Recovery Plan for the Point Arena Mountain Beaver

Aplodontia rufa nigra (Rafinesque)

POINT ARENA MOUNTAIN BEAVER

Aplodontia rufa nigra (Rafinesque)

RECOVERY PLAN

Prepared by

Dale T. Steele

and

Laurie Litman

for

Region 1

U.S. Fish and Wildlife Service

Portland, Oregon

Approved: _____

Regional Director, U.S. Fish and Wildlife Service

Date: 6/2/98

Disclaimer

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Costs indicated for task implementation and/or time for achievement of recovery are only estimates and subject to change. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service ***only*** after they have been signed by the Regional Director or Director as ***approved***. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature Citation should read as follows:

U.S. Fish and Wildlife Service. 1998. Point Arena Mountain Beaver *(Aplodontia rufa nigra* (Rafinesque)) Recovery Plan. Region 1, Portland, OR. 71 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
301/492-3421 or 1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan.

Acknowledgments

The following individuals contributed significant information/assistance during recovery plan preparation:

Dan Campbell
Jim Dines
Gary Fellers
Kim Fitts
Sarah Flowers
Gordon Gould
Rickye Heffner
Mike Horton
Kevin Joe
Caryla Larson
Alan Levine
Darlene McGriff
Richard Meredith
Phil Northen
Renee Pasquinelli
Bert Pfeiffer
Ron Schlorff
Brad Valentine
Alison Willy
Ted Wooster

Special acknowledgement for the pioneering *Aplodontia rufa nigra* research by C. Camp and E. Pfeiffer.

The cover drawing is used courtesy of the California Wildlife Habitat Relationships Program, California Department of Fish and Game, Wildlife Management Division from: D.C. Zeiner, W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1990. California's Wildlife, Vol. III, Mammals. California Statewide Wildlife Habitat Relationships System. State of California, The Resources Agency, Department of Fish and Game, Sacramento, California.

Executive Summary

Current Species Status: The Point Arena mountain beaver *(Aplodontia rufa nigra)* is a federally listed endangered subspecies. This subspecies of mountain beaver is only known from a small area of coastal Mendocino County, California, where 26 apparently separate populations have been found, with an estimated 200 to 500 animals total. Potential threats to the habitat of the species include elimination or degradation from land development, grazing, timber harvest, and invasion by alien plant species. Direct threats to the subspecies may include predation by household pets and feral animals, poisoning, genetic isolation and genetic drift, and human caused disturbance. Basic biological data are lacking to determine the level of vulnerability of the mountain beaver to each of these factors.

Habitat Requirements and Limiting Factors: *A. r. nigra* requires a cool moist environment. It lives in underground burrow systems under dense stands of perennial vegetation where soil conditions allow for easy excavation.

Recovery Objective: The ultimate objective of this plan is to delist the Point Arena mountain beaver, however, criteria for downlisting to threatened are also established.

Recovery Criteria: The species will be considered for downlisting when:

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.
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.
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.

4. The amount of additional habitat needed for population interconnectivity, travel, and dispersal habitat has been determined.
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.

The species will be considered for delisting when:

1. Thirty populations are protected from 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.
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.
3. All 30 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 15 years (following attainment of criterion #1), as documented through establishment and implementation of a scientifically acceptable population monitoring program.
4. Additional habitat needed for population interconnectivity, travel , and dispersal habitat has been protected and is being managed appropriately.
5. Adaptive management prescriptions have been determined and implemented for all populations.

Actions Needed:

1. Protect known populations.
2. Protect suitable habitat, buffers, and corridors.
3. Develop management plans and guidelines.

4. Gather biological and ecological data necessary for conservation of the subspecies.
5. Determine feasibility of, and need for, relocation.
6. Monitor existing populations and survey for new ones.
7. Establish an outreach program.

Estimated Cost of Recovery: $1,047,000+. The total cost of this recovery effort could be higher than this figure. The costs for several tasks needed for recovery have yet to be determined.

Date of Recovery: Downlisting could be initiated in 2015 and delisting by 2025.

Table of Contents

List of Figures

List of Tables

I. Introduction

A. DESCRIPTION

The Point Arena mountain beaver *(Aplodontia rufa nigra)* was listed as a federally endangered species by the U.S. Fish and Wildlife Service on December 12, 1991 (50 **FR** 64716). It is also listed as a highest priority "Species of Special Concern" by the State of California (Williams 1986). This subspecies has been given a recovery priority number of 3 given that it is faced with a high degree of threat and has a high recovery potential.

The first published account of mountain beaver, *Aplodontia rufa* (Rafinesque), comes from the journals of Lewis and Clark in 1805 (Godin 1964). The Point Arena subspecies was originally described by Taylor (1914) as a separate species, *Aplodontia nigra,* because of its unique color and certain anatomical features. It was later revised to subspecies status, *Aplodontia rufa nigra,* due to overlap of characteristics with other subspecies and lack of representative specimens (Taylor 1918). This classification has been upheld through several revisions (Dalquest and Scheffer 1945, Hall and Kelson 1959, Hall 1981). A considerable degree of geographical and individual variation exists within subspecies of *Aplodontia* (Dalquest and Scheffer 1945). Isolation is probably a major factor in the speciation (*i.e.,* the process of differentiation into species and subspecies) of the genus (Finley 1941).

The mountain beaver has been compared to an overgrown pocket gopher (Ingles 1965) and a muskrat without a tail (Racy 1922). Its body is stout, compact and cylindrical. An average adult measures slightly more than 30.5 centimeters (1 foot) in length and weighs 0.8 to1.8 kilograms (2 to 4 pounds) (Feldhamer and Rochelle 1982). The skull is relatively broad, massive, laterally compressed, and notable for its flat upper surface and lack of postorbital processes (spur of bone above the eye socket) (Hall 1981). Long, stiff whiskers (vibrissae) are present on the nose, and guard hairs are plentiful in the fur. A little patch of white hair occurs at the base of each ear. The eyes and ears are quite small. Limbs are short, the fore and hind limbs of about equal length. The forefeet have functionally

opposed thumbs, and all digits have long, curved claws. A distinctive feature of its external anatomy is its cylindrical stump of a tail.

Several characteristics distinguish the Point Arena mountain beaver from other subspecies. The most obvious is its unique black coloration. The outline of the nasals is also distinctive, as are some cranial measurements (Taylor 1914). *A. r. nigra* is also the smallest of the Californian subspecies.

The mountain beaver, also known as sewellel, boomer, and many other names, is not closely related to true beavers *(Castor). Aplodontia* are considered to be the oldest group of living rodents, being the sole extant member of the superfamily Aplodontoidea, which has been almost morphologically unchanged in the fossil record since the Miocene (Simpson 1945). This "living fossil" is thought to be ancestral to the squirrel family (Shotwell 1958).

B. GEOGRAPHICAL DISTRIBUTION

The Point Arena mountain beaver is known only from its type locality, an area of about 62 square kilometers (24 square miles), entirely in western Mendocino County (Camp 1918). The seven subspecies of mountain beaver are found in cool, moist climates along the Pacific Coast of North America, from southern British Columbia to Point Reyes, California and east to the Cascade and Sierra Nevada Ranges (Scheffer 1929) (Figure 1). Four subspecies are found along the northern coast of California—the Humboldt mountain beaver *(Aplodontia rufa humboldtiana),* the Point Reyes mountain beaver *(A. r. phaea)*, the Point Arena mountain beaver *(A. r. nigra)*, and the Pacific mountain beaver *(A.r. pacifica).* The Point Arena and Point Reyes subspecies are isolated by considerable distances (Steele 1986). The Point Arena mountain beaver is about 130 kilometers (80 miles) south of the Humboldt mountain beaver, and the Point Reyes mountain beaver is 100 kilometers (60 miles) south of the Point Arena mountain beaver. The length of time these populations have been isolated is not known. Also, note that the Sierra Nevada mountain beaver is not endemic to California, as it has been collected within the Nevada portion of the Tahoe Basin.

Historical records of *A. r. nigra* are scarce (Table 1). Camp (1918) reported that

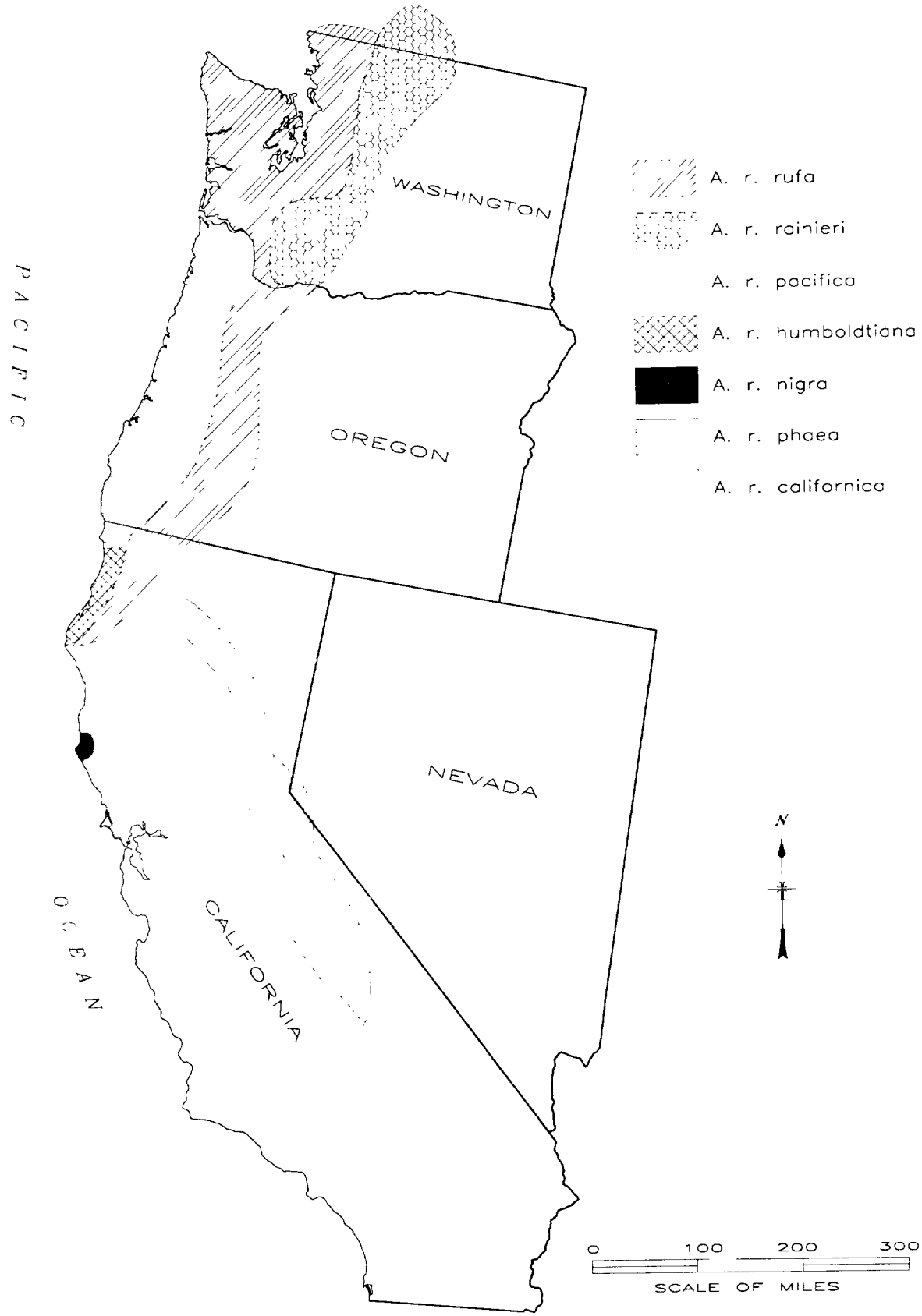

Figure 1. Distribution of known *Aplodontia rufa* subspecies (modified from Godin 1964).

Table 1. Museum specimens of the Point Arena mountain beaver.

Collector	Date	Location	Sex	Age	Weight (grams)	Length (millimeters)	Skin	Skull	Skeleton	Museum	Comments
C.L. Camp	7-9-13	Point Arena or Alder Creek	Male	Unknown	Unknown	310 mm	X	X	Complete	University of California at Berkeley, Museum of Vertebrate Zoology	Type specimen
C.L. Camp	7-9-13	Point Arena or Alder Creek	Male	Unknown	908+ g	316 mm	X	X	Partial	University of California at Berkeley, Museum of Vertebrate Zoology	
C.L. Camp	7-9-13	Point Arena or Alder Creek	Unknown	Unknown	Unknown	Unknown				University of California at Berkeley, Museum of Vertebrate Zoology	Foot only
C.L. Camp	7-10-13	Point Arena or Alder Creek	Unknown	Unknown	Unknown	Unknown	X	X	Partial	University of California at Berkeley Museum of Vertebrate Zoology	Type specimen
C.L. Camp	7-11-13	Point Arena or Alder Creek	Male	Unknown	908 g	325 mm	X	X	Complete	University of California at Berkeley, Museum of Vertebrate Zoology	Type specimen
T. Storer	7-13-31	Alder Creek?	Female	Unknown	Unknown	328 mm				University of California at Berkeley, Museum of Vertebrate Zoology	
D.H. Johnson *et. al*	12-32	Unknown	Unknown	Unknown	Unknown	Unknown		X	None	University of California at Berkeley, Museum of Vertebrate Zoology	
W.F. and F. Wood	3-4-39	Point Arena	Male	Adult	Unknown	316 mm	X	X	X	Carnegie Museum of Natural History	Age based on curator evaluation of tooth eruption and fusion of skull sutures
W.F. and F. Wood	8-23-39	Point Arena	Female	SubAdult	Unknown	306 mm	X	X	X	Carnegie Museum of Natural History	Age based on curator evaluation of tooth eruption and fusion of skull sutures
W.F. and F. Wood	8-23-39	Point Arena	Female	Adult	Unknown	306 mm				Carnegie Museum of Natural History	Age based on curator evaluation of tooth eruption and fusion of skull sutures
E.W. Pfeiffer	9-3-51	Christensen Ranch (near Bridgeport Landing)	Female	Unknown	1069 g	307 mm	X	X	None	University of California at Berkeley, Museum of Vertebrate Zoology	Reproductive research
E.W. Pfeiffer	11-25-51	Christensen Ranch	Female	Unknown	1045 g	333 mm	X	X	None	University of California at Berkeley, Museum of Vertebrate Zoology	Reproductive research
B. Jones	4-89	2 miles east of Point Arena	Female	Unknown	Unknown	Unknown	X	X	Complete	University of California at Berkeley, Museum of Vertebrate Zoology	Tissue collected and preserved
B. Jones	8-89	Point Arena (Kinney Road at Manchester Beach State Park)	Female	Unknown	Unknown	Unknown	X	X	Complete	University of California at Berkeley, Museum of Vertebrate Zoology	Tissue collected and preserved
K. Fitts	3-29-94	Hwy 1 - Kinney Road	Female	Unknown	495 g	310 mm	X	X		Sonoma State University Vertebrate Museum	Hit by car

NOTES: Data results from contacting more than 50 museums and universities and reviewing data on over 1,000 mountain beaver specimens.

