Serpentine Outcrops of Modini Ingalls Ecological Preserve of Audubon Canyon Ranch: Inventory Findings and Management Recommendations

Native wildflowers on a serpentine outcrop on MIEP

Sherry Adams
Modini Mayacamas Preserves Audubon Canyon Ranch
Healdsburg, CA 95448
Sherry.Adams@egret.org

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4900 Shoreline Highway
Stinson Beach, CA 94970

In 2010 Audubon Canyon Ranch initiated an inventory of the serpentine outcrops of the Modini Ingalls Ecological Preserve (MIEP) in northeast Sonoma County. This report contains the findings of that project. In 2010 we used aerial photography and field reconnaissance to map the serpentine outcrops of the preserve and to develop a preliminary species list. In 2011 all patches were visited at least once in the spring and all species found within each patch were noted.

Table 1 lists all plants found and on how many of the 36 outcrops each was found on. Of the 161 taxa identified, 141 are native, 35 are found only in California, 23 are serpentine endemic or indicator species, and five are included in the California Native Plant Society's rare plant inventory. Ninety-one are annual species. Specimens from the preserve of the two plants which are ranked as moderately threatened are accessioned at the UC Berkeley Jepson Herbarium. In the case of *S. hesperidis* it is the only published record of the plant in Sonoma County.

Management Recommendations

Throughout California, serpentine areas are biodiversity hotspots. While serpentine is only 1.5% of the area of California, 15% of all plant taxa listed as threatened or endangered in the state show some degree of association with serpentine (Safford et al. 2005). ACR has a responsibility to be good stewards of the serpentine outcrops on MIEP. Below are identified threats and associated management recommendations.

The top threat to conservation targets in this region as elsewhere is direct conversion to development or agriculture, which the serpentine outcrops on MIEP are largely protected from. The only possible exception would be something akin to what happened on neighboring lands where a government agency appropriated a right of way for a utility corridor, including where this passed through a serpentine outcrop harboring rare plants. Being responsible stewards of this habitat and the species that inhabit it means protecting them from any development.

Many of the species found on these outcrops have a small range, some are limited to just a few counties and a handful of occurrences. While dispersal between occurrences has significant barriers, any interbreeding between patches can provide an important extinction buffer via increased genotypic diversity. As such, seeing that serpentine outcrops across the region and the natural areas that connect them are protected from development is also part of being responsible stewards of this habitat. For example a nearby serpentine area in Lake County owned by the Bureau of Land Management has been proposed for a wind farm.

One crucial point is that not all development occurs through official channels. The most significant disturbance that has occurred around the serpentine outcrops of MIEP during the past five years is an extensive marijuana planting site that we discovered in May of 2013. Based on the empty bags we found, at least 100 pounds of fertilizer were imported to the site which was on the western edge of a large serpentine outcrop. For several years there were people camped out at the site during the growing season. There was an extensive network of irrigation hose and areas set aside for propagation of plants. Marijuana cultivation in wildlands is a widespread problem in this region. It is a threat not only to the plants that are directly removed, but also can have a lasting impact through the importation of nutrients in the fertilizer. The very low nutrients found on serpentine soils helps to make the habitat less readily invaded by introduced species. Being responsible stewards of this habitat means working to prevent illegal marijuana cultivation in natural areas.

After development, invasive species are generally considered the second most pressing threat to conservation. Serpentine soils present challenging conditions for plants-- they are low in necessary nutrients and high in heavy metals which can be toxic to plants. As a result they typically exhibit reduced levels of invasion compared to adjacent non serpentine lands. However the few plants that are able to invade serpentine outcrops may pose a particularly difficult management challenge. Barbed goatgrass (*Aegilops triuncialis*) has extensively invaded serpentine grasslands at the McLaughlin reserve, a nearby University of California property that straddles the Lake/Napa county border. In some areas managers there have been

broadcasting grass-specific herbicide on dozens of acres at a time, repeating the treatment in multiple years, in an effort to reverse the impacts of the goatgrass invasion. During the inventory of serpentine outcrops conducted for this report, we found one small patch of barbed goatgrass on the edge of a serpentine patch. During the treatment of that patch and associated reconnaissance for invasive species, we found another small patch of barbed goatgrass nearby. For three years we have been hand pulling these patches resulting in near eradication. Effective stewardship of this habitat requires enough time visiting these locations and having sufficient knowledge of invasive threats of the region to recognize problematic invasives while their abundance is low and they can be successfully controlled with minimal disturbance to desirable species.

