Climate change on the North Coast: state of the science and adaption strategies

Eel River Forum

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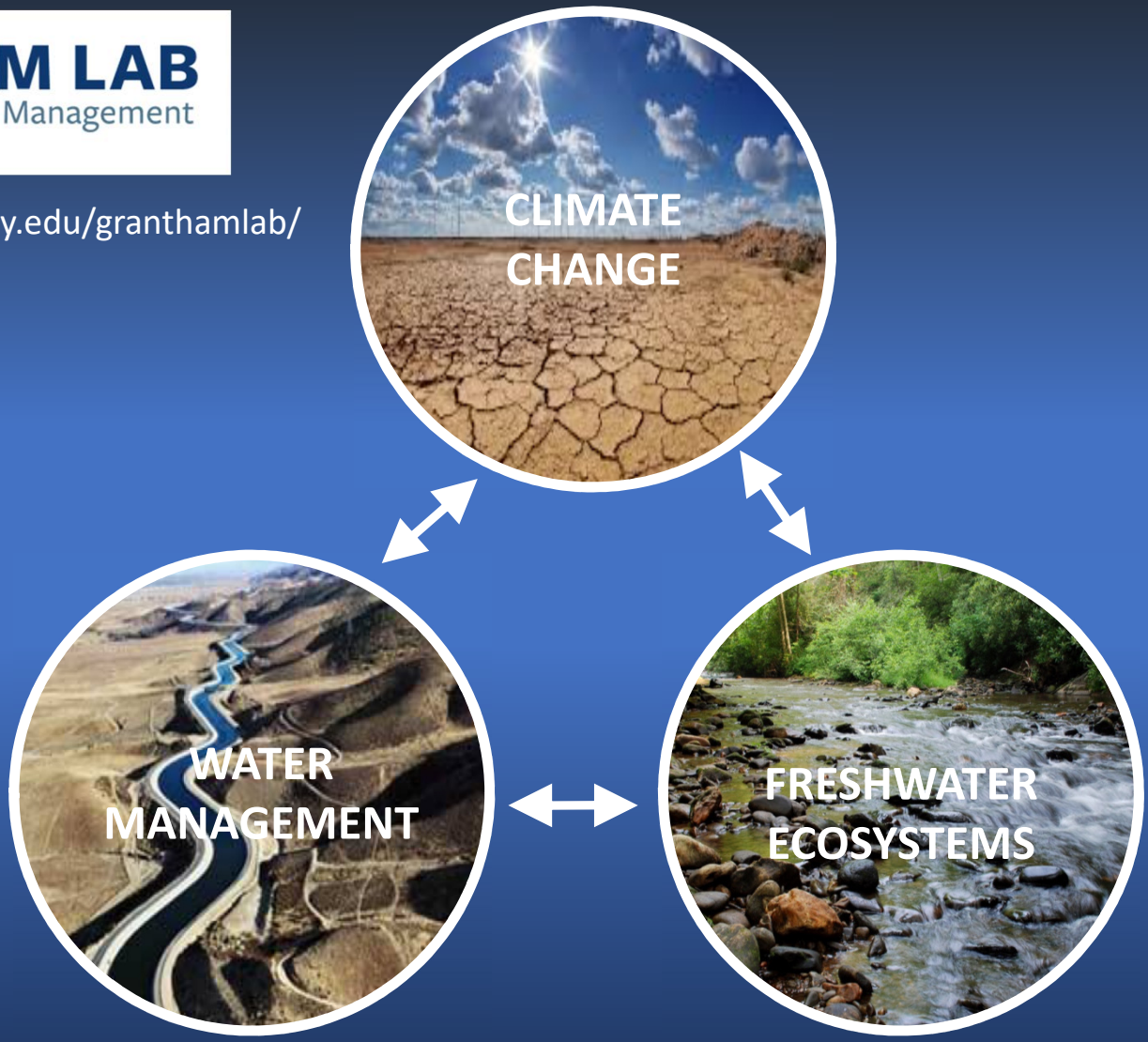
https://nature.berkeley.edu/granthamlab/



Today's Talk

- California's Fourth Climate Assessment
- North Coast Regional Report
- Strategies for managing freshwater ecosystems

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- **California's Fourth Climate Assessment**
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CA.GOV
Media
About the Assessment
Settings
CALIFORNIA'S FOURTH
CLIMATE CHANGE
ASSESSMENT
STATEWIDE
REGIONAL
TECH REPORTS
TOOLS
EVENTS
WHAT IS THE CLIMATE ASSESSMENT?
California's Climate Change Assessments contribute to the scientific foundation for understanding climate-related vulnerability at the local scale and informing resilience actions, while also directly informing State policies, plans, programs, and guidance, to promote effective and integrated action to safeguard California from climate change.
www.climateassessment.ca.gov

California's Climate Change Assessments

Since California's landmark executive order (S-3-05) in 2005, the state has conducted periodic scientific assessments of regional climate change impacts

First California Climate Change Assessment (2006)

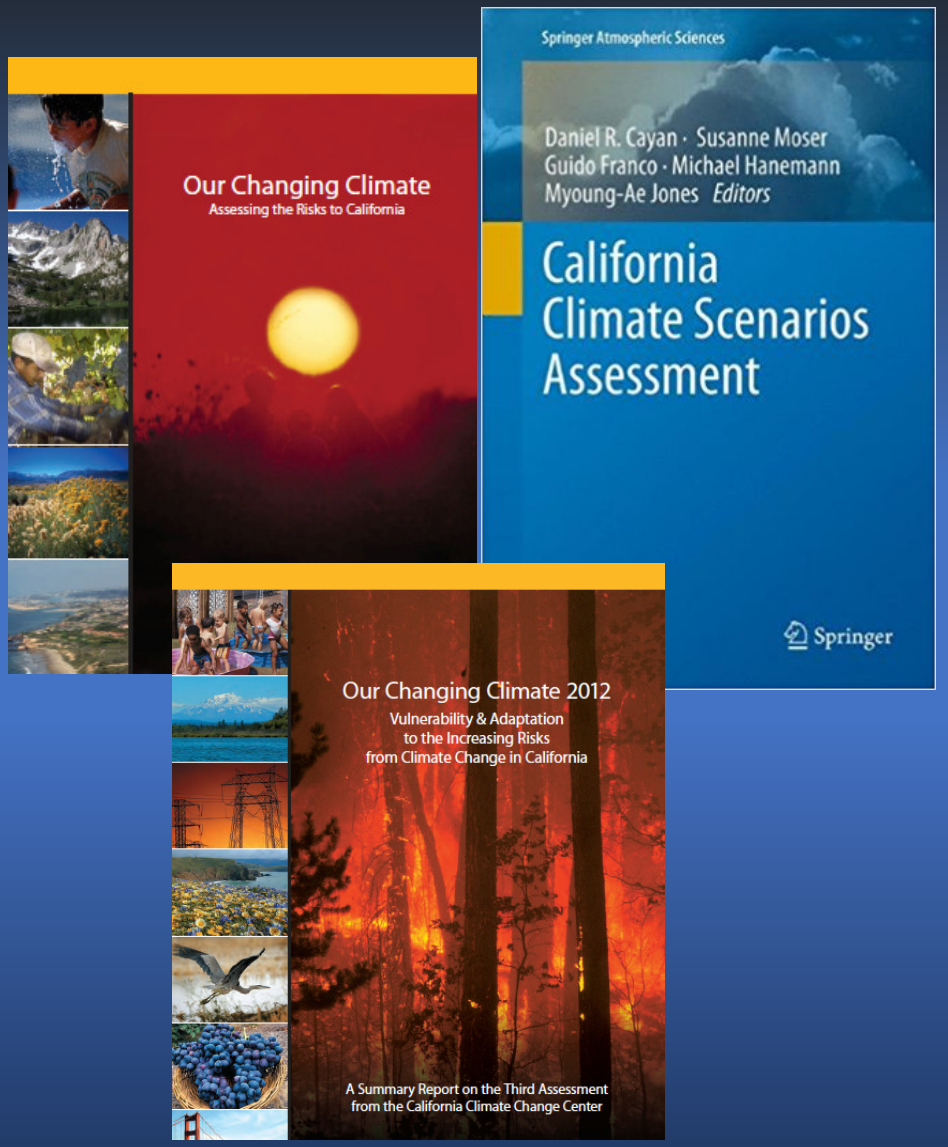
- Documented severity of potential impacts
- Supported passage of AB 32

Second California Climate Change Assessment (2009)

- Recognized importance of adaptation
- Informed California Climate Adaptation Strategy (2009)

Third California Climate Change Assessment (2012)

- Regional and local studies
- Identified barriers to adaptation
- Improved understanding of interactions between local vulnerabilities and climate risks



The Fourth Assessment

Features more than 50 reports:

- 44 technical studies
- 9 regional synthesis reports
- 3 statewide topical reports
  - Ocean & coast communities
  - Tribal and indigenous communities
  - Climate justice
- 1 statewide summary/integration report

Over 100 contributing authors

Emphasis on **<u>regional climate adaptation</u>**

Regional reports

Regional climate projections

- Temperature
- Precipitation
- Sea Level Rise
- Wildfire

Threats and adaptation strategies for

- Terrestrial and freshwater ecosystems
- Agriculture, forests, and working lands
- Water, energy, and transportation infrastructure
- Public health
- Tribes and indigenous communities

Topical assessments

"While all Californians are impacted by climate change, certain communities are in a better position to respond, recover, and adjust as these changes occur, while others are more vulnerable. In many cases, the most vulnerable are the same communities that already experience social, racial, health, and economic inequities. Building a resilient California requires increasing the capacity of communities and people to be able to withstand and recover from climate-related disruptions, and learning to adapt in the face of this change"

- Safeguarding California Plan: 2018 Update

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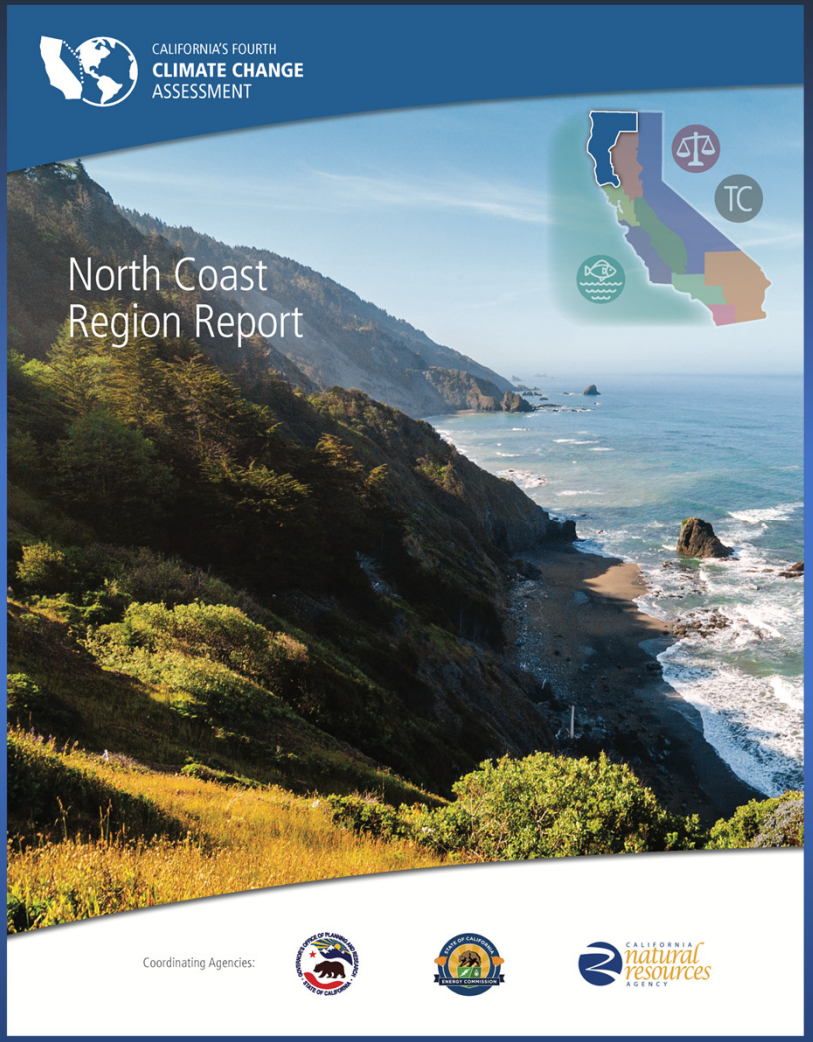

