SPECIES ASSESSMENT FOR PREBLE'S MEADOW JUMPING MOUSE (*ZAPUS HUDSONIUS PREBLEI*) IN WYOMING

prepared by

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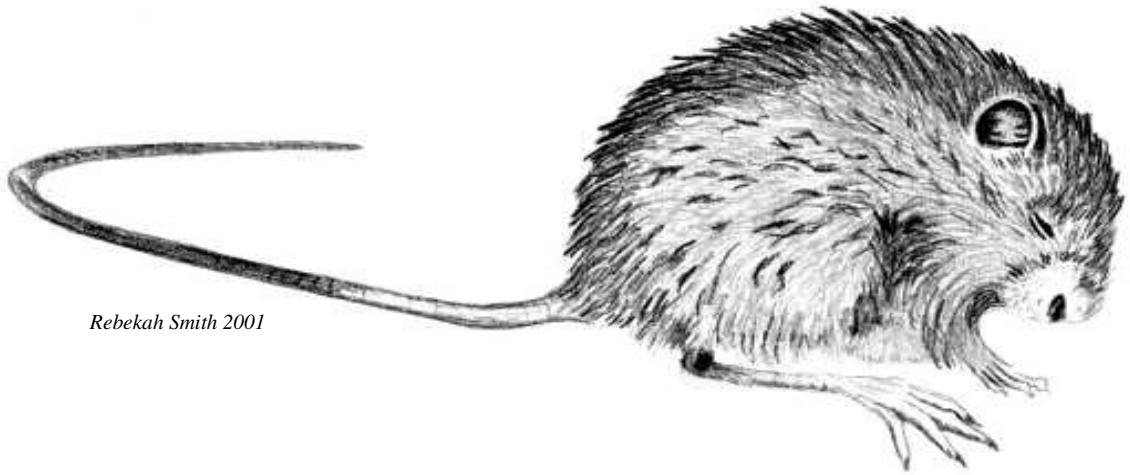

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Introduction

"Following the Preble's listing as a threatened species in 1998, knowledge about its distribution, habitat requirements, abundance, and population dynamics has grown substantially. However, much of the biology and ecology of the Preble's is still not well understood"(USFWS 2003b).

The management of Preble's meadow jumping mouse (Preble's; *Zapus hudsonius prebeli*) is a high priority for natural resource professionals in southeast Wyoming and north-central Colorado. It is currently listed as Threatened under the U.S. Endangered Species Act (Act; USFWS 1998), and discrete units of critical habitat necessary for the subspecies' recovery have been designated by the USDI Fish and Wildlife Service (Service; USFWS 2003b). New land use regulations designed to enhance recovery within critical habitat units have the potential to alter traditional uses of natural resources throughout the subspecies' range.

The scientific controversy surrounding the conservation and management of jumping mice in southeast Wyoming is whether or not the species meadow jumping mouse, *Z. hudsonius*, and the subspecies Preble's meadow jumping mouse, *Z. h. preblei*, are distinct and valid taxa here. Unfortunately there are no straightforward criteria with which to evaluate the validity of within-genera taxa. It has long been recognized that biological diversity at this level exists as a continuum, with gradations (as opposed to quanta) of difference between individuals, populations, and races. The traditional taxonomic system forces the identification of artificially discrete units along that continuum. In this context, no single trait can adequately partition the continuum, necessitating a "weight of evidence" approach that considers multiple traits (e.g., morphology, genetics) to define within-genera taxa (DeWeerdt 2002).

Two recent petitions to remove the Preble's meadow jumping mouse from the federal list of threatened and endangered species, and recent genetic findings (Ramey et al. 2004) have prompted the Mountain-Prairie Region of the Service to initiate a status review of the Preble's (USFWS 2004). Because of the similarity in steps taken by the Service to prepare a 12-month finding on a petition to de-list a species, and the 5-year review of the listing action, these efforts will be conducted simultaneously. Within the next calendar year (through 03/31/05) the Service is scheduled to rule whether Preble's should remain listed or be proposed for delisting.

Natural History

Morphological Description

Genus *Zapus*

The following generally describes individuals of both *Z. hudsonius* and *Z. princeps*. A small rodent with hind legs much longer than forelegs. The tail is longer than the body, sparsely haired, and darker above than below. Eyes are midway between the nose and the ear. Ears are dark but edged with white. There are 18 teeth, with upper incisors having distinct grooves on their outer faces. Cheek pouches are absent. Fur on the back is yellow olive-brown with scattered, long, black-tipped hairs which create a faint dorsal stripe. The sides are light yellow-brown, and the belly is white to light buff. Young tend to have softer, lighter fur than adults. Adult pelage appears rather coarse (Long 1965, Armstrong 1972, Clark and Stromberg 1987, Fitzgerald et al. 1994, USFWS 2002a).

The general appearance of jumping mice is relatively unique; it is difficult to confuse them with other rodents in Wyoming. The extremely long tail and large hind feet are especially good characters for recognizing jumping mice. Woodland jumping mice (*Napeozapus insignis*) are very similar in appearance, but do not occur within ca. 500 mi of Wyoming (Figure 1).

Species - *Zapus hudsonius*

The following dimensions are in addition to the above description of individuals in the genus *Zapus*. Adult measurements: total length 180-220 mm; head and body length <89 mm; tail 115-136 mm; hind foot 28-31 mm; ear 11-16 mm; weight 12-22 g (Clark and Stromberg 1987, Compton and Hugie 1993). In addition, incisive foramina <4.6 mm; palatal breadth at last molariform tooth <4.2 mm; condylobasal length usually <20.3 mm; and maxillary toothrow usually <3.7 mm (Whitaker 1972).

When specimens from distant sites are compared, known *Z. hudsonius* are on average smaller in several gross body dimensions than known *Z. princeps* (e.g., Hall 1981, Jones 1981, Schorr 2001). For several years it was thought that total body length and other gross dimensions were reliable indicators of species identity within the suspected range of *Z. h. preblei* (e.g., Clark and Stromberg 1987). However, it has since become clear that there is substantial overlap in these measurements between purported *Z. hudsonius* and purported *Z. princeps* from this region. This, coupled with essentially indistinguishable pelage and body shape, has lead most mammalogists in the region to conclude that no external morphological character can be used to classify specimens from here into 2 distinct taxa.

Using multivariate analysis techniques, Conner and Shenk (2001) compared precisely-measured skull dimensions of *Zapus* specimens from low elevations (purported *Z. hudsonius*) to those of *Zapus* specimens from high elevations (purported *Z. princeps*) in northcentral Colorado and southeast Wyoming. At a sub-millimeter scale, low-elevation skulls were significantly and consistently smaller than those from high elevations. Also, known *Z. hudsonius* typically possess an anterior median tooth fold (Kilngener 1963), and many of the low-elevation *Zapus* with small skulls identified by Conner and Shenk (2001) also had this character. These results support the

contention that there are 2 *Zapus* taxa in the region that are separated by skull size and elevation in a manner predicted by general knowledge of *Z. princeps* and *Z. hudsonius*.

However, some data suggests that this separation is less apparent in the North Platte and extreme northern South Platte river basins than in areas to the south. Conner and Shenk (2001) documented a steady decline in the size of high-elevation *Zapus* skulls when moving north from Colorado into southern Wyoming; i.e., although still statistically significant, the elevation-dependent difference in skull dimensions was less in Wyoming than in Colorado. Furthermore, some *Zapus* specimens recently captured at mid-elevations (ca. 7200') in the North Platte River basin in Wyoming have large skulls, suggesting *Z. princeps*, but also possess an anterior median tooth fold, suggesting *Z. hudsonius*. Preliminary analyses of other recently-captured specimens from southeast Wyoming indicate that individuals with large skulls and no tooth folds (suggesting *Z. princeps*) were captured within a few meters of individuals with small skulls and present tooth folds (suggesting *Z. hudsonius*; C. Meaney and C. Jones, personal communication; Denver Museum of Nature and Science).

Subpecies *Zapus hudsonius preblei*

Compared to *Z. h. campestris* and *Z. h. pallidus*, *Z. h. preblei* is described as slightly smaller and duller in color, with a less distinct dorsal band and fewer black-tipped hairs (Krutzsch 1954).

As discussed above, there are no external morphological characters that can reliably classify specimens of *Zapus* from southeast Wyoming to species. Therefore, for live specimens that cannot be resolved to species, it is unreasonable to expect external morphology to reliably indicate subspecies; i.e., uncertainty at the species level would propagate to the subspecies level.

Even for prepared specimens tentatively classified as *Z. hudsonius*, external morphology is likely to be an inexact indicator of subspecies because distinctions at this level are qualitative and

usually require subjective evaluation; e.g., ochraceous upper parts for *Z. h. preblei* versus "brighter ochraceous (and more blackish) upper parts" for *Z. h. campestris* (Long 1965). Although some *Zapus* from Wyoming and surrounding states may match the description of a particular subspecies quite well, most are likely to span the descriptions of 2 or more of the 5 subspecies in the region. This is probably especially true in and near areas where the subspecies co-occur and interbreed (e.g., the contact zone between *Z. h. campestris*, *Z. h. pallidus*, and *Z. h. intermedius* in northwest South Dakota; Figure 2).

Krutzsch (1954) first established the subspecies *Z. h. preblei* in southeast Wyoming and northcentral Colorado based on comparisons of precisely-measured body dimensions of prepared museum specimens. In a subsequent re-analysis using a larger sample of specimens, Jones (1981) concluded that although *Z. hudsonius* in this area were geographically isolated, there was insufficient morphological evidence to support their subspecific status, or indeed the subspecific status of any *Z. hudsonius* population.

Taxonomy and Distribution

Genus *Zapus*

North America supports 2 genera of jumping mice: *Napeozapus* and *Zapus*. Only the latter occurs in the state and vicinity of Wyoming (Hall 1981, Whitaker 1999a, Whitaker 1999b, Cranford 1999, Gannon 1999; Figure 1). A similar genus, *Eozapus*, occupies eastern Asia (Krutzsch 1954).

Species *Zapus hudsonius*

The genus *Zapus* includes 3 species. Two of these, the western jumping mouse, *Z. princeps*, and the meadow jumping mouse, *Z. hudsonius*, occur within the state and vicinity of Wyoming (Figure 1; Figure 2). The more common and westerly-distributed *Z. princeps* generally occurs

along streams and in mesic upland vegetation in montane and subalpine zones, occasionally ranging into foothills and even prairie zones along stream courses. The more easterly-distributed *Z. hudsonius* is rarer in this region, occurs in riparian zones in prairie and foothills environments, and occasionally ranges into montane areas along stream courses (Quimby 1951, Krutzsch 1954, Long 1965, Armstrong 1972, Whitaker 1972, Hall 1981, Clark and Stromberg 1987, Fitzgerald et. al. 1994, Cranford 1999, Whitaker 1999a).

Subspecies *Zapus hudsonius preblei*

E.A. Preble made the first scientific collection of *Z. hudsonius* in this region at a site near present day Loveland, Colorado, in 1899 (Preble 1899). Early specimens of *Z. hudsonius* from southeast Wyoming and northern Colorado were classified as *Z. h. campestris* (e.g., Warren 1910, Cary 1911). This trinomial is currently reserved for the Bear Lodge meadow jumping mouse, a separate subspecies now thought to occur only in the Black Hills region (Whitaker 1999a; Figure 2). Krutzsch (1954) first described the subspecies *Z. h. preblei* in southeast Wyoming and northern Colorado.

Mammalogists currently recognize 5 subspecies of *Z. hudsonius* in the vicinity of Wyoming (Whitaker 1999a, Hafner et al. 1981, Morrison 1992; Figure 2). Only *Z. h. preblei* and *Z. h. campestris* are thought to occur in the state (southeast and northeast corners, respectively). Three subspecies (*Z. h. intermedius*, *Z. h. campestris*, *Z. h. pallidus*) are regarded as contiguous (i.e., interbreed regularly along the boundaries of their respective distributions) and essentially represent the westernmost extent of the continuous distribution of *Z. hudsonius* in the United States (Hall 1981, Whitaker 1999a). The remaining 2 subspecies, *Z. h. preblei* and *Z. h. luteus*, are thought to be Pleistocene relicts completely isolated from each other and other *Z. hudsonius* subspecies (Hafner et al. 1981, Jones 1981, Morrison 1992, Hafner 1997; Figure 1, Figure 2).