One way that existing plant diversity in a place protected from development can be diminished is through the alteration of natural processes. A classic example in California grasslands is vernal pool grasslands long managed through grazing experiencing a decline in native plant richness after cattle are removed. Likewise fire suppression can result in the loss of native plant richness in habitats with historic regimes of frequent fire and resident species adapted to fire. However there is little literature on the issues of managing broad scale processes on protected serpentine areas. While there are some published studies on the impacts of grazing on serpentine grasslands, these are not applicable to the outcrops covered in this study where the standing biomass is extremely low and the terrain is quite steep, resulting in near complete avoidance by the cattle that graze MIEP. The limited evidence on the importance of fire to outcrops such as these suggests that they may be less fire-dependent than the surrounding landscape, though still harbor some species that are fire adapted (Safford and Mallek 2011). This is as expected given that these habitats are in a matrix surrounded by non-serpentine habitats, and that a low intensity fire may skip over serpentine areas with their associated lower fuel levels, whereas the occasional high intensity fire would likely burn the vegetation on the serpentine outcrops. As a result, we can hypothesize that these outcrops historically did experience fire, but at a reduced frequency from the surrounding landscape. The only specific management recommendation suggested by this would be in the case of regular prescribed fire--something not planned for MIEP at this time. In such a case it would be appropriate to plan less frequent burning of the serpentine outcrops.

Finally, we are interested in any implications for management of the preserve from the impacts of climate change. The literature suggests that the most applicable recommendation for resilience in this community is the same as for the rest of the preserve, to maintain existing connectivity across the landscape (Harrison & Rajakaruna 2011). However, those authors warn that one proposed geoengineering response to climate change involves large scale mining of minerals from serpentine outcrops, underlining the vigilance called for above in protecting serpentine lands from development.

References

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Table 1.
Plants of the serpentine outcrops of Modini Ingalls Ecological Preserve.

Longevity: a=annual, p=perennial.

Form: h=herb, s=shrub, t=tree.

Status: 1B.2=California Native Plant Society (CNPS) rare plant rank moderately threatened, 4.2 or 4.3=CNPS watch list, CBR=considered but rejected listing in CNPS rare plant inventory, high impact=California Invasive Plant Council designation. For more information, see https://cnps.org/cnps/rareplants/ranking.php and http://www.cal-ipc.org/paf/site/paf/245. Plants with very small ranges are noted.

Nativity: n=native to California, i=introduced to California.

Serpentine affinity scores (Safford et al. 2005; range 1.0 to 6.25): > 5.5=strict serpentine endemics with 95% of occurrences on ultramafics, ≥ 2.5=considered an indicator or endemic, <2.5 and > 1=occurs more frequently on than off of serpentine.

No. of patches: of the identified 36 serpentine patches in MIEP, how many the given species was found on.

CA endemic: Not documented to grow outside of California.

