SPECIES ASSESSMENT FOR PYGMY RABBIT (*BRACHYLAGUS IDAHOENSIS*) IN WYOMING

prepared by

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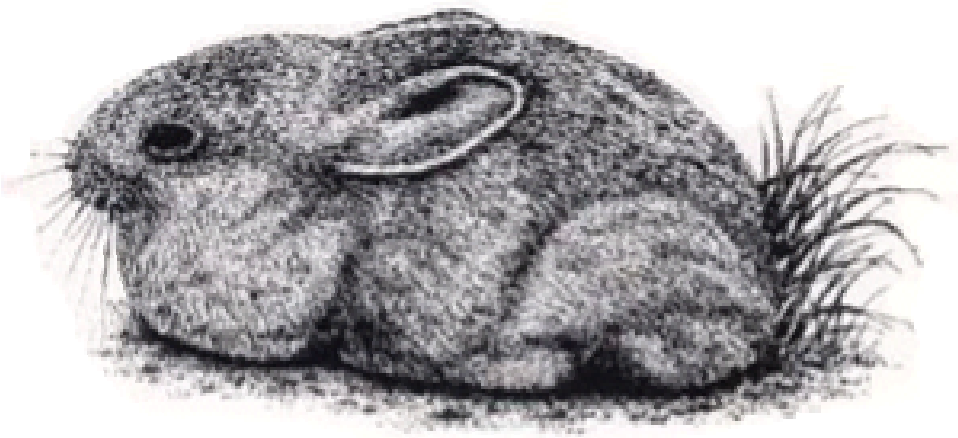

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Table of Contents

Introduction

The pygmy rabbit (*Brachylagus idahoensis*) is the smallest of any North American rabbit species. It was first described as *Lepus idahoensis* in 1891 by Meriam (Meriam 1891). It is endemic to sagebrush habitats in the Great Basin and adjacent intermountain areas and typically occupies tall and dense sagebrush patches. Pygmy rabbits are dietary specialists on big sagebrush. They are considered a keystone species in big sagebrush communities because they don't thrive in habitats dominated by other shrub species, they exhibit a unique fossorial behavior, other species of vertebrates and invertebrates use their extensive burrow system, and they provide a reliable food supply for terrestrial and avian predators (Wilson and Ruff 1999). This species is locally threatened in parts of its range by alteration of sagebrush steppe habitat resulting in fragmented and isolated populations vulnerable to extinction.

Natural History

Morphological Description

Pygmy rabbits are the smallest rabbit species in North America, their weight ranges from 375-435 grams (0.83-0.96 lbs) for males and 246-458 grams (0.54-1.0 lbs) for females and are 250-290 mm (9.8-11.4 inches) in total length (Clark and Stromberg 1987). Females tend to be slightly larger than males as adults. They have a buff gray to slate gray coat often tipped with brown, on their upper parts, that is long and silky when new in the fall but turns silvery gray when worn in mid-winter (Figure 1). Their legs, chest, and nape are typically tawny, cinnamon brown. Their abdomen is typically clear white tinged with buff hairs. Hind legs are relatively short as compared to other rabbits and their feet are comparatively wide and heavily haired. Hind feet range from 65-72 mm (2.5-2.8 inches) in length. They have short ears (36-48 mm, 1.6-1.9 inches) that are

thickly furred inside and out (Figure 1b), a short inconspicuous tail (20-30 mm, 0.8-1.2 inches) that is buff to tan and not white on the underside (Clark and Stromberg 1987, USFWS 2001). The pygmy rabbit is distinguishable from other Leporids by its small size, short ears, gray color, small hind legs, distinctive hopping motion, and lack of white on the tail. Pygmy rabbits may also produce alarm vocalizations in response to threats, which is uncommon among leporids (Green and Flinders 1981).

Taxonomy and Distribution

The pygmy rabbit is a member of the family Leporidae, which includes hares and rabbits. This species was formerly included in the genus *Sylvilagus* (Diersing 1984), but was later placed into its own monotypic genus, *Brachylagus,* based on analysis of skull and dental characteristics, molt cycles, serum and hemoglobin patterns, as well as ecology and behavior (Jones et al. 1992, UWFWS 2003). There are no recognized subspecies of pygmy rabbit.

The Washington state, or Columbia Basin, population is a geographically isolated and genetically distinct segment that has been disjunct from the remainder of the species for at least 10,000 years (Lyman 1991, USFWS 2001). This isolated group is classified as a distinct population segment by the USFWS, but it is not recognized as a distinct subspecies at this time (Green and Flinders 1980b).

Current resource managers are interested in more definitively establishing the range-wide genetic diversity of the pygmy rabbits, because there are questions of connectivity between fragmented areas of occupation (see below). Of primary concern at a recent western meeting dedicated to pygmy rabbits (Grenier 2003) was whether those rabbits in the Great Basin (Idaho, Utah, and Wyoming) are genetically divergent from those elsewhere in the species range.

Pygmy rabbits are distributed across most of the Great Basin and parts of adjacent areas in the intermountain western United States. Their range extends from southeastern Oregon to northeastern and east-central California, across northern and central Nevada to northwestern and central Utah, southern Idaho, southwestern Montana, and southwestern Wyoming; they also occur as an isolated population in east-central Washington (Figure 2).

The distribution of this species is not continuous within this range but is patchy, primarily in plains dominated by big sagebrush (*Artemesia tridentata*) and alluvial fans where shrubs occur in dense stands, and the soil is relatively deep and friable (Green and Flinders 1980a and 1980b, Dobler and Dixon 1990, USFWS 2001). The local distribution of this patchy habitat and thus the distribution of pygmy rabbits likely shifts over time in response to disturbances such as fire, flooding, grazing, and crop production as well as weather patterns. Historically, dense sagebrush along permanent and intermittent stream corridors, alluvial fans, and sagebrush flats probably provided travel corridors and dispersal habitat for pygmy rabbits between appropriate core areas (Green and Flinders 1980b). Since European settlement of the Great Basin states, dense sagebrush habitat has been converted for agricultural use and fragmented by development and grazing. Fossil records suggest that pygmy rabbits were more widely distributed and more abundant prior to 7,000 years ago than they have been anytime since this period. Gradual climate changes that have affected the distribution and composition of sagebrush communities is thought to have resulted in a gradual reduction of pygmy rabbit range within the Columbia Basin during the late Holocene (3000 years before present) (USFWS 2001).

Habitat Requirements

General

A variety of factors influence habitat use by pygmy rabbits. Pygmy rabbits depend upon stands of tall, dense sagebrush in conjunction with deep, friable soils, the combination of which provides cover, food, and burrows (Figure 3). They often occupy patches of sagebrush with the greatest canopy cover. Studies have shown that pygmy rabbits Idaho occupy sites where shrub cover and height are significantly greater than the surrounding landscape (Gabler et al. 2001, Green and Flinders 1980a). They are vulnerable to avian predators, so shrub cover and adequate access to escape burrows are important components of habitat used by pygmy rabbits. Often there are extensive well-used runways beneath the sagebrush canopy that serve as travel and escape routes for pygmy rabbits in core use areas and corridors between patches of foraging habitat (Green and Flinders 1980a).

The most important determinants of habitat suitability for pygmy rabbits seem to be the presence and structural complexity of sagebrush and the texture of soil. In general pygmy rabbits inhabit big sagebrush (*Artemesia tridentata*) habitat in areas where big sagebrush grows in tall, dense stands (Orr 1940, Green and Flinders 1980a and 1980b, Weiss and Verts 1984, USFWS 2001, 2003). The actual measure of sagebrush height and cover in which the rabbits are found seems to vary by locality. Reported shrub height and cover of occupied pygmy rabbit habitat, which is usually dominated by sagebrush, has been reported from 30 cm to 84 cm and 20% to 46% respectively (e.g., 84 cm and 28% in Weiss and Verts 1984; 56 cm and 46% in Green and Flinders 1980a; ~30cm and 20% in Gabler et al. 2001). Despite this variation, in virtually all cases, the stands in which rabbits are found are significantly taller and denser than other stands in the area of occurrence (Green and Flinders 1980a, Weiss and Verts 1984, Dobler and Dixon 1990, Gabler et al. 2001) and selecting areas within those sagebrush stands that have the greatest relative densities

of shrub cover (Orr 1940, Green and Flinders 1980a). This suggests that pygmy rabbits are selecting for greater relative cover rather than for a specific cover threshold. They are very dependent on sagebrush to provide both shelter and food throughout the year, although they do not appear to be associated with a certain subspecies of *A. tridentata* (e.g., Weiss and Vert 1984).

During a study of habitat use in southwest Wyoming, Katzner (1994) found that pygmy rabbit use areas had more, taller, and wider sagebrush (usually *Artemesia tridentata tridentata*) and less non-sage ground cover than non-use areas. Use areas also had significantly greater vertical shrub structure (over 10 cm from the ground), while non-use areas had denser ground cover of forbs and low shrubs. Among use sites, the highest use occurred in areas with greater vertical structure. These sites often had more snow accumulation and the rabbits were found to make extensive use of the subnivean environment. These findings are supported by unpublished data from Wyoming (Chris Garber pers. comm.) that suggests pygmy rabbits are found predominantly where a dense canopy of sagebrush occurs with a similarly dense sagebrush understory. In this study, surveys of historic areas found that when the understory of sagebrush was reduced, generally due to heavy grazing pressure, one was less likely to find pygmy rabbits. Katzner (1994) further found that higher use areas tended to have a greater dead sage component to the overstory, which, when considered with the above-noted use of areas with high structural diversity, may indicate a preference by pygmy rabbits for decadent sagebrush stands. Some of Katzner's findings in Wyoming are somewhat contradicted by Gabler et al. (2001), whose studies in Idaho suggest that occupied burrows have a dead shrub component less than or equal to non-use areas and a live shrub component greater than non-use areas.

There is some disagreement on what other aspects of vegetative cover are important to pygmy rabbits. Some studies suggest pygmy rabbits favor areas with relatively little herbaceous ground

cover (Weiss and Vert 1984, Katzner 1994), while Gabler et al. (2001) showed forb cover to be greater on occupied burrow sites than unoccupied sites. Green and Flinders (1980a) found that although total grass and forb biomass did not statistically differ between pygmy rabbit use and non-use sites, areas with abundant rabbits had more forb cover and less grass cover than elsewhere. These differences again imply geographic variation in habitat use and suggest possible ecological differentiation of the Wyoming population.

Pygmy rabbits are one of only two Leporids known to excavate their own burrows (the other being the volcano rabbit, *Romerolagus diazi*; USFWS 2003), but they may also use burrows from other animals (e.g. badgers and marmots) when available, and occasionally holes among volcanic rocks, stone walls, and abandoned buildings. Areas with relatively deep, stable soils are necessary for burrows which pygmy rabbits depend upon for protection from predators, severe weather, and as a secure location for raising young (Bradfield 1974, Weiss and Vert 1984). Gabler found active burrow sites on areas with a greater percent sand (81.0%) and lower percent clay (5.1%) than non-use areas (51.6% sand, 14.4% clay). There is likely a range of sand-to-clay proportions that is capable of holding a suitable burrow, but this proportion probably varies geographically with soil types and surficial geology. Further, most burrow systems in Idaho seem to occur in areas with relatively little topography at the landscape scale, since the mean slope near burrow sites was 8.6% (range 0% – 25%; Gabler et al. 2000). However, the actual burrow entrances take advantage of local relieve, as they are often in the side of a small rise (Dobler and Dixon 1990) and at the base of a sagebrush plant. Burrows are often simple arced tunnels several meters in length with an entrance on both ends, less than 1 m beneath the soil surface, having no distinct chambers, and sometimes having a lateral passage that may or may not lead to a third entrance (UWFWS 2003, Green and Flinders 1980a and 1980b, Bradfield 1974).

Pygmy rabbits are active year round and dig extensive tunnels in the snow to access sagebrush forage during the winter when it compromises as much as 99% of there diet, but there appear to be no major seasonal shifts in pygmy rabbit habitat use patterns.

Area Requirements

Pygmy rabbits tend to have relatively small home ranges during the winter and have been documented remaining within 30 meters (98 ft) of their burrows (Orr 1940, Janson 1946). However, Bradfield (1974) documented that some burrow systems are expansive and may extend up to 100 meters (328 ft), particularly in snow. This indicates that while activity is focused around burrows during winter months, it may span a larger area than would be indicated by a single burrow entrance. Limited research suggests that pygmy rabbits have larger home ranges in the spring and summer (Orr 1940, Janson 1946, Gahr 1993). Research from Washington indicates that during the breeding season females make short movements within a small core area and have home ranges covering approximately 2.7 hectares; males tend to make longer movements and their home ranges, which cover approximately 20.2 hectares and overlap several female home ranges (Gahr 1993). These figures are larger than suggested by data elsewhere, including Wyoming (USFWS 2003, Katzner and Parker 1997, WDFW 1995). Research in southwestern Wyoming during the winter indicates that pygmy rabbit home ranges are highly variable between individuals, especially between males and females, and that they frequently overlap (Katzner 1994), indicating that defined territories are not defended. Katzner (1994) documented home ranges of pygmy rabbits within Fossil Butte National Monument, WY that ranged from 0.05-0.35 hectares among females and from 0.33-1.8 hectares among males.

There is evidence of long distance movements among pygmy rabbits for example Gahr (1993) documented rabbits traveling up to 1.2 km (0.75 mi) from their burrows and Katzner (1994) documented rabbits traveling up to 3.5 km (2.17 mi) during an apparent dispersal.

Landscape Pattern

It is unknown how the landscape-level pattern of sagebrush affects pygmy rabbit populations. We know that the type of sagebrush habitat described in the above sections (dense, tall, and structurally complex with little understory vegetation) is currently very fragmented throughout the west, causing a similarly patchy distribution of pygmy rabbits throughout their range. Interestingly, this type of sagebrush habitat may not have been more prevalent or contiguous before human settlement (Dobler and Dixon 1990). Thus, pygmy rabbits may have coped with such fragmentation for centuries. However, the local distribution of these habitat patches has likely shifted across the landscape in response to disturbance (e.g., fire, flood, land-use change) and weather patterns, and rabbit distribution has analogously shifted. Given increasingly restrictive land-use pressures, the natural shift in the sagebrush mosaic has likely been altered potentially hindering the ability of pygmy rabbits to cope. Moreover, it may be that currently documented declines are a delayed result of a long-term trend in sagebrush habitat that was occurring before human settlement and has been accelerated by that settlement. There has been no research that would allow us to make this determination.

In the absence of direct study, we can deduce what a landscape conducive to a persistent metapopulation of pygmy rabbits might look like. We know that pygmy rabbits use a specific type of sagebrush habitat, are poor dispersers, and are reluctant to use areas of less suitable habitat. It is therefore logical that maintaining a mosaic of suitable patches within a relatively undisturbed matrix of less dense sagebrush is desirable.

Movement and Activity Patterns

Dispersal

Relatively little is known about the dispersal patterns of pygmy rabbits, and most of the information comes from reports of homing behavior (Green and Flinders 1979a). They observed a juvenile female that was captured and brought to a pen facility escape and return to the site of capture 2.5 km away. This indicates that pygmy rabbits which typically occupy small home ranges (Bradfield 1974) are capable of long distance movements, especially in the case of homing movements. It is not absolutely clear whether the same distance movements are made away from established territories.

Research has indicated that pygmy rabbits are hesitant to cross open habitats or areas with sparse shrub cover (Bradfield 1974) which suggests that habitat fragmentation may limit their dispersal capabilities. Pygmy rabbits may be more vulnerable to predation in open habitats, because their typical mode of escape (maneuvering in dense cover) is not available, which could result in corridors of marginally suitable habitat being population sinks due to increased predation on dispersing animals in these areas.

Katzner (1994) observed male pygmy rabbits in his study area that were not present before the breeding season, and he had accounted for all rabbits within 1 km of the study area. This implies that these new males dispersed from farther than 1 km away presumably in search of potential female rabbits. Katzner (1994) also observed a male rabbit disperse 3.5 km from the study area during a time when female rabbits were scarce. These results indicate that dispersal among males may be driven by breeding, and that long distance dispersals may occur frequently during the breeding season.

Migration

There is no evidence to indicate that pygmy rabbits migrate during any stage in their life history. However, as mentioned above male pygmy rabbits may make long distance movements in search of groups of females during the breeding season. In some cases it appears that males may move between activity centers within their home range (Gahr 1993), or they may be moving to a new area where they have previously not been active (Katzner 1994).

Daily Activity

There are conflicting reports of pygmy rabbit daily activity patterns; Janson (1946) observed peak activity at dawn and dusk, Bradfield (1974) observed higher levels of activity in mid-morning, while Gahr (1993) and Katzner (1994) observed that pygmy rabbits could be active at any time of day or night. These observations suggest that daily activity patterns of pygmy rabbits may vary between areas, and perhaps seasonally. Further, activity is likely influence by weather extremes, particularly in the winter months, when rabbits avoid above-ground activity in cold and windy situations (Bradfield 1974, Katzner 1994). The authors' personal observations in Wyoming indicate that pygmy rabbit activity increases at night, even though they can be observed during the day. At a study site in Idaho, daily, above-ground activity levels peaked in May in August, with lows in July and December – January (Bradfield 1974).

Reproduction and Survivorship

Breeding Behavior

Information on the breeding habits of wild pygmy rabbits is lacking. Pygmy rabbits are probably polygamous breeders since male home ranges overlap the home ranges of several females. It is not known precisely where young are born and raised, since no signs of nest, nesting material or lactating females have been observed in normal burrows. Observations of captive

pygmy rabbits suggest that young may be born in special natal burrows excavated by the females several days before giving birth (USFWS 2003). These natal burrows are usually short, shallow, proximate to the normal burrows, have a bedding of clipped grass, and are often backfilled by the female to "avoid detection" (USFWS 2003). Individual juveniles have been observed under clumps of sagebrush although it is not known if they may be routinely hidden at the bases of scattered shrubs or within burrows (Wilde 1978).

Breeding Phenology

Pygmy rabbits are capable of breeding during their second year and breeding appear to be highly synchronous within a local population. Male pygmy rabbits sexual development begins in January, peaks in March and declines in June (Janson 1946, Wilde 1978). Sexual development is hypothesized to be regulated by changes in photoperiod (Wilde 1978). Females are typically fertile between for approximately two months between February and May depending on photoperiod and vegetative condition of the habitat in the region (Wilde 1978). Gestation lasts from 26 to 28 days (Bradfield 1974) and litter sizes average six (range 5-8) (Wilde et al. 1976, Wilde 1978). Young are born in an altricial state (Kritzman 1977) requiring extensive parental care and by two months they are completely self sufficient (Larrison 1970). Females are capable of producing up to three litters per year (Green 1978).

