

Recovery Plan
Preble's Meadow Jumping Mouse
(*Zapus hudsonius preblei*)
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U.S. Department of the Interior, U.S. Fish and Wildlife Service
Mountain-Prairie Region



Illustration by David Hesker (ERO Resources)

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U.S. FISH AND WILDLIFE SERVICE'S MISSION IN RECOVERY PLANNING

Section 4(f) of the Endangered Species Act (ESA; 16 U.S.C. 1531 et seq.), as amended, directs the Secretary of the Interior and the Secretary of Commerce to develop and implement Recovery Plans for species of animals and plants listed as endangered or threatened unless such plans will not promote the conservation of the species. The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service have been delegated the responsibility of administering the ESA. Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are reduced, so that its long-term survival in nature can be ensured. The goal of the process is the maintenance of secure, viable wild populations of species with the minimum necessary investment of resources so that federal ESA protections are no longer necessary and can be removed.

DISCLAIMER

Recovery Plans delineate reasonable actions that are believed to be required to recover and protect listed species. Plans are published by the USFWS, sometimes prepared with the assistance of recovery teams, contractors, state agencies, and others. Recovery Plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the Plan formulation, other than the USFWS. They represent the official position of the USFWS only after they have been signed as approved. Recovery Plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this Plan should be construed as a commitment or requirement that any federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved Recovery Plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

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- <http://www.fws.gov/endangered/species/recovery-plans.html>
- <https://www.fws.gov/mountain-prairie/es/preblesMeadowJumpingMouse.php>

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Many of the threats to the Preble's meadow jumping mouse are associated with habitat loss and urbanization of the east slope of the Rocky Mountain Front Range. To aid in the urban and population planning process, several approved Recovery Plans were reviewed, and we express our thanks to the authors of other Recovery Plans.

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EXECUTIVE SUMMARY

Current Species Status: The Preble's meadow jumping mouse (*Zapus hudsonius preblei*) was listed as threatened in 1998, pursuant to the ESA. Although there is no single range-wide population estimate, there are estimates for a few local populations (e.g., U.S. Air Force Academy). In addition, numerous surveys have documented the subspecies' presence or absence at locations of suitable habitat; some locations were historically known to be occupied and other locations had no known previous surveys. It is believed that there are sufficient populations present today to allow recovery of the subspecies; however, many of these populations face threats to their persistence.

Habitat Requirements and Limiting Factors: The Preble's meadow jumping mouse (Preble's mouse) is found in high plains riparian habitat often reaching to foothills riparian habitats from southeastern Wyoming to south central Colorado. The subspecies is often found in dense, herbaceous riparian vegetation, which may have an over-story canopy layer. Preble's mice regularly use upland grasslands adjacent to riparian habitat, and they may be dependent upon some amount of open water. The subspecies hibernates near riparian zones from mid-October to early May. Loss of riparian habitats and other factors associated with urbanization appear to be the major threat to the subspecies.

Recovery Goal: The goal of this Plan is to sufficiently reduce threats such that we can remove the Preble's mouse from the list of threatened species. This Plan proposes five criteria for delisting that when met, and following an analysis of the ESA listing factors by the USFWS, should ensure that protection of the subspecies under the ESA will no longer be necessary.

Criteria for Delisting:

The Preble's mouse will be considered recovered and eligible for delisting when:

1. Two large and five medium populations distributed across the range maintain stable or increasing trends over a 10-year period based on data obtained from standardized monitoring methods. Population sizes are defined on page 39 of this Plan. The recovery populations will be distributed among two Recovery Units (on page 46).
2. Sufficient numbers of small populations are protected to provide for representation, resiliency, and redundancy. In each of the 10 HUCs that are not occupied by a large or medium population and that contain suitable Preble's mouse habitat, an additional three small populations are maintained over a 10-year period based on data obtained from standardized monitoring methods.
3. At least the estimated stream mileage for each population size (large population = 57 miles, medium population = 11 miles, small population = 3 miles, see Section 5 under Recovery Strategies of this Plan) is maintained as suitable habitat of functionally connected stream for a reasonable time frame (10 years or more) and is not expected to

be impacted by negative management actions for the foreseeable future. Priority is given to public and other protected lands and habitats that provide connectivity.

4. State, county or local government regulations or other mechanisms, as set forth in the delisting criteria for Factor D, protect Preble's mouse habitat and abate known threats into the foreseeable future.
5. As required by the ESA, a post-delisting management plan for the Preble's mouse and its habitat is completed, in cooperation with state and local governments, to ensure the designated recovery populations are maintained at self-sustaining levels.

Cost and Duration of Recovery: Recovery is anticipated to take at least 10 years and cost \$12,535,000. This is an estimate of when it could be demonstrated that all large, medium, and small populations met their recovery criteria. It could happen within a timeline of 10 years if all monitoring is conducted simultaneously and sufficiently to demonstrate needed metrics for recovery.

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BACKGROUND

Listing History

The Preble's meadow jumping mouse (*Zapus hudsonius preblei*; herein referred to as Preble's mouse) was listed as a threatened subspecies under the ESA in May of 1998 (63 FR 26517). A special 4(d) rule provides exemption from take protections for certain activities related to rodent control, ongoing agricultural activities, landscape maintenance, and existing uses of water. The current critical habitat designation was completed in 2010, designating approximately 411 miles of rivers and streams and 34,935 acres in Colorado; no critical habitat has been designated in Wyoming. This rare subspecies of meadow jumping mouse was added to the State of Colorado's list of "threatened" species by the Colorado Division of Wildlife (now Colorado Parks and Wildlife) on November 12, 1998 (Colorado Parks and Wildlife Regulations, Chapter 10, Article III, #1003.A.3). The Preble's mouse is designated as Native Species Status 4 by the Wyoming Game and Fish Department, because population size and distribution are restricted and limiting factors due to human activity are moderate and likely to increase in severity (WGFD 2010). Both Colorado and Wyoming provide protection for the species (*Zapus hudsonius*) by requiring permits for take and possession as well as for educational and scientific purposes.

The Preble's mouse is considered critically imperiled in Colorado by the Colorado Natural Heritage Program (1999a) and in Wyoming by the Wyoming Natural Diversity Database (Keinath *et al* 2003). In their evaluation of the conservation status of rodents of North America, Hafner *et al.* (1998) classified Preble's mouse as "endangered" in the IUCN Red List.

Species Description

Since the Preble's mouse was listed by the USFWS in 1998, knowledge about distribution, population dynamics, abundance, taxonomy and habitat of the subspecies has grown substantially. Some aspects of the biology and ecology of the Preble's mouse remain poorly understood. Where gaps in knowledge exist, scientists have relied on information from closely-related subspecies whose biology and ecology are believed to be similar to the Preble's mouse. Information that is specific to Preble's mouse will be described as being relevant to the subspecies ("Preble's mouse"), but when information is gleaned from what is known about other subspecies it will be described as pertinent to the species ("meadow jumping mouse").

The Preble's mouse is a relatively small rodent (0.53–1.1 ounces as an adult) with a long tail, and large hind feet (Figure 1). The tail is not strongly bicolored, lightly-furred and typically twice as long as the body. The hind feet can be twice as large as those of other mice, such as the deer mouse (*Peromyscus maniculatus*), that are found in the same habitat. The adult Preble's mouse has a distinct, dark, broad stripe on its back that runs from head to tail and is bordered on either side by lighter tan to



Figure 1. Preble's meadow jumping mouse. Source: Rocky Flats Photo Library, 9/1/1996, Negative #49187-5.

orange-brown fur. This characteristic develops in juveniles in their first summer and is apparent by first hibernation. The hair on the back of all jumping mice appears coarse compared to other mice. The underside fur is white and much finer in texture. Total length of adult Preble's mice is approximately 7-10 inches, with the tail constituting 4-6 inches of that length (Armstrong *et al.* 2011).

Typically, juveniles weigh less than 0.46 ounces and adults weigh 0.53 ounces or more (Whitaker 1963). Upon emergence from hibernation, adult Preble's mice can weigh as little as 0.50 ounces (Meaney *et al.* 2003). In a 2003 study from Boulder County, the mean weight of 78 adult male Preble's mice captured prior to June 18 was 0.65 ± 0.07 ounces, and of 47 adult females was 0.65 ± 0.1 ounces; ten of the females were pregnant or lactating and weighed more than 0.79 ounces (Meaney *et al.* 2003). Through late August into mid-September, adult Preble's mice gain weight in preparation for hibernation and typically attain weights up to 1.13 ounces or more (Schorr 2001).

Taxonomy

The Preble's mouse is a member of the family *Dipodidae* (jumping mice and jerboas; Armstrong *et al.* 2011), which contains six subfamilies (Wilson and Reeder 2005). Two genera, *Zapus* and *Napaeozapus*, are found in North America (Kruttsch 1954). The three species within the genus *Zapus* are *Z. hudsonius* (meadow jumping mouse), *Z. princeps* (western jumping mouse), and *Z. trinotatus* (Pacific jumping mouse) (Kruttsch 1954). Meadow jumping mice were first documented from Colorado by Edward A. Preble (1899). The Preble's mouse was described as a separate subspecies of meadow jumping mouse by Kruttsch (1954). The Preble's mouse is now recognized as 1 of 12 subspecies of meadow jumping mouse (Hall 1981).

Two subspecies of meadow jumping mouse occur in Colorado: Preble's mouse and *Z. h. luteus*. The subspecies *Z. h. luteus* was previously known as *Z. princeps luteus*, but was subsequently assigned to *Z. hudsonius* by Hafner *et al.* (1981). Although *Z. h. luteus* mainly occurs within central New Mexico and eastern Arizona, it was recently discovered in southern Colorado by Jones (1999) and Frey (2008). *Z. h. luteus* is listed as an endangered species under the ESA throughout its range (79 FR 33119). Two subspecies of meadow jumping mouse also occur in Wyoming: Preble's mouse and *Z. h. campestris* (Hall 1981, Clark and Stromberg 1987). The subspecies *Z. h. campestris* was described from northeastern Wyoming, southeastern Montana, and western South Dakota (Hall 1981); it is not listed under the ESA.

The range of the western jumping mouse (*Z. princeps*) overlaps that of the Preble's mouse (Hall 1981), and the two species are similar in appearance. Compared to western jumping mice, Preble's mice are generally smaller, have a more distinctly bicolored tail, and a less obvious dorsal stripe. However, field identification of western jumping mice and Preble's mice where their ranges overlap is difficult due to their similarity in size and color. Consequently, a number of techniques have been used to differentiate between Preble's mice and western jumping mice, including dental and cranial morphology (Conner and Shenk 2003a; Klingener 1963; Conner and Shenk 2003b) and genetic analyses (Riggs *et al.* 1997; King *et al.* 2006a, b; Ramey *et al.* 2004).

Currently, where the species overlap, genetic analyses are the preferred and accepted method for identification (King *et al.* 2006a).

The taxonomy of the Preble's mouse has been the subject of scientific debate and research. A recent study that used genetics to investigate the taxonomy of all north American jumping mice, including the Preble's mouse, suggests that the Preble's mouse is a valid subspecies, although it is the most genetically similar to two other subspecies of meadow jumping mice found in Alaska and Canada (Malaney and Cook, 2013). This study also used genetics and other factors to rank conservation priorities of meadow jumping mice across North America. The study reports that the genetic lineage that includes the Preble's mouse is not restricted to Wyoming and Colorado, but extends to the far north in Alaska and Canada, although meadow jumping mice in Colorado and Wyoming are now disconnected from these closest genetic relatives found in Alaska and Canada. Although the Preble's mouse might have historically been connected to its genetic relatives in Malaney and Cook's (2013) "northern lineage," the Preble's mouse is geographically isolated from these genetic relatives today. Furthermore, the Malaney and Cook 2013, study does not propose to revise the formal taxonomy of the Preble's mouse or any of the other subspecies of jumping mice. Specifically, the study concludes, "additional tests will be required before hypotheses of infraspecific taxonomic synonymy can be implemented... [and that] a revised taxonomy of the group is needed but is outside the context of this study" (Malaney and Cook 2013). The authors recommend that a "taxonomic re-evaluation should include a set of tests that encompasses the emerging historical-biogeographical perspective and more finely assesses hypotheses of both evolutionary independence and adaptive variation" (Malaney and Cook 2013). Additionally, any claims regarding conservation status based on purported lineages or grouping of meadow jumping mouse based solely on genetics would be premature until a more thorough and comprehensive review of the taxonomy is completed. We continue to agree with Malaney and Cook (2013) that the data presented in their study are not sufficient to formally change the taxonomy of the Preble's mouse. The best available information continues to indicate that the Preble's mouse is a valid taxonomic subspecies.

Distribution

The Preble's mouse is found in both the North and South Platte River basins, from the eastern flank of the Laramie Mountains and the Laramie Plains in southeastern Wyoming south along the eastern flank of the Front Range in Colorado and into the headwaters of the Arkansas River Basin near Colorado Springs, Colorado (Long 1965; Hall 1981; Clark and Stromberg 1987; Armstrong *et al.* 2011; Clippinger 2002). The most recent knowledge regarding the distribution of the Preble's mouse comes from live-trapping locations and specimens from site-specific research efforts, range-wide survey efforts, and numerous additional surveys conducted in Colorado and Wyoming since the mid-1990s (from the USFWS's Preble's mouse distribution database, Figure 2; more detailed maps available online at <https://www.fws.gov/mountain-prairie/es/preblesMeadowJumpingMouse.php>). Most specimens collected in recent years are housed at the Denver Museum of Nature and Science; survey reports from live-trapping efforts are filed with the USFWS Field Offices in Colorado and Wyoming. Museum specimens from Colorado Springs mark the southern distributional limit of the Preble's mouse. The northern end

is marked by museum specimens from the southern notch of Converse County, Wyoming, but trapping records of *Zapus* are recorded as far north as Douglas, Wyoming (Williams and Rogers 1999), where a single Preble's mouse was confirmed in 1999 (King *et al.* 2006a). Due to overlap with western jumping mice in Wyoming, all Wyoming capture locations have been confirmed by genetic analysis.

The Preble's mouse is generally found at elevations between 4,650 feet and 8,100 feet. At the lower end of this elevation gradient, the semi-arid climate of southeastern Wyoming and eastern Colorado limits the extent of riparian corridors and restricts the range of the subspecies (Beauvais 2001). The Preble's mouse is likely an Ice Age relict; once the glaciers receded from the Front Range of Colorado and the foothills of Wyoming and the climate became drier, the Preble's mouse was confined to riparian systems where moisture was more plentiful (Armstrong *et al.* 2011; Smith *et al.* 2004).

In Colorado, the distribution of the Preble's mouse forms a band along the Front Range from the Wyoming border southward to Colorado Springs, with the eastern margin delineated by captures in western Weld County, western Elbert County, and north-central El Paso County. In Colorado, the Preble's mouse has not been found on the extreme eastern plains (Clippinger 2002). The western boundary of the Preble's mouse range in Colorado appears related to elevation along the Front Range, with 7,600 feet as an approximate upper limit (USFWS 2004). The eastern boundary for the Preble's mouse is defined ecologically by the dry, short grass prairie, which may present a barrier to eastward expansion (Beauvais 2001). In Wyoming, the Preble's mouse has not been found east of Slater, Platte County (Beauvais 2001). Habitat modeling and trapping suggest the subspecies does not occur in Wyoming's Goshen, Niobrara, and eastern Laramie counties (Keinath 2001).

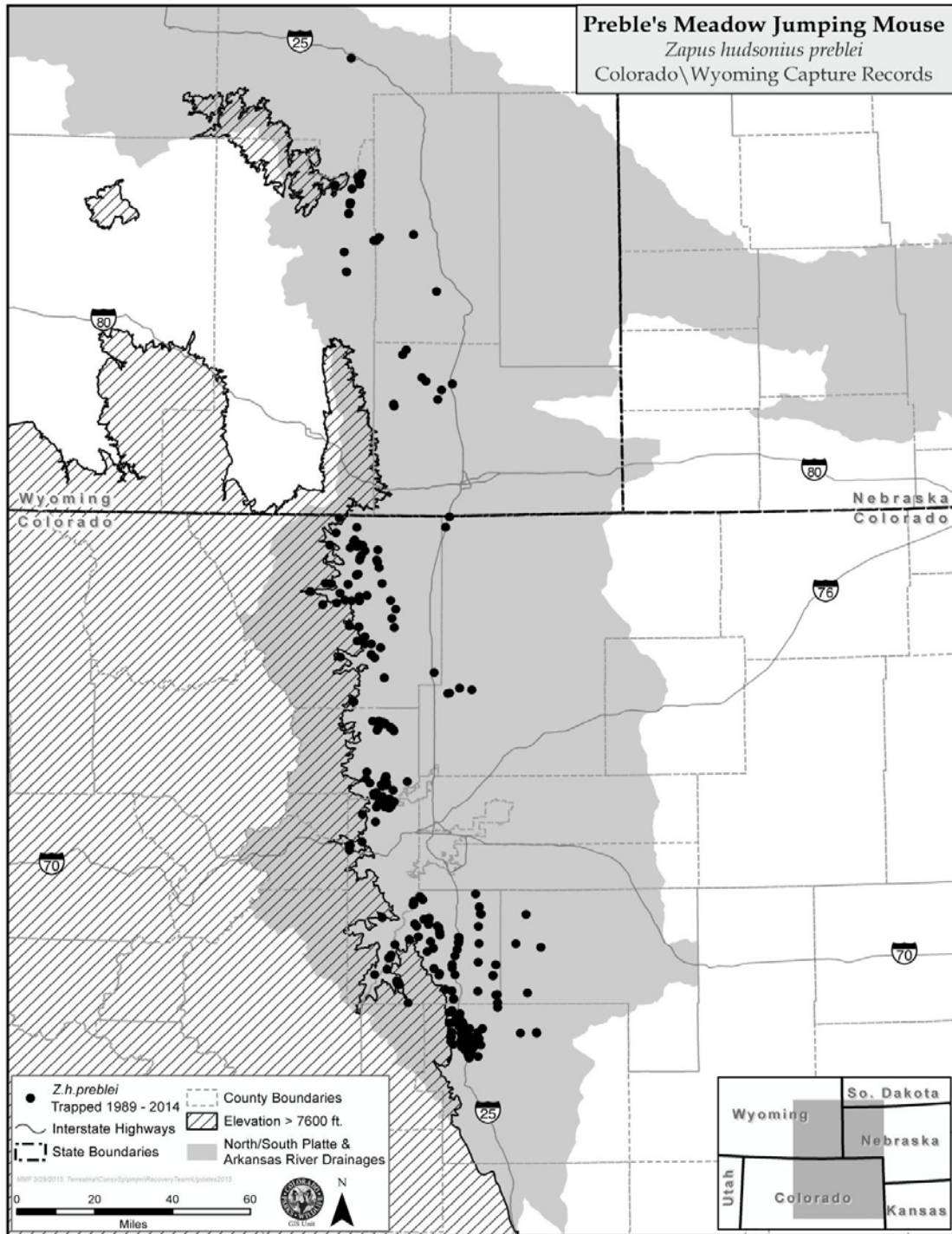


Figure 2. Distribution of capture localities of the Preble's meadow jumping mouse (*Z. h. preblei*) in Colorado and Wyoming through 2015. (Bowe and Beauvais 2012, USFWS 2015). Point locations represent where presence of Preble's mouse has been confirmed.

At higher elevations, discerning the status of the Preble's mouse is complicated by the overlap in the ranges of the Preble's mouse and the western jumping mouse (Long 1965; Clark and Stromberg 1987; Schorr 1999; Bohon *et al.* 2005; Schorr *et al.* 2007). Generally, the western jumping mouse occurs in the montane and subalpine zones and the Preble's mouse occurs lower in the plains and foothills (Smith *et al.* 2004). However, meadow jumping mice have been found at elevations typically associated with western jumping mice (Smith *et al.* 2004), leading to difficulty in making identification based on elevation. Identification is further complicated by the ability of the Preble's mouse to travel long distances and tolerate other jumping mice (see Behavior for further discussion). Drainages where overlapping ranges have been verified include: the Lower Laramie and Horse Creek drainages in Wyoming (Meaney 2003; King *et al.* 2006a; King *et al.* 2006b); and the Cache La Poudre, Big Thompson, and Upper South Platte River drainages in Colorado (Bohon *et al.* 2005; T. King, USGS, pers. comm.; King *et al.* 2006a; King *et al.* 2006b; Schorr *et al.* 2007).

At least two specimens of both Preble's mice and western jumping mice have been collected from three drainages where both species appear to occur within a distance of approximately 8 miles: Upper South Platte in Douglas and Teller Counties, Colorado, and the Laramie River and Horse Creek drainages in Wyoming (Shenk 1998; Schorr 1999; Ensign Technical Service 2001b; Bowe and Beauvais 2012). Trout Creek originates in the Rampart Range, flows north through rolling hills, and empties into the South Platte River. In Wyoming, the Laramie River and Horse Creek provide access for the Preble's mouse to the Laramie Plains. Whereas most of the Laramie Mountains have a "divide" along the top which restricts the Preble's mouse to the eastern flank, the Laramie River flows through a low saddle enabling the Preble's mouse to occur upstream on the Laramie Plains (Smith *et al.* 2004). The western jumping mouse population likely also extends downstream from the higher-elevation headwaters in the mountains of Larimer County, Colorado.

Zones of co-occurrence raise the question of hybridization (Beauvais 2001). In New Mexico and Arizona, *Z. hudsonius* and *Z. princeps* coexist in narrow zones of contact where limited hybridization between the two species may occur (Hafner 1998). However, Krutzsch (1954) examined areas of potential hybridization and found no evidence of hybridization at the species level. Future genetic studies will likely clarify this issue.

Although there is little information on the past distribution or abundance of the Preble's mouse, surveys have identified various locations where the subspecies was historically present but is now absent (Ryon 1996). Despite increased trapping effort, the Preble's mouse has not been found in Denver, Adams, and Arapahoe Counties in Colorado in the past two decades (USFWS 2004, USFWS 2016).

Natural History and Ecology

Reproduction

Little research has been done on the number or size of Preble's mouse litters, but researchers assume that they are similar to other subspecies of meadow jumping mouse. Meadow jumping mice usually have two litters per year (Whitaker 1963), but Quimby (1951) reports the possibility of three litters per year. The size of a litter can range from two to eight young but averages five young (Quimby 1951; Whitaker 1963), and a Preble's mouse nest with six young was found in Jefferson County, Colorado (Ryon 2001). After 4 weeks of age, meadow jumping mouse young are independent and resemble adults (Whitaker 1963). First reproduction can occur at 2 months of age for young of early litters (born in June); young of later litters appear to have their first reproduction in the next year (Quimby 1951).

Longevity and Mortality

The annual survival rate of the Preble's mouse is low, and varies seasonally (Schorr *et al.* 2009). The Preble's mouse is fairly long-lived for a small mammal, with some individuals documented as living at least 3 years (Meaney *et al.* 2003). The Preble's mouse seems to survive better during winter hibernation (but see Schorr *et al.* 2009), and most mortalities probably occur when the subspecies is active during the summer. Summer survival rates, defined as June through August or October, ranged from 5 to 46 percent. Overwinter survival rates, defined as August or October to May or June, ranged from 13 to 54 percent (Shenk and Sivert 1999b; Ensight Technical Services 2001a; Schorr 2001; Meaney *et al.* 2003; Schorr *et al.* 2009). A model was fit to these data to account for the different lengths of time between trapping sessions in each study and in order to include Shenk and Sivert's (1999b) estimates for summer only. Based on this fitted model, Preble's mouse average summer survival standardized to 4 months was 11 percent (5.6 percent standard error) and average winter survival over 8 months was 83.4 percent (8.8 percent standard error). The average annual survival rate (summer rate x winter rate) based on the full data set was 9.1 percent (5.2 percent standard error) (Bruce Lubow, Colorado Division of Wildlife, unpublished data). Mark-recapture analysis of the U.S. Air Force Academy (Academy), Colorado Springs, Colorado, population showed dramatic annual variability in sex-specific seasonal survival rates, with overwinter survival being best predicted by individual body mass and winter conditions (Schorr *et al.* 2009). The geometric mean survival rate for the Preble's mouse over a 7-year period at the Academy was 0.10 (range = 0.03 - 0.27) (Schorr 2012). These annual survival rates are based upon limited field observation, and may change as additional information is obtained.

Causes of Mortality

The Preble's mouse has a host of known predators including garter snakes (*Thamnophis* spp.), prairie rattlesnakes (*Crotalus viridis*), bullfrogs (*Lithobates catesbiana*), foxes (*Vulpes vulpes* and/or *Urocyon cinereoargenteus*), house cats (*Felis catus*), long-tailed weasels (*Mustela frenata*), and red-tailed hawks (*Buteo jamaicensis*) (Shenk and Sivert 1999a; Schorr 2001).

Other potential predators of jumping mice include coyotes (*Canis latrans*), barn owls (*Tyto alba*), great horned owls (*Bubo virginianus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), northern harriers (*Circus cyaneus*), northern pike (*Esox lucius*), and creek chub (*Semolilus atromaculatus*) (Whitaker 1963; Poly and Boucher 1997; Trainor 2004).

Other mortality factors for the Preble's mouse include drowning and occasional losses associated with vehicles (Shenk and Sivert 1999a; Schorr 2001). Shenk and Sivert (1999a) assumed starvation, exposure and disease to be additional causes of death. Mortality factors known for other subspecies of meadow jumping mice, which are also likely causes of Preble's mouse mortality, include cannibalism (in captivity) and insufficient fat stores for hibernation (Sheldon 1934; Whitaker 1963; Schorr *et al.* 2009).

Diet

Although fecal analyses have provided the best data on the Preble's mouse diet to date, they overestimate the components of the diet that are less digestible and underestimate food items that are digested more completely, such as vegetation. Based on fecal analyses, Preble's mice eat arthropods, fungus, moss, pollen, willow (*Salix* spp.), lamb's quarters (*Chenopodium* sp.), Russian thistle (*Salsola* sp.), sunflowers (*Helianthus* spp.), sedge (*Carex* spp.), mullein (*Verbascum thapsus*), grasses (*Bromus*, *Festuca*, *Poa*, *Sporobolus* and *Agropyron* spp.), bladderpod (*Lesquerella* sp.), rushes (*Equisetum* sp.), and assorted seeds (Shenk and Eussen 1999; Shenk and Sivert 1999a). Willows were present in 38 percent of scats from Larimer County, Colorado (Shenk and Eussen 1999). The diet shifts seasonally, consisting primarily of arthropods and fungus after emerging from hibernation and fungus, moss, grass seed, and pollen during mid-summer (July-August), with arthropods added again in September (Ensign Technical Services 2001a, Shenk and Sivert 1999a). The shift in diet along with shifts in mouse movements suggests that the Preble's mouse may require specific seasonal diets, especially with the physiological demands of hibernation (Shenk and Sivert 1999a). If we assume the Preble's mouse eats similar vegetation as documented for *Z. h. luteus*, then the Preble's mouse may consume seeds of threesquare (*Schoenoplectus* spp.), spikerush (*Eleocharis* spp.), saltgrass (*Distichlis* spp.), foxtail barley (*Hordeum* spp.), wildrye and wheatgrass (*Elymus* spp.), brome (*Bromus* spp.), and knotgrass (*Paspalum* spp.) (Wright and Frey 2015) where similar plant species occurs within Preble's mouse range.

Hibernation

The Preble's mouse is a true hibernator, usually entering hibernation in September or October and emerging the following May, after a potential hibernation period of 7 or 8 months (Whitaker 1963; Meaney *et al.* 2003). Adults are the first age group to enter hibernation because they accumulate the necessary fat stores earlier than young-of-the-year (Wunder and Harrington 1996). Adults reach weights that enable them to enter hibernation by the third week in August, whereas young-of-the-year typically enter hibernation in September and October (Meaney *et al.* 2003). The earliest Preble's mouse capture in Colorado was May 5 and the latest was October 27; both were captured at Rocky Flats Environmental Technology Site (Harrington 1996). As

with other subspecies of meadow jumping mouse, the Preble's mouse does not store food, but survives on fat stores accumulated prior to hibernation (Whitaker 1963).

Meadow jumping mice may dig their own hibernation burrows and hibernate alone or in pairs; separate hibernacula, or hibernation nests, may be located close together (Whitaker 1963). Fifteen apparent Preble's mouse hibernacula have been located through radio-telemetry, all found between 3.3 feet and 335 feet of a perennial stream bed or intermittent tributary (Bakeman 1997, Shenk and Sivert 1999a; Schorr 2001; Ruggles *et al.* 2004; T. Ryon, National Renewable Energy Laboratory, pers. comm.). Those hibernating outside of the 100-year floodplain may be less vulnerable to flood-related mortality. Apparent hibernacula have been located under willow, chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpos albus*), skunkbrush (*Rhus trilobata*), sumac (*Rhus* spp.), clematis (*Clematis* sp.), cottonwood (*Populus* spp.), Gambel's oak (*Quercus gambelii*), thistle (*Cirsium* spp.), alyssum (*Alyssum* spp.) (Shenk and Sivert 1999a), and poison ivy (*Toxicodendron rydbergii*). One confirmed Preble's mouse hibernaculum, located at Rocky Flats Environmental Technology Site, occurred in poison ivy and leaf litter 11.8 inches below the surface in coarse textured soil (Bakeman 1997).

Behavior

Knowledge of a species' behavior is an essential component of developing a successful conservation program (Caro 1998, Gosling and Sutherland 2000), yet very little is known about the behavior of meadow jumping mice. The Preble's mouse is primarily nocturnal or crepuscular but also may be active during the day, when they have been seen moving around or sitting still under a shrub (Shenk 1998). The subspecies has also displayed an ability to travel long distances both along riparian areas as well as overland. Mark-recapture studies conducted at the Academy from 2000 – 2002 documented 10 percent of all jumping mice tagged along Monument Creek moving at least 1/3 mile from their location of first capture, sometimes at distances greater than 2.5 miles (Schorr 2003). Further, a radio-collared mouse at Rocky Flats was observed moving 764 feet from its point of original capture in Rock Creek perpendicularly into a tributary in a 24-hour period, indicating likely overland movement (T. Ryon, National Renewable Energy Laboratory, pers. comm.).

Meadow jumping mice are not antagonistic toward one another (Quimby 1951; Whitaker 1972). They may however, compete with meadow voles (*Microtus pennsylvanicus*) and may be kept at low densities by these voles (Boonstra and Hoyle 1986). A meadow jumping mouse was killed by a meadow vole when the two were confined together (Quimby 1951). Based on mark-recapture data, the Preble's mouse may experience reduced survival during years with high deer mouse (*Peromyscus maniculatus*) abundance, likely due to the high dietary overlap, and the reduction in abundance of food items favored by Preble's mice during these years. Higher recruitment during years with high meadow vole abundance has been observed by Schorr (2012), which may be a reflection of both species' preference for similar habitat conditions. Further, habitat alterations caused by voles may positively influence meadow jumping mouse survival and recruitment, and predators may select voles more frequently when they are abundant (Schorr 2012).

Little is known about the interaction among social behavior, social strategies, and survival in this subspecies. However, E. A. Preble (1899) described globular nests built above ground in late summer that are inhabited by two individuals, presumably a pair. Jones and Jones (1985) described lively social interactions in which several meadow jumping mice were observed jumping into the air and squeaking in close proximity to one another suggesting that they formed a gregarious unit. At Woodhouse Ranch in 1999 and 2000, three radio-collared Preble's mice came from different day-nest locations to meet at one particular spot every night for the month that their radio-collars were active (T. Shenk, Colorado Division of Wildlife, pers. comm.).

Habitat

Typical habitat for the Preble's mouse is composed of well-developed riparian vegetation, relatively undisturbed adjacent grassland communities, and a nearby water source (Bakeman 1997); White and Shenk (2000) determined that the amount of these attributes are good predictors of Preble's mouse densities. At the Academy, Preble's mouse densities were correlated with vertical vegetation density and total grass cover (Schorr 2001). In addition, Trainor *et al.* (2007) found that high-use areas for the Preble's mouse tended to be close to creeks and were positively associated with the percentage of shrubs, grasses, and woody debris. Well-developed riparian vegetation includes a fairly dense combination of grasses, forbs, and shrubs with the possible inclusion of a taller tree and shrub canopy (Bakeman 1997; Meaney *et al.* 1997a; Shenk and Eussen 1999; Schorr 2001). The shrub canopy is often willow, although other shrub species, such as snowberry, chokecherry, hawthorn (*Crataegus* sp.), Gambel's oak, alder (*Alnus incana*), river birch (*Betula fontinalis*), skunkbrush, wild plum (*Prunus americana*), lead plant (*Amorpha fruticosa*), and dogwood (*Cornus sericea*) may occur (Bakeman 1997; Shenk and Eussen 1999). Montane riparian woodlands where Preble's mice have been found are characterized by spruce (*Picea pungens*) and occasionally aspen (*Populus tremuloides*), with lush and diverse understories of shrubs and forbs (Ruggles *et al.* 2001). Mountain riparian sites may be surrounded by dense forest vegetation (*P. ponderosa* in Colorado), and sites on the plains have less woody vegetation. For example, montane tributaries to the South Platte River are constrained by steep mountainous slopes of dry forest. These streams are often only 30 – 60 feet wide and supports only narrow ribbons of riparian habitat. Further, these narrow corridors of habitat are separated from each other by miles of mountainous terrain and dry forest, likely a barrier to Preble's mouse movements (Hansen 2006). Occasionally, riparian patches with thick cover interspersed with more open areas may provide important movement corridors between dense vegetation (Bakeman and Meaney 2001).

In a comparison of existing habitat data within Preble's mouse range in Colorado, Clippinger (2002) found that subshrub cover and plant species richness are higher at most sites where meadow jumping mice are present versus where they are absent, particularly at 49 to 82 feet from streams. In a study comparing Preble's mouse capture locations on the Rocky Flats Environmental Technology Site and the Academy, the Academy sites had lower plant species richness at capture locations but considerably greater numbers of Preble's mice (Schorr 2001). It may be that the density of the Preble's mouse is not driven by the richness of plant species alone, but also by the density and abundance of riparian vegetation (Schorr 2001). However, the

Academy sites had higher densities of both grasses and shrubs. Trainor *et al.* (2007) looked at habitat use of the Preble's mouse in sites throughout Douglas County, Colorado. They found that areas with three times more grass cover than forb cover and a greater proportion of wetland shrub and grass cover were the most frequently used by the Preble's mouse.

