



Monitoring Riparian Plant Species Diversity in the Mediterranean Coast Network

*Results from a pilot study in the Santa Monica Mountains
National Recreation Area*

Natural Resource Report NPS/MEDN/NRDS—2012/343



ON THE COVER

Solstice Creek, Santa Monica Mountains. Photograph by Randy Philips

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Executive Summary

Five streams representing the range of biotic and physical conditions that occur in the region were surveyed in 2009 and 2010 to provide preliminary data for guiding the development of a protocol for long-term monitoring of riparian vegetation in the Mediterranean Coast Inventory and Monitoring Network. Variability among streams and between years was higher than expected. While patterns of individual species' occurrences were generally explainable, relationships among sampled stream sections were difficult to determine. This may reflect the specific choice of streams to represent the variability in the study area. Differences within streams between years may result from the interaction of dynamic stream scouring and deposition with the dispersion and establishment characteristics of native and non-native species. The unexpected variability may also in part be a result of the sampling protocol, with more transects and more formally defined transect boundaries required. Questions of sampling adequacy will be addressed during development of the monitoring protocol in fiscal year 2011.

Acknowledgments

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Introduction

This report summarizes the methods and findings of a 2-year pilot study of the riparian vegetation in five selected streams in the Santa Monica Mountains of Southern California. The purpose of this study was to characterize the spatial and temporal variability of riparian species assemblages. The data obtained will be used to guide development of a riparian long-term monitoring protocol that will include tracking changes in riparian species distribution and community composition.

In semi-arid Southern California, streams and their accompanying riparian vegetation are important to ecosystem function. Riparian corridors buffer landscapes against erosion, regulate nutrient cycling, serve as conduits for materials movement, and act as barriers to fire spread. They also provide food and shelter for a wide variety of animals and are important corridors for wildlife movement (Faber et al. 1989, Rundel and Sturmer 1998).

Riparian corridors are also significant components of native species richness and plant diversity in Southern California. They harbor greater numbers of species than surrounding upland habitats of equivalent area and support species unique to the riparian habitat (Sabo et al. 2005). In the Santa Monica Mountains, Simi Hills, and environs (“Santa Monica Mountains,” the study area) riparian corridors comprise 4 % of the land area supporting native vegetation, but support 24 % of the native species that occur here.¹ In comparison, chaparral, the most common vegetation type, occupies 44% of the land area and supports 31% of the native species. Expressed on a unit area basis, riparian areas contain 29 native species per 1,000 acres, while chaparral contains only 3 native species per 1,000 acres. Of the 213 species that occur in riparian habitats, 54% (114 species) are unique to that habitat. Species unique to riparian habitats constitute 13% of native species occurring in the study area.

This rich native diversity is threatened by population growth in the region. In southern California, riparian corridors occur in a landscape mosaic of human land uses (primarily urban and suburban development in the Santa Monica Mountains) interspersed among undeveloped native shrublands (Oneal and Rotenberry 2008). Proximity to development can alter water quantity and quality (Paul and Meyer 2001) and result in altered geomorphology and nutrient cycling (Groffman et al. 2002). Heavy recreational use associated with urban areas can directly impact riparian soils and understory plant species (Wetlands Recovery Project 2001).

Introductions of horticultural and other non-native species can occur as escapes from nearby development or be imported by recreational visitors (Wetlands Recovery Project 2001). Once introduced, species may be sustained by anthropogenic physical and biotic alterations. (Oneal and Rotenberry 2008). Riparian areas, due to their association with water and a relatively high level of natural disturbance, are likely subject to occupation by a greater diversity of non-native

¹All statistics for the Santa Monica Mountains and environs were calculated by the authors of this manuscript. Calculations are based on the riparian community types described in the park vegetation classification (Keeler-Wolf and Evens 2006), plant community delineations provided in the park vegetation map (Aerial Information Systems 2007), the park plant species list maintained in the National Parks Service species database (NPSpecies, National Park Service 2010), and invasive species designated by the California Invasive Plant Council (Cal-IPC 2006).

species than upland types. This is evidenced in the Santa Monica Mountains, where riparian habitats contain 34% of non-native species that occur in the area, versus only 16% for chaparral. There are 46 non-native species that occur only in riparian habitats, compared to 27 only in chaparral. All of the 31 species identified as problematic invasives occur in riparian, while only 1 occurs in chaparral.

It is difficult to predict how and to what degree riparian species diversity will change in the future. Climate models predict regionally higher temperatures and longer periods of drought punctuated by fewer, more intense rain events, resulting in greater hydrologic instability coupled with anticipated increases in anthropogenic disturbance (Moser et al. 2009). At the same time, development has been observed in some areas to result in more continuous water inputs that increase available water and moderate seasonal hydrologic dynamics (Hu and Hibbs 2010).

The richness and unique species composition of riparian habitats in the Santa Monica Mountains imparts an intrinsic floristic value to these habitats that is in addition to their value in supporting ecosystem processes. This native plant diversity is perceived to be particularly sensitive to physical and biotic changes which can be only vaguely predicted and which will have combined impacts that are not well understood. For this reason, our long-term monitoring program will seek to assess not just changes in elements that affect function (e.g. canopy cover), but also to directly assess changes in riparian community composition and species diversity. Our objectives are to determine the status and trends in native and non-native species distribution and abundance in riparian habitats in the Santa Monica Mountains National Recreation Area and its environs. The data collected in this pilot study will be used during protocol development to determine the best sampling design for achieving these objectives.

