Climate Change Effects on Environmental Flows

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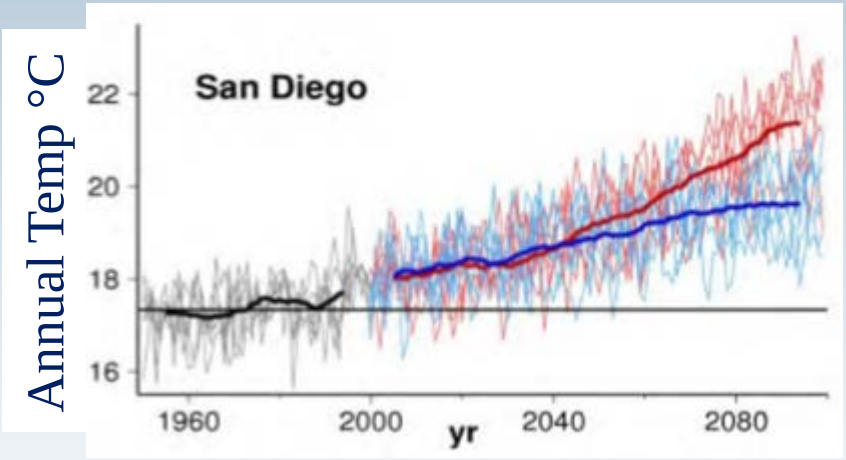
Overview

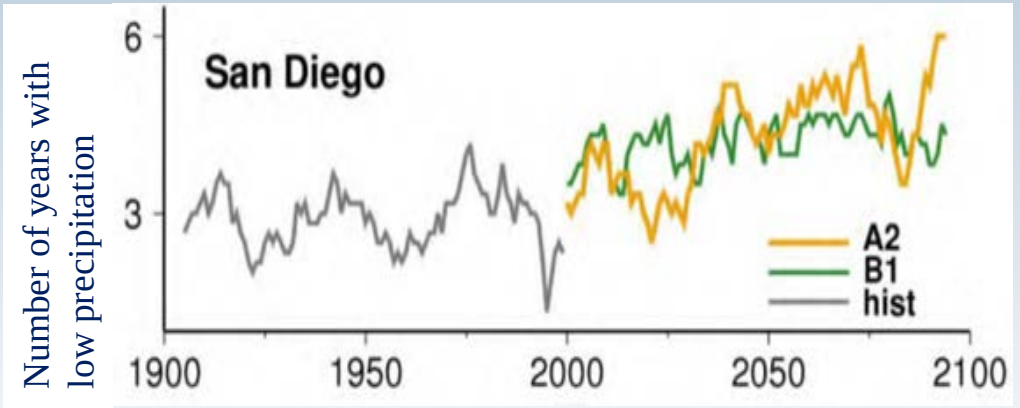
- Climate change has the potential to alter stream ecosystems and affect beneficial uses
  - Temperature
  - Rainfall – runoff
- Environmental flows are an important consideration for climate change
- Assessing effects requires looking beyond impacts to benthic invertebrate communities
- Need a comprehensive framework to help inform management decisions

What Does the Future Hold?

