

# Towards a more heterogeneous Delta

Peter B Moyle  
Center for Watershed Sciences  
UC Davis  
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# SF Estuary viewed as a steady-state system

**Delta**

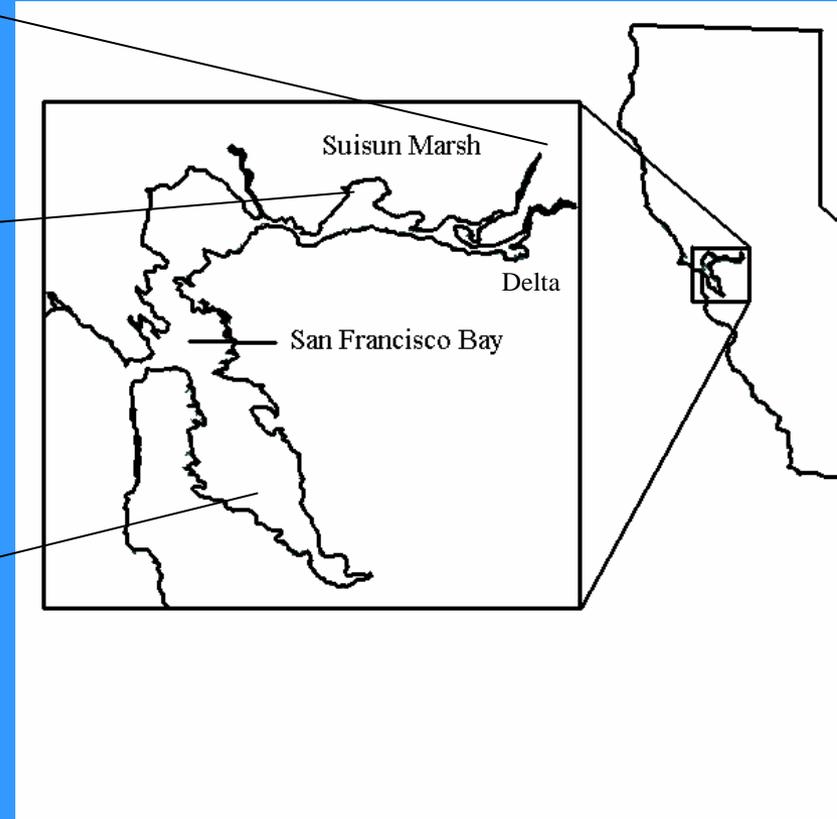
**Fresh water**

**Suisun Bay and Marsh**

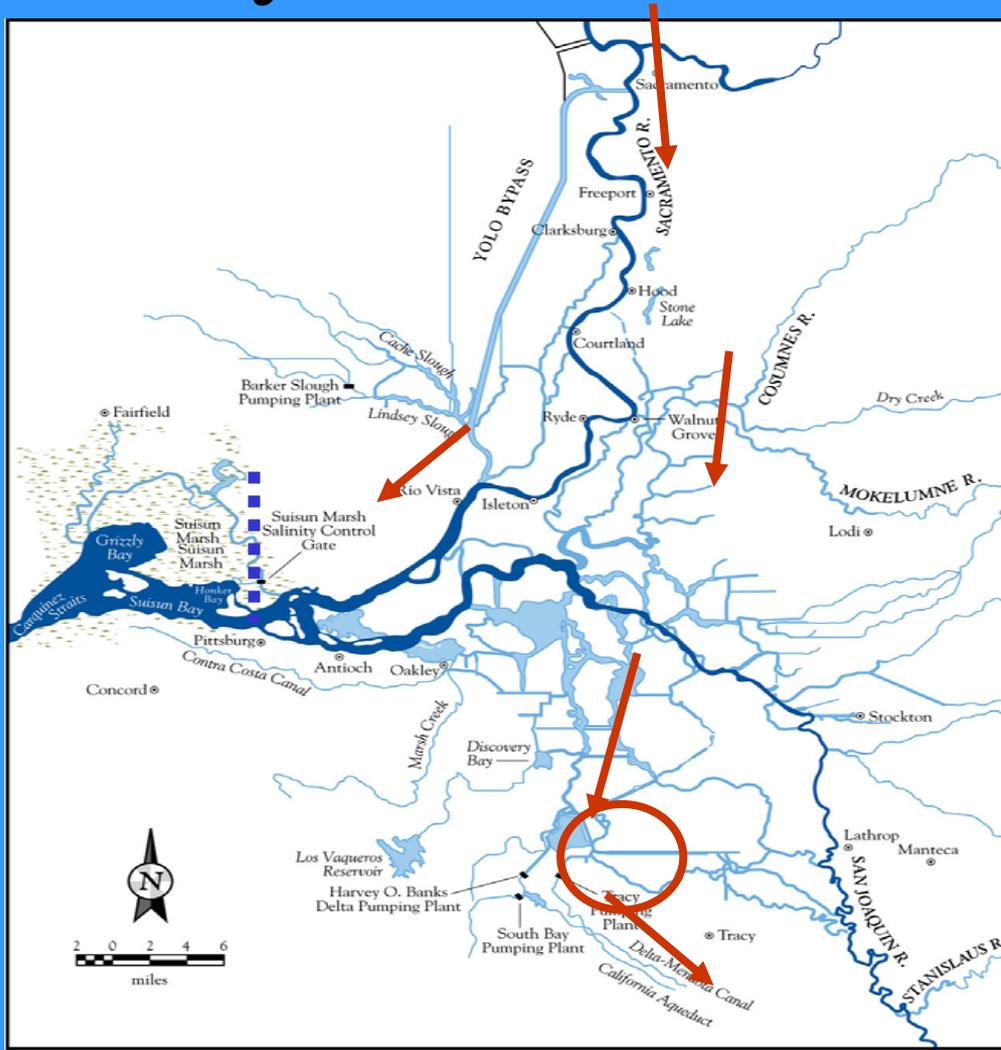
**Brackish water**

**San Francisco Bay**

**Salt water**

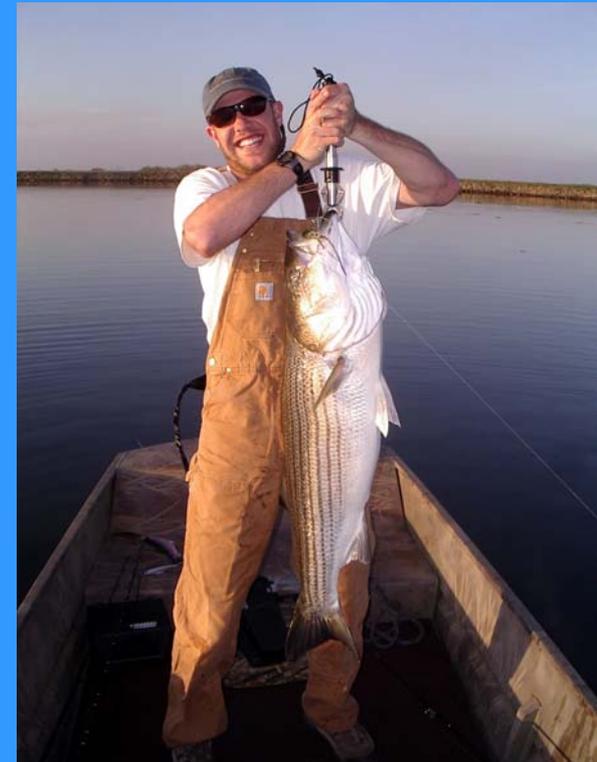


# Freshwater Delta maintained by Hydraulic Barrier



# Present estuary not working well for desirable fishes

- Native endemics
  - Delta smelt, longfin smelt, splittail
  - Six others
- Native sport fish
  - White sturgeon, green sturgeon
  - Chinook salmon, steelhead
- Non-native estuarine sport fish
  - Striped bass