Biogeography

Genus *Zapus*

Genera immediately ancestral to *Zapus* and *Napeozapus* are known from North American sites dating to the early Pliocene. *Zapus* in its current form has been relatively widespread in North America since the early Pleistocene, when the continent was occupied by at least *Z. hudsonius* and 2 other, now-extinct species. *Napeozapus* is thought to have achieved its current form in the mid-Pleistocene. Diversification of early *Zapus* into the 3 extant species likely occurred during repeated geographic isolation of eastern and western groups during Pleistocene glaciations. The eastern isolate generated *Z. hudsonius*, whereas the western isolate generated *Z. trinotatus* and *Z. princeps* (Krutzsch 1954). The current interglacial has allowed *Z. hudsonius* and *Z. princeps* to come into close contact, including broad zones of sympatry in the northern U.S. and southern Canada and narrower zones of sympatry along the Rocky Mountain front in New Mexico, Colorado, and Wyoming (Figure 2). Such "re-contact" between the 2 species is assumed to have occurred during earlier interglacial periods as well, alternating in cycle with isolation during glacial periods.

Species - *Zapus hudsonius*

During the late Pleistocene (ca. >10,000 years ago) the eastern slope of Southern Rocky Mountains and adjacent lowlands supported more cool and mesic grassland suitable for *Z. hudsonius*, presumably leading to larger and more widespread populations of the species here. At this time *Z. princeps* was probably isolated to the west of the Rocky Mountains in the Great Basin and adjacent regions. The warming and drying of the western United States during the early Holocene shifted mesic grassland, and thus the main center of occurrence of *Z. hudsonius*, to the north and east; *Z. h. campestris* now occupies the periphery of this shifted range (Figure 2).

However, pockets of suitable habitat remained along the Southern Rocky Mountain front, allowing disjunct populations to persist here. Through the combined forces of founder effect, genetic drift, and adaptation, these disjunct populations are thought to have diverged to the subspecies level and now exist as *Z. h. luteus* and *Z. h. preblei* (Hafner et al. 1981, Jones 1981, Morrison 1992, Hafner 1997). The Holocene climatic amelioration presumably also allowed *Z. princeps* to move east onto the Rocky Mountains to its present position (Figure 2).

It is generally accepted that *Z. princeps* occurs at higher elevations than *Z. hudsonius* in Colorado and Wyoming. The former species is thought to primarily occupy subalpine and montane zones, with peripheral extensions into foothills and possibly even prairie environments along riparian corridors. In contrast, *Z. hudsonius* is thought to primarily occupy prairie riparian environments, with peripheral extensions into the foothills and montane zones along riparian corridors. This pattern obviously suggests zones of *Z. princeps* X *Z. hudsonius* co-occupation along mountain-front riparian systems.

Zones of co-occupation are likely to be rather narrow along the Front Range of Colorado, where the abrupt mountain front and high terminal elevations can be expected to sharply divide prairie and montane biota. Some areas of likely sympatry between *Z. hudsonius* and *Z. princeps* along the Front Range are currently being studied (e.g., Trout Creek, Douglas County, Colorado; Schorr 1999).

Importantly, the biogeographic situation changes rather markedly in the extreme northern South Platte River basin (ca. Cache La Poudre River and points north) and North Platte River basin. A large area of sympatry between *Z. hudsonius* and *Z. princeps* in northern Colorado and southeast Wyoming has been suspected, if not conclusively demonstrated, by mammalogists for quite some time (e.g., Long 1965, Armstrong 1972). The major mountain range here, the Laramie

Mountains, has a rather gradual east slope (leading to much interdigitation of prairie, foothills, and montane biota), a low crest (<7500' in many places), and is bisected by a major river system (Laramie River) that connects large areas of mixed grass prairie on either side of the range. These factors suggest that the zone of co-occupation may be quite broad along the Laramie Mountains and that this range is not a western barrier to *Z. hudsonius*. Since 1998 the USDA Forest Service and other field workers have captured several suspected *Z. hudsonius* between 7500 - 8500 ft elevation in the Laramie Range (WYNDD, unpublished data).

Also, four capture locations to the west of the Laramie Range in Wyoming bear mentioning in this context:

1. A *Zapus* specimen captured in the Snowy Range (southwest Albany County, Wyoming) in the 1970's was originally identified as *Z. hudsonius*, but then was subsequently relabeled *Z. princeps* based on the relatively high elevation of the capture location. However, preliminary results using the methods of Conner and Shenk (2001) suggest that this specimen may in fact be *Z. hudsonius* (C. Jones, Denver Museum of Nature and Science, personal communication). It is assumed that the specific identity of this specimen is currently being investigated more thoroughly.
2. In summer 2000, WYNDD zoologists captured several *Zapus* on the floor of the Laramie Valley (central Albany County, Wyoming; ca. 7200'). These individuals were taken from a cottonwood-willow riparian corridor bordered by mixed grassland, several miles from the nearest montane forest; such habitat suggests *Z. hudsonius* rather than *Z. princeps.* It is assumed that the specific identity of these specimens is currently being investigated with methods of Conner and Shenk (2001), and that tissue from these specimens will be included in ongoing genetic analyses (Ramey et al. 2002).
3. In summer 2002 WYNDD zoologists captured several *Zapus* spp. along the Laramie River ca. 30 mi north of the town of Laramie, Wyoming (ca. 7100'). These individuals were taken in a grass- and willow-dominated riparian corridor bordered by mixed grassland, several miles from the nearest montane forest; such habitat suggests *Z. hudsonius* rather than *Z. princeps.* Preliminary results using the methods of Conner and Shenk (2001)

suggest that some of these specimens may be *Z. hudsonius*; oddly, others in this group (which were all captured within several meters of one another) appear to be *Z. princeps* (C. Meaney and C. Jones, Denver Museum of Nature and Science, personal communication). It is assumed that tissue from these specimens will be included in ongoing genetic analyses (Ramey et al. 2002).

4. In summer 2002 WYNDD zoologists captured several *Zapus* spp. at Hutton Lake National Wildlife Refuge, ca. 12 mi southwest of the town of Laramie, Wyoming. These individuals were taken in a grass- and reed-dominated wetland bordered by mixed grassland, several miles from the nearest montane forest; such habitat suggests *Z. hudsonius* rather than *Z. princeps.* Preliminary results using the methods of Conner and Shenk (2001) suggest that some of these specimens may be *Z. hudsonius* (C. Meaney and C. Jones, Denver Museum of Nature and Science, personal communication). It is assumed that tissue from these specimens will be included in ongoing genetic analyses (Ramey et al. 2002).

If further analyses continue to suggest that some of these specimens are *Z. hudsonius*, the suspected range of the species in southeast Wyoming may need to be extended west to include the drainage basins of the Upper Laramie River, Little Laramie River, Rock Creek, and possibly Medicine Bow River.

Subspecies *Zapus hudsonius preblei*

The uncertainty regarding the species level taxonomy of *Zapus* in southeast Wyoming makes it difficult to accurately portray distributions of subspecies here. As currently understood, presumed *Z. h. preblei* have been documented in both the North Platte and South Platte river basins of Wyoming, with collection sites as far north as the town of Douglas, west to the town of Boxelder, and east to the vicinity of Slater (Figure 3). The crest of the Laramie Mountains is generally regarded as the western boundary of *Z. h. preblei* in Wyoming. However, as discussed above, this may be untenable and further analyses may show the western boundary of *Z. h. preblei* farther to the west in Wyoming.

It is generally accepted that *Zapus* in southeast Wyoming are geographically isolated from populations to the north (*Z. h. campestris*) and east (*Z. h. pallidus*) because the intervening shortgrass prairie is too dry and sparsely-vegetated, even on the borders of streams, to provide suitable habitat (Figure 2). However, there have been very few surveys for *Zapus* in these intervening areas. Also, habitat suitability for *Zapus* has been increasing in these areas over the past century, largely due to the westward progression of gallery forests (Choate and Reed 1986, Knopf 1986, Knopf and Samson 1996), and both Choate et al. (1991) and Frey (1992) have demonstrated recent westward expansions in the ranges of *Z. h. intermedius* and *Z. h. pallidus*. These trends suggest increasing likelihood of connectivity between *Zapus* in southeast Wyoming and populations to the north and east. Connectivity between these populations could have two major management implications: (1) increased effective population size and genetic diversity, possibly reducing the risk of local extinction, and (2) erosion of any unique genetic and morphological characters currently maintained in the populations.

In summer 2000, *Zapus* surveys were performed on the USDA Forest Service Thunder Basin National Grassland on streams in the headwaters of the Cheyenne River. No *Zapus* were found (T. Byer, USDA Forest Service, personal communication). In summer 2002, *Zapus* surveys were performed at 6 sites in Goshen County, Wyoming, again with no *Zapus* captured. These efforts lend direct support to the geographic separation of *Zapus* in southeast Wyoming from *Z. h. campestris* and *Z. h. pallidus*. More such surveys are needed in these areas to corroborate these initial findings.

It is important to note that separation between *Z. hudsonius* subspecies is also an issue in southern Colorado where *Z. h. preblei* and *Z. h. luteus* approach each other. Indeed, this is another area where *Z. princeps* come into close contact, and possibly sympatry, with *Z. hudsonius*. The

issues of range overlap, potential hybridization, and taxonomic clarity explored above for *Zapus* in southeast Wyoming may have parallels in southern Colorado.

Habitat Requirements

General

Genus *Zapus*

All members of *Zapus* and *Napeozapus* show strong affinities for heavily-vegetated habitats in proximity to open and flowing water (Whitaker 1972, Whitaker 1999a, Whitaker 1999b, Cranford 1999, Gannon 1999). *Napeozapus* prefer forested and woodland habitats and are rarely found elsewhere; in contrast, *Zapus* commonly occupies grass and forb-dominated wetlands as well as wooded sites. Fungi may be more important in the diet of *Napeozapus* than *Zapus*, with the latter genera depending more on seeds and vegetation. Members of both genera hibernate for approximately half the year (Whitaker 1999b).

Species *Zapus hudsonius*

The general life history of *Z. hudsonius* has been described by several authors (e.g., Long 1965, Armstrong 1972, Whitaker 1972, Clark and Stromberg 1987, Fitzgerald et al. 1994, Whitaker 1999a), as has similar information for *Z. princeps* (e.g., Long 1965, Armstrong 1972, Clark and Stromberg 1987, Fitzgerald et al. 1994, Cranford 1999). The major distinction between the 2 species in this region appears to be elevation of occurrence: the distribution of *Z. princeps* is primarily montane, whereas that of *Z. hudsonius* is centered on prairie. Both species are strongly associated with riparian habitats. However, *Z. princeps* is known to range relatively frequently into uplands in montane and subalpine areas, whereas *Z. hudsonius* rarely strays from riparian zones in prairie environments (but see discussion of *Z. hudsonius* upland forays in Shenk and Sivert 1999, Ryon 1999, Schorr 2001). It is difficult to know whether this stems from an intrinsic

biological difference between the taxa or is simply due to the fact that high elevation uplands are more mesic than prairie uplands.

Aside from elevation of occurrence, *Z. princeps* and *Z. hudsonius* are ecologically very similar in this region, although it must be recognized that there is a relative paucity of comparative field studies. There is no indication that these species diverge in life history traits to any substantial degree; with the currently limited knowledge base, it appears that within-species variation in most ecological traits may be as great as between-species variation.

