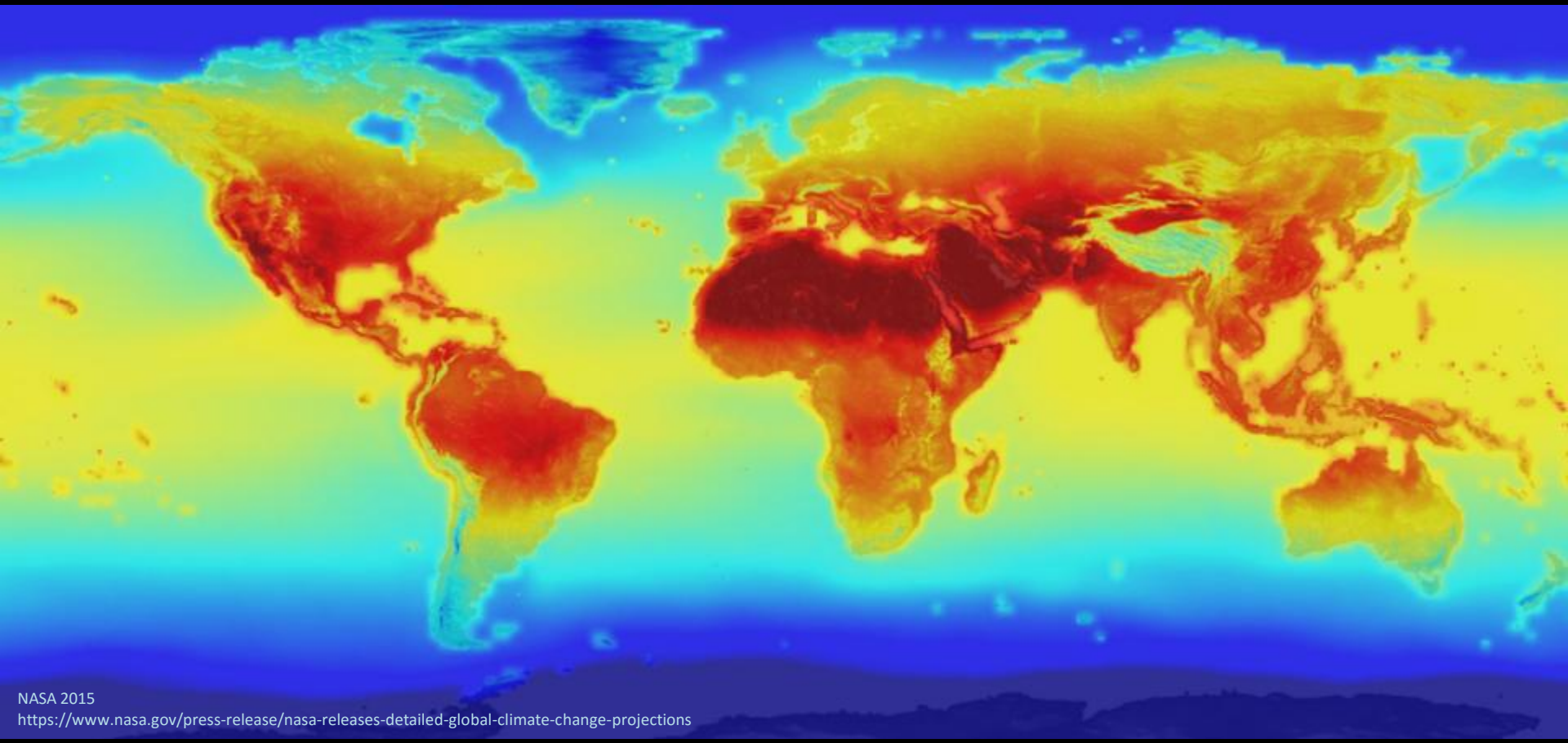
Warming up to (climate) change



NASA 2015
https://www.nasa.gov/press-release/nasa-releases-detailed-global-climate-change-projections

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WATERSHED SCIENCES

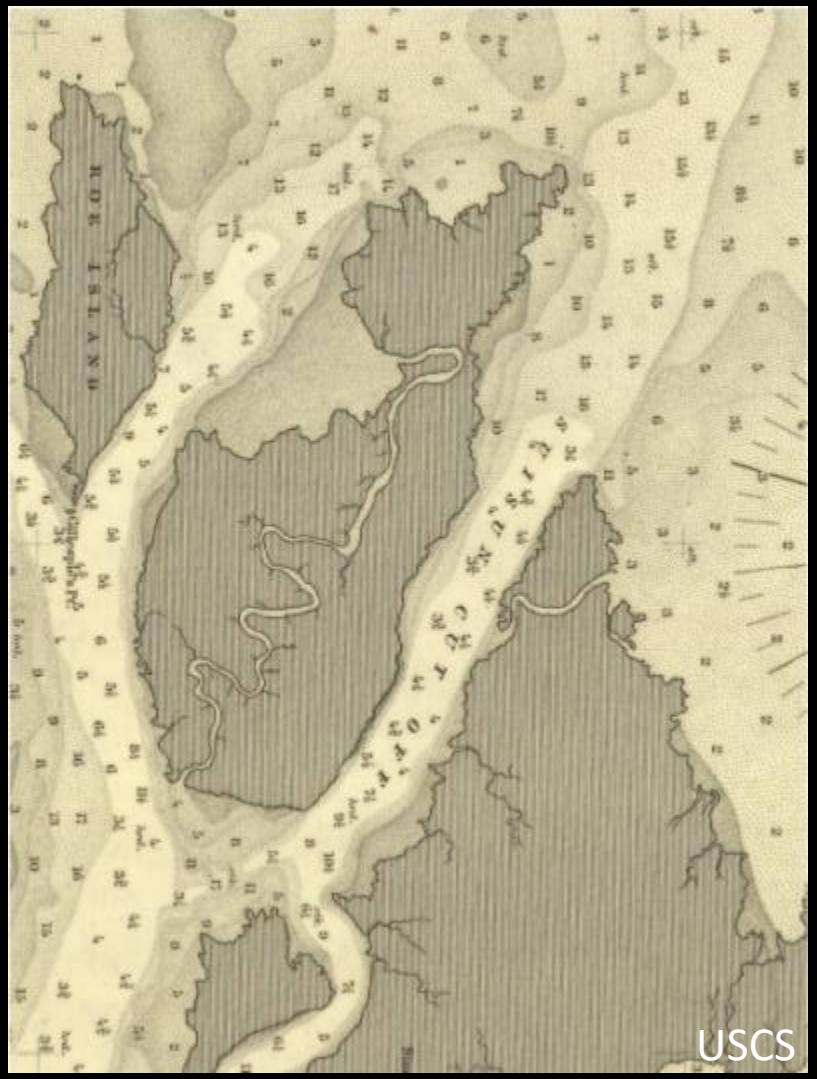
September 9, 2016

Okanagan Basin Water Board

Annual Meeting

Professional background

- Research
  - Physical geography
  - Historical ecology
- Specialties
  - Spatial analysis
  - Cartography
  - Fish
  - Wetlands



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Today's topics

- Climate change & California's drought
- Planning for change
  - Thinking like a landscape
  - Futurecasting 101
  - Emerging solutions

1. California drought

- Regional overview
- Effects

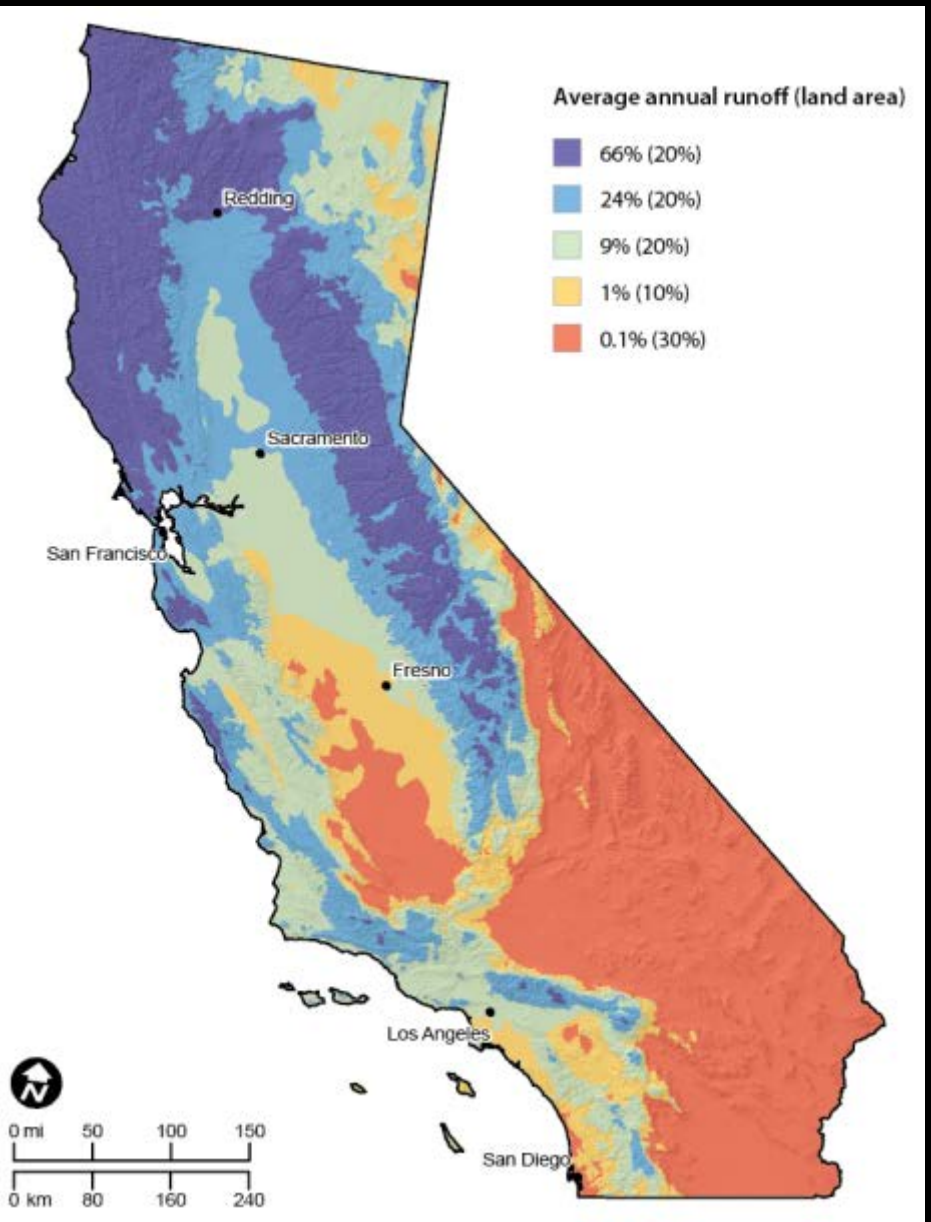
Photoshopped reconstruction of California c. 1850

