Why should we talk about *doing no harm*

when we're trying to do such good?

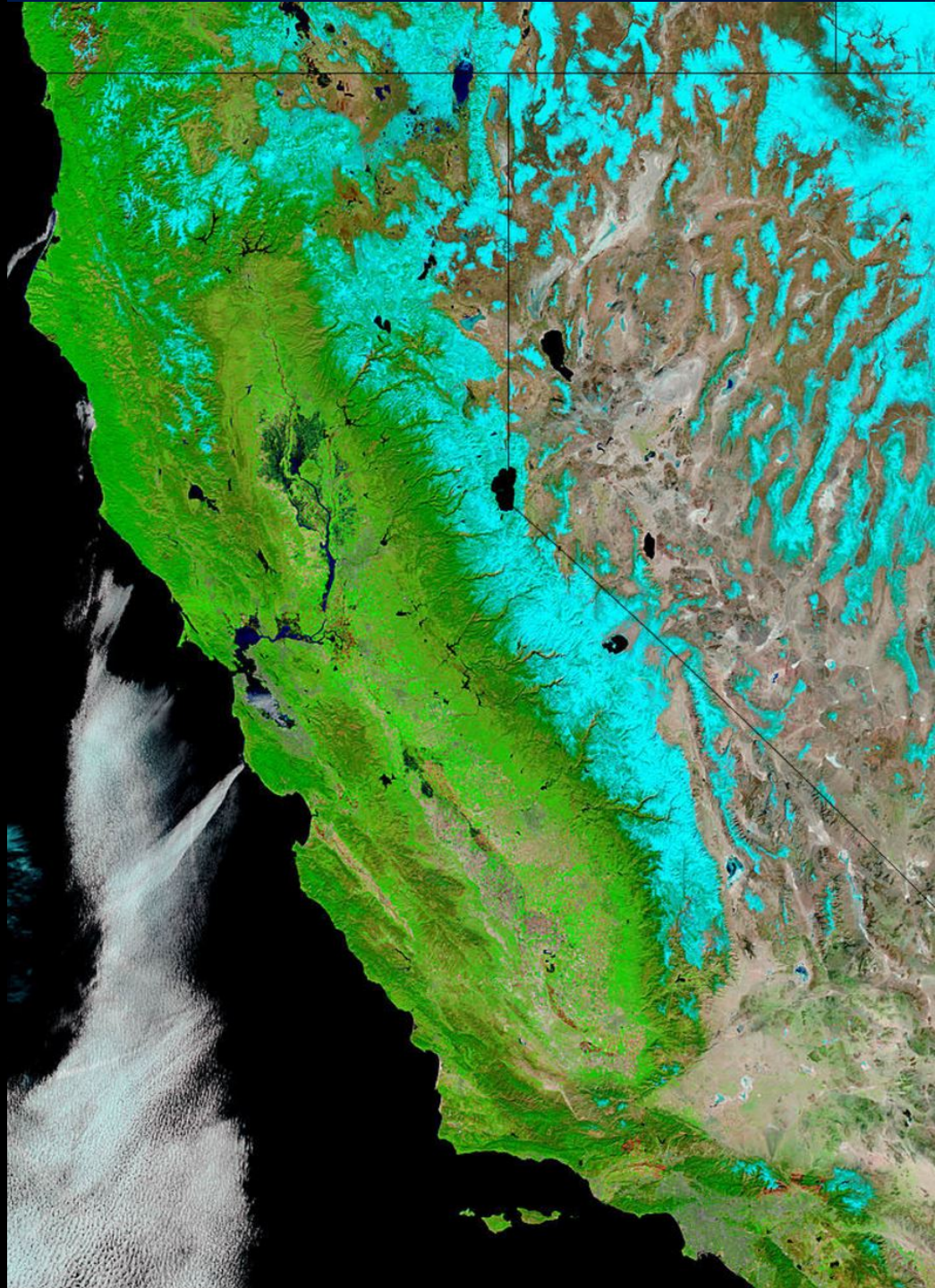
Tom Scott[12] Edith Allen[3] Travis Bean[3] Elise Gornish[4]

[1]Department of Environmental Science Policy and Management University of California Berkeley,
[2]Department of Earth Sciences, University California, Riverside
[3]Department of Botany and Plant Sciences, University of California, Riverside
[4]Department of Plant Sciences, University of California, Davis

Start
Higher
Provincialism

John Muir
Bret Hart
Jack London
Andres Pico
Annie Alexander
Joseph Grinnell
Kate Brandegee
Ina Coolbirth
Joseph Brewer
David Brower
Ansel Adams
Elna Bakker
Alice Eastwood
Clarence King
Starker Leopold
Willis Jepson
Sarah Lemon
Richard Dana
Joaquin Miller
John Steinbeck
Juan Rodríguez Cabrillo
Theodora Kroeber
Helen Hunt Jackson
Florence Merriam Bailey

California is like no other place on Earth



Provincialism and the California Floristic Province

3500 species in the California Floristic Province (4800 taxa including subspecies)

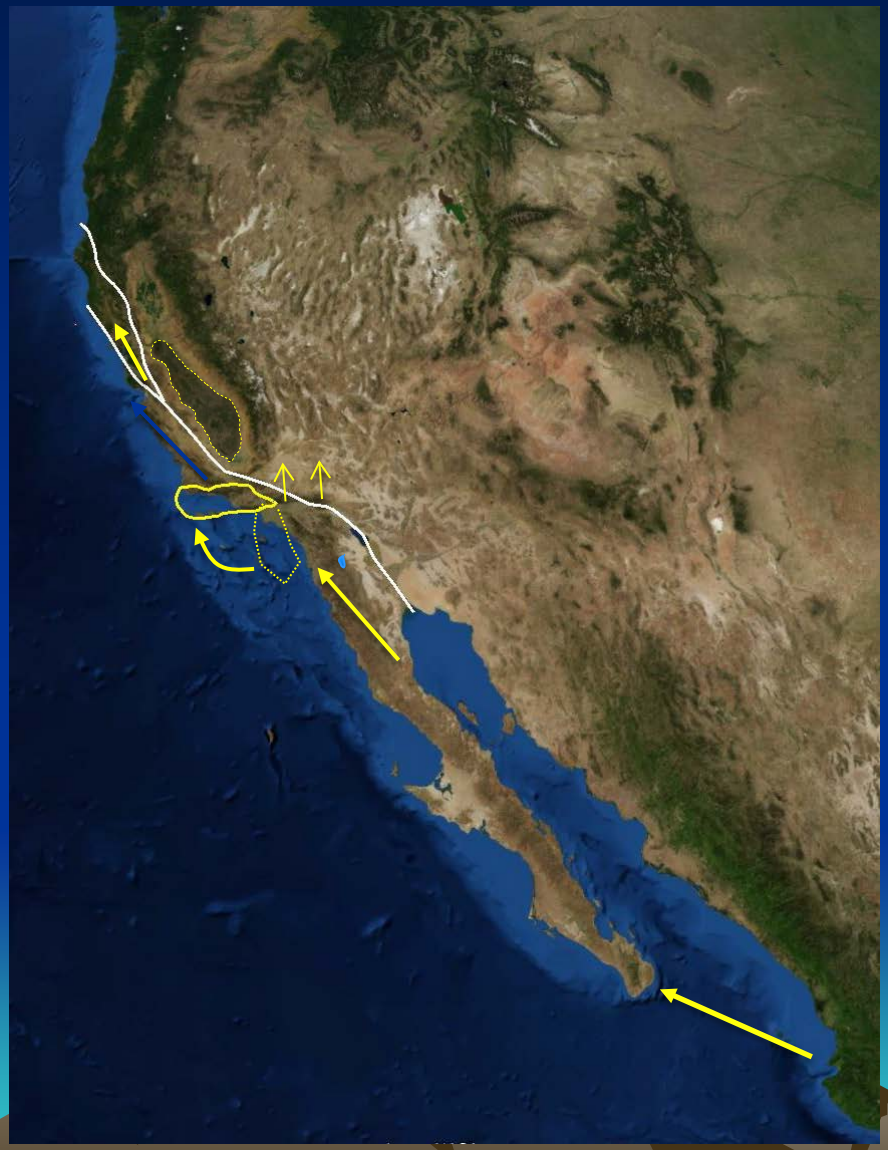
61% of species are endemic to the CFP

39% have limited distributions

More listed species that any other area in Continental United States

>6000 Species within the state

Start with the remarkably complex and dynamic geology



Our Plants were

Dragged >350km north by tectonic movement of the Pacific Plate

Isolated by the opening of the Sea of Cortez and Salton Trough and Sierras

by rivers changing directions, volcanism, inland seas, 15-km-long landslides, and a calliope geological activity

