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Response of *Montia howellii* (Howell's montia) to Road Management in California Coastal Timberlands[1]

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Abstract

Howell's montia (*Montia howellii* S. Watson), a tiny annual plant with a California Rare Plant Rank of 2.2 (rare in California but more common elsewhere), is found throughout its range in seasonally wet, natural and disturbed habitats. On Humboldt Redwood Company timberlands it occurs on native surface or lightly rocked roads and turnouts, and in wet meadows used by cattle. We examined the spatial and temporal extent of Howell's montia on 10 road complexes over 6 years by counting the plants in consecutive fixed 10 meter segments of road. Using GIS event routing, we documented the changes in plant numbers in each segment, the movement of plants into new segments, and their decline and disappearance from segments over time. We found that opening and using seasonal, native surface roads was related to increases in plant numbers and spatial spread. After road use ceased, plants declined in both numbers and spatial extent. On rocked roads with heavy use and annual maintenance, populations were not well sustained even with a nearby seed source. We conclude that where Howell's montia occurs on roads, periodic seasonal use and road maintenance appears to maintain the local population.

Key words: GIS event routing, Howell's montia, *Montia howellii*, rare plant mitigation, road management, seed bank

Introduction

Howell's montia (*Montia howellii*, *fig. 1*) is a tiny annual of the Portulacaceae (purslane family). Germinating in late fall, it grows through the early spring, flowers from February to May, then sets seed and quickly disappears. Its range generally coincides with the maritime coastal forests from southern British Columbia to Northern California (CNPS 2011, Hickman 1996, Hitchcock and Cronquist 1973). The Global Status is G3G4, or vulnerable to secure (NatureServe 2011). In California it is ranked S3 (CNPS 2011), in Oregon and British Columbia it is ranked S3S4, (Oregon Biodiversity Information Center 2010), and in Washington it has been dropped to watch status because it has been found to be more abundant than previously assumed (Washington Natural Heritage Program 2011).

Throughout its range, Howell's montia typically occurs in sparsely-vegetated moist to seasonally wet lowland areas such as river and pond edges, cattle and game trails, open fields, vernal pools, seeps, and wet prairies, often on compacted soil (CNPS 2011, Hickman 1996, Kaye 1991, Wilson 1998). It is also found on human-

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Figure 1—A single plant of *Montia howellii,* a quarter, and redwood twigs.

disturbed habitats such as dirt roads, skid trails, landings, turnouts, parking areas, and lawns (CNPS 2011, Kaye 1991, personal observation), and it appears to need disturbance for survival (Kaye 1991, Wilson 1998). It occurs from near sea level to over 800 m (CNPS 2011, personal observation).

It was believed extirpated in California until rediscovered in 1999 near the Van Duzen River in Humboldt County during plant surveys conducted prior to timber harvesting. Since then, 69 populations have been located in California (CNPS 2011), and threats are believed to exist from logging, road construction and maintenance, vehicles, and competition. On Humboldt Redwood Company land (84,000 ha), we have documented 43 populations totaling over 300,000 plants.

From monitoring that we conducted from 1999 to 2004, we found wide site-level fluctuations in both plant numbers and spatial extent. Howell's montia numbers declined and the density of other herbaceous species increased where we avoided impacts to Howell's montia by closing roads, barricading turnouts with rebar stakes and flagging, and placing signs directing drivers to stay on the road running surface, (*fig. 2*). We found that plant numbers typically increased the following year after barricades were removed to allow road use in the summer while the populations existed as seeds. Plant numbers decreased where dirt road segments were upgraded to rocked segments, usually done to minimize sediment inputs to streams.

To better understand the changes that occur in Howell's montia populations, we developed this case study to document the extent of temporal fluctuations in the numbers and locations of Howell's montia on selected roads, and to correlate observed changes with the timing of road use and other disturbances.

a)

b)

Figure 2—Effects of mitigation applied 1999 to 2004 showing herbaceous overgrowth: a) Sign with overgrown turnout behind it, and b) a turnout barricaded for 6 years; both sites are no longer suitable habitat for Howell's montia.