"colonies" extend from the town of Point Arena to Alder Creek, 12 kilometers (7.5 miles) to the north. This range was extended north another 7 kilometers (4.5 miles) when animals were collected at Christianson Ranch in 1951 by Pfeiffer. In 1991, when the species was listed as endangered, 10 populations had been located at Mallo Pass Creek, Irish Gulch, Alder Creek, Manchester Beach State Park, Lagoon Lake, Lower Hathaway Creek, and Point Arena (U.S. Fish and Wildlife Service 1991). Currently, at least 26 apparently separate populations are known (Table 2), including populations along Mills Creek, Mallo Pass Creek, Irish Gulch, Alder Creek, Manchester Beach State Park, Lagoon Lake, Lower Hathaway Creek, Point Arena, lower and middle Brush Creek, and Hathaway Creek (Figure 2). The size of the total known population is roughly estimated to be 200 to 500 animals (D. Steele, T. Wooster, unpublished data).

C. HABITAT

Mountain beaver live in underground burrow systems with openings under vegetation (Scheffer 1929), often on steep north-facing slopes or in gullies (Steele 1986). The burrows are found in moist areas with well-drained soil (Ingles 1965). Studies suggest that the most important factors in habitat use are a cool thermal regime, adequate soil drainage, and abundant food supply (Beier 1989), a high percent cover of small diameter woody material, and soft soil (Hacker and Coblentz 1993). Mountain beaver require large amounts of lush vegetation for survival (Voth 1968). Distribution limits are associated with rainfall and soil conditions that promote lush vegetation and high humidity within burrows (Voth 1968).

Within the range of the Point Arena mountain beaver, the historical conversion of heavily forested areas to agriculture, including cattle grazing, may have altered the distribution of populations (T. Wooster *in litt.* 1997). To date, no burrow systems of the Point Arena mountain beaver have been found in a forest setting of large trees with large root systems (T. Wooster *in litt.* 1997). One burrow system was found in Mills Creek where several of the entrances were found under the live roots of a redwood tree, but the remainder of the system was away from the tree in open, low vegetation (T. Wooster *in litt.* 1997). Studies done on Oregon subspecies of mountain beaver (Humboldt mountain beaver and Pacific mountain

Table 2. Known populations of the Point Arena mountain beaver.

POPULATION ID #	SITE	AREA (ha)[1]	TOTAL # BURROWS[2]	HABITAT TYPE[3]	POTENTIAL THREATS	OWNERSHIP	ESTIMATOR	YEAR	COMMENTS
1	Bridgeport Landing			CS		Private			Possible easement
2	Mills Creek	0.02	20+	Nettles, Herbs	Grazing, Fire, Timber Harvest	Private	Wooster	1992, 1994, 1996, 1997	
3	Mallo Pass Creek	1.50	55+	CS, ferns	Water Diversion, Roads, Fire	Private	Steele, Booth, Wooster, Shively	1985, 1986, 1987, 1992, 1993, 1994, 1996, 1997	
4	Irish Gulch	1.50	50	R, C	Housing Development, Feral Pets, Roads, Trails	Private	Steele, Wooster, McKay	1981, 1985, 1986, 1994, 1997	
5	Bluff between Irish Gulch and Alder Creek	0.50	NA[4]	CS	Grazing[5], Fire	CDPR[6]	Wooster	1992, 1994, 1997	"Riddled with burrows"
6	Alder Creek, 1st north tributary (Owl Creek)	0.05	NA	NA	Grazing, Timber Harvest, Fire	Private	Wooster	1992, 1997	Two small sites
7	Alder Creek, 2nd north tributary (Wildcat Creek)	0.13	74+	Alder, ferns	Grazing, Timber Harvest, Fire	Private	Wooster	1992	Three small sites
8a	Alder Creek	2.90	100+	CS, R	Grazing, Roads, Herbicides, Foot Traffic	CDPR, Private	Steele, Wooster	1981, 1985, 1986, 1993, 1994, 1996	Fault area
8b	Alder Creek (MCI Study site)	2.12[6]	324+[7]	CS	Fire, Mud Slides, Human Access	CDPR	Fitts	1997	MCI Monitoring, Robust population
9a	Manchester Complex (Manchester Beach)	0.75	18	CS, CSt	Campground, Feral Pets, Roads, Trails	CDPR	Steele	1989, 1994	Pedestrian impacts
9b	Manchester Complex (Davis Pond)	0.50	40	CS, CSt	Human Access	CDPR	Steele	1985, 1989	Skull found
9c	Manchester Complex (AT&T Facility)	1.50	250+	CS, CSt	Construction, Human Access, Operation and Maintenance, Storm Damage	CDPR, Private	Steele	1985, 1989, 1996	MCI Monitoring
9d	Manchester Complex (AT&T Facility, MCI Study site)	2.70	272+[7]	CS, CSt	Fire, Operation and Maintenance, Feral Pets, Human Access	Private	Fitts	1997	MCI Monitoring, Point Arena mountain beaver utilizing ice plant
9e	Manchester Complex (Kinney Road, MCI Study site)	1.93[6]	237+[7]	CS, CSt	Fire Trails, Feral Pets, Human Access	CDPR	Fitts	1997	MCI Monitoring
9f	Manchester Complex (KOA Campground)	0.10	NA	CS	Pets, Fire	CDPR	Steele	1986	Small site
10	Middle Brush Creek	2.90	NA	R	Pets, Herbicides, Streambed Disturbance	Private	Steele[8], Wooster	1981, 1992, 1997	

POPULATION ID #	SITE	AREA (ha)[1]	TOTAL # BURROWS[2]	HABITAT TYPE[3]	POTENTIAL THREATS	OWNERSHIP	ESTIMATOR	YEAR	COMMENTS
11	Lagoon Lake	0.75		CS	Feral Pets Fire Trails	CDPR	Steele	1985 1986	Recent fire
12	Lagoon Creek	2.20	NA	CS	Grazing Utility Corridor Fire	Private	Steele	1992	
13	Lagoon Creek, south tributary	5.30	NA	CS	Grazing Utility Corridor Fire	Private	Steele	1992	
14	Garcia River, 3rd south tributary	2.30	NA	CS R	Grazing Fire	Private?	Steele Wooster	1992 1993 1994 1997	
15	Garcia River 2nd south tributary	2.00	NA	CS R	Grazing Fire	Private	Steele	1992	
16	Lower Hathaway Creek	1.00	43	CS R	Feral Pets Roads Grazing	Private	Steele Wooster	1981 1985 1986 1994 1996	
17a	Hathaway Creek 1st south tributary (Levine Property)	0.05	1	CS	Grazing? Fire	Private	Steele Wooster	1994 1995 1997	Possible easement
17b	Hathaway Creek, 1st south tributary (Atwood Ranch)	1.0	3	R	Water Diversion Pets Fire	Private	Fitts	1994	Travel corridor
18	Hathaway Creek, 1st north tributary	7.30	22	R CS	Grazing Fire	Private	Steele, Wooster Kelly	1992, 1993 1994, 1996	Two small sites
19	Upper Hathaway Creek	3.0	NA	CS	Grazing Fire	Private	Steele Wooster	1992 1993, 1994 1996, 1997	
20	Point Arena Creek	1.50	97	CS	Grazing Herbicides Feral Pets Roads	City of Pt Arena, Private	Steele Wooster	1985 1986 1994	Dog killed Point Arena mountain beaver
21	Garcia River	0.05	36+	R	Fire Grazing Human Access Floods	Private	Mohr Wooster	1996, 1997	
22	Spanish Creek	0.5	481	CS	None	Private	Wooster	1995 1996	
23	Garcia River 1st south tributary	5.50	NA	R	Grazing Fire	Private	Steele	1992	Drifting disturbance
24	Lower Brush Creek	0.10	NA	R	Grazing Human Disturbance Streambank Erosion Disturbance	Private	Steele	1981	
25	Garcia River Windy Hollow Rd	4.82	NA	CS	Cattle Grazing	Private?	Wooster	1997 1998	
26	Mill Creek	0.01	NA	R	Encroachment of dense forest into riparian area	Private	Wooster	1997	

[1] Area (ha) - Area (in hectares) with sign of mountain beaver activity/burrows; [2] Total # Burrows - estimation techniques vary (transect line data, rough estimates of burrow numbers).
[3] CS=Coastal Scrub, R=Riparian, CSt Coastal Strand C Coniferous; [4] NA - Not Available, [5] CDPR - California Department of Parks and Recreation; Area = total area of study site; [6] Area – total number of burrows = total number of active burrows; [8] Steele, unpubl. data (1992) [7] Wooster, unpubl. data (1992, 1993)

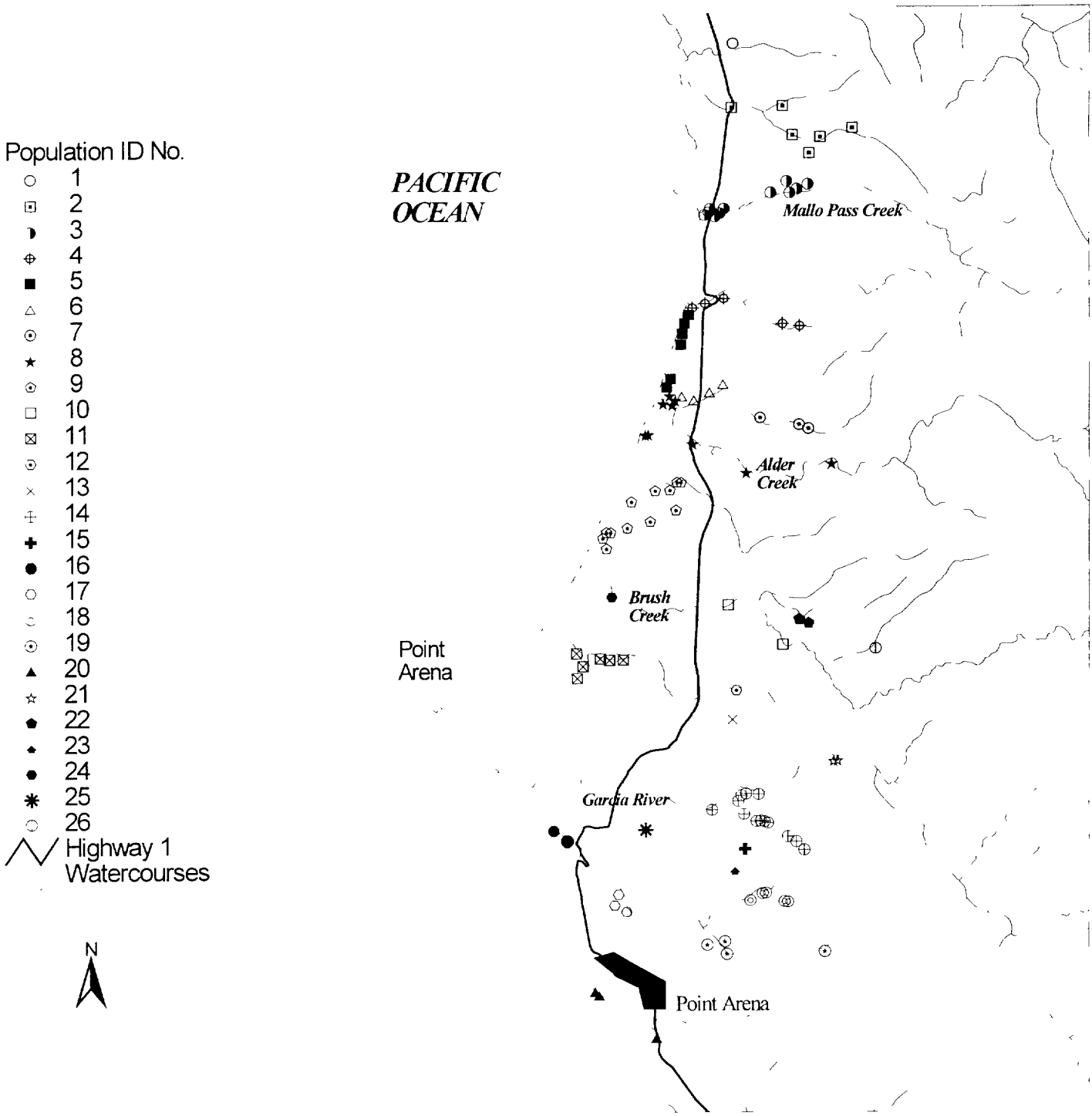

Figure 2. Known distribution of Point Arena mountain beaver, Mendocino County, California (California Department of Fish and Game, Point Arena Mountain Beaver Database, 1998).

beaver), have confirmed that populations are very low in dense conifer stands (Hooven 1973). Brushy openings in stands provide suitable habitat that often supports populations of these subspecies (Hooven 1973).

Populations of the Point Arena mountain beaver are found in a variety of habitat types including coastal scrub, coastal strand, conifer forest, and riparian plant communities (Steele 1986). The vegetation at the Point Arena, Lower Hathaway Creek, Lagoon Lake, Alder Creek, and Mallo Pass Creek sites is coastal scrub. Common coastal scrub species include cow parsnip *(Heracleum lanatum)*, coyote brush *(Baccharis pilularis)*, wax myrtle *(Myrica californica)*, California blackberry *(Rubus ursinus)*, salmonberry *(R.. spectabilis)*, and thimbleberry (*R. parviflorus*). Riparian vegetation is present at several population locations. Common species include skunk cabbage *(Lysichitum americanum)*, horsetail *(Equisetum telmateia)*, willows *(Salix lasiolepis* and *S. sitchensis)*, red alder *(Alnus rubra)*, wood rose (*Rosa gymnocarpa*), and California blackberry. The Irish Gulch site has a conifer overstory with Douglas-fir *(Pseudotsuga menziesii)*, grand fir *(Abies grandis)*, and Bishop pine *(Pinus muricata)*. The understory includes elements of both riparian and coastal scrub habitats, including thimbleberry, stinging nettle *(Urtica* sp.*)*, sword fern *(Polystichum munitum)*, salmonberry, and elderberry *(Sambucus* sp.*)*.

At least three mountain beaver sites at Manchester Beach State Park occupy a habitat type that differs from that of other populations (Steele 1986). These populations are found in stabilized dunes dominated by bush lupine *(Lupinus arboreus)* and other coastal strand species including coyote brush, coast goldenrod *(Solidago spathulata)*, dune grasses, and ice plant *(Carpobrotus* sp.*)*. The soil on these dunes is more stabilized and compacted than that found on open dunes, there is substantially more ground cover, and burrow openings are found under shrubs. These sites offer less cover, fewer food plants, and poorer burrowing conditions than other *A. r. nigra* sites, but these small populations seem to have persisted over 10 years of observation (D. Steele pers. obs.).

A recently discovered population (population i.d. #21 in Table 2), on the south side of the Garcia River, is about 15 meters (50 feet) from the river, between a riparian zone dominated by red alder and California laurel (*Umbellularia*

californica), and a hill slope forested with redwood (*Sequoia sempervirens*) and grand fir. The colony area is covered by dense, 1.0 to 1.2 meters (3 to 4 feet) high vegetation dominated by cow parsnip, stinging nettle, horsetail (*Equisetum arvense*), and California blackberry. Shrubs of cascara (*Rhamnus purshiana*) and coyote brush surround the site on all but the north side (A. Mohr pers. comm. 1996).

