Workshop on Large-scale Adaptive Management

Adaptive Management of Large-Scale Ecosystems in California

Peter Goodwin

with contributions from many . . . .

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

IAHR AIRH
International Association for Hydro-Environment Engineering and Research
Supported by
Spain Water and IWHR, China

C.P. Snow

Godkin Lecture, Harvard University, 1960

Let me say at once that I have no easy answers at all. If there were any easy answers, they would have been found by now. The whole problem is an intractable one, one of the most intractable that organised society has thrown up. It is partly the expression, in political and administrative terms of the split between two cultures that I have said something about elsewhere.[42]

Primary Points

1. Champions
2. Common Expectations
3. Complexity and Scale
4. Governance and ‘science to inform policy’ – when is science good enough?
5. Performance Metrics and Recognition

Other Critical factors:

- funding
- building and sustaining the human capital

1. Champions

- Committed to a vision
- Influential
- Beyond conventional thinking
- Courage

A success story: challenged by unusual conditions

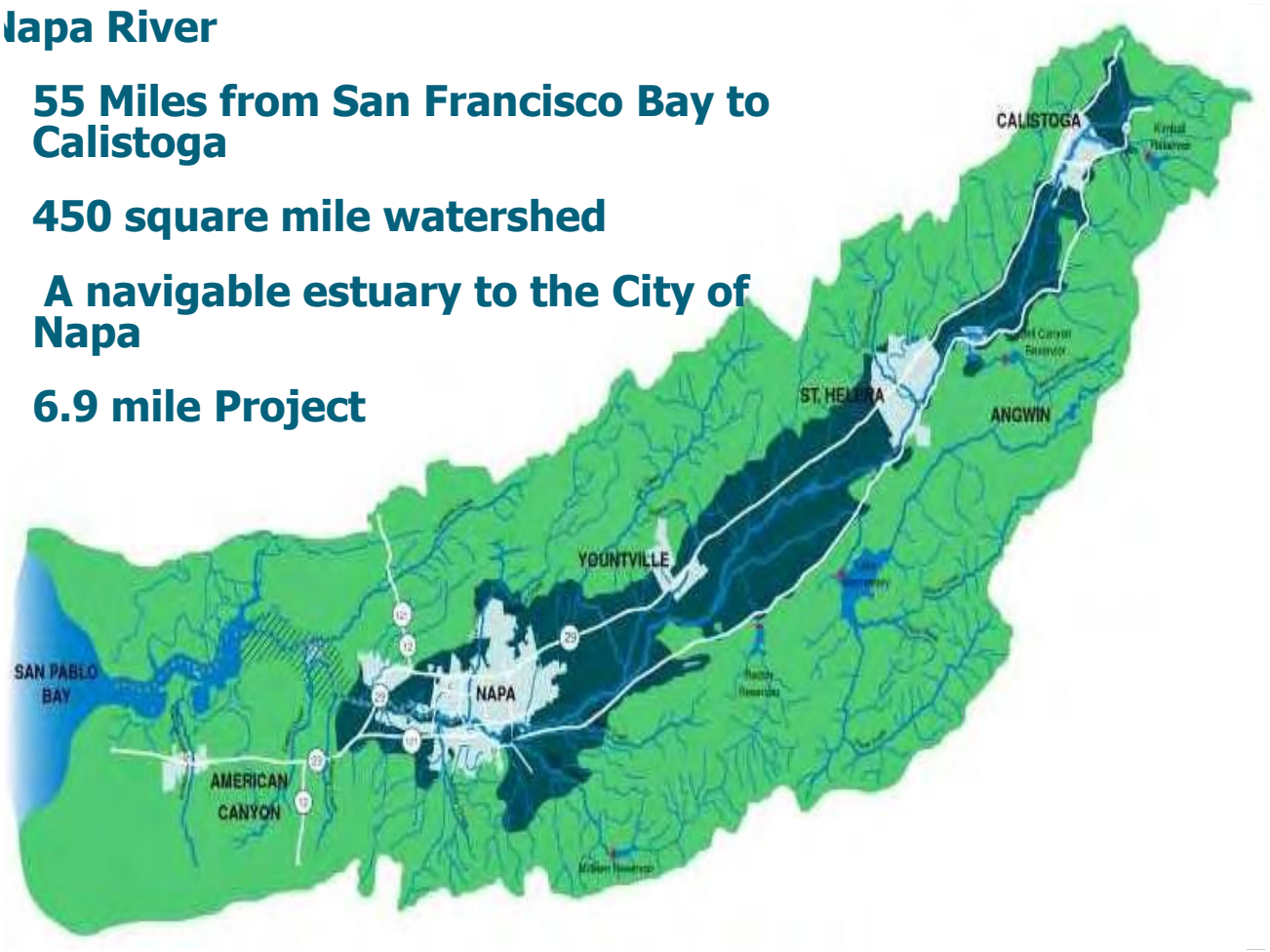
Napa River

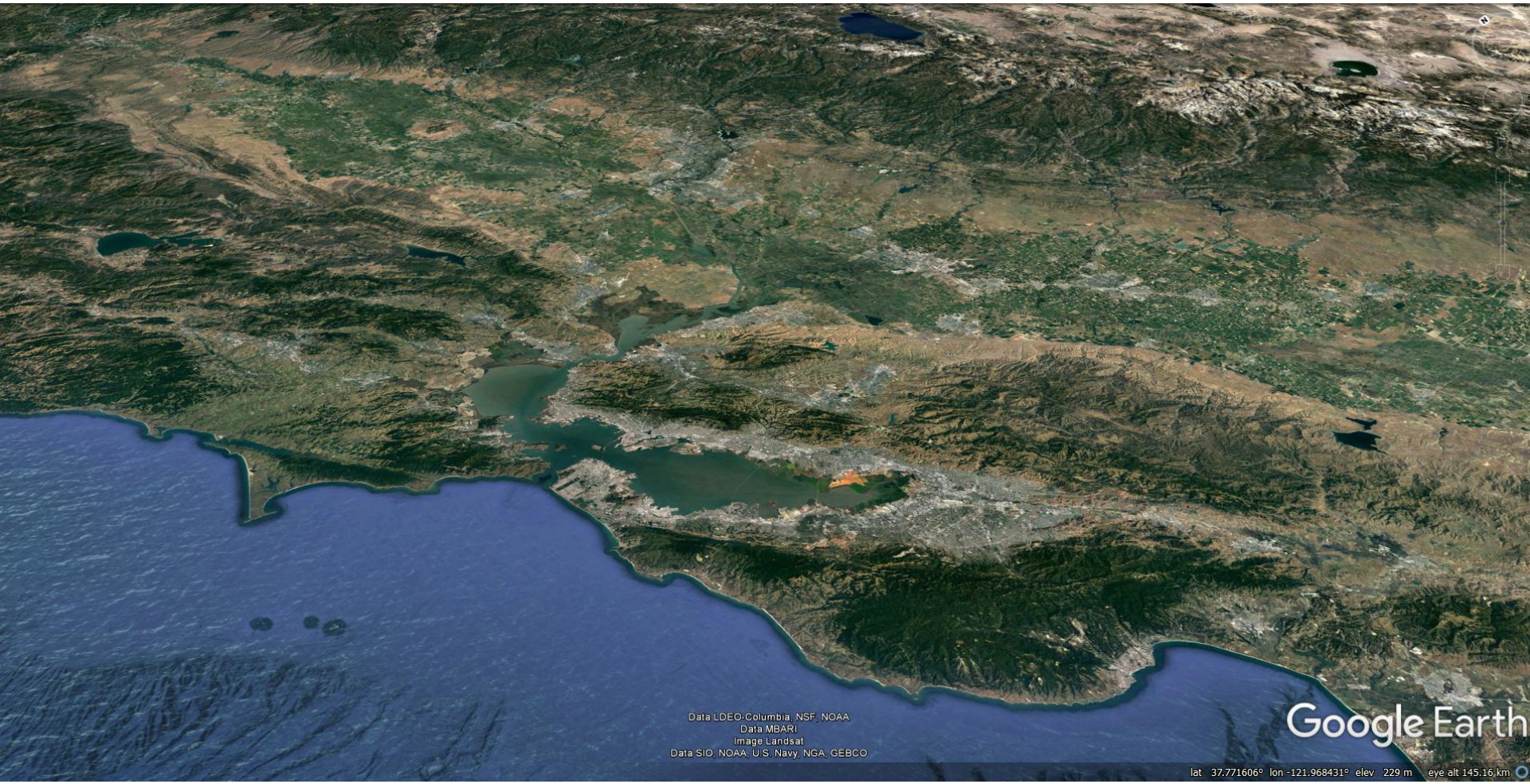
55 Miles from San Francisco Bay to Calistoga

450 square mile watershed

A navigable estuary to the City of Napa

6.9 mile Project

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Data MBARI
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth
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27 major floods in past 120 years


1 8 2003

COMMUNITY COALITION FORMED

27 local stakeholder groups and 24 agencies

Napa to tame river by letting it run free

3-5-98 West Ans

■ Voters approve a historic tax measure that aims to reduce flooding through natural methods

By Denis Cuff
and John Simerman
TIMES STAFF WRITERS

NAPA — Flood fighters in the West tamed their creeks and small rivers by deepening and narrowing them with dredgers and concrete.

Voters in this historic wine county bucked that tide Tuesday when they approved a precedent-setting flood project to make the unruly Napa River wider and more natural with room to meander without sloshing into bedrooms and stores.

Planners and politicians predict Napa County will lead California on a new path to minimize flooding by letting rivers run a little freer and making people do more to stay out of the way.

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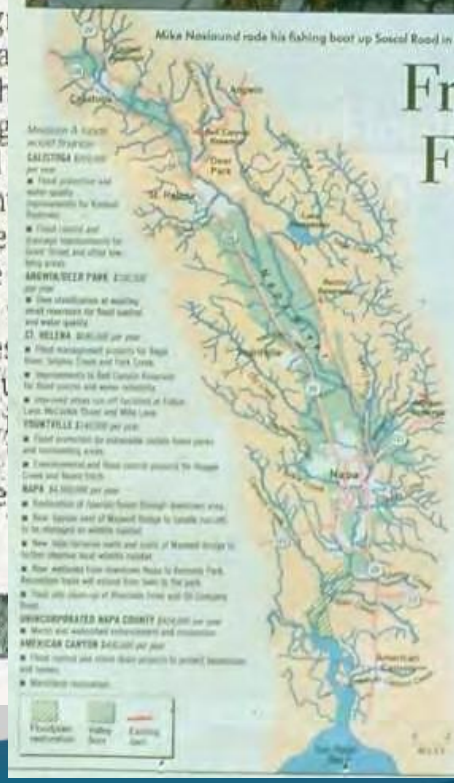
Mike Nastaund rode his fishing boat up Soscol Road in Napa, which has suffered repeated inundations



Freeing Napa From Floods

Unique river plan goes before voters

By Glen Martin
Chronicle Staff Writer

Napa County residents who have had it up to here with perennial flooding are preparing to vote tomorrow on a revolutionary plan that could end their woes once and for all — and restore the sickly Napa River in the process.

If approved by a two-thirds majority vote tomorrow, Measure A, also known as the Napa County flood protection and watershed management plan, could make the Napa Valley virtually immune to catastrophic floods.

It would also restore wetlands, forests and fish and wildlife to the river, which has suffered greatly from decades of urban growth and intensive viticulture.

The measure will raise $6 million annually for the next 20 years through a sales tax amounting to one half cent on every dollar.

What makes the plan unique, its advocates say, is the emphasis on river restoration, not destruction. Traditional flood control projects involve channelling rivers and creeks, confining them in straitjackets of concrete.

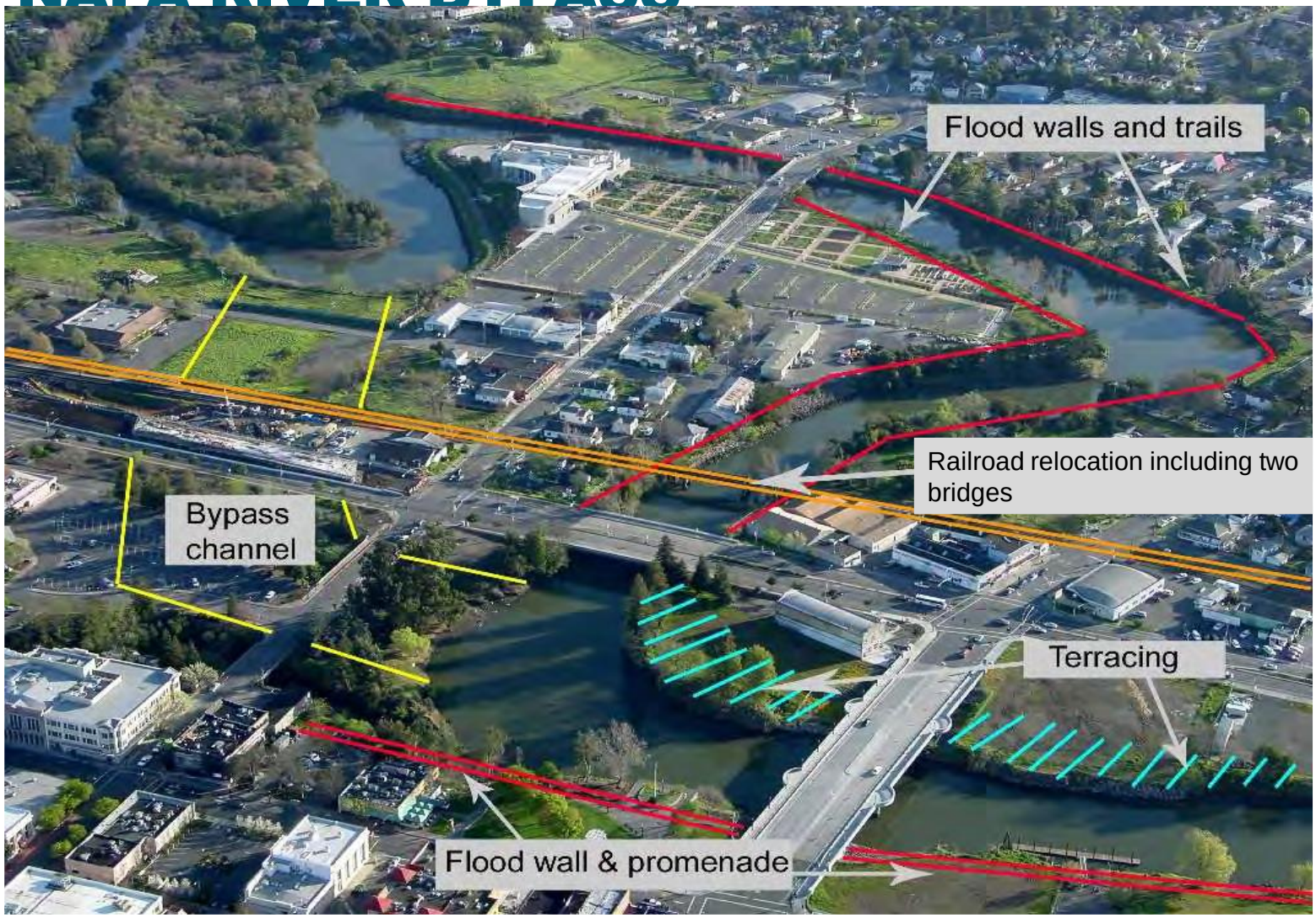
By contrast, the Napa River plan would achieve its primary ends by restoring marshlands and riparian forest. The use of

NAPA, Page A16 Col 1

Bridge raised, maintained historic and aesthetic quality

Creation of 659 acres of wetland, mudflat and open water

NAPA RIVER BYPASS

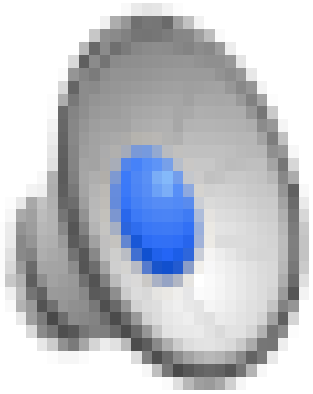


Napa Floodplain Restored

California Drought 2012-16

2017 Wettest Winter in Recorded History

Very Dry summer



Fundamental Question:
will the ecosystem recover or was the fire a tipping point?

2. Common Expectations

2. Common Expectations

Photograph courtesy of Minette Lane

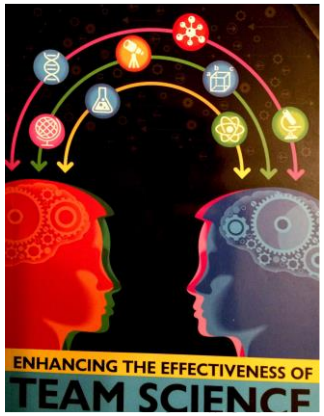
Change is the only constant

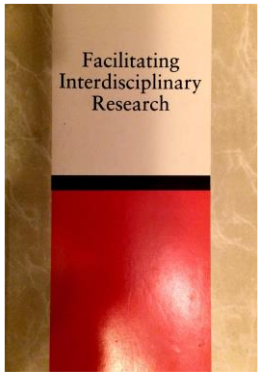
'Stationarity is Dead' Milly et al. , 2008

We can no longer rely solely on the past to predict future conditions

Pressures include:
Climate change
Shifting land-use patterns
Population growth

Invasive species

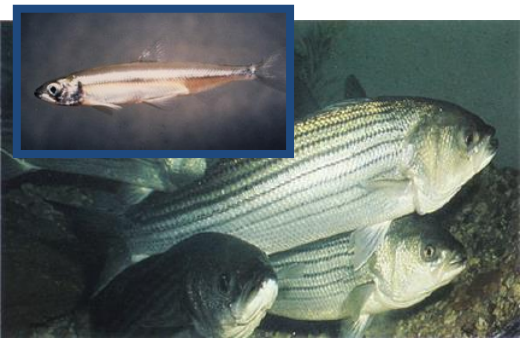


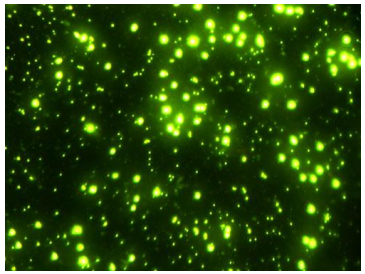


System complexity (Wim Kimmerer)

Number of species in Delta ~

1 × 30 × 35 × 50 × 1000!