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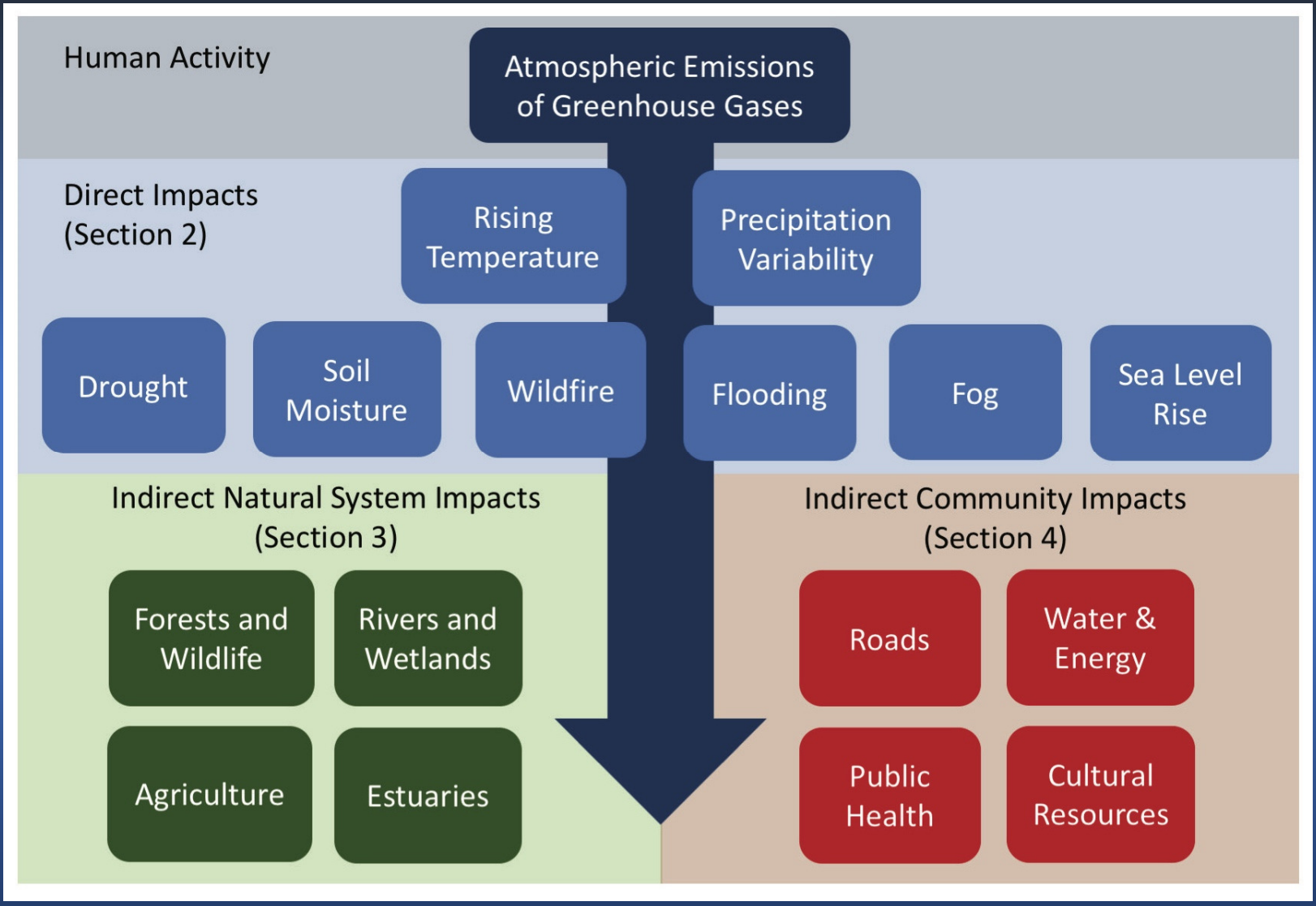
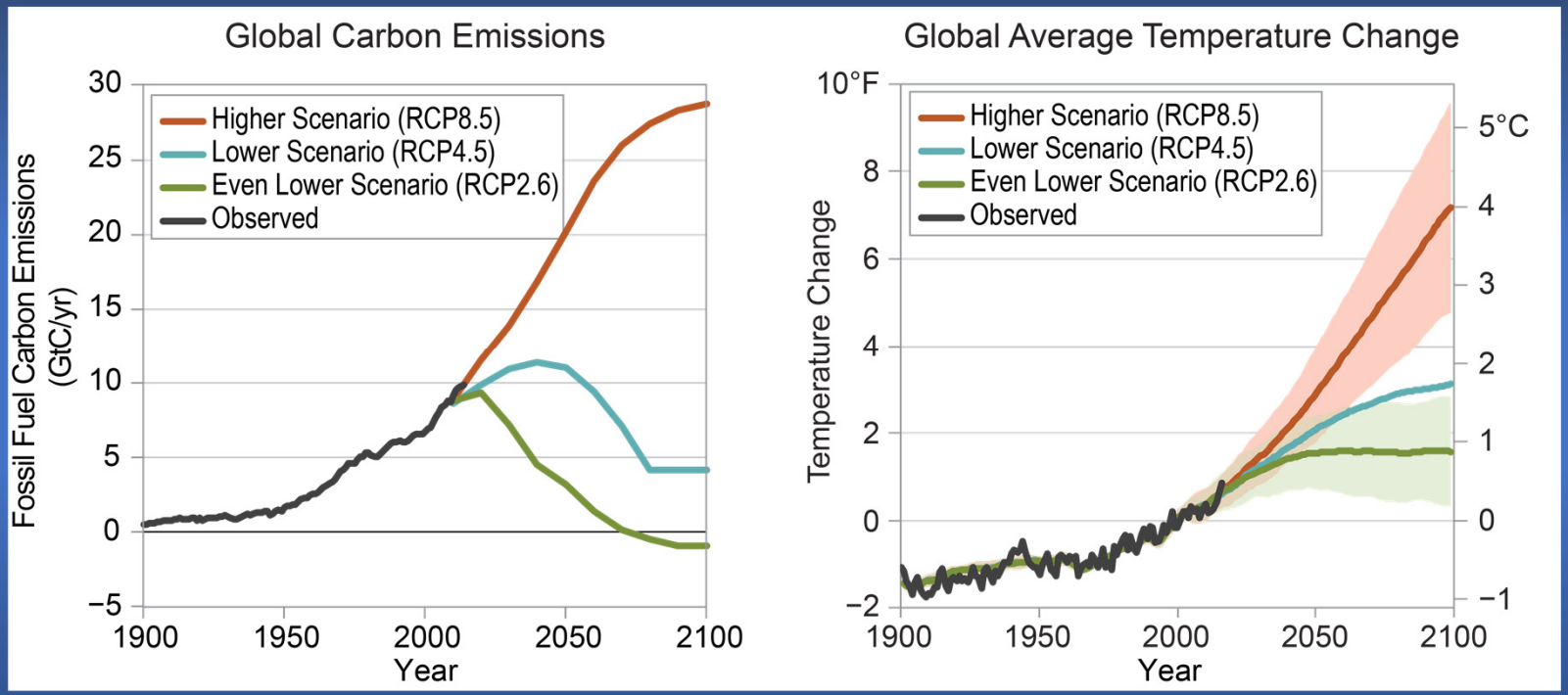
www.climateassessment.ca.gov

	POPULATION	AREA(MI²)
Mendocino	87,628	3,506
Humboldt	136,646	3,568
Del Norte	27,540	1,006
Lake	64,116	1,256
Trinity	12,782	3,179
Siskiyou	43,603	6,278
Total	**372,315**	**18,793**
% of State	*0.9%*	*11.5%*

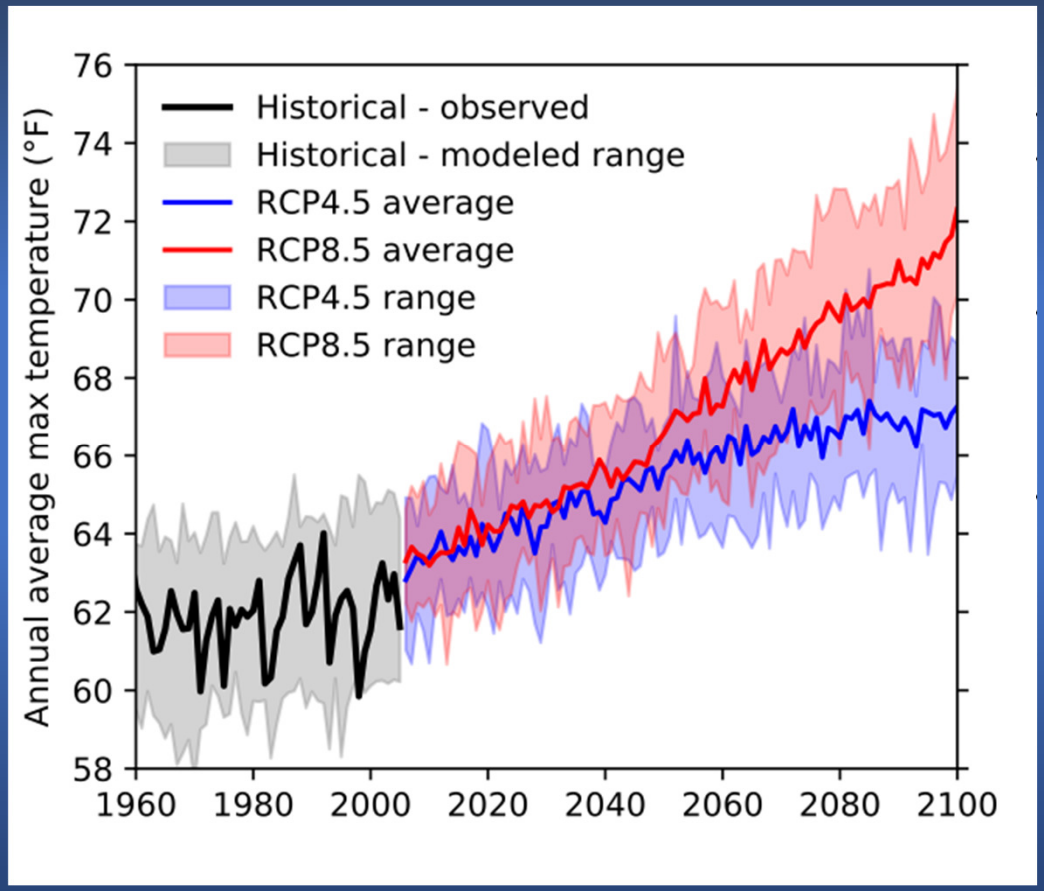

Human Activity
Atmospheric Emissions of Greenhouse Gases
Direct Impacts (Section 2)
Rising Temperature
Precipitation Variability
Drought
Soil Moisture
Wildfire
Flooding
Fog
Sea Level Rise
Indirect Natural System Impacts (Section 3)
Forests and Wildlife
Rivers and Wetlands
Agriculture
Estuaries
Indirect Community Impacts (Section 4)
Roads
Water & Energy
Public Health
Cultural Resources