Methods

Study Area

The Santa Monica Mountains of southern California are a small but rugged anticlinal mountain range bordered on the south by the Pacific Ocean and extending 70 km from the Oxnard plain (Ventura County) in the west to the City of Los Angeles in the east. They are 5 to 21 km wide with the crest generally ranging between 450 and 600 m elevation (948 m maximum). They experience a typical wet winter—dry summer Mediterranean-type climate with high year-to-year precipitation variability. Despite their location within the second largest population center in the nation, the Santa Monica Mountains retain 80% native vegetation cover and high vegetation diversity, containing some of the best remaining chaparral, coastal sage scrub, and riparian habitats in southern California. Most streams originate within the mountains and to varying extent flow through protected parklands. While some drainages are almost entirely protected, the lower reaches of streams tend to be in proximity to or flow through developed areas. The largest drainage, Malibu Creek, originates in the Conejo Valley north the Santa Monica Mountains and flows south through the range.

Site Selection

Five streams at widely dispersed locations within the central and western portion of the Santa Monica Mountains (Figure 1) were selected as representative of the range of biotic and physical conditions and human influences that occur in the region. Streams also varied in the degree of human development within their watersheds (Table 1). Transect locations were selectively chosen based on the presence of high herbaceous plant diversity, accessibility, and absence of side drainages within the reach. The same locations were surveyed in each of 2 consecutive years (2009-2010).

Field sampling

Two 100-meter belt transects separated by 50-100 meters were established along each of the 5 streams (Figure 2). The width of each belt transect was determined by the active riparian boundary: the intersection of surfaces dominated by riparian vegetation with surfaces dominated by upland vegetation. The width of these boundaries, and thus the belt transects, varied among locations.

All understory vascular plant species occurring within the active riparian boundary were recorded, including plants rooted in the stream bottom and growing on bars. The one exception to this protocol was Malibu Creek, which is a large perennial stream with a wide, deep channel containing no emergent plants. Here, only one side of the creek (channel bank to riparian boundary) was surveyed. To facilitate the accurate collection of data, each transect was broken into five 20-meter segments. The second intent in subdividing transects was to allow estimation of changes in species abundance over time at each site based on frequency of occurrence within transect segments. However, analysis of year-to-year changes in abundance at each site is not presented in this report.

Transects were sampled in March-June 2009 and again in March-June 2010. In both years plants were in similar phenological stages and significant changes in annual species occurrence or perennial species expression was not observed over the 4-month sampling period in either year.

Data Analysis

Species occurrence at all locations in each year was summarized and evaluated for differences among locations within each year and between years at each location. Since the intent of this study was to provide an overview of floristic spatial and temporal variability to guide development of a monitoring protocol, only tabular data is presented; no statistical comparisons were performed.

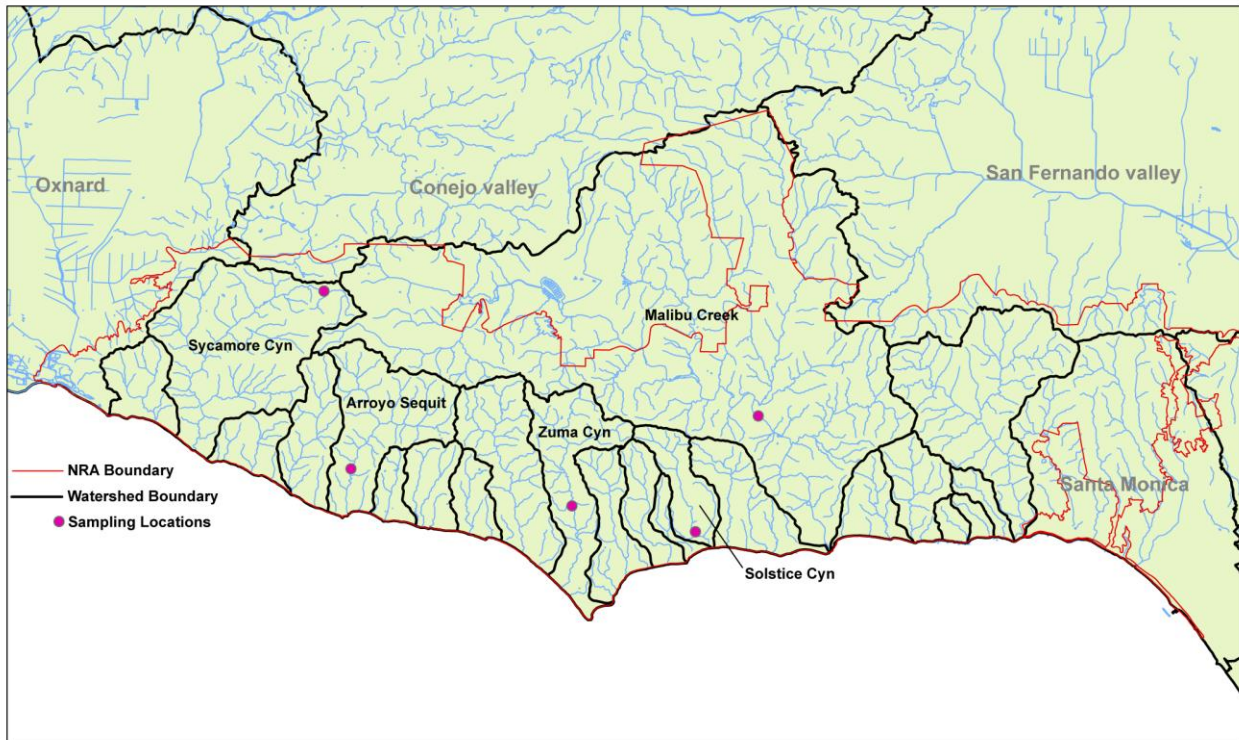


Figure 1. Stream sampling locations in the Santa Monica Mountains National Recreation Area

