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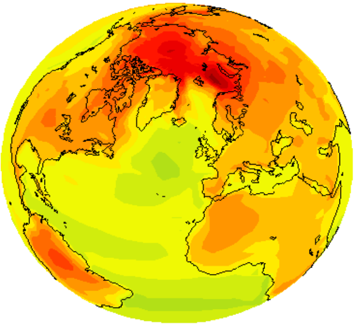

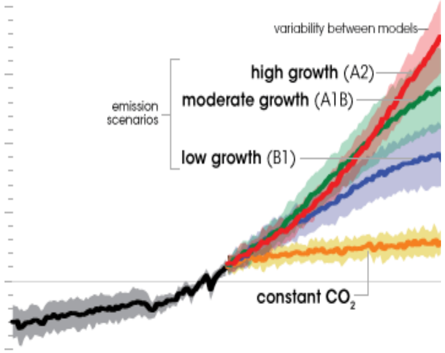

Doing restoration in a climate change context: examples for riparian systems

Thomas Gardali and Nathaniel E. Seavy

4 May 2010, *Stream Restoration Success II, Novato CA*

Presentation Outline

1. Climate change and restoration
2. Restoration goals and strategies
3. Importance of riparian habitat
4. Specific examples

Climate Change and Restoration – CHALLENGES

1. Rapid speed of change
2. Uncertainty is high
3. Moving target
4. Uncharted territory
5. Why bother?

Climate Change and Restoration

Novel ecosystems

ecosystems that differ in composition and/or function from present and past systems

Climate Change and Restoration

Novel ecosystems: implications for conservation and restoration

Richard J. Hobbs[1], Eric Higgs[2] and James A. Harris[3]

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[2] School of Environmental Studies, University of Victoria, Victoria, BC, V8W 2Y2, Canada
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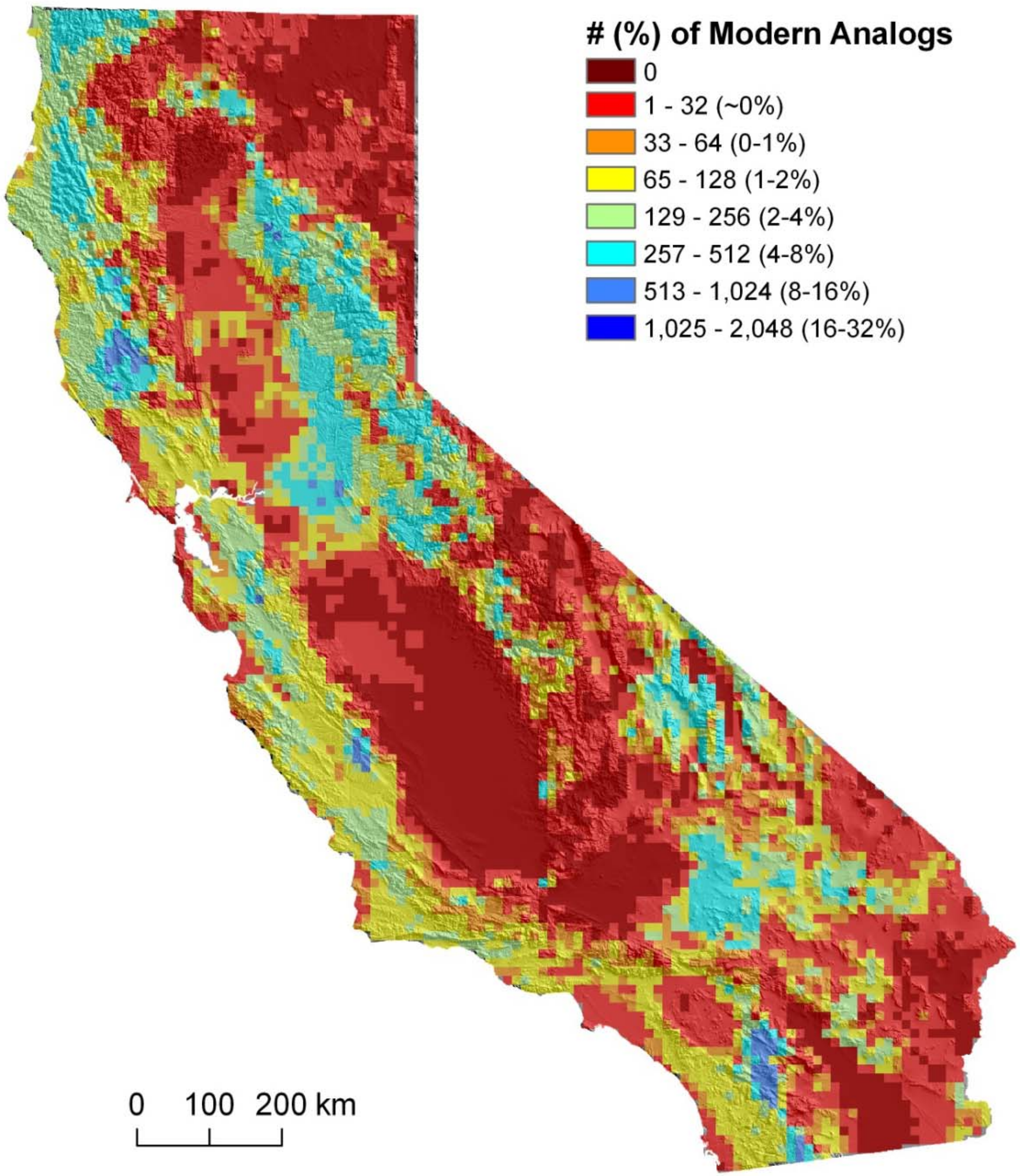
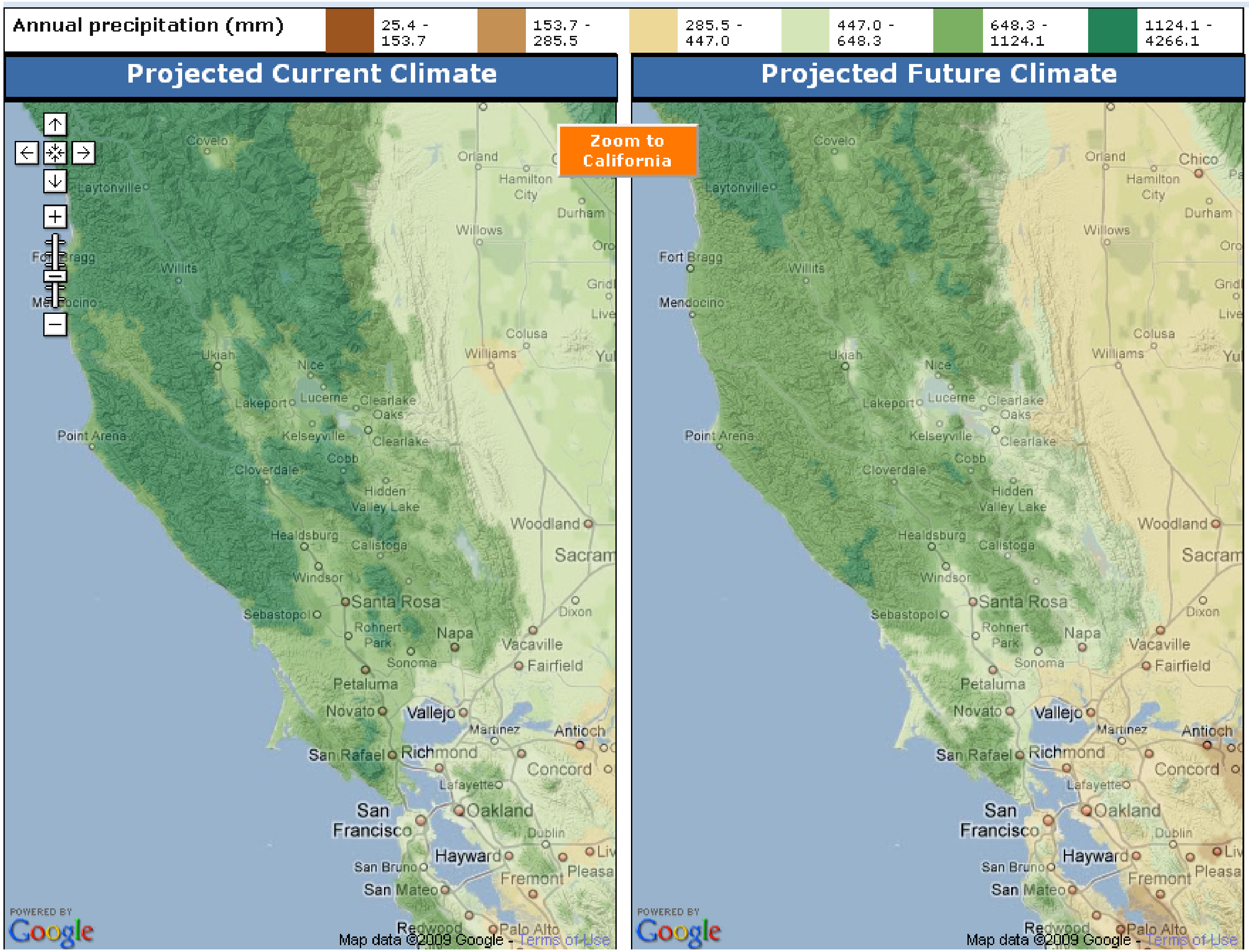


