



California's Strong Modeling Legacy and an AI-Inspired Future

Peter Goodwin

May 12, 2025

Presentation Outline

- Big Messages from CWEMF 2024 (30th Anniversary)
- The 2024 Messages Applied to Tidal Wetland Recovery
- Two Contemporary Challenges
- The **Lund** Challenge – what can AI tell us?

An Internationally Recognized Legacy

– Selected Examples

- Native Fish Species.
- Modeling of Hydrodynamic and Sediment Dynamics.
- Role of Nutrients in Estuaries.
- Identification, fate and effects of contaminants: notable examples include selenium and mercury.
- Adaptive management principles
- SFEWS Journal

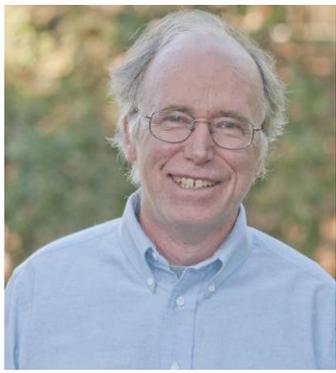
Source: Sam Luoma

Delta Science Plan Workshop February 20, 2025

Innovation is not surprising

4th largest economy in the world

3 of top 10 and 7 of top 50 universities in the world



Messages from 2024



Dr. Jay Lund's 2024 CWEMF Keynote

The Unsung Heroes: Tribute to Francis Chung for the vision of CALSIM.

- Sociology of modeling is important
 - Within a modeling group
 - Modeling group within larger contexts
 - Technical – IT, data providers, software support, etc.
 - Interagency and multi-group contexts, contracts, etc.
 - Policy/management users of results
 - Finance, deadlines, continuity, etc.
 - Communications, norms, information diffusion
- CWEMF's many virtues for improving social aspects of modeling ...

Messages from 2024

John Burau: (Stacy Tanaka, 2025)

*You have to be out here and observe before you try to model
Physics to Fish, USGS Open-File Report: 2023-1087*

'Community modeling before it existed'

Francis Chung [Water Management]

Ralph T. Cheng [Hydrodynamics]

Hugo Fischer [Hydrodynamics plus shared data]

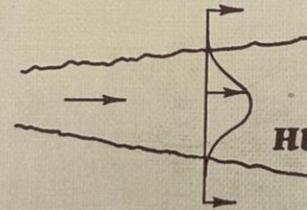
'Contemporary Initiatives'

Randi Fields and Colleagues: Water Temperature Modeling Platform

Hugo Fischer



MIXING in Inland and Coastal Waters



**HUGO B. FISCHER
E. JOHN LIST
ROBERT C. Y. KOH
JÖRG IMBERGER
NORMAN H. BROOKS**



Hugo Fischer



Hugo Fischer and CE209
Class, May 1982



Hugo Fischer



Hugo Fischer and CE209
Class, May 1982

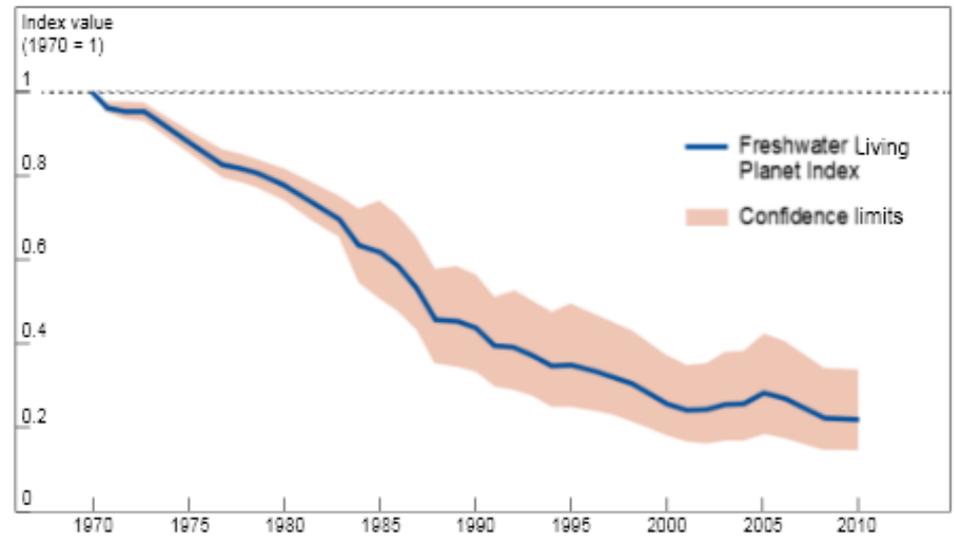
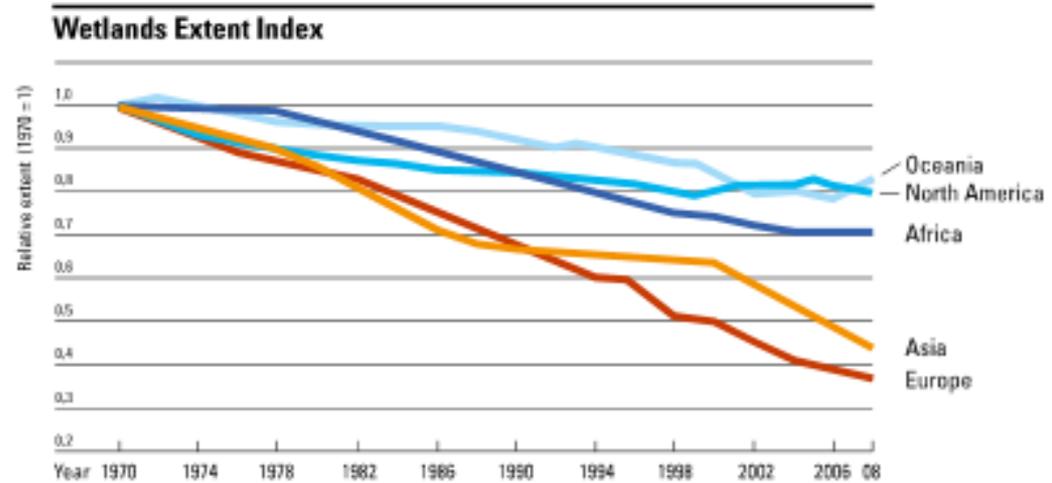
Image: California Invasive Plant Council
<https://www.cal-ipc.org/plants/profile/eichhornia-crassipes>

Global Wetland Losses

Ramsar, 2015

Global loss of 87% since 1700s
(Ramsar, 2015)

- Agriculture + Silviculture
- Grazing
- Water Diversions
- Coastal Development
- Conversion to deepwater conditions
- Nutrients and Pollution



The Freshwater Living Planet Index shows a decline of 76% between 1970 and 2010 based on trends in 3,066 populations of 757 mammal, bird, reptile, amphibian and fish species.