Stream	Hydrology	Morphology	Canopy	Riparian Vegetation	Surrounding Upland Vegetation	Geology	Watershed
Sycamore (Upper)	Seasonal	Narrow, incised	Partially open	Oak-sycamore	Ceanothus chaparral with patches of coastal sage scrub (North); oak woodland with patches of California walnut and coastal sage scrub (South)	Volcanic	5,500 ha No Urbanization
Malibu	Perennial	Wide, shallow	Closed	Willow	Oak woodland and coastal sage scrub (West); oak woodland with laurel sumac and tall shrub (East)	Volcanic	28,500 ha Significant Urbanization
Zuma (Lower)	Seasonal - intermittent	Narrow, incised	Mostly open	Sycamore with willow understory	Mountain mahogany chaparral (West); ceanothus chaparral (East)	Sedimentary	2,600 ha Minor Urbanization
Arroyo Sequit (Lower)	Perennial	Narrow, incised	Partially open	Sycamore	Mountain mahogany with laurel sumac (West); oak woodland with coastal sage scrub (East)	Sedimentary	3,000 ha Minor Urbanization
Solstice	Perennial	Variable	Closed	Oak-sycamore and white alder, both with willow understory	Coastal sage scrub and chaparral (West); California walnut with coastal sage scrub understory (East)	Sedimentary	1,100 ha Minor Urbanization

Table 1. Characteristics of study streams within the Santa Monica Mountains National Recreation Area.

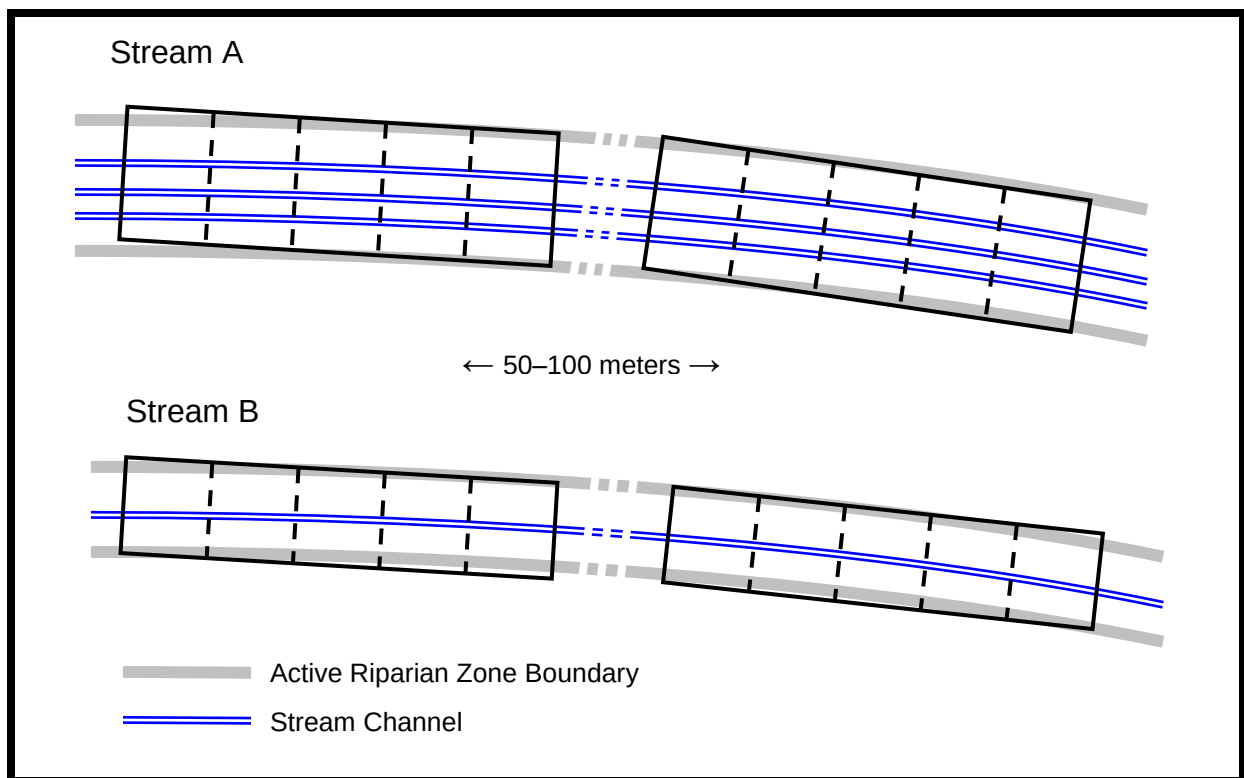


Figure 2. Schematic representation of sampling transects. Each transect is 100 meters long and of variable width, determined by the active riparian zone boundary. Transects are separated by 50-100 meters.

Results and Discussion

A total of 191 species were observed during 2 seasons of monitoring at the 5 stream locations (Appendix A). Native species comprised 71% (136 species) of all species recorded. In both seasons, perennial forbs were the most common native life form, while among the non-native species, annual forbs contributed to the species spectrum slightly more than perennial forbs. The native species recorded comprised 64% of the 213 native riparian species known to occur in the study area. Non-native species (55 species) represented 45% of the 121 non-native species known from riparian areas in the study area.

