

Point Arena Mountain Beaver
(Aplodontia rufa nigra)

**5-Year Review:
Summary and Evaluation**



**U.S. Fish and Wildlife Service
Arcata Fish and Wildlife Office
Arcata, California**

March 2009

5-YEAR REVIEW

Point Arena Mountain Beaver (*Aplodontia rufa nigra*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

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. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

As summarized from the Recovery Plan for this subspecies (Service 1998), the Point Arena mountain beaver (*Aplodontia rufa nigra*) is extremely limited in distribution, known only from a small area of coastal Mendocino County, California. *Aplodontia* are considered to be the oldest group of living rodents, being the sole extant member of the superfamily Aplodontoidea. The Point Arena mountain beaver's unique black coloration, outline of the nasals and some cranial measurements distinguish it from other subspecies of *Aplodontia rufa*. The Point Arena mountain beaver is one of seven subspecies of mountain beaver which are found from southern British Columbia to Point Reyes, California, and east to the Cascade and Sierra Nevada Ranges (Feldhamer and Rochelle 1982). This subspecies differs from the other subspecies by its unique black coloration and small size, as well as differences in other morphological measurements (Taylor 1914, 1918).

Methodology Used to Complete This Review:

This review was prepared by the Arcata Fish and Wildlife Office (AFWO), following the Region 8 guidance issued in March 2008. We used information from the 1998 Recovery Plan, survey information from experts who have been monitoring localities of this subspecies, and information on file in this office. The Recovery Plan and personal communications with experts were our primary sources of information used to update the subspecies' status and threats. We received one comment letter from the public in response to our Federal Notice initiating this 5-year review. This 5-year review contains updated information on the subspecies' biology and

threats, and an assessment of that information compared to that known at the time of listing. We focus on current threats to the subspecies that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the subspecies and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on March 5, 2008 (Service 2008). One comment letter from the Attorney General of California was received on May 5, 2008.

Listing History:

Original Listing

FR Notice: 56 FR 64716

Date of Final Listing Rule: December 12, 1991

Entity Listed: Subspecies, Point Arena mountain beaver (*Aplodontia rufa nigra*)

Classification: Endangered

Associated Rulemakings: No associated rulemakings have been completed for this subspecies.

Review History: This is the first formal status review for this subspecies.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for the Point Arena mountain beaver is 9C according to the Service's 2007 Recovery Data Call for the AFWO. This number is based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a subspecies that faces a moderate degree of threat and has a high potential for recovery. The "C" indicates conflict with construction or other development projects or other forms of economic activity.

Recovery Plan or Outline

Name of Plan or Outline: Point Arena Mountain Beaver *Aplodontia rufa nigra* (Rafinesque) Recovery Plan

Date Issued: June 2, 1998

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Act defines “species” as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife (DPS). This definition of species under the Act limits listing as DPSs to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase “distinct population segment” for the purposes of listing, delisting, and reclassifying species under the Act.

The Point Arena mountain beaver is not listed as a DPS. There is no new information on the Point Arena mountain beaver regarding application of the DPS policy. There are no discrete and significant population segments within this subspecies’ limited range, an 85-square kilometer (33-square mile) area entirely in western Mendocino County, California. Due to this subspecies extremely limited distribution and small population size, it is in danger of extinction throughout all of its range; therefore, a significant portion of the range analysis is not necessary.

Information on the Species and its Status

Species Biology and Life History

Aplodontia are thought to be the oldest group of living rodents, and *Aplodontia rufa* is the only extant species in both the genera and family (Aplodontidae). Mountain beavers are stout, compact and cylindrical with adults typically being slightly more than 30 centimeters (12 inches) in length and weighing 453-1,814 grams (1-4 pounds). Limbs are short, the tail is short and cylindrical, and all digits have long, curved claws. Mountain beavers have a unique auditory system that is specialized for the detection of slow changes in air pressure (Merzenich et al. 1973). While little is known about their actual hearing sensitivity, their semi-fossorial habits and anatomy suggest high sensitivity to ground vibration and noise. Unlike other rodents, mountain beavers have a relatively low reproductive potential. The Point Arena mountain beaver’s unique black coloration, outline of the nasals, and some cranial measurements distinguish it from other subspecies of *Aplodontia rufa*.

Mountain beavers have a very simple kidney structure that lacks the anatomical features necessary to concentrate urine effectively (Schmidt-Nielson and Pfeiffer 1970). They likely can meet their water needs through metabolic water production and preformed water in food (Crocker et al. 2007). The inability to concentrate urine and the necessity of a large daily water intake may account for their limiting distribution to areas with rainfall and soil characteristics that promote lush vegetation and near 100 percent humidity within burrows (Crocker et al 2007); Nungesser and Pfeiffer 1965).

At the time of listing, there were few published papers dealing with the Point Arena mountain beaver (Taylor 1914, 1918; Camp 1918; Pfeiffer 1958; and Fitts 1996), therefore much of the information regarding its life history was inferred from work on the other subspecies and

unpublished information. More recently, Fitts et al. (2002a), BioConsultants LLC (2006), Pilgrim et al. (2006), Zielinski and Mazurek (2006), and Zielinski et al. (2007) have conducted studies of Point Arena mountain beavers.

Reproduction

Little data have been collected on reproduction of the Point Arena mountain beaver. Information collected by Zielinski and Mazurek (2006) suggests that the breeding season for the Point Arena mountain beaver starts in late November or early December. Zielinski and Mazurek (2006) provided a rough estimate of dates of parturition from early- to mid-April. Juvenile Point Arena mountain beavers may not be independent until at least mid-July; perhaps later (Zielinski and Mazurek 2006).

Spatial Distribution

The Point Arena mountain beaver is only known from an 85-square kilometer (33-square mile) area entirely in western Mendocino County, California. The range of this subspecies is disjunct from all other mountain beavers; the Point Arena mountain beaver's range is about 129 kilometers (80 miles) south of the Humboldt mountain beaver's range (*A. r. humboldtiana*) and about 97 kilometers (60 miles) north of the Point Reyes mountain beaver's range (*A. r. phaea*).

Limited information is available on the historic distribution of this subspecies. Camp (1918) reported "colonies" of Point Arena mountain beaver extending from the town of Point Arena north, approximately 10.9 kilometers (6.8 miles), to Alder Creek (Figure 1). In 1951, the range was extended north another 7.2 kilometers (4.5 miles) when animals were collected by Pfeiffer (Service 1998). At the time of listing, occupied sites were known from Mallo Pass Creek south to Point Arena (Service 1991). In the Recovery Plan, occupied sites were known from Bridgeport Landing (two drainages north of Mallo Pass Creek) to Point Arena (Service 1998). Currently, Point Arena mountain beaver occupied sites are known from Bridgeport Landing south to Moat Creek, a distance of approximately 19.3 kilometers (12 miles). All known sites occur within 7.2 kilometers (4.5 miles) of the coast. The Service considers the subspecies' potential range to include the area from 3.2 kilometers (2 miles) north of Bridgeport Landing, south to 4.8 kilometers (3 miles) south of Point Arena, a distance of about 24.6 kilometers (15.3 miles) (Figure 1). This potential range buffers all known sites by 3.2 kilometers (2 miles) (Figure 1).