WWF, 2014

Tidal Wetlands in California

Loss is significant

80% in California - 97% in San Francisco Bay

80% loss in habitat => 50% loss in species [E.O. Wilson]

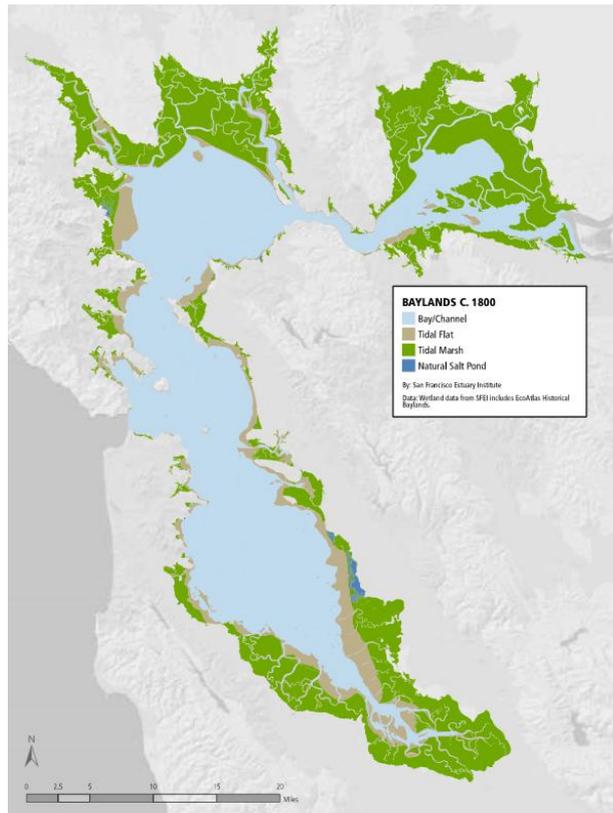
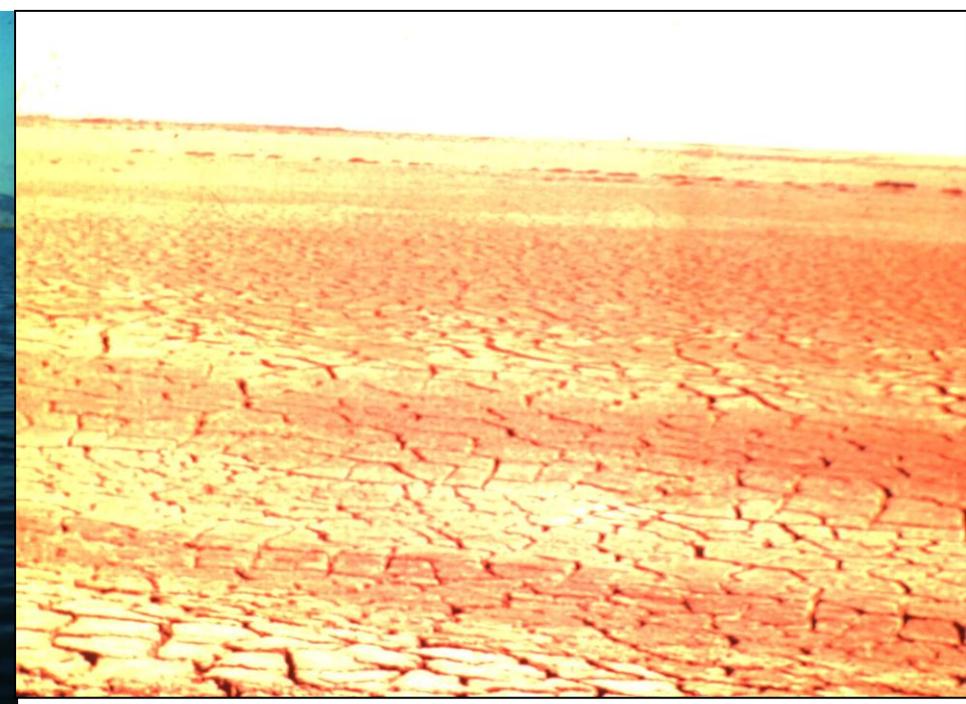


Figure 4 Baylands habitats c. 1800. See box 2 for more detail about the data and assumptions for this map.



First Generation of Modeling for Tidal Wetland Recovery (1970s)

- Phyllis Faber, Mike Josselyn, Phil Williams, California Coastal Conservancy (Reed Holderman, Laurel Marcus et al.)
- Restore Tidal Action
- Single Discipline
- Observation – it has to be more than elevation.

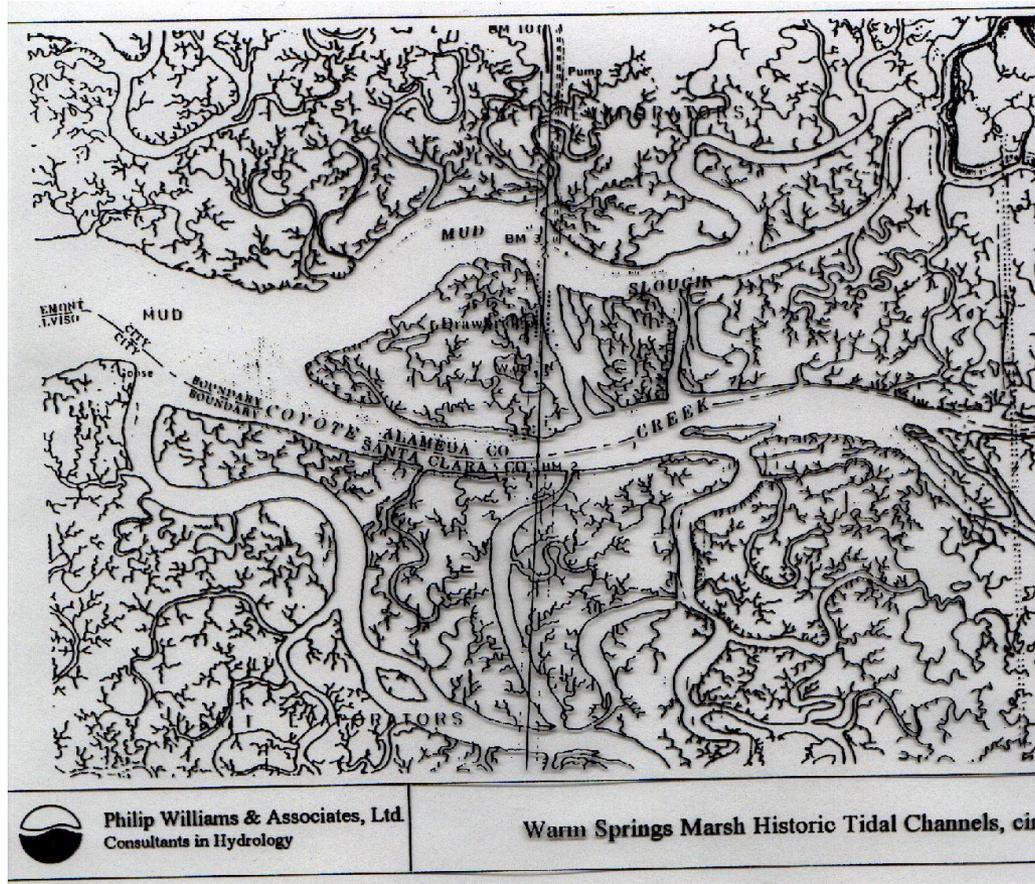


Raymond Pestrong:

Raymond Pestrong:

PESTRONG, R. 1965. The development of drainage patterns on tidal marshes. *Stanford University Publications, Geological Sciences* 10:1–87.

[Google Scholar](#)



Historic Marsh
US Coast and Geodetic Survey
c. 1870

Second Generation of Modeling for Tidal Wetland Recovery – 1980s

Phil Williams (Luna Leopold).

Hydraulic geometry.

