nest sites.

The overall impact of competitors on the flicker population remains unknown.

Parasites, Disease, Mutualistic Interactions

Northern flickers are likely to be affected by similar parasites as other woodpecker species. The reported parasites include a cestoda, *Liga punctata*, nematodes, and acanthocephalid worms (Weatherly and Canaris 1961; Moore 1995).

Other Complex Interactions

Flickers are an important primary excavator, making holes that other species use for nests later (Moore 1995). Woodpeckers provide cavities for secondary nesters including: swallows, bluebirds, nuthatches, kestrels, wrens, owls, flycatchers, tufted titmice, chickadees, warblers, starlings, squirrels, and even bees and wasps (Beebe 1974; Scott and others 1980). Dobkin (1995) also discusses the importance of primary cavity nests as nest sites for secondary cavity-nesters. Raphael and White (1984) found that secondary cavity-nesters (animals which do not excavate their own cavities) used cavities made by primary cavity-nesters 67% of the time.

Gutzwiller and Anderson (1988) dispute the limiting factors are these cavities for secondary nesters and this is supported in other studies. In a California oak/pine forest blocking cavities did not change the bird densities (Waters and others 1990). Although secondary cavity-nesters do use cavities made by primary cavity-nesters, the needs of secondary cavity-nesters may be limited by other factors than cavity availability (Sedgwick and Knopf 1992). For example, snag density may not accurately determine the habitat availability for secondary cavity-nesters.

Risk Factors

Moore (1995) identifies two main risks for northern flicker populations as competition with European starlings and habitat loss. The total effect of starlings on flickers or other woodpeckers needs more investigation (see above).

Flicker habitat loss in the Black Hills may be due to removal of large diameter trees or snags. Fire suppression also plays a factor by reducing the number of new snags that are created. As with other woodpecker species, changes in habitat due to timber management, fire and insect suppression may have affected population sizes (Parrish and others 1996).

Response To Habitat Changes

Management Activities

Timber Management

Timber harvesting has an immediate effect on flickers if active nest trees are removed. However, the effect on a landscape scale is more important to the whole population. Replacing mature stands with young stands through timber harvest will reduce the number of large diameter trees and snags that the flickers use for nests. Northern flickers significantly decreased in old growth ponderosa pine forest in Arizona after a cutting treatment that removed all trees and snags except for a few aspen snags, but increased in stands where conifer snags (4.1 per 0.4 ha [1 acre]) as well as aspen snags remained and in stands where no cutting was done (Scott and Oldemeyer 1983b). Cavity-nesting birds as a group fed more often in uncut units than in cut stands in Montana larch/fir forest (McClelland 1980).

Different cutting strategies differ in their severity of impact due to the differences in how much they affect snags and basal area. In Arizona, flicker populations significantly declined in areas where snags were removed (Scott and Oldemeyer 1983b). Clear-cutting treatments and treatments that removed all trees larger than one inch dbh leaving all residue had negative effects on feeding activity (McClelland 1980). When snags were left in California Douglas fir clear-cuts, significantly more cavity-nesters were present than in plots with no snags (Marcot 1983). Hagar (1999) found flickers used riparian areas as refuges in logged areas in Oregon.

Using clear-cuts to mimic burns may not be effective. In a 2,100 ha section of Minnesota mixed conifer/hardwood forest, a comparison of logged (clear-cut with some patches remaining) versus burned areas found more birds in burned than logged areas but these results were not significant due to the small sample sizes (Schulte and Niemi 1998). More work must be done to satisfactorily answer this question.

The effects of other types of cutting treatments is unclear. In Oregon, the maximum density of northern flickers occurred in moderately harvested stands (Bate 1995). Flicker density did not differ significantly between plots after different harvest treatments in Arizona ponderosa pine forest (Scott 1979). The effects of thining and group selection on flickers are unknown.

Although salvage cutting reduces snags (Beebe 1974), flickers may not be as affected by this as other woodpeckers. Unlike in other woodpecker species, flickers' nesting success showed no significant difference between salvage logged and unlogged areas of a burn (Saab and Dudley 1998). These studies do not indicate the amount of large diameter trees remaining in treated areas which may mediate some effects. In Montana mixed-conifer forest, density of flickers was not significantly different ($p=0.43$) between salvage logged and unlogged areas after a burn (Hitchcox 1996). Nesting success was much higher in unlogged areas (94.7%) than in salvage logged areas (66.6%), but significance could not be tested because only one nest failed in the unlogged area (Hitchcox 1996).

Recreation

The effect of recreational activity is unclear. Moore (1995) states that flickers are not terribly disturbed by human activity. At nest sites disturbances may have a different effect. Flickers may abandon nests if they are disturbed by humans, either transporting eggs to another location or dropping the eggs and leaving the area (Baker 1975). In the Black Hills, the large numbers of roads (see glossary for discussion of road density) means the birds have very few refuges away from activity. "[T]he number of roads on the forest and the amount of off-road travel that occurs presents a negative impact to black-backed and three-toed woodpeckers, at least partially due to increased disturbance of nesting birds. … where there are people and other animals, disturbance could be a problem. Young birds are often noisy in response to disturbance, and may attract predators such as marten. Under current management, high road densities and the allowance of off-road travel contribute to such instances." (pgs. 89-90 in USDA Forest Service 2001b). Flickers may be similarly affected.

Impact may be severe if users looking for wood for campfires cut down snags. Due to the large number of roads in the Black Hills National Forest, this is likely to be a factor. (See Fuelwood Cutting section below.)

Livestock Grazing

Grazing probably has limited impact on these woodpeckers as long as sufficient forage is available for the woodpeckers. However, Dobkin and others (1995) state that grazing inhibits recruitment of new trees (especially aspen or cottonwoods) in riparian areas where some of these birds are found. Therefore, it is the opinion of this author that overgrazing, which would limit new tree recruitment, could be detrimental to flickers.

Mining

Mining activity may be detrimental if preferred habitat is lost or if mining roads increase recreational activity.

Fire Suppression

Although others predict fire suppression has a positive effect on northern flickers (Saab and Dudley 1998), the author of this review disagrees and predicts a negative effect on these birds. Many authors have noted positive associations of flickers with burned areas (Bock and Lynch 1970; Roppe 1974; Bock and others 1978; Pfister 1980; Taylor and Barmore 1980; Raphael and others 1987; Caton 1996). Since fire frequency in the Black Hills has decreased from historic levels (Progulske 1974; Brown and Sieg 1996; Parrish and others 1996), further suppression may have a negative effect.

Prescribed Fire

Prescribed fires would have a positive effect on flickers if they provide more snags and nesting habitat for these birds. Others predict a negative effect from low-intensity prescribed fires (Saab and Dudley 1998). This negative effect of lower-intensity fires is supported in a study which found flickers only in high-intensity portions of burns and not lower-intensity areas (Taylor and Barmore 1980). Many authors have noted positive associations of flickers with burned areas (Bock and Lynch 1970; Roppe 1974; Bock and others 1978; Pfister 1980; Taylor and Barmore 1980; Raphael and others 1987; Caton 1996). Since fire frequency in the Black Hills has decreased from historic levels (Progulske 1974; Brown and Sieg 1996; Parrish and others 1996), so it is likely that high intensity prescribed burns would have a positive effect.

Non-Native Plant Establishment And Control

Non-native plants probably do not have much effect on northern flickers. Control methods may affect these birds if chemical sprays also impact plants or insect populations on which the woodpeckers feed.

Fuelwood Harvest

Fuelwood harvesting will affect these woodpeckers if large numbers of snags are easily accessible (i.e. near roads). Due to the large number of roads in the Black Hills National Forest (see glossary for discussion of road density), this is likely to be a factor. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags (>25.4 cm [10 inches] dbh) of ponderosa pine per 40.5 ha (100 acres) (USDA Forest Service 1996). A separate study found an average of 3.6 snags/0.4 ha (1 acre) (>25.4 cm [10 inches] dbh) in stands not actively managed for 20 to 30 y ears on the Black Hills National Forest (Lentile and others 2000). These numbers show many stands have sufficient snags recommended for flickers. Thomas and others (1979) recommended 93 snags (>30.5 cm [12.01 inches]) per 40.5 ha (100 acres) of mixed conifer forest will support 100 % of their maximum population. However, Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Insect Pest Control

Pesticides may negatively impact woodpecker populations because the chemicals can kill insect prey (Beebe 1974).

Natural Disturbance

Insect Epidemics

Insects are beneficial for northern flickers because they serve as prey items. Outbreaks of insects may encourage more flickers to set up foraging areas in a particular area, assuming enough snags or nest trees are available nearby. However, these birds are not as dependent as other woodpeckers on insects known for large outbreaks, such as wood-boring and bark-beetles (see Foraging section above). Therefore, flickers may be less positively affected by these types of outbreaks, although presumably they would respond positively to outbreaks of other types of insects that they prefer.

Wildfires

Fires are likely beneficial for these birds because more snags will be created (Saab and Dudley 1998). Many authors have noted positive associations of flickers with burned areas (Bock and Lynch 1970; Roppe 1974; Bock and others 1978; Pfister 1980; Taylor and Barmore 1980; Raphael and others 1987; Caton 1996). Since fire frequency in the Black Hills has decreased from historic levels (Progulske 1974; Brown and Sieg 1996; Parrish and others 1996), new fires will have a positive effect. Large wildfires in the Black Hills during 2000 and 2001 may provide more habitat for these birds and should be investigated.

Wind Events

Blowdowns may increase insect infestations (Furniss and Carolin 1977), which would benefit some woodpeckers. However, since flickers are less dependent on wood-boring insects, the effect on flickers is likely to be less than on other woodpeckers. Therefore, the author of this review predicts a neutral effect of blowdowns on flickers.

SUMMARY

Northern flickers are a widespread species that plays an important role in the ecosystem, eating many insect pest species and excavating cavities that can be used by secondary cavity users. See Figure 14 for an envirogram of the ecological relationships important for northern flickers.

The summer range is from the tree line in northern North America to the Gulf Coast and continues south in high elevation areas through Central America. They migrate for the winter. The winter range is the southern United States and Mexico. The Black Hills are in the hybrid zone for yellow-shafted and red-shafted flickers.

They nest in large diameter trees or snags. The size of the nest tree varies with the type of habitat. "Optimal" sizes are said to be between 30 and 120 cm (11.8 and 47.2 inches) dbh. Nest areas are in relatively open forest with large trees. They usually lay six to eight eggs each summer.

These birds consume mostly ground-dwelling insects, but also some insects that they glean from trees. They also eat berries and seeds.

Population trends of northern flickers are declining nationwide, although population trends in the Black Hills are unclear. European starlings are believed to be affecting the flickers by competing for nest sites. Predators, such as the Cooper's hawk, cause some mortality, but it is unknown what their real impact on the population is.

They are associated with burn areas, probably due to insect outbreaks. Flickers decline when snags are removed during harvest, but they may not be as affected by some measures (i.e. salvage logging). Fire supression, fuelwood harvest, and chemical insect control may negatively affect these birds.

Figure 14. Envirogram of the Northern Flicker in the Black Hills National Forest

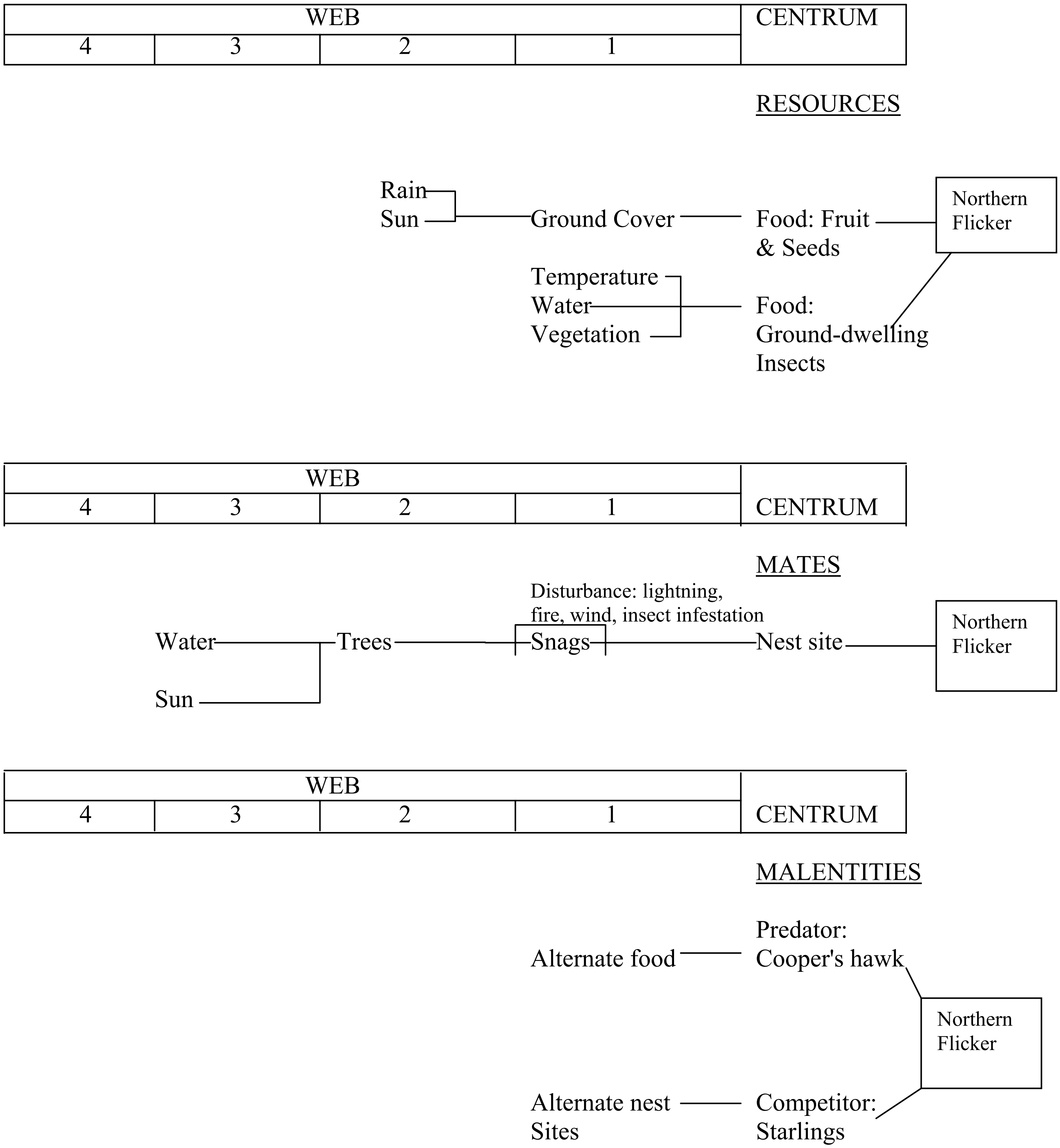


Table 13. Comparison of Population Trends Among Woodpecker Species in the Black Hills

Species	Overall Trend	Black Hills Trend
Black-backed woodpecker	0	?
Three-toed woodpecker	0	?
Lewis's woodpecker	-	?
Red-headed woodpecker	-[a], 0[b]	?
Downy woodpecker	0[a],+ [b]	0
Hairy woodpecker	0	-?
Northern flicker	-	-?