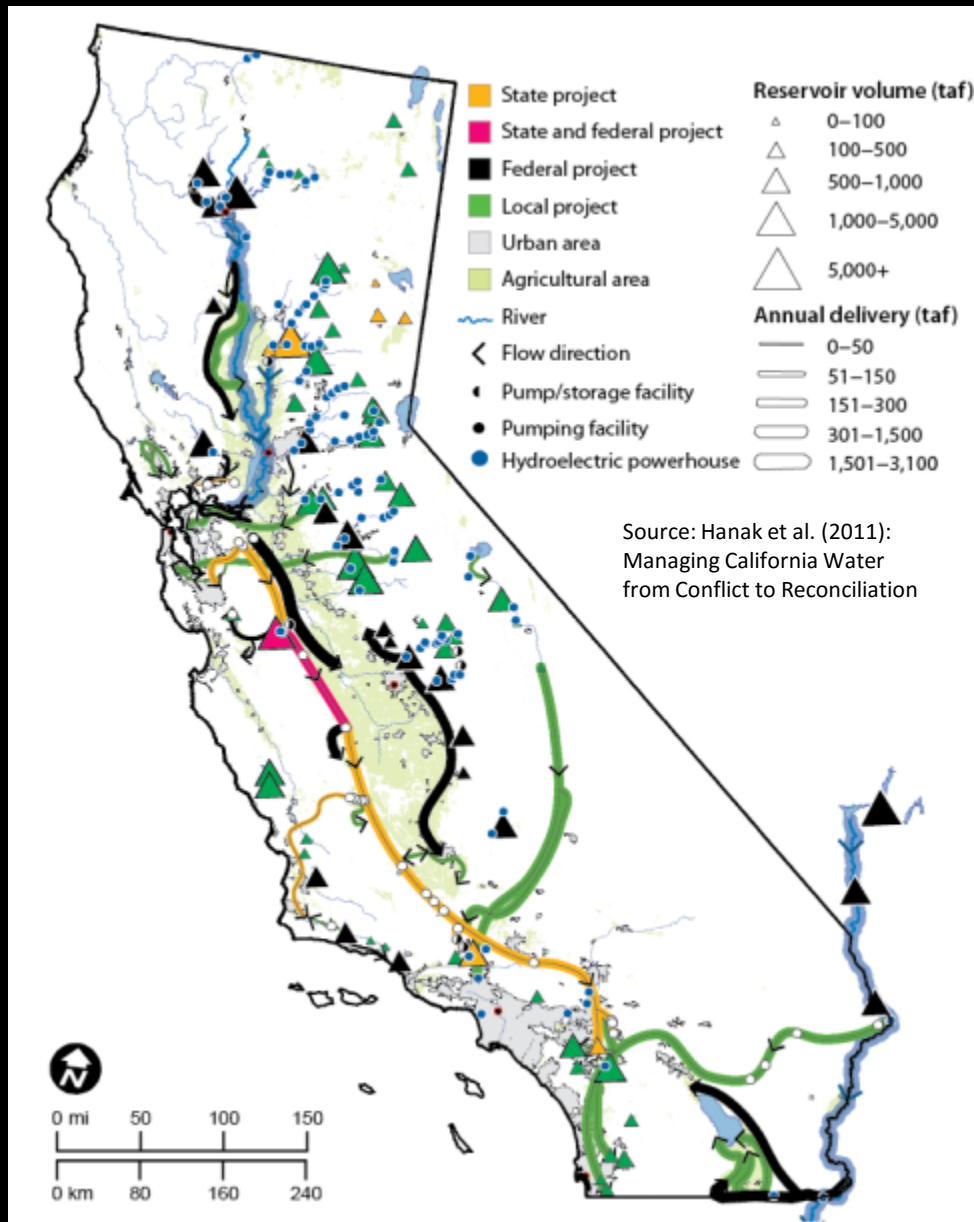
http://bigthink.com/strange-maps/557-the-first-satellite-map-of-california-1851

