Substrate Enhancements and Botanical Diversity for Successful Oak Habitat Creation

Richard B. Lewis III, ENV SP
Senior Restoration Ecologist, Psomas

Public Works
LOS ANGELES COUNTY

PSOMAS

This is a PDF-version of the slide show that accompanied Psomas' oral presentation at the Southern California Academy of Sciences' Annual Meeting in the City of Orange, California, on May 4, 2024. The narration from that presentation has been added via text boxes to this PDF version.

Los Angeles County Public Works operates Santa Anita Dam and Reservoir in the San Gabriel Mountains.

Sediment Removal:

- Stormwater capacity
- Public safety / Water supply

Sediment is periodically removed for stormwater capacity, public safety, and to benefit water supply.

PSOMAS


Angeles National Forest
Middle SPS
Lower SPS
The sediment was moved to two sediment placement sites (or SPS) located downstream of the dam.
San Gabriel Valley
Santa Anita Park
210
N Santa Anita Ave
Huntington Dr
S 2nd
PSOMAS

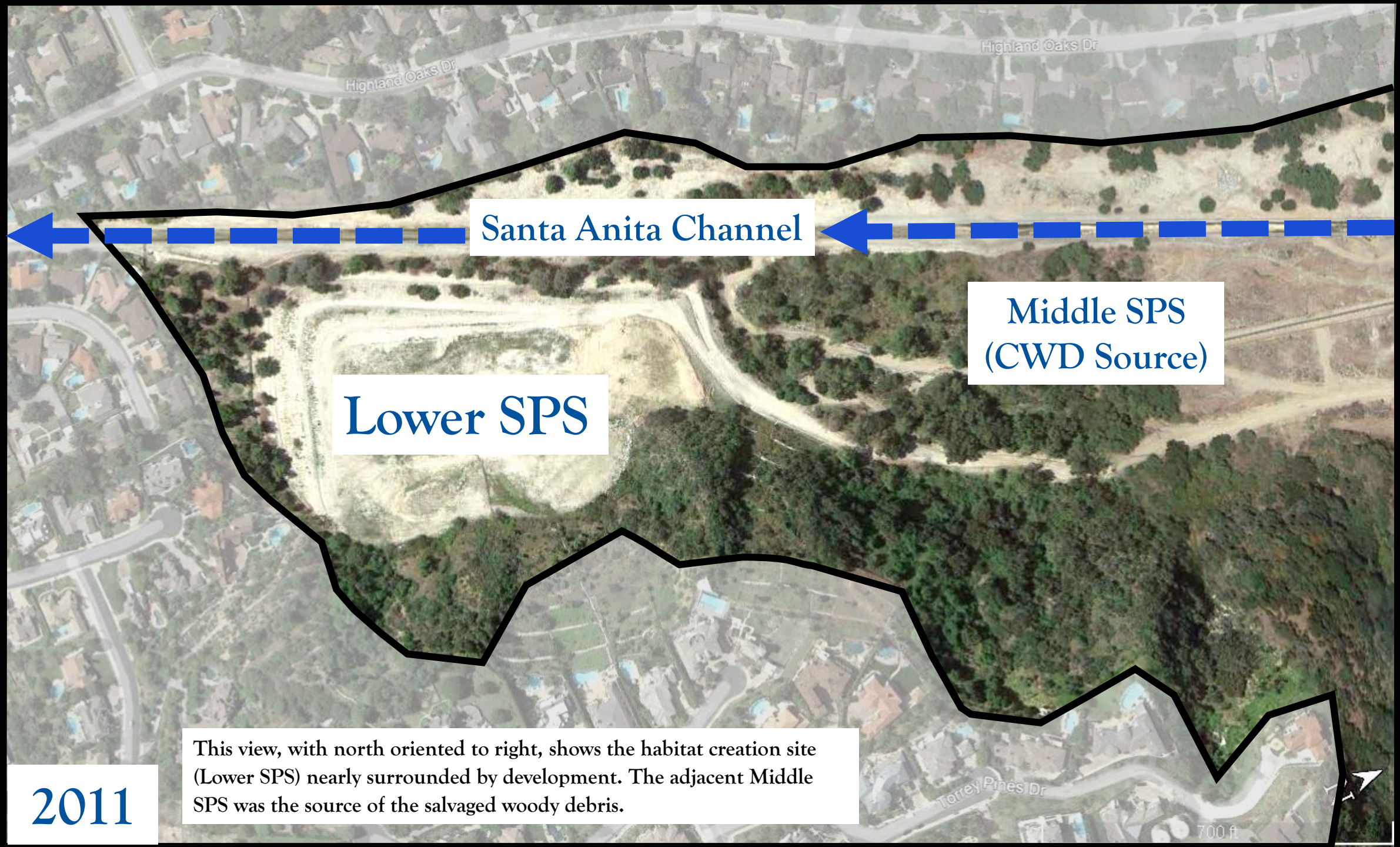
The Lower SPS is the habitat creation site. It is located at the tip of a wedge of open space that extends into the urban grid. This is relevant for my later comments on plant pathogens.

Middle SPS

2009

The adjacent Middle SPS was the vegetation impact site. Note the understory vegetation is badly degraded by invasive herbs, similar to other regional woodlands. Public Works retained Psomas in 2009 to prepare the habitat mitigation plan.

PSOMAS



This view, with north oriented to right, shows the habitat creation site (Lower SPS) nearly surrounded by development. The adjacent Middle SPS was the source of the salvaged woody debris.

2011

2009

Here's the Lower SPS prior to the placement of the final 30 feet of sediment. Public Works engaged in community outreach leading up to the project. The California Department of Fish and Wildlife (CDFW) had three primary concerns about suitability and function: Soil compaction, hydrology, and bio-diversity.

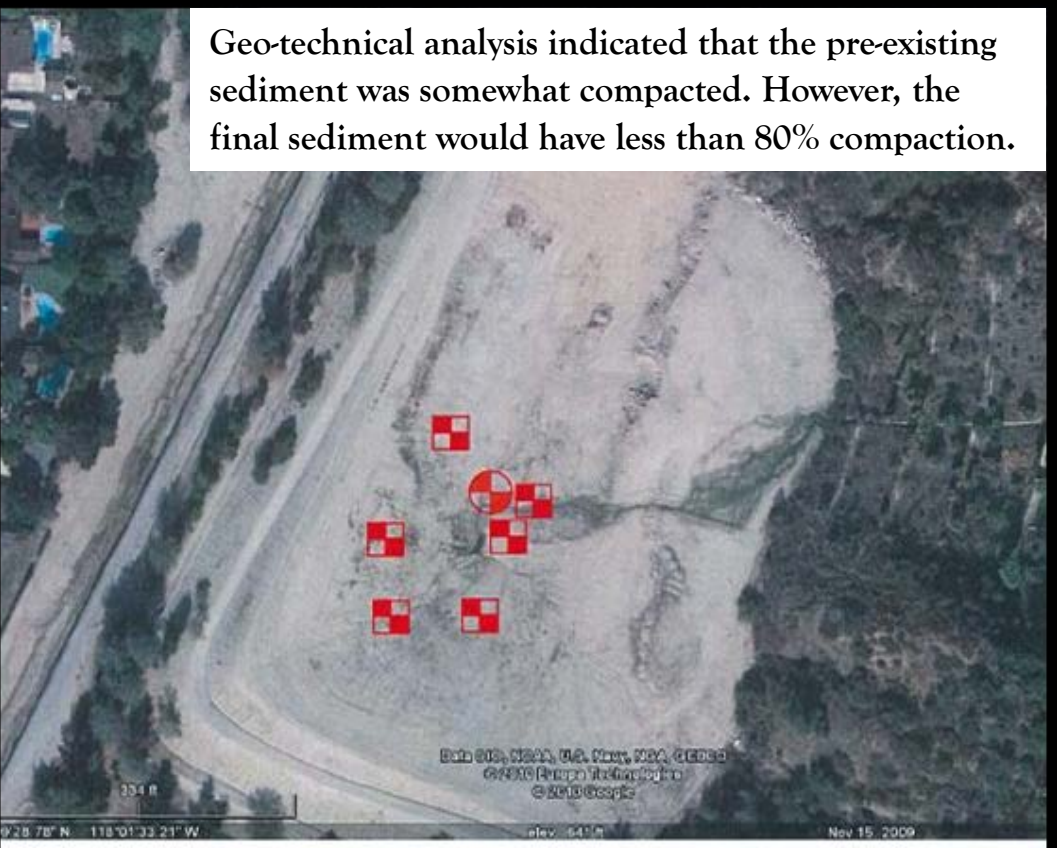
- Lower SPS prior to final 30' sediment placement
- Public Works' performs community outreach to constituents
- CDFW: Soil compaction / hydrology / bio-diversity

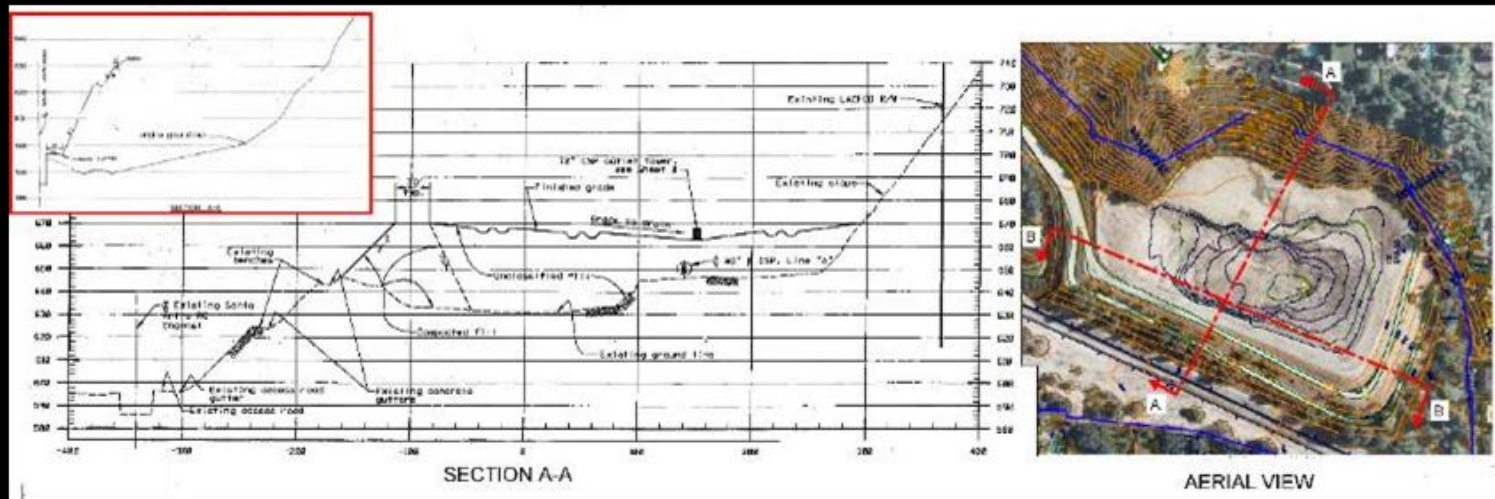
PSOMAS

Sediment Placement/Analysis

- Pre-Existing 78% to 90% Compaction Gradient (0 to 53')
- 30' of New Sediment to Complete Lower SPS
- New Sediment Compaction < 80% (Deck)
- Slope Compaction at Least 80% for Stability

Geo-technical analysis indicated that the pre-existing sediment was somewhat compacted. However, the final sediment would have less than 80% compaction.