As much as half of California could be occupied by new bird communities by 2070

Source: PRBO, Stralberg et al. 2009. PLoS ONE v4

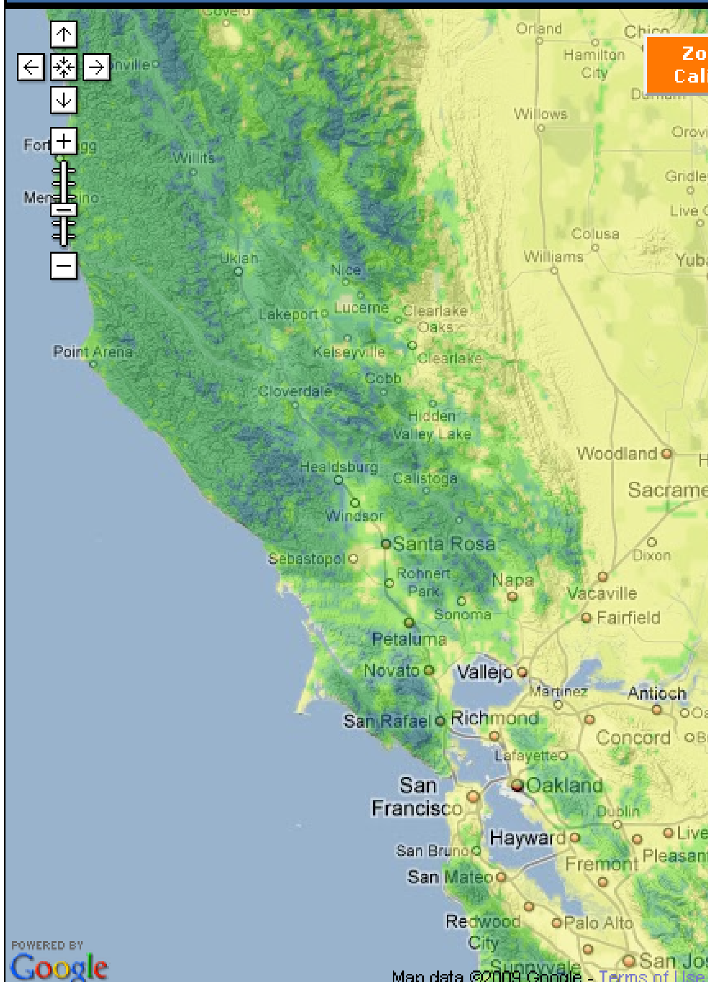
Climate Change and Restoration – Challenges