California Water Made Simple

Jay Lund

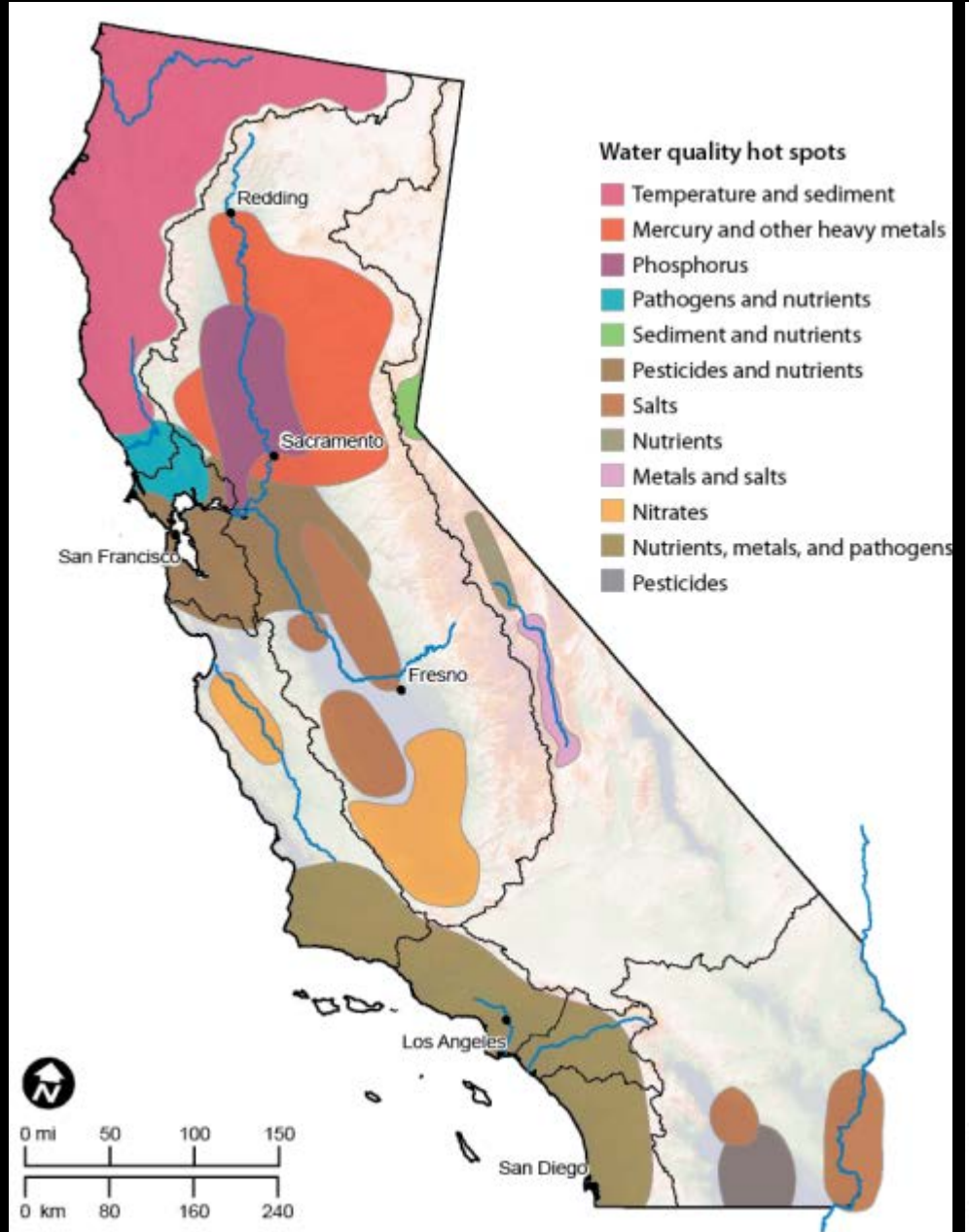
Water Resources

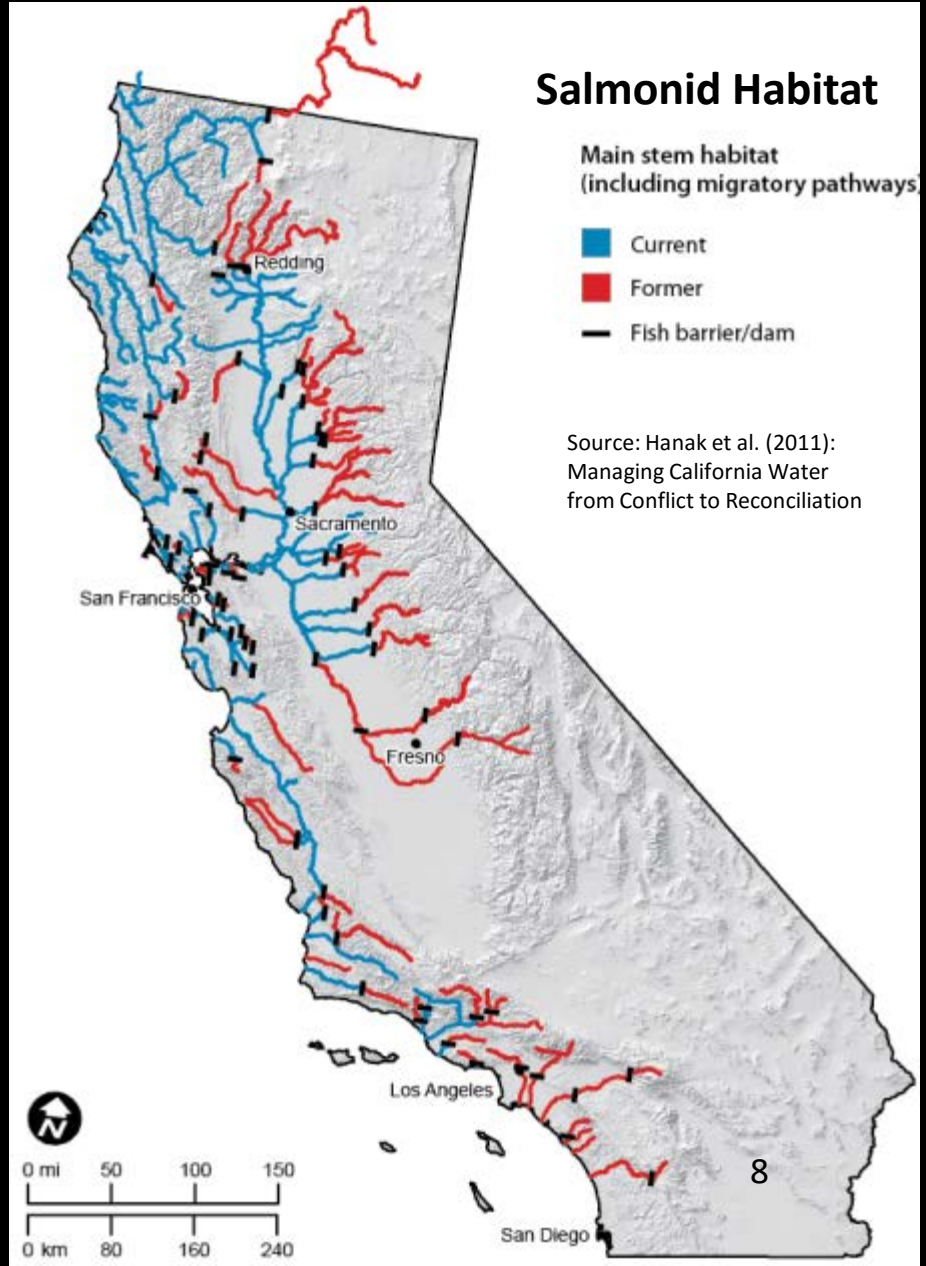




Source: Hanak et al. (2011): Managing California Water from Conflict to Reconciliation

Hydrography



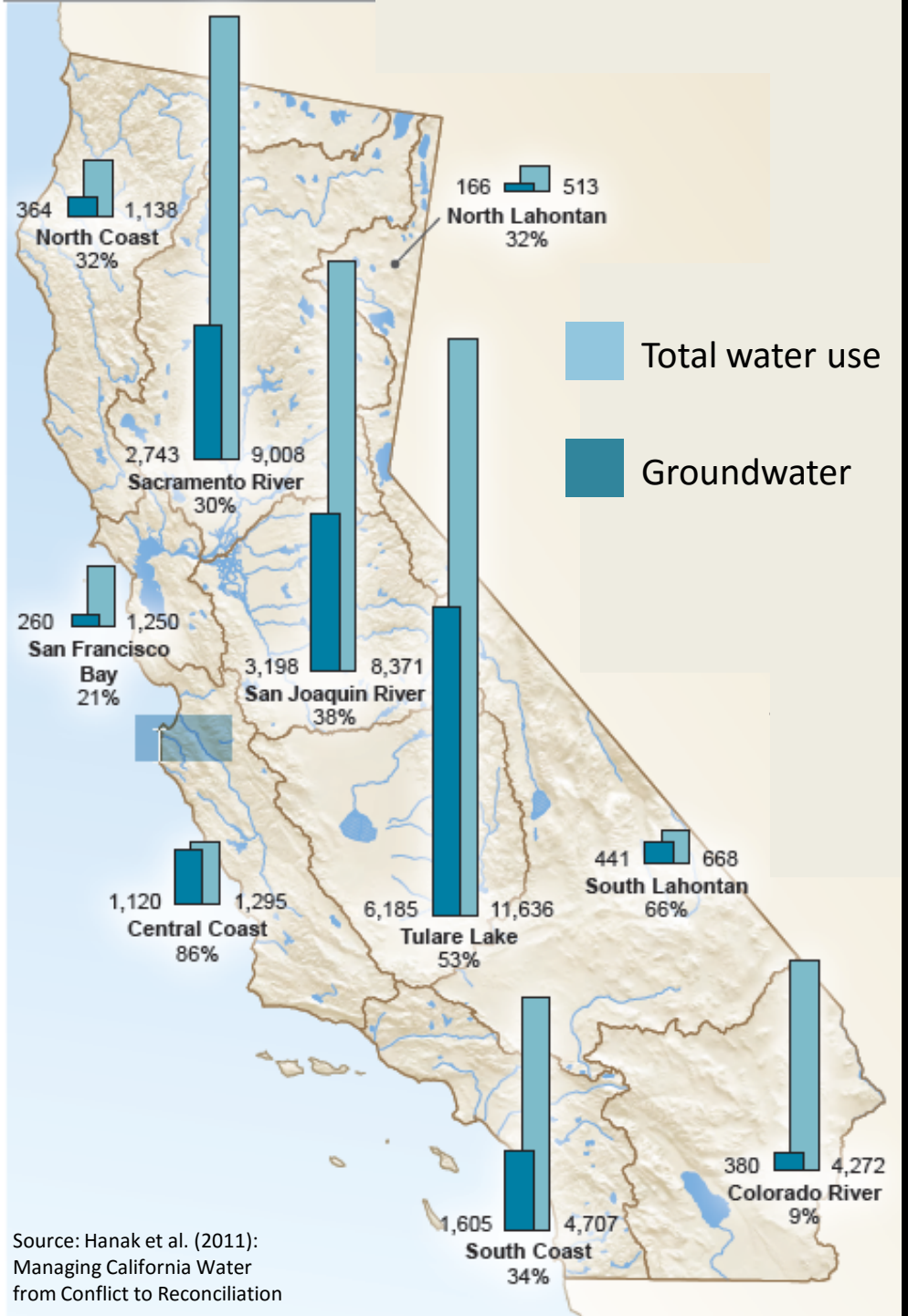


Climate change effects on precipitation

- No large changes in total annual precipitation
  (but some models say much drier)
- Mediterranean pattern will continue
  - most precipitation in winter and spring
- Big shifts from snow to rain esp. in mid-elevations
- 60-90% loss of snow pack in Sierra Nevada

= Big impacts to stream flows of snow-fed systems

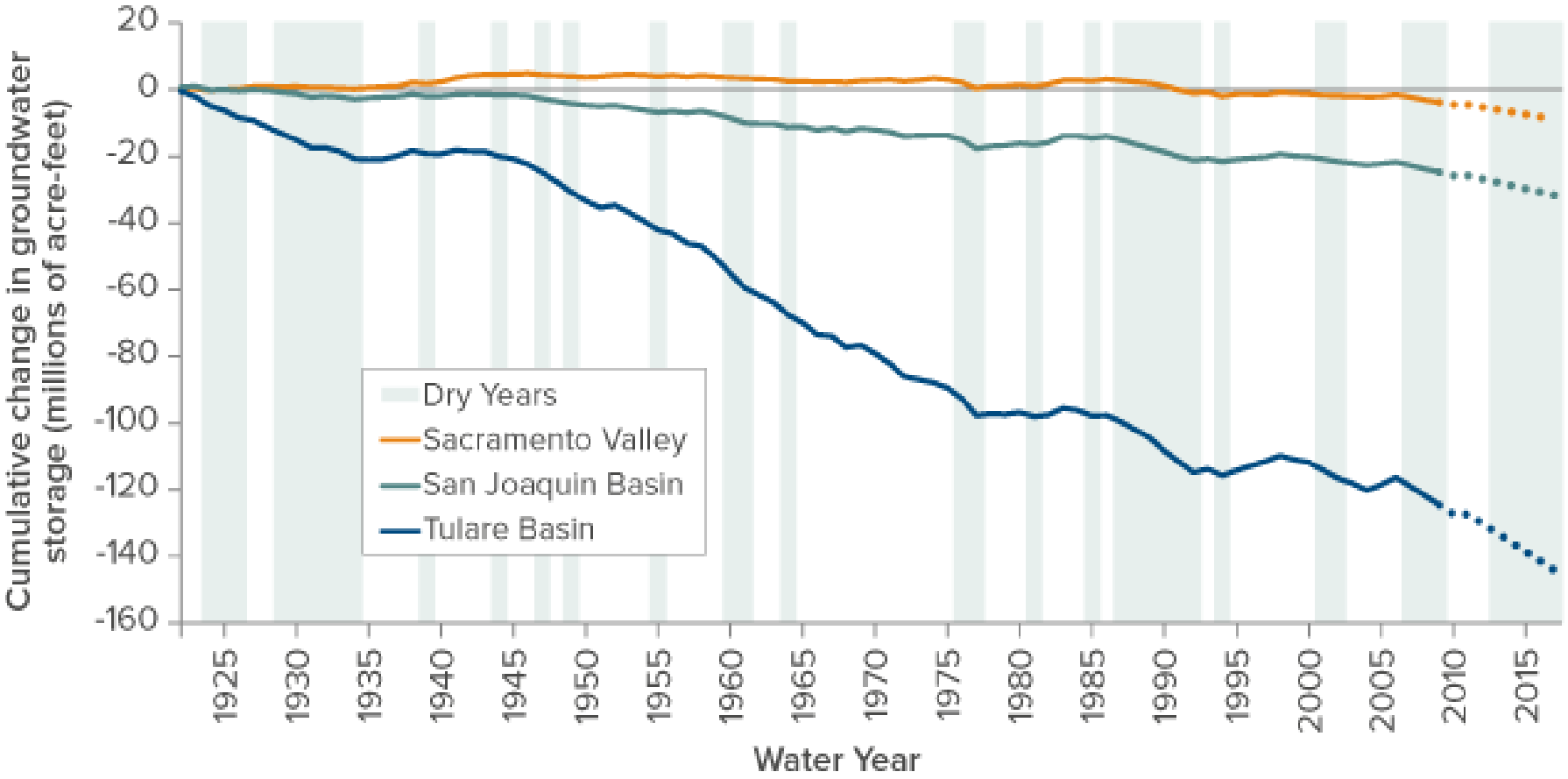
Irrigated agriculture water sources



Source: Hanak et al. (2011): Managing California Water from Conflict to Reconciliation

