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Editor's Note: It is with a heavy heart and deep sense of personal loss that I announce the retirement of Scott White as co-editor of *Crossosoma*. Scott's meticulous and thorough critical review had a profound influence on the content and quality of this publication for several years. His contribution will be sorely missed (as will our "Executive Editorial Board Meetings" at *The Back Abbey* in Claremont).

Moving forward, I will remain as Editor for the next few issues. SCB is always looking for new Co-Editors, as well as manuscript reviewers. We have some great content coming up, but remain constantly on the look-out for new articles and notes. So spread the word.

Michael Honer

Cover:

Helenium bigelovii (Bigelow's sneezeweed) interspersed with occasional *Aquilegia formosa* (western columbine) in a snow melt gully below Lily Spring, San Gabriel Mountains, CA.
Photograph by Graham Bothwell, July 27, 2012.



Reid Moran collecting plants at Puerto Refugio, Isla Angel de la Guarda, c. 1962
© San Diego Society of Natural History.

DEDICATION: Reid Moran, 1916–2010

A major figure in succulent botany has left us: Reid Moran died on January 25, 2010, at the age of 93.

Dr. Moran was born in Los Angeles and grew up in Pasadena. He became interested in plants as a child. One person who encouraged that interest was Ellen Rooksby, editor of *Desert Plant Life*, in which appeared, in 1942, one of his first articles, *The Crassulaceae of Yosemite National Park*. He later published several important works in the same journal about his favorite family, the Crassulaceae. He also wrote numerous articles for the *Cactus & Succulent Journal* (US) and its yearbook, *Haseltonia*, mostly about *Echeveria*, *Pachyphytum*, and *Sedum*.

World War II interrupted his career from 1942 to 1946, when he was a flight navigator in the Army Air Force. He received the Distinguished Flying Cross after his plane was shot down over Yugoslavia during a bombing mission. Parachuting into German-occupied territory, the crew was able to avoid capture. Making the most of this opportunity, Reid managed to jot down notes about several interesting plants he observed during his escape.

He had obtained a biology degree at Stanford in 1939 and went on to earn his master's at Cornell in 1942 and his doctorate at the University of California, Berkeley, in 1951. For 25 years he was Curator of Botany at the San Diego Natural History Museum, concentrating on nearby Baja California, Mexico. Most of his explorations of that peninsula were carried out during the 1950s and 1960s and involved much travel on rough, unpaved roads or even by mule-back along trails. He had a major interest in the Mexican island of Guadalupe — some 160 miles west of the mainland — and visited it 20 times, recording the flora that was declining due to introduced goats. His important monograph, *The Flora of Guadalupe Island*, was published in 1996. Appropriately, his ashes have been scattered in the Pacific adjacent to Baja California.

Reid was well-known in the botanical world for his wise botanical decisions and meticulous writing but also for his distinctive sense of humor. While botanizing on Okinawa, he sent a hard-boiled egg to the head of the UC Berkeley botany department; it was unpackaged but stamped and had the name and address written on

the shell. The mailman delivered it uncracked, handling it gingerly in case it was a raw egg. Reid also wrote a taxonomic key for identifying the staff-members of the department, using botanical terms to describe their physical attributes, including gender.

My first trip to Mexico was in 1959, when I spent six weeks travelling with Reid. I always sent my articles to him for corrections and suggestions — he was my mentor!

Myron Kinnach

*Director Emeritus, Huntington Botanical Gardens
San Marino, California*



Reid Moran with Annetta Carter, 1990. © San Diego Society of Natural History.

**PHENOLOGY OF HIGH ELEVATION PLANTS
OF THE SAN GABRIEL MOUNTAINS:
A 1981-2011 COMPARISON**

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ABSTRACT: We repeated a phenology study conducted by Wayne Sawyer in 1981 and published in *Crossosoma* 13(1): 5-10, 1987. We called the study the Lily Spring Area Survey because the 145 hectare region under investigation between Little Jimmy Spring and Throop Peak surrounds Lily Spring in the San Gabriel Mountains. We compared flowering phenology for the taxa Sawyer described and found that for the group as a whole, flowering onset in 2011 was not significantly different from that observed in 1981. However, early season taxa flowered earlier and late season taxa flowered later. We also noted a substantial increase in average flowering duration from 5.4 weeks in 1981 to 8.9 weeks in 2011. We attribute these changes in phenology to a combination of factors that include differences in methodology between the 1981 and 2011 studies, generally warmer temperatures, differences in precipitation, and the Curve Fire of 2002 that burned over 90 percent of the study area. Of the 100 taxa recorded in the 1981 study, we found 98 still growing there. We also found 34 taxa not included in the 1981 study. The presence of the additional 34 taxa observed in 2011 may also be explained by the Curve Fire and by differences in methodology, i.e., a focus on biotically pollinated angiosperms in 1981 and more observers making more frequent observations in 2011.

KEYWORDS: phenology, Lily Spring Area Survey, San Gabriel Mountains, 2002 Curve Fire.

INTRODUCTION

Phenology, the timing of recurring biological events, can provide information about how plants and animals in a specific area respond to changes in the local environment (National Phenology Network, online). However, historical information about the phenology in specific locations is not often available thus complicating the documentation of changes over time. A set of historical phenology data is available from a 1981 study conducted by the late Wayne E. Sawyer, published in *Crossosoma* 13(1): 5-10, February 1987. The study, which

comprised a portion of the research for Sawyer's masters thesis *Competition for Pollination and Floral Diversity* (Sawyer 1985), California State Polytechnic University, Pomona, reported flowering phenology for 95 biotically pollinated angiosperms in a high elevation region of the San Gabriel Mountains that includes Lily Spring. Our study, the Lily Spring Area Survey, repeated the 1981 work with the goals of verifying the composition of the plant community and determining if flowering phenology has changed in the intervening thirty years.

There have been several phenology studies published recently (Bradley et al. 1999; Ahas et al. 2002; Fitter and Fitter 2002; Miller-Rushing and Primack 2008; Tooke and Battey 2010) that analyzed first flowering dates over several decades and correlated the changes observed with temperature increases. These studies report that first flowering dates for a wide range of species have been occurring earlier as temperatures have gotten warmer; 0.6 to 4 days per °C increase (Bradley et al. 1999; Fitter and Fitter 2002; Miller-Rushing and Primack 2008). Not all species responded to warmer conditions by flowering earlier. Some showed no response (Bradley et al. 1999) and others exhibited delayed first flowering dates (Abu-Asab et al. 2001; Fitter and Fitter 2002).

Other factors such as lengthening photoperiod (Keller and Korner 2003) and low precipitation in previous seasons (Franks et al. 2007), may bring about earlier flowering. Delayed flowering has also been observed following dry seasons (Penuelas et al. 2004). Fire is another possible influence on flowering time. With sufficient precipitation, plants frequently grow larger and flower more prolifically in the season immediately following a fire (Keeley and Keeley 1987; Lunt 1994). Jarrad et al. (2008) reported that plants flowered earlier in a burned area five years after a fire had occurred. Wroblewski and Kauffman (2003) stated that flowering for some species occurred earlier and persisted longer in the season following a fire. Fire may also affect the species richness in an area, at least until the overstory regrows (Keeley and Keeley 1987; Laughlin and Fule 2008).

In the Lily Spring Area Survey, we observed the onset and duration of flowering and compared observations for one season in 1981 with observations in 2011. In this paper we present analyses of local climate data that indicate the study area was warmer and drier in 2011 than it was in 1981. The pattern of annual precipitation was also different in the two years. In addition, the Curve Fire of 2002 burned over 90 per cent of the study area and resulted in significant deforestation in some locations (US Forest Service, online). We discuss our observations in the context of a study area that has undergone substantial changes since 1981.

METHODS

Plant Identification and Botanical Names

Plants were identified according to both editions of *The Jepson Manual* (Hickman 1993 and Baldwin et al. 2012) and with the assistance of Tom Chester, R. John Little (Sycamore Environmental, Inc.), Naomi Fraga (Rancho Santa Ana Botanic Garden), and LeRoy Gross (Rancho Santa Ana Botanic Garden). Latin names of taxa are from the second edition of *The Jepson Manual* (Baldwin et al. 2012) with older names from *A Flora of Southern California* (Munz 1974). Vouchers for both the 1981 and 2011 surveys were collected and are retained in the herbarium at Rancho Santa Ana Botanic Garden (RSA), Claremont, California.

The Study Area

Topography. The study area is in the Angeles National Forest in Los Angeles County, California. The map in Figure 1 indicates the location of the study area within the Angeles National Forest. Also shown is a topographical map of the study area, outlined in black, as described by Sawyer (1987). The northern boundary is defined by California State Route 2 while the southern boundary follows the ridge above the highway. The 145 hectare area is bounded on the west by Little Jimmy Spring and on the east by the South Fork of the Big Rock Creek drainage below Throop Peak. Elevations range from about 2,200 m on the highway below Little Jimmy Spring to about 2,600 m at the highest point on the ridge.

Vegetation. Sawyer's 1987 description of the communities in the study area included the following vegetation types: montane meadows at Little Jimmy Spring and Lily Spring; moist yellow pine forest characterized by *Abies concolor*, *Pinus jeffreyi*, and *Pinus lambertiana*; montane chaparral dominated by *Chrysolepis sempervirens*; forested ridges with *Pinus flexilis* and *Pinus contorta* subsp. *murrayana*; and edaphically controlled fell fields on the ridgetops. These plant communities or alliances are roughly similar today, especially the springs and exposed ridgetops. However, the 2002 Curve Fire resulted in mixed conifer forests containing dead trees that allow more sunlight to reach the forest floor, ridges that have lost the original lodgepole pine forest, and dry slopes that have increased in area at the expense of formerly forested slopes.

Phenology Comparison

Methodology. Sawyer's 1987 article stated that a species was considered to be flowering if "a few individuals each bore many open flowers, or many individuals

each bore a few open flowers.” Our flowering criteria were similar but somewhat more explicit: a species was said to be flowering if there were three individuals with three open flowers in more than one location. Exceptions included taxa found only in one location, taxa that produce only one or two flowers per plant, and taxa for which fewer than three individuals were found in the study area. Examples of taxa occurring in only one location were *Cycladenia humilis* var. *venusta*, *Delphinium glaucum* and *Penstemon caesius*. These taxa were said to be flowering if three individuals each bore three open flowers. For those taxa producing only one or two flowers per plant, e.g., *Calochortus invenustus*, flowering was said to be occurring if three or more flowers were present on several plants in one or more locations. For relatively rare taxa in the study area, e.g., *Fritillaria pinetorum* and *Mimulus suksdorfii*, we said the species was flowering if we observed an individual with open flowers.

It should be noted that our criteria for flowering included all individuals of a particular species in the study area. In addition, if multiple observations were made in one week, Saturday through Friday, as we believe was the case for the 1981 study, they were grouped for that week.

Routes. Sawyer’s article states that plants accessible by hiking trails were observed twice a week starting Saturday, 2 May 1981, and continuing through Friday, 11 Sep 1981. In 1981, hiking trails in the study area included the Pacific Crest Trail (PCT) and a trail connecting the PCT with Lily Spring. The Lily Spring trail is no longer maintained, but remnants are still visible on the slope down to the spring. We assumed from Sawyer’s statement that he observed plants that were reasonably accessible. These plants would have included those along California State Route 2, along the PCT, on the crests of the ridge above the PCT, as well as those at Lily Spring. A typical observation route in 2011 roughly followed the perimeter of the study area and included a visit to Lily Spring. Although we also explored less accessible locations on slopes and in drainages away from the highway and trail and found many of the same taxa as those in more easily reached areas, we generally did not include these observations in the phenology comparison. The less accessible areas appeared to be more protected from sun and wind and experienced snowmelt at later dates than areas along the PCT, highway and main ridge.

In 2010, we learned the identities of the plants and their locations. For the 2011 survey, we began observing plants in the study area as soon as the snow had melted sufficiently to permit safe access, 5 Apr 2011, and continued the observations through 3 Nov 2011. Although our observation period was longer than Sawyer’s, we include in the phenology comparison only observations for the same time period, i.e., the first week of May through the second week of September.

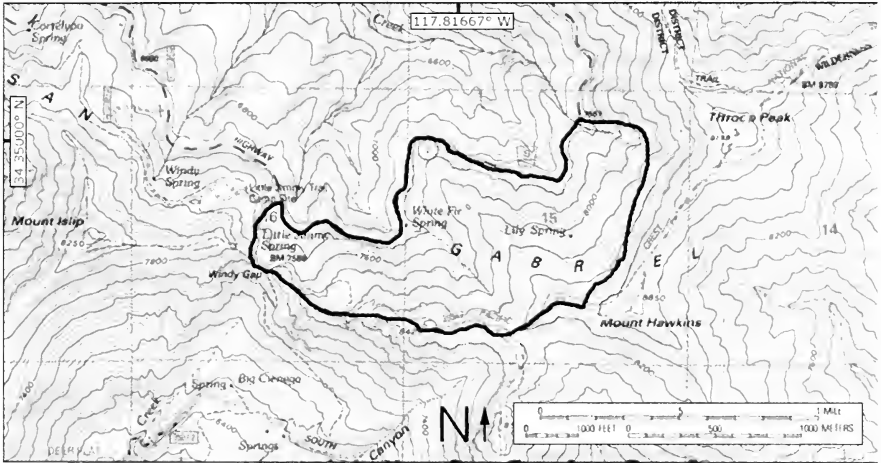
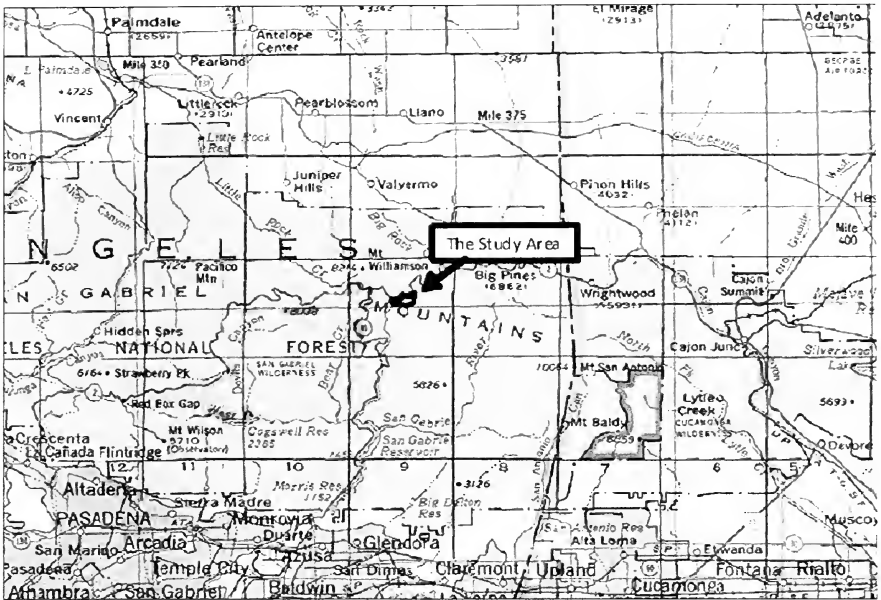


Figure 1: Top: Map of Angeles National Forest showing general location of Lily Springs. Bottom: Topographical Map of Lily Springs Study Area with boundaries outlined in black. Both maps created with TOPO® ©2003 National Geographic. (www.nationalgeographic.com/topo)

We collected vouchers in 2012. The 2010 and 2012 observations were not as complete as those in 2011 and are not included in the phenology comparison.

RESULTS

Phenology Comparison

Differences in Taxa Observed in 1981 and 2011. Sawyer included 95 of the 100 taxa he observed in the study area in a phenology table. Four of the excluded taxa, *Corallorhiza maculata*, *Mimulus johnstonii*, *Penstemon caesius* and *Sisymbrium altissimum*, were omitted because they were in fruit at the time they were observed. The fifth taxon, *Calyptidium parryi* var. *parryi* was seen in the study area in 1980, but not in 1981. We observed the 95 taxa included in the original phenology table as well as *Mimulus johnstonii*, *Penstemon caesius*, *Sisymbrium altissimum*, and additional taxa that are listed below. We did not find *Calyptidium parryi* var. *parryi* or *Corallorhiza maculata* in the study area in 2011 or during our less complete visits to the area in 2010 and 2012.

Table 1 lists taxa that have undergone name changes as a result of taxonomic revision as well as several taxa in Sawyer's 1981 phenology table that have since been re-identified from their vouchers (referenced in the table). In addition, Sawyer reported a disjunct bloom for pink-flowered and yellow-flowered *Mimulus rubellus*. A voucher collected in the area of Lily Spring (R.F. Thorne 286778 RSA) of the yellow-flowered plant was later re-identified as *Mimulus suksdorfii*. We included *M. suksdorfii* in our phenology comparison, but did not include the pink-flowered *M. rubellus* because we did not find it until 2012.

Flowering Times in 1981 and 2011. Table 2 lists 1981 and 2011 flowering times for the original set of 95 taxa. For the purpose of future comparisons, we included in the table the entire 2011 observation period from the beginning of April through the first week of November. However, the phenology comparisons discussed below pertain only to the 1981 observation period, the beginning of May through the second week of September.

Figure 2 shows the number of taxa in flower for each week of observation for both 1981 and 2011. The figure includes all 95 taxa listed in Table 2. Flowering in 1981 and 2011 followed a roughly similar pattern, but in 1981 the maximum number of taxa in flower, 44, occurred during the fourth week of July, while in 2011, the maximum, 71, occurred during the first week of August. The larger number of taxa in flower during any one week in 2011 can probably be attributed to the longer duration of flowering; taxa were in flower for 8.9 weeks on average in 2011 as compared to 5.4 weeks in 1981.

Name used in 1981 (Munz 1974)	Name listed in The Jepson Manual (Baldwin et al. 2012)	Re-identification (Voucher) or taxonomic revision
<i>Oxytheca parishii</i> var. <i>parishii</i>	<i>Acanthoscyphus parishii</i> var. <i>parishii</i>	taxonomic revision
<i>Lotus argophyllus</i> var. <i>decorus</i>	<i>Acmispion nevadensis</i> var. <i>davidsonii</i>	taxonomic revision and W.E. Sawyer 330794 RSA
<i>Arctostaphylos parryana</i>	<i>Arctostaphylos patula</i>	W.E. Sawyer 330759 RSA
<i>Arabis platysperma</i>	<i>Boechera platysperma</i>	taxonomic revision
<i>Arabis repanda</i>	<i>Boechera repanda</i>	taxonomic revision
<i>Draba stenoloba</i> var. <i>nana</i>	<i>Draba albertina</i>	taxonomic revision
<i>Potentilla glandulosa</i> ssp. <i>nevadensis</i>	<i>Drymocallis cuneifolia</i> var. <i>ewanii</i>	taxonomic revision and W.E. Sawyer 332610 RSA
<i>Potentilla glandulosa</i> ssp. <i>reflexa</i>	<i>Drymocallis glandulosa</i> var. <i>reflexa</i>	taxonomic revision
<i>Zauschneria californica</i>	<i>Epilobium canum</i>	taxonomic revision
<i>Epilobium brevistylum</i>	<i>Epilobium ciliatum</i> subsp. <i>ciliatum</i>	taxonomic revision
<i>Epilobium oregonense</i>	<i>Epilobium glaberrimum</i>	W.E. Sawyer 330814 RSA
<i>Chrysothamnus nauseosus</i>	<i>Ericameria nauseosa</i>	taxonomic revision
<i>Rhamnus californica</i> ssp. <i>cuspidata</i>	<i>Frangula californica</i> subsp. <i>cuspidata</i>	taxonomic revision
<i>Heuchera elegans</i>	<i>Heuchera caespitosa</i>	taxonomic revision
<i>Holodiscus microphyllus</i> var. <i>microphyllus</i>	<i>Holodiscus discolor</i> var. <i>microphyllus</i>	taxonomic revision
<i>Leptodactylon pungens</i> ssp. <i>pulchriflorum</i>	<i>Linanthus pungens</i>	taxonomic revision
<i>Smilacina stellata</i>	<i>Maianthemum stellatum</i>	taxonomic revision
<i>Monardella cinerea</i>	<i>Monardella australis</i> subsp. <i>cinerea</i>	taxonomic revision
<i>Osmorhiza chilensis</i>	<i>Osmorhiza berteroi</i>	taxonomic revision
<i>Senecio ionophyllus</i>	<i>Packera ionophylla</i>	taxonomic revision
<i>Penstemon bridgesii</i>	<i>Penstemon rostriflorus</i>	taxonomic revision
<i>Phacelia curvipes</i>	<i>Phacelia mohavensis</i>	W.E. Sawyer 310140 RSA
<i>Habenaria leucostachys</i>	<i>Platanthera dilatata</i> var. <i>leucostachys</i>	taxonomic revision
<i>Habenaria sparsiflora</i>	<i>Platanthera sparsiflora</i>	taxonomic revision
<i>Salsola iberica</i>	<i>Salsola tragus</i>	taxonomic revision
<i>Sambucus caerulea</i>	<i>Sambucus nigra</i> subsp. <i>caerulea</i>	taxonomic revision
<i>Silene verecunda</i> ssp. <i>platyota</i>	<i>Silene verecunda</i>	taxonomic revision
<i>Sisyrinchium eastwoodiae</i>	<i>Sisyrinchium bellum</i>	taxonomic revision
<i>Solidago californica</i>	<i>Solidago velutina</i> subsp. <i>californica</i>	taxonomic revision
<i>Symphoricarpos parishii</i>	<i>Symphoricarpos rotundifolius</i> var. <i>parishii</i>	taxonomic revision
<i>Viola purpurea</i> ssp. <i>xerophyta</i>	<i>Viola pinetorum</i> subsp. <i>grisea</i>	taxonomic revision

Table 1: Name changes from taxonomic revision and voucher re-identification.

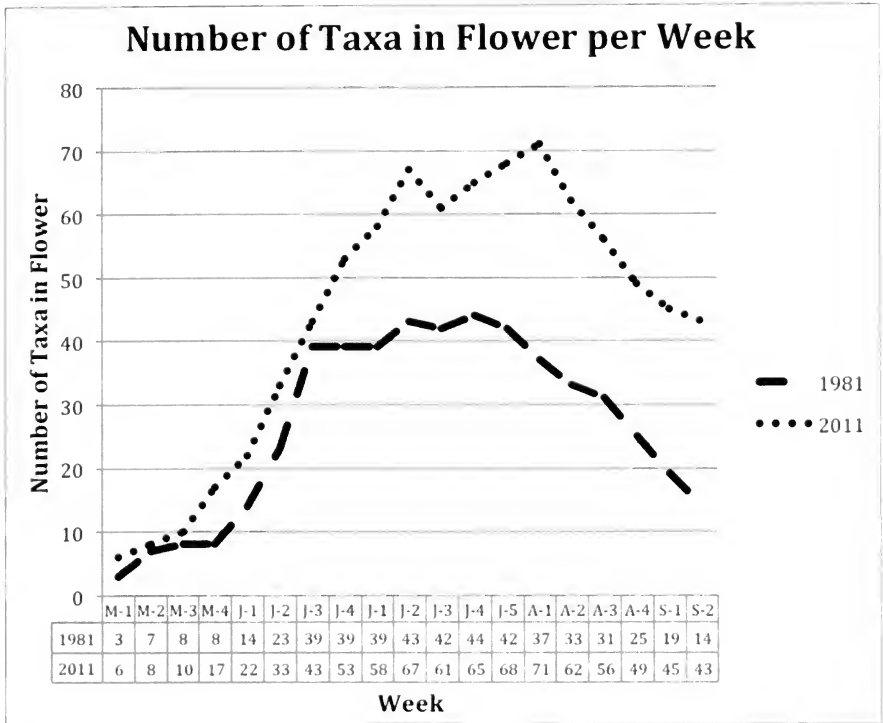


Figure 2: The number of taxa in flower for each week was determined and plotted. The notation M-1 to M-4 corresponds to the four weeks of May and similarly for June, July, August, and September. Both 1981 and 2011 observations include the same set of 95 taxa.

Flowering Onset. The numbers of taxa that flowered earlier in 2011 than in 1981, at the same time, or later than in 1981 are similar: 32 earlier, 28 at the same time and 32 later. Three taxa, *Arctostaphylos patula*, *Cercocarpus ledifolius* and *Salix lasiolepis*, that flowered before the first week of May in 2011 and were already in flower when Sawyer began his observations in 1981, were excluded from further comparisons of flowering onset.

Early Season versus Late Season. Figure 3 shows that a large fraction (73%) of all taxa that began flowering in April or May 2011 flowered earlier than in 1981. Many (44%) of the June flowering taxa tended to flower at the same time as in 1981. Taxa that flowered later in the season tended to flower later than in 1981.

The number of weeks of change in flowering onset between 2011 and 1981 was determined from Table 2. Figure 4 shows a frequency distribution of the percent of taxa flowering from four weeks earlier in 2011 through three weeks later.

