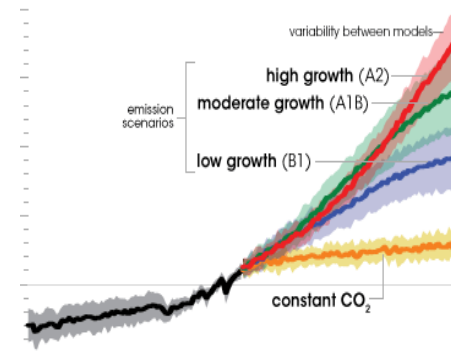
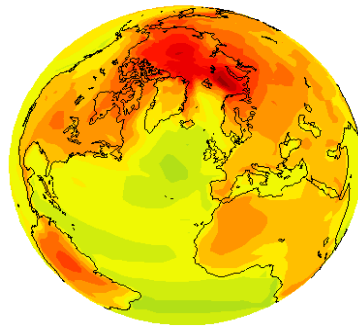




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PRBO Conservation Science



# Climate-smart ecological restoration: framework and lesson learned from a coastal California stream

Thomas Gardali, Nathaniel E. Seavy, John J. Parodi, Leia Giambastiani, and Stephanie C. Nelson

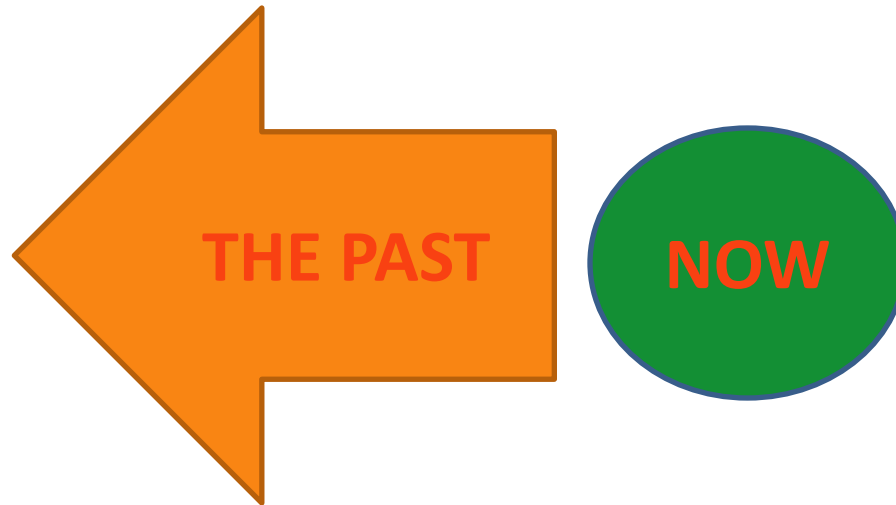
June 2013 – Middle Sacramento River Science Conference, Chico, CA

# Presentation Outline

1. Restoration Ecology
2. Climate-smart ecological restoration defined
3. Climate-smart ecological restoration principles
4. Principles to practice
5. Case study – lesson learned