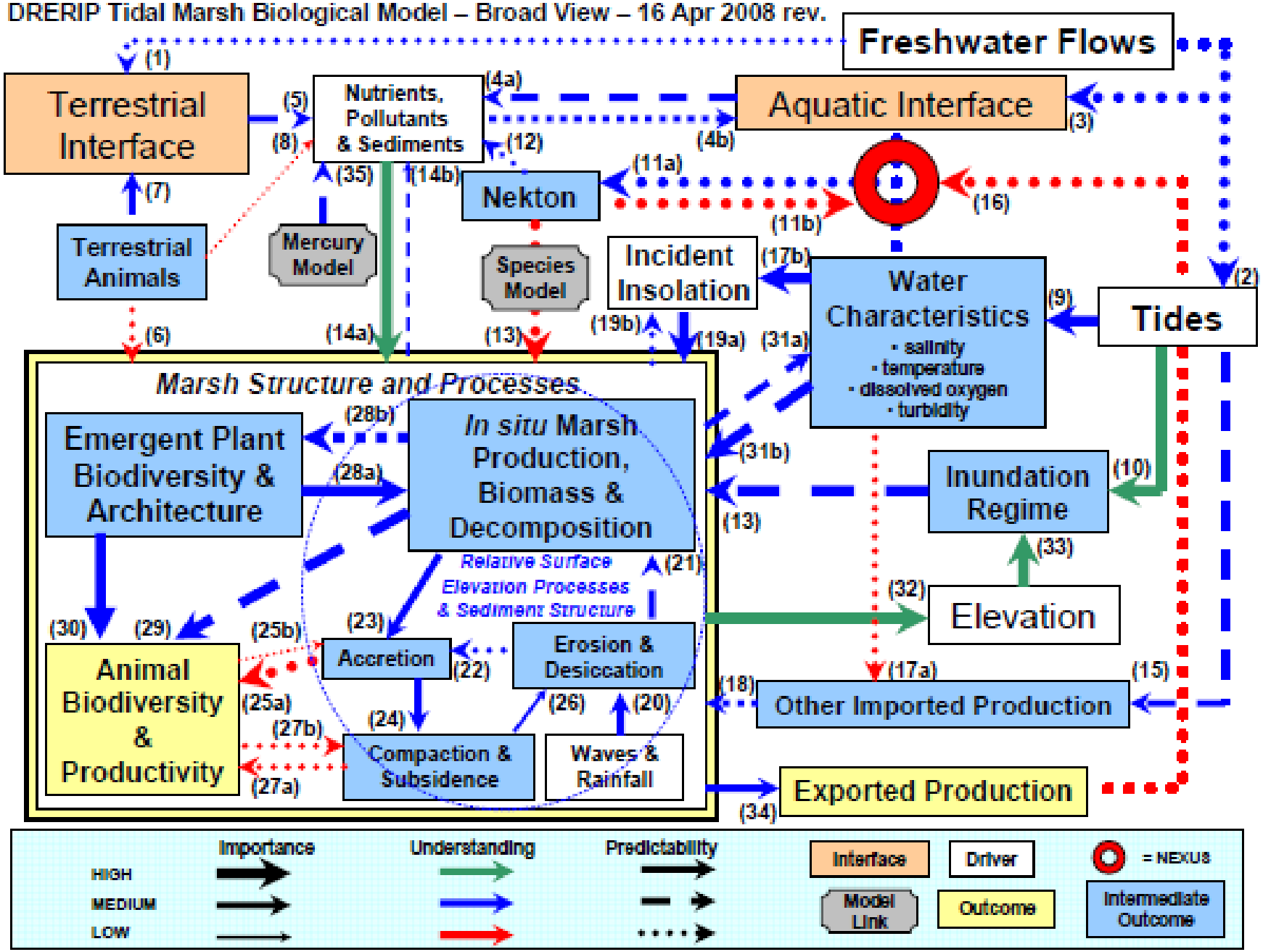


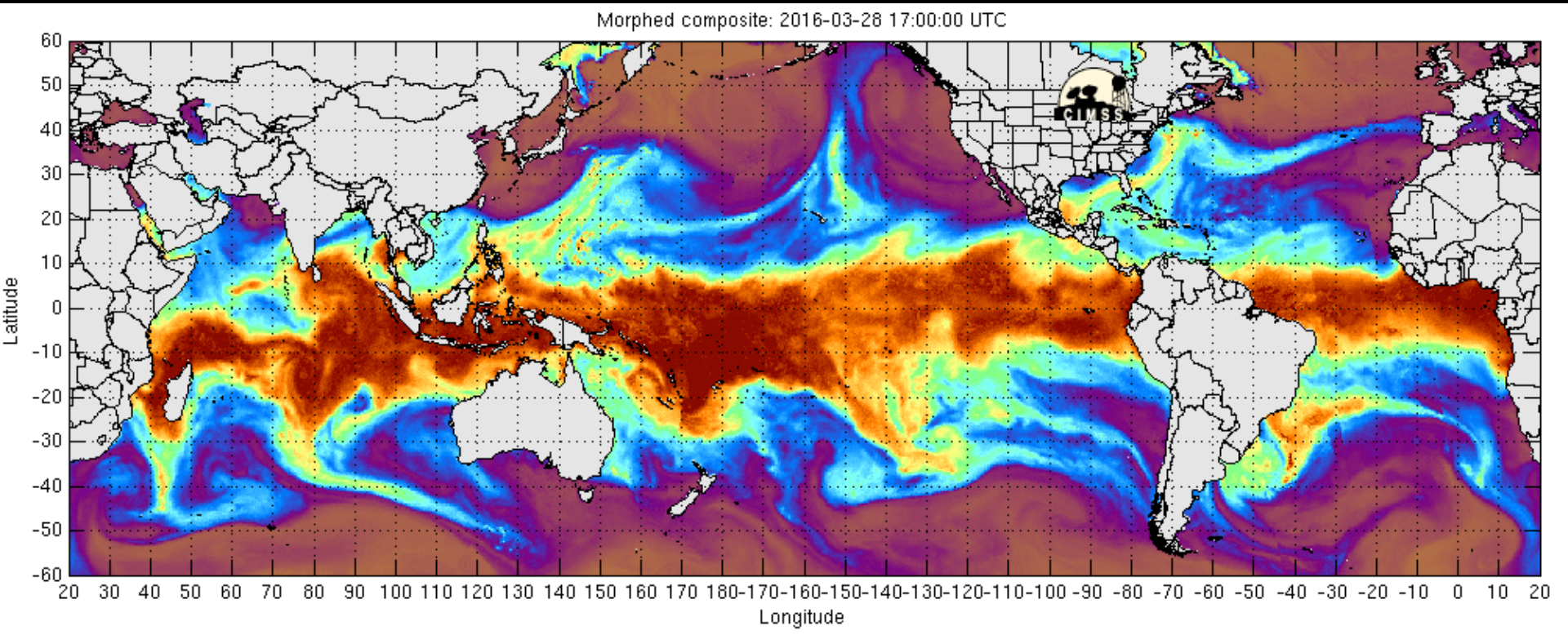
Number of Individuals in Delta ~

10^8 10^{10} 10^{12} 10^{15}

And they can all interact!! Potential *Chaotic Systems*



Kneib *et al.* 2008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CIMSS

3. Complexity and Scale

Unknown

Tidal Marsh Profile

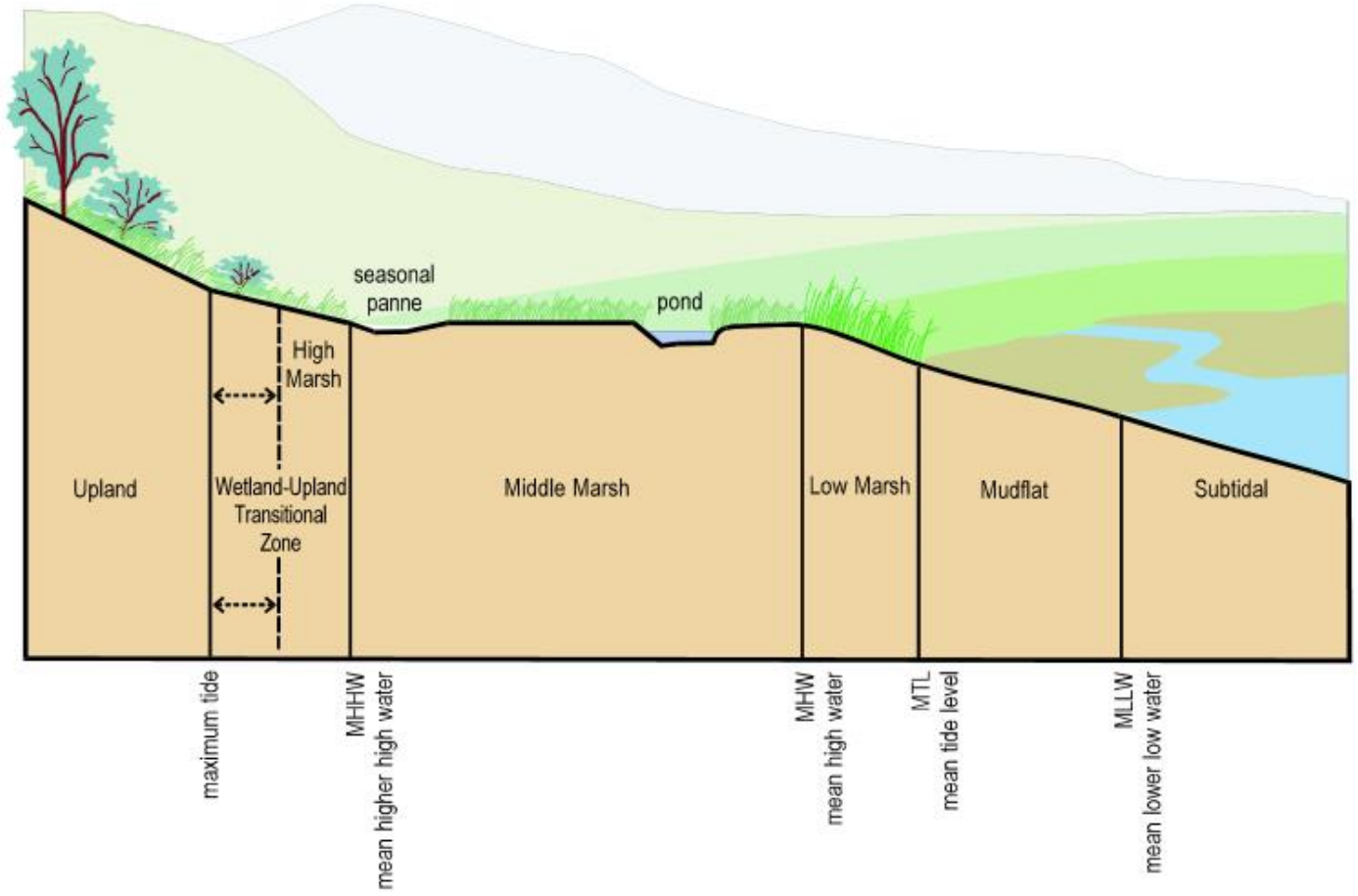


figure 2

Note:
The landward boundary of the high marsh shifts from year to year within the wetland-upland transition zone.

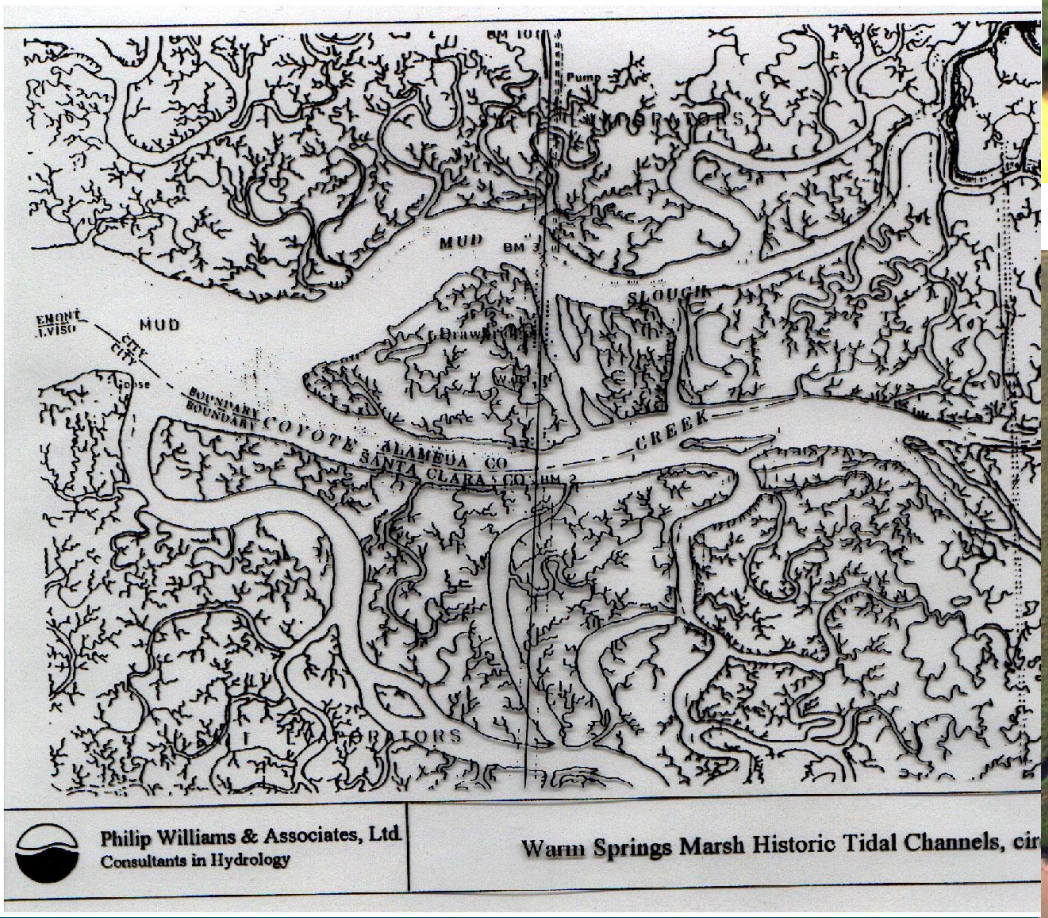
Tidal Wetland Restoration Handbook

Vertical Profile of Tidal Marsh

1632/VertProfileTdlMrsh.cdr

PWA

Historic Marsh
US Coast and Geodetic Survey
c. 1870

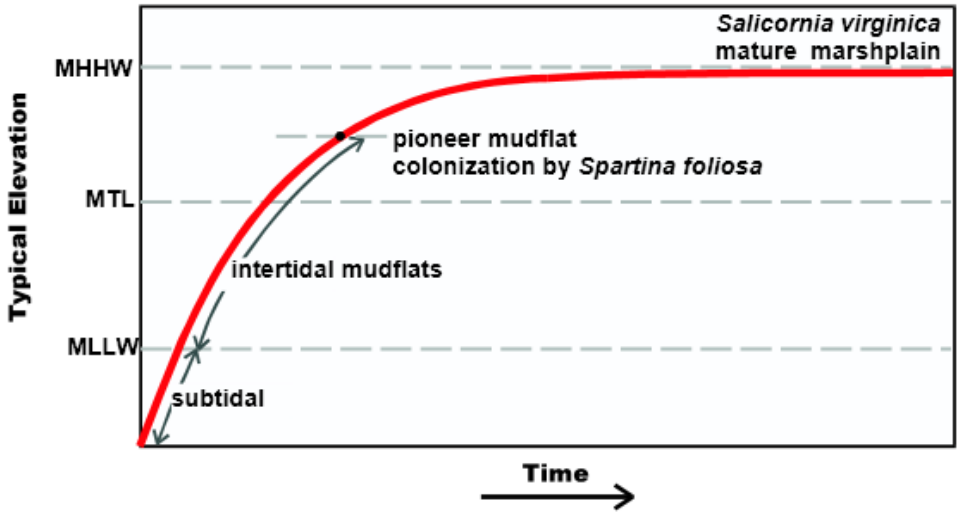


Ancient Marsh – about 2500 old

Modern Marsh – 1920s

Tidal Marsh Evolution

Muzzi Marsh, 1980



Muzzi Marsh, 1984

Muzzi Marsh, 2003

Tidal Wetlands Restoration

Third Generation -1990s

- Refinement of models, data collection, databases of characteristics, interpretation
- Designs much closer to dynamic equilibrium
- Examples: Delaware Bay, San Dieguito Lagoon, Sonoma Baylands
- Adaptive management

Tidal Wetlands Restoration: Fourth Generation

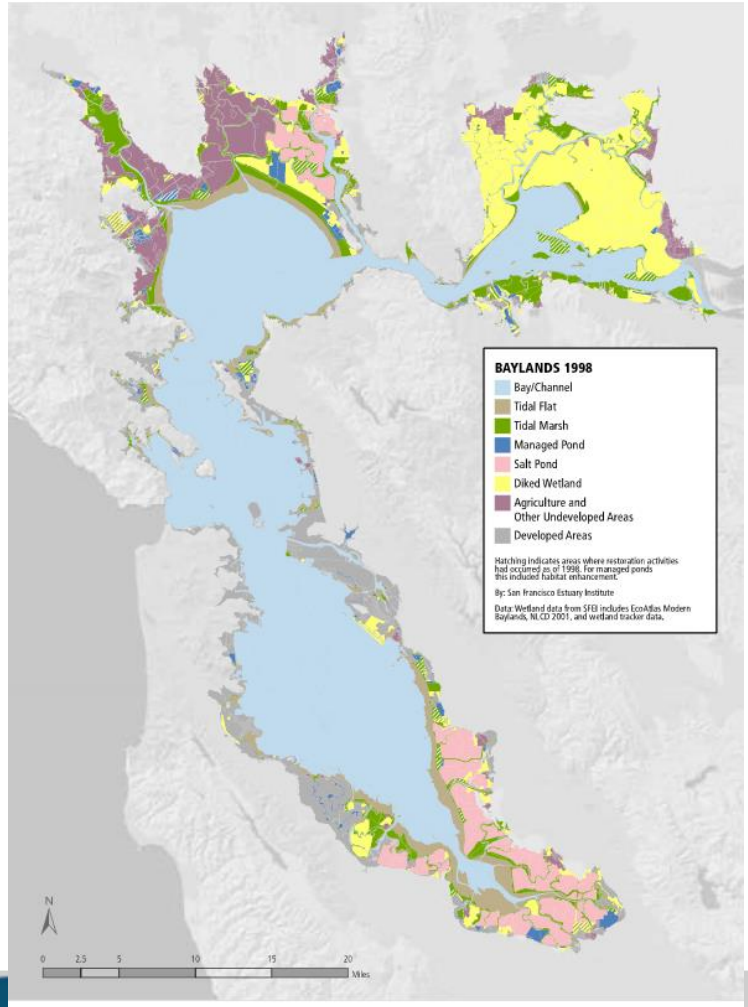


Figure 5 Baylands habitats in 1998. See box 2 for more detail about the data and assumptions for this map.

- Landscape Ecology
- Historical Ecology
- Not to 'restore' since landscape irreversibly altered
- Understand key process to restore ecosystem function
- Mosaic of habitats
- Scale to restore processes

Baylands Climate Change Update, 2015

3. Complexity and Scale

What do we mean by natural flows in complex and irreversibly altered systems?

Novel ecosystems (Moyle, 2014): resilient and desirable

Landscape ecology vs cumulative projects

Yarnell, S.M. et al. 2015. *Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities* BioScience 2015. doi: 10.1093/biosci/biv102

4. Science to inform Policy

Time-frame to inform management decisions

Mark Cowin, Director, California Department of Water Resources

When is good science good enough?

John Wiens, Independent Science Board. Delta Science Program

Polymath or Translators

Expert Panel on Adaptive Management, BDCP and NRC Recommendations

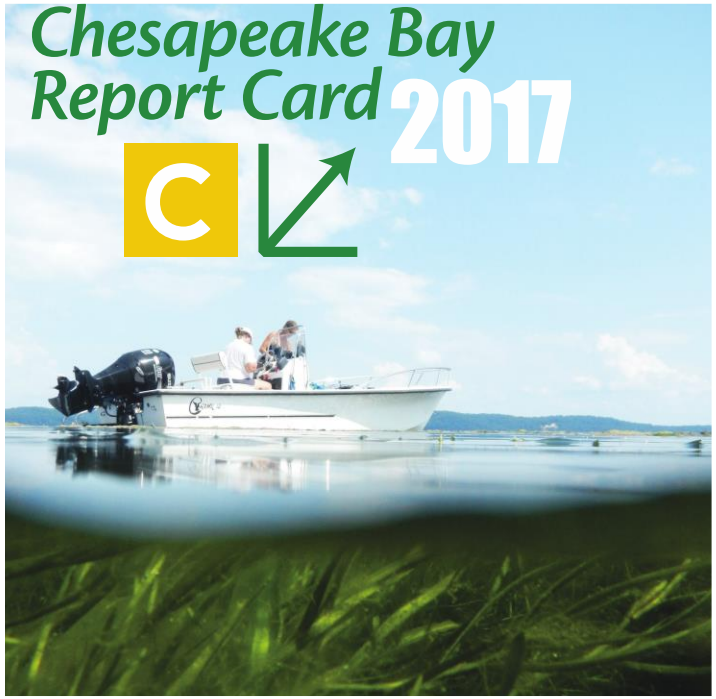
Who has responsibility and who has authority?

Universal challenge.

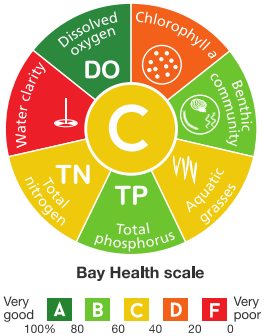
Other challenges include:

- Agencies are mission-bound
- Perturbations that induce significant change
- Environmental research is a journey not a destination – but '*experimentation*' is not embraced by legislatures!
- Sustained commitment to resources is needed
  - monitoring
  - SYNTHESIS with the right team
  - communication

5. Performance Metrics and Recognition



Bay health is moderate overall



The overall score for the Chesapeake Bay Health Index for 2017 was 54%, the same score as 2016. Bay-wide, dissolved oxygen continued to be the best scoring indicator with an 89% in 2017, an A. Aquatic grasses scored a C- (44%), improved from last year's D+ (39%). Water clarity scored an F (17%), a decrease from last year's D- (24%). Benthic community in the bay improved from a C (54%) to a B- (60%). Total nitrogen scored C+ (59%), an improvement from last year's C+ (55%). Total phosphorus scored B+ (76%), declining from an A- (82%) in 2016. Chlorophyll *a* scored D+ (35%), the same as last year.

Total phosphorus, total nitrogen, dissolved oxygen, and aquatic grasses are showing positive and significant improvements. These improvements are encouraging for water quality, and have positive impacts on the ecosystem. Water clarity and chlorophyll *a* have significantly declining trends. Benthic community shows no significant change in health over time.

There are seven indicators that make up the Bay Health Index for the Chesapeake Bay Report Card. Each indicator is compared to scientifically derived thresholds or goals and scored to determine the overall grade.

Where we are seeing improvements

Elizabeth River

2017 Score: C

The Elizabeth River improved from a D to a C in 2017, making this the highest score it has ever received. There were improvements in total nitrogen, chlorophyll *a*, and dissolved oxygen. Over time, this region has a significantly improving trend.

James River

2017 Score: B-

The James River improved from a C+ to a B- in 2017. There were improvements in aquatic grasses, water clarity, and total phosphorus. Over time, this region has a significantly improving trend.

Upper Western Shore

2017 Score: C

The Upper Western Shore improved from a C- to a C in 2017. There were improvements in total nitrogen, total phosphorus, and benthic community. Over time, this region has a significantly improving trend.

Marshland at Paradise Creek Nature Park along the Elizabeth River in Portsmouth, VA. Photo by Chesapeake Bay Program.

A shoreline along the banks of the James River at Presquile National Wildlife Refuge. Photo by USFWS.

The Gunpowder River, part of the Upper Western Shore region. 'Gunpowder River' by Phil Romans used under CC BY.

http://ian.umces.edu/work_with_us/environmental_report_card_production/

Provide unbiased and objective evidence for identifying and defining problems

Advise on selecting the next generation of follow-up actions

Communicate limitations and opportunities of goals and objectives

Specify or develop appropriate conceptual and quantitative models; identify critical uncertainties; develop hypotheses; model alternative actions; identify data necessary to test hypotheses

Communicate new scientific understanding to decision-makers

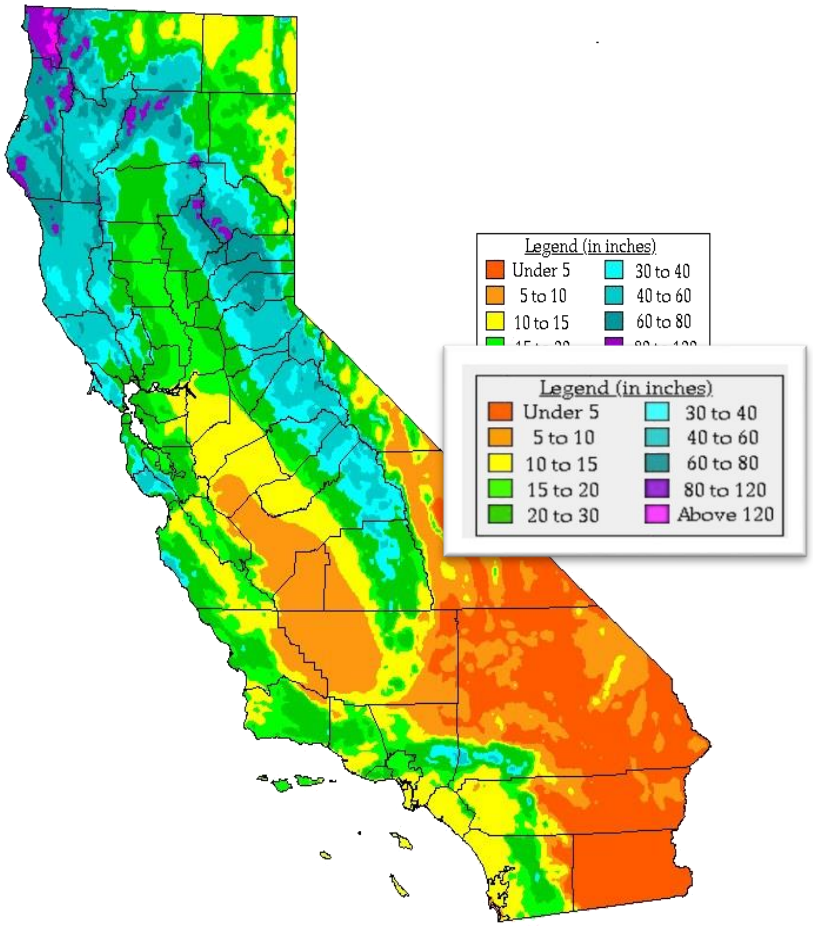
Evaluate alternative actions using information from models and decision support tools (Box 3-2); use models to develop performance measures

