Camissonia benitensis
(San Benito evening primrose)

Written by:
Ryan Emery O'Dell
Natural Resource Specialist
Bureau of Land Management
Central Coast Field Office
940 2nd Avenue
Marina, CA 93933
rodell@blm.gov

Acknowledgements

The recovery of *Camissonia benitensis* has been the culmination of more than 30 years of efforts by the Bureau of Land Management Central Coast Field Office (formerly Hollister FO; BLM); US Fish and Wildlife Service Ventura Office and Sacramento Office (USFWS); Natural Resources Conservation Service Hanford Soil Survey Office (NRCS); academic institutions including UC Davis, UC Berkeley, UC Santa Cruz, Santa Clara University; Friends of Clear Creek Management Area (FOCMA); California Native Plant Society (CNPS); private consultants; and numerous other stakeholders and volunteers.

Annual census data collection and habitat monitoring were conducted by Charlotte Bowen (Camberlain; BLM; 1982), Laurie Kiguchi (BLM; 1983-87), Dean Taylor (1988-91), Bruce Delgado (BLM; 1991-95), Richard White (BLM; 1996-97), Sam Fitton (BLM; 1998-99), Julie Anne Hopkins (Hamon; BLM; 1999-2006), and Ryan O'Dell (2007 – present). Dean Taylor conducted extensive key ecological research and suboccurrence introductions of *Camissonia benitensis* under an assistance agreement with the BLM 1988 – 1991 (Taylor 1990, 1992, 1995). Ryan O'Dell conducted additional ecological research with a primary focus on seed bank quantification and seed viability as well as suboccurrence introductions 2008 – present (BLM 2008, 2009, 2010, 2011, 2012, 2013, 2014a). Victor P. Claassen (UC Davis) and Ryan O'Dell conducted serpentine revegetation research at San Carlos Creek in 2008 and 2009. Justen Whittall and Cindy Dick (Santa Clara University) conducted a genetics study on *Camissonia benitensis* in collaboration with Ryan O'Dell, under an assistance agreement with BLM in 2012 and 2013 (Dick et al. 2014). The California Native Plant Society conducted vegetation mapping of CCMA under an assistance agreement with BLM in 2006 (CNPS 2006). The Natural Resource Conservation Service (NRCS) conducted a soil survey of CCMA under an assistance agreement with BLM in 2011. PTI Environmental Services conducted an erosion and sedimentation analysis of the Clear Creek watershed under contract with BLM in 1993 (PTI 1993). The Dynamac Corporation conducted a geomorphic field evaluation of serpentine soil barrens at CCMA under contract with BLM in 1998 (Dynamac 1998).

The following private land owners are acknowledged and thanked for granting access to survey for *Camissonia benitensis* on their private lands: World International LLC (Dough Carney) at Diablo Grande; Adobe Springs Water Company (Paul Mason) at Del Puerto Canyon; Doodlebug Ranch (Bob Simonin and Charles Eilers) at Cerro Bonito; Rock Springs Ranch (Jason Bumann) at Rock Springs Peak; Kurz Ranch (Jerry Kurz) at Hernandez Valley; Buffalo Run Ranch (Mark Costa and Gary Filizetti) at Laguna Mountain and Panther Peak; Fawn Lake Ranch (Lee Scazighini and Barb Galliotto) at Upper San Benito River; Los Gatos Ranch (David Teague) at White Creek; Francisco Salcedo at Priest Valley; Frank Johnson at Charley Mountain; and V6 Ranch (Jack Varian) at Parkfield. I additionally thank Liz Clark and Kimberly Guilliam at Ft. Hunter-Liggett for access to survey at Burro Mountain.

Many thanks to George Franchois and Shyamalika Ghoshal at the Department of Interior Library for fulfilling numerous requests for published literature used as supporting references for this document. Extra special thanks to Victor P. Claassen for maintaining my temporary affiliate status at UC Davis, which has provided invaluable access to the Web of Science and University of California libraries. Additional thanks to Jason Alexander at Consortium of California Herbaria (CCH) for *Camissonia* herbarium specimen label habitat data download.

Executive Summary

All Recovery Actions specified in the Recovery Plan for *Camissonia benitensis* (USFWS 2006) have been completed and additionally the Bureau of Land Management Central Coast Field Office states that *Camissonia benitensis* has been recovered for the following five reasons:

1) The primary identified threat of OHV recreation has been eliminated by the 2014 Record of Decision (ROD) for the approved Clear Creek Management Area Resource Management Plan which limits access to the Serpentine ACEC to highway licensed vehicles only and entry by permit for five days a year only on a designated touring route;

2) Additional scientific data and improved understanding of the disturbance ecology of the species. *Camissonia benitensis* is specialized in unstable habitat and adapted to soil surface disturbance and therefore soil surface disturbance – whether natural or anthropogenic - cannot constitute a valid threat;

3) Discovery of several hundred new suboccurrences and extensive additional potential habitat, much of which is located outside of the former OHV recreation area of Clear Creek Management Area;

4) Population genetic research indicates that the entire species functions as a single, giant metapopulation, thereby buffering the species from extinction; and -

5) Soil seed bank research that indicates that the species has very large, long-lived soil seed banks that are well-distributed throughout the soil profile that strongly buffers the species from extinction.

The BLM suggests a Recommended Listing Action for *Camissonia benitensis* of "Delist" with the most appropriate reason for delisting according to 50 CFR 424.11 of "Original data for classification in error." The BLM asserts that fundamental errors were made by the USFWS in evaluation of the ecology and state of the species in the final rule for Federal listing (USFWS 1985) including: 1) lack of recognition of specialization of *Camissonia* to unstable habitat types that experience high levels of natural background soil disturbance and adaptation of the species to frequent soil surface disturbance, and 2) no recognition at all of the presence of soil seed banks for the species, inclusion of soil seed banks in census of the species, or acknowledgement that soil seed banks are an integral part of the plant populations. The very large, long-lived soil seed banks constitute the majority of individuals in suboccurrences of *Camissonia benitensis* – more than 1000x the number of emergent individuals in any given year.

Camissonia benitensis Ecology

Life Cycle and Demography

Camissonia benitensis (San Benito evening primrose) is a short-lived annual plant in the plant family Onagraceae. As with all annual plant species adapted to unstable, unpredictable habitats, it is an r-selected species. *Camissonia benitensis* seeds in the near surface soil seed bank germinate with the first significant rainfall event (> 25 mm; 1 in) in November or December. *Camissonia benitensis* exhibits a Type 2 to Type 3 (depending on varying annual conditions) survivorship curve, typical of r-selected species, with high, early mortality at the two to four leaf stage due to combined, interacting stresses of daily, cyclic soil frost heave action in winter (December, January, February; Taylor 1990; BLM 2011, 2012). Soil frost heave occurs during periods of high soil moisture in winter, which overlaps with the early to middle portion of the life cycle of *Camissonia benitensis* and most other winter annuals, when young plants are establishing their root systems. Nighttime freezing temperatures causes water near the soil surface to freeze and expand up to 50 mm (2 in), uprooting *Camissonia benitensis* and other annuals (Taylor 1990; BLM 2011, 2012). This natural disturbance occurs over extensive areas – estimated at 30% - of the total occupied habitat of the species. The frost (ice) melts during the day, causing the soil surface to collapse. The freeze (expand) - thaw (collapse) cycle may occur up to 30 times during the winter.

Camissonia benitensis seedlings that survive and grow into juveniles December – March, produce numerous small, linear leaves on wiry, decumbent stems. Most individuals remain small (< 5 cm tall; < 2 inches), while a small proportion of individuals will grow large under favorable local conditions with several decumbent branches (Taylor 1990; R.E. O'Dell personal observations). The plants mature and begin producing small, yellow, four-petaled flowers in April. Despite producing relatively showy yellow flowers, *Camissonia benitensis* is self-pollinating (autogamous; Raven 1969; Taylor 1990). Self-pollination ensure seed production without pollinators. Under natural conditions, each plant produces between one and 25 capsule fruits with each fruit containing 90 - 100 tiny black seeds (**Figure 1**; Taylor 1990). All reproductive (fecundity) parameters including number of capsules per plant, capsule length, and number of viable seeds per capsule of *Camissonia benitensis* is either the same or greater than the two most closely related species *Camissonia strigulosa* and *Camissonia contorta* (Taylor 1990).

The capsules of *Camissonia* typically partially dehisce upon drying and fully dehisce upon rain drop impact. Seeds drop to the soil surface to either germinate shortly thereafter with the first rains in fall, or become incorporated into the soil and part of the persistent soil seed bank.

Although few individuals of *Camissonia benitensis* emerge in any given year and survive to produce seeds within suboccurrences, those that do produce enough new seeds to replace seeds that exit the soil seed bank through seed predation, mortality, or germination (Taylor 1990).

Demographic analysis is key to understanding the trajectory of a suboccurrence (population) and foundational to Population Viability Analysis (PVA). *Camissonia benitensis* exists in two distinctive life cycle stages – 1) emergent as a seedling, juvenile, or flowering adult, or 2) non-emergent as a seed dormant in the soil seed bank (**Figures 2** and **3**). For annual plant species, the life cycle stage matrix model can be simplified to transition rates from soil seed bank seeds to reproductive adult and from reproductive adult (seeds produced) back to the soil seed bank (seeds out – seeds in; Schmidt and Lawlor 1983). For annual plant species with very large, long-lived soil seed banks, the life cycle stage matrix model becomes overwhelmingly dominated by the extremely high (>0.99) transition rate from soil seed bank to soil seed bank with most seeds in any given year remaining dormant in the soil seed bank (**Figure 3**). The seeds of *Camissonia benitensis* are tiny – as small as grains of sand and virtually invisible in the soil seed bank (**Figure 1**) – yet represent the vast majority of individuals in the suboccurrence (Taylor 1990; BLM 2011, 2012, 2013).

The Federal Register for Federal listing of *Camissonia benitensis* (USFWS 1985) focused analysis of the status of the species based on emergent plant counts and included no discussion - *at all*- of the presence of a soil seed bank, the potential size and longevity of the soil seed bank, or the importance of soil seed banks in annual plant population dynamics. The BLM has conducted annual emergent plant census for suboccurrences of *Camissonia benitensis* every year for 35 years (only 1989 to 2017 shown in **Figure 4**) in a futile attempt to document and understand suboccurrence size relationship to varying abiotic and biotic factors. Although emergent individuals are the primary indicator of habitat suitability for the species, they are not adequate for conducting a comprehensive census for a species where the majority of individuals reside dormant in the soil seed bank. Large, long-lived (persistent) seed banks ("storage effect") buffer annual plant species ("bet-hedging in time") against uncertain interannual climate variability and unstable (unpredictable) habitat types and prevent extirpation and extinction (Cohen 1966, 1967, 1968; Pavlik 1987; Pavlik and Barbour 1988; Baker 1989; Kalisz and McPeek 1992, 1993; Baskin and Baskin 1998; Higgins et al. 2000; Meyer et al. 2005, 2006; Evans et al. 2007).

Dean Taylor (1990) conducted the first soil seed bank quantification studies of *Camissonia benitensis* in 1987 and provided the first glimpse that biologists were missing the majority of individuals in the suboccurrences – hidden in the soil seed bank - during census monitoring. It was discovered that up to 100x the number of individuals in a suboccurrence resided as seeds in the soil seed bank. Additional extensive soil seed bank studies conducted by Ryan O'Dell 2011 - 2013 have now established that the number of viable seeds in the soil seed bank ranges from an average of 519x (BLM 2011, 2012) to 3435x (BLM 2012, 2013) the number of emergent individuals in any given year. These soil seed banks are extensive – underlying the entire occupied habitat – and deeply anchored by being well-distributed throughout the soil profile up to 48 cm (19 inches; maximum sampling depth; BLM 2011). The seeds of *Camissonia benitensis* in soil seed banks have been indirectly measured to have maximum seed longevity between 20 and 120 years (BLM 2011, 2014a). Direct measurement of maximum seed longevity (viability) for seeds stored dry at room temperature (seed obtained from herbarium specimens) is ~30 years for *Camissonia contorta* (3% viability at 26 yrs; 17% at 21 yrs; BLM CCFO unpublished data). A reasonable maximum soil seed bank longevity for *Camissonia benitensis*, with no new seed inputs, may then be between 30 and 80 years (Taylor 1990; BLM 2011, 2014a; BLM CCFO unpublished data; Telewski and Zeevaart 2002) with some exceptional outliers up to 80 to 120 years (BLM 2014a). The Onagraceae family (Myrtales) has seed characteristics that confer exceptional seed longevity (Pavlik 1987; Pavlik and Barbour 1988; Hendry et al. 1994; Probert et al. 2009)

Bruce Pavlik demonstrated the presence of very large, long-lived soil seed banks for another Federally listed taxon of Onagraceae – *Oenothera californica* subsp. *eurekensis* (Pavlik 1987; Pavlik and Barbour 1988). The soil seed banks of *Oenothera* which includes several desert species, are known to be very large (Pavlik 1987; Pavlik and Barbour 1988; Evans et al. 2007) and particularly long-lived with a demonstrated maximum soil seed viability of 80 years (Telewski and Zeevaart 2002). Soil seed bank quantification was crucial to demonstrating that despite widely fluctuating numbers of emergent individuals, the very large, long-lived soil seed bank strongly buffers the sand dune endemic *Oenothera californica* subsp. *eurekensis* from extinction. The very large, long-lived soil seed banks of *Oenothera californica* subsp. *eurekensis* were a major factor in non-integrated trend analysis that resulted in the USFWS selecting a recommended classification of "Delist" in their 5 Year Review in 2007 (USFWS 2007). *Oenothera californica* subsp. *eurekensis* was finally delisted in 2018 (USFWS 2018).

Non-integrated trend analysis is used in place of Population Viability Analysis (PVA) when demographic variables cannot be numerically related to one another, for example when there are very large, long-lived soil seed banks (Pavlik 1994) – as demonstrated for *Camissonia benitensis*. Non-integrated trend analysis relies on parallel interpretation of data on survivorship, reproduction, and frequency of establishment (Pavlik 1994). Parameters that Pavlik (1994, pg 329, Table 13.2, based on Harper 1977) established as indicative of population stability include: 1) *Survivorship* – mortality inflection point on survivorship curve (Type 1) follows onset of seed production; 2) *Seed Production* – seed production of an endangered taxon equals or exceeds that of a non-endangered relative with similar life form; 3) *Seed Bank* – density of viable seeds in soil prior to season of germination far exceeds the average density of established individuals + year to year changes in density of viable seed are not correlated with changes in the density of established, reproductive individuals; and 4) *Frequency of Establishment* – frequency of establishment is less than the half-life of seeds in the soil seed bank. *Camissonia benitensis* easily achieves the Seed Production, Seed Bank, and Frequency of Establishment criteria. These three parameters, especially Seed Bank, compensate for the Type 2 to Type 3 (higher early mortality) survivorship curve of the species. Non-integrated trend analysis indicates that *Camissonia benitensis* is stable and well buffered from extinction by very large, long-lived soil seed banks.

Although wildflowers (emergent plants) are the most tangible connection that we have to annual plant species that are easy to see and monitor, we should not forget that the tiny seeds we can't easily see the soil seed bank are an integral part of the suboccurrence as well, and in many cases like *Camissonia benitensis*, represent the vast majority of individuals in the suboccurrence. The number of emergent individuals fluctuates widely from year to year with varying annual growing conditions (**Figure 5**), making it appear that *Camissonia benitensis* is unstable, but the very large, long-lived soil seed banks containing the vast majority of the individuals of the suboccurrence indicate very high stability (**Figure 6**). In the demography of an annual plant species with very large, long-lived soil seed banks, the only purpose of emergent individuals is to produce a small quantity of new seeds to replace seeds that have exited the seed bank through predation, mortality, or germination. The production of new seeds also serves the important function of resetting the soil seed bank longevity "clock" back to maximum (**Figure 3**). Monitoring of annual plants, including post-delisting monitoring of *Camissonia benitensis* should focus monitoring on quantifying soil seed banks on 2 to 10 year intervals and only casually monitor emergent plants as a general indicator of the continued suitability of the habitat to support the species (BLM 2016).

Figure 1. Seeds of *Camissonia benitensis*. The seeds are approximately 1 x 0.5 mm. The coin is 19 mm (0.75 inch) in diameter – life size when document is viewed at full size.

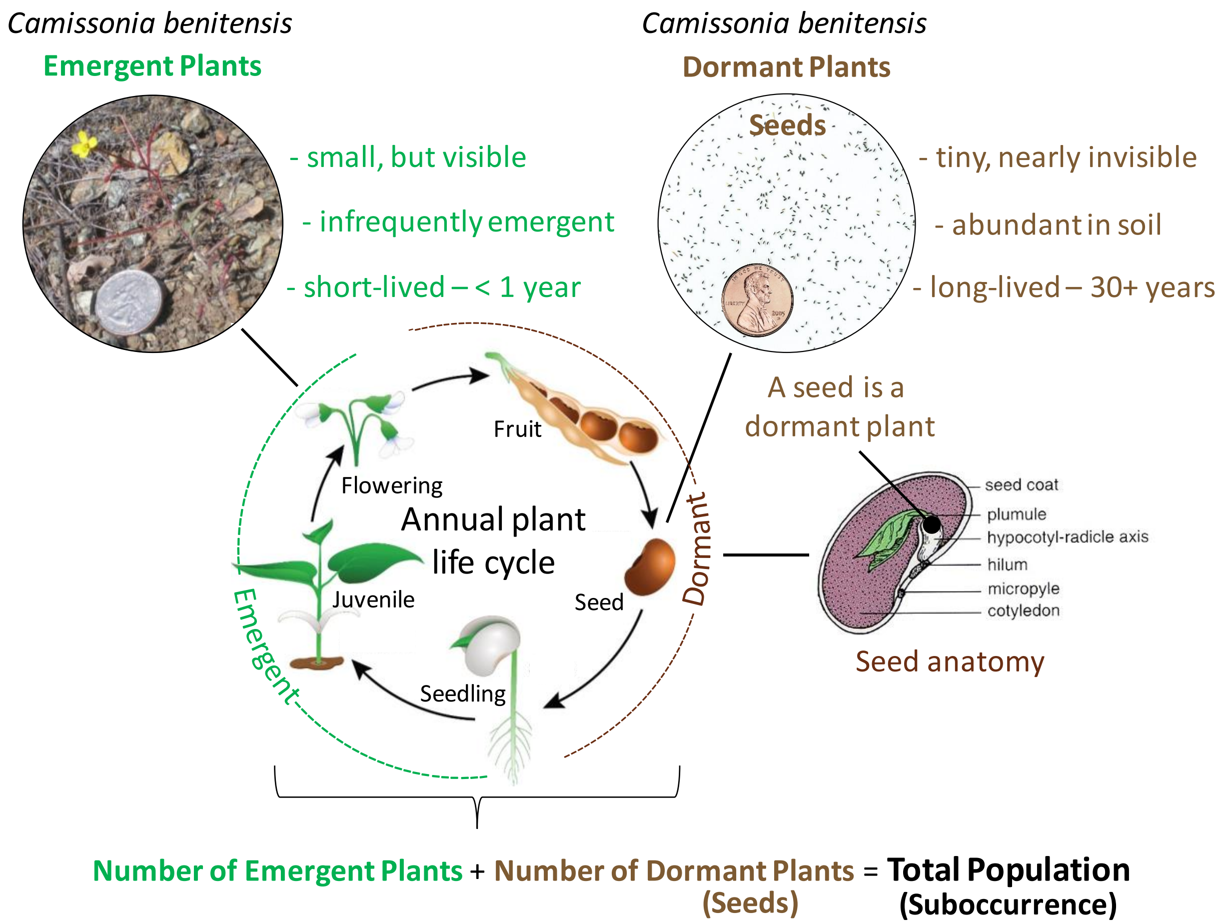


Figure 2. The life cycle of an annual plant. Emergent plants are the most conspicuous portion of a plant's life cycle; however, inconspicuous seeds in the soil seed bank often represent the vast majority of individuals within the plant population. Annual plants spend most of their lives as dormant seeds in the soil seed bank and only a short time emergent, growing, flowering, and producing new seed to replenish the soil seed bank.

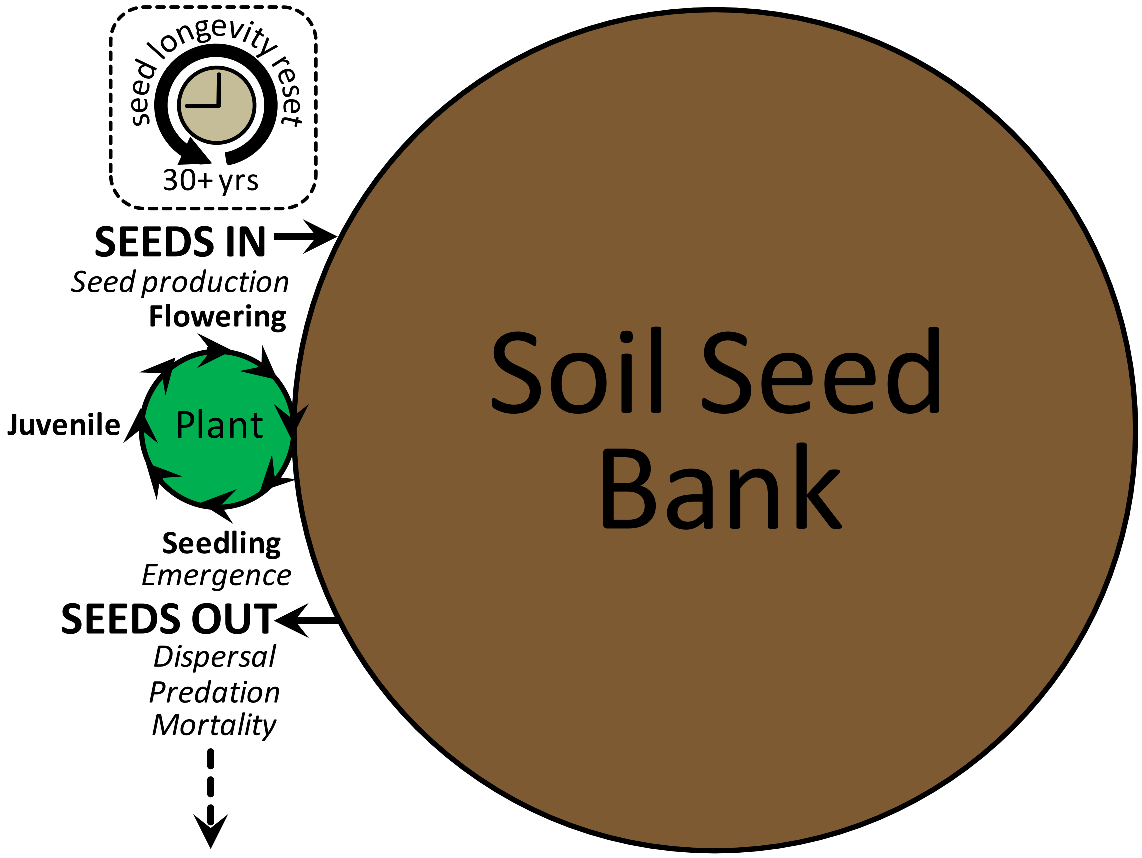


Figure 3. A generalized model of an annual plant with a large, long-lived soil seed bank based on Schmidt and Lawlor 1983; Kalisz and McPeek 1992, 1993; Caswell 2001; Doak et al. 2002; Adams et al. 2005; Meyer et al. 2005, 2006). The soil seed bank contains the vast majority of individuals in the population. Seeds may exit the soil seed bank via emergence (germination), dispersal out of the population, predation, and mortality (natural seed death). Emergent plants that successfully flower, produce new seeds to replenish the small portion of seeds that exit the seed bank. The production of new seeds also serves the important ecological function of resetting the seed longevity clock (maximum duration the population may remain non-emergent) back to maximum.

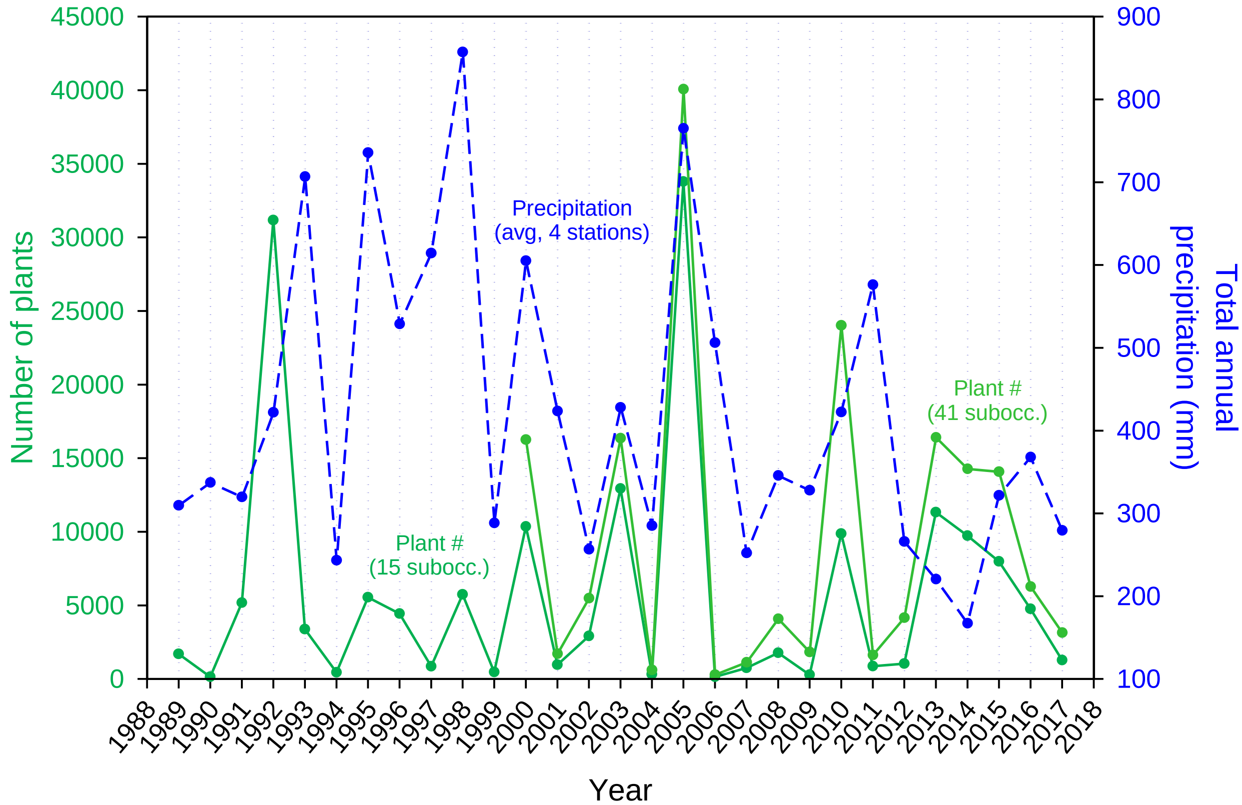


Figure 4. Number of plants counted for **15 suboccurrences** of *Camissonia benitensis* for which there is continuous data for dating back to 1989 (29 years); number of plants for **41 suboccurrences** of *Camissonia benitensis* for which there is continuous data for dating back to 2000 (18 years); and **total annual precipitation** (average of four stations: Hernandez [HDZ], Mustang Ridge [MTG], Priest Valley [PSV], and Smith Mountain [SMI]; California Department of Water Resources). 100 mm = 0.4 inch.