# Ecological Restoration

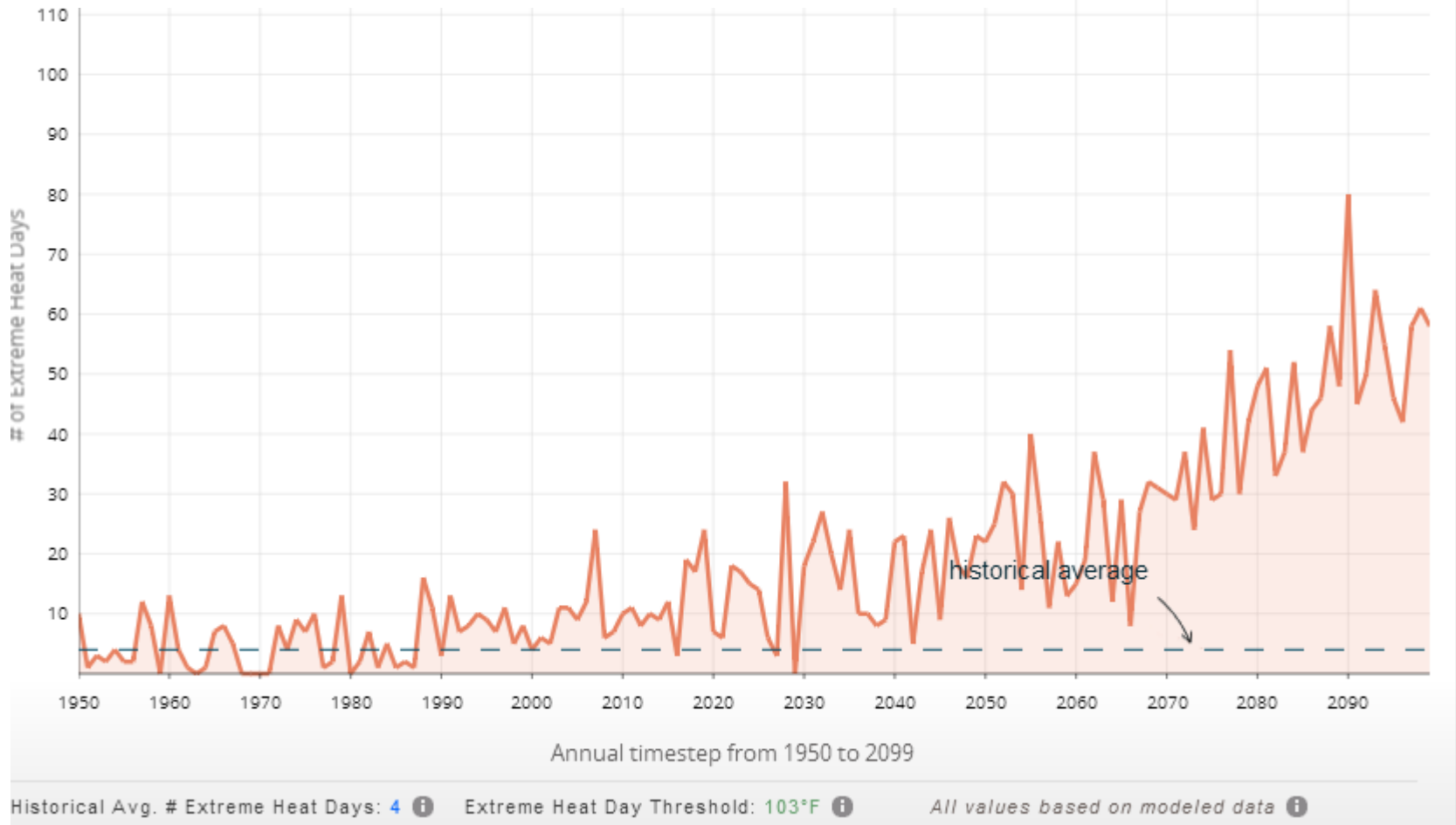




**Ecological restoration** is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Society for Ecological Restoration 2004)

# Climate Change: Restoration Game Changer

## Number of Extreme Heat Days by Year



# Climate-smart Ecological Restoration defined

**Climate-smart ecological restoration** is the process of enhancing ecological function of degraded, damaged, or destroyed areas in a manner that prepares them for the consequences of a rapidly changing climate.

