

# COOPERATIVE ECOLOGICAL INVESTIGATIONS IN THE SAN FRANCISCO ESTUARY



## Interagency Ecological Program

COOPERATIVE ECOLOGICAL  
INVESTIGATIONS SINCE 1970

## SCIENCE FOR A CHANGING STATE

Anke Mueller-Solger  
2008-2014: IEP Lead Scientist  
USGS California Water Science Center



Delta Science Program  
Delta Stewardship Council





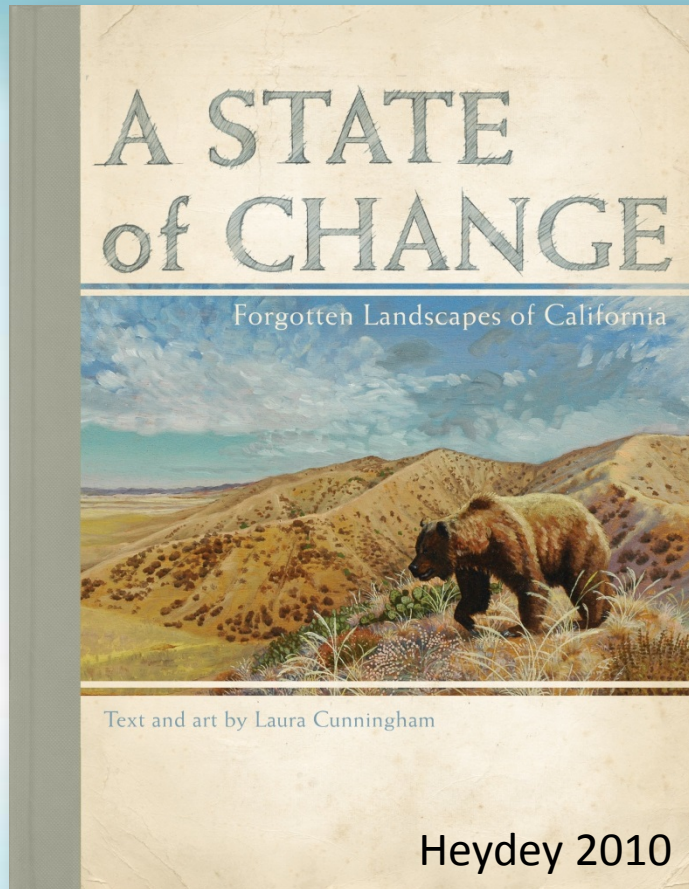


# 3 Stories:

1. California: State of Change
2. Interagency Ecological Program
3. California Terraforming 2.0



# California: State of Change

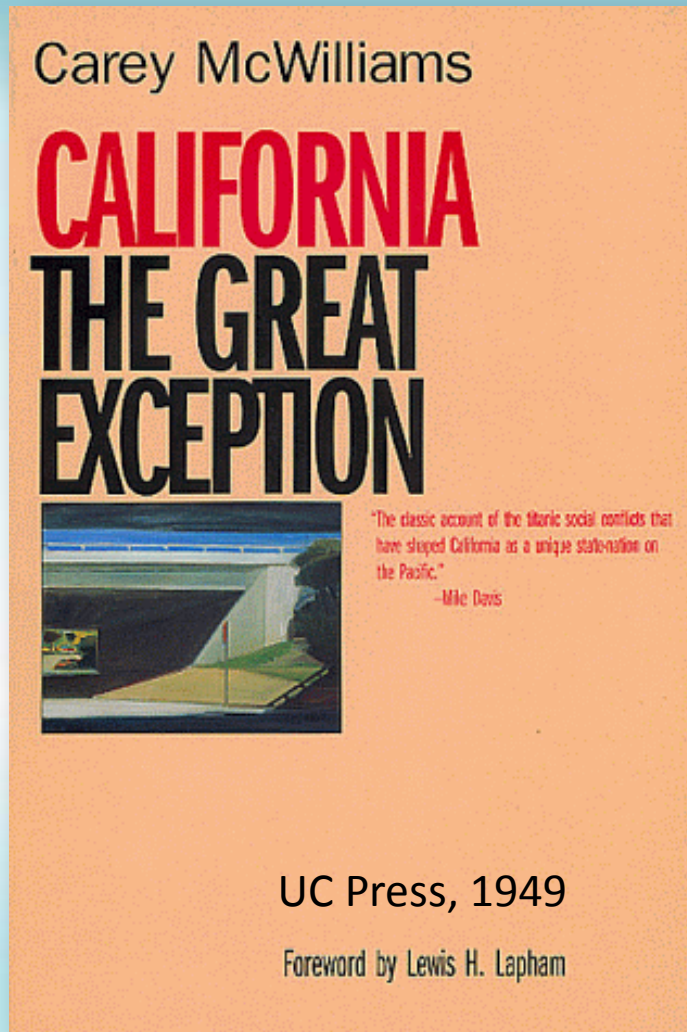




# California: State of Change

*exceptional*

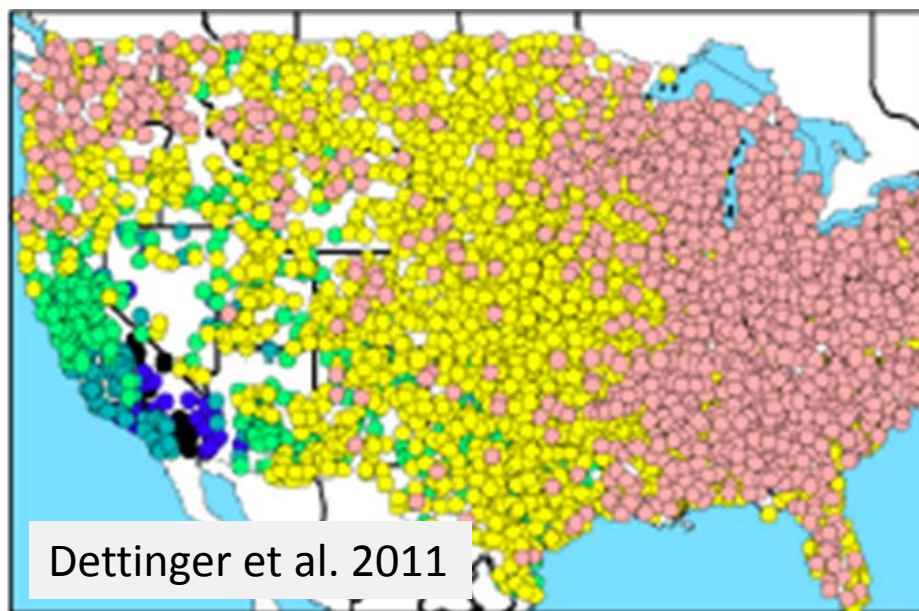
- Precipitation
- People
- Place



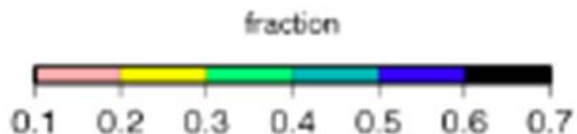


# Precipitation

## Large Interannual Changes

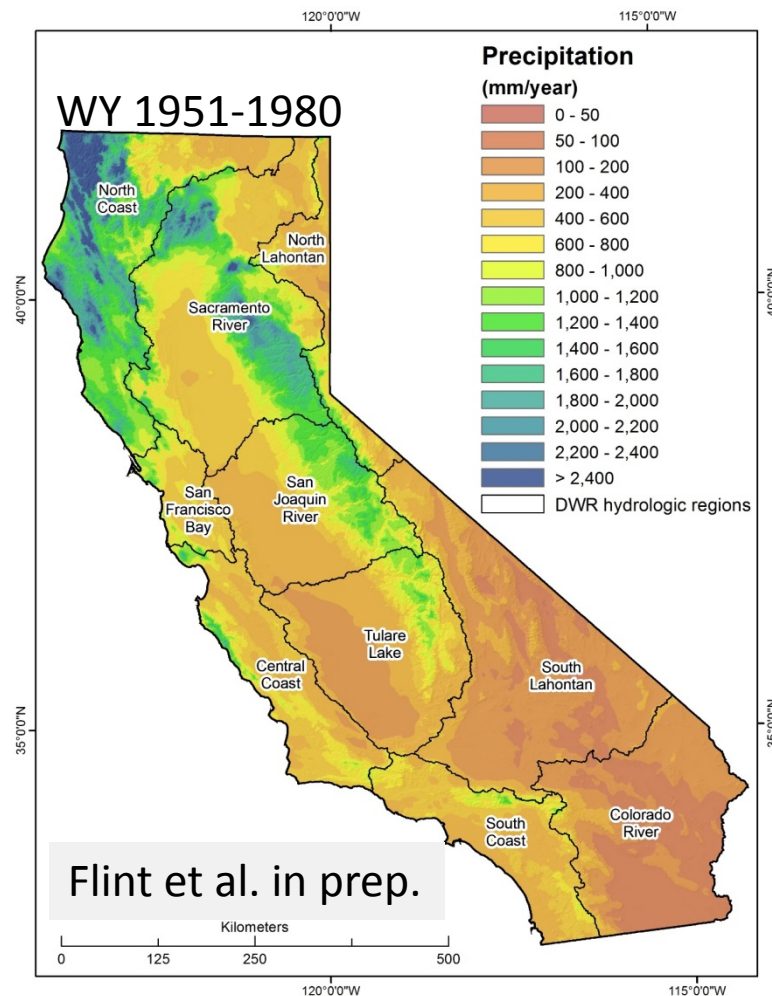


Dettinger et al. 2011



Coefficients of Variation of  
Total Precipitation, WY 1951-2008

## Large Spatial Changes

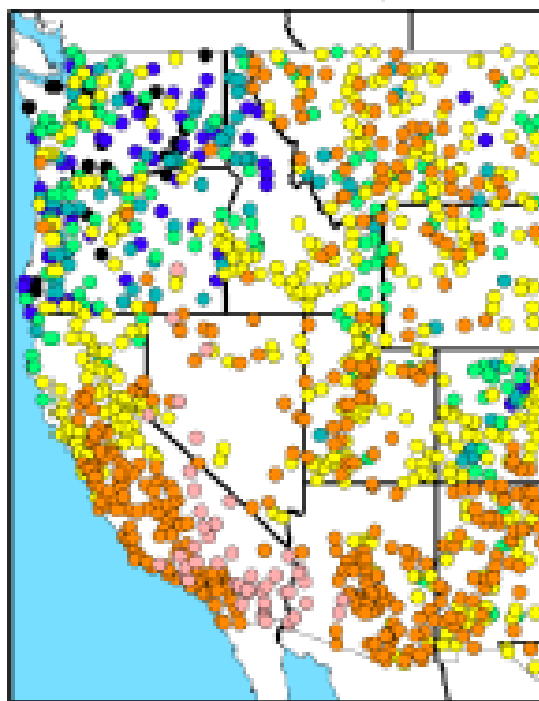


Flint et al. in prep.



# Precipitation

## Most in Few Days/Year

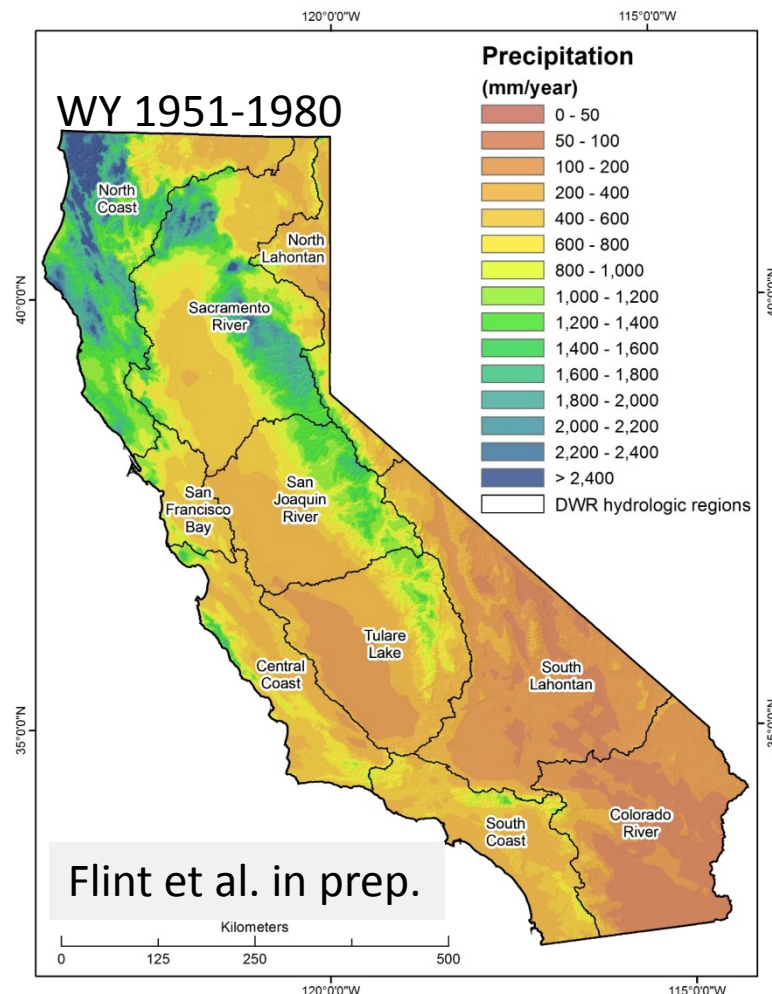


Dettinger  
et al. 2011



Average Number of Days/Year to obtain half  
of total annual precipitation, WY 1951-2008