Spatial Variability

Streams varied in species richness. In 2009, native species counts ranged from 29 at Malibu Creek to 67 at Solstice Canyon. Non-natives were present in similar proportion (26-36%) in all streams, except for upper Sycamore Creek where they only comprised 10% of the total species present (Table 2). In all streams perennial forbs were the most common native life form, while non-native species showed a more variable pattern, with annual forbs and grasses being important. Native and non-native species counts and patterns were similar in 2010 (Appendix A).

Species Occurrence Among Streams

The breadth of native species occurrence among streams was relatively limited (Table 3; Appendix A). In both years only 24 native species occurred in 3 or more streams, while 90 species (79%) in 2009 and 66 species (73%) in 2010 were limited to only 1 or 2 streams. Only 3 species in 2009 and 6 species in 2010 occurred in all 5 streams.

Non-native species showed a similar pattern. In 2009 only 1 species occurred in all 5 streams and 36 species (77%) occurred in only 1 or 2 streams. Highly invasive species did not occur in more than 3 streams, with the greatest number of these species occurring in only 1 stream (Table 3). In 2010, only 2 of 39 non-native species occurred in all 5 streams and 25 species (64%) were recorded from only 1 or 2 streams. One highly invasive species occurred in 5 streams and one in 4 streams. Six occurred in three or less streams (Appendix A).

Most of the species sampled in both years are common throughout the region and we had generally expected species to be more widely distributed among streams than was found in our study. Nevertheless, some patterns of species distribution may be interpreted.

Of the 24 native species occurring in the understory of 3 or more streams in each year, 17 did so in both years. The 3 species that occurred in all 5 locations in both years were sycamore (*Platanus racemosa*), arroyo willow (*Salix lasiolepis*), and mugwort (*Artemisia douglasiana*), a perennial forb. Sycamore and willow are ubiquitous components of the riparian overstory and mugwort is common throughout the range in moist, shaded areas. All 3 species are well adapted to seasonal/intermittent availability of water and have relatively wide ecological amplitude in substrate and moisture.

The majority of the native species found in 3 or more streams require year-round water and are generally associated with shaded, cooler areas in narrow canyon sections containing rock outcrops that create pools which retain water through the dry season. The presence of these

shaded pools in all of the streams sampled may account for the ubiquity of this species group. This group also included a number of common upland species which benefit from the increased moisture in the riparian zone and occur there as ecotone species or waifs on the sandbars.

A number of species occurring in 3 streams and most of the species occurring in 1 or 2 streams are present throughout the range in naturally low numbers. However, several of these species are known to occur in all five streams. It may be that employing two 100-meter transects, which detected 64% of riparian species occurring in the study area, is not sufficient to consistently detect occurrence in any given stream. The possible benefits in detection of less common species to be gained by increasing the number of transects will be formally assessed in the coming year.

Species Shared by Stream Pairs

The average number of native species shared by all 10 stream pairs was 13 (11%) and ranged from only 4 species shared by Sycamore and Malibu (11% and 14% respectively) to 29 species shared by Arroyo Sequit and Solstice (59% and 43% respectively). In general, streams tended to share the greatest number of species with Solstice and Arroyo Sequit; in part a result of the high number of native species supported by these 2 streams.

Non-native species showed a similar pattern to natives; the ten stream pairs also shared an average 11% of all species (6 species). Sycamore and Zuma shared the smallest number of species (25% and 7% respectively) while Malibu and Solstice shared the largest number (66% and 31% respectively). Streams shared the highest number of non-native species with Solstice, which, as for natives, also had the greatest number of non-native species. Streams shared only a small proportion of their non-natives with Sycamore, owing to the occurrence of only 4 non-native species at that site.

There were no definitive patterns in relationship as expressed by shared species for either native or non-native species. This may reflect the unique character of each of the streams, which were selected to represent the variety of types found in the study area.

Temporal Variability

Species Richness in 2009 and 2010

Total species counts declined from 164 species in 2009 (117 natives and 47 non-natives) to 129 in 2010 (90 natives and 39 non-natives). Most of the decline in native species occurred at Solstice and Arroyo Sequit which dropped by 23 species (34%) and 16 species (33%) respectively. In contrast, Zuma increased by 8 native species (32%). Non-native species in streams remained stable or increased, with the exception of Solstice which lost 12 non-native species (37%). Zuma and Malibu gained 9 (64%) and 7 (44%) non-native species respectively.

Species Reoccurrence in Streams

A total of 136 native species were observed over the 2 seasons at all sites. Of these, 71 species (52%) were recorded in both years, 46 species (34%) observed only in 2009, and 19 species (14%) recorded only in 2010. Species observed in streams in 2009 that also occurred in the same stream in 2010 ranged from 53% at Arroyo Sequit to 72% at Zuma (Table 4).

There were 55 non-native species observed over the 2 seasons at all sites, with 31 species (56%) recorded in both years, 16 species (29%) observed only in 2009, and 8 new species (15%) recorded in 2010 (Table 5). Species observed in streams in 2009 that also occurred in the same stream in 2010 ranged from 25% at Sycamore to 88% at Malibu. The Sycamore results are somewhat anomalous in that there were only 4 species that occurred in 2009, 1 of which occurred in 2010. After Sycamore, the smallest proportion reoccurring in 2010 was 53% at Solstice (Table 4).