**DRAFT**

# Climate-smart Ecological Restoration Principles

## **1. Look forward but don't ignore the past**

- *Forward looking goals, use climate predictions, historic analogs*

## **2. Consider the broader context**

- *Landscape, non-climate threats, prioritization*

## **3. Build in ecological insurance**

- *Redundancies, ecological diversity*

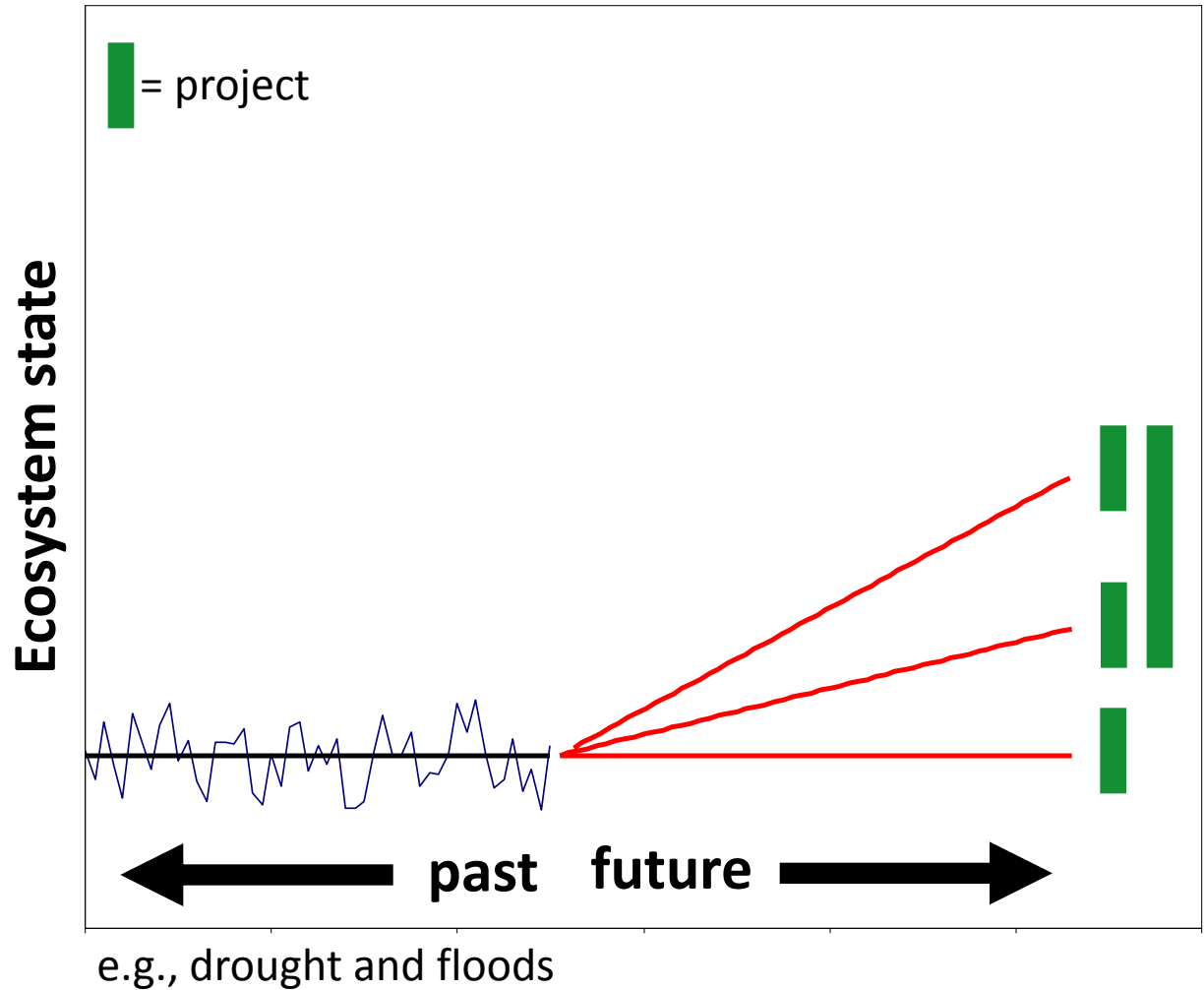
## **4. Build evolutionary resilience**

- *Increase size/connectedness, source seeds from other regions*

## **5. Include the human community**

- *To implement, monitor, steward*

# Principles in action

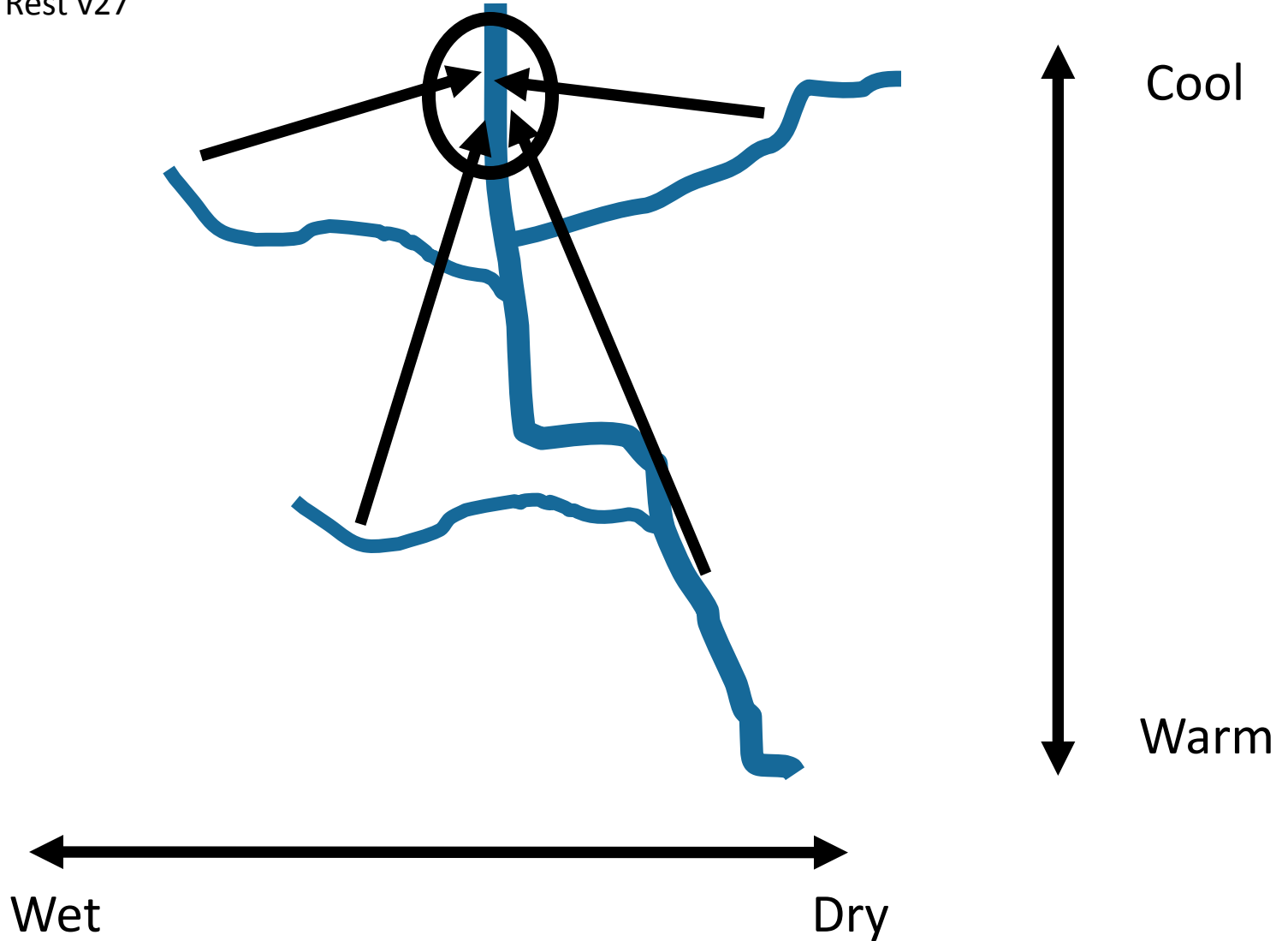


Prioritize and design projects that could succeed under multiple scenarios



# Principles in action

Seavy et al., Ecol. Rest v27



# Principles in action

## Increase Component and Structural **Redundancy**



# Principles in action



## California Bird Species of Special Concern

Home Maps Resources About Partners

This Bird Species of Special Concern (BSSC) Implementation website, a collaboration between PRBO Conservation Science and the California Department of Fish and Game, aims to implement the recommendations detailed in the 2008 BSSC monograph in order to prevent further declines of California's native birds. [Learn more.](#)