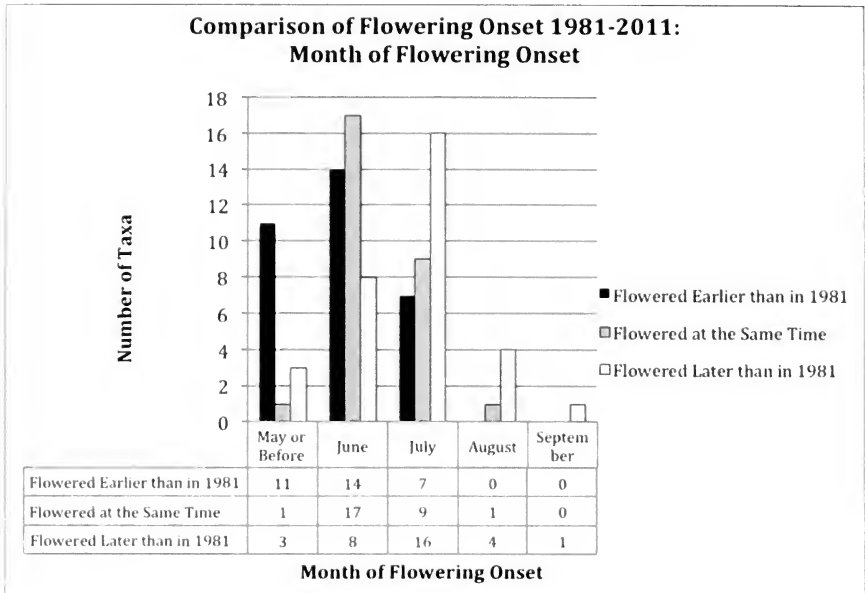


Figure 3: 92 of the 95 taxa included in Sawyer's 1987 phenology table were categorized from Table 2 as flowering earlier, at the same time, or later than they did in 1981, and then sorted according to the month in which flowering began. Three taxa were excluded because flowering was already in progress when the observation started in 1981.

Positive numbers indicate the number of weeks taxa flowered earlier in 2011. Zero indicates that taxa flowered at the same time as in 1981, and negative numbers indicate the number of weeks taxa flowered later. The frequency distribution for taxa flowering in April and May peaks at two weeks earlier. The distribution of taxa flowering in June roughly follows that of all taxa, while the distribution for taxa flowering in July peaks at one week later. Taxa flowering in August and September show a frequency distribution shifted to later dates by as much as three weeks. Since the observation period in 1981 ended during the second week of September, we do not see the entire distribution for these late flowering taxa. Paired t-tests were performed using Microsoft Excel and the results are consistent with the above analysis. Early flowering taxa (those that flower in April and May) and late flowering taxa (those that flower in August and September) had flowering onsets that were significantly different ($p = 0.00206$ and 0.010 , respectively) in 2011 than in 1981. The change in flowering onset for June and July flowering taxa was not significant ($p = 0.056$ and 0.110 , respectively).

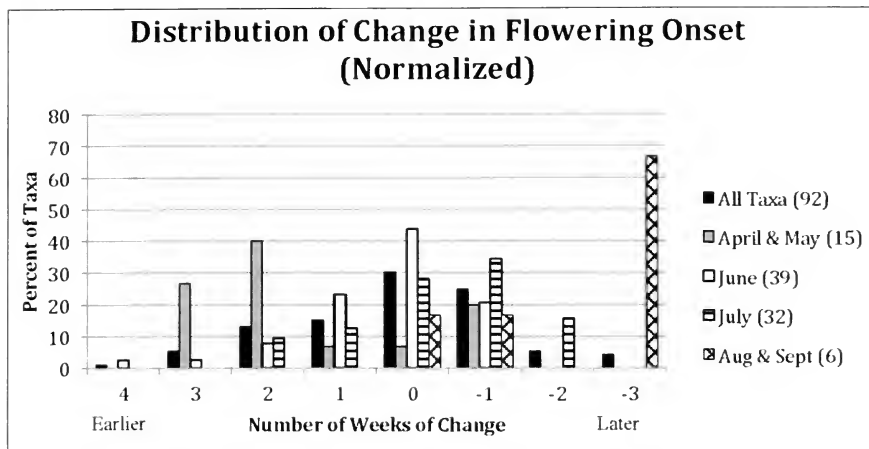


Figure 4: The number of weeks of change in flowering onset was determined from Table 2. Taxa were categorized according to the month of flowering and the frequency distribution was plotted for each category.

Annuals vs. Perennials. Figure 5 shows that about 52% of annuals flowered earlier in 2011 than in 1981. In contrast, perennials were almost evenly divided among the categories of flowering earlier (30%), at the same time (30%) or later (40%) than in 1981. When the change in flowering onset between 1981 and 2011 was determined and paired t-tests performed, the change in flowering onset for both annuals and perennials was not significant ($p = 0.087$ and 0.790 , respectively).

Duration of Flowering. As mentioned above, taxa flowered longer in 2011: 8.9 weeks on average compared to 5.4 weeks on average for 1981. These average durations pertain to the 1981 observation period beginning the first week of May and continuing through the second week of September. Figure 6 shows the number of taxa that flowered for 2 weeks or less, 3-5 weeks, 6-8 weeks and 9-13 or more weeks for both 1981 and 2011. In 1981, the duration of flowering for most taxa was 3-5 weeks, while in 2011, it was 9 weeks or longer. Only 9 taxa had shorter flowering durations in 2011. Five of these were late flowering taxa that began flowering later in 2011 and continued to flower beyond the second week of September. By the second week of September, 14 taxa (14.7%) were still flowering in 1981 while 43 (45.3%) were still flowering in 2011. Annuals and perennials behaved similarly, with an average increase in flowering duration of 4.5 weeks for annuals and 3.2 weeks for perennials.

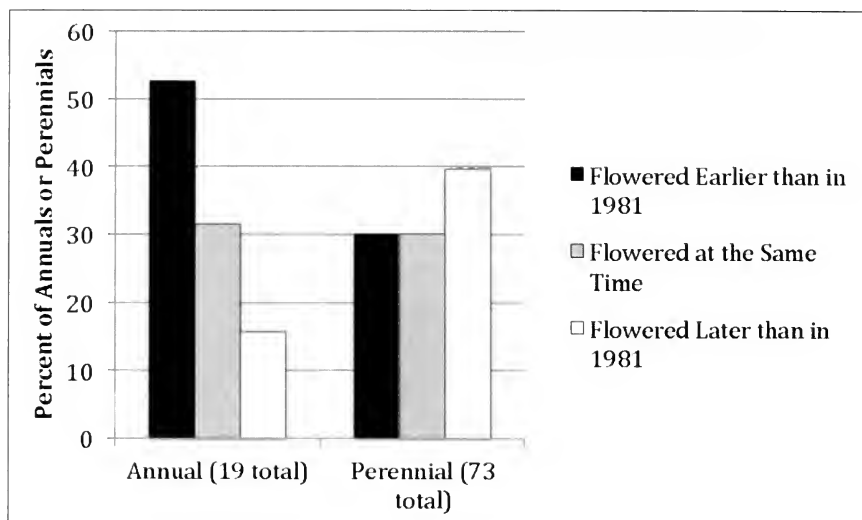


Figure 5: Annuals *versus* Perennials. 92 of the 95 taxa included in Sawyer's 1987 phenology table were categorized in the same way as for Figure 3 and then sorted according to whether they were listed in *The Jepson Manual* as annuals or perennials. One biennial, *Draba corrugata*, was classified as a perennial.

Effect of Study Area Conditions on Observations

Precipitation and Temperature. The comparison of single year observations is complicated by the wide variation in normal weather conditions, which can show large differences in temperature and precipitation from year to year. The distribution of precipitation throughout the year and the timing of warm and cold spells can also affect plant behavior (Fitter and Fitter 2002; Inouye et al. 2003; Franks et al. 2007). Figure 7 shows total monthly precipitation for 1980-1981 and 2010-2011, respectively (Western Regional Climate Center, online; MesoWest, online). The data are from three weather stations: Mt. Wilson Station, approximately 25 km from the study area, Big Pines, approximately 10 km from the study area, and Big Bear Lake, approximately 85 km from the study area. These stations were chosen because they flank the study area on the east and west and their records are reasonably complete for the time periods of interest. In addition, the study area is on the same side of the mountains (the desert or north side) as Big Pines (San Gabriel Mountains) and Big Bear (San Bernardino Mountains). The elevations at Big Pines and Big Bear (each about 2,100 m) are more similar to those in the study area (2,200 m to 2,600 m) than the elevation at Mt. Wilson (1,750 m).

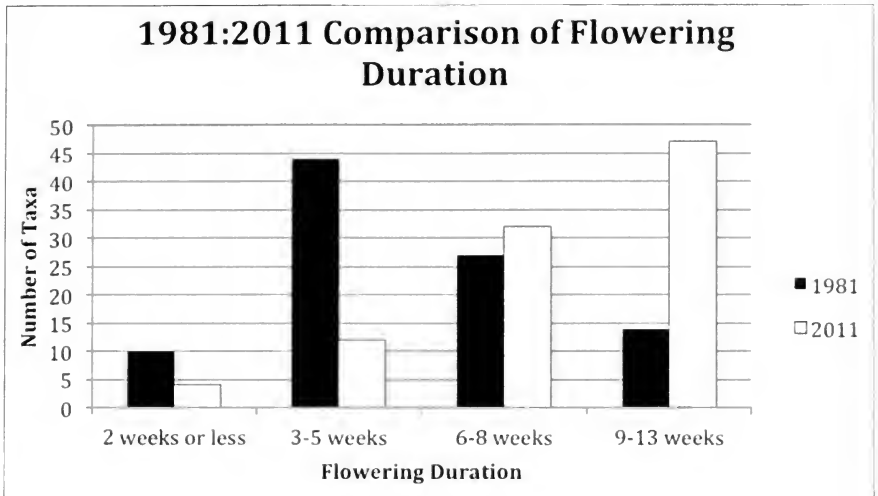


Figure 6: The number of weeks in flower for all taxa in 1981 and 2011 from the first week of May through the second week of September. Determined from Table 2.

We organized the monthly precipitation in the way that we thought would most directly affect the observation season, beginning in October preceding the observations and ending in September of the observation year. The distributions of precipitation throughout the year for 1980-1981 and 2010-2011 show most of the precipitation falling during the winter and spring and little precipitation during the summer. More summer precipitation fell at Big Pines and Big Bear in 2010-11 than in 1980-81; there was essentially no precipitation in June, July and August at Mt. Wilson in either year. An examination of the average monthly precipitation from 1960 to 1995 for the three stations (Figure 8) shows that the usual pattern includes summer precipitation (July and August) on the desert side of the mountains. The annual precipitation totals for 2010-2011 were substantially larger for Big Pines and Big Bear than the 1980-81 totals (699 mm vs. 396 mm for Big Pines and 867 mm vs. 245 mm for Big Bear), indicating that 2010-2011 was a much wetter year on the desert side of the mountains than 1980-81.

We also examined monthly precipitation for the eight years preceding both studies, 1973 to 1980 and 2003 to 2010. We used an eight-year time period because the Western Regional Climate Center records for Big Pines end in 1996 and the MesoWest records for this station begin in 2002. [We feel confident in using data from two sources as the coordinates given for the two sets of records are almost identical; station metadata for Big Pines from the Western Regional

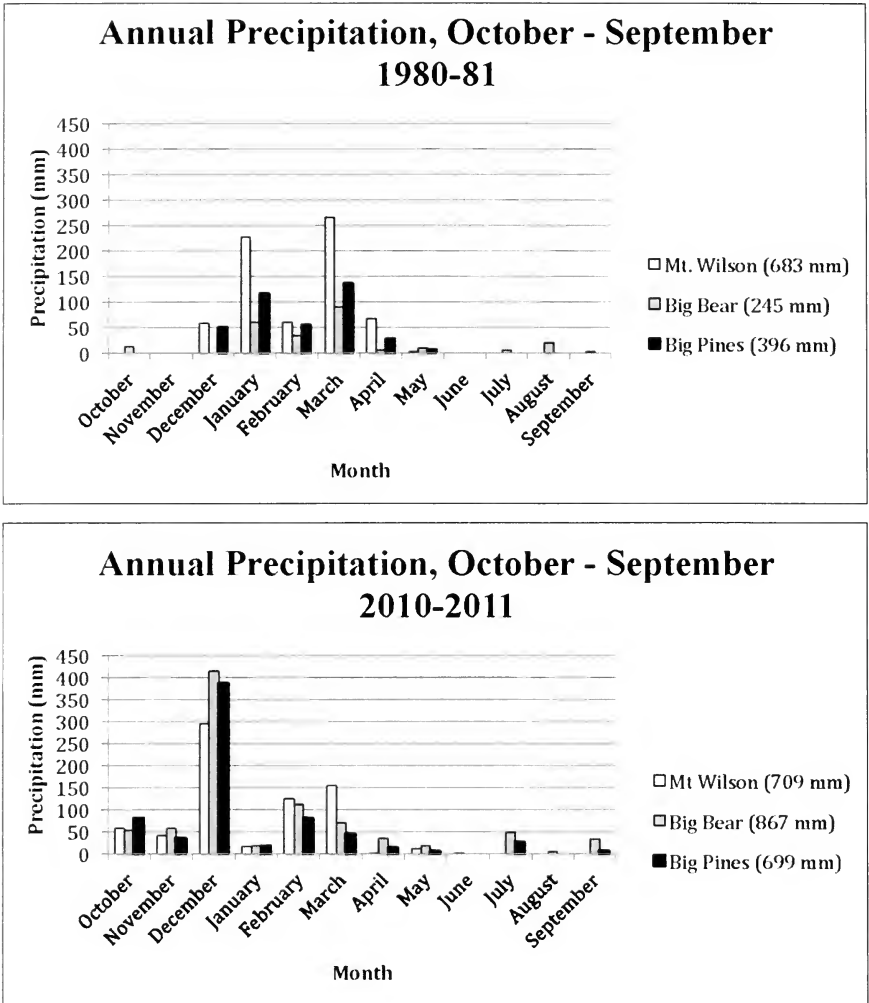


Figure 7: Precipitation data were obtained from the Western Regional Climate Center (online) for Mt. Wilson, Big Bear and Big Pines 1980-81, and from MesoWest (online) for Big Pines 2010-11. All numbers converted from inches to mm.

Climate Center (online) gives the coordinates as N37° 23', W-117° 41' and that from MesoWest (online) gives the coordinates as N37° 22.7', W-117° 41.5']. Table 3 lists annual precipitation averaged over these eight-year periods and shows that 1973 to 1980 was a wetter period than 2003 to 2010 and the 35-year comparison period for all three stations. The period 2003 to 2010 was drier than

the comparison period for Mt. Wilson and Big Pines, but not for Big Bear. We infer from these data that the study area also experienced eight years of relatively wet conditions before the 1981 observations and eight years of relatively dry conditions prior to the 2011 observations.

Station (source)	Lat. Long.	Average Annual Precipitation		
		1973 to 1980	2003 to 2010	1960 to 1995
Mt. Wilson (WRCC)	34° 14' -118° 04'	1207 mm	501 mm	992 mm
Big Bear (WRCC)	34° 15' -116° 53'	719 mm	625 mm	586 mm
Big Pines (WRCC)	34° 23' -117° 41'	777 mm		666 mm
Big Pines (MesoWest)	34° 22.7' -117° 41.5'	.	502 mm	

Table 3: Annual Precipitation Averaged Over the Eight-Year Periods 1973 to 1980 and 2003 to 2010. Data were obtained from the Western Regional Climate Center (WRCC, online) and MesoWest (online) for the three weather stations listed above and were converted from inches to millimeters.

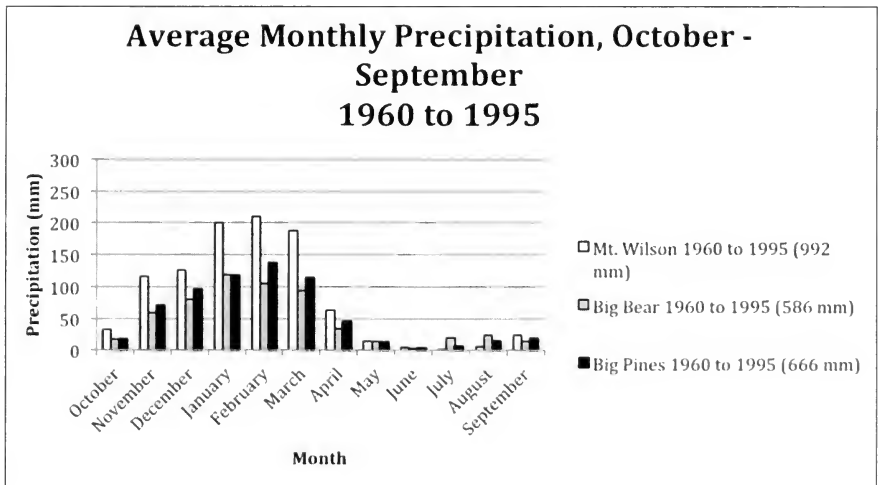


Figure-8: Average monthly precipitation from October 1960 to September 1995. Obtained from the Western Regional Climate Center. The data were converted from inches to mm.

We conducted analyses of temperature in each year and for the decades preceding the observation years. The results are shown in Figures 9 and 10. Figures 9a and 9b show average monthly temperatures for the observation years 1980-81 and 2010-11 and for a longer comparison period, 1961 to 2011 for Mt Wilson (Figure 9a) and Big Bear (Figure 9b). There are no temperature records for Big Pines before 2002. The figures show that for both stations, 1980-81 was slightly warmer than the average year in the period 1961 to 2011, with both highs and lows warmer than those in the comparison period, especially during the month of June. 2010-2011 had high temperatures during the winter that were above those of the comparison period and was warmer in August and September. Figures 10a (Mt. Wilson) and 10b (Big Bear) show average monthly temperatures during the

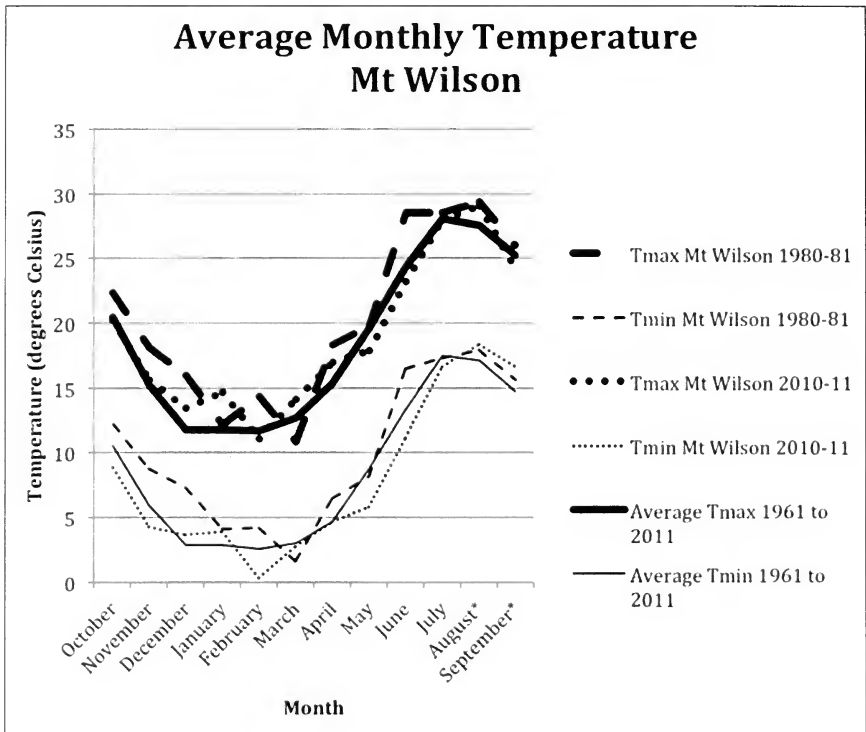


Figure 9a: Maximum (Tmax) and minimum (Tmin) temperatures for each month of October 1980 through September 1981, and October 2010 through September 2011 were obtained from the Western Regional Climate Center (online) for the Mt. Wilson Station and converted from degrees F to degrees C. *August and *September indicate that for those months in 2011, more than five days of data were missing. Average monthly temperatures for each month in the comparison period, October 1961 to September 2011 are included for reference.

respective twenty-year periods preceding the 1981 and 2011 observation years. Both stations had higher maximum and minimum temperatures in the period 1991 to 2011 than for 1961 to 1981. The average annual maximum temperature at Mt. Wilson was 1.4 °C warmer in the period 1991 to 2011 while the average annual minimum temperature was warmer by 1 °C. At Big Bear, the average annual maximum temperature for 1991 to 2011 was 0.72 °C warmer than for 1961 to 1981 and the average annual minimum temperature was 1.4 °C warmer.

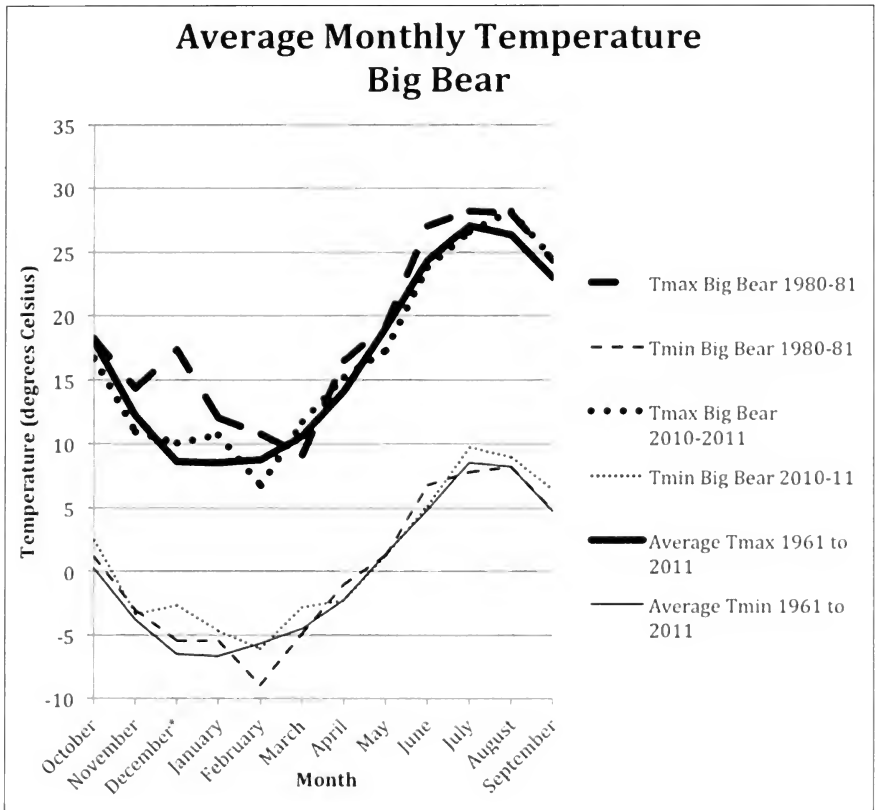


Figure 9b: Maximum (Tmax) and minimum (Tmin) temperatures for each month of October 1980 through September 1981, and October 2010 through September 2011 were obtained from the Western Regional Climate Center (online) for the Big Bear Lake Station and converted from degrees F to degrees C. Average monthly temperatures for each month in the comparison period, October 1961 to September 2011 are included for reference.

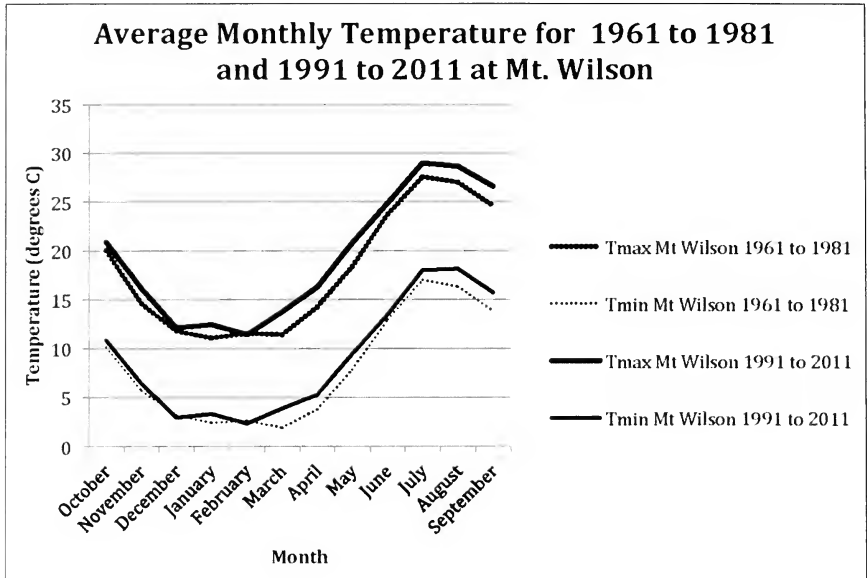


Figure 10a: Maximum (Tmax) and minimum (Tmin) temperatures for each month of the twenty-year period, October 1961 through September 1981 and October 1991 through September 2011 were obtained from the Western Regional Climate Center (online) for the Mt. Wilson Station and converted from degrees Fahrenheit to degrees Celsius.

