

U.S. Water Management in the Anthropocene: New Challenges, Regulatory Fragmentation, and Adaptive Water Governance

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So, What Is Happening?

Climate Change Impacts to Water Resources in the U.S.

Water Withdrawals in the United States, 2015

Thermoelectric power generation: 41%
Irrigation: 37%
Public Supply: 12%

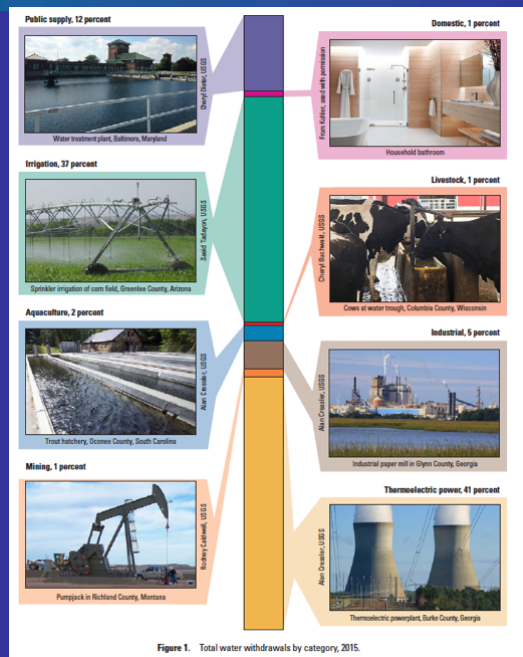
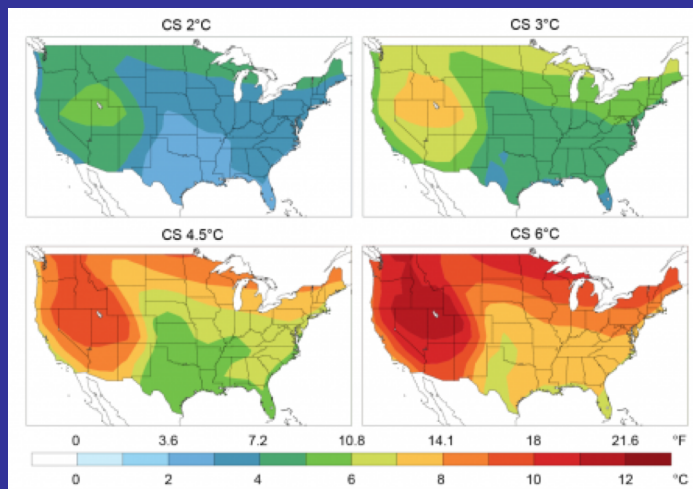
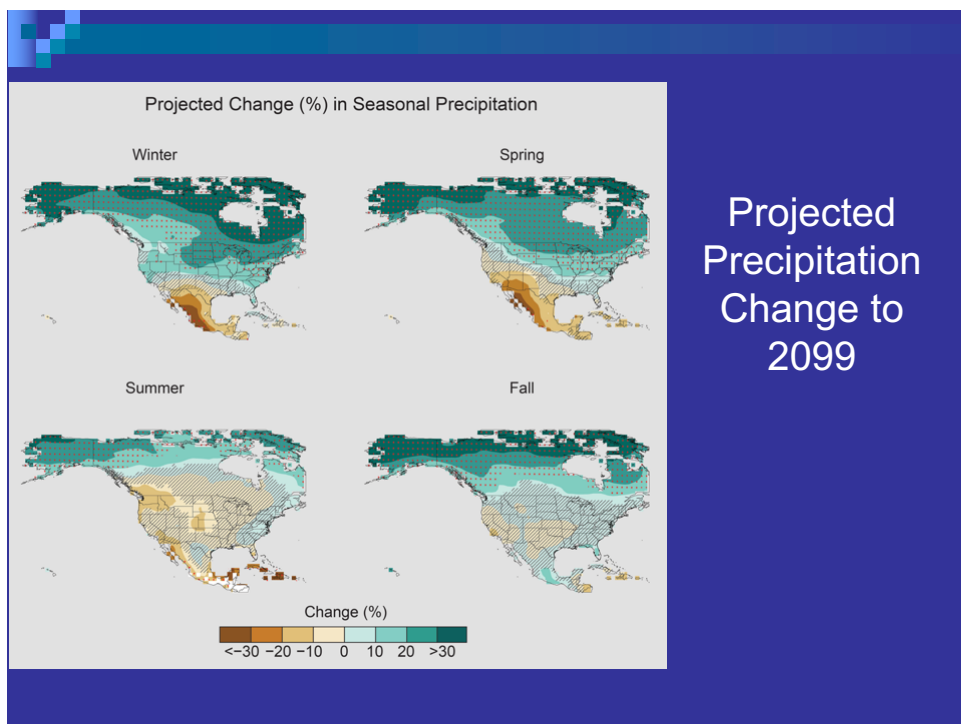
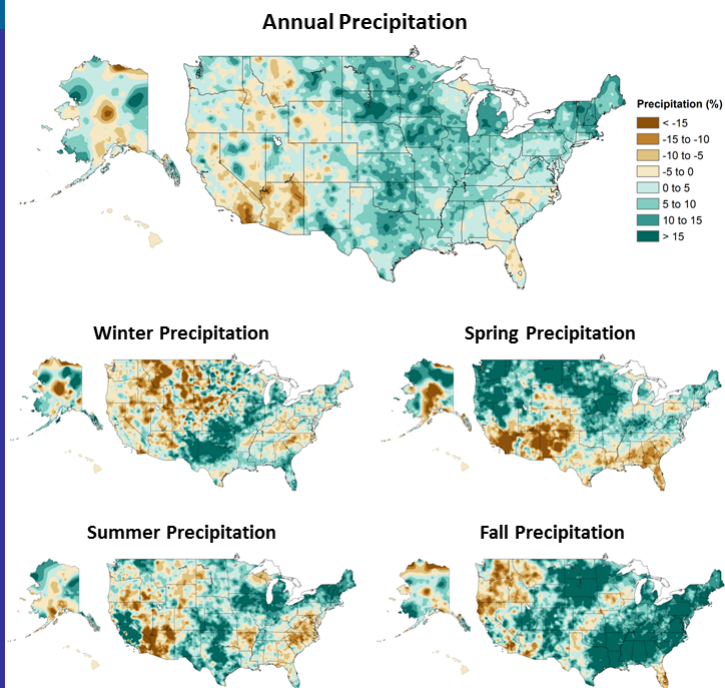