Design Guidelines for Tidal Channels in Coastal Wetlands

US Army Corps of Engineers. 1995 and subsequent updates
[PWA/ESA]

Dynamics of Tidal Inlets

- up to 50% change in inlet area in one tidal cycle

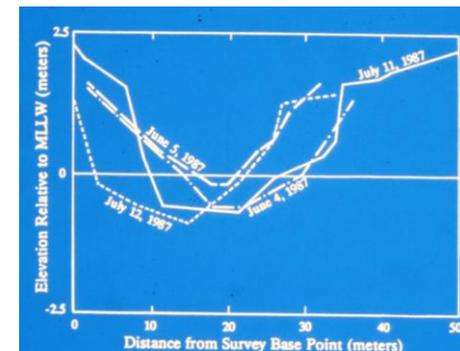
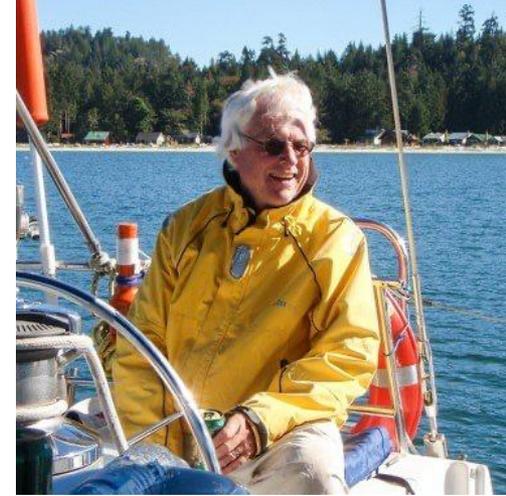
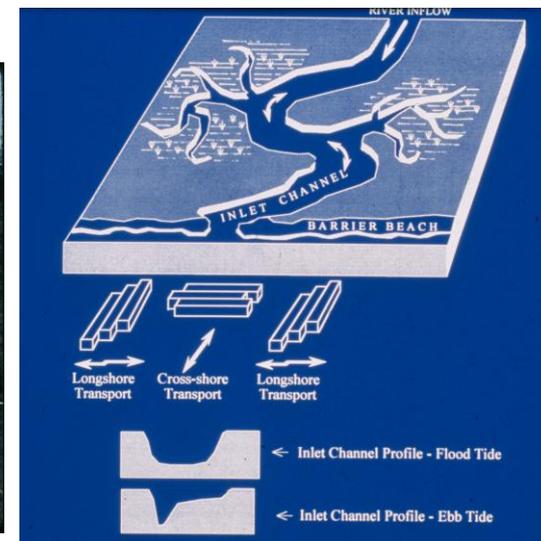


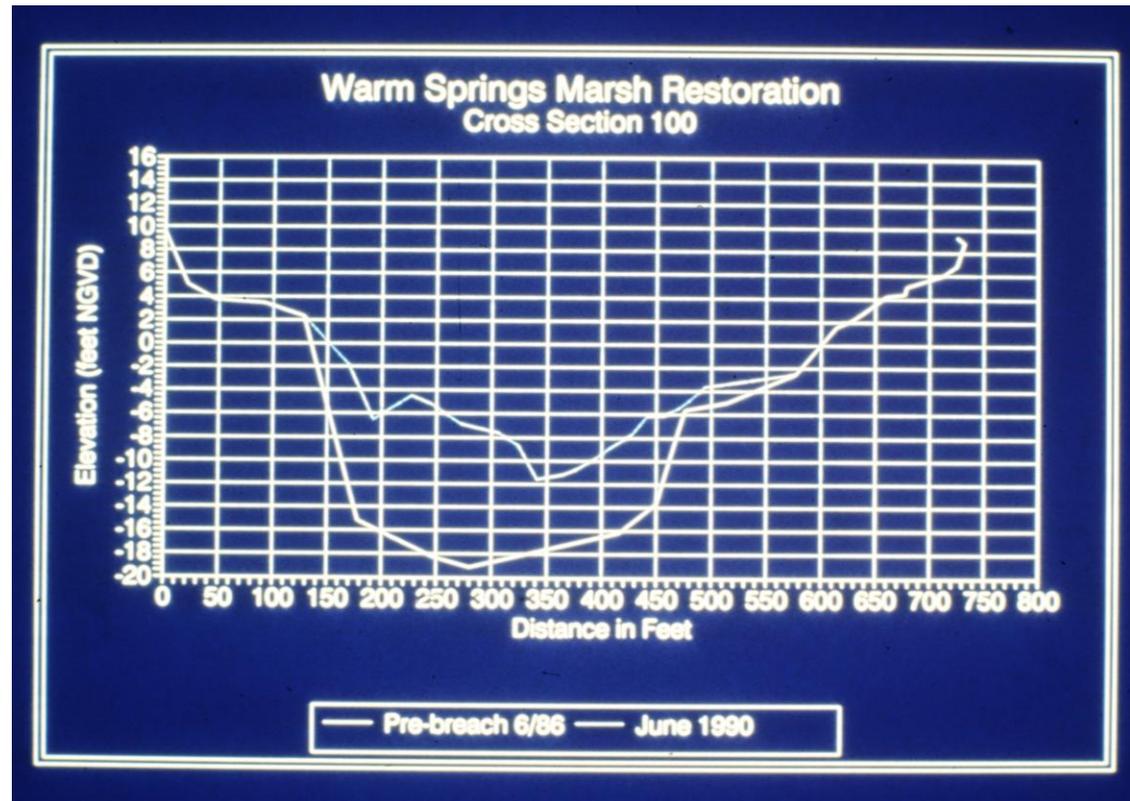
Figure 3 Variation of the Tijuana Estuary Inlet Channel Area (Data Source: Webb, 1989)

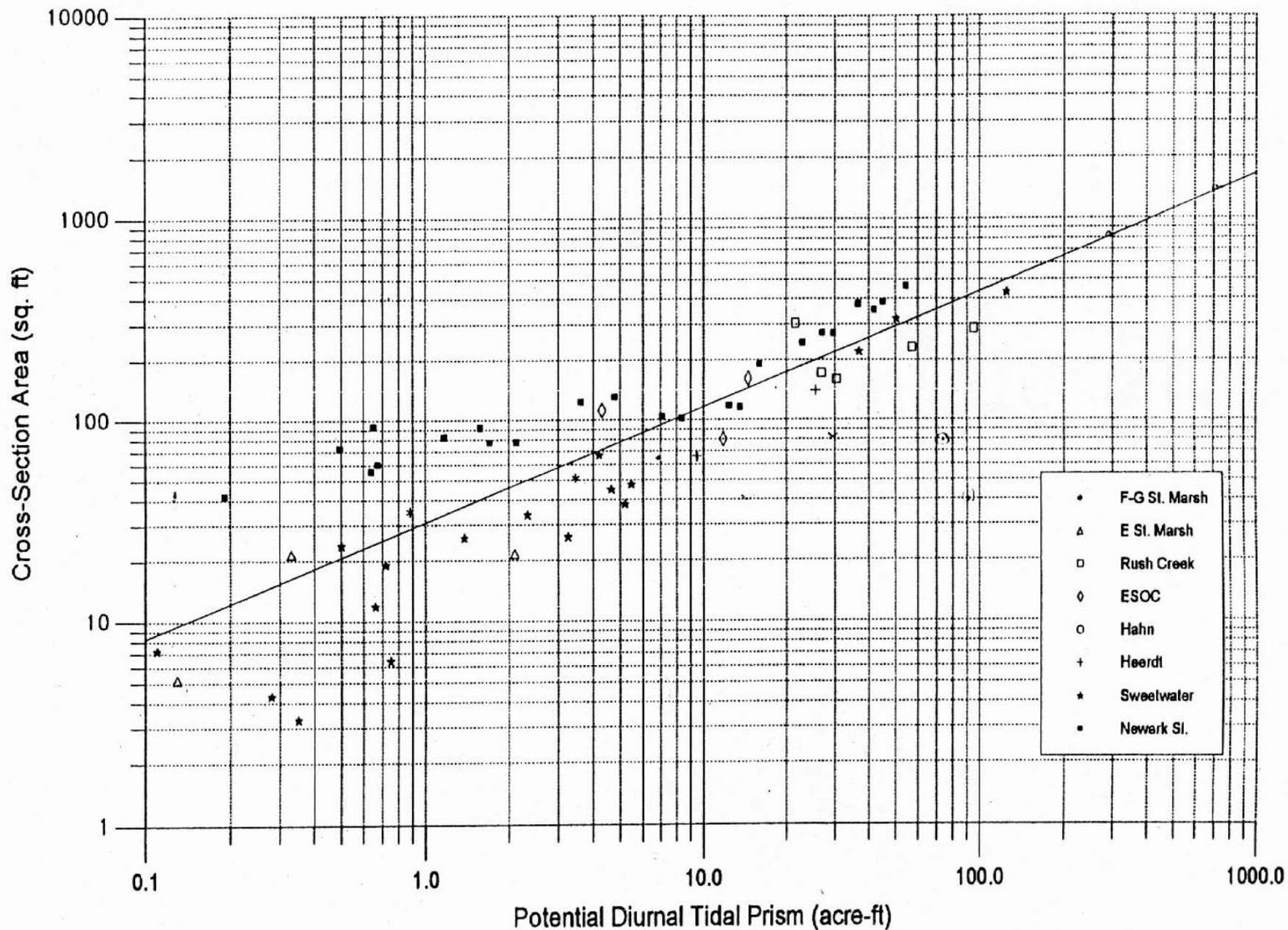
Second Generation of Modeling for Tidal Wetland Recovery – 1980s