Large areas of seemingly suitable habitat are unoccupied by mountain beaver. Camp (1918) noted that (in observations of the Point Reyes mountain beaver) "overcrowded conditions may prevail in one place, while territory of the same character remains unoccupied nearby".

In their 5-year study of Point Arena mountain beaver, Northen and Fitts (1993, 1998) investigated the types of vegetation found in association with this subspecies. In their studies, vegetative factors were analyzed in terms of their relationship with total burrows at three sites: Alder Creek, Kinney Road, and the AT&T site.

Results indicated that burrows are most common in moderately tall vegetation of mesic sites; presence of burrows correlated significantly with plant height on all sites. According to Northen and Fitts (1993), a grouping of short plants on the southern portion of Alder Creek was negatively correlated with burrows, but many of the plant species were positively associated with each other, including California poppy (*Eschscholzia californica*), spring vetch (*Vicia sativa*), English plantain (*Plantago lanceolata*), sheep sorrel (*Rumex acetosella*), and geranium (*Geranium* spp.).

Overall, the Kinney Road study site (Northen and Fitts 1993) showed the largest number of plant species that strongly correlated both positively and negatively with mountain beaver activity, suggesting that the environmental gradient is steeper between "good" and "bad" habitat on this site than the two other sites. Positive association was observed with Pacific reedgrass (*Calamagrostis nutkaensis*), coyote brush, yellow bush lupine, all tall perennials, and many smaller associate species. Northen and Fitts (1993) speculate that the larger plants help establish a "microclimate" in which some smaller food plants grow (*e.g.*,

miner's lettuce (*Claytonia perfoliata* spp. *perfoliata*)).

Northen and Fitts (1993) revealed that at least two different associations of taller plants support mountain beaver; an area dominated by California reedgrass on Kinney Road, and an area having moist coastal bluff associates on Alder Creek. Northen and Fitts (1993) hypothesize that the Point Arena mountain beaver is more restricted to plant species *per se*, than to the soil and climatic conditions that favor such plant associations.

In their 1997 study, Northen and Fitts (1998) found that bugle hedge nettle (*Stachys ajugoides* var. *rigida*) seemed to be a preferred plant, and was common on all three study sites. Bush lupine and seaside woolly sunflower (*Eriophyllum staechadifolium*) were also found to be frequently utilized by the mountain beaver. The data from their 5-year study show that populations have increased on sparsely vegetated coastal strand on the AT&T site. Here, bush lupine, coyote brush, ice plant, and wild radish (*Raphanus sativus*), as well as various grasses, have been found to be important for cover, and possibly for nesting material and food.

Other rare animal and plant species may occur in the vicinity of Point Arena mountain beaver habitat. These species are birds, including the western snowy plover (*Charadrius alexandrinus nivosus*), marbled murrelet (*Brachyramphus marmoratus*) (B. Valentine *in litt.* 1997), and northern spotted owl (*Strix occidentalis caurina*) (B. Valentine *in litt.* 1997); amphibians, including the foothill yellow-legged frog (*Rana boylei*); fish, including the tidewater goby (*Eucyclogobius newberryi*), Central California coast coho salmon (*Oncorhynchus kisutch*) (B. Valentine *in litt.* 1997), and Northern California steelhead trout (*Oncorhynchus mykiss*) (B. Valentine *in litt.* 1997); invertebrates, including Behren's silverspot butterfly (*Speyeria zerene behrensii*); and plants, including swamp harebell (*Campanula californica*), Mendocino Coast Indian paintbrush (*Castilleja mendocinensis*), coast lily (*Lilium maritimum*) (S. Flowers *in litt.* 1997), maple-leaf sidalcea (*Sidalcea malachroides*) (S. Flowers *in litt.* 1997), fringed false-hellebore (*Veratrum fimbriatum*) (S. Flowers *in litt.* 1997), pink sand verbana (*Abronia umbellata*) (S. Flowers *in litt.* 1997), and Blasdale's bent grass (*Agrostis blasdalei*) (S. Flowers *in litt.* 1997).

D. LIFE HISTORY/BIOLOGY/ECOLOGY

Little research has been done on the Point Arena mountain beaver. The only historical records available are from Taylor (1914 and 1918), who first described the subspecies; Camp (1918), who made some natural history observations; and Pfeiffer, who in 1951 captured two animals for reproduction studies (Table 3). Some basic surveying and monitoring have been done since 1982. Most studies have been conducted on the more abundant subspecies of *Aplodontia rufa,* primarily those in Oregon and Washington. Nevertheless, knowledge of the biology and ecology of the genus is limited and often based solely on anecdotal records. Given its ancient lineage, unusual physiological characteristics, unique food niche and fascinating behavior, this amazing animal could provide insights in a variety of fields.

Burrows

Mountain beaver are seldom seen, being most often identified by extensive underground burrow systems that have numerous openings to the outside (Taylor 1914, Camp 1918). These openings are approximately 15 centimeters (6 inches) in diameter and occur every few feet (Racy 1922). Burrows are usually in moderately firm soil where digging is easy, but mountain beaver have been known to dig in other soil types, even sticky clay (Hubbard 1922). Tunnels generally run within 0.3 meter (1 foot) of the surface, but sometimes descend to depths of 1 to 1.5 meters (3 to 5 feet) (Racy 1922, Martin 1971). Burrow systems vary in size. Camp (1918) reported a burrow system of *A. r. phaea* that extended for more than 100 meters (330 feet) in one direction. The burrow territory of a single animal, however, probably does not exceed 25 meters (80 feet) (Voth 1968). Burrow excavations have shown that mountain beaver burrows contain narrow tunnels (Ingles 1965) that seem to be related to animal size, so that the whiskers can reach both sides (Voth 1968). Tunnels seem to meander with no apparent plan (Scheffer 1929). The direction, extent, and placement of runways and openings is determined by external factors such as obstructions, soil composition, bank slope, etc. (Scheffer 1929). Burrow openings may be used for entrance and exit, for pushing out excavated earth or debris, or may result from erosion or cave-ins (Scheffer 1929). Burrow activity decreases in the winter (Scheffer 1929).

Table 3. Chronology of research on the Point Arena mountain beaver.

Author	Reference	Year	Comments
Taylor, W.	A previously undescribed *Aplodontia* from the middle north coast of California. University of California Publications in Zoology 12:297-300.	1914	Taxonomy
Camp, C.	Excavations of burrows of the rodent *Aplodontia* with observations on the habits of the animal. University of California Publication in Zoology 17(18):517-535.	1918	Natural history observations, specimens collected
Pfeiffer, E.	The reproductive cycle of the female mountain beaver. Journal of Mammalogy 39(2):223-235.	1958	Reproduction, specimens collected
Steele, D.	An ecological survey of mountain beaver (*Aplodontia rufa)* in California. Non-game Wildlife Investigations, Job IV-16.1, California Department of Fish and Game.	1982	Preliminary survey based on museum records
Steele, D.	A review of the population status of the Point Arena mountain beaver (*Aplodontia rufa nigra*). Final Report No. 10188-5671-5, U.S. Fish and Wildlife Service, Sacramento Endangered Species Office.	1986	Population surveys
Steele, D.	An ecological survey of the Mountain Beaver (*Aplodontia rufa*) in California, 1970-83. Wildlife Management Division Administrative Report No. 89-1.	1989	Revision of 1982 report
Northen, P. and K. Fitts	Monitoring of the Point Arena mountain beaver for MCI Telecommunications Corp. (Year One through Year Five Reports)	1993 - 1998	5-year mitigation monitoring

Voth (1968) found that mountain beaver cut and store about 2.5 times more food than they eat. However, through part of the winter season or during the full moon, much less is harvested than is eaten, suggesting storage facilities for as much as a 2-week supply of forage. Storage locations are numerous, including outside caches, covered caches, and food chamber caches (Voth 1968).

Mountain beaver are not colonial animals and exhibit little social interaction (Scheffer 1929). The burrows of several animals are often connected, which led early investigators to misname them "colonies" (Camp 1918), a misconception that continues to create confusion. Mountain beaver exhibit a "contagious" distribution, that is, the presence of one or more animals in a given area seems to encourage the settlement of others (Goslow 1964). However, they are solitary animals, except during a short breeding period (Godin 1964).

Mountain beaver are not found in continuous burrow systems, one after the other (T. Wooster *in litt* 1997). Populations are generally found in a "clumpy" distribution (Cafferata 1992) with groups of burrow systems separated by varying distances.

Population Density

There are no hard data available on the density of the Point Arena mountain beaver population. Population estimates are crude, and have been based on observations and conservative counts of approximately 5 to 10 burrow openings per animal. The burrow openings that honeycomb the ground may appear to indicate a large population, but this is probably not the case. Population density is difficult to determine, because several animals may share the same contiguous burrow system with each individual's portion having many openings to the outside. Camp (1918) found a total of 11 *A. r. phaea* in a burrow system measuring 30 by 152 meters (100 by 500 feet), with over 100 burrow entrances. Population estimates have ranged from 0.61 to 0.81 individuals per hectare (0.25 to 0.33 per acre) in studies of *A. r. rufa* and *A. r. pacifica,* respectively (Neal and Borrecco 1981, Lovejoy and Black 1979), to 3.6 to 4 individuals per hectare (1.5 to 1.6 per acre) in a study of *A. r. phaea* (Camp 1918). Temporarily high densities have been estimated at 6.5 per hectare (2.6 per acre) in studies of *A. r. pacifica*

(Voth 1968). At least one small site in Kings County, Washington, had a mountain beaver density of 14 per hectare (5.7 per acre) (Morris *et al.* 1995).

Nest

There are five types of underground chambers within mountain beaver burrows—nest, food, refuge, fecal pellet, and earth ball storage (Voth 1968). The nest is an enlarged chamber, often 50 to 60 centimeters (20 to 25 inches) in diameter and 36 centimeters (14 inches) high, and is usually deeper than other parts of the burrow (Voth 1968). Nests used by adults may contain as much as 0.3 square meter (1.2 square feet) of vegetative material, while subadult nests contain less (Martin 1971). Voth (1968) found differences between the nests of males and females, both in nesting material and the fact that female nests had fewer parasites. Nests are constructed of two shells—an outer shell of coarse vegetation and an inner shell with soft, dry vegetation (Martin 1971). Only one animal lives in a nest (Hubbard 1922, Martin 1971).

Mountain beaver spend about 75 percent of their time in the nest chamber (Ingles 1959, Kinney 1971). The burrow system and nest chamber offer a cool, moist refuge in the summer and a warm and protected environment during the winter (Johnson 1971).

Burrows also contain earth ball storage chambers in which "mountain beaver baseballs" are stored (Voth 1968). These "baseballs" are rocks or lumps of hard clay encountered while digging. They usually weigh about 80 to 200 grams (3 to 7 ounces). They may be used for two purposes: 1) to close nest-feeding chambers during the animal's absence, and 2) to provide abrasive material to trim their incisors (Camp 1918, Voth 1968).

Burrow Community

Mountain beaver burrow systems support a community of vertebrates and other animals (Scheffer 1945). Skunks, salamanders, moles, voles, shrews, chipmunks, ground squirrels, mice, woodrats, gophers, weasels, mink, hares, and brush rabbits have all been recovered from mountain beaver burrows (Pfeiffer 1953, Voth 1968,

Whitaker *et al.* 1979, Maser *et al.* 1981). These animals may have been present as commensals, predators, or by accident.

A unique invertebrate fauna also associates with mountain beaver. Perhaps the most striking example is *Hystricopsylla schefferi,* the largest flea in the world, which grows to 9 millimeters (0.5 inch) in length (Scheffer 1929). An invertebrate community also lives in the fecal pellet chambers and aids in decomposition (Voth 1968). Several species of host-specific mites are associated with mountain beaver (Whitaker *et al.* 1979). Other parasites include ticks and tapeworms (Canaris and Bowers 1992). Neither lice (Scheffer 1969) nor nematodes (Canaris and Bowers 1992) have been identified from mountain beaver. The parasite community of the Point Arena mountain beaver has not been investigated.

Cleanliness

Mountain beaver are fastidious creatures (Wright 1969) that keep their tunnels clean and free of debris (E. Ingles 1960). Special blind tunnels are used as refuse and fecal chambers (Martin 1971). Unused portions of vegetation are placed with other discarded materials in the refuse chamber (Voth 1968) or pushed out of burrow openings (D. Steele pers. obs).

Defecation is accomplished in a precise manner in which the animals takes each fecal pellet in its mouth as it is extruded from the anus and tosses it with a flip of its head into the fecal pile (Kindschy and Larrison 1961). This is done for 2 to 5 minutes at a time. An average of 40 to 160 pellets during a 24-hour period is produced in the field (Voth 1968). One out of every 10 to 13 pellets is reingested directly as it is expelled (Ingles 1961). These special pellets are soft, green and larger than the brown, hard pellets which are discarded. The function of this coprophagy is not known, but it may allow maximum use of nutrients and vitamins contained in the food (Ingles 1961). A number of other rodents, as well as rabbits and hares, also form a special kind of feces from the contents of the caecum (the blind pouch which forms the beginning of the large intestine) which is reingested directly from the anus (Schmidt-Nielsen 1975). Studies have shown that coprophagy in these other animals has great nutritional importance, providing

vitamins, and increasing digestibility, protein utilization, and nitrogen retention.

Foraging

Mountain beaver are strict herbivores (Ingles 1965). They are known to eat a wide range of plant species, which often includes just about all the species within reach of the burrows (Camp 1918, Scheffer 1929). Herbaceous plants are eaten whole, while woody plants are discarded after the bark has been peeled off for food (Scheffer 1929). Clipped vegetation can often be observed near burrow systems (D. Steele pers. obs.).

Mountain beaver are voracious eaters (E. Ingles 1960). Studies have shown that 73 percent of their active time is spent gathering, handling and eating food (Ingles 1959). They seldom venture far from their burrows, which may open directly into suitable vegetation (Camp 1918, Martin 1971). The animals forage for short distances above ground and then carry or drag the cut vegetative material, which may vary in length from a few inches to several feet, to the burrow (Scheffer 1929). There, the material is cut into short sections at the burrow entrance and carried into the burrow to be eaten or stored (Scheffer 1929, Martin 1971). Animals may eat vegetation outside of the burrow, but most often consume it in feeding chambers, adjacent to the nest (Martin 1971).

While mountain beaver gather many of the plants in their vicinity, there seems to be a decided preference for certain types of plants (Camp 1918, Voth 1968, Allen 1969) including shrubs and smaller trees (Crouch 1968). The coastal mountain beaver subspecies are predominantly fern and root eaters (Camp 1918). Some of their preferred foods include plants that are unpalatable or toxic to other mammals such as bracken fern (*Pteridium aquilinum*), sword fern, stinging nettles, thistles (*Cirsium* spp.), corn lily (*Veratum* sp.), salal (*Gaultheria shallon*), foxglove (*Digitalis purpurea*), larkspur (*Delphinium* sp.), and skunk cabbage (Voth 1968, Lacy 1991). This gives the mountain beaver a largely uncontested food niche (Johnson 1971). This ability to consume plants with such a variety of toxic secondary compounds is unusual and may involve a metabolic "cost" to the animal (Lacy 1991).