Figure 1. Total water withdrawals by category, 2015.

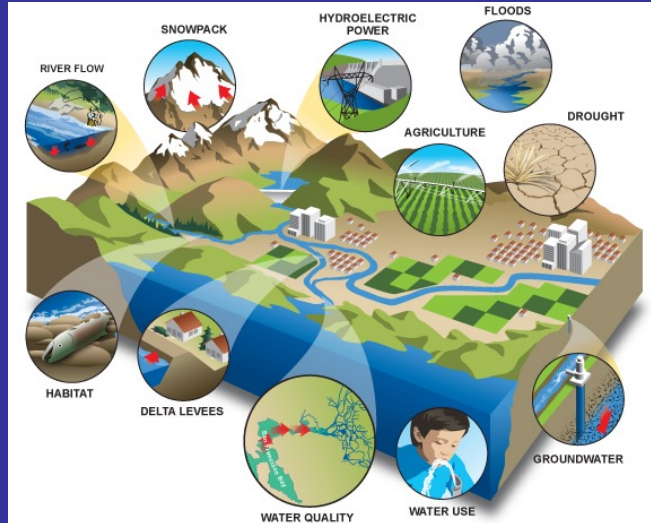
Temperature Change Projections for the U.S.



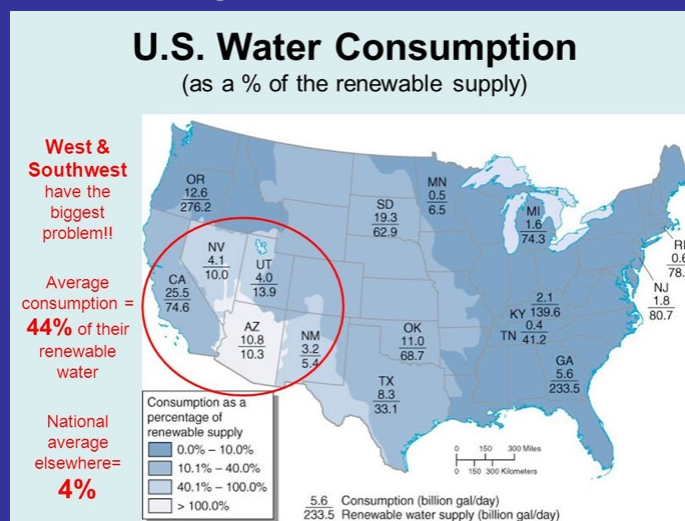
Observed
Annual
Average
Precipitation
Change in the
U.S.
1986-2015
compared to
1901-1960
average



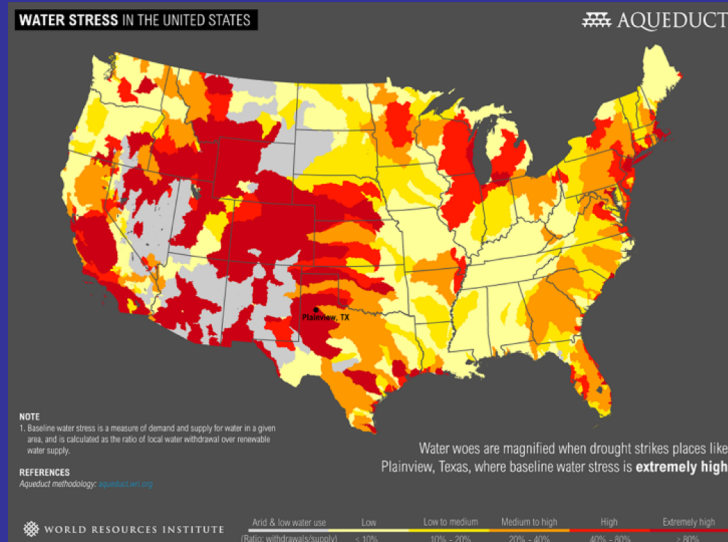
Climate Change and Water Resources



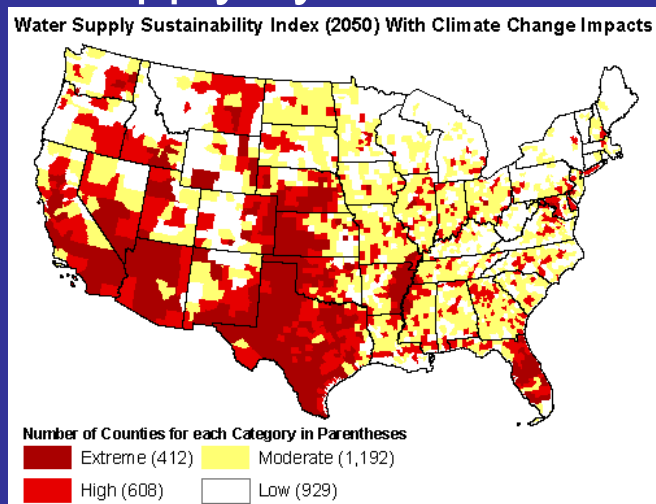
Water Consumption in the U.S. as a Percentage of Available Supply