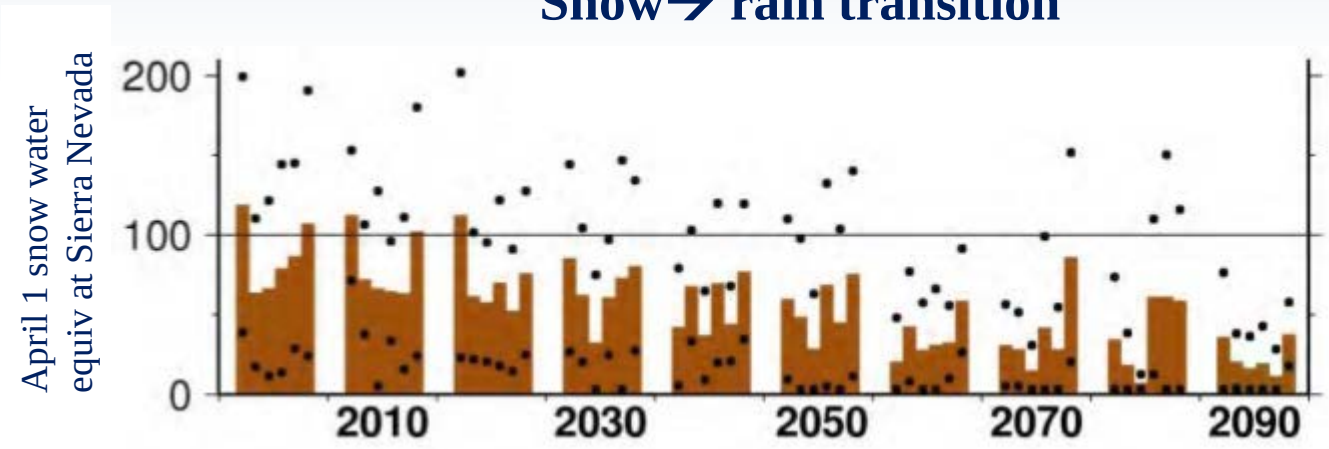
Hotter



Drier

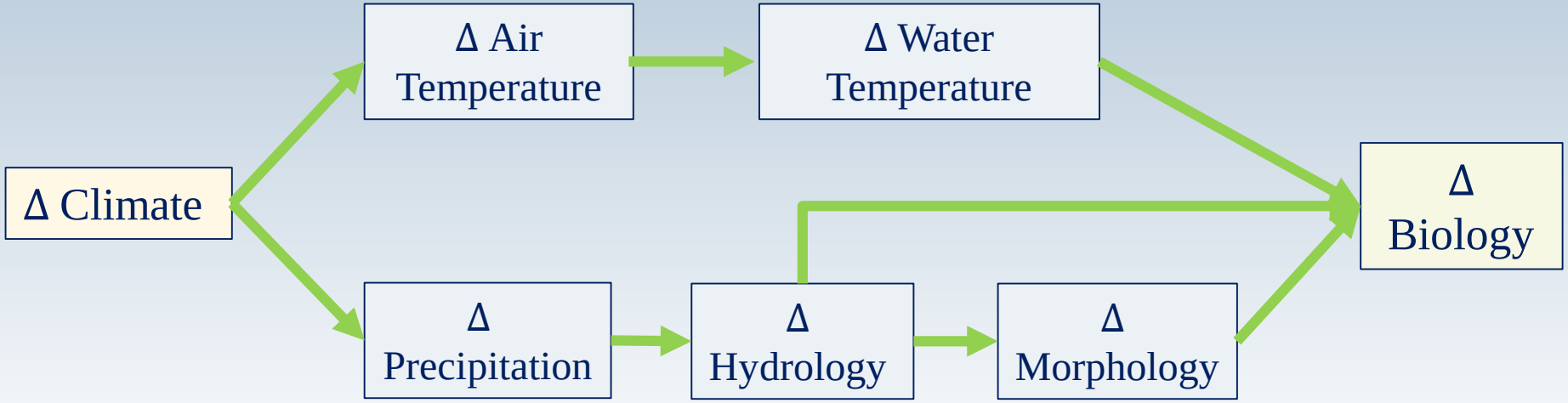


Snow→ rain transition



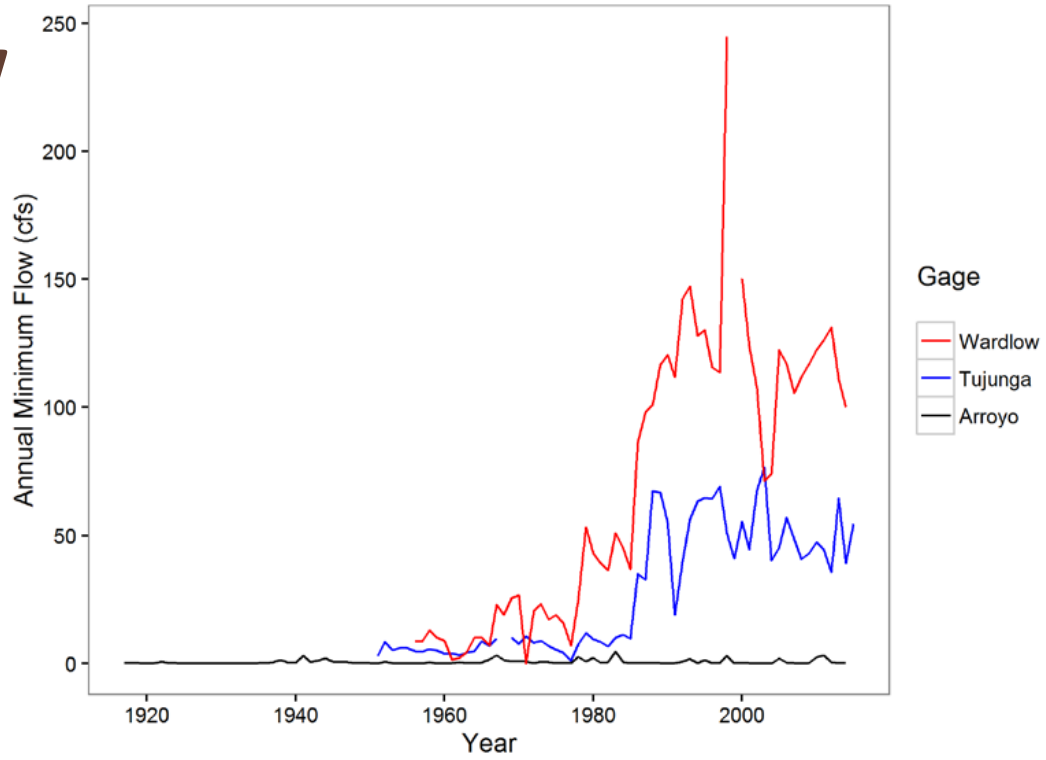
Figures: Cayan, Dan, Mary Tyree, David Pierce, Tapash Das (Scripps Institution of Oceanography). 2012. *Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment*. California Energy Commission. Publication number: CEC- 500-2012-008.

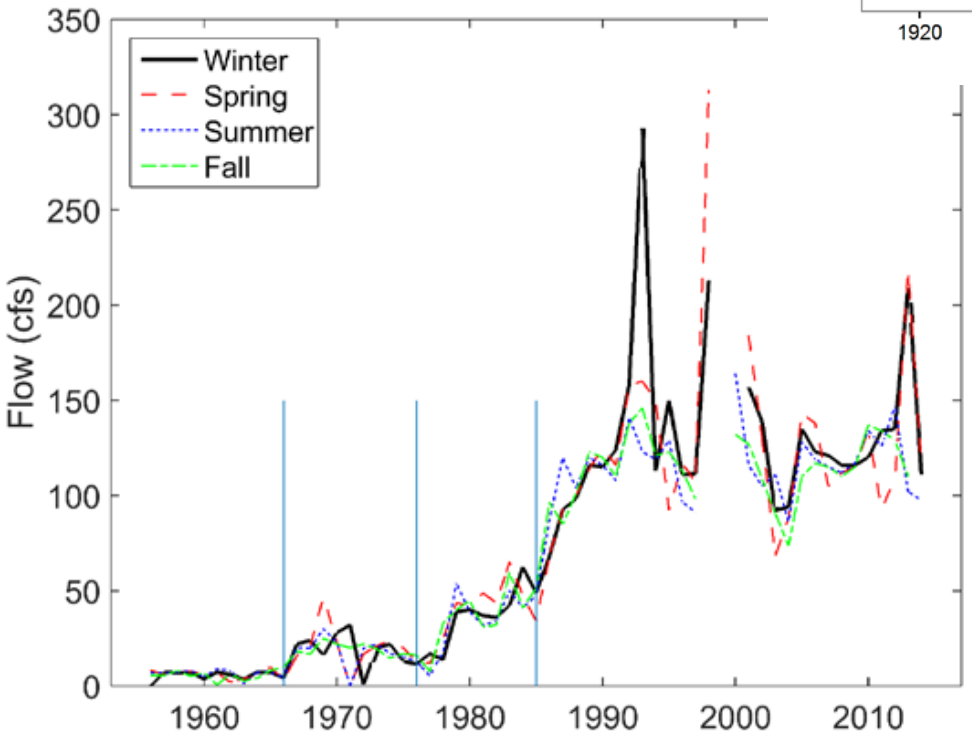
Hydrology is a Key Determinant of Stream Health