Methods and materials

Study area selection

We selected 10 road complexes for this study (*table 1*) on Humboldt Redwood Company land. They include a full range of small to large populations, elevations from 45 m (150 ft) to over 800 m (2,625 ft), and are located in several major stream drainages representing the majority of the company's land base and road management practices. Both rocked and native-surfaced roads were present in the road complexes, except for Chadd and Larabee which had no rocked roads. Mainline rocked roads and some of the seasonal native-surface roads have regular use and maintenance each year, while most seasonal roads have disturbance only in years when they are used for timber harvesting operations. Prior to beginning the study, we were aware that some areas had periodic light-vehicle or foot-traffic disturbance from our watershed monitoring activities or from trespassers. Other areas had continuing disturbance from cattle.

Table 1—*Road complexes used in the study.*

Road complex	Cal Planning Watershed Sub-basins	Elevation range (m)	Topographic location	Km
Booth's Run	Booth's Run	524-610	Upper slopes	1.82
Chadd	Chadd Cr.	183-408	Lower/middle slopes	5.20
Cummings Cr.	Cummings Cr.	122-305	Lower/middle slopes	4.65
Jordan	Jordan Cr.	61-122	Lower slopes	6.50
Larabee	Scott Cr. Complex	701-884	Ridges, upper slopes	5.63
Monument A55	Monument Cr. and Kiler Cr.	183-427	Ridges, upper slopes	5.70
Stafford A51	Jordan Cr.	524-610	Ridges, upper slope	1.29
Van Duzen L35	Hely Cr.	61-110	Lower slopes	4.02
Van Duzen L64	Root Cr.	76-171	Lower slopes	4.02
Wrigley	Lower N. Fork Elk R.	30-104	Lower slopes	2.57
			Total Km in the study	41.40

The locations used for this study are shown in *figure 3*. We incorporated approximately 25 percent of the populations[4] on the property, collectively encompassing approximately 80 percent of the plants as of 2004.