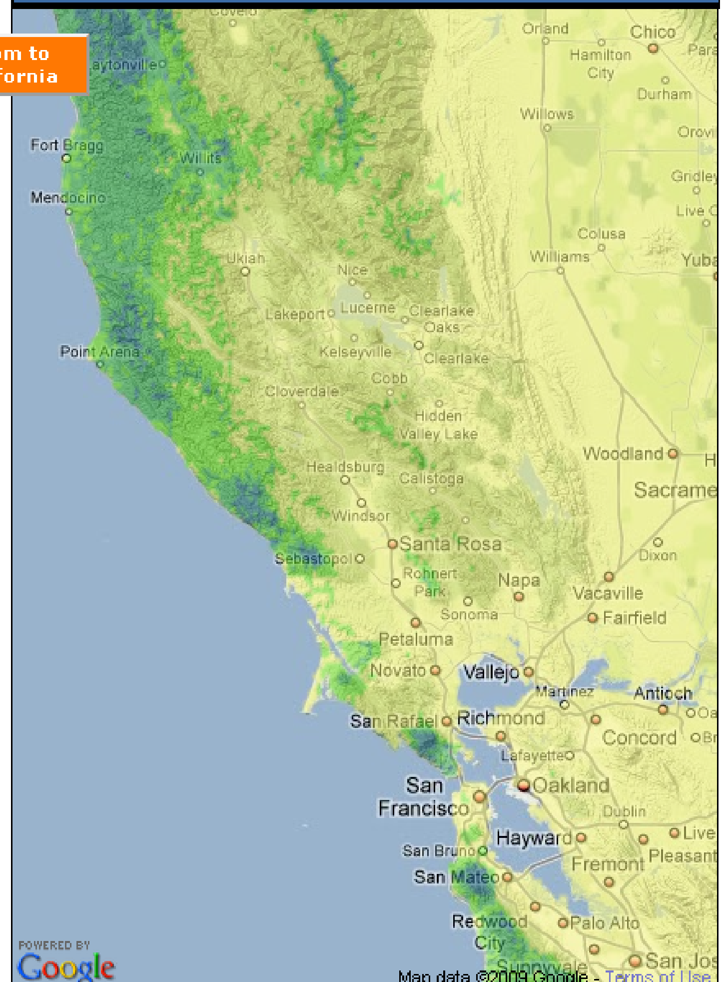
Climate Change and Restoration – Challenges

Probability of occurrence: 0-20% | 20-40% | 40-60% | 60-80% | 80-100%

Projected Current Distribution



Projected Future Distribution



Warbling Vireo

Photo (c) Peter LaTourrette

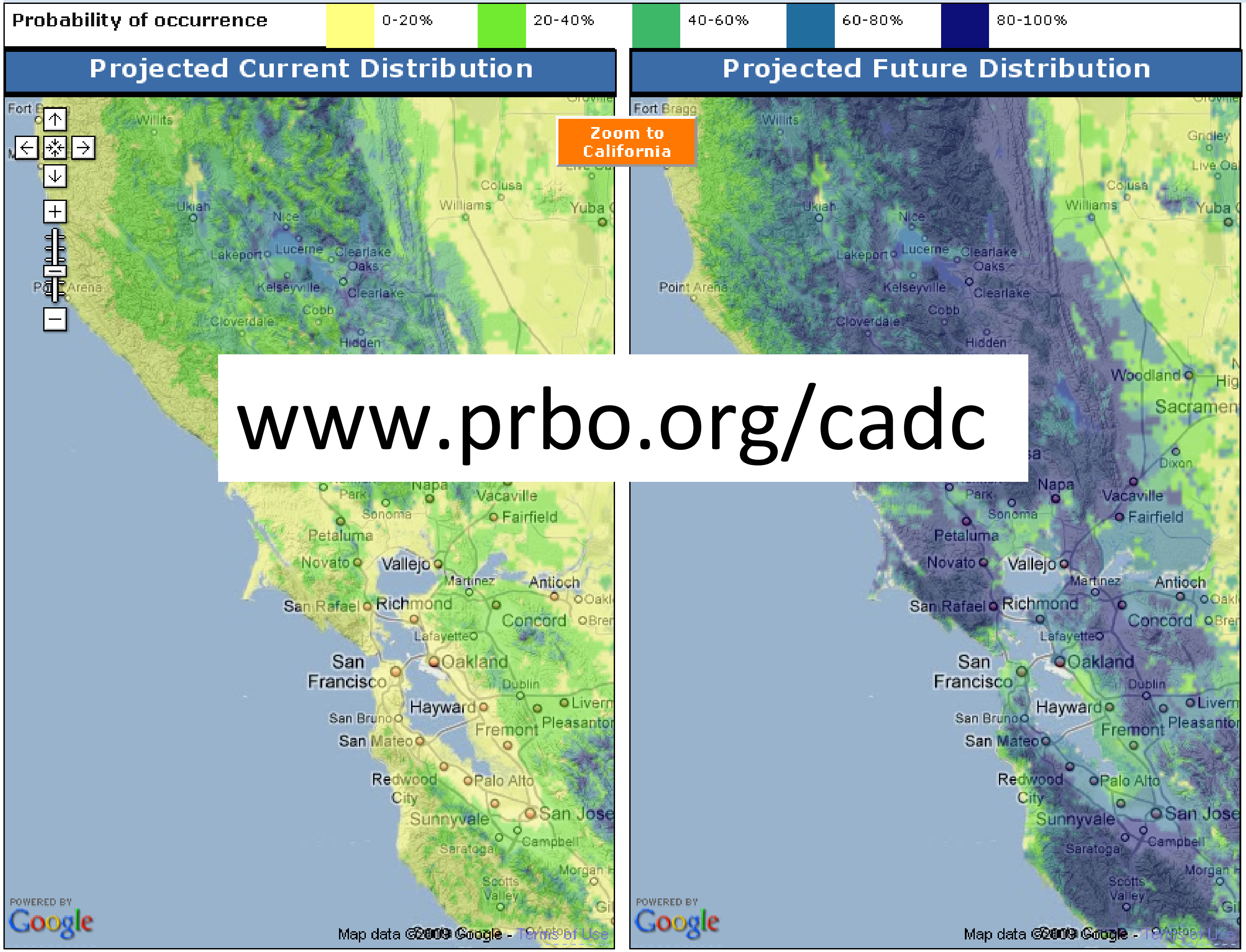
Learn more about the **Warbling Vireo** at All About Birds or read the Partners In Flight species account