# Working well for undesirable aliens

Largemouth bass,

Spotted bass

Inland silverside

Bluegill,

Redear sunfish

Red shiner

Golden shiner

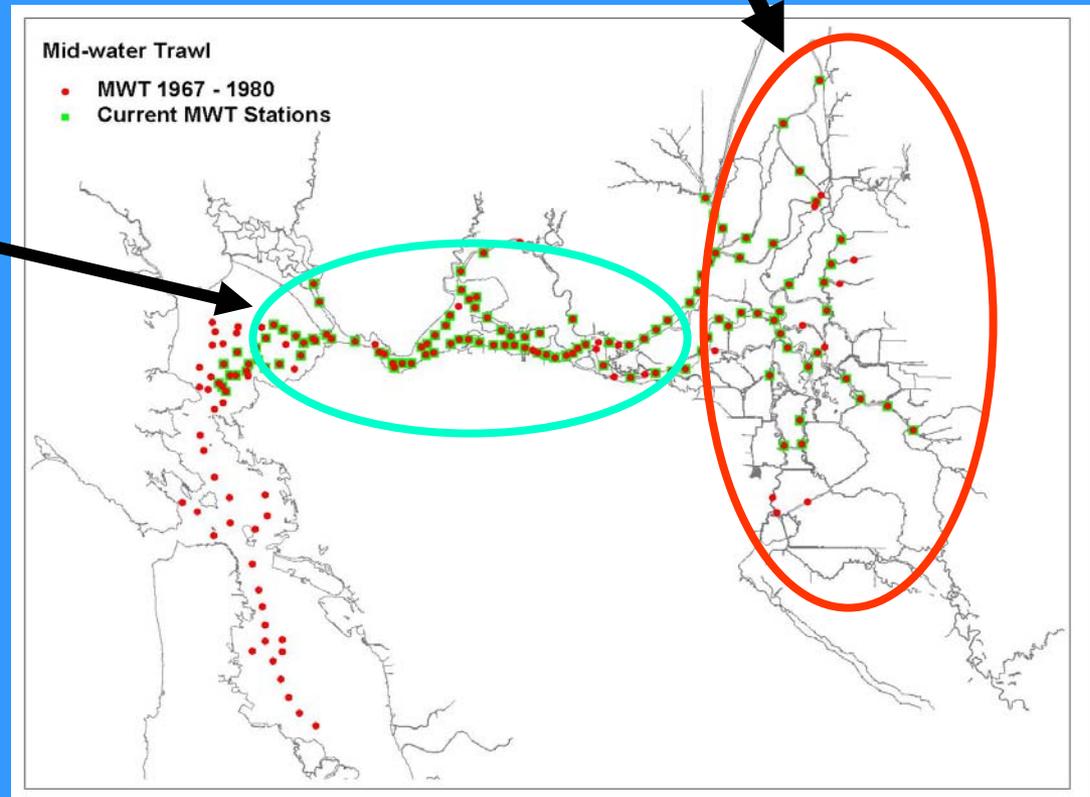
Common carp



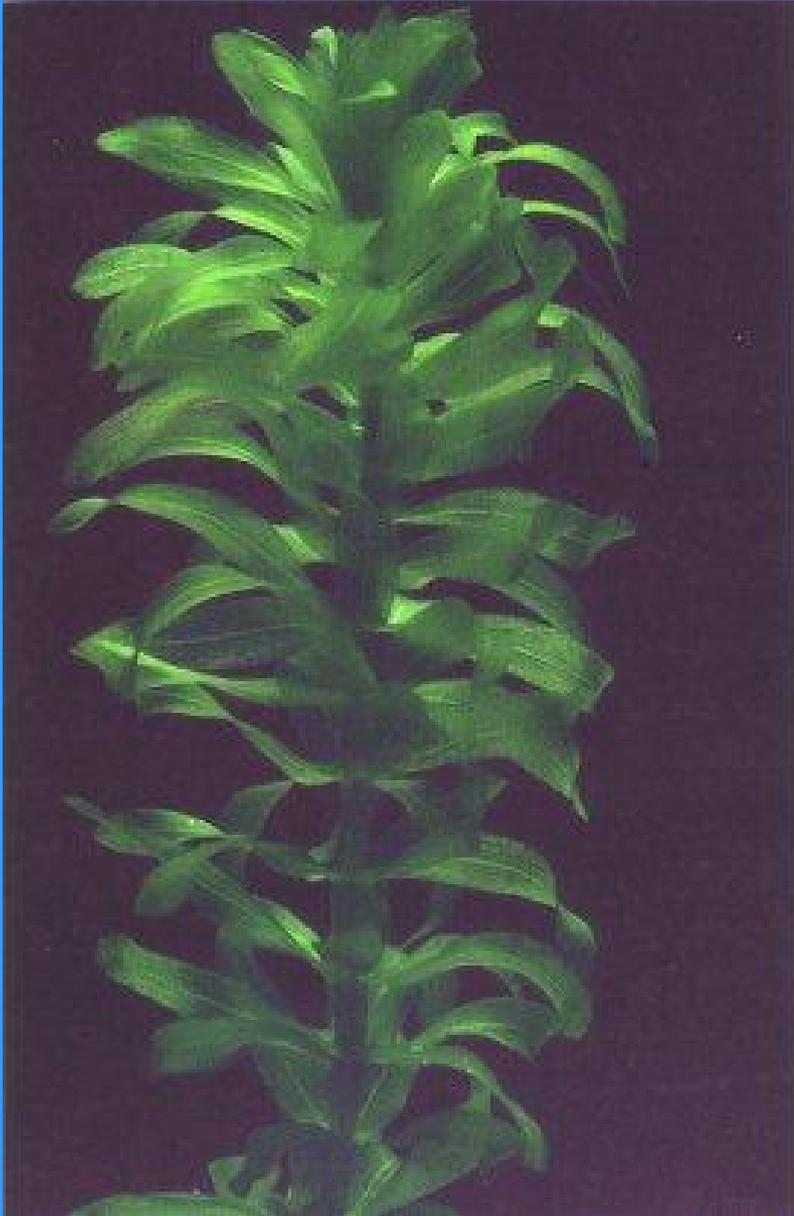
# Alien ecosystem engineers have changed the restoration game

Brazilian waterweed

Overbite clam



# Brazilian waterweed, *Egeria densa*



# Overbite clam

Invasion:  
1980s

Suisun Bay



# MAJOR CHANGES HIGHLY LIKELY IN NEAR FUTURE

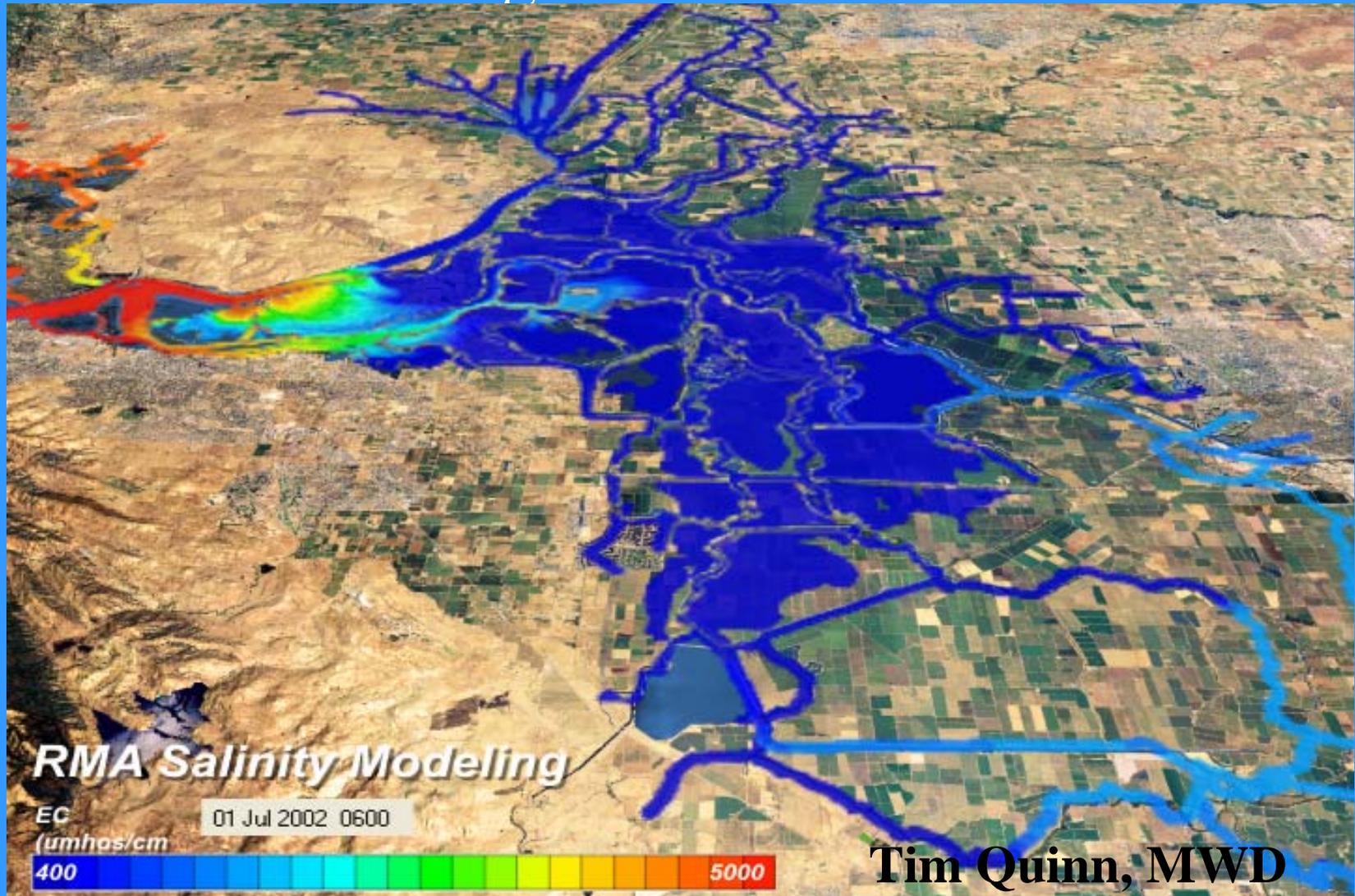
## UCD-PPIC Study



# RECIPE FOR LARGE-SCALE CHANGE

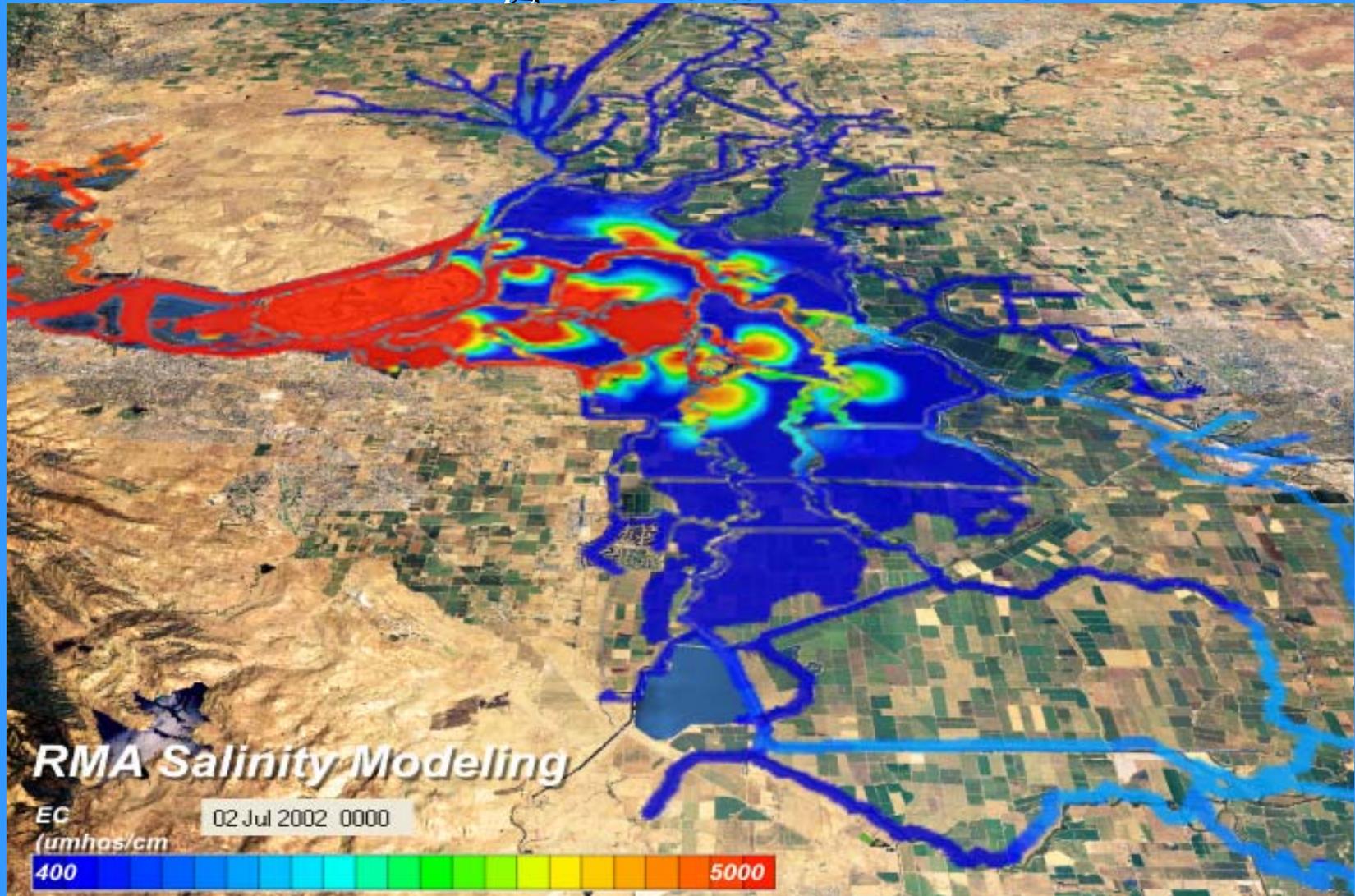
- INCREASING PROBABILITY OF EARTHQUAKE
- +SUBSIDING DELTA ISLANDS
- +RISING SEA LEVEL
- +MORE FREQUENT BIG FLOODS
- +INCREASING URBANIZATION
- = INEVITABLE LARGE SCALE CHANGE