Projected global carbon emissions scenarios

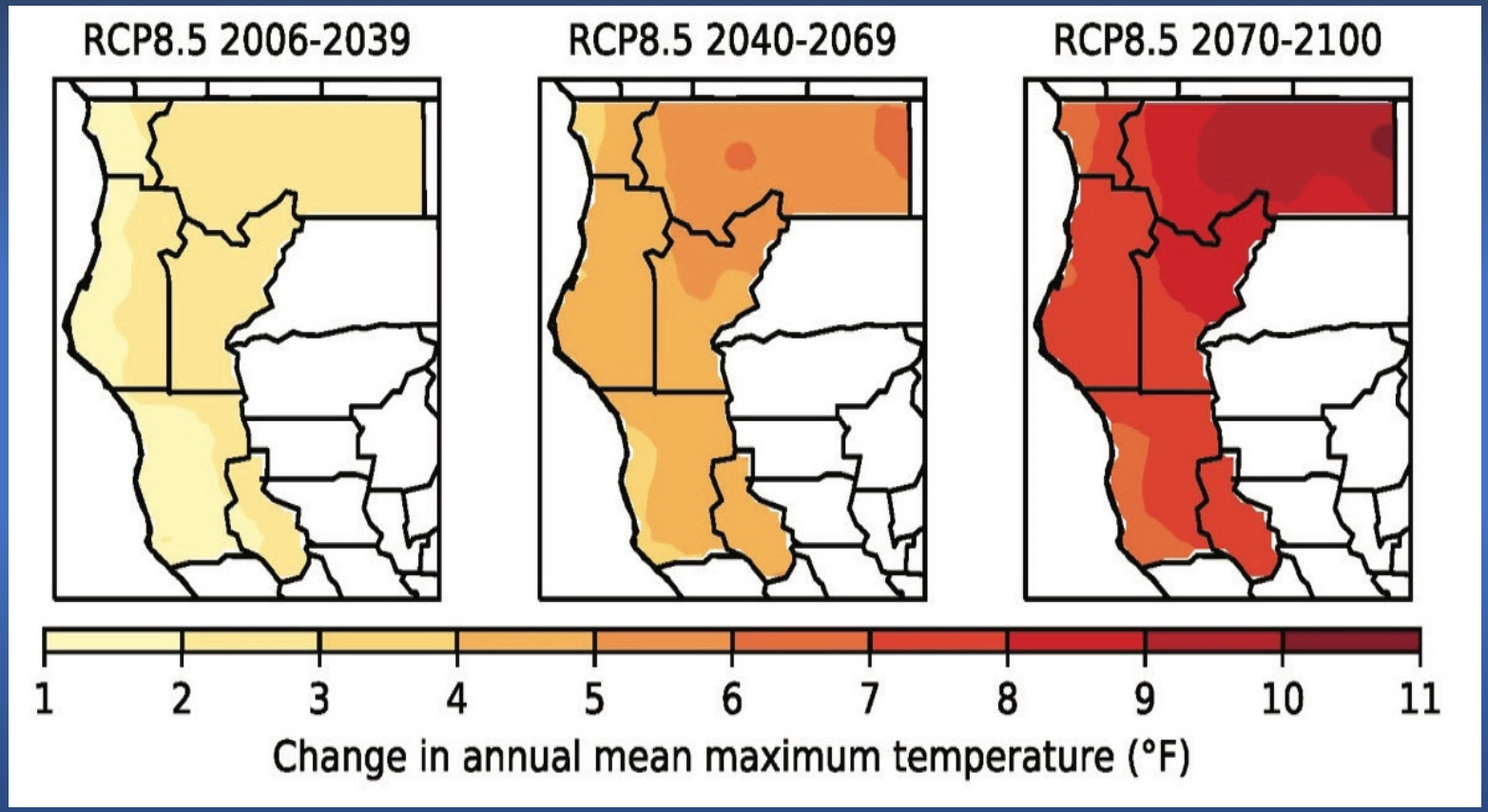


Source: National Climate Assessment 2018

Projected temperature increases



Projected temperature increases



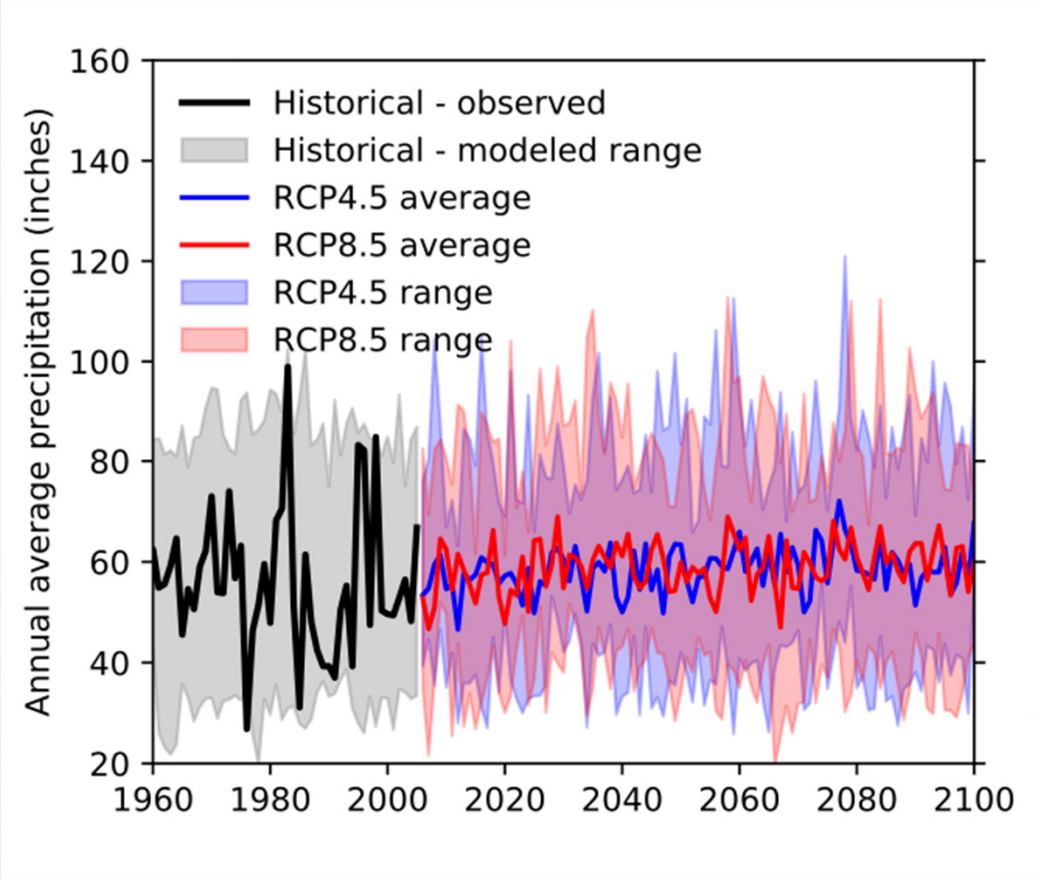
Willow Creek Heat Days (> 100 F)