Nakae & Associates, Inc.
11159 Jeffrey Rd.

Irvine CA 92602

Soil & Plant Laboratory, Inc.
Leaders in Soil & Plant Testing Since 1946
4741 E. Hunter Ave, Suite A Anaheim, CA 92807 714-282-8777 (phone) 714-282-8575 (fax)
www.soilandplantlaboratory.com

Project : Arcadia

Report No : **13-275-0012**
Purchase Order : L307010
Date Recd : 10/02/2013
Date Printed : 10/07/2013
Page : 1 of 1

COMPREHENSIVE SOIL ANALYSIS

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
West Slope CSS	13	5.8	1.7	2	9	8	104	914	198	3.5	1.2	6	104	1.0	11989
	61	None		0.4		0.5	1.6	1.1	1.7	5.4	0.5	1.1	4.2		
10:1 CSS Slope	15	5.1	2.1	9	11	0	100	966	181	4.9	3.4	6	194	1.6	11990
	59	None		0.7		0	1.5	1.1	1.5	7.4	1.3	1.1	7.8		
South Channel	15	5.8	1.5	5	12	1	111	1077	169	4.9	1.2	7	243	1.8	11991
	66	None		0.6		0.1	1.4	1.1	1.3	6.6	0.4	1.2	8.7		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
12.1	5.4	2.9	0.5	0.26	20.4	1.0	12.2	20.1	16.5	19.0	48.4	10.6	5.3	Gravelly Loamy Sand	11989
16.9	6.7	1.5	0.5	0.44	27.0	0.4	7.4	20.3	13.9	16.8	49.2	15.6	4.3	Gravelly Loamy Sand	11990
12.0	4.3	1.4	0.4	0.47	18.2	0.5	5.6	13.7	14.6	13.9	51.4	15.6	4.3	Gravelly Loamy Sand	11991

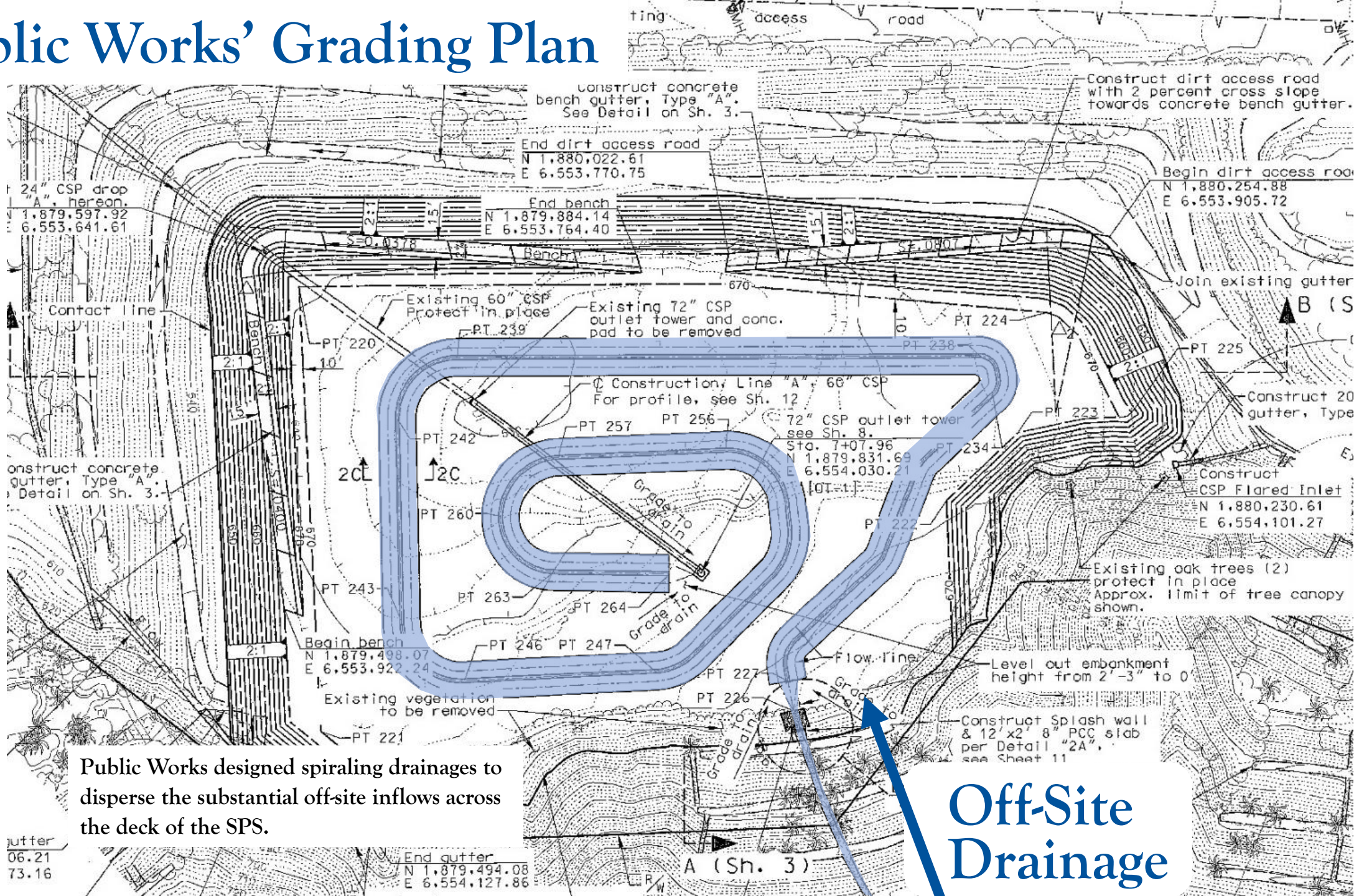
We did soil testing of the final sediment material and did not identify any serious fertility issues.

- Upper SPS: Coast live oaks and coastal sage scrub
- Non-irrigated / south- and west-facing slopes

We had observed several large coast live oaks (*Quercus agrifolia* var. *agrifolia*) and sage scrub on the nearby Upper SPS in good condition, growing in placed material from the same source (Santa Anita Reservoir).

PSOMAS

Public Works' Grading Plan



Public Works designed spiraling drainages to disperse the substantial off-site inflows across the deck of the SPS.

Off-Site Drainage

This resulted in 1,800 linear feet of drainage versus 200 linear feet if flows had been conveyed directly to the outlet tower.

PSOMAS

Hydrology ✓

2013

Early flows into the drainages suggested we've optimized hydrology.

EIR MM's / CDFW Permit / Habitat Mitigation Plan:

- 7 to 10-year maint./monit.
- Non-irrigated for 2 years
- Oaks
  - 363 Plantings
  - 80% Survival (≥ 290 oaks)
  - ≥ 2% Canopy cover
  - Certified Arborist evaluations (≥ 1x/yr)
- Botanical Diversity
  - Oak woodland: ≥ 24 spp.
  - Coastal sage scrub: ≥ 18 spp.
- Vegetation cover: by type

Brief summary of performance standards from the permits and HMP: Note the 80% survival requirement for planted oaks, and 2% minimum oak (tree spp.) canopy cover. Vegetation cover has targets by type.

PSOMAS

Oak Woodland Native Veg Cover Standards:

- Native (All): ≥ 75%
- Large shrubs: ≥ 5%
- Medium shrubs: ≥ 18%
- Spiniferous shrubs: ≥ 2%
- Sub-shrubs: ≥ 5%
- Herbaceous: ≥ 30%
- Non-Native: ≤ 5%

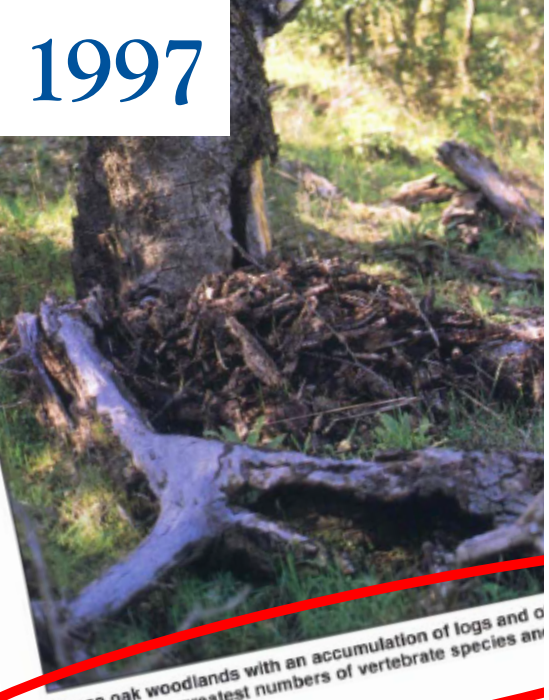
Here are the other targets, with minimum 30% cover of native herbs.

PSOMAS

2012

Here's the Lower SPS in 2012—basically a moonscape. We needed a creative and assertive, science-based approach.

1997



Dense oak woodlands with an accumulation of logs and o
supported the greatest numbers of vertebrate species an
individuals.

Vertebrates divers
well-structured oa

William D. Tietje ❑ Justin K. Vreeland

2002

Coarse Woody Debris in Oak Woodlands of California

I was glad to read multiple papers by Dr. Bill Tietje and others on the importance, and widespread deficiency, of coarse woody debris in California's oak woodlands.

William D. Tietje, *Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720;* **Karen L. Waddell**, *USDA Forest Service, Pacific Northwest Research Station, Forest Sciences Laboratory, 620 SW Main, Suite 400, Portland, OR 97205;* **Justin K. Vreeland**, *U.C. Cooperative Extension, 2156 Sierra Way, Suite C, San Luis Obi[illegible] and* **Charles L. Bolsinger** *(retired), USD[illegible] Station, Forest Sci[illegible]*

ABSTRACT:
woody debris (C[illegible]
reserved areas.
incapable of proc[illegible]
morphophysiolog[illegible]
3 million ac of woo[illegible]
of CWD was <12 in[illegible]

Chapter 3

2005

Oak Woodlands as Wildlife Habitat

William Tietje, Kathryn Purcell, and Sabrina Drill

[illegible] provides local planners and policymakers with information on the [illegible] woodland wildlife, wildlife habitat needs, and how [illegible] abundance and diversity. Federal [illegible] Species Act and

The statement below was especially interesting, plus the correlations between downed wood and wildlife.