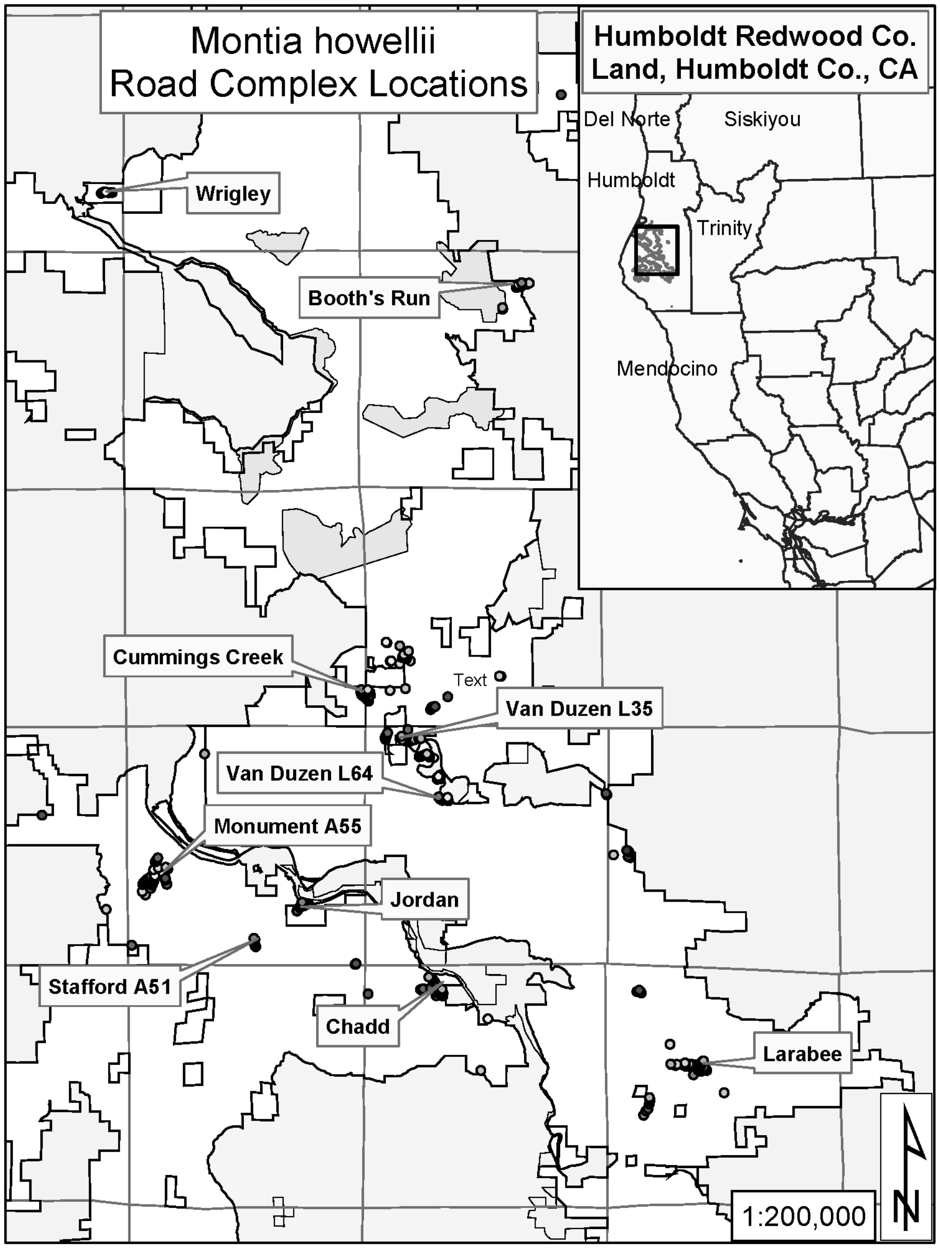

Figure 3—Location of study sites on Humboldt Redwood Company lands in Humboldt County, California. Map inset shows the property in relation to surrounding counties in California.

Data collection

Howell's montia typically occurs in sparse to dense clumps of plants often separated by long road segments with few or no plants. Given the miniscule size of

[4] Populations are defined as collections of occurrences separated by at least ¼ mile.

this plant and the variation in density, we knew that standard methods of sampling would result in non-normal, highly skewed, zero-rich data (McCune and Grace 2002). A random allocation of fixed-area quadrats, especially where there were unoccupied segments of road in a sparsely-occupied road complex, would be an inefficient design (Green 1979, Salzer and Willoughby 2004). It would result in an inflation of the error variation among quadrats because of the clumped differences in abundance, and small new groups would be easily missed. For the same reason, point intercept or line intercept sampling methods would also be ineffective (McCune and Grace 2002). Therefore, we elected to conduct an extensive survey of the entire road prism and associated turnouts and landings along all interconnected roads in each study area; in other words, we counted the entire population at each site in each visit. Even though we did not use a sampling process, this study is sufficiently inclusive to enable us to make inferences about the management of Howell's montia on roads in managed timberland settings in California (Elzinga et al. 1998, Elzinga et al. 2001, Mueller-Dombois and Ellenberg 2002, Quinn and Keough 2002).

We collected data from mid-February through mid-April (end of March in dry springs), starting with lower elevation roads before progressing to higher elevations. From a random start outside the area containing plants, we divided the road into fixed 10 m lengths and counted the plants in each segment. If the area was sparsely occupied we counted individual plants; where the plants were denser, we made a careful estimate of the number[5]. We monumented the random start so we could re-establish the location of the fixed 10 m segments in subsequent years. We continued for a fixed distance of 500 m (0.31 mi) beyond the last observed Howell's montia plant or until the habitat became unsuitable. This ensured that we were likely to find plants that had spread beyond the original extent of the occupied area.

Data analysis

We recorded the data in a Microsoft Access table and linked it to our Global Information System (GIS) roads layer. We added a conversion to account for discrepancies between road (slope) distance and GIS (planar) representation, although we had to accept a small level of error on roads with steep slopes. This process gave each 10 m segment, as measured on the ground, an address along the road system in our GIS. This type of analysis is known as "event routing," which characterizes each 10 m segment as an "event" containing the data while the GIS road layer is the "route" on which that data rides. We then used the event route tables to create a map set that very accurately displayed the plant locations and numbers for each year of the study.