Habitat for the Preble's mouse ranges from large perennial rivers such as the South Platte River (Armstrong 1972; Colorado Natural Heritage Program 1999b) to small ephemeral drainages only 3 to 10 feet in width such as those found at Rocky Flats Environmental Technology Site (Bakeman 1997) to montane habitats, low moist areas, dry gulches (T. Shenk, Colorado Division of Wildlife. pers. comm.), agricultural ditches (Meaney *et al.* 2003), and wet meadows and seeps near streams (Ryon 1996).

Although the Preble's mouse has rarely been trapped in uplands adjacent to riparian areas (Corn *et al.* 1995; Bakeman 1997; Dharman 2001), radiotelemetry studies have documented individuals using these habitats for feeding and resting (Schorr 2001). These studies suggest that Preble's mice use uplands at least as far out as 328 feet beyond the stream edge (Shenk and Sivert 1999b; Ryon 1999; Schorr 2001). Adjacent upland habitats used by the mouse are extremely variable, and range from open grasslands to ponderosa pine (*Pinus ponderosa*) woodlands (Corn *et al.* 1995; Pague and Grunau 2000).

Hayfields and grasslands are used by the Preble's mouse in some situations (Bakeman and Meaney 2001). Additional areas used by the Preble's mouse include shrub patches set back from the drainage (T. Shenk, Colorado Division of Wildlife, unpublished data), and downed woody debris, which creates good cover for day nests (Trainor 2004).

Preble's mice can have multiple day nests in both riparian and grassland communities (Schorr 2001), which are composed of grasses, forbs, sedges, rushes, and other available plant material (Bain and Shenk 2002). These nests may be globular in shape or simply raised mats of litter, and are most commonly above ground but also can be below ground (Ryon 2001; Bain and Shenk 2002). They are typically found under debris at the base of shrubs and trees, or in open grasslands (Shenk and Sivert 1999a; Ryon 2001; Schorr 2001). Ryon (2001) found day nests to be abandoned after approximately 1 to 3 weeks of use.

One definite and 14 possible Preble's mouse hibernacula have been located; they were all between 3 and 394 feet from a main drainage or tributary (Shenk and Sivert 1999a; R. Schorr, Colorado Natural Heritage Program, unpublished data). Hibernacula have been located under willow, chokecherry, snowberry, skunkbrush, sumac, clematis, cottonwoods, Gambel's oak, thistle, mullein, and alyssum (Shenk and Sivert 1999a).

Changes to Preble's mouse habitat can be caused by flooding events, plant succession, native and nonnative herbivory (grazing or browsing), water table fluctuations, fire, invasive noxious weeds, and other natural and human-caused impacts (Busch and Scott 1995). Further, extensive urbanization in Adams, Arapahoe, and Denver Counties, Colorado, has reduced, altered, or completely eliminated the riparian habitat needed for Preble's mouse occupancy (Ryon 1996).

Flooding and fire are common and natural events in riparian systems along the Front Range of Colorado and in Wyoming, and as a consequence, Preble's mouse habitat naturally fluctuates. These periodic natural disturbances help create a dense vegetative community by stimulating re-sprouting from willow shrubs and allowing cottonwoods, forbs and grasses to take advantage of newly-deposited soil (Schmidt 1983). Sources of the flooding can be winter snow melt and/or summer rain events. Major flooding events occurred at least once every 5 to 20 years with some of the most severe and frequent flooding events occurring within Preble's mouse habitat along the South Platte and Arkansas River drainages along the Front Range (Follansbee and Sawyer 1948).

In September 2013, Colorado's northern Front Range experienced severe flooding that resulted in significant erosion, sediment deposition, and soil removal that denuded or buried existing riparian habitat in many places. Observations in Boulder County found that patches of well-developed riparian habitat (riparian trees, shrubs and herbaceous understory) survived the flood with minimal damage, though stream reaches with quarry ponds were heavily damaged where breaches resulted in dewatered waterways and destruction of riparian habitat. Many areas with substantial erosion or sediment deposition experienced a subsequent pulse of native woody seedling establishment (e.g., *Populus* spp. and *Salix* spp.); however, many non-native species also established. In the trajectory of post-flood vegetation succession it is clear that Preble's mouse habitat will suffer without significant weed management efforts. Post-flood surveys in Boulder County detected Preble's mice in areas that, although inundated in the flood event, did not experience altered channel form or significantly damaged riparian or upland habitat. This indicates that structurally complex riparian habitat that serves Preble's mice well also serves to abate adverse flooding impacts (T. Shafer, Boulder County, pers. comm.).

Reasons for Listing and Potential Threats to Recovery

The following factors have been identified as potential threats to Preble's mouse populations and recovery. Much of the following comes from the Preble's mouse Science Team's Threat Assessment (Pague and Grunau 2000), the May 13, 1998, rule listing the mouse under the ESA (63 FR 26517), the July 10, 2008, rule amending the previous listing under the ESA (73 FR 39789), and the May 24, 2013, 12-month finding on petitions to delist the Preble's mouse (78 FR 31680).

Factor A. The Destruction, Modification, or Curtailment of the Species' Habitat or Range

Changes in habitats and their component plant communities affect the composition of the mammalian community found within them (Andersen *et al.* 1980; Honeycutt *et al.* 1981). The Preble's mouse is closely associated with riparian ecosystems that are relatively narrow and represent a small percentage of the landscape. If habitat for the Preble's mouse is destroyed or modified, populations in those areas will decline or be extirpated. Habitat fragmentation also limits the extent and abundance of Preble's mouse populations; conversely, the connectivity of habitat patches is extremely valuable in facilitating the movement of Preble's mice between different patches and components of suitable habitat. Smaller patches of habitat are unable to

support as many Preble's mice as larger patches of habitat (see Section 3, Recovery Strategies, of this Plan). If the threats to persistence are the same, larger populations are believed to be more secure from extinction than smaller ones (Primack 2002).

The decline in the extent and quality of Preble's mouse habitat is considered the main factor threatening the subspecies (Bakeman 1997, Hafner *et al.* 1998; Shenk 1998; Pague and Grunau 2000). As stated in the rule listing under the ESA (63 FR 26517), Preble's mouse populations face continued threats due to loss and fragmentation of their habitat from human land uses, including urban, suburban, and recreational development; highway and bridge construction; water development; instream changes due to increased runoff and flood control efforts; higher peak and sustained flows in urban areas leading to channel incision; sand and gravel mining; and overgrazing. These human land use activities affect the Preble's mouse by directly destroying its protective cover, nests, food resources, and hibernation sites; disrupting behavior; or acting as a barrier to movement. Since 1999, the USFWS has recommended that projects within 300 feet of the 100-year flood plain of rivers and streams, and projects that may have secondary impacts to such areas, be assessed for their potential to impact the Preble's mouse and its habitat. Factors that should also be considered, in addition to a determination of presence/absence, include the connectivity and juxtaposition of the affected area with suitable habitat.

These threats differ in magnitude in Wyoming and Colorado. For example, currently urban, suburban, and recreational development are a dominant use of Preble's mouse habitats in Colorado, while agricultural uses are a dominant use of Preble's habitat in Wyoming based on known population locations. Over time, as more areas are surveyed and more populations are detected, the locations and magnitude of these threats may change.

i. Residential and Commercial Development

Residential and commercial development has both direct and indirect impacts on Preble's mouse habitat. The direct impact of development is in the removal and alteration of habitat making it unsuitable for the Preble's mouse. Private land ownership typically follows valley bottoms, thus disproportionately impacting areas favored by the Preble's mouse (Riebsame *et al.* 1996; Theobald *et al.* 2001). Development in the plains and nearby foothills further limits downstream connectivity and fragments habitats.

The indirect effects of human settlement have resulted in declines in native trees and shrubs, greater canopy closure, increases in non-native predators and competitors, and a more open understory with reduced ground cover within riparian habitat (Miller *et al.* 2003; see Factor E vi. Secondary Impacts of Human Development, of this Plan). An open understory does not favor the Preble's mouse, which prefers dense ground cover of grasses and shrubs and is less likely to use open areas where predation risks are assumed to be higher (Trainor *et al.* 2007; Clippinger 2002).

Fragmentation is another impact of development, limiting the extent and size of Preble's mouse populations by disrupting movement throughout the habitat and reducing connectivity. As populations become fragmented and isolated, their persistence becomes more difficult (Primack

2002) due to the risks associated with demographic and environmental stochasticity, and loss of genetic diversity. On a landscape scale, maintenance of dispersal corridors linking patches of Preble's mouse habitat may be critical to the subspecies' conservation (Shenk 1998). Limited travel distances recorded for the Preble's mouse underscore the importance of continuous, interconnected suitable habitats.

There are multiple historic records from Denver and Colorado Springs, but despite numerous surveys, Preble's mouse has not recently been found in these metropolitan areas despite each having suitable habitat patches, and is believed to be extirpated as a result of extensive urban development. In recognition of the impact of urban development on Preble's mouse populations, the USFWS has established "block clearance" zones in the Denver metropolitan area, along Monument Creek through downtown Colorado Springs, and along the majority of Cottonwood Creek, El Paso County, Colorado, and its tributaries, where the Preble's mouse is no longer believed to exist and where no further surveys are needed to determine its absence.

Clippinger (2002) concluded that the likelihood of successful trapping of Preble's mouse was reduced by either low- or high density residential developments within 690 feet of the trapping sites. These data suggest that nearby development increases the risk of local extirpation of Preble's mouse from occupied sites. A study in Boulder County found that as the degree of proximity to urban environments increased, the number of small mammals captured decreased (Bock *et al.* 1998).

Due to the reasons listed above, residential and commercial development constitutes a HIGH threat to Preble's mouse populations.

ii. Transportation, Recreation, and Other Rights-of-Way through Habitat

Transportation corridors frequently cross Preble's mouse habitat and may negatively affect adjacent populations. As new roads are built and old roads are maintained, habitat can be destroyed and possibly fragmented. Roads, and other linear development features, have also been identified as partial or complete barriers to dispersal (63 FR 26517). Train and truck accidents within riparian areas may release spills of chemicals, fuels, and other substances that can impact the Preble's mouse or its habitat.

Trail systems frequently parallel or intersect riparian communities within Colorado (Meaney *et al.* 2002). The development of trail systems can impact the Preble's mouse by modifying its habitat, nesting sites, and food resources in both riparian and upland areas. Humans and pets using an area for activities such as hiking may alter activity and feeding patterns (Theobald *et al.* 1997) of Preble's mouse and cause a decrease in survival and reproductive success. Meaney *et al.* (2002) suggest fewer Preble's mice were found on sites with trails than on sites without trails.

Many utility lines (sewer, water, communications, gas, electric, municipal water ditches) cross Preble's mouse habitat. Current and future utility rights-of-way through these habitats represent a threat from habitat destruction and fragmentation from new construction and periodic

maintenance. However, utility corridors are currently short-term disturbances, due to project review and reclamation required since listing in 1998.

Due to the reasons listed above, transportation, recreation, and other rights-of-way constitute a MEDIUM threat to Preble's mouse populations.

iii. Hydrologic Changes

Establishment and maintenance of riparian plant communities are determined by the interactions between surface water dynamics, groundwater, and river channel processes (Busch and Scott 1995). Changes in hydrology can alter the channel structure, riparian vegetation, and valley floor landforms (Gregory *et al.* 1991; Busch and Scott 1995). Thus, changes in the timing and abundance of water may be detrimental to the persistence of the Preble's mouse in these riparian habitats due to resultant changes in vegetation (Bakeman 1997). Such changes in hydrology may occur in many ways, but two of the more prevalent are the disruption of natural flow regimes below dams, diversions, and alluvial wells and excessively high and excessively low runoff cycles in watersheds with increased areas of paved or hardened surfaces (Schorr 2012). Excessive runoff can result in incised channels and the elimination of woody riparian community.

Similarly, depletion of groundwater via wells and water diversion or capture affects Preble's mouse habitat by replacing riparian vegetation with more xeric plant communities. The conversion of these habitats from mesic, shrub-dominated systems to drier grass- or forb-dominated systems makes the areas less suitable for the Preble's mouse.

Bank stabilization, channelization, and other methods of hardening stream banks can increase the rate of stream flow, narrow riparian areas, and destroy riparian vegetation (Pague and Grunau 2000). As water flows are captured or diverted, or as groundwater supplies are depleted through wells, natural flow patterns are changed, and more xeric plant communities may replace the riparian vegetation. On-stream reservoirs disrupt natural sediment transport and deposition. Loss of sediment encourages channel down-cutting, which in turn affects groundwater levels (Katz *et al.* 2005). These impacts can alter plant composition, soil structure, and physiography of riparian systems to the point where Preble's mouse populations can no longer persist there.

The May 20, 2004, permanent extension of the 4(d) rule allows for normal and customary ditch maintenance activities that should result only in temporary or limited disturbance of Preble's mouse habitat, and that should result in only minimal take of the Preble's mouse. This exemption is intended to apply only to manmade ditches and not to alteration of habitat along naturally occurring streams and watercourses. This exemption not only provides relief to those who maintain active ditches, but assures that currently existing Preble's mouse habitat along ditches remains functionally intact and viable. Should limited ditch maintenance not be allowed to continue, these ditches may no longer be capable of conveying water and any habitat dependent on this water would degrade over time and eventually be lost.

Due to the reasons listed above, hydrologic changes constitute a HIGH threat to Preble's mouse populations.

iv. Aggregate Mining

Alluvial aggregate extraction may produce long-term changes to Preble's mouse habitat by altering hydrology and removing shrub and herbaceous vegetation. Often, mined pits are constructed with impervious liners and converted to steep-sided water reservoirs after aggregate is removed. This conversion reduces the riparian shoreline vegetation zone and alters adjacent groundwater flow. Armstrong speculated that mining impacts the deposits of alluvial sands and gravels that may be important hibernation locations for Preble's mice (D. Armstrong, University of Colorado, pers. comm.).

Due to the reasons listed above, aggregate mining constitutes a **MEDIUM** threat to Preble's mouse populations.

v. Oil, Gas, and Mineral Exploration and Extraction

Energy development activities have the potential to destroy and fragment habitat through exploration for and extraction of oil, natural gas, and minerals, including coal. However, the Preble's mouse range does not overlap any potential coal fields in Colorado, and overlap of coal fields is minimal in Wyoming. In Colorado, habitat is only minimally impacted by current oil and gas development areas, and, in Wyoming, much of the range of the Preble's mouse overlaps areas that represent low potential for oil and gas, and only one oil and gas field currently occurs within the Preble's mouse range in the state. Additionally, when developed, well pads tend to be placed in upland areas and infrastructure can be located to minimize potential impacts to Preble's mouse habitat. However, although oil and gas potential throughout the range of the Preble's mouse is variable, it is also widespread (Copeland *et al.* 2009) and, given the increasing demand for natural resources, is likely to lead to increased production.

Although the USFWS has previously found that oil and gas exploration and extraction are not currently threats to the Preble's mouse (78 FR 31680), due to the reasons listed above, particularly the widespread oil and gas potential within the range of the Preble's mouse, oil, gas, and mineral exploration and extraction constitutes a **MEDIUM** threat to Preble's mouse populations.

vi. Agriculture

The Preble's mouse uses native grass and alfalfa hayfields that are in or adjacent to suitable riparian habitat. Mowing of hay may directly kill or injure Preble's mouse, reduce food supply, and remove cover. Additionally, hay production close to floodplains may limit growth of willows and other shrubs that are important as hibernation habitat for the Preble's mouse. However, some Preble's mouse populations have persisted in areas hayed for many years (Taylor 1999), but it is unclear if populations have been altered. Haying operations that allow dense riparian vegetation to remain in place are likely compatible with persistence of Preble's mouse populations.

Compton and Hugie (1993) found that human activities, including conversion of grasslands to farms and livestock grazing had adversely impacted the Preble's mouse. They also concluded that development of irrigated farmland had a negative impact on Preble's mouse habitat and that any habitat creation it produced was minimal (Compton and Hugie 1993). However, overall loss of habitat to farmland is minimal and haying practices have been shown to be compatible and occasionally beneficial for Preble's mouse populations (Taylor 1999); consequently, ongoing agricultural practices are covered under the 4(d) rule (69 FR 29101).

Although the USFWS has previously found that agriculture is not currently a threat to the Preble's mouse (78 FR 31680), due to the reasons listed above, particularly for agricultural practices that are incompatible with Preble's mouse populations, agriculture constitutes a LOW threat to Preble's mouse populations.

vii. Livestock Grazing

Impacts to riparian habitat from poorly managed livestock are well documented in the scientific literature (Kauffman and Krueger 1984; Armour *et al.* 1991; Fleischner 1994; Belsky *et al.* 1999; Freilich *et al.* 2003). Adverse impacts of overgrazing include changes to stream channels (downcutting, trampling of banks, increased erosion), flows (increased flow and velocity, decreased late-season flow), and vegetation (loss to grazing, trampling, altered hydrology) (Kauffman and Krueger 1984). Such impacts from cattle grazing to other jumping mice have been documented by Frey (2005), Giuliano and Homyack (2004), and Medin and Clary (1989). Ryon (1996) cited livestock grazing as a contributor to the lack of structural habitat diversity he observed on historical Preble's mouse sites. On a working ranch in Douglas County, Preble's mice were detected within cattle exclosures, but not on grazed areas. Trapping conducted prior to construction of the cattle exclosures documented the Preble's mouse upstream and downstream, but not on the ranch (Ensign Technical Services 2004). Further, Boulder County Parks and Open Space created six cattle exclosures along stretches of the South Branch of the St. Vrain Creek and restored the areas with native forbs and shrubs. Six years later, trapping surveys detected Preble's mice in four of the six exclosures, where vegetation was taller and more diverse than in the surrounding grazed areas (BCPOS 2015).

Alternatively, when grazing has been managed at appropriate levels, populations of the Preble's mouse have been documented on sites with a long history of grazing. For example, jumping mice were trapped at 18 of 21 sites on True Ranches properties (mice from 14 of these sites have since been confirmed as Preble's mouse (King *et al.* 2006a)), primarily within sub-irrigated hay meadows that have been subjected to livestock grazing and hay production for approximately 100 years (Taylor 1999). Grazing and haying, used as land management tools, continue on Boulder County Open Space sites currently supporting the Preble's mouse. In their study of small mammals on Boulder County Open Space, Meaney *et al.* (2002) found no adverse effects of limited grazing on abundance of individual small mammal species or on species diversity. As suggested by Bakeman (1997) and Pague and Grunau (2000), and as supported by the examples above, grazing is compatible with Preble's mouse when timing and intensity are appropriately managed; consequently, ongoing grazing is covered under the 4(d) rule (69 FR 29101).

Due to the reasons listed above, livestock grazing constitutes a LOW threat to Preble's mouse populations.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The Preble's mouse is not collected for commercial or recreational reasons. Some collection of specimens has occurred for scientific and educational purposes, but only through permits issued by the USFWS, Colorado Parks and Wildlife (CPW), and Wyoming Game and Fish Department (WGFD). Although unintentional mortalities have resulted from capture and handling of Preble's mice by permitted researchers, the USFWS has concluded that the level of take associated with this activity does not rise to the level that would affect populations of the Preble's mouse.

Due to the reasons listed above, overutilization for commercial, recreational, scientific or educational purposes DOES NOT constitute a threat to Preble's mouse populations.

Factor C. Disease or Predation

i. Disease

As with most small mammals, the Preble's mouse carries parasites and diseases that may reduce vigor, curtail reproductive success, and cause death. There is no evidence that any disease has caused a significant impact to Preble's mouse populations. Schorr and Davies (2002) documented the first case of a Preble's mouse parasitized by a grey flesh fly (*Wohlfahrtia vigil*); the Preble's mouse was later euthanized due to the infection. Between 1998 and 2003, Ruggles (2003) documented 18 animals with unexplained alopecia (hair loss) in the South Boulder Creek floodplain; molting, fleas, mites, fungus, and general skin irritation were ruled out in all cases.

Due to the reasons listed above, disease DOES NOT constitute a threat to Preble's mouse populations.

ii. Predation

Predation is a natural occurrence in Preble's mouse populations and would not normally be considered a threat. However, the increasing presence of humans near Preble's mouse habitats may result in an increased level of predation that may pose a threat to the mouse. Striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), red foxes (*Vulpes vulpes*) and domestic and feral cats (*Felis catus*) are found in greater densities in and around areas of human activity and all of these species feed opportunistically on small mammals (Churcher and Lawton 1987; Rosatte *et al.* 1991). Therefore, Preble's mouse populations that are near suburban settings likely are subjected to greater predation. The predation pressure from domestic cats can be particularly difficult to mediate since these predators will hunt regardless of their need to sustain themselves (Adamec 1976). Introduction of non-native aquatic species, such as bullfrogs, has resulted in additional predation on the subspecies (Trainor 2004 and T. Shenk, Colorado Division of Wildlife, pers. comm.). The fact that summer mortality is higher than overwinter mortality, as

discussed under *Longevity and Mortality*, underscores the impact that predators can have on the Preble's mouse and other small mammals.

Due to the reasons listed above, predation constitutes a LOW threat for Preble's mouse populations, but is likely most pronounced in those areas with a high abundance of human-associated predators.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

Various federal, state, and local regulations have the potential to impact Preble's mouse status and habitat. The USFWS found that, even though many of these regulations currently provide some protections for the Preble's mouse, it is not ensured that those protections will continue after delisting of the subspecies.

Federal laws that provide some protections for the Preble's mouse and its habitat include the Clean Water Act (33 U.S.C. 1251 et seq.), the Sikes Act Improvement Act of 1997 (16 U.S.C. 670a et seq.), the National Forest Management Act (16 U.S.C. 1600 et seq.), and the Federal Land Policy and Management Act (43 U.S.C. 1701 et seq.). Sections 404 and 303 of the Clean Water Act (CWA) provide protections to some of the habitat needed by the Preble's mouse. Section 404 generally requires avoidance, minimization, and mitigation of adverse impacts to jurisdictional wetlands and waters of the United States. These protections do not extend to non-jurisdictional riparian and upland areas that may be used by the Preble's mouse. Section 303 establishes water quality and Total Maximum Daily Load standards through the states. These standards can lead to the creation of watershed plans, which in turn may provide some protections to riparian areas. In general, watershed plans are not mandatory and do not cover the entire range of the Preble's mouse. Thus, the CWA provides only limited protection to the habitats of the Preble's mouse and is not capable of substantially reducing threats to the subspecies.

Federal lands provide some protections to the Preble's mouse and its habitat through the Sikes Act Improvement Act, the National Forest Management Act, and the Federal Land Policy and Management Act. Currently, the Preble's mouse is found on the following federal lands – the Medicine Bow/Routt National Forests/Thunder Basin National Grassland, the Arapaho/Roosevelt National Forests/Pawnee National Grassland, the Pike/San Isabel National Forests/Cimarron/Comanche National Grasslands, the U.S. Air Force Academy, and the Rocky Flats National Wildlife Refuge. The Land and Resource Management Plans (LRMP) for these National Forests/Grasslands contain standards and guidelines that pertain to the Preble's mouse and its habitats in various contexts. Only the LRMP for the Medicine Bow National Forest contains standards and guidelines specific to the Preble's mouse. All of the LRMPs contain standards and guidelines applicable to riparian habitats. These standards and guidelines are designed to manage for healthy functional riparian systems. Much of the current protections on these properties would likely remain after delisting of the Preble's mouse.

The Preble's mouse also receives some protection throughout the listed range due to USFWS-approved Habitat Conservation Plans (HCPs). HCPs are set up to provide private, local, and

state land managers with incidental take permits, which require management measures that protect, restore, and enhance the habitat for the Preble's mouse. HCPs are voluntary in nature and may be terminated by the permittees. There is also a Preble's mouse Conservation Bank in Castle Rock, Colorado that was approved after successful hydrologic restoration of East Plum Creek.

CPW currently lists the Preble's mouse as Threatened in Colorado, as well as a non-game species and a Tier 1 Species of Greatest Conservation Need under the Colorado State Wildlife Action Plan. Non-game designation requires that personnel obtain a permit to legally take Preble's mouse in Colorado. The Preble's mouse is classified as a Tier II Species of Greatest Conservation Need in Wyoming. Additionally, the WGFD classifies all meadow jumping mice (*Zapus hudsonius*) as "nongame species," which are protected under the Wyoming Game and Fish Commission (1998) Nongame Wildlife Regulations and thus require state permits for take for scientific and educational purposes. There are also numerous lands protected by state, local and private conservation organizations that provide Preble's mouse habitat. Finally, Preble's mouse research and habitat protection can receive funding through various state and federal programs.

Existing regulatory mechanisms at the local level provide limited protections to Preble's mouse and its habitat. Many local jurisdictions require land development proposals to be reviewed for impacts to wildlife, wetlands, and other natural habitats, but have no mandatory measures requiring avoidance or mitigation of impacts. These regulations seldom deal specifically with the Preble's mouse. It is also unlikely that these regulations effectively control land uses, such as grazing, mowing, or burning, that may have secondary effects on Preble's mouse habitat. However, the 4(d) rule exempts certain activities, such as rodent control, ongoing agricultural activities, ongoing ditch maintenance, landscape maintenance, existing water uses and weed control (69 FR 29101).

Due to the reasons listed above, the lack of adequate existing regulatory mechanisms constitutes a MEDIUM to HIGH threat to Preble's mouse populations.

Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence

i. Floods

Flooding is a natural component of the Colorado and Wyoming foothills and plains where the Preble's mouse is found. Flood events are believed to impact Preble's mouse populations and their habitat, though these impacts may be temporary if the flood event is not frequent or severe. Flooding may also provide benefits to Preble's mouse by maintaining the vegetative communities that provide suitable habitat by developing habitat heterogeneity and regenerating native vegetation. An increase in impervious surfaces and denuding of vegetation caused by human activity can result in increased frequency and severity of flood events and prevent the re-establishment of riparian communities (Schorr 2012). In September 2013, stochastic flash floods adversely affected Preble's mouse populations, riparian and upland habitats, and designated critical habitats in Larimer, Boulder, Jefferson, Weld, and El Paso Counties, Colorado. By

scouring vegetation, removing topsoil, and depositing erosion and debris, early estimates suggest that the flood disaster affected approximately 60 percent of the Preble's mouse overall range and approximately 70 percent of its designated critical habitat in Colorado (USFWS 2014).

The flash floods may have significantly decreased Preble's mouse populations throughout the flood disaster zone by drowning mice and destroying habitats. After the floods, Preble's mice that escaped drowning by dispersing upslope likely encountered reduced forage, less cover, and increased predation, especially in habitats previously fragmented by urban or agricultural development.

These surviving Preble's mice may have been unable to accumulate sufficient fat stores or locate suitable hibernacula before winter, increasing overwintering mortality and contributing to population declines. Furthermore, the flash floods likely affected the subspecies' distribution if mice that dispersed or were washed downstream survived. Finally, recovery from the floods will be slow and it may take many years for the streamside habitats impacted by the floods to revegetate sufficiently to support Preble's mouse populations. Trapping surveys, habitat evaluations, and other techniques will be necessary to gauge the full effect of the flood on Preble's mouse populations and distribution in Colorado. As indicated by the flooding that has occurred in Colorado, increased flood severity has the potential to eliminate an entire Preble's mouse population, especially if the impacted population is small and isolated.

The compound impacts of alternating extremes in flooding and drought can exacerbate Preble's mouse habitat degradation. For example, frequent, extreme flooding can incise floodplains, creating cutbanks and lowering the water table. When such events are followed by drought that desiccates soils and further reduces stream flows, riparian vegetation may be too removed from the hydrology that once supported it to flourish. The two extremes in hydrologic events work to create inhospitable conditions for the riparian habitat that would support the Preble's mouse.

Due to the reasons listed above, floods constitute an UNKNOWN threat to Preble's mouse populations, although the impacts of floods are likely VARIABLE.

ii. Wildfire

Fire is a natural component of the Colorado Front Range and Wyoming foothill systems, and Preble's mouse habitat naturally adjusts with fire events. Overall, fire may be one of the methods needed to maintain riparian, transitional, and upland vegetation within Preble's mouse habitat. In a review of the effects of grassland fires on small mammals, Kaufman *et al.* (1990) found a positive effect of fire on meadow jumping mice in one study and no effect of fire on the species in another study. An additional report found that approximately 4 months after a fire at the Rocky Flats Environmental Technology Site, two adult Preble's mice were captured in a trap located approximately 6 feet from a burn area and another adult was observed within the burned area itself (DOE 2003). Upland fire adjacent to Preble's mouse populations appeared to have no impact on populations at the Academy (R. Schorr, CNHP, pers comm.; B. Muhlbachler, USFWS, pers comm.).

As human presence has increased in and near Preble's mouse habitat, significant effort has been made to suppress fires. Long periods of fire suppression may result in a build-up of fuel and result in a catastrophic fire such as the 2002 Hayman Fire in portions of Douglas, Jefferson, Park, and Teller Counties, which burned approximately 138,000 acres, including 100 stream miles and approximately 73 acres of potential Preble's mouse habitat. Although there are no records of fire killing a Preble's mouse, it is possible that fire may take a limited number of individuals. Catastrophic fire in particular can alter habitat dramatically, changing the structure and composition of the vegetation communities such that Preble's mice may no longer persist. Precipitation falling in a burned area may degrade Preble's mouse habitat by causing greater levels of erosion and sedimentation along creeks, as seen in drainages within and downstream of the Hayman Fire.

Although the USFWS has previously found that wildfires continue to be a threat to the Preble's mouse (78 FR 31680), due to the reasons listed above, particularly the importance of wildfires to the system as a whole and differing effects on Preble's mice depending on wildfire severity, wildfire constitutes an UNKNOWN threat to Preble's mouse populations, and the impacts are likely VARIABLE depending on the scope and severity of fires.

iii. Drought

Drought may be another factor that can have a negative effect on the Preble's mouse. Drought lowers stream flows and the adjacent water table, in turn impacting riparian habitat on which the Preble's mouse is dependent. Frey (2005) found that drought had a major influence on the status and distribution of the New Mexico meadow jumping mouse (*Z. h. luteus*) in New Mexico. In 2002, a year with regional drought conditions, Bakeman (2006) failed to capture Preble's mice at two sites where substantial populations had previously been documented. Conversely, at the Academy precipitation did not predict seasonal and annual survival (Schorr 2012). While Preble's mouse populations have coexisted with periodic drought, significant increase in frequency or severity of drought could impact the persistence of small, isolated populations.

As mentioned in Section E i. *Floods* (above), the compound impacts of alternating extremes in drought and flooding can exacerbate Preble's mouse habitat degradation. For example, frequent, extreme flooding can incise the stream channel and lower the water table. When such events are followed by drought that desiccates soils and further reduces stream flows, riparian vegetation may be too removed from the hydrology that once supported it to flourish. The two extremes in hydrologic events work to create inhospitable conditions for the riparian habitat that would support the Preble's mouse.

Due to the reasons listed above, drought constitutes a MEDIUM threat to Preble's mouse populations.

iv. Nonnative Plants

Invasive, noxious plants can encroach upon a landscape; displace native plant species, from monocultures of vegetation, and negatively impact cover and food for the Preble's mouse. The

control of noxious weeds may entail large-scale removal of vegetation and mechanical mowing operations, which also may impact the Preble's mouse. The tolerance of the Preble's mouse for invasive plant species is not well understood. Leafy spurge (*Euphorbia esula*) may be of particular concern, since it can form a monoculture, displacing native vegetation and thus reducing available habitat (Selleck *et al.* 1962). Diffuse knapweed (*Centaurea diffusa*), in combination with Canada thistle (*Cirsium arvense*), common mullein (*Verbascum thapsus*), moth mullein (*V. blatteria*), and downy brome (*Bromus tectorum*), has degraded riparian areas at Rocky Flats (J. Nelson, Navarro, pers. comm.). Within Larimer and Weld Counties of Colorado, Russian olive (*Elaeagnus angustifolia*) occurred in six (33 percent) of the areas where no jumping mice were found, while it was absent in areas where jumping mice were captured (Shenk and Eussen 1999). However, Russian olive was present in Wyoming sites where jumping mice were captured (R. Taylor, True Ranches, pers. comm.).

Although the USFWS has previously acknowledged the lack of information to conclude that nonnative plants are a threat to the Preble's mouse (78 FR 31680), due to the reasons listed above, particularly the potential for reduction in or total replacement of native vegetation, nonnative plants constitute a LOW threat to Preble's mouse populations.

v. Pesticides and Herbicides

It remains unknown to what extent Preble's mouse populations are affected by point and non-point source pollution (sewage outfalls, road de-icers, spills, urban, or agricultural runoff) that degrades water quality in their habitat. From an examination of their kidney structure, Preble's mice likely must drink free water, and are not able to meet their water requirements metabolically (Wunder 1998). It is unclear however, whether the pesticides and herbicides commonly used in the range of the Preble's mouse have any direct or indirect effects on the populations or their habitat.

Due to the reasons listed above, pesticides and herbicides constitute an UNKNOWN threat to Preble's mouse populations and likely require further evaluation.

vi. Secondary Impacts of Human Development

Introduced animals associated with human development may displace, prey upon, or compete with the Preble's mouse. Domestic cats have been found to prey upon the Preble's mouse in Colorado (Shenk and Sivert 1999a). Feral cats and house mice (*Mus musculus*) were common in and adjacent to historic capture sites where Preble's mice were no longer found (Ryon 1996). While no cause-and-effect relationship was documented, the Preble's mouse was 13 times less likely to be found at sites where house mice were present (Clippinger 2002).

Human development may also lead to secondary impacts due to increased human presence, noise, increased lighting, and the degradation of air and water quality. These secondary impacts may interact with and result from other threats identified in this section.