Other Conditions. The study area has remained relatively free from disturbances such as construction of new trails and firebreak cutting, especially in the areas away from California State Route 2. The PCT is cleared of fallen trees and other debris every summer for the Angeles Crest 100 mile Endurance Run. We assumed that the drainage gullies and culverts adjacent to the highway were subject to similar maintenance schedules by Caltrans in both 1981 and 2011.

The Curve Fire of 2002. As mentioned above, the Curve Fire burned almost the entire study area. Several deforested portions of the area are along the ridge above the Pacific Crest Trail, on a sloping bench between the Big Rock Creek drainage and Lily Spring and on the southwest face of the northwest-southeast ridge known as Claude's Ridge. These areas were still relatively open in 2011 with many standing dead and downed burned trees.

Phenology of Taxa not Included in Sawyer's 1981 Study

We extended Sawyer's work by listing all taxa present in the study area and reporting their flowering phenology. Table 4 lists 34 non-graminoid taxa observed

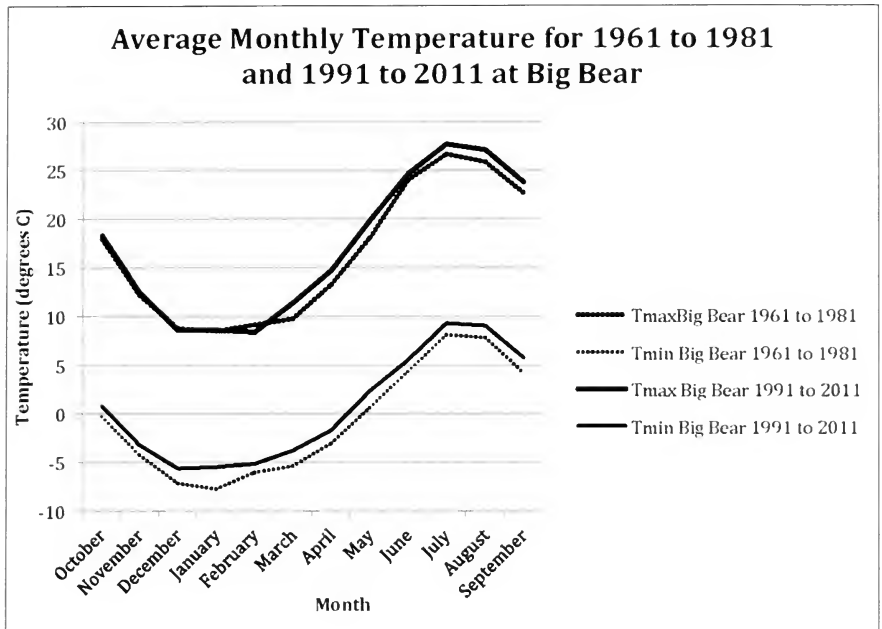


Figure 10b: Maximum (Tmax) and minimum (Tmin) temperatures for each month of the twenty-year period, October 1961 through September 1981 and October 1991 through September 2011 were obtained from the Western Regional Climate Center (online) for the Big Bear Lake Station and converted from degrees F to degrees C.

in 2011 that were not included in the 1981 study. Flowering onsets and durations are reported for the 2011 observation period beginning the first week of April and ending the first week of November.

DISCUSSION

Phenology Changes

This study differs from other recent phenology work in that we compared flowering onset and duration for two seasons thirty years apart, while other studies (for example, Bradley et al. 1999; Abu-Asab et al. 2001; Fitter and Fitter 2002; Miller-Rushing and Primack 2008) described continuous observations made over several decades. Since our objective was to compare our 2011 observations with Sawyer's 1981 observations, we adopted his method of recording the weeks of flowering for each taxon rather than actual dates for flowering, with the understanding that this practice introduced approximately half a week of uncertainty into our data. We also report flowering duration in weeks rather than in days. (We have uploaded a

spreadsheet containing dates of our observations to the California Native Plant Society Rare Plant Phenology Forum, which can be accessed at <http://www.cnps.org/cnps/rareplants/forum-phenology.php>.

Our observations that some taxa flowered earlier in 2011 than in 1981, some flowered later and some flowered at the same time are similar to observations made by others. Abu-Asab et al. (2001) reported that 84% of taxa observed in the vicinity of Washington, DC, over a period of 30 years flowered earlier while 11% flowered later. Fitter and Fitter (2002) reported that in the last ten years (1991 to 2000) of a 47-year period, 16% of taxa flowered earlier and 24% flowered later in south-central England. Dunnell and Travers (2011), working in the Red River Valley area of North Dakota, compared observations from 2007 to 2010 with historical records from 1910 to 1961 and observed species that flowered both earlier and later as well those (slightly over half) whose flowering phenology was unchanged from previous decades.

We observed that taxa flowering in April and May flowered about 1.5 weeks earlier on average in 2011 than in 1981, which is consistent with reports of Ahas et al. (2002), Fitter and Fitter (2002) and Sherry et al. (2007) that early season flowering taxa flowered earlier than in previous decades. Our observation that taxa flowering after July 1st were more likely to flower later in 2011 than in 1981 is also consistent with reports by Sherry et al. (2007) and Dunnell and Travers (2011) that taxa which normally flower late in the season showed delayed first flowering dates compared with previous decades.

Although 52% of annuals flowered earlier in 2011 than in 1981, this change is not statistically significant (a paired t-test yielded a p value of 0.087). Perennials as a group did not appear to flower earlier in 2011. Miller-Rushing and Primack (2008) also observed that annuals did not flower significantly earlier.

Conditions Show Wide Variation from Year to Year

Temperature. We compared temperature and precipitation for the individual seasons 1981 and 2011 as well as for the twenty-year periods preceding these observation seasons to see if there were changes that might help explain our observations. Although 1980-81 had warmer maximum temperatures than 2010-11, two thirds of the taxa observed flowered either earlier or later in 2011. Average annual temperatures during the period 1991 to 2011 were on the order of one degree C warmer than those for the period 1961 to 1981. Thus the phenology shifts for 67.4% of taxa in our study may be a result of this latter warmer period.

Precipitation. Given changes in other conditions in the study area, we cannot attribute the shift in flowering times observed in 2011 entirely to an increase in temperature. We discovered that the 1980-81 season was drier than the 2010-11 season, but followed a wetter eight-year period. The 2010-11 season, although wetter than the 1980-81 season, followed a drier eight-year period. In addition, there was little or no summer rain in 1981 while there was summer rain in 2011; for example, summer precipitation at Big Pines in 1981 was zero for June, July and August, while in July of 2011, there was about 25 mm. The summer rain in 2011 may have delayed flowering in some taxa and extended the flowering durations of both annuals and perennials (T. Chester, 2012, personal communication).

Reduced snowpack in the study area, a result of lower precipitation and warmer winter temperatures, could also have contributed to longer flowering durations. There are several reports that indicate earlier snowmelt dates can lead to earlier flowering (Dunne et al. 2003; Inouye and McGuire 1991; Inouye 2008; Steltzer et al. 2009). The longer flowering durations observed in 2011 are also consistent with the report of Dunne et al. (2003) that experimental warming and snow removal resulted in longer flowering for some species.

The Curve Fire of 2002. As mentioned above, the fire that killed many of the trees on the slopes and ridges has resulted in substantially less canopy cover in many parts of the study area. Although we conducted the Lily Spring Area Survey nine years after the fire, our observations of both earlier and delayed flowering and longer duration of flowering are consistent with other reports (Wroblewski and Kauffman 2003; Jarrad et al. 2008) for one or two seasons following a fire.

Methodology. Another factor that could contribute at least partially to the observed differences between 1981 and 2011 is methodology. As far as we know, Sawyer was the only person making observations in 1981, and these observations occurred once or twice per week. In 2011, as many as three observers made one to four independent observations every week. Miller-Rushing et al. (2008) reported that population size and sampling frequency may influence observed phenology, with larger population sizes and more frequent sampling resulting in earlier first flowering dates. We have no information about population sizes in 1981, but the larger number of observers making more trips to the study area possibly resulted in exaggerated advances in flowering times.

The large differences observed in flowering duration between 1981 and 2011 may also be attributed to methodology as well as to the combined effects of temperature, precipitation patterns and fire. Our method for determining flowering may have resulted in the inclusion of more taxa undergoing residual flowering, while for the same taxa, Sawyer's methods may have indicated that flowering had concluded.

We note that it is more difficult to determine the cessation of flowering than it is to determine flowering onset. In addition, our criteria for flowering included taxa found anywhere within the study area; we did not confine our observations to specific individuals or small groups of individuals. In cases where taxa were found in different habitats, this criterion lengthened the flowering duration. An extreme example is *Arctostaphylos patula*, which we found flowering first on the crests of the ridges, then on the open bench between the Big Rock Creek drainage and Lily Spring, and finally along California State Route 2, where it was growing at the bottom of an avalanche chute and did not flower until after the snow melted in mid-June. Each group of *A. patula* plants in the different habitats flowered for four to six weeks, but combined, this taxon flowered for 12 weeks.

Additional Taxa Observed in 2011. The presence of some of the additional taxa listed in Table 4 may be attributed to more observers making more frequent trips to the study area in 2011, but Sawyer may have excluded some taxa on the basis of his interest in insect pollination.

Wind Pollinated Taxa. Since the 1981 observations were conducted as part of Sawyer's masters thesis on pollination (Sawyer, 1985), he did not include wind pollinated angiosperms (except for *Chrysolepis sempervirens*) even though we know from Sawyer's vouchers that some were present in the study area at that time. Eight of the 34 additional taxa we observed are wind pollinated: *Ambrosia acanthicarpa*, *Artemisia dracuncululus* (W.E. Sawyer 330761 RSA), *Artemisia tridentata* subsp. *vaseyana*, *Chenopodium berlandieri*, *Chenopodium fremontii*, *Chenopodium pratericola* (W.E. Sawyer 330799 RSA), *Dysphania botrys* and *Urtica dioica* subsp. *holosericea* (W.E. Sawyer 338449 RSA).

Fire Followers. After the 2002 Curve Fire, we would expect to see fire followers that were probably not present in 1981, since it is unlikely that a fire had occurred in that particular area in the previous decade. Three of the new taxa listed in Table 4, *Eriodictyon parryi*, *Hulsea heterochroma* and *Nicotiana attenuata* are fire followers.

New Non-natives. The presence of non-native plants is always of concern with respect to preserving the natural biodiversity of an area. Therefore, it is important to note additions to the list of non-native taxa that were present in the study area in 1981. Three non-native taxa were recorded in 1981, *Polygonum aviculare* subsp. *depressum*, *Salsola tragus* and *Sisymbrium altissimum*. We observed these three and seven others, *Dysphania botrys* (also a wind-pollinated taxon that may have been present in 1981), *Cirsium vulgare*, *Elaeagnus angustifolius*, *Lactuca serriola*, *Malus pumila*, *Melilotus albus* and *Taraxacum officinale*. These new non-natives may have been brought in by an increasing number of visitors to the

area and/or were able to become established after the Curve Fire (Lambert et al. 2010; Keeley et al. 2011). In addition, although Poaceae were not included in either the 1981 or 2011 surveys, we noted the presence in 2011 of three non-native grasses, *Bromus tectorum*, probably due to the Curve Fire, *Elymus hispidus* which according to a voucher collected by R.F. Thorne (232279 RSA) was probably planted along California State Route 2 near mile marker 66.43, and *Poa pratensis*, vouchered by Wayne Sawyer (332609 RSA) and by us, Jane Tirrell (788826 RSA) near Little Jimmy Spring.

Other Taxa. Several of the remaining new taxa listed in Table 4 were relatively rare in the study area, with only one or a few occurrences (*Asclepias eriocarpa*, *Mentzelia dispersa*, *Mentzelia montana* and *Viola pinetorum* subsp. *pinetorum*). There were others for which we did not find flowers every year (*Agoseris retrorsa*, *Lactuca serriola*, *Mimulus guttatus* and *Orobanche californica* subsp. *feudgei*), and one (*Claytonia perfoliata* var. *perfoliata*) which was ephemeral. Several taxa were so small that they may have been easily overlooked by Sawyer (*Mimulus breweri*, *Sagina saginoides* and *Viola macloskeyi*) and could have become obscured by the foliage of other plants as the season progressed. *Lupinus peirsonii*, California Rare Plant Rank 1B.3, situated on a highway berm, was probably brought into the study area by workers as they deposited gravel from other locations. Other taxa not previously reported in the study area (*Achillea millefolium*, *Chamaesyce serpyllifolia* subsp. *serpyllifolia*, *Epipactis gigantea*, *Mentzelia laevicaulis*, and *Stephanomeria virgata* subsp. *virgata*) were present in sufficient size and number that it is unlikely they would have been overlooked if they had been present in 1981.

Conclusion

We observed flowering phenology in a region of the San Gabriel Mountains near Lily Spring and compared our findings to a set of observations made 30 years previously. Although as a whole, the group of plants included in the study showed no average change in flowering time between 1981 and 2011, we noted that early flowering taxa generally flowered earlier and late flowering taxa flowered later. Nearly all taxa flowered longer. We attributed these changes to a combination of factors that include warmer temperatures, different patterns of precipitation in 1981 and 2011, the Curve Fire of 2002, and larger numbers of observers and observations in 2011. We also recorded 34 additional taxa that were not included in 1981. The presence of most of the additional taxa can be explained by an exclusion of wind pollinated taxa in 1981, and increases in fire followers and non-natives after the Curve Fire. Further studies at future dates will be necessary to provide a clearer picture of how phenology is changing and which factors are most influential in bringing about these changes.

ACKNOWLEDGEMENTS. We thank Amy Braverman, Jet Propulsion Laboratory, for advice on statistical analyses; Tom Chester for reviewing the manuscript and making significant comments; Liz Matthews, California Phenology Project, University of California, Santa Barbara, for advice on data interpretation; Aaron Sims, California Native Plant Society, for assistance with the Rare Plant Phenology Forum upload; Amber Swanson and others at California Native Plant Society, for plant presses; Katie VinZant, Angeles National Forest, for plant collection permit; Gary Wallace, Rancho Santa Ana Botanic Garden, for suggesting the project and for general advice; and Helen Wong Nyerges, Eaton Canyon Nature Center, for making available Wayne Sawyer's slide collection.

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NOTEWORTHY COLLECTION
SAN DIEGO COUNTY, CALIFORNIA

Lactuca virosa L. (Asteraceae) – San Diego County: Hidden Meadows, north of Escondido, private residence on Cerveza Drive, near 33° 13' 31.1" N, 117° 06' 0.3" W (WGS 84), about 1400 ft (425 m) elevation. A single individual growing in mulch under a peach tree in a backyard garden. Collected with permission and encouragement 30 July 2011, S. De Groot 6759 (SD, RSA). Identification confirmed by Jon Rebman (SD), Oct. 2011.

Lactuca virosa is said to be “usually biennial” (P. A. Munz and D. D. Keck, 1959, *A California Flora*, Univ. of California Press, Berkeley) or a “biennial from taproot” (B. G. Baldwin et al. [eds.], in press, *The Jepson Manual: Vascular Plants of California*, Univ. of California Press, Berkeley; retrieved from <http://ucjeps.berkeley.edu/tjm2/review/>, on 4 Aug 2011). The plant reported here was in flower during its first growing season; however, it did have a large, well-developed taproot that may have persisted (if given the chance). The whole plant was about 1.6 m (5 ft) tall, with a very well-developed rosette of serrate, but otherwise entire, obovate leaves. All parts of the plant readily exuded white latex when touched. The corollas were light yellow, with a pappus of simple bristles. The seeds were dark brown to black, compressed, with several ridges on each face, and with a long, slender beak.

Previous knowledge. The earliest specimen of *Lactuca virosa* in California was collected in 1903 in Alameda County, and the species, which is native to Europe, has generally been restricted to the San Francisco Bay area (Munz & Keck 1959). Of the 17 records for this species on the Consortium of California Herbaria (CCH), 14 are from Alameda or Contra Costa Counties. The earliest collection outside of that area was made in 1996 on Fort Hunter Liggett in Monterey County (Neese & Painter HL-3007). In 1999 *L. virosa* was collected in Santa Cruz County, and in 2000, in Napa County (CCH records, <http://ucjeps.berkeley.edu/consortium/>, accessed 4 Aug 2011). The online version of the revised Jepson Manual gives its range as San Francisco Bay (SnFrB) and northern outer South Coast Ranges (n SCoRO; B. G. Baldwin et al., in press). A search of the San Diego County Plant Atlas database, which lists thousands of plant collections from all over that county, did not return any records for *L. virosa*, although there were 113 records of *L. serriola* (<http://www.sdplantatlas.org/>, accessed 4 Aug 2011).

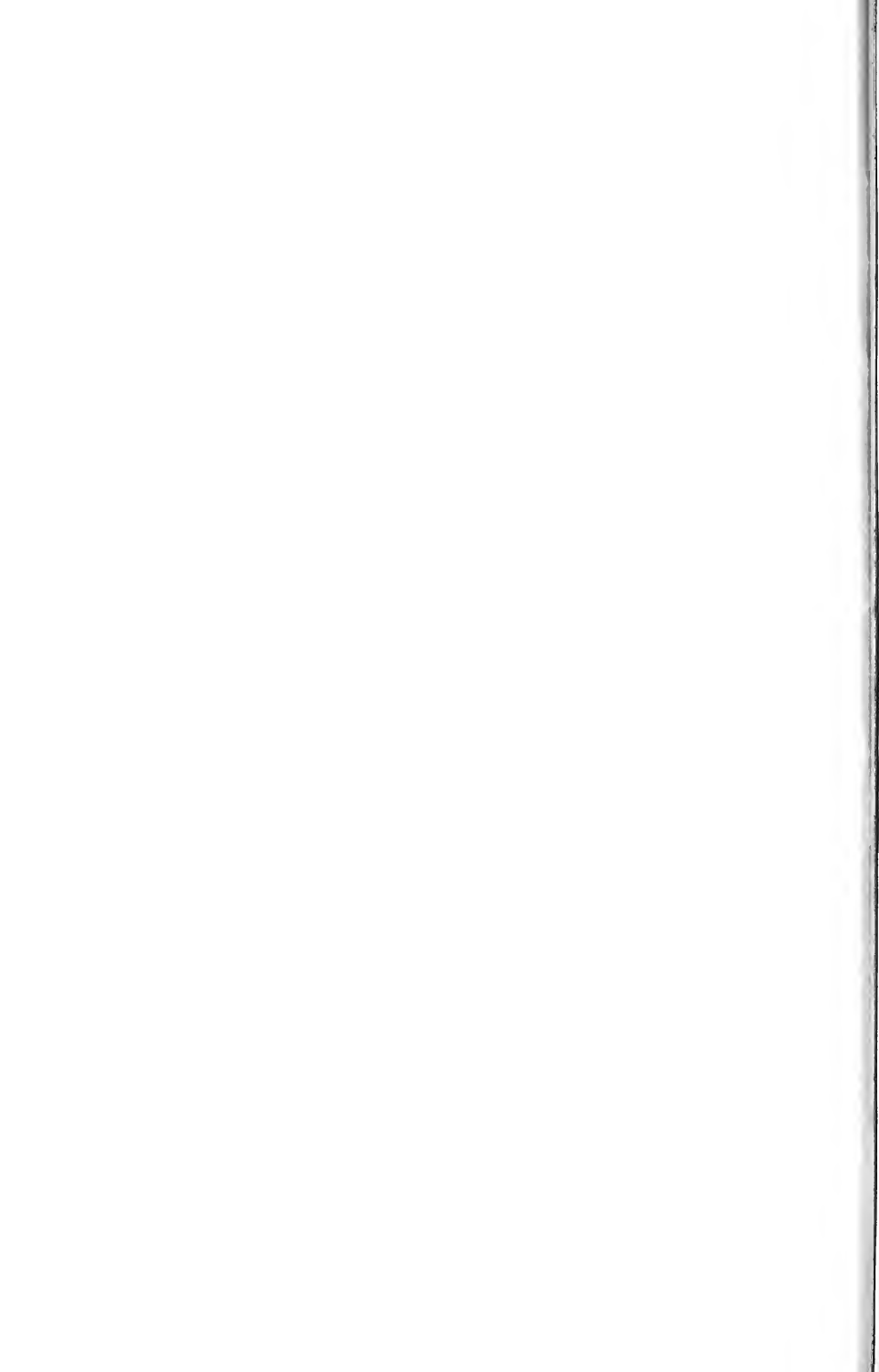
Significance. This collection is the first record of *L. virosa* from San Diego County, representing a southeast range extension of almost 300 miles (480 km). While there were no other individuals seen at this site, it is probable that other individuals exist in the wider area.



Lactuca virosa is not listed in the California Invasive Plant Council (Cal-IPC) Inventory (<http://www.cal-ipc.org/ip/inventory/weedlist.php>, accessed 4 Aug 2011), nor is it on their watch list (http://www.cal-ipc.org/ip/inventory/pdf/Cal-IPCWatchlist_Dec2010.pdf, accessed 4 Aug 2011). It is not clear how it arrived at this San Diego locality. While it is possible that there have been multiple introductions from Europe, specimen data also are consistent with a pattern of a species expanding its range, both to the north (Napa County) and south (San Diego County), after a period of acclimatization in the Bay area. Specimens collected since 1996 indicate that this species may no longer be restricted to the San Francisco Bay region. The individual reported here was growing in a site with some irrigation, but not heavily irrigated. Therefore *L. virosa* may have some difficulty becoming established in dry wildlands, but has potential to invade riparian areas.

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Photo: S. De Groot



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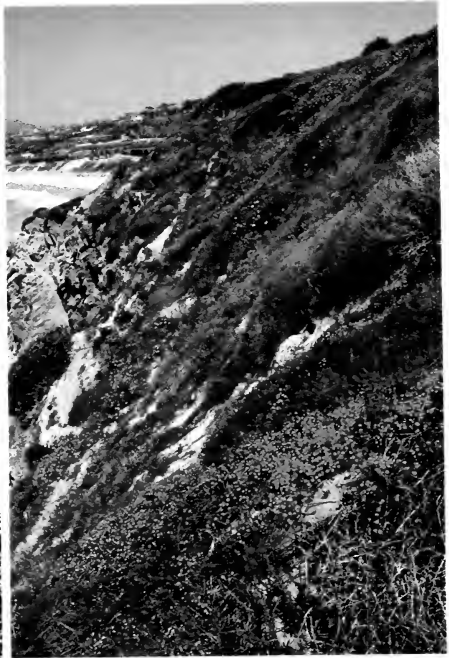
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Top left: *Malacothrix saxatilis* var. *saxatilis* on edge of southern cliffs. Top right: wildflower display along the sandy cliff rim, Dana Strand Beach in the background. Visible are *Lasthenia gracilis*, *Camissoniopsis bistorta*, *C. cheiranthifolia*, and *Aphanisma blitoides* (reddish foliage). Bottom: view of the mesa top and southern rim from the western edge looking southeast showing a mix of coastal sage scrub and coastal bluff scrub. *Encelia californica* in bloom.

All photos by Fred M. Roberts.

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**VASCULAR PLANTS OF THE
DANA POINT HEADLANDS,
ORANGE COUNTY, CALIFORNIA**

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ABSTRACT: The Dana Point Headlands (Headlands) is a coastal promontory located within the City of Dana Point, southern Orange County, California. Between 2008 and 2010, I conducted a series of floristic and sensitive plant surveys at three preserves. Dana Point Preserve managed by the Center for Natural Lands Management (CNLM), Hilltop Park and Harbor Point Park, both managed by the City of Dana Point. These lands conserve about 60 acres, the majority of natural habitat at this location. Based on this Study, which included a review of herbarium specimens, I am presenting an annotated catalogue of the vascular plants found at the Headlands. Two-hundred and forty-four taxa are reported. Over the last three decades, nineteen species of conservation concern have been reported for the Headlands, an especially rich diversity considering the size of the Study Area. Thirteen of these taxa were relocated during the study.

KEYWORDS: Floristics, Orange County, Dana Point, Dana Point Headlands, Center for Natural Lands Management Dana Point Preserve, Hilltop Park, Harbor Point Park, vascular plants, rare plants, southern southern coastal bluff scrub.

INTRODUCTION

The Dana Point Headlands has long been known as providing habitat to an unusually high diversity of special status plant species as compared to other areas of comparable size in Orange County. The Headlands is also one of four known locations supporting the critically endangered Pacific pocket mouse (*Perognathus longimembris pacificus*) and also supports a stable but isolated population of the threatened coastal California gnatcatcher (*Poliioptila californica californica*).

In association with various development proposals between 1988 and 2004, the Headlands had been examined by various professional survey efforts and members of the public, especially associated with the California Native Plant Society (CNPS). Public access to most of the Headlands was restricted following 2004 during restoration activities, which included the eradication of non-native species and habitat enhancement. Additionally, a system of public trails was installed during this time. The trails were opened to the public use starting in late 2009.