Breeding Habitat

In general, pygmy rabbits breed in the same habitat type that they use for other activities; tall, dense stands of sagebrush. There is some disagreement about whether young pygmy rabbits are born in burrows or at the ground surface. Bradfield (1974) reported that young pygmy rabbits are born in burrows. However, examination of burrows by other researchers reveal no evidence of

nest material, chambers, or young in burrows with lactating females (Janson 1946, Bradfield 1974, Gahr 1993).

Population Demographics

Fecundity and Survivorship

Based on studies in Washington and Idaho, pygmy rabbits are able to breed by their second year, and can have up to three litters a year with an average litter size of six (USFWS 2003, Green 1978, Wilde 1978), but this probably varies substantially across their range, particularly in the number of litters per year. The quality of the habitat in terms of the condition of sagebrush and other forage species can influence the timing of female readiness for breeding and thus the number of litters born per year (Wilde 1978). Sex ratios may vary over time and between areas, but research in Idaho indicates that sex ratios typically don't differ greatly from 1:1 (Green and Flinders 1980a). Adult mortality is greatest in the late winter and early spring and may be as high as 88% (Wilde 1978). Juvenile pygmy rabbits also suffer higher mortality rates (50%) up to about 5 weeks of age (Wilde 1978).

Limiting Factors

The primary factor that is limiting growth or expansion of pygmy rabbit populations is loss and/or fragmentation of sagebrush habitat. Conversion of sagebrush for dryland farming, irrigated cropland, and rangeland has reduced or eliminated sagebrush shrub cover used for food and shelter by pygmy rabbits (Wilde 1978, Gahr 1993). This fragmentation of dense sagebrush stands also limits dispersal since pygmy rabbits have been documented avoiding open ground (Bradfield 1974).

Metapopulation Dynamics

Metapopulation dynamics among pygmy rabbits are not well understood at this point. It is suspected that localized populations do become isolated by habitat fragmentation and may become extinct. Due to the fact that pygmy rabbits avoid crossing open ground (Bradfield 1974), it is unlikely that isolated populations which become extinct can be easily re-colonized by natural dispersal between source and sink populations. Despite these limitations it is possible that pygmy rabbit range has expanded in some areas in Wyoming which would suggest that they are capable of dispersing across unsuitable habitats. Movement between populations, especially by males, during the breeding season may improve genetic diversity in isolated populations of pygmy rabbits.

Genetic Concerns

Small isolated populations of pygmy rabbits are vulnerable to decreased genetic diversity, and are at risk to extinction from stochastic events or genetic drift (Green and Flinders 1980a). The Columbia Basin population in eastern Washington, which is disjunct from the main North American population, exhibits significantly less genetic diversity as compared to other populations (USFWS 2003). This low genetic diversity is likely the result of long term isolation. It is possible that other peripheral populations may also suffer from low levels of genetic diversity and demonstrate inbreeding depression or other genetic consequences of reduced gene flow dependent on their level of isolation. Further investigations are needed to adequately identify and evaluate isolated populations of pygmy rabbits so that declines can be prevented.

Food Habits

Food items

Sagebrush (*Artemesia* spp.), and primarily big sagebrush (*A. tridentata*), followed by grasses and forbs are the preferred forage for pygmy rabbits. Sagebrush accounts for over half their diet in the spring and summer months when herbaceous vegetation is relatively more abundant, but comprises up to 99% of there diet during winter months (October-May) (e.g., Bradfield 1974, Green and Flinders 1980a). There does not appear to be selection for one subspecies of *A. tridentata* over another, but rabbits may preferentially feed on certain populations of sagebrush depending on season of harvest (White et al. 1982). Monoterpenoid content of sagebrush does not seem to be a factor influencing forage selection by pygmy rabbits (White et al. 1982), as may be the case with some other animals (Nagy and Regelin 1977).

Grasses, primarily *Agropyron spp.* (wheatgrasses) and *Poa spp.* (blugrasses), were observed to make up 39% of the pygmy rabbits diet during summer and early fall, while forbs (e.g., *Achillea millefolieum*, *Antennaria rosea*, and *Astragalus* spp.) made up 10% of the diet during the same period in southern Idaho (Green 1978, Green and Flinders 1980a). Preference indices indicate that grasses and forbs (especially wheatgrass and bluegrass) were consumed by pygmy rabbits in much greater proportion than they occurred in the environment (Green and Flinders 1980a). This suggests that even though rabbits may select habitats with lower grass and forb cover, they seek out this vegetation for forage.

Additional food items that have been reported include *Chrysothamnus nauseosus* (rabbit brush), *Purshia tridentata* (bitterbrush), *Ribes spp.* (e.g., gooseberrys and currants), *Elymus spp.* (e.g., squirrel tail), *Bromus tectorum* (cheatgrass), *Carex spp.* (sedges), *Koeleria cristata* (junegrass), *Oryzopsis hymenoides* (Indian mountain-ricegrass), *Eriogonum heracleoides* (wild

buckwheats), Lipinus spp. (lupines), and *Penstemon spp.* (e.g., beard tongue) (Bradfield 1974, Green and Flinders 1980a). Most of these additional forage species were found only occasionally or in trace amounts in pygmy rabbit scat, and none of them constitute a substantial portion of the diet during any season.

Foraging Strategy

Pygmy rabbits generally forage individually, and primarily browse on the leaves of sagebrush as described above. They will seasonally consume grasses and forbs during the summer months. Since they are dependent of sagebrush for forage their distribution is highly dependent on sufficiently dense stands of sagebrush to provide food and shelter. They construct extensive burrows in snow during the winter, presumably to aid in foraging on sagebrush covered by deep snow. They have also been observed climbing in tall sagebrush to access leaves higher above the ground than they can normally reach.

Community Ecology

Pygmy rabbits use a very restricted range of habitats that limits the species with which they are commonly associated. Although they often select for different fine-scale habitat characteristics, pygmy rabbits can often be found in a landscape mosaic that contains other sagebrush or sage-grassland species, such as sage grouse (*Centrocercus urophasianus*), sage sparrow (*Amphispiza belli*), sage thrasher (*Oreoscoptes montanus*), and pronghorn antelope (*Antilocapra americana*).

The primary predators of pygmy rabbits appear to be coyote (*Canis latrans*) and badger (*Taxidea taxus*), which often excavate burrows to retrieve rabbits, and common raven (*Corvus corax*) (Wilde 1978, Dobler and Dixon 1990, USFWS 2003). Raptors, including great horned owl (*Bubo virginianus*), long-eared owl (*Asio otus*), ferruginous hawk (*Buteo regalis*), and northern harrier (*Circus cyaneus*) have been shown to take pygmy rabbits, but at unknown frequency.

Other potential, but likely less significant, predators include weasels (*Mustela* spp.) and bobcat (*Lynx rufus*) (USFWS 2003).

Pygmy rabbits are slower and less prone to leap than other Leporids. Their escape strategy is to maneuver in dense shrub cover near their burrows and/or to retreat into the burrows. It has therefore been suggested that pygmy rabbits are vulnerable to predation in more open habitats, where their typical mode of escape is not available. This could result in corridors of marginally suitable habitat being population sinks due to increased predation on dispersing animals in these areas.

Conservation

Conservation Status

Federal Endangered Species Act

The Columbia Basin population of pygmy rabbits was listed as endangered under the distinct population segment provision of the Endangered Species Act in March, 2003 (USFWS 2003). This followed an emergency listing in November 2001 due to significant decrease in the population that "caused it to be susceptible to the combined influence of catastrophic environmental events, habitat, or resource failure, disease, predation, and the loss of genetic heterogeneity" (USFWS 2001). All other pygmy rabbits are not classified as threatened or endangered at this time, but there is a proposal for listing rangewide as of May 2003 (Committee for the High Desert 2003). As of the date of this assessment, no formal decision regarding listing had been made by the USFWS.

Bureau of Land Management

The pygmy rabbit is ranked as a sensitive species by the BLM in Wyoming (BLM Wyoming 2001, Table 1), Idaho (IDFG 2002), Nevada (BLM Nevada in prep).

Forest Service

The pygmy rabbit is not ranked by the Forest Service.

State Wildlife Agencies

The Washington State Department of Fish and Wildlife (WDFW) lists the Columbia Basin population of pygmy rabbits as endangered, which makes it illegal to "kill, injure, capture, harass, possess, or control individuals of the species" (WDFW 1995, USFWS 2003), but makes no specific regulatory framework for protecting essential habitat.

The pygmy rabbit is classified as Native Species Status 3 (NSS3) in Wyoming. This designation means they are a species in which (1) habitat is not restricted, but populations are greatly restricted or declining extirpation appears possible); or (2) habitat is restricted or vulnerable (but no recent loss has occurred) and populations are declining or restricted in numbers or distribution (but extirpation is not imminent); or (3) significant habitat loss is on-going but the species is widely distributed and population trends are thought to be stable.

Heritage Ranks

Pygmy rabbit range encompasses 8 states (Figure 2), none of which rank it as demonstrably secure. It is ranked as critically imperiled (S1) in Washington and Wyoming (Keinath et al. 2003, Keinath and Beauvais 2003); imperiled (S2) in Montana, Utah, and Oregon; and vulnerable (S3) in Idaho, Nevada, and California. The pygmy rabbit was ranked as critically imperiled in Wyoming due to the following factors (Keinath et al. 2003):

1. its range encompasses a small proportion (<10%) of the state
2. it exhibits low range occupation within this area (<20%)
3. its abundance within this range is uncertain but likely rare
4. the population trend in the state is unknown
5. pygmy rabbits have high intrinsic vulnerability due to their restriction to tall and dense sagebrush habitat and limited dispersal ability

6. pygmy rabbit habitat is moderately at risk to extrinsic threats such as conversion of sagebrush or fragmentation of sagebrush habitat
7. the range-wide distribution of the pygmy rabbit is patchy and the Wyoming portion is possibly disjunct from the main population (e.g., Campbell et al 1982).

The pygmy rabbit's Wyoming Contribution Rank is "high," because it is a native resident with a moderate proportion of its otherwise restricted continental range in Wyoming. Further, given the lack of knowledge regarding Wyoming populations, it is uncertain whether it is more or less secure in Wyoming than elsewhere in its range.

Biological Conservation Issues

Abundance

Estimates of local population density seem to vary greatly (e.g., 0.7 to 45 per hectare) and are likely tied to suitability of habitat and absence of disturbance (Janson 1946, Green 1978, Dobler and Dixon 1990). Some researchers believe that these dramatically different densities are due to cyclic fluctuations in pygmy rabbit populations, however, Green and Flinders (1980b) believe that there are no cyclic fluctuations in pygmy rabbit populations, instead they hypothesize that observed changes in density are the result of habitat and/or social behavior leading to aggregations (Orr 1940, Green 1978). Using known density estimates to extrapolate population sizes beyond the local scale is very problematic, because the distribution of suitable habitat is very patchy and the proportion of such habitat that is actually occupied varies greatly. Moreover, efforts to model the amount and distribution of suitable habitat have met with minimal success and are useful primarily to limit areas for future survey (e.g., Gabler et al 2000, Grenier 2003).

There is no good data on the abundance of pygmy rabbits across their range in Wyoming. It is assumed that the abundance of pygmy rabbits in Wyoming is low based upon the relatively limited number of observations recorded for this species and the limited area of suitable habitat within the

state. The Wyoming Natural Diversity Database ranks the state abundance of the pygmy rabbit as rare, although it can be locally prevalent.

Trends

There are really three types of trends with which conservationists should be concerned: abundance trends, distribution trends, and habitat trends. In general, range-wide it is believed that pygmy rabbit abundance is declining in most known populations (Dobler and Dixon 1990). The Washington population segment has declined to near extinction in the last 5 years (Hays 2001; Figure 4). In Oregon, Weiss and Vert (1984) found a marked decrease in site occupancy based on revisiting areas of historic collections. Information from these populations suggests that pygmy rabbit populations can decline rapidly in areas where suitable habitat is altered (Weiss and Vert 1984, Gahr 1993).

The most pronounced changes in the distribution of pygmy rabbits have occurred in the Columbia Basin in eastern Washington. Several thousand years ago, this population was probably contiguous with the main populations in Oregon and Idaho, but has since become completely disjunct from the main population, likely due to climate shifts that altered sagebrush distribution (Lyman 1991). Investigations of the biogeography of pygmy rabbits in southeastern Oregon and Nevada indicate that range reductions of this species corresponded with warming and drying trends which influenced vegetation distributions and thus availability of suitable habitats. Biogeographic records from the middle Holocene suggest a similar pattern in the Great Basin populations of Utah, wherein pygmy rabbits became regionally extinct as the climate during that period became increasingly arid (Grayson 2000). More recent range contracts have been seen in Washington and Oregon (e.g., USFWS 2003) and suggested by anecdotal observations elsewhere (Grenier 2003), but the magnitude of these changes has not been thoroughly investigated.

In general across the range of the pygmy rabbit in North America there are different trends in habitat quality and availability. In some areas (e.g. Columbia basin in Washington) habitat has declined due to conversion and fragmentation of sagebrush-steppe areas for agricultural use, while in contrast some localized areas appear to have a higher density of sagebrush that what was historically reported (e.g, south-central Idaho; Green 1978). Overall, the trend in Great Basin shrubsteppe habitat may be negative due to both anthropogenic and natural factors (e.g., fire, invasive plant species, land conversion and fragmentation; Whisenant 1990, Knick and Rotenberry 1995 and 1997). All else being equal, such decline in shrubsteppe habitat is likely to result in declines in animals obligate to those habitats, including pygmy rabbits.

The abundance trend in pygmy rabbit populations in Wyoming is currently unknown, as there has been no effort to determine this information for Wyoming populations. The known distribution of pygmy rabbits has expanded in southwest Wyoming, perhaps simply due to increased survey efforts in areas previously not examined (Garber 1993, WYNDD unpublished data).

Range Context

Wyoming's pygmy rabbit population is on the eastern periphery of the main population and was thought to account for a relatively small proportion of the total range. Recent mapping efforts suggest Wyoming represents a slightly broader distribution than previously thought (e.g., Garber and Beauchaine 1993; Figure 2). Further, the Wyoming populations may be isolated from the main range (Campbell et al. 1982), which would make them relatively more important as a distinct population segment. However, Garber and Beauchaine (1993) state that habitat continuity suggests no substantial break between Wyoming, Utah and Idaho. Survey efforts are necessary to

confirm the extent of the Wyoming pygmy rabbit populations and their continuity with the rest of the North American range.

Intrinsic Vulnerability

A variety of factors can contribute to a species being intrinsically vulnerable to disturbance, including low or variable population density, restrictive home range requirements, low fecundity, poor dispersal ability, poor competitive ability compared to invasive species, susceptibility to hybridization, habitat specificity and site fidelity, high susceptibility to disease, and sensitivity to habitat alteration. Based on information presented in the previous sections (and paraphrased below), pygmy rabbits seem to have a fairly high intrinsic vulnerability because of the following:

1. Dispersal: Despite occasional long distance (probably < 3.5 km) movements by males during breeding season, pygmy rabbits seem to have relatively low dispersal capabilities due in part to their close connection to burrow systems (Orr 1940, Janson 1946) and reluctance to cross open spaces (Bradfield 1974). Extirpated populations that are not connected to inhabited areas by relatively contiguous suitable habitat will likely not be naturally restocked (Dobler and Dixon 1990).
2. Habitat specificity: Pygmy rabbits are obligate to dense, structurally complex sagebrush stands growing on substrate suitable for burrow excavation and retention. They optimal combination of these components is limiting in the environment, particularly so in western Wyoming.
3. Sensitivity to habitat alteration: Reliance on specific habitat components combined with dispersal restriction makes pygmy rabbits potentially susceptible to changes in the structure of habitat (e.g., from overgrazing, invasive weeds, fire, or sagebrush eradication) and the fragmentation of habitat (e.g., from dispersed resource extraction activities) (Katzner 1994, Dobler and Dixon 1990, Holecheck 1981).

Extrinsic Threats and Reasons for Decline

Anthropogenic Impacts and Invasive Species

The primary anthropogenic impacts on pygmy rabbits (and indeed the primary threats in general) are land use practices which change the quality and continuity of sagebrush habitat. These habitat changes are primarily caused by conversion of shrub-steppe to other uses (e.g.,

cropland, urban and rural development, and petroleum development), sagebrush removal for cattle grazing, and change in the fire regime. Conversion to other uses permanently prevents pygmy rabbits from inhabiting the impacted areas and contributes to fragmentation of available habitat. It is the primary cause of the near extinction of the Columbia Basin population (see references in USFWS 2003). The impacts of livestock grazing on pygmy rabbits are likely to be negative on balance (Table 2), but this is somewhat unclear and requires further study.

Habitat changes in corridor areas which provide connectivity between populations can also be a threat to the persistence of pygmy rabbit populations. Pygmy rabbit populations which are isolated from the core populations by fragmentation of sagebrush habitats have a greatly reduced ability to recover if stochastic events cause them to become locally extirpated.

The expansion of non-native vegetation, such as cheat grass (*Bromus tectorum*) and knapweed (*Centauria spp.*), in sagebrush-grassland habitats following disturbance events may decrease the availability of sagebrush habitat for pygmy rabbit populations. Such invasive annuals provide fine fuels than can alter fire frequency, ultimately facilitating reduction of the remaining shrub component (WDFW 1995) and pygmy rabbits have been shown to avoid dense stands of cheat grass (Weiss and Verts 1984).

Increases in generalist meso-carnivores such as raccoon, red fox, skunk, and coyote have the potential to impact pygmy rabbit; particularly as such increases are facilitated by human alteration of the landscape (e.g., Hayes 2001 and see discussion under “Natural Predation and Disease”). This will have the greatest impact on isolated and/or declining populations, such as that in Washington state. The extent to which it is a problem in the main range of pygmy rabbits is unknown.

Parasites introduced into sagebrush habitats by livestock may carry diseases detrimental to pygmy rabbit populations, but there is no study to verify this hypothesis (USFWS 2003).

Stochastic Factors

Environmental stochasticity can result in variation in food resources, disease vectors, predators, parasites and climate, all of which may have an affect on the persistence of pygmy rabbit populations. Research by Lyman (1991) into the influence of environmental changes on the biogeography of pygmy rabbits in Eastern Washington indicates that pygmy rabbit ranges have expanded and contracted in response to climatic changes which influenced vegetation distribution. Grayson (2000) showed a similar response over the long term, as pygmy rabbits declined to extinction in several Great Basin localities as a result of mid-Holocene aridity. Fire (natural and anthropogenic) has the potential to severely impact pygmy rabbit populations (USFWS 2003), and even short term shifts in climatic conditions (e.g., drought), can have profound impacts on local fire regimes. The main range of pygmy rabbits is not thought to be under current threat from these environmental factors, but they can become important if fragmentation of pygmy rabbit populations increases.