Climate Change

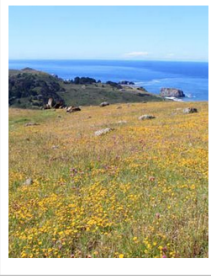


BSSC Publication

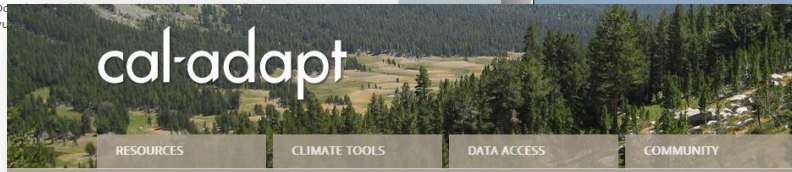


Explore Maps

Mouse over an image above to change your options

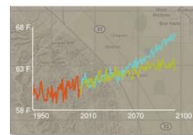


### Climate Change Vulnerability



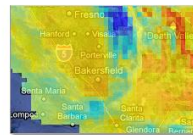
### Climate Tools

Local Snapshot • Temperature • Snowpack • Precipitation • Sea Level Rise • Wildfire



### LOCAL CLIMATE SNAPSHOTS

The Local Climate Snapshot tool has been developed to provide quick access to some of the most change data for a given location. Just enter an address or click on the map and you will get simple statistics for your area.



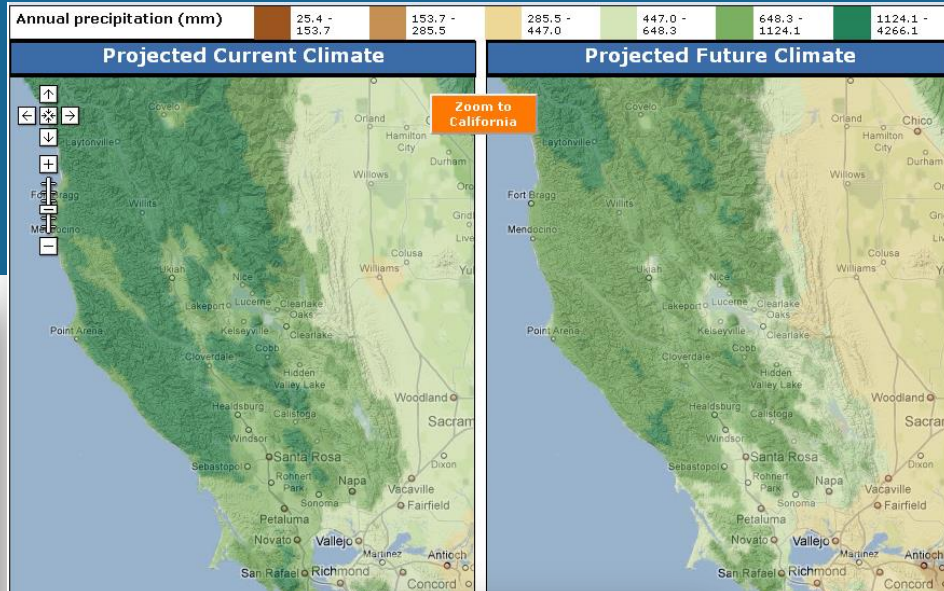
### TEMPERATURE: DECADEAL AVERAGES MAP

View a map displaying the projected temperature for each decade from 1950-2099 for each month of the year using a variety of climate models and scenarios.



### TEMPERATURE: DEGREES OF CHANGE MAP

Not all areas of the state will experience the same amounts of changing temperatures. View a map displaying the degrees of change that is projected to occur throughout California



**OPEN ACCESS study available online**

**A Climate Change Vulnerability Assessment of California's At-Risk Birds**

Thomas Gardali<sup>1</sup>, Nathaniel E. Seavy<sup>1</sup>, Ryan T. D'Antonio<sup>1</sup>, Lyann A. Comstock<sup>1</sup>

**Abstract**  
Conservationists must develop new strategies and adaptation tools to address the consequences of anthropogenic climate change. To support evidence-based conservation, we developed a framework for assessing climate change vulnerability of California's at-risk birds and mammals. We created California Bird Species of Special Concern (BSSC) and Mammal Species of Special Concern (MSC) lists. We estimated the magnitude of climate change expected for each taxon. Using the combined sensitivity and exposure scores we ranked BSSC and MSC taxa and identified 22 at-risk bird species and 12 at-risk mammal species. We ranked the largest representation on the list relative to other taxonomic groups. Of the 29 taxa or federally listed taxa, 21 were also classified as climate-vulnerable. Further, among climate-vulnerable BSSC and MSC taxa, 10 were also classified as species of special concern. The authors have made the taxonomic lists and all metadata publicly available for use. Our program illustrates a simple, reproducible action that can be taken to inform climate change adaptation strategies for birds.

