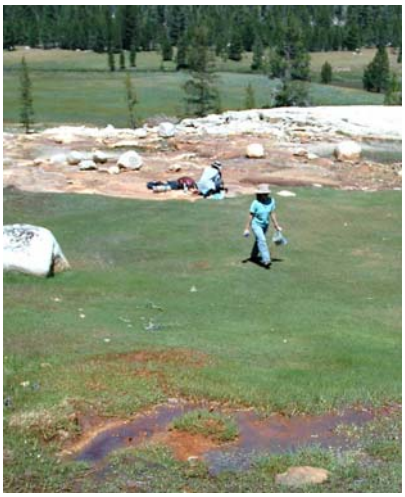
Rare Plant Surveys in Unusual Habitats of Yosemite National Park, California

Final Report



Prepared for:

National Park Service
Yosemite National Park

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Rare Plant Surveys in Unusual Habitats of Yosemite National Park, California

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Final Report

Prepared for:

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(Cover photos: marble outcrop; snow willow [*Salix nivalis*]; upswept moonwort [*Botrychium ascendens*]; mineral spring habitat, Lyell Fork of the Tuolumne River, Yosemite National Park)

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Executive Summary

This report covers one season's work to document the rare flora of two unusual habitats in Yosemite National Park: metamorphic outcrops and mineralized springs. We undertook this work to supplement a state-of-knowledge assessment of the flora of Yosemite National Park completed in 2003 by the National Park Service Inventory and Monitoring Program. This assessment, based on herbarium specimens and distribution information, indicated that documentation of the park's floristic diversity was incomplete. Based on the history of botanical work in the park and patterns of species occurrence, we surmised the undocumented portion of the flora might be associated with the most geographically restricted and unusual habitats. We identified these as including metamorphic outcrops and mineralized springs due in part to their uncommon soil chemistry.

Among the scattered metamorphic features in the far western and eastern portions of the park, we focused on those mapped as metasedimentary on USGS 15 minute geologic maps, and we distributed surveys among low, medium and high elevations. We relied on unpublished reports for locations of mineralized springs. We surveyed habitats between 1400 and 3200 m (4600 and 10,550 ft.), documenting species composition and habitat characteristics within samples of each.

We surveyed 28 areas of unusual habitat, added 14 species to the park plant list, documented 52 new populations of special status plant species, and found a moss new to science. Species surveyed and mapped included those on California Native Plant Society (CNPS) List 1B (Rare, threatened, or endangered in California and elsewhere), Forest Service Sensitive species, federal species of concern, CNPS List 2 species (rare in California, more common elsewhere), CNPS List 4 species (watch list), and some that are listed as park sensitive. Of the 14 new park records, eight were from metamorphic features, three were from mineralized springs, and three were from other habitats.

In addition to new park records, we provided specimen evidence for species only reported and for species rarely collected in the park; and we compiled maps, photographs, and detailed habitat data for each new special status plant population found. We present soil and spring water analysis results and discuss them in the context of species occurrence, and we describe patterns of species occurrence on marble outcrops.

During the course of our surveys, we found some of the most unusual habitats to harbor some of the most unusual species in Yosemite. In light of this, uncommon habitats deserve special protection from administrative and other activities. Although assessing biodiversity is an important aspect of protected area management, managers are faced with diminishing returns for effort expended to find and document the rarest species. Yet park management and resource protection would be well served by a more complete understanding of Yosemite's floristic diversity and species distributions. Efficiencies such as those presented here may be helpful in such efforts.

Introduction

Yosemite National Park (Yosemite), a permanent reserve and World Heritage Site, covers nearly 1200 square miles and contains a large and diverse flora by virtue of its wide elevational range, numerous ecological zones, and geologic history. It constitutes a large portion of a region that harbors many endemic species – those found nowhere else. Some of these are paleoendemics - botanical relicts from ancient climates prior to the uplift forming the Sierra Nevada approximately two million years ago, such as the giant sequoia (*Sequoiadendron giganteum*). The park also harbors neoendemics such as the tiny Yosemite woolly sunflower (*Eriophyllum nubigenum*), restricted to a few locations on the granitic domes that appeared subsequent to the Sierran uplift and subsequent glaciation around Yosemite Valley. Yosemite boasts a relatively undisturbed flora because it was set aside as a biological reserve in 1864, over a century before the origin of our present day reserve concept. In a landscape impacted by human activity, Yosemite is increasingly becoming an island of relatively intact habitat and a refuge of biological diversity. At the same time, broad-scale anthropogenic impacts, such as airborne contaminants and climate change, threaten the persistence of ecosystem components within the park. This underscores the need for improving our understanding of park biota and their support systems in anticipation of future change.

In 2000, the National Park Service (NPS) initiated a program to document park flora and fauna. This was done in anticipation of establishing a program to monitor indicator biota and processes. In connection with this effort, the U.S. Geological Survey assisted with documenting the park flora based on herbarium records and conducted field surveys, adding several species previously unknown in the park. The pace of recent additions to the park flora and the significant number of species expected within the park based on regional distributions indicate current information on park floristic diversity falls short of a full accounting. The additional, undocumented portion of the flora could be expected to have poor detectability and to be associated with the most geographically restricted and unusual habitats. Our goal, therefore, was to expand knowledge of the park's flora by conducting directed searches in these types of habitats.

Previous botanical work in the park

The floral diversity of the Yosemite region attracted the attention of botanists soon after Euro-American contact, including some considered pioneers of American botany. In 1860, with the fame of Yosemite and the "Big Trees" having just made its way to the Eastern U.S., the California legislature directed that a geological survey be conducted, with an additional objective of "…a full and scientific description of its rocks, fossils, soils, and minerals, and of its botanical and zoölogical productions, together with specimens of the same." Over the period 1862-1866, two members of this geologic survey, William Brewer and Henry Bolander, worked in the area in pursuit of what was the first comprehensive botanical survey in the New World. They were followed, in later decades, by a number of prominent American botanists and leaders in California botany. However, the 19th century goal of a comprehensive botanical survey remains unattained 150 years later.

Gaps in botanical knowledge

The degree to which a flora is documented is negatively correlated with the number of new geographic records for existing species and new species that are discovered (Hartman and Nelson 1995). Few new species have been discovered in the New England region (Hartman and Nelson 1995) in recent decades. In contrast, an average of five new plants is described annually from California. It is therefore startling to modern botanists that, despite the attractions of this 'crown-jewel' of national parks that drew their predecessors, the flora of large sections of Yosemite National Park remains incompletely documented. The obvious reason for this is the challenging terrain, coupled with the park's protected status, resulting in few roads into its higher elevations and remote valleys.

The locality data from herbarium specimens collected in the park show that most botanists did not collect very far from park roads, leaving the flora in large tracts of the less accessible regions of the park without physical documentation. The total number of specimens from Yosemite known to be in U.S. herbaria to date is approximately 11,000 representing approximately 1,500 taxa (NPS Yosemite flora database 2003). These collections inadequately represent the current range and variation of the park flora. In particular, the flora of rare habitats within the park has not, for the most part, been previously targeted for documentation.

The problem of an under-documented flora becomes increasingly clear with each passing year as accelerating anthropogenic threats affect floras both globally and in the Yosemite region. The particular threats to the Yosemite region are 1) replacement of the native flora by alien weeds (Macdonald et al. 1988), 2) potential extirpation of native flora by the climatic and hydrologic impacts of global climate change (Hayhoe et al. 2004, Dettinger et al. 2004), 3) negative effects on native flora by exogenous atmospheric nitrogen deposition (largely from burning of fossil fuels, Aber et al. 1989, Schulze 1989, Skeffington and Wilson 1988, Vitousek et al. 1997) and 4) interruption of natural fire regimes (Chang 1996). The NPS charge – preservation of Yosemite's splendors, great and small – requires informed management based on comprehensive data. It is the species with specialized requirements for restricted and rare habitats that could be first affected by these changes. If they are not found and documented soon, part of Yosemite's biological diversity may well disappear before it is fully known.

The NPS Inventory and Monitoring Program, begun for the Sierra Nevada in 2000, provided funds for improving the knowledge of park floras. The goal of this program was for national parks to have 90 percent of their flora documented and recorded in databases by 2005 (NPS 2001). The reason the 90 percent level was chosen is that the rarest members of the flora, by definition, are difficult to find. There is, therefore, a diminishing return for effort expended to find and document the rarest species. One might describe the results of the effort to document a flora as a curve having a geometric increase approaching an asymptote equal to the actual total number of species present. This type of curve describes the historic pace of species discovery in Yosemite (Figure 1).

There is reason to believe, however, that in the case of Yosemite, the decline in new species discovery since the 1940s reflects not so much a complete knowledge of the flora as a waning intensity of documentation efforts. If this is the case, then the true asymptotic portion of the curve has not yet been reached. For example, in 2003 and 2004, Inventory and Monitoring teams (3 people each year) discovered, incidental to their work in surveying known rare species, eight species previously unknown in the park and one species, an orchid, that is new to science (Colwell et al., *in prep*.). Two of the additions are non-native species, one of which is an invasive annual. *An Illustrated Flora of Yosemite National Park* (Botti 2001) puts the number of vascular plant species in the park at 1,427. The additional 160 species documented in herbaria but not covered in the flora are represented by the upward tick of the curve at the upper right of the graph. This addition brings the total to 1,587 taxa. In addition, there are 600 species that have been documented from areas adjacent to the park, on habitats and elevation ranges that occur within the park. It is likely that a significant number of these species inhabit the park as well (Dean Wm. Taylor, pers. comm.). This raises the potential total number of vascular plant species up to 2,187. The recent addition of 8 species and the additional expected species suggest that the current level of knowledge of the flora is below the 90 percent target level of the NPS Inventory and Monitoring Program.

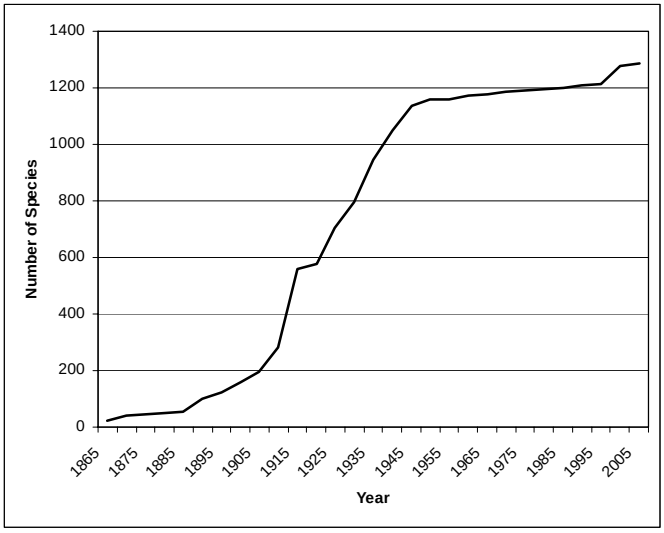

Figure 1. Rate of vascular plant discovery in Yosemite National Park, 1863-2004, based on herbarium specimens residing at local and regional collections.

Targeted habitat types

We expected that the undocumented segment of the flora were relatively uncommon species. There are four reasons why a species might be uncommon in the park, in order of probability: 1) the species has habitat requirements that are currently met only in limited areas within the park, 2) the species has recently colonized the park from elsewhere and has yet to expand into available habitat, 3) the species has habitat requirements that were previously rare in the park, and has yet to fill the habitat currently available to it, or 4) it is a newly evolved species which has yet to expand into available habitat. Of these four possibilities, the first gave us the strongest basis for productively searching this large and rugged park given limited resources (i.e., to target habitats in the park that are limited in size and are rare).

This approach of targeting rare habitats is not new; rare species often are found in rare habitats that represent ‘ecological islands’ in a ‘sea’ of normal habitat (Stebbins 1976,

1980, Kruckeberg 1991). In particular, rare soil types are known to harbor rare plant species that are adapted to the particular profile of mineral nutrients that the soil provides. These are called ‘edaphic endemics’ (Mason 1946a, b). These species may be physiologically tolerant of the presence of toxic minerals or of imbalances of nutritive minerals. It has been shown that edaphic endemic species may be able to grow on other soil types, but are found largely or exclusively on the rare soils because of a poor ability to compete with other species on more common soils (Gankin and Major 1964, Tansley 1917).

A well-documented example of edaphic endemism is California’s serpentine soils. Although they comprise less than one percent of the land of California, they are known to harbor over 12 percent of California’s endemic species (Kruckeberg 1984, Jepson Online Interchange 2005), including 300 taxa of rare plants (Fiedler 2001). Although only a few extremely small outcrops of serpentine rock exist in Yosemite, there are examples of edaphic specialists on other soil types in the Yosemite area. Examples found on soils derived from metamorphic rock are the state-listed Yosemite onion (*Allium yosemitense*) that grows primarily on metamorphic outcrops on either side of the western park boundary and *Collinsia linearis*, a close relative of blue-eyed Mary (*Collinsia parviflora*). *C. linearis* is limited to metamorphic outcrops of El Portal and along the South Fork of the Merced River. Other examples are seaside arrowgrass (*Triglochin maritimum*) and Nuttall’s alkali grass (*Puccinellia nuttalliana*) which are representative of a halophytic specialist community inhabiting the salt encrusted clay pans around mineralized springs. Both of these species have been documented at Soda Springs in Tuolumne Meadows.

Other unusual habitats in the park that would be profitable include unglaciated surfaces, deep cold lakes, fens, and iron springs. In the present study, we focused on mineralized springs and metamorphic features because they provide some of the most unusual soil chemistry in a landscape largely dominated by upland soils derived from igneous parent material and wetlands fed by fresh water. In addition, both mineralized springs and metamorphic outcrops are rare in the park and remain largely unsurveyed. For example, the flora of mineralized springs is documented only at one site, Soda Springs in Tuolumne Meadows.

Study Area

Yosemite National Park, in the central Sierra Nevada of California, ranges from 650 m to nearly 4,000 m (2,100 to 13,114 ft.) in elevation. The park lies on the west slope of the range and encompasses nearly the full range of vegetation zones and habitats of the western slope, including foothill oak woodland, lower montane forests, upper montane forests, subalpine forests, and alpine plant communities. It is comprised of two watersheds, the Tuolumne in the north and the Merced in the south. The dominant mountain building processes of the region were orogenic uplift and intrusion of plutonic rock followed by erosion and exposure of the granitic and granodioritic domes for which the park is known.

An exception within Yosemite's glaciated, granitic landscape is the occurrence of metamorphics in the far western and eastern portions of the park (Figure 2). These are, in part, old seafloor sediments that rose with the uplift of the Sierra Nevada and persisted despite erosional processes that carved the remainder of the landscape down to basement rock.

The erosional processes that exposed the Sierra Nevada batholith began as rivers carving canyons that were later widened into u-shaped valleys by glacial advance. Along these valleys, there are scattered mineralized springs, in addition to widely distributed fresh-water springs, that are poorly understood as to their origin and composition. They appear to range from 1,400 to over 3,000 m (4,610 to over 10,000 feet) and occur in both the Tuolumne and Merced watersheds (Figure 3).

The mineralized springs can be categorized as one of two types: 1) those where outflow runs over bedrock or boulders and produces caliche or flowstone but largely evaporates apparently without substantially influencing soil chemistry and 2) those where outflow saturates soil and modifies soil chemistry. The latter commonly occur in meadow settings where flow rates and slope steepness have an influence on the extent to which the habitat is modified for plants.

The source of spring mineralization is not yet known. Portions of ground water may derive minerals from non-granitic geologic features prior to emerging as mineralized waters.

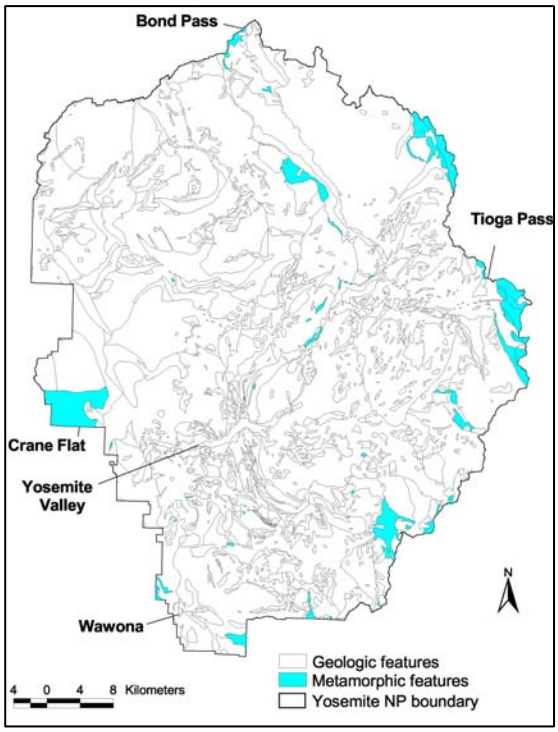

Figure 2. Metamorphic rock in the predominantly granitic landscape of Yosemite National Park is limited largely to the far western and eastern portions of the park.

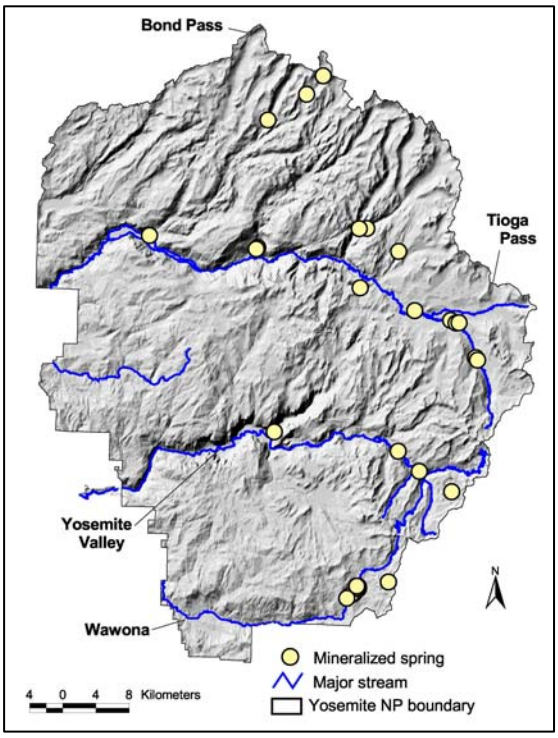

Figure 3. Mineralized spring locations in Yosemite derived from published sources and interviews with National Park Service staff.

Methods

Survey site selection

The distribution of metamorphic substrates and mineralized springs allowed us to stratify surveys across a range of elevations and latitudes. We gathered information on the location of habitats of interest from available sources and stored it in data table and geographic information system (GIS) formats. We selected survey sites across a range of elevations and latitudes to capture some of the plant diversity among habitats.

Metamorphic substrates. For our surveys of metamorphic substrates, we focused on areas mapped as metasedimentary on USGS 15 minute geologic maps. Metamorphic features were mapped in the Yosemite region at the 1:62,500 scale by Chesterman (1975), Peck (1980, 2002), Wahrhaftig (2000) and others. The NPS is creating GIS versions of these data, but they will not be available until later in 2006. As a result, we made use of the simplified "Geologic Map of Yosemite National Park and Vicinity" (Huber et al. 1989) that is available in GIS format and of published versions of 15 minute geologic maps. Using these and other resources, we refined the selection of survey areas according to access and logistical considerations. We also took into account the degree to which metasedimentary areas near roads had been surveyed previously (e.g., Mts. Dana and Gibbs near Tioga Pass).

Mineralized springs. Literature sources only provided locations for springs in Yosemite Valley and Soda Springs in Tuolumne Meadows (Presser 1980). Interviews with U.S. Geological Survey and National Park Service staff, however, provided 24 additional spring locations. The Yosemite Park Historian (retired), Jim Snyder, provided the majority of these mineralized spring locations from his work on the Yosemite Wilderness Historic Resources Surveys (Snyder et al. 1989:30, 1990:42-44, 1995**,** pers. comm.).

Using available information on spring locations, we selected springs over a range of elevations and between both the Tuolumne and Merced watersheds. We took into consideration access issues and information provided by the Park Historian on the character of each spring.

Survey methods

Metamorphic substrates. A team of three to four surveyors accessed selected metamorphic features and surveyed for species of interest. We surveyed the entire habitat whenever feasible for special status plant species and species not previously known from the park. Following the general survey, we selected areas representative of the habitat surveyed. Within these representative areas, we established 0.01 ha plots and described physical site characteristics, ground cover, soil characteristics, vegetation structure, and floristic composition. This plot size was sufficient because nearly all surveys took place in herb-dominated vegetation. When we encountered special status plant species, we collected detailed habitat data from within the population rather than from areas representative of the habitat in general.

Mineralized springs. We made exhaustive inventories of floristic composition within spring-affected areas, and we collected habitat information from 0.01 ha plots placed within those areas. At the same time, most surveys were by necessity single visits to sites, and, as a result, may have missed species flowering much earlier or much later than the survey date.

Data collection

Survey information. We located survey areas in the field using GIS maps, 7.5 minute topographic and geologic quadrangles, Trimble GeoExplorer 3 (Trimble, Sunnyvale, Calif.) global positioning system (GPS) units and 1997 aerial photographs (1:15,840 scale). We limited survey areas to those within Yosemite National Park and conducted surveys in a systematic manner to ensure entire survey areas were examined for the presence of any species of interest. We defined surveys as searches throughout a defined area of interest. That is, spring surveys sought species of interest from within areas visibly influenced by spring outflows. Typically, this was defined by the extent of a mineral crust on the soil, a change in vegetation density and composition compared with the surroundings, and, sometimes, signs of a vernally wet depression. We defined metamorphic survey areas as selected features mapped on 15 minute geologic maps. We relied on geologic maps, topographic quadrangles, and substrate evaluation to remain within metamorphic feature boundaries in the field. In addition, we used hydrochloric acid (10 % solution) to verify marble feature boundaries.

Species of interest included those on the Yosemite Special Status Plant List of 2005, those on the California Native Plant Society (CNPS) listings (CNPS 2004), those that represented range expansions, and those not previously collected from the park. When we located species on the CNPS or the Yosemite National Park sensitive plant lists, we estimated population sizes, mapped population perimeters, and collected habitat data. We made complete censuses of small populations and estimated abundances of large, extensive populations. We made estimates by subsampling representative areas and extrapolating counts from measured areas to larger, mapped population boundaries. The subsample counts took place within one- to 20-meter square areas.