In 2007, I was approached by CNLM to conduct floristic and sensitive species survey of the Dana Point Preserve, which is located on the western portion of the promontory in largely sandy habitat. The survey was conducted primarily in 2008 with supplemental surveys in the spring of 2009. A floristic and sensitive species survey of Hilltop Park and Harbor Point Park was conducted at the request of the City of Dana Point in 2010. These parks included the natural habitat in the eastern and northern portions of the promontory. Supplementary surveys were conducted into early 2011. All three studies extended to the mean high tide line at the base of the cliffs. Environmental reports associated with the Headlands and herbarium specimens originating from the Headlands were reviewed as part of the study. A few historical collections taken from Dana Point prior to 1960 are likely from the Headlands, but the majority of the pre-study collections came from the period between 1983 and 2004.

PHYSICAL SETTING

Site Location

The Dana Point Headlands is located in southern Orange County within the City of Dana Point (See Figure 1). The preserve lands are bordered by the Dana Point Harbor and Green Lantern Street on the east, Pacific Coast Highway on the north, Shoreline Drive and Dana Strand Road on the northwest, and the Pacific Ocean on the west and south. The Headlands is entirely within the Dana Point 7.5 minute USGS quadrangle. A series of trails within the three preserves allow restricted public access. A representation of the Headlands, its relationship to surrounding features and the association of the CNLM Dana Point Preserve and Hilltop and Harbor Point Parks are presented in Figure 2.

Topography and geology

The Dana Point Headlands is a coastal promontory consisting of a coastal mesa with a gentle south to southwest-facing aspect, abruptly ending in steep or vertical cliffs on the west, south, and east side. The cliff base is near sea level and the rim is generally at about 50 meters (150 feet) to 70 meters (215 feet) above sea level. The highest point, often called "the hilltop" and situated within Hilltop Park, rises to about 85 meters (260 feet) elevation.

The bedrock is San Onofre Breccia overlain with marine terrace deposits primarily composed of sandstone (Watchell 1978). The San Onofre Breccia is exposed on cliff faces, especially along Harbor Point Park. The primary soils unit within the CNLM Dana Point Preserve and Harbor Point Park is Marina loamy sand.

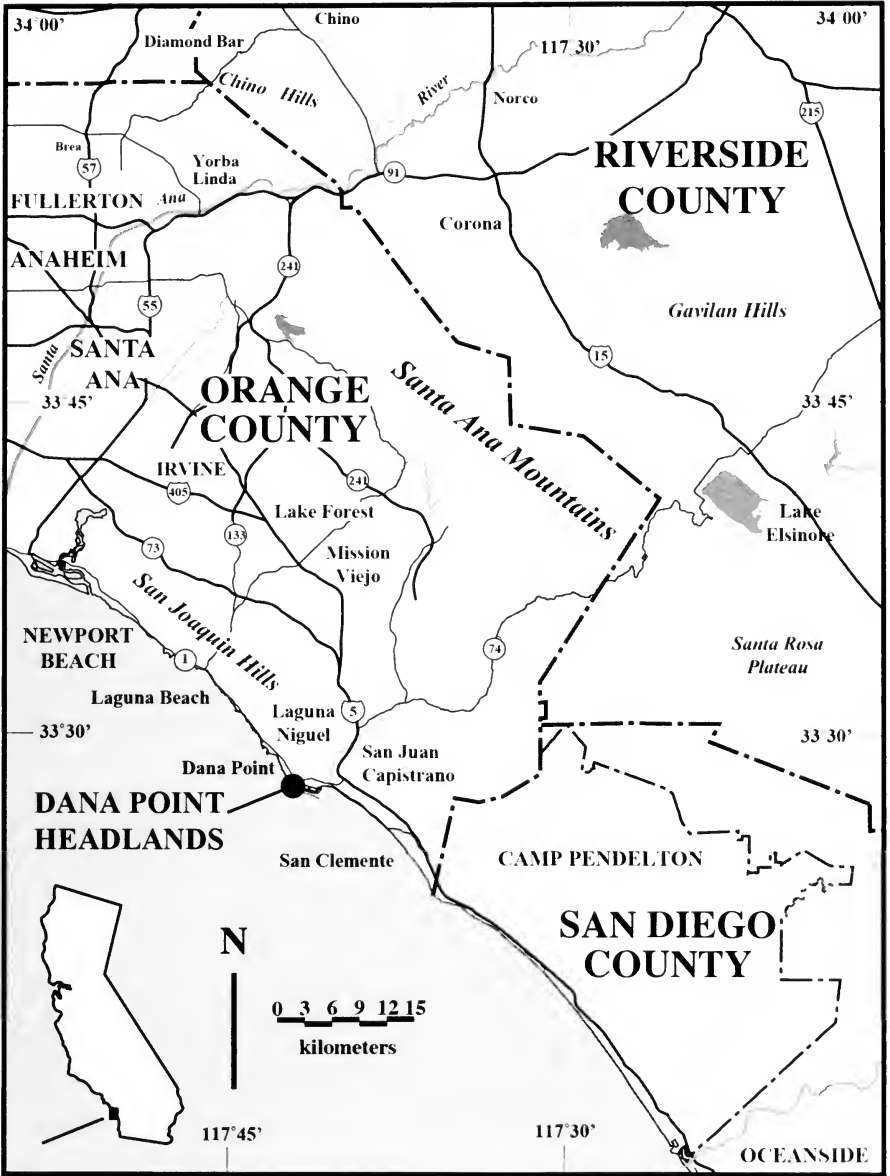


Figure 1: The general location of the Dana Point Headlands in relationship to California and features within the vicinity of the Headlands.

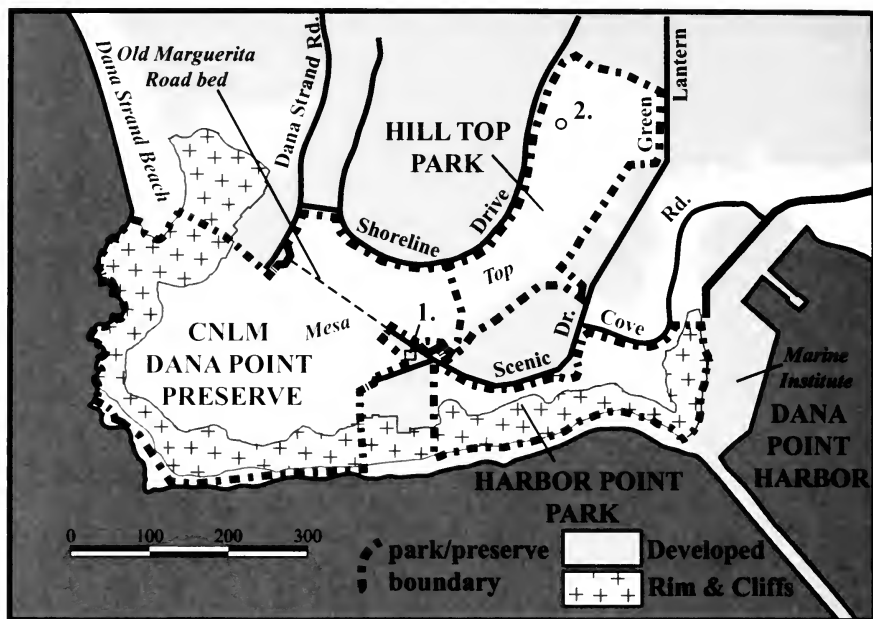


Figure 2: The Dana Point Headlands showing the relationship of the CNLM Dana Point Preserve, Hilltop Park, and Harbor Point Park, roads, development and open space, the location of the cliffs and rims, and other features. 1 = Interpretive Center, 2 = Hilltop Overlook.

A small area within the western portion of the Headlands is within San Andreas sandy loam and the western cliffs below the rim of the mesa are within the Cieneba sandy loam series. Hilltop Park and a small portion of the CNLM preserve is mapped as Marina loamy sand with some Rock-outcrop-Cieneba complex but mostly consists of compacted, often cobbly, clay to loamy clay soils not specifically identified by Watchell (1978).

Relictual mima mound topography was widespread south of what is now Hilltop Overlook when I first examined the area in the 1980s but is difficult to detect today due to recent soil surface modifications.

Previous Studies

The Dana Point Headlands has been subject to a number of informal and formal studies associated with environmental documentation. Additionally, there are specimens documenting various species on the Headlands dating back to 1924. B.D. Stark first documented *Euphorbia misera* from what is likely the future Har-

bor Point Park or CNLM Dana Point Preserve in December 1932 (Stark 4425 [RSA]). Additional cliff spurge collections were made by a number of collectors including G. Wallace [Wallace 522, 30 Apr 1966 (RSA)] and G.L. Webster [Webster 7479, 11 Dec 1966 (RSA)], which also likely came from the Headlands. Theodore Minthorne first documented *Dudleya blochmaniae* from the Dana Point Headlands (as San Juan Point) in 1924 (Minthorne s.n., 30 May 1924 (JEPS, UCR). R.L. Dressler made more collections of *D. blochmaniae* in May 1949 [Dressler 808 (MACF)]. Lyman Benson almost certainly was collecting on the Dana Point Headlands when he made his "ocean bluff" collections on March 26, 1926. That day he made a dozen collections, including *Phacelia distans* and *Dichelostemma capitatum* (Consortium 2013). Overall about two-dozen species were documented on or near the Dana Point Headlands prior to 1960. A few more species were found on or near the Headlands between between 1960 and 1982 but there was no comprehensive summary of plants known to occur on the Headlands and the label information was often too vague to be certain collections were from the Headlands.

The winter rains of 1983 had been exceptionally heavy in southern Orange County. In the spring of that year, Karlin Marsh, a member of the California Native Plant Society (CNPS) discovered a large number of *Dudleya blochmaniae* growing on the Headlands. This small, white-flowered geophyte was found to be fairly common, especially within a four-acre area immediately south of the future Hilltop Overlook but was generally widespread over clayish soils in the future Hilltop Park.

Following the discovery, CNPS, in association with the Museum of Systematic Biology at the University of California, Irvine, was involved with a series of informal surveys of the Headlands' flora. In 1983, Bob Allen and I examined a 23-acre Study Area, focusing on areas within the future Hilltop Park and the CNLM Dana Point Preserve. The results of our study were summarized in a letter prepared by Fred Adjarian, President of the Orange County Chapter of CNPS, and Karlin Marsh to the Orange County Supervisors (in litt., 23 May 1983). The survey results included 120 plant taxa, including 81 native and 39 non-native species. About a third of these species were documented with the specimens deposited at the Museum of Systematic Biology, U.C. Irvine (IRVC).

Several environmental studies associated with proposed development projects contributed to our knowledge of sensitive plant species on the Headlands including Pacific Southwest Biological Services (PSBS) (1993), URS (2001), and Glenn Lukos and Associates (GLA) (2002). URS conducted additional sensitive plant surveys following habitat restoration in 2009 and 2010 within Hilltop Park and

Harbor Point Park. While most of these studies included a list of plants observed, only a few specimens were collected and their primary value is in tracking the history of sensitive plant taxa found on the Headlands.

METHODS

During the field study, all accessible portions of the Headlands were investigated. Inaccessible cliffs along the southern and eastern edge of the Study Area were examined with binoculars. Primary surveys within the CNLM Dana Point Preserve were conducted between March and October 2008, and again in April and September 2009. Hilltop and Harbor Point Parks were examined between March and July 2010. Teresa Salvato (Herbarium, University of California, Riverside) conducted two supplementary collection visits to the Headlands in association with this Study during September and October 2010, obtaining 33 specimens. The base of the cliffs at Harbor Point were also examined in January 2011.

I attempted to collect at least one representative specimen for each taxa encountered, especially if there was no previous documentation or existing collections were older than 15 years. In many cases, I was able to obtain a representative voucher for each park and preserve on the Headlands. The specimens were primarily deposited at Rancho Santa Ana Botanical Garden (RSA) with duplicates deposited at the University of California, Riverside (UCR).

A review of herbarium specimens known to have been collected from, or suspected of having been collected on the Dana Point Headlands included both the Consortium of California Herbaria (2013) and my personal Orange County Herbarium Specimen Inventory. The Orange County Herbarium Inventory, compiled between 1986 and 2007 from a direct examination of over 20,000 specimens stored at various herbaria across California, includes many specimens that do not have matching entries in the Consortium.

Various environmental documents (PSBS 1993, GLA 2002, and URS 2001, 2009) and letters written on behalf of the Museum of Systematic Biology, University of Irvine, were reviewed for taxa and sensitive plant species reported to occur on the Dana Point Headlands. Virtually all the environmental reports include lists of vascular plants observed during their surveys. Unfortunately, many of these reports contain unusual or unlikely species observations that cannot be verified, highlighting the importance of obtaining collections. Unverifiable or questionable records were not included within this Study.

All sensitive species occurrences were recorded by UTM coordinates (WGS 84) obtained from Garmin Map60 CSX receivers. The number of individuals, habitat,

and associated plant species were noted at each locality. Specific details for sensitive species were reported in papers prepared for CNLM and the City of Dana Point (Roberts 2008b, 2009, and 2011).

RESULTS AND DISCUSSION

Vegetation

The Headlands vegetation is primarily composed of three plant communities, coastal sage scrub, southern coastal bluff scrub, and xeric rock cliff. There are small patches of grassland, sumac chaparral, and disturbed plant communities. Vernal pool-like depressions were known to occur at what is now Hilltop Park as recently as 1993 but these depressions were never systematically examined before off road vehicle damage caused their loss.

Sumac Chaparral. Sumac chaparral is found primarily on the eastern flank of the Hilltop above Green Lantern Street. The community is almost entirely reconstructed and replacing sites where the non-native *Hypericum canariense* once dominated but since has been removed. The primary cover is *Rhus integrifolia* with some *Opuntia littoralis*, *Heteromeles arbutifolia*, and *Diplacus aurantiacus*. Small stands of sumac chaparral of indigenous origin are also found on the eastern cliffs above the Marine Institute.

Coastal Sage Scrub. Coastal sage scrub is an association of low, often aromatic drought-deciduous woody shrubs and suffrutescent perennials. Coastal sage scrub is mostly associated with the bluff top and the central mesa. In the western portion, primarily within the CNLM Dana Point preserve and the western section of Harbor Point Park, the coastal sage scrub occurs on sand and varies from open to dense consisting predominately of *Artemisia californica*, *Encelia californica*, *Eriogonum fasciculatum*, and *Opuntia x vaseyi*. Other fairly common components include *Solanum douglasii*, *Marah macrocarpus*, *Acmispon glaber*, *Isocoma menziesii*, with scattered individuals of *Baccharis pilularis* subsp. *consanguinea*, *Sambucus nigra*, *Cylindropuntia prolifera*, and *Dudleya pulverulenta*.

Toward the northern border of the Dana Point Preserve, the habitat along a sandy ridge has been modified through enhancement plantings and management, especially increasing the abundance of *Baccharis pilularis* subsp. *consanguinea* and *Opuntia x vaseyi*.

In areas of clay soils, including Hilltop Park and the eastern, flat portion of Harbor Point Park consist primarily of coastal sage scrub that has been modified or enhanced through restoration beginning in 2005. The vegetation is typical of

Venturan/Diegan transitional coastal sage scrub with the primary species similar to those observed in the sandy portions except that *Opuntia littoralis* appears to have replaced *O. x vaseyi*. Other fairly common species include *Isocoma menziesii*, *Rhus integrifolia*, *Marah macrocarpa*, *Acmispon glaber*, *Dudleya lanceolata*, *Baccharis pilularis* subsp. *consanguinea*, *Cylindropuntia prolifera*, and *Mirabilis laevis*.

Prior to 2005, there were significant differences between the annual and perennial herbaceous component diversities of coastal sage scrub on the sandy soils (Dana Point Preserve) and clay soils (Hilltop Park and much of Harbor Point Park). The coastal sage scrub on clay soils generally supported a higher diversity than the coastal sage scrub on the sandy soils. However, during the Study, many of the annual and herbaceous perennial species previously associated with the clay soils were absent or scarce where historically they were once common. Although restoration increased the density of the coastal sage scrub habitat in Hilltop and Harbor Point Parks improving the habitat for California gnatcatchers, soil disturbance and increased shrub density reduced the number of understory species historically seen in these habitats.

The loss in diversity appears to be related to the loss of naturally occurring patches of compacted cobbly-clay soils, primarily at Hilltop Park. These thinly vegetated areas, observed between 1983 and 2004, previously provided refugia for sensitive plant species including *Pentachaeta aurea* subsp. *allenii*, *Senecio aphanactis*, *Atriplex coulteri*, and *Dudleya blochmaniae*. The compacted cobbly-clay soils were less suitable for shrubs and many common herbs, including weedy species, to colonize. These thinly vegetated areas with cobbly-clay soils were largely absent in 2010.

Sensitive plant species within coastal sage scrub currently or historically include *Atriplex coulteri*, *Dudleya blochmaniae*, *Harpagonella palmeri*, *Dichondra occidentalis*, *Pentachaeta aurea* subsp. *allenii*, *Senecio aphanactis*, *Hordeum intercedens*, *Microseris douglasii* subsp. *platycarpa*, *Lycium californicum*, and *Quercus dumosa*. The presence of *Lycium californicum*, a key component of coastal bluff scrub, scattered over the central mesa suggests a transition to coastal bluff scrub. Many new plantings of *L. californicum* have been established at Hilltop Park and Harbor Point Park since 2004 as part of the restoration but these plants are readily separable from the scattered plants of indigenous origin as the later are quite large and likely decades old.

Disturbances on the mesa top included a series of dirt roads that were relatively unchanged between at least the 1960s and mid-1990s. Increasing impacts from foot traffic and expanding roadbeds gradually decreased some areas of the natural

vegetation, resulting in a reduction in sensitive plant species, and an increase in the number of non-native species by the early 2000s.

Southern Coastal Bluff Scrub. Southern coastal bluff scrub is found primarily in sandy soils and occasionally within clay along the margins of the bluff top, along the eroded slopes of the rim and cliffs of the mesa, and steep cliffs within the CNLM Dana Point Preserve and Harbor Point Park. Because of steep terrain, coastal bluff scrub generally was not subject to restoration activities and the primary habitat has a richer diversity of herbaceous taxa than the mesa top. Conversely, a number of perennial non-native species, such as *Limonium perezii*, *Malephora crocea*, *Myoporum laetum* and *Carpobrotus edulis*, which are now absent on the mesa remain established along the rim and on cliffs.

The community is best defined by the presence of *Euphorbia misera*. Other key components include *Eriogonum parviflorum*, *Lycium californicum*, *Rhus integrifolia*, *Encelia californica*, *Cylindropuntia prolifera*, *Opuntia oricola*, *Ambrosia chamissonis*, and *Peritomia arborea*. Some of the slopes and cliffs in the western section have a north-facing aspect and support large and dense stands of *R. integrifolia* and *Clematis pauciflora* with an understory including a number of fern species and *Claytonia parviflora* subsp. *parviflora*.

Sensitive species associated with southern coastal bluff scrub include *Aphanisma blitoides*, *Atriplex pacifica*, *Cistanthe maritima*, *Chaenactis glabruiscula* var. *ortcutiana*, *Euphorbia misera*, *Lycium californicum*, and *Malacothrix saxatilis* var. *saxatilis*.

Annual Grassland. Patches of annual grassland are frequently associated with irrigation lines, especially south of the Hilltop Overlook and in a large patch on Harbor Point south of Cove Road. The primary components are *Bromus madriensis* subsp. *rubens*, *Festuca myuros*, *Brachypodium distachyon*, *Hordeum intercedens*, *Deinandra fasciculata*, *Erodium botrys*, *Schismus barbatus*, and *Grindelia camporum*. *Hordeum intercedens* is especially common in dense patches adjacent to irrigation lines representing a strong native component to the annual grassland at these locations.

Xeric Rock Cliff. Xeric rock cliffs dominate the southern exposures of the Headlands. The faces of these cliff are mostly free of vegetation, or contain thinly scattered elements of southern coastal bluff scrub.

Sensitive species associated with southern xeric rock cliff include *Euphorbia misera*, *Lycium californicum*, and *Malacothrix saxatilis* var. *saxatilis*.

FLORA

The vascular flora of the Dana Point Headlands includes a total of 243 taxa, representing 55 families. This total includes 238 species and five additional subtaxa. A numerical summary of the floristic diversity on the Dana Point Headlands is presented in Table 1. The largest families include Asteraceae with 53 taxa and Poaceae with 34 taxa. The five most diverse families are detailed in Table 2. A summary of life forms are presented in Table 3. The number of taxa on the Headlands site is similar to the 242 taxa reported to occur on the University of California Natural Reserve System's San Joaquin Freshwater Marsh Reserve (Bowler and Elvin, 2003) and the 244 taxa reported to occur at the Donna and Richard O'Neill Land Conservancy (Roberts and Bramlet 2007). However, the Headlands, at about 60-acres, is much smaller than the 202-acre San Joaquin Freshwater Marsh or Donna and Richard O'Neill Land Conservancy's 1,172-acre area.

One hundred and fifty-one taxa (62 percent) found on the Dana Point Headlands are of native origin, while 92 taxa (38 percent) are of non-native origin. A number of the non-native taxa are native to southern California but evidently introduced to the site in association with restoration projects, including *Festuca microstachys*, *Salvia leucophylla*, and *Oenothera elata*. The non-native component of the Headlands is relatively high and is likely a reflection of mild coastal environment, proximity to residential housing, and recent disturbances.

Table 1. Statistical summary of floristic diversity on the Dana Point Headlands

Group	Family	Genera	Species	var. & subsp.	Tot. Taxa	Native	Non-native
Ferns	2	3	3	1	4	4	0
Eudicots	43	135	187	4	191	127	64
Monocots	10	33	48	0	48	20	28
TOTALS:	55	171	238	5	244	151	92

Table 2. The Five Largest Families

Family	Number of Taxa	% of total	Native Taxa	Non-Native Taxa
Asteraceae	53	21.8%	39	14
Poaceae	34	14.0%	13	21
Brassicaceae	11	04.5%	4	7
Chenopodiaceae	10	04.1%	7	3
Solanaceae	8	03.2%	6	2

Table 3. Life Forms of the Dana Point Headlands Flora

Life Form	Number of Taxa	% of total
Annual	119	48.8%
Perennial herb	69	28.3%
Shrub	33	13.5%
Suffruticose perennial	12	08.0%
Geophyte	7	02.9%
Tree	5	02.0%
Vine	2	0.08%

NOTEWORTHY COLLECTIONS

Five new additions to the Orange County flora were obtained during the Study. These include *Ambrosia confertiflora*, a southern California native but here possibly introduced to the Headlands, and four non-native species, *Argyranthemum foeniculatum*, *Asparagus aethiopicus*, *Geranium incanum*, and *Raphiolepis indica*. The two latter taxa are most likely waifs, persisting only because of over spray from irrigation into natural areas. Also noteworthy is the collection of *Atriplex pacifica*. For many years, plants growing along the rim of the cliff at Harbor Point Park had been reported as *A. coulteri* (GLA 2002, URS 2009). *Atriplex coulteri* and *A. pacifica* are closely related and both considered sensitive (CNPS 2014).

SPECIAL STATUS PLANT SPECIES

The Headlands has been long recognized as a significant location for sensitive plant species. Prior to 2008, 13 taxa included within the California Native Plant Society's Rare, Threatened, and Endangered Plant Inventory (CNPS 2014) and one additional taxon considered of local conservation concern in Orange County had been reported to occur on the Headlands. I was able to relocate six of these 14 original taxa and documented four new additions, including *Atriplex pacifica*, *Chaenactis glabriuscula* var. *orcuttiana*, *Cistanthe maritima*, and *Malacothrix saxatilis* var. *saxatilis*.

A list of special status plants at the CNLM Dana Point Preserve, Hilltop Park, and Harbor Point Park, including their rank, number of sites, and number of individuals encountered are summarized in Table 4. A summary of the diversity of special status plant species at the Headlands is on Table 5.

Table 4. Special status plant species on the Dana Point Headlands

Family	Taxon	Rank	Found ¹
Pteridaceae	<i>Pentagramma triangularis</i> subsp. <i>viscosa</i>	LC	Yes; DP
Asteraceae	<i>Chaenactis glabriuscula</i> var. <i>orcuttiana</i>	1B.1	Yes; HP
Asteraceae	<i>Malacothrix saxatilis</i> var. <i>saxatilis</i>	4.2	Yes; DP
Asteraceae	<i>Microseris douglasii</i> subsp. <i>platycarpha</i>	4.2	Yes*; HT
Asteraceae	<i>Pentachaeta aurea</i> subsp. <i>allenii</i>	1B.1	No
Asteraceae	<i>Senecio aphanactis</i>	2B.2	No
Boraginaceae	<i>Harpagonella palmeri</i>	4.2	No
Chenopodiaceae	<i>Aphanisma blitoides</i>	1B.2	Yes; DP, HP
Chenopodiaceae	<i>Atriplex coulteri</i>	1B.2	No
Chenopodiaceae	<i>Atriplex pacifica</i>	1B.2	Yes; HP
Chenopodiaceae	<i>Suaeda taxifolia</i>	4.2	No
Convolvulaceae	<i>Dichondra occidentalis</i>	4.2	Yes; HT, HP
Crassulaceae	<i>Dudleya blochmaniae</i>	1B.1	No
Euphorbiaceae	<i>Euphorbia misera</i>	2B.2	Yes; DP, HP
Fagaceae	<i>Quercus dumosa</i>	1B.2	Yes; DP
Montiaceae	<i>Cistanthe maritima</i>	4.2	Yes; DP
Poaceae	<i>Hordeum intercedens</i>	3.2	Yes; HT
Polygonaceae	<i>Chorizanthe procumbens</i>	LC	Yes; DP, HP
Solanaceae	<i>Lycium californicum</i>	4.2	Yes; DP, HT, HP

DP= Dana Point Preserve

HT= Hill Top Park

HP= Harbor Point Park

¹ Observed during the course of the Study between 2008 and 2010.* I did not personally observe *Microseris douglasii* var. *platycarpha* but it was reported to occur at Hilltop Park by URS (2009).**Federal Designations:**

FE = Federally Endangered

FT = Federally Threatened

State Designations:

CE = California Endangered

CT = California Threatened

California Rare Plant Rank (CRPR):

1A = Plants presumed extinct in California.