1997

Dense oak woodlands with an accumulation of logs and o supported the greatest numbers of vertebrate species an individuals.

Vertebrates divers
well-structured oa

William D. Tietje Justin K. Vreeland

2002

Coarse Woody Debris in Oak Woodlands of California

William D. Tietje, *Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720;* Karen L. Waddell, *USDA Forest Service, Pacific Northwest Research Station, Forest Sciences Laboratory, 620 SW Main, Suite 400, Portland, OR 97205;* Justin K. Vreeland, *U C Extension, 2156 Sierra Way, Suite C, San Luis Obi*
Charles L. Bolsinger *(retired), USD Station, Forest Sci*

ABSTRACT:
woody debris (C reserved areas. incapable of proc morphophysiolog 3 million ac of woo of CWD was <12 in

2005

Chapter 3

Oak Woodlands as Wildlife Habitat

William Tietje, Kathryn Purcell, and Sabrina Drill

provides local planners and policymakers with information on the woodland wildlife, wildlife habitat needs, and how dance and diversity. Federal Species Act and

"...Downed wood is mostly lacking over at least half of the oak woodlands in California (Tietje et al. 2002)...Downed wood serves as a source of nutrients that can be released slowly back to the woodland during decomposition.

It may also aid oak regeneration by providing physical protection for an emerging or growing sapling or seedling..."

We needed some building blocks.

2011

During the habitat impact phase, Psomas worked with Public Works and their contractor to salvage a huge volume of removed debris—trunks, stumps, brush piles, including trunks with root masses attached to install as natural snags.

Many tons of boulders were salvaged from the reservoir during sediment removal.

2012

2013

Here's some stockpiled natural materials. Whatever trunks/stems were not retained whole, were mulched for use in conditioning the placed sediment. We essentially used 'the whole animal' in terms of woody vegetation from the adjacent Middle SPS.

PSOMAS

Preliminary / Ongoing Weed Control:

- Avoid Seed Dispersal
- Avoid Adverse Impacts
- Voluntary Buffer Areas (8 Acres)

2013

Assertive weed control was performed at all phases of this project.

PSOMAS

Nakae & Associates, Inc., Restoration Contractor (Psomas' Subcontractor)

Psomas' subcontractor Nakae & Associates is starting to place the huge volume of salvaged mulch on the deck area.

2013

2013

- Large volume of salvaged mulch ripped to minimum 2-feet depth
- Urea added for nitrogen balance

The mulch was ripped to a minimum depth of 2 feet using a dozer, and urea was added for nitrogen balance.

PSOMAS

Compaction ✓

2013

Here, we think we've addressed CDFW's concerns about soil compaction.

2013

In terms of diversifying the substrate, here are massive boulders being imported and placed.

Psomas' Ecologists worked with Nakae to create naturalistic assemblages of material.

2013

Psomas' Ecologists worked with Nakae to create naturalistic assemblages of material.

2013

Psomas' Ecologists worked with Nakae to create naturalistic assemblages of material.

2013

2013

We also pushed dirt around to create microtopography—pits and hummocks all over the place.

2013

A total of 14 natural snags were erected, and you can see the scale of these. Within minutes these features were being used by raptors and songbirds.

2013

A total of 14 natural snags were erected, and you can see the scale of these. Within minutes these features were being used by raptors and songbirds.

2013

Many kinds of equipment were used for the CWD placement including these grapple attachments.

2013

Many kinds of equipment were used for the CWD placement including these grapple attachments.

2013

None of these assemblages appear on a map or plan. It was all placed intuitively, drawing on our team's collective hundreds of years in local wildlands, toward re-creating a natural landscape.

2013

Here are some of the boulders and scatters of woody debris.

PSOMAS






2013

I encouraged our team to 'get creative', and here are some of their works of art in the medium of wood and stone.

PSOMAS

This is the resulting landscape with the substrate assertively enhanced. Imagine the attraction for wildlife already, prior to any planting or seeding.

2013

Wildlife did want an invitation, but we weren't quite ready.

An eight-foot perimeter fence was installed (shown here mid-construction) to temporarily exclude large mammals—especially mule deer (*Odocoileus hemionus*)—to avoid excessive herbivory or trampling of the establishing vegetation, oak seedlings, etc.

2013

Because we temporarily fenced-off some water resources, we installed some temporary ‘drinker tanks’ for wildlife, and these have been heavily used.

Oak Collection:

- 50+ source trees
- Coast live oak
- Engelmann oak
- Canyon live oak
- San Gabriel oak

Quercus engelmannii

Q. agrifolia var. *agrifolia*

Acorns were collected from at least 50 source trees to capture adequate genetic diversity of local stands.

PSOMAS

Native Seed/Cuttings Collection:

- Started 2011 – S&S Seeds, Inc. / Psomas
- Subwatershed only
- Cities of Arcadia, Monrovia, Sierra Madre
- 2,000+ Ac. of open space
- Seeding performed every year
- 147 native spp. collected

Penstemon spectabilis

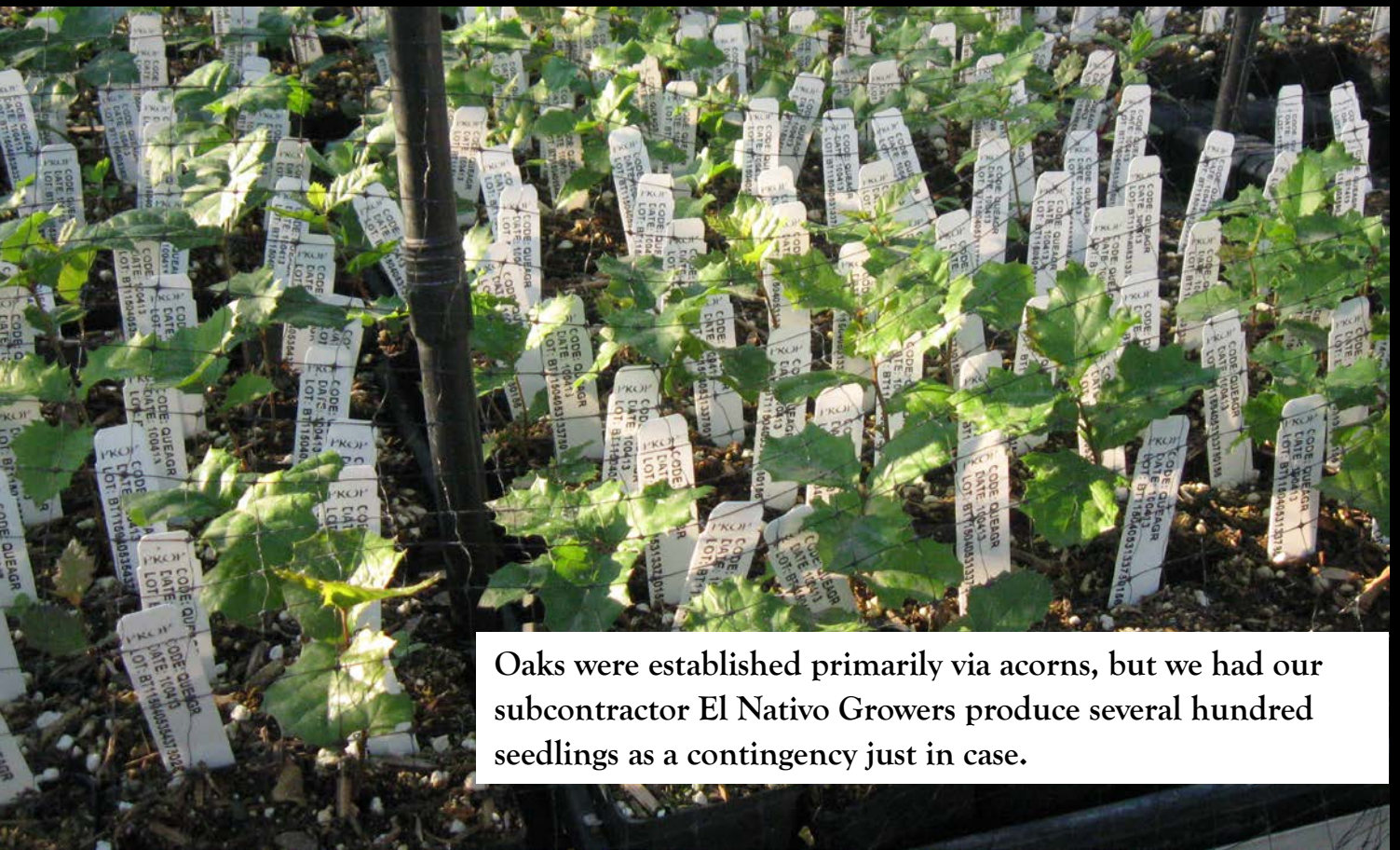
Clematis lasiantha

Overall seed collection started in 2011, two years before habitat installation. Public Works arranged access with local cities for collection in adjacent habitats. 147 seed species were collected to-date.

PSOMAS

Oaks:

- Established primarily via acorns
- 400 *contingency* oaks propagated
- Rare oaks



Oaks were established primarily via acorns, but we had our subcontractor El Nativo Growers produce several hundred seedlings as a contingency just in case.