Due to the reasons listed above, secondary impacts of human development constitute a MEDIUM threat to Preble's mouse populations.

vii. Instability of Small Populations

Colorado's State Wildlife Action Plan lists "scarcity" as a threat to the Preble's mouse that may lead to inbreeding depression (CDOW 2006). Small populations can be threatened by stochastic, or random, changes in a wild population's demography or genetics (Brussard and Gilpin 1989; Primack 2002). A stochastic demographic change such as a skewed age or sex ratio (e.g., a loss of adult females) can negatively affect reproduction, especially in a small population. Isolation of populations may disrupt gene flow and create unpredictable genetic effects that could impact Preble's mouse persistence in a given area. While stochastic events are not known to be an immediate threat to Preble's mouse populations, the tendency for Preble's mouse numbers to vary widely over time heightens concern for small and isolated populations.

Due to the reasons listed above, the instability of small populations constitutes a MEDIUM threat to Preble's mouse populations.

viii. Interspecific Competition

The relative ranges, abundances, and relationship between the Preble's mouse and the western jumping mouse are not yet clearly understood. In Wyoming, Preble's mouse and western jumping mouse ranges overlap substantially, and individuals of both species have occasionally been captured during the same survey session (Cudworth and Grenier 2014). It is unknown whether western jumping mice are actively competing with Preble's mice, affecting Preble's mouse population size, and possibly limiting distribution, or if the general lack of coexistence is unrelated to their interaction. More research is needed on the interactions with other native rodent species, such as meadow vole and deer mouse and the impacts of their high dietary overlap (Boonstra and Hoyle 1986, Duesser and Porter 1986, Schramm and Clover 1994, Schorr 2012). Interspecific competition is a natural occurrence and likely most pronounced when populations of other native rodents increase in response to habitat or other changes but does not constitute a threat under normal conditions.

Due to the reasons listed above, interspecific competition DOES NOT constitute a threat to Preble's mouse populations.

ix. Global Climate Change

The USFWS's latest 12-month finding (78 CFR 31680) provides an updated general global climate change discussion and potential global climate change impacts to the Preble's mouse. The 12-month finding is provided herein by reference. In summary, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that greenhouse gas emissions (GHG) will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced

substantially by the extent of GHG emissions. Based on climate records and projections for western North America, Wyoming and Colorado, climate models predict a trend of continued warming, with hotter summers, warmer winters, decreased snowpack, earlier spring melts, increased evaporation, more droughts, and reduced summer flows throughout the Preble's mouse's range. Some models predict increases in heavy rainfall events; the projections for Colorado are less certain (Western Water Assessment 2013). Overall, climate change may decrease the quality and quantity of some the subspecies' riparian habitats, and as a result, the Preble's mouse is especially vulnerable when faced with the projected changes in a changing climate. Therefore, the effects of climate change are a threat to Preble's mouse (Pocewicz *et al.* 2014).

Overall, climate change may decrease the quality and/or quantity of the Preble's mouse's riparian habitats, and as a result, the Preble's mouse is vulnerable when faced with the expected changes in climate. Please see Factor E, Section i. *Floods* and iii. *Drought* (above) for more details on how extremes in hydrologic events, such as those that might accompany climate change, can work to degrade Preble's mouse habitat.

Although the USFWS has previously found that the effects of climate change are a threat to the Preble's mouse (78 FR 31680), due to the reasons listed above and particularly the difficulty in predicting small-scale, localized impacts, global climate change constitutes an UNKNOWN threat to Preble's mouse populations.

Management and Conservation Efforts

Starting in the early 1990s, federal, state, local, and private groups have conducted research, managed habitat, and developed conservation plans. These efforts form the basis for the listing of the subspecies and development of this Recovery Plan.

Research

Research efforts for the Preble's mouse increased in the early 1990s. Research conducted by numerous independent researchers was compiled by Bakeman (1997) into one document that provided the state of knowledge on Preble's mouse habitat. Research also was conducted by Bruce Wunder of Colorado State University to help clarify the physiology of the Preble's mouse (Wunder and Harrington 1996; Wunder 1998). Many presence/absence surveys contributed to knowledge of the subspecies' distribution and can be found at USFWS offices, CPW offices, WGFD offices, Colorado Natural Heritage Program, and Wyoming Natural Diversity Database. Recent research has focused on population demographics at a number of different sites (White and Shenk 2000). Other studies include the impact of recreational trails (Meaney *et al.* 2002), morphometric analyses (Conner and Shenk 2003b), radio-telemetry studies of movement patterns (Dharman 2001; Ryon 1999; Shenk and Sivert 1999a; Schorr 2001), and nest descriptions (Ryon 2001; Bain and Shenk 2002). The effects of transportation projects on Preble's mouse habitat and populations were investigated at sites in El Paso and Douglas

Counties (Ensign Technical Services 1999, 2001a). Most of the information gathered through this research appears in the Background Section of this Plan.

In 2005, a genetics and morphometrics study proposed synonymizing Preble's mouse with two adjoining subspecies (*Z. h. campestris* and *Z. h. intermedius*) (Ramey *et al.* 2005). In early 2006, a study (King *et al.* 2006) found no evidence to support this conclusion and instead found strong genetic support for the Preble's subspecies as described by Krutzsch (1954). A September 2013 publication in *Molecular Ecology* further evaluated the genetic relationship between jumping mice, including the Preble's mouse (Malaney and Cook, 2013). While the two previous studies (Ramey *et al.* 2005; King *et al.* 2006) evaluated 5 adjoining subspecies, this study broadly evaluated the entire *Zapus* genus, including all 12 subspecies of meadow jumping mice (*Z. hudsonius*). This study confirmed that the Preble's mouse is distinct from neighboring subspecies that were previously proposed to be taxonomically synonymized (*Z. h. campestris* and *Z. h. intermedius*) (Malaney and Cook, 2013). However, the study concludes that the Preble's mouse is closely related to two meadow jumping mouse subspecies that are found in Alaska and Canada (*Z. h. tenellus* and *Z. h. alascensis*), which the study refers to as the "northern lineage" of meadow jumping mice (Malaney and Cook 2013). Although the study suggests that the Preble's mouse is genetically similar to two subspecies of jumping mice found in Alaska and Canada, it does not propose to revise the formal taxonomy of Preble's mouse or any of the other subspecies of jumping mice (Malaney and Cook 2013).

Research has also been conducted on the impacts of severe flooding in Preble's mouse habitat. Studies conducted by the Boulder County Parks and Open Spaces division have collected presence/absence data, habitat data (following the Ruggles *et al.*'s (2004) Preble's mouse habitat monitoring protocol), and mark-recapture population data.

Habitat Conservation and Restoration

In Colorado, conservation of Preble's mouse populations and conservation and restoration of their riparian habitats have occurred through land easements and other acquisitions by non-governmental organizations, public agencies, and private landowners. Examples of habitat improvements include restoration of groundwater levels and connectivity on 0.54 miles of Preble's mouse habitat on East Plum Creek, Douglas County, as well as additional restoration on Cherry Creek in Douglas County; protection of approximately 120 acres of riparian and adjacent upland habitats in El Paso County; and protection and management of 13.5 miles of stream on the Academy in El Paso County. Further, Community Development Block Grant-Disaster Recovery funds were used for stream restoration planning, Federal Emergency Management Agency flood recovery funding was used for stream restoration, including habitat features in some cases, Natural Resource Conservation Service-Emergency Watershed Program funding were used for implementation of stream restoration that involved significant planting, and a CPW Wetlands grant was used for restoration of Preble's mouse habitat (associated with a fish passage project, not flood recovery directly). In addition, protection and management of 1,227 acres of habitats on the Rocky Flats National Wildlife Refuge in Jefferson County will benefit the species.

In addition, we have approved 22 single-species HCPs for the Preble's mouse, all in Colorado. These 22 HCPs and their associated permits allow approximately 696 acres of permanent or temporary impacts to Preble's mouse habitat in exchange for the preservation and enhancement of habitats. For example, the HCP for Douglas County and the Towns of Castle Rock and Parker allows impacts of up to 430 acres, in exchange for the acquisition of 15 miles of stream (1,132 acres of habitat) acquired and preserved for the long-term benefit of the Preble's mouse.

Recovery

The recovery planning approach is based upon the assumption that if specific criteria are met for certain existing populations, the Preble's mouse can be delisted. These criteria require that populations are maintained in designated habitats distributed throughout the existing range, the populations and habitats are secure from decline due to the threats listed above, the populations are self-sustaining and persistent, a long-term management plan and cooperative agreement is completed, and there is effective public involvement.

When the recovery criteria are met, it is anticipated that protection of the subspecies under the ESA will no longer be necessary. The decision on whether to delist will be made by the USFWS after analysis of the five ESA listing factors (destruction of habitat, overutilization, disease or predation, inadequacy of existing regulatory mechanisms, and other natural or manmade factors affecting the subspecies' persistence).

It is believed that there are adequate numbers and distributions of Preble's mouse populations present today to allow recovery of the subspecies; however, many of these populations face threats to their persistence. Further analysis of the extent and stability of these populations, as well as management of the threats to habitat, is needed to achieve recovery. Consequently, this Recovery Plan focuses on abating threats and promoting habitat persistence.

Throughout the development of this Recovery Plan, the following Guiding Principles and Recovery Strategies have been employed.

Guiding Principles

The recovery team found the following principles to be useful in the development of this Plan. These Guiding Principles ensured that the team members remained focused on the long-term success of this Plan and ultimate recovery of the Preble's mouse. These principles are also intended to guide the recovery activities necessary to implement this Plan and are expanded upon further in the remainder of this Plan.

1. Achievability

This Recovery Plan should be an achievable document that will feasibly lead to recovery of the Preble's mouse in a meaningful time frame.

2. Research

Many important aspects of Preble's mouse ecology and management are not known. Thus, continuing research in conjunction with adaptive management is crucial.

3. Monitoring and Adaptive Management

Designated Preble's mouse recovery populations and habitats will be monitored for a period of time that will be determined by the approved Population and Habitat Monitoring Methodologies. The results of such monitoring efforts and their implications will be evaluated within an adaptive management framework, and the management goals will be modified accordingly. Any modifications will be vetted through and agreed upon by state and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation by the USFWS. This process will continue until management efforts allow the achievement of self-sustaining populations. Unless scientific evidence points to the contrary, the recommended initial management strategy for each area occupied by the Preble's mouse is to continue the existing land uses at current levels.

Timeline for Preble's mouse Population Monitoring

The temporal scale for how long Preble's mouse populations should be monitored requires an understanding of the expected cyclical patterns, if any, that are inherent to Preble's mouse populations. In a 7-year study to assess Preble's mouse survival and population growth at the Academy in Colorado Springs, Colorado, most of the parsimonious models of survival included cyclical patterns of 2 and 3 years (Schorr 2012), which appear to translate into an approximate 1-year time lag in abundance (Figure 3, Schorr, unpublished data).

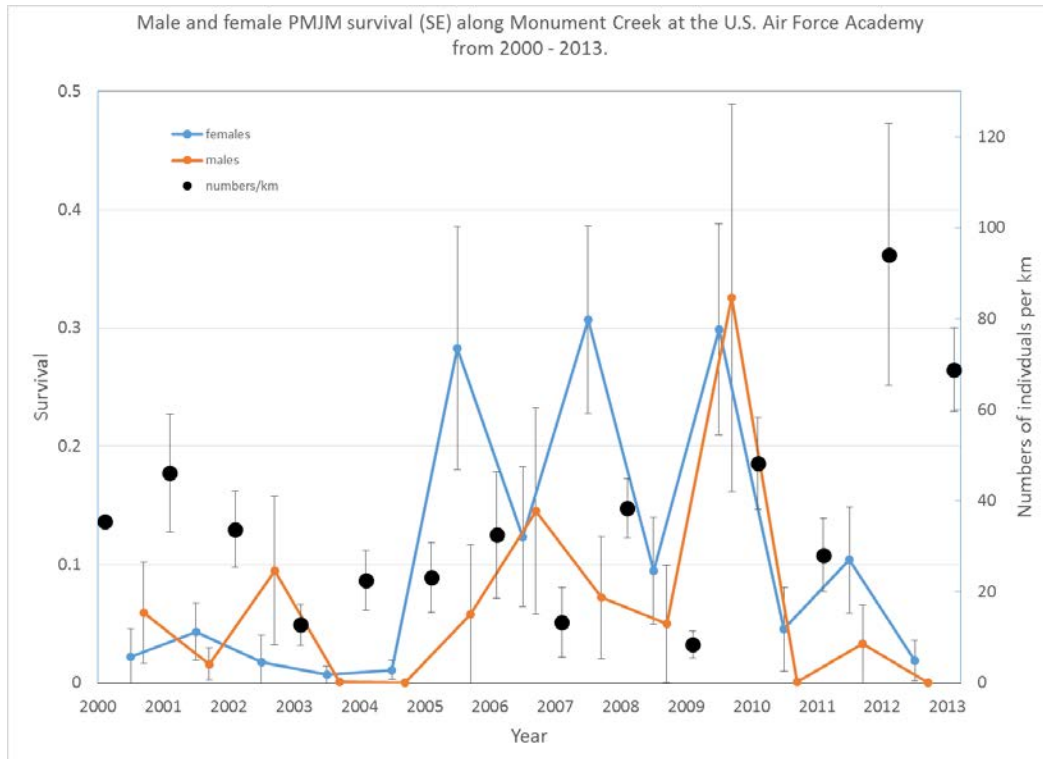


Figure 3. Male and female survival (\pm SE) and annual abundance (numbers of individuals per stream kilometer (km)) of Preble's mice along Monument Creek at the Academy from 2000 - 2013.

The geometric mean of annual survival (S) for Preble's mouse during the 7-year analysis at the Academy was 0.10 ± 0.05 SE. Expected lifespan ($l = -1/(\ln S)$) for Preble's mouse based on this survival estimate is 0.43 year or approximately 5.2 months. Using the upper 95 percent confidence interval of the estimate of survival, lifespan would be 0.62 year or 7.4 months. These estimates of lifespan reflect a low survival rate for a small mammal with a host of natural and non-native forms of mortality. However, there are exceptions to the expected low lifespan with some individuals being capture 4 years since original marking (3 years old) (Schorr, pers. comm.)

Given the short lifespan and the few instances of lifespan in excess of 2 years, it is likely that monitoring Preble's mouse populations for 10 years will elucidate multiple occasions of peak and trough in population abundance. A span of 10 years will likely include at least 3 Preble's mouse lifespans, and may include as many as 5 lifespans that would show cyclical patterns in Preble's mouse populations. Such a span of time should allow estimates of population decline or increase at local areas, given enough sampling and sample size to estimate parameters well.

The results of such monitoring efforts and their implications will be evaluated within an adaptive management framework, and the management goals will be modified accordingly. Any modifications will be vetted through and agreed upon by state and federal management agencies

responsible for Preble's mouse recovery prior to acceptance and implementation by the USFWS. This process will continue until management efforts allow the achievement of self-sustaining populations. Unless scientific evidence points to the contrary, the recommended initial management strategy for each area occupied by the Preble's mouse is to continue the existing land uses at current levels.

4. Local Involvement

The Plan encourages all aspects of local involvement, particularly by those entities that own or manage lands on which Preble's mouse populations may exist. Examples of entities that should be involved with the recovery of the Preble's mouse include state wildlife management agencies, state park and natural resource agencies, state land boards, county and city open space programs, public water boards, water conservation districts, private landowners, non-governmental organizations, other elements of federal, state, county, and local governments, and other interested parties.

5. Cooperative Management

Numerous agencies, landowners, and organizations (listed above) have responsibility for lands that contain Preble's mouse habitat. These entities need to continue to be involved in recovery efforts, and cooperative management will be fostered wherever possible.

6. Incentives

Incentives should be developed to encourage participation, build partnerships, and foster cooperation with recovery efforts. These can include incentives at the federal, state, or county level to encourage active conservation measures on private lands, or the establishment of a recognition system for participation in recovery programs.

7. Education Programs

The Preble's mouse is an indicator of healthy riparian habitat. Preserving these landscapes also preserves ecological processes and services such as high biodiversity, aquifer recharge, and carbon storage. Education programs that focus on Preble's mouse populations and habitat protection can benefit recovery objectives. Education programs are encouraged, and should focus on the loss of habitat near urban centers. Educational messages should also describe what funding sources are available to implement this Recovery Plan.

Goal and Objectives

The goal of this Recovery Plan is to remove the Preble's meadow jumping mouse from the federal list of Endangered and Threatened Wildlife (50 CFR 17.11). The Recovery Plan's objectives are:

1. To ensure long-term persistence of multiple self-sustaining populations across the geographic range of the subspecies;
2. To conserve sufficient habitat to support these populations;
3. To reduce known threats to the extent possible;
4. To develop and distribute educational materials on the natural history of the Preble's mouse, its habitat requirements, funding opportunities for habitat protection projects, and appropriate management guidelines for the subspecies and its habitat.

Recovery Strategy

As described in the USFWS' recovery planning guidance (NMFS and USFWS 2010), the recovery strategy provides "a logical construct that identifies the assumptions and logic underlying the selection of one path over another to achieve the objectives and goal." Thus it constitutes the framework linking key facts and assumptions about the subspecies' biology, threats, and environmental constraints with the recommended recovery actions.

The major threats and constraints affecting the Preble's mouse, as stated in the rule listing the mouse under the ESA (63 FR 26517), include habitat alteration, degradation, loss, and fragmentation resulting from urban development, flood control, water development, agriculture, and other human land uses, which have adversely impacted Preble's mouse populations. Strategically, these issues can be reduced to two overriding concerns: loss, degradation and fragmentation of habitat and the instability of small/isolated populations. Therefore, while our recovery strategy for the Preble's mouse broadly addresses threats abatement, population management, research, and monitoring, our recovery criteria are designed specifically to meet objectives (outlined in the following section) for reducing negative impacts associated with habitat loss, degradation, and fragmentation and small/isolated populations. Throughout, we emphasize either conserving self-sustaining populations within dispersed population units that represent the genetic diversity necessary to provide adaptive flexibility and avoid inbreeding, or conserving multiple population sources in a dynamic ecosystem subject to unpredictable stochastic events such as floods or wildfires.

In the development of the Recovery Plan, the following processes were developed to implement this strategy:

1. Establishing Site Conservation Teams

Site Conservation Teams will help guide and implement this Plan at the local level. They will be formed from a wide range of stakeholders, including federal, state, and local agencies, as well as private landowners. The Preble's mouse Site Conservation Teams may work with more than one designated recovery population, and could be closely tied to existing Habitat Conservation Plan groups. Site Conservation Teams will develop Site-specific Threat Abatement Plans. The Recovery Team and the USFWS will take the lead in establishing the Site Conservation Teams.

2. Establishing Recovery Units

A Recovery Unit is a special unit that is geographically identifiable and is necessary to conserve genetic robustness, demographic robustness, and important life history stages of the Preble's mouse. Recovery Units were selected to represent the full range of the subspecies and provide for redundancy and resiliency within and between units. Because the Preble's mouse populations north and south of the Denver metro area are isolated from each other, genetic composition of the subspecies has been documented (King *et al.* 2006a) as different, and the threats in each of these areas differ in type and intensity, the Preble's mouse will be most effectively managed by considering them separately. To ensure conservation of the breadth of Preble's mouse genetic variability and to protect the current population and habitat distribution, the populations north of the Denver metro area will be managed as the North Recovery Unit and the populations south of the Denver metro area will be managed as the South Recovery Unit. Both Recovery Units are important to the long-term sustainability of the subspecies, so recovery will be final when both Recovery Units meet the criteria established in this Plan.

3. Selecting Hydrologic Unit as the Scale for Recovery

Because the Preble's mouse is a riparian-associated subspecies, river drainages provide an appropriate geographic scale and unit for addressing its conservation. Species well-distributed across their historic range are less susceptible to extinction and more likely to reach recovery than species confined to a small portion of their range (Abbitt and Scott 2001). Distributing populations throughout different drainages reduces the risk that a large portion of the range-wide population will be negatively affected by any particular natural or anthropogenic event at any one time. Spreading the recovery populations across hydrologic units throughout the range of the subspecies also preserves the greatest amount of the remaining genetic variation and may provide some genetic security to the range-wide population.

Disjunct or peripheral populations have often diverged genetically from central populations due to isolation, genetic drift, adaptation to local environments, or some combination of these factors (Lesica and Allendorf 1995). Therefore, conservation of these outlying populations protects genetic diversity. Data on endangered mammals also show that many species have declined from the centers of their ranges outward, which also suggests that protecting both central populations and those more widely distributed is important (Lomolino and Channell 1995).

To address these conservation issues, hydrologic units (corresponding to stream or watershed size) were selected as the basis for determining appropriate locations for the recovery populations. The United States is divided and sub-divided into successively smaller hydrologic units, which are designated by hydrologic unit codes (HUCs) developed by the U.S. Geological Survey. There are 21 two-digit, 222 four-digit, 352 six-digit, and 2,150 eight-digit HUCs found within the United States. In this Plan, the distribution of recovery populations is based upon the eight-digit HUC. The geographic units for designation of recovery populations are HUCs within the Platte and Arkansas River drainages that have known or potential populations of the Preble's mouse (Figure 4).

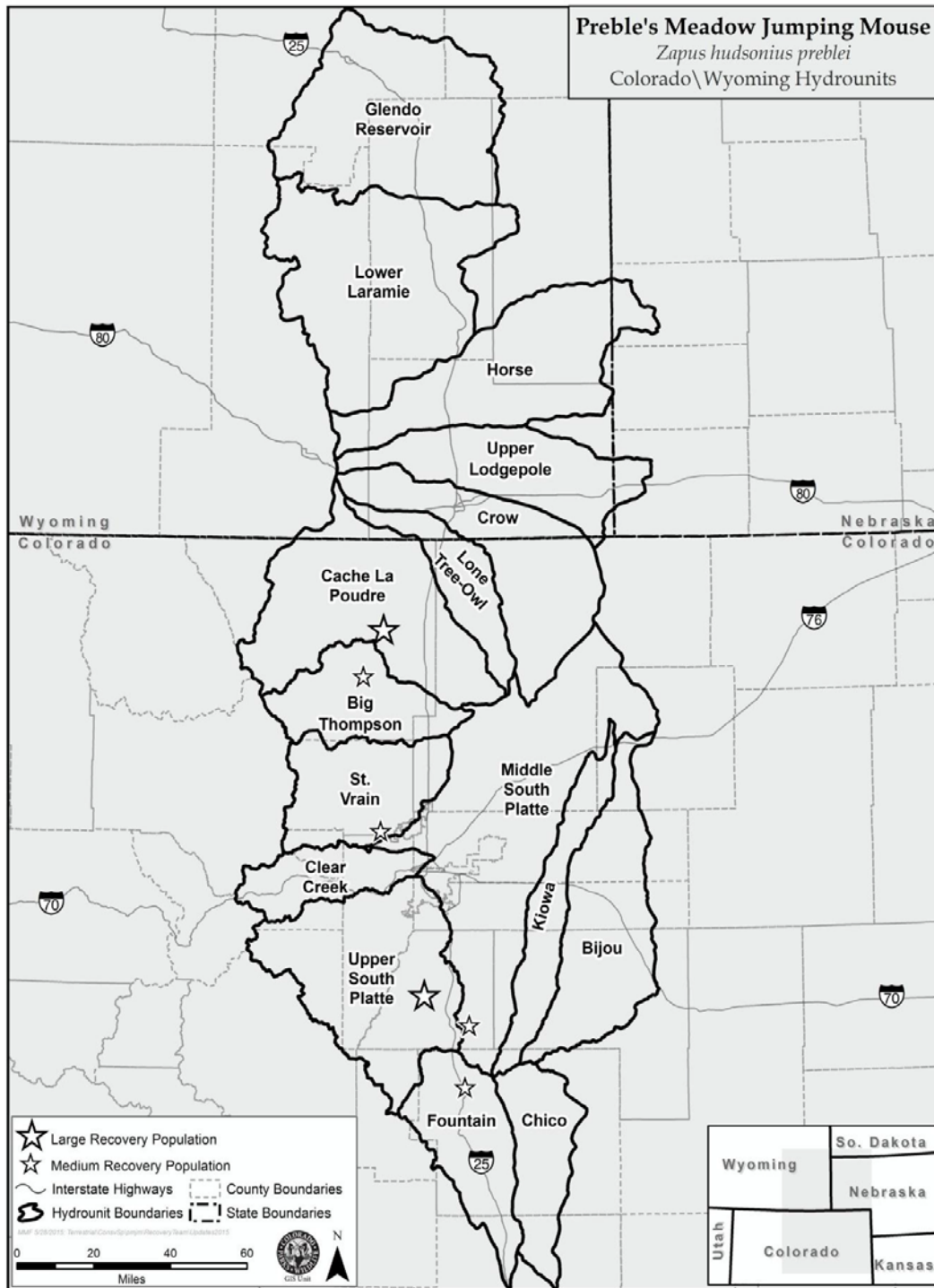


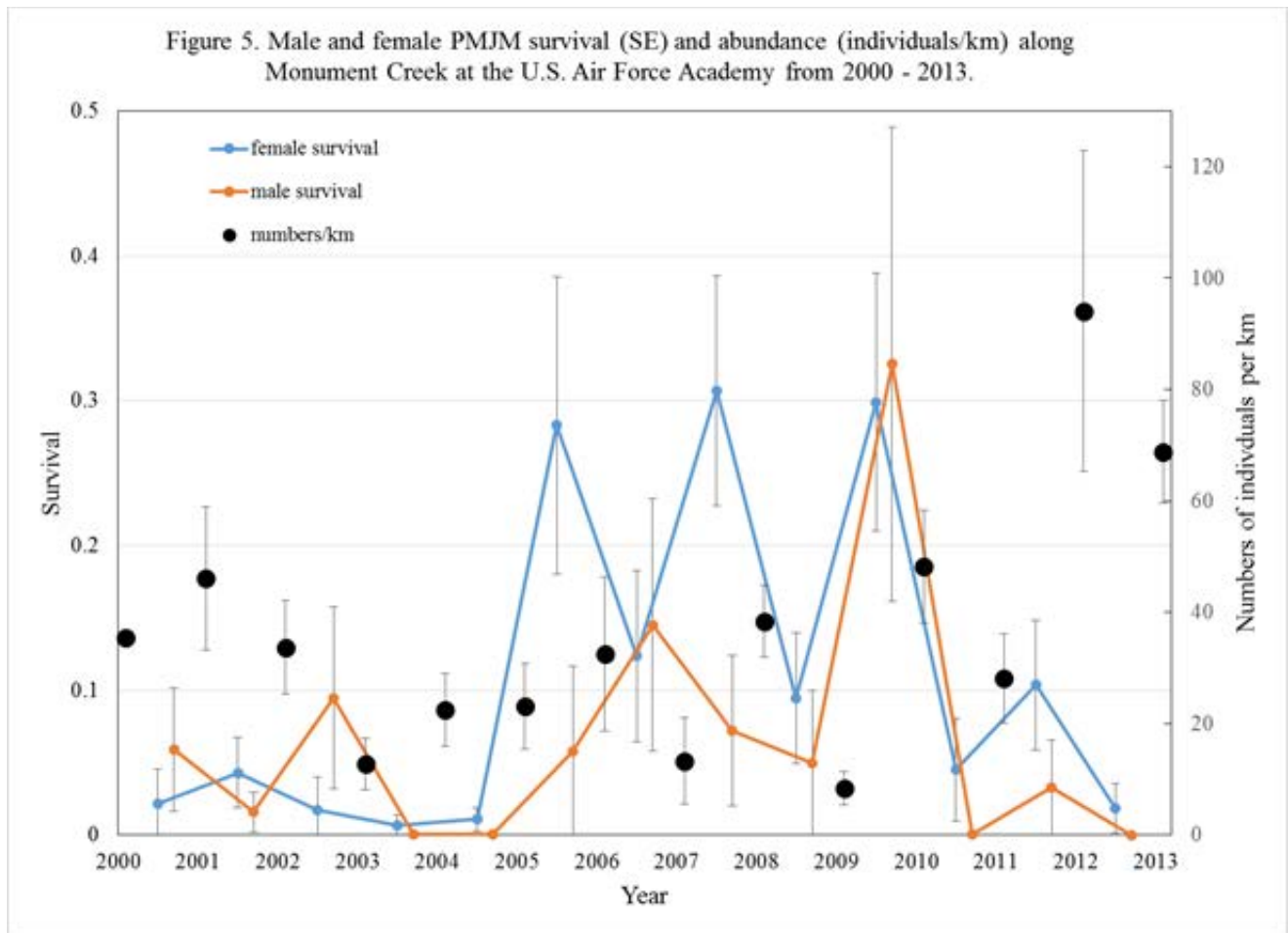
Figure 4. Hydrologic Unit Codes (HUCs) in Colorado and Wyoming with Location of Potential Large and Medium Sized Preble's Meadow Jumping Mouse (*Z. h. preblei*) Recovery Populations. Small-sized Recovery Populations have yet to be designated. The North and South Recovery Units are also depicted in Table 2.

4. Designating Small, Medium, and Large Recovery Populations

Conservation biology literature suggests various numbers of individuals may be necessary to support viability. The general rule of thumb used in conservation biology has been the 50/500 rule: isolated populations need to have a genetically effective population size of at least 50 individuals for short-term persistence, and a genetically effective population size of about 500 for long-term survival (Franklin 1980). The genetically effective population size designates that part of the population in which all individuals have an equal probability of mating and having offspring. In most natural populations the effective population of breeding individuals is often much smaller than the total population size (CSIESA 1995). An effective population size of about 500 individuals translates into a total population size of several times this number (CSIESA 1995; Lacy 1995; Soule 1987).

Some biologists have questioned the adequacy of the 50/500 rules. Mangel and Tier (1994) indicate that the probability of environmental catastrophes greatly increases the need for larger populations. Lande (1995) estimated the need for a genetically effective population size of approximately 5,000 for long-term persistence, which may translate to a total population size of 10,000 to 20,000 individuals. However, the generalization that a population size in the low thousands is the smallest number of individuals needed for long-term persistence is widely accepted (Soule 1987; CSIESA 1995) and was used to guide the selection of populations for this Plan.

Recovery population sizes, extent, and distribution were selected to provide a reasonably high probability of persistence for each individual population as well as for the entire subspecies. The sizes were based upon general conservation biology theory regarding population viability as well as input from biologists with knowledge of Preble's mouse distribution, habitat condition, and life history. Probability of persistence is enhanced by combining population size with redundancy in the development of this recovery strategy. Historical population sizes of this subspecies are not documented; although, it is expected that some hydrological units contained large populations, some medium and some small due to habitat variability in time and space. Preble's mouse population abundance can show dramatic variability over time and space (Schorr 2012; Figure 4 of new Preble's mouse estimates). Unfortunately, the degree to which Preble's mouse abundances vary spatially is not well understood because of the paucity of Preble's mouse studies assessing population size within the range. The population estimates shown in Figure 4, corroborate the previous estimates of population abundance. However, the population estimates from 1997 and 1998 are more informative because they represent a spatial variability that the later estimates do not.



Based on the literature described above, recovery population sizes are defined as follows:

Large populations are self-sustaining, naturally occurring populations that demonstrate abundance estimates of 2,500 Preble's mice, with no long-term significant negative population trend. The size of large populations was designated based on a belief that 5 times the minimum population of 500 would be stable over time. Population abundance and trend are determined using the Population Monitoring Plan (see task 2.2.1). Larger population sizes provide greater physical diversity of habitats and less vulnerability to natural or anthropogenic catastrophic events, while reducing the per unit area management costs. Due to the size of the habitat required to support large populations, most of the ecological processes associated with the subspecies would be incorporated into these landscapes.

Medium populations are self-sustaining, naturally occurring populations that demonstrate abundance estimates of 500 to 2,499 Preble's mice, with no long-term significant negative population trend. Population abundance and trend are determined using the Population Monitoring Plan (see task 2.2.1). Based upon conservation theory (Groom *et al.* 2006; Primack 2002), medium populations are at greater risk of extirpation than large populations, but have a higher probability of persistence than small populations. For maximum protection of this

subspecies, most medium populations identified by this Plan should be as large and numerous as possible to increase the probability of the subspecies' persistence.

Small populations may be self-sustaining, naturally occurring populations that demonstrate abundance estimates of fewer than 500 Preble's mice. The long-term significant population trend may not be known and population estimates may be unreliable due to low capture rates. Therefore, a small population may alternatively be defined as containing any number of mice within a 3-mile reach of connected Preble's mouse habitat. In this manner, smaller sections of occupied habitat can be used to identify small population locations. Although small populations are expected to be approximately 150 Preble's mice, regardless of the stream miles in association with the population, no minimum population size is required for small populations. Small populations are intended to provide geographic distribution throughout the existing range and are expected to conserve the existing range of genetic diversity in the subspecies.

The numbers identified above for large, medium and small populations are based on the best available science and represent estimations. If new estimation techniques or data become available that increase our knowledge of Preble's mouse recovery needs and result in changes to recovery criteria, the USFWS will confer with the Recovery Team and state and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation.

5. Establishing Guidelines for Estimating Stream Miles Required for Recovery Sites

The associated habitat lengths for the defined size classes of populations were developed with input from researchers with direct knowledge of Preble's mouse populations and habitat. The habitat lengths for a particular category of population size are considered minimum miles of a connected stream network whose hydrology supports riparian vegetation, provides Preble's mouse habitat, including adjacent uplands, and includes mainstem drainages and tributaries.

Because Preble's mice are found in linear riparian communities, the length of riparian habitat required for large, medium, and small populations is based on average density of mice per kilometer or mile of stream corridor. Abundances for a specified length of stream have been estimated for the subspecies in Colorado using capture-recapture techniques as described in Otis *et al.* (1978) and Anderson *et al.* (1983).