Historical (1960-1990) 8 d/yr

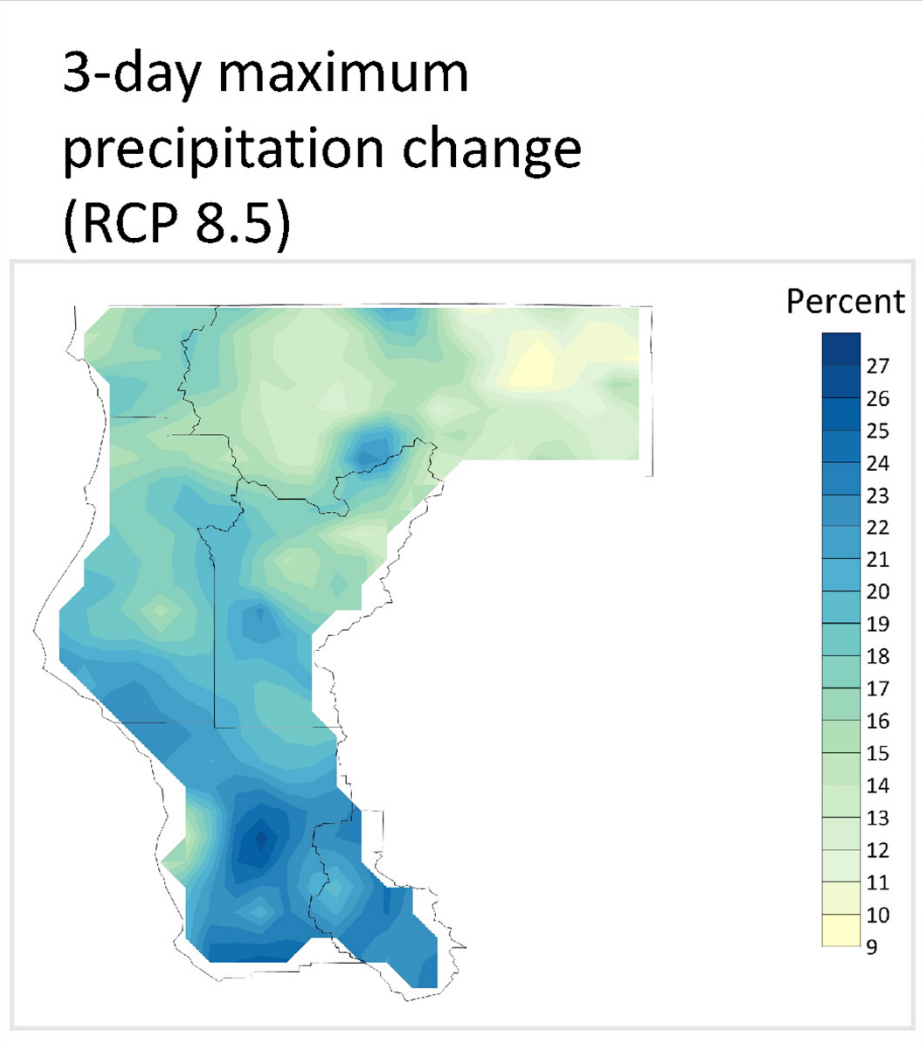
Future (2070-2100) 40 d/yr

Source: Cal-Adapt.org

Uncertain change in annual precipitation

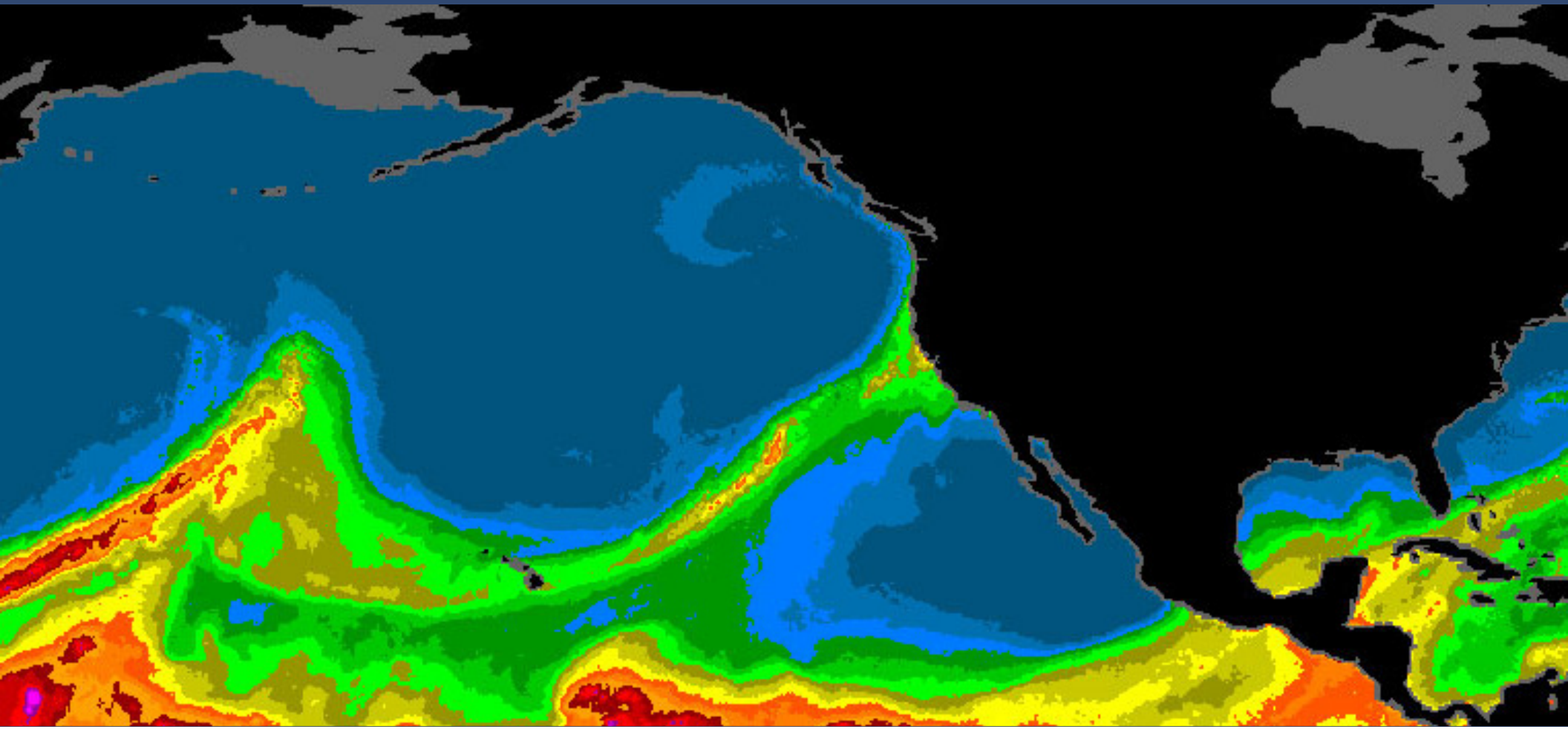


Increase in precipitation extremes

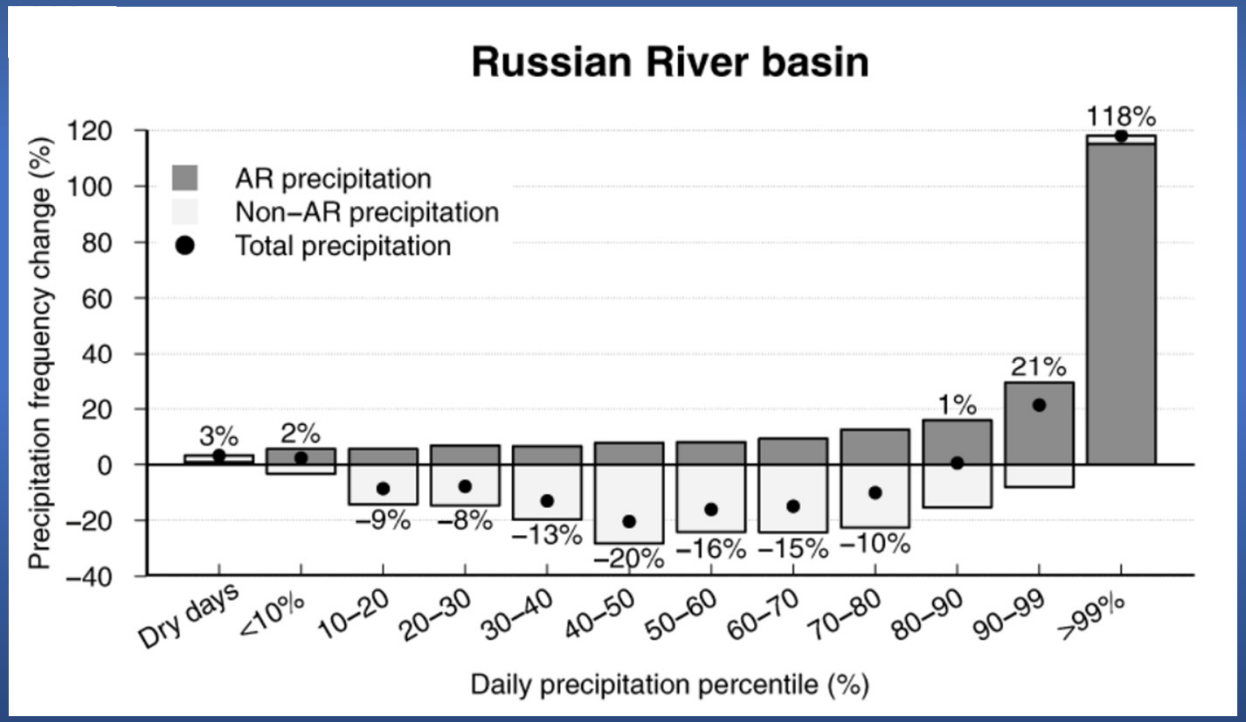


Source: Cayan et al. 2018

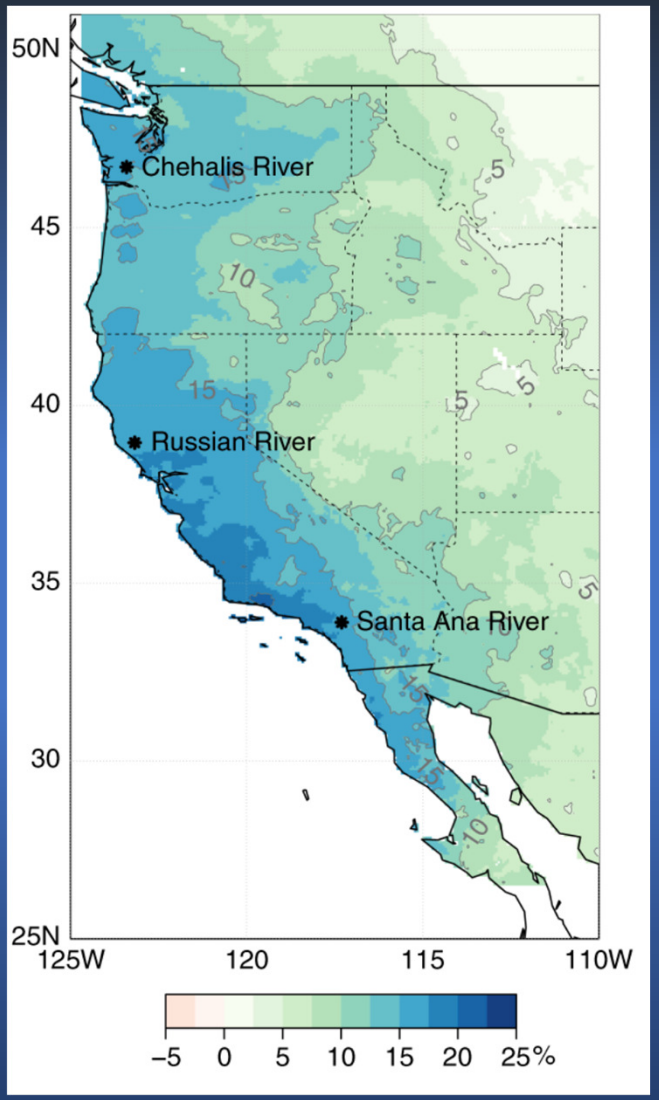
Atmospheric rivers



Increasing proportion of precipitation delivered by atmospheric rivers



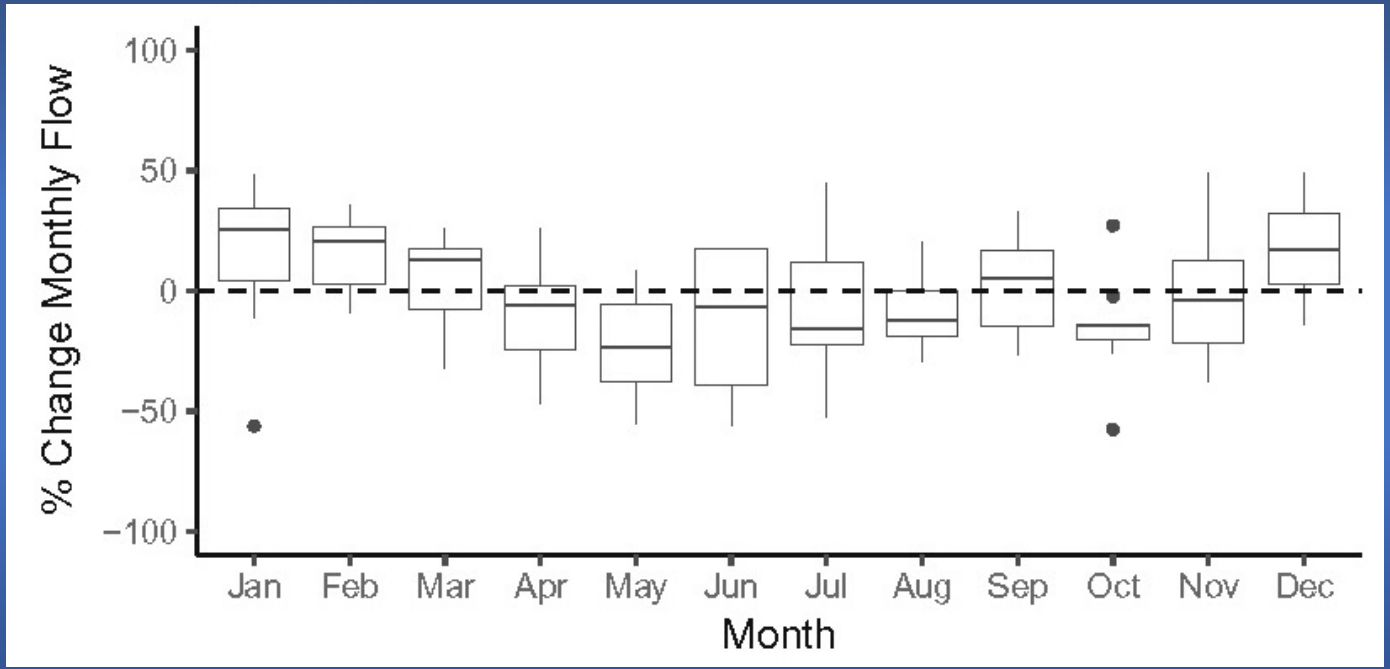
Gershunov et al. 2019 Scientific Reports



"Extreme precipitation in the Russian River basin becomes more than twice as likely in the second half of the 21st century compared to the second half of the 20th. This projected change is due essentially to ARs."

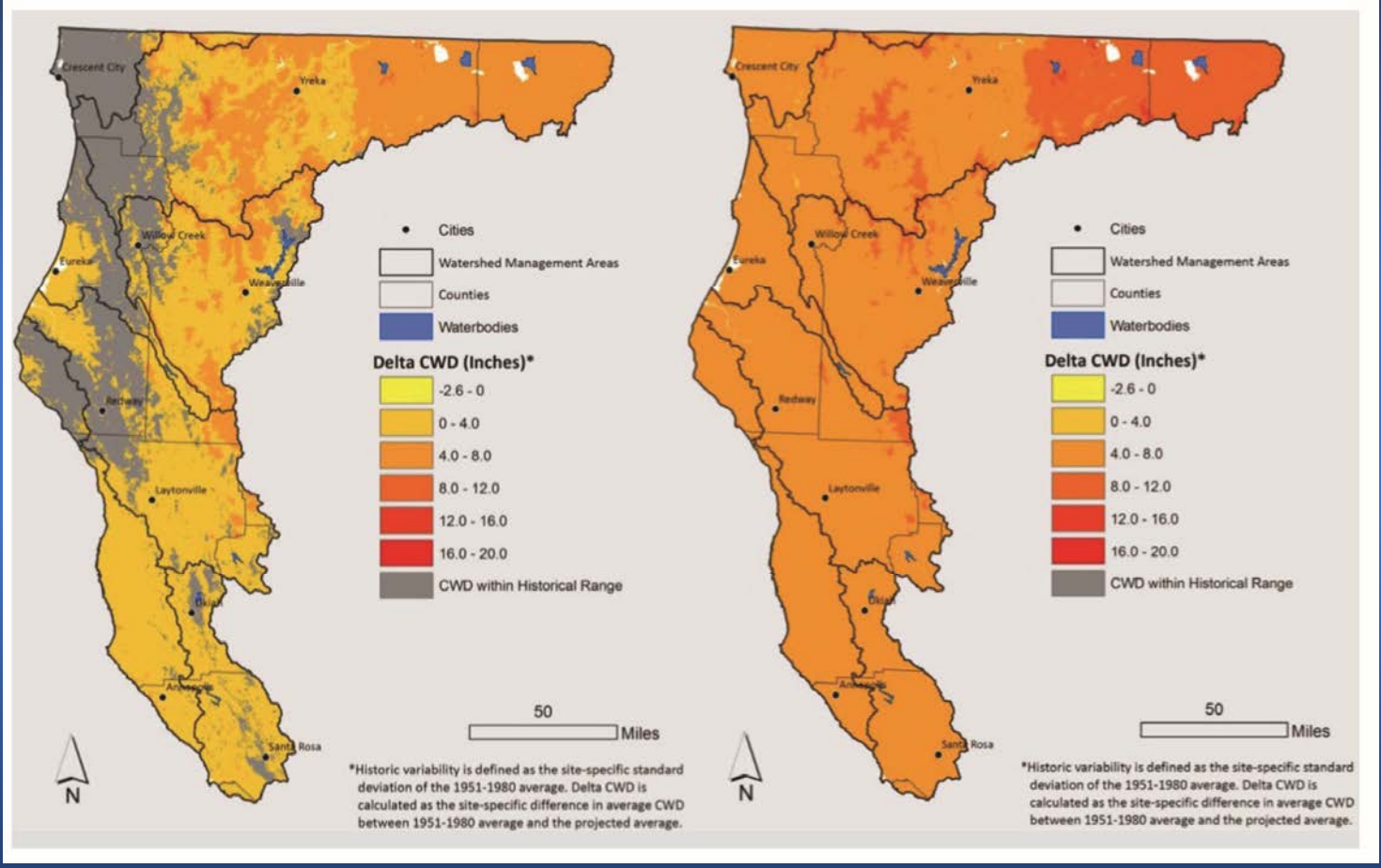
Gershunov et al. 2019 Scientific Reports