We queried our road work database and project archives to create a management history for each road system that included the specific roads used in any year and the type of management that occurred each year starting in 2004.

Results

Plant number changes

Plant numbers fluctuated widely at most sites (*fig. 4*) and even within individual 10 m segments, similar to what we had documented prior to initiating this study. The

[5] All team members are experienced in counting and estimating Howell's montia numbers.

dates shown on the graphs in *figure 4* indicate when the greatest amount of road use from timber harvesting operations occurred. Operational activities took place in the summer after plant counts were taken; any changes in numbers that may have resulted from the disturbance from operations were recorded in the next scheduled survey year. Plant numbers increased in all populations following disturbance, and declined within 2 years after disturbance ended.

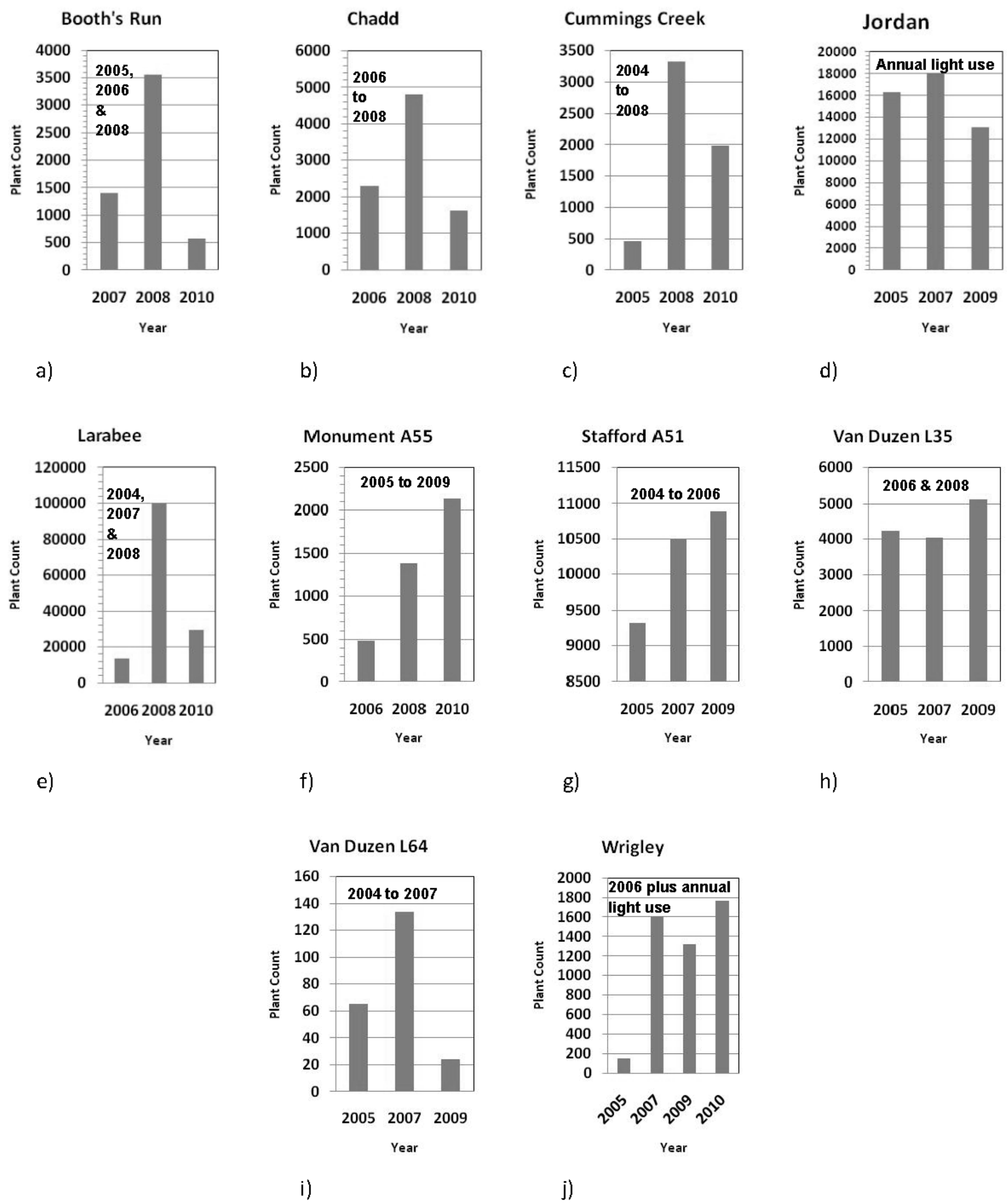

Figure 4—*Montia howellii* plant numbers, 2005 to 2010: a) Booth's Run, b) Chadd, c) Cummings Creek, d) Jordan, e) Larabee, f) Monument A55, g) Stafford A51, h) Van Duzen L35, i) Van Duzen L64, and j) Wrigley. Dates indicate years of maximum disturbance.

In addition to disturbance from road use associated with timber harvesting, there were other sources of disturbance documented in all road complexes except the Chadd and Van Duzen L64 road complexes. Disturbance from cattle was present at

Booth's Run, Larabee, Monument A55, and Stafford A51. At Cummings Creek, Jordan, Van Duzen L35, and Wrigley there was light vehicle use of the roads and turnouts by pickups and all-terrain vehicles. Where disturbance continued to maintain lightly-vegetated habitat conditions, plant numbers did not decline.

Changes in density and location

Two examples of temporal changes in plant density and location are shown in the following figures, generated from GIS event routing. Similar changes took place at the other road complexes.

The Chadd road complex (*fig. 5*) illustrates what we found when disturbance ended: competing vegetation became dominant while Howell's montia numbers declined. Timber harvesting and road maintenance in 2006 and 2007 required opening all but the most eastern road. The population increased in 2008 to 4,880 plants, more than double the 2,361 plants found in 2006, and plants were documented on two spur roads that had no plants at the beginning of the study. In 2008, road work occurred at two stream crossings; plant numbers in 2010 remained high near those locations but declined on all the other roads.