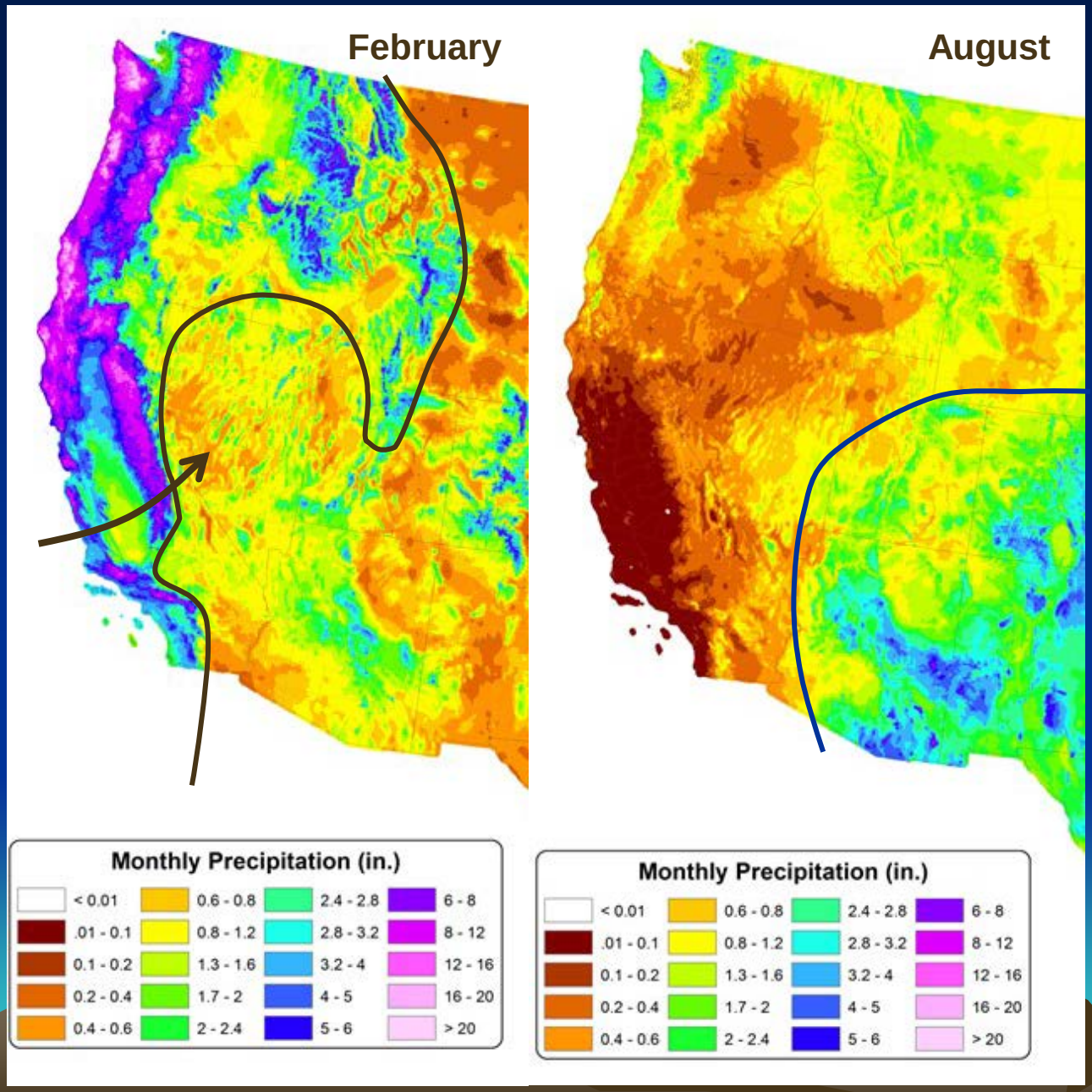
by 23 mountain peaks within 80 km of the Pacific Ocean >8000 ft

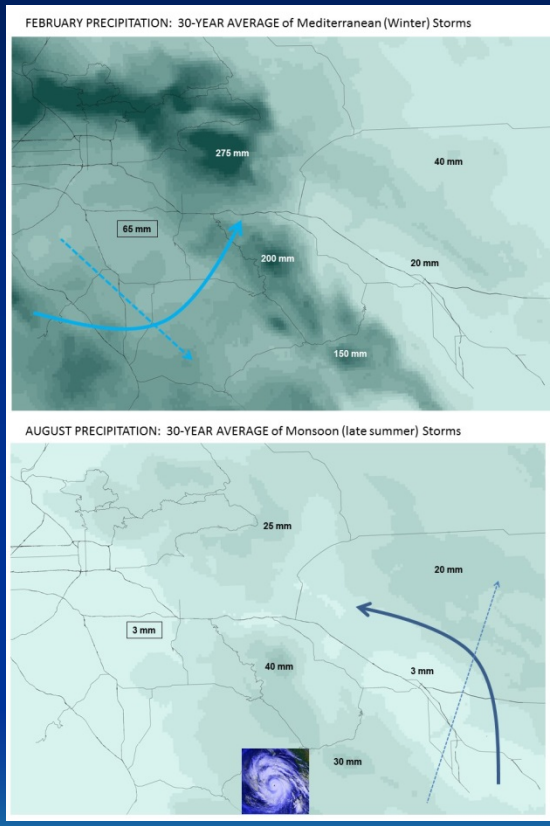
They evolved among unique pockets of Serpentine and Gabbro soils

and remarkable heterogeneity of soils and substrates


10 Million years ago
Today

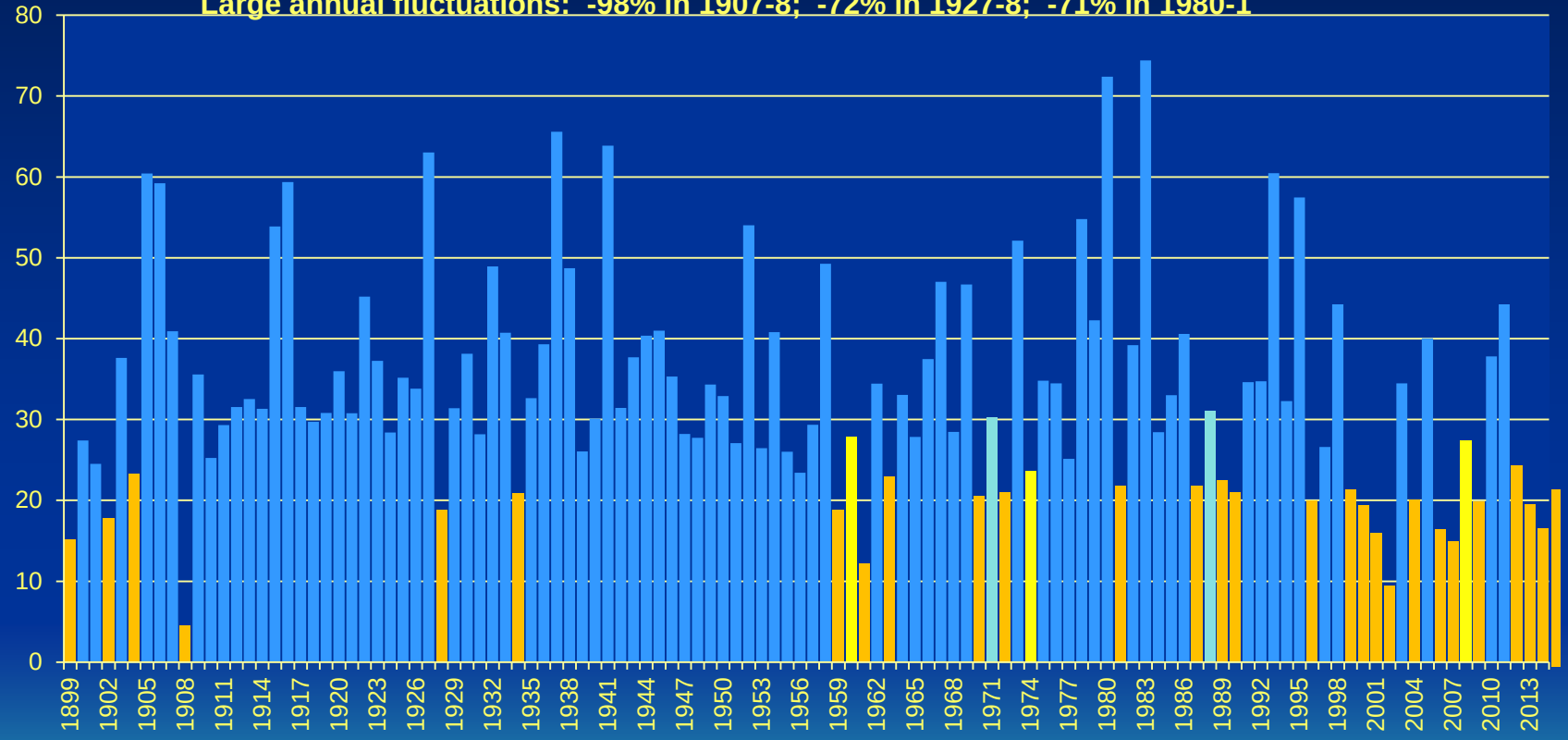
30-year averages of monthly precipitation