Subspecies *Zapus hudsonius preblei*

The basic ecology of *Z. h. preblei* has been outlined by several authors (see USFWS 2002a). All purported subspecies of *Z. hudsonius* in Wyoming and surrounding states are strongly associated with riparian habitats. It is assumed that *Z. h. campestris*, *Z. h. pallidus* and *Z. h. intermedius* range more into uplands than either *Z. h. preblei* and *Z. h. luteus*, but that this may be a function of climate (uplands are more mesic and heavily-vegetated in the Black Hills and central Great Plains relative to the Rocky Mountain front) rather than intrinsic differences in the subspecies' biology. Variations in food habits, hibernacula, reproductive characteristics, and other traits may all similarly vary with geography. Clippinger (2002) suggests physiognomy, or vegetation structure, predicts Preble's presence or absence better than any particular plant species. As is the case with full species of *Zapus*, there is a general lack of field studies that compare subspecies. Current information suggests no great degree of ecological divergence between subspecies.

Breeding

There are no unique breeding habitat requirements of Preble's, beyond the characteristics of general summer range. Historically, grass nests of meadow jumping mice have been described as

day nests, maternal nests, or chambers. Quimby (1951) described nests of jumping mice as requiring some form of protective substrate, such as a hollow log or tree, or placement underground. Nests in eastern Colorado (n=5) were close to streams (3.1 m ± 4.0 *SE*), and had shrub and a thick grass cover component (Ryon 2001). Ryon surmised that day nests are commonly above ground, and maternal nests are more substantial underground dwellings.

Winter

The species winter habitat is not different from breeding habitat, hibernating in flood-safe areas of riparian zones from mid-October to early May (USFWS 2002a). Confirmed or suspected hibernaculum (n=15) have been documented between one and 78 m from either a main drainage or tributary. Clippinger (2002) cites studies which have detected active hibernaculae over 300 m away from riparian corridors. The Service recovery plan (2002) reports hibernacula located under willow (*Salix* spp.), chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpus* spp.), skunkbrush (*Rhus trilobata*), sumac (*Rhus* spp.), clematis (*Clematis* spp.), cottonwoods (*Populus* spp.), Gambel's oak (*Quercus gambelli*), thistle (*Cirsium* spp.), and alyssum (*Alyssum* spp.). Attributes were described from an excavated hibernaculum at Rocky Flats, which was found 9 m (30 ft) above the stream bed, in a dense patch of chokecherry and snowberry (Bakeman and Deans *in* USFWS 2003b). There is an inherent structural complexity to hibernacula; in this case, the nest was constructed of leaf litter 30 centimeters (12 in) below the surface in coarse textured soil.

Area Requirements

Trapping success is generally low outside of the riparian floodplain; however, ecological studies of Preble's have confirmed feeding and nesting behavior in upland habitats to distances of 100m from the 100-year floodplain boundary (Ryon 1999). Travel in riparian corridors has been measured to upwards of 1.6 km (1 mi.) in a single evening (Ryon 1999, Shenk and Sivert *in*

USFWS 2003b). Density and abundance were studied over a two year period in Colorado (White and Shenk 2000 *in* USFWS 2003b), wherein riparian shrub cover, tree cover, and amount of available open water nearby where characterized as good predictors of Preble's densities. Per linear km of occupied stream habitat, abundance varied from 4 to 67 mice (6-110 mice per mi), and averaged 33 mice (53 mice per mi). Mean habitat width during the breeding season was on average 215 ± 9.0 m (T. Shenk, Colorado Division of Wildlife, pers. comm. *in* Meaney et al. 2003). Based on the occurrence of 22.7 to 85.6 animals per linear km, an approximate mean density equals 1.1 to 4.0 mice/ha.

Landscape Pattern

Hydrolgic regimes that support the meadow jumping mouse are varied in size and landscape context. Perennial rivers and streams, as large as the South Platte river, or those as small as montane creeks one to three meters in width, provide suitable habitat. The Service (2002) reports a variety of lentic and lotic systems in Colorado and southeastern Wyoming with available meadow jumping mouse habitat; such as, ephemeral streams, low moist areas and dry gulches, agricultural ditches, and wet meadows and seeps near streams.

The pattern of associated habitats within the matrix of hydrologic features appears to be critical to Preble's distribution. Although critical thresholds for specific habitat types are undetermined, the matrix is most commonly represented by well-developed plains riparian vegetation, associated grassland communities, and a nearby water source (USFWS 2002a). Within these broad descriptive classes, consistent habitat attributes include multi-storied cover, consisting of a shrub canopy with an understory of dense grasses and forbs. In a multivariate comparison of vegetation between Preble's capture sites and non-capture sites, there was a high degree of similarity of the vegetation within 15 m of the waters edge. However, at distances of greater than

15 m, breadth and diversity of cover type were greater at capture sites. Higher species richness, subshrub cover and forb cover were common characteristics of occupied Preble's habitat (Clippinger 2002). Neighboring upland communities are highly variable, from open grasslands to woodlands of Ponderosa Pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), spruce (*Picea pungens*), and occasional aspen (*Populus tremuloides*; USFWS 2002a). At the landscape scale, riparian areas with higher percentages of shrubs and subshrubs with adjacent forested land support Preble's (Clippinger 2002).

Clippinger (2002) provides evidence that the Preble's is an indicator of environmental integrity, integrity which in ecological terms means, "…a system (at whichever scale one choses) with a complete set of biotic components (native species), its vegetational structure intact, a landscape in which there is opportunity for species to move unencumbered by anthropogenic structures, and a relatively normal hydrographic regime." Ecological processes of integrated habitats would include flooding, which adds new soils into a system, encourages regeneration of native shrubs such as willows, and influences establishment of dense vegetative communities (Gregory et al. *in* USFWS 2002a), herbivory, fire, and hydrological impoundments such as beaver dams.

Movement and Activity Patterns

Daily Activity

Preble's often utilize the security of heavy cover by day, such as day nests in dense riparian vegetation, venturing further into adjacent grasslands at night to forage. Activity patterns are predominantly nocturnal or crepuscular, however daytime observations are not uncommon. Quimby (1951) noted that daytime observations of Preble's were most common on damp, overcast days.

Day Nests

The Preble's constructs day nests, "composed of grasses, forbs, sedges, rushes, and other available plant material. They may be globular in shape or simply raised mats of litter, and are most commonly above ground but can also be found below ground. They are typically located under debris at the base of shrubs and trees or in open grasslands (Ryon 2001). An individual mouse can have multiple day nests in both riparian and grassland communities (Shenk and Sivert 1999a), and may abandon a nest after approximately a week of use (Ryon 2001)" (USFWS 2003b).

Meadow jumping mice are capable of leaps in excess of one meter, yet if pursued will utilize progressive hops of 30 centimeters (Whitaker 1972). General means of movement is not normally jumping, as *Zapus* will move slowly through vegetation, walking or crawling on all fours, and take very little hops (± 10 cm). Swimming as a means of locomotion by Preble's has been reported regularly (Meaney et al. 2003, Clippinger 2002).

Broad-scale Movement Patterns

Multi-year trapping studies have detected low trap site fidelity, or transiency in Preble's (Meaney et al. 2003, Whitaker 1972), a likely reflection of high species mobility. Meaney et al. (2003) observed regular travel distances of 200 meters, and occasional travel distances of approximately 600 meters. This propensity for long distance travel was detected in a seperate study in Colorado, in which Preble's moved an average of 526 meters and a maximum of 1,610 meters in a 24-hour period (Ryon 1999).

Reproduction and Survivorship

Breeding Behavior

Only the most general assumptions can be made about the breeding behavior of Preble's at this time. Very little is known about the behavior of jumping mice in general, and therefore the authors we will not make any assertions about Preble's breeding behavior in this document.

Breeding Phenology

Meadow jumping mice in the eastern United States have exhibited two seasonal peaks in reproduction, one in July followed by a second peak in August. Adults emerge from hibernation exhibiting the lowest annual measured weights (14-14.5 g, n=5; Meaney et al. 1999). The earliest capture of a pregnant female during research along South Boulder Creek, Colorado (1997-2000), was in the second week of June, though earliest reproduction occured more commonly in the third week of June (Meaney et al. 2003). Characteristics of pregnant females include weight in excess of 22 g, lactation (enlarged nipples), and visibly enlarged abdomens. Mean annual survival rate of females was estimated at 17.5 percent (± 10.8), hence females will commonly have a single reproductive season (Meaney et al. 2003). Meadow jumping mice commonly bare two litters in a season, although third litters have been reported (Quimby 1951)

Fecundity and Survivorship

Meadow jumping mice commonly produce two litters per year, but there are records of three litters per year (Quimby 1951). They average five young born per litter, but litter size can range from two to eight young (Quimby 1951, Whitaker 1972). Preble's is capable of reproduction in the season of birth, yet it is presumed that this occurs infrequently (Meaney et al. 1999)

A four-year population study of Preble's along the Colorado Front Range was able to clearly detect depressed survival rates during summer (Meaney et al. 2003). A trapping effort in excess of

21,000 trap nights monitored populations before and after a birth pulse in July. Except for two instances, population estimates along trap grids in August were unchanged. The lack of an expected population expansion following reproduction was related to lower summer survivorship in addition to dispersal and other factors, although methods could not distinguish between dispersal and mortality (Meaney et al. 2003). This study reported over-winter survival of 54.1% ± 18.8%, which was in excess of reported rates from research conducted in New York and Massachusetts. Through late August and into mid-September the weight range of Preble's prepared for hibernation was 25-34 g.

Difference in summertime survivability between sexes has been observed (Meaney et al. 2003). Females had twice the survival rate when compared to males during the Meaney study. This may be a reflection of increased vagility in males while searching for mates. Dispersal may be a confounding factor, yet evidence suggests that males are more exposed to predation during the breeding season.

Population Demographics

Metapopulation Dynamics

The authors are not aware of any current literature suggesting metapopulation dynamics are observed in meadow jumping mouse populations.

Genetic Concerns

Genetics: Genus *Zapus*

At this time there is no significant debate among mammalogists over the validity of the genus *Zapus*. It is generally accepted as a distinct and biologically-meaningful taxon and thus its genetic distinction from similar genera will not be fully explored here. It is assumed that *Napeozapus* is

the genus most closely allied with *Zapus*, and thus would show the most similar genetic patterns. As discussed above, *Napeozapus* does not occur within ca. 500 mi of Wyoming (Figure 1).

Species *Zapus hudsonius*

Genetic analyses have shown *Z. hudsonius* to be a unique and identifiable species that is relatively easily distinguished from similar species, especially when specimens from distant sites are compared. Hafner et al. (1981) used genetic analyses to identify and distinguish *Z. hudsonius* from nearby *Z. princeps* in Arizona and New Mexico. Wunder and Harrington (1996; *in* Schorr 2001) were similarly successful in using genetic patterns to resolve *Z. hudsonius* from *Z. princeps* in the South Platte River Basin in Colorado.

Riggs et al. (1997) used mitochondrial DNA to analyze the genetics of *Zapus* along the Southern Rocky Mountain front in Colorado and southeast Wyoming. Their main conclusion was that *Zapus* specimens from low elevations, suspected to be *Z. h. preblei*, formed a relatively homogenous genetic group. However, the northernmost samples in the study, including several from southeast Wyoming, were more closely allied with *Z. princeps*; these samples could not be reliably assigned to species. The general consensus among regional mammalogists is that *Z. hudsonius* X *Z. princeps* hybridization in extreme northern Colorado and southeast Wyoming is the most parsimonious explanation for such results (Hafner 1997, Riggs et al. 1997, Pague and Grunau 2000, Schorr 2001). Hybridization between related species in areas of co-occurrence is well known for other vertebrates (see examples in Pague and Grunau 2000, Hafner 1997). Krutzsch (1954) stated that *Z. hudsonius* X *Z. princeps* hybridization did not seem to occur in other areas of sympatry, such as British Columbia, but his conclusion was informed by morphological comparisons only without any genetic information.