0 = no significant trend
? = not enough sample size for the analysis
-? = slight decline determined from small sample size
[a]Trend from Breeding Bird Surveys.
[b]Trend from Christmas Bird Counts.

These data are from several sources described further in the text (Sauer and others 1996; Sauer and others 1999; Patterson 2000; Sauer and others 2001).

Cautionary note: Woodpeckers may not be adequately monitored by the Breeding Bird Survey (BBS) because of their low population densities (Gunn and Hagen 2000). Population patterns from BBS and CBC data should be interpreted with discretion because woodpeckers often have sporadic distributions, are relatively uncommon, and sometimes show cyclical patterns of localized abundance (Tobalske 1997).

Table 14. Comparison of Habitat Requirements of Woodpecker Species in the Black Hills

Species	General Habitat	Black Hills Forest Tree Species	Nest Tree DBH/ cm[1]	Home Range / ha	Food Sources	Foraging Methods
Black-backed WP	Old stands and early-successional burn areas with snags	Pine, spruce	22-45 (see Table 1)	61-328 ha (Dixon and Saab 2000)	Mainly wood-boring insects, some fruit, mast	Gleaming, pecking, scaling, and excavating on trunks
Three-toed WP	Mature stands and early-successional burn areas with snags	Pine, spruce, aspen	24-43 (see Table 2)	53-304 ha (Goggans and others 1989)	Mainly wood-boring beetles, also other insects	Scaling, excavating, flaking, and drilling on trunks
Lewis's WP	Open forest or burns with snags, cottonwood riparian areas	Pine, oak, rare cottonwood	45-113 (see Table 4)	Unknown	Flying insects, berries, mast	Flycatching
Red-headed WP	Open forest, edge habitat with snags	Pine, oak, aspen, birch	>30.6 (Smith and others 2000)	1.2-2.4 (Haldeman 1980)	Flying insects, berries, mast, bird eggs	Flycatching, some gleaning
Downy WP	Riparian areas or older stands with snags	Spruce, aspen, pine	20-43 (see Table 6)	2-10 ha breeding season (Ritchison 1999)	Beetles & other wood-boring insects, fruit, seeds	Scanning, gleaning, pecking, probing, excavating, flycatching on branches
Hairy WP	Open stands with snags & little down woody	Pine, aspen, birch	22-92 (see Table 8)	>4 ha (Sousa 1987)	Wood-boring & crawling insects, fruit, seeds	Scaling, pecking, flaking, gleaning, drilling on trunks, branches and ground
Northern Flicker	Open stands with ground cover & snags	Spruce, pine	34-61 (see Table 11)	48-101 in winter (Moore 1995)	Ground insects, seeds, berries	Mainly ground probing, also excavating, pecking, gleaning, flycatching on trees and ground

[1]Nest tree measurements are the range of averages from various studies listed in the tables in the text, unless otherwise cited. Note that not all of these studies were conducted in similar habitat to the Black Hills. See text and individual species' tables for more details.

Table 15. Comparisons of Responses to Habitat Changes Among Woodpeckers in the Black Hills

Species	Timber Harvest	Salvage Sale	Recreation	Grazing	Mining	Fire Suppression	Prescribed Fire	Non-native plants & control	Fuelwood Harvest	Insect Control
Black-backed Woodpecker	**-**	**-**	**?/-**	**?/0**	**0/-**	**-**	**?/+**	**0/-**	**-**	**-**
Three-toed Woodpecker	**-**	**-**	**?/-**	**?/0**	**0/-**	**-**	**?/+**	**0/-**	**-**	**-**
Lewis's Woodpecker	**-/+**	**?/0**	**?**	**0/-**	**0/-**	**-**	**+**	**0/-**	**-**	**-**
Red-headed Woodpecker	**?(-/+)**	**?**	**?/-**	**0/?**	**0/-**	**-**	**?/+**	**0/-**	**-**	**-**
Downy Woodpecker	**0/-**	**0/-**	**?/-**	**0/-**	**0/-**	**?/-**	**?/+**	**0/-**	**?/-**	**-**
Hairy Woodpecker	**0/-**	**-**	**?/-**	**0/-**	**0/-**	**-**	**+**	**0/-**	**?/-**	**-**
Northern Flicker	**?/-**	**?/0**	**?/-**	**0/-**	**0/-**	**?/-**	**?/+**	**0/-**	**?/-**	**-**

+ = positive response
- = negative response
0 = neutral response
? = unknown or unclear response
-/+ = mixed response

?/0 = unknown, but likely neutral
0/- = likely neutral, but possible negative response in certain conditions
?/- = unclear, but likely negative
?/+ = unclear, but likely positive
?(+/-) = unknown, but likely mixed

These are the expected effects with no mitigation measures. For more information see text of report.

REVIEW OF CONSERVATION PRACTICES

Management Practices

Conservation measures from the literature are summarized here with an evaluation of their potential effectiveness and feasibility in the Black Hills.

Snag Retention And Recruitment

Currently, snags are retained in the Black Hills for the benefit of a variety of species, including woodpeckers (USDA Forest Service 1997). Two sets of data are available that address the current state of snags on the forest. Snag surveys on the Black Hills National Forest showed an average of 173 hard snags of ponderosa pine per 100 acres (>10 inches dbh) (USDA Forest Service 1996). A separate study investigated snag densities in stands not actively managed for 20 to 30 years on BHNF in three size classes and found: 17 snags/0.4 ha (1 acre) (dbh>7.62 cm [3 inches]), 3.6 snags/0.4 ha (1 acre) (dbh>25.4 cm [10 inches]), 0.3 snags/acre (dbh>50.8 cm [20 inches]) (Lentile and others 2000). In addition, 60% of the snags do not last (i.e. fall, are cut down, etc.) 10 years and are generally evenly distributed, not clumped (Lentile and others 2000). Lentile and others (2000) assumed the stands they surveyed (stands not actively managed from 20 to 30 years) were "natural, near-equilibrium" snag conditions for the area To the author of this review it seems that snag densities would still be largely the result of previous management activities since many potential snags would have been cut in previous management treatments, so the results of Lentile and others (2000) may not be an accurate reflections of "natural" conditions across the entire forest.

The Revised Land and Resource Management Plan (USDA Forest Service 1997) called for 1.08 hard snags per 0.4 ha (1 acre), where the minimum diameter is 25.4 cm (10 inches). However, the Amendment One Decision Notice for the Black Hills (USDA Forest Service 2001a) now requires 2 to 4 ponderosa pine snags (at least 10 inches with 25% greater than 20 inches or from the largest diameter class available) per 0.4 ha (1 acre) and 6 snags (at least 25.4 cm or 10 inches) per 0.4 ha (1 acre) of other species. Although not specifically stated, these requirements are presumably for unburned forests.

Many authors have proposed snag retention guidelines for unburned forests that include density and size of snags as outlined below and in Table 14. Thomas and others (1979) recommend 339 snags (>30.5 cm [12.01 inches]) per 100 ha (247.1 acres) to maintain all primary cavity-nester populations at carrying capacity in ponderosa pine forest or mixed conifer forest. (Thomas and others also made species recommendations, which can be found within each species section in this report). However, Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).

Recommendations for a mixed conifer forest in Oregon include leaving snags in clumps, leaving 10 to 20 trees larger than 50.8 cm (20 inches) dbh per ha (2.5 acres), and allowing seed trees to remain in seed cut areas as sources of larger diameter trees (Bate 1995). Raphael and White (1984) also recommend leaving snags in clumps, with minimum snag diameter equal to the average nest tree diameter for that species, which in their study was 61 cm (24.02 inches) for northern flickers. Since finding 75% of the snags with cavities were at least 48.26 cm (19 inches) dbh in ponderosa pine forest, Scott and Oldemeyer (1983a) suggest stands be maintained with 2 to 3 snags (at least 48.3 cm [19.02 inches] dbh) per acre to benefit all cavity-nesting birds.

Suggestions from a snag study in a Douglas fir forest in western Oregon include maintaining snags larger than 50 cm (19.69 inches) in different decay stages, as well as retaining large trees for future snags (Cline and others 1980). Snags at least 38.1 cm (15 inches) in diameter, 22.86 m (75 ft) tall, and with more than 40% bark remaining were used significantly more than others by cavity-nesters (including flickers, hairy woodpeckers, and northern three-toed woodpeckers) in a ponderosa pine forest in Arizona (Scott 1978). Suggestions for cavity-nesters as a group in a mixed-conifer Washington forest include: snags should be retained in stands of all age classes, with a minimum of 6 hard and 3 soft snags per ha (2.5 acres) (although in areas where snags are much reduced, even more snags should be retained), snags should be mostly larger than 50 cm (19.69 inches), with some larger than 23 cm (9.06 inches) and some larger than 75 cm (29.53 inches) in all stands, and snags should be a mix of species (Zarnowitz 1985). A Texas study recommend retaining or creating more than 5 snags per ha (2.5 acres) , paying special attention to hardwood snags (Dickson and others 1983). Mannan and others (1980) recommend retaining and/or creating snags in a range of decay and sizes, and for Douglas fir, snags should be at least 60 cm (23.62 inches) dbh and at least 15 m (49.21 ft) tall.

Table 16. Snag Retention Recommendations in the Literature

Minimum DBH, cm	# of hard snags per ha	Height, m	Forest Type	Location of Study	Citation
30.5	3.39	---	Ponderosa pine	Oregon	(Thomas and others 1979)[a]
50.8	10 to 20	---	Mixed conifer	Oregon	(Bate 1995)
48.3	5 to 7.5	---	Ponderosa pine	Arizona	(Scott and Oldemeyer 1983a)
Average nest tree diameter for species	---	---	---	California	(Raphael and White 1984)
50	---	---	Douglas fir	Oregon	(Cline and others 1980)
38.1	---	22.86	Ponderosa pine	Arizona	(Scott 1978)
Include mostly >50, but some >23 and some >75	6	---	Mixed conifer	Washington	(Zarnowitz 1985)
---	5	---	Hardwood	Texas	(Dickson and others 1983)
50.8	---	9.14	Douglas fir/ western larch	Montana	(McClelland 1977)
60	---	15	Douglas fir	Oregon	(Mannan and others 1980)
53[b]	---	---	Ponderosa pine/ Douglas fir	Idaho	(Saab and Dudley 1998)
23 (with some >53)[b]	59 (Lewis's)[b] 104 (Black-back)[b]	---	Mixed forest	Columbia Basin	(Wisdom and others 2000)

[a]Thomas and others' suggestions are disputed since they were not based on actual habitat use data (Johnson and O'Neill 2001; Mellen 2002).
[b]The recommendations from these sources are for burned forest, all other recommendations are for unburned forest.

Managing for woodpeckers as a group will involve more than one size range of snags. Raphael and White (1984) found that cavity-nesting bird diversity (including black-backed, Lewis's, and hairy woodpeckers and northern flickers, among other birds) was strongly related related to the density of large snags (r=0.86) as well as the diversity of snag sizes (r=0.89). Different size snags were utilized for foraging and nesting, but large trees were especially important.

Conner (1979b) cautions that basing snag recommendations on minimum diameters may not be sufficient for maintaining woodpeckers. Smaller diameter trees may result in smaller nests or nests lower on the tree which may be more susceptible to predation (Conner 1979b). Conner (1979b) also notes that smaller trees may snap easier. He suggests using the average size of nest trees or one standard deviation below the average.

A few studies have addressed snag retention guidelines for burned forests. Saab and Dudley (1998) recommend snags larger than 53 cm (20 inches) be retained because larger snags will lengthen the time a burn area is useful for woodpeckers. Wisdom and others (2000) suggested retaining a minimum of 59 snags/ha (24/acre) at least 23 cm (9 inches) dbh for Lewis's woodpeckers. Of the 59 snags, at least 15 per ha (6 per acre) should be larger than 53 cm (21 inches) dbh. Their recommendations for black-backed woodpeckers are to retain 104 snags/ha (42/acre) at least 23 cm (9 inches) dbh.

Swallow and others (1986) found that birds in New York used snags more as dbh increased, bark decreased, and snag height decreased. The authors of the study relate the latter two variables are related to snag age or amount of decay. However, they also found the structure of the forest to be important, especially the amount (basal area) and species diversity (i.e. diversity of foraging substrates) of the snags present. The authors suggest that where snags are abundant, factors not related to snags themselves (such as forest structure) may be more important. This study involved forests of maple, ash, and elm, which is a much different species composition than the Black Hills National Forest. In addition, the study does not discuss individual bird species, so these conclusions may be different for some woodpeckers.