Variables in order of Importance

1. Distance to stream
2. Precipitation of driest quarter
3. Annual precipitation
4. Vegetation
5. Precipitation seasonality
6. Mean temperature of the warmest quarter
7. Isothermality
8. Temperature seasonality
9. Annual mean temperature
10. Mean diurnal range

? - variable definitions

Climate Change and Restoration – Challenges



www.prbo.org/cadc

Blue-gray Gnatcatcher

Photo (c) Peter LaTourrette

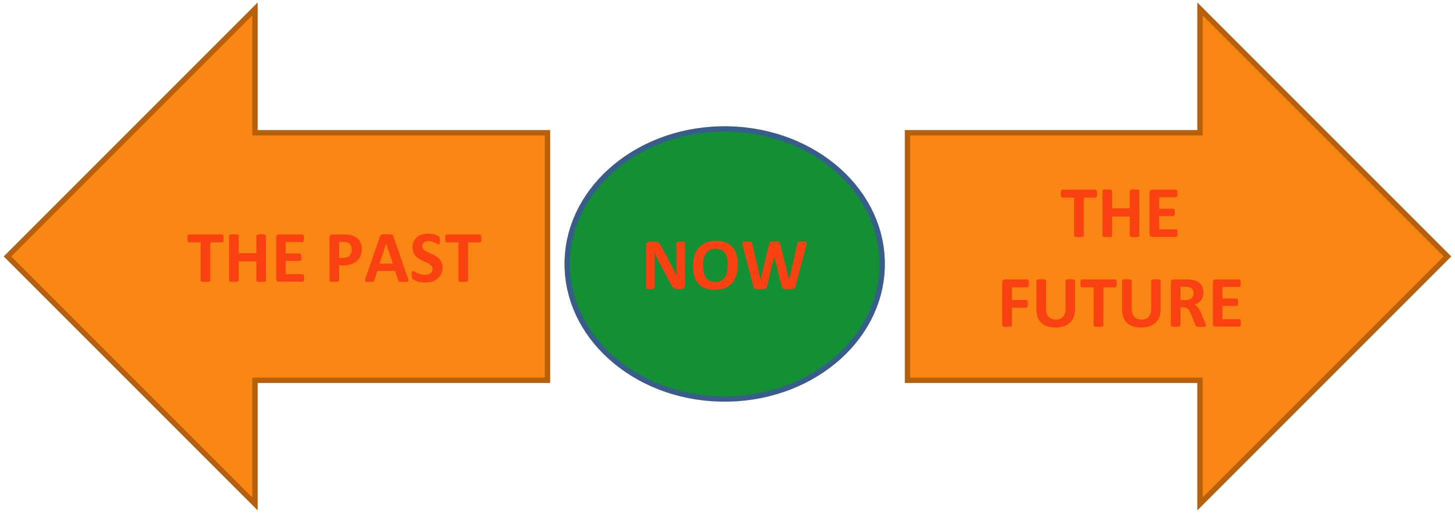
Learn more about the **Blue-gray Gnatcatcher** at All About Birds or read the Partners In Flight species account

Variables in order of Importance

1. Vegetation
2. Precipitation seasonality
3. Precipitation of driest quarter
4. Annual precipitation
5. Isothermality
6. Distance to stream
7. Annual mean temperature
8. Mean diurnal range
9. Mean temperature of the warmest quarter
10. Temperature seasonality

? - variable definitions

Restoration Goals and Strategies



Restoration often has past (historic) systems as a goal, but also needs to consider future conditions

Restoration Goals – the historical perspective

What do we restore for now?

Specific species (e.g., threatened and endangered)

Species groups (e.g., migratory birds)

Historic acreage

Community composition

Restoration Goals

What are some alternative restoration goals?