Many observers have described a behavior called "haystacking," in which mountain beaver cut bundles of plants and lay them on logs or on the ground to wilt (Camp 1918, Godin 1964, Voth 1968). Haystacking has generally been assumed to provide dried vegetation for nesting or food storage (Scheffer 1929). Voth (1968), however, suggests that the purpose of haystacking is to regulate the moisture content of the food by mixing wilted with fresh vegetation.

Activity

Aplodontia are mostly nocturnal animals but they are seen in the daytime (Ingles 1959, Wright 1969). During a study by Ingles (1959), mountain beaver exhibited 6 to 7 activity periods in a 24-hour period, with a total of 8 to 9 active hours and 15 to 16 hours of rest. The longest rest period was in the daytime (4.25 hours) and the longest activity period (2.75 hours) at night. This study showed that *Aplodontia* may be active outside its burrow at any hour, but is 50 to 60 percent more active at night (Ingles 1959).

Bright sunlight appears to make *Aplodontia* drowsy (Godin 1964). Mountain beaver have been observed to stop while foraging or even in mid-flight, nod, and then fall asleep in open, unprotected areas. This seemingly nonadaptive "narcolepsy" may be a reaction to bright light, warmth, panic or other conditions (Goslow 1964, D. Steele pers. obs.).

Mountain beaver do not hibernate (Scheffer 1929). They remain active during the winter (Hall and Kelson 1959, Ingles 1965), although activity decreases during this time of year (Voth 1968).

Data from radiotelemetry studies on animals in Washington showed that 90 percent of the animals remain within 24 meters (80 feet) of their nest chamber (Martin 1971). The average home range (the above-ground area in which the animal forages) varies depending on habitat and has been reported as 0.08 to 0.16 hectares (0.2 to 0.4 acre) with no apparent difference in mean ranges of males and females (Martin 1971, Neal and Borrecco 1981). A scrotal male moved 197 meters (350 feet) from his nest as compared to a maximum movement of 49 meters (160 feet) for all other animals studied (Martin 1971). Mountain beaver

walk with a wide, shuffling gait, "like a bear" (Fisler 1965). They can run backwards as quickly as forward, an obvious advantage for narrow tunnel living (Camp 1918, D. Steele pers. obs.). They can also climb trees (L. Ingles 1960), sometimes to a height of 4.6 meters (15 feet) (Herlocker 1950).

While not aquatic animals, mountain beaver do not avoid water. For the northern subspecies, surface water is known to be diverted down burrows (Herlocker 1950), and they wade through partially flooded tunnels going about business as usual (Scheffer 1929). They traverse puddles and streams and can swim (Scheffer 1929, E. Ingles 1960). When free water is available, mountain beaver bathe regularly while digging or foraging (Goslow 1964).

Thermoregulation

One explanation for the limited distribution of mountain beaver is their limited ability to thermoregulate (*i.e.*, regulate body temperature) (Johnson 1971, Kinney 1971). They seem to tolerate low temperature extremes better than high ones, with a lethal body temperature of about 42 degrees Centigrade (108 degrees Fahrenheit) (Johnson 1971). When exposed to high ambient temperatures, animals in captivity respond by either reducing their activity and changing their body conformation (sprawling out their body), or by attempting to escape (Kinney 1971). Mountain beaver lack such behavioral responses as panting or salivation to reduce heat stress (Johnson 1971) and do not sweat. An annual summer molt decreases insulation, letting them tolerate greater heat (Johnson 1971).

Burrows provide a highly stable microclimate (Kinney 1971). Tunnels, and especially the nest chamber, which is lower in elevation and insulated with nesting material, maintain a stable temperature gradient (Kinney 1971). Daily temperature variation never exceeds 4 degrees Centigrade (7 degrees Fahrenheit), and the mean annual range is from 2 to 14 degrees Centigrade (36 to 57 degrees Fahrenheit) (Johnson 1971). The burrow maintains a relative humidity of nearly 100 percent (Voth 1968).

The Point Arena area has a relatively mild climate due to the buffering effect of the ocean. Little range in temperature occurs either daily or annually, with

average temperatures between 7.0 to 16.2 degrees Centigrade (45 to 61 degrees Fahrenheit) (U.S. Weather Bureau 1963). Point Arena has one of the longest growing seasons in California, over 300 days annually (Steele 1989).

Osmoregulation (Water Balance)

The mountain beaver has a very simple kidney structure that lacks the anatomical features necessary to concentrate urine effectively (Pfeiffer *et al.* 1960, Schmidt-Nielson and Pfeiffer 1970). It has been suggested that *Aplodontia* might have been one of the first mammals to have a primitive renal mechanism for concentrating its urine (Dicker and Eggleton 1964). One consequence of this inability to concentrate urine is that mountain beaver require large quantities of water to replace that lost through excretion (Nungesser *et al.* 1960, Dolph *et al.* 1962, Nungesser and Pfeiffer 1965), a need that may be a major reason why mountain beaver are restricted to moist environments (Pfeiffer 1965). Mountain beaver consume about 33 percent of their body weight in water daily and excrete most of this in urine (Nungesser and Pfeiffer 1961). Animals in captivity are known to drink a great deal of free water (Pfeiffer 1953, Schmidt-Nielson and Pfeiffer 1970). If free water is withheld, animals in captivity *(A. r. pacifica)* have survived for periods of several months without apparent distress, obtaining water entirely from the succulent vegetation they consume (Fisler 1965, Johnson 1971).

The importance of free water for Point Arena mountain beaver is not known. Some populations seem to live a considerable distance from free water. At these locations, free water comes from ephemeral puddles that form during rainstorms. The marine climate around Point Arena includes significant amounts of moisture from fog. Condensation of fog may provide adequate free water.

Behavior

Mountain beaver can be aggressive animals, have been called "cantankerous" or "vicious" (Smurthwaite 1986), and are swift, strong biters (Maser *et al.* 1981). However, captive animals have been reported to become quite docile and even eat out of people's hands (Davis 1941, Herlocker 1950), although they do not exhibit affection or friendliness (Herlocker 1950, Smurthwaite 1986).

Territorial behavior is strong in mountain beaver (Nolte *et al.* 1993). Pfeiffer (1953) reports that males will kill females or other males if they are placed together in the same cage. Battles are common when animals encounter one another (Herlocker 1950). Although nests are defended fiercely, it is thought that tunnels are used in common by animals in a burrow system (Scheffer 1929). The response to meeting in a tunnel is unknown. Animals may forage in the same home range and meet with no apparent territorial response (Martin 1971). The fact that they tend to live in close association suggests some level of tolerance, perhaps based on chemical cues.

Mountain beaver have two scent glands at the base of their tail (Racy 1922). These give the animals a strong body odor, and may be a primary means of recognizing their own kind (Scheffer 1929). A sweet, musky smell in the urine is distinctive (Kindschy and Larrison 1961), and becomes accentuated during the breeding season (Fisler 1965). Scent-marking behavior has been observed (Nolte *et al.* 1993).

Mountain beaver produce large amounts of a milky eye secretion, which can at times cause their eyes to close. This secretion may be an indication of stress in captive animals (D. Steele pers. obs.), or a defense against eye damage while excavating (Maser *et al.* 1981). It has also been suggested that the eye secretion may induce a tonic immobility to avoid attack or may function in chemical communication (Nolte *et al.* 1993).

Senses

As is true of many burrowing animals, mountain beaver have highly developed tactile senses and will respond quickly to the slightest disturbance of their guard hairs or whiskers (Camp 1918, Scheffer 1929). Their senses of smell and taste also seem to be well developed. They will frequently raise their noses to sniff the air (Camp 1918, Voth 1968), and feeding is reduced when food is exposed to predator odors (Epple *et al.* 1993) or other repellent material (Campbell and Evans 1989). Their eyesight is poor and animals will frequently bump into objects in their path (Fisler 1965). Night vision is better than day vision (Voth 1968).

Although mountain beaver show little response to sharp noises (Fisler 1965), little is actually known about their auditory acuity. The possibility that mountain beaver can detect low or even very low frequencies is under investigation (R. Heffner pers. comm.). *Aplodontia* also has a very large and unique cochlear nuclear complex in the brain, which may indicate the ability to detect subtle changes in air pressure, perhaps an adaptation to burrow living (Merzenich *et al.* 1973).

Several types of vocalizations have been attributed to mountain beaver, including grunts, growls, cough-like sounds, sharp, high pitched coughs (Fisler 1965), and a harsh chattering-grating sound produced by gnashing the teeth (Maser *et al.* 1981). Scheffer (1929) states that mountain beaver do not whistle, but Kindschy and Larrison (1961) reported a shrill, whistle-like squeal from their captive animal. Mountain beaver do not make booming noises, as erroneously believed by early observers (Scheffer 1929).

Demographics

No information is known on the demographics of the Point Arena mountain beaver. In general, mountain beaver have an unusually low reproductive rate for a rodent (Pfeiffer 1958). Females typically do not breed until their second year (Pfeiffer 1958), and the breeding season is short and well-defined (Lovejoy and Black 1979). Females are monestrous, that is, they produce only one litter a year, and all breeding females ovulate at about the same time (Pfeiffer 1958). The gestation period is 28 to 30 days (Scheffer 1929, Pfeiffer 1958). Litters consist of two, three, or rarely four (Scheffer 1929, Dalquest 1948) or five (Herlocker 1950, Maser *et al.* 1981) offspring.

Newborn *Aplodontia* are naked and blind at birth (Cramblet and Ridenhour 1956, Lovejoy *et al.* 1978). Growth is rapid, and within 2 weeks, newborns are completely covered with hair (Lovejoy and Black 1974). Lactation extends for about 2 months (Pfeiffer 1958, Lovejoy and Black 1974). Pregnant and lactating females have a dark patch of mammary hairs around the nipples, which may be a physiological relict lost by more advanced mammals (Pfeiffer 1955).

Juveniles have fine, gray fur, but within a year most have a coarse pelage and are difficult to distinguish from adults (Lovejoy and Black 1974). Pfeiffer (1958) identified four age classes, based on the degree of closure of the epiphyseal femoral suture and tooth wear. Voth (1968) identified eight classes based on weight. Lovejoy and Black (1979) worked with three age groups based on both weight and external characteristics and questioned the validity of weight classes. Mountain beaver are thought to live at least 5 to 6 years (Lovejoy and Black 1979).

Male and female *Aplodontia* are not easily distinguished by external characteristics (Scheffer 1929, D. Steele pers. obs.), except in the breeding season when it is easy to distinguish male and female genitalia when visible (Godin 1964). Females are on average slightly smaller (Lovejoy and Black 1974), but not enough to be a diagnostic difference. During the breeding season, the sexes of adults can be distinguished because the testes in males, which are normally abdominal, become semiscrotal (Pfeiffer 1956, Lovejoy *et al.* 1978). Pregnant and lactating females can be identified by the dark hair around the nipples (Pfeiffer 1955).

The sex ratio of juvenile *Aplodontia* is 1:1 (Lovejoy and Black 1979). However, trapping results of adult animals have indicated a skewed sex ratio of 3:1 favoring males (Hubbard 1922). Other trapping studies have also shown a preponderance of males, at levels of 63.6 percent (Voth 1968), and 61.9 percent (Lovejoy and Black 1979). This may be a true representation of the population and not an artifact of trapping (Lovejoy and Black 1974), but no explanation has been given for this phenomenon.

No data are available on reproduction of Point Arena mountain beaver. The breeding season is thought to be from about mid-December to early January, based on data collected by Pfeiffer (1958) on *Aplodontia rufa phaea,* the Point Reyes mountain beaver. Gestation would then be from about mid- to late-January, and animals born in late January might begin to forage for themselves by early April. Size of litters, survival of young, sex ratio and other demographic information are unknown for the Point Arena mountain beaver.

Juvenile dispersal is generally thought to be completed by early fall. Also, dispersal of juvenile *Aplodontia* is thought to be primarily through excavation within the burrow system (Blair 1953), although some overland migration is seen (Martin 1971). Of 11 subadult animals monitored through radiotelemetry, 9 remained near the initial site of capture while 1 moved as far as 564 meters (1,850 feet). There seems to be no real difference between the movement of males and females (Martin 1971).

Dispersing animals may make several attempts to establish a nest before finding a suitable situation (Lovejoy and Black 1979, Martin 1971). Once the animal establishes its nest site, the site is used for long periods of time (Martin 1971). Animals may move quickly into an unoccupied nest (Martin 1971, Nolte *et al.* 1993).

Mortality factors are not easily studied in underground species. Mountain beaver are known to be prey of bobcats *(Lynx rufus)*, fishers (*Martes pennanti*), coyotes (*Canis latrans*), great horned owls (*Bubo virginianus*) (Ingles 1965), striped skunks *(Mephitis mephitis)*, eagles (Accipitridae family), minks *(Mustela vison)*, and other predators (Ingles 1965, Knick 1984). Little is known of other mortality factors such as disease.

Aplodontia are not considered valuable game or fur animals today (Ingles 1965) although, in the past, Native American Indians wore robes made of mountain beaver and valued their meat (Herlocker 1950). The Indian robes, called "she-wal-lal," were the origin of the mountain beaver nickname, sewellel, which Lewis and Clark misunderstood to be the name of the animal (Godin 1964).

Fragility

There is no information on the Point Arena mountain beaver in captivity. At least one Point Arena mountain beaver was trapped and held for several days without any apparent harm, and several individuals have been live-trapped and released with similar results (D. Steele pers. obs.). Observations based on other subspecies provide conflicting reports on the species' fragility. Camp (1918) stated that *Aplodontia* are not hardy and do not live long if injured in the least. Pfeiffer

(1953) noted that some animals recovered from injury and even from biopsies of parts of the reproductive system. Captured animals in the Pacific Northwest have a high trap mortality (Dodge and Campbell 1965, Lovejoy and Black 1979) and mountain beaver are known to die unexpectedly in captivity (Kindschy and Larrison 1961, D. Steele pers. obs.). Others report that mountain beaver are easy to maintain in captivity for long periods of time (Fisler 1965, Davis 1941).

The sensitivity of mountain beaver to disturbance is not well known. Although most burrow openings are in isolated areas or under dense vegetation or on steep slopes, a population of *Aplodontia rufa nigra* has coexisted since at least 1981 with campers in the Manchester Beach State Park campground (D. Steele pers. obs.). However, crushing of vegetation and burrows by campers at Manchester Beach State Park resulted in a decrease in active and new burrows near the campground (S. Flowers *in litt.* 1997, K. Fitts *in litt.* 1997). Scheffer (1929) reported that animals remained in their burrows despite clearing of vegetation, nearby blasting, burning of log and brush piles, and obstruction of burrow openings. Similar observations were made by Campbell *et al.* (1988) in studies in the State of Washington. Gyug (1997) noted that ground disturbance resulting from logging was inversely related to the presence of mountain beaver in southern British Columbia. The 1995 Mt. Vision fire at Point Reyes National Seashore may have destroyed 50 to 60 percent of the available Point Reyes mountain beaver habitat with very low survival in these populations (G. Fellers pers. comm. 1996).