Subspecies *Zapus hudsonius preblei*

Hafner et al. (1981) and Riggs et al. (1997; see also Hafner 1997) used genetic analyses to support subspecific status of *Z. h. preblei* as distinct from other *Z. hudsonius* subspecies, based on specimens from the South Platte and Arkansas river basins. However, as outlined above, genetic tests were unable to conclusively assign subspecies, or even species, identity to specimens from southeast Wyoming.

New genetic studies, with the intent of resolving both the species- and subspecies-level distinctions of *Zapus* in this region, have been submitted to the Office of the Governor in Wyoming and the US Fish and Wildlife Service, yet remain unpublished (Ramey et al. 2004). The thesis set forth in Ramey et al. (2004) refutes the currently accepted taxonomic distinction of *Z. h. preblei*. Instead, mitochondrial DNA sequence data suggests that *Z. h. preblei* is a less genetically variable population of *Z. h. campestris*. The Ramey (2004) study had not undergone scientific review from specialists in the fields of genetics and mammalian systematics at the time of this assessments preparation.

Food Habits

Food Items

Much of the following dietary information is found in unpublished reports of the Colorado Division of Wildlife, and reported in the federal register documents (USFWS 1998, 2003b). At present, the authors are unaware of dietary analysis from Preble's in Wyoming. It is evident, however, that Preble's utilizes a wide variety of insects and plant parts from throughout available habitat. Fecal analyses from Colorado based studies have provided the best data on the Preble's diet to date, yet components of the diet that are more digestible may be underreported. Based on fecal analyses Preble's eats insects; fungus; moss; pollen; willow; *Chenopodium sp.* (lamb's quarters); *Salsola* sp. (Russian thistle); *Helianthus* spp. (sunflowers); *Carex* spp. (sedge);

Verbascum sp. (mullein); *Bromus, Festuca, Poa, Sporobolus* and *Agropyron* spp. (grasses); *Lesquerella* sp. (bladderpod); *Equisetum* spp. (horsetail); and assorted seeds (Shenk and Eussen 1998, Shenk and Sivert 1999a *in* USFWS 2003b). The seasonal diet of Preble's consists primarily of insects (up to 100% in June) and fungus after emerging from hibernation, shifts to fungus, moss, seeds and fleshy fruits during midsummer (July-August), with insects again added in September. Shift in diet along with changes in mouse movement patterns suggests that the Preble's may require specific seasonal diets, perhaps related to the physiological constraints imposed by hibernation (Shenk and Sivert 1999a *in* USFWS 2003b).

Foraging Stategy

Given the length of the hibernation period, Preble's accomplish reproduction, recruitment, and physiological preparation for the lengthy winter in a very short period of time (in Colorado ± 85 days; Clippinger 2002). Hence, the description of foraging strategy would be opportunism. The diversity of food items (above) reflects the great variety of forage, and the only observed pattern is that the forage most available in any given season is commonly taken.

Foraging Variation

Preble's is a deep hibernator, remaining in hibernation as long or longer than most mammals (Whitaker 1972). The length of the hibernation period necessitates several weeks of pre-hibernation fattening, a critical period to Preble's survival. Given the relatively short period of summertime activity, the Preble's is not selective at any given time, rather forages opportunistically on available food items. Vegetative diversity may be a key to over-winter survival, as failure of a particular seed crop, if dominant on the landscape, may lead to insufficient fat stores, and high over-winter mortality. Spring foraging success may impact annual fitness, as

young born in early litters are more likely to survive hibernation that those from late litters (Muchlinksi 1988 *in* Meaney et al. 2003).

Community Ecology

Predators and Competitors

Preble's are primarily either nocturnal or crepuscular, which may prevent them from being highly visible to daytime predators. However, a wide suite of species are capable of depredating Preble's including garter snakes (*Thamnophis* spp.), prairie rattlesnakes (*Crotalus viridus*), bullfrogs (*Rana catesbiana*), foxes (*Vulpes vulpes* and *Urocyon cinereoargenteus*), house cats (*Felis catus*), long-tailed weasels (*Mustela frenata*), and red-tailed hawks (*Buteo jamaicensis*) (Shenk and Sivert 1999a, Schorr 2001 *in* USFWS 2000b). Other potential predators include coyotes (*Canis latrans*), Barn Owls (*Tyto alba*), Great Horned Owls (*Bubo virginianus*), Screech Owls (*Otus* spp.), Long-eared Owls (*Asio otus*), Northern Harriers (*Circus cyaneus*), and large predatory fish (USFWS 2000b). Preble's appear to have very little means of protection against predators, and will use concealment or remain perfectly still to avoid detection (Whitaker 1972).

Parasites and Disease

Preble's are known to carry parasites and diseases, yet there is no known factor of this kind which has extensive negative impacts on Preble's at the population level (USFWS 2002b). Parasites and diseases common to small mammals are known to reduce vigor, reproductive success, and mortality among individuals. Ticks, fleas, bot-flys, and mites are all common external parasites of jumping mice. Endoparasites including nematodes, trematodes, a fluke, and a protozoa of the *Eimeriidae* have also been reported, yet it is uncertain if any of these is common for Preble's. Bacteria common to *Zapus hudsonius* include *Escherichia coli, Bacillus mycoides, Klebsiella* sp., and *Bacteriodes* sp. (Whitaker 1972). Currently known parasites and diseases

described above are not known to be a serious threat to populations of Preble's at this time (USFWS 2002b).

Conservation

Conservation Status

Federal Endangered Species Act

Concern over the viability and persistence of *Z. h. preblei* began as early as September, 1985 when the USFWS gave the taxon Category 2 status, which indicated that at the time a proposal to list under the Act may have been appropriate but conclusive biological information to support such a proposal did not yet exist. This was followed by 20 other official USFWS decisions over the next 18 years, as documented in the Federal Register (see: http://ecos.fws.gov/species_profile/SpeciesProfile?spcode=A0C2). These decisions include the Final Rule to list as Threatened in May 1998 (USFWS 1998), Proposed Special Regulations in August 2001, and Designation of Critical Habitat for the Preble's Meadow Jumping Mouse (USFWS 2003a). For further information regarding protections afforded Preble's through administration of the Act see Existing Regulatory Mechanisms below.

Bureau of Land Management

The current status of *Z. h. preblei* as Threatened under the Act precludes it from receiving other special designations from federal land management agencies in Wyoming, such as the USDA Forest Service (Region 2) and the USDI Bureau of Land Management (Wyoming State Office). Although each of these agencies maintains a Sensitive Species list to help guide management actions (e.g., USDA Forest Service 1994, USDI Bureau of Land Management 2001), each list specifically excludes taxa already listed under ESA because those taxa receive automatic and pre-determined management priorities. Wyoming Natural Diversity Database biologists have

surveyed land under the jurisdiction of the Casper Field Office (Ehle and Keinath 2001, Beauvais 2003). Two years of WYNDD studies for the Casper Field Office resulted in the capture of four jumping mice at one survey location: Corduroy Creek, Parcel 17, in dense aspen overstory with occasional subalpine fir (Ehle and Keinath 2001). It appears that Preble's is very thinly distributed in this region (Figure 4), and that environments in extreme eastern Wyoming, including those administered by the BLM , are possibly unsuitable for Preble's (Beauvais 2003).

Forest Service

As pertains to the USDI Bureau of Land Management (*see above*), the current status of *Z. h. preblei* as Threatened under the Act precludes it from receiving other special designations from the USDA Forest Service (Region 2). Although each of these agencies maintains a Sensitive Species list to help guide management actions (e.g., USDA Forest Service 1994, USDI Bureau of Land Management 2001), each list specifically excludes taxa already listed under ESA because those taxa receive automatic and pre-determined management priorities. As described in Biogeography (see above) *Z. hudsonius* conspecifics are extant in Wyoming on both the Medicine Bow-Routt National Forest and the Black Hills National Forest. Much of the capture data and specimens from Wyoming come from work conducted on the Medicine Bow-Routt National Forest in southeastern Wyoming (USDA Forest Service, unpublished reports 1998, 1999, 2001). An ongoing WYNDD study, funded by the Medicine Bow–Routt National Forest will address distribution and tolerance of Preble's to management practices on the Laramie and Douglas ranger districts.

State Wildlife Agencies

This meadow jumping mouse subspecies is considered "threatened" by the Colorado Division of Wildlife (1998) and of "unknown status" by the Wyoming Game and Fish Department. The species (*Zapus hudsonius*) is protected under the Wyoming Nongame Wildlife Regulations.

Heritage Ranks and WYNDDs Wyoming Significance Rank

Zoologists at WYNDD have ranked *Z. h. preblei* as G5 T2 S1, with a Wyoming Contribution Score of Very High. Importantly, these designations are predicated on the assumption that the subspecies is valid, identifiable, and distributed throughout lowland riparian systems in north-central Colorado and southeast Wyoming as currently understood by the USFWS:

- G5 = The full species *Z. hudsonius* is demonstrably widespread, abundant, and secure with a very low probability of extinction from its entire range.
- T2 = The subspecies *Z. h. preblei* is rare and imperiled with a high probability of extinction from its entire range.
- S1 = The subspecies *Z. h. preblei* is rare and imperiled with a very high probability of extinction from the state of Wyoming.
- Wyoming Contribution Very High = The subspecies *Z. h. preblei* is a native, resident taxon with a small continental range and a high percentage of that range within the state of Wyoming; thus Wyoming populations of *Z. h. preblei* contribute very highly to the rangewide persistence of the taxon.

Hafner et al. (1998) classified *Z. h. preblei* as "Endangered" under the system used by the International Union for Conservation of Nature and Natural Resources.

Biological Conservation Issues

The final rule to designate critical habitat for the Preble's, the Service (2003b) summarizes the circumstances of the subspecies decline, "The Preble's meadow jumping mouse is closely associated with relatively narrow ecosystems that are adjacent to rivers and streams and that

represent a small part of the landscape. The decline in the extent and quality of this habitat is considered the main factor threatening the Preble's meadow jumping mouse. Habitat alteration, degradation, loss, and fragmentation resulting from urban development, flood control, water development, agriculture, and other human land uses have adversely impacted mouse populations. Habitat destruction may harm individual mice directly. It may also harm them indirectly by eliminating nest sites, food resources, and hibernation sites; by disrupting behavior; or by forming a barrier to movement."

Abundance and Trends

In the early 1990's perceived rarity and extirpation from historically occupied habitat triggered the concern over long-term viability of the Preble's. According to the draft recovery plan (USFWS 2003c) no rangewide population estimates exist for the species. Without a comprehensive understanding of current subspecies abundance, the only basis for trend assessments is presence or absence surveys in historical habitat. In lieu of a broad population estimate, recovery team analysis of limited site specific data indicates that adequate numbers, sizes, and distribution of populations may currently exist to meet recovery criteria. However, the extant ecological threats to these populations have not been successfully abated at this time to prevent further decline and endangerment of the species.

Range Context

The decline in extent of suitable habitat is one of the two major factors currently impacting the Preble's. Urban and suburban development has fragmented and/or destroyed suitable habitat, as well as facilitated the introduction of domesticated predators and habitat generalists. Rapid urban development along the Colorado Front Range has led to the extirpation of Preble's from the greater Denver and Colorado Springs metropolitan areas. Generally, the meadow jumping mouse

(*Z. hudsonius*) is not found in mixed grasslands, reclaimed grasslands, shortgrass prairie, row crop fields, or areas directly associated with human structures (Clippinger 2002). Given the broad overlap of Preble's habitat and the expanding urban and suburban development along the Colorado Front Range continued loss of Preble's habitat is expected (USFWS 2003b). Present distributional boundaries in Wyoming include dry shortgrass prairie to the east, and an elevational ecotone to the west along the Laramie Range, possibly extending locally further north and west in Albany and Converse counties. General upward limit of distribution in Wyoming is 2470m (8,100'); in Colorado 2,300m (7,600'; USFWS 2003b).