**Introduction**  
Climate change poses significant threats to global biodiversity (1). Our understanding of these threats is in part based on scientific evidence that examines the effects that climate change has had on natural systems (2,3,4) and on the specific growing number of models that predict declines in when species diversity or climate conditions are projected to occur under various climate change scenarios (5, 6). Higher resolution climate data analysis, this information does not, by itself, provide clear direction to conservationists. To address this gap, conservation scientists and practitioners have been working at several spatial and temporal scales to find meaningful ways to assess the threats of climate change. In a similar, there are general conservation principles and recommendations for adapting management to the projected consequences of climate change (7,8). However, such general principles may fail to provide clear and targeted guidance in the absence of information about which species and communities are most vulnerable to climate change and how vulnerability interact with conservation (9,10). One approach that appears promising for identifying vulnerable and prioritizing adaptation efforts is to modify existing conservation tools by incorporating vulnerability assessment back as missing elements and proposed local-scale change with one-to-one species-level climate change. Traditional conservation planning has relied heavily on lists of sensitive species to guide policy and priority.

**Methods**  
To assess the vulnerability of California's at-risk birds and mammals to climate change, we developed a framework for assessing climate change vulnerability of California's at-risk birds and mammals. We created California Bird Species of Special Concern (BSSC) and Mammal Species of Special Concern (MSC) lists. We estimated the magnitude of climate change expected for each taxon. Using the combined sensitivity and exposure scores we ranked BSSC and MSC taxa and identified 22 at-risk bird species and 12 at-risk mammal species. We ranked the largest representation on the list relative to other taxonomic groups. Of the 29 taxa or federally listed taxa, 21 were also classified as climate-vulnerable. Further, among climate-vulnerable BSSC and MSC taxa, 10 were also classified as species of special concern. The authors have made the taxonomic lists and all metadata publicly available for use. Our program illustrates a simple, reproducible action that can be taken to inform climate change adaptation strategies for birds.

**Discussion**  
Conservationists must develop new strategies and adaptation tools to address the consequences of anthropogenic climate change. To support evidence-based conservation, we developed a framework for assessing climate change vulnerability of California's at-risk birds and mammals. We created California Bird Species of Special Concern (BSSC) and Mammal Species of Special Concern (MSC) lists. We estimated the magnitude of climate change expected for each taxon. Using the combined sensitivity and exposure scores we ranked BSSC and MSC taxa and identified 22 at-risk bird species and 12 at-risk mammal species. We ranked the largest representation on the list relative to other taxonomic groups. Of the 29 taxa or federally listed taxa, 21 were also classified as climate-vulnerable. Further, among climate-vulnerable BSSC and MSC taxa, 10 were also classified as species of special concern. The authors have made the taxonomic lists and all metadata publicly available for use. Our program illustrates a simple, reproducible action that can be taken to inform climate change adaptation strategies for birds.

**Conclusion**  
Conservationists must develop new strategies and adaptation tools to address the consequences of anthropogenic climate change. To support evidence-based conservation, we developed a framework for assessing climate change vulnerability of California's at-risk birds and mammals. We created California Bird Species of Special Concern (BSSC) and Mammal Species of Special Concern (MSC) lists. We estimated the magnitude of climate change expected for each taxon. Using the combined sensitivity and exposure scores we ranked BSSC and MSC taxa and identified 22 at-risk bird species and 12 at-risk mammal species. We ranked the largest representation on the list relative to other taxonomic groups. Of the 29 taxa or federally listed taxa, 21 were also classified as climate-vulnerable. Further, among climate-vulnerable BSSC and MSC taxa, 10 were also classified as species of special concern. The authors have made the taxonomic lists and all metadata publicly available for use. Our program illustrates a simple, reproducible action that can be taken to inform climate change adaptation strategies for birds.

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**Projected Effects of Climate Change in California: Ecological Summaries Emphasizing Consequences for Wildlife**