# 6.5 Magnitude Earthquake causing 20-Island Failure



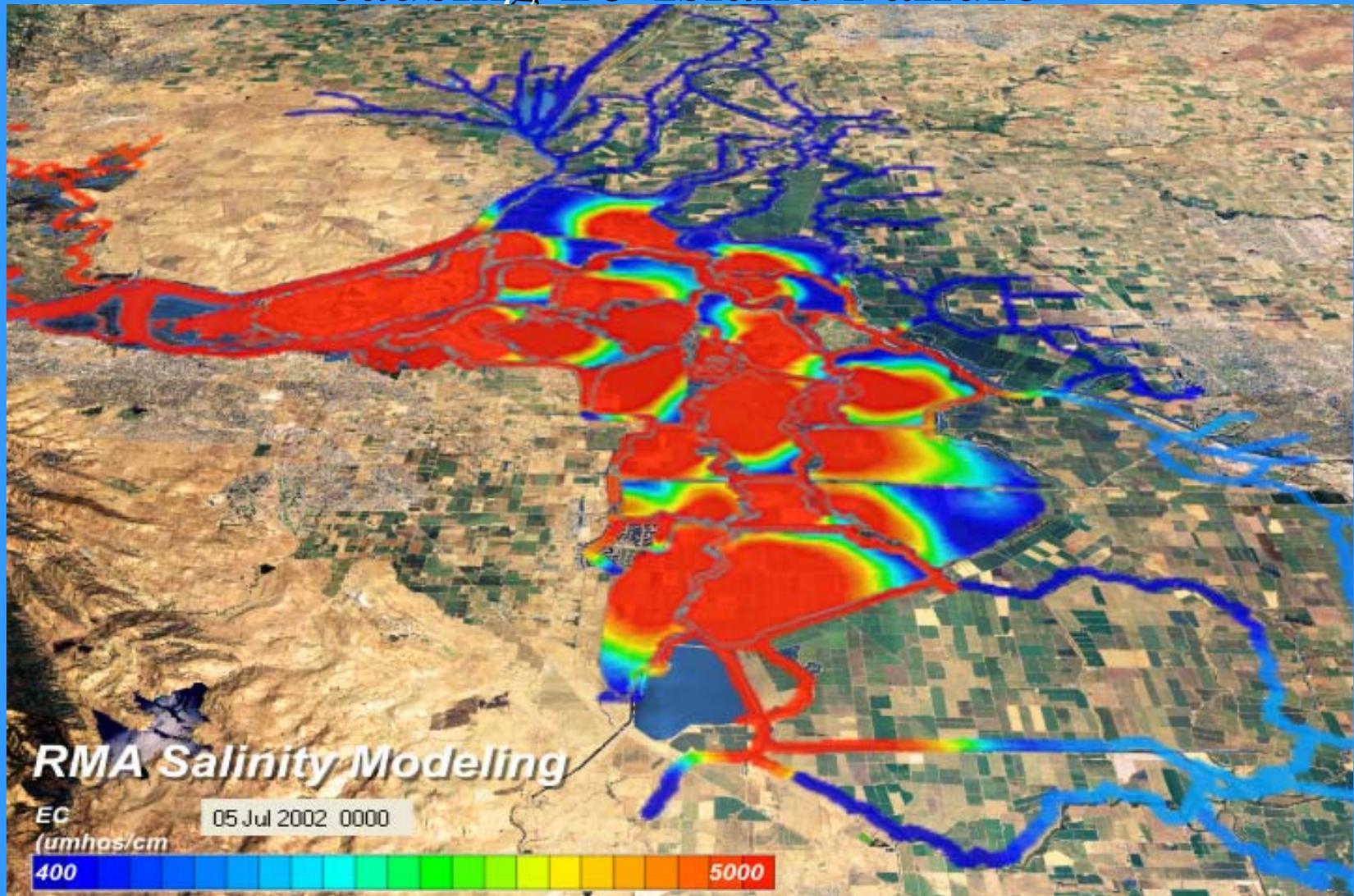
0 – 6 hours:

# 6.5 Magnitude Earthquake causing 20-Island Failure



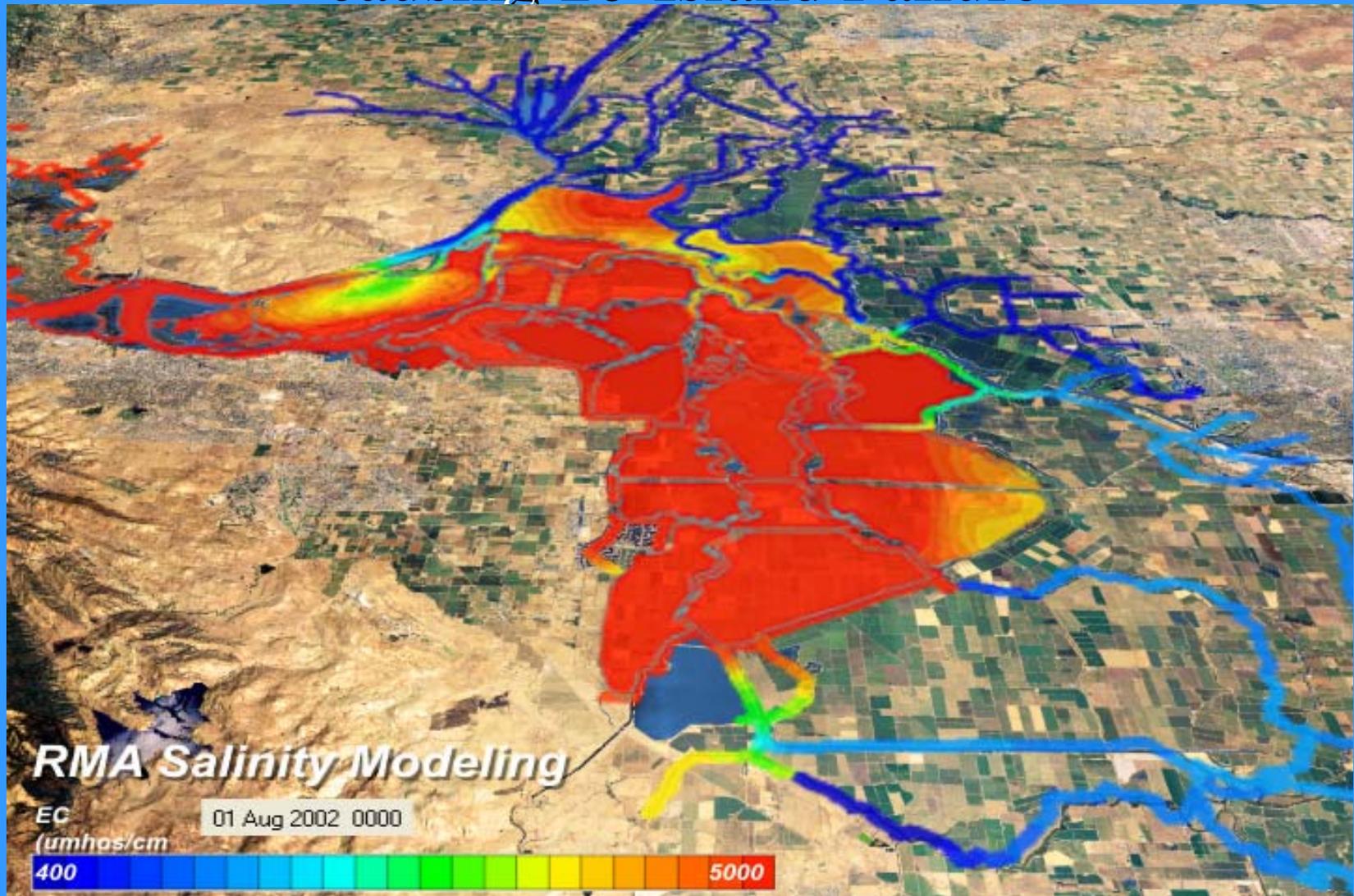
12 – 24 hours:

# 6.5 Magnitude Earthquake causing 20-Island Failure



1 – 7 days:

# 6.5 Magnitude Earthquake causing 20-Island Failure

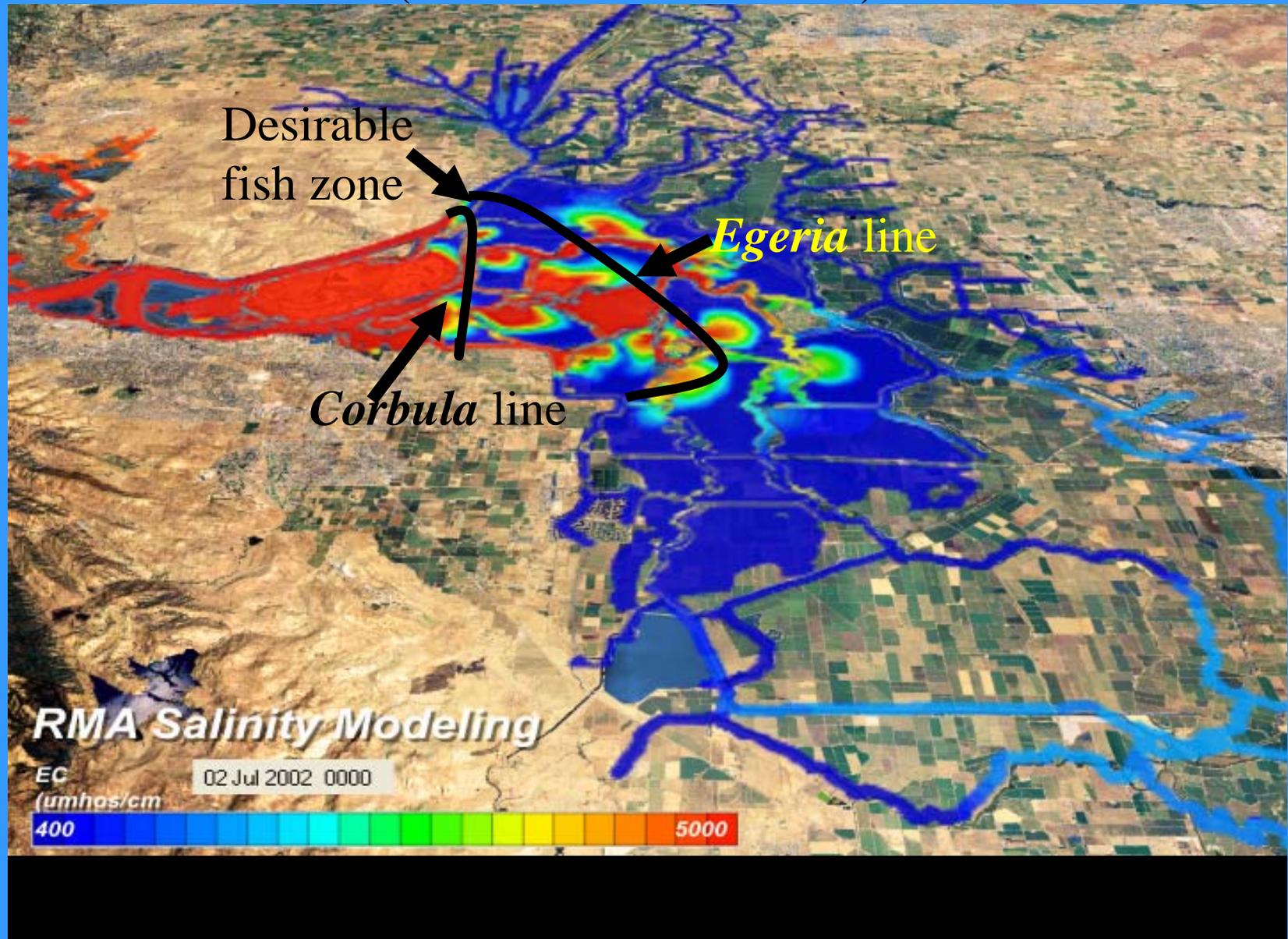


30 days:

# Positive aspects (fish perspective)

- More aquatic habitat created
  - Diverse in depth & structure
- Pumping in south Delta halted
- Large areas of variable salinity and temperature
- High productivity of flooded islands (1-3 yrs)

Creation of zone with low pondweed and overbite clam populations?  
(width of zone variable)

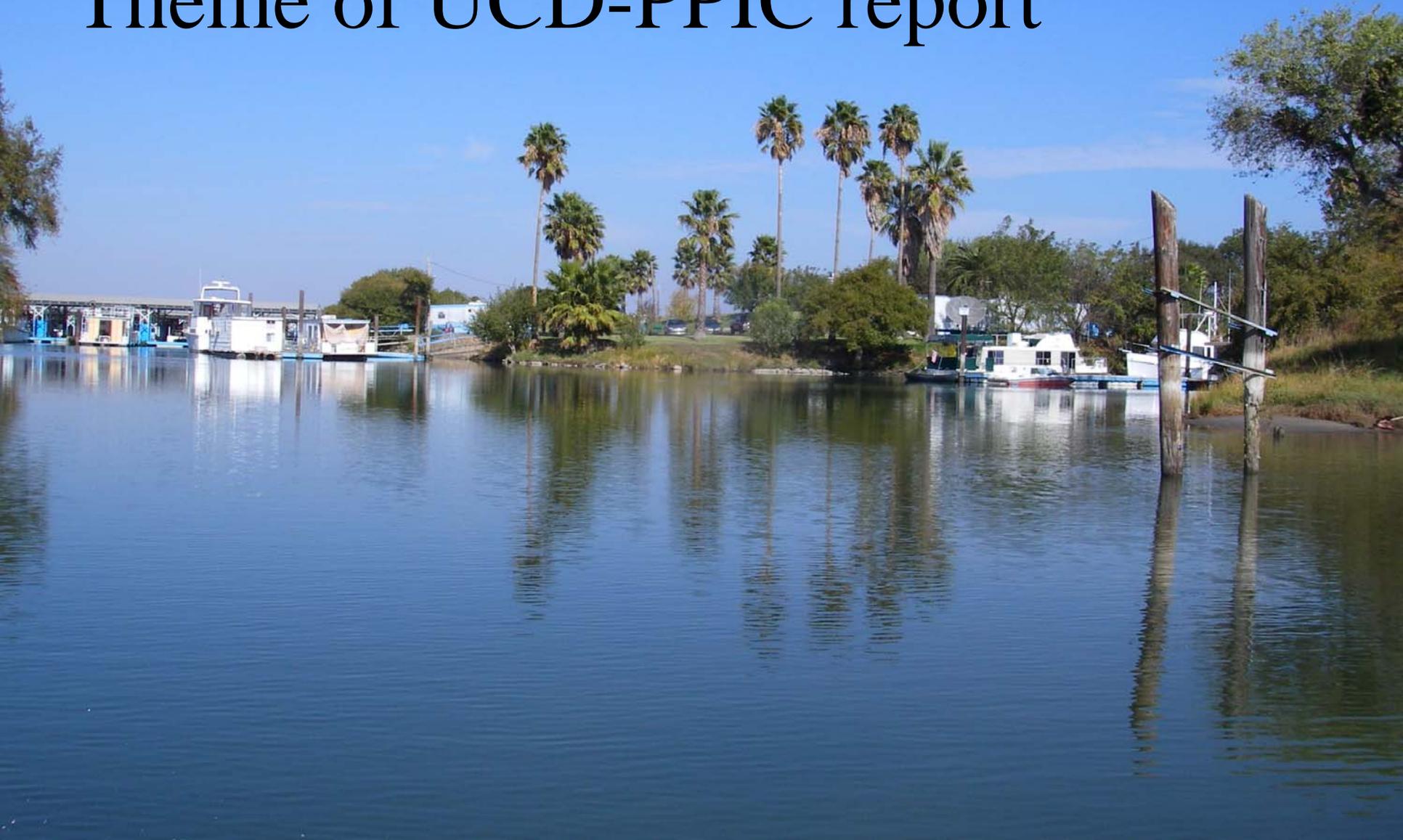


# Negative Aspects (fish perspective)

- Fish kills in initial flooding?
  - Delta smelt
- Larval starvation (if timing right)
- Increased habitat for overbite clam
- Confusion of San Joaquin salmon migration?
- Unpredictable environment