- Groundwater is backup for ag during droughts
- Most demand in Tulare basin

Groundwater Depletion, Especially in California's Tulare Lake Basin

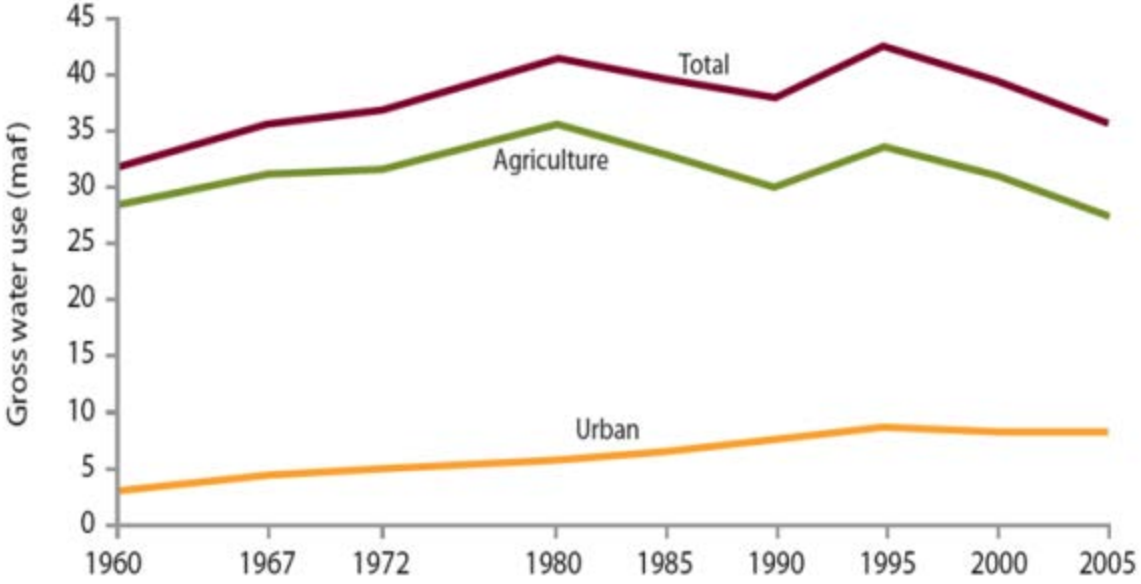


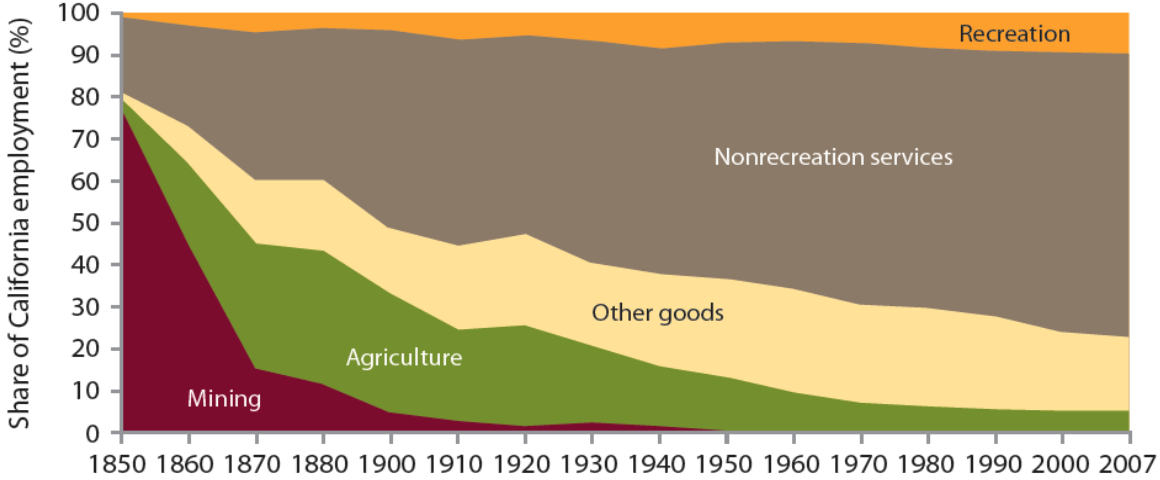
SOURCE: What If California's Drought Continues? (PPIC, 2015), Figure 3.Data through 2009 from DWR; author estimates after 2009. Projections since 2009 may underestimate depletions since the onset of the latest drought (2012+)..

Drought effects on groundwater

- Increases pressure on resource
- Increases management attention
- Groundwater regulation in early stages
- Tools like markets, water banking, and portfolio approaches needed

Some Reasons for Hope





- Human water use peaked?

- Economy depends less on water abundance than in past

- Agriculture robust due to groundwater reliance and diversified economy

- Water markets can shift use and civilize change

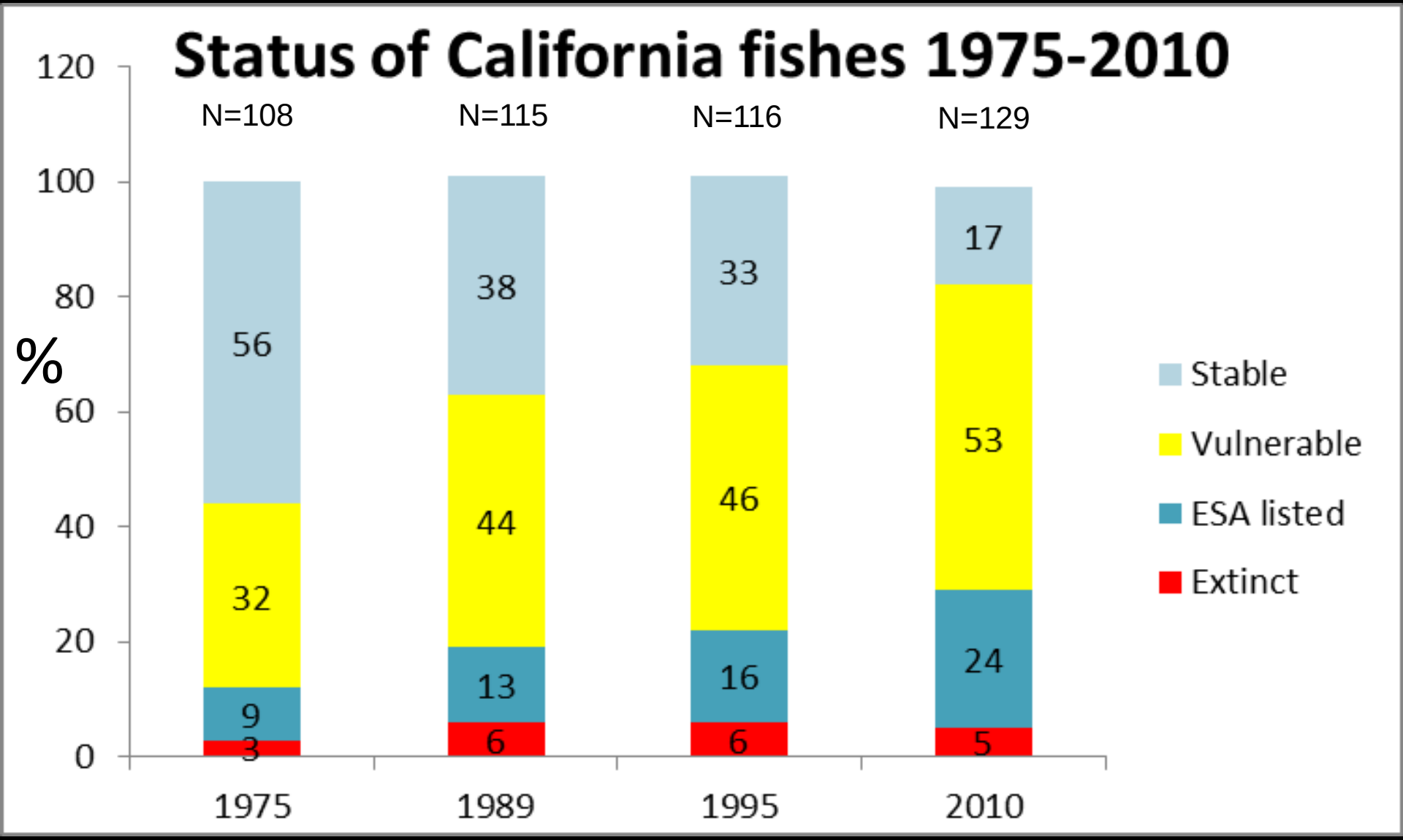
Source: Dr. Josue Medellin-Azuara/ UCD Center for Watershed Sciences

Climate change stream flow effects

- More variable flows
- Peak flows
  - larger (some years)
  - earlier
- Base flows
  - longer
  - lower

Climate change effects on streams

- Net loss of 60-99% cold water habitats
- Range shift northward & upward
- Warmer streams favor non-native species