Pest Control

The California subspecies of mountain beaver are generally found in low numbers in isolated areas. However, in other portions of its range, especially in Washington and Oregon, mountain beaver are thriving and considered pests because of damage inflicted on commercial Douglas-fir plantations (Martin 1971, Maser *et al.* 1981, Smurthwaite 1986). The Point Arena subspecies is not known to cause problems beyond some minor garden pilfering and burrows in unwanted places.

E. REASONS FOR LISTING AND THREATS TO SURVIVAL

The vulnerability of the Point Arena mountain beaver results from two basic facts: 1) this subspecies has few populations, all of which have an extremely limited distribution; and 2) the number of individuals in the populations are presumed low. Add to this its low reproductive rate, and any catastrophe, whether natural or human-caused, has a high potential to severely impact the subspecies. Urban development and related facilities, livestock grazing, human disturbance, riparian habitat destruction, transportation and utility corridors, and catastrophic natural events all pose some degree of direct or indirect threat to Point Arena mountain beaver at various locations. However, the extent to which each of these factors threaten Point Arena mountain beaver populations is largely unknown. Several of these factors may pose a greater threat to this subspecies, but no quantitative assessment of risk has been made.

Historically, the conversion of heavily forested areas to agriculture, including grazing, may have created suitable habitat for Point Arena mountain beavers in some areas (T. Wooster *in litt.* 1997). Conversely, livestock grazing may have substantially reduced the extent of historical coastal scrub habitat in the area (Steele 1986) offsetting any gains from forest conversions. Today, grazing is considered to be the most important factor limiting the expansion of extant Point Arena mountain beaver populations (T. Wooster *in litt.* 1997). Many populations are found near agricultural or ranch land and are impacted by livestock that step on *Aplodontia* burrows and destroy runways (D. Steele pers. obs., Steele 1986). Sheep and cattle grazing at the AT&T communications facility also may have impacted the mountain beaver population there.

Urban development and associated activities may directly or indirectly affect mountain beaver populations. At Irish Beach, the mountain beaver population at this site (Irish Gulch) may have been affected indirectly by trash dumping and an increase in predation by feral and nonferal house pets. Construction of private and county roads has also resulted in some habitat loss, such as along Hathaway Creek where a population was bisected by an access road to a residence (T. Wooster *in litt.* 1997). The latest revision to the Mendocino County Land Use Plan shows additional housing developments, creating a potential for additional

indirect and direct disturbance to the mountain beaver population in the Irish Gulch area.

Transportation and utility facilities may adversely affect mountain beaver in various ways. Recent fiber optics projects have drilled under Point Arena mountain beaver populations and caused noise, vibration, and some physical impacts to their habitat. The significance of these actions is not known and needs further monitoring. Habitat loss is likely as a result of construction and secondary impacts from use of the AT&T communications facility. It is not known how large this mountain beaver population was prior to construction of the communication facility, but the present population roughly estimated at about 20 animals, continues to be impacted by pedestrians and occasional project activities. Roadways may reduce or eliminate the ability of young Point Arena mountain beaver to disperse successfully from natal areas. Three observations of mountain beaver killed crossing Highway 1 have been made, one at Gasker Slough bridge (K. Joe pers. comm.), and two at Kinney Road (D. Steele pers. obs., K. Fitts pers. obs.). Populations at Lower Hathaway Creek, Alder Creek, Manchester Beach State Park, and Irish Beach have burrows near roadways (Steele 1986), and therefore, may be subjected to higher mortality rates than other populations. It is not known if these populations were present before road construction, but they have persisted since being discovered.

Human disturbance from recreational activities also may adversely affect mountain beaver populations. At Manchester Beach State Park, campers had wandered off the designated trails into mountain beaver habitat, thus trampling vegetation and crushing burrows. This impact resulted in a decrease in active and new burrows near the campground and on trails. Three campsites were closed to the public in 1995. Since closure, fresh burrows have been excavated (Fall 1995, 175 burrows; Fall 1996, 215 burrows) and increased activity in established burrows has been noted (S. Flowers *in litt.* 1997, K. Fitts *in litt.* 1997).

The Irish Beach-to-Manchester Alternative Coastal Trail has been proposed to provide non-vehicular beach access at Irish Beach, Alder Creek Beach Road, Kinney Road, and Stoneboro Road. This project includes construction of a parking area, an interpretive center, and access to the proposed trail at both Irish

Gulch and Alder Creek. Also, the town of Point Arena plans to develop a trail along Point Arena Creek. These projects could increase human disturbance to mountain beaver populations and could reduce habitat quality. No information exists on how the Point Arena mountain beaver would react to such human disturbance.

Unauthorized destruction of riparian habitat continues to occur on a regular basis within the range of the Point Arena mountain beaver (E. Ramos pers. comm.). In some cases, unauthorized activities have resulted in destruction of mountain beaver habitat or potential habitat from heavy equipment use, vegetation cutting, and/or vegetation burning (D. Steele pers. obs.). A study by Motobu (1978) on the effects of controlled slash burning on a population of Washington mountain beavers (*A. r. rufa*), revealed that fire substantially reduced the mountain beaver population within burn units. Also, predator activity increased substantially within the burn units after the fire.

Succession of shrubby open habitat preferred by the Point Arena mountain beaver to dense, closed canopy forest may threaten mountain beaver populations at several locations (T. Wooster *in litt.* 1997).

Pest control is an on-going threat to *A. r. nigra.* Past gopher control programs in western Mendocino County may have impacted Point Arena mountain beaver. Maintenance workers at the KOA campground near Manchester Beach State Park placed poison bait and traps out to kill mountain beaver they mistakenly thought to be gophers. Rodent trapping and baiting, often associated with residences and gardens, is still common along the Mendocino Coast (Steele 1986). Baits laced with strychnine or anticoagulants are the most widely used (Steele 1986). Other damaging chemicals, to which mountain beaver may be exposed, include copper sulfate, which is sometimes applied to wet spots and seeps to control sheep liver fluke (Steele 1986), and herbicides, which are regularly sprayed on vegetation near mountain beaver populations to maintain road edges and utility corridors. No information is available assessing the impacts of such activities on the Point Arena mountain beaver. Any mountain beaver that may have succumbed to chemical poisoning would likely have died unobserved within its burrow. The small, isolated populations of Point Arena mountain beaver are highly vulnerable

to extirpation from lethal chemicals.

Several alien plants occur in Point Arena mountain beaver habitat including gorse *(Ulex europaeus)*, broom *(Cytisus* sp.), pampas grass *(Cortaderia selloana)*, German ivy *(Senecio mikanioides)*, ice plant (*Mesembryanthemum* sp.), and European beachgrass (*Ammophila arenaria)*. In some areas these species are established and relatively widespread, and may reduce or improve the quality and quantity of Point Arena mountain beaver habitat. For example, German ivy is known to be a problem in some areas and spreading, but more survey work is needed to determine the extent of detrimental effects. No specific impacts to occupied habitat have been documented but are likely (D. Steele pers. comm.). German ivy favors shady and disturbed areas, and is renowned for invading riparian areas. Native to South Africa, it is generally found below 180 meters (600 feet) (K. Fuller pers. comm.).

Ice plant is slowly spreading in some older dune areas. Observations of some mountain beaver burrows at Manchester Beach State Park revealed partially eaten pieces of ice plants (Fitts 1996, D. Steele pers. obs.), which may provide the mountain beaver with a year-around food source that is high in water content. Ice plant also may be beneficial in that its root structure may stabilize sandy soil through which the mountain beaver burrows (Fitts 1996).

European beachgrass has displaced native vegetation at the AT&T population site and at Manchester Beach State Park. There are burrows at the edge of the habitat, but no signs of foraging (D. Steele pers. comm.). European beachgrass is found at several burrows in the Point Arena area. Many of the burrows are located underneath the plants, and runways are found under large clumps of dead beachgrass. The root system of beachgrass is an important soil stabilizer, and the canopy provides cover (Fitts 1996).

The importance of alien species, such as ice plant and European beachgrass, to the Point Arena mountain beaver is not fully known. Further studies should be undertaken to assess their significance, and careful consideration should be given to the effects of their management on the mountain beaver (Fitts 1996).

Little is known regarding diseases of mountain beaver or their potential to threaten mountain beaver populations. Animals in captivity have succumbed to infection and intestinal disease. Mountain beaver are known to harbor tapeworms and other parasites (Canaris and Bowers 1992).

Mountain beaver are preyed upon by most predators of small mammals including coyotes, skunks, owls, weasels, raptors, etc. Sign of predation by bobcat on Point Arena mountain beaver has been reported (T. Wooster pers. comm.) as well as raptor predation (D. Steele pers. obs.). Domestic and feral dogs are known to kill Point Arena mountain beaver, and cats are suspected predators of young mountain beaver. Domestic and feral animal predation would be expected to be greater for those mountain beaver populations located adjacent to urban and agricultural developments such as Irish Gulch, Alder Creek, and Point Arena. This is supported by the discovery of a Point Arena mountain beaver killed by a domestic dog (K. Joe pers. comm.). The impact of predation on small populations has the potential to become critical.

Because Point Arena mountain beaver have a clumped and fragmented distribution, they are more vulnerable to localized catastrophic events such as storms, fire, flooding, landslides, disease, or prolonged drought than species exhibiting a more widespread and continuous distribution. In the last 10 years, fires, flooding, mud slides, and beach erosion have destroyed Point Arena mountain beaver habitat at several locations (D. Steele pers. obs.). Natural disasters could easily eliminate all individuals in a population or further depress already low population numbers to a point where they could not recover. Fragmentation would prevent individuals from other populations from recolonizing unoccupied habitat.

Point Arena mountain beaver population numbers may be so low that the effects of inbreeding among closely-related individuals could result in an increase in deleterious genes in the population. Individuals possessing such deleterious genes are less likely to be capable of adapting to environmental changes, even relatively minor ones. Moreover, small populations are subject to the effects of genetic drift, the random decline in genetic variation that can occur in small populations. This too limits the flexibility of a population to respond to environmental changes.

The effects of genetic drift and inbreeding depression are genetically similar.

Habitat fragmentation is a major concern because it can increase the genetic isolation among populations of mountain beaver. Habitat fragmentation can reduce population size, thereby increasing the probability of genetic drift and inbreeding depression. This may result in less viable and adaptable populations of mountain beaver.

F. CONSERVATION MEASURES

The following are efforts to protect Point Arena mountain beaver:

EFFORTS CURRENTLY IN PLACE:

- Listing the Point Arena mountain beaver as a federally endangered species has given the subspecies a certain amount of protection.

- Timber Harvest Plans must determine the presence or absence of Point Arena mountain beaver and take steps to avoid disturbance, if present. Section C (Biological Resources) of Appendix-Technical Rule Addendum No. 2 in "California Forest Practice Rules, Title 14, California Code of Regulations" states that: "Biological assessment areas will vary with the species being evaluated and its habitat. Factors to consider in the evaluation of cumulative biological impacts include: 1. Any known rare, threatened, or endangered species or species of special concern . . . that may be directly or indirectly affected by project activities...". Section 1034 describes the requirement of the contents of the proposed Timber Harvest Plan, including "information on the presence and protection of known habitat or individuals of any listed species which may be significantly impacted by the timber operation."

- The California Department of Fish and Game's California Natural Diversity Database lists known populations of the Point Arena mountain beaver and provides this information for planning purposes.

- The AT&T Corporation has placed funds in an escrow account to be dedicated for holding and disbursing monies as part of mitigation for the bentonite spill of 1992. It was apparently not possible to procure a satisfactory conservation easement in the Point Arena area, as was previously anticipated.

- A 5-year study to monitor Point Arena mountain beaver as part of mitigation for an MCI microwave tower has been completed (Northern and Fitts 1993-1996, 1998). In this study, burrows were monitored along transects on the impacted site as well as two control sites, and data on vegetation were collected. Construction of the MCI facility caused a decrease in the number and areal extent of active burrows, however, the project did not adversely affect the Point Arena mountain beaver, and there has been a gradual recovery since 1993 in active and total number of burrows per plot on the impact site (Northern and Fitts 1995, 1998).

EFFORTS CURRENTLY UNDERWAY:

- Due to the Federal listing, planning decisions must take possible threats to the mountain beaver into consideration.

- Recommendations have been made for the placement of ramps to cover fragile mountain beaver habitat within the Manchester Beach State Park camping area. However, lack of funds and a "low priority" ranking have impeded this important method of protection from taking place (S. Flowers *in litt.* 1997).

- The City of Point Arena has wording in its General Plan for mapping and protection of the Point Arena mountain beaver, however, the City has not yet accomplished its General Plan mandated tasks in this area (A. Levine *in litt.* 1997).

- The North Coast Regional Water Quality Control Board has completed a draft report entitled "Staff Report on the Proposal to Include a Water Quality Attainment Strategy (Total Maximum Daily Load) for the Garcia

River Watershed into Section 4, Nonpoint Source Measures, of the *Water Quality Control Plan for the North Coast Region"* (1997). This planning effort by the Regional Board provides an opportunity for the Regional Board, working with the Mendocino Resource Conservation District (*Garcia River Watershed Enhancement Plan*, Mendocino Resource Conservation District [1992]), to enhance habitat for the Point Arena mountain beaver during restoration efforts in the Garcia River Watershed area.

- The U.S. Environmental Protection Agency and California Department of Pesticide Regulation are in the process of developing an Endangered Species Protection Program to protect federally listed threatened and endangered species and their critical habitat from harm due to pesticide use. In the interim, the two agencies have produced a rodenticide bulletin entitled "Protecting Endangered Species, Interim Measures for Use of Rodenticides in Mendocino County" (U.S. Environmental Protection Agency and California Department of Pesticide Regulation 1998). This bulletin recommends methods of pesticide application to protect wildlife species, including the Point Arena mountain beaver.

- The "Manchester State Park General Plan" was prepared by the California Department of Parks and Recreation in December 1992 (California Department of Parks and Recreation 1992). The "Directive" for the Point Arena mountain beaver states: "Any potential habitat not yet investigated in the unit shall be surveyed for the presence of Point Arena mountain beaver, and for potential mountain beaver habitat. Perpetuation and protection of mountain beaver habitat shall be a high priority in management of both potential and occupied habitat areas. The department shall work with the Department of Fish and Game and the U.S. Fish and Wildlife Service in management of this sensitive species, including cooperating in the determination of critical habitat and in preparing the recovery plan. Potential habitat and occupied colonies should be mapped on unit base maps, and should not be available to the general public. If deemed necessary, occupied habitat areas may be closed to visitor use to avoid disturbance to shallow burrow systems" (California Department of Parks and Recreation 1992).

II. Recovery

A. OBJECTIVE AND CRITERIA

The objective of this recovery plan is to delist the Point Arena mountain beaver. Detailed information on many aspects of the biology, habitat requirements, and distribution of the Point Arena mountain beaver is lacking. The recovery criteria for downlisting and delisting, therefore, reflect the best biological knowledge and assumptions regarding the species. These reclassification criteria should be considered preliminary and may be revised when new data become available.

Downlisting criteria:

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.

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.

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.

4. The amount of additional habitat needed for population interconnectivity, travel, and dispersal habitat (i.e. to prevent inbreeding and genetic drift) has been determined.