Longevity	Form	Status	Nativity	Serpentine affinity	Plant family	Plant name	No. of patches	CA endemic
p	s		n	0	Anacardiaceae	*Toxicodendron diversilobum*	15	
a	h		n	0	Apiaceae	*Daucus pusillus*	5	
p	h		n	0	Apiaceae	*Lomatium macrocarpum*	2	
p	h		n	2.1	Apiaceae	*Perideridia kelloggii*	1	√
p	h		n	0	Asteraceae	*Agoseris grandiflora*	4	
a	h		n	1.4	Asteraceae	*Agoseris heterophylla*	15	
a	h		n	3.3	Asteraceae	*Ancistrocarphus filagineus*	4	
a	h		i	0	Asteraceae	*Carduus pycnocephalus*	1	
a	h		i	0	Asteraceae	*Centaurea melitensis*	1	
a	h		n	2.5	Asteraceae	*Chaenactis glabriuscula*	11	√
a	h		n	0	Asteraceae	*Cirsium sp*	1	
p	h	1B.2	n	5.7	Asteraceae	*Erigeron greenei*	5	√
p	h		n	0	Asteraceae	*Eriophyllum lanatum*	24	
p	h		n	0	Asteraceae	*Grindelia camporum*	2	√
a	h		n	0	Asteraceae	*Hemizonia congesta ssp luzulifolia*	28	√
a	h		i	0	Asteraceae	*Hypochaeris glabra*	2	
a	h		i	0	Asteraceae	*Lactuca saligna*	18	
a	h		i	0	Asteraceae	*Lactuca serriola*	7	
a	h		n	0	Asteraceae	*Lasthenia californica*	3	
a	h		i	0	Asteraceae	*Leontodon taraxacoides*	4	
a	h		n	0	Asteraceae	*Madia exigua*	10	
a	h		n	0	Asteraceae	*Madia gracilis*	23	
a	h		n	2.1	Asteraceae	*Malacothrix floccifera*	7	
a	h		n	0	Asteraceae	*Micropus californicus v. californicus*	15	
a	h		n	1.3	Asteraceae	*Microseris ?douglasii douglasii*	2	
p	h		n	5.3	Asteraceae	*Packera greenei*	2	√
a	h		n	1.9	Asteraceae	*Rigiopappus leptocladus*	2	
a	h		i	0	Asteraceae	*Silybum marianum*	1	
a	h		n	0	Asteraceae	*Stephanomeria virgata ssp. pleurocarpa*	9	
a	h		n	0	Asteraceae	*Uropappus lindleyi*	28	

Longevity	Form	Status	Nativity	Serpentine affinity	Plant family	Plant name	No. of patches	CA endemic
a	h	CBR	n	6	Boraginaceae	*Cryptantha hispidula*	12	√
a	h		n	0	Brassicaceae	*Athysanus pusillus*	1	
a	h		n	5.7	Brassicaceae	*Streptanthus breweri*	1	√
a	h		n	1.9	Brassicaceae	*Streptanthus g. ssp. glandulosus*	6	√
a	h	limited range	n	3.3	Brassicaceae	*Streptanthus glandulosus ssp. sonomensis*	16	√
a	h	1B.2	n	6.1	Brassicaceae	*Streptanthus hesperidis*	3	√
a	h		n	0	Brassicaceae	*Thysanocarpus curvipes*	6	
a	h		n	0	Campanulaceae	*Githopsis specularioides*	5	
p	s		n	0	Caprifoliaceae	*Sambucus nigra*	1	
a	h		n	3	Caryophyllaceae	*Minuartia douglasii*	29	
a	h		i	0	Caryophyllaceae	*Petrorhagia dubia*	12	
a	h		i	0	Caryophyllaceae	*Silene gallica*	9	
p	h		n	0	Caryophyllaceae	*Silene laciniata ssp. californica*	6	
p	h	4.2	n	5.6	Convolvulaceae	*Calystegia collina ssp. oxyphylla*	20	√
p	h		n	0	Convolvulaceae	*Calystegia s. ssp. subacaulis*	2	√
p	h		n	0	Crassulaceae	*Dudleya cymosa*	1	√
a	h		n	0	Crassulaceae	*Crassula connata*	4	
p	s		n	0	Ericaceae	*Arctostaphylos sp*	13	
a	h		n	0	Fabaceae	*Acmispon brachycarpus*	35	
p	s		n	0	Fabaceae	*Acmispon glaber*	3	
a	h		n	0	Fabaceae	*Acmispon parviflorus*	1	
a	h		n	0	Fabaceae	*Acmispon wrangelianus*	9	
a	h		n	0	Fabaceae	*Astragalus gambelianus*	1	
p	h		n	0	Fabaceae	*Lathyrus vestitus*	3	
a	h		n	0	Fabaceae	*Trifolium oliganthum*	2	
a	h		n	1.3	Fabaceae	*Trifolium willdenovii*	13	
a	h		n	0	Fabaceae	*Trifolium bifidum*	3	
a	h		n	0	Fabaceae	*Trifolium ciliolatum*	1	
a	h		n	0	Fabaceae	*Trifolium dichotomum*	5	√
a	h		n	1.4	Fabaceae	*Trifolium microcephalum*	4	
a	h		n	0	Fabaceae	*Trifolium microdon*	1	√
a	h		i	0	Fabaceae	*Vicia sativa*	1	
p	t		n	0	Fagaceae	*Quercus agrifolia*	12	
p	s		n	0	Fagaceae	*Quercus berberidifolia*	1	√
p	s		n	5.8	Fagaceae	*Quercus durata*	16	√
p	t		n	0	Fagaceae	*Quercus garryana*	3	
p	s		n	0	Hydrophyllaceae	*Eriodictyon californicum*	11	
p	h		n	0	Hypericaceae	*Hypericum concinnum*	2	√
p	h		n	0	Iridaceae	*Sisyrinchium bellum*	8	
p	h		n	0	Iridaceae	*Iris fernaldii*	7	√
p	h		n	0	Lamiaceae	*Monardella sp*	6	
p	t		n	0	Lauraceae	*Umbellularia californica*	6	
p	h		n	4.2	Liliaceae	*Allium falcifolium*	1	
p	h		n	0	Liliaceae	*Brodiaea elegans*	1	
p	h		n	0	Liliaceae	*Calochortus amabilis*	15	√
p	h		n	0	Liliaceae	*Chlorogalum pomeridianum*	33	
p	h		n	0	Liliaceae	*Dichelostemma capitatum*	18	
p	h		n	0	Liliaceae	*Dichelostemma congestum*	1	