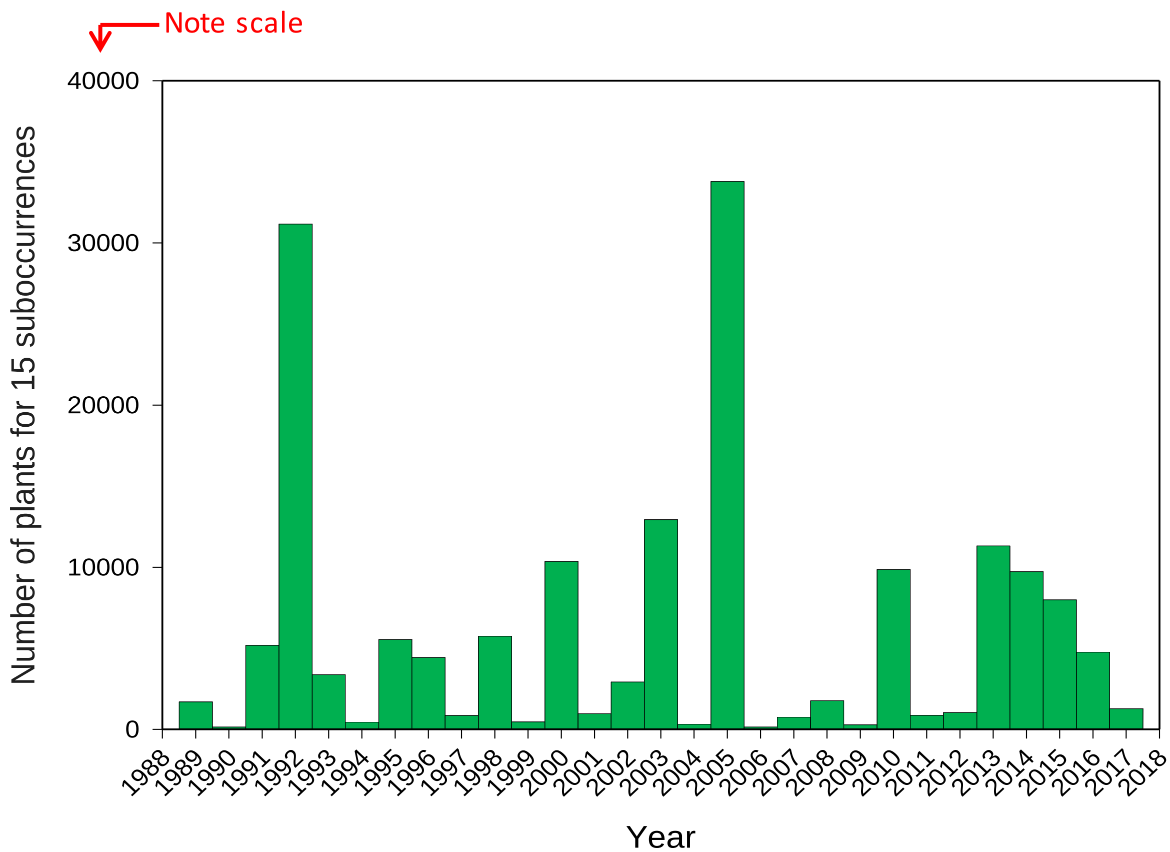


Figure 5. Number of plants counted for 15 suboccurrences of *Camissonia benitensis* for which there is continuous data for dating back to 1989 (29 years). This is the same data as presented in **Figure 4**, but presented again here as a bar graph for comparison to soil seed bank size in **Figure 6**.

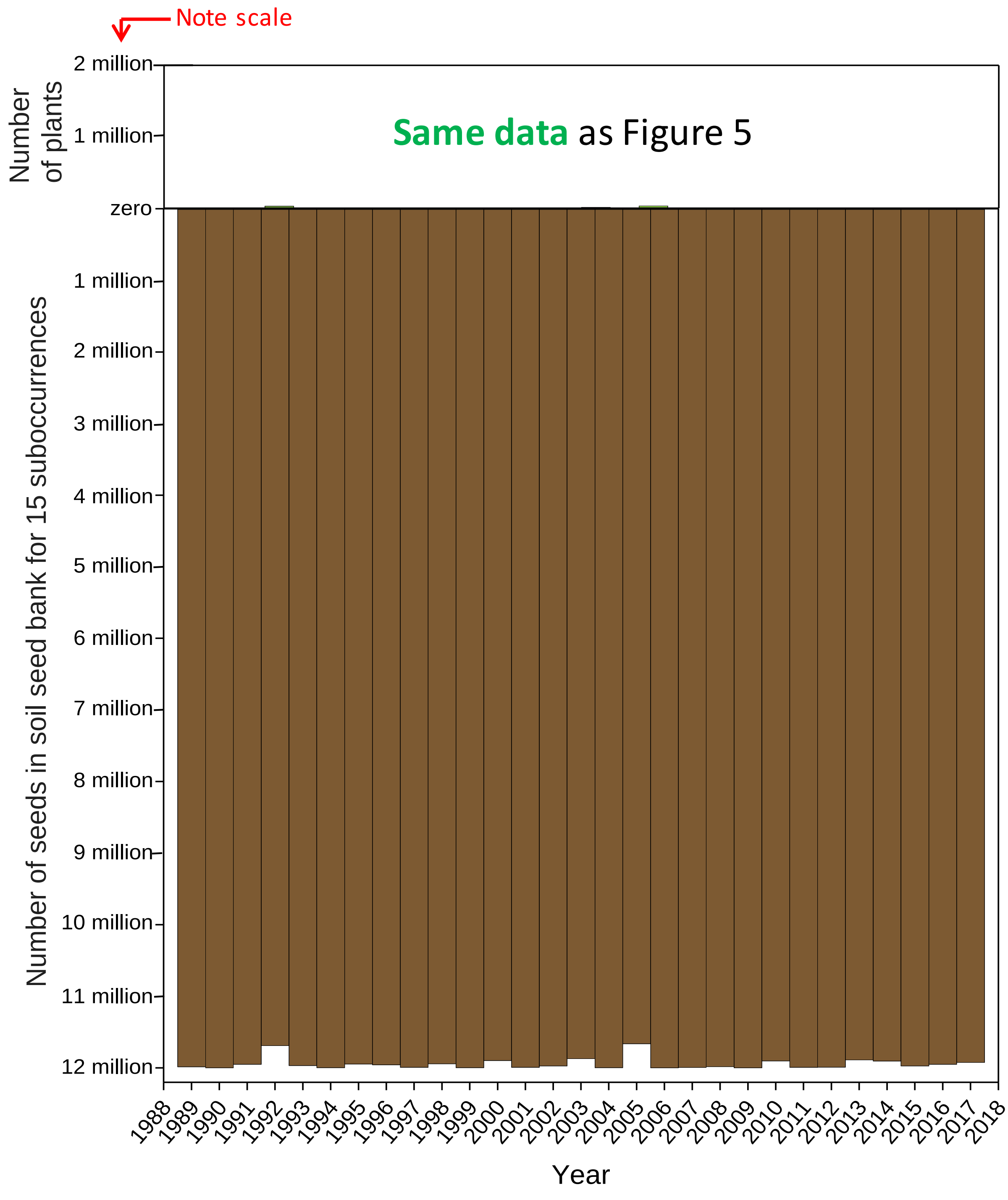


Figure 6. Number of seeds in the soil seed bank calculated based on Taylor 1990 and BLM 2011, 2012, 2013, 2014a, as compared to number of plants (same data as **Figure 5**) counted for 15 suboccurrences of *Camissonia benitensis* for which there is continuous data for dating back to 1989 (29 years). Note that the number of seeds in the soils seed bank (dormant, non-emergent individuals) exceeds the number of plants (emergent individuals) by >1000x.

Adaptations – Tolerance Mechanisms

All taxa of the plant family Onagraceace are specialized in and adapted to unstable habitats that experience frequent natural soil disturbance (**Table 1;** Raven 1969; Baldwin et al. 2012; BLM 2016; see calphotos.berkeley.edu for habitat photos). It is an ecological hallmark of Onagraceae and the primary reason for adaptive radiation (species diversification) of all taxa in the family to unstable habitat types (Raven 1969). All taxa of *Camissonia* are specialized in and highly adapted to unstable habitats that experience frequent natural soil disturbances – water erosion and alluvial deposition from flash floods (stream terraces and washes); wind erosion and alluvial deposition (sand blow outs, sand dunes, beaches); colluvium (talus) movement on slopes; frost heave (winter daily freeze-thaw cycles); ungulate herd trampling; and wildfire (Raven 1969). The very large, long-lived soil seed banks of *Camissonia* is an important tolerance mechanism that allows the species to escape unpredictable, unfavorable conditions and strongly buffers the species against extirpation and extinction (BLM 2011, 2012, 2013, 2014a, 2016; BLM CCFO unpublished data).

All *Camissonia* taxa have a very high affinity for sandy textured substrates (**Table 1;** Raven 1969; Baldwin et al. 2012). Two taxa including *Camissonia lacustris* (Lake County, California) and *Camissonia benitensis* have additionally become specialized to sandy soils derived from serpentine, which has extreme adverse chemical properties. The serpentinite of the New Idria serpentine mass (Serpentine ACEC) is pervasively sheared and pulverized (tectonically milled), resulting in extensive, natural true barrens (moonscape) that have naturally high erosion rates due to the lack of stable woody vegetative cover (Kruckeberg 1984; PTI 1993; Dynamac 1998; Alexander et al. 2006; **Figures 7** and **8**). The very high natural background erosion rates and adverse substrate physical and chemical properties renders the New Idria serpentine mass an extreme physical and chemical environment for plants to establish and grow. It is exactly these extreme conditions; however, that promoted the evolution (adaptive radiation; peripatric speciation) of the serpentine endemic *Camissonia benitensis* from its presumed non-serpentine progenitor, *Camissonia strigulosa* (Raven 1964, 1969; USFWS 1985).

Sandy soils (substrates) in semi-arid and arid climates are typically derived from harder rock types including volcanic, granite, metamorphic (including serpentine), and sandstone that weather under the prevailing climate conditions to produce hard, angular particles. Sandy soils in semi-arid and arid climates present an extreme soil physical challenge to plant species due to low soil cohesion properties (soil particles do not readily aggregate; unstable and easily erodible) and low water holding capacity (drought prone). The high level of specialization and adaptation of *Camissonia* taxa to unstable habitat types that experience frequent natural soil disturbance, also conveys high tolerance to frequent anthropogenic soil disturbances. The source of a soil disturbance, whether natural or anthropogenic, is not differentiated by the species.

Anthropogenic soil disturbance should not automatically be assumed to be adverse to plant species, despite the fact that the effect on the landscape is unnatural in appearance and perhaps unaesthetic. Analysis of the threat of a disturbance to a species must be evaluated in the scientific context of landscape stability, background habitat disturbance, and disturbance tolerance thresholds of the species (Sousa et al. 1984; Pavlik 1987; Pavlik and Barbour 1988; Alexander et al. 2009; Eager et al. 2013).

Table 1 shows that a substantial percentage of *Camissonia strigulosa* (12.3%) and *Camissonia contorta* (14.8%) herbarium specimens collected from throughout the ranges of the species were collected from anthropogenically disturbed landscapes including active and abandoned road edges, active agriculture field margins, and abandoned graded fields and lots (CCH 2018). *Camissonia benitensis* was documented to emerge following fire and soil disturbance associated with prescribed fire at CCMA (BLM 2012, 2013, 2014a) and suboccurrences of the species entirely overlap with both Native American and historic European settler habitation sites (BLM 2009). The original road alignment of Clear Creek Road once passed directly through *Camissonia benitensis* suboccurrence 11100 (specimen P.H. Raven 15094 – "1.8 mile east of Hernandez"; Raven 1969). The species recolonized the road bed after it was abandoned, demonstrating its resiliency to disturbance. Six suboccurrences including 41100, 51100, 51200, 71300, 91100, and 261100 that frequently have the highest number of emergent *Camissonia benitensis* individuals, have evidence of intensive, long-term, historic human occupation that not only did not extirpate the populations, but actually appeared to promote them (BLM 2009).

Camissonia benitensis has a high level of specialization and adaptation to unstable habitat types that experience frequent natural soil disturbance. *Camissonia benitensis* was Federally listed due to perceived threats of soil disturbance from OHV recreation (primary threat); other light recreation activities including camping, gem hunting, and prospecting; road construction; and prospecting with bulldozers (USFWS 1985, 2006). A species that is adapted to frequent natural soil disturbance cannot at the same time be endangered by frequent anthropogenic soil disturbance of a similar magnitude and within its disturbance tolerance thresholds. Whether the soil disturbance is *natural* - flash flood, wind erosion, frost heave, ungulate herd trampling, and wildfire - or *anthropogenic* - human occupation, motorized recreation, other light recreation, and wildfire – it is all similar in the context of disturbance ecology of the species.

Table 1. Summary of herbarium specimen label habitat descriptions for 415 specimens of *Camissonia strigulosa* and 169 specimens of *Camissonia contorta* (CCH 2018).

	Camissonia strigulosa **(n=415)**		***Camissonia contorta*** **(n=169)**	
With herbarium label information description of ↓	← Number of specimens	% of total	← Number of specimens	% of total
Sandy soil	271	65.3	97	57.4
Stream terrace/Alluvium/Wash	88	21.2	53	31.4
Barrens/Open areas	16	3.9	12	7.1
Sand Dunes	22	5.3	6	3.6
Anthropogenic soil disturbance	51	12.3	25	14.8
Burned areas	21	5.1	1	0.6

Figure 7. Overview of the New Idria serpentine mass (Serpentine ACEC) in Clear Creek Management Area. View from San Benito Mountain peak looking west towards Clear Creek drainage. Note the abundance of natural moonscape serpentine barrens.

Figure 8. Natural moonscape serpentine barrens of the New Idria serpentine mass (Serpentine ACEC) in upper Clear Creek drainage near San Benito Mountain peak. These barrens are distributed throughout the New Idria serpentine mass and comprise about one half (6,000 hectare; 15,000 acres) of the 12,000 hectare (30,000 acre) serpentine area. The serpentinite of the New Idria serpentine mass is pervasively sheared and pulverized, so as to have a loose, powdery consistency on the surface. The serpentine contains high concentrations of chrysotile asbestos in the mineralogy. The unusual combination of extremely adverse chemistry and low cohesiveness of the serpentine substrate results in naturally very low (virtually no) vegetative cover and very high natural erosion rates, contributing high sediment loads to all of the drainages.

Habitat – Soils and Vegetation

Camissonia benitensis was originally believed to be a strict serpentine soil endemic and that its habitat was exclusively limited to serpentine soil alluvial stream terraces (Raven 1969; Taylor 1990, 1992, 1995; USFWS 2006), likely due to the type locality description stating "on serpentine by small stream," with further statement that it "is apparently an endemic of serpentine soils" (Raven 1969). The limited type specimen habitat description apparently lead subsequent biologists working with the species to limit their surveys primarily to serpentine alluvial stream terraces (Griffin 1977, 1978; Taylor 1990; USFWS 1985, 2006; BLM 2010). Both of the long-standing ecological assumptions that *Camissonia benitensis* is a strict serpentine soil endemic and that its habitat is limited to serpentine alluvial stream terraces are now known to be incorrect (BLM 2010, 2011, 2012, 2013, 2014a, 2016).

Camissonia benitensis was discovered by Dean Taylor (1991, 1992) on serpentine debris flows on hill toeslopes, but this habitat type was regarded at the time as a variant of alluvial stream terrace habitat. Additional suboccurrences of the species, including suboccurrence 251100 (Jade Mill) were later found on serpentine soil at elevated landscape positions, but also recognized as a variant of alluvial stream terrace habitat. Ryan O'Dell incidentally discovered *Camissonia benitensis* occurring at even higher landscape positions above suboccurrence 251100 in 2010 and that resulted in the recognition that the species has a much broader habitat than originally recognized (BLM 2010). The serpentine soil habitat occurs at the margins of serpentine masses, serpentine landslides, and serpentine alluvium deposits in uplands – typically at the interface between serpentine and non-serpentine substrate types. Based on the consistent geologic interface location of this habitat type, it was called Geological Transition Zone habitat (GTZ; BLM 2010). Subsequent additional minor habitat types on other substrates have also been discovered including on large, hard serpentine rock outcrops; greywacke (hard, angular sandstone; Franciscan Complex); and on syenite (ultrabasic intrusive, similar to granite; BLM 2010, 2011, 2012, 2013, 2014a, 2016).

Serpentine, greywacke, and syenite all weather to produce gravelly, sandy textures soils, which all taxa of *Camissonia* have a high affinity for. Like all *Camissonia* taxa, *Camissonia benitensis* is adapted to sandy soils, but additionally the species has adapted tolerance to (specialization for) serpentine soils. *Camissonia strigulosa* co-occurs with *Camissonia benitensis* in the lower Clear Creek watershed, Larious Creek watershed, upper San Benito River watershed, and White Creek watershed. Both *Camissonia strigulosa* and *Camissonia contorta* have equivalent landform habitat types to *Camissonia benitensis* including sandy soils on stream terraces and washes ("alluvial stream terrace"), sandy soils on slopes and uplands (~"Geologic Transition Zone"), and rock outcrops/talus (Baldwin et al. 2012; Calflora 2018; CCH 2018)

Subsequent intensive survey of the Geologic Transition Zone, serpentine rock outcrops, greywacke rock outcrops, and syenite rock outcrop on BLM and private lands by Ryan O'Dell resulted in a nearly 10x (order of magnitude) increase in the number of known suboccurrences of *Camissonia benitensis* in nine years (2009 to 2018). By targeting these specific habitat types for intensive survey at an increasing radius from Clear Creek Management Area, the range limits of the species have been determined with a high level of certainty (BLM 2011, 2012). The small range of the *Camissonia benitensis*, along with the scattered distribution of suboccurrences (occupied habitat) of the species with interspersed potential habitat, suggests that that most if not all of the suboccurrences interact as a single, giant metapopulation (see "Population Genetics and Gene Flow via Seed Dispersal," below). Metapopulation theory proposes that dispersal among small populations is the key to species stability and persistence because it permits declining suboccurrences to be rescued (rescue effect) and vacant habitats to be recolonized by immigrants from other populations (Schemske et al. 1994; Harrison et al. 2000; Harrison and Ray 2002).

In order to better understand the potential stabilizing effects of metapopulation dynamics, habitat for *Camissonia benitensis* is divided and mapped as two habitat types – Occupied Habitat and Potential Habitat.

Occupied Habitat

Occupied habitat contains documented extent of the suboccurrences of *Camissonia benitensis* based on observation of emergent individuals. Given that the species may persist long periods of time non-emergent as dormant soil seed bank when the current habitat condition is not conducive to emergence (Taylor 1990; BLM 2011, 2012, 2013, 2014a) the area extent of occupied habitat is likely substantially underestimated.

Potential Habitat

Potential habitat is identified based on a combination of soils, topography, microclimate, and vegetation parameters that indicate that the area has high potential (conducive) to support *Camissonia benitensis*. Potential habitat mapping has been based on the extensive observations by Ryan O'Dell (BLM 2010, 2011, 2012, 2013, 2014a, 2016) of the combination of environmental parameters that support the species including:

Substrate - sandy or sandy loam soils derived primarily from serpentine (Taylor 1990; BLM 2010); may include minor proportions of non-serpentine sandy substrates such as greywacke, chert, and syenite. Soil texture appears to be the dominant soil characteristic determining suitability for *Camissonia benitensis*. A significant proportion of coarser particle sizes including gravel and cobbles in the substrate appears to convey greater survival for *Camissonia benitensis* by disrupting frost heave during the winter (BLM 2011).

Topography – *Camissona benitensis* is not topographically limited, but tends to favor locally gently sloped to moderately sloped areas on toeslopes and ridges. Due to the high degree of topographic complexity within the range of the species, it can and does occur on locally gentle slopes of benches and flats of broadly much steeper mountain slopes (BLM 2010, 2011, 2012, 2013, 2014, 2016).

Vegetation – Chaparral or blue oak woodland with open gaps. *Camissonia benitensis* occurs in open gaps within woody vegetation or at the interface between grasslands and woody vegetation. The woody vegetation may be important for providing microclimate heterogeneity which allows emergent individuals to (Taylor 1990).

Presence of Indicator Herbaceous Species – There are numerous annual and herbaceous perennial plant species that frequently co-occur with *Camissonia benitensis*. Due to the strong overlap in the habitat conditions for those species with *Camissonia benitensis*, they are used as indicators of the suitability for habitat to support *Camissonia benitensis* (Taylor 1990, 1992; USFWS 2006; BLM 2010, 2016).

Areas of occupied habitat (long-dormant soil seed bank) may occur with identified potential habitat. No areas of potential habitat for *Camissonia benitensis* have been mapped for non-serpentine substrates due to too few known suboccurrences of the species on non-serpentine substrates upon which to build a reliable substrate habitat model. Such a model, however, would include sandy substrates derived from the Franciscan Complex (greywacke and chert) and possibly the Red Mountain greenstone, a limited rock type west of Hernandez Valley.

Topography and Climate

The range of *Camissonia benitensis* is located within the highest elevations of the Inner South Coast Range around San Benito Mountain peak (Elev. 1605 m; 5267 ft). The topography of the range of the species is complex with valleys, hills, and rugged mountains (**Figure 9**). The Köppen climate is Csa – Hot summer-Mediterranean. The average annual rainfall ranges from a minimum of 400 mm (17 in) at 588 m (1929 ft) elevation to a maximum of 525 mm (21 in) at 1428 m (4684 ft) on San Benito Mountain peak (**Figure 10**; WRCC 2018). The average annual temperature ranges from 15.0°C (59°F) at the lowest elevations to 12.2°C (54°F) on San Benito Mountain peak (WRCC 2018).

The closely related species, *Camissonia strigulosa* and *Camissonia contorta*, have broader occurrence ranges in California and therefore, broader climatic ranges (Baldwin et al. 2012; Calflora 2018; CCH 2018). Both *Camissonia* species have a relatively broad distribution throughout the true California Floristic Province (CFP), and very limited distributions at the western edges of the San Joaquin Desert and the Mojave Desert. The apparent arid climate limit of *Camissonia strigulosa* and *Camissonia contorta* is approximately 200 mm (8 in) average annual rainfall and 17.2°C (63°F) average annual temperature – Köppen BWk - Cold desert. The arid climatic tolerance range of these two *Camissonia* species is likely closer to the true conserved climate tolerance threshold of *Camissonia benitensis*, despite its limited edaphically constrained range.

Projected Climate Change Effects

For the high emissions scenario (SRES A2 ~ RCP 6.0), average annual rainfall within the range of *Camissonia benitensis* is projected to decline ~20% to a minimum of 320 mm (13.6 in) at the lower elevations to a maximum of 420 mm (16.8 in) on San Benito Mountain peak (drier; high level of uncertainty; Hayhoe et al. 2004; Ackerly et al. 2010; Torregrosa et al. 2013; Thorne et al. 2016; Field et al. 2016; Cal-Adapt 2018). The average annual temperature is projected to increase an average of 3.1°C (°F) within the range of *Camissonia benitensis*, resulting in an average annual temperature of 18.1°C (64.6°F) at lower elevations to 15.3°C (59.5°F) on San Benito Mountain peak. A serpentine locality in South Coast Range with an analog climate similar to the projected future 2100 climate for the range of *Camissonia benitensis* is Del Puerto Canyon (Lat. 37.409559, Lon. -121.418408) in western Stanislaus County. The dominant woody vegetation type on serpentine at Del Puerto Canyon is serpentine chaparral, similar to CCMA.

Due to its closer proximity to the Pacific Coast and higher elevations, the range of *Camissonia benitensis* has relatively low (< 50%) projected exposure to climate change (Torregrosa et al. 2013, see Figure 6, lower right corner is San Benito Mountain; Thorne et al. 2016, see Figure 3). For the high emissions scenario projected to 2100, the entire current range of *Camissonia benitensis* is predicted to remain well above the arid climate tolerance limit of the species itself, as well as the chaparral vegetation important to maintaining local habitat microclimate effects. Even in the single worst drought year in 2000 years in 2014 when the total annual precipitation was only 167 mm (6.6 in; technically a desert), *Camissonia benitensis* was relatively abundantly emergent (BLM 2014). *Camissonia benitensis* is also self-pollinating which will continue to assure reproductive success in the absence (disruption) of pollinators with projected climate change (Evans et al. 2011).

Figure 9. Looking towards the east across the geographic range of *Camissonia benitensis* from Hepsedam Peak to San Benito Mountain (CCMA) on the far horizon. Note the rugged terrain and geologic complexity manifested by dramatic shifts in vegetation type. *Camissonia benitensis* occurs across a substantial range of elevation (588 to 1428 m; 1929 to 4685 ft) and microclimate due elevation and aspect, which will buffer the species from projected climate change. The species will be able to endure prolonged droughts dormant in the soil seed bank.