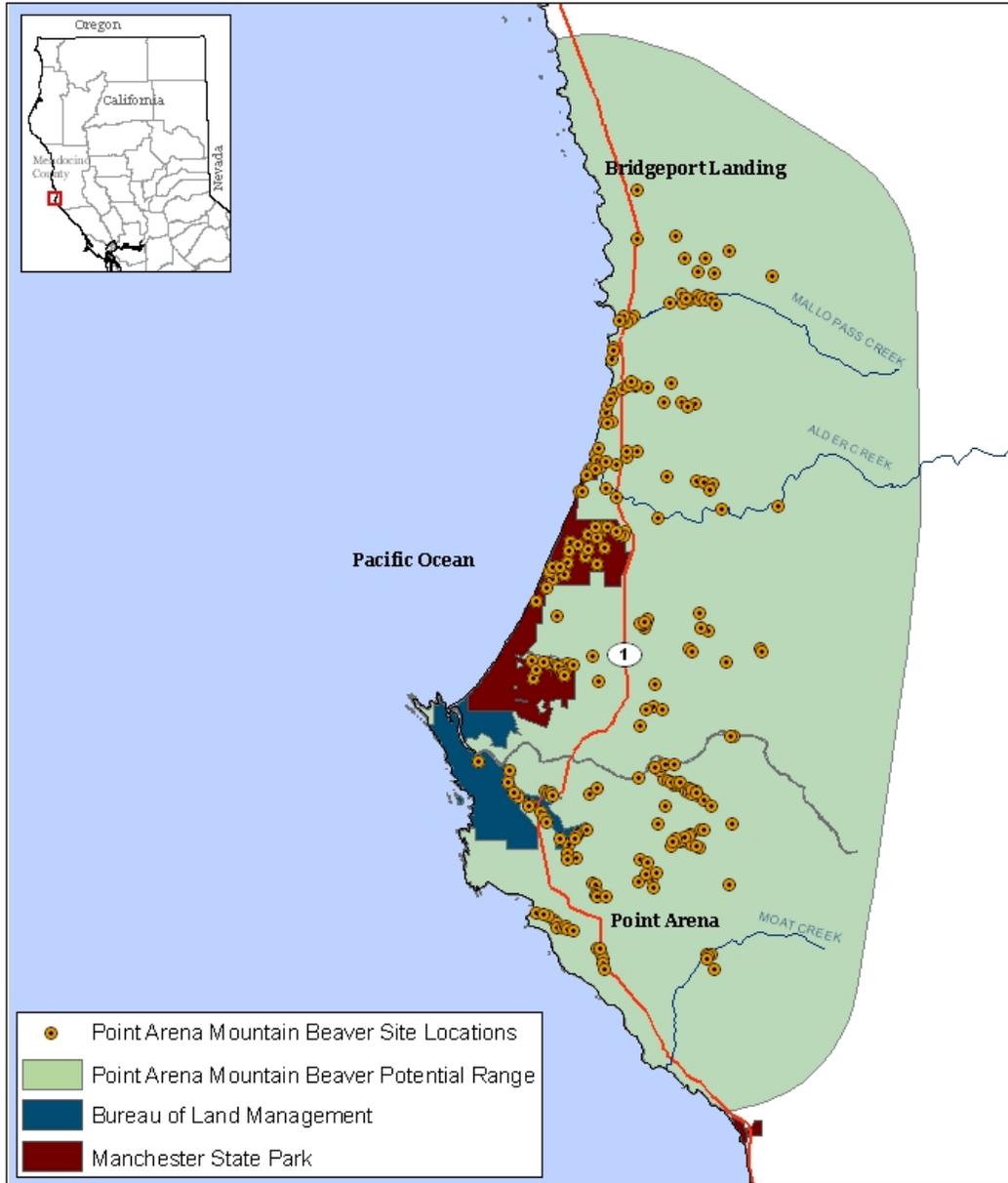
Abundance

Population Size and Trends

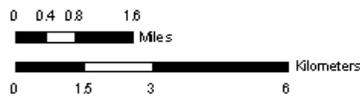
A total of 10 "populations" were identified and the total population size estimated at 100 individuals when the subspecies was listed as endangered in 1991 (Service 1991). In the 1998 Recovery Plan, at least 26 separate "populations" were identified and the total population size was revised and estimated at 200 to 500 individuals (Service 1998). To date, a total of 262



Point Arena Mountain Beaver Potential Range



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individual records (points) with burrow systems have been mapped range wide (Figure 1). There are many limitations to these point records including little to no information on current status, population size, or area. The status is unknown because many of these records occur on private lands and have not been visited in recent years. Many of these occurrences may consist of isolated burrow systems with only 1-2 individuals. Fifty-two of the point records occur on public lands [40 on Manchester State Park (Park) and 12 on the Bureau of Land Management's (BLM) Stornetta Public Lands], 21 on Mendocino Redwood Company lands, and the remaining 189 on private lands. Currently, no specific data exist on population size, trend, or density on a range wide basis.

The majority of the individual points occur in the general area of the 26 "populations" identified in the Recovery Plan. Individual points have been preliminarily aggregated into 14 geographic groups based on the "populations" in the Recovery Plan, drainages, and vegetation (Figure 2). Information on gene flow between occurrences, dispersal barriers, dispersal corridors, and potential dispersal distance is needed to more accurately delineate population (management) units.

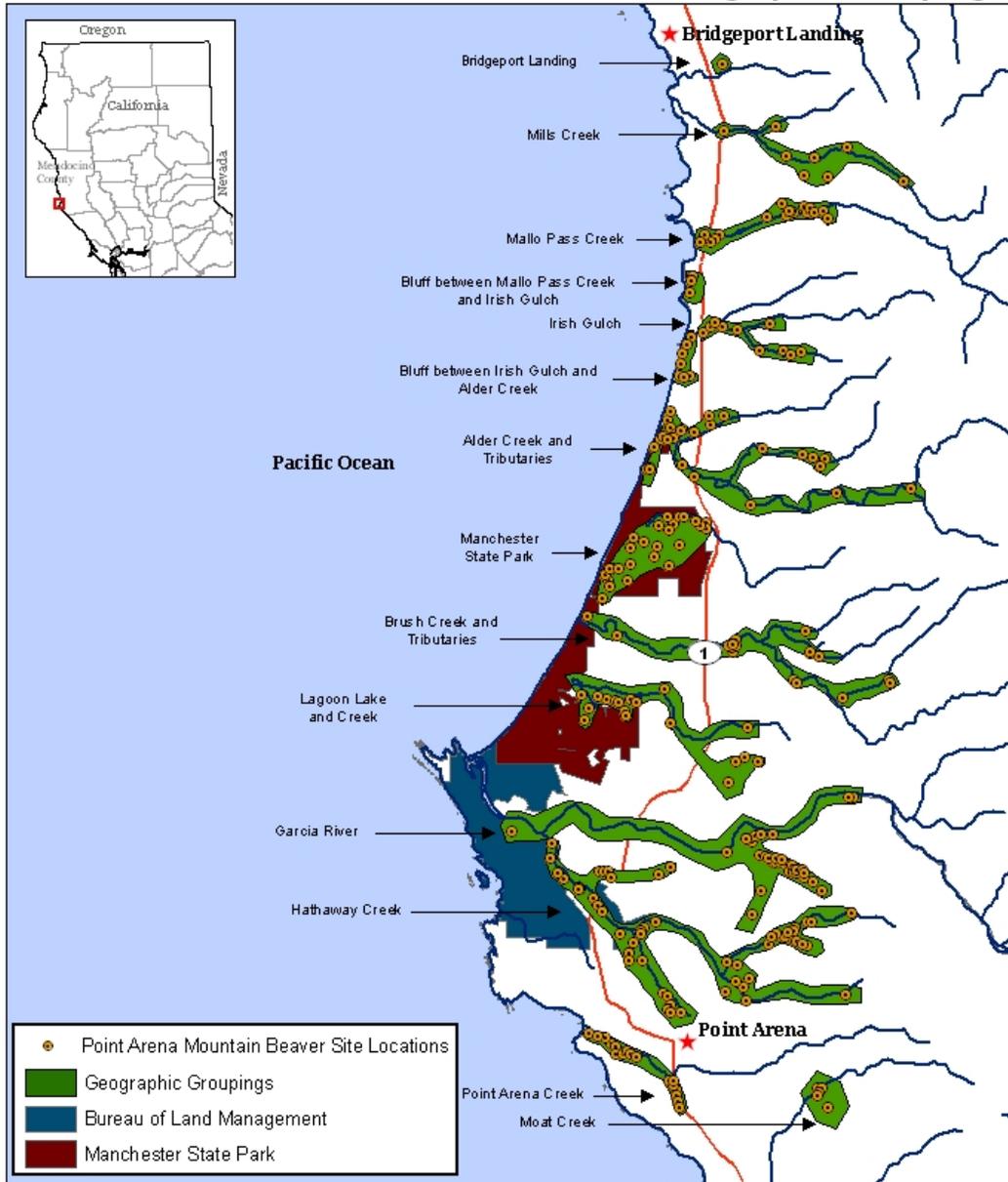
Mountain beavers appear to exhibit a high degree of site fidelity. At least one Point Arena mountain beaver location (Alder Creek) appears to have been occupied since 1913. In 1981, Dale Steele relocated the population first identified by Camp in 1913 at Alder Creek (Service 1991). This site is currently occupied; therefore, it appears that this site has been occupied for at least 94 years.