Natural Predation and Disease

Although predation is the main direct source of pygmy rabbit mortality (Green 1980b), it does not represent a significant threat to the long term persistence of larger pygmy rabbit populations that are not experiencing other stressing factors (USFWS 2003, WDFW 1995). However, small and/or highly fragmented local populations, such as that in the Columbia Basin of Washington, could be severely impacted by a high predator load, particularly if introduction of the predators are enhanced by human alteration of the landscape. In Wyoming's Green River Basin, it is likely that the predator composition has changed as a result of human settlement. Large carnivores (e.g., wolves, grizzly bears) were formally present, but are currently non-existent due to extirpation by humans. Elimination of these species and simultaneous introduction of changes in surface water flow and agricultural land-use patterns have facilitated population increases of generalist meso-carnivores (e.g., red fox, coyote, raccoons, skunks) that are potential predators of pygmy rabbits. Further development of road networks (e.g., from petroleum development) has the potential to further facilitate dispersal of these predators into pygmy rabbit habitat (Mahon et al 1998, Steelman et al 2000, Engeman et al 2002), but this requires further study.

Little is known regarding the suite of diseases that infect pygmy rabbits or the extent to which they can cause population-level impacts in rabbit abundance. Like many wild mammals, pygmy rabbits can have high parasite lodes that are potential vectors for diseases such as plague and tularemia (e.g., fleas, ticks, lice). Populations of other fossorial small mammals (e.g., prairie dogs) have been heavily impacted by these diseases, and some Leporid populations have been affected as well, but this has not been demonstrated in pygmy rabbits. If pygmy rabbits are indeed susceptible to high-levels of mortality from such pathogens, it could pose a substantial threat to isolated population segments. Further research needs to be done on the sensitivity of pygmy rabbits to disease to determine the extent to which management plans should consider this issue.

Genetic Factors

Small, isolated populations that are disjunct from the main population may suffer genetic effects (e.g. drift, inbreeding depression) which may increase the probability of extinction in these populations. The only population for which such genetic separation has been studied is that in Washington state, which was shown to have a reduction in genetic variability compared to the main population (Hays 2001). Given the recent reduction the Washington state population, a genetic bottleneck may be present and could impact captive breeding efforts currently underway. This is not currently likely to be the case for pygmy rabbits anywhere within the main population, but could become locally important if declines and habitat fragmentation are evident.

Protected Areas

Very little pygmy rabbit habitat in Wyoming falls in areas formally designated for protection of wildlife. In Wyoming, more than two thirds of pygmy rabbit habitat occurs on multiple use land managed by the BLM (Figure 5). The remaining third is largely on private land and some state land, with small parcels also owned by the National Park Service (NPS; Fossil Butte National Monument), the Fish and Wildlife Service (USFWS; Seedskadee National Wildlife Refuge), and the Bureau of Indian Affairs (BIA). Of the BLM ownership, only on the order of 1% falls on designated Areas of Critical Environmental Concern (ACECs).

Conservation Action

Existing or Future Conservation Plans

A recovery plan for the Washington population segment was drafted in 1995 (WDFW 1995) and amended in 2001 (Hays 2001) due to the necessity of implementing emergency conservation measures to prevent extirpation. The recovery strategies and tasks from this plan are listed below and recounted in more detail in Appendix 2 (WDFW 1995).

1. Monitor the pygmy rabbit population.
    a. Determine population trends through fall/winter burrow surveys.
    b. Develop techniques for estimating pygmy rabbit numbers.
    c. Survey areas of potential pygmy rabbit occurrence.
2. Protect the pygmy rabbit population.
    a. Reduce potential for destructive fires.
        i. Limit vehicular access.
        ii. Develop green strips.
        iii. Establish burning permit rules.
        iv. Develop fire response readiness.
    b. Track and if necessary reduce predation.
    c. Reduce non-target killing by hunters.
3. Manage habitat to increase pygmy rabbit abundance and distribution.
    a. Improve suitability of existing habitat.
    b. Determine amount of habitat necessary to support a recovered population.
    c. Identify areas that should be managed as pygmy rabbit habitat.
        i. Use GIS to identify suitable habitat.
        ii. Survey identified areas and evaluate their potential.
    d. Pursue management of selected areas by natural resource agencies.
        i. Acquire habitat.
        ii. Develop and apply site-specific management plans.
    e. Create suitable habitat in areas selected for management as pygmy rabbit habitat.
        i. Identify techniques for habitat creation.
    f. Monitor habitat conditions in pygmy rabbit habitat areas.
4. Establish populations in new areas.
    a. Investigate techniques for introduction of rabbits into unoccupied habitat.
    b. Conduct genetic comparisons of rabbits from potential transplant source populations.
    c. Implement introduction of captive-reared or wild-caught juvenile rabbits to unoccupied suitable habitat.
5. Enforce restrictions designed to protect pygmy rabbits.
6. Establish information management and retrieval systems.
    a. Maintain repository for pygmy rabbit records.
    b. Produce an annual pygmy rabbit status review.
7. Coordinate and cooperate with public agencies and other landowners.
    a. Review and recommend revisions to state regulations.

   b. Develop management plans.
   c. Provide management recommendations to landowners.
      i. Work with landowners to manage grazing.
   d. Secure cooperative funding to support recovery activities.
   e. Create information exchange network between agencies.
8. Complete scientific investigations that will benefit recovery efforts.
   a. Investigate influence of grazing.
   b. Investigate pygmy rabbit dispersal.
   c. Determine population dynamics (survival, recruitment, etc.).
9. Develop public information and education programs.
   a. Develop educational materials.
   b. Promote media contact.
   c. Conduct public workshops.

To date, recovery actions conducted as a result of this plan have included surveys for new populations and burrow counts of select known populations (inventory and monitoring); land acquisition, land management agreements, fire containment, and predator control (habitat protection); habitat restoration; research on habitat use and genetic viability; and the initiation of a captive breeding program that has thus far focused on capturing wild animals and developing effective husbandry techniques.

Given the short history since initial implementation of this conservation plan, its efficacy is not clear. As noted above (e.g., Figure 4), populations in Washington have declined drastically since its inception, but it is likely that this was a continuation of a pre-existing trend and that implementation of concerted conservation efforts began too late to reverse the decline. Whether diligent enactment of the plan, currently focusing on captive propagation and reintroduction, can reverse declines and prevent extinction remains to be seen.

In addition, as a result of ESA listing, a federally mandated recovery plan will be put in place for the Columbia Basin population to consolidate federal, state, local, and tribal conservation

efforts. This plan should be completed by fall of 2004 (Dave Hays pers. comm.) and will likely draw extensively on the Washington state plan (WDFW 1995). It will consider the following as priorities for management action and scientific investigation (USFWS 2003):

1. Fire: implementation of agreements between fire-fighting districts and/or agency departments to provide adequate coverage, construction of fire breaks, availability of fire-fighting equipment, fire-fighting techniques, weed control, use of prescribed fire, and removal or restriction of unimproved road access and informal recreational activities.
2. Livestock Grazing: investigating impacts due to seasons of use, stocking rates and types, location of supplemental water and salt/minerals, loading and transport facilities, exclusion fencing, and removal.
3. Habitat Protection and Restoration: control of exotic and/or invasive plant species, planting types and techniques, soils and hydrologic analyses, land acquisition and connectivity, and control of unauthorized access.
4. Predation: identification of primary predators and predation patterns, development of protocols for fence removal and/or new fence construction, and predator deterrents and/or lethal control of predators to protect the wild and captive portions of the population.
5. Disease: identification and control of potential disease and disease vectors in wild and captive portions of the population.
6. Capture, husbandry, and reintroduction: development of protocols for survey, capture, handling, and husbandry techniques; maintenance and security of multiple holding facilities for captive stock; inventory and evaluation of appropriate release sites; and development of release and site maintenance protocols.
7. Genetics: identification of additional genetic markers, implementation of appropriate breeding scenarios, and establishment of a minimum effective population for captive breeding and reintroduction efforts.

There are no existing conservation plans for any other population of pygmy rabbits, nor are there efforts to initiate such documents. The fate of the Washington sate population segment demonstrates that development of such a plan is advisable sooner rather than later, particularly

given the current uncertain status of populations throughout the west. A conservation plan with a clear implementation strategy could avert USFWS listing action. In any event, a conservation plan will be required if USFWS listing is approved.

Conservation Elements

The first thing that needs to occur for pygmy rabbit conservation is the development of a rangewide conservation plan. This could be part of a sagebrush ecosystem plan that makes special provision for pygmy rabbits. The main conservation elements that should be included in this plan are listed below and address in more detail in subsequent sections. They are derived from several sources (e.g., WDFW 1995, Hays 2001, USFWS 2003) as interpreted to best meet the situation in Wyoming. There are several major elements of the referenced plans (e.g., captive propagation and reintroduction) that should not be currently incorporated into a Wyoming conservation strategy.

1. Inventory: To manage a species, it is important to know where the species occurs. The goal of an inventory effort should be to identify the distributional limits and population centers of pygmy rabbits in Wyoming. A rangewide inventory of pygmy rabbits will likely be commissioned by the Bureau of Land Management beginning in the summer of 2005 (Tom Rinkes pers. comm..)
2. Monitoring: To manage a species, it is important to be able to discern population trends, which requires long-term monitoring of the relative abundance of local populations. A monitoring plan should be professionally developed such that it is statistically valid. In short, monitoring should occur at a subset of pygmy rabbit habitats in Wyoming that is geographically dispersed, covers core and peripheral populations, and affords sufficient power to detect moderate changes in abundance. Such a plan will likely involve visiting a subset of sites every 2 or 3 years.
3. Habitat Preservation: Since pygmy rabbits depend on specific habitat conditions for their survival, it is important to identify and protect habitat that meets these ecological needs. Important habitat can fall into several categories (in order of decreasing importance): core population segments (abundant rabbits in large tracts of suitable habitat), marginal populations (areas of lower abundance peripheral to core segments or areas of lower abundance in sub-optimal habitat), suitable but unoccupied habitat (especially close to occupied areas), and dispersal corridors.

4. Threat Management: The level of suggested threats (e.g., fire, cattle grazing, fragmentation, human land-use change, predation, climactic shifts, etc.) to local pygmy rabbit persistence should be evaluated and prioritized specific to Wyoming and individual management areas. These threats should then be mitigated by coordinated efforts of public and private land managers.
5. Research: An active research program should be maintained focusing on information needs outlined below.
6. Data management: All data on pygmy rabbit distribution, abundance, trends, and management should be collected in a centralized location and made available to those with a stake in the management of the rabbits.

Inventory and Monitoring

Live trapping of pygmy rabbits does not appear to be an effective method of survey or abundance estimation, since rabbits do not readily enter traps (Bradfield 1974, Green and Flinders 1979b). Some alternative techniques for live capture of pygmy rabbits have proved more efficient that live trapping (Green and Flinders 1979b).

Active burrow counts are not a reliable way of determining abundance of pygmy rabbits. The number of active burrows may not be directly related to the number of individual rabbits in an area, because the number of rabbits using a burrow is variable, with some rabbits maintaining multiple burrows while other burrows being used by several rabbits (USFWS 2003, Gahr 1993, WDFW 1995).

Pygmy rabbit sign (e.g., burrows, scat, and tracks) can be readily confused with that of other species (e.g., cottontail rabbits, ground squirrels, badgers), so surveyors must be sure to note the differences between pygmy rabbit signs and those of similar species. Since measurements of signs can overlap and vary greographically, it also helps to gain first-hand field exposure with a person knowledgeable about the local pygmy rabbit populations. It is always advisable to visit a known pygmy rabbit population in the vicinity of new survey efforts to gain a search image of pygmy

rabbit relevant to the area of interest. Due to the ambiguity of some rabbit sign, it is best to obtain at least two independent signs before concluding that pygmy rabbits inhabit an area (e.g., appropriate looking burrow AND pellets).

To make an initial determination of scatological evidence, it has been noted (Garber and Beauchaine 1993) that cottontail pellets are typically flattened relative to the slightly rounder pygmy rabbit scat. The authors feel this is a subjective determination that requires the development of a firm search image based on much field experience, and thus should not be used by inexperienced surveyors. Another potentially distinguishing feature of pygmy rabbit scat is that it tends to occur in large accumulations at resting areas near burrow entrances, as apposed to cottontail scat which is relatively more dispersed. Garber (1991) reports the following pellet sizes for Leoporids in Wyoming: *B. idahoensi*s = 5.5 mm (range 4.7-6.2); *S. nuttallii* and *S. audobonii* = 8.7 mm (range 6.8-10.8); and *L. townsendii* = 11.5 (range 9.1-16.8). Genetics techniques have been developed to differentiate pygmy rabbit scat from cottontail scat, but facilities are limited to taking very limited samples from outside Washington and cost can be prohibitive (Dave Hays pers. comm.). However, the methods developed in Washington may be adapted by other regional genetics labs if needed.

A copy of the most extensive set of survey guidelines developed to date is included in Appendix 1 (Ulmschneider 2004). In general, the recommended survey procedure is hierarchical:

1. Choose a Target Landscapes: Use GIS data to eliminate blocks of evidently unsuitable habitat.
2. Choose Focal Areas: Use aerial photos, flight transects, and local knowledge to add or delete areas from the target landscape.
3. Choose Survey Routes: Select specific routes to survey by making observations in the field.

4. Focus on Quality Patches: Focus survey effort along routes on patches of tall, thick sage that are most likely to contain pygmy rabbits. These searches should be looking for obvious sign, such as burrows and scat piles.
5. Concentrate on Evidence: In those patches were some sign is found, conduct intensive area surveys to correlate signs (e.g., find scat in proximity to burrows) or sight actual rabbits. Such areas are perfect choices for using remote cameras at burrow entrances.

There as some substantial seasonal issues associated with conducting pygmy rabbit surveys. Pellets can be scarce in late summer and early fall. Burrows are less used, and therefore less maintained, in summer and fall. Burrow entrances, tracks, and pellets are more evident in winter. Pregnant female pygmy rabbits make larger pellets in spring (often as large as cottontails). Also, juvenile cottontails make pellets similar in size to pygmy rabbits during late spring and early summer. Thus, if weather and site access are not prohibitive, late fall and winter surveys can be more effective. If surveys are conducted in other seasons, the above noted issues should be kept in mind.

Habitat Preservation and Restoration

Since the pygmy rabbit populations in Wyoming are not in imminent danger of extirpation, habitat preservation should be the main focus of Wyoming conservation efforts. The main habitat-related tasks for pygmy rabbit conservation, as outlined in the Washington stat conservation plan (WDFW 1995, Hays 2001) and modified to fit Wyoming include:

1. Refine descriptions of suitable pygmy rabbit habitat. This must be done through field research and habitat evaluation.
2. Identify locations were potential and high-quality habitat exist. This can be done through a combination of field survey and remote sensing.
3. Evaluate the extent, connectivity, and relative quality of existing habitat. This can be done in a GIS system once sufficient habitat data has been collected.

4. Select priority areas for habitat acquisition and management. Priority areas should consider where rabbits are most abundant and habitat is contiguous over large areas.
5. Incorporate pygmy rabbits into federal, state, and local planning efforts. Conservation must insure not only that there is current habitat, but that such habitat does not deteriorate or become fragmented in the future.
6. Identify, protect, and monitor wild pygmy rabbit populations. The ultimate arbiter of successful habitat preservation is weather pygmy rabbits are stable relative to unmanaged populations. Therefore, no habitat work should be planned without also reducing direct threats and conducting associated inventory and monitoring activities.
7. Evaluate the interaction of pygmy rabbits with grazing. Since the predominant land use of pygmy rabbit habitat in Wyoming is cattle grazing and petroleum exploration, the compatibility of these uses with persistence of pygmy rabbits must be assessed.

Captive Propagation and Reintroduction

A captive breeding program for the Washington population segment was initiated in 2000 (Hays 2001, USFWS 2003). To our knowledge no such programs have been attempted elsewhere in the species range, nor are such actions recommended at this time. Unless regional populations undergo substantial crashes that threaten imminent extirpation, conservation effort is more fruitfully spent in habitat preservation and restoration. Moreover, a reintroduction program will only be successful if there is adequate habitat for reintroduction, so habitat preservation is integrally linked to captive propagation efforts.

Information Needs

The habitat requirements of pygmy rabbits in Wyoming must be quantified. As noted in the habitat section of this document, it appears that pygmy rabbits are selecting habitat that has greater relative vertical cover (shrub canopy density, shrub canopy complexity, and shrub height), but studies have not documented rangewide thresholds for these values. Further, most studies have investigated presence-absence or indexed abundance of rabbits, so it is not known how cover values affect the population demography of the species (e.g., adult and juvenile survival rates, reproductive output, population density). Also, contrary to popular opinion, the type of sagebrush habitat described in this document may not have been more prevalent or contiguous before human settlement (Dobler and Dixon 1990), which means that pygmy rabbits may have coped with such fragmentation for centuries and may not be as sensitive to this as typically thought. However, it may also be that currently documented declines are a delayed result of a long-term trend in sagebrush habitat that was occurring before human settlement (e.g., Grayson 2000) and has been accelerated by that settlement. There has been no research to date that would allow us to make this determination. Research should be implemented that investigates how the size and distribution of sagebrush patches in the environment affect the pygmy rabbit demographic parameters.

Given the necessity for prioritizing survey efforts, many states have also expressed the need for an effective predictive map of pygmy rabbit distribution. Several states (California, Idaho, Nevada, Oregon) have attempted to generate such a map, but with little practical success (Grenier 2003). WYNDD is completing a Wyoming predictive distribution map following this assessment, and hopes to use it to target surveys in the coming years, thereby validating its effectiveness as a field tool.

Current resource managers are interested in more definitively establishing the range-wide genetic diversity of the pygmy rabbits, because there are questions of connectivity between fragmented areas of occupation. Of primary concern at a recent western meeting dedicated to pygmy rabbits (Grenier 2003) was whether those rabbits in the Great Basin (Idaho, Utah, and Wyoming) are genetically divergent from those elsewhere in the species range.

Finally, given the relative lack of information on disease in pygmy rabbit populations and the potential of epizootics to cause substantial declines in infected small-mammal populations, research needs to be done to clarify the sensitivity of pygmy rabbits to naturally occurring and introduced diseases.