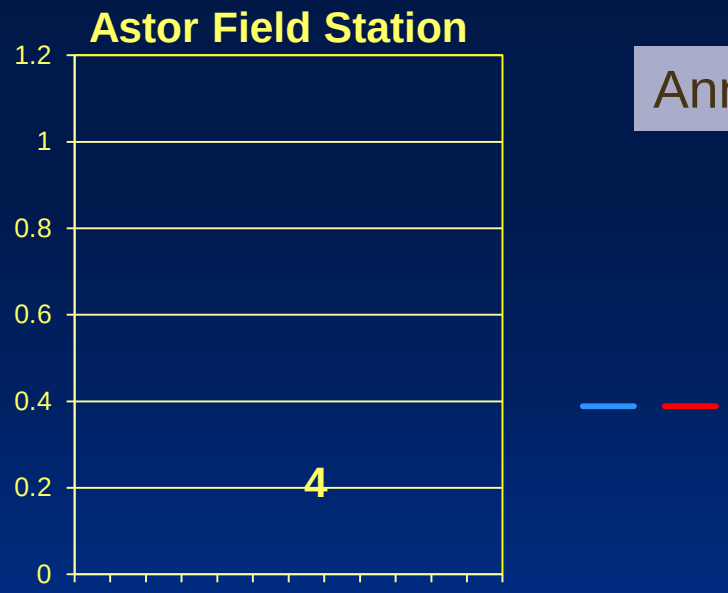


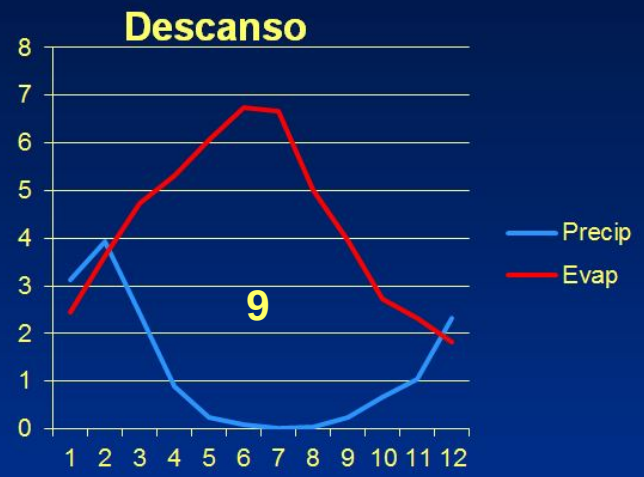
Unpredictable Water-year precipitation at Cuyamaca Reservoir since 1899

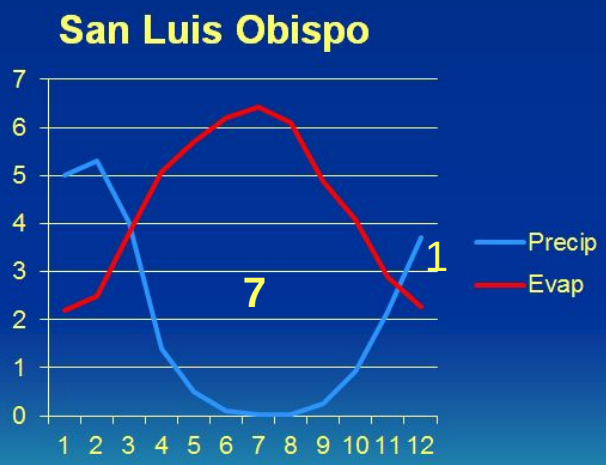
Drought years with heavy precipitation every 4 to 7 years
Large annual fluctuations: -98% in 1907-8; -72% in 1927-8; -71% in 1980-1

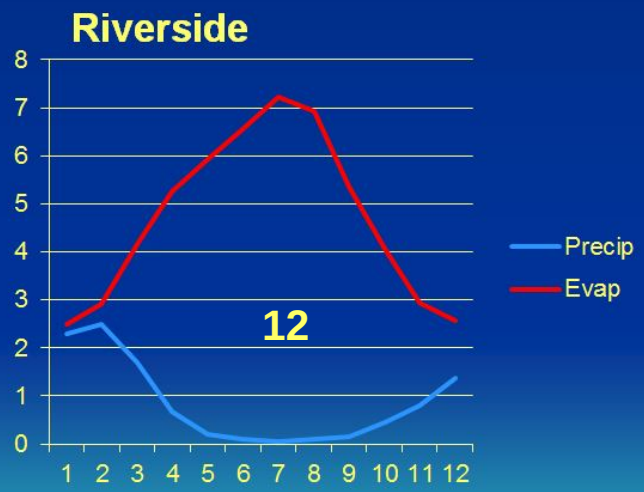


Annual drought is stronger than precipitation



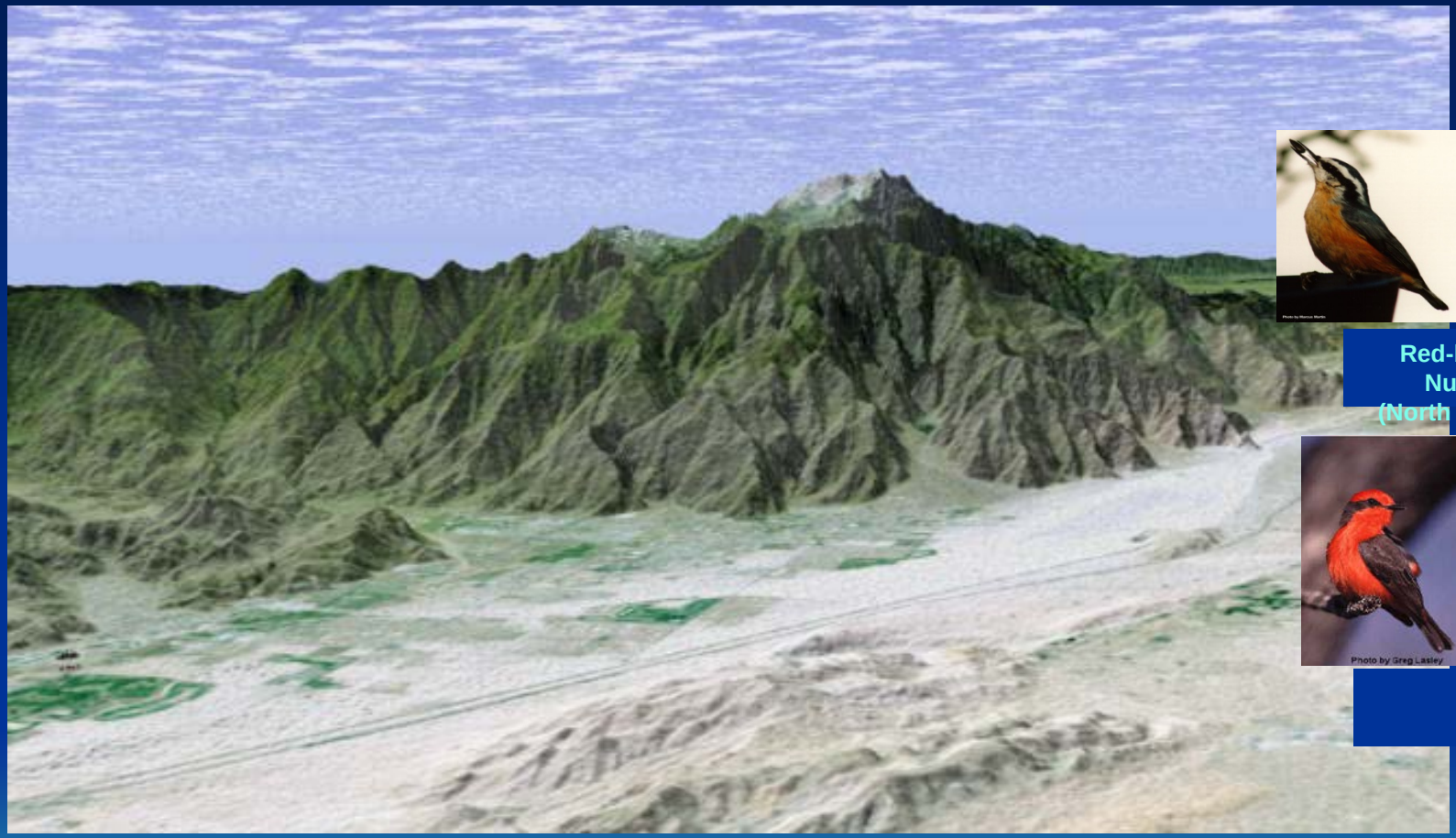


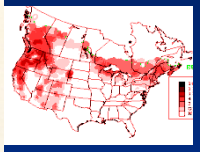




Steepest scarp in North America (8700 ft gain in 4 miles)

Only 5 miles of separation between species found in boreal Canada from species found at the equator





Red-breasted Nuthatch (North to Yukon)

Vermillion Flycatcher (South to Equator)

Four intrinsic characteristics that dramatically increase the value of native populations/ecosystems

Very large disparity in conditions over very short distances
Biodispariety not Biodiversity