1B = Plants considered rare, threatened, or endangered in California and elsewhere.

2 = Plants rare, threatened, or endangered in California, more common elsewhere.

4 = Plants of limited distribution, sometimes locally rare.

CRPR Threat Ranks:

0.1 – Seriously threatened in California

0.2 – Moderately threatened in California

0.3 – Not very threatened in California

LC = Local Concern in Orange County, presumably more common elsewhere.

Table 5: Summary of sensitive plant species diversity

FE	FT	CE	CT	1A	1B	2B	3	4	LC
0	0	0	0	0	6	2	1	7	2

Of the newly added taxa, all four were associated with sandy eroded soils along the margin of the coastal cliffs at the southern margin of the Headlands. *Malacothrix saxatilis* var. *saxatilis* (see cover upper left) had been found in 1999 less than two kilometers to the west on coastal bluffs in Laguna Niguel (R.E. Riefner 99-289 and 99-360 [RSA]). *Cistanthe maritima* (Plate 1B) and *C. glabriuscula* var. *orcuttiana* (Plate 1C) had both last been reported in Orange County over 80-years ago along the cliffs of Laguna Beach.

Atriplex pacifica (See Plate 1D & E) at Harbor Point Park was first reported as *A. coulteri* by Glenn Lukos and Associates (2002). However, no voucher specimen had been collected and the identification of these plants could not be verified independently prior to this Study. The annual nature of these plants and the minute bracts are not characteristic of *A. coulteri*, a perennial with larger, somewhat fan-shaped, toothed bracts (Zacharias 2012). In Orange County, *A. pacifica* has been found relatively recently only at San Clemente State Park where it was associated with the sandy flats between mima mounds in 1994 (R.E. Riefner 94-377, 22 May 1994 [RSA]). Other specimens from Orange County were obtained early in the last century (Consortium 2014). While *Atriplex coulteri* was a historic element of the Headlands on what is now Hilltop Park, it was not relocated during the surveys between 2008 and 2011 by either myself or URS (2009) (see discussion of *A. coulteri* below).

Prior to my study, *Aphanisma blitoides* (See Plate 1A), was known only from a single specimen brought to the University of California, Riverside, a couple years prior to my Study (E. Maher s.n., 2 May 2006 [UCR]). It was unclear where on the Headlands the collection was made. I was able to relocate *Aphanisma blitoides* and found that it was not at all uncommon along the rim of the south-facing bluffs in the Dana Point Preserve. A single site with a few individuals was also located at the west end of Harbor Point Park.

Chorizanthe procumbens had previously been identified as a species of local concern in Orange County (Roberts 2008a). The Headlands site is one of the more important sites for this taxon in Orange County. In favorable years, well over 20,000 individuals have been estimated to occur on sandy soils in openings and between shrubs in the coastal sage scrub southwest of the Interpretive Center on the Dana Point Preserve.

The six sensitive taxa I was able to relocate during the Study included *Dichondra occidentalis*, *Euphorbia misera*, *Quercus dumosa*, *Chorizanthe procumbens*, *Lycium californicum*, and *Hordeum intercedens*. URS also relocated *Microseris douglasii* subsp. *platycarpha* at the time of the Study.

A lone, broad and rounded individual of *Quercus dumosa* was found on the sandy soils east of Dana Strand Road within the Dana Point Preserve. The plant was first documented in 1983 (Roberts & Marsh 1094 [IRVC]) and remained virtually unchanged during the following 25 years. To my knowledge, this is the only example of *Q. dumosa* that is truly associated with coastal sage scrub. Typically this species grows in scrub oak, southern maritime, and occasionally mixed chaparral or mixed coastal sage scrub and chaparral.

Hordeum intercedens was known from a few scattered individuals prior to the restoration. The plant responded favorably to irrigation associated with restoration activities and by 2010, *H. intercedens* formed dense patches of native annual grassland, especially following irrigation lines. The abundance of this species is anticipated to decline once irrigation ends.

I did not relocate *Microseris douglasii* subsp. *platycarpha*, but URS (2011) did locate a small patch of about 80 individuals at the time of my surveys.

I am proposing the addition of *Pentagramma triangularis* var. *viscosa* as a taxon of local concern in Orange County. *Pentagramma triangularis* var. *viscosa* was once relatively common on shaded slopes near the coast in southern Orange County, and especially within the city limits of Dana Point (Laguna Beach: I.M. Johnston 1926, 4 May 1918 [POM 828, UC 218598]; L.L. Kiefer 1099, 17 Nov 1963 [LA 210786]; K.G. & G.A. Marsh s.n., 18 mar 1978 [IRVC 18319]; K.G. Marsh s.n., 13 Apr 1983 [IRVC 13961]; K.G. Marsh, s.n., 14 Apr 1983 [IRVC 19788]; F.M. Roberts 1683, 30 Apr 1985 [IRVC 22498]; and Dana Point: F.M. Roberts C70, 24 Feb 1978 [Saddleback Community College 96]). Many of the areas from which these specimens were obtained have undergone significant loss of habitat. The Dana Point Headlands specimen collected during this Study represents the only specimen for *P.t.* subsp. *viscosa* obtained in Orange County over the last 30 years

I was unable to relocate six sensitive taxa known to occur on the Headlands prior to 2005. These species were also not located by URS (2009). *Senecio aphanactis* and *Harpagonella palmeri* have not been reported since the 1980s. Only a few individuals of these species had ever been found, even at the time of discovery in 1983. Neither species has been reported since 1985. It is likely, rainfall patterns in

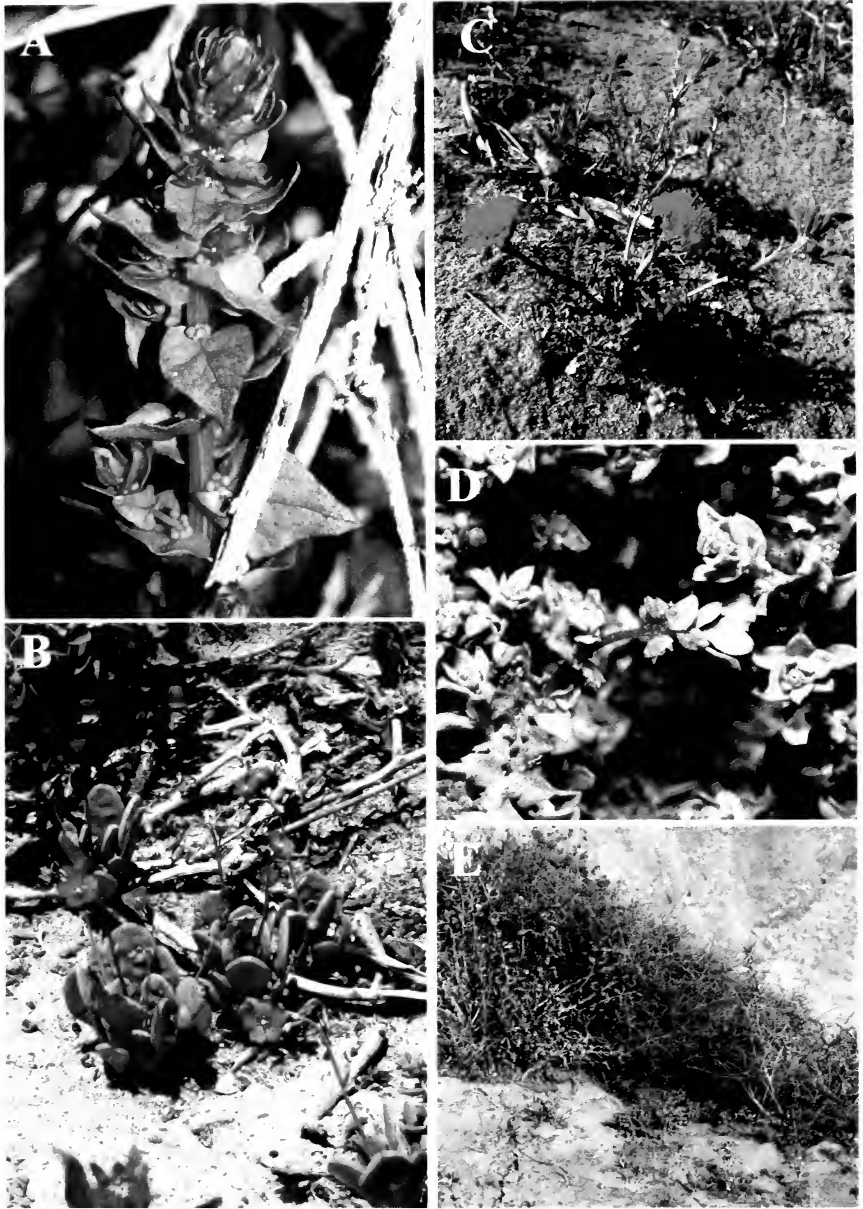


Plate 1: Selected sensitive species. **A:** *Aphanisma blitoides*. **B:** *Cistanthe maritima*. **C:** *Chaenactis glabriuscula* var. *orcuttiana*. **D:** *Atriplex pacifica* (leaves and bracts), and **E:** *Atriplex pacifica* (plant and surrounding habitat at cliff edge)

subsequent years contributed to these taxa not being relocated. While 1983 was a very wet year, the years between 1984 and 1991 were characterized as dry to very dry. Habitat impact was relatively negligible prior to 1992 but was a growing factor after the mid 1990s.

Three special status plant species, *Dudleya blochmaniae*, *Pentachaeta aurea* subsp. *allenii*, and *Atriplex coulteri* were regularly reported at the Headlands between 1983 and 2004. During subsequent years, the status of rare plants sites were not independently verifiable while restoration activities were taking place. None of the three were relocated between 2008 and 2011.

Dudleya blochmaniae subsp. *blochmaniae* was among the earliest reported species on the Headlands having been documented from the Headlands as early as 1924 by Theodore Minthorne (Minthorne s.n., 30 May 1924 (JEPS, UCR). On the Headlands it was typically found in open patches of bare or thinly vegetated, cobbly compacted clayish soils. By 1983, when Karlin Marsh first encountered this plant south of Hilltop Overlook, it was considered a special status plant species. Although no formal counts were taken in 1983, in 1987, I estimated between 2,000 and 3,000 individuals at the time of discovery (CNDDDB 2014). Based on experience and counts made at later date, I believe this was an under estimate. Regardless, the number of individuals and area occupied by this plant when discovered, the number of individuals seen in subsequent years was generally less than 1,400 (Roberts 2011).

Pentachaeta aurea subsp. *allenii* was a frequent associate of *D. blochmaniae* at the Headlands and found in the same compacted soils. This taxon was also last seen in 2004 prior to soil disturbances at Hilltop Park.

While absent from the Headlands at the time of the Study, both species were present at reference sites in 2008, 2009, and 2010. *Dudleya blochmaniae* at Marblehead in San Clemente, growing in similar habitat and conditions about 6.5 kilometers (4 miles) from the Headlands, displayed no evidence of stress during the years of the Study so dry conditions or other ecological reasons are unlikely for the absence of this taxon on the Headlands. Regardless of the reason for its disappearance, *Dudleya blochmaniae* subsp. *blochmaniae* was re-introduced to Hilltop Park circa 2011 from material taken from corms salvaged prior to restoration. It is too soon to determine if the re-introduction has been successful. No such effort has yet been undertaken to re-introduce *Pentachaeta aurea* subsp. *allenii*.

Atriplex coulteri was first located on the Headlands in May 1983 (F.M. Roberts & R.L. Allen 191 [RSA]). Originally found in several close by locations on the

southwest and southern side of the Hilltop in compacted cobbly clay soils. The main cluster, consisting of fewer than 10 individuals looked very much the same in 2004 as it did 20-years earlier. However, the location where these plants were previously seen was not clearly recognizable because of minor changes in topography and increased shrub density in 2010. No plants were located despite intense and multiple surveys of the site. Unlike *A. pacifica*, *A. coulteri* is a perennial and typically is detectable year round.

Suaeda taxifolia has been reported only once (GLA 2002) as occurring at the base of the slopes at Dana Strand. The few individuals reported by GLA apparently did not survive the intervening years between 2002 and 2008 even though there have been no obvious changes to the habitat for this species. A reliable site for this taxon is known about 100 meters beyond the Study Area boundary near the South Strand Stair to Dana Strand Beach.

Table 6 includes a list of sensitive species not relocated during the Study and includes the date and current park equivalent where last observed.

Table 6: Last observations of Special Status Plants not observed during this Study

Species	Last Observed	Location
<i>Atriplex coulteri</i>	2004	Hilltop Park
<i>Dudleya blochmaniae</i> subsp. <i>blochmaniae</i>	2004	Hilltop Park
<i>Harpagonella palmeri</i>	1985	Hilltop Park
<i>Pentachaeta aurea</i> subsp. <i>allenii</i>	2004	Hilltop Park
<i>Senecio aphanactis</i>	1983	Hilltop Park
<i>Suaeda taxifolia</i>	2002	D. P. Preserve

The Dana Point Headlands represent a unique coastal landscape in southern California. Despite the relatively small area of natural habitat and relative isolation, the site continues to support a high diversity of native plant species, especially special status taxa. At the Dana Point Preserve, the diversity of both was found to be higher than previously known while at Hilltop Park and Harbor Point Park, the diversity was less than previously known.

There is little direct observational data available from the years between 2005 and 2007 to indicate beyond certainty why important special status taxa present in 2004 were no longer present in 2008. However, the degree of restoration applied to the eastern and western portions of the Headlands during this time frame was significantly different. Restoration at the Dana Point Preserve was largely limited to exotic species removal and involved little soil disturbance.

At the two city parks, restoration activities resulted in significant disturbance of soils and especially compacted, cobbly clay soils. In many cases, species associated with clayish soils are significantly less tolerant of soil disturbance than those associated with sand. This does suggest, that at least in part, the soil disturbance was likely at least a contributing cause to the apparent loss of some plant species and reduced diversity. As additional evidence, the highest floristic diversity at Harbor Point and Hilltop Park was found in areas that were generally difficult or inaccessible to restoration efforts. The diversity of rim species special status taxa was found to be somewhat higher than suggested by previous surveys while the mesa top special status plant taxa diversity was lower.

Follow-up broad scope special status plant taxa and floristic surveys were conducted at the Dana Point Preserve while the site was near its baseline condition. This was not the case at the Hilltop and Harbor Point Parks where similar surveys were conducted after the baseline condition was significantly altered.

It is interesting to note that despite the Headlands having undergone numerous botanical surveys in association with the environmental regulatory process, additional special status plants were found that had not been previously reported, including *Aphanisma blitoides*, *Cistanthe maritima*, *Malacothrix saxatilis* var. *saxatilis*, *Atriplex pacifica* (a misidentification), and *Chaenactis glabriuscula* var. *orcuttiana* (this was reported independently by URS in 2009). This is undoubtedly a result of methodology. While I had the opportunity for repeated visits during much of the year, surveys associated with the environmental regulatory process are often limited in scope and field examinations per season, as often necessitated by fiscal constraints. Additionally, previous surveys may have glossed over areas less likely to be disturbed by proposed projects even though these areas will be significantly affected by proximity to urbanization. This however, is certainly not isolated to the Headlands. In San Diego County, for example, while working for the County and City on Multiple Habitat Species Conservation preserves circa 2001, I typically found about five to eight special status plant species localities for every one reported by through the environmental regulatory process in the vicinity (Roberts 2001).

There is little doubt that the restorations at Hilltop and Harbor Point Parks were successful at their primary goal, improving habitat quality for the coastal California Gnatcatcher. However, a better understanding of the distribution of special status plant species prior to the restoration, and simple avoidance would likely have led to the persistence of these plants today in addition to enhanced habitat for the coastal sage scrub habitat.

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I would like to thank Lee Ann Carranza, manager of the CNLM Dana Point Preserve, and Jeff Rosaler, Resource Officer for the City of Dana Point during the years 2010 and 2011, for their assistance in conducting these surveys. Teresa Salvato deserves thanks for assistance with obtaining important collections in September and October, 2010 when I was unable to do so. I would also like to thank CNLM and the City of Dana Point for the opportunity to investigate the Dana Point Headlands, which has been a place of interest to me since I first set foot there in March 1983.

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ANNOTATED CATALOG OF THE VASCULAR PLANTS OF THE DANA POINT HEADLANDS

The following is a list of vascular plant taxa documented on the Dana Point Headlands Study Area. The catalog reports the results of field work during 2008 through 2010 within the CNLM Dana Point Preserve, Hilltop Park, and Harbor Point Park, and herbarium searches as of September 2013. Classification largely follows *The Jepson Manual: Higher Plants of California*, 2nd edition (Baldwin et al., 2012) and *Vascular Plants of Orange County, an Annotated Checklist* (Roberts, 2008a). Where names differ from the Baldwin et al. (2012), the alternate name is offered in brackets.

The majority of species on the list are documented by voucher specimens. Because of the relatively small area, I have elected to list all known specimens known to be associated with the Headlands rather than a single representative voucher. A few taxa are not represented by a representative voucher when they could not be obtained safely, were very scarce, lacked reproductive material, or were not relocated during the Study but reliably reported elsewhere. Collections made by the author during the Study are indicated by collector and number only. Collections made prior to the Study also include the collection date.

Non-native taxa are denoted by an asterisk (*).

Sensitive taxa are denoted by a dagger (†).

Herbarium codes:

IRVC = the Museum of Systematic Biology Herbarium at University of California, Irvine

MACF = California State University, Fullerton

POM/RSA = Rancho Santa Ana Botanic Garden, Claremont, California (RSA/POM)

SDKC = Saddleback Community College

UCR = University of California, Riverside, Herbarium

UCSB = University of California, Santa Barbara

PTERIDOPHYTES

POLYPODIACEAE

Polypodium californicum Kaulf. CALIFORNIA POLYPODY. Perennial from rhizome. Scarce, patchy, in openings, along trails, and under shrubs, slopes above Dana Strands Beach and along Cove Road. *F.M. Roberts 880, 10 Mar 1983 (IRVC), F.M. Roberts 6907 (RSA)*.

PTERIDACEAE

Pellaea andromedifolia (Kaulf.) Fee COFFEE FERN. Scarce perennial from rhizome, found on north-facing slopes above Dana Strands Beach. *F.M. Roberts 6908 (RSA)*.

Pentagramma triangularis (Kaulf.) Yatsk., Windh., & Wollenw. subsp. *triangularis* GOLDENBACK FERN. Perennial. Scarce, once found in coastal sage scrub on sandy soils in coastal sage scrub. Site likely under Shoreline Drive. *F.M. Roberts & K.G. Marsh 1093, 26 May 1983 (IRVC)*.

Pentagramma triangularis subsp. *viscosa* (D.C. Eaton) Yatsk., Windh., & Wollenw. SILVERBACK FERN. Perennial. Local Concern. Scarce on north-facing slopes above Dana Strands Beach. *F.M. Roberts 7009 (RSA)*.

MAGNOLIOPHYTA

EUDICOTYLEDONS

ADOXACEAE

Sambucus nigra L. subsp. *caerulea* (Raf.) Bollie [*S. mexicana* C. Presl ex D.C., *S. caerulea* Raf.] BLUE ELDERBERRY. Small tree. A few scattered individuals found on the central bluff top in coastal sage scrub; rarely in mesic coastal bluff scrub. *F.M. Roberts 6944 (RSA)*.

AIZOACEAE

**Aptenia cordifolia* (L.f.) N.E. Br. BABY SUN ROSE. Perennial. Scarce weed escaping from adjacent residential yards. *T. Salvato 5114, 27 Oct 2010 (UCR)*.

**Carpobrotus edulis* (L.) Rotm. HOTTENTOT-FIG. Suffruticose succulent perennial. Widespread but mostly patchy and uncommon. Most frequently found in on the slopes along the rim, cliffs, and other areas with poor access. Until recently fairly common in sandy areas along the bluff top but aggres-

sive weeding has significantly reduced presence. *F.M. Roberts & E. Maher 7067 (RSA)*, *F.M. Roberts 7398 (RSA)*.

- **Malephora crocea* (Jacq.) Schwantes CROCEUM ICE PLANT. Succulent perennial. Occasional escape, mostly found along rim and on cliffs, especially along cliff bases. *F.M. Roberts et al. 7126 (RSA)*, *F.M. Roberts 7400 (RSA)*.
- **Mesembryanthemum crystallinum* L. CRYSTAL ICE PLANT. Annual. Occasional to fairly common in open sandy places, mostly found on slopes and cliffs along rim, less common on central bluff top. *F.M. Roberts 6864, 7375 (RSA)*.
- **Mesembryanthemum nodiflorum* L. SMALL-FLOWERED ICEPLANT. Succulent annual. Scattered along base of cliffs in disturbed coastal bluff scrub. Formerly fairly common along dirt roads in association with clay soil grassland. *F.M. Roberts & K.G. Marsh 1051, 13 May 1983 (IRVC)*, *F.M. Roberts 7156, 7317 (RSA)*.
- **Tetragonia tetragonioides* (Pallas) Kuntze NEW ZEALAND SPINACH. Succulent annual. Uncommon in disturbed areas. *F.M. Roberts 6840, 7229 (RSA)*, *T. Salvato 5112 (UCR)*.

ANACARDIACEAE

- Rhus integrifolia* (Nutt.) Benth. & Hook. f. ex Rothr. LEMONADE BERRY. Shrub. Uncommon and patchy on bluff top in coastal sage scrub and sumac chaparral; widespread and locally abundant on eroded slopes along rim. *F.M. Roberts 6722, 7184 (RSA)*, *T. Salvato 5136, 27 Oct 2010 (UCR)*.
- **Schinus molle* L. PERUVIAN PEPPER TREE. Tree. Scarce on disturbed soil. Hilltop Park. *F.M. Roberts 7300 (RSA)*.

APIACEAE

- Apiastrum angustifolium* Nutt. MOCK PARSLEY. Annual. Scattered to fairly common on sandy soils, often under shrubs on central bluff top, less common along rim. *F.M. Roberts 6734 (RSA)*.
- Daucus pusillus* Michx. RATTLESNAKE WEED. Annual. Once common and widespread on clayish soils in coastal sage scrub. Only a few plants seen in 2010. *F.M. Roberts et al., 11 May 2003 (RSA)*, *F.M. Roberts 6857 (RSA)*.
- **Foeniculum vulgare* Mill. SWEET FENNEL. Perennial. Scarce, a few plants established near Hilltop Overlook. *T. Salvato 5132, 27 Oct 2010 (UCR)*.
- Sanicula arguta* J.M. Coult. & Rose SHARP-TOOTH SANICLE. Perennial. Formerly common in grassy places. Only a few individuals seen near Hilltop Overlook in 2010. A fresh application of herbicide to these plants discouraged collection and highlighted the importance of adequate recognition of native species within a restoration crew. *F.M. Roberts 905, 10 Mar 1983 (IRVC)*.

Yabea microcarpa (Hook. & Arn.) Koso-Pol. CALIFORNIA HEDGE-PARSELEY. Annual. Old record from Hilltop Park. *Sexton s.n.*, 26 Apr 1965 (IRVC).

ARALIACEAE

**Hedera helix* L. ENGLISH IVY. Woody vine. Scarce, escaping from irrigated landscaping along northwest edge of Dana Point Preserve near houses. *F.M. Roberts & C.A. Roberts 7115 (RSA)*.

ASTERACEAE

Amblyopappus pusillus Hook. & Arn. COAST WEED. Annual. Fairly common on sandy soils and eroded silty clay soils along bluff rim; southern coastal bluff scrub. *F.M. Roberts 6862, 7278 (RSA)*.

Ambrosia chamissonis (Less.) Greene BEACH-BUR. Perennial. Uncommon on steep, sandy slopes above Dana Strand Beach in open southern coastal bluff scrub. *F.M. Roberts 6976 (RSA)*.

Ambrosia confertiflora DC. WEAK-LEAVED BURWEED. Perennial. A single patch growing in the fuel break along the east edge of Hilltop Park. Apparently recently established in disturbed soils. *F.M. Roberts 7321 (RSA)*.

Ambrosia psilostachya DC. WESTERN RAGWEED. Perennial. Historically uncommon on mesic sites, especially in ravines, slopes above Dana Strand Beach in disturbed southern coastal bluff scrub. Fairly common and spreading along old dirt roads in irrigated coastal sage scrub. *R.L. Allen & C.H. Barnhill 12316, 11 May 2003 (MACF)*, *F.M. Roberts 7066 (RSA)*, *T. Salvato 5121 (UCR)*.