Extrinsic Threats

There is an extensive list of direct and indirect effects of anthropogenic influences on the landscape inhabited by Preble's. It is important to qualify this list in that further research is needed to discern qualitatively what thresholds exist, and when usage becomes prohibitive to Preble's occupation. For instance, many recent Preble's capture sites on the Medicine Bow National Forest occur on grazed rangeland, whereas the Service indicates (2003b) intensive grazing is detrimental to Preble's. Many of the following extrinsic threats have cascading effects, wherein the biology is altered at multiple scales which comprise the ecosystem; from plant and animal community assemblages, physical structure of live and dead biomass, hydrology, ultimately to soil structure and geochemistry.

Development

Expanding human populations near Preble's habitats may result in increased level of predation, through "subsidized" predators, or those species which benefit directly or indirectly from human habitation. The striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), and the domestic and feral cat (*Felis silvestris*) are found in greater densities in and around areas of human activity; all four of these species feed opportunistically on small

mammals. Analyses of land use patterns around occupied and unoccupied sites along the Colorado Front Range suggest that high and low intensity residential developments are detrimental to Preble's occupancy up to 210 meters from trapping locations (Clippinger 2002).

Construction of new trails, roads, and bridges, in addition to maintenance of the existing infrastructure, fragments habitat, impedes dispersal movement, and may lead to localized contamination of watercourses. As noted below (*see* Intrinsic Vulnerability), vehicle collision is a known cause of mortality to Preble's.

Agriculture

"Conversion of native riparian ecosystems to commercial croplands and grazed rangelands was identified as the major threat to Preble's persistence in Wyoming" (Clark and Stromberg 1987, Compton and Hugie 1993 *in* USFWS 2003b). Intensive haying and grazing operations may significantly effect Preble's populations through habitat reduction or direct mortality. There is evidence that certain agricultural and grazing practices can be compatible with Preble's conservation, yet this requires protection of riparian vegetative diversity and structure. The Service (2003b) acknowledges the potential for coexistence of Preble's and livestock, yet reports that overgrazing can decimate riparian communities on which the Preble's depends.

Invasive Species

There are no conclusive data regarding Preble's tolerance of exotic plant species. Habitat degradation is a concern in cases where non-native plants such as Russian olive (*Elaeagnus angustifolia*) or leafy spurge (*Euphorbia esula*) displace native vegetation and reduce available habitat (USFWS 2003b). Landscape usage which may facilitate colonization by invasives include fragmentation, alteration of hydrography (xerification), introduction of foreign seed stock, and heavy utilization of Preble's habitat by livestock.

There is strong evidence that non-native predators and "subsidized predators" (cats and dogs; Clippinger 2002) are capable of decimating the local fauna. In conjunction with habitat fragmentation, decrease in native plant cover, and increase in asphalt and concrete, these predators are able to hunt out areas to the exclusion of even the most common native species (Soule' et al. 1988 *in* Clippinger 2002).

Alteration of Hydrography

The hydrology of upland systems may be the limiting factor to Preble's distribution and survival. Dewatering through diversion, removal of mesic plant associates, or measures to address flooding and stormwater runoff (riprap, lining of ditches) will result in more xeric habitats, which may not be habitable by Preble's. Similarly, channelization and increased stream flow will degrade Preble's habitat (USFWS 2003b). Periodic flooding is a common and natural event throughout the Preble's range Disruption of periodic flood events reduces the introduction of newly deposited soil, and may stunt regeneration of dense, riparian vegetative communities.

Fire Suppression

Kaufman et al. (1990 *in* USFWS 2003b) reviewed the impacts of wildland fire on small mammals in grassland communities. In one study, impacts of fire on meadow jumping mice were positive, and in a second study fire had no measured effect. Wildland fire is a natural component of Front Range and Wyoming foothills ecosystems, and hence influences processes which meadow jumping mice have co-evolved with. Preservation of the natural periodicity and intensity of fire in these landscapes may maintain riparian, transitional, and upland vegetation throughout the Preble's range (USFWS 2002b). Fire suppression disrupts the natural fire regime, and may result in an unnatural accumulation of fire fuels and catastrophic fire events. Effects of catastrophic fire include direct mortality, habitat destruction, soil erosion, and the breakdown of connectivity between populations (USFWS 2002b).

Intrinsic Vulnerability

Habitat specialization is a significant life history trait of the Preble's which jeopardizes its survival. This subspecies relies upon riparian ecosystems which are physically narrow, and represent a very small percentage of the landscape. Specialization on the specific characteristics and processes of this ecosystem has caused declines in the species where integrity of this ecosystem is compromised. The Service (2003b) lists mortality factors other than predation as drowning, vehicle collision, and likely factors know for conspecifics such as starvation, exposure, disease, and insufficient fat stores for hibernation. Given the duration of hibernation (± 210 days; Clippinger 2002) Preble's reproductive potential is relatively low, which may impact survivability of populations in small, isolated patches of habitat. Small populations are more susceptible to extirpation from stochastic events (USFWS 2003b). The relatively short period of time in which most life history requirements are met suggests that Preble's may be more exposed to predation, or other external threats, as less effort is afforded to vigilance.

Protected Areas

The only formally protected areas for Preble's are the stream reaches included in the designated critical habitat (*see below* Existing Regulatory Mechanisms; USFWS 2003b). However, outside of the current activities addressed in the amended Special Rule and areas addressed in approved Habitat Conservation Plans, Preble's is protected as a listed Threatened species by authority of the Act at all times (*see above* Federal Endangered Species Act).

Conservation Action

Existing or Future Conservation Plans

Existing Regulatory Mechanisms

The final rule to list the Preble's Meadow Jumping Mouse as a threatened species pursuant to the Endangered Species Act (Act) of 1973, as amended, was published May 13, 1998 (USFWS

1998). All principle regulatory mechanisms which deal specifically with Preble's, stem from administration of this ruling. Subsequent to the listing, a Special Rule pursuant to section 4(d) of the Act was issued. Under section 4, exemptions from illegal take as defined in section 9 of the act are established. Special regulations governing allowable take of Preble's were published in May 22, 2001, amended October 1, 2002, and proposed for extension on February 24, 2004. Protections of the Preble's, as defined by the Act, are described in the final rule to list (USFWS 1998). These include consultation requirements, recovery planning, and protective prohibitions of unauthorized take. The special rule and amendment have lifted prohibition of incidental take during activities such as rodent control near human dwellings, ongoing agricultural activities, landscape maintenance, existing uses of water, and certain activities related to noxious weed control, and ongoing ditch maintenance (USFWS 2004).

The following language which describes Critical Habitat designation and the implementation of Habitat Conservation Plans was taken from the US Fish and Wildlife Service Mountain- Prairie Region, Endangered Species Program website http://mountain-prairie.fws.gov/preble/ .

Critical Habitat

The U. S. Fish and Wildlife Service final rule designating Critical Habitat in Wyoming and Colorado was published in the Federal Register (Vol. 68, No. 120) on June 23, 2003. The three Critical Habitat Units in Wyoming, Cottonwood Creek, Chugwater Creek, and Lodgepole Creek with Upper Middle Lodgepole Creek are found at the back of this assessment (Figures 5-8).

> "Critical habitat identifies specific areas, both occupied and unoccupied, that are essential to the conservation of a listed species and that may require special management considerations or protection. Section 7 of the Act will prohibit destruction or adverse modification of critical habitat by any activity funded, authorized, or carried out by any Federal agency, and Federal agencies proposing

actions affecting areas designated as critical habitat must consult with the Service on the effects of their proposed actions, pursuant to section 7(a)(2) of the Act.

In determining which areas to designate as critical habitat the Service is required to use the best scientific and commercial data available and to consider physical and biological features (primary, constituent elements) that are essential to conservation of the species, and that may require special management considerations and protection. The primary constituent elements for the PMJM include those habitat components essential for the biological needs of reproducing, rearing of young, foraging, sheltering, hibernation, dispersal, and genetic exchange. The Preble's is able to live and reproduce in and near riparian areas located within grassland, shrubland, forest, and mixed vegetation types where dense herbaceous or woody vegetation occurs near the ground level, where available open water exists during their active season, and where there are ample upland habitats of sufficient width and quality for foraging, hibernation, and refugia from catastrophic flooding events.

The critical habitat designation for PMJM defines the width of designated critical habitat as a distance outward from the river or stream edge (as defined by the ordinary high water mark) varying with the size (order) of a river or stream. The designation includes river and stream reaches and adjacent floodplains and uplands that are within the known geographic and elevational range of the PMJM, in the North Platte River and South Platte River drainages in Colorado and Wyoming."

Habitat Conservation Plans

"Private landowners, corporations, state or local governments, or other non-Federal landowners who wish to conduct activities on their land that might incidentally harm (or "take") PMJM must first obtain an incidental take permit from the Service. To obtain a permit, the applicant must develop a Habitat Conservation Plan (HCP), designed to ensure there is adequate minimizing and mitigating of the effects the proposed activity might have to PMJM or PMJM habitat. This process allows development to proceed legally that would otherwise result in the illegal take of PMJM, while promoting PMJM conservation on private (non-federal) lands. In general, HCPs are required by the Service when permanent

> or temporary disturbance to habitat occurs within 300 feet of the 100 year floodplain of any drainages or subdrainages in the PMJM range. HCPs for PMJM have been approved by the Service for private residences, large-scale commercial and residential developments, natural resource management, and multiple-use trails. Currently the Service is working with Front Range county planning and open space departments to develop regional HCPs which would address multiple planning objectives."

Eleven Habitat Conservation Plans with incidental take permits have been approved to date (04/12/04) by the Service. All HCPs are in the state of Colorado; primarily in Douglas, El Paso, Boulder, and Denver Counties.

In the 1998 rule to list the subspecies the Service acknowledges the need for federal oversight of Preble's management, as local ordinances were insufficient in providing direct protection for Preble's or its habitat. Inadequacy of existing regulatory mechanisms is cited as a significant factor in the decline of Preble's. "Various existing federal laws, such as the Clean Water Act, Endangered Species Act, Federal Power Act, Fish and Wildlife Coordination Act, Food Security Act, and National Environmental Policy Act have not in the past been effective in protecting occupied riparian habitat" (USFWS 2002b).

Existing Management Plans

In an unpublished report to the U.S. Air Force Academy, Grunau et al. (1999) prepared the Conservation and Management Plan for the Preble's Meadow Jumping Mouse on the U.S. Air Force Academy (47 pp.). To date, this is the most extensive conservation management plan, designed with the following conservation goals 1. Maintain and enhance AFA populations of Preble's, and associated native plant and animal species. 2. Protect the integrity of the USAFA portion of the main stem of Monument Creek (approximately 6.5 miles). 3. Protect seven miles of

USAFA tributaries to Monument Creek that are currently occupied by Preble's, and contain Preble's habitat that is connected to the habitat along Monument Creek.

Existing Conservation Strategies

The principle guiding influence on Preble's conservation strategy is the U. S. Fish and Wildlife Service. Pursuant to section 4(f) of the Act, the Service organized a recovery team to develop and implement a plan to stay the decline of Preble's, and address existing threats to ultimately ensure the long term survival of this subspecies. A recovery plan, "delineates, justifies, and schedules the research and management actions necessary to support recovery of a subspecies. The current Preble's Meadow Jumping Mouse Recovery Plan is in a draft form. The completed plan will be published in the Federal Register, and represents the official position of the Service only after they have signed it as approved.

The lack of suitable habitat in Colorado and Wyoming limits current Preble's distribution and abundance. Maintenance of existing, quality habitat if the current conservation goal strived for by the Service (1998), the following conservation strategy language is taken from the Preble's Meadow Jumping Mouse Recovery Team – Draft Recovery Plan (USFWS 2003c):

> **Recovery Objective**:
> The purpose of (the Recovery) Plan is to remove the Preble's meadow jumping mouse from the list of threatened species. This plan proposes four criteria for delisting under Section II of the Plan. When the four criteria are met, and following an analysis of the ESA listing factors, the species will no longer be considered in need of protection under the ESA and may be delisted.
>
> **Recovery Criteria For Delisting**:
> 1. Document and maintain wild, self-sustaining Preble's meadow jumping mouse populations.
> 2. Protect and manage habitat of Preble's meadow jumping mouse populations.
> 3. Abate threats to Preble's meadow jumping mouse populations.