PSOMAS

Container Plants:

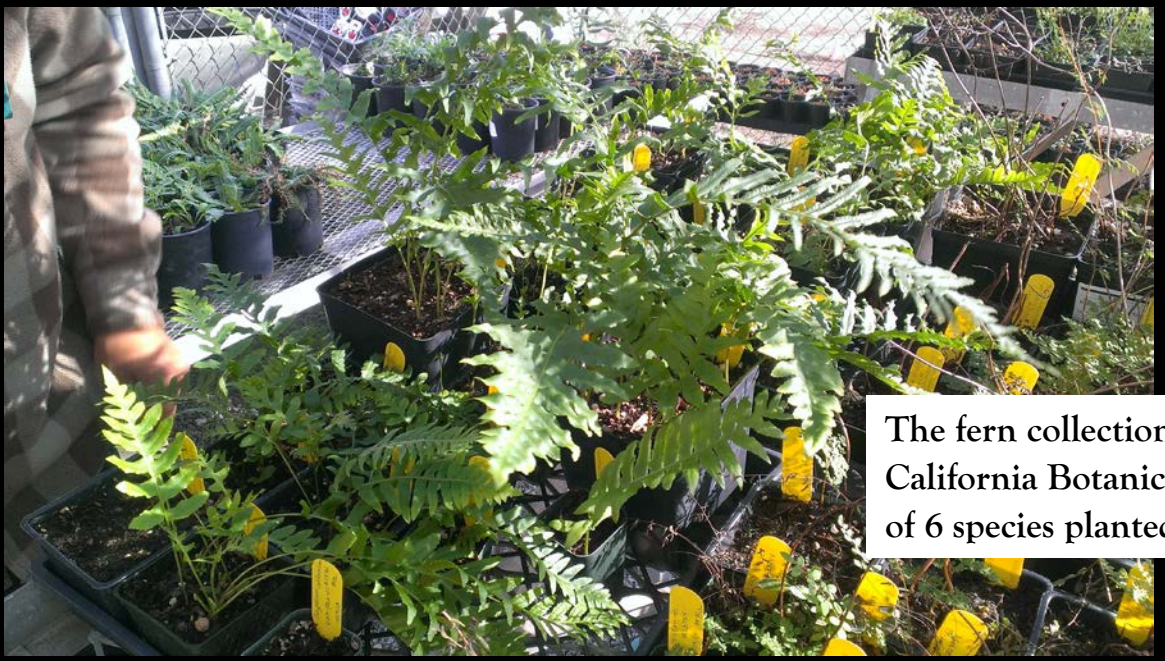
- January 2014 and December 2014 (Initial)
- Supplemental through Fall 2021
- El Nativo Growers (6,775 total plants)
- California Botanic Garden
  - Rare oaks, ferns, rushes, etc.
- 50 container species propagated

50 species of container plants were installed to-date. Our subcontractor California Botanic Garden focused their efforts primarily on rare oaks, ferns, rushes, and other specialty lots.

PSOMAS

Ferns:

- Innovative methodology
- California Botanic Garden
- 6 species propagated
- 600 planted since 2014



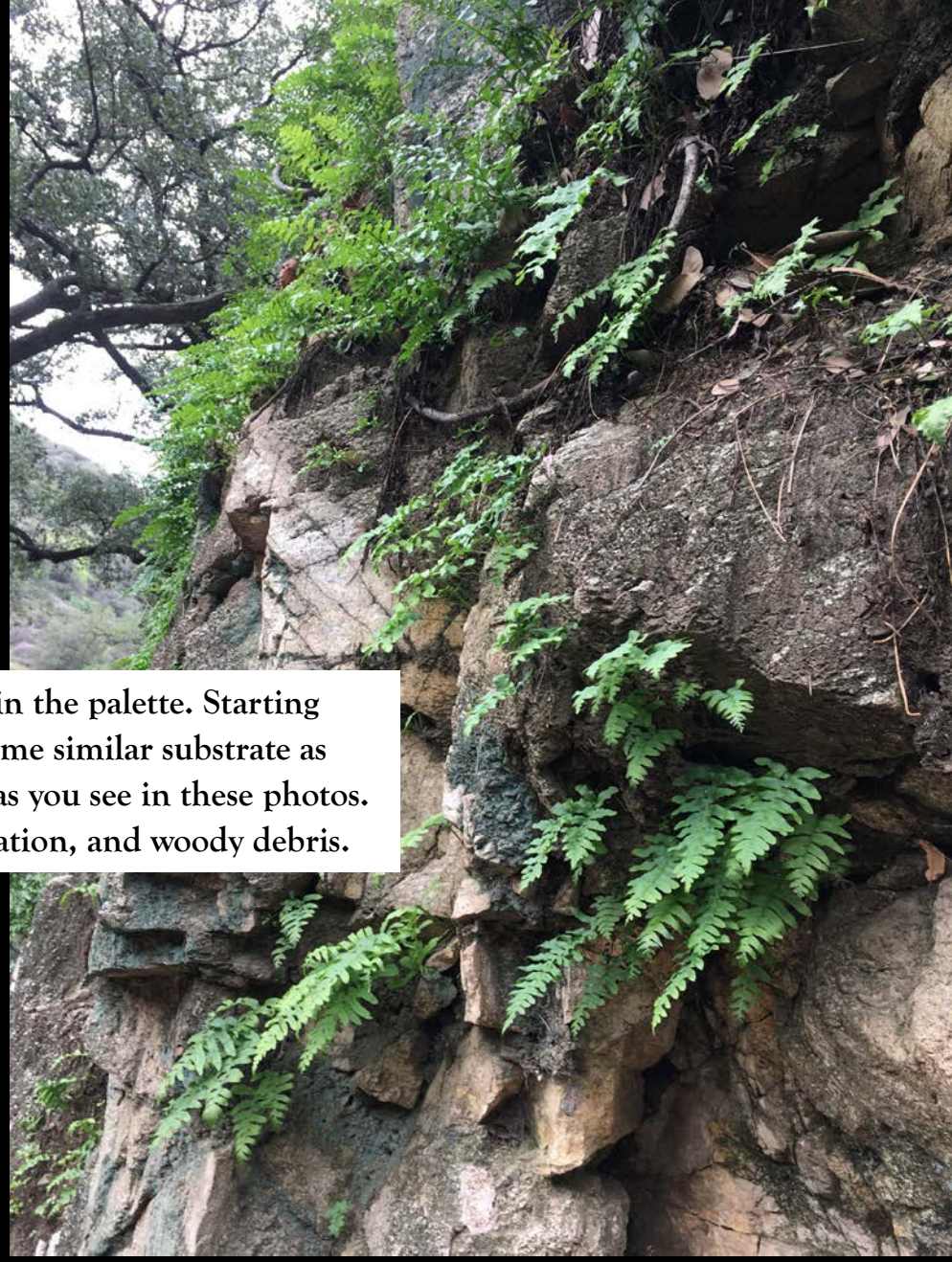
Polypodium californicum

Pellaea mucronata

Dryopteris arguta

The fern collection/propagation methodology we developed with California Botanic Garden was very successful, with over 600 ferns of 6 species planted on the Lower SPS.

PSOMAS

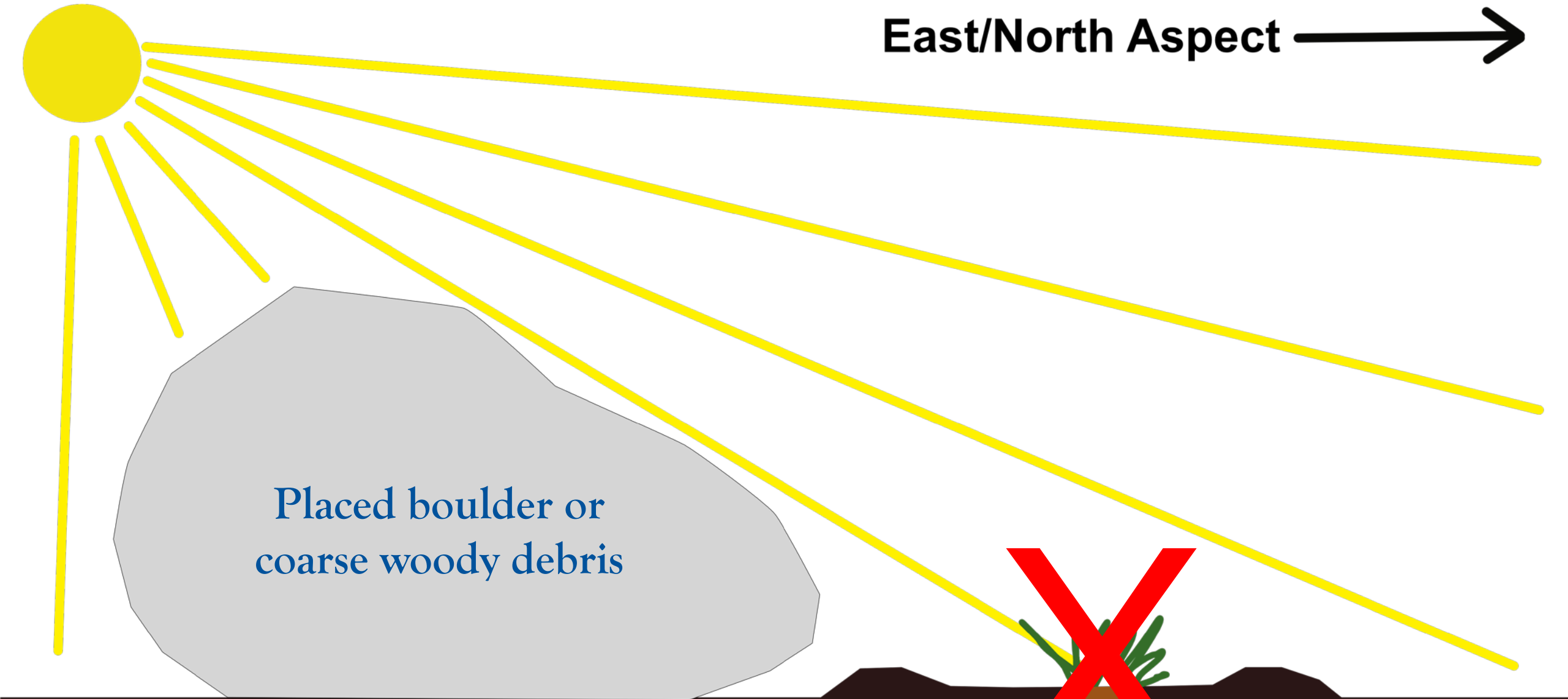


CDFW requested that ferns be included in the palette. Starting with a moonscape, we knew we'd need some similar substrate as ferns occurring in local canyon habitats, as you see in these photos. Note the rock outcrops, topographic variation, and woody debris.

PSOMAS

CDFW requested that ferns be included in the palette. Starting with a moonscape, we knew we'd need some similar substrate as ferns occurring in local canyon habitats, as you see in these photos. Note the rock outcrops, topographic variation, and woody debris.

