

1. INTRODUCTION

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. Based on the outcome of the 5-year review, we recommend whether the species should: (1) be removed from the list of endangered and threatened species; (2) be changed in status from endangered to threatened; (3) be changed in status from threatened to endangered; or (4) remain unchanged in its current status. If we recommend a change in listing status based on the results of the 5-year review, a separate rulemaking process must be conducted to implement the recommendation.



Figure 1: A Preble's meadow jumping mouse, or Preble's, in cold-induced torpor (sleep) at the U.S. Air Force Academy in El Paso County, Colorado. The Preble's extremely long tail and large hindfeet distinguish it from other mice. (USFWS)

We must use the best scientific and commercial information available when we write a 5-year review. Therefore, we published a Federal Register notice on November 26, 2012, requesting any new information since the last review of the species ([77 FR 70410](https://www.federalregister.gov/documents/2012/11/26/77-fr-70410)). We received eight comments in response to this request (Docket ID: FWS-R6-ES-2012-0095, available online at [Regulations.gov](https://www.regulations.gov)). We also reviewed a new study that evaluated the rangewide genetic relationships between jumping mice, including the Preble's (Malaney and Cook, 2013).

Biologists from the Colorado Ecological Services Field Office prepared this 5-year review, with contributions and review provided by cooperating field and regional offices. This 5-year review recommends that the Preble's status remain unchanged.

2. BACKGROUND ON THE SUBSPECIES' LISTING HISTORY

Scientific and Common Name:	Preble's meadow jumping mouse (Preble's or PMJM) <i>Zapus hudsonius preblei</i>
Listing Classification:	Threatened rangewide
Listing History:	Listed as a threatened species on May 13, 1998 (63 FR 26517) Table 1 below summarizes our listing actions.
Critical Habitat:	Designated in Colorado on December 15, 2010 (75 FR 78429) Table 1 below summarizes our actions regarding critical habitat.

**U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW FOR
THE PREBLE'S MEADOW JUMPING MOUSE (*Zapus hudsonius preblei*)**

2014

Other Associated Rules: Final 4(d) special rule adopted on May 20, 2004 (69 FR 29101)
Table 1 below summarizes our special rules.

Recovery Planning: Preliminary Draft Recovery Plan; November 2003

Lead Agency, Region: Mountain-Prairie Region, U.S. Fish & Wildlife Service

Lead Field Office: Colorado Ecological Services Field Office

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Table 1. The U.S. Fish and Wildlife Service's regulatory actions for the Preble's meadow jumping mouse.

Date	FR Citation	Action Type	Federal Register Document Title (<i>click to open links</i>)	Action Summary
05/24/2013	78 FR 31679 31712	Listing: 12-Month Finding	12-Month Finding on Two Petitions To Delist the Preble's Meadow Jumping Mouse (Appendix B)	Delisting not warranted.
11/26/2012	77 FR 70410 70411	Listing: Initiation of Status Review and 5-Year Review	Endangered and Threatened Wildlife and Plants; Initiation of Status Review and 5-Year Review of the Preble's Meadow Jumping Mouse	Initiate Status Review
08/05/2011	76 FR 47490 47491	Listing	Reinstatement of Listing Protections for the Preble's Meadow Jumping Mouse	Reinstate threatened status rangewide, including in Wyoming.
12/15/2010	75 FR 78430 78483	Critical Habitat: Final Rule	Revised Critical Habitat for the Preble's Meadow Jumping Mouse in Colorado; Final Rule	Final designation of critical habitat in Colorado.
10/08/2009	74 FR 52066 52107	Critical Habitat: Proposed Rule	Revised Critical Habitat for the Preble's Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>) in Colorado: Proposed rule.	Proposed critical habitat designation
07/10/2008	73 FR 39790 39838	Listing: Final Rule	Final Rule To Amend the Listing for the Preble's Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>) To Specify Over What Portion of Its Range the Subspecies Is Threatened; Final Rule	Final rule to remove listing protections for Preble's in Wyoming based on Significant Portion of the Range (SPR) analysis. Also removed critical habitat designation in Wyoming.

**U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW FOR
THE PREBLE'S MEADOW JUMPING MOUSE (*Zapus hudsonius preblei*)**

2014

Date	FR Citation	Action Type	Federal Register Document Title (click to open links)	Action Summary
11/07/2007	72 FR 62992 63024	Listing: Proposed Rule	Revised Proposed Rule To Amend the Listing for the Preble's Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>) To Specify Over What Portion of Its Range the Subspecies Is Threatened	Proposed rule to remove listing protections for Wyoming Preble's based on SPR.
02/02/2005	70 FR 5404 5411	Listing: 12-Month Finding & Proposed Delisting	12-Month Finding on a Petition To Delist the Preble's Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>) and Proposed Delisting of the Preble's Meadow Jumping Mouse	Warranted finding and proposed delisting rule
05/20/2004	69 FR 29101 29105	Other Rules: 4(d) Extensions	Extension of Amended Special Regulations for the Preble's Meadow Jumping Mouse	Extension of 4(d) regulations
03/31/2004	69 FR 16944 16946	Listing: 90-Day Finding on Delisting & 5-Year Status Review	90-Day Finding for a Petition to Delist the Preble's Meadow Jumping Mouse in Colorado and Wyoming and Initiation of a 5-Year Review	Substantial petition finding.
03/23/2004	69 FR 13504 13505	Other Rules: 4(d) Extensions	Extension of Amended Special Regulations for the Preble's Meadow Jumping Mouse	Extension of 4(d) regulations
02/24/2004	69 FR 8359 8364	Other Rules: 4(d) Extensions	Extension of Amended Special Regulations for the Preble's Meadow Jumping Mouse	Extension of 4(d) regulations
12/18/2003	68 FR 70523 70526	Listing: 90-Day Finding	90-Day Finding for a Petition to Delist the Preble's Meadow Jumping Mouse in Colorado and Wyoming	Not substantial petition finding
06/23/2003	68 FR 37276 37332	Critical Habitat: Final Rule	Designation of Critical Habitat for the Preble's Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>); Final Rule	Final designation of critical habitat rangewide
01/28/2003	68 FR 4160 4161	Critical Habitat: Proposed Rule	Endangered and Threatened Wildlife and Plants; Proposed Designation of Critical Habitat for the Preble's Meadow Jumping Mouse	Proposed designation of critical habitat rangewide
10/01/2002	67 FR 61532 61537	Other Rules: Addition of activities to 4(d) rule	Amended Special Regulation for the Preble's Meadow Jumping Mouse	Amend special 4(d) regulations To include weed control and ditch maintenance activities.
07/17/2002	67 FR 47154 47210	Critical Habitat: Proposed Rule	Designation of Critical Habitat for the Preble's Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>)	Proposed designation of critical habitat rangewide
08/30/2001	66 FR 45829 45833	Other Rules: Proposed 4(d)	Proposed Special Regulations for the Preble's Meadow Jumping Mouse	Amend special rule to include other activities
05/22/2001	66 FR 28125 28131	Other Rules: Final 4(d)	Final Special Regulations for the Preble's Meadow Jumping Mouse	Final special rule

Date	FR Citation	Action Type	Federal Register Document Title (click to open links)	Action Summary
12/03/1998	63 FR 66777 66784	Other Rules: Proposed 4(d)	Proposed Special Regulations for the Preble's Meadow Jumping Mouse	Proposed special rule
05/13/1998	63 FR 26517 26530	Listing: Final Rule	Final Rule to List the Preble's Meadow Jumping Mouse as a Threatened Species	Final listing as threatened species
03/25/1997	62 FR 14093 14101	Listing: Proposed Rule	Proposal To List the Preble's Meadow Jumping Mouse as a Endangered Species	Proposed listing as an endangered species.
03/15/1995	60 FR 13950 13952	Listing: 90-Day Finding	90-Day Finding for a Petition to List the Preble's Meadow Jumping Mouse as Threatened or Endangered	Substantial petition finding that listing may be warranted

3. REVIEW OF THE LISTABLE ENTITY

3.1 Taxonomic Information

Our latest 12-month finding (May 24, 2013; [78 FR 31679](#), Appendix B) provides detailed taxonomic information for the Preble’s. We briefly summarize this information below and evaluate new information published after our last 12-month finding.

The Preble’s is a member of the family Dipodidae (jumping mice) (Wilson and Reeder 1993, p. 499), which contains four extant genera, or living family members. Two of these genera, *Zapus* (jumping mice) and *Napaeozapus* (woodland jumping mice), are found in North America (Hall 1981, p. 841; Wilson and Ruff 1999, pp. 665–667). The Preble’s is one of 12 recognized subspecies of meadow jumping mice (*Z. hudsonius*) distributed across North America.

In 2005, a genetics and morphometrics study proposed synonymizing Preble’s 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.

Our previous 12-month findings reevaluated the information and have reconfirmed that the best scientific and commercial data available support the conclusion that the Preble’s is a valid subspecies (73 FR 39790, July 10, 2008; 78 FR 31679, May 25, 2013). Specifically, the Preble’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 meets or exceeds numerous, widely accepted subspecies definitions.

However, a recent Service-funded study (published after our 2008 and 2013 findings) also

warrants consideration due to its consideration of Preble's taxonomy. Specifically, a September 2013 publication in *Molecular Ecology* further evaluated the genetic relationship between jumping mice, including the Preble's (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 is distinct from neighboring subspecies that were previously proposed to be taxonomically synonymized (*Z. h. campestris* and *Z. h. intermedius*) (Malaney and Cook, 2013, pp. 8, 10). However, the study concludes that Preble's 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, p. 8, 10).

Although the study suggests that the Preble's 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 or any of the other subspecies of jumping mice (Malaney and Cook 2013, p. 10). 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, p. 10).

We agree that this new information is not sufficient to formally change the taxonomy of the Preble's.

3.2 Application of the Distinct Population Segments (DPS) Policy

The Preble's is listed as threatened rangewide and is not listed at the population level. Therefore, formal application of the Service's DPS policy is not necessary when considering whether the Preble's is a valid listable entity (the Act allows listing species, subspecies and DPSs) and by extension, whether a change in its listed status is necessary.

However, we recognize that Malaney and Cook's (2013) recent study raises questions regarding the Preble's taxonomic validity. Thus, we felt that it would be prudent to conduct a preliminary or hypothetical DPS assessment for the Preble's based on this new information. Our preliminary DPS assessment follows below.

Pursuant to the Act, valid listable entities include species, subspecies, and DPSs. To interpret and implement the DPS provision of the Act and congressional guidance, the Service and the National Marine Fisheries Service published a policy regarding the recognition of distinct vertebrate population segments under the Act (61 FR 4722, February 7, 1996). Under this policy, the Service considers two factors to determine whether the population segment is a valid DPS—(1) discreteness of the population segment in relation to the remainder of the taxon, and (2) the significance of the population segment to the taxon to which it belongs.

Regarding discreteness, under our DPS Policy, a population segment of a vertebrate taxon may be considered discrete if it satisfies either one of the following conditions—(1) is markedly separated from other populations of the same taxon as a consequence of physical, physiological,

ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or (2) is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

The Preble's is genetically isolated from its nearest neighbors found in Wyoming and New Mexico (73 FR 39790, July 10, 2008; 78 FR 31679, May 25, 2013; Malaney and Cook 2013, p. 10). Furthermore, the most recent evaluation of genetic lineage indicates that Preble's is most closely related to two subspecies that occur in Alaska and western Canada (Malaney and Cook 2013, p. 10). These subspecies are geographically separated from the Preble's by more than 800 miles. Given meadow jumping mice dispersal capabilities, which have not been recorded to exceed 2.3 miles (Schorr 2003, p. 10; Schorr 2012, pp. 1274, 1278; May 24, 2013, 78 FR 31682), and the lack of any known populations of the subject subspecies in intervening areas, this geographic separation would appear to satisfy the discreteness criterion of the DPS policy.

Regarding significance, we are to consider, but not limit our analysis to, consideration the following factors: (1) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon; (2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon; (3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; and/or (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. Satisfying any one of these factors meets the significance prong of the DPS policy. It is our assessment that Preble's would appear to meet the significance standard as the loss of this southernmost population along the Front Range would represent a range retraction of more than seven latitudinal degrees to the north, likely resulting in a significant gap in the range of the taxon.

Thus, based on the above preliminary assessment, we believe Preble's would satisfy the criterion of the DPS policy, should such a formal application ever be necessary. However, we conducted this preliminary, hypothetical DPS analysis out of an abundance of caution only, as the Preble's continues to be considered a valid subspecies based on the best scientific and commercial information available.

3.3 Recommendation

The best available information indicates that the Preble's is a genetically and geographically distinct subspecies of jumping mouse. A recent study provides additional insight into the Preble's genetic similarity to other jumping mice, but it does not provide sufficient information to revise the Preble's taxonomy. Although the Preble's may be genetically similar to two other subspecies found more than 800 miles away, the Preble's is genetically distinct from its closest neighbors to the north and south. If a formal taxonomic change did ever occur and lump the Preble's with a larger "northern lineage," the Preble's would appear to meet the distinctness and significance criteria of our DPS policy and warrant listing as a DPS.

4. BASIC SPECIES INFORMATION

4.1 BRIEF SPECIES DESCRIPTION

The Preble's is a small mouse with an extremely long tail, large hind feet, and long hind legs, which allow the mouse to escape from predators by making incredible jumps. The distinctively long tail is bicolored, lightly furred, and often twice as long as the body, occupying more than 60 percent of the total body length (Figure 1). The Preble's has a dark broad stripe on its back that runs from head to tail and is bordered on either side by gray to orange-brown fur. These features distinguish the Preble's from more common small mammals, such as deer mice (*Peromyscus maniculatus*) or voles (*Microtus* spp.).

4.2 BASIC LIFE HISTORY AND BIOLOGICAL LIMITING FACTORS

The Preble's lives in heavily vegetated streamside riparian habitats with adjacent grassland cover in southeastern Wyoming, southward along the eastern edge of the Front Range foothills south to Colorado Springs in El Paso County, Colorado. The Preble's depends on well-developed, plains riparian vegetation with relatively undisturbed grassland communities and a nearby water source (Figure 2). The Preble's relies on these riparian habitats to feed, breed, shelter, and hibernate. The Preble's also uses grassy uplands at least as far out as 100 meters beyond the 100-year flood plain and hibernates in underground burrows for eight months during the winter.

Our most recent 12-month status review (May 24, 2013; [78 FR 31679](#)) provides detailed life history information regarding the Preble's.



Figure 2. Preble's habitats feature dense riparian vegetation, such as willows, and adjacent grassy uplands within 300 feet of the 100-year floodplain, with an open water source nearby. (USFWS)

4.3 DISTRIBUTION

The Preble's overall range is best described as a narrow strip of land extending along the eastern edge of the Front Range foothills of the Rocky Mountains from southeastern Wyoming to Colorado Springs, Colorado (Figure 3). The Preble's preference for riparian vegetation that borders streams and other waterbodies greatly restricts the Preble's distribution within this range. The dry, arid prairies of eastern Colorado and Wyoming limit the Preble's expansion to the east. Intense human development likely extirpated the Preble's from the Denver and Colorado Springs metropolitan areas and any downstream habitats. Additionally, the Preble's range does not extend west past the crest of the Laramie Range in Wyoming.

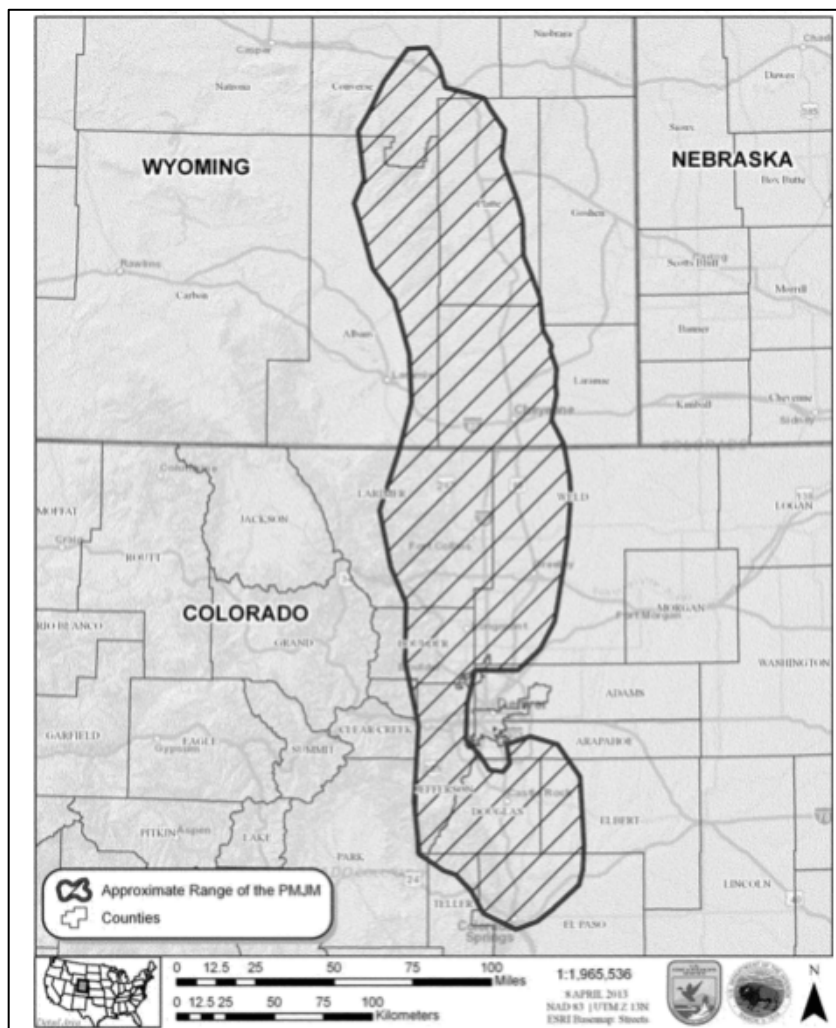


Figure 2. The Preble's overall range extends from southeastern Wyoming to Colorado Springs, Colorado, and is bordered by mountainous terrain to the west and the dry, arid prairie to the east. The Preble's reliance on riparian vegetation that borders streams and waterways greatly restricts its distribution within this overall range.

4.4 POPULATION STATUS

Because trapping the Preble's is time consuming and often difficult, there are few estimates of population sizes in Colorado and none for Wyoming. In high quality habitats along the plains, populations average 44 mice per mile (27 mice per kilometer). There is also very little current trend information for Preble's populations. However, Preble's populations in well-protected habitats at the U.S. Air Force Academy in El Paso County, Colorado, declined over seven years, suggesting that populations in less-protected habitats may have also declined (Schorr 2012a, p.

1277). Additionally, low trapping success rates, particularly near urban areas and in montane habitats, indicate that Preble's populations are low.

5. RECOVERY PROGRESS

After listing in 1998, the Service assembled a Preble's Recovery Team (Recovery Team), composed of scientists and stakeholders to develop a plan to recover the subspecies. In June 2003, the Preble's Recovery Team provided their recommendations for the recovery of the Preble's in a draft recovery plan. The Service revised this working draft in November 2003. Although the Recovery Team drafted this Preliminary Draft Recovery Plan in the format of a Recovery Plan, and used the term "Recovery Plan" within the document, the document was not approved as an official draft Recovery Plan. Instead, it remains a Preliminary Draft Recovery Plan (USFWS 2003b). However, the document remains the best available source of scientific information regarding the Preble's recovery needs.

The Preliminary Draft Recovery Plan outlines four recovery criteria for the Preble's:

1. Document and maintain wild, self-sustaining Preble's populations;
2. Protect and manage habitat of Preble's populations;
3. Abate threats to Preble's populations; and
4. Develop and implement a long-term management plan and cooperative agreement prior to delisting.

The Preliminary Draft Recovery Plan provides a series of tasks necessary to attain each of these draft recovery goals. However, the Recovery Team completed very few tasks and the draft recovery goals have not been reached. For example, trapping studies needed to document self-sustaining populations have decreased in frequency.

The best available information indicates that Preble's populations have decreased since the Recovery Team drafted its recovery plan in 2003. Therefore, we recommend that the Recovery Team reconvene as soon as possible to update, finalize, and implement a recovery plan for the Preble's. Each year that passes without a recovery plan in place will make the recovery of Preble's more difficult, especially in light of potential population-level losses to the September 2013 flood disaster.

6. SUMMARY OF FACTORS AFFECTING THE SPECIES

Our latest 12-month finding (May 24, 2013; [78 FR 31679](#), Appendix B) provides a thorough review of the best available scientific and commercial information regarding the factors affecting the Preble's. Our 5-factor analysis identified threats to the Preble's under Factors A (the present or threatened destruction, modification, or curtailment of its habitat or range), D (the inadequacy of existing regulatory mechanisms), and E (other natural or manmade factors affecting its continued existence). Specific threats to the Preble's include human urbanization, the

inadequacy of existing regulatory mechanisms in the absence of the Act's protections, wildfire, drought, small population sizes, and modifications to habitats resulting from climate change. Our review determined that the Preble's is still a threatened subspecies and should not be removed from the Federal list of Threatened and Endangered Species.

The growth of the human population within the Front Range of the Rocky Mountains in Colorado and Wyoming has led to the loss and alteration of Preble's habitats. This loss results from urban development, flood control, water development, aggregate mining, and other human land uses. These threats are ongoing and will increase in magnitude as human populations in Colorado and Wyoming continue to expand.

Additional threats to the Preble's include wildfire, drought, small population sizes, and modifications to habitats resulting from climate change. We determined that floods, agriculture, grazing, and nonnative plants are not currently threats to the Preble's, but may increase in magnitude over time as human populations expand and climate change increases the frequency and intensity of wildfires and droughts. Many of these threats act cumulatively to further degrade habitats and negatively impact Preble's populations.

In September 2013, stochastic flash floods adversely affected Preble's 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 overall range and approximately 70 percent of its designated critical habitat in Colorado. The flash floods may have significantly decreased Preble's populations throughout the flood disaster zone by drowning mice and destroying habitats. After the floods, Preble's 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 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 Preble's 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 populations. Trapping surveys, habitat evaluations, and other techniques will be necessary to gauge the full effect of the flood on Preble's populations and distribution in Colorado.

6.1. Recommendation

The flood disaster of September 2013 may have significantly reduced Preble's populations and changed the subspecies' distribution in Colorado. Although population-level effects were likely severe, potentially impacting up to 60 percent of the Preble's overall range in Colorado, additional information will be required to reevaluate the Preble's recovery priority number (RPN) in its post-flood environment. When additional information regarding the magnitude of the flood's impacts becomes available, we recommend reevaluating the Preble's RPN.

7. SYNTHESIS

Our May 24, 2013, 12-month finding ([78 FR 31679](#), Appendix B) provides a comprehensive evaluation of the Preble's status, including its taxonomy, distribution, abundance, population trends, and threats. We relied on this thorough 12-month finding to inform this 5-year review. The Preble's is a valid subspecies of meadow jumping mouse and a listable entity under the Act. The loss and alteration of Preble's habitats from urban development and other human activities continues to impact the species. Our review concluded that the Preble's is likely to become endangered throughout all of its range within the foreseeable future and should retain its threatened status under the Act. Therefore, this 5-year review determines that the Preble's status should remain unchanged.

8. RECOMMENDATIONS FOR FUTURE ACTIONS

Administrative Actions:

- Reconvene the Recovery Team.
- Update and finalize the Preliminary Draft Recovery Plan.

Surveys and Monitoring:

- Implement long-term population monitoring trapping surveys to assess populations and trends rangewide.
- Monitor populations impacted by the September 2013 flash floods to assess recovery from stochastic events.

9. REFERENCES CITED

Malaney, J. L., & Cook, J. A. (2013). Using biogeographical history to inform conservation: the case of Preble's meadow jumping mouse. *Molecular ecology*, 22(24), 6000-6017.

Schorr, R.A. (2012a). Using a temporal symmetry model to assess population change and recruitment in the Preble's meadow jumping mouse (*Zapus hudsonius preblei*). *Journal of Mammalogy* 93(5).

USFWS. U.S. Fish and Wildlife Service. (2003b). Draft Recovery Plan Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*). Region 6, Lakewood, Colorado. November 5, 2003. 95 pp.

Our May 24, 2013, 12-month finding ([78 FR 31679](#), Appendix B) provides a complete list of references cited.

RESULTS

Classification: Threatened
Current Classification: 9c

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No revision needed

If change in status is recommended, assign a Reclassification Priority Number per our 1983 guidance (48 FR 43098, September 21, 1983):

No change in status recommended.

Recovery Priority Number per our 1983 guidance (48 FR 43098, September 21, 1983):

Prior to this review: 9c

Revised Recovery Priority Number: No revision needed.


See Appendix A for rationale.

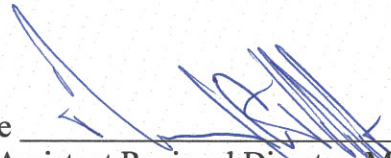
LEAD AUTHORS

Review Conducted By: Craig Hansen, Colorado Ecological Services Field Office

APPROVAL

ACTING FOR

Approve  Date 4/18/14
Lead Field Supervisor, Colorado Ecological Services Field Office

Approve  Date 5/8/14
Lead Assistant Regional Director, Mountain-Prairie Region

APPENDIX A:

The following table lays out the Service’s ranking system for determining Recovery Priority Numbers per our 1983 policy (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

Brief Rationale:

The Preble’s faces a moderate degree of threats and a high recovery potential. Threats are moderate because the Preble’s will not immediately face extinction if recovery is temporarily delayed; however, populations continue to decline and human activities and other factors continue to impact Preble’s habitats. The Preble’s has a high recovery potential because its limiting factors, primarily its dependence on riparian habitats, and its threats, the loss and fragmentation of riparian habitats, are well understood and easily alleviated. Based on our consultation history for the Preble’s under section 7 of the Act and the propensity for urban development to expand along highly productive riparian corridors, the subspecies’ recovery may conflict with construction, other development projects, or other forms of economic activity. Finally, the Preble’s is a genetically distinct subspecies of meadow jumping mouse. Therefore, we assign the Preble’s a Recovery Priority Number of 9C.

APPENDIX B:

May 24, 2013, 12-month finding ([78 FR 31679](#)) for the Preble's meadow jumping mouse.



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Part III

Department of the Interior

Fish and Wildlife Service

50 CFR Part 17

Endangered and Threatened Wildlife and Plants; 12-Month Finding on Two Petitions To Delist the Preble's Meadow Jumping Mouse; Proposed Rule

DEPARTMENT OF THE INTERIOR**Fish and Wildlife Service****50 CFR Part 17**

[Docket No. FWS-R6-ES-2012-0095;
FXES1113090000-134-FF09E30000]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on Two Petitions to Delist the Preble's Meadow Jumping Mouse

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on two petitions to delist the Preble's meadow jumping mouse (*Zapus hudsonius preblei*) under the Endangered Species Act of 1973, as amended (Act). After review of the best available scientific and commercial information, we find that delisting the Preble's meadow jumping mouse is not warranted at this time. We base our determination on the continued loss and modification of the Preble's meadow jumping mouse's habitat to human development, the inadequacy of existing regulatory mechanisms, and other natural factors, including wildfire and threats associated with global climate change. Although delisting is not warranted at this time, we ask the public to submit to us at any time any new information that becomes available concerning conservation measures or threats to this subspecies or its habitat.