Population data. For each sensitive plant population found, we followed California Natural Diversity Database (CNDDB) methods for documenting population status (CNDDB 2003) and Grossman et al. (1998) methods for describing habitat. We recorded the total estimated population size (number of plants), its absolute percent cover of the ground surface, the spatial distribution of individuals within the population boundary, whether or not it represented a California Natural Diversity Database (CNDDB) numbered occurrence, and whether or not we collected a specimen (see field form available in Appendix A). We categorized species distribution pattern as scattered individuals within the population, scattered small clumps, large clumps, or widespread throughout. We also estimated the proportion of the population in vegetative, flowering or fruiting stage.

Mapping. Field staff used Trimble GeoExplorer 3 GPS units to map special status plant population perimeters. Position Dilution of Precision (PDOP), a measure of the quality of satellite geometry and a reflection of positional accuracy, was set to 6 to maximize positional accuracy. GPS data were downloaded from Trimble units to a desktop computer and post-processed with downloaded Trimble base station data primarily from the Forest Service Remote Sensing Lab in Sacramento (www.r5.usfs.gov/rsl). We post-processed field GPS data to correct positions to 1-2 m accuracy using Trimble Pathfinder Office v2.9 software. We exported corrected GPS data to ArcView shape file format and imported resulting files into a single data theme reserved for mapped populations (<Rare_plants-2005>). We labeled each polygon in the <Rare_plants-2005> theme with the species name, species code, survey code, survey date, source of data (USGS, NPS), Universal Transverse Mercator (UTM) coordinates (easting and northing) of each population center (UTM Zone 11 projection, North American Datum 1927 datum), number of discreet polygons used to map the population, and spatial extent of the population (m sq and ha).

We documented our survey effort in terms of person hours spent searching, size of area surveyed, whether the survey area was mapped, the proportion of the mapped survey area that was searched, and a description of the area(s) surveyed. We mapped areas surveyed by collecting GPS points on survey area perimeters, by hand drawing maps on overlays of 1997 1:15,840 aerial photographs, or by doing both. We digitized survey areas into a GIS theme named <2005areasurveyed> using ArcView v3.3 (Environmental System Research Institute 2002) and on-screen digitizing. Spatial data used to assist in accurately locating survey areas included hydrography, topography, digital raster graphs showing landscape features, and Digital Ortho Quarter Quads (DOQQs) from 1993. We compared the DOQQs and other information with the 1997 photograph on which the survey perimeter had been drawn and any GPS perimeter points collected prior to on-screen digitizing. Each polygon in the <2005areasurveyed> theme is labeled with a species name, survey date, survey code, and survey area size (m sq, ha, and acres). For each survey, there is a polygon for each species sought during the survey, whether or not the species was found.

In addition to mapping population locations with GPS units and digitizing and storing the result in a GIS theme, we recorded location information separately in a tabular database for permanent storage with the population and habitat data. These location data included a place name, county, landowner, USGS 7.5 minute topographic quadrangle name, and UTM coordinates of the population center. We derived UTM coordinates from either the approximate center of the mapped polygon or from a GPS point taken from the approximate center of small populations. For each population coordinate, we recorded UTM easting, northing, UTM zone, datum, source of coordinates (GPS, 7.5 minute topographic quadrangle, ArcView Polygon Centroid), and GPS make and model.

At each population, we took digital (4.0 megapixel, jpeg format) images of the special status plant, its habitat, and, in most cases, the plot to characterize it and assist with relocation. We recorded the camera make and model and exposures taken to assist with image labeling. We labeled each digital image with, at a minimum, subject, location, survey code, photographer, date.

We categorized overall site quality as excellent, good, fair, or poor based on the degree of apparent human disturbance and noted any current land use in the vicinity, source of disturbance, and any evident threats to the species or the site. We included comments and observations related to any of these.

Habitat Data. We established plots within populations and largely followed the methods of Grossman et al. (1998) to characterize rare species habitats. Plots were subjectively placed in characteristic habitat within the population. The standard size and shape of plots was 10 by 10 m square, but plot shapes and sizes were adjusted where necessary (and recorded for each site) to scale to the population and habitat being characterized. Within each plot, we collected information on physical site characteristics, substrate, vegetation characteristics, and associated species.

More specifically, we characterized the topography and physiography in terms of elevation (m), slope steepness (percent), slope aspect (degrees azimuth), topographic position, landform at three different scales, and surficial geology (categories available in Appendix A). We categorized sites into hydrologic regimes (Cowardin et al. 1979) where appropriate, including riverine, palustrine, and lacustrine systems along with nontidal water regime modifiers from saturated to permanently flooded. We wrote summary site descriptions (which were also useful for herbarium labels) and assigned percent cover values to seven categories of unvegetated ground surface to characterize the growing substrate: bedrock, large rocks, small rocks, sand, litter/duff, wood, and bare soil. To further characterize the growing medium, we assigned soil texture to one of 12 categories and soil drainage to one of six categories (see Appendix A).

We noted the leaf habit (evergreen, cold deciduous, etc.), leaf type (broad leaved, needle-leaved, etc.), and physiognomic class of the site, and we identified the plant community to the association level using a semi-dichotomous key (NatureServe 2004). We then described vegetation structure by noting dominant species in each of six vegetation strata (emergent tree, canopy tree, subcanopy tree, shrub, herbaceous, nonvascular) and assigning a cover class to each stratum (0-1%, 1-5%, 5-25%, 25-50%, 50-75%, >75%). We derived species richness and composition by listing each species present together with a cover class for each. Finally, we summarized total vegetative cover with one cover class assignment and a separate estimate for total non-native species cover.

Soil and rock samples. To characterize soil nutrient status at all sites, we collected one-pint samples of soil from five locations within each site for later analysis. We separated soil from rock fragments > 2 mm and recorded the proportion of rock in the soil to represent soil rockiness. We then had the soil analyzed for organic matter content, macronutrients, pH, and cation exchange capacity (A&L Western Agricultural Laboratories, Modesto, California).

At metamorphic survey sites, we collected representative rock samples to verify rock type. We made on-site verifications when surveys took place on marble using hydrochloric acid (HCl, 10 percent solution) to gage the bubbling reaction that occurs with calcium carbonate (due to the generation of CO_2 gas).

Water samples. To characterize spring chemistry and its potential influence on plant species composition, we measured approximate conductivity, pH, and alkalinity in the field and collected filtered and acidified water samples for further analysis. Lab analyses included boron, calcium, chloride, iron, magnesium, potassium, sodium, and sulfate. We sent samples to the U.S. Geological Survey National Water Quality Laboratory in Denver, CO, (http://nwql.usgs.gov/) for analysis.

Plant collections. Plant collections were a key aspect of the survey project serving to provide for accurate identification, to document and permanently voucher species on survey sites, and to add to the knowledge of species distributions in the park. We collected specimens of selected species for the purpose of accurate identification using additional time and tools available in a laboratory setting (for a complete list of collections, see the <PlantCollections-2005.mdb> database). Specimen collections followed the voucher policy in the Sierra Nevada Network Biological Inventory Plan (National Park Service 2001: 31). The policy specifies that investigators will be required to collect adequate vouchers to document species occurrence. We interpreted this to include documenting overall species composition on survey sites as well as new locations for special status plant species. The policy also specifies, for locally rare species (i.e., park sensitive only), that a "voucher should only be collected if at least…25 individuals of a plant species are present at a given sample site."

Plant specimen preparation and labeling were done in accordance with NPS guidelines in the Biological Inventory Plan (National Park Service 2001). The NPS specifies that "voucher preparation will be the responsibility of inventory [investigators]." We pressed, dried, mounted, and labeled all specimens collected that were of sufficient quality to mount (a few specimens of associated species were too depauperate for mounting). In recognition that all vouchers taken on NPS lands are the property of the NPS, we are submitting prepared vouchers to the Yosemite Museum Herbarium (YM) for permanent storage. The museum will provide duplicates to University/Jepson herbaria at University of California, Berkeley (UC/JEPS) through a loan agreement.

Data management. Surveyors recorded data in the field on a four page data form (Appendix A) and later transcribed them into Microsoft Access© databases (Microsoft Corp. 1992-1999). All data collected in connection with special status plant populations are stored in a database titled 'California Native Species Field Survey Database' (filename = CNSFSR.mdb) along with all field survey data collected for special status plants in Yosemite for the last three years. Habitat data collected where no listed species occurred are stored in a database titled 'Habitat Surveys-2005' (filename = HabitatSurveys-2005.mdb). The former database provides summaries of single surveys, summaries by species, summaries of population size for all populations surveyed, as well as reporting forms for the California Department of Fish and Game Natural Diversity Database that is the repository for sensitive plant and animal information state wide.

Results

Field survey results

We surveyed 28 areas of unusual habitat (Table 1), added 14 species to the park plant list (Table 2), documented 52 new populations of special status plant taxa (Table 3), and found a moss new to science in 2005. Species surveyed and mapped included those on CNPS List 1B (Rare, threatened, or endangered in California and elsewhere; Yuba Pass willowherb [*Epilobium howellii*], slender lupine [*Lupinus gracilentus*], Torrey's popcornflower [*Plagiobothrys torreyi* var. *torreyi*]), Forest Service Sensitive (2 species including upswept moonwort [*Botrychium ascendens*]), federal species of concern (2 species), CNPS List 2 (RTE in Calif. more common elsewhere, 6 species), CNPS List 4 (watch list, 6 species), and park sensitive (Table 3). There is duplication among the categories because individual plant taxa may have multiple listing statuses among organizations (e.g., all Forest Service sensitive taxa are CNPS 1B). The number of surveys ranged from one for a species (e.g., Kruckeberg's sword fern [*Polystichum kruckebergii*], Yosemite bulrush [*Scirpus clementis*]) to three (Sierra starwort [*Pseudostellaria sierrae*]).

Table 1. Plant surveys of unusual habitats completed in 2005, Yosemite National Park.

Survey Type	Survey Location	No. Surveys
Spring[1]	Piute Creek	2
Spring	Washburn Lake	1
Spring	Soda Springs, Tuolumne Meadows	1
Spring	Lyell Canyon	3
Spring	South Fork Merced River	2
Spring	Alkali Creek	1
Substrate[2]	Turner Ridge (contact metamorphic)	2
Substrate	Crane Flat (quartzite)	1
Substrate	Mt. Hoffman (marble)	4
Substrate	Return Lake (hornfels)	1
Substrate	Virginia peak (quartzite)	1
Substrate	Head of Virginia Canyon (marble)	1
Substrate	Virginia Pass (amphibolite and schist)	1
Substrate	Bond Pass (quartzite)	1
Substrate	Bigelow Peak (quartzite)	1
Substrate	SW side Bigelow Peak (gabbro)	1
Substrate	W side Jack Main Canyon (metasedimentary)	2
Substrate	Jack Main Canyon (calcite)	1
Substrate	SE of Dorothy lake (granite)	1
		28

[1]Springs are all mineralized springs with conductivity measures exceeding 500 µS (microSiemens)

[2]Substrates are all metamorphic with two exceptions: SW Bigelow Pk (gabbro) and SE of Dorothy Lk (granite)

Surveys of mineralized springs varied from 1400 – 2700 m (4,610 – 8,880 feet) and from the lower mixed conifer zone (canyon live oak and ponderosa pine - incense-cedar – black oak) to the subalpine forest zone (lodgepole pine) (Figure 4). The latitudinal range was from 37° 33.5' near the south boundary of the park to 37° 56.5' along Piute Creek. We had information on isolated springs in remote areas near the north end of the park in Stubblefield and Thompson canyons, but time and logistical considerations precluded surveys in those areas. Instead, we focused on groupings of springs that provided for what we expected would be more representative expressions of mineralized spring vegetation and for more efficient use of field time. The largest groupings of springs

occurred along the South Fork of the Merced River above Gravelly Ford, along the Lyell Fork of the Tuolumne River, and along Alkali Creek.

Surveys of metamorphic substrates varied from 1530 – 3215 m (5,020 – 10,550 feet) elevation and from 37° 34.0' to 38° 10.4' latitude (Figure 5). There are metasedimentary features around 600 m (2,000 ft.) in El Portal, but we surveyed those, for the most part, within Yosemite National Park and NPS property in 2003 (Moore et al. 2005).

New park species records. With plant collections made during the course of surveys, we added 14 species to the park plant list (Table 2). Of these, we encountered three during the course of activities unrelated to springs and metamorphic features. For example, we made a directed search for Yuba Pass willowherb (*Epilobium howellii*; Hoch 1992) in appropriate habitat following training in its identification and habitat. *E. howellii* (CNPS 1B, rare in California and elsewhere), was known until quite recently from only six occurrences in California. Its habitat is not uncommon, and it is expected to be more common than collection information suggests. As a result, additional information is needed regarding its distribution.

Little combseed (*Pectocarya pusilla*) and forget-me-not popcornflower (*Plagiobothrys myosotoides*) were casual encounters in the western portion of the park during surveys for Torrey's popcornflower (*Plagiobothrys torreyi* var. *torreyi*). The latter is a CNPS List 1B species known only from Yosemite Valley. Forget-me-not popcornflower is

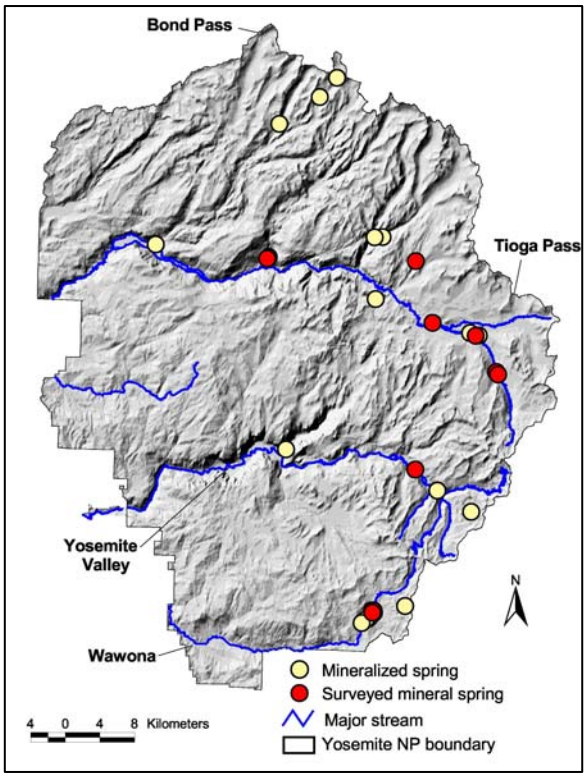

Figure 4. Mineralized springs surveyed for special status plants, 2005, Yosemite National Park, Calif.

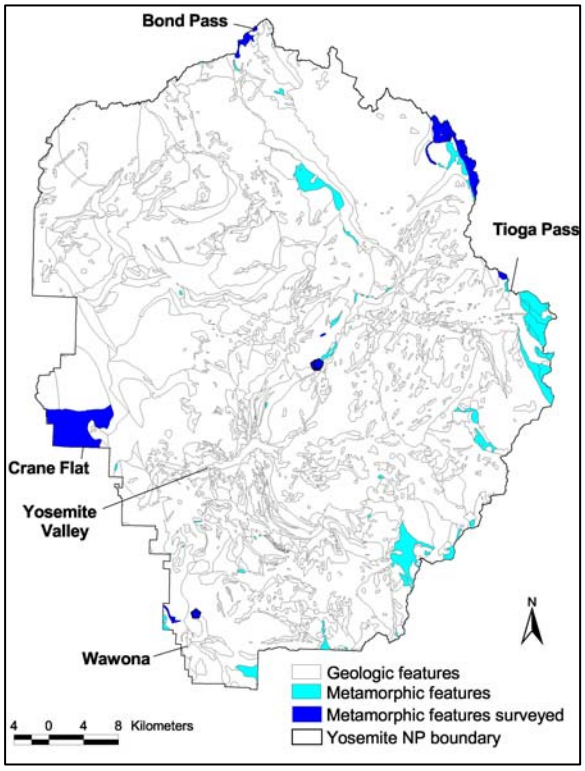

Figure 5. Metamorphic features surveyed for special status plants, 2005, Yosemite National Park, Calif.

Table 2. Additions to the Yosemite National Park flora made from botanical collections in 2005 (14 species total in 21 populations).

Scientific Name	Common Name	Family	County Record	CNPS listing	Populations
Anemone drummondii	Drummond's anemone	Ranunc.	no	none	1
Botrychium ascendens[FSS, FSC]	upswept moonwort	Ophiogloss.	yes	List 2	1
Distichlis spicata	saltgrass	Poaceae	yes	none	1
Epilobium howellii	Yuba Pass willowherb	Aster.	yes	List 1B	1
Erigeron clokeyi	Clokey's fleabane	Aster.	yes	none	1
Erigeron eatonii var. *sonnei*	Eaton's fleabane	Aster.	yes	none	1
Muhlenbergia asperifolia	scratchgrass	Poaceae	yes	none	4
Pectocarya pusilla	little combseed	Boragin.	no	none	1
Phoenicaulis cheiranthoides	daggerpod	Brassic.	no	none	2
Plagiobothrys myosotoides	forget-me-not popcornflower	Boragin.	yes	List 4	3
Stenotus acaulis	stemless goldenweed	Aster.	yes	none	1
Triglochin palustris	marsh arrow-grass	Juncagin.	yes	List 2	2
Viola purpurea ssp. *venosa*	goosefoot violet	Viol.	yes	none	1
Zigadenus exaltatus	giant deathcamas	Liliaceae	yes	none	1

[FSS] Forest Service Sensitive

[FSC] Federal Species of Concern

on CNPS List 4, a group about which more information is needed. The taxonomy of forget-me-not popcornflower is under revision. In particular, the synonymy of its California and South American components is in question, as is its relationship to Torrey's popcornflower. As currently recognized, forget-me-not popcornflower's North American distribution was limited to Santa Clara, Fresno, and Tulare counties.

Little combseed (*Pectocarya pusilla*) is a small annual of dry sites in grassland and woodlands. It can be found in northwestern and central western California as well as the Sierra Nevada foothills. Our collection is from a vernally moist outcrop in the vicinity of Discovery View near the southwestern edge of the park.

The remainder of the additions to the park flora (11 taxa) were from the two main habitats of interest. We found the *Anemone*, *Botrychium*, *Erigeron clokeyi*, *E. eatonii*, *Phoenicaulis*, *Stenotus*, *Viola*, *Zigadenus* in metamorphic habitat, and the *Distichlis*, *Muhlenbergia*, *Triglochin* at mineralized springs.

Two of the new species are included on CNPS list 2: rare, threatened, or endangered in California, but more common elsewhere. Upswept moonwort (*Botrychium ascendens*), a pteridophyte in the adder's-tongue family, is known in California from approximately seven occurrences in the southern Cascade Range and the northern Sierra Nevada (CNPS 2004, Figure 6). It is on the watch list in Nevada, a candidate for state listing in Oregon, and is state-listed as Sensitive in Washington. This collection represents a county record as well as a range extension south from El Dorado County. Another specimen of upswept moonwort was collected in the Convict Creek drainage in Inyo National Forest by Dean Wm. Taylor within a week of our collection. Both collections present intriguing variations from other *B. ascendens* in California and deserve further study (Donald R. Farrar, Iowa State University, pers. comm.).

Figure 6. Upswept moonwort (*Botrychium ascendens*), Virginia Canyon, Yosemite N.P., California. 7/30/2005 (USGS-A.E.L. Colwell)

The second CNPS List 2 species, marsh arrow-grass (*Triglochin palustris*) is a monocot in the arrow-grass family. It is known in California from fewer than 10 occurrences in the central and southern Sierra Nevada (Inyo, Mono, and Tulare counties) although it also occurs in Idaho, New Mexico, Nevada, Utah, Washington, and elsewhere (CNPS 2004, Figure 7). *T. palustris* is slight in habit and easily overlooked in its meadow, wet flat, stream and lake margin habitat. Where its local congener, seaside arrow-grass (*Triglochin maritimum*), is limited to saline, brackish and alkaline marshes, marsh arrow-grass appears to occur in both fresh and saline environments.

Figure 7. Marsh arrow-grass (*Triglochin palustris*) in fruit, Lyell Canyon, Yosemite N.P., California. 8/11/2005. (USGS-A.E.L. Colwell)

Drummond's anemone (*Anemone drummondii*) occurs from the Klamath Ranges in the north, south through the southern Cascade Range to the southern Sierra Nevada. It had been reported previously east of the park on Tioga Crest (Botti 2001) and collected north of the park in the Sonora Pass vicinity (SMASCH 2002). Taylor (*in prep*) indicates Drummond's anemone is common in snow accumulation sites on the lee of ridges and in cirque basins, and this largely describes the habitat in which it was found: a protected concavity in talus at the very head of Virginia Canyon on the lee side of Virginia Peak adjacent to a mapped snowfield.

Saltgrass (*Distichlis spicata*) and scratchgrass (*Muhlenbergia asperifolia*) are both widespread grasses throughout California in moist alkaline sites. Saltgrass and scratchgrass are known to occur up to

1550 and 2150 m elevation respectively. The new localities of 2670 and 2705 m elevation expand those ranges somewhat.

Clokey's fleabane (*Erigeron clokeyi*) and Eaton's fleabane (*Erigeron eatonii* ssp. *sonnei*) both occur within the Sierra Nevada, Great Basin east of the Sierra Nevada, and White and Inyo mountains (plus the desert mountains for *E. clokeyi*). Both are known from California and Nevada (plus Utah for *E. clokeyi*). Neither is rare within its range, and Clokey's fleabane is reportedly frequent in sagebrush scrub, pinyon woodland, and curl-leaf mountain mahogany woodland (Taylor *in prep*, Jepson Online Interchange 2004). Eaton's fleabane is uncommon in grassland and sagebrush scrub in the northern and central Sierra Nevada and east of the Sierra Nevada (Taylor *in prep*, Jepson Online Interchange 2004). The closest Eaton's fleabane locality to our site near Bigelow Peak is approximately 20 km north at Sonora Pass at the Tuolumne – Alpine – Mono county boundary. Nearly all specimens of Clokey's fleabane in the SMASCH database (Jepson Online Interchange 2004) are from Mono and Inyo counties above 2700-3000 m (9-10,000 ft.) in the White, Inyo, and Panamint mountains. A few collections are from high elevations in the Sierra Nevada, including a Dunderberg Peak collection by Carl Sharsmith (UC712501) 34 km from the first Yosemite locality near Bigelow Peak.