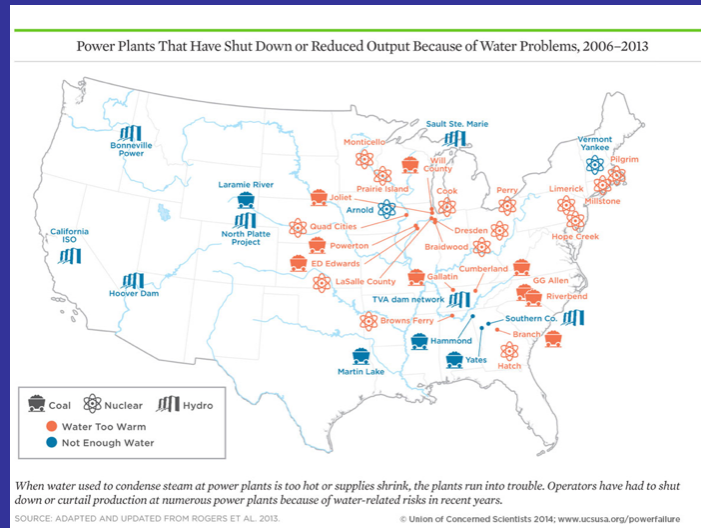
Existing Water Stress in the U.S.



Climate Change Impact on Water Supply by 2050



One Example: Heat, Drought and Electricity Generation



Three Aspects of U.S. Law that Really Matter to Water Management in the Anthropocene

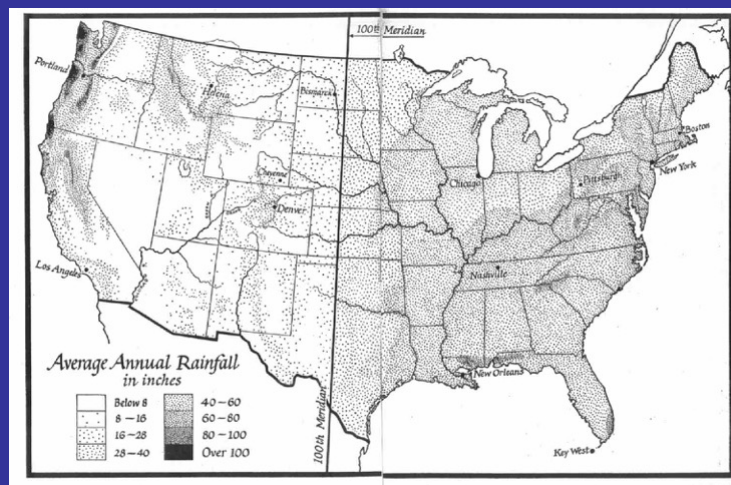
but also become a source of regulatory fragmentation!

Water Allocation Law

STATE Law,

generally implemented through a state water agency and sometimes regional sub-state agencies

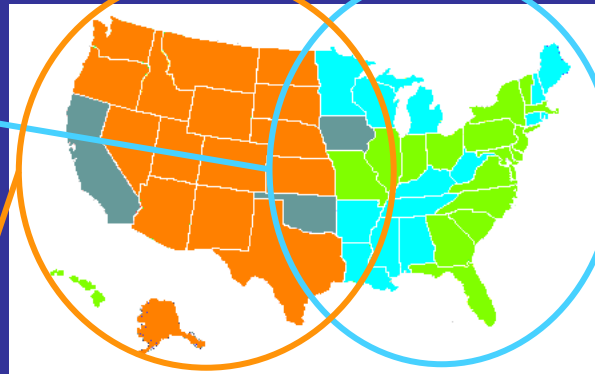
Surface Water Allocation: The United States' Great Divide



Surface Water Allocation Legal Doctrines

Flexibility in re-allocating water; sharing basis; water left for the environment.

Limited ability to reallocate water; priority hierarchy basis; waterbodies drained dry; 80-85% to irrigation