**Argyranthemum foeniculatum* (Willd.) Schultz-Bip. CANARY ISLAND MARGEURITE. Shrubby perennial. Uncommon escape from cultivation near homes on the central bluff top. *F.M. Roberts & L. Carranza 6451, 25 Oct 2006 (RSA)*, *F.M. Roberts 6814 (RSA)*.

Artemisia californica Less. COASTAL SAGEBRUSH. Shrub. Widespread and abundant in coastal sage scrub, less frequent along rim in southern coastal bluff scrub. *F.M. Roberts & L.A. Carranza 6456, 25 Oct 2006 (RSA)*, *F.M. Roberts 6453 (RSA)*, *T. Salvato 5127 (UCR)*.

Baccharis pilularis DC. subsp. *consanguinea* (DC.) C.B. Wolf. COYOTE BRUSH or CHAPARRAL BROOM. Shrub. Occasional on central bluff top; coastal sage scrub. Less common on mesic slopes north slopes overlooking Dana Strand Beach. Especially common in irrigated area on northern ridge where heavily seeded on old dirt roads. *R.L. Allen 12312, 11 May 2003 (MACF)*, *F.M. Roberts & L.A. Carranza 6456, 25 Oct 2006 (RSA)*; *F.M. Roberts 7098 (RSA)*, *T. Salvato 5126, 5131 (UCR)*.

- Baccharis pilularis*** subsp. *pilularis* NORTHERN COYOTE BRUSH or CHAPARRAL BROOM. Prostrate and creeping shrub. Scarce along base of harbor cliffs, evidently spreading into natural habitat from plantings at the Marine Institute. Not vouchered (not blooming).
- Baccharis salicifolia*** (Ruiz & Pav.) Pers. MULE FAT. Shrub. Uncommon along ravines, mostly on the slopes above Dana Strands Beach. Recently becoming established in coastal sage scrub of the bluff top within irrigated areas. *F.M. Roberts & E. Maher 6799 (RSA)*, *F.M. Roberts 7185 (RSA)* *T. Salvato 5127 (UCR)*.
- Brickellia californica*** (Torr. & A. Gray) A. Gray CALIFORNIA BRICKELL-BUSH. Shrub. Uncommon on eroded sedimentary soils along rim, and occasional to fairly common on lower slopes of harbor cliffs close to the beach; Harbor Point Park. *F.M. Roberts 887, 10 Mar 1983 (IRVC)*, *T. Salvato 5120 (UCR)*.
- ****Centaurea melitensis*** L. TOCALOTE. Annual. Formerly very common, especially along roads and in clay soil grassland. Widespread but now generally uncommon at time of the Study. *F.M. Roberts 7154 (RSA)*, *F.M. Roberts & D. E. Bramlet 7322 (RSA)*, *F.M. Roberts 7366 (RSA)*.
- Chaenactis glabriuscula*** DC. var. *glabriuscula* YELLOW PINCUSHION. Annual. Fairly common to abundant in sandy areas, Dana Point Preserve, especially in open and along trails on the slopes north of the Interpretive Center, uncommon elsewhere. *A. Wolf 294B, 15 May 1998 (UCR)*, *F.M. Roberts C21, 4 Apr 1977 (SDKC)*, *F.M. Roberts 1950, 13 May 1983 (IRVC)*, *F.M. Roberts et al., 5847, 11 May 2003 (RSA)*, *R.L. Allen 12325 & 12326, 11 May 2003 (MACF)*, *F.M. Roberts 6975, 7276 (RSA)*.
- †***Chaenactis glabriuscula*** DC. var. *orcuttiana* ORCUTT'S PINCUSHION. Annual. CRPR 1B.1. Uncommon and restricted to the bluff edge and rim near the end of Green Lantern Street, Harbor Point Park. Apparently the plants are associated with the transition from compacted sand to silty clay soils. Some intergradation with *C.g.* var. *glabriuscula*. *F.M. Roberts 7277 (RSA)*.
- Cirsium occidentale*** (Nutt.) Jepson var. *occidentale*. COBWEB THISTLE. Perennial. Formerly uncommon but widespread. Now apparently scarce along rim above Dana Strand Beach. *F.M. Roberts & Lee Ann Carranza 7141 (RSA)*, *F.M. Roberts & R.L. Allen 942, 27 Mar 1983 (IRVC)*.
- Corethrogyne filaginifolia*** var. *virgata* (Benth.) A. Gray [*Lessingia f.* (Hook. & Arn.) M.A. Lane var. *filaginifolia*] VIRGATE SAND ASTER. Perennial. Uncommon in sandy openings of coastal sage scrub. *F.M. Roberts & E. Maher 7072 (RSA)*.
- ****Cynara cardunculus*** L. subsp. *flavescens* Wiklund CARDOON or GLOBE ARTICHOKE. Perennial. A few seedlings seen in grassy coastal sage scrub. Not vouchered.

- Deinandra fasciculata*** (DC.) Greene FASCICLED TARPLANT. Annual. Fairly common on clay soils of central mesa, otherwise uncommon in sandy areas. This plant was once very abundant on compacted clay soils along dirt roads prior to 2004. *F.M. Roberts & R.L. Allen 1090, 21 May 1983 (IRVC)*, *A. Wolf 295, 15 May 1998 (UCR)*, *F.M. Roberts et al. 5858, 11 May 2003 (RSA)*, *F.M. Roberts 7305, 7109, 7064 (RSA)*.
- ****Dimorphotheca ecklonis*** DC. TRAILING AFRICAN DAISY. Suffruticose perennial. Uncommon weed forming dense patch at base of steep slope at Dana Strand Beach. *F.M. Roberts 7122 (RSA)*, *F.M. Roberts, S. Leatherman, & J. Pariti 7149 (RSA)*.
- Encelia californica*** Nutt. CALIFORNIA ENCELIA. Shrub. Common to locally abundant and widespread, less common on clay. *F.M. Roberts & S.L. Fritzke 497 (UCSB)*, *F.M. Roberts 883, 10 Mar 1983 (IRVC)*, *R.L. Allen 12347, 11 May 2003 (MACF)*, *F.M. Roberts & L.A. Carranza 6452, 25 Oct 2006 (RSA)*, *F.M. Roberts 7194, 7177 (RSA)*.
- Erigeron canadensis*** L. COMMON HORSEWEED. Annual. Uncommon in disturbed soils. *F.M. Roberts & C.A. Roberts 7113 (RSA)*.
- Erigeron foliosus*** Nutt. var. *foliosus* LEAFY DAISY. Perennial. Scarce in coastal sage scrub, Hilltop Park. *F.M. Roberts 1087, 21 May 1983 (IRVC)*.
- ****Glebionis coronarium*** L. GARLAND CHRYSANTHEMUM. Annual. Scarce in disturbed places. *F.M. Roberts & Lee Ann Carranza 7138 (RSA)*, *F.M. Roberts 7193 (RSA)*.
- Grindelia camporum*** BIG GUMPLANT. Perennial. Occasional and patchy on clay soils, mostly Hilltop Park. *F.M. Roberts 7338, 7369 (RSA)*.
- ****Hedynois cretica*** (L.) Dum. Cours. CRETE WEED. Annual. Occasional on clay soils. *F.M. Roberts & S.L. Fritzke 493, 3 Apr 1982 (UCSB)*, *F.M. Roberts 940, 27 Mar 1983 (IRVC)*, *A. Wolf 287, 15 May 1998 (UCR)*. *F.M. Roberts 7244 (RSA)*.
- Heterotheca grandiflora*** Nutt. TELEGRAPH WEED. Summer annual or biennial. Uncommon in disturbed sand. *F.M. Roberts & C.A. Roberts 7110 (RSA)*, *F.M. Roberts 7379 (RSA)*.
- ****Hypochaeris glabra*** L. SMOOTH CAT'S EAR. Annual. Scattered weed about trails and openings, especially along the rim. *F.M. Roberts 877, 10 Mar 1983 (IRVC)*, *F.M. Roberts 6867, 7008, 7221 (RSA)*.
- ****Hypochaeris radicata*** L. HAIRY CAT'S EAR. Perennial. Uncommon weed on sandy soils, open coastal sage scrub. *F.M. Roberts & R.L. Allen 1084, 21 May 1983 (IRVC)*, *F.M. Roberts et al. 5844, 11 May 2003 (RSA)*.
- Isocoma menziesii*** (Hook. & Arn.) G.L. Nesom var. *sedoides* (Greene) Nesom PROSTRATE GOLDENBUSH. Succulent-leaved shrub. Uncommon on steep slopes above Dana Strand Beach. Most plants on this slope appear intermediate to *I.m.* var. *vernonioides* in having taller stature but thickened succulent leaves. *F.M. Roberts 7123 (RSA)*.

- Isocoma menziesii* var. *vernonioides*** (Nutt.) G.L. Nesom COASTAL GOLDEN-BUSH. Shrub. Fairly common, especially in restored habitats. *R.L. Allen 12313, 11 May 2003 (MACF), F.M. Roberts & L.A. Carranza 6458, 25 Oct 2006 (RSA), F.M. Roberts 7195 (RSA).*
- Laennea coulteri*** (A. Gray) G.L. Nesom COULTER'S HORSEWEED. Annual. Common on the old Santa Margarita Road bed in association with restoration, otherwise uncommon. *F.M. Roberts & C.A. Roberts 7111 (RSA), F.M. Roberts & L.A. Carranza 7162 (RSA), T. Salvato 5139, 27 Oct 2010 (UCR).*
- Lasthenia gracilis*** (DC.) Greene COASTAL GOLDFIELDS. Annual. Formerly common throughout, but now uncommon and associated mostly with sandy slopes along rim at the Dana Point Preserve. *F.M. Roberts & E. Maher 6732 (RSA), F.M. Roberts 7228, 7307 (UCR).*
- Layia platyglossa*** (Fischer & C.A. Mey.) A. Gray COMMON TIDY TIPS. Annual. Formerly common on open sandy slopes along the rim, now fairly scarce. Some plants possibly re-introduced through seed mixes. *F.M. Roberts 945, 27 Mar 1983 (IRVC), F.M. Roberts 6983, 7256 (RSA).*
- Logfia filaginoides*** (Hook. & Arn.) Morefield CALIFORNIA FILAGO or FLUFF-WEED. Annual. Uncommon to occasional in openings and along trails, more common on sand on the bluff top. *F.M. Roberts 1032, 24 Apr 1983 (IRVC), F.M. Roberts 7342 (RSA).*
- ****Logfia gallica*** (L.) Cosson & Germain NARROW-LEAVED FILAGO. Annual. Reported to occur within the preserve by Eliza Maher in 2007. Not vouchered.
- †***Malacothrix saxatilis*** (Nutt.) Torr. & A. Gray var. *saxatilis* CLIFF MALACOTHRIX. CRPR 4.2. Perennial. Patchy, but locally common on steep sandy slopes and cliffs along western rim above Dana Strand Beach and along southern cliff face; southern coastal bluff scrub, and xeric rock cliffs. *F.M. Roberts 6978 (RSA), F.M. Roberts 7068 (RSA), F.M. Roberts & R.L. Allen 7397 (RSA).*
- †***Microseris douglasii*** (DC.) Sch. Bip. subsp. *platycarpa* (A. Gray) Chambers SMALL-FLOWERED MICROSERIS. CRPR 4.2. Annual. Uncommon on clay soil of central bluff top; clay soil grasslands, native grassland, and open coastal sage scrub. *F.M. Roberts & S.L. Friktze 409, 3 Apr 1983 (SDKC), F.M. Roberts & K.G. Marsh 1057, 13 May 1983 (IRVC), A. Wolf 289, 15 May 1998 (UCR).*
- Microseris lindleyi*** (DC.) A. Gray [*Uropappus l.* (DC.) Nutt.] SILVER PUFFS. Annual. Occasional in coastal sage scrub. *F.M. Roberts & E. Maher 6796 (RSA).*
- Osmadenia tenella*** Nutt. OSMADENIA. Relatively scarce in openings of coastal sage scrub. Formerly more abundant, especially at Hilltop Park. *F.M. Roberts 1060, 13 May 1983 (IRVC), R.L. Allen 12318, 12319, & 12320, 9 May 2003 (MACF), A. Wolf 291, 15 May 1998 (UCR), F.M. Roberts 6984 (RSA).*

- †*Pentachaeta aurea* Nutt. subsp. *allenii* Keil ALLEN'S DAISY. CRPR 1B.1. Annual. Once fairly common on the central bluff associated with clay soil grassland and open coastal sage scrub. Not seen since 2004. *F.M. Roberts & R.L. Allen 941, 27 Mar 1983 (IRVC), R.L. Allen 12324, 11 May 2003 (MACF).*
- Pseudognaphalium biolettii* Anderb. BIOLETTI'S or BICOLORED CUDWEED. Suffruticose perennial. Uncommon throughout. *F.M. Roberts 6980 (RSA).*
- Pseudognaphalium californicum* (DC.) Anderb. CALIFORNIA EVERLASTING. Short-lived perennial. Occasional throughout. *F.M. Roberts 16, 17 Feb 1980 (UCSB), R.L. Allen 12345, 11 May 2003 (MACF), F.M. Roberts 6986, 16 May 2008 (RSA), F.M. Roberts 7206, 7255 (RSA), T. Salvato 5134 (UCR).*
- Pseudognaphalium canescens* (D.C.) Anderb. subsp. *microcephalum* (Nutt.) Kartesz [*Gnaphalium canescens* subsp. *m.* (Nutt.) Stebb. & Keil, *P. m.* (Nutt.) Anderb.] WHITE EVERLASTING. Perennial. Scarce on sandy soil, western bluff top. Not vouchered.
- **Pseudognaphalium luteoalbum* (L.) Hilliard & B.L. Burtt WEEDY CUDWEED. Annual. Occasional weed, especially in somewhat mesic disturbed places. Most commonly seen near irrigation lines. *F.M. Roberts 7265 (RSA), F.M. Roberts 7324 (RSA).*
- Pseudognaphalium ramosissimum* (Nutt.) Anderb. PINK EVERLASTING. Biennial. Formerly found on sandy soils in coastal sage scrub on north-facing slopes. *C.W. Sexton s.n. 26 Apr 1965 (IRVC), F.M. Roberts & S.L. Fritzke 496, 3 Apr 1982 (UCSB).*
- Pseudognaphalium stramineum* (Kunth.) Anderb. COTTON-BATTING PLANT. Annual or biennial. Generally uncommon but sometimes found in dense patches, sandy openings, coastal sage scrub. *F.M. Roberts 1083, 21 May 1983 (IRVC), F.M. Roberts 6804, 7310, 7378 (RSA).*
- †*Senecio aphanactis* Greene CALIFORNIA GROUNDSEL. Annual. CRPR 2.2. Formerly scarce on rocky clay in openings and about margins of shrubs on the slopes south of Hilltop Overlook. Taxon not seen since circa 1983. *F.M. Roberts 898, 10 Mar 1983 (IRVC).*
- Senecio californicus* DC. CALIFORNIA BUTTERWEED. Annual. Fairly common along western rim in sand, southern coastal bluff scrub, otherwise scattered. *L. Benson 3199, 26 Mar 1932 (POM), F.M. Roberts 899, 10 Mar 1983 (IRVC), F.M. Roberts 6719 (RSA).*
- **Senecio vulgaris* L. COMMON GROUNDSEL. Annual. Uncommon weed. *F.M. Roberts 6859 (RSA).*
- **Sonchus oleraceus* L. COMMON SOW-THISTLE. Annual. Infrequent weed. *F.M. Roberts 6725 (RSA), F.M. Roberts 7201 (RSA), F.M. Roberts 7218 (RSA).*
- Stephanomeria diegensis* Gottlieb SAN DIEGO WREATH-PLANT. Annual.

Scattered, coastal sage scrub and disturbed places. *T. Salvato 5129, 27 Oct 2010 (UCR).*

Stephanomeria exigua Nutt. subsp. *exigua* SMALL WREATH-PLANT. Annual. Widespread and abundant in summer, especially toward the west on sandy soils. *F.M. Roberts & L. Carranza 6459, 25 Oct 2006 (RSA), F.M. Roberts 7065 (RSA), F.M. Roberts 7377 (RSA), T. Salvato 5109 (UCR).*

Stylocline gnaphaloides Nutt. EVERLASTING NEST-STRAW. Annual. Local and patchy on open sand, mostly along western rim. *F.M. Roberts 500, 3 Apr 1982 (UCSB), A. Wolf 293, 15 May 1998 (UCR), R.L. Allen 12328, 11 May 2003 (MACF), F.M. Roberts et al. 5846, 11 May 2003 (RSA), F.M. Roberts 6856 (RSA).*

BORAGINACEAE

Amsinckia intermedia Fisch. & C. Mey COMMON FIDDLENECK. Annual. A few individuals observed in poor condition on central mesa, Hilltop Park. No voucher.

Cryptantha clevelandii Greene var. *clevelandii* CLEVELAND'S CAT'S-EYE. Annual. Fairly common in sandy openings. *F.M. Roberts 891, 10 Mar 1983 (IRVC, UCSB), R.L. Allen 12331, 11 May 2003 (MACF), F.M. Roberts 6782, 6855, 7179 (RSA).*

Cryptantha intermedia (A. Gray) Greene COMMON CAT'S-EYE. Annual. Occasional to fairly common in sandy openings. *F.M. Roberts & S.L. Fitzke 499, 3 Apr 1982 (UCSB, IRVC), F.M. Roberts et al. 5854, 11 May 2003 (RSA), F.M. Roberts 6716 (RSA), F.M. Roberts 7193, 7217, 7219, 7309 (RSA).*

****Echium candicans*** L. f. PRIDE OF MADERA. Shrub. Scarce in somewhat disturbed, scrubby, mesic draw on steep north slopes above Dana Strands Beach. *F.M. Roberts 6979 (RSA).*

†***Harpagonella palmeri*** A. Gray PALMER'S GRAPPLING-HOOK. CRPR 4.2. Annual. Formerly scarce on rocky clay along the western margin of the central bluff along what is now Shoreline Drive. Not seen since circa 1985. *F.M. Roberts 1063, 13 May 1983 (IRVC).*

Heliotropium curassavicum L. subsp. *oculatum* (Heller) Thorne SALT or ALKALI HELIOTROPE. Perennial. Scarce at base of southern cliffs, Dana Point Preserve. *F.M. Roberts 7157 (RSA).*

Phacelia distans Benth. COMMON PHACELIA. Annual. Widespread and fairly common. Especially common on slopes just north of Interpretive Center site where forming dense stands. *F.M. Roberts 888, 10 Mar 1983 (IRVC), F.M. Roberts et al. 5855, 11 May 2003 (RSA), R.L. Allen 12339 and 12340, 1 May 2003 (MACF), F.M. Roberts 6789 (RSA), F.M. Roberts & E. Mahar 6800 (RSA), F.M. Roberts 6806, 7306, 7235 (RSA), Lyman Benson 3197, 26 May*

1932 (POM), collected on the south slope of an Ocean Bluff, Dana Point, likely was taken on the western portion of the Headlands.

Plagiobothrys collinus (Philbr.) I.M. Johnst. *var. gracilis* (I.M. Johnst.) Higgins
SAN DIEGO POPCORN-FLOWER. Annual. Occasional on rocky clay, mostly in the vicinity of Hilltop Overlook. *F.M. Roberts 7199, 7281 (RSA)*.

BRASSICACEAE

**Brassica geniculata* (Desf.) J. Ball [*Hirschfeldia incana* (L.) Lagr.-Fossat]
SHORTPOD or SUMMER MUSTARD. Perennial. Occasional weed on disturbed soils. *F.M. Roberts 7339, 7374, 7707 (RSA)*.

**Brassica nigra* (L.) W.D.J. Koch BLACK MUSTARD. Annual. Uncommon weed in open areas of Hilltop Park. *F.M. Roberts 7282, 7346 (RSA)*.

**Brassica tournefortii* Gouan SAHARA MUSTARD. Annual. Scattered patches along the rim and along the old Maguerita Avenue roadbed. Evidently spreading. *F.M. Roberts & E. Maher 6801 (RSA)*, *F.M. Roberts, Lee Ann Carranza, & E. Maher 7144 (RSA)*, *F.M. Roberts 7227 (RSA)*.

**Cakile maritima* Scop. SEA-ROCKET. Annual. Locally common on beach and at base of steep slopes at Dana Strand Beach. *F.M. Roberts, S. Leatherman, & J. Pareti 7147 (RSA)*.

Descurainia pinnata (Walter) Britton subsp. *brachycarpa* (Richardson) Detling
WESTERN TANSY-MUSTARD. Annual. Known from a single large patch on open sand near the western gate of the Dana Point Preserve in disturbed southern coastal bluff scrub, less frequent elsewhere. *F.M. Roberts 6797, 7183, 7200 (RSA)*.

**Lepidium didymum* (L.) Smith LESSER WART-CRESS. Annual. Uncommon, mostly in mesic disturbed sites. *F.M. Roberts 7288 (RSA)*.

Lepidium lasiocarpum Torr. & A. Gray *var. lasiocarpum* SAND PEPPER-GRASS. Annual. Local and patchy in southern coastal bluff scrub along rim, Dana Point Preserve. *F.M. Roberts 1012, 24 Apr 1983 (IRVC)*, *F.M. Roberts 6783 (RSA)*.

Lepidium nitidum Nutt. *var. nitidum* SHINING PEPPERGRASS. Annual. Uncommon on clayish soils. *F.M. Roberts 7211 (RSA)*.

**Lobularia maritima* (L.) Desv. SWEET-ALYSSUM. Annual. Scarce waif once collected near Cove Road, Harbor Point Park. *F.M. Roberts 14, 17 Feb 1980 (UCSB)*.

**Raphanus sativus* L. WILD RADISH. Annual. Scarce weed. *F.M. Roberts 6841, 7315 (RSA)*.

**Sisymbrium irio* L. LONDON ROCKET. Annual. Scarce weed in disturbed places. *F.M. Roberts 7303 (RSA)*.

CACTACEAE

- Cylindropuntia prolifera* (Engelm.) F.M. Kunth COASTAL CHOLLA. Succulent shrub. Scattered to fairly common, especially near and below rim of south and east-facing coastal bluffs; mostly southern coastal bluff scrub. *F.M. Roberts 7117 (RSA)*.
- Opuntia littoralis* (Engelm.) Cockerell COASTAL PRICKLY PEAR. Succulent shrub. Once found mostly in association with a dense patch of cactus near the intersection of Cove Road and Green Lantern Drive. Situated at a proposed future hotel site, these plants were salvaged and the pads have been widely planted on Hilltop and Harbor Point Parks. The distribution of *O. x vaseyi* and *O. littoralis* not clearly worked out on the Headlands. *F.M. Roberts 7382 (RSA)*, *T. Salvato 5125 (UCR)*.
- Opuntia x occidentalis* Engelm. & J.M. Bigelow WESTERN PRICKLY PEAR. Succulent shrub. Cactaceae. Once collected above the intersection of Cove Road and Green Lantern Street. *D. Walkington 167 and 171, 17 May 1963 (POM)*.
- Opuntia oricola* Philbrick ORACLE CACTUS. Succulent shrub. Occasional to patchy, especially along the rim and on cliffs above Dana Point Harbor. *D. Walkington 170, 17 May 1963 (POM)*, *F.M. Roberts 7385 (RSA)*, *T. Salvato 5128, 27 Oct 2010 (UCR)*.
- Opuntia x vaseyi* (J.M. Coulter) Britton & Rose MESA PRICKLY PEAR. Succulent shrub. Apparently fairly common, especially on central bluff top in the Dana Point Preserve in coastal sage scrub. *D. Walkington 169, 17 May 1963 and D. Walkington 217, 13 Sep 1963 (POM)*, *F.M. Roberts 7127 (RSA)*.

CARYOPHYLLACEAE

- Cardionema ramosissimum* (Weinm.) A. Nelson & J.F. Macbr. SAND MAT. Perennial. Scattered on open compacted sand, mostly near rim, Dana Point Preserve. *F.M. Roberts 502, 3 Apr 1982 (UCSB)*, *R.L. Allen 12333, 11 May 2003 (MACF)*, *F.M. Roberts 6794 (RSA)*, *F.M. Roberts 6913 (RSA)*.
- **Polycarpon tetraphyllum* (L.) L. var. *tetraphyllum* FOUR-LEAVED POLYCARP. Annual. Occasional, especially on sandy slopes along western rim. *F.M. Roberts & F.L. Fritzsche 501, 3 Apr 1982 (UCSB)*, *F.M. Roberts 1064, 19 May 1983 (IRVC)*, *F.M. Roberts 7071, 7383 (RSA)*.
- Silene antirrhina* L. SLEEPY CATCHFLY. Annual. Infrequent on compacted sand slopes along south rim and historically on rocky clay on the south slope of Hilltop Overlook. *F.M. Roberts & D.E. Bramlet 4772, 21 Apr 1991 (RSA)*, *F.M. Roberts 6813 (RSA)*.