Tables and Figures

Table 1: Official Status of Wyoming's pygmy rabbit population(s), with annotation.

Heritage Rank	Federal	State	WY Counties	Range Notes
G4/S2	USFWS –not ranked USFS R2 –not ranked BLM -Sensitive	WYG&F- NSS3	SUB, LIN, UIN	Peripheral

HERITAGE RANKS: WYNDD uses a standardized ranking system developed by The Natural Heritage Network to assess the global and statewide conservation status of each plant and animal species, subspecies, and variety. Each taxon is ranked on a scale of 1-5, from highest conservation concern to lowest. Codes are as follows:

G - Global rank: rank refers to the rangewide status of a species.

S - State rank: rank refers to the status of the taxon (species or subspecies) in Wyoming. State ranks differ from state to state.

1 - Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.

2 - Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species vulnerable to extinction.

3 - Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).

4 - Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.

5 - Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.

FEDERAL MANAGEMENT STATUS: USFS Region 2 (Rocky Mountain Region) and 4 (Intermountain Region) have developed official Sensitive species lists to track organisms warranting special attention on USFS lands. Sensitive species are defined as "those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by: (a) significant current or predicted downward trends in population numbers or density, and/or (b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution." US Forest Service Region 2 includes Bighorn, Black Hills, Medicine Bow, and Shoshone National Forests and Thunder Basin National Grassland. US Forest Service Region 4 includes Ashley, Bridger-Teton, Caribou, Targhee, and Wasatch-Cache National Forests.

WYOMING STATE MANAGEMENT STATUS: Wyoming Game and Fish Department (WYGF): The WYGF has developed a matrix of habitat and population variables to determine the conservation priority of all native, breeding bird and mammal species in the state. Six classes of Native Species Status (NSS) are recognized, of which classes 1, 2, 3, and 4 are considered to be high priorities for conservation attention.

NSS1: Includes species with on-going significant loss of habitat and with populations that are greatly restricted or declining (extirpation appears possible).

NSS2: Species in which (1) habitat is restricted or vulnerable (but no recent or significant loss has occurred) and populations are greatly restricted or declining; or (2) species with on-going significant loss of habitat and populations that are declining or restricted in and distribution (but extirpation is not imminent).

NSS3: Species in which (1) habitat is not restricted, but populations are greatly restricted or declining extirpation appears possible); or (2) habitat is restricted or vulnerable (but no recent loss has occurred) and populations are declining or restricted in numbers or distribution (but extirpation is not imminent); or (3) significant habitat loss is on-going but the species is widely distributed and population trends are thought to be stable.

NSS4: Species in which (1) habitat is stable and not restricted (2) populations are greatly restricted or declining, extirpation appears possible.

Table 2: Potential impacts of livestock grazing on pygmy rabbits adapted from information presented by USFWS (2003) and Gahr (1993).

Evidence for negative impacts	Evidence for positive impacts
1. Documentation of larger home ranges and longer movements during the breeding season in recently grazed versus non-grazed areas. 2. Documentation of fewer burrows in recently grazed areas. 3. Documentation of a greater proportion of sagebrush relative to forbs in the diet of pygmy rabbits on grazed sites. 4. Nutritional quality of forage (grasses and shrubs) on recently grazed land is less in the fall, winter, and spring compared to non-grazed areas. 5. Livestock can directly limit burrow systems through trampling. 6. Sagebrush control efforts are more prevalent on grazed lands. 7. Possible increase in the predator population (e.g., coyotes) through introduction of artificial watering and feeding of livestock. 8. Possible structural damage to dense sagebrush stands by livestock. 9. Removal of herbaceous and residual cover of native grasses and forbs by livestock foraging. 10. Changes in the distribution of invasive weed species.	1. Increased vigor of grass species due to mechanical disturbance by livestock. 2. Increase in the relative abundance of sagebrush by removal of competing vegetation through selective livestock foraging. 3. Possible increase in the diversity and/or abundance of wildlife and vegetation species on grazed lands.

Figure 1a: Adult pygmy rabbit at burrow in southern Idaho (photographer unknown).

Figure 1b: Adult pygmy rabbit, ear detail (photographer unknown)

Figure 2a: North American Distribution Map adapted from Hall (1981) and Patterson et al. (2003).

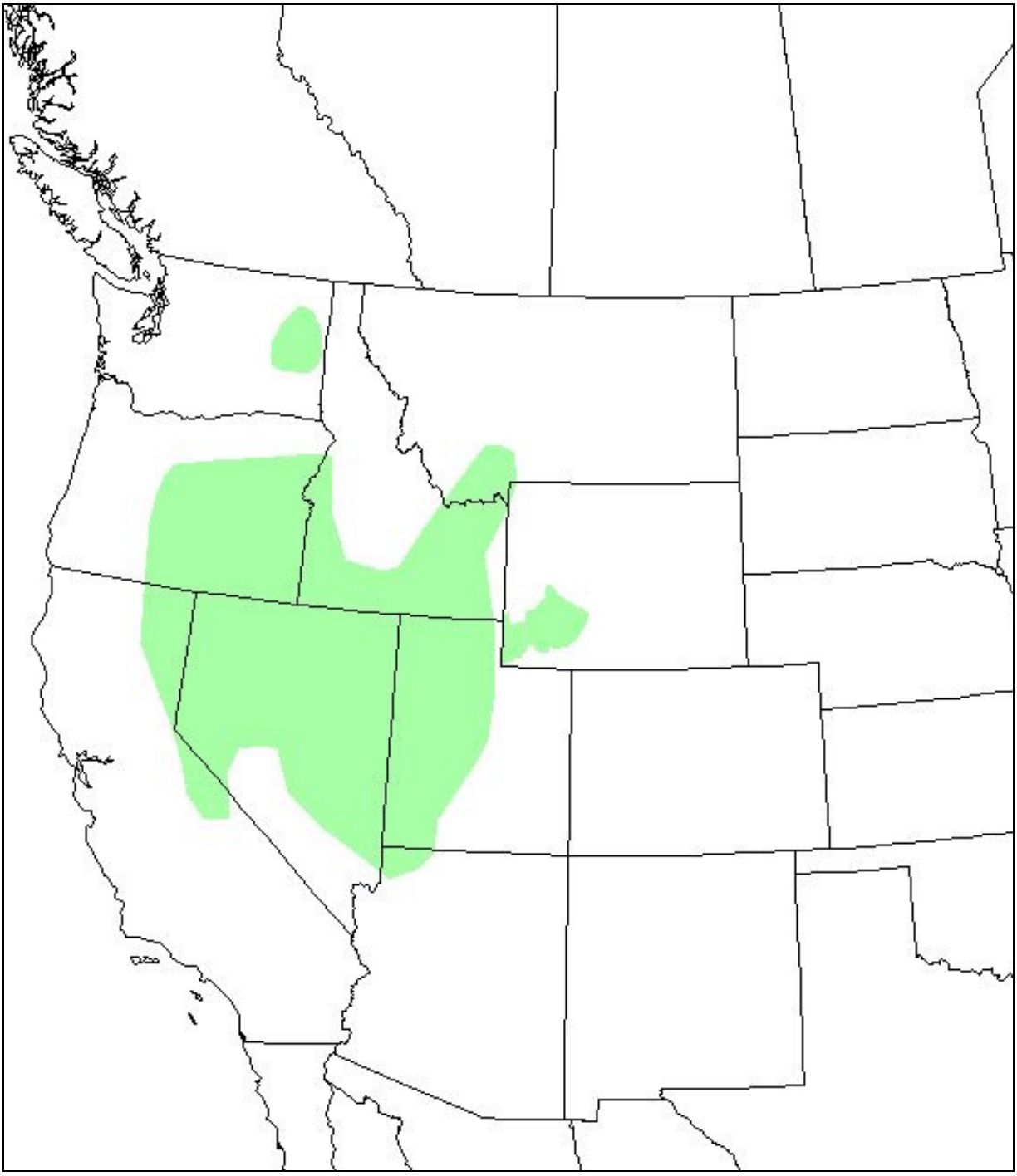


Figure 2b: Probable Wyoming distribution map, based on known occurrence points in the Wyoming Natural Diversity Database and predictive habitat descriptors.

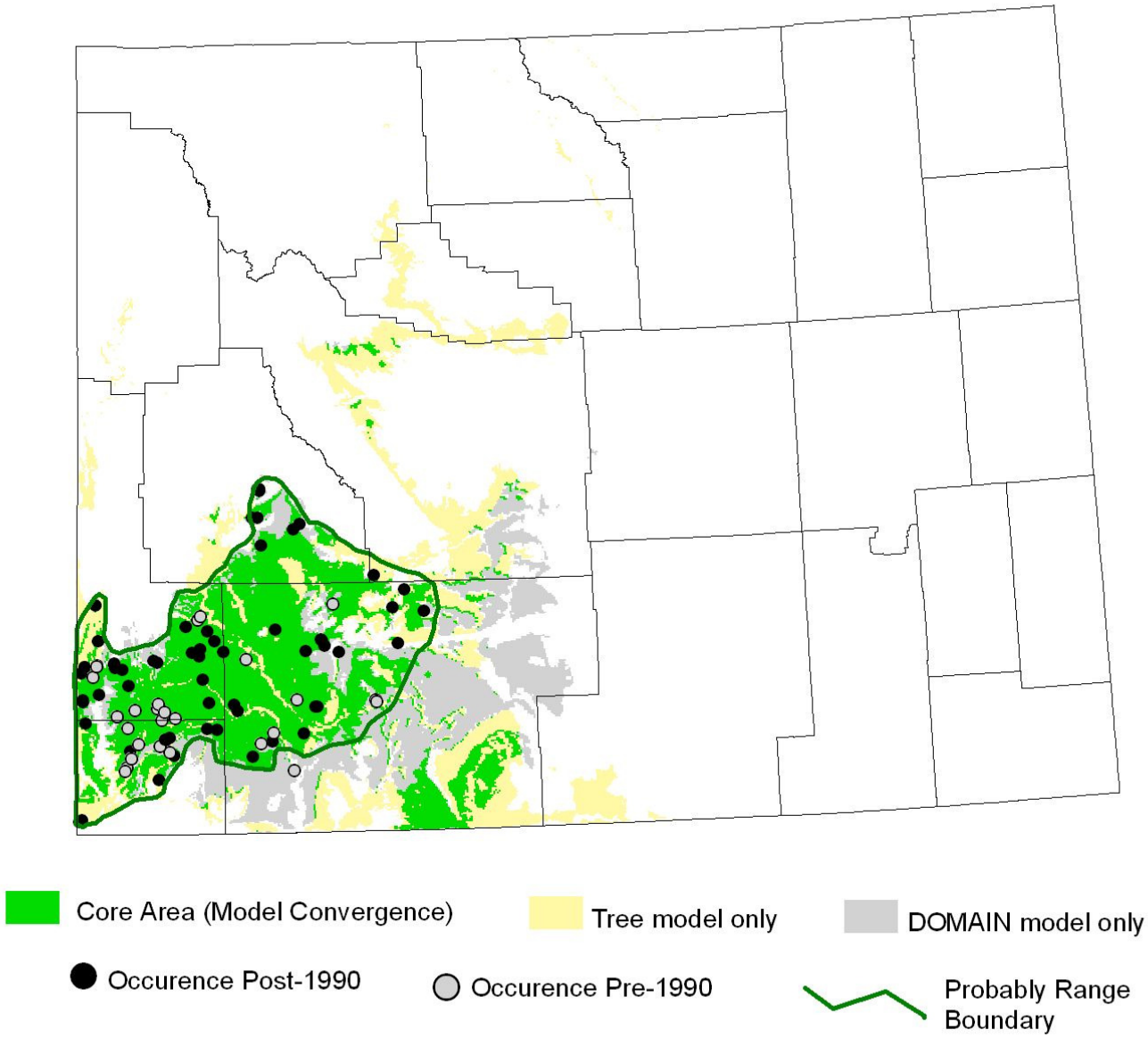


Figure 2c: Regional range map showing probable range in the Rocky Mountain states (light green polygon), with occurrence records from the Natural Heritage Programs of Idaho, Utah and Wyoming (purple circles), and range extensions based on this data (dark green polygons). Information adapted from NatureServe, the Idaho Natural Heritage Program, the Utah Natural Heritage Program, and the Wyoming Natural Diversity Database.

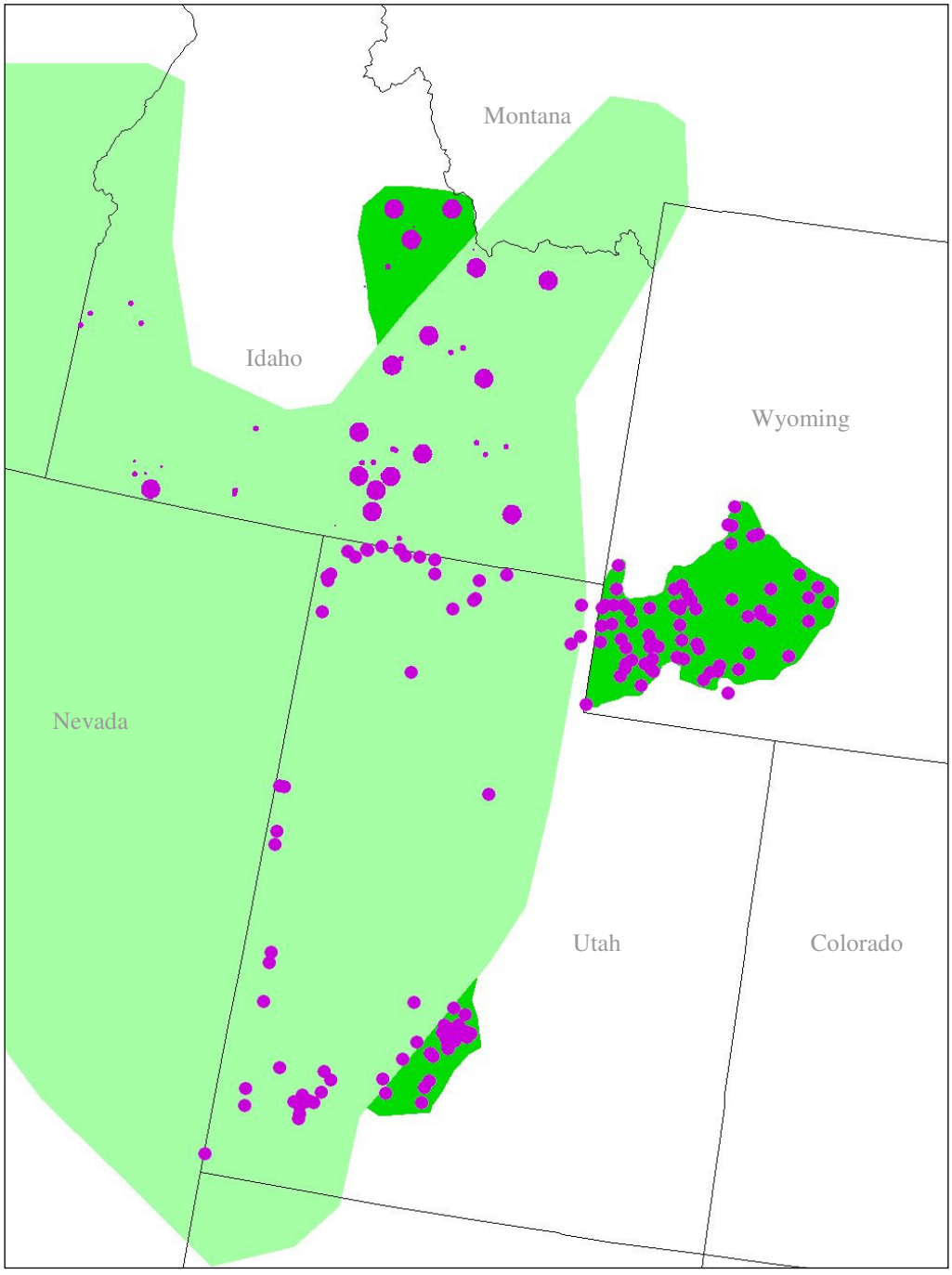


Figure 3a: Sagebrush steppe habitat in southwestern Wyoming with pygmy rabbit occupation (photograph © Jeff Gruver, WYNDD).