Snag retention increases nesting habitat, but snags have a limited lifespan so without a large number of snags, eventually the habitat disappears. Marcot (1983) recommends leaving extra snags because some will be lost and taking care not to disturb or burn snags when working in stands. Retained snags should include all stages of decay to insure enough present and future nest sites for woodpeckers (Horton and Mannan 1988). How long snags last varies with type of forest and geographical area. In an Arizona ponderosa pine forest, 34% of snags were lost in the winter in a harvested stand compared to only 10% lost in a control area (Scott 1978). After a burn in a mixed-conifer forest in California, snags had decreased 90% over 25 years, but on unburned plot snags increased (Raphael and others 1987). Raphael and White (1984) found 81% of snags created by a burn in California fell within 15 years, with white fir lasting longer than Jeffrey pine. Lentile and others (2000) found 60% of the snags in the Black Hills National Forest were gone within 10 years, although strangely they found no relationship between decay class and time since tree death. A Texas study which created snags and followed them for four years found that smaller snags did not last as long as larger snags and that oak snags lasted longer than other hardwood snags (Dickson and others 1983). A study of snags in Douglas fir forests in western Oregon (Cline and others 1980) provides some other important data on snags. Larger snags decayed slower and lasted longer. Also, the size of snags was correlated with stand age, with snag density highest at 25 to 60 years of age.

In order to reduce their loss, large snags should be retained during treatments, fuelwood restrictions should be created and enforced where snags are in low abundance, and roads should be closed to minimize the cutting of snags along roads (Wisdom and others 2000). Fuelwood restrictions are also recommended by other authors (McClelland 1977; Conner 1978). In the Black Hills where there are an abundance of roads, making access to snags easy, restrictions may be useful. In fact, current restrictions on firewood cutting are in effect (USDA Forest Service 2001a).

Creating snags is also a viable alternative in areas with few snags. Management for the production of snags is necessary since large snags are not retained and produced in a typical harvest rotation (Ohmann and others 1994). Other authors also support snag creation (Conner 1978; Mannan and others 1980). Snags can be created by girdling trees or innoculating them with fungus (Conner 1978). Scott and others (1980) suggest using nest boxes in areas without snags, but they caution that natural snags are preferable. Nest boxes have been shown to increase numbers of certain species of birds in some areas (Brush 1983).

Another option which could be incorporated into a snag program was described in an experiment by Bergvinson and Borden (1991). Glyphosate (a herbicide) was applied to lodgepole pines in British Columbia which increased the amount of foraging that downy woodpeckers did on those particular trees, decreased resin content which woodpeckers do not like, increased pine beetles in higher reaches of the trees, increased the ease of bark removal by weakening the bark, and increased the size of pine beetle larvae. They did not follow the woodpeckers to determine if the chemical had any lingering effect on the birds. Due to the unknown consequences, this method is not recommended by the author of this assessment.

When snags were left using published guidelines, cut areas did not differ significantly from unlogged areas in abundance of hairy woodpeckers and northern flickers (Tobalske and others 1991). The authors caution that their sample sizes were very small and the power of their statistical tests was very low, meaning that it would have been difficult to detect differences between the treatments. In addition, they point out that woodpeckers may respond to the presence of last year's nest tree in setting up a breeding territory, and that might actually result in birds breeding in poor habitat. Monitoring reproductive success would be necessary to see if this was the case.

Foresters need to manage for more than a certain number of snags per acre (McClelland and others 1979). One study conducted in southcentral Wyoming illustrates that adequate snag policies are more complicated than just a single number. Loose (1993) found no relationship between the number of snags retained and the amount of woodpecker foraging. In addition, three-toed woodpeckers still foraged in clear-cuts, even those without snag-retention policies. However, snags were rarely used for nesting. This result was probably due to the small dbh of the available snags and the fact that many of the snags originally available in clear-cuts fell due to exposure. (Clumps of snags could help reduce such exposure.)

Also, the presence of widely dispersed snags do not provide multiple nest or roost sites options and may not provide enough prey resources. Raphael and White (1984) recommend retaining snags in clumps. The presence of multiple nest sites is especially important if starlings are competing with woodpeckers in the Black Hills.

Allowing for the recruitment of future snags is also important. Mannan and others (1980) recommend lengthening rotation periods to >100 years to maintain some old timber. Conner (1978) also recommends cutting rotations of 100 years minimum. Other recommendations from a study of Douglas fir forests in western Oregon, call for cutting rotations of more than 200 years for some stands interspersed with younger stands (Cline and others 1980).

Some adjustment of snag retention policies is possible on the Black Hills. Current snag retention policies for ponderosa pine are very similar to other recommendations. However, the small diameter of trees available in many stands may mean snag retention needs to be offset by other measures (i.e. more snags retained in some areas to compensate, snag creation, longer stand rotation, etc.). The cost from a timber perspective of adopting any of these more conservative snag recommendations is most likely less than the cost of establishing extensive woodpecker management areas (see below).

Logging Mitigation Measures

Hagar (1999) suggests that undisturbed buffers of at least 40 m (131.23 ft) each side of the water adjacent to logged areas may serve to mitigate effects of logging for some species of birds like northern flickers. This may be possible in the Black Hills, however, many logged areas are not near substantial riparian zones.

Conner and others (1975) recommends retaining dead snags with heartrot during any treatments. Specifically, snags should be left when thinning stands and new snags should be intentionally created (Ohmann and others 1994). In an Arizona ponderosa pine old-growth forest, cavity-nesters as a group declined 52% after harvest in plots without snags, but increased on both unharvested areas and harvested areas where snags remained (Scott 1979).

Firewood Policies

Scott and others (1980) document firewood cutting is removing huge numbers of snags from some areas. Firewood restrictions should be created and enforced where snags are in low abundance, and roads should be closed to minimize the cutting of snags along roads (Wisdom and others 2000). Firewood restrictions are also recommended by Conner (1978) and McClelland (1977). Firewood cutting should be restricted to those trees less than 38.1 cm (15 inches) dbh and some roads should be closed to protect snags if firewood cutting is too severe (McClelland and others 1979). In the Black Hills where there are an abundance of roads, which makes access to snags easy, restrictions may be useful. In fact, current restrictions on firewood cutting are in effect (USDA Forest Service 2001a).

Fire Management

Prescribed Fires

Shackelford and Conner (1997) recommend prescribed burns. Prescribed burns will create more snags and dead branches for the birds to use. Woodpeckers closely associated with burns (i.e. black-backed woodpeckers and three-toed woodpeckers) would benefit most from high-intensity prescribed burns. Prescribed burns of high intensity should be planned to protect large snags, especially if there are not many larger snags in the landscape (Horton and Mannan 1988). Lower-intensity fires may have a negative effect on some of these birds as is supported in a study that found flickers only in high-intensity portions of burns and not lower-intensity areas (Taylor and Barmore 1980). Fires should be scheduled so they do not decrease the available ground cover woodpeckers (especially downys) use for forage during winter. Fires have become less frequent in the Black Hills than they were historically (Progulske 1974; Brown and Sieg 1996), so prescribed fires may help these birds. No studies have been done in the Black Hills that can evaluate the effect of prescribed fires on local woodpeckers.

Fire Suppression

Woodpecker species that favor burned forest are likely negatively affected by fire suppression. However, no studies are available in the Black Hills that evaluate various fire regimes. A range of fire intensities is needed to accommodate all woodpecker species (Saab and Dudley 1998). By allowing stand-replacement fires in pre-determined areas, the forest may be able to manage for a mosaic of fire conditions over large landscapes that will provide habitat for all woodpecker species occurring in the area (Wisdom and others 2000).

Post-Burn Management

Post-burn management should be a high priority in the Black Hills National Forest following the large fires of the 2000 and 2001 Fire Season. These burned areas that are unlogged will likely provide essential habitat for fire-dependent species, such as black-backed (Dixon and Saab 2000) and three-toed woodpeckers (Leonard 2001), as well as provide opportunities to study and understand the effects of fires and post-burn management on woodpeckers in the Black Hills.

Fires do indeed contribute to insect outbreaks. In a burned area of forest in southern Idaho that was salvage-logged, 70% of trees were attacked by bark beetles, but the intensity of attacks on a particular tree were low, and only 61% of the attacks were successful (i.e. resulted in a dead tree) (Furniss 1965). A study of insect infestation after a fire in Yellowstone, found lower overall infection rates, but much higher levels of success (more than 80% of some tree types were girdled) (Amman and Ryan 1991). Amman and others (1997) suggest that the timing of the fires influences the initial infestation since insects that are not currently emerging are not available to infest other trees immediately.

Salvage Logging

In order to reduce insect infestations, Furniss (1965) suggests salvage cutting after fires should include fire-killed trees, larger fire-injured trees, trees with 60% of crown burned, and trees defoliated more than 20%. However, these recommendations are in direct conflict with the needs of most of the woodpeckers discussed in this document. Several mitigating measures are discussed here.

Delaying salvage logging is recommended by several authors. Harris (1982) recommends not logging until late summer when the birds have already completed nesting. Murphy and Lehnhausen (1998) also suggest delaying salvage logging so woodpeckers have a chance to use some of the snags. Hoffman (1997) goes so far as to suggest that removal of timber should be delayed for three years after fires for the benefit of woodpeckers. She states that most loss in timber value is in the first year, then it gradually decreases, so relative economic costs decreases as the delay increases. Hoffman (1997) also suggests that guidelines for the market value of beetle and fire killed trees (for wood products) should be devised so economic decisions could be made.

Conservative salvage cutting could have less of a negative impact on woodpecker populations than complete salvage cutting. Harris (1982) recommendations for post-burn management in Montana include: leaving all western larch (larch was preferred by three-toed woodpeckers in Montana, but is not present in the Black Hills), leaving many trees at least 34 cm (13 inches) dbh, not cutting evenly throughout the burn but leaving patches of trees, and not logging until late summer. Other recommendations include leaving patches of unlogged areas, not just individual trees (Hitchcox 1996). Other options include salvage cutting in only part of the burn, or not taking trees in size classes preferred by the birds (Hutto 1995). In large burned forests of western Idaho, Saab and others (in press) suggest managing for a range of habitat conditions characteristic of black-backed and Lewis's woodpeckers that will likely accommodate other members of the cavity-nesting bird community. Unlogged landscapes with large, dense stands of Douglas-fir in close proximity were typical of black-backed woodpeckers, whereas partially logged landscapes of ponderosa pine were favored by Lewis's woodpeckers.

Woodpecker Management Areas

Goggans and others (1989) proposed setting aside large amounts of older forest for conserving woodpeckers, primarily black-backed and three-toed woodpeckers. Setterington and others (2000) also recommend setting aside large amounts of old forest (>80 years old). Guidelines for the amount of habitat needed suggest 214 ha (528 acres) of mature lodgepole pine or mixed conifers over 1372 m [4500 ft] elevation per pair of three-toed woodpeckers and 387 ha (956 acres) of lodgepole pine or mixed conifers (including some habitat below 1371 m [4500 ft] elevation) per pair for black-backed woodpeckers (Goggans and others 1989). Non-harvest areas should be wilderness to benefit species needing mature forest (Conner 1978). McClelland (1979) suggests that in larch/fir forests, woodpeckers need 40.5 ha (100 acres) of old-growth per 405 ha (1000 acres) of forest, which needs to be spread throughout the forest, but not too far away from each other, and connected with corridors. He further recommends the areas should be square, not linear, unless they are along streams. The old-growth could be in roadless areas, campgrounds, scenic areas, etc. (McClelland and others 1979). The size required for a ponderosa pine area in the Black Hills is unknown.

Downy woodpeckers, hairy woodpeckers, and northern flickers would probably also benefit from such areas if they result in large, older stands with larger diameter trees and more snags being available. However, some species (i.e. downys) do not seem to be as dependent on large tracts of forest (based on Villard and others 1999), so this option is probably not essential to maintaining healthy downy populations. In addition, if downy and hairy woodpeckers are utilizing aspen stands more than other woodpeckers, a management area set up for black-backs may not encompass some of the downy woodpeckers' preferred areas. Thus, a range of conditions is needed to meet the habitat requirements of the woodpecker assemblage.

Setting aside woodpecker management areas is the most conservative (from a woodpecker standpoint) and most costly option. However, if woodpecker conservation becomes a priority for the Black Hills National Forest, it may be the best option.

Models

Very few models are available that evaluate habitat use or the effects of habitat changes on woodpeckers. The available models are discussed here.

Habitat Suitability Index Models (HSI) exist for hairy woodpeckers (Sousa 1987), downy woodpeckers (Schroeder 1983), and Lewis's woodpeckers (Sousa 1983). These models use field data from various studies to develop suitable habitat parameters for a species. Optimal habitat is defined by size, canopy cover, snag size, etc. However, these models are simplistic and only evaluate local vegetation conditions without consideration for macrohabitat or landscape influences on habitat selection. It is important to remember that these models should be viewed as a hypothesis of how the species interacts with its habitat (Van Horne and Wiens 1991). No HIS models are currently available for three-toed woodpeckers, black-backed woodpeckers, red-headed woodpeckers, or northern flickers. Development of these models should be investigated.

HABCAP (HABitat CAPability) is the most detailed model available to evaluate potential habitat for a range of species in the Black Hills. HABCAP analysis of Lewis's woodpeckers was discussed in the Final Environmental Impact Statement (USDA Forest Service 1996). The analysis for Lewis's woodpeckers used 15 acres as territory size to determine the amount of acceptable habitat (acceptable habitat fell into ponderosa pine stages 4A, 4B and 5 or mature oak stands) on the Black Hills National Forest. Under the original alternatives in the Forest Plan, HABCAP predicts some decline in the overall amount of suitable habitat for Lewis's woodpeckers (USDA Forest Service 1996). One assumption of this analysis is that there are sufficient arrangements (clumps) of snags of useable diameter in those types of habitat.