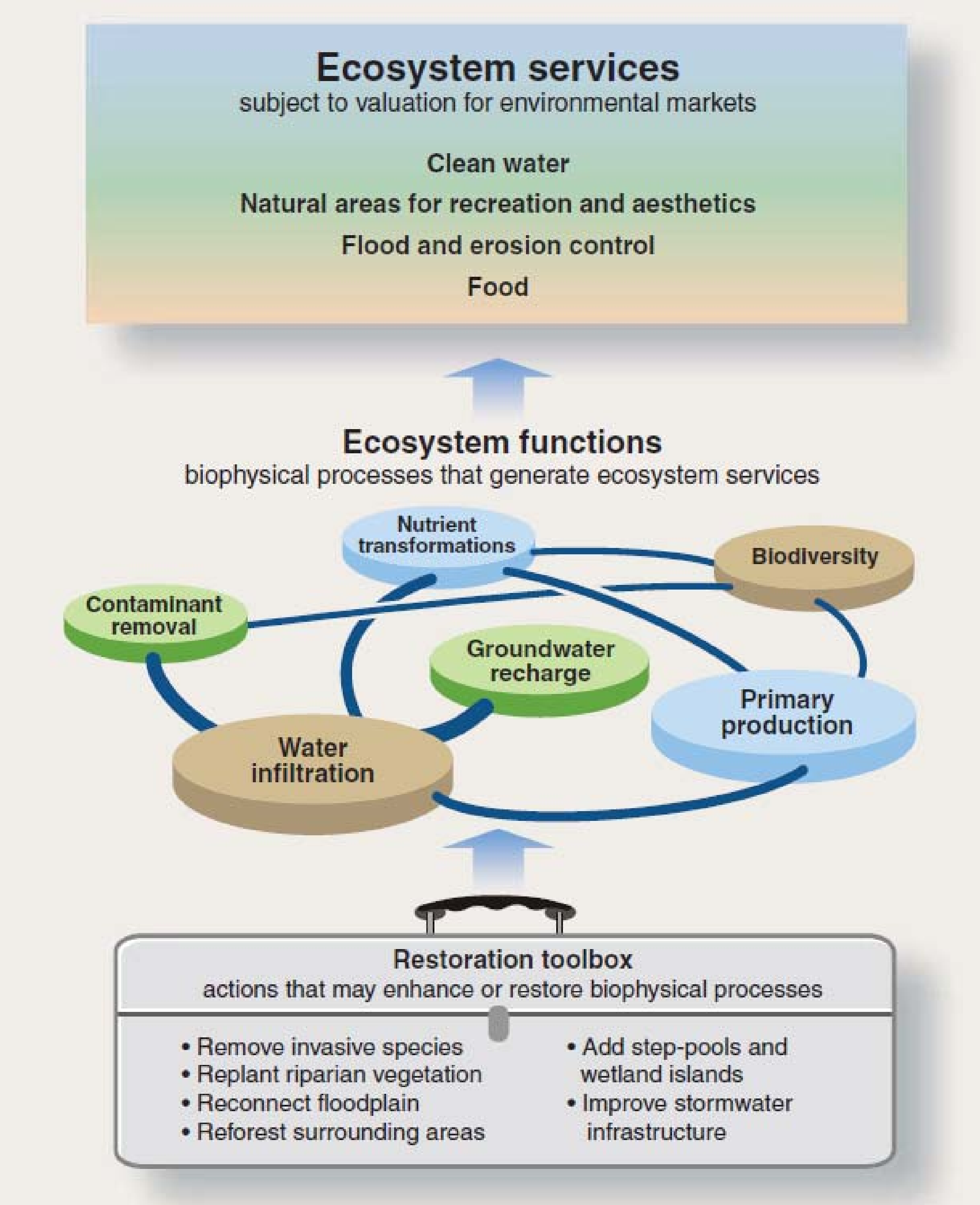
Ecosystem Structure
Shape and spatial distribution of ecosystem components

Ecosystem Function
Biophysical processes and ecosystem features

Ecosystem Services
The benefits humans derive from ecosystems

Goals not mutually exclusive

Set specific goals and quantitative performance measures



Source: Palmer & Filoso, Science v325

Adapting to Climate Change

The good news is . . . .

Ecological restoration IS an essential adaptation strategy for climate change.

E.g., Makes systems more resilient to extreme events such as storms and floods

Source: West et al., Environ. Manag. v44

Climate change makes riparian restoration more important than ever

Characteristics of riparian areas:

1. naturally resilient
2. provide linear habitat connectivity
3. link aquatic and terrestrial ecosystems
4. create thermal refugia for wildlife

Source: PRBO, Seavy et al., Ecol. Rest. v27

Restoration Strategies for an uncertain future

Component Redundancy & Functional Redundancy

ACTION:

Increase or replicate the number of components (e.g., species) and those with similar functions.

CONSEQUENCE:

- Increased survival due to higher abundance and increased genetic diversity
- Taxa better suited to future climates introduced
- More individuals = higher likelihood of successful adaptation (genetic diversity)

Source: Dunwiddie et al., Ecol. Rest v27

Restoration Strategies

Increased Connectivity

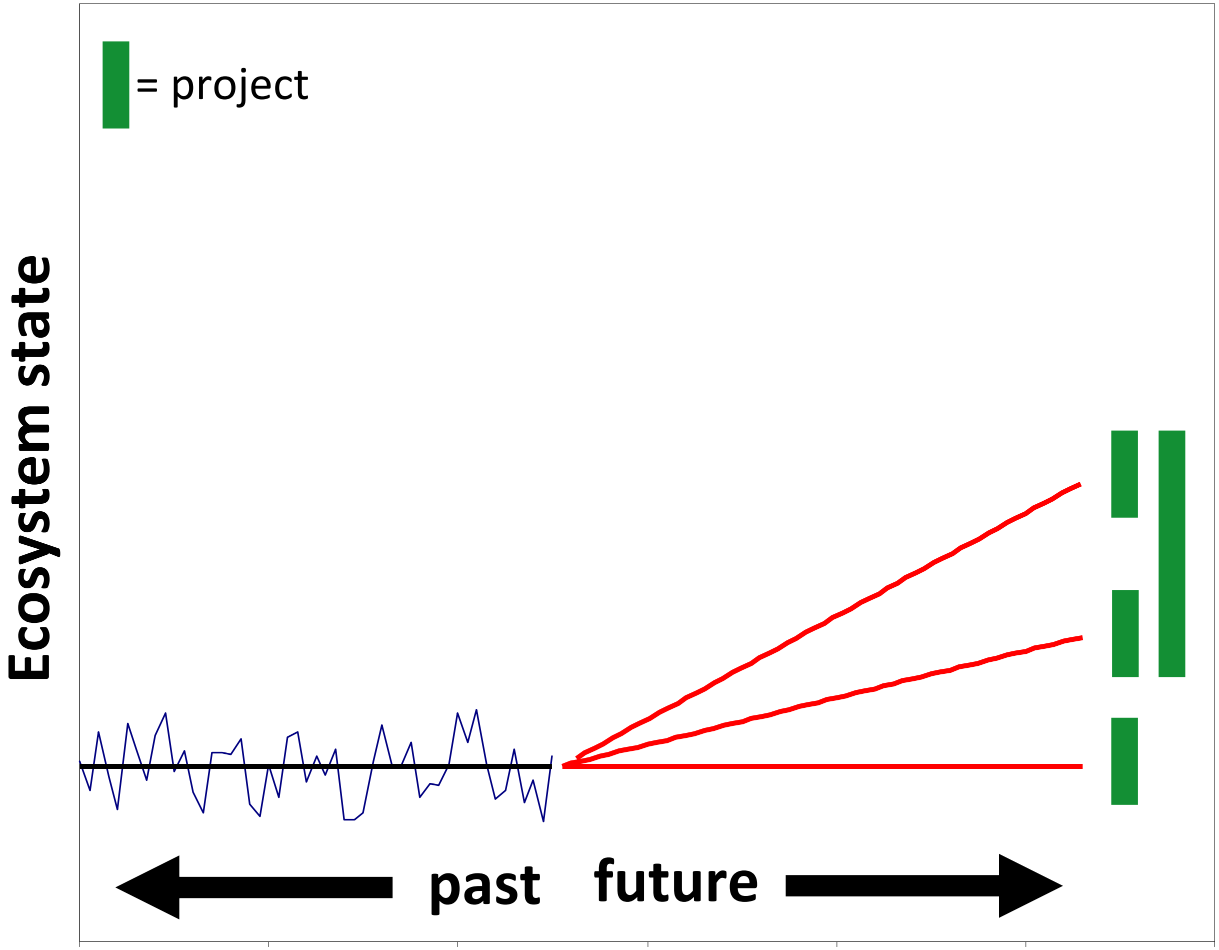
ACTION: restore areas important for dispersal between populations or to new habitats