- **Silene gallica* L. WINDMILL PINK or COMMON CATCHFLY. Annual. Uncommon in sandy openings. *F.M. Roberts 6728 (RSA)*.
- **Stellaria media* (L.) Vill. COMMON CHICKWEED. Annual. Local and patchy, mostly on north-facing bluff slopes in mesic southern coastal bluff scrub, scattered in drier locations. *F.M. Roberts 6730, 6780, 7210, 7257 (RSA)*.
- **Spergularia villosa* (Pers.) Cambess VILLOUS SAND SPURRY. Perennial. Scarce in disturbed, open places. Not vouchered.

CHENOPODIACEAE

- †*Aphanisma blitoides* Moq. APHANISMA. CRPR 1B.2. Annual. Local and patchy on sandy soils in openings and sprawling over shrubs on slopes along western and southern rim; southern coastal bluff scrub, Dana Point Preserve, Harbor Point Park. Foliage turning a striking orange-red mid spring. *E. Maher s.n., 2 May 2006 (UCR), F.M. Roberts 6736 7233 (RSA)*.
- Atriplex californica* Moq. CALIFORNIA SALTBUUSH. Perennial. Fairly common on sandy slopes along rim and on steep cliffs; southern coastal bluff scrub. *F.M. Roberts 904, 10 Mar 1983 (IRVC, UCSB), F.M. Roberts 6731, 7073 (RSA)*.
- †*Atriplex coulteri* (Moq.) D. Dietr. COULTER'S SALTBUUSH. CRPR 1B.2. Perennial. Formerly uncommon on compacted, cobbly clay soils on slopes south of Hilltop Overlook; open coastal sage scrub. Last observed in 2004. *F.M. Roberts & R.L. Allen 191, 21 May 1983 (RSA)*.
- Atriplex lentiformis* (Torr.) S. Watson BREWER'S SALTBRUSH. Shrub. Uncommon in somewhat disturbed sites on central bluff top and on slopes above Dana Strand Beach. Possibly originating from non-native plantings and seed dispersal. *F.M. Roberts & C.A. Roberts 7112 (RSA)*.
- †*Atriplex pacifica* A. Nelson SOUTH COAST SALTBUUSH. CRPR 1B.1. Annual. Uncommon, restricted to a few small patches on the bluff edge beyond the end of Green Lantern Street, Harbor Point Park. *F.M. Roberts & J. Rosaler 7464 (RSA)*.
- **Atriplex semibaccata* R. Br. AUSTRALIAN SALTBUUSH. Shrubby perennial. Scattered on eroded soils, mostly along rim and at base of cliffs. *F.M. Roberts 7070, 7273 (RSA), T. Salvato 5105, 27 Oct 2010 (UCR)*.
- Chenopodium californicum* (S. Watson) S. Watson CALIFORNIA GOOSE-FOOT. Perennial. Occasional, mostly seen on sandy soils, Dana Point Preserve, less common at Hilltop Park. *F.M. Roberts 893, 10 Mar 1983 (IRVC, UCSB), F.M. Roberts et al. 5856, 11 May 2003 (RSA), F.M. Roberts 6909, 7190 (RSA)*.
- **Chenopodium murale* L. NETTLE-LEAVED GOOSEFOOT. Annual. Uncommon to occasional weed in disturbed soils. *F.M. Roberts 6808, 7213, 7301 (RSA)*.

**Salsola tragus* L. RUSSIAN-THISTLE. Annual. Scattered on eroded soils, mostly below bluff rim and on southern cliffs; uncommon along irrigation lines. *F.M. Roberts 7069, 7370 (RSA)*.

†*Suaeda taxifolia* Standl. WOOLLY SEA-BLITE. CRPR 4.2. Shrub. Scarce, possibly extirpated. Reported to occur at base of steep sandy slope adjacent to Dana Strand Beach (GLA 2002) but I was unable to locate it at this location. Known reliably to occur just northwest of the Dana Point Headlands near the South Strand Switchback above Dana Strand Beach a short distance north of the Dana Point Preserve.

CLEOMACEAE

Peritoma arborea Nutt. BLADDERPOD. Shrub. Fairly common along south bluff rim in southern coastal bluff scrub, otherwise uncommon. *F.M. Roberts 21, 17 Feb 1980 (UCSB), F.M. Roberts 6812, 7313, 7319 (RSA)*.

CONVOLVULACEAE

Calystegia macrostegia subsp. *cyclostegia* (House) Brummitt PURPLE-BRACTED MORNING-GLORY. Perennial vine. Formerly scarce in coastal sage scrub. Not seen during 2010 surveys. *B.T. Gittins s.n., 14 Mar 1965 (IRVC), B.T. Gittins 1203, 12 Apr 1966 (IRVC)*.

Calystegia macrostegia subsp. *intermedia* (Abrams) Brummitt SHORT-LOBED MORNING-GLORY. Perennial vine. Occasional and relatively widespread, Hilltop Park, scarce elsewhere. *F.M. Roberts 7331 (RSA)*.

†*Dichondra occidentalis* House WESTERN DICHONDRA. CRPR 4.2. Perennial. Occasional and patchy on rocky clay at Hilltop and Harbor Parks. Often obscure and hidden below shrubs. Not seen in 2008 on the Dana Point Preserve but once was very abundant there for a few years following fire in March 1990 that burned about an acre north of the Interpretive Center. *A. Wolf 288, 15 May 1998 (UCR), F.M. Roberts 7208 (RSA), T. Salvato 5122 (UCR)*.

CRASSULACEAE

**Cotyledon orbiculata* L. var. *oblongata* (Haw.) DC. COTYLEDON. Succulent shrub. Occasional along rim of bluff, especially near houses at west end of Harbor Point; southern coastal bluff scrub. *T. Salvato 5107 (UCR)*.

**Crassula argentea* Thunb. JADE PLANT. Succulent perennial. Scarce escape from cultivation, southern coastal bluff scrub, Harbor Point Park. *T. Salvato 5116 (UCR)*.

Crassula connata (Ruiz & Pav.) A. Berger SAND PIGMY-STONECROP. Succulent annual. Uncommon in sandy openings at the time of the survey but likely more common in other years. *F.M. Roberts 6803 (RSA)*.

**Crassula tillaea* Lest.-Garl. MOSSY PIGMY-STONECROP. Succulent annual. Uncommon weed, found only in a single large patch on sand along trail south of the Interpretive Center. *F.M. Roberts 6807 (RSA)*.

†*Dudleya blochmaniae* (Eastw.) Moran subsp. *blochmaniae* BLOCHMAN'S DUDLEYA. CRPR 1B.1 Succulent perennial geophyte. Formerly fairly common on the eastern bluff top, Hilltop Park; coastal sage scrub and clay soil grassland. Last seen in 2004. *T.W. Minthorn s.n., 30 May 1924 (JEPS), R. Dressler 808, 8 May 1949 (MACF), F.M. Roberts 1014, 24 Apr 1983 (UCSB), F.M. Roberts et al. 5863, 11 May 2003 (RSA)*.

Dudleya lanceolata (Nutt.) Britton & Rose LANCELEAF or COASTAL DUDLEYA or LIVE-FOREVER. Succulent perennial. Scattered to fairly common on the central bluff top. Many plants at Hilltop and Harbor Point Parks were moved as part of the restoration project. The plants at the Dana Point Preserve are in their original locations. *F.M. Roberts 6974, 7074, 7345, 7372 (RSA)*.

Dudleya pulverulenta (Nutt.) Britton & Rose CHALK LIVE-FOREVER. Succulent perennial. Scattered, mostly on sandy soils. *F.M. Roberts 7076 (RSA), T. Salvato 5103 (UCR)*.

CUCURBITACEAE

Marah macrocarpus (Greene) Greene var. *macrocarpus* WILD CUCUMBER or CUCAMONGA MANROOT. Trailing perennial vine from massive tuber. Widespread and common in the early spring draping over shrubs and growing across sandy openings. *F.M. Roberts 6723, 7230 (RSA)*.

EUPHORBIACEAE

Croton californicus Muell. Arg. CALIFORNIA CROTON. Shrubby perennial. Occasional in sandy openings, Dana Point Preserve and Harbor Point Park. *F.M. Roberts 18, 17 Feb 1980 (RSA), F.M. Roberts & L.A. Carranza 6454, 25 Oct 2006 (RSA), F.M. Roberts 7230 (RSA)*.

†*Euphorbia misera* Benth. CLIFF SPURGE. CRPR 2B.2. Shrub. Locally common on compacted sandy slopes along southern rim and southern cliffs, with some plants on bluff top; mostly in southern coastal bluff scrub. *B.D. Stark 4425, 9 Dec 1932 (RSA), G. Wallace 522, 30 Apr 1966 (RSA), G.L. Webster 7479, 11 Dec 1966 (RSA), F.M. Roberts & L. Carranza 6455, 25 Oct 2006 (RSA), F.M. Roberts 7175 (RSA), T. Salvato 5106 (UCR)*.

- **Euphorbia peplus* L. PETTY SPURGE. Annual. Scarce on sandy soil just above Dana Strands Beach. *F.M. Roberts, S. Leatherman, & J. Pareti 7151 (RSA)*.
Euphorbia polycarpa Benth. var. *polycarpa* [*Chamaesyce polycarpa* (Benth.) Millsp.] GOLONDRINA or SMALL-SEED SANDMAT. Perennial. Scarce, found only on bed of trail, Hilltop Park. *F.M. Roberts 7336 (RSA)*.

FABACEAE

- **Acacia longifolia* (Andrews) Willd. SYDNEY GOLDEN WATTLE. Shrub or small tree. Occasional on slopes above Dana Strand Beach and near base of south cliffs. *F.M. Roberts, S. Leatherman, & J. Pareti 7152 (RSA), T. Salvato 5118 (UCR)*.
Acmispon glaber (Vogel) Brouillet var. *glaber* COASTAL DEERWEED. Shrubby perennial. Widespread and fairly common on bluff top, less common along bluff rim and on southern cliffs. Some plants likely planted. *F.M. Roberts 17, 17 Feb 1980 (UCSB), F.M. Roberts et al. 5851, 11 May 2003 (RSA), F.M. Roberts 6729, 7155, 7180, 7192 (RSA), T. Salvato 5110 (UCR)*.
Acmispon strigosus (Nutt.) Brouillet STRIGOSE LOTUS. Annual. Scattered but widespread, sandy openings. *F.M. Roberts 947, 27 Mar 1983 (RSA), F.M. Roberts 6727 (RSA)*.
Lupinus succulentus K. Koch ARROYO LUPINE. Annual. A single plant seen on northeast slope adjacent to Green Lantern St., possibly originating from seed scattered in association with the restoration. Not vouchered.
Lupinus truncatus Nutt. COLLAR LUPINE. Annual. Occasional to fairly common along southwestern bluff rim in early spring, scarce elsewhere. *F.M. Roberts 892, 10 Mar 1983 (IRVC), F.M. Roberts et al. 5852, 11 May 2003 (RSA), F.M. Roberts 6726, 7225 (RSA)*.
 **Medicago polymorpha* L. BUR-CLOVER. Annual. Uncommon weed. *F.M. Roberts 6733, 7262 (RSA)*.
 **Melilotus indicus* (L.) All. YELLOW SWEET-CLOVER. Annual. Uncommon and patchy weed, seen mostly along irrigation lines. *F.M. Roberts 1059, 13 May 1983 (IRVC), F.M. Roberts 7274 (RSA), F.M. Roberts 6786 (RSA)*.

FAGACEAE

- †*Quercus dumosa* Nutt. NUTTALL'S SCRUB OAK. CRPR 1B.1 Shrub. Scarce, known only from a single large individual on northern ridge; coastal sage scrub. First reported in 1982. *F.M. Roberts & K.G. Marsh 1094, 26 May 1983 (IRVC), F.M. Roberts 7097 (RSA)*.

GENTIANACEAE

Zeltnera venusta (A Gray) G. Mans. CANCHALAGUA. Annual. A single plant seen growing on compacted sand in openings between shrubs, bluff top, Harbor Point Park. Not vouchered.

GERANIACEAE

**Erodium botrys* (Cav.) Bertol. LONG-BEAKED FILAREE. Annual. Occasional to fairly common, mostly along trails, roadsides, and grassy disturbed places. *F.M. Roberts 7325, 7259 (RSA)*.

**Erodium brachycarpum* (Godr.) Thell. SHORT-FRUITED FILAREE. Annual. Uncommon, coastal sage scrub. *F.M. Roberts et al. 5848, 11 May 2003 (RSA)*.

**Erodium cicutarium* (L.) Aiton RED-STEMMED FILAREE. Annual. Occasional weed in open areas. *F.M. Roberts 6781, 7197, 7224, 7371 (RSA)*.

**Erodium moschatum* (L.) Aiton WHITE-STEMMED FILAREE. Annual. Uncommon, observed within grassy disturbed sites. *F.M. Roberts 7226 (RSA)*.

**Geranium incanum* Burm f. CARPET GERANIUM. Annual. Scarce, growing in annual grassland along the eastern border of Hilltop Park, escaping from adjacent gardens. *F.M. Roberts 7327 (RSA)*.

**Pelargonium zonale* (L.) L'Her. ZONAL GERANIUM. Shrubby perennial. Formerly uncommon in coastal sage scrub on the central mesa. Removed during the restoration. *F.M. Roberts 2648, 19 Mar 1986 (IRVC)*.

HYPERICACEAE

**Hypericum canariense* L. CANARY ISLANDS ST. JOHN'S-WORT. Shrub. Once forming a dense, slowly spreading, showy, thicket on the slopes between Hilltop Overlook and Green Lantern Street. The majority of the plants were removed during the restoration and replaced by native shrub species. The thicket had increased in area about 20 percent between 1983 and 2004 suggesting a determined, but slow spreading invader. A few new seedlings were found widely scattered across the Headlands during the Study. *F.M. Roberts 1092, 26 May 1983 (IRVC)*, *F.M. Roberts 1361, 29 Apr 1984 (RSA)*, *F.M. Roberts 6946, 7329 (RSA)*.

LAMIACEAE

Salvia columbariae Benth. CHIA. Annual. Occasional in open southern coastal bluff scrub mostly along southwestern bluff rim. *F.M. Roberts & E. Maher 6795 (RSA)*, *F.M. Roberts 6912 (RSA)*.

**Salvia leucophylla* Greene PURPLE SAGE. Shrub. Scarce near the end of Harbor Point Trail, Harbor Point Park where a single large individual has been established. Evidently introduced by accident through the restoration project. Native to the foothills and Santa Ana Mtns. of northern Orange Co. *T. Salvato 5126 (UCR)*.

Salvia mellifera Greene BLACK SAGE. Shrub. Occasional to fairly common and patchy on cliffs above Dana Point Harbor. Uncommon and evidently planted on eastern bluff top at Harbor Point Park. *F.M. Roberts 7247 (RSA)*.

Stachys rigida Benth. subsp. *quercetorum* (A.A. Heller) Epling HILLSIDE HEDGE-NETTLE Perennial. Occasional and patchy, most common on slope north of Hilltop Overlook but also seen in other areas of the central bluff on clayish soils. Formerly more abundant and associated mostly with patches of native grassland. *F.M. Roberts 7289 (RSA)*.

MALVACEAE

**Malva parviflora* L. CHEESEWEED. Annual. Uncommon weed in disturbed soils. *F.M. Roberts 7335 (RSA)*.

MONTIACEAE

Calandrinia ciliata (Ruiz & Pav.) DC. RED MAIDS. Annual. Infrequent on sandy soil along rim of coastal bluff, Dana Point Preserve. *F.M. Roberts 6860 (RSA)*.

†*Cistanthe maritima* (Nutt.) Hershk. SEASIDE CALANDRINIA. CRPR 4.2. Annual. Uncommon and local on terraces and slopes along the southern coastal bluff rim, southern coastal bluff scrub, Dana Point Preserve. Often under shrubs. *F.M. Roberts 6843 (RSA)*.

Claytonia parviflora Hook. subsp. *parviflora* NARROW-LEAVED MINER'S-LETTUCE. Annual. Fairly common but patchy on slopes above Dana Strands Beach in mesic southern coastal bluff scrub, otherwise absent. *F.M. Roberts 6779, 6905 (RSA)*.

MYRSINACEAE

**Anagallis arvensis* L. SCARLET PIMPERNEL. Annual. Occasional to fairly common weed, mostly found under shrubs, especially in disturbed places. *F.M. Roberts et al. 5861, 11 May 2003 (RSA)*, *F.M. Roberts 6972, 7254, 7333 (RSA)*.

NYCTAGINACEAE

Mirabilis laevis (Benth.) Curran var. *crassifolia* (Choisy) Spellenberg CALIFORNIA WISHBONE BUSH. Perennial. Scattered to fairly common in sandy or rocky soils, especially along bluff rim. *F.M. Roberts 6712, 7178, 7191 (RSA)*.

ONAGRACEAE

Camissoniopsis bistorta (Torr. & A. Gray) W.L. Wagner & Hoch CALIFORNIA SUNCUP. Annual. Widespread and fairly common on sandy soils, especially in openings. Scarce on clayish soils. *F.M. Roberts C20, 4 Apr 1977 (SDKC), R.L. Allen 12336 & 12337, 11 May 2003 (MACF), F.M. Roberts et al, 5843, 11 May 2003 (RSA), F.M. Roberts 6802, F.M. Roberts 7216, 7222, 7223, 7308 (RSA)*.

Camissoniopsis cheiranthifolia (Spreng.) W.L. Wagner & Hoch subsp. *suffruticosa* (S. Watson) W.L. Wagner & Hoch BEACH EVENING PRIMROSE. Perennial, sometimes shrubby. Uncommon on central bluff top to fairly common on sandy soils along bluff rim, especially in sandy openings of southern coastal bluff scrub. The few individuals found at Harbor Point Park undoubtedly introduced by seed mix. *F.M. Roberts & S.L. Fritzke 503 and 506, 3 Apr 1982 (UCSB), F.M. Roberts 6737, 7181, 7299 (RSA), T. Salvato 5108 (UCR)*.

Camissoniopsis micrantha (Spreng.) W.L. Wagner & Hoch SMALL PRIMROSE. Annual. Fairly common on sand; coastal sage scrub, Dana Point Preserve. *F.M. Roberts 7143 (RSA)*.

**Oenothera elata* Kunth subsp. *hirsutissima* (S. Watson) W. Dietr. GREAT MARSH EVENING PRIMROSE. Biennial. Scarce, seen only on disturbed habitat adjacent to Green Lantern Street. Likely introduced to site, persisting in association with irrigation from restoration project. Not expected to persist once irrigation ends. *T. Salvato, 5130 (UCR)*.

OROBANCHACEAE

Castilleja exserta (A.A. Heller) Chuang & Heckard subsp. *exserta* PURPLE OWL'S CLOVER. Annual. Formerly fairly common and widespread, now apparently scarce on central bluff top in coastal sage scrub, Dana Point Preserve. *L. Benson 3191, 26 Mar 1932 (POM), F.M. Roberts C19, 4 Apr 1977 (SDKC), F.M. Roberts 948, 27 Mar 1983 (IRVC), F.M. Roberts 6866 (RSA)*.

OXALIDACEAE

Oxalis albicans Kunth CALIFORNIA WOOD SORREL. Perennial. Infrequent, found only on rocky soil on west of Hilltop Overlook, Hilltop Park; coastal sage scrub. *F.M. Roberts 7207 (RSA)*.

**Oxalis pes-caprae* L. BERMUDA-BUTTERCUP or SOUR-GRASS. Perennial. Scattered and patchy in disturbed places and openings in the early spring, especially adjacent to houses. *F.M. Roberts 6738, 7215, 7304 (RSA)*.

PAPAVERACEAE

Eschscholzia californica Cham. CALIFORNIA POPPY. Annual. Patchy, mostly found in disturbed places. Possibly these plants were introduced through seed mixes. *F.M. Roberts 7272, 7384 (RSA)*.

Platystemon californicus Benth. CALIFORNIA CREAMCUPS. Annual. Scarce on sand, western coastal bluff rim; southern coastal bluff scrub. Formerly more common. *F.M. Roberts 903, 10 Mar 1983 (IRVC), F.M. Roberts 6910 (RSA)*.

PHRYMACEAE

Diplacus puniceus Nutt. [*M. puniceus* (Nutt.) Steudel, *Mimulus aurantiacus* var. *p.* (Nutt.) D. Thoms.] COAST MONKEYFLOWER. Red to red-orange-flowered shrub. Scarce, Dana Point Preserve. *F.M. Roberts 6981 (RSA)*.

Diplacus x *australis* (McMinn ex Munz) Tulig [*M. aurantiacus* Curtus subsp. *australis* McMinn]. SOUTHERN BUSH MONKEYFLOWER. Shrub. Occasional and widely scattered in coastal sage scrub and sumac chaparral. Some plants undoubtedly planted but origin of individual plants difficult to determine. Impressive stands of monkey flower, with a wide range of flower colors (including plants identified as *D. puniceus* (Nutt.) Steudel) once occurred on the north-facing slopes above the Weyerhouser Nursery facility just north of what is now Shoreline Drive. Karlin Marsh, an early advocate of Headlands conservation once noted the irony that new varieties of cultivars were being developed at the Weyerhouser facility but this incredible source of native monkey flower stock just beyond their doors was ignored. These plants were buried in 2005 with grading of the South Strand development. *F.M. Roberts et al. 5853, 11 May 2003 (RSA), F.M. Roberts 7316 (RSA)*.

PITTOSPORACEAE

**Pittosporum undulatum* Vent. VICTORIAN BOX. Tree. A few scattered seedlings found at Hilltop and Harbor Point Parks. *T. Salvato 5119 (UCR)*.

PLANTAGINACEAE

Antirrhinum nuttallianum Benth. subsp. *subsessile* (A. Gray) D.M. Thomps. BIG-GLAND NUTTALL'S SNAPDRAGON. Annual. Scattered and fairly widespread, especially along bluff rim. *F.M. Roberts & R.L. Allen 944, 27 Mar 1983 (IRVC)*, *F.M. Roberts & R.L. Allen 6316, 15 Oct 2005 (RSA)*, *F.M. Roberts 6784, 7337 (RSA)*.

Nuttallanthus texanus (Scheele) D.A. Sutton LARGER BLUE TOAD-FLAX. Annual. Mostly scattered and patchy in openings of coastal sage scrub and southern coastal bluff scrub. *F.M. Roberts & R.L. Allen 950, 27 Mar 1983 (IRVC)*, *F.M. Roberts 6787 (RSA)*.

Plantago erecta E. Morris CALIFORNIA PLANTAIN. Annual. Uncommon, found mostly in association with clayish soils; coastal sage scrub. Formerly, quite common on the bluff top, Hilltop Park. *F.M. Roberts 6982, 7341 (RSA)*.

PLUMBAGINACEAE

**Limonium perezii* (Stapf) Hubb. PEREZ'S SEA-LAVENDER. Perennial. Scattered to fairly common, mostly on sand, eroded slopes of bluff rim and on southern cliffs, now scarce on central bluff top but formerly more abundant before aggressive removal. *F.M. Roberts 6861, 7320 (RSA)*.

POLEMONIACEAE

Linanthus dianthiflorus (Benth.) Greene GROUND-PINK. Annual. Formerly occasional to fairly common and patchy in grassy openings of coastal sage scrub and clay soil grassland at Hilltop Park prior to 2005. No plants observed during the surveys. Likely extirpated. *L. Benson 3192, 26 Mar 1932 (POM)*, *F.M. Roberts 897, 10 Mar 1983 (IRVC)*, *F.M. Roberts et al, 5860, 11 May 2003 (RSA)*.