A known bias in capture-recapture studies from trapping transects or lines is that the traps tend to attract mice from some unknown distance away from the trapping transect (White and Shenk 1999). Furthermore, study areas have unequal lengths of stream reaches trapped. Therefore, simple density estimates of the number of mice divided by stream length is biased high, more so for shorter transects than for longer ones. To remove this bias, a correction factor was developed using radio-telemetry data to estimate the proportion of time radio-collared mice spent within the original trapline once the traps were removed (White and Shenk 1999). Data from six study sites with radio-collared Preble's mice were used to estimate this correction factor (called "p") for population estimates from linear traplines or grids. Corrections were applied to all study areas with the function relating (p) to trapline length (L) developed from these data. Research

conducted between 1998 to 2001, found the mean estimate of mice per mile of stream was 44 mice/mile (standard error = 6 mice/mile, sample size = 25 sites), with a range of 3 to 107 mice/mile (White and Shenk 2000, T. Shenk, Colorado Division of Wildlife, unpublished data; R. Schorr, Colorado Natural Heritage Program, unpublished data; C. Meaney, University of Colorado, unpublished data; T. Ryon, Greystone Consultants, unpublished data; M. Bakeman, Ensign Technical Services, unpublished data; M. Fink, unpublished data). Further analysis with new sites and additional years of data may change the above estimate.

Estimates of mean density (mice/mile) from studies prior to 2002 suggested approximately 44 mice/mile could be expected along occupied habitat. However, there is substantial temporal and spatial variability in Preble's mouse density (Figure 4). Updated estimates, along with the historical estimates, demonstrate the dramatic spatial and temporal variability in Preble's mouse density from various locations throughout Colorado (Table 1). Average mice/mile from all known studies (Table 1) is approximately 51 mice/mile and approximates previous estimates of 44 mice/mile used to develop population size categories below.

Based upon the mean density of 44 mice/mile (standard error of 6 mice/mile) from studies through 2002, the following provides guidelines for estimated stream miles for large and medium recovery populations, and required miles for small populations:

Table 1. Average Preble's meadow jumping mouse abundance (PMJM) (individuals/km; individuals/mile) at various locations in Colorado. These estimates are based on the estimates provided by various researchers studying PMJM in Colorado. The number of sampling locations (sites) these averages are based on is in parentheses.

County	Study Area	Creek	Year	Average individuals per mile
Boulder	South Boulder Creek	S. Boulder Creek (6 sites)	1998	76
Boulder	South Boulder Creek	S. Boulder Creek (6 sites)	1999	60
Boulder	South Boulder Creek	S. Boulder Creek (6 sites)	2000	65
Boulder	South Boulder Creek	S. Boulder Creek (11 sites)	2014	102
Boulder	South Boulder Creek	adjacent ditches (1 site)	1998	48
Boulder	South Boulder Creek	adjacent ditches (1 site)	1999	45
Boulder	South Boulder Creek	adjacent ditches (2 sites)	2000	86
Boulder	St. Vrain corridor	St. Vrain River and ditches (6 sites)	2005	21
Douglas	Castle Rock	E. Plum Creek	1999	67
Douglas	Castle Rock	E. Plum Creek	2000	42
Douglas	Maytag	E. Plum Creek (1 site)	1998	52
Douglas	Maytag	E. Plum Creek (1 site)	1999	46
Douglas	Maytag	E. Plum Creek (1 site)	2000	10
Douglas	Maytag	E. Plum Creek (1 site)	2001	33
Douglas	Pine Cliff	Garber Creek (1 site)	1998	92
Douglas	Pine Cliff	Garber Creek (1 site)	1999	86
Douglas	Pine Cliff	Garber Creek (1 site)	2000	27
Douglas	Woodhouse	Indian Creek (1 site)	1998	25
Douglas	Woodhouse	Indian Creek (1 site)	1999	78
Douglas	Woodhouse	Indian Creek (1 site)	2000	62
Douglas	Woodhouse	Indian Creek (1 site)	2001	3
El Paso	Dirty Woman Creek	Dirty Woman Creek (Mark)	1998	33
El Paso	Dirty Woman Creek	Dirty Woman Creek	1999	11
El Paso	Dirty Woman Creek	Dirty Woman Creek	2000	11
El Paso	Kettle Creek	Kettle Creek (Mark)	2000	30
El Paso	Monument Creek	Monument Creek (4 sites)	1998	107
El Paso	Monument Creek	Monument Creek (4 sites)	1999	46
El Paso	Monument Creek	Monument Creek (4 sites)	2000	69
El Paso	Monument Creek	Monument Creek (4 sites)	2001	56
El Paso	Monument Creek	Monument Creek (4 sites)	2002	54
El Paso	Monument Creek	Monument Creek (8 sites)	2003	56
El Paso	Monument Creek	Monument Creek (4 sites)	2004	38
El Paso	Monument Creek	Monument Creek (4 sites)	2005	40
El Paso	Monument Creek	Monument Creek (4 sites)	2006	53
El Paso	Monument Creek	Monument Creek (4 sites)	2007	21
El Paso	Monument Creek	Monument Creek (4 sites)	2008	61
El Paso	Monument Creek	Monument Creek (4 sites)	2009	13
El Paso	Monument Creek	Monument Creek (4 sites)	2010	77
El Paso	Monument Creek	Monument Creek (4 sites)	2011	45
El Paso	Monument Creek	Monument Creek (4 sites)	2012	150
El Paso	Monument Creek	Monument Creek (4 sites)	2013	110
Jefferson	Rock Creek	Rock Creek (1 site)	1998	6
Jefferson	Walnut Creek	Walnut Creek (1 site)	1999	8
Jefferson	Woman Creek	Woman Creek (1 site)	2000	12

Large populations (abundances of 2,500 individuals or greater) will likely need a 57-mile (45- to 78-mile) network of functionally connected streams whose hydrology supports riparian

vegetation and provides Preble's mouse habitat; this will include the mainstem plus tributaries. Functionally connected is defined in this Plan as a stream or riparian corridor with small stretches of less than suitable habitat that the Preble's mouse is capable of traversing and maintaining genetic flow between otherwise fragmented habitat. For the purpose of this Plan, streams are functionally connected if the distance of less than suitable habitat (but not bare ground) is less than ¼ mile; approximately two times the documented travel distance (215 m) of Preble's in unsuitable habitat (RFETS 1998). This current estimate of miles to maintain 2,500 mice is based upon the mean number of mice that occur per stream mile as estimated from current data (1998-2013), and may not necessarily apply to a specific site due to variations in habitat condition. The intent is to protect enough stream miles of habitat to support the population goal of 2,500 mice.

Medium populations (abundances of 500 individuals or greater) will likely need an 11-mile (9- to 16-mile) network of functionally connected streams whose hydrology supports riparian vegetation and provides Preble's mouse habitat; this will include the mainstem plus tributaries. This current estimate of miles to maintain 500 mice is based upon the mean number of mice that occur per stream mile as estimated from current data (1998-2013), and may not necessarily apply to a specific site due to variations in habitat condition and quality. For maximum protection of this subspecies, most medium populations should occupy stream habitats that exceed the minimum to support 500 mice.

Small populations (defined as those showing at least continued presence of Preble's mouse) must have at least 3 miles of connected stream habitat.

It must be emphasized that the recovery goal for large and medium populations is numbers of mice, not numbers of stream miles inhabited. Thus, enough stream miles need to be protected to ensure that numeric population goals for large and medium populations can be maintained. Because the figure of 44 mice/mile is a mean for the current Preble's mouse research populations, at least some populations of any particular size are likely to show a lower density and, therefore, would need a larger stretch of habitat in order to meet population recovery goals. Alternatively, some sites may support higher densities of mice than the estimated mean, and could meet population recovery goals with fewer stream miles.

6. Determining Number and Distribution of Recovery Populations

The distribution of Preble's mouse recovery populations is designed to minimize the impacts of threats such as weather, disease, fragmentation, anthropogenic factors, loss of genetic diversity and other threats to the subspecies. The recommended approach to conserving the geographic and genetic diversity of the Preble's mouse is to conserve at least one recovery population within each HUC within the existing range of the taxon to maintain redundancy and representation for the subspecies between Recovery Units as follows (Table 2):

North Recovery Unit. One large and three medium populations in four separate HUCs, as well as three small populations within each of the remaining six HUCs within the North Recovery Unit.

South Recovery Unit. One large population and two medium populations in three separate HUCs, as well as three small populations in each of the remaining three HUCs within the South Recovery Unit.

At this time, additional survey data are needed to establish whether some of these HUCs in the North and South Recovery Units are, or are not, occupied by the Preble's mouse. These HUCs will be evaluated based on a number of factors, including targeted surveys in Preble's mouse habitat, assessment of habitat suitability, opportunities for restoration and enhancement, etc. If a HUC is found not to contain any Preble's mouse populations following a survey(s) approved by the USFWS, no recovery populations will be required for that HUC. If a HUC is found to support only one or two small populations, then those populations will be designated as recovery populations, and designation of additional recovery populations will not be required in that HUC. Supporting data will be compiled and presented to the Recovery Team when a HUC is proposed for removal or when the number of required populations is reduced. The Team will then review the results and make a recommendation to the USFWS who will then make a final determination regarding the classification of currently designated HUCs. If a HUC is in need of further evaluation, the Recovery Team and the USFWS will provide guidance on how to proceed. Despite considerable survey effort, only western jumping mice have been found in the Upper Lodgepole and Crow HUCs. Once the population monitoring methods have been developed, it is possible the existing data for certain HUCs (e.g., Upper Lodgepole and Crow) may be adequate to conclude that a HUC is unoccupied, obviating the need to conduct additional surveys. In addition, historic Preble's mouse ranges may be investigated for the potential of establishing new populations.

If criteria for protecting the specified large and medium populations of the Preble's mouse have been met for a recovery unit, but the goal of conserving three small or one medium population in each of the remaining HUCs has not been met, the USFWS will determine whether the geographic and genetic diversity for the Preble's mouse has been adequately conserved in that recovery unit. In making this determination, the USFWS will consider conservation efforts to date, existing data regarding presence and geographic distribution of the Preble's mouse, potential for conducting additional surveys, opportunities for habitat enhancement or mitigation, any available data regarding genetic diversity, and current and future threats to the geographic or genetic diversity of the Preble's mouse.

It is important for a Recovery Plan to incorporate new scientific information as it arises and to support implementation of recovery through adaptive management. As described in strategy 4 (above), the number of recovery populations identified for each recovery unit is based on the best available science. Therefore, this strategy may need to be altered in the future if changes are supported by new scientific information. If new estimation techniques or data become available that increase our knowledge of Preble's mouse recovery needs and result in changes to recovery criteria, the USFWS will confer with the Recovery Team, and state and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation.

Table 2. Locations of Potential Recovery Populations.

North Recovery Unit		
	HUC Name/8-Digit Number	General Location
1 Large	Cache La Poudre/10190007	North Fork Cache la Poudre River
3 Medium	Big Thompson/10190006	Buckhorn Creek
	St. Vrain/10190005	South Boulder Creek (or St. Vrain River)
	Glendo Reservoir/10180008 (or Lower Laramie/10180011)	To be determined
18 Small	Lower Laramie/10180011 (or Glendo Reservoir/10180008)	To be determined
	Lower Laramie/10180011 (or Glendo Reservoir/10180008)	To be determined
	Lower Laramie/10180011 (or Glendo Reservoir/10180008)	To be determined
	Horse/10180012	To be determined
	Horse/10180012	To be determined
	Horse/10180012	To be determined
	Upper Lodgepole/10190015	To be determined
	Upper Lodgepole/10190015	To be determined
	Upper Lodgepole/10190015	To be determined
	Crow/10190009	To be determined
	Crow/10190009	To be determined
	Crow/10190009	To be determined
	Lone Tree-Owl/10190008	To be determined
	Lone Tree-Owl/10190008	To be determined
	Lone Tree-Owl/10190008	To be determined
	Clear Creek/10190004	To be determined
	Clear Creek/10190004	To be determined
	Clear Creek/10190004	To be determined
South Recovery Unit		
1 Large	Upper South Platte/10190002	West Plum Creek and Plum Creek
2 Medium	Fountain/11020003	Monument Creek/Air Force Academy
	Middle South Platte - Cherry Creek ¹ /10190003	Middle South Platte-Cherry Creek

¹ HUC occurs both north and south of Denver, recovery populations occur south of Denver.

South Recovery Unit (continued)		
9 Small	Chico/11020004	To be determined
	Chico/11020004	To be determined
	Chico/11020004	To be determined
	Kiowa/10190010	To be determined
	Kiowa/10190010	To be determined
	Kiowa/10190010	To be determined
	Bijou/10190011	To be determined
	Bijou/10190011	To be determined
	Bijou/10190011	To be determined

Note: HUCs listed as “to be determined” have the potential to hold Preble’s mouse populations but have not yet been assigned designated sites for recovery populations. Some HUCs contain excellent habitat that either has not been trapped or short-term trapping efforts did not result in any Preble’s mouse captures. Additionally, in some cases, the species was captured, but subsequent trapping efforts failed to verify its occupancy.

7. Delineating Preble’s mouse Habitat

Preble’s mouse habitat includes riparian systems, transition slopes between riparian and upland communities, and upland grasslands (Bakeman 1997; Shenk and Sivert 1999a; Schorr 2001). Shenk and Sivert (1999a) observed summer movements in excess of 328 feet outward from the stream, but in most instances upland habitat use was within 328 feet of the 100-year flood plain delineation. Most presumed hibernation sites also were located within 328 feet of the 100-year flood plain delineation of the main stream. Therefore, in order to ensure protection of sufficient habitat, this Plan defines the width of Preble’s mouse habitat as the 100-year flood plain plus 328 feet on both sides of the creek. Final habitat delineations for each recovery site will be determined by each Site Conservation Team and approved by the USFWS. However, alternatives to the 100-year flood plain rule will be considered if:

- 1) The area delineated provides all the necessary resources for the mice to nest, breed, find cover, travel, feed, and hibernate; i.e., for long-term survival; or
- 2) The area delineated includes the three contiguous geomorphological components used by Preble’s mouse: alluvial flood plain, transition slopes, and pertinent uplands (grasslands for feeding and suitable hibernation sites).

8. Designating Self-sustaining Populations as the Measure of “Recovery”

For this Plan, recovery populations are defined as self-sustaining, naturally functioning populations that are not maintained by “stocking” or captive breeding. Translocations and captive breeding may be difficult and can present potentially high risks, and will only be

considered as a last resort for maintaining a population or as a means to maintain genetic diversity.

Restoration of individuals to previously occupied areas, without an understanding of why the area no longer supports the subspecies, would likely result in resources (e.g., animals, time, and money) being lost to establish reintroduced populations that may meet the same fate as the original population that occupied the area. Furthermore, restocking areas with individuals genetically dissimilar from the individuals in the original population does not protect genetic variability.

9. Selecting Public Lands Over Private Lands as Areas for Preble's mouse Recovery

Selecting public lands as areas for recovery may ensure the implementation of timely and effective land management for the mouse. Where possible, recovery sites are designated on public lands because the likelihood of maintaining stable populations is greater on public lands. Managing land for a common purpose and ensuring consistency in land management practices is easier on larger public lands than on a host of smaller private parcels. Also, designating recovery populations on public property minimizes and/or avoids the potential conflict between private landowners' land management strategies and those strategies recommended for conservation of the Preble's mouse; such conflict-avoidance may increase support for achieving recovery. Lastly, many public lands have natural resource management strategies in place to conserve the mouse or its habitat.

10. Collaborating with Private Landowners to Achieve Recovery

Given the expansive private lands in eastern Colorado and Wyoming, it is likely that public lands will be unable to succeed in attaining recovery on their own. Private landowners in these states have a long and successful history of conservation efforts. Where designation and protection of Preble's mouse recovery populations will require private landowner collaboration, it will be important to seek incentives for conservation efforts in order to assist private landowners in managing and protecting habitat and offset potential costs associated with recovery. Incentives should be developed to encourage participation, build partnerships, and foster cooperation with recovery efforts. These can include Preble's mouse recovery funds and tax incentives at the federal, state, or county level to encourage active conservation measures on private lands, including but not limited to the establishment of financial award / reward systems for participation in recovery programs, creation of conservation banks, and / or funding for voluntary conservation easements.

11. Protecting Lands Not Designated as Recovery Sites

Protecting additional habitat for Preble's mouse populations will ensure that the subspecies reaches recovery more quickly. Although a set number of large, medium, and small populations will be designated as recovery populations, a greater chance of achieving recovery is possible by protecting additional habitat where it is found in future survey efforts. Preble's mouse populations may fluctuate greatly in size, but recovery will only be achieved by ensuring that

populations are stable or increasing over many years. Therefore, it may be advantageous to identify additional non-designated recovery populations for habitat conservation efforts as insurance in the event that one or more of the designated populations declines. Also, by protecting more occupied habitat than is necessary for recovery, the threat to the subspecies as a whole from a catastrophic event is reduced.

12. Identifying Additional Research Needs

Previous research on Preble's mouse taxonomy, distribution, demography, ecology, and habitat has been essential in informing the best approaches to its conservation. These descriptive and quantitative studies have been helpful in understanding the subspecies' biology and suggesting why it uses certain habitats. Research designed to determine cause-and-effect relationships between the mouse and its habitat needs to be conducted. Understanding how habitat factors affect populations is important to ensuring the persistence of this subspecies.

Much additional research is still needed, both descriptive and experimental. This includes research on the systematics, range, and distribution of the mouse; identification of management practices that enhance habitat and populations; identification of threats to the persistence and distribution of populations; further refinement of suitable habitat criteria; and development of threat abatement strategies for habitat. Some specific examples of needed research to facilitate recovery include, but are not limited to, projects identified in Appendix C (Research).

13. Using Adaptive Management

Adaptive management is a process by which policy decisions are implemented within a framework of scientifically-driven experiments to test predictions and assumptions inherent in management plans. There is still much about Preble's mouse biology and habitat management that is not well understood. A well-designed adaptive management program may answer some of these questions and be used to modify existing management strategies. The USFWS will confer with the Recovery Team, state, and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation. Adaptive management should be a consideration in the development of site-specific threat abatement strategies developed by the Site Conservation Teams.

14. Focusing on Single Species Recovery

The development of this Plan focused on a single species strategy for recovery of the Preble's mouse within the Platte and Arkansas River drainages of Colorado and Wyoming. Although the actions recommended by the Plan are focused on the Preble's mouse, the protection of populations and habitat for this subspecies may benefit other listed and declining species within riparian habitats of Colorado and Wyoming. At some time in the future, a multi-species plan for declining Wyoming-Colorado Front Range species may be considered.

15. Managing for Genetic Diversity

Prior to our 1998 listing, the Colorado Division of Wildlife (now CPW) funded a genetic analysis of the Preble's mouse (Riggs *et al.* 1997). This analysis examined 433 base-pairs in one region of the mitochondrial deoxyribonucleic acid (mtDNA) (maternally inherited genetic material) across five subspecies of meadow jumping mouse (92 specimens) (Riggs *et al.* 1997). The study concluded that the Preble's mouse formed a homogenous group recognizably distinct from other nearby populations of meadow jumping mice (Riggs *et al.* 1997). At the request of the USFWS, Hafner (1997) reviewed the Riggs study, inspected Riggs' original sequence data, and agreed with its conclusions. The supporting data for this report remain privately held (Ramey *et al.* 2003). The Riggs *et al.* (1997) results were not published in a peer-reviewed journal, but were peer reviewed by Hafner. Prior to listing, this study was the only available information concerning the genetic uniqueness of the Preble's mouse relative to neighboring subspecies, as Krutzsch's original subspecific designation relied on morphological characteristics and geographic isolation.

In 2005, a genetics and morphometrics study proposed synonymizing Preble's mice with two adjoining subspecies (*Z. h. campestris* and *Z. h. intermedius*) (Ramey *et al.* 2005). In early 2006, a study (King *et al.* 2006) found no evidence to support this conclusion and instead found strong genetic support for the Preble's subspecies as described by Krutzsch (1954). Both of these studies evaluated five neighboring subspecies. An independent peer review panel reviewed both of these reports and found that the preponderance of evidence supported the validity of the Preble's subspecies.

We reevaluated the information and have reconfirmed that the best scientific and commercial data available support the conclusion that the Preble's mouse is a valid subspecies (73 FR 39790, July 10, 2008; 78 FR 31679, May 25, 2013). Specifically, the Preble's mouse's geographic isolation from other subspecies of meadow jumping mice has resulted in the accretion of considerable genetic differentiation. The available data suggest that the Preble's mouse meets or exceeds numerous, widely accepted subspecies definitions.

However, a recent USFWS-funded study (published after our 2008 and 2013 findings) also warrants consideration due to its consideration of the Preble's mouse taxonomy. Specifically, a September 2013 publication in *Molecular Ecology* further evaluated the genetic relationship between jumping mice, including the Preble's mouse (Malaney and Cook, 2013). While the two previous studies (Ramey *et al.* 2005; King *et al.* 2006) evaluated 5 adjoining subspecies, this study broadly evaluated the entire *Zapus* genus, including all 12 subspecies of meadow jumping mice (*Z. hudsonius*). This study confirmed that the Preble's mouse is distinct from neighboring subspecies that were previously proposed to be taxonomically synonymized (*Z. h. campestris* and *Z. h. intermedius*) (Malaney and Cook, 2013). However, the study concludes that the Preble's mouse is closely related to two meadow jumping mouse subspecies that are found in Alaska and Canada (*Z. h. tenellus* and *Z. h. alascensis*), which the study refers to as the "northern lineage" of meadow jumping mice (Malaney and Cook 2013).

Although the study suggests that the Preble's mouse is genetically similar to two subspecies of jumping mice found in Alaska and Canada, it does not propose to revise the formal taxonomy of the Preble's mouse or any of the other subspecies of jumping mice (Malaney and Cook 2013). Specifically, the study concludes, "additional tests will be required before hypotheses of infraspecific taxonomic synonymy can be implemented... [and that] a revised taxonomy of the group is needed but is outside the context of this study" (Malaney and Cook 2013).

The goal of genetic management within this Plan is to preserve and conserve the range of unique morphological, ecological, and behavioral characteristics of the subspecies that are presumed to exist on a population by population basis. Work completed to date on mitochondrial DNA (Riggs *et al.* 1997; King *et al.* 2006a) indicated that Preble's mouse is a distinct genetic lineage. The Recovery Team may consider completing a genetics management plan in the future, based upon information obtained through the completion of genetic research proposed by this Plan.

16. Concentrating Recovery on Delisting Factors

Section 4 of the ESA governs the listing, delisting, and reclassification of species, the designation of critical habitat, and recovery planning. Regulations implementing listing, delisting, reclassification, and critical habitat designation are codified at 50 CFR 424.

The process of delisting a species (or subspecies), is essentially the same as that of listing: a proposed rule describing the justification for the action is published in the Federal Register, a public comment period is opened (including public hearings if requested), and, within 1 year of the proposal, either a final rule delisting the species or a notice withdrawing the proposed delisting is published in the Federal Register.

In considering whether to delist a species, the same five factors considered in the listing process are evaluated:

- Factor A. The present or threatened destruction, modification, or curtailment of the species' habitat or range;
- Factor B. Overutilization for commercial, recreational, scientific, or educational purposes;
- Factor C. Disease or predation;
- Factor D. The inadequacy of existing regulatory mechanisms;
- Factor E. Other natural or manmade factors affecting the species' continued existence.

It is believed that there are currently sufficient Preble's mouse populations to ensure the subspecies' survival. However, there are substantial threats to many of the populations that, if left unabated, may cause their decline or extirpation in the future. Therefore, this Recovery Plan focuses on designating enough recovery populations of sufficient size over a broad geographic range and protecting them from threats to their survival.

The abatement of threats relating to criteria one through five, identified below, are believed to be adequate for delisting Preble's mouse. When these threats are lessened or eliminated for each

recovery population, an analysis of the above factors should show the subspecies is no longer in need of protection under the ESA.

Recovery Criteria for Delisting

The Preble's mouse will be considered recovered and eligible for delisting when it is demonstrated that:

1. Two large and five medium populations distributed across the range maintain stable or increasing trends over a 10-year period based on data obtained from standardized monitoring methods. Population sizes are defined on pages 43 through 44 of this Plan. The recovery populations will be distributed among the following Recovery Units:

North Recovery Unit. One large and three medium (one being in Wyoming) populations in four separate HUCs will be located within the North Recovery Unit.

South Recovery Unit. One large population and two medium populations in three separate HUCs will be located within the South Recovery Unit.

At this time, it is unclear if sufficient survey data exist to establish whether some of these HUCs are, or are not, occupied by the Preble's mouse. These HUCs will be assumed to be occupied by the Preble's mouse unless trapping surveys of suitable habitat following USFWS-approved protocol (i.e., the Peer-Reviewed Preble's mouse Population Monitoring Methodology) demonstrate that a HUC is not occupied. If a HUC is found to support only one or two small populations, then those populations will be designated for Criterion 2 below. If a HUC is found not to contain any Preble's mouse populations as per surveys conducted under the USFWS-approved protocol, recovery populations will not be recommended in that HUC. For example, despite considerable survey effort, only western jumping mice have been found in the Upper Lodgepole and Crow HUCs. Once the population monitoring methods have been developed and approved, existing data may be adequate to conclude that one or more HUCs are unoccupied, obviating the need to conduct additional surveys in those HUCs. In addition, historic Preble's mouse ranges may be investigated for the potential of establishing new populations.

2. Protection of small populations to provide for representation, resiliency, and redundancy. Three small populations are maintained over a 10-year period in each of the 9 HUCs that do not have large or medium populations but contain suitable habitat. At present, we estimate that 8 of 9 targeted HUCs do not support large or medium populations. If a HUC is found that it can only support one or two small populations, then those populations will be selected and will satisfy this recovery criterion for that HUC. Designation of additional populations will not be required in that HUC. If a HUC is found not to contain any Preble's mouse populations following a survey(s), no recovery populations will be required for that HUC. Any data that are used to determine if this

criterion is completed will be obtained using standardized methods approved by the USFWS.

3. At least the estimated stream mileage for each population size (large population = 57 miles, medium population = 11 miles, small population = 3 miles, see Section 5 under Recovery Strategies of this Plan) is maintained as suitable habitat of functionally connected stream for a reasonable time frame (10 years or more) and is not expected to be impacted by negative management actions for the foreseeable future. When multiple populations are available to assist with recovery criteria, or when populations span areas with multiple jurisdictions, priority is given to public and other protected lands and habitats that provide connectivity.
4. State, county, or local government regulations or other mechanisms, as set forth in the delisting criteria for Factor D, protect Preble's mouse habitat such that known threats in the Recovery Units are abated into the foreseeable future. For example, Federal, state, or local regulations to protect Preble's mouse habitat from the effects of disturbance activities (such as commercial or residential development, grazing, mowing, and burning) would ensure those threats are reduced within portions of that Recovery Unit.
5. As required by the ESA, a post-delisting management Plan for Preble's mouse and its habitat is completed, in cooperation with state and local governments, to ensure the designated recovery populations are maintained at self-sustaining levels.

Table 3 consolidates the potential threats to the Preble's mouse population and recovery found on pages 20 through 33, the recovery criteria above, and the recovery actions described on pages 65 through 73 below.

Table 3. Threat tracking table of the current and previously identified threats for the Preble's meadow jumping mouse, by the five listing factors, with their associated recovery criteria and recovery actions.

Threat	Recovery Criteria (point at which the threat is abated)	HUC	Recovery Action
Listing Factor A - The present or threatened destruction, modification, or curtailment of the species' habitat or range			
Livestock Grazing	3	Glendo Reservoir, Lower Laramie, Horse, Upper Lodgepole ² , Crow ² , Lone Tree-Owl, St. Vrain	In cooperation with local Site Conservation Teams, develop and implement grazing practices that are compatible with Preble's mouse habitat and include minimizing grazing and livestock trampling within the riparian area; Promote incentives to encourage conservation and offset potential costs associated with recovery (Actions: 2.4 - 2.6, 5.0, 5.4)
Agriculture (row crops, haying, irrigated)	3	Glendo Reservoir, Lower Laramie, Horse, Upper Lodgepole, Crow, Lone Tree-Owl, St. Vrain	In cooperation with local Site Conservation Teams, develop and implement agriculture practices that are compatible with Preble's mouse habitat that include minimizing agriculture within the riparian area; Where necessary and feasible, provide incentives to slow the conversion to agriculture (Actions 2.4 - 2.5, 5.0, 5.4)
Residential and Commercial Development	3,4	Lower Laramie, Crow, Cache La Poudre, Big Thompson, St. Vrain, Clear Creek, Upper South Platte, Fountain, Middle South Platte, Kiowa, Chico, Lone Tree-Owl	Work with county commissions and land-use planners to identify and protect known and potential Preble's mouse habitat, avoid development in areas of known Preble's mouse populations, promote low-impact development, and develop and implement guidelines that are compatible with Preble's mouse persistence; Evaluate gradations of development on Preble's mouse populations (Actions: 2.3, 2.4, 3.1, 3.8, 4.3, 5.0)

² Despite considerable survey effort, only western jumping mice have been found in the Upper Lodgepole and Crow HUCs.

Threat	Recovery Criteria (point at which the threat is abated)	HUC	Recovery Action
Hydrologic Changes	3,4	All HUCs	Work with the local water community to improve hydrological function for Preble's mouse within the context of water law and at all applicable scales, maintain or restore current, suitable hydrologic regimes that maintain habitat of Preble's mouse; Plans should include urban and conservation water uses and ground and surface water; Avoid locating reservoir and diversion projects at known Preble's mouse sites whenever possible; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 1.1, 2.3, 2.4, 2.6, 3.5, 3.8, 4.1, 5.0, 5.4)
Transportation, Recreation, and other Rights-of-way Through Habitat	3,4	All HUCs	Develop and implement compatible practices for Preble's mouse habitat that improve and restore existing infrastructure to minimize impacts and avoid or minimize additional impacts to riparian areas; Promote habitat connectivity through the use of mouse passable structures (culverts and ledges); Prevent or minimize night-time use and lighting in urban areas by adhering to dark-sky compliant lighting (Actions: 2.3 - 2.6, 3.2 - 3.4, 3.8, 5.0)
Aggregate Mining	3,4	Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Chico, Bijou, Middle South Platte, Kiowa, Crow	Work with the mining industry to develop and implement compatible practices that avoid, minimize, or mitigate actions in Preble's mouse habitat and avoid known Preble's mouse populations; Develop restoration standards to maximize protection and restoration of Preble's mouse and its habitat and return riparian areas to a condition conducive to Preble's mouse (Actions: 1.1, 2.3 - 2.6, 3.6, 3.8, 5.0)

Threat	Recovery Criteria (point at which the threat is abated)	HUC	Recovery Action
Oil, Gas, and Mineral Exploration and Extraction	3,4	Upper Lodgepole, Crow, Lone Tree-Owl, Middle South Platte, Kiowa, Bijou, Chico, St. Vrain	Work with state and local regulatory agencies and industry to develop guidelines for practices compatible with Preble's mouse habitat and populations that include: mining, roads and other infrastructure, water, and toxicity; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 1.1, 2.4, 2.5, 3.7, 3.8, 5.0, 5.4)
Listing Factor C - Disease or predation.			
Skunk, Raccoon, Domestic/Feral Cats, Bullfrogs	4	Lower Laramie, Crow, Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Clear Creek, Upper South Platte, Fountain, Chico, Bijou, Kiowa, Middle South Platte	Develop and distribute recommendations that encourage adoption of policies to minimize human-associated predators to educate residents and minimize availability of food to mesocarnivores; Remove human-associated predators and bullfrogs where feasible and appropriate (Actions: 4.3, 5.0)

Listing Factor D – The inadequacy of existing regulatory mechanisms			
Residential and Commercial Development	4	Lower Laramie, Crow, Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Clear Creek, Upper South Platte, Fountain, Chico, Bijou, Kiowa, Middle South Platte	Increase protection of Preble’s mouse through the creation, strengthening, and enforcement of regulatory mechanisms to protect riparian systems and minimize or remove identified threats to Preble’s mouse on federal and state lands; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 3.1, 3.8, 5.4)
Hydrologic Changes	4	All HUCs	Increase protection of Preble’s mouse by creating, strengthening, and enforcing regulatory mechanisms to protect riparian systems; Minimize or remove identified threats to Preble’s mouse on federal and state lands; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 3.5, 3.8, 5.4)
Transportation, Recreation, and other Rights-of-way Through Habitat	4	All HUCs	Increase protection of Preble’s mouse through the creation, strengthening, and enforcement of regulatory mechanisms to protect riparian systems and minimize or remove identified threats to Preble’s mouse on federal and state lands; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 3.2 - 3.4, 3.8, 5.4)
Aggregate Mining	4	Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Chico, Bijou, Middle South Platte, Kiowa, Crow	Increase protection of Preble’s mouse through the creation, strengthening, and enforcement of regulatory mechanisms to protect riparian systems and minimize or remove identified threats to Preble’s mouse on federal and state lands; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 3.6, 3.8, 5.4)

Oil, Gas, and mineral Exploration and Extraction	4	Upper Lodgepole, Crow, Lone Tree-Owl, Middle South Platte, Kiowa, Bijou, Chico	Increase protection of Preble's mouse through the creation, strengthening, and enforcement of regulatory mechanisms to protect riparian systems and minimize or remove identified threats to Preble's mouse on federal and state lands; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 3.7, 3.8, 5.4)
Listing Factor E – Other natural or manmade factors affecting the species' continued existence			
Instability of Small/Isolated Populations	1,2,3	All HUCs	Improve, expand, and promote habitat to increase population sizes and improve and maintain connectivity; Evaluate genetics to determine and protect genetically important populations; Evaluate feasibility and develop protocols for translocation if needed; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 1.1, 1.3, 1.4, 2.2 - 2.6, 5.4)
Non-native Plants	3	All HUCs	Implement existing Integrated Pest Management (IPM) policies and develop and implement IPM protocols specific to Preble's mouse habitat; Remove non-native plants whenever possible; Evaluate research needs on the importance of non-native plants on Preble's mouse populations; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 2.4, 5.0, 5.4)

Drought	3,5	All HUCs	Work with the local water community to improve hydrological function for Preble's mouse within the context of water law and maintain or restore current, suitable hydrologic regimes that maintain habitat of Preble's mouse; Plans should include urban and conservation water uses and ground and surface water and seek to maintain resiliency in light of drought; In drought years, focus on minimizing secondary impacts to riparian areas; Investigate water use policies that might benefit stream hydrology during drought; Utilize natural processes to promote resiliency such as beavers and willows; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 2.4, 2.5, 3.5, 3.8, 4.1, 4.2, 5.0, 5.4)
Global Climate Change	3,5	All HUCs	Implement climate change adaptation and resiliency (Gordon and Ojima 2015, Colorado climate change vulnerability study); Management actions could include restoring riparian areas with native vegetation, conducting prescribed fires to reduce risk of large wildfires, restoring beavers to streams to enhance wetlands, preventing and controlling invasive species, and maintaining and enhancing connectivity. (Actions: 3.8, 4.1, 4.2, 5.0)
Flood	3,5	All HUCs	Encourage maintenance of natural sinuosity of streams and vegetation in an effort to promote resiliency; Restore floodplain connectivity; Look into policies that maintain appropriate habitat for Preble's mouse; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 2.3 - 2.6, 3.5, 3.8, 4.1, 4.2, 5.0, 5.4)

Wildfire	3,5	Glendo Reservoir, Lower Laramie, Crow, Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Clear Creek, Upper South Platte, Fountain, Chico, Bijou, Kiowa, Middle South Platte	Evaluate prescribed burning to reduce fuels if necessary and develop and implement protocols to promote habitat resiliency; Implement post-fire habitat management that addresses vegetation, invasive species, and hydrology to benefit Preble's mouse; Ensure populations of Preble's mouse are prioritized in plans for habitat management; Fire wise communities should consider Preble's mouse habitat needs when implementing control in riparian habitat; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 2.3 - 2.6, 3.8, 4.1, 4.2, 5.0, 5.4)
Secondary impacts	3	Lower Laramie, Crow, Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Clear Creek, Upper South Platte, Fountain, Chico, Bijou, Kiowa, Middle South Platte	Develop and implement education campaigns to make public aware of issues to wildlife from secondary impacts; Work with county commissions and land-use planners to identify and protect known and potential Preble's mouse habitat, promote low-impact development, and develop and implement guidelines that are compatible with Preble's mouse persistence; Develop and distribute recommendations that encourage the adoption of policies to minimize human-associated competitors to educate residents; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 3.1, 4.3, 5.0, 5.4)

Pesticides / herbicides	3	Lower Laramie, Horse, Upper Lodgepole, Lone Tree-Owl, Cache La Poudre, Big Thompson, St. Vrain, Clear Creek, Upper South Platte, Fountain, Chico, Bijou, Kiowa, Middle South Platte	Conduct research on use of pesticides and herbicides and the level of threat to Preble's mouse populations; Distribute information to and through county weed managers regarding the impacts of pesticides and herbicides on Preble's mouse; Ensure appropriate training and certification is obtained for applying herbicides and pesticides when applicable and that labels are properly followed; On private lands, work with landowners to seek and acquire incentives to promote conservation efforts and offset potential costs (Actions: 4.4, 5.0, 5.4)
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Recovery Action Narrative

1. Monitor status of existing populations of the Preble's mouse

- 1.1. Identify Large, Medium, and Small Preble's mouse Recovery Populations.** Recovery populations will be identified in coordination with the appropriate land management agency or landowner. Priority will be given to lands in federal, state, or other public ownership. Most required large and medium recovery populations within the existing range of the Preble's mouse in the North and South Recovery Units have been identified (Table 1); one medium population still needs to be identified in Wyoming. Some small recovery populations must also still be identified. However, all recovery populations will be delineated within 3 years of the establishment of the Site Conservation Team.