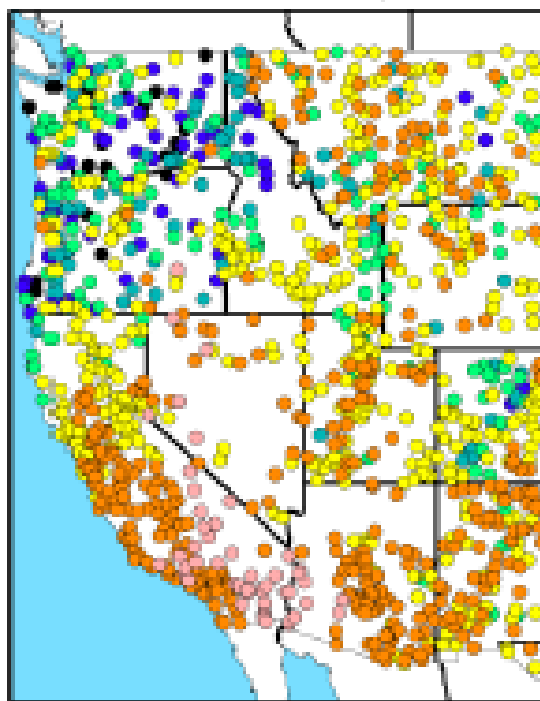
## Large Spatial Changes





# Precipitation

Most in Few Days/Year

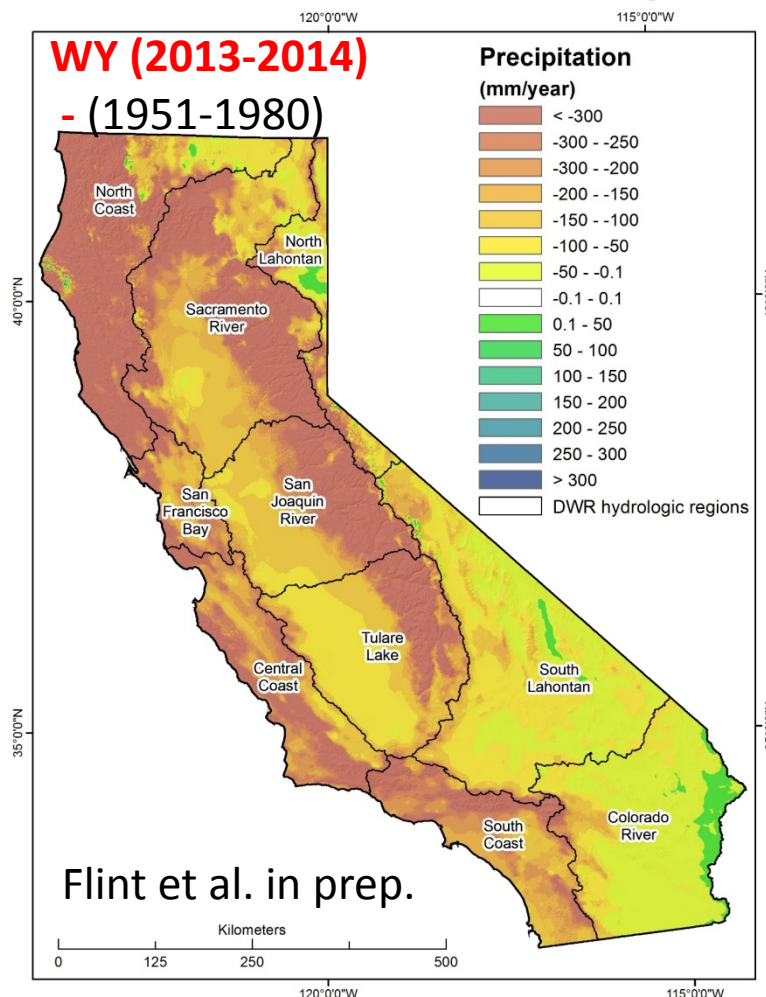


Dettinger  
et al. 2011



Average Number of Days/Year to obtain half  
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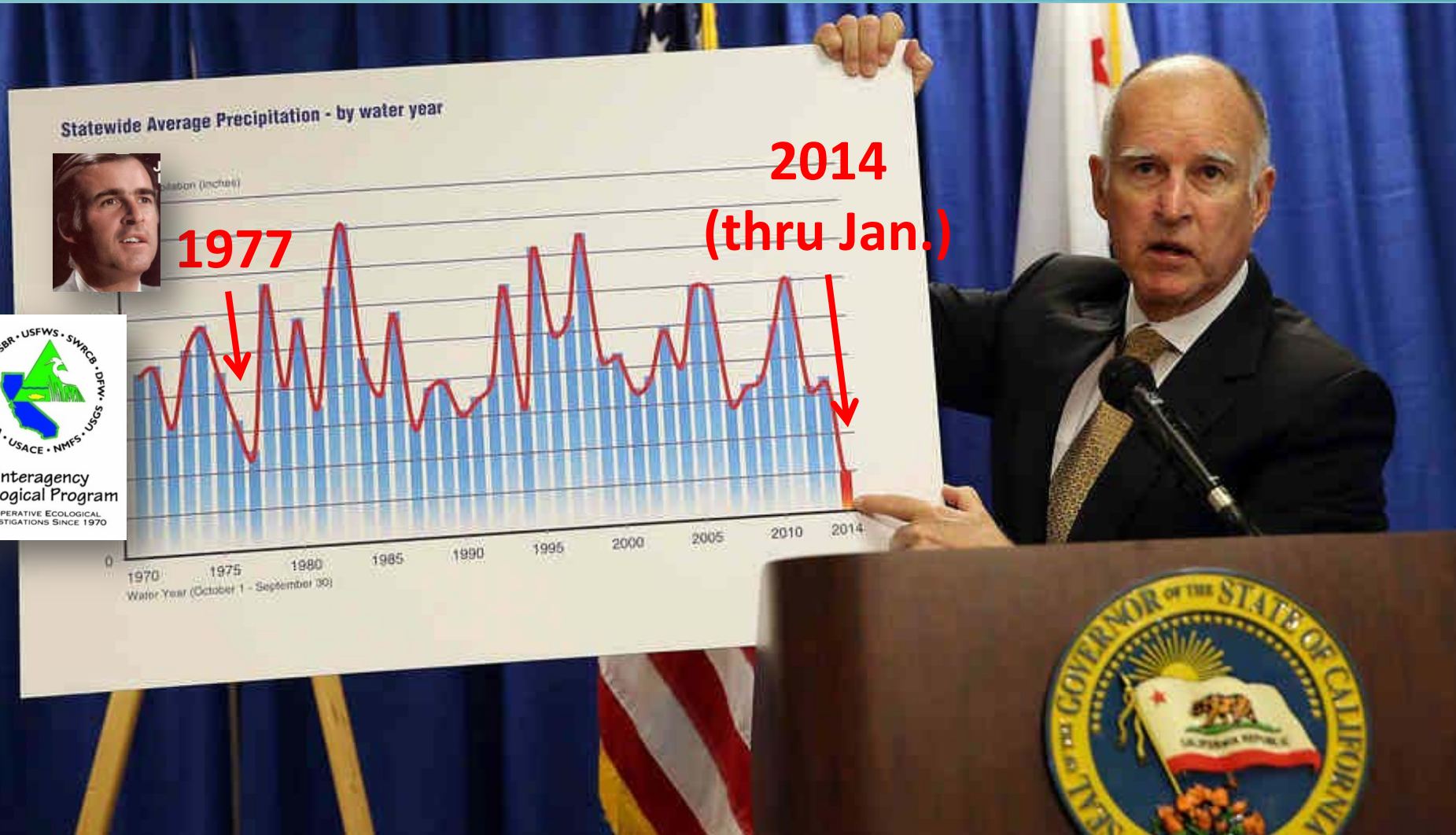
Without them: Drought!



Flint et al. in prep.



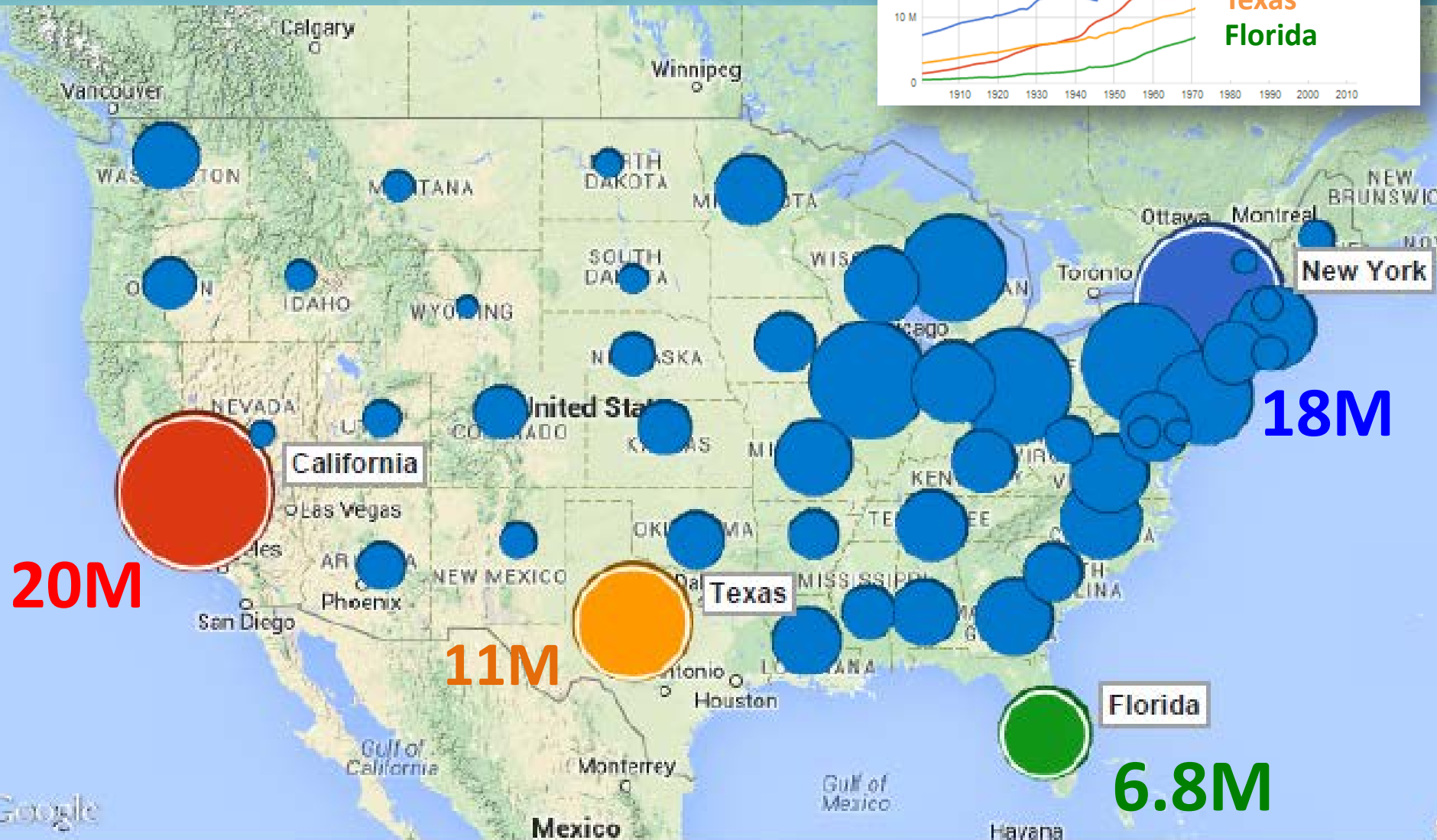
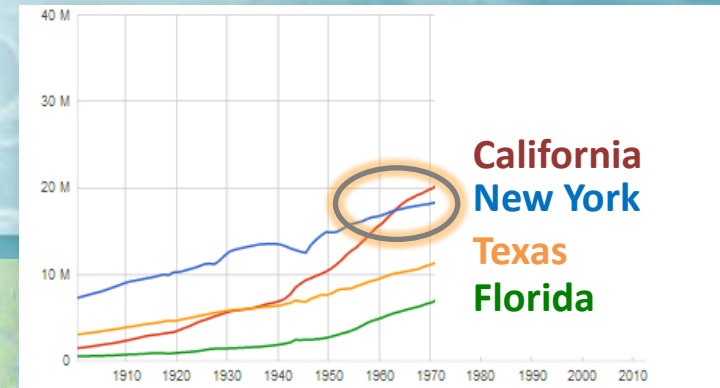
# Precipitation



CA Governor Jerry Brown declares a drought state of emergency, 1-17-2014

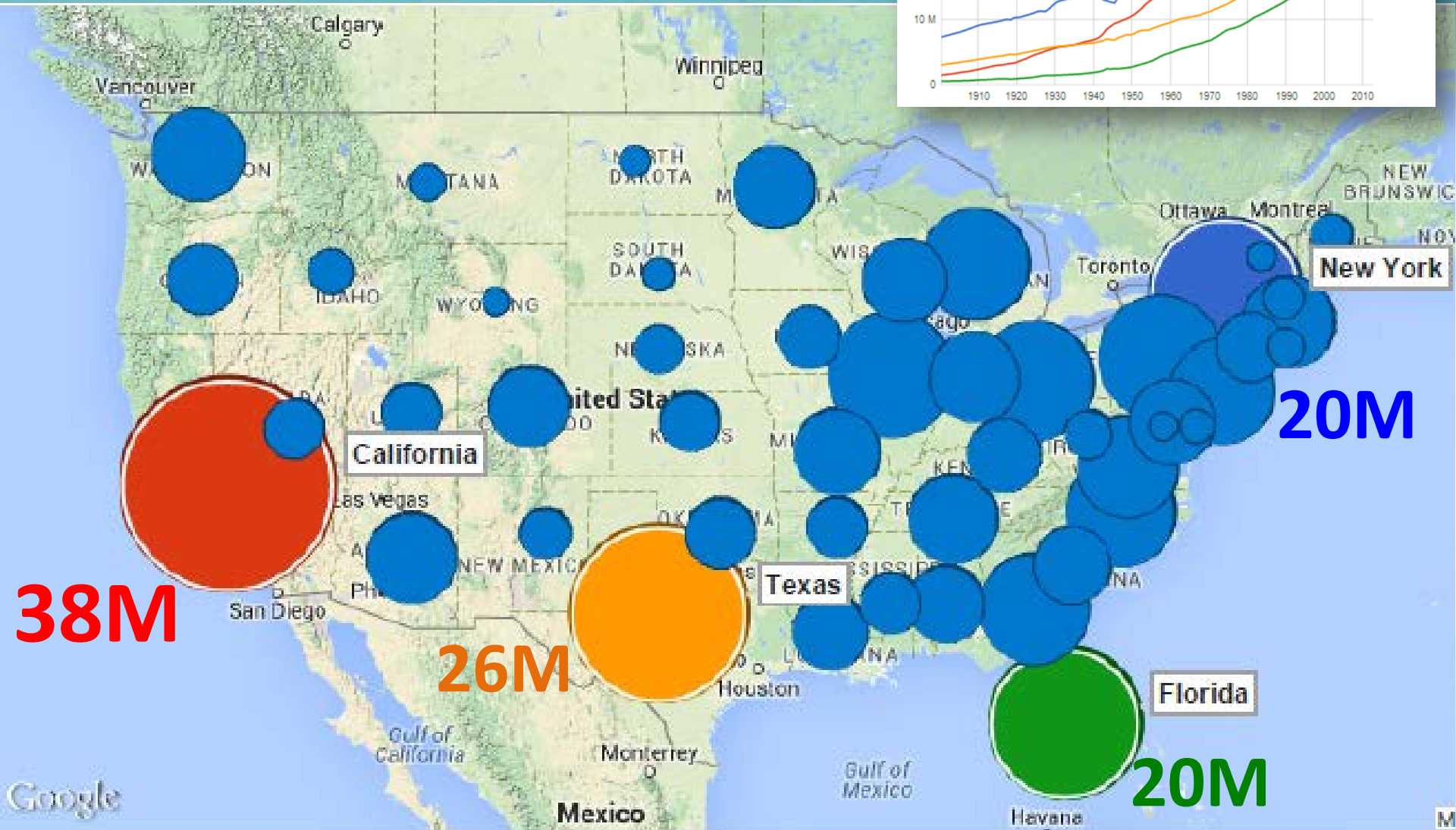
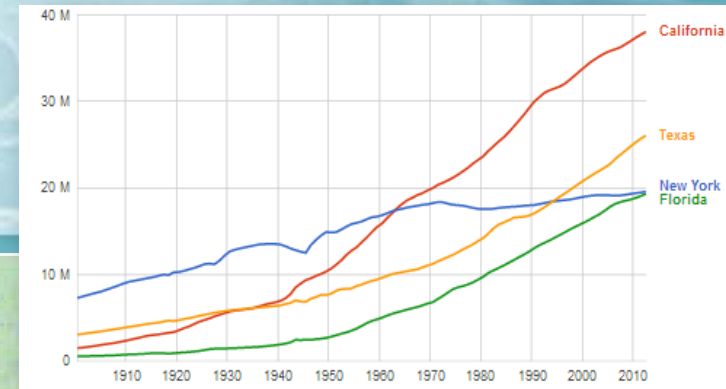


