Evens: Identification and Mapping of Rare Plant Communities
Proceedings of the CNPS Conservation Conference, 17–19 Jan 2009
pp. 49–55
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IDENTIFICATION AND MAPPING OF RARE PLANT COMMUNITIES— STATE OF KNOWLEDGE AND ADOPTION OF STANDARDIZED TECHNIQUES

JULIE M. EVENS

California Native Plant Society, 2707 K Street, Suite 1, Sacramento, California 95816 (jevens@cnps.org)

ABSTRACT

Knowledge and protection of natural plant assemblages are key objectives of the California Native Plant Society (CNPS). The CNPS Vegetation Program has a floristic classification system to define and map vegetation in the state, including rare and common vegetation. Rare vegetation represents important and distinctive assemblages of biodiversity, and over 60% of the described vegetation alliances in California are rare or threatened. Since development pressures, climate change, invasive species, and other disturbances continue to threaten their existence, we need effective and efficient tools to identify and protect these rare types. CNPS is working collaboratively to establish a multi-step process to identify, map, and track rare vegetation throughout the state. Through an ad hoc committee, CNPS is adopting standardized techniques to collect reliable data, to evaluate rarity and monitor threats for each described vegetation type, to better inform agencies and land managers, and to strengthen our conservation efforts for preserving rare vegetation. Current techniques include standardized vegetation field survey protocols, detailed mapping using color aerial photography, classification and rarity ranking using a national system of the Natural Heritage Program, and estimation of total acreages and threats to rare vegetation assemblages. With these methods, we are working to establish key projects with other agencies, including California Department of Fish and Game, University of California, and United States Forest Service, to support efforts to identify and protect rare vegetation in different parts of the state.

Key words: classification, rare plant communities, surveying and mapping, vegetation.

INTRODUCTION

CNPS and other organizations recognize the need to identify and protect both rare and common vegetation types as units of biodiversity. Vegetation types provide key ecosystem services, including maintaining water cycles, removing carbon dioxide from the atmosphere, and providing habitat for rare plant and animal species. Conversion and degradation of rare vegetation types can disrupt the integrity of the ecological functions of our natural environments, leading to losses of sensitive plant and animal species and decreases in biodiversity. The inherent values of vegetation have lead scientists and conservationists to make use of vegetation patterns as a surrogate for ecosystems for many years. For over 30 years, the Natural Heritage network, formerly with The Nature Conservancy and now NatureServe, has used natural communities as a "coarse filter" in combination with rare plant and rare animal species to assess the ecological health and the conservation value of regions around the world, recognizing that conservation and management of natural communities can provide a cost-effective means for simultaneous conservation and recovery of groups of species (Keeler-Wolf 1993; Noss et al. 1995). Both state and federal agencies have formalized Natural Community Conservation Planning and Habitat Conservation Planning as integral regional conservation efforts (California Department of Fish and Game [CDFG] 2009). These processes are grounded in inventory and mapping of vegetation/habitat to protect a suite of natural communities in which rare species occur.

Of key importance to CNPS are those plant communities that are, in and of themselves, rare. California is full of examples of rare and endangered vegetation, with 60% of our state's described vegetation alliances being signified as rare (ranked as S3 or below; Sawyer et al. 2009). Some of these, such as old-growth coast redwood stands, giant sequoia groves, Monterey cypress stands, or Torrey pine groves, are well-known and regarded as important natural assets in the state. Others are less well known but of equal importance. More than 20 of the state's 60 manzanita (*Arctostaphylos* Adans.) species are only known from limited areas, yet they appear locally abundant enough to form their own vegetation stands or types (Sawyer et al. 2009). In addition, rare plant species can form rare vegetation, stands of common species that are rarely in a particular stage of development (e.g., old-growth

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forest or old-growth chaparral) can be considered rare, and rare and unusual assemblages of common species (such as at bio-geographic mixing zones where desert species blend with coastal species) are important markers for global climate change and shifting conditions.

Since vegetation types are easily sampled, mapped, and measured, they are one of the most direct reflections of our ecological landscapes in almost any part of terrestrial California. However, no agency or organization in the state is systematically inventorying and mapping the distribution and extent of rare vegetation, let alone their loss, even though land-use and land-cover are changing rapidly across the state. Some of California's rare vegetation types were once common and have been reduced by human activities. Examples include riparian woodlands and savannas of valley oak (*Quercus lobata* Née), vernal pools with goldfields (*Lasthenia fremontii* (Torr. ex A.Gray) Greene) and *Downingia* Torr., high-quality stands of native north coastal terrace prairie, and the once extensive and intact coastal scrub of south coastal California. Upon rigorously identifying and mapping vegetation types, we can monitor their change over time and have a series of markers for ecological health, integrity, and change at a broader landscape level than we could hope to master using a single-species approach. Those communities identified as rare, threatened, or in decline, and those identified as pristine versus degraded can be inventoried, identified, and safeguarded.