Prior Appropriation

Common-Law Riparianism

Mixed States

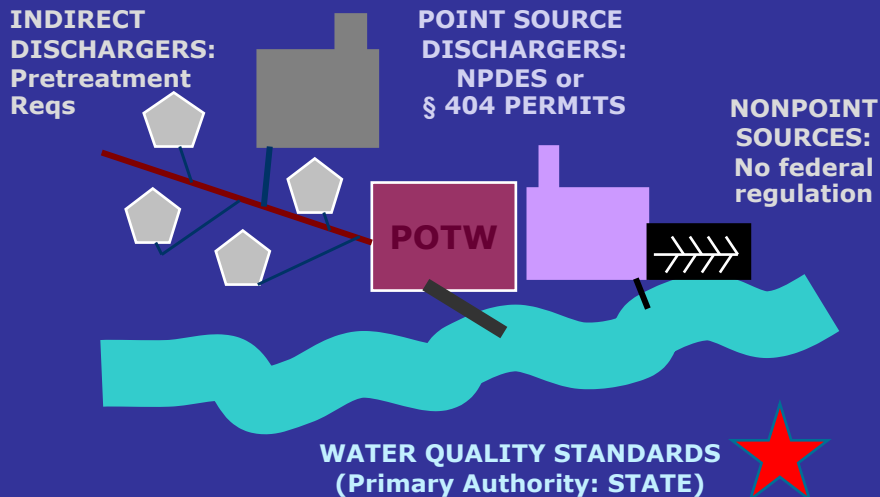
Regulated Riparianism

The Clean Water Act

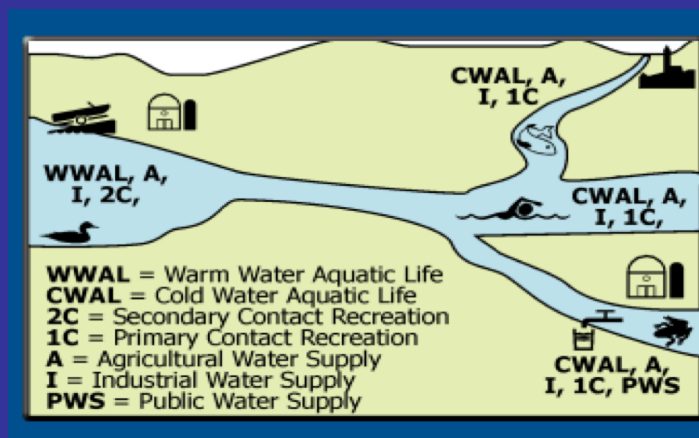
FEDERAL Law,

implemented by the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and state water quality agencies (which generally are NOT the same as the water allocation agencies)

Overview of the Clean Water Act



The Climate Change Issue: Achieving Water Quality Standards in a Changing World



EPA graphic.

The Clean Water Act's Climate Change Disconnect: Water Quality Standards

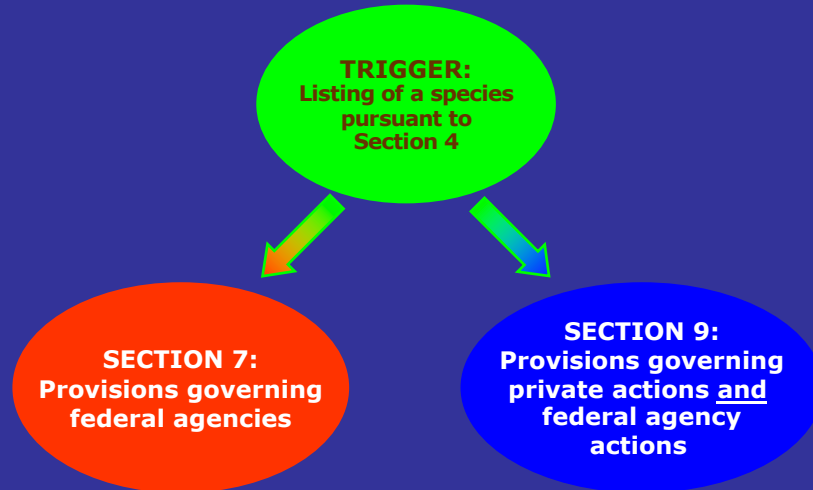


The Endangered Species Act

FEDERAL Law,

implemented by the U.S. Fish & Wildlife Service and the National Marine Fisheries Service/NOAA Fisheries, with help or opposition from state wildlife agencies

Endangered Species Act Basics



Species Listed under the ESA at Least in Part Because of Climate Change Impacts



Picture courtesy of the U.S. Fish & Wildlife Service



Picture courtesy of NOAA



Picture courtesy of the U.S. Department of the Interior

ESA-Listed Species Affect the Management of Freshwater Aquatic Ecosystems

- The ESA has already generated MANY court challenges to freshwater management.
- AND they are increasing.

Edwards Aquifer, TX/
Klamath River Basin, CA/
Salmon River, WA/
Gila River, AZ/
Colorado River, AZ/
Columbia River, OR/
Snake River, ID/
Lost River, CA/
Texas Wild Rice

Prioritizing Water Management in the Anthropocene

Anthropocene Water Basin Management as Triage

It's not at high risk of immediate threshold crossing.

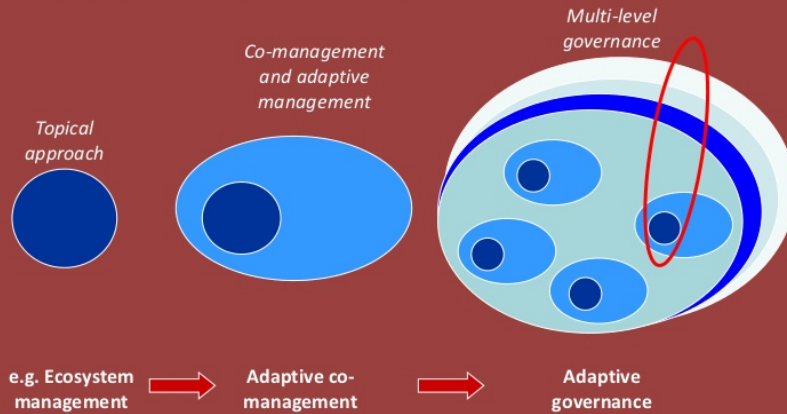
Relatively minor interventions will fix existing issues.



It's heading quickly toward an ecosystem threshold.

It's transforming or going to transform.