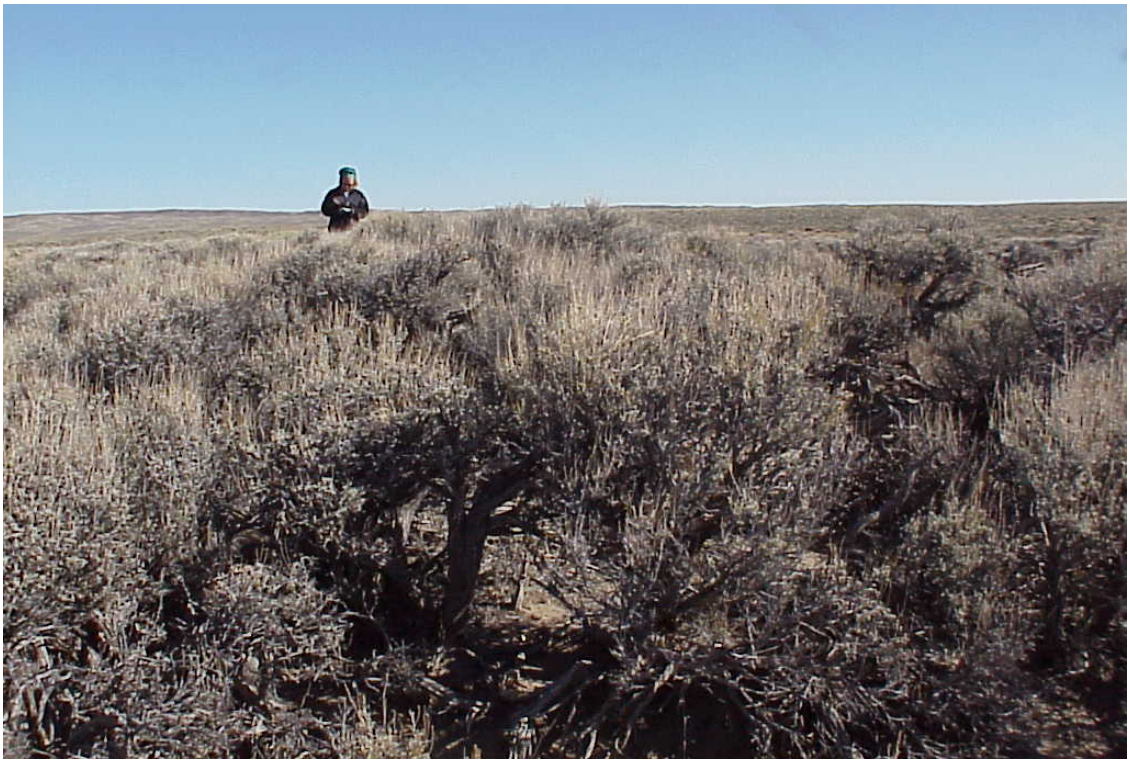
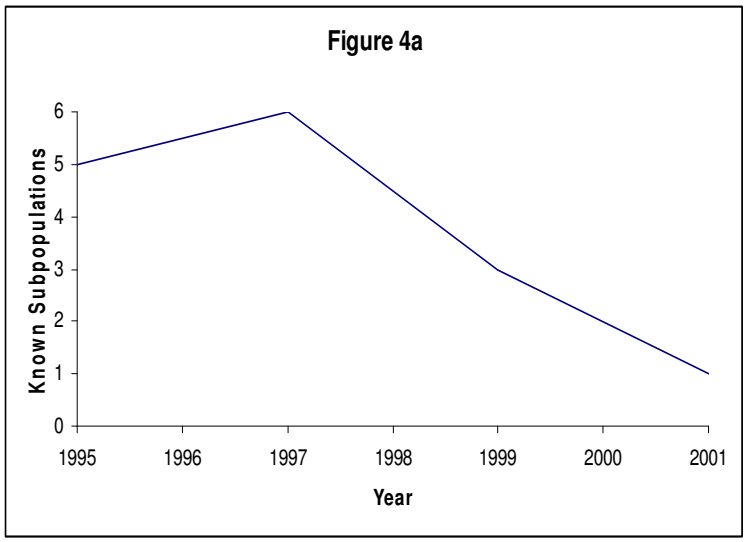
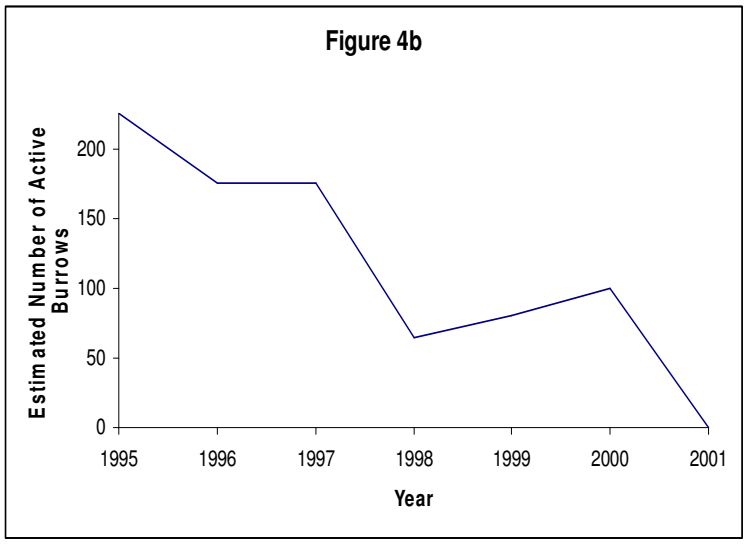


Figure 3b: Pygmy rabbit burrow in southwestern Wyoming with AA battery for size comparison (photograph © Jeff Gruver, WYNDD).

Figure 4: Trends in the endangered Washington state population. Trends in (a) subpopulation persistence within the Washington state population segment, (b) estimated active burrows at the Sagebrush Flat subpopulation in Washington, and (c) historic versus current range occupation. Adapted from Hays (2001) and UWFWS (2001, 2003).





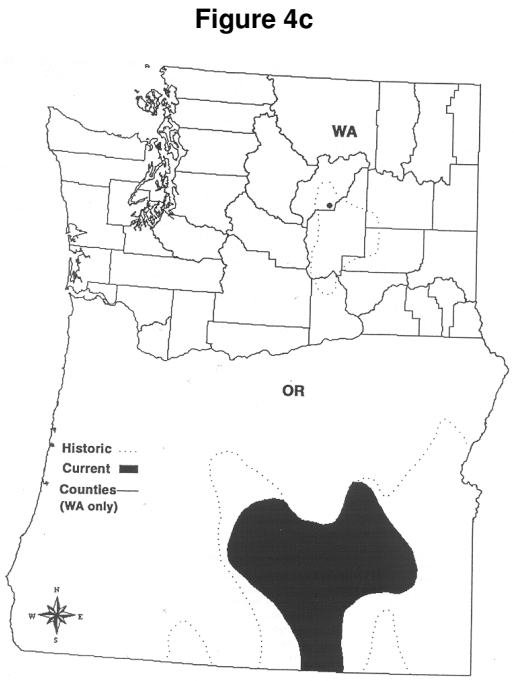


Figure 5: Maps of surface ownership of potential pygmy habitat in Wyoming based on (a) probable range and (b) predicted distribution from habitat models generated by WYNDD (see Figure 3b). These areas represent potential pygmy rabbit habitat and are not an estimate of land area actually occupied; much of the highlighted land may be unsuitable or suitable but unoccupied.

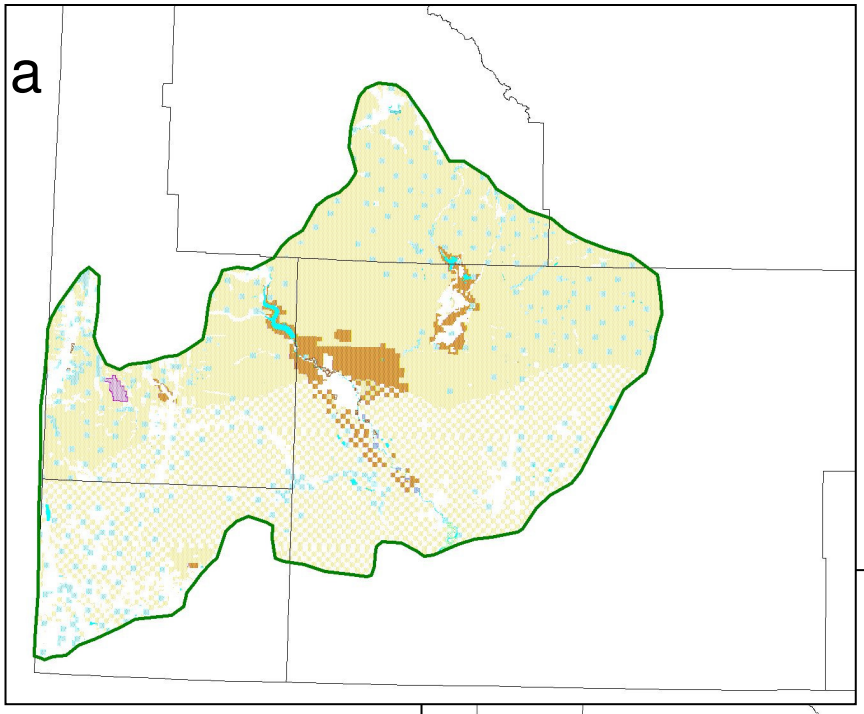


Figure 5a: Land area totals for pygmy rabbit range. Of BLM land on this map, only 1.3% is designated ACEC.

Owner Name	% of Land Area
BLM	64.0%
Private	31.3%
State	4.0%
USFWS	0.4%
NPS	0.2%
FS	0.1%
BR	<0.05%
WGFD	<0.05%

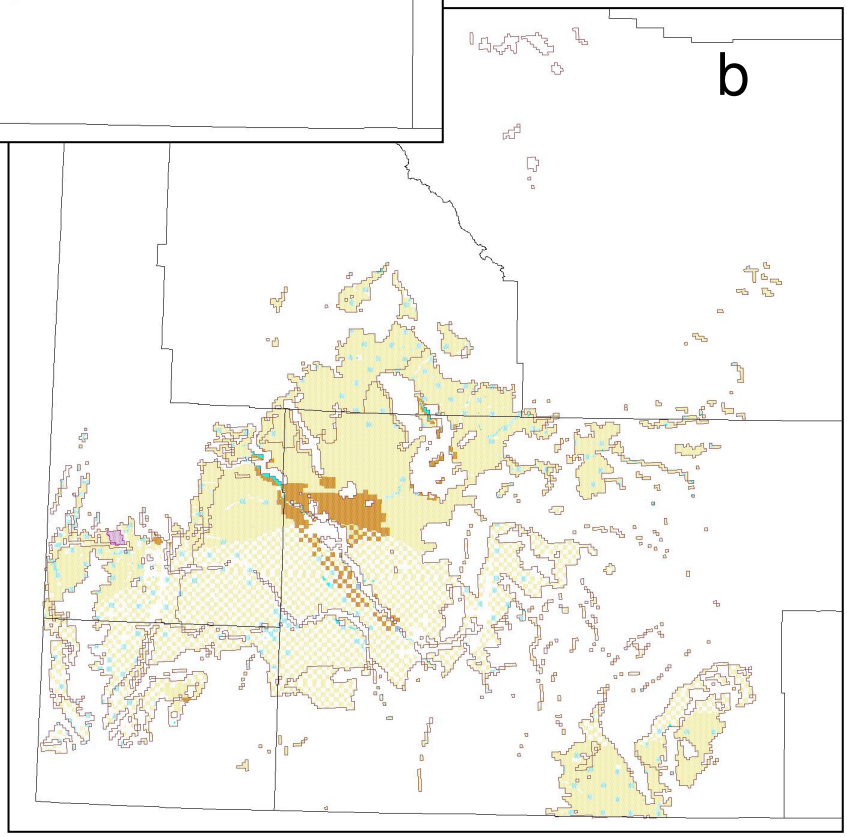


Figure 5b: Land area totals for modeled pygmy rabbit distribution. Of BLM land on this map, only 0.3% is designated ACEC.

Owner Name	% of Land Area
BLM	67.5%
Private	27.9%
State	3.3%
BIA	0.9%
USFWS	0.3%
NPS	0.1%
FS	<0.05%
BR	<0.05%

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Appendix 1: Draft Guidelines for Conducting pygmy rabbit (*Brachylagus idahoensis*) surveys

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SURVEYING FOR PYGMY RABBITS (*Brachylagus idahoensis)*

Third Draft - Feb. 10, 2004

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Purpose

This paper describes pygmy rabbit habitat, how to recognize and evaluate sign, an approach for organizing and conducting broad-scale surveys, and how to record data. It also includes discussion of some other survey techniques. It includes photos of habitat and burrows in an appendix. This is a work in progress and may be modified as we learn more about the variety of habitats used by pygmy rabbits, pygmy rabbit sign, and about surveying for these rabbits.

The goal of the broad scale survey described here is primarily to find populations of the rabbit – presence/absence. However, by conducting surveys in the manner described, a measure of burrow density and relative age can be obtained which can provide a baseline index for population monitoring. This kind of survey will document not only where the rabbits are but also where they are not, which is useful information for refining habitat models, and for land managers.

We hope that surveyors and researchers across the range of the species will use the included form to gather the basic population data identified (burrow locations and status), although they may add or delete other data (not essential to comparing population indices across areas and years).

Background

On February 26, 2003, biologists from various federal and state agencies and universities met in Reno to discuss the current state of knowledge and future work needed for pygmy rabbits. Development of a consistent method for surveying for pygmy rabbits across their range was identified as a high priority. A survey subgroup was formed, which combined its efforts with a previously established effort from Idaho BLM, in preparing this document. This paper attempts to combine the knowledge gained in various states from field experience of all its contributors.

Field Training

A key piece of advice: Before surveying, go look at some actual pygmy rabbit habitat, burrows and sign with an experienced person in the field. Also look at badger and ground squirrel diggings if possible, to help you learn to distinguish the differences. Descriptions and pictures are helpful, but there's no substitute for seeing it in the field. Experienced biologists from different states are listed at the end.

Habitat

There are two main features of pygmy rabbit habitat: thick sagebrush (*Artemisia tridentata)* (but see below) and deep soils.

Sagebrush: Usually burrows are found in the taller and thicker big sagebrush in an area, with a height of about thigh-high to chest-high. Various subspecies of sagebrush are used, including Wyoming (*A. t. wyomingensis*), mountain (*A. t. vaseyana*), and Great Basin (*A. t. tridentata*). There may be other shrub species present, including bitterbrush

(*Purshia tridentata)*, rabbitbrush (*Chrysothamnus spp.)*, greasewood (*Sarcobatus vermiculatus)*, snowberry (*Symphoricarpos spp.)*, and juniper (*Juniperus spp*.), and this will vary from area to area.

In some pygmy rabbit areas in Oregon and Nevada, rabbitbrush is dominant or co-dominant with sagebrush, and burrows occasionally or commonly occur under large dense rabbitbrush (T. Forbes, OR; E. Sequin, NV, pers. comm). The burrows are so hidden under the canopy that they are often only found by lifting the vegetation.

Pygmy rabbits also may occupy habitat that does not appear ideal: with short sage and bad soil. Katzner (pers. comm.) emphasizes that it is important to keep an open mind, and not develop set ideas about pygmy rabbit habitat too early. In Wyoming, Katzner has seen pygmy rabbits in areas that he would never pick as good habitat. In Montana, the average sagebrush height in occupied sites was only 37 cm (~ 15 inches). There, Rauscher has often found them in areas where the sagebrush is not very dense and only knee high or less, especially in mountain bowls and where sagebrush has been manipulated (pers. comm.)

Soils: Generally, pygmy rabbits burrow in loamy soils deeper than 20 inches. Soil composition needs to be able to support a burrow system with numerous entrances, but also must be soft enough for digging. The current habitat model from the Univ. of Idaho (Rachlow and Svancara 2003) uses a clay content of 13 to 30%, but models from Idaho State (Simons and Laundre 2001) used <13.5 % clay. In Washington State, pygmy rabbits are found only in deep loamy soils. In southwest Idaho, they are in soils classified as stony sandy loam, and sandy loam over sandy clay and clay loam. In east central Idaho, soils are gravelly outwash plains with lime-coated rocks. On the lava plains of southeast Idaho, rabbits will often burrow between or under lava boulders. In Nevada, soils are described as light-colored and friable.

At the Landscape Scale: Pygmy rabbits are found in alluvial fans, swales in a rolling landscape, large flat valleys, the foot of mountains, along creeks and drainages, in bowls in the mountains, or other landscape features where soil may have accumulated to greater depths. They are generally on flatter ground, sometimes on moderate slopes, and not on steep ground.

Idaho: Areas with mounded topography – 'mima mounds' – are prime suspects. In the Salmon, Idaho area, the alluvial plains where rabbits are found are dotted with mounds about 15 ft in diameter, 1-2 ft tall, several hundred feet or yards apart, where the sagebrush is taller than in the surrounding intermound spaces. On 1:24,000 aerial photos these mounds can be seen as a pattern of darker dots, extending over many miles of landscape; and from the ground, the mounds appear as lenses of darker taller sage. The mounds are where the pygmy rabbits burrow.

However, in the mahogany (*Cercocarpus ledifolius)* savannah in southwest Idaho, where the rabbits are found in swales of taller sage, the mounding of the soil is present, but not as clear. A dotted pattern is not always visible on 1:24,000 aerial photographs, although careful examination can show subtle and dim dotting. The soil does end up mounded where the pygmy rabbits have been digging their burrows and maintaining them over time. However, there is not as clear a distinction between mound and intermound.

In southwest Idaho, another habitat is areas where low sage (*Artemisia arbuscula)* and big sage intermingle, where the big sage may form islands within the low sage matrix. These kinds of areas are also visible on aerial photos.

Oregon: Habitats in Oregon are very similar to those in Idaho. Most habitat is comprised of areas where big sagebrush inclusions are mixed with low sagebrush, rabbit brush, or shorter stature big sagebrush. Mounding similar to 'mima mounding' occurs in most of these sites. Sagebrush on the mounds is usually 1-3 feet taller than that of the surrounding area. These mounds or clumps of big sagebrush can be spaced from a few feet to several hundred feet apart.

The second most common type of habitat in Oregon is small drainage bottoms where deeper soils have collected. Most of these sites are vegetated with basin big sagebrush in the drainage bottom, surrounded by Wyoming big sagebrush, low sagebrush, or mountain big sagebrush in the surrounding uplands. Some mounding can occur in these areas, but it is absent or very subtle. Burrows in these areas seem to be restricted to the very bottom of the drainages or the lower inside slopes of the drainage itself.

Nevada: In Nevada pygmy rabbits are found in broad valley floors, stream banks, alluvial fans, and other areas with friable soils. Burrows can be located in mounds (either natural or human caused) when they are available in these types of soils. Pygmy rabbit burrows are easiest to find in light colored, friable soils. These soils are usually found in valley bottoms and can be associated with rabbitbrush / sagebrush vegetation. The understory can vary from almost none (as in the Reese Valley) to dense (as in the Sheldon). When there are a lot of rabbits present in a valley they are generally distributed throughout the area. However, when there are only a few individuals these few are generally located in the largest, most dense clumps of vegetation.

Montana: Pygmy rabbits are found in habitats similar to Idaho and Oregon; large intermountain valley bottoms, alluvial fans, mountain valleys and bowls, stream bottoms, plateaus, rolling sagebrush plains and isolated patches of sagebrush in grasslands. The preferred habitat in Montana appears to be gently sloping or nearly level floodplains where adequate sagebrush and appropriate soils exits. However, many occupied sites have marginal sagebrush cover and shallower soils. Areas that contain mima-like mounds are good areas to investigate. If pygmy rabbits are found in these areas, they generally occur throughout the continuous sagebrush coverage at varying densities and up into sagebrush drainages.

Wyoming: Pygmy rabbits occur in swales of taller, thicker sage in a setting hillsides with thinly distributed, shorter sage. Although there have been no quantitative studies comparing habitats in different areas, the habitat in Wyoming appears different from that in Washington, Oregon, Nevada, and western Idaho (Katzner, pers. comm.) The overall impression from observation is that the sage is thicker and often less heavily grazed, with more standing dead sagebrush, and more Great Basin Big sage. The general areas used by pygmy rabbits have evenly distributed, taller, and more structurally diverse sage with a dense canopy. Three subspecies of big sagebrush can be present, Great Basin, Wyoming, and mountain. Surrounding unused areas have fewer, shorter, shrubs with less vegetative cover.

At the Patch Scale:

Look for tall, thick big sage (not low sage) and areas where there appears to be a non-uniform distribution of sage, in other words, where the texture of the sagebrush stand is uneven or lumpy in both height and density. When scanning across a valley these clumps stand out as taller, or as having a different color. It is fairly effective to go directly to these areas to begin a search. Also look for signs of digging, and for soil surface that is not flat and level. The rabbits tend to mound up the soil where they have been burrowing over the years.