Differences in life form occurrences between 2009 and 2010 reflected their overall representation in the streams. Perennial forbs, which were the most common native life-form observed, generally showed both the greatest number of species present in both years and the greatest number occurring in only one year (Table 5). For non-native species, where annual and perennial forbs are equally common, this pattern was observed for both life forms. The low presence of other life forms (subshrubs, shrubs, and tree seedlings) precludes comparison of occurrence patterns between the common and uncommon life forms.

We expected greater consistency (less species observed in only one year) in perennial forbs. The variability may result from differences in transect placement and boundary definition, particularly for uncommon species. While the transect start points were roughly marked, small offsets in placement may have occurred in 2010. Furthermore, the width of each transect was defined by visual assessment of the riparian boundary. Year-to-year differences in boundary determination may result in the inclusion or exclusion of species, particularly ecotonal upland species. However, all streams were surveyed by the same observer each year and when the data were reanalyzed excluding upland species, no differences in results were observed.

The differences between years likely reflects the natural dynamic of these streams, where scouring regularly occurs and new sand bars are formed each season. Most perennial (and annual) forbs are widely distributed in scattered locations and may be easily removed and easily established under the natural dynamic. In addition, the high year-to-year variability in rainfall in the region may affect new occurrence or reestablishment of seedlings. We did not differentiate between life stages in our survey and therefore cannot determine to what degree reoccurring species resulted from year-to-year persistence versus reestablishment.

Summary and Conclusions

Five streams representing the range of biotic and physical conditions that occur in the region were surveyed in 2009 and 2010. The variability both among streams and between years was higher than we expected. While patterns of individual species' occurrences were generally explainable, relationships among sampled stream sections were difficult to define. This may reflect the specific choice of streams to represent the variability in the study area. Differences within streams between years may result from an interaction of dynamic stream scouring and

deposition together with the dispersion and establishment characteristics of both native and non-native species. The unexpected variability may in part be a result of the sampling methods: 1) transect sites did not have permanent markers, 2) boundaries were defined by the observer each year, and 3) more transects may be necessary to capture common but infrequent species.

These problems, as well as application of methodologies to increase interpretability (e.g. noting seedling versus mature, creating up and downstream pairs), will be addressed during future protocol development.

Table 2. Native and non-native plant life forms in the study streams (Spring 2009).

	Sycamore	Malibu	Zuma	Arroyo Sequit	Solstice
Total Species	40	44	39	66	99
Native					
Fern	4	1	1	3	1
Grass, sedge, rush : annual	0	0	0	0	0
Grass, sedge, rush : perennial	2	6	6	4	3
Forb : annual	2	3	1	5	18
Forb : perennial	13	8	9	22	26
Sub-shrub	2	0	3	3	1
Shrub	9	5	2	8	11
Tree	4	6	3	4	7
Total Native (Percent)	36 (90%)	29 (66%)	25 (64%)	49 (74%)	67 (68%)
Non-native					
Grass, sedge, rush : annual	0	2	1	1	3
Grass, sedge, rush : perennial	1	3	5	2	4
Forb : annual	0	7	3	6	18
Forb : perennial	3	3	5	7	7
Sub-shrub	0	0	0	0	0
Shrub	0	0	0	1	0
Tree	0	0	0	0	0
Total Non-native (Percent)	4 (10%)	15 (34%)	14 (36%)	17 (26%)	32 (32%)

Table 3. Numbers of native and non-native species found in 1 or more of the 5 study streams (Spring 2009). Numbers in parentheses are counts of species that are highly invasive and believed ecologically damaging in the Santa Monica Mountains.

Streams Occupied	<u>Native Species</u>		<u>Non-native Species</u>	
	Count	%	Count	%
5	3	3	1	3
4	8	7	3	7
3	13	11	7 (4)	15
2	25	21	10 (1)	22
1	68	58	26 (7)	54
Total Species	117		47	

Table 4. Number and percentage of native and non-native species shared by each pair of streams (Spring 2009). The number of shared species for each pair is shown in the upper right portion of the matrix. Shared species as a percent of all species occurring in each stream shown in the lower left (Percent of species in stream indicated in column heading / percent of all species occurring in the stream indicated in the row heading).

		Sycamore	Malibu	Zuma	Arroyo Sequit	Solstice
Native Species		36	29	25	49	67
Sycamore	36		4	8	15	18
Malibu	29	11 / 14		11	12	12
Zuma	25	22 / 32	38 / 44		14	11
Arroyo Sequit	49	42 / 31	41 / 24	56 / 29		29
Solstice	67	50 / 27	41 / 18	44 / 16	59 / 43	
Non-native Species		4	15	14	17	32
Sycamore	4		2	1	2	2
Malibu	15	50 / 13*		7	6	10
Zuma	14	25 / 07	50 / 47		7	9
Arroyo Sequit	17	50 / 12	40 / 35	50 / 41		10
Solstice	32	50 / 06	66 / 31	64 / 28	59 / 31	

Table 5. Native and non-native species occurrence in streams in 2009 and 2010.

	Total species observed	2009 Total	2010 Total	2009 Only	2010 Only	Both 2009 & 2010		
						Count	% of 2009	% of 2010
Native								
All Streams	136	117	90	46	19	71	61	79
Sycamore	46	36	34	12	10	24	67	71
Malibu	40	28	30	10	12	18	64	60
Zuma	40	25	33	7	15	18	72	55
Arroyo Sequit	54	49	33	21	7	26	53	79
Solstice	75	67	44	31	8	36	54	82
Non-native								
All Streams	55	47	39	16	8	31	66	79
Sycamore	7	4	4	3	3	1	25	25
Malibu	24	16	23	2	8	14	88	61
Zuma	27	14	23	4	13	10	71	43
Arroyo Sequit	27	17	19	8	8	11	65	58
Solstice	35	32	20	15	3	17	53	85

Table 6. Native and non-native plant life forms occurring in the study streams in 2009 only, 2010 only, and in both 2009 and 2010. Hyphens indicate that a life form did not occur in a given stream in either year.

