Droughts, Climate Change and Dams, O My: Making a Future of California's Native Inland Fishes

Peter B. Moyle
Center for Watershed Sciences
Department of Wildlife, Fish, and Conservation Biology

Droughts, Climate Change and Dams, O My: Making a Future of California's Native Inland Fishes

- Drought
- Predicted effects of climate change on aquatic habitats in California
- Climate change & native fishes
- What can we do: A conservation strategy
- Reconciliation ecology



POTRERO HILLS, JANUARY 28, 2014

The 2013-14 Drought

- 3rd dry year
- One year w/o significant rain
  - Until now...
- Reservoirs near-empty
- Fish vs people arguments arise again
- *Under climate change scenarios, these conditions are likely to become chronic*

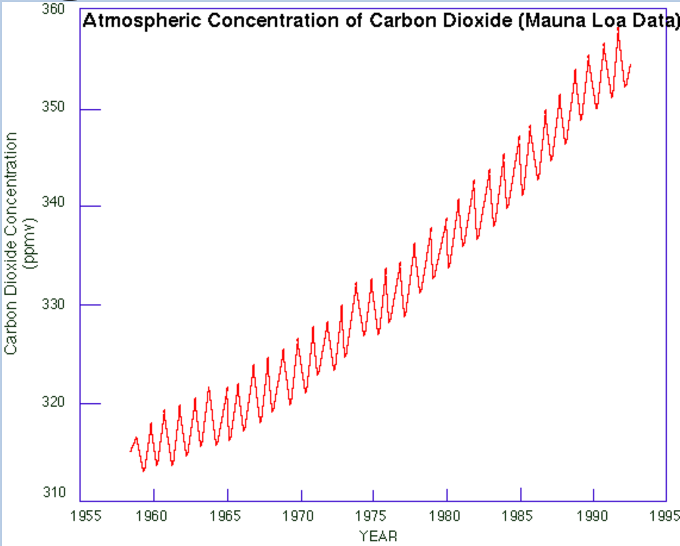
JANUARY 28, 2014

CLIMATE CHANGE

- Is already happening
- CO_2 continues to rise
- Human populations continue to grow
- Models to 2100
- Not good news for fish

  or people

IF PRESENT TRENDS CONTINUE



Predicted effects on aquatic ecosystems

- Sea level rise
- Changes in precipitation patterns
- Changes in stream flows
- Increases in water temperatures
- Increases in droughts and floods

Sea level rise

- 1.4- 1.7 meters by 2100 (conservative)

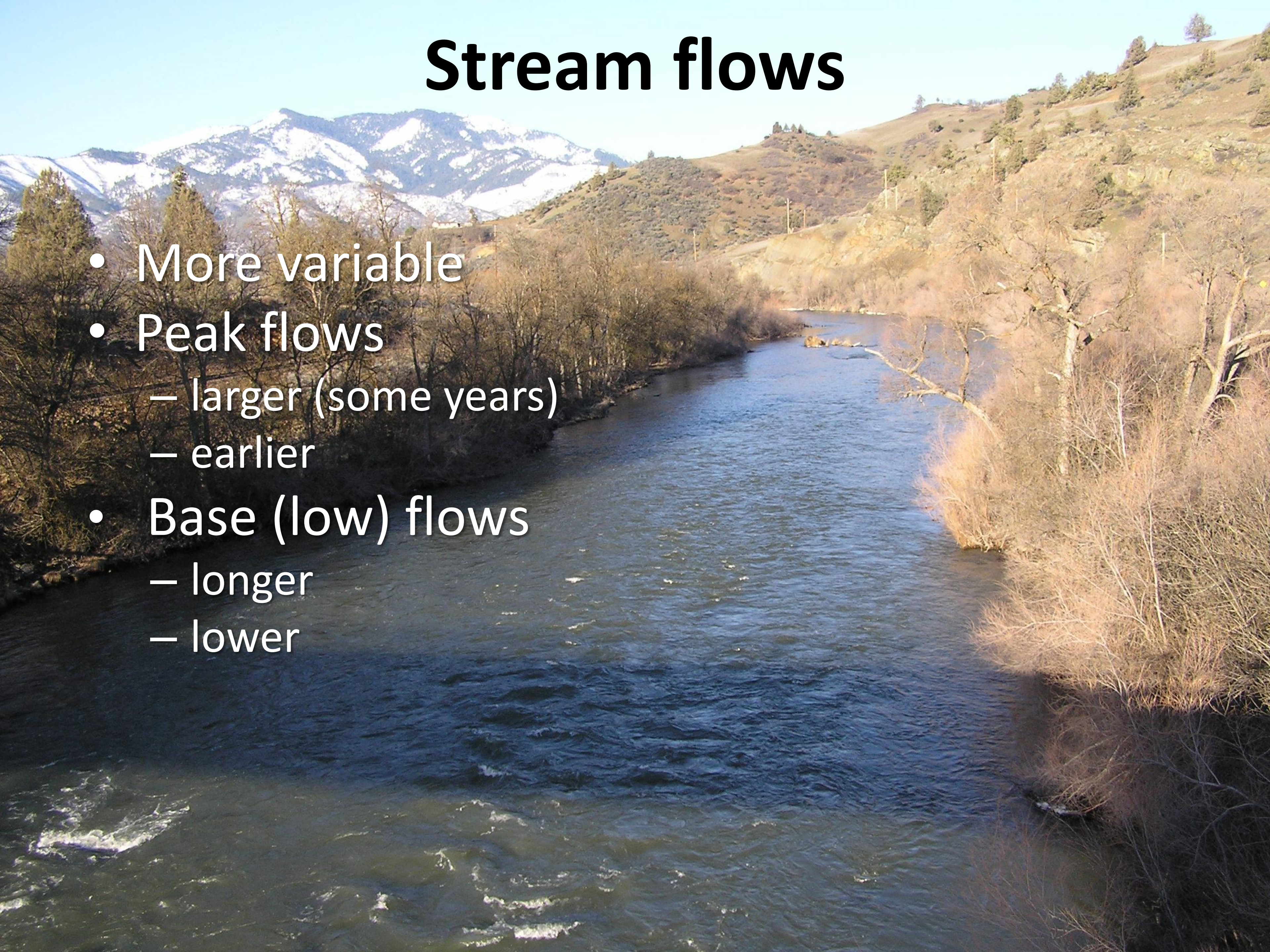
Rapid rise + hardened fringes =

Loss of estuarine habitat

Precipitation

- Less annual precipitation, on average
  - but how much less??
- More variable
  - Mediterranean pattern
  - most precipitation in winter and spring
- More rain, less snow
  - 60-90% loss of snow pack in Sierra Nevada

= Big impacts to stream flows of snow-fed systems

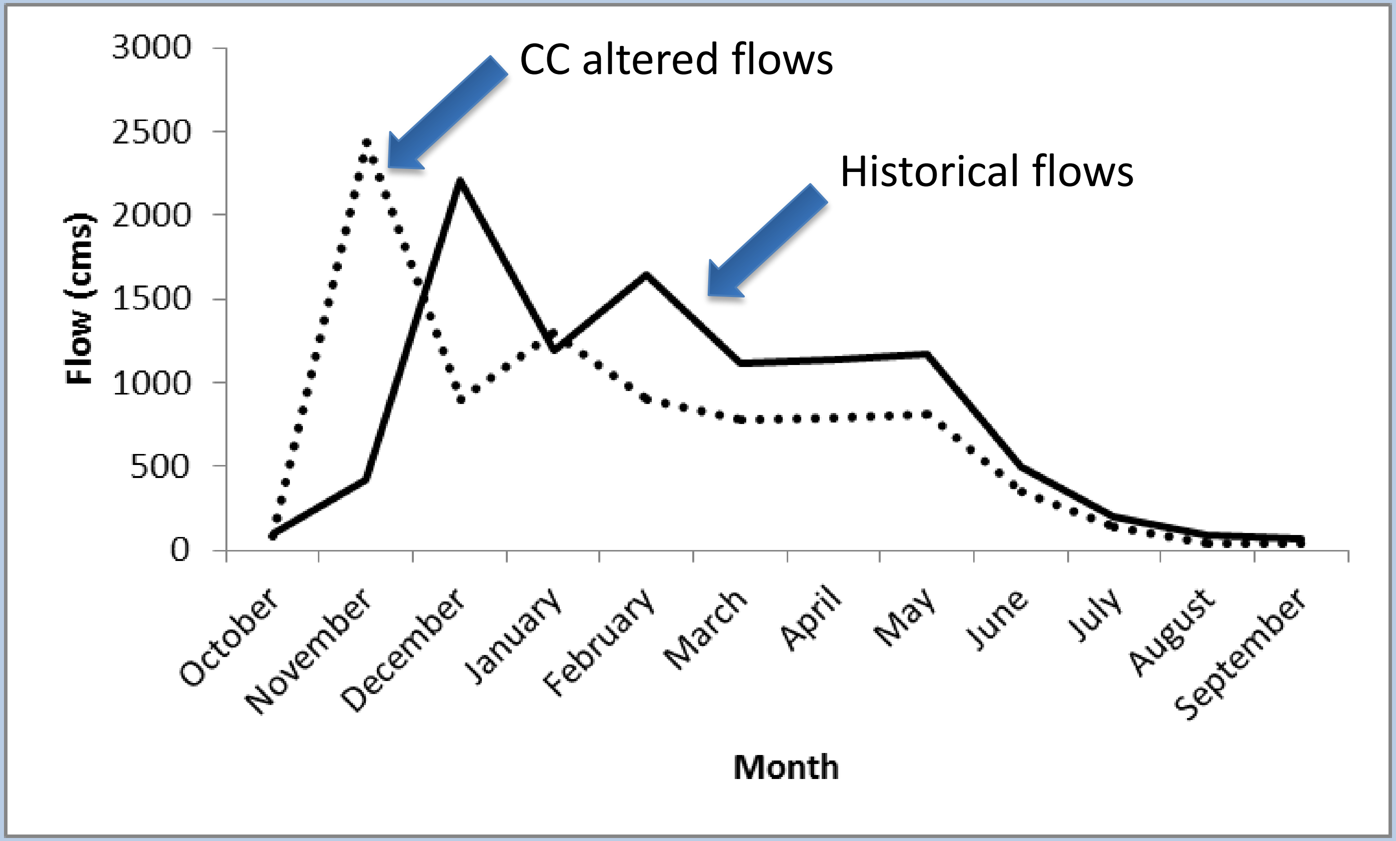


Stream flows

- More variable
- Peak flows
  - larger (some years)
  - earlier
- Base (low) flows
  - longer
  - lower