# Planning for a less dramatic future

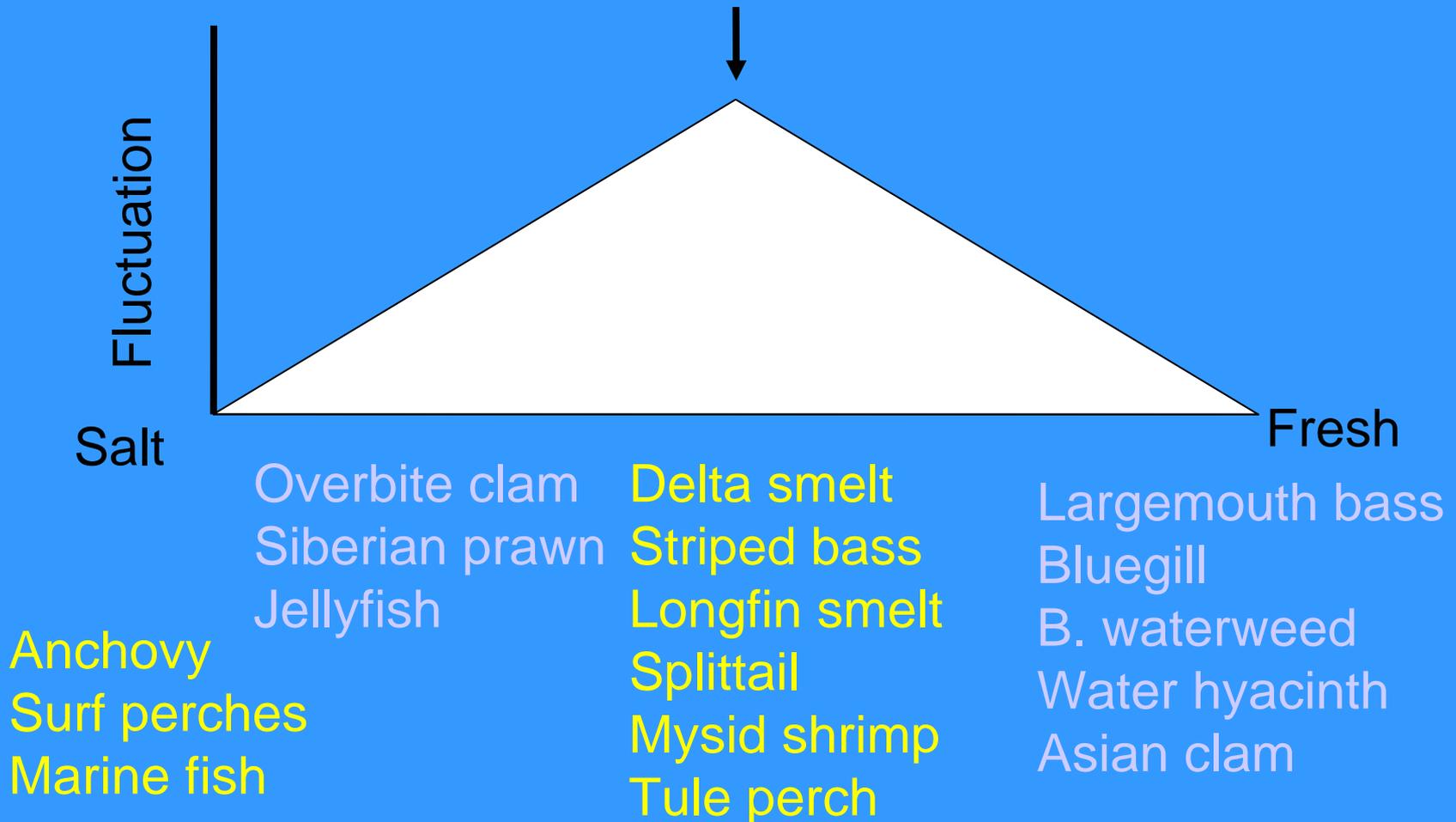
## Theme of UCD-PPIC report



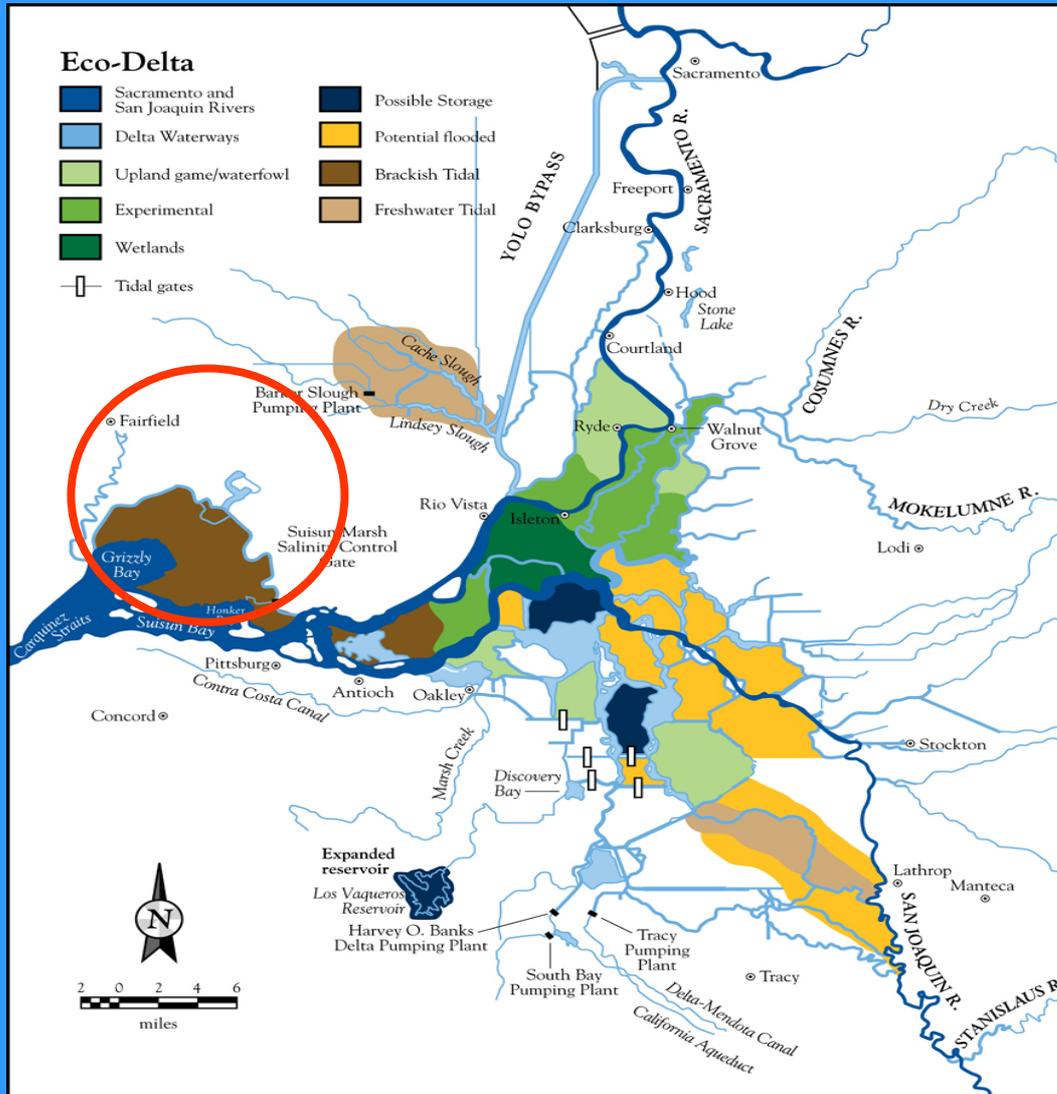


# Desirable and Undesirable Species In A Salinity Gradient With Seasonal and Annual Fluctuations

High seasonal and interannual fluctuations



# Suisun Marsh



- Permanent brackish tidal marsh
- Natural channel structure; tidal drainage
- Manage salinity with tidal gates?
- Manage for native fish and other species

# 2m DEM from 2005 LiDAR survey (Enright)

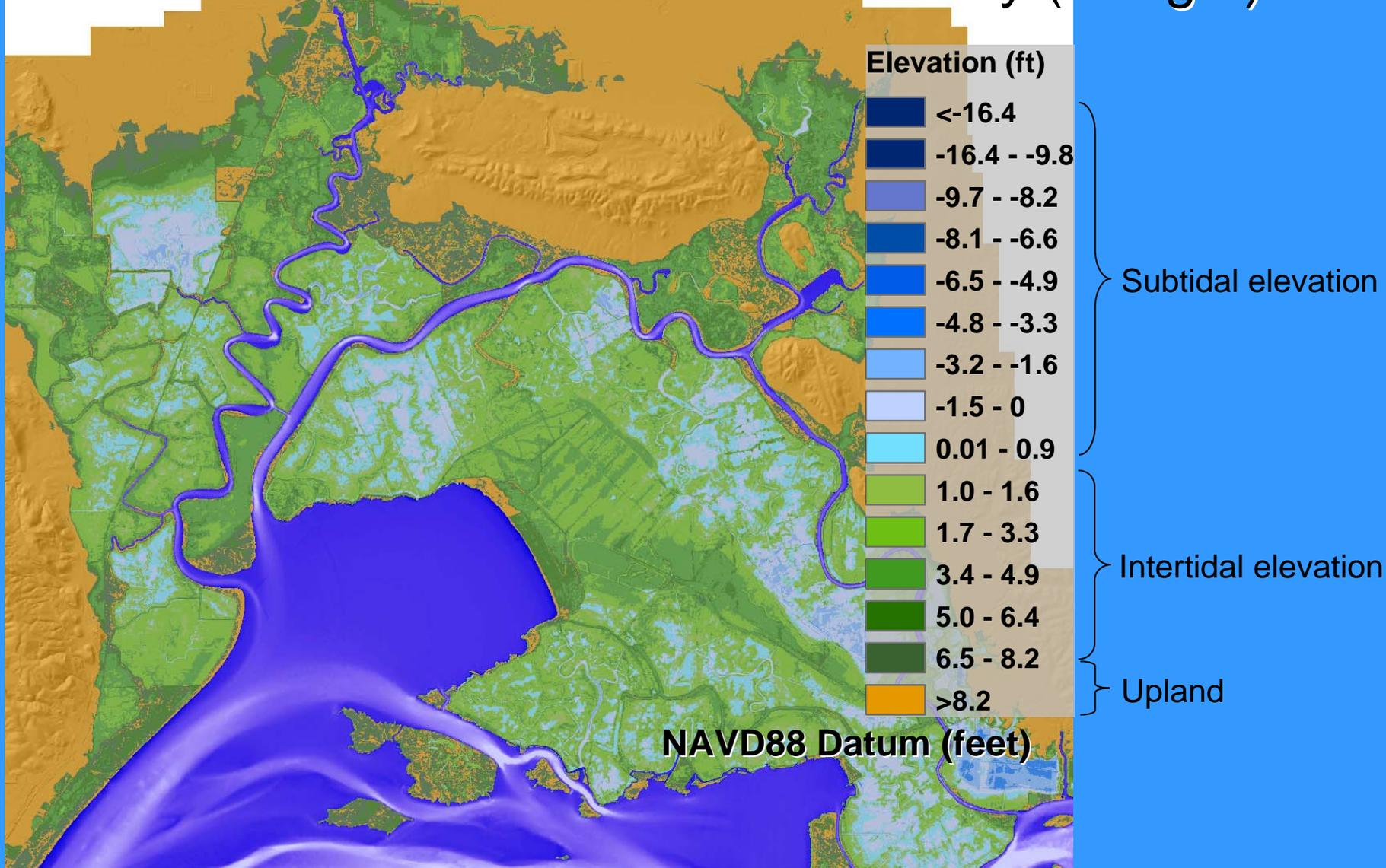
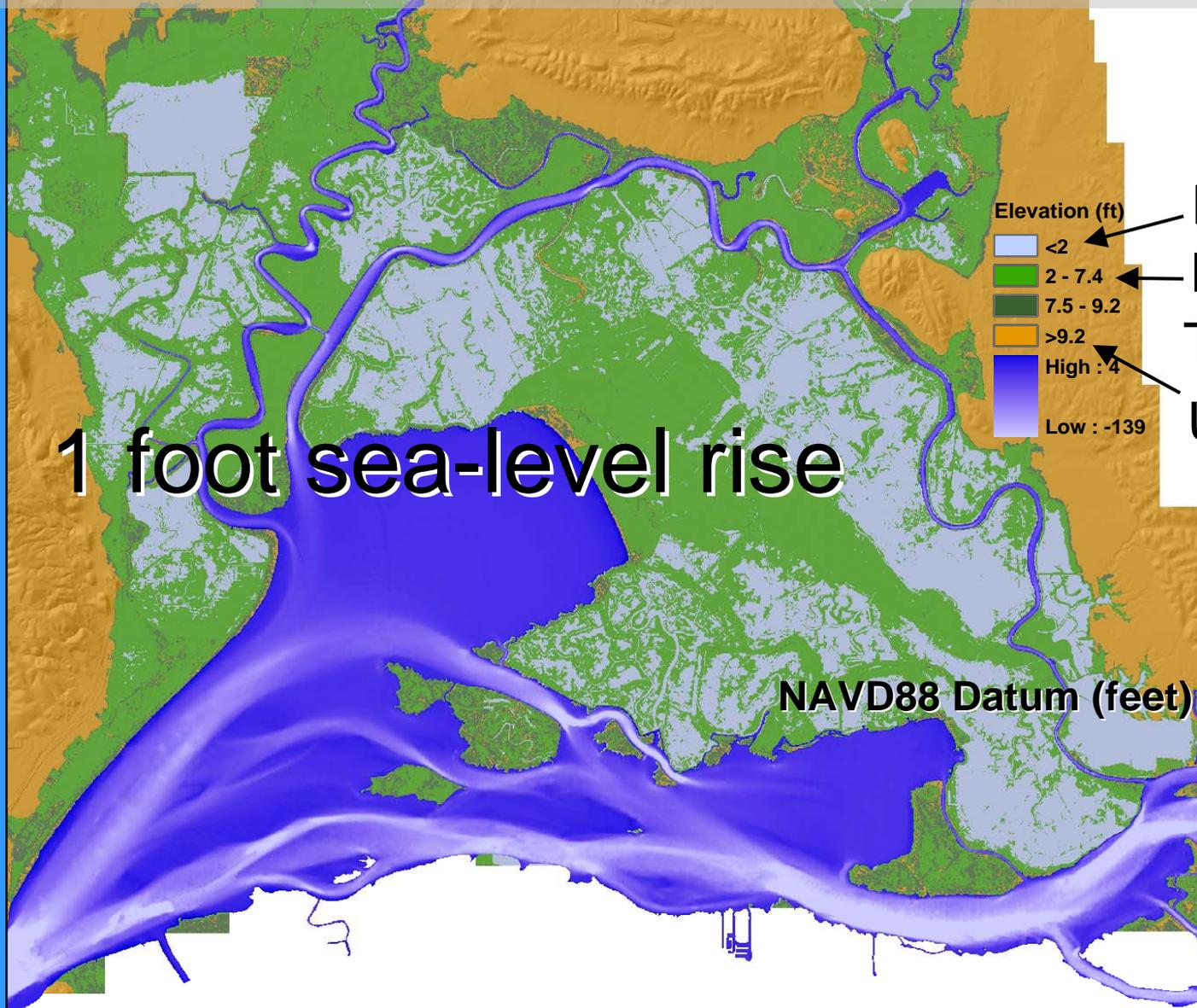


Figure 2. Digital elevation model based on 2m grid from September 2005 lidar survey. Regions in blue are subsided below local mean lower low water. Regions in green have intertidal elevation (between ~1 and 6.7 feet). Upland regions are shown in brown. Generally, indicated elevations are biased high because lidar reflects elevation at plant height. Bays and sloughs are USGS 10m bathymetry grid. In general, land area that is less than about 6.7 feet has undergone some degree of soil oxidation and subsidence due to land use practices. Note that LiDAR data is biased high. Actual elevation is ~1-3 feet lower.