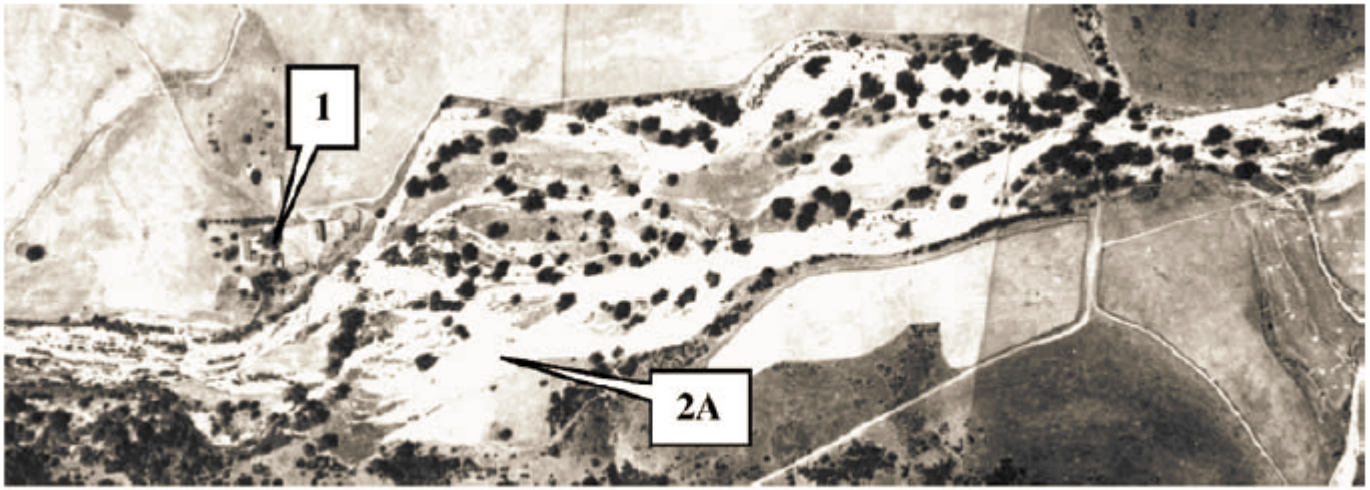
Augmented Flow Over Time

Urban runoff



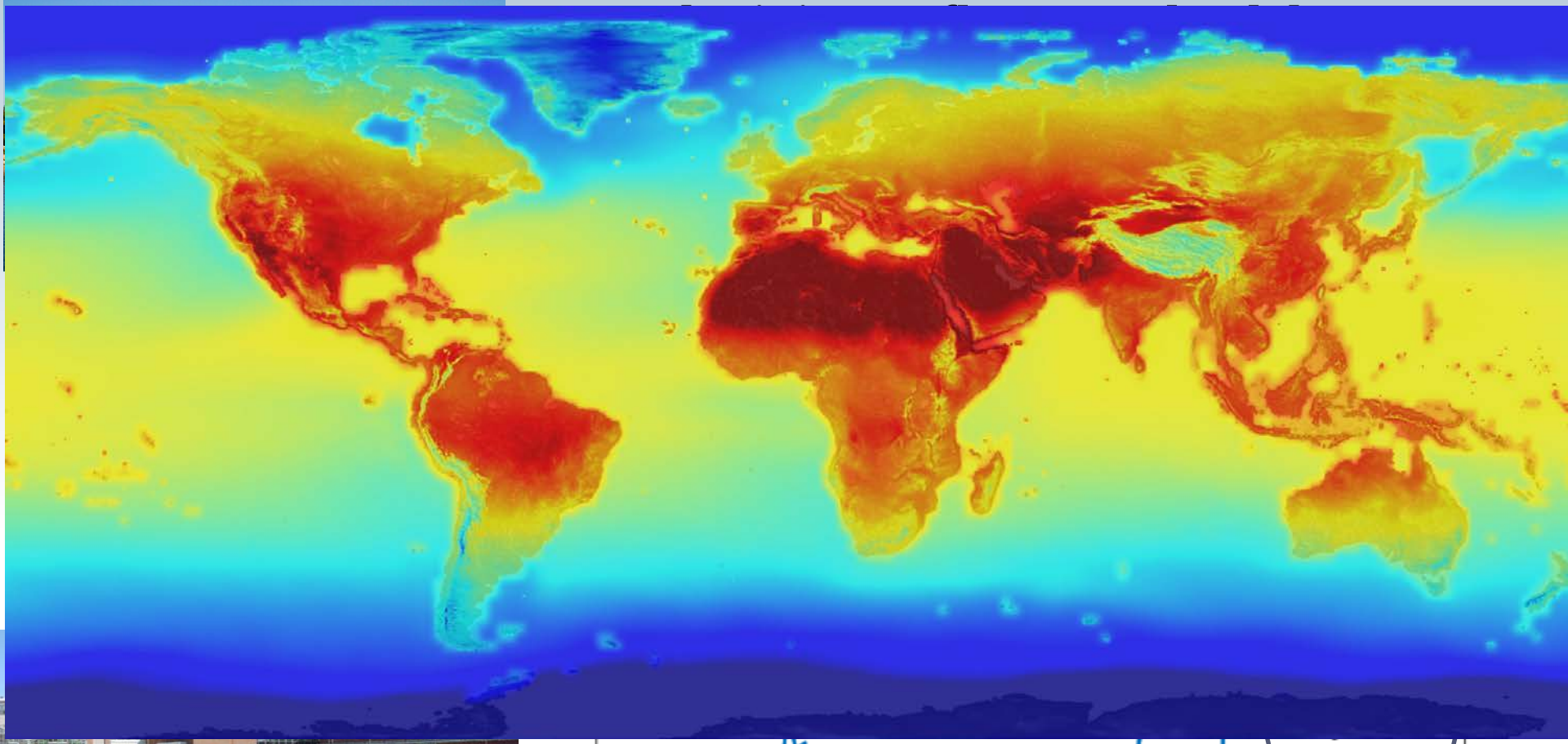


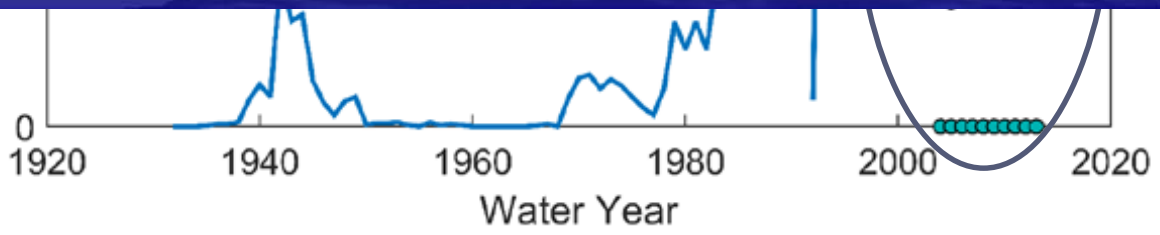
Treated Wastewater Discharge



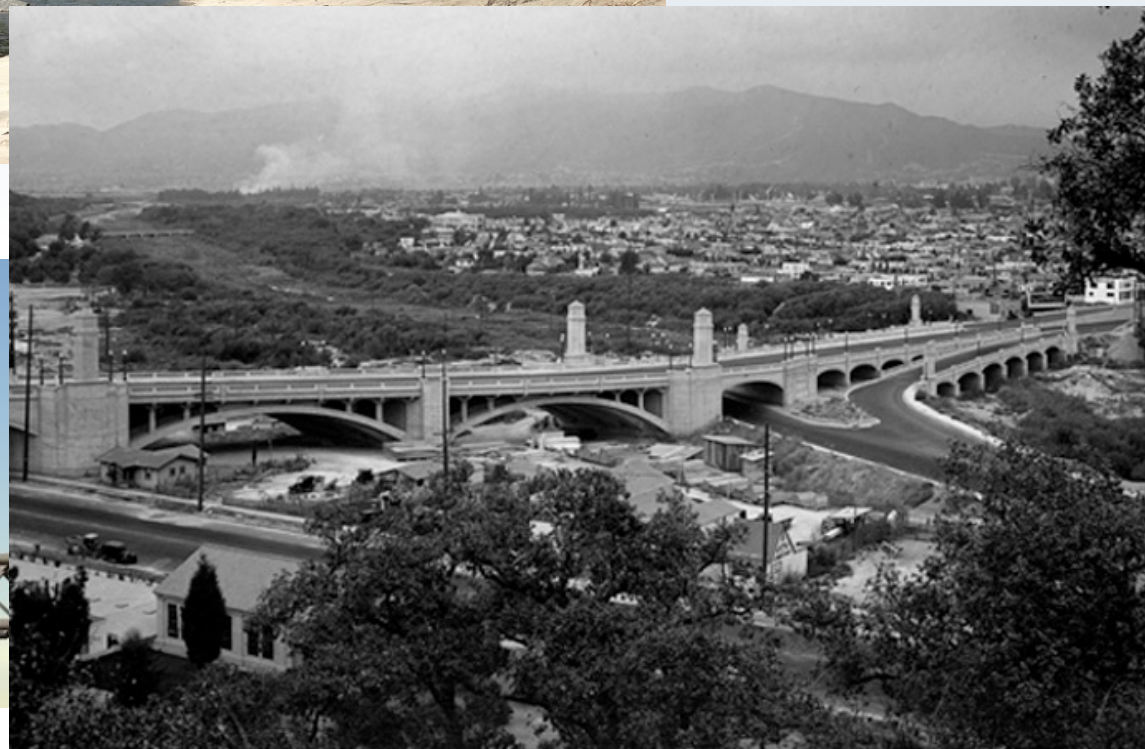
A. 1928

Changes in Wastewater and Stormwater Management





What are Appropriate Targets?

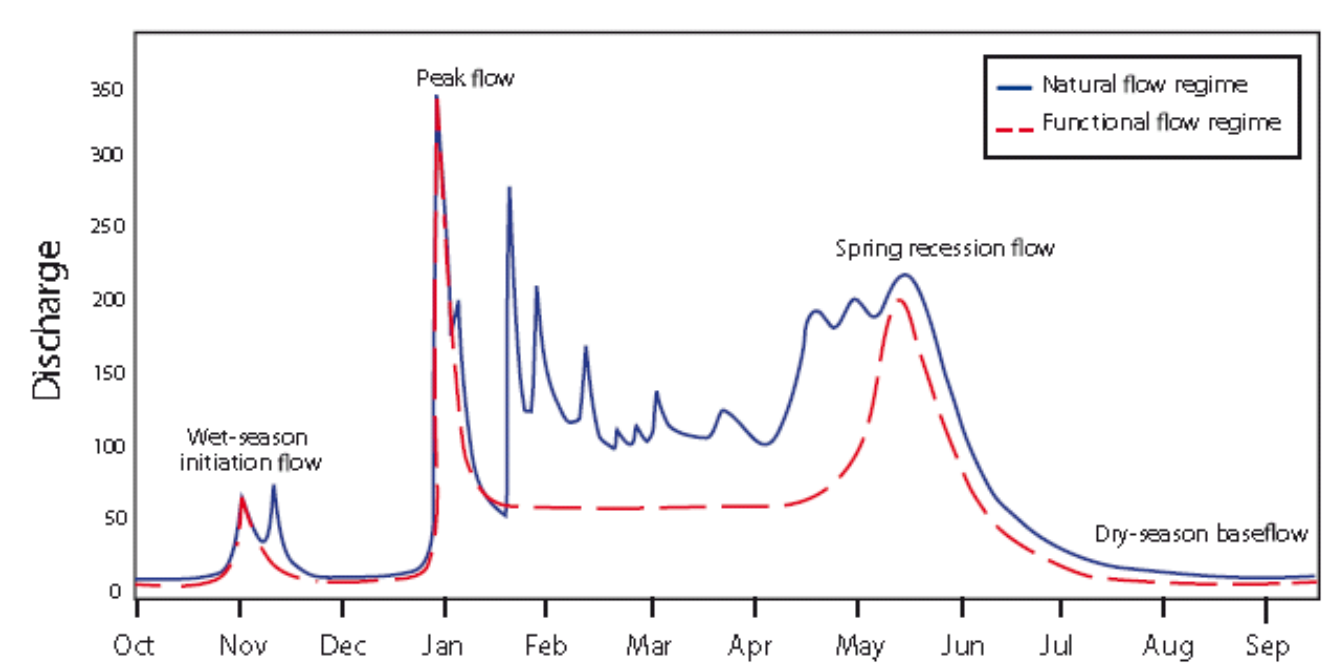


Need for Environmental Flow Targets

- Set instream flow standards to protect biological communities
- Assess vulnerability of streams to future changes in flow conditions associated with climate change
  - Prioritize areas for restoration/management
- Evaluate/inform management actions
  - e.g., reservoir operations, water withdrawals

