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Conservation Assessment for the Broad-Winged Hawk in the Black Hills National Forest, South Dakota and Wyoming

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for

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INTRODUCTION

This document assesses the biology and overall conservation status of the broad-winged hawk (Buteo platypterus) in the Black Hills National Forest (BHNF). Our goal is to provide information that assists the BHNF of South Dakota and Wyoming in managing for the viability of this species. The specific topics of this document include systematics, distribution and abundance, population trends, movement patterns, habitat characteristics, food habits, breeding biology, demography, community ecology, risk factors, response to habitat changes, a review of conservation practices, and additional information needs. An enviro-gram of the broad-winged hawk's ecological web linkages is also presented (Figure 1; Andrewartha and Birch 1984).

An attempt was made to base this assessment primarily on peer-reviewed literature with a focus on broad-winged hawks in the Black Hills. However, limited data are available in this area so peer-reviewed literature from other North American studies was also used. When possible, information from areas as close to the BHNF as possible was used. As the distance increases between the Black Hills and the areas from which inferences were made, there is likely to be a large amount of uncertainty that accompanies these inferences. Additionally, information subject to less rigorous review, such as Master's theses, doctoral dissertations, State, United States Forest Service (USFS), and U.S. Fish and Wildlife Service (FWS) reports were used to provide a more thorough understanding of the biology and status of the broad-winged hawk in the BHNF.

CURRENT MANAGEMENT SITUATION

Management Status

The FWS and USFS have not designated the broad-winged hawk with any special conservation status. The Nature Conservancy designates the species with a global rank "G5", meaning they are demonstrably secure, though they may be quite rare in parts of their range, especially at the periphery (Fertig and Beauvais 1999). The Wyoming Natural Diversity Database also considers this hawk to be common and does not give them any special conservation status either (Fertig and Beauvais 1999). In South Dakota, the broad-winged hawk is designated as "S2B" during the breeding season, meaning it is imperiled because of rarity or because of some factor(s) making it vulnerable to extinction (South Dakota Natural Heritage Database 2001). It should be noted that Powder River Eagle Studies (2000) has recently reported that broad-winged hawks are a common nesting raptor in the Black Hills of Wyoming and South Dakota. During the non-breeding season it is designated as "SZN", meaning there are no definable occurrences for conservation purposes.

Existing Management Plans, Assessments, or Conservation Strategies

The following is the only species assessment, management plan, or conservation strategy we found for the broad-winged hawk.

Goodrich, L. J., S.C. Crocoll, and S. E. Senner. 1996. Broad-winged Hawk (Buteo platypterus). In The Birds of North America, No. 218 (A. Poole and F. Gill, eds.). The Academy of Natural

Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D. C.

REVIEW OF TECHNICAL KNOWLEDGE

Systematics

Goodrich et al. (1996) reviewed the systematics of the broad-winged hawk. Six subspecies have been described: B. p. platypterus (North American mainland), B. p. cubanensis (Cuba), B. p. brunnescens (Puerto Rico), B. p. insulicola (Antigua, Barbados), B. p. rivieri (St. Lucia, Dominica, Barbados, Martinique), and B. p. antillarum (Trinidad, Tobago, Grenada, St. Vincent, Grenadines). B. p. platypterus is the subspecies present in the Black Hills and therefore is the focus of this document.

Distribution and Abundance

In North America, broad-winged hawks occurs in deciduous or mixed deciduous-coniferous forests from Nova Scotia to central Alberta, south from North Dakota to Texas, and east to the Atlantic coast (Goodrich et al. 1996). In the Black Hills, broad-winged hawks are a common nesting raptor (Powder River Eagle Studies 2000). They were the second-most encountered raptor in the northern Black Hills during 1996 – 1997 calling surveys (Powder River Eagle Studies 2000). However, the South Dakota Breeding Bird Atlas classifies broad-winged hawks as 'rare and local' (Peterson 1995). During field work for the Atlas (1988 – 1993), four breeding pairs were 'confirmed', the presence of another breeding pair was 'probable', and the presence of another five breeding pairs was 'possible' (Peterson 1995). In Wyoming, broad-winged hawks are considered a rare migrant (Wyoming Game and Fish Department 1999).

During the winter, they are a resident in Mexico, Central America, and South America. Some birds also winter in southern Florida. U.S. Fish and Wildlife Service band recoveries of birds banded during the breeding season or fall migration and recovered between December and February showed 27.3% were in South America, 45.5% in Central America, 9.1% in Mexico, and 18.2% in the U.S. (Goodrich et al. 1996).

Population Trend

The North American Breeding Bird Survey (BBS) did not detect a population trend (+0.63%; P = 0.42) for broad-winged hawks throughout the entire survey area between 1966 and 2000 (Sauer et al. 2001). The Christmas Bird Count (CBC) also did not detect a population trend (trend = -0.1; CI = -1.2 – 0.9) between 1959 – 1988 (Sauer et al. 1996). However, estimates from the BBS and CBC are unreliable due to small sample sizes. Counts from migration lookout stations suggest that broad-winged hawk numbers in eastern North America are stable (Bednarz et al. 1990, Latta 1994).

Broad-Scale Movement Patterns

Goodrich et al. (1996) summarized broad-scale movement patterns of broad-winged hawks. They are a complete migrant. They generally migrate in large flocks, or "kettles," ranging from several individuals to thousands. In the fall, broad-winged hawks from eastern and central

Canada skirt the Great Lakes and move south along the Atlantic shoreline and Appalachian Mountains. Presumably, most kettles head southwesterly through Louisiana and eastern Texas, flying around the Gulf of Mexico. Central Flyway birds appear to disperse south through the Mississippi Valley to converge with Eastern Flyway birds in Texas. Migration routes west of the Mississippi River are poorly known. Small but increasing numbers follow the Rocky Mountains south. Migration routes south of the U.S. are not as well documented with most broad-winged hawks entering and leaving through southeast Texas. The spring migration is typically more dispersed than the fall migration.

Goodrich et al. (1996) summarized various aspects of the timing of migration of broad-winged hawks. Broad-winged hawks are one of the earliest fall migrants of any North American raptor, and one of the latest in the spring. Timing of migration is possibly related to their reliance on cold-blooded prey. In eastern North America, migration occurs from mid-August to early October with peak flights occurring 10 – 20 September. At Hawk Mountain, Pennsylvania, 95% of all fall migrants pass within a two-week period in mid-September. In south Texas, major flights occur the last week of September and the first week of October. Spring migration occurs from March through May with the peak from mid- to late April in the Mid-Atlantic States. Subadults are typically the latest migrants to return to breeding areas. No known differences in migration are known to occur between males and females.