	Sycamore			Malibu			Zuma			Arroyo Sequit			Solstice		
	Only 2009	Only 2010	Both 09&10	Only 2009	Only 2010	Both 09&10	Only 2009	Only 2010	Both 09&10	Only 2009	Only 2010	Both 09&10	Only 2009	Only 2010	Both 09 & 10
Native															
Fern	1	2	3	0	0	1	1	2	0	1	1	2	1	1	0
Grass, sedge, rush : annual	-	-	-	-	-	-	0	0	5	-	-	-	-	-	-
Grass, sedge, rush : perennial	0	1	2	3	3	3	1	3	0	1	2	3	0	2	3
Forb : annual	1	2	1	1	2	2	1	2	0	3	0	2	13	0	5
Forb : perennial	5	3	8	2	3	6	1	6	8	9	2	12	12	2	14
Sub-shrub	0	0	2	0	2	0	1	0	2	2	1	1	0	1	0
Shrub	3	2	6	2	2	2	1	2	1	5	0	3	0	1	9
Tree	2	0	2	3	1	3	1	0	2	1	1	3	0	1	6
Non-native															
Fern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grass, sedge, rush : annual	0	1	0	0	1	2	3	2	1	0	2	0	0	1	3
Grass, sedge, rush : perennial	-	-	-	2	2	1	0	1	2	1	2	2	1	0	3
Forb : annual	0	2	0	0	4	7	1	4	2	2	2	4	12	2	6
Forb : perennial	3	0	1	0	2	3	0	5	5	4	1	4	2	0	5
Sub-shrub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shrub	-	-	-	0	0	1	0	1	0	1	1	0	0	1	0
Tree	-	-	-	-	-	-	-	-	-	0	1	0	-	-	-

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Appendix: List of plant species found in study streams

Species observed during surveys in 2009 and 2010. Streams are Sycamore (SY), Malibu (MA), Zuma (Zu), Arroyo Sequit (AS) and Solstice (SO). An asterisk (*) notes species that are invasive and observed or presumed to cause environmental harm to native plant populations and/or communities.

Native Species	Life-form	Perennity	2009					2010				
			SY	MA	ZU	AS	SO	SY	MA	ZU	AS	SO
<i>Adiantum capillus-veneris</i>	fern	perennial	x					x				
<i>Agrostis exarata</i>	grass	perennial		x	x							
<i>Alisma plantago-aquatica</i>	herb	perennial			x							
<i>Allophyllum glutinosum</i>	herb	annual					x					
<i>Alnus rhombifolia</i>	tree	perennial					x					x
<i>Ambrosia psilostachya</i>	herb	perennial		x	x	x	x		x	x	x	x
<i>Artemisia californica</i>	shrub	perennial	x			x	x				x	x
<i>Artemisia douglasiana</i>	herb	perennial		x	x	x	x	x	x	x	x	x
<i>Asclepias fascicularis</i>	herb	perennial				x						
<i>Baccharis pilularis</i>	shrub	perennial		x		x	x					x
<i>Baccharis plummerae</i>	shrub	perennial								x		
<i>Baccharis salicifolia</i>	shrub	perennial		x	x	x	x	x	x	x		x
<i>Berula erecta</i>	herb	perennial	x									
<i>Boykinia rotundifolia</i>	herb	perennial	x					x				
<i>Brickellia californica</i>	subshrub	perennial			x	x			x	x	x	x
<i>Bromus carinatus</i>	grass	perennial					x					x
<i>Calystegia macrostegia</i>	herb	perennial	x			x	x				x	
<i>Camissonia micrantha</i>	herb	annual					x					
<i>Carex senta</i>	sedge	perennial			x	x				x	x	
<i>Carex spissa</i>	sedge	perennial			x					x		
<i>Castilleja minor</i>	herb	annual					x					
<i>Ceanothus spinosus</i>	shrub	perennial			x							
<i>Chaenactis artemisiifolia</i>	herb	annual					x					
<i>Cirsium occidentale</i>	herb	annual		x			x					x
<i>Claytonia perfoliata</i>	herb	annual				x						
<i>Conyza canadensis</i>	herb	annual					x					
<i>Crytantha intermedia</i>	herb	annual					x					
<i>Cyperus eragrostis</i>	sedge	perennial	x	x	x			x	x	x	x	
<i>Datisca glomerata</i>	herb	perennial	x		x	x	x	x		x	x	x
<i>Digitaria saguinalis</i>	herb	perennial				x						
<i>Dryopteris arguta</i>	fern	perennial	x					x				
<i>Dudleya cymosa</i> ssp. <i>cymosa</i>	herb	perennial								x		
<i>Dudleya lanceolata</i>	herb	perennial	x									
<i>Eleocharis macrostachya</i>	rush	perennial								x		
<i>Eleocharis parishii</i>	rush	perennial		x					x			
<i>Elymus glaucus</i>	grass	perennial							x			
<i>Emmenanthe penduliflora</i>	herb	annual					x					
<i>Epilobium canum</i>	subshrub	perennial	x		x			x			x	
<i>Epilobium ciliatum</i>	herb	annual	x			x	x	x	x	x	x	x
<i>Epipactis gigantea</i>	herb	perennial			x	x				x	x	
<i>Equisetum hyemale</i> ssp. <i>affine</i>	fern	perennial				x				x	x	
<i>Equisetum laevigatum</i>	fern	perennial		x		x	x		x	x	x	
<i>Equisetum telmateia</i>	fern	perennial			x			x			x	x

List of plant species found in study streams, continued.