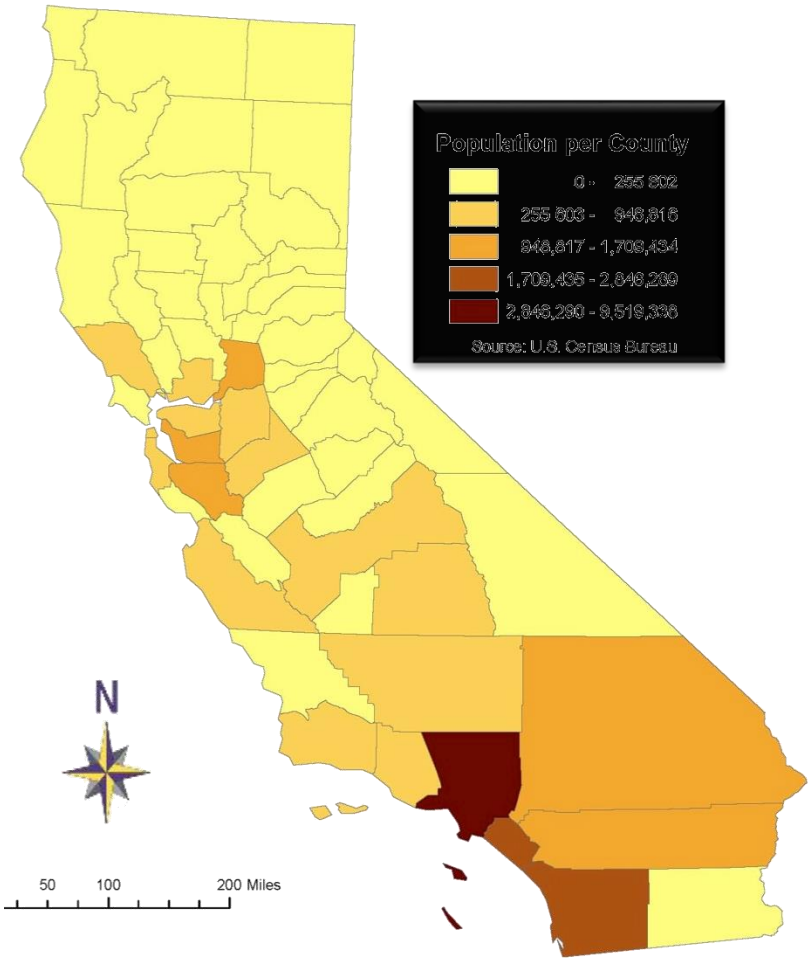
Analyze data, synthesize scientific information, and evaluate progress based on performance measures

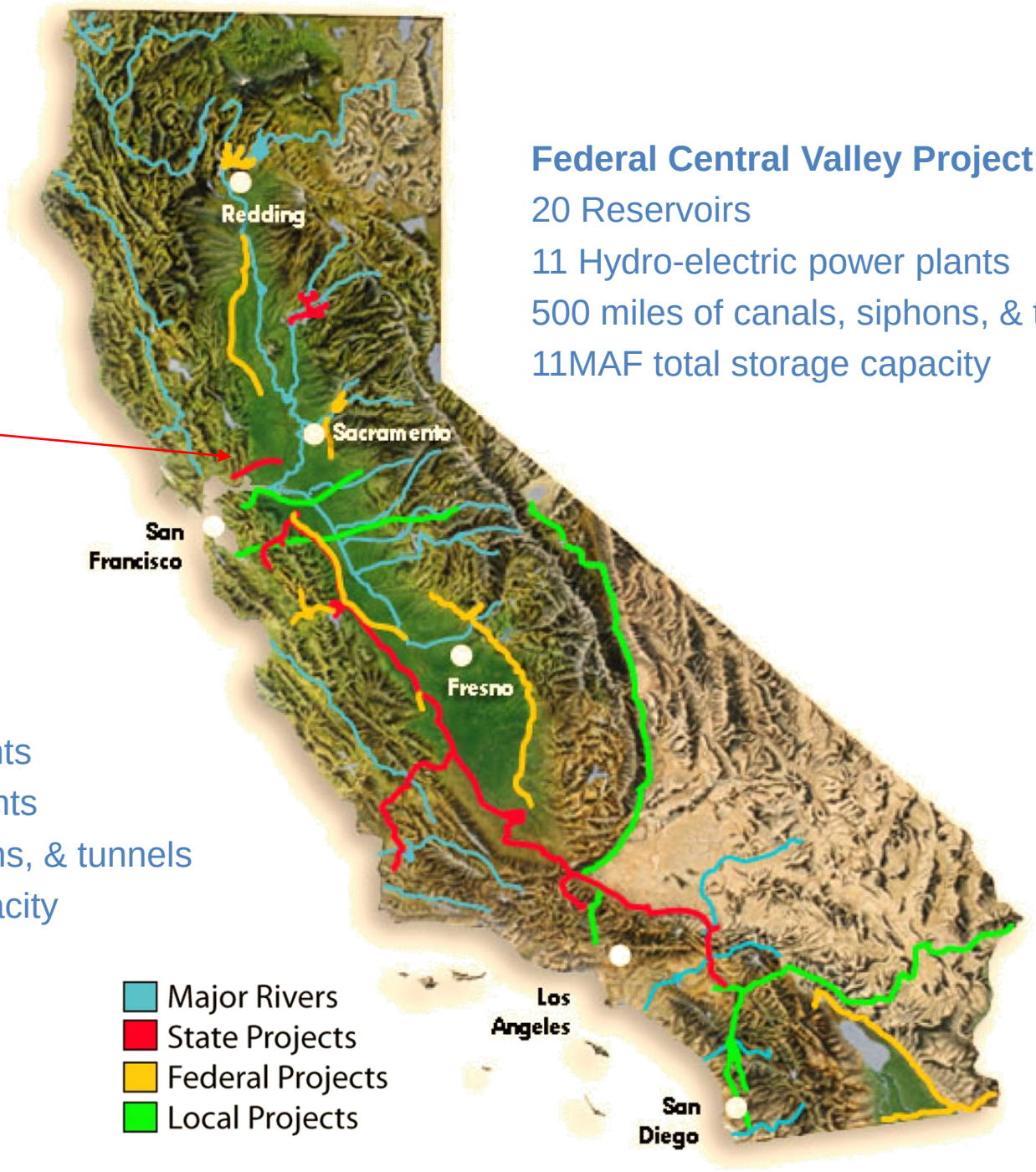
Use models and tiered management questions to design monitoring. Collect, manage and share data.

Design and implement actions to test assumptions and predicted outcomes and reduce scientific uncertainties

California Precipitation and Population







Sacramento-San Joaquin Delta

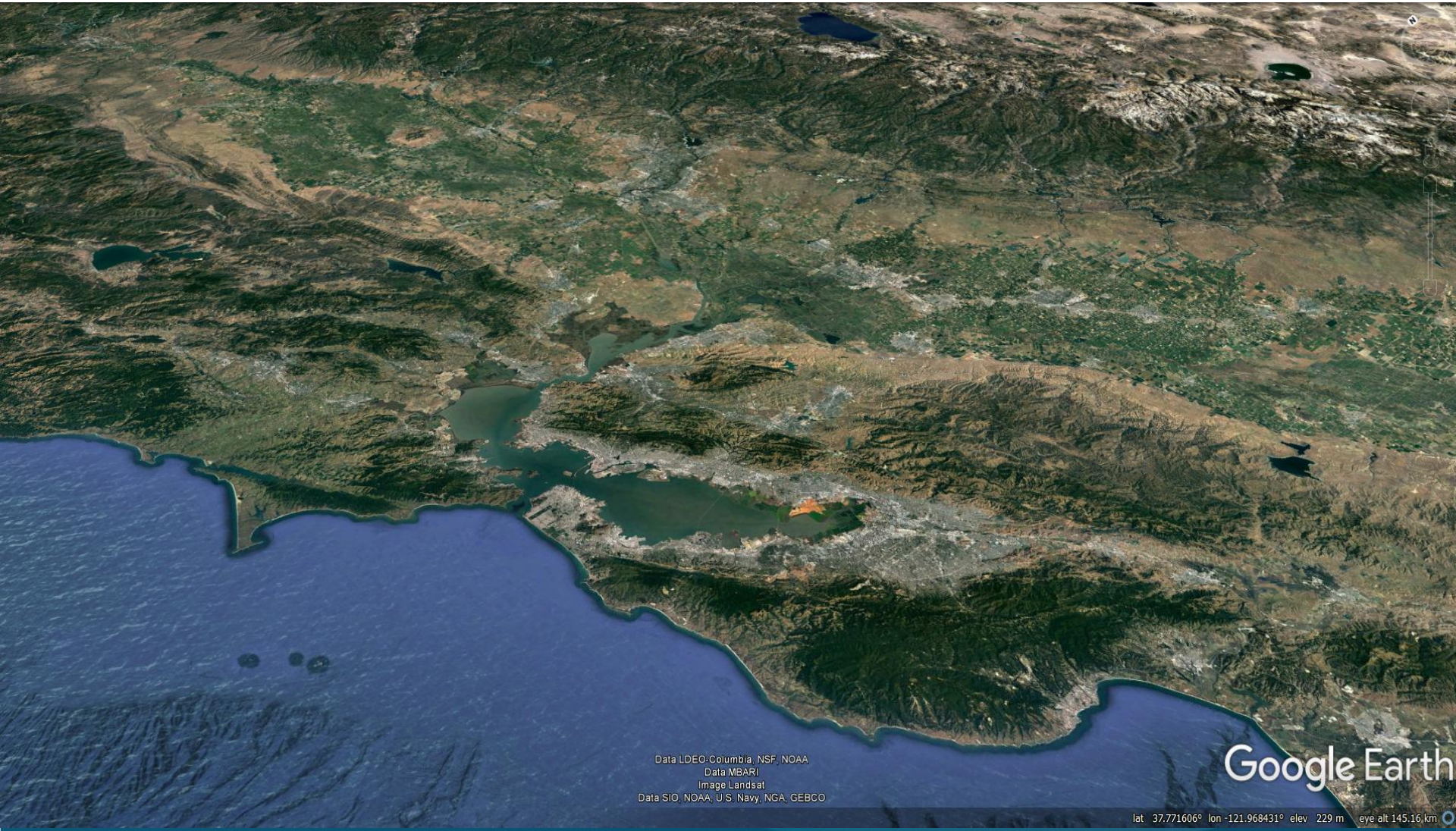
State Water Project

21 Reservoirs
17 Pumping Plants
3 Pumping-generating plants
5 Hydro-electric power plants
660 miles of canals, siphons, & tunnels
5.8 MAF total storage capacity

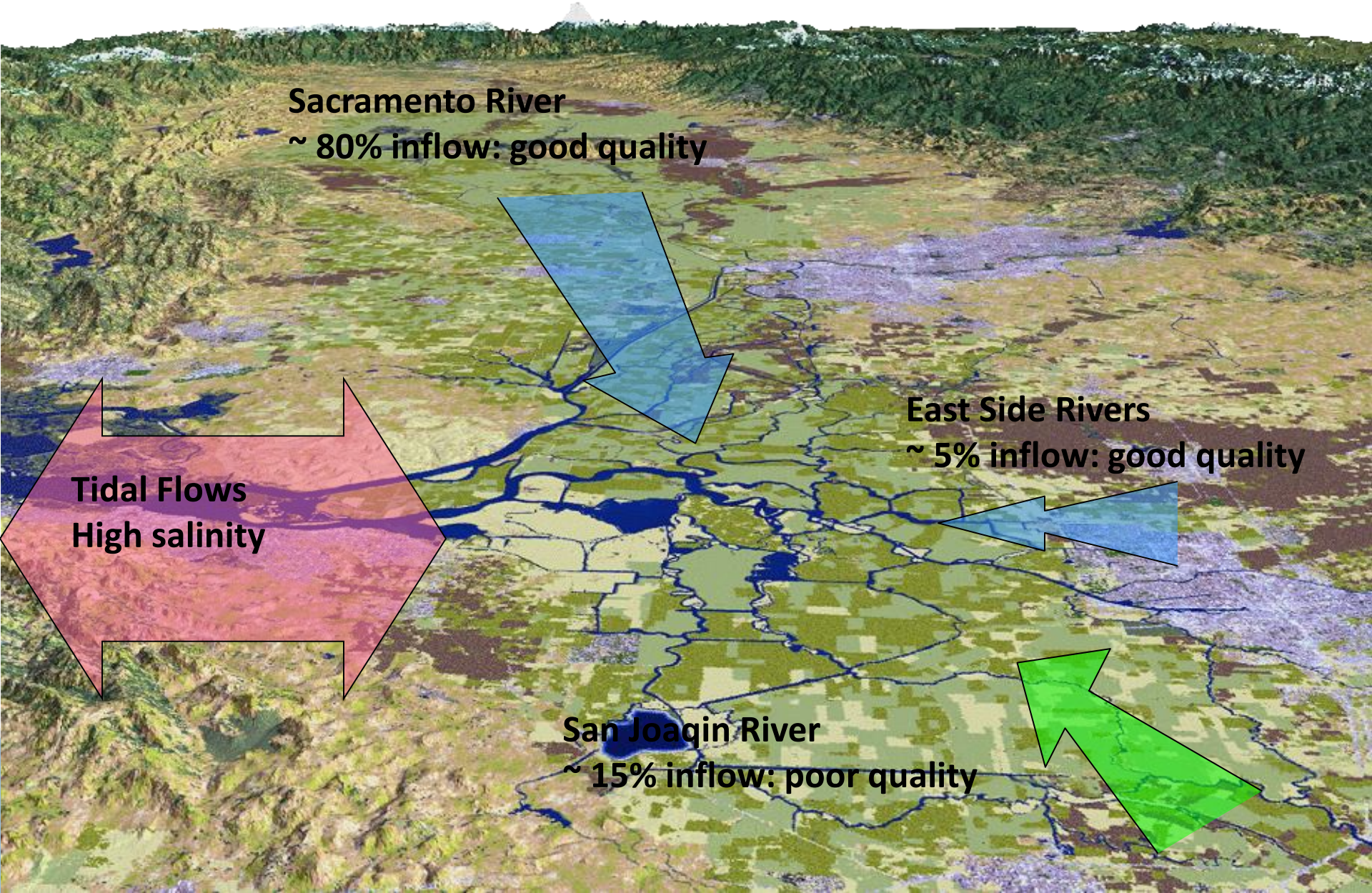
Federal Central Valley Project

20 Reservoirs
11 Hydro-electric power plants
500 miles of canals, siphons, & tunnels
11MAF total storage capacity

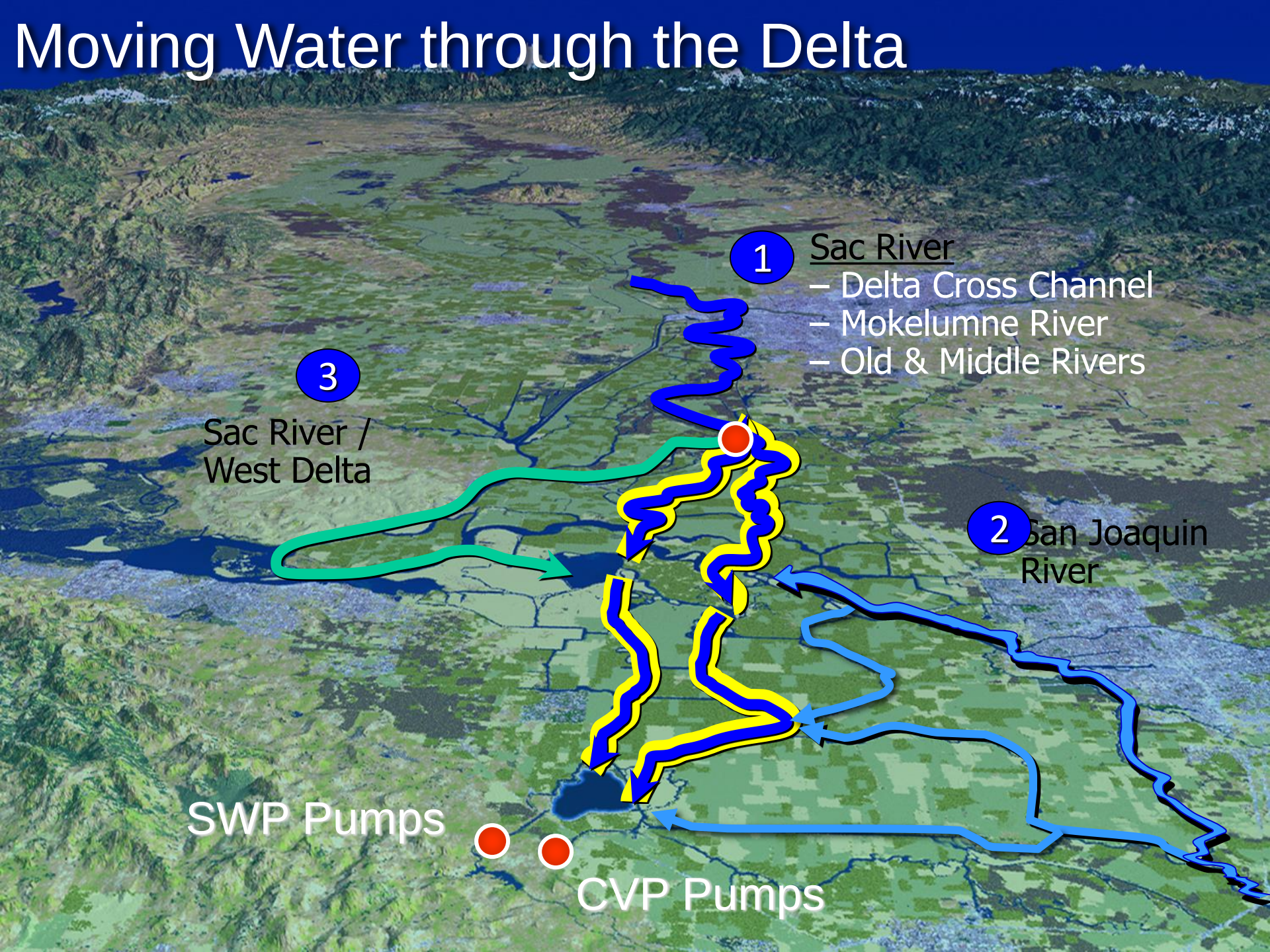
San Francisco Bay Delta

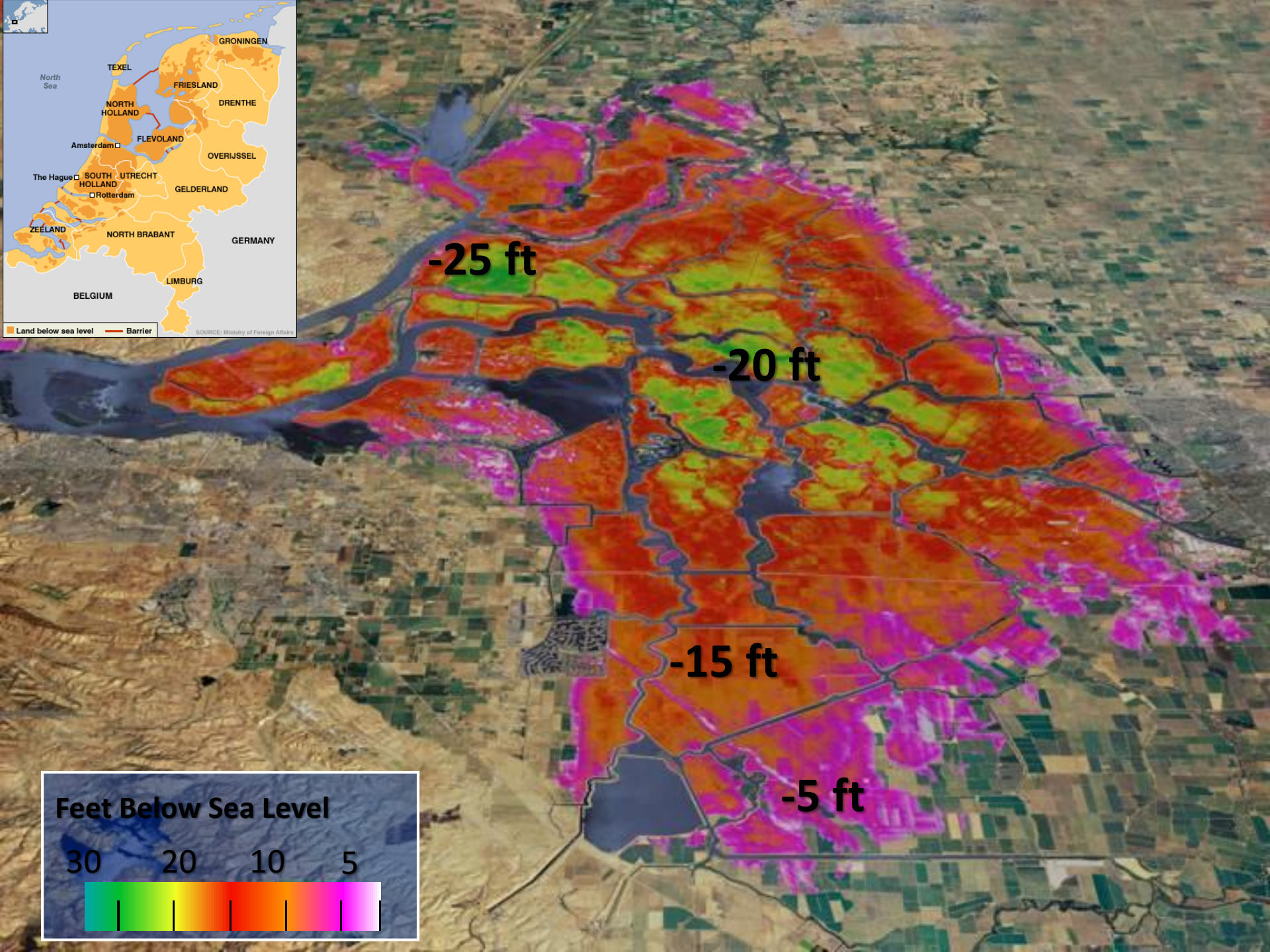


Delta Inflows



Moving Water through the Delta




GRONINGEN
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OVERIJSSEL
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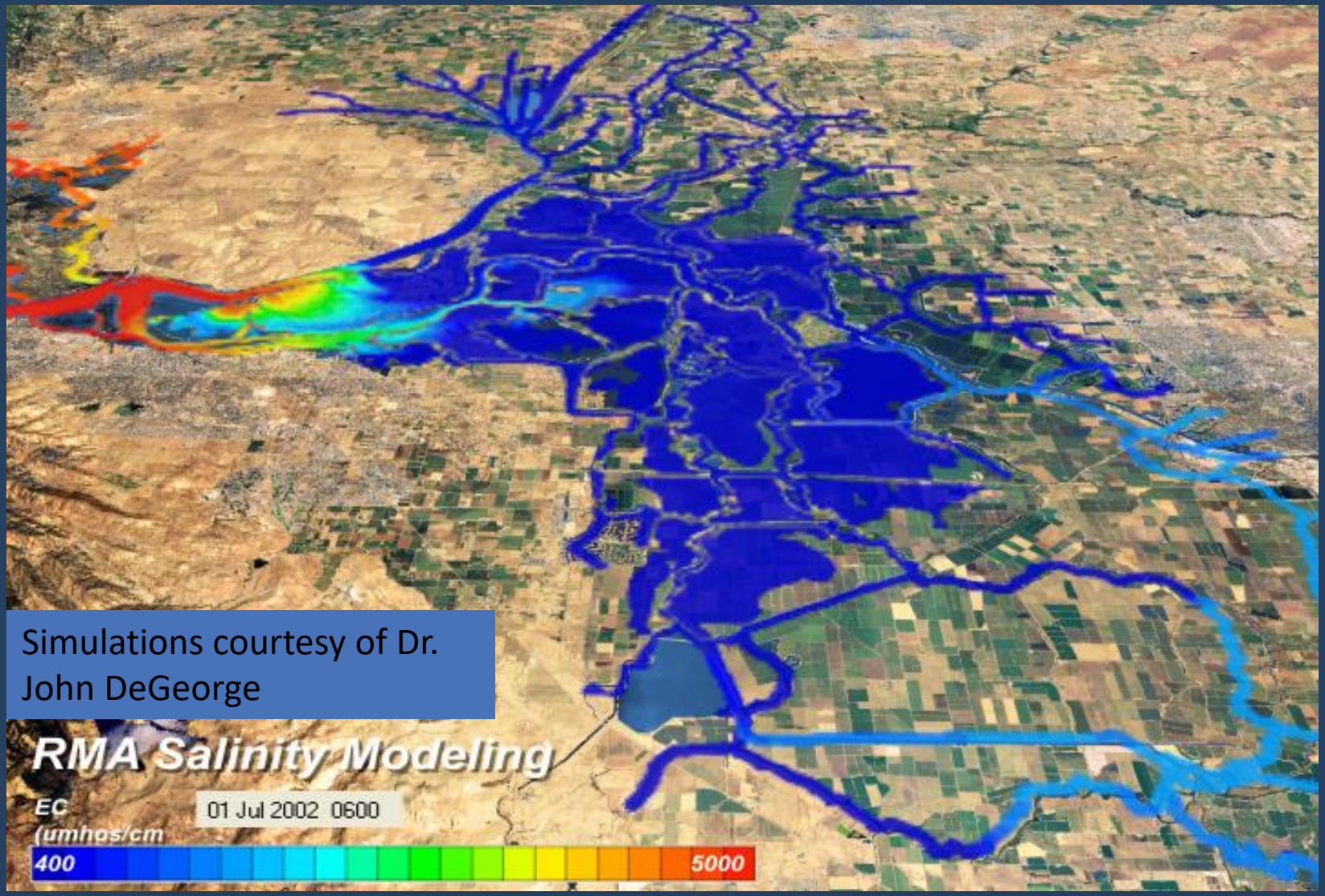
Rotterdam
GELDERLAND
ZEELAND
NORTH BRABANT
GERMANY
LIMBURG
BELGIUM
Land below sea level
Barrier
SOURCE: Ministry of Foreign Affairs
-25 ft
-20 ft
-15 ft
-5 ft
Feet Below Sea Level
30
20
10
5