Subadult broad-winged hawks are known to make large movements during the summer (Mueller 1965). For example, on 26 June 1960, approximately 300 – 1,000 subadult broad-winged hawks were observed soaring in a south to westerly movement in northeastern Wisconsin. Apparently, they were non-breeding individuals. It is unknown if these birds were migrating considerably later than the breeding adults were, or if they just spend the summer doing a certain amount of wandering.

Habitat Characteristics

Broad-winged hawks predominately nest in a variety of hardwood tree species across their breeding range (Rosenfield 1984a). Woodland openings and wet areas are common characteristics of their nesting habitat (Hohn 1986, Keran 1978, Matray 1974, Rosenfield 1984a, Titus and Mosher 1981). Additionally, broad-winged hawks select nest sites with trees whose diameter at breast height (DBH) is greater than what is randomly available (Titus and Mosher 1987). Only one study is known in which foraging habitat was studied with radio telemetry (Steblein 1991). Steblein (1991) suggested that broad-winged hawks select foraging sites high in prey availability. These areas were classified as mature to old-growth forests, forest streams, and forest roads. Other studies (Keran 1978, Crocoll 1984, Rosenfield 1984a) have reported that openings near forested areas are commonly used for foraging.

In Minnesota and Wisconsin, the average stand density in broad-winged hawk nest stands was 204 trees per hectare, and the trees used for nesting were 35 – 50 years of age. Nest sites of broad-winged hawks were characterized as being within 124 m of an upland opening and 143 m of a wetland (Keran 1978). Upland openings appeared to provide the majority of food. Broad-winged hawks were often seen perched at the edge of wooded roads and trails. Nest setback from an edge appeared to be related to the amount of noise and disturbance at the opening. Nests were typically closer to woodland trails and farther from gravel roads. Nests were likely selected in areas close to wetlands due to the importance of amphibians and insects in the diet (Keran

1978). Wetlands closest to the nest had two things in common: standing water and the presence of frogs.

Rosenfield (1984a) reported that aspen (Populus tremuloides) and white birch (Betula papyrifera) supported 51% and 29% of all broad-winged hawks nests, respectively, for another site in Wisconsin. Mean nest tree DBH was 32 cm and mean nest height was 8 m. These averages are less than those reported in other studies (Table 1). Rosenfield (1984a) suggested that his Wisconsin study area has the highest reported nest density of broad-winged hawks due to the interspersion of habitat types. Conversion of forests to farmland in his study area had created more upland openings and edge habitat than were originally present. Such openings may be important to nesting broad-winged hawks because they are utilized as primary hunting sites (Keran 1978).

Table 1. Comparison of DBH of nest trees and height of broad-winged hawk nests.

Source	N	DBH (cm)	Nest Height (m)
Burns (1911)	167	N/A	10.1
Matray (1974)	14	54.1 ± 8 .3	13.3 ± 1.4
Powder River Eagle Studies (2000)	27	40.2	10.7
Rosenfield (1984a)	72	31.5 ± 6.3	8.2 ± 2.7
Titus and Mosher (1981)	24	38.0 ± 9.5	± 3.0

In New York, broad-winged hawk nests occurred in areas with moist, poorly drained soils found close to small streams, lakes, or swampy areas (Matray 1974). The main tree species selected for nesting was yellow birch (Betula alleghaniensis). The mean height of nests was 13 m, the mean DBH of nest trees was 54 cm, and 12 of 14 nests occurred in the first main crotch. Another study in New York reported that the mean distance to the nearest opening was 90 ± 54 m, mean height of the nest was 12 ± 3 m, and 10 different tree species were used for nesting, indicating that broad-winged hawk can exploit a variety of habitats (Crocoll 1984).

Nesting habitat of broad-winged hawks in the Black Hills differs from most other studies in two distinct ways: (1) selection for areas with wetlands and upland openings is not apparent (H. Postovit and B. Postovit, Two Ravens Inc., personal communication) and (2) pine trees are the primary tree used for nesting as opposed to deciduous trees. In the Black Hills of South Dakota and Wyoming, broad-winged hawks generally nest in mixed pine/deciduous habitat, sometimes intermixed with spruce (Powder River Eagle Studies 2000). Twenty-five of 27 broad-winged hawk nests were in ponderosa pine (Pinus ponderosa), one was in an aspen, and one in a paper birch. Nest trees were generally large with a mean DBH of 40 cm and a height of 17 m. Nests averaged 11 m above ground level, and were most frequently placed against the trunk or in a main crotch. Canopy cover in nest stands ranged from 45% – 96%, with a mean of 66%. Nest sites usually had minor slopes (< 10%), and aspects varied with most either east, north, or flat.

Food Habits

Broad-winged hawks typically hunt by watching from a low, inconspicuous perch in a tree or on a fence post, from which prey is detected and taken with a sudden short glide (Fitch 1974). They are opportunistic and are capable of utilizing a wide variety of prey forms (Keran 1978, Rusch and Doerr 1972).

In New York, prey items of broad-winged hawks included amphibians, reptiles, birds, and small mammals, including chipmunks (Tamias spp.) and red squirrels (Tamiasciurus hudsonicus) (Crocoll 1984, Matray 1974). In Kansas, birds were the dominant prey items while ring-necked snakes (Diadophis punctatus), prairie voles (Microtus ochrogaster), shrews (Blarina spp. and Cryptotis spp.), cottontails (Sylvilagus spp.), and skinks (Scinicidae spp.) were also common prey items (Fitch 1974).

For broad-winged hawks in Alberta, ruffed grouse (Bonasa umbellus) formed the largest component of prey biomass in the diet and snowshoe hare (Lepus americanus) were the second-most abundant prey item. (Rusch and Doerr 1972). Most of the grouse were fledglings less than nine weeks of age and all hares were juveniles averaging 18 days in age. Red-backed voles (Clethrionomys gapperi) and meadow voles (Microtus pennsylvanicus) were the most numerous species in the diet. Reptiles and amphibians are scarce in this area and thus, were not a significant part of the diet.

In Wisconsin, American toads (Bufo americanus) were delivered most frequently, but eastern chipmunks (Tamias striatus) contributed most to biomass (Rosenfield 1984b). Nestling and fledgling, small passerines were also common prey items.