Native Species	Life-form	Perennity	2009					2010				
			SY	MA	ZU	AS	SO	SY	MA	ZU	AS	SO
Eriogonum cinereum	shrub	perennial	x				x	x				
Eriophyllum confertiflorum	herb	perennial					x					
Eschscholzia californica	herb	annual					x					
Eucrypta chrysanthemifolia	herb	perennial					x					
Euthamia occidentalis	herb	perennial		x	x	x	x		x	x	x	x
Fraxinus dipetala	tree	perennial							x			
Fraxinus velutina	tree	perennial		x					x			
Galium angustifolium	herb	perennial				x	x		x			
Galium aparine	herb	annual				x						
Gnaphalium bicolor	herb	perennial					x					
Gnaphalium californicum	herb	perennial				x	x					
Gnaphalium canescens	herb	perennial					x					
Gnaphalium stramineum	herb	annual			x							
Helenium puberulum	herb	annual		x					x			
Helianthus gracilentus	herb	perennial					x					x
Hemizonia fasciculata	herb	annual					x					
Heteromeles arbutifolia	shrub	perennial	x									
Hoita macrostachya	herb	perennial	x		x	x	x	x		x	x	x
Juglans californica	tree	perennial		x		x	x				x	x
Juncus macrophyllus	rush	perennial			x	x	x			x	x	x
Juncus xiphioides	rush	perennial	x		x	x	x	x		x	x	x
Keckiella cordifolia	shrub	perennial	x				x	x				
Lathyrus vestitus	herb	perennial	x			x	x	x				
Leptochloa uninervia	grass	perennial		x								
Lessingia filaginifolia	subshrub	perennial			x					x		
Leymus condensatus	grass	perennial				x						x
Lilium humboldtii	herb	perennial	x			x		x				
Lotus salsuginosus	herb	annual					x					x
Lotus scoparius	subshrub	perennial				x	x					
Lupinus latifolius	herb	perennial						x				
Lythrum californicum	herb	perennial				x					x	
Madia gracilis	herb	annual					x					
Malacothamnus fasciculatus	shrub	perennial					x					x
Malacothrix saxatilis	herb	perennial					x			x	x	x
Malosma laurina	shrub	perennial					x					
Melica imperfecta	grass	perennial						x				
Mimulus aurantiacus	shrub	perennial	x			x	x					x
Mimulus cardinalis	herb	perennial	x		x	x	x	x		x	x	x
Mimulus floribundus	herb	annual					x					
Mimulus guttatus	herb	annual				x	x	x		x	x	
Osmorhiza brachypoda	herb	perennial	x									
Paspalum distichum	grass	perennial							x	x		
Pellaea andromedifolia	fern	perennial						x				

List of plant species found in study streams, continued.

Native Species	Life-form	Perennity	2009					2010				
			SY	MA	ZU	AS	SO	SY	MA	ZU	AS	SO
<i>Phacelia cicutaria</i>	herb	annual				x	x					x
<i>Phacelia grandiflora</i>	herb	perennial					x					
<i>Phacelia ramosissima</i>	herb	perennial					x					
<i>Phacelia viscida</i>	herb	annual					x					x
<i>Pholistoma auritum</i>	herb	annual	x									
<i>Platanus racemosa</i>	tree	perennial	x	x	x	x	x	x	x	x	x	x
<i>Pluchea odorata</i>	herb	perennial		x								
<i>Polygala cornuta</i> var. <i>fishiae</i>	subshrub	perennial							x			
<i>Polygonum amphibium</i>	herb	perennial								x		
<i>Polypodium californicum</i>	fern	perennial	x									
<i>Polypogon interruptus</i>	grass	perennial								x	x	x
<i>Populus balsamifera</i>	tree	perennial		x			x		x			x
<i>Potentilla glandulosa</i>	herb	perennial										x
<i>Pteridium aquilinum</i>	fern	perennial				x						
<i>Quercus agrifolia</i>	tree	perennial	x				x				x	
<i>Rafinesquia californica</i>	herb	perennial				x						
<i>Rhamnus californica</i>	shrub	perennial										x
<i>Rhamnus ilicifolia</i>	shrub	perennial	x									
<i>Ribes speciosum</i>	shrub	perennial	x					x				
<i>Rorippa nasturtium-aquaticum</i>	herb	perennial				x	x		x		x	x
<i>Rosa californica</i>	shrub	perennial		x		x		x	x			
<i>Rubus ursinus</i>	shrub	perennial	x	x		x	x	x			x	x
<i>Rumex salicifolius</i>	herb	perennial					x	x				x
<i>Salix exigua</i>	shrub	perennial							x			
<i>Salix laevigata</i>	tree	perennial		x	x	x						x
<i>Salix lasiolepis</i>	tree	perennial	x	x	x	x	x	x	x	x	x	x
<i>Salvia mellifera</i>	shrub	perennial					x					x
<i>Sambucus mexicana</i>	tree	perennial					x					x
<i>Scirpus acutus</i>	sedge	perennial							x			
<i>Scirpus californicus</i>	sedge	perennial		x								
<i>Scirpus maritimus</i>	sedge	perennial		x					x			
<i>Scrophularia californica</i>	herb	perennial	x				x	x				
<i>Solanum douglasii</i>	herb	perennial				x	x					x
<i>Solanum xanti</i>	herb	perennial					x					x
<i>Solidago californica</i>	herb	perennial				x						
<i>Stachys albens</i>	herb	perennial				x	x	x	x	x	x	x
<i>Stachys bullata</i>	herb	annual					x	x				
<i>Symphoricarpos mollis</i>	subshrub	perennial	x			x		x				
<i>Symphyotrichum subulatum</i>	herb	perennial		x								
<i>Thalictrum polycarpum</i>	herb	perennial	x				x					
<i>Toxicodendron diversilobum</i>	shrub	perennial	x			x		x	x	x	x	x
<i>Typha domingensis</i>	herb	perennial		x	x		x		x	x	x	x
<i>Typha latifolia</i>	herb	perennial								x		

