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SEASHORE, 10 YEARS AFTER THE VISION FIRE

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ABSTRACT—The 1995 Vision Fire burned 5000 ha and destroyed 40% of the habitat of the Point Reyes Mountain Beaver (*Aplodontia rufa phaea*). Surveys immediately post-fire and in 2000 showed that only 0.4 to 1.7% of Mountain Beavers within the burn area survived. In 2000, dense, ground-hugging Blue-blossom Ceanothus (*Ceanothus thrysiflorus*) appeared to make coastal scrub thickets much less suitable for Mountain Beavers even though the number of burrows at our 11 study sites had returned to 88% of pre-fire numbers. In 2005 (10 y post-fire), the habitat appeared to be better for Mountain Beavers; Blue-blossom Ceanothus had diminished and vegetation more typical of northern coastal scrub, such as Coyote Brush (*Baccharis pilularis*) overstory with a lower layer of herbaceous vegetation, had greatly increased; but the number of Mountain Beaver burrows had declined to 52% of pre-fire numbers and there was little change in the number of sites occupied between our 2000 and 2005 surveys. With the expected successional changes in thicket structure, Mountain Beaver populations are likely to recover further, but there will probably be considerable variation in how each population stabilizes.

Key words: Point Reyes Mountain Beaver, *Aplodontia rufa phaea*, fire, recovery, California

Mountain Beavers (*Aplodontia rufa*) are small (0.8 to 1.2 kg), primitive rodents restricted to a narrow range in the Pacific Northwest. They feed on a variety of vegetation and live in burrows that are dug in forest openings or dense thickets. Burrows are 15 to 18 cm in dia, and the presence of multiple burrow openings is often the most conspicuous evidence of Mountain Beaver activity (Grinnell and Storer 1924). Typically, there are 8 to 10 burrow entrances in an area of about 14 to 16 m². Camp (1918) found that burrow systems at Point Reyes, California were only a few centimeters underground, though some reached a depth of nearly 20 cm. The kidneys of Mountain Beaver are inefficient at conserving water (Sperber 1944), so they need to obtain about 1/3 of their body weight in water (292 to 450 ml) every day (Nungesser and Pfeifer 1965). This physiological requirement restricts Mountain Beavers to areas near water, or areas with extensive summer fog. The Point Reyes Mountain Beaver (*Aplodontia*

rufa phaea) is only known from a 35 × 5 km area where they are found on north-facing slopes in moderately dense northern coastal scrub or (less frequently) openings in Bishop Pine (*Pinus muricata*) or Douglas-fir (*Pseudotsuga menziesii*) forests. The Point Reyes Mountain Beaver is listed by the California Department of Fish and Game as a species of Special Concern (Williams 1986) and is listed by the IUCN as Vulnerable (Hafner and others 1998).

The Vision Fire of 3–12 Oct 1995 burned 5000 ha of forest, scrubland, and grassland, including 40% of the known range of the Point Reyes Mountain Beaver (hereafter Mountain Beaver). In most of the non-forested areas, the fire effectively cleared the ground of both litter and standing vegetation, revealing thousands of Mountain Beaver burrow openings, which are the most conspicuous evidence of Mountain Beaver activity. In the first 6 mo after the fire, Fellers and others (2004) surveyed burned coastal scrub and riparian habitat and estimated that only 0.4 to 1.7% of Mountain Beavers within the burn area survived the fire and immediate post-fire period. After 5 years, Mountain Beavers were found at only 8 sites within the burn area,

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TABLE 1. Number of active Mountain Beaver burrows at 11 study sites within the 1995 Vision Fire burn area at Point Reyes National Seashore. Data prior to 2005 are from Fellers and others (2004).