DATES: The finding announced in this document was made on May 24, 2013.

ADDRESSES: This finding is available on the Internet at <http://www.regulations.gov> at Docket Number FWS-R6-ES-2012-0095. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Colorado Field Office at 134 Union Blvd., Suite 670, Lakewood, CO 80228. Please submit any new information, materials, comments, or questions concerning this finding to the above street address.

FOR FURTHER INFORMATION CONTACT: Susan Linner, Field Supervisor, U.S. Fish and Wildlife Service, Colorado Field Office (see **ADDRESSES**); by telephone at (303) 236-4773; or by facsimile at (303) 236-4005. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800-877-8339.

SUPPLEMENTARY INFORMATION:**Background**

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*), requires that, for any petition to revise the Federal Lists of Endangered and Threatened Wildlife and Plants that contains substantial scientific or commercial information that delisting the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In this finding, we will determine that the petitioned action is: (1) Not warranted, (2) warranted, or (3) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are endangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register**.

The term "species" is specifically defined as a term of art in the Act to include "subspecies" and, for vertebrate species, "distinct population segments," in addition to taxonomic species. 16 U.S.C. 1532(16). Therefore, when we use the term "species" in this finding, with or without quotation marks, we generally mean to refer to this statutory usage, which includes species, subspecies, and distinct population segments in general. When referring more specifically to the Preble's meadow jumping mouse (PMJM), we use the term subspecies.

Previous Federal Actions

We listed the PMJM as threatened under the Act on May 13, 1998 (63 FR 26517).

On May 22, 2001, we published a final section 4(d) special rule for the PMJM that prescribed the regulations necessary and advisable to conserve the subspecies. When we establish a special rule for a threatened subspecies, the general regulations for some prohibitions under the Act do not apply and the special rule contains the prohibitions, and exemptions, necessary and advisable to conserve the subspecies. The 4(d) rule for the PMJM applied the prohibitions for threatened animals (50 CFR 17.31) except it allowed "take" for certain rodent control activities, ongoing agricultural activities, maintenance and replacement

of existing landscaping, and existing uses of water from May 22, 2001, through May 22, 2004 (66 FR 28125). The Act defines "take" as harass, harm, pursue, hunt, shoot, would, kill, trap, capture, or collect any threatened or endangered species or subspecies. Harm may include significant habitat modification where it kills or injures a listed species by impairing essential behaviors, such as breeding, feeding, or sheltering. Unless allowed by special regulations or a permit, take of a listed animal is unlawful under the ESA. On October 1, 2002, we amended the 4(d) rule for the PMJM to allow take for certain noxious weed control and ditch maintenance activities from October 1, 2002, through May 22, 2004 (67 FR 61531). We made the special rule, as amended, permanent on May 20, 2004 (69 FR 29101).

After listing, we assembled a Preble's meadow jumping mouse Recovery Team (Recovery Team), composed of scientists and stakeholders to develop a plan to recover the subspecies. In June 2003, the PMJM Recovery Team provided their recommendations for the recovery of the PMJM in a draft recovery plan. The Service revised this working draft in November 2003. Although the Recovery Team drafted the Preliminary Draft Recovery Plan in the format of a Recovery Plan, and used the term "Recovery Plan" within the document, the document was not approved as an official draft Recovery Plan. However, this Preliminary Draft Recovery Plan (USFWS 2003b) remains the best source of scientific information available concerning the recovery needs of the PMJM. The Recovery Team intends to reconvene following this finding.

We published a final rule designating critical habitat for the PMJM on June 23, 2003 (68 FR 37276). On December 15, 2010, we published a final rule revising critical habitat for the PMJM in Colorado (75 FR 78430).

On December 23, 2003, we received two nearly identical petitions, from the State of Wyoming's Office of the Governor and Coloradans for Water Conservation and Development, seeking to remove the PMJM from the Federal List of Endangered and Threatened Wildlife (Freudenthal 2003; Sonnenberg 2003). The petitions maintained that the PMJM should be delisted based on the taxonomic revision suggested by Ramey *et al.* (2003). Additionally, the petitioners alleged that the subspecies was no longer threatened based upon new distribution, abundance, and trend data (Freudenthal 2003, p. 1; Sonnenberg 2003, p. 1).

In response to these petitions, we published a notice in the **Federal**

Register on March 31, 2004 (69 FR 16944), announcing a 90-day finding that the petitions presented substantial information indicating that the petitioned action to delist the subspecies may be warranted and initiating a status review of the subspecies. On February 2, 2005, we published a 12-month finding (70 FR 5404) that the petitioned action was warranted and published a proposed rule to remove the PMJM from the Federal List of Endangered and Threatened Wildlife.

On February 17, 2006, the Service announced (71 FR 8556) that we were extending the rulemaking process an additional 6 months, as allowed under section 4(b)(6)(B)(i) of the Act, in order to rectify the conflicting conclusions of two studies of the PMJM's taxonomy and that we were reopening the comment period on the February 2, 2005, proposed rule. We assembled a panel of experts to carefully review and assess the studies by Ramey *et al.* (2005) and King *et al.* (2006a).

On September 26, 2006, the State of Wyoming submitted a 60-day notice of intent to sue over our failure to publish a final determination on our 2005 proposed delisting rule within the timeframes allowed by the Act. On June 22, 2007, the Service and the State of Wyoming reached a settlement agreement, which required that by October 31, 2007, we submit to the **Federal Register** for publication either: (1) A withdrawal of our 2005 proposed delisting regulation; or (2) a new proposed regulation considering the PMJM's taxonomy and the subspecies' threatened status in light of all current distribution, abundance, and trends data (*State of Wyoming v. U.S. Department of the Interior*, No. 07CV025J (District of Wyoming 2007)). In addition, the Service agreed that if we did publish a new proposed regulation, we would submit a final determination on that proposed regulation to the **Federal Register** no later than June 30, 2008.

On November 7, 2007, we published a revised proposed rule (72 FR 62992) to amend the listing of the PMJM to specify over what portion of its range the subspecies is threatened.

On July 10, 2008, we published a final rule (73 FR 39790) amending the listing determination that removed the Act's protections for the PMJM in Wyoming. In this rule, we relied on the March 16, 2007, Memorandum Opinion from the Department of the Interior's Office of the Solicitor (Opinion M-37013) to interpret the Act's term "significant portion of the range," or SPR. Under Opinion M-37013, we determined that the PMJM was not threatened

throughout all of its range, but that the portion of its range located in Colorado represented a significant portion of the range where the subspecies should retain its threatened status. Therefore, this SPR determination recognized a difference in status between the Wyoming and Colorado portions of the PMJM's range.

On June 23, 2009, the Center for Native Ecosystems challenged our interpretation of the SPR language as applied to the July 10, 2008, amended PMJM decision in the United States District Court for the District of Colorado. After that lawsuit was filed, two courts vacated listing decisions for two other species that relied on the same statutory interpretation contained in Opinion M-37013. On May 4, 2011, the Solicitor of the Department of the Interior withdrew Opinion M-37013, and the Service announced its intent to propose a joint policy with the National Marine Fisheries Service (NMFS) regarding the interpretation and implementation of the Act's statutory phrase "in danger of extinction throughout all or a significant portion of its range." In light of these court decisions and the subsequent withdrawal of Opinion M-37013, we filed a motion for voluntary remand and vacatur of the 2008 PMJM amended listing decision. On July 7, 2011, the United States District Court for the District of Colorado granted this motion and ordered the 2008 amended listing decision vacated and remanded as of August 6, 2011 (*Center for Native Ecosystems, et al. v. Salazar, et al.*, 09-cv-01463-AP-JLK, 2011 U.S. Dist. LEXIS 72664). On August 5, 2011, the Service issued a final rule (76 FR 47490) complying with the court order, which reinstated the Act's regulatory protections for the PMJM in Wyoming on August 6, 2011.

In addition to remanding the amended listing determination, the court ordered that we complete a status review for the PMJM to address the December 23, 2003, delisting petitions submitted by the State of Wyoming and Coloradoans for Water Conservation and Development. The court required that we publish our 12-month finding in the **Federal Register** by June 1, 2013. On November 26, 2012, we announced the initiation of this status review and encouraged all interested parties to submit any new information regarding the PMJM and its threats (77 FR 70410). This finding addresses these petitions.

On December 9, 2011, FWS and the National Marine Fisheries Service published a notice (76 FR 76987) of draft policy to establish a joint interpretation and application of SPR

that reflects a permissible reading of the law and its legislative history, and minimizes undesirable policy outcomes, while fulfilling the conservation purposes of the Act. To date, we have not finalized our draft SPR policy.

Species Information

Meadow jumping mice (*Zapus hudsonius*) are small rodents with long tails, large hind feet, and long hind legs. The fur is coarse, shiny, and rusty, yellow-brown in color with black-tipped hairs forming a dark, distinctive stripe on the back (Hansen 2006, p. 10; Fitzgerald *et al.* 2011, pp. 188–189). Although body shape and size are similar to other small rodents, such as deer mice (*Peromyscus maniculatus*), meadow jumping mice are distinguished by their unusually long tails and large hind feet (Hansen 2006, pp. 11–13). The sparsely haired tail occupies approximately 60 percent of the total body length (Fitzgerald *et al.* 1994, p. 291; Fitzgerald *et al.* 2011, p. 188). The large hind feet enable meadow jumping mice to make long leaps, with horizontal distances recorded between 1 to 2 meters (3 to 6 feet) (Hansen 2006, p. 12). After using the hind legs to spring from the ground, meadow jumping mice whip their long tails like a rudder to change the direction of their jump in midair (Hansen 2006, p. 11; Fitzgerald *et al.* 2011, p. 191).

Streams and other watercourses with well-developed riparian vegetation, adjacent relatively undisturbed grasslands, and a nearby water source define typical PMJM habitat (Bakeman 1997, pp. 22–31; Fitzgerald *et al.* 2011, p. 190; Trainor *et al.* 2012, p. 429). PMJM prefer riparian areas featuring multi-storied, horizontal cover with an understory of grasses and forbs (Bakeman 1997, pp. 22–31; Bakeman and Deans 1997, pp. 28–30; Meaney *et al.* 1997a, pp. 15–16; Meaney *et al.* 1997b, pp. 47–48; Shenk and Eussen 1998, pp. 9–11; Schorr 2001, pp. 23–24; Schorr 2003, p. 18). Willow species (*Salix* spp.) typically dominate the shrub canopy, although other shrub species may occur (Shenk and Eussen 1998, pp. 9–11). High-use areas for the PMJM tend to be close to creeks and are associated with a high percentage of shrubs, grasses, and woody debris (Trainor *et al.* 2007, pp. 471–472). The hydrologic regimes that support PMJM's habitat range from large perennial rivers such as the South Platte River to small drainages that are only 1 to 3 meters (m) (3 to 10 feet (ft)) wide (USFWS 2013). The PMJM is likely an Ice Age (Pleistocene) relict; once the glaciers receded from the Front Range of Colorado and the foothills of Wyoming

and the climate became drier, the PMJM was confined to riparian systems where moisture was more plentiful (Fitzgerald *et al.* 1994, p. 194; Meaney *et al.* 2003, p. 611; Smith *et al.* 2004, p. 293; Fitzgerald *et al.* 2011, p. 189).

Meadow jumping mice are primarily nocturnal or crepuscular (active during twilight), but may also be active during the day (Whitaker 1963, p. 231; Fitzgerald *et al.* 2011, p. 191). During the day, mice rest within day nests that they weave from grasses (Hansen 2006, p. 136; Fitzgerald *et al.* 2011, p. 191). Although lush, riparian vegetation near water is the PMJM's primary habitat, mice venture into bordering uplands, as far out as 100 m (330 ft) beyond the 100-year floodplain (Shenk and Sivert 1999a, p. 11; Ryon 1999, p. 12; Schorr 2001, p. 14; Shenk 2004; USFWS 2003b, p. 26). During the winter, the PMJM hibernates, remaining underground longer than most hibernating mammals (Whitaker 1963, p. 232; Hansen 2006, p. 15). PMJMs typically enter their underground hibernacula to hibernate in late September or early October and emerge the following May (Whitaker 1963, p. 232; Meaney *et al.* 2003, pp. 618, 621; Fitzgerald *et al.* 2011, p. 191).

Radio telemetry and mark-recapture data provide insight into the PMJM's home ranges and dispersal capabilities. At Plum Creek in Douglas County, Colorado, the PMJM's home ranges averaged 0.50 hectares (ha) (1.24 acres (ac)) based on radio-telemetry (Trainor *et al.* 2012, p. 432). In the Pike National Forest of Colorado, travel distances averaged 413.9 m with an approximate home range size of 1.02 ac (Hansen 2006, p. 158). At the Air Force Academy in El Paso County, Colorado, home ranges were between 0.17 to 3.84 ha (0.42 to 9.49 ac), with an average home range of 1.41 ha (3.48 ac) (Schorr 2003, p. 9). During this study, the farthest distance moved by individual PMJMs ranged from 43 to 3,176 ft (13 to 968 m), with an average maximum travel distance of 1,188 ft (362 m) (Schorr 2003, p. 9). An earlier study documented a PMJM moving as far as 1.1 kilometers (km) (0.7 mile (mi)) in 24 hours (Ryon 1999, p. 12). However, compared to radio telemetry data, mark-recapture data suggest that the PMJM may have longer dispersal capabilities. Mark-recapture data between active seasons identified mice traveling more than 4 km (2.3 mi) along a linear riparian system (Schorr 2003, p. 10; Schorr 2012, pp. 1274, 1278).

For additional information on the biology of this subspecies, please reference our May 13, 1998, final rule to list the PMJM as threatened (63 FR 26517) and the October 8, 2009,

proposed rule to revise the designation of critical habitat for the PMJM (74 FR 52066).

Taxonomy

The PMJM is a member of the family Dipodidae (jumping mice) (Wilson and Reeder 1993, p. 499), which contains four extant genera, or living family members. Two of these genera, *Zapus* (jumping mice) and *Napaeozapus* (woodland jumping mice), are found in North America (Hall 1981, p. 841; Wilson and Ruff 1999, pp. 665–667).

Below we summarize and evaluate the scientific studies regarding PMJM's taxonomy.

Pre-Listing Taxonomic Information

In his 1899 study of North American jumping mice, Edward A. Preble concluded the *Zapus* genus consisted of 10 species (Preble 1899, pp. 13–41). According to Preble (1899, pp. 14–21), *Z. hudsonius* (the meadow jumping mouse) included five subspecies. Preble (1899, pp. 20–21) classified all specimens of the meadow jumping mouse from North Dakota, Montana, South Dakota, Wyoming, Nebraska, Colorado, and Missouri as a single subspecies, *Z. h. campestris*. Cockrum and Baker (1950, pp. 1–4) later designated specimens from Nebraska, Kansas, and Missouri as a separate subspecies, *Z. h. pallidus*.

After studying the morphological (physical form and structure) characteristics of 3,600 specimens, Krutzsch revised the taxonomy of the *Zapus* genus (1954, pp. 352–355). His revision reduced the number of species within this genus from 10 to 3, including *Z. hudsonius* (the meadow jumping mouse), *Z. princeps* (the western jumping mouse), and *Z. trinotatus* (the Pacific jumping mouse). According to Krutzsch (1954, pp. 385–453), the meadow jumping mouse genus included 11 subspecies distributed across North America.

Krutzsch (1954, pp. 452–453) further refined the taxonomy of *Zapus* by describing and naming the subspecies the Preble's meadow jumping mouse (*Zapus hudsonius preblei*) based on geographic separation and morphological differences from other subspecies. Krutzsch (1954, pp. 452–453) discussed the presence of physical habitat barriers and the lack of known intergradation (merging gradually through a continuous series of intermediate forms or populations) between the PMJM, known only from eastern Colorado and southeastern Wyoming, and other identified subspecies of meadow jumping mice ranging to the east and north.

Additionally, Krutzsch (1954, pp. 452–453) examined the morphometric characteristics of four adult and seven non-adult specimens. Krutzsch (1954, pp. 452–453) reported seven distinguishing traits, but only published quantitative results (nine measurements) on two of these traits for three specimens (Krutzsch 1954, p. 465). Acknowledging the small number of samples upon which his conclusion was based, Krutzsch (1954, p. 453) nonetheless concluded that the differences between PMJMs and neighboring meadow jumping mice was considerable and enough to warrant a subspecific designation.

In Krutzsch's analysis, subspecies neighboring the PMJM included *Z. h. campestris* in northeastern Wyoming, southwestern North Dakota, and southeastern Montana; *Z. h. intermedius* in North Dakota, and northwestern, central, and eastern South Dakota; and *Z. h. pallidus* (Cockrum and Baker 1950) in Nebraska, Kansas, and Missouri (Krutzsch 1954, pp. 441–442, 447–452). In 1981, Hafner *et al.* (1981, p. 501) identified the New Mexico jumping mouse (*Z. h. luteus*) from Arizona and New Mexico as another neighboring subspecies of meadow jumping mouse. Scientists previously assumed that these Arizona and New Mexico populations were subspecies of western jumping mice, not meadow jumping mice (Krutzsch 1954, pp. 406–407; Hall and Kelson 1959, pp. 774–776; Jones 1981, p. iv). Among recognized subspecies, Krutzsch (1954, p. 452) found that the PMJM most closely resembled *Z. h. campestris* from northeastern Wyoming, but documented differences in coloration and skull characteristics.

Krutzsch's description (1954), as modified by Hafner *et al.* (1981, p. 501), with 12 subspecies of meadow jumping mice in North America, has been generally accepted by most small mammal taxonomists for the past half-century (Hall and Kelson 1959, pp. 771–774; Long 1965, pp. 664–665; Armstrong 1972, pp. 248–249; Whitaker 1972, pp. 1–2; Hall 1981, pp. 841–844; Jones *et al.* 1983, pp. 238–239; Clark and Stromberg 1987, p. 184; Wilson and Reeder 1993, p. 499; Hafner *et al.* 1998, pp. 120–121; Wilson and Ruff 1999, pp. 666–667).

Other Taxonomic Information Available Prior to Listing

As part of his doctoral dissertation, Jones (1981, pp. 4–29, 229–303, 386–394, 472) analyzed the morphology of 9,900 specimens within the *Zapus* genus from across North America, including 39 PMJM specimens. Jones' dissertation (1981, p. 144) concluded that the Pacific jumping mouse was not

a valid taxon and suggested reducing the number of species in the *Zapus* genus to two: The western jumping mouse and the meadow jumping mouse. At the subspecific level, Jones (1981, pp. V, 303) concluded that no population of meadow jumping mouse was sufficiently isolated or distinct to warrant subspecific status. Regarding the PMJM, Jones (1981, pp. 288–289) wrote, “No named subspecies is geographically restricted by a barrier, with the possible exception of *Zapus hudsonius preblei* [Preble’s meadow jumping mouse],” which “appears to be isolated,” but that “no characteristics indicate that these populations have evolved into a separate taxon.” Jones’ taxonomic conclusions regarding the PMJM are questionable, as he did not compare the subspecies to *Z. h. campestris*, the closest neighboring subspecies, nor did he conduct statistical tests of morphological differences between the PMJM and any other subspecies (1981, p. 144). Regardless, Jones’ doctoral committee approved his dissertation in 1981, but Jones did not publish his research in a peer-reviewed journal (Jones 1981, p. ii). Thus, Jones’ findings were not incorporated into the formal taxonomy for jumping mice.

Prior to our 1998 listing, the Colorado Division of Wildlife (now Colorado Parks and Wildlife (CPW)) funded a genetic analysis of the PMJM (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, p. 1). The study concluded that the PMJM formed a homogenous group recognizably distinct from other nearby populations of meadow jumping mice (Riggs *et al.* 1997, p. 12). At the request of the Service, Hafner (1997, p. 3) 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, p. 3). 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 PMJM relative to neighboring subspecies, as Krutzsch’s original subspecific designation relied on morphological characteristics and geographic isolation.

Our original listing determined that Krutzsch’s (1954) revision of the meadow jumping mouse species, including the description of the PMJM

subspecies, was widely supported by the scientific community as evidenced by the available published literature (63 FR 26517, May 13, 1998). Our 1998 determination weighed the information in unpublished reports, such as Jones (1981), and public comments on the rule and found that they did not contain enough scientifically compelling information to suggest that revising the existing taxonomy was appropriate (63 FR 26517, May 13, 1998). Our 1998 conclusion was consistent with Service regulations that require us to rely on standard taxonomic distinctions and the biological expertise of the Department of the Interior and the scientific community concerning the relevant taxonomic group (50 CFR 424.11).

Taxonomic Information Solicited After Listing

In 2003, the Service, the State of Wyoming, and the Denver Museum of Nature and Science funded a study to resolve ongoing questions about the taxonomic relationship between the PMJM and neighboring meadow jumping mice (USFWS 2003a, pp. 1–2). In December 2003, we received a draft report from the Denver Museum of Nature and Science examining the uniqueness of the PMJM relative to other nearby subspecies of meadow jumping mice (Ramey *et al.* 2003). In 2004, the Service and other partner agencies provided additional funding to expand the scope of the original study (USFWS 2004). In August 2005, the journal *Animal Conservation* published an expanded version of this original report (Ramey *et al.* 2005). This publication included an examination of morphometric differences, mtDNA, and microsatellite DNA (a short, noncoding DNA sequence that is repeated many times within the genome of an organism). Ramey *et al.* (2005, pp. 339–341) also examined the literature for evidence of ecological exchangeability among subspecies (a test of whether individuals can be moved between populations and can occupy the same ecological niche).

Ramey *et al.*’s morphometric analysis tested nine skull measurements of 40 PMJMs, 40 *Zapus hudsonius campestris*, and 37 *Z. h. intermedius* specimens (Ramey *et al.* 2005, p. 331). Their results did not support Krutzsch’s (1954, p. 452) original description of the PMJM as “averaging smaller in most cranial measurements” (Ramey *et al.* 2005, p. 334). Ramey *et al.* (2005, p. 334) found that only one cranial measurement was significantly smaller, while two cranial measurements were significantly larger.

Additionally, Ramey *et al.* examined 346 base-pairs in one region of the mtDNA across five subspecies of meadow jumping mice (205 specimens) (Ramey *et al.* 2005, pp. 331–332, 335). Ramey *et al.* (2005, p. 335, 338) found low levels of difference between the PMJM and neighboring subspecies. The subspecies failed Ramey *et al.*’s tests of uniqueness in that the subspecies did not show greater molecular variance among than within subspecies or did not demonstrate nearly complete reciprocal monophyly (genetic similarity) with respect to other subspecies. The data demonstrated that all of the mtDNA haplotypes (alternate forms of a particular DNA sequence or gene) found in the PMJM were also found in *Zapus hudsonius campestris*. The mtDNA data produced by the researchers demonstrated evidence of recent gene flow between the PMJM and neighboring subspecies (Ramey *et al.* 2005, p. 338).

Additionally, Ramey *et al.* (2005, pp. 333–334, 338) analyzed five microsatellite loci across five subspecies of meadow jumping mice (195 specimens). During these tests, the subspecies failed Ramey *et al.*’s uniqueness criteria: The subspecies did not show greater molecular variance between than within subspecies and that multiple private alleles were not at a higher frequency than shared alleles at the majority of loci (Ramey *et al.* 2005, p. 333). Ramey *et al.* (2005, p. 340) concluded that these results were consistent with their morphometric and mtDNA results.

Finally, Ramey *et al.*’s review of the literature found no published evidence of adaptive or ecological differences between the PMJM and other subspecies of jumping mouse. Therefore, Ramey *et al.* (2005, pp. 339–341) concluded that the lack of morphological difference supported the proposition of no adaptive or ecological difference between the subspecies.

To summarize, based on hypothesis testing using four lines of evidence (morphometrics, mtDNA, microsatellites, and a lack of recognized adaptive differences), Ramey *et al.* concluded that the PMJM and *Zapus hudsonius intermedius* should be synonymized with *Z. h. campestris* (2005, p. 340).

Prior to the publication of Ramey *et al.* (2005) in *Animal Conservation*, the CPW and the Service solicited 16 peer reviews of the 2004 draft report provided to the Service (Ramey *et al.* 2004a). Fourteen reviewers provided comments (Armstrong 2004; Ashley 2004; Bradley 2004; Conner 2004; Crandall 2004; Douglas 2004; Hafner

2004; Meaney 2004; Mitton 2004; Oyler-McCance 2004; Riddle 2004; Sites 2004; Waits 2004; White 2004). In 2005, the Service approached the same 16 experts to review Ramey *et al.* 2004b (an expansion of Ramey *et al.* 2004a). Eleven of these reviewers provided comments (Ashley 2005; Baker and Larsen 2005; Bradley 2005; Crandall 2005; Douglas 2005; Hafner 2005; Maldonado 2005; Mitton 2005; Oyler-McCance 2005; Waits 2005; White 2005). In 2006, some of these reviewers provided comments on Ramey *et al.* (2005) as part of their review of King *et al.* (2006a). Krutzsch (2004) also reviewed Ramey *et al.* (2004a). In August 2006, *Animal Conservation* published two critiques of Ramey *et al.* (2005) (Martin 2006; Vignieri *et al.* 2006) and two responses (Crandall 2006b; Ramey *et al.* 2006a).