CONSEQUENCE:

- Increased survival of populations due to increased pathways to dispersal and repopulation
- Increase diversity of pathways/corridors
- Increase potential for inter-population breeding = ability to adapt more quickly

Source: Dunwiddie et al., Ecol. Rest v27

Plan for extremes, wider range of variability



e.g., drought and floods

Prioritize projects that could succeed under multiple scenarios

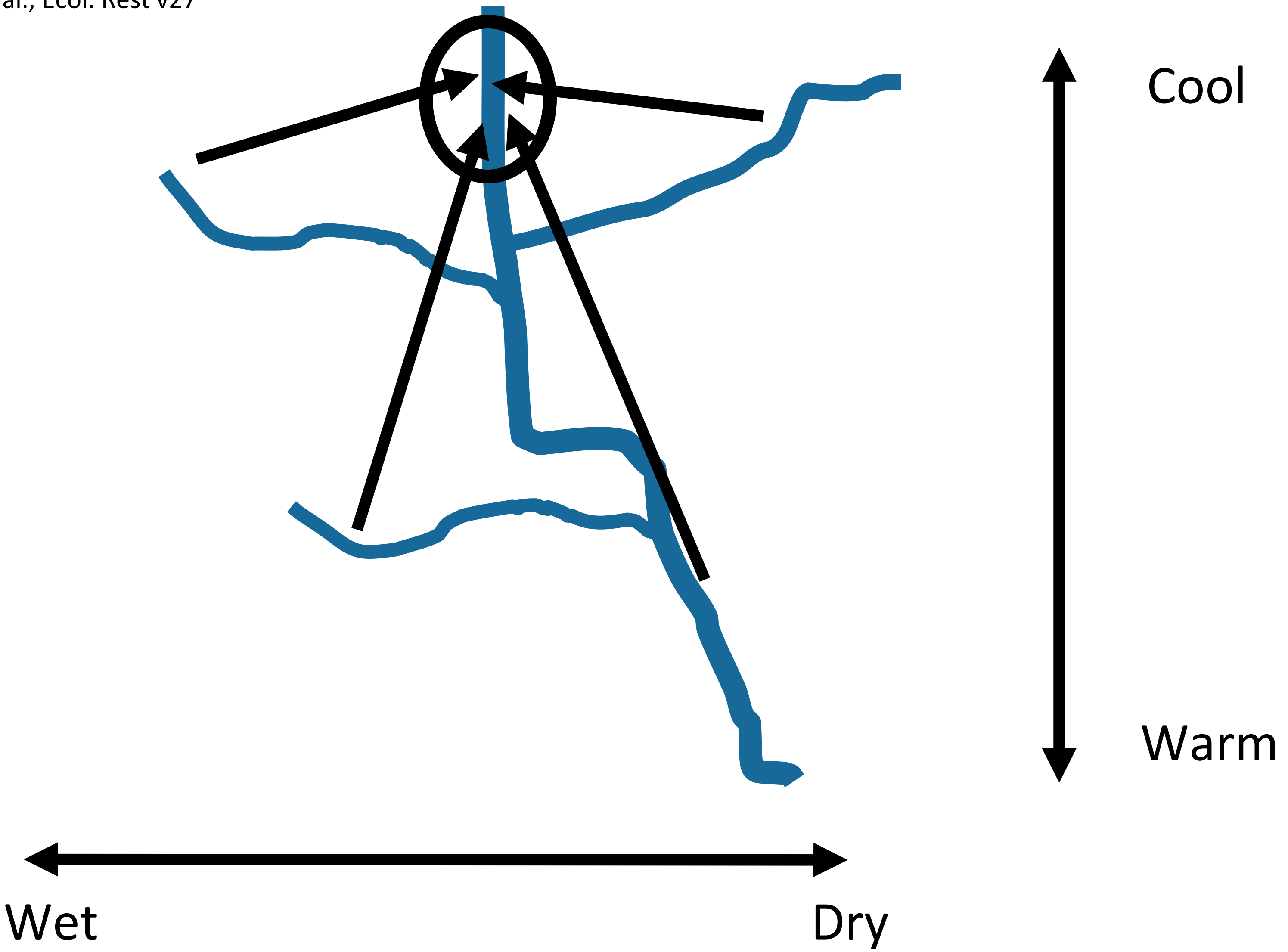
Projects could cover any of the strategies