Flows in Salmon River, Klamath basin

Projected shift due to climate change



Solid line = historical flows; **dotted line** = predicted flows with 10% increase in winter flows, 30% reduction in spring and summer flows, and 30 day shift in peak flows (as in Leung et al. 2004, Kim 2005, Stewart et al. 2005)

Temperatures

- 4-6°C increase in average air temperature by 2100
- 3-5°C increase water temps
  - Depends on stream elevation and size
- Lethal temperatures more frequent
  - Higher air temperature
  - Lower flows in late summer

Temperature shifts & fish

- large loss of cold water (<18-20°C in summer) habitats
- Shift northward & upward of cool water streams
- Warmer streams favor non-native species

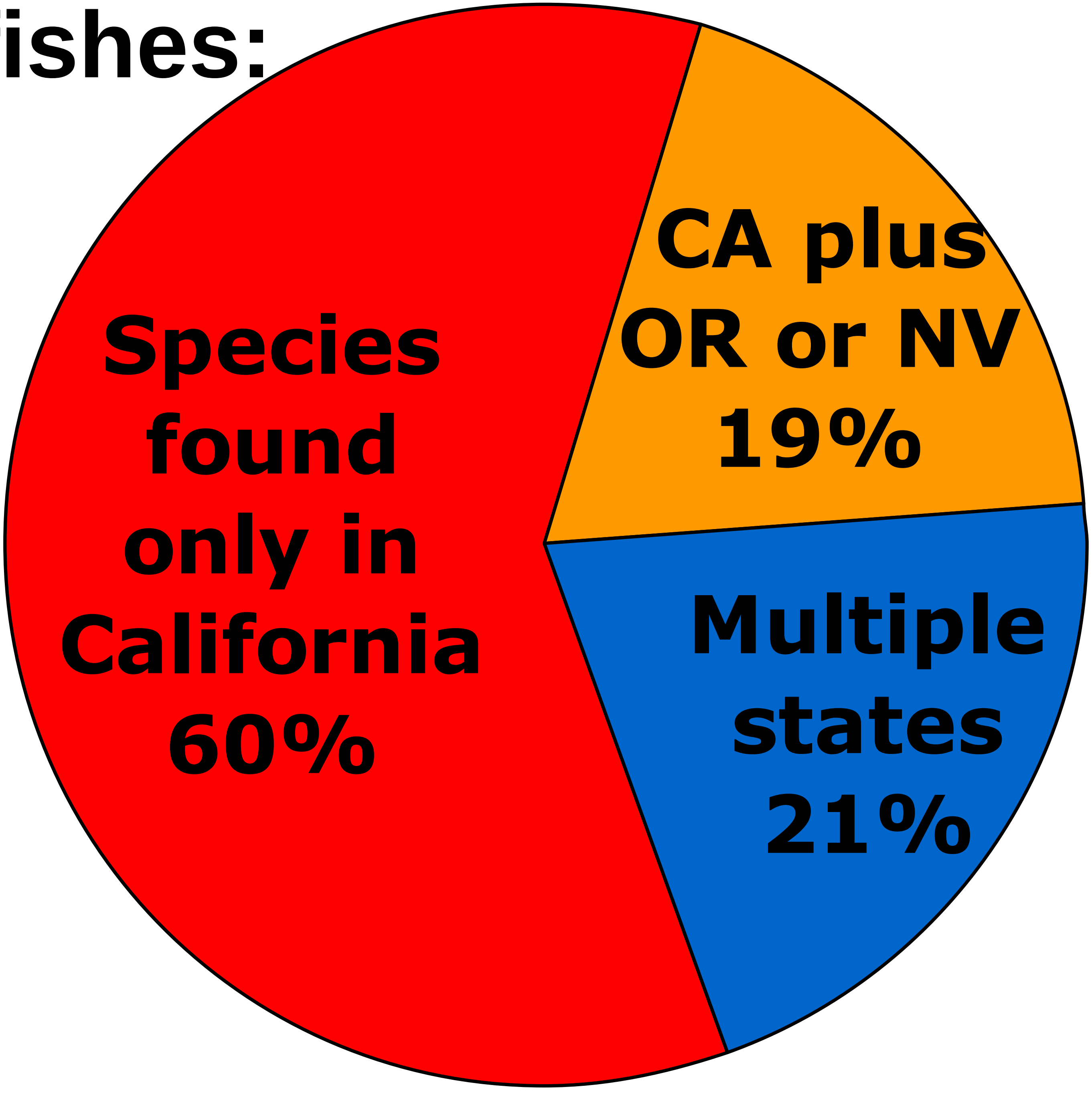
Effects of climate change
on
native fishes

Native fishes:

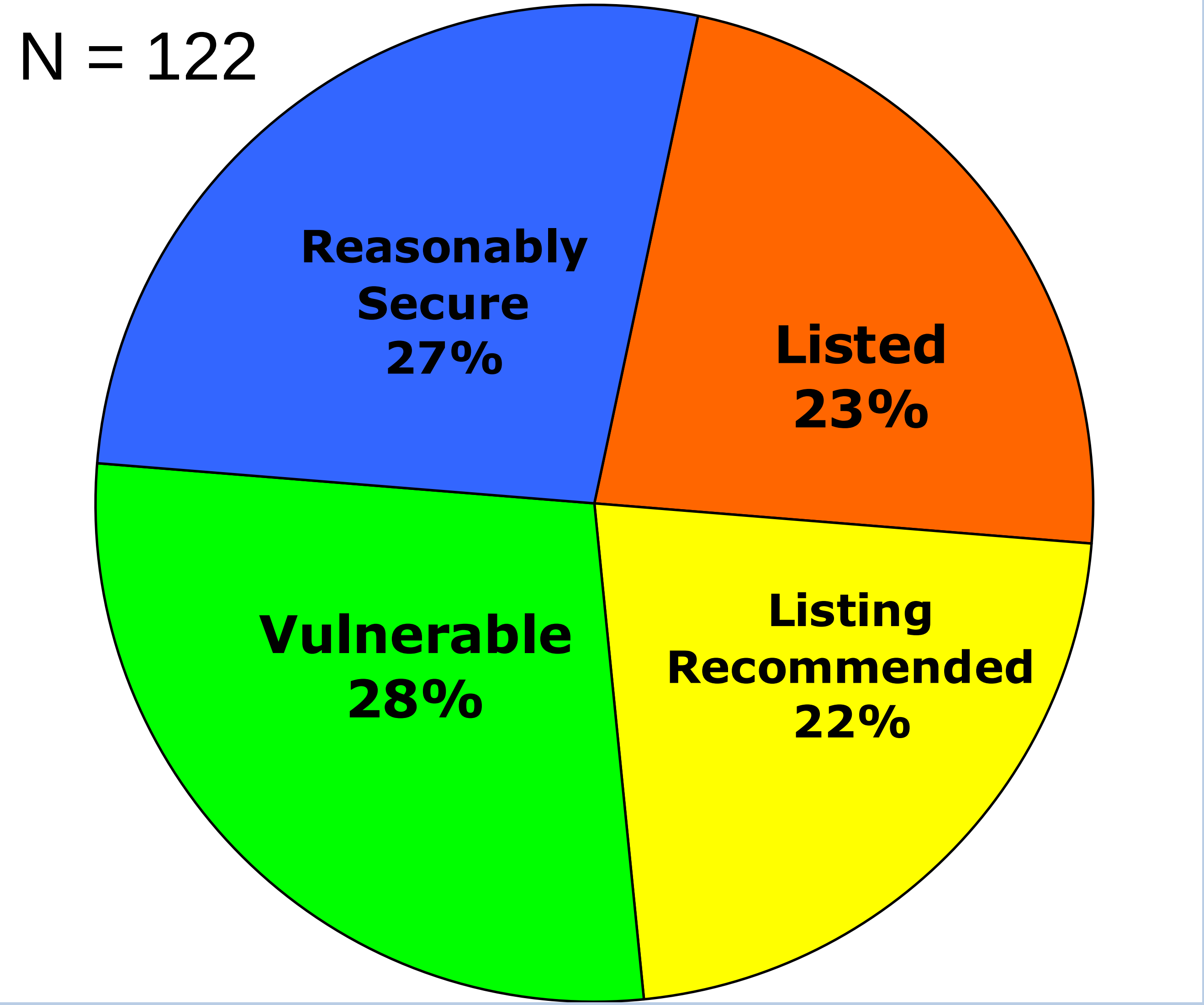
79% are found only in CA Region

% increasing

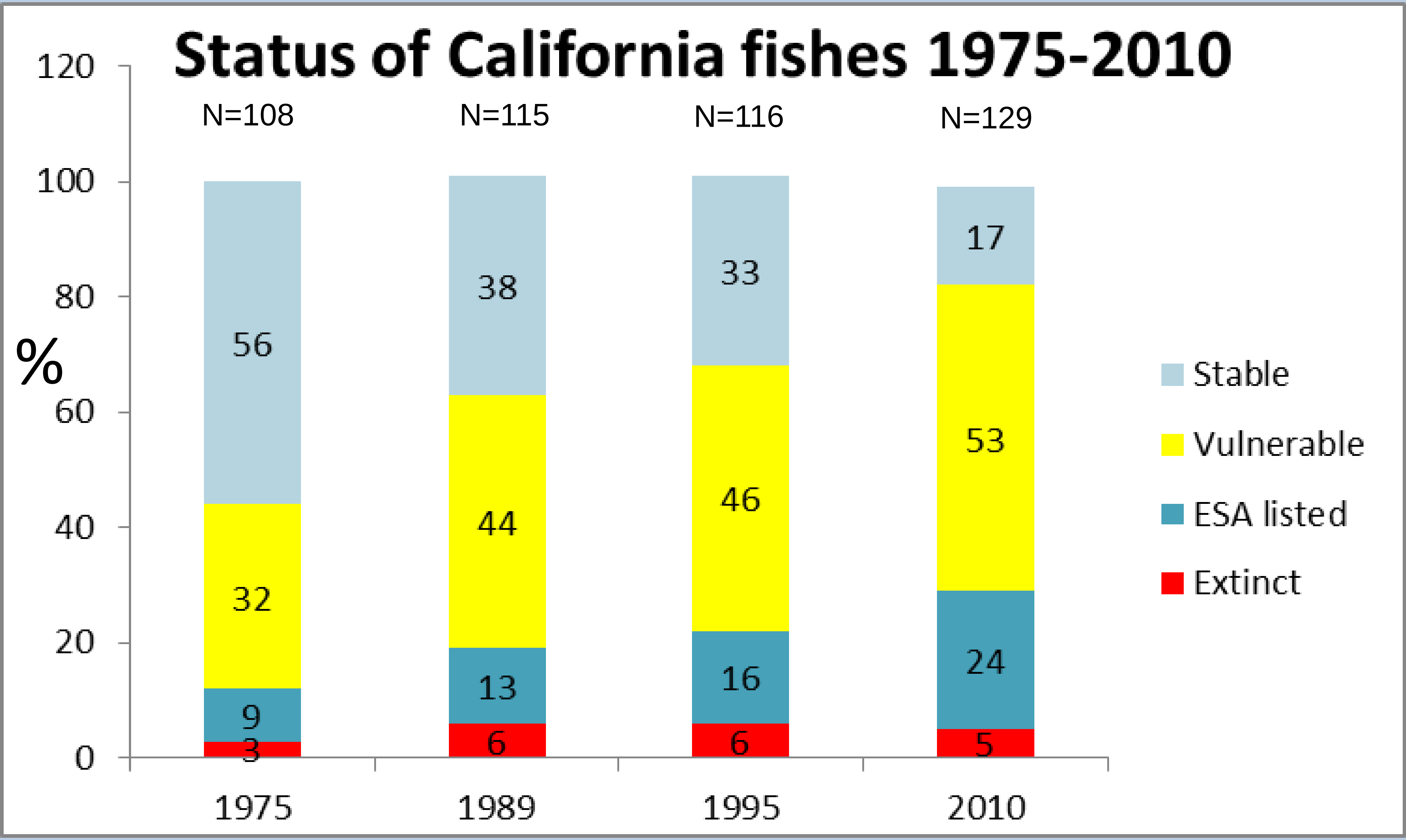
N = 129



80% of native fishes in decline



Moyle, Katz, and Quiñones (2011)



Listed species, 2014 = 28

FISH SPECIES OF SPECIAL CONCERN IN CALIFORNIA
Out soon, California Dept of Fish & Wildlife

Peter B. Moyle, Rebecca M. Quiñones, Jacob Katz, and Jeff Weaver

70 species of special concern

28 species already listed

7 species extinct

24 species OK

Based on systematic scoring methods in Moyle et al. (2011)

DRAFT so

Status numbers subject to change

Globally extinct 1950s →

EXTINCTION HAPPENS!

7 species lost from CA

Extinct in California 1970s

Causes of native fish declines (the 1-2 punch)

#1 Habitat loss and degradation

Shasta Lake in 1977 when it hit its lowest point ever. (Courtesy: Bureau of Reclamation)

#2 Alien fishes

Favored by altered habitats

Climate change: an additional stressor

- Climate change vulnerability study
  - California Landscape Conservation Cooperative
  - Evaluated vulnerability to extinction
  - 100 years
  - 121 native fishes
  - 43 alien fishes

Moyle PB, Kiernan JD, Crain PK, Quiñones RM. 2013. PLoS One 8:e63883.

Methods

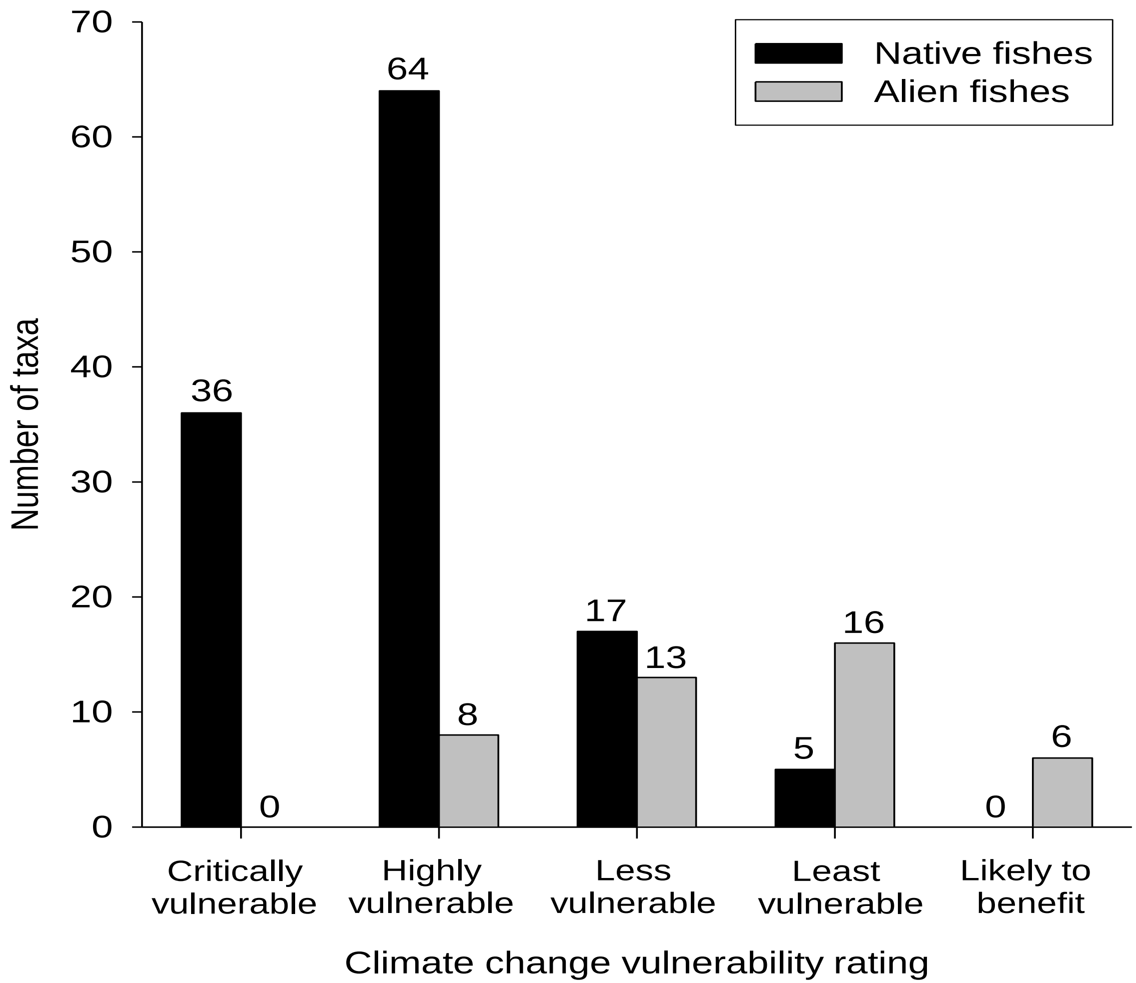
- Compile literature and observations
- Determine baseline vulnerability to extinction
  - 10 metrics
- Determine climate change vulnerability
  - 10 metrics
- Goal: repeatable, verifiable score for each species

Moyle PB, Kiernan JD, Crain PK, Quiñones RM. 2013. PLoS One 8:e63883.


Baseline Vulnerability

- ~49% of 121 native species rated as already critically or highly vulnerable to extinction (without climate change)
- All non-native species rated as low vulnerability to extinction

Climate change vulnerability



critical or high vulnerability to extinction

Natives = 82%

vs.

Aliens = 19%

Taxa about = to species

Most native fishes face severe decline or extinction in next 100 years

Alien fishes will become increasingly abundant

If present trends continue…

Managing California's Water

From Conflict to Reconciliation

So....
What can we do?