# People - 1970



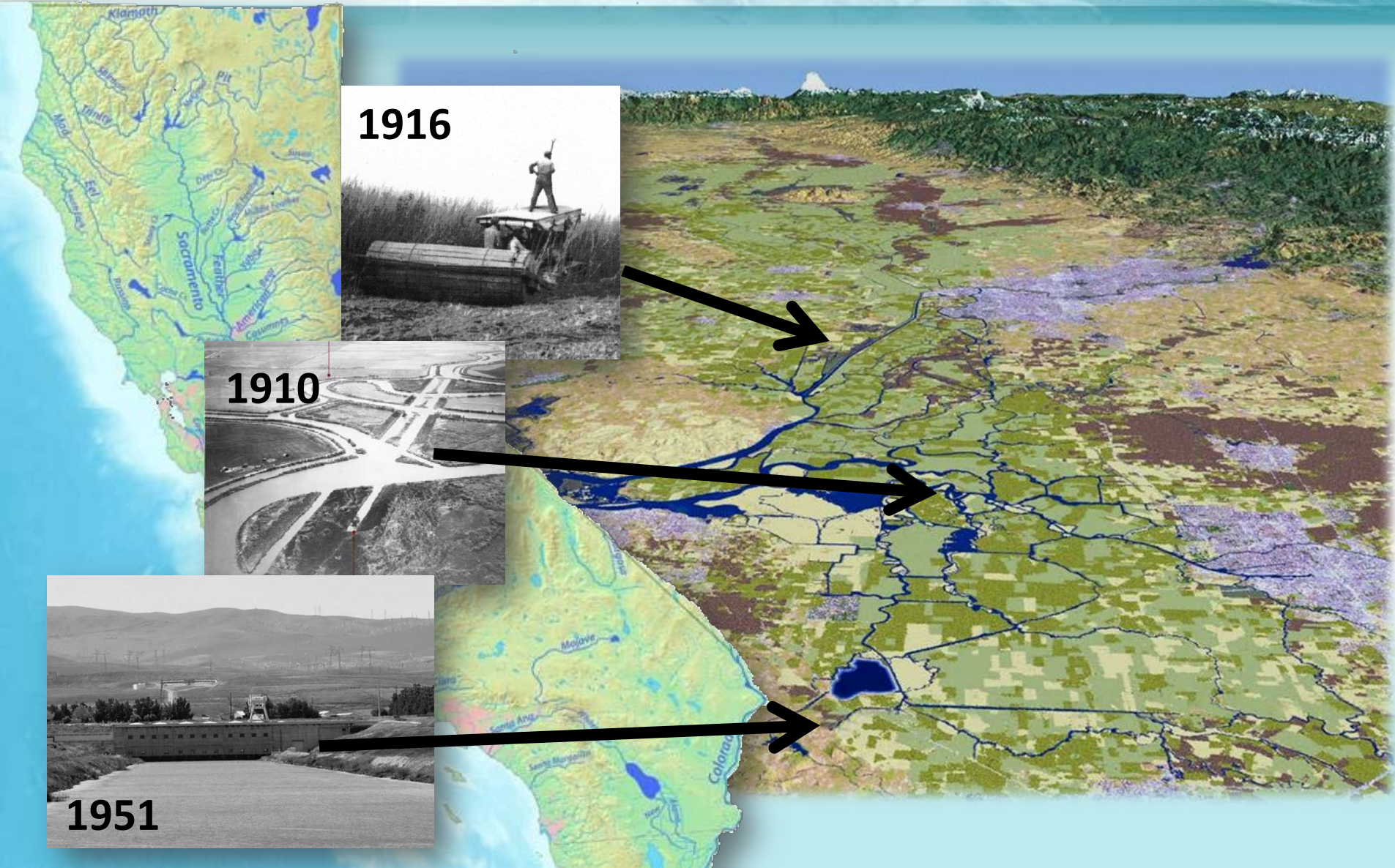


# People - 2013





# Place







# Place





# Place

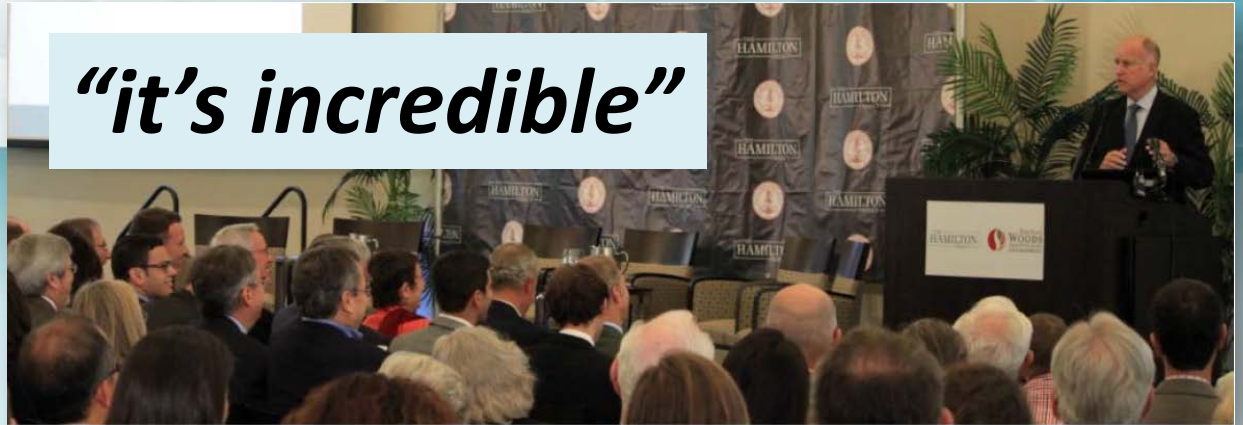




# Place



***“it’s incredible”***



*“California has manipulated and interfered with and managed the hydrologic cycle in ways that probably have **no comparison anywhere** in the world. California is a highly engineered and managed water state [...] it’s incredible.”*

*CA Governor Jerry Brown, 10/20/2014*



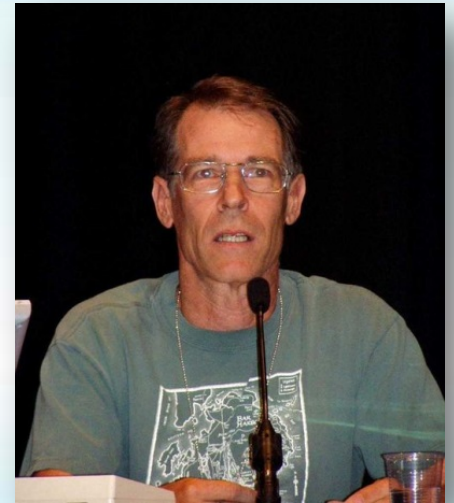
# Place

*"California is a **terraformed space**. I think we have accidentally become terraformers, but of course we are not gods. We don't actually **know enough** about ecology, or even about bacteria, **to do what we want to do here.**"*

Kim Stanley Robinson

*Boom Winter 2013, Vol. 3, No. 4*

## Surprises!

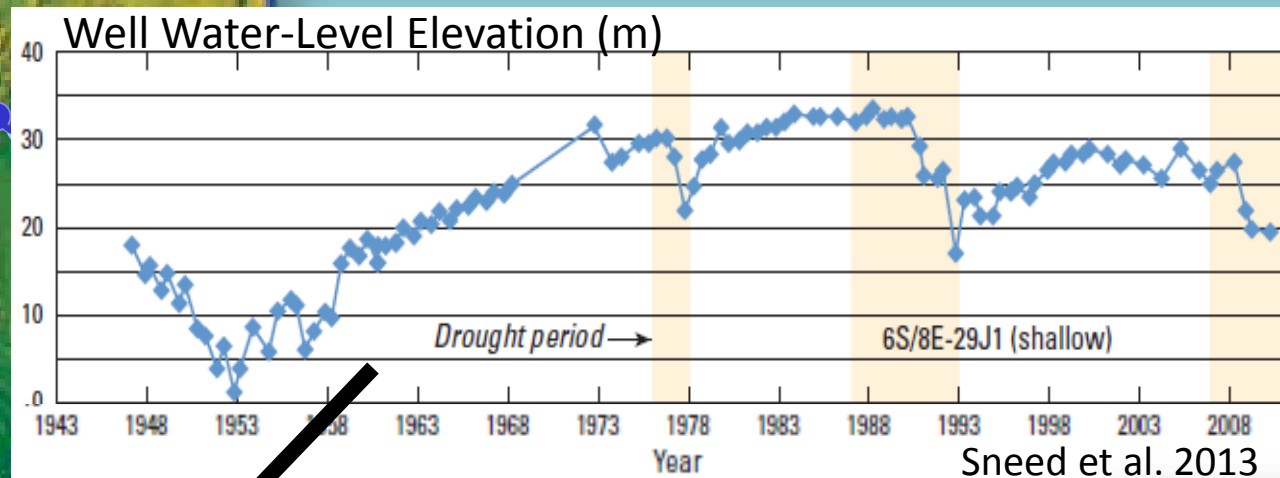


*Terraform: transform a planet so that it can support terrestrial (human) life*





# Land subsides



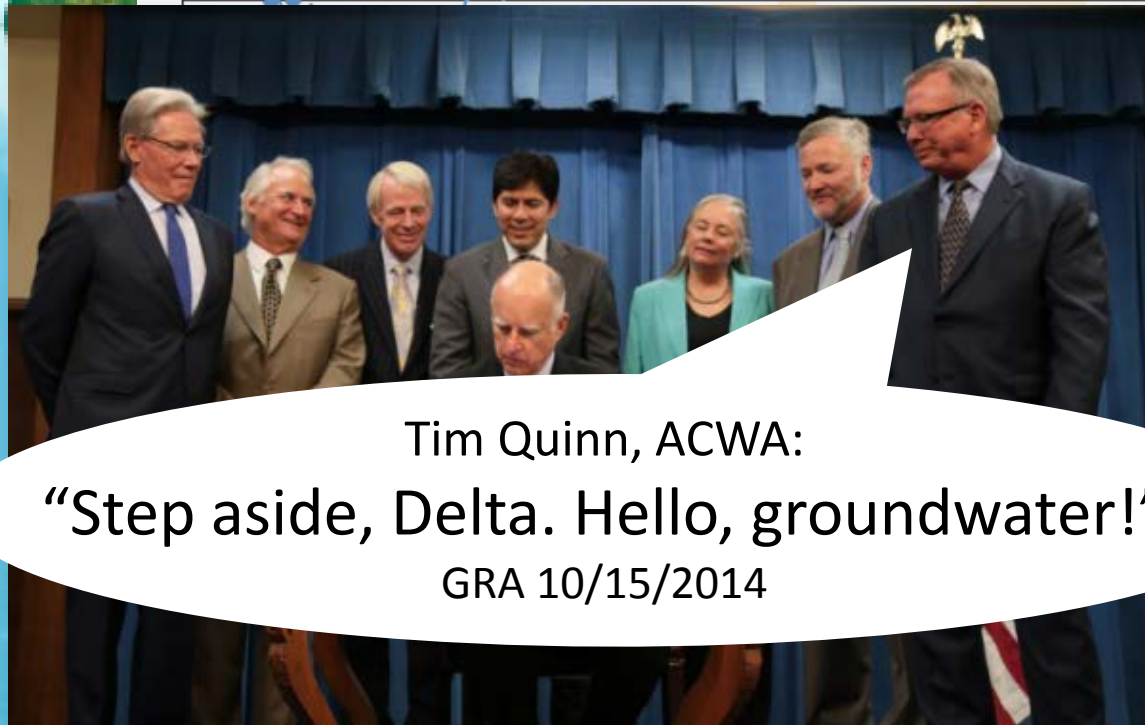
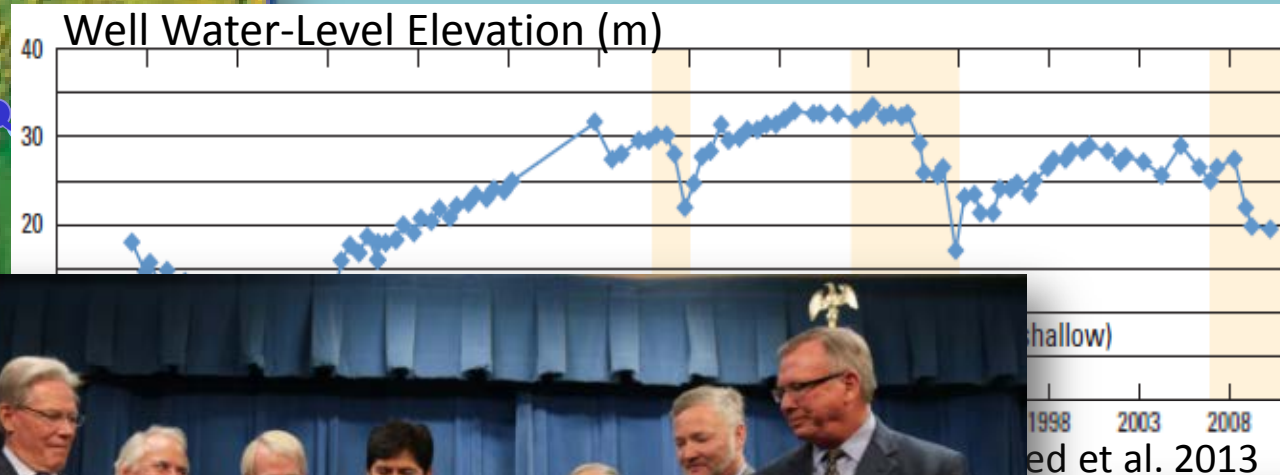
CVP