Daggerpod (*Phoenicaulis cheiranthoides*; Figure 8) is occasional east of Yosemite on windswept ridges, pumice flats and sparse sagebrush scrub below 3300 m (10,800 ft.; Taylor *in prep*). It also occurs in northwestern California and the Cascade Range and in Washington and Idaho (Hickman 1993). There are Tuolumne County collections of daggerpod from Eagle Peak and Emigrant Meadows (Jepson Online Interchange 2004) but no previous collections in Yosemite. This large-podded mustard with long, broad, pubescent leaves in a rosette is striking at higher elevations where it is surrounded by short, compact alpine perennials.

Stemless goldenweed (*Stenotus acaulis*; Figure 9) is a species of the Cascade – Sierra axis as well as the Warner, Inyo, White, and desert mountains. It ranges in elevation from 1900 – 3200 m (6,200 – 10,500 ft.). Stemless goldenweed is infrequent on rocky, windswept, alpine ridges and sagebrush scrub (Taylor *in prep*) on granitic, volcanic, and marble substrates (Jepson Online Interchange 2004). The majority of the 30 specimens in the SMASCH database are from the White and Inyo mountains and eastern slope of the northern Sierra Nevada with a handful from the Sierra Crest. The new Yosemite locality is on a ridge at 3075

Figure 8. Daggerpod (*Phoenicaulis cheiranthoides*) in fruit, Virginia Pass, Yosemite N.P., California (USGS-Peggy Moore)

m on metamorphics with some marble present and just 4 km from the Sierra Crest.

Goosefoot violet (*Viola purpurea* ssp. *venosa*) is a species of the Great Basin, Modoc Plateau, and desert mountains in California and thence to Washington, Wyoming, and Colorado (Jepson Online Interchange 2004). The 14 specimens listed in the SMASCH database for California indicate the range may be poorly understood for the state, requiring more work. We offer the first central or southern Sierra Nevada specimen as a contribution to furthering that understanding. The specimen is from metamorphic substrate at 3170 m in Virginia Canyon.

Figure 9. Stemless goldenweed (*Stenotus acaulis*), Near County Line Hill, White Mountains, Mono Co, California. (Christopher

Giant deathcamas (*Zigadenus exaltatus*; Figure 10), like little combseed, is more typically in the foothill zone. It is a bulbiferous perennial in the lily family and may reach 1 m in height. Giant deathcamas was on Quartzite of Pilot Ridge (early Paleozoic), a metasedimentary feature northwest of Wawona, in partial shade of ponderosa pine (*Pinus ponderosa*) and incense-cedar (*Calocedrus decurrens*) at 1390 and 1539 m elevation. Its typical range is 600 – 1500 m in the Sierra Nevada foothills. However, the only other collections from our three-county area are from Chinese Camp and nearby Chinese Station at 400 m elevation, approximately 50 km west of the park and approximately 80 km northwest of the new locality (W.L. Jepson JEPS62306, L.R. Heckard JEPS76792, R.F. Hoover UC765941, and Rimo Bacigalupi JEPS17643).

Figure 10. Giant deathcamas (*Zigadenus exaltatus*) on metasedimentary rock, Yosemite National Park, California. 6/9/2005 (USGS-A.E.L. Colwell)

<u>New population locations</u>. We documented 52 new populations of special status species with previous park records (Table 3). Some were from metamorphic features, some from mineralized springs, and some from more common habitats. Survey information (abundance, location, habitat information) is lacking for some populations because either those plant collections were not identified until after field work was completed or collections were from non-target habitats and were encountered during other activities.

Table 3. USGS botanists found 52 new populations of Yosemite special status plant species in 2005, 26 of which they surveyed and mapped. They documented unsurveyed populations by collecting a specimen for deposit in the Yosemite Museum herbarium and University Herbarium, Univ. of California, Berkeley.

Scientific Name	Common Name	Family	New Populations	Surveys	Total Abundance
Agrostis humilis[2]	mountain bent grass	Poaceae	2	0	
Astragalus kentrophyta var. *danaus*[4]	Sweetwater Mtns. milkvetch	Fab.	2	2	>1,100
Carex buxbaumii[4]	Buxbaum's sedge	Cyper.	2	1	
Carex congdonii[4]	mud sedge	Cyper	3	1	366
Carex limosa[2]	bog sedge	Cyper.	1	0	
Claytonia megarhiza[2]	fell-fields claytonia	Portul.	3	3	899
Cuscuta suksdorfii[PS]	mountain dodder	Cuscut.	3	2	4,038
Epilobium howellii[1B, FSS]	Yuba Pass willowherb	Onagr.	1	1	714
Epilobium latifolium[PS]	arctic willowherb	Onagr.	1	1	569
Erigeron barbellulatus[PS]	shining daisy	Asteraceae	1	0	
Erigeron linearis[PS]	yellow daisy	Aster.	1	1	16,600
Isoetes occidentalis[PS]	western quillwort	Isoetaceae	1	0	
Juniperus communis var. *montanus*[PS]	common juniper	Cupress.	2	1	8
Leucothoe davisiae[PS]	Sierra laurel	Ericaceae	1	0	
Lupinus gracilentus[1B]	slender lupine	Fabaceae	1	0	
Lycopus uniflorus[4]	northern bugleweed	Lam.	1	1	20
Minuartia obtusiloba[4]	alpine sandwort	Caryoph.	1	1	500
Mitella pentandra[PS]	bishop's cap	Saxifrag.	1	0	
Piperia colemanii[4]	Coleman's piperia	Orchid.	1	1	41
Plagiobothrys torreyi var. *torreyi*[1B, FSC]	Torrey's popcornflower	Borag.	4	0	
Platanthera yosemitensis[PS]	Yosemite bog-orchid	Orchid.	1	1	2
Polemonium pulcherrimum ssp. *pulcherrimum*[PS]	Jacob's ladder	Polemon.	1	1	102
Polystichum kruckebergii[PS]	Kruckeberg's sword fern	Dryopter.	1	1	3
Potamogeton epihydrus[2]	ribbonleaf pondweed	Potamoget.	2	0	
Pseudostellaria sierrae[3]	Sierra starwort	Caryoph.	3	3	723,837
Salix reticulata var. *nivalis*[2]	snow willow	Salic.	1	1	
Scirpus clementis[PS]	Yosemite bullrush	Cyper.	2	1	24,732
Tofieldia occidentalis ssp.*occidentalis*[PS]	tofieldia	Liliaceae	1	0	

Scientific Name	Common Name	Family	New Populations	Surveys	Total Abundance
Triglochin maritimum[PS]	seaside arrow-grass	Juncag.	3	0	
Triglochin palustris[2]	marsh arrow-grass	Juncagin.	2	2	102,040
Vaccinium parvifolium[PS]	red huckleberry	Ericaceae	2	0	
		Total	52	26	

[1B]CNPS List 1B: Rare, threatened, or endangered in California and elsewhere
[2] CNPS List 2: Rare, threatened, or endangered in California, but more common elsewhere
[3] CNPS List 3: We need more information about this plant (Review List)
[4] CNPS List 4: Species of limited distribution (Watch List)
[FSS] Forest Service Sensitive: U.S. Forest Service, Region 5, Sensitive Plant List
[FSC] Federal Species of Concern: U.S. Fish and Wildlife Service, Sacramento Office
[PS] Park Sensitive

Metamorphic habitats: The majority of new populations of special status plant species occurred on metamorphic substrates at high elevations (i.e., above 3050 m). These included Sweetwater Mountains milkvetch (*Astragalus kentrophyta* var. *danaus*), Congdon's sedge (*Carex congdonii*), arctic willowherb (*Epilobium latifolium*), shining daisy (*Erigeron barbellulatus*), yellow daisy (*Erigeron linearis*), dwarf juniper (*Juniperus communis* var. *montanus*), showy polemonium (*Polemonium pulcherrimum* ssp. *pulcherrimum*), Kruckeberg's swordfern (*Polystichum kruckebergii*), snow willow (*Salix reticulata* var. *nivalis*), and western tofieldia *Tofieldia occidentalis* ssp. *occidentalis*. The exception was Sierra starwort (*Pseudostellaria sierrae*). We found three populations of this species on areas mapped as Quartzite of Pilot Ridge (early Paleozoic) at approximately 1900 m elevation. Sierra starwort was recently separated from sticky starwort (*P. jamesiana*) (Rabeler and Hartman 2002) based on differences in pubescence (*P. sierrae* glabrous), inflorescence type (flowers solitary in *P. sierrae*, cymose in *P. jamesiana*), and stamen number (5 in *P. sierrae* vs. 10 in *P. jamesiana*). Rabeler and Hartman (2002) listed two Tioga Road collections from Yosemite one of which provided the Gin Flat locality of our first collection.

Two CNPS List 4 species in this list, Sweetwater Mountains milkvetch and Congdon's sedge, as well as showy polemonium, are occasional in Yosemite's alpine areas. The Sweetwater Mountains milkvetch is endemic to the central and southern Sierra Nevada and the White and Sweetwater mountains (Botti 2001, Taylor *in prep*, Jepson Online Interchange 2004). It appears to be restricted to metamorphics in the alpine zone at least in the Tioga Pass region. Congdon's sedge, a central and southern Sierra Nevada endemic, is more frequent and occurs on both granitic and metamorphic talus or cliff bases in the subalpine (Taylor *in prep*). The more broadly distributed showy polemonium occurs in the Klamath Ranges, High North Coast Ranges, northern and central High Sierra Nevada, and east of the Sierra Nevada (Jepson Online Interchange 2004). Its status is Park Sensitive, and it, like arctic willowherb, shiny daisy, yellow daisy, Kruckeberg's swordfern, snow willow, and western tofieldia, is known from just a handful of sites

(only one site each for arctic willowherb, shiny daisy, yellow daisy, Kruckeberg's swordfern prior to this work).

Mineralized Springs: Species with new populations at mineralized springs included mountain bent grass (*Agrostis humilis*), Buxbaum's sedge (*Carex buxbaumii*), Suksdorf's dodder (*Cuscuta suksdorfii*), and seaside arrow-grass (*Triglochin maritimum*). Buxbaum's sedge was previously known in the park only from Soda Springs in Tuolumne Meadows (2620 m) and Swamp Lake west of Hetch Hetchy Reservoir (1530 m). Our collection from a pond 160 m north of Soda Springs (A.E.L. Colwell AC05-257) and our collection from Lyell Canyon east of Rafferty Creek (A.E.L. Colwell AC05-219) represent a similar range of habitats and add two localities to the park. Suksdorf's dodder was first reported from Yosemite in 2004 (AC04-116, AC04-159) from the Snow Flat area. The 2005 surveys added two localities in Lyell Canyon, both at springs and both associated with other special status plant species (e.g., *Triglochin palustris* and/or *T. maritimum*).

Additions to the park species list from spring surveys included, as indicated above, saltgrass (*Distichlis spicata*), scratchgrass (*Muhlenbergia asperifolia*), and marsh arrow-grass (*Triglochin palustris*). Each of these is known to occur at mesic saline or alkaline sites. The saltgrass and scratchgrass are very widespread throughout California in appropriate habitat.

Other Habitats: The remaining species in Table 3, largely those without survey data, are based on collections made during the course of this project and other work. For example, we found alpine sandwort (*Minuartia obtusiloba*) on gabbro in the course of metamorphic surveys at the north end of the park, and we collected shore sedge (*Carex limosa*) while investigating a meadow habitat. Sierra laurel (*Leucothoe davisiae*) was along an old logging road in a Sierra starwort survey area, and slender lupine (*Lupinus gracilentus*) was along the approach to springs in Alkali Creek.

New Voucher Evidence. In addition to previously-undocumented taxa (Table 2), we provided voucher evidence for three taxa reported from the park (e.g., Botti 2001) but not previously documented with a herbarium specimen (Table 4).

The buckwheat (*Eriogonum prattenianum* var. *prattenianum*) in Table 4 reportedly

Table 4. Collections for three plant species that were unvouchered previously in Yosemite. Previously unvouchered plant species are those with reported locations in S. Botti's *An Illustrated Flora of Yosemite National Park* (2001), but which had no known voucher residing in an herbarium as documentation.

Scientific Name	Common Name	Family
Eriogonum prattenianum var. *prattenianum*	buckwheat	Polygonaceae
Isoetes howellii	Howell's quillwort	Isoetaceae
Sambucus melanocarpa	black elderberry	Caprifoliaceae

occurs in the central and southern Sierra Nevada, although very few collections could be located to document that distribution. There is a single collection from Trumbull Peak west of the park (Taylor and Clifton 11202, JEPS87070), and Botti (2001) reports a single station in the Merced River Canyon below Merced Lake. Our specimen is from a mineralized spring site in the South Fork of the Merced River on granitic rock. The Merced Canyon site is granitic as well but the Trumbull Peak site is metamorphic.

Howell's quillwort (*Isoetes howellii*) occurs throughout the western portion of California from the coast ranges to the Cascade Range and Sierra Nevada foothills. It is a quillwort of seasonally wet places such as vernal pools and the edges of ponds and lakes. Although Botti (2001) indicates it occurs in "scattered locations throughout much Yosemite below the high subalpine," we found no other specimen records for the park and only two for surrounding counties (one from Tuolumne Co. and one from Madera Co.). Our specimen is from a small lake southwest of Pate Valley at 1352 m elevation.

Finally, black elderberry (*Sambucus melanocarpa*) ranges from British Columbia to New Mexico and, according to Botti (2001), is found in the Harvey Monroe Hall Research Natural Area northeast of Tioga Pass and along the Dana Fork of the Tuolumne River. It is more typically an east slope species in our region (Botti 2001), and it appears to be under-collected throughout California as we located only four voucher records, none from the Yosemite area. We collected this species on the slope southwest of Virginia Pass in the head of Virginia Canyon at 3091 m elevation.

Under-documented species and range extensions. In addition to specimens of unvouchered taxa, we made collections of species for which there appeared to be just one or two previous specimens from Yosemite, e.g., Holboell's rock cress (*Arabis holboellii var. pendulocarpa*), Lyall's rock cress (*Arabis lyallii* var. *lyallii*,), western mountain aster (*Aster occidentalis* var. *occidentalis*), woolly-pod locoweed (*Astragalus purshii* var. *lectulus*, specimen from boundary between Tuolumne and Mono counties).

We added to the known distribution in the park for several other rarely-collected taxa as well: gray tansy mustard (*Descurainia incana*), hairy water-clover (*Marsilea vestita* ssp. *vestita*), naked buckwheat (*Eriogonum nudum var. scapigerum*), desert yellow fleabane (*Erigeron linearis*), snow willow (*Salix reticulata* var. *nivalis*), and Sierra starwort (*Pseudostellaria sierrae*). For example, we found and mapped populations of the newly described Sierra starwort where the only previous records consisted of two decades-old collections from 'Tioga Road' (Rabeler and Hartman 2002). We surveyed and mapped a desert yellow fleabane population over 40 km from the only previously-documented population and snow willow over 20 km from the only two previously reported occurrences in Yosemite. Three previous collections of the gray tansy mustard (UC551451, UC164736, SJSC13249) formed the basis for its previously-known occurrence in Yosemite; we added a new locality southwest of Bigelow Peak at the north end of the park (Colwell AC05-319). Only one previous collection documented the occurrence of hairy water-clover in the park (UCR19525); our collection adds a new locality at a small lake southwest of Pate Valley (AC05-50).

Bryophytes. In documenting vascular plant occurrence, we made some associated moss collections. The collections from marble substrates appear to be most interesting thus far (James Shevock and Dan Norris, pers. comm.). There are two collections of Jungerman's platydictya moss (*Platydictya jungermannioides*), one from upper Jack Main Canyon and one from south of Mt. Hoffman (Alison Colwell AC05-269 and AC05-78). This is a new park record of a species that is found sparingly throughout California most often in shaded creek valleys (Dan Norris, pers. comm.). Even more interesting, the latter collection from south of Mt. Hoffman included a fragment of an additional species that almost certainly is new to science at the genus level (J. Shevock, pers. comm.). It is clearly not known from North America. Further work in 2006 is planned to verify and scientifically describe the new species.

Additional observations. In addition to vouchered and mapped populations, we are submitting to the NPS 38 observations of special status plant species encountered during 2005 field work (Appendix D). Among these there are six species listed as Park Sensitive, four species on CNPS List 4 (watch list), one species on CNPS List 3 (review list), one species on CNPS List 2 (Rare, threatened, or endangered in California, but more common elsewhere), and two species on CNPS List 1B (Rare, threatened, or endangered in California and elsewhere).

We did not voucher these locations because they were not in our target habitats and were largely species rated lower priority for surveys (Moore et al. 2005). That is, there was insufficient time during the short 2005 growing season to survey many off-target habitats or species. However, we offer these observations as fodder for future surveys that aim to derive baseline status information for additional sensitive plant species or to establish monitoring efforts.

Soil analysis results

Metamorphic substrates. Soil samples from metamorphic sites, were low in macronutrients (N, P, K, Mg; Table 5). The exceptions were high phosphorus at the marble sites and high calcium at most sites. Some of the highest calcium values were from marble sites (6.92 – 22.48 cmol/kg, mean=12.2 cmol/kg) with coincident higher pH values (6.9 – 8.1, mean=7.75). The relatively high calcium values at non-marble sites (1.62 – 8 cmol/kg, mean=4.2 cmol/kg), nevertheless, suggest the presence of marble in the substrate (A. Kruckeberg, pers. comm.). The preponderance of non-marble components at these sites, however, resulted in slightly more acidic soils (pH=5.4 – 7.1, mean=6.1). Base saturations also reflect the moderate acidity of the non-marble sites (mean base saturations=85 percent) in relation to the marble sites (mean base saturations =99.7). Although no special status species occurred at the purely marble sites, snow willow (*Salix reticulata*), daggerpod (*Phoenicaulis cheiranthoides*), Sweetwater Mountains milkvetch (*Astragalus kentrophyta* var. *danaus*), Holboell's rock cress (*Arabis holboellii* var. *pendulocarpa*) occurred at sites with high calcium levels. Yellow daisy (*Erigeron linearis*) was on a soil largely derived from marble along with other metamorphic parent material. Soil pH at that site was 7.8 and base saturation was 100 percent.

Table 5. Soil sample analysis results from metamorphic sites surveyed for special status vascular plant species in 2005, Yosemite National Park, California. CEC=Cation exchange capacity. OM=organic matter content. BSP=Base saturation percentage (relative proportion of Ca^{2+}, Mg^{2+}, K^{+}, Na^{+} [i.e., common cations not including H^{+} and Al^{3+}] on soil particle surfaces; see text).

Survey Code	Type	CEC (Meq/100g)	OM (%)	pH	N (ppm)	P (ppm)	Cations (cmol/kg)				BSP
							K	Ca	Mg	Na	
PSSI10-1	Meta	5.8	14.8	6.2	2	21	0.35	4.43	0.30	0.06	88.1
PSSI10-2	Meta	4.7	15.5	5.6	5	60	0.28	3.04	0.26	0.04	76.4
PSSI10-3	Meta	4.6	7.5	6.2	2	54	0.25	3.40	0.35	0.04	87.9
PHCH10-1	Meta	8.9	2.8	6.3	7	19	0.33	6.97	0.46	0.19	89.4
ASKE12-1	Meta	8.1	3.2	6.1	6	21	0.41	5.86	0.63	0.12	86.0
POPU10-1	Meta	3.2	1.6	7.1	5	12	0.15	2.73	0.24	0.07	99.9
SARE10-1	Meta	9.8	6.8	6.1	6	9	0.14	8.00	0.20	0.09	85.9
Substrate7	Meta	2.4	3.9	5.7	8	25	0.09	1.62	0.12	0.06	79.1
Substrate6	Mbl	3.4	12.8	5.4	9	31	0.16	2.05	0.16	0.03	71.5
Substrate2	Mbl	10.6	2.7	7.9	3	32	0.04	10.26	0.33	0.04	100
Substrate3	Mbl	7.3	2.8	6.9	6	35	0.06	6.92	0.16	0.04	98.5
Substrate4	Mbl	11.1	3.2	7.7	5	24	0.09	10.73	0.23	0.04	100
Substrate8	Mbl	11.5	2.3	8.1	6	24	0.07	11.30	0.17	0.02	99.9
Substrate9	Mbl	12.2	2.4	8.1	5	16	0.05	11.80	0.29	0.04	99.9
ERLI20-2	Meta/ Mbl	23.1	3	7.8	6	28	0.09	22.48	0.53	0.03	100

Not surprisingly, organic matter was highest at the three lower elevation, forested sites where Sierra starwort (*Pseudostellaria sierrae*) occurred (Table 5, PSSI10-1, 2, 3). Of the metamorphic sites visited, these sites had the deepest soils, moderately acidic pH values ranging from 5.6 to 6.2, some of the lowest calcium levels, and high levels of other macronutrients (P, K, Mg). More surprising is the high cation exchange capacity at the alpine ridge site with yellow daisy (*Erigeron linearis*; 23.1 meq/100g). It was not associated with high organic matter content (OM=3%), so it is presumably due to higher clay content than the other metamorphic substrates sampled (clay content not measured). Other unusual species at that site included Eaton's fleabane (*Erigeron eatonii* var. *sonnei*), daggerpod (*Phoenicaulis cheiranthoides*), and long-leaved hawksbeard (*Crepis acuminata*). The former two are more typical of the east slope; the hawksbeard is occasional at lower elevations in Yosemite.