In Maryland, prey deliveries at broad-winged hawk nests consisted of 52% mammals, 10% birds, and 6% reptiles (Janik and Mosher 1982). Eastern chipmunks occurred most frequently in the diet. Prey items identified to species included eastern chipmunks, voles (Microtus spp.), mice (Peromyscus spp.), short-tailed shrews (Blarina brevicauda), red squirrels, ruffed grouse, wild turkeys (Meleagris gallopavo), northern flickers (Colaptes auratus), and eastern towhees (Pipilo erythrophthalmus).

During the inspections of broad-winged hawk nest sites in the Black Hills, common prey items appeared to be chipmunks, voles, and birds (H. Postovit and B. Postovit, Two Ravens Inc., personal communication). Earthworms were also observed to be a common prey item by at least two nesting pairs in the Black Hills.

Breeding Biology

Phenology of Courtship and Breeding

Nesting broad-winged hawks in the Black Hills arrive at nest territories from late April through the first two weeks of May (H. Postovit and B. Postovit, Two Ravens Inc., personal communication). Males are thought to arrive before females. Ring et al. (1987) reported that incubation occurs from late May to late June, hatching occurs around late June, and fledging occurs from early to mid-August in the Black Hills (Ring et al. 1987).

In Kansas, arrival dates of broad-winged hawks at nest sites occurred from 13 April to 28 April, with an average at 19 April (Fitch 1974). The hawks established territories, acquired mates, and

built nests quickly. By the end of April, birds were laying eggs. Nestlings fledged in early July, at an age of about 35 days. The phenology of courtship and breeding is likely delayed at more northern latitudes as the mean hatching date in central Alberta was 2 July (Rusch and Doerr 1972).

From 1978 – 1980, broad-winged hawks in New York were first seen at a study area between 12 April and 23 April (Crocoll 1984). Construction of new nests or relining of old nests occurred soon after arrival. The nest construction period lasted approximately three weeks, the last week in April through the second week in May. Egg laying occurred mainly during the second and third weeks of May. The mean hatching date was 10 June. Eggs hatch asynchronously at approximately 1.4 days between hatching. Fledging occurred at five to six weeks old, during the second and third weeks of July. Dispersal occurred during the first days of September.

Courtship Characteristics

Goodrich et al. (1996) reviewed the courtship characteristics of broad-winged hawks. Three types of courtship flights have been observed: (1) high circling – This advertising display begins immediately after arrival. The birds are conspicuous and noisy, emitting a peeeurr call. One bird, presumably the male, sideslips or dives downward very close to touching the other. (2) sky-dancing – A bird leaves the perch, flapping upward in widening circles, calling. Then with spread wings and tail, it soars lightly back and forth, still going upward until nearly lost from sight. Then it "descends with long sweeps and curves, terminating with a long dash" horizontal to the ground. (3)tumbling – A circling bird drops toward the earth checking its headlong course just before reaching the ground.

Copulatory behavior starts with the male and female perched apart. The male calls a 2-note wheeooou, then flies to the female. The female turns away. The male alights on her back and copulates for a full minute, calling throughout.

Nest Characteristics

Broad-winged hawk nests are usually placed in the main crotch or against the trunk of a tree (Matray 1974, Powder River Eagle Studies 2000). In the Black Hills, nests are overwhelmingly constructed of pine twigs, although deciduous and spruce twigs are sometimes incorporated (Powder River Eagle Studies 2000). Nests in the Black Hills vary in size, depending upon the size of the supporting crotch. Mean nest dimensions were 46 x 35 cm.

Clutch Initiation and Size

Clutch initiation of broad-winged hawks in the Black Hills occurs from mid- to late May (H. Postovit and B. Postovit, Two Ravens Inc., personal communication). No information was found on clutch size in the Black Hills. In New York, clutch initiation occurred during mid-May and mean clutch size was 2.6 eggs (Crocoll 1984). In Wisconsin, mean clutch size was 2.4 eggs (Rosenfield 1984a).

Parental Care

Lyons and Mosher (1987) described parental care of broad-winged hawks during the nesting season. The adult female does the majority brooding and feeding. As nestlings mature, the female devotes less time at the nest and presumably spends more time hunting for food. The

female removes uneaten parts of prey from nests and frequently appears to retrieve cached items for subsequent feeding bouts. The adult male rarely, if ever, broods the nestlings and spends little time at nests. His visits typically do not exceed three minutes. A male was observed feeding the nestlings at 15 – 17 and 22 – 24 days posthatch. Nestlings leave the nest around 29 – 31 days. After this, young hawks spend much time on branches close to their nest and return for food delivered by parents during brief nest visits.

Rosenfield (1982) observed an unusual case of nest sanitation. The feces from a brood of two broad-winged hawk nestlings had not cleared the nest. An individual adult of a breeding pair entered the nest and nibbled at recently excreted feces. It is believed that the adult consumed the feces.

Site and Mate Fidelity

Adult broad-winged hawks in Wisconsin and Minnesota usually return to nest territories but nest in different trees in subsequent years while the young do not return (Keran 1978). The reoccupancy rate of nest territories from another Wisconsin study was 0.60 (Rosenfield 1984a). When reoccupying a nesting area, broad-winged hawks usually build a new nest in a different tree. Rosenfield (1984a) reported that nests were reused on only five of 28 occasions; three the next year and two the second year.

Little information is available on mate fidelity. Presumably, broad-winged hawks are monogamous. Matray (1974) trapped a pair near the same nest site during two succeeding years, which suggests a pair bond can last greater than one year. Other pairs are known to take new mates between years though (Goodrich et al. 1996).

Demography

Life history Characteristics

The maximum reported age of a broad-winged hawk is 14 years (Goodrich et al. 1996). Average survival of broad-winged hawks banded as nestlings and recovered at a later date was 12.0 months (Keran 1981). Most recorded mortality occurs during incubation and results from predation (Rosenfield 1984a, Crocoll and Parker 1989).

Broad-winged hawks breed as early as one year of age but breeding is delayed until two years of age for most birds (Crocoll 1984). Differences in productivity have been noted between breeding yearlings and adults (Crocoll 1984). The percentage of eggs hatching in breeding pairs containing a yearling was lower than for pairs with two adults. Also, broad-winged hawks that rebuilt nests from the previous year hatched considerably fewer eggs than hawks in new nests.