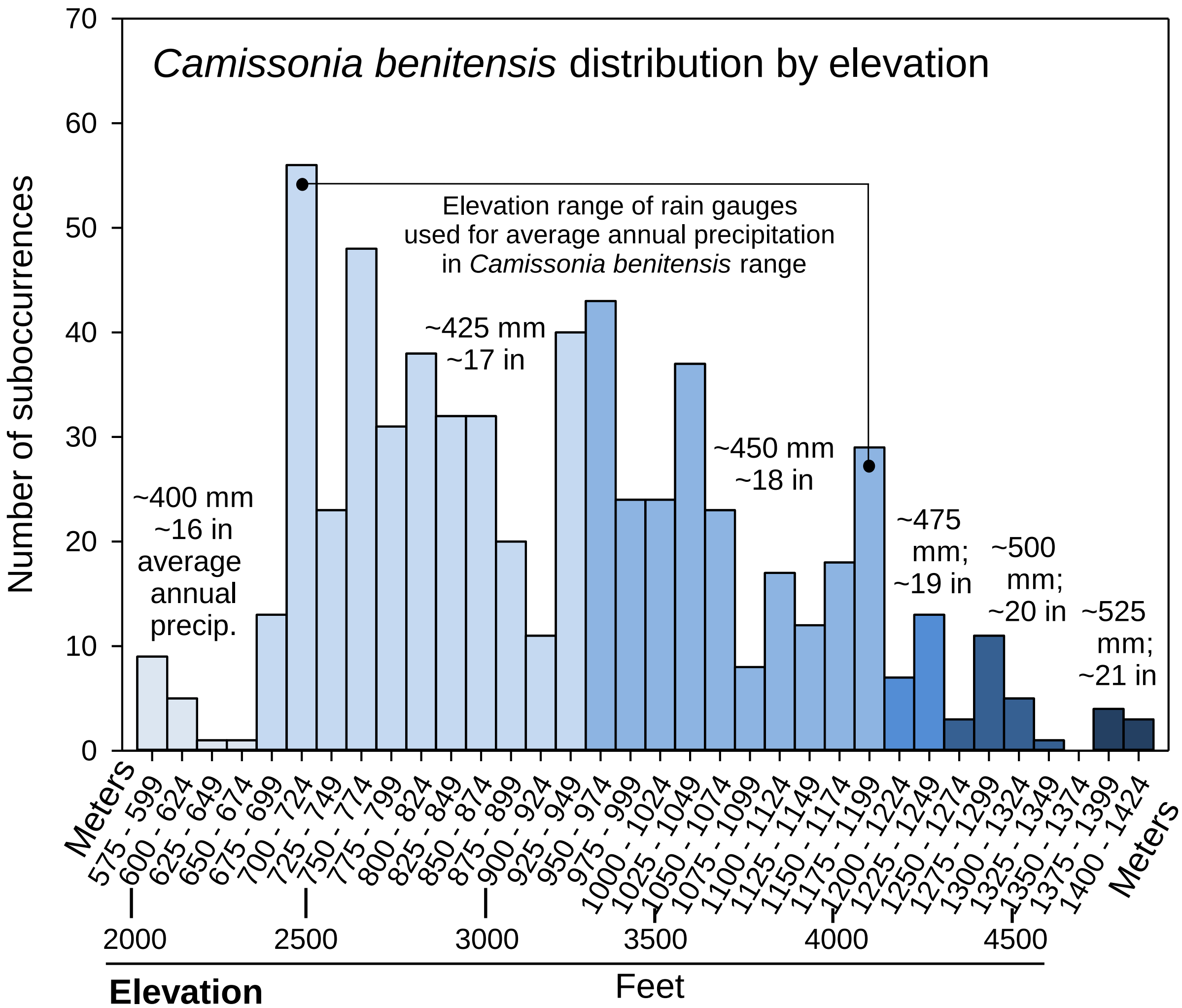


Figure 10. Elevation distribution of all 658 suboccurrences of *Camissonia benitensis*. 1 m = 3.28 ft. 25 mm = 1 in

Geographic Range Limits

The current known geographic range encompasses 44,974 ha (111,133 ac; **Table 2;** BLM 2011) with the core range occurring within the BLM Clear Creek Management Area (CCMA). This current known range is 38x larger than that known at the time of Federal listing in 1985 when the entire known range encompassed only 10 suboccurrences of the species in Clear Creek Canyon and San Carlos Creek, entirely within the CCMA (**Figures 11, 12, 13, 14, 15,** and **16**).

The current known geographic range limits are:

Northern Limit – Johnson Canyon on the north side of Hernandez Reservoir (Lat. 36.421610, Lon. -120.852211) and Sampson Creek on the north side of CCMA (Lat. 36.420288, Lon. -120.724611)

Southern Limit –HWY 198 between Mustang Ridge and Priest Valley (Lat. 36.200949, Lon. -120.734591), eastern Monterey County.

Eastern Limit – Headwaters of White Creek on the east side of CCMA (Lat. 36.298656, Lon. -120.563674), western Fresno County.

Western limit – BLM Section 8 Administrative Site on Coalinga Road (Lat. 36.377608, Lon. -120.909693) , southern San Benito County.

The geographic range of *Camissonia benitensis* contains 12,397 ha (30,633 ac) of serpentine substrates (**Table 2**). About 27% of the known range of the species is underlain by serpentine substrates.

Table 2. Current known geographic range area and area of serpentine substrate within the range of *Camissonia benitensis*.

Area of the Geographic Range	Hectares	Acres
Known in 1985 - at Federal listing	1,183	2,923
Known in 2010 - before new habitat types discovered	21,455	53,016
Known in 2018 - current	44,974	111,133

Area of Serpentine Substrate	Hectares	Acres
Serpentine mass area	10,933	27,016
Serpentine landslides area	1,145	2,829
Serpentine alluvium area	319	788
TOTAL Serpentine area	**12,397**	**30,633**

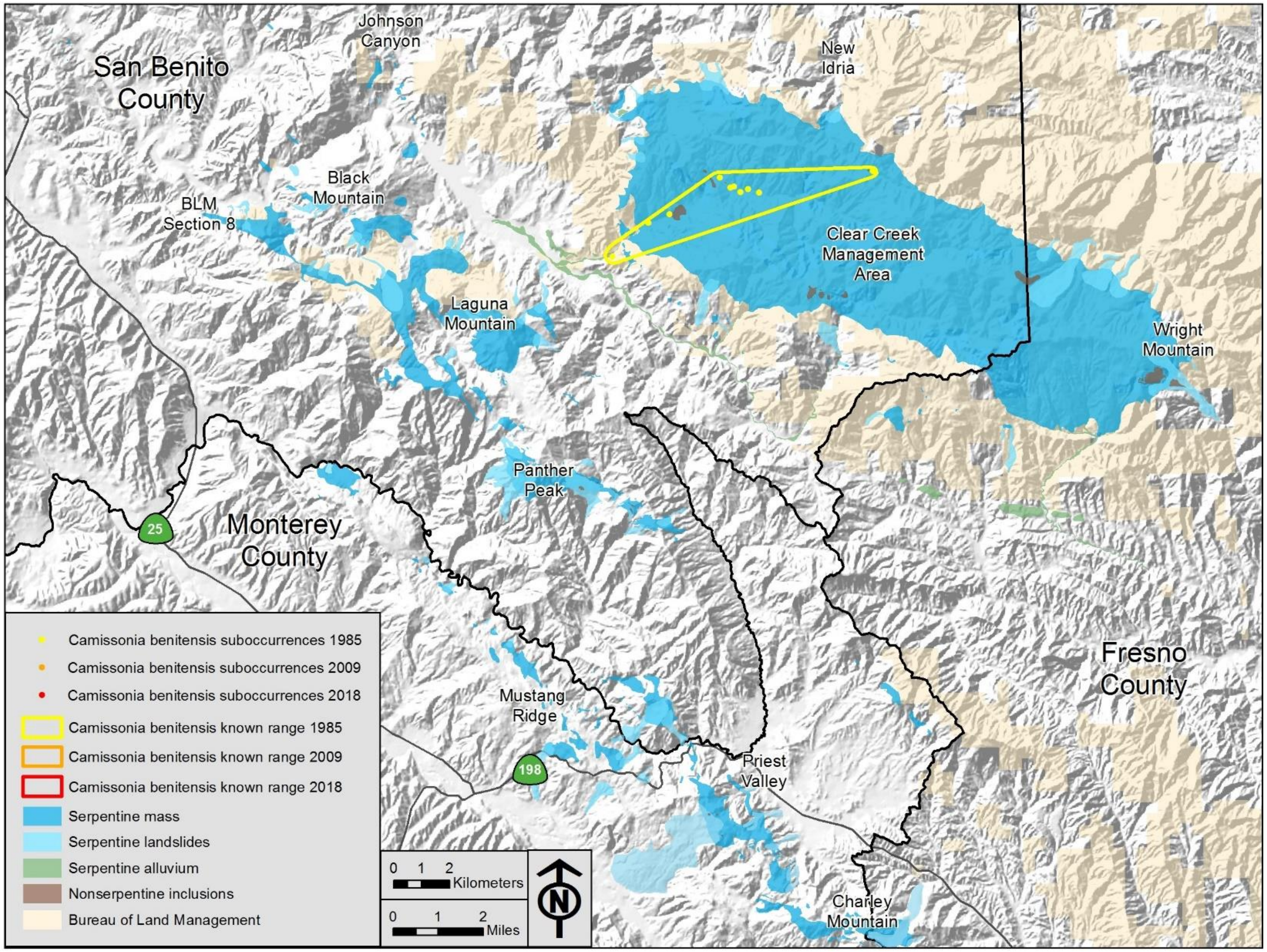


Figure 11. Known suboccurrences and geographic range of *Camissonia benitensis* at Federal listing in 1985. Note that only ten suboccurrences were known at the time and the entire known geographic range at the time was primarily located within the Clear Creek drainage of CCMA – the most intensively used area for OHV recreation at the time.

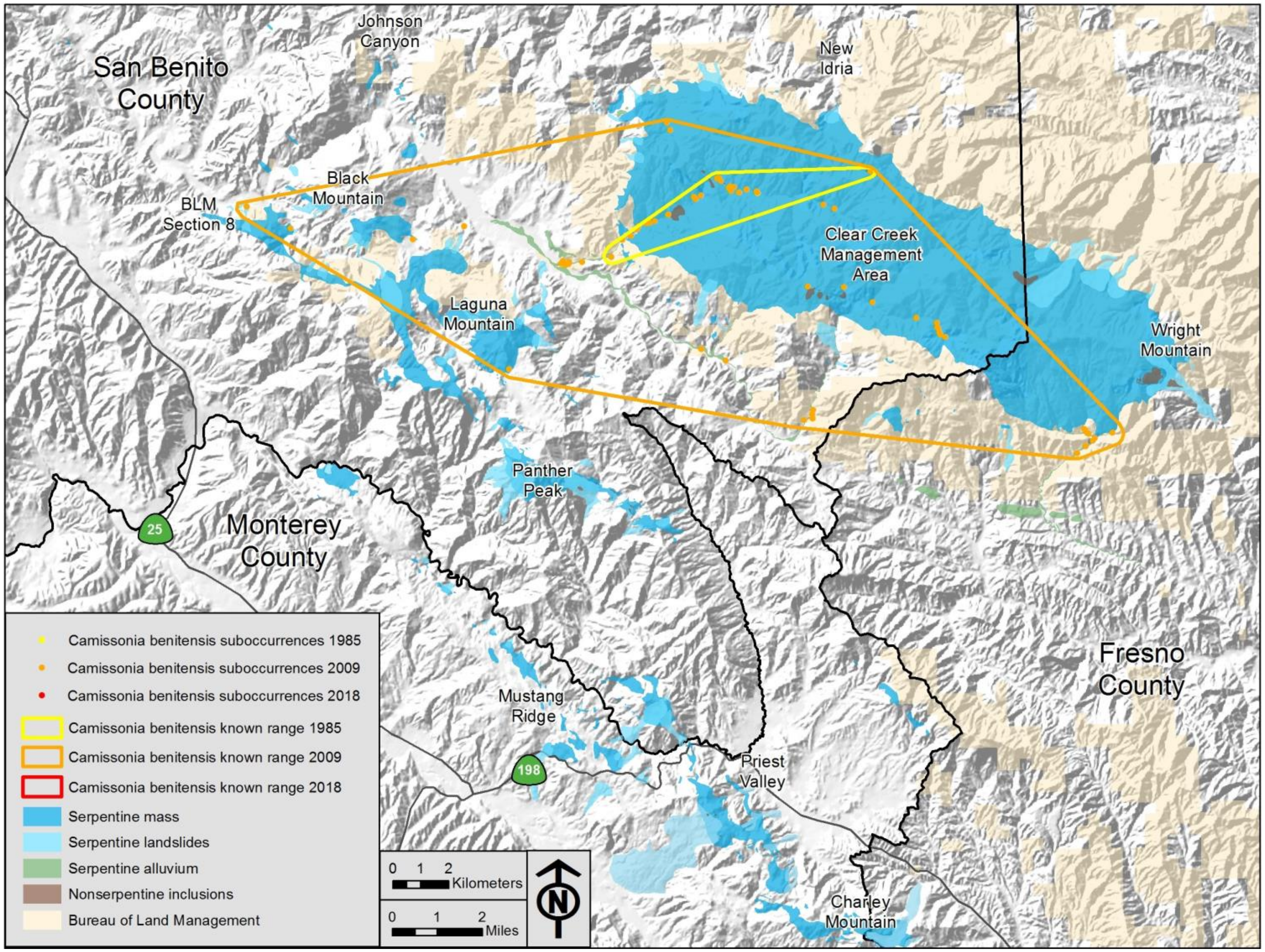


Figure 12. Known suboccurrences and geographic range of *Camissonia benitensis* in 2009, prior to discovery of the Geologic Transition Zone habitat and other new habitat types. Note that between 1985 and 2009, only an additional 58 suboccurrences had been found after exhaustively surveying the alluvial stream terrace habitat.

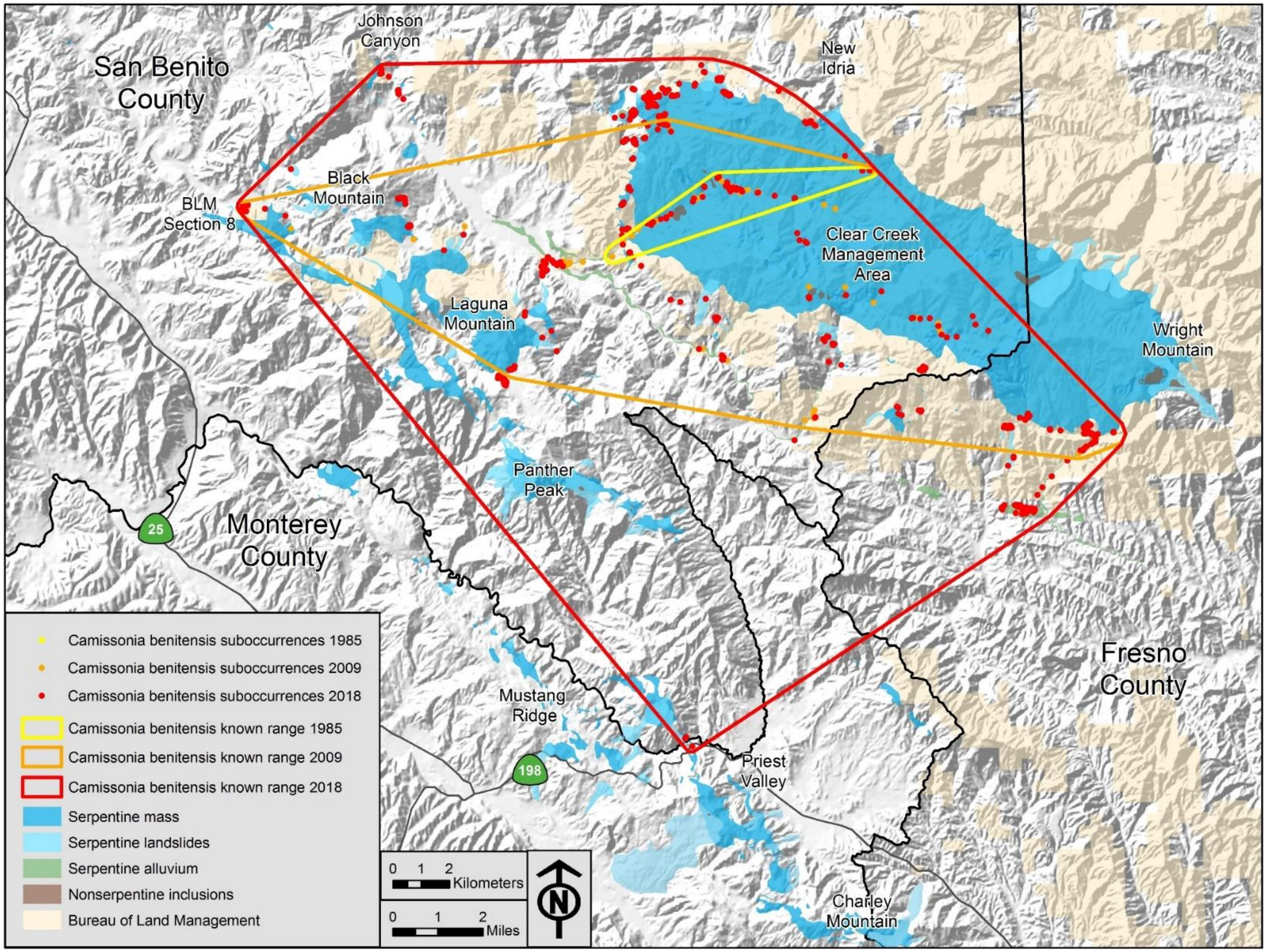


Figure 13. Known suboccurrences and geographic range of *Camissonia benitensis* in 2018. Discovery of the Geologic Transition Zone habitat and other new habitat types, followed by intensive survey on BLM and private lands resulted in several hundred additional suboccurrences. The known geographic range expanded south to include the area between Mustang Ridge and Priest Valley.

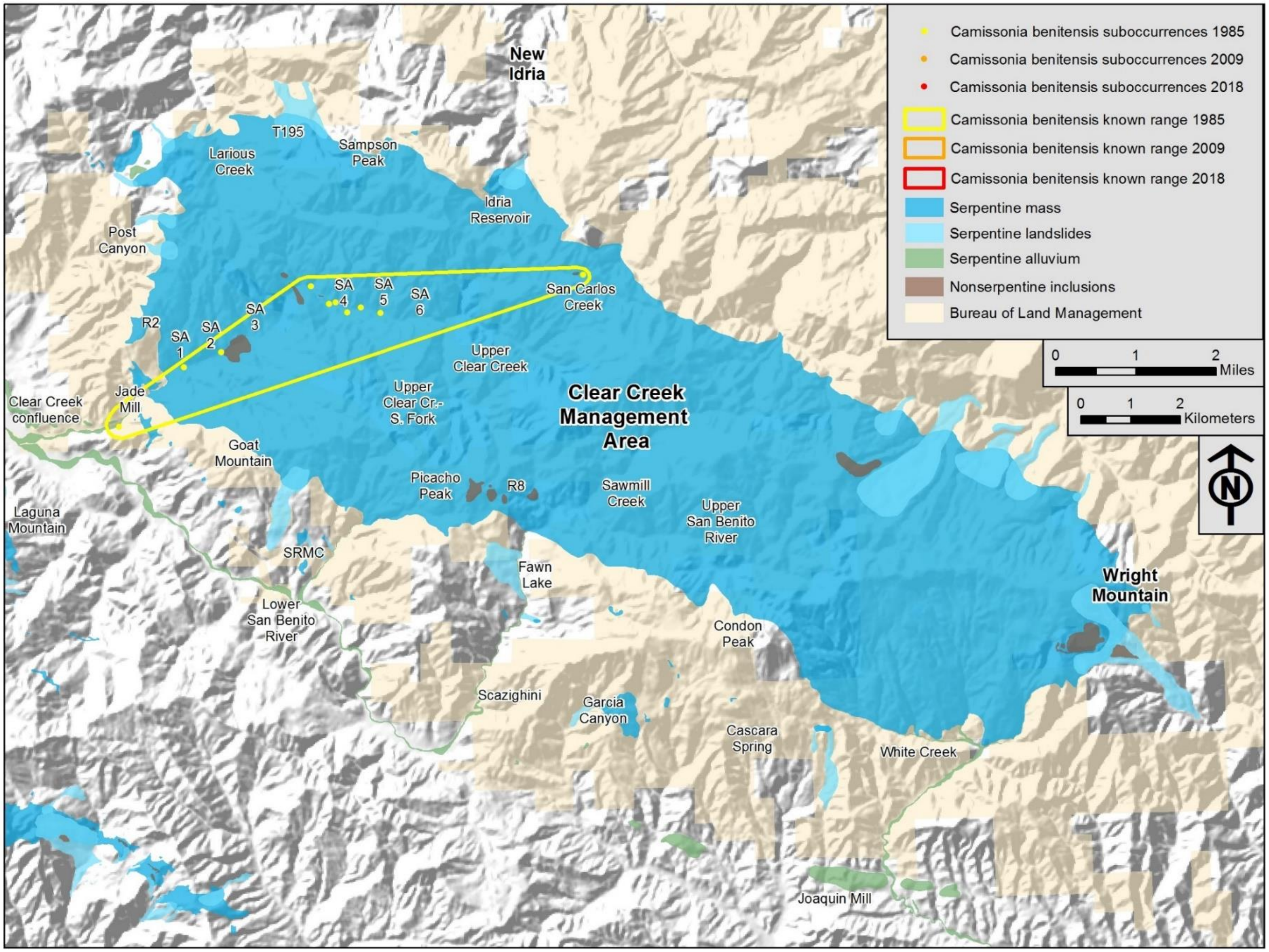


Figure 14. The ten known suboccurrences of *Camissonia benitensis* in CCMA at Federal listing in 1985.

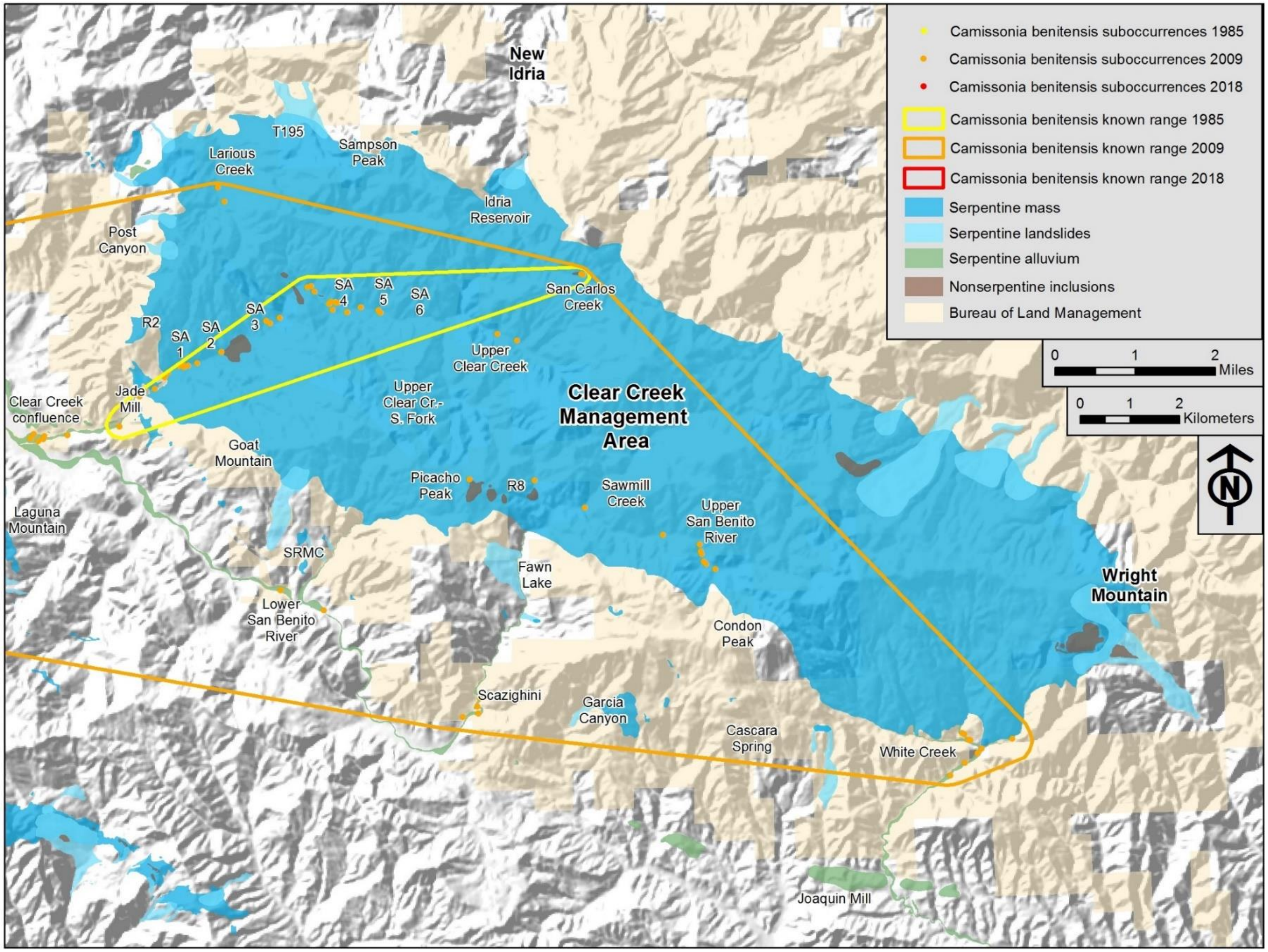


Figure 15. Known suboccurrences of *Camissonia benitensis* in CCMA in 2009.

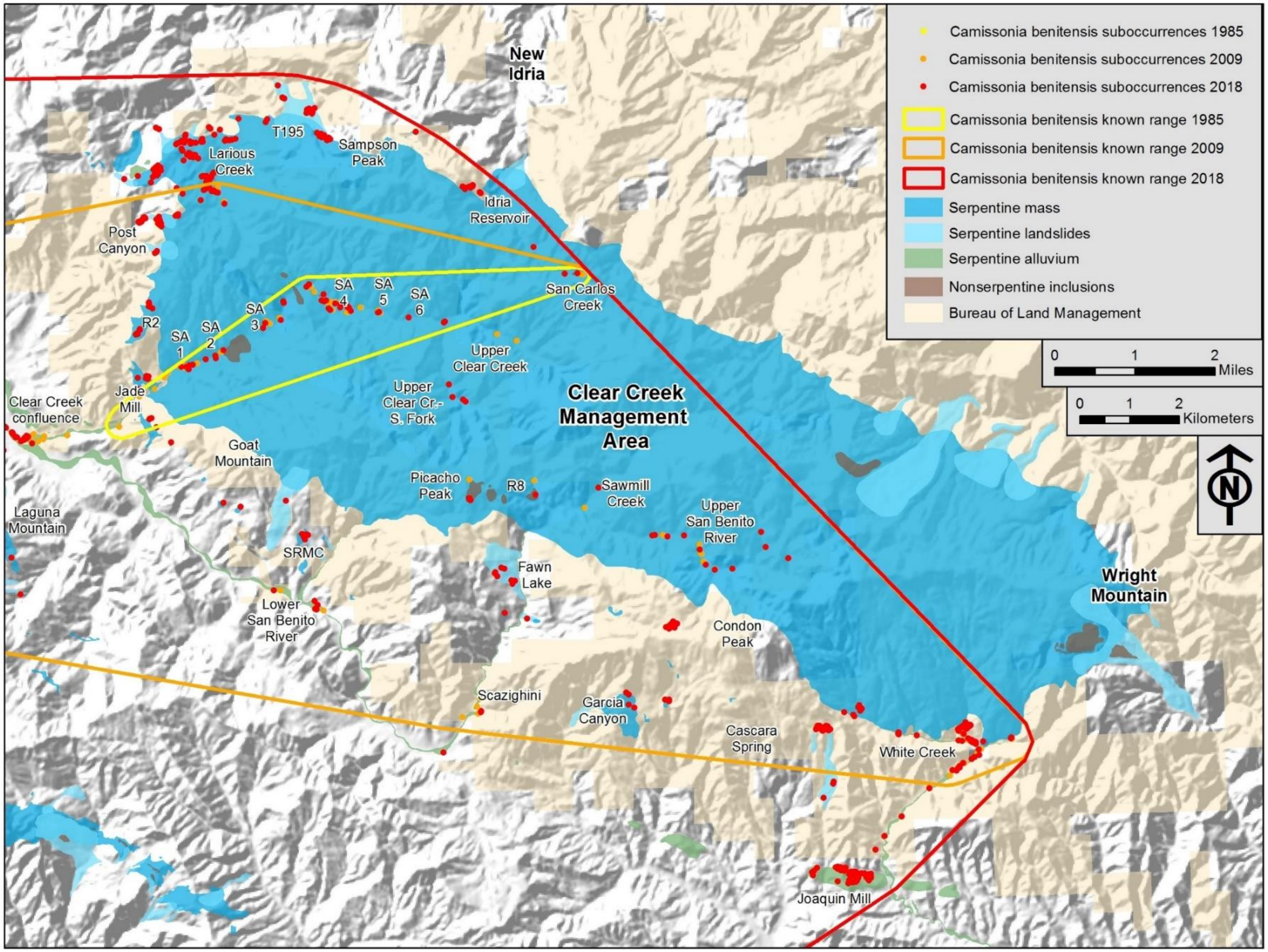


Figure 16. The several hundred known suboccurrences of *Camissonia benitensis* in CCMA in 2018.