Adaptive Governance



After Per Olsson,
Stockholm Resilience Centre

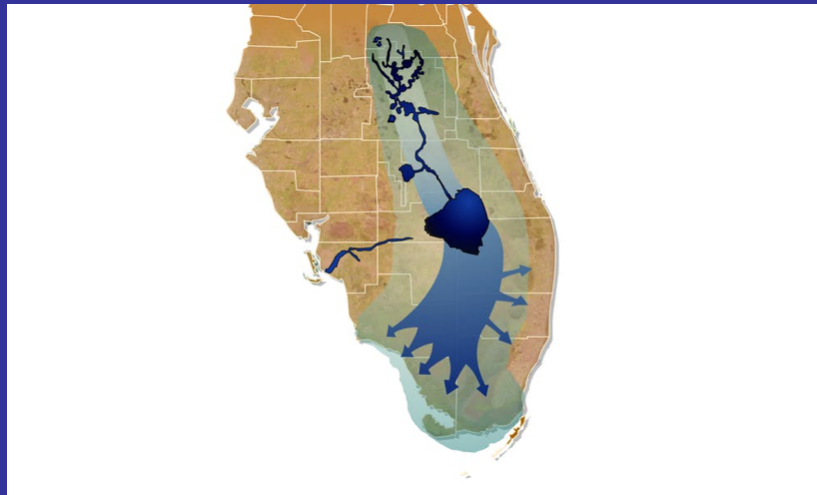


Three Major U.S. Watershed Management Examples

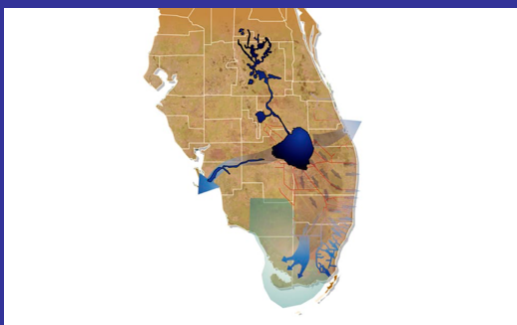


The Florida Everglades
It's Going to Transform

Historic Flow of the Everglades



Current Everglades



Everglades Water Quality Issues



Everglades Endangered Species



Everglades Invasive Species



EVERGLADES INVASION

While taxpayers are spending billions of dollars to restore the Everglades, a deadly army of foreign species is undermining the effort by pushing out native plants and animals.

By Sharon Gaddy

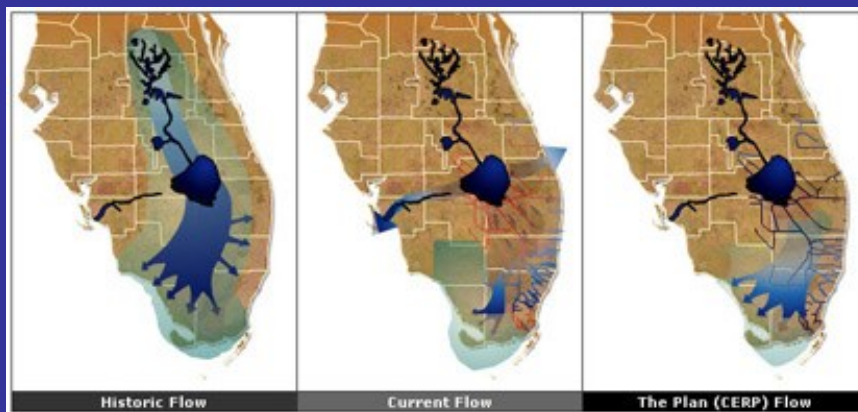
AN AMERICAN ALLIGATOR in the Florida Everglades chomps down on a Burmese python. The snake is an invasive species that now numbers in the tens of thousands in the Everglades, where it feeds on such native wildlife as birds, fish and mammals. Park staff are trying new methods of python control. Of several large snake species living in the park, the Burmese python is the only one known to be breeding.

PHOTO BY SHARON GADDY

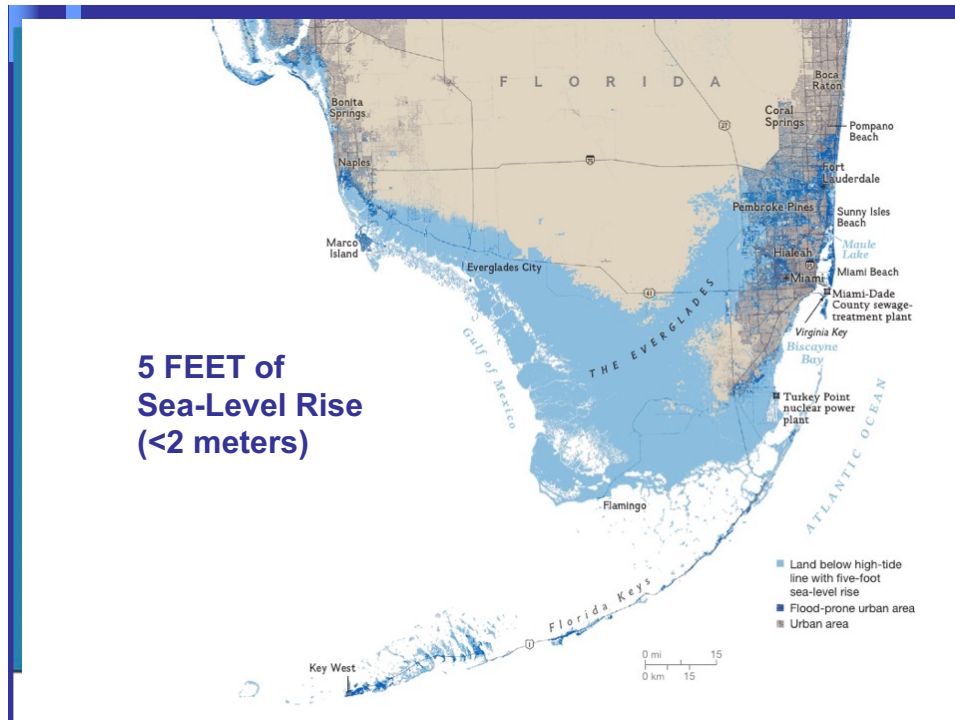
Skip Snow, a wildlife biologist at Florida's Everglades National Park, is staring intently into a Martha Stewart laundry bag before quickly reaching inside and pulling out a writhing 6-foot Burmese python. It is a powerful animal and a beautiful one, with the sun glinting off its chestnut, black and gold body. But this species is a native of Southeast Asia and doesn't belong in the Everglades. Snow believes that such pythons, popular in the pet trade, were first released into the state by those owners who the reptiles became too big to handle. One of the largest snakes in the world, it can grow to more than 20 feet long and weigh as much as 200 pounds. These snakes open the reptile's mouth, revealing the long, dagger-sharp, backward-curving teeth that, along with its