The HABCAP three-toed woodpecker analysis used 213 ha (525 acres) as the minimum patch size to determine the amount of acceptable habitat (acceptable habitat included mature spruce stages 4C and 5 along with feeding areas of pine 3A, 3B, 4A, 4B, and 5). Under the original alternatives HABCAP predicts a constant amount of available habitat (USDA Forest Service 1996). However, this assumes that there are snags, preferably clumps, of useable diameter in all of those patches which may not be the case.

The HABCAP analysis of black-backed woodpeckers used 385 ha (950 acres) as territory size to determine the amount of acceptable habitat (acceptable habitat fell into stages 4A, 4B, 4C, and 5) on the Black Hills National Forest. Under the original Alternative G, over 295,431 ha (730,000 acres) of high quality habitat would be available for black-backed woodpeckers after 10 years (USDA Forest Service 1996). The BHNF has been operating for 4 years under the Revised Forest Plan (USDA Forest Service 1997), so part of that time period has expired. One assumption of this analysis is that there are sufficient arrangements (clumps) of snags of useable diameter in those types of habitat.

Another model was developed to see how downy and hairy woodpeckers responded to different habitat arrangements (Penhollow and Stauffer 2000). The GIS/Fragstats model showed downys were significantly related to the amount of forest over 70 years old, and the population declined as patch diversity increased (i.e. they are habitat specialists preferring a homogeneous habitat). The same model showed hairy woodpeckers avoid edge areas.

Villard and others (1999) was able to relate presence of hairy woodpeckers with cover and landscape variables (i.e. amount of edge) in a landscape level model.

Another model is available which is applicable to management of burn areas (Saab and others in press). This model, based on satellite images of pre-burn classifications in Idaho, showed the best predictors of post-burn black-backed nests on landscape level are: “1) proximity of stands characterized by burned, ponderosa pine/high crown closure, 2) proximity and 3) area of burned Douglas fir/high crown closure stands, and 4) area of burned, Douglas fir/low crown closure stands” with positive relationship to numbers 2 & 3, negative relationship to 1 & 4 (Saab and others in press). Lewis's woodpecker nests were positively related to “proximity of burned stands characterized by ponderosa pine moderate crown closure” in unlogged areas. In logged areas, nests were significantly related to “1) nearest neighbor of burned, ponderosa pine high crown closure stands [negative relationship with number of nests], 2) area of burned, ponderosa pine high crown closure stands [positive relationship], 3) area of burned, ponderosa pine/Douglas fir high crown closure [negative relationship], 4) area of burned, ponderosa pine/Douglas fir moderate crown closure “ [positive relationship]. This model is limited in its applicability to forests where detailed satellite images are available before fires. Whether the same relationships are applicable in ponderosa pine forest are unknown.

Another interesting model was developed from number of snags (at least 28 cm [11.02 inches] dbh) found in different aged stands on non-federal forest land in Oregon and Washington (Ohmann and others 1994). The model used the maximum potential population (MPP) needs of woodpecker species (calculated from snag requirements) to determine the habitat capability of stands of various types. The results for conifer/hardwood stands showed that only hairy woodpeckers' and northern flickers' snag needs were met 100% of the time, and then only in the large mature and old growth stands (these averaged 479 snags per 40 ha [100 acres]). In ponderosa pine stands, no species needs were met 100% of the time in any of the age classes--even in mature forest with 100 snags per 40 ha (100 acres). In mixed conifer stands mean snag density ranged from 181 snags/40 ha (100 acres) in sapling stands to 401 snags per 40 ha (100 acres) in mature/old growth stands. In these conifer stands, all conditions supported 100% MPP for flickers and black-backed woodpeckers were supported in all but the youngest stands. The model's assumptions include the following: 1) snags larger than the minimum will be used, but not snags smaller; 2) soft snags are not equal to hard snags, 3) a snag may be reused by the same or different species in subsequent season, and 4) snag species, height, and spatial arrangement were ignored in the model. The authors point out that the latter assumption can lead to over-estimates of use and habitat capability. Therefore the results are probably conservative estimates of what stands are capable of supporting woodpeckers.

Using breeding bird annual survey data from France, Tobalske and Tobalske (1999) developed a model to predict where European woodpeckers might occur. They combined survey data and habitat variables with GIS and used logistic regression to create predictive models. The prediction ability of the models varied among species, from 14 to 39% better than chance. The authors point out several drawbacks to their models. First, the survey data was in grid-format, which did not necessarily conform to the habitat data, so it is possible that a woodpecker might be recorded in a cell with mostly incorrect habitat due to the grid lines. The model was also not tested on independent data. Additionally, the habitat variables were fairly course, although the habitat variables were able to distinguish among species. These types of models are relatively cheap to develop assuming census data are available and can potentially be quite useful to test management strategies, indicate the amount of fragmentation, or even to develop improved surveys by focusing on cells where rare species were not observed even though they contain suitable habitat.

Survey And Monitoring Approaches

For the purpose of this discussion, a survey involves a study to determine the presence, abundance, and/or density of birds or nests during a particular time period (i.e. one breeding season), whereas monitoring refers to repeated surveys to obtain trend data. While surveys may be as simple as a single sample, successful monitoring involves repeated observations using the same methods. Since woodpecker populations seem to fluctuate with food and habitat availability (Yunick 1985; Villard and Schieck 1997), it is difficult to study trends without long-term data. Establishing a standardized sampling method to repeat on a regular schedule is critical for collecting trend data. For any method selected, a statistician should be consulted during the survey design stage to ensure the monitoring strategy is repeatable and statistically sound. The following section discusses several methods that have been used, some advantages and disadvantages of each, and cost concerns.

Different survey and monitoring approaches are appropriate in different situations, depending on the specific type of information that is desired. British Columbia Ministry of Forests (1997) outlines several methods useful for surveying woodpeckers and the situations where they are best applied. When the goal is to detect the presence or determine the relative abundance of woodpeckers in different areas, they suggest call playback or sign surveys. To determine absolute abundance of woodpeckers in an area, spot-mapping is more appropriate. Each of these are discussed in more detail below. Other methods have been used to collect detailed information for specific purposes, such as radiotagging to obtain foraging information (Goggans and others 1989) and banding individuals to study whether woodpeckers return to the same nesting area in following years (Moore 1995).

For all survey methods, observers should survey from 30 minutes past sunrise to noon, only on days with the temperatures over 7°C (for breeding season surveys) and winds less than 12 km (7.5 miles) per hour (British Columbia Ministry of Forests 1997). The response of the woodpeckers varied with the time of day starting at 30 minutes after sunrise, peaking at 1 to 2 hours after sunrise, and responding again in the evening (Goggans and others 1989).

Call playback surveys involve walking or driving along a set route playing a call or drumming (either a recording of drumming or actually imitating drumming by beating sticks together) at 100 to 600 m (328 to 1,969 ft) intervals and recording any woodpeckers that respond (British Columbia Ministry of Forests 1997). Setterington and others (2000) recommend transects at least 1 km (0.62 miles) long for effective surveying. Goggans and others (1989) successfully used recordings of drumming woodpeckers along transects with playbacks at 0.16km (0.1 mile) intervals.

The British Columbia Ministry of Forests (1997) caution that the time of year may affect what species respond to recordings. Goggans and others (1989) recommend surveying for black-backed woodpeckers between May 1 to June 1 at 1,311 to 1,341 m (4,300 to 4,400 ft) in elevation and in mid-May for habitat at 1,615 m (5,300 ft).

The second general type of survey is the sign survey. In this type of survey, visual sightings of nest cavities or drilling activity are recorded as the surveyor walks along a transect (British Columbia Ministry of Forests 1997). Spot mapping, a third type of survey, involves mapping bird territories on specific plots (British Columbia Ministry of Forests 1997).

Abundance can also be estimated from statistical analyses of transect or circular plot surveys (British Columbia Ministry of Forests 1997). Circular plots were used by Shackelford and Conner (1997). At least in some cases, variable circular plots are more precise for density estimates than variable width transects (Bate 1995). An ongoing study in the Black Hills to determine abundance of three-toed and black-backed woodpeckers is using call playbacks along line transects (Mohren and Anderson 2000). Sometimes call playbacks are used to increase the likelihood of observing woodpeckers. In one Texas study, the surveyors found woodpecker detections significantly increased when he imitated a barred owl call (Shackelford and Conner 1997). The design of any of these types of surveys must adhere to rigorous experimental design principles if observers wish to extrapolate across areas and obtain a measure of overall abundance or density (for more information on these distance-based analyses see Burnham and others 1980).

Setterington and others (2000) recommend nest searches and landscape studies over long time periods (years), but recognizes these types of studies are very cost intensive for widely spaced, secretive species like woodpeckers. Any of these methods can involve many hours to find enough individuals for a reliable count, which is of course expensive. Call playback surveys may be the least expensive method, especially if transects are motorized. However, road surveys may not detect some species of woodpeckers accurately if they avoid edges as suggested by (Penhollow and Stauffer 2000). For example, Breeding Bird Survey routes in the Black Hills, which usually follow roadways, rarely detect woodpeckers (Sauer and others 1999; Patterson 2000).

Spot mapping is the most intensive method, and therefore the most expensive. Only a few survey areas could be covered with a minimal number of hours. Extrapolating from a small number of plots to a large area (i.e. the entire Black Hills) that includes different habitat types than were sampled, would be extremely suspect.

Sign/nest surveys and transect/point count methods involve similar time commitments. With either method, relative abundance can be determined. Transects/point count methods may provide a higher sample size if combined with recordings. For any method selected, a statistician should be consulted during the survey design stage to ensure adequate sample size and distribution of survey points among the habitat types.

Ammand and Baldwin (1960) compared several methods of censusing woodpeckers in Colorado forests including: fixed plots (stopping at intervals along transects for ten seconds recording all woodpeckers within a fixed distance), one-acre method (subsampling of a fixed plot in one-acre units), quarter acre plots (sampling several plots for five minutes on each plot), strip sampling (traveling a transect or a road and counting all observed woodpeckers and their distances from the line), and several variable strip methods (similar to strip sampling, but recording woodpeckers at only within a specified distance; widths of transects are determined by observation or some other calculation). The study found that the first three methods did not differ significantly. The authors conclude that the "best" method is a variable strip method using the greatest distance of each species for half the width of the transect. However, the study was not able to determine what method is the most accurate.

Monitoring for quality and quantity of potential habitat is possible, if an accurate model is available relating woodpecker presence and/or abundance to particular habitat types. However, currently abundance data for these woodpecker species in the Black Hills National Forest is not sufficient for these models to be used instead of surveys. For a discussion of modeling, see previous section heading "Models".

The British Columbia Ministry of Forests (1997) states "…there is not enough information on the logistics of surveying particular woodpecker species to recommend species specific methods." However, the particular woodpecker's habits and/or habitats make some methods more appropriate. For example, point transects taken in a range of habitats was an effective way to monitor flickers, hairy woodpeckers, and perhaps Lewis's woodpeckers, but more intensive methods may be needed for black-backed, three-toed, downy, and red-headed woodpeckers in the Black Hills (Panjabi 2001b).

ADDITIONAL INFORMATION NEEDS

Several pieces of information are essential for effective management of northern flicker populations on the Black Hills National Forest. The importance and feasibility of these research needs are explored here. For a cost analysis, see Table 17.

Table 17. Cost-Benefit Analysis of Information Needs

Information Need	Relative Priority for Forest Management[a]	Relative Cost[b]	Notes
Population size in the Black Hills	High	Low to High	Cost varies depending on surveying method chosen and whether an actual population estimate is desired or just an index
Use of Burns in Black Hills	High	High	Including nest success analysis and movement among burn areas
Habitat Use in the Black Hills	High	Moderate	Can be incorporated into monitoring program or determination of home range study
Why are some species declining?	Low	High	
Determination of Home Range	Moderate	Moderate	
Basic Ecology (population density, natal dispersal, nest success, survival rates)	Moderate	High	

[a]Priority cateogries are defined as follows: High (absolutely essential for scientifically sound management of woodpeckers in the Black Hills), Moderate (would improve management, but not absolutely essential for immediate management), Low (Not essential for immediate management needs).
[b]Relative Costs categories are defined as follows: High (over $50,000), Moderate ($10,000 to $50,000), and Low (less than $10,000).

First, information on population sizes of all the woodpecker species in the Black Hills National Forest is needed. A monitoring program is essential to determine population trends. Several monitoring options are discussed in the Survey/Monitoring section.

If sufficient populations exist, a better understanding of how woodpeckers (especially black-backed and three-toed woodpeckers) are using burn areas in the Black Hills would be very valuable information. Do three-toed woodpeckers follow the same patterns of burn use as black-backed woodpeckers? Are the birds utilizing only high intensity burn areas and not low-intensity areas or edges of burns? Are these burns serving as source areas to supply birds to non-burn habitats? How long do these burn areas remain useful to the birds? Some of these questions could be answered in conjunction with a long-range monitoring program as long as survey points are set up in appropriate locations (habitat type replicates) to allow statistical testing. Nest-success and movement among habitats would need to be determined in order to fully answer the source/sink question.

An investigation of what types of habitat are being used by the other species in the Black Hills is also essential. Do they utilize burn areas as much as black-backed and three-toed woodpeckers?

Are red-headed woodpeckers using pure ponderosa pine stands or only stands with oaks? Is red-headed woodpeckers' choice of habitat related to the amount of mast available? How does this change over time? Are Lewis's woodpeckers using riparian areas or ponderosa pine stands? Without this information for the Black Hills, it is difficult to predict the best management options. Some of these questions also could be answered in conjunction with a long-range monitoring program as long as survey points are set up in appropriate locations (habitat type replicates) to allow statistical testing.