Many of the reviewers generally supported the findings of Ramey *et al.* (Baker and Larsen 2005; Bradley 2004, 2005; Crandall 2004, 2005; Hafner 2004; Krutzsch 2004; Maldonado 2005; Meaney 2004; Mitton 2004, 2005; Riddle 2004; Sites 2004; Waits 2004, 2005). However, the reviewers raised a number of important issues. Because these experts reviewed the unpublished reports (Ramey *et al.* 2004a, 2004b), many of the criticisms were addressed prior to publication in *Animal Conservation* (Ramey *et al.* 2005). For example, reviewers recommended that the study be augmented to include microsatellite data; this information was added to the published version (Ramey *et al.* 2005). Some of the most significant unresolved issues identified included:

- (1) Reliance upon museum specimens, which can be prone to contamination (Douglas 2004, 2005, 2006; Hafner 2006; Maldonado 2005);
- (2) The reliability of, and failure to validate, specimens' museum identification tag (Ashley 2005; Douglas 2004, 2005; Hafner 2004; Oyler-McCance 2004, 2005, 2006);
- (3) The sampling regime and its impact on the analysis (Ashley 2006; Crandall 2006a; Douglas 2006; Hafner 2006; Maldonado 2005, 2006; Oyler-McCance 2004, 2006);
- (4) Reliance upon a small portion (346 base-pairs) of mtDNA (Ashley 2004, 2005; Baker and Larsen 2005; Crandall 2004, 2005, 2006a; Douglas 2004, 2005, 2006; Hafner 2005, 2006; Maldonado 2005; Oyler-McCance 2004, 2005, 2006; Riddle 2004; Sites 2004; Waits 2004, 2005);
- (5) The small number of microsatellite DNA loci examined (five) (Crandall 2006a; Oyler-McCance 2006; Hafner 2006; Vignieri *et al.* 2006, p. 241);

(6) The statistical tests employed (Crandall 2004; Douglas 2004, 2005; Hafner 2006; Maldonado 2005; Mitton 2005; Oyler-McCance 2005, 2006);

(7) The criteria used and factors considered to test taxonomic validity as well as alternative interpretations of the data (Ashley 2004; Conner 2004; Douglas 2004, 2005, 2006; Hafner 2005, 2006; Oyler-McCance 2004, 2005; Vignieri *et al.* 2006, pp. 241–242; White 2004);

(8) Whether the western jumping mouse was an appropriate outgroup (a closely related group that is used as a rooting point of a phylogenetic tree) (Douglas 2004);

(9) Failure to measure all of the morphological traits examined by Krutzsch (1954) (Vignieri *et al.* 2006, p. 238); and

(10) An inadequate evaluation of ecological exchangeability and habitat differences among subspecies (Ashley 2004; Conner 2004; Douglas 2004; Meaney 2004; Mitton 2004; Oyler-McCance 2004, 2005; Sites 2004; Vignieri *et al.* 2006, p. 238; Waits 2004, 2005).

Collectively, these critiques indicated that delisting the PMJM based on the conclusions of Ramey *et al.* alone might be premature.

Post-Listing Taxonomic Scientific Debate

Because our February 2, 2005, proposed rule (70 FR 5404) to delist the PMJM relied solely upon an unpublished report (Ramey *et al.* 2004a) that had received mixed peer reviews as described above, verifying these results was a high priority for the Service (Morgenweck 2005; Williams 2004). Thus, the Service contracted with the U.S. Geological Survey (USGS) to conduct an independent genetic analysis of several meadow jumping mouse subspecies (USGS 2005, pp. 1–4). Contrary to Ramey *et al.*'s conclusion, the USGS study concluded that the PMJM should not be synonymized with neighboring subspecies (King *et al.* 2006a, pp. 2, 29). The journal *Molecular Ecology* published an expanded version of this report (King *et al.* 2006b). This study included an examination of microsatellite DNA, two regions of mtDNA, and 15 specimens critical to the conclusions of Ramey *et al.* (2005).

The USGS study analyzed more genetic material than Ramey *et al.* (2005). King *et al.*'s (2006b, p. 4336) microsatellite analysis examined approximately 4 times the number of microsatellite loci (21) and more than 1.75 times more specimens (348 specimens) than Ramey *et al.* (2005) across the same five subspecies of

meadow jumping mice. King *et al.* (2006b, p. 4337) concluded that their microsatellite data demonstrated a strong pattern of genetic differentiation between the PMJM and neighboring subspecies. King *et al.* (2006b, pp. 4336–4341) also reported that multiple statistical tests of the microsatellite data verified this differentiation.

In their evaluation of mtDNA, King *et al.* (2006b, p. 4341) examined approximately 4 times the number of base-pairs across two regions (374 control region and 1,006 cytochrome-B region base-pairs) and more than 1.5 times more specimens (320 specimens for the control region analysis and 348 for the cytochrome-B analysis) than Ramey *et al.* (2005) across the same five subspecies of meadow jumping mice. King *et al.* (2006b, p. 4341) concluded that these data suggested strong, significant genetic differentiation among the five subspecies of meadow jumping mice surveyed.

Additionally, King *et al.*'s mtDNA results indicated that the PMJM did not share haplotypes with any neighboring subspecies (King *et al.* 2006b, p. 4341). Such haplotype sharing contributed to Ramey *et al.*'s (2004a, pp. 1, 9; 2005, p. 335) conclusion that the PMJM was not unique and that the PMJM was a less genetically variable population of *Zapus hudsonius campestris*. Because of these conflicting results, King *et al.* (2006b, pp. 4355–4357) reexamined 15 specimens from the University of Kansas Museum collection that were key in Ramey *et al.*'s determination that neighboring subspecies shared haplotypes. King *et al.* (2006b, p. 4357) could not duplicate the mtDNA sequences reported by Ramey *et al.* for these specimens. If these specimens were removed from the analysis, neither study would illustrate haplotype sharing between the PMJM and neighboring subspecies. Therefore, King *et al.* (2006b, p. 4357) concluded that “these findings have identified the presence of a systemic error in the control region data reported by Ramey *et al.* (2005)” that “calls into question all of the results of Ramey *et al.* (2005) based on the mtDNA genome and prevents analysis of the combined data.” King *et al.* (2006, p. 4357) noted that possible reasons for the difference in sequences included contamination, mislabeling of samples, or other procedural incongruity. Ramey *et al.* (2007, pp. 3519–3520) proposed a number of alternative explanations for these contradictory results including: Nuclear paralogs, or copies of mtDNA sequence that have been incorporated into the nuclear genome and are now pseudogenes, or non-functional genes;

heteroplasmy, or the existence of more than one mitochondrial type in the cells of an individual; different amplification primers and conditions between the studies; and template quality.

Overall, King *et al.* (2006b, p. 19) concluded that considerable genetic differentiation occurred among all five subspecies and found no evidence to support the proposal to synonymize the PMJM, *Zapus hudsonius campestris*, and *Z. h. intermedius*.

Prior to its release, King *et al.* (2006a) underwent an internal peer review per USGS policy (USGS 2003, pp. 3, 6, 12, 28–33). In an effort to provide consistent, comparable reviews, we solicited peer reviews from the same 16 reviewers asked to review Ramey *et al.* (2004a, 2004b). Nine of the experts provided comments (Armstrong 2006; Ashley 2006; Bradley 2006; Crandall 2006a; Douglas 2006; Hafner 2006; Maldonado 2006; Oyler-McCance 2006; Riddle 2006). Ramey *et al.* (2006b, 2007) also critiqued King *et al.* (2006a, 2006b).

Most of the reviewers supported the findings of King *et al.* (Armstrong 2006; Ashley 2006; Douglas 2006; Hafner 2006; Maldonado 2006; Oyler-McCance 2006; Riddle 2006). These reviews offered a number of issues and possible explanations why King *et al.*'s results differed from those of Ramey *et al.* Because reviewers were asked to review King *et al.*'s unpublished report (King *et al.* 2006a), some of their comments were addressed by the authors in their *Molecular Ecology* publication (King *et al.* 2006b). For example, numerous reviews suggested expanding the geographic range of the study by adding a PMJM population in Wyoming; this issue was addressed in the published version (King *et al.* 2006b). Similarly, the *Molecular Ecology* publication incorporated the suggestion to retest the museum specimens Ramey *et al.* (2005) identified as having shared haplotypes for signs of cross contamination. Other issues raised by the reviewers of the King *et al.* study included:

(1) The sampling regime and its impact on the analysis (Armstrong 2006; Ashley 2006; Crandall 2006a; Douglas 2006; Oyler-McCance 2006; Ramey *et al.* 2007, p. 3519; Riddle 2006);

(2) Failure to evaluate morphometrics and ecological exchangeability (Crandall 2006a);

(3) Reliance upon a small portion of control region mtDNA (Riddle 2006);

(4) The number of loci examined (*i.e.*, too many), the programs used to analyze the data, and the resulting sensitivity in detecting difference (Crandall 2006a; Ramey *et al.* 2006b; Ramey *et al.* 2007, p. 3519);

(5) A specimen collection methodology that could cause contamination (Ramey *et al.* 2007, p. 3519);

(6) The statistical tests employed (Crandall 2006a; Douglas 2006; Maldonado 2006; Riddle 2006); and

(7) The criteria used and factors considered to test taxonomic validity and alternative interpretations of the data (Bradley 2006; Crandall 2006a).

Given the discrepancies between the Ramey *et al.* and King *et al.* reports, we contracted a scientific review to analyze, assess, and weigh the reasons why the data, findings, and conclusions of the two studies differed (USFWS 2006, p. 14). Following an open and competitive bid process, we selected the Sustainable Ecosystems Institute (SEI) as the contractor (USFWS 2006).

SEI assembled a panel of genetic and systematics experts (SEI 2006a, pp. 7, 56–82). The panelists reviewed, discussed, and evaluated all of the literature relevant to PMJM's taxonomy, including published literature, unpublished reports, third-party critiques, public comments, and other materials suggested by interested parties (SEI 2006a, pp. 48–55). Additionally, the panel examined and reanalyzed the raw data (SEI 2006a, pp. 8, 21) used by Ramey *et al.* and King *et al.*, including the mtDNA data, microsatellite DNA data, and original sequence chromatograms (automated DNA sequence data output recordings) (SEI 2006a, pp. 8, 23). The scientific review panel was open to the public and allowed for interactions among panel members, Dr. King, Dr. Ramey, other scientists, and the public.

In July 2006, SEI delivered a report outlining its conclusions to the Service (SEI 2006a). Although the panelists were not obligated to reach a consensus, they did not disagree on any substantive or stylistic issues (SEI 2006a, p. 9). The panel organized its evaluation into four sections corresponding with the different types of scientific evaluations performed, including morphology, ecological exchangeability, mtDNA, and microsatellite DNA. Below, we briefly summarize the panel's findings (SEI 2006a).

Morphology: The panel found that all seven of the morphological characters examined by Krutzsch (1954, pp. 452–453) should have been reexamined in order to support Ramey *et al.*'s proposed taxonomic revision. The panel also concluded that the type specimen (the original specimen from which the description of a new species is made) of each taxon should have been included in the analysis. The panel's conclusion was that an insufficient test of the

morphological definition of the PMJM had been conducted to support the synonymy of the PMJM with other subspecies (SEI 2006a, p. 41).

Ecological Exchangeability: The panel concluded that no persuasive evidence was presented regarding ecological exchangeability, and that the ecological exchangeability of the subspecies remains unknown (SEI 2006a, p. 41).

MtDNA: The panel noted that data provided by Ramey *et al.* (2005) and King *et al.* (2006b) differed in geographic sampling strategy, amount of sequence data examined, aspects of the analysis, and quality (SEI 2006a, p. 41). All of these could help explain why the two studies came to differing conclusions. However, the panel noted that the most significant difference between the two studies in terms of mtDNA was whether the PMJM shared any mtDNA haplotypes with other subspecies of meadow jumping mice. Upon review of the raw data, the panel found evidence of contamination within some of the key sequences reported by Ramey *et al.* and that the supporting data for the samples in question were of poor quality and/or quantity (SEI 2006a, pp. 23–32). The panel concluded that no reliable evidence existed of any haplotype sharing between the PMJM and neighboring subspecies (SEI 2006a, p. 42). The panel determined that if the conflicting mtDNA sequences were removed from consideration, the two studies' mtDNA data would largely agree (SEI 2006a, p. 32). The panel also suggested that because the western jumping mouse and the meadow jumping mouse are distantly related, western jumping mouse may perform poorly as an outgroup, leading to poor resolution of relationships among meadow jumping mouse subspecies. While both Ramey *et al.* and King *et al.* used western jumping mice as their outgroup, an unrooted analysis (an analysis without these genetic points of reference or any ancestral assumptions) showed clearer phylogenetic structuring between the subspecies (SEI 2006a, p. 42).

Microsatellite DNA: The panel found that the two microsatellite datasets contained similar information. The panel pointed out that both the Ramey *et al.* (2005) and King *et al.* (2006b) microsatellite data, as well as Crandall and Marshall's (2006) reanalysis of these data, strongly support a statistically significant independent cluster that corresponds to the PMJM, providing support for a distinct subspecies (SEI 2006a, pp. 42–43). The panel indicated that while the microsatellite data alone did not make a strong case for evolutionary significance, in concert

with the mtDNA data (discussed above), the two datasets corroborated the distinctness of the PMJM (SEI 2006a, pp. 43).

The panel's overall conclusion was that the available data are broadly consistent with the current taxonomic status of the PMJM as a valid subspecies and that no evidence was presented that critically challenged its status (SEI 2006a, p. 4). In August 2006, Ramey *et al.* (2006c) submitted a statement to the Service disputing the approach and conclusions of the SEI report. Some of the most significant issues raised included:

(1) Objection to the deference given to Krutzsch (1954);

(2) Disagreement with the suggestion that all seven morphometric characters examined by Krutzsch (1954) and the type specimen should be reexamined;

(3) Dispute with the assertion that Ramey *et al.*'s (2005) evaluation of ecological significance was inadequate;

(4) Dispute with the contention that the PMJM and neighboring subspecies remain weakly genetically differentiated; and

(5) Objection to SEI's failure to develop objective standards for testing the validity of suspect subspecies.

However, no new data or analyses were presented in this statement, and the panel previously considered most of these contentions (Ramey *et al.* 2003, 2004a, 2004b, 2005, 2006a, 2006b; SEI 2006a, 2006b, 2006c). Other evaluations of the available literature and data include Ramey *et al.* (2007), Grandall and Marshall (2006), Spencer (2006b), and Cronin (2007).

Taxonomic Conclusions

When listed in 1998, the scientific community widely recognized the PMJM as a valid subspecies (Hall and Kelson 1959, pp. 771–774; Long 1965, pp. 664–665; Armstrong 1972, pp. 248–249; Whitaker 1972, pp. 1–2; Hall 1981, pp. 841–844; Jones *et al.* 1983, pp. 238–239; Clark and Stromberg 1987, p. 184; Wilson and Reeder 1993, p. 499; Hafner *et al.* 1998, pp. 120–121; Wilson and Ruff 1999, pp. 666–667). At the time of listing, Krutzsch (1954) represented the best available information on the taxonomy of the PMJM (63 FR 26517, May 13, 1998). Our 1998 conclusion was consistent with Service regulations that require us to rely on standard taxonomic distinctions and the biological expertise of the Department and the scientific community concerning the relevant taxonomic group (50 CFR 424.11). We rely on the best available science in listing decisions. Such considerations influenced our February 2, 2005,

proposal (70 FR 5404) to delist the PMJM based upon information that questioned the subspecies' taxonomic validity.

At the time of our 2008 final rule (73 FR 39790), the best available information supported the conclusion that the PMJM is a valid subspecies. For this status review, we extensively reviewed all of the scientific data and again determined that the best scientific and commercial data available support the conclusion that the PMJM is a valid subspecies. Specifically, the PMJM's geographic isolation from other subspecies of meadow jumping mice (Krutzsch 1954, pp. 452–453; Long 1965, pp. 664–665; Beauvais 2001, p. 6; Beauvais 2004; SEI 2006a, p. 34; Fitzgerald *et al.* 2011, p. 190) has resulted in the accretion of considerable genetic differentiation (King *et al.* 2006b, pp. 4336–4348; SEI 2006a, pp. 41–43). The available data suggest that the PMJM meets or exceeds numerous, widely accepted subspecies definitions (Mayr and Ashlock 1991, pp. 43–45; Patten and Unitt 2002, pp. 26–34; SEI 2006a, p. 44; WGFD 2012, pp. 1, 3). In reaching this conclusion, we have not presumed that we must rely on the established taxonomy in the absence of contradictory data (see SEI report at p. 39). Rather, the best scientific and commercial information currently available indicates that the PMJM is a valid subspecies. Therefore, the taxonomic revision for the PMJM proposed by the petitioners in 2003 and suggested in our proposed delisting rule (70 FR 5404, February 2, 2005) is unfounded, and we recognize the PMJM as a valid subspecies and listable entity under the Act. This determination is consistent with our 2008 determination.

We are aware of two ongoing research studies using genetics to address taxonomic or evolutionary questions regarding the PMJM. One study seeks to clarify genetic relationships between meadow jumping mice across North America (Malaney 2013, p. 1). The second study seeks to analyze genetic relationships between PMJM populations in Colorado (Schorr and Oyler-McCance 2012, p. 1). We will evaluate any new information as it becomes available for the PMJM.

Historical Range and Recently Documented Distribution

The PMJM's current range includes portions of the North Platte, the South Platte, and the Arkansas River basins in Colorado and Wyoming (Long 1965, p. 665; Armstrong 1972, pp. 248–249; Clark and Stromberg 1987, p. 184; Fitzgerald *et al.* 1994, p. 293; Clippinger

2002, p. 20; Fitzgerald *et al.* 2011, p. 189).

When listed in 1998, we used the available trapping information and historic records to approximate the subspecies' historical range. We described the historical range of the PMJM in Wyoming to include five counties (Albany, Laramie, Platte, Goshen, and Converse), but cited only two locations with recent reports of jumping mice likely to be the PMJM. Additionally, we cited a report that suggested that the subspecies might be extirpated (extinct locally) in Wyoming or highly restricted to isolated patches of suitable habitat based on a lack of known captures in over 40 years (Compton and Hugie 1993b, p. 6). At that time, the Wyoming Game and Fish Department (WGFD) also provided comments that the PMJM had likely been extirpated from most or all of its historical range in Wyoming due to the loss and degradation of riparian habitat (Wichers 1997, p. 1). The reports indicated that there were no known populations in Wyoming (Compton and Hugie 1993b, p. 6). Therefore, the best available information at the time of listing influenced our assumption that most of the subspecies' current range occurred in Colorado. The final 1998 listing rule presumed a historical range in Colorado that included portions of 10 counties (Adams, Arapahoe, Boulder, Denver, Douglas, El Paso, Elbert, Jefferson, Larimer, and Weld). The rule also cited recent documentation of the subspecies within only 7 of these 10 counties (Boulder, Douglas, El Paso, Elbert, Jefferson, Larimer, and Weld).

After listing in 1998, trapping studies increased, greatly improving our knowledge of the PMJM's distribution within this presumed historical range. More than 1,650 trapping studies in Colorado and 1,280 records in Wyoming collected over the last 15 years documented the PMJM's presence or likely absence within riparian or adjacent upland habitat (Bowe and Beauvais 2012, p. 11; USFWS 2013). Trapping studies revealed that the PMJM still occurs in both Wyoming and Colorado, although the PMJM's distribution is limited to suitable patches of riparian habitat. Additionally, the lack of captures around human development despite large trapping efforts revealed that the PMJM was likely extirpated from dense, urban areas.

While many trapping efforts targeted locations with no record of historical surveys, most surveys occurred within the presumed historical range of the PMJM or in adjacent drainages with apparently suitable habitat. Over time,

more trapping efforts identified more sites with PMJMs and improved our understanding of the PMJM's range. However, the increase in positive captures, or known occupancy data, merely reflects the increased trapping effort, not a change in the PMJM's range. In other words, while more trapping improved our understanding of the PMJM's distribution, the data did not contract or expand the presumed range of the subspecies. The trapping data refine our understanding of the PMJM's current distribution and presumed response to habitat changes.

Additionally, although we have an improved understanding of the PMJM's current range, the resulting occupancy data are not long-term studies, and so provide limited insight into population sizes or trends (Beauvais 2008, p. 2). However, the low capture rates for PMJM throughout its current range, despite extensive trapping efforts in suitable habitats, suggests that population sizes may be low.

In southeastern Wyoming, trapping studies conducted after 1998 identified many additional sites occupied by jumping mice, whether genetically or morphometrically confirmed as PMJMs or western jumping mice, or left unidentified to species. Recent captures and confirmed identifications compiled by the Wyoming Natural Diversity Database (WYNDD) improved our knowledge of the distribution of the PMJM in Wyoming. Trapping studies identified 31 plains, foothills, and montane sites occupied by the PMJM in Wyoming (Bowe and Beauvais 2012, pp. 8, 16). These new data reveal that the PMJM occurs in only four of the five Wyoming counties that we originally described as the likely historical range at the time of listing. The four counties of occupancy in Wyoming are Albany, Laramie, Platte, and Converse Counties. While generalized range maps (Long 1965, p. 665; Armstrong 1972, pp. 248–249; Clark and Stromberg 1987, p. 184) historically depicted the PMJM's range extending east into Goshen County, the new data indicate that the subspecies does not occupy Goshen County (Bowe and Beauvais 2012, pp. 8, 16; Mead 2012, p. 1). This new information does

not signify a real, biological contraction of the PMJM's range, but rather reflects our improved understanding of the PMJM's historical and current range in Wyoming.

WYNDD provides the most current data regarding the distribution of the PMJM in Wyoming (Bowe and Beauvais 2012, p. 8). They refute the previously reported presence of the PMJM west of the Laramie Mountains in the North Platte River basin and in the Upper Laramie River drainage in Albany County, as described in our July 10, 2008, final rule (73 FR 39813; Bowe and Beauvais 2012, p. 8). In 2008, we assumed that occurrence of PMJM populations west of the Laramie Mountains and in the Upper Laramie River drainage in Albany County would represent a significant expansion of the formerly known range of the PMJM in Wyoming. However, WYNDD's new data refute previous speculation that the range of the PMJM extends into the Upper Laramie River, Little Laramie River, Rock Creek, and possibly the Medicine Bow River (Smith *et al.* 2004, p. 12; Bowe and Beauvais 2012, p. 8). WYNDD's report concludes that no confirmed, likely, or possible records of the meadow jumping mouse fall west of the crest of the Laramie Mountains (Bowe and Beauvais 2012, p. 8).

Specifically, genetic analysis revealed that a jumping mouse from Hutton National Wildlife Refuge in Albany County, Wyoming, previously thought to be a PMJM, was a western jumping mouse (Ramey *et al.* 2005, Appendix 3). Additionally, non-genetic analysis suggested that the purported PMJM caught on private land north of Laramie was a western jumping mouse (Beauvais 2012). The elevation of capture, body size, and abundance suggest that jumping mice captured in 2011 and 2012, in the Elk Mountains, at the Little Laramie River, the Rock Creek-Rock River area, and the Upper Medicine Bow River, were potentially western jumping mice, not the PMJM (Beauvais 2012; Bowe and Beauvais 2012, p. 8). Although genetic analysis is required for definitive identification, the new data suggest that the PMJM is not as widely distributed in Wyoming as previously

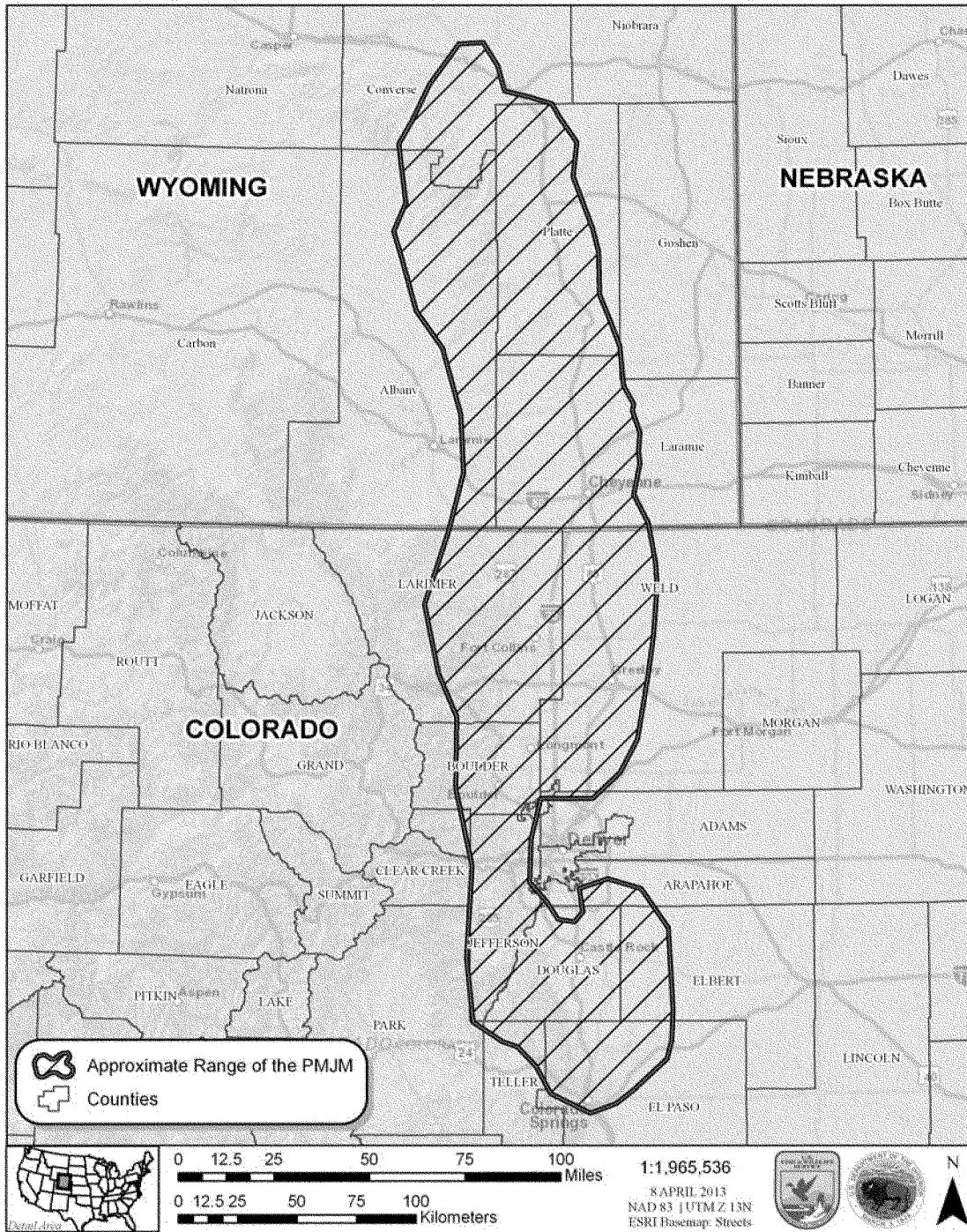
assumed. Genetic results for these captures are pending. Additionally, a lack of meadow jumping mouse captures in the Niobrara, Cheyenne, and Upper Powder River Basins suggests very little connectivity between the PMJM in southeastern Wyoming and *Zapus hudsonius campestris* in northern Wyoming (Bowe and Beauvais 2012, p. 8). These new data improve our understanding of the PMJM's range in Wyoming and clarify previous speculation. Because genetics have now correctly identified previously captured meadow jumping mice, the data do not represent an actual biological contraction of the PMJM's range in Wyoming.