Habitat Area Extent

Although serpentine alluvial stream terrace was identified as the original habitat type for the species, the Geologic Transition Zone habitat type is now known to account for the majority of both occupied and potential habitat (**Table 3**). Total occupied habitat is 25.454 hectares (62.897 acres). Total identified potential habitat within the range of the species is 105.343 hectares (260.308 acres). Approximately 0.84% of the total area of serpentine substrates is classified as potential habitat. Approximately 0.21% of the total area of serpentine substrates is confirmed as occupied habitat. The Geologic Transition Zone type habitat is the most occupied habitat type at 32.53% (**Table 4**), followed by serpentine alluvial stream terraces outside of the Serpentine ACEC at 12.9%, and lastly by serpentine alluvial stream terraces inside the Serpentine ACEC at 9.21%. Approximately 0.06% of the entire total range of the species is occupied. Additional extensive potential habitat has been identified outside of the current known range of the species to the north, south, and west of the range limits (BLM 2011).

Table 3. Area of occupied habitat and area of potential habitat for *Camissonia benitensis*.

Area of Occupied Habitat	Hectares	Acres
Occupied habitat area - Geologic transition zone	21.313	52.664
Occupied habitat area - Alluvial terrace within ("in") the Serpentine ACEC	2.493	6.160
Occupied habitat area - Alluvial terrace outside ("out") of the Serpentine ACEC	1.648	4.073
TOTAL Occupied habitat area	**25.454**	**62.897**

Area of Potential Habitat	Hectares	Acres
Potential habitat area - Geologic transition zone	65.516	161.892
Potential habitat area - Alluvial terrace within the Serpentine ACEC	27.054	66.852
Potential habitat area - Alluvial terrace outside of the Serpentine ACEC	12.773	31.564
TOTAL Potential habitat area	**105.343**	**260.308**

Table 4. Percentage of occupancy for *Camissonia benitensis*.

Percentage of Occupancy	Percent (%)
Percentage of the entire current known range that is serpentine substrate	27.56
Percentage of the entire current known range that is occupied	0.06
Percentage of all serpentine substrate that is potential habitat	0.84
Percentage of all serpentine substrate that is occupied habitat	0.21
Percentage of all geologic transition zone habitat that is occupied	32.53
Percentage of all alluvial terrace "in" habitat that is occupied	9.21
Percentage of all alluvial terrace "out" habitat that is occupied	12.9

Number of Suboccurrences

The current total number of known suboccurrences of *Camissonia benitensis* is 658 (**Tables 5, 6, 7,** and **8**). This is about 66x as many suboccurrences as were know at the time of Federal listing in 1985 (**Figure 17**). A total of 624 suboccurrences are natural, zero suboccurrences are enhanced (additional seed introduction), and 34 suboccurrences are reintroductions following presumed extirpation (**Table 5).** Most (2/3) of the suboccurrences are located on Geologic Transition Zone habitat (**Tables 6, 7,** and **8**). About half of the suboccurrences are located on BLM land and half are located on private ranch land.

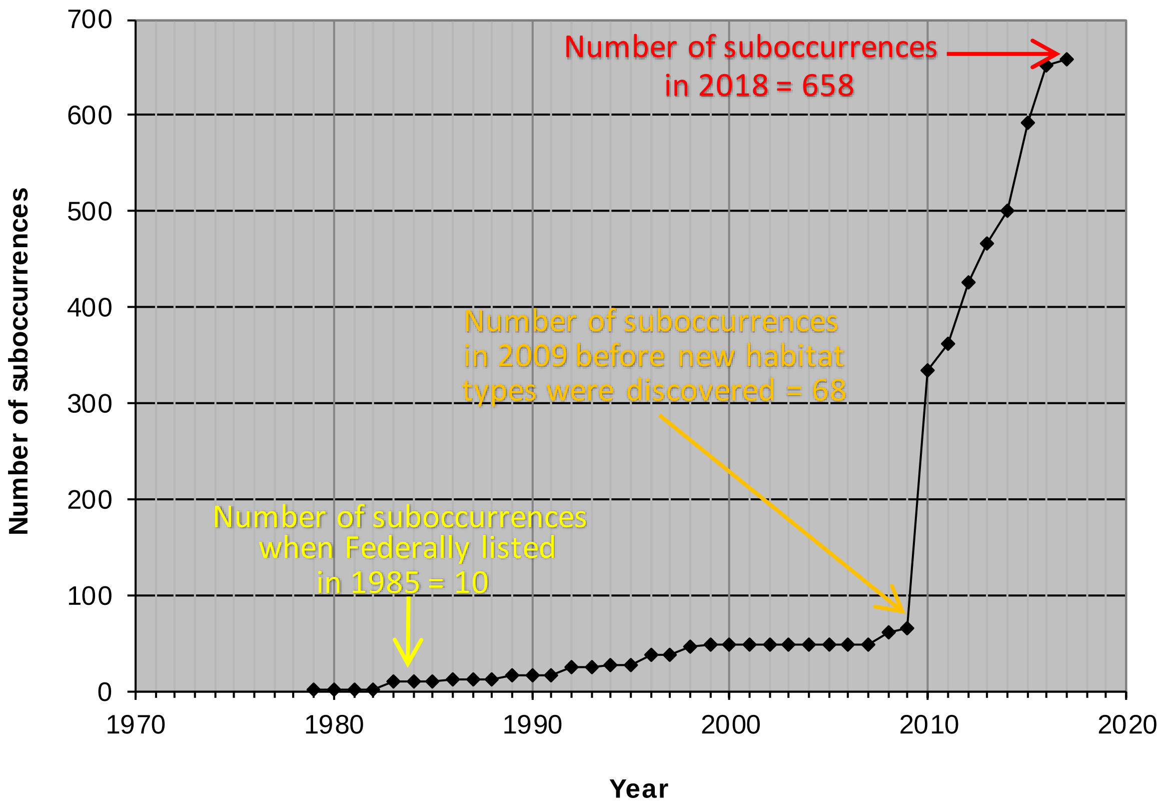


Figure 17. The number of known suboccurrences of *Camissonia benitensis* has increased about 66x since Federal listing in 1985, primarily due the discovery of new habitat types followed by intensive survey.

Table 5. Current number of known suboccurrences.

Status	Number of suboccurrences
Natural	624
Enhanced	0
Reintroduced	34
TOTAL	**658**

Table 6. Number of known suboccurrences through time by habitat type and location.

		At Listing in 1985	Known in 2009	Known in 2018
Habitat type	Alluvial terrace	10	35	50
	Geologic transition	0	7	426
	Terrace & transition	0	27	47
	Rock Outcrop - Serpentine	0	0	3
	Rock Outcrop - Syenite	0	0	23
	Rock Outcrop - Greywacke	0	1	39
Location	CCMA - Inside	10	65	367
	CCMA - Outside	0	3	221
	Serpentine ACEC - Inside	8	42	232
	Serpentine ACEC - Outside	2	25	356
	Ownership - BLM	10	63	298
	Ownership - Private	0	5	290
	TOTAL Suboccurrence number	**10**	**68**	**658**

Table 7. *Camissonia benitensis* suboccurrences known in 2009. Suboccurrences known in 1985 at the time of Federal listing are highlighted yellow. Suboccurrences found between 1986 and 2009 are highlighted orange. Suboccurrence number, location UTM (Zone 10S) coordinates, occurrence group, habitat type, location, land ownership status, and 2010 through 2016 plant counts. * = introduction in 1991; . = not monitored/no data.

Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	---Habitat type---					---Location---				Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	Alluvial terrace	Geologic transition	Rock outcrop: Serpentine	Rock outcrop: Syenite	Rock outcrop: Greywacke	CCMA: Inside	CCMA: Outside	Serpentine ACEC: Inside	Serpentine ACEC: Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
151000	151100	?	?	?	?	Black Mountain												.	.	.	.	.	.	.	.
191000	191100	612	2007	687792	4027829	BLM Section 8												2088	81	274	341	292	987	773	105
111000	111100	767	2516	699768	4025926	Clear Creek confluence												0	8	0	13	17	0	0	0
291000	291100	754	2473	699131	4025780	Clear Creek confluence												144	26	7	151	266	24	134	4
291000	291200	764	2506	699280	4025853	Clear Creek confluence												0	0	0	0	0	0	0	0
291000	291300	755	2477	699078	4025951	Clear Creek confluence												0	0	0	0	0	0	0	0
291000	291400	752	2467	699016	4025861	Clear Creek confluence												0	0	0	0	0	0	0	0
291000	291500	759	2490	699273	4025918	Clear Creek confluence												97	5	7	0	21	1	6	5
11000	11100	780	2559	700813	4026106	Jade Mill												2308	6	137	15	1938	235	2708	8
141000	141100	809	2654	701519	4026858	Jade Mill												0	0	0	0	0	0	0	0
251000	251100	843	2765	701725	4027090	Jade Mill												87	3	11	36	29	251	109	5
251100	251200	824	2703	701779	4027186	Jade Mill												13	6	31	10	143	4	0	5
281000	**281100***	792	2598	701218	4026714	Jade Mill												0*	10*	13*	0*	0*	0*	1*	0*
221000	221100	1173	3848	697165	4022071	Laguna Mountain												.	14	7	.	.	.	.	.
61000	61100	928	3047	702788	4030910	Larious Creek													57	624	1943	1929	3678	76	89
61000	61110	941	3087	702716	4030843	Larious Creek												4400	0	0	0	1	3	0	0
61000	61120	941	3087	702752	4030805	Larious Creek													1	0	13	0	9	9	38
61000	61200	941	3087	702806	4030664	Larious Creek												81	0	0	6	0	1	0	0
161000	161100	799	2621	704045	4022816	Lower San Benito River												0	0	158	14	371	398	39	163
161000	161200	812	2664	704859	4022403	Lower San Benito River												0	0	0	0	50	0	12	0
271000	271100	1343	4406	707897	4025019	Picacho Peak												53	14	24	233	31	23	199	21
131000	131100	1193	3914	709149	4025019	R8												1	0	0	0	0	0	0	0
21000	21100	832	2729	702103	4027300	SA 1												0	0	0	0	0	0	0	0
21000	21200	830	2723	702132	4027306	SA 1												0	0	0	0	0	0	0	0
21000	21300	842	2762	702069	4027368	SA 1												1191	13	41	301	1413	601	27	72
21000	21400	830	2723	702000	4027318	SA 1												175	15	12	25	134	43	27	212
21000	21500	834	2736	702074	4027316	SA 1												58	4	2	3	9	0	1	2
21000	21600	833	2732	702113	4027326	SA 1												0	11	0	38	2	0	7	11
21000	21700	832	2729	702184	4027328	SA 1												111	45	343	28	17	3	5	7
21000	**21800†**	837	2746	702372	4027375	SA 1												7†	0†	0†	0†	0†	0†	0†	1†
31000	31100	855	2805	702858	4027604	SA 2												235	107	716	512	677	6	12	5
241000	**241100†**	933	3061	704030	4028293	SA 3												4†	8†	5†	15†	2†	1†	2†	43†
241000	**241200†**	926	3038	703842	4028176	SA 3												9†	12†	3†	0†	0†	0†	4†	0†
241000	**241300†**	920	3018	703764	4028230	SA 3												51†	1†	6†	0†	1†	0†	0†	0†
41000	41100	962	3156	704658	4028924	SA 4												24	30	1	26	6	29	530	219
41000	**41200***	966	3169	704730	4028818	SA 4												138*	4*	79*	173*	10*	48*	90*	50*
51000	51100	974	3195	705028	4028620	SA 4												565	54	46	995	873	381	48	30
51000	51200	972	3188	704982	4028560	SA 4												758	50	110	4840	3687	4482	770	493
51000	51300	990	3248	705091	4028448	SA 4												30	4	0	5	0	4	20	57
51000	**51400***	983	3225	705366	4028419	SA 4												42*	14*	0*	388*	1*	138*	59*	10*
51000	**51500***	988	3241	705673	4028506	SA 4												189*	19*	21*	105*	15*	12*	7*	17*
51000	**51600†**	985	3231	705326	4028518	SA 4												0†	5†	0†	0†	0†	0†	0†	0†
81000	81100	998	3274	706013	4028444	SA 5												0	0	0	0	0	0	11	1
81000	81200	1002	3287	706073	4028393	SA 5												373	146	93	234	122	124	45	68
81000	**81300†**	998	3274	705931	4028418	SA 5												8†	0†	0†	8†	2†	0†	0†	0†
91000	91100	1282	4206	710128	4029166	San Carlos Creek												7849	533	7	4406	2519	2612	579	439
91000	91200	1281	4202	710090	4029169	San Carlos Creek												7	23	0	56	21	18	6	0

Table 7, continued.

							----------------Habitat type ----------------					----------------- Location -----------------													
Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Alluvial	Geologic	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
181000	181100	1167	3828	710161	4024461	Sawmill Creek												21	1	1	0	0	0	0	0
71000	71100	876	2874	708040	4020600	Scazighini												1	3	12	0	0	13	2	0
71000	71200	876	2874	707954	4020436	Scazighini												0	0	0	0	0	0	10	0
71000	71300	869	2851	707944	4020341	Scazighini												326	47	1911	312	253	846	153	51
71000	71400	873	2864	707717	4020265	Scazighini												0	0	0	0	0	0	0	0
121000	121100	1110	3641	708798	4027824	Upper Clear Creek												118	42	5	9	0	69	191	37
122000	122100	1098	3602	708399	4027967	Upper Clear Creek												197	8	0	80	2	18	21	42
101000	101100	1208	3963	711794	4023940	Upper San Benito River												118	16	0	4	0	26	31	18
261000	261100	1241	4071	712558	4023394	Upper San Benito River												54	24	0	71	13	53	268	0
261000	261110	1243	4078	712777	4023254	Upper San Benito River												59	62	1	56	0	91	1	26
261000	261120	1238	4061	712518	4023543	Upper San Benito River												48	47	0	90	35	109	378	78
261000	261130	1237	4058	712497	4023587	Upper San Benito River												71	12	3	115	27	39	488	138
261000	261140	1232	4041	712476	4023726	Upper San Benito River												409	161	65	789	204	280	1128	338
201000	201100	789	2588	717876	4019795	White Creek												312	1	52	6	2	109	25	0
201000	201110	801	2627	717759	4019938	White Creek												44	3	0	0	0	0	36	0
201000	201120	799	2621	717799	4019900	White Creek												271	1	7	36	0	10	1	34
201000	201130	789	2588	717907	4019795	White Creek												926	1	48	97	47	262	35	33
201000	201200	775	2542	718060	4019528	White Creek												582	8	183	119	2	200	48	134
201000	201300	763	2503	717809	4019335	White Creek												16	0	7	0	0	0	0	0
201000	201400	775	2542	718126	4019593	White Creek												298	7	10	4	0	8	3	6
201000	201500	752	2467	717505	4019085	White Creek												1419	41	35	137	0	23	56	25
201000	201600	755	2477	717516	4019152	White Creek												127	0	1	1	0	0	1	0
201000	201700	814	2670	718768	4019828	White Creek												51	0	166	46	0	8	9	0
																TOTAL -		**26564**	**1814**	**5285**	**16905**	**15184**	**16280**	**9201**	**3140**

Table 8. *Camissonia benitensis* suboccurrences found between 2010 to 2017 are highlighted red. Suboccurrence number, location UTM (Zone 10S) coordinates, occurrence group, habitat type, location, land ownership status, and 2010 through 2016 plant counts. [ ] = suboccurrences found in 2010; [ ] = suboccurrences found in 2011; [ ] = suboccurrences found in 2012; [ ] = suboccurrences found in 2013; [ ] = suboccurrences found in 2014. [ ] = suboccurrences found in 2015. [ ] = suboccurrences found in 2016. [ ] = suboccurrences found in 2017. † = introduction in 2008; ‡ = introduction in 2012; – = no data prior to discovery of suboccurrence; . = not monitored/no data.

Occ. number	Subocc. number	Elevation (meters)	Elev. (feet)	UTM 10S		Location group	Habitat type: Alluvial terrace	Habitat type: Geologic transition	Habitat type: Rock outcrop			Location: CCMA		Location: Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
				E	N				Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	658	2158	689126	4027574	Black Mountain												50	.	.	.	.	.	.	.
None	None	641	2103	689326	4029249	Black Mountain												19	.	.	.	.	.	.	.
None	None	932	3057	693157	4028194	Black Mountain												33	.	.	.	.	.	.	.
None	None	939	3080	693162	4028166	Black Mountain												8	.	.	.	.	.	.	.
None	None	928	3044	693216	4028191	Black Mountain												783	.	.	.	.	.	.	.
None	None	914	2998	693262	4028219	Black Mountain												559	.	.	.	.	.	.	.
None	None	891	2923	693362	4028218	Black Mountain												503	.	.	.	.	.	.	.
None	None	883	2896	693390	4028216	Black Mountain												34	.	.	.	.	.	.	.
None	None	868	2847	693408	4028121	Black Mountain												2	.	.	.	.	.	.	.
None	None	840	2755	693417	4027996	Black Mountain												3	.	.	.	.	.	.	.
None	None	814	2670	693503	4027190	Black Mountain												5	.	.	.	.	.	.	.
None	None	809	2654	693536	4027165	Black Mountain												212	.	.	.	.	.	.	.
None	None	812	2664	693554	4027231	Black Mountain												18	.	.	.	.	.	.	.
None	None	809	2654	693587	4027244	Black Mountain												18	.	.	.	.	.	.	.
None	None	806	2644	693609	4027204	Black Mountain												932	.	.	.	.	.	.	.
None	None	783	2568	695503	4026899	Black Mountain												20	.	.	.	.	.	.	.
None	**None‡**	974	3195	694798	4026343	Black Mountain												---	---	---	3‡	16‡	51‡	16‡	.‡
None	**None‡**	597	1958	688400	4027828	Black Mountain												---	---	---	35‡	6‡	102‡	104‡	3‡
191000	191200	588	1929	687562	4027959	BLM Section 8												280	1	15	5	40	103	28	0
191000	191300	590	1935	687562	4027938	BLM Section 8												324	0	72	0	65	155	296	1
None	None	593	1945	687506	4027860	BLM Section 8												---	---	8	0	10	0	0	0
None	None	593	1945	687572	4027940	BLM Section 8												---	---	---	---	---	4	1	0
None	None	594	1950	687726	4028001	BLM Section 8												---	---	---	---	---	0	12	1
None	None	599	1965	687784	4027963	BLM Section 8												---	---	---	---	---	14	0	8
None	None	623	2045	687711	4027751	BLM Section 8												---	---	---	---	---	252	51	13
None	None	619	2031	687680	4027750	BLM Section 8												---	---	---	---	---	66	550	186
None	None	597	1958	687587	4027965	BLM Section 8												---	---	---	---	---	---	17	13
None	None	597	1958	687590	4027904	BLM Section 8												---	---	---	---	---	---	5	1
None	None	606	1989	687643	4027833	BLM Section 8												---	---	---	---	---	---	159	0
None	None	614	2014	687722	4027733	BLM Section 8												---	---	---	---	---	---	18	3
231000	231100	746	2447	698536	4026085	Clear Creek confluence												183	51	42	0	226	383	46	13
None	None	807	2648	698511	4026099	Clear Creek confluence												---	---	---	---	---	31	0	0
291000	291600	752	2467	699057	4025774	Clear Creek confluence												273	21	1	653	266	226	15	0
291000	291700	751	2463	698840	4025812	Clear Creek confluence												484	32	51	43	143	8	2	19
291000	291800	751	2463	698949	4025873	Clear Creek confluence												208	3	7	54	185	5	14	7
291000	291900	751	2463	698728	4025886	Clear Creek confluence												85	6	3	0	0	0	0	21
None	None	790	2591	698281	4025765	Clear Creek confluence												32	2	0	.	.	.	.	.
None	None	788	2585	698281	4025752	Clear Creek confluence												3	0	0	.	.	.	.	.
None	None	795	2608	698303	4025554	Clear Creek confluence												159	5	130	.	.	.	.	.
None	None	804	2637	698315	4025488	Clear Creek confluence												70	0	184	.	.	.	.	.
None	None	801	2627	698315	4025507	Clear Creek confluence												5	0	0	.	.	.	.	.
None	None	801	2627	698335	4025520	Clear Creek confluence												76	3	28	.	.	.	.	.
None	None	800	2624	698336	4025538	Clear Creek confluence												51	0	0	.	.	.	.	.
None	None	762	2500	698430	4025894	Clear Creek confluence												28	14	5	.	.	.	.	.
None	None	762	2500	698441	4025873	Clear Creek confluence												688	20	0	.	.	.	.	.

Table 8, continued.

							----------------Habitat type ----------------					----------------- Location -----------------													
Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Alluvial	Geologic	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	750	2460	698755	4025887	Clear Creek confluence												---	6	3	1	23	4	3	0
None	None	751	2463	698899	4025839	Clear Creek confluence												---	35	4	303	29	227	125	1
None	None	794	2606	698854	4025832	Clear Creek confluence												---	---	---	---	---	23	.	0
None	None	813	2667	698318	4025433	Clear Creek confluence												---	4	0	.	.	.	.	.
None	None	781	2562	698479	4025630	Clear Creek confluence												---	1	0	.	.	.	.	.
None	None	787	2582	698455	4025605	Clear Creek confluence												---	1	0	.	.	.	.	.
None	None	800	2624	698348	4025536	Clear Creek confluence												---	---	1	.	.	.	.	.
None	None	801	2627	698346	4025527	Clear Creek confluence												---	---	1	.	.	.	.	.
None	None	756	2480	698354	4025952	Clear Creek confluence												---	---	7	.	.	.	4	.
None	None	768	2519	698426	4025866	Clear Creek confluence												---	---	41	.	.	.	.	.
None	None	771	2529	698410	4025825	Clear Creek confluence												---	---	30	.	.	.	.	.
None	None	750	2460	698739	4025899	Clear Creek confluence												---	---	5	4	13	10	12	3
None	None	749	2457	698658	4025987	Clear Creek confluence												---	---	---	---	220	27	1	16
None	None	751	2463	698904	4025876	Clear Creek confluence												---	---	---	---	6	9	0	0
None	None	750	2460	698676	4025952	Clear Creek confluence												---	---	---	---	467	154	855	134
None	None	805	2640	698656	4025982	Clear Creek confluence												---	---	---	---	---	47	0	20
None	None	806	2643	698664	4025982	Clear Creek confluence												---	---	---	---	---	49	37	0
None	None	752	2467	698974	4025903	Clear Creek confluence												---	---	---	---	5	20	0	0
None	None	790	2592	698949	4025873	Clear Creek confluence												---	---	---	---	---	5	0	7
None	None	753	2470	698952	4025920	Clear Creek confluence												---	---	---	---	---	---	---	24
None	None	1427	4681	711908	4022116	Condon Peak												64	11	1	25	6	0	102	0
None	None	1427	4681	711989	4022137	Condon Peak												---	---	1	41	66	526	505	75
None	None	1427	4681	711865	4022097	Condon Peak												---	---	---	---	3	4	0	45
None	None	1171	3841	711930	4022123	Condon Peak												---	---	---	---	---	54	110	393
None	None	1423	4670	711890	4022113	Condon Peak												---	---	---	---	---	15	4	3
None	None	1426	4679	711990	4022117	Condon Peak												---	---	---	---	---	---	155	148
None	None	1426	4679	711977	4022164	Condon Peak												---	---	---	---	---	---	5	15
None	None	1426	4678	711946	4022161	Condon Peak												---	---	---	---	---	---	58	58
None	None	1428	4684	711946	4022184	Condon Peak												---	---	---	---	---	---	11	4
None	None	1426	4680	711976	4022097	Condon Peak												---	---	---	---	---	---	107	120
None	None	1426	4678	711932	4022099	Condon Peak												---	---	---	---	---	---	5	105
None	None	1427	4681	711925	4022076	Condon Peak												---	---	---	---	---	---	535	475
None	None	1425	4676	711907	4022094	Condon Peak												---	---	---	---	---	---	303	248
None	None	1424	4672	711882	4022088	Condon Peak												---	---	---	---	---	---	17	0
None	None	1426	4678	711869	4022046	Condon Peak												---	---	---	---	---	---	5	.
None	None	1422	4667	711805	4022071	Condon Peak												---	---	---	---	---	---	9	0
None	None	1426	4680	712026	4022142	Condon Peak												---	---	---	---	---	---	---	8
None	None	1426	4680	711980	4022060	Condon Peak												---	---	---	---	---	---	---	3
None	None	1425	4676	711906	4022138	Condon Peak												---	---	---	---	---	---	---	2
None	None	1026	3366	714817	4020016	Cascara Spring												80	2	0	13	1	22	11	0
None	None	1024	3359	714845	4020056	Cascara Spring												188	2	62	284	19	50	28	1
None	None	1025	3362	714856	4020085	Cascara Spring												154	0	1	21	13	202	7	0
None	None	1031	3382	714871	4020039	Cascara Spring												57	0	4	0	0	0	0	0
None	None	1043	3421	714919	4020015	Cascara Spring												11	0	0	0	0	49	37	0
None	None	1052	3451	714957	4020004	Cascara Spring												114	8	0	29	16	195	154	33
None	None	1034	3391	714954	4019987	Cascara Spring												---	---	---	---	---	121	0	22
None	None	1048	3438	714988	4020031	Cascara Spring												---	---	---	---	---	2	0	0
None	None	814	2670	714976	4018641	Cascara Spring												5	.	.	.	.	.	.	.
None	None	1063	3487	714986	4020017	Cascara Spring												68	1	2	52	5	103	36	3
None	None	1074	3523	715006	4020021	Cascara Spring												70	0	37	0	0	53	4	11
None	None	1071	3513	715032	4020034	Cascara Spring												16	0	30	20	0	0	0	1
None	None	1048	3438	715094	4020032	Cascara Spring												93	0	0	0	0	0	0	0
None	None	869	2851	715169	4018920	Cascara Spring												33	.	.	.	.	.	.	0
None	None	867	2844	715173	4018965	Cascara Spring												14	.	.	.	.	.	.	0
None	None	1057	3467	715056	4020080	Cascara Spring												---	---	12	34	2	223	19	11
None	None	1069	3507	715023	4020086	Cascara Spring												---	---	10	60	1	12	72	2
None	None	1060	3477	715034	4020060	Cascara Spring												---	---	---	---	---	125	35	3

Table 8, continued.