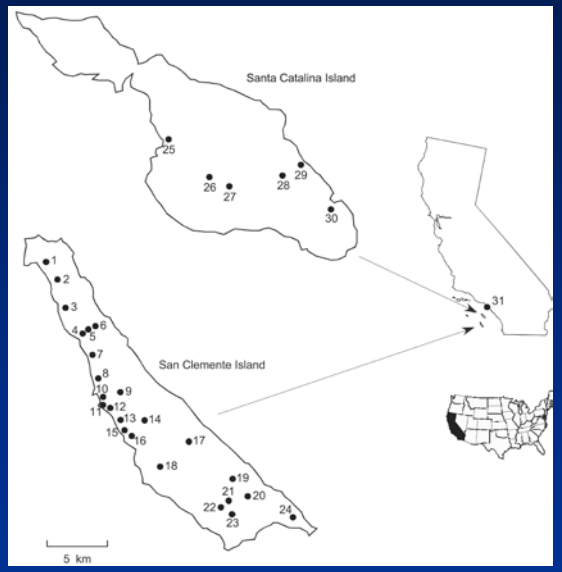
Also see isolation driven by heterogeneous landscapes and rare substrates

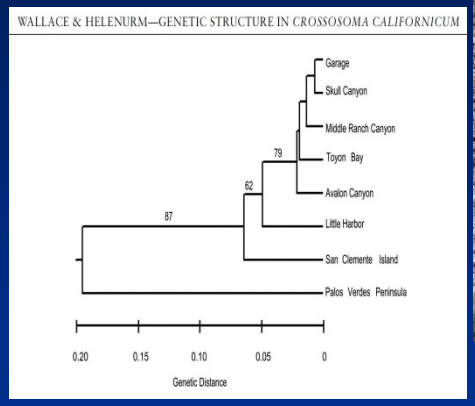
Remarkable persistence and of plant and animal taxa in relatively unpredictable ecosystems (Absence of glaciation over most of the area)

Small scale differences are strong enough to select against hybrids and intermediate, maintaining relatively pure forms of species that frequently hybridize.

(And 4 reasons to be exercise caution in California restoration projects)

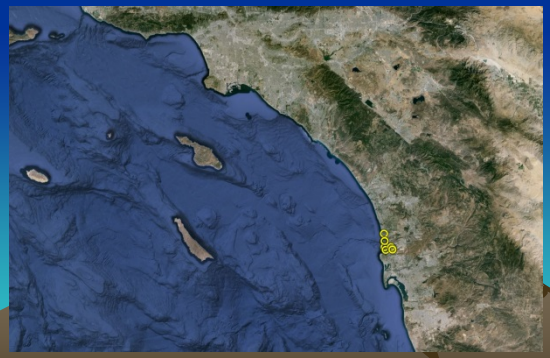
Crossosoma californicum distribution
Small range with few individuals





©2011 Neal Kramer

Dudleya brevifolia in Del Mar



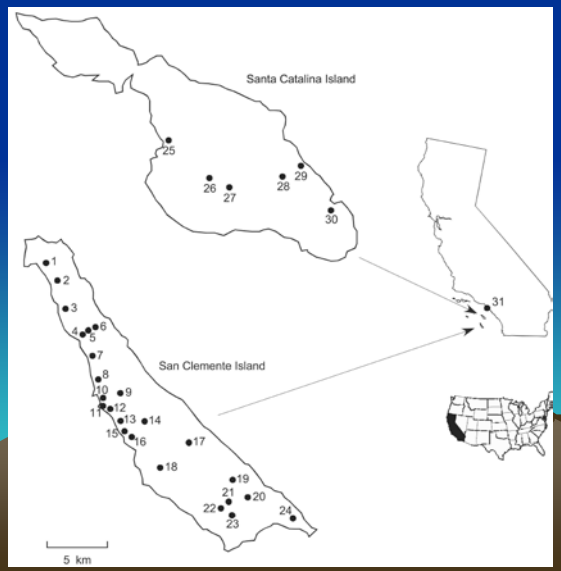
distribution data from data provided by the participants of the Consortium of California Herbaria -(ucjeps.berkeley.edu/consortium

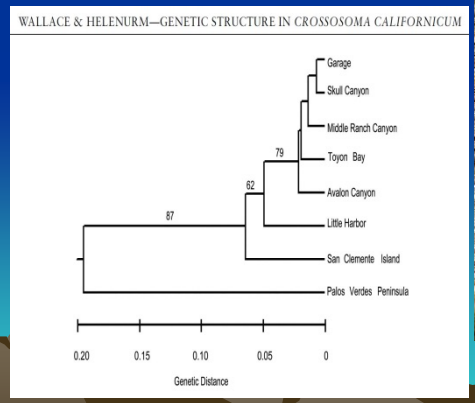
California's Remarkable level of endemism and rarity

Dudleya brevifolia in Del Mar – Limited to a few canyons

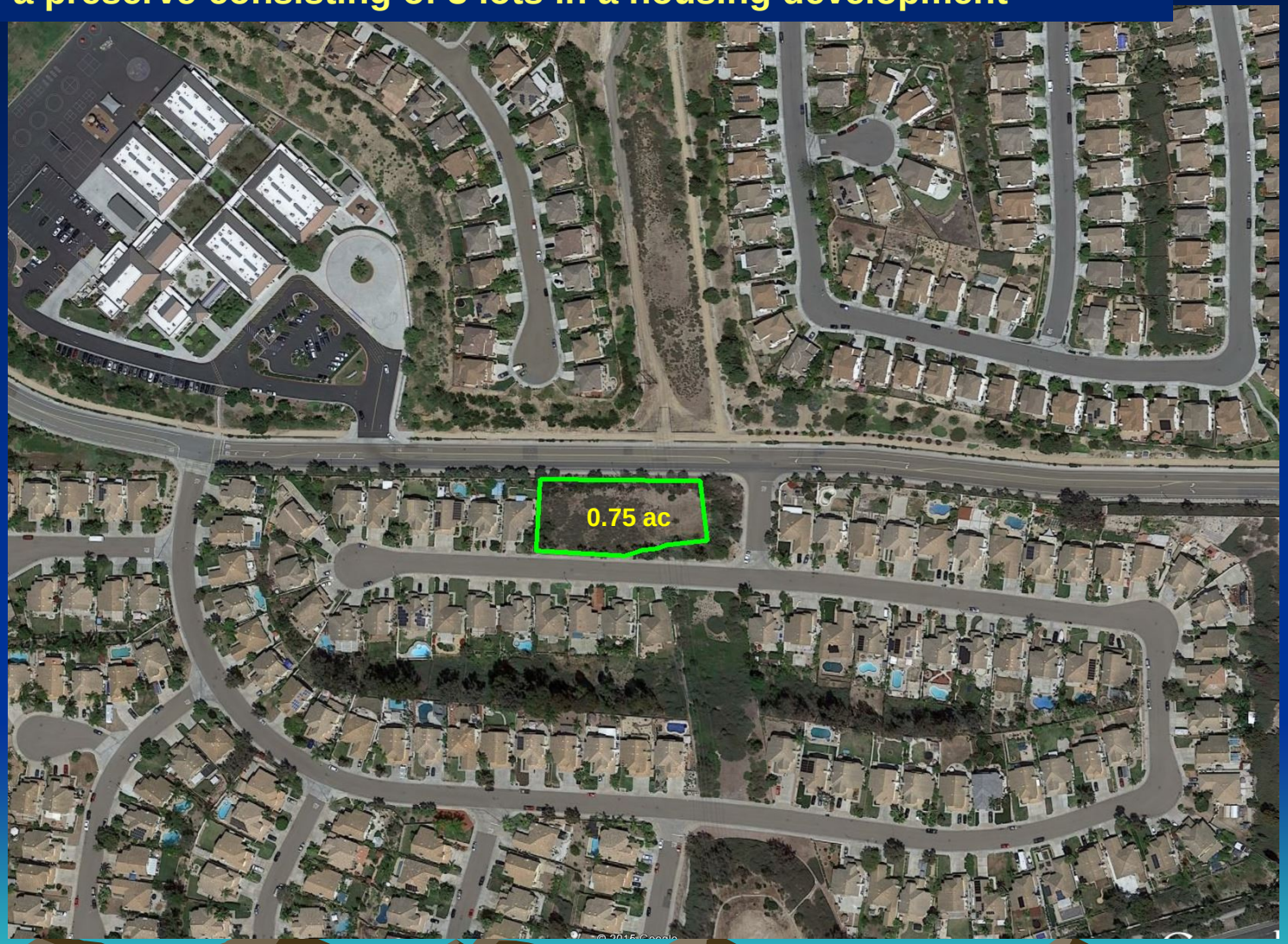
distribution data from data provided by the participants of the Consortium of California Herbaria -(ucjeps.berkeley.edu/consortium

Crossosoma californicum distribution
Small range with few individuals





A lot of our rare ecosystems occur where we build houses:
The epitome of our situation can be found in the Hemizonia Zoo[1]
a preserve consisting of 3 lots in a housing development



[1]Coined by Julie Vanderweier 1993

The epitome of our situation can be found in the Hemizonia Zoo a preserve consisting of 3 lots in a housing development

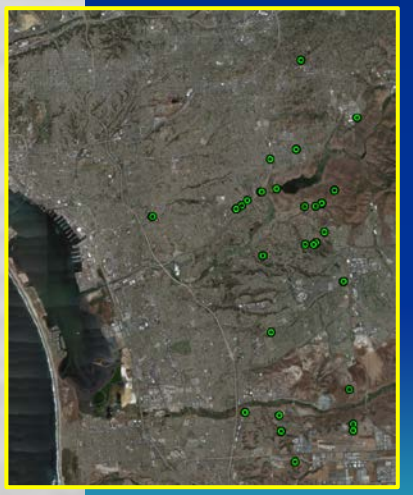
Only 0.3 ac of area is *Deinandra conjugens* habitat in preserve