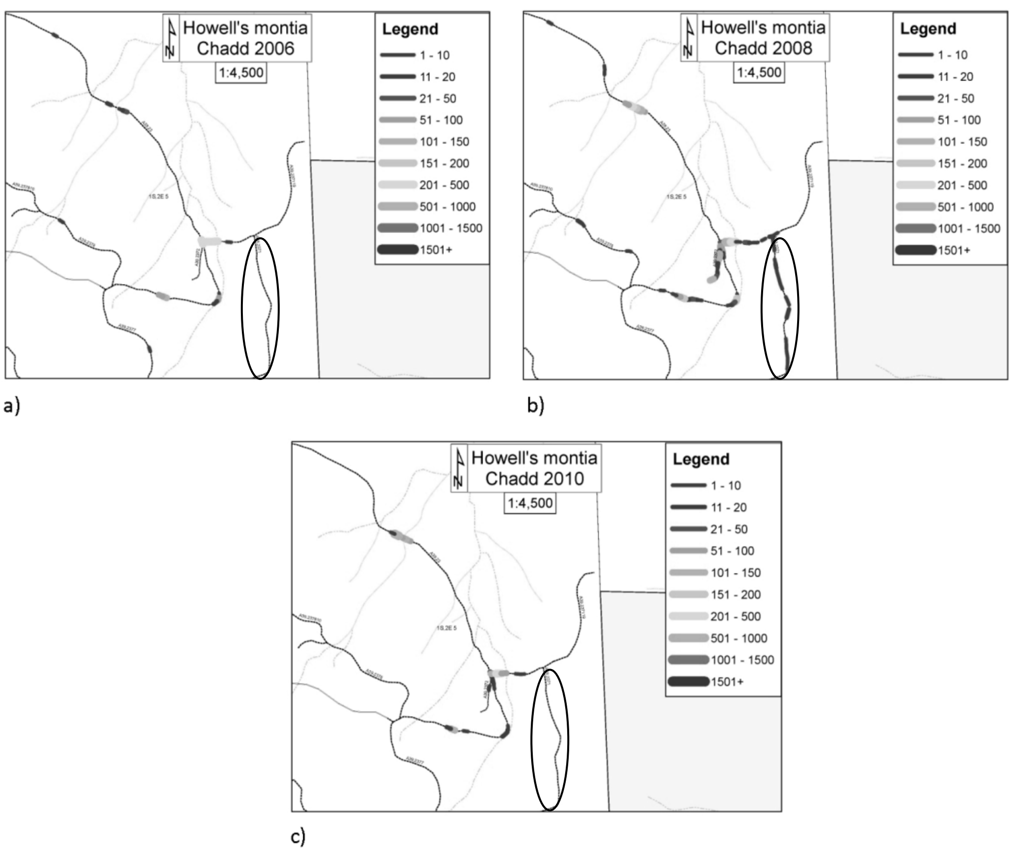

Figure 5—Spatial changes at the Chadd road complex generated from GIS event routing: a) 2006, b) 2008, c) 2010; width of the symbol indicates number of plants in the 10 m segment.

For example, the southeast spur road outlined in *figure 5* had no plants in 2006 before it was opened and used for logging. In 2008 it had a low density of up to 20 plants per 10 m, but no plants in 2010. The declining numbers documented on spur roads such as this one resulted in a decrease in total plant numbers throughout the road complex to just over 1,600 in 2010.

The Monument A55 road complex (*fig. 6*) is an example of what can happen when forest management operations open roads that are subsequently used by cattle. Here, timber harvesting and road maintenance took place 2005 to 2009 on the mainline road but the spur roads were opened and used only during 2005 to2006. Overall plant numbers in the entire road complex showed a steady increase from 486 plants in 2006 to 2,133 plants in 2010.