# Sea Level rise

## What area is below the tidal frame?



Below MLLW

Inter-tidal (MLLW-MHHW)

TM, and upland tr.

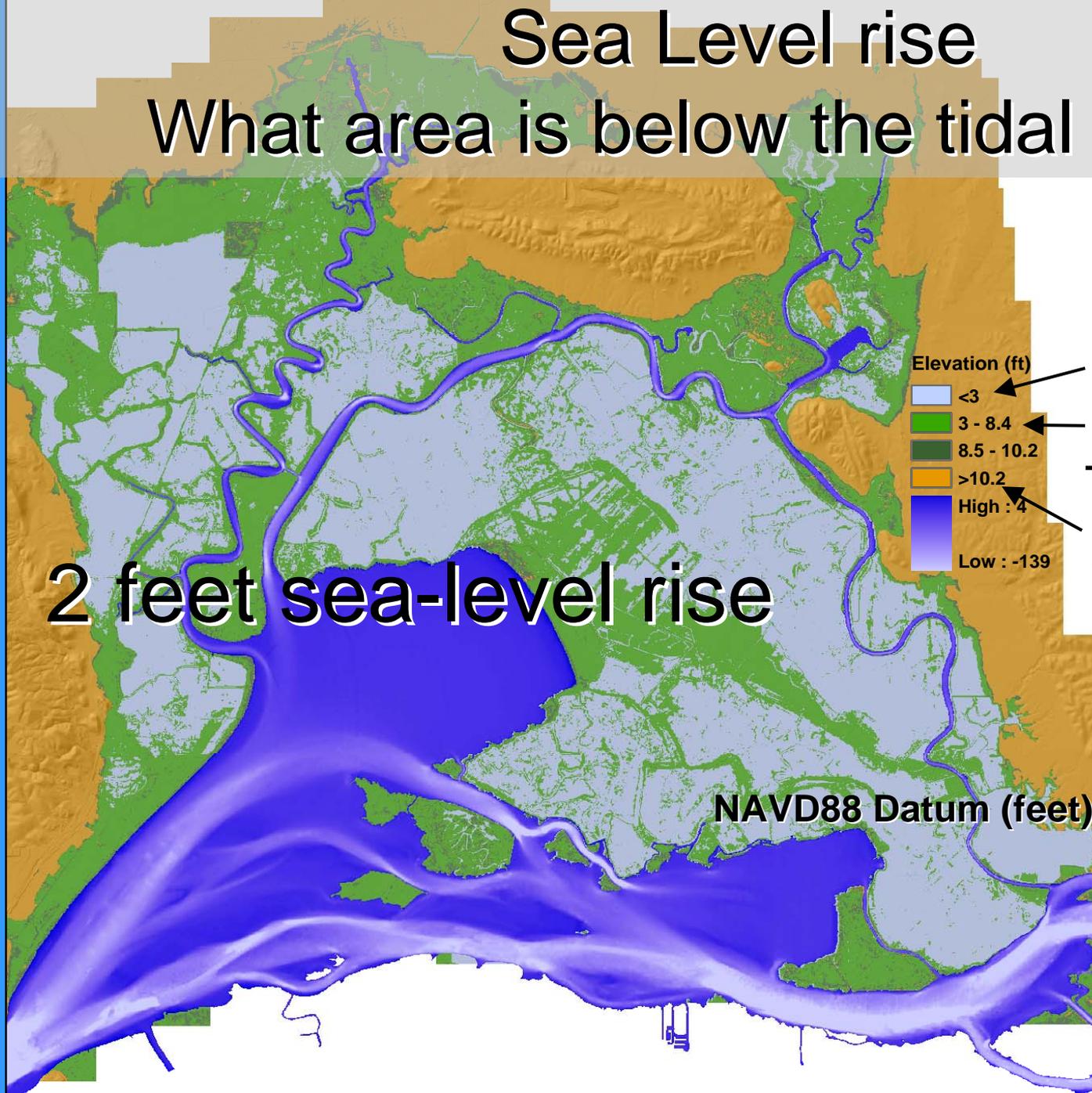
Upland

1 foot sea-level rise

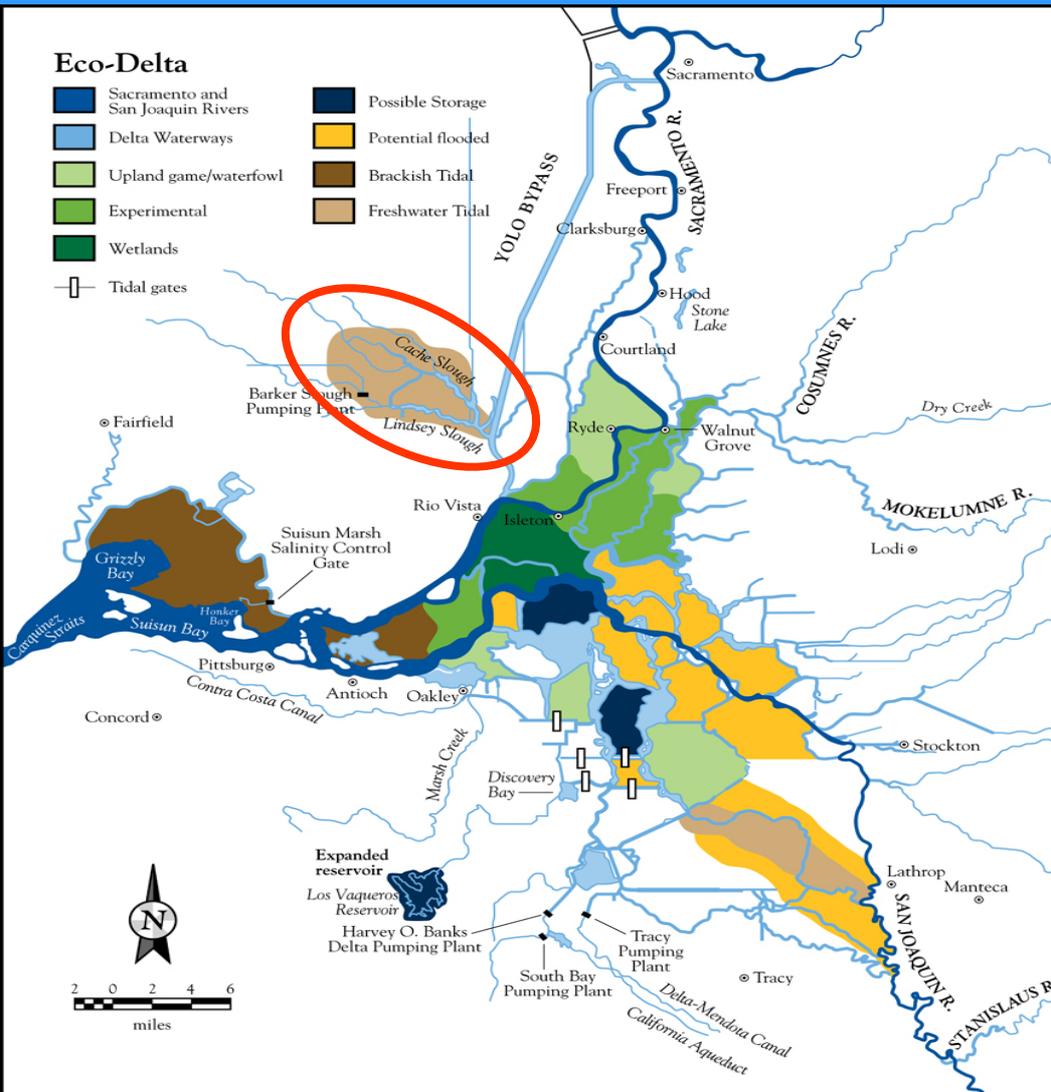
NAVD88 Datum (feet)