Site	Area (m ²)	Active Burrows Pre-Fire	Active Burrows 1995–1996	Active Burrows 2000	Active Burrows 2005–2006
A	6000	600	1	1260	408
B	1600	240	5	240	150
C	500	100	10	280	227
D	6000	500	10	820	411
E	13,600	270+	65	370	300
F	45,000	600+	4	45	0
G	36,000	1000+	11	60	0
H	800	20	4	0	0
X	3000	500	0	88	91
Y	12,000	1500	0	0	297
Z	1200	150	0	0	0
Totals		3610	110	3163	1884
Percent of Pre-Fire Burrows		100	3.0	87.6	52.2

and there was little or no recovery. They estimated that it would take the Mountain Beaver population 15 to 20 y to recover. The goal of the current study was to evaluate recovery 10 y post-fire (2005) by resurveying the same portions of the fire area surveyed in 1995 and 2000 by Fellers and others (2004).

METHODS

Study Area

Our study was conducted at Point Reyes National Seashore (UTM: Zone 10, 510000 E, 4214000 N, NAD27), a 26,000-ha natural area located along the California coast 50 km northwest of San Francisco. Major plant communities include Douglas-fir forest, Bishop Pine forest, northern coastal scrub, and grasslands (Barbour and Major 1988). Mountain Beaver surveys were conducted within the Vision Fire area 10 y prior to the fire, immediately after the fire (1995), 5 y post-fire (2000) (Fellers and others 2004), and 10 y post-fire (2005) (this study). Our study sites were the same as those of Fellers and others (2004), and were all in northern coastal scrub habitat. Sites A–H (Table 1, Fig. 1) were originally selected because Mountain Beavers survived in these areas immediately after the Vision Fire; these sites were included in our current study so we could evaluate the long-term survival and recovery of Mountain Beavers. Three sites (X, Y, and Z; Table 1, Fig. 1) were surveyed because Fellers and others (2004) did not find any active burrows in those areas

immediately post-fire though they had been occupied prior to the fire. Located near the fire perimeter, these 3 sites could be used to evaluate dispersal into the burned area. In 2000, only 1 of the sites had been reoccupied (Fellers and others 2004). Note that the map in Fellers and others (2004) had sites Y and Z switched; this is corrected here (Fig. 1).

Field Surveys

We used the same survey techniques as Fellers and others (2004). Study sites were located using aerial photos, 7.5' topographic maps, and GPS units with 10-m accuracy. We conducted our surveys between November 2005 and February 2006, 10 y post-fire. Thickets were surveyed by walking around the perimeter and exploring natural openings and indentations in the vegetation. A stout wooden pole was used to move aside vegetation to facilitate observation of Mountain Beaver burrow openings. The densest thickets were examined only around the edge, but most thickets were entered to allow for more extensive burrow searches. We noted the presence of active burrow openings, counted the number of openings, and recorded the locations of openings.

In addition to their distinctive size, Mountain Beaver burrow systems always have multiple openings (Lyon 1907; Camp 1918). We assumed that Mountain Beavers had constructed a burrow system when we found >5 suitably sized burrow openings in an area of <25 m² (Fellers and others 2004).