Environmental Flows

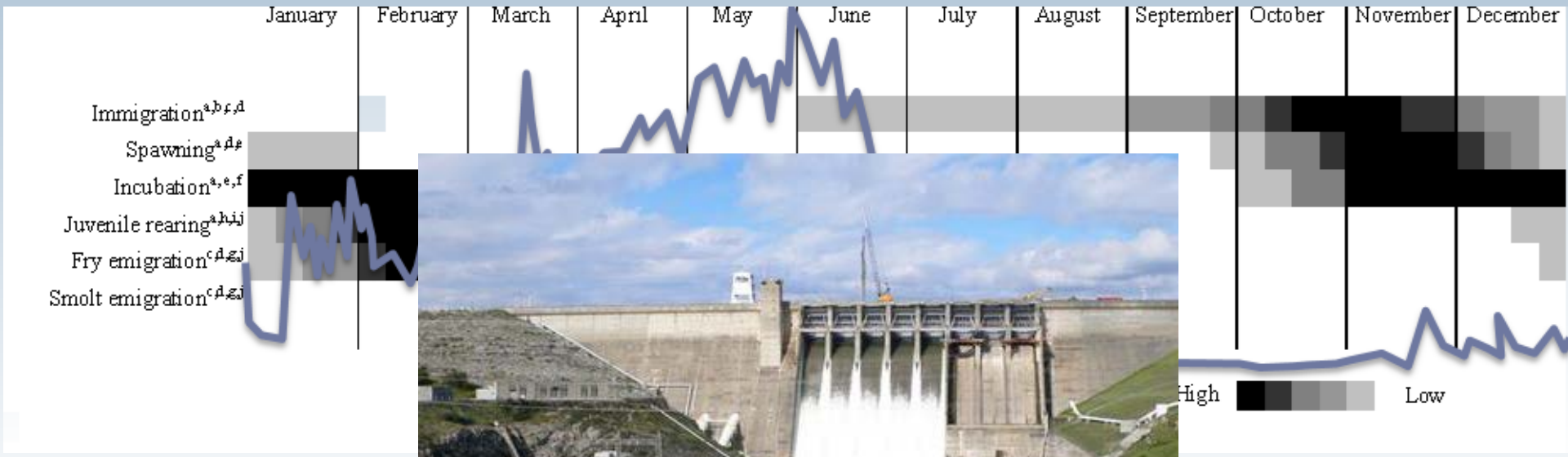
The magnitude, timing, duration, rate of change, and frequency of flows and associated water levels necessary to sustain the biological composition, ecological function, and habitat processes within a water body and its margins



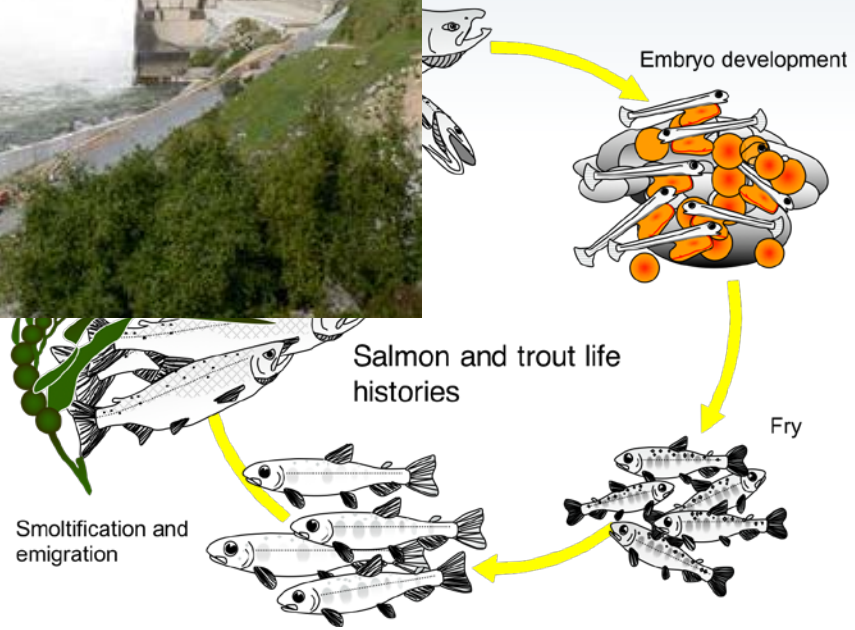
Key Questions for Establishing Environmental Flow Targets

- What ecological endpoints should be prioritized?
- Which flow metrics should be used?
- How do we establish targets based on flow-ecology relationships

Fish are a Big Driver Across CA



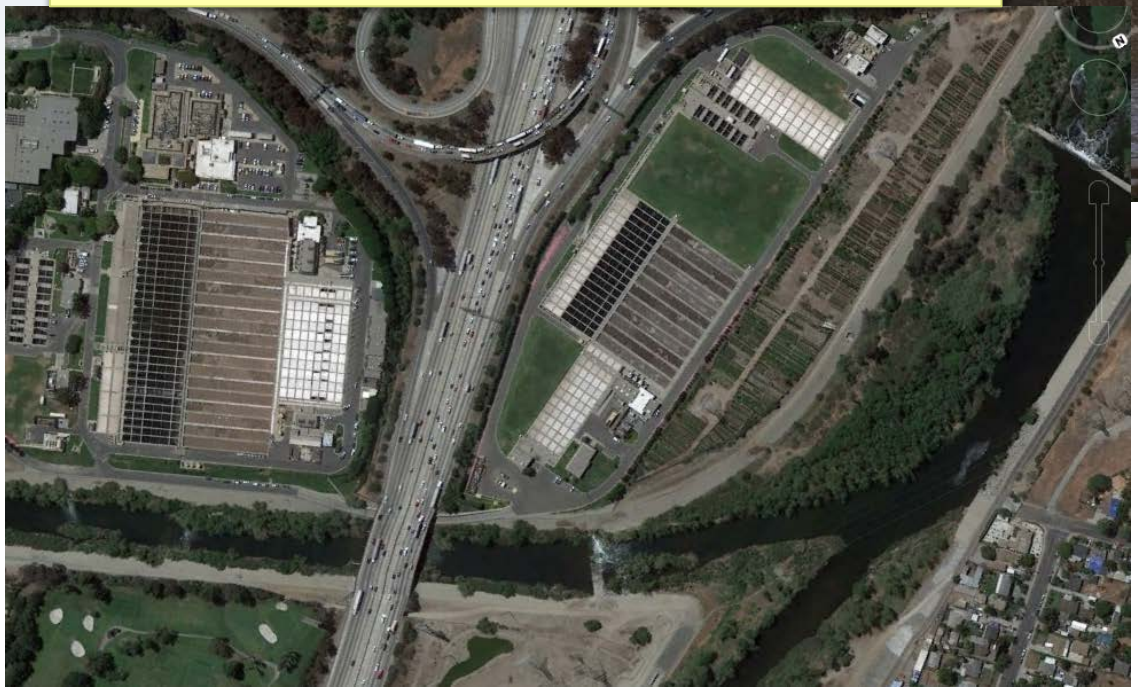
Physically Focused – engineering/geomorphology	Ecolo mana
Bank Full	Spaw flow
100 year flood	Reari
Bed Mobilization	Life stage strategies
Effective Discharge	Habitat maintenance
Peak Discharge	Decoupling Predator/ Competitor Habitat



