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Conservation Assessment for the Western Burrowing Owl in the Black Hills National Forest, South Dakota and Wyoming

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INTRODUCTION

The western burrowing owl (*Athene cunicularia hypugaea*) inhabits prairie grassland, desert and shrub steppe ecosystems of Midwestern and western North America. These ecosystems are some of the continent's most manipulated wildlife habitats. Thus, remaining grassland is at further risk to perturbation by human hands. This report assesses the biology and conservation status of the burrowing owl in the Black Hills National Forest (BHNF) of South Dakota and Wyoming. The goal of this assessment is to assimilate historical and current literature on the burrowing owl and to provide managers and the general public with an objective overview of this species status within the Black Hills. In general, peer-reviewed scientific literature was used in this report; however, use of unpublished federal and state government reports, as well as academic documents (Master's theses) provided additional, valuable insight. Little has been published specific to the burrowing owl in the Black Hills region of South Dakota and Wyoming. Therefore, extrapolation of information across geographic lines was necessary. This extrapolation assumed that behavior and biology of burrowing owls was similar across geographic regions. Efforts were made to use literature that was based on geographic areas as close to South Dakota and Wyoming as possible.

Areas Of Uncertainty

Extrapolation of information across geographic lines can be cause for concern. Few regions across the United States and Canada are an exact match in grassland species composition, elevation, etc., so behavior of burrowing owls in the Black Hills may be different from owls on the west coast. Unfortunately, little has been published on the burrowing owl in the Black Hills so extrapolations were necessary.

CURRENT MANAGEMENT SITUATION

Management Status/Existing Management Plans

Habitat loss, fragmentation and alteration of the prairie ecosystem have contributed to burrowing owl declines. The reduction and fragmentation of the black tailed prairie dog (*Cynomys ludovicianus*) dominated ecosystems over the past 100 years has likely had the strongest impact on burrowing owl populations. The burrowing owl has experienced both local and regional population declines and is listed in most of the 18 states and four Canadian provinces in which it occurs (Sheffield 1997). Within Canada the burrowing owl is considered a species in decline and is listed as either threatened, endangered or extirpated throughout the provinces where studies have shown severe population declines (Ayers et al. 1999). The Canadian Burrowing Owl Recovery Team suggested that the species is declining at about 16% per year (Erickson 1987). Since 1971 the burrowing owl has been on the journal of *American Birds'* Blue List, indicating that bird researchers identify it as a declining species (Arbib 1971, Buchanan 1997).

In the United States the burrowing owl was considered a Category 2 Candidate Species for federal listing through 1996. This designation was discontinued however and the current management status has yet to be reviewed (Ayers et al. 1999). Of central interest to this report is

the status of the burrowing owl in South Dakota, Wyoming and neighboring western states. South Dakota, Wyoming, Montana, Nebraska, North Dakota, and Idaho all list the burrowing owl as a species of special concern (Sheffield 1997).

The burrowing owl is listed on South Dakota's Natural Heritage Species List (NHSL). Birds are included on this list because of few sightings and/or questions about breeding status, abundance and distribution. The NHSL ranks species according to rarity and risk of extirpation on a 1-5 scale, with 1 being rarest and most at risk, and 5 being secure. The burrowing owl is assigned a 4 on this scale (Peterson 1995).

In Wyoming the burrowing owl is listed as a Species of Special Concern, Category 4, which indicates the species is widely distributed and population status and trends are unknown (Luce et al. 1999).

REVIEW OF TECHNICAL KNOWLEDGE

Systematics/Taxonomy

The American Ornithologists' Union (AOU) (1983) placed the burrowing owl in the genus *Athene*, but revised the classification to include *Speotyto* in 1991. Eighteen subspecies of the burrowing owl are currently recognized. Three occur in North America, three in Central America (two of which are extinct) and the remaining twelve in South America. Desmond and Savidge (2001) demonstrated a genetic split between North American and South American owls, which is consistent with species level distinction. This report addresses the western burrowing owl subspecies *A. c. hypugaea*.

The western burrowing owl is a semi-fossorial bird of the short grass and mixed-grass prairie (Trulio 1997). Males and females are nearly identical in size and weight, with males ranging from 19.5-25.0 cm and females ranging from 19.0-25.0 cm in length and both sexes weighing about 150 gm (Haug et al.1993).

Adults are sandy brown above, with white spots on their crown, back and wings. They are white below with brown barring. Burrowing owls have a white throat and upper breast separated by a dark collar. The head is round, without ear tufts. The face shows white eyebrows with yellow eyes (Farrand 1988). As the brood rearing season progresses the male shows marked lightening of its plumage due to extended exposure to the sun. Some male owls may appear almost white at times. As the female emerges from the nest burrow after brooding, she is distinctively darker than the male.

The western burrowing owl is a ground dwelling, diurnally active species, but primarily forages at crepuscular and nocturnal hours. Long-legged, they can be seen perched on fence posts, short bushes such as sagebrush (*Artemesia tridentata*), and on burrows of fossorial mammals.

Distribution And Abundance

Overall Range

The western burrowing owl ranges throughout western North America. All states directly south

from North Dakota and west to the Pacific Coast report burrowing owls. Canadian provinces include British Columbia, Alberta, Saskatchewan, and Manitoba. Occurrence is variable in well-drained grasslands, steppes, deserts, prairies and agricultural lands (Haug et al. 1993).

Local Distribution

The South Dakota Breeding Bird Atlas (Peterson 1995) considers the burrowing owl an uncommon and scattered species across the state. It reports sightings in almost every county west of the Missouri River, and in about half of the counties east of the Missouri River.

The South Dakota Ornithologists' Union (SDOU 1991) considers the burrowing owl a locally common summer resident in the western part of the state except for the Black Hills region where it is rare. In the eastern part of the state it is considered uncommon. There are reports of sightings of breeding burrowing owls in the Black Hills region of Wyoming (Luce et al. 1999). Because burrowing owls in South Dakota and Wyoming probably rely heavily on prairie dogs for nest burrows, it is likely that they will be locally common within areas that support prairie dog colonies.