Some of the greatest challenges to be addressed are the conservation and protection of rare plant communities. Part of the challenge is that, unlike species, we have few legal ways to support protection for plant communities. No equivalents to the federal Endangered Species Act or California Endangered Species Act exist for the protection of endangered plant communities. However, in California, we have specific measures that do offer limited recognition for the protection for rare natural communities (Wagner 2006). We can justify protection of rare vegetation in the state through the California Environmental Quality Act (CEQA) and within coastal areas of Environmentally Sensitive Habitat Areas through the California Coastal Act (e.g., see section IV (b), (c) and (e) of the Environmental Checklist in Appendix G of the CEQA Guidelines; Wagner 2006). Yet for both acts, we need strong definitions, inventories, and/or maps to clearly support their existence.

Another part of our challenge is that previous state governmental programs enacted to identify, map, and track rare plant communities (e.g., Holland 1986; Keeler-Wolf 1993) have lost their funding or are not currently staffed. While local consulting firms and planning efforts produce maps of rare habitats/vegetation, no entity currently reviews and compiles this information. A past symposium covering this topic occurred almost two decades ago in southern California (Schoenherr 1990). Since no state agency or organization systematically inventories and analyzes their rarity, the conservation of rare plant communities continues to be seriously threatened. To fulfill this great need, CNPS proposes a multi-step process to survey, map, substantiate, and track rare communities in the state. The main objectives of this process will be to assist local and regional efforts throughout the state, including local CNPS chapter and other partner organization efforts.

MATERIALS AND METHODS

Through an ad-hoc committee, CNPS is reinvigorating efforts to collect reliable rare vegetation data through organized methods, to evaluate their rarity and monitor their threats, and to strengthen conservation efforts for preserving rare vegetation. Current techniques to identify and protect rare vegetation include the following: (1) field sampling of vegetation stands, (2) classification of distinct floristic units, (3) detailed mapping of the vegetation, (4) ranking rarity from mapped occurrences, estimated acreages, and known declines, and (5) defining conservation areas, evaluating threats, and other management objectives (see Fig. 1).

CNPS and other state agencies adhere to a national and state system of classification and rarity ranking as defined by NatureServe (2009) and Sawyer et al. (2009). This includes the classification of alliances and associations, which are floristically based units of vegetation defined by the dominant and characteristic plants in the over- and under-story. This classification is based upon sampling and analysis of repeating stands of vegetation, with field sampling methods such as the CNPS point-intercept and relevé protocols (Sawyer and Keeler-Wolf 1995; CNPS 2009; Sawyer et al. 2009) and analysis methods such as cluster analysis and ordination (McCune and Grace 2002).

For mapping rare vegetation, various methods exist. One process is to inventory a demonstrably rare vegetation type across its range. Another is to identify rare types as part of a regional mapping project, and an additional course is to identify types containing known rare species. These are typically multi-step processes to describe their vegetative

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features, geographical extent, and distribution. They also typically involve field-based surveying and aerial-photo mapping to depict the features, locations, and boundaries of patches or stands of rare vegetation.

Rare vegetation is defined by a global and state ranking system for natural communities or vegetation, where rarity values are based on a community's number of occurrences, amount of acreage, and/or level of decline (NatureServe 2009). Table 1 denotes this ranking system, where a ranking of G3 or S3 or below signifies rarity; that is, a vegetation type is rare when it is geographically restricted to 100 or fewer occurrences and/or 50,000 acres or less acreage within the state.

Upon defining, mapping, and ranking vegetation, organizations have a quantitative means to assess and prioritize conservation areas to preserve a maximum number of both rare and common vegetation assemblages. The Nature Conservancy is

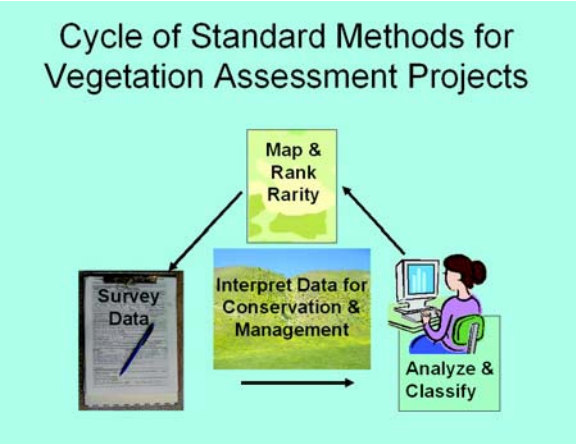

Fig. 1. Vegetation assessment approach using standardized techniques to identify, classify, and map rare vegetation, where projects can be introduced at any stage in the cycle.