PHOTO BY SHARON GADDY

Everglades Restoration Plan



START DATE: 2000
COST: USD \$16.4 BILLION AND COUNTING



But Governance Is Caught in a
Rigidity Trap . . .

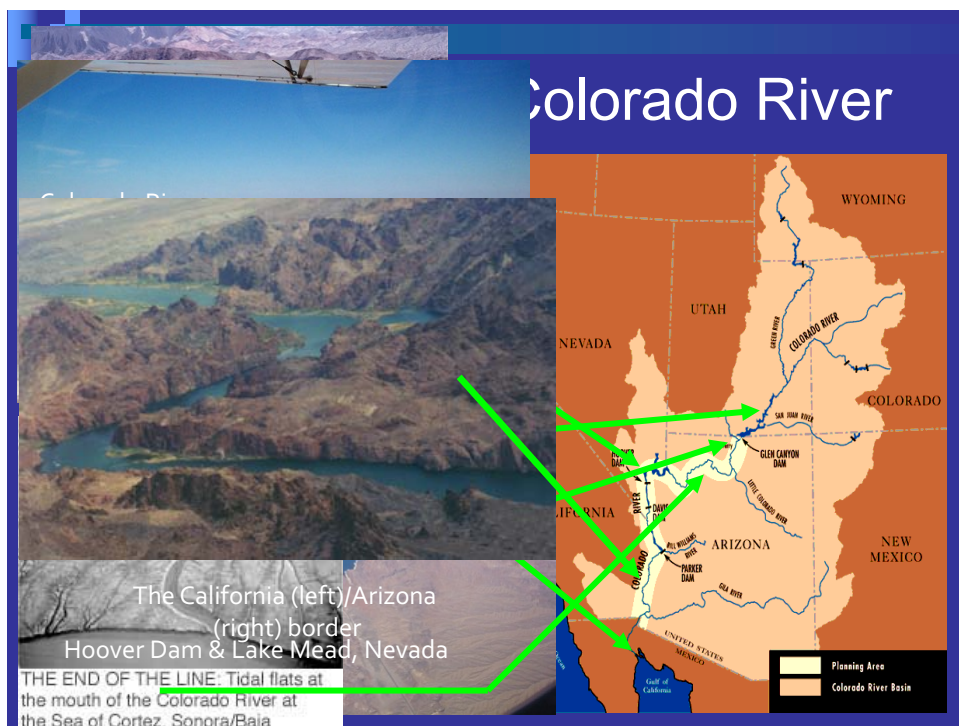
Everglades Forever





The Colorado River

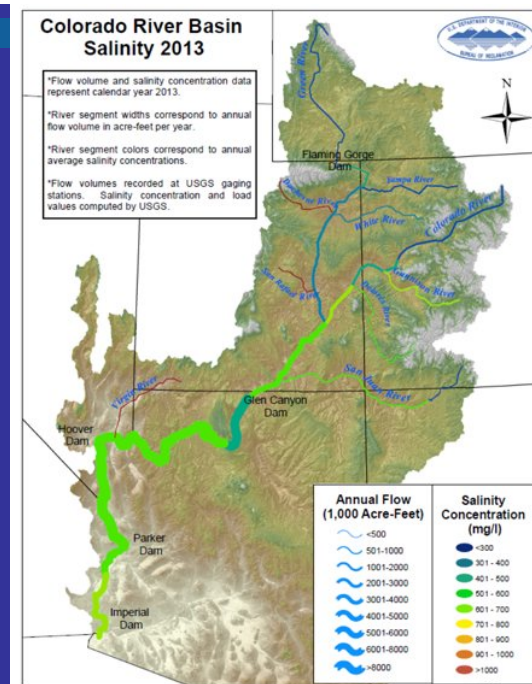
**Major Action Needed,
NOW!**



Colorado River Endangered Species



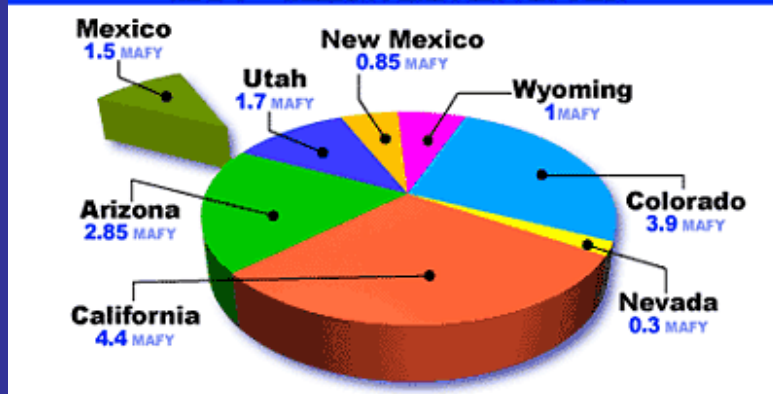
Colorado River Water Quality Issues



The BIG Issue: Water Allocation & “The Law of the River”