Local Abundance

No studies have directly addressed abundance of burrowing owls on BHNF lands; however, the SDOU considers the bird rare in the Black Hills region. Burrowing owls in the area are directly tied to the presence of black-tailed prairie dogs for nest burrows. Within BHNF boundaries there are approximately 40.5 hectares of prairie dog towns (B. Phillips per. comm.). Of this total area, one colony is approximately 32 hectares, and the rest are small and scattered. Although specific surveys for burrowing owls have not been conducted, owls have not been observed using the colonies (B. Phillips per. comm.). Based on the few references and small area of available habitat it is assumed that local abundance of burrowing owls is low.

Population Trends

Both the Breeding Bird Survey (BBS) (Sauer et al. 2000), and the Christmas Bird Count (CBC) (Sauer et al. 1996) show long term declines in burrowing owl populations in both the United States and Canada. Although the numbers do show ocilating trends, between 1966 – 1994, the BBS shows an overall 0.6% decline per year. Trends of states within the region are: Nebraska (+ 6.0%), Colorado (- 3.8%), North Dakota (+ 4.2%) and South Dakota (- 5.8%) (Sheffield 1997). Wyoming showed a 37% decline for the time period 1971-1996 (Korfanta et al. 2001) however, BBS trends for WY may be suspect because of small sample sizes (N. Korfanta per. comm.). Reasons for population declines include destruction and alteration of burrowing owl breeding and wintering habitat and most notably loss of black-tailed prairie dog colonies (Sheffield 1997). However it should be recognized that the BBS probably does not provide accurate information on burrowing owl trends due to the patchy distribution of prairie dog populations.

Broad Scale Movement Patterns

Northern populations of burrowing owls are migratory. Little is known about the routes and timing of migration. Birds from Canada and the northern U.S. are thought to migrate south between September and October, and return north between March and April (SDOU 1991, Haug et al. 1993). Breeding burrowing owls banded in the central states have been recovered during

winter months in North Dakota, Iowa, Nebraska, Arkansas, Oklahoma, Texas, Missouri, and Mexico illustrating southward movement (SDOU 1991, Haug et al. 1993). Little is known about burrowing owl winter ranges or habitats, especially within the United States and Mexico. Holroyd and Wellicome (1997) reported that prairie dog colonies in northeastern Mexico held more burrowing owls in the winter than they did in the summer, suggesting that owls use similar habitat in the winter and summer.

Nomadism in burrowing owls is doubtful. A study in Saskatchewan suggested that they are not nomadic. In 1997 there was an outbreak of meadow voles (*Microtus pennsylvanicus*) on the Regina Plain. The same year the burrowing owl population hit a historic low. The next year vole populations were down and the burrowing owl population made a significant increase. This shows an asynchronous response to prey populations, and refutes any signs of nomadism in the studied population (Poulin et al. 1998).

Habitat Characteristics

Habitat Requirements

Historic burrowing owl breeding habitat is short grass prairie, desert and shrub steppe, but as these systems have been altered, owls have come to occupy other habitats as well. Haug et al. (1993) described burrowing owl habitat as "dry, open, shortgrass, treeless plains, often associated with burrowing mammals. Also golf courses, cemeteries, road allowances within cities, airports, vacant lots in residential areas and university campuses, and fairgrounds." This description encompasses many open habitats that might occur in the modern western landscape, rural or urban.

Most habitat descriptions include level, open areas with low grass cover, available burrows, and perch sites (MacCracken et al. 1985a, Johnsgard 1988, Haug et al. 1993). Prairie dogs, particularly black-tailed prairie dogs, are of central importance for providing nest sites for burrowing owls. Prairie dogs also manipulate grasses and forbs to provide optimal cover around nest sites for owls (MacCracken et al. 1985a, Korfanta et al. 2001). Burrowing owls have been reported to nest in the burrows of several other mammals as well including badgers (*Taxidea taxus*), ground squirrels (*Spermophilus* spp.), marmots (*Marmota* spp.), skunks (*Mephitis* spp.), armadillos (*Dasypus novemcinctus*), kangaroo rats (*Dipodomys spectabilis*), and tortoises (*Gopherus agassizii*) (Haug et al. 1993).

A study conducted south of the BHNF in the Conata Basin found that burrowing owls were selecting for vacant black-tailed prairie dog burrows with specific ground cover specifications (MacCracken et al. 1985a). Nest burrows had lower vegetation height than the surrounding prairie. Blue gramma (*Bouteloua gracilis*) was the dominant grass cover at non-nest burrows while buffalo grass (*Buchloe dactyloides*) was dominant around active nests. The authors gave several reasons why burrowing owls might select vacant prairie dog burrows. First, nest burrows had greater cover of annual forbs by the time the nestlings emerged from the burrow. This may have allowed for concealment of the young while still allowing adults to observe the area. Second, the annual forb cover probably meant that the burrow was recently vacated by prairie dogs and thus would be in better shape and have less chance of caving in. Finally, nest burrows were in sandier soil than non-nest burrows. This probably allowed for easier modification of the burrow by the owls and aided in draining soils before nests could be flooded in rainstorms

(MacCraken et al. 1985).

Very similar results were found in a study of burrowing owls in eastern WY. Again, owls were selecting for vacant black-tailed prairie dog burrows that were surrounded by vegetation in early successional stages (Thompson 1984). Although plant species composition was different, annual forbs surrounded the nest burrow as compared to perennial grasses and low shrubs at non-nest burrows. Also the sand content of nest burrow soils was higher than non-nest burrows. Finally, burrowing owl nests in the study were within at least 1 km of agricultural land. These areas, and areas adjacent to agricultural lands, proved to be important hunting grounds for the owls studied (Thompson 1984).

Caution should be used when considering the standard of active nest burrows being near agricultural land. The author did not specify actual search area. Agricultural lands are often searched more thoroughly because there are higher densities of roads. This could lead to the false conclusion that owls select for areas near croplands when other areas simply are not searched as rigorously. Desmond and Savidge (1996) found similar numbers of owls in agricultural and range dominated habitats in western Nebraska.

Though the studies cited above suggest that vacant prairie dog burrows are preferred by burrowing owls, others refute this claim and propose the owls actually evict prairie dogs from the burrows. This is evidenced by fresh scat at nest or satellite burrow entrances. Additionally adult owls may keep prairie dogs out of those burrows while they were being used by juvenile owls (Desmond and Savidge 1999). Further evidence showed that prairie dogs would quickly take over a burrow if an owl nest failed (Griebel 2000).