Listed fish species in 2013 = 28

https://californiawaterblog.com/2013/12/26/the-esa-fish-and-me/

Extreme conditions push the envelope

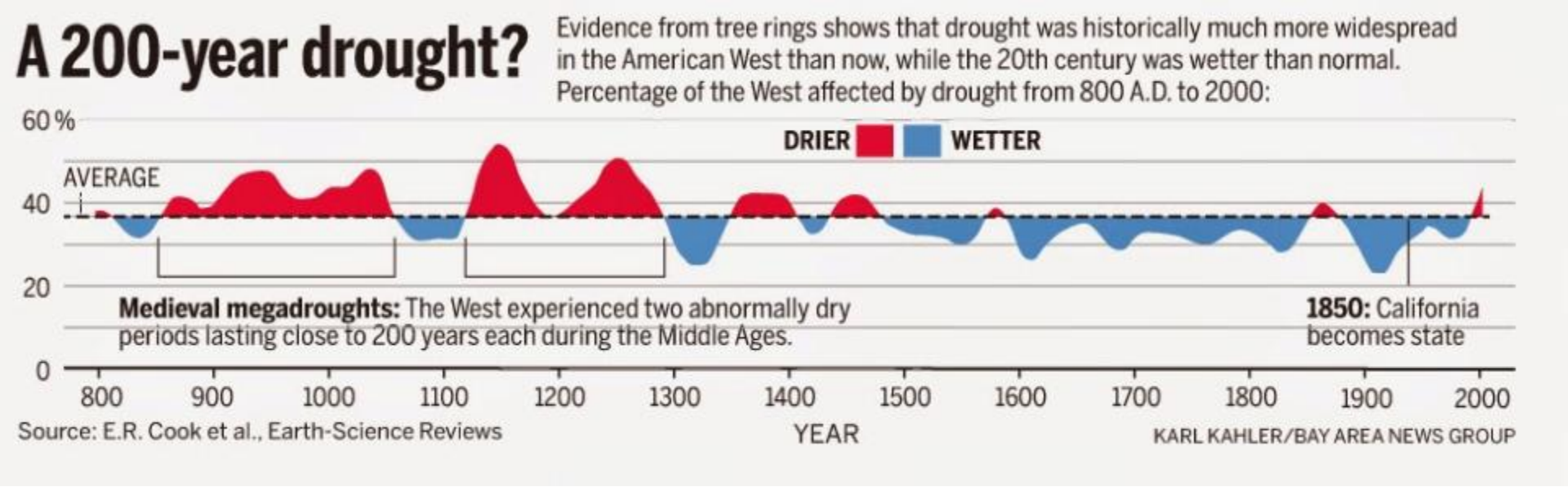
- Reveal system weaknesses
- Force rethinking system structure
- Encourage preparedness

When is it a drought?

- Definition not set in stone
- Past 150 years cooler and wetter than average in the west, and planning is based on this record
- Recent “drought” is within range of normal variation in past 2,000 years
- Lack of long-term information misled planning, we may need to correct course

Droughts in western North America

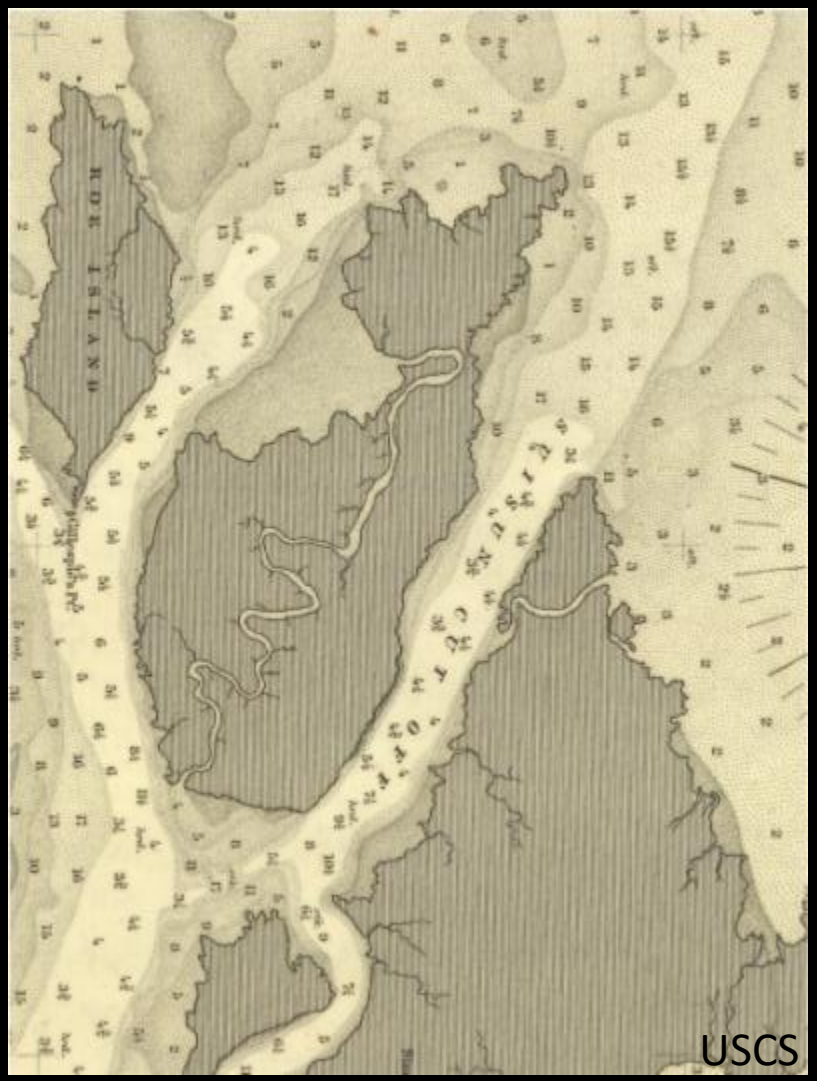
- Occur over annual, decadal and longer time scales
- Recent drought coincided with historically high water demands



SOURCE: Western Regional Climate Center. See also: Malamud-Roam et.al. Holocene Climate Connections

Researching landscape change

- Provides temporal perspective; brackets possibilities
- 100 - 200+ year analyses reveal processes
- Including environmental processes in natural resources management
  - Predictable (erosion)
  - Stochastic (fire, drought)



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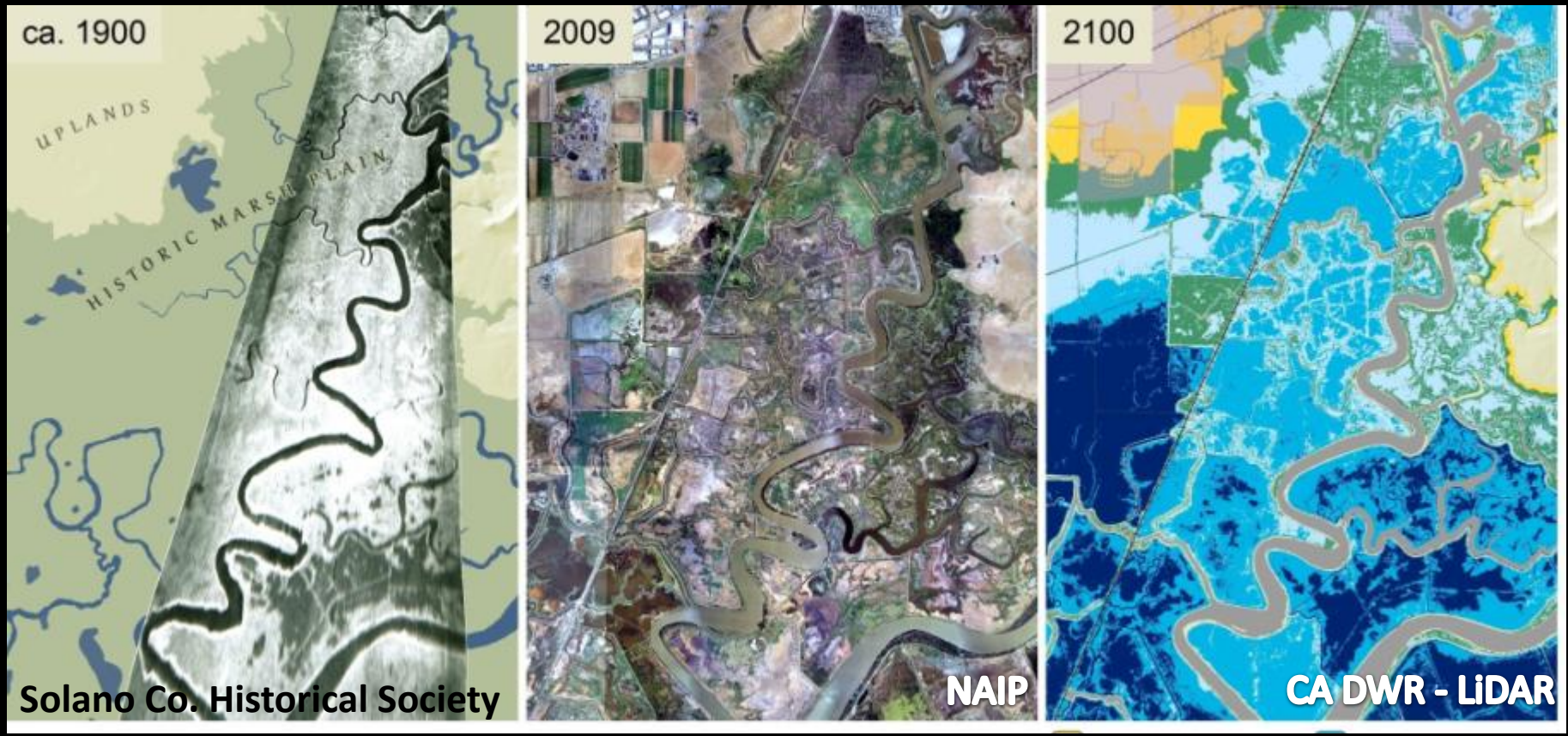
2. Thinking like a landscape

- Goal: cultivating landscape processes
  - Geomorphic
  - Habitat function, connectivity



Environmental processes

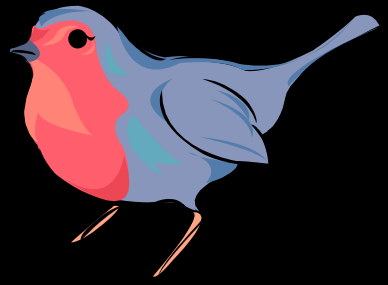
- In many locations, extreme events are
  - Normal
  - Healthy
  - Necessary
  - Define ecological parameters
  - *Even if infrequent*

Environmental processes

- Conceptualizing processes as “normal” rather than exceptional
  - Informs decision making
  - Encourages development that accommodates systems
    - Less long-term cost
    - Multibenefit function