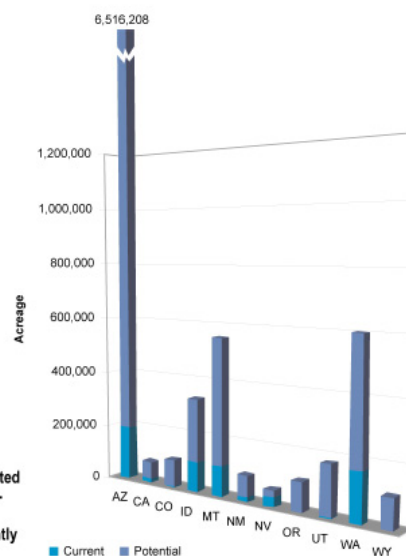
16.5 MAFY APPORTIONMENT

MAFY = MILLION ACRE-Feet PER YEAR

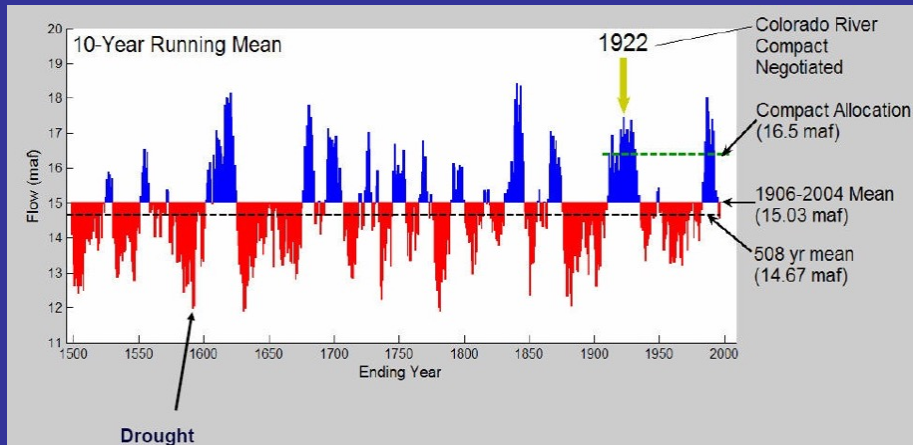


BUT: Many Tribal Water Rights Have Yet to Be Settled

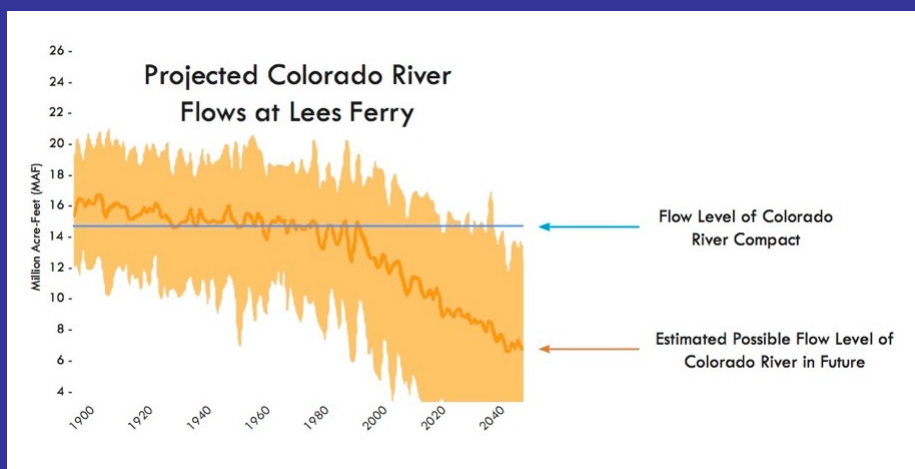
Acreage of Indian lands that are currently being irrigated (brighter blue at bottom of bars) and that could potentially be irrigated (blue at top of bars). Substantially increasing the area of irrigated lands would significantly increase water demand.



PLUS, The Law of the River Was Wrong from the Beginning . . .



AND Climate Change Will Make It Worse!



Lake Powell

2015



2018



Lake Mead

2015



2018

However, Trust & Flexibility ARE Emerging in Governance



Minute 319: The pulse flow delivered a total of 1321 million cubic meters (mcm) (107,000 acre-feet [af]) to the riparian corridor of the Colorado River Delta, March 23 to May 18, 2014.

Klamath River Basin

We're Down to Money . . .

Klamath Project Main Diversion Canal, 1908



Klamath Basin Water Use

The Klamath Basin

A U.S. Bureau of Reclamation project taps water from Upper Klamath Lake and steers it through canals and ditches to 190,000 acres of farms. Reclamation project farms have increasingly pumped well water since 2001 as lake water allocations have been cut. Another 310,000 acres of farms in the basin but "off-project," irrigate with water from rivers and wells.

Source: U.S. Geological Survey



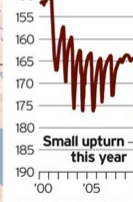
DAVID BADDERS/THE OREGONIAN

Groundwater pumping

A monitoring well near Malin illustrates the drop in water levels since 2001, when more farms began irrigating with well water.