Burrowing owl literature indicates that prairie dog colonies, low ground cover, sandy soils, and available perches are important characteristics for breeding habitat. Prairie dog towns within BHNF lands have many of these characteristics and may support a burrowing owl population. Desmond et al. (1995) demonstrated that the size of the prairie dog colony occupied by owls was important in determining distribution of owls within that area. Prairie dog colonies that were greater than 35 ha showed owls clustered within that area. Colonies that were less than 35 ha supported a random distribution of owls. Because the largest colony within the BHNF is approximately 32 ha owls are probably randomly distributed throughout the colonies.

Food Habits

On the basis of numerical abundance of prey items, the burrowing owl's summer diet consists mainly of insects (Johnsgard 1988). Large insects such as beetles (order *Coleoptera*), grasshoppers (order *Orthoptera*), crickets (order *Orthoptera*) and dragonflies (order *Odonata*) are major prey items. Although insects represent the majority of prey items taken, small mammals and birds comprise most of the biomass of the burrowing owl diet, particularly during winter months (Thompson 1984, Haug et al. 1993).

MacCracken et al. (1985b) found burrowing owls in South Dakota consumed a wide variety of animals and some vegetation. Through pellet analysis it was found that insects were the most abundant prey item with small mammals the next most abundant. Shifts in frequency of prey items were observed. Mammals were most often found in pellets in May, June and July, and decreased in August and September. Insects were observed more frequently as mammal remains decreased.

Thompson (1984) also conducted a pellet analysis on burrowing owls in eastern Wyoming. On average, insects represented 66.5% of prey items taken, and made up 27% of the biomass of food. Small mammals made up the remainder of prey items, with 33.5% of total prey items and 73% of the biomass. Mammals most often recorded in pellets were Wyoming ground squirrels (*Spermophilus elegans*), thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*), and deer mice (*Peromyscus maniculatus*). The most common insects were darkling beetles (*Tenebrionidae*), ground beetles (*Carabidae*), hister beetles (*Histeridae*), and grasshoppers (*Acrididae*).

It should be noted that pellets might not encompass all prey items that owls are taking. Birds, reptiles and amphibians have been observed being eaten by owls without their remains showing up in pellets (Thompson 1984, MaCracken et al. 1985, Haug et al. 1993, Duxbury and Holroyd 1998). It is clear that burrowing owls are opportunistic feeders and take a wide variety of prey within a certain size range.

Breeding Biology

Migratory populations of burrowing owls normally return to breeding areas in March or April. Owls may arrive singly or in pairs. Upon arrival, males occupy burrows, prepare them for nesting and begin courtship and territorial displays (Johnsgard 1988, Haug et al. 1993).

Courtship Characteristics

Courtship flights typically consist of the male rising rapidly, then hovering or circling in tight circles over the nest burrow (Thomsen 1971). Other displays observed include the male and female in close contact, preening and rubbing bills. The male may also present the female with food, and sing his primary call (Johnsgard 1988, Haug et al. 1993). Copulation usually ensues. Martin (1973) found copulation to occur mainly during the first hour after sunset and was seen up to 8 times in 35 minutes. Before and after copulation, both sexes typically display the "White and Tall" stance. The male stands tall, shows his white facial patches, and ruffles his feathers. The female also exposes her white facial feathers, but she does not ruffle her feathers or stand as erect as the male (Haug et al. 1993).

Nest Characteristics

Western burrowing owls generally use prairie dog burrows for nesting. However, they will use the burrows of other mammals as well, e.g.: badgers, ground squirrels, marmots, skunks, armadillos, kangaroo rats, and tortoises (Haug et al. 1993). Often the owls renovate a nest burrow. Both sexes are known to dig excess material from the burrow walls and floor. Nest burrows have been found to be in sandier soil than unused burrows (Thomsen 1971, Thompson 1984, MacCracken et al. 1985a, Haug et al. 1993).

Eggs are laid within a burrow chamber in a nest lined with dry grasses and other plants. Males often line the burrow chamber and entrance with cow or horse dung, which is thought to provide insulation and mask the scent of the nest from predators (Green and Anthony 1989).

Clutch Initiation And Size

Clutch initiation dates vary. In the western United States eggs may be laid from late April to

mid-August (Voous 1989). Bent (1938) reported dates for the Dakotas to be May 1 to June 13.

Clutch size is reported to be 6 – 11 eggs (Bent 1938). Within the Great Plains, Murray (1976) showed an increase in clutch size from east to west. The female starts incubation with the first egg laid and continues for 28 - 30 days (Thomsen 1971, Haug et al. 1993).

Parental Care

Only the female broods. This presumably continues until the young can thermoregulate (Haug et al. 1993). The male provides food for the female who in turn will feed the young. Haug et al. (1993) reported that feeding is so exclusive to the female that if she dies, the young will die even though the male continues to bring food to the burrow. After 3 – 4 weeks the female will join the male in hunting, stimulated by calls of the young and thereafter both sexes will feed the young (Martin 1973).

Within prairie dog colonies (and probably other burrow systems) adults use food to lure chicks away from the nest burrow and to spread them out among other burrows. This action is likely a defense against predation as it will be less likely that a whole brood will be lost if they are spread out (Desmond and Savidge 1999).

Mate And Site Fidelity

Burrowing owls reflect a predominantly monogamous mating system, although polygny has been reported (Haug et al. 1993). Martin (1973) found that, though monogamous, burrowing owls probably do not create permanent pair bonds. Through banding it was determined that of nine pairs of owls, no pairs were renewed between study years in New Mexico.

Non-migratory populations show a high degree of site fidelity (Haug et al. 1993). There may be site fidelity exhibited by migratory burrowing owls as well. Of nine male owls banded in New Mexico, six returned the next breeding season and specifically sought out their previous years' burrow (Martin 1973). In Saskatchewan, 74% of reencountered adult birds returned to the same pastures that they previously inhabited (Haug et al. 1993). However, the literature reflects that differences may occur geographically. In a Colorado study, of 555 owls that were banded, 513 owls (92%) were never reencountered after the banding year (Plumpton and Lutz 1998). Similarly in other Canadian studies philopatry appears to be rare in burrowing owls (De Smet 1997).

Demography

Life History Characteristics

Burrowing owls nest in loose aggregations in prairie dog colonies or as solitary pairs. Usual clutch size is 6-11 eggs (Bent 1938). Burrowing owls are able to breed at one year of age with an interval of one year between breedings (Haug et al. 1993).