Southern CA Has Other Drivers

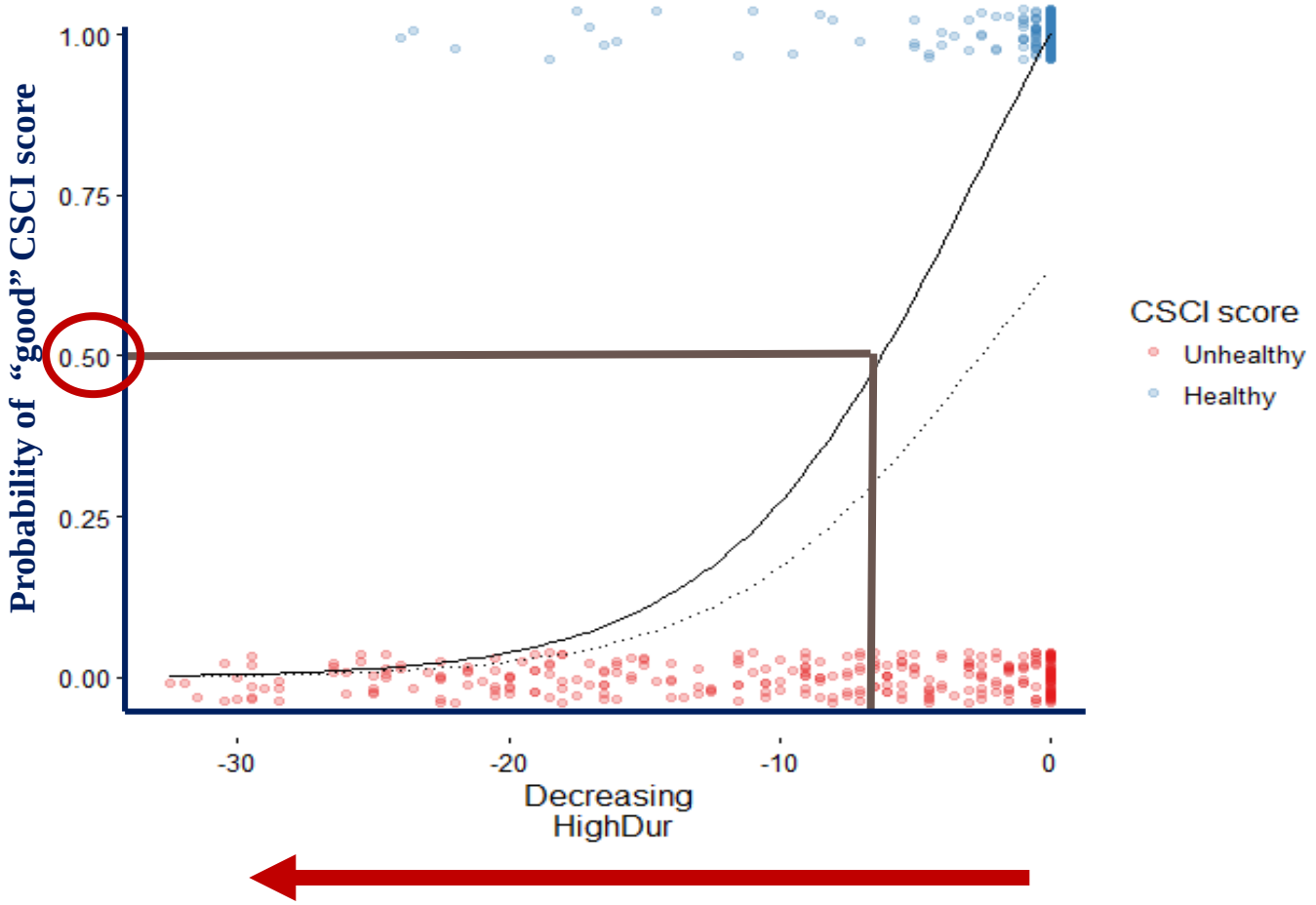
Stormwater Retention

Use or Reuse of Treated Effluent



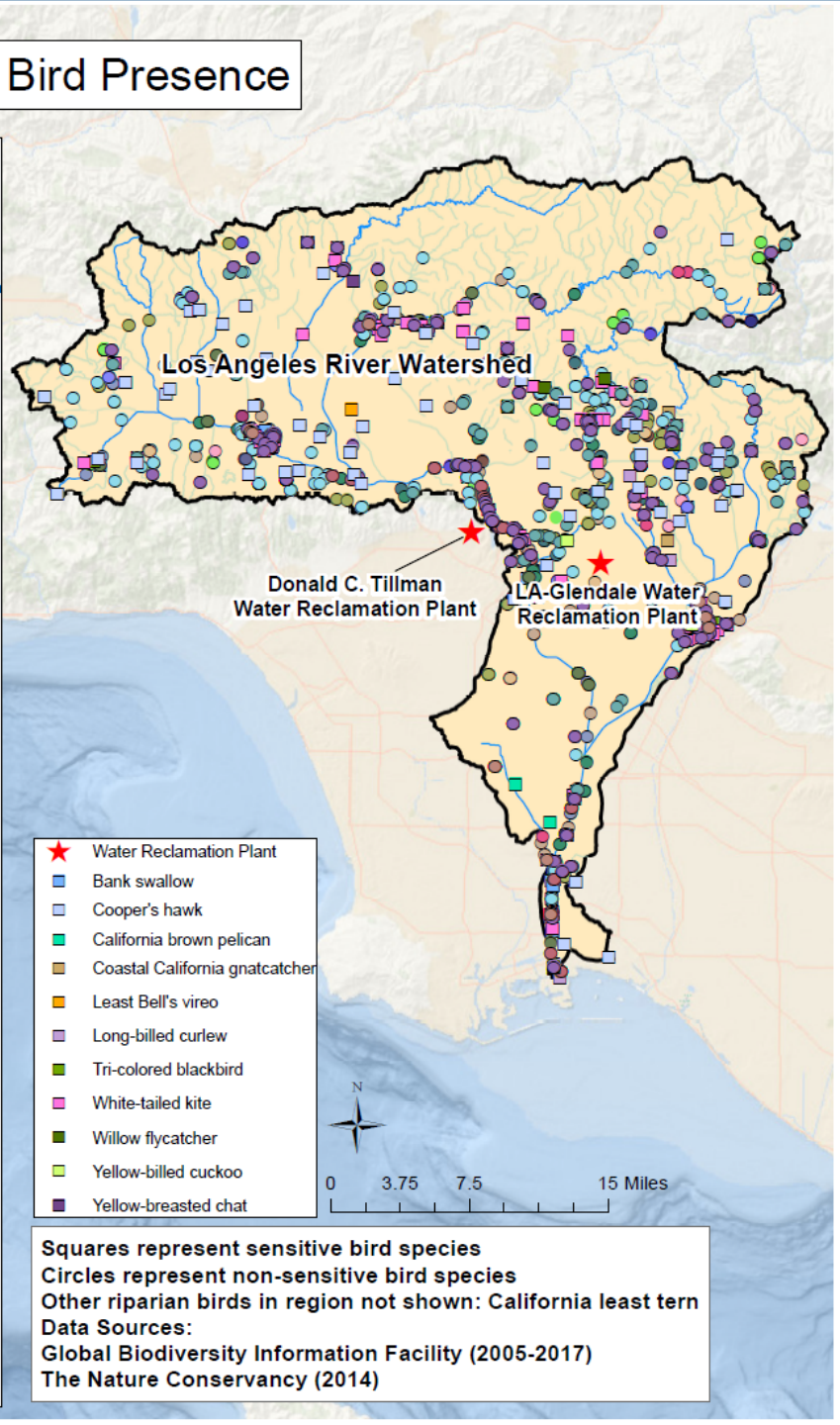
Our Past Work Has Focused on Benthic Invertebrates

Logistic regression: Likelihood of healthy biology at each level of hydrologic alteration



Riparian Bird Presence

- American bittern
- American coot
- American dipper
- Black swift
- Black-crowned night heron
- Brown-headed cowbird
- Cattle egret
- Cinnamon teal
- Common moorhen
- Common yellowthroat
- Downy woodpecker
- Eared grebe
- Gadwall
- Great blue heron
- Great egret
- Green heron
- Least bittern
- Lincoln's sparrow
- Long-eared owl
- MacGillivray's warbler
- Mallard
- Marsh wren
- Northern pintail
- Northern shoveler
- Pied-billed grebe
- Red-shouldered hawk
- Redhead
- Ruddy duck
- Snowy egret
- Song sparrow
- Sora
- Spotted sandpiper
- Swainson's thrush
- Wilson's snipe
- Wilson's warbler
- Wood duck
- Yellow warbler
- Yellow-headed blackbird