In areas that have a relative uniform coverage of sagebrush, stream banks and sagebrush draws are often used by pygmy rabbits. When searching these areas, burrows can be difficult to find.

Pygmy Rabbit Sign

Burrows

- The size of pygmy rabbit burrows usually surprises biologists the first time they see them - they are larger than they would have thought – many think badger instead of pygmy rabbit. The burrows vary in size, but range from 5-10 inches across, and some as small as about 4 inches. The older a burrow is, the more the entrance seems to get enlarged.
- Burrows are most often placed right at the base of a sage bush, or occasionally another shrub. Sometimes an entrance will be more in the open, but the majority of entrances in an area will be underneath sage.
- At burrows, usually you will find the sage so thick that walking is difficult, you have to thread your way through it (which means >30% canopy cover). Where there are not burrows, you will be able to walk more freely.
- The opening usually flares out, and there is often a large pile of dirt outside the entrance, several feet in diameter.
- Usually, there will be more than one entrance in a burrow system, up to 7, but 2-4 most common. However, sometimes there is only one.
- The burrow can slope down very steeply or moderately, and the burrow often narrows down from the flared entrance to about 4-5 inches in diameter.
- At currently used burrows, there will often be a lot of fresh dirt piled outside the entrances. Key in on piles of fresh dirt to find burrows.

- Burrow systems will rarely be isolated; there will be a number of them in a habitat area. It is difficult to identify with certainty the species responsible for isolated burrows without pellets.
- A key feature of pygmy rabbit burrow systems is that they show evidence of having been built up and used over many years, unlike ground squirrel or badger diggings, which are a one-time affair. Sage grows taller and thicker on the mounded dirt. As pygmy rabbits 'remodel' over the years, filling in one tunnel and digging new ones within the same burrow system, they create overlapping mounds of varying ages in one area, forming a complex mounded area maybe 15 to 30 ft in diameter. Thus pygmy rabbit burrow areas show old mounding that has plants and shrubs growing on them in addition to the current fresh dirt piles.
- A used sage area will have a more open understory from a browse line.

In general, unoccupied old burrows appear to last some years. However, in Nevada, Sequin (pers. comm.) has observed extensive burrow systems "melt" completely into non-existence over the course of two to four weeks of wet weather in certain soils. All evidence of there ever having been a burrow was erased. Some of these burrows had been associated with very high pygmy rabbit activity just a few weeks prior.

Pellets

Rabbit pellets are distinctive: round, without dents or points, different from those of any other group of animals. Pygmy rabbit pellets are the smallest of the rabbit pellets, averaging 4-6 mm. However, the size can vary. Pregnant females produce bigger pellets, even up to 11 mm! (Dave Hays, pers. comm.) Young cottontails can produce very small pellets. Usually the size will be uniform from any pellet group.

- The pellets are in little groupings near the burrow entrance and under sage nearby. At an active burrow, there will often be a carpet of evenly small pellets. Large quantities of uniformly small pellets around a burrow entrance are diagnostic.
- Mountain cottontail pellets average 6-10 mm, but can be smaller. Usually the sizes will be mixed from cottontails, perhaps from adults with the young ones. Thus they can overlap in size with pygmy rabbit pellets, creating potential for confusion. Be cautious: in Washington, genetic testing of pellets thought to be pygmy rabbit revealed they were cottontail (Dave Hays, pers. comm.).
- Cottontails may use some of the same areas as pygmy rabbits, and may use their burrows. Beware particularly if there are rocky outcrops nearby. This is less of an issue in some places such as the Lemhi Valley, where the two do not commonly coexist. It can be more of a problem in smaller pygmy rabbit habitat patches intermixed with rock outcrops, such as in the Owyhee uplands. However, in Lakeview, Oregon, a telemetry project revealed cottontails using the same habitats and some of the same burrows as the pygmies, but there are no rock outcrops for miles.
- Full-grown whitetail jackrabbit scat is 11-12 mm; blacktail jackrabbit pellets are about 9-10 mm.
- Rodents, including ground squirrels, have oblong droppings.
- Recent rabbit pellets are usually a dark to medium brown to greenish color. Very fresh pellets have sheen or appear somewhat glossy. Older pellets appear somewhat dull and eventually weather to gray. If the rabbits have been eating a lot of dry grass, fresh pellets may be more tan, the color of dry grass, and a little larger. If rabbits have been eating green wet feed in the spring, the pellets can be almost black on the outside, green on the inside, and may be more elongated and have little pinched ends, being softer when they came out.
- We don't know how long pellets last or how long they take to turn grey. Weather conditions affect how fast they turn grey; dry pellets will stay brown, wet pellets will turn grey faster. Pellets under winter snow may stay very fresh looking until uncovered the next spring. In an experiment at 6000' in SW Idaho, pellets gathered fresh in April and placed under a sage were still brown in December. It may take the wet of winter snows and spring rains to turn them gray.
- Some ants collect the pellets, so if you are not finding much, it may be due to ants. Look for them on the conical ant piles and make notes.
- Rabbits sometimes eat their own pellets (coprophagy), apparently mostly the night pellets (Dave Hays, pers. comm.)

Tracks in Snow:

During winter, pygmy rabbit tracks and pellets in the snow can be more obvious than other times of the year. Pygmy rabbit tracks can generally be distinguished from other rabbits by the size of the hind foot (see table below, from

information in Forrest 1988, Green and Flinders 1980, and Katzner 1994). During winter, juvenile cottontails should have achieved nearly the same size as adults, which should minimize overlap in track size between the species.

Both Rauscher and Katzner (pers. comm.) have observed that pygmy rabbits traveling in fresh snow will re-use the same tracks, leaping from spot to spot a few inches apart (launching-and-landing sites), and leaving a diagnostic pattern. This keeps the rabbits relatively clear of snow and means that they can move much more easily in new snow than if they had to break trail every time they moved. As the rabbits use those sites for several days, the launching-and-landing sites get larger and larger and eventually become a continuous trail. Other rabbit species do not create this initial stage of re-used launching-and-landing sites. Over time, in older snow, pygmy rabbits create a complex maze of continuous trails between burrows (Ulmschneider, pers. obs.)

It can be quite effective and efficient to drive two track roads in sagebrush areas a day or two after a light snow, looking for launching and landing sites, measuring rabbit tracks, and following weasel or other predator tracks to locate pygmy rabbits in areas of high or low density of rabbits (Rauscher, Katzner pers. comm.) To find burrows, it can also be useful to look where snow on a sagebrush forms an umbrella with a cave underneath. Rabbits often use these areas and pellets and tracks will be found underneath. (Sequin, pers. comm.) In the snow, active burrows will be obvious with tracks in and out .

	Pygmy Rabbit		**Cottontail**		**Jackrabbit**	
Back foot length	1.8-2.5 in	46-71 mm	3-3.5 in	77-90 mm	3.5 -4 in	90-103 mm
One track set (4 feet)	6-8 in		6.5-11 in		10-30 in	
Between track sets	6-16 in		8-22 in		10-60 in	

Other Burrows:

- A key difference between pygmy rabbit and badger or ground squirrel burrows is that pygmy rabbit burrow systems show evidence of use over years: complex and old mounding, with shrubs and grass growing on the mounds, whereas badger and ground squirrel burrows are one-time affairs. Pygmy rabbits remodel in the same spot year after year, creating mounded areas with taller thicker sage growing on the old dirt piles, and evidence of burying the lower stem of nearby sagebrush over time. The undug areas between these mounded areas will have a fairly level ground surface. The other burrowers will not develop areas with old mounding built up, where sage and grass have grown back in (observation from Dana Quinney, expert on badger and ground squirrel diggings, Idaho Army National Guard).
- Richardson's ground squirrels make smaller holes the size of the diameter of their bodies (2 -3 inches or so) and do not usually have a flared entrance or much of a pile of dirt out front. They usually place them in the open and overall occupy more open areas. They are often associated with a wet area of some kind. Belding's ground squirrel burrows are similar, but are in dry areas, and can be under sagebrush as well as in the open. Any ground squirrel may use pygmy rabbit burrows, and may be mingled with them. They may dig their smaller burrows off of pygmy rabbit tunnels (Dana Quinney, Idaho National Guard, pers. comm.).
- Piute (Townsend's) ground squirrels also have small burrows with little dirt around them, and may be both under bushes or out in the open, but not particularly near water.
- Antelope ground squirrels have many small entrance holes placed in a mound of dirt maybe 5 -10 ft across and a foot or so high. Kangaroo rat burrows are similar. Both tend to be in sandier soils than pygmy rabbit.
- Badger diggings are typically bigger than pygmy rabbit, 12-18 inches and very round. Where there are ground squirrels, badger diggings may be numerous. Typically, however, you will see the large badger-dug holes next to small ground squirrel holes, at least while ground squirrels are active. So instead of several moderate-sized burrow entrances near each other, like a pygmy rabbit burrow system, there will be big and small together. Additionally, badger hunting burrows are one-time affairs, and even their natal burrows are only used briefly during one year.
- Where badgers have dug out pygmy rabbit burrows, everything will look right for pygmy rabbit except the entrance will be big and round with a large pile of dirt. You probably will find both badger-dug and regular pygmy rabbit burrows in the area.

- Coyote and fox burrows are bigger, and more in the open, not under the sage. There will be only one burrow system in an area, not a number of them.
- Chipmunks, pocket mice, and deer mice all have burrows that are tiny (1 inch or so) and no or little loose dirt outside.
- Pocket gophers produce a mound of dirt about a foot or so in diameter, maybe 4-6 inches high, and the entrance hole is under the mound of dirt and not obvious, maybe 2-3 inches in diameter. There will be a number of these in an area, and they are usually more in the open, between the bushes. They tunnel under snow and fill the tunnels with soil; these will produce ropes of soil after the snow melts. They move about on the landscape as they burrow, rather than maintaining a stationary burrow system.

Deciding whether burrows are pygmy rabbit or not:

It is the combination of all indicators that you need to think about, both of the burrow itself, pellets, and the pattern on the landscape. There is no other animal that digs burrows with the combination of features of pygmy rabbit: in tall thick sage habitat, burrow entrance 5-7 inches average diameter, located under sage bushes, a number of burrow systems in an area, small round pellets, especially if they form a carpet around the burrow.

- First, you need to find both burrows and pellets together.
- For burrows that look right but have no pellets, search further in the area, and/or look at another time of year. If you find other burrows with pellets in the area, then you can figure that other, similar burrows without pellets are also pygmy rabbit. Look for the big pattern. Old burrows may tell us something about changes in population extent or density (although we're not sure how to interpret it yet!), and are important to map also.
- If you find small rabbit pellets but no burrows, they are probably mountain cottontail, especially near rocks. Burrows are an essential piece of evidence, because the pygmy rabbit seldom ventures far from them. (However, see the section on seasonal considerations.) There should be a number of burrow systems in an area, within a habitat patch.
- Is it the right habitat – big sage and deep soils?
- Are the burrows placed underneath sage? Are they the right size and shape?
- What other animals are around? Be aware there may be cottontails and perhaps young jackrabbits producing confusing pellets, or ground squirrels, badgers, or other burrowers to sort out.
- Cottontails and ground squirrels may use burrows originally dug by pygmy rabbits, and further confuse the issue. However, of the rabbits, only pygmy rabbits actually dig burrows. We are interested in burrows dug originally by pygmy rabbits, even if they are now occupied by another animal.
- Finally, you may use other methods discussed at the end to confirm presence of pygmy rabbits.

Organizing and Conducting Surveys

Targeting habitat

Pygmy rabbits are not randomly distributed within the sagebrush landscape, they are patchily distributed, because they choose particular soils and sagebrush habitats, and they do not appear to be abundant. Additionally, we cannot yet accurately predict with models where they will be. With a patchy distribution, random survey methods that might work well for a more evenly distributed animal would be ineffective and inefficient. It is necessary to first target habitat as well as you can, that is, to sort out the most likely habitat. We describe below a several-stage approach to doing this, using aerial photos, soil and vegetation maps, Geographic Information Systems (GIS, if available), field knowledge, and driving and walking in the field as the final step to target where to look for pygmy rabbits.

A caution about GIS models: in southwest Idaho, 2 GIS models have been attempted. The first attempt was totally unsuccessful in helping find pygmy rabbits. Indeed, it eliminated the area where pygmy rabbits were discovered the next year by an experienced observer. A second model has also not proved very helpful in southwest Idaho: it ranks large areas as highest priority to search, where only a few possible burrows were found during field surveys in 2003, and misses the new areas where rabbits were found in 2003. The problems appear to be both with the data used (inaccurate and too coarse) and with the sagebrush and soil parameters of the model. The lessons are that better habitat models are needed, to use with finer-scale, more accurate data, but also that there is no substitute for knowing what to look for from field experience, and going in the field and looking.

Landscape Scale: For an example of GIS models from Idaho, see Rachlow and Svancara 2003, or Gabler et al 2000. John Himes (Nevada Department of Wildlife) has attempted one for east-central Nevada. The most basic components to use in a GIS model or other map are sagebrush types overlaid on soils (composition and depth). Some models have added slope, aspect, fire history, and elevation, but these don't appear as useful as sage and soils. Fire history is only relevant for whether sage has come back in or not; the timescale for this will vary enormously depending on whether its mountain sage (maybe 15 years) or Wyoming sage (maybe 100 years or never). Fire maps will be useful when vegetation maps have not been updated to show recent fires. Aspect appears only relevant if deeper soils are being deposited on the lee sides of hills, as in Gabler's model for the Idaho National Engineering and Environmental Laboratory (INEEL). Slope and elevation may be somewhat useful, but will not provide much help in most of the sagebrush ranges, because most of the areas will fall within the parameters.

If you have vegetation maps that distinguish between sagebrush species, look particularly where big and low sage are intermingled.

Mid-scale: Examine aerial photos, topographic maps, and use local knowledge to add or delete areas from your initial map. It is usually possible to distinguish thick sage or to see mounds of taller, thicker sage as a dotted or mottled pattern on aerial photos. Local knowledge will help to eliminate burned areas that haven't regrown to sage- e.g. there area some large old fires in the very southwest corner of Idaho that are still grass, but aren't eliminated on the 2003 GIS model. In Oregon, some people have had success with flying over sagebrush landscapes and identifying dense areas of sage for future ground surveys. You could combine surveys for sage grouse or big game with surveys for pygmy rabbit habitat.

Rank the areas you end up with, and start with the most likely areas. These would be the largest blocks on the sagebrush and soils map which weren't eliminated by your refinements, areas surrounding past records, where aerial photos show mounds of sage as a dotted pattern (see example photo at end), where big and low sage are interspersed, and where there are swales of deep soils and tall thick sage.

Fine scale: You will probably have to make the final choice of where to walk a survey route while you are in the field, because the available data are not at a fine enough scale to do this from a distance. While you are driving to or in a chosen area, look for thick tall sage, especially with a "lumpy" or uneven texture, as well as for signs of digging. Sometimes, particularly where soils are light-colored or contain white, lime-covered rocks thrown out by digging, the mounds of freshly dug soil or white rocks are visible from the road. However, in darker soils this is not true, and you have to walk to see burrows. When a suitable area is spotted, stop and walk a survey route.

Your sampling scheme will be dictated by your particular circumstances, both how your habitat lays and what person-power you have. Your planned survey intensity for each area will vary with its priority, the amount of ground you want to cover and the people available to do it. Depending on travel time and whether you are finding burrows, (which will slow you down), you might expect to cover about 3 to 7 miles of walking transects in a day. Do the heaviest sampling in the high priority areas, lighter sampling in the lower priority areas. Portion your survey efforts among your highest priorities, with some scattered lighter sampling in lower priority habitat also, as a check on your ability to target habitat.

In snow: Areas where pygmy rabbits are concentrated will attract predators: coyote, badger, bobcat, and weasel. You can use their tracks to help guide you to pygmy rabbit areas, and even to burrows.

Patch scale: While you are walking a survey route you will need to target the tallest, thickest patches of sage. These patches look like islands that stand out above the rest.

Survey Routes:
The goal of a survey route is to check enough habitat in an efficient manner to determine whether there are pygmy rabbits there or not, and secondarily to get an index of density of burrows. It is not to map out the total patch of habitat or to map every burrow within the habitat. Therefore you will not be trying to walk the perimeter of the population to map it out, or to completely cover the habitat, because this can be very time-consuming. Mapping a polygon requires a lot of walking to determine, first, whether rabbits are there, and then their extent, and also walk the whole perimeter (if you are mapping with a GPS unit). It is simpler and faster to walk a meandering line through a habitat patch, targeting the most likely looking places (instead of the edge), and then continue on to the next swale or

habitat patch, or loop back the other side of the valley. If you map your route and record results well, especially if you use a GPS unit, your survey route will be repeatable. Thus you can create a baseline for long term monitoring at the same time as doing an initial survey. Additionally, the pattern of burrow points along your survey line will help illuminate the extent of habitat patches.

If you are alone, walk in a loop or triangle, targeting patches of taller, thicker sage, looking for pygmy rabbit burrows and scat. The goal of a looping or triangular route is to survey during all your walking time, and to avoid 'deadhead' time. Using a topo map, you should be able to design a route that takes you up one swale and down another, or up and down two sides of a valley. In patchy habitat and where patches are small and follow the contours of the land, following the landforms and targeting the taller sage clumps will be most effective. This means your survey line will be meandering.

If the habitat is uniform or on extensive flats, as in Nevada, straight transect lines arranged in a triangle, or a spiral pattern may be appropriate. For a spiral transect, walk directly to the center of a large, dense sage patch, and then spiral your way out, gradually increasing the diameter of your circle until the habitat is no longer appropriate. To fully check out a potential site often takes about one hour of survey time (Eveline Sequin, pers. comm.)

Transect length should be dictated by the extent of the habitat patch, road distribution, and the amount of overall habitat you have identified to cover. Because of the distances between burrow systems in many situations, experience in Idaho has shown that you will likely need to walk at least ½ mile to check an area out with any degree of confidence, unless you find burrows immediately.

With two people working together, one-way linear transects may work, by "leapfrogging": one person is dropped off to begin a survey route, the second drives ahead and starts another survey route; the first person ends up at the truck and drives ahead to pick up the second. If two people walk a survey route in tandem, the width each can cover will be determined by the habitat, but may be on the order of 100 ft., or 50 ft to each side.