# Sea Level rise

## What area is below the tidal frame?



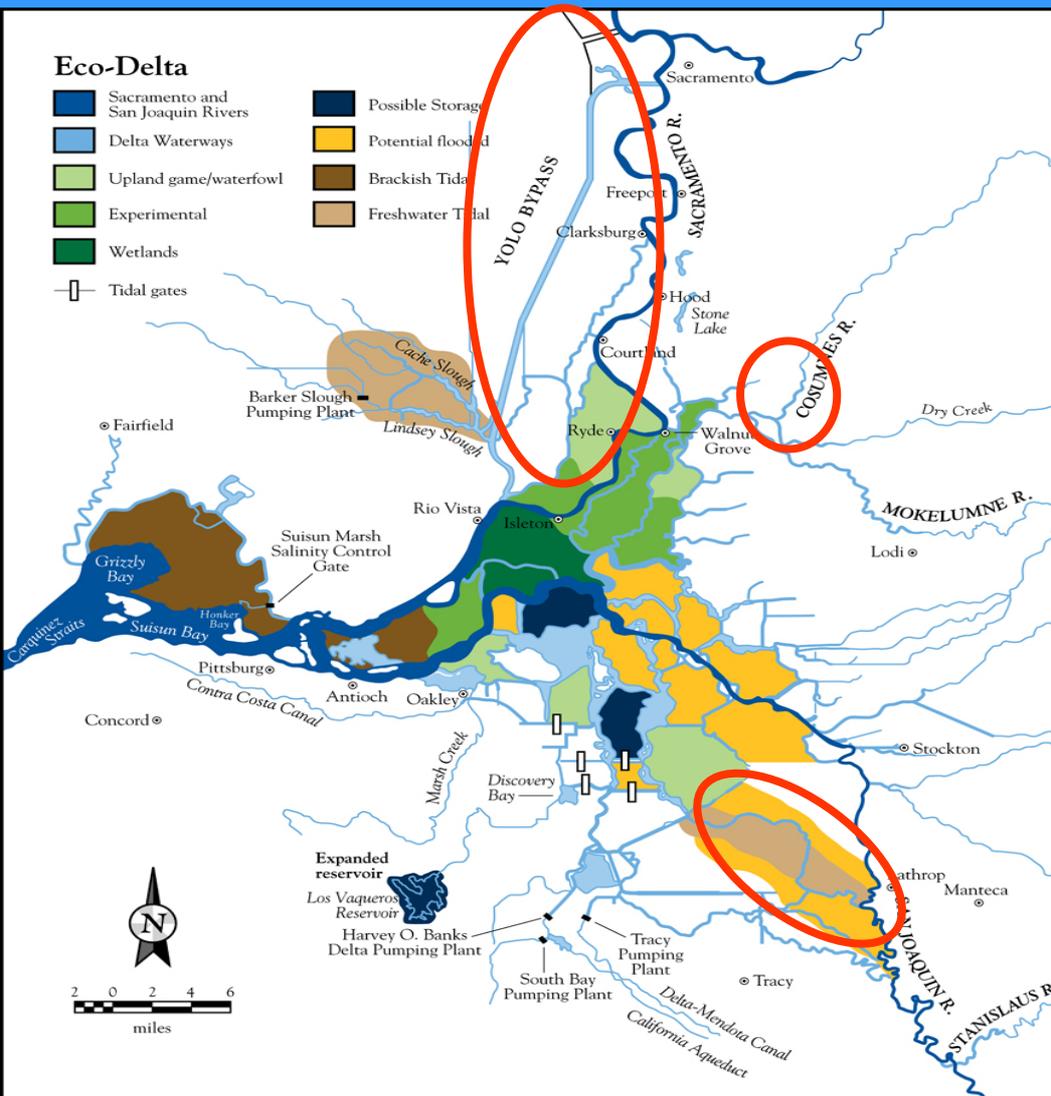
# Cache Slough Region



Freshwater tidal  
marsh

Channels managed  
for DS spawning  
and rearing

# Floodplains

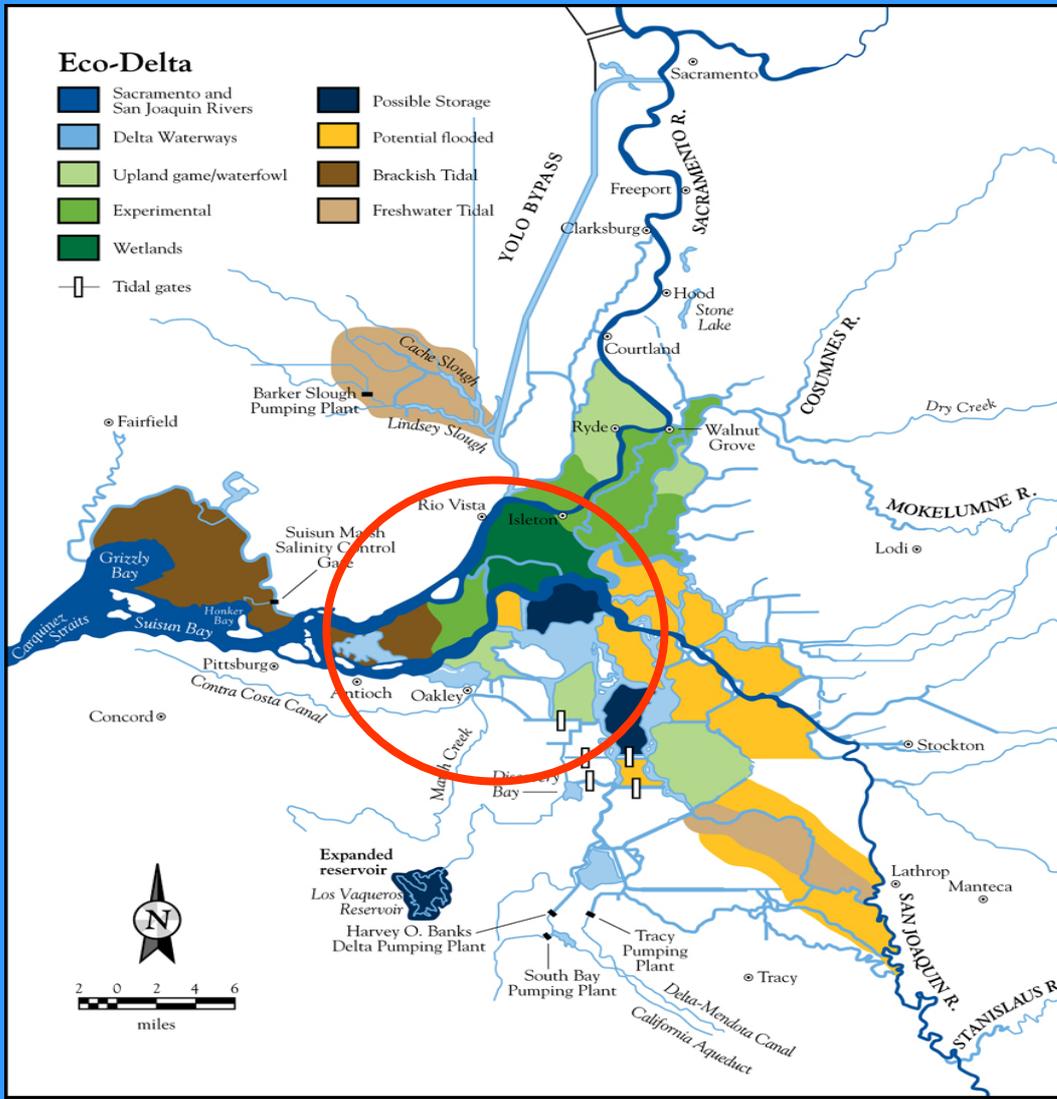


Manage Yolo Bypass for annual small-scale flooding

Create flood bypass on San Joaquin River

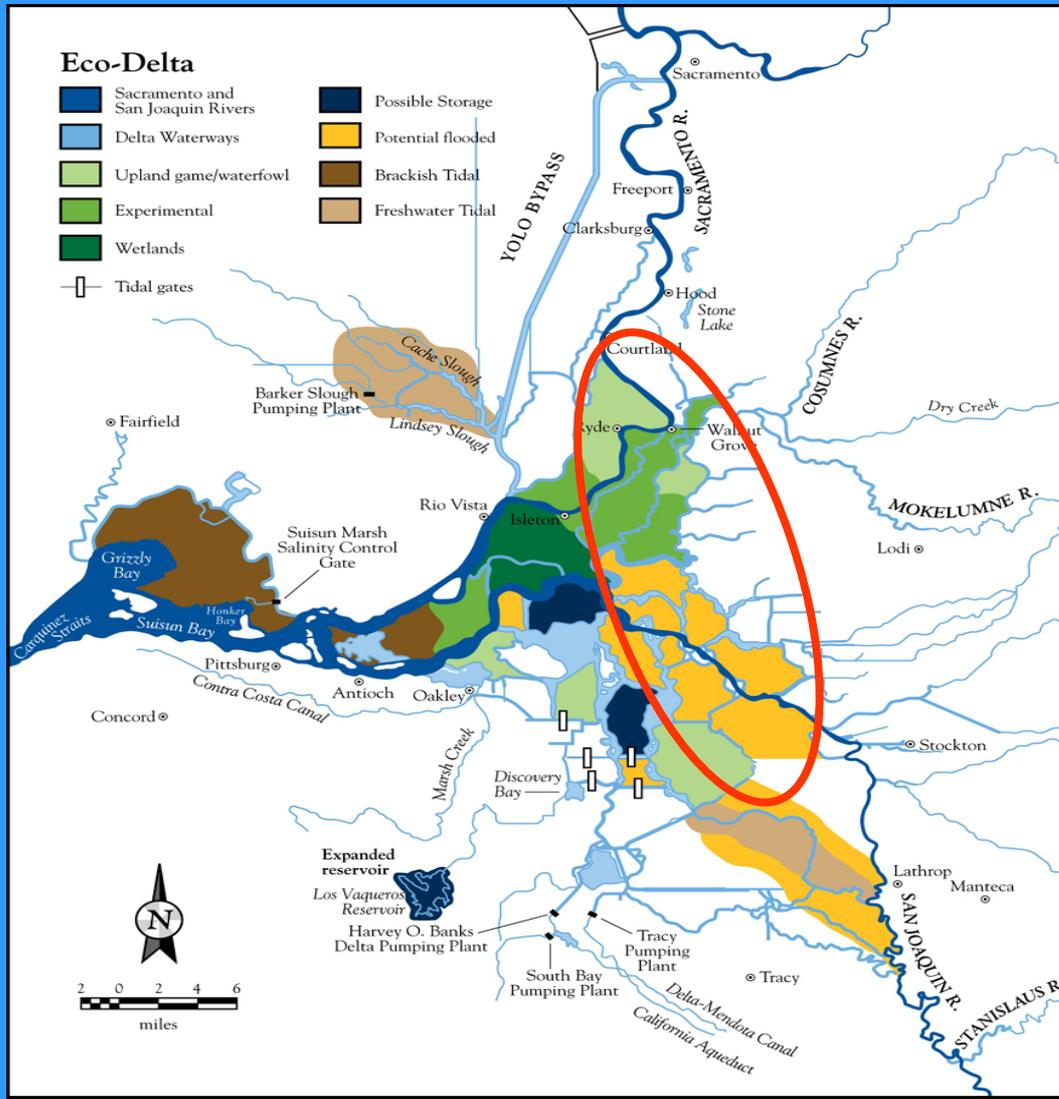
Protect naturally frequently flooded areas