5. Sufficient information is available on the subspecies habitat requirements and life history to permit adaptive management, and any management

actions necessary to ensure the continued success of these populations (in criterion #1) have been fully implemented.

Delisting criteria:

1. Thirty populations are protected from 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.

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.

3. All 30 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 15 years (following attainment of criterion #1), as documented through establishment and implementation of a scientifically acceptable population monitoring program.

4. Additional habitat needed for population interconnectivity, travel , and dispersal habitat has been protected and is being managed appropriately.

5. Adaptive management prescriptions have been determined and implemented for all populations, including repatriated populations if deemed necessary.

The estimated date for downlisting to threatened status is 2015 and delisting is by 2025.

The goals and objectives stated here are subject to change as more information becomes available on the Point Arena mountain beaver through the work undertaken in this recovery effort, and as advances are made in the field of conservation biology and in our understanding of endangered species.

B. STEPDOWN NARRATIVE

1. Protect existing mountain beaver populations.

Twenty-six Point Arena mountain beaver populations have been found to date. Long-term habitat protection is vital for the protection of Point Arena mountain beaver populations. Most of the threats to the animal are a result of habitat destruction and degradation. All known populations must be protected in perpetuity from the threats identified in Section I.E. (with special consideration for unusual habitats).

1.1 Protect existing populations through land acquisitions, easements, conservation agreements, or other mechanisms.

The priorities for land protection should be based on size of mountain beaver populations, degree of threats to habitat, and willing landowners. It may be advantageous to look at areas that would benefit several other species of concern in addition to the Point Arena mountain beaver. Areas protected should include appropriate buffers to protect the population from outside disturbances. Suitable, but currently unoccupied, habitat may be a necessary reservoir for mountain beaver to ensure population structure and dynamics (Todd 1990). It is, therefore, necessary to protect not only habitat currently occupied by mountain beaver, but also unoccupied habitat to allow for population expansion. Habitat protection can be achieved through acquisition, easements, conservation agreements, or other mechanisms, including zoning ordinances.

1.2 Develop and implement management plans for Point Arena mountain beaver populations on public lands.

Management plans should be developed for all populations on public lands. Methods to minimize or eliminate identified threats

to mountain beavers at each population should be included in the management plan. Management plans should be adaptable to the results of research and monitoring. Each plan should include contingencies in the event that the mountain beaver population declines to low levels. Management measures that should be considered include fencing to keep out recreationists and grazing animals, elevated walkways or footpaths to divert foot traffic away from mountain beaver habitat, open culverts or other devices to provide safe passageways for mountain beavers under roadways, vegetation management such as exotic plant control, and control of domestic and feral animal predation.

1.3 Develop and implement management guidelines to protect existing populations of Point Arena mountain beaver on private lands.

Guidelines should be developed to include specific policies for managing existing populations of mountain beaver on private lands. These policies should address identified threats to the species such as predation by domestic and feral dogs and cats. Vegetation management and exotic plant control should also be addressed. The guidelines should cover pesticide use, domestic animals, protective measures, etc. A section on emergency response for contingencies such as fire and other natural and human-caused disasters should also be included. Implementation and enforcement should also be covered. These guidelines should be revised regularly as more information becomes available on the Point Arena mountain beaver.

These guidelines should be developed and implemented by agencies and individuals including the County of Mendocino, Caltrans, California Department of Forestry, California Coastal Commission, local fire departments, the timber industry, City of Point Arena, Manchester (Point Arena) Rancheria, and local citizens, with the assistance of the U.S. Fish and Wildlife Service and California Department of Fish and Game.

1.4 Enhance/restore habitat at existing populations, where appropriate.

Enhancement/restoration can increase the suitability and availability of habitat for Point Arena mountain beaver. Guidelines for enhancement and restoration of habitat should be determined using data gathered in Task 4.7. Enhanced or restored habitat should be monitored to assure that clearly identified standards of success are met. The results of monitoring studies should be used to identify adaptive management strategies to further enhancement and restoration goals and objectives.

1.4.1 Evaluate and identify protected sites for enhancement and restoration.

Priorities should include buffer habitat adjacent to existing populations and degraded mountain beaver habitat with a high degree of potential for success.

1.4.2 Develop and implement site-specific enhancement and restoration strategies.

A strategic plan should be developed for each enhancement/ restoration site outlining procedures, site treatments, plant species selections, costs, timeline, and success criteria. This plan should then be implemented at each site.

1.4.3 Develop and implement vegetation monitoring plans for enhanced/restored sites.

Restoration sites must be monitored for a period of time to be determined under Task 5.2. Monitoring techniques should be designed to contribute to our knowledge of the habitat requirements of Point Arena mountain beaver. Techniques should be selected from existing mitigation

guidance, expert input, and comparison with conditions at other representative population and reference sites. Sampling methodologies should be clearly defined. Goals and success criteria should be developed for, but not necessarily limited to, biological factors such as plant species composition, survivorship, plant height, plant vigor and health, percent vegetative cover, natural reproduction and recruitment, and any physical factors found to be representative of Point Arena mountain beaver habitat.

Contingency plans should be developed to guide remedial actions in the event success criteria are not met. Population trends of the mountain beaver, if present, should also be monitored at restoration sites (see Task 1.5).

1.5 Monitor existing Point Arena mountain beaver populations.

A better understanding of population numbers and distribution will give a fuller picture of population viability and threats to Point Arena mountain beaver. These numbers are necessary to assess the subspecies' status over time. Techniques for monitoring should be evaluated and developed (Task 4.3). All known populations should be monitored to determine population trends and habitat changes and identify threats to populations. To use available time and funding most effectively, this monitoring should be both qualitative and quantitative, with all populations being assessed qualitatively, and only selected populations monitored using more quantitative techniques.

1.5.1 Develop protocols for qualitative and quantitative monitoring.

Protocols for the collection and analysis of qualitative and quantitative monitoring data should be developed using

information from Task 4.3.

1.5.2 Conduct qualitative assessments of all known populations.

Each population should be monitored to determine its status. Parameters to be noted include presence/absence of burrows, activity (digging, clipping, debris, cobwebs, etc.), habitat modification, disturbance, or threats, and other factors using protocols developed under Task 1.5.1. Monitoring should be undertaken at the same time of year, preferably in the spring or summer.

1.5.3 Conduct quantitative assessments of representative populations.

Representative populations will be chosen to be monitored in greater detail, using protocols identified under Task 1.5.1 and techniques developed in Task 4.3.

2. Survey to locate new populations.

The historic range of the Point Arena mountain beaver should be surveyed to identify any new populations. Much of the suitable mountain beaver habitat, however, is on private land or in inaccessible areas. Therefore, gaining access to these areas is essential to accomplishing this task. New populations found beyond the current known range would be particularly significant discoveries.

2.1 Develop a survey protocol.

A presence-absence survey protocol should be developed to guide surveying efforts.

2.2 Identify suitable habitat for surveying.

The latest aerial mapping techniques should be used to identify vegetation types known to provide suitable habitat for Point Arena mountain beaver. Information gathered in Task 4.7 should assist in identification of suitable habitat. Areas for surveying should include class I and II streams to the east of the known range, as well as stream drainages and other suitable habitat to the north and south of the existing range. This mapping will help identify buffers needed in Task 1.1, corridors between existing populations (see Task 3), and/or other areas that may need special management consideration.

2.3 Obtain permission from landowners to survey for Point Arena mountain beaver.

Before conducting surveys, the landowner must grant permission.

2.4 Survey suitable habitat for additional populations.

Once permission to survey is obtained from landowners, surveys should be conducted in suitable habitat identified in Task 2.2. Also, the opportunity should be taken to collect Point Arena mountain beaver data during other activities, such as Timber Harvest Plan reviews, permitting, etc.

2.5 Update the California Natural Diversity Data Base (CNDDB).

To maintain a current and accurate database, all new population information should be sent to the CNDDB for updating. When making planning decisions, State and local agencies and private entities rely on data from the CNDDB to identify areas that may contain Point Arena mountain beaver. Agencies and individuals do not always send new population findings to the CNDDB, resulting in planning decisions based on outdated or insufficient

information on Point Arena mountain beaver.

2.6 Develop maps of the distribution of the Point Arena mountain beaver.

Maps of the distribution of Point Arena mountain beaver should be developed using a Geographic Information System (GIS). Each known population should be surveyed using Global Positioning System (GPS) equipment to determine the precise location and extent of burrow systems. These data could be combined with monitoring data to quantify population sizes, habitat, and land uses to accurately map the distribution of the subspecies. Mapping may also help define a population as it relates to groups of burrow systems. This term has been loosely applied to isolated burrows, some of which likely have only one or two animals. Some populations may actually be part of larger metapopulations. Using information gained through mapping, along with genetic analysis (Task 4.6), it should be possible to better define the population structure of Point Arena mountain beaver.

3. Establish corridors between populations, where feasible.

Corridors should be maintained or established, where feasible, to allow movement and genetic exchange among populations. As more information becomes available on the distribution and habitat requirements of Point Arena mountain beaver, it is expected that more corridors will be identified.

3.1 Identify corridors needing protection.

Using information gathered in Tasks 2.2, 2.4, and 4.7, identify existing habitat that could provide corridors between mountain beaver populations.

3.2. Protect identified corridors.

Corridors identified in Task 3.1 should be protected through purchase, conservation easements or other appropriate mechanism. Corridors should be monitored for mountain beaver activity (Task 1.5.2), and managed appropriately (Task 1.2 or 1.3). Habitat within corridors should be enhanced/restored if deemed necessary (Task 1.4.1).

4. Conduct research on Point Arena mountain beaver.

More research is needed to determine what historic and current land use activities favor or impact Point Arena mountain beaver populations. Also, little information exists on the biology or ecology of the Point Arena mountain beaver. Even anecdotal observations are scarce. Most of our knowledge and assumptions are based on studies of other, more abundant, subspecies of mountain beaver. To make informed management decisions (i.e., applying adaptive management, which means conducting essential research, analyzing the results, and revising management accordingly), it is imperative to learn more about the Point Arena mountain beaver. Researchers who have been studying mountain beaver in Washington State and British Columbia have expressed interest in sharing information and may be able to provide helpful insights and techniques for use with the Point Arena subspecies.

4.1 Establish a library of literature on mountain beaver.

A comprehensive library of mountain beaver and related literature should be gathered and made available to researchers. This will save time and facilitate research because some of the literature is difficult to find. A literature search should be undertaken annually to keep the library current.

4.2 Design studies to gather biological/ecological data on Point Arena mountain beaver.

When techniques are developed, design a study or series of studies to collect data on parameters. Some of the basic parameters that need to be determined include: density, dispersal, travel corridors, population interconnectivity, age structure, litter size, longevity, and sex ratio.

4.3 Develop safe and accurate monitoring techniques.

Because mountain beaver spend most of their time underground, it is difficult to gather certain data without capturing animals. Indirect study methods should be used whenever feasible. Much of the research on mountain beaver has been accomplished through sacrificing animals. New techniques will need to be developed for handling animals with minimum disturbance and risk. A review of the literature to find successful surveying techniques used with similar animals would supplement this effort. All techniques must be perfected using other subspecies of mountain beaver before being attempted on Point Arena mountain beaver. The Point Reyes mountain beaver is most similar to the Point Arena mountain beaver and, therefore, would be the subspecies of choice for this work. The October 1995 fire at Point Reyes National Seashore resulted in monitoring of the surviving Point Reyes mountain beaver population. Monitoring there involves transect surveys of burrows to determine the beaver's survival and distribution within the burn area, and "automated" monitoring of burrows to determine short-term survival, reproductive success, and habitat suitability (BAER Team 1995). Many of these techniques could be used for the Point Arena mountain beaver.

Monitoring of the Point Arena mountain beaver was also done for the MCI Telecommunications Corporation. Method descriptions

can be found in Northen and Fitts (1993-1996, 1998). These methods may be suitable for use in future Point Arena mountain beaver monitoring activities.

4.3.1 Develop indirect monitoring techniques.

Indirect techniques, including cameras, smoke plates, microphones, activity counters, trip wires, hair traps and others, are preferable since they involve the least disturbance to the animals. These techniques need to be evaluated to determine which are most effective.

4.3.2 Develop safe live-trapping/handling techniques.

Mountain beaver are known to suffer from high trap mortality, at least in the Pacific Northwest (Dodge and Campbell 1965). Methods to minimize danger to the animal (and to the handler) must be perfected using other subspecies, prior to conducting any extensive live-trapping of the Point Arena mountain beaver.

4.3.3 Develop and implement safe radiotelemetry techniques.

Certain types of information, such as movement and dispersal activity, and home range, can only be gathered by following individuals through time. Radiotelemetry is an effective way of doing this. This technique should be adapted to Point Arena mountain beaver, again being perfected on a more abundant subspecies.

4.4 Study effects of scent on population establishment and dispersal.

Pheromone analysis may help determine whether chemical cues are causing Point Arena mountain beaver to cluster and occupy some

habitat and not to occupy other seemingly appropriate habitat.

4.5 Study effects of disturbance.

The Point Arena mountain beaver's sensitivity to disturbance is largely unknown. There have been several recent questions about disturbances of various kinds and the appropriate buffer zones needed to protect animals. More work needs to be done in these areas. Disturbance needs to be evaluated, including the effects of electromagnetic fields, noise, vibration, toxins, microwaves, and habitat modification, including fire, timber harvesting, and invasion of exotic plants such as German ivy, ice plant, and European beach grass. The ability of buffers to minimize disturbances should be evaluated. Results of this task should be used to update the comprehensive guidelines prepared in Task 1.3.

4.6 Conduct genetic analysis.

It is generally accepted that Point Arena mountain beaver has been geographically isolated from other subspecies for a long time, but the length and degree of genetic isolation are unknown. Insights could be provided through genetic analysis and comparison with other subspecies. It may be that full species status is more appropriate, as originally believed by Taylor (1914). This task is not considered to be of sufficient priority to warrant sacrificing animals. Material appropriate for genetic analysis should be salvaged, as appropriate, from animals that have died due to other causes, according to the necropsy/salvage protocol developed in Task 4.10. Also, hair, tissue, and blood samples could be collected from live animals.

4.7 Determine habitat requirements for Point Arena mountain beaver.

There is little quantitative information on the habitat requirements

of Point Arena mountain beaver. Populations have been found in a variety of habitat types, but basic limiting factors are not known. This information is necessary for management purposes and possible habitat restoration work.

Data should be collected on the following habitat parameters: vegetation associations (including exotic plants) and cover values, soil characteristics, slope/aspect, microclimate, hydrology, etc. Studies should be done on the spectrum of mountain beaver habitats. Historic aerial photos and mapping can be used to compare previous vegetation and land uses with current habitat use.

The duration and methodologies of this research should be determined under Task 4.2. It may be best to collect data over a longer period of time if unusual conditions such as drought occur.

4.8 Study the relationship of Point Arena mountain beaver to successional habitat.

The importance of successional habitat to Point Arena mountain beavers needs to be investigated at several sites where mountain beaver populations are found near recent timber harvesting activities.