Delta Levees – Seismic Hazard

6.5 Magnitude Earthquake

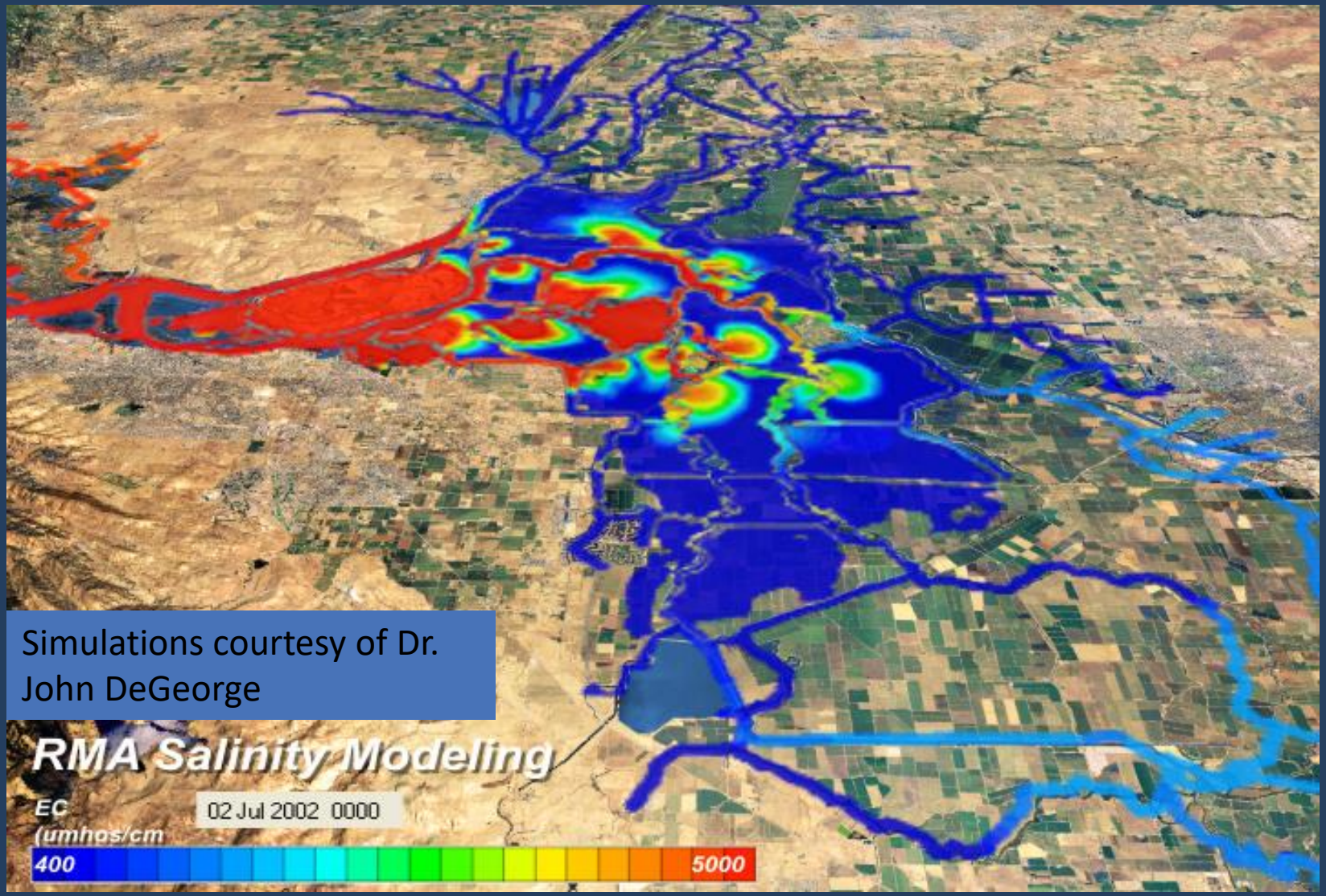
causing 20-Island Failure



0 – 6 hours: Islands flood with fresh water

6.5 Magnitude Earthquake

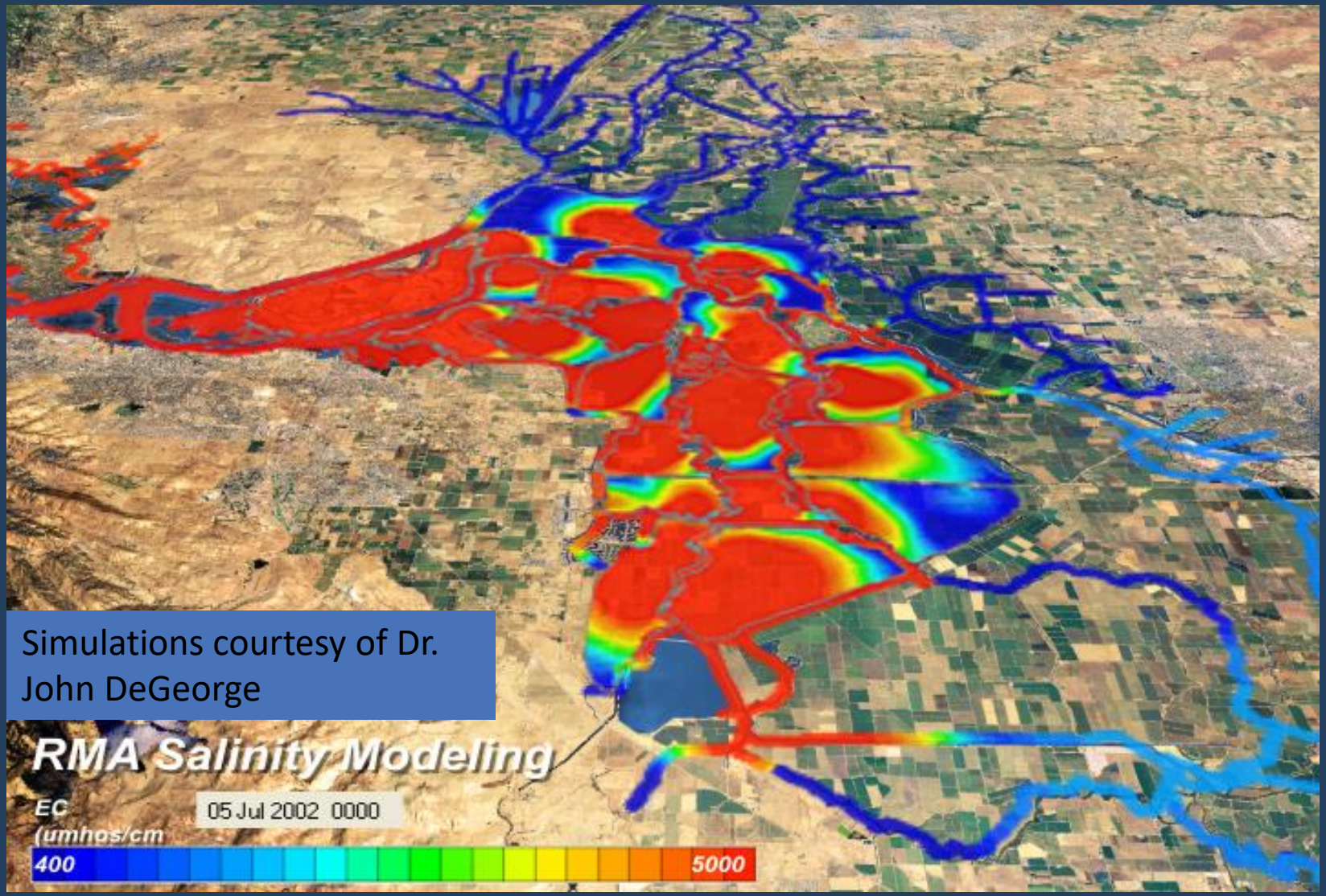
causing 20-Island Failure



12 – 24 hours: Salt water intruding into Delta

6.5 Magnitude Earthquake

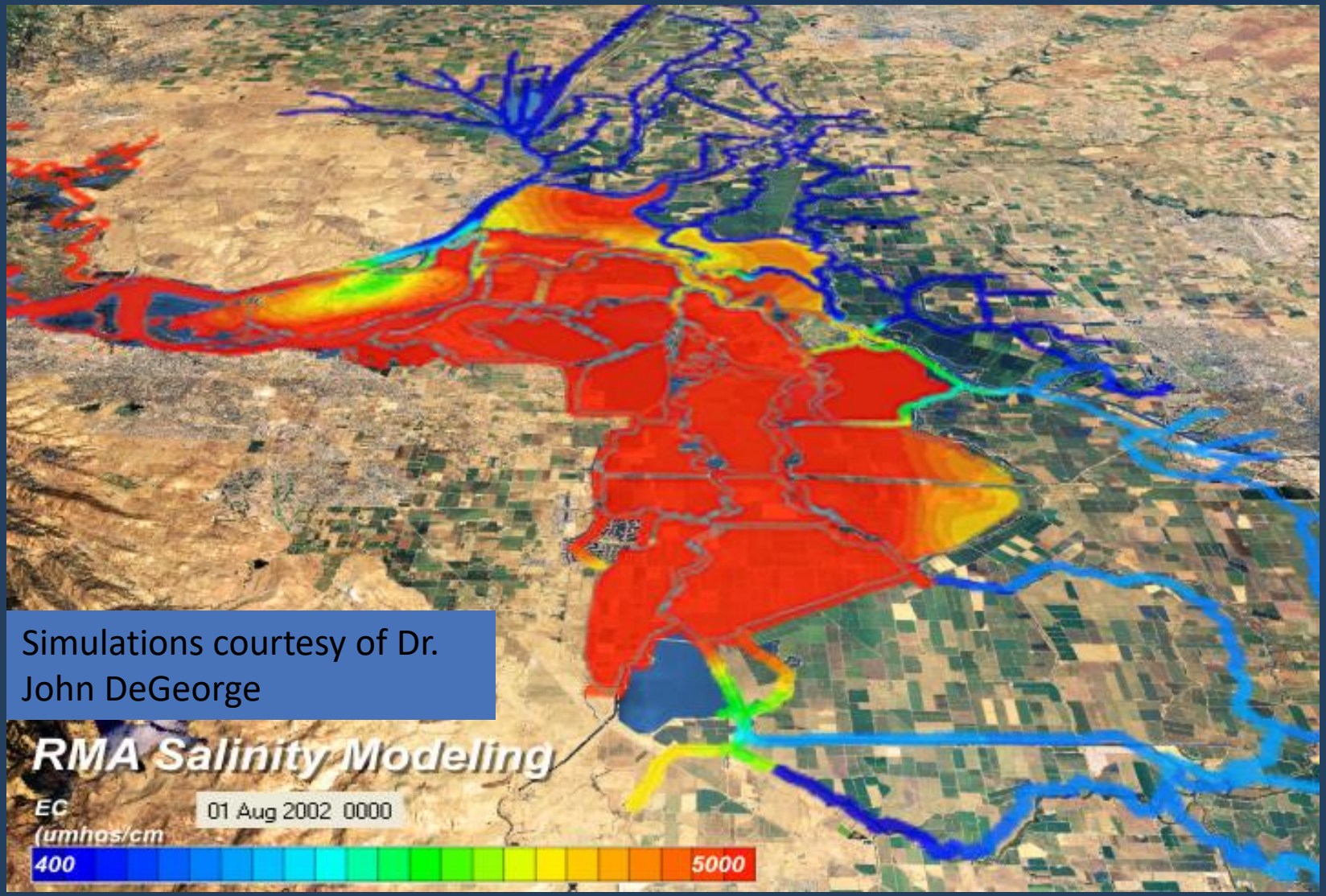
causing 20-Island Failure



1 – 7 days: Salt water throughout Delta

6.5 Magnitude Earthquake

causing 20-Island Failure



30 days: A saline estuary

What do we mean by natural flows in complex and irreversibly altered systems?

Novel ecosystems (Moyle, 2014): resilient and desirable

Landscape ecology vs cumulative projects

Yarnell, S.M. et al. 2015. *Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities* BioScience 2015. doi: 10.1093/biosci/biv102

The Problems facing California

→ 2/3 of California residents rely on Delta water

→ Irrigates up to 4 million acres of California farmland

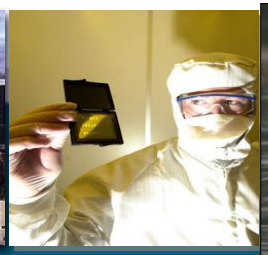
→ 80% of California's commercial fishery species rely on the Bay-Delta

→ Habitat for 700 species, including 50+ threatened or endangered

→ Hotspot for biodiversity

→ Greatest loss of biodiversity



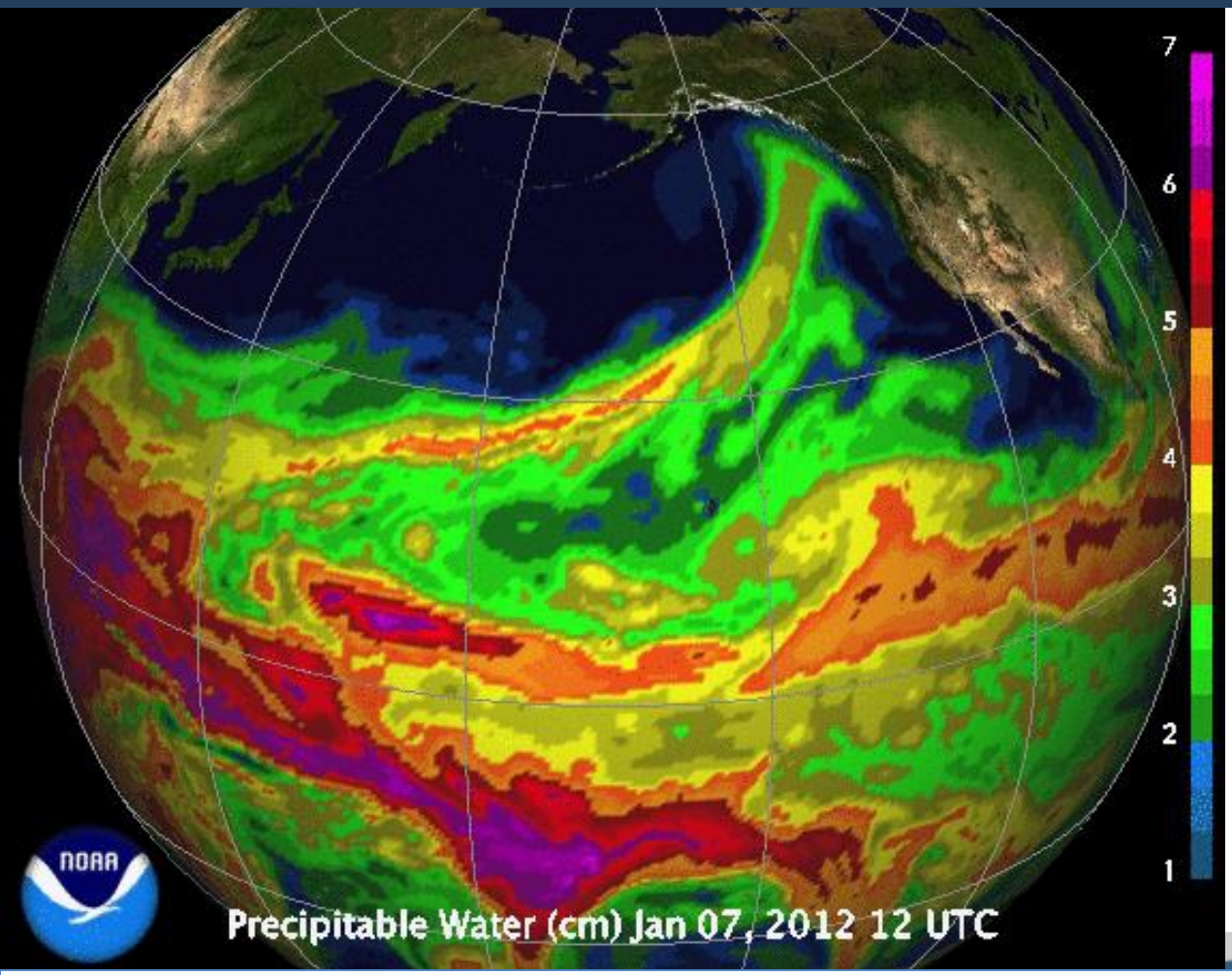


California Water

- Small average number of wet days per year needed to accumulate most of annual precipitation (ranging from 5 to 15 days)
- California receives some of the largest 3-day storm totals in the country
- Atmospheric River storms contribute from 20–50% of the state's precipitation totals
  - Most of water resources
  - Largest flood threat

(Dettinger et al., 2011)

Atmospheric Rivers (3 weeks in Jan. 2012)



-**Lateral structure from satellite data**
(~400 km width & 2000 km long)
- *(10-20 Mississippis)*

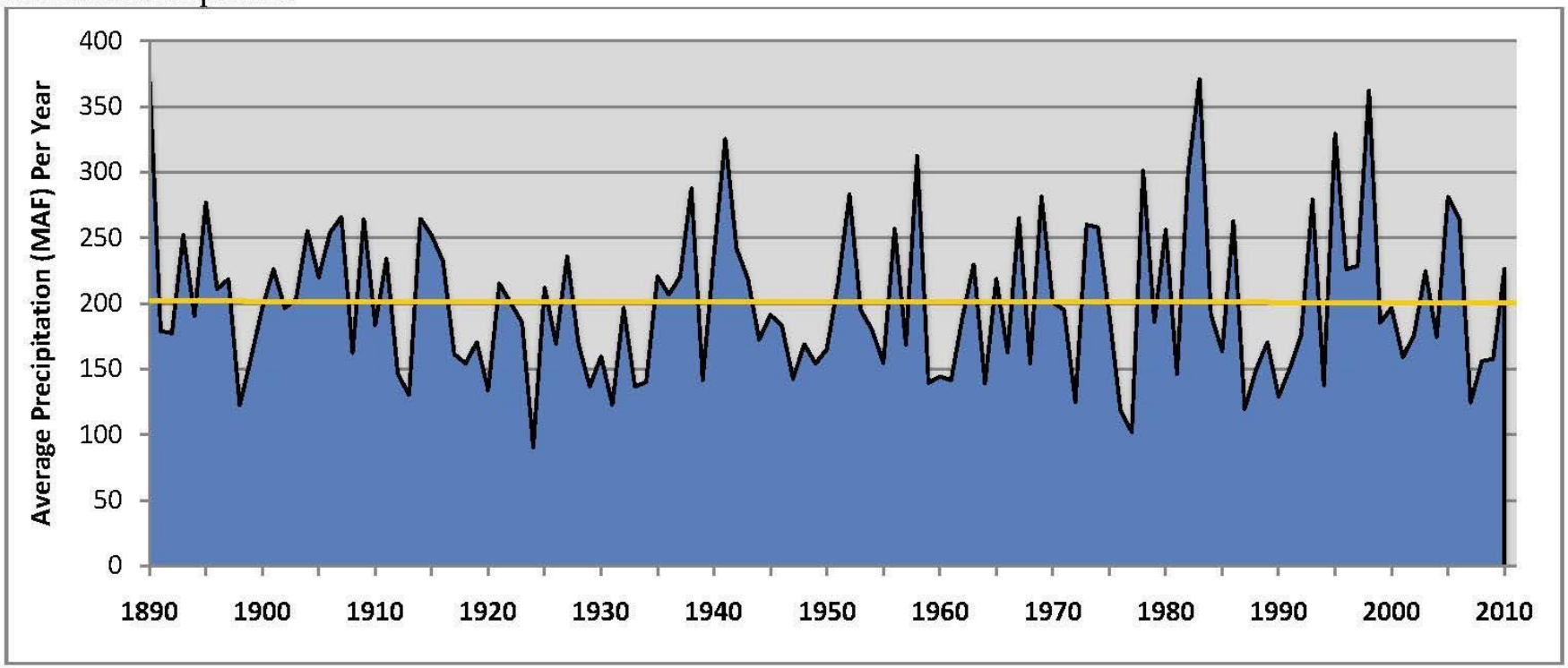
Mike Dettinger et al.