When you drive through unsuitable looking habitat within a generally potential habitat area, stop occasionally and walk a short survey route, to make sure whether there is or isn't pygmy rabbit sign, and record your transect walked. Note whether the habitat looks suitable or not, and why. Remember that 'zeroes' are as important to record as finding pygmy rabbit sign. These data will be used to refine habitat models, and will let us know where to focus and where not to focus management for pygmy rabbits.

Area search:

When you find several current burrows and you are in a new area, (and if you have not yet seen a pygmy rabbit in the area) take about a half hour to search the area looking for pygmy rabbits. This will help confirm whether you have pygmy rabbits, and will help you gain confidence in your ability to distinguish pygmy rabbit sign. So far you have had the search image for a burrow, and have been looking down. Now, switch, get the search image for movement and rabbits, and walk slowly, widening circles around the active sites, looking ahead. Rabbits will often slip quietly into the burrow as you approach, and you have to be alert for the slight movement. Once you learn how to look for the actual animal, you will begin to see them more. (Dave Hays, pers com.).

Pygmy rabbits are easy to distinguish from mountain cottontails. When scampering away, the white of a mountain cottontail tail is usually visible. Pygmy rabbits do not have any white on their tail. Also, pygmy rabbits seldom run far as would a mountain cottontail. Pygmy rabbits will scamper a short distance and stop, often under sagebrush plant or near a burrow entrance.

Seasonal Considerations

Surveys in Washington, Idaho, Nevada, and Oregon have shown considerable variation in the amount of fresh sign at burrows over the course of a year. Late summer and early fall appear to have the least amount of pellets at burrows. Places that had lots of sign in winter or spring may appear almost deserted in late summer, with burrows but few pellets, and then appear repopulated later.

Pygmy rabbits may use burrows less in summer and fall. In the fall, in SW Idaho, Ulmschneider found many burrows in big sage islands on a valley bottom, with a mix of old and a few brown pellets; several hundred yards away, under very thick tall sage and bitterbrush on a rocky side slope, there were lots of fresh small pellets and a

pygmy rabbit was seen, but no burrows were found right there. Rachlow found a similar situation in the summer in Montana, where there were lots of small pellets but no burrows in some very tall sage, and lots of burrows with few pellets in a nearby area. Apparently the pygmy rabbits may abandon their burrows at that time of year in favor of dense cover, perhaps due to parasites.

In Nevada, Sequin has observed that pygmy rabbits use certain areas dominated by rabbitbrush only during the dryer part of the year, late spring through fall. These areas have "loamier" soils that are much wetter in winter. Burrows in these areas often disintegrate during the winter, and there is no evidence of rabbits remaining in the area, by tracks, photo monitoring, or sightings. New burrows are then excavated in this habitat in spring. However, during all seasons, rabbits were still found in the adjacent sagebrush-dominated areas.

Winter may be a better time of year to confirm rabbit presence than the summer and fall because tracks and pellets are obvious in the snow. It is very easy to survey when there is a fresh light snow, when fresh tracks and fresh pellets are obvious. Also, rabbits are active cleaning out burrow entrances after a snow. Pygmy tracks can often be followed to a burrow entrance.

Winter logistics may become difficult, though, as snow deepens. Although initial surveys may be conducted in the summer, if you find possible or "old" pygmy rabbit sign, plan to return in late fall or winter and check again. When you are at the stage of monitoring known populations, the time of the year to monitor will have to be consistent.

In the spring, rabbits appear to be active at their burrows, however, pellets can be more confusing because pregnant females make larger pellets that can be confused with cottontail.

Recording data

The basics to record are where and when you surveyed, whether you found burrows and pellets or not, and burrow locations and status. If you did find pygmy rabbit burrows, categorize, count them, and map them and your survey route.

Classify pygmy rabbit burrow systems (not each entrance) according to the following system:

Used burrow plus fresh pellets (B+FP): brown pellets near a burrow, at least one entrance open, without cobwebs or debris that shows lack of use, usually shows a trail. In snow, tracks and/or pellets visible.
Unused burrow plus fresh pellet (UB+FP): burrow entrances have cobwebs, grass seeds, or other debris in entrance, but with brown pellets. May show transitory use.
Burrow plus old pellets (B+OP): only grey pellets at a burrow, entrances may show signs of non-use.
Burrow, no pellets (B): burrow entrance is not collapsed but no pellets found. Also use this category for burrows in snow where no tracks or pellets are visible.
Collapsed burrow (Col): No pellets
Pellets only (P): No burrows found, but pellets appear right for pygmy rabbit. (Collect and label.)
Fresh digging at a burrow but no pellets (B+dig): Digging may have been by a predator such as coyote or badger. If it was a predator, it was most likely digging after prey, and the prey may have been pygmy rabbit.
Possible PR burrow (Poss): Burrow seems right for pygmy rabbit, but there are confusing pellets or no pellets, or it is not in association with other pygmy rabbit burrows (identified by pellets or sightings).

There are several options for how to record data, depending on the equipment you have available: electronically with GPS units, paper data forms, topo maps, and aerial photos. With GPS units, one might think that it would be easy to map a polygon delineating a pygmy rabbit population, instead of walking a transect and mapping burrows. However, in the field one soon finds that mapping polygons is difficult and complicated, unless they are very small, and generally requires much more wandering about than walking a transect through a habitat patch, as you try to determine the extent of an often complicated population, exactly where the burrows stop, and then try to walk the perimeter. Additionally, a transect with burrow points added up along it will give you an index of burrow density that can be remeasured (most GPS units are accurate within about 2 meters), which a polygon will not give you. If you try to do both, you will lose efficiency enormously! The simplest way is to delineate the habitat, if you wish, is to draw the approximate extent of the habitat on a topographic map or aerial photo, after you finish your transect.

1. GPS unit with a data dictionary (e.g., GeoExplorer 3): *note your projection on a data sheet e.g., NAD 27.* (A "data dictionary" is an electronic data form that can be filled out directly into the GPS unit, and later downloaded directly to a computer. It can be created to match the paper data form given at the end of this paper.)
With a Geo Explorer III or other GPS unit that has capability for a data dictionary:
   - Record your survey route (where you walked) using a line feature. You can interrupt the line where you record a pygmy rabbit point, and then resume it after.
   - Record each pygmy rabbit burrow system (not individual openings) as a point feature, using a pygmy rabbit data dictionary that includes the essential information on the data form at the end of this paper). Use the "repeat' feature, and when you become skilled, it will only take about 30 seconds to record a burrow. Burrow systems may be about 15 ft across. In areas with dense burrows, it may be difficult to decide when to record a new burrow system. One rule of thumb is to record a new burrow system at least 30 ft apart (however they can be much denser than that; in Montana, Rauscher found an area with 8 burrow systems within 30 m).
   - Take daily field notes of where you surveyed for the day, habitat, numbers of burrows in each status category, extent of habitat, why you thought they were or weren't pygmy rabbit, general findings (no sign, old sign, lots of current sign, other critters), any other notes that would help someone else determine where you looked, what you found, and the validity of what you found, (remembering that it is possible to lose GPS data, and that general notes are often extremely useful in interpreting the data!) Remember zeroes are important to record and discuss!
   - Map your survey areas on a topographic map or aerial photo, with date, your name, and a key to any symbols used.
   - When finding pygmy rabbit sign in a new area, take samples of droppings and label each container with date, location, and your name (film canisters work well, or plastic Ziploc bags).
   - Take photos of burrows, landscape setting, and any other sign (tracks, trails, bones, pellets). Label your photos with date, location (Township, Range, Section and ¼ section), your name, and what it shows.
   - Also mark your driving routes on the maps, when you are within a search area and looking for target habitat to do foot surveys.

2. GPS unit without a data dictionary:
   - Record your survey route using a line feature and pygmy rabbit burrow systems using a point feature, as above.
   - Use the paper data form to record the necessary information.
   - Collect pellets and take photos as above.
   - Mark your survey areas on a topographic map or aerial photos, with date, your name, and general findings.
   - Also mark your driving routes on the maps.

3. No GPS unit (or GPS unit with a dead battery!)
   - Use aerial photos and/or topographic maps to record locations of any burrow systems found and of your survey route. Label each map and photo with "Pygmy Rabbit Survey," dates, your name, and a key to burrow classification and survey routes.
   - Alternatively, if burrows are too dense to map separately, map out the area where burrows are found,
   - Keep a tally of burrow systems in each category as you walk a transect within the area delineated (see data sheet). Also mark your driving routes on the maps.

Other methods

Traps:

Trapping is not appropriate for general surveys. It may be useful once you know where you have the right burrows for further study or to confirm presence. Even in areas with known dense populations of pygmy rabbits, and putting traps right in the entrances of burrows that show fresh activity, trapping success rates are low (0-4%). Burrows are always there and usually distinctive, and therefore are more useful for general surveys.

Camera with automatic trigger (from Eveline Sequin):

Cameras can be used to determine if pygmy rabbits are currently active in an area. Photographs provide direct and convincing evidence that rabbits are present and provide a permanent record. Once burrows are located, or unconfirmed sightings are reported, cameras can be left at the site with minimal human attention to collect the required data. Cameras are able to visually detect pygmy rabbits at locations where other survey methods do not detect

them, and may be especially helpful in the spring when the potential presence of other young rabbits may confuse pellet surveys.

First a site inspection should be conducted by walking around the area looking for burrowing activity, animals and fresh pellets. Next, set up one active infrared-triggered camera in a central location (near burrows if they have been located). Cameras can be set either across the entrance of an active burrow, or across an open area nearby. Active infrared cameras have proven to be more cost effective than passive cameras because they can easily be set into vegetated areas without being triggered by the surrounding moving vegetation. The receiver should be set to trigger the camera if the infrared beam is blocked for 0.5 seconds (1 infrared pulse, or the minimum amount of pulses the unit will allow). To make the camera units even more sensitive, reduce the width of the infrared lens to 1 mm with black electrical tape. This combination of settings is responsive enough to capture full body images of rabbits even when they are surprised by the flash or noise. Set the transmitter about 2-4m from the receiver and camera allowing plenty of area for rabbits to travel between the two units. The beam should be set at a height of approximately 5 cm. Set a camera delay of 1 or 2 minutes so that one animal will not use up the entire roll of film. Use 100 or 200 ASA film, and set the cameras to be active 24 hours a day. In locations where pygmies are known to be active, it was shown that cameras were usually able to record their presence over the course of one week. Depending on the site and the season the film will fill in a few days or over the span of the week. In winter, snow may trigger the camera and use all film in an hour.

It is possible to distinguish pygmy rabbits from other rabbits (juvenile jackrabbits, cottontails) using this method. Adult pygmy rabbits can be distinguished reliably by their tails, heads, ear shape, and size in relation to camera equipment. Juvenile cottontails and jackrabbits can be distinguished by tails, head and ear shape, and coloration. Individual rabbits are generally photographed multiple times at one camera location. This means that even if not every photograph is entirely conclusive, the multiple angles of single individuals allow for conclusive evidence. If for some reason only one questionable photograph is received, the camera can always be set out for another week. Comparison photos of the species by Eveline Sequin (University of Nevada – Reno) may be viewed at www.wildlife.utah.gov/habitat.

Spotlighting:
It is possible to see pygmy rabbits by spotlighting at night; however, it is not as effective or efficient as looking for burrows. Burrows are permanent and easy to spot once you know what to look for, and you can look for them in the day. Spotlighting may be useful for confirming presence by seeing a rabbit once you find an area with burrows, however, the daytime area searches described above are probably more practical. Rauscher reports, "I attempted to spotlight pygmy rabbits in an area I knew to have a relatively high density of rabbits. I only saw 2 pygmy rabbits. This method is not very effective."

Peeper Probe:
This is a flexible cable with an infrared camera on the end, allowing you to look down a burrow. It may be useful, once you have found burrows, in spotting a rabbit or helping to identify what species dug a burrow in questionable cases. You may be able to figure out how to distinguish the underground features of pygmy rabbit burrows versus other burrows. Rauscher in Montana has used these probes in known occupied sites, and was able to spot pygmy rabbits; however, he thinks that it is probably not too useful or effective for general surveys. The peeper probe may be useful for some aspects of demographic studies, such as looking into natal dens (J. Rachlow, pers. comm.) Females apparently dig single, simple burrows for giving birth, and fill the entrance with dirt, so these burrows may be hard to find.

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PYGMY RABBIT SURVEY FORM

Observer(s): _____ Affiliation: _____

Address: _____ Phone: _____

Observation Date: _____ Site Name: _____ Co.: _____ State: _____ Site #: _____

Township: _____ Range: _____ Meridian: _____ Section: _____ Quarter/Quarter: _____ of Quarter: _____

Project / Transect ID #: _____ Field Map ID: _____

Survey Method: _____ Search Time: Start: _____ Stop: _____

GPS Data

Projection: Decimal Degrees ☐ Decimal Minutes ☐ Degrees/Minutes/Seconds ☐ UTM Zone: 10 ☐ 11 ☐

Datum: NAD27 ☐ NAD83 ☐ WGS84 ☐

Coordinates:
Starting point Easting _____ Northing _____ Elevation _____

Accuracy: PDOP _____ FOM _____ +/- _____ Feet ☐ Meters ☐

Land Ownership: State ☐ BLM ☐ USFS ☐ USFWS ☐ Private* ☐ (state below)
Tribal ☐ Military ☐ Nat. Park ☐ Other: _____

*Private landowner / Address / Phone: _____

Potential Threats to Area: Agriculture ☐ Fire ☐ Development ☐ Grazing ☐ OHV ☐ None Other: _____

Summary of Results for Survey Route Pellets collected? Yes ☐ No ☐

Pygmy rabbit observed? Yes ☐ No ☐ Pygmy Rabbit sign observed? Yes ☐ No ☐ Possible burrows ☐ Possible Pellets ☐

Summary of numbers of burrows B+FP: _ B+OP: B: _ _ UB+FP: Col: _ _ B+dig:__ FP alone: _ ____

Length of survey route Miles: Feet: Meters:

Predators (T- tracks, S–scat, V-visual) Coyote T S V Fox T S V Badger T S V Weasel T S V Bobcat T S V
Raptor T S V Other

Notes. *Provide directions, describe landscape setting, note other animals, explain why if no pygmy rabbits were found, describe behavior of any pygmy rabbits seen, etc.*

CODES FOR DATA

Burrow Status	**B+FP –** used burrow plus brown, green, or black pellets	**B+OP** – burrow plus grey pellets	**B –** open burrow, no pellets	**UB +FP** Unused burrow, fresh pellets	**Col –** collapsed burrow	**B+dig –** burrow, fresh digging, no pellets	**FP –** fresh pellets alone	**Poss** Possible PR burrow
Burrow Details	**T** –Clean trail **O** – Open **Col** – Collapsed **Deb**- Debris filled **Dig** - Fresh digging **TS** – tracks in snow **US** – Untracked snow **B** - At base of bush **R** - At base of rock **E**– Enlarged by predator							
Pellet Quantity	**H –** high**,** lots, a carpet **M –** moderate **F-** few							
Soil	**L** - Loam **S** - sand **C** - Clay **G -** Gravelly **R** - Rocky							
CanopyCover (20 ft radius)	**S –** shrubs **F -** Forbs **G** – grass **B** - bare ground **0** –(0 – Trace) **1** - (1-10%) **2 -** (11-25%) **3 -** (26-50%) **4** - (51-75%) **5** – (76-100%							
Grazing use level	**0** - None **1** - slight **2** - light **3** - moderate **4** - heavy **5** – severe *Use descriptions from BLM's Landscape Appearance Method*							

Burrow #	UTM Easting	UTM Northing	Status	Burrow details	Pellets	Soil	Canopy Cover				Grass Use levels	Pygmy rab seen	# of entrances	Comments
							Shrub	Grass	Forbs	Bare				

BLM's Landscape Appearance Method for classifying Grazing Use Level:

1. **None** (0-5 %). The rangeland shows no evidence of grazing use; or the rangeland has the appearance of negligible grazing.
2. **Slight** (6-20%). The rangeland has the appearance of very light grazing. The key herbaceous forage plants may be topped or slightly used. Current seedstalks and young plants of key herbaceous species are little disturbed.
3. **Light** (21-40%). The rangeland may be topped, skimmed, or grazed in patches. The low value herbaceous plants are ungrazed and 60 to 80 % of the number of current seedstalks of key herbaceous plants remain intact. Most ground plants are undamaged.
4. **Moderate** (41-60%). The rangeland appears entirely covered as uniformly as natural features and facilities will allow. Fifteen to 20 % of the number of current seedstalks of key herbaceous species remains intact. No more than 10 % of the number of low value herbaceous forage plants are utilized. (Moderate use does not imply proper use.)
5. **Heavy** (61-80%). The rangeland has the appearance of complete search. Key herbaceous species are almost completely utilized with less than 10 % of the current seedstalks remaining. Shoots of rhizomatous grasses are missing. More than 10 % of the number of low value herbaceous forage plants have been utilized.
6. **Severe** (81-100%). The rangeland has a mown appearance and there are indications of repeated coverage. There is no evidence of reproduction or current seedstalks of key herbaceous species. Key herbaceous forage species are completely utilized. The remaining stubble of preferred grasses is grazed to the soil surface.

Pygmy Rabbit Summary Sheet

Burrows

- 5-10 inches in diameter
- Placed under sage
- In relatively tall thick sage

Pellets

Pygmy Rabbit	**Cottontail**	**Jackrabbit**
4-6 mm – in carpets near burrow is diagnostic	6-10 mm	9-12 mm

Tracks – length of hind foot

Pygmy Rabbit	**Cottontail**	**Jackrabbit**
46-69 mm	77-90 mm	90-103 mm

Visual

Pygmy Rabbit	**Cottontail**	**Jackrabbit**
Brown tail	White tail, obvious from rear	Black-tipped tail (blacktail) or whitish tail (whitetail)
Ears 2 1/4 – 2 1/2 in, about length of head	Ears 2 1/5 – 2 3/5 in, about length of head	Ears 5-7 in, way longer than head, and black tipped
Won't run far, often stops at sagebush or burrow	Bolts fast and far	Bolts fast and far
Small – 8 1/2-11 in	Medium – 12-14 in	Large – 17-21 in Blacktail; 18-22 in Whitetail.

Appendix 2: Recovery Strategies and Tasks from the Washington State pygmy rabbit conservation plan (WDFW 1995)

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1. Monitor the pygmy rabbit population.

Knowing the distribution and abundance of pygmy rabbits is essential to making informed management decisions. Efforts to determine population trends at existing sites must be continued. In other areas, sighting reports should be evaluated and follow-up surveys conducted to attempt to verify pygmy rabbit presence.