Site Conservation Teams will designate remaining recovery populations in each of the following HUCs (Table 1):

- Bijou, Clear Creek, Crow, Glendo Reservoir, Horse, Kiowa, Lone Tree-Owl, Lower Laramie, and Upper Lodgepole HUCs in the Platte drainage (North Recovery Unit)
- Chico HUC of the Arkansas drainage (South Recovery Unit)

At this time, additional survey data are needed to establish whether some of these HUCs are, or are not, occupied by the Preble's mouse. These HUCs will be evaluated based on a number of factors, including targeted surveys in Preble's mouse habitat, assessment of habitat suitability, opportunities for restoration and enhancement, etc. If a HUC is found not to contain any Preble's mouse populations following a survey(s) approved by the USFWS, no recovery populations will be required for that HUC. If a HUC is found to support only one or two small populations, then those populations will be designated as recovery populations, and designation of additional recovery populations will not be required in that HUC. Supporting data will be compiled and presented to the Recovery Team when a HUC is proposed for removal or when the number of required populations is reduced. The Team will then review the results and make a recommendation to the USFWS who will then make a final determination regarding the classification of currently designated HUCs. If a HUC is in need of further evaluation, the Recovery Team and the USFWS will provide guidance on how to proceed.

If Preble's mice are present within a HUC and recovery populations are not designated within 3 years of the establishment of the Site Conservation Team, the USFWS will designate the remaining recovery populations.

- 1.2. Implement long-term monitoring programs.** Monitoring of designated recovery populations is needed to determine their existing size and trend according to the Preble's mouse Population Monitoring Methodology (see Action 1.3). Other monitoring methodologies may be considered in the future, if they are found by the USFWS to be scientifically valid in determining population trend (e.g., occupancy modeling). In Wyoming, for example, it is necessary to conduct genetic testing on captures because of the overlap of Preble's mice and western

jumping mice. This additional component adds substantial cost to the effort. In such cases, the monitoring methodology will need to be tailored to ensure that scientifically valid sampling can be conducted in a cost-effective manner. Site-specific Threat Abatement Plans developed by Site Conservation Teams can be adapted depending on documented trends to better promote recovery. Results of the monitoring will be provided to the USFWS and/or the Recovery Team.

1.2.1. Establish monitoring program for all known large and medium recovery

populations. Designated large and medium recovery populations will be monitored for population sizes and trends according to the Population Monitoring Methodology (see Action 1.3). Monitoring will begin within 2 years of delineation of the Preble's mouse recovery population. Results of the monitoring will be used to evaluate and modify the Threat Abatement Plans using adaptive management.

1.2.2. Establish monitoring program for small recovery populations as needed for

recovery to document persistence. All designated small recovery populations will be monitored at a minimum for presence/absence according to the Population Monitoring Methodology. Monitoring will begin within 2 years of delineation of the Preble's mouse recovery population. Results of the monitoring will be used to evaluate and modify the Threat Abatement Plans using adaptive management.

1.3. Develop a Peer-Reviewed Preble's mouse Population Monitoring Methodology.

A Population Monitoring Methodology will be developed by experts in population monitoring. This will describe a methodology to assess current population status and identify population trends. This Methodology will be completed within 1 year of the approval of this Plan and updated as new scientific information and techniques become available. The state and federal management will propose a Population Monitoring Methodology before approval by the USFWS and the Recovery Team. The Population Monitoring Methodology will be made available on the USFWS website.

1.4. Investigate the potential of establishing new populations within historic Preble's mouse

range. Although we do not anticipate the need for population supplementation or reintroduction in order to recover the Preble's mouse, this investigation will allow for the potential to do so should unforeseen events require more intensive population management.

1.5. Further investigate the genetic variation within and among Preble's mouse populations.

This research will use accepted scientific techniques to further inform the distribution of the Preble's mouse, as well as their genetic diversity and integrity. This research may also be used to refine future recovery strategies.

2. Identify, protect, evaluate, and restore Preble's mouse habitat.

2.1. Develop a Peer-Reviewed Preble's mouse Habitat Monitoring Methodology.

A Habitat Monitoring Methodology will be developed by experts in habitat monitoring. This will describe a methodology to assess current habitat status and identify habitat trends. This Methodology will be completed within 1 year of the approval of this Plan and updated as new scientific

information and techniques become available. The state and federal management agencies will review the proposed Habitat Monitoring Methodology before approval by the USFWS and the Recovery Team. The Habitat Monitoring Methodology will be made available on the USFWS website.

- 2.2. **Map and monitor habitat of Preble's mouse recovery populations.** Habitat within delineated Preble's mouse recovery populations will be mapped as described in the approved Preble's mouse Habitat Monitoring Methodology. Site Conservation Teams will complete this mapping within 2 years of delineation of the recovery population. Preble's mouse habitat in all delineated recovery populations will be monitored to determine trends in habitat quantity and quality, according to the Preble's mouse Habitat Monitoring Methodology. Other monitoring methodologies may be considered in the future if they are found by the Recovery Team and USFWS to be scientifically valid in determining trends in habitat quality and quantity. Results of all habitat monitoring will be reported to the USFWS as required by the Habitat Monitoring Methodology. Results of the monitoring will be maintained by the USFWS.
- 2.3. **Identify potential Preble's mouse habitat.** Identify and survey potential recovery sites to designate additional recovery populations. Estimated population size and distribution will be necessary to designate the remaining undesignated medium-sized population. Surveys are still needed in the following HUCs:
- Bijou, Clear Creek, Crow, Glendo Reservoir, Horse, Kiowa, Lone Tree-Owl, Lower Laramie, and Upper Lodgepole HUCs in the Platte drainage
 - Chico HUC of the Arkansas drainage

Within other HUCs, additional surveys may prove useful for providing options during the designation of recovery populations and when recovery populations are delineated. Where appropriate, newly discovered populations can replace designated recovery populations if they meet the Recovery Criteria.

- 2.4. **Protect existing Preble's mouse habitat on federal, state, local, and private lands.** Habitat protection of designated recovery populations is needed to maintain habitat quantity and quality as required for recovery. Non-designated populations are important because they could contain genetic information not found in designated populations. Protection of non-designated sites also provides additional research locations as well as replacement or alternative recovery populations if needed to meet recovery goals. Site Conservation Teams will work with land management agencies and land owners to identify habitat protections needed within populations and to implement these actions.
- 2.4.1. **Protect and conserve Preble's mouse populations through federal actions.** Section 7 of the ESA mandates that all federal agencies shall utilize their authorities to conserve listed species on their lands. To implement Preble's mouse recovery, federal agencies are responsible for identifying, protecting and mapping all Preble's mouse populations on federal lands, abating threats, and where biologically appropriate, restoring and/or improving habitat on their lands to enhance Preble's mouse populations. When conducting, funding or permitting activities on non-federal land, each federal agency will ensure those

activities include measures that support recovery objectives. At federal sites with a history of Preble's mouse research that research will continue in order to facilitate gathering long-term information on Preble's mouse habitat and ecology.

- 2.4.2. Protect and conserve Preble's mouse populations through state and local public agency actions.** State agencies and county and municipality open space programs all manage lands known to support the Preble's mouse. To further Preble's mouse recovery, these agencies are encouraged to identify and protect all Preble's mouse populations, abate threats, and where biologically appropriate, restore and/or improve Preble's mouse habitat on these lands. Cooperative agreements or other mechanisms will be encouraged to protect and conserve the Preble's mouse and its habitat.

Public water boards, water conservation districts and other water management entities are encouraged to evaluate how current management and proposed future actions might affect the Preble's mouse, determine what actions might be taken to minimize impacts or improve conditions, and implement actions to support Preble's mouse recovery.

- 2.4.3. Protect and conserve Preble's mouse populations on private lands.** Private lands are important to the recovery of the Preble's mouse throughout its range. To implement Preble's mouse recovery, private landowners are encouraged to identify and protect Preble's mouse populations, abate threats, and where biologically appropriate, restore and/or improve Preble's mouse habitat on their lands. Private landowners must ensure that actions on their properties do not result in unpermitted take as defined by the ESA. Private landowners are encouraged to work with public agencies to implement recovery activities on their lands.

- 2.5. Restore riparian systems on federal, state, local, and private lands.** The restoration of habitat is an important component of the recovery of the Preble's mouse. Because of the subspecies' limited habitat preferences, impacts to existing habitat could greatly affect the overall health of populations. Efforts to restore habitat that has been impacted by human activities or natural events should be accomplished to provide the highest quality habitat over its range (for example Poff *et al.* 1997). Site Conservation Teams will work with land management agencies and landowners to identify habitat needing restoration and to implement such restoration.

- 2.5.1. Map riparian systems in need of restoration.** The data developed in Action 2.2 would provide the basis for those riparian systems that are in need of restoration.

- 2.5.2. Develop restoration plan for riparian systems.** Each Site Conservation Team will work with land management agencies and land owners with Preble's mouse habitat to develop a restoration plan, if they have not done so already, that defines standards and procedures for conducting riparian restoration projects based on accepted riparian restoration guidelines.

2.5.3. Develop or update existing restoration guidance for riparian systems on private lands. Restoration guidance that helps private landowners restore their riparian habitat is important. Develop or update existing documents that describe standard, accepted methods to restore riparian systems, cost associated with these restoration efforts, sources of funding for restoration projects in the form of landowner incentive programs, grants, sources for technical assistance, etc.

2.5.4. Restore riparian systems and hydrologic integrity. Restoration projects need to be prioritized and initiated for riparian systems identified in Action 2.5.1 using standards and procedures established in Action 2.5.2. Provide assistance to private landowners seeking to restore their riparian systems.

2.5.5. Establish a monitoring program to assess the effectiveness of restoration efforts. Establishing a monitoring program is an important component of any restoration effort. Without developing a monitoring program for restoration efforts, the effectiveness of these efforts would not be known. Monitoring needs to consist of consistent, standardized protocol for measuring the quality of riparian habitat. Part of this monitoring effort could include regular surveys to document Preble's mouse activity in the area.

2.6. Restore and maintain habitat connectivity. When restoration and other habitat projects are planned, consideration should be given to areas that maintain or enhance connectivity. Particular attention should be paid to areas that promote connectivity between known populations as well as between a known population and currently unoccupied, but suitable habitat in order to promote genetic exchange and increase access to suitable habitat. Site Conservation Teams will work with land management agencies and land owners to ensure habitat connectivity is maintained and restored during all habitat projects.

2.7. Minimize and investigate the threat of non-native plants to Preble's mouse and riparian systems. The importance of non-native plants as a threat to Preble's mouse is currently unknown. When assessing and maintaining habitat, it is important to evaluate this threat on Preble's mouse populations and, where appropriate and necessary, to minimize the threat of non-native plants.

3. Create, strengthen and enforce regulatory mechanisms to protect riparian habitat and minimize or remove identified threats to the Preble's mouse.

3.1. Work with local and county land use planning agencies to ensure protection of Preble's mouse habitat in residential and commercial development. Regulatory mechanisms need to be implemented to ensure Preble's mouse populations and habitats are considered and protected when planning for residential and commercial development.

3.2. Work with federal, state, county and local transportation agencies and industry stakeholders to ensure protection of Preble's mouse habitat in transportation corridor planning. Transportation corridors frequently bisect the riparian habitat upon which Preble's mice depend. Regulatory mechanisms need to be developed and implemented to ensure

Preble's mouse habitat is considered and protected when planning for new corridors and maintaining existing corridors.

- 3.3. **Work with federal, state, county and local open space/parks and recreation agencies to ensure protection of Preble's mouse habitat in recreational planning.** Designated green spaces and recreation areas can provide habitat for the Preble's mouse. However, development for the purposes of recreation, such as trails, needs to be compatible with the persistence of Preble's mouse populations and ensure Preble's mouse habitats are protected.
- 3.4. **Work with federal, state, county and local utility agencies and industry stakeholders to ensure protection of Preble's mouse habitat in utility rights-of-way planning.** Utility corridors frequently bisect the riparian habitat upon which the Preble's mouse depends. Regulatory mechanisms need to be developed and implemented to ensure Preble's mouse habitat is considered and protected when planning for new corridors and maintaining existing corridors.
- 3.5. **Work with federal, state, county, local and industry stakeholders to ensure protection of Preble's mouse habitat in water planning.** Water use can impact Preble's mouse populations in a variety of ways, including changing stream flows and removing habitat through creation of reservoirs. Regulatory mechanisms need to be implemented to ensure Preble's mouse populations and habitats are considered and protected when planning for water development and use projects.
- 3.6. **Work with state, county and local agencies and industry stakeholders to ensure protection of Preble's mouse habitat in aggregate mine planning.** Aggregate mining may impact Preble's mouse habitat through changes in hydrology as well as through direct habitat loss. Regulatory mechanisms are needed to ensure that Preble's mouse habitat is considered and protected when planning for aggregate mining operations. These regulatory mechanisms should extend through and beyond the lifespan of the mine to ensure habitat is not lost during reclamation efforts.
- 3.7. **Work with state, county and local agencies and industry stakeholders to ensure protection of Preble's mouse habitat in oil/gas/mineral exploration and extraction.** Natural resource exploration and extraction is likely to continue throughout the range of the Preble's mouse. Regulatory mechanisms are needed to ensure Preble's mouse populations and habitat are considered and protected when planning for natural resource extraction projects. Regulatory mechanisms should extend through and beyond the lifespan of the extraction operation and should include any associated infrastructure that may impact Preble's mouse habitat in the vicinity of the extraction operation.
- 3.8. **Encourage landscape level planning to reduce threats and protect/restore Preble's mouse habitat.** Although individual threats may be localized on the landscape, it is important to think broadly when developing regulatory mechanisms. Development plans need to consider potential impacts to Preble's mouse populations and their habitats beyond the boundaries of the project area in order to minimize impacts up and down stream as well as the creation of movement barriers.

4. **Remove, minimize, or investigate other natural or manmade threats.**
 - 4.1. **Minimize the potential catastrophic effect of drought, flood, wildfire, and climate change on the Preble's mouse.** Preble's mice are exposed to a number of landscape level threats, both natural and manmade, that have the potential to negatively impact populations. The spatial and temporal extent of these threats can vary. Although these threats cannot be completely removed, some steps can be taken to minimize the threats. Establishing multiple populations (see Action 1.1) and developing a plan that would set forth an emergency response would help to minimize the likelihood the populations would be extirpated by a single catastrophic event.
 - 4.2. **Develop and implement emergency response plan, if warranted.** An emergency response plan would consist of steps needed to protect and conserve the affected populations and habitat during the emergency response activities following catastrophic events. This plan should include but not be limited to: restoration of impacted habitat and initiation of survey and monitoring activities post-event.
 - 4.3. **Minimize and investigate the threat of urban/human supported wildlife populations within riparian systems.** The presence of house mice in Preble's mouse habitat has been suggested to pose a competitive threat to the Preble's mouse, and human-associated predators can directly kill the Preble's mouse when present. Quantifying these threats will be important to better understand their impact on Preble's mouse populations within areas that also support human populations.
 - 4.3.1. **Identify if and to what extent human-supported wildlife populations impact Preble's mouse populations and their habitat.** Human-supported wildlife may have varying impacts on Preble's mouse populations. These impacts need to be quantified in order to develop appropriate management actions.
 - 4.3.2. **Work with landowners to remove or minimize factors that attract urban/human-supported wildlife populations, if appropriate.** By eliminating or minimizing factors that attract or benefit house mice and human-associated predators (i.e., abandoned buildings, non-animal proof garbage containers, etc.), these human-supported wildlife populations would be less likely to establish in riparian systems.
 - 4.3.3. **Monitor the effectiveness of reducing the occurrence of urban/human-supported wildlife within Preble's mouse habitat.** A monitoring program needs to be established to monitor the status of human-supported wildlife in Preble's mouse habitat.
 - 4.4. **Minimize and investigate the threat of pesticides and herbicides on the Preble's mouse and riparian systems.** The impact of pesticides and herbicides on the Preble's mouse is currently unknown. Additional investigation is needed to assess the level of this potential threat, and, where appropriate and necessary, actions will need to be taken to minimize this threat to the Preble's mouse and its habitat.

5. **Facilitate stewardship of Preble's mouse recovery through increased public awareness and education.** Education of the general public, private landowners, commercial landowners, etc., can facilitate recovery of the subspecies. The following actions would help to develop an effective outreach plan for a wide range of audiences.
- 5.1. **Provide information on the Preble's mouse.** Develop and implement strategies for distributing information on Preble's mouse ecology, and conservation.
- 5.2. **Provide information on threats to the Preble's mouse and minimization strategies.** Develop and implement strategies for distributing information on threats and threat abatement strategies.
- 5.3. **Provide information on laws and regulations.** Develop and implement strategies for distributing information on the ESA and related laws and regulations.
- 5.4. **Develop and provide incentives to abate threats and conserve Preble's mouse and its habitat.** Encourage the development of federal, state, and county incentive programs for conservation of the subspecies and its habitat for private and public landowners. Build partnerships and collaborative processes among the public and private entities to leverage resources and achieve economies of scale.
- 5.4.1. **Encourage the development of Preble's mouse recovery funds.** These funds may be provided by federal, state, and local governments, as well as private sources. All federal, state, and local agencies should investigate methods of funding implementation of Preble's mouse recovery.
- 5.4.2. **Support efforts to create tax incentives at federal, state, and/or county levels to encourage active conservation measures to recover the subspecies.** Tax incentives should recognize possible loss of use or value of private property caused by designation and requirements of a Site Conservation Team Threat Abatement Plan. Examples include:
- Federal tax benefits to landowners of designated recovery sites
 - Tax credits of up to 100 percent for expenditures for furthering the recovery of the Preble's mouse
 - Provide for a property tax credit for private property or a portion thereof that is managed to promote recovery of Preble's mouse
 - Deductions from the gross estate of a decedent in an amount equal to the value of real property subject to designation as a recovery site
- 5.4.3. **Support efforts to establish a system of awards and rewards for participation in voluntary and cooperative Preble's mouse recovery site designation, monitoring, and conservation.** Examples of award and reward programs may include:
- Encourage the development of federal, state, and/or county grants for Preble's mouse recovery sites
 - Provide transfer of development rights that are equivalent to the current county zoning

- Streamline, reduce, or eliminate regulations and administrative paperwork to expedite conservation and management of recovery sites

5.4.4. Support additional incentives to promote recovery efforts on private lands, including establishing conservation easements, mitigation banks, safe harbor agreements, or other protective measures. Most habitat occurs on private lands, and currently there is a lack of incentives available to assist private landowners in managing and protecting habitat. Additional funding and attention from all involved parties will be needed to successfully implement this Recovery Plan. Incentives should be developed to encourage participation, build partnerships and collaboration, foster cooperation with recovery efforts, and offset potential costs associated with recovery efforts.

IMPLEMENTATION SCHEDULE

The following implementation schedule outlines the recovery actions with associated time and cost estimates for the Preble's Mouse Recovery Plan. This schedule is a guide for meeting the recovery objectives and criteria within this Plan. It provides the Action Number, a description of the action to be performed, and an assigned priority for the Recovery Action. It also identifies the agency(s) and/or other Lead Parties that are the best candidates for accomplishing the Recovery Action. We envision that the Lead Party(ies) will coordinate and vet actions; however, the Lead Party(ies) are not expected to fund the entire effort. Instead, the costs of recovery will be shared among all parties, though the amount contributed by each party will vary depending on the action, availability of resources, in-kind contributions, etc. In addition, the USFWS commits to sharing costs and supporting recovery efforts with direct funding and other resources, such as grants or in-kind contributions.

The schedule is laid out by the overarching recovery actions and associated actions needed to help achieve the overarching recovery action. Recovery action priorities, time and cost estimates, and responsible parties are not assigned to the overarching recovery actions. The reader should refer to the recovery narrative outline for a full description of all identified recovery actions. Implementation of all actions listed in the implementation schedule will lead to recovery. Initiation of these actions is subject to availability of funds.

Key to Action Priority Numbers (Column 1)

<u>Priority #</u>	<u>Priority Definition</u>
1	Any action that must be taken to prevent endangerment or prevent the species from declining irreversibly in the foreseeable future
2	Any action that must be taken to prevent a significant decline in the species' population, habitat quality, or some other significant negative impact short of endangerment
3	All other actions necessary to provide full recovery

Key to Acronyms for Agencies and Organizations

CDA = Colorado Department of Agriculture
CDOT = Colorado Department of Transportation
COG = Council of Government
Consults = Consultants
CPW = Colorado Parks and Wildlife
CNHP = Colorado Natural Heritage Program
CWCB = Colorado Water Conservation Board
DEQ = Wyoming Department of Environmental Quality
DRMS = Division of Reclamation Mining and Safety
USFWS = United States Fish and Wildlife Service
NGO = Non-Governmental Organizations
PUC = Public Utilities Commission
RTD = Regional Transportation District
SCT = Site Conservation Team

TPR = Transportation Planning Region
Univs = Universities
USAFA = United States Air Force Academy
USACOE = United States Army Corp of Engineers
USDA = United States Department of Agriculture
USDOE = United States Department of Energy
USFS = United States Forest Service
WDA = Wyoming Department of Agriculture
WGFD = Wyoming Game and Fish Department
WYDOT = Wyoming Department of Transportation
WYNDD = Wyoming Natural Diversity Database

Key to Definitions for Terms Used

On-going Task is currently being implemented and will continue until actions are no longer necessary for recovery, currently estimated to be at least 10 years.

Priority Number: 1 – High Priority, 2 – Medium Priority, 3 – Low Priority

Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
	1	Monitor Status of Existing Populations of Preble's mouse										
1	1.1	Identify large medium and small Preble's mouse recovery populations	1,2	3 years	CPW, WGFD	CNHP, SCTs, WYNDD, USAFA, USFS, USFWS, Counties, Cities	240	80	80	80		
2	1.2.1	Establish monitoring programs for all known large and medium recovery populations	1	on-going	CPW, WGFD	USFWS, SCTs, USAFA, USDOE, USFS, Counties, Cities	2,000	200	200	200	200	200
2	1.2.2	Establish monitoring programs for small recovery populations as needed for recovery to document persistence	2	on-going	CPW, WGFD	USFWS, SCTs, USAFA, USDOE, USFS, Counties, Cities	1,000	100	100	100	100	100
2	1.3	Develop a peer-reviewed Preble's mouse population	1,2	2 years	USFWS	Univs, NGOs, Consults, CPW, WGFD	30	15	15			

		monitoring methodology										
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
3	1.3	Investigate the potential of establishing new populations within historic Preble's mouse range	1,2	1 year	USFWS	CPW, SCTs, WGFD	5			5		
3	1.4	Further investigate the genetic variation within and among Preble's mouse populations	1,2	2 years	USFWS	CPW, WGFD, CNHP, WNDD	200		100	100		
	2	Identify, Protect, Evaluate and Restore Preble's mouse Habitat										
2	2.1	Develop a peer-reviewed Preble's mouse habitat monitoring methodology	3	2 years	USFWS	Univs, NGOs, Consults, CPW, WGFD	30	15	15			
2	2.2	Map and monitor habitat of recovery populations	3	on-going	CPW, WGFD	USFWS, USAFA, USDOE, USFS, SCTs, Counties, Cities	400	40	40	40	40	40
2	2.3	Identify potential	3	1 year	CPW, WGFD	USFWS, SCTs,	50		50			

		Preble's mouse habitat				USAFA, USDOE, USFS, Counties, Cities						
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
2	2.4.1	Protect and conserve Preble's mouse populations through federal actions	3,4	on-going	USFWS	USFS, USAFA, USDOE,	500	50	50	50	50	50
2	2.4.2	Protect and conserve Preble's mouse populations through state and local public agency actions	3,4	on-going	CPW, WGFD	Counties, Cities	500	50	50	50	50	50
2	2.4.3	Protect and conserve Preble's mouse populations on private lands	3	on-going	CPW, WGFD	CDA, SCTs, WDA, NGOs,	500	50	50	50	50	50
2	2.5.1	Map riparian systems in need of restoration	3	on-going	USFWS	USFS, USAFA, CPW, SCTs, WGFD, CNHP, WNDD, Counties, Cities	45			10	5	5

2	2.5.2	Develop restoration plan for riparian systems	3	3 years	USFWS	SCTs, CPW, WGFD	60	20	20	20		
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
3	2.5.3	Develop or update existing restoration guidance for riparian systems on private lands	3	3 years	NGO	USFWS	60	20	20	20		
2	2.5.4	Restore riparian systems	3	on-going	CPW, WGFD	USFS, USAFA, SCTs, Counties, Cities	5,000	500	500	500	500	500
3	2.5.5	Establish a monitoring program to assess the effectiveness of restoration efforts	3	5 year	USFWS	CPW, WGFD, SCTs, Counties, Cities	25	5	5	5	5	5
2	2.6	Restore and maintain habitat connectivity	3	on-going	CPW, WGFD	USFS, USAFA, SCTs, Counties, Cities	500	50	50	50	50	50
3	2.7	Minimize and investigate the threat of non-native plants to Preble's mouse	3	on-going	USFWS	USFS, USAFA, CPW, WGFD, CNHP,	150	30	30	30	30	30

		and riparian systems				WNDD, Counties, Cities						
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
	3	Create, Strengthen and Enforce Regulatory Mechanisms to Protect Riparian Habitat and Minimize or Remove Identified Threats to Preble's mouse										
1	3.1	Work with local and county land use planning agencies to ensure protection of Preble's mouse habitat in residential and commercial development	4	on-going	USFWS	CPW, WGFD	50	5	5	5	5	5
1	3.2	Work with federal, state, county, and local transportation agencies and industry stakeholders to ensure protection of Preble's mouse habitat in transportation corridor planning	4	on-going	USFWS	CDOT, Counties, TPRs, WYDOT, COGs, RTD	50	5	5	5	5	5

2	3.3	Work with federal, state, county, and local open space/parks and recreation agencies to ensure protection of Preble's mouse habitat in recreational planning	4	on-going	USFWS	Counties, Cities, USFS, CPW, WGFD,	50	5	5	5	5	5
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
3	3.4	Work with federal, state, county and local utility agencies and industry stakeholders to ensure protection of Preble's mouse habitat in utility rights-of-way planning	4	on-going	USFWS	PUCs	50	5	5	5	5	5
2	3.5	Work with federal, state, county, local and industry stakeholders to ensure	4	on-going	USFWS	CWCB, Water Districts, USACOE, County	50	5	5	5	5	5

		protection of Preble's mouse habitat in water planning				Water Boards						
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
3	3.6	Work with state, county and local agencies and industry stakeholders to ensure protection of Preble's mouse habitat in aggregate mine planning	4	on-going	USFWS	DRMS, Mining industry, DEQ	50	5	5	5	5	5
2	3.7	Work with state, county and local agencies and industry stakeholders to ensure protection of Preble's mouse habitat in oil/gas/mineral exploration and extraction	4	on-going	USFWS	DRMS, Mining industry, DEQ	50	5	5	5	5	5
1	3.8	Encourage landscape level planning to	4	on-going	USFWS	CPW, WGFD, Counties,	100	10	10	10	10	10

		reduce threats and protect/restore Preble's mouse habitat				Cities, NGOs						
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
	4	Remove, Minimize or Investigate Other Natural or Manmade Threats										
2	4.1	Minimize the potential catastrophic effect of drought, flood, wildfire, and climate change on Preble's mouse	3,4	on-going	USFWS	CPW, WGFD, USFS, USACOE, State Forest, Special Districts, Counties, Cities	100	10	10	10	10	10
3	4.2	Develop and implement emergency response plan if warranted	3,4	1 year	USFWS	CPW, WGFD	50	50				
3	4.3.1	Identify if and to what extent human-supported wildlife populations impact Preble's mouse and their habitat	1, 2, 3	2 years	NGO	USDA	60	30	30			
3	4.3.2	Work with landowners to	1, 2, 3	on-going	USDA		100	10	10	10	10	10

		remove or minimize factors that attract urban/human-supported wildlife populations, if appropriate										
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Duration	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
3	4.3.3	Monitor the effectiveness of management actions to reduce the occurrence of urban/human-supported wildlife within Preble's mouse habitat	1, 2, 3	5 years	USDA		10	2	2	2	2	2
3	4.4	Minimize and investigate the threat of pesticides and herbicides on Preble's mouse and riparian systems	3	on-going	FWS	CPW, WGFD, Univs, Counties, Cities, USFS, USAFA,	70	15	15	5	5	5
	5	Facilitate Stewardship of Preble's mouse Recovery Through Increased Public Awareness and Education										
3	5.1	Provide information on Preble's mouse		on-going	CPW, WGFD	USFWS, USFS, Consults,	100	10	10	10	10	10

						NGOs, SCTs, Counties, Cities						
Priority Number	Action Number	Action Description	Recovery Criteria Number	Action Durati on	Lead Party	Other Parties	Total Costs (\$1,000s)	FY1	FY2	FY3	FY4	FY5
3	5.2	Provide information on threats to Preble's mouse and minimization strategies		on- going	CPW, WGFD	USFWS, USFS, Consults, NGOs, SCTs, Counties, Cities	100	10	10	10	10	10
3	5.3	Provide information on laws and regulations		on- going	CPW, WGFD	USFWS, USFS, Consults, NGOs, SCTs, Counties, Cities	100	10	10	10	10	10
3	5.4	Provide information on incentives		on- going	CPW, WGFD	USFWS, Consults, NGOs, SCTs, Counties, Cities, CDA, WDA	100	10	10	10	10	10

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Appendix A. Glossary

Abundance Estimate. An estimate of the number of individuals within a specific area.

Adaptive Management. Refers to a process in which policy decisions are implemented within a framework of scientifically driven experiments to test predictions and assumptions inherent in management plans. In most management situations, there is little past experience, or knowledge is lacking for some aspects of Preble's mouse biology. Although research is recommended in this plan, research may take years to complete. The only practical approach is adaptive management, where some type of management is specified, population responses are monitored, the outcome is evaluated, and management is adjusted accordingly. Any modifications will be vetted through and agreed upon by state and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation by the USFWS. This process will continue until definitive research is completed, and self-sustaining Preble's mouse populations are documented.

Collaborative process. The process of individuals, governmental groups, and any other willing partners working together to resolve an issue. For example, the USFWS, Colorado Parks and Wildlife, Wyoming Game and Fish Department, and others will work with local governments and Site Conservation Teams to address tasks identified within the Plan.

Conservation Status. The status of the preservation, protection, and management of an environment that takes into account recreational and aesthetic needs, in addition to preserving the natural fauna and flora and allowing for harvesting of natural resources and agriculture.

Conserve. In general, to keep natural resources in a safe or sound state, and avoid wasteful or destructive uses. Specific to the ESA, to use all methods and procedures necessary to bring a listed species to the point at which the measures provided pursuant to the ESA are no longer necessary.

Cooperative Agreement. An agreement between governmental agencies, organizations, or private individuals, that outlines responsibilities, authorities, limitations, future actions, and funding within a given time period.

Cross-Site. Having application to more than one Preble's mouse population. For example, the population and habitat monitoring plans will be used for all Preble's mouse populations and will have a cross-site function.