If certain species are declining, information is needed on what is causing the decline. Are starlings actually resulting in lost nest success for any woodpecker species? A study to investigate this is very important for the Black Hills and other forests, but it may be expensive because evaluations of nest success require large amounts of person-hours.

Determination of home range sizes in the Black Hills habitat would be useful information, especially for development and further use of HABCAP models. No studies could be found with any sort of home range estimate for this habitat. However, studies of home range may involve intensive study of radio tagged birds, which can be quite expensive.

Many areas of the basic ecology of these woodpeckers lack information. Studies on a range of topics would be very helpful for better understanding this species. Information on population density, natal dispersal, nest success, survival rates would also be useful (Goggans 1989b). These questions are of lesser importance than the above for the immediate purposes of forest management and may not be cost-effective to pursue at this time. For example, information on natal dispersal or adult survival requires intensive study of many marked individuals over many years.

COMMON AND SCIENTIFIC NAMES OF SPECIES MENTIONED IN THIS REPORT

Plants

Note: Those plants marked with an * are known to be found in the Black Hills area according to Larson and Johnson (1999), although not necessarily on the Black Hills National Forest.

Common Name	Scientific Name
Black alder	*Alnus sp.*
Almond	*Prunus amygdalus*
Mountain ash	*Sorbus americana, Sorbus scopulina*
Aspen*	*Populus tremuloides*
White ash	*Fraxinus americana*
Barberry*	*Berberis sp.*
Bayberry	*Myrica carolinensis*
American beech	*Fagus grandifolia*
Beechnut	*Fagus americanus*
Paper birch*	*Betula papyrifera*
Blackberry*	*Rhubus sp.*
Green brier	*Smilax sp.*
Red cedar	*Juniperus virginiana*
Wild black cherry	*Prunus serotina*
Blueberry	*Vaccinium sp.*
Boxelder*	*Acer negundo*
Cacti*	Cactaceae
Chokeberry	*Aronia sp.*
Chokecherry*	*Prunus virginiana*
Clover*	*Trifolium sp.*
Bur clover	*Medicago denticulatum*
Cottonwood*	*Populus deltoides*
Dewberry	*Rubus flagellaris*
Dogwood	*Cornus sp.*
Elder	*Sambucus glauca*
Elderberry	*Sambucus canadensis*
Elm*	*Ulmus sp.*
Filaree	*Erodium cicutarium*
Balsam fir	*Abies balsamea*
Douglas fir	*Pseudotsuga menziesii*
Noble fir (aka red fir, white fir)	*Abies procera*
Silver fir	*Abies alba*
Subalpine fir	*Abies lasiocarpa*
Gooseberry	*Ribes menziesi*
Grasses*	Poaceae
Foxtail grass	*Ixophorus sp.*
Frost grape	*Vitis cordifolia*
Wild grape	*Vitis sp.*

Gum	*Nyssa sp.*
Sour gum	*Nyssa*
Sweet gum	*Liquidambar sp.*
Hackberry*	*Celtis occidentalis*
Hawthorn*	*Crataegus sp.*
Hazelnut*	*Corylus sp.*
Mountain hemlock	*Tsuga mertensiana*
Shagbark hickory	*Carya ovata*
Hornbeam	*Carpinus caroliniana*
Huckleberry*	*Gaylussacia sp.*
Juniper*	*Juniperus sp.*
Knotweed*	*Polygonum sp.*
Western larch (aka tamarack)	*Larix decidua*
Magnolia	*Magnolia foetida*
Red maple	*Acer rubrum*
Milkweed*	*Asclepias incarnata*
Mulberry	*Mus sp.*
Mullein*	*Verbascum thapsus*
Black mustard	*Brassica nigra*
Oak	*Quercus sp.*
Peach	*Prunus sp.*
Pepperberry	*Schinus molle*
Pigweed	*Amaranthis sp.*
Jack pine	*Pinus banksiana*
Jeffrey pine	*Pinus jeffreyi*
Juneberry (aka serviceberry)*	*Amelanchier sp.*
Loblolly pine	*Pinus taeda*
Lodgepole pine*	*Pinus contorta*
Longleaf pine	*Pinus palustris*
Ponderosa pine*	*Pinus ponderosa*
Red pine	*Pinus resinosa*
Shortleaf pine	*Pinus echinata*
Poison ivy*	*Rhus radicans, Rhus aromatica*
Poison oak	*Rhus diversiloba*
Ragweed*	*Ambrosia sp.*
Poison sumac	*Rhus vernix*
Pokeberry	*Phytolacca decandra*
Wild plum*	*Prunus americana*
Purslane*	*Portulaca sp.*
Wild raspberry*	*Rubus sp.*
Salmonberry (aka thimbleberry)*	*Rubus parviflorus*
Sassafras	*Sassafras sassafras*
Serviceberry	*Amelanchier canadensis*
Smartweed*	*Polygonum sp.*
Sorrel*	*Rumex sp.*
Spiceberry	*Benzoin benzoin*
Spicebush	*Lindera benzoin*
Black spruce	*Picea mariana*
Engelmann spruce	*Picea engelmannii*

White spruce*	*Picea glauca*
Wild strawberry*	*Fragaria sp.*
Sumac*	*Rhus sp.*
Smooth sumac*	*Rhus glabra*
Sunflower*	*Helianthus sp.*
American sycamore	*Platanus occidentalis*
Bur thistle	*Centaurea melitensis*
Star thistle	*Centaurea calcitrapa*
Vervain*	*Verbena sp.*
Viburnum*	*Viburnum sp.*
Virginia creeper*	*Parthenocissus vitacea*
Willow*	*Salix sp.*
Woodbine*	*Parthenocissus quinquefolia*

Animals - Birds

Common Name	Scientific Name
Black-backed woodpecker	*Picoides arcticus*
Northern three-toed woodpecker	*Picoides tridactylus*
Lewis's woodpecker	*Melanerpes lewis*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
Northern flicker	*Colaptes auratus*
Nuttall's woodpecker	*Picoides nuttallii*
White-headed woodpecker	*Picoides albolarvatus*
Acorn woodpecker	*Melanerpes formicivorus*
Red-bellied woodpecker	*Melanerpes carolinus*
Sapsuckers	*Sphyrapicus sp.*
Golden eagle	*Aquila chrysaetos*
Cooper's hawk	*Accipiter cooperii*
Broad-winged hawk	*Buteo platypterus*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Sharp-shinned hawk	*Accipiter striatus*
Northern goshawk	*Accipiter gentiles*
Northern harrier	*Circus cyanus*
American kestrel	*Falco sparverius*
Peregrine falcon	*Falco peregrinus*
Eastern screetch owl	*Otus asio*
Great horned owl	*Bubo virginianus*
Mountain bluebird	*Sialia currucoides*
Western bluebird	*Sialia mexicana*
Tree swallow	*Tachycineta bicolor*
Plain titmouse	*Parus inornatus*
European starling	*Stunus vulgaris*
Blue jay	*Cyanocitta cristata*

Steller's jay	*Cyanocitta stelleri*
American crow	*Corvus brachyrhynchos*
Fish crow	*Corvus ossifragus*
Chickadee	*Parus sp.*
Nuthatch	*Sitta sp.*
Cowbird	*Molothrus ater*
Common raven	*Corvus corax*
Baltimore oriole	*Icterus galbula*
Eastern phoebe	*Sayornis phoebe*
Eastern kingbird	*Tyrannus tyrannus*
Great-crested flycatcher	*Myiarchus crinitus*
Ruby-crowned kinglet	*Regulus calendula*
Golden-crowned kinglet	*Regulus satrapa*
Brown creeper	*Certhia americana*

Animals - Other Vertebrates

Common Name	Scientific Name
Flying squirrel	*Glaucomys sp.*, *Pteromys volucella*
Tree squirrel	*Tamiasciurus sp.*
Red squirrel	*Tamiasciurus hudsonicus*
Raccoon	*Procyon lotor*
Red fox	*Vulpes fulva*
Weasel	*Mustela vulgaris*
Opossum	*Didelphis virginiana*
Black rat snake	*Elaphe obsoleta obsoleta*
Bull snake	*Pituophis melanoleucus sayi*

Animals - Invertebrates

Common Name	Scientific Name
Ants	Order Hymenoptera, Family Formicidae
Beetles	Order Coleoptera
Bark beetles (includes pine and spruce beetles)	(Family Scolytidae) *Dendroctonus sp.*
Engraver beetle	(Scolytidae) *Ips sp.*
Bark Beetles	(Scolytidae) *Pityogenes sp., Pityokteines sp., Pityophthorus sp.*
Metallic wood-boring beetles	(Buprestidae) *Melanophila sp., Agrilus sp.*
Long-Horned beetles	(Cerambycidae) *Acanthocinus sp., Saperda sp., Monochamus sp.*
White-spotted sawyer	*Monochamus scutellatus*
Mayflies	Order Ephemeroptera
Crickets	Order Orthoptera, Family Gryllidae
Grasshoppers	Order Orthoptera--Suborder Ensifera
Rocky Mountain grasshopper	*Melanophes spretus*
Horntails	Order Hymenoptera, Family Siricidae) *Trimex sp.*

Butterflies	Order Lepidoptera--Superfamily Papilionoidea
Moths	Order Lepidoptera (many superfamilies)
Wasps	Order Hymenoptera (many superfamilies)
Weevils	Order Coleoptera--Superfamily Curculionoidea
Grubs	larvae of Coleoptera--Subfamily Melolonthinae
Gall insects	Usually aphids, beetles or wasps that create galls
Scale insects	Order Homoptera--Superfamily Coccoidea
Aphids	Order Homoptera--Superfamily Aphidoidea
Leafhoppers	Order Homoptera, Family Cicadellidae
Froghoppers	Order Homoptera, Family Cercopidae
Katydids	Order Orthoptera, Family Tettigoniidae, Subfamilies Phaneropterinae and Pseudophyllinae
Cockroaches	Order Blattaria
Sowbugs	Order Isopoda
Silverfish	Order Thysanura
Termites	Order Isoptera
Chewing lice	Order Phthiraptera
Spiders	Class Arachnida, Order Araneae
Pseudoscorpions	Class Arachnida, Order Pseudoscorpiones
Millipedes	Class Diplopoda
Snails	Phylum Mollusca, Class Gastropoda

NOTE: All invertebrates listed above spiders are in Class Insecta. Scientific classifications are given according to Borror and others (1992)

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LITERATURE CITED

Amman G. D., P. H. Baldwin. 1960. A comparison of methods for censusing woodpeckers in spruce-fir forests of Colorado. Ecology 41:699-706.

Amman G. D., K. C. Ryan. 1991. Insect infestation of fire-injured trees in the greater Yellowstone area.: United States Department of Agriculture Forest Service. Report # INT-398.

Amman G. D., M. D. McGregor, R. E. J. Dolph. 1997. Mountain pine beetle. www. na.fs.fed.us/spfo/pubs/fidls/mt_pine_beetle/mt_pine.htm.

Andrewartha H. G., L. C. Birch. 1984. The Ecological Web: More on the Distribution and Abundance of Animals. Chicago: University of Chicago Press.

Association for Biodiversity Information. 2001. www. abi.org/datasets_zoo/docs/birdus.htm.

Baker J. N. 1975. Egg-carrying by a common flicker. Auk 92:614-615.

Baldwin P. H. 1968. Woodpecker feeding on Engelmann spruce beetle in wind-thrown trees. USDA Forest Service, Rocky Mountain Forest Range Experiment Station Research Note RM-105.

Bancroft J. 1983. Red-headed woodpecker. Blue Jay 41(3):164-165.

Bate L. J. 1995. Monitoring woodpecker abundance and habitat in the central Oregon Cascades [Master of Science]: University of Idaho.

Beal F. E. L. 1911. Food of the woodpeckers of the United States. U. S. Department of Agriculture. Report # 37.

Beardmore R. M. 2001. British Columbia's Living Landscapes Program. www. livingbasin.com/endangered/Birds.

Beebe S. B. 1974. Relationships between insectivorous hole-nesting birds and forest management. New Haven, Connecticut: Yale University School of Forestry & Environmental Studies.

Bent A. C. 1939. Life Histories of North American Woodpeckers. Bulletin of the Smithsonian Institution U.S. National Museum 174. (1992 reprint: Bloomington, Indiana: Indiana University Press.)

Bergvinson D. J., J. H. Borden. 1991. Enhanced woodpecker predation on the mountain pine beetle, Dendroctonus ponderosae Hopkins, in glyphosate-treated lodgepole pines. Canadian Entomology 124:159-165.

Blackford J. L. 1955. Woodpecker concentration in burned forest. Condor 57:28-30.

Blake J. G. 1982. Influence of fire and logging on nonbreeding bird communities of ponderosa pine forests. Journal of Wildlife Management 46:404-415.

Block W. M., L. A. Brennan. 1987. Characteristics of Lewis' woodpecker habitat on the Modoc Plateau, California. Western Birds 18:209-212.

Bock C. E. 1971. Pairing in hybrid flicker populations in eastern Colorado. Auk 88:921-924.

Bock C. E., J. H. Bock. 1974. On the geographical ecology and evolution of the three-toed woodpeckers, Picoides tridactylus and P. Arcticus. Canadian Field-Naturalist 92(2):397-405.

Bock C. E., J. F. Lynch. 1970. Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. Condor 72:183-189.

Bock C. E., M. G. Raphael, J. H. Bock. 1978. Changing avian community structure during early post-fire succession in the Sierra Nevada. Wilson Bulletin 90:119-123.

Borror D. J., C. A. Triplehorn, N. F. Johnson. 1992. An Introduction to the Study of Insects. Fort Worth, Texas: Saunders College Publishing.

British Columbia Ministry of Forests. 1997. Standardized inventory methodologies for components of British Columbia's biodiversity: woodpeckers. www.for.gov.bc.ca/ric/TEBIODIV/woodpeckers.