POLYGONACEAE

†*Chorizanthe procumbens* Nutt. PROSTRATE SPINEFLOWER. Annual. Local Concern. Widespread and locally common in the Dana Point Preserve along trails and openings on compacted sand in coastal sage scrub and southern

coastal bluff scrub, especially on central bluff top; scarce along rim. Absent from Hilltop Park and a single plant seen at Harbor Point Park in 2010. *C.D. Hardham 8944, 4 Apr 1962 (CAS), C.W. Sexton s.n., 26 Apr 1965 (IRVC), F.M. Roberts 1006, 24 Apr 1983 (IRVC, UCSB), D.E. Bramlet 1388, 28 May 1983 (UCR), C. Rieser s.n., 18 Apr 1991 (SD), A. Wolf 290, 15 May 1998 (UCR), K. Stockwell s.n., 18 Jun 2000 (UCR), R.L. Allen 12342, 12343, & 12344, 11 May 2003 (MACF), F.M. Roberts et al. 5845, 11 May 2003 (RSA), F.M. Roberts 6842, 6973 (RSA).*

Eriogonum elongatum Benth. var. *elongatum* LONG-STEMMED or TALL BUCKWHEAT. Perennial. Uncommon on rocky soil near Hilltop Overlook; coastal sage scrub. *T. Salvato 5135 (UCR).*

Eriogonum fasciculatum Benth. subsp. *fasciculatum* CALIFORNIA BUCKWHEAT. Shrub. Widespread and common. Many plants on northern slopes are stunted and have a spreading stature. These plants are the source of similar cultivars available in the nursery trade. *F.M. Roberts 286, 25 Jun 1981 (SDKC, UCSB), F.M. Roberts 6721, 7231, 7330 (RSA).*

Eriogonum parvifolium Smith BLUFF BUCKWHEAT. Shrub. Fairly common along western coastal bluff rim and slopes above Dana Strand Beach, less common at base of southern cliffs; southern coastal bluff scrub, Dana Point Preserve. *F.M. Roberts 901, 10 Mar 1983 (IRVC, RSA, UCSB), F.M. Roberts & L. Carranza 6957, 25 Oct 2006 (RSA).*

****Polygonum aviculare*** L. COMMON KNOTWEED. Annual. Uncommon on disturbed sandy flats. *F.M. Roberts 6858 (RSA).*

Pterostegia drymarioides Fischer & C. Meyer GRANNY'S HAIRNET. Annual. Common to abundant and widespread but patchy, especially under shrubs on bluff top. In wet years forming extensive dense mats under the shrubs. Mostly found on sand, Dana Point Preserve, uncommon to occasional elsewhere. *F.M. Roberts & S.L. Fritzke 498, 3 Apr 1982 (SDKC, UCSB), F.M. Roberts et al. 5850, 11 May 2003 (RSA), F.M. Roberts 6714, 7220, 7311 (RSA).*

****Rumex crispus*** L. CURLY DOCK. Perennial. A few plants scattered along irrigation lines, Hilltop Park. *F.M. Roberts 7312 (RSA).*

RANUNCULACEAE

Clematis pauciflora Nutt. ROPEVINE. Woody perennial climber. Restricted to north-facing slopes above Dana Strand Beach where found in large stands draping over *Rhus integrifolia*. *F.M. Roberts 6904 (RSA).*

Delphinium parryi subsp. *parryi* PARRY'S LARKSPUR. Perennial. Uncommon on coastal bluff rim; southern coastal bluff scrub, Dana Point Preserve. *F.M. Roberts 902, 10 Mar 1983 (IRVC).*

RESEDACEAE

Oligomeris linifolia (M. Vahl) J.F. Macbr. NARROW-LEAVED OLIGOMERIS. Annual. Uncommon on silty soils, eroded slopes along the rim; southern coastal bluff scrub, Harbor Point Park. *F.M. Roberts 7318 (RSA)*.

ROSACEAE

Heteromeles arbutifolia (Lindl.) Roem. TOYON or CHRISTMAS BERRY. Shrub. Uncommon to occasional on central bluff top. Most plants above Green Lantern Street likely planted. *F.M. Roberts 6884 (RSA)*. *T. Salvato 5123, 5138 (UCR)*.

**Raphiolepis indica* (L.) Lindl. INDIAN HAWTHORN. Shrub. Scarce, a few individuals found escaping from adjacent landscaping along the northwest border of the Dana Point Preserve. *F.M. Roberts 7116 (RSA)*.

RUBIACEAE

Galium angustifolium Nutt. subsp. *angustifolium* NARROW-LEAVED BEDSTRAW. Shrubby perennial. Scarce on rocky clay, Hilltop Park. *F.M. Roberts 7267, 7344 (RSA)*.

**Galium aparine* L. COMMON BEDSTRAW. Annual. Relatively scarce in disturbed coastal sage scrub, Hilltop Park. *F.M. Roberts 7283 (RSA)*.

SAXIFRAGACEAE

Jepsonia parryi (Torr.) Small COAST JEPSONIA. Perennial from corm-like underground stem. Scarce, a few individuals seen on compacted clay soil on the north-facing slope north of Hilltop Overlook, Hilltop Park. Photographed but not vouchered.

SCROPHULARIACEAE

**Myoporum laetum* Forster MYOPORUM. Shrub. Occasional, mostly on north slopes above Dana Strand Beach; southern coastal bluff scrub. *F.M. Roberts 6977, 7381, TS 5117 (UCR)*.

SOLANACEAE

Datura wrightii Regel JIMSONWEED. Annual or perennial. Uncommon on central bluff top. *F.M. Roberts 7075 (RSA)*.

- Lycium californicum*** Nutt. CALIFORNIA BOX THORN. CRPR 4.2. Shrub. Occasional and patchy, mostly eroded slopes, coastal bluff rim and xeric rock cliffs; southern coastal bluff scrub. Old, long-established isolated mature individuals are also growing on rocky soil clayish soils on central bluff top in coastal sage scrub. Many recent plantings on the bluff top, especially at Harbor Point Park. *F.M. Roberts 884, 10 Mar 1983 (IRVC), F.M. Roberts 7010, 7176 (RSA), T. Salvato 5101 (UCR).*
- Nicotiana clevelandii*** A. Gray CLEVELAND'S TOBACCO. Annual. Local and patchy on sandy soils of slopes above Dana Strand Beach; disturbed southern coastal bluff scrub, Dana Point Preserve. *F.M. Roberts 7140 (RSA).*
- ****Nicotiana glauca*** Grah. TREE TOBACCO. Small tree. Scattered weed on central bluff top and base of southern cliffs. *F.M. Roberts et al. 7125 (RSA), F.M. Roberts 7401 (RSA).*
- ****Salpichroa origanifolia*** (Lam.) Baillon LILY-OF-THE-VALLEY VINE. Perennial from rhizome. Scarce on disturbed soils, Hilltop Park. *F.M. Roberts 7298 (RSA).*
- ****Solanum americanum*** Mill. WHITE NIGHTSHADE. Annual to shrubby perennial. Fairly common weed in openings of coastal sage scrub, especially on sandy soils. *F.M. Roberts 6809 7000, 7380 (RSA), T. Salvato 5133, (RSA).*
- Solanum douglasii*** Dunal DOUGLAS' NIGHTSHADE. Perennial, sometimes shrubby. Widespread and relatively common on sand, especially on central bluff top in southern coastal bluff scrub, Dana Point Preserve, scattered elsewhere. *F.M. Roberts & L. Carranza 6915 (RSA), F.M. Roberts 7001, 7314 (RSA).*
- Solanum umbelliferum*** Eschsch. var. *glabrescens* Torr. BLUE WITCH. Perennial, sometimes shrubby. A single large patch on sand, western central bluff top, Dana Point Preserve, scattered individuals elsewhere. *F.M. Roberts & L. Carranza 6916 (RSA), F.M. Roberts 7291 (RSA).*

URTICACEAE

- Hesperocnide tenella*** Torr. WESTERN NETTLE. Annual. Fairly common on sand under shrubs on the western bluff top, mostly near the coastal bluff rim, Dana Point Preserve. *F.M. Roberts 6785 (RSA).*
- Parietaria hesperia*** B.D. Hinton var. *californica* B.D. Hinton CALIFORNIA PELLITORY. Annual. Scarce, sandy soils on shaded slope in disturbed southern coastal bluff scrub, Dana Point Preserve. *F.M. Roberts et al. 7150 (RSA).*

MONOCOTYLEDONS

AGAVACEAE

Chlorogalum parviflorum S. Watson SMALL-FLOWERED SOAP PLANT. Perennial from bulb. Scarce on rocky clay soil, especially on the slope north of Hilltop Overlook, Hilltop Park. Formerly widespread and fairly common on clay soil grassland and open, grassy coastal sage scrub. *F.M. Roberts 3004, 7 Jun 1986 (IRVC)*.

Chlorogalum pomeridianum (DC.) Kunth var. *pomeridianum* WAVY-LEAVED SOAP PLANT. Perennial from bulb. Formerly scarce, central bluff top, Hilltop Park. Not seen in 2010. *K. Stockwell s.n., 18 Jun 2000 (UCR)*.

AMARYLLIDACEAE

**Narcissus papyraceus* Ker.-Gawl. PAPERWHITES. Reported to be fairly common on the western central bluff near the rim, Dana Point Preserve (PSBS 1993, URS 2001). Numerous immature plants were observed in 2008 but most of these were removed prior to flower and no voucher specimen was collected.

ARECACEAE

**Washingtonia robusta* H. Wendl. MEXICAN FAN PALM. Tree. A single individual found on the xeric rock cliffs at the southeastern border of the Dana Point Preserve; southern coastal bluff scrub. Not collected due to lack of access.

ASPARAGACEAE

**Asparagus aethiopicus* L. EMERALD-FERN. Perennial. Scarce. A single individual growing at border of irrigated landscaping and sumac chaparral on the central bluff top, Dana Point Preserve. Only a waif here but well established in giant thickets along southern cliffs below homes just adjacent to Study Area. *F.M. Roberts & C.A. Roberts 7118 (RSA)*.

**Asparagus asparagoides* (L.) Druce SMILAX. Twining perennial. Local and patchy weed, scattered locations on the bluff top. *F.M. Roberts 7002, 7328, 7376 (RSA), T. Salvato 5113 (UCR)*.

ASPHODELACEAE

- **Aloe arborescens* Mill. CANDELABRA ALOE. TORCH PLANT. Succulent shrub. Scarce garden escape well established adjacent to houses on south-facing slope below the coastal bluff rim on compacted sand at west end of Harbor Point Park. *T. Salvato 5115, 27 Oct 2010 (UCR)*.
- **Aloe saponaria* (Ait.) Haw. SOAP ALOE. Succulent perennial. Scarce, growing in a single large clump on west-facing bluff slope just below the rim of the coastal bluff, Dana Point Preserve. *F.M. Roberts 6735 (RSA)*.

IRIDACEAE

- **Chasmanthe floribunda* (Salisb.) NE. Br. AFRICAN CORNFLAG. Perennial. Scarce garden escape becoming established adjacent to houses, eastern edge, Hilltop Park. *F.M. Roberts 7326 (RSA)*.
- Sisyrinchium bellum* S. Watson CALIFORNIA BLUE-EYED GRASS. Perennial. Fairly common on the bluff top, especially on Hilltop and Harbor Parks in association with irrigation lines. Scarce or uncommon in less disturbed habitats, such as the southwest bluff top and along the rim of the bluff. Most plants seen during study likely established from seed mixes as these areas are generally too dry based on observations prior to 2005. Historically seen mostly on the north-facing slopes north of Hilltop Overlook. *F.M. Roberts 906, 10 Mar 1983 (IRVC), F.M. Roberts 6985, 7286 (RSA)*.

JUNCACEAE

- Juncus bufonius* L. var. *bufonius* TOAD RUSH. Annual. Formerly local and patchy along margins of vernal pool-like depressions along dirt road, central bluff top, Hilltop Park. *F.M. Roberts 1010, 24 Apr 1983 (IRVC), A. Wolf 292, 15 May 1998 (UCR)*.

LILIACEAE

- Calochortus splendens* Benth. SPLENDID MARIPOSA LILY. Perennial from bulb. Scattered in coastal sage scrub. *Dressler 806, 8 May 1949 (MACF), F.M. Roberts 5684, 11 May 2003 (RSA, F.M. Roberts 7250, 7286 (RSA))*.

POACEAE

- Agrostis exarata* Trin. SPIKE BENT GRASS. Perennial. Once found along northern boundary of the Dana Point Preserve, where described as "abundant

- on north-facing slope in coastal sage scrub in sandy soil." *F.M. Roberts 1085, 21 May 1983 (IRVC)*.
- **Arundo donax* L. GIANT REED. Perennial. Uncommon at base of bluffs along Dana Strand Beach. *F.M. Roberts 7121 (RSA)*.
- **Avena barbata* Link SLENDER WILD OAT. Annual. Scattered weed. *F.M. Roberts 7025, 7248 (RSA)*.
- **Avena fatua* L. WILD OAT. Annual. Mostly scattered and uncommon on disturbed soils. *F.M. Roberts 6717, 7202, 7249 (RSA)*.
- Bothriochloa barbinodis* (Lag.) Herter CANE BLUESTEM or PLUMED BEARDGRASS. Perennial. Fairly common on at base and lower portion of harbor cliffs adjacent to Marine Institute. Scarce elsewhere. *F.M. Roberts 7332, 7399 (RSA)*.
- **Brachypodium distachyon* (L.) Beauv. PURPLE FALSE BROME. Annual. Fairly common in annual grassland and coastal sage scrub on clayish soils, especially in the vicinity of Hilltop Overlook, Hilltop Park. Scattered along bluff top in Harbor Point Park. *F.M. Roberts & K.G. Marsh 1055, 13 May 1983 (IRVC)*, *A. Wolf 286, 15 May 1998 (UCR)*, *F.M. Roberts et al. 5865, 11 May 2003 (RSA)*, *F.M. Roberts 7270, 7261 (RSA)*.
- Bromus carinatus* Hook. & Arn. CALIFORNIA BROME GRASS. Perennial. Scarce in coastal sage scrub. *F.M. Roberts 7292 (RSA)*.
- **Bromus diandrus* Roth COMMON RIPGUT GRASS. Annual. Overall uncommon. *F.M. Roberts 6724, 7182, 7209 (RSA)*.
- **Bromus hordeaceus* L. SOFT CHESS. Annual. Uncommon to scattered weed, mostly in lightly disturbed sites. *F.M. Roberts 6914, 7243, 7290 (RSA)*.
- **Bromus madritensis* L. subsp. *rubens* (L.) Husn. FOXTAIL CHESS or RED BROME. Annual. Widespread, fairly common on the central bluff top at Hilltop Park, less common elsewhere. *F.M. Roberts 6715, 7189, 7234 (RSA)*.
- **Cortaderia selloana* (Schult. & Schult. f.) Asch. & Graeb. SELLOW'S PAMPAS GRASS. Perennial. Scarce in sand on slope above Dana Strand Beach and on southern cliff. Not collected due to challenging access.
- **Cynodon dactylon* (L.) Pers. BERMUDA GRASS. Perennial. Encountered on the slopes adjacent to Dana Strand beach in October 2008, and along the southern cliffs. Not seen in flower or vouchered.
- Distichlis spicata* (L.) Greene SALT GRASS. Perennial. Local and patchy, often forming dense stands where found as on the rim above Dana Strands Beach, or at seepy sites along the base of the southern cliff. *F.M. Roberts 7124 (RSA)*.
- **Ehrharta erecta* Lam. PANIC VELDT GRASS. Perennial. Uncommon, found only at margin of irrigated landscaping *F.M. Roberts & E. Maher 6798 (RSA)*, *F.M. Roberts 7214 (RSA)*.
- Elymus condensatus* J. Presl GIANT WILDRYE. Perennial. Uncommon, Dana Point Preserve. *F.M. Roberts 6945 (RSA)*.

- **Festuca bromoides* L. FALSEBROME FESCUE. Annual. Scarce weed. *F.M. Roberts 7284 (RSA)*.
- Festuca microstachys* Nutt. PACIFIC FESCUE. Annual. Scattered, mostly in disturbed ground adjacent to trails, Hilltop Park. Evidently introduced to the site by seed associated with the restoration. *F.M. Roberts 7269 (RSA)*.
- **Festuca myuros* L. FOXTAIL FESCUE. Annual. Widespread and fairly common in annual grassland and coastal sage scrub, occasional in southern coastal bluff scrub. *F.M. Roberts 882, 10 Mar 1983 (UCSB), F.M. Roberts 6854, 6911, 7212, 7245 (RSA)*.
- Festuca octoflora* Walter var. *octoflora* SIX-WEEKS FESCUE. Annual. Occasional on sand near west rim, coastal sage scrub, Dana Point Preserve. *F.M. Roberts, Lee Ann Carranza, & Eliza Maher 7145 (RSA)*.
- **Festuca perennis* (L.) Columbus & J.P. Sm. RYE GRASS. Annual or short-lived perennial. Occasional on clayish soils, mostly near irrigation lines. Formerly fairly common on slopes north of Hilltop Overlook. *F.M. Roberts 7334 (RSA)*.
- **Festuca temulenta* (L.) Columbus & J.P. Sm. DARNEL. Annual. Formerly scarce on slopes north of Hilltop Overlook. *F.M. Roberts & K.G. Marsh 1056, 10 Mar 1983 (IRVC)*.
- **Gastridium phleoides* (Nees & Meyen) C.E. Hubb. NITGRASS. Annual. Uncommon. Hilltop Park. Formerly fairly common, especially on slope north of Hilltop Overlook. *F.M. Roberts & K.G. Marsh 1054, 13 May 1983 (IRVC), F.M. Roberts 7343 (RSA)*.
- Hordeum intercedens* Nevski VERNAL BARLEY. CRPR 3.2. Annual. Fairly common to locally abundant central near Hilltop Overlook, Hilltop Park; open grassy coastal sage scrub and patches of mixed grasslands. Especially common adjacent to irrigation lines. Reported to occur also at Harbor Point Park (GLA 2002, URS 2009). Prior to 2005, scattered to uncommon. *F.M. Roberts 1015, 24 Apr 1983 (IRVC), A. Wolf 285, 15 Apr 1998 (UCR), F.M. Roberts et al. 5857, 11 May 2003 (RSA), F.M. Roberts 7275 (RSA)*.
- **Hordeum murinum* L. subsp. *leporinum* (Link) Arcang. [*H. leporinum* Link] HARE BARLEY or FOXTAIL BARLEY. Annual. Scarce, open grassy places. *F.M. Roberts 7279, 7260 (RSA)*.
- **Lamarckia aurea* (L.) Moench GOLDENTOP. Annual. Uncommon. *F.M. Roberts 7196, 7263 (RSA)*.
- Melica imperfecta* Trin. SMALL-FLOWERED MELIC GRASS. Perennial. Occasional along rim in mesic southern coastal bluff scrub and in the vicinity of Hilltop Overlook, otherwise scarce. *F.M. Roberts 881, 895, 10 Mar 1983 (IRVC), F.M. Roberts 7204 (RSA), F.M. Roberts 6906, 6985, 7251 (RSA)*.
- Muhlenbergia microsperma* (DC.) Kunth LITTLESEED MUHLY. Annual. Uncommon in sandy openings in southern coastal bluff scrub on slopes along

southern coastal bluff rim, Dana Point Preserve. *F.M. Roberts & E. Maher 6811 (RSA)*.

**Parapholis incurva* (L.) C.E. Hubb. EUROPEAN SICKLE-GRASS. Annual. A single dense stand on beach and on lower slopes adjacent to Dana Strands Beach; disturbed southern coastal bluff scrub and coastal strand. *F.M. Roberts, S. Leatherman, & J. Pareti 7148 (RSA)*.

**Phalaris paradoxa* L. PARADOX CANARY GRASS. Annual. Scarce weed on disturbed slopes. *F.M. Roberts 7273 (RSA)*.

**Polypogon monspeliensis* (L.) Desf. ANNUAL BEARD GRASS. Annual. Fairly common but patchy, along irrigation lines and where water pools at base of wall along western edge of central mesa, otherwise scarce. *F.M. Roberts 7264, 7287 (RSA)*.

**Polypogon viridis* (Goian) Breister WATER BENTGRASS. Perennial. Scarce in irrigated areas. *F.M. Roberts 6987 (RSA)*.

**Schismus barbatus* (L.) Thell. MEDITERRANEAN SCHISMUS. Annual. Widespread and fairly common in open areas on sand, less common elsewhere. *F.M. Roberts & S.L. Fritzke 504, 3 Apr 1983 (IRVC)*; *F.M. Roberts & E. Maher 6805 (RSA)*, *F.M. Roberts 7198, 7232 (RSA)*.

Stipa lepida Hitchc. FOOTHILL NEEDLEGRASS. Perennial. Uncommon but scattered among shrubs, mostly found at south margin of central bluff top and along southern bluff rim. Formerly more common at Hilltop Park. *F.M. Roberts 886, 10 Mar 1983 (IRVC)*, *F.M. Roberts et al. 5862, 11 May 2003 (RSA)*, *F.M. Roberts 6865 (RSA)*, *F.M. Roberts 7203 (RSA)*.

Stipa pulchra Hitchc. PURPLE NEEDLEGRASS. Perennial. Scarce in grassy openings and among shrubs. Formerly more common at Hilltop Park. *F.M. Roberts 6863, 7258 (RSA)*.

THEMIDACEAE

Bloomeria crocea (Torr.) Cov. var. *crocea* COMMON GOLDENSTAR. Perennial from corm. Scarce in coastal sage scrub on slopes north of Hilltop Overlook. Formerly common in this area. *F.M. Roberts 7340 (RSA)*.

Dichelostemma capitatum Alph. Wood subsp. *capitatum* SCHOOL BELLS or BLUE DICKS. Perennial from corm. Uncommon to scattered, mostly on undisturbed eroded slopes of bluff rim. *R.L. Allen 12315, 11 May 2003 (MACF)*, *F.M. Roberts 6718, 7268 (RSA)*.

BOOK REVIEW

Wildflowers of Orange County and the Santa Ana Mountains

Robert L. Allen and Fred M. Roberts Jr. (2013)

Laguna Wilderness Press, PO Box 149, Laguna Beach, CA 92652

(\$35.00)

This long-awaited color photo book about the flowering plants of Orange County is now available. Bob Allen and Fred Roberts, in 500 pages, have done a wonderful job of summarizing this topic. It is, however, more than just a photo book. The first 35 pages cover brief descriptions of geography, geology, plant communities, plant anatomy, and principles of plant classification. For the lay person, as an aid to plant identification, inside the front cover are diagrams of flower and leaf morphology which are repeated in the first chapter. There is even a section on field protocol and possible dangerous animals to watch for. Using an alphabetical arrangement of updated plant families, as delineated by the second edition of *The Jepson Manual* (Baldwin et.al. 2012), the body of the text includes a description of each plant, its habitat, where it might be found locally, and an explanation of nomenclatural etiology. Each description is accompanied by a color photo of the entire plant as well as a close-up of the flower. Where it is appropriate, photos of distinctive fruits are included. Interestingly, tucked into various locations, one may find thought-provoking quotations.

In the geography section there is an excellent map of Orange County, including important place names. It also shows major roads, and public lands are color-coded for ease of identification with respect to managing agencies. The last chapter of the book entitled, "Where to Go Wildflower-watching" includes a series of trail maps to various popular localities on public lands. Each map is accompanied with a description of the topography and what plants might be observed along the way. The section concludes with an alphabetical listing of public lands along with a brief description and contact information.

For the purpose of organization and field identification of plants, different books use different techniques. There are several options for Orange County. In *The Jepson Manual*, plant families and species of the entire state are covered alphabetically. Treatment of each taxon is very thorough and there are elaborate taxonomic keys. Not every taxon is illustrated, and illustrations are black and white drawings. Allen and Roberts have arranged the plants alphabetically by family, but there are no keys. Most of the plants covered lend themselves to color photography. There is no comprehensive coverage of trees. Various trees are mentioned as components of plant communities, but not described taxonomically or

illustrated by color photos. Among the genera not illustrated are *Alnus*, *Populus*, *Pinus*, *Salix*, and *Quercus*. In another color photo treatment, Clarke, et. al. (2007), in the *Flora of the Santa Ana River and Environs*, have arranged plant families according to traditional phylogeny, which is an approach that may appeal to botanists who are more familiar with traditional taxonomy. This book also includes lower plants such as Waterweeds, Club Mosses, and Ferns. Another approach, which may be easier for lay persons, particularly those who turn pages until they recognize a photograph, is to arrange color photographs of plants and/or animals according to habitat. This is the approach taken by Schoenherr (2011) in *Wild and Beautiful: A Natural History of Open Spaces in Orange County*. A similar approach is followed by Elisabeth Brown (2007) in her diminutive but handy, *Back Pocket Field Guide: An Introduction to Orange County Wildlands*. Finally, another way to appeal to lay persons, unfamiliar with the rules of taxonomy, is to arrange the plants according to flower color. While there is no book, specifically about Orange County that uses this approach, in this regard, Allen and Roberts have included an index to the plants according to color.

As a special bonus, associated with certain plants, under the heading of "Guilds," Allen and Roberts have included images of unique pollinators, and/or interesting insects. For example, in the section on the Milkweed Family (Apocinaceae) we can learn about milkweed bugs, aphids, wood-borer beetles, Dogbane Moths, and two kinds of milkweed butterflies, the Monarch and the Queen. In the Carrot Family (Apiaceae) there is a discussion of different kinds of Swallowtail Butterflies whose larvae feed on members within the family. Birds such as the Cactus Wren, which is associated with various cacti, might also be included in a guild. Also in the cactus guild we learn about Cochineal Insects, various bugs, beetles, and flies. There is also a set of diagrams that help to identify prickly-pear cacti by pad morphology. In association with the California Sycamore there is a discussion of Anthracnose Fungus, pseudoscorpions, Lace Bugs, Twenty-spotted Ladybird Beetles, the Western Tiger Swallowtail, Sycamore Borer Moth, and Anna's Hummingbird. Interestingly, California Sycamore is one of the few trees described in this book. While there are no taxonomic keys, helpful tables and diagrams are included to help with identification. For groups of related species such as the California Lilacs (*Ceanothus* spp.) or Buckwheats (*Eriogonum* spp.) there is an accompanying table that summarizes significant characteristics for each taxon.

Serious botanists will love this new book on Orange County wildflowers. Probably, they will be familiar already with the relatively new classification and arrangement of species into families that is present in the second edition of *The Jepson Manual*. If they have need for a taxonomic key they can use *The Jepson Manual* to identify a plant to species, and then they may refer to the color photographs in Allen and Roberts to verify their identification.

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