Delineated. For this plan, the process that establishes the exact boundaries of a designated Preble's mouse recovery population.

Demography. The study of populations, size, density, distribution, trend, and other vital statistics of the population.

Designated. For this plan, the selection of recovery populations and sites required to delist the subspecies at the landscape level within river drainages, or hydrological units. For example, a medium Preble's mouse recovery population is designated in the upper Monument Creek drainage.

Distribution. The occurrence of a species over that total area in which it occurs, that is, its range.

Effective Population Size. The number of breeding individuals in a population. The effective population size is usually smaller than the actual population size.

Ecological Process(es). The physical, chemical, and biological processes vital to the integrity of maintaining Preble's mouse habitat (e.g., a hydrological regime that supports a dynamic riparian community, plant succession, and periodic disturbance).

Ecosystem. A dynamic complex of plant, animal, fungal, and microorganism communities and their associated nonliving environment interacting as an ecological unit.

Emigration. The movement of organisms beyond the area they currently inhabit to a new area they inhabit.

Exotic. Introduced from another location. Plants and animals not native to the location where currently found.

Fragmentation. The disruption of extensive habitats into smaller, isolated patches. Fragmentation has two negative components: loss of total habitat area, and isolation of remaining habitat patches.

Front Range. A mountain range on the eastern edge of the Rockies in north-central Colorado and southeastern Wyoming. The term commonly refers to the area where the eastern boundary of the Rocky Mountains meets the western boundary of the Great Plains, the Colorado piedmont. Within Colorado and Wyoming, much of the human population and growth is located in this area, including the cities of Colorado Springs, Denver, and Fort Collins, Colorado, and Cheyenne, Wyoming.

Federal Lands. Land owned, or administered, by the U.S. government agencies. For this plan, this includes, but is not limited to, lands owned by the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, Department of Defense, and Department of Energy.

Functionally Connected Streams. A stream or riparian corridor with no barriers (e.g., exposed unvegetated riprap, concrete, asphalt, etc.) or with only small stretches of less than suitable habitat that Preble's mouse is capable of traversing and maintaining genetic flow between otherwise fragmented habitat. For the purpose of this plan, streams are functionally connected if the distance of less than suitable habitat (but not bare ground) is less than ¼ mile; approximately 2 times the documented travel distance (215 meters) of Preble's mice in unsuitable habitat.

Habitat. Suite of existing environmental conditions required by an organism for survival and reproduction. The place where an organism typically lives.

Habitat Fragmentation. See Fragmentation.

Habitat Conservation Plan(s) (HCP). Under section 10 of the ESA, a planning document that is a mandatory component of an incidental take permit application. The process is an opportunity to provide species protection and habitat conservation within the context of non-federal development and land use activities. Overall, the HCP process promotes negotiated solutions to endangered species conflicts, and provides an alternative to litigation.

Hibernacula/Hibernaculum. A shelter used during the winter by a dormant animal. For Preble's mouse, hibernating animals enter an underground nest in the fall, where they remain until late spring. Successful Preble's mouse hibernacula appear to be located above the riparian zone, to avoid flooding during the normal spring run-off.

Historic Range. The area known to have been used by an animal within modern times.

HUC (Hydrologic Unit Code). Watersheds are delineated by the U.S. Geological Service using a nationwide system based on surface hydrologic features. This system divided the country into 21 regions (2-digit), 222 subregions (4-digit), 352 accounting units (6-digit), and 2,262 cataloguing units (8-digit). Eight-digit HUCs are used within the Recovery Plan as a means of assessing distribution of populations and assessing risks to populations from storm events.

Hydrology. The science of the properties of water, including the distribution and circulation of water on the surface of the land, in the soil, underlying rocks, and the atmosphere.

Immigration. The movement of individuals from other areas into a given area.

Implement. To give practical effect, and ensure actual fulfillment by concrete measures.

Landscape. As used in the recovery plan, refers to broad heterogeneous geographic areas characterized by diverse interacting ecosystems that also include the interaction of land use, land cover and ecological processes.

Mean. The sum of a set of scores divided by the number of scores, the average. For example, the mean of the numbers 13, 9, 12 and 10 is 11 (sum of 44 divided by 4).

Mesic. Relating to conditions between wet or dry, moderately moist. The specific quality of being adapted to moderate moisture.

Model. A representation of reality, based on a set of assumptions that is developed and used to describe, analyze, and understand the behavior of a system.

Monitoring. The process of collecting information to track changes over time.

Monitoring Plan. A detailed program of action to collect information over time.

Monitoring Methodology. For this plan, the established method of collecting information to track changes in populations and habitat.

Noxious Weeds. Those plants designated by the State of Colorado, the State of Wyoming, or local government under weed control regulations.

Overstory. The highest limbs and foliage of a tree, and consequently extending and relating to the upper layers of a forest canopy.

Occupancy. Within this Plan, the occurrence of Preble's mouse within a given area. One individual within a given area is equal to "occupancy."

Peer Review. Review by others knowledgeable in the subject. For this Plan, the Recovery Team and the USFWS received comments on various aspects of this Plan from knowledgeable experts not involved in the development of this Plan.

Persistence. The capacity of a population to maintain numbers and distribution over time.

Population. A collection of individuals per unit area.

Population viability. The probability that a population will persist for a specific period of time.

Potential Recovery Site. Sites identified in the recovery plan that may support a small or medium population of Preble's mouse; however, the presence of Preble's mouse at these sites was not known at the time the recovery plan was developed.

Prescribed Fire. Prescribed fire is the controlled application of fire under specified environmental conditions (the "prescription") to accomplish specific natural resources management objectives. Fires may be planned or unplanned ignitions. The use of unplanned ignitions are predicated on an established fire management plan specific to the area, and are usually manned to agency standards as long as they stay within the prescription. Once any prescribed fire exceeds the parameters established in the prescription, it is either controlled immediately, or if it escapes control, becomes classified as an escaped fire which triggers emergency suppression response the same as any other wildfire.

Range. The region to which a plant or animal is native.

Recovery. As provided by the Endangered Species Act and its implementing regulations, the process of returning a threatened or endangered species to the point at which protection under the Endangered Species Act is no longer necessary.

Recovery Plan. As provided by the Endangered Species Act, a plan for management of a threatened or endangered species that lays out the steps necessary to recover a species.

Recovery Team. A team made up of experts appointed by the U.S. Fish and Wildlife Service whose charge is development of a draft recovery plan. The team serves only in an advisory capacity to USFWS, with the USFWS responsible for producing a final approved recovery plan.

Recovery Unit. Recovery units are individually necessary to conserve genetic and demographic robustness for the Preble's mouse. The recovery plan identifies two recovery units: 1) North Recovery Unit and 2) South Recovery Unit. Both recovery units are necessary for the viability of Preble's mouse, and both recovery units need to meet the recovery criteria before the Preble's mouse can be delisted.

Recruitment. The addition of individuals to a population from birth and immigration.

Redundancy. Redundancy contributes to the ability of population types to withstand catastrophic events (hurricanes, wildfires, etc.). The number and distribution of populations of each representative type contribute to the retention of the various representative types, despite catastrophic events, by ensuring that the loss of a population doesn't lead to the loss of representation.

Representation. Representation is the breadth of genetic, ecological, demographic, and behavioral diversity across a species' range and may contribute to its capacity to adapt over time. Measures of genetic and life history variability among populations, distribution of populations across a range of ecologically diverse locations or niches, etc., on the landscape are considered.

Resilience. Resilience is a species' or population's potential to adapt in response to rapidly changing environmental conditions and refers to the ability to tolerate environmental and demographic stochasticity, such as fluctuations in temperature or genetic drift.

Richness. The number of species in a community.

Riparian. Of or relating to a river; specifically applied to ecology, "riparian" describes the land immediately adjoining and directly influenced by streams. For example, riparian vegetation includes any and all plant-life growing on the land adjoining a stream and directly influenced by that stream.

Self-Sustaining Population. For this Plan, a population of animals that maintains itself through natural reproduction within its habitat.

Site Conservation Team. The Site Conservation Team will help guide and implement the recovery plan at the local level, and should include stakeholders from federal, state, and local agencies, and private landowners. A Site Conservation Team may work with more than one designated recovery population.

Stochastic. Random or uncertain.

Subspecies. A variety of organisms distinguished from other varieties of the same species. Often an incomplete tendency toward reproductive isolation is a factor in designating and naming a subspecies.

Succession. The natural, sequential change of species composition of a community in a given area. For example, community development begins with pioneering species, which are replaced by a series of other species, until a relatively stable community is established that is in equilibrium with local conditions. However, the introduction of disturbances (fires, floods, etc.) to the existing conditions may reset the communities to the pioneer species.

Suitable Habitat. Well-developed riparian vegetation consisting of a fairly dense combination of grasses, forbs, and shrubs, typically willows, with the possible inclusion of a taller tree and shrub canopy; relatively undisturbed adjacent grassland communities, which may include hayfields; and a nearby water source, which may range from large perennial rivers such as the South Platte River to small ephemeral drainages only 3 to 10 feet in width.

Take. As defined in the ESA and implementing regulations, take means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect a species [listed as threatened or endangered], or attempt to do so.” “Harass” and “harm” are further defined in federal regulations and case law as follows:

“Harass” means an intentional or negligent act or omission that creates the likelihood of injuring wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns that include, but are not limited to, breeding, feeding, or sheltering.

“Harm” means an act that actually kills or injures wildlife. Such acts may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

Taxa. Plural of taxon.

Taxon. Any grouping within the classification of organisms, such as species, genus, and order.

Taxonomy. The classification of fossil and living organisms according to knowledge of their evolutionary relationships.

Team. The Preble’s Meadow Jumping Mouse Recovery Team.

Transition Slope. The habitat that exists between the riparian zone and the dry upland habitat.

Upland. For this plan, “upland” habitat refers to the dry habitats that are often grasslands surrounding a riparian zone. The upland habitat, in context with the riparian and transitional habitat, is an important habitat component for Preble’s mouse.

Viability. The ability of a population to persist through time.

Wild. Living in a state of nature and not ordinarily tame or domesticated.

Xeric. Of or relating to perennially dry conditions or the specific quality of being adapted to dry conditions.

Appendix B. Threat Assessment

Parameters and Ranking Values

Threat assessment parameters and ranking values were defined as (the value within the parentheses (), below, denotes the corresponding numeric value assigned):

Severity - measure of the degree or level that a stressor poses a threat to the subspecies or its habitat over time under current conditions.

Level of Impact - degree reference for severity. Level of Impact is defined as the degree at which the stressor poses a threat. Ranking values were: High (4); Medium (3); Low (2); Unknown (1).

Immediacy - temporal reference for severity. Immediacy is defined as a stressor that is occurring now or is a potential stressor in the future. Ranking values were: Current stressor (2); Potential stressor (1).

Likelihood - likelihood is defined as the likelihood the stressor in itself could cause endangerment of the subspecies. This was a way of measuring the degree by which the stressor is an independent stressor or a cumulative/additive stressor. In other words, does it pose an endangerment threat by itself or does it pose an endangerment threat not by itself, but in combination with other stressors? Ranking values were: High (4) - high likelihood that could cause endangerment by itself; Moderate (3) - somewhat likely it could cause endangerment by itself; Low (2) - not very likely it will cause endangerment by itself; Unknown (1).

Scope - the extent, both spatially and temporally, that a stressor poses a threat to the subspecies.

Spatial Extent - a spatial reference for scope. Spatial extent is defined as the geographic extent for which the stressor poses a threat to the subspecies. For instance, does the stressor only pose a threat to part of the known range or the entire range? Ranking values were: Entire (4) - entire range; Regional (3) - more than one part of the range; Local (2) - one part of the range; Unknown (1).

Temporal Extent - a temporal reference for scope. Temporal extent is defined as the seasonal extent for which the stressor poses a threat to the subspecies. For instance, does the stressor only pose a threat during part of the year (e.g., wildfire) or the entire year (e.g., development)? Ranking values were: Continuous (3) - all the time; Seasonal (2) - part of the year; Unknown (1).

Management - management is defined as a measure of conservation actions taken to preserve, protect, and/or conserve the subspecies.

Response - the likelihood that a management action(s) to remove the stressor will result in a positive response. Ranking values were: High (4) - high likelihood of responding to management; Medium (3) - medium likelihood of responding to management; Low (2) - low likelihood of responding to management; Unknown (1).

Feasibility - the measure of our ability to develop management for the stressor. This encompasses technical, fiscal, logistical, legal and/or social roadblocks. Ranking values were: Feasible (3) - Feasible to manage; Possible (2) - Possible to manage; Unknown (1).

The threat assessment parameters for each stressor were then given an overall score based on the ranking values.

Score - Score is a priority rank for each stressor. The priority rank score was calculated by summing the values assigned to each threat assessment parameter for each of the stressors. This score attempts to take into account the overall threat a stressor poses to the subspecies and how well these stressors can be abated. This is an attempt to guide us in addressing which stressors result in the greatest threats for the subspecies.

Threat - Threat priority rank score looks at the overall threat the stressor poses to the subspecies based on severity and scope. By ranking stressors just by severity and scope we are able to identify which stressors are perceived to pose the greatest threat to the subspecies. Management parameters were not figured into this score because it was thought that it would obscure which stressors posed the greatest threat. The overall threat rank was calculated by:

Severity Score = Level of Impact + Immediacy + Likelihood

Scope Score = Spatial Extent + Temporal Extent

Overall Threat = Severity Score + Scope Score

Management - Management priority rank score looks at the overall “value” of addressing the threat with some management action. Threat assessment based on severity and scope measures allows us to identify those stressors that are of greatest threat to the subspecies. The management priority rank score allows subsequent prioritization of those stressors based on which ones would give us the best “bang for the buck”. This most notably comes into play when two or more stressors obtain the same priority rank score based on severity and scope measures. The management priority rank score allows those equally scored stressors to be prioritized by which ones would be more effective and feasible to manage. This addresses cost/benefit. The overall management rank was calculated by:

Overall Management = Response + Feasibility

Overall - Overall score is the summation of all severity, scope and management parameter values. This provides the overarching priority of each stressor taking into account the degree of

threat and the management of that threat (i.e., the higher the overall score, the higher the priority). The overall rank was calculated by:

$$\text{Overall} = \text{Overall Threat Score} + \text{Overall Management Score}$$

Threat Scoring Table

Sources	Listing Factor	Severity			Scope		Management		Score				
		Level of Impact (high, medium, low, unknown)	Immediacy (current, potential)	Likelihood (high, moderate, low, unknown)	Spatial Extent (Entire, Regional, local, unknown)	Temporal Extent (Continuous, seasonal, unknown)	Species response to mgmt (high, medium, low, unknown)	Feasibility of mgmt actions (feasible, possible, unknown)	Severity	Scope	Threat (Severity + Scope)	Mgmt	Overall (Threat + Mgmt)
Hydrologic Changes	A, D	High (4)	Current (2)	High (4)	Entire (4)	Continuous (3)	High (4)	Possible (2)	10	7	17	6	23
Residential and Commercial Development	A, D	High (4)	Current (2)	High (4)	Regional (3)	Continuous (3)	High (4)	Feasible (3)	10	6	16	7	23
Transportation, Recreation, and other Rights-of-way Through Habitat	A, D	Medium (3)	Current (2)	Moderate (3)	Entire (4)	Continuous (3)	High (4)	Feasible (3)	8	7	15	7	22
Aggregate Mining	A, D	Medium (3)	Current (2)	Moderate (3)	Regional (3)	Continuous (3)	High (4)	Feasible (3)	8	6	14	7	21
Instability of Small/Isolated Populations	E	Medium (3)	Current (2)	Moderate (3)	Local (2)	Continuous (3)	High (4)	Possible (2)	8	5	13	6	19
Livestock Grazing	A	Low (2)	Current (2)	Low (2)	Regional (3)	Continuous (3)	High (4)	Feasible (3)	6	6	12	7	19
Oil, Gas and Mineral Exploration and Extraction	A, D	Medium (3)	Current (2)	Moderate (3)	Local (2)	Continuous (3)	Medium (3)	Possible (2)	8	5	13	5	18

Secondary impacts of human development (predation and hydrologic changes that are sources by themselves)	E	Medium (3)	Current (2)	Moderate (3)	Local (2)	Continuous (3)	Medium (3)	Possible (2)	8	5	13	5	18
Flood	E	Unknown/V ariable (1)	Potential (1)	High (4)	Entire (4)	Seasonal (2)	High (4)	Possible (2)	6	6	12	6	18
Skunk, Raccoon, Domestic/Feral Cats, Bullfrogs	C	Low (2)	Current (2)	Low (2)	Entire (4)	Continuous (3)	Low (2)	Possible (2)	6	7	13	4	17
Agriculture (row crops, haying, irrigated)	A	Low (2)	Potential (1)	Low (2)	Local (2)	Continuous (3)	High (4)	Feasible (3)	5	5	10	7	17
Non-native Plants	E	Low (2)	Current (2)	Low (2)	Local (2)	Continuous (3)	Medium (3)	Possible (2)	6	5	11	5	16
Wildfire	E	Unknown/V ariable (1)	Potential (1)	Low (2)	Entire (4)	Seasonal (2)	High (4)	Possible (2)	4	6	10	6	16
Drought	E	Medium (3)	Potential (1)	Low (2)	Entire (4)	Seasonal (2)	Unknown (1)	Unknown (1)	6	6	12	2	14
Global Climate Change	E	Unknown (1)	Potential (1)	Unknown (1)	Entire (4)	Continuous (3)	Unknown (1)	Unknown (1)	3	7	10	2	12
Pesticides and Herbicides	E	Unknown (1)	Current (2)	Low (2)	Local (2)	Seasonal (2)	Unknown (1)	Possible (2)	5	4	9	3	12

Appendix C. Research

A research program on Preble's mouse distribution, demography, and ecology whose primary objectives are to enhance understanding of Preble's mouse biology and to assess how land management practices affect Preble's mouse population viability is needed. Information gained from these studies will facilitate recovery by improving the ability to identify the distribution and range of Preble's mouse, more clearly identify management practices that enhance Preble's mouse populations, and identify threats to the persistence and distribution of populations. The research topics listed below are just suggestions and are not prioritized.

- Distribution of Preble's mouse populations
 - Design and conduct studies to better define elevational and ecological boundaries of the range of Preble's mouse. Current information indicates that the upper elevational limit of Preble's mouse is about 7,600 feet in Colorado and 8,100 feet in Wyoming; however, more information is needed to verify this assumption.
 - Design and conduct studies to determine the distribution of Preble's mouse in relation to other closely related species. Studies need to be designed and conducted to determine if and where *Z. h. preblei* occurs sympatrically, allopatrically, or parapatrically with *Z. princeps*, *Z. h. campestris*, and *Z. h. luteus*.
 - Develop and evaluate new methodologies for detecting the presence of Preble's mouse (e.g., camera traps, hair traps, tracking plates, fecal DNA analyses). Simpler, faster, more efficient, and inexpensive survey and monitoring methods will be beneficial to conduct efficient and economical surveys.
 - Conduct research to describe the potential differences among populations of *Z. h. preblei* through systematic and molecular genetic studies. Studies of potential differences among various populations of *Z. h. preblei* will help identify the genetic viability of individual populations and will help guide possible future relocations or translocations of the subspecies between populations if needed.
- Demography of Preble's mouse
 - Conduct studies to estimate over-summer survival, over-hibernation survival, densities, and other trends.
 - Investigate possible factors affecting the demographic parameters listed above to provide information on how habitat can be improved to support high fitness populations of Preble's mouse. These factors include, but are not limited to: weight, sex, age, abundance (i.e., density-dependent response), weather, predation, competition, exotic species, parasitism, and disease.
 - Study dispersal behavior of Preble's mouse. Dispersal is a key process in meta-population theory and maintains genetic diversity between isolated subpopulations. Key research is needed to describe dispersal of individual Preble's mouse within and between populations. This would

include, but is not limited to, who disperses, timing of dispersal, and estimates of the rate of dispersal.

- Design and conduct behavioral and physiological studies to provide information on the mechanisms driving habitat selection.
- Ecology of Preble's mouse populations
 - Does the presence of *Mus musculus* (house mice) and *Rattus norvegicus* (Norway rats) eliminate the presence or suppress the density of Preble's mouse?
 - Does the presence of *Zapus princeps princeps* eliminate the presence or suppress the density of Preble's mouse?

An experimental research program on Preble's mouse habitat is needed. The primary objectives are to enhance our understanding of Preble's mouse habitat and to assess how land management practices affect Preble's mouse population viability. Information gained from these studies will facilitate recovery by improving our ability to more clearly define, qualify, and quantify Preble's mouse habitat elements, more clearly identify management practices that enhance Preble's mouse habitat, and help develop threat abatement strategies for Preble's mouse habitat.

- Preble's mouse habitat
 - Identify and describe habitat used for nesting, breeding, cover, travel, feeding, dispersal, and hibernation.
 - What habitat results in the highest density and survival of Preble's mouse?
 - What habitat features facilitate or impede the most successful dispersal?
 - What habitat components result in the highest hibernation survival?
 - What are the effects of habitat features on the demography of Preble's mouse?
 - Is Preble's mouse density increased with increasing shrub cover?
 - Are Preble's mouse movement patterns and survival influenced by shrub density adjacent to open water? Are the same patterns seen in adjacent upland areas?
 - Are Preble's mouse movement patterns and survival influenced by composition of upland vegetation adjacent to riparian vegetation?
 - Evaluate effects of habitat management techniques and threat abatement strategies to maintain and enhance habitat, and the effect on distribution and demography of Preble's mouse.

- Investigate how stream flow patterns influence Preble's mouse distribution, movement patterns, and habitat.
- Effects of threat abatement strategies
 - Evaluate impacts of non-native predators.
 - Evaluate impacts of urban predators and competitors on abundance and distribution of Preble's mouse.
 - Evaluate impacts of climate change.
 - Evaluate impacts of management activities, including but not limited to water management, land use management, and mouse habitat management.

Appendix D. Summary of Public Comments

On April 11, 2016, we published a notice in the Federal Register soliciting public comments on our release of a draft revised recovery plan for the threatened Preble's meadow jumping mouse (Preble's mouse) (81FR21374).

The new revised recovery plan constitutes the first revision of the recovery plan since 1982. The revised recovery plan documents the current understanding of the species' life history requirements, identifies probable threats that were not originally recognized, includes revised recovery criteria, and based on improved understanding of the species, describes those actions believed necessary to eventually delist the species.

In our announcement, we requested assistance in the recovery plan revision effort by providing the public with the opportunity to review the revised plan and solicited any additional information related to Preble's mouse that was not already included in the draft revision. Specifically, we requested any new information, analyses, or reports that summarize and interpret: population status and threats, demographic or population trends; genetics and competition; dispersal and habitat use; habitat condition or amount; and adequacy of existing regulatory mechanisms, management, and conservation planning.

Following the public comment period, we solicited independent peer review of the document from three individuals prominent in the field of conservation biology of small mammals.

The 60-day public comment period closed on June 10, 2016 and we are grateful for the contributions from those who provided information during this review and comment period.

Peer-review and public comments ranged from minor editorial suggestions to providing recommendations on plan content. As appropriate, we have incorporated all applicable comments into the text of this revised recovery plan. All comment letters are on file at the Colorado Ecological Services Field Office in Lakewood, Colorado.

List of commenters:

Peer Reviewers

Tom Ryon

Mark Bakeman

Jennifer Frey

Additional Commenters

Boulder County Parks and Open Space
Colorado Department of Transportation
City of Fort Collins, Colorado
City of Greeley, Colorado
Colorado Parks and Wildlife
Defenders of Wildlife
Ben Guillon, WRA, Inc.
Roy Hugie
Wyoming Farm Bureau

Summary of Major Public Comments and USFWS Responses on the *Draft Recovery Plan for the Preble's Meadow Jumping Mouse Ecosystems of Colorado and Wyoming*

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*=Asterisk represents comments submitted by peer reviewers of *Draft Recovery Plan for Preble's Meadow Jumping Mouse*

1. Grouped Comments

a. Recovery criteria

- 1.) *Comment:* Additional clarification is needed in the Plan for Recovery Criteria 3 and 4. As we begin to move forward with recovery actions, the Department and others who will contribute toward recovery of this species need specific criteria for what will constitute 'protected ' habitat and what regulatory mechanisms will be considered to have 'adequate compliance and enforcement'. What more regulations and protection are needed to be adequate? The Preble's mouse is found exclusively in southeastern Wyoming, which has very little public land. Substantial private landowner support will be necessary to locate and maintain recovery populations. The Department and landowners will need clearly defined expectations so that steps taken to protect habitat will be considered adequate for recovery, so Department personnel can explain requirements in detail and honestly answer private landowner questions. Consequently, given the importance of Factor D in the decision to list the Preble's mouse as threatened and its importance to recovery and delisting, specific guidance will be necessary before proceeding with these criteria.

Response: Text was added to the document in the *Criteria for Delisting* section indicating that county and local government regulations or other mechanisms will protect Preble's mouse and abate known threats into the foreseeable future.

- 2.) **Comment:* The Big Sandy HUC was not included on Figure 4.

Response: The caption to the figure has been clarified to state that point locations do not represent abundance of Preble's mice, but only effort for where trapping has been conducted. More specific maps for the distribution of capture localities will be provide online. Post delisting monitoring plans will examine the long term stability of the populations and their trends so that management changes may be implemented to get those populations on track to recovery. The team does feel that the delisting criteria are adequate. Based on the data that have been collected to date, we do not know how many current populations exist in each size category and how that relates to historic distribution. We do think every current population is valuable and necessary for recovery. We further believe there are enough Preble's mice in each of the small, medium and large populations, and by addressing the threats we will be able to recover the species.

- 3.) *Comment:* Under this draft plan, it seems that many currently existing populations could be extirpated in the future, and yet the species would still meet the delisting criteria. Based on Figure 2 (please note my comments above about the problem with this figure which make interpretation difficult) and my reading of other cited documents, such as the 2013 delisting decision. It appears that the Preble's mouse is still widely distributed and well represented throughout its historical range, with the exception within some urban areas and perhaps some peripheral eastern populations (i.e., at the more arid edge of the subspecies range). In fact, compared to many other taxa these declines in range seem rather modest. Regardless, the USFWS defines recovery as "The process by which the decline of an endangered or threatened species is arrested or reversed, or threats to its survival neutralized so that its long-term survival in nature can be ensured.

(<https://www.fws.gov/Midwest/endangered/glossary/index.html>).” In part, the criteria for delisting stipulates: 1) 2 large and 5 medium populations that are stable or increasing for 20 years; 2) 3 small populations in each other HUCs that exist for 20 years. That is a total of 37 recovery populations. How many total populations in each size category currently exist based on the wealth of data collected since 1989? What fraction of the total does this represent? How does that relate to the historical distribution? Based on Figure 2 and other information, it appears that many populations that are not included as recovery populations could be extirpated without having an impact on delisting. This does not make sense to me. If this taxon is truly threatened, I would think that every current population is valuable and that efforts be made to prevent any further extirpations. With regards to the 30 small recovery populations, the stipulation is only that they exist for 20 years. They could be on a downward trajectory over 20 years, and then be extirpated and still meet the goal of delisting. How can allowing populations to be extirpated be consistent with recovery? In what way is maintaining 7 populations over the long-term and allowing potential extirpation of all the remaining populations a reversal or stopping of decline or threats? I do not think this plan meets the concept of recovery.

Response: The caption to Figure 1 has been clarified, and more specific maps for the distribution of capture localities will be provide online. Point locations indicated on Figure 2 do not represent abundance of Preble’s mice, but only effort for where trapping has been conducted. The post-delisting monitoring plan (delisting criterion #5) will address longer term persistence of populations. Monitoring plans will examine the long term stability of the populations and their trends so that management changes may be implemented to get those populations on track to recovery. We believe that the delisting criteria are adequate; please reference the paragraph above Guiding Principles that discusses the focus is on threat abatement. Based on the data that has been collected to date, we do not know how many current populations exist in each size category and how that relates to historic distribution. We do think every current population is valuable and necessary for recovery. We further believe there are enough Preble’s mice in each of the small, medium and large populations, and by addressing the threats we will be able to recover the species.

b. Time and Cost Estimates

Recovery Timeline Clarification

- 1.) *Comment:* The Plan indicates the time period for which populations and habitats need to be monitored will be determined in the approved population and habitat monitoring methodologies. However, the Plan also indicates that populations need to demonstrate increasing or stable trends for 20 years to be considered self-sustaining and contribute toward recovery. This length of time seems unnecessarily long for a threatened species and inconsistent with Recovery Plans for other western species (e.g., black-footed ferrets: maintain downlisting objectives for 3 years before downlisting, and maintain delisting objectives for 3 years before delisting) or other taxonomic groups (e.g., St. Andrews beach mouse: stable or increasing trends for 10 years to downlist, 20 years to delist from endangered). There is no explanation of why the recovery is estimated to take an additional 40 years to recover when the subspecies has already been listed for 18 years. According to scientific literature, the population of the subspecies is recovered, even though there isn't a specific estimate in the population in many parts of its range, and the only reason that it cannot be delisted is because there is still a threat to the habitat (Smith, 2004). Certainly if the population numbers have been

recovered in the last 18 years; despite the requirement for the recovery plan to include time duration and cost estimates based upon some regulatory protection of the critical habitat, such recovery should continue under current management. Thus, this recovery plan should include an explanation of why another additional 40 years is needed to protect the same habitat that has been successfully protected in the last 18 years.

Additional clarification of this timeline in the Plan is needed to ensure this recovery criterion is clear and consistently interpreted. We specifically request clarification on how the USFWS will interpret trend data. Our experience in monitoring populations and the experience in Colorado with monitoring this species makes clear that no population is always stable or always increasing. Will the USFWS interpret trend on an annual or short-term (2-3 year) basis or will this interpretation be conducted over longer periods (4-6 years) so that stochastic events can be accounted for?

Response: The timeline for monitoring and recovery was revisited and modified based on data from study of one of the southern populations of Preble's mice. Ten-year monitoring will likely include at least 3 to 5 Preble's mouse lifespans that will show cyclic patterns of abundance cycles to allow estimates of population decline or increase at local areas, given enough sampling and sample size to estimate parameters well, thus allowing for a robust assessment of population trends. Additional text was added in the plan to describe this analysis.

Cost of Recovery

- 1.) *Comment:* We have previously expressed concern regarding the long time and high cost estimates needed to reach recovery and delisting. We recognize that recovering a threatened species will take time and money, given the state's expected level of commitment to recovery of this species, as well as, the existing and future commitments to other listed, sensitive, and other wildlife species in the state. We express concern about our ability to commit to the duration and costs implied in this draft Recovery Plan without a firm commitment from the USFWS in the Recovery Plan to substantially contribute to recovery costs. While partnerships may make funding available for some conservation efforts, these partnerships are unlikely to fund basic inventory and the DNA-based identification needs for recovery of this species. Since history indicates this obligation will fall to the states, any such obligation would need to be balanced with other funding priorities. The anticipated cost of implementing this Recovery Plan over the next 40 years will likely exceed \$40 million dollars. Before I can commit to implementation, the USFWS should firmly commit to contribute substantial resources to Preble's mouse recovery.

Response: After reviewing comments, we determined that recovery could be reached in 10 years rather than 40, which would bring costs down to \$12,535,000. As money is available there will be opportunities to provide the states with funds to assist with Preble's mouse recovery efforts.

- 2.) *Comment:* The estimated cost of the recovery is also included in the plan. That estimation is \$47,155,000. Tax payers should have an explanation as to why it will cost so much money to protect habitat. Specifically, there should be a description of each aspect of the recovery plan and the costs for each implementation item.

Response: These are conservative estimates because there is uncertainty as to how long each of the recovery tasks will take. More specific information will be developed by the Site Conservation Teams. After reviewing comments, we determined that recovery could occur in 10 years rather than 40, which would bring costs down to \$12,535,000. These estimates were based on actual research costs associated with current research and recovery efforts being conducted to date.

- 3.) **Comment:* The implementation/funding schedule further demonstrates that the recovery plan has little to no commitment to insuring the survival of small recovery or non-designated populations. More funding should be allocated to basic survey work to identify potentially occupied habitat and all current populations and to accomplish landscape scale planning to strategize for increasing the number of populations that exist along at least 15.5 miles. The amount of resources allocated to monitor the 5 medium and 2 large populations seems excessive and out of proportion to the relative lack of attention to the numerous, but uncounted, populations that represent the species occurrence throughout its range and which are highly vulnerable to extinction. More funding should be diverted from the monitoring of those few populations to restoring habitat and to increasing size and connectivity of habitat and populations, which might include establishing new populations to insure connectivity.

Response: We have allocated \$1,500,000 for protecting and conserving known and potential habitat on federal, state, and private lands, we believe this is a sufficient start to protecting these habitats. We allocated \$5,500,000 for restoration of riparian systems and maintaining habitat connectivity. We believe we have done a thorough survey effort to determine the rangewide population, at this time we are interested in protecting the mice in the known population areas.

- 4.) *Comment:* Estimated cost too low.

Response: These are estimates based on the best available information; this information may change with time.

- 5.) *Comment:* The cost of recovery is in excess of 12 million dollars, which is excessive and unattainable by the state with existing resources. The Service should provide funding for Preble's mouse recovery, or rewrite the plan (i.e., recovery criteria) to bring the costs down even more.