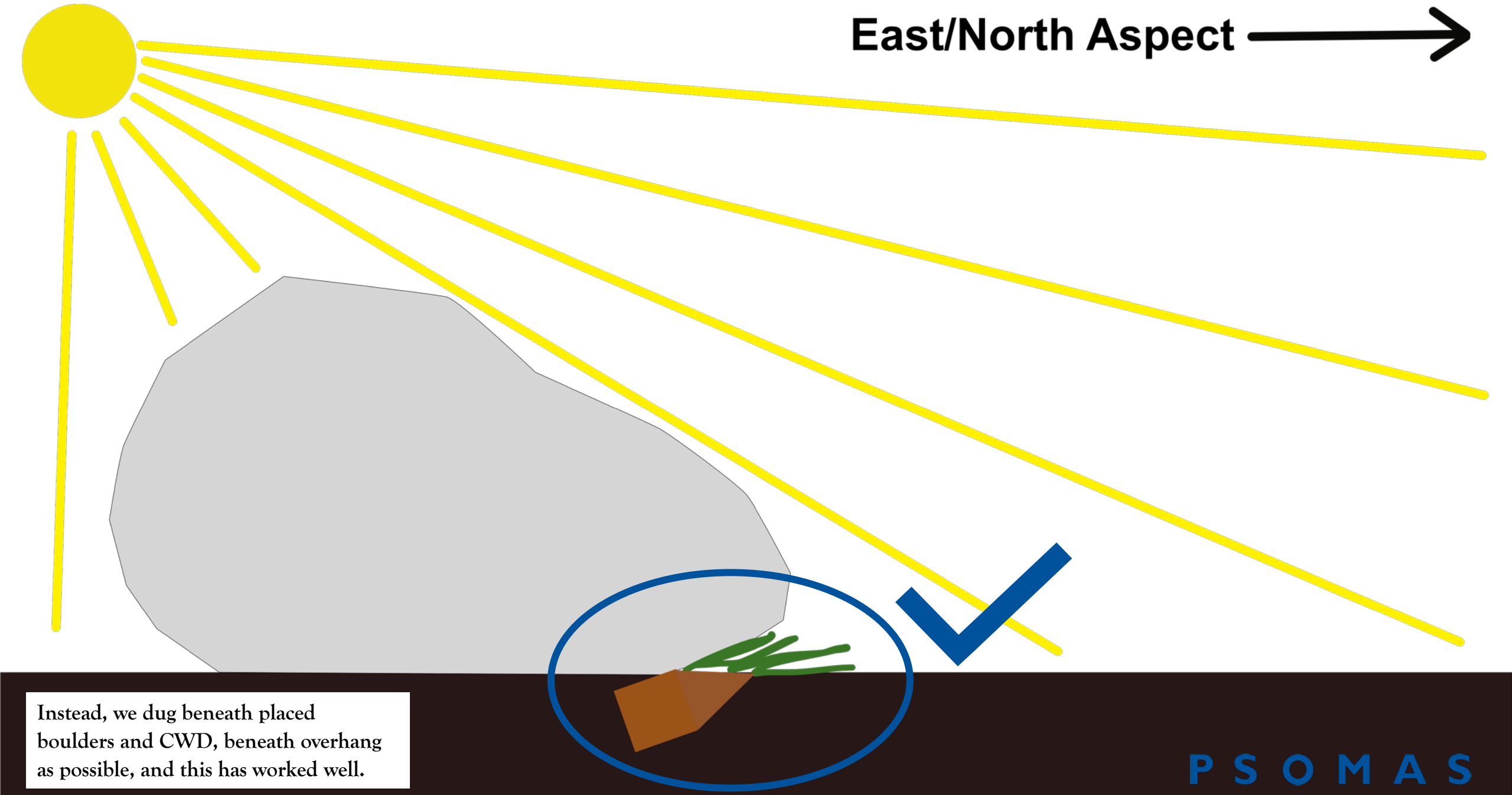
PSOMAS



Fern Planting

We did not plant our ferns with a fully concentric basin—too much exposure to sun and wind.

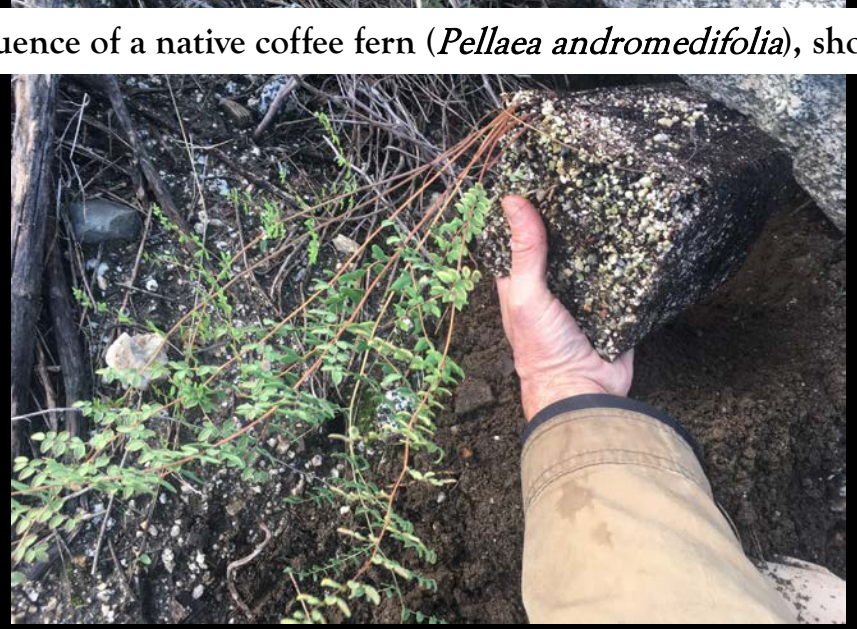
PSOMAS



Instead, we dug beneath placed boulders and CWD, beneath overhang as possible, and this has worked well.

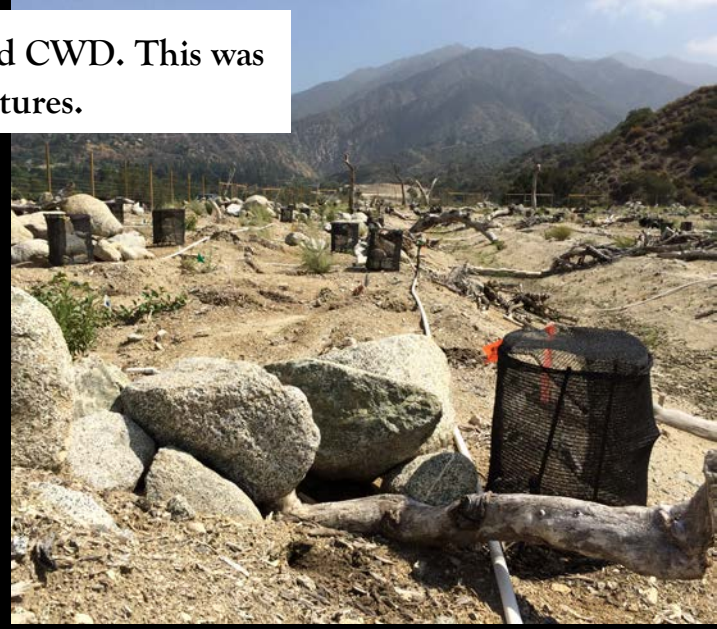
PSOMAS

Here's a planting sequence of a native coffee fern (*Pellaea andromedifolia*), showing this method.



PSOMAS

A Dingo™ was used to auger the oak planting holes. The seedlings were caged and mostly positioned adjacent to rock and CWD. This was to provide protection from sun and wind, and so the oaks roots could benefit from cooler and moist soils under these features.



Initial Planting / Seeding

PSOMAS

Oak Protection

Here are more of the oak cages, including a more robust type that was used on the surrounding slopes, outside the 8-foot fence. We experimented with planting a single California sagebrush (*Artemisia californica*) plant on the southwest exposure of some oak plantings to serve as a kind of nurse plant. A combination of interpretive signs, and warning signs (shown here), were installed to deter trespassing.

PSOMAS

Some interim conditions, showing the rapid growth of native vegetation amongst the stone and downed wood. As I mentioned, wildlife immediately colonized the site, such as this California ground squirrel (*Otospermophilus beecheyi*) and cedar waxwing (*Bombycilla cedrorum*).

PSOMAS

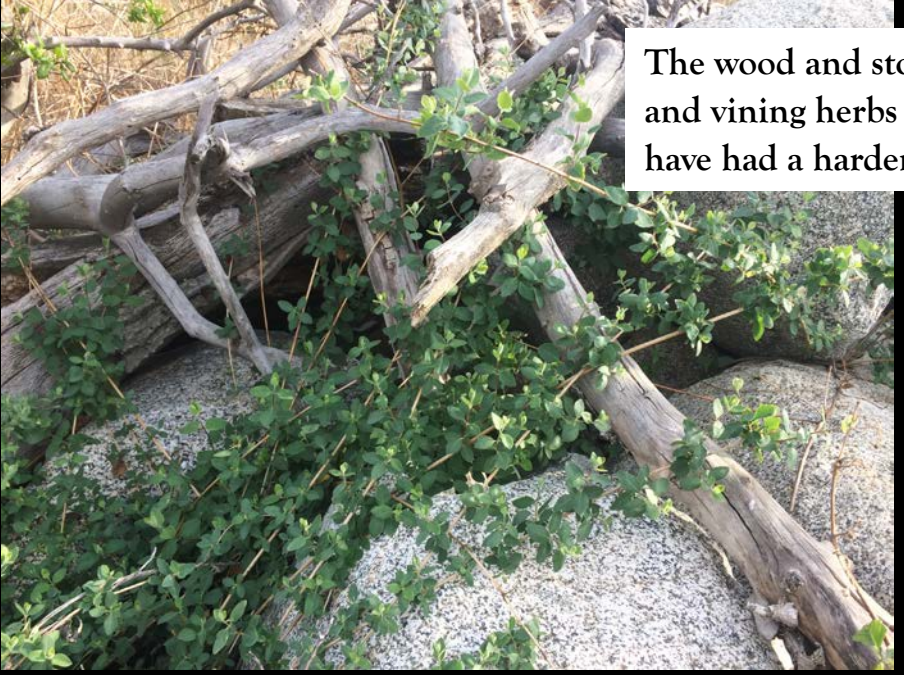





More of the interim conditions. Some oak saplings to the lower right, and some temporary ponding in the drainages (top right).

PSOMAS

The wood and stone also support vines and vining herbs and shrubs that would have had a harder time otherwise.