Squares represent sensitive bird species
Circles represent non-sensitive bird species
Other riparian birds in region not shown: California least tern
Data Sources:
Global Biodiversity Information Facility (2005-2017)
The Nature Conservancy (2014)

Evaluating Environmental Flow Needs

Compile species occurrence information

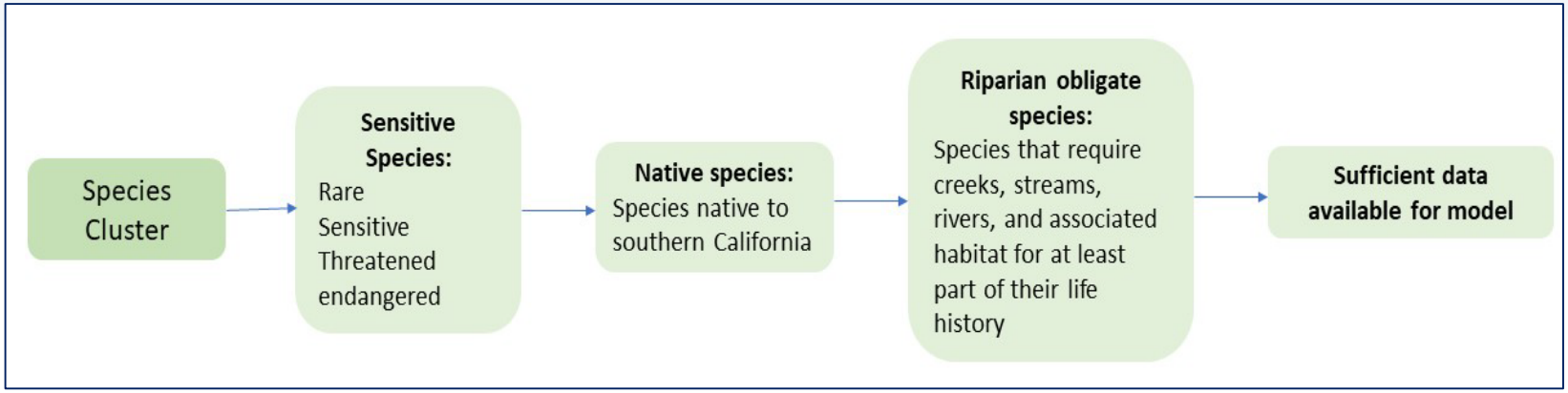
Species habitat requirements

Clustering for focal species selection

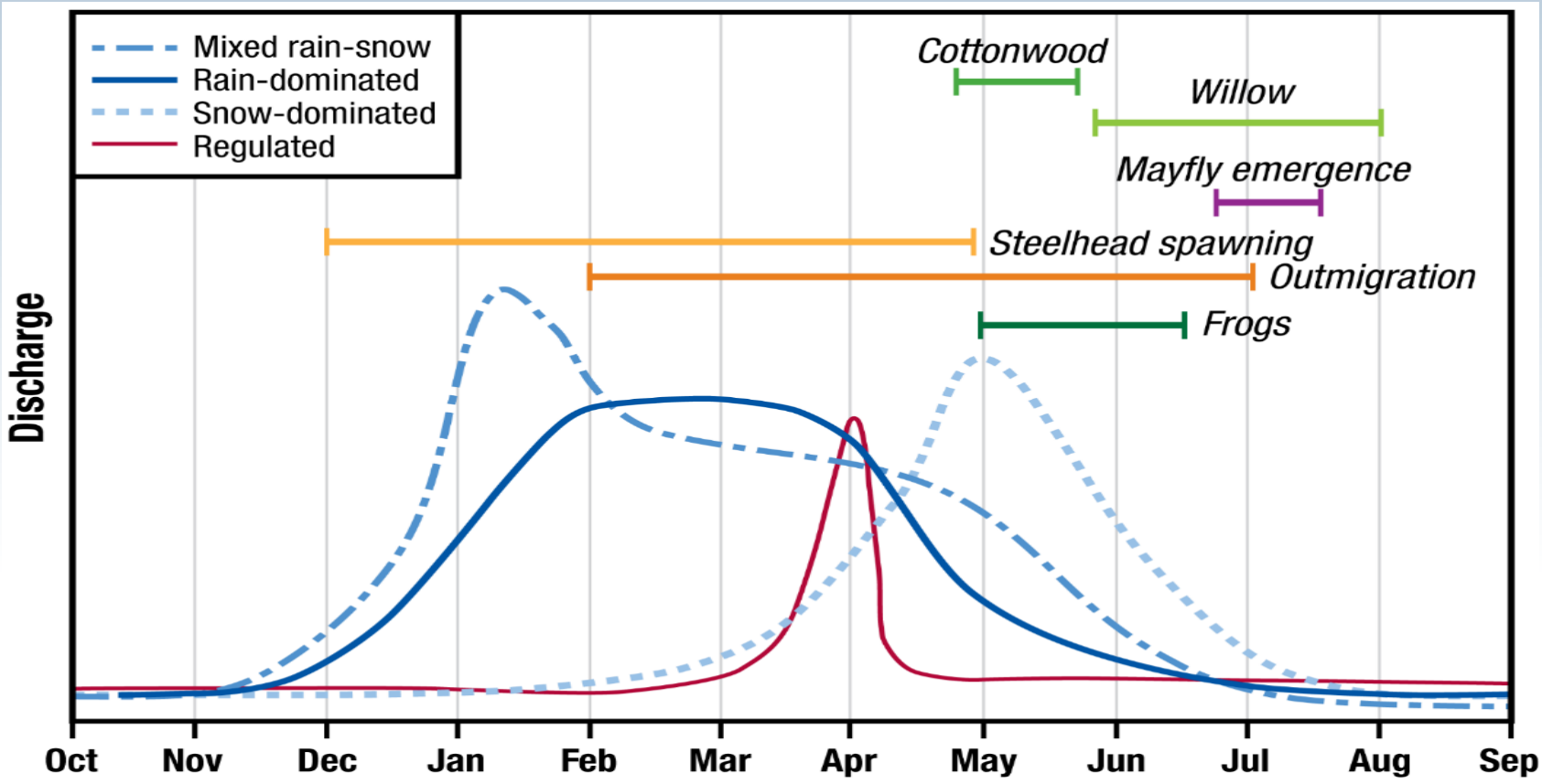
Model species distributions based on future streamflow patterns and temperature

Focal Species

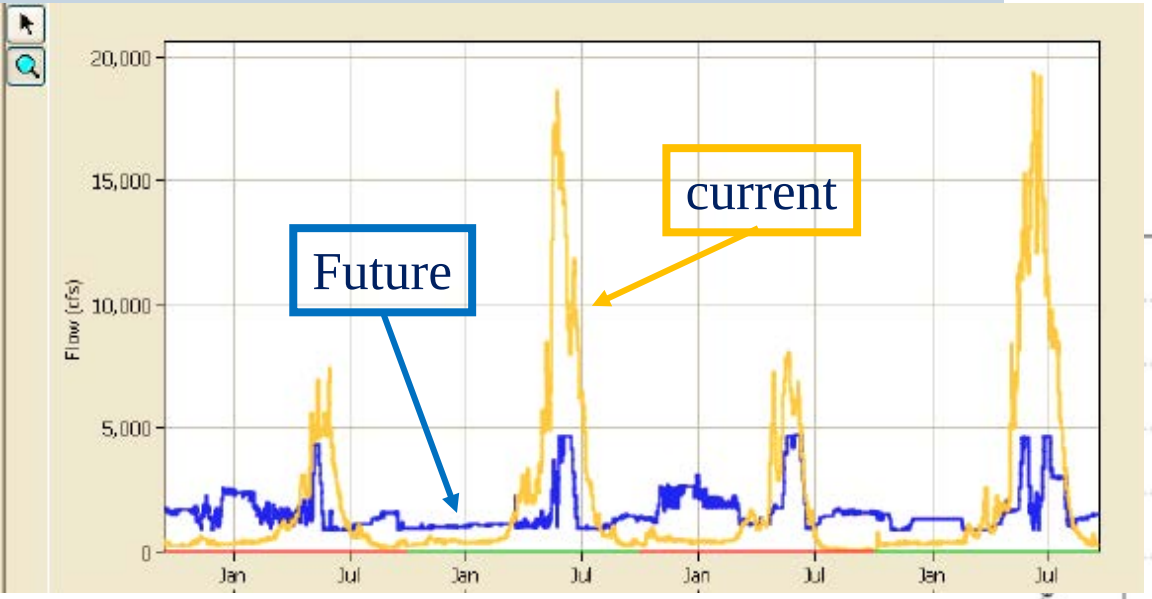
- Representative of their species with similar life history needs with regard to flow, temperature etc.
- Sensitive to changes in flow and/or temperature
- Available data on life-history needs to support modelling