Brown P. M., C. H. Sieg. 1996. Fire History in Interior Ponderosa Pine COmmunities of the Black Hills, South Dakota, USA. International Journal of Wildland Fire 6(3):97-105.

Bruns H. 1960. The economic importance of birds in forests. Bird Study 7:193-208.

Brush T. 1983. Cavity use by secondary cavity-nesting birds and response to manipulations. Condor 85:461-466.

Bull E. L., S. R. Peterson, J. W. Thomas. 1986. Resource partitioning among woodpeckers in Northeastern Oregon. LaGrande, Oregon: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Report # PNW-444.

Burnham K. P., D. R. Anderson, J. L. Laake. 1980. Estimation of density from line transect sampling of biological populations. Wildlife Monographs 72:1-202.

Caton E. L. 1996. Effects of fire and salvage logging on the cavity-nesting bird community in northwestern Montana [Ph.D.]. Missoula: University of Montana.

Cerovski, A., M. Gorges, T. Byer, K. Duffy, and D. Felley. 2001. Wyoming Bird Conservation Plan, version 1.0. Wyoming Partners In Flight. Lander, Wyoming: Wyoming Game and Fish Department.

Cline S. P., A. B. Berg, H. M. Wight. 1980. Snag characteristics and dynamics in Douglas fir forests, western Oregon. Journal of Wildlife Management 44:773-786.

Conner R. N. 1976. Nesting habitat for red-headed woodpeckers in southwestern Virginia. Bird-Banding 47(1):40-43.

Conner R. N. 1978. Snag management for cavity-nesting birds. In: R.M. DeGraaf, editor. Proceedings of the Workshop Management of Southern Forests for Nongame Birds, January 24-26, 1978. Asheville, North Carolina: U.S. Department of Agriculture Forest Service.

Conner R. N. 1979a. Seasonal changes in woodpecker foraging methods: strategies for winter survival. In: J.G. Dickson, R.N. Conner, R.R. Fleet, J.A. Jackson, J.C. Kroll, editors. The Role of Insectivorous Birds in Forest Ecosystems. New York: Academic Press, Inc. p 95-106.

Conner R. N. 1979b. Minimum standards and forest wildlife management. Wildlife Society Bulletin 7(4):293-296.

Conner R. N. 1980. Foraging habitats of woodpeckers in southwestern Virginia. Journal of Field Ornithology 51(2):119-127.

Conner R. N. 1981. Seasonal changes in woodpecker foraging patterns. Auk 98:562-570.

Conner R. N. 1993. Foraging differences among female and male downy and hairy woodpeckers. The Raven 64(2):74-83.

Conner R. N., C. S. Adkisson. 1976. Discriminant function analysis: a possible aid in determining the impact of forest management on woodpecker nesting habitat. Forest Science 22:122-127.

Conner R. N., C. S. Adkisson. 1977. Principal component analysis of woodpecker nesting habitat. Wilson Bulletin 89:122-129.

Conner R. N., H. S. Crawford. 1974. Woodpecker foraging in Appalachian clearcuts. Journal of Forestry 72:564-566.

Conner R. N., R. G. Hooper, H. S. Crawford, H. S. Mosby. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. Journal of Wildlife Management 39:144-150.

Conner R. N., O. K. J. Miller, C. S. Adkisson. 1976. Woodpecker dependence on trees infected by fungal heart rots. Wilson Bulletin 88:575-581.

Conner R. N., D. C. Rudolph, J. R. Walters. 2001. The Red-Cockaded Woodpecker: Surviving in a Fire-Maintained Ecosystem. Austin, Texas: University of Texas Press. 363 p.

Constantz G. D. 1974. Robbing of breeding Lewis' woodpecker food stores. Auk 91:171.

Cornell Laboratory of Ornithology, National Audubon Society. 2001. BirdSource. http: //birdsource.tc.cornell.edu/cbcdata/.

Davis P. R. 1976. Response of vertebrate fauna to forestfire and clear-cutting in south central Wyoming [Ph.D.]. Laramie, Wyoming: University of Wyoming.

Dickson J. G., R. N. Conner, J. H. Williamson. 1983. Snag retention increases bird use of a clear-cut. Journal of Wildlife Management 47:799-804.

Dickson J. G., J. H. Williamson, R. N. Conner. 1995. Longevity and bird use of hardwood snags created by herbicides. Proceedings of the Annual Conference of SEAFWA 1995:331-339.

Dixon R. D., V. A. Saab. 2000. Black-backed woodpecker (Picoides arcticus). In: A. Poole, F. Gill, editors. The Birds of North America. Philadelphia, PA: The Birds of North America, Inc.

Dobkin D. S., A. C. Rich, J. A. Pretare, W. H. Pyle. 1995. Nest-site relationships among cavity-nesting birds of riparian and snowpocket aspen woodlands in the northwestern Great Basin. Condor 97:694-707.

Doherty P. F., T. C. J. Grubb, C. L. Bronson. 1996. Territories and caching-related behavior of red-headed woodpeckers wintering in a beech grove. Wilson Bulletin 108(4):740-747.

Eells M. M. 1980. Predation on a nesting common flicker by a common raven. The Murrelet 61:36-37.

Evans W. G. 1966. Perception of infra-red readiation from forest fires by Melanophila acuminata DeGreer (Coleoptera: Buprestidae). Ecology 47:1061-1065.

Fletcher S. D., W. S. Moore. 1992. Further analysis of allozyme variation in the northern flicker, in comparison with mitochondrial DNA variation. Condor 94:988-991.

Franz J. M. 1961. Biological control of pest insects in Europe. Annual Review of Entomology 6:183-200.

Furniss M. M. 1965. Susceptibility of fire-injured Douglas fir to bark beetle attack in southern Idaho. Journal of Forestry 63:8-11.

Furniss R. L., V. M. Carolin. 1977. Western Forest Insects. U. S. Department of Agriculture

Forest Service. Miscellaneous Publication No. 1339.

Goggans R. 1989a. Black-backed woodpecker. In: Clark and others, editor. Rare, sensitive, and threatened species of the greater Yellowstone Ecosystem. p 88-89.

Goggans R. 1989b. Three-toed woodpecker. In: Clark and others, editor. Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. p 90-91.

Goggans R., R. D. Dixon, L. C. Seminara. 1989. Habitat use by three-toed and black-backed woodpeckers Deschutes National Forest, Oregon. Oregon: Oregon Department of Fish and Wildlife.

Grubb T. C., Jr., M. S. Woodrey. 1990. Sex, age, intraspecific dominance status and the use of food by birds wintering in temperate-deciduous and cold-coniferous woodlands: a review. Studies in Avian Biology 13: 270-279.

Gunn J. S., J. M. Hagann III. 2000. Woodpecker abundance and tree use in uneven-aged managed, and unmanaged, forest in northern Maine. Forest Ecology and Management 126:1-12.

Gutzwiller K. J., S. H. Anderson. 1986. Trees used simultaneously and sequentially by breeding cavity-nesting birds. Great Basin Naturalist 46(2):358-360.

Gutzwiller K. J., S. H. Anderson. 1987. Multiscale associations between cavity-nesting birds and features of Wyoming streamside woodlands. Condor 89:534-548.

Gutzwiller K. J., S. H. Anderson. 1988. Co-occurrence patterns of cavity-nesting birds in cottonwood-willow communities. Oecologia 76:445-454.

Hadow H. H. 1973. Winter ecology of migrant and resident Lewis' woodpeckers in southeastern Colorado. Condor 75:210-224.

Hagar J. C. 1999. Influence of riparian buffer width on bird assemblages in Western Oregon. Journal of Wildlife Management 63(2):484-496.

Haldeman J. R. 1980. Final Report: Non-Game Bird Habitat Management. Custer, South Dakota: Black Hills National Forest. Report # RQ Rs-79-269.

Hanula J. L., K. Franzreb. 1998 Source, distribution and abundance of macro-arthropods on the bark of longleaf pine: potential prey of the red-cockaded woodpecker. Forest Ecology and Management 102: 89-102.

Hanula J. L., K. Franzreb, W. D. Pepper. 2000. Longleaf pine characteristics associated with arthropods available for red-cockaded woodpeckers. Journal of Wildlife Management 64(1): 60-70.

Harris M. A. 1982. Habitat use among woodpeckers in forest burns [M. S.] Missoula, Montana: University of Montana.

Hejl S. J., R. L. Hutto, C. R. Preston, D. M. Finch. 1995. The effects of silvicultural treatments in the Rocky Mountains. In: T.E. Martin, D.M. Finch, editors. Ecology and Management of Neotropical Migratory Birds. New York: Oxford University Press. p 489.

Hilton-Taylor C. 2000. IUCN Red List of Threatened Species. Gland, Switzerland: IUCN.

Hitchcox S. M. 1996. Abundance and nesting success of cavity-nesting birds in unlogged and salvage-logged burned forest in northwestern Montana [M. S.]. Missoula: University of Montana.

Hoffman N. J. 1997. Distribution of Picoides woodpeckers in relation to habitat disturbance within the Yellowstone area [M. S.]. Bozeman: Montana State University.

Hogstad O. 1978. Sexual dimorphism in relation to winter foraging and territorial behavior of the three-toed woodpecker Picoides tridactylus and three Dendrocopos species. Ibis 120:198-203.

Hogstad O. 1991. The effect of social dominance on foraging by the three-toed woodpecker Picoides tridactylus. Ibis 133:271-276.

Horton S. P., R. W. Mannan. 1988. Effects of prescribed fire on snags and cavity-nesting birds in southeastern Arizona pine forests. Wildlife Society Bulletin 16:37-44.

Hutchison F. T. 1951. The effects of woodpeckers on the Engelmann spruce beetle Dendroctonus engelmanni Hopkins [M. S.]. Fort Collins, Colorado: Colorado State University.

Hutto R. L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (USA) conifer forests. Conservation Biology 9(5):1041-1058.

Imbeau L., J. P. L. Savard, R. Gagnon. 1999. Comparing bird assemblages in successional black spruce stands originating from fire and logging. Canadian Journal of Zoology 77:1850-1860.

Ingold D. J. 1989. Nesting phenology and competition for nest sites among red-headed and red-bellied woodpeckers and European starlings. Auk 106:209-217.

Ingold D. J. 1987. Documented double-broodedness in red-headed woodpeckers. Journal of Field Ornithology 58(2):234-235.

Ingold D. J. 1996. Delayed nesting decreases reproductive success in northern flickers: implications for competition with European starlings. Journal of Field Ornithology 67(2):321-326.

Ingold D. J. 1998. The influence of starlings on flicker reproduction when both naturally excavated cavities and artificial nest boxes are available. Wilson Bulletin 110(2):218-225.

Jackson J. A. 1970. A quantitative study of the foraging ecology of Downy woodpeckers. Ecology 51(2):318-323.

Jackson J. A. 1976. A comparison of some aspects of the breeding ecology of red-headed and red-bellied woodpeckers in Kansas. Condor 78:67-76.

Johnson , O'Neill. 2001. Wildlife-habitat relationships in Oregon and Washington. Corvallis, Oregon: Oregon State University Press, 768 p.

Kerpez T. A., N. S. Smith. 1990. Nest-site selection and nest-cavity characteristics of gila woodpeckers and northern flickers. Condor 92:193-198.

Kilham L. 1958. Territorial behavior of wintering red-headed woodpeckers. Wilson Bulletin 70(4):347-358.

Kilham L. 1959. Early reproductive behavior of flickers. Wilson Bulletin 71(4):323-336.

Kilham L. 1960. Courtship and territorial behavior of Hairy woodpeckers. Auk 77:259-270.

Kilham L. 1961. Downy woodpeckers scaling bark on diseased elms. Wilson Bulletin 73(1):89.

Kilham L. 1966. Nesting activities of black-backed woodpeckers. Condor 68:308-310.

Kilham L. 1968. Reproductive behavior of Hairy woodpeckers II. Nesting and habitat. Wilson Bulletin 80:286-305.

Kilham L. 1970. Feeding behavior of Downy woodpeckers I. Preference for paper birches and sexual differences. Auk 87:544-556.

Kilham L. 1973. Dying elms: boon to woodpeckers. American Birds 27(4):736-738.

Kilham L. 1978. Sexual similarity of red-headed woodpeckers and possible explanations based on fall territorial behavior. Wilson Bulletin 90(2):285-287.

Kisiel D. S. 1972. Foraging behavior of Dendrocopos villosus and D. pubescens in eastern New York state. Condor 74:393-398.

Knowlton G. F., G. S. Stains. 1943. Flickers eat injurious insects. Canadian Entomologist:118.

Koehler G. M. 1981. Ecological requirements for Lewis' woodpeckers (Melanerpes lewis), potential impacts of surface mining on their habitat and recommendations for mitigation. U. S. Fish & Wildlife Service.

Koenig W. D. 1986. Geographical ecology of clutch size variation in North American woodpeckers. Condor 88:499-504.

Koplin J. R. 1969. The numerical response of woodpeckers to insect prey in subalpine forest in Colorado. Condor 71:436-438.

Koplin J. R., P. H. Baldwin. 1970. Woodpecker predation on an endemic population of Engelmann spruce beetles. American Midland Naturalist 83:510-515.

Koplin J. R. 1972. Measuring predator impact of woodpeckers on spruce beetles. Journal of Wildlife Management 36(2):308-320.

Kreisel K. J., S. J. Stein. 1999. Bird use of burned and unburned coniferous forests during winter. Wilson Bulletin 111:243-250.

Kroll J. C., R. N. Conner, R. R. Fleet. 1980. Woodpeckers and the southern pine beetle. USDA. Agricultural Handbook #564. 23 p.

Kroll J. C., R. R. Fleet. 1979. Impact of woodpecker predation on over-wintering within-tree populations of the southern pine beetle (Dendroctonus frontalis). In: J.G. Dickson, R.N. Conner, R.R. Fleet, J.A. Jackson, J.C. Kroll, editors. The Role of Insectivorous Birds in Forest Ecosystems. New York: Academic Press, Inc.