Lonicera subspicata

Rubus ursinus

Calystegia macrostegia

Phacelia ramosissima

Keckiella cordifolia

PSOMAS

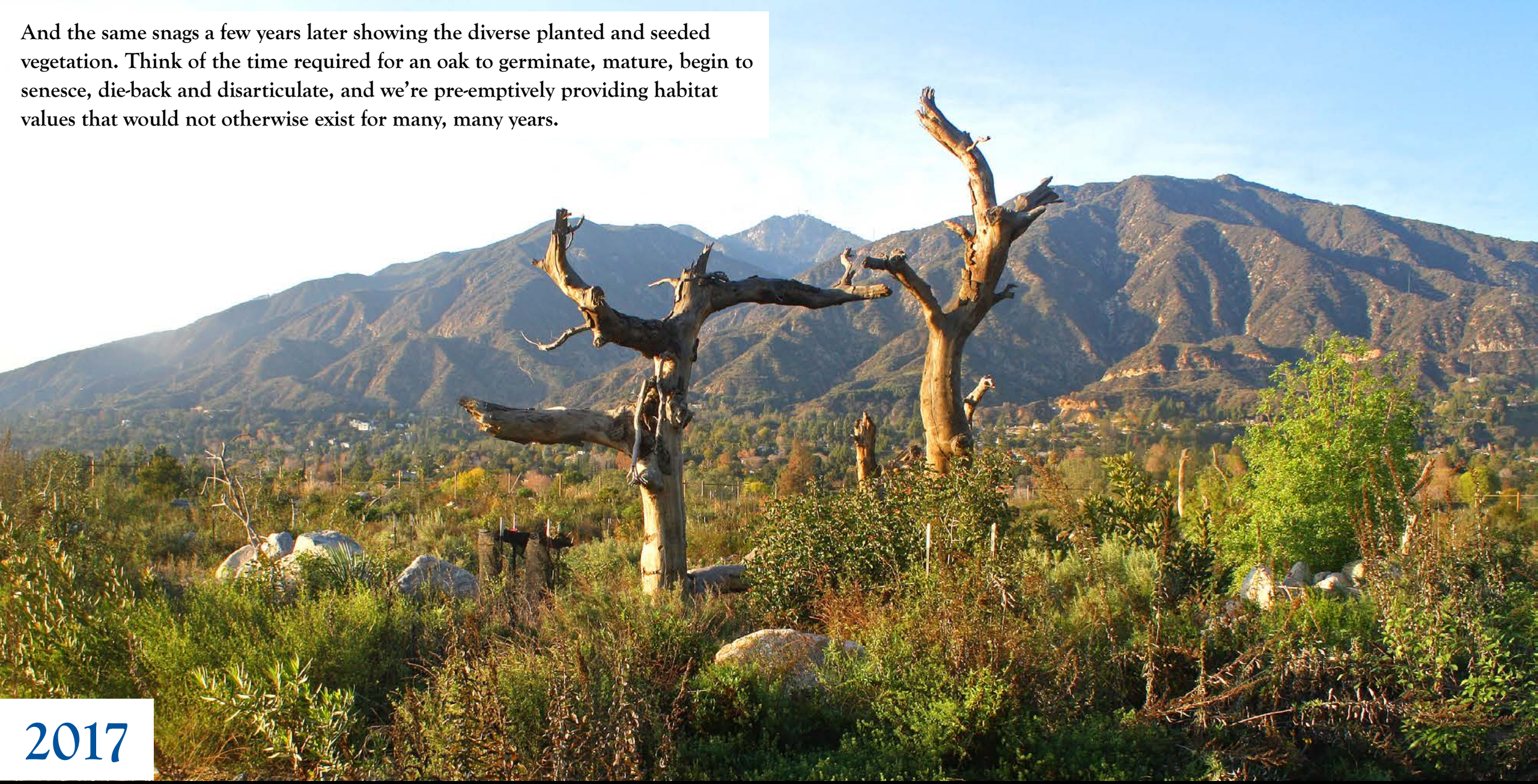
A native meadow habitat where woody shrubs were deliberately excluded to yield more of a mosaic cover. A broad swath of native four-spot (*Clarkia purpurea* ssp. *quadrivulnera*) and other wildflowers. As you likely know, this is very difficult to achieve due to intense competition with invasive herbs.

2016

2014

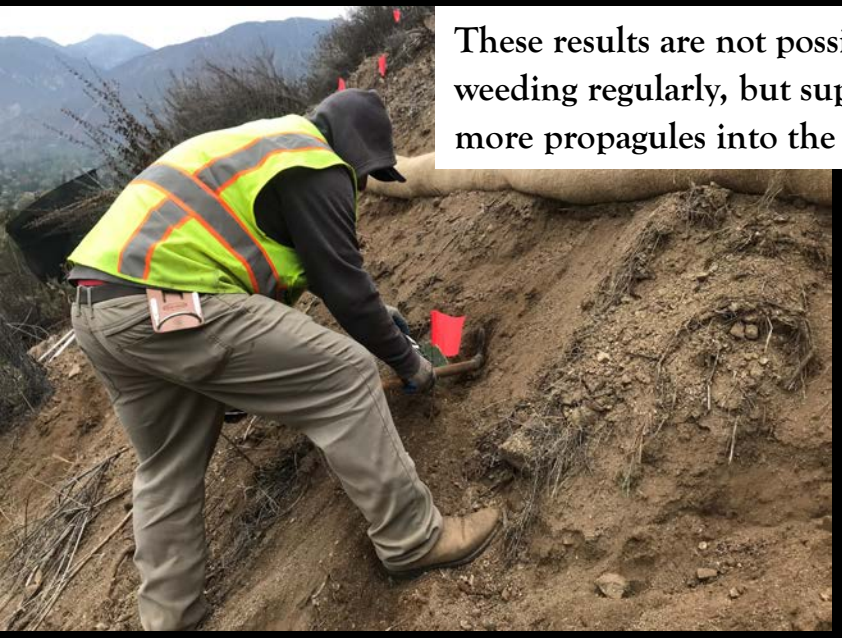
Two placed snags shortly after the initial planting.

And the same snags a few years later showing the diverse planted and seeded vegetation. Think of the time required for an oak to germinate, mature, begin to senesce, die-back and disarticulate, and we're pre-emptively providing habitat values that would not otherwise exist for many, many years.



2017

PSOMAS



These results are not possible without diligent maintenance. We're not only weeding regularly, but supplemental plantings, seeding—continually loading more propagules into the site to facilitate natural recruitment.

Maintenance / Enhancement

PSOMAS

2013

These panoramas show the progress at a landscape level.

2024

2013

2024

These panoramas show the progress at a landscape level.

And these are some typical scenes on the site the past two years.

2022

PSOMAS

And these are some typical scenes on the site the past two years.

2023

PSOMAS

Healthy, drought-resilient oaks in a mosaic of understory vegetation and natural debris.

2022

Very important that some outcrops are fully emergent and not covered with vegetation, to support some wildlife values.

2022

PSOMAS

In addition to the large snags, we often place smaller branches among the assemblages, and these are heavily used by critters.

2022

PSOMAS

And some areas are just a lovely mess, with tangles of placed stone and brush and clambering vegetation.

2022

PSOMAS

2022

The placed CWD continues to weather and decay.

PSOMAS






Just more scenes from the site. There are all kinds of niches, resources, every time you turn around there's something different and interesting to see.

PSOMAS

2022

The oaks are resilient despite periods of drought. The oak habitat has not been irrigated since 2018, and the CSS areas not since 2015. We only received 3/4 of average rainfall in 2021, and 1/3 of average in 2020—really some acute drought.

PSOMAS

2022

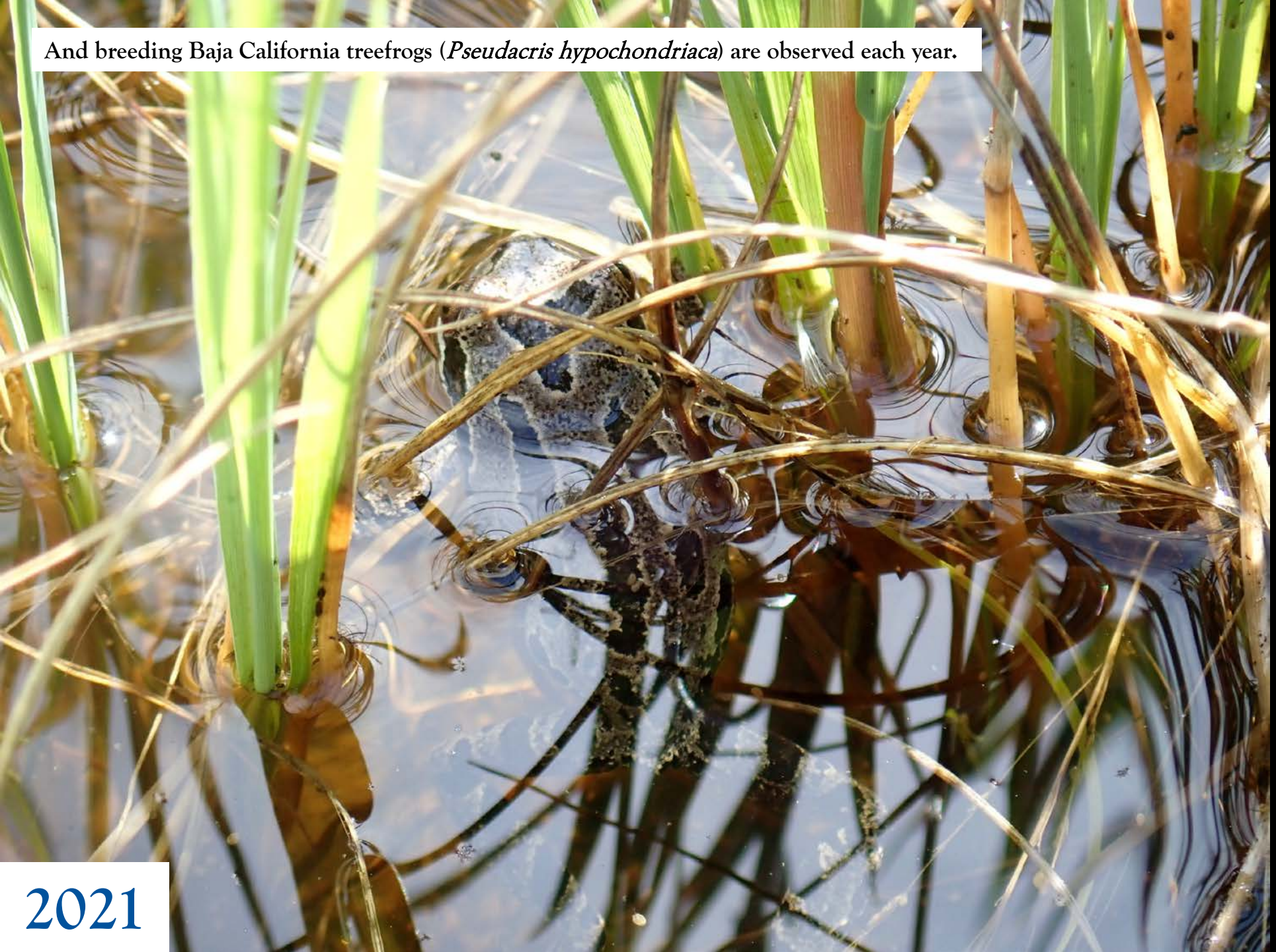
The spiraling drainages are well vegetated with native sedges, rushes...

PSOMAS

2022

...native riparian shrubs and grasses.

PSOMAS



And breeding Baja California treefrogs (*Pseudacris hypochondriaca*) are observed each year.

2021

PSOMAS

A few volunteer willows and sycamores were retained for diversity.