At the time of listing, we discussed how increased trapping efforts in Colorado had recently documented the PMJM's distribution in Elbert, Larimer, and Weld Counties. We also suggested other sites where trapping should occur to determine if the PMJM was present. Additional trapping since the time of listing has expanded the documented distribution of the PMJM in Colorado to include: (1) Additional foothill and montane sites along the Front Range in Larimer, Boulder, Jefferson, and Douglas Counties; (2) previously untrapped, rural, prairie and foothill streams in southern Douglas County and adjacent portions of Elbert County; and (3) additional prairie and foothill streams in northwestern El Paso County. Although we have identified many additional sites in Colorado occupied by the PMJM since the original listing, approximately 70 percent of trapping efforts in Colorado and Wyoming that targeted the PMJM failed to capture jumping mice (USFWS 2013, p. 2). These numerous negative trapping results, even with extensive trapping efforts in suitable habitats, suggest that the subspecies is rare or extirpated from many portions of the subspecies' historical range. Under Factor A in our five-factor threats analysis, we discuss geographic areas where the PMJM may be extirpated.

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Figure 1—Map of PMJM's current range based on trapping efforts.

FIGURE 1 - APPROXIMATE RANGE OF THE PREBLE'S MEADOW JUMPING MOUSE



To summarize, the PMJM was previously assumed extirpated from Wyoming at the time of listing, but is now documented in portions of Albany, Laramie, Platte, and Converse Counties, Wyoming (Bowe and Beauvais 2012, p. 8). In Colorado, the PMJM was assumed to occupy 10 counties at the time of listing, but now occupies portions of 7 counties including: Boulder, Douglas, El Paso, Elbert, Jefferson, Larimer, and Weld Counties, Colorado (Figure 1).

Although habitats are suitable and connected to occupied habitats across the Douglas County line, trapping has not captured the PMJM in Arapahoe or Teller Counties, Colorado. The North Platte River at Douglas, Wyoming, marks the northernmost confirmed location for the PMJM (Bowe and Beauvais 2012, pp. 8, 16). Specimens from Colorado Springs, Colorado, mark the southernmost documented location for the PMJM.

Elevation and Overlapping Range With the Western Jumping Mouse

The PMJM is generally found at elevations between 1,420 m (4,650 ft) and 2,300 m (7,600 ft). At the lower end of this elevation gradient, the semi-arid climates of southeastern Wyoming and eastern Colorado limit the extent of riparian corridors, thereby restricting the range of the PMJM (Beauvais 2001, p. 3). As a result, the dry, shortgrass prairies likely define the eastern

boundary for the PMJM, serving as a barrier to eastward expansion (Beauvais 2001, p. 3). In Wyoming, the PMJM has not been found east of Cheyenne, Laramie County, or west of the Laramie Mountains (Keinath 2001, p. 7; Keinath *et al.* 2010, p. A6–185, Bowe and Beauvais 2012, pp. 8, 16). In Colorado, the PMJM has not been found on the extreme eastern plains (Clippinger 2002, pp. 20–21; USFWS 2013).

At the higher elevations, overlapping range with the western meadow jumping mouse complicates discerning areas occupied by the PMJM (Long 1965, pp. 665–666; Clark and Stromberg 1987, pp. 184–187; Schorr 1999, p. 3; Bohon *et al.* 2005; Hansen 2006, pp. 24–27; Schorr *et al.* 2007, p. 5).

Unfortunately, differentiation between the PMJM and the western jumping mouse is difficult in the field (Conner and Shenk 2003a, p. 1456), complicating the results of surveys at high elevations. Generally, the western jumping mouse occurs in montane and subalpine zones, and the PMJM occupies lower elevations, in the plains and foothills (Smith *et al.* 2004, p. 10; Bowe and Beauvais 2012, pp. 1, 8, 15–16). The PMJM may also have a stronger preference for riparian and wetland environments than the western jumping mouse, with limited forays into adjacent uplands (Bowe and Beauvais 2012, p. 1).

Because of this difficulty of field identification, many jumping mice have been trapped and released without being conclusively identified as either a PMJM or a western jumping mouse. Western jumping mice have been verified at elevations well below the upper elevation limit of the PMJM (Smith *et al.* 2004, p. 11) leading to difficulty in making assumptions regarding identification based on elevation. Overlapping ranges for these subspecies have been verified within the Glendo Reservoir and the Lower Laramie and Horse Creek drainages in Wyoming (Conner and Shenk 2003b, pp. 26–27, 34–37; Meaney 2003; King 2006a; King 2006b; King *et al.* 2006b, pp. 4351–4353), and within the Cache La Poudre, Big Thompson, and Upper South Platte River drainages in Colorado (Bohon *et al.* 2005; Hansen 2006, pp. 24–27; King 2005; King 2006a; King *et al.* 2006b, pp. 4351–4353; Schorr *et al.* 2007).

Although difficult to distinguish in the field, body weight, body length, dentition, skull measurements, and genetic analysis can differentiate meadow jumping mice from western jumping mice (Kruttsch 1954, pp. 351–384; Klingenger 1963, p. 252; Riggs *et al.* 1997, pp. 6–11; Conner and Shenk 2003a; Ramey *et al.* 2005, p. 332; King

et al. 2006b, p. 4341). The approximation of the PMJM's range emphasizes locations where individual mice were positively identified through genetic analysis, or secondarily, with high probability through morphometric measurements rigorously analyzed by statistic methods, such as discriminate function analysis (DFA) (Conner and Shenk 2003a). Positive identification of individual mice through genetic analysis or other means is most important in habitats where the PMJM and the western jumping mouse coexist.

In Wyoming, the highest elevation, genetically confirmed PMJM capture is from approximately 2,300 m (7,600 ft), but the second highest is from only approximately 2,100 m (6,800 ft). The lowest confirmed western jumping mouse is from approximately 1,900 m (6,200 ft) (Bowe and Beauvais 2012, pp. 15–16). Therefore, overlap with western jumping mice appears to occur in most of Wyoming's drainages that are occupied by the PMJM. In Colorado, with few exceptions, jumping mice positively identified below 2,050 m (6,700 ft) have been PMJMs. Between 2,050 m (6,700 ft) and 2,320 m (7,600 ft) in Colorado, PMJMs and western jumping mice are known to have overlapping distribution in the Cache La Poudre, Big Thompson, and Upper South Platte River drainages.

In coordination with WYNDD, the State of Wyoming, and CPW, we maintain a PMJM trapping database (Service 2013). We used this database to map the PMJM's approximate current range as illustrated in Figure 1. Given the wide areas of overlapping range between the PMJM and western jumping mice in Wyoming, we require that each Wyoming specimen be assessed via genetic analysis (consistent with Bowe and Beauvais 2012) in order to be considered a confirmed PMJM. In Colorado, we consider a jumping mouse to be a PMJM when identification has been confirmed via genetic analysis or DFA, or when, if unconfirmed, the mouse was captured below 2,050 m (6,700 ft), where western jumping mice have rarely been documented.

Trapping results approximate a species' range, but may not provide a definitive range because surveys have not occurred throughout all locations where the PMJM is likely to be present. For example, PMJMs were trapped at two sites approximately 19 km (12 mi) apart along Kiowa Creek in Elbert County (Service 2013). Suitable habitats between these capture locations suggest that the PMJM likely occurs both between these sites and farther downstream in the drainage. However, no trapping has occurred to confirm or

deny this assertion. Similarly, on Trout Creek, trapping identified a PMJM in Douglas County near the Teller County line, and it is reasonable to assume the subspecies also may occur farther to the south in Teller County (Service 2013). Therefore, in the absence of trapping records, we rely on habitat suitability and connectivity to approximate the PMJM's current range.

Abundance and Populations

Due to the difficulty of implementing long-term trapping studies, quantitative studies designed to estimate PMJM populations have occurred at only a few sites in Colorado. As a result, we lack a reliable regional, Statewide, or rangewide population estimate for the PMJM. Without long-term trapping studies, our understanding of population densities is limited for the PMJM in Wyoming (WGFD 2005, p. 36; WGFD 2010, p. IV–2–66). In Colorado, we have several population estimates but little trend information for PMJM populations. In addition, because jumping mouse population sizes in a given area vary significantly from year to year (Quimby 1951, pp. 91–93; Whitaker 1972, p. 4), short-term studies may not accurately characterize abundance. In one ongoing trapping study, population highs of 24 and 69 PMJMs per site were estimated for two control sites in 1999; subsequent trapping in 2002, during regional drought conditions, found no PMJMs present at either site (Bakeman 2006, p. 11). Over 4 years, PMJM populations varied widely and were absent at certain sites during some seasons, suggesting that 10 or more years of study might be necessary to assess the full extent of variation in PMJM populations (Meaney *et al.* 2003, p. 620).

Because the PMJM occupies linear riparian communities, researchers estimate abundance as the number of mice per km (or mi) of riparian corridor. Estimates of linear abundance range widely, from 2 to 67 mice per km (3 to 107 mice per mi) with a mean of approximately 27 mice per km (44 mice per mi) (Shenk 2004).

The above abundance estimates, coupled with sufficient knowledge of occupied stream miles, may provide a rough indicator of PMJM numbers within a stream reach or drainage. The Recovery Team used the 27 mice per km (44 mice per mi) population estimate (Shenk 2004) to approximate the number of stream miles required to support varying sized populations of the PMJM (USFWS 2003b, p. 25). However, Hayward (2002) cautioned that reliance on an average number of mice per length of stream to predict population

sizes would result in the overestimation of actual population size for about half of all sites. Of additional concern in any assessment of PMJM's population size is the potential for including western jumping mice in the estimate (Bohon *et al.* 2005; Hansen 2006, p. 174; Schorr *et al.* 2007, p. 4). Overestimation is of particular importance in areas where the PMJM and western jumping mouse coexist, including many sites in Wyoming and higher elevation sites in Colorado. At these locations, actual densities of the PMJM are likely much lower than the trapping data suggest.

Although available PMJM population estimates do not incorporate estimates for riparian corridors along mountain, or montane, streams or any sites in Wyoming, capture rates provide insight into potential population sizes for these locations. At higher elevation riparian sites in Douglas, Jefferson, and Teller Counties, Colorado, capture success rates range from 0.32 percent to 0.6 percent, despite incredible trapping efforts (Hansen 2006, p. 94; Schorr *et al.* 2007, p. 4). In Wyoming, capture rates ranged from 0.5 percent to 1.3 percent (Griscom *et al.* 2007). These low capture rates were likely lower, with results confounded by the coexistence of the western jumping mouse. Comparatively, capture rates ranged from 3.4 percent to 3.5 percent in high-quality habitat at lower elevations with similar trapping efforts (Schorr 2001, p. 18; Meaney *et al.* 2003, p. 616). Therefore, montane and headwater stream reaches likely support a lower density of mice than plains and foothill sites, and are potentially less secure than their counterparts on the plains, especially where isolated.

Population Trends

As with abundance estimates, the difficulty of implementing long-term trapping studies limits the availability of population trend data for the PMJM. Since listing, there have been few attempts to characterize changes in PMJM populations over time. One long-term study at the Air Force Academy (Academy) in El Paso County, Colorado, provides the most thorough estimate of population trends for the subspecies. Mark-recapture data over 7 years at the Academy suggested that populations were declining (Schorr 2012a, p. 1277).

Without comprehensive population estimates for the PMJM, surveys at historically documented sites provide the primary basis for assessing population trends (Smith *et al.* 2004, p. 29). As previously discussed, we now have much more information regarding PMJM's distribution in Wyoming and Colorado than we had at time of listing in 1998. For Wyoming, we initially cited

only 2 known occupied sites, but trapping efforts since then have identified at least 30 occupied sites (Bowe and Beauvais 2012, p. 16). Much of what we noted at the time of listing to be historical range of the PMJM in Wyoming has now been found to currently support the subspecies, except for habitats west of the Laramie Mountains and in Goshen County. However, while many jumping mice captures have been confirmed as PMJM in the North Platte River basin through genetics or other techniques, trapping records suggest the subspecies is uncommon in the South Platte River basin, with only western jumping mice confirmed at several locations within the presumed historical range of the PMJM. Because trapping efforts targeting the PMJM prior to listing were few compared to those post-listing, we cannot infer population trends from the Wyoming trapping data. However, low capture rates for the PMJM suggest that the mouse may not be widely distributed (Cudworth and Grenier 2011, p. 154).

In Colorado, historical trapping records establish that the PMJM was present in a range that included major plains streams from the base of the Colorado Front Range east to at least Greeley, Weld County (Armstrong 1972, p. 249; Fitzgerald *et al.* 1994, p. 293; Clippinger 2002, p. 18). However, recent trapping efforts have documented that the PMJM is currently rare or absent from these same areas (Ryon 1996, p. 2; Clippinger 2002, p. 22; USFWS 2013). This pattern is especially apparent along prairie riparian corridors directly or indirectly impacted by human development.

Summary of Information Pertaining to the Five Factors

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

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

We must consider these same five factors in delisting a species. We may delist a species according to 50 CFR 424.11(d) if the best available scientific and commercial data indicate that the species is neither endangered nor threatened for the following reasons:

- (1) The species is extinct;
- (2) The species has recovered and is no longer endangered or threatened; or
- (3) The original scientific data used at the time the species was classified were in error.

In making this finding, information pertaining to the PMJM in relation to the five factors provided in section 4(a)(1) of the Act is discussed below. In considering what factors might constitute threats, we must look beyond the mere exposure of the species (or in this case, subspecies) to the factor to determine whether the species responds to the factor in a way that causes actual impacts to the species. If there is exposure to a factor, but no response, or only a positive response, that factor is not a threat. If there is exposure and the species responds negatively, the factor may be a threat and we then attempt to determine how significant a threat it is. If the threat is significant, it may drive or contribute to the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined by the Act. This does not necessarily require empirical proof of a threat. The combination of exposure and some corroborating evidence of how the species is likely impacted could suffice. The mere identification of factors that could impact a species negatively is not sufficient to compel a finding that listing is appropriate; we require evidence that these factors are operative threats that act on the species to the point that the species meets the definition of an endangered or threatened species under the Act.

Foreseeable future is determined by the Service on a case-by-case basis, taking into account a variety of species-specific factors such as lifespan, genetics, breeding behavior, demography, threat-projection timeframes, and environmental variability. For the purposes of this finding, we define foreseeable future based upon a threat-projection timeframe because future development intensity and patterns are likely to be the single greatest factor contributing to the subspecies' future conservation status. As described in more detail below, human-population-growth projections extend out to 2040 in Colorado and 2030 in Wyoming. Similarly, water requirements are estimated through 2030 in Colorado and

2035 in Wyoming. A Center for the West model predicting future land-use patterns projects development changes within the range of the PMJM through 2040 in Colorado and 2050 in Wyoming. Climate change models formulate predictions through 2050 for the PMJM's range. Such projections frame our analysis as they help us understand what factors can reasonably be anticipated to meaningfully affect the subspecies' future conservation status. Therefore, we consider the foreseeable future for PMJM, based on the currently available data, to extend to approximately 2040. While it is likely some of the above estimates could be extrapolated out into the more distant future, development projections beyond this point are of increasingly lower value as uncertainty escalates. We also believe that not all threat factors are necessarily foreseeable over the same time horizon. When reliable data are available, we consider a longer time horizon, while recognizing that there may not necessarily be just one foreseeable future.

In making our 12-month finding on these petitions, we considered and evaluated the best available scientific and commercial information.

Factor A. Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Introduction: Decline in the extent and quality of PMJM habitat due to land-use changes associated with human development remains the primary factor threatening the subspecies (Bakeman 1997, p. 78; Hafner *et al.* 1998, p. 122; Pague and Grunau 2000). In our 1998 final rule to list the PMJM as threatened, we stated that land in Colorado, east of the Front Range, and adjacent areas of southeastern Wyoming had changed over time from predominantly prairie habitat intermixed with perennial and intermittent streams, and associated riparian habitats, to an agricultural and increasingly urban setting (63 FR 26517, May 13, 1998). We find that this trend continues, with human development contributing to the continued loss and degradation of PMJM habitat, as discussed further below.

In our original listing decision, we determined that PMJM populations had experienced a decline and faced continued threats linked to widespread loss and fragmentation of the subspecies' required riparian habitat from human land uses. Threats included: Urban, suburban, and recreational development; highway and bridge construction; water development; instream changes associated with

increased runoff and flood control efforts; aggregate (sand and gravel) mining; and overgrazing (63 FR 26517, May 13, 1998). These human land-use activities affect the PMJM by directly destroying its protective cover, nests, food resources, and hibernation sites; disrupting normal feeding, breeding, or sheltering behaviors; or acting as a barrier to movement. We noted that such impacts reduced, altered, fragmented, and isolated habitat to the point where PMJM populations may no longer persist. We also noted that patterns of capture suggested that PMJM populations fluctuate greatly over time at occupied sites, raising questions regarding security of currently documented populations that are isolated and affected by human development.

For this status review, we received no new information or data that dispute these assertions. Rather, human populations and the corresponding threats associated with human development continue to expand and affect the PMJM and its habitats. Therefore, we find that the PMJM continues to face threats associated with loss and degradation of its habitats from human development, as is described below.

Absence of PMJM from historically occupied sites: Pre-1980, historical records of the PMJM in Colorado illustrate areas of occupancy along the Front Range within both foothill and prairie riparian corridors (Armstrong 1972, p. 249; Fitzgerald *et al.* 1994, p. 293; Fitzgerald *et al.* 2011, p. 189). Between 1980 and 2011, the human population of Colorado counties within this historic part of the PMJM's range increased by approximately 84 percent, from approximately 1.9 million to 3.5 million (Colorado Demography Office 2011). As explained below, the apparent absence of the PMJM in areas affected by substantial development, where trapping had previously confirmed the subspecies' presence, supports the conclusion that human land uses adversely affect PMJM populations.

Trapping studies and investigations into land-use changes suggest that urban development directly altered or fragmented habitats such that the PMJM disappeared from these habitats (Ryon 1996, pp. 1, 25, 30). PMJMs were captured at only one of seven historically occupied sites with suitable habitats (Ryon 1996, p. 1). Additionally, distribution maps developed from museum records, published accounts, and unpublished reports suggest a loss of PMJM populations in expanding urban and suburban areas, especially around Cheyenne, Denver, Colorado

Springs, and along the eastern extent of historical range (Clippinger 2002, pp. 14–29). The apparent loss of the PMJM from historically occupied sites suggests that human development negatively impacts PMJM's habitats.

As a result of habitat loss due to human development, PMJM populations have little likelihood of occurrence along large portions of major river and stream reaches within the subspecies' historical range in Colorado including:

- The Cache La Poudre River within the Fort Collins and downstream to its confluence with the South Platte River at Greeley, 60 km (37 mi);
- The Big Thompson River and Little Thompson River through the Front Range urban corridor east to I–25, approximately 50 km (32 mi);
- The Saint Vrain River from Hygiene to its confluence with the South Platte River, 35 km (22 mi);
- Boulder Creek from the Boulder east to its confluence with the Saint Vrain River, approximately 35 km (22 mi);
- Walnut, Woman, and Dry creeks downstream from Rocky Flats National Wildlife Refuge (NWR) to the confluence of Dry Creek, and beyond to the South Platte River, 40 km (25 mi);
- Ralston Creek and Clear Creek through the urban corridor to the South Platte River, approximately 40 km (25 mi);
- The South Platte River downstream of Chatfield Reservoir through Denver to Brighton, 60 km (38 mi);
- The South Platte River downstream from Brighton to Greeley, approximately 55 km (34 mi) (one recent nearby capture is described above);
- Cherry Creek from the Arapahoe County-Douglas County line downstream through Denver to the South Platte River, 30 km (19 mi); and
- Monument Creek downstream from its confluence with Cottonwood Creek through Colorado Springs, approximately 15 km (9 mi).

In summary, PMJM populations appear to have little likelihood of occurrence along historically occupied river and stream reaches within and downstream from areas of concentrated human development. Despite these downstream extirpations, many of these same rivers and streams continue to support PMJM populations in their upstream foothills or montane reaches and tributaries, where human development is limited or has not occurred.

The PMJM Science Team developed a conservation planning handbook that addressed threats within each of seven Colorado counties supporting PMJM populations (Pague 1998; Pague and

Grunau 2000). The document identified potential threats operating in known or suspected PMJM habitat, and assigned a qualitative risk assessment level to each of the identified threats. The document provides important, science-based insight into threats to, and potential conservation strategies for, the PMJM in Colorado on a county-by-county basis (Pague and Grunau 2000). Habitat-related “issues” identified by the Science Team as high or very high priority include: Habitat conversion through housing, commercial, and industrial construction; travel corridor, or roadway, construction; travel corridor maintenance; fragmentation of habitat and corridors; hydrological flow impairment; habitat conversion to a reservoir; bank stabilization; high-impact livestock management; rock and sand extraction; invasive weeds; and catastrophic fire (Pague and Grunau 2000, pp. 1–15, 2–12, 3–13, 4–14, 5–14, 6–15, 7–14; Pague 2007).

CPW’s Comprehensive Wildlife Conservation Strategy cites threats to PMJM habitat and range including habitat conversion due to housing, urban, and exurban development, and habitat degradation due to altered native vegetation and altered hydrological regime (CPW 2006, p. 102). The Wyoming State Wildlife Action Plan (SWAP) describes suitable PMJM habitat as widely distributed, but naturally fragmented and very limited (WGFD 2010, p. IV–2–66). Wyoming’s SWAP noted that while distribution is restricted with limited ability to increase distribution, extirpation is not imminent in Wyoming. However, the SWAP considers human activity to be a moderate limiting factor for the PMJM in Wyoming (WGFD 2010, p. IV–2–66). Wyoming’s Comprehensive Wildlife Conservation Strategy identified potential threats to habitat areas most likely to support the PMJM as invasive plants, residential development radiating from Cheyenne, and recreation (WGFD 2005, pp. 53, 55, 56).

The loss of the PMJM from historically occupied sites suggests that human land uses adversely affect the PMJM. It is unlikely that the PMJM can return to historically occupied habitats that are now heavily developed. Furthermore, the PMJM’s apparent local extirpation from areas of human development foreshadows the potential impacts of future development within the remaining range of the PMJM. Threats associated with human development, as discussed in more detail below, will continue to adversely affect the PMJM in large portions of its current range now and into the foreseeable future. If the protections of

the ESA were to be removed, threats from human development would go unchecked.

Since listing in 1998, the Act’s protections have slowed impacts of development on the PMJM and its habitat. One indication of human development pressure is the number of formal consultations performed to date under section 7 of the Act and the number of section 10 permits issued to date in conjunction with approved habitat conservation plans (HCPs). Section 7 of the Act requires Federal agencies to consult with the Service to ensure that their actions do not jeopardize the continued existence of the subspecies or cause destruction or an adverse modification of critical habitat. Thus far, the section 7 process has been successful in preventing Federal actions from jeopardizing the continued existence of the subspecies or resulting in the destruction or adverse modification of critical habitat. Section 10(a)(1)(B) of the Act authorizes the Service to issue permits for non-Federal actions that result in the incidental taking of listed wildlife. Incidental take permit applications must be supported by an HCP that identifies conservation measures that the permittee agrees to implement for the species to avoid, minimize, and mitigate the impacts of the requested incidental take. Below, we summarize our regulatory activities for the PMJM under the Act to illustrate the scope of impacts that would potentially occur in the absence of the Act’s protections.

As of April 8, 2013, we have conducted 170 formal section 7 consultations (153 in Colorado, 17 in Wyoming) since the time of listing. Additionally, we issued 21 HCP-related incidental take permits (all in Colorado) for projects affecting the PMJM. We authorized take of the PMJM for actions that did not jeopardize the subspecies, but may have resulted in permanent impacts to over 320 ha (790 ac) of PMJM habitat, and temporary impacts to 609 ha (1,505 ac) of habitat, or approximately 0.8 percent and 1.7 percent of the subspecies’ occupied range based on data layers provided by Colorado Parks and Wildlife (USFWS 2013). These projects incorporated conservation measures or mitigation to avoid or minimize the adverse impacts to the PMJM. Since 2006, we collaborated on more than 1,900 Federal or non-Federal projects, to avoid and minimize impacts to the PMJM and its habitat such that formal consultation under section 7 or an HCP was unnecessary.

However, even with the protections afforded to the subspecies under the

Act, we have concluded that habitat overall has continued to decline in quality and quantity since listing, especially in Colorado. In the absence of listing, development projects in PMJM habitat would go forward with reduced Federal oversight. Under Factor D, we evaluate other Federal, as well as State and local regulatory mechanisms that may provide protection for the PMJM and its habitat.

Below we evaluate specific modes of human development and how they affect the PMJM, including: (1) Residential and commercial development; (2) transportation, recreation, and other rights-of-way through PMJM habitats; (3) hydrologic changes associated with human development; (4) aggregate mining; (5) oil and gas exploration and extraction; (6) agriculture; and (7) cattle grazing.

Residential and Commercial Development: Clippinger (2002) assessed the impacts of residential development on the PMJM. He analyzed Colorado land-cover data compared to positive and negative trapping results for the PMJM in a GIS analysis and concluded that the likelihood of successful trapping of PMJMs within its historical range was reduced by either low- or high-density residential developments when the developments were within 210 m (690 ft) of the trapping sites (Clippinger 2002, pp. iv, 94). The PMJM can be a useful indicator of environmental integrity in riparian areas and associated upland areas in the Colorado Piedmont (Clippinger 2002, p. iv). These data suggest that nearby development increases the risk of local extirpation of the PMJM from occupied sites.

Both housing density and spatial patterns can influence effects of residential development on wildlife habitat (Theobald *et al.* 1997). While clustered development can decrease habitat disturbance (Theobald *et al.* 1997, p. 34), much of the Rocky Mountain West is experiencing “rural sprawl,” where rural areas are growing at a faster rate than urban areas (Theobald *et al.* 2001, p. 4). In Colorado, residential demand and State law encourage developers to design subdivisions with lots of at least 14 ha (35 ac) each with one house, to avoid detailed county subdivision regulations (Riebsame *et al.* 1996, p. 420). The Larimer County Master Plan (Larimer County Planning Division 1997) cites a trend toward residential properties with relatively large lots that leads to scattered development and more agricultural land taken out of production. Where public and private lands are intermingled, private land

ownership typically follows valley bottoms (Theobald *et al.* 2001, p. 5), thus rural development is likely to disproportionately affect valley-bottom riparian areas (Riebsame *et al.* 1996, p. 402), the favored habitat of the PMJM. Beyond direct impact to habitat, when ranches are subdivided, subsequent residential construction and associated disturbance can result in the disruption of wildlife movement along stream corridors (Riebsame *et al.* 1996, p. 402). Rural development also disproportionately occurs around edges of undisturbed public lands and affects the conservation value of the undisturbed public lands (Hansen *et al.* 2005, p. 1900).