USGS, Scripps Institute of Oceanography

Southwest Climate Science Center

California's Water Supply Is Not Growing And It Arrives Erratically

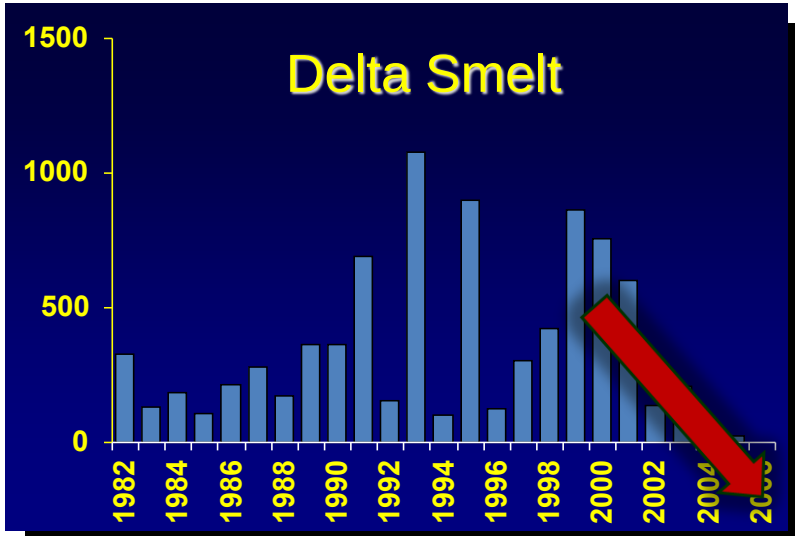
Historical Precipitation



120 year average: 201.3 MAF
Driest 30 year span (1908-1937): 180 MAF
Wettest 30 year span (1977-2006): 210.5 MAF

Source: Delta Stewardship Council. 2012. Sacramento, CA. Adapted from data compiled by Jim Goodridge, state climatologist formerly of DWR, and updated by Michael Anderson, DWR State Climatologist.

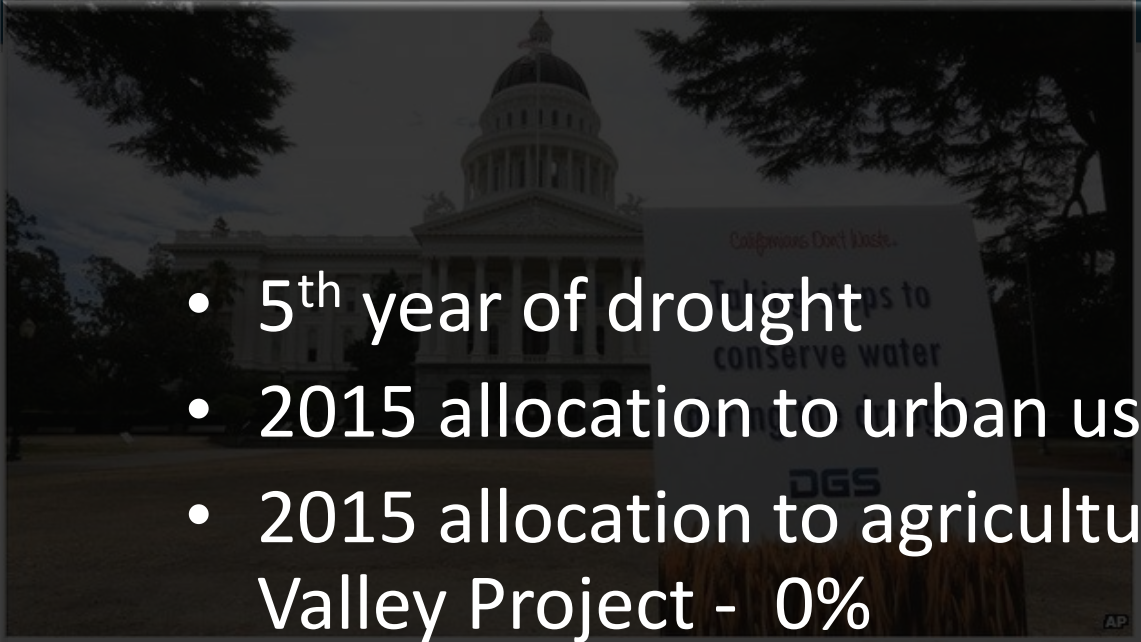
A Collapse in Delta Smelt
Protected by Endangered Species Act



There are many other endangered species – many have conflicting needs (seasonally and spatially).

Who decides?

- 5th year of drought
- 2015 allocation to urban users – 25%
- 2015 allocation to agriculture through Central Valley Project - 0%



RESEARCH ARTICLE

Unprecedented 21st century drought risk in the American Southwest and Central Plains

Benjamin I. Cook, Toby R. Ault, Jason E. Smerdon

THE SACRAMENTO BEE

Sunday, February 22, 2015 sacbee.com $2

Funding ties cast doubt on climate scientist

PAYMENTS FOR REPORTS WENT UNDISCLOSED

By Justin Gillis and John Schwartz
The New York Times

For years, politicians wanting to block legislation on climate change have bolstered their arguments by pointing to the work of a handful of scientists who claim that greenhouse gases pose little risk to humanity.

One of the names they invoke most often is Wei-Hock Soon, known as Willie, a scientist at the Harvard-Smithsonian Center for Astrophysics who contends that variations in the sun's energy can largely explain recent global warming. He has often appeared on conservative news programs, testified before Congress and in state capitals, and starred at conferences of people who deny the risks of global warming.

But newly released documents show the extent to which Soon's work has been tied to funding he received from corporate interests.

He has accepted more than $1.2 million from the fossil-fuel industry over the last decade, while failing to disclose

The ongoing drought in the San Joaquin Valley not only parches farms, it kills jobs and makes the future an open-ended question for those farmers and laborers who depend on water. They wish for rain, help and, possibly, a different way of life.

Hector Amezcua hamezcua@sacbee.com

Santos Bautista works on tying down young almond trees at an orchard in Firebaugh in January. Almonds better tolerate water pumped from wells.

Hope on fallowed fields

ARIZONA REPUBLIC

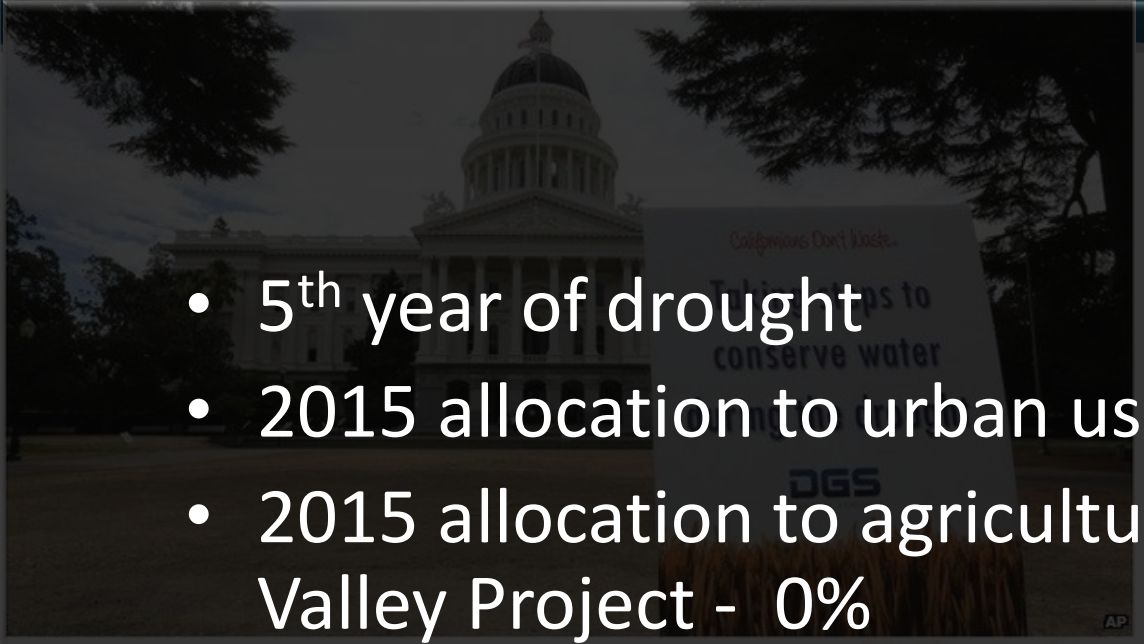
SUNDAY, MARCH 1, 2015 R1 azcentral.com A GANNETT COMPANY

AS THE RIVER RUNS DRY

CRISIS ON TAP

How users respond to the dwindling Colorado River will decide whether the Southwest can sustain its growth

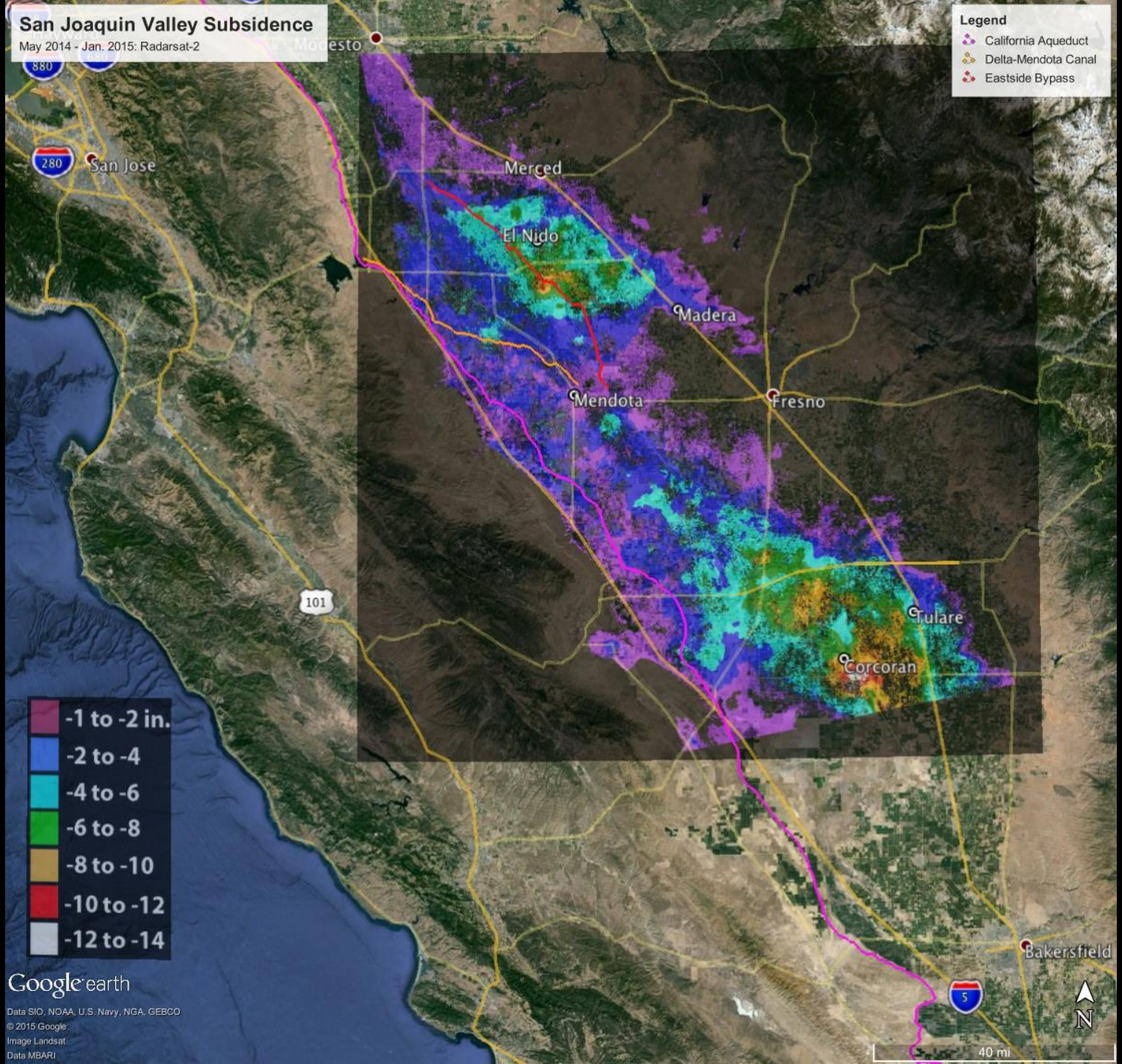
- 5th year of drought
- 2015 allocation to urban users – 25%
- 2015 allocation to agriculture through Central Valley Project - 0%
  - for the second straight year



RESEARCH ARTICLE

Unprecedented 21st century drought risk in the American Southwest and Central Plains

Benjamin I. Cook, Toby R. Ault, Jason E. Smerdon


San Joaquin Valley Subsidence
May 2014 - Jan. 2015: Radarsat-2
Legend
California Aqueduct
Delta-Mendota Canal
Eastside Bypass
Modesto
San Jose
Merced
El Nido
Madera
Mendota
Fresno
Tulare
Corcoran
Bakersfield
880
280
101
5
-1 to -2 in.
-2 to -4
-4 to -6
-6 to -8
-8 to -10
-10 to -12
-12 to -14
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2015 Google
Image Landsat
Data MBARI
N
40 mi

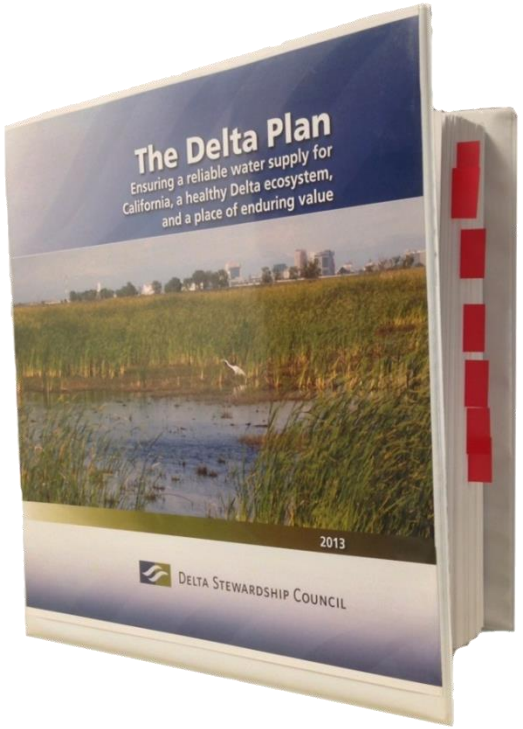
2009 State of California Legislation
The Coequal Goals

- "'Coequal goals' means the two goals of providing a **more reliable water supply for California** and **protecting, restoring, and enhancing the Delta ecosystem**. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." *(California Water Code §85054).*

Delta Stewardship Council created to:

- Develop enforceable plan to achieve coequal goals of ecosystem restoration and statewide water supply reliability
- Ensure progress towards those goals
- Oversee and coordinate activities in the Delta among various agencies
- Inform decision-making with best available independent science

What is the Delta Plan?



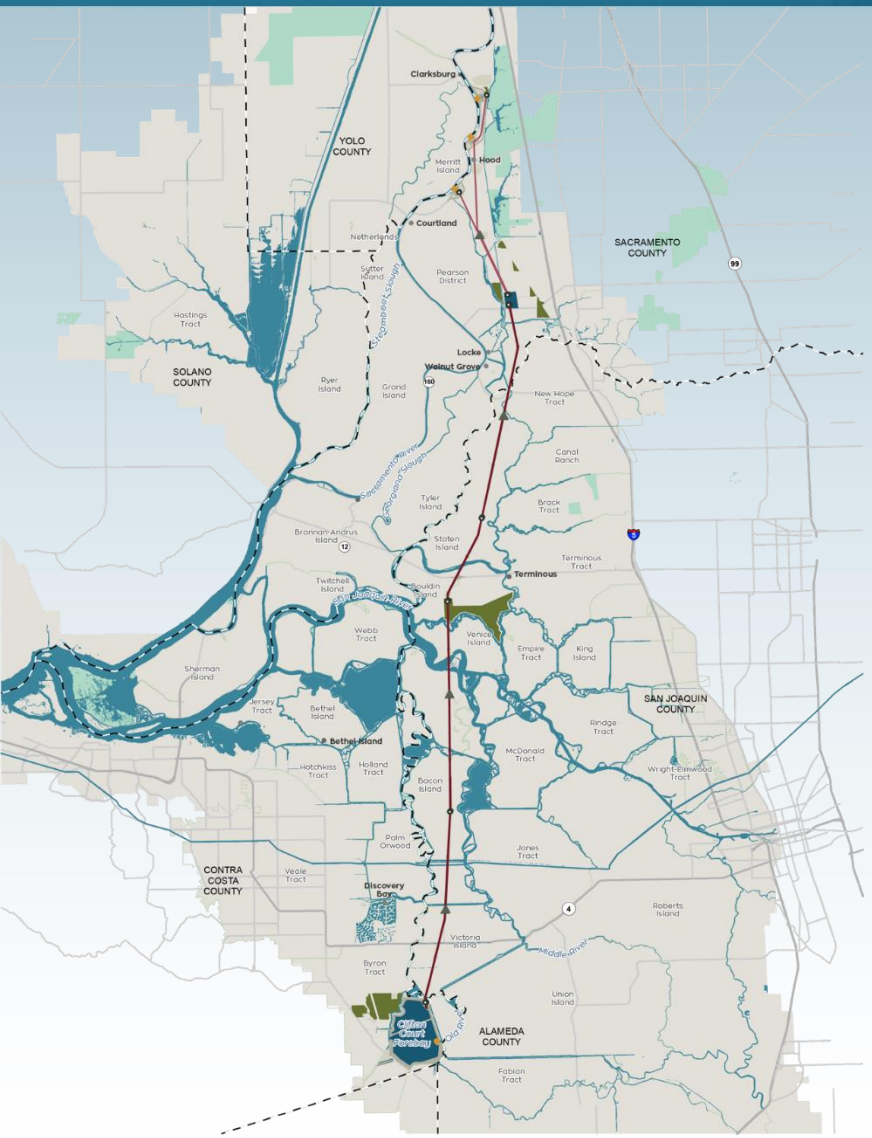
- Delta Plan draws upon existing state and federal laws and policies and ongoing programs to chart a big-picture course
- The Delta Plan is:
  - ✓14 regulatory policies; 73 recommendations
  - ✓A plan that encourages state and local agencies to implement local and regional projects

Delta Plan Themes:

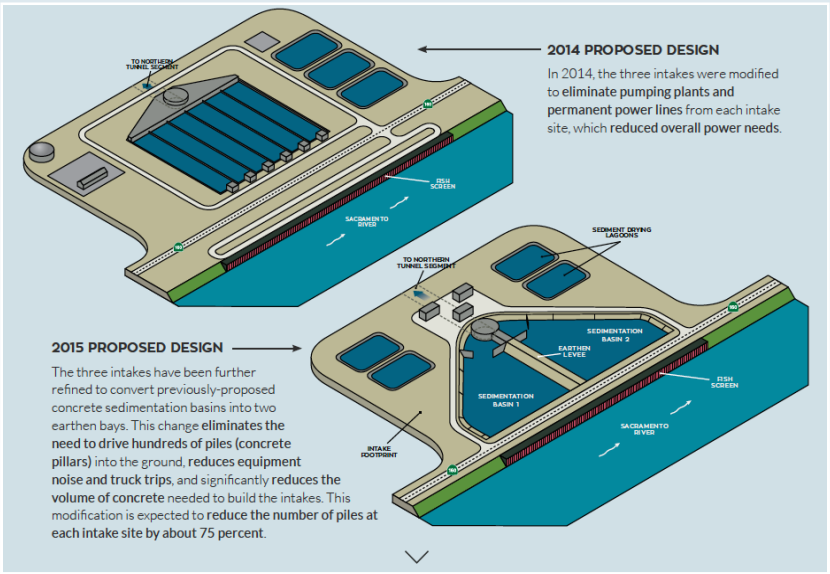
- Conservation & Efficiency
- Reduce Flood Risk
- Ecosystem Restoration
- Supply Reliability & Storage
- Protect the Delta
- Science & Adaptive Management

BAY DELTA CONSERVATION PLAN / CALIFORNIA WATER FIX

BAY DELTA CONSERVATION PLAN/CALIFORNIA WATER FIX
PARTIALLY RECIRCULATED DRAFT ENVIRONMENTAL IMPACT REPORT/SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT



Sacramento-San Joaquin Delta /Project Area



BAY DELTA CONSERVATION PLAN / CALIFORNIA WATER FIX

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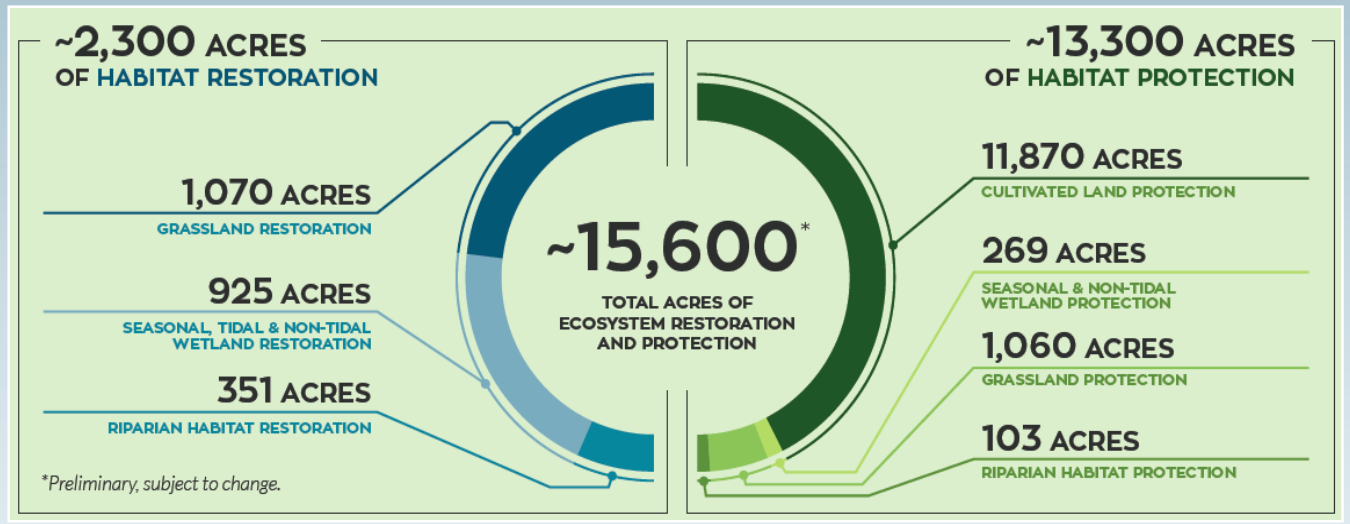


Environmental Mitigation

CALIFORNIA ECO RESTORE
A STRONGER DELTA ECOSYSTEM

20,000 hectares

Target: 450 km²

Role of Science

- Through our joint federal-state partnership, and with science as our guide, we are taking a comprehensive approach to tackling California's water problems…"

  From July 25, 2012 Governor Brown and President Obama Administration joint announcement on California's water future.

- "In carrying out this section the Council shall make use of the **best available science**."

  California Water Code §85302(g)

What is Best Available Science?