SWP





# Land subsides



Tim Quinn, ACWA:  
“Step aside, Delta. Hello, groundwater!”  
GRA 10/15/2014

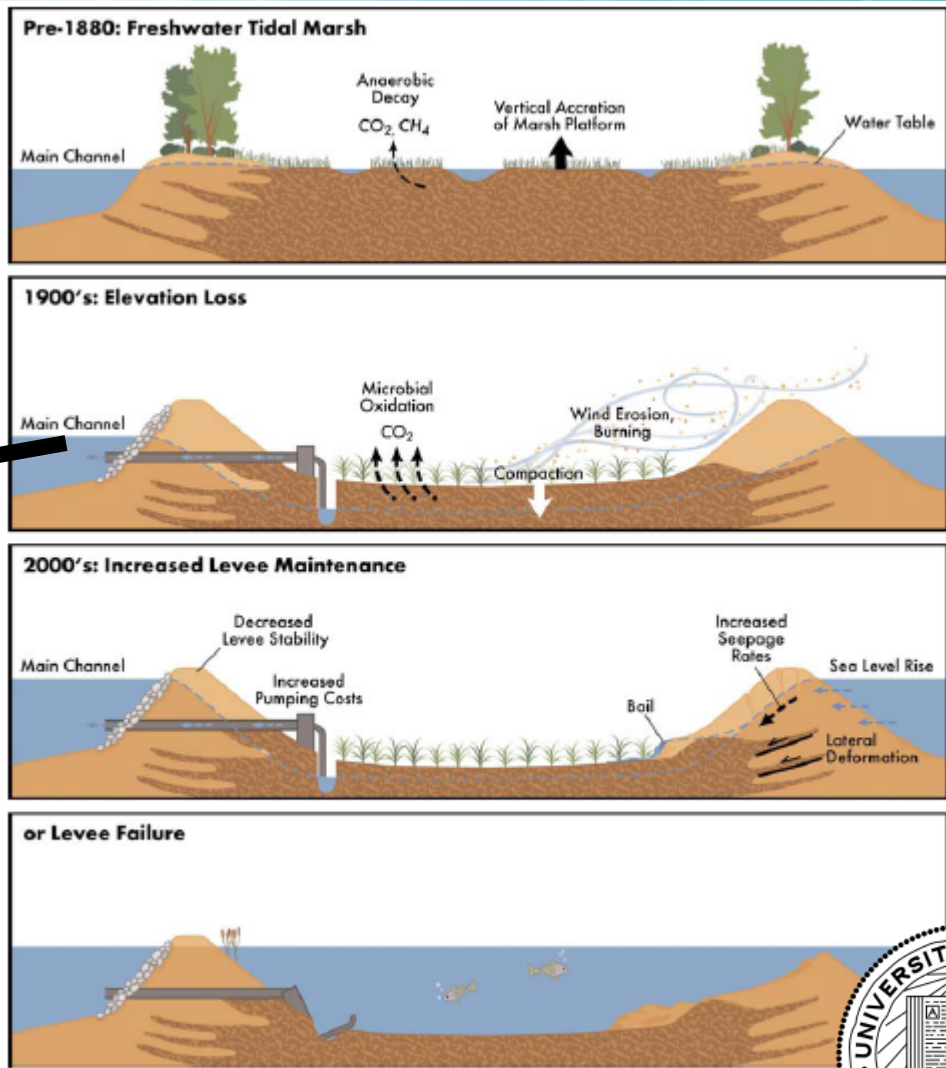
**USGS**  
science for a changing world



**Governor Brown signs Sustainable Groundwater Management Act, 9/16/2014**



# Land subsides



Mount & Twiss 2005, SFEWS

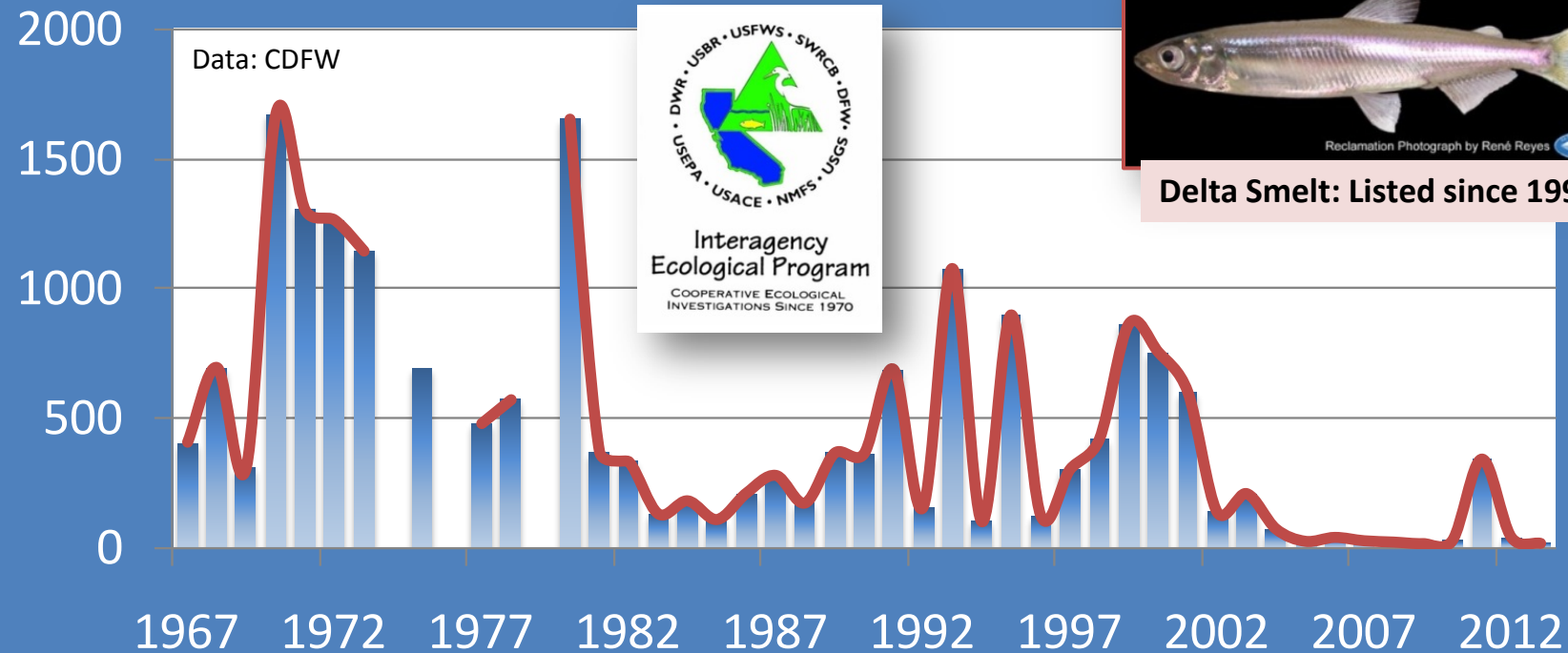




# Native species decline

(CA: 149 ESA-listed species)

## Annual Delta Smelt Abundance Index



Delta Smelt: Listed since 1993

Longfin Smelt: Listed since 2009



Green Sturgeon: Listed since 2006



Chinook Salmon: Listed since 1989(+)

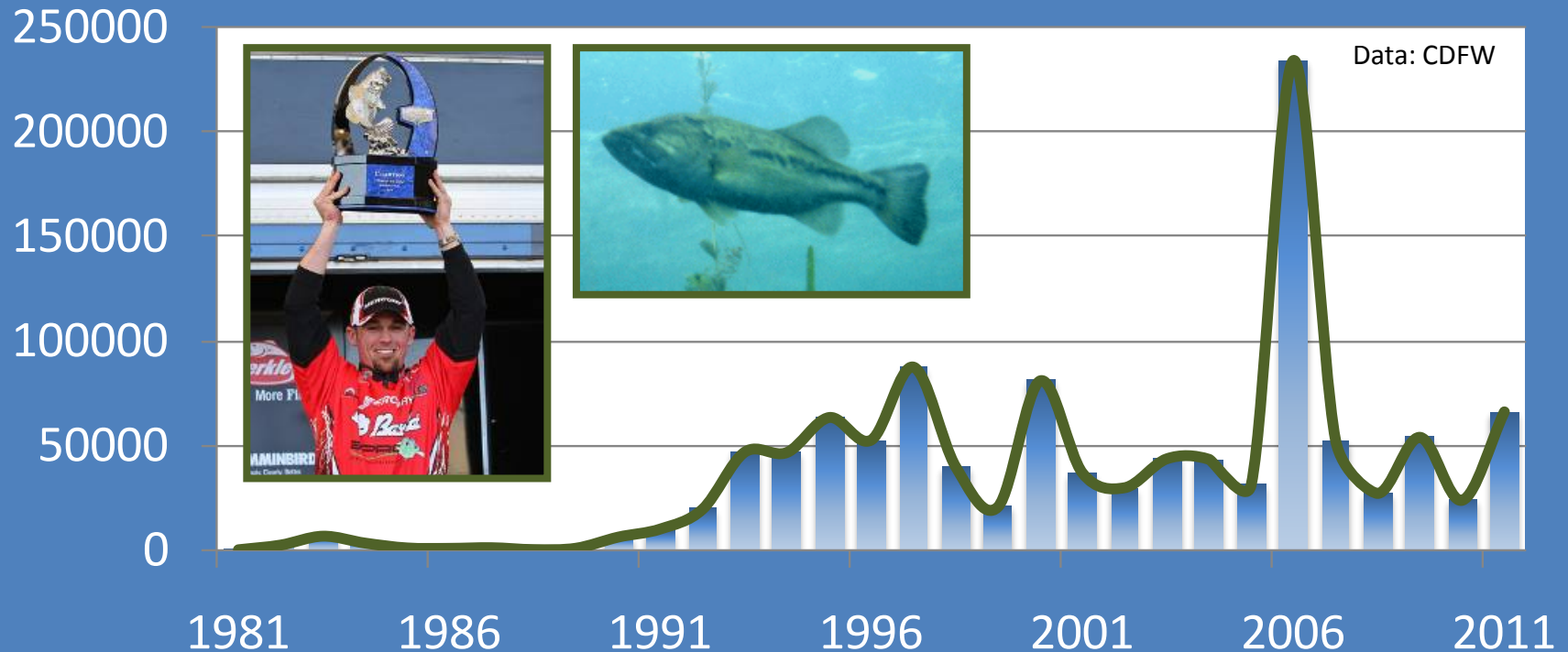




# Non-natives boom

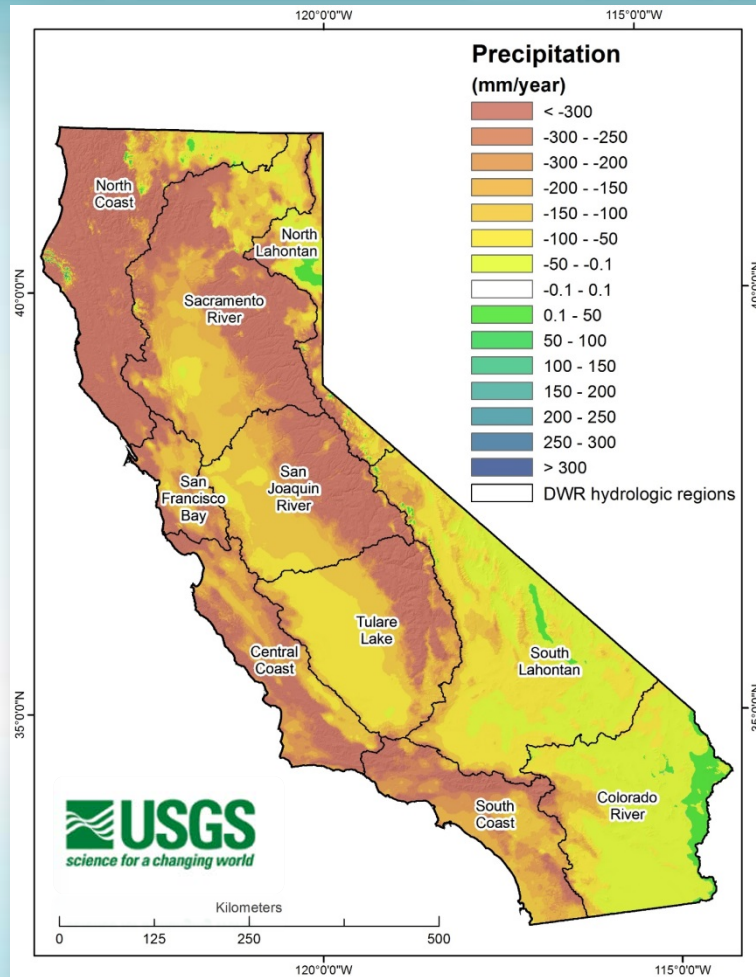
Total Annual Largemouth Bass "Salvage" at SWP & CVP

(~4 new species/year)

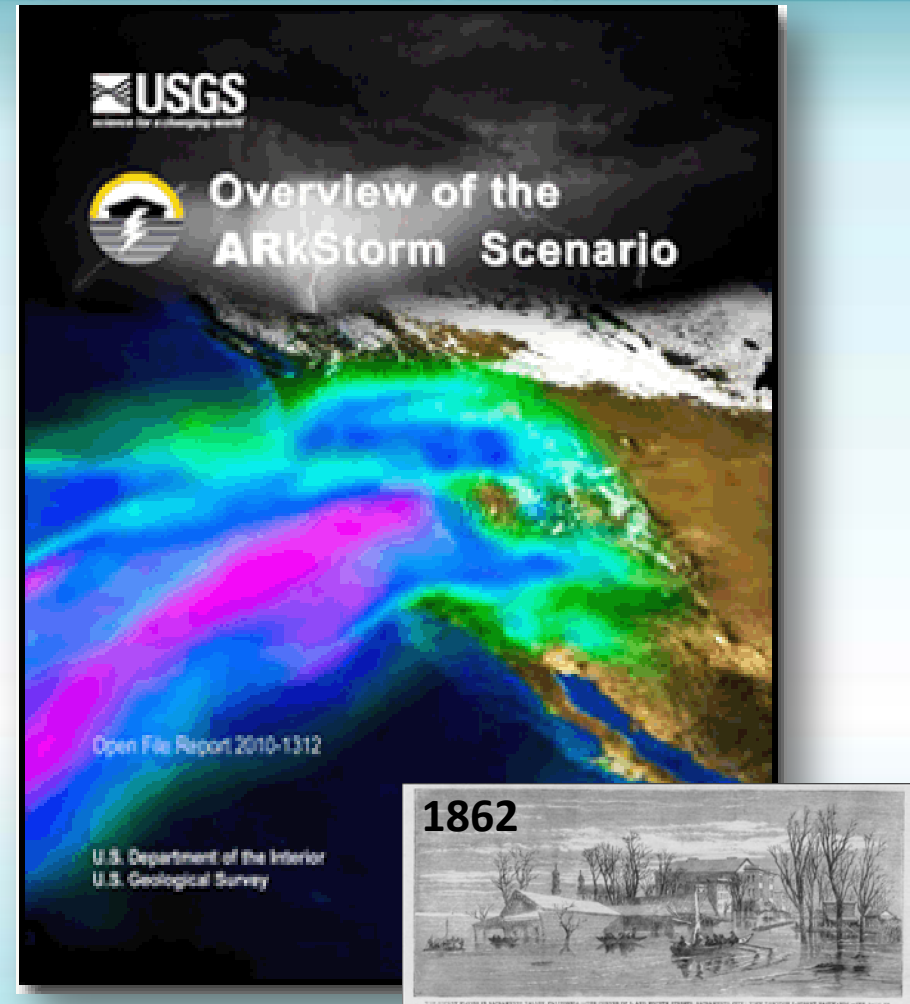




# Droughts, floods, climate change



Flint et al., USGS, in prep.