Larson G. E., J. R. Johnson. 1999. Plants of the Black Hills and Bear Lodge Mountains. Brookings, South Dakota: South Dakota State University Agriculture Experiment Station.

Lawrence L. d. K. 1967. A comparative life-history study of four species of woodpeckers. Ornithological Monograph No.5, 156 pgs.

Lentile L., F. W. Smith, W. Shepperd. 2000. Final Report: Snag populations on the Black Hills National Forest. Fort Collins, Colorado: USDA Forest Service. 28 p.

Leonard, D. L., Jr. 2001. Three-toed woodpecker (Picoides tridactylus). The Birds of North America, No. 588 (A. Poole and F. Gill, eds). Philadelphia, Pennsylvania: The Birds of North America, Inc. 24 p.

Lester A. N. 1980. Numerical response of woodpeckers and their effect on mortality of mountain pine beetles in lodgepole pine in northwestern Montana [M. S.]. Missoula: University of Montana.

Li P., T. E. Martin. 1991. Nest-site selection and nesting success of cavity-nesting birds in high elevation forest drainages. Auk 108:405-418.

Liggett C., G. Hayward, N. Warren. 2001. Should region 2 ecological assessments and species assessments include management recommendations? Denver, Colorado: USDA Forest Service. 9 p.

Lima S. L. 1984. Downy woodpecker foraging behavior: efficient sampling in simple stochastic environments. Ecology 65:166-174.

Linder K. A. 1994. Habitat utilization and behavior of nesting Lewis' woodpeckers (Melanerpes lewis) in the Laramie Range, Southeastern Wyoming [M. S.]. Laramie, Wyoming: University of Wyoming.

Linder K. A., S. H. Anderson. 1998. Nesting habitat of Lewis' woodpeckers in southeastern Wyoming. Journal of Field Ornithology 69(1):109-116.

Lisi G. 1988. A field study of black-backed woodpeckers in Vermont.: Vermont Fish & Wildlife Dept. Nongame & Endangered Species Program. Report # Tech Report 3. As cited in Dixon and Saab 2000.

Loose S. S. 1993. Woodpecker habitat use in the forests of southeast Wyoming [Master of Science]. Laramie: University of Wyoming.

Loose S. S., S. H. Anderson. 1995. Woodpecker habitat use in the forests of southeast Wyoming. Journal of Field Ornithology 66(4):503-514.

Luce B., A. Cerovski, B. Oakleaf, J. Priday, L. VanFleet. 1999. Atlas of Birds, Mammals, Reptiles and Amphibians in Wyoming. Lander, WY: Wyoming Game and Fish Department.

Ludlow W. 1875. Report of a reconnaissance of the Black Hills of Dakota, made in the summer of 1874: Washington Government Printing Office.

MacRoberts M. H. 1975. Food storage and winter territory in red-headed woodpeckers in northwestern Louisiana. Auk 92:382-385.

Mannan R. W., E. C. Meslow, H. M. Wight. 1980. Use of snags by birds in Douglas fir forests, western Oregon. Journal of Wildlife Management 44:787-797.

Marcot B. G. 1983. Snag use by birds in Douglas fir clear-cuts. In: J.W. Davis, G.A. Goodwin, R.A. Ockenfels, editors. Snag Habitat Management: Proceedings of the Symposium, June 7-9, 1983, Flagstaff, Arizona: U.S. Forest Service, General Technical Report RM-99. p 134-139.

Martin T. E. 1993. Evolutionary determinants of clutch size in cavity-nesting birds: nest predation or limited breeding opportunities? American Naturalist 142:937-946.

Martin T. E. 1995. Avian life history evolution in relation to nest sites, nest predation, and food. Ecological Monographs 65:101-127.

McCambridge W. F., F. B. Knight. 1972. Factors affecting spruce beetles during a small outbreak. Ecology 53:830-839.

McClelland B. R., S. S. Frissell. 1975. Identifying forest snags useful for hole-nesting birds. Journal of Forestry 73:414-417.

McClelland B. R. 1977. Relationships between hole-nesting birds, forest snags, and decay in western larch- Douglas fir forests of the northern Rocky Mountains. Missoula: University of Montana.

McClelland B. R., S. S. Frissell, W. C. Fischer, C. H. Halvorson. 1979. Habitat managment for hole-nesting birds in forests of western larch and Douglas fir. Journal of Forestry 77:480-483.

McClelland B. R. 1980. Influences of harvesting and residue management on cavity-nesting birds. Proceedings of a symposium on environmental consequences of timber harvesting in Rocky Mountain coniferous forests. Ogden, Utah: U.S. Department of Agriculture Forest Service, General Technical Report INT-90. p 469-496.

Mellen, K. 2002. Inadequacy of biological potential models for snag species. USDA Forest Service, Mt. Hood National Forest.

Meng H. 1959. Food habits of nesting cooper's hawks and goshawks in New York and Pennsylvania. Wilson Bulletin 71(2):169-174.

Mills T. R., M. A. Rumble, L. D. Flake. 2000. Habitat of birds in ponderosa pine and aspen/birch forest in the Black Hills, South Dakota. Journal of Field Ornithology 71(2):187-206.

Mohren S., S. Anderson. 2000. Black-backed woodpeckers (Picoides articus) and three-toed woodpeckers (Picoides tridactylus) in the Black Hills National Forest of Wyoming and South Dakota: Annual Report for 2000 Summer Field Season. Laramie, Wyoming: Wyoming Cooperative Fish and Wildlife Research Unit.

Mohren S., S. Anderson. 2001. Black-backed woodpeckers (Picoides articus) and three-toed woodpeckers (Picoides tridactylus) in the Black Hills National Forest of South Dakota and Wyoming: Annual Progress Report for 2001. Laramie, Wyoming: Wyoming Cooperative Fish and Wildlife Research Unit.

Moore W. S., J. H. Graham, J. T. Price. 1991. Mitochondrial DNA variation in the northern flicker (Colaptes auratus, Aves). Molecular Biology and Evolution 8:327-344.

Moore W. S. 1995. Northern Flicker (Colaptes auratus). In: A. Poole, F. Gill, editors. The Birds of North America. Philadelphia, Pennsylvania: The Academy of Natural Sciences. p 28.

Muehter V. R. 1998. Watchlist Website. www. audubon.org/bird/watch/list.html.

Murphy E. C., W. A. Lehnhausen. 1998. Density and foraging ecology of woodpeckers following a stand-replacement fire. Journal of Wildlife Management 62(4):1359-1372.

Mury-Meyer E. J. 1981. The capture efficiency of flickers preying on larval tiger beetles. Auk 98:189-191.

National Geographic Society, editor. 1987. Field Guide to the Birds of North America. 2nd ed. Washington, D. C.: National Geographic Society.

Nichols L. L., J. A. Jackson. 1987. Interspecific aggression and the sexual monochromism of red-headed woodpeckers. Journal of Field Ornithology 58(3):288-290.

Ohmann J. L., W. C. McComb, A. A. Zumrawi. 1994. Snag abundance for primary cavity-nesting birds on nonfederal forest lands in Oregon and Washington. Wildlife Society Bulletin 22:607-620.

Otvos I. S. 1965. Studies on avian predators of Dndroctonus brevicomis LeConte (Coleoptera: Scolytidae) with special reference to Picidae. Canadian Entomologist 97:1184-1199.

Otvos I. S. 1979. The effects of insectivorous bird activities in forest ecosystems: an evaluation. In: J.G. Dickson, R.N. Conner, R.R. Fleet, J.A. Jackson, J.C. Kroll, editors. The Role of Insectivorous Birds in Forest Ecosystems. New York: Academic Press Inc. p 341-374.

Palmer J. S. 1997. The 1997 Summer Season. South Dakota Bird Notes 49:101-107.

Palmer J. S. 1998a. The 1997 fall season. South Dakota Bird Notes 50(1):17-27.

Palmer J. S. 1998b. The 1998 summer season. South Dakota Bird Notes 50(4):93-100.

Panjabi A. 2001a. The Partners in Flight handbook on species assessment and prioritization, version 1.1. Fort Collins, Colorado: Partners in Flight and Rocky Mountain Bird Observatory. 26 p.

Panjabi A. 2001b. Monitoring the birds of the Black Hills: Year 1 Report to the Black Hills National Forest. Fort Collins, Colorado: Rocky Mountain Bird Observatory. 96 p.

Parrish J. B., D. J. Herman, D. J. Reyher. 1996. A Century of Change in Black Hills Forest and Riparian Ecosystems. South Dakota: U. S. Forest Service. Report # B 722. 20 p.

Partners In Flight. 2001. Physiographic Scores--Breeding, Northern Shortgrass Prairie. http://rmb.wantjava.com/Physio_Breeding3?queryString=S39&AREA=Northern%20

Shortgrass%Prairie.

Patterson R. 2000. A Report: Black Hills National Forest USGS BRD Breeding Bird Survey Summary 1992-2000. U. S. Forest Service.

Penhollow M. E., D. F. Stauffer. 2000. Large-scale habitat relationships of neotropical migratory birds in Virginia. Journal of Wildlife Management 64(2):362-373.

Peterson B., G. Gauthier. 1985. Nest site use by cavity-nesting birds of the cariboo parkland, British Columbia. Wilson Bulletin 97:319-331.

Pfister A. R. 1980. Postfire avian ecology in Yellowstone National Park [M. S.]: Washington State University.

Progulske D. R. 1974. Yellow Ore, Yellow Hair, Yellow Pine: A Photographic Study of a Century of Forest Ecology. Brookings, South Dakota: South Dakota State University Agriculture Experiment Station. Bulletin 616.

Pulliam H. R. 1988. Sources, sinks, and population regulation. American Naturalist 132:652-661.

Pulliam H. R., B. J. Danielson. 1991. Sources, sinks, and habitat selection: a landscape perspective on population dynamics. American Naturalist 137(Supplement):S50-S66.

Raphael M. G., M. White. 1984. Use of snags by cavity-nesting birds in the Sierra Nevada. Wildlife Monographs 86:1-66.

Raphael M. G., M. L. Morrison, M. P. Yoder-Williams. 1987. Breeding bird populations during twenty-five years of postfire succession in the Sierra Nevada. Condor 89:614-626.

Reed J. M. 1995. Relative vulnerability to extirpation of montane breeding birds in the Great Basin. Great Basin Naturalist 55(4):342-351.

Reller A. W. 1972. Aspects of behavioral ecology of red-headed and red-bellied woodpeckers. American Midland Naturalist 88:270-290.

Ritchison G. 1999. Downy Woodpecker. Mechanicsburg, Pennsylvania: Stackpole Books. 120 p.

Rogers D. T. Jr., J. A. Jackson, B. J. Schardien, M. S. Rogers. 1979. Observations at a nest of a partial albino red-headed woodpecker. Auk 96:206-207.

Roppe J. A. 1974. Effects on wildlife of a fire in a lodgepole pine forest [M. S.]. Fort Collins: Colorado State University.

Rumble M. A., B. L. Dykstra, L. D. Flake. 2000. Species-area relations of song birds in the Black Hills, South Dakota. Intermountain Journal of Sciences 6(1):33-48.

Runde D. E., D. E. Capen. 1987. Characteristics of northern hardwood trees used by cavity-nesting birds. Journal of Wildlife Management 51(1):217-223.

Saab V. A., C. E. Bock, A. C. Rich, D. S. Dobkin. 1995. Livestock grazing effects in western North America. In: T.E. Martin, D.M. Finch, editors. Ecology and Management of Neotropical Migratory Birds. New York: Oxford University Press. p 311-353.

Saab V. A., J. G. Dudley. 1998. Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas fir forests of southwestern Idaho. Ogden, Utah: U. S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Report # RMRS-RP-11. 17 p.

Saab V. A., R. Brannon, J. Dudley, L. Donohoo, D. Vanderzanden, V. Johnson, H. Lachowski. in press. Selection of fire-created snags at two spatial scales by cavity-nesting birds. In: P.J. Shea, J. W. F. Laudenslayer, B. Valentine, C.P. Weatherspoon, T.E. Lisle, editors. Proceedings of the Symposium on the Ecology and Management of Dead Wood in Western Forests, Nov. 2-4, 1999, Reno, Nevada. Albany, California: USDA, Forest Service, Pacific Southwest Research Station.

Sallabanks R. 1995. Effects of wildfire on breeding bird communities in coniferous forests of northeastern Oregon.: Blue Mountains Natural Resources Institute.

Salt J. R. 1985. A note on "condominimum" nesting of the northern flicker, Colaptes auratus, in western Alberta. Canadian Field-Naturalist 99(4):534-535.

Sauer J. R., S. Schwartz, B. Hoover. 1996. The Christmas Bird Count Home Page. www.mbr.nbs.gov/bbs/cbct.

Sauer J. R., J. E. Hines, G. Gough, I. Thomas, B. G. Peterjohn. 1999. The North American breeding bird survey results and analysis. www.mbr-pwrc.usgs.gov/bbs/bbs.

Sauer J. R., K. Pardieck, J. E. Hines, J. Fallon. 2001. The North American Breeding Bird Survey, Results and Analysis 1966-2000, Version 2001.2. Laurel, MD: USGS Patuxent Wildlife Research Group.

Schenck R. F. 1999a. 1998-1999 winter season. South Dakota Bird Notes 51(2):43-47.

Schenck R. F. 1999b. The 1999 summer season. South Dakota Bird Notes 51(4):93-99.

Schenck R. F. 2000. The 2000 summer season. South Dakota Bird Notes 52(4):86-91.

Schepps J., S. Lohr, T. E. Martin. 1999. Does tree hardness influence nest-tree selection by primary cavity-nesters? Auk 116:658-665.