4. Develop and implement a long-term management plan and cooperative agreement prior to delisting.

Guiding Principles and Actions:

1. Manage species by river drainage (South Platte, North Platte, Arkansas).
2. Conduct research on preble's habitat and taxonomy.
3. Use monitoring and adaptive management to achieve stable preble's populations.
4. Encourage local involvement in conserving preble's populations.
5. Encourage cooperative management to achieve preble's recovery efforts.
6. Use economic incentives to encourage conservation of preble's populations.
7. Use public education to achieve preble's recovery objectives.

Conservation Elements

Inventory and Monitoring

Guidelines for surveys to determine the presence or absence of Preble's have been developed be the Service, in consultation with experts in the field. These guidelines establish the minimum standard for a valid survey, and are designed with an emphasis on gathering ecological and distributional data, and to ensure individuals of the subspecies are protected from undue harassment or harm. All trapping and handling of Preble's is administered through a federal permit process, and cannot be undertaken under any circumstances without first meeting established permitting qualifications through the Service.

In southeast Wyoming annual inventory and monitoring of Preble's has not been a common practice. Intermittent surveys on the Douglas and Laramie Ranger Districts of the National Forest have been performed. F.E. Warren Air Force Base, near Cheyenne, WY, has funded the only multi-year inventory of Preble's, an eight year study of Crow Creek and adjoining tributaries. This is the only long-term small mammal study designed to monitor Preble's populations in Wyoming.

Otherwise, inventory for Preble's, to the knowledge of the authors, has only been conducted on a site specific, ESA/National Environmental Policy Act- (NEPA) clearance basis.

Habitat Preservation and Restoration

According to the draft recovery plan of the Preble's recovery team (2003c) riparian habitat and Preble's population conservation has been approached in the form of land easements and acquisitions, which preceded the designation of critical habitat. Examples of such protections in Colorado include acquisition of Circle Ranch in Larimer County and Greenland Ranch easement in Douglas County.

Captive Propagation and Reintroduction

The authors are not aware of any current literature reporting on attempted or successful captive propagation of meadow jumping mice.

Information Needs

The status of Preble's as a subspecies of meadow jumping mouse is under review in the scientific literature. Unpublished research on meadow jumping mouse systematics has been forwarded to the U.S. Fish and Wildlife Service. It is premature to evaluate or use information stemming from this research without the understanding that current standards of peer-review and publication in acceptable scientific literature are, at this time, not met. This underscores the need for scientific studies which will contribute to the shaping of effective management guidelines to ensure the long-term viability of what, at this time, is still regarded as Preble's Meadow Jumping Mouse.

Additional complexity is added to the question of the taxonomic validity of this subspecies, due to suspected hybridization zones with a species from another *Zapus* genus, the Western jumping mouse (*Zapus princeps princeps*; Western). Type specimens of Western and Preble's

have been utilized to develop a reliable laboratory technique to discern the two species, yet identification to species of any jumping mouse in the field is not reliable (Conner and Shenk (2003). It is essential to the future validity of meadow jumping mouse conservation, to reach consensus, if possible, on the systematics of evolutionarily significant units within the taxa *Zapus*.

The 1998 listing of *Z. h. preblei* has stimulated *Zapus* surveys and specimen collections in southeast Wyoming. Collected specimens have been sent to various analytical labs, most commonly the Denver Museum of Nature and Science (Denver, Colorado), where they undergo a series of analyses and tests. The results of these tests are not always made widely available, nor are they organized in a discrete summary showing the results of all tests on all collected specimens. Such a summary for all specimens collected throughout the entire suspected range of *Z. h. prebeli* would substantially improve our understanding of *Zapus* taxonomy and distribution in the region.

There is very little known about meadow jumping mouse behavior, from virtually any of the 12 conspecifics in the genus *hudsonius* (USFWS 2002b). Development of an accurate conservation program for the meadow jumping mice will hinge upon a greater understanding of environmental thresholds by which viable populations will persist. Until our understanding of acceptable modifications of Preble's habitat improves, conservative management schemes, and the potential prolonged status of the Preble's as a federally listed species will persist.

Tables and Figures

Figure 1. Distribution of jumping mice in North America. Modified from Hafner et al. (1981), Hall (1981), and Wilson and Ruff (1999)

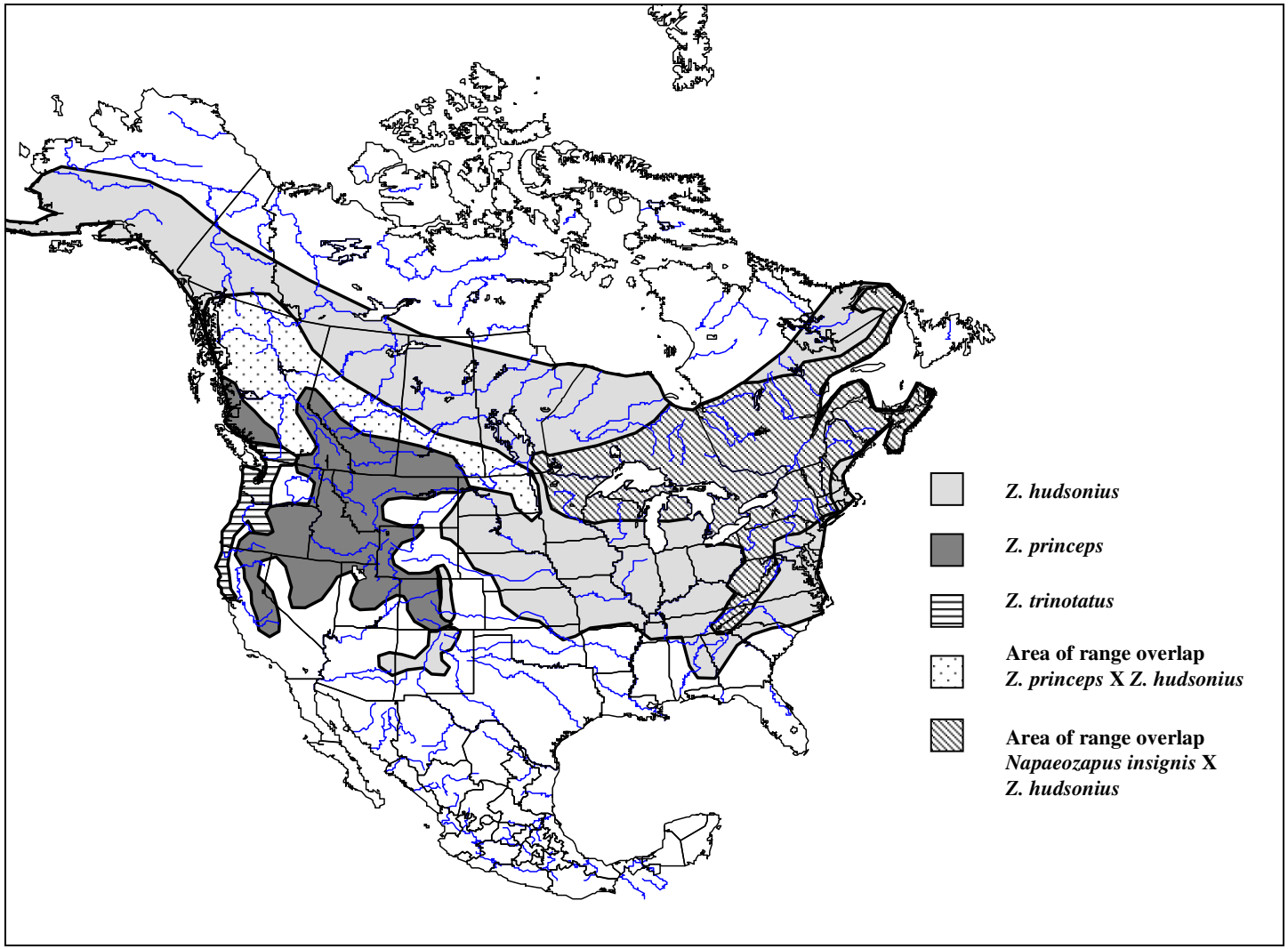


Figure 2. Distribution of jumping mice along the Rocky Mountain front. Modified from Hall (1981) and Hafner et al. (1981). Subspecies of *Z. princeps* are not shown for the sake of clarity.

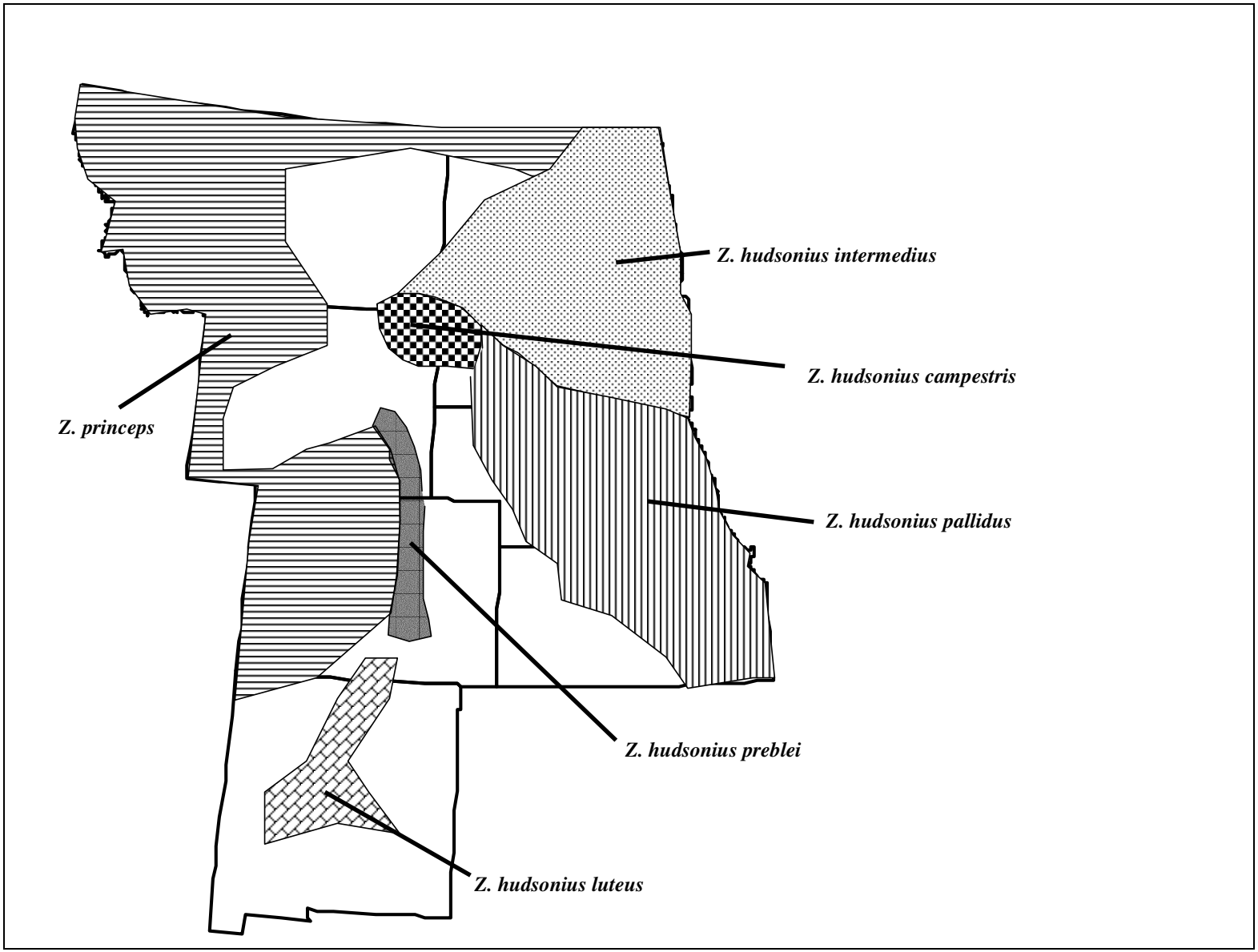


Figure 3. Distribution of Zapus species in southeast Wyoming. All data is on file at the Wyoming Natural Diversity Database, University of Wyoming. Bold lines indicate county boundaries; fine lines indicate major roads.