Response: We recognize there is a hefty price tag for the recovery of the Preble's mouse; however, the total amount is based on reasonable estimates of the costs needed to implement activities to achieve the recovery criteria that were developed based on the principles of representation, redundancy, and resiliency. Modifying the recovery criteria to a point where the costs of recovery are substantially lower would likely impact the 3Rs, and hence the species recovery. While the price tag is high, the costs will be shared by the Service, Colorado, and Wyoming (and others). Given the distribution of mice and the threats faced by the species, it is likely Colorado will bear a higher share of the total costs. There will still be needs in Wyoming, and we realize funding is limited. While we cannot guarantee a consistent, dedicated source of funding (or how much at this time), the Service certainly intends to provide resources for recovery. Having a completed recovery plan will help us compete for funding and may expand the number of sources that could be used.

c. Monitoring Plan

- 1.) *Comment:* There is still a need to develop an approved monitoring methodology for Preble's recovery. Given that captured individuals cannot be reliably identified in hand and that elevational separation between Preble's and western jumping mice does not exist in Wyoming as it does in Colorado, occupancy modeling, as mentioned in the Plan, provides a realistic, cost-effective, and robust analysis tool. Again, given survey limitations in Wyoming, we are concerned that mark recapture modeling or some method designed to estimate numbers throughout a HUC based on a density estimate from a sample of that HUC may prove untenable and is likely unnecessary. For Wyoming, we suggest that occupancy modeling is the only viable way forward and recommend the USFWS adopt an occupancy based monitoring approach. We realize this tool does not allow managers to address population size for large or medium populations. Consequently, we are willing to work with the USFWS to modify the Plan as needed. Additionally, given that the monitoring methodology still needs to be developed, we urge the USFWS to address this action as soon as possible since the Department will not be able to move forward with monitoring populations until the methodology has been developed and approved. Finally, since the state agencies are listed as the lead for all monitoring efforts, the Department requests that recovery action 1.3 be modified to include the following language: "The Population Monitoring Methodology will be approved by the USFWS, the Recovery Team, and the state wildlife agencies before being implemented and will subsequently be made available on the USFWS website."

Response: Currently, occupancy modeling does not allow for estimates of population size, which are needed for large and medium populations. Small populations only require documented presence. Because recovery criteria do not specify how trends should be analyzed, should occupancy modeling allow for these estimates in the future, this approach could be used at that time.

- 2.) *Comment:* Population monitoring is not given enough priority and not explicitly planned out. There are not enough existing data to be able to appropriately select conservation populations.

Response: Population monitoring is an action item in the recovery plan and will be developed within 1 year (Task 1.3).

- 3.) *Comment:* Methodologies are not developed in the Plan. Referenced potential approaches do not support Recovery Plan metrics. What areas need to be protected and restored depend on an undeveloped habitat monitoring plan. Need to be reviewed by state agencies and other stakeholders.

Response: The habitat monitoring plan has not been developed yet. We have added language to the plan to address the comment regarding state agency and stakeholder review of the habitat monitoring plan.

- 4.) *Comment:* Provide the monitoring plan when complete.

Response: The monitoring plan will be available under the USFWS's website for this plan.

- 5.) *Comment:* The monitoring methods can include already established and proven elements including live-trapping protocols, timing of surveys, calculation and correction of linear density estimates. Program MARK has been the analytical tool that has proved valuable for population estimates. There have been several previous efforts to map habitat using different classifications and at

different scales. It would be useful to use a single habitat classification so that differences in habitat and future changes can be noted. This could include a combination of acceptable GIS layers as well as field measurements. I have used Ruggles' field protocol and found it to be applicable and relatively easy to use.

Response: Thank you for your comment; we will consider it when we develop the monitoring plan in the future.

- 6.) **Comment:* Would long-term monitoring methods include the collection of DNA samples so that genetic investigations are possible? This should be included in methods or mentioned in Section 1.2.

Response: Thank you for your comment we will keep this in mind when we develop the monitoring plan in the future.

- 7.) *Comment:* Are Preble's mice visually indistinguishable from more common jumping mice. Consequently, identification requires genetic analysis. The Recovery Plan therefore requires unrealistic sampling and analyses that could impact Wyoming's ability to satisfy recovery criteria. The Recovery Plan should address this concern in a substantive way.

Response: Under the Recovery Action Narrative Task 1.2 we have added the following language to address this comment: this additional component of genetic testing does add substantial cost to the effort. In such cases, the monitoring methodology will need to be tailored to ensure that scientifically valid sampling can be conducted in a cost-effective manner. Site-specific threat abatement plans developed by Site Conservation Teams can be adapted depending on documented trends to better promote recovery. Results of the monitoring will be provided to the USFWS and/or the Recovery Team.

- 8.) *Comment:* The Recovery Team has not evaluated the current data from the HUCs in question but has set up a process to compile and evaluate those data upon completion of the Recovery Plan. We again request specific monitoring criteria be provided by the Service to determine if a HUC is occupied.

Response: Without an approved population monitoring method, it is unclear whether existing data are adequate to conclude that the Preble's mouse does or does not occur in the Upper Lodgepole and Crow HUCs. Developing monitoring criteria is a high priority and is included as specific actions 1.3 (population monitoring) and 2.1 (habitat monitoring methods) outlined in the plan. For a variety of reasons, the recovery team has asked that experts develop the monitoring program and criteria, which will be completed in the first year after the plan is approved. Once the population monitoring methods are developed and approved, the existing data from the Upper Lodgepole and Cow HUCs will be evaluated to determine if these HUCs are unoccupied. Certainly, as data become available showing certain HUCs are not occupied, those HUCs will be identified as unoccupied, and a process is provided in the plan on page 48 to accomplish this.

d. Reason for Listing

General Threats

- 1.) **Comment:* The section on “Reasons for Listing and Threats to Recovery” would seem to list the threats related to each listing factor. However, this seemed more an evaluation of potential threats to the Preble’s mouse. Some elements discussed were concluded not to be threats (e.g., interspecific competition). In order to decipher a complete list of threats (upon which the recovery plan is supposed to be based), it would be helpful to have more explicit accounting of the threats that are recognized with perhaps a separate section on other threats that were evaluated but excluded. Otherwise, it becomes very confusing trying to determine what factors are or are not considered threats relevant to the plan. The language used on the Threats Assessment is inconsistent, not all of the threats receive a level.

Response: Under the *reasons for listing and potential threats to recovery* section of this plan we have added concluding statements of the threat level of each potential threat. In addition, Table 3 also tracks the current and previously identified threats of the Preble’s mouse.

- 2.) *Comment:* There are several different sections of the document that are not specific enough. For example, the recovery plan lacks specifics when explaining the factors that need to be mitigated. As agriculturists, this is a major concern that we have. If there are new regulations on the land where we operate, there could be significant consequences for land owners that should be disclosed. Additionally, there are no specific details as to what is considered "development". Development could be a house or it could be a horse corral. The USFWS should include specific details on what these plans are implicating for the land owner.

Response: In this plan residential and commercial development is considered. Specifics of development such as a horse corral should be developed by the local Site Conservation Teams.

- 3.) *Comment:* The major threats or limiting factors are not as well understood as the Recovery Plan suggests, you need to address connectivity of the different habitats.

Response: We have provided more information in the threats of residential and commercial development section on the known fragmentation and reductions of connectivity between Preble’s mouse habitats.

Factor A

- 4.) **Comment:* Add “higher peak and sustained flows in urban areas leading to channel incision” before sand and gravel mining. The last paragraph of i, add, “despite each having suitable habitat patches.” The evidence indicates roads can be a severe filter but would rarely be a barrier. Preble’s mice are known to readily cross 2 lane dirt roads, and have been documented using 300 foot long culverts under I-25 in El Paso County. Direct boring techniques under riparian areas can minimize utility impacts to habitat. It is important to point out that one consequence of downcut (incised) channels is that a woody riparian community may be eliminated, and the site will transition to a grassland. The issue concerning Aggregate Mining is with restoration of the ponds after mining is completed. The

issue is the ponds are often steep-sided and there is a very limited riparian zone. Shallow-sided ponds could have much more riparian habitat development. Suggests a re-write of sentence to "This conversion reduces the riparian shoreline vegetation zone and alters adjacent groundwater flow."

Response: We have changed the text of the aggregate mining section as follows: Often, mined pits are constructed with impervious liners and converted to steep-sided water reservoirs after aggregate is removed. This conversion reduces the riparian shoreline vegetation zone and alters adjacent groundwater flow.

- 5.) *Comment: One commenter stated there is an agricultural trend in Colorado that removes more riparian habitat in more recent years than previously; farmers are now more willing to remove cottonwood stands in riparian areas.

Response: We have no published evidence to suggest that riparian areas are being converted to agricultural use in eastern Colorado. The risk of conversion in Wyoming was identified as moderate, but due largely to residential growth (Pocewicz *et al.* 2014). Agricultural conversion was not mentioned. However, increasing population and density of human residences often cause changes in habitat and its use and may create increased threats to the Preble's mouse and its habitat. We believe that the descriptions of high quality habitat and development of well-managed and protected lands are incorporated in the Recovery Plan.

- 6.) *Comment: The commenter agrees that grazing is a low threat and sent information on grazing exclosures on the Della Croce Ranch, where mice were captured within exclosures. The recovery plan should have a discussion on the success of habitat exclosures.

Response: In the livestock grazing section we have provided more information from the most up to date studies, concerning Preble's mouse detection in cattle exclosures. Thank you for your comment, this information was added in the livestock grazing section. We've added a discussion of the success of habitat exclosures to the section on livestock grazing in the reasons for listing and potential threats to recovery section.

- 7.) *Comment:* Hydrologic change is another factor that the recovery plan claims needs to be mitigated. Hydrologic changes could include the cleaning or maintaining of irrigation ditches, some of which now hold occupancy of Preble's Meadow Jumping Mouse (Fish and Wildlife Service, 2004). This area of the recovery plan would severely encroach upon landowners in Wyoming's water and private property rights. Strict regulations on diversion of waters in a stream restrict land owners' ability to use their appropriated amount of water. This could also off set the amount of water that other landowners in the same basin have. Is the recovery plan implying that building and maintaining irrigation ditches would be prohibited? Preble's habitat could be lost if these activities continue. Does the extent to which one can build or maintain irrigation ditches depend upon range or density of the population? The USFWS should add more specific language to the document so that land owners and communities know what questions to ask so that they can work with local governments to possibly create conservation plans in attempt to delist the Preble's Meadow Jumping Mouse when all of the requirements have been completed.

Response: We have added language to the Factor D. The Inadequacy of Existing Regulatory Mechanisms section of the plan to address the exemptions for maintenance activities on manmade ditches under the 4(d) rule.

- 8.) *Comment:* Transportation is also considered a factor that needs to be mitigated. Once again, the USFWS fails to adequately define “transportation.” Does “transportation” include only motor vehicles or is walking or riding a horse also considered “transportation” across the habitat. For example, how will the mitigation of “transportation” impact every day ranching needs such as feeding hay if the rancher needed to cross Preble’s Meadow Jumping Mouse habitat.

Response: Transportation is discussed on page 22 of this recovery plan. Also, the Site Conservation Teams will address how this specific action would be mitigated. Ongoing agricultural activities are covered as described under the 4(d) rule and are exempt from take provisions provided that impacts and encroachment upon Preble’s mouse habitat do not increase.

- 9.) *Comment:* Another problem is the failure to adequately describe what will be required as mitigation for grazing. There are no specifics about the number of livestock that are able to graze within Preble’s mouse critical habitat. This single regulation could shut down entire livestock operations if they cannot graze a certain number of cattle. Without the grazing rights, an operator would have to sell their cattle. In the final rule to list the Preble’s Meadow Jumping Mouse in 1998 states “Since Preble’s exists on some sites where grazing, mowing, and other human land uses occur, these activities should not be considered threats” (USFWS 1998). When the subspecies was listed, and the population was lower, livestock grazing wasn’t considered a threat. Now that there are other protections in place, the USFWS should include an explanation as to why it is considered a threat now.

Response: Ongoing agricultural activities are covered and, as described under the 4(d) rule, are exempt from take provisions provided that impacts and encroachment upon Prebles’s mouse habitat do not increase. We have added this language to the Recovery Plan. The Site Conservation Teams will decide site-specific mitigations for these activities.

- 10.) *Comment:* Programs are needed that compensate farmers for restoring productive agricultural land to native vegetation that will enhance Preble’s mouse habitat.

Response: Incentive programs would be specific to each area and would be addressed as part of the Site Conservation Teams incentives tasks 5.4, 5.4.1, 5.4.2, 5.4.3, and 5.4.4.

- 11.) *Comment:* Fragmentation may result in isolation of populations within major floodways from those in smaller waterways. This isolation may preclude genetic rescue effects and recolonization of flood-affected sites from adjacent populations.

Response: We have added language concerning the effects of fragmentation to the Factor A, the destruction, modification, or curtailment of the species’ habitat or range section in the Plan to address this comment.

- 12.) *Comment:* Conversion of wetland and riparian habitat has occurred since European settlement. A buffer needs to be maintained between habitat disturbances and Preble's mouse habitat. There should be incentives to restore agricultural lands back to wetland and riparian habitats. This plan should more forcefully state the case of habitat loss from an evolutionary context of the Preble's mouse riparian adaptation.

Response: We acknowledge that habitat conversion has occurred since development of the west; however we feel that we covered this as part of the baseline conditions considered in this Recovery Plan.

- 13.) *Comment:* Agricultural producers are large users of decreed water rights in CO. Ditches and leaky ditches, return flows, and seeps have become important features for conservation but there are no regulations to protect and maintain them.

Response: We added language under the hydrologic changes section of the Plan. This particular topic should be addressed by the Site Conservation Teams.

Factor D

- 14.) *Comment:* The draft recovery plan includes several different factors of mitigation that are merely anticipated to affect the Preble's mouse population. For example, overutilization for scientific and educational purposes is one problem that the USFWS would like to mitigate. There has not been enough research done on the subspecies to indicate harvesting for scientific or educational purposes has had any effect on the population at all. It is not clear why the USFWS wants to mitigate for a problem if the USFWS does not know how or whether the problem affects the population. Another concern is that when there are factors that are being mitigated that do not affect the subspecies population, who is to say that there won't be burdensome regulations that could affect the community.

Response: In the *Reasons for Listing and Potential Threats to Recovery* section of the Recovery Plan, we determined that overutilization for commercial, recreational, scientific or educational purposes DOES NOT constitute a threat to Preble's mouse populations.

- 15.) *Comment:* Does the new Clean Water Rule affect Factor D analysis of the adequacy of existing regulatory mechanisms? If so, how?

Response: We only address rules that are currently in effect, this rule is still pending and therefore we do not address it at this time.

- 16.) *Comment:* The recovery plan should mention section 6 funding. Great Outdoors Colorado Funds creating and expanding trails in riparian habitat and potential detrimental effects to the Preble's mouse. A discussion of local exemptions for ditch clearing and alteration of natural hydrology should be added.

Response: We have added language to *Transportation, Recreation, and Other Rights-of-Way through Habitat* section to address how the Preble's mouse changes their use of the habitat due to trails.

- 17.) **Comment:* One peer reviewer noted a lack of a discussion of the Preble's mouse Conservation Bank in Castle Rock Colorado that was approved after successful hydrologic restoration of East Plum Creek and also requested that we update the Recovery Plan with information regarding the 2002 Hayman Fire in the mountains west of Denver that burned about 250,000 acres and Preble's mouse mountain habitat.

Response: We have added language to the *wildfire* section to address how the Hayman Fire affected Preble's mouse habitat.

- 18.) *Comment:* The recovery plan should expand on the importance of floods to maintaining habitat heterogeneity and regeneration of native vegetation. Modifying stream morphology to keep a stream "in its banks" is more of a threat than flooding.

Response: We have added language to the *flood section of the Factor E other natural or manmade factors affecting the species' continued existence* section, to address the importance of flooding to maintaining the vegetative communities that provide suitable habitat by developing habitat heterogeneity and regenerating native vegetation..

- 19.) *Comment:* The recovery plan should include a discussion on the effects of diversion structures on in-stream flow. Preble's mouse presence has been shown to be negatively correlated with bare ground/leaf litter and positively correlated with the presence of native shrubs (Clippinger 2002) and non-native tree species that have a deep root system that draws its water supply from the nearby water table, such as crack willow can create these conditions. Non-native grass species should be included as a threat because they create a monoculture and reduce habitat.

Response: We feel the existing text addresses this comment in the *Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence, iv. Nonnative Plants* section of the *Recovery Plan*.

- 20.) *Comment:* The recovery plan should describe non-natives as a high threat given what the Preble's mouse eats.

Response: We do not believe this to pose a high level of threat as described in the *Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence, iv. Nonnative Plants* section of the *Recovery Plan*.

- 21.) *Comment:* Add discussion of neonicotinoids to the Recovery Plan because these could pose a threat to small mammals and to Preble's mouse's diet.

Response: The existing text in the *diet section* addresses this comment. Task 4.4 will also address this comment.

- 22.) *Comment:* Add recreation to the Factor E other natural or manmade factors affecting the species' continued existence section of the plan.

Response: This comment is addressed in Factor A. The Destruction, Modification, or Curtailment of the Species' Habitat or Range, ii. Transportation, Recreation, and Other Rights-of-Way through Habitat section.

- 23.) *Comment:* How are flood effects documented? Floods are beneficial but may also eliminate populations.

Response: The potential exists for a flood to impact a Preble's mouse recovery population to the point that the recovery criteria would not be met; however, flooding may be beneficial and recovery criteria may not be affected. We do not believe delisting criteria would need to be added to address these factors.

- 24.) *Comment:* Consider whether a project has any potential to reduce the effects of drought through maintaining minimum flows or retain riparian/wetland habitats, protection against flooding.

Response: We would address this during the ESA section 7 or 10 consultation process.

- 25.) **Comment:* Effects to hibernation timing from climate change (time to begin hibernation, time to emerge) may have multiple effects, such as mice emerging too early. The recovery plan should include information on climate change effects on length of growing season, frost-free days, etc.

Response: We acknowledge the threats of climate change to the Preble's mouse in this plan. Climate change will not be resolved in the Recovery Plan. However, the Plan includes the best responses for reserve design, habitat enhancement, and monitoring. Achievement of the Plan's goals will still be the evidence of recovery.

- 26.) **Comment:* I disagree that interspecific competition is not a threat. Other research (e.g., Boonstra and Hoyle 1986, Duesser and Porter 1986, Schramm and Cover 1994, Schorr 2012) has shown that *Z. hudsonius* is susceptible to impacts due to other rodents, including native and nonnative species. At minimum, this is a potential threat that requires additional research.

Response: We have provided more information on the interspecific competition of the Preble's mouse and the western jumping mouse to Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence, viii. Interspecific Competition.

- 27.) *Comment:* Pesticides and herbicides are also considered a factor to be mitigated. According to the USFWS, the concern is that the Preble's could drink water off of a plant that was sprayed with a pesticide and the pesticide in the water could have negative effects on the subspecies. In contrast, the document also states that there is not enough research to determine what the main source of water for Preble's is. There is also no evidence through the studies done on the kidneys of the Preble's mouse that show that pesticides and herbicides have any effect on the subspecies, yet, the

USFWS is advocating to mitigate for something that may not be an issue by placing regulations on pesticides and herbicides in Preble's mouse habitat.

Response: It is unclear whether the pesticides and herbicides commonly used in the range of the Preble's mouse have any direct or indirect effects on the populations or their habitat. In the plan we have determined that this is an unknown threat to the Preble's mouse population and requires further evaluation.

- 28.) *Comment:* The draft plan acknowledges the threat of climate change, but it is not adequately addressed. Lower montane habitats might become more important in the future and this is not adequately accounted for in the spatial distribution of habitat in response to climate change.

Response: We acknowledge the threats to the Preble's mouse in this plan. Climate change will not be resolved in the Recovery Plan. However, the Plan includes the best responses for reserve design, habitat enhancement, and monitoring. Achievement of the Plan's goals will still be the evidence of recovery.

- 29.) *Comment:* The Plan should identify areas that will potentially become more suitable for occupation in the future. The discussion focuses too much on the current range.

Response: We provide examples of recovery strategies to improve habitat resiliency and maintain or improve habitat within the subspecies' current range. We have focused on the current range, but the Recovery Plan also encourages Site Conservation Teams to protect additional habitat areas to provide resiliency in the face of climate change. Further, post-delisting monitoring plans (delisting criterion #5) will address longer term persistence of populations.

e. Guiding Principles

- 1.) *Comment:* Expand efforts to include the species' importance to regional biodiversity and ecosystem services as an indicator species, including more details and recommendations on how habitat protection benefits recovery.

Response: We have added language to the education programs of the guiding principles section addressing the importance of biodiversity.

- 2.) **Comment:* According to the Recovery Plan, the adaptive management and monitoring processes are driven by "achievement of self-sustaining populations". However, there is not a definition or measure of what a self-sustaining Preble's mouse population is and how it would be recognized. Other terms are also used later in the Recovery Strategy such as "long-term presence" and "long-term viability." These all seem similar terms and it may be more consistent to use one, defined term.

Response: We have a definition for "self-sustaining" in the Appendix A glossary.

- 3.) **Comment:* There is an opportunity to provide some positive information in the Education Programs section about the health of riparian areas and Preble's mice. An example could be, "The Preble's mouse is an indicator of pristine or near-pristine riparian habitat and adjacent, healthy

grasslands. By encompassing the entire life-cycle of the mouse, ecological processes are also preserved. As written, the focus is on loss of habitat and may not aspire to explain why it is good to support high-quality land conditions.

Response: We have added language to the education programs of the guiding principles section addressing the relationship of Preble's mouse to healthy riparian systems.

f. Recovery Strategy

- 1.) *Comment:* In the second paragraph last sentence "enigmatic" should be added to the sentence.

Response: We believe the language we have written for this section is appropriate to our target audience.

- 2.) **Comment:* Establishing Recovery Units, first sentence: this sentence refers to "listed entity", but it is not clear what this is referring to in regards to a Recovery Unit. Is this the land owner, the U.S. Fish and Wildlife Service, the Site Conservation Team by another name? Please clarify.

Response: We have removed this reference and provided clear language defining the recovery unit.

- 3.) **Comment:* Establishing Recovery Units: It seems more ecologically relevant and perhaps more equitable for jurisdictions if Wyoming had more responsibilities in setting up recovery units. It seems that the North Platte River is under-represented in this plan and has been added to the northern portion of the South Platte. One could argue that three major divisions, Arkansas, South Platte, and North Platte, would make more sense from a geographic perspective and relates better to HUCs as the scale for recovery. Also, this would put more emphasis on recovering Preble's mice in Wyoming. Please consider.

Response: We believe the existing text describes how the species' genetics was a driver for determining the North and South recovery units.

- 4.) **Comment:* The recovery team needs to define the terms "core population" and "genetic diversity" in terms of the recovery of the Preble's mouse.

Response: We have added language to the recovery strategy to explain the terms core population and genetic diversity to address this comment.

- 5.) *Comment:* Adaptive management needs to be used in a way that does not undermine or diminish the benefits of previously completed recovery efforts. The draft plan is ambiguous, and presents risks that future scientific developments could necessitate wholesale revisions to the Plan. The Fish and Wildlife Service should address this concern before finalizing a Recovery Plan.

Response: We have added language describing the adaptive management process at the end of the *Determining Number and Distribution of Recovery Populations* section.

- 6.) *Comment:* The use of "burden" is suggestive.

Response: We have provided alternative wording in the *Collaborating with Private Landowners to Achieve Recovery* section, emphasizing the history of private landowners' conservation efforts.

- 7.) *Comment:* The Recovery Plan needs to expand on how the Site Conservation Teams might share ideas and experiences, ensure consistency between teams, and describe who will lead this effort.

Response: We are not designating leaders of the Site Conservation Teams at this time.

- 8.) **Comment:* It is not clear, at what geographical level these teams will operate.

Response: We have provided additional information in the Establishing Site Conservation Teams section, explaining the geographical range the team should cover.

- 9.) *Comment:* Are two recovery units enough given diversity of habitats and human influences within each? If one meets objectives, can more actions occur there than in other areas? Connectivity within a HUC may be more important than the drainage itself.

Response: We believe we addressed the comment concerning diversity of habitats and human influences within each recovery unit. Further, both recovery units must meet recovery criteria before delisting will be considered.

- 10.) *Comment:* Explain resiliency of occurrences within a recovery unit more clearly.

Response: We have added a definition for resilience to the glossary.

- 11.) *Comment:* The unit of measurement for small, medium, and large populations is unclear; stream length, HUC, or density might be better than abundance.

Response: We have defined the size categories by what we wanted to attain, and believe this is a good and practical estimator.

- 12.) **Comment:* It is not clear how the number and distribution of large, medium, and small populations within the recovery units was determined.

Response: This was based on known populations in known habitat and extrapolated throughout the entire range.

- 13.) **Comment:* I believe that the "Small" recovery populations (and likely also the "Medium" recovery populations) will essentially represent "walking dead" populations. The plan provided no information on connectivity of populations so I can only assume that populations are isolated. Based on the information provided in the draft plan, an effective population size (N_e) of at least 500, and as much as 5,000 according to some experts, is necessary for long-term survival of an isolated population. Since N_e reflects only the breeding individuals the actual population size must be several times larger (using the 5x as in the plan, 2500-25000 individuals). In the case of *Zapus hudsonius*, evidence suggests the N_e is much lower proportionately than for comparable populations of other small mammals because only a fraction of the adult (survived at least 1 year) females might actually breed. Females must emerge from hibernation with enough body mass to successfully

breed. If they don't, they might delay breeding for a short time while they try to put on enough mass, which might result in a late litter (or they might not breed at all during the year). However, young of late litters have lower survival rates and adult females producing late litters are expected to have lower survival rates (see review in Frey 2015). A Small population was defined as 3 miles of connected habitat harboring ca 150 individuals. Using the same 5x conversion factor as used in the recovery plan, this translates into an $N_e=30$. Given that the best available science says that the N_e must be at least 500, and possibly as large as 5,000 in order to insure long-term persistence, an $N_e=30$ almost certainly dooms Small populations to extinction. Stochastic demographic forces in such small populations can cause rapid extinction, even in ideal environments. When a population also faces threats, then the likelihood of extinction increases all the more. This same problem is likely to threaten long-term persistence of most Medium recovery populations, as only those nearer to the size of a Large population will have N_e large enough to insure long-term persistence. The minimum size of a Medium population 5 of 6 is 500 (11 miles), which translates to an $N_e=100$, which is a fifth to a fiftieth the size of what experts believe is minimally necessary to prevent extinction. To designate these populations as recovery populations and to protect the habitat and make management plans for these stream reaches may do little to prevent their extirpation in the long term. The problem is compounded by the fact that the recovery plan "allows" populations to go extinct by virtue of the way it was constructed (i.e., there is no goal for persistence of all populations; small populations and undesignated populations are "expendable"). Under the draft plan only the 2 Large populations are expected to have the capacity for long-term persistence. The only way to circumvent the problem of low N_e and insure the long-term survival of Small and most Medium populations is to increase their size and connectivity. Consequently, more attention should be focused on identifying all currently known populations, landscape scale planning to increase the area of occupied habitat, and restoring intervening habitats to increase connectivity. For instance, Schorr (2012) considered the population of Preble's mouse that occurred along 25 km (15.5 miles) of the Monument Creek watershed at the Air Force Academy had questionable long-term stability due to a lack of immigration from other populations that could offset population losses due to low fecundity and high mortality. Therefore 15.5 miles would seem to be a reasonable bare minimum threshold for the size of recovery populations. Anything less goes against the best available science.

Response: The Recovery Team used examples of good habitat to develop population size estimators that favor larger than currently available population size; therefore, the estimators are believed to be reasonable based on those assumptions.

- 14.) *Comment:* One commenter was uncertain of the level of survey effort needed to demonstrate that a site is not occupied. A paragraph should be included about not finding populations in a HUC despite efforts - may discourage entities from finding them. If populations are not found, maintaining/enhancing habitat for future recovery should still be important.

Response: We have added information to the *Recovery Criteria for Delisting* section regarding the level of survey effort needed to demonstrate when a site is not occupied.

- 14.) *Comment:* 2,500 may not be achievable or feasible in each of the drainage systems, especially the Poudre. Population size ranges need to be more flexible and adaptable to specific situation.

Response: We believe there is a large population in the Poudre HUC based on current data. We feel that there is built-in flexibility in the recovery criteria as seen in Recovery Strategy 6.

- 15.) *Comment:* One commenter suggested modifying the definition of effective population size, such that it clarifies the number of mice required in recovery populations. June effective population is less than number actually needed. The commenter suggested the data be re-evaluated to update population sizes and if a reanalysis of data or future research indicate that a lower threshold is viable and persistent, and then the plan could be modified. The commenter also noted that mileages are inconsistently noted and the range is absent from the delisting criteria and wondered if the 44 mice/per mile metric includes juveniles.

Response: We have changed the language for the effective population size and trends section of the plan.

- 16.) **Comment:* Multiple reviewers commented that we need to provide a better analysis on how the number of mice in each population size category were derived.

Response: These numbers were based on known populations in known habitat and extrapolated throughout the entire range.

- 17.) **Comment:* The idea of small populations is confusing to me. It seems only academic in this plan. There is no clear development of what these small populations become and how they aid in recovery. They are just left to wink on and wink off with no connection to other populations or even how they would support the subspecies. It is true that genetically, they may be important, but only if individuals from these populations, someday, intermix with others. If small populations are practically to be addressed later on in the recovery process, then this should be stated. If not, the general concept needs to be explained further. Designating Small, Medium, and Large Recovery Populations, Large Populations, last sentence: Please more clearly describe what is meant by stating that, "...large populations should incorporate most of the landscape-level ecological processes..." is this statement simply further clarifying what a Large population naturally is, or is it a management goal to be attained upon recovery? Designating Small, Medium, and Large Recovery Populations, Small Populations: Small populations are described in a completely different manner than large or medium populations making it harder to compare and contrast the differences. I suggest that the description be rewritten as such, "Small populations may be self-sustaining, naturally occurring populations that demonstrate a June abundance estimate of 1 to 500 adults. The long-term significant trend in percent occupancy may not been known and population estimates may be unreliable due to low capture rates. Therefore a small population may alternatively be defined as containing any number of mice within a 3 mile reach of connected Preble's mouse habitat. In this manner, smaller sections of occupied habitat can be used to identify small population locations. Although small populations are expected to be approximately 150 adults, regardless of the stream miles in association with the population, no minimum population size is required for small populations.

Response: We provided a better description of small populations in the *Small Population* section of *Designating Small, Medium, and Large Recovery Populations*. Further, recovery and maintenance of small populations are part of the delisting criteria.

- 18.) *Comment:* One commenter questioned whether some of the references cited reflected the most current science.

Response: The references we have used are still valid, relevant, and accepted.

- 19.) **Comment:* The Recovery Plan should provide more discussion of the high variability in population estimates. Longer term monitoring that shows average or median population values is needed to really discern stability or upward or downward trajectories.

Response: We added Figure 2 and accompanying text to address this comment.

- 20.) **Comment:* The Recovery Plan contains a statement that an effective population size of about 500 individuals translates into a total population size of several times this number and one commenter requested clarification on whether several times this number 2,500.

Response: We need more than 500 individuals, and using estimates of low thousands as a good conservation number, we estimate 2,500. We found no evidence that the effective population size and the actual population size would differ in the populations.

- 21.) **Comment:* One commenter suggested including a table showing the population and habitat values at each surveyed side. Additional sites and analyses could also be included. Such a table could illustrate the wide variability in population numbers.

Response: This evaluation will not be done in the timeline we have to complete this plan, but it will be completed under an adaptive management effort when the recovery plan is finalized.

- 22.) **Comment:* One reviewer commented that the Recovery Plan needs to provide more transparency regarding the determination of the small, medium and large population sizes as well as the average number of mice/mile, because these are critical metrics, and further suggested providing a table displaying the population data from which these metrics were derived.

Response: We believe that the description of how population sizes and goals were derived is clear. The Recovery Team believes that with current information and theory, the estimates are reasonably supported and valid in comparison to current occupied and high quality habitat. In addition, they reflect the current and much of the historical distribution of the mouse. There is some evidence from population estimates obtained that population density can be higher than 44 mice/mile. We believe that the conditions for recovery identified in the document, i.e., habitat protection and restoration, re-connection, dedication to recovery of habitat and connectivity in each population can achieve the highest number possible, and that the current goals reflect an effective recovery goal.

- 23.) **Comment:* One reviewer commented that the 44 mice/mile number is not accurate enough to ensure adequate protection of habitat, and that the number should not be applied universally.

Response: The 44 mice/mile metric incorporates an estimate of how much habitat needs to be protected. The Recovery Plan also include population criteria specific to each HUC.

- 24.) *Comment:* The plan should include updates to the mouse/mile metric.

Response: This evaluation will not be done in the timeline we have to complete this plan, but it will be completed under an adaptive management effort when the Recovery Plan is finalized.

- 25.) *Comment:* One commenter asked why the Plan focused on the number of mice rather than some other recovery metric such as density.

Response: Density cannot be the only criterion for recovery, and we also need to consider population extent and distribution. In addition, high density in a small stretch of habitat may not provide the needed resiliency for recovery.

- 26.) *Comment:* Multiple commenters expressed concern that the Recovery Plan addresses populations that are not designated as recovery populations, but does not protect habitat that at this time may not be occupied.

Response: This concern is addressed in the Plan in Task 2.6.

- 27.) *Comment:* The initial selection of conservation populations needs to be more flexible and thorough. Five years of monitoring should be required before the species is considered extirpated from a location. Unoccupied habitat should be marked for restoration or reintroduction if it can't be naturally recolonized. Unoccupied habitats should also be considered a key component of recovery, especially given climate change.

Response: The Plan allows for restoration and reintroduction and Task 2.6 addresses protection of habitat.

- 28.) **Comment:* Population estimates can be obtained later in the season, if captured juvenile animals are eliminated from the counts. Juveniles are readily identifiable by both pelage and mass.

Response: We have added language to the *Designating small, medium, and large recovery populations* sections of the recovery plan to address this comment.

- 29.) **Comment:* Add upland habitat to description of connected stream network in Establishing Guidelines for Estimating Stream Miles Required for Recovery Sites Preble's mouse.

Response: We added the requested language to the uplands habitat description.

- 30.) **Comment:* Delineating Preble's mouse Habitat, second sentence of the first paragraph: The statement regarding the width of habitat appears to be misrepresented. Later in this section habitat wide is described as, "...328 feet from the edge of the 100-year floodplain. It is confusing to have the definition of the width of habitat based on 328 feet from the stream then discuss studies that suggest the width of habitat being 328 feet from the edge of the floodplain. This section should be edited to be more consistent or otherwise stated more clearly.

Response: We added language to the *Delineating Preble's Mouse Habitat* section of the plan to clarify habitat width.