Mineralized Springs. Mineral Spring 2 soil (one of three springs visited in Lyell Canyon) was saline with a sodium level over 6.12 cmol/kg and a pH value of 8 (Table 6). This site supported the halophyte *Triglochin palustris* and the parasitic plant *Cuscuta suksdorfii*. Similarly, Mineral Spring 8 in Lyell Canyon was saline and supported a near monoculture of the halophyte seaside arrow-grass (*Triglochin maritimum*). Calcium levels were high at nearly all springs while nitrogen and magnesium were low and phosphorus was variable. Sites that were fairly alkaline (pH > 7.3) were limited to those between Soda Springs in Tuolumne Meadows and Lyell Canyon (TRPA20-2, CUSU20-2, TRPA20-1/CUSU20-1, MS-8). In contrast, soil samples from Snow Creek (mapped as glacial deposits) were strongly acidic (pH=4.4-4.8). *Cuscuta suksdorfii* occurred at one of

the Snow Creek sites in 2004 as well as *Agrostis humilis*, a CNPS List 2 species (soon to be subsumed in Flora of North America under *A. thurberiana*, a more common species; M.J. Harvey, pers. comm.). The other strongly acidic site was the mineral spring above Merced Lake near Washburn Lake (MS-5) with a pH of 4.9 and a base saturation of 56 percent. No special status species occurred at that site though it was the second recorded occurrence of *Muhlenbergia asperifolia* for the park.

Table 6. Soil sample analysis results from mineralized springs surveyed for special status vascular plant species in 2005, Yosemite National Park, California. CEC=Cation exchange capacity. OM=organic matter content. BSP=Base saturation percentage (relative proportion of Ca^{2+}, Mg^{2+}, K^{+}, Na^{+} [i.e., common cations not including H^{+} and Al^{3+}] on soil particle surfaces; see text). TRPA=*Triglochin palustris*, CUSU=*Cuscuta suksdorfii*, TRMA=*T. maritimum*.

Survey Code	Species	CEC (Meq/ 100g)	OM (%)	pH	N (ppm)	P (ppm)	Cations (cmol/kg)				BSP
							K	Ca	Mg	Na	
MS-1	TRPA	19.6	5.7	7.7	12	23	0.15	18.03	0.85	0.61	100
MS-2	TRPA, CUSU	23.6	1.6	8	3	11	0.20	14.44	2.90	6.12	89
MS-3		12	12.6	5.5	65	26	0.38	7.34	0.33	0.86	74
MS-4		8.7	6	6.8	12	13	0.12	7.54	0.39	0.44	97
MS-5		6.4	5.3	4.9	1	13	0.14	2.70	0.31	0.46	56
MS-6		21.1	4.7	7.1	9	22	0.24	17.78	1.09	2.00	100
MS-7		6.7	5.8	6.3	7	12	0.07	5.30	0.48	0.19	89
MS-8	TRMA	27.9	13.4	7.7	3	72	1.57	17.23	2.35	6.83	100
MS-9	CUSU	15.8	3	8.2	11	41	0.31	11.55	1.84	2.12	100
MS-10		5.2	5.3	6.2	4	29	0.08	3.66	0.39	0.49	88

Water analysis results

The pH values of sampled spring waters were near neutral, ranging from 6.3 to 7.6 (median=6.6; Table 7). Conductivity varied from 1.74 to 9.2 microSiemens/centimeter (mS/cm). Conductivity reflects the quantity of dissolved salts or salinity and influences the kinds of plants that a site can support. For comparison, sea water has an electrical conductivity of 5 mS/cm and drinking water typically falls between 0.0005 and 0.05 mS/cm. Some of the highest values we found were from MS-8 and MS-9 in the Lyell Fork and MS-4 in Piute Creek. Alkalinity, a measure of the acid neutralizing capacity (ANC) of a solution, was more problematic due to the speed with which samples deteriorate after collection and prior to analysis. Validated lab alkalinities were wide ranging, varying from 88 to 1110 mg/L. Again, the highest values were from springs in the Lyell Fork (MS-9 and MS-10). Potassium, magnesium, and sulfate values were high in spring water samples; sodium, iron, and chloride values were very high. Calcium values were very high as well, particularly at MS-6 (S Fork Merced River), MS-8 (Washburn Lake), and MS-3 and MS-4 above Piute Creek.

Table 7. Spring water sample analysis results from mineralized springs surveyed for special status vascular plant species in 2005, Yosemite National Park, California. Species=rare species occurring on site. pH=measure of acidity. EC=electrical conductivity in microSiemens/centimeter. Alk=alkalinity as $CaCO_3$. B=boron, Ca=calcium, Cl=chloride, Fe=iron, Mg=magnesium, K=potassium, Na=sodium, SO_4=sulfate. TRPA=*Triglochin palustris*, CUSU=*Cuscuta suksdorfii*, TRMA=T*riglochin. maritimum*.

Survey Code	Species	pH	EC mS/cm	Alk mg/L	B ug/L	Ca mg/L	Cl mg/L	Fe ug/L	Mg mg/L	K mg/L	Na mg/L	SO_4 mg/L
MS-1	TRPA	6.3	1.76	--	1.47	210	58	5.59	20.9	6	232	21
MS-2	TRPA, CUSU	7.6	2.56	--	4.73	93	624	0.25	44.1	3.44	243	31.6
MS-3		6.7	5.63	102	2.55	554	1810	4.14	14.4	6.5	517	35.3
MS-4		6.9	7.70	88	3.69	782	2510	3.18	17.7	9.5	752	48.4
MS-5		6.0	4.65	256	20.5	539	1510	4.07	48.4	18.5	543	46.4
MS-6		6.5	6.92	296	0.48	818	1550	13.3	149	13.8	568	69.7
MS-8	TRMA	6.8	6.80	--	--	--	--	--	--	--	--	--
MS-9	CUSU	6.4	9.20	1110	0.44	259	1750	14.7	106	59.9	1240	31.6
MS-10		6.6	5.18	822	10.5	208	1070	1.51	21	24.8	885	59.8

Novel vegetation

Phacelia hastata– Phlox diffusa – Erysimum capitatum on marble. Patterns of co-occurring species appeared to emerge in association with particular habitats surveyed. One was the fairly consistent occurrence of timberline phacelia (*Phacelia hastata*), spreading phlox (*Phlox diffusa*), and western wallflower (*Erysimum capitatum* var. *perenne*) on marble outcrops. These three species co-occurred on seven out of eight marble outcrops in the vicinity of Mt. Hoffman and Jack Main Canyon between 2500 and 3030 m (8,260 and 9,950 ft.; survey codes Substrate2, Substrate3, Substrate4, Substrate8, Substrate9, ERLI20-2, and an un-coded site in upper Jack Main Canyon). At one of the Mt. Hoffman sites (Substrate4) and the upper Jack Main Canyon marble, *Phacelia* and *Erysimum* occurred while *Phlox* was not present.

The six sites for which we recorded detailed information had low total vegetative cover averaging 20.5 percent. Shrubby species did not dominate, but sagebrush (Artemisia sp.) and Wright's buckwheat (*Eriogonum wrightii* var. *subscaposum*) were present at half of the sites (Table 8). *Erysimum capitatum* and *Phlox diffusa* had 100 percent constancy but low cover while *Phlox diffusa* had 83 percent constancy but relatively high cover. Other species commonly occurring among these eight sites included squirreltail grass (*Elymus elymoides* ssp. *californicus*), alpine paintbrush (*Castilleja nana*), yarrow (*Achillea millefolium*), and cushion buckwheat (*Eriogonum ovalifolium* var. *nivale*). An additional nine species occurred at a third of the marble sites, and an additional 29 species occurred at one marble site each.

Table 8. Cover and constancy of species occurring within eight sites representing a putative *Phacelia hastata* ssp. *compacta* - *Phlox diffusa* - *Erysimum capitatum* var. *perenne* Herbaceous Association. All sites were located on marble outcrops. Values based on seven sites for which quantitative information is available.

	Species	**Const**	**Mean % Cover**
Shrubs	Artemisia sp.	50	0.67
	Eriogonum wrightii var. subscaposum	50	0.25
	Ribes lasianthum	17	0.08
Herbs	Erysimum capitatum var. perenne	100	0.50
	Phacelia hastata ssp. compacta	100	1.33
	Elymus elymoides ssp. californicus	83	0.83
	Phlox diffusa	83	6.50
	Castilleja nana	66	0.17
	Achillea millefolium	50	0.25
	Achnatherum occidentale ssp. occidentale	50	0.25
	Arabis sp.	50	0.25
	Calochortus sp.	50	0.25
	Carex rossii	50	0.25
	Eriogonum ovalifolium var. nivale	50	0.67
	Cymopterus terebinthinus var. californicus	50	1.08
	Pellaea breweri	50	0.17
	Arabis lyallii var. lyallii	33	0.17
	Elymus sierrus	33	0.17
	Ivesia gordonii	33	0.58
	Linum lewisii var. lewisii	33	0.17
	Potentilla glandulosa	33	1.00

Aspect on these sites was typically southerly (104 – 192 degrees) with one northerly exception; topographic position was most often midslope with one ridge top situation and one low slope; landform was usually a bedrock outcrop on a hill slope. Soil texture was typically sandy loam to loamy sand. Soil pH was neutral to moderately alkaline (6.9 to 8.1 with most above 7.7) due to the influence of calcium carbonate in the marble. Sodium levels were low (4 to 10 ppm). Soil calcium levels were very high at 6.92 to 22.48 (mean=12.2) cmol/kg (95 to 97 percent base saturation) perhaps accounting for soil alkalinity.

The anomalous marble site where the phacelia, phlox, and wallflower did not co-dominate (Substrate6) had scattered marble boulders near a feature mapped as marble at the head of Virginia Canyon. That site was dominated by mesic site species such as red heather (*Phyllodoce breweri*), bilberry (*Vaccinium caespitosum*), and shorthair reed grass (*Calamagrostis breweri*). None of the diagnostic species was present.

Mineralized springs. There were indications of species occurrence patterns among mineralized springs but these patterns were not as consistent as those found on marble outcrops. The species patterns varied according to the character of the spring. Many of the springs along the South Fork of the Merced River were closely associated with granitic bedrock and had limited areas of mineralized soil. Meadow barley (*Hordeum brachyantherum*), annual hairgrass (*Deschampsia danthonioides*), and Herman's dwarf rush (*Juncus hemiendytus*) occurred at both of the sampled springs in that vicinity, with the *Deschampsia* observed at a third spring and the *Hordeum* at a fourth.

The somewhat more consistent pattern was that of several species occurring in different combinations among the springs stretching approximately 15 to 20 km from Alkali Creek southeast to Soda Springs in Tuolumne Meadows and up Lyell Canyon to approximately Ireland Creek. These were the springs we categorized as those where spring outflow saturates soil and modifies soil chemistry. Seaside arrow-grass (*Triglochin maritimum*) formed near monocultures at two sites while a combination of alpine pyrrocoma (*Pyrrocoma apargioides*), Mexican rush (*Juncus mexicanus*), and short-rayed daisy (*Trimorpha lonchophylla*) characterized four of these spring-affected areas. Seaside arrow-grass occurred at two additional springs along with Suksdorf's dodder (*Cuscuta suksdorfii*) and the above three species. These four sites had among the highest concentrations of soil calcium. The only site with higher percent cation saturation for sodium was Mineral Spring 8 where seaside arrow-grass formed a near monoculture. The other notable feature about the seaside arrow-grass monocultures was the apparent anaerobic condition of the growing substrate (wetland soil) indicated by soil mottling and oxidized rhizospheres (root channels) in the upper 12 inches of the soil.

Another arrow-grass species, marsh arrow-grass (*Triglochin palustris*; CNPS List 2), co-occurred with seaside arrow-grass and short-rayed daisy at two sites. The springs where arrow-grass species (*Triglochin* spp.) occurred had the highest soil pH values among the mineral springs surveyed (7.7 to 8.2 versus 4.9 to 6.3)

Data management

Following NPS Inventory and Monitoring (I&M) guidelines, we stored tabular data in MS Access format and spatial data in ArcView GIS format. The database storing habitat survey results consists of 9 data tables, a separate table for each type of information collected in the field, and 19 tables to provide standardized terms during data entry. Types of information stored in the former include location information, reporter names, site characteristics, vegetation description, associated species, and lists of digital images collected at each site. The latter tables provide 'pick lists' that reduce data entry errors and limit the entries to the possible range of values acceptable for a given field (e.g., topographic quadrangle names, vegetation types, and park plant species list). Currently, there are 15 records in the 'SurveyLocationDescription' table, each record representing a single survey of a habitat not supporting rare plant species. Other tables link to this table via the 'SurveyCode' field. We supplied metadata for this database in the form of field definitions in each table in the MS Access table structure view.

Detailed plant specimen collection information is stored separately in a MS Access database titled, "PlantCollections-2005.mdb." We designed the plant specimen table to match the format needed by the Yosemite Museum for the ANCS+ curatorial database. As a result, the data on each plant specimen can be imported directly into ANCS+ software following duplication of any records for which there are duplicate specimens and for which ANCS+ therefore needs a separate record. The "PlantCollections-2005.mdb" database includes a query and associated report for producing formatted herbarium labels for mounted specimens.

Over the last year, we worked with the NPS application development specialist at Yosemite on the development of a database that stringently meets data management quality standards. It was designed to address the need for NPS managers to store special status plant survey data in the future and to incorporate plant species standardized nomenclature according to the standard used by the I&M Program. We stored all rare plant survey data from 2005 in this database which is accessible to park staff on a computer server.

We specified our spatial data management procedures in the methods section above, including GPS settings and equipment, post processing, vector file creation and how vector files were attributed. The resulting 'rare_plants-2005' vector file contains perimeter data for 26 rare plant populations. The '2005areasurveyed' shape file contains data for 26 survey perimeters.

We mounted and labeled plant specimens to prepare them for accession to the herbarium of the Yosemite Museum (YM) with duplicates available for loan to the University and Jepson herbaria at U.C. Berkeley (UC/JEPS). There are 435 specimens of vascular plants and 31 moss collections in the set. We noted in the database the location of duplicates intended for loan to other institutions using herbarium codes from *Index Herbariorum* (http://sciweb.nybg.org/science2/IndexHerbariorum.asp). We labeled each of approximately 750 digital images with, at a minimum, subject, location, date, photographer, survey code, and any additional relevant information.

Discussion

Field survey results

The approach of seeking special status plant species in unusual habitats of Yosemite was successful in bringing to light species not previously known from the park and additional populations of species rare in the park. Surveys of just 4.6 percent (456 ha) of the area mapped as metamorphic in Yosemite (9930 ha; Huber et al. 1989) added eight additional taxa (0.5 percent of known vascular plants) to a park that has seen botanical work for more than 150 years. Furthermore, surveys covering a total of 512 ha on both metamorphic and mineral spring features detected 28 new special status plant populations (not including those encountered on other substrates). In contrast, an examination of vegetation plot data collected in 1998 and 1999 from 237 sites predominantly (93 percent) on granitic substrates between 860 and 3430 m (2,820 and 11,250 ft.) elevation, did not document new species for the park (unpublished NPS data).

The addition of eight species to the park flora falls short of the 100 year discovery rate of 10.9 taxa per year but exceeds the approximate rate over the last 20 years of 4.25 taxa per year and over the last 50 years of 2.6 taxa per year. This lends some support to the idea that directed searches in unusual habitats are a reasonable approach for documenting some of the rarest members of a flora. Applying equal detection effort across a nature reserve will most thoroughly document species occurrence for the most common habitats.

Species limited to small, atypical habitats are likely to escape detection without focused effort.

Substrate characteristics and species affinities

The relatively consistent patterns of rare plant species occurrence in some of the habitats surveyed, namely metasedimentary substrates and mineralized springs (in part), implies special status plant species have affinities with particular habitats that contribute to the species' rarity. Halophytes have an affinity with habitats in which they can compete and persist through adaptations for dealing with high levels of sodium. The nutrient requirements of some plants leave them ill equipped for nutrient limitations found on acidic soils (i.e., granitic soils).

Metamorphic Substrates. Soils derived from metamorphic rock in the central Sierra Nevada differ from the dominant granitic substrates in both chemical content and physical properties. These properties are relevant to plant distributions because they determine the nutrient status, water holding capacity, and other characteristics to which plants adapt.

The Relevance of Chemical Properties of Metamorphic Rocks. Soils derived from granitic parent material have low fertility and high acidity (Taskey 1995). They tend to have few available basic cations (Ca, K, Mg, Na) due to leaching and poor buffering capacity (resistance to changes in pH or changes in nutrient concentrations) due to the low surface area to volume ratio associated with coarse texture. Plants adapted to acidic soils typically have a low requirement for basic cations and tolerate the higher Al and Mn levels associated with lower pH. Our soil sample data suggest that soils derived from metasedimentary parent material have more available basic cations, indicating higher fertility, and higher base saturations[1] (mean among non-marble metamorphics=85 percent; mean among marble sites=99.7 percent), indicating lower acidity and better nutrient availability.

Dahlgren et al. (1997) found comparable levels of exchangeable cations in igneous soils at a similar elevation to the *Pseudostellaria sierrae* sites (and approximately 70 km south), but lower base saturations at the 0-18 cm depth. Base saturations at the site south of Yosemite were 22 to 46 percent compared with 76 to 88 percent at the *Pseudostellaria* site, indicating higher acidity and reduced cation availability. Calcium levels at our higher elevation metamorphic sites appeared to be higher than those of Dahlgren et al. (1997: 0.89-1.18 cmol/kg), sodium and potassium were generally comparable, and magnesium was slightly higher. However, base saturations of the metamorphic sites appeared to differ quite significantly, ranging from 71.5 to 99.9 percent compared with

[1] Percent base saturation is the fraction of cation exchange capacity (CEC) occupied by the base cations, Ca^{+2}, Mg^{+2}, K^{+1} and Na^{+1}. If calcium has a base saturation value of 50% and magnesium has a base saturation value of 20%, then calcium occupies half of the total cation exchange capacity and magnesium occupies one-fifth of the total. If all the base cations total 100%, then there is no exchangeable acidity. Acidity on a soil test report is the amount of the total CEC occupied by the acidic cations (H^{+1} and Al^{+3}). Percent base saturation is directly related to pH and reflects the availability of base cations.

those of igneous soils at 3 to 10 percent. These low base saturations reflect higher acidity levels of the igneous soils and reduced availability of non-metallic nutrients (e.g., N, K, Ca, Mg; Taskey 1995).

Taskey (1995) posited that ecosystems with high base saturations would be more affected by acidic deposition than systems with low base saturations because biota in the latter are more adapted to acidic conditions. Human alternation of the global nitrogen cycle has acidified soil, decreased soil nutrient levels (e.g., losses of Ca, K), and modified storage of organic carbon (Vitousek et al. 1997). Our results hint at vulnerabilities to the effects of nitrogen deposition in Yosemite's high elevation metamorphic areas, especially their position downwind of the San Joaquin Valley agricultural areas.

The Relevance of Physical Properties of Metamorphic Rocks. The soils derived from metasedimentary parent material tend to be fine grained with a high surface area to volume ratio resulting in higher water holding capacities. Soils on nearby granitic areas have coarse texture and high permeability (Taskey 1995) resulting in lower water holding capacities. Thus, species with higher moisture requirements may be found on the former, such as species that normally occupy higher elevations or species with more northerly distributions. For example, surveys of the metasedimentary areas on the western boundary of the park revealed populations of Sierra starwort (*Pseudostellaria sierrae*). Outside of Yosemite, this species is recorded to date from more northern locations in Plumas, Nevada, Sierra and Placer counties. The populations of this plant found in Yosemite to date are confined to areas of metamorphic substrate. These soils, like the other metamorphic-derived soils sampled, have higher than normal calcium, lower than normal magnesium and low nitrogen. They also have high phosphorus levels and high proportions of organic matter (See Table 5). In the case of Sierra starwort, it may be the physical quality of the soil that affects the distribution of this species more so than the balance of soil nutrient components. This plant forms large patches connected by fine fleshy horizontal rhizomes at 20 cm depth or more. Shallow, coarse grained, granitic soils may not as readily support this habit. Stebbins (1980) reiterated the observation by John Muir (1912: Chap. 7) that giant sequoia (*Sequoiadendron giganteum*) "grows only in the parts of the Sierra Nevada that escaped the glacial ice, and are underlain by deep, heavily weathered soils." In Yosemite, the groves of giant sequoias are limited largely to areas mapped as metasedimentary or metavolcanic (Dodge and Calk 1987, Peck 2002), and the *Pseudostellaria* is found adjacent to the Tuolumne Grove of giant sequoias.

Other examples of plants with more northerly distributions discovered on metamorphic sites during these surveys are: Kruckeberg's swordfern (*Polystichum kruckebergii*), upswept moonwort (*Botrychium ascendens*), and arctic willowherb (dwarf fireweed, *Epilobium latifolium*). During these surveys, we found no examples of species occurring at lower than normal elevational ranges on metamorphic substrates, although snow willow and showy polemonium (*Polemonium pulcherrimum* ssp. *pulcherrimum*) were at the lowest end of their known elevational ranges.

<u>Mineral Springs</u>. Although three species new to the park occurred at mineralized springs, the majority of springs did not support species new to the park or special status species.

However, springs where the most unusual species occurred had the most unusual soil chemistry. The most alkaline sites supported *Cuscuta suksdorfii*, *Triglochin maritimum*, and *T. palustris*. Sites with low cation exchange capacities typical of the region did not support special status species or species new to the park (MS-5, MS-7, and MS-10).

High levels of soil salinity, like that of mineral springs 2 and 8 along the Lyell Fork of the Tuolumne River, impose extreme stresses on plants by lowering water availability in the soil. The accumulation of toxic ions such as sodium, chloride, and magnesium can disrupt plant metabolism (Gauch and Wadleigh 1944). Saline soils often have low fertility due to limited nitrogen. As a result, plants at these sites are often limited to those adapted to such conditions or those that can only compete under such conditions (Bacca 1995). Saltgrass (*Distichlis spicata*) is known to be a strong competitor in such conditions and, in the presence of disturbance, to threaten a special status species adapted to saline conditions (*Puccinellia howellii*; Bacca 1995). This could be a consideration in monitoring *Cuscuta suksdorfii*, *Triglochin maritimum*, and *T. palustris* populations.