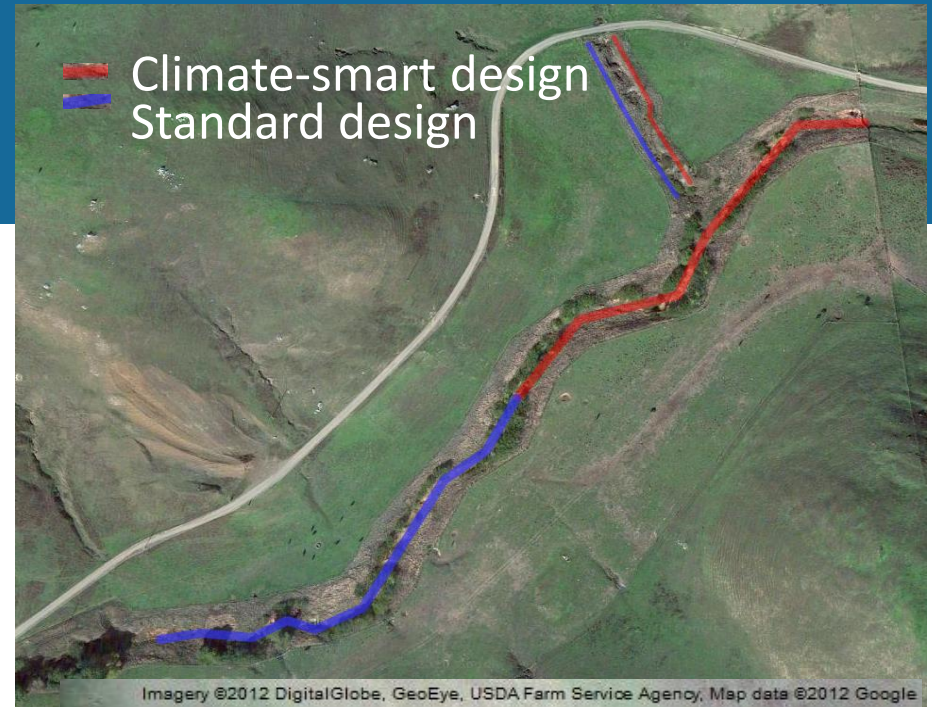
Version 1.0 • 10 February 2011

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# Project Description

- Riparian restoration (revegetation)
- 0.35 river miles
- Side-by-side comparison

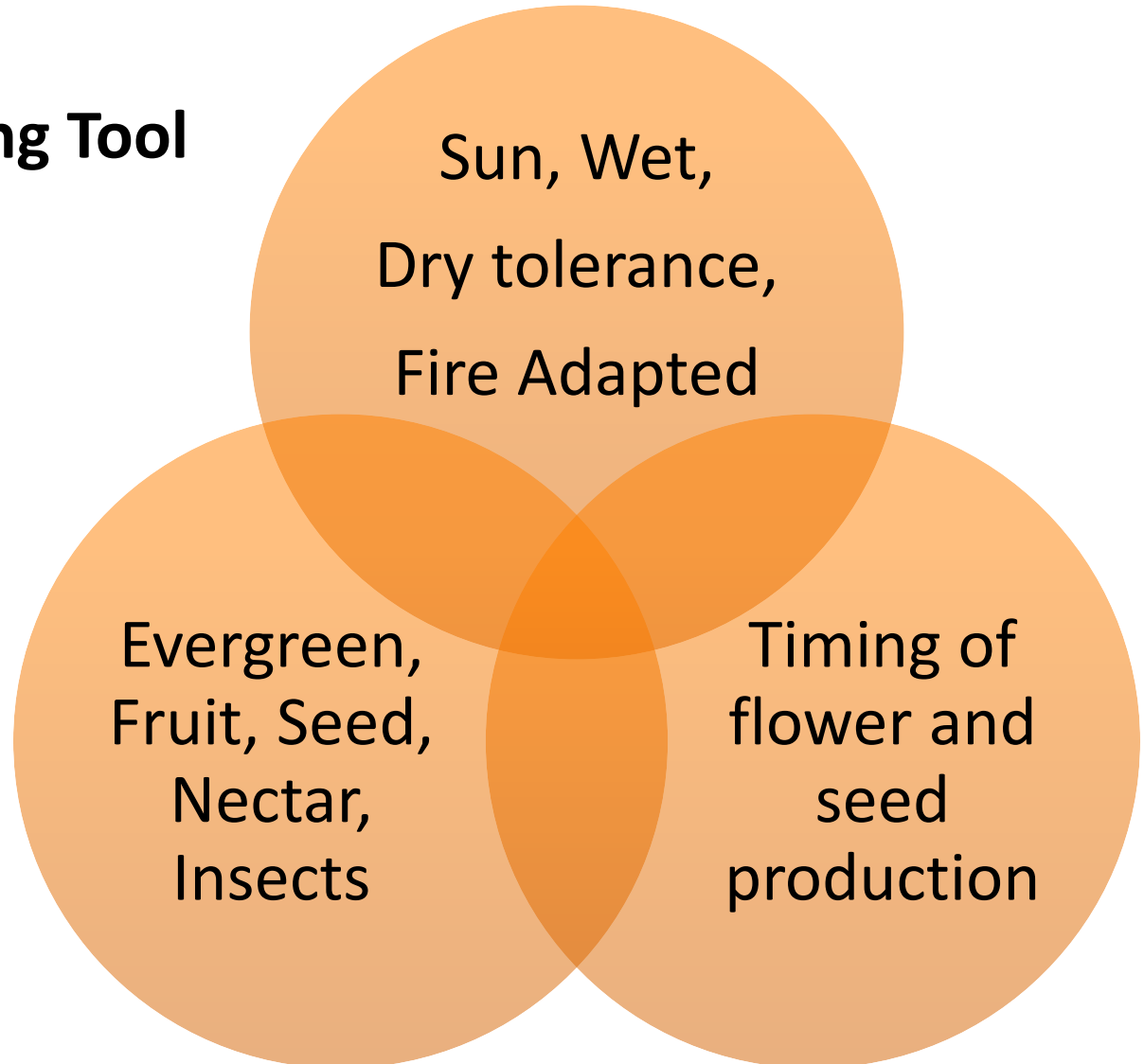


## GOALS - water quality and wildlife habitat

- (1) Reduce the vulnerability of the area to extreme weather events by increasing the capacity of the restoration to rebound from longer and/or more frequent periods of drought, floods, and to a lesser extent fire.
- (2) Reduce the vulnerability of wildlife to phenological mismatches by increasing the number of months and the amount of resources (cover, food) available.