Schroeder R. L. 1983. Habitat Suitability Index Models: Downy Woodpecker.: U. S. Department of Interior, U. S. Fish & Wildlife Service. Report # FWS/OBS-82/10.38.

Schulte L. A., G. J. Niemi. 1998. Bird communities of early-successional burned and logged forest. Journal of Wildlife Management 62(4):1418-1429.

Scott V. E. 1978. Characteristics of ponderosa pine snags used by cavity-nesting birds in Arizona. Journal of Forestry 76:26-28.

Scott V. E. 1979. Bird response to snag removal in ponderosa pine. Journal of Forestry 77:26-28.

Scott V. E., J. A. Whelan, P. L. Svoboda. 1980. Cavity-nesting birds and forest management.

Workshop Proceedings on Management of Western Forests and Grasslands for Nongame Birds, GTR-INT-86. Ogden, Utah: U.S. Department of Agriculture Forest Service. p 311-324.

Scott V. E., J. L. Oldemeyer. 1983a. Cavity-nesting bird requirements and response to snag cutting in ponderosa pine. Washington, D.C.: U.S. Forest Service. Report # RM-99.

Scott V. E., J. L. Oldemeyer. 1983b. Cavity-nesting bird requirements and response to snag cutting in ponderosa pine. In: J.W. Davis, G.A. Goodwin, R.A. Ockenfels, editors. Snag Habitat Management: Proceedings of the Symposium, June 7-9, 1983, Flagstaff, Arizona. Flagstaff, Arizona: U. S. Department of Agriculture Forest Service, General Technical Report RM-99. p 19-23.

Sedgwick J. A., F. L. Knopf. 1990. Habitat relationships and nest site characteristics of cavity-nesting birds in cottonwood floodplains. Journal of Wildlife Management 54(1):112-124.

Sedgwick J. A., F. L. Knopf. 1992. Cavity turnover and equilibrium cavity densities in a cottonwood bottomland. Journal of Wildlife Management 56:477-484.

Selander R. K., D. R. Giller. 1956. Interspecific relations of woodpeckers in Texas. Wilson Bulletin 71(2):107-124.

Setterington M. A., I. D. Thompson, W. A. Montevecchi. 2000. Woodpecker abundance and habitat use in mature balsam fir forests in Newfoundland. Journal of Wildlife Management 64(2):335-345.

Shackelford C. E., R. N. Conner. 1997. Woodpecker abundance and habitat use in three forest types in eastern Texas. Wilson Bulletin 109(4):614-629.

Short L. L. 1974. Habits and interactions of North American three-toed woodpeckers (Picoides arcticus and Picoides tridactylus). American Museaum Novitates(2547):1-42.

Short L. L. 1982. Woodpeckers of the World. Greenville, Delaware: Delaware Museum of Natural History.

Skinner N. G. 1989. Seasonal avifauna use of burned and unburned lodgepole pine forest ecotones [M. S.]. Missoula: University of Montana.

Smith K. G., T. Scarlett. 1987. Mast production and winter populations of red-headed woodpeckers and blue jays. Journal of Wildlife Management 51(2):459-467.

Smith K. G., J. H. Withgott, P. G. Rodewald. 2000. Red-headed woodpecker (Melanerpes erythrocephalus). In: A. Poole, F. Gill, editors. The Birds of North America. Philadelphia, Pennsylvania: The Birds of North America, Inc. p 1-28.

Sorenson E. 1986. A precipitous decline in Lewis' woodpeckers in Salt Lake and Davis couties. Utah Birds 2:45-54.

Sousa P. J. 1983. Habitat Suitability Index Models: Lewis' Woodpecker.: Department of Interior, U. S. Fish & Wildlife Service. Biological Report 82/10.32.

Sousa P. J. 1987. Habitat Suitability Index Models: Hairy Woodpecker.: U. S. Department of Interior, U. S. Fish & Wildlife Service. Biol. Rep. 82/10.146.

South Dakota Bird Notes. 1998. Christmas Counts. South Dakota Bird Notes 50(2):43-46.

South Dakota Bird Notes. 1999. Christmas Counts 1998-1999. South Dakota Bird Notes 51(2):39-42.

South Dakota Bird Notes. 2000. Christmas Counts 1999-2000. South Dakota Bird Notes

52(2):39-42.

South Dakota Department of Game Fish and Parks. 2000. Rare, threatened, and endangered animals species tracked by the South Dakota Natural Heritage Program. www. state.sd.us/gfp/Diversity/RareAnimal/htm.

South Dakota Ornithologists Union. 1991. The Birds of South Dakota. Aberdeen, South Dakota: South Dakota Ornithologists' Union.

Spring L. W. 1965. Climbing and pecking adaptations in some North American woodpeckers. Condor 67:457-488.

Swallow S. K., R. J. Gutierrez, R. A. J. Howard. 1986. Primary cavity-site selection by birds. Journal of Wildlife Management 50:576-583.

Tashiro-Vierling K. Y. 1994. Population trends and ecology of the Lewis' woodpecker (Melanerpes lewis) in southeastern Colorado [M. A.]. Boulder, CO: University of Colorado. As cited in Tobalske 1997.

Taylor D. L., W. J. J. Barmore. 1980. Post-fire succession of avifauna in coniferous forests of Yellowstone and Grand Teton National Parks, Wyoming. Management of Western Forests and Grasslands for Non-Game Birds: U. S. D. A. Forest Service, General Technical Report INT-99. p 130-145.

Taylor R. V., S. K. Albert. 1999. Human hunting of nongame birds at Zuni, New Mexico, USA. Conservation Biology 13(6):1398-1403.

Tennant M. R. 1991. Phylogenetic systematics of the Picinae [Ph. D.]. Detroit, Michigan: Wayne State University.

Thomas J. W., R. G. Anderson, C. Maser, E. L. Bull. 1979. Snags. In: J.W. Thomas, editor. Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington. Washington, D. C.: U. S. Department of Agriculture. p 60-77.

Tobalske B. W., R. C. Shearer, R. L. Hutto. 1991. Bird populations in logged and unlogged western larch/ Douglas fir forest in northwestern Montana.: U.S.D.A. Forest Service. Report # INT-442.

Tobalske B. W. 1996. Scaling of muscle composition, wing morphology, and intermittent flight behavior in woodpeckers. Auk 113:151-177.

Tobalske B. W. 1997. Lewis' woodpecker (Melanerpes lewis). In: A. Poole, F. Gill, editors. The Birds of North America. Washington, D.C.: The American Ornithologists' Union.

Tobalske C., B. W. Tobalske. 1999. Using atlas data to model the distribution of woodpecker species in the Jura, France. Condor 101:472-483.

Travis J. 1977. Season foraging in a downy woodpecker population. Condor 79:371-375.

USDA Forest Service. 1992. Interim Management Recommendations Sensitive Species: Black-backed woodpecker.: U.S. Department of Agriculture Forest Service, Region 1.

USDA Forest Service. 1996. Final Environmental Impact Statement: Land and Resource Management Plan for the Black Hills National Forest. Custer, South Dakota: U. S. Department of Agriculture.

USDA Forest Service. 1997. Revised Land and Resource Management Plan for the Black Hills National Forest. Custer, South Dakota: U. S. Department of Agriculture.

USDA Forest Service. 1999. Decision for Appeals of the Black Hills National Forest Land and Resource Management Plan. Washington, D. C.: U. S. Department of Agriculture. Report #97-13-00-0085, 0120, and 0125.

USDA Forest Service. 2001a. 1997 Revised Forest Plan Ammendment 1 Decision Notice.: U. S. Forest Service.

USDA Forest Service. 2001b. Expert Interview Summary for the Black Hills National Forest Land and Resource Management Plan Ammendment.

Van Horne B., J. A. Wiens. 1991. Forest Bird Habitat Suitability Models and the Development of General Habitat Models. Washington, D.C.: United States Department of the Interior, Fish and Wildlife Service. Report # 8. 30 p.

Vierling K. T. 1997. Habitat selection of Lewis' woodpeckers in southeastern Colorado. Wilson Bulletin 109(1):121-130.

Vierling K. T. 1998. Interactions between European starlings and Lewis' woodpeckers at nest cavities. Journal of Field Ornithology 69(3):376-379.

Villard M.-A., J. Schieck. 1997. Immediate post-fire nesting by black-backed woodpeckers, Picoides arcticus, in Northern Alberta. Canadian Field-Naturalist 111(3):478-479.

Villard M.-A., M. K. Trzcinski, G. Merriam. 1999. Fragmentation effects on forest birds: relative influence of woodland cover and configuration on landscape occupancy. Conservation Biology 13(4):774-783.

Villard P. 1994. Foraging behavior of black-backed and three-toed woodpeckers during spring and summer in a Canadian boreal forest. Canadian Journal of Zoology 72:1957-1959.

Virkkala R., M. Heinonen, P. Routasuo. 1991. The response of northern taiga birds to storm disturbance in the Koilliskaira National Park, Finnish Lapland. Ornis Fennica 68:123-126.

Waters J. R., B. R. Noon, J. Verner. 1990. Lack of nest site limitation in a cavity-nesting bird community. Journal of Wildlife Management 54:239-245.

Weatherly N. F., A. G. Canaris. 1961. Some parasites of Oregon and Washington vertebrates. Journal of Parasitology 47:230.

Weibel A. C., W. S. Moore. 2002. Molecular phylogeny of a cosmopolitan group of woodpeckers (Genus Picoides) based on coI and cyt b mitochondrial gene sequences. Molecular Phylogenetics and Evolution 22: 65-75.

Weikel J. M., J. P. Hayes. 1999. The foraging ecology of cavity-nesting birds in young forests of the northern coast range of Oregon. Condor 101:58-66.

Weitzel N. H. 1988. Nest-site competition between the European starling and native breeding birds in northwestern Nevada. Condor 90:515-517.

Welp L., W. F. Fertig, G. P. Jones, G. P. Beauvais, S. M. Ogle. 2000. Fine filter analysis of the Bighorn, Medicine Bow, and Shoshone National Forests in Wyoming. Laramie, Wyoming: Wyoming Natural Diversity Database.

Wesolowski T., L. Tomialoje. 1986. The breeding ecology of woodpeckers in a temperate primaeval forest--preliminary data. Acta Ornithologica 22:1-21.

West J. D., J. M. Speirs. 1959. The 1956-1957 invasion of three-toed woodpeckers. Wilson Bulletin 71:348-352.

Winternitz B. L., H. Cahn. 1983. Nestholes in live and dead aspen. In: J.W. Davis, G.A. Goodwin, R.A. Ockenfels, editors. Snag Habitat Management: Proceedings of the Symposium, June 7-9, 1983, Flagstaff, Arizona. Flagstaff, Arizona: U. S. Department of Agriculture Forest Service, General Technical Report RM-99.

Wisdom M. J., R. S. Holthausen, B. C. Wales, C. D. Hargis, V. A. Saab, D. C. Lee, W. J. Hann, T. D. Rich, M. M. Rowland, W. J. Murphy, M. R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the interior Columbia basin: broad-scale trends and management implications. Portland, Oregon: U. S. Department of Agriculture Forest Service. Report # PNW-GTR-485.

Yunick R. P. 1985. A review of recent irruptions of the black-backed woodpecker and three-toed woodpecker in eastern North America. Journal of Field Ornithology 56(2):138-152.

Zarnowitz J. E. 1985. The effects of forest management on cavity-nesting birds in northwestern Washington. Journal of Wildlife Management 49:255-263.

Zink R. M., S. Rohwer, A. V. Andreev, D. L. Dittmann. 1995. Trans-Beringia comparisons of mitochondrial DNA differentiation in birds. Condor 97: 639-649.

DEFINITIONS

Abiotic: referring to non-living factors in the environment.

Breeding Bird Survey: an annual survey of birds during the breeding season conducted across North America.

Christmas Bird Count: an annual survey of birds at Christmastime across North America, coordinated by Audubon society.

DBH: diameter at breast height, the diameter of a tree as measured at about 4 meters above ground.

Disjunct: a population that is separated from the other parts of the species' range.

Drumming: a repeated, rhythmic tapping of the woodpecker's bill on a hard surface.

Excavating: a foraging method that involves drilling into the bark or substrate to obtain prey, i.e. probing.

Fledging: the time in the development of birds where they leave the nest.

Gleaning: a foraging method that involves visual inspection of the tree surface and cracks to find invertebrate prey.

HABCAP: habitat capability model which is used to investigate how habitat changes affect different species.

Mast: the fruit portion of a tree, usually referring to acorns or nuts.

Monophyletic: all the members of a group are descended from a common ancestor.

Pecking: a foraging method that involves tapping on the surface to locate insect tunnels or to stimulate insects to move.

Phenology: the timing of events.

Primary cavity-nester: an animal that is able to excavate a cavity for its nest.

Probing: a foraging method that involves drilling into the bark or substrate to obtain prey, i.e. excavating.

Road density: measured in miles of roads per square mile of land. In the Black Hills National Forest, there are 2.7 miles of road per square mile. This was calculated from total land (1,246,865 acres=1,948 sq. miles) and 5,204 miles of official forest roads. This is actually a conservative estimate for most of the forest since there are some lands where motorized travel is prohibited (approx. 27,036 acres) and there are 3,430 miles of unofficial roads (two-tracks). Figures from USDA Forest Service (1996).

Scaling: "prying off layers of bark to access insects in the superficial bark" (Dixon and Saab 2000).

Secondary cavity-nester: an animal that nests in a cavity, but is not able to excavate its own cavity.

Severity (of fire): the effects of a fire on the ecosystem or part of the ecosystem.

Sink: a patch of habitat which is not able to produce enough offspring to maintain the current population and must depend on individuals migrating from source patches to maintain the population.

Snag: a dead tree.

Source: a patch of habitat which is able to produce more offspring than are needed to replace the population in that site.

Taiga: the region south of the tundra, which is characterized by conifer forest.