Survival And Reproduction

Reproductive success varies geographically and temporally. In New Mexico a study found that 4.9 young were produced per owl pair and fledging success was 94% (Martin 1973). In California, Thomsen (1971) found that owls produced 2.7 young per pair, with 33% fledging

success.

Differences in fledging success between urban and natural settings have also been studied in New Mexico. Owls in urban settings had higher chick production and fledging success (78%) than natural settings (64%) (Botelho and Arrowood 1996).

A current study in New Mexico indicates no difference in reproductive success between urban and grassland sites, influences on reproductive success differ between the areas. For owls nesting in re-established prairie dog colonies fledging success was negatively associated with nearest-neighbor distance. Reproductive success for owls nesting in urban areas was positively associated with numbers of pairs nesting in the area. These results are likely related to the availability of burrows for nest sites in the two habitats (Berradeli and Desmond unpub. data).

Griebel (2000) found that burrowing owls nesting in prairie dog colonies in Buffalo Gap National Grassland, South Dakota, had higher fledging success when several parameters were met. Higher fledging success was accomplished when nests were in burrows that had been used by owls the previous year; successful pairs also had earlier clutch initiation dates. Greater nearest neighbor distances appeared to positively effect nest success. In 1999 the most successful nest was 296 m from its nearest neighbor, and in 2000 was 267 from its nearest neighbor. Burrow length to the nest also appeared to be a factor with a mean length of 2.3 m being optimal.

In more isolated colonies in western Nebraska, nearest-neighbor distance for owl nests averaged 125 m. Prairie dog density and nearest-neighbor distance positively influenced reproductive success, but not in all years. Year to year variation was attributed to prairie dog control, which led to artificially low prairie dog numbers within the colonies (Desmond unpub. data, Desmond and Savidge 2000). Prairie dog control is likely the reason for differences in results of studies conducted in western Nebraska and neighboring South Dakota.

Survival of burrowing owls is not well studied. Through banding data, one bird was found to have survived nearly nine years in the wild (Haug et al. 1993).

Social Pattern For Spacing

Burrowing owls can be found nesting in loose colonies, thus densities can vary widely across locations. One New Mexico study found 15 pairs along 3.7 linear kilometers of habitat (Martin 1973). A California study found 10–15 pairs on 355 acres of highly urbanized habitat (*Barclay* 1998). In North Dakota, Murphy et al. (1998) found a density of 0–3 pairs per 100 km^2. The Nebraska panhandle supported a mean of 0.85 pairs per ha with a range of .01–5.0 pairs per ha (Desmond 1991). Densities within the BHNF are not known, however they may be quite low due to the limited amount of suitable habitat available to the birds.

Territorial behavior is most common during periods of pair formation. Displays include posturing, such as *standing* tall and exposing white facial patches (Johnsgard 1989). Thomsen (1971) suggested three methods by which male burrowing owls maintained territories: primary call, posturing displays, and direct physical contact. Haug et al. (1993) reported that owls only defend territories against other burrowing owls and that only burrows are defended, while feeding areas are not.

Just as densities of *owls* can vary widely home range sizes can vary as well. Thomsen (1971)

suggested that owls in her California study occupied home ranges averaging .8 ha in size with a range of 0.04–1.6 ha. In Saskatchewan, six radio tagged males averaged home ranges of 2.41 km^2 with a range of 0.14 – 4.18 km^2 (Haug and Oliphant 1990).

Local Density Estimates

No information is available on local density estimates in the BHNF. However, it is probable that densities and populations are low. This statement is based on the fact that suitable habitat within the BHNF is limited.

Limiting Factors

Many authors cite habitat as the greatest limiting factor affecting western burrowing owls. Declines in owl populations throughout their range are often attributed to destruction of suitable grassland habitat and prairie dog colonies. Short grass prairie habitat and prairie dog populations are a fraction of what they historically were (prairie dogs have declined 90-98% since the turn of the century) (Desmond et al. 2000). Numerous studies have found high densities of owls in urban settings however this cannot be construed as optimal habitat. Declines of burrowing owl populations are reported in almost every region in which they occur and extirpation has taken place in several parts of their former range such as western Canada. The destruction of prairie dog colonies, caused by the conversion of short grass prairie habitat for agriculture, competition with cattle, urbanization and in some cases plague is one aspect of the burrowing owl's decline. Though, the overall causes of burrowing owl population declines are probably complex and multi-faceted and cannot be attributed to one activity, loss of black-tailed prairie dog colonies is likely the major cause. Within the BHNF suitable burrowing owl habitat is scarce. Impacts to prairie dog colonies may create the greatest limiting factors to burrowing owls within the BHNF.

Community Ecology

Predators And Relation To Habitat Use

Burrowing owls are susceptible to a variety of predators. Weasels (*Mustela* spp.), skunks (*Mephitis* spp.), foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), and raccoons (*Procyon lotor*) are all capable of digging up and killing nestlings and brooding females (Wellicome 1997); however, North American badgers are by far the greatest predator on burrowing owls (Desmond et al. 2000). Specifically, owls that nest in prairie dog colonies with reduced numbers of prairie dogs show significantly higher susceptibility to badger predation. The prairie dogs within the colony presumably act as the preferred food source. Birds of prey including Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), red-tailed hawk (*Buteo jamaicensis*), and Cooper's hawk (*Accipiter striatus*), merlin (*Falco columbarius*), prairie falcons (*Falco mexicanus*), and peregrine falcons (*Falco peregrinus*), great-horned owls (*Bubo virginianus*), and American crows (*Corvus brachyrynchos*) will prey on burrowing owls (Haug et al. 1993). Rattlesnakes (*Crotalus* spp.) also prey on owls.

Although humans are not considered a major predator of burrowing owls, some shooting mortalities do occur during the course of prairie dog shooting. Killing of burrowing owls may or may not be intentional by shooters.

Competitors

Interspecific competition for burrows likely includes prairie dogs or ground squirrels. Burrowing owl studies demonstrate that owls will use either abandoned burrows or may evict prairie dogs or ground squirrels from active burrows (Haug et al. 1993, N. Korfanta per. comm.). With regard to competition for food, most grassland raptor species exploit larger prey species than burrowing owls; however, Swainson's hawks probably compete on a lower level for insects.