# Practices on-the-ground

## Simple Planting Tool

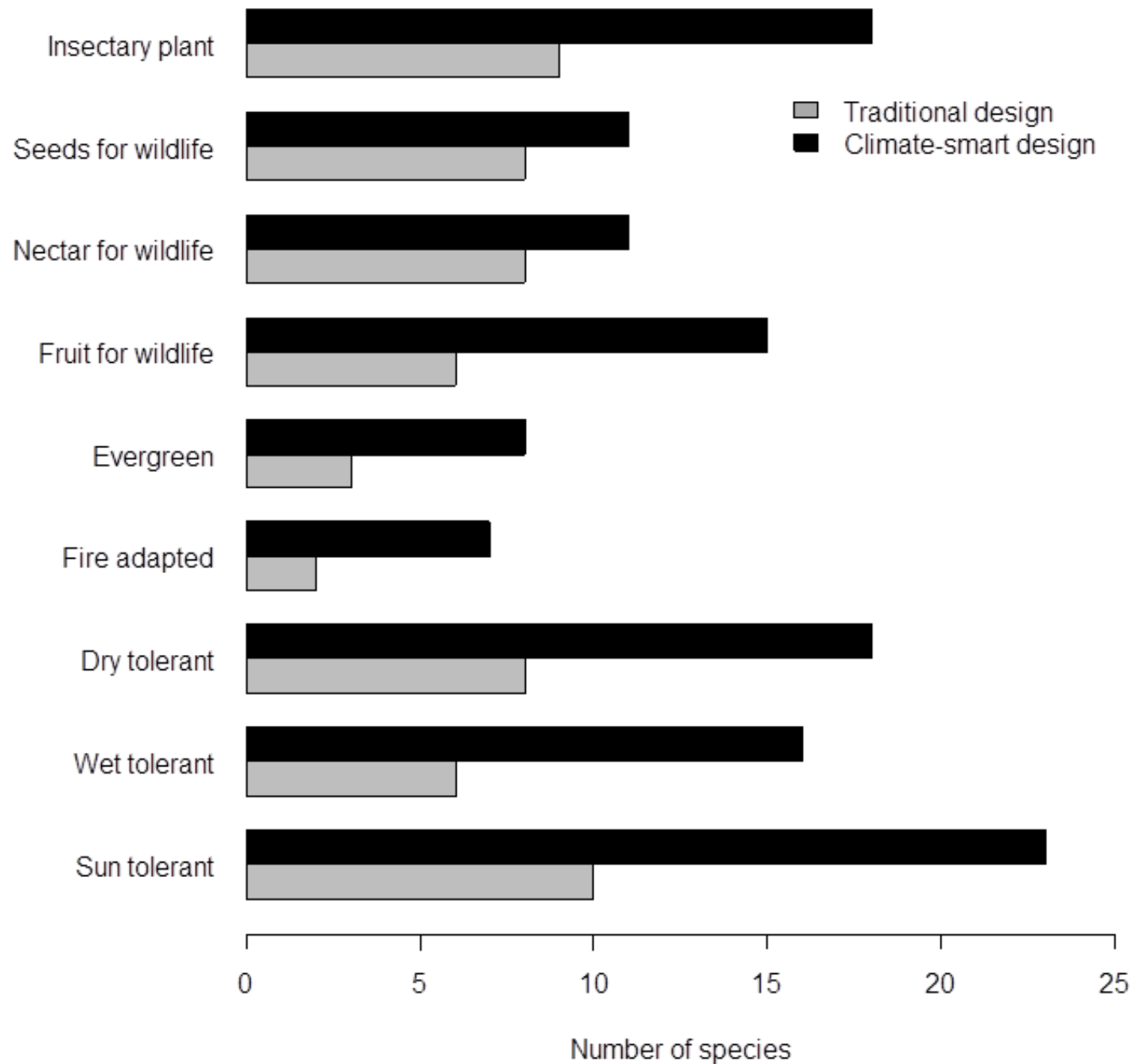


# Developed Planning Matrix

We created a tool to evaluate appropriate plant species and their environmental qualities