Decreasing summer stream flow



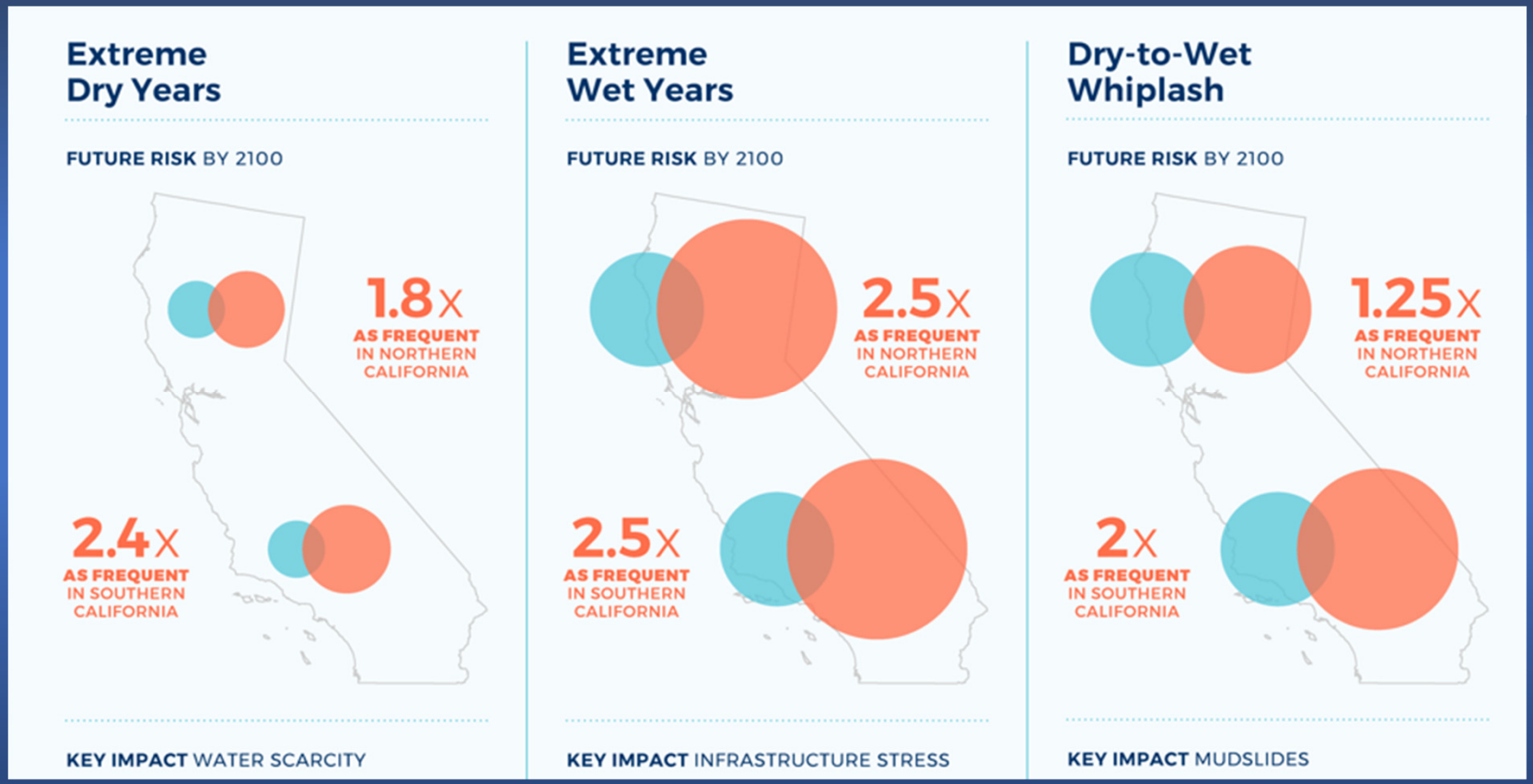
Source: Grantham et al. 2018

Decreasing soil moisture



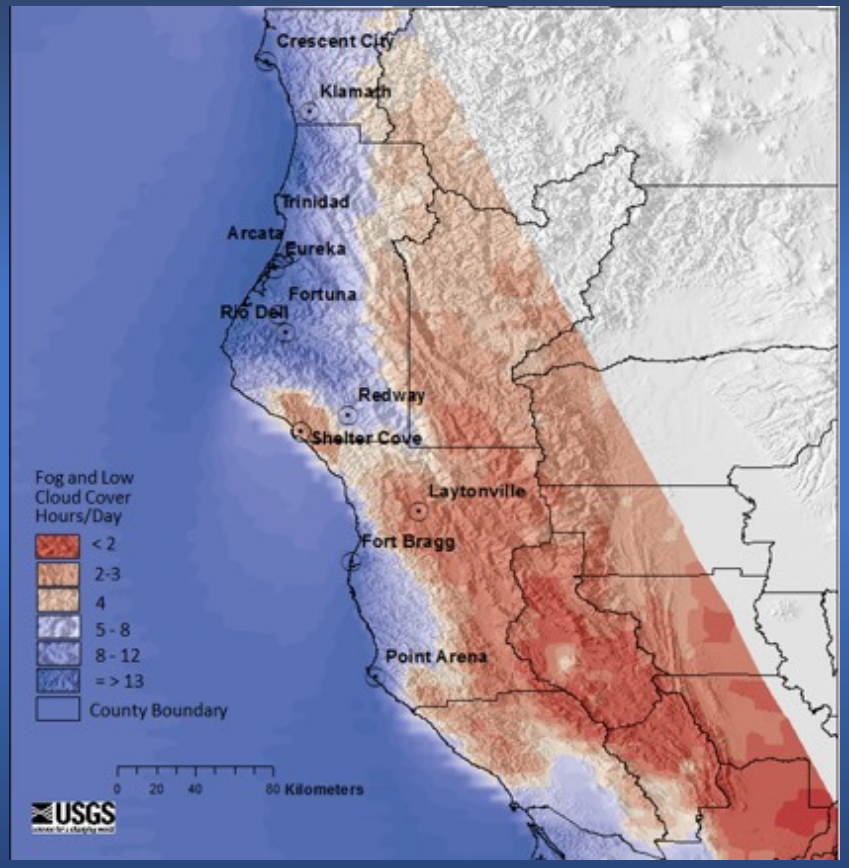
Source: Micheli et al. 2018

Climate change ”whiplash” effect



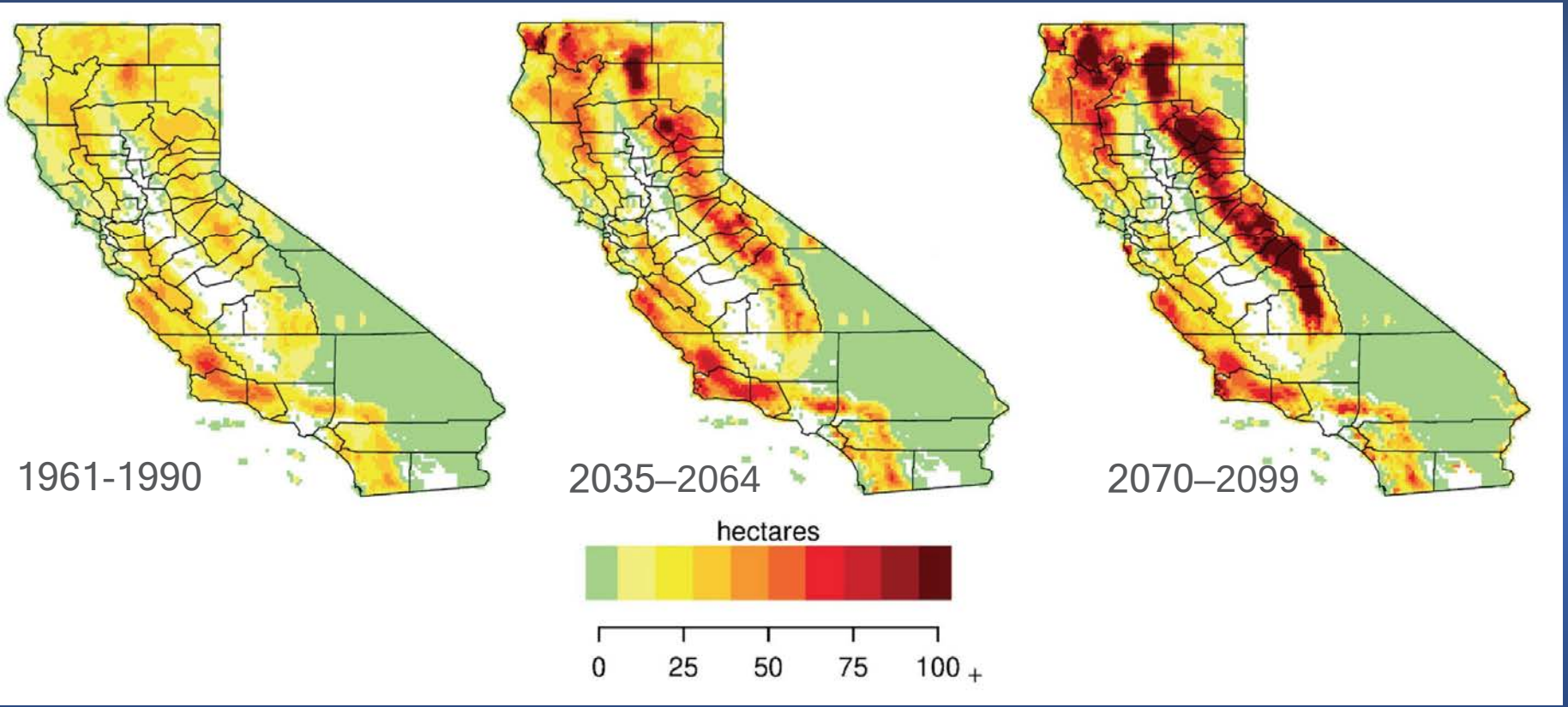
www.ioes.ucla.edu/project/future-extreme-precipitation-california

Uncertain changes in coastal fog



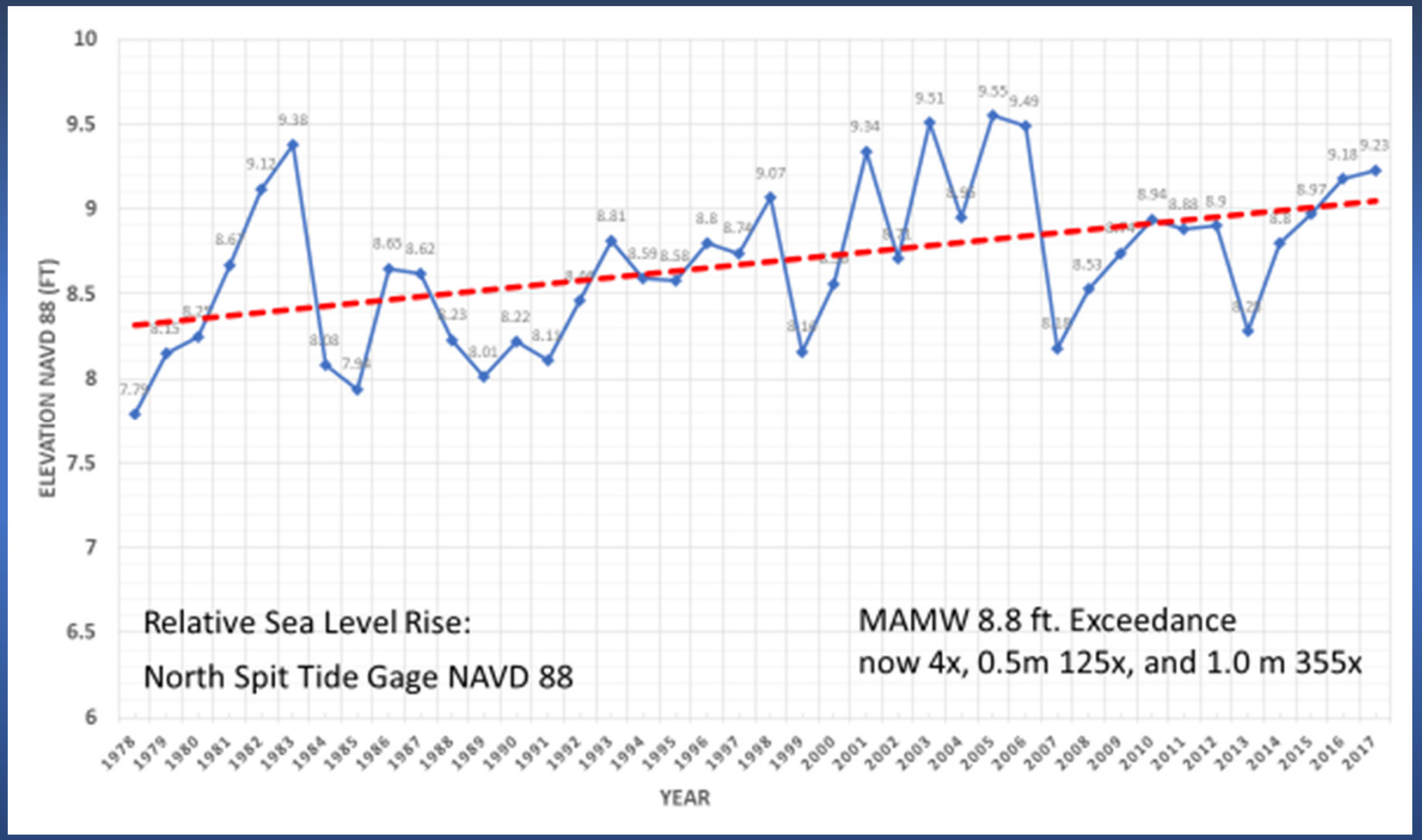
Source: Torregrosa et al. 2014

Increasing wildfire: annual area burned



Source: Westerling 2018

Sea level rise: Humboldt Bay maximum high tide



Source: A. Laird

Community impacts

- Vulnerable infrastructure, including transportation, water supply, energy and communication systems
- Public health risks from wildfire, floods, and disease vectors
- Disproportionate impacts to disadvantaged communities

Recommendations

- Short- and long-term infrastructure planning
- Investment in emergency planning and response systems
- Promote community-engaged approaches to climate vulnerability assessment and adaptation

Ecosystem impacts

- Habitat loss for sensitive plant and wildlife species
- Change in vegetation types
- Reduced productivity of rangeland and pastureland systems

Recommendations

- Enhance ecosystem monitoring network
- Protect habitat corridors and climate refugia
- Prescribed fire on grassland and forest ecosystems

Key findings of regional assessment

North coast has unique challenges and opportunities for adapting to climate change

While everyone will be affected by climate change, vulnerable communities are most at risk

Land use decisions are critical to increasing (or decreasing) the impacts of climate change

Tribes are leading climate adaptation action in the region

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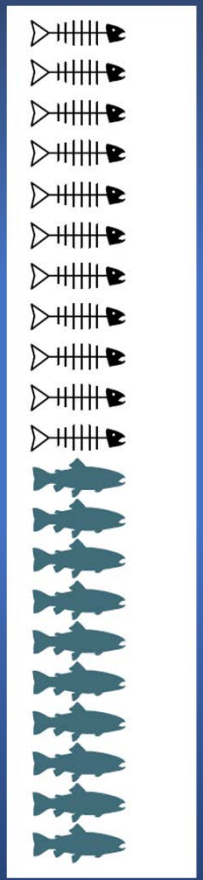
- North Coast Regional Report
- **Strategies for managing freshwater ecosystems**


Freshwater ecosystem threats
• Changing temperature and flow regimes
• Habitat loss
• Introduced species



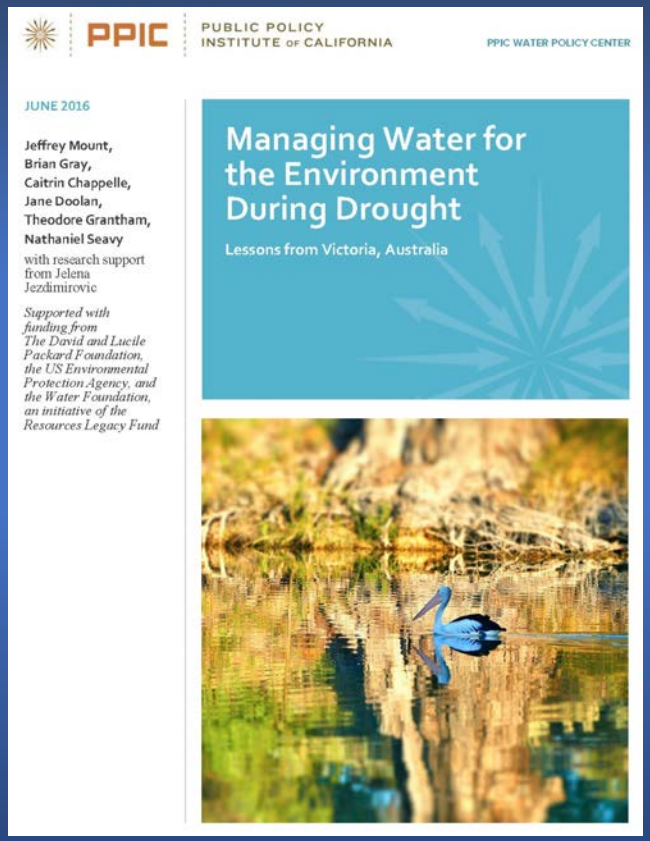
If present trends continue...