- Recognition of Role of Physical Processes – including wave action
- Development of geomorphic templates
- Monitoring of performance
- Adaptive Learning/Management



Second Generation of Modeling for Tidal Wetland Recovery – 1980s





CKCA YDGEOM/TPXS94K.GR1/7-27-94



Department of the Army
 Waterways Experiment Station
 US Army Corps of Engineers
 PO Box 631
 Vicksburg, Mississippi 39180

CHANNEL CROSS-SECTIONAL AREA VS.
 TIDAL PRISM IN TIDAL SLOUGHS

FIGURE
 5.2-3

Tidal Marsh Evolution

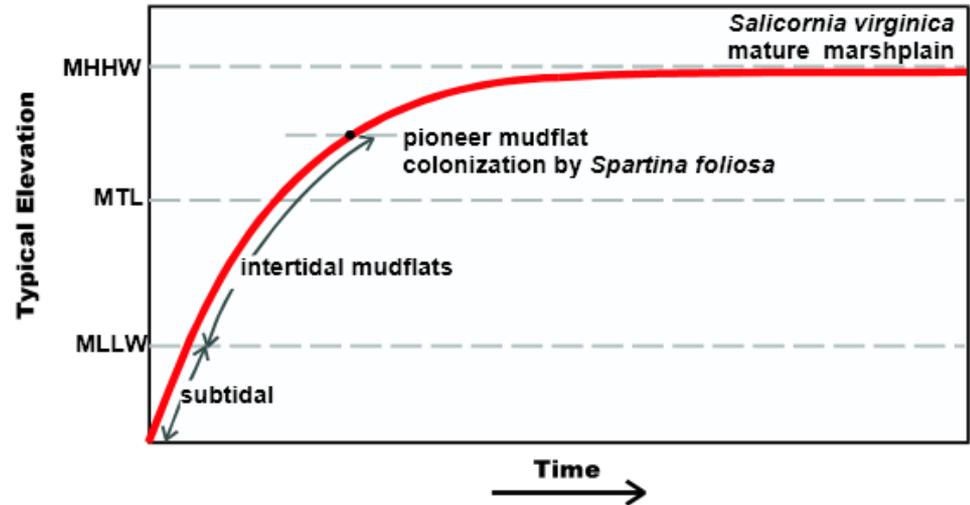


Muzzi Marsh, 1980



Muzzi Marsh, 1984

Krone algorithm for sedimentation



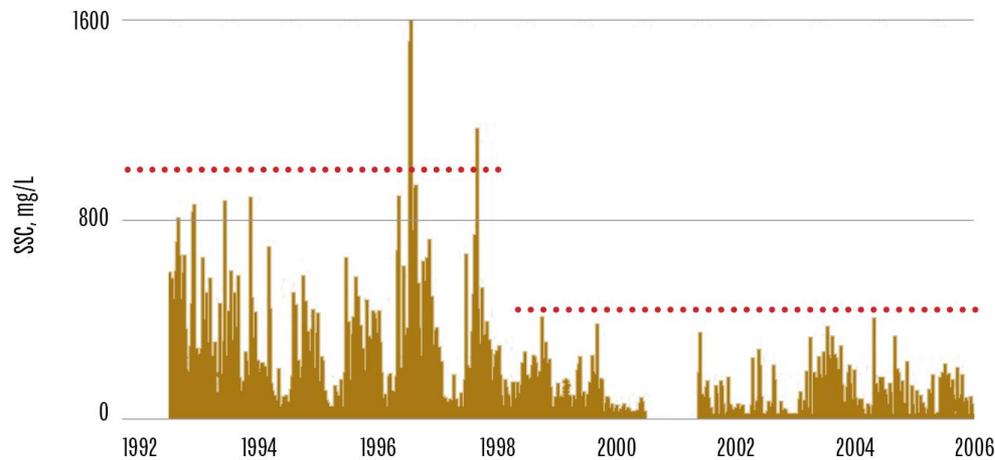
Muzzi Marsh, 2003

Influence of Hydraulic Mining on Bay Wetlands

Ray Krone/ Dave Schoelhamer

SEDIMENT SUPPLY *reduction*

Courtesy
Dave Schoelhamer
2011





Ancient Marsh – >1000 years old

Modern Marsh – 1920s



Third Generation of Modeling for Tidal Wetland Recovery – 1990s

Refinement of models, data collection, databases of characteristics, interpretation

Adaptive management and commitment to long-term monitoring

Designs much closer to dynamic equilibrium

Third Generation of Modeling for Tidal Wetland Recovery – 1990s

Flooding and Drying – Lisa Roig, Ian King UC Davis and RMA

Jeff Lewandowski and
Rod Sobey UCB

Josh Collins:
mapping micro-channels.



The importance of drainage density and sufficiency of shear stress to create 1st and 2nd order channels

Sonoma Baylands

- Study completed 1991
- Reintroduction of tidal flows, 1996

Philosophy:

Pump material into site.

Allow to settle and consolidate

Breach levees on small scale and allow tidal channels to evolve around a template that reduced wind and wave action.

Will material stay in place or flow back into the Bay?