4.9 Study food habits.

While it is known that Point Arena mountain beaver utilize many, if not most, of the plant species in their vicinity, there is little information on which plants are most important in their diet. A fecal analysis study could help to determine important food plants. Fecal material should be gathered over time, because food preferences may change throughout the year. Stomach contents from fresh carcasses can also be analyzed, according to the

protocol developed in Task 4.10.

4.10 Develop protocol for necropsies on any acquired carcass.

A protocol must be developed for treating animals found dead, to maximize the information available on the Point Arena mountain beaver. This protocol should include procedures for handling dead animals, salvaging and storing parts for further study, identifying the responsible party, data collection and analysis, necropsy procedures, museum or other repository consignment, and reporting of results.

4.11 Conduct a population viability analysis (PVA).

Conduct a PVA assessment using information gathered from Task 4.2. The PVA results should be used to assess the adequacy of the criteria for downlisting, delisting, and population stability, if possible.

4.12 Develop indices to track the active number of Point Arena mountain beaver burrows.

Indices should be developed to keep track of all active Point Arena mountain beaver burrows.

5. Restore the Point Arena mountain beaver to suitable habitat.

Restoration of Point Arena mountain beavers to suitable habitat may be a necessary tool for recovery if additional populations are not found to meet recovery criteria. The feasibility and necessity of relocating animals, however, should be evaluated after basic information is gathered about Point Arena mountain beaver and its habitat requirements.

5.1 Determine feasibility and necessity of relocation.

The feasibility and necessity of relocation should be assessed based on all available information.

5.2 Develop relocation protocols and conduct relocations, if feasible and necessary.

If relocation is deemed appropriate and necessary, a plan should be developed that identifies suitable habitat for relocation activities, appropriate animals to be relocated (*e.g.*, dispersing juveniles), and practical/technical aspects of the relocation project. Relocations would likely be conducted over several years. Relocated populations should be protected (Task 1.1); management plans should be developed and implemented, that include a contingency plan in the event that success criteria are not met (Task 1.2); and populations should be monitored (Task 1.5).

6. Conduct outreach.

To enlist the long-term support of landowners with Point Arena mountain beaver populations, the U.S. Fish and Wildlife Service, with assistance from the California Department of Fish and Game, should work one-on-one with each landowner to develop a program to protect the beaver and its habitat.

6.1 Develop and implement an outreach plan.

Outreach is an essential component of implementing this plan. A plan should be developed to provide factual information about the Point Arena mountain beaver and the recovery process to interested and effected landowners. For private lands with reported populations of the Point Arena mountain beaver, landowners should be apprised of the significance of the populations on their

lands and should be provided with information about available conservation mechanisms, such as conservation easements and incentive programs. For private lands with suitable habitat for Point Arena mountain beaver, permission should be sought from cooperative landowners to conduct on-site surveys (Task 2.4). If surveys identify populations, landowners should be apprised of their significance and offered incentives to continue current land uses that support mountain beaver habitat.

6.1.1 Develop and implement economic or other incentives for conservation and recovery of the Point Arena mountain beaver.

Economic and other incentive programs (*e.g.*, relief from taxes, tax credits, tax deductible habitat management expenses, Williamson Act, Conservation Reserve Program, Partners for Wildlife, etc.) may be important to gaining the support and assistance of private landowners in conserving and recovering the Point Arena mountain beaver. Such programs, if appropriate, should be developed for the planning area. Incentive programs could play an important role in protection of habitat on private property.

6.1.2 Produce and disseminate outreach materials.

A comprehensive outreach program could include the following materials:

- A booklet for adults that presents information on the biological importance of the Point Arena mountain beaver.

- A separate brochure to inform landowners of resources

available to them and steps they can take to protect mountain beaver on their land.

- An activity/educational book for children, geared for ages 6 to 12. This booklet could be disseminated through schools, at Manchester Beach State Park, through agency offices, etc.

- Other interpretive materials, such as models, are an important part of any outreach effort. The possibility of a permanent display should be explored.

- Periodic press releases on the recovery effort for dissemination to the media.

- Selected materials from this effort should be made available on the Internet and possibly in an electronic form, such as a compact disc, which can be used for educational purposes.

C. LITERATURE CITED

Allen, L. 1969. Preferential food habits of *Aplodontia rufa.* Masters Thesis, Central Washington State College, Ellensberg, WA.

BAER Team, North Zone. 1995. Mount Vision fire incident, burned area emergency rehabilitation (BAER) plan. Prepared for the U.S. Department of Interior, U.S. Park Service, Point Reyes National Seashore; California State Parks, Tomales Bay State Park; Marin County, Department of Public Works; Natural Resources Conservation Service, Petaluma District.

Beier, P. 1989. Use of habitat by mountain beaver in the Sierra Nevada. Journal of Wildlife Management 53(3):649–654.

Cafferata, S.L. 1992. Chapter 11, Mountain Beaver. *In* Silvicultural approaches to animal damage management in Pacific Northwest Forests. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. General Tech Report PNW-GTR-287.

Camp, C. 1918. Excavations of burrows of the rodent *Aplodontia* with observations on the habits of the animal. University of California Publication in Zoology 17(18):517–535.

Campbell, D. and J. Evans. 1989. Aversive conditioning with thiram to reduce mountain beaver damage to Douglas-fir seedlings. Northwest Science 63(2): 70.

Campbell, D., J. Ocheltree and M. Carey. 1988. Adaptation of mountain beavers *(Aplodontia rufa)* to removal of underground nests. Northwest Science 62(2):75.

Canaris, A. and D. Bowers. 1992. Metazoan parasites of the mountain beaver, *Aplodontia rufa* (Rodentia: Aplodontidae), from Washington and Oregon, with a checklist of parasites. Journal of Parasitology 78(5):904–906.

Carey, M., D. Campbell, and C. Campbell. Physical structure, flora and fauna of mountain beaver nests. 1989. Northwest Science 63(2):70.

California Department of Parks and Recreation. 1992. Manchester Beach State Park, General Plan. Mendocino, California.

Cramblet, H. and R. Ridenhour. 1956. Parturition in *Aplodontia*. Journal of Mammalogy 37(1):87–90.

Crouch, G. 1968. Clipping of woody plants by mountain beaver. Journal of Mammalogy 49(1):151–152.

Dalquest, W. and V. Scheffer. 1945. The systematic status of the races of the mountain beaver *(Aplodontia rufa)* in Washington. Murrelet 26(3):34–37.

Davis, J. 1941. Notes on a captive mountain beaver. Murrelet 22(3):60–61.

Dicker, S. and M. Eggleton. 1964. Renal function in the primitive mammal *Aplodontia rufa* with some observations on squirrels. Journal of Physiology 170:186–194.

Dodge, W. and D. Campbell. 1965. Two techniques to reduce capture mortality. Journal of Mammalogy 46(4):707.

Dolph, C., H. Braun, and E. Pfeiffer. 1962. The effect of vasopressin upon urine concentration in *Aplodontia rufa* and the rabbit. Physio. Zool. 35:263-269.

Epple, G., J. Mason, D. Nolte, and D. Campbell. 1993. Effects of predator odors on feeding in the mountain beaver *(Aplodontia rufa)*. Journal of Mammalogy 74(3):715–722.

Feldhamer, G. and J. Rochelle. 1982. Mountain beaver-Aplodontia rufa. Pages 167–175 *In* Wild Mammals of North America (J.A. Chapman and G.A. Feldhamer eds.). John Hopkins University Press, Baltimore, MD. 1147 pp.

Finley, Jr., R. 1941. Geographic variation in the rodent *Aplodontia rufa.* Murrelet 22(3):45–51.

Fisler, G. 1965. A captive mountain beaver. Journal of Mammalogy 46(4):707–709.

Fitts, K. 1996. Observations on use of two non-native plants by the Point Arena mountain beaver. California Fish and Game 82(1):59-60.

Franklin, I. 1980. Evolutionary change in small populations. Pages 153–149 *In* M.E. Soulé and B.A. Wilcox, eds. Conservation biology, an evolutionary-ecological perspective. Sinauer Assoc., Sunderland, Mass.

Godin, A. 1964. A review of the literature on the mountain beaver. U.S. Fish and Wildlife Service Special Scientific Report, Wildlife #78.

Goslow, G. 1964. The mountain beaver, *Aplodontia rufa.* Unpublished MA Thesis. Humboldt State College, Arcata, CA.

Gyug, L.W. 1997. 1997 Forest development plan, red- and blue-listed species inventory for: mountain beaver, Cascade mantled ground squirrel, sagebrush northern bog lemming, and tailed frog. Prepared for B.C. Ministry of Environment.

Hacker, A. and B. Coblentz. 1993. Habitat selection by mountain beavers recolonizing Oregon coast range clearcuts. Journal of Wildlife Management 57(4):847–853.

Hall, E. 1981. The mammals of North America. Volume 1, second edition. Wiley and Sons, New York NY.

Hall, E. and K. Kelson. 1959. The mammals of North America. Ronald Press Co, New York. Vol. 1, p. 290–292.

Herlocker, E. 1950. Mountain beaver-biological curiosity. Audubon Magazine

387–390.

Hooven, E.F. 1973. Effects of vegetational changes on small forest mammals. Pages 75-97 *In* Hermann, R.K., Lavender, D.P., eds. Even-age management: Proceedings of a symposium, August 1, 1972, Corvallis, OR, School of Forestry, Oregon State University. pp. 75-97.

Hubbard, C. 1922. Some data upon the rodent *Aplodontia.* Murrelet 3(1):14–18.

Ingles, E. 1960. Underground dwellers in the forest. Audubon Magazine 210–213.

Ingles, L. 1959. A quantitative study of mountain beaver activity. American Midland Naturalist 61(2):419–423.

Ingles, L. 1960. Tree climbing by mountain beavers. Journal of Mammalogy 41(1):120–121.

Ingles, L. 1961. Reingestion in the mountain beaver. Journal of Mammalogy 42:(3):411–412.

Ingles, L. 1965. Mammals of the Pacific States. Stanford University Press. Palo Alto, CA.

Johnson, S. 1971. Thermoregulation, microclimate and distribution of *Aplodontia rufa.* Unpublished PhD Thesis, Oregon State University, Corvallis, OR.

Kindschy Jr, R. and E. Larrison. 1961. Observations on a captive mountain beaver. Murrelet 42(1):1–3.

Kinney, J. 1971. Environmental physiology of a primitive rodent *(Aplodontia rufa).* Unpublished PhD Thesis, University of Oregon, Eugene.

Knick, S. Food habits of bobcats *(Lynx rufus)* in Washington. 1984. U.S. Fish

and Wildlife Service Report W-84-R-7 II-S.

Lacy, T. 1991. Comparison of the digestible and metabolizable energy of plants consumed by mountain beaver *(Aplodontia rufa)*. Unpublished MA Thesis. Humboldt State University, Arcata, CA.

Lovejoy, B. and H. Black. 1974. Growth and weight of the mountain beaver, *Aplodontia rufa pacifica*. Journal of Mammalogy 55(2):364–369.

Lovejoy, B. and H. Black. 1979. Population analysis of the mountain beaver, *Aplodontia rufa pacifica* in Western Oregon. Northwest Science 53(2):82–89.

Lovejoy, B., H. Black, and E. Hooven. 1978. Reproduction, growth, and development of the mountain beaver *(Aplodontia rufa pacifica)*. Northwest Science 52(4):323–328.

Martin, P. 1971. Movements and activities of the mountain beaver *(Aplodontia rufa)*. Journal of Mammalogy 52(4):717–723.

Maser, C., B. Mate, J. Franklin and C. Oyrness. 1981. Natural history of Oregon Coast mammals. U.S. Forest Service General Technical Report PNW-133. 496 pp.

Mendocino County Resource Conservation District. 1992. Garcia River watershed enhancement plan. Prepared for the California State Coastal Conservancy, Ukiah, CA.

Merzenich, M., L. Kitzes, and L. Aitkin. 1973. Anatomical and physiological evidence for auditory specialization in the mountain beaver *(Aplodontia rufa)*. Brain Research 58:331–344.

Morris, K., C. Champ, G. Morris, and J. Ha. 1995. The influence of proximity to humans on population density and home range size of mountain beaver (*Aplodontia rufa*). Annual Conference of the Society for Northwestern Vertebrate Biology.

Motobu, D. 1978. Effects of controlled slash burning on the mountain beaver (*A. r. rufa*). Northwest Science, Vol. 52, No. 2:92-99.

Neal, F. and J. Borrecco. 1981. Distribution and relationship of mountain beaver to openings in sapling stands. Northwest Science 55(2):79–82.

Nolte, D., G. Epple, D. Campbell, and J. Mason. 1993. Response of mountain beaver *(Aplodontia rufa)* to conspecifics in their burrow system. Northwest Science 67(4):251–255.

North Coast Regional Water Quality Control Board. 1997. Water quality control plan for the north coast region. Santa Rosa, California.

Northen, P.T and K.M. Fitts. 1993. Monitoring of the Point Arena mountain beaver for MCI Telecommunications Corporation. Year One Report.

_____. 1994. Monitoring of the Point Arena mountain beaver for MCI Telecommunications Corporation. Year Two Report.

_____. 1995. Monitoring of the Point Arena mountain beaver for MCI Telecommunications Corporation. Year Three Report.

_____. 1996. Monitoring of the Point Arena mountain beaver for MCI Telecommunications Corporation. Year Four Report.

_____. 1998. Monitoring of the Point Arena mountain beaver for MCI Telecommunications Corporation. Year Five Report.

Nungesser, W. and E. Pfeiffer. 1965. Water balance and maximum concentrating capacity in the primitive rodent, *Aplodontia rufa.* Comparative Biochemical Physiology 14:289–297.

Pfeiffer, E. 1953. Animals trapped in mountain beaver *(Aplodontia rufa)* runways, and the mountain beaver in captivity. Journal of Mammalogy 34(3):396.

Pfeiffer, E. 1955. Hormonally induced mammary hairs of a primitive rodent, Aplodontia rufa. Anatomical Record 122(2): 241–256.

Pfeiffer, E. 1958. The reproductive cycle of the female mountain beaver. Journal of Mammalogy 39(2):223–235.

Pfeiffer, E. 1956. The male reproductive tract of a primitive rodent, *Aplodontia rufa.* Anatomical Record 122:629–635.

Pfeiffer, E., W. Nungesser, D. Iverson, and J. Wallerius. 1960. The renal anatomy of the primitive rodent, *Aplodontia rufa,* and a consideration of its functional significance. Anatomical Record 137(3):227–235.

Racey, K. 1922. The mountain beaver *(Aplodontia rufa).* Canadian Field Naturalist 36:30–32.

Scheffer, T. 1929. Mountain beavers in the Pacific Northwest: their habits, economic status and control. U.S. Department of Agriculture Farmers Bulletin #1598.

Scheffer, T. 1945. Burrow associations of small mammals. Murrelet. 26(2):24–26.

Scheffer, V. 1969. Superflea meets mountain beaver. Natural History 78(5): 54–55.

Schmidt-Nielson, B., and E. Pfeiffer. 1970. Urea and urinary concentrating ability of the mountain beaver, *Aplodontia rufa.* American Journal of Physiology 218(5):1370–1375.