The mean values for various reproductive parameters of broad-winged hawks in Wisconsin were: 2.4 eggs laid, 1.8 hatched, 1.5 young fledged per nest attempt, and 79% nest success (Rosenfield 1984a). In New York, the mean values for various reproductive rates per nest were: clutch size = 2.6, eggs hatched = 1.9, fledglings = 1.5, fledglings per successful nest = 2.3, and nest success was 67% (Crocoll 1984). In Ontario, fledgling success averaged 1.5 young per nest, 1.7 young per successful nest, and nest success was 88% (Armstrong and Euler 1983).

Survival and Reproduction

Starved or emaciated immature broad-winged hawks are found consistently in Panama during migration (Goodrich et al.1996). Given the extent and duration of migration, mortality during the winter is probably higher for broad-winged hawks than for many other raptors (Goodrich et al.1996).

Social Pattern for Spacing

Nesting density of broad-winged hawks in Minnesota and Wisconsin was estimated at one pair per 3.2 km2 (Keran 1978). Nest density at another Wisconsin site was one pair per 2.4 km2 (Rosenfield 1984a). Distance to the nearest active broad-winged hawk nest in New York was 1,441 ± 331 m and nest density was estimated at 200 ha of forested land per pair (Crocoll 1984).

Local Density Estimates

No estimates of broad-winged hawk densities in the BHNF are available but Powder River Eagle Studies (2000) reported that broad-winged hawks were the second most commonly-encountered raptor, after red-tailed hawks (Buteo jamaicensis), during broadcast surveys in 1996 and 1997.

Limiting Factors

In the BHNF, the single most imminent threat to broad-winged hawks, presumably, is habitat alteration and/or destruction in their summer and winter range. Habitat loss decreases the availability of nest sites, which can limit raptor populations (Reynolds 1983). Broad-winged hawks were detected more frequently in undisturbed, mixed conifer-deciduous forests of Maine than in areas used for agriculture or forestry (Devaul 1990 in Goodrich et al. 1996). However, the impacts of habitat alteration are somewhat uncertain, as broad-winged hawks have been documented to successfully breed in Ontario, Canada in the midst of lakeshore cottage development (Armstrong and Euler 1983). Additionally, migrants are still shot on winter ranges in Mexico and further south where they are viewed as pests, and protective laws are not enforced (Goodrich et al. 1996).

Patterns of Dispersal

Information on natal and adult dispersal of broad-winged hawks is scarce. Only two returns from banded nestlings were found (Goodrich et al. 1996). One was recovered approximately 320 km west of the banding site five years after hatching. The other was recovered five years after banding in the nest area where it was banded. Adults probably reuse the same breeding area for several years (Goodrich et al. 1996).

Community Ecology

Predators and Relation to Habitat Use

Predation in this document is considered killing for food (Taylor 1984). Information on predators and relation to habitat use is scarce, relative to broad-winged hawks. Predators of broad-winged hawk nests include raccoons (Procyon lotor), porcupines (Erethizon dorsatum), great horned owls (Bubo virginianus), and American crows (Corvus brachyrhynchos) (Rosenfield 1984a, Goodrich et al. 1996).

Competitors

Competition is considered the "…negative effects which one organism has upon another by consuming, or controlling access to, a resource that is limited in availability" (Keddy 1989). Intraspecific competition occurs between broad-winged hawks during the breeding season as they have been observed defending home ranges (Goodrich et al. 1996). Fitch (1974) reported on the interspecific interactions between broad-winged hawks, red-shouldered hawks (Buteo lineatus), and red-tailed hawks during the breeding season. Dominance or aggression was not noted between broad-winged hawks and red-shouldered hawks. However, broad-winged hawks and red-tailed hawks were observed with one or two individuals of each kind soaring and making occasional threatening swoops. Aggressive displays towards each species may be related to a dietary overlap. Armstrong and Euler (1983) observed aggressive interactions between red-shouldered hawks and broad-winged hawks. The authors suggested that red-shouldered hawks have an advantage in competition for nesting sites, because they begin nesting earlier.

Parasites, Disease, and Mutualistic Interactions

Goodrich et al. (1996) summarized the available information on parasites, disease, and mutualistic interactions of broad-winged hawks. Larvae of the fly Protocalliphora avium have been found infesting the ear cavities of 18 – 26 day old nestlings. These larvae cause swelling, some bleeding, and scab formation, but are not known to cause mortality. Haemoproteus elani and Plasmodium spp., blood parasites, have also been identified in broad-winged hawks.

Risk Factors

Practices that reduce nesting and foraging habitat quality are presumed to be the major threats to broad-winged hawk viability in the BHNF. Habitat loss decreases the availability of nest sites and prey, which can limit raptor populations (Reynolds 1983). Timber harvest is likely to be the most common cause of habitat loss on the BHNF. Additional risk factors include nest abandonment due to human disturbance, collisions with vehicles, and predation.

Broad-winged Hawk Responses to Habitat Change

Management activities

Timber Harvest

Broad-winged hawks nest in habitats with specific structure. This specificity makes them susceptible to changes in forest stands brought about by timber harvest. It should be noted though that impacts of timber harvest to broad-winged hawks will be unique from site to site depending on the structure of the forest at the time of harvest, the form and intensity of harvest, and the temporal perspective. Mitchell and Millsap (1990 in Goodrich et al. 1996) suggested that short timber rotations of less than 40 years may be inadequate to maintain this species as a breeder in the southern U.S.

The BHNF has proposed the following levels of timber harvest under Alternative G, the preferred alternative (BHNF 1996). Over the next ten years, 5,400 acres per year of precommercial thinning harvests and 25,500 acres per year of commercial harvesting would occur. Several different forms of commercial harvest would occur but the two main forms

proposed are shelterwood seed cuts (15,600 acres/year) and overstory removal harvest (6,100 acres/year), which would combine to 85% of the commercial harvest. Presented below is a discussion of how these forms of harvest might affect broad-winged hawks.

Precommercial thinning occurs in stands with trees too small in diameter to be sold for wood products and it results in decreased sapling density (BHNF 1996). The effects of precommercial thinning are presumed to be minimal to broad-winged hawks as they select stands with larger trees than are randomly available for nesting. However, precommercial harvest could negatively impact broad-winged hawks if the operation occurred in areas adjacent to nest stands during the nesting season.