Human development often has subtle effects on riparian habitat. Human settlement results in declines in native trees and shrubs, greater canopy closure, and a more open understory with reduced ground cover within riparian habitat (Miller *et al.* 2003, p. 1055; Pennington *et al.* 2008, pp. 1235, 1240–1244). An open understory does not favor the PMJM, which prefers dense ground cover of grasses and shrubs and is less likely to use open areas where predation risks are higher (Clippinger 2002, pp. 69, 72; Trainor *et al.* 2007, pp. 472–476). Human development tends to increase densities of invasive plants that can outcompete native riparian and upland vegetation. Human development also increases populations of human-associated predators, such as domestic cats, red fox, or racoons that may impact PMJM populations.

Furthermore, human development fragments PMJM habitats, which isolates populations and reduces connectivity. The PMJM is closely associated with narrow riparian systems that represent a small percentage of the overall landscape within the subspecies' range. As a result, PMJM habitats may be naturally fragmented by a lack of connectivity, as montane and foothill drainages form rivers that flow onto the plains and may only join east of the potential range of the PMJM. However, human development, most intense on the plains and nearby foothills, further limits downstream connectivity and fragments habitats. Fragmentation of these linear riparian habitats limits the extent and size of PMJM populations. As populations become fragmented, isolated, and smaller, it becomes more difficult for them to persist (Caughley and Gunn 1996, pp. 165–189). The Recovery Team determined that small, fragmented units of habitat will not be as successful in supporting the PMJM in the long term as would larger areas of contiguous habitat (USFWS 2003b, p. 21). On a landscape scale, maintenance

of dispersal corridors linking patches of PMJM habitat, and therefore connecting populations, may be crucial to the subspecies' conservation (Shenk 1998, p. 21; Schorr 2012a, pp. 1273, 1279). Limited travel distances recorded for the PMJM underscore the importance of continuous, interconnected suitable habitats.

Rapid development accompanied the growth of human populations along Colorado's Front Range (Kuby 2007; Schorr 2012, p. 1279). Population forecasts predict that Colorado's human population will increase by 1.5 percent per year between 2012 and 2017, with the growth rate increasing to 1.7 percent per year by 2020 (DeGroen 2012, p. 3). The State of Colorado expects the population of counties supporting the PMJM to increase by an additional 1.2 million people, a 50 percent increase, from 2011 to 2040 (Colorado Demography Office 2012). These expected population increases into the foreseeable future accompanied by more development, support Pague and Grunau's (2000) conclusion that habitat conversion to human development is a very high concern to the PMJM.

Although Wyoming has a smaller human population than Colorado, Wyoming's human population continues to increase within the range of the PMJM. Between 1980 and 2011, Wyoming's human population within the counties supporting the PMJM increased by 23 percent, from 123,755 to 152,120 people. In Cheyenne, Wyoming, human populations increased by 27 percent, from 47,283 to 60,096 (Wyoming Department of Administration and Information 2012). Over the 10-year period between 2000 and 2010, human populations increased by an average of 9.8 percent in Albany, Converse, Platte, and Laramie Counties, with a population decrease recorded for Platte County (Wyoming Department of Administration and Information 2012). Population forecasts predict that all four Wyoming counties within the PMJM's range will experience population increases by 2030. The models predict that populations in the counties supporting the PMJM will increase by 20,410 people, or 13 percent, between 2012 and 2030 (Wyoming Department of Administration and Information 2012). Laramie County will experience the largest increase, approximately 13,470 people between 2012 and 2030, or a 14 percent increase, with Cheyenne gaining approximately 8,372 people (Wyoming Department of Administration and Information 2012).

Population growth rates and projections provide valuable insight into future development pressures

throughout the PMJM's range, but may overestimate impacts to areas that are already developed. For example, human population increases within already dense metropolitan centers, such as Cheyenne, Fort Collins, Greeley, Longmont, Denver, and much of Colorado Springs, are likely to have little direct impact on the PMJM because the mouse is likely absent within these heavily developed areas and any habitats downstream. However, development-related impacts would likely concentrate at the edges of these metropolitan areas, especially as they expand outward into undeveloped habitats to accommodate increasing populations. For example, substantial human population increases in the Laramie Foothills of Larimer County, Colorado, or southern portions of Douglas County, Colorado, are likely to impact the PMJM. In Wyoming, given the smaller projected population increases, rural development may continue to have fewer or more-localized impacts to the PMJM than in Colorado. However, rural development in the Wyoming and Colorado foothills targets valley bottoms with riparian habitats (Riebsame *et al.* 1996, p. 402; Theobald *et al.* 2001, pp. 4–5), resulting in an increased loss and fragmentation of PMJM habitats.

Modeling exercises also provide insights into future land-use development patterns. While these models have weaknesses, such as an inability to accurately predict economic upturns or downturns, uncertainty regarding investments in infrastructure that might drive development (such as roads, airports, or water projects), and an inability to predict open-space acquisitions or conservation easements, such models can add to our understanding of likely development patterns. For example, in 2005, the Center for the West produced a series of maps predicting growth through 2040 for the West, including the Colorado Front Range and Wyoming (Travis *et al.* 2005, pp. 2–7). The projections for the Colorado Front Range illustrate significant increases in urban/suburban, low-density suburban, and exurban land uses across virtually all private lands within the Colorado portion of the PMJM's range. These models also predict urban and exurban expansion around Cheyenne through 2050 (Center of the American West 2001). These projections depict that only small, isolated patches of PMJM habitat in public ownership, including headwater areas in Federal ownership, would avoid the direct impacts of residential and associated commercial

development. While land-use modeling and projections retain uncertainties and are not at a resolution useful for assessing habitat patterns, both the empirical record and the projections show development filling gaps along the Colorado Front Range (Travis 2008).

Our regulatory activities under the Act provide insight into the scope of development-related impacts that have occurred since listing. Of the 153 formal consultations and 21 HCPs completed in Colorado, 19 section 7 consultations and 10 HCPs were specifically for residential and commercial developments with direct adverse effects to the PMJM or its habitat. Approved projects allowed for permanent or temporary adverse impacts in excess of 210 ha (520 ac) of PMJM habitat. While conservation measures or mitigation in various forms have been incorporated into all permitted projects, implementation of these habitat restoration and enhancement measures has been hampered by factors such as drought or flooding. We also have worked with other Federal agencies and a substantial number of landowners and developers on more than 1,900 projects to avoid adverse impacts to PMJM habitat, thus avoiding formal consultation or the need for HCPs.

Additional planned residential and commercial development projects that would adversely affect PMJM habitat in Colorado are continually being reviewed by the Service. Since 2006, our biologists provided technical assistance to more than 470 development projects in Colorado with potential impacts to the PMJM (TAILS 2013). These data indicate that listing did not eliminate development pressures due to residential or commercial developments. Since listing, protections afforded under the Act have slowed, but not eliminated, the loss of PMJM habitat due to residential and commercial development in Colorado. Therefore, we conclude that in the absence of the protections under the Act, PMJM habitat in Colorado and the populations it supports would be lost at a greatly increased rate from residential and commercial development.

Based upon known impacts to the PMJM associated with current development and best available projections for future development, we conclude that residential and commercial development constitutes a substantial threat to the PMJM, now and into the future.

Transportation, Recreation, and Other Rights-of-Way through Habitat: At the time of listing, we concluded that roads, trails, or other linear development through the PMJM's riparian habitat

could act as partial or complete barriers to dispersal (63 FR 26517, May 13, 1998). These forms of development have continued to affect and fragment PMJM habitat. Since listing, we have conducted 69 formal consultations under section 7 of the Act for road or bridge projects (62 in Colorado and 7 in Wyoming), resulting in permitted impacts to approximately 84 ha (207 ac) of PMJM habitat. In addition, a formal 2005 programmatic section 7 consultation with the Federal Highway Administration for the Wyoming Statewide Transportation Improvement Program could result in 19 future highway projects with impacts to 42 ha (104 ac) of PMJM habitat. Under the Douglas County (Colorado) Regional HCP for the PMJM, completed in May 2006, 67 approved road and bridge construction projects by Douglas County, and the cities of Parker and Castle Rock, may affect up to 122 ha (302 ac) of PMJM habitat over a 10-year period.

One of the largest proposed road projects in PMJM habitat is the improvement to I-25 in El Paso County, Colorado. The proposed construction will affect all of the eastern tributaries of Monument Creek thought to support the PMJM (Bakeman and Meaney 2001, p. 21). Impacts to the PMJM will include habitat fragmentation and modification, change in population size, and behavioral impacts (Bakeman and Meaney 2001, pp. 18–20). While measures to avoid, minimize, and mitigate impacts were identified, the project will have significant cumulative effects on the PMJM in the Monument Creek drainage, especially east of I-25 (Bakeman and Meaney 2001, pp. i, ii, 22–27). Anticipated impacts include the permanent loss of 26 acres and temporary impacts to 36 acres of PMJM habitat (USFWS 2003, p. 23). A second large transportation project is the improvement of U.S. Highway 36 in Boulder County, Colorado. This project will permanently impact 42 acres of PMJM habitat along Boulder Creek (USFWS 2009, p. 23).

As the human population increases, more road construction and maintenance projects will be necessary to accommodate new development and transportation needs. Based on ongoing and anticipated transportation projects within the range of the PMJM, we determine that transportation-related threats continue to affect the PMJM. In the absence of the Act's protective measures, impacts to the PMJM and its habitats from these activities would likely increase.

Anthropogenic impacts associated with recreation include the

development and use of backcountry roads, trails, and campgrounds, which are often located along streams and near water (WGF 2005, p. 56). Recreational trail systems are frequently located within riparian corridors (Meaney *et al.* 2002, p. 116). The development of trail systems can affect the PMJM by modifying its habitat, nesting sites, and food resources in both riparian and upland areas. Use of these trails by humans or pets can alter wildlife activity and feeding patterns (Theobald *et al.* 1997, p. 26). Fewer PMJMs are found within sites near trails than on sites without trails (Meaney *et al.* 2002, pp. 131–132). While temporal and spatial variation in PMJM numbers resulted in low precision of population estimates and weak statistical support for a negative trail effect, the authors considered the magnitude of the potential effect sufficient to encourage careful management and additional research (Meaney *et al.* 2002, pp. 115, 131–132).

Since the listing of the PMJM in 1998, 18 recreational trail projects with proposed impacts to PMJM habitat in Colorado received authorization for take or permits through section 7 consultations or HCPs, with impacts to approximately 36 ha (90 ac) of PMJM habitat. The Douglas County Regional HCP permitted an additional 24 trail projects in Colorado. Demand for recreational development in public open space and on conservation properties will likely increase as human populations increase (Bowker *et al.* 2012, pp. 1, 5, 25–26). While human population growth is expected to be significant only along the Front Range of Colorado and perhaps in the Cheyenne, Wyoming area, increased recreational demand will radiate outward from dense, urban centers and extend into more, undeveloped rural lands. For example, the Pike National Forest immediately to the west of Denver, Colorado, experienced a 50 percent increase in recreational visitors between 2001 and 2006 (USFS 2013, p. 1). Without protections afforded by the Act, PMJM populations on properties free from residential and commercial development threats will still be subject to threats from future recreational development and increased human use.

Many utility lines (sewer, water, gas, communication, and electric lines, and municipal water ditches) cross PMJM habitat. Current and future utility rights-of-way through these habitats will cause habitat destruction and fragmentation from periodic maintenance and new construction. Since the listing of the PMJM, 68 utility projects adversely affecting the PMJM and its habitat have

been evaluated through section 7 consultations (64 in Colorado, 4 in Wyoming). In addition, an approved HCP with Denver Water permits impacts to 34 ha (84 ac) of PMJM habitat at multiple sites in Colorado. While often more costly than trenching, avoidance measures such as directional drilling under riparian crossings can reduce or avoid impacts to the PMJM. If the PMJM were to be delisted, it is unlikely that project proponents would voluntarily avoid adverse impacts to the PMJM by directionally boring underneath habitat of Prebles to avoid impacts.

To summarize, as human populations increase, threats associated with transportation, recreation, and other rights-of-way through PMJM habitats will also increase. Because human populations are increasing and are projected to grow in the future, we expect these threats will continue to impact PMJM populations in Colorado and Wyoming in the foreseeable future. Wyoming's population will increase more slowly than Colorado's population, suggesting that there will be relatively lower impacts resulting from transportation, recreation and rights of way to PMJM populations in Wyoming.

Hydrologic Changes: Establishment and maintenance of riparian plant communities depend on the interactions between surface-water dynamics, groundwater, and river-channel processes (Gregory *et al.* 1991, pp. 542–545). Changes in hydrology can alter the channel structure, riparian vegetation, and valley-floor landforms (Gregory *et al.* 1991, pp. 541–542; Busch and Scott 1995, p. 287). Thus, changes in the timing and abundance of water can be detrimental to the persistence of the PMJM in these riparian habitats due to the resultant changes in vegetation (Bakeman 1997, p. 79). Changes in hydrology may occur in many ways, but two of the more prevalent are the excessively high and excessively low runoff cycles in watersheds with increased areas of paved or hardened surfaces, and disruption of natural flow regimes downstream of dams, diversions, and alluvial wells (Booth and Jackson 1997, pp. 3–5; Katz *et al.* 2005, pp. 1019–1020).

Urbanization can dramatically increase the frequency and magnitude of flooding while decreasing base flows (the portion of stream flow that is not surface runoff and results from seepage of water from the ground into a channel slowly over time; base flow is the primary source of running water in a stream during dry weather) (Booth and Jackson 1997, pp. 8–10; National Research Council 2002a, pp. 182–186). Impervious surfaces significantly reduce

infiltration of precipitation by natural soil substrates. The magnitude of peak flows increases in urban areas as water runs off as direct overland flow. Increased peak flows can exceed the capacity of natural channels to transport flows, trigger increased erosion, and degrade habitat (Booth and Jackson 1997, pp. 3–5). Changes in hydrology associated with urbanization can result in channel downcutting, lowering of the water table in the riparian zone, and creation of a “hydrologic drought,” which in turn alters vegetation, soil, and microbial processes (Goffman *et al.* 2003, p. 317). Meanwhile, reduced infiltration results in reduced groundwater recharge, reduced groundwater contributions to stream flow, and, ultimately, reduced base flows during dry seasons (National Research Council 2002a, p. 182; Goffman *et al.* 2003, p. 317). Established methods of mitigating downstream impacts of urban development, such as detention basins, have only limited effectiveness; downstream impacts are probably inevitable without limiting the extent of watershed development (Booth and Jackson 1997, p. 17).

In response to altered hydrology, stormwater-management, flood-control, and erosion-control efforts occur along many streams within the former and current range of the PMJM. The methods used include channelization; construction of detention basins, outfall structures, drop structures, riprap banks, and impervious cement channels; and other structural stabilization. Structural stabilization methods designed to manage runoff and control erosion can increase the rate of stream flow, shorten channel length, narrow riparian areas, destroy riparian vegetation, and prevent or prolong the time required for vegetation reestablishment (Booth and Jackson 1997, p. 4). These impacts may affect plant composition, soil structure, and physiography of riparian systems to the point where habitat supporting the PMJM is so altered that populations can no longer persist. Bank stabilization is a high-priority issue for the PMJM in Weld and El Paso Counties (Pague and Grunau 2000, p. 15). Since the listing of the PMJM, 22 stormwater management, stream stabilization, or outfall structure projects with impact to PMJM habitat have been addressed through formal section 7 consultations in Colorado; none have occurred in Wyoming.

The PMJM's apparent absence downstream from most areas of extensive urbanization (including Cheyenne, Wyoming, and Fort Collins, Longmont, Boulder, Golden, Denver,

Parker, and Colorado Springs, Colorado) may be attributed to such changes in hydrology described above. Multiple researchers expressed concern regarding upstream development activities and the integrity of protected riparian habitats on Monument Creek and its tributaries through the Air Force Academy (Corn *et al.* 1995, p. 14; Schorr 2001, p. 30; Schorr 2012a, p. 1279). In 2007, all eastern tributaries of Monument Creek on the Academy experienced adverse impacts to occupied PMJM habitat due to erosive head cutting, channel degradation, and impacts to vegetation attributed to regional stormwater management, and commercial and residential developments that occurred upstream and downstream (Mihlbachler 2007; Schorr 2012a, p. 1279). Despite the Air Force Academy's conservation efforts, damage to habitats on the Academy due to adjacent urbanization may be irreparable (Carley 2012).

If we were to delist the PMJM, runoff-related impacts to riparian habitats within and downstream of development would likely increase. Additionally, in the absence of the Act's protection the restoration of impacted riparian systems would be less likely to occur.

Hydrologic factors, such as surface flows and groundwater, influence the riparian habitats on which the PMJM depends. Water development and management alters vegetation composition and structure, riparian hydrology, and flood-plain geomorphology directly, as well as through alterations to habitats located downstream. The creation of irrigation reservoirs at the expense of native wetlands is a factor that negatively affected PMJM populations over the previous century (Fitzgerald *et al.* 1994, p. 293). Reservoirs with barren shorelines can fragment populations and create barriers to the PMJM's movements. As reservoirs are maintained and developed, these factors continue to impact the PMJM and its habitats.

Population growth drives water consumption, so as Colorado's population doubles by the year 2050, so will the demand for water (CWCB 2010, pp. ES–4, ES–7). Current and future reservoir construction will be necessary to respond to municipal water needs. By 2050, municipal and industrial demand for water in Colorado's South Platte River basin would increase by 93 percent and by 78 percent in the Arkansas River basin, as measured in acre feet (af) per year under medium-use scenarios (Colorado Water Conservation Board 2010, p. 3–11, Table 3–3). Additionally, demand within the

Denver metropolitan area would increase by 59 percent under medium-use scenarios (Colorado Water Conservation Board 2010, p. 3–11, Table 3–3). The expanded storage and transport of water that will be needed to address these demands has the potential to significantly impact PMJM habitat. Pague and Grunau (2000) considered hydrological impacts (water quality, flow regime, and groundwater) to be a high-priority issue to the PMJM in all Colorado counties supporting populations.

Since the listing of the PMJM, we have conducted two section 7 consultations for new reservoirs in Colorado, the Reuter-Hess Reservoir in Douglas County and the Pinewood Springs Reservoir in Larimer County. Through these consultations, 7 ha (17 ac) of impacts to PMJM habitat were authorized. Three water projects currently proposed would, if developed, significantly affect PMJM habitat, including the proposed expansions of existing Halligan Reservoir and Seaman Reservoir in the Cache La Poudre drainage, Larimer County, Colorado, and Chatfield Reservoir Storage Reallocation Project in the Upper South Platte drainage, Jefferson and Douglas Counties, Colorado. Options being considered at Halligan Reservoir could inundate up to 4.0 km (2.5 mi) of PMJM habitat and affect the PMJM's critical habitat at the site of the proposed dam. At Seaman Reservoir, the currently favored option would inundate about 4.0 km (2.5 mi) of the PMJM's critical habitat. The preferred alternative for the Chatfield Reservoir Storage Reallocation Project estimates that up to 183 ha (453 ac) of existing PMJM habitat, including 63 ha (155 ac) of critical habitat, would be inundated. These and other water projects also will result in alteration of flows that could further affect PMJM habitat downstream.

In Wyoming, estimates of projected water use in the Platte River Basin through 2035 range from a 38 million m³ (31,000 af) decrease to a 90 million m³ (73,000 af) increase (Wyoming Water Development Commission 2006, p. 10). No significant reservoir projects are currently planned within PMJM habitat in Wyoming. While the Platte River Plan identifies "upper Laramie River storage" as a future storage opportunity (Wyoming Water Development Commission 2006, p. 31), potential impacts to the PMJM are uncertain because it is not known whether the PMJM occurs in the drainage.

Beyond direct effects to the PMJM and its habitat through construction or inundation, changes in flows related to water diversion, storage, and use also

affect downstream riparian habitats in a variety of ways. In the future, a number of changes in amount and timing of diversions, water uses, and return flows will affect many streams supporting the PMJM. However, the cumulative impacts of such changes to specific PMJM populations, both adverse and some potentially beneficial, are difficult to predict. As 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 downcutting, which in turn affects groundwater levels (Katz *et al.* 2005, p. 1020). The resulting conversion of habitats from moist or mesic, shrub-dominated systems to drier grass- or forb-dominated systems make the area less suitable for the PMJM.

Considering the projected future demands for water, we conclude that major water development projects affecting the PMJM would likely occur regardless of the status of the subspecies under the Act. However, if we delisted the PMJM, conservation measures designed to minimize and compensate impacts to PMJM and its habitats are less likely to be incorporated into project plans. Although development pressures for water resources are likely less in Wyoming, a similar scenario of increased population growth, followed by increased development and demand for water, suggests that if delisted, fewer projects would incorporate PMJM-specific conservation measures. Therefore, we determine that hydrologic changes are a threat to the PMJM.

Aggregate Mining: At the time of listing, we concluded that alluvial aggregate mining was a threat to the PMJM. Aggregate mining removes mineral materials from floodplains, where mineral resources most commonly occur. These mining operations often occur on the same gravel deposits that provide important PMJM hibernation sites (63 FR 26517, May 13, 1998). As a result, alluvial aggregate mining continues to be a threat to the PMJM and may produce long-term changes to PMJM habitat by altering hydrology and permanently removing shrub and herbaceous vegetation. Additionally, after mining removes the aggregate minerals, operators often line the remaining pits with impervious substrates, effectively converting the mine pit into a water reservoir. This conversion precludes the restoration of riparian shoreline

vegetation and alters adjacent groundwater flow.

Since listing, we have conducted formal consultation under section 7 of the Act regarding impacts to the PMJM at two aggregate mines in Colorado. We have worked with project proponents to avoid impacts at others. Previously, private aggregate mining activities at Rocky Flats National Wildlife Refuge (NWR) in Colorado could potentially affect PMJM habitat directly or through alteration of hydrology along Rock Creek. However, a recent land exchange and donation of mineral estates prevents future mining on an additional 245 ha (605 ac) within the Refuge boundary (USFWS 2012, pp. 19–20). Therefore, aggregate mining is not likely to impact the PMJM or its habitat at Rocky Flats NWR.

Elsewhere, aggregate mining continues to affect floodplains along Colorado's Front Range, but many project sites are along downstream reaches of larger streams and rivers where PMJM populations now appear absent. Pague and Grunau (2000) considered "rock and sand extraction" to be a high-priority issue in Weld, Jefferson, and Douglas Counties. While some stream channels within the range of the PMJM in Wyoming have historically been mined for aggregate, including the Laramie River at Laramie and Lodgepole and Crow creeks at Cheyenne, mining is not as widespread as in Colorado (Wyoming State Geological Survey (WSGS) 2008, 2012).

Construction aggregates are low in value relative to their weight, so transporting the minerals is expensive and mines are usually located as close to the point of use as possible (WSGS 2008). As a result, threats related to aggregate mining are likely to be more intense near areas with human development. Thus, we deduce that aggregate mining will continue throughout the subspecies' range, but may have a greater impact on PMJM populations in Colorado where development pressures are greater than in Wyoming. However, these pressures could increase in Wyoming alongside projected increases in human population and urban development, particularly around Cheyenne. Therefore, we conclude that aggregate mining is a threat to the PMJM.

Oil, Gas, and Mineral Exploration and Extraction: We investigated whether oil, gas, and mineral exploration and extraction pose a threat to the PMJM. A large portion of the subspecies' Wyoming range overlaps with exposed, undifferentiated precambrian rocks or other formations with low potential for oil and gas development (DeBruin

2002). A GIS analysis of oil and gas potential (Anderson 1990) relative to the subspecies' likely range (Beauvais 2004) indicates that approximately 79 percent of the PMJM's range in Wyoming occurs in areas with low oil and gas potential. This analysis also indicates that less than 1 percent of the PMJM's range in Wyoming occurs in areas with high oil and gas potential, while approximately 20 percent of the range overlaps with areas of moderate oil and gas potential. Even within these moderate and high potential areas, only one oil and gas field occurs in PMJM habitat (DeBruin 2002). In addition, coalfields and the range of the PMJM have little overlap in Wyoming (DeBruin 2004, p. 2), indicating a minimal risk of PMJM habitat being altered for coal production. Additionally, the PMJM's range does not overlap with coal production areas in Colorado.

In Colorado, many new wells are drilled on the plains within or to the east of the Front Range urban corridor, with many new wells in Weld County. Few PMJMs exist in areas of current oil and gas exploration and production, and few PMJM habitats overlap with these areas. In addition, wells are usually located in upland areas away from riparian habitats that support PMJM populations, though associated roads and pipelines may cross or parallel creeks and riparian habitats. Based on the limited potential for development of these resources within the range of the PMJM, we conclude that oil and gas activities (directly or indirectly) will not meaningfully affect the conservation status of the PMJM throughout its range now or in the future. Therefore, we conclude that oil and gas exploration and extraction are not currently threats to the PMJM.

Agriculture: At the time of listing, we cited conclusions by Compton and Hugie (1993a; 1993b) that human activities, including conversion of grasslands to farms and livestock grazing, had adversely impacted the PMJM. They concluded that development of irrigated farmland had a negative impact on PMJM habitat, and that any habitat creation it produced was minimal (Compton and Hugie 1993a; Compton and Hugie 1993b). In general, negative trapping results suggest that the PMJM does not occur in areas cultivated for row crops. Historically, the rapid rate of native habitat conversion to row crops likely had a significant adverse impact on the PMJM. Because conversion of native habitat to row crops has become increasingly rare in both Colorado and Wyoming (USDA 2009, Tables 2, 3, & 9), such conversions are unlikely to present

a similar threat in the future in any portion of the subspecies' range.

Although future pressures to increase agricultural production may result from changes in the industry, including potential demand for biofuels, we are not aware of information that suggests this would result in meaningful decreases in the PMJM's riparian habitat in Colorado or Wyoming. We conclude that in the absence of protections afforded by the Act, only a little of the subspecies' habitat is at risk from agricultural conversion. In Wyoming, where such a scenario in PMJM habitat appears more likely than in Colorado, we explored whether former cropland removed from production for conservation purposes is now being returned to production. For example, through the Farm Bill's Conservation Reserve Program (CRP), farmers and ranchers enroll eligible agricultural land in 10- to 15-year contracts and plant appropriate cover, such as grasses and trees, in crop fields and along streams. The plantings help prevent soil and nutrients from running into regional waterways and affecting water quality. The long-term vegetative cover also improves wildlife habitat and soil quality. Wildlife habitat provided through the CRP can be at risk when CRP contracts expire and lands are returned to agricultural production.

Within the current range of the PMJM in Wyoming, Laramie County has the largest percent of croplands enrolled in the CRP program, at 9 percent (FSA 2013, p. 97). Total enrollment within the four counties (Converse, Laramie, Platte, and Albany) is approximately 17 percent (FSA 2013, p. 97). Between 2013 and 2027, CRP contracts that will eventually expire for Wyoming counties within the current range of the PMJM include: 1,146 ha (2,832 ac) currently enrolled in Converse County; 17,891 ha (44,210 ac) currently enrolled in Laramie County; 17,436 ha (43,086 ac) currently enrolled in Platte County (FSA 2012); and 25 ha (63 ac) currently enrolled in Albany County. Between 2007 and 2012, enrollments declined 969 ha (2,395 ac) in Converse County; declined 11,923 ha (29,463 ac) in Laramie County; declined 6,971 ha (17,225 ac) in Platte County; and did not change in Albany County (Farm Service Agency 2012). However, with only 17 percent of croplands currently enrolled in the CRP program in Wyoming, future changes in enrollments are unlikely to affect the PMJM or its habitats.