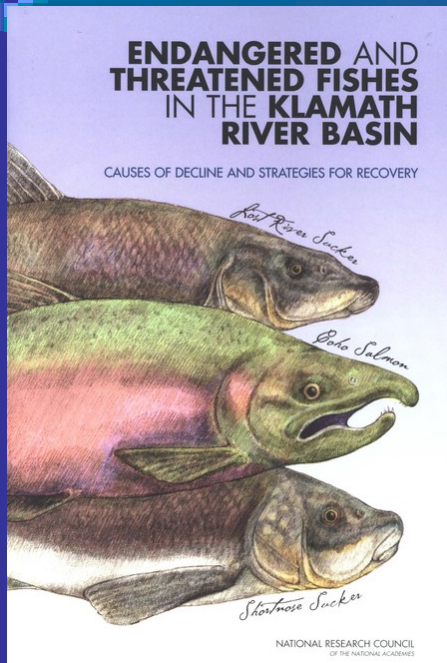
Water level

Feet below ground



Source: Oregon Water Resources Department

Klamath Basin Water Quality



Klamath Basin Endangered Species

Drought 2001



Fish Die-Off 2002



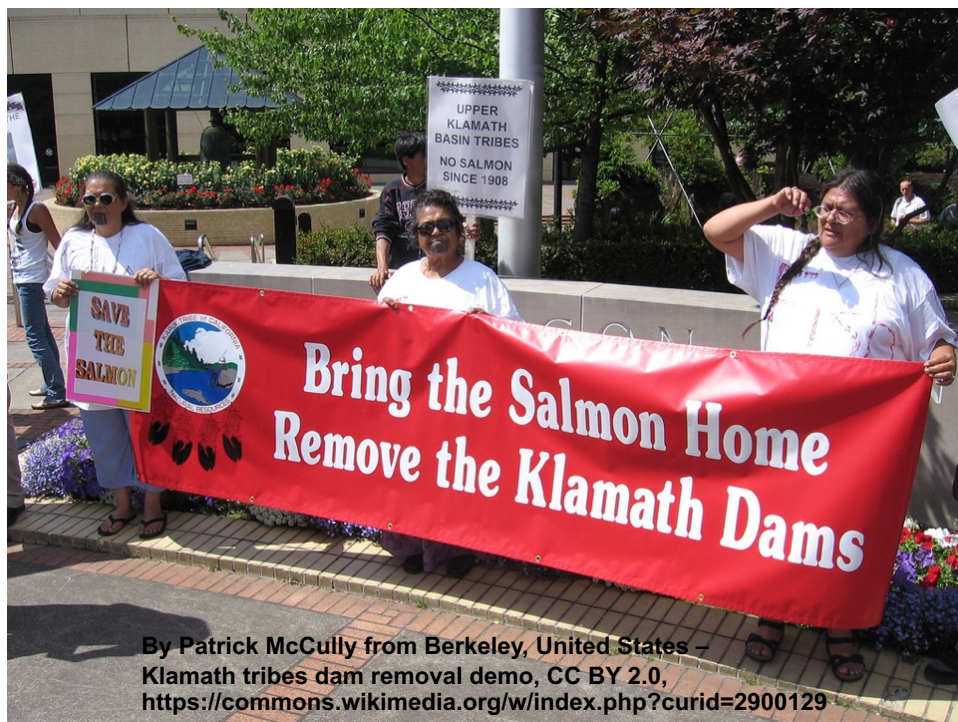
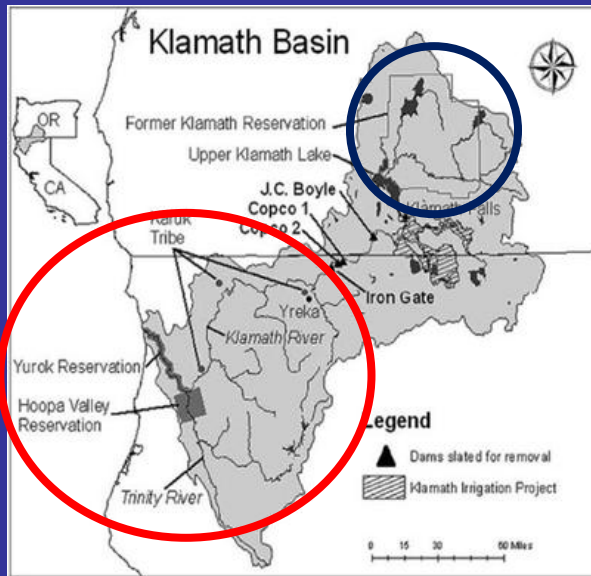
The Battle Lines

The collage illustrates the conflict between environmental advocates and federal agencies over water rights and pipeline construction. On the left, logos for Oregon, NOAA National Marine Fisheries Service, Earthjustice, Oregon Wild, and Waterwatch are displayed. On the right, images of a pipeline, a 'GIVE US BACK OUR WATER' sign, and logos for the U.S. Department of the Interior Bureau of Reclamation and U.S. Fish & Wildlife Service are shown. A large 'VS.' is in the center.

BUT Adaptive Governance Emerged, with Agreements in 2010, 2014, & 2016

A photograph showing a group of people, including men and women in professional attire, standing around a long table outdoors and signing documents. This represents the signing of agreements in 2010, 2014, and 2016.

PLUS Water Rights Shift (2013)



THANK
YOU