Longevity	Form	Status	Nativity	Serpentine affinity	Plant family	Plant name	No. of patches	CA endemic
p	h	4.2	n	4.5	Liliaceae	*Erythronium helenae*	1	√
p	h		n	0	Liliaceae	*Triteleia laxa*	14	√
a	h	limited range; CBR	n	4.7	Linaceae	*Hesperolinon spergulinum*	22	√
a	h		n	2.6	Malvaceae	*Sidalcea diploscypha*	1	
a	h		n	0	Onagraceae	*Clarkia concinna*	2	√
a	h		n	0	Onagraceae	*Clarkia gracilis ssp gracilis*	6	
a	h		n	0	Onagraceae	*Clarkia gracilis ssp sonomensis*	29	
a	h		n	0	Onagraceae	*Clarkia purpurea*	2	
a	h		n	2	Onagraceae	*Epilobium minutum*	31	
p	h		n	0	Orobancheacea	*Orobanche fasciculata*	1	
p	h		n	0	Papaveraceae	*Eschscholzia californica*	14	
a	h		n	1.7	Papaveraceae	*Platystemon californicus*	2	
p	s		n	0	Papaveraceae	*Dendromecon rigida*	2	
p	t		n	0	Pinaceae	*Pseudotsuga menziesii*	1	
p	t		n	1.4	Pinaceae	*Pinus sabiniana*	18	
a	h		n	1	Plantaginaceae	*Plantago erecta*	15	
a	h	high impact	i	0	Poaceae	*Aegilops triuncinalis*	1	
p	h		n	0	Poaceae	*Agrostis pallens*	4	
a	h		i	0	Poaceae	*Aira caryophylllea*	8	
a	h		i	0	Poaceae	*Avena barbata*	31	
a	h		i	0	Poaceae	*Brachypodium distachyon*	19	
a	h		i	0	Poaceae	*Briza maximus*	32	
a	h		i	0	Poaceae	*Bromus diandrus*	4	
a	h		i	0	Poaceae	*Bromus hordeaceus*	25	
p	h		n	0	Poaceae	*Bromus carinatus carinatus*	1	
p	h		n	1.7	Poaceae	*Bromus laevipes*	16	
a	h		i	0	Poaceae	*Bromus madritensis*	9	
a	h		i	0	Poaceae	*Cynosurus echinatus*	5	
p	h		n	0	Poaceae	*Elymus glaucus*	8	
p	h		n	0	Poaceae	*Elymus multisetus*	26	
p	h		n	0	Poaceae	*Festuca californica*	2	
a	h		n	2.3	Poaceae	*Festuca microstachys*	36	
a	h		i	0	Poaceae	*Festuca myuros*	2	
a	h		i	0	Poaceae	*Gastridium ventricosum*	12	
p	h		n	0	Poaceae	*Hordeum brachyantherum*	1	
a	h		i	0	Poaceae	*Hordeum murinum leporinum*	1	
a	h		i	0	Poaceae	*Lolium mulitflorum*	19	
p	h		n	0	Poaceae	*Melica californica*	26	√
p	h		n	0	Poaceae	*Melica torreyana*	19	√
p	h		n	0	Poaceae	*Poa secunda secunda*	28	
p	h		n	0	Poaceae	*Stipa pulchra*	1	
a	h	4.3	n	5.6	Polemoniaceae	*Collomia diversifolia*	1	√
a	h		n	1.6	Polemoniaceae	*Gilia capitata ssp capitata*	15	
a	h		n	0	Polemoniaceae	*Gilia tricolor*	6	√
a	h		n	0	Polemoniaceae	*Leptosiphon bicolor*	2	
a	h		n	0	Polemoniaceae	*Leptosiphon parviflorus*	15	√
p	h		n	0	Polygalaceae	*Polygala californica*	3	
a	h		n	3.8	Polygonaceae	*Eriogonum luteolum v. luteolum*	31	√