The PMJM uses native grass and alfalfa hayfields that are in or adjacent to suitable riparian habitat. Because hay production requires large amounts of water, hayfields are often near

waterways and, thus, PMJM's riparian habitat. Mowing of hay may directly kill or injure PMJMs; reduce food supply, especially if plants do not mature to produce seed; and remove cover. Late season mowing may be especially problematic, because PMJM are approaching hibernation and their nutritional needs are high (Clippinger 2002, p. 72). Additionally, hay production may preclude the growth of willows and other shrubs that provide important hibernation sites for the PMJM. Ditch systems often irrigate hayfields, and the PMJM may use overgrown water conveyance ditches and pond edges, or other agricultural ditches as dispersal routes (Meaney *et al.* 2003, pp. 612–613). As a result, ditch maintenance activities may kill individual PMJMs and periodically alter their habitat. However, existing special regulations at 50 CFR 17.40(1) exempt certain ditch maintenance operations from the take prohibitions of the Act in recognition that habitat that the ditches provide is dependent on the ditches retaining their function. Furthermore, PMJM populations have persisted in hayed areas for many years (Taylor 1999), so haying operations that allow dense riparian vegetation to remain in place are likely compatible with persistence of PMJM populations. Therefore, agriculture is not currently a threat to the PMJM.

Livestock grazing. Multiple scientific studies document the effects to riparian habitats from livestock grazing (Kauffman and Krueger 1984, pp. 431–435; Armour *et al.* 1991, pp. 7–11; Fleischner 1994, pp. 629–638; Belsky *et al.* 1999, pp. 419–431; Freilich *et al.* 2003, pp. 759–765). Livestock have damaged 80 percent of stream and riparian ecosystems in the western United States (Belsky *et al.* 1999, p. 419). Adverse impacts of grazing include: Changes to stream channels (downcutting, trampling of banks, increased erosion), flows (increased flow and velocity, decreased late-season flow), the water table (lowering of the water table), and vegetation (loss to grazing, trampling, and through altered hydrology) (Kauffman and Krueger 1984, pp. 432–435).

Researchers have documented impacts to meadow jumping mice from cattle grazing (Medin and Clary 1989; Giuliano and Homyack 2004; Frey and Malaney 2009). Livestock grazing contributes to the lack of structural habitat diversity on historical PMJM sites in Colorado (Ryon 1996, p. 3). Grazing practices that assure maintenance of riparian shrub cover may be a key consideration in maintaining PMJM populations (Ensign

Technical Services 2004, p. 9). On a working ranch in Douglas County, Colorado, PMJMs were detected within cattle enclosures, but not on grazed areas. Previous trapping had documented PMJMs upstream and downstream of the working ranch, but not on the grazed ranch itself (Ensign Technical Services 2004, p. 9). On private lands in Douglas County, Colorado, Pague and Schuerman (1998, pp. 4–5) observed a swift rate of residential land development and significant fragmentation of habitat, but noted that in some cases accompanying secession of grazing had allowed recovery of degraded riparian habitats. Along the Poudre River in the Arapaho Roosevelt National Forest in Larimer County, Colorado, continued vegetation monitoring reveals that resting overgrazed areas improved PMJM's riparian and upland habitats (Hansen and Ellwood 2013).

A 5-year study of factors affecting jumping mice (*Zapus* spp.) on the Medicine Bow National Forest in Wyoming demonstrated an inverse relationship between percent utilization of cattle forage (mostly grasses) and nearby jumping mouse numbers. Grazing levels that resulted in more than 40 percent forage utilization were more influential in reducing jumping mouse numbers than lower grazing intensities (Griscom *et al.* 2009, pp. 11–12). In Colorado, City of Boulder lands endured intensive grazing, farming, or haying regimes until they became part of the Boulder Open Space system. Grazing and haying, used as land management tools, continue on Boulder Open Space sites currently supporting the PMJM. However, in their study of small mammals on Boulder Open Space, Meaney *et al.* (2002, p. 133) found no adverse effects of managed grazing on abundance of individual small mammal species or on species diversity.

Overgrazing threats are not limited to large livestock producing operations. On subdivided ranch properties, often termed “ranchettes,” horses and other livestock can heavily affect the small tracts within which they are fenced (Pague and Grunau 2000, pp. 1–14). In Colorado, many large ranch properties are subdivided into smaller ranchettes, with multiple homes and grazing pastures. We have concluded that this represents a widespread threat to undeveloped areas of Colorado, where an increase in rural development is forecast in the future. Pague and Grunau (2000) considered “high impact livestock grazing” to be a high-priority issue for the PMJM in Larimer, Weld, Elbert, and El Paso Counties in

Colorado, largely due to the projected increase in such ranchettes.

In Wyoming, where large-scale commercial ranching is more prevalent in the PMJM's range than in Colorado, overgrazing occurs sporadically across the landscape, in particular where cattle congregate in riparian areas during the winter and spring. Grazing has occurred within PMJM habitat for many decades, and populations of PMJMs 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 PMJMs (King *et al.* 2006b, pp. 4351–4353)), primarily within sub-irrigated hay meadows that have been subjected to livestock grazing and hay production for approximately 100 years (Taylor 1999, p. 5).

At the time of listing, we addressed overgrazing by livestock. We stated that it may cause significant impacts to PMJM habitat, but that timing and intensity of grazing were probably important in maintaining habitat and that maintenance of woody vegetative cover could be key (63 FR 26517, May 13, 1998). Overgrazing was thought to have eliminated the PMJM from much of its former Wyoming range (Clark and Stromberg 1987, p. 185; Compton and Hugie 1993b, p. 4). However, trapping efforts since listing identified PMJM in Wyoming and greatly expanded our understanding of the subspecies' range, disproving early theories that overgrazing eliminated the PMJM in Wyoming.

As suggested by Bakeman (1997, p. 79) and Pague and Grunau (2000, pp. 1–17), and as supported by the examples above, grazing is compatible with the PMJM when timing and intensity are appropriately managed. We now believe that agricultural operations that have maintained habitat supportive of PMJM populations are consistent with conservation and recovery of the subspecies. As a result, we adopted special regulations at 50 CFR 17.40(1) in 2001, which exempted existing agricultural activities, including grazing, plowing, seeding, cultivating, minor drainage, burning, mowing, and harvesting, from the prohibitions of the Act. The exemption does not apply to new agricultural activities or to those that expand the footprint or intensity of the activity. We established the exemption to provide a positive incentive for agricultural interests to participate in voluntary conservation activities and to support surveys and studies designed to determine status, distribution, and ecology of the PMJM,

which in turn could lead to more effective recovery efforts.

The number of cattle in counties currently known to support the PMJM in Wyoming totaled 288,000 head in 2012 (National Agriculture Statistics Service 2012). Cattle numbers appear stable in Albany, Converse, and Laramie Counties, but higher than the average for the last 20 years in Platte County. Cattle numbers in Colorado counties supporting the PMJM totaled 706,900 head in 2012. Approximately 80 percent, or 565,000 cattle, were in Weld County, where limited occupied PMJM habitat is known to exist (National Agriculture Statistics Service 2012). Excluding Weld, all of these Colorado counties have shown a marked downward trend in cattle numbers over the past 20 years, reflecting human development on former agricultural lands (National Agriculture Statistics Service 2012).

Overall, we expect traditional grazing operations to continue in Wyoming. Such operations have generally proven compatible with maintenance of PMJM populations, suggesting timing and intensity have generally been managed appropriately. This management has taken place without oversight of the Act as allowed in the special regulations at 50 CFR 17.40(1). Researchers observed a correlation between grazing and drought while studying the New Mexico meadow jumping mouse, with populations more tolerant of grazing during wet years (Frey and Malaney 2009, p. 37). While the management of these ranches may not change in a manner adverse to the PMJM into the future, cumulative impacts with future climate change and grazing present concerns (see Factor E discussion below).

Conservation Efforts To Reduce Habitat Destruction, Modification, or Curtailment of Its Range

In Colorado, restoration of degraded riparian habitats has occurred in part as mitigation for adverse impacts to the PMJM. Restoration of 0.86 km (0.54 mi) of PMJM habitat on East Plum Creek, Douglas County, appears to have increased vegetation cover and the PMJM's use (Bakeman 2006, pp. 4, 8). The effort has restored connectivity of upstream and downstream riparian habitat through this previously degraded urban stream reach. Similarly, recent projects on Cherry Creek, Douglas County, have restored groundwater levels and downcut channels in or near PMJM habitat by employing rock or sheet pile drop structures.

State programs have been available to help preserve the PMJM through the

acquisition, preservation, and management of its habitat. These include the Great Outdoors Colorado Trust Fund and the Species Conservation Trust Fund. There are many State and local initiatives that could provide for conservation of the PMJM, independent of Federal oversight, including nearly 40 conservation projects in 5 Front Range Colorado counties where the PMJM "may be present" (George 2004). However, the conservation value of many of these and other more recent projects is uncertain, since most were developed without specific regard to the PMJM's distribution and its conservation.

Service-approved HCPs and their incidental take permits contain management measures and protections for identified areas that protect, restore, and enhance the value of these lands as habitat for the PMJM. These measures, which include explicit standards to avoid, minimize, and mitigate any impacts to the covered (sub)species and its habitat, are designed to ensure that the biological value of covered habitat for the PMJM is maintained, expanded, or improved. Large regional HCPs expand upon the basic requirements set forth in section 10(a)(1)(B) of the Act and reflect a voluntary, cooperative approach to large-scale habitat and (sub)species conservation planning. The primary goal of such HCPs is to provide for the protection and management of habitat essential for the conservation of the (sub)species while directing development to other areas. In any HCP, permittees may terminate their participation in the agreement and abandon the take authorization set forth in the permit.

To date, we have approved 19 single-species HCPs for the PMJM, all in Colorado. These 19 HCPs and their 21 associated permits allow approximately 282 ha (696 ac) of permanent or temporary impacts to PMJM habitat. The HCPs describe the preservation and enhancement of habitats to offset impacts from proposed activities. The approved HCP for Douglas County and the Towns of Castle Rock and Parker allows impacts of up to 170 ha (430 ac), in exchange for the acquisition of 24 km (15 mi) of stream (455 ha (1,132 ac) of habitat) acquired and preserved for the long-term benefit of the PMJM.

Another HCP, issued in January 2006, is the Livermore Area HCP in Larimer County. The planning area for this HCP includes a large portion of Larimer County, approximately 1,940 square km (750 square mi), including a PMJM "conservation zone" estimated at approximately 324 km (201 mi) of

stream and 8,570 ha (21,320 ac). The HCP cites protection of 114 km (71 mi) of stream, mostly on CPW lands; however, it is not clear what proportion of these areas support the PMJM. Local landowners and public agencies holding land within the boundaries of this HCP may opt for coverage under the HCP and receive take permits on their own from us for activities consistent with the HCP. The Livermore Area HCP is designed to support current land uses, including ranching and farming. However, inclusion of landowners is optional, and they may choose to pursue land uses inconsistent with those specified in the HCP. Thus far, we have issued no individual permits under this HCP.

Of the two other regional HCPs that have been in development, the El Paso County effort is proceeding slowly, if at all, and the Boulder County effort has been discontinued. It is unlikely that these or other conservation plans would be completed or implemented if the PMJM did not remain listed under the Act.

Summary of Factor A: Human land uses within the PMJM's current range continue to destroy, degrade, and fragment habitats. Since the time of listing, the Act's protections have avoided, minimized, and helped to compensate for many direct human land-use impacts to PMJM habitats. Direct and secondary impacts to riparian habitats have likely diminished the areas capable of sustaining PMJM populations. Given the projections for future human population growth in Colorado and Wyoming, and absent protections associated with Federal activities and listing under the Act, we have concluded that threats posed by human development activities as discussed above will increase in the foreseeable future. Regulatory mechanisms other than the Act could help reduce such negative impacts, but are currently limited, as is discussed under Factor D below.

Wyoming's human population is expected to increase by 2030. Human populations will grow more slowly in Wyoming than in Colorado, suggesting that fewer development-related threats are likely to occur in this portion of the subspecies' range than in Colorado. In the North Platte River basin in Wyoming, the PMJM appears to be more widely distributed than assumed at the time of listing, but the confirmed range is limited to a relatively narrow band east of the crest of the Laramie Mountains (Bowe and Beauvais 2012, p. 8). An improved understanding of the subspecies' distribution suggests that to date the PMJM has largely coexisted

with historical and well-managed agricultural activities, such as grazing and haying. A continuation of these long-standing activities may support existing PMJM populations. However, we have little information to suggest if or how these agricultural practices are likely to change in the future.

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

We have no information to suggest that the PMJM is currently collected for commercial or recreational purposes. We also have no information to indicate that collection or overutilization of the subspecies for commercial or recreational purposes would occur if the species were delisted.

Conversely, collection of PMJM specimens for scientific and educational purposes does occur, primarily for research or during presence or absence trapping surveys related to development projects. The Act largely motivates these surveys and ensures that the collection does not jeopardize the subspecies. If delisted, we assume that scientific collection would decrease.

Additionally, we assume that State wildlife agencies would continue to recognize PMJM as a non-game species if delisted; thus scientific and commercial activities would continue to be permitted under existing State regulations in both Colorado and Wyoming. Although the capture and handling of the PMJM by permitted researchers has resulted in unintentional mortalities, levels of take associated with scientific collection are very small and do not rise to a level that would affect populations of the subspecies. It follows that levels of take associated with scientific collection would not likely increase should we remove the protections of the Act. Furthermore, we have no information to indicate that collection for scientific or educational reasons is likely to become a significant threat to the subspecies, even if the protections afforded the subspecies under Colorado and Wyoming State laws were removed (see our discussion below under Factor D). Therefore, we determine that overutilization for commercial, recreational, scientific, or educational purposes is not a threat to the PMJM.

Factor C. Disease or Predation

At the time of listing, we had no evidence of disease causing significant impacts to the PMJM (63 FR 26517, May 13, 1998). At this time, we have no additional evidence that any disease or parasite has caused a significant impact to the subspecies. Although

relationships between plague and North American rodents are poorly understood, plague may interact synergistically with other natural and human-induced disturbances, thereby increasing risk of local extirpation and rangewide extinction (Biggins and Kosoy 2001, p. 913). Although plague has not been documented in the PMJM, Pague and Grunau (2000, p. 19) considered disease to be a potentially high-priority issue for the subspecies. They cited a lack of information regarding immunological resistance of the PMJM to plague and other diseases. The researchers also noted that small, isolated populations could be especially vulnerable to effects of disease.

In 1998, we evaluated potential predators of the PMJM whose densities could increase in the suburban or rural environment, including striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and the domestic cat (*Felis catus*) (63 FR 26517, May 13, 1998). The increased impacts of native and exotic predators that accompany rural development can affect PMJM's viability (Hansen *et al.* 2005, p. 1899). We noted that free-ranging domestic cats and feral cats presented a problem to PMJM populations in habitats near human development. Where generalist predator populations increase through human land uses, they may contribute to the loss or decrease of the PMJM.

Proponents of new residential developments near PMJM habitats are generally receptive to instituting prohibitions on free-ranging cats and dogs (*Canis domesticus*) when negotiating minimization measures through section 7 of the Act. However, enforcement is often through covenants administered by homeowners' associations, with uncertain success. Additionally, introduction of nonnative bullfrogs (*Rana catesbeiana*) in Colorado has resulted in predation on the PMJM (Trainor 2004, p. 58). However, we have no information to suggest that predation from bullfrogs has affected PMJM populations.

While uncertainties remain regarding disease and predation, we believe the best available scientific and commercial data suggest that disease is most likely to affect only small and fragmented PMJM populations. Additionally, increases in predation will likely only contribute to the reduction, fragmentation, and loss of PMJM populations when such populations are exposed to increased human presence. As noted under Factor A, increased human presence is expected to be more significant along the Front Range of Colorado or surrounding towns or cities in Wyoming, where predation may have

a more of an effect than in rural areas. If the PMJM were to be delisted, covenants that address PMJM predation by domestic pets would be less likely to be enacted or enforced. Therefore, we conclude that disease is currently not a threat to the PMJM. However, when analyzed cumulatively with increases in commercial and residential development, as discussed under Factor A, predation by human-associated predators may be a threat to the PMJM.

Factor D. Inadequacy of Existing Regulatory Mechanisms

The Act requires us to examine the adequacy of existing regulatory mechanisms with respect to existing and foreseeable threats that may affect PMJM. The existing regulatory mechanisms were found to be inadequate to protect the PMJM from the threats identified at the time of listing (63 FR 26517, May 13, 1998). Since it was listed as threatened, the Act has been and continues to be the primary Federal law that affords protection to PMJM. As explained below, the Service uses sections 7, 9, and 10 of the Act to assist in the conservation of the PMJM.

Section 7(a)(1) of the Act requires all Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species. Section 7(a)(2) of the Act requires Federal agencies to ensure that actions they fund, authorize, or carry out do not "jeopardize" the continued existence of a listed species or result in the destruction or adverse modification of habitat in areas designated by the Service to be critical. Critical habitat has been designated for the PMJM. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A project may receive a non-jeopardy determination, documented in a biological opinion, if it includes reasonable and prudent measures that minimize the extent of impacts to listed species associated with a project.

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally listed wildlife. Section 3(18) defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm"

to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harassment" is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species.

Listing the PMJM provided a variety of protections within areas under Federal jurisdiction and the conservation mandates of section 7 for all Federal agencies. Since it was first listed in 1998, we have consulted and coordinated with multiple Federal agencies regarding the effects of proposed actions on the PMJM. For example, the USFS consulted and coordinated with us on more than 80 projects regarding the effects of recreation, forestry, or transportation projects occurring on federally owned National Forests. The U.S. Army Corps of Engineers has consulted and coordinated with us on more than 320 projects regarding various impacts to PMJM and its habitat associated with commercial and residential developments, mining, or other activities impacting jurisdictional wetlands or waters. Additionally, the Federal Highway Administration coordinated and consulted with us on more than 262 projects regarding the effects of various transportation related activities to PMJM and its habitat. If the PMJM were not listed, these protections would not be provided. Thus, we must evaluate whether other regulatory mechanisms would provide adequate protections absent the protections of the Act.

National Environmental Policy Act (NEPA)

All Federal agencies must comply with the NEPA of 1970 (42 U.S.C. 4321 *et seq.*) for projects they fund, authorize, or carry out. The Council on Environmental Quality's regulations for implementing NEPA (40 CFR parts 1500–1518) state that agencies shall include a discussion on the environmental impacts of the various project alternatives (including the proposed action), any adverse environmental effects that cannot be avoided, and any irreversible or irretrievable commitments of resources involved (40 CFR part 1502). NEPA does not regulate activities that might affect

the PMJM, but does require full evaluation and disclosure of information regarding the effects of contemplated Federal actions on sensitive species and their habitats. It also does not require minimization or mitigation measures by the Federal agency involved. Therefore, Federal agencies may include conservation measures for the PMJM as a result of the NEPA process, but such measures would be voluntary in nature and are not required by the statute. Absent the listing of the PMJM, we would expect Federal agencies to continue to meet the procedural requirements of NEPA for their actions. However, as explained above, NEPA does not itself regulate activities that might affect the PMJM or its habitat

Clean Water Act (CWA)

The CWA (33 U.S.C. 1251 *et seq.*) protects rivers and streams of the United States. The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The CWA's general goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 U.S.C. 1251 (a)). When practicable, section 404 of the CWA generally requires avoidance, minimization, and mitigation of adverse impacts associated with filling jurisdictional wetlands and waters of the United States. Human impacts to jurisdictional wetlands may be permitted when alternatives that would avoid wetlands are found not to be practicable. Section 404 of the CWA does not apply to non-jurisdictional waters or wetlands. In these cases, activities affecting these waters or wetlands would not require Federal permits under section 404 of the CWA. More importantly, section 404 of the CWA provides no comparable safeguards for non-jurisdictional riparian and upland habitat areas important to the PMJM.

Section 303 of the CWA establishes the water quality standards and total maximum daily load (TMDL) programs. Water quality standards are set by States, Territories, and Tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. Colorado and Wyoming are required under section 305(b) of the CWA to complete an

assessment of their surface waters. From this assessment, a CWA 303(d) list of impaired water bodies is developed. These are waters that are not currently meeting their designated uses because of impairments to the waters.

Through the CWA, the Environmental Protection Agency (EPA) encourages communities, watershed organizations, and local, State, tribal, and Federal environmental agencies to develop and implement watershed plans to meet water quality standards and protect water resources. These plans can include measures that will help protect riparian areas and may in some cases provide benefits to the PMJM. For example, in Wyoming, the Crow Creek Watershed Plan coordinated by the Laramie County Conservation District includes recommendations to protect riparian habitat because of the benefits to water quality (LCCD 2007, p. 1). The plan's amendment also recognizes suitable PMJM habitats within the Pole Mountain Area and encourages proponents to recognize and comply with the Act's protections (LCCD 2007, pp. 17, 21). While these efforts to improve water quality have the potential to improve or protect riparian habitat, the measures are typically not mandatory, and such watershed planning efforts do not encompass the range of the subspecies. Thus, the CWA provides only limited protection of habitats utilized by the PMJM and is not capable of substantially reducing threats to individual PMJM populations or to the subspecies as a whole.

National Forest Management Act (NFMA)

The NFMA (16 U.S.C. 1600 *et seq.*) requires the USFS to prepare management plans for each National Forest. These management plans address management issues such as recreation, range, timber, biological diversity, and economic and social factors. On lands administered by the USFS, the PMJM's threatened status under the Act promotes USFS policies that contribute to its protection and recovery. Of the three National Forests supporting PMJM populations, the Medicine Bow-Routt National Forest has a forest management plan that includes standards and guidelines specific to conservation of the PMJM. The Arapahoe-Roosevelt National Forest and the Pike-San Isabel National Forest have forest plans that predate the listing of the PMJM (Warren 2007). If delisted, the USFS could potentially continue to recognize the PMJM as a subspecies warranting conservation concern with some degree of conservation priority. However, without the Act's protections,

there is no guarantee that Federal agencies would continue to prioritize PMJM conservation.

Sikes Act Improvement Act (Sikes Act)

The Sikes Act of 1997 (16 U.S.C. 670) authorizes the Secretary of Defense to develop cooperative plans with the Secretaries of Agriculture and the Interior for natural resources on public lands. The Sikes Act requires Department of Defense installations to prepare Integrated Natural Resources Management Plans (INRMPs) that provide for the conservation and rehabilitation of natural resources on military lands consistent with the use of military installations to ensure the readiness of the Armed Forces. INRMPs incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary to sustain military land uses. INRMPs are developed in coordination with the State and the Service, and are generally updated every 5 years. Although an INRMP is technically not a regulatory mechanism, because its implementation is subject to funding availability, it is an important guiding document that helps to integrate natural resource protection with military readiness and training

The Air Force Academy (Academy) in El Paso County, Colorado, has an INRMP in place, a conservation and management plan, and a programmatic consultation under section 7 of the Act, which provide guidance for Air Force management decisions for certain activities that may affect the PMJM. Research on the PMJM is ongoing at the Academy, and the conservation and management plan is designed to be updated as new information is collected. Warren Air Force Base in Laramie County, Wyoming, also has an INRMP and a conservation and management plan, which addresses the PMJM, even though the base may only support the western jumping mouse. These plans adequately reduce threats to the PMJM on these bases. Both plans are updated every 5 years, but the emphasis given to conservation of the PMJM may decline in the future if the subspecies were to be delisted.

National Wildlife Refuge System Improvement Act

The National Wildlife Refuge System Improvement Act of 1997 and the Fish and Wildlife Service Manual (601 FW 3, 602 FW 3) require maintaining biological integrity and diversity, comprehensive conservation planning for each refuge, and set standards to ensure that all uses of refuges are compatible with their purposes and the

Refuge System's wildlife conservation mission. The comprehensive conservation plans (CCP) address conservation of fish, wildlife, and plant resources and their related habitats for a refuge, while providing opportunities for compatible wildlife-dependent recreation uses. An overriding consideration reflected in these plans is that fish and wildlife conservation has first priority in refuge management, and that public use be allowed and encouraged as long as it is compatible with, or does not detract from, the Refuge System mission and refuge purpose(s).

Although survey efforts for PMJMs at National Wildlife Refuges (NWRs) have been limited, trapping surveys documented PMJM at the Rocky Flats NWR near Boulder, Colorado, and a jumping mouse at Hutton Lake NWR near Laramie, Wyoming. However, genetic analysis later determined that the mouse field-identified as a PMJM at Hutton Lake NWR was actually a western jumping mouse (Ramey *et al.* 2005, Appendix 3). Therefore, the capture at Rocky Flats NWR represents the only documentation of a PMJM on an NWR. The Service continues to manage Rocky Flats NWR in a manner consistent with conservation of the PMJM. Management of Rocky Flats or other NWRs that may support PMJM or its habitats is unlikely to change if the PMJM were to be delisted.

Fish and Wildlife Coordination Act (FWCA)

The FWCA requires that proponents of Federal water development projects, including those involving stream diversion, channel deepening, impoundment construction, and/or general modifications to water bodies, consider their impacts to fish and wildlife resources. FWCA also requires that impacts to water bodies be offset through mitigation measures developed in coordination with the Service and the appropriate State wildlife agency. Therefore, FWCA may provide some protection for the PMJM and its habitat through avoidance and minimization measures that may be incorporated into Federal projects. Therefore, the FWCA is an adequate regulatory mechanism to address threats within the confines of its applicability, but its applicability is limited. The minor benefits provided by FWCA would continue in the absence of the Act's protection.

State Protections: Under the nongame provisions of the CPW Regulations (Chapter 10, Article IV) the PMJM currently may only be taken legally by permitted personnel for educational, scientific, or rehabilitation purposes.

Wyoming classifies meadow jumping mice as a "nongame species" under section 11 of chapter 52 (Nongame Wildlife) of the Wyoming Game and Fish Commission regulations. As in Colorado, these regulations protect the PMJM from takings and sales by allowing the issuance of permits only for the purpose of scientific collection. As described under Factor B, overutilization for commercial, recreational, scientific, or educational purposes is not now, nor is it likely to become, a significant threat to the subspecies, even if the protections afforded the subspecies under Colorado and Wyoming laws were removed. However, classification of the PMJM as a nongame species in Colorado or Wyoming, which prohibits non-scientific collection, does not address threats associated with habitat loss and modification as described under Factor A.