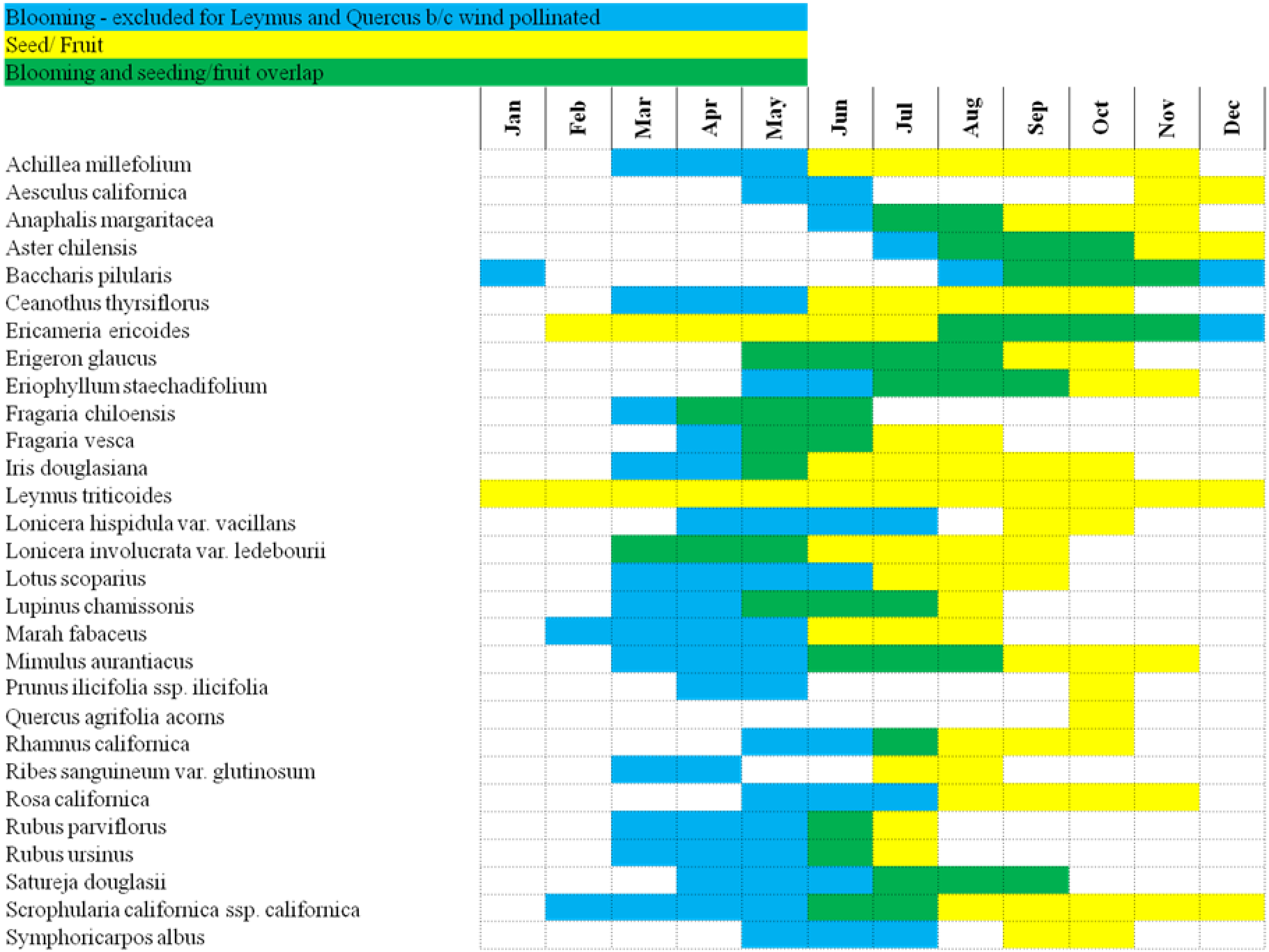
Source: PRBO, Seavy et al., Ecol. Rest v27

Plant for genetic diversity

to prepare for unexpected conditions

Source: PRBO, Seavy et al., Ecol. Rest v27





Blooming - excluded for Leymus and Quercus b/c wind pollinated
Seed/ Fruit
Blooming and seeding/fruit overlap
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Achillea millefolium
Aesculus californica
Anaphalis margaritacea
Aster chilensis
Baccharis pilularis
Ceanothus thyrsiflorus
Ericameria ericoides
Erigeron glaucus
Eriophyllum staechadifolium
Fragaria chiloensis
Fragaria vesca
Iris douglasiana
Leymus triticoides
Lonicera hispidula var. vacillans
Lonicera involucrata var. ledebourii
Lotus scoparius
Lupinus chamissonis
Marah fabaceus
Mimulus aurantiacus
Prunus ilicifolia ssp. ilicifolia
Quercus agrifolia acorns
Rhamnus californica
Ribes sanguineum var. glutinosum
Rosa californica
Rubus parviflorus
Rubus ursinus
Satureja douglasii
Scrophularia californica ssp. californica
Symphoricarpos albus