Prior to 2006, the only trend data collected was on the number of active and inactive burrows at a limited number of individual sites. The number of burrows, not individuals, was monitored at the following three study sites over a 5-year period between 1992 and 1997: American Telephone and Telegraph Company (AT&T); Kinney Road in the Park; and Alder Creek in the Park (Northen and Fitts 1998). This monitoring effort sought to determine if construction of a microwave tower at the AT&T site adversely affected the mountain beaver. The spatial distribution of active burrows on the two control sites, Kinney Road and Alder Creek, remained essentially stable, but the number of active burrows increased significantly during the study period. At the AT&T site, the number of active burrows increased and their distribution expanded into the construction zone during the study period. In 2002, the two Park control sites were monitored again and the results compared to conditions observed in 1992 (Fitts et al. 2002b). The number of active burrows at the Alder Creek site remained fairly constant. In contrast, the number of active burrows steadily increased at the Kinney Road site. This increase was attributed to the closure of four campsites and expansion of a native grass (Fitts et al. 2002b).

In 2008, a portion of the AT&T site was resurveyed (BioConsultants LLC 2008). In addition to the AT&T site, the 2008 survey included an adjacent site in the Park that was occupied in 2002. This recent survey found no evidence of occupied mountain beaver burrows where hundreds of burrows were present during the previous AT&T and Park studies (BioConsultants LLC 2008). BioConsultants LLC (2008) noted that various sized patches of ice plant (*Carpobrotus edulis*) have displaced coastal scrub vegetation and now cover much of the survey area.



Fourteen Point Arena Mountain Beaver Geographic Groupings



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 File: pamb_5yearReview_fig1re2.mxd



The Park and BLM lands are the only portion of the range that has been systematically surveyed in recent years (Fitts et al 2002a; BioConsultants LLC 2006). In 2002, all Point Arena mountain beaver burrow areas in the Park were mapped and the number of active and inactive burrows in each area was estimated (Fitts et al. 2002a). Burrow areas delineate the boundaries of the outermost burrows within similar vegetation types (Fitts et al. 2002a). The number of burrow areas does not correspond to the number of site locations represented on Figures 1 and 2. Forty burrow areas were identified in four general areas (Alder Creek, Lake Davis, Kinney, and Stoneboro) in the Park. Table 1 shows the estimated number of active and inactive burrows in each burrow area. The number of burrow areas (n = 7-13) was similar at the four areas, but much variation was observed in the number of active or inactive burrows per site.

In 2006, all Point Arena mountain beaver burrow areas on BLM lands were mapped and the number of active and inactive burrows estimated (BioConsultants LLC 2006). Twelve burrow areas were identified in three general areas (Miner Hole, Highway 1, and Hathaway Creek). Table 1 shows the estimated number of active and inactive burrows in each burrow area.

Table 1. Estimated number of active and inactive burrows in mapped burrow areas located on Park and BLM lands (Fitts et al. 2002a; BioConsultants LLC 2006).

Ownership	General Area	Number of Burrow Areas	Number of Active Burrows	Number of Inactive Burrows	Survey Date
Park	Alder Creek	7	785-975	1,650-2,100	2002 ¹
	Lake Davis	10	190-330	540-910	2002 ¹
	Kinney	13	1,150-1,470	2,836-3,685	2002 ¹
	Stoneboro	10	15-35	122-265	2002 ¹
BLM	Miner Hole	5	208-243	288-353	2006 ²
	Highway 1	3	274-295	296-305	2006 ²
	Hathaway Creek	4	6-15	214-315	2006 ²

¹ All data from Fitts et al. 2002a

² All data from BioConsultants LLC 2006

In 2006, two permanent grids were established in the Park to monitor population density (Zielinski et al. 2007). Hair snares were placed throughout the grids to collect DNA. Genotyping analysis was used to identify individuals from the snared hair. In 2006, the minimum number of Point Arena mountain beavers alive (MNA) at the Kinney Beach grid was 14 (5 male; 3 female; 6 unknown) with a crude MNA density of 5.4 animals/hectare (2.2 animals/acre) (Zielinski et al. 2007). In 2007, the Kinney Beach MNA was 7 with a crude MNA density of 2.7 animals/hectare (1.1 animals/acre) (W. Zielinski, USDA Forest Service, Pacific Southwest Research Station, pers. comm. 2008). In 2006, the MNA at the Alder Creek grid was 12 individuals (7 males; 4 females; 1 unknown) with a crude MNA density of 10.7 animals/hectare (4.3 animals/acre) (Zielinski et al. 2007). In 2007, the MNA at Alder Creek was 11 individuals with a crude MNA density of 9.8 animals/hectare (4.0 animals/acre) (Zielinski, pers. comm. 2008). Zielinski et al. (2007) summarize the results of previous telemetry and

trapping studies on the density of other subspecies of mountain beavers as ranging from a low of 0.49 animals/hectare (0.2/acre) (Arjo et al. 2007) to a high of 4.38 animals/hectare (1.8/acre) (Arjo et al. 2007) and 4.8 animals/hectare (1.9/acre) (Lovejoy and Black 1979).

The Service has recently funded collection of the third and fourth year of data from the two permanent hair-snaring grids in the Park. Zielinski et al. (2007) propose to analyze the data using the program MARK that will allow them to estimate population size and density annually and to monitor survival rates and recruitment, by gender, over time.

Demography

Mountain beaver appear to exhibit a relatively low reproductive potential, compared to other rodents. Based on information collected on other mountain beaver subspecies, females typically do not breed until their second year, the sex ratio (i.e., number of males to females) of juvenile mountain beavers is 1:1, and in the wild they live an estimated 5-6 years (Lovejoy and Black 1979). All females ovulate at about the same time (Pfeiffer 1958). One litter per year is produced (Feldhamer and Rochelle 1982). Litters typically consist of two or three offspring, and rarely four or five (Herlocker 1950; Maser et al. 1981).

Very little information on demographic parameters exists for Point Arena mountain beavers. Zielinski et al. (2007) found that five Point Arena mountain beavers identified by genetic means had also been captured during a previous study (Zielinski and Mazurek 2006). This suggests a naïve estimate of 19 percent (5 of 26) of the population survives to greater than 2 years of age (Zielinski et al. 2007). Continued monitoring of the hair-snaring grids will provide an opportunity to estimate survival rates with greater precision.

Habitat or Ecosystem

Point Arena mountain beaver are found in a variety of plant community types, including northern coastal scrub, coastal bluff scrub, northern riparian scrub, northern dune scrub, freshwater seep, north coast riparian, and closed-cone conifer forest (Service 1998; Fitts et al. 2002a; BioConsultant LLC 2006). General site characteristics include moderate slopes, friable soils, plant communities rich in herbaceous vegetation, and to a lesser degree mesic aspects (BioConsultants LLC 2006). In the Park, the highest densities of mountain beavers occur in northern coastal scrub, coastal bluff scrub, and northern riparian scrub (Fitts et al. 2002a). Sites in the eastern portions of the range are found in alder (*Alnus rubra*)-dominated riparian zones extending inland in narrow strips with coniferous forest on either side. Occupied sites in the riparian zone may contain a greater proportion of stinging nettle (*Urtica dioica*) and sword fern (*Polystichum munitum*) than unoccupied sites (Billig and Douglas 2007).

Mountain beavers live in underground burrow systems which exhibit numerous openings under moderately tall, lush, perennial vegetation (Service 1998). Burrow systems typically occur in cool, moist areas located on north-facing slopes or in gullies, probably due to the mountain beaver's inability to avoid heat stress (Johnson 1971; Kinney 1971). Soils in occupied habitat are typically friable and well-drained, although the presence of water in tunnels is not uncommon. Beier (1989) summarized habitat use by mountain beavers in the Sierra Nevada by saying that it involves strict requirements for a cool thermal regime and adequate soil drainage,

and somewhat more flexible requirements for food. Distribution limits are associated with rainfall and soil conditions that promote lush vegetation and high humidity within burrows (Voth 1968).