Numerous State lands (CPW and WFGD lands, State Park lands, State Land Board lands) and mitigation properties (such as those of the Colorado Department of Transportation) would continue to provide a measure of protection for the PMJM, should it be delisted. While some of these conservation properties may have management specifically designed to preserve and enhance PMJM habitat, others are managed more generally for wildlife habitat, for human recreation, or for multiple uses.

Local Protections: At the time of listing, we noted that, while a myriad of regional or local regulations, incentive programs, and open-space programs existed, especially in Colorado, few specifically protected the PMJM or its habitat from inadvertent or intentional adverse impacts (63 FR 26517, May 13, 1998). Many local regulations create a process of site-plan review that "considers" or "encourages" conservation of wildlife, wetlands, and other natural habitats, but have no mandatory measures requiring avoidance or mitigation of impacts. Effectiveness of local regulations in maintaining naturally functioning riparian corridors varies greatly depending on how these apparently flexible regulations are implemented.

Following listing under the Act, development and other projects in and near PMJM habitat have received increased scrutiny from local jurisdictions, often in coordination with the Service. Open-space acquisitions and easements also have taken the PMJM and its habitat into account. It is not clear what level of interest in PMJM conservation would continue following delisting. Local governments would

likely relax review procedures for projects in known or suspected PMJM habitat. Beyond the direct impact to PMJM habitat, secondary impacts of development (including increased recreational use, altered flow regimes and groundwater levels, and increased domestic predators) are unlikely to be adequately addressed. While certain local regulations are designed to conserve wetlands or floodplains on private lands, it is unlikely they would effectively control land uses (grazing, mowing, cutting, and burning) that may affect the hydrology, vegetation, and hibernacula sites on which the PMJM depends. The adequacy of such protective measures is more important within Colorado than Wyoming given the intense development pressures in the Colorado counties where the PMJM occurs.

Douglas County, Colorado, owns 14 properties that encompass 24 km (15 mi) of stream and associated riparian habitats potentially beneficial to the PMJM (Matthews 2004). Of Douglas County streams on non-Federal property within the county-mapped Riparian Conservation Zone, 105 km (65 mi), or 23 percent, are under some form of permanent protection (Matthews 2004), including 77 km (48 miles) on Plum Creek and its tributaries and 25 km (16 mi) on Cherry Creek and its tributaries (Matthews 2008, Douglas County HCP). However, occurrence of the PMJM on many of these properties has not been extensively documented. For example, while there are 23.4 km (14.5 mi) of mapped riparian corridors on the large Greenland Ranch conservation property, the presence of the PMJM has been documented at only two sites. Future conservation efforts to augment protected areas and to link protection over large expanses of connected streams in Douglas County could contribute greatly to maintaining secure PMJM populations in the Upper South Platte and Middle South Platte-Cherry Creek drainages. If the PMJM were delisted, management priorities on protected lands and the direction of future conservation efforts would likely change in the absence of formalized agreements or plans.

Larimer County has acquired or secured easements to considerable lands, including some properties under the Laramie Foothills Project, in partnership with The Nature Conservancy, the City of Fort Collins, and the Legacy Land Trust. While conservation efforts have increased, especially in the Livermore Valley, residential development remains the largest threat to the PMJM in the county (Pague 2007). The extent to which

PMJM populations are supported by these properties, the fate of remaining private lands in the North Fork and Cache La Poudre River and its tributaries, and the ability to link conservation lands and traditional agricultural lands supporting the PMJM along stream reaches are key to protecting the potentially large PMJM population thought to exist in this area.

The City of Boulder, Boulder County, and Jefferson County have extensive lands protected under their open-space programs. While the extent of known PMJM occurrences in these counties is limited compared to that documented in Larimer and Douglas Counties, known populations exist on open space protected from residential and commercial development.

Overall, the CPW examined land ownership on over 58,000 ha (143,000 ac) in Colorado that they considered occupied by the PMJM. The CPW estimated the area of PMJM occupancy in Colorado by buffering habitats around documented capture locations. The CPW's analysis estimated that approximately 45 percent of the PMJM occupied area occurs on protected lands, such as those in public ownership, land trusts, or conservation easements (Nesler 2008). However, the trapping surveys used in this buffer analysis disproportionately targeted public lands or sites of proposed development, due largely to ease of accessibility. Therefore, the 45 percent statistic may overestimate the actual amount of PMJM habitat that occurs on protected lands. Although this percentage suggests meaningful progress toward recovery of the subspecies in Colorado, it does not indicate that protected status adequately reduces threats to the PMJM.

At the request of the Service, in 2008, the CPW conducted a similar evaluation for specific areas we consider of high importance to PMJM conservation in Colorado. These included units designated as PMJM critical habitat and additional units of proposed critical habitat that were excluded from the 2010 final designation (75 FR 78430, December 15, 2010) due to ongoing conservation efforts. While our proposal and designation of critical habitat units focused on lands in public ownership, which may bias the results, examination of these areas provides some perspective into potential protections in place in Colorado. Public lands, land trusts, or conservation easements comprise approximately 51 percent of the critical habitat.

While estimated percentages of lands in protected ownership categories are encouraging, and these lands may be

critical to the PMJM's recovery, existing protections on these lands do not fulfill preliminary draft recovery plan objectives, nor do they assure the future viability of these PMJM populations. Therefore, these local regulatory mechanisms on protected lands inadequately reduce threats to the PMJM at this time.

As discussed under Factor A, fragmentation of PMJM habitat and resulting impacts on the future security of PMJM populations is a significant concern. Even in drainages where lands in public ownership or private properties dedicated to conservation are relatively extensive, development of intervening private lands is likely to fragment habitat and may impact PMJM populations.

Many of the public ownership areas are relatively high-elevation, montane headwater habitats. As discussed previously, such areas may have less suitable habitat that supports lower density PMJM populations than at plains and foothill sites. Additionally, as elevation increases, there is an increased occurrence of the western jumping mouse. Overlap in ranges of the two species seems greatest in Wyoming, where a more gradual rise from the plains to the Laramie Mountains allows for a greater extent of mid-range elevations occupied by both species. Thus, in order to rely upon the contribution that protection or public ownership of these higher elevation areas provides to the long-term security of the PMJM, positive identification to species and localized demographic data would be required.

Finally, public ownership may not preclude properties from human development, other land uses, or management priorities that may affect the PMJM or its habitat. Although public lands may be protected and managed in a manner compatible with the needs of the PMJM, activities off site may indirectly affect the PMJM. Most prominent among these secondary impacts are those resulting from changes in stream flow regimes. Recent evidence suggests secondary impacts from development of private land upstream from the Academy (proposed as critical habitat Unit A1, now designated as critical habitat Unit 11) threaten the integrity of habitat present and the PMJM population it supports (Schorr 2012a, p. 1277).

In Wyoming, as would be expected in areas where development pressures are substantially less, the regional and local regulations affecting PMJM habitat appear to be less extensive than in the Colorado portion of its range. Currently Albany, Laramie, Converse, and Platte

Counties in Wyoming have zoning regulations, including the regulation of subdivision development (USFWS 2012b). These and other local protections provide some protection of water resources and floodplains and reduce soil erosion. However, overall, there are few local regulatory protections in the Wyoming portion of the PMJM's current range.

Summary of Factor D: In the absence of the Act's protective measures, Federal conservation efforts for the PMJM would largely be limited to Federal properties, where the subspecies could be maintained as a priority or sensitive subspecies and conserved through existing or future management plans. However, in the absence of the Act's protections, there are no guarantees at this time that Federal agencies would continue to recognize PMJM as sensitive or in need of protection.

If retained as a non-game species, State regulations in both Colorado and Wyoming would continue to regulate purposeful killing of the PMJM, which we do not view as a significant concern as summarized under Factor B. State and local regulations do little to conserve the PMJM or its habitat on private lands. Public land holdings, conservation easements, and other conservation efforts, past and future, could support the PMJM on specific sites. The extent and pattern of conservation efforts in relation to PMJM's distribution, and the appropriate management of PMJM habitat, would largely dictate the long-term viability of PMJM populations.

As described in the preliminary draft recovery plan (USFWS 2003b), no large populations and few medium-sized populations are known to exist on contiguous stream reaches that are secure from development. Management plans that specifically address threats to the PMJM are few, and management priorities would likely change if we were to delist the subspecies. Much of the intervening private lands would likely be subject to development in the future (this issue is described in more detail under Factor A above). If we were to delist the subspecies, given current and projected levels of population protections, we believe that existing regulatory mechanisms would not be adequate to mitigate the impacts of identified threats to most PMJM populations in Colorado and in the vicinity of Cheyenne, Wyoming.

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

The PMJM is susceptible to other natural or manmade factors, including

impacts from floods, wildfire, drought, invasive weeds and weed control programs, pesticides and herbicides, and secondary impacts associated with human-caused development (63 FR 26517, May 13, 1998). For most of these factors, we have little more information now than we had at the time of listing. Additional concerns that were not considered at the time of listing include the potential for competition between the PMJM and the western jumping mouse, small population sizes, and future effects of changing climate, including its potential to augment threats from fire and drought. We evaluate each of these factors below.

Floods: Floods are natural components of the Wyoming and Colorado foothills and plains. PMJMs and their habitats evolved under historic flood regimes, so populations and habitats naturally respond to flooding events. While floods may affect PMJM populations by killing individuals and destroying riparian and adjacent upland habitats, the effects to vegetation are usually temporary. Vegetation typically reestablishes quickly after floods, although larger floods may delay recovery. Normal flooding may help maintain the vegetative communities that provide suitable habitat for the PMJM.

However, manmade increases in impervious surfaces and the loss of vegetation caused by human activities or catastrophic wildfire can result in an increased frequency and severity of flood events. Flooding is often a byproduct of wildfires and may act synergistically to alter the composition and structure of riparian ecosystems for many years (Ellis 2001, p. 159). Therefore, extreme floods may prevent the re-establishment of the PMJM's favored riparian vegetation, forcing mice to disperse until habitats recover. While an extreme flood can eliminate an entire PMJM population in an affected stream reach, floods are less likely to eliminate the PMJM across an entire drainage system if populations extend into side tributaries or headwater unaffected by the flood. Therefore, maintaining the connectivity of riparian habitats between stream reaches is crucial to maintaining the security of PMJM populations faced with an increased incidence of flooding.

At this time, we lack information to conclude that flooding alone is a threat to the PMJM. However, flooding will increase under a warming climate (Milly *et al.* 2002, p. 514), with extreme floods potentially becoming increasingly problematic throughout the PMJM's range. Additionally, floods could develop into more a substantial threat as

more human development increases impervious surfaces and removes vegetation.

Wildfire: Over the last 50 years, more dry summers, more human-caused fires, and a history of fire suppression have increased the frequency, size, and severity of wildfires (Auclair and Bedford, 1994, p. 249; Sackett *et al.*, 1994, p. 115; Swetnam and Betancourt, 1998, p. 3128; Ellis, 2001, p. 160). In the western United States, large wildfire activity increased in the mid-1980s, marked by higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons (Westerling *et al.* 1996, p. 940). In Colorado and Wyoming, temperatures and numbers of wildfires have increased since 1970 (Climate Central 2012, p. 4). Rising spring and summer temperatures, along with shrinking snowpacks, increased the risk of wildfires in most parts of the West, with global climate change likely to further increase the frequency of wildfires throughout the region in the future (Westerling *et al.* 1996, p. 940; Climate Central 2012, p. 1). Satellite data and climate models predict an increase in fire risk across the United States by 2050, and drier conditions and more extreme fire events augment the risk (Hansen and Gran 2012, p. 1). Within the PMJM's range, climate models predict that wildfires will be more frequent and more severe, potentially burning 4 to 5 times more area, even when the models account for uncertainty associated with precipitation (Climate Central 2012, p. 9). Extreme fire years, such as 2002 with the Hayman Fire and 2012 with the High Park and Hewlett Fires, may occur 2 to 4 times more per decade than they do currently by 2050 (Hansen and Gran 2012, p. 1).

As wildfires burn, the intense heat, combustion gases, and consumption of organic material kills or displaces animals and may dramatically alter the structure and composition of habitats (Quinn 1979, p. 126). Small mammals die during wildfires from burns, asphyxiation, heat stress, overexertion, stampedes, and predation (Kaufman *et al.* 1990, p. 47). Wildfires may also interrupt the breeding cycles and movements of surviving animals, while affecting the quality and quantity of food, the availability of nest sites, the pressures of predation and competition, and the incidence of disease and parasites (Kaufman *et al.* 1990, p. 47). Although riparian plants do not depend on fire for regeneration, wildfire influences these habitats by changing their structure and composition (Ellis 2001, p. 159). Wildfire may promote the invasion of nonnative plants, which

when established, alter fire regimes, increase water use, and change the structure of the native community (Fornwalt *et al.* 2003, p. 515). Additionally, where wildfires destroy vegetation and change soil properties, they alter hydrology and sediment-transport processes, which increase erosion and the deposition of sediment (Verdin *et al.* 2012, pp. 1–2). Because these factors may affect the PMJM during or following a wildfire, Pague and Granau (2000) considered catastrophic fire to be a high-priority issue.

Wildfires burn riparian habitats, although the fires within these ecosystems may be less frequent or less intense than the adjoining uplands. Because the plant species, hydrology, microclimates, and fuel characteristics of riparian ecosystems differ from adjacent uplands, riparian areas possess different fire environments, fire regimes, and fire properties (Dwire and Kaufmann 2003, pp. 61, 71). Compared to upland habitats, moist fuels and the rapid decomposition of organic litter lessen the frequency of wildfires within riparian habitats (Busch 1995, p. 259). Generally, fire frequencies and intensities are lower in riparian habitats than in adjoining uplands (Dwire and Kaufmann 2003, pp. 61, 71). In Colorado for example, the Hayman Fire of 2002 burned significantly cooler in riparian areas than upslope areas, although burn intensities correlated positively to the burn intensity of the surrounding watershed (Decker *et al.* 2006, pp. 1, 3). Additionally, riparian habitats along smaller streams burned hotter, like the uplands, but riparian habitats along larger streams experienced cooler burns (Decker *et al.* 2006, pp. 1, 3). Wildfires in PMJM's riparian habitats during Colorado's High Park Fire of 2012 exhibited similar fire characteristics, where light, wet fuels either slowed the burn at the riparian zone or restricted burning to herbaceous, understory vegetation (Oberlag 2012, p. 2).

Periodic, low-severity wildfires may actually maintain PMJM habitats by removing understory fuels and promoting the regrowth of willows and other riparian vegetation. In the tallgrass prairies of Illinois, meadow jumping mouse populations displayed a positive response to fire in one study, but no response to fire in a second study (Kaufman *et al.* 1990, p. 55). Alternatively, in Colorado, trapping and telemetry data indicated that PMJMs did not enter burned habitats for at least 3 years after the Hayman Fire (Hansen 2006, pp. 163–164). Wildfires, especially those with high-severity burns, may render habitats unsuitable to

the PMJM for many years. If left untreated, nonnative, invasive plants may alter the post-fire dynamics of riparian areas 50 to 100 years after a wildfire (Graham 2003, pp. 22–23).

Although wildfires within riparian habitats may be less frequent or less intense than burns in uplands, wildfires have burned PMJM habitats throughout the subspecies' range. Colorado's High Park Fire of 2012 burned PMJM habitats lightly, with burned herbaceous vegetation expected to regrow in 1 to 3 years (Oberlag 2012, p. 2). Similarly, the majority of PMJM habitats burned by Colorado's Hewlett Fire of 2012 and Crystal Fire of 2011 experienced low-intensity burns, with some loss of herbaceous vegetation (Oberlag 2011, p. 1; Oberlag 2012, pp. 1–2).

Comparatively, the Fourmile Canyon Fire in Colorado during the summer of 2010 moderately and severely burned approximately 37 percent of potential PMJM habitats within the fire perimeter (Baker 2010, p. 2). Severe, high-intensity burns also occurred in PMJM habitats during 2002. During the early summer of 2002, the Hayman and Schoonover fires in Colorado burned over 3,000 ha (7,500 ac) of potential PMJM habitat, or approximately 20 percent of the potential habitat within the boundaries of the Pike National Forest (Elson 2003, p. 2). Additionally, the Hayman Fire severely burned approximately 342 ha (844 ac) of proposed critical habitat for the PMJM, which prompted the removal of several proposed areas from the final 2003 critical habitat designation (68 FR 37276, June 23, 2003).

Superimposing PMJM's critical habitat and occupied habitats with perimeters of wildfires provides estimates of PMJM habitats potentially burned by wildfires over the last 12 years. Burn area perimeter analyses for wildfires collected since 2000 calculate that wildfires potentially burned approximately 2,376 ha (5,873 ac), or 17 percent, of designated PMJM critical habitat in Colorado (USFWS 2013, p. 1). Perimeter datasets also estimate that Colorado wildfires potentially burned approximately 4,150 ha (10,254 ac), or approximately 10 percent, of trapped habitats identified as occupied by PMJM (USFWS 2013, p. 1). In Wyoming, burn area perimeter datasets collected since 2000 identify three wildfires that potentially burned PMJM habitats: The Hensel and Reese Mountain Fires of 2002 and the Arapaho Fire of 2012 (USFWS 2013, p. 1). However, none of these wildfires have likely impacted areas formerly designated as PMJM critical habitat in Wyoming and we lack an estimate for occupied habitats in Wyoming in order to approximate

burned habitats (USFWS 2013, p. 1). Although these analyses do not account for variance in burn severity within the perimeter of the wildfire, they illustrate that wildfires potentially burned more than 17 percent of PMJM's designated critical habitats in Colorado over the last 12 years. The perimeter analyses also do not consider any auxiliary effects of wildfire, such as flooding, erosion, or sedimentation, that may affect habitats within or outside the burn area perimeter, so these estimations may underestimate actual impacts to PMJM habitats. Additionally, these perimeter datasets may not capture all wildfires that burned within PMJM habitats.

Wildfires continue to affect the PMJM and its habitats. In the future, a warmer, drier climate will increase the frequency and intensity of wildfires throughout the PMJM's range. Therefore, wildfires continue to be a threat to the PMJM.

Drought: Like wildfire and floods, drought is another factor that negatively affects the PMJM. Drought lowers stream flows and the adjacent water table, in turn impacting the PMJM's riparian habitats. Frey (2005, p. 62) found that drought had a major influence on the status and distribution of another subspecies, the New Mexico jumping mouse in New Mexico. In 2002, a year with regional drought conditions, Bakeman (2006, p. 11) failed to capture any PMJMs at two sites where he had previously documented substantial populations. While PMJM populations have coexisted with periodic drought, significant increases in frequency or severity of drought, as is predicted as a consequence of global climate change throughout the subspecies' range, could impact the persistence of PMJM. Models predict increased global aridity, with severe and widespread droughts over the next 30 to 90 years resulting from decreased precipitation and increased evaporation (Dai 2012, p. 52). The effects of drought will likely be a more significant factor for small and fragmented populations, while large populations with substantial tracts of suitable habitat with steady hydrologic regimes will be better isolated from the effects of drought. However, drought may exacerbate adverse impacts of cattle grazing on PMJM habitat as livestock seek forage in riparian habitats. Additionally, climate change and the promotion of noxious weeds may exacerbate the effects of drought. Therefore, drought is a threat to the PMJM.

Nonnative plants: Invasive, noxious plants can encroach upon a landscape, displace native plant species, form monocultures of vegetation, and may negatively affect food and cover for the

PMJM. The control of noxious weeds may entail large-scale removal of vegetation and mechanical mowing operations, which also may affect the PMJM. The tolerance of the PMJM for invasive plant species remains poorly understood. Leafy spurge (*Euphorbia esula*) may form a monoculture, displacing native vegetation and thus reducing available habitat (Selleck *et al.* 1962; Pague and Grunau 2000, p. 1–18). Nonnative species including tamarisk, or saltceder (*Tamarix ramosissima*), and Russian olive (*Elaeagnus angustifolia*) may adversely affect the PMJM (Garber 1995, p. 16; Pague and Grunau 2000, p. 18). Existing special regulations at 50 CFR 17.40(1) exempt incidental take of the PMJM during the control of noxious weeds. This exemption recognizes that control of noxious weeds is likely to produce long-term benefits to the native vegetation of PMJM habitats.

Although we lack information to conclude that nonnative plants are a threat to the PMJM, nonnative plants may become increasingly problematic as climate change and drought favor drought-tolerant species that alter the structure and function of riparian communities.

Pesticides and Herbicides: The effect of point and non-point source pollution (sewage outfalls, spills, urban or agricultural runoff) that degrades water quality in potential habitats on the abundance or survival of the PMJM remains unclear. From an examination of their kidney structure, it is uncertain whether the PMJM requires drinking water from open water sources, or may obtain water exclusively through dew and food (Wunder 1998), which would influence its potential exposure to pollution. Likewise, it is unknown whether pesticides and herbicides, commonly used for agricultural and household purposes within the range of the PMJM, pose a threat to the PMJM directly, or through its food supply, including possible bioaccumulation of hazardous chemicals. Therefore, at this time we lack information to conclude that pesticides and herbicides are a threat to the PMJM.

Secondary Impacts of Human Development: Human development creates a range of additional potential impacts (through human presence, noise, increased lighting, introduced animals, and the degradation of air and water quality) that could alter the PMJM's behavior, increase its levels of stress, and ultimately contribute to loss of vigor or death of individuals, and eventual extirpation of populations. Introduced animals associated with human development may displace, prey upon, or compete with the PMJM. Feral

cats and house mice were common in and adjacent to historical capture sites where the PMJM was no longer found (Ryon 1996, p. 26). While no cause-and-effect relationships were documented, the PMJM was 13 times less likely to be present at sites where house mice were found (Clippinger 2002, p. 104). As described under Factor A, the absence of the PMJM in portions of drainages where riparian habitat appears relatively favorable but human encroachment is pervasive, suggests a potential cause-and-effect relationship attributable to a variety of primary or secondary influences. Cumulative impacts from a variety of factors in addition to habitat loss and fragmentation may contribute to local extirpations.

Instability of Small Populations: Colorado's Comprehensive Wildlife Conservation Strategy identifies "scarcity" as a threat to meadow jumping mice that may lead to inbreeding depression (CPW 2006, p. 102). Stochastic, or random, changes in a wild population's demography or genetics can threaten small populations (Brussard and Gilpin 1989, pp. 37–48; Caughley and Gunn 1996, pp. 165–189). A stochastic demographic change in small populations, such as a skewed age or sex ratios (for example, a loss of adult females), can depress reproduction and increase the risk of extirpation. Isolation of populations, whether through habitat loss or fragmentation, may disrupt gene flow and create unpredictable genetic effects that could impact the persistence of PMJM populations in a given area. While the susceptibility of the PMJM to stochastic events has not been specifically researched, the documented tendency for PMJM population estimates to vary widely over time heightens concern for small and isolated populations. Within populations, periodic lows in numbers of PMJMs present more accurately reflect potential vulnerability than typical or average numbers present. Although many trapping efforts have targeted the PMJM in small, isolated reaches of apparently acceptable habitat, few have documented presence. Small, fragmented PMJM populations, including those fragmented in the future by human development, are likely to be unsustainable. Therefore, we conclude that the instability of small populations is a threat to the PMJM.

Intraspecific Competition: The relative ranges, abundance, and relationship between the PMJM and the western jumping mouse are not yet clearly understood, especially in Wyoming. However, recent confirmation of extensive range overlap in Wyoming and the apparent

predominance of the western jumping mouse in some southern Wyoming drainages with few or no recent records of PMJM provide reason for concern (Bowe and Beauvais 2012, p. 15). It is unclear whether western jumping mice are actively competing with PMJMs, affecting PMJM population size, and possibly limiting distribution, or if this distribution pattern is unrelated to their interaction. Additional study is needed to clarify these issues. Although questions remain, we do not have information to indicate that presence of the western jumping mouse and potential intraspecific competition currently constitutes a threat to the PMJM.

Global Climate Change: Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007a, p. 30; and Solomon *et al.* 2007, pp. 35–54, 82–85). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a, pp. 5–6 and figures SPM.3 and SPM.4; Solomon *et al.* 2007, pp. 21–35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded it is extremely likely that approximately 75

percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl *et al.* 2007, entire; Ganguly *et al.* 2009, pp. 11555, 15558; Prinn *et al.* 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, 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 GHG emissions 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 (IPCC 2007a, pp. 44–45; Meehl *et al.* 2007, pp. 760–764 and 797–811; Ganguly *et al.* 2009, pp. 15555–15558; Prinn *et al.* 2011, pp. 527, 529). (See IPCC 2007b, p. 8, for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2011(entire) for a summary of observations and projections of extreme climate events.)

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a, p. 89; see also Glick *et al.* 2011, pp. 19–22). There is no single method for conducting such analyses that applies to

all situations (Glick *et al.* 2011, p. 3). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

As is the case with all stressors that we assess, even if we conclude that a species is currently affected or is likely to be affected in a negative way by one or more climate-related impacts, it does not necessarily follow that the species meets the definition of an “endangered species” or a “threatened species” under the Act. If a species is listed as endangered or threatened, knowledge regarding the vulnerability of the species to, and known or anticipated impacts from, climate-associated changes in environmental conditions can be used to help devise appropriate strategies for its recovery.

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (*e.g.*, IPCC 2007a, pp. 8–12). Therefore, we use “downscaled” projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al.* 2011, pp. 58–61, for a discussion of downscaling).

We reviewed climate records and projections for western North America, Wyoming, and Colorado to evaluate potential impacts of climate change on the PMJM. As described in more detail below, 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 PMJM’s range. These conditions will favor more drought-tolerant nonnative plants, dramatically altering species compositions within riparian habitats and inducing upstream migrations of plants and animals to cooler refugia (Perry *et al.* 2012, p. 828). Drier conditions and weaker spring flows will lower water tables and narrow riparian corridors (Perry *et al.* 2012, p. 830), effectively shrinking the PMJM’s riparian habitats. As a riparian obligate, the PMJM completes the majority of its life cycle within the lush, multi-storied riparian vegetation that borders streams or other waterbodies. Riparian trees and shrubs, such as cottonwoods and willows, dominate the overstory and

provide cover, while a diverse, grassy understory with beds of dense herbaceous vegetation provides food and shelter. The riparian vegetation, and in turn, the entire riparian ecosystem, depends on water and other hydrologic processes, which the models predict will change or be limited under a warmer, drier climate (Perry *et al.* 2012, p. 826). Additionally, increased human populations, development, and demand for water may exacerbate the impacts of climate change on riparian habitats. Overall, climate change will decrease the quality and quantity of the PMJM’s riparian habitats, and as a result, the PMJM is especially vulnerable when faced with a changing climate.