Parasites and Diseases

Owls in California were found to carry sticktight fleas (*Echidnophaga gallinacea*), human fleas (*Pulex irritans*), and lice (*Colpocephalum pectinatum*) (Thomsen 1971). *P. irritans* generally parasitizes wild carnivores, especially those that inhabit burrows or caves (Smith and Belthoff 2001).

Hunter et al. (1987) reported that 5 juvenile burrowing owls died due to an infestation by the respiratory tract nematode, *Cyathostoma americana*. The source of the infestation was unknown, however it was thought that it was a result of the owls having had access to earthworms, which are intermediate hosts, and to shrews (*Blarina brevicada*) and star-nosed moles (*Condylura cristata*), which may act as paratenic hosts.

Risk Factors

The greatest risk factors that burrowing owls face in the Black Hills region include severe overgrazing and failure to protect prairie dog towns. Roughly 40.5 ha of prairie dog colonies exist within the boundaries of the BHNF. Assuming that these colonies are in suitable condition for burrowing owls, there may be birds present. However, this area is so small that only a small population could exist. Therefore any detrimental effects will have relatively large, population-wide repercussions for burrowing owls in the BHNF. Certain grazing and fire regimes would benefit prairie dogs, which would indirectly benefit burrowing owls. Pesticides, over grazing and conversion of land to agriculture may pose the greatest risk to burrowing owls in the BHNF.

Response To Habitat Changes

Management Activities

Timber Harvest

Forestry and silvicultural practices should have no foreseeable effect on burrowing owl populations within the BHNF. Suitable burrowing owl habitat in the BHNF is exclusively short grass prairie or similar short grass environs where no trees persist.

Recreation

Recreation could have detrimental effects on burrowing owls in the BHNF. In parts of the burrowing owl's range, prairie dog shooting is common. Shooters, using large caliber rifles set up on colonies and may spend days firing at prairie dogs. Although most shooters consciously avoid birds of prey that are within the colony, burrowing owls may be a casualty of shape. Owls perch on top of burrows, or within burrow entrances, exposing only their heads. At long range (even with high power scopes) a burrowing owl has a similar shape to a prairie dog and may be

inadvertently shot. Burrowing owls inhabiting colonies with recreational prairie dog shooting appear to adjust to the noise and presence of people. They have been observed staying within 50 m of people as they are shooting (A. Johnson per. comm.); however, impacts on reproductive success have not been measured.

Other forms of recreation within grasslands are rare. Disturbance from off-road vehicles is probably minimal to burrowing owls, unless there is driving directly through nesting areas and over active burrows. An indirect effect that recreationists may have is the introduction of dogs into nesting areas. Thomsen (1971) found that within her California study area, dogs accounted for 20% of damaged burrows.

Livestock Grazing

This section focuses on a number of relationships; first, the relationship between prairie dogs and burrowing owls. Burrowing owls within the BHNF rely on prairie dogs to create nest burrows. Thus, grazing effects on prairie dogs may filter down to affect burrowing owls. The second relationship is between ungulates and prairie dogs. There are complex herbivory interactions that take place between these animals. Again this means that the relationship may have indirect effects on burrowing owls within prairie dog colonies. Much of this discussion will focus on the complex relationships between burrowing owls, prairie dogs and ungulate grazers.

Prairie dogs are often associated with intensively grazed areas. A study conducted in Montana suggested that prairie dogs might colonize areas after soil disturbance caused by intensive grazing. Colonization occurred at stock water sites and homesteads suggesting that prairie dogs arrived only after disturbance occurred (Knowles 1986). This might imply that within the BHNF, grazing could increase prairie dog and possibly, burrowing owl numbers. This is dependent; however, on grazing levels being kept at a threshold where severe overgrazing does not take place.

Ungulate/prairie dog interactions have been studied extensively, focusing on the relationship with bison (*Bison bison*). Prairie dogs tend to concentrate on grasses while feeding. This has several implications for plants within colonies. Clipping graminoids stimulates new growth and secondarily causes the competitive release of forbs. Bison, and other ungulates such as cattle, are drawn to these areas to graze the new grass shoots. Pronghorn antelope (*Antilocapra americana*) were found to prefer forbs (Detling 1998). Grazing helps keep ground cover low, which benefits both prairie dogs and burrowing owls in predator detection. Also, as ungulates graze, they drop nitrogen in the form of urine, which aids in regrowth of grasses and forbs, and the cycle continues.

Since burrowing owls will use abandoned prairie dog colonies, but require short vegetation, it can be speculated that cattle grazing may allow burrowing owls to persist in these colonies. However, Desmond et al. (2000) suggested that owls that used abandoned prairie dog colonies did poorly reproductively (mainly due to predation) and eventually abandoned the area themselves. A North Dakota study found burrowing owls were present in heavily and moderately grazed areas (by cattle) as opposed to lightly grazed and mowed areas (Kantrud 1981).

Based on the symbiotic relationship between ungulates and prairie dogs it seems reasonable that grazing in the BHNF could benefit burrowing owls. However, overgrazing and over stocking of

cattle in these areas may decrease any benefits and lead to detrimental effects.

Mining

There are no studies currently published that directly address the impact of mining on burrowing owls. However, mining may be an important consideration, as the largest underground gold mine in North America exists in the Black Hills at Lead. The final Black Hills National Forest Environmental Impact Statement (USFS 1996) remarks that, "Most National Forest System land is open for mineral entry under all alternatives unless formerly withdrawn or controlled by some other congressional action." Also, it is stated that oil and gas are the only known leasable minerals on the BHNF. Thus, there is the possibility that areas containing burrowing owls could be explored and eventually exploited of minerals. It has been suggested that burrowing owls are one of the least affected raptors by human disturbance (Martin 1973). Unless there is physical destruction of habitat and nest sites, owls appear to tolerate many disturbances. Studies have looked at owls within airport grounds, golf courses and on university campuses (Thomsen 1971, Botelho and Arrowood 1996). Therefore, it might be assumed that mineral exploration and the mining of oil and gas might not disturb the birds enough to cause them to leave or for them to experience decreased productivity or increased mortality. This assumes however that habitat destruction is not wide spread.

Prescribed Fire

Like grazing, the effect of fire is perhaps best discussed in the context of the relationship of owls, prairie dogs and ungulates. It has been speculated that bison and cattle may be so attracted to prairie dog towns that they will over-select these areas to graze. This leads eventually to suboptimal foraging (Coppock and Detling 1986). One method for attracting cattle away from prairie dog colonies is using prescribed burning to stimulate new grass growth in other areas.