Because mountain beavers have primitive kidneys and a limited ability to concentrate urine, they must drink water daily or consume succulent vegetation (Nungesser and Pfeiffer 1965; Schmidt-Nelson and Pfeiffer 1970). Free-flowing water apparently is not an essential habitat component, since captive mountain beavers have been maintained on a diet of succulent vegetation and no water (Fisler 1965). Recent studies on the Point Reyes mountain beaver have shown that they can likely meet their water needs through metabolic water production and preformed water in food and do not require access to free water (Crocker et al. 2007).

Mountain beavers are strictly herbivorous, and are known to eat many plants toxic to other species including bracken fern (*Pteridium aquilinum*), sword fern, stinging nettle (*Urtica* sp.), thistle (*Cirsium* spp.), and larkspur (*Delphinium* sp.) (Voth 1968; Lacy 1991; Service 1998). Based primarily on plants clipped and/or haystacked near burrow openings, presumed food and/or nesting plants of the Point Arena mountain beaver include sword fern, cow parsnip (*Heracleum lanatum*), wild radish (*Raphanus sativus*), angelica (*Angelica hendersonii*), Douglas iris (*Iris douglasiana*), hedge nettle (*Stachys ajugoides*), bush lupine (*Lupinus arboreus*), seaside woolly sunflower (*Eriophyllum staechadifolium*), miner's lettuce (*Claytonia perfoliata*), ice plant (*Carpobrotus* spp.), seaside daisy (*Erigeron glaucus*), and many others (Camp 1918; Fitts 1996; Service 1998; Fitts et al. 2002b; Zielinski and Mazurek 2006).

Acreage

At the time of listing in 1991, it was believed there were only about 40.5 hectares (100 acres) of occupied habitat (Service 1991). In 2002, all suitable Point Arena mountain beaver habitat in the Park was mapped (Fitts et al. 2002a). Data were also collected on type of plant community, average plant height, habitat quality, associated plant species, slope gradient, aspect, and disturbance at each burrow area. The Park contains about 194.7 hectares (481 acres) of suitable habitat (Fitts et al. 2002a). Mountain beavers occupied approximately 23.1 hectares (57 acres) of the suitable habitat within the Park (Fitts et al. 2002a). In 2006, suitable habitat was mapped on BLM lands (BioConsultants LLC 2006). Approximately 28.3 hectares (70 acres) of suitable habitat were identified on BLM lands and mountain beavers occupied approximately 2.8 hectares (7 acres) (BioConsultants LLC 2006). Approximately 6.3 hectares (15.6 acres) of occupied habitat have been identified on Mendocino Redwood Company lands.

In 2006, vegetation within the range of the Point Arena mountain beaver (16,556 hectares; 40,910 acres) was mapped using 2005 NAIP 1m color orthoimagery (K. Wear, pers. comm. 2006). The accuracy was limited by the resolution of the imagery and has not been ground-truthed. Approximately 10.1 percent of the area (1,677 hectares; 4,144 acres) was identified as potentially suitable habitat. Suitable vegetation types included coastal scrub (673 hectares; 1,664 acres); riparian scrub (424 hectares; 1,047 acres); dune scrub (223 hectares; 550 acres); coastal bluff scrub (100 hectares; 248 acres); and riparian forest (257 hectares; 635 acres). The remaining 89.9 percent (14,879 hectares; 36,766 acres) was identified as unsuitable. The unsuitable types included forest and non-native trees, crop and non-native grassland, developed, coastal dunes, water, and coastal prairie.

Distribution

A qualitative assessment of known occupied sites and land-use patterns suggests suitable habitat is highly fragmented by agricultural use, roads, residential construction, and other human development especially in the western portions of the range. Approximately 30 percent of the range is currently characterized as crop, non-native grassland, or developed (Wear, pers. comm. 2006). Suitable habitat occurs primarily in or near riparian areas and in coastal scrub habitat. The degree to which areas of suitable habitat are connected by suitable dispersal corridors have not been assessed. Data are lacking for this subspecies regarding potential barriers to dispersal and what constitutes dispersal habitat. Arjo et al. (2007) documented the following dispersal distances for *A. r. rufa* on their Washington study sites: three males 142.7 ± 47.5 m (156 ± 51.9 yards), one male 222 m (242.8 yards), one male 23m (25.2 yards), one male 39 m (42.6 yards), and a female 326 m (356.5 yards). Maximum dispersal distances reported for other non-*nigra* subspecies of mountain beaver include 449.9 m (492.0 yards) (Hacker and Coblenz 1993) and 563.9 m (616.7 yards) (Martin 1971). Genetic information is currently being collected and analyzed that will aid us in assessing connectivity between various occupied sites throughout the range of this subspecies. See discussion below under Genetics.

Quality

In the Park, coastal scrub, northern coastal scrub, and northern riparian scrub support the highest density of burrows and are considered high quality habitat (Fitts et al. 2002a). Coastal prairie, northern dune scrub, freshwater seep, and riparian areas support isolated and scattered burrow areas (Fitts et al. 2002a). Fitts et al. (2002a) characterized habitat quality within the Park based on plant community, proximity to occupied burrows, aspect, and slope. The 195 hectares (481 acres) of suitable habitat within the Park are described as follows: 100 hectares (247 acres) of high quality habitat; 60 hectares (148 acres) of moderate quality habitat; and 35 hectares (86 acres) of low quality habitat (Fitts et al. 2002a). Little to no information is available on habitat quality outside of the Park.

Land Ownership

Approximately 52 (20 percent) of the known 262 individual occurrences (points) with mountain beaver burrows are located on public land (Park and BLM) with the remainder of the occurrences located on private lands. Ownership information for individual points on private land has not been compiled. Approximately 29 percent of the potentially suitable habitat occurs on public land.

Changes in Taxonomic Classification or Nomenclature

In 2008, a study was initiated to use mitochondrial DNA to test the hypothesis that there are seven unique subspecific level lineages with *Aplodontia rufa* (Arjo and Piaggio, unpubl. data, no date).

Genetics

Understanding how genetic variation is distributed within and among the small, potentially isolated occurrences of Point Arena mountain beaver is critical for development of a

conservation strategy, especially relative to delineating conservation units and maintenance of gene flow among conservation units. Delineation of appropriate conservation units for management and the determination of the effective population sizes necessary for their long-term persistence will be greatly informed by genetic information. In 2006, nine polymorphic loci were developed for the Point Arena mountain beaver (Pilgrim et al. 2006). An estimate of variability at each locus was determined by scoring tissue samples from 35 unique individuals. Twenty-eight alleles were discovered across the nine loci; observed heterozygosity ranged from 0.09 to 0.66. All loci conformed to Hardy-Weinberg proportions as tested in program GENEPOP. These markers provide sufficient power to distinguish individuals and are being used to calculate population size, density, sex ratio, and survival rates on two permanent monitoring grids located in the Park (Zielinski et al. 2007). This tool allows identification of individuals from DNA collected from hair samples (Zielinski et al. 2007).

A study was recently funded to collect and analyze range wide genetic samples. The study will compare genetic variation within individual sites and between sites and will estimate effective population size for each site sampled. The range wide sampling is scheduled to take place in the spring of 2009 and will be conducted at six sample sites. Two sample sites will be located in each of three east-west riparian corridors; within each riparian corridor one sample will be placed near the coast and another sample will be placed further inland. Of the three riparian corridors, one will be located in the northern portion of the range, one in the middle, and another in the southern portion of the range. This design will allow a variety of comparisons such as genetic relatedness within drainages versus genetic relatedness between drainages. In 2006, a study was started to collect hair samples for genetic analysis from the north, south, east, and west portions of the subspecies' range (Zielinski et al. 2007). In 2006, collected hair samples were sent for genetic analysis, a total of 71 individual mountain beavers were identified (33 male; 29 female; 9 unknown) (Zielinski et al. 2007). To date, these samples represent 3 individuals from the northern; 58 individuals from the western; 9 individuals from the southern; and 1 individual from the eastern portions of the range. The goal of the study is characterize genetic substructure across the range of the subspecies in order to identify population management units.

Summary of Recent Research on Point Arena Mountain Beaver

2002 (Fitts et al. 2002a). Mountain beaver survey and burrow area mapping for the Park.