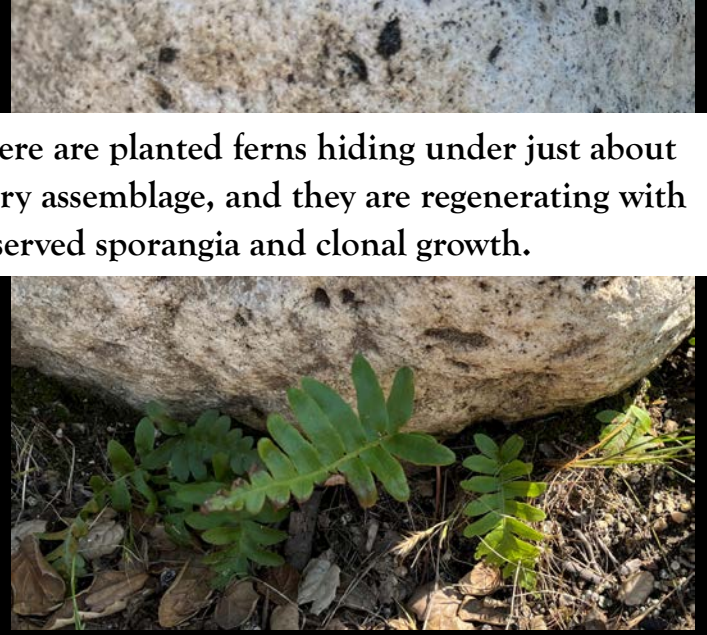
2024

PSOMAS

The coastal sage scrub mitigation areas are a mosaic that includes large patches of spiniferous shrubs—cactus and yucca.

2023

PSOMAS



There are planted ferns hiding under just about every assemblage, and they are regenerating with observed sporangia and clonal growth.

Fern growth and *regeneration*

PSOMAS



The placed CWD enables a beneficial decomposition food web that would have otherwise taken many years to establish.



Beneficial decay processes

PSOMAS






We see all kinds of detritivores and their associated predators.

Decomposition food web

PSOMAS























151 native vascular plant taxa

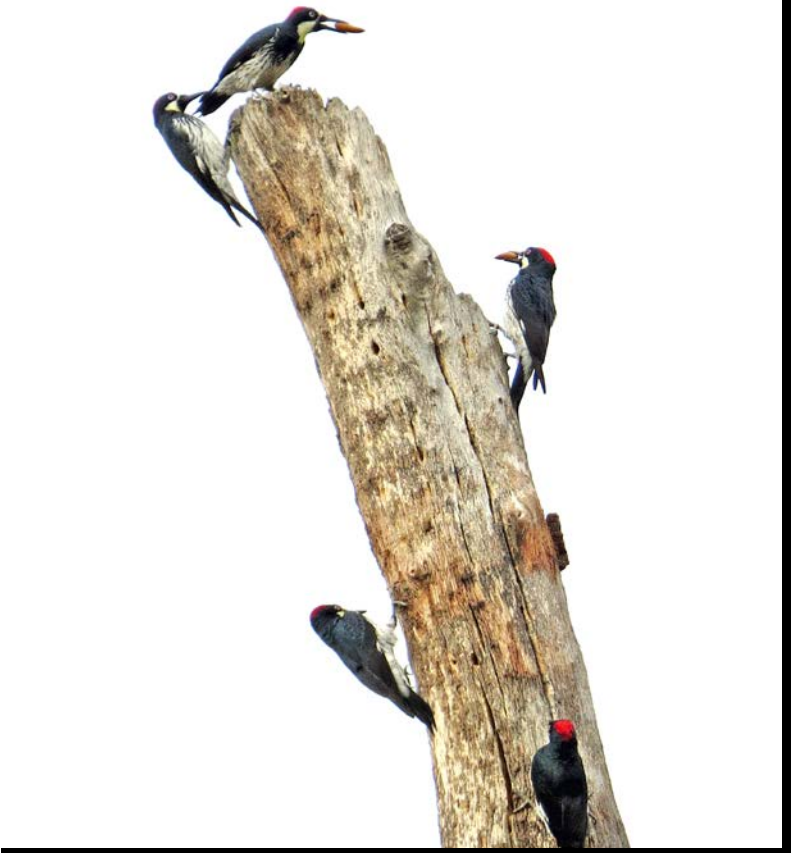
PSOMAS

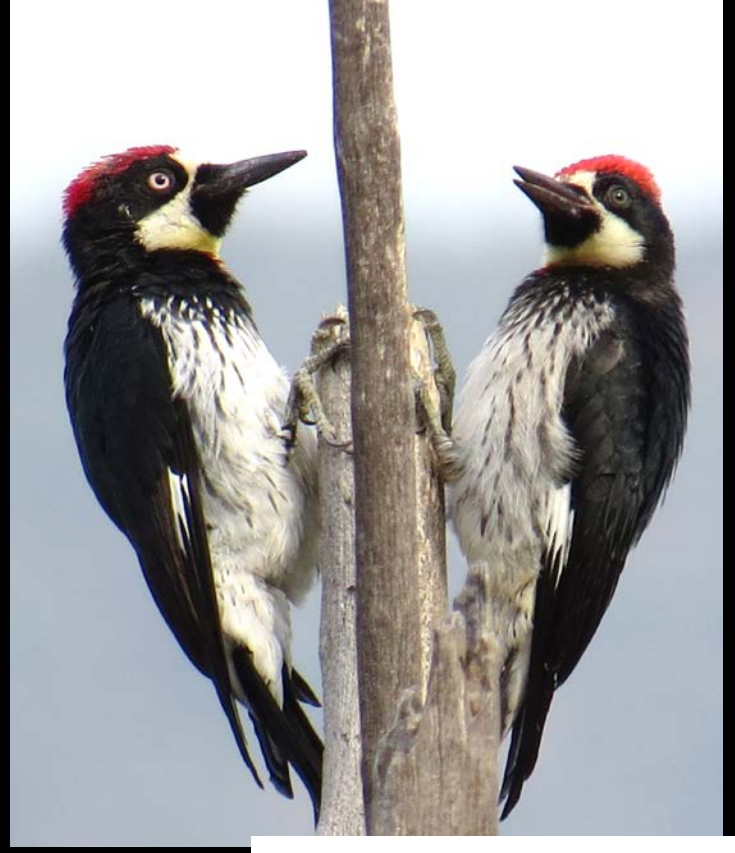
Arthropod abundance / diversity

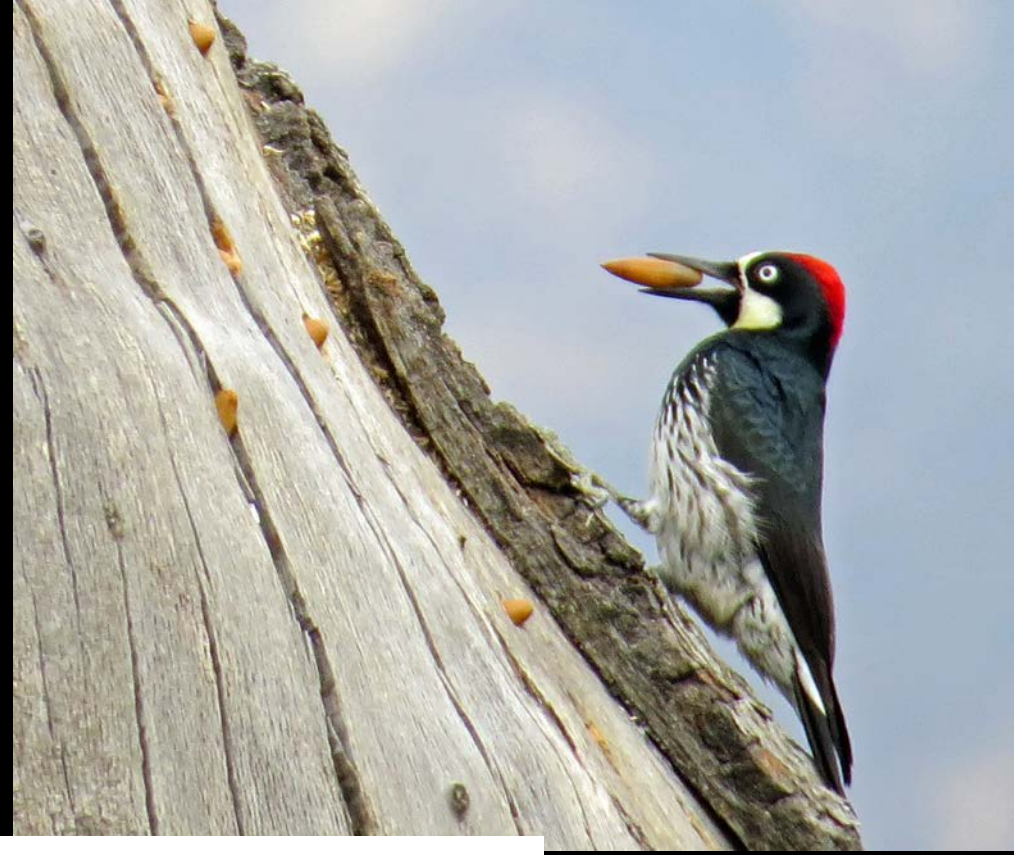
Arthropods are abundant and diverse.

We observed an abundance of volunteer, short-fruited willowherb (*Epilobium brachycarpum*) on the site and protected it. Later, we saw hundreds of sphinx moth (*Hyles lineata*) larvae using this as their host plant, and later the adults nectaring on the site. We placed some carpenter bee houses on the site and they used them, but the acorn woodpeckers (*Melanerpes formicivorus*) had other plans...

PSOMAS







The acorn woodpeckers colonized the snags overnight, excavating nest cavities and caching acorns to create valuable granaries.

PSOMAS

One of Psomas' Wildlife Biologists called me from the site in the first couple of years, to say he had four wrens on the site. I said, "Great—Bewick's wren? House wren?" and he said "No, four SPECIES of wren", including Bewick's and house, plus rock wren and canyon wren.

PSOMAS

There is heavy use by raptors including hawks, kestrels; and vultures and owls also use the snags.

PSOMAS

Wildlife camera placed at suspected woodrat nest

I saw some telltale signs of woodrats, so we placed wildlife cameras at several assemblages.

PSOMAS

Wildlife camera placed at suspected woodrat nest

Bryant's woodrat

We confirmed Bryant's woodrat are present.