1.1 Determine population trends through fall/winter burrow survey**s**.

Monitoring of pygmy rabbit populations is needed to provide baseline data from which to discern population trends, changes in distribution, and other population parameters. To avoid trapping and handling pygmy rabbits, trend data should be obtained through survey and classification of burrows. Burrow surveys should be conducted between late fall and early spring, the seasons when pygmy rabbits are most closely associated with burrows. Estimates of active burrows over an entire habitat area are best obtained from randomly selected, circular plots that allow for 100% detection of active burrows. Pins driven into the ground mark plot centers at Sagebrush Flat and these should be used in surveys conducted annually. Burrow activity classification should be based on whether or not passages are open and recent tracks or fecal pellets are present. This technique will provide an indication of population trend.

1.2. Develop techniques for estimating pygmy rabbit numbers.

Techniques suitable for estimating numbers of pygmy rabbits need to be developed. Chosen techniques should minimize mortality. Mark recapture techniques that have been used to estimate rabbit populations should not be used if significant mortality would occur. Marking, in combination with spotlight transects or camera sets are among the techniques that should be considered. Randomly sited circular plots may prove valuable for population estimation, perhaps in combination with counts of active burrows or fecal pellets. These techniques should be considered and, if warranted, refined and tested for their applicability to pygmy rabbits. A population assessment provided by burrow counts will provide needed information in the near term. However, eventually, estimates of pygmy rabbit population sizes should be obtained. A wide variety of techniques should be considered so that one or two of the most promising methods can be tested, refined, and implemented.

1.3. Survey areas of potential pygmy rabbit occurrence.

Areas determined to have good potential to support pygmy rabbits (based on examination of soil type maps, aerial photos, or other sources) should be surveyed on the ground. Similarly, reported pygmy rabbit sightings should be evaluated and, if deemed to be likely, the area of the sighting should be surveyed on the ground.

2. Protect the pygmy rabbit population.

Management actions designed to protect the existing population and increase population size should be initiated. At this time, occupied pygmy rabbit habitat in Douglas County is the highest priority for recovery actions.

2.1. Reduce the potential for destructive fires.

Reducing the risk of devastating fire will involve regulating access, requiring outdoor fire permits, and planning for quick control or suppression of fires that get started.

2.1.1. Limit vehicular access in the vicinity of pygmy rabbit areas.

Reducing accessibility for vehicles can reduce the potential for range fires. Methods for controlling access need to be devised and implemented.

2.1.2. Develop green strips to protect pygmy rabbit habitat areas from fire.

Green strips are comprised of planted perennial grasses that remain green through spring and early summer when lightning-caused fires are most likely to occur. The presence of perennial grasses tends to exclude cheatgrass (a fire risk increaser) and provide a fire resistant strip that will often stop the spread of a range fire. Mowing of the green strip during mid to late summer would provide additional security.

2.1.3. Establish districts surrounding pygmy rabbit areas where outdoor burning permits are used

to enforce standards that prevent range fires. Fire permit requirements should be developed and applied to areas in and adjacent to pygmy rabbit habitat. Local fire districts should be enlisted and contracted, if necessary, to administer permits and enforcement.

2.1.4 Develop strategies and partnerships for fire response readiness.

Equipment and responsible staff need to be identified for response to fires in or adjacent to pygmy rabbit habitat. Local fire districts, State Strike Teams, and others may be incorporated into a fire response plan.

2.2. Keep records on the relative abundance of predators and all evidence of predation. If warranted, take steps to reduce predation.

Mammalian and avian predators may be a threat to pygmy rabbit populations because of the small number of rabbits and the small extent of area they occupy. During pygmy rabbit population monitoring, notes should be taken on predator species observed (including sign) and evidence of predation on pygmy rabbits. If there are indications of regular and widespread predation on pygmy rabbits, steps should be taken to discourage predators from frequenting pygmy rabbit habitat areas. In the long-term it is expected that increasing pygmy rabbit numbers and distribution, as well as maintaining adequate vegetative cover conditions, will make predation unimportant.

2.3. Reduce the potential for mistaken identity killing of pygmy rabbits.

At this time, there is little hunting of any kind in areas known to have pygmy rabbits. If, in the future, pygmy rabbits are found in areas where rabbit hunting occurs, signs should be posted alerting hunters to the presence of protected pygmy rabbits. Areas could also be closed to rabbit hunting if the risks to pygmy rabbits are determined to be significant.

3. Manage habitat to increase pygmy rabbit abundance and distribution.

To establish populations large enough to sustain themselves into the distant future, existing habitat should be enhanced and additional habitat created and managed. The amount of habitat and space required for the achievement of the recovery objective must be determined and sites chosen for management as pygmy rabbit habitat.

3.1. Improve the suitability of existing pygmy rabbit habitat.

Existing pygmy rabbit areas, if enhanced, should be capable of supporting larger numbers of pygmy rabbits. It may be possible to enhance the suitability of existing habitat areas by increasing sagebrush cover or by increasing the availability of favored grasses and forbs. If grazing occurs on a site, it should be managed for compatibility with pygmy rabbits. Grazing management should be responsive to the results of research into the effects of grazing on pygmy rabbits and their habitat. Increasing soil depth or microtopography may prove to be legitimate enhancements and should be tested. Other enhancements may be developed as an outgrowth of research findings.

3.2. Determine the amount of habitat needed to support a recovered population.

A method for estimating the amount of habitat needed for a recovered population should be developed and applied. The method should reflect the influences of soil types, soil depth, topography, and climate on carrying capacity.

3.3. Identify areas that should be managed as pygmy rabbit habitat.

Using information derived from task 3.2., identify areas that could be managed for pygmy rabbit recovery.

3.3.1. Use Geographic Information Systems technology to identify areas suitable for field survey.

Conduct a broad analysis of landscapes within the historic range of the species in Washington (Douglas, Lincoln, Grant, Kittitas, Yakima, Benton, Franklin, Adams, and Walla Walla counties) to determine the locations of the best areas to be enhanced or restored to a condition attractive to, and capable of supporting, pygmy rabbits. Information on soils, topography, current land uses, ownership, and vegetation should be used to identify areas that could be pursued for inclusion in a management program designed to increase pygmy rabbit numbers and distribution. Initial efforts should be directed toward identification of lands with appropriate soils, topography, and a big sagebrush plant community. Lands in public ownership or those owned by supportive private landowners should be given priority consideration.

3.3.2. Survey identified areas to evaluate their habitat potential.

Conduct surveys designed to characterize habitat conditions and habitat potential. Since pygmy rabbit habitat requirements are fairly well known, measurement of specific characteristics will provide a useful indication of habitat suitability or the potential for developing suitable habitat characteristics.

Priority for surveys should be given to public lands. Private lands should be surveyed when they provide an important link between parcels of public land or when their habitat values are potentially superior to anything available on public land. In some instances croplands with the appropriate soil and topographic characteristics could benefit pygmy rabbit recovery if returned to a sagebrush-dominated plant community.

After the results of these surveys have been evaluated, potential pygmy rabbit habitat areas should be selected. A discussion of management or enhancement needs and estimated costs should be developed for each habitat area.

3.4. Pursue management of selected areas by natural resource agencies.

Areas selected as candidates for providing pygmy rabbit habitat areas may be best managed by natural resource agencies. However, a variety of options for managing the land to benefit pygmy rabbits should be pursued.

3.4.1. Support or facilitate fee acquisition of existing or potential habitat through purchase, land exchange, or charitable donation.

The Department should facilitate or support acquisition of pygmy rabbit habitat by agencies, persons, or groups that intend to conserve pygmy rabbits and their habitat. Acquisition should be pursued where there are willing sellers and it is determined to be the best means for securing needed habitat for pygmy rabbits.

3.4.2. Support or facilitate the application of less-than-fee mechanisms to provide habitat for pygmy rabbits.

Conservation easements and tax incentives such as open space designation may be used to encourage private landowners to protect pygmy rabbit habitat. Within landscapes of importance to pygmy rabbit recovery, Coordinated Resource Management Plans, access regulation, fire risk reduction, and other management actions should be pursued where fee acquisition is not possible or not warranted.

3.4.3. Develop and apply site-specific management plans.

Site-specific management plans provide guidance for dealing with the needs of a specific pygmy rabbit habitat area. The management considerations or activities required to conserve pygmy rabbit habitat differ from one parcel to another and are influenced by land uses on the parcel as well as land uses on adjacent parcels. A site-specific management plan is important in establishing the habitat and population monitoring and management needs of the site. Detailed site-specific management plans, agreed to and implemented by WDFW and other involved parties, can be considered the means for achieving habitat security to meet pygmy rabbit recovery objectives.

3.5. Create suitable habitat in areas selected for management as pygmy rabbit habitat.

Develop techniques to create or enhance pygmy rabbit habitat, taking full advantage of expertise in soils, range, and other sciences to attain the desired results. Apply these techniques in areas being managed for pygmy rabbits. To provide for an increased pygmy rabbit population in Washington, increases in both the suitability of existing habitat and the quantity of habitat overall need to be achieved. The techniques for accomplishing these objectives have not been refined. Vegetative cover and soil characteristics are important to pygmy rabbits and may need to be managed for optimal conditions. This includes control of invading exotics that could degrade habitat conditions. To expand the habitat area available to pygmy rabbits, croplands in some areas

should be restored to a predominantly sagebrush cover. These areas will provide an opportunity to experiment with artificially created habitat, such as soil mounds similar to those that are often chosen for burrow construction.

3.5.1. Identify and apply land uses and techniques suitable for enhancing, creating, and sustaining habitat characteristics which benefit pygmy rabbits.

A variety of habitat enhancement techniques should be attempted and evaluated. These could include methods to establish sagebrush, increase sagebrush cover, or create desirable microtopography and soil conditions. For areas currently without a sagebrush plant community, these and other techniques should be tested to learn which techniques produce the best results.

3.6. Monitor habitat conditions in pygmy rabbit habitat areas.

The characteristics of vegetative communities are important to pygmy rabbits. Vegetative cover conditions at sites being managed for pygmy rabbits should be assessed periodically. Descriptive information on the height, density, and species composition of vegetative cover should be collected from sample plots.

4. Establish populations in new areas.

When suitable habitat is secured or created, reintroductions will likely be necessary to restore the species to portions of its former range.

4.1. Investigate techniques for introduction of rabbits to unoccupied habitat.

A wide variety of considerations (e.g., costs, survival advantages, transplant success rates) must be evaluated to determine how to establish new populations in unoccupied habitat. Evaluate and test reintroduction techniques, including use of captive-reared versus wild-caught pygmy rabbits for introduction to unoccupied habitat.

4.2. Conduct genetic comparisons of rabbits from potential transplant source populations.

Genetic comparisons between Washington populations and potential transplant source populations should be conducted and evaluated. This information should be used to help guide decisions about sources of rabbits for transplants.

4.3. Implement introduction of captive-reared or wild-caught juvenile rabbits to unoccupied suitable habitat.

As an outcome of the evaluations described above, a reintroduction method should be selected. Reintroduction should proceed contingent upon adequate habitat provision as described under sections 3.2 and 3.4.

5. Enforce restrictions designed to protect pygmy rabbits.

Under the Wildlife Code of Washington, killing pygmy rabbits is the primary activity prohibited by law and enforcement of this law may be necessary. However, the Department should seek assistance in establishing and enforcing access restrictions, outdoor burning permit requirements, and other rules that serve to protect pygmy rabbits and their habitat.

6. Establish information management and retrieval systems.

Ready access to information gathered during surveys and investigations will be critical for management decision makers. A centralized information system, Wildlife Survey Data Management, exists at the Department of Fish and Wildlife. Summaries of data should be prepared annually and distributed to interested persons and agencies.

6.1. Maintain repository for pygmy rabbit records.

New pygmy rabbit habitat area locations should be submitted to Wildlife Survey Data Management at the earliest opportunity following discovery. Data entry, manual storage, and incorporation into a Geographic Information System should be done as appropriate.

6.2. Produce an annual pygmy rabbit status review.

A report describing the status of the pygmy rabbit population, as well as management activities and their effects, should be prepared and distributed each year. An annual threatened and endangered species status report, combining information for all listed species, is one way to make this information readily available.

7. Coordinate and cooperate with public agencies and other landowners.

Working in concert with other entities will enhance the potential success of WDFW recovery activities.

7.1. Review and recommend revisions to State regulations to protect pygmy rabbit populations and habitat.

State lands are often leased for the purposes of grazing, growing crops, extracting minerals, and other uses. Existing regulations on leasing of state lands may not provide adequate provisions for conserving habitat for endangered species. A comprehensive review of the rules which govern the leasing process needs to be conducted and recommendations developed for improving protection afforded to endangered species.

7.2. Develop management plans which protect pygmy rabbit populations and habitat.

For pygmy rabbit areas on public lands, protection of pygmy rabbits and pygmy rabbit habitat should be a primary goal of Coordinated Resource Management Plans, lease agreements, and other land use plans. For State Trust Lands there may be Trust compensation required. The existing Coordinated Resource Management Plan for Sagebrush Flat should be revised at the earliest opportunity to incorporate additional information on pygmy rabbit monitoring and habitat needs. For pygmy rabbits on private lands, the Department should encourage landowners to follow mutually agreeable land use management plans which protect pygmy rabbits and their habitat. Soil Conservation Service personnel should continue to be involved in management of pygmy rabbits because of their expertise in soils and vegetation and because of their frequent interactions with landowners in the range of the pygmy rabbit.

7.3. Provide management recommendations to landowners.

Pygmy rabbit management recommendations which address grazing management, access control, strategies to reduce the risk of range fires, and other strategies to benefit pygmy rabbits should be developed. Agency staff should provide these recommendations to public and private landowners and encourage implementation of the management recommendations to protect existing populations and enhance or create habitat to allow for new or larger populations. Pygmy rabbit recovery will benefit from landowner cooperation. The Department should initiate discussions with landowners to determine current land use practices and to find ways to improve conditions for pygmy rabbits.

When unoccupied habitats that are suitable for enhancement or restoration are identified, Department staff should work with landowners to encourage them to initiate activities that create or enhance habitat conditions for pygmy rabbits. Adjacent landowners should also be encouraged to implement management recommendations which benefit pygmy rabbits.

7.3.1. Work with public landowners to manage grazing and other activities to the benefit of pygmy rabbits.

On public lands, particularly, leases for grazing and other land uses should be contingent upon compatibility with pygmy rabbits. This necessitates cooperation and communication between wildlife professionals and landowners so that biological information can be used to adjust and refine land use practices to meet pygmy rabbit habitat requirements.

7.3.2. Work with private landowners to manage grazing and other activities to the benefit of pygmy rabbits.

Private landowners should be encouraged to manage grazing and other land uses for compatibility with pygmy rabbits. This necessitates cooperation and communication between wildlife professionals and landowners so that biological information can be used to adjust and refine land use practices to meet pygmy rabbit habitat requirements.

7.4. Secure cooperative funding to support recovery activities.

Pygmy rabbit recovery will not be accomplished without the participation of many organizations and individuals. Additional funds will be necessary. Success at completing the recovery tasks outlined in this plan will be contingent upon securing funding for habitat acquisition and restoration and reintroductions of rabbits.

7.4.1. Pursue funding to implement recovery strategies. Pursue cost or resource-sharing arrangements, federal challenge grants, private foundation grants, Washington Wildlife Recreation Coalition funds, and other sources of funds to implement recovery strategies.

7.5. Create information exchange network between agencies.

State and federal agencies involved in pygmy rabbit management should exchange information so that the management activities of each can benefit from the other's efforts.

7.5.1. Provide locations of critical pygmy rabbit habitat areas to local governments and other agencies for use in land management decisions. Subdivisions, commercial development, and conversion to cropland destroy vegetative cover conditions that are needed to support pygmy rabbits. The Department should help local governments conserve habitat for threatened and endangered species by identifying locations of critical habitats. Department biologists should make themselves available to local governments and other agencies to assist with assessing the effects of proposed developments and mitigating measures that might be implemented.

8. Complete scientific investigations that will benefit recovery efforts.

Much remains to be learned in Washington and throughout the range of the pygmy rabbit about the species' reproduction, dispersal, response to habitat change and other processes. Washington biologists should develop survey methods to monitor pygmy rabbit abundance. They should also remain abreast of research and management activities elsewhere in the pygmy rabbit's range.

8.1. Investigate the influence of different grazing strategies on pygmy rabbit population density and health.

Knowledge of the effects of variable intensities and durations of cattle grazing is important to achieving pygmy rabbit recovery goals. The potentially large extent of lands necessary to achieve recovery goals make it necessary that options for continued economic uses of the lands be considered. Research should be directed at understanding the effects of grazing on pygmy rabbits and identifying grazing strategies that have the potential to coexist with a healthy, viable pygmy rabbit population.

8.2. Investigate pygmy rabbit dispersal capabilities and the influence of vegetative cover conditions on dispersal.

Knowledge of pygmy rabbit dispersal capability is important for establishing whether or how quickly the species will be able to colonize vacant or newly created habitat at varying distances from existing populations. It is also a key to understanding the degree of isolation of pygmy rabbits in one area from those in another area. This knowledge is important for genetic considerations and for understanding a population's vulnerability to extirpation.

8.3. Determine population dynamics, including survivorship and recruitment patterns at breeding areas.

Pygmy rabbit population dynamics are not well-known. Population estimation techniques, which minimize handling and mortality, should be developed. The reasons for considerable population fluctuation in pygmy rabbits are not known. This aspect of their population dynamics has a bearing on population vulnerability to extirpation and should be investigated so that recovery objectives can confidently reflect a low risk of extirpation.

9. Develop public information and education programs.

Restoring endangered and threatened species to healthy, self-sustaining populations is a tremendous challenge. Successes in endangered species recovery require public funds and resource protection policies that are established as a result of broad public support. Information and education programs provide the means for the public to gain an understanding of recovery programs and needs. These are vital to both recovery of endangered species and long-term viability of wildlife populations.

9.1. Develop educational materials.

Local support for efforts to recover pygmy rabbit populations may be gained through development of quality educational materials. A fact sheet or poster could be designed to communicate information on the pygmy rabbit's special needs. A video and/or slide show describing the pygmy rabbit, its habitat, and recovery efforts could be produced.

9.2. Promote media contact.

Encourage the production of news releases, public service announcements, and articles in newspapers and magazines.

9.3. Conduct workshops and involve the public in recovery efforts, where possible.

Providing information to people who own or lease pygmy rabbit habitat should be the highest priority because these individuals have the greatest capability to affect pygmy rabbits and their habitat. Solicit and coordinate volunteer participation in habitat restoration and other recovery actions.