2002 (Fitts et al. 2002b). Follow-up monitoring in the Park of two Point Arena mountain beaver study sites established in 1992, 1994-2002.

2004-2006 (Zielinski and Mazurek 2006). Radio telemetry study in the Park partially funded by an Endangered Species Act section 6 grant. The primary objectives were to describe reproductive chronology and home range characteristics. Attempts to determine home range size were unsuccessful using radio telemetry (Zielinski and Mazurek 2006). Marked individuals were rarely located outside of their den locations and only 5 of the 16 radio-marked individuals survived for more than 3 months (Zielinski and Mazurek 2006). Rather than risk additional mortality, the collars were removed and a noninvasive DNA method was developed (Pilgrim et al. 2006).

- 2004 (Haas et al. unpublished manuscript). Investigation of copper and iron concentrations in tissues of mountain beavers.
- 2006 (Hunter and Hamlin, Service). Work is ongoing to characterize vegetation at known den sites.
- 2006 (BioConsultants LLC 2006). Mountain beaver survey and burrow area mapping for BLM lands.
- 2006-2007 (Zielinski et al. 2007). Study to develop a noninvasive DNA survey method. Primary objective was to use noninvasive hair snaring methods to estimate home ranges, population sizes, and densities at multiple locations within the Park. In addition, they used hair snares to sample DNA across the subspecies' range with a goal of describing population genetic substructure. This study determined that the use of noninvasive survey methods to estimate home range is not feasible; therefore, future efforts will focus on estimating population size and density at various locations and characterizing genetic variation. Two permanent hair snare population monitoring grids were established on the Park.
- 2006 (Pilgrim et al. 2006). Developed a tool to allow identification of individuals from DNA collected from hair samples.
- 2008 (Hunter and Mazurek, Service). Work is ongoing to identify ectoparasites and pathogens.
- 2008 (Zielinski and Schlexer, Pacific Southwest Research Station and Schwartz, Rocky Mountain Research Station). Work is ongoing to conduct the third and fourth year of sampling of the two population monitoring grids on the Park. This work using DNA collected from hair snares will provide information on survival rates, recruitment, and turnover, by gender over time. Work is also ongoing to conduct range wide genetic sampling and characterize genetic substructure across the range.
- 2009 (Arjo and Piaggio, unpubl. data, no date). Work is ongoing to use mitochondrial DNA to test the hypothesis that there are seven unique subspecific level lineages with *Aplodontia rufa*.

The following researchers are currently working on Point Arena Mountain beaver projects: William Zielinski and Ric Schlexer (Pacific Southwest Research Station) in conjunction with Kristine Pilgrim and Michael Schwartz (Rocky Mountain Research Station).

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The listing rule identified habitat loss as a primary threat. The rule states that given the amount of habitat that has been developed for urban and agricultural purposes, it is likely that substantial habitat loss has occurred in the last century. Cattle, brought to the area by the Spanish, may well have substantially modified historical habitats. Five of the ten populations known at the time of listing were located near agricultural or ranch land and subject to continued impacts from livestock. The Recovery Plan considered livestock grazing to be the most important factor limiting the expansion of extant populations (Service 1998). Cattle or sheep grazing can remove or degrade habitat and cause the crushing of burrows. Grazing continues to threaten occupied sites and suitable habitat on private and public lands. Most of BLM's Stornetta Public Lands are currently unsuitable due to long term grazing and agricultural practices (BioConsultants LLC 2006). In the mid 1900s, agricultural crops such as peas and potatoes were grown on acreages along the coast. Currently, about 72 percent of the non-conifer forest area (6,617 hectares; 16,352 acres) within the range of the Point Arena mountain beaver is crop and non-native grassland (4,515 hectares; 11,156 acres) or developed (276 hectares; 681 acres) (Wear, pers. comm.. 2006). In the western portion of the range, historically much of this area that has been converted may have been suitable habitat that provided a north-south connection between extant occurrences (Figure 2).

The listing rule also noted that habitat has been lost due to road and home construction, water diversions, and recreation facilities (Service 1991). Developments, such as subdivisions, not only remove habitat for buildings and supportive infrastructure, but also may directly or indirectly affect mountain beaver populations by pet predation, vehicle mortality, and disturbance. Feral and non-feral house pets and water diversions associated with new housing probably also impact Point Arena mountain beavers through direct mortality and indirect habitat degradation. Roads may inhibit dispersal and are a source of direct mortality when animals are struck by vehicles.

According to the Mendocino County General Plan, the Irish Beach/Manchester/Point Arena planning area contains the majority of the coast's full time, large-acreage ranches and prime agricultural soils (County of Mendocino 2005). The Mendocino coast contains highly desirable scenic and valuable property. Consequently, development pressures have increased since listing. As of 1991, about 100 homes had been constructed at the Irish Beach subdivision. Today the subdivision has some 460 parcels on which approximately 165 homes have been built (Irish Beach Information 2008). The human population in the southwest part of Mendocino County grew approximately 16 percent between the 1990 census and 2000 census (1990, 5,152; 2000, 5,982) and the number of houses increased approximately 25 percent (1990, 2,886; 2000, 3,605) (County of Mendocino 2004). County-wide population growth projections from 2000 to 2020 range from an increase of 15 to 38 percent (County of Mendocino 2004). Much of the private land within the range of the Point Arena mountain beaver has high development value due to its location along the Mendocino coast. Of the total 262 known individual mountain beaver occurrences, about 80 percent are located on private land which may be subject to future development.

Development projects within the range of the Point Arena mountain beaver are permitted by the Mendocino County Department of Planning and Building Services. Mendocino County and the City of Point Arena have their own local program for implementation of the California Coastal Act. Due to the listing of the Point Arena mountain beaver, permit application packets are routinely reviewed by the Service. Mendocino County will not issue coastal development permits if the Service determines that additional information is needed or if incidental take of mountain beavers may occur. In many cases, Service staff work with the project proponent to adjust the project so that take does not occur and the permit can be issued. Although the process has been working well, occasionally a project will be approved without Service review.

Since listing, the destruction of less than 0.4 hectare (1 acre) of occupied or suitable Point Arena mountain beaver habitat has occurred as a result of unpermitted development. In the last 5 years, the Service has been notified of six incidences of habitat destruction. Of these six unauthorized incidents, one was a road improvement project and five involved vegetation clearing.

The Recovery Plan identifies impacts from recreational activities as a threat due to potential trampling of vegetation and crushing of burrows (Service 1998). A study conducted in the Park found that volunteer trails cause significant burrow destruction and trampling of fragile habitats (BioConsultants LLC 2006). After closure of several campsites and trails in the Park, the number of active burrows increased twofold (BioConsultants LLC 2006). Zielinski and Mazurek (2006) caution future researchers to minimize foot traffic in burrow areas because burrows with thin ceilings easily collapse and vegetation can be flattened over large areas if traffic is not restricted.

Protection and Management Activities

Since listing, historic and ongoing habitat modification has been partially minimized by the following actions.

BLM

In 2004, The Nature Conservancy in partnership with the State Coastal Conservancy, Service, and the State of California Wildlife Conservation Board purchased approximately 688 hectares (1,700 acres) of the Stornetta Brothers Ranch and donated the property to the BLM. At purchase, an agricultural easement was provided to the seller allowing continued grazing at historical levels until 2014. Livestock grazing has removed, fragmented, and degraded much of the mountain beaver habitat on the property. In 2006, this property was surveyed for mountain beavers and 12 occupied burrow areas were identified with a combined acreage of approximately 2.8 hectares (7 acres) (BioConsultant LLC 2006).

In 2006, BLM adopted an interim management plan for the Stornetta Public Lands. The intent of the interim plan is to provide immediate management for the area and allow for a minimal level of services, public uses, resource protection, and habitat restoration. To date, BLM has completed two protective fencing projects to exclude cattle from mountain beaver habitat: 1) the Miner Hole Road fence protected 0.2 hectare (0.5 acre) of occupied habitat and 0.6 hectare (1.5 acres) of suitable unoccupied habitat and 2) the Mud Flat fence protected 5.3 hectares (13 acres) of suitable unoccupied habitat and 4 hectares (10 acres) unsuitable habitat. Additional protective fencing may be constructed during the interim management period if funding becomes available.