Spring waters. Our investigation of spring-water chemistry found characteristics that differed from freshwater springs but were comparable to soda springs sampled by others in the Sierra Nevada. Feth et al. (1964) sampled both ephemeral and perennial freshwater springs and found alkalinities averaging 20 and 54 mg/L, respectively. This contrasts with our mean of 445 mg/L (range=88-1110 mg/L). Mariner et al. (1977) sampled thermal springs in the central Sierra Nevada. Their results were more comparable, bracketing our values and ranging from 28 to 1880 mg/L (mean=749 mg/L). Presser et al. (1980) investigated nonthermal soda spring waters and, of those occurring on granitic substrates, alkalinities were consistently high, ranging from 1200 to 2400 mg/L. Not surprisingly, our samples were consistently higher in calcium, chloride, iron, magnesium, potassium, sodium, and sulfate than those of Feth et al. (1964) from ephemeral and perennial freshwater springs. In contrast, we obtained comparable values to Presser et al.'s (1980) soda spring samples for calcium, chloride, magnesium, potassium, sodium, and sulfate, resulting in nearly the same range of values. The exceptions were a higher value for sulfate at MS-10 and a higher value for potassium at MS-9 that somewhat exceeded values in Presser et al. (1980). Calcium values from thermal springs sampled by Mariner et al. (1977) ranged from 1.4-120 mg/L (mean=50.3) while ours ranged from 93 to 818 mg/L (mean=406). Our results for chloride and magnesium also appeared to be higher; whereas, levels of boron, potassium, and sodium appeared comparable.

Spring-water chemistry varies according to contact with different types of bedrock, water source (e.g., deep vs. shallow groundwater), residence duration, and other factors. Our results were comparable to results from other mineralized springs in the Sierra Nevada (Presser et al. 1980). The chemical makeup of water from these springs appears to increase soil salinity and chloride and magnesium levels. This sometimes selects for plants that tolerate such conditions. Where that is not the case, springs nevertheless support different plant species composition than surrounding areas in the same habitat no doubt due to longer periods of water availability.

Mineralized springs in Yosemite play a role in habitat use by wildlife as well. Mule deer (*Odocoileus hemionus*) frequent mineralized springs judging by the multiple, well-formed trails accessing many of the sites, the abundance of hoof prints, and soil removal observed at a number of springs (Snyder et al. 1989). We observed birds that prefer open ground (e.g., Killdeer) using the areas with low vegetative cover around springs. However, most of the springs visited are ephemeral and dry by mid-summer, limiting their role as reliable water sources.

Floristic relationships

Among species found during these surveys, both park records and special status species, there are some with Great Basin affinities, some with more northern affinities, and some more common at lower elevations in the California Floristic Province. Of the park records, *Erigeron linearis*, *Viola purpurea* ssp. *venosa*, *Erigeron clokeyi*, and *Erigeron eatonii* ssp. *sonnei* are more typical of the Great Basin (although *E. clokeyi* also occurs in California's desert mountains). Their occurrence along the northern and northwestern boundary of the park may be partly a consequence of geographic proximity and shared floristic history with the Great Basin at the eastern boundary of Yosemite (Taylor 1977), and partly that they are adapted to the chemical properties of metamorphic substrates that predominate east of the Sierra Crest (Huber et al. 1989). Taylor (1976) considered several species to be disjunct Great Basin species that migrated west of the Sierra Crest during the warm, dry Xerothermic Period (6600 to 3500 B.P.). These include *Stenotus acaulis*, *E. linearis*, and *Phoenicaulis cheiranthoides*. Other species at our survey sites that Taylor (1976) considered Great Basin disjuncts on azonal soils include *Astragalus purshii* var. *lectulus* (with *Phoenicaulis cheiranthoides*), *Crepis acuminata* (with *Erigeron linearis*), and *Poa cusickii* (with *Carex congdonii*). It is not surprising that the species of the most xeric, rocky habitats on high elevation ridges (all of the above) are those having affinities with the flora of the xeric Great Basin bioregion (Stebbins 1982, Kimball et al. 2004). Stebbins (1982) recognized 16 percent of the montane, subalpine, and alpine flora of the Sierra Nevada to be of Great Basin origin and 39 percent originating from the Western Cordillera.

Species with Cascade-Sierran and other Western Cordilleran affinities likely migrated down the Cascades to establish their central and southern Sierra Nevada ranges (Chabot and Billings 1972, Raven and Axelrod 1978). Even disjunct Rocky Mountain species were more likely to migrate via the Western Cordillera than across the Great Basin even during the Pleistocene (Chabot and Billings 1972). *Tofieldia occidentalis* ssp. *occidentalis*, a species of boggy areas, has eastern U.S. affinities and belongs to a circumpolar group (Stebbins and Major 1965), but the subspecies is known outside California only from southwestern Oregon. Within California it occurs on the north coast and in the Cascade range (Jepson Online Interchange 2004). Other examples of species from our surveys with northern affinities include *Carex buxbaumii*, *Triglochin maritimum*, *T. palustris* from springs and *Epilobium latifolium* and *Salix reticulata* var. *nivalis* from alpine metamorphic sites.

Species from lowland California that showed up in our surveys at low elevations near the western park boundary include *Pectocarya pusilla* and *Zigadenus exaltatus*. *Z. exaltatus* was first described by Alice Eastwood from a collection by F. E. Blaisdell at Mokelumne Hill in Calaveras County (GH 30212; Eastwood 1906), and it is currently known only from the Sierra Nevada foothills (Jepson Online Interchange 2004). Anticipated changes in climate could result in the expansion of additional foothill species into the western portion of the park.

Kimball et al. (2004) suggest that Sierra Nevada species of high elevation wet sites tend to have large ranges perhaps because they are species with northern affinities at the southern extent of widespread mesic or wet habitats. They further suggest that species of dry, rocky habitats have small ranges perhaps because they are isolated from dry mountains and have diverged from other dry-mountain species due to this isolation. Species found during these surveys partially support this hypothesis. Wet site species *Carex buxbaumii*, *C. limosa*, *Lycopus uniflorus*, *Mitella pentandra*, *Polystichum kruckebergii*, *Triglochin palustris*, and *T. maritimum* have large ranges extending to Alaska or circumboreal regions. Dry site species *Carex congdonii* and *Erigeron barbellulatus* have narrow ranges in the Sierra Nevada (plus southern Cascades in California for *E. barbellulatus*; also consider *Eriophyllum nubigenum* which is restricted to dry, granitic gravel with low organic matter content on domes of Mariposa Co., central Sierra Nevada). Exceptions include *E. linearis*, *Juniperus communis*, and *Polemonium pulcherrimum* var. *pulcherrimum* with their broad ranges and xeric, high-elevation habitat preferences and *Scirpus clementis* with its wet habitat preference and small range in the central and southern Sierra Nevada.

Plant communities

Novel vegetation. From among 1,900 plots that formed the basis of a vegetation classification for Yosemite National Park and surrounding areas, no community emerged with the diagnostic species *Phlox diffusa*, *Phacelia hastata* ssp. *compacta* and *Erysimum capitatum* var. *perenne* (NatureServe 2004). However, marble sites were not sampled during that effort, most likely due to their rarity. The only recognized association with *Phacelia hastata* ssp. *compacta* as a diagnostic species is the *Hulsea algida-Ericameria discoidea-Phacelia hastata* ssp. *compacta* Herbaceous Vegetation in the *Hulsea algida* Alliance, a truly alpine type (NatureServe 2004). An alpine *Phlox diffusa* Herbaceous Alliance is recognized for Washington State with two described associations: *Phlox diffusa* ssp. *longistylis* - *Arenaria capillaris* Herbaceous Vegetation and *Phlox diffusa* ssp. *longistylis* - *Carex spectabilis* Herbaceous Vegetation (NatureServe 2005). Hamann (1972) considered this to be pioneer vegetation on alpine slopes with little soil development. A single, undescribed *Phacelia hastata* Sparsely Vegetated Vegetation is recognized from the Rock Mountains of Montana and Alberta with a single association recognized thus far (NatureServe 2005). *Erysimum capitatum* is not a diagnostic species for any existing alliance or association, and the *Phlox* and *Phacelia* are not diagnostic for any recognized types in California.

We surmise the putative *Phacelia hastata* ssp. *compacta – Phlox diffusa – Erysimum capitatum* var. *perenne* Association may be limited to marble substrates in the Yosemite region, but it requires more sampling for verification. Additional marble features are available for sampling at 1) Hoffman Creek (a fourth site we did not visit in that vicinity); 2) 2.25 km north of Mt. Hoffman on the Tuolumne/Mariposa county boundary (a steep site;); 3) southwest of May Lake and west of the trail to May Lake within a feature mapped as calc-silicate hornfels, quartzite, and schist (Allen Glazner, Univ. North Carolina, pers. comm.); 4) Cathedral Creek downstream from the May Lake-Glen Aulin trail; and 5) the west side of Gray Peak (safe access should be assessed; Peck 1980; Appendix C).

Relationships with previously described vegetation. Our single sample with *Salix nivalis* can be placed within the *Salix nivalis* Association of Pemble (1970) on the basis of species composition and environmental setting. Of his eight samples, six occurred on marble substrate, two on "metamorphic other than marble." The new sample had 21 species total, including 26 percent (10 of 38) of the species on Pemble's "metamorphic other than marble." The diagnostic species, *Salix nivalis*, was present on the new site, but neither the non-marble differential species, *Carex haydeniana*, nor the marble differential species, *Thalictrum alpinum*, occurred within our plot. However, half of the species on the new site occurred on sites Pemble classified as *Salix nivalis* Association, including some of Pemble's species with the greatest constancy. The new sample was on calc-silicate hornfels with some marble present in the boulders on the site (per HCl fizz test). Topographic characteristics, soil drainage, soil pH, total vegetative cover, bare ground, and litter were similar on the new site to Pemble's habitat description. The setting was similar as well; the new sample was near the base of a slope in a "depression with persistent snow," ensuring late season moisture availability. Some of our sites also support Pemble's *Muhlenbergia richardsonis* - *Achnatherum pinetorum* Association (site ASKE12-1) and Taylor's (1984) *Sambucus racemosa* var. *microbotrys* - *Carex congdonii* Association (site CACO90-1).

Potential threats to species in unusual habitats

Implications of climate change. There is now a preponderance of evidence to show that observed changes in geographic ranges, population biology, and the timing of life-history events are consistent with a climate change explanation (McCarty 2001, Parmesan 1996, Root et al. 2003, Walther et al. 2002). As a result, it is reasonable to assume that habitat quality for Yosemite's higher-elevation plant species may be declining. Artificial warming experiments have shown declines in plant fitness (decreased flower production and increased bud loss; Saavedra et al. 2003, Penuelas el al. 2004), indicating species decline in response to climate change. This has implications for the persistence of vulnerable, high-elevation species within the park and within the region.

Species with specialized requirements or at the limits of their physiological tolerance are among the most vulnerable to climate change impacts (IPCC 2001, Dirnbock et al. 2003). Drummond's anemone (*Anemone drummondii*) and snow willow (*Salix nivalis*) occurred adjacent to two permanent snowfields at 3173 m (10,410 ft.) elevation on the Dunderberg

Peak 7.5 minute topographic quadrangle (USGS 1990; Figure 11). Only two other populations of snow willow are known to occur west of the Sierra crest (National Park Service unpublished data), and the species is limited in the Sierra Nevada to scattered populations from Parker Pass to Virginia Canyon, a distance of approximately 30 km. Habitat is largely unglaciated surfaces in the high alpine (Taylor *in prep*.) on metamorphic substrates (Pemble 1970). Drummond's anemone is known in California from the Sierra Nevada, southern Cascade Range, and the Klamath Ranges (thence to Idaho and Alaska). All of the 82 specimens represented in the Consortium of California Herbaria (Jepson Online Interchange 2004) are from northern Mono County and north, implying the park may be at the southern edge of the species' range. In the Yosemite region, Drummond's anemone is known only from sites above 2865 m (9,400 ft.). Occurrence is typically limited to snow accumulation sites on the lee of ridges and cirques (Taylor, *in prep*.). These two species, with populations at sites that may have had longer growing seasons in recent years due to earlier loss of snowpack (in spite of recent heavy winters), may be candidates for monitoring for changes in distribution and abundance along with more common members of the alpine flora.

Figure 11. Drummond's anemone (*Anemone drummondii*, left arrow) and snow willow (*Salix nivalis*, right arrow), both rare in Yosemite, occurred adjacent to permanent snowfields at the head of Virginia Canyon. (USGS-Peggy Moore)

The restricted and discrete nature of habitat 'islands,' whether alpine retreats, non-granitic soils, or mineralized springs, may retard the ability of species to migrate in response to climate change (Collingham and Huntley 2000, Malcolm et al. 2002). Collingham and Huntley (2000) found that simulated migration rates slowed dramatically when habitat availability fell below 25 percent of the landscape. And rates decreased most markedly when habitat patches were isolated and few in numbers (Collingham and Huntley 2000). Although modern migration rates are typically lower than immediately post-Pleistocene, it is difficult to predict whether rates will increase or decrease with global warming (Malcolm et al. 2002).

Other potential threats. The extreme small size of some of the unusual habitats makes the plants that occupy them vulnerable to local extinction due to localized events. In some cases, mineral springs surveyed had such low flow levels that, despite bearing highly mineralized water, there was insufficient flow to create a spring habitat to support specialist communities. Should flow rates at more productive springs be modified by anthropogenic impacts to the local environment, those habitats may no longer support the rare halophytes present today. For example, trail-related blasting occurred at a spring sampled near Washburn Lake, and a road in Tuolumne Meadows bisects a spring that

ceased flowing coincident with road realignment and adjacent infrastructure changes (the spring is still evident along the road accessing the current location of the concession corral; it is marked with a rock ring at the historic emergence point where a couple of species persist that are typical of local springs; light colored bare soil surrounds the rock ring).

Management Implications

We found some of the most unusual habitats to harbor some of the most unusual and rare species in Yosemite. In light of this, mineral springs, marble outcrops, and other unusual habitats should be considered for protection from administrative and other activities (e.g., wilderness base camps, stock use, fire suppression, etc.). To the extent that rare plants have been surveyed and mapped, as in this effort, that information can be used in planning. In other cases, review of available habitat information (e.g., vegetation types, geology maps, other map resources) can help reduce impacts to rare plants and plant communities.

Between surveys of selected habitats and more opportunistic encounters, we added 14 species to the park list, including two species on the park's list of special status plant taxa expected to occur in the park. The expected taxa were snow willow (*Salix nivalis*; no previous voucher specimens from the park) and Yuba Pass willowherb (*Epilobium howellii*). These taxa were expected to occur in the park because their range overlaps the park, and there is suitable habitat available. Drummond's anemone and daggerpod are known outside the park from within five km of new park populations and Clokey's fleabane (*Erigeron clokeyi*) from within 34 km; little combseed (*Pectocarya pusilla*) and giant deathcamas are known from the foothill zone outside the park. However, upswept moonwort and forget-me-not popcornflower (*Plagiobothrys myosotoides*) are disjunct from known ranges by 62 km south and 80 km north, respectively. With records of several hundred additional taxa in the region for which the park has habitat (Dean Wm. Taylor, pers. comm.) as well as the occurrence of unexpected taxa, the park's vascular plant inventory appears less than complete. A more complete accounting of Yosemite's floristic diversity would be well served by additional work on unsurveyed metamorphic features as well as other unusual habitats.

The addition of bryophyte taxa to the park list, including a moss genus new to science, indicates the nonvascular plant inventory for Yosemite is incomplete as well. Continued support of efforts to further our knowledge on the diversity and distribution of plant life in Yosemite will go a long way in informing management decisions on many fronts.

Although assessing biodiversity is an important aspect of protected area management, managers are faced with diminishing returns for effort expended to find and document the rarest species. So, efficiencies such as those presented here may be helpful if additional such work is to be attempted. This is particularly true for larger reserves where travel time is a large proportion of the data collection cost.

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Appendix A. Field form for rare plant survey in unusual habitat of Yosemite National Park, California, 2005.

California Natural Diversity Database Department of Fish and Game 1807 13th Street, Suite 202 Sacramento, CA 95814 Fax: (916) 324-0475 http://www.dfg.ca.gov/whdab/natspec.pdf	*For CNDDB Use Only* Source Code _____ Quad Code _____ Elm Code _____ Occ. No. _____ EO Index No._____ Map Index No._____	Resources Management Yosemite National Park P. O. Box 700 El Portal, CA 95318 Fax: (209) 379-1116

Survey Code:	**Date (yyyy-mm-dd):** _____ - _____ - _____

California Native Species Field Survey Form – NPS Surveys

Scientific Name:

Common Name (Hickman 1993):

Species Found? ' Yes ' No If not, why?					
Plant Count		%Cover		Subseq Visit?	' Y ' N
Areal extent of pop'n / stand		' m^2 ' ha ' acres			
Characterized area >Veg Map MMU (0.5 ha)?	' Y ' N				

Distrib. on site: ' Scattered individuals ' Scattered small clumps ' Large clumps ' Widespread throughout

Existing NDDB occurrence? ' Y Occ #_____ ' N ' unk

Collection? _____ _____ _____
Collector Coll # Museum / Herbarium
' Mounted & Labelled ' Accessioned (Catalog # _____)
' Entered in NPSpecies (I&M sp occurrence database)

UTM of collection site if different from plot:

Plant Information Phenology:	_____ % vegetative	_____ % flowering	_____ % fruiting

Reporter(s):

Address: Peggy Moore
USGS, WERC, Yosemite Field Station
P. O. Box 700, El Portal CA 95318

E-mail address: **peggy_moore@usgs.gov**
Phone: 209-379-1309

Survey Effort:	Survey area waypoints (if applicable):		
Size of area searched	' m^2 ' ha ' acres		
Survey area mapped ?	' Y ' N	% area searched	
Search duration (person hours)			

Search Area Description:

Determination: (check one or more, and fill in blanks)
' Keyed (cite reference): _____
' Compared with specimen housed at: _____
' Compared with photo / drawing in: _____
' By another person (name): _____
' Other: _____
Comments (including plant characteristics):

Photographs: (check one or more)	Slide	Print	Digital
Plant			
Habitat			
Diagnostic feature			
Plot			

Dig Camera ID		Expos			
Film Camera ID		Roll No.		Expos	
Plot Expos & dir					

May NDDB obtain duplicates at their expense? ' Y ' N

LOCATION

Location Name (from quad map)					
County		**Landowner** / Mgr		**Quad** Name (7.5')	
Population Coordinates	Easting / Longitude			Northing / Latitude	
Datum (circle one)	NAD27 NAD83 WGS84	**Coordinate System**:	UTM Zone 10 UTM Zone 11 OR Geographic (Lat. & Long.)		
Source of Coordinates	' GPS ' 7.5 min. topo. Map ' GIS Polygon Centroid	**GPS** Make/Model/Unit no.			
Horizontal Accuracy	' m ' ft	**PDOP**		' Max for line/poly	**GPS File** Name

GPS File Contents (check one):
' Point: >> ' Approx. center of stand/population >> **Radius to edge of stand** _____(m) ' Other: _____
' Perimeter points
' Line: Perimeter of stand / population? ' yes ' no: _____
' Polygon: Perimeter of stand / population? ' yes ' no: _____
GPS Comments:

SITE INFORMATION

Overall **Site Quality**: ' Excellent ' Good ' Fair ' Poor	
Current / surrounding **land use**:	
Visible **disturbances**:	
Threats:	
Comments:	

Plot Size (m^2):	Length	Width	or Radius	**Plot Shape**	
Plot UTM coordinates	Easting	Northing	Datum	Horiz accuracy	PDOP
Coord Loc in Plot:					

Elevation ' ft ' m	**ElevSource** ' GPS ' Altim ' 7.5' map	**Slope** ' deg ' %	**Aspect** (deg):
Topographic Position (see cheat sheet)			
Landform (see cheat sheet)	Macro	Meso	Micro
Surficial Geology (see cheat sheet)			

Cowardin System

___Upland ___ Palustrine
___ Riverine ___Lacustrine

Nontidal

___Permanently Flooded ___Saturated ____ Unknown
___Semipermanently Flooded ___Seasonally Flooded
___Temporarily Flooded ___Intermittently Flooded

Site Description / Environmental Comments (vegetation and habitat description, microhabitat, fire history, etc.)