Ray Krone and Ashish Mehta

Image courtesy of ESA

Project Team

ESA (PWA)

Sonoma Land Trust

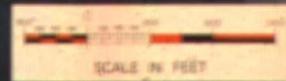
Coastal Conservancy

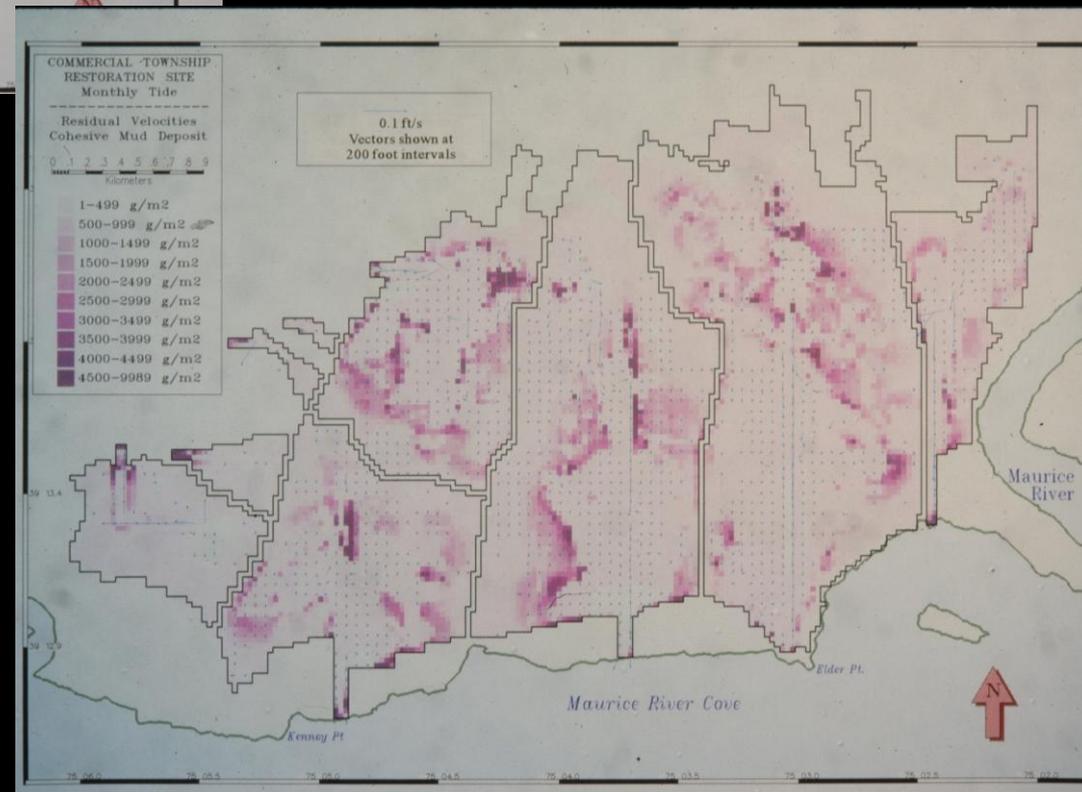
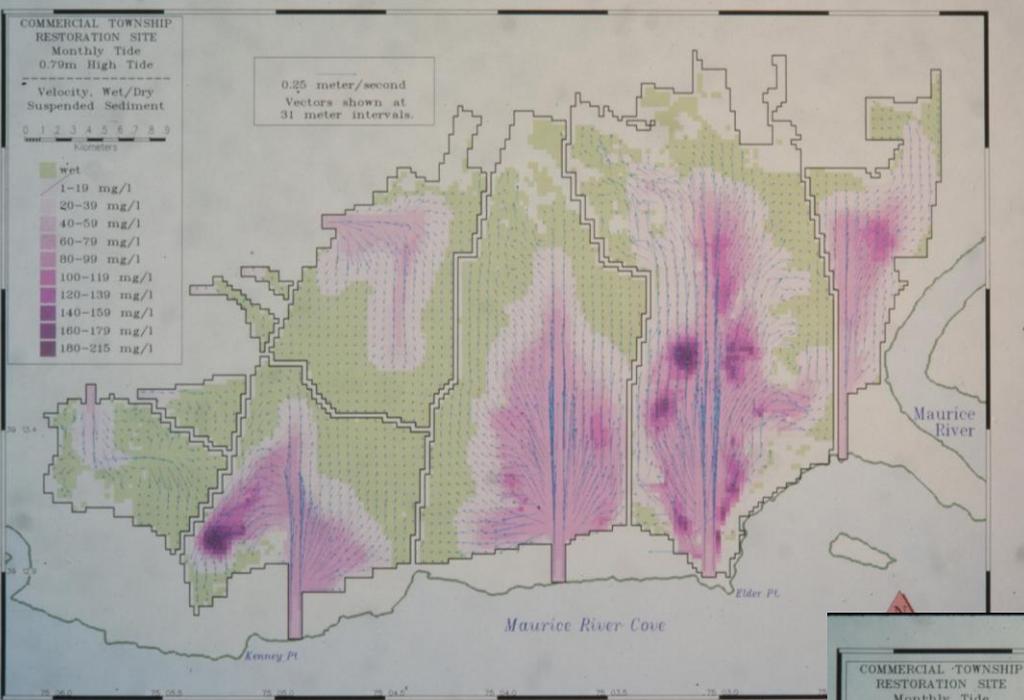
US Army Corps of Engineers

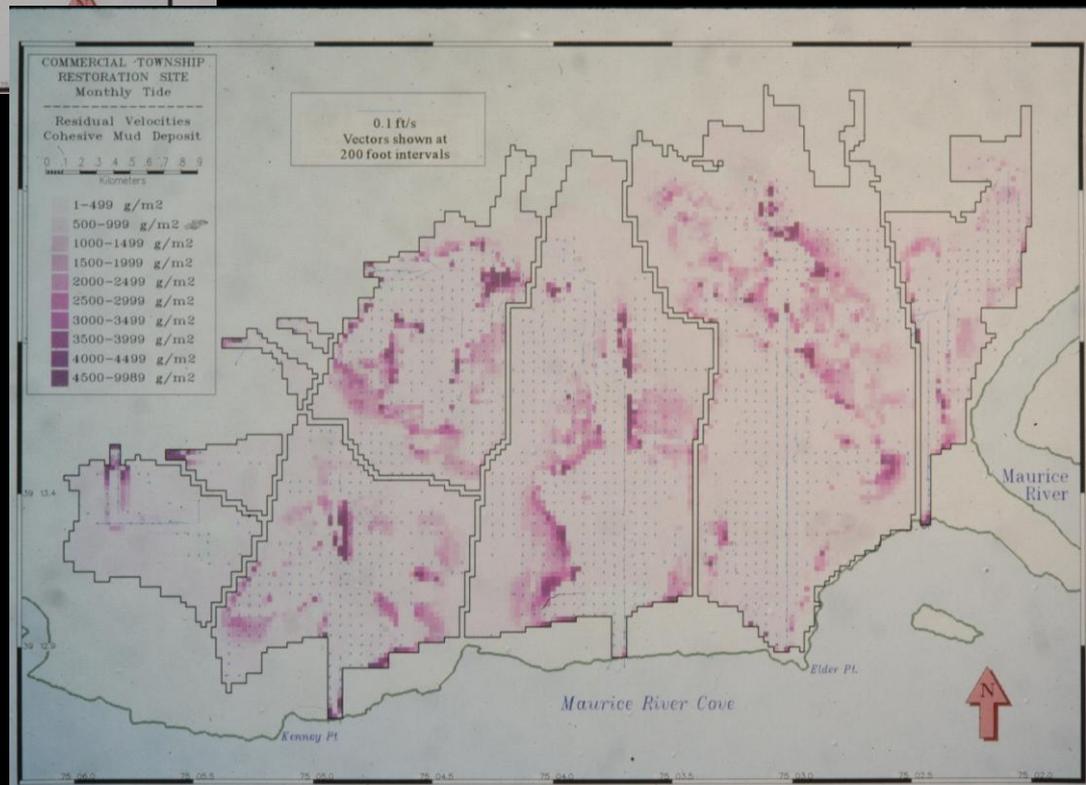
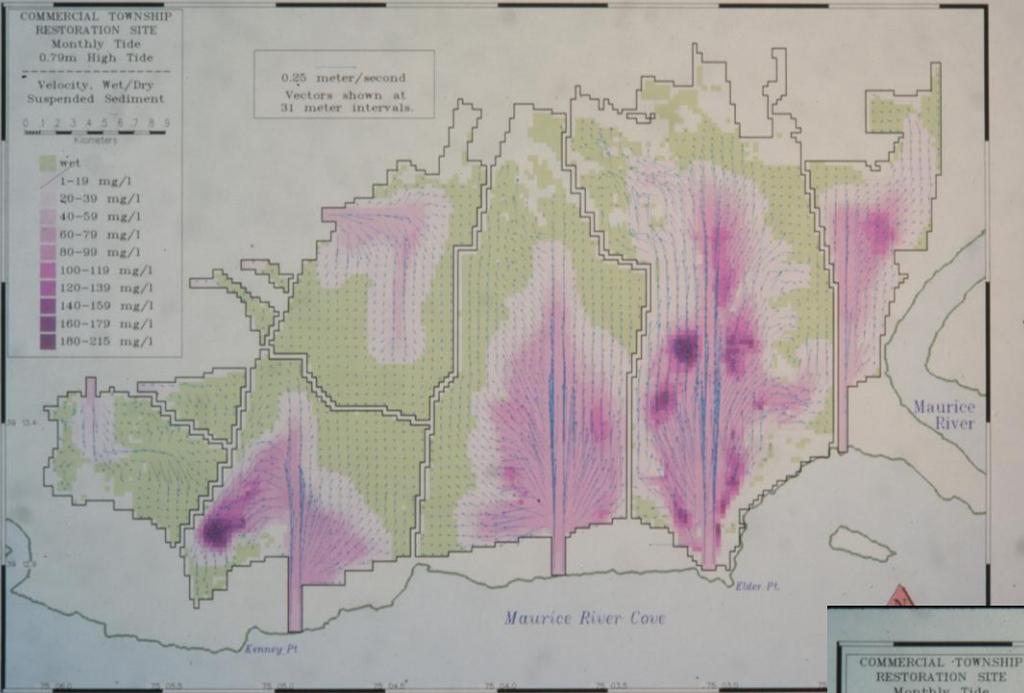