The objective of shelterwood seed cuts, the primary form of harvest, is to cut all trees except those needed to produce seed to regenerate the stand and to meet future dead stand requirements. Shelterwood seed cuts could have variables influences upon broad-winged hawks. In stands used for nesting, it is possible that these harvests would result in avoidance of the site. Nesting habitat of broad-winged hawks has been described as sites with large trees interspersed with smaller trees. Shelterwood seed cuts would alter these stands so that only a few large trees where remaining. However, creating openings by shelterwood seed cuts might improve habitat for foraging.

The objective of overstory removal harvest, the second most common form of harvest, is to remove the remaining trees that were left to seed the area from the previous seed cut. This form of harvest is presumed to negatively impact broad-winged hawks since remaining perch sites would be removed.

Recreation

The BHNF (1996) measures recreation through both dispersed and developed recreation. Dispersed recreation is outdoor recreation that occurs on all areas of the Forest outside developed recreation sites (BHNF 1996). Developed recreation includes all recreational activities that take place on a developed recreation site (BHNF 1996). Over the next 10 years, the BHNF will construct an estimated 138 miles of new roads and 22 recreation sites for developed recreation. Through the building of roads and new recreation sites, developed recreation will cause habitat loss and potentially increase the incidence of vehicle collisions with broad-winged hawks. The frequency of vehicle collisions is likely to be lower on dirt roads than paved roads due to slower-moving traffic on dirt roads. However, studies have documented that open areas such as roads are used by broad-winged hawks so it is possible that these clearings might be beneficial (Armstrong and Euler 1983). Another risk of developed recreation is that the possibility of nest failure. Site tenacity of most raptors is weakest at the time of territorial establishment, which could make it one of the most critical periods for nest desertion (Fyfe and Lednforff 1976 in Armstrong and Euler 1983). Hohn (1986) reported that broad-winged hawks generally left the nest on the approach of an observer but sat tight when incubation was advanced. Keran (1978) suggested that nest setback from an edge appeared to be related to the amount of noise and disturbance at the opening. Nests were typically closer to woodland trails and farther from gravel roads (Keran 1978). Ultimately, the impacts of human disturbance from recreation to nesting broad-winged hawks are likely to be negligible so long as activities do not occur specifically at the nest site (H. Postovit and B. Postovit, Two Ravens Inc., personal communication).

Livestock Grazing

Livestock grazing throughout the BHNF is common as 84% of Forest lands are suitable. Habitat changes resulting from grazing could be either structural, through modification of vertical diversity, or compositional, through changes in the vegetative species (BHNF 1996). If habitat changes resulting from livestock grazing do not decrease prey populations, it is unlikely that broad-winged hawks will be affected by grazing.

Mining

Effects of ground disturbance from mining could have variable levels of impacts to broad-winged hawks and their prey depending on the extent and intensity of the disturbance. Over time, the most important minerals to the Black Hills economy have been gold, silver, iron, uranium and pegmatite minerals (BHNF 1996). In Idaho, Henny et al. (1994) reported that mining and smelting resulted in high concentrations of lead in Couer d'Alene River sediments and the floodplain downstream, where several species of raptors nested. Measurements of blood characteristics from American kestrels (Falco sparverius) and Northern harriers (Circus cyaneus) indicated higher levels of lead-exposure on treatment sites compared to control sites. However, no raptor deaths related to lead were observed, and the production rates of raptors at control and treatment sites were similar. Several traits of raptors apparently reduce their potential for accumulating critical levels of lead which is primarily stored in bones of prey species (Henny et al. 1994).

The impacts of mining in the Black Hills to nesting broad-winged hawks are likely to be negligible (H. Postovit and B. Postovit, Two Ravens Inc., personal communication). Broad-winged hawks in the Black Hills are known to nest successfully in the vicinity of surface gold mines (Powder River Eagle Studies 2000). Stampfli and Parrish (1987) documented the presence of an active nest less than 400 feet to the east of an active, open-pit, gold mine in the Black Hills. One of the two nestlings fledged and the fate of the other nestling was unknown. Stampfli and Parrish (1987) also reported that broad-winged hawk sightings were common within a 0.5 mile radius of the surface mining activity.

A potential negative impact of mining is from the construction of new roads associated with the development of new mining sites. Increased traffic might increase the likelihood of collisions with vehicles, and the loss and fragmentation of nesting and foraging habitat.

Prescribed Fire

On the BHNF, 5,600 – 8,000 acres are proposed to be burned annually by prescribed fires (BHNF 1996). These burns simulate natural forms of disturbance that occur periodically across the landscape that reduce the density of understory conifers in forests. It is likely that open understories are an important characteristic of broad-winged hawk foraging habitat.

Fire Suppression

"Perhaps the most subtle but far-reaching human effect on the Black Hills has been fire suppression" (Knight 1994). Fire suppression has been a guiding principle for land management in the BHNF. Historically, surface fires every 5 – 25 years characterized ponderosa pine forests, the most common cover type in the BHNF. Burning kills most young trees but usually not the older trees, because of their thick bark. Fire also maintains a more open forest with low amounts

of fuel. How increased tree density interferes effects broad-winged hawks should depend on the degree that tree density increases. If tree density is too high, it could interfere with the ability of the broad-winged hawk to fly and hunt. Additionally, increased tree density could increase the likelihood of crown fires that could cause large-scale, long-term habitat loss. The Elk Mountain Complex Fire and the Jasper Fire are recent examples of this in the BHNF. See the section below on wildfire for a more detailed discussion on the impacts of high-intensity crown fires. Studies that have reported values of tree density at broad-winged hawk nest sites (Keran 1978, Titus and Mosher 1981, Armstrong and Euler 1983) provide a range of values that can serve as guidelines for what broad-winged hawks can tolerate (Table 2).

Table 2. Tree density at broad-winged hawk nest sites .