Ellen Hanak, Jay Lund, Ariel Dinar
Brian Gray, Richard Howitt, Jeffrey Mount, Peter Moyle, Barton "Buzz" Thompson

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Managing California's Water

From Conflict to Reconciliation

BE WELL INFORMED ON WATER ISSUES

Ellen Hanak, Jay Lund, Ariel Dinar
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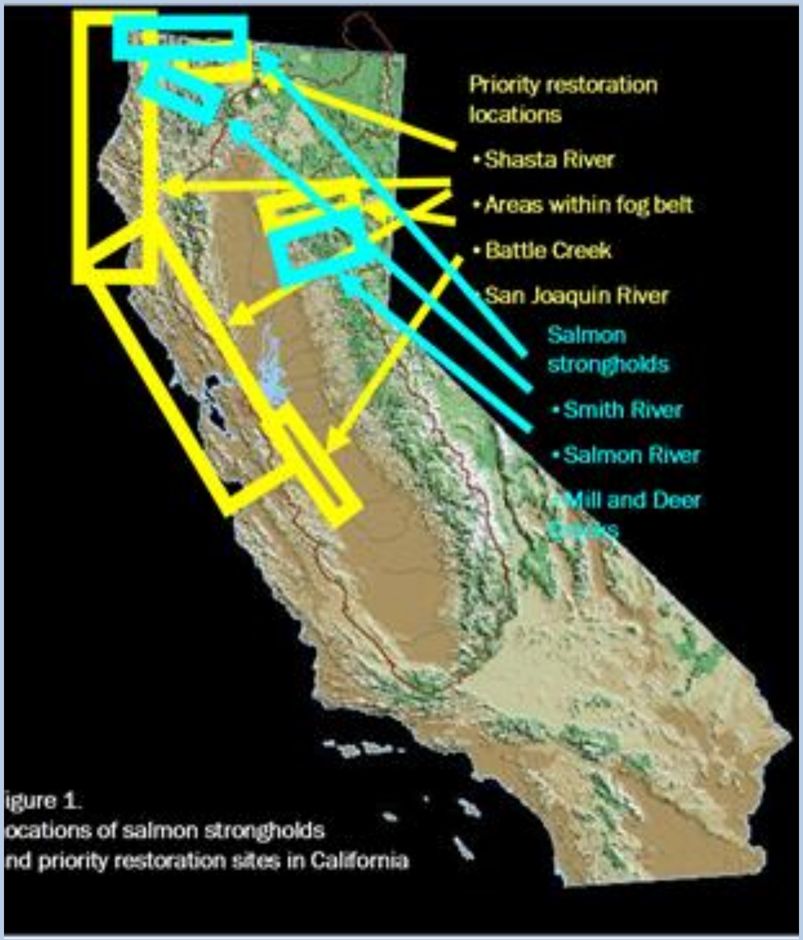
Statewide strategy for aquatic conservation is needed

- GOALS:
- Protect examples of all major habitats
- Self-sustaining populations of all native species



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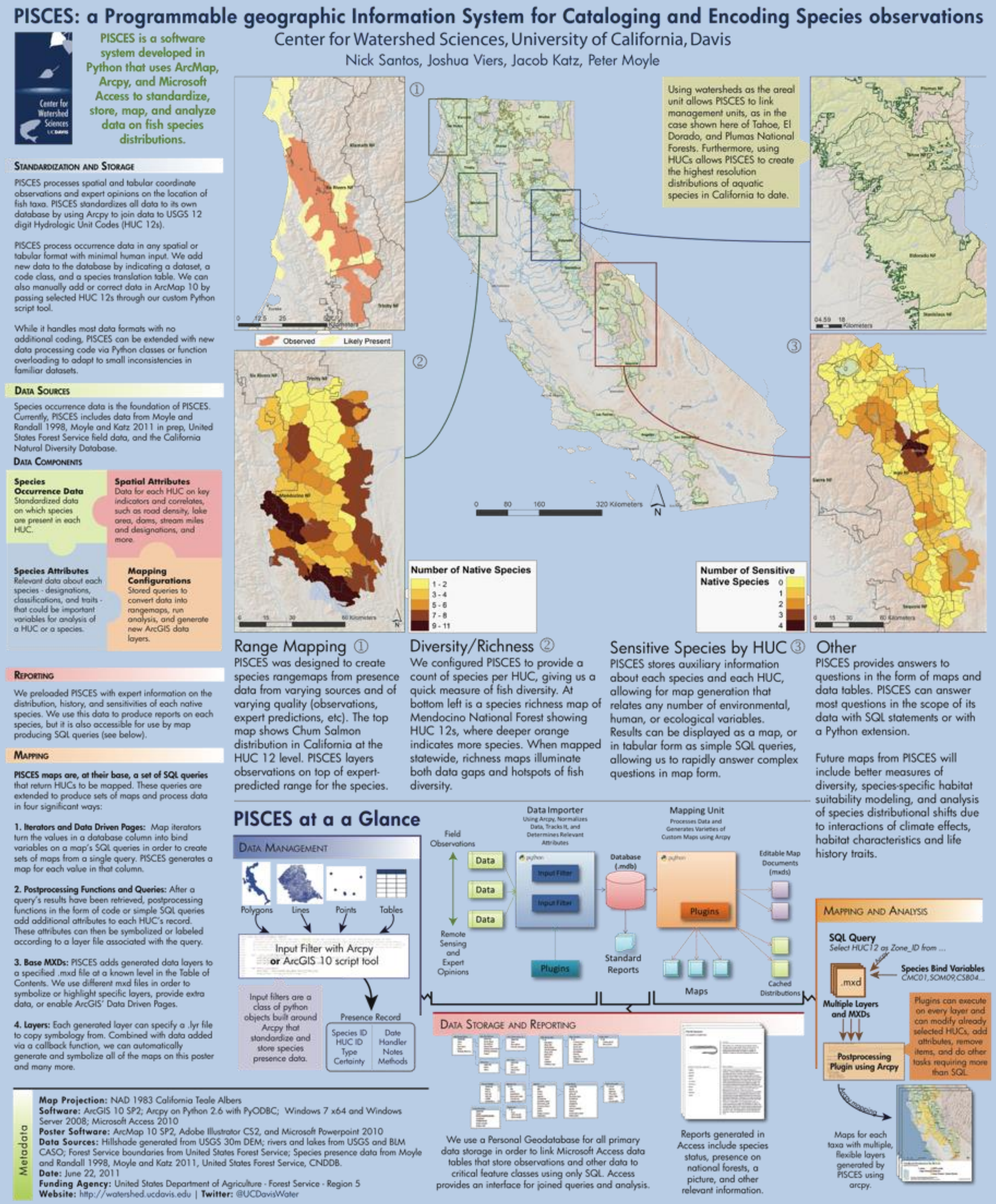
Some key components

- Native fish rescue facilities
- Database (PISCES)
- Protect best of what's left
- Environmental flows below dams
- Dam removal
- Manage floodplains
- Manage estuaries

Native Fish Rescue Facilities

- “Emergency rooms” for fish
  - Drought
- Proposed Rio Vista facility for Delta fishes
- “Re-purposing” trout hatcheries
  - e.g., Mt Shasta Hatchery
- Ponds and other facilities statewide
  - Need for Clear Lake facility



Data base: PISCES

Programmable geographic
Information
System for
Cataloging and
Encoding
Species observations

A database that tracks changes in fish distributions

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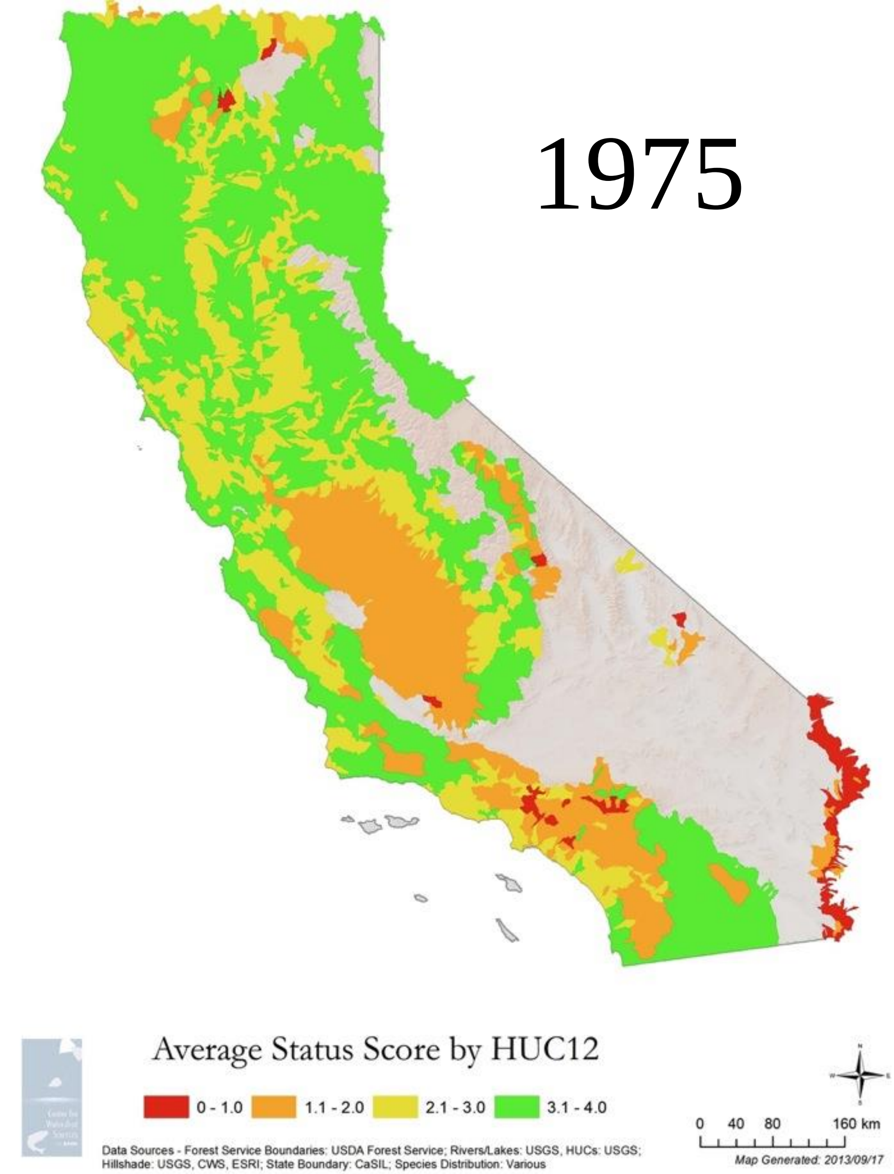