Schmidt-Nielsen, K. 1975. Animal Physiology: Adaptation and Environment. Cambridge University Press, New York. 699 pp.

Shotwell, J. 1958. Aplodontid and Mylagaulid rodents. Evolution 12:465–484.

Simpson, G. 1945. Classification of mammals. Bulletin of the American Museum of Natural History 85:200-202.

Smurthwaite, D. 1986. Mountain beaver-the rodent that gets no respect. American Forests 46–50.

Steele D. 1986. The mountain beaver *(Aplodontia rufa)* in California. Unpublished MS Thesis, University of California, Davis.

Steele, D.T. 1986. A review of the population status of the Point Arena mountain beaver. Final Report for U.S. Department of the Interior, Fish and Wildlife Service, Endangered Species Office. Sacramento, California.

Steele D. 1989. An ecological survey of endemic mountain beavers *(Aplodontia rufa)* in California, 1979–1983. State of California, Department of Fish and Game, Wildlife Management Division, Administrative Report #89-1.

Taylor, W. 1914. A previously undescribed *Aplodontia* from the middle north coast of California. University of California Publications in Zoology 12:297–300.

Taylor, W. 1918. Revision of the rodent genus *Aplodontia.* University of California Publication in Zoology 12(16):497–501.

Todd, P. 1990. The distribution, abundance, and habitat requirements of the Sierra mountain beaver in Yosemite National Park. Unpublished MA Thesis, University of Montana, Missoula.

U.S. Environmental Protection Agency and California Department of Pesticide Regulation. 1998. Protecting endangered species, interim measures for use of rodenticides in Mendocino County. Pesticides and toxic substances bulletin (H-7506C).

U.S. Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants; Point Arena mountain beaver (*Aplodontia rufa nigra*) determined to be

endangered. 56(239): 64716-64722.

U.S. Weather Bureau. 1963. The Climate of Mendocino County. Univ. Calif. Extension Service Publication.

Voth, E. 1968. Food habits of the Pacific mountain beaver, *Aplodontia rufa pacifica.* Unpublished PhD Thesis, Oregon State University, Corvallis.

Whitaker Jr., J., C. Maser, W. Wallace. 1979. Parasitic mites of the mountain beaver *(Aplodontia rufa)* from Oregon. Northwest Science 53(4):264–267.

Williams, D. 1986. Mammalian species of special concern in California. Department of Fish and Game Wildlife Management Division Administrative Report 86-1.

Wright, J. 1969. Mountain beaver *(Aplodontia rufa)* behavior: extreme southern limits. Unpublished Masters Thesis, California State University, Chico.

D. PERSONAL COMMUNICATIONS

Fellers, G. 1996. Biological Resources Division, U.S. Geological Survey, Point Reyes National Seashore. Point Reyes, California.

Fitts, K. 1994. Wildlife Biologist. Santa Rosa, California.

Fuller, K. 1996. Botanist, U.S. Fish and Wildlife Service. Sacramento, California.

Heffner, R., PhD. 1994. University of Toledo, Department of Psychology. Toledo, Ohio.

Joe, K. 1989. Park Ranger, California Department of Parks and Recreation, Manchester Beach State Park. Mendocino, California.

Mohr, A. 1996. Alan Mohr and Associates, Inc. Point Arena, California.

Ramos, E. 1994. California Department of Fish and Game. Yountville, California.

Steele, D. 1992, 1994, 1998. Ecologist - Mountain Beaver Research. Stockton, California.

Wooster, T. 1992, 1997. California Department of Fish and Game. Yountville, California.

E. *IN LITT.* REFERENCES

Flowers, S. 1997. Letter to Wayne S. White, U.S. Fish and Wildlife Service, Sacramento, CA, commenting on Draft Point Arena Mountain Beaver Recovery Plan.

Levine, A. 1997. Letter to Wayne S. White, U.S. Fish and Wildlife Service, Sacramento, CA, commenting on Draft Point Arena Mountain Beaver Recovery Plan.

Valentine, B. 1997. Letter to Wayne S. White, U.S. Fish and Wildlife Service, Sacramento, CA, commenting on Draft Point Arena Mountain Beaver Recovery Plan.

Wooster, T. 1997. Letter to Wayne S. White, U.S. Fish and Wildlife Service, Sacramento, CA, commenting on Draft Point Arena Mountain Beaver Recovery Plan.

III. Implementation Schedule

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program of *Aplodontia rufa nigra*. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat. Cost estimates provided here are intended as gross estimates for general planning purposes. More detailed budget analyses will be necessary by the responsible agencies.

Definition of Priorities:

Priority 1: An action that ***must*** be taken to prevent extinction or to prevent the species from declining irreversibly in the ***foreseeable*** future.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to meet the recovery objectives.

Task Duration:

Continuous: A task that will be implemented on a routine basis once begun.

Unknown: Either task duration or associated costs are not known at this time.

Acronyms and Abbreviations:

CDF	-	California Department of Forestry and Fire Protection
CDFG	-	California Department of Fish and Game
CDPR	-	California Department of Parks and Recreation
CNDDB	-	California Natural Diversity Database
COUN	-	County of Mendocino
FWS	-	U.S. Fish and Wildlife Service
TBD	-	To Be Determined

Implementation Schedule for the Point Arena Mountain Beaver

Priority	Task #	Task Description	Duration (Yrs.)	Responsible Party	Total Cost	Costs in $1,000					Comments
						FY1[1]	FY2	FY3	FY4	FY5	
1	1.1	Protect existing populations	5	FWS, CDFG, CDPR	500.0		100.0	100.0	100.0	100.0	
1	1.2	Develop and implement management plans	continuous	FWS, CDFG, CDPR	50.0	3.0	3.0	3.0	3.0	3.0	
2	1.3	Develop and implement management guidelines	continuous	FWS, CDFG, CDPR, COUN, CDF, others	50.0	3.0	3.0	3.0	3.0	3.0	
2	1.4.1	Identify habitat for restoration	2	FWS, CDFG	5.0		2.5	2.5			
2	1.4.2	Develop and implement site-specific restoration strategies	1	FWS, CDFG	TBD				TBD		
2	1.4.3	Monitor restoration	5	FWS	20.0					4.0	
2	1.5.1	Develop monitoring protocol	1	FWS, CDFG	3.0	3.0					
2	1.5.2	Conduct qualitative monitoring of populations	continuous	FWS, CDFG	25.0	2.5	2.5	2.5	2.5	2.5	
2	1.5.3	Conduct quantitative monitoring of populations	5	FWS, CDFG	10.0		2.0	2.0	2.0	2.0	
2	2.1	Develop a survey protocol	1	FWS, CDFG	5.0	5.0					
2	2.2	Identify suitable habitat for surveying	1	FWS, CDFG	5.0	5.0					

Implementation Schedule for the Point Arena Mountain Beaver

Priority	Task #	Task Description	Duration (Yrs)	Responsible Party	Total Cost	Costs in $1,000					Comments
						FY1[1]	FY2	FY3	FY4	FY5	
2	2.3	Obtain landowner's permission to survey	1	FWS, CDFG	2.0	2.0					
2	2.4	Survey for additional populations	3	FWS, CDFG, CDF	15.0		5.0	5.0	5.0		
2	3.1	Identify corridors to protect	5	FWS, CDFG	0.0						
2	3.2	Protect identified corridors	unknown	FWS	TBD						
2	4.2	Design studies to gather biological/ ecological data	2	FWS, CDFG	TBD						
2	4.3.1	Develop indirect monitoring techniques	4	FWS, CDFG	50.0		20.0	10.0	10.0	10.0	
2	4.3.2	Develop safe live-trapping/handling techniques	2	FWS	20.0		10.0	10.0			
2	4.3.3	Develop radiotelemetry studies	4	FWS	50.0			20.0	10.0	10.0	
2	4.4	Study effects of scent	2	FWS	TBD						
2	4.5	Study effects of disturbance	5	FWS	60.0		20.0	10.0	10.0	10.0	
2	4.7	Determine habitat requirements	5	FWS, CDFG	60.0		20.0	10.0	10.0	10.0	

Implementation Schedule for the Point Arena Mountain Beaver

Priority	Task #	Task Description	Duration (Yrs)	Responsible Party	Total Cost	Costs in $1,000					Comments
						FY1[1]	FY2	FY3	FY4	FY5	
2	4.9	Study food habits	2	FWS	20.0						
3	2.5	Update CNDDB	continuous	CDFG	0.0						
3	2.6	Develop GIS map	continuous	FWS, CDFG	0.0						
3	4.1	Establish library	continuous	FWS	0.0						
3	4.6	Conduct genetic analyses	2	FWS	20.0		10.0	10.0			
3	4.8	Study relationship of successional habitat	5	FWS, CDFG	50.0		10.0	10.0	10.0	10.0	
3	4.10	Develop protocol for necropsies	1	FWS	2.0	2.0					
3	4.11	Conduct population viability analyses	1	FWS, CDFG	10.0						
3	5.1	Determine feasibility of relocation	1	FWS	0.0						
3	5.2	Plan and conduct relocations	if feasible and needed	FWS	TBD						
3	6.1.1	Develop and implement incentives for recovery	continuous	FWS, CDFG	TBD						
3	6.1.2	Produce outreach materials	1	FWS, CDPR	15.0	15.0					

[1]FY1 designates the first fiscal year following approval of the Recovery Plan.

IV. Appendix A: Summary of the Agency and Public Comments on the Draft Recovery Plan for the Point Arena Mountain Beaver

I. Summary of Comments

In July 1997, the Service released the Draft Recovery Plan for the Point Arena Mountain Beaver (Draft Plan) for a 60-day comment period ending on October 20, 1997 for Federal agencies, State and local governments, and members of the public (62 FR 4413). Dr. Paul Beier, Mr. Gordon Gould, and Mr. John Harris were requested to peer review the Draft Plan.

This section summarizes the content of significant comments on the Draft Plan. A total of 11 letters were received, each containing varying numbers of comments. Many specific comments re-occurred in letters.

This section provides a summary of general demographic information, including the total number of letters received from various affiliations and states. It also provides a summary of the eight major comments. A complete index of the commenters, by affiliation, is given in the Section B. All letters of comment on the Draft Plan are kept on file in the Arcata Fish and Wildlife Office.

A. Demographic Information

The following is a breakdown of the number of letters received from various affiliations:

State agencies	4 letters
local governments	2 letters
business and industry	1 letter
environmental/conservation organizations	3 letters
academia/professional	1 letter

B. Reviewers of the Draft Recovery Plan

Dahlhoff, Leslie, City of Point Arena, 451 School Street, P.O. Box 67, Point Arena, CA 95468

Fellers, Gary, U.S. Department of the Interior, U.S. Geological Survey, Biological Resources Division, Point Reyes National Seashore, Point Reyes, CA 94956

Fitts, Kimberley, 5243 Beaumont Way, Santa Rosa, CA 95409

Flowers, Sarah, Department of Parks and Recreation, Russian River/Mendocino District, P.O. Box 440, Mendocino, CA 95460

Gould, Gordon, California Department of Fish and Game, 1416 Ninth Street, P.O. Box 944209, Sacramento, CA 94244

Griffin, Jenny, Jenny Griffin Landscaping, P.O. Box 1503, Mendocino, CA 95460

Hodgson, Ann, Resource Designs, Inc., 1349 S. 101 Street, Suite 304,Omaha, NE 68124

Levine, Alan, Coast Action Group, P.O. Box 215, Point Arena, CA 95468

Northen, Philip, Sonoma State University, School of Natural Resources, 1801 East Cotati Avenue, Rhonert Park, CA 94928

Valentine, Bradley, California Department of Forestry and Fire Protection, Coast-Cascade Region, P.O. Box 670, 135 Ridgway Avenue, Santa Rosa, CA 95402

Wooster, Theodore, California Department of Fish and Game, P.O. Box 47, Yountville, CA 94599

II. Summary of Comments and Service Responses

Issue 1: A number of comments were received that contained requests to include additional information such as updated population locations of the Point Arena mountain beaver, additional species of concern, etc.

Response: This new information has been incorporated into the Final Plan.

Issue 2: More surveys need to be done to establish locations of other, new Point Arena mountain beaver populations.

Response: Please see the "Stepdown Narrative", Task 2.0 of the Final Plan, which is "Survey to locate new populations".

Issue 3: There is little quantitative support and explanation for, and possibly attainability of, the recovery criteria (downlisting and delisting). Also, for #1, #2 and #3 of the downlisting and delisting criteria, why are the existing populations found along the creeks listed, singled out as being the main populations to be protected?

Response: Recovery criteria have been revised to better reflect existing information based on best knowledge of existing conditions. These criteria may be further revised when new information becomes available. Reference to specific existing populations found along creeks has been deleted from the recovery criteria.

Issue 4: The discussion on "Reasons for Listing and Threats to Survival" contains no substantiation on importance, no plan to address the threats, no determination of importance, and some threats cannot be planned for and are not as catastrophic as suggested.

Response: This section has been revised to better reflect importance of threats and substantiation of threats. Also, some threats which "cannot be

planned for" (*e.g.*, fire), were eliminated from the text. Threats are also discussed in the "Stepdown Narrative" under Task 1.2.

Issue 5: A broad-scale effort should be undertaken to solicit the opinions of the public regarding their perceptions about mountain beavers as pests. Flexible solicitation of public opinions and ongoing public forums to involve and educate the public about the management concerns related to this species is necessary. The Draft Plan proposes an outreach effort which would include the productions and dissemination of educational materials, but may not effectively invoke "ownership" and broad-scale participation by the community.

Response: In the "Stepdown Narrative", Task 6.0, we have elaborated on this issue.

Issue 6: The Draft Plan reflects a general literature review for the species as a whole, with little regard to the fact that the Point Arena mountain beaver lives in somewhat unusual habitat and in an unusual setting.

Response: The "Habitat" section has been modified to better reflect the literature specifically available on the Point Arena mountain beaver versus other subspecies of mountain beaver.

Issue 7: Elevate task "Survey along drainages for limits of Point Arena mountain beaver" to top priority level.

Response: The U.S. Fish and Wildlife Service cannot consider surveys as Priority 1 tasks (see "Definition of Priorities" given in Section III of the Final Plan). Alone, this task would not prevent the extinction of the species.

Issue 8: At this time, the City of Point Arena and landowners need specific management guidelines from the U.S. Fish and Wildlife Service concerning the Point Arena mountain beaver. A review of Section 5.24 of

the City's Zoning Ordinance, which explains the Mountain Beaver Buffer Area (MBBA), and the special rules that apply to it, need to be reviewed by the U.S. Fish and Wildlife Service for accuracy of the statements regarding the Federal Endangered Species Act and protection measures.

Response: The Sacramento Fish and Wildlife Office has forwarded a copy of the City's Zoning Ordinance, with specific questions from the City of Point Arena about this proposed Ordinance, to the Arcata Fish and Wildlife Office. Due to the location of Fish and Wildlife Offices in the state, and a change in Ecoregion organization since the Recovery Plan for the species was begun, the Arcata Fish and Wildlife Office now has primary responsibility for the Point Arena mountain beaver.

Region 1
U.S. Fish and Wildlife Service
Ecological Services
911 N.E. 11th Avenue
Portland, Oregon 97232-4181

June 1998