Park

In 2002, the Park developed a Point Arena mountain beaver habitat protection and restoration plan (Fitts et al. 2002a). To date, the Park has implemented the following actions from their plan: permanently closed 28 campsites, 4 pit toilets, and 1 trail located in mountain beaver habitat; removed asphalt surfaces from all campground roads within 30.5 meters (100 feet) of habitat; and constructed a fence to protect habitat near the campground and day use area (Pasquinelli, pers. comm. 2008). This restoration work was accomplished under recovery permit number TE134347-0. Mountain beaver habitat in the Park is protected from removal; however, it is subject to impacts such as recreational activities, maintenance operations, and invasive vegetation.

The California Department of Parks and Recreation acquired the proposed Hunters Lagoon Subdivision parcels near Lagoon Lake from 1978 and 1985 (R. Pasquinelli, California Department of Parks and Recreation, pers. comm. 2008). Since acquisition, this area has been designated as a Natural Preserve (Pasquinelli, pers. comm. 2008). The acquired parcels contain all or portions of six of the Park's identified burrow areas (California Department of Parks and Recreation 1992; Fitts et al. 2002a).

Private Lands

Two Incidental Take Permits have been issued that cover the Point Arena mountain beaver. In 2002, AT&T Corporation was issued a 10-year permit for a low effect Habitat Conservation Plan (HCP) that authorized harassment of all mountain beavers associated with 1.2 hectares (3 acres) of occupied habitat and harm of all mountain beavers associated with 1.4 square meters (1.7 square yards) of suitable habitat that was permanently removed. Mitigation in this HCP included rehabilitation of 0.4 hectare (1 acre) of unsuitable habitat through the removal of non-native conifers.

In 2007, an Incidental Take Permit was issued to the Fisher Family for the development and occupancy of approximately 9.7 hectares (24 acres) for a home site. This permit allows for the loss of 0.16 hectare (0.39 acre) of occupied and 1.8 hectare (0.45 acre) of unoccupied habitat, and harm of up to 28 mountain beavers. Mitigation described in the HCP associated with this permit includes the management of 3.1 hectares (7.75 acres) in perpetuity for mountain beavers.

A third HCP is under development by a commercial timber company that could cover several occupied Point Arena mountain beaver sites. This HCP will likely include measures to minimize and mitigate impacts from timber harvest activities on this subspecies.

Since listing, the following two conservation easements to protect Point Arena mountain beavers have been established: Dobbins (Population 17 Hathaway Creek, first south tributary mentioned in Recovery Plan); and Salvation Army (small portion of population 4 Irish Gulch mentioned in Recovery Plan).

Summary

In summary, the loss and modification of suitable habitat continues to be the primary threat to Point Arena mountain beavers, especially on private lands. Point Arena mountain beaver

populations on public lands can be impacted by the loss of suitable habitat on the surrounding private lands by preventing dispersal of mountain beavers between sites. In addition, suitable habitat on public and private lands continues to be impacted by livestock grazing, recreation activities, water diversions, and invasion by exotic vegetation.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial, recreational, scientific, or educational purposes was not known to be a factor in the 1991 final listing rule (Service 1991) and does not appear to be an on-going threat at this time. However, the low number of individuals at isolated sites makes mountain beavers vulnerable to extirpation from any type of collection.

In 2004-2005, a radio telemetry study experienced unusually high mortality (Zielinski and Mazurek 2006). Of the 16 radio-collared individuals, 11 (69 percent) died during the one-year study (Zielinski and Mazurek 2006). The researchers hypothesized that the high mortality rate may have been due to either (1) a handicap imposed by the radio-collar, (2) disturbance caused by the regular presence of the field crew, or (3) a combination of both factors (Zielinski and Mazurek 2006). Because of these concerns, future radio telemetry studies are not recommended.

FACTOR C: Disease or Predation

Predation by dogs and cats was identified as a threat in the 1991 final listing rule (Service 1991). The impact of this predation pressure on small populations was considered to have the potential to become critical, since a determined predator could possibly extirpate a mountain beaver site. This continues to be a concern especially near residential areas such as Irish Beach, Kinney Road, City of Point Arena, and Windy Hollow Road.

Mountain beavers have a number of natural predators, such as coyote (*Canis latrans*), bobcat (*Felis rufus*), long-tailed weasel (*Mustela frenata*), spotted skunk (*Spilogale gracilis*), and great-horned owl (*Bubo virginianus*). Natural rates of predation are likely high. Zielinski and Mazurek (2006) captured or observed numerous potential predators in their Point Arena study area, especially long-tailed weasels and spotted skunks that frequently use mountain beaver burrows. No data are available on trends in predation.

The final listing rule made no mention of disease as a threat (Service 1991). The Recovery Plan states that little is known regarding diseases of mountain beavers or their potential to threaten populations (Service 1998). To date, we are not aware of any evidence suggesting that this subspecies is threatened by disease. Three Point Arena mountain beaver carcasses that were recovered intact during the radio telemetry study were submitted for necropsy (Zielinski and Mazurek 2006). The following necropsy results are from Zielinski and Mazurek (2006): results were inconclusive for the female carcass; results for the male carcass included leptospirosis, pneumonia, and elevated copper and iron concentrations in the liver; results for the third animal (sex unknown) included pneumonia, testicular hemorrhage, and elevated copper and iron concentrations in the liver. Elevated copper and iron concentrations could possibly be indicative of copper toxicosis and liver storage disease (Haas et al. unpublished manuscript). Metals in soil

and plant tissue samples collected from the territories of the necropsied animals were within expected range (Haas et al. unpublished manuscript). Livers of other subspecies of mountain beavers from other locations also showed high copper and iron, suggesting that copper and iron might be naturally higher in mountain beavers relative to other rodent species (Haas et al. unpublished manuscript).

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing, regulatory mechanisms thought to provide some protection for the Point Arena mountain beaver included: (1) the California Coastal Act; 2) the Mendocino County Land Use Plan; and 3) California Department of Fish and Game (CDFG)'s designation as a "species of special concern". The listing rule (Service 1991) provides an analysis of the level of protection that was anticipated from these regulatory mechanisms. The rule anticipated that because all known locations were in the Coastal Zone, the California Coastal Act and the Mendocino County Land Use Plan would provide some indirect habitat protection. However, it concluded that mountain beavers were not protected from development activities or other potentially adverse impacts because there were no regulations or guidelines that actually protected the animal or its habitat. The final rule anticipated that the CDFG designation "species of special concern" provides no legal status to protect habitat. This analysis appears to remain currently valid. The listing rule failed to analyze the effectiveness of the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA). At the time of listing, no BLM lands occurred within the range of the Point Arena mountain beaver; therefore, the rule did not analyze the effectiveness of the Federal Land Policy and Management Act of 1976 (FLPMA). These regulations are discussed below. Since listing, the Act has been the primary regulatory mechanism providing protection for this subspecies.

California Environmental Quality Act. CEQA requires review of any project that is undertaken, funded, or permitted by the State or a local government agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, at the discretion of the lead agency involved. However, because Mendocino County and the City of Point Arena consider take of a species listed under the Act to be a significant effect under the CEQA, they have consistently not issued coastal development permits if unpermitted take of Point Arena mountain beavers would occur.

National Environmental Policy Act. NEPA (42 U.S.C. 4371 *et seq.*) applies to activities undertaken, authorized, or funded by Federal agencies. NEPA may afford some protection to populations affected by Federal activities. It requires all Federal agencies to formally document, consider, and publicly disclose the environmental impacts of Federal actions and management decisions affecting the human environment. NEPA requires agencies to consider mitigation alternatives, however, it does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

Federal Land Policy and Management Act of 1976. FLPMA requires BLM to incorporate Federal, State, and local input into their management decisions. Although the BLM has a

multiple-use mandate under the FLPMA which allows for grazing, mining, and off-road vehicle use, the BLM also has the ability under the FLPMA to establish and implement special management areas such as Areas of Critical Environmental Concern (ACEC) which can reduce or eliminate actions that adversely affect species of concern. In 2006, BLM designated 359 hectares (887 acres) of the Stornetta Public Lands as an ACEC. Habitat for the Point Arena mountain beaver was identified as one of the primary features receiving special management by this designation (BLM 2006).