Unvegetated Surface (percent cover of substrate materials)

_____ Bedrock _____ Large rocks (cobbles, boulders > 10 cm) _____ Small rocks (gravel, 0.2–10 cm)
_____ Litter, duff _____ Wood (> 1 cm)
_____ Sand (0.1–2 mm) _____ Bare soil _____ Other:

Soil Texture:

___ sand ___ loamy sand ___ sandy loam ___ loam
___ silt loam ___ silt ___ clay loam ___ silty clay
___ clay ___ peat ___ muck ___ silty clay loam

Soil Drainage

___ Rapidly drained ___ Well drained
___ Moderately well drained ___ Somewhat poorly drained
___ Poorly drained ___ Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)

Trees and Shrubs
_____Evergreen
_____Cold deciduous
_____Drought deciduous
_____Mixed evergreen - cold deciduous
_____Mixed evergreen – drought decid
Or Herbs
_____Annual
_____Perennial

Leaf Type (of dominant stratum)

____Broad-leaved
____Needle-leaved
____ Microphyllous
____ Graminoid
____ Forb
____ Pteridophyte

Physiognomic class

____ Forest
____ Woodland
____ Shrubland
____ Dwarf-Shrubland
____ Herbaceous
____ Nonvascular
____ Sparsely Vegetated

VEGETATION DESCRIPTION (cont'd)

Plant Community(ies): _____ ' Alliance ' Association

_____

_____

Cover Class Intervals Strata and Unvegetated Surface					
1 0–1%	**2** > 1–5%	**3** > 5–25%	**4** > 25–50%	**5** > 50–75%	**6** > 75%

	Cover Class	**Dominant Species** (scientific names)
Emergent tree		
Canopy tree		
Subcanopy tree		
Shrub		
Herbaceous		
Nonvascular		

Total Vegetation Cover (Class)		Total Non-Native Cover (Class)	

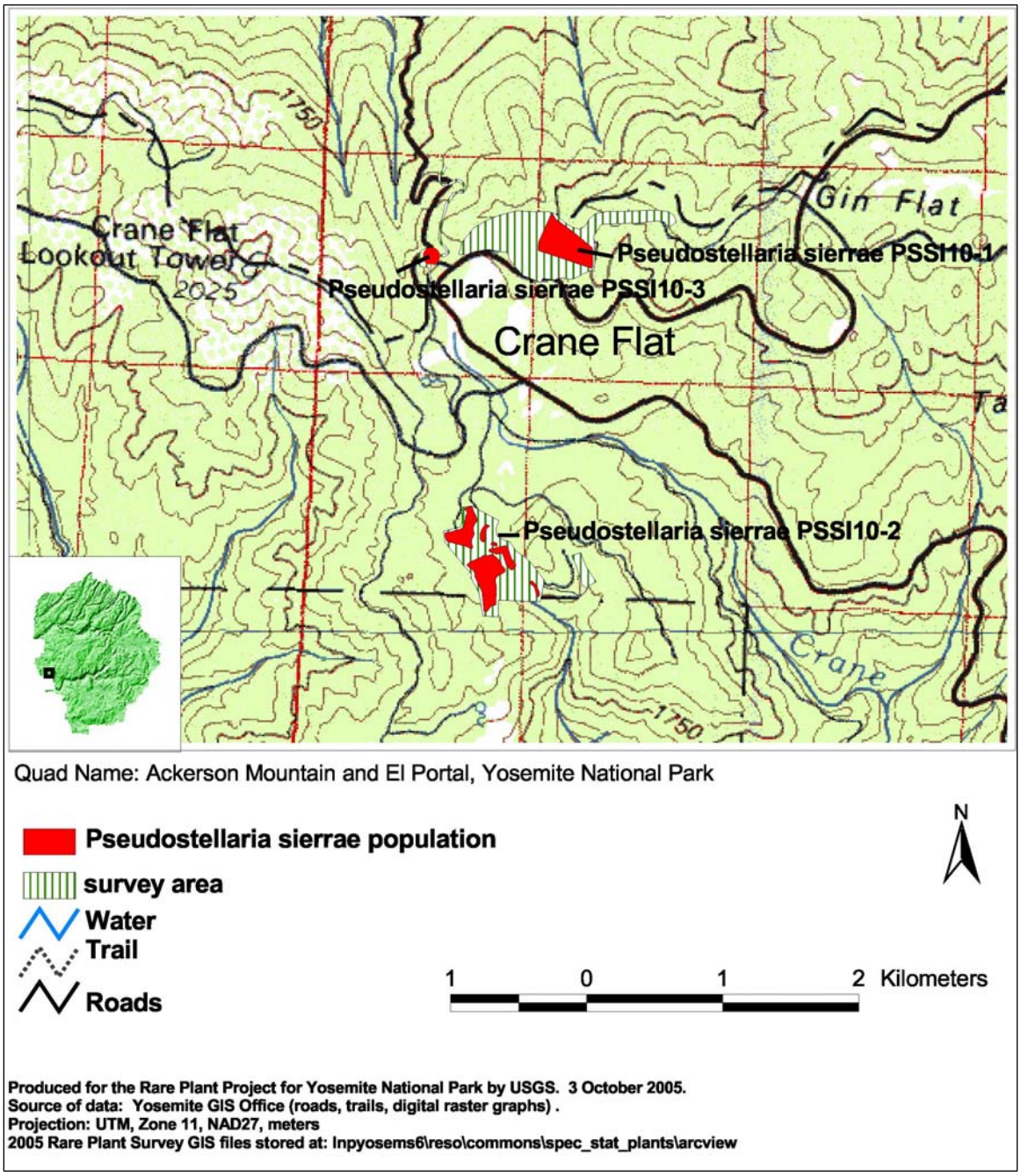
G	S	T	**Associated Species (or moss, lichen, cryptogamic crust)**	**Cover Class**

G=Ground,Layer S= Shrub layer, T = Tree layer (check one)

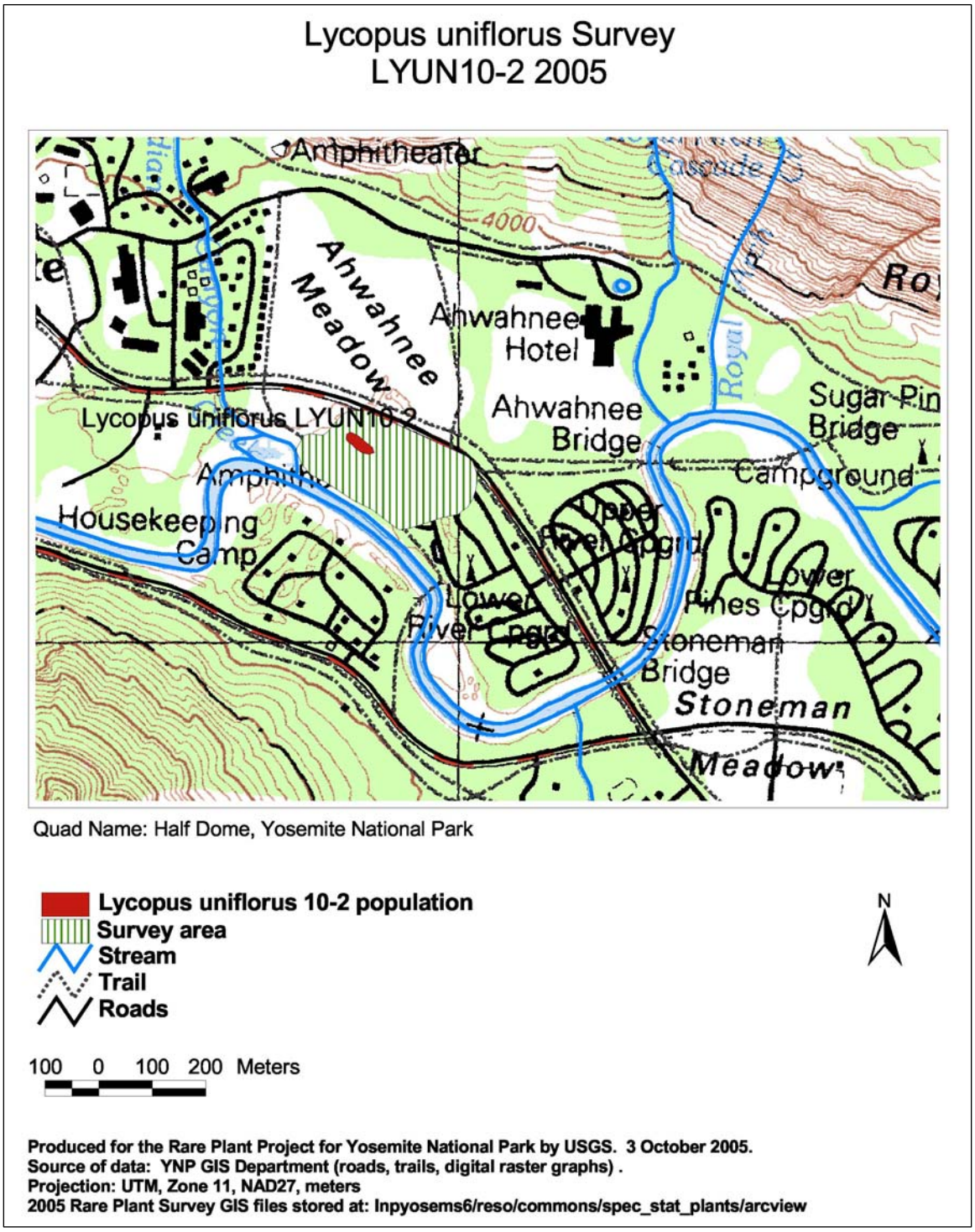
G	S	T	Associated Species (or moss, lichen, cryptogamic crust) (continued)	Cover Class

Comments: (survey comments, similar species on site, phenology comments, year-specific comments, etc.)

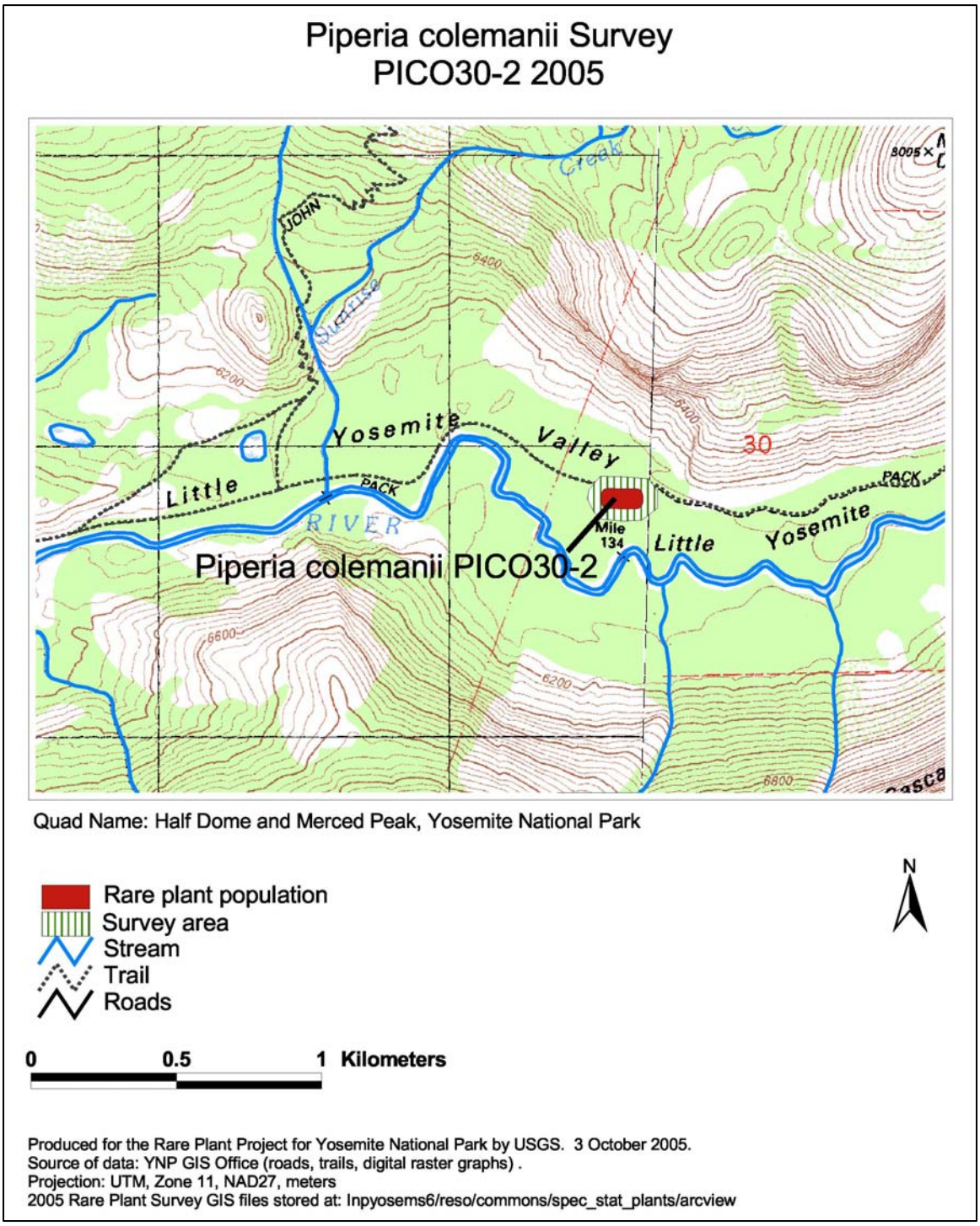
Appendix B. Special status vascular plant populations mapped by the U.S. Geological Survey in 2005, Yosemite National Park, California



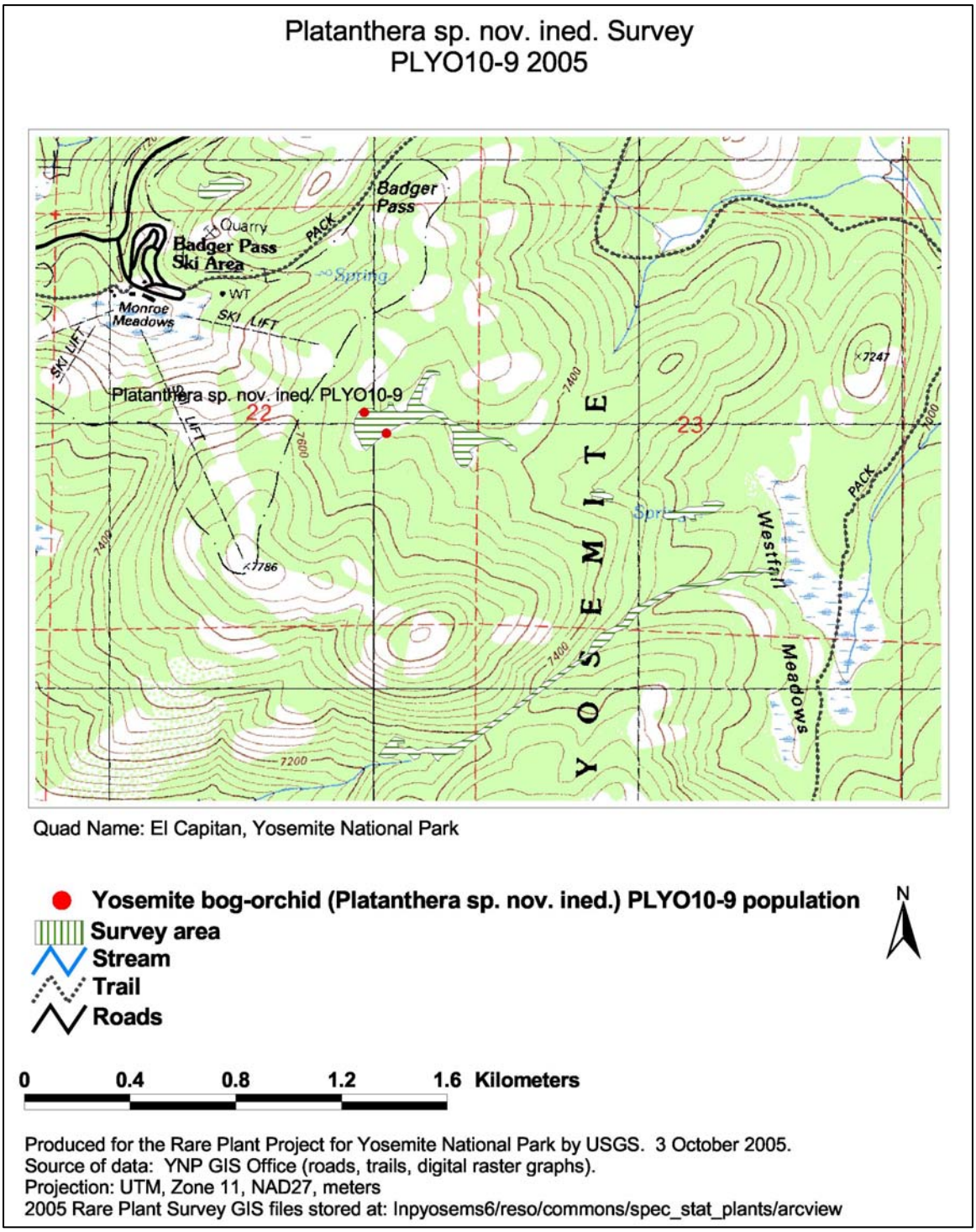
The USGS mapped three Sierra starwort (*Pseudostellaria sierrae*) populations in the vicinity of Crane Flat and Gin Flat in 2005. Surveys were based on reports of two herbarium specimens from Tioga Road of this newly described species (Rabeler and Hartman 2002. Novon 12: 82-86).



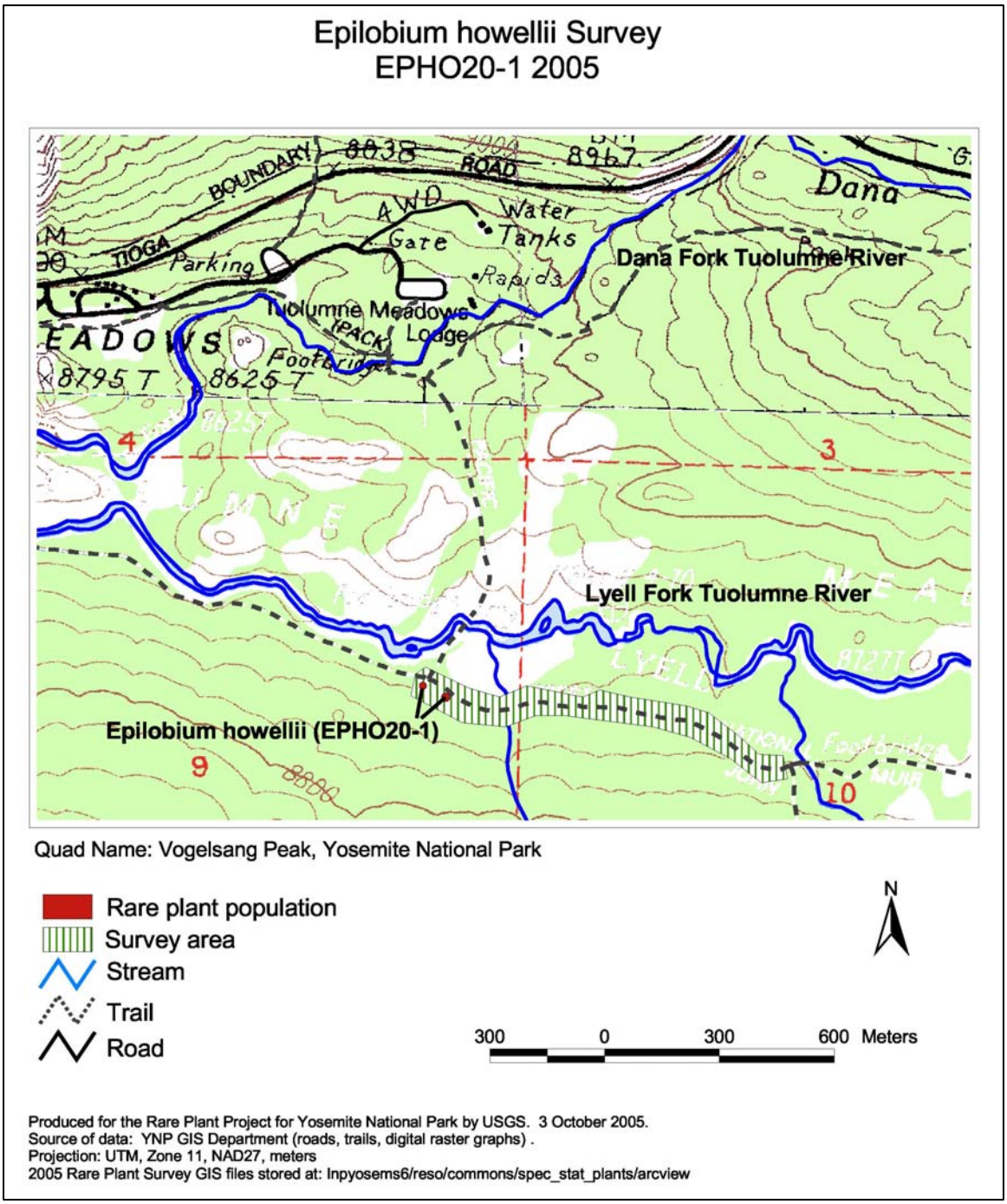
USGS botanists mapped a small population of bugleweed (*Lycopus uniflorus*) on September 18, 2005, in the vicinity of Ahwahnee Meadow based on a reported location (Dean Wm. Taylor, pers. comm.).



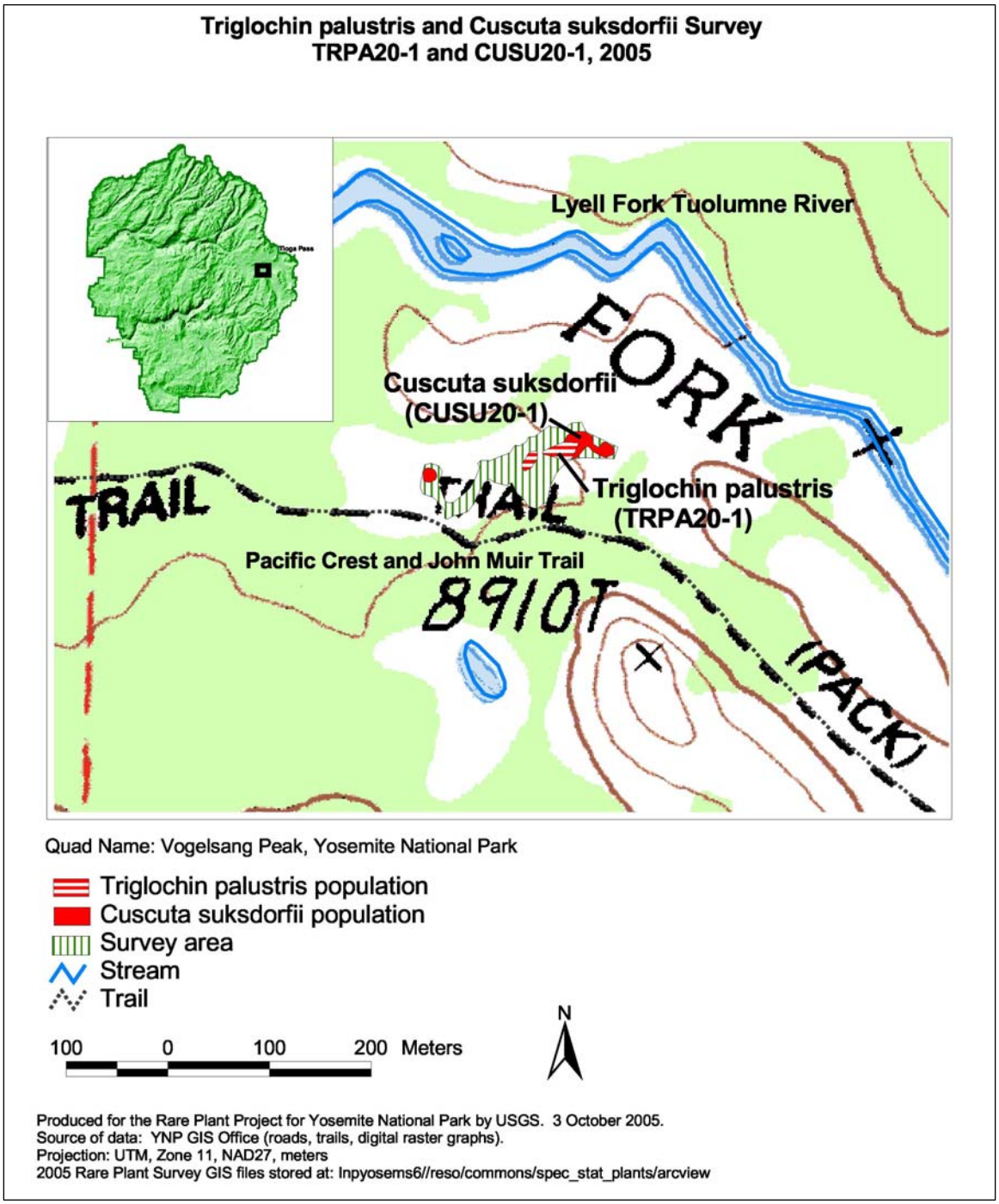
USGS botanists found and mapped a population of Coleman's piperia (*Piperia colemanii*) in Little Yosemite Valley during an opportunistic search on July 21, 2005. Plants were well dispersed in the shade of conifers. Transverse piperia (*Piperia transversa*) was present in other portions of the valley bottom.