DELAWARE BAY







Tidal Wetlands Restoration: Fourth Generation

- Landscape Ecology
- Historical Ecology
- Not to 'restore' since landscape irreversibly altered
- Understand key process to restore ecosystem function
- Carbon Sequestration
- Mosaic of habitats
- Scale to restore processes
- Systems Perspective
- Building elevation: Brian Bergamaschi
- 'Win-Win-Win' Strategies

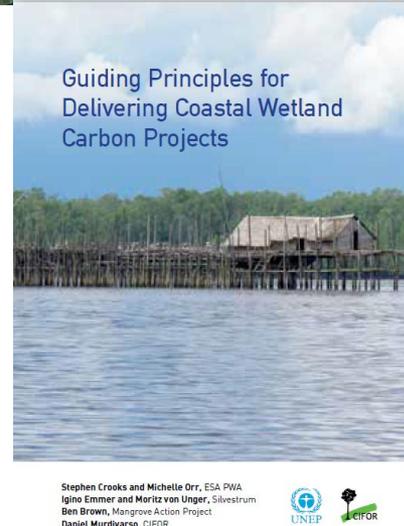
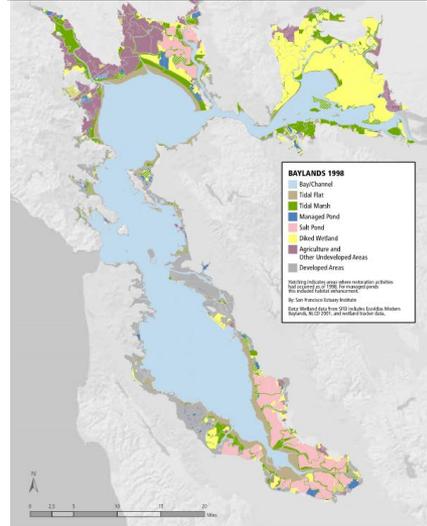
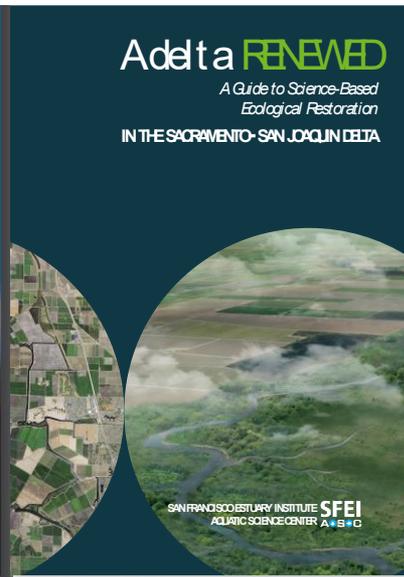
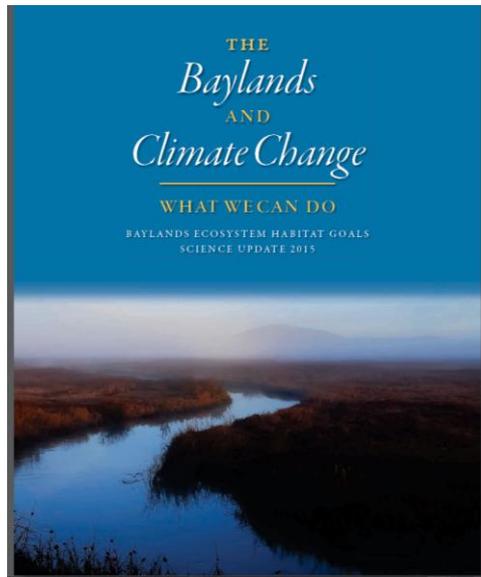


Figure 5 Baylands habitats in 1998. See box 2 for more detail about the data and assumptions for this map.

R. Grossinger, Alison Whipple, L. Grenier, C. Enright, J. Burau, S. Crooks and many many others

Contemporary Challenges:

Our Collective Responsibility

Trust in Science, Engineering and Modeling

A recognized problem for 20+ years:

Science: Becoming the Messenger. NSF Workshops with Dan Agan, Chris Mooney et al.