Table 1. Global and state ranking system for natural communities per NatureServe (2009) and Sawyer et al. (2009).

Rank—Title	Definition	Abundance
G1 or S1—Critically Imperiled	At very high risk of extinction due to extreme rarity, very steep declines, or other factors	Fewer than six viable occurrences and/or 2000 acres (worldwide or statewide)
G2 or S2—Imperiled	At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors	6-20 viable occurrences and/or 2000-10,000 acres (worldwide or statewide)
G3 or S3—Vulnerable	At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors	21-100 viable occurrences and/or 10,000-50,000 acres (worldwide or statewide)
G4 or S4—Apparently Secure	Uncommon but not rare; some cause for long-term concern due to declines or other factors	Greater than 100 viable occurrences and/or greater than 50,000 acres (worldwide or statewide)
G5 or S5—Secure	Community demonstrably secure due to common and widespread abundance	Widespread and abundant (worldwide and statewide)

Table 2. Special stands recognized in Sawyer et al. (2009).

Woodland Special Stands	Shrubland and Herbaceous Special Stands
Bursera microphylla Woodland	*Arctostaphylos (purissima, rudis)* Shrubland
Callitropsis abramsiana Woodland	*Arctostaphylos bakeri* Shrubland
Callitropsis goveniana Woodland	*Castela emoryi* Shrubland
Callitropsis macrocarpa Woodland	*Koeberlinia spinosa* Shrubland
Callitropsis stephensonii Woodland	*Ziziphus obtusifolia* Shrubland
Juglans hindsii Woodland	*Swallenia alexandrae* Herbaceous
Lyonothamnus floribundus Woodland	
Pinus edulis Woodland	
Pinus torreyana Woodland	
Quercus tomentella Woodland	

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Fig. 2. *Callitropsis goveniana* Woodland Special Stands in the foreground on a coastal terrace above Point Lobos (left), and *Callitropsis macrocarpa* Woodland Special Stands in the background at Point Lobos, Monterey County, California (right). (Photographs by author).

one organization that has directed their conservation efforts to conserving samples of natural communities with an unprecedented goal of conserving 10% of every natural community across the globe (The Nature Conservancy 2007), and they particularly focus on areas with concentrations of rare units. CNPS supports these and other conservation efforts by collecting and sharing necessary scientific information about locally important and rare vegetation types, so that land-planners and land-managing agencies can make informed decisions. Currently, CNPS generates and shares rare vegetation information derived from local chapter knowledge and from local/regional studies on an ad-hoc basis, though the Vegetation Program is working to support and standardize efforts in a more directed fashion, starting with pilot projects.

RESULTS

Based on the established classification and ranking systems, California contains at least ten tree and ten shrub types that have a state rarity of S1 (Sawyer et al. 2009). Many of these are also designated as "special stands" where rare plant species themselves are dominant and form distinctive stands of vegetation, and 16 special stands are recognized presently for their conservation importance (Table 2; Sawyer et al. 2009). In addition, current data indicate 97 alliances are very rare (S1 or S2) and 192 alliances are rare (S3) in California, or 60% out of approximately 435 alliances. For example, most of the state's 11 species of cypress (*Callitropsis*) species form naturally rare alliances or special stands, including the *Callitropsis abramsiana*, *Callitropsis goveniana*, *Callitropsis macrocarpa*, and *Callitropsis stephensonii* Woodland Special Stands (see Fig. 2 and Table 2).

Fig. 3. *Arctostaphylos montana* Shrubland Association identified at Mount Tamalpais, Marin County, California. (Photograph by author).

Past statewide efforts to identify and map rare alliances included the CDFG's previous Natural Communities Program to inventory sycamore alluvial woodland. This effort was a practical study to identify and locate the most extensive occurrences of a putatively rare vegetation type, using a CNPS sampling procedure. One project goal was to determine if the community was indeed unique and differentiated from other similar vegetation, and, if so, to map and analyze the data collected at each occurrence. This riparian study evaluated and ecologically aggregated riparian stands of sycamore

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(*Platanus racemosa* Nutt.), based on similar environmental attributes and floristics, and vegetation data analysis revealed four types of sycamore alluvial woodland (Keeler-Wolf et al. 1997). In this example, a quantitative approach was taken to establish definitions and range maps of the sycamore stands and to drive a conservation prioritization effort. Several other similar efforts were undertaken in the 1990's by CNPS volunteers or cooperators for southern maritime chaparral (Hogan et al. 1996) and alluvial fan scrub (Barbour and Wirka 1997).