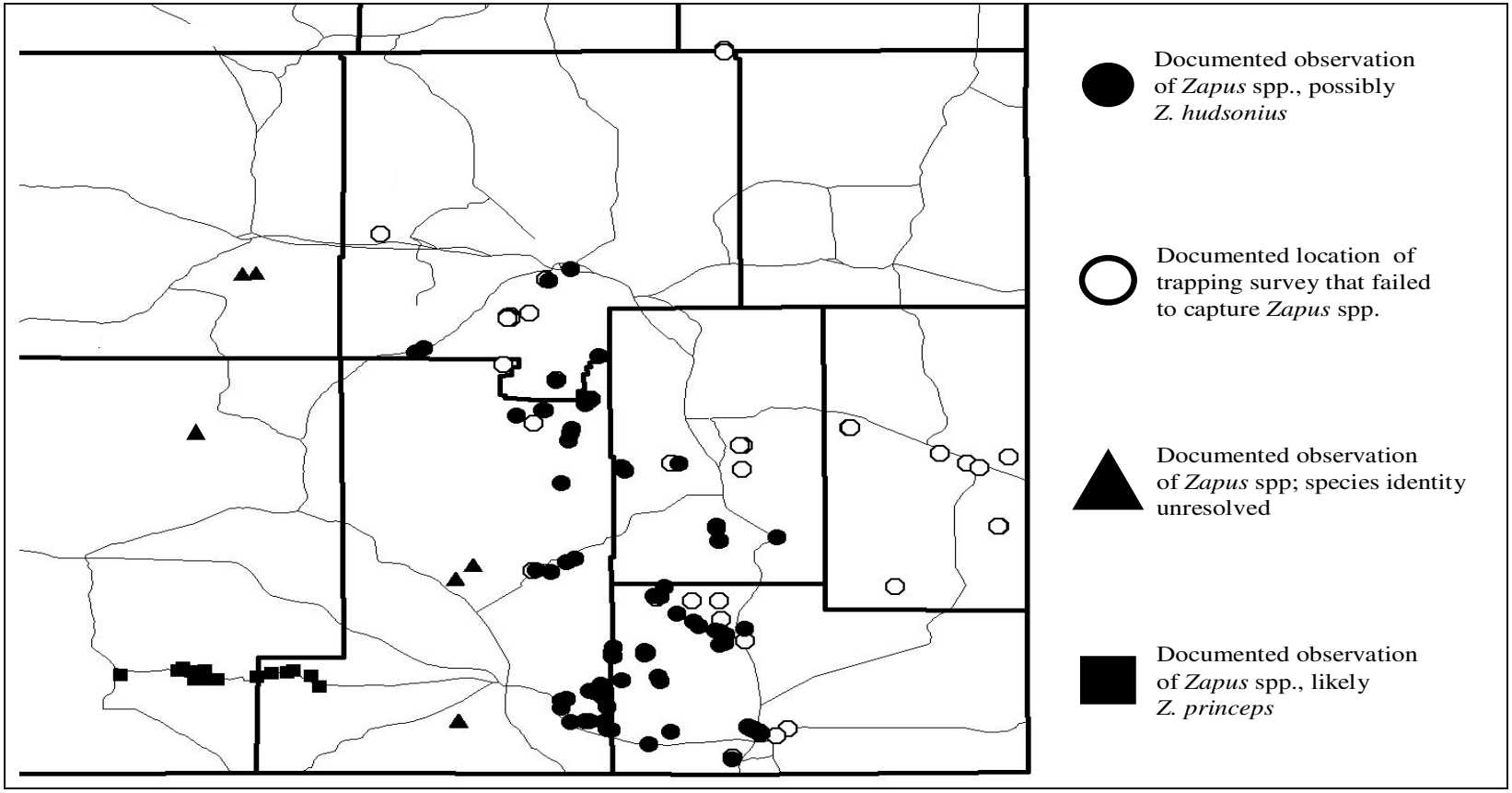


Figure 4. Observations of suspected Preble's meadow jumping mice within the boundary (bold red line) of the Casper Field Office (Wyoming) of the USDI Bureau of Land Management. Black lines show county boundaries; green lines show major roads. Blue dots show all known Preble's mouse capture sites to date (no captures were documented during this study). Gray dots show Preble's mouse trapping efforts that failed to record the taxon, excluding efforts from this study. All data on file at the Wyoming Natural Diversity Database at the University of Wyoming, Laramie, Wyoming.

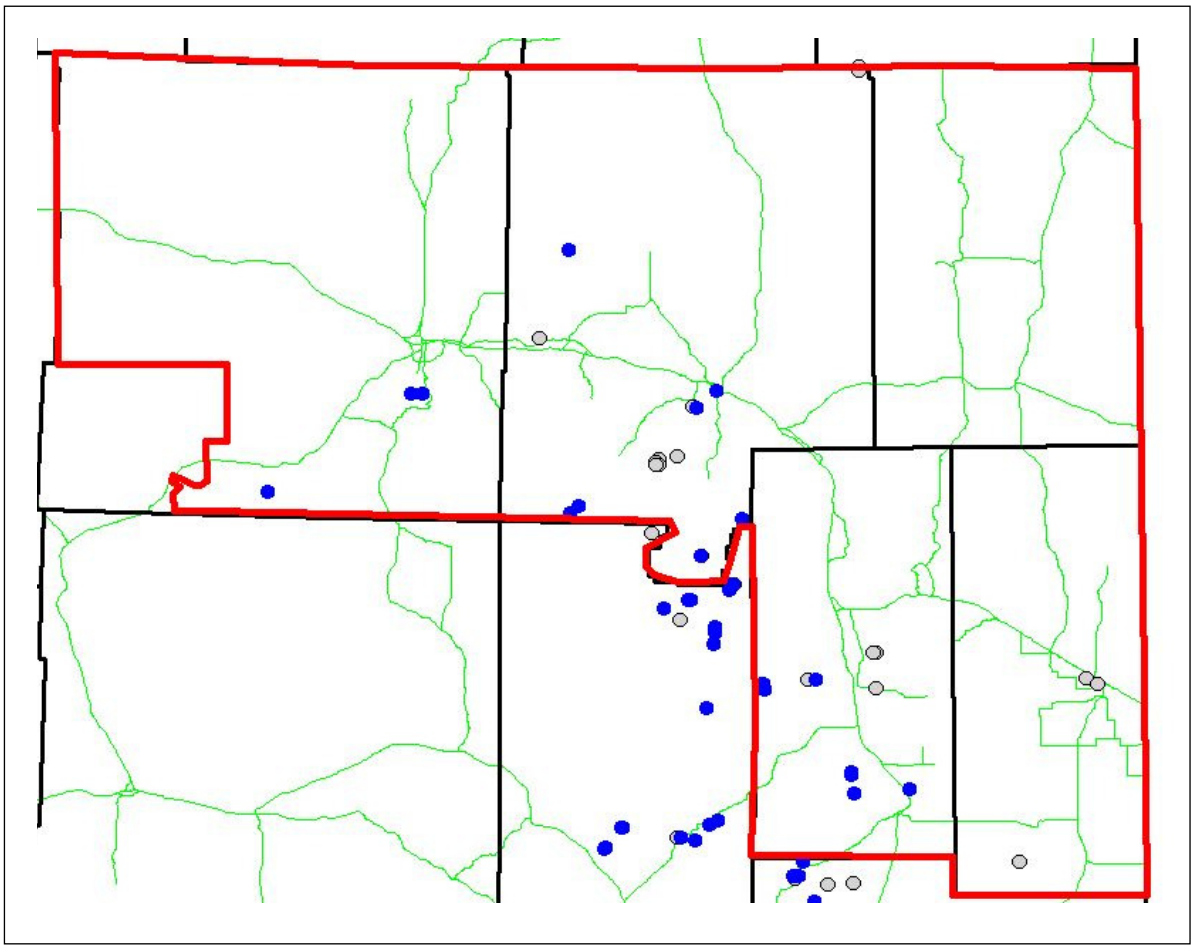


Figure 5. Preble's Meadow Jumping Mouse Critical Habitat, Wyoming Index Map

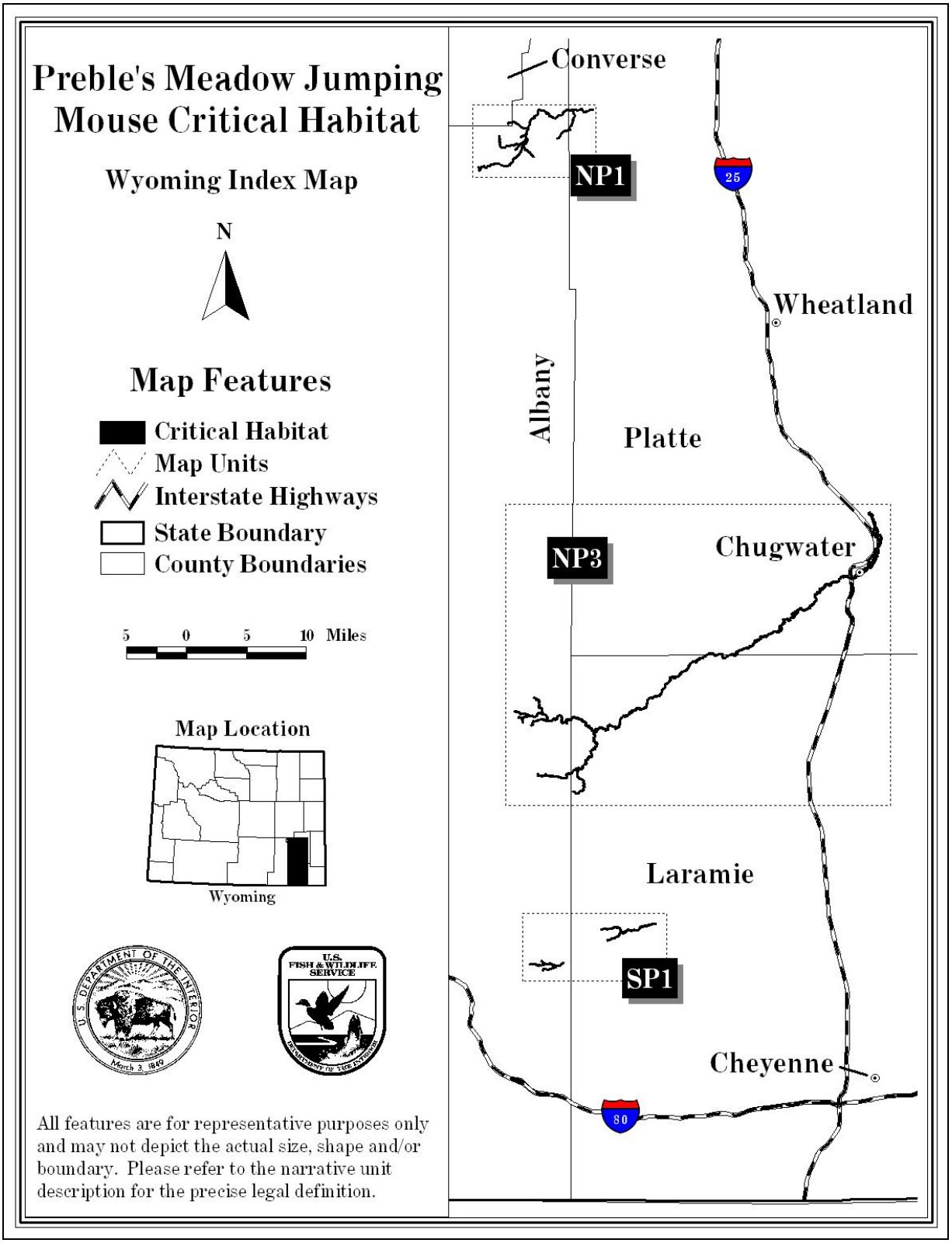


Figure 6. Preble's Meadow Jumping Mouse Critical Habitat, Unit NP1 (Cottonwood Creek)