Maryland – Titus and Mosher (1981)			
Tree DBH	**Density/0.04 ha**	**Random Plot (0.04 ha)**	**Mean Density/ha**
< 25 cm	6.4 ± 5.4	14.6 ± 11.8	160
26 – 50 cm	5.9 ± 2.9	4.8 ± 2.8	148
> 50 cm	0.3 ± 0.7	0.2 ± 0.6	8
Basal area (m^2/ha)		20.3 ± 5.6	19.0 ± 5.7

Ontario – Armstrong and Euler (1983)		
Tree DBH	**Density/0.04 ha**	**Mean Density/ha**
8 – 32 cm	24.6 ± 10.0	615
> 32 cm	4.0 ± 2.8	100

Minnesota and Wisconsin – Keran (1978)	
Tree Density (> 10 cm DBH) per ha	204

Non-Native Plant Establishment And Control

No information was found on the effect of non-native plant establishment and control on broad-winged hawks. There are a number of invasive plants and noxious weeds that may be, or have the potential to be present in areas of the BHNF, including cheatgrass (Bromus spp.), Japanese brome (Bromus japonicus), Canada thistle (Cirsium arvense), bull thistle (Cirsium lanceolatum), Russian thistle (Salsola autralis), spotted knapweed (Centauria biebersteinii), leafy spurge (Euphorbia esula) and perennial pepperweed (Lepidium desiflorum) (R. Olsen, University of Wyoming, personal communication).

Knight (1994) reviewed the impacts of cheatgrass. This exotic species invades areas after a disturbance from nearby sites, leads to the rapid accumulation of a highly flammable fuel, and shortens the fire-free interval. Fires occur more frequently, thereby diminishing the chances of sagebrush reestablishment and causing a decline in some perennial grass species, thus favoring

cheatgrass expansion still further. The ultimate result is a loss in the heterogeneity of the landscape, and probably lowered prey diversity, abundance, and availability for broad-winged hawks. The invasion of this species can be hastened by the burning of areas adjacent to cheatgrass and also by livestock grazing.

Fuelwood Harvest

Fuelwood harvest in the BHNF occurs by individuals that search out dead and down material to cut up for their personal use while in the Forest. It is possible that fuelwood harvest could adversely affect broad-winged hawks if snags are removed that are used as perch sites and if harvest occurs near the nest during the nesting cycle.

Natural Disturbance

Insect Epidemics

The most aggressive and destructive insect in the Black Hills, from the commercial forest management perspective, is the mountain pine beetle (Dendroctonus ponderosae; BHNF 1996). When populations of this beetle grow to large numbers, they are capable of killing many trees and most of the mortality occurs to the large trees (Knight 1994). The insect prefers dense pine stands, containing trees between 17.8 – 33.0 cm (7 to 13 in) DBH (Lessard 1982 in BHNF 1996). Suppression of wildfire this century has resulted in more densely stocked stands of timber that are more susceptible to attack (BHNF 1996). When large-scale mountain pine beetle attacks occur, the likelihood of high-intensity crown fires will increase and possibly result in large expanses of habitat being lost.

Wildfire

Wildfire can have a wide range of potential effects on landscapes of the Black Hills, depending on size and intensity of fire, stand type, fire frequency, and post-fire successional trajectory (Buskirk 2001). In the BHNF, 2,000 – 3,100 acres are burned annually by wildfire (BHNF 1996).

Surface fires every 5 – 25 years have historically characterized ponderosa pine forests in the BHNF (Knight 1994). These low-intensity fires are likely to be beneficial to broad-winged hawks by maintaining open understories and visibility. However, abnormally high fuel build-ups resulting from years of fire suppression have increased the probability of large, catastrophic fires that could destroy vast expanses of habitat. This became apparent during the Jasper Fire of August 2000 and the Elk Mountain Complex Fire of 2001. The Jasper Fire burned 83,000 acres of which 39% burned at high intensity meaning trees were devoid of needles (http://www.fs.fed.us/r2/blackhills/fp/fire/Jasper/Jasper.htm), and the Elk Mountain Complex Fire burnt 26,000 acres. Areas of complete mortality that are far removed from a viable seed source could take as long as 200 years to regenerate (http://www.fs.fed.us/r2/blackhills/fp/fire/Jasper/Jasper.htm). These are long-term, large-scale losses of broad-winged hawk habitat that could possibly decrease population size and viability on the BHNF.

Wind Events

Wind, especially tornadoes and microbursts, is capable of altering the physical structure of forests very quickly, killing large numbers of trees (Veblen et al. 1989). However, these effects are typically small in scale and short in duration so the impacts to the broad-winged hawk population over the long-term are thought to be negligible.

Other Weather Events

Other weather events that could potentially effect broad-winged hawks are cold temperatures, freezing rain, heavy snowfall, and drought during the breeding season. Freezing rain and snowfall during the breeding season could cause high nestling mortality and decreased recruitment. Drought could cause low survivorship of prey nestlings and thus, insufficient prey availability to reproduce successfully.

SUMMARY

Broad-winged hawks are a small, stocky buteo with conspicuous, broad white-and-black tail bands (Goodrich et al. 1996). B. p. platypterus is the subspecies present in the Black Hills. Total length is 33 – 44 cm and mass is 265 – 560 g, with females being slightly larger. Powder River Eagle Studies (2000) reported that broad-winged hawks are a common nesting raptor in the Black Hills of Wyoming and South Dakota. They are a complete migrant; therefore no hawks remain in the Black Hills during winter.

The North American Breeding Bird Survey (BBS) did not detect a trend in broad-winged hawk numbers (+0.63%; P = 0.42) between 1966 and 2000 throughout the entire survey area (Sauer et al. 2001). Counts from migration lookout stations suggest that broad-winged hawk numbers in eastern North America are stable (Bednarz et al. 1990, Latta 1994). No information is available on population trends in the BHNF but Powder River Eagle Studies (2000) reported that broad-winged hawks were the second-most encountered raptor in the northern Black Hills during 1996 – 1997 calling surveys.

Little information is available on the survival rates of broad-winged hawks. Average survival of broad-winged hawks banded as nestlings and recovered at a later date was 12.0 months (Keran 1981). Most recorded mortality occurs during incubation and results from predation (Rosenfield 1984a, Crocoll and Parker 1989).

Breeding is delayed until two years of age for most broad-winged hawks but they occasionally breed at one year of age (Crocoll 1984). Mean ranges of various reproductive parameters for broad-winged hawks are: clutch size = 2.4 – 2.6, eggs hatched = 1.8 – 1.9, young fledged per nest attempt = 1.5, fledglings per successful nest = 1.7 – 2.3, and reproductive success = 67 – 88%. Nesting density of broad-winged hawks in Minnesota and Wisconsin was estimated to range from one pair per 2.4 km2 to 3.2 km2 (Keran 1978, Rosenfield 1984a).