Occ. number	Subocc. number	Elevation (meters)	Elev. (feet)	UTM 10S E	UTM 10S N	Location group	Habitat type: Alluvial terrace	Geologic transition	Rock outcrop: Serpentine	Rock outcrop: Syenite	Rock outcrop: Greywacke	Location: CCMA Inside	CCMA Outside	Serpentine ACEC Inside	Serpentine ACEC Outside	Ownership: BLM	Private	Plant # 2010	Plant # 2011	Plant # 2012	Plant # 2013	Plant # 2014	Plant # 2015	Plant # 2016	Plant # 2017
None	None	1054	3457	715105	4020015	Cascara Spring												---	---	---	---	---	---	3	0
None	None	1048	3439	715073	4020003	Cascara Spring												---	---	---	---	---	---	1	1
None	None	1057	3468	715063	4020040	Cascara Spring												---	---	---	---	---	---	16	1
None	None	1039	3408	714893	4020085	Cascara Spring												---	---	66	0	15	43	29	2
None	None	1076	3531	714994	4020065	Cascara Spring												---	---	---	---	---	---	---	1
None	None	1179	3868	708362	4023155	Fawn Lake												6	0	.	.	.	.	.	.
None	None	1184	3884	708371	4023179	Fawn Lake												144	8	.	.	.	.	.	.
None	None	1167	3828	708413	4023093	Fawn Lake												451	38	.	.	.	.	.	.
None	None	1174	3851	708493	4023269	Fawn Lake												423	359	.	.	.	.	.	.
None	None	1161	3809	708550	4023250	Fawn Lake												38	0	.	.	.	.	.	.
None	None	1056	3464	708564	4022357	Fawn Lake												398	2	.	.	.	.	.	.
None	None	1124	3687	708694	4023016	Fawn Lake												583	6	.	.	.	.	.	.
None	None	1112	3648	708722	4022949	Fawn Lake												432	3	.	.	.	.	.	.
None	None	1106	3628	708746	4022994	Fawn Lake												79	0	.	.	.	.	.	.
None	None	1098	3602	708766	4023002	Fawn Lake												55	0	.	.	.	.	.	.
None	None	1039	3408	709007	4022242	Fawn Lake												39	.	.	.	.	.	.	.
None	None	1202	3943	711052	4020721	Garcia Canyon												84	3	4	146	0	39	10	5
None	None	1132	3713	711169	4020456	Garcia Canyon												28	0	0	0	0	4	2	0
None	None	1139	3736	711782	4020620	Garcia Canyon												150	22	44	208	0	6	54	4
None	None‡	1131	3709	711863	4020583	Garcia Canyon												---	---	---	---	---	45‡	103‡	32‡
None	None	1214	3982	711001	4020757	Garcia Canyon												---	---	---	4	0	0	1	0
None	None‡	1146	3759	711055	4020511	Garcia Canyon												---	---	---	4‡	2‡	13‡	11‡	0‡
None	None‡	1139	3736	711866	4020619	Garcia Canyon												---	---	---	---	---	---	6‡	0‡
None	None	970	3182	702904	4024578	Goat Mountain												65	0	.	.	.	.	.	.
None	None	1004	3293	703252	4024496	Goat Mountain												385	2	.	.	.	.	.	.
None	None	1066	3497	704160	4024610	Goat Mountain												8	0	.	.	.	.	.	.
None	None	1318	4324	707716	4030929	Idria Reservoir												---	---	---	2	0	0	.	1
None	None	1310	4297	707766	4030909	Idria Reservoir												---	---	---	9	19	4	.	0
None	None	1292	4238	707918	4030964	Idria Reservoir												---	---	---	1	0	9	.	0
None	None	1289	4229	707904	4030953	Idria Reservoir												---	---	---	30	3	0	.	3
None	None	1281	4202	707909	4030936	Idria Reservoir												---	---	---	10	0	0	.	0
None	None	1244	4081	708055	4030818	Idria Reservoir												---	---	---	32	2	0	.	0
None	None	1237	4058	708084	4030798	Idria Reservoir												---	---	---	1901	157	599	.	13
None	None	1283	4209	707917	4030946	Idria Reservoir												---	---	---	---	3	0	.	1
None	None	1298	4258	707860	4030918	Idria Reservoir												---	---	---	---	2	33	.	2
None	None	1293	4242	707877	4030914	Idria Reservoir												---	---	---	---	18	57	.	0
None	None	1318	4324	707716	4030929	Idria Reservoir												---	---	---	---	10	6	.	1
None	None	1255	4118	707853	4030932	Idria Reservoir												---	---	---	---	---	5	.	4
None	None	1253	4112	707844	4030930	Idria Reservoir												---	---	---	---	---	8	.	0
None	None	1305	4283	707764	4030884	Idria Reservoir												---	---	---	---	---	---	---	5
251000	251300	865	2837	701401	4027113	Jade Mill												200	2	0	14	130	0	20	1
251000	251400	880	2887	701350	4027079	Jade Mill												128	0	0	9	19	58	54	4
251000	251500	879	2883	701181	4027086	Jade Mill												19	0	0	1	0	5	24	7
None	None	920	3018	701431	4026266	Jade Mill												38	0	0	40	12	92	248	191
None	None	835	2738	701419	4026255	Jade Mill												---	---	---	---	---	---	1	5
None	None	923	3028	701459	4026274	Jade Mill												20	0	0	3	0	0	45	0
None	None	957	3139	701558	4026096	Jade Mill												12	0	1	44	0	0	10	11
None	None	1003	3290	701856	4025787	Jade Mill												100	10	0	36	0	14	60	13
None	None	876	2874	701387	4027069	Jade Mill												---	---	---	28	12	210	19	10
None	None	879	2883	701378	4027064	Jade Mill												---	---	---	115	25	18	30	1
None	None	854	2801	701165	4026883	Jade Mill												---	---	---	33	22	15	11	2
None	None	829	2719	701198	4026551	Jade Mill												---	---	---	45	.	.	.	.
None	None	869	2851	701355	4027122	Jade Mill												---	---	---	---	2	0	17	0
None	None	957	3140	701560	4026090	Jade Mill												---	---	---	---	---	---	---	3

Table 8, continued.

				UTM 10S			Habitat type					Location														
Occ. number	Subocc. number	Elevation (meters)	Elev. (feet)	E	N	Location group	Alluvial terrace	Geologic transition	Rock outcrop: Serpentine	Rock outcrop: Syenite	Rock outcrop: Greywacke	CCMA: Inside	CCMA: Outside	Serpentine ACEC: Inside	Serpentine ACEC: Outside	Ownership: BLM	Ownership: Private	Plant # 2010	Plant # 2011	Plant # 2012	Plant # 2013	Plant # 2014	Plant # 2015	Plant # 2016	Plant # 2017
None	None	759	2490	692518	4032646	Johnson Canyon												131	0	0	.	.	.	.	.
None	None	769	2522	692528	4032681	Johnson Canyon												1	0	0	.	.	.	.	.
None	None	767	2516	692541	4032704	Johnson Canyon												23	0	0	.	.	.	.	.
None	None	751	2463	692545	4032645	Johnson Canyon												82	12	585	.	.	.	.	.
None	None	766	2513	692547	4032710	Johnson Canyon												17	0	0	.	.	.	.	.
None	None	780	2559	692555	4032856	Johnson Canyon												26	0	0	.	.	.	.	.
None	None	754	2473	692560	4032673	Johnson Canyon												263	0	0	.	.	.	.	.
None	None	762	2500	692560	4032715	Johnson Canyon												7	1	1	.	.	.	.	.
None	None	771	2529	692564	4032805	Johnson Canyon												420	4	18	.	.	.	.	.
None	None	749	2457	692571	4032667	Johnson Canyon												77	0	0	.	.	.	.	.
None	None	716	2349	692822	4032548	Johnson Canyon												68	.	0	.	.	.	.	.
None	None	757	2483	693157	4032047	Johnson Canyon												6	0	0	.	.	.	.	.
None	None	753	2470	693160	4032071	Johnson Canyon												29	0	0	.	.	.	.	.
None	None	759	2490	693163	4031949	Johnson Canyon												3	0	0	.	.	.	.	.
None	None	763	2503	693181	4031928	Johnson Canyon												8	0	0	.	.	.	.	.
None	None	778	2552	693346	4031747	Johnson Canyon												261	0	0	.	.	.	.	.
None	None	757	2483	693171	4032066	Johnson Canyon												---	---	29	.	.	.	.	.
None	None	755	2477	693156	4032055	Johnson Canyon												---	---	1	.	.	.	.	.
None	None	1107	3631	697690	4024007	Laguna Mountain												63	6	0	.	.	.	.	.
None	None	1101	3612	697694	4024130	Laguna Mountain												5	0	2	.	.	.	.	.
None	None	1100	3608	697704	4024136	Laguna Mountain												51	1	0	.	.	.	.	.
None	None	1075	3526	698319	4023222	Laguna Mountain												253	0	0	.	.	.	.	.
None	None	1074	3523	698642	4023469	Laguna Mountain												1158	20	22	.	.	.	.	.
None	None	1189	3900	697006	4021545	Laguna Mountain												---	1	18	.	.	.	.	.
None	None	1195	3920	696981	4021529	Laguna Mountain												---	2	0	.	.	.	.	.
None	None	1179	3868	696963	4021656	Laguna Mountain												---	2	19	.	.	.	.	.
None	None	1180	3871	696768	4021876	Laguna Mountain												---	5	4	.	.	.	.	.
None	None	1170	3838	696951	4021809	Laguna Mountain												---	11	0	.	.	.	.	.
None	None	1176	3858	696969	4021675	Laguna Mountain												---	2	33	.	.	.	.	.
None	None	1172	3845	697306	4022114	Laguna Mountain												---	12	21	.	.	.	.	.
None	None	1172	3845	697273	4022105	Laguna Mountain												---	12	17	.	.	.	.	.
None	None	1003	3290	698829	4022733	Laguna Mountain												---	---	9	.	.	.	.	.
None	None	1181	3874	697326	4022203	Laguna Mountain												---	---	1	.	.	.	.	.
None	None	1179	3868	697311	4022169	Laguna Mountain												---	---	2	.	.	.	.	.
None	None	1178	3864	697303	4022160	Laguna Mountain												---	---	3	.	.	.	.	.
None	None	1173	3848	697310	4022123	Laguna Mountain												---	---	1	.	.	.	.	.
None	None	1173	3848	697288	4022116	Laguna Mountain												---	---	5	.	.	.	.	.
None	None	1172	3845	697238	4022090	Laguna Mountain												---	---	9	.	.	.	.	.
None	None	1172	3845	697231	4022076	Laguna Mountain												---	---	3	.	.	.	.	.
None	None	1175	3854	697202	4022084	Laguna Mountain												---	---	54	.	.	.	.	.
None	None	1178	3864	697191	4022106	Laguna Mountain												---	---	69	.	.	.	.	.
None	None	1170	3838	697129	4022073	Laguna Mountain												---	---	25	.	.	.	.	.
None	None	1174	3851	696743	4021864	Laguna Mountain												---	---	8	.	.	.	.	.
None	None	1186	3891	696726	4021777	Laguna Mountain												---	---	11	.	.	.	.	.
None	None	1169	3835	696956	4021802	Laguna Mountain												---	---	9	.	.	.	.	.
None	None	1181	3874	696898	4021734	Laguna Mountain												---	---	18	.	.	.	.	.
None	None	1178	3864	696935	4021701	Laguna Mountain												---	---	14	.	.	.	.	.
None	None	1171	3841	697030	4021650	Laguna Mountain												---	---	6	.	.	.	.	.
None	None	1177	3861	697033	4021613	Laguna Mountain												---	---	8	.	.	.	.	.
None	None	1185	3887	696943	4021632	Laguna Mountain												---	---	64	.	.	.	.	.
None	None	1188	3897	696964	4021587	Laguna Mountain												---	---	3	.	.	.	.	.
None	None	1190	3904	696965	4021572	Laguna Mountain												---	---	69	.	.	.	.	.
None	None	1192	3910	696964	4021563	Laguna Mountain												---	---	7	.	.	.	.	.
None	None	1193	3914	696955	4021557	Laguna Mountain												---	---	105	.	.	.	.	.

Table 8, continued.

							----------------Habitat type ----------------					----------------- Location -----------------													
Occ. number	Subocc. number	Elevation (meters)	Elev. (feet)	UTM 10S		Location group	Alluvial terrace	Geologic transition	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
				E	N				Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	1193	3914	696969	4021553	Laguna Mountain												---	---	14	.	.	.	.	.
None	None	1192	3910	696987	4021544	Laguna Mountain												---	---	12	.	.	.	.	.
None	None	1192	3910	696992	4021535	Laguna Mountain												---	---	3	.	.	.	.	.
None	None	1192	3910	696999	4021530	Laguna Mountain												---	---	58	.	.	.	.	.
None	None	1191	3907	697012	4021513	Laguna Mountain												---	---	3	.	.	.	.	.
61000	61300	981	3218	702924	4030584	Larious Creek												224	2	275	41	33	9	.	.
61000	61400	967	3172	702563	4030888	Larious Creek												274	9	50	333	13	419	.	.
61000	61500	966	3169	702593	4030981	Larious Creek												182	2	1	18	0	23	.	.
61000	61510	957	3139	702560	4031028	Larious Creek												199	8	0	13	0	7	.	.
61000	61600	952	3123	702531	4031147	Larious Creek												449	0	6	139	42	81	.	.
61000	61800	934	3064	702321	4031527	Larious Creek												74	9	6	11	0	20	.	0
61000	61810	942	3090	702177	4031570	Larious Creek												22	1	0	6	0	17	.	0
61000	61900	1009	3310	702448	4030661	Larious Creek												73	1	1	13	1	22	.	0
None	None	812	2664	701550	4032116	Larious Creek												119	5	23	14	0	43	.	.
None	None	938	3077	702118	4031813	Larious Creek												20	0	0	0	0	13	.	.
None	None	912	2992	702127	4031873	Larious Creek												82	0	0	89	17	88	.	.
None	None	890	2919	702132	4031948	Larious Creek												21	0	0	0	0	26	.	.
None	None	883	2896	702151	4031973	Larious Creek												256	0	0	27	0	13	.	.
None	None	915	3001	702229	4031840	Larious Creek												410	33	0	0	0	643	.	.
None	None	923	3028	702287	4031815	Larious Creek												505	136	4	695	24	497	.	.
None	None	916	3005	702349	4031809	Larious Creek												108	0	1	17	0	81	.	.
None	None	888	2913	702462	4031850	Larious Creek												54	3	0	3	0	42	.	.
None	None	897	2942	702462	4031834	Larious Creek												---	---	---	---	---	9	.	.
None	None	893	2930	702492	4031832	Larious Creek												---	---	---	---	---	14	.	.
None	None	964	3162	702065	4031856	Larious Creek												---	---	---	---	---	44	.	.
None	None	963	3161	702065	4031688	Larious Creek												---	---	---	---	---	10	.	.
None	None	913	2995	702715	4031215	Larious Creek												---	---	---	---	---	12	.	.
None	None	919	3015	702697	4031182	Larious Creek												---	---	---	---	---	13	.	.
None	None	940	3085	702659	4031117	Larious Creek												---	---	---	---	---	7	.	.
None	None	957	3141	702519	4031134	Larious Creek												---	---	---	---	---	42	.	.
None	None	965	3167	702491	4031149	Larious Creek												---	---	---	---	---	24	.	.
None	None	880	2887	702479	4031892	Larious Creek												67	8	0	7	0	15	.	.
None	None	803	2634	702830	4032077	Larious Creek												6	.	.	.	.	.	.	.
None	None	867	2844	703032	4031859	Larious Creek												174	0	0	0	2	0	.	.
None	None	876	2874	703064	4031869	Larious Creek												34	14	0	14	5	46	.	.
None	None	878	2880	703080	4031874	Larious Creek												33	8	0	8	0	0	.	.
None	None	890	2919	703150	4031895	Larious Creek												5	0	.	.	.	.	.	.
None	None	865	2837	703208	4032299	Larious Creek												25	.	.	.	.	.	.	.
None	None	994	3261	703758	4032225	Larious Creek												62	6	2	5	0	71	0	.
None	None	987	3238	703784	4032294	Larious Creek												50	0	0	0	0	0	.	.
None	None	853	2799	702961	4031883	Larious Creek												---	---	---	---	---	5	.	.
None	None	857	2812	702964	4031868	Larious Creek												---	---	---	---	---	16	.	.
None	None	795	2608	702726	4031972	Larious Creek												---	---	---	---	---	1	.	.
None	None	794	2605	702639	4032097	Larious Creek												---	---	---	---	---	34	.	.
None	None	803	2633	702610	4032131	Larious Creek												---	---	---	---	---	16	.	.
None	None	939	3081	702758	4030824	Larious Creek												---	---	---	---	---	15	.	0
None	None	948	3111	702696	4030840	Larious Creek												---	---	---	---	---	43	.	36
None	None	954	3129	702674	4030842	Larious Creek												---	---	---	---	---	26	.	0
None	None	954	3129	702668	4030866	Larious Creek												---	---	---	---	---	38	.	0
None	None	954	3129	702015	4031814	Larious Creek												---	6	0	2	0	39	.	.
None	None	970	3182	701951	4031783	Larious Creek												---	14	7	94	0	9	.	.
None	None	931	3054	702054	4031837	Larious Creek												---	12	0	26	0	64	.	.
None	None	929	3047	702244	4031794	Larious Creek												---	1	3	321	10	1	.	.

Table 8, continued.

							----------------Habitat type----------------					----------------- Location -----------------													
Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Alluvial	Geologic	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	972	3188	702506	4030866	Larious Creek												---	7	0	36	0	0	.	.
None	None	848	2782	702940	4031857	Larious Creek												---	38	0	23	0	0	.	.
None	None	943	3093	702236	4031531	Larious Creek												---	5	0	0	0	10	.	0
None	None	941	3087	702297	4031516	Larious Creek												---	7	0	1	0	3	.	0
None	None	824	2703	701607	4032086	Larious Creek												---	2	0	.	0	0	.	.
None	None	956	3136	702625	4031014	Larious Creek												---	---	7	103	9	67	.	.
None	None	959	3146	702618	4030961	Larious Creek												---	---	2	0	0	0	.	.
None	None	933	3061	702342	4031537	Larious Creek												---	---	1	157	5	39	.	5
None	None	972	3188	702473	4031131	Larious Creek												---	---	1	1	0	11	.	.
None	None	941	3087	702716	4030848	Larious Creek												---	---	---	34	0	2	.	0
None	None	956	3136	702607	4031031	Larious Creek												---	---	---	1	0	0	.	.
None	None	947	3106	702570	4031143	Larious Creek												---	---	---	7	2	9	.	.
None	None	962	3156	702102	4031458	Larious Creek												---	---	---	1	0	.	.	.
None	None	929	3048	702402	4031498	Larious Creek												---	---	---	56	0	0	.	.
None	None	940	3084	702335	4031570	Larious Creek												---	---	---	1	0	1	.	0
None	None	937	3074	702324	4031559	Larious Creek												---	---	---	4	0	1	.	0
None	None	934	3064	702296	4031551	Larious Creek												---	---	---	59	2	15	.	0
None	None	939	3081	702303	4031575	Larious Creek												---	---	---	13	6	6	.	.
None	None	946	3104	702215	4031610	Larious Creek												---	---	---	59	0	11	.	0
None	None	953	3127	702083	4031651	Larious Creek												---	---	---	103	0	126	.	.
None	None	968	3176	701970	4031807	Larious Creek												---	---	---	7	0	23	.	.
None	None	933	3061	702792	4030809	Larious Creek												---	---	---	---	7	0	.	0
None	None	799	2621	703922	4022817	Lower San Benito River												---	---	---	5	153	10	271	45
None	None	680	2231	703429	4008906	Mustang Ridge												295	.	.	.	.	.	.	.
None	None	684	2244	703456	4008947	Mustang Ridge												75	.	.	.	.	.	.	.
None	None	727	2385	703674	4008618	Mustang Ridge												70	.	.	.	.	.	.	.
None	None	1395	4577	707842	4024669	Picacho Peak												24	0	0	4	0	4	0	.
None	None	1394	4573	707850	4024652	Picacho Peak												57	4	1	2	0	0	0	.
None	None	1393	4570	707860	4024667	Picacho Peak												---	---	4	99	0	0	31	.
None	None	1390	4560	707872	4024626	Picacho Peak												---	---	7	4	1	0	0	.
61000	61700	1040	3412	702083	4030792	Post Canyon												176	10	1	29	0	21	12	52
None	None	946	3104	700910	4031083	Post Canyon												26	0	0	0	0	17	.	.
None	None	976	3202	701185	4031145	Post Canyon												149	13	14	130	6	258	.	3
None	None	932	3058	701217	4030207	Post Canyon												36	0	4	70	0	9	.	.
None	None	937	3074	701228	4030234	Post Canyon												10	0	0	0	0	12	.	.
None	None	948	3110	701284	4030283	Post Canyon												50	0	0	0	0	30	.	.
None	None	948	3110	701300	4030306	Post Canyon												146	5	0	108	14	25	.	.
None	None	953	3127	701304	4030285	Post Canyon												534	0	13	165	29	154	.	.
None	None	953	3127	701321	4030312	Post Canyon												28	0	0	3	0	0	.	.
None	None	958	3143	701337	4030297	Post Canyon												96	0	14	15	0	12	.	.
None	None	1003	3291	701525	4029599	Post Canyon												144	21	154	245	5	283	.	3
None	None	1028	3373	701542	4031247	Post Canyon												214	64	0	5	0	0	.	.
None	None	1002	3287	701558	4030274	Post Canyon												420	10	37	155	17	128	.	.
None	None	1010	3314	701562	4029615	Post Canyon												352	110	44	906	90	574	.	32
None	None	1032	3386	701565	4031155	Post Canyon												85	3	4	339	0	13	.	.
None	None	1012	3320	701573	4029636	Post Canyon												19	2	1	0	0	5	.	12
None	None	1014	3327	701607	4030322	Post Canyon												126	0	0	.	0	0	.	.
None	None	1022	3353	701635	4030250	Post Canyon												25	0	0	.	0	0	.	.
None	None	1052	3451	701652	4030146	Post Canyon												22	0	0	2	8	93	.	.
None	None	1015	3330	701585	4031359	Post Canyon												---	2	.	83	0	.	.	.
None	None	1028	3373	701610	4031254	Post Canyon												---	1	0	0	0	2	.	.
None	None	1026	3366	701555	4031195	Post Canyon												---	3	0	0	0	7	.	.
None	None	1025	3363	701527	4031198	Post Canyon												---	6	0	21	0	18	.	.

Table 8, continued.

Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Habitat type: Alluvial	Geologic	Rock outcrop			Location: CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	1017	3337	701493	4031121	Post Canyon												---	2	4	3	0	0	.	.
None	None	1116	3661	701939	4030346	Post Canyon												---	4	0	3	0	25	11	2
None	None	1029	3376	701606	4030170	Post Canyon												---	2	0	16	22	14	.	.
None	None	1026	3366	701592	4030192	Post Canyon												---	25	0	.	0	0	.	.
None	None	941	3088	701258	4030227	Post Canyon												---	---	---	---	---	1	.	.
None	None	931	3056	701192	4030223	Post Canyon												---	---	---	---	---	1	.	.
None	None	1048	3438	701651	4030194	Post Canyon												---	49	0	178	0	32	.	.
None	None	1043	3422	701634	4030180	Post Canyon												---	2	0	0	0	44	.	.
None	None	1011	3317	701601	4030279	Post Canyon												---	---	6	40	35	20	.	.
None	None	1028	3373	701451	4031010	Post Canyon												---	---	10	122	0	0	.	.
None	None	1026	3366	701534	4031187	Post Canyon												---	---	1	81	0	17	.	.
None	None	1026	3366	701530	4031281	Post Canyon												---	---	158	1034	21	64	.	.
None	None	1026	3366	701563	4031283	Post Canyon												---	---	28	13	0	34	.	.
None	None	1023	3357	701539	4031314	Post Canyon												---	---	---	---	---	1	.	.
None	None	1020	3345	701495	4031272	Post Canyon												---	---	---	---	---	57	.	.
None	None	1114	3654	701998	4030371	Post Canyon												---	---	---	---	---	1	0	0
None	None	1118	3669	701991	4030348	Post Canyon												---	---	---	---	---	11	0	0
None	None	1048	3438	701963	4030898	Post Canyon												---	---	---	---	---	---	2	0
None	None	1026	3366	701545	4031220	Post Canyon												---	---	1	167	0	28	.	.
None	None	1123	3684	701974	4030363	Post Canyon												---	---	---	119	3	28	45	8
None	None	1023	3356	701638	4031314	Post Canyon												---	---	---	56	8	52	.	.
None	None	1022	3353	701652	4031260	Post Canyon												---	---	---	1	0	0	.	.
None	None	1057	3468	701664	4030132	Post Canyon												---	---	---	---	1	4	.	.
None	None	1032	3386	701588	4031176	Post Canyon												---	---	---	---	8	41	.	.
None	None	1024	3360	701515	4031265	Post Canyon												---	---	---	---	4	38	.	.
171000	171100	1068	3504	701171	4027988	R2												445	1	0	55	29	80	21	27
171000	171200	1065	3494	701144	4027959	R2												46	0	0	31	12	103	3	2
171000	171300	1079	3540	701222	4028045	R2												15	0	0	72	7	1	5	10
None	None	1051	3448	701412	4028606	R2												29	2	0	66	159	1037	55	12
None	None	1070	3510	701475	4028480	R2												18	0	0	0	0	0	36	0
None	None	1063	3488	701417	4028544	R2												---	---	---	1	0	22	0	0
None	None	1059	3474	701407	4028527	R2												---	---	---	4	101	398		0
None	None	1050	3446	701406	4028594	R2												---	---	---	---	---	66	0	0
None	None	1080	3542	701230	4028065	R2												---	---	---	---	---	11	0	2
None	None	1068	3503	701189	4027970	R2												---	---	---	---	---	248	28	7
None	None	1051	3447	701407	4028527	R2												---	---	---	---	---	---	5	0
None	None	1196	3924	709180	4024740	R8												249	13	8	41	32	8	8	.
None	None‡	833	2733	702054	4027306	SA 1												---	---	---	1‡	30‡	1‡	25‡	320‡
None	None‡	839	2753	702208	4027254	SA 1												---	---	---	0‡	2‡	0‡	8‡	1‡
None	None‡	831	2726	702217	4027336	SA 1												---	---	---	0‡	5‡	2‡	0‡	0‡
None	None‡	833	2733	702285	4027348	SA 1												---	---	---	0‡	4‡	7‡	5‡	0‡
None	None‡	867	2845	702152	4027307	SA 1												---	---	---	---	---	1	0	0‡
31000	31200	856	2808	702909	4027641	SA 2												9	0	0	0	0	3	0	0
None	None‡	842	2762	702554	4027456	SA 2												---	---	---	0‡	3‡	1‡	3‡	2‡
None	None‡	851	2792	702754	4027480	SA 2												---	---	---	0‡	37‡	0‡	22‡	39‡
None	None‡	857	2812	702748	4027527	SA 2												---	---	---	---	---	25	0	6
None	None	933	3061	704059	4028250	SA 3												---	---	---	1	0	0	0	0
None	None	939	3081	704116	4028596	SA 3												---	---	---	---	5	0	10	6
None	None‡	916	3005	703702	4028088	SA 3												---	---	---	0‡	2‡	1‡	2‡	2‡
None	None	950	3118	704111	4028627	SA 3												---	---	---	---	---	---	31	3‡
None	None	932	3058	703742	4028193	SA 3												---	---	---	---	---	---	21	1
None	None‡	987	3238	705405	4028518	SA 4												---	---	---	1‡	120‡	0‡	9‡	0‡
None	None‡	978	3209	705253	4028504	SA 4												---	---	---	0‡	50‡	6‡	0‡	0‡

Table 8, continued.