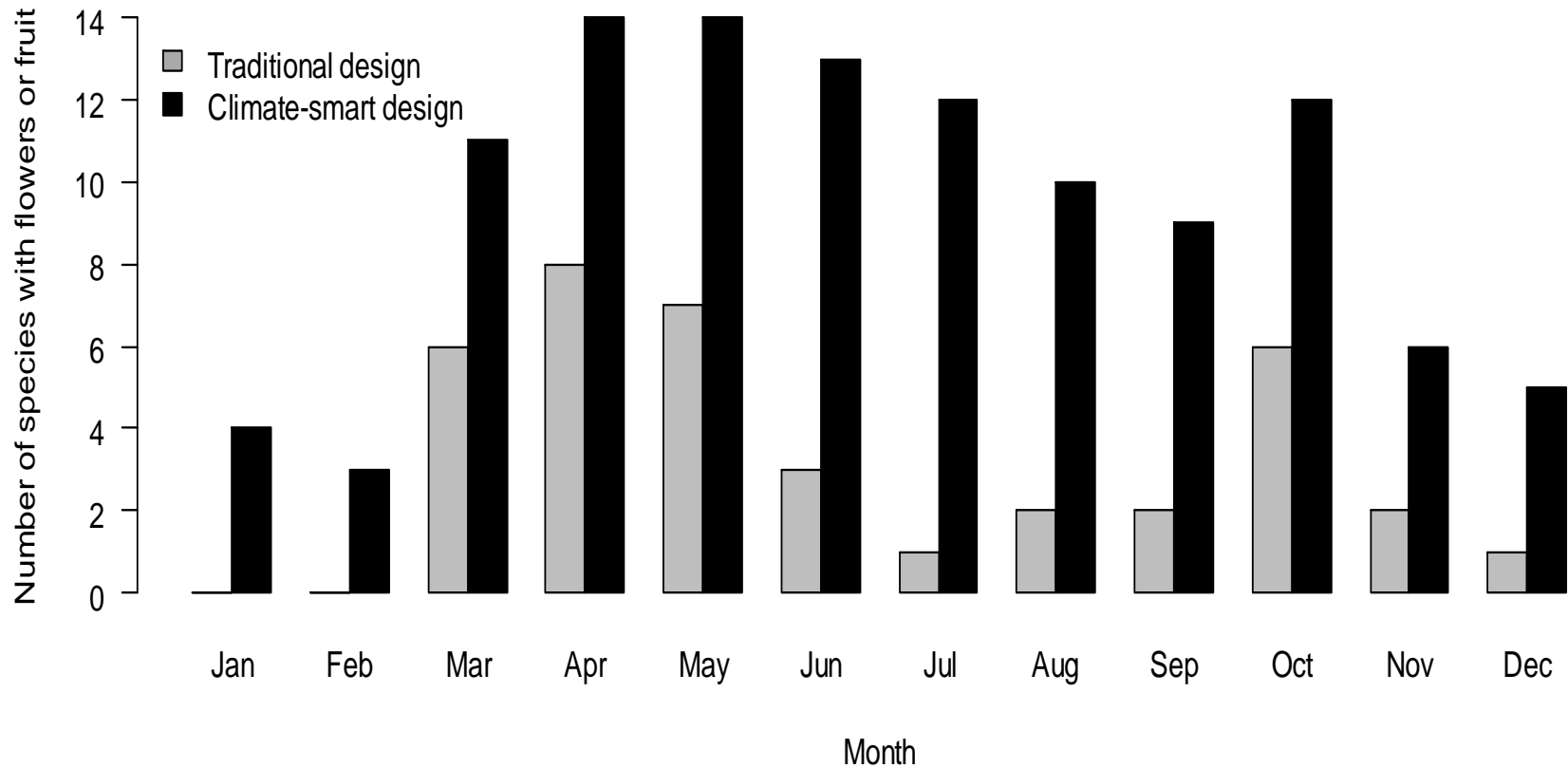
Common Name	Tolerates full or partial sun	Tolerates clay soil	Tolerates wet conditions	Tolerates dry conditions	Evergreen	Fire Adapted	Wildlife fruit source	Wildlife Nectar source	Wildlife Seed Source	Insectary Plant
Sticky manzanita	1		0	1	1	1	1	1		1
common manzanita	1	1	0	1	1	1	1	1		1
Bearberry	1	1	0	1	1	1	1	1		1
Marin manzanita	1		0	1	1	1	1	1		1
CA Sagebrush	1	1	0	1	1	1	0	1	1	1
Salt Marsh Baccharis	1	1	1	1	0					1
coyote brush	1	1	1	1	1	1	1	0	1	1
spice bush	1	1	1	1	0		0	0	0	1
Ceanothus	1			1	1	1	0	1	1	1
blue blossom	1		0	1	1	1	0	1	1	1
Mountain Mahogany	1	1	0	1	0	1	0	1	1	1
Creek dogwood	1	1	1	0	0		1	1	0	1
hazelnut	1	1	1	0	0		0	1	1	1
Hawthorne	1	1	1	1	0		1	1	1	1
Western leatherwood	1	1	1	0			1			
fremontia/ flannelbush	1	1	0	1	1	1	0	1	1	1
Toyon	1	1	0	1	1		1	1		
Greenthumb	1	1	1	1	0		0	1	1	1







# Implementation: Practices on-the-ground



# Implementation: Practices on-the-ground

282 students and 82 parents

Climate-smart design: 24 species

Traditional design: 10 species



*Planting more species required higher planting densities . . . .*

Climate-smart: 249 individual plants

Traditional: 123 individuals plants

The cost of the climate smart restoration was only 1.5 times that of the traditional design, despite the higher densities and number of species.

# Lessons Learned

- Species were not available from nurseries, limiting the final project's design
- A larger minimum project size is necessary for redundancy and self-propagation
- Potential regulatory challenges for projects with strict performance criteria
- There is a need to look beyond revegetation
- The public, planners, resource managers, etc. are inspired and hungry to take actions to adapt to climate change



# Next Steps

## Science

- More case studies are needed
- New online tools such as analogue climates and planting designs
- Partnering with engineers – e.g., large woody debris projects
- Expanding our planting palette tool
- Working with a geneticist to include evolutionary resilience

## Practice

- Additional habitat types
- Increase scale by expanding partnerships
- Restoration funders put language in their RFPs about how each project will address climate change in the context of our definition and principles.

## Policy

- Work with the agencies that approve restoration plans to include climate-smart designs
- Work with agencies that provide guidance on restoration to include climate-smart designs
- Work with DFG to update their restoration handbook

Thanks!

**Tom Gardali**

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**Point Blue**  
Conservation  
Science