Prescribed burning will probably have little effect on burrowing owl habitat other than reducing standing dead grasses, forbs and litter. This may be especially important in abandoned prairie dog colonies, where cover is not browsed. Burning may increase prey items as shown in ponderosa pine/grassland ecotones in the Black Hills (Bock and Bock 1983).

Fire Suppression

The natural fire regimes of the Great Plains grasslands were between 2 – 25 years (Knight 1994). Like fire suppression in forested landscapes, grasslands accumulate standing dead material and litter in years when burning does not occur. Accumulation of this biomass has several consequences. The main effect will be hotter than normal fires when they do finally occur. Grassland plants tend to have perennating buds that are close to the ground. In cool fires, perennating buds are not damaged as heat travels upward, and the plants regenerate quickly after the fire is out. In hot fires with accumulated ground litter, the perennating buds and root crowns in the soil can be burned, killing the plant (Knight 1994).

The effect of this cycle on burrowing owls may be negligible, however there are caveats. Through fire suppression, wildfires have the potential to kill large areas of vegetation in an owl's home range. If this occurs, prey availability could be limiting. It could be argued however that standing dead grasses are cropped by prairie dogs in areas that burrowing owls are expected to nest in the BHNF, so intense fires should not occur in these areas. Roughly 40.5 ha of prairie

dog colonies exist within the BHNF. These towns are currently active, and are grazed by cattle, as is the surrounding landscape (B. Phillips per. comm.). Therefore, accumulation of standing dead grass and litter should be minimal and it is probable that fire suppression in these areas will have little consequence to burrowing owls.

Non-Native Plant Establishment And Control

Currently there is no information published on burrowing owls and non-native plant invasion. Speculation can be made however on whether non-native plants would have any effect. 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 tectorum*), Japanese brome (*Bromus japonicus*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium lanceolatum*), Russian thistle (*Salsola australis*), spotted knapweed (*Centauria biebersteinii*), leafy spurge (*Euphorbia esula*) and perennial pepperweed (*Lepidium desiflorum*). Within Thunder Basin National Grassland in northeastern Wyoming, burrowing owls use habitat dominated by cheatgrass. This non-native grass invades primarily after disturbances and out-competes native grasses. In the early stages of its growth cattle will eat cheatgrass. Once cured though, it becomes unpalatable to most ungulates and becomes a highly flammable fuel source (R. Olsen per. comm.). Cheatgrass grows quickly, and produces prolific amounts of seed, which may be eaten by small mammals and birds (McMurray and Longland 1997). Growth can be in patches or large expanses. Burrowing owls are generalist with regard to habitat use and foraging areas. Therefore just as owls hunt in stands of sagebrush, rabbit brush, croplands, and short grass plains, they may hunt within areas of cheatgrass or other non-native plants; however, this relationship is not well documented and does not appear to be well understood.

We could not find information on chemical control of noxious weeds and effects on burrowing owls or prairie dogs. Proper application of herbicides is important to reduce drift to non-target species. Guidelines generally include using materials of low volatility in air temperatures less than 24 degrees Celcius; with greater than 50 % humidity and in winds less than 10 km per hour (Heady 1994). Tests conducted on mammals and birds showed that normal application of chemicals such as 2, 4-D had no toxic effects. The question of effects on burrowing owls; however, would likely involve effects on prey species such as insects. We do not know what indirect effect herbicides might have on burrowing owls, their prey base or prairie dogs.

Fuelwood Harvest

Taking of wood products will have no foreseeable effects on burrowing owls within the BHNF.

Natural Disturbance

Insect Outbreaks

Within grassland ecosystems the most likely insect to reach outbreak levels is the grasshopper (*Orthopteran* spp.). These outbreaks are most often associated with drought conditions (Knight 1994). Burrowing owls feed on grasshoppers (Thomsen 1971, Thompson and Anderson 1988, MacCracken et al. 1985b), thus an outbreak of these insects would probably have positive effects on the burrowing owl population.

Wildfires

Wildfires should have no direct effect on burrowing owls. If fire were to break out within nesting areas, owls would either fly to safer locations or go underground. Indirect effects would be seen on prey species. Small mammals would temporarily lose food sources. Grasshoppers however, may benefit from hot fires. Grassland soils, after hot fires, may mirror drought condition soils, which tend to harbor large stores of grasshopper eggs. In drier times, these eggs are able to hatch, possibly because certain hydrophilic bacteria are not present, which suppress the viability of the eggs (Knight 1994). Thus, wildfire could boost the availability of this food source for the owls.

Wind Events

Wind events will have no foreseeable effect on burrowing owls. Again, because they can go underground, burrowing owls are able to find safety from most aboveground weather events.

Other Weather Events

Burrowing owls return to Great Plains breeding areas between March and April. Heavy rain can cause collapse of nest burrows and can contribute to both young and adult mortalities (Haug et al. 1993). Additionally, burrowing owl aggregations in close proximity to agricultural land may be threatened by runoff after heavy rain events. The possibility of spring snow and/or ice storms or extreme cold spells may pose a threat to owls. Soil is a good insulator; however if cold and snow persist for extended periods, the owls will most likely show signs of stress.

SUMMARY

The western burrowing owl is declining throughout much of its range in North America. It is considered endangered in all the Canadian provinces. In the United States, the burrowing owl is not federally listed, but in most states where it occurs, it is considered endangered or a species of special concern (Sheffield 1997). Declines in populations of burrowing owls are attributed almost solely to destruction and alteration of black-tailed prairie dog colonies and suitable habitats.

Optimal burrowing owl habitat is short grass prairie, desert and shrub steppe associated with colonial burrowing mammals. Due to agricultural development and extermination of prairie dog colonies, these historic habitats have begun to disappear. But the burrowing owl has taken advantage of other habitat opportunities. The owl can be found in urban centers in states such as California, Florida and New Mexico, taking up residence on airports, golf courses, university campuses and highway right-of-ways. This alludes to the fact that burrowing owl habitat requirements may be met in semi-urban landscapes, wherever burrows, short vegetation and a prey base are found. However, urban habitats have also been considered sinks where large numbers of fledglings get hit by cars, and direct human encroachment is a major issue. Occurrence is variable in well-drained grasslands, steppes, deserts, prairies and agricultural lands (Haug et al. 1993).