							Habitat type					Location													
Occ. number	Subocc. number	Elevation (meters)	Elev. (feet)	UTM 10S		Location group	Alluvial terrace	Geologic transition	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
				E	N				Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None‡	985	3232	705405	4028499	SA 4												---	---	---	0‡	30‡	1‡	0‡	7‡
None	None‡	985	3232	705427	4028501	SA 4												---	---	---	0‡	90‡	0‡	2‡	1‡
None	None‡	984	3228	705471	4028436	SA 4												---	---	---	0‡	4‡	0‡	4‡	86‡
None	None‡	996	3269	704924	4028767	SA 4												---	---	---	---	---	36‡	21‡	8‡
None	None	979	3212	705149	4028586	SA 4												---	---	---	---	---	---	78	138
None	None	984	3230	705260	4028560	SA 4												---	---	---	---	---	---	7	1
None	None	987	3239	705047	4028448	SA 4												---	---	---	---	---	---	36	0
None	None	983	3224	705023	4028479	SA 4												---	---	---	---	---	---	6	0
None	None	975	3199	704966	4028648	SA 4												---	---	---	---	---	---	9	45
None	None	976	3201	704930	4028622	SA 4												---	---	---	---	---	---	67	0
None	None	974	3195	704878	4028646	SA 4												---	---	---	---	---	---	53	4
None	None	964	3162	704631	4028970	SA 4												---	---	---	---	---	---	17	42
None	41300	963	3158	704573	4028920	SA 4												---	---	---	---	---	---	50	137
None	None‡	997	3271	706035	4028411	SA 5												---	---	---	5‡	244‡	2‡	14‡	38‡
None	None‡	1004	3293	706016	4028403	SA 5												---	---	---	---	---	1‡	18‡	54‡
None	None‡	1013	3323	706629	4028297	SA 6												---	---	---	0‡	15‡	0‡	1‡	2‡
None	None	1243	4078	706773	4032038	Sampson Peak												43	8	.	0	.	0	.	.
None	None	1287	4222	710027	4029195	San Carlos Creek												---	---	---	6	0	16	7	4
None	None‡	1262	4140	709765	4029184	San Carlos Creek												---	---	---	0‡	12‡	0‡	8‡	0‡
None	None‡	1225	4018	709141	4029715	San Carlos Creek												---	---	---	---	---	6‡	1‡	0‡
None	None	1182	3878	710451	4024874	Sawmill Creek												---	---	---	17	4	0	4	3
None	None	860	2822	707334	4019549	Scazighini												---	---	239	.	0	.	.	.
None	None	872	2861	708077	4020362	Scazighini												---	---	170	0	0	0	2	0
None	None	872	2860	708085	4020378	Scazighini												---	---	---	---	---	---	13	0
None	None	972	3189	704487	4023942	SRMC												15	2	.	.	.	.	.	.
None	None	952	3123	704526	4023884	SRMC												55	0	.	.	.	.	.	.
None	None	949	3114	704541	4023835	SRMC												4	0	.	.	.	.	.	.
None	None	960	3150	704579	4023938	SRMC												2	0	.	.	.	.	.	.
None	None	950	3117	704604	4023923	SRMC												10	3	.	.	.	.	.	.
None	None	811	2661	704802	4022519	SRMC												---	---	3	8	3	14	17	0
None	None	813	2667	704782	4022428	SRMC												---	---	---	---	80	14	30	0
None	None	812	2664	704746	4022443	SRMC												---	---	---	---	45	8	45	0
None	None	810	2658	704735	4022596	SRMC												---	---	---	---	---	---	---	13
None	None	1044	3425	704588	4032441	T195												1695	3	0	269	0	8	.	.
None	None	1039	3409	704628	4032499	T195												---	---	1	1	0	9	.	.
None	None	1014	3327	704735	4032507	T195												47	0	11	0	0	0	.	.
None	None	1025	3363	704700	4032433	T195												---	---	---	---	---	40	.	.
None	None	1029	3376	704691	4032404	T195												---	---	---	---	---	28	.	.
None	None	1045	3428	704587	4032483	T195												---	---	---	---	---	40	.	.
None	None	1045	3429	704622	4032443	T195												---	---	---	---	---	45	.	.
None	None	1046	3432	704581	4032412	T195												---	---	---	---	---	40	.	.
None	None	1152	3780	705006	4031885	T195												191	2	63	144	8	98	.	.
None	None	1146	3760	705051	4031880	T195												---	---	---	---	---	46	.	.
None	None	1145	3757	705023	4031914	T195												---	---	---	---	---	71	.	.
None	None	1148	3766	704990	4031866	T195												---	---	---	---	---	91	.	.
None	None	1146	3759	704970	4031896	T195												---	---	---	---	---	119	.	.
None	None	1135	3725	704930	4031964	T195												---	---	---	---	---	31	.	.
None	None	1120	3675	704875	4031923	T195												---	---	---	---	---	21	.	.
None	None	1110	3643	704844	4031948	T195												---	---	---	---	---	50	.	.
None	None	1117	3664	704867	4031995	T195												---	---	---	---	---	210	.	.
None	None	1097	3598	704802	4032003	T195												---	---	---	---	---	6	.	.
None	None	1088	3571	704787	4032016	T195												---	---	---	---	---	8	.	.
None	None	847	2779	704003	4032963	T195												150	84	4	126	5	48	.	.
None	None	893	2930	704108	4032717	T195												50	2	0	0	0	0	.	.

Table 8, continued.

Occ. number	Subocc. number	Elevation (meters)	Elev. (feet)	UTM 10S E	UTM 10S N	Location group	Habitat type: Alluvial terrace	Geologic transition	Rock outcrop: Serpentine	Syenite	Greywacke	Location: CCMA Inside	CCMA Outside	Serpentine ACEC Inside	Serpentine ACEC Outside	Ownership: BLM	Private	Plant # 2010	Plant # 2011	Plant # 2012	Plant # 2013	Plant # 2014	Plant # 2015	Plant # 2016	Plant # 2017
None	None	891	2923	704094	4032720	T195												20	0	0	0	0	0	.	.
None	None	896	2940	704126	4032705	T195												200	39	0	0	0	406	.	.
None	None	1146	3760	705039	4031893	T195												---	---	---	---	2	3	.	.
None	None	1041	3415	707359	4028215	Upper Clear Creek												---	---	---	2	22	48	17	16
None	None	1038	3406	707336	4028199	Upper Clear Creek												---	---	---	---	3	0	0	0
None	None	1113	3652	707727	4026649	Upper Clear Cr. - S. Fork												---	---	---	1	0	5	0	.
None	None	1106	3629	707517	4026701	Upper Clear Cr. - S. Fork												---	---	---	---	3	0	0	.
None	None	1124	3688	707776	4026605	Upper Clear Cr. - S. Fork												---	---	---	---	---	2	0	.
None	None	1134	3720	707437	4026952	Upper Clear Cr. - S. Fork												---	---	---	---	---	---	2	.
None	None	1246	4088	713138	4023247	Upper San Benito River												---	---	---	---	4	2	0	0
None	None	1315	4313	714270	4023461	Upper San Benito River												---	---	---	---	---	33	2	.
None	None	1285	4217	713811	4023687	Upper San Benito River												---	---	---	---	---	41	67	149
None	None	1299	4263	713714	4023991	Upper San Benito River												---	---	---	---	---	7	18	28
None	None	1233	4046	712485	4023637	Upper San Benito River												---	---	---	---	---	18	8	29
None	None	1241	4070	712788	4023227	Upper San Benito River												---	---	---	---	---	---	60	63
None	None	1239	4064	712601	4023332	Upper San Benito River												---	---	---	---	---	---	98	115
None	None	1224	4015	712171	4023912	Upper San Benito River												---	---	---	---	---	---	97	46
None	None	1214	3982	711835	4023893	Upper San Benito River												---	---	---	---	---	---	127	41
None	None	1208	3963	711584	4023929	Upper San Benito River												---	---	---	---	---	---	64	24
None	None	1206	3958	711531	4023916	Upper San Benito River												---	---	---	---	---	---	14	5
200000	200100	717	2352	716541	4018268	White Creek												10	0	0	0	0	16	31	0
200000	200200	736	2415	717097	4018830	White Creek												162	11	12	9	0	4	16	0
201000	201140	805	2641	717691	4019989	White Creek												113	0	0	3	0	51	4	17
201000	201210	771	2530	718016	4019460	White Creek												160	2	12	0	0	2	8	3
201000	201220	772	2533	718100	4019501	White Creek												133	2	0	0	0	10	1	0
201000	201800	755	2477	717565	4019195	White Creek												757	3	94	0	0	0	24	1
211000	201900	759	2490	717677	4019239	White Creek												170	3	41	11	0	1	2	0
211000	211100	794	2605	717755	4019790	White Creek												108	17	8	10	18	39	31	12
211000	211200	838	2749	716850	4019900	White Creek												310	8	0	30	0	133	46	6
211000	211300	867	2844	716479	4019962	White Creek												518	127	70	270	15	18	2	3
None	None	782	2566	718034	4019728	White Creek												---	---	---	---	---	---	---	6
None	None	777	2550	718089	4019609	White Creek												---	---	---	---	---	12	0	0
None	None	818	2684	718182	4019776	White Creek												---	---	---	---	---	1	1	.
None	None	791	2594	718032	4019761	White Creek												---	---	---	---	---	2	0	0
None	None	790	2593	717955	4019806	White Creek												---	---	---	---	---	27	33	23
None	None	790	2592	717981	4019781	White Creek												---	---	---	---	---	14	1	1
None	None	785	2577	717966	4019760	White Creek												---	---	---	---	---	73	8	2
None	None	787	2583	717937	4019773	White Creek												---	---	---	---	---	308	7	16
None	None	794	2604	717686	4019793	White Creek												---	---	---	---	---	31	11	7
None	None	858	2814	716469	4019936	White Creek												---	---	---	---	---	23	7	0
None	None	856	2809	716487	4019921	White Creek												---	---	---	---	---	861	387	68
None	None	838	2748	717833	4020165	White Creek												---	---	---	---	---	22	0	0
None	None	852	2795	717855	4020122	White Creek												---	---	---	---	---	22	37	17
None	None	847	2778	717838	4020118	White Creek												---	---	---	---	---	29	77	19
None	None	859	2819	717874	4020094	White Creek												---	---	---	---	---	29	1	0
None	None	847	2780	717838	4020094	White Creek												---	---	---	---	---	28	36	28
None	None	853	2800	717857	4020080	White Creek												---	---	---	---	---	41	65	0
None	None	849	2784	717843	4020076	White Creek												---	---	---	---	---	25	30	16
None	None	839	2754	717793	4020056	White Creek												---	---	---	---	---	1	7	0
None	None	831	2725	717768	4020056	White Creek												---	---	---	---	---	43	30	0
None	None	826	2710	717758	4020071	White Creek												---	---	---	---	---	22	19	0
None	None	823	2700	717753	4020080	White Creek												---	---	---	---	---	5	10	0
None	None	792	2597	717879	4019834	White Creek												---	---	---	---	---	---	3	8
None	None	808	2651	717679	4020020	White Creek												---	---	---	---	---	---	3	1

Table 8, continued.

							----------------Habitat type----------------					---------------- Location ----------------													
Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Alluvial	Geologic	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	809	2655	717696	4020039	White Creek												---	---	---	---	---	---	1	0
None	None	840	2755	717802	4020067	White Creek												---	---	---	---	---	---	4	0
None	None	845	2775	717845	4020032	White Creek												---	---	---	---	---	---	11	0
None	None	837	2745	717817	4020125	White Creek												---	---	---	---	---	---	5	0
None	None	853	2797	717854	4020100	White Creek												---	---	---	---	---	---	9	0
None	None	843	2764	717818	4020071	White Creek												---	---	---	---	---	---	47	16
None	None	843	2766	717818	4020093	White Creek												---	---	---	---	---	---	139	42
None	None	864	2836	717900	4020088	White Creek												---	---	---	---	---	---	5	3
None	None	860	2823	717892	4020071	White Creek												---	---	---	---	---	---	60	66
None	None	855	2806	717865	4020063	White Creek												---	---	---	---	---	---	24	98
None	None	867	2845	717927	4020104	White Creek												---	---	---	---	---	---	40	6
None	None	867	2845	717919	4020114	White Creek												---	---	---	---	---	---	64	0
None	None	802	2631	717786	4019930	White Creek												---	---	4	21	0	8	0	2
None	None	769	2523	717946	4019417	White Creek												---	---	72	0	0	0	0	8
None	None	764	2507	717774	4019335	White Creek												---	---	7	0	0	0	1	8
None	None	759	2490	717707	4019276	White Creek												---	---	2	1	0	1	0	0
None	None	760	2493	717703	4019248	White Creek												---	---	36	0	0	0	0	0
None	None	763	2503	717642	4019184	White Creek												---	---	3	0	0	0	62	.
None	None	1036	3399	715392	4020363	White Creek												22	0	0	6	.	68	.	.
None	None	998	3274	715596	4020282	White Creek												326	13	78	105	.	9	.	.
None	None	1004	3294	715569	4020308	White Creek												---	---	---	---	---	7	.	.
None	None	967	3173	715676	4020459	White Creek												1	.	.	.	.	.	.	.
None	None	972	3189	715696	4020508	White Creek												3	.	.	.	.	.	.	.
None	None	955	3133	715716	4020388	White Creek												10	.	.	.	.	.	.	.
None	None	968	3176	715741	4020429	White Creek												15	.	.	.	.	.	.	.
None	None	815	2674	718743	4019835	White Creek												25	0	0	0	0	0	5	3
None	None	818	2684	718747	4019844	White Creek												6	0	0	0	0	0	2	0
None	None	823	2700	718747	4019857	White Creek												8	0	0	0	0	0	0	0
None	None	715	2346	716021	4017603	White Creek												---	---	---	---	---	---	46	.
None	None	703	2308	716203	4017868	White Creek												---	---	---	---	---	---	10	.
None	None	723	2372	714843	4017232	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	719	2359	714786	4017177	Joaquin Mill												130	.	.	.	.	.	.	.
None	None	708	2323	714744	4017145	Joaquin Mill												100	.	.	.	.	.	.	.
None	None	718	2356	714764	4017079	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	720	2362	715255	4016957	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	733	2405	715564	4016944	Joaquin Mill												10	.	.	.	.	.	.	.
None	None	749	2457	715473	4016916	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	739	2425	715494	4016976	Joaquin Mill												10	.	.	.	.	.	.	.
None	None	735	2411	715502	4017006	Joaquin Mill												10	.	.	.	.	.	.	.
None	None	717	2352	715217	4017244	Joaquin Mill												40	.	.	.	.	.	.	.
None	None	719	2359	715259	4017250	Joaquin Mill												40	.	.	0	.	.	.	.
None	None	725	2379	715272	4017233	Joaquin Mill												20	.	7	0	.	.	.	.
None	None	732	2402	715259	4017214	Joaquin Mill												100	.	10	16	.	.	.	.
None	None	738	2421	715289	4017199	Joaquin Mill												120	.	8	8	.	.	.	.
None	None	734	2408	715307	4017212	Joaquin Mill												220	.	37	0	.	.	.	.
None	None	743	2438	715316	4017187	Joaquin Mill												40	.	4	.	.	.	.	.
None	None	745	2444	715336	4017181	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	723	2372	715293	4017239	Joaquin Mill												170	.	3	0	.	.	.	.
None	None	724	2375	715309	4017240	Joaquin Mill												100	.	29	0	.	.	.	.
None	None	723	2372	715323	4017242	Joaquin Mill												70	.	129	0	.	.	.	.
None	None	734	2408	715355	4017209	Joaquin Mill												50	.	5	5	.	.	.	.
None	None	736	2415	715375	4017203	Joaquin Mill												200	.	6	.	.	.	.	.

Table 8, continued.

							----------------Habitat type ----------------					----------------- Location -----------------													
Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Alluvial	Geologic	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	746	2448	715387	4017176	Joaquin Mill												50	.	.	0	.	.	.	.
None	None	739	2425	715397	4017193	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	734	2408	715388	4017206	Joaquin Mill												120	.	25	.	.	.	.	.
None	None	743	2438	715360	4017187	Joaquin Mill												---	---	51	10	.	.	.	.
None	None	722	2369	715399	4017234	Joaquin Mill												70	.	.	.	.	.	.	.
None	None	719	2359	715418	4017237	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	709	2326	715500	4017134	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	717	2352	715488	4017102	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	720	2362	715503	4017104	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	728	2388	715507	4017086	Joaquin Mill												100	.	.	.	.	.	.	.
None	None	708	2323	715519	4017153	Joaquin Mill												10	.	.	.	.	.	.	.
None	None	711	2333	715530	4017142	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	708	2323	715538	4017154	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	713	2339	715552	4017143	Joaquin Mill												100	.	.	.	.	.	.	.
None	None	709	2326	715559	4017156	Joaquin Mill												70	.	.	.	.	.	.	.
None	None	710	2329	715578	4017152	Joaquin Mill												200	.	.	.	.	.	.	.
None	None	715	2346	715569	4017137	Joaquin Mill												150	.	.	.	.	.	.	.
None	None	719	2359	715561	4017124	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	719	2359	715580	4017112	Joaquin Mill												300	.	.	.	.	.	.	.
None	None	720	2362	715575	4017095	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	724	2375	715558	4017098	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	717	2352	715595	4017084	Joaquin Mill												150	.	.	.	.	.	.	.
None	None	715	2346	715614	4017061	Joaquin Mill												200	.	.	.	.	.	.	.
None	None	711	2333	715615	4017094	Joaquin Mill												200	.	.	.	.	.	.	.
None	None	707	2320	715636	4017095	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	703	2306	715669	4017091	Joaquin Mill												20	.	32	.	.	.	.	.
None	None	708	2323	715652	4017062	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	708	2323	715655	4017042	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	707	2320	715672	4017058	Joaquin Mill												70	.	7	.	.	.	.	.
None	None	709	2326	715603	4017153	Joaquin Mill												11	.	.	.	.	.	.	.
None	None	708	2323	715618	4017150	Joaquin Mill												22	.	.	.	.	.	.	.
None	None	712	2336	715645	4017012	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	718	2356	715652	4016989	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	722	2369	715644	4016974	Joaquin Mill												120	.	.	.	.	.	.	.
None	None	722	2369	715618	4016973	Joaquin Mill												120	.	.	.	.	.	.	.
None	None	726	2382	715625	4016949	Joaquin Mill												70	.	.	.	.	.	.	.
None	None	709	2326	715668	4017027	Joaquin Mill												---	---	2	.	.	.	.	.
None	None	698	2290	715688	4017112	Joaquin Mill												20	.	9	.	.	.	.	.
None	None	696	2283	715730	4017126	Joaquin Mill												30	.	13	.	.	.	.	.
None	None	695	2280	715791	4017119	Joaquin Mill												21	.	.	.	.	.	.	.
None	None	697	2287	715806	4017106	Joaquin Mill												60	.	.	.	.	.	.	.
None	None	692	2270	715876	4017104	Joaquin Mill												30	.	.	.	.	.	.	.
None	None	695	2280	715862	4017082	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	699	2293	715873	4017064	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	699	2293	715857	4017059	Joaquin Mill												60	.	.	.	.	.	.	.
None	None	699	2293	715838	4017056	Joaquin Mill												10	.	.	.	.	.	.	.
None	None	702	2303	715837	4017043	Joaquin Mill												80	.	.	.	.	.	.	.
None	None	705	2313	715861	4017035	Joaquin Mill												120	.	.	.	.	.	.	.
None	None	707	2320	715860	4017022	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	709	2326	715865	4017007	Joaquin Mill												150	.	.	.	.	.	.	.
None	None	710	2329	715878	4016999	Joaquin Mill												70	.	.	.	.	.	.	.
None	None	711	2333	715885	4016985	Joaquin Mill												50	.	.	.	.	.	.	.
None	None	705	2313	715923	4017032	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	703	2306	715898	4017049	Joaquin Mill												50	.	.	.	.	.	.	.

Table 8, continued.

							----------------Habitat type ----------------					----------------- Location -----------------													
Occ.	Subocc.	Elevation	Elev.	UTM 10S		Location	Alluvial	Geologic	Rock outcrop			CCMA		Serpentine ACEC		Ownership		Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #	Plant #
number	number	(meters)	(feet)	E	N	group	terrace	transition	Serpentine	Syenite	Greywacke	Inside	Outside	Inside	Outside	BLM	Private	2010	2011	2012	2013	2014	2015	2016	2017
None	None	703	2306	715910	4017050	Joaquin Mill												40	.	.	.	.	.	.	.
None	None	701	2300	715916	4017062	Joaquin Mill												10	.	.	.	.	.	.	.
None	None	701	2300	715930	4017067	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	699	2293	715914	4017075	Joaquin Mill												20	.	.	.	.	.	.	.
None	None	694	2277	715926	4017110	Joaquin Mill												2	.	.	.	.	.	.	.
																TOTAL -		**32075**	**1795**	**4487**	**12537**	**4113**	**15863**	**8586**	**4850**

Ex Situ Seed Banking and Horticultural Seed Increase

Ex situ seed banking of *Camissonia benitensis* was conducted by the BLM from 2008 to 2014 ((BLM 2008, 2010, 2011, 2012, 2013, 2014a). A substantial *ex situ* conservation seed bank of *Camissonia benitensis* and other rare plant species is stored at room temperature at the BLM Central Coast Field Office. Additionally, *Camissonia benitensis* seed has been collected and is stored long-term at sub-zero temperatures at the Santa Barbara Botanic Garden Conservation Seed Bank. The BLM conducted horticultural seed increase for four source suboccurrences of *Camissonia benitensis* 2008 to 2014. The species was grown on raised beds of potting soil at outdoor ambient conditions for Hollister, California (**Figure 18**). The species grew vigorously under these conditions and produced millions of seeds which are seed banked at room temperature at the BLM Central Coast Field Office. These seeds were used for suboccurrence introductions in 2008 and 2012. The species is highly conducive to growth in a horticultural setting (Taylor 1990; BLM 2008, 2010, 2011, 2012, 2013, 2014a) and has high potential for further massive bulk seed increases and extensive suboccurrence introductions into potential habitat, if necessary, in order to achieve recovery and delisting. A range-wide population genetics study of *Camissonia benitensis* recommends mixing seeds from all three identified genetic clusters to maximize genetic diversity in suboccurrence introductions (Dick et al. 2013).

Figure 18. *Camissonia benitensis* growing on a raised bed of potting soil at the former BLM Hollister Field Office location. Individual plants were multi-branched and more than 30 cm (1 ft) in diameter. This 1.2 m (48 in) x 3.3 (128 in) seed increase bed produced millions of seeds which are seed banked at the BLM Central Coast Field Office.

Population Genetics and Gene Flow via Seed Dispersal

A range-wide population genetics study of *Camissonia benitensis* was conducted in 2011 (Dick et al. 2013). The study found three genetic clusters that did not correlate with habitat type, watershed, or physical distance between populations, supporting the theory that all suboccurrences of the species largely interact as a single, giant metapopulation (**Figure 19**). The apparently random distribution and mixed frequency of genetic clusters suggests that long-distance seed dispersal is not strongly limited. The most likely continuously present seed vector involved in long-distance dispersal of *Camissonia benitensis* between watersheds is seed in mud stuck to vertebrates (epizoochory; USFWS 2006). During the last 50 years, motorized vehicles including dirt bikes may have also begun to become a significant vector in seed dispersal of the species. More limited dispersal of *Camissonia benitensis* within watersheds likely occurs by water and with alluvium (USFWS 2006). The range-wide population genetics study recommends mixing seeds from all three identified genetic clusters of *Camissonia benitensis* to maximize genetic diversity in suboccurrence introductions.

Camissonia benitensis was measured to have exceptionally high levels of inbreeding in comparison to *Camissonia strigulosa* and *Camissonia contorta* (Dick et al. 2013). The inbreeding coefficient for *Camissonia benitensis* was 0.813 from GenePop – 11x that of *Camissonia strigulosa* and 5x that of *Camissonia contorta*. Counterintuitively, the magnitude of inbreeding depression decreases with inbreeding as deleterious alleles are expressed and purged through selection (Husband and Schemske 1996; Dart and Eckert 2013a,b, studies of *Camissoniopsis*; Onagraceae). Additionally, although it has long been presumed that selfing is an evolutionary dead-end in plant species (Stebbins 1950), recent research in Onagraceae – *Oenothera* refutes the dead-end hypothesis (Evans et al. 2009; Johnson et al. 2010, 2011; Godfrey and Johnson 2014). Net diversification rates in self-pollinating *Oenothera* lineages were determined to be eight times faster than in out-crossing lineages, primarily due to high speciation rates in selfing lineages.

The role of self-pollination (autogamous) is clear as a potent force in the diversification of *Camissonia*, particularly where edaphically stressful habitats occur. In *Camissonia*, eight of eleven taxa are self-pollinating (Raven 1969; Baldwin et al. 2012). *Camissonia benitensis, Camissonia lacustris,* and *Camissonia integrifolia* are all self-pollinating species derived from self-pollinating *Camisosnia strigulosa* (Raven 1969; Baldwin et al. 2012). The self-pollination breeding system and high level of inbreeding in *Camissonia benitensis* are not a threat to the species and in fact, played a key role in the origin and evolution of *Camissonia benitensis* from the more widespread *Camissonia strigulosa* (Raven 1969; USFWS 1985).

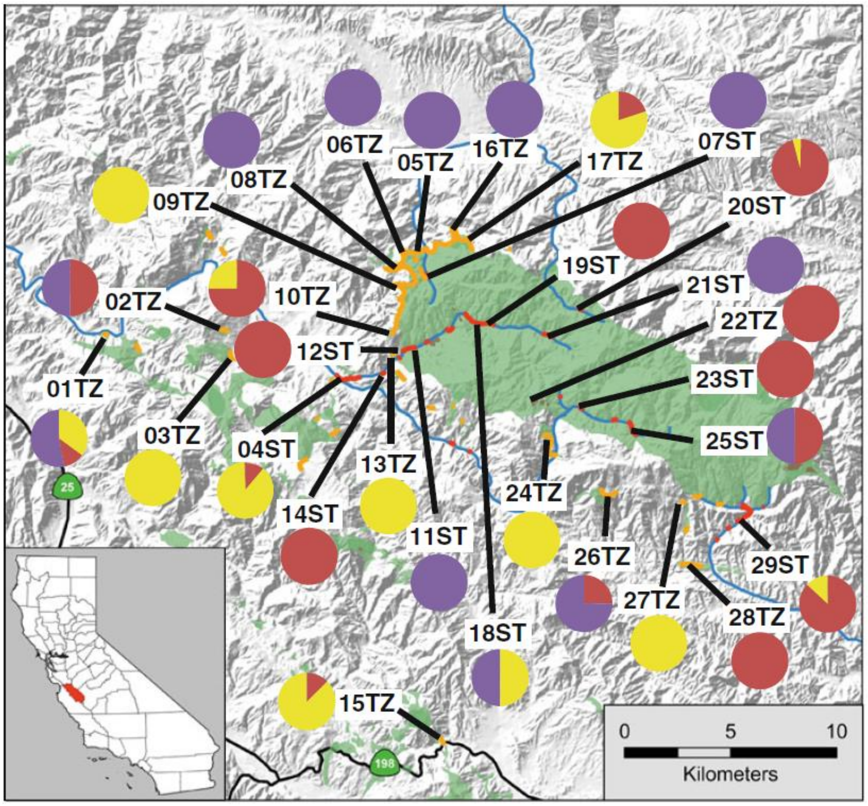


Figure 19. Figure 1 from Dick et al. 2013. The map denotes serpentine soils (green), major streams and rivers (blue lines, known *Camissonia benitensis* stream terrace populations (red), and known geologic transition zone populations (orange). Note the mostly random distribution of the three genetic clusters (red, yellow, purple) with some populations containing mixed individuals indicating that most if not all of the suboccurrences interact as a single, giant metapopulation.