Broad-winged hawks are opportunistic and are capable of utilizing a wide variety of prey (Keran 1978, Rusch and Doerr 1972). During inspections of broad-winged hawk nest sites in the Black Hills, common prey items appeared to be chipmunks, voles, birds, and earthworms (H. Postovit and B. Postovit, Two Ravens Inc., personal communication).

Broad-winged hawks predominately nest in a variety of hardwood tree species across their

breeding range (Rosenfield 1984a). Woodland openings and wet areas are common characteristics of their nesting habitat (Hohn 1986, Keran 1978, Matray 1974, Rosenfield 1984a, Titus and Mosher 1981). Nest trees are larger diameter trees than are randomly available and are interspersed among smaller trees (Titus and Mosher 1987). Nesting habitat of broad-winged hawks in the Black Hills differs from most other studies in two distinct ways: (1) selection for areas with wetlands and upland openings is not apparent (H. Postovit and B. Postovit, Two Ravens Inc., personal communication) and (2) pine trees are the primary tree used for nesting as opposed to deciduous trees. Broad-winged hawks in the Black Hills generally nest in mixed pine/deciduous habitat, sometimes intermixed with spruce (Powder River Eagle Studies 2000). Twenty-five of 27 broad-winged hawk nests were in ponderosa pine trees. Nest trees were generally large with a mean DBH of 40.2 cm and a height of 17.8 m. Nests averaged 10.7 m above ground level, and were most frequently placed against the trunk or in a main crotch. Canopy cover in nest stands ranged from 45-96%, with a mean of 66%. Nest sites usually had minor slopes (< 10%), and aspects varied with most either east, north, or flat.

Loss of nesting and foraging habitat are presumably the greatest risks to broad-winged hawk viability in the BHNF. Timber harvest is the most common form of habitat loss on the Forest but it can also improve habitat. The impacts from timber harvest depend on the location, method, intensity of harvest, and temporal perspective.

It is unlikely that the levels of recreation, mining, and livestock grazing proposed under Alternative G by the BHNF (1996) would have important effects on broad-winged hawk viability. Prescribed fire could benefit broad-winged hawks by killing understory plants that cause abnormally high densities of vegetation in the forest. Fire suppression in the area might adversely affect broad-winged hawks by increasing tree density and causing high fuel build-up. High fuel build-up might result in high-intensity wildfires that destroy vast expanses of nesting habitat. The effects of non-native plant establishment and control in the BHNF is unknown. The effect of fuelwood harvest to broad-winged hawks in the BHNF likely depends on the form and extent. Over the long term, insect disturbances and weather events are unlikely to adversely effect broad-winged hawk viability on the BHNF as the species has evolved with these disturbances.

REVIEW OF CONSERVATION PRACTICES

Management Practices

The Migratory Bird Treaty Act of 1972 protects broad-winged hawks throughout their range. Management practices in North America that specifically target broad-winged hawks are rare. On the BHNF, an ecosystem management approach has been used in an attempt to follow the guidelines in the National Forest Management Act and its implementing regulations. The goal is to manage for a mix of habitats across the entire Forest to provide for species diversity and viability while also managing for different uses. With respect to individual species such as broad-winged hawks, the impacts of activities on the Forest are assessed before they occur and an attempt is made to mitigate negative impacts. Successful ecosystem management on the Forest is often a difficult task due to the large number of species with diverse habitat needs and the large number of management activities such as timber harvest, recreation, mineral extraction, etc. Other than these assessments, management activities by the BHNF specifically for this

species are limited.

Several authors have made management suggestions for other species of hawks that use similar habitats as the broad-winged hawk. Reynolds (1983) recommended that managers attempting to maintain populations of Cooper's hawks in western coniferous forests: (1) leave uncut areas of approximately 6 ha should be left around active nests, (2) management of Accipiter habitat must consider the turnover of nest sites due to time. Prospective replacement nest sites within the home range of each pair should be selected and managed accordingly, (3) active and prospective nest sites should not be precommercially or commercially thinned, because this will result in reduced stand densities and deeper tree crowns, and (4) determine the desirable nesting density and maintain the landscape so that an appropriate number of nest sites are available.

Forest management recommendations from Kennedy (1988) were: (1) search all proposed timber sales for Accipiter nests during the nestling stage, (2) leave uncut areas of approximately 10 ha around active nests, (3) do not isolate nest sites by silvicultural treatments such as clearcutting or total canopy removal, (4) minimize logging of riparian canyons as these areas tend to have large-diameter trees and provide nesting habitat, (5) in areas where commercial thinning occurs, create brush piles to provide habitat for medium-sized mammals such as cottontails or chipmunks, (6) if commercial thinning occurs at a nest site, maintain a minimum of 10 snags/ha, and (7) minimize human disturbance near nest sites during the breeding season.

Models

There are no models we are aware of that model habitat, effects, or other items of interest to broad-winged hawk managers.

Survey and Inventory Approaches (presence/absence)

Several techniques are used to survey and inventory the presence of broad-winged hawks. The use of different techniques depends on the scale of the area to be inventoried. Throughout North America, the BBS (Sauer et al. 2001) and CBC (Sauer et al. 1996) are used to survey broad-winged hawk presence and to inventory population trends. A strength of these surveys is that data are collected throughout most of North America in an attempt to detect rangewide trends. Some weaknesses are that many people are needed, it is very time consuming to compile and analyze all the data, and statistical significance is often low.

At a smaller scale, yearly surveys can be conducted for breeding raptors, which are aimed at identifying and protecting habitat, and estimating local population trends. The BHNF does not maintain a collection of historical broad-winged hawk nest sites on the Forest (Rob Hoelscher, BHNF, personal communication). If such information was collected, it would provide habitat use information specific to the Black Hills from which the impacts of future management activities could be more accurately mitigated. Methods used to survey breeding raptors include visiting historical nest sites to assess reoccupancy and the playback of conspecific calls to increase detectability of raptors (Rosenfield et al. 1988). Broadcast surveys using great horned owl or conspecific calls can increase the detectability of broad-winged hawks (Balding and Dibble 1984, Mosher and Fuller 1996). Timing of the surveys is important because broad-winged hawks are secretive during the incubation phase of nesting. Response rates to surveys are highest after hatching, which is usually around 4 July through 15 July (H. Postovit and B. Postovit, Two Ravens Inc., personal communication). Surveys using conspecific calls across the

entire BHNF would require a significant amount of time and money. A more cost-effective option would be to survey historical nest sites and areas of concern such as proposed timber harvest sites.