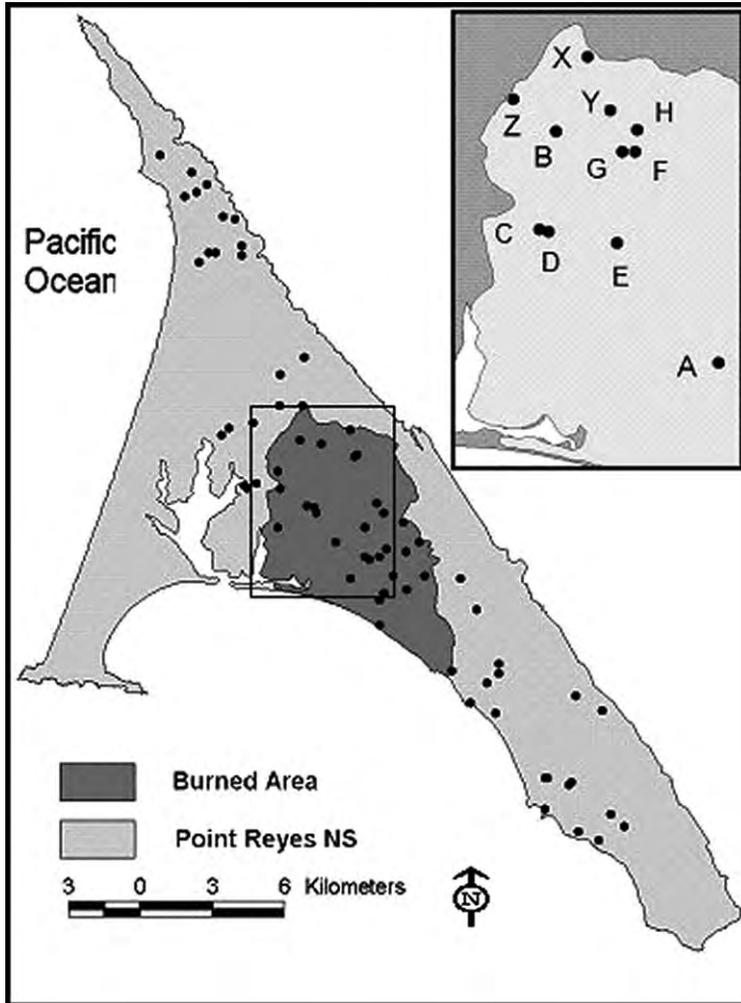


FIGURE 1. Distribution of the Point Reyes Mountain Beaver (dots = 74 known localities) prior to the October 1995 Vision Fire on Point Reyes peninsula, California. Light gray shading is Point Reyes National Seashore (NS), and dark gray shading is the 1995 Vision Fire. Inset enlarges the northwest portion of the fire area and shows the location of 8 sites where Mountain Beavers were present immediately after the fire (A–H) and 3 localities that were monitored for immigration (X–Z). Figure modified from Fellers and others (2004); note that the original figure had sites Y and Z switched.

We could not accurately estimate the number of Mountain Beavers present during our surveys because the ground and burrow openings were frequently obscured by thick vegetation. Immediately after the fires, when very little vegetation remained, Fellers and others (2004) could make almost complete burrow counts. While we recorded the number of burrow openings that we observed at each site in these surveys, we did not attach any significance to changes in burrow opening counts unless these were >50% between the

survey periods because we felt our more recent counts were incomplete due to the regrowth of vegetation.

RESULTS

There are 2 metrics that could be used to evaluate recovery of the Point Reyes Mountain Beaver at the 11 study sites. One is to look at the number of sites that were occupied and the other is to compare the number of active burrow openings.

Occupied Sites

The 1995 Vision Fire eliminated Mountain Beavers at 3 of the 11 study sites. In 2000, two of those sites were still unoccupied and the 3rd site had been recolonized (Table 1). A 4th site that had only 4 burrows immediately post-fire (1995) had none in 2000. Ten years post-fire (2005), two of the sites that were unoccupied in 2000 remained unoccupied, while 2 additional sites with <100 burrows each had been extirpated by 2005. In addition, one site that had been unoccupied immediately post-fire in 1995, and also in 2000, had been recolonized by 2005. Overall, these shifts have resulted in little change in the number of sites occupied since the fire (Table 1).

Burrow Openings

The number of Mountain Beaver burrow openings in 2000 and 2005 (5 and 10 y post-fire; Table 1) at the 11 study sites varied widely, compared with the pre-fire numbers (3610 burrow openings). Immediately post-fire (1995), there were only 3% (110) of the pre-fire number. That increased to 88% (3163) by 2000, but then declined to 52% (1884) in 2005. There was no consistent pattern across the 11 study sites. Comparing 2000 and 2005, we found a $\geq 50\%$ decrease in the number of burrow openings at 2 sites (A and D). We found no burrow openings at 2 sites that were occupied in 2000 (F and G), and we found nearly 300 openings at a site where none were found in 2000 (Y). Sites B, C, and E showed declines ranging from 19 to 38%, but we do not believe this represents significant change due to the difficulty of making accurate counts in the dense thickets that have developed since the fire. Sites X (about 90 burrows) and Y (no burrows) showed no change from 2000 to 2005.