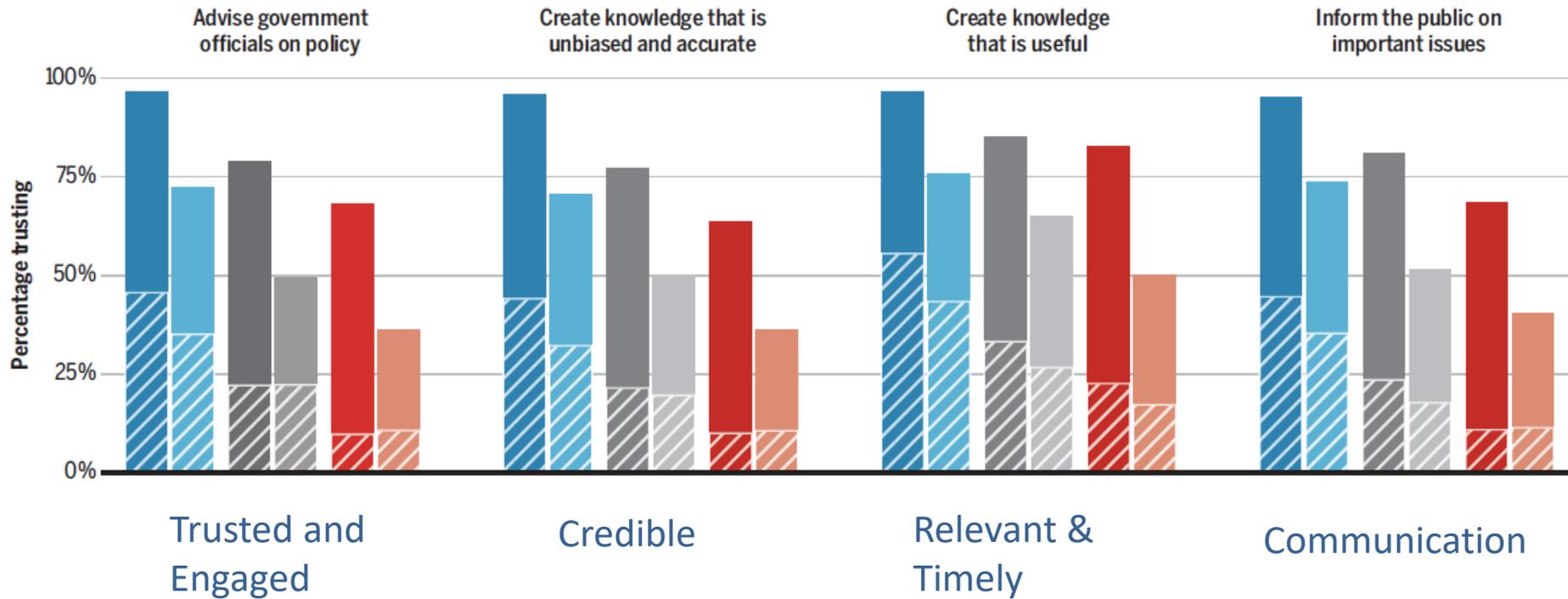
Alan Alda Center for Communicating Science, Stony Brook University

Rising Above the Gathering Storm. and many others

Different models, differing scientific findings can inspire innovation and accelerate discovery:

but if not managed constructively this can result in inaction, side-lining of science, foster belief in *tobacco science* and generate lack of trust.

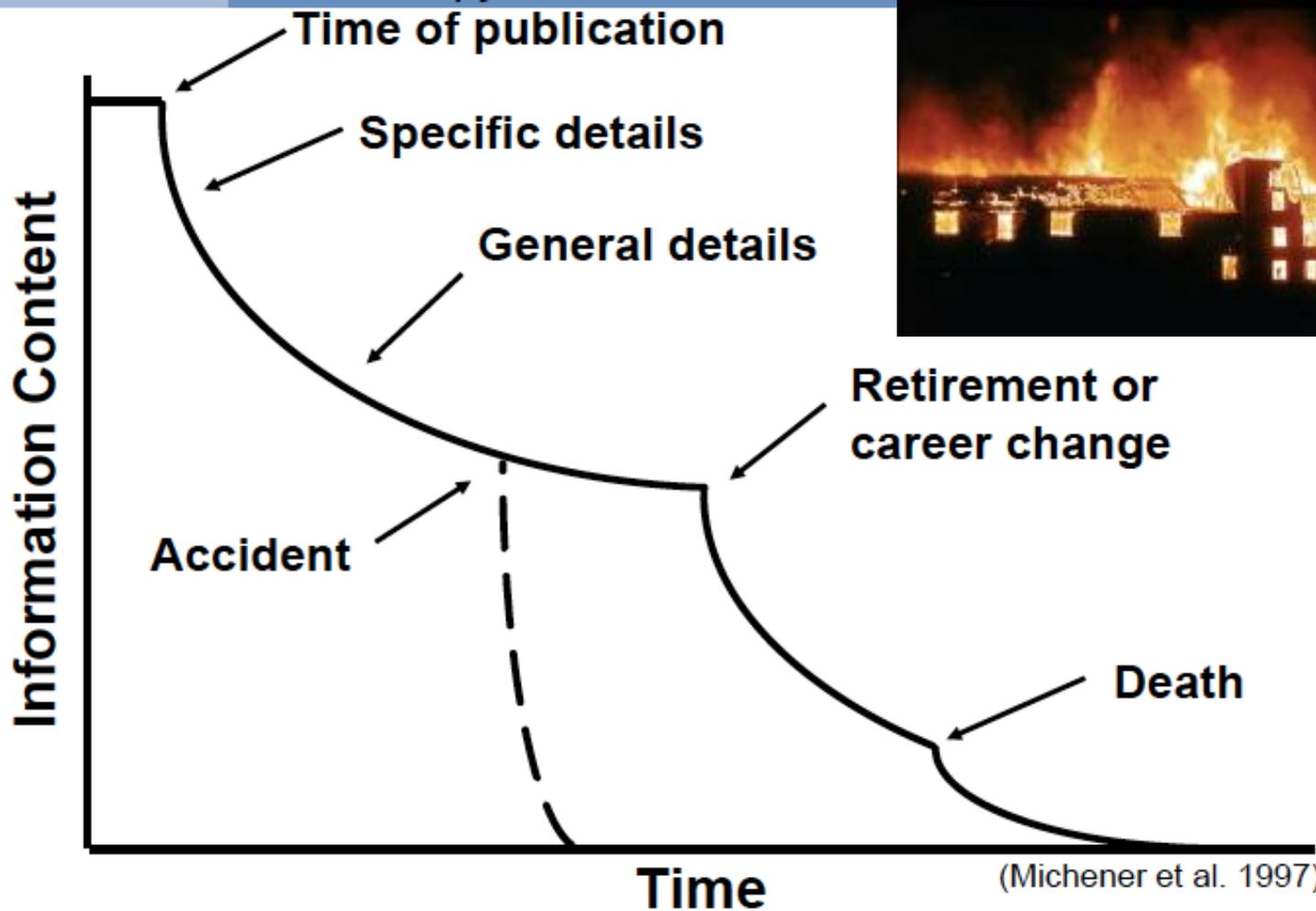
How much do you distrust or trust scientists to _____ ?