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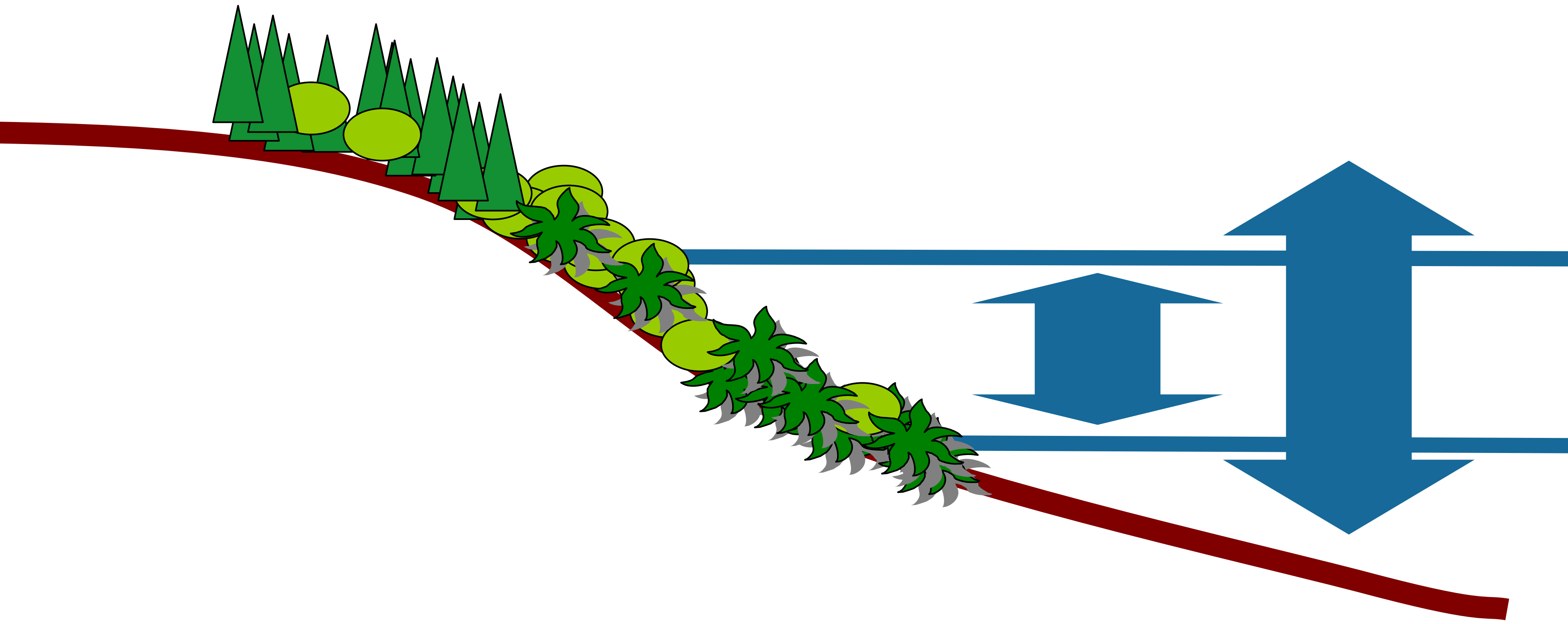
Plan restorations for an unpredictable hydrograph



Plant early seral colonizers adapted to flooding together with late seral species that may be less tolerant of flooding but grow better on drier sites.

Source: PRBO, Seavy et al., Ecol. Rest v27 “new but nearby” species

Increase connectivity

Actively partner with adjacent landowners - public and <u>private</u>

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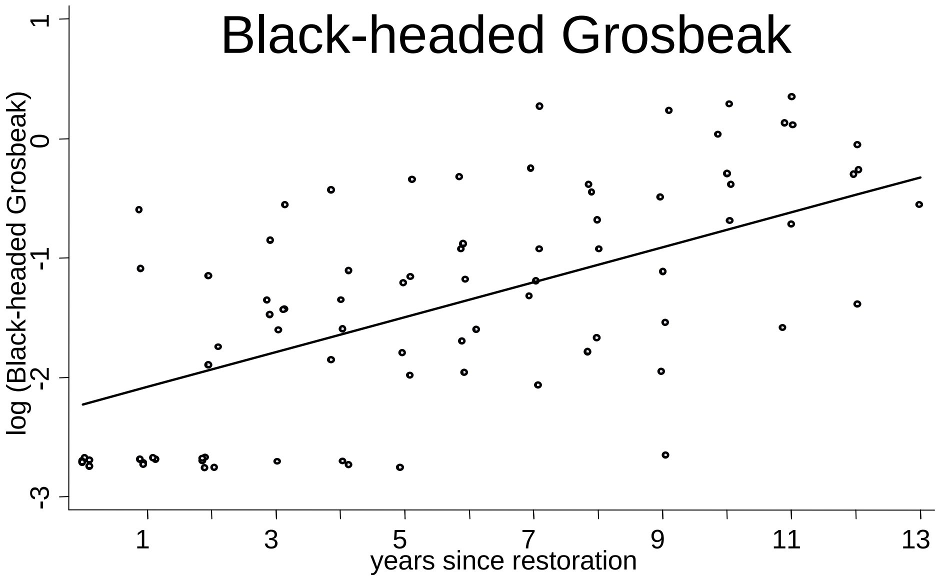
Measuring success



Source: PRBO, Gardali et al., Rest. Ecol v14

Restoration Goals and probability for success

Consider the San Joaquin Valley . . . .

Metric	**Current conditions**	**Worst case climate predictions**
Historical hydrograph	Unlikely	Unlikely
Salmon	Possible	Unlikely
Community composition	Possible	Unlikely
Component redundancy	Likely	Likely
Connectivity	Likely	Likely

Risks and considerations

Given uncertainties of change, our limited understanding of complex systems, etc. **<u>all restoration strategies mentioned here have risks.</u>**

For example . . . .

- Unanticipated species interactions
- Homogenization of species
- Loss of locally adapted genotypes
- Facilitate movement of pathogens
- Etc., etc.

Risks and considerations

"Business as usual" restoration is also a risk!

Ignoring the future is not an option

What can science do to help reduce risk?

- Reduce uncertainty of predictions
- Study novel systems
- Indentify specific risks and benefits of different strategies
- Monitoring and Adaptive Management - *It is time to really put this into practice*

Acknowledgments

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PRBO people especially Diana Stralberg and John Wiens

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Questions, comments, ideas?

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