County of San Diego lists ~2.8 ac *Deinandra conjugens* vegetation

22 known locations of *Deinandra conjugens* from herbaria specimens

25 locations identified by the USFWS (2009); 10 major locations

Loss of any population could mean >5% loss of individuals; (possibly 2 million extant plant)



Deinandra conjugens distribution data from data provided by the participants of the Consortium of California Herbaria - (ucjeps.berkeley.edu/consortium/)

Restoration becomes an obvious tool to help these species persist in human dominated landscapes

These endemic plants and animal, challenged in changing landscapes begin to resemble patients with significant and complex medical problems

Our emphasis of "Do no harm" in restoration comes from the strong parallel between restoration practices and medicine:

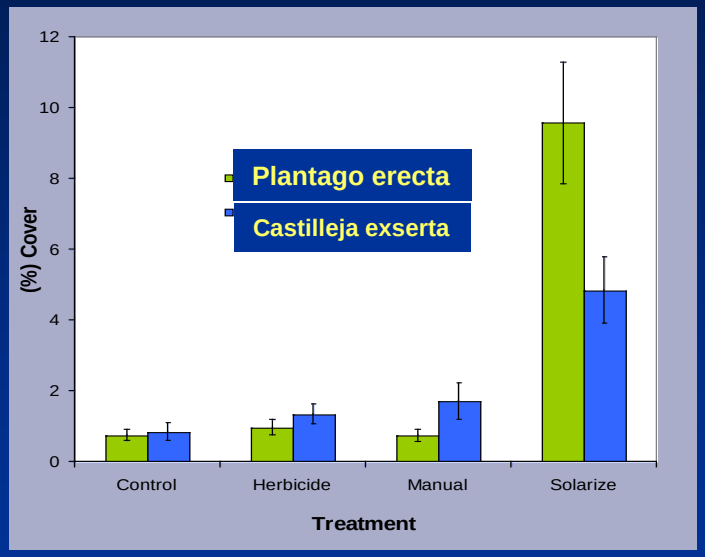
Both medicine and restoration are based on **INTERVENTIONS** (into ongoing natural processes /situations)

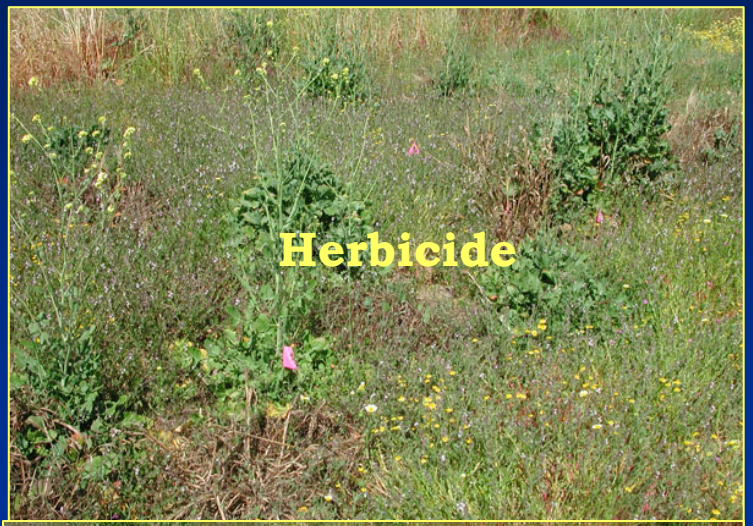
balancing **INVASIVE** actions with

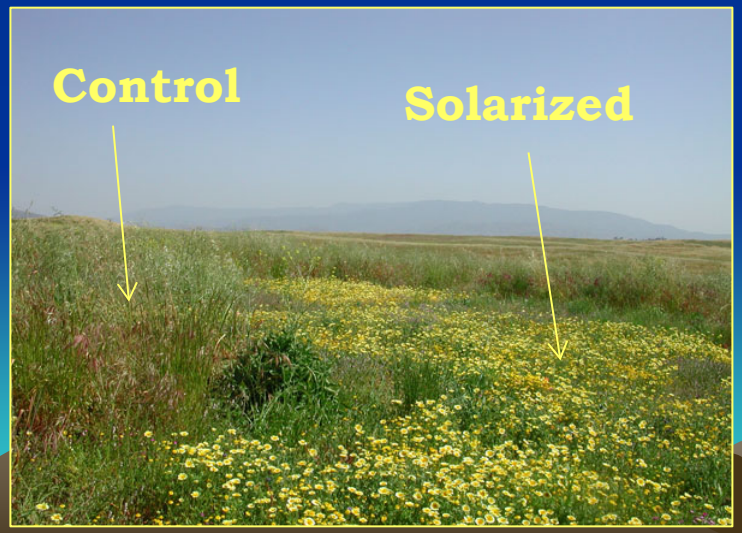
natural **RECUPERATION**

San Diego River riparian restoration and creation for endangered least Bell's vireo: Mitigation for CalTrans highway project 15 acres of riparian area were created in 1990

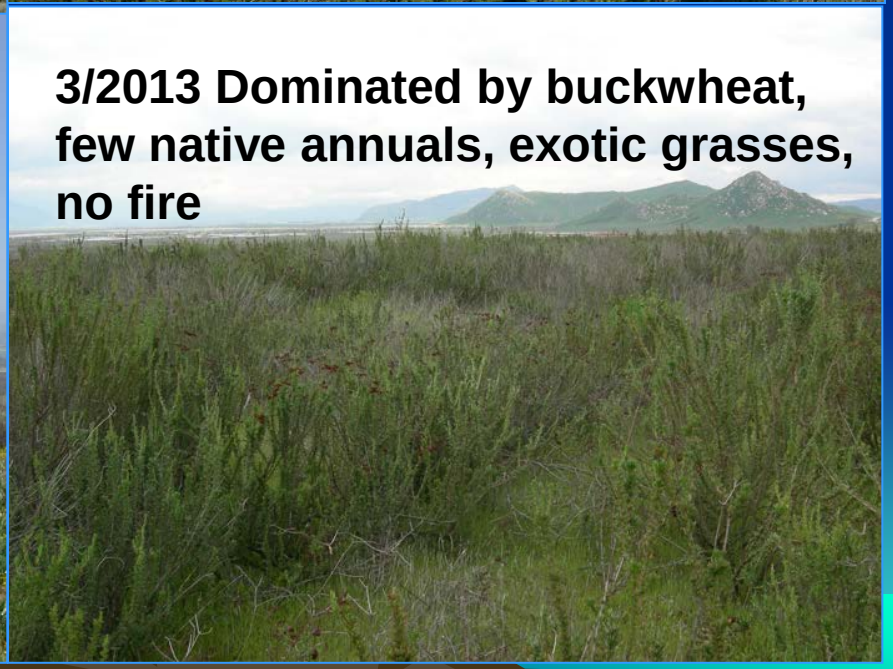
Restoration for endangered Quino Checkerspot *(Euphydryas Editha)* host plants on abandoned farmland acquired for Riverside County MSHCP. Solarization was Most effective for restoring native forbs. (Marushia & Allen 2011)







Restoration of coastal sage scrub in abandoned farmland, ~ 30 acres restored at San Jacinto Wildlife Area (Allen et al. in press)



What was the genesis of restoration interventions?

First - economic gain and efforts to stabilize soil

Reforestation – Scientific Forestry (Gifford Pinchot) 1880s

Production of wood (BMPs)

Rangeland improvement – Taylor Grazing Act (1934)

Range Utilization and forage Improvement

Erosion control and stabilization – Soil Erosion Service (1933) and Soil Conservation Service (1935)

Stabilization of ongoing damage Recovery from past damage practices

Second: a legal structure for restoration mitigation and remediation

Four Laws in the 1970s**:**

California Environmental Quality Act CEQA 1970

Clean Water Act 33 U.S.C. §1251 et seq. (1972)

Endangered Species Act (1973)

Surface Mining and Reclamation Act (1975)

Two Acts of Congress that codified interventions by restoration and remediation

Clean Water Act 33 U.S.C. §1251 et seq. (1972)

- 404 Permits - Off-site mitigation for wetlands loss
- No net loss of wetlands – replacement / remediation
- Section 319: vegetation could be planted as abatement for pollution

Endangered Species Act (1973)

- Defined “take” in term of ecosystems
- Loss of unoccupied habitat considered take - habitat mitigation
- Section 10(a) was amended in 1982 to allow incidental take under a 10(a) Habitat Conservation Plan could include habitat restoration

Legal Structure for Restoration Mitigation and Remediation

California Environmental Quality Act CEQA 1970

- Disclosure of habitat loss
- Created the concept of mitigation for loss (NEPA, 1969)
- Discretionary Actions by Local Governments – permits
- Compensation for the impact by replacing or providing substitute resources or environments (40 CFR Part 1508.20).
- Rectification of impacts by repairing, rehabilitating, or restoring the affected environment;

Surface Mining and Reclamation Act (1975) California State Law

- Compliance standards for reclamation (safe and useful) to assure that adverse environmental impacts are minimized and mined lands are reclaimed to a usable condition."