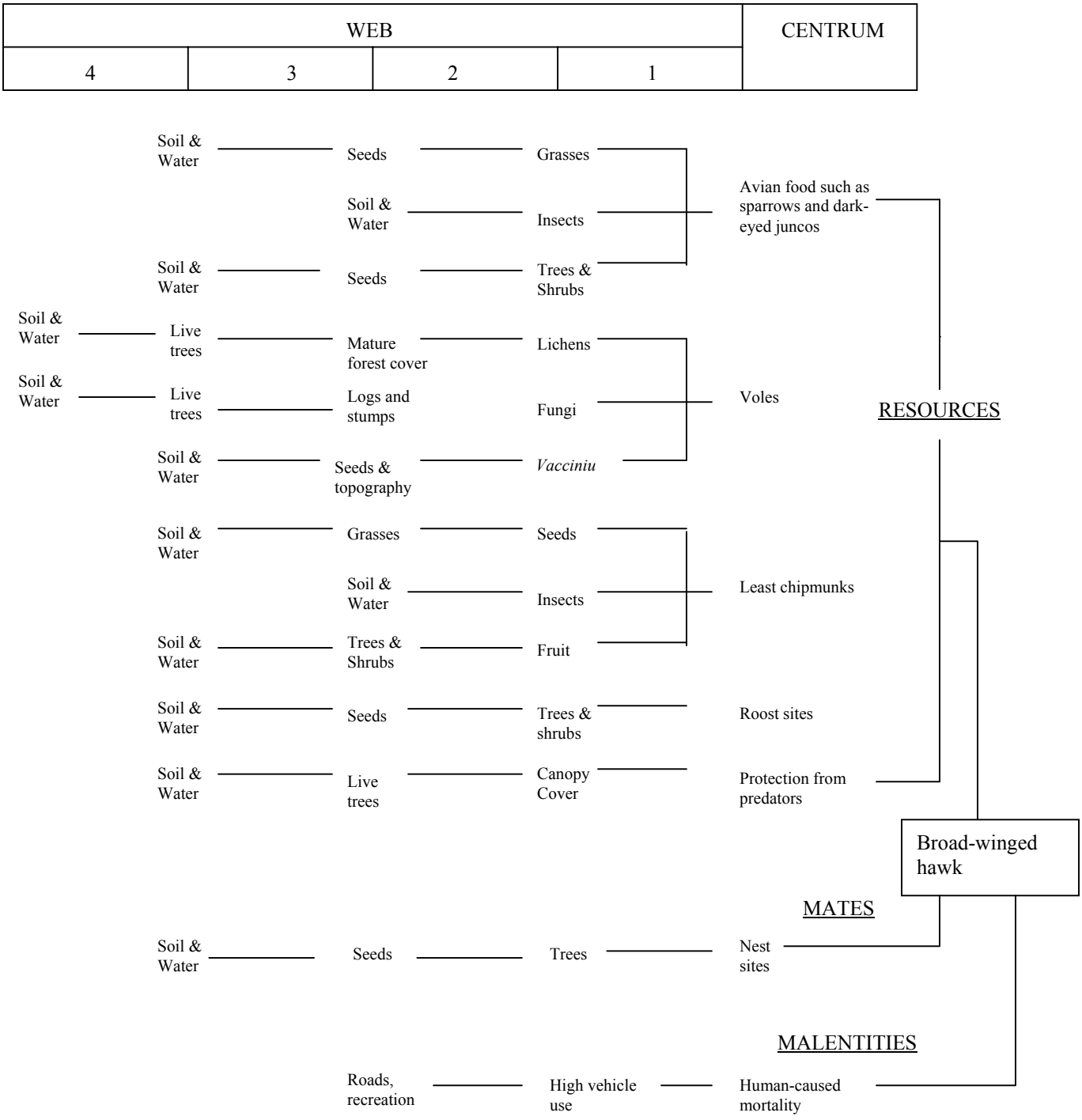
Monitoring Approaches (habitat, population trend, presence/absence and persistence)

The BBS, CBC, searching historic nest sites to monitor nest reoccupancy, and the systematized searching of new areas for signs of breeding activity are approaches used to monitor broad-winged hawks that have already been discussed above. Migration counts, banding, and radio telemetry are additional methods that monitor habitat, population trends, presence/absence and persistence. Migration counts can establish population trends over periods of time. A limitation associated with migration counts is that multiple years of data are required before meaningful estimates of population trends can be made. Also, the counts do not assess where the birds originated so the application of the data to specific areas such the BHNF is limited. Banding can also be used to study survivorship and dispersal. A disadvantage of banding is that a sometimes unrealistically large number of bands are needed due to low recovery rates. Keran (1981) reported that the return rate for banded broad-winged hawks was 1.2%. A radio telemetry study of broad-winged hawks nesting within the BHNF would be beneficial by providing home range and habitat use information during the breeding season, and possibly, the timing of migration. Problems associated with this technique are that radio telemetry equipment is expensive, acquisition of the data is time consuming, and broad-winged hawks occur at low densities in the BHNF. Low densities of breeding broad-winged hawks could result in questions about the statistical validity of the data due to a small sample of radio telemetered birds.

ADDITIONAL INFORMATION NEEDS

Currently, management directives aimed specifically at broad-winged hawks on the BHNF are limited. Initially, data of historical nest sites on the Forest should be collected. Additionally, these nest sites could be monitored on a yearly basis. Information from nest monitoring would establish population trend, reoccupancy rates, recruitment rates, and habitat use information of nest sites. If habitat use information were collected at multiple spatial scales (i.e., nest tree, within-territory, and the landscape level), the data would provide a clearer picture of the overall nesting habitat needs. Ideally, nestlings should be banded so that information on survival and dispersal might be collected. A radio telemetry study of broad-winged hawks within the BHNF would be beneficial by providing information about home range and habitat use, including foraging habitat, during the breeding season. Habitat requirements specific to the BHNF would be the ultimate goal of such a study and would better enable managers to mitigate the impacts of management activities to broad-winged hawks.

Figure 1. Enviro-gram representing the web of linkages between the broad-winged hawk and the ecosystem in which they occur.



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DEFINITIONS

Adult dispersal – distance between the previous and present year's nest site.

Complete migrant - all individuals of a population migrate away from the breeding area during the winter.

Intraspecific competition – competition between organisms of the same species.

Interspecific competition - competition between organisms that are different species.

Natal dispersal – movement between birth place and breeding site.