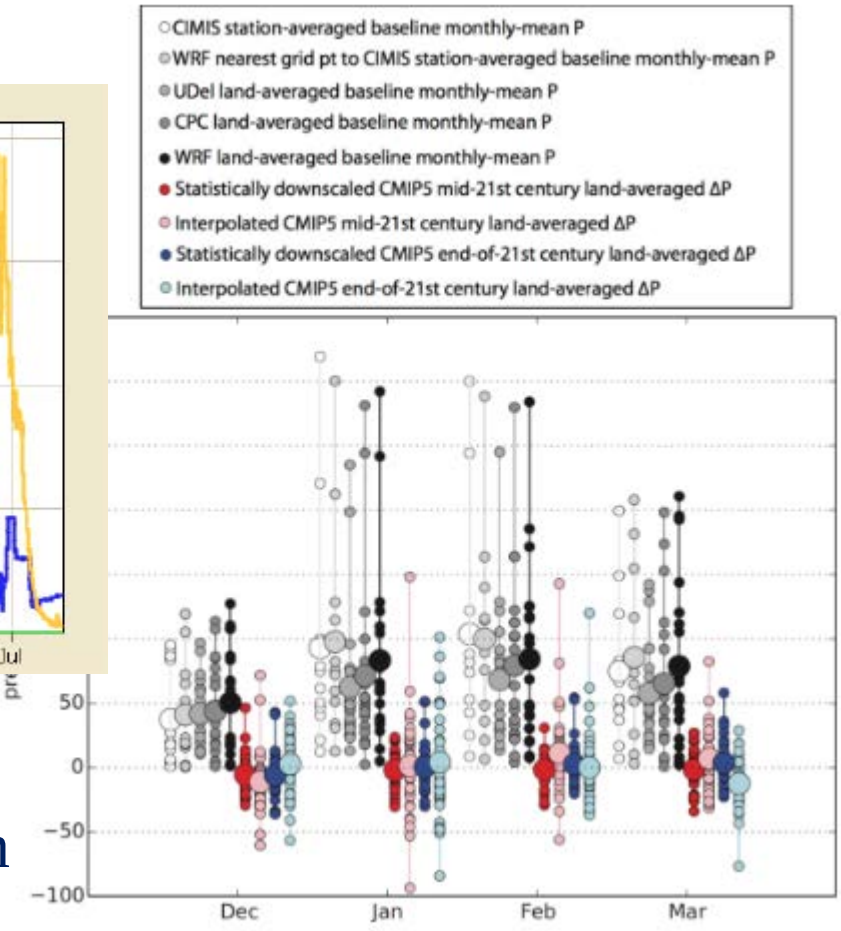


Flow-Ecology Relationships



Estimating Hydrologic Change: Climate Change + Management Actions



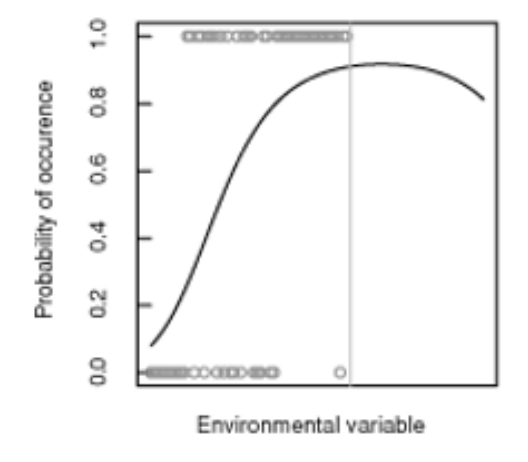


Change is probably species distribution

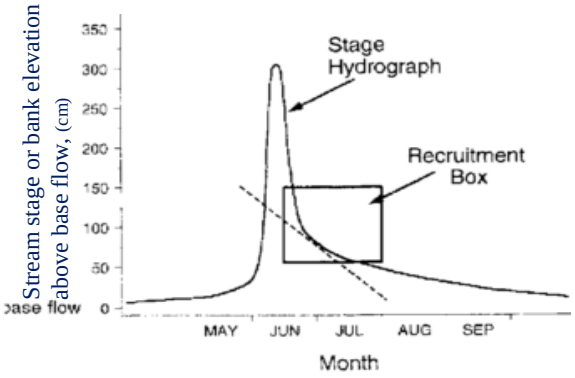
Change in level of beneficial use

Courtesy of Alex Hall, UCLA

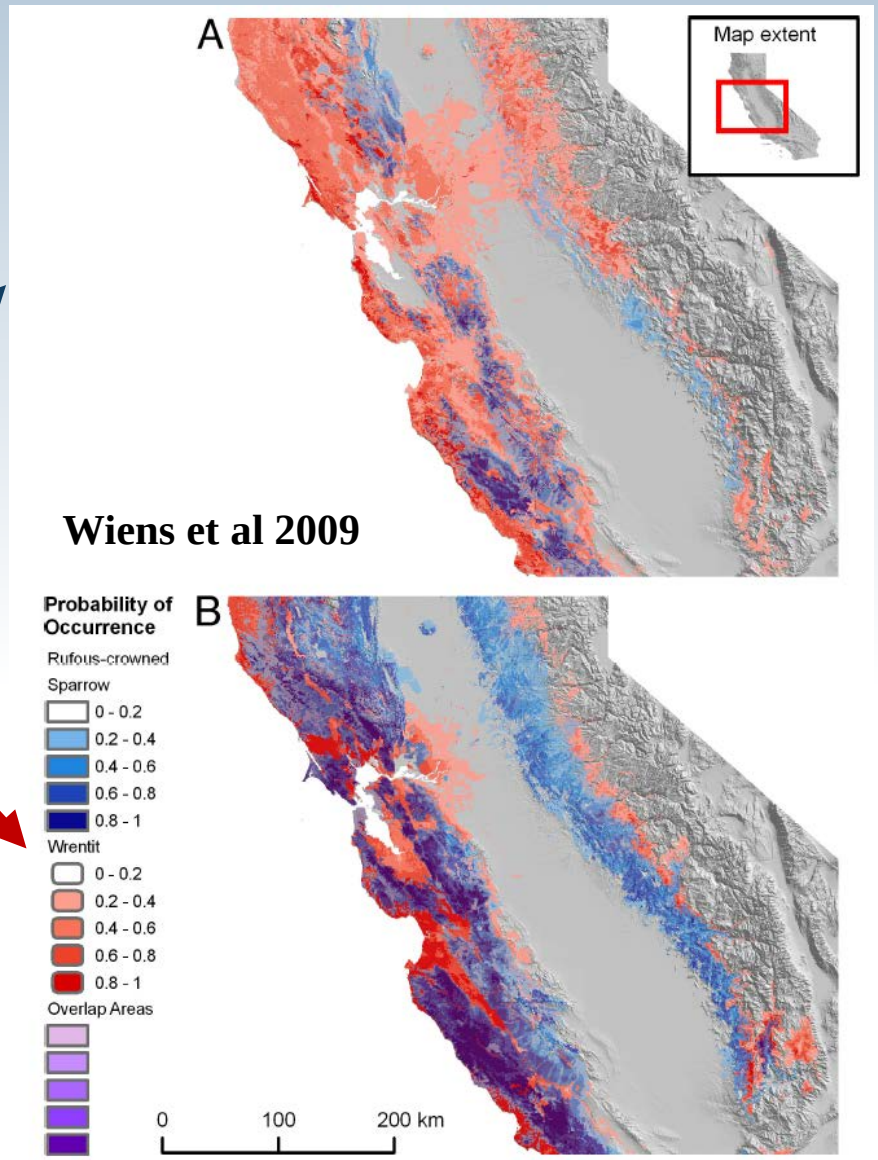
Use Ecologically Relevant Flows to Model Probability of Species Occurrences