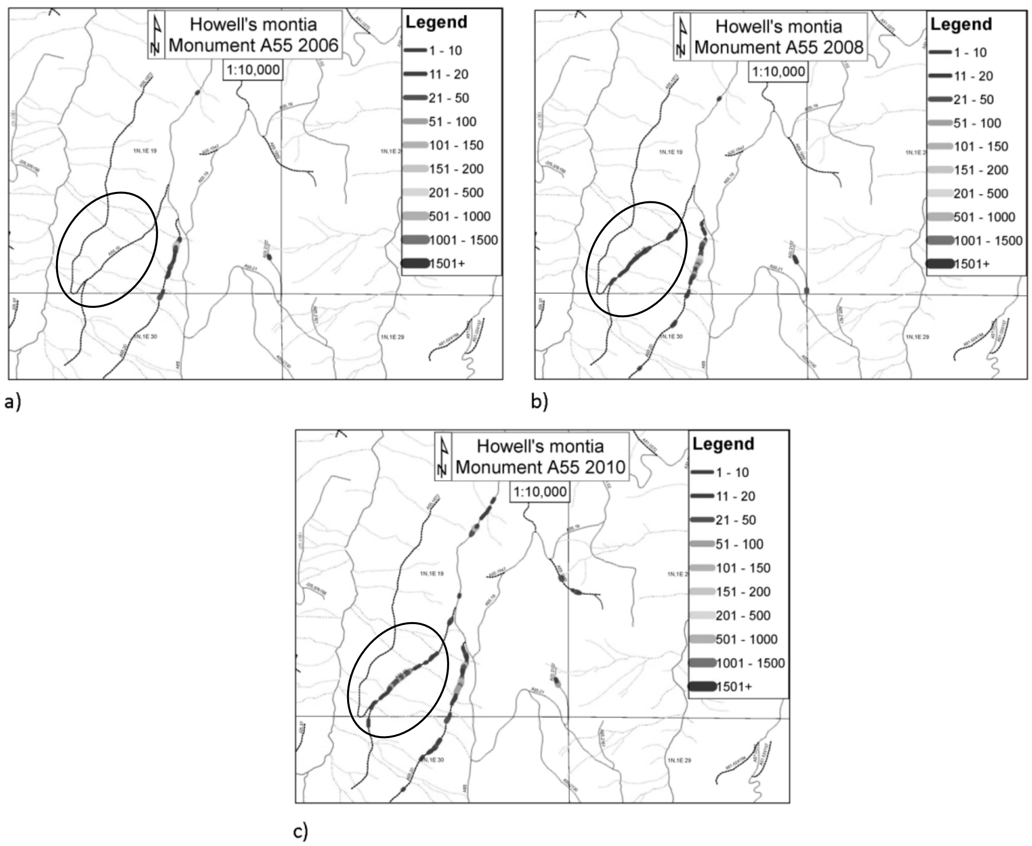

Figure 6—Spatial changes at the Monument A55 road complex generated from GIS event routing: a) 2006, b) 2008, and c) 2010; width of the symbol indicates number of plants in the 10 m segment.

On the southwest spur road outlined in *figure 6*, our previous monitoring from 2004 documented only 20 plants in a 670 m length. In the spring of 2006, the first time we counted the population for this study, we found no plants on this spur road. It was opened to allow harvesting in summer of 2006, and in 2008 and 2010 we recorded 171 and 673 plants respectively with plants present all along a previously unoccupied 400 m length of road. The increase through 2010 occurred even though the road was only used for harvesting operations in 2006 and closed when operations were completed. However, cattle are abundant in the area (from legal leases) and the increases in Howell’s montia numbers and locations were associated with continuing use of the newly-opened roads by cattle.

In all areas, heavily used graveled mainline roads did not support plants except in some turnouts, even though large numbers of plants were present on nearby roads.

Discussion

When roads known to be occupied by Howell's montia were opened and used for timberland management, we found short-term and sometimes surprisingly large increases in plant abundance as well as local changes in spatial extent following disturbance from operational activities. Plants spread into adjacent, previously unoccupied road segments in all 10 study areas when these roads were opened for use. Howell's montia numbers typically declined within a year after the cessation of disturbance as the roads and turnouts became dominated by grasses and forbs. We speculate that new groups of Howell's montia that appeared after opening some of these roads came from an in-situ seed bank, as may be the case for the Monument A55 spur described above. Other new groups may have come from seed spread by road graders and other equipment from nearby sites containing active populations.

After roads were opened, in locations where the sparsely vegetated habitat on seasonal roads was maintained by cattle or light vehicle use, plant numbers either increased or declined more slowly than in the areas where there was no continued disturbance from cattle or vehicles. For example, at Stafford A51 (disturbance from cattle) and Wrigley (light vehicle use), plant numbers continued to increase after the roads were no longer used for harvesting operations. High numbers were also maintained at Jordan where no harvest-related use occurred on the roads occupied by Howell's montia, but where there was ongoing light vehicle use. This disturbance apparently maintained the conditions needed to sustain Howell's montia population numbers at these and other similar sites. Conversely, at Chadd and Van Duzen L64, where neither cattle nor light vehicle use were present to maintain an open, lightly-vegetated habitat, population numbers decreased sharply following the end of road use.

An unexpected benefit derived from this work has been to apply the GIS event routing mapping to operational needs. For example, work on a Van Duzen L35 road in 2008 was adjusted to avoid significant impacts to most of the 10 m segments containing Howell's montia. Plant counts more than doubled on that road the following year.

The study results indicate that maintaining populations of this species can be compatible with active forest management. Where ongoing disturbance to populations from summer road maintenance and use occurs, conditions favorable to Howell's montia have been preserved and population numbers remain fairly stable. As part of our Howell's montia management strategy, we avoid heavy road rocking, excavation, and deep grading where plants are known to occur, since these activities can alter the microsite conditions or bury the seed bank. We will also continue periodic surveys, though on a less intensive schedule.

The Global and California state status of Howell's montia are not likely to change as a result of this study. The southern range extent in California is limited to two counties, and while known populations there can have high numbers of plants, most are on managed timberlands. If more populations are recorded on non-commercial timberlands and submitted to the Biogeographic Data Branch of the California Department of Fish and Game, this plant will be eligible for status review. Until then, more surveys are needed.

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