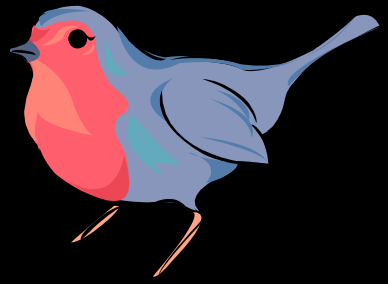
Reconciliation Ecology

- Reserve system not sufficient to achieve cultural environmental goals
- Must create functional habitat in human-dominated landscapes to meet goals
- Reconciles human environmental demands with requirements of natural systems



Reconciliation Ecology

- Goals
  - Restoring function
  - Multi-benefit
  - Risk reduction
  - Resiliency
- Examples
  - Birdhouses, butterfly gardens
  - Flooding farms in off-season to create wetlands for fish and birds



4. Emerging solutions

- Case studies
- Quelling controversy with communication

Environmental flows

- Putah Creek

Environmental flows

- Putah Creek
  - Precedent-setting environmental flows case
  - Water needed to meaningfully improve habitat with environmental flows typically very small relative to other users
  - Paired with in-stream habitat improvements
- Water budgeting
  - Define flow needed to sustain target species of fish
  - Accounting system for tracking water availability and use

Multi-benefit floodplains

- Knaggs Ranch

Jacob Katz

Multi-benefit floodplains

- Knaggs Ranch
  - Former floodplain of Sacramento river, now part of flood bypass system which only receives flow in extreme high water events
  - Rice fields have been experimentally flooded
  - Shallow water works like a solar cell powering ecosystems

Multi-benefit floodplains

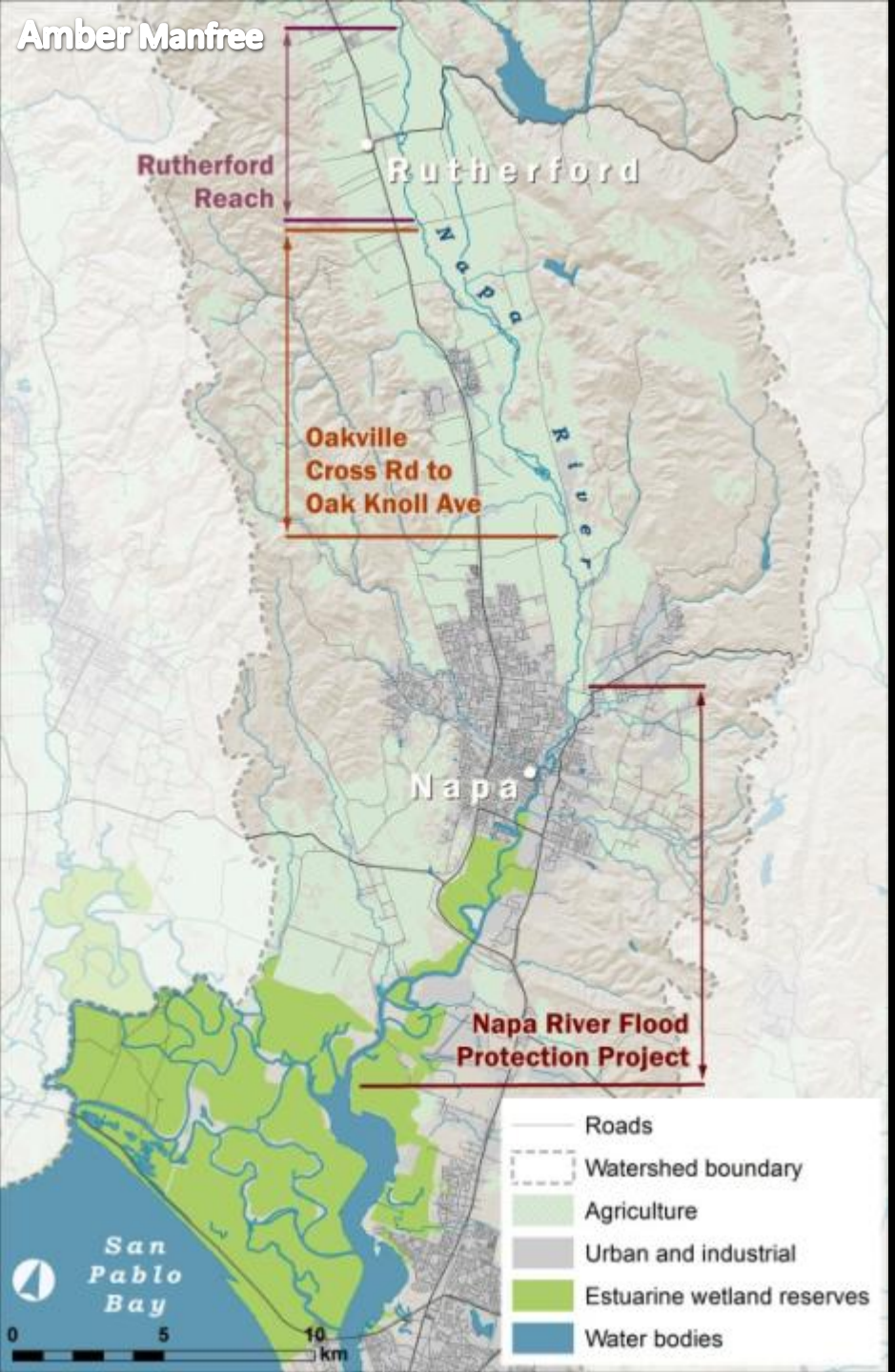
- Knaggs Ranch
  - Salmonids reared on floodplain grow several times as fast as those in adjacent river
  - More likely to survive perilous trip to ocean
  - Flooded fields also benefit birds

Multi-benefit floodplains

- San Joaquin - Accounting for environmental benefits

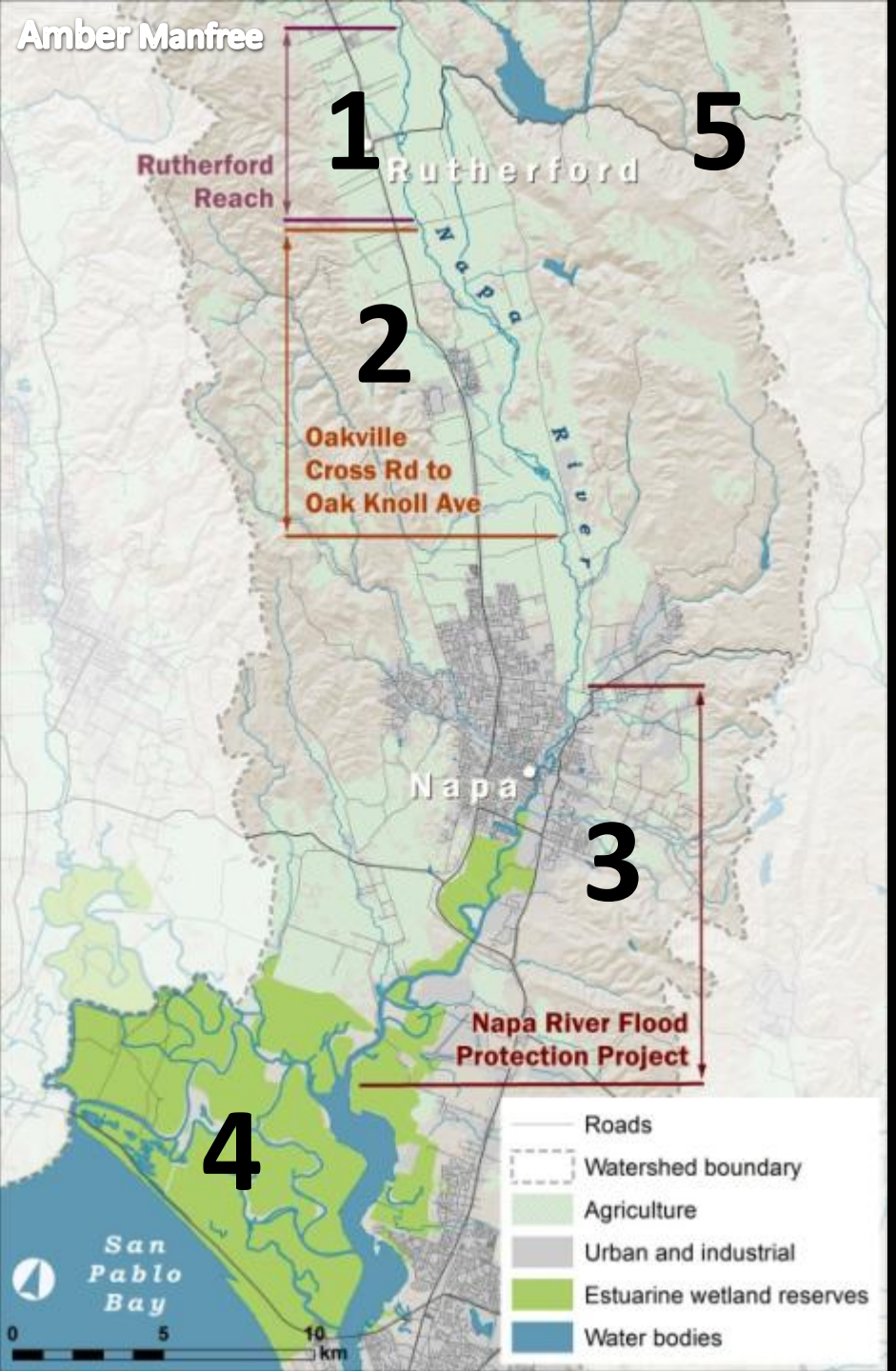
Multi-benefit floodplains

- San Joaquin - Accounting for environmental benefits
  - Only farmland value typically counted is crop yield
  - Flooding fields can:
    - Reduce flood risk in developed locations
    - Recharge aquifer
    - Provide habitat
    - May reduce crop yields; can be offset by gov't
  - Accounting for ALL associated factors can tip the scales in favor of multi-benefit management



Napa River

- Watershed- scale conservation
- Wide variety of stakeholders
- Numerous projects plus ordinances and outreach
- 20+ year process