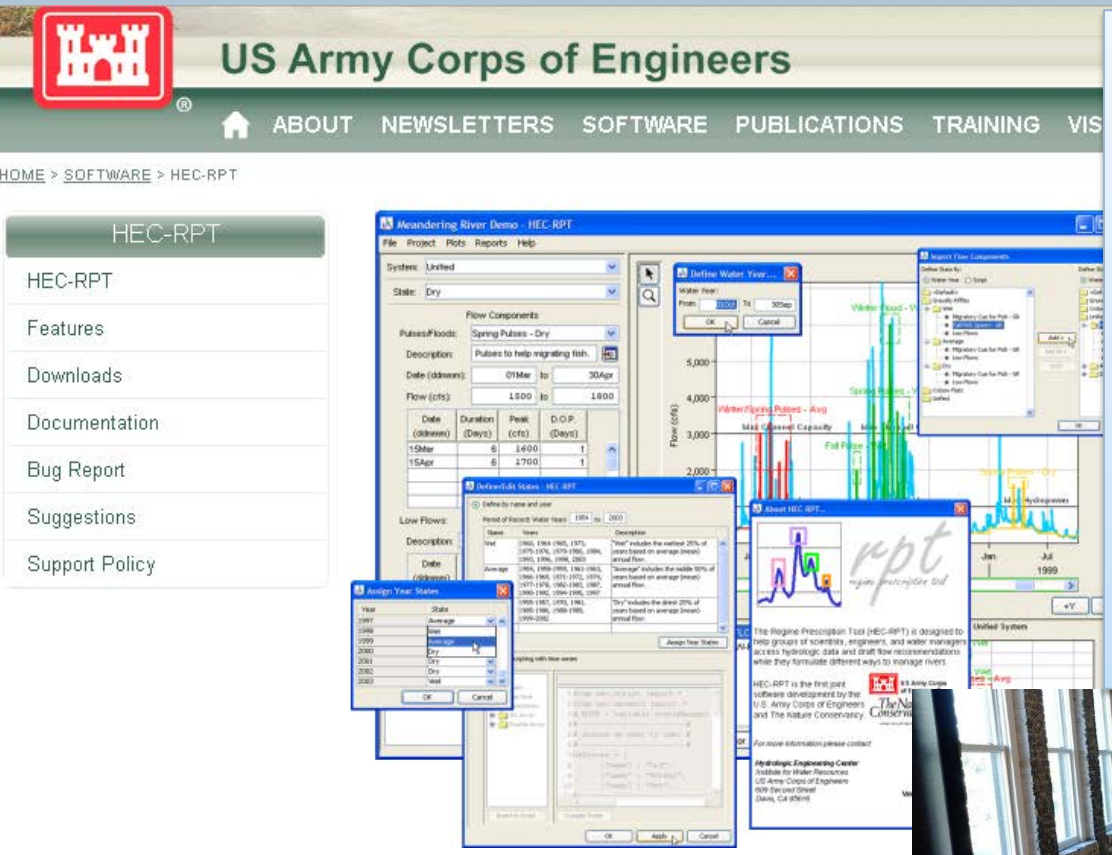
Probability of species occurrence using Generalized Additive Model



Mechanistic models



Balancing Competing Needs



How can we balance uses and needs?

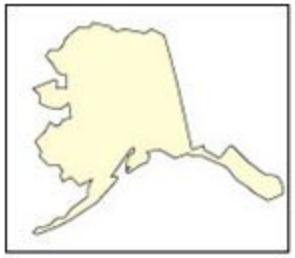
- Habitat
- Water supply
- Flood Control
- Recreation
- Water Quality

The Regime Prescription Tool (HEC-RPT)

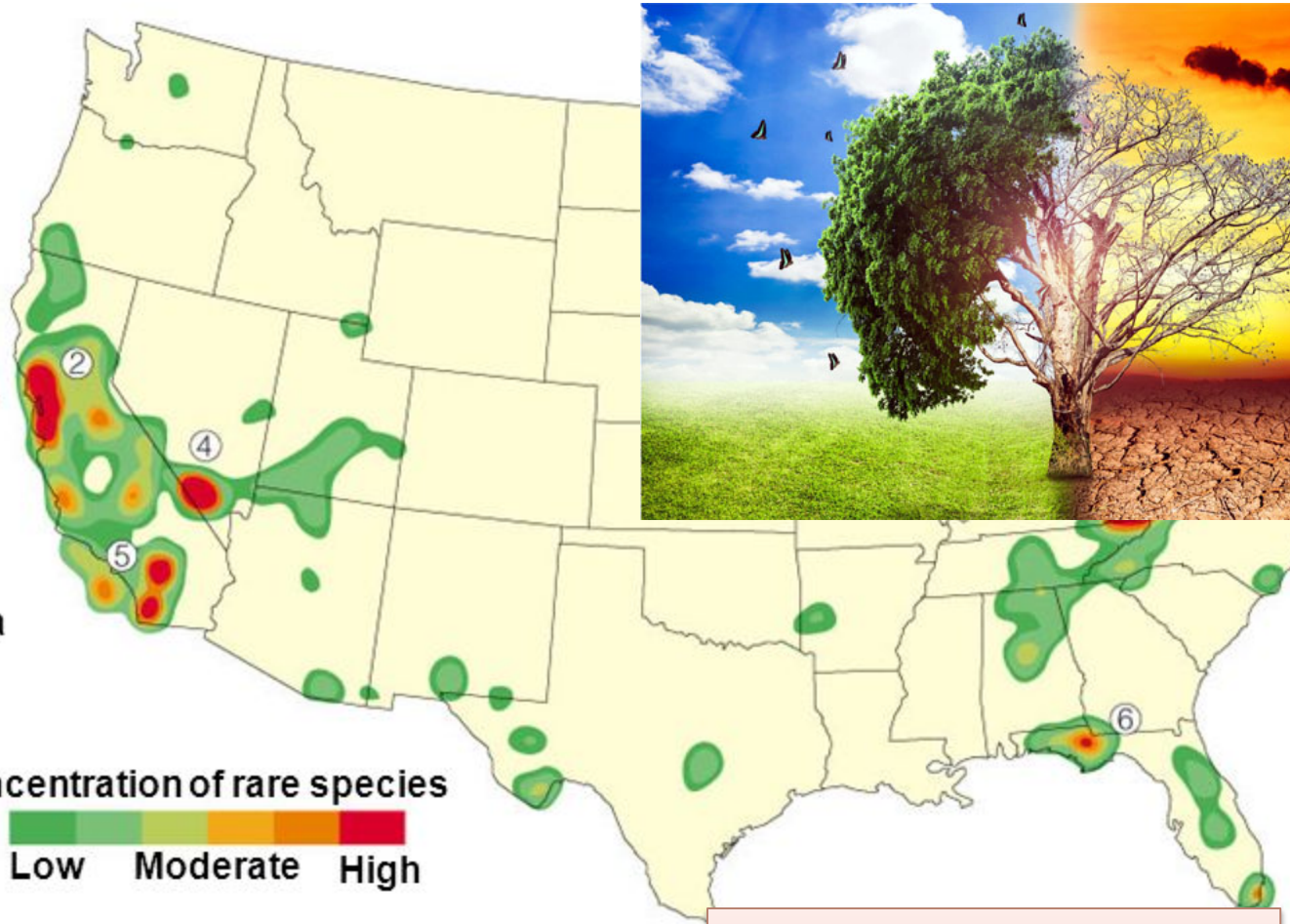
Expected Products & Future Efforts

- Evaluate probability of change in species occurrences based on future flow regimes due to climate change
- Evaluate effect of different flow management scenarios
  - Wastewater and stormwater management
  - Water recycling
- Develop recommendations for flow targets to maintain desired habitats or species

Questions



Top Six Hot Spots
1 Hawaii
2 San Francisco Bay area
3 Southern Appalachians
4 Death Valley
5 Southern California
6 Florida Panhandle



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