- **§ 2756. "**grading, backfilling, resoiling, revegetation, soil compaction …. soil erosion control, water quality, … and flood control.

- Not as strict as the federal Surface Mine Control and Reclamation Act (1977, applies only to coal mining states) that specifies revegetation with native species.

What can be said of the goals for intervention?

Early reclamation :

- **Production**
- **Utilization**
- **Stabilization**

Goals are production, not necessarily long-term

Legal Structure:

- **Disclosure**
- **Mitigation**
- **Off-site**
- **Permits**
- **Compliance**
- **Replacement**
- **Take**

Ecological goals can be detrended from project goals

But the elephant in to the room is the reliability of restoration interventions when the primary goal is a permit, take, or compliance rather then saving the patient

Certainty of the permit and habitat destruction; Promise of restoration, maintenance , and compliance

Unbalanced negotiation

No incentive for project success, cost disincentive for best management practices

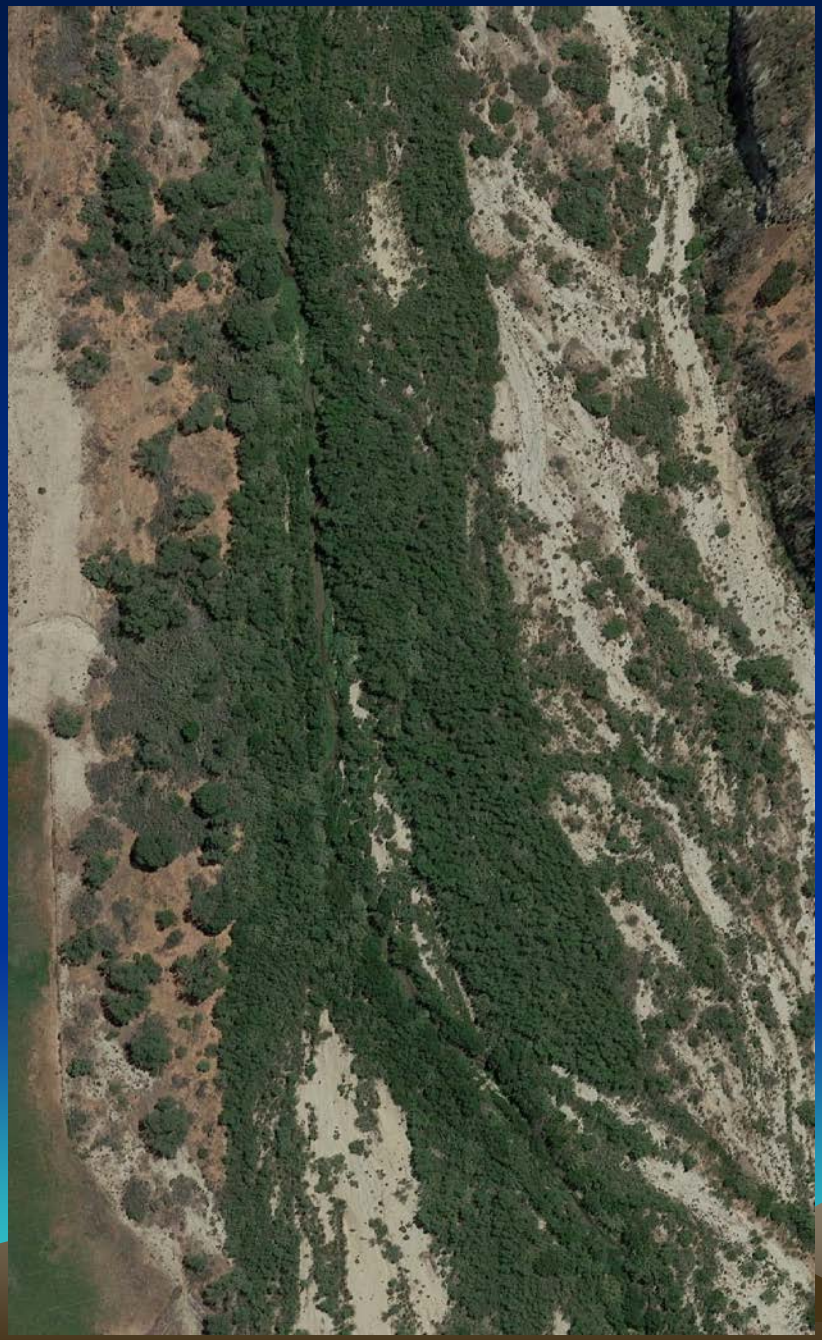
Creates leverage for market forces influence professional judgements

No structure to handle the unforeseen

influenced by cost controls

Imperfect incentive to improve the restoration outcome

Two proposed project with restoration as mitigation



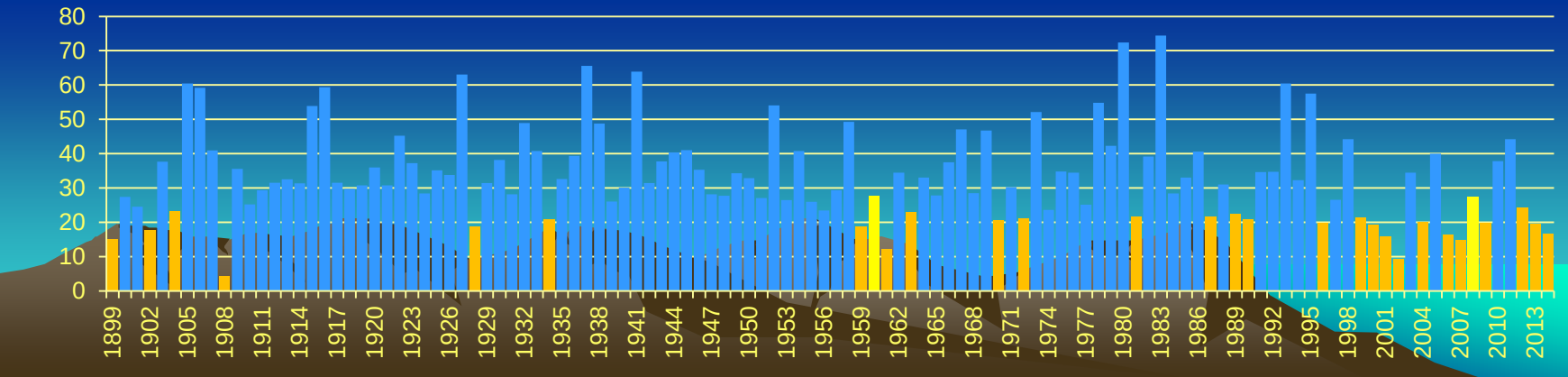
Two projects to remove native vegetation to plant willows and oaks in the gaps

Permit certainty coupled with restoration unknowns
It is often difficult to project the trajectory or success of restoration projects

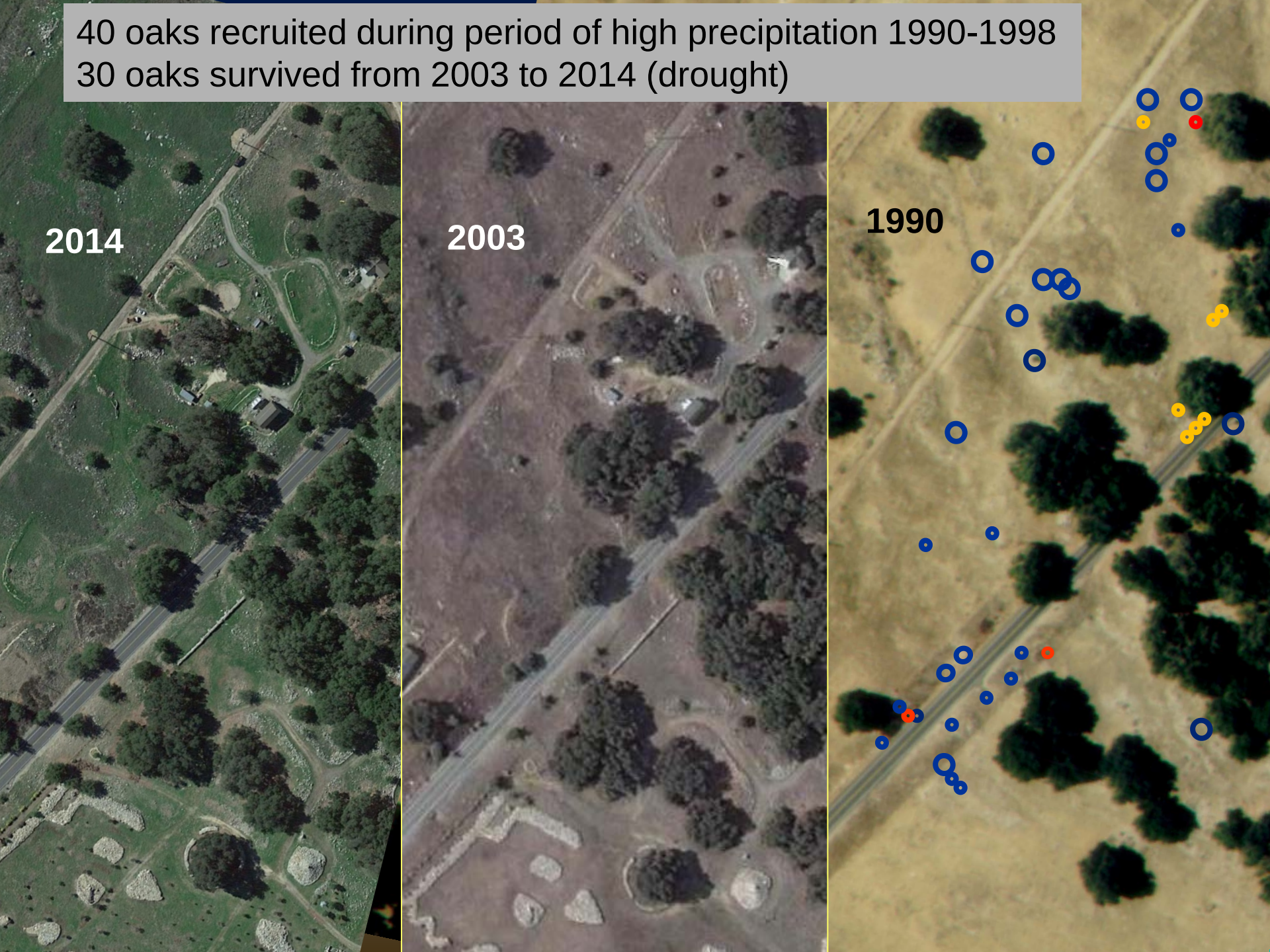
Drought related mortality – How bad can it get?