Fence and Pipe Barrier Protections at CCMA

Up to 48 km (30 mi) of wire fence and steel pipe barrier was constructed by BLM at CCMA between 1985 and 2011 to protect *Camissonia benitensis* habitat from OHV impacts (USFWS 2006; BLM 2011). Vegetation has recovered markedly in recent decades as the result of fence and steel pipe barrier construction to exclude OHV impacts (**Figure 20**).


1970. Before pipe barrier at Staging Area 1.


2009. After pipe barrier at Staging Area 1.


1970. Before fence near Staging Area 4.


2008. After fence near Staging Area 4.

1982. Before pipe barrier at Staging Area 4.


2008. After pipe barrier at Staging Area 4.

1982. Before pipe barrier at Staging Area 4.

2008. After pipe barrier at Staging Area 4.

1982. Before pipe barrier at Staging Area 4.

2008. After pipe barrier at Staging Area 4.

Figure 20. Landscape monitoring photo comparisons of vegetation condition before and after fencing to exclude OHVs.

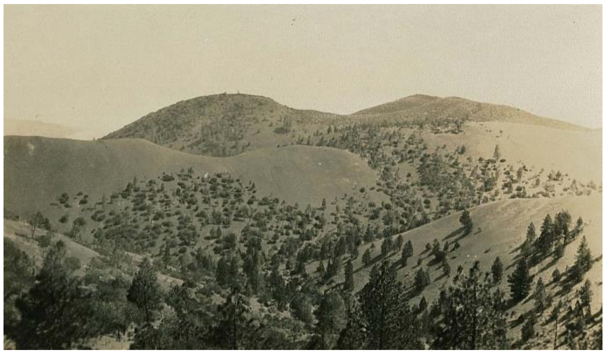
Signing at CCMA

The information signs that existed prior to the 2008 Emergency Closure of CCMA remain in place (**Figure 21**). With implementation of the 2014 Record of Decision (ROD) for the approved Clear Creek Management Area Resource Management Plan (BLM 2014b), the two primary access points to CCMA – Clear Creek and New Idria – have been gated to control public access. The 2014 ROD limits access to the Serpentine ACEC to highway licensed vehicles only and entry by permit for five days a year only on a designated touring route. Permanent information signs have been posted at both locked gates informing visitors that multiple permits are required for access and to call the BLM Central Coast Field Office for information.

Figure 21. Kiosk information sign at Oak Flat Campground at CCMA that present the geology, ecology, and history of the Serpentine ACEC. Rare serpentine endemic plants including *Camissonia benitensis* appear at lower left on the sign.

Landscape Photomonitoring at CCMA

Historic photos and aerial images have proven useful to evaluate long-term vegetation change at CCMA (**Figures 20**, **22, 23,** and **24**). Landscape monitoring photos provide valuable insight into the resiliency of natural serpentine barrens to vegetation establishment and also to establish a baseline vegetative cover target for areas where vegetation loss has occurred.



1915. San Carlos Creek, looking east.

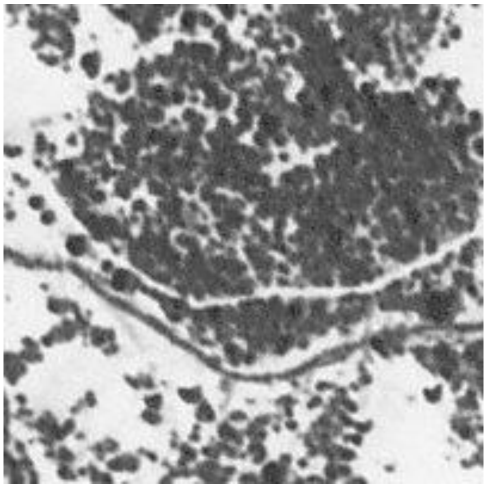
2009. San Carlos Creek, looking east.

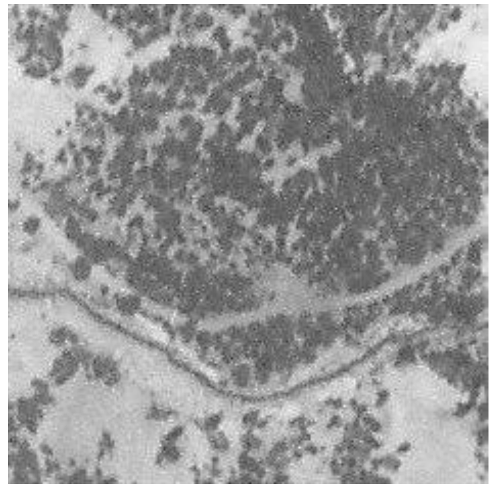
Figure 22. Historic photo comparison for San Carlos Creek drainage. Most woody vegetation was harvested from the San Carlos Creek drainage between 1850 and 1900 to fuel the mercury retorts at New Idria (Sloane 1914; Iddings 2015). The photos show the woody vegetation has reestablished where it was removed and serpentine barrens maintained their same extent.

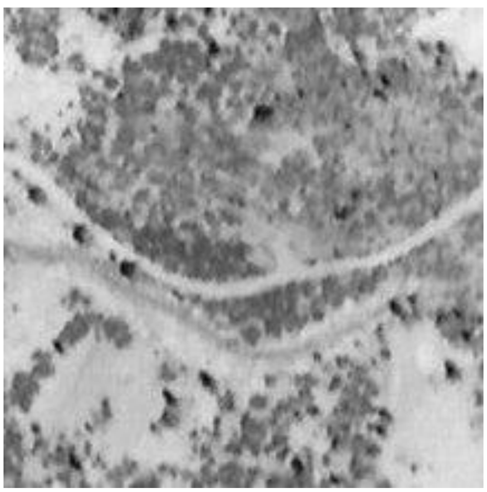
1932. Clear Creek Canyon.

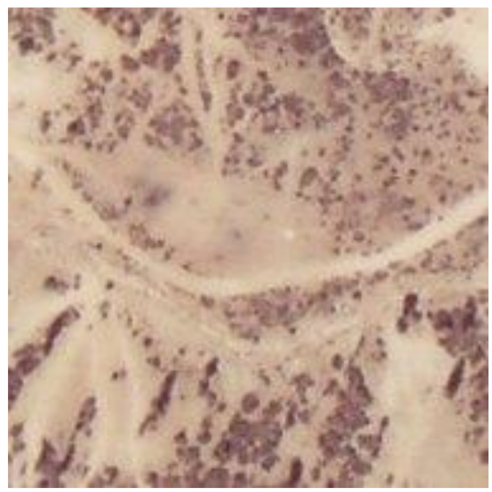
2008. Clear Creek Canyon.

Figure 23. Historic photo comparison for Clear Creek drainage. This same photo comparison appears in two books on California serpentine ecology by Art Kruckeberg (1984, 2006). The extreme substrate conditions of the serpentine barrens substrate severely limits plant establishment and growth.


1939


1949


1959


1976


2010


2015

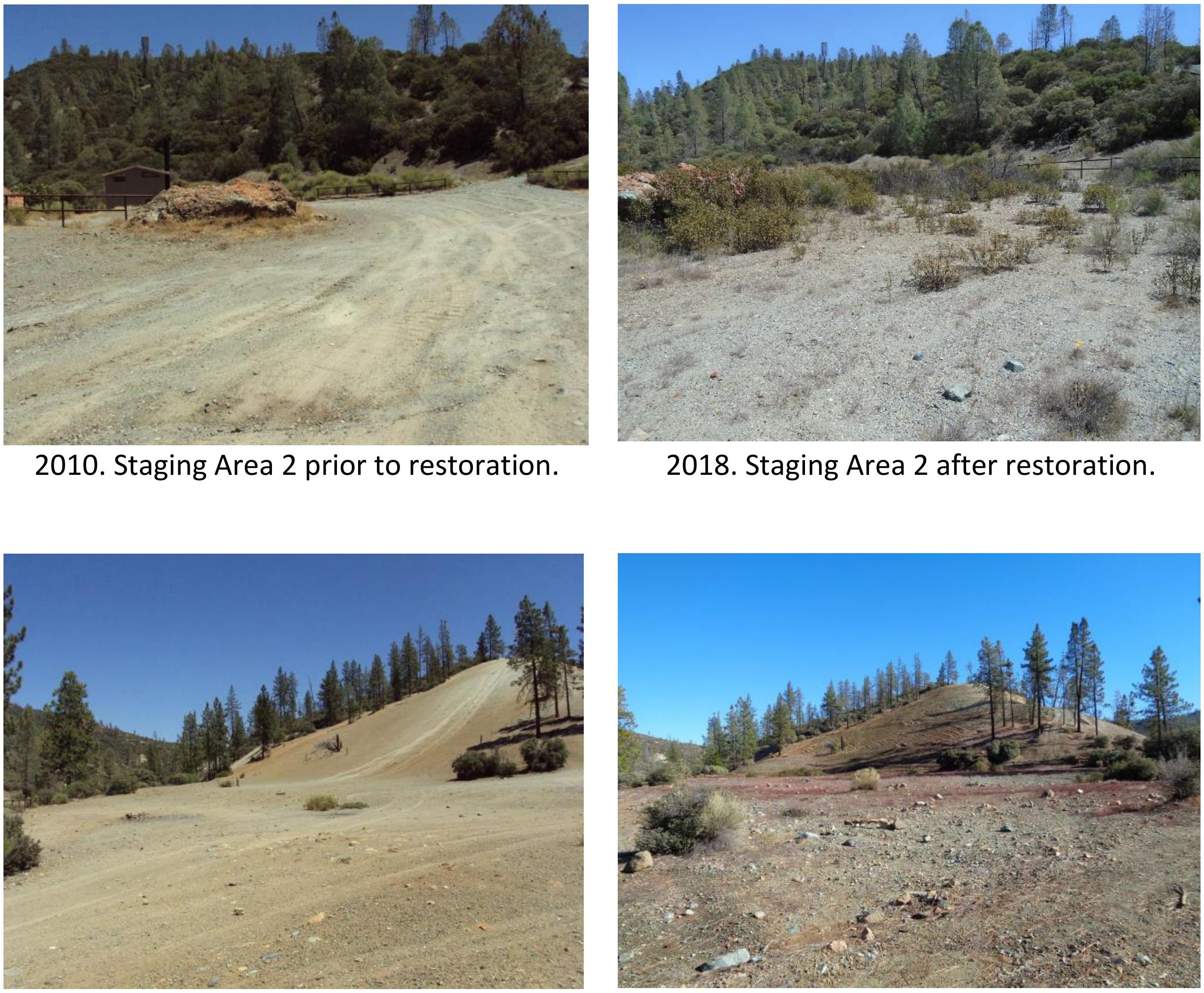
↑ **Figure 24**. Historic aerial and satellite imagery of former OHV Staging Area 1 showing original woody vegetative cover (1939 – 1959), followed by removal of woody vegetative cover due to OHV impacts by 1976. Construction of pipe barrier around the perimeter of the Staging Area in the 1990s allowed the woody vegetation cover to reestablish outside of the delineated Staging Area - compare 1976 to 2010. Final closure and restoration of the delineated Staging Area in 2011 has allowed woody vegetation to reestablish. *Camissonia benitensis* has been successfully introduced to former delineated Staging Area 1.

Habitat Restoration at CCMA

Following the Emergency Closure of CCMA in 2008, formal closure and restoration of the OHV Staging Areas was conducted in 2011 (**Figure 25**; BLM 2011). Focal areas for restoration included Staging Areas 1, 2, and 4. Restoration included removal of accumulated raw serpentine alluvium with a bulldozer to expose the original soil surface. The soil was then deep ripped to decompact it and smoothed. After restoration, the Staging Areas were barricaded with permanent steel pipe barriers. Reintroduction of *Camissonia benitensis* seeds to Staging Areas 1, 2, 4, and 5 was conducted in 2012 (BLM 2012). Native woody vegetation is re-establishing on all of the Staging Areas and *Camissonia benitensis* has successfully established (**Table 8**).

2010. Staging Area 1 prior to restoration.

2018. Staging Area 1 after restoration.



2010. Staging Area 2 prior to restoration.

2018. Staging Area 2 after restoration.

2010. Staging Area 4 during restoration.

2018. Staging Area 4 after restoration.

Figure 25. Landscape monitoring photo comparisons of vegetation condition before and after restoration of Staging Areas 1, 2, and 4.

Suboccurrence Introductions

Prior to and after the introductions of *Camissonia benitensis* at Staging Areas 1, 2, 4, and 5, several other introductions of the species were made to unoccupied potential habitat in 1991, 2008, and 2012. Those successful introductions of *Camissonia benitensis* are listed in **Tables 7** and **8**.

Current Status of OHV Recreation at CCMA

BLM Clear Creek Management Area (CCMA; 30,352 ha; 75,000 ac) and the 12,545 ha (31,000 ac) Serpentine ACEC comprises the core geographic range and contains most of the occupied and potential habitat for *Camissonia benitensis* (USFWS 2006). Historically, CCMA was a popular Off-Highway Vehicle (OHV) recreation area - the primary threat for which *Camissonia benitensis* was Federally listed in 1985 (USFWS 2006). Prior to 2006, there was no route designation for CCMA and all existing routes on BLM lands were open to OHV use. Between 2006 and 2008, the CCMA was managed under the 2006 Record of Decision (ROD) for Route Designation Amendment (BLM 2006) to the 1984 Clear Creek Management Area Resource Management Plan (BLM 1984). The 2006 ROD designated 390 km (242 miles) of open OHV routes and formally closed all other routes to OHVs (**Figure 26**). On May 1, 2008 the Environmental Protection Agency (EPA) released the CCMA Asbestos Exposure and Human Health Risk Assessment to the public (EPA 2008). Based on the EPA findings, the BLM placed the Serpentine ACEC of CCMA under an Emergency Closure on the same day. The BLM Hollister Field Office then initiated drafting of a new Resource Management Plan for CCMA.

Following the public release of the Record of Decision for the approved Clear Creek Management Area Resource Management Plan (BLM 2014b), the Serpentine ACEC within the CCMA was reopened on February 11, 2014 after being subject to an Emergency Closure for 5 years and 9 months, with no OHV access permitted during that time. Access to CCMA is now permitted to highway licensed vehicles only. Entry to the Serpentine ACEC is authorized under a permit and limited to five days as indicated by the CCMA Asbestos Exposure and Human Health Risk Assessment. The Serpentine ACEC open route network includes 32 miles consisting of R1, R10, R11, R14, and R15 (**Figure 27**). All other routes are closed to general permit entry except by special backcountry access permits, which are only granted in special circumstances. The Clear Creek entrance (Clear Creek Road; R1; west access) via Coalinga Road and New Idria entrance (Spanish Lake Road; R11; east access) via New Idria Road are the only two permitted entry points. Both entrances have been gated and contain combination locks. Additionally, a gate was constructed on R2 on the north side of Jade Mill campground and T153 was barricaded with boulders at Idria Reservoir to prevent entry from those points. The BLM has formerly taken possession of the former county road system consisting of R1, R11, R15, and T158 from San Benito County.

The Clear Creek entrance (Clear Creek Road; R1) and New Idria entrance (Spanish Lake Road; R11) gates always remain closed and contain a series of combination locks for entry. The lock combinations are changed every month. Access by the public is granted through a new permit system administered by Recreation.gov. Individuals that wish to enter the Serpentine ACEC apply for a permit through Recreation.gov. Once an individual is issued a permit by Recreation.gov the individual is directed to contact the BLM Central Coast Field Office for the gate lock combination. An average of 1,000 visitors a year obtained permits for entry to the Serpentine ACEC between 2014 and 2018. This is about $1/20^{th}$ to $1/30^{th}$ the average annual number of visitors, primarily for OHV recreation, that visited CCMA annually prior to 2008.

A new road was constructed by BLM from Condon Peak campground to connect to T220 and the existing 39 km (24 mile) open route network in the Condon Peak area. The Condon Peak route network was originally connected to the Serpentine ACEC route network by only a single route - R16. A gate was constructed on R16 between the two route networks to prevent entry to the Serpentine ACEC at that point. Unlimited vehicle entry duration to Condon Peak from Condon Peak campground is allowed without permit. Vehicle travel is restricted to the existing route network. Approved vehicles include full-sized vehicles, highway licensed (street and dual-sport) motorcycles, and ATVs (quads) and UTVs. ATVs and UTVs are approved to support hunting access. Several hundred visitors, primarily hunters, access the Condon Peak area of CCMA annually.

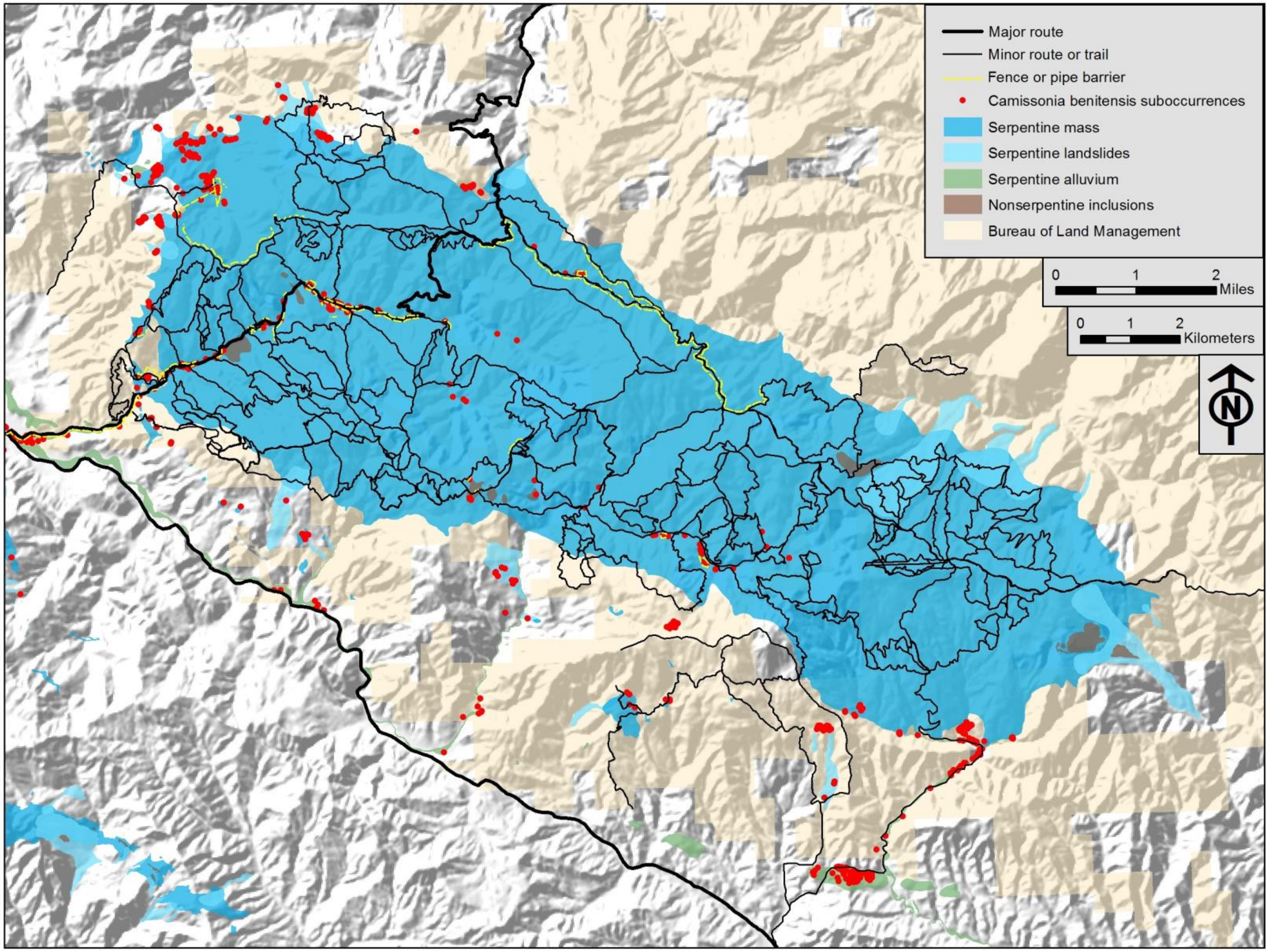


Figure 26. The 390 km (242 mi) OHV open route network designated with the 2006 ROD for the CCMA RMP Amendment.

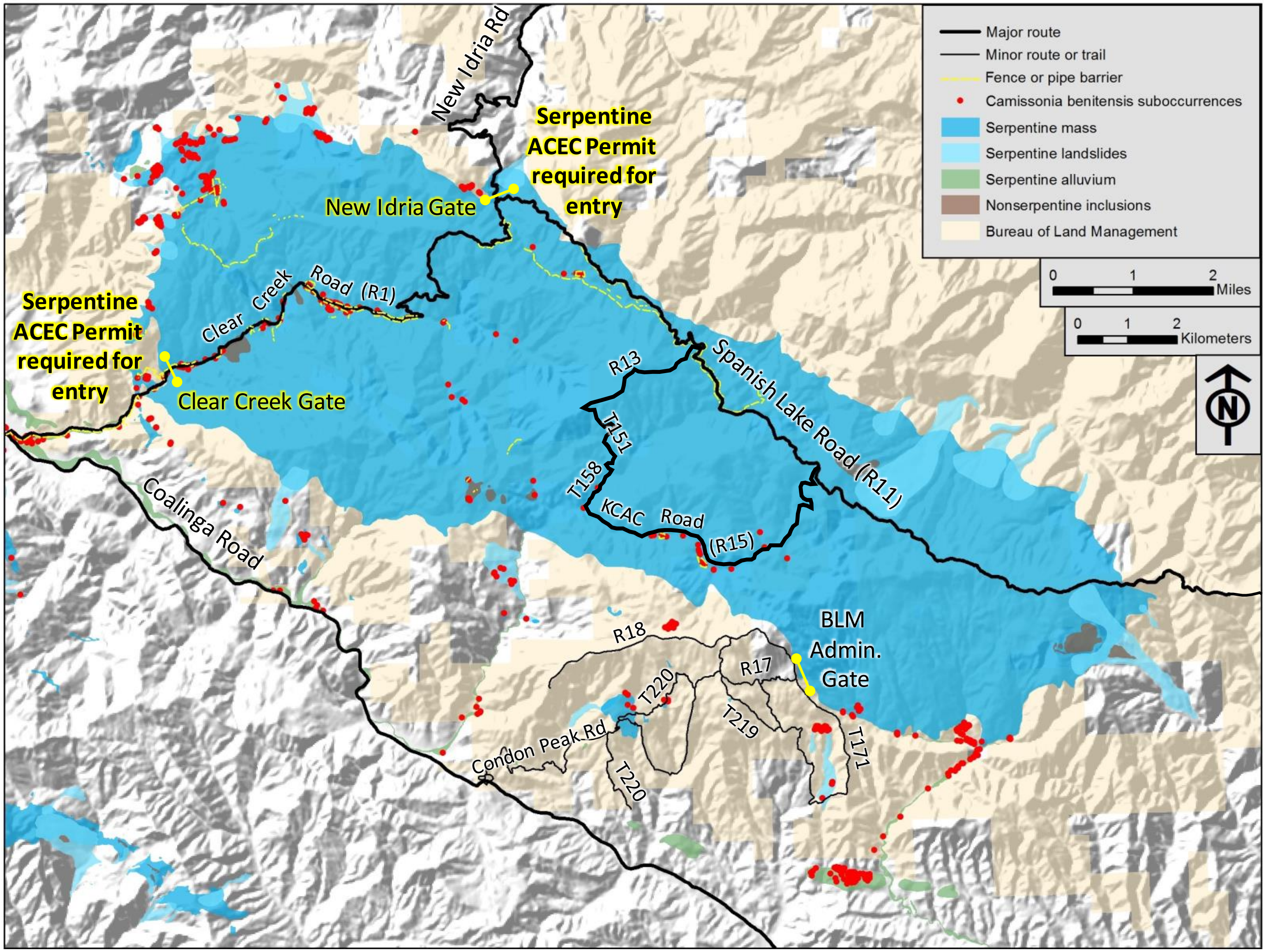


Figure 27. The current 92 km (57 mi) OHV open route network designated with the 2014 ROD for the new CCMA RMP (BLM 2014b).

Weeds Control Program at CCMA

The extreme physical and chemical properties of serpentine soil largely limit invasion of *Camissonia benitensis* habitat by non-native annual plant species. Control of the non-native annual forb *Centaurea solstitialis* (yellow starthistle; Asteraceae) within the vicinity of *Camissonia benitensis* occupied and potential habitat at lower Clear Creek has been ongoing since 2005 (BLM 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2016).. The most effective treatments have included prescribed fire (**Figure 28**) followed by broadcast application of clopyralid - specific to annual Asteraceae. The treatment combination of prescribed fire and broadcast application of clopyralid has reduced the cover of *Centaurea solstitialis* in the lower Clear Creek drainage by >95% and *Camissonia benitensis* has either dispersed into the improved habitat or re-emerged from the soil seed bank (BLM 2013, 2016).

Figure 28. Prescribed fire conducted by the BLM at lower Clear Creek in summer 2009 to burn *Centaurea soltitialis* and grass thatch, clearing the ground for broadcast application of clopyralid herbicide to *Centaurea solstitialis* rosettes the subsequent winter.

Analysis of Potential Future Threats

Despite being geographically located between two of the most populated regions of California – the San Francisco Bay Area and Los Angeles - the range of *Camissonia benitensis* is sparsely populated with less than four people per 100 hectares (ten people per square mile; **Figure 29**). The primary economy within the geographic range of *Camissonia benitensis* is cattle ranching. Due to the great distance from major populated areas and little economic potential beyond existing land uses, it is unlikely that substantial areas within the range of *Camissonia benitensis* will be developed in the foreseeable future.