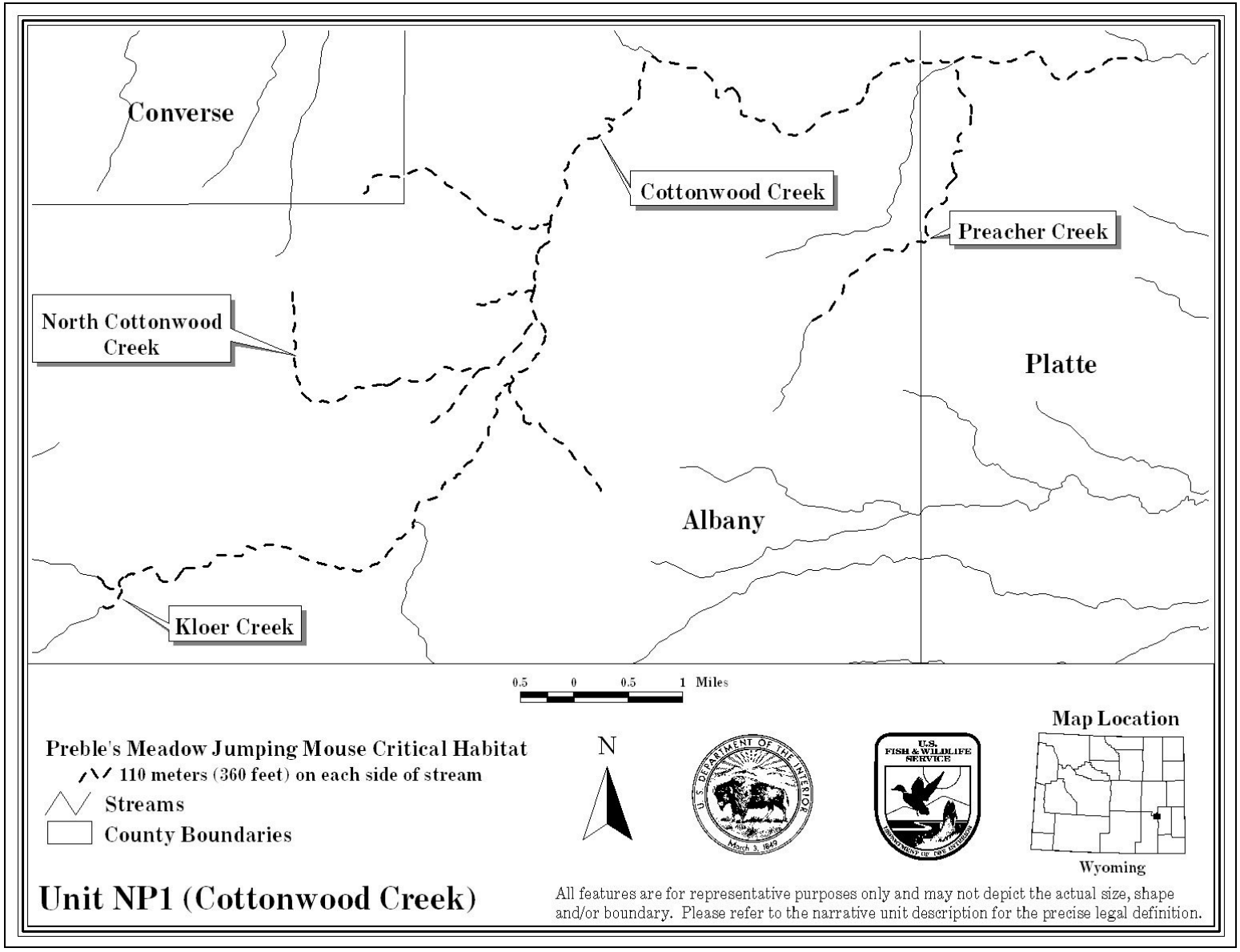


Figure 7. Preble's Meadow Jumping Mouse Critical Habitat, Unit NP3 (Chugwater Creek)

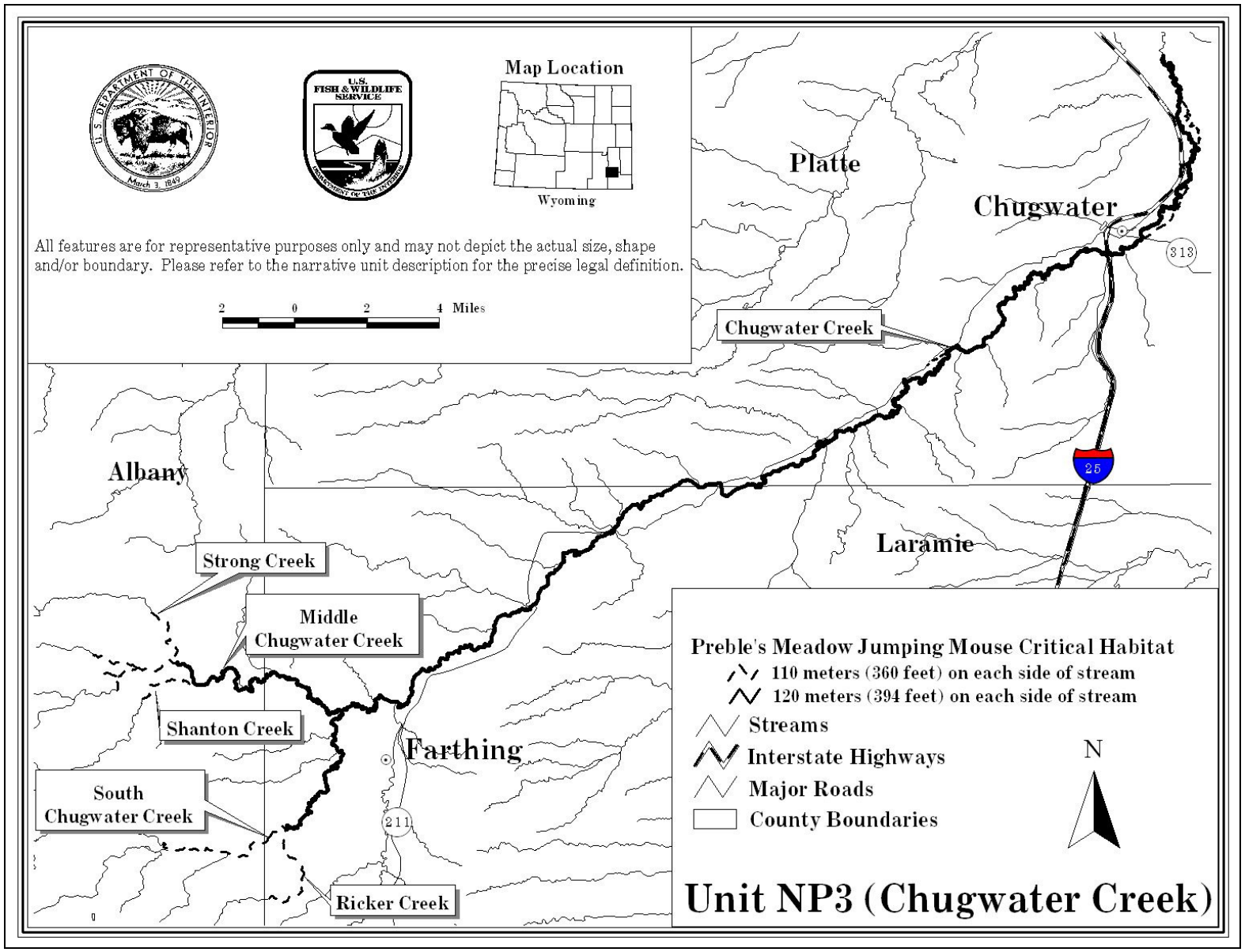
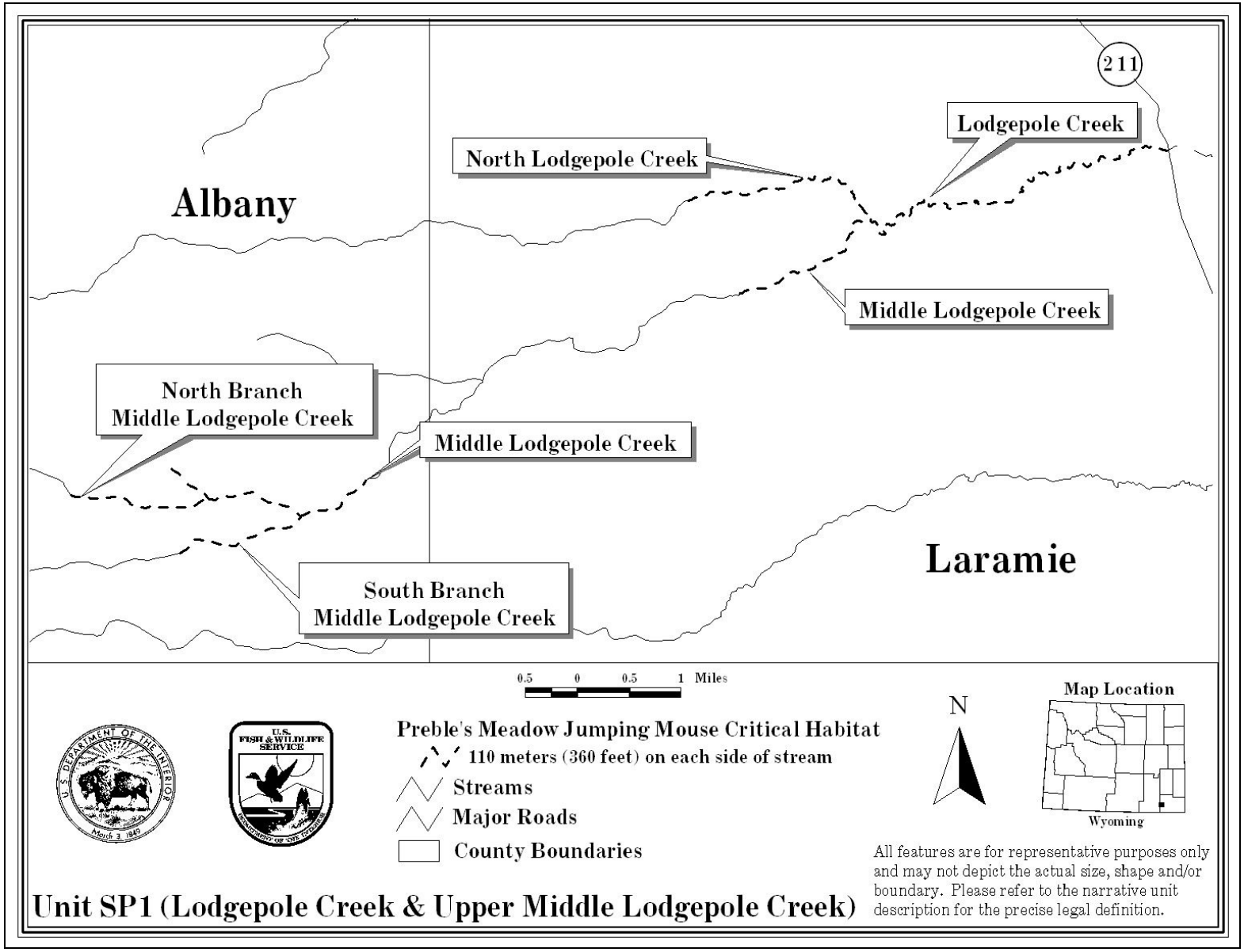


Figure 8. Preble's Meadow Jumping Mouse Critical Habitat, Unit SP1 (Lodgepole Creek and Upper M. Lodgepole Creek.



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