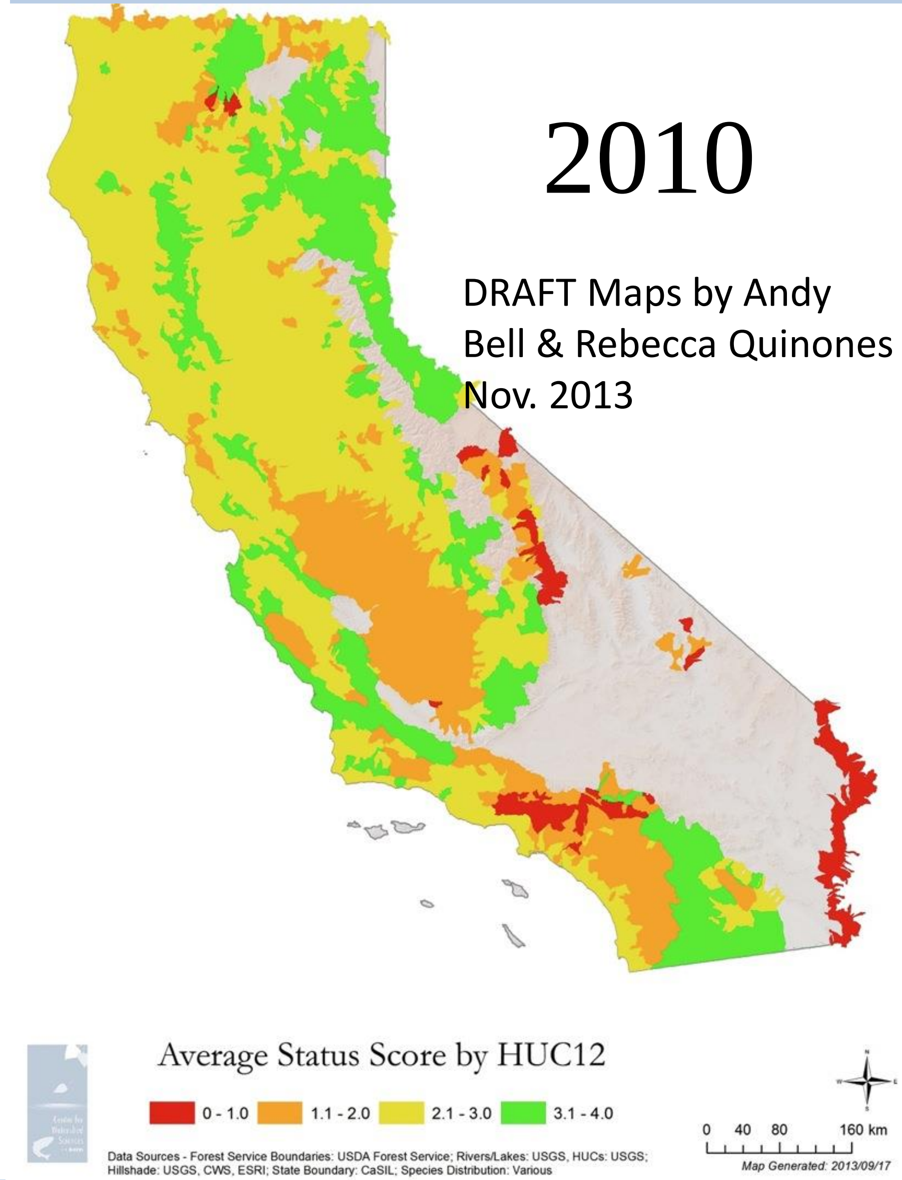

AVERAGE STATUS SCORES: NATIVE FISHES

GREEN – BEST RED - WORST

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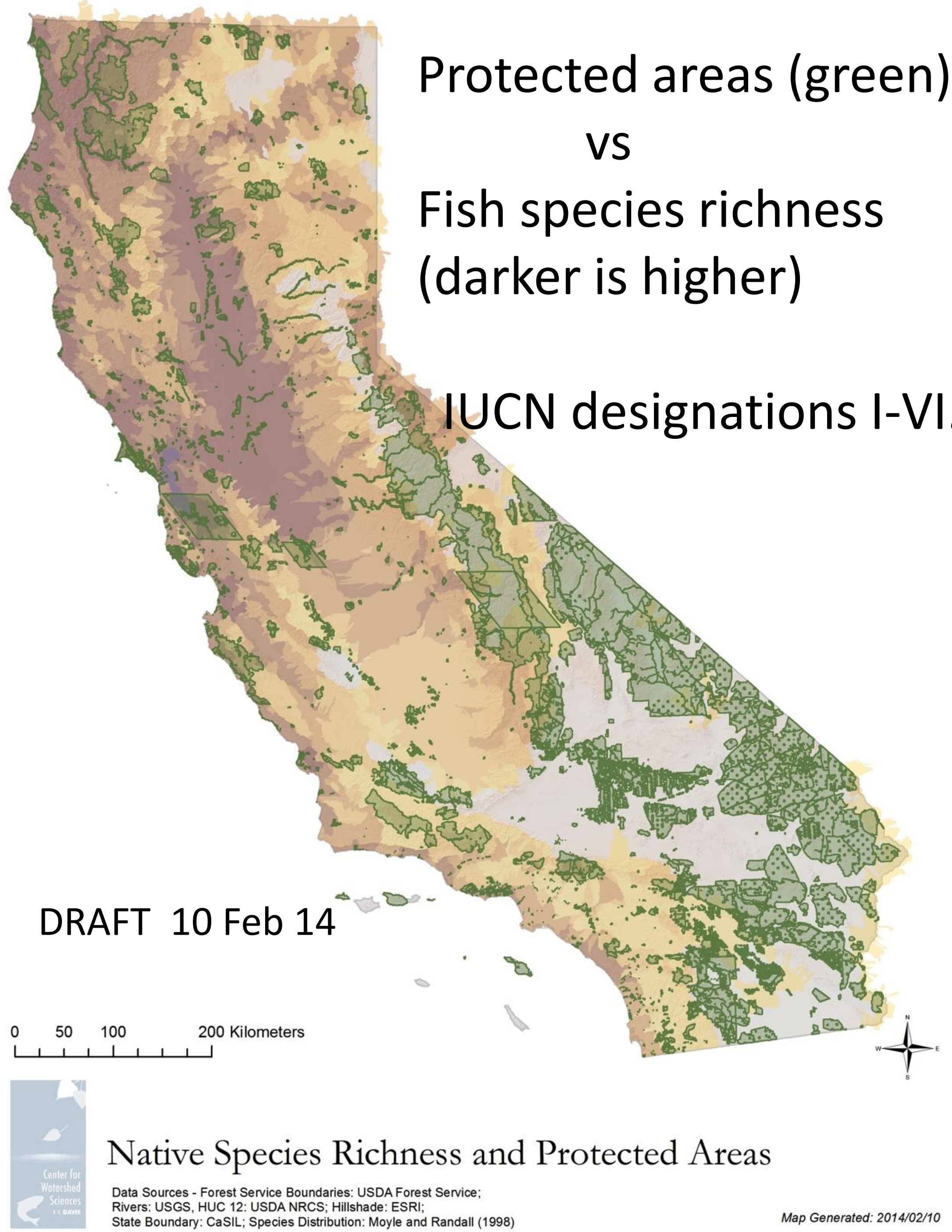
How much aquatic habitat is protected?

- Not much!