DISCUSSION

At Point Reyes, Mountain Beavers are found predominantly in the northern coastal scrub plant community, a fire-adapted community that extends in a narrow coastal strip from southern Oregon to central California (Ornduff 1974). Coastal scrub at Point Reyes is composed of 2 layers, an upper canopy about 2 m high dominated by Coyote Brush (*Baccharis pilularis*), and a lower layer about 0.3 m high composed

primarily of Western Sword Fern (*Polystichum munitum*), but with lesser amounts of Salal (*Gaultheria shallon*), Hazelnut (*Corylus cornuta*), California Blackberry (*Rubus ursinus*), Bracken Fern (*Pteridium aquilinum*), and Wild Rye (*Elymus condensatus*) (Grams and others 1977). Mountain Beavers are not found along the coast south of Point Reyes, perhaps because of the more open and less lush growth of scrub habitat. The lower layer of herbaceous vegetation that is lacking to the south may be a critical source of food and an essential source of moisture for Mountain Beavers, a species with a primitive, inefficient kidney (Sperber 1944).

The 1995 Vision Fire burned much of the preferred scrub habitat within the range of the Point Reyes Mountain Beaver (Fellers and others 2004). Five years after the fire (2000), most of the northern coastal scrub habitat within the fire area was overgrown with Blue-blossom Ceanothus (*Ceanothus thrysiflorus*), which formed a low, dense thicket at ground level. Structurally, these thickets were largely impenetrable for animals the size of Mountain Beavers (Fellers and others 2004), and the Blue-blossom Ceanothus shaded the ground so completely that there was little or no herbaceous ground cover that would provide a succulent food supply. At the time of our current study (2005, 10 y post-fire), the vegetation had matured with Coyote Brush forming a canopy similar to pre-fire conditions. Concomitantly, the dense growth of vegetation at ground level had become more open with a nearly complete loss of Blue-blossom Ceanothus in many areas, and a return of species such as California Blackberry, California Nettle (*Urtica dioica*), and Poison Oak (*Toxicodendron diversilobum*). This change has allowed medium- and small-sized animals to develop runways through the understory, making the thickets more accessible to Mountain Beavers and other small wildlife. A rich layer of ground cover also has developed, providing a good source of moisture and forage. Overall, the vegetation in much of the burn area looks very much as it did prior to the Vision Fire.

Though the Mountain Beaver habitat appears to have largely recovered 10 y post-fire, the status of the Mountain Beaver is less clear. The number of occupied sites has declined by 1 site (8 to 7), which is probably not a significant

change; however, the total number of burrows has declined from 88% of pre-fire levels in 2000 (5 y post-fire) to 52% in 2005. Since the number of burrow openings is an indication of the number of individuals present at a site, this change suggests that the population has not fully recovered, and is at a lower level than in 2000. One confounding factor is that it is more difficult to survey for and locate Mountain Beavers and their burrow openings 5 and 10 y post-fire because of the re-growth of vegetation than it was immediately after the fire when nearly all of the vegetation had been burned. However, locating burrow openings did not seem to be more difficult in 2005 than it was in 2000, even though the structure of the coastal scrub habitat has changed as the habitat has matured. This suggests that the smaller number of burrow openings is not an artifact of our surveys.

The habitat within the burn area has improved for Mountain Beavers since immediately after the fire when most of the vegetation was burned to bare ground (Fellers and others 2004). Immigration into the fire area has been slow, but it has occurred at 2 sites, one at the fire perimeter (site X) and another 1 km inside (Y) (Fig. 1). While the reasons for the decline in burrow numbers from 2000 to 2005 (5 to 10 y post-fire) are unknown, our expectation is that the ground-hugging Blue-blossom *Ceanothus* will diminish throughout the fire area, and vegetation more typical of northern coastal scrub (such as Coyote Brush overstory with a lower layer of herbaceous vegetation) will return to its former dominance. With these successional changes in thicket structure, Mountain Beaver populations are likely to recover, but we expect there will continue to be considerable variation in the way populations stabilize at each of our 11 study sites. It would be worthwhile to conduct similar surveys 15 to 20 y post-fire to evaluate future Mountain Beaver population trends as well as plant community successional changes.

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