Porter et al., USGS 2010

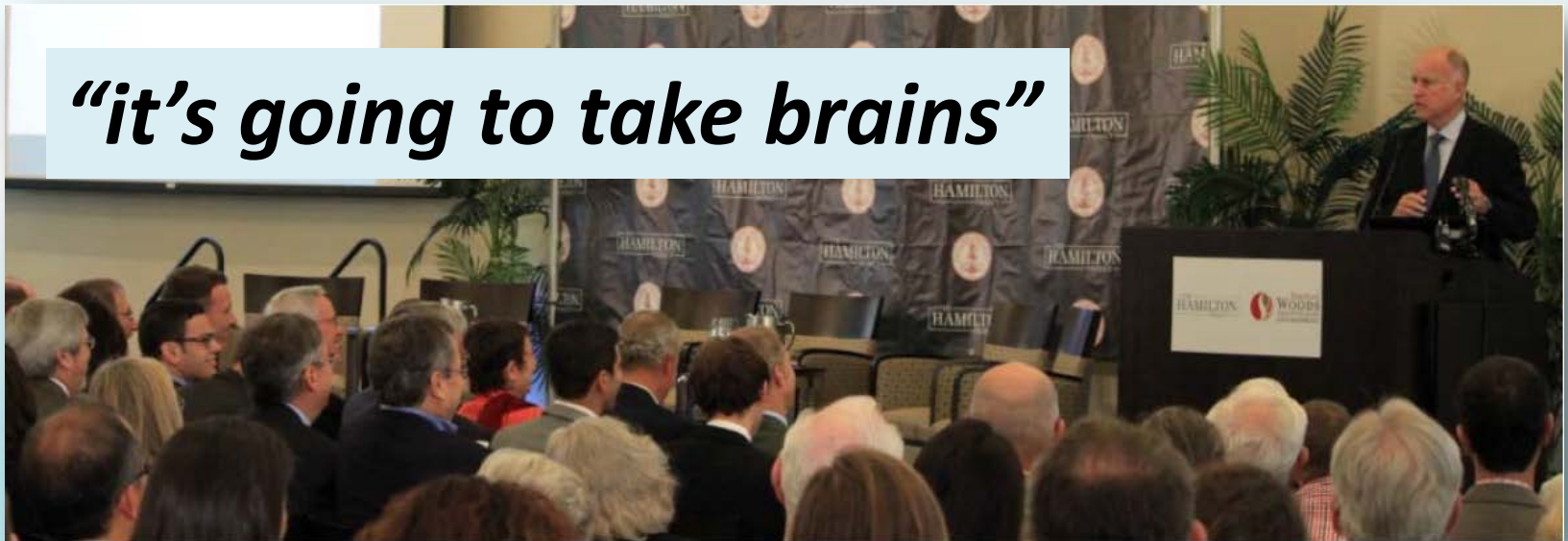


*so we have a management challenge*

*that's going to take **money**, it's going to take **brains**,  
it's going to take **innovation**, and it's going to take all  
the **magic** of the marketplace to bring out the best of  
our **creativity**...*

*CA Governor Jerry Brown, 10/20/2014*

***“it's going to take brains”***





# It's going to take ALL OUR brains!

to know enough --- Science



Interagency  
Ecological Program



Delta Science Program  
Delta Stewardship Council





# It's going to take ALL OUR brains!

to know enough --- Science

to do --- Management



Interagency  
Ecological Program



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Delta Stewardship Council





# It's going to take ALL OUR brains!

to know enough

--- Science

to do

--- Management

what we want  
to do here

--- Policy

***“We are smarter than me!”***



Interagency  
Ecological Program



Delta Science Program  
Delta Stewardship Council





# 2. Interagency Ecological Program

Cooperative Ecological Investigations since 1970



It's about scientists working together on Bay-Delta science informing solutions for a changing state.  
Long-term.



Interagency  
Ecological Program



Delta Science Program  
Delta Stewardship Council



***“We are smarter than me!”***



# “On-the-Water” Scientists

## Interagency Ecological Program Strategic Plan



Interagency  
Ecological Program  
COOPERATIVE ECOLOGICAL  
INVESTIGATIONS SINCE 1970

IEP Member Agencies:  
California Department of Fish and Wildlife  
California Department of Water Resources  
State Water Resources Control Board  
National Marine Fisheries Service  
U.S. Army Corps of Engineers  
U.S. Bureau of Reclamation  
U.S. Environmental Protection Agency  
U.S. Fish and Wildlife Service  
U.S. Geological Survey

10/22/2014

[water.ca.gov/iep](http://water.ca.gov/iep)

1. Hard work & engagement
2. Collaborative science teams
3. Relevant, responsive, adaptive
4. Recognized results – scientific excellence, expertise

“Our mission is to get the science nailed down.” R. Brown, DWR People, 1998





# IEP Lead Scientist



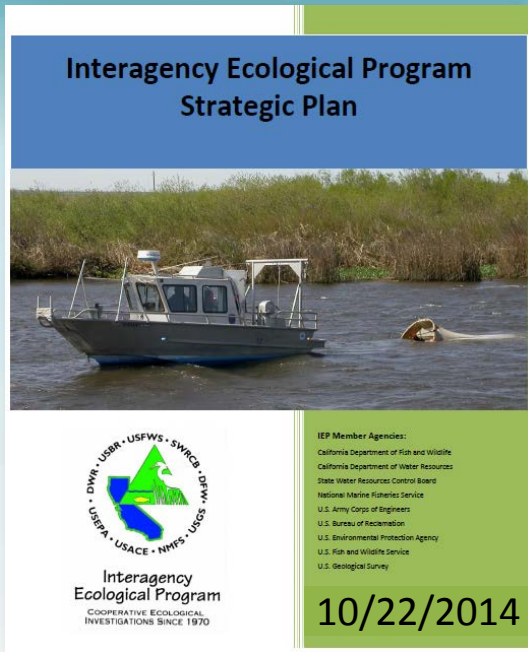
1. Hard work & engagement
  2. Collaborative science teams
  3. Relevant, responsive, adaptive
  4. Recognized Results— scientific excellence, expertise
  5. Analysis, Synthesis, Communication
  6. Nexus to DSP, others – “Advice”
  7. Oversight, Seizing Opportunities
- Not much say over \$\$, Direction

“Our mission is to get the science nailed down.” R. Brown, DWR People, 1998





# “On & off-the-Water” Science



- Observe
- Understand
- Model, Predict
- Assess, Report
- Make Connections

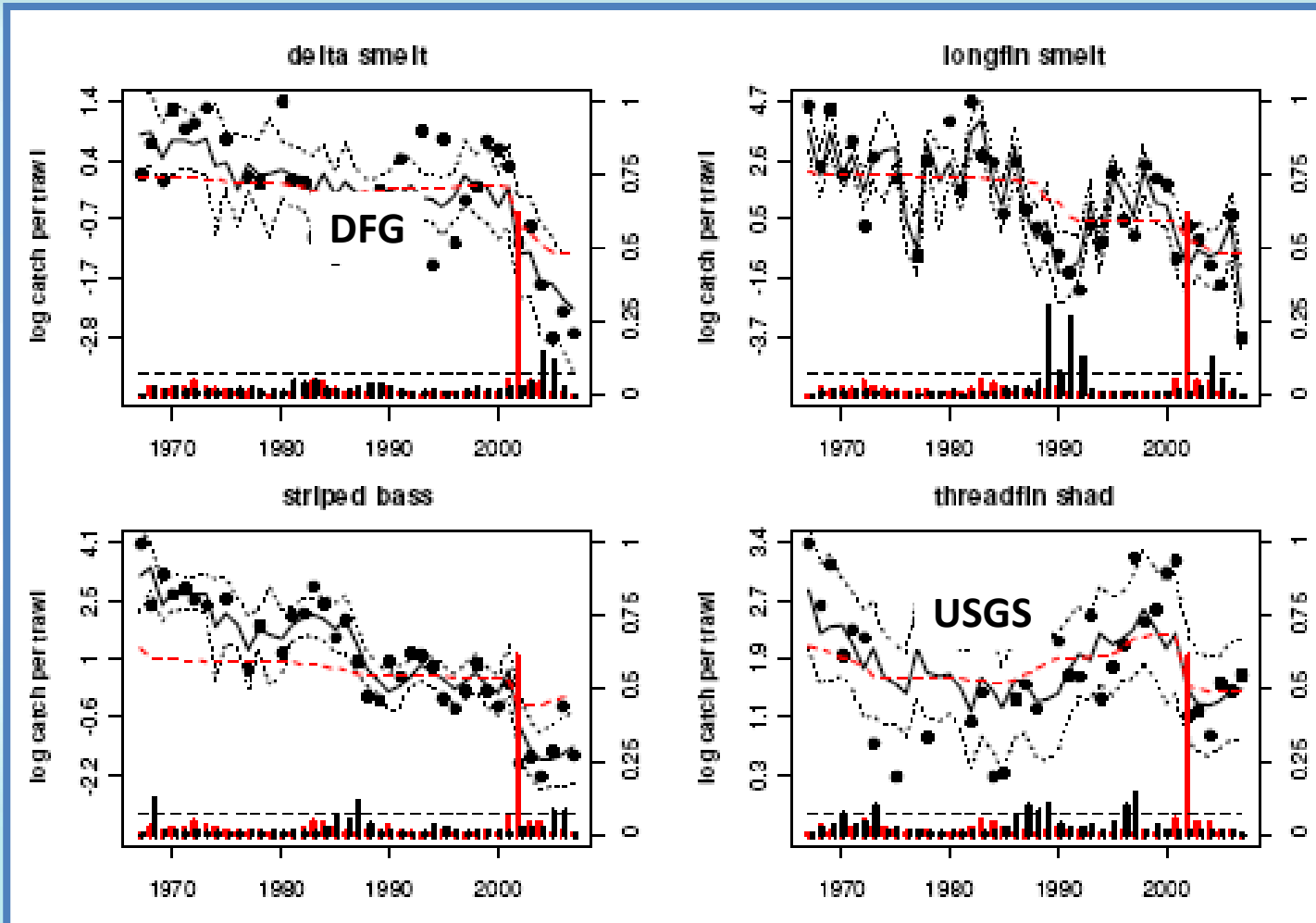
<http://water.ca.gov/iep/>



# Observe Changes



## Pelagic Organism Decline (POD) “Change Point” in 2002



Thomson et al 2010,  
Ecological Applications





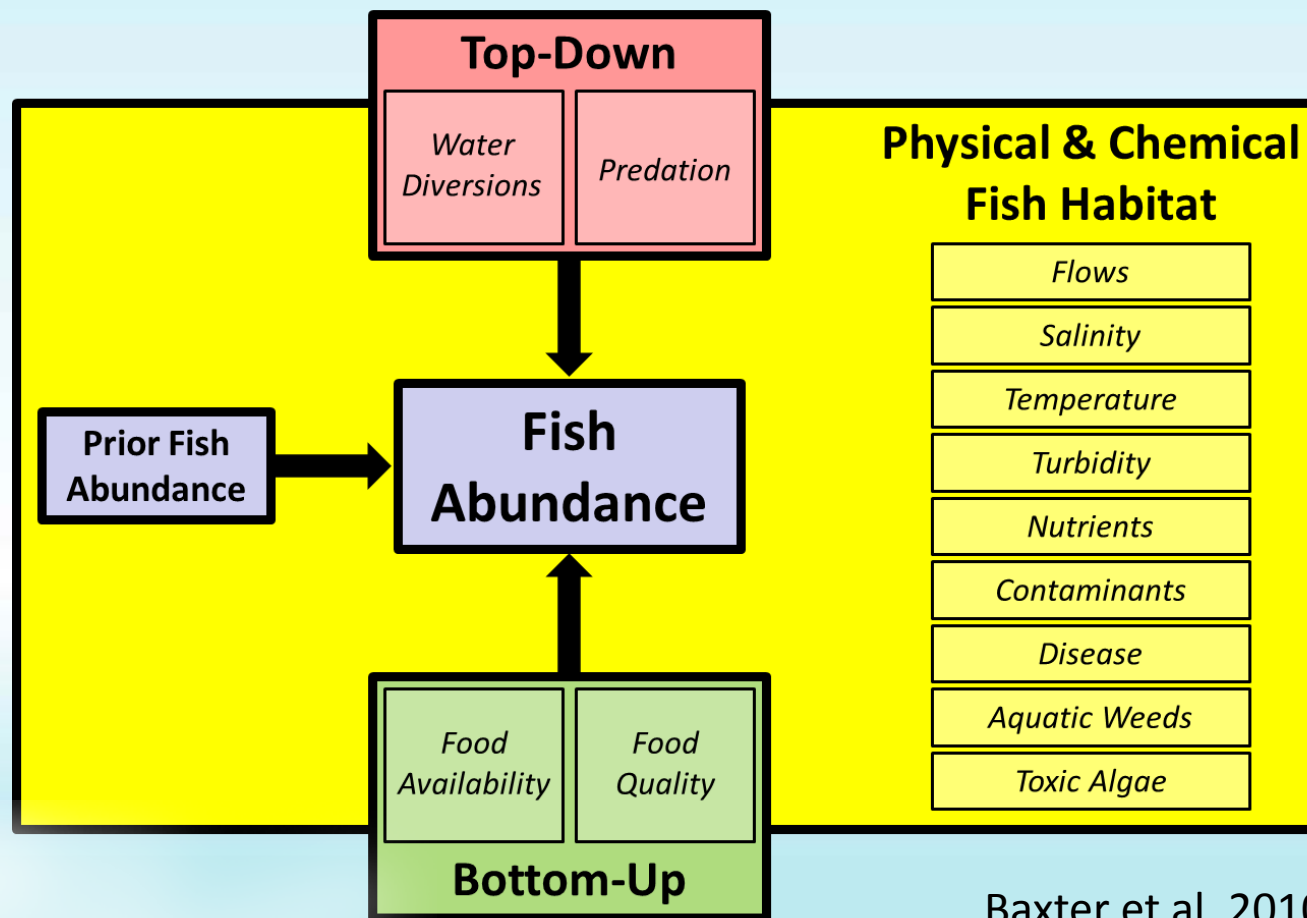
# Understand Changes

NRC 2012:

*“landmark  
change in  
thinking”*

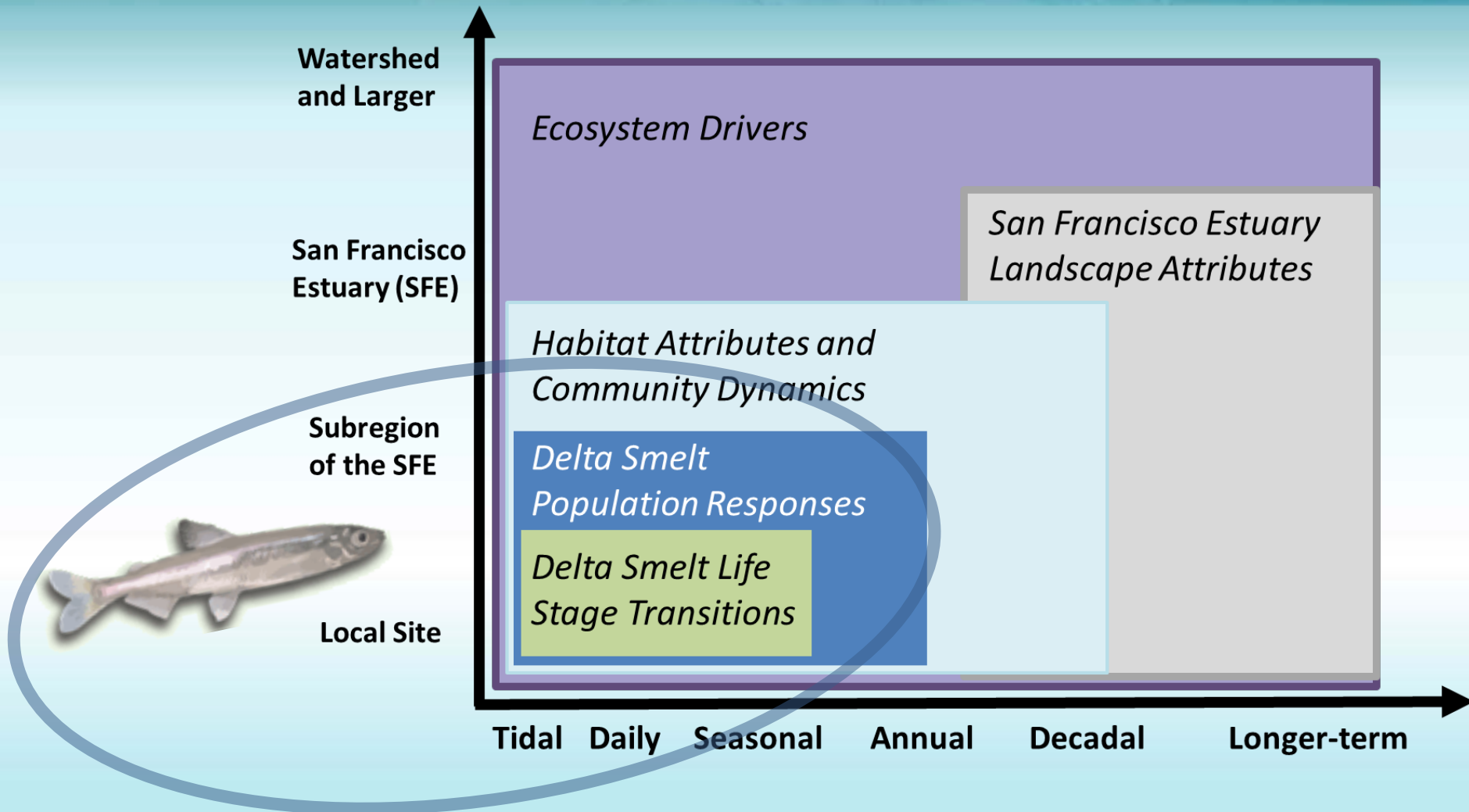
POD: multiple stressors in combination

Analysis  
and  
Synthesis





# Understand Changes

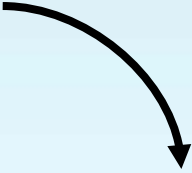




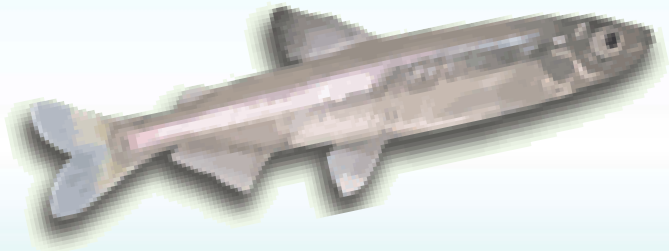
# Model, Predict Changes



Model



Predict



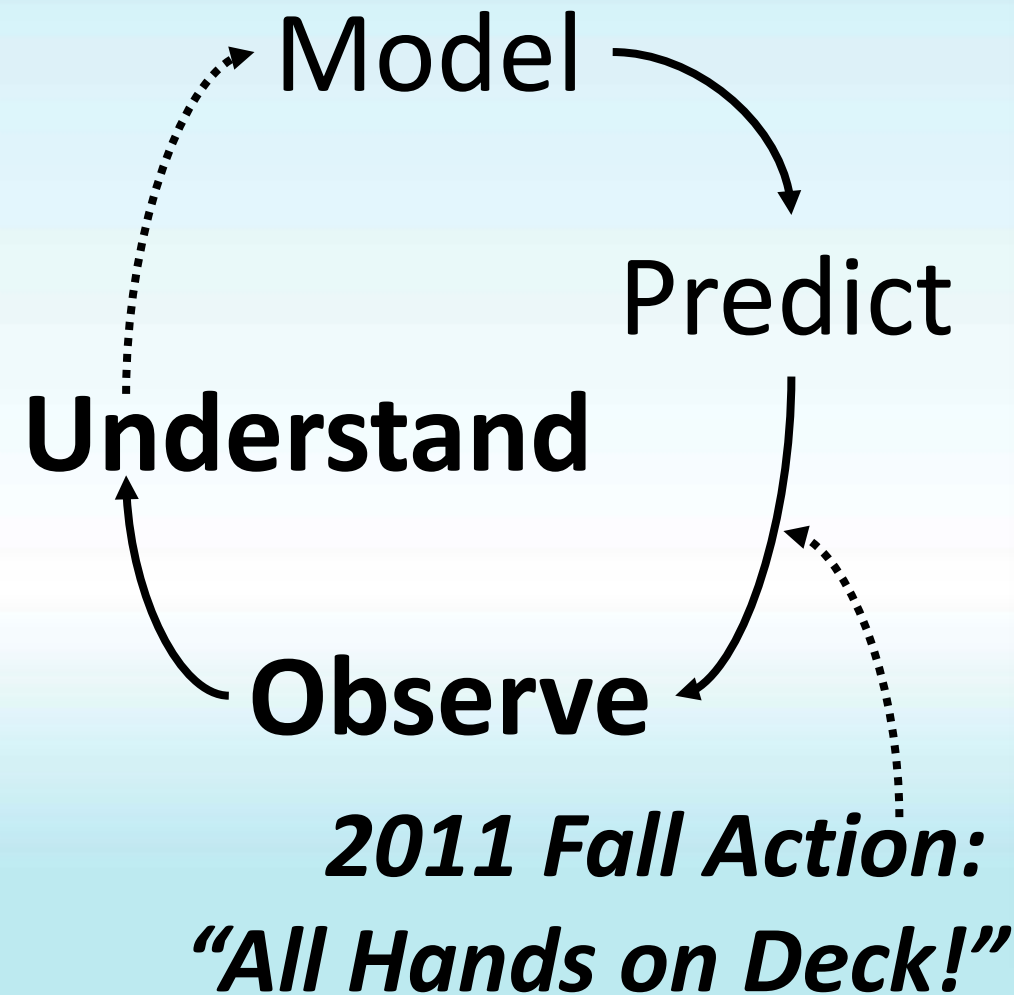
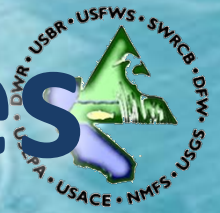
*“Fall Action”  
to benefit delta smelt*

“Scenarios”  
*e.g. Drought*





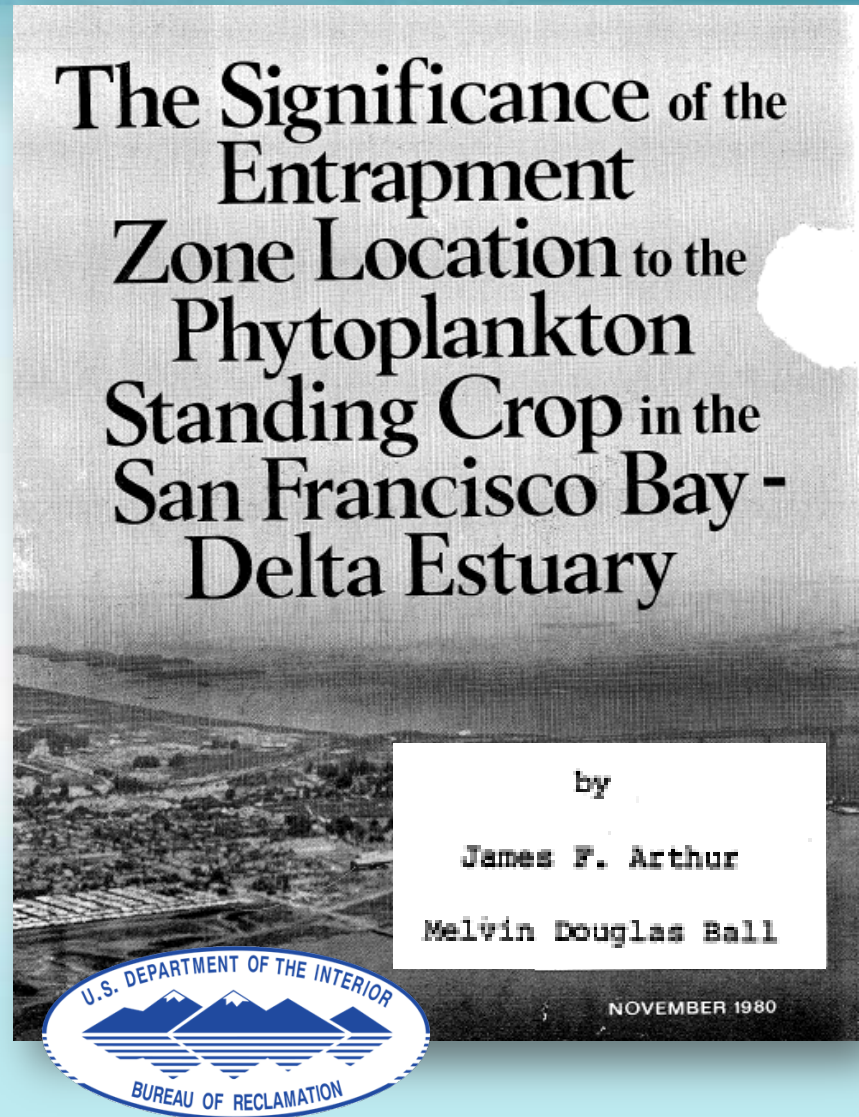
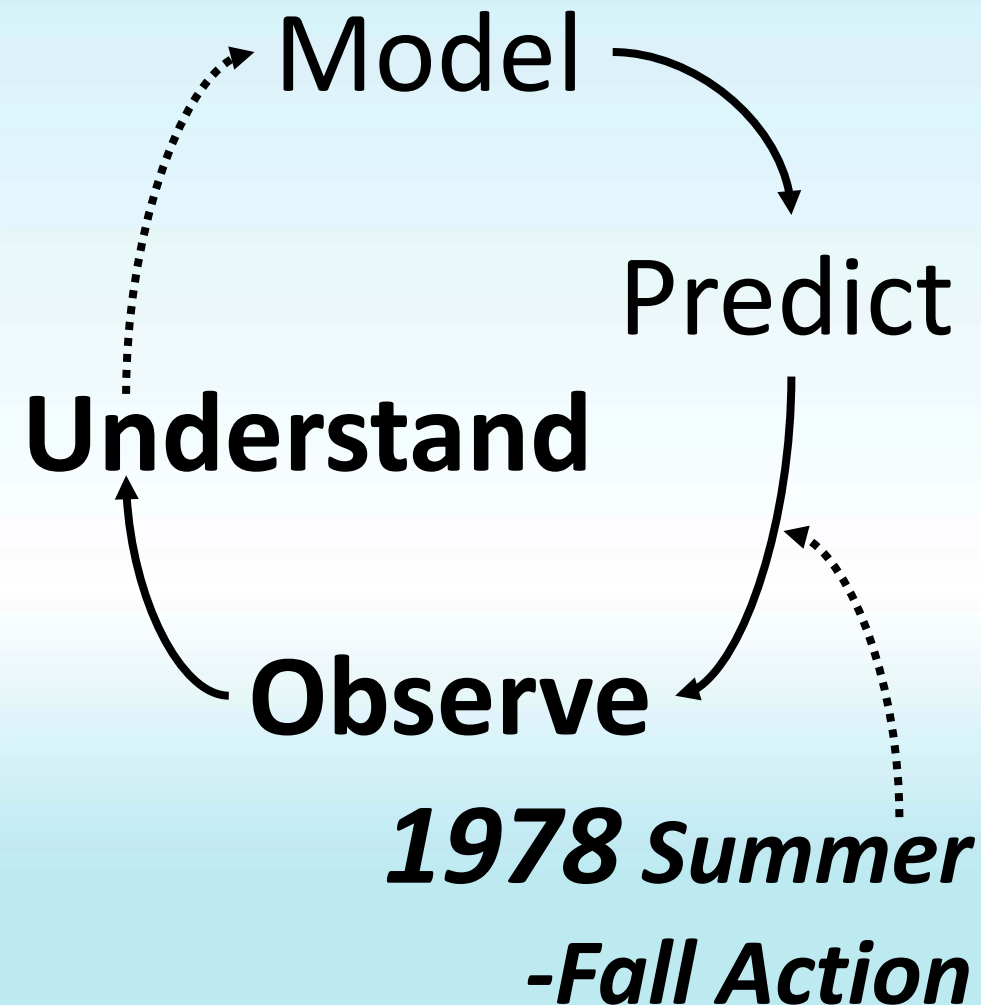
# Assess, Report Changes



FLaSH Independent Review Panel (2012):  
“It was an **impressive mobilization** of field researchers that demonstrated **professional, collegial collaboration** among different research groups working toward a common goal”