With recent regional data collection, classification, and mapping, rare alliances are being identified in an ad hoc manner. For example, the *Arctostaphylos montana* Shrubland Alliance was identified on serpentine at Mount Tamalpais in Marin Co. (Keeler-Wolf et al. 2003; Evens and Kentner 2006), including the *Arctostaphylos montana* Shrubland Association (Fig. 3). This and other alliances were mapped across a region to evaluate and maintain existing resources through an effort by Marin Municipal Water District. When compared to all other types defined in that region, this alliance had the highest frequency of rare plant species, including these eight: *Calamagrostis ophitidis* (J.T.Howell) Nygren, *Calochortus umbellatus* Alph. Wood, *Lessingia micradenia* Greene var. *micradenia*, *Navarretia rosulata* Brand, *Streptanthus batrachopus* J.L.Morrison, *Streptanthus glandulosus* Hook. subsp. *pulchellus* (Greene) Kruckeb., and *Eriogonum luteolum* Greene var. *caninum* (Greene) Reveal. Having knowledge of the range and extent of this alliance, the Water District can adaptively manage and reduce anthropogenic impacts in this type.

From 2001 to present, UC Davis professor Michael Barbour and colleagues have been sampling and classifying vernal pool vegetation across California, and they have identified seven alliances in the Central Valley based on herb species that are diagnostically present or dominant. Barbour and others have increased our understanding of vernal pool plant communities in a detailed manner by distinguishing vernal pool alliances and associations, ascertaining which are broadly distributed and which are rare, and discussing restoration criteria and conservation implications (Barbour et al. 2003, 2005, 2007). With this level of resolution, people can more effectively conserve and restore the natural vegetation found in Central Valley vernal pools.

Two current efforts to identify, map, rank, and conserve rare vegetation include a pilot project with CNPS, the United States Forest Service (USFS), and other partners for a fen conservation assessment on Forest Service lands in 2009–2010, and another pilot project with CNPS, UC Santa Cruz, and other partners for central maritime chaparral assessment beginning in 2009. The results of these projects will be presented in databases, reports, and maps.

DISCUSSION

Many benefits result from an integrated effort in identifying and mapping of vegetation. These include new abilities to identify vegetation as habitat for rare species, to accurately identify habitat locations suitable for covered species in conservation and management plans, to identify locally rare and specific vegetation types of an area, to prioritize conservation and land management activities, and to model current and potential threats. With a focused effort on systematically identifying and mapping rare vegetation, we have an effective means towards defending and conserving these rare units of biodiversity.

The CNPS State Vegetation Program is poised to work collaboratively with local CNPS chapters, agencies, and other NGO's in this effort. We need to act now because climate change, development and habitat fragmentation, destructively frequent fires, and other pressures are upon us. While the Vegetation Program has trained various local chapters to sample rare vegetation, we need a more concentrated effort to amass new and existing survey data, to produce maps, to evaluate and assign rarity, and to defend rare vegetation types in local and regional conservation planning processes across the state.

Regional vegetation mapping projects have begun to make headway in this effort, with CNPS being involved in various projects (e.g., western Riverside County and the northern Sierra Nevada foothills); however, they tend to focus on the more common vegetation types that are easier to identify and map than the rare types that are more difficult and costly to discern. Nevertheless, these maps can be used to identify important habitats for rare species, to identify locally rare vegetation types of an area, and to identify important biodiversity elements and hotspots of biodiversity at the landscape level (e.g., Evens and Klein 2006). Also, many of these regional efforts are based upon field sampling and vegetation classification, and thus they often offer occurrence information in the form of plot data for rare vegetation types and for rare plant species (e.g., Evens et al. 2006; Klein and Evens 2006).

At this time, many habitats need more comprehensive inventories and mapping to establish

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their features and conservation values, including the following: (1) maritime chaparral, coastal prairie, and other coastal types, (2) fen, other wetland, and riparian types, (3) many localized types in the Klamath Mountains and North Coast Ranges, and (4) Mediterranean and desert grasslands and forblands. CNPS and other partners have begun work on pilot projects for some of these habitats, while more funding and collaborations are needed to complete these projects.

ACKNOWLEDGMENTS

Key staff and volunteers of the Vegetation Program that deserve recognition for their contributions include Jennifer Buck, Hazel Gordon, Brett Hall, Steve Hartman, Suzanne Harmon, Todd Keeler-Wolf, Eric Peterson, Danielle Roach, Kendra Sikes, and many others including the local CNPS chapter vegetation chairs. A special thank you goes to Donna Shorrock and other contributors to the draft white paper on rare natural communities: Brian Fulfost, Brett Hall, and Susan Bainbridge. The program's work is supported by federal agency collaborators including Diane Ikeda of the USFS, and John Willoughby and Christina Lund of the Bureau of Land Management. State agencies that have infused support, provided data, and utilized products of the program include California Department of Parks and Recreation, CDFG, and University of California.

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