- 31.) **Comment:* The Recovery Plan recommended that at least one population be designated a recovery population in each HUC yet only 13 of 16 HUCS will contain recovery populations. Also, several reviewers noted the omission of the Big Sandy HUC from Figure 4.

Response: Although the Recovery Plan recommends at least one recovery population in each HUC, the Plan allows for flexibility because we currently lack the survey data in a few of these HUCs to know whether they are or are not occupied. The Big Sandy HUC was removed as a potential recovery location because we do not believe habitats with that HUC support the Preble's mouse.

- 32.) **Comment:* No biological justification was provided for the number of recovery populations. Given that the Small and Medium recovery populations are not likely big enough to provide an N_e large enough to avert extinction, I do not think the goal of 2 large recovery populations is adequate. A reasonable science based goal would be to have at least one recovery population of at least 15.5 miles of interconnected habitat in each HUC. That would insure long-term persistence, redundancy, distribution wide presence, and genetic maintenance. The draft plan for 2 large and 5 medium seems completely arbitrary, at least on biological basis. Should all populations become extirpated other than the 2 Large and 5 Medium populations, delisting would be possible. However, I don't think anybody would think that a recovery had occurred and that the species was now out of risk if the taxon was reduced from its current widespread distribution to just 7 populations. The reduction in number of populations and lack of redundancy creates its own threats due to chance of catastrophic events and loss genetic variable. It is putting all proverbial eggs in one (or a few) baskets. More effort is needed in the plan to assure the long-term survival of many more populations throughout the range of the subspecies. Again, that can only be achieved by increasing the size and connectivity of a larger number of populations.

Response: The number of recovery populations is based on the amount of contiguous habitat available and represent what was believed to present on the landscape at the time. We do feel that larger populations would be better so more smalls and mediums would be preferred if they are possible. We have addressed this comment with Tasks 2.5 and 2.6 and recovery strategy #11.

- 33.) **Comment:* This quote from Tear et al (2005; <http://www.bioone.org/doi/pdf/10.1641/0006-3568percent282005percent29055percent5B0835percent3AHMIETRpercent5D2.0.COpercent3B2>) explains the overarching problem with this draft recovery plan: "Conservation objective setting often mixes scientific knowledge with political feasibility in such a way that one cannot tell where the science stops and the political pragmatism takes over. For example, Tear and colleagues (1993, 1995) found that for federally threatened and endangered species with recovery plans, over a quarter of the plans set quantitative recovery objectives at or below the species' existing population size or number of populations. How could the recovery plans for threatened and endangered species have objectives that did not promote increasing populations? Most likely these objectives were so low because they were politically palatable (Scott *et al.* 1995)." The Preble's mouse draft recovery plan clearly set the recovery objectives in terms of numbers of populations likely to persist in the long-term far less than the currently existing number of populations. I see no scientifically defensible reasoning for the number of recovery populations and consider the reasoning for designating the medium and small populations flawed. The Small and most Medium recovery populations cannot guarantee long-term persistence. Thus, the fate of the subspecies rests with the 2 Large recovery populations. No justification was provided for the adequacy of the number of populations required

for recovery. The Tear et al (2005) paper provides excellent suggestions that could improve this draft recovery plan.

Response: While the number of populations of this species is reduced from the historical number, we believe the remaining populations continue to be highly threatened and that the Recovery Plan addresses those threats. Recovery will be accomplished by protecting the designated number of large, medium, and several small populations. The site conservation groups will determine which small populations need to be conserved to meet recovery otherwise recovery will not be met.

- 34.) *Comment:* There should be additional guidance regarding the effort needed to adequately survey a HUC for the presence of the Preble's mouse and the criteria needed to eliminate HUCs from the recovery criteria if survey data indicate that Preble's mice are not present. In Wyoming, the particular HUCs of interest are Upper Lodgepole and Crow. Considerable survey effort has been dedicated within these HUCs, but Preble's mice have yet to be detected in them; all jumping mouse captures have been genetically confirmed to be western jumping mice (*Zapus princeps*). Specific information detailing what the USFWS deems necessary to determine if a given HUC is occupied or not is needed. With limited funding and personnel, resources should not be spent surveying for non-existent populations at the expense of recovering and monitoring known populations.

Response: We have added language to the *Determining Number and Distribution of Recovery Populations* section of this Plan to address survey methodology and the adoption of new population estimation techniques that may be available in the future.

- 35.) *Comment:* When assessing HUCs in Wyoming, only individuals confirmed by genetics should be considered when assessing survey needs and recovery goals. Because of the difficulty in identification and likely misidentification of individuals in the absence of genetic analyses in Wyoming, including unconfirmed individuals unnecessarily complicates recovery and may lead to erroneous conclusions and wasted effort.

Response: When we designate the monitoring protocol we will have a requirement of identifying the genetic integrity to help confirm presence, the right species is present, and the number of individuals indicated in the recovery plan is present.

- 36.) *Comment:* The plan should include a statement such as existing occupied habitat, potential habitat, or habitat that could be restored, enhanced, or created. Also identify habitat that might be important to restore or improve connectivity. In general, need better habitat descriptions.

Response: We have assumed that all sites that contain jumping mice also contain suitable habitat. All other habitats that don't have confirmed jumping mouse populations should be addressed by the site conservation teams to address a suitable approach on habitat conservation, improvement etc.

- 37.) *Comment:* Habitat quality is as important as quantity of habitat.

Response: Quantifying quality is difficult because the mice may be picking up on habitat cues that we may not ever be able to determine. The habitat monitoring plan will include habitat conditions and habitat quality parameters that we have the ability to measure. The document provides descriptions of habitat quality that have been determined to date, and provides information that the

Site Conservation Teams will be able to use as they create site specific plans for conservation and rehabilitation.

- 38.) **Comment:* The plan needs to better document how the numbers of populations of various sizes were assigned to the recovery units.

Response: They are based on the amount of contiguous habitat available and represent what was believed to present on the landscape at the time. The text in Recovery Strategy 11 and tasks 2.5 and 2.6 addresses this comment.

- 39.) *Comment:* The plan should include a paragraph about not finding populations in a HUC despite efforts to avoid creating a scenario where populations and/or habitats could be ignored in the Recovery Plan, even though they might be important for range-wide recovery of the species.

Response: Task 2.3 calls for identifying and surveying potential Preble's mouse habitat to designate additional recovery populations, and lists those HUCs where surveys are especially important because of a lack of information there. Where appropriate, newly discovered populations can replace designated recovery populations if they meet the Recovery Criteria. Tasks 2.5 and 2.6 call for restoring riparian habitat and restoring and maintaining connectivity.

g. Criteria for Delisting

- 1.) *Comment:* Who facilitates protection under a management plan and how does designating a recovery population affect consultation?

Response: We have added language to the plan to address this comment. ESA section 7 consultation is still required on all individuals and populations of jumping mice until the species is designated as recovered.

- 2.) *Comment:* Would the USFWS consider delisting a given area (i.e., Large Pop) ahead of others? Or facilitate project approval if a project creates, enhances, or restores habitat in a Large Population area?

Response: ESA section 7 consultation is still required on all individuals and populations of jumping mice until the species is designated as recovered. Projects that create, enhance and restore projects also have to be consulted on regardless of population size.

- 3.) *Comment:* The Management Plan should consider allowing a decision of a recovered population within subunits of a large population unit.

Response: Under the ESA, species are considered recovered when they have met all the parameters of the Recovery Plan.

- 4.) **Comment:* If a HUC is found not to contain any Preble's mouse populations following a survey(s) approved by the USFWS, then no recovery populations should be required for that HUC.

Response: We have added language to the second delisting criterion to address HUCs where the Preble's mouse does not occur.

h. Threat Tracking Table

- 1.) **Comment:* Why would anyone want to participate in recovery? What existing mechanisms are available to promote participation?

Response: Task 5.4 addresses this comment.

- 2.) **Comment:* A statement regarding promoting habitat connectivity through the use of mouse passable structures such as culverts and ledges, should be added to the Transportation, Recreation, etc., ROW

Response: We have added the requested language to the threat tracking table in the line for *Transportation, Recreation, and Other Rights-of-Way Through Habitat* section.

- 3.) **Comment:* Many municipalities are using old aggregate mines adjacent to the South Platte, and likely other places, as small water storage areas. One would assume that this greatly increases the riparian vegetation in these areas and along the South Platte. Research focused on this phenomenon could provide information regarding whether it would be advantageous to recovery and if future populations could be supported in these areas, and could be a way to partner with the mining industry, municipalities, and agriculture to increase habitat along the South Platte.

Response: Task 2.5 addresses this comment.

- 4.) **Comment:* Non-native Plants should be included as a threat in all HUCs.

Response: We have added the requested language to the threat tracking table in the line for the non-native plants.

- 5.) *Comment:* Cats should be added as a threat in the Disease and Predation discussion. Livestock Grazing should be added as a threat in the St. Vrain HUC. The Oil and Gas section should include a discussion that current moratoriums in Boulder County will be removed and future development may occur in the St. Vrain HUC. Several Recovery Actions should be added to the *Flood* section, such as restore floodplain connectivity and allow overbank flows at frequent high water events to promote heterogeneity and establishment of flood dependent riparian species; remove development from the floodway/floodplain; retain large downed wood in the floodplain; retain cobble and sand on overbanks and in channel.

Response: We believe this is already addressed in the document.

- 6.) *Comment:* Agricultural activities also contribute to the threat posed by the use of pesticides and herbicides but effects can be minimized by timing the application of herbicides with the species' inactive period or using species- or species-group specific herbicides so as not to kill valuable native plants.

Response: We believe this is already addressed in the document.

i. Recovery Action

- 1.) **Comment:* Hydrologic integrity is essential to healthy riparian systems. Hydrologic restoration needs more investigation to make it attractive to private and public sector landowners. Create incentives for public and private stakeholders to address the goals and objectives of a Recovery Plan.

Response: Added text to the document to address the first part of the comment. The second part of this comment is addressed in task 5.4.

j. Appendix C. Research

- 1.) *Comment:* Add a discussion of recent post-flood surveys done by Boulder County Parks and Open Space and the City of Boulder Open Space and Mountain Parks.

Response: Information concerning post-flood surveys has been added to the Habitat section of the plan.

- 2.) *Comment:* The plan should have examples of landscape features that are an impediment to successful dispersal.

Response: Instead of preparing a list of examples of impediments that may not be totally inclusive, we chose to provide a description of habitat types that provide for connectivity and dispersal.

- 3.) *Comment:* The plan should promote research regarding population as well as management and ecology.

Response: We have added this topic to the appendix C Research.

- 4.) *Comment:* Habitat Suitability Indexes are useful in targeting habitat for preservation, expansion, avoidance, study, and other uses for management; this method should be used, and then verified.

Response: The Site Conservation Teams can decide how they want to target habitat for preservation, but we agree that HSIs are useful tools to do this.

- 5.) **Comment:* Landscape level changes have resulted in changes to the South Platte by reducing peak flows and changed the river from an open, braided floodplain to a narrower channel more heavily wooded with cottonwood and shrubs and off-channel reservoirs for water storage. Both indicate that preferred riparian habitats may have expanded downstream, which could be a topic for future research.

Response: We have added this topic to Appendix C.

k. Specific Wording

- 1.) *Comment:* The Plan indicates the number of individuals needed for each population is: based on the best available science and represent estimations. It must be recognized that these numbers may be altered in the future if changes are supported by new scientific information and approved by the USFWS. The Department agrees that recovery criteria should be based on the best available science and represent adequate numbers to achieve recovery. However, based on our experience with other listed species where recovery goals have changed throughout the recovery process and the long time-frame proposed for recovery of this species, we are concerned about moving forward with recovery criteria that may be changed in the future. A late date change to recovery criteria or multiple changes would set back ongoing recovery efforts and damage landowner support for the species and its recovery. Consequently, to ensure that everyone is kept abreast of the most current science and recovery needs, we request that the language in the Plan be modified to: "The numbers identified above for large, medium, and small populations are based on the best available science and represent estimations. If new estimation techniques or data become available that increase our knowledge of Preble's mouse recovery needs and may result in changes to recovery criteria, any modifications to the criteria will be vetted through and agreed upon by state and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation by the USFWS."

Response: This language has been adopted in the *Determining Number and Distribution of Recovery Populations* section.

- 2.) *Comment:* Similarly, we request the following modification of the Plan on page 31: "As described in strategy 3 (above), the number of recovery populations identified for each recovery unit is based on the best available science. If new estimation techniques or data become available that increase our knowledge of Preble's mouse recovery needs and may result in changes to recovery criteria, these will be vetted and agreed upon by state and federal management agencies responsible for Preble's mouse recovery prior to acceptance and implementation by the USFWS."

Response: This language has been adopted in the *Determining Number and Distribution of Recovery Populations* section.

- 3.) **Comment:* The legend to Figure 2 says that it is a map of museum specimens identified by Conner and Shenk AND capture locations of the Preble's mouse. First, all museum specimens 2 of 6 were at one time captured so the legend does not make sense. Second, the dot symbols apparently indicate Preble's mouse that were trapped 1989-2014. This implies that all of Conner and Shenk's museum specimens were also captured since 1989. However, Conner and Shenk included specimens dating to 1901 in their study. Consequently, I have no idea what this map is trying to show. Is it the sum total of all known specimens of Preble's mouse? Or, perhaps the dots are just the specimens since 1989 but the map maker forgot to add the historical specimens identified by Conner and Shenk? There is no way for a reader to interpret this map.

Response: The Figure 2 description has been updated to include the correct information.

- 4.) *Comment:* The description of map the states that is shows the 8-digit HUCs but it doesn't.

Response: The description for the figure has been updated to include the correct information.

- 5.) *Comment:* The plan should mention conservation banks.

Response: We have added language concerning conservation banks to the collaborating with private landowners to achieve recovery section.

- 6.) *Comment:* The plan should include the Table Top bank.

Response: We believe it is too early in the process of the Table Top bank for it to be included in this plan, since this bank hasn't been completed yet.

- 7.) *Comment:* The plan should include a short discussion of areas or habitat known to be avoided by the species such as cliff faces, extensive areas devoid of vegetation, or locations well away from live water. This would help guide enhancement or restoration. Include more detail of adjacent habitat, too. More detail in comment letter.

Response: Our survey guidelines and block clearance zone that can be found online provide habitat and non habitat descriptions (<https://www.fws.gov/mountain-prairie/species/mammals/preble/CONSULTANTS/pmjm2004guidelines.pdf>).

- 8.) *Comment:* The 300 feet from 100-year floodplain needs to be more specific about what an assessment needs to include. "Trap the mice don't guess then plan for mitigation or the need for management."

Response: We have added language to the Factor A: The Destruction, Modification, or Curtailment of the Species Habitat or Range section of the plan to address this comment.

- 9.) **Comment:* The Big Sandy HUC was not included on Figure 4.

Response: The draft Plan had erroneously listed the Big Sandy HUC as a location for a small Recovery Population in Table 1. We removed it from the Table.

- 10.) **Comment:* The caption of is photo should be changed, which has been widely distributed, originated from the Rocky Flats Photo Library and was taken on September 1, 1996 (Negative Number 49187-5). I don't know if the library exists anymore, but if it did, it would be under the purview of the DOE Legacy Management Organization. Just wanted to be certain this statement is correctly stated for Rob Schorr's work. As stated in the previous sentences of this paragraph, I also recall that Colorado biologists speculated that higher *Microtus* populations influenced abundance of Preble's, not *Peromyscus*. The influence of *Microtus* was also a hypothesis of Fred Harrington, suggesting that when *Microtus* populations were high, Preble's would be low and supposedly, the opposite would also be true. However, if trapping is the only measure, another explanation could be trap availability. Any increased abundance of another commonly captured small mammal could influence the capture rate of Preble's which may skew population estimates. Please check with Schorr as to the accuracy of this quote.

Response: We have changed the language in Figure 2 to address the requested comment.

- 11.) *Comment:* The travel distance and overland travel is missing and important because not typical of other small mammals. Has habitat management implications and could be worth further research. For example, the design of habitat linkages could benefit from understanding the potential for Preble's mice to move greater distances in a short period of time as compared to what would be expected for other small mammals, such as voles and deer mice. Also, overland travel has been observed, but this is not mentioned under the Behavior Section. I believe I provided a description of overland travel I observed to Carron Meaney, recently, please include.

Response: We have added information on travel distance to the *Residential and Commercial Development* section of this plan to address this comment.

- 12.) **Comment:* This second sentence misquotes Wunder 1998. He did indeed find that Preble's mice are more like other mammals that cannot get all water required through metabolism. They likely must drink free water and are closely tied to a mesic habitat. So, I would restate the sentence to say, "From an examination of their kidneys, their water concentrating capacities are like those mammals that must drink free water, not those that are able to meet their water requirements metabolically." I re-read Wunder 1998 to be sure I was remembering this correctly. Therefore, and this is my opinion, there is a threat to Preble's from drinking polluted water. Big Sandy HUC is missing. Differentiate which HUCs are in the north Recovery Unit and which are in the South. SC23 - a few of the citations are duplicated or at least I suspect they are duplicates – Harrington vs Wunder and Harrington...RFETs and DOE...

Response: We have re-written the Wunder 1998 information provided in the *Pesticides and Herbicides* section to address this comment.

- 13.) **Comment:* We sent some data to add to references and discussion. We sent those for Dirty Woman Creek 1998-2005. Why was CDOT's East Plum Creek bank not included in discussion on page? In the Executive Summary to say we have no rangewide population estimate is misleading because we do have some that do not represent the entire range of the Preble's mouse, but they do convey an idea of potential populations in a good portion of the range. Bakeman also provides a caveat comment. In the background you should add that Colorado requires a State Collection Permit, too. The dorsal band is not present on juveniles first out of the nest, but develops in the summer season and is apparent by first hibernation. Add to the photo caption photograph from live-trapping Preble's mouse at Rocky Flats in 1995 from June-October. Wyoming should be added to Converse County.

Response: We have added language to the *Executive Summary*, the *Background*, and Figure 2 to address these comments.

- 14.) **Comment:* This implies Preble's mice eat willow stems, which are unlikely, could it be willow flowers or seeds?

Response: This information was unspecified in the literature and we do not have enough information currently to differentiate what part of the willow was being consumed.

- 15.) **Comment:* Seeds are also an important component of the summer diet. Hibernaculum from Rocky Flats excavated in 1995 with Harrington, Wunder, and Deans. Poison ivy should be added to the diet list. We thought that R. Schorr had recorded traveled distances of around 3 miles on Monument Creek in the USAFA. "Mountain riparian sites may be surrounded by dense forest vegetation (P.ponderosa in Colorado), and sites on the plains have less woody vegetation." Should be added to first paragraph or someplace. "Grasslands" after "hayfields" should be added in third paragraph. Flooding is also the primary means of Populus deltoides reproduction.

Response: We have added language to the *Diet and Hibernation* sections of this plan to address these comments.

- 16.) **Comment:* A summary of the Colorado floods of 2013 should be included, which affected much of Preble's mouse habitat, would be informative, including any before/after analyses of habitat, and observations on stream geomorphology. Did channel incision occur to the extent that a woody riparian community was precluded?

Response: Yes, incision occurred, among other flood impacts. Trees were washed down stream, knocked over, or were buried sufficiently to be killed. Trees were also dewatered due to down cutting of the channel or channel abandonment, resulting in disconnection from groundwater. This affect is patchy, as there are many areas where the riparian forest still stands and is vigorous.

- 17.) *Comment:* In my opinion, the first step to planning for the recovery of a taxon should be to identify the distribution (historical and current) and status of all known populations. Without this, I find it difficult to understand how one could evaluate the status of the taxon, threats, or necessary steps and criteria for recovery. Yet, despite that fact that there has been a concerted effort to identify all historical records and that over the last ca 15 years there has been at least 1,650 trapping studies in Colorado and at least 1,280 records in Wyoming that have documented the Preble's mouse (USFWS 2013 delisting decision), the recovery plan asserts that there is incomplete information on the current distribution of the taxon. I can accept that there may be additional populations that have not been detected. However, there are a large number of populations that are known to exist (or recently existed in past 15 years). The ca > 3,000 records/studies have a lot of data to work with. How many populations are there? Where do they occur? What barriers are present [what is the potential for connectivity among existing populations]? What areas within the potential range have NOT been surveyed but where undiscovered populations may exist. Is there a habitat suitability model to define the historical range? I think that these questions must form the groundwork for any recovery plan but I did not see evidence that this was done for the Preble's mouse. Without these data any selection of recovery populations and targeting locations for recovery of habitat is guesswork. How can we know how many populations are necessary to preserve the species natural heritage? How can we know if additional populations should be restored to insure redundancy, corridors, or maintenance of genetics? Without a full understanding of the subspecies historical and current distribution, the selection of the number and location of recovery units seems entirely arbitrary. None of this ground work seems to have been done, or if so, it was not communicated in a meaningful way as part of the recovery plan. A poorly reasoned plan may fail to recover the species (may even fail to maintain the current status) and may waste valuable resources.

Response: The current text explains the extent of the current data we have. We have spent decades surveying in nearly all the potential habitat Preble's may occur, we have done as complete a job as feasible, given the current access limitations, private land access is limited. Most of the surveys have been done on public land, or there were projects where public interest made the survey efforts possible. We left some flexibility to site conservation teams, where we have good information and where habitat support occurs. We will be making detailed maps of current known populations available online.

- 18.) *Comment:* Individual isolated populations maybe self-sustaining, but are vulnerable to local extinction. Current land uses and stream water management are contributing to the decline of Preble's mouse. A definition of the Type and Quality of Research that is needed to change existing land uses at current levels should be included in the plan. These coalitions serve as a mechanism to plan for waterways at the watershed scale and are multi-stakeholder and community-based. These coalitions serve as a mechanism to plan for waterways at the watershed scale and are multi-stakeholder and community-based.

Response: We have added language to the *Establishing Site Conservation Teams* section plan to address this comment.

- 19.) *Comment:* We are concerned about the taxonomy and validity of the subspecies research, particularly Melaney and Cook (2013).

Response: We have added language to the *Managing Genetic Diversity* section of this plan to address this comment.

- 20.) *Comment:* There needs to be a straightforward description of habitat and non-habitat in the Management Plan.

Response: Our survey guidelines and block clearance zone that can be found online provide habitat and non habitat descriptions (<https://www.fws.gov/mountain-prairie/species/mammals/preble/CONSULTANTS/pmjm2004guidelines.pdf>).

- 21.) **Comment:* Self-sustaining, persistent, public involvement need to be more clearly defined. SC1 - habitat description is misleading and inaccurate. Re-write to, "The Preble's....is found in high plains riparian habitat often reaching to foothills riparian from southeastern Wyoming..."

Response: We have added language to the *Habitat* section plan to address this comment.

- 22.) *Comment:* Add grant-funded restoration that has occurred on public land (BCPOS use of CPW money in St. Vrain corridor).

Response: We have added language to the *Habitat Conservation and Restoration* section of this plan to address this comment.

- 23.) *Comment:* Rocky Flats CH will be affected by upcoming trail construction and increase in humans and dogs.

Response: This comment is addressed in Table 2 of this plan.

I. Need to Add Citations

- 1.) **Comment:* I understand that the intent of this document is to provide for recovery of the taxon traditionally known as *Z. h. preblei*. I am aware of the history of controversy surrounding the taxonomic status of this subspecies and the resulting listing decisions. However, I am deeply troubled by the seeming dismissal of the most recent and most comprehensive genetic data concerning the Preble's mouse—that by Malaney and Cook (2013). The Malaney and Cook study was published after the most recent review of the taxonomic debate (2006) and after the delisting decision (2013). Malaney and Cook (2013) convincingly demonstrate that *preblei* is part of the “northern lineage” that occurs from the range of *preblei* and extends northward up the Rocky Mountains and into Alaska. Genetic differences between animals from Colorado and animals from Alaska are slight and animals occupy the same fundamental niche (see especially the tables and figures in the supplemental files). Prior researchers missed this critically important finding because they failed to include comparative material from throughout the range of the species. This finding is critically important because it casts serious doubt on the taxonomic validity of *preblei* and it demonstrated that the northern lineage occupies the largest geographic range and has an overall low extinction risk, and that limited conservation resources would be better applied to lineages with higher risk. Much of the recovery plan spoke to the need to preserve genetic characteristics of the taxon. However, few specifics were mentioned and no reference was made to how those genetic characteristics fit into the wider evolutionary context of the populations (i.e., Malaney and Cook 2013). Given the huge geographic range of the northern lineage, it is conceivable that the genetic variation of *preblei* is well represented elsewhere.

Response: We have added language to the *Taxonomy* section of this plan to address this comment.

m. Additional Comments

- 1.) **Comment:* As an example, I had difficulty understanding the relationship of one “list” with other “lists”. At minimum these lists included the following: 1) reasons for listing and threats to recovery (page 11-20), 2) criteria for delisting I (page 21-22), 3) guiding principles of plan (page 22-23), 4) recovery plan goals and objectives (page 23), 5) “processes” to implement recovery strategy (page 23-37), 6) criteria for delisting II (page 37-38), 7) recovery action narrative (page 48-56). Some of the relationships among these “elements” were summarized in Table 2 and yet the information in that table is not easy to link back to material presented in the text. For instance, the third column in Table 2 is “Recovery Criteria (point at which the threat is abated)” and each cell beneath contains a number from 1-5. I do not know what the numbers refer to, yet it seems to be the crux of the plan. Is it the five recovery criteria mentioned in paragraph form on pages 21-22 or is it the 5 criteria for delisting on pages 37-38? Why are there two separate lists for recovery criteria? What is the relationship between them? Which must the plan adhere to? Both? What is meant by the “point at which the threat is abated”? This same problem also shows up in the implementation schedule, but this time the column heading is “Recovery Criteria Number”. Is that the same thing as the criteria for delisting on page 21-22 or the criteria for delisting on pages 37-38? Is it something else?

Response: We feel that these lists and tables provide an efficient form of displaying data for this plan.

- 2.) *Comment:* Needs objective measurable criteria, site-specific management action plans and time estimates. Too many important details are deferred such as designation of conservation populations and habitat required to protect them. They provide a primer on the 3Rs (resiliency, redundancy, and representation) for recovery and suggest we explicitly discuss how the recovery criteria for Listing Factor A will create these.

Response: We feel the site specific action plan need to be deferred in order to have the ability to work with private land owners in the future.

- 3.) *Comment:* Unclear if the USFWS is able and willing to undertake the level of work outlined in plan. The USFWS needs to develop Pop Monitoring Methodology and habitat mapping for restoration quickly. Also, Habitat Mon Methodology needs to be developed quickly. Who at the USFWS will implement the plan, e.g., establish the Site Conservation Teams?

Response: Thank you for your comment.

- 4.) *Comment:* “Well developed” and “relatively undisturbed” are unclear and subject to interpretation. Should provide definitions in the glossary from literature or established regulations or include guidance language that frames expectations or goals. Add “less than suitable” (in definition of “functionally connected”) to this list.

Response: We believe the plan already addresses this comment in the *Habitat* section.

- 5.) *Comment:* We want to be able to participate in the recovery strategy.

Response: Yes this is covered under recovery strategy # 9.

- 6.) *Comment:* Incorporate 7(a)(1) into the planning process as well as 7(a)(2) and section 10 permitting.

Response: We advocate for any mechanism that facilitates the conservation and recovery of the Preble’s mouse.

- 7.) *Comment:* As another example, the implementation schedule gives a priority number. Yet, there are two different definitions for priority number. On page 56 they are called “Action priority numbers” and given a definition with respect to how the action might impact the taxon, but on page 57 there is something called “Priority Rankings”, which defines the three numbers in simple terms. Are these priority numbers the same thing? If not, what does the second refer to? If so, why is priority defined differently in two separate places?

Response: We have language defining the priority language to be consistent in the plan to address this comment.

- 8.) *Comment:* Hydrologic function and natural stream processes, including floods, are critical to the long-term maintenance and sustainability of high quality Preble's mouse habitat.
- Response:* We have added language to the *Hydrologic Changes* section of the plan to address this comment.
- 9.) *Comment:* Connectivity across populations and habitat needs to be clarified.
- Response:* We have added language to the *Residential and Commercial Development* section plan to address this comment.
- 10.) *Comment:* Critical habitat with an occupied area needs to be noted as having a potential for enhancement, restoration, or be made to be connective.
- Response:* We believe the site conservation teams will be able to delineate this appropriately.
- 11.) *Comment:* We strongly oppose the enforcement of new federal regulations on private property without clear evidence that these regulations will be effective. The regulations that are currently in place have increased the population of the Preble's Meadow Jumping Mouse. At this point, there should be an effort to eliminate regulations to determine if the population can sustain itself. It is stated that there have been local involvement through conservation easements which have been implemented in Colorado. There should be a report on how effective these have been. Conservation easements may help a species in a short term but they can be detrimental to rancher's operations. When a conservation easement is sold, there are new requirements and rules about what can and cannot be done on the property, while these regulations may positively affect the subspecies now, those regulations are still in affect even after the population has been recovered, still prohibiting the landowner from using is private property and water rights.
- Response:* We are not proposing new regulations on private property in this plan. Any future conservation easements on private property would be voluntary.
- 12.) **Comment:* Overall, I found the draft recovery plan very difficult to digest. I had to read many sections several times in order to try to understand meaning. I am still uncertain whether this problem stemmed from poor writing, lack of attention to detail, and an excess of "cut/paste" material from other documents, or was due to vagueness of content and lack of clarity and inconsistency of logic. Either way, I am left feeling very uneasy about the usefulness of the plan, especially given the questionable taxonomic distinctiveness of *Z. h. preblei* (Preble's mouse) and the time and money that execution of this plan would require. The lack of clarity in the presentation will undoubtedly result in a lack of clarity in implementing the plan and in decision making for delisting. Consequently, as currently presented, I am unable to provide a recommendation to accept the plan
- Response:* Thank you for your comment.
- 13.) *Comment:* The USFWS has failed to comply with the National Environmental Policy Act prior to issuing this plan (NEPA, 2015). NEPA analyses are required for any major federal environmental action that could have a significant effect on the environment (including beneficial environmental

impacts) or the people in the communities of the environment. Because the USFWS proposes a cost of \$47 million, this constitutes as a major federal action. Additionally, the NEPA document would also consider the impacts of the implementation of this plan on local communities and the tax base.

Response: Recovery Plans are not subject to the regulations of NEPA. Thank you for your comment.

- 14.) *Comment:* I support recovery planning so long as it is based on objectives that state and federal governments can reasonably meet. The Preble's mouse draft plan fails this test and requires additional attention before receiving my support. The adaptive management framework is ambiguous, implementation costs are not accounted for and the requirement to genetically identify makes reaching delisting milestones tenuous. An effective recovery plan should create certainty. This is not the case within the draft. It leaves too many issues unresolved, or worse, open to future interpretation. The draft should be changed to address these issues.

Response: We have added language to the *Monitoring and Adaptive Management, Determining Number and Distribution of Recovery Populations, Using Adaptive Management, and the Recovery Action Narratives* sections of this plan to address this comment.

- 15.) *Comment:* Regarding the section of the draft recovery plan that discusses Preble's mouse use in montane habitats, it is suggested that a reference to Craig Hansen's M.S. Thesis work on Preble's movement patterns and reduced upland use in narrow montane stream systems be included (Hansen, C.M. 2006. Monitoring and movements of the Preble's meadow jumping mouse (*Zapus hudsonius preblei*) in montane drainages of Pike National Forest, Colorado. M.S. Thesis, Univ. of Colo., Colorado Springs. 181 pp.)

Response: We have added language to the *Habitat* section of the plan to address this comment.

- 16.) *Comment:* I would like to have seen more detail about how the population monitoring data would feed back into understanding population status currently and predicted. There seems to be so little known about populations other than occupancy, that range wide population demographic and status information seems to be a particular gap and need for informing status of populations and recovery progress. What will be done with that data (i.e. population modeling, sensitivity analyses?) and who would manage the data and analyses? Is there a need for development of a central recovery program database? Rather than the data just answering questions of occupancy and persistence over time at sites.

Response: There is a recovery program database established. The research needs section addresses much of this comment. The monitoring protocol will attempt to address some of the concerns raised in this comment.

- 17.) *Comment:* It looks like USFS should be added in the "Other Parties" column in the Implementation Schedule for Action Items # 5.1 (page 65), 5.2 (page 66), and 5.3 (page 66)

Response: We have added language to the *Implementation Schedule* section plan to address this comment.

- 18.) *Comment:* It was suggested that the USFWS or other member(s) of the Preble's mouse Recovery Team give a presentation to the federal Interagency Level 1 Teams regarding the development of the revised Preble's mouse recovery plan. This would include the SE Colorado, NE Colorado, and SE Wyoming Level 1 Teams which have jurisdictions for Preble's mouse.

Response: Thank you for your comment.

- 19.) *Comment:* County and local governments in Wyoming have not been a part of the recovery or recovery planning process, and it is unrealistic to expect local governments in Wyoming to be a driving force in Preble's mouse recovery.

Response: When considering delisting the Preble's mouse, the Service will need to consider the adequacy of existing regulatory mechanisms (Factor D). County and local governments in Colorado have a substantial role to play in the Preble's mouse's recovery; therefore, the focus of this criterion is to recognize the efforts that will be needed in Colorado, where much more of the habitat occurs in urban areas and areas with development pressure. In Wyoming, the habitat tends to occur in rural areas with little development pressure. In addition, many of the existing activities that occur in Wyoming are exempted from incidental take by the 4(d) rule, so there is little need (currently) for local or county governments to play an active role. However, over the life of the recovery plan, county or local governments will have opportunities to assist with recovery, potentially as members or champions of Site Conservation Teams and the Service would engage with them as partners.

Where large, medium, and small populations have been designated, including those in Wyoming, adequate regulatory mechanisms will be needed to ensure these populations will persist into the foreseeable future. However, in recovering the Preble's mouse, we are looking for willing partners. If a municipality is unwilling or unable to provide adequate regulatory mechanism(s), other protections will likely need to be explored, such as actions that could be taken by a county or state government. Alternatively, another nearby population of similar size might be identified and protected, alleviating the need for the municipality to take action. In summary, recovery should be a collaborative effort with willing partners, and we are willing to consider novel and creative ideas to achieve recovery, and we also hope to provide incentives for recovery.