Endangered Species Act. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. Section 9 prohibits the taking of any federally listed endangered or threatened species. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). For projects without a Federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take permits to non-Federal applicants pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved HCP that details measures to minimize and mitigate the project's adverse impacts to listed species.

Summary

In summary, the Endangered Species Act is the primary Federal law that has provided protection for this subspecies since its listing as endangered in 1991. Approximately 80 percent of the known occurrences are on private lands where the only protections for the animal or its habitat are provided by section 9 of the Endangered Species Act. Other Federal and State regulatory mechanisms provide discretionary protections for the subspecies based on current management direction, but do not guarantee protection for the subspecies absent its status under the Endangered Species Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the Point Arena mountain beaver in absence of the Endangered Species Act.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

The listing rule identified the following potential threats: mortality due to vehicles, rodent control, treatment of seeps with copper sulfate to control sheep liver fluke, and spread of exotic plants (Service 1991). The listing rule also identified the potential for stochastic events such as fire, flooding, disease, drought or earthquake to eliminate populations or reduce numbers to the point where they could not recover. Additionally, the rule discusses risks of small population size, such as inbreeding depression, genetic drift, and habitat fragmentation. The Recovery Plan states that the Point Arena mountain beaver is vulnerable due to two basic facts: 1) low number of populations, all of which have an extremely limited distribution; and 2) the presumed low number of individuals in the populations (Service 1998). These factors, in combination with a low reproductive rate and any manmade or natural catastrophe, have a high potential to severely

impact the subspecies (Service 1998). Additional factors of concern are the low number of protected occurrences and the mountain beaver's specialized habitat requirements.

No quantitative assessment has been made of the threats identified in the listing rule. We believe that threats such as collision with vehicles, spread of exotic vegetation, and rodent control, have likely increased since listing, due to increased development. We have no current information that treatment of seeps with copper sulfate is an on-going threat.

The listing rule raises concerns about exotic species such as gorse (*Ulex europaeus*), broom (*Cytisus* spp.), and pampas grass (*Cortaderia selloana*) (Service 1991). The Recovery Plan includes German ivy (*Senecio mikanioides*), ice plant, and European beachgrass (*Ammophila arenaria*) in the list of exotic species that may be a threat to mountain beaver habitat. It also mentions succession of shrubby open habitat to closed canopy forest as a potential concern (Service 1998). We do not have recent information on the spread of gorse, broom, pampas grass, or German ivy at occupied sites. However, the spread of ice plant and European beachgrass in occupied burrow areas is documented in the Park (Fitts et al. 2002a) and at the AT&T site (BioConsultants LLC 2008). In 2002, 14 burrows sites with ice plant were identified in the Park (Fitts et al. 2002a). Since this time, ice plant has displaced the native vegetation and completely covered the burrows at some of these sites. In 2008, surveys at the AT&T site and an adjacent Park site where ice plant has reduced the amount and quality of habitat found that the burrow areas are no longer occupied by mountain beavers (BioConsultants LLC 2008).

The potential for random events, such as weather extremes, to eliminate population occurrences continues to be a concern. Over the long-term, fire may play an important role in maintaining early seral-stage habitats suitable for mountain beavers. However, data collected after a large wildland fire near Point Reyes support concerns that fires in occupied sites could eliminate or severely reduce populations (Fellers et al. 2004). Fellers et al. (2004) estimated that only 0.4 to 1.7 percent of the Point Reyes mountain beavers (*A. r. phaea*) survived post-fire and that it would take the population 15 to 20 years to recover.

Human-caused disturbance is also a threat which may disrupt significant behaviors, such as breeding, feeding, or dispersal. Mountain beavers' semi-fossorial habits and anatomy suggest high sensitivity to ground vibration and noise. Potential sources of disturbance include, but are not limited to, noise and visual disturbance associated with human activities, mechanically-induced noise or ground vibration, and night lighting.

Threats associated with small population size and small numbers of isolated occurrences continue to be factors. The following are rough estimates of the number of individuals that may occur on public lands: Park, 62 to 246 animals and BLM, 8 to 30 animals. These estimates were derived using the highest and lowest annual crude minimum number alive density estimates from the two permanent grids established in the Park (Zielinski et al. 2007), estimated amount of occupied habitat in the Park (Fitts et al. 2002a), and estimated amount of occupied habitat in BLM (BioConsultants LLC 2006).

Many (approximately 52 percent) of the identified burrow areas in the Park and BLM contain less than 20 active burrow openings (Fitts et al. 2002a; BioConsultants LLC 2006). At the time

of the Recovery Plan no data were available on the density of Point Arena mountain beaver populations. Population estimates were based on a ratio of one animal for every 5 to 10 burrow openings (Service 1998), however, little empirical justification exists for this ratio, and no distinction is made between active and inactive burrow openings. For some of the other subspecies, some site-specific estimates are available on the relationship between the number of burrow openings and number of animals. For example, a total of 11 *A. r. phaea* were found in a burrow system with over 100 entrances, providing a ratio of 9 burrow openings per animal (Camp 1918). Using these estimates, it is likely that many of these small Point Arena mountain beaver sites with less than 20 active burrow openings are occupied by only one or two individuals. Sites with only a few individuals are particularly vulnerable to extirpation from a number of factors such as habitat disruption, skewed sex ratios, and predators.

New Threats – Global Warming

Since listing, information on the potential threat of climate change has become available. A comment letter was received from the Attorney General of California regarding global warming impacts. The letter urges the Service to carefully analyze both the probability of increased drought due to global warming and its impact on the Point Arena mountain beaver and global warming impacts more generally.

The Intergovernmental Panel on Climate Change (IPCC) has concluded that warming of the climate is unequivocal and continued greenhouse gas emissions at or above current rates would cause further warming (Intergovernmental Panel on Climate Change 2007). The IPCC also projects that there will likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation (Intergovernmental Panel on Climate Change 2007). A report from the California Climate Change Center makes the following findings (Cayan et al. 2006a):

- (1) Although climate model results are inconclusive as to whether California's precipitation will change over the next century, all climate models show increases in temperature, with the aggregate of several model runs containing a range of warming from 2000 to 2100 from about +2°C to about +6°C (+3.6°F to +10.8°F).
- (2) Some of the most dramatic climate change impacts will be experienced as increased frequency and severity of extreme events, such as heat waves, wildfires, and flooding.

A possible explanation for the restricted distribution of mountain beavers is their limited ability to thermal regulate at high ambient temperatures (Johnson 1971; Kinney 1971). In addition, mountain beavers may be confined to moist environments due to their simple kidney structure and inability to concentrate urine (Nungesser and Pfeiffer 1965). The Point Arena area's maritime climate provides a significant amount of moisture from fog and a relatively mild climate with little daily or annual fluctuations in temperature. Thus, the mountain beaver's unique physiology may make them especially vulnerable to increased drought conditions and temperature. The present geographic distribution of mountain beavers is thought to reflect range retractions which have resulted from drying due to regional climate and topographic changes since the Eocene (Shotwell 1958). Accordingly, a drier and or warmer climate regime would likely result in further retractions in the range of the Point Arena mountain beaver over time.

California's global model predictions indicate that California's coast will experience increasing sea levels over the next century (Cayan et al. 2006b). Sea level rise projected by the 2070 to 2099 period range from 13 to 62 centimeters (5.1 to 24.4 inches) for simulations using the lower greenhouse gas emissions scenario to 21.6 to 89.4 centimeters (8.5 to 35.2 inches) for the higher scenario (Cayan et al. 2006b). When storm effects, such as heavy surf and wind-driven waves, coincide with high tides, the chances of coastal damage are greatly heightened (Cayan et al. 2006b). Increases in sea level due to climate change makes this problem even more severe (Cayan et al. 2006b) potentially resulting in increasing coastal erosion, flooding, and faster cliff retreat. Approximately 5 percent of the known Point Arena mountain beaver sites are located on the edge of coastal bluffs and therefore may be susceptible to cliff erosion. The occupied coastal bluff areas may provide for connectivity between adjacent drainages. Thus, the loss of coastal bluff populations may have a more pronounced effect on the overall mountain beaver population than the 5 percent figure implies. In addition, approximately 10 percent of the known sites occur at elevations of 12.2 meters (40 feet) or less and may be susceptible to flooding due to extreme storm events.