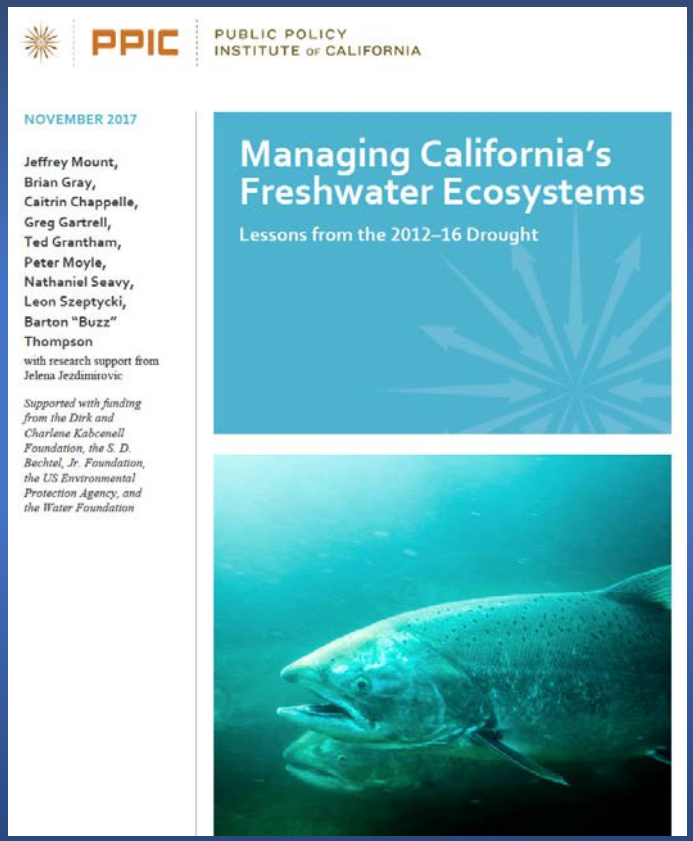
Within 50 years 11 of 21 (52%) of California's anadromous species are likely to be extinct.

Moyle et al. 2017 CalTrout

2012-2016 Drought: a glimpse into the future

Lessons learned from the drought





Public Policy Institute of California Water Policy Center

Freshwater ecosystem threats

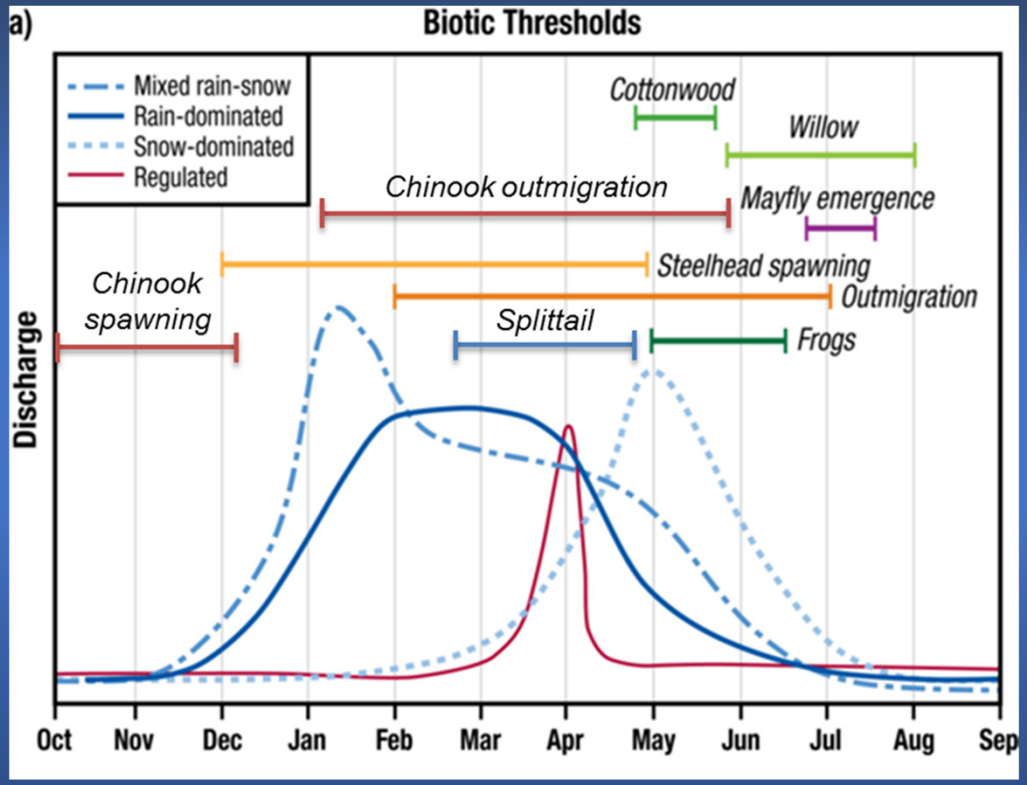
- Changing temperature and flow regimes
- Habitat loss
- Introduced species

Adaptation strategies

- Secure water for the environment
- Reconnect rivers
- Actively manage native and non-native species

(1) Managing water for the environment

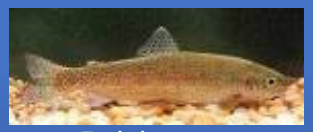
- **Environmental water budgets**: annual environmental water allocations that can be managed flexibility
- **Functional flows**: components of the flow regime that control important physical, biochemical, and ecosystem functions



Yarnell et al. 2010

Example: Functional flows in practice

Putah Creek


Rainbow trout


Prickly sculpin

native


Sacramento pikeminnow


Sacramento sucker


California roach


Hitch

native


Bigscale logperch


Common carp

non-native

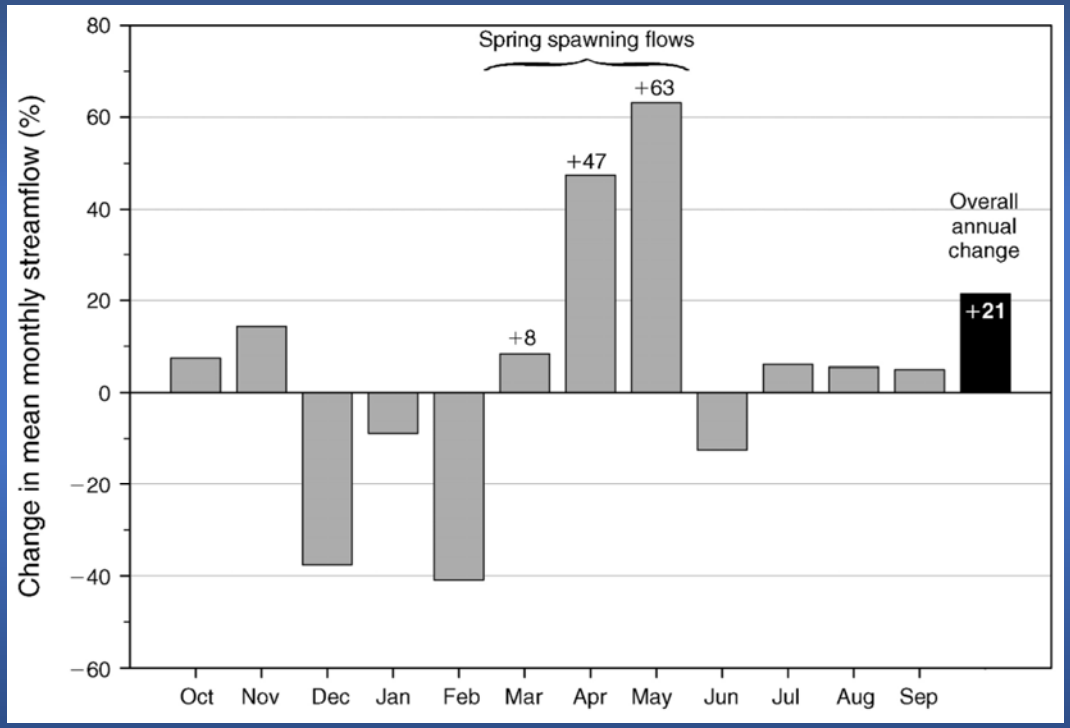

Channel catfish


Bluegill


Black crappie

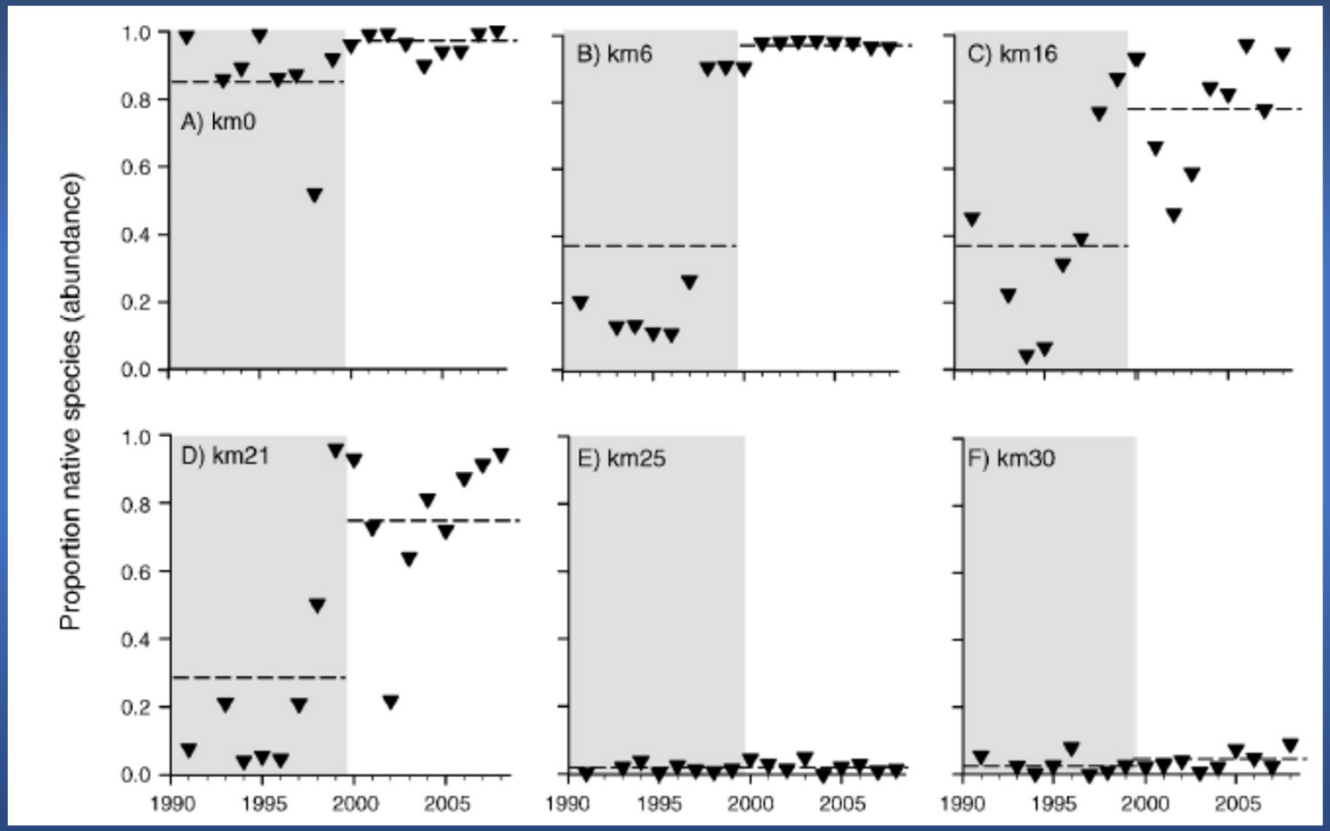
Putah Creek Flow Recommendations

- Ecosystem-based flow recommendations
  - Enhanced spring flows for spawning and rearing of resident natives
  - Summer baseflows to maintain connectivity
  - Enhanced winter baseflows to support salmon migration and spawning
  - Habitat maintenance pulse flows to redistribute sediment and control non-natives