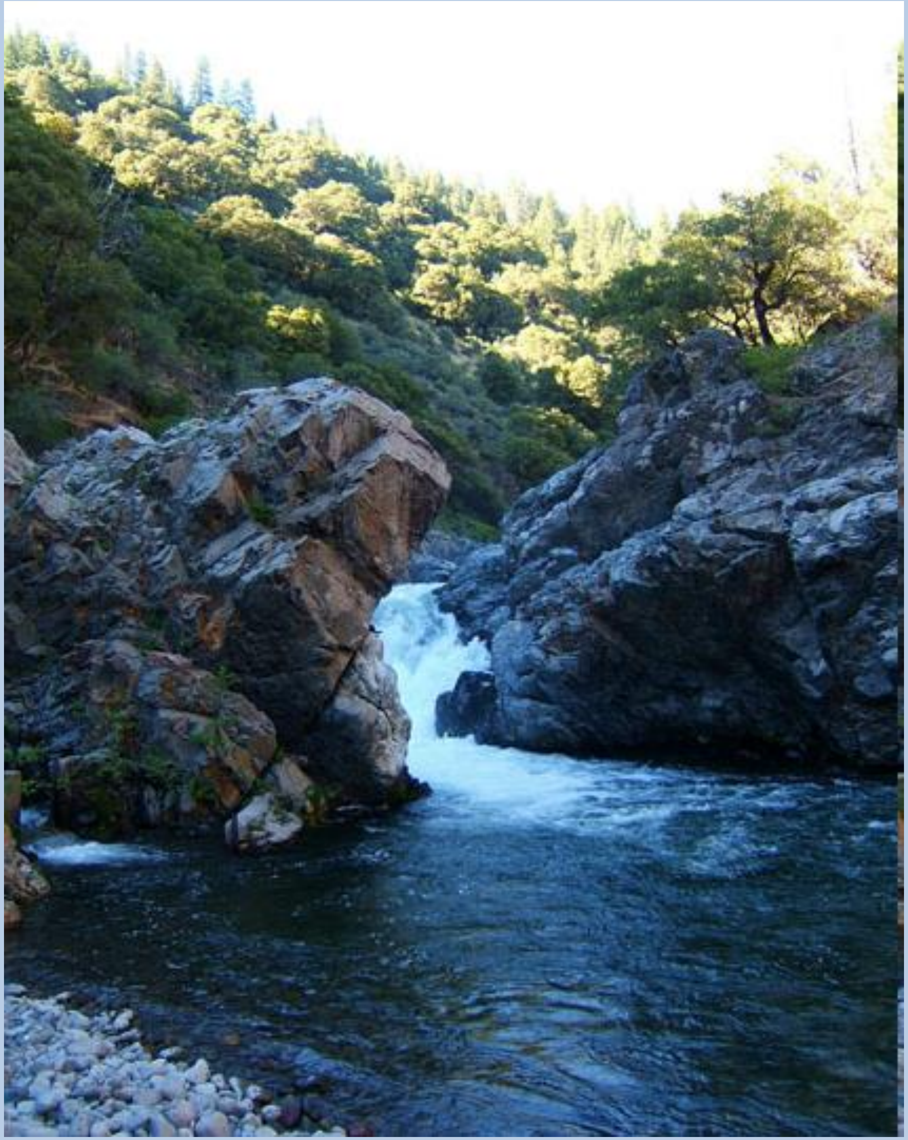
Protected areas (green)
vs
Fish species richness
(darker is higher)

IUCN designations I-VI.



DRAFT 10 Feb 14

Protect best of what is left



Blue Creek

Yurok Tribal Salmon Sanctuary

westernrivers.org

WESTERN RIVERS CONSERVANCY

Big Springs Creek Restoration
Shasta Valley

The Nature Conservancy

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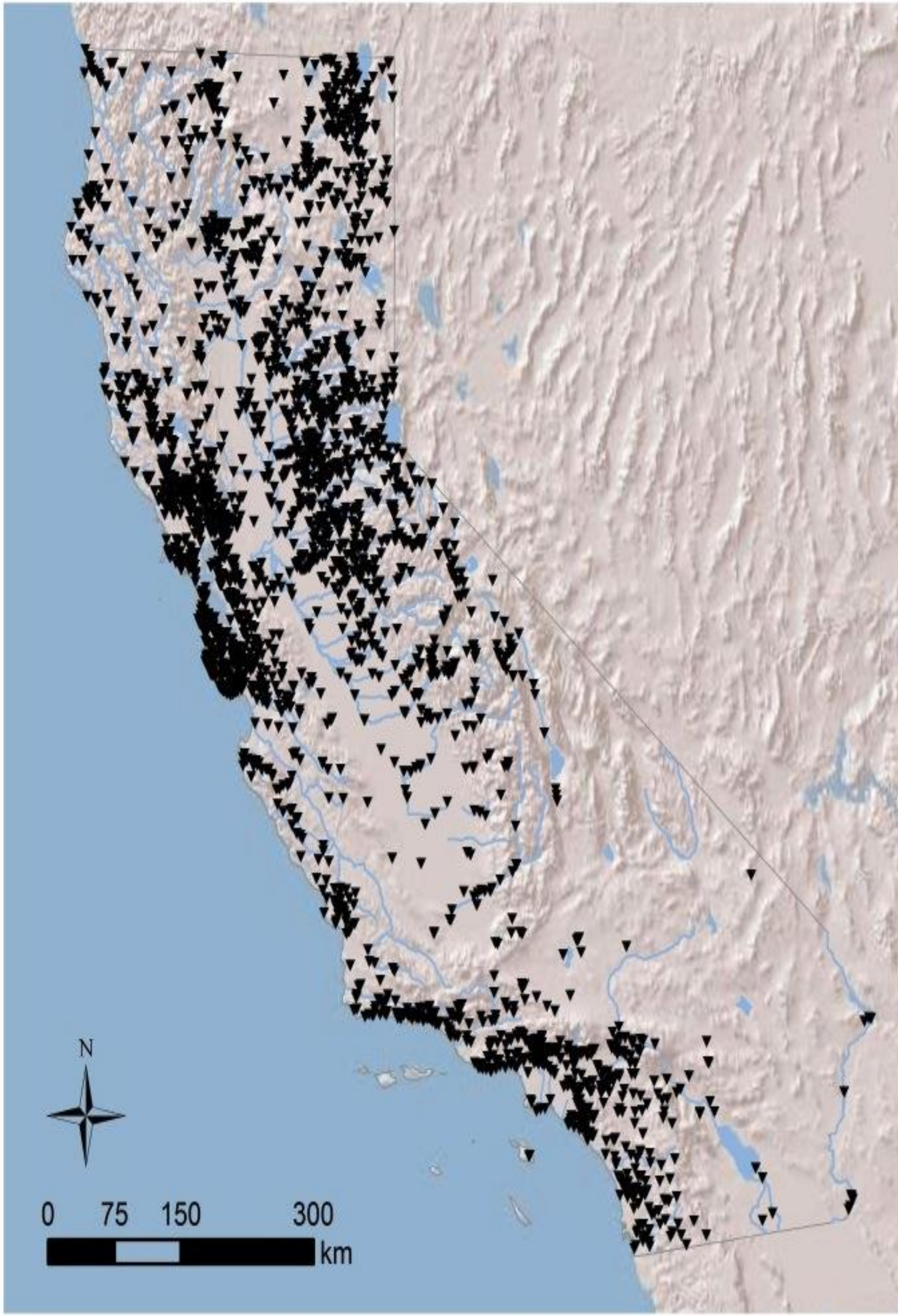
Environmental Flows Below Dams

FOLSOM RESERVOIR, AMERICAN RIVER

JAN 2014

Dam Reoperation Study

By Ted Grantham, CWS



1400 'large' dams

200 candidate dams
(20 case histories)

Legal tools for dam reoperation

- Section 5937, California Fish and Game Code

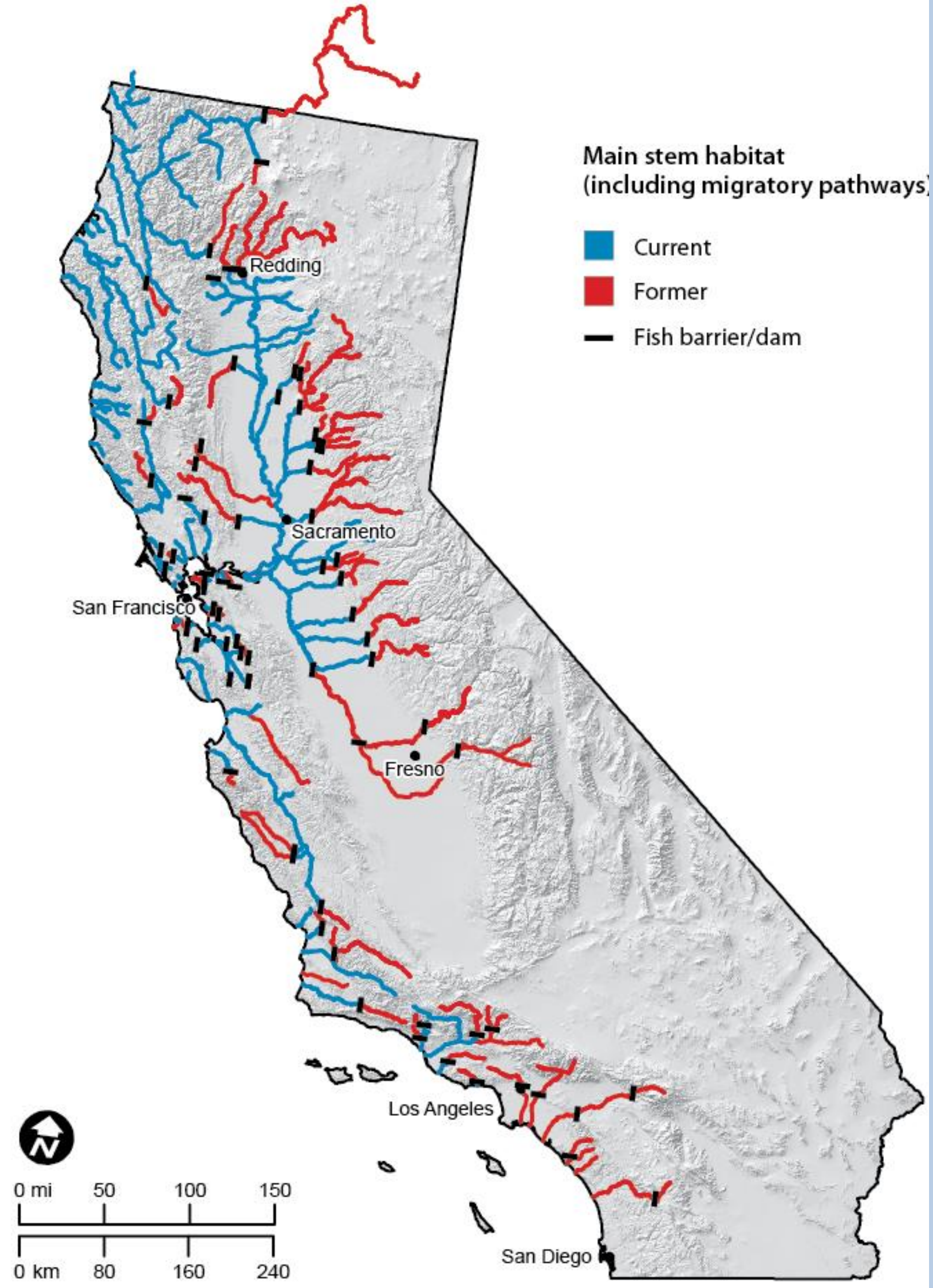
- Public Trust Doctrine

- Endangered Species Acts (state and federal)

Dam Removal

Matilija Dam, Ventura River

Quiñones et al. in press



70+% of anadromous salmon habitat above dams

Manage Floodplains

for Floods, Fish, Wildlife and Farming.