Elements include:

- Conceptual Models
- Quantitative Models
- Journal articles [inc. SFEWS]
- Traditional knowledge
- Reports, conference papers
- Peer Review
- Collaborative synthesis

Fish Net Effects Assessment

- Delta smelt effects (excerpt)
  - Zooplankton abundance: critical importance (high certainty) * moderate change (low certainty) = moderate effect (low certainty)

Category	Appendix	Attributes	Definition	Eggs	Larvae	Juvenile	Adults
Food	E	Zooplankton community	Species composition of the zooplankton community and presence of suitable prey species	NA	Zero	Zero	
		Zooplankton abundance	The abundance of zooplankton	NA	Moderate	Moderate	Very Low
		Benthic & Epibenthic prey abundance	The abundance of epibenthic prey species such as amphipods	NA		Moderate	Low
		Insect abundance	The abundance of insect prey	NA		Low	Very Low
Entrainment & Impingement	B	North Delta Intakes	Potential entrainment/impingement from the proposed North Delta intakes	NA	Very Low	Very Low	Very Low
		South Delta Pumps	Pumping rate from the CVP/SWP south Delta export facilities and resulting entrainment	NA	Low	Very Low	Moderate
		North Bay Aqueduct	Entrainment from the SWP NBA facilities	NA	Very Low		
		Ag Diversions	Entrainment from Agriculture Diversions	NA	Very Low	Very Low	Very Low

Certainty

Contrast with Pacific Northwest:

Under restoration scenario 1, the predicted mean increase in number was 1,459,254 (117%) and 285,302 (140%) for coho salmon parr and smolts

Source: P. Roni, G. R. Pess, T. J. Beechie, S. A. Morley

There has to be a better way

230+ agencies

Combat Science vs. Collaborative Science

Principles: Relevant, Credible, Legitimate, Transparent and Timely

Develop a Shared "*State of Delta Knowledge*"

Science should not be used as an excuse for inaction

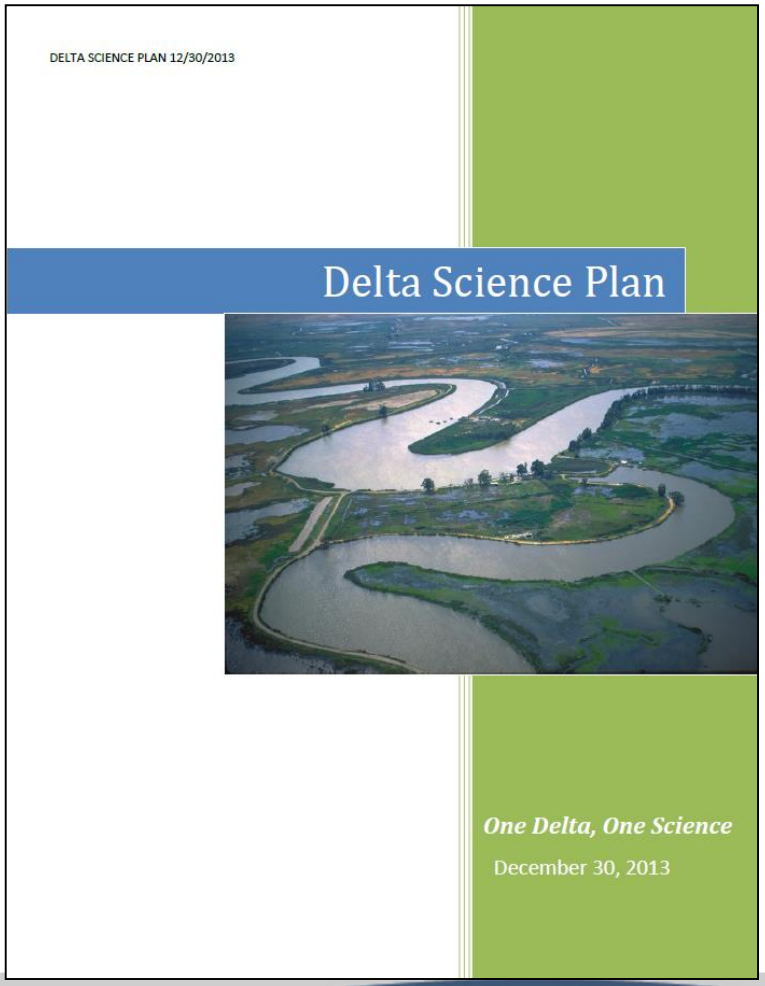
A Framework for Collaborative Science

Delta Science Plan

One Delta, One Science

Completed
December 30, 2013
Updated Dec 2016

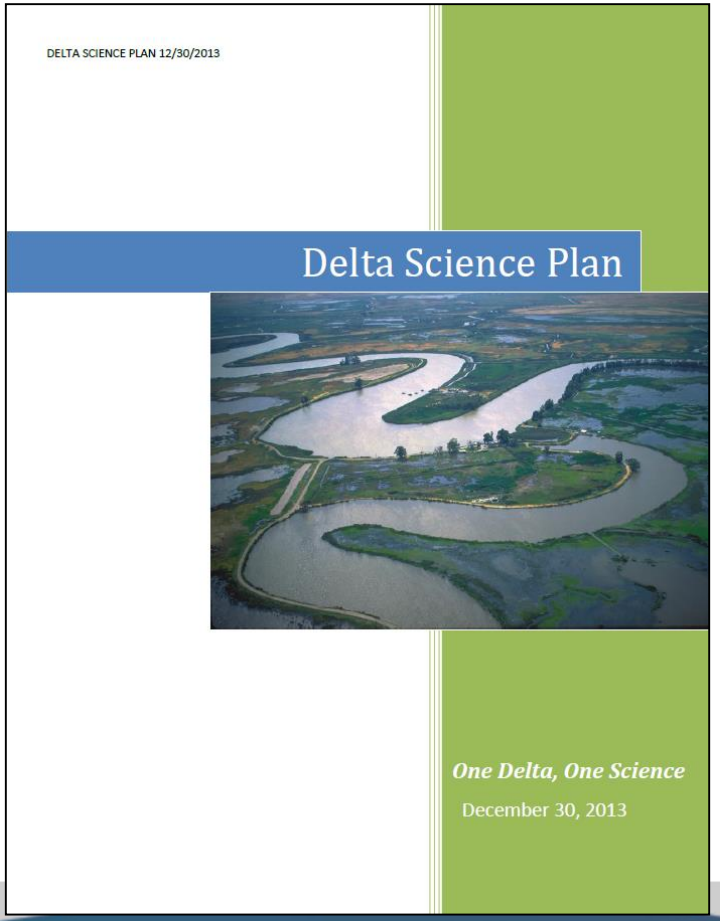
1000+ contributors
from 230+ organizations



Delta Stewardship Council
Delta Science Program

- Building a common body of knowledge
  - Credible, Legitimate, Relevant and Transparent
- Managing scientific conflict
  - embrace legitimate differences of opinion
  - sift out selective, obfuscated, biased information
- Infrastructure for Science
  - Data accessibility
  - Community Modeling
  - Coordinates people's time, meeting facilities and tools
- It takes a community with shared resources

  ONE DELTA ONE SCIENCE



Delta Science Strategy

DELTA SCIENCE PLAN

- ✓ Policy-Science Forum
- ✓ Science Steering Committee
- ✓ Science Infrastructure Summits
- ✓ Common Peer Review Process
- ✓ Integrative Adaptive Management at System Level
- ✓ Teams to develop common understanding
- ✓ 'Sounding Board'

SCIENCE ACTION AGENDA

- ✓ Common prioritized science actions
  - Directed Research
  - Competitive Research
  - Science Fellows
  - Emerging technologies
  - Infrastructure

State of Bay-Delta Science

- ✓ Summary of the state of scientific knowledge, including summary of funded projects

State of Bay-Delta Science 2016

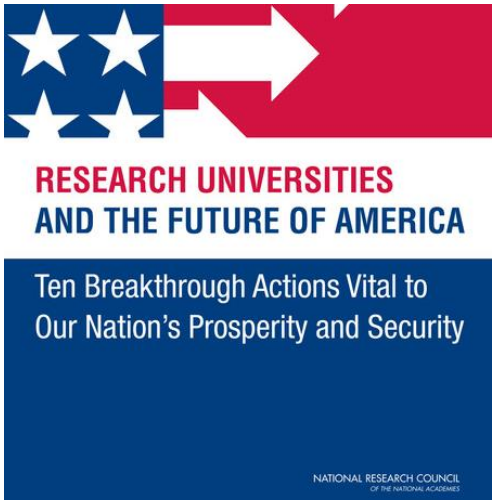
Thanks to:

Sam Luoma

Lauren Muscatine

Building the Science Community

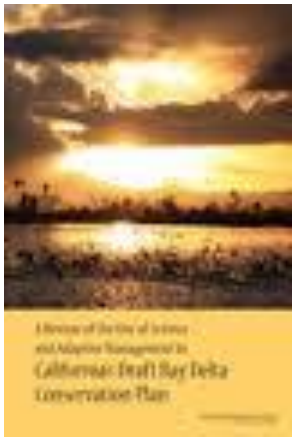
Examples:



- CAMT
- IEP
- CWEMF
- Next – Gen: Sea Grant State Fellows
  Science Fellows
  Internships

Managing Scientific Conflict

Credible, Legitimate, Relevant and Transparent



Synthesis

- ✓ Sounding Board
- ✓ Invited paper
- ✓ Invited review panel
- ✓ Expert and Community Workshops
- ✓ '*Delta Collaborative Analysis and Synthesis*' mechanism – Team Science
- ✓ Conferences
- ✓ Collaborative Proposal Solicitation Package Grant
- ✓ Science Fellow

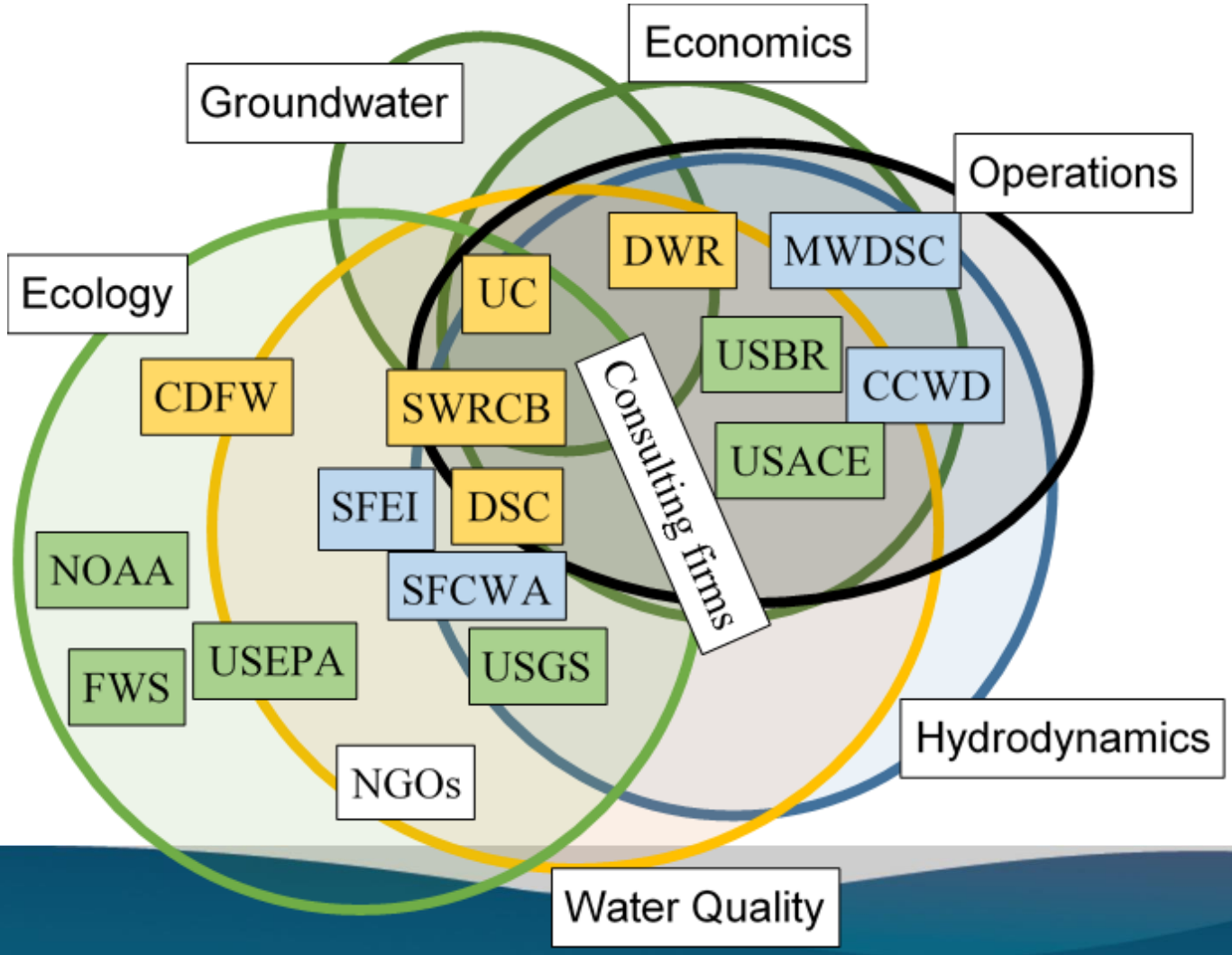
Accountability and Recognition

- Maven's Blog – Award Winning Reporting
  Service to consulting, agency, academic and NGO community
- State of the San Francisco Estuary Conference
  Karen McDowell and Organizing Committee
- 2015 State of the Estuary Report
- Baylands Ecosystem Habitat Goals Science Update

Foster Innovation

- Support ‘High Risk’ potentially ‘High Payoff’
- Innovation Prize

Major modeling organizations and areas of activity and interest



(Federal- orange, State – brown, Local – blue, Other – white)

The Power of Community Modeling

Snake River Plain Water Rights Adjudication

157,000+ claims adjudicated

Number of legal challenges to the computer model used for conjunctive administration of surface and groundwater.

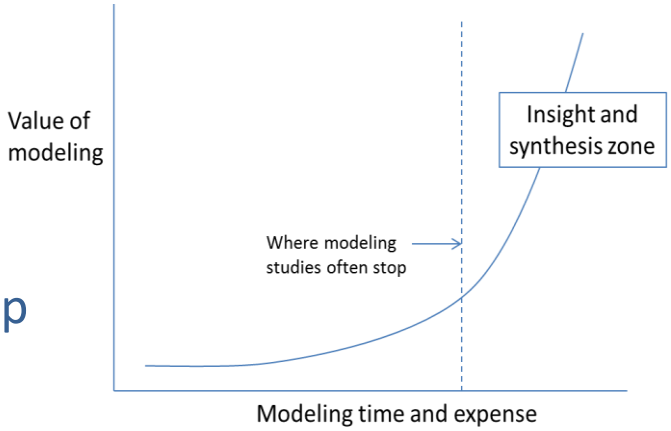
Tools change how we interact with one another, how we behave and therefore how we think.

Wilson Miner www.wilsonminer.com

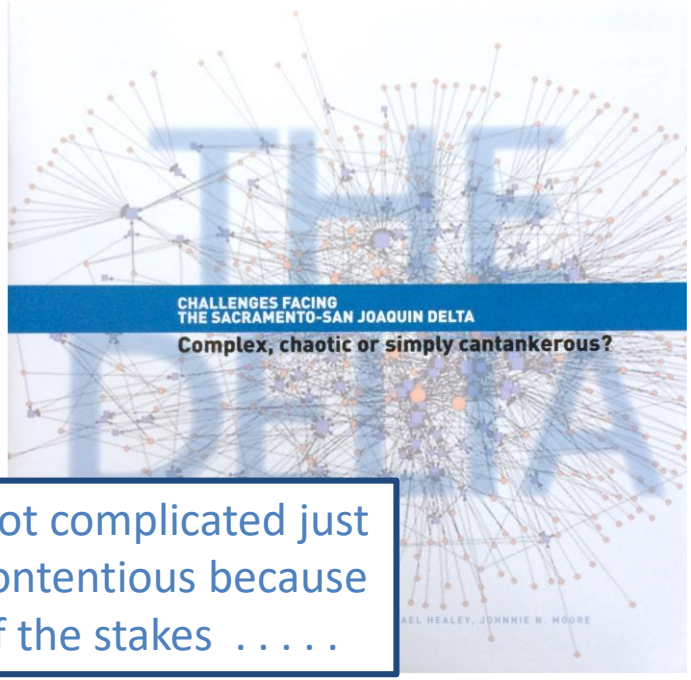
Models are never completed,

only abandoned.

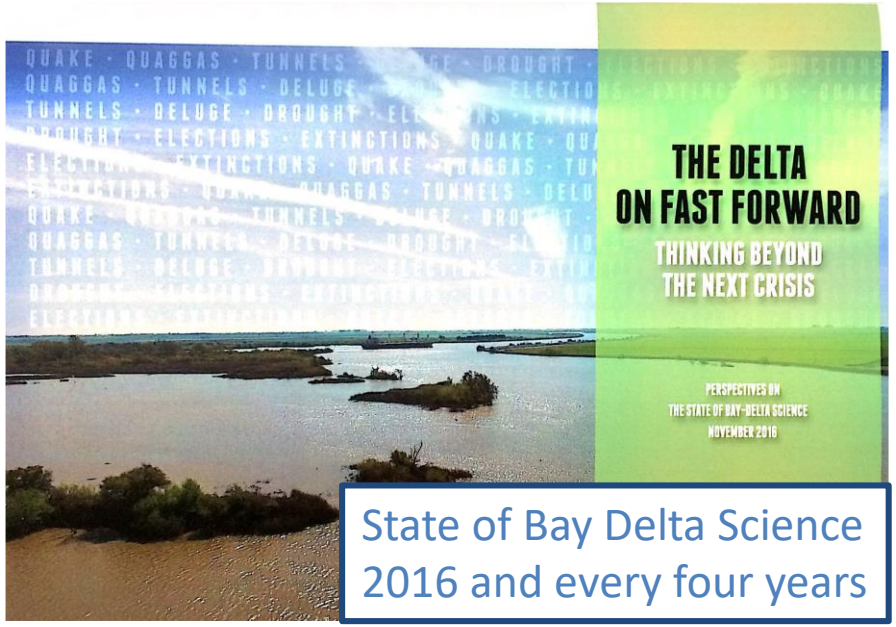
Jay Lund, DSP-NSF Workshop



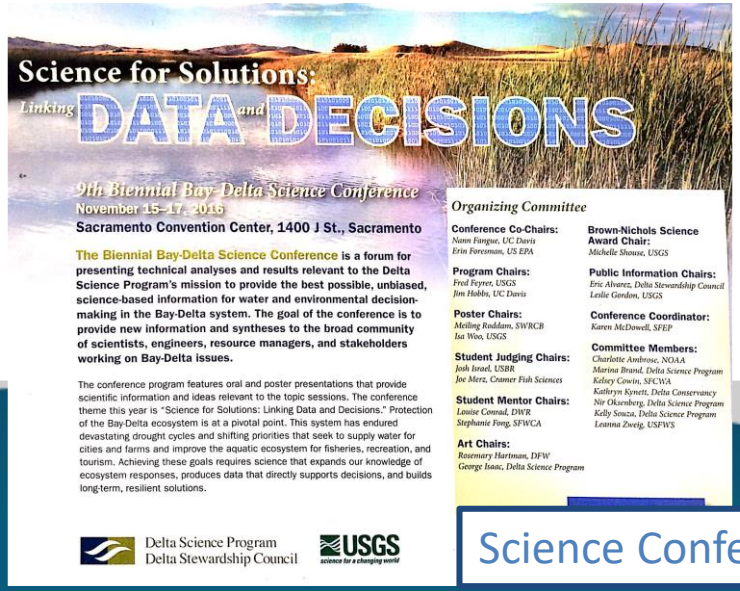
Science-Policy Interface Products



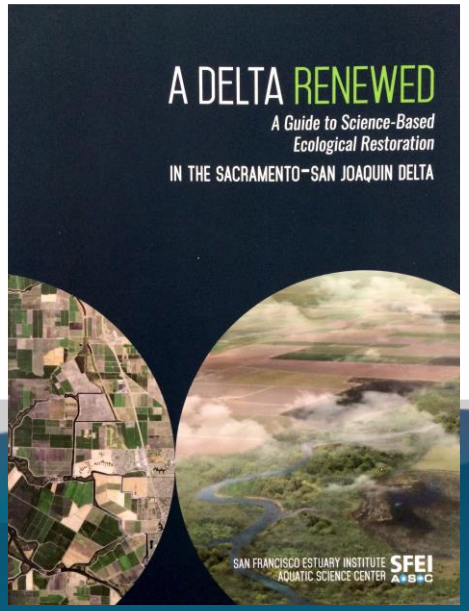
Not complicated just contentious because of the stakes . . . . .



State of Bay Delta Science 2016 and every four years



Science Conferences



Whose Science Plan is it anyway?