# Flooded Islands



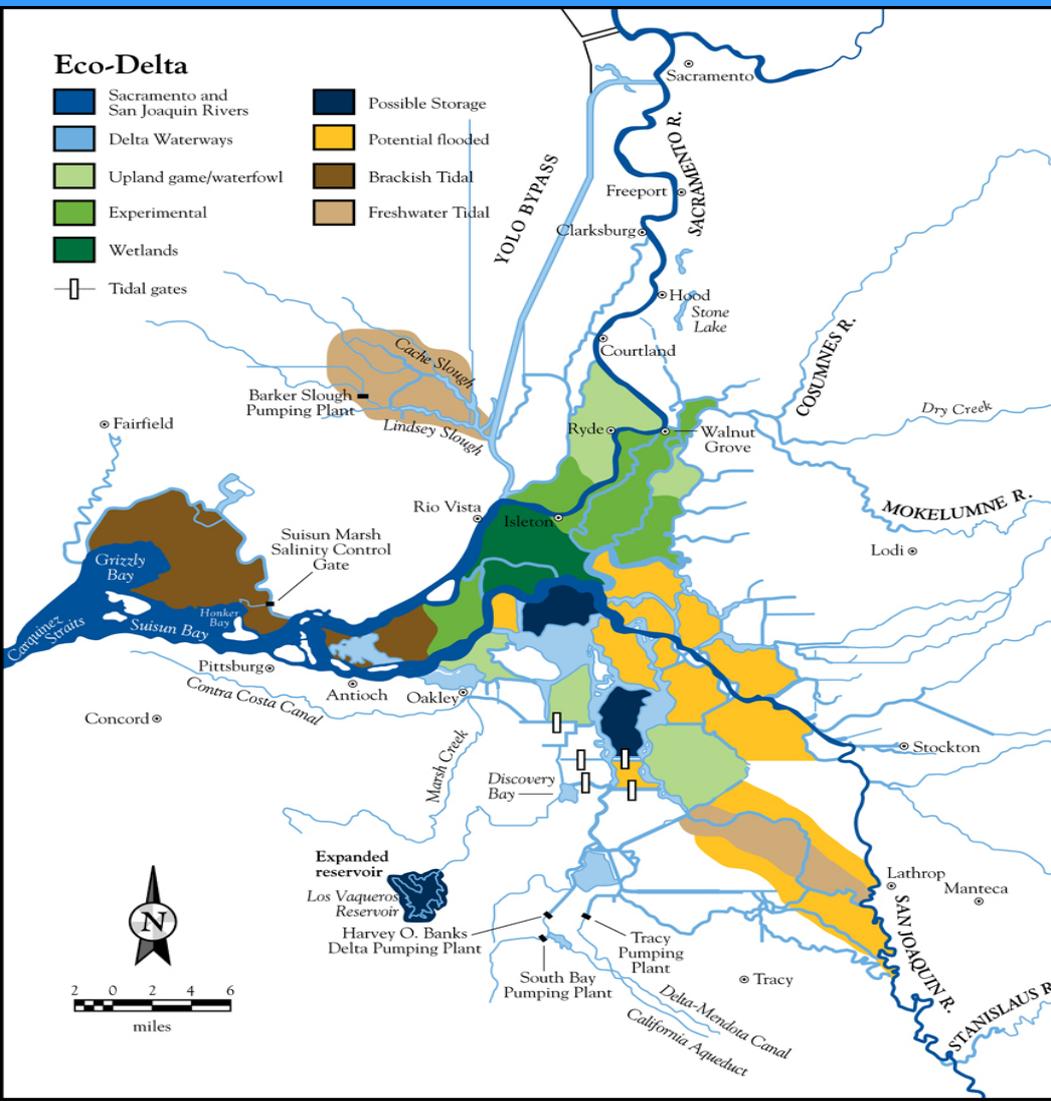
- Diverse
- Some experimentally flooded (Delta wetland model)
- Most permanently flooded
- Carbon sequestration sites?

# Upland Islands



- Agriculture
- Non-urbanized
- Wildlife habitat
- Subsidence reversal

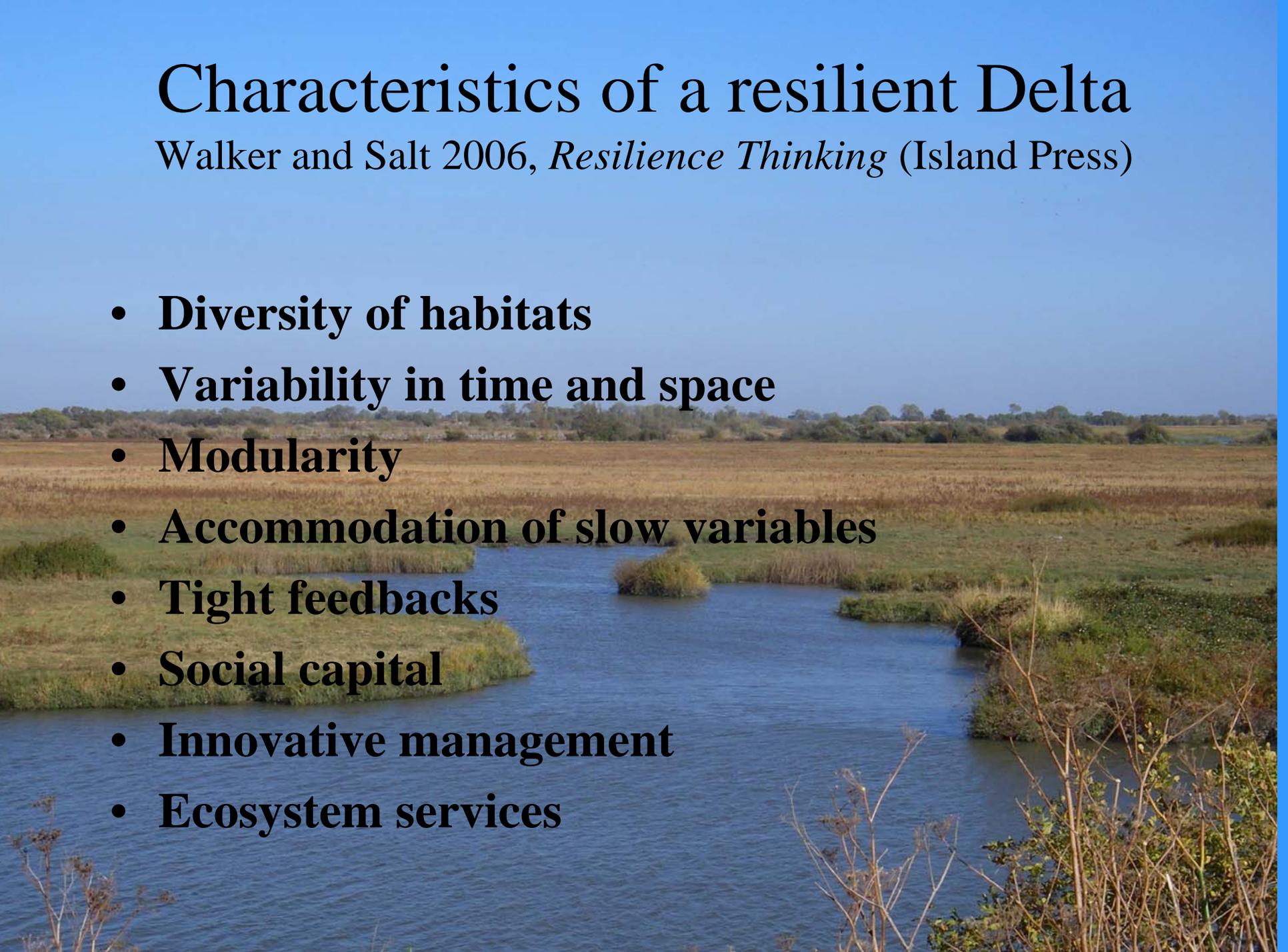
# Other Considerations



- Migration corridors
  - Salmon and steelhead
  - Sturgeon
- Habitat connectivity
- Societal needs
  - Peripheral canal

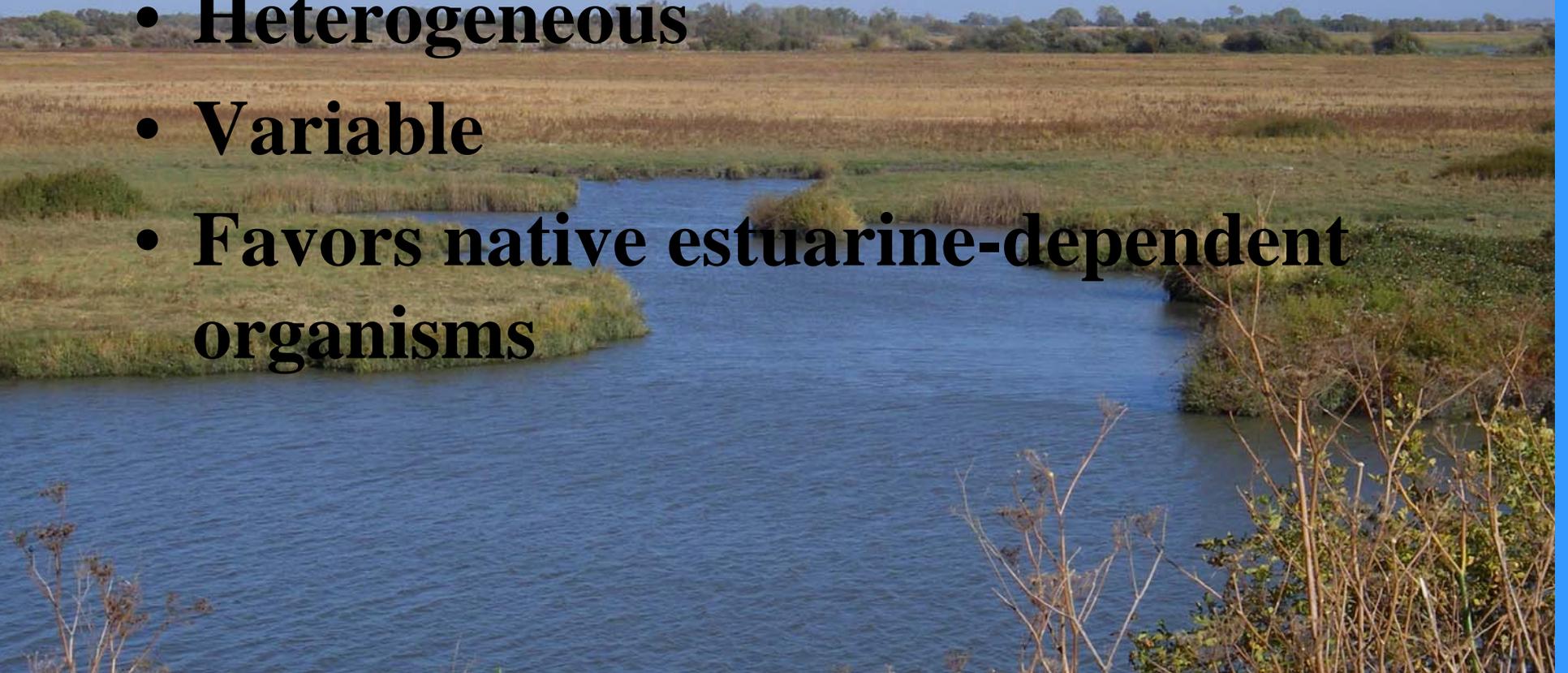
# Characteristics of a resilient Delta

Walker and Salt 2006, *Resilience Thinking* (Island Press)

- **Diversity of habitats**
  - **Variability in time and space**
  - **Modularity**
  - **Accommodation of slow variables**
  - **Tight feedbacks**
  - **Social capital**
  - **Innovative management**
  - **Ecosystem services**
- 
- A photograph of a delta landscape. A winding river flows through a vast, flat expanse of land. The river is surrounded by marshes and grasslands. The sky is clear and blue. The overall scene is a natural, open landscape.

# Characteristics of a Delta ecosystem that is a better place for desirable fishes

- **Resilient**
- **Heterogeneous**
- **Variable**
- **Favors native estuarine-dependent organisms**



# Thank you



I  
hope your future  
includes me!