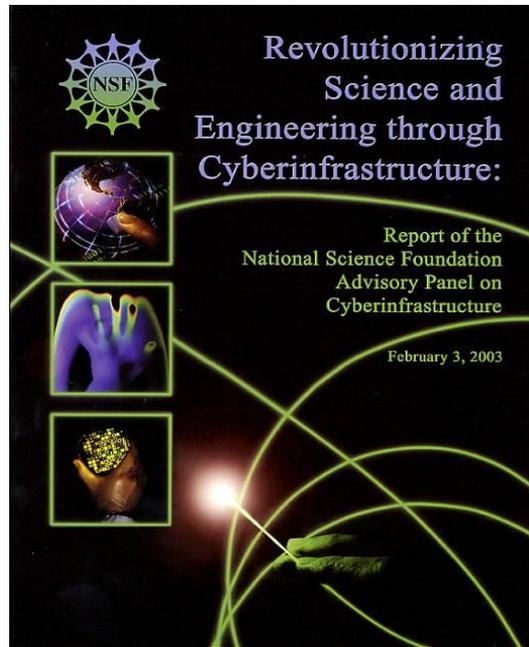
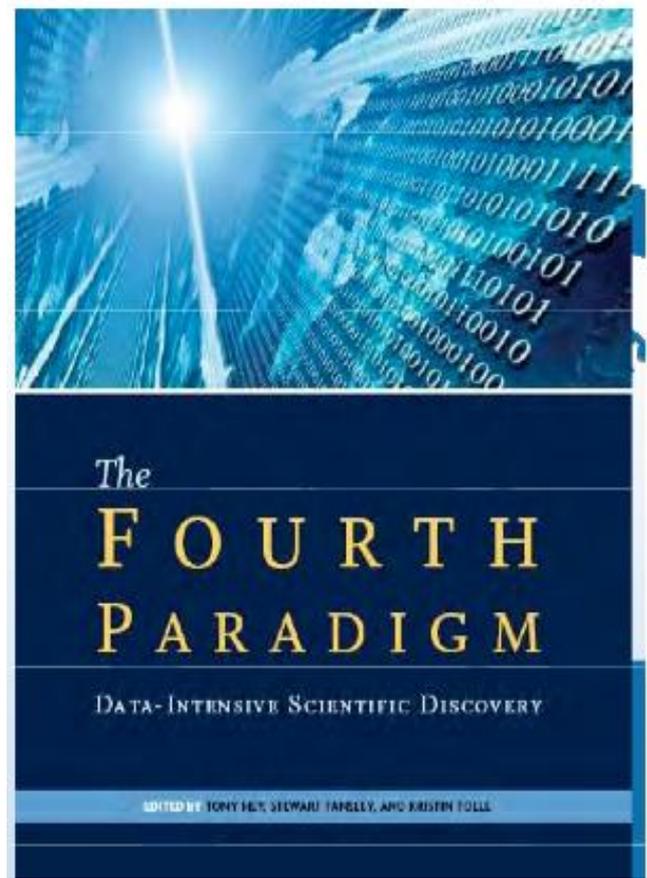
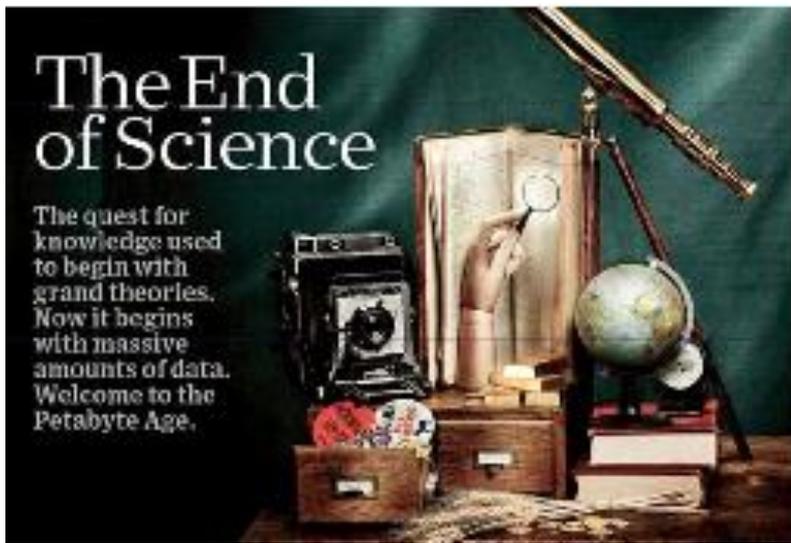


Darker colors represent 'Political Elites'
 Lighter colors represent 'Likely Voters'
 Solid colors represent 'Partially Trust'
 Hatched columns represent 'Completely Trust'

Source: Furnas, A.C., T.M. LaPira and D. Wang, 2025. Partisan disparities in the use of science in policy. *Science*. V. 388, Issue 674.5. 362-367.

“data entropy”





Atkins Report, NSF, 1996

*Cyberinfrastructure Is Ever-Increasing.
Dr. Bement, April 2006*

*Science and Scholarship are team sports
A. Blatecky NSF CI Director, 2003*

California's Modeling Community

Progress:

Integrated Modeling Steering Committee

CWEMF/DSP/Tetrattech Products

USBR Water Temperature Modeling Platform

DWR Training and Sustaining a CALSIM community

(per vision of Francis Chung)

Refer to Dr. Lisamarie Windham-Myers and Delta Science Program

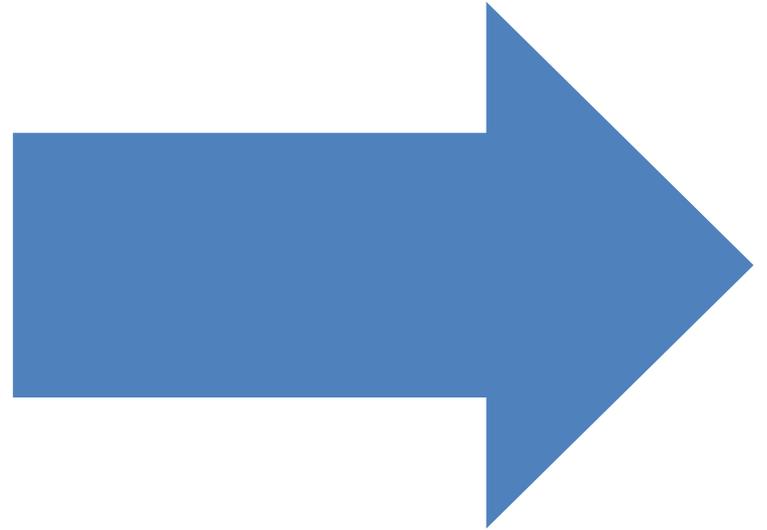
In this next technology revolution What does AI tell us?

chatGPT o1 Pro: Deep Research

DeepSeek

Perplexity AI

Google Gemini



AI: not just for generating emojis or code

You said:

I want you to give me a highly technical report on the topic of California water management with a focus on modeling. Include references. Specific issues include: What is the best? Include experiences of what has worked well in other large water and ecological management programs

ChatGPT said:

To create a comprehensive and highly technical report on California water management with a focus on modeling, I'd like to clarify a few details:

.

RAPID SYNTHESIS – with references that is a starting point for discussion

The *California Water and Environmental Modeling Forum (CWEMF)* is a long-standing example of a public-private partnership bringing together state and federal agencies, universities, consultants, and stakeholders to improve modeling. By creating neutral ground for technical exchange, CWEMF has helped standardize practices (e.g. model peer reviews, protocols) and foster a community of practice.

Recent initiatives aim to formalize collaborative modeling for complex challenges. In the Delta – the state’s most contentious water region – the **Delta Stewardship Council’s Delta Science Program** convened

USGS feature heavily and many others

Executive Charter

In light of the analysis above, it is clear that improving the use of modeling in California's water management will require concerted action from policymakers, agencies, and researchers. This **Executive Charter** outlines a set of actionable recommendations – a call to arms for elevating modeling as a foundation of water decision-making:

- 1. Establish a Statewide Modeling Governance Board:**
- 2. Invest in Open Data and Model Libraries:** Accelerate implementation of AB 1755 by.
- 3. Enhance Training and Capacity Statewide:** Launch a *“California Water Modeling Academy”*
- 4. Mandate Transparency and Peer Review in Policy Models:**
- 5. Foster Collaborative Modeling Hubs:** Examples: **Central Valley Modeling Collaborative** and **Urban Water Modeling Consortium**
- 6. Pilot Advanced Technologies with Targeted Projects:**
- 7. Align Regulations with Modeling Insights:**
- 8. Promote a Culture of Continuous Improvement and Collaboration:**

**Problems can become
come together**

opportunities when the right people

Robert Redford

**We have solved harder
problems in the past**

Dr. J. Lund

Plenary talk at the CWEMF 30th Anniversary

Thank you for your attention.