Interagency
Ecological Program
COOPERATIVE ECOLOGICAL
INVESTIGATIONS SINCE 1970

CALIFORNIA DEPARTMENT OF
FOOD & AGRICULTURE

COUNCIL

US Army Corps
of Engineers®

SACRAMENTO - SAN JOAQUIN
DELTA CONSERVANCY
A California State Agency

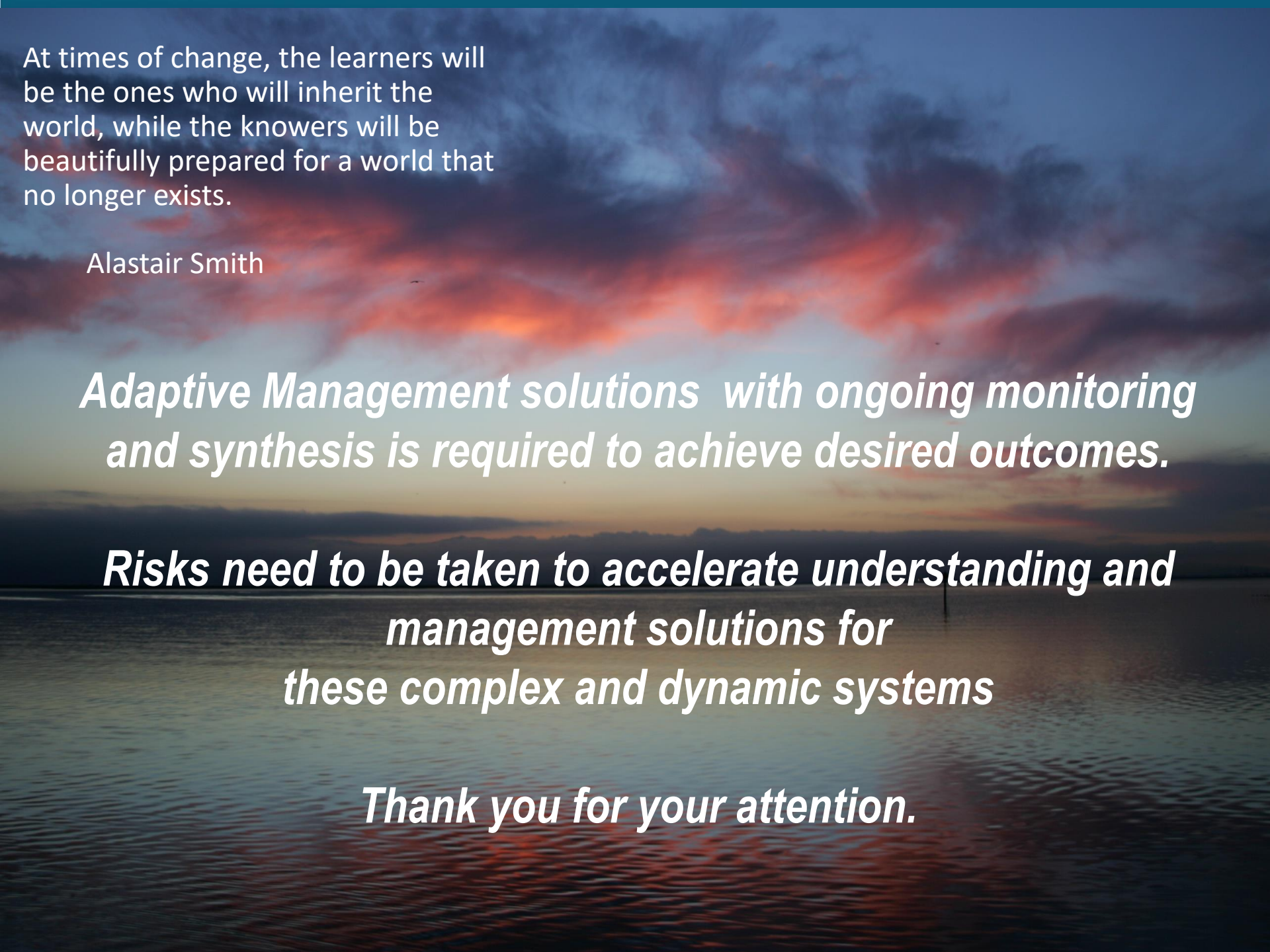
SFCWA
State & Federal Contractors
Water Agency

Everyone's

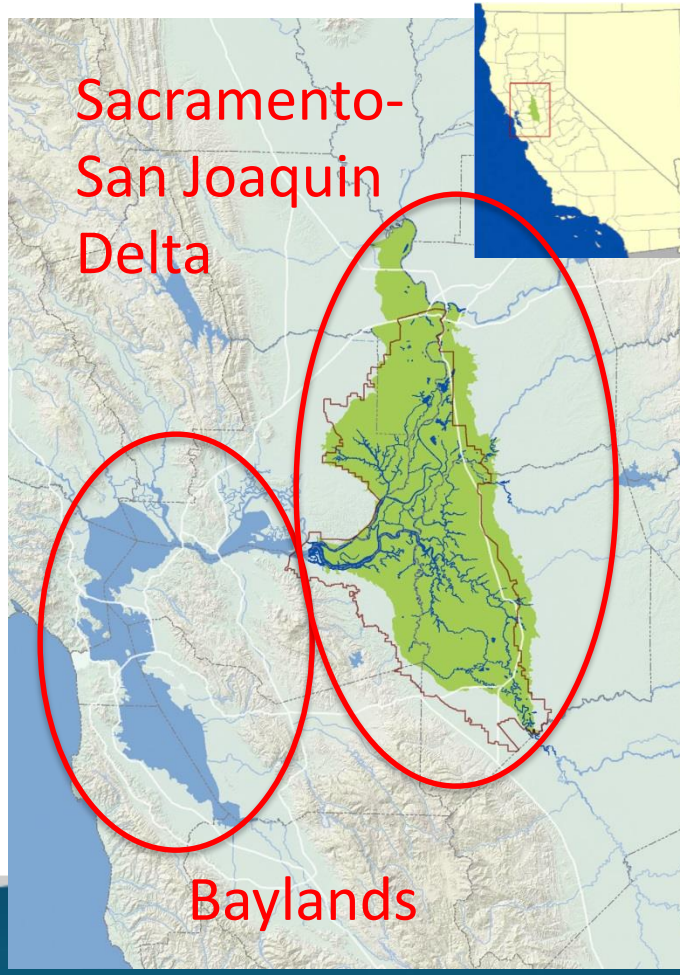
Can we learn from C.P. Snow?

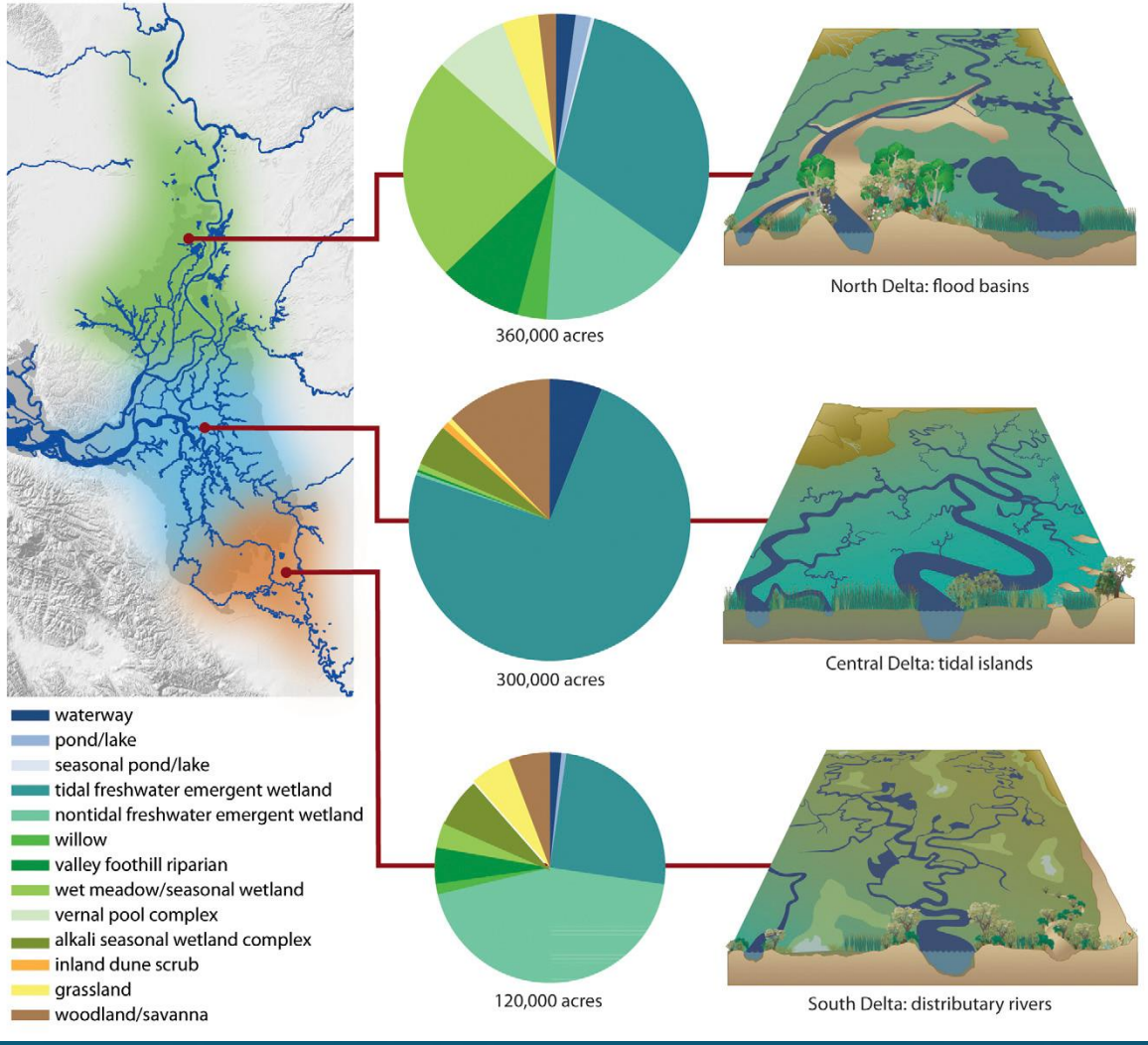
(1) The objective must be clear and not too grandiloquently vast. A scientific committee set to advise on the welfare of all mankind is not likely to get very far. The objective of the Tizard Committee—to defend England in a foreseeable short-term future against air attack—is about as much as anyone can hope actually to cope with.

Delta Stewardship Council www.deltacouncil.ca.gov


At times of change, the learners will be the ones who will inherit the world, while the knowers will be beautifully prepared for a world that no longer exists.
Alastair Smith
Adaptive Management solutions with ongoing monitoring and synthesis is required to achieve desired outcomes.
Risks need to be taken to accelerate understanding and management solutions for these complex and dynamic systems
Thank you for your attention.

Baylands and the Sacramento -San Joaquin Delta





Habitat Loss and Fragmentation

Extensive Floodplains, 1927

Tidal Marsh, 1905

Adelta RENEWED

A Guide to Science-Based Ecological Restoration

IN THE SACRAMENTO - SAN JOAQUIN DELTA

SAN FRANCISCO ESTUARY INSTITUTE
AQUATIC SCIENCE CENTER
SFEI
ASC

The Baylands and Climate Change: WHAT WE CAN DO

SPUR
16 Feb 2016
San Francisco, CA

LETITIA GRENIER
SAN FRANCISCO ESTUARY INSTITUTE

SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

Email: letitia@sfei.org
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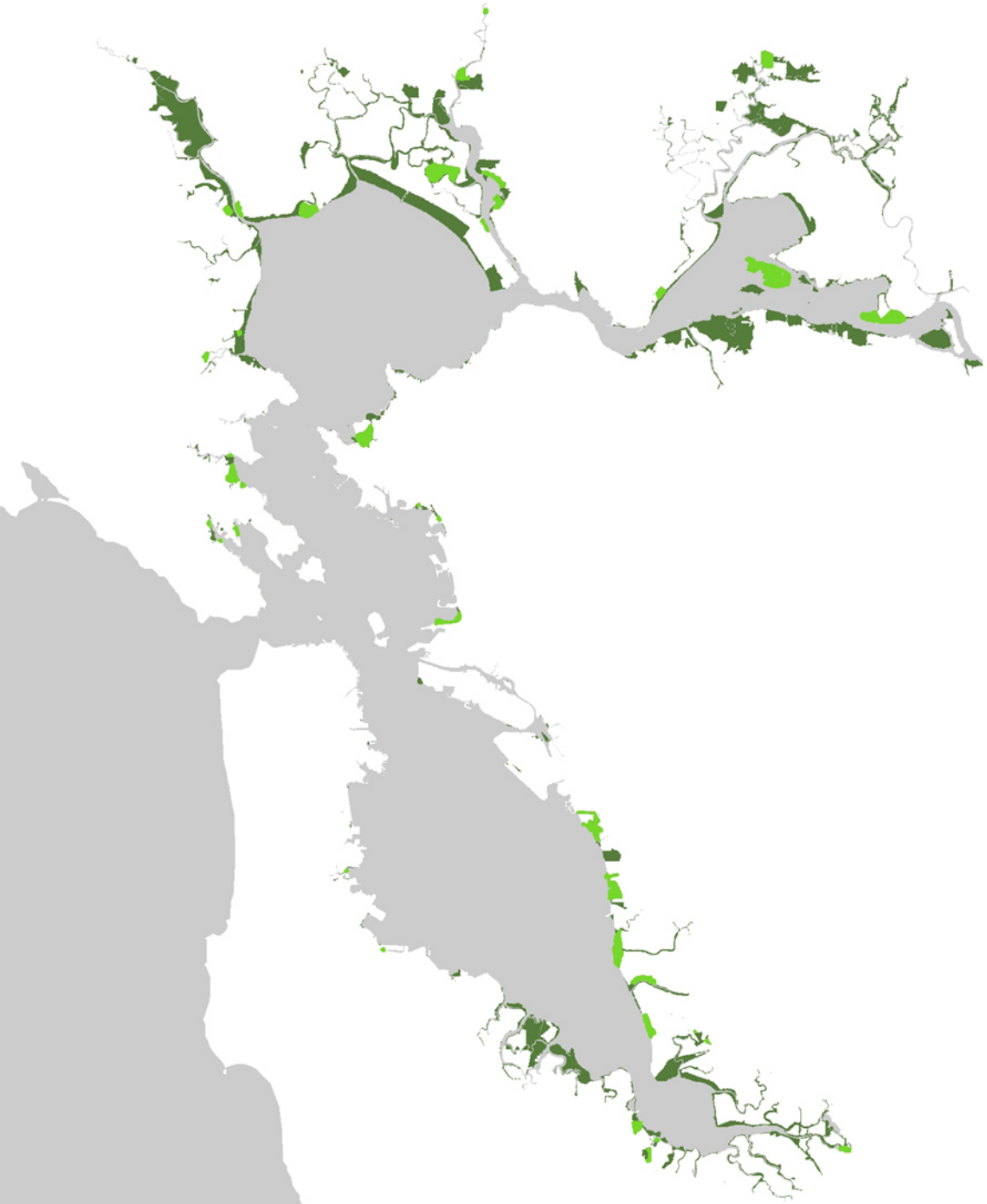

1998

Tidal Marsh

Restored Tidal Marsh

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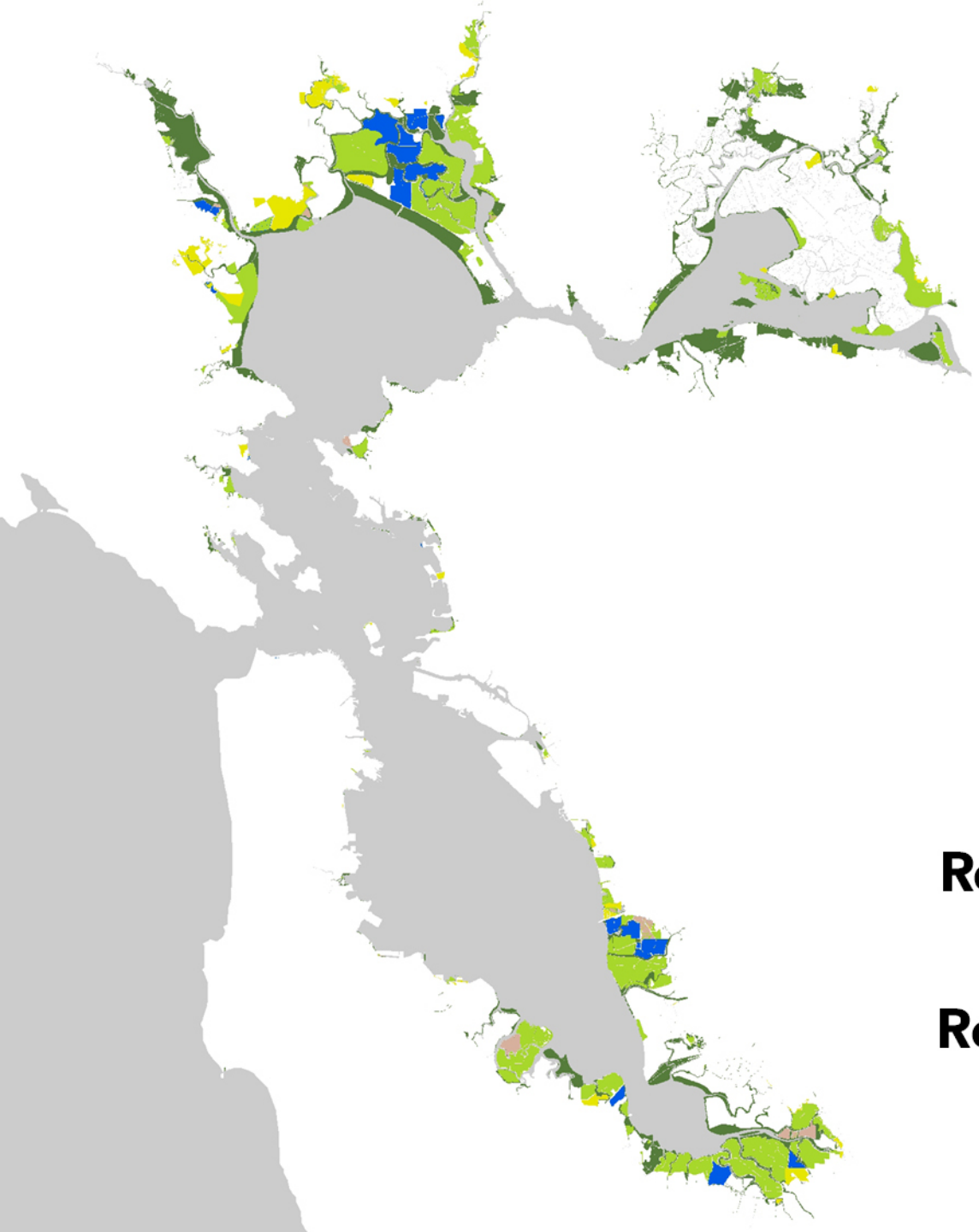

FUTURE

Existing Tidal Marsh

Restored Tidal Marsh

Restored Tidal Flat

Restored Diked Wetland

Restored Managed Pond

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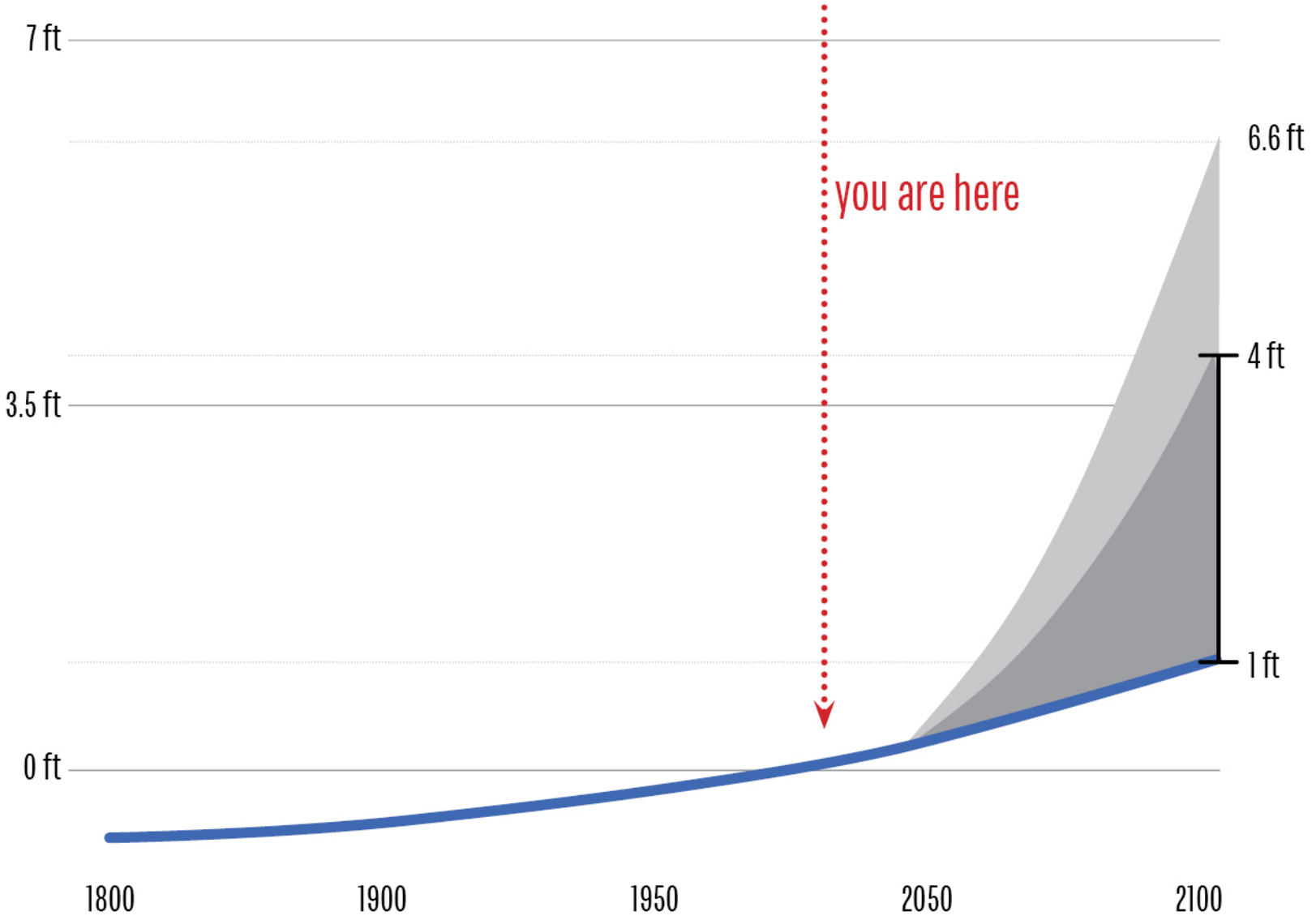
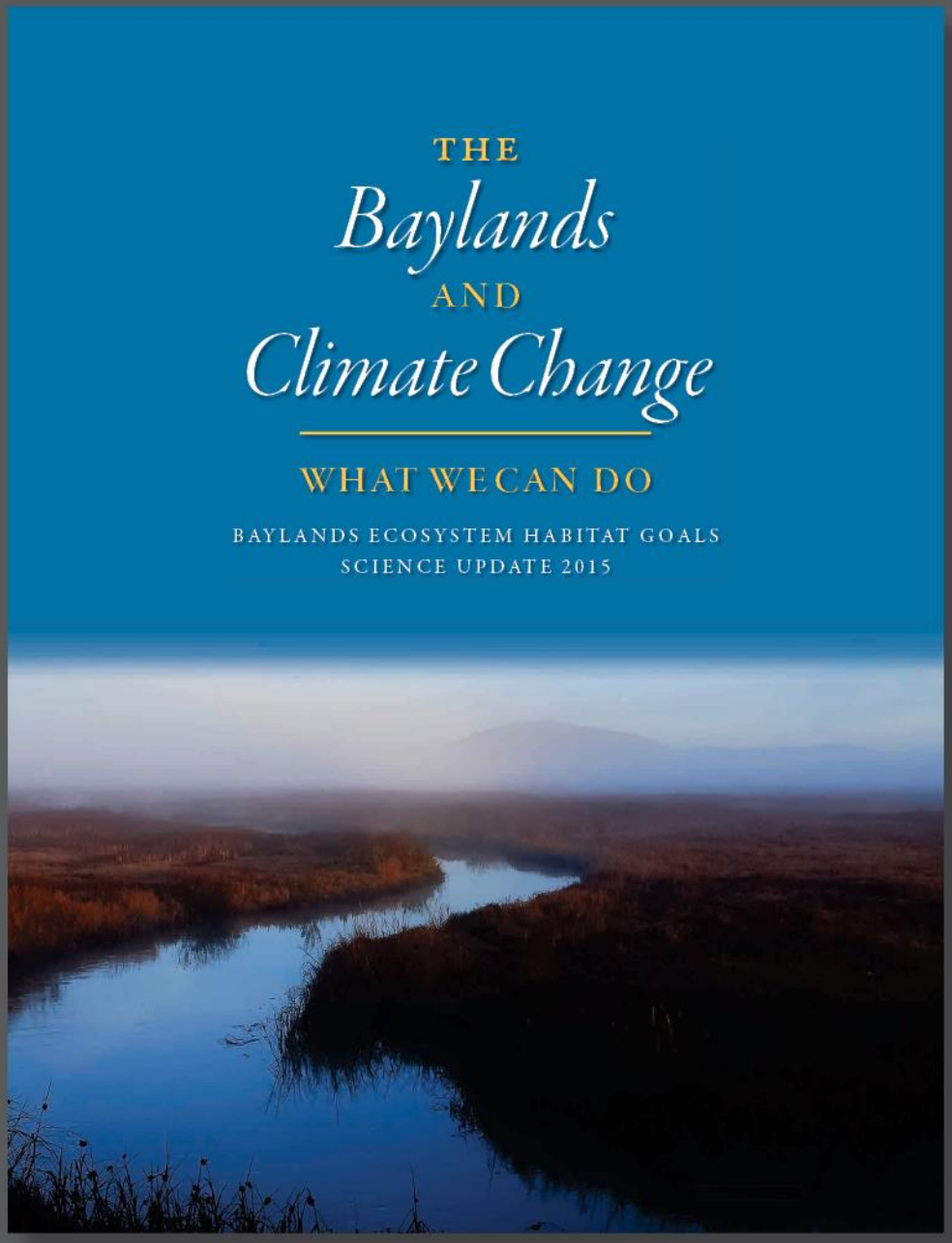
GLOBAL SEA LEVEL *change* SINCE 1800