Annual rate of mortality (dead/yr per 100 trees)	Infestation Area (Descanso)	Edge of Infestation (Santa Ysabel)	Outside of Infestation (Oak Grove)
1930 -1996	0.20%	0.05%	0.18%
1996 - 2006	0.30%	0.70%	1.60%
2006-2009	17.97%	5.89%	0.00%
2009-2010	10.22%	7.00%	0.00%

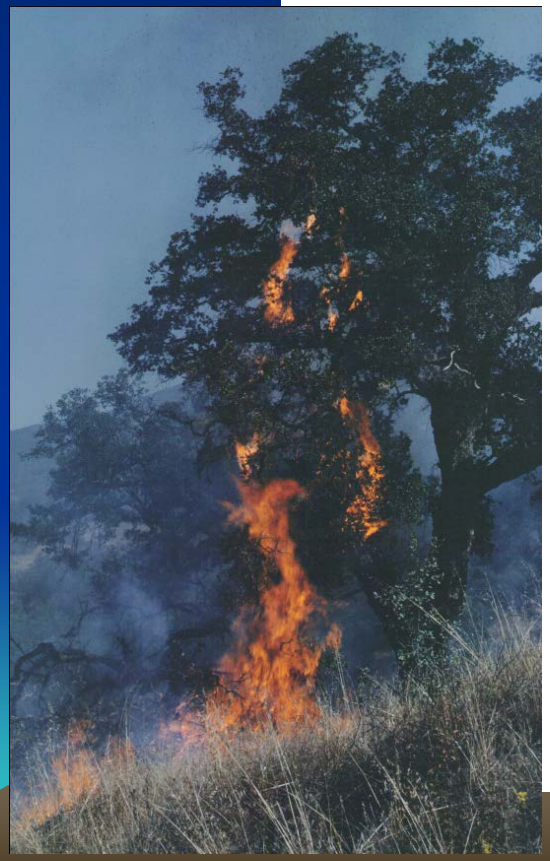
Precipitation at Cuyamaca Reservoir

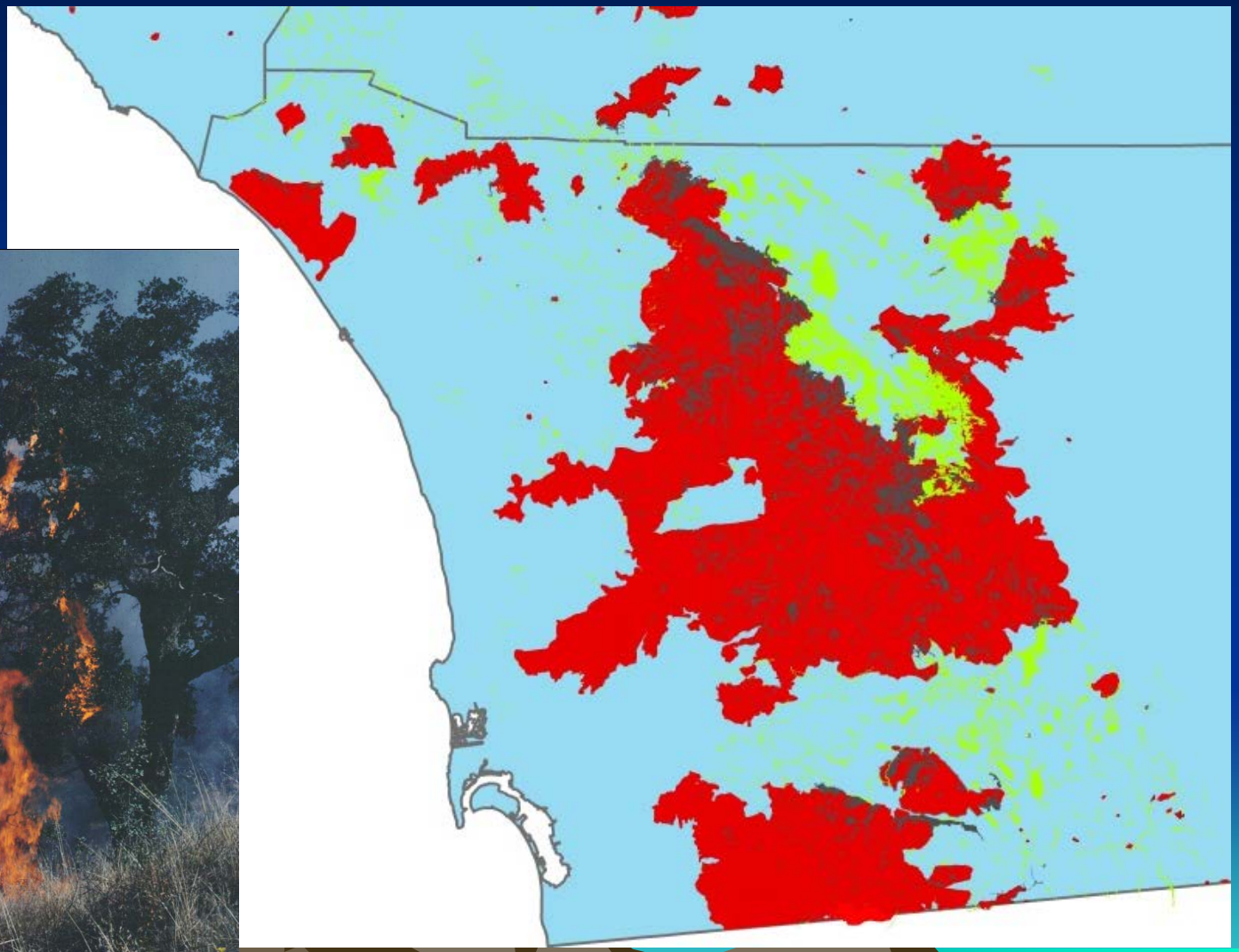


40 oaks recruited during period of high precipitation 1990-1998
30 oaks survived from 2003 to 2014 (drought)



Another factor: about 46% of the distribution of Coast Live Oak (*Quercus agrifolia*) burned between 2003 and 2007

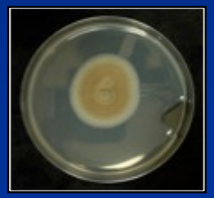




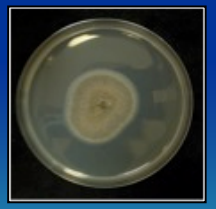
Aggressive native and non-native pathogens


Diplodia corticola

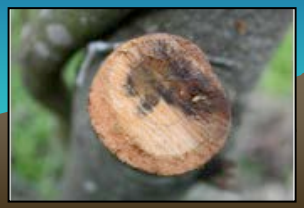

Pezicula spp.

Diatrypella sp.

Togninia fraxinopennsylvanica




Bionectria ochroleuca

Slide provided by Shannon Lynch and Akif Eskalan

Restoration of abandoned agricultural land may be limited by legacy fungal pathogens

(Hilbig & Allen 2015)

Restoration of native forbs for Stephen's Kangaroo Rat habitat at Lake Mathews. Citrus was removed when the site was acquired as part of the Riverside County MSHCP.