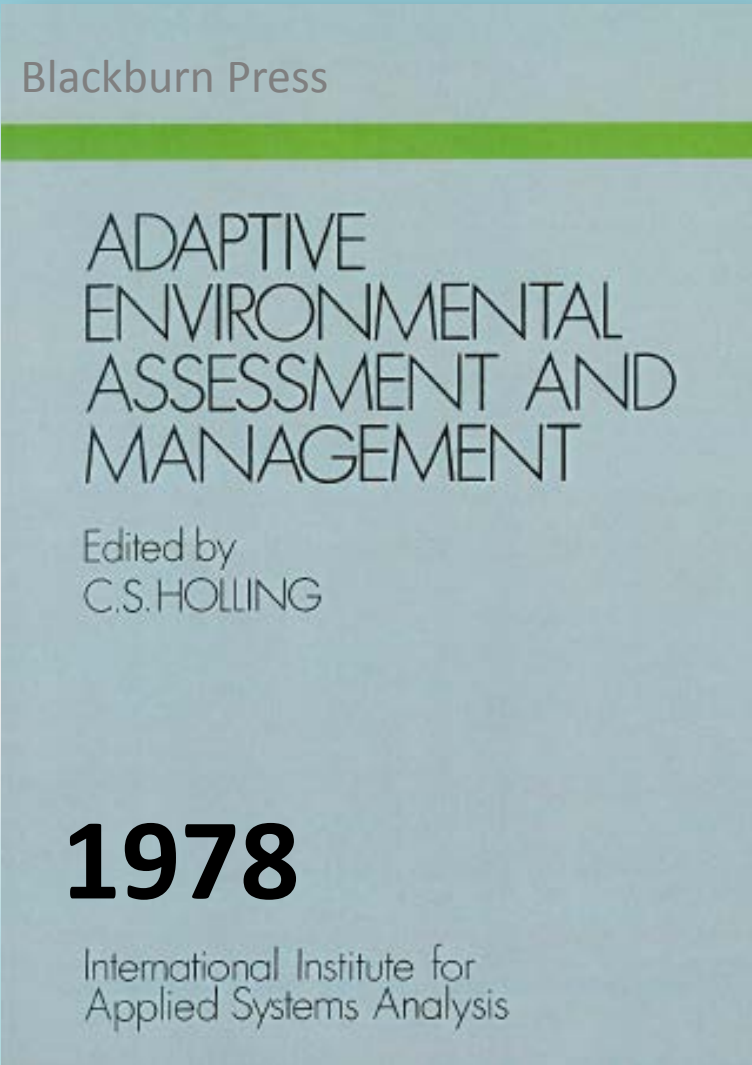
# 1978 Experiment





# 1978: “Adaptive Management”

If “we don’t know enough to do what we want to do,” we should do everything as experiments; surprises are opportunities for learning

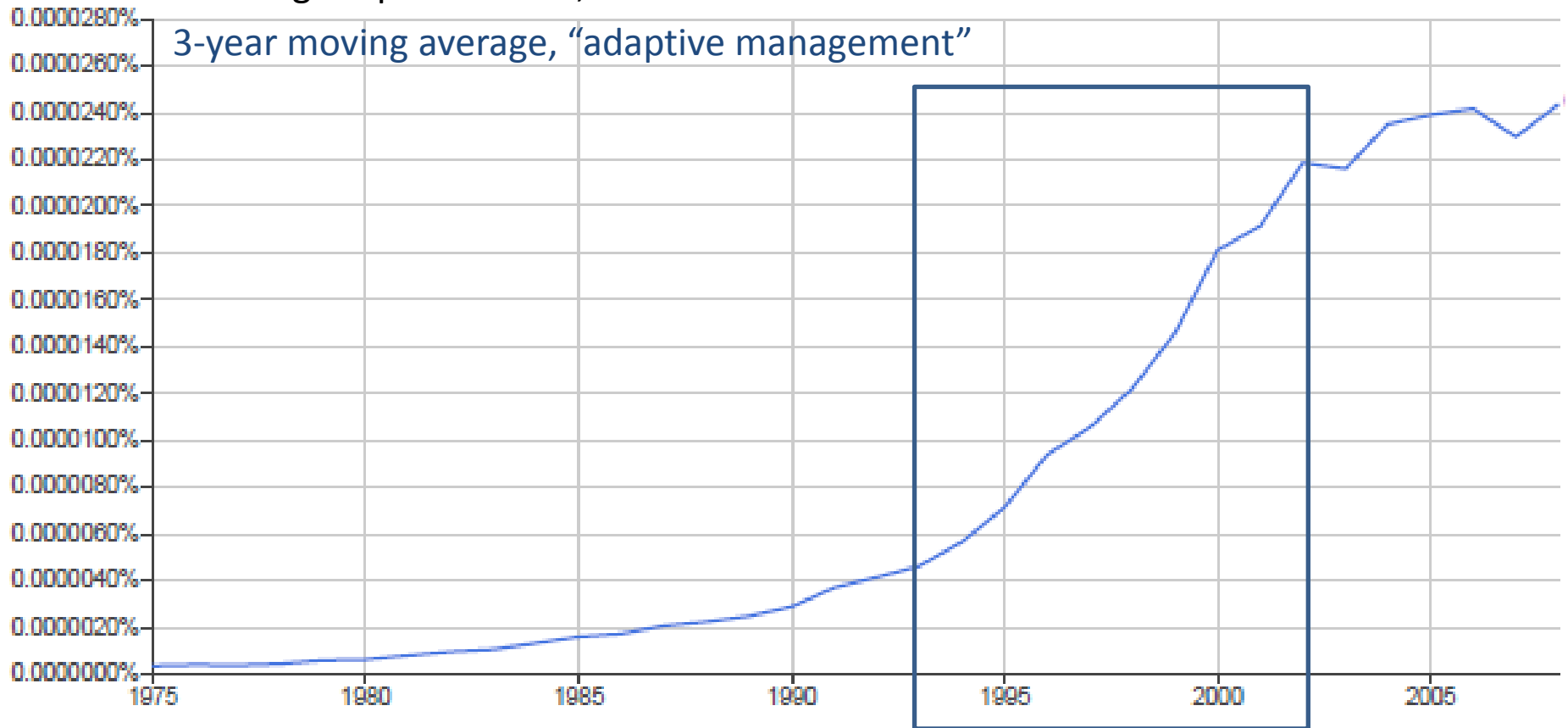




# Adaptive Management

% in English publications, 1975-2008

3-year moving average, "adaptive management"



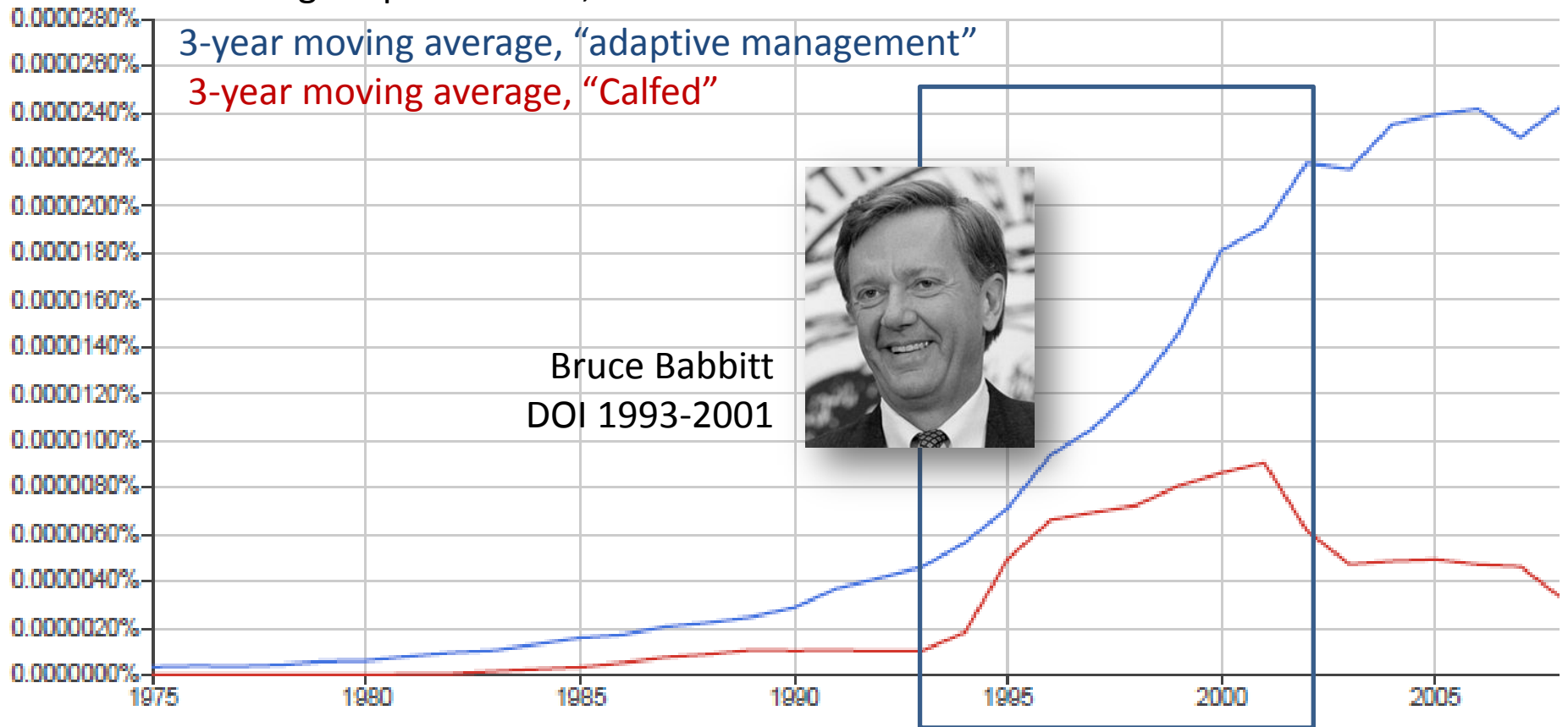


# Adaptive Management

% in English publications, 1975-2008

3-year moving average, "adaptive management"

3-year moving average, "Calfed"

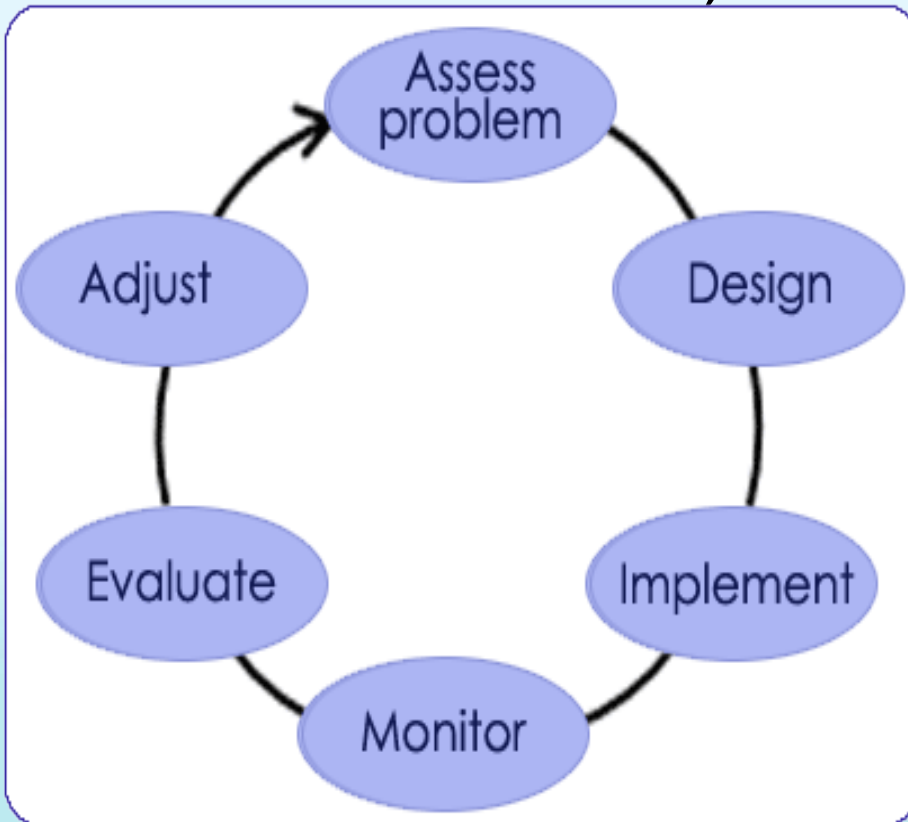




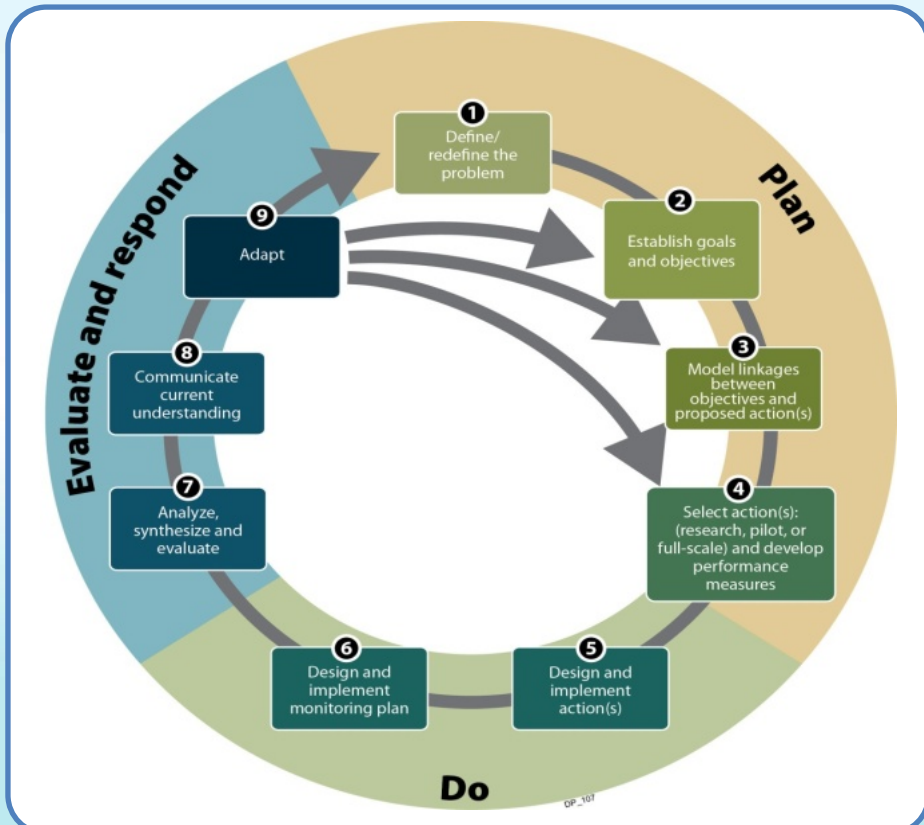
# 3. CA Terraforming 2.0

Let's experiment – and learn!