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Manage Estuaries

- Endangered statewide
  - Sea level rise
  - Decreased inflows
  - Habitat alterations

Delta
Where the Wild Things Aren't: Making the Delta a Better Place for Native Species

Peter Moyle, William Bennett, John Durand, William Fleenor, Brian Gray, Ellen Hanak, Jay Lund, Jeffrey Mount

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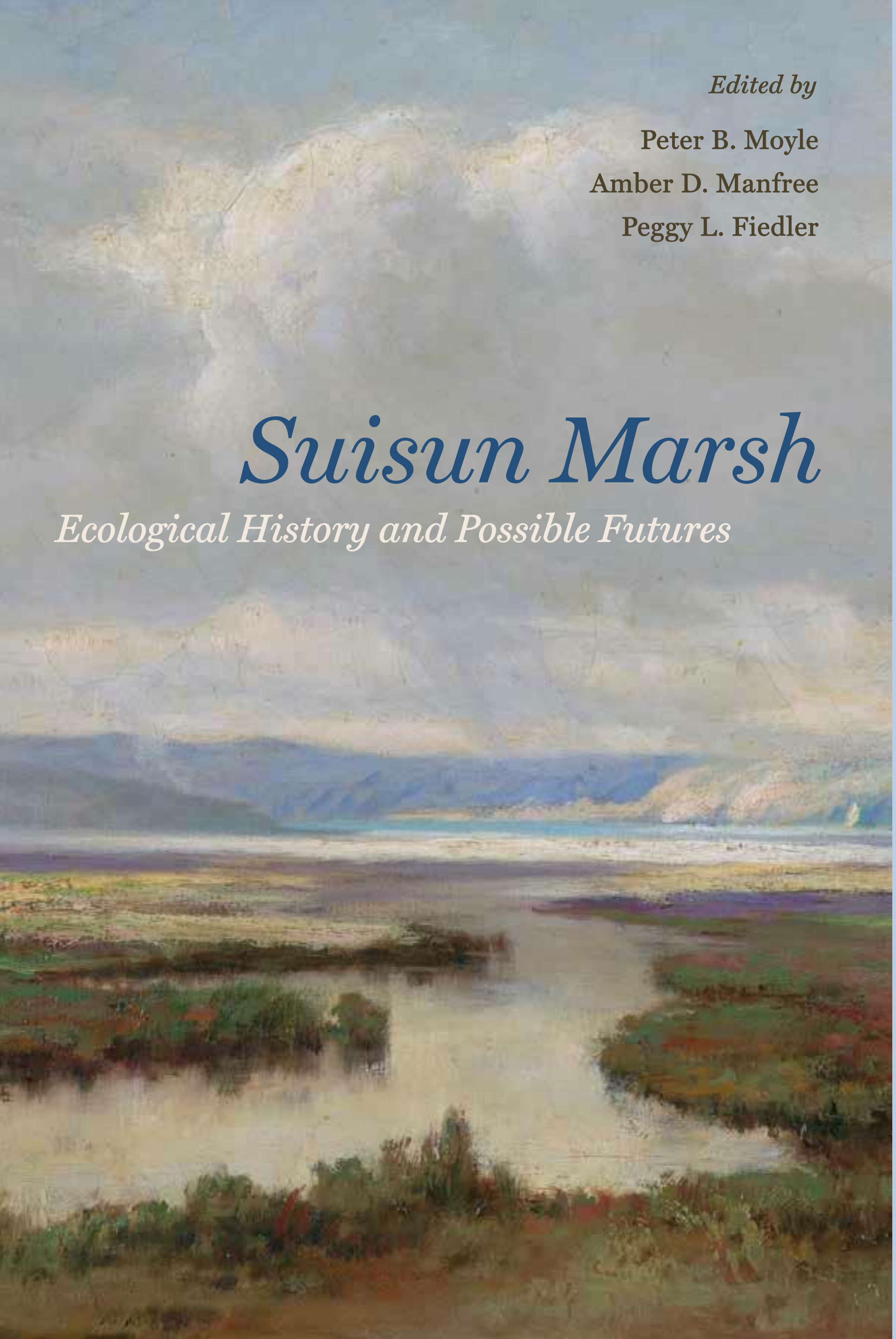
Funding by the S.D. Bechtel, Jr. Foundation



Suisun Marsh

Ecological History & Possible Futures

UC Press,
March 2014

William F. Jackson. ca 1900
Suisun Marshes
Crocker Art Museum

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Reconciliation Ecology

A basic approach to conservation

- Humans dominate all ecosystems
- Most ecosystems are novel ecosystems
- Alien species & altered habitats
- Climate change increases need
- What species do we want to save?

CASE STUDY

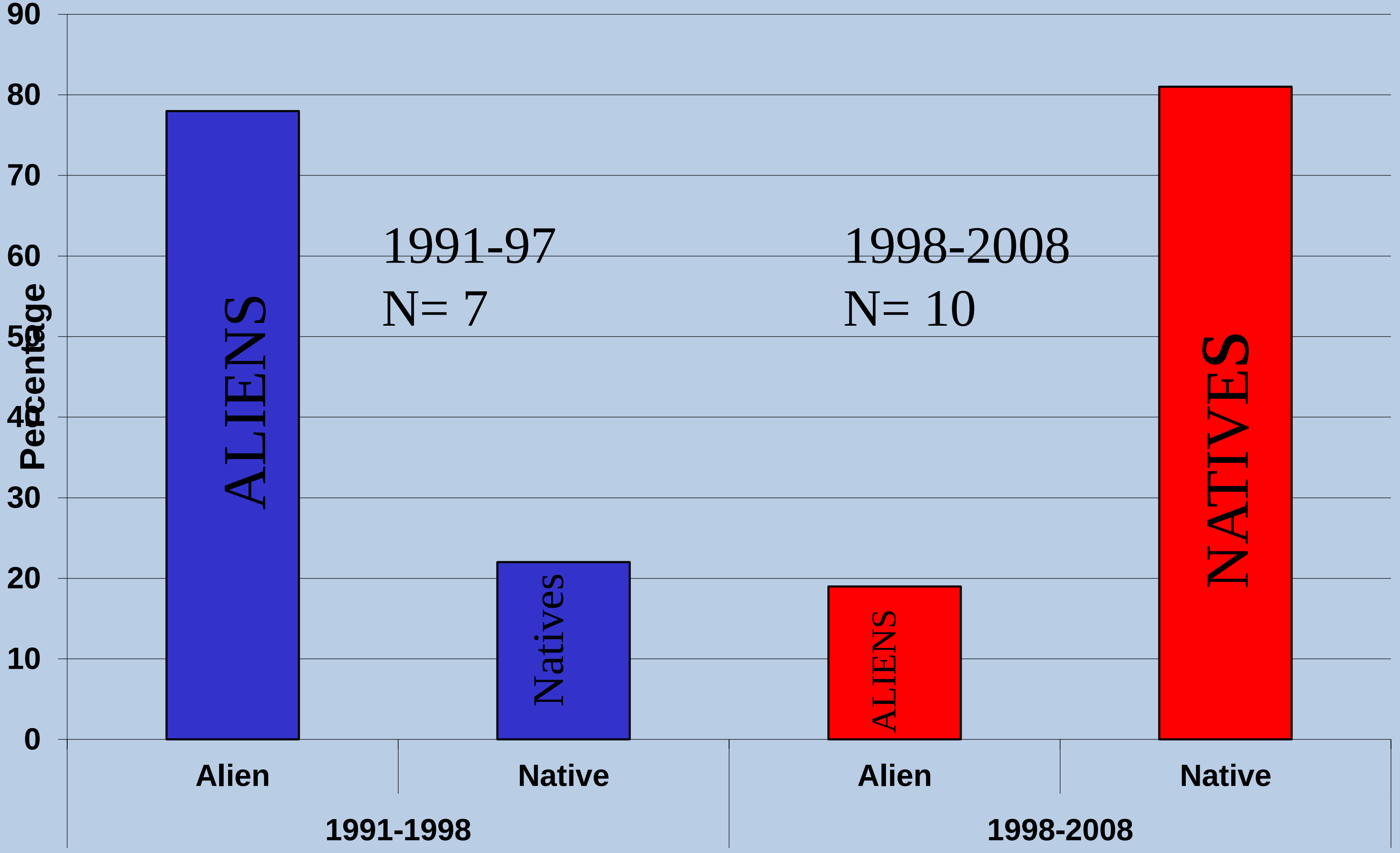
LOWER PUTAH CREEK

- Regulated by dams
- 30km Riparian “shred”
- Novel Ecosystem
- Model for reconciled aquatic/riparian ecosystems