The climatic record for western North America indicates that concentrations of GHG emissions and mean annual temperatures have increased within the range of the PMJM. Atmospheric levels of carbon dioxide (CO₂), the product of GHG emissions, have increased from 280 parts per million (ppm) to 390 ppm by volume since 1750, with CO₂ concentrations predicted to potentially reach 850 ppm by 2100 (IPCC 2007, p. 37; Perry *et al.* 2012, p. 824). Mean annual temperatures in western North America increased by 0.5 to 2 degrees C (32.9 to 35.6 degrees F) between 1948 and 2002 (Perry *et al.* 2012, p. 824). Winter and spring temperatures increased significantly and spring warming occurred earlier, while autumn temperatures remained relatively stable during this time (Perry *et al.* 2012, p. 824).

Climate models predict that temperatures within the range of the PMJM will continue to increase over time. Most models predict that annual temperatures in western North America will increase by an additional 2 to 4 degrees C during the 21st century (Perry *et al.* 2012, p. 824). Projections for Wyoming predict that the annual mean temperature will increase by 4 degrees by 2050 and 6 degrees by 2080 (WWA 2010). Wyoming will likely experience more warming during the summer, with less warming in the winter (WWA 2010). Colorado summers are also expected to warm more than winters (CWCB 2008, p. 1). Between 1997 and 2006, Colorado’s mean annual temperature increased by approximately 2 degrees (WWA 2010). Relative to the 50-year temperature baseline, climate models predict that Colorado will warm by 2.5 degrees by 2025 and 4 degrees by 2050 (WWA 2010). As a result, summer temperatures typical of the eastern Colorado plains will shift westward and upslope, with temperature regimes of the Front Range eventually mirroring those currently experienced at the

Kansas border (CWCB 2008, p. 1). In both Wyoming and Colorado, climate models predict an approximately 4 degrees increase in mean annual temperatures throughout the range of the PMJM by 2050.

Precipitation predictions for western North America are less clear than the temperature predictions, with variation and uncertainty largely attributable to weather systems, such as El Niño (Perry *et al.* 2012, p. 824). However, most models agree that in the southwest, winter and spring precipitation will decline (Perry *et al.* 2012, p. 825). Over the last 50 to 100 years, the climatic record shows that warming has reduced total snow cover and snow water equivalents over much of western North America, with continued declines in mountain snowpack (Perry *et al.* p. 825). The warming trend throughout the mountains of western North America has decreased snowpack, hastened spring runoff, and reduced summer flows (IPCC 2007, p. 11). As a result, over the last 50 to 100 years, warming and changes in precipitation increased the frequency and severity of droughts (Perry *et al.* 2012, p. 825). As precipitation decreases and warmer temperatures increase evaporation, the models predict that the frequency and magnitude of droughts will intensify during the next century (Perry *et al.* 2012, p. 825). Increased evaporation due to warming will likely offset any projected increases in precipitation, leading to greater aridity throughout western North America (Perry *et al.* 2012, p. 825).

Increased warming, evaporation, and drought, coupled with decreased precipitation throughout the range of the PMJM, have strong implications for its riparian habitats. The IPCC summarized that changes in climate and land use will inflict additional pressures on already stressed riparian ecosystems, impacting wetland plants and animals and potentially resulting in the loss of biodiversity (IPCC 2007, p. 234). Riparian ecosystems depend on water and hydrologic processes, such as base streamflows, the magnitude and timing of floods, and water management and use, factors that are sensitive to climate change (Perry *et al.* 2012, p. 822). As a result, scientists expect that climate change will greatly alter riparian hydrology across the world (Perry *et al.* 2012, p. 822).

Specifically, climate change will likely impact the physiology and geographic distribution of the riparian vegetation that define PMJM habitats. Although increased levels of atmospheric CO₂ may physiologically benefit riparian vegetation, such as

cottonwoods or willows, by improving water use and uptake, limited water availability by warming-induced drought, hydrologic changes, and increased evaporation will likely supersede any gains (Perry *et al.* 2012, p. 826). Additionally, maximum summer temperatures above 45 degrees C may damage or kill leaf tissues of most riparian plant species, increasing heat stress and stunting growth in riparian plants (Perry *et al.* 2012, p. 827). Lower maximum temperatures between 25 degrees C and 45 degrees C can reduce germination, growth, flowering, fruit ripening, and seed set (Perry *et al.* 2012, p. 827). Relatively drought-intolerant species, such as cottonwoods and willows, may be particularly vulnerable to less water, promoting colonization by more drought-tolerant, nonnative species, such as tamarisk and Russian olive (Perry *et al.* 2012, pp. 826–827). Monocultures of these drought-tolerant, nonnative species may adversely affect the PMJM (Garber 1995, p. 16; Pague and Grunau 2000, p. 1–18). As water levels drop and vegetative communities change in favor of drought-tolerant, nonnative plants, warming will shift plant species upstream toward higher elevations, potentially displacing other plants at these upper limits (Perry *et al.* 2012, p. 828). Therefore, by physiologically impacting riparian plants and dramatically altering species compositions toward unfavorable, nonnative plant communities, global climate change will likely diminish the quality of PMJM habitats throughout the subspecies' range.

Furthermore, earlier and weaker spring floods associated with a warming climate may constrict available PMJM riparian habitats. Earlier spring floods may decrease the recruitment and establishment of riparian tree species by desynchronizing spring runoff with the release of seeds (Perry *et al.* 2012, p. 829). Although earlier and weaker spring floods may stabilize streams, eventual channelization and narrowing of the flood plains will favor more drought-tolerant plants (Perry *et al.* 2012, p. 829). Where reduced spring flows channelize or lower the water table, plant roots will deepen and soil moistures will decrease, effectively narrowing the riparian corridor (Perry *et al.* 2012, p. 830). Within these narrowed riparian corridors, canopy heights and cover will decrease as species shift from drought-intolerant cottonwoods, willows, and perennial herbs to more drought-tolerant, nonnative species, such as tamarisk or Russian olive (Perry *et al.* 2012, p. 830). Communities

dominated by nonnative plants with short canopies that provide less cover and an open understory do not provide suitable PMJM habitat (Garber 1995, p. 16; Pague and Grunau 2000, p. 1–18; Clippinger 2002, pp. 69, 72; Trainor *et al.* 2007, pp. 472–476). Some waterways may dry seasonally, drastically transitioning from perennial to intermittent flows, radically altering species composition such that obligate wetland species may disappear (Perry *et al.* 2012, p. 830). Therefore, as a warming climate reduces spring flows, constricts riparian corridors, and favors nonnative plants over willows, cottonwoods, and lush, herbaceous understories, PMJM and its habitats may similarly disappear.

Stark alterations to riparian plant communities stemming from climatic warming may reduce the quality and quantity of PMJM habitat throughout its range. As habitats diminish and disappear, it follows that the diversity and abundance of animal species that rely on these habitats will also decrease (Perry *et al.* 2012, p. 836). As with plants, compositions of animals under a warming climate will shift to species that are more drought-tolerant and adapted to drier conditions. Additionally, warmer maximum temperatures will increase animal mortality from heat stress and dehydration (Perry *et al.* 2012, p. 831–832). As a riparian obligate, the PMJM will likely be maladapted to the drier and hotter habitats expected by 2050.

Like plants, animal species may escape rising temperatures and diminishing habitats by expanding northward, to higher elevations, or by retreating upstream (Perry *et al.* 2012, p. 832). As the climate dries and riparian habitats disappear from the eastern boundary of the PMJM's range, mice may move upstream toward the west, seeking refuge in higher elevation habitats. However, maximum travel distances for PMJM as recorded by trapping do not exceed 4.3 km (2.7 mi) (Schorr 2012a, p. 1274). This travel distance may limit the PMJM's dispersal capabilities, especially where riparian habitats are already fragmented and isolated by expansive tracts of dry, inhospitable prairies, mountains, or human development. In Colorado, a western migration of the PMJM may be further limited by the steep, inhospitable, decomposing-granite terrain of the Front Range foothills that may geographically isolate montane PMJM populations from the prairie populations to the east. In Wyoming, the Laramie Range may similarly inhibit a western retreat as the climate dries and riparian habitats slowly disappear.

Additionally, these upstream, smaller-order streams and tributaries may be too small to support or develop extensive riparian habitats and hence will be unable to sustain larger populations of the PMJM. Therefore, a warming climate may further confine the PMJM to shrinking habitats within its already narrow range, with little possibility of mice seeking refuge within remaining upstream habitats.

The degree of human development, the natural variability in stream flow, the ratio of precipitation lost to evaporation, and rates of groundwater depletions in the three major river basins that support the PMJM may augment the effects of climate change throughout its range (Hurd *et al.* 1999, p. 1404). In other words, impacts associated with human development, including groundwater depletions, may exacerbate predicted impacts of climate change on the PMJM. Therefore, we conclude that the effects of climate change are a threat to the PMJM.

Summary of Factor E: While uncertainties remain regarding the impacts of other natural or manmade factors on the PMJM and its habitats, the best available scientific and commercial information indicate that these factors are a threat to the long-term conservation of the PMJM. Specifically, wildfires and droughts continue to impact the PMJM by reducing the quality and quantity of its riparian habitats. Intensities and frequencies of these events are predicted to increase over time, coupled with increases in floods and nonnative species, especially under a warming climate resulting from global climate change. Additionally, to the extent that meaningful impacts are possible, small and fragmented mouse populations are likely to be more vulnerable to these threats.

Cumulative Effects From Factors A Through E

Many of the threats described in this finding may cumulatively or synergistically impact the PMJM beyond the scope of each individual threat. For example, residential and commercial development may reduce and fragment PMJM habitats. However, development also increases the frequency and intensity of floods and wildfires, promotes the establishment of nonnative plants, and increases predation. Additionally, water use and management by humans strongly reduces flows and influences the effects and properties of wildfire, which are likely to be frequent and intense during periods of drought (Gresswell 1999; Dwire and Kaufman 2003, p. 71). Consequently, increased frequencies

and intensities of wildfires within riparian habitats or adjacent uplands encourage more intense, destructive floods. Furthermore, human population growth and demand for more water may intensify the drying effects of droughts by promoting the establishment of drought-tolerant, nonnative plants, which are in turn more susceptible to wildfire. In addition, livestock grazing alone may have little effect on the PMJM or its habitats, but when coupled with invading nonnative plants and increasing drought, improper grazing may degrade and fragment PMJM habitats across larger landscapes.

Finally, climate change may ultimately augment many of these threats acting on the PMJM and its habitats. Within the three river basins that support the PMJM, climate change may exacerbate the effects of human development, stream flows, the ratio of precipitation lost to evaporation, and rates of groundwater depletions (Hurd *et al.* 1999, p. 1404). The warming climate could intensify conflicts between human need for water and the sustainability of wetlands and riparian areas that are critical to the PMJM. Similarly, hotter summer temperatures resulting from climate change may increase the frequency and intensity of wildfires, while expanding the influence of drought across larger landscapes (IPCC 2007, p. 13). Stream-flow reductions or seasonal changes in flow due to climate change and increased human demand will probably cause a greater disruption in those watersheds with a high level of human development (Hurd *et al.* 1999, p. 1402). Therefore, multiple threats, whether stemming from human development, improper grazing, wildfire, floods, or climate change, are likely acting cumulatively to further increase the likelihood that the PMJM will become endangered within the foreseeable future.

Finding

As required by the Act, we considered the five factors in assessing whether the PMJM is endangered or threatened throughout all of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the PMJM. We reviewed the two petitions, information available in our files, and other available published and unpublished information, and we consulted with recognized PMJM experts and other Federal, State, and local agencies. New information revealed that the PMJM occupies a smaller range in Wyoming than previously thought, and is likely

limited to areas east of the crest of the Laramie Mountains (Bowe and Beauvais 2012, p. 8). Additionally, PMJM populations at the Air Force Academy in El Paso County, Colorado, declined over 7 years, despite conservation efforts, underscoring the importance of reducing upstream impacts and maintaining habitat connectivity (Schorr 2012a, p. 1277).

Our review determined that the alteration, degradation, loss, and fragmentation of habitat resulting from urban development, flood control, water development, aggregate mining, and other human land uses have adversely affected PMJM populations. These threats are ongoing and will increase in magnitude as human populations in Colorado and Wyoming continue to expand. Additional threats to the PMJM include wildfire, drought, small population sizes, and modifications to habitat resulting from climate change. We determined that floods, agriculture, grazing, and nonnative plants are not currently threats to the PMJM, but may increase in magnitude over time as human populations expand and climate change increases the frequency and intensity of wildfires and droughts. Many of these threats act cumulatively to further degrade habitats and negatively impact PMJM populations. Furthermore, we concluded that in the absence of the Act, the existing regulatory mechanisms are not currently adequate to mitigate the effects of identified threats to PMJM.

Based on our review of the best available scientific and commercial information pertaining to the five factors, we find that the threats have not been removed nor their imminence, intensity, or magnitude sufficiently reduced, and that the species is likely to become endangered within the foreseeable future throughout all of its range. Therefore, we find that delisting the PMJM is not warranted at this time.

Significant Portion of Its Range

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Act defines “endangered species” as any species which is “in danger of extinction throughout all or a significant portion of its range,” and “threatened species” as any species which is “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” The definition of “species” is also relevant to this discussion. The Act defines “species” as follows: “The term ‘species’ includes any subspecies of fish

or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature.” The phrase “significant portion of its range” (SPR) is not defined by the statute, and we have never addressed in our regulations: (1) The consequences of a determination that a species is either endangered or likely to become so throughout a significant portion of its range, but not throughout all of its range; or (2) what qualifies a portion of a range as “significant.”

Two recent district court decisions have addressed whether the SPR language allows the Service to list or protect less than all members of a defined “species”: *Defenders of Wildlife v. Salazar*, 729 F. Supp. 2d 1207 (D. Mont. 2010), *vacated as moot*, 2012 U.S. App. Lexis 26769 (9th Cir. Nov. 7, 2012), concerning the Service’s delisting of the Northern Rocky Mountain gray wolf (74 FR 15123, April 2, 2009); and *WildEarth Guardians v. Salazar*, 2010 U.S. Dist. LEXIS 105253 (D. Ariz. September 30, 2010), concerning the Service’s 2008 finding on a petition to list the Gunnison’s prairie dog (73 FR 6660, February 5, 2008). The Service had asserted in both of these determinations that it had authority, in effect, to protect only some members of a “species,” as defined by the Act (*i.e.*, species, subspecies, or DPS), under the Act. Both courts ruled that the determinations were arbitrary and capricious on the grounds that this approach violated the plain and unambiguous language of the Act. The courts concluded that reading the SPR language to allow protecting only a portion of a species’ range is inconsistent with the Act’s definition of “species.” The courts concluded that once a determination is made that a species (*i.e.*, species, subspecies, or DPS) meets the definition of “endangered species” or “threatened species,” it must be placed on the list in its entirety and the Act’s protections applied consistently to all members of that species (subject to modification of protections through special rules under sections 4(d) and 10(j) of the Act).

In our July 10, 2008, final rule (73 FR 39790) we stated that the SPR language allowed us to list less than all members of a defined “species” and we amended the listing for PMJM to specify that the subspecies was threatened in only the Colorado portion of its range, effectively delisting the subspecies in Wyoming. We determined that the PMJM was not likely to become endangered in the foreseeable future throughout all of its range. We based this conclusion primarily on a lack of present or

threatened impacts to the PMJM or its habitat in Wyoming. We found that PMJM populations and corresponding threats were concentrated in Colorado such that the Colorado portion of the PMJM range warranted further consideration as a SPR. Through our analysis, we determined that the Colorado portion of the range constituted a SPR and that the PMJM was threatened in this SPR. Consistent with our interpretation of the SPR phrase at that time, we amended the listing for PMJM to specify that the subspecies was threatened in only the Colorado portion of its range, effectively delisting PMJM in the Wyoming portion of its range.

Consistent with the district court decisions discussed above, and for the purposes of this finding, we now interpret the phrase “significant portion of its range” in the Act’s definitions of “endangered species” and “threatened species” to provide an independent basis for listing; thus there are two situations (or factual bases) under which a species would qualify for listing: A species may be endangered or threatened throughout all of its range; or a species may be endangered or threatened in only a significant portion of its range. If a species is in danger of extinction throughout a significant portion of its range, the species is an “endangered species.” The same analysis applies to “threatened species.” Based on this interpretation and supported by existing case law, the consequence of finding that a species is endangered or threatened in only a significant portion of its range is that the entire species shall be listed as endangered or threatened, respectively, and the Act’s protections shall be applied across the species’ entire range.

We conclude, for the purpose of this finding, that interpreting the significant portion of its range phrase as providing an independent basis for listing is the best interpretation of the Act because it is consistent with the purposes and the plain meaning of the key definitions of the Act; it does not conflict with established past agency practice (*i.e.*, prior to the 2007 Solicitor’s Opinion), as no consistent, long-term agency practice has been established; and it is consistent with the judicial opinions that have most closely examined this issue. This interpretation of the significant portion of its range phrase does not allow us to reach a similar conclusion for the PMJM in Colorado as we did in our 2008 final rule. Instead, as discussed below, if we find a species to be endangered or threatened in a significant portion of its range, the entire species would be listed as endangered or threatened. Having

concluded that the phrase “significant portion of its range” provides an independent basis for listing and protecting the entire species, we next turn to the meaning of “significant” to determine the threshold for when such an independent basis for listing exists.

Although there are potentially many ways to determine whether a portion of a species’ range is “significant,” we conclude for the purposes of this finding that the significance of the portion of the range should be determined based on its biological contribution to the conservation of the species. For this reason, we describe the threshold for “significant” in terms of an increase in the risk of extinction for the species. We conclude that a biologically based definition of “significant” best conforms to the purposes of the Act, is consistent with judicial interpretations, and best ensures species’ conservation. Thus, for the purposes of this finding, and as explained further below, a portion of the range of a species is “significant” if its contribution to the viability of the species is so important that without that portion, the species would be in danger of extinction.

We evaluate biological significance based on the principles of conservation biology using the concepts of redundancy, resiliency, and representation. *Resiliency* describes the characteristics of a species and its habitat that allow it to recover from periodic disturbance. *Redundancy* (having multiple populations distributed across the landscape) may be needed to provide a margin of safety for the species to withstand catastrophic events. *Representation* (the range of variation found in a species) ensures that the species’ adaptive capabilities are conserved. Redundancy, resiliency, and representation are not independent of each other, and some characteristic of a species or area may contribute to all three. For example, distribution across a wide variety of habitat types is an indicator of representation, but it may also indicate a broad geographic distribution contributing to redundancy (decreasing the chance that any one event affects the entire species), and the likelihood that some habitat types are less susceptible to certain threats, contributing to resiliency (the ability of the species to recover from disturbance). None of these concepts is intended to be mutually exclusive, and a portion of a species’ range may be determined to be “significant” due to its contributions under any one or more of these concepts.

For the purposes of this finding, we determine if a portion’s biological

contribution is so important that the portion qualifies as “significant” by asking whether *without that portion*, the representation, redundancy, or resiliency of the species would be so impaired that the species would have an increased vulnerability to threats to the point that the overall species would be in danger of extinction (*i.e.*, would be “endangered”). Conversely, we would not consider the portion of the range at issue to be “significant” if there is sufficient resiliency, redundancy, and representation elsewhere in the species’ range that the species would not be in danger of extinction throughout its range if the population in that portion of the range in question became extirpated.

We recognize that this definition of “significant” (a portion of the range of a species is “significant” if its contribution to the viability of the species is so important that without that portion, the species would be in danger of extinction) establishes a threshold that is relatively high. On the one hand, given that the consequences of finding a species to be endangered or threatened in a significant portion of its range would be listing the species throughout its entire range, it is important to use a threshold for “significant” that is robust. It would not be meaningful or appropriate to establish a very low threshold whereby a portion of the range can be considered “significant” even if only a negligible increase in extinction risk would result from its loss. Because nearly any portion of a species’ range can be said to contribute some increment to a species’ viability, use of such a low threshold would require us to impose restrictions and expend conservation resources disproportionately to conservation benefit: Listing would be rangewide, even if only a portion of the range of minor conservation importance to the species is imperiled. On the other hand, it would be inappropriate to establish a threshold for “significant” that is too high. This would be the case if the standard were, for example, that a portion of the range can be considered “significant” only if threats in that portion result in the entire species’ being currently endangered or threatened. Such a high bar would not give the significant portion of its range phrase independent meaning, as the Ninth Circuit held in *Defenders of Wildlife v. Norton*, 258 F.3d 1136 (9th Cir. 2001).

The definition of “significant” used in this finding carefully balances these concerns. By setting a relatively high threshold, we minimize the degree to which restrictions will be imposed or

resources expended that do not contribute substantially to species conservation. But, we have not set the threshold so high that the phrase “in a significant portion of its range” loses independent meaning. Specifically, we have not set the threshold as high as it was under the interpretation presented by the Service in the *Defenders of Wildlife v. Norton*, 258 F.3d 1136 (9th Cir. 2001), litigation. Under that interpretation, the portion of the range would have to be so important that current imperilment there would mean that the species would be *currently* imperiled everywhere. Under the definition of “significant” used in this finding, the portion of the range need not rise to such an exceptionally high level of biological significance. (We recognize that if the species is imperiled in a portion that rises to that level of biological significance, then we should conclude that the species is in fact imperiled throughout all of its range, and that we would not need to rely on the significant portion of its range language for such a listing.) Rather, under this interpretation we ask whether the species would be endangered everywhere without that portion, *i.e.*, if that portion were completely extirpated. In other words, the portion of the range need not be so important that even the species being in danger of extinction in that portion would be sufficient to cause the species in the remainder of the range to be endangered; rather, the *complete* extirpation (in a hypothetical future) of the species in that portion would be required to cause the species in the remainder of the range to be endangered.

The range of a species can theoretically be divided into portions in an infinite number of ways. However, there is no purpose to analyzing portions of the range that have no reasonable potential to be significant or to analyzing portions of the range in which there is no reasonable potential for the species to be endangered or threatened. To identify only those portions that warrant further consideration, we determine whether there is substantial information indicating that: (1) The portions may be “significant,” and (2) the species may be in danger of extinction there or likely to become so within the foreseeable future. Depending on the biology of the species, its range, and the threats it faces, it might be more efficient for us to address the significance question first or the status question first. Thus, if we determine that a portion of the range is not “significant,” we do not need to

determine whether the species is endangered or threatened there; if we determine that the species is not endangered or threatened in a portion of its range, we do not need to determine if that portion is “significant.” In practice, a key part of the determination that a species is in danger of extinction in a significant portion of its range is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats to the species occurs only in portions of the species’ range that clearly would not meet the biologically based definition of “significant,” such portions will not warrant further consideration.

If a species has been found to meet the definition of “threatened species” throughout its range, as we have found for PMJM, we must then analyze whether there are any significant portions of the range that meet the definition of “endangered species.” If the subspecies is determined to be “endangered” within the “significant” portion of the range, then the entire subspecies should be listed as “endangered.” We consider the “range” of the PMJM to include portions of four counties (Albany, Laramie, Platte, and Converse) in Wyoming and portions of seven counties (Boulder, Douglas, El Paso, Elbert, Jefferson, Larimer, and Weld) in Colorado.

To determine whether the PMJM could be considered an endangered species in a “significant portion of its range,” we reviewed the best available scientific information with respect to the geographic concentration of threats and the significance of portions of the range to the conservation of the species. We evaluated whether substantial information indicated (i) The threats are so concentrated in any portion of the species’ range that the species may be currently in danger of extinction in that portion; and (ii) whether those portions may be significant to the conservation of the species. Our rangewide review of the species concluded that the PMJM is a threatened species throughout its range. As described above, to establish whether any areas may warrant further consideration, we reviewed our analysis of the five listing factors to determine whether any of the potential threats identified were so concentrated that some portion of the PMJM’s range may be in danger of extinction now or in the foreseeable future.

We found that threats occur throughout the PMJM’s range, in both Colorado and Wyoming, but are more

concentrated in Colorado. These threats include, but are not limited to: Wildfire, drought, climate change, small populations, and the inadequacy of existing regulations. We identified the continued decline in the extent and quality of habitat as the primary threat to the PMJM. Activities resulting in this decline, include, but are not limited to: Residential and commercial development, transportation projects, hydrologic changes, and aggregate mining. Additionally, we found that many of these threats act cumulatively to further reduce the extent and quality of PMJM habitat now and in the future. Although threats occur throughout the PMJM’s range, human population projections suggest that the magnitude of many of these threats will increase over time more in Colorado than Wyoming. For instance, Colorado’s human population will grow more than populations in Wyoming, suggesting that threats associated with development, transportation, and hydrologic changes will be greater in Colorado than Wyoming. Given this concentration of threats in Colorado, we analyzed whether the Colorado portion of the PMJM’s range meets the definition of “significant.” Because the Colorado portion of the range comprises the majority of the PMJM population, if this portion were to become extirpated, it is likely that the remaining portion in Wyoming would be imperiled due to its small size and the continued presence of threats. In other words, the representation, redundancy, or resiliency of the remaining, smaller PMJM populations in Wyoming following the extirpation of the PMJM in Colorado would be so impaired that the subspecies would have an increased vulnerability to threats to the point that the overall species would be in danger of extinction (*i.e.*, would be “endangered”). Therefore, the Colorado portion of the range meets the definition of “significant.”

After determining that Colorado represents a significant portion of the PMJM’s range, we analyzed whether threats rise to a level such that the subspecies is currently in danger of extinction, or “endangered,” in Colorado. We determined that they do not, because none of those threats, either independently or collectively, reduced, destroyed, or fragmented habitats such that the PMJM is currently in danger of extinction in Colorado. While these threats continue and may have increased since our original listing, we have no information to indicate that populations declined or the threats increased such that the PMJM is

currently in danger of becoming extinct in Colorado. Although capture rates are low and populations have declined, trapping surveys continue to capture the PMJM in habitats previously identified as occupied. Therefore, the available information suggests that the PMJM is not currently in danger of becoming extinct in Colorado, but remains threatened throughout its range as described above in Factors A through E.

Our review of the best available scientific and commercial information indicates that the PMJM is likely to become endangered within the

foreseeable future throughout all of its range. Therefore, we find that delisting the PMJM under the Act is not warranted at this time. We request that you submit any new information concerning the status of, or threats to, the PMJM to our Colorado Fish and Wildlife Office (see **ADDRESSES** section) whenever it becomes available. New information will help us monitor the status of the PMJM and contribute to its conservation and recovery.

References Cited

A complete list of references cited is available on the Internet at [http://](http://www.regulations.gov)

www.regulations.gov at Docket No. FWS-R6-ES-2012-0095 and upon request from the Colorado Field Office (see **ADDRESSES**).

Authors

The primary authors of this document are staff located at the Colorado Field Office (see **ADDRESSES**).

Dated: May 13, 2013.

Stephen Guertin,

Deputy Director, Fish and Wildlife Service

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