As mentioned above, burrowing owls are almost invariably tied to burrowing mammals such as prairie dogs, ground squirrels and badgers for nest sites, as these owls do not normally excavate their own burrows. Owls will however, alter burrows with their wings and feet. Soils of active

burrows tend to have higher sand content than unused sites (MacCracken et al. 1985a, Thompson 1984).

Burrowing owls are generalists in their food habits. Small mammals and insects are mainly taken, however birds, amphibians, reptiles, and even crustacean remains have been reported around nest burrows.

Burrowing owls are migratory in their northern range, but exact patterns of migration are not known. Owls banded in the Great Plains have been recovered mainly in Oklahoma and Texas. Winter populations are also known to exist in California and Mexico. The owls may seek similar habitat in the winter to what they seek during the breeding season.

The factor most limiting to burrowing owls in the Black Hills is lack of suitable habitat. There are only about 40.5 ha of prairie dog colonies available within BHNF lands. Any major disturbance to these areas that alter or destroy foraging and nesting sites may result in local extirpation. Because of site fidelity exhibited by burrowing owls, and the isolation of suitable prairie dog colonies in the BHNF, if these sites are destroyed there are no immediately adjacent alternative sites for burrowing owls to inhabit within the BHNF. It has been reported in the literature that owls use ground squirrel colonies, and badger holes, but prairie dogs are presumed to be the only animals within the BHNF that are able to support colonies of burrowing owls.

It is legal to shoot prairie dogs in the BHNF though colonies are difficult to access. Shooting could be considered a direct threat to the burrowing owl. Most people who shoot prairie dogs do so at long range and targets are not always clear. A burrowing owl head emerging from a burrow looks very similar to a prairie dog head at 150 m away. Cattle graze these areas as well. Besides severe over grazing there are no obvious threats from this activity yet identified to the burrowing owl. In abandoned towns, grazing may help keep the birds in the area; however, the viability of abandoned colonies as nesting sites is in question.

REVIEW OF CONSERVATION PRACTICES

Management Practices

California has begun to implement several management practices to preserve burrowing owls in the state. Five protection methods were used: 1) protecting existing habitat, especially nest burrows 2) evicting owls and allowing them to move to a new burrow within their nest territory (passive relocation), 3) allowing owls to move to newly created habitat patches, 4) actively moving birds to new burrows outside their nesting territory but within their geographic location (active relocation), and 5) reintroduction of owls into new geographic regions (Trulio 1997). Results of these strategies were mixed. Protection of existing habitat calls for long term data collection so no results were given. Passive relocation worked well as long as replacement burrows were placed within 75 m of the original burrows. Five of six relocated pairs immediately moved to replacement burrows. The use of new habitat patches also seems to have promise. Three new pairs of owls settled a newly closed landfill 1 km from existing occupied habitat. This area had a large population of ground squirrels. Active relocation had poor results, as 17 of 27 owls disappeared from relocation sites. Reintroduction efforts showed similar results to relocations. None of three reintroduction programs in Manitoba, British Columbia and Minnesota resulted in self-sustaining populations (Trulio 1997).

Sheffield (1997) reviewed conservation practices that were implemented for burrowing owls in Canada. Artificial burrows led to the establishment of small colonies of owls. Also, the installation of perches aided hunting and predator detection. Pesticide label restrictions and warnings are used with chemicals harmful to burrowing owls. Protection of private lands from cultivation and reseeding has occurred and mandatory mitigation of developmental impacts, in and around active colonies, is being implemented in some areas.

Within the BHNF, management practices should focus on protection and expansion of available habitat. So little suitable habitat is available that small impacts are likely to have large implications for owls present. If these areas are severely impacted, it is likely there will be no other places on BHNF lands for them to go. Given the poor success of reintroduction programs elsewhere, efforts should be made to retain the species and its habitat in this area.

Models

Lutz and Plumpton (1997) used a Leslie matrix model to project population growth over time of a burrowing owl population on the Rocky Mountain Arsenal National Wildlife Refuge (RMANWR) in Colorado. Models were set up as a population of birds using "good" and two combinations of "fair" habitat including "increasing fair" and "average fair". "Good" habitat had no implication for population persistence. Their models suggested that the RMANWR could act as a source population only if a combination of 'good' and 'increasing fair' habitat were available and used by the birds. If 'good' and 'average fair' habitat were used, models suggested a declining population.

Survey And Inventory Approaches

There are several different techniques used to survey for burrowing owls. The simplest method is to observe prairie dog or ground squirrel colonies and look for owls. Call-playback can also be used to elicit vocal and visual responses, which increases detectability. Finally, burrow by burrow searches can be done to find individual nest sites. Thompson (1984) confirmed actual nest sites through four criteria: 1) The presence of whitewash, pellets or prey remains around the mouth of the burrow, 2) The presence of dried manure, feathers, or dried vegetation, which were used to line the entire burrow, 3) Visual observations of owls modifying the nest burrow or placing lining material within it, and 4) visual observation of juvenile owls.

Martell et al. (1997) developed a special survey protocol for burrowing owls in the Badlands National Park in South Dakota. Point-transect survey methods were employed on a number of prairie dog colonies. Transects were established through the middle of a town and survey points were spaced at 300m intervals. Observers stopped at each point for 10 minutes to look and listen for owls. The colonies were visited six times each. Data were analyzed using the area occupied method. This statistical technique was developed to estimate the proportion of an area that is occupied by a species, thus providing an index of a species abundance. This study resulted in a 49% probability of detecting an owl at any occupied station (Martell et al. 1997).

Within the BHNF, survey techniques should be relatively simple. The largest prairie dog colony is approximately 32 ha. Simply establishing transects and checking each burrow in the colony could be accomplished in relatively little time. Other prairie dog colonies are small enough that simple observation will reveal whether burrowing owls are occupying the area or not.