While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. It appears reasonable to assume that if temperatures increase species that have a limited ability to thermoregulate and concentrate urine effectively, such as mountain beavers, may be adversely impacted. Also, species such as mountain beavers that occur on coastal bluffs and low elevations may be susceptible to erosion and flooding.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

The recovery criteria for the Point Arena mountain beaver are not explicitly threats-based, but they do address Factor A (present or threatened destruction, modification or curtailment of its habitat or range), Factor D (inadequacy of existing regulatory mechanisms), and Factor E (other, natural or manmade factors affecting its continued existence). Factor A was identified as the

primary factor affecting this subspecies at the time of listing, and is only partially addressed in the recovery criteria. The recovery criteria only address protection of a subset of sites and do not address the continued loss and degradation of the remaining sites. Factor C (disease or predation) was addressed in the Recovery Plan as a potentially serious threat and is not addressed in the recovery criteria. Factor B (overutilization for commercial, recreational, scientific, or educational purposes) is not relevant to this subspecies.

The following downlisting criteria were included in the Recovery Plan for the Point Arena mountain beaver:

1. At least 16 populations are protected from human-caused disturbance in perpetuity. Each population shall contain at least 20 hectares (49 acres) of suitable habitat of which at least 10 hectares (25 acres) are occupied habitat (addresses Listing Factors A, D, and E).

When the Recovery Plan was developed in 1998, 26 “populations” were identified. To date, 14 geographic groupings based on drainages and individual point locations have been preliminarily delineated; however, data are not available on gene flow between these groups, dispersal barriers, and dispersal corridors. Research is on-going to describe the genetic substructure within the subspecies. These data along with habitat information will help to more appropriately delineate population (management) units. This information will be used to determine the number, size, and distribution of population units and to design a strategy to maintain gene flow among historically connected locations. The results of this research should be used to revise downlisting criterion 1.

2. These populations shall have a mean density of at least 4 Point Arena mountain beavers per hectare (1.6 per acre) of occupied habitat, unless new data show that a lower density is healthy and stable (addresses Listing Factor E).

In 2006, a noninvasive genetic method was developed for identifying individuals and estimating population densities (Zielinski et al. 2007). To date, this method has been used at two locations. The 2006 density estimates for these two sites were 5.4 animals/hectare (2.2 per acre) and 10.7 animals/hectare (4.3 per acre) and the 2007 density estimates were 2.7 animals/hectare (1.1 per acre) and 9.8 animals/hectare (4.0 per acre) (Zielinski et al. 2007). We recently funded a study to collect two more years of data at these two sites to determine the amount of year-to-year variability in density. Prior to the development of this method, no reliable, safe technique was available to quantify existing population variables (*e.g.*, density). Downlisting criterion 2 has been partially met through the development of noninvasive technique to estimate population density (Zielinski et al. 2007). However, to fully meet this criterion downlisting criterion 1 needs to be revised to determine the desired number of population units, units need to be protected, and their densities sampled. Recent density data should be used to determine the desired density for a stable population.

3. All 16 populations are stable (*i.e.*, no more than a 25 percent change in estimated population size from highest to lowest value) or increasing for a period of at least 10 years (following attainment of criterion #1), as documented through establishment and

implementation of a scientifically acceptable population monitoring program (addresses Listing Factor E).

In 2006, a noninvasive genetic method was developed for identifying individuals and estimating population sizes (Zielinski et al. 2007). This method is being used at two study sites in the Park. Sampling grids were set up at both sites and have been monitored annually since 2006 (Zielinski et al. 2007). This method will be used to estimate population size annually and to monitor survival rates over time. Results of this sampling will be used to develop a scientifically acceptable range wide population monitoring program. To date, only two sites are regularly surveyed with sufficient effort to effectively monitor population trends. Therefore, downlisting criterion 3 has not been met. This criterion also can not be attained until criterion 1 is revised and achieved.

4. The amount of additional habitat needed for population interconnectivity, travel, and dispersal habitat has been determined (addresses Listing Factors A and E).

Research is currently underway to describe the subspecies' population genetic substructure. This will help determine whether gene flow occurs between inland and coastal population sites and the degree of north-to-south connectivity. Currently, no data are available on dispersal distances, dispersal barriers, or potential corridors. Downlisting criterion 4 has not been met.

5. Sufficient information is available to permit adaptive management, and any management actions necessary to ensure the continued success of these populations (in criterion #1) have been fully implemented.

Downlisting criterion 5 has been partially fulfilled through the development of a noninvasive method to estimate population size and density (Zielinski et al. 2007). This technique can be used to identify when populations are declining and in need of special management actions. A range wide monitoring strategy needs to be developed. This criterion can not be attained until criterion 1 is revised and achieved.

IV. SYNTHESIS

The Point Arena mountain beaver is only known from an 85-square kilometer (33-square mile) area in coastal Mendocino County, California. The loss and modification of habitat from development, livestock grazing, and recreation continue to be the primary threat, especially on private lands. Much of the private land within the range of the Point Arena mountain beaver has high development value due to its location along the Mendocino coast.

To date, a total of 262 individual records (points) with burrow systems have been mapped range wide. Some of these individual point localities may consist of isolated burrow systems with only 1-2 individuals. In addition, the current status of many of these occurrences is unknown because they occur on private lands and have not been visited in recent years. Approximately 80 percent of the points are located on private land which may be subject to future development. The individual points have been preliminarily aggregated into 14 geographic groups.

The recovery criteria for this subspecies have not been met. Three out of five criteria are based on the protection of at least 16 populations. However to date, information on gene flow between occurrences, dispersal barriers, dispersal corridors, and potential dispersal distance is needed to more accurately delineate population (management) units. Research is on-going to describe the genetic substructure within the subspecies. This research will help to determine whether sites that occur along, or in close proximity to streams may be appropriate to delineate as population units. When available this information should be used to revise the downlisting criteria.

The subspecies' vulnerability results from a low number of occupied sites and the small number of animals at each site. Most occurrences are small enough that they are vulnerable to extirpation from stochastic factors alone. Because of these factors, combined with a low reproductive rate and manmade and natural threats, the status of the Point Arena mountain beaver should remain endangered. We are optimistic that the recovery potential for this subspecies is high primarily because it occupies such a small land area. On the public lands (Park and BLM) that have been intensively surveyed, mountain beavers occupy only 25.8 hectares (64 acres). Occupied sites and dispersal corridors on private land could be protected through mechanisms such as acquisition, easements, and landowner agreements.

V. RESULTS

Recommended Listing Action:

- Downlist to Threatened
- Uplist to Endangered
- Delist (indicate reason for delisting according to 50 CFR 424.11):
 - Extinction*
 - Recovery*
 - Original data for classification in error*
- No Change

New Recovery Priority Number and Brief Rationale: No change.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Continue research to characterize the genetic diversity within and among individual occurrences.
2. Continue to monitor the established survey grids to estimate abundance, survival rates, and recruitment.
3. Identify and map suitable habitat, potential dispersal corridors, dispersal barriers, and restoration areas.
4. Delineate appropriate conservation units for management based on data on gene flow, dispersal barriers, and potential dispersal distances.

5. Develop and implement a non-invasive sampling program to monitor range wide trends in abundance and distribution. Also develop a sampling plan to monitor habitat quantity, quality, and threats.
6. Once sufficient information is gathered revise the current recovery plan to include updated recovery criteria and tasks.
7. Identify key areas for protection, such as conservation easements and acquisition, this will enable the Service to work with partners when opportunities arise.
8. Identify sites for vegetation management, such as exotic plant removal or livestock exclosures.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Point Arena Mountain Beaver (*Aplodontia rufa nigra*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

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

Review Conducted By: Arcata Fish and Wildlife Office

Date Submitted to Region 8: February 13, 2009

FIELD OFFICE APPROVAL:

Acting
Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve *[Signature]* Date 2/23/09

REGIONAL OFFICE APPROVAL:

Lead Regional Director, U.S. Fish and Wildlife Service, Region 8

Approve *[Signature]* Date 4/1/09