Courtesy 3rd National Climate Assessment, 2014





State of California
Coastal Conservancy

BAY AREA ECOSYSTEMS CLIMATE CHANGE CONSORTIUM


Shira Bezalel

WHAT WE CAN DO

- *Restore complete systems, including processes*
- *Restore soon, in areas marshes are likely to persist*
- *Plan for the Baylands to migrate*

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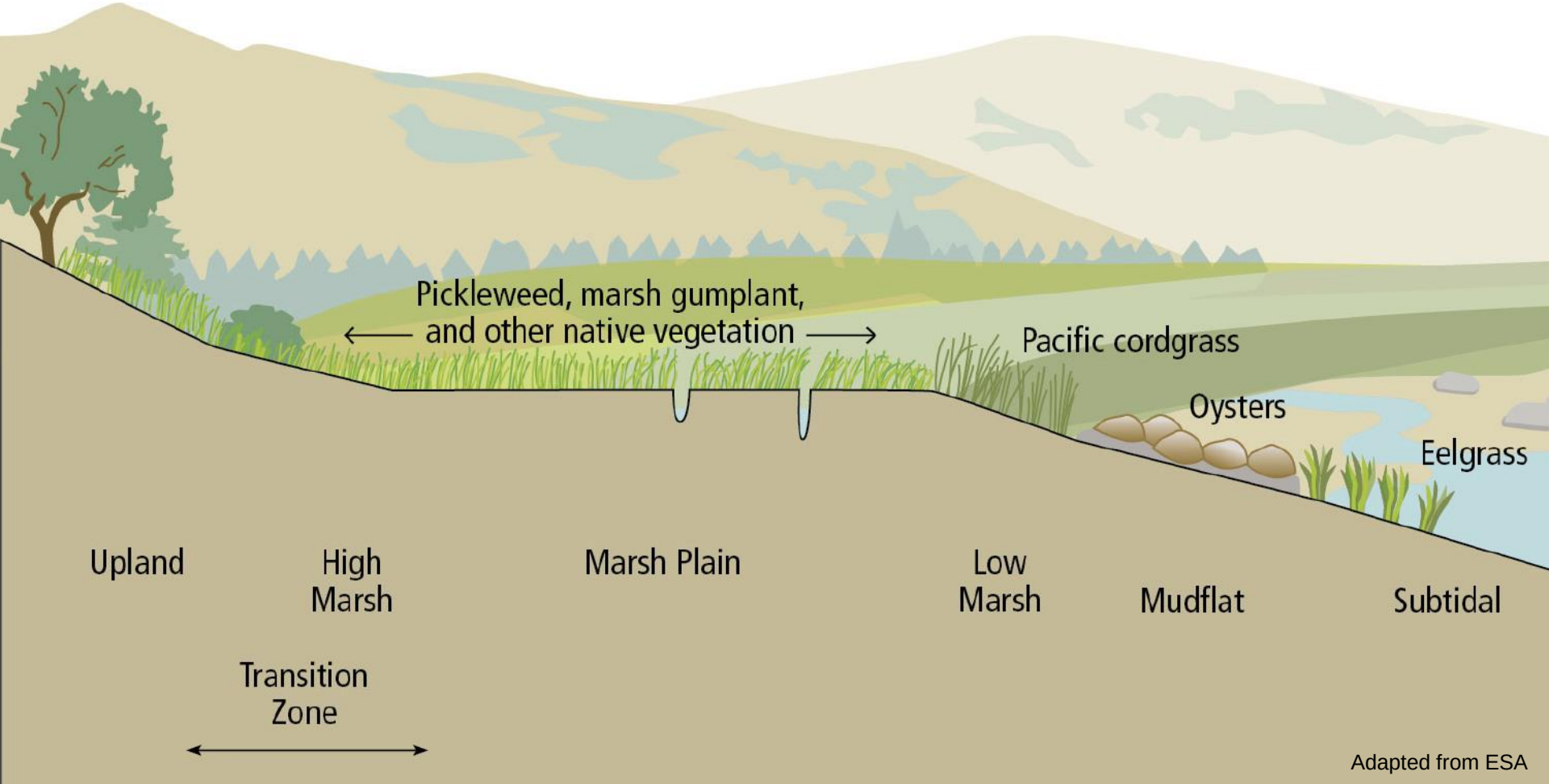
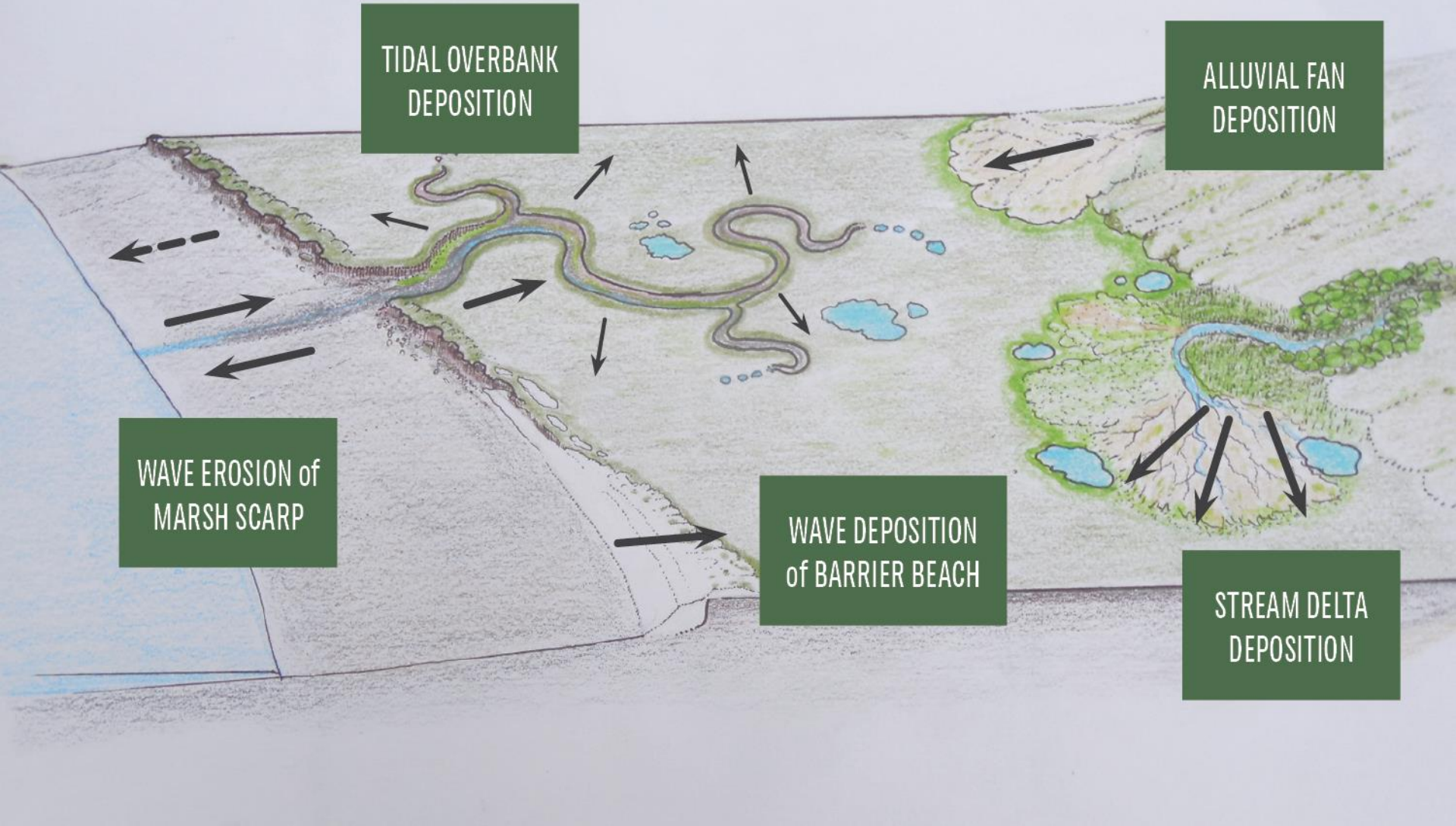
Restore COMPLETE SYSTEMS



Adapted from ESA

MEANS RESTORING PROCESSES NOT JUST PLACES

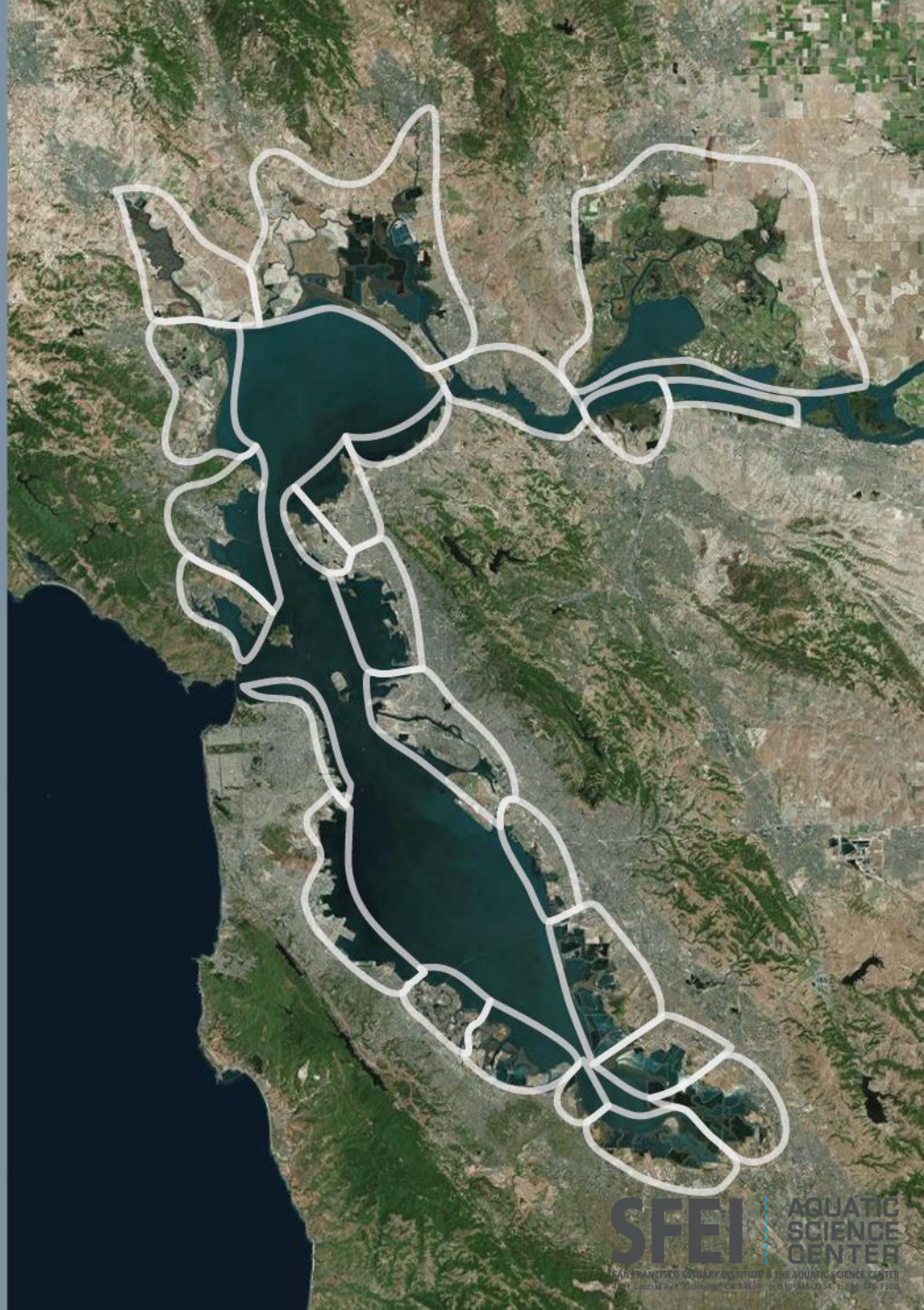
COURTESY PETER BAYE



Collaborative local

VISIONS & PLANNING

- *Define practical, science-based shoreline units*
- *Pair with appropriate adaptation strategies*
- *Convene stakeholders to create long-term vision for resilience*



PLAN FOR THE BAYLANDS TO *migrate*

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PLAN FOR THE BAYLANDS TO *migrate*

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PLAN FOR THE BAYLANDS TO *migrate*

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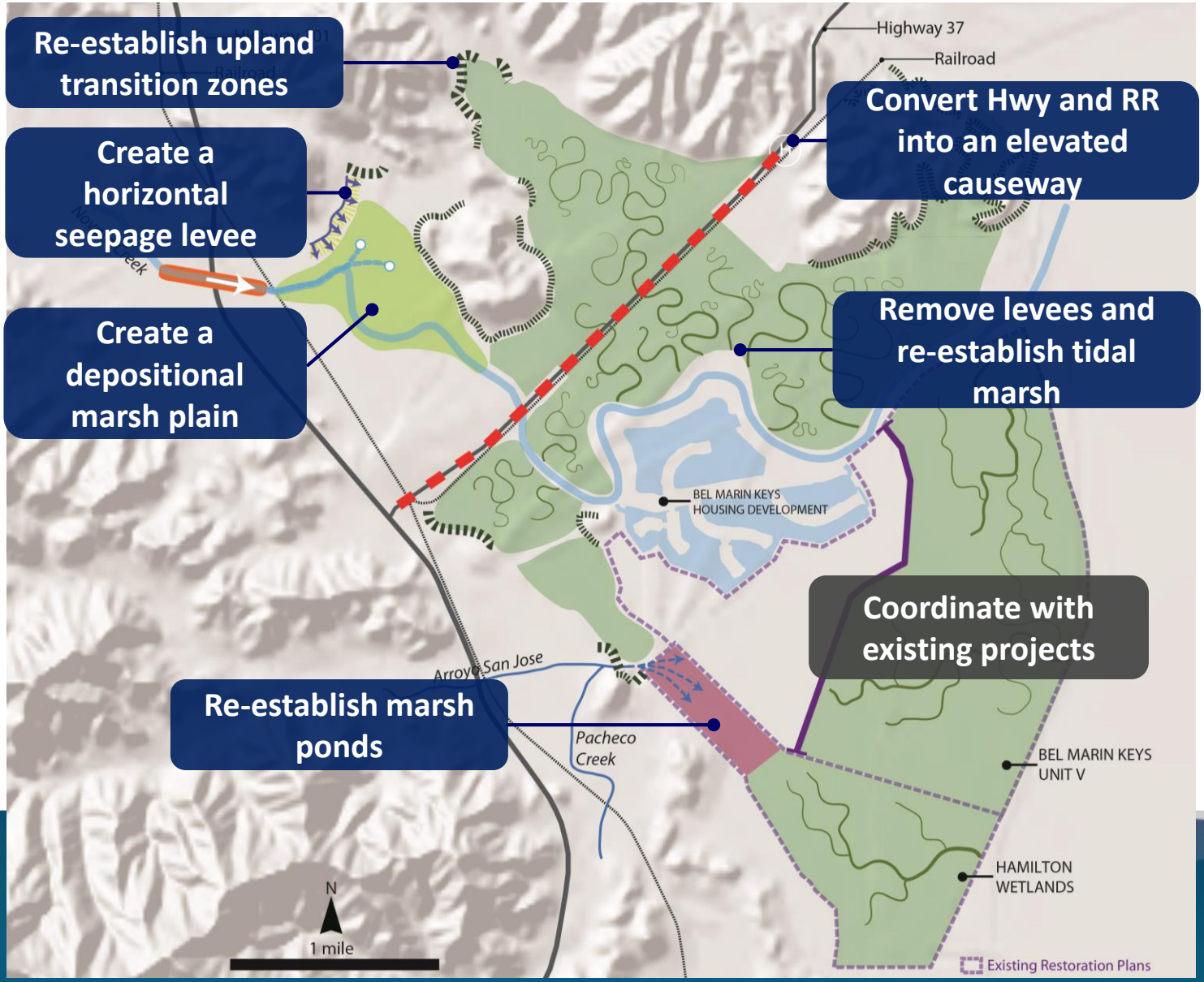
Novato Creek Baylands Long-term Vision



WE HAVE *choices to make*

Baylands Goals Science Update

www.BaylandsGoals.org

Nate Kauffman

Provide unbiased and objective evidence for identifying and defining problems

Advise on selecting the next generation of follow-up actions

Communicate limitations and opportunities of goals and objectives

Specify or develop appropriate conceptual and quantitative models; identify critical uncertainties; develop hypotheses; model alternative actions; identify data necessary to test hypotheses

Communicate new scientific understanding to decision-makers

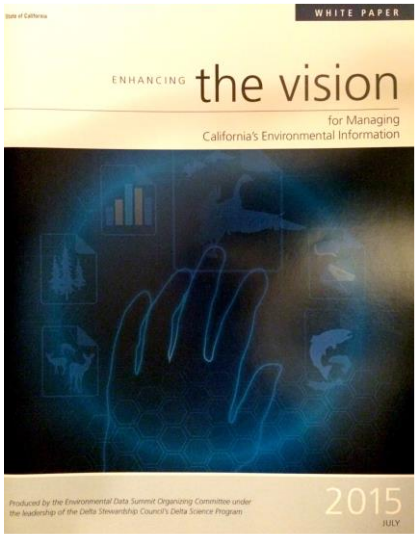
Evaluate alternative actions using information from models and decision support tools (Box 3-2); use models to develop performance measures

Analyze data, synthesize scientific information, and evaluate progress based on performance measures

Use models and tiered management questions to design monitoring. Collect, manage and share data.

Design and implement actions to test assumptions and predicted outcomes and reduce scientific uncertainties

Problem: Inaccessible Data and Inadequate Models to Describe Complex Interactions

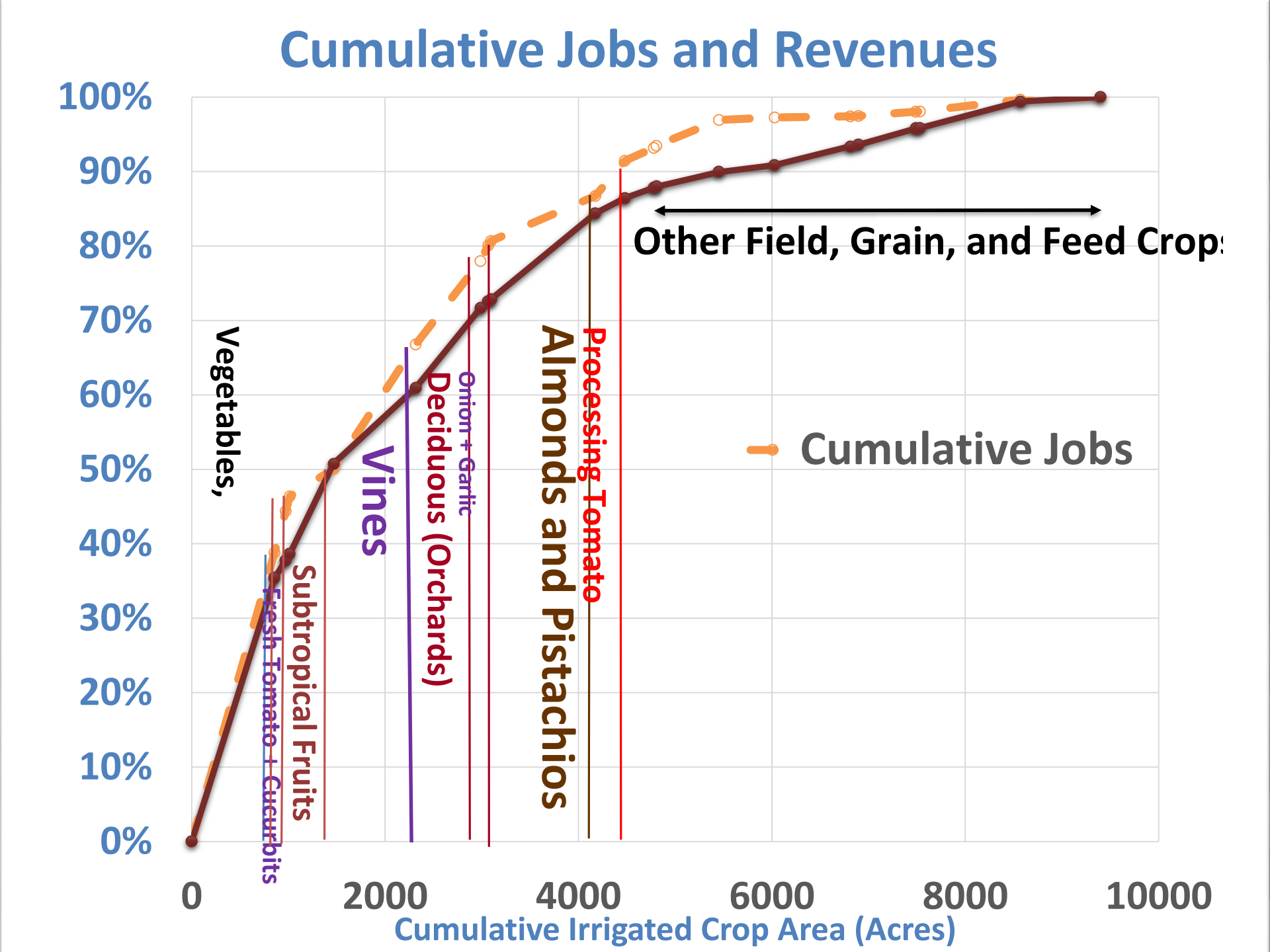


Environmental Data Management in the Era of "Big Data"
June 5-6, 2014.

Business Model, Visualization, Open Source vs Private Sector – Partnerships

http://environmentaldatasummit2014.deltacouncil.ca.gov/

Inter-disciplinary Integrated Community Modeling
May 20-22, 2015. With support from the National Science Foundation, IAHR and the California Water and Environmental Modeling Forum.


Cumulative Jobs and Revenues
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2000
4000
6000
8000
10000
Cumulative Irrigated Crop Area (Acres)
Other Field, Grain, and Feed Crops
Cumulative Jobs
Vegetables,
Subtropical Fruits
Fresh Tomato + Cucurbits
Vines
Deciduous (Orchards)
Onion + Garlic
Almonds and Pistachios
Processing Tomato