Monitoring

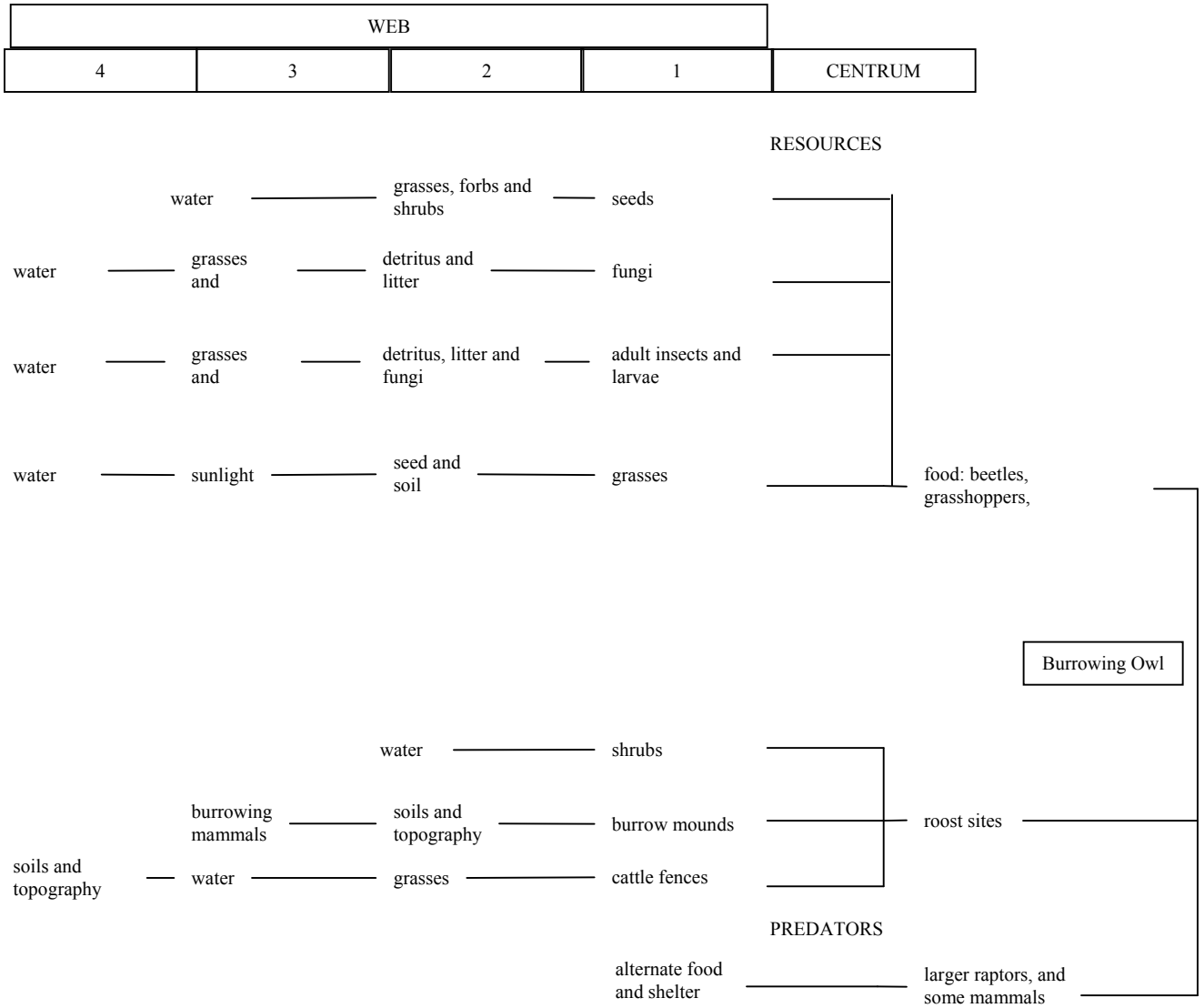
Banding is a common method for monitoring migratory bird species. However, data for banding burrowing owls is extremely limited due to low recovery rates. After banding, burrowing owls seem to simply disappear. Banding can be useful though in trying to identify birds that have returned to breeding areas.

The Christmas Bird Count (CBC) and the Breeding Bird Survey (BBS) have been used to monitor burrowing owl populations (Sheffield 1997, Sauer et al. 1996, Sauer et al. 2000). These techniques have been criticized though because the effort to detect owls is not standardized (Holroyd and Takats 1997). Neither the CBC nor the BBS record many owls. BBS methods are not well suited to burrowing owls because the birds are so locally patchy. If a BBS route does not run through a prairie dog town or ground squirrel colony, then no owls will be recorded (N. Korfanta per. comm.).

ADDITIONAL INFORMATION NEEDS

Presently within the BHNF no burrowing owls have been recorded within suitable habitat, i.e. prairie dog colonies (B. Phillips per. comm.). This is probably due to the lack of a concerted effort to locate birds. Currently we believe the greatest need is to determine presence or absence of owls within the BHNF. If owls are present, the probability of detecting birds should be high. Once it is established that burrowing owls are present, more accurate management decisions can be made with regard to burrowing owls specific to the BHNF of South Dakota and Wyoming.

Figure 1. Envirogram of the burrowing owl in the Black Hills National Forest.



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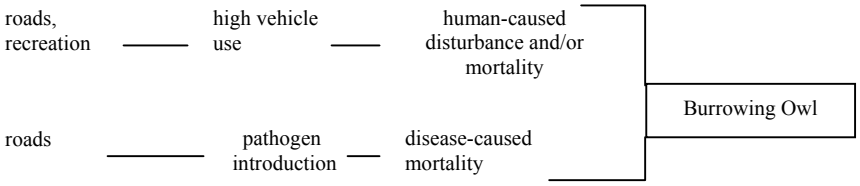

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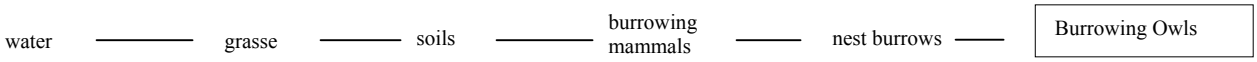

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DEFINITIONS

Diurnal – Active during daylight hours.

Extirpated – To remove totally.

Fidelity – The degree of restriction of a species to particular situation or community.

Fossorial – Adapted for digging or burrowing.

Interspecific competition – Between species; between individuals or populations of different species.

Intraspecific competition – Within a species; between individuals or populations of the same species.

Perennating buds – Plant parts such as rhizomes, bulbs, and buds that enable many plants to live more than one year.

Symbiotic – Describes an association between two species that live together in direct contact; when beneficial to both organisms, the symbiosis is referred to as mutualism.