Species group (#)	Percent alien species
Trees (46)	35
Shrubs (39)	23
Herb. plants (198)	61
Butterflies (31)	25
Fish (35)	63
Amphibians (3)	33
Reptiles (10)	10
Birds (92 breeding)	3
Mammals (31)	11

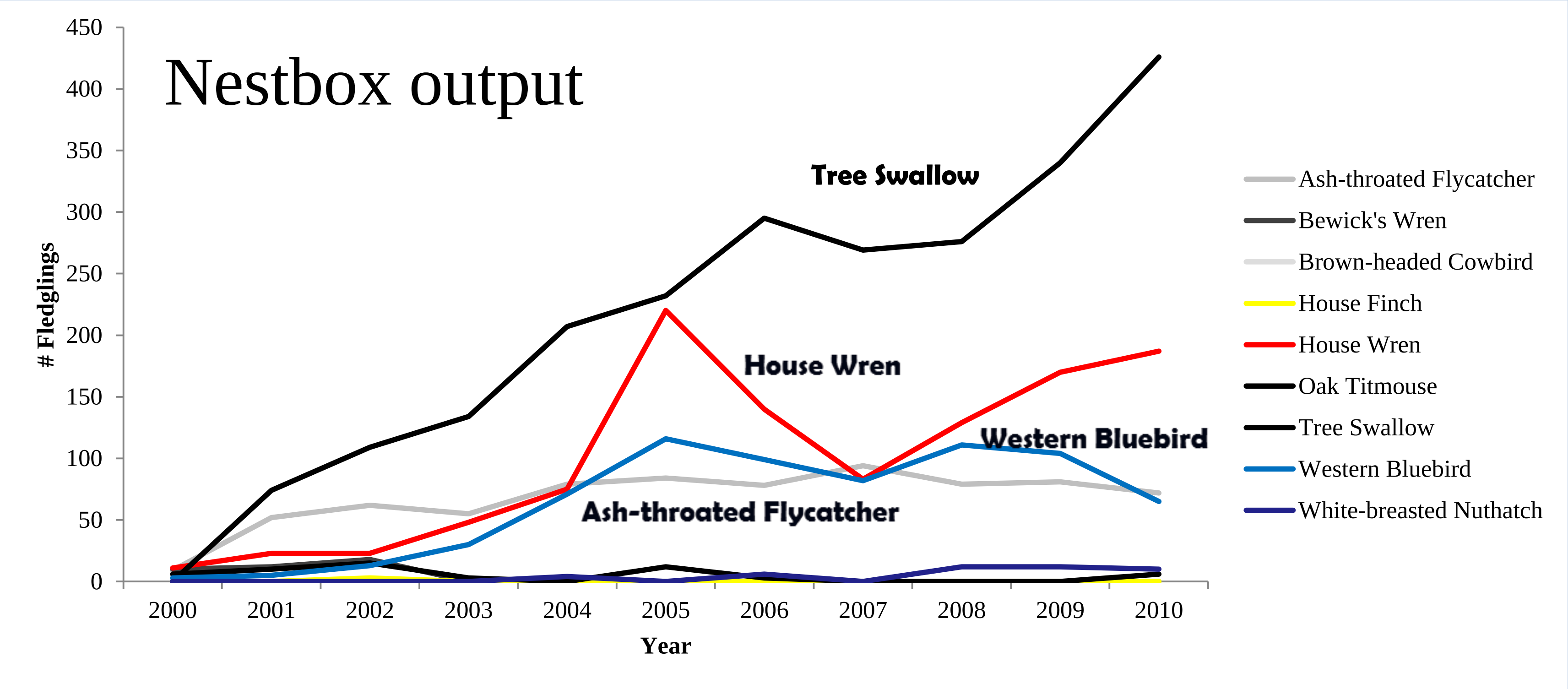
Percent aliens of recorded species, Putah Creek, UCD

MANAGING THE FLOW REGIME FOR NATIVE FISHES



BEFORE AFTER

Nestbox management & monitoring



>8000 fledglings produced so far . . .

What does it take to manage Putah Creek as a Reconciled Ecosystem?

- VISION
    - Accord
- WATER
- Water Agency Cooperation
- Streamkeeper
- Community involvement
    - – Putah Creek Council
- Landowner co-operation
- Monitoring program

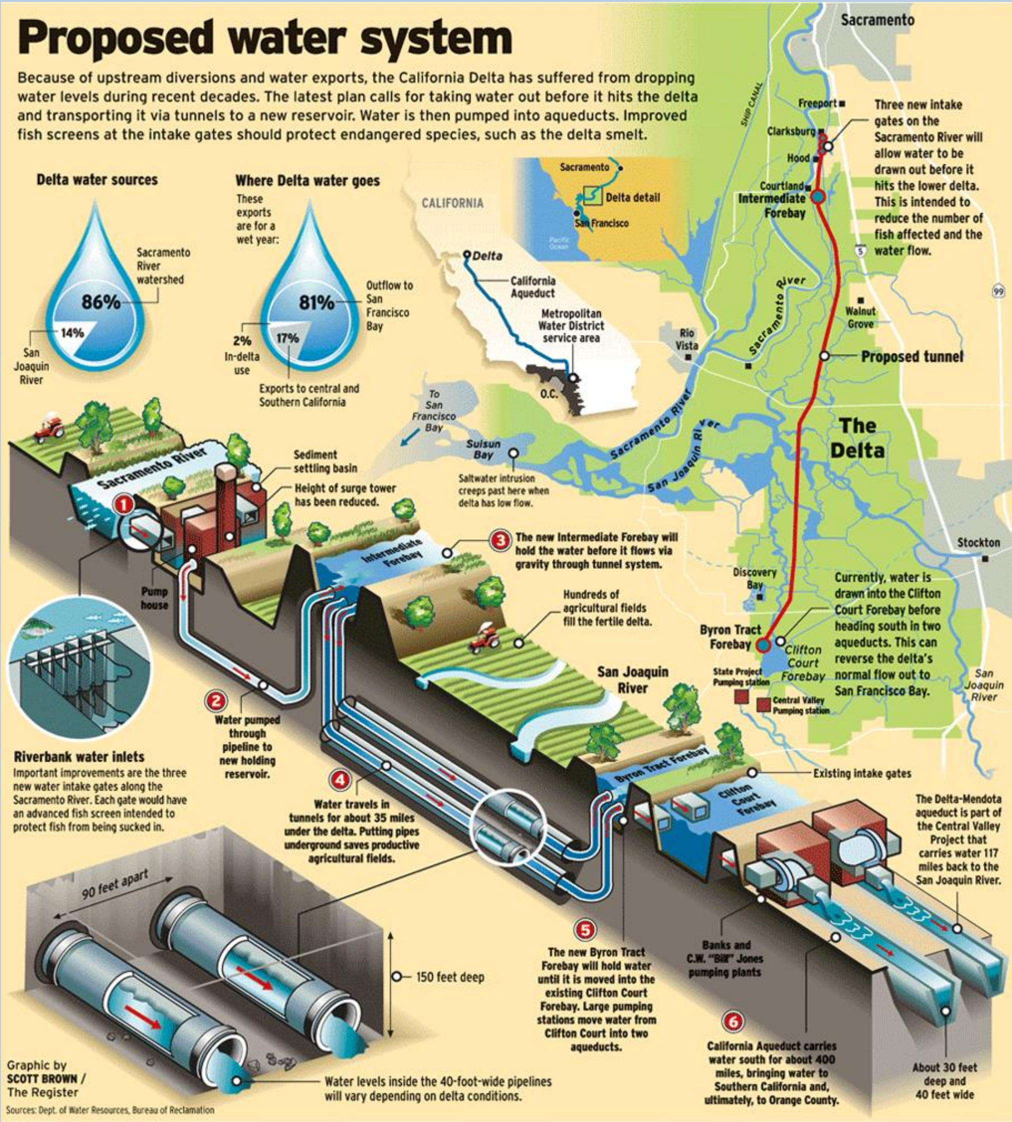
MONEY IS NEEDED (Lots of It)

[Why give away fish flows for free during a drought?]

Posted on [February 11, 2014]

By Jay Lund, Ellen Hanak, Barton “Buzz” Thompson, Brian Gray, Jeffrey Mount and Katrina Jessoe

California Water Blog



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Conclusions

- Systematic actions needed to save California's endemic aquatic species
  - We can do it!
- Climate change is accelerating rate of declines
- 2014 drought –example of what is to come...
  - If we let present trends continue

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Questions?

Further reading

- Moyle PB, Kiernan JD, Crain PK, Quiñones RM. 2013. Climate change vulnerability of native and alien freshwater fishes of California: a systematic assessment approach. Plos One 8:e63883.

- Katz JV, Moyle PB, Quiñones RM, Israel J, Purdy S. 2013. Impending extinction of salmon, steelhead and trout (Salmonidae) in California. Environmental Biology of Fishes 96:1169-1186.

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- Quiñones RM and Moyle PB. In press. California's freshwater fishes – status and management. Fishes in Mediterranean Environments. Invited review.

- Moyle, P. B., and R. M. Yoshiyama. 1994. Protection of aquatic biodiversity in California: A five-tiered approach. Fisheries 19:6-18.