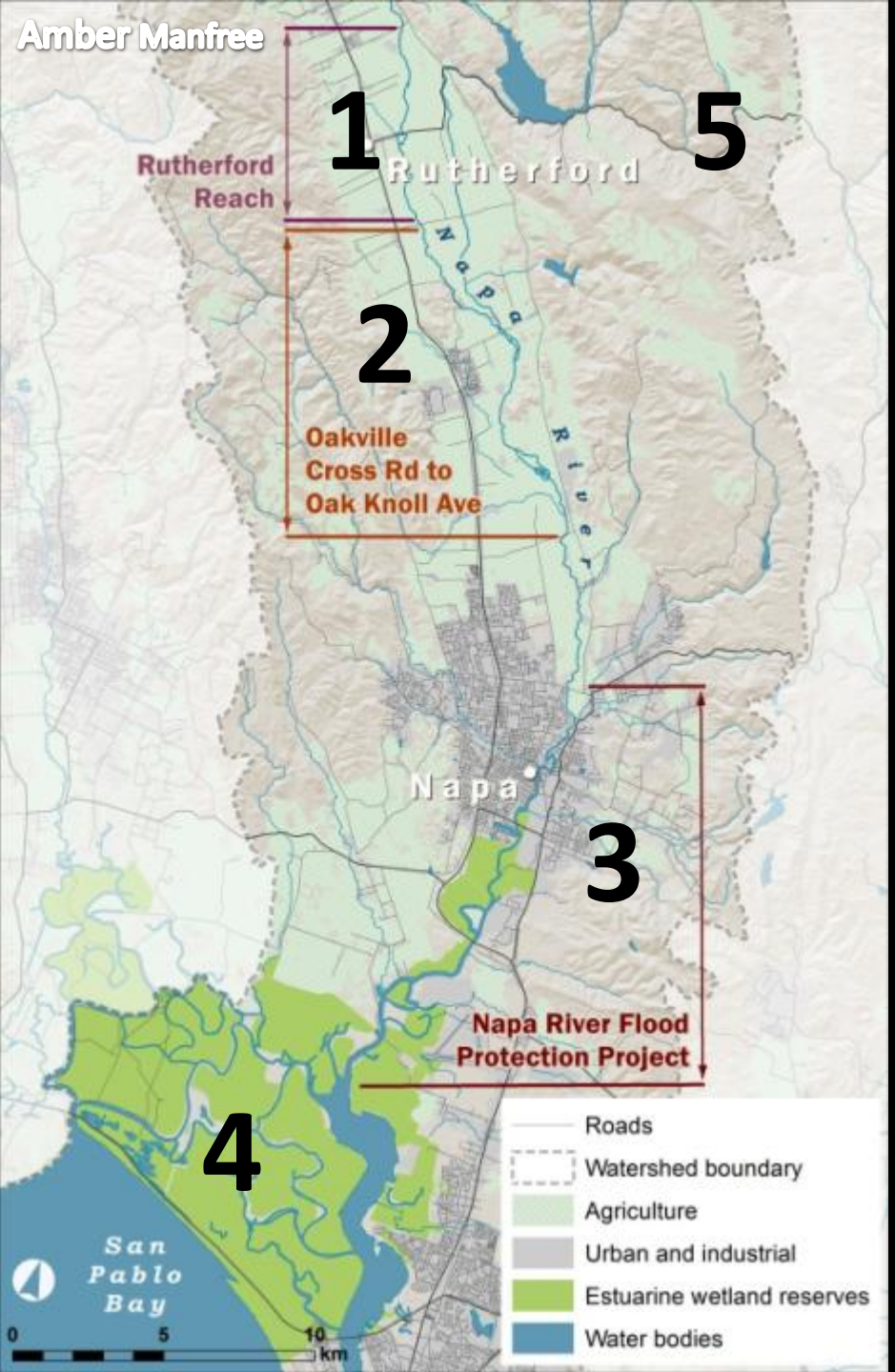


Napa River

1. Rutherford Reach
   - Landowner-led
   - Financed by landowners and gov't
   - Benefits: TMDL compliance, risk reduction, PR boost

2. Oakville to Oak Knoll
   - Similar to Rutherford Reach

3. Napa River Flood Protection
   - Local water agency led elaborate stakeholder process
   - "Room for the River" model



Napa River

4. Tidal wetland restoration
   - US Fish and Wildlife, land trust, water agency buy and restore former salt evaporation ponds

5. Local environmental policies protect watersheds
   - Erosion control ordinance
   - Developable area per parcel limited to 60 %
   - Most projects subject to public review process

- No change in site hydrograph for new urban projects
- Environmental ed campaigns

Summary

- Adversarial business vs. environmentalist narrative unproductive, simplistic
- Reconciliation, multi-benefit thinking more productive
- Tailor to socio-environmental system