Although the New Idria serpentine mass (Serpentine ACEC) was intensively mined for mercury, magnesite, and chrysotile asbestos throughout the 20th century (Iddings 2015), there is no longer a viable market for any of these minerals. Activities at New Idria between 1850 and 1972 resulted in mining disturbances and removal of large volumes of wood (trees and shrubs) from the New Idria serpentine mass (Sloane 1914; Iddings 2015). The woody vegetation has largely recovered since that time. New Idria was abandoned in 1972 and was designated as an EPA Superfund site in 2011. The Atlas Asbestos Mine (chrysotile asbestos) ceased operations in 1979 and was designated as an EPA Superfund site in 1984. The KCAC Mine (chrysotile asbestos) ceased operations in 2002. The Serpentine ACEC of Clear Creek Management Area was withdrawn from locatable mineral entry (mining claims) with the 2014 Record of Decision for the approved Clear Creek Management Area Resource Management Plan (BLM 2014b), prohibiting any future mining.

Under the 2014 Record of Decision for the approved Clear Creek Management Area Resource Management Plan, OHV recreation is no longer a threat to *Camissonia benitensis*. Improved understanding of the disturbance ecology of *Camissonia benitensis* suggests that even during peak years of OHV recreation at CCMA, anthropogenic soil surface disturbance effects were likely only slightly to moderately above background natural soil disturbance (annual winter soil frost heave) and erosion rates (including flash flood events). *Camissonia benitensis* is adapted to soil disturbance, like all other *Camissonia* species and most other taxa in Onagraceae. Analysis of the threat of a disturbance to a species must be evaluated in the scientific context of landscape stability, background habitat disturbance, and disturbance tolerance thresholds of the species. Based on additional scientific data and improved understanding of the disturbance ecology of the species, *Camissonia benitensis* can no longer be regarded as threatened by natural or anthropogenic soil surface disturbance.

Non-native *Centaurea solstitialis* has been controlled at its leading edge in lower Clear Creek drainage. The extreme physical and chemical properties of serpentine soil limit invasion of *Camissonia benitensis* habitat by non-native annual plant species.

There is no indication of the potential for range contraction of *Camissonia benitensis* for projected climate change under the high emissions scenario (SRES A2 ~ RCP 6.0).

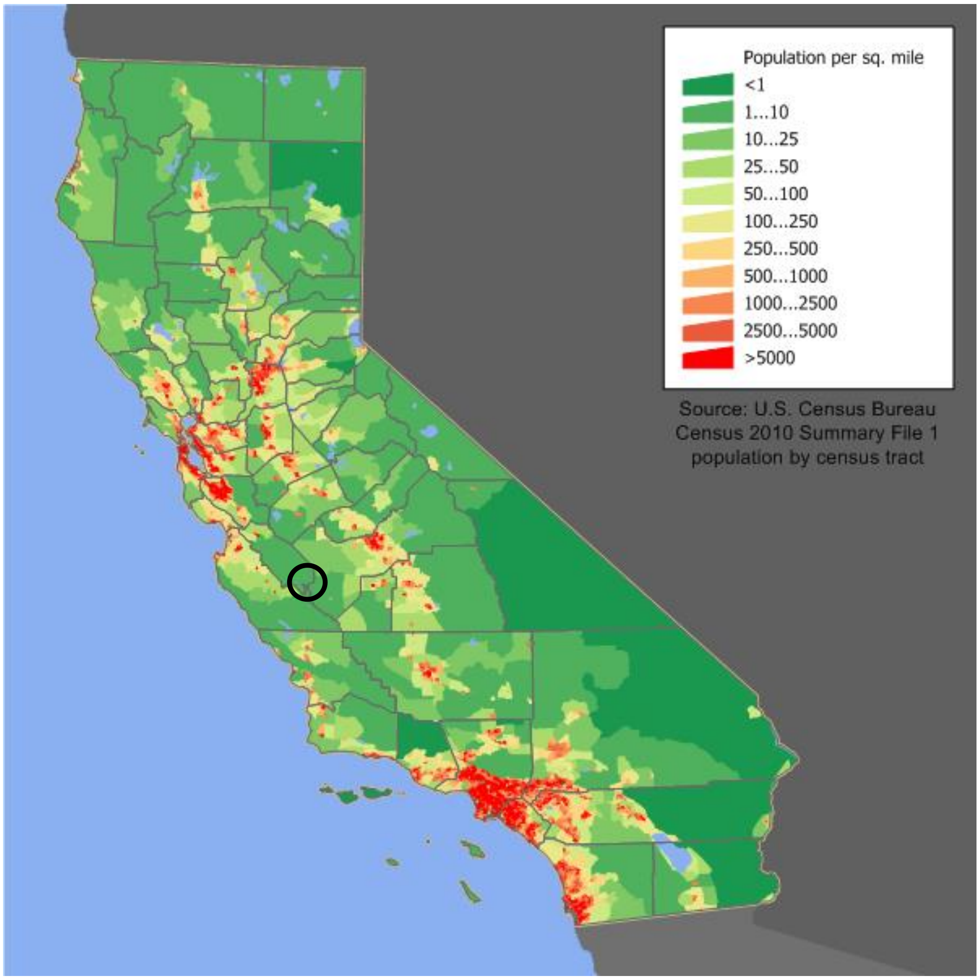


Figure 29. California state population density map based on Census 2010 data. The black circle denotes the geographic range of *Camissonia benitensis*. 1 square mi = 640 ac = 259 ha

Camissonia benitensis Recovery

Five-Factor Analysis

1. Listing Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range.

Off-Highway Vehicle Recreation

OHV recreation is no longer a threat to *Camissonia benitensis* due in combination to:

1) Public release of the 2014 Record of Decision (ROD) for the approved Clear Creek Management Area Resource Management Plan (BLM 2014b) which limits access to the Serpentine ACEC to highway licensed vehicles only and entry by permit for five days a year only on a designated touring route;

2) Discovery of several hundred new suboccurrences and extensive additional potential habitat, much of which is located outside of the former core OHV recreation area of Clear Creek Management Area; and –

3) Additional scientific data and improved understanding of the disturbance ecology of the species.

Soil Loss and Elevated Erosion Rates

The New Idria serpentine mass is naturally highly erosive and unstable due to the abundance of moonscape serpentine barrens. Naturally high sediment loads in the drainages are inherently natural to the barren serpentine landscape. It is exactly these extreme conditions that promoted the evolution (adaptive radiation) of the serpentine endemic *Camissonia benitensis* from its presumed non-serpentine progenitor, *Camissonia strigulosa*. *Camissonia benitensis* is adapted to soil disturbance, like all other *Camissonia* species and most other taxa in Onagraceae. Analysis of the threat of a disturbance to a species must be evaluated in the scientific context of landscape stability, background habitat disturbance, and disturbance tolerance thresholds of the species. Based on additional scientific data and improved understanding of the disturbance ecology of the species, *Camissonia benitensis* can no longer be regarded as threatened by natural or anthropogenic soil surface disturbance.

Facilities Construction and Maintenance

BLM Section 8 Administrative site was decommissioned as a naturally occurring asbestos decontamination facility with the construction of the new Clear Creek Administrative Site in 2010. The Clear Creek Administrative Site (Lat. 36.359299, Lon. -120.773893) was not constructed on occupied or potential habitat for *Camissonia benitensis*. Although the original disturbances and structures remain at BLM Section 8 Administrative site, the site is no longer subject to intensive use and the discovery of numerous new suboccurrences and potential habitat of *Camissonia benitensis* throughout the range of the species minimize this historic impact and loss of habitat.

Mining Activities

All large-scale commercial mining in Clear Creek Management Area ceased in 2002 with closure of the KCAC Mine. The Serpentine ACEC of Clear Creek Management Area was withdrawn from locatable mineral entry (mining claims) with the 2014 Record of Decision (ROD) for the approved Clear Creek Management Area Resource Management Plan (BLM 2014b). Mining activity is no longer a threat to *Camissonia benitensis*.

Habitat Alteration due to Invasive Species

Centaurea solstitialis is no longer a threat to habitat of *Camissonia benitensis* as the result of highly effective control methods and long-term BLM Central Coast Field Office weeds control program at CCMA which has virtually eradicated the invasive species from the lower Clear Creek drainage. The extreme physical and chemical properties of serpentine soil limit invasion of *Camissonia benitensis* habitat by non-native annual plant species.

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

The USFWS does not regard overutilization for commercial, recreational, scientific, or educational Purposes as a threat to *Camissonia benitensis* (USFWS 2006).

3. Listing Factor C: Disease or Predation

The USFWS does not regard disease or predation as a threat to *Camissonia benitensis* (USFWS 2006).

4. Listing Factor D: The Inadequacy of Existing Regulatory Mechanisms

The 2014 Record of Decision for the approved Clear Creek Management Area Resource Management Plan (BLM 2014b) currently limits access to the Serpentine ACEC to highway licensed vehicles only and entry by permit for five days a year only on a designated touring route. Entry to the Serpentine ACEC is regulated by gates with combination locks at the Clear Creek entrance (Clear Creek Road; R1; west access) and New Idria entrance (Spanish Lake Road; R11; east access). The 2014 ROD provides an effective regulatory mechanism to control vehicle access. The regulatory mechanisms utilized by BLM are now fully adequate to minimize threats to *Camissonia benitensis*.

5. Listing Factor E: Other Natural or Manmade Factors Affecting its Continued Existence

Succession to Woody Shrub Community

Succession of habitat from open shrub gaps to closed chaparral is no longer regarded as a threat to *Camissonia benitensis* due to the discovery of hundreds of new suboccurrences and extensive additional potential habitat of *Camissonia benitensis* throughout the range of the species. Additionally, new soil seed bank data indicates that *Camissonia benitensis* has very large, long-lived soil seed banks that can remain dormant through long periods of unsuitable habitat condition and then re-emerge when conditions become suitable again.

Stochastic Events

Due to the discovery of hundreds of new suboccurrences and extensive additional potential habitat of *Camissonia benitensis* throughout the range of the species and a range-wide population genetics study that strongly suggests that most if not all of the suboccurrences interact as a single, giant metapopulation, stochastic events are no longer regarded as a threat to the species. Very large, long-lived soil seed banks that are well-distributed throughout the soil profile strongly buffer suboccurrences from extirpation and the species from extinction.

Recovery Actions Summary

All of the Recovery Actions specified in the Recovery Plan for *Camissonia benitensis* (USFWS 2006) have been completed (**Table 9**).

Table 9. Recovery actions specified in the Recovery Plan for *Camissonia benitensis* (USFWS 2006) and current status of Recovery Action.

Action Priority	Action Number	Action Description	Mitigated by 2014 ROD	Ongoing	Completed
Recovery Action 1: Protect known occurrences and suitable habitat for *Camissonia benitensis* in the CCMA.					**X**
1	**1.1.1**	Design and implement signing plan for open and closed areas for OHV use.	X		
1	**1.1.2**	Maintain signs.		X	
1	**1.1.3**	Close selected terrace sites to camping.			X
1	**1.1.4**	Continue barrier construction at *Camissonia benitensis* habitat.	X		
1	**1.1.5.1**	Ensure law enforcement staff is adequate.		X	
1	**1.1.5.2**	Develop enforcement procedures.			X
1	**1.1.5.3**	If public compliance is lacking, develop contingency measures.			X
1	**1.2**	Establish and maintain a weed control program.		X	
1	**1.3.1**	Develop informational materials for private landowners.			X
1	**1.3.2**	Determine land-use goals for private lands within *Camissonia benitensis* habitat.			X
1	**1.3.3**	Survey private parcels to identify threats to *Camissonia benitensis* populations.			X
1	**1.3.4**	Develop and implement management plans for private lands with *Camissonia benitensis*.			X
Recovery Action 2: Reduce or eliminate soil erosion and stream sedimentation above natural levels in watersheds that support *C. benitensis*.					**X**
2	**2.1**	Use interagency technical expertise to develop watershed management strategy.			X
2	**2.2**	Continue to identify and prioritize sites for restoration of *Camissonia benitensis* habitat.			X
2	**2.3**	Continue to monitor effectiveness of habitat.			X
2	**2.3.1**	Use photography to monitor landscape-scale changes over time.			X
2	**2.3.2**	Compare photography to determine user compliance.			X
2	**2.3.3**	Monitor soil loss from the 5 watersheds in the CCMA.			X
Recovery Action 3: Develop and Implement a species management strategy, including monitoring, for *Camissonia benitensis*.					**X**
2	**3.1**	Use of technical specialists to assist in implementation of monitoring and research needs for *Camissonia benitensis*.			X
2	**3.2.1**	Conduct annual population surveys.			X
2	**3.2.2**	Monitor woody vegetation on terrace sites.			X
2	**3.2.3**	Revise photo monitoring point protocol.			X
2	**3.3.1**	Continue seedbank research.			X
2	**3.3.2**	Continue population introduction research.			X
2	**3.3.3**	Conduct research on terrace replacement rates.			X
2	**3.3.4**	Construct population viability models.			X
2	**3.3.5**	Conduct fire research.			X
2	**3.4**	Search for additional occurrences.			X
2	**3.5**	Revise management based on monitoring and research results.			X
Recovery Action 4: Establish an ex situ seed collection.					**X**
3	4	Establish ex situ seed collection			X
Recovery Action 5: Develop and implement a public awareness program for conserving *Camissonia benitensis* and its habitat.					**X**
3	5.1	Install and maintain interpretive signs, and implement other interpretive activities.		X	
3	5.2	Work with OHV and other user groups to conserve habitat.	X		

References

Ackerly D.D., Loarie S.R., Cornwell W.K., Weiss S.B., Hamilton H., Branciforte R., and N J.B. Kraft. 2010. The geography of climate change: implications for conservation biogeography. Diversity and Distributions 16:476-487.

Adams V.M., Marsh D.M., and J.S. Knox. 2005. Importance of the seed bank for population viability and population monitoring in a threatened wetland herb. Biological Conservation 124:425-436.

Alexander E., Coleman R.G., Keeler-Wolf T., and S.P. Harrison. 2007. Serpentine geoecology of western North America. Oxford University Press.

Alexander H.M., Pilson D., Moody-Weis J., and N.A. Slade. 2009. Geographic variation in dynamics of an annual plant with a seed bank. Journal of Ecology 97:1390-1400.

Baker H.G. 1989. Some aspects of the natural history of seed banks. Pp. 9-21 in M. A. Leck, V. T. Parker, and R. L. Simpson RL (eds.), Ecology of soil seed banks. Academic Press.

Baskin C.C. and J.M. Baskin. 1998. Seeds. Ecology, biogeography, and evolution of dormancy and germination. Academic Press.

Bureau of Land Management. 2006. Clear Creek Management Area Resource Management Plan Amendment and Route Designation. Hollister Field Office.

Bureau of Land Management (BLM). 2008. Annual summary report for the 2007-2008 OHV use season monitoring and status of *Camissonia benitensis* and implementation of the 2006 Record of Decision. Hollister Field Office. Unpublished report. 37 pp.

Bureau of Land Management (BLM). 2009. Annual summary report for the 2008-2009 OHV use season monitoring and status of *Camissonia benitensis* and implementation of the 2006 Record of Decision. Hollister Field Office. Unpublished report. 50 pp.

Bureau of Land Management (BLM). 2010. Annual summary report for the 2009-2010 season monitoring and status of *Camissonia benitensis* and implementation of the 2006 Record of Decision. Hollister Field Office. Unpublished report. 32 pp.

Bureau of Land Management (BLM). 2011. Annual report for the 2010-2011 season monitoring and status of *Camissonia benitensis* and implementation of the 2006 Record of Decision. Hollister Field Office. Unpublished report. 45 pp.

Bureau of Land Management (BLM). 2012. Annual report for the 2012 season monitoring and status of *Camissonia benitensi*s and implementation of the 2006 Record of Decision. Hollister Field Office. Unpublished report. 27 pp.

Bureau of Land Management (BLM). 2013. Annual report for the 2013 season monitoring and status of *Camissonia benitensi*s and implementation of the 2006 Record of Decision. Hollister Field Office. Unpublished report. 48 pp.

Bureau of Land Management (BLM). 2014a. Annual report for the 2014 season monitoring and status of *Camissonia benitensi*s under the 2014 Clear Creek Management Area Resource Management Plan. Hollister Field Office. Unpublished report. 48 pp.

Bureau of Land Management (BLM). 2014b. Clear Creek Management Area Resource Management Plan and Record of Decision. Hollister Field Office.

Bureau of Land Management (BLM). 2016. Annual report for the 2015 and 2016 season monitoring and status of *Camissonia benitensis* under the 2014 Clear Creek Management Area resource Management Plan. Central Coast Field Office. Unpublished report. 37 pp.

Cal-Adapt. 2018. Cal-Adapt. Exploring California's climate change research. This analysis of *Camissonia benitensis* references the high greenhouse gas emissions scenario SRES A2 modeled by Cal-Adapt with PCM1, CCSM3, GFDL, and CNRM. Website http://v1.cal-adapt.org/

Caswell H. 2001. Matrix projection models: Construction, analysis, and interpretation. Sinauer Associates, Inc. Publishers.

Cohen D. 1966. Optimizing reproduction in a randomly varying environment. Journal of Theoretical Biology 12:119-129.

Cohen D. 1967. Optimizing reproduction in a randomly varying environment when a correlation may exist between the conditions at the time a choice has to be made and the subsequent outcome. Journal of Theoretical Ecology 16:1-14.

Cohen D. 1968. A general model of optimal reproduction in a randomly varying environment. Journal of Ecology 56:219-228.

Dart S. and C.G. Eckert. 2013a. Experimental manipulation of flowers to determine the functional modes and fitness consequences of self-fertilization: unexpected outcome reveals key assumptions. Functional Ecology 27:362-373.

Dart S. and C.G. Eckert. 2013b. Experimental and genetic analyses reveal that inbreeding depression declines with increased self-fertilization among populations of a coastal dune plant. Journal of Evolutionary Biology 26: 587-599.

Dick C.A., Herman J.A., O'Dell R.E., Lopez-Villalobos A., Eckert C., and J.B. Whittall. 2014. Cryptic genetic subdivision in the San Benito evening primrose (*Camissonia benitensis*). Conservation Genetics 15:165-175.

Doak D.F., Thomson S., and E.S. Jules. 2002. Population Viability Analysis for plants: Understanding the demographic consequences of seed banks for population health. Pp. 312-337 in S.R. Beissinger and D.R. McCullough (eds.), Population Viability Analysis. The University of Chicago Press.

Dynamac Corporation. 1998. Draft geomorphic field evaluation of serpentine soil barrens, Clear Creek Management Area (CCMA). Prepared for the Bureau of Land Management Hollister Field Office. Unpublished report.

Eager E.A., Haridas C.V., Pilson D., Rebarber R., and B. Tenhumberg. 2013. Disturbance frequency and vertical distribution of seeds affect long-term population dynamics: A mechanistic seed bank model. The American Naturalist 182:180-190.

Environmental Protection Agency (EPA). 2008. Clear Creek Management Area asbestos exposure and human health risk assessment. Region 9.

Evans M.E.K, Ferrière R., Kane M.J., and D.L. Venable. 2007. Bet hedging via seed banking in desert evening primroses (*Oenothera*, Onagraceae): Demographic evidence from natural populations. The American Naturalist 169:184-194.

Evans M.E.K., Smith S.A., Flynn R.S., and M.J. Donoghue. 2009. Climate, niche evolution, and diversification of the "bird-cage" evening primroses (Oenothera, sections *Anogra* and *Kleinia*). The American Naturalist 173:225-240.

Field C. B., N. R. Chiariello, and N. S. Diffenbaugh. 2016. Climate Change Impacts. Pp. 251-264 in H. Mooney and E. Zavaleta, Ecosystems of California. University of California Press, Berkeley, CA.

Godfrey R.M. and M.T.J. Johnson. 2014. Effects of functionally asexual reproduction on quantitative genetic variation in the evening primroses (*Oenothera*, Onagraceae). American Journal of Botany 101:1906-1914.

Griffin J.R. 1977. Rare plant status report – *Camissonia benitensis*. California Native Plant Society. Unpublished report.

Griffin J.R. 1978. Study of rare and endangered plants, Clear Creek Recreation Area, San Benito-Fresno Counties. Bureau of Land Management Hollister Field Office. Unpublished report.

Harper J.L. 1977. The population biology of plants. Academic Press.

Harrison S., Maron M., and G. Huxel. 2000. Regional turnover and fluctuation in populations of five plants confined to serpentine seeps. Conservation Biology 14:769-779.

Harrison S. and C. Ray. 2002. Plant population viability and metapopulation-level processes. Pp. 109-122 in S.R. Beissinger and D.R. McCullough (eds.), Population viability analysis. The University of Chicago Press.

Hayhoe K., Cayan D., Field C.B., Frumhoff P.C., Maurer E.P., Miller N.L., Moser S.C., Schneider S.H., Cahill K., Cleland E.E., Dale L., Drapek R., Hanemann R.M., Kalkstein L.S., Lenihan J., Lunch C.K., Neilson R.P., Sheridan S.C., and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences 101:12422-12427.

Hendry G.A.F., Thompson K., Moss C.J., Edwards E., and P.C. Thorpe. 1994. Seed persistence: a correlation between seed longevity in the soil and ortho-dihydroxyphenol concentration. Functional Ecology 8:658-664.

Higgins S.I., Pickett S.T.A., and W.J. Bond. 2000. Predicting extinction risks for plants: environmental stochasticity can save declining populations. TREE 15:516-520.

Husband B.C. and D.W. Schemske. 1996. Evolution of the magnitude and timing of inbreeding depression in plants. Evolution 50:54-70.

Iddings R. 2015. Historic guide to San Benito Mountain and Joaquin Rocks region of Central California. CreateSpace Independent Publishing Platform

Johnson M.T.J., Smith S.D., and M.D. Rausher. 2010. Effects of plant sex on range distributions and allocation to reproduction. New Phytologist 186:769-779.

Johnson M.T.J., FitzJohn R.G., Smith S.D., Rausher M.D., and S.P. Otto. 2011. Loss of sexual recombination and segregation is associated with increased diversification in evening primroses. Evolution 65-11:3230-3240.

Kalisz S. and M.A. McPeek. 1992. Demography of an age-structured annual: Resampled projection matrices, elasticity analyses, and seed bank effects. Ecology 73:1082-1093.

Kalisz S. and M.A. McPeek. 1993. Extinction dynamics, population growth and seed banks: an example using an age-structured annual. Oecologia 95:314-320.

Kruckeberg A.R. 1984. California serpentines: Flora, vegetation, geology, soils, and management problems. University of California Publications in Botany.

Kruckeberg A.R. 2006. Introduction to California soils and plants. University of California Press.

Meyer S.E., D. Quinnery, and J. Weaver. 2005. A life history study of the Snake River Plains endemic *Lepidium papilliferum* (Brassicaceae). Western North American Naturalist 65:11-35.

Meyer S.E., Quinney D., and J. Weaver. 2006. A stochastic population model for *Lepidium papilliferum* (Brassicaceae), a rare desert ephemeral with a persistent seed bank. American Journal of Botany 93:891-902.

Pavlik B.M. 1987. Attributes of plant populations and their management implications. Pp. 311-319 in T.S. Elias (ed.), Rare and Endangered Plants: A California Conference. Proceedings of the Symposium. California Native Plant Society Special Publication 8.

Pavlik B.M. and M.G. Barbour. 1988. Demographic monitoring of endemic sand dune plants, Eureka Valley, California. Biological Conservation 46:217-242.

Pavlik B.M. 1994. Demographic monitoring and the recovery of endangered plants. Pp. 322-350 in M.L. Bowles and C.J. Whelan (eds.) Restoration of endangered species: Conceptual issues, planning, and implementation. Caimbridge University Press.

PTI Environmental Services. 1993. Erosion and sedimentation in the Clear Creek Watershed, San Benito River Basin, Central California. Prepared for the Bureau of Land Management Hollister Field Office. Unpublished report.

Probert R.J., Daws M.I., and F.R. Ray. 2009. Ecological correlates of *ex situ* seed longevity: a comparative study on 195 species. Annals of Botany 104:57-69.

Raven P.H. 1964. Catastrophic selection and edaphic endemism. Evolution 18:336-348.

Raven P.H. 1969. A revision of the genus *Camissonia* (Onagraceae). Contributions to the U.S. National Herbarium 37:155-396.

Schemske D.W., Husband B.C., Ruckelshaus M.H., Goodwillie C., Parker I.M., and J.G. Bishop. 1994. Evaluating approaches to the conservation of rare and endangered plants. Ecology 75:584-606.

Schmidt K.P. and L.R. Lawlor. 1983. Growth rate projection and life history sensitivity for annual plants with a seed bank. The American Naturalist 121:525-539.

Sloane N.H. 1914. Resources and Plan of Operation of Monterey National Forest. Monterey National Forest. Unpublished report.

Taylor D. 1990. Ecology and life history of the San Benito evening-primrose (*Camissonia benitensis*). Unpublished report. BioSystems Analysis, Inc. 87 pp.

Taylor D. 1992. Ecology and life history of the San Benito evening-primrose (*Camissonia benitensis*). 1992 final supplemental report. Unpublished report. BioSystems Analysis, Inc. 20 pp.

Taylor D. 1995. Ecology and life history of the San Benito evening-primrose (*Camissonia benitensis*). 1995 supplemental report. Unpublished report. BioSystems Analysis, Inc. 13 pp.

Thorne J.H., Boynton R.M., Holguin A.J., Stewart J.A.E., and J. Bjorkman. 2016. A climate change vulnerability assessment of California's terrestrial vegetation. Final report to California Department of Fish and Wildlife. University of California, Davis. Website https://lccnetwork.org/sites/default/files/Resources/California%20Climate%20Vulnerability%20Assessment%20of%20Macrogroup%20Vegetation_01.31.2016_FINAL.pdf

Torregrosa A., Taylor M.D., Flint L.E., and A.L. Flint. 2013. Present, future, and novel bioclimates of the San Francisco, California Region. PLoS ONE 8:e58450 https://doi.org/10.1371/journal.pone.0058450

U.S. Fish and Wildlife Service (USFWS). 1985. Determination of threatened status for "*Camissonia benitensis*" (San Benito evening-primrose). Federal Register Vol. 50, No. 29. Tuesday, February 12, 1985. https://cdn.loc.gov/service/ll/fedreg/fr050/fr050029/fr050029.pdf

U.S. Fish and Wildlife Service (USFWS). 2006. Recovery plan for *Camissonia benitensis* (San Benito evening-primrose). U.S. Fish and Wildlife Service. ix + 97 pp.

US Fish and Wildlife Service (USFWS). 2007. *Oenothera californica* ssp. *eurekensis* (=*O. avita* ssp. *eurekensis*). Eureka Valley evening-primrose. 5-Year Review: Summary and Evaluation. https://www.fws.gov/cno/es/images/Eureka%20Valley%20evening%20primrose%205YR%20CNO%20FINAL%2031Jul07.pdf

U.S. Fish and Wildlife Service (USFWS). 2018. Removing *Oenothera avita* ssp. *eurekensis* from the Federal list of endangered and threatened plants, and reclassification of *Swallenia alexandrae* from endangered to threatened. Federal Register Vol. 83, No. 38. Tuesday, February 27, 2018. Docket No. FWS-R8-ES-2013-0131; FXES11130900000-145-FF09E42000. https://www.federalregister.gov/documents/2018/02/27/2018-03769/endangered-and-threatened-wildlife-and-plants-removing-oenothera-avita-ssp-eurekensis-from-the

Western Regional Climate Center (WRCC). 2018. Western Regional Climate Center. Website http://www.wrcc.dri.edu/