Kiernan et al. 2012

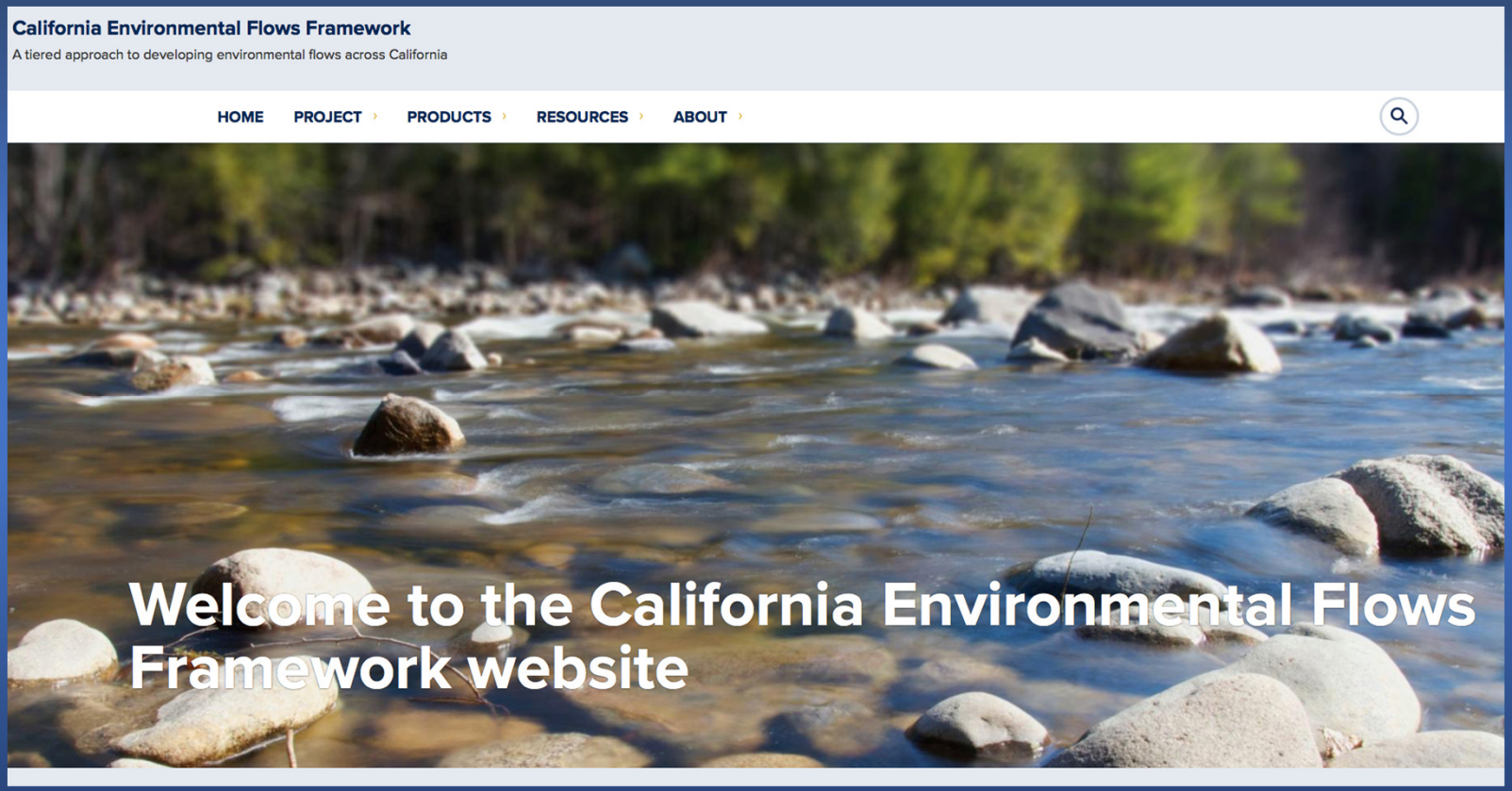
Ecosystem Response to Functional Flows



Kiernan et al. 2012

Putah Creek: A reconciled ecosystem

Scaling Up



ceff.ucdavis.edu

California Environmental Flows Framework

Tier 1

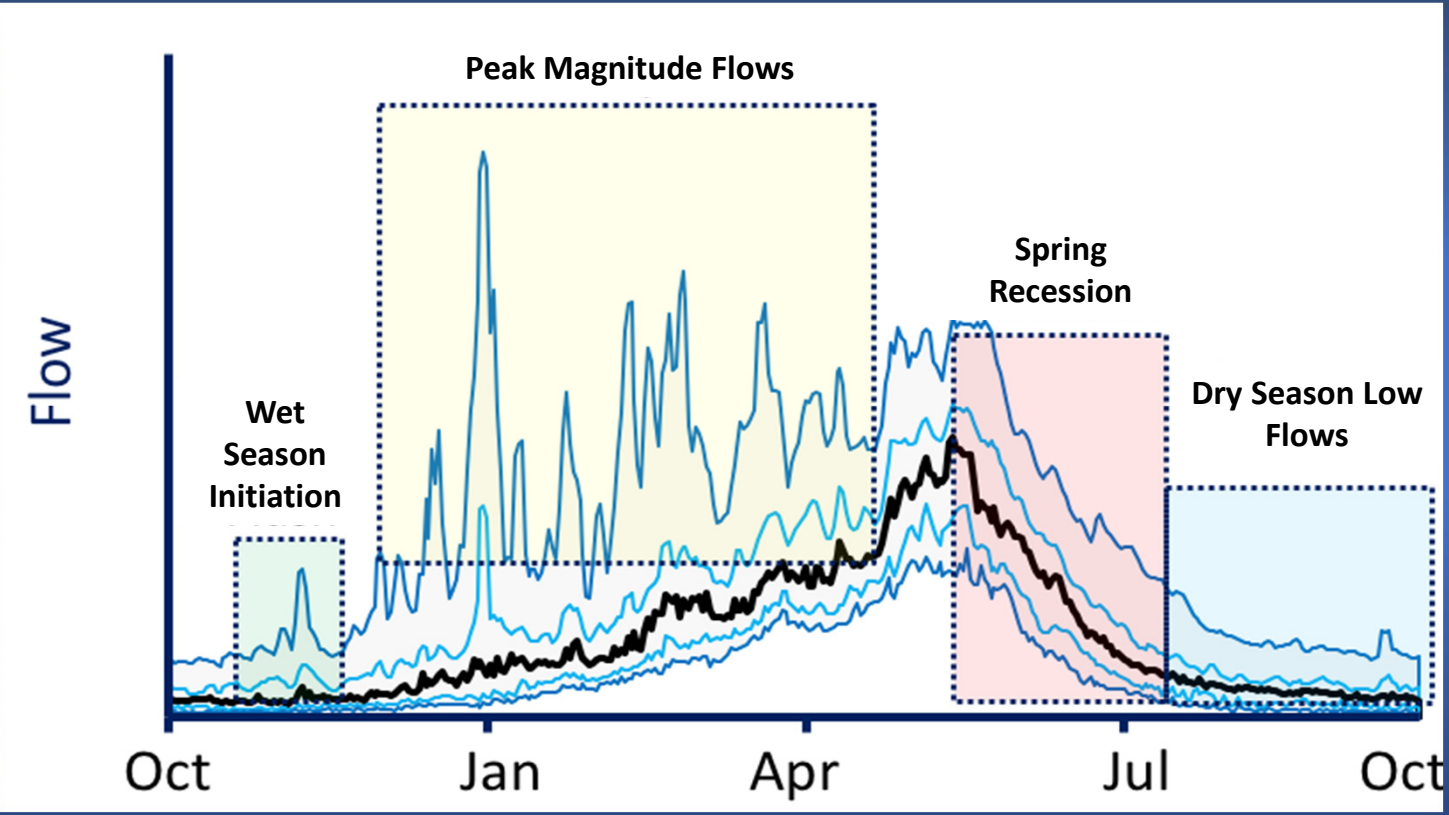
Statewide approach for setting reference-based flow targets

Tier 2

Regional or site-specific refinement where necessary

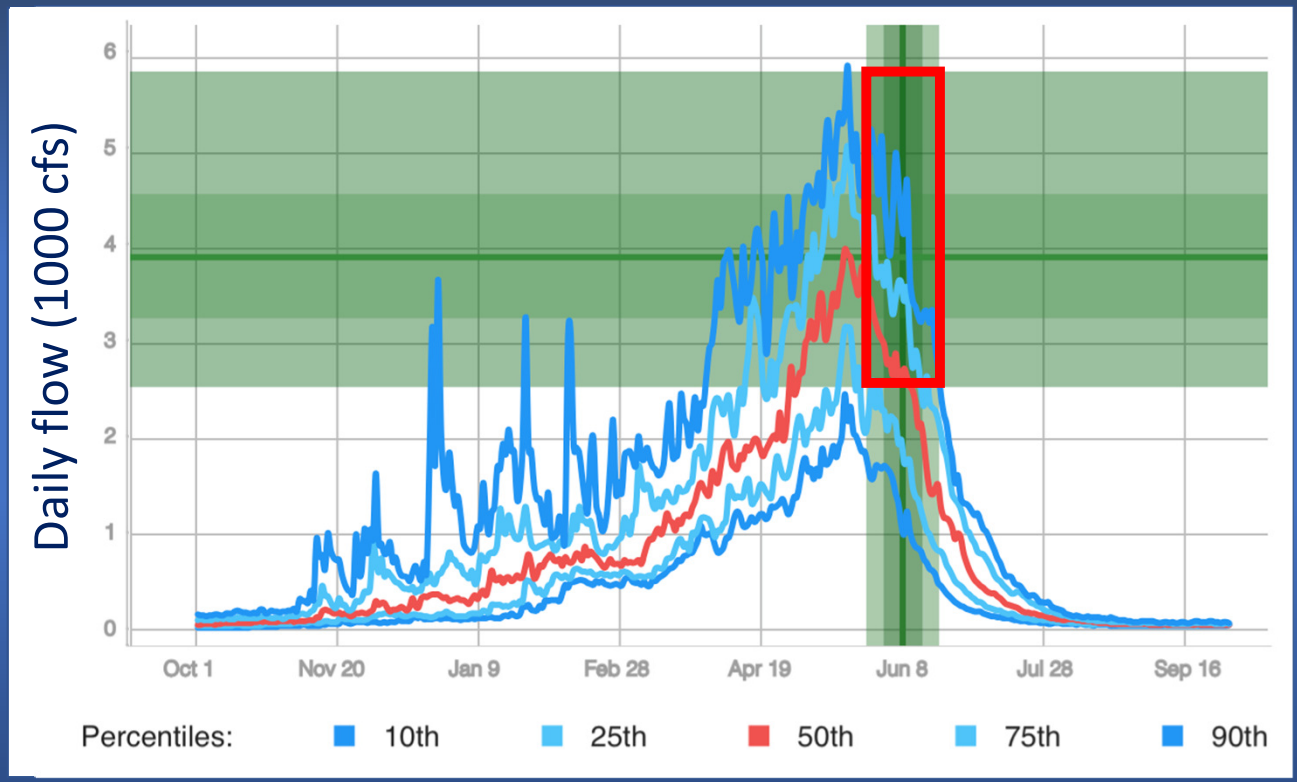
Data sharing and information dissemination to the public