PSOMAS

Wildlife camera placed at suspected woodrat nest

Bryant's woodrat: California Species of Special Concern

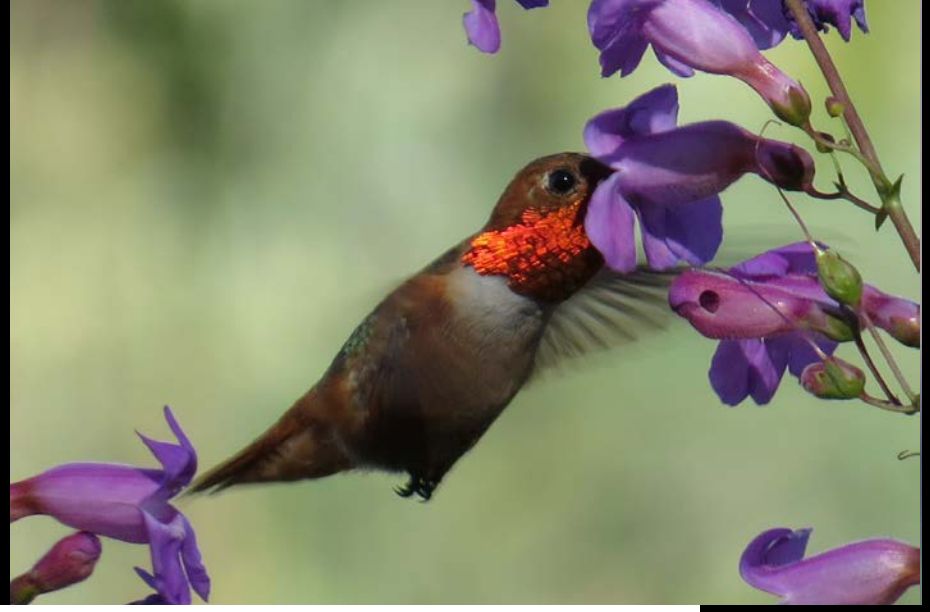
We confirmed Bryant's woodrat are present—a California Species of Special Concern.

PSOMAS

Here's another California Species of Special Concern, the San Diegan tiger whiptail (*Aspidoscelis tigris stejnegeri*)—upper left.

115 observed native vertebrate spp. (15 spp. nesting birds)

PSOMAS



We're observing new species all the time, from minute insects up to large predators.
So we think we've pretty well exceeded the bio-diversity goals of the program.

Bio-Diversity ✓

115 observed native vertebrate spp. (15 spp. nesting birds)

PSOMAS

These kind of results were mainly possible due to the active collaboration of all team members, with Public Works (top center) taking an active role throughout the planning and implementation phases.

Active collaboration

PSOMAS

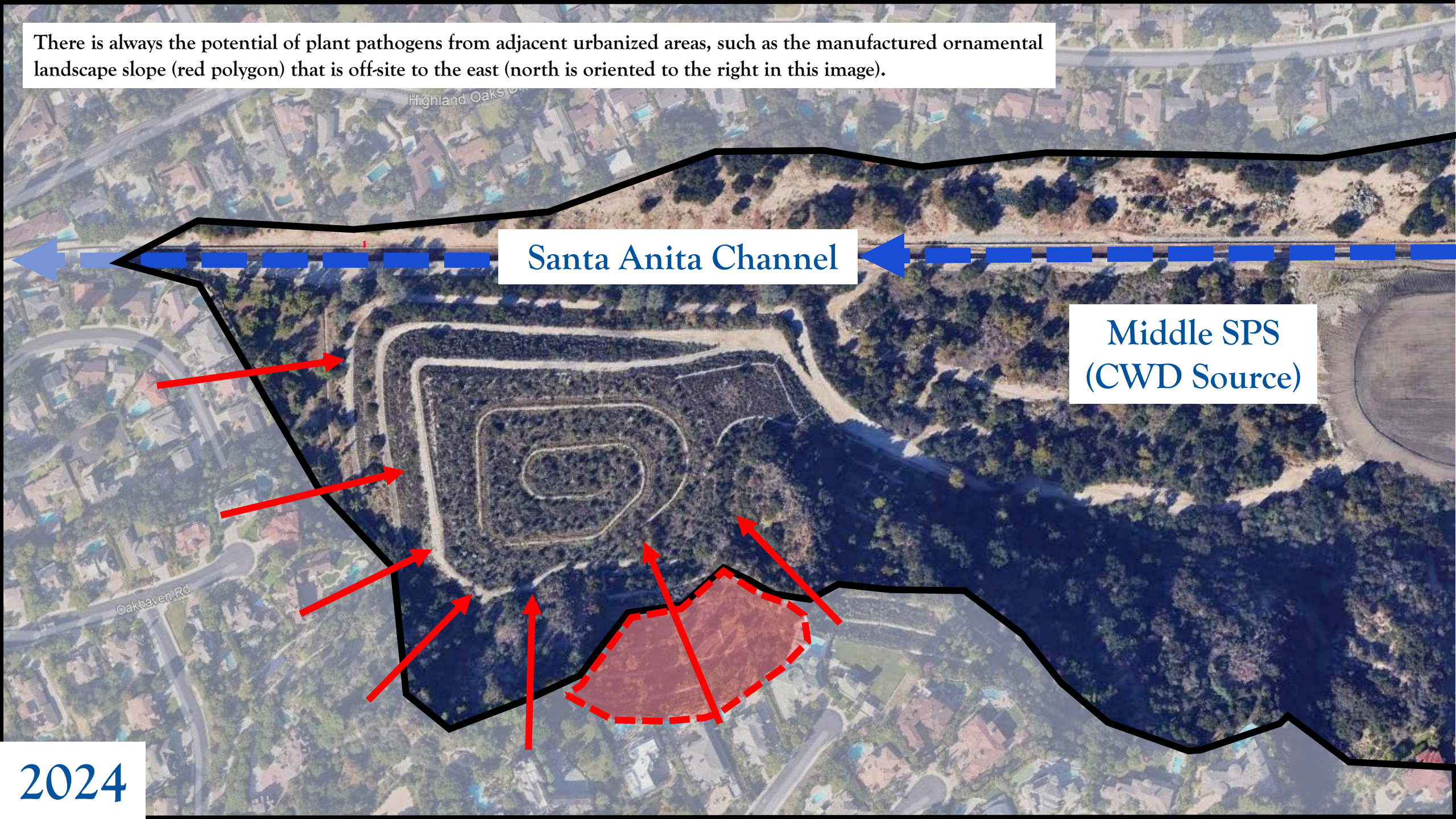
What About Pathogens?

- Must be mindful of potential disease vectors
- These substrate enhancement methods are likely unsuitable for many habitat creation/restoration sites in California
- Select sites offer good opportunities for experimentation without risking contamination of sensitive habitat areas
- **Practitioners must carefully evaluate materials to be salvaged/moved, site locality and configuration, and the overall bio-resource context**

Serious plant pathogens such as *Phytophthora* spp. have not been identified on this habitat creation site to-date. In general, practitioners must be very careful in evaluating biotic materials for relocation.

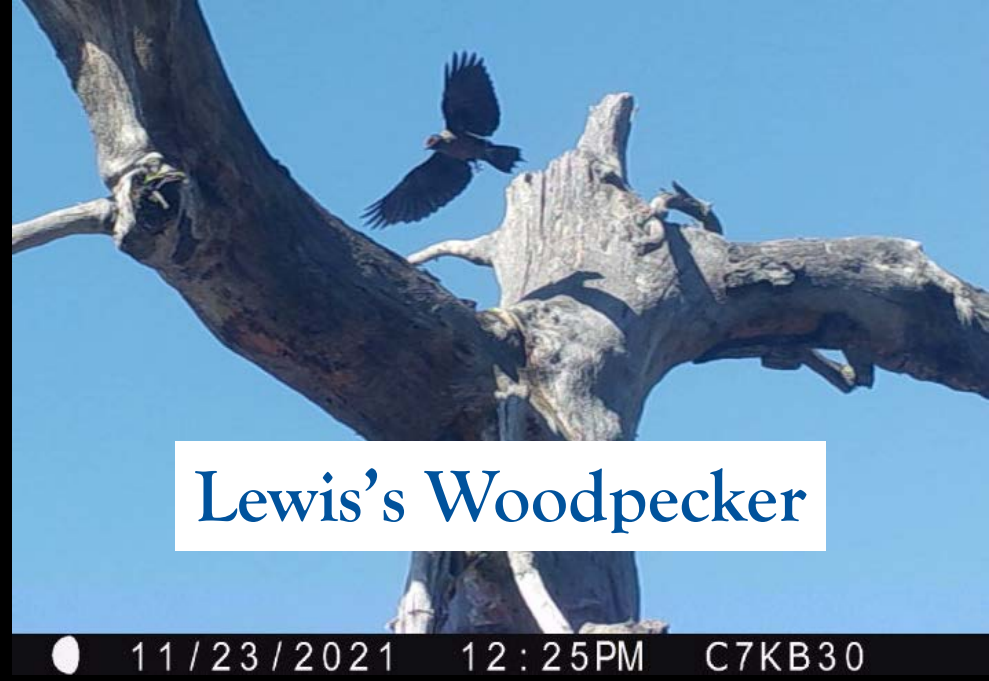
PSOMAS

The specific location and configuration of this site, at the tip of a wedge of habitat surrounded by development, and the use of woody debris from an immediately adjacent source, make it a good candidate for experimentation without risking the contamination of sensitive natural areas.


There is always the potential of plant pathogens from adjacent urbanized areas, such as the manufactured ornamental landscape slope (red polygon) that is off-site to the east (north is oriented to the right in this image).
Highland Oaks
Santa Anita Channel
Middle SPS
(CWD Source)
Oakhaven Rd
2024

Performance Summary – 2024:

- Excellent oak survival/growth/health
- Very high bio-diversity of flora/fauna
- Drought-adapted habitat mosaic
- Site has met most 10-year standards



We've demonstrated that by radically enhancing our substrate and optimizing botanical bio-diversity, excellent results of oak growth, health, and drought adaptation and survival can be achieved, with intensive wildlife colonization on a recently graded landform.

The planted Engelmann oaks were fruitful starting in 2022, and we just observed the first catkins on planted coast live oaks in 2024. Multiple bird species such as this phainopepla (*Phainopepla nitens*) have been nesting in the planted oaks. The measured oak canopy cover in 2023 exceeded 10% on this developing woodland.

Q. engelmannii

2022

Q. agrifolia var. *agrifolia*

2024

Phainopepla

Here's our full project team, not previously mentioned are Cornerstone Studios who prepared irrigation plans and photo-simulations, and Leatherman BioConsulting who have provided supplemental botanical expertise throughout the project.

Public Works
LOS ANGELES COUNTY

PSOMAS

LAKPAE & associates, inc.
Landscape Construction • General Engineering • Construction Management

CORNERSTONE STUDIOS
106 W. 4th Street • 5th Floor • Santa Ana, CA 92701-4646
PLANNING • RESOURCE ANALYSIS • LANDSCAPE ARCHITECTURE • URBAN DESIGN

LEATHERMAN BIOCONSULTING, INC.
Biological Surveys, Management & Monitoring

El Nativo Growers, Inc.
Growers of Quality Plants for the California Landscape

California
BOTANIC GARDEN

S&S SEEDS

On behalf of Los Angeles County Public Works, thank you for your time, and the website is here for more information.

Thank You

https://dpw.lacounty.gov/wrd/Projects/SAHMP/index.cfm

Public Works
LOS ANGELES COUNTY

PSOMAS