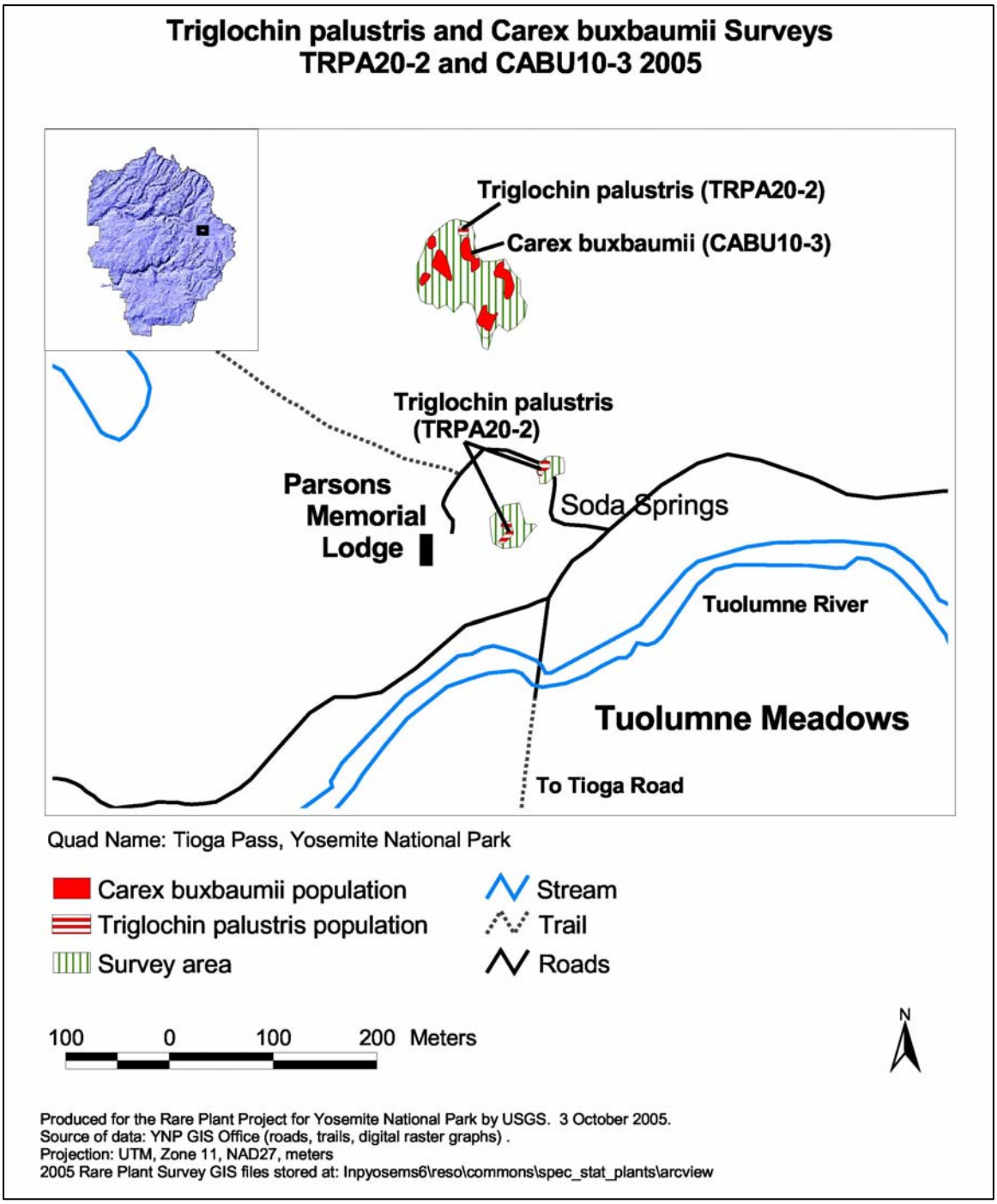
A single directed survey for Yosemite bog-orchid resulted in a ninth mapped population in the vicinity of Glacier Point Road. Only two plants were found during the survey on August 27 and 28, 2005. Both sparse-flowered bog-orchid (*Platanthera sparsiflora*) and white-flowered bog-orchid (*P. leucostachys*) occurred near the small population of *Platanthera* sp. nov. ined.



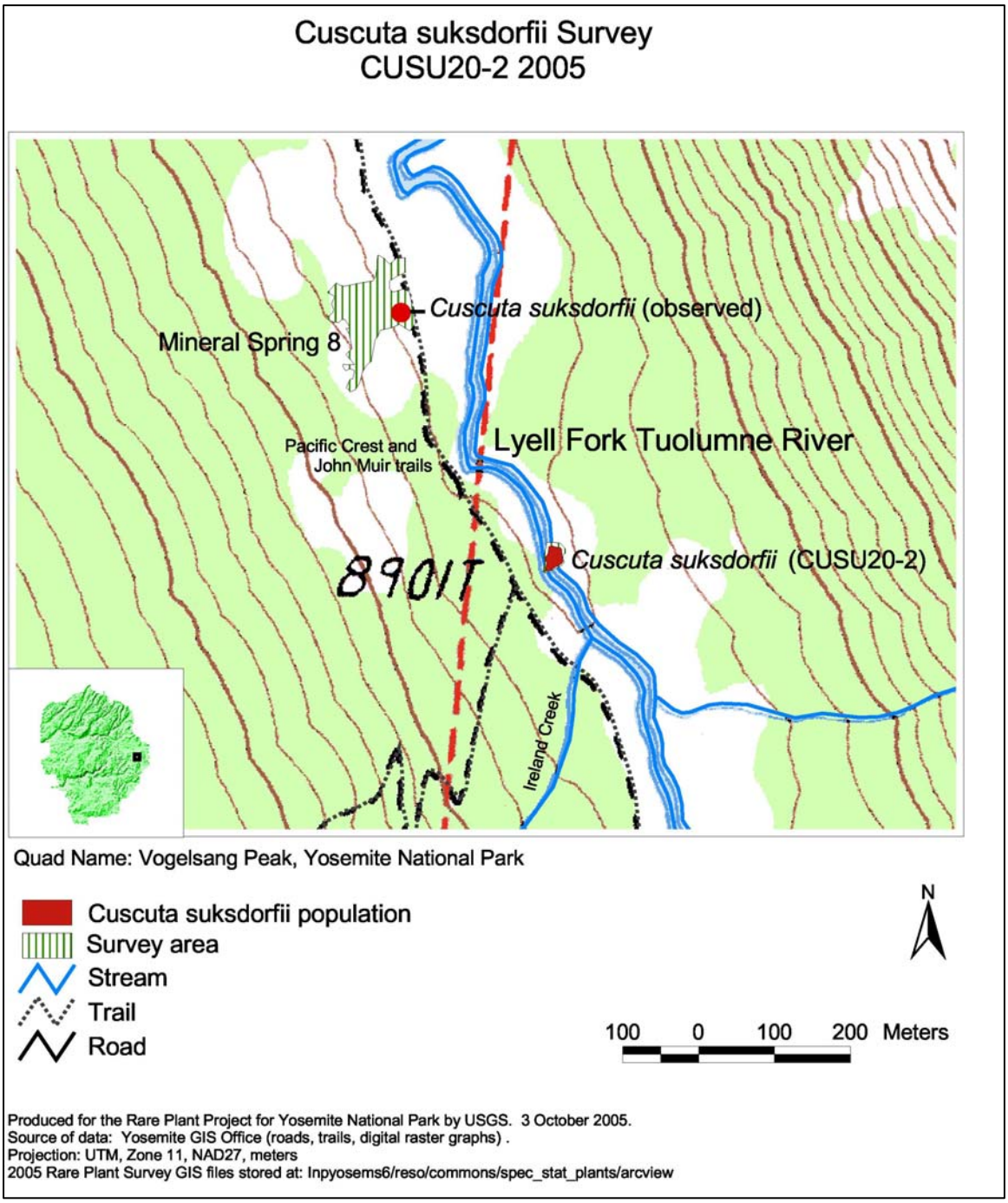
During an opportunistic survey for Yuba Pass willowherb (*Epilobium howellii*), USGS mapped a population near the Lyell Fork of the Tuolumne River. The plant was found in dappled shade of lodgepole pine (*Pinus contorta* ssp. *murrayana*) with moderate cover of a rich mixture of perennials in a mesic setting. *E. howellii* was replaced by *E. halleanum* and *E. ciliatum* in nearby similar habitat.



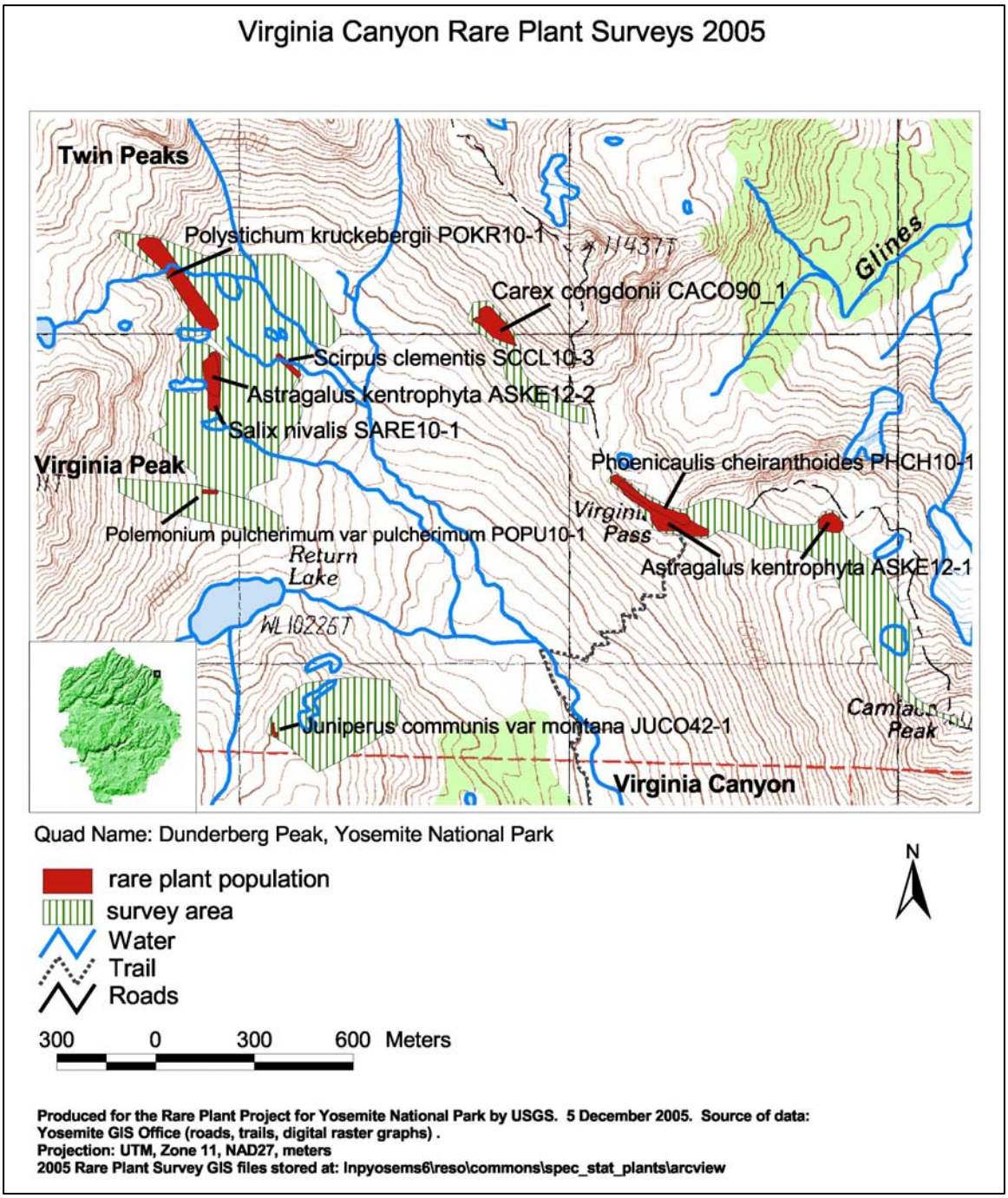
The Lyell Fork of the Tuolumne River was the first reported locality for marsh arrow-grass (*Triglochin palustris*) in Yosemite based on an August 2005 collection. Associated species included seaside arrow-grass (*Triglochin maritimum*), short-rayed daisy (*Trimorpha lonchophylla*), Suksdorf's dodder (*Cuscuta suksdorfii*), round-fruited road rush (*Juncus bufonius* var. *occidentalis*) and Mexican rush (*J. mexicanus*).



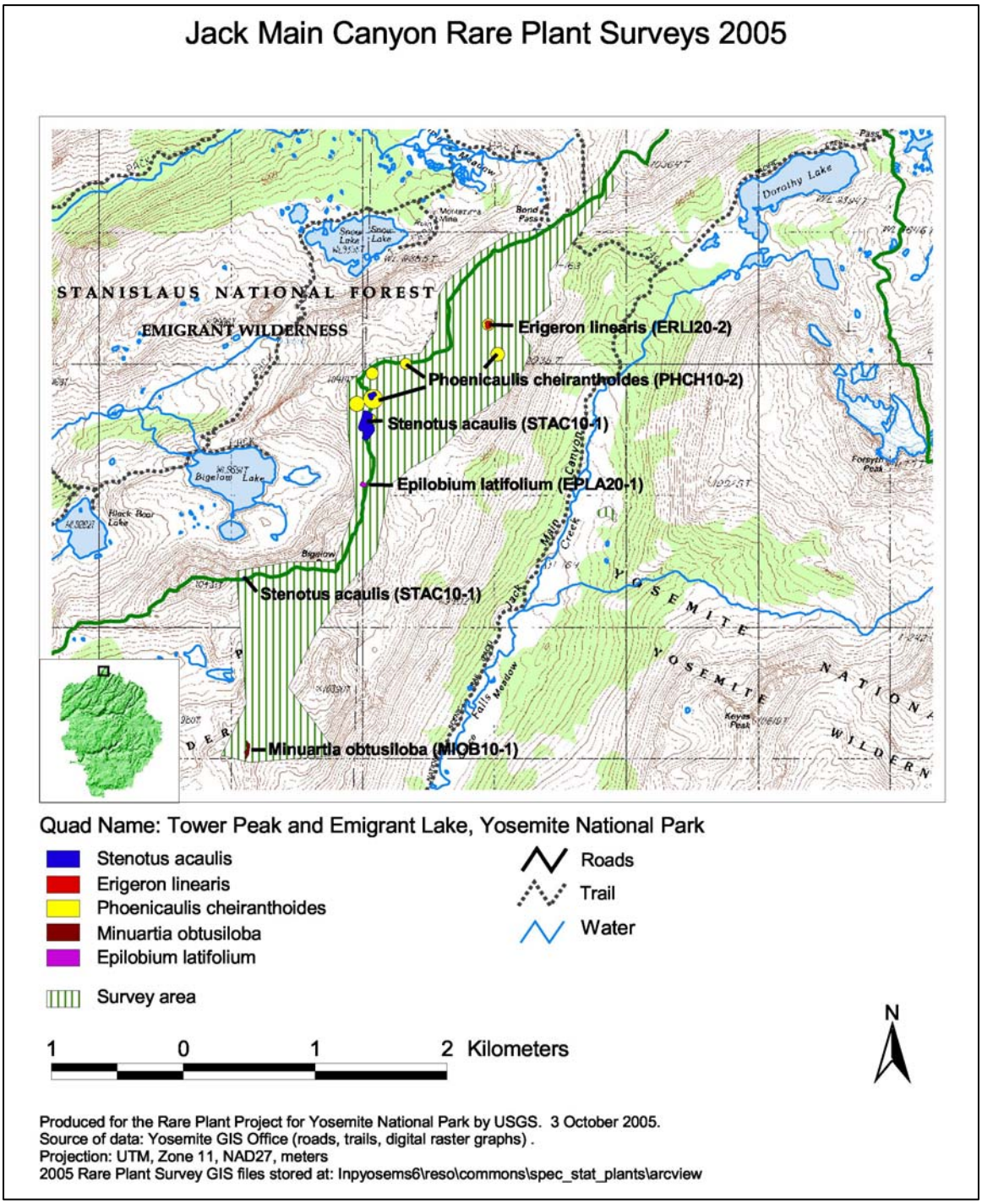
USGS mapped new locations for marsh arrow-grass (*Triglochin palustris*) and Buxbaum's sedge (*Carex buxbaumii*) populations in the vicinity of Soda Springs, Tuolumne Meadows, Yosemite National Park, Tuolumne Co., California on August 11, 2005. Marsh arrow-grass is difficult to detect due to fine, wiry stems and cryptic coloring. It has been found thus far growing in sparse stands on mud flats. Buxbaum's sedge was previously known from Soda Springs but the site 200 m north was heretofore undocumented.



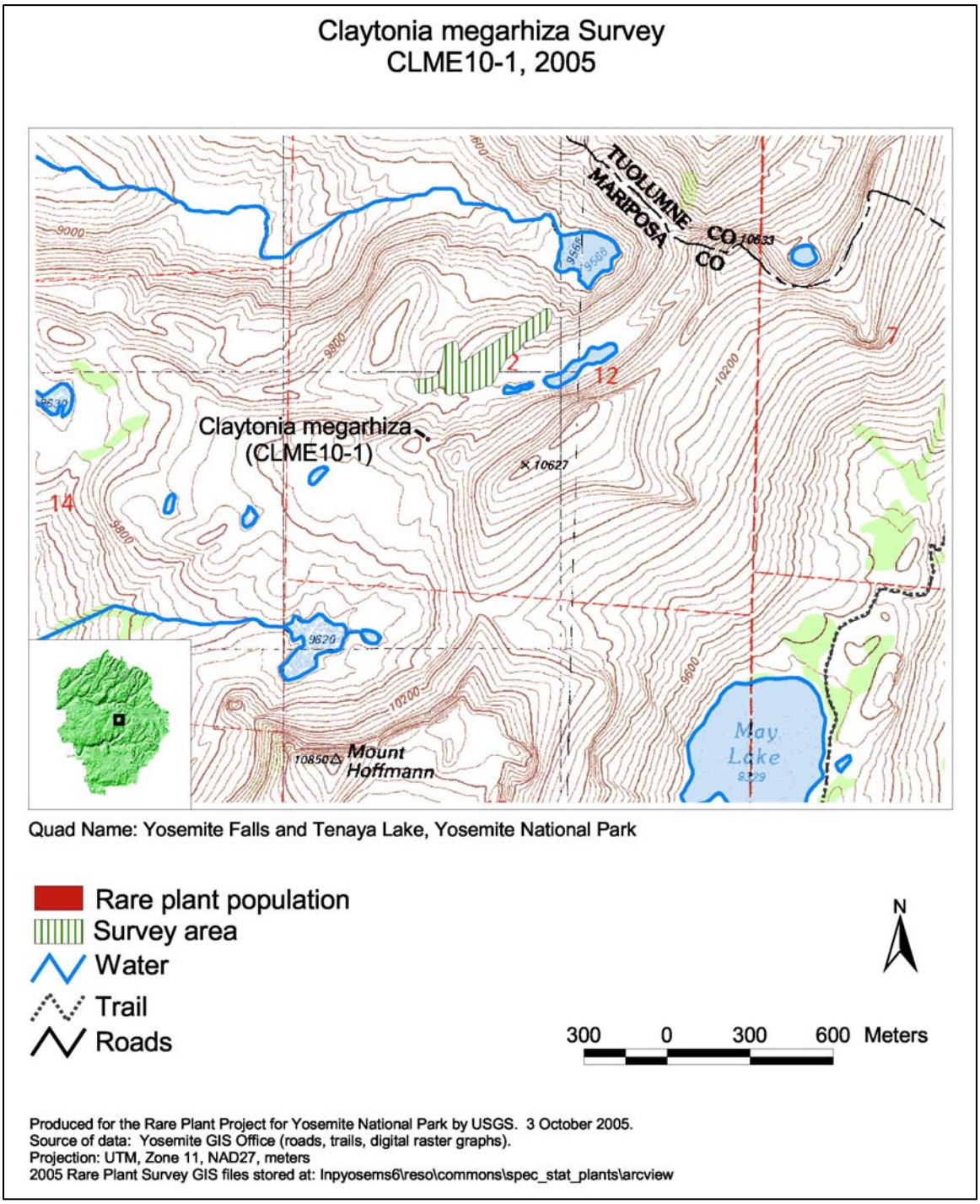
Suksdorf's dodder (*Cuscuta suksdorfii*) was first reported from Yosemite in 2004 from the vicinity of Snow Flat (USGS specimen submitted to the Yosemite Museum [YM YOSE 118146]). That locality was a montane meadow with acidic soil; the Lyell Fork sites are mineral springs with neutral to alkaline conditions. Associated species included seaside arrow-grass (*Triglochin maritimum*), short-rayed daisy (*Trimorpha lonchophylla*), scratchgrass (*Muhlenbergia asperifolia*), and Mexican rush (*Juncus mexicanus*).