Functional flow components



Quantifying functional flows

- Spring flow recession

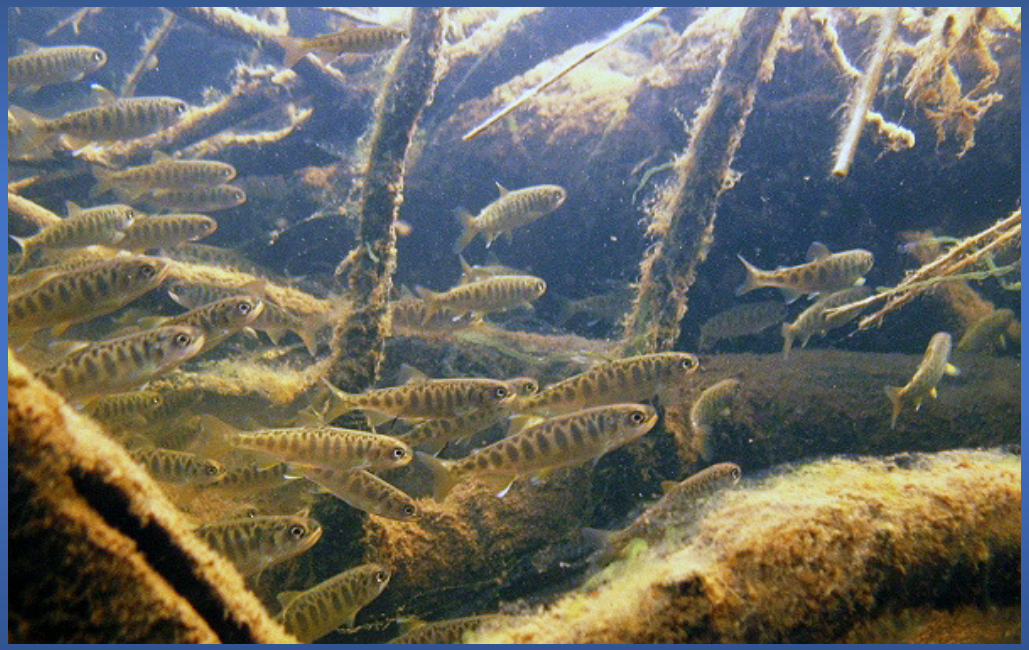


(2) Reconnecting rivers

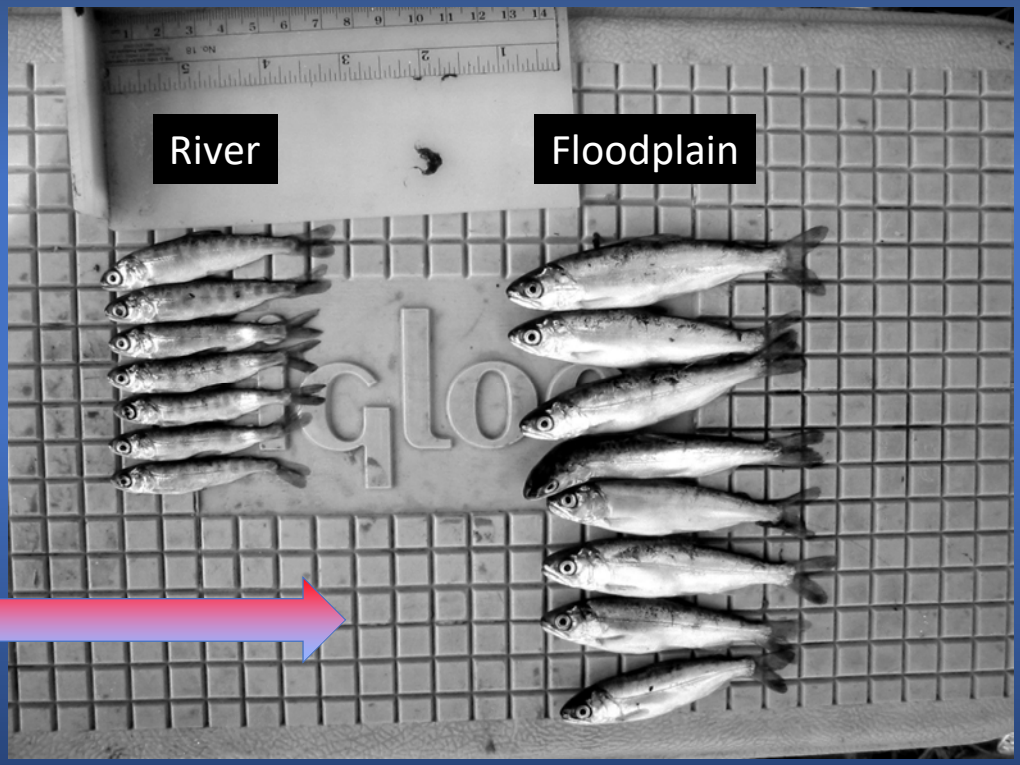
J.C. Boyle Dam, Klamath River

Cosumnes River Preserve

Example: Restoring floodplains



Priming the Productivity Pump

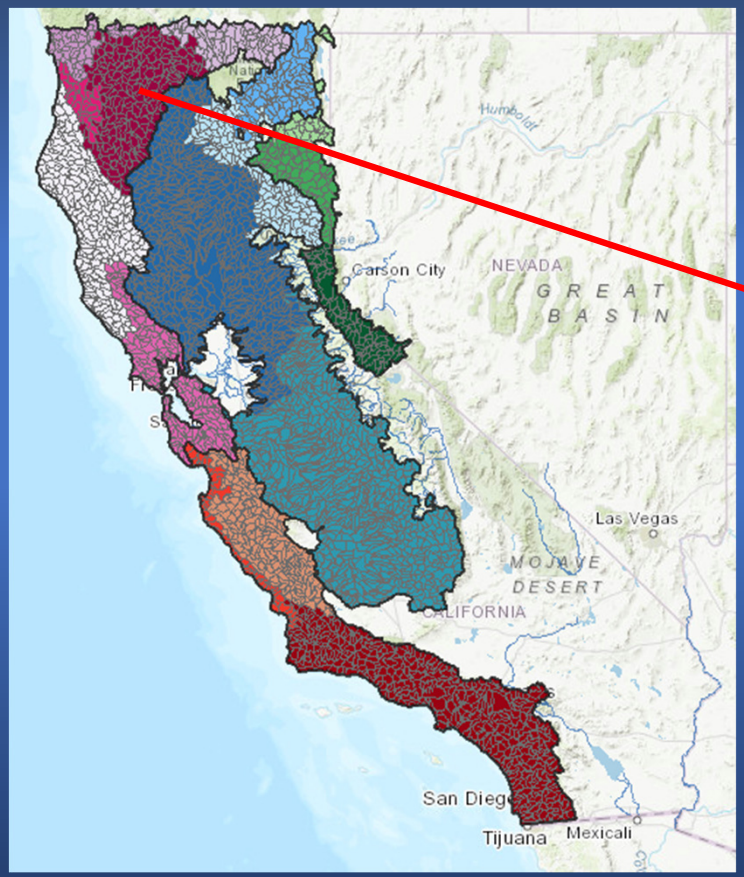


Jeffres et al. 2008

Towards multi-benefit floodplain management

(3) Managing species assemblages

Example: Trait-based approaches

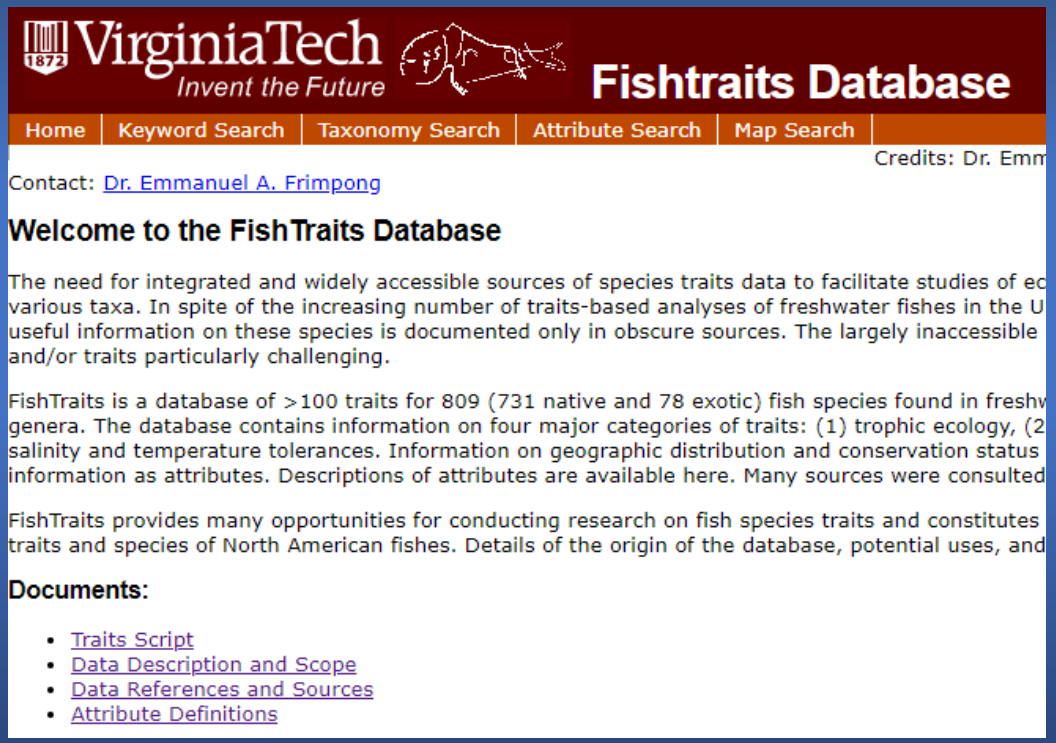


Chinook salmon, Coastrange sculpin, Coho salmon, Green sturgeon, Klamath River lamprey, Klamath smallscale sucker, Lamprey, Marbled sculpin, Prickly sculpin, Speckled dace, Threespine stickleback, Trout (mykiss), Western brook lamprey, White sturgeon

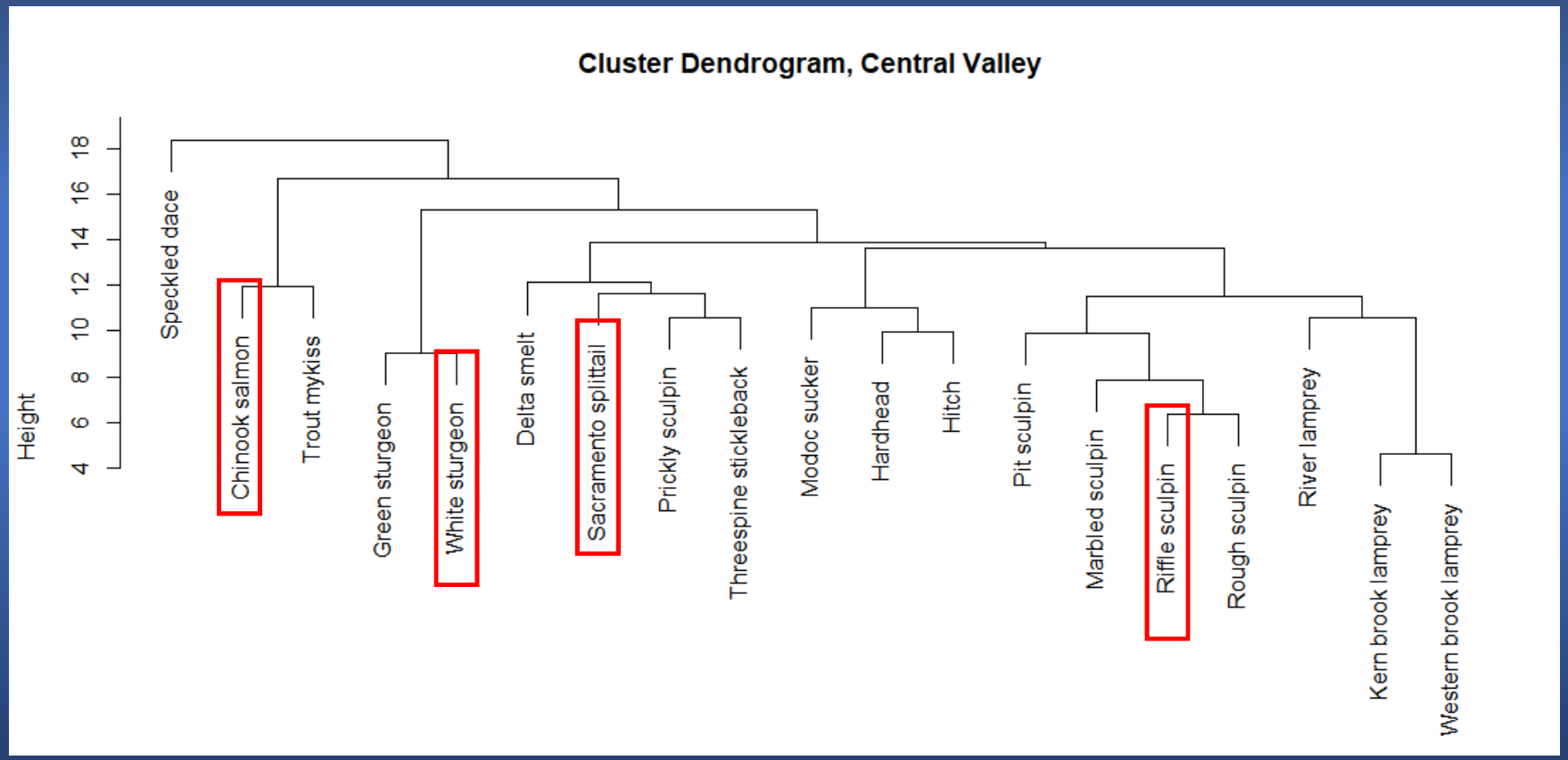
Species traits assessment

National FishTraits Database

- Trophic ecology
- Body size
- Reproductive ecology (life history)
- Habitat associations
- Salinity and temperature tolerance



Trait-based clustering and indicator species selection



A few concluding thoughts…

Climate change will intensify current threats to freshwater ecosystems and native species

Managing water for the environment, coupled with the restoration of river network and river-landscape connectivity will enhance ecosystem resilience

Management of novel aquatic ecosystems will require adaptive approaches that focus on indicators beyond endangered species


Thank you!
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