Napa in stream restoration in urban area

3. Futurecasting 101

- Demystifying the prediction process

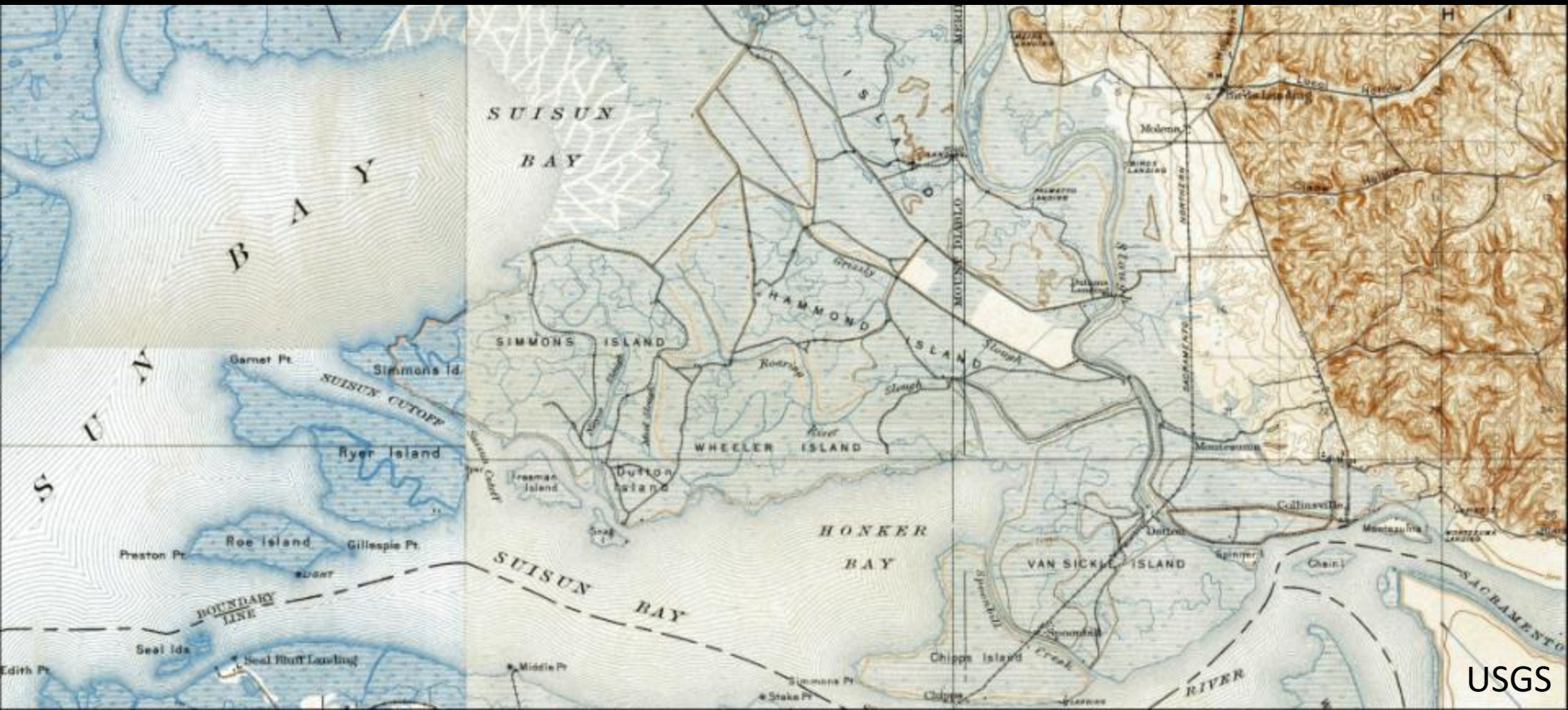
3. Futurecasting 101

1. Track change

Sediment accretion in a shallow wind-affected bay

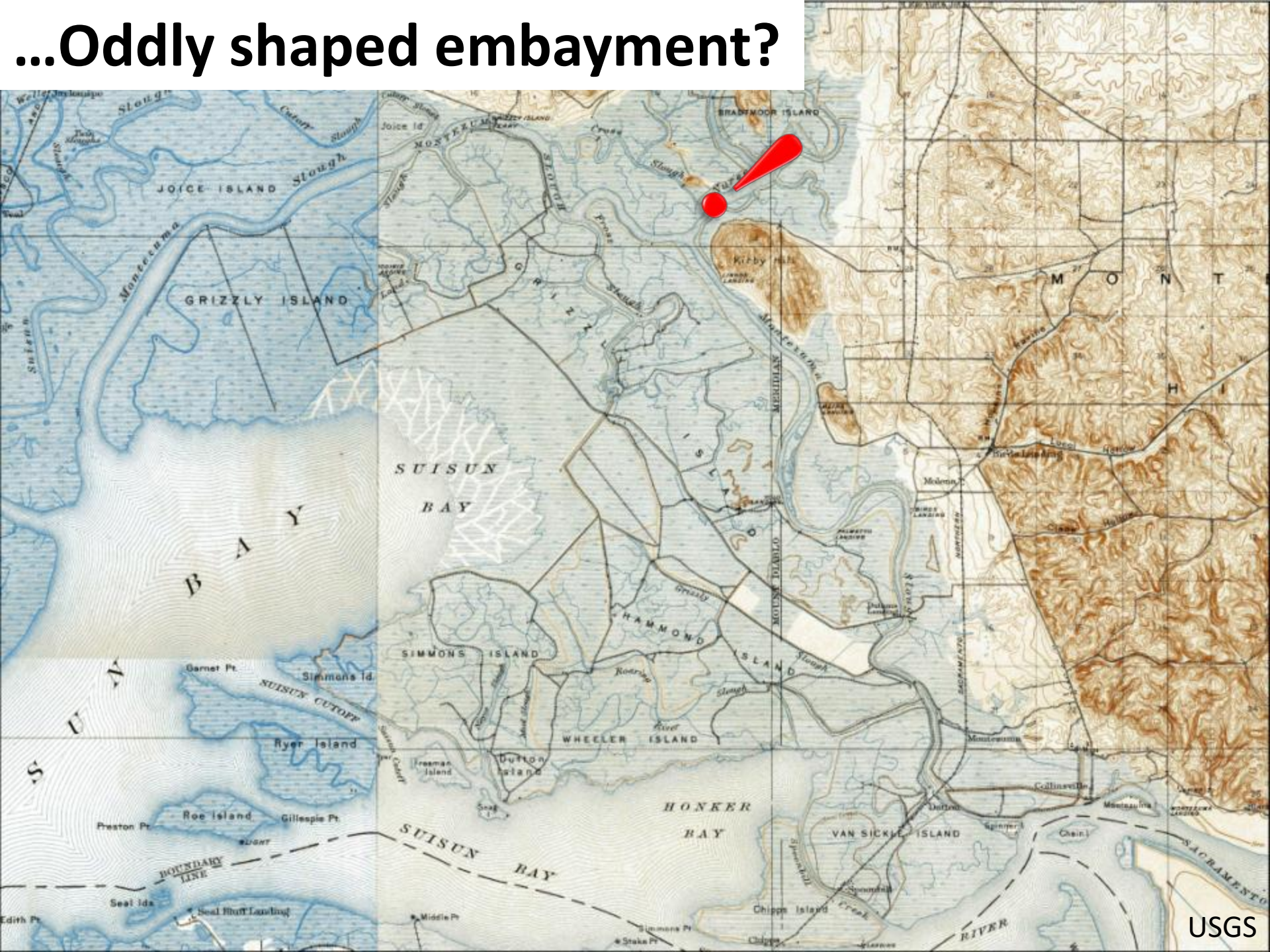
3. Futurecasting 101

1. Track change
2. Look for patterns

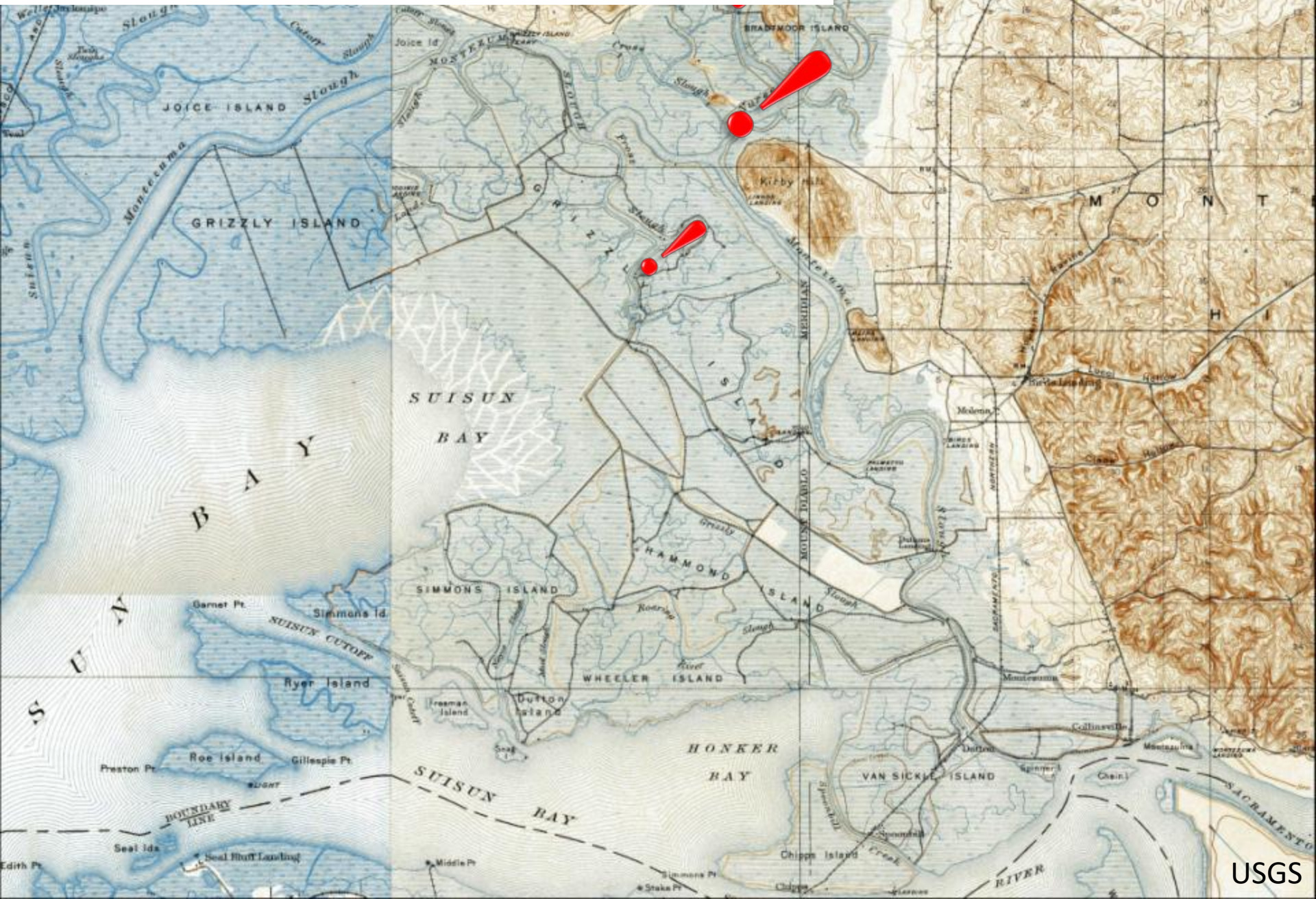


USGS

…Oddly shaped embayment?

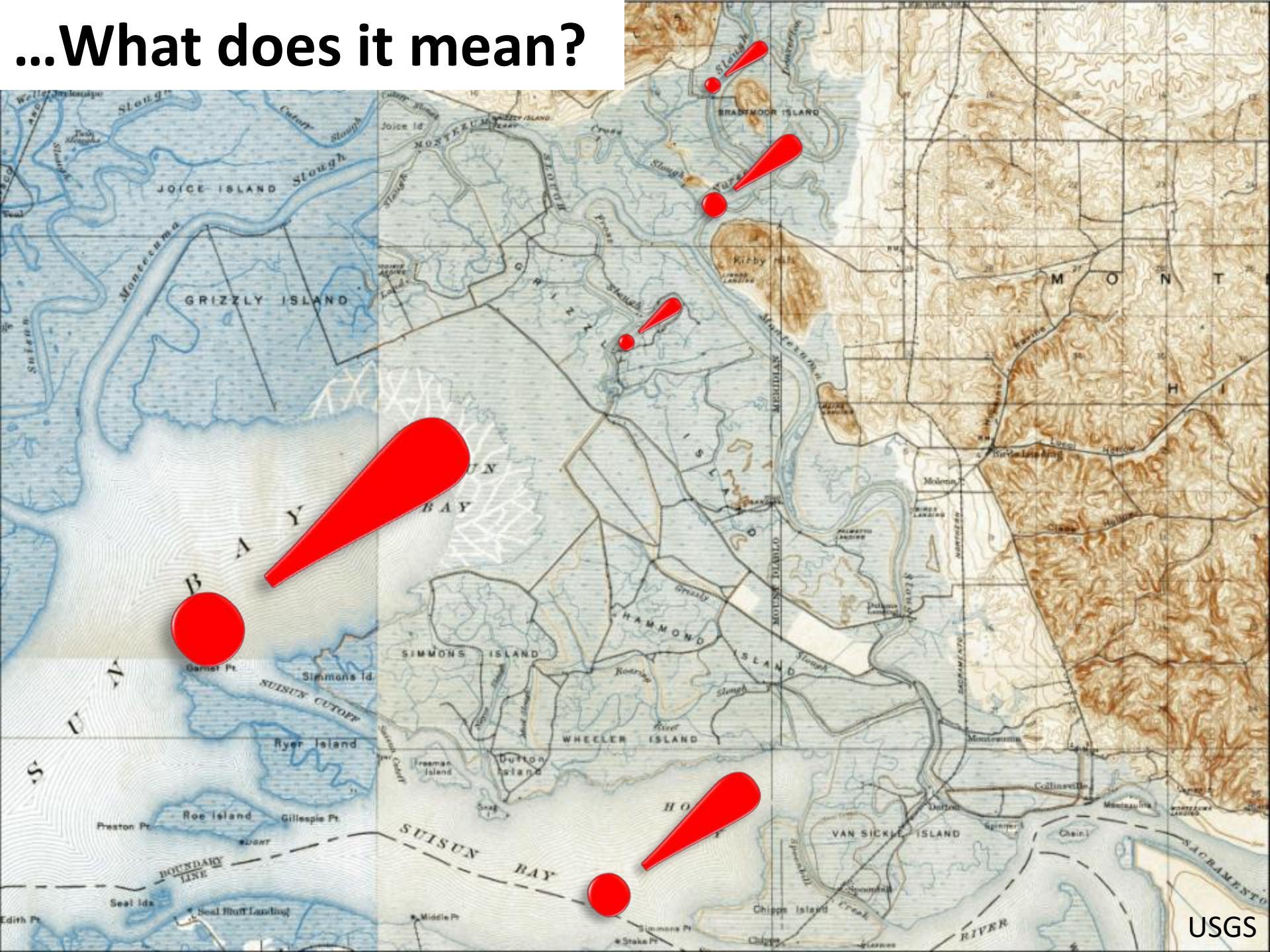


…Repeated in other locations