List of plant species found in study streams, continued.

Native Species	Life-form	Perennity	2009					2010				
			SY	MA	ZU	AS	SO	SY	MA	ZU	AS	SO
Umbellularia californica	tree	perennial	x									
Urtica dioica	herb	perennial		x					x			
Venegasia carpesioides	shrub	perennial	x			x	x	x				x
Verbena lasiostachys	herb	perennial		x		x			x		x	
Vitis girdiana	herb	perennial								x		
Woodwardia fimbriata	fern	perennial	x					x				
Xanthium strumarium	herb	annual		x					x			

Non-native Species	Life-form	Ann/Per	2009					2010				
			SY	MA	ZU	AS	SO	SY	MA	ZU	AS	SO
Amaranthus albus	herb	annual					x					
Anagallis arvensis	herb	annual				x	x					x
Apium graveolens	herb	annual		x					x			
Arundo donax *	grass	perennial				x						
Bidens pilosa	herb	annual					x					
Brachypodium distachyon	grass	annual								x		
Carduus pycnocephalus *	herb	annual		x		x	x	x	x	x	x	x
Centaurea melitensis *	herb	annual					x					
Chenopodium album	herb	annual			x		x					
Chenopodium murale	herb	annual										x
Conium maculatum *	herb	annual		x			x		x	x		x
Cynodon dactylon	grass	perennial			x				x			
Cyperus involucratus *	sedge	perennial			x	x	x				x	x
Delairea odorata *	herb	perennial				x						
Ehrharta erecta	grass	perennial		x	x		x					x
Euphorbia peplus	herb	annual					x					
Euphorbia terracina	herb	perennial					x		x	x		x
Festuca arundinacea	grass	perennial		x	x					x	x	
Foeniculum vulgare *	herb	perennial			x	x	x		x	x	x	x
Genista monspessulana *	shrub	perennial								x		
Hirschfeldia incana	herb	annual				x	x		x		x	x
Lactuca serriola	herb	annual					x		x			
Lepidium latifolium *	herb	perennial		x					x			
Marrubium vulgare	herb	perennial					x					
Medicago polymorpha	herb	perennial	x									
Melilotus alba	herb	annual		x	x	x		x	x	x	x	
Melilotus indica	herb	annual					x		x	x	x	x
Mentha piperita	herb	perennial			x	x				x	x	
Phalaris aquatica *	grass	perennial								x	x	
Picris echioides	herb	annual					x					
Piptatherum miliaceum	grass	perennial	x	x	x	x	x	x	x	x	x	x
Pittosporum sp.	tree	perennial									x	

List of plant species found in study streams, continued.

Non-native Species	Life-form	Ann/Per	2009					2010				
			SY	MA	ZU	AS	SO	SY	MA	ZU	AS	SO
<i>Plantago lanceolata</i>	herb	perennial			x		x			x		x
<i>Plantago major</i>	herb	perennial		x	x	x	x		x	x		x
<i>Poaceae</i> (undifferentiated)	grass	annual		x			x		x	x	x	x
<i>Polypogon monspeliensis</i>	grass	annual		x	x		x		x	x		x
<i>Polypogon viridis</i>	grass	annual					x	x	x		x	x
<i>Ricinus communis</i> *	shrub	perennial				x						x
<i>Rumex conglomeratus</i>	herb	perennial	x	x		x	x		x	x	x	x
<i>Rumex crispus</i>	herb	perennial									x	
<i>Rumex stenophyllus</i>	herb	perennial								x		
<i>Silene gallica</i>	herb	annual					x			x		
<i>Silybum marianum</i> *	herb	annual					x					
<i>Sisymbrium irio</i>	herb	annual										x
<i>Sisymbrium orientale</i>	herb	annual					x					
<i>Sonchus</i> spp.	herb	annual		x	x	x	x		x	x	x	x
<i>Spartium junceum</i> *	shrub	perennial		x					x	x	x	
<i>Stellaria media</i>	herb	annual				x	x					
<i>Stenotaphrum secundatum</i>	grass	perennial					x					
<i>Taraxacum officinale</i>	herb	perennial					x			x		
<i>Torilis arvensis</i>	herb	annual		x			x		x		x	
<i>Tropaeolum majus</i> *	herb	perennial				x						
<i>Urtica urens</i>	herb	annual		x					x			
<i>Veronica anagallis-aquatica</i>	herb	perennial	x		x	x				x	x	
<i>Vicia villosa</i>	herb	annual							x			
<i>Vinca major</i> *	herb	perennial				x						

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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