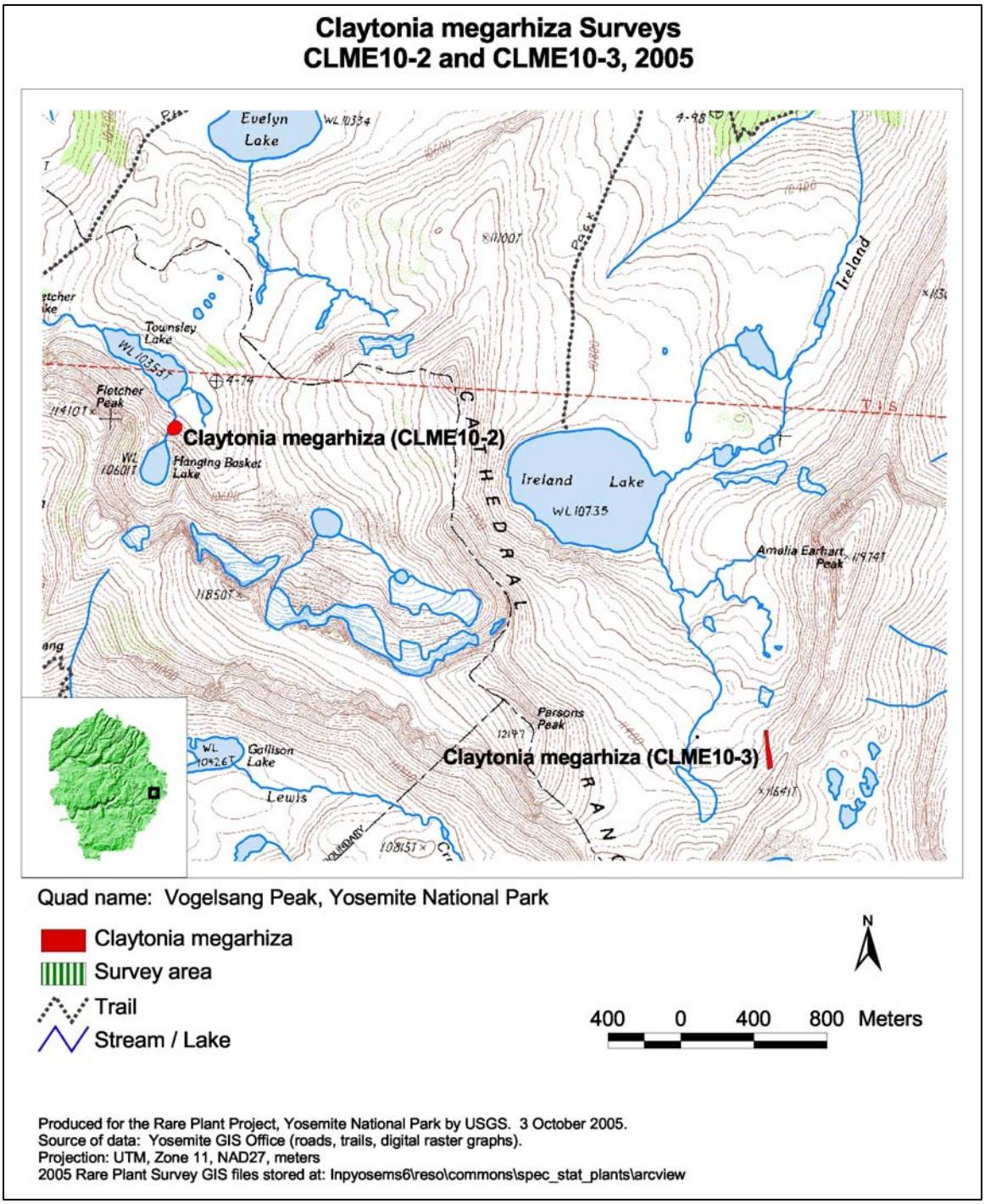
Surveys documented a number of new populations in Virginia Canyon for species on the 2005 Yosemite Special Status Vascular Plant List. Upper Virginia Canyon is comprised of a variety of metasedimentary substrates, contributing to the species richness of the area. Kruckeberg's swordfern (*Polystichum kruckebergii*) was found on marble, showy polemonium (*Polemonium pulcherrimum* var. *pulcherrimum*) on quartzite, and snow willow (*Salix nivalis*) on calc-silicate hornfels. Moisture gradients in the canyon and proximity to the Sierra Crest also appeared to contribute to species richness.



Surveys of marble features in upper Jack Main Canyon produced a new moss record for the park, Jungerman's platydictya moss (*Platydictya jungermannioides*), but no other special status plants. In contrast, high elevation non-marble metamorphics along the park boundary supported an array of park sensitive taxa mapped between August 16 and 21, 2005.



Approximately 100 fell-fields claytonia plants (*Claytonia megarhiza*) comprise a population 1 km north of Mt. Hoffman in a north-facing gully. The survey area north of this population represents an examination of the calcite dome at that locale. The arctic willow herb (*Epilobium latifolium*) known from the vicinity of the dome was not relocated, perhaps due to late-lying snow on the northwest side of the dome on August 31, 2005.



USGS botanists mapped new populations of fell-fields claytonia (*Claytonia megarhiza*) at the outlet of Hanging Basket Lake and south of Amelia Earhart Peak in September 2005. Minimum estimates of population size were 76 and 720 plants, respectively, based on time-limited censuses. Additional habitat was noted in the area. It consisted of open, sandy, granitic substrate with scattered boulders in north-facing draws. Associated species included one-sided pussypaw (*Calyptridium monospermum*), Heller sedge (*Carex helleri*; indicator of late-lying snow), Lemmon's draba (*Draba lemmonii*) and alpine sorrel (*Oxyria digyna*).

Appendix C. Locations of mineralized springs and metamorphic features of interest for special status plant surveys in 2005 at Yosemite National Park, California

Appendix C.1. Mineralized springs of interest for plant surveys, Yosemite National Park, 2005

No.	Location	Nearby place names	Source	Quad	UTME	UTMN	UTM Zone	DATUM
1	Iron Sprng,Yosemite Vly	Mirror Lake	Jan van Wagtendonk	Half Dome	275045	4180232	11	NAD27
2	Hetch Hetchy Reservoir	Below typical reservoir level	Jim Snyder	Hetch Hetchy	260000	4203910	11	NAD27
3	Rancheria Falls	Hetch Hetchy Reservoir	Erin Anders, Yosemite NP Trails Branch	Hetch Hetchy	261978	4204122	11	NAD27
4	Piute Creek[1]	Approx 1 mi above Pate Valley trail jct	WHRS (Jim Snyder)	Ten Lakes	273040	4202420	11	NAD27
5	Piute Creek[1]	250 yards below other Piute Cr spring	Jim Snyder	Ten Lakes	272867	4202257	11	NAD27
6	Upstream of Washburn Lk	Washburn Lake, Merced Lake	Jim Roche, Park Geologist (acting)	Merced Peak	292528	4175457	11	NAD27
7	Washburn Lake[1]	Just below Washburn Lk	WHRS (Jim Snyder)	Merced Peak	289990	4177890	11	NAD27
8	Soda Springs, Tuol. Mdws[1]	Parsons Lodge	7.5 min map	Tioga Pass	291947	4194770	11	NAD27
9	E soda spring, Tuol. Mdws	Concession corral road at 90 degree turn	Margaret Eissler, Tuol. Ranger Naturalist	Tioga Pass	292730	4194790	11	NAD27
10	NW of upper settling pond, W of Parsons Lodge	Parsons Lodge, Tuolumne Meadows	Greg Wass, EP WWTP	Tioga Pass				
11	Alkali Creek[1]	Glen Aulin vicinity; 1.5-2 mi N of Jct with Conness Creek	WHRS (Jim Snyder)	Falls Ridge	290050	4201955	11	NAD27
12	Lyell Fk Tuolumne River	NE side of a large meadow	WHRS (Jim Snyder)	Vogelsang Pk	296320	4193630	11	NAD27
13	Lyell Fk Tuolumne River[1]	Just N of John Muir Trail at 8740'	WHRS (Jim Snyder)	Vogelsang Pk	296950	4193300	11	NAD27
14	Lyell Fk Tuolumne River	1000 ft. ENE of Point B	WHRS (Jim Snyder)	Vogelsang Pk	297300	4193340	11	NAD27
15	Lyell Fk Tuolumne River[1]	1300 ft. N by trail from Ireland Cr jct	WHRS (Jim Snyder)	Vogelsang Pk	299320	4189100	11	NAD27
16	Lyell Fk Tuolumne River[1]	250 ft. ENE of Ireland Cr trail jct on John Muir Trail	WHRS (Jim Snyder)	Vogelsang Pk	299540	4188820	11	NAD27
17	South Fk Merced River	W of Chain Lakes at S Fk Merced R	WHRS (Jim Snyder)	Sing Peak	285120	4161540	11	NAD27
18	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285140	4161560	11	NAD27
19	South Fk Merced River[1]		WHRS (Jim Snyder)	Sing Peak	285170	4161550	11	NAD27
20	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285200	4161440	11	NAD27
21	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285110	4161400	11	NAD27
22	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285190	4161300	11	NAD27
23	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285200	4161280	11	NAD27
24	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285110	4161250	11	NAD27
25	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	284690	4160740	11	NAD27
26	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	284540	4160640	11	NAD27
27	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	284230	4160460	11	NAD27
28	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	285020	4161300	11	NAD27
29	South Fk Merced River[1]		WHRS (Jim Snyder)	Sing Peak	285020	4161330	11	NAD27
30	South Fk Merced River		WHRS (Jim Snyder)	Sing Peak	284990	4161560	11	NAD27
31	South Fk Merced River	W of Chain Lakes @ S Fk Merced R	Sonny Montague,NPS	Sing Peak	283800	4160100	11	NAD27
32	Cathedral Creek	N of May Lake-Glen Aulin trail	WHRS (Jim Snyder)	Falls Ridge	285410	4197570	11	NAD27
33	Virginia Canyon	on Return Creek	WHRS (Jim Snyder)	Falls Ridge	286200	4204760	11	NAD27
34	Matternhorn Creek	Near Junction with Return Creek	WHRS (Jim Snyder)	Falls Ridge	285280	4204720	11	NAD27

No.	Location	Nearby place names	Source	Quad	UTME	UTMN	UTM Zone	DATUM
35	Stubblefield Canyon	1.9 mi. N of PCT crossing of Stubblefield Cyn	WHRS (Jim Snyder)	Tower Peak	274280	4217870	11	NAD27
36	NW of Breeze Lake	Below Fernandez Pass and above Moraine Meadow	Bob Mariner, USGS	Sing Peak	288815	4162077	11	NAD27
37	Between Harriet Lk and Foerster Pk		Bob Mariner, USGS	Mt. Lyell	296442	4172984	11	NAD27
38	Grace Meadow	Below lower end of Grace Meadow	Jim Snyder	Tower Peak				
39	Thompson Canyon	W side Thompson Cyn below Ernbeck Pk	Jim Snyder	Buckeye Ridge	280950	4223200	11	NAD27
40	Thompson Canyon	W side Thompson Cyn	Jim Snyder	Piute Mtn	278940	4220970	11	NAD27
41	Parker Pass Creek	Mono Pass Trail	Brian Huggett	Mt. Dana			11	NAD27

[1]Sampled in 2005

Appendix C.2. Marble and other metamorphic features of interest in Yosemite National Park for plant surveys, 2005

Locality	Map Symbol	Geology	Location	Nearby Place Names	Quad	UTME	UTMN	Elevation (ft.)	Source	Comments
Virginia Canyon	PPq	Quartzite and quartzofeldspathic hornfels	Below Summit Lk at Return Cr	Where trail from Summit Lk meets Return Cr		294988	4213343	9,300'	Matterhorn quad	Easy access; **Note:** Serpentenite in Spiller Cyn very difficult to access from Virginia Cyn, believe it was visited by Hugh Safford
Virginia Canyon[1]	PPm	Marble	NE side Virginia Peak	Head of Return Creek, WNW VA Pass		294074	4216040	~10,400'	Matterhorn quad	2.5 mi from Summit Lk; adjacent to creek; UTM approximately the center of the outcrop
Virginia Canyon[1]	PPh	Calc-silicate&quartzofeldspathic hornfels&marble	NE side Virginia Peak	Head of Return Creek, NE VA Pk		293930	4215880	11,150'	Matterhorn quad	Surrounds marble feature above & runs N; E facing
Virginia Canyon[1]	PPq	Quartzite and quartzofeldspathic hornfels	E & N sides Virginia Peak			293965	4215350	10,300'	Matterhorn quad	Adjacent to marble & PPh features above; coordinate taken from gently sloped S end of feature; E facing
Virginia Canyon[1]	PPh	Calc-silicate&quartzofeldspathic hornfels&marble	N side Grey Butte	due W of Camiaca Peak		294252	4214880	10,470'	Matterhorn quad	Permanent ice fields mapped in feature
Virginia Canyon[1]	PPq	Quartzite and quartzofeldspathic hornfels	Obliquely parallels Shepherd Crest						Matterhorn quad	Long narrow feature on side slope (probably difficult to follow with assurance)
Grace Meadow[1]	msm	marble	upper Grace Mdw		Tower Peak	271740	4225745	8,880	Tower Pk geol quad	
Grace Meadow	msm	marble	SE of Bond Pass		Tower Peak	272185	4226860	9,170	Tower Pk quad	from Erin Anders
Grace Meadow[1]	msq	quartzite	S of Bond Pass		Tower Peak?	271324	4227526	9,740	Tower Pk geol quad	
Grace Meadow[1]	msq	quartzite?	Summit of Bigelow Peak	W of Grace Meadow	Emigrant Lake?	269800	4225420	10,539	Tower Pk quad	Is marked JMS on King Huber map
Grace Meadow		marble	Falls Creek caves	Grace Meadow area	Tower Peak	272140	4227190	9,130	WHRS (Jim Snyder)[2]	Coordinates are for Falls Creek caves; stream goes underground
Grace Meadow		marble	Falls Creek caves	Grace Meadow area	Tower Peak	272140	4227110		WHRS (Jim Snyder)	Creek reemerges
Grace Meadow		marble	Falls Creek caves	Grace Meadow area	Tower Peak	272140	4227070		WHRS (Jim Snyder)	stream goes underground
Grace Meadow		Marble	Falls Creek caves	Grace Meadow area	Tower Peak	272080	4227020		WHRS (Jim Snyder)	Creek reemerges
Tuolumne Vicinity[1]		marble	Hoffman Creek	West of May Lake Rd	Yosemite Falls	279270	4189840		WHRS (Jim Snyder)	
Tuolumne Vicinity[1]		marble	Hoffman Creek	West of May Lake Rd	Yosemite Falls	279060	4189560		WHRS (Jim Snyder)	
Tuolumne Vicinity[1]		marble	Hoffman Creek	West of May Lake Rd	Yosemite Falls	278900	4189660		WHRS (Jim Snyder)	
Tuolumne Vicinity		marble	Hoffman Creek	West of May Lake Rd	Yosemite Falls	278850	4189860		WHRS (Jim Snyder)	
Tuolumne Vicinity[1]		marble	Mt. Hoffman	N of peak	Yosemite Falls	279780	4193080	10,080	Jim Snyder	
Tuolumne Vicinity		marble	Mt. Hoffman	Tuolumne/Mariposa co. boundary		280070	4193840	10,000	WHRS (Jim Snyder)	
Tuolumne Vicinity	pKcs	Calc-silicate hornfels, quartzite, & schist	W of Snow Cr	W of May Lk HSC trail	Tenaya Lk/Yosemite Falls	280170	4190700	9,580	Tuol Mdws geol quad	
Tuolumne Vicinity		'Different rock from the Hoffman Creek marbles'	May Lake road	S of May Lk/W of May Lk trailhead	Yosemite Falls	279970	4190390	9,370	Jim Snyder	
Tuolumne Vicinity		marble	Cathedral Creek	Below May Lake-Glen Aulin trail	Falls Ridge	283520	4197980	7,470	Jim Snyder	Mapped as massive quartzite
Buck Camp		Limestone	Givens Creek	0.4 mi downstream from Chiquito Pass trail crossing of Givens Creek	Sing Peak	281640	4159620	7700'	WHRS (Jim Snyder	3 small outcrops of limestone in a large sand flat in an alcove of the canyon of Givens Creek, 7700', in an area dominated by granodiorite of Illilouette Cr; largest outcrop rises 8' above the level of the flat and is about 20' in diameter
Gray Peak	Jmm	marble	W side Gray Peak						Merced Pk quad	
Benson Lake	ms	metasedimentary	Benson Lake						Tower Pk quad	

[1]**Sampled in 2005**

[2] WHRS= Wilderness Historic Resources Surveys (see Snyder et al. 1989, 1990); Jim Snyder, Park Historian (retired)

Note: All Virginia Canyon coordinates approximate from Matterhorn geologic quadrangle

Note': Coordinates are in North American Datum 1927 and Universal Transverse Mercator Zone 11; coordinates listed are estimated from 7.5 minute USGS quadrangles

Appendix D. Reported locations for 38 populations of special status plant species. Locations represent observations by USGS botanists and were unvouchered and unmapped at the time of report submission. Details can be found in the file Inpyosems6\reso\Commons\Spec_Stat_Plants\Data\PlantObs.mdb.

Species	Location	Observer	Date
Asarum lemmonii [PS]	Creek bottom just N of park boundary, at end of old road SE of Crane Flat Campground	Alison Colwell, Dena Grossenbacher, Holly Wannamaker	06/30/05
Bolandra californica[4]	Harden-Pate Valley trail	Peggy Moore	07/06/05
Bolandra californica[4]	On road to Hetch Hetchy Reservoir	Alison Colwell, Dena Grossenbacher	05/23/05
Bolandra californica[4]	Hillside above Wawona Tunnel.	Alison Colwell	05/21/05
Carex congdonii[4]	East facing slope above Grace Meadow	Alison Colwell, Dena Grossenbacher	08/21/05
Carex congdonii[4]	Ridge south of Bond Pass	Alison Colwell, Dena Grossenbacher	08/20/05
Carex congdonii[4]	South side of cone west of Bigelow Peak	Alison Colwell, Dena Grossenbacher	08/19/05
Carex congdonii[4]	250 NW of pond south of Bond Pass	Peggy Moore, Dena Grossenbacher	8/17/05
Carex congdonii[4]	North side Bigelow Peak	Peggy Moore, Dena Grossenbacher	8/17/05
Carex congdonii[4]	Summit Peak 10,035 south of Bond Pass	Peggy Moore	8/17/05
Ceanothus fresnensis[4]	Rockefeller Grove Road	Dena Grossenbacher, Holly Wanamaker	07/13/05
Ceanothus fresnensis[4]	Old road south from Crane Flat Campground near park boundary.	Alison Colwell, Dena Grossenbacher, Holly Wannamaker	06/30/05
Cypripedium montanum[4]	Wawona Meadow	Susan Roberts	06/12/05
Cypripedium montanum[4]	Wawona Meadow	Susan Roberts	06/12/05
Hulsea brevifolia[1B]	North-facing slope just inside the boundary with Stanislaus forest, south of Crane Flat Campground.	Alison Colwell, Dena Grossenbacher, Holly Wannamaker	06/30/05
Hulsea brevifolia[1B]	Old road south from Crane Flat Campground near park boundary	Alison Colwell, Dena Grossenbacher, Holly Wannamaker	06/30/05
Hulsea brevifolia[1B]	West of Gin Flat Ski Trail	Alison Colwell, Dena Grossenbacher	06/23/05
Lupinus gracilentus[1B]	Lyell Canyon on either side of trail	Alison Colwell, Dena Grossenbacher, Holly Wannamak	08/10/05

Species	Location	Observer	Date
Madia yosemitana[3]	Bench about 15 meters below trail above Vernal Falls.	Dena Grossenbacher	07/19/05
Madia yosemitana[3]	On North side of river near bridge above Lost Valley.	Alison Colwell, Dena Grossenbacher	07/19/05
Madia yosemitana[3]	Harden-Pate Valley trail	Dena Grossenbacher	07/06/05
Madia yosemitana[3]	Along road south of Discovery View tunnel about 1/4-1/2 mile	Alison Colwell, Dena Grossenbacher	06/24/05
Madia yosemitana[3]	Along trail to Lake Vernon from Hetch Hetchy	Dena Grossenbacher	06/15/05
Madia yosemitana[3]	Slabs above Discovery View parking lot	Alison Colwell, Dena Grossenbacher, Peggy Moore	06/09/05
Madia yosemitana[3]	Road from Mather to Hetch Hetchy Entrance Station	Alison Colwell, Dena Grossenbacher	05/22/05
Pleuricospora fimbriolata [PS]	Westfall Meadow	Alison Colwell	08/28/05
Potamogeton robbinsii[2]	Chain of Lakes, Toiyabe National Forest	Alison Colwell, Peggy Moore, Dena Grossenbacher	08/14/05
Scirpus clementis [PS]	Bench northeast of Townsley Lake	Peggy Moore	09/05/05
Scirpus clementis [PS]	Ireland lake	Peggy Moore	09/05/05
Scirpus clementis [PS]	Outlet of Vogelsang Lake	Peggy Moore	09/04/05
Scirpus clementis [PS]	Townsley Lake	Peggy Moore	09/04/05
Scirpus clementis [PS]	Grace Meadow	Alison Colwell, Dena Grossenbacher	08/21/05
Scirpus clementis [PS]	Head of Virginia Canyon	Alison Colwell, Dena Grossenbacher	07/30/05
Scirpus clementis [PS]	Tuolumne Meadows	Peggy Moore	06/22/05
Senecio clarkianus [PS]	Meadow east of Badger Pass Ski area	Alison Colwell	08/27/05
Vaccinium parvifolium [PS]	Creek bottom just N of park boundary, at end of old road SE of Crane Flat Campground	Alison Colwell, Dena Grossenbacher, Holly Wannamaker	06/30/05
Whitneya dealbata [PS]	On upper bank of Gin Flat Ski Trail	Alison Colwell, Dena Grossenbacher	06/23/05
Whitneya dealbata [PS]	Near Gin Flat Ski Trail	Alison Colwell, Dena Grossenbacher	06/23/05

[1B]CNPS List 1B: Rare, threatened, or endangered in California and elsewhere
[2] CNPS List 2: Rare, threatened, or endangered in California, but more common elsewhere
[3] CNPS List 3: We need more information about this plant (Review List)
[4] CNPS List 4: Species of limited distribution (Watch List)
[PS] Park Sensitive