Longevity	Form	Status	Nativity	Serpentine affinity	Plant family	Plant name	No. of patches	CA endemic
p	h		n	0	Polygonaceae	*Eriogonum nudum*	1	
p	h		n	0	Polypodiaceae	*Polypodium californicum*	1	
a	h		n	0	Portulacaceae	*Calandrinia ciliata*	6	
a	h		n	3.4	Portulacaceae	*Claytonia exigua exigua*	13	
a	h		n	3.1	Portulacaceae	*Claytonia gypsophiloides*	18	√
a	h		n	0	Portulacaceae	*Claytonia perfoliata*	1	
a	h		i	0	Primulaceae	*Anagallis arvensis*	7	
p	h		n	0	Pteridaceae	*Adiantum jordanii*	1	
p	h		n	3.4	Pteridaceae	*Aspidotis densa*	16	
p	h		n	0	Pteridaceae	*Pellaea andromedifolia*	6	
p	h		n	0	Pteridaceae	*Pellaea mucronata*	1	
p	h		n	0	Pteridaceae	*Pentagramma t. ssp. triangularis*	17	
p	h		n	0	Ranunculaceae	*Ranunculus occidentalis*	3	
p	s		n	1.5	Rhamnaceae	*Ceanothus cuneatus cuneatus*	1	
p	h	CBR	n	6	Rhamnaceae	*Ceanothus jepsonii albiflorus*	4	√
p	s		n	0	Rhamnaceae	*Frangula californica ssp californica*	5	√
p	s		n	1.5	Rhamnaceae	*Frangula californica ssp. tomentella*	7	
p	s		n	0	Rosaceae	*Adenostoma fasciculatum*	15	
a	h		n	0	Rosaceae	*Aphanes occidentalis*	7	
p	s		n	0	Rosaceae	*Cercocarpus betuloides v. betuloides*	6	
p	s		n	0	Rosaceae	*Heteromeles arbutifolia*	20	
p	h		n	0	Rubiaceae	*Galium andrewsii*	1	
a	h		n	0	Rubiaceae	*Galium aparine*	4	
a	h		i	0	Rubiaceae	*Galium parisiense*	1	
p	s		n	0	Rubiaceae	*Galium porrigens*	12	
a	h		n	2.2	Scrophulariaceae	*Antirrhinum vexillocalyculatum*	1	
a	h		n	2.4	Scrophulariaceae	*Castilleja rubicundula ssp. lithospermoides*	1	
a	h	CBR	n	5.2	Scrophulariaceae	*Collinsia greenei*	2	√
a	h		n	1.7	Scrophulariaceae	*Collinsia sparsiflora*	2	
p	s		n	0	Scrophulariaceae	*Mimulus aurantiacus*	11	
a	h		n	2.7	Scrophulariaceae	*Mimulus douglasii*	1	
p	h		n	0	Scrophulariaceae	*Mimulus guttatus*	1	
p	h		n	0	Selaginellaceae	*Selaginella bigelovii*	3	
a	h		n	0	Valerianaceae	*Plectritis macrocera*	2	