DOI Tech. Guide 2007, 2009

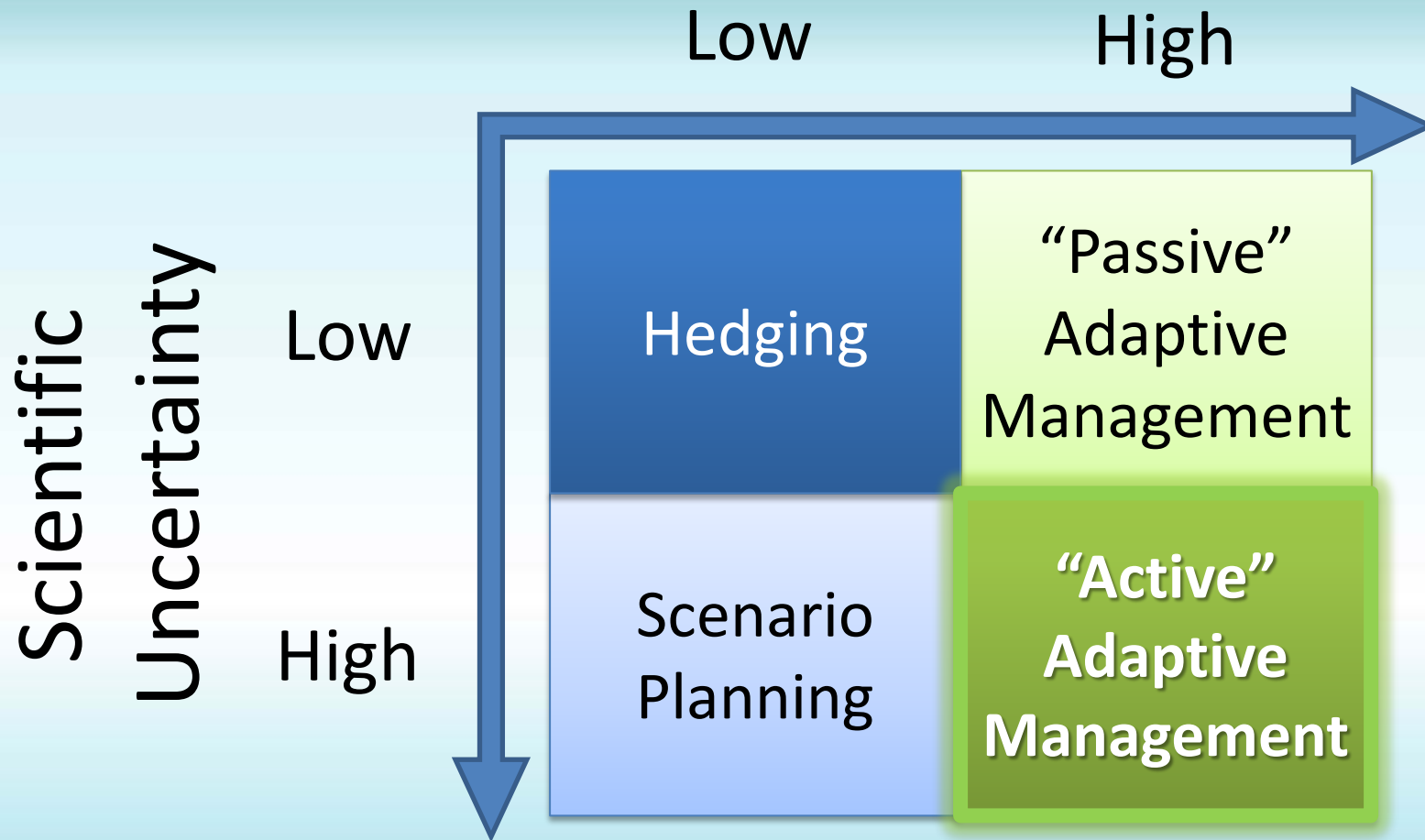


DSC Delta Plan 2013



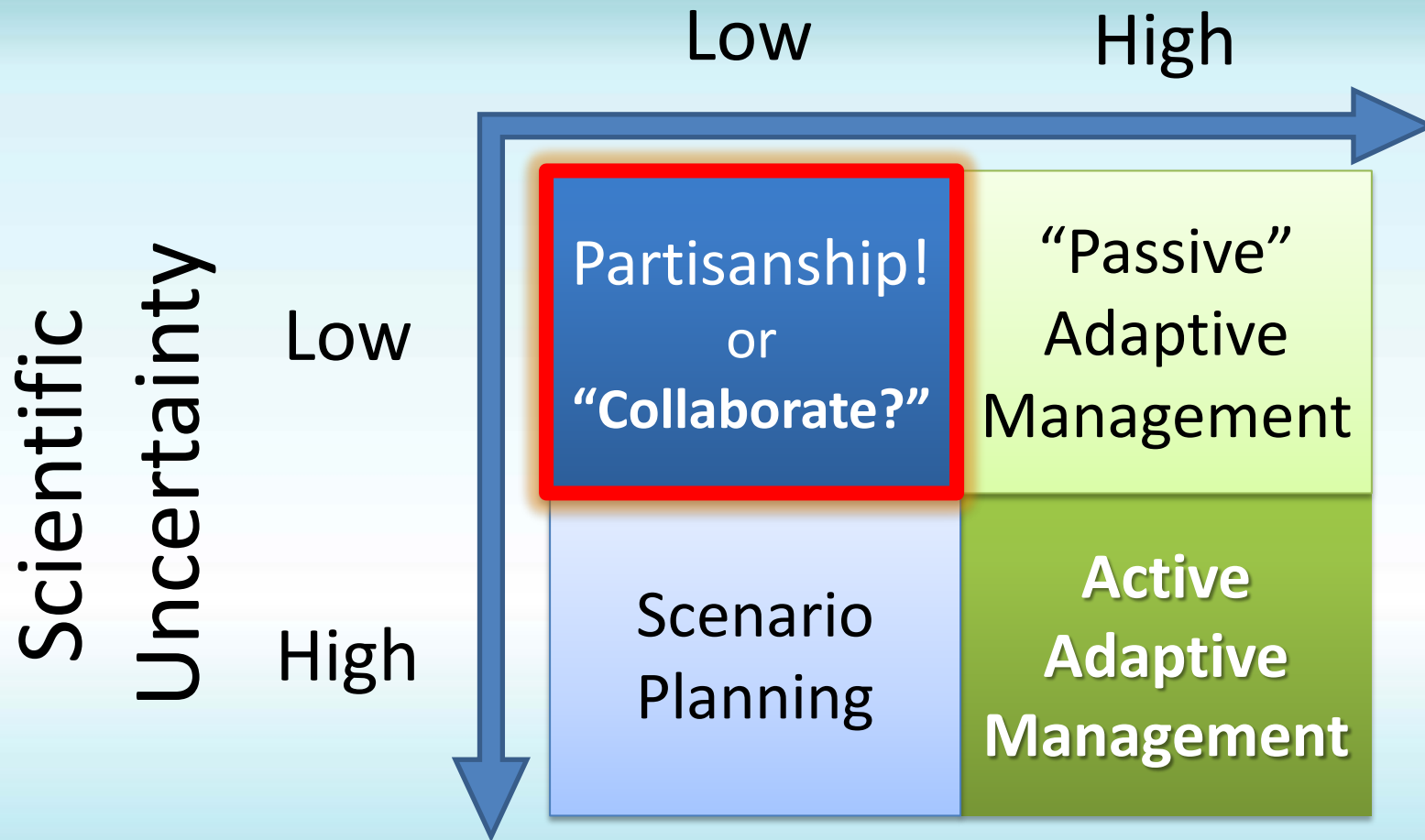


# AM needs Controllability





# and Agreement on Goals





# Collaborative Adaptive Management



- Credible
- Relevant
- Legitimate

Scarlett 2013





# “Collaborate”

1. work jointly on an activity, especially to produce or create something

synonyms: cooperate, join forces, team up, band together, work together, participate, combine, ally



# “Collaborate”

1. work jointly on an activity, especially to produce or create something

synonyms: cooperate, join forces, team up, band together, work together, participate, combine, ally

2. work traitorously with an enemy

synonyms: collude, conspire, fraternize, consort, sympathize



# “Collaborate”

1. work jointly on an activity, especially to produce or create something

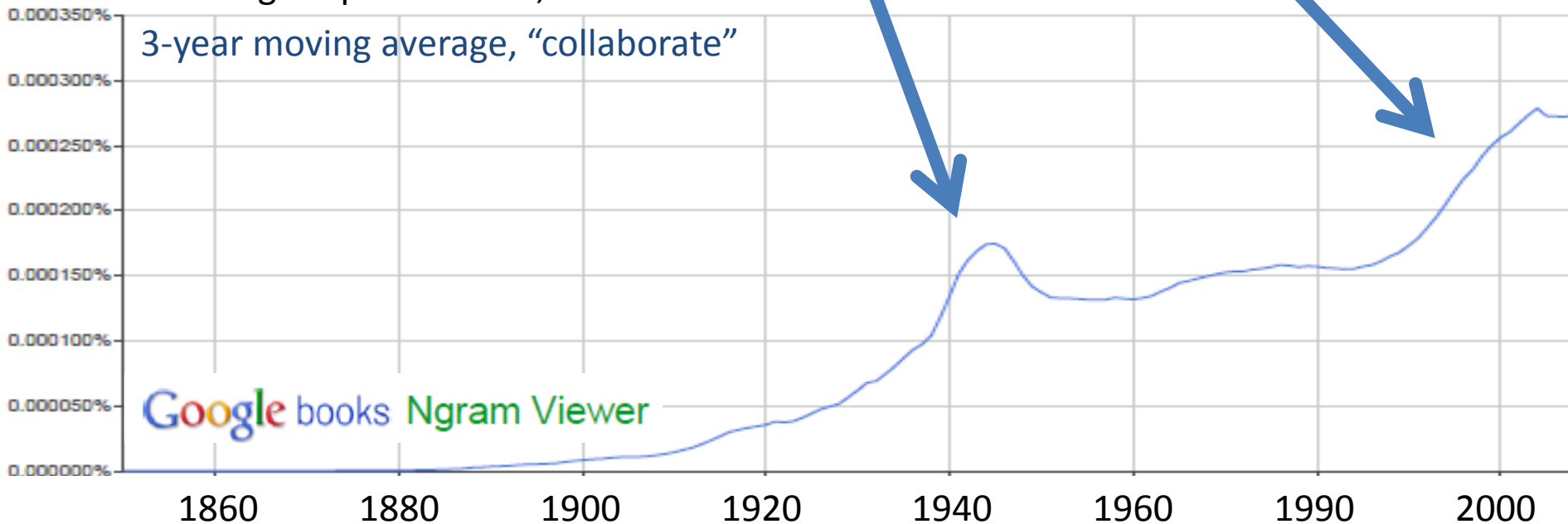
synonyms: cooperate, join forces, team up, band together, work together, participate, combine, ally

2. work traitorously with an enemy

synonyms: collude, conspire, fraternize, consort, sympathize

% in English publications, 1850-2008

3-year moving average, “collaborate”





# “Cooperate”

1. act or work with another or others
  2. associate with another or others for mutual benefit
- synonyms: collaborate, band (together), concur, conjoin, conspire, join, league, team (up), unite, make common cause, play ball, pull together





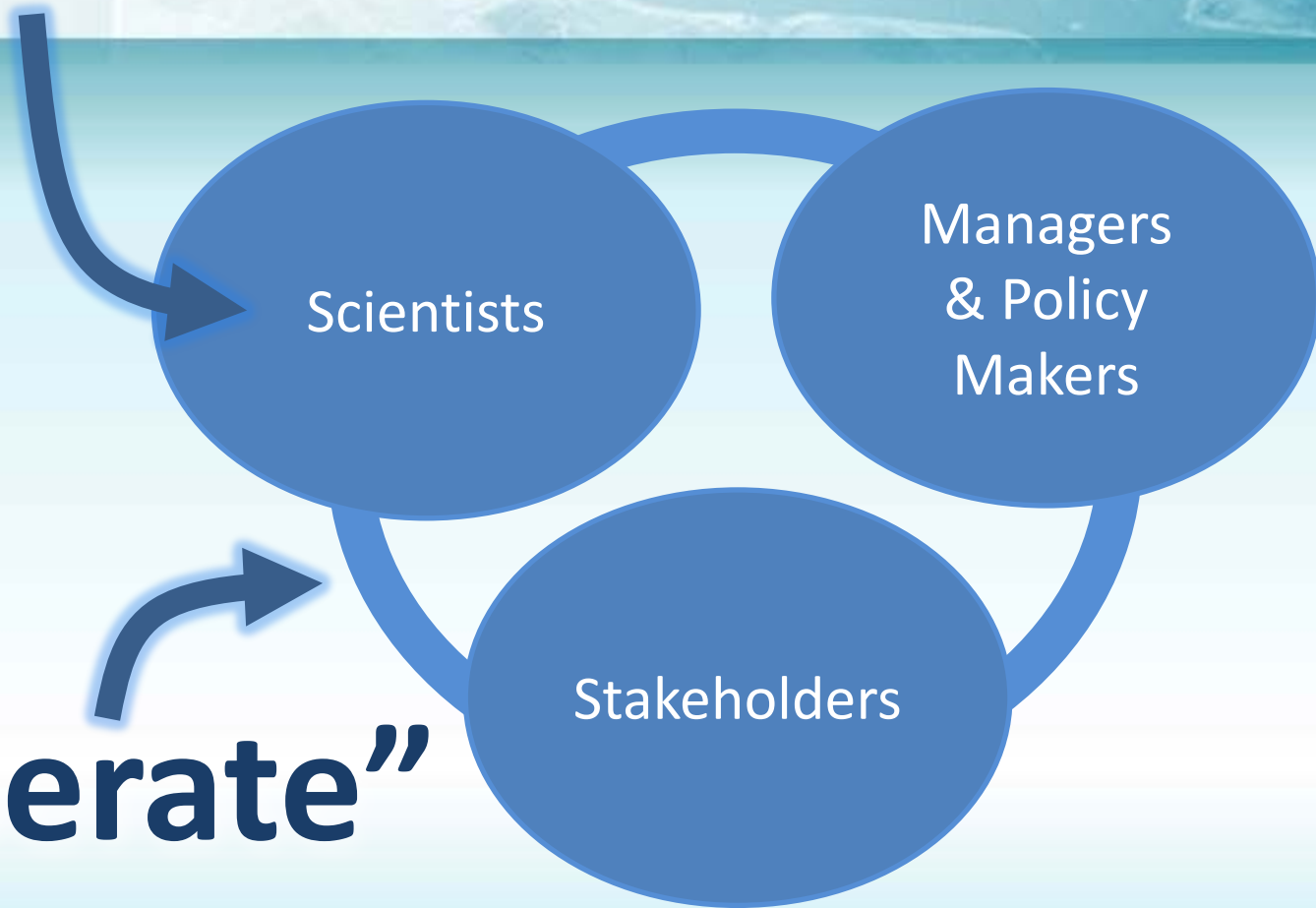
# “Collaborate” (one score)



# “Cooperate” (independent scores)



# “Collaborate”



# “Cooperate”



Interagency  
Ecological Program



Delta Science Program  
Delta Stewardship Council





# “Collaborate”

Lead Scientist(s)

*“One Delta,  
One Science”*

Scientists

Managers  
& Policy  
Makers

Stakeholders

# “Cooperate”

Delta Stewardship Council



Interagency  
Ecological Program



Delta Science Program  
Delta Stewardship Council





# It's going to take All OUR brains!

to know enough --- Science

to do --- Management

what we want  
to do here --- Policy

***Let's make connections –  
We are smarter than me!***



Interagency  
Ecological Program



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