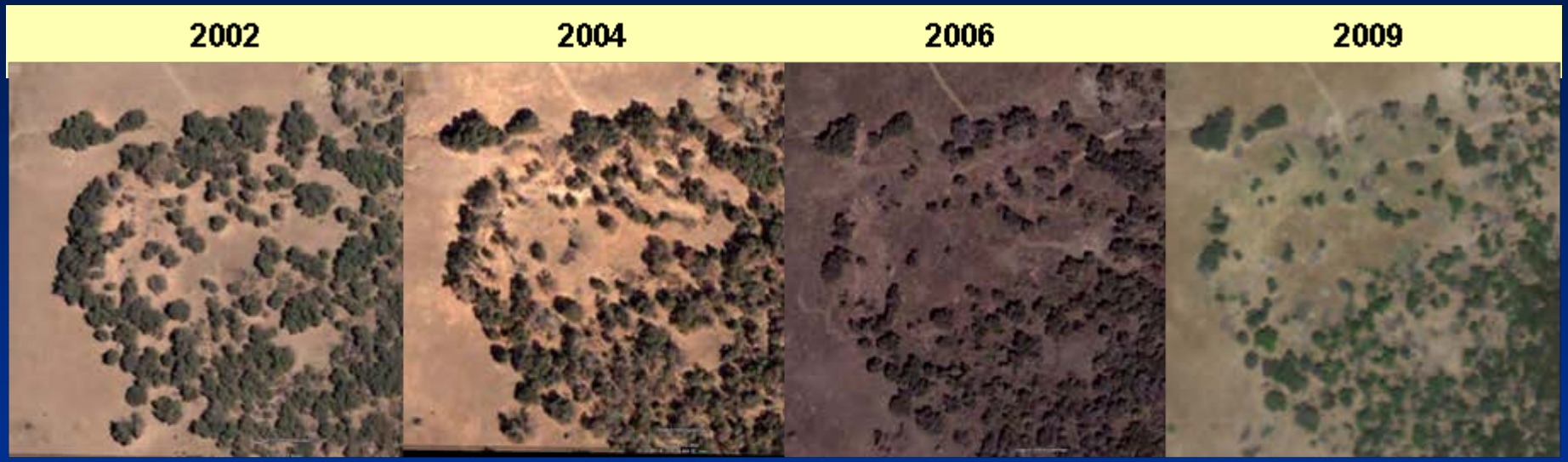
***Phytophthora* spp in native forb root**

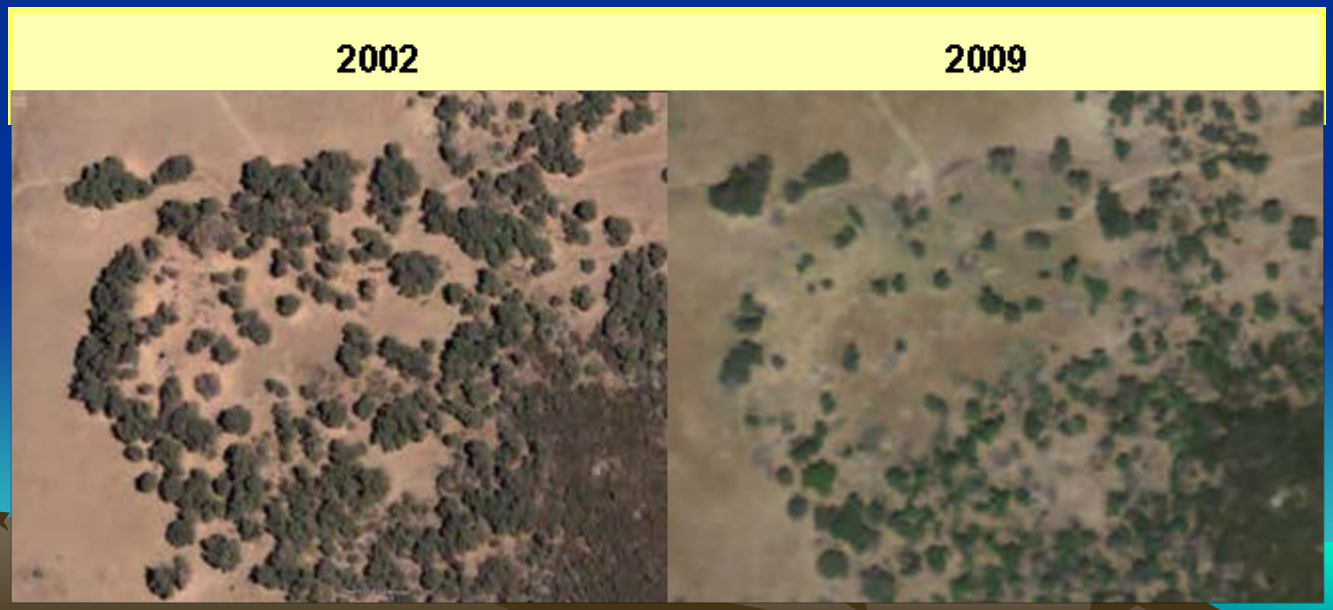
***Rhizoctonia* spp isolated from forb roots**

Recuperation: It is often difficult to project the trajectory of ecosystem recuperation

Resilience, plasticity, response to perturbation in all ecosystems

INTERVENTION: DEATH IN A COMMON CALIFORNIA OAK SPECIES





Our emphasis of "Do no harm" in restoration comes from the strong parallel between restoration practices and medicine:

Both medicine and restoration are based on **INTERVENTIONS** (into ongoing natural processes /situations)

balancing **INVASIVE** actions with

natural **RECUPERATION**

So you're willing to conceptualize ecosystems as patients, then the history of medical practices provides strong lessons for restoration ecology

Written into the 4th century BCE compendium of Greek medicine (*Hippocratic Corpus, Epidemics* I.11):

" As to diseases, make a habit of two things: to help, or at least to do no harm."

Thomas Sydenham (1624-1679) quoted by Thomas Inman (*Foundation for a New Theory and Practice of Medicine,*1860):

"Primum non nocere" **(above all, do no harm!)**

The need to invoke *Primum non nocere* in medicine now seem self evident:

Bleeding patients was a common practice from the ancient Egyptians until the start of the 20th Century.

In 1799 George Washington was bled 5 times in 13 hours by his physicians

- **Removed about 53% of his blood volume (3.75 liters)**
- **Although he was considered a robust 68-year old, he died of a combination of hypovolemic shock (>20% blood volume loss), exacerbated by a throat infection**
- **Wasn't discussed as a cause until 1903, still ignored in a 1933**

Even though the medical concept of hemostasis (stopping death by blood loss) preceded the practice of bloodletting, physicians routinely jeopardized their patients with this practice

So a practice from the dark ages was still considered a treatment for general conditions in 1860.

Bleeding survived into a 1923 Medical Text (William Osler, *Principles and Practice of Medicine)*.

So as physicians have struggled with the extent of their interventions, *Primum non nocere* became entrenched in the oral history of modern medicine as:

"First do no harm"

This concept is such a conventional wisdom that most of us assume that this phrase is enshrined in the Hippocratic Oath

….but it isn't. It's left over as an unspoken principle, to be adopted ad hoc by practitioners to balance humility to hubris.

…so just like medical practitioners, we need to routinely assess our restoration practices to insure that our interventions don't harm the ecosystems we seek to improve.

With that said,

no intervention is free of risk.

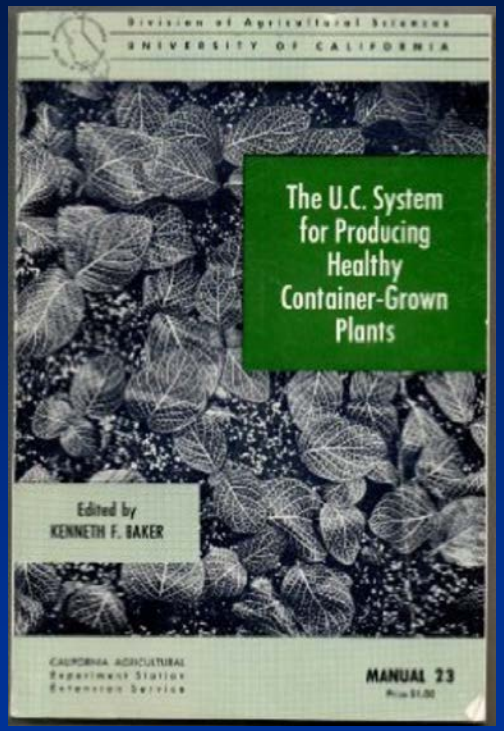
Like the Star Wars missile shield, no amount of BMPs, funding, and vigilance can guarantee that pathogens will be kept out of rare plant populations

Some population of rare plants may too important and too challenged to risk even a slightest chance of pathogen introduction

Some populations may never recuperate on their own

So we have to balance the risks and consequences of intervention and enhanced recuperations in any restoration project

Today we're discussing a nursery stock and disease



Baker, KF. 1957. The U.C. system for producing healthy container-grown plants: Through the use of clean soil, clean stock, and sanitation (California Agricultural Extension Service. Manual 23) 331 pages

Zentmyer, GA, 1967. Avocado root rot (Circular / University of California, College of Agriculture, Agricultural Experiment Station) 221 pages.

Zentmyer G A and H D Ohr. 1978 Avocado Root Rot University of California leaflet 2440. 12 pages

We know Best Management Practices for container stock in nurseries, we know how to minimize the spread of disease in container stock. But we have to follow these practices and to make sure that those BMPs are understood by those who manage restoration projects, who create project specifications, standards, and monitoring, as well as those who pay for restoration.

In that spirit, this first annual workshop today is not designed to tell you what to do.

And when we suggest

(first) Do no harm

We’re hoping to present information about current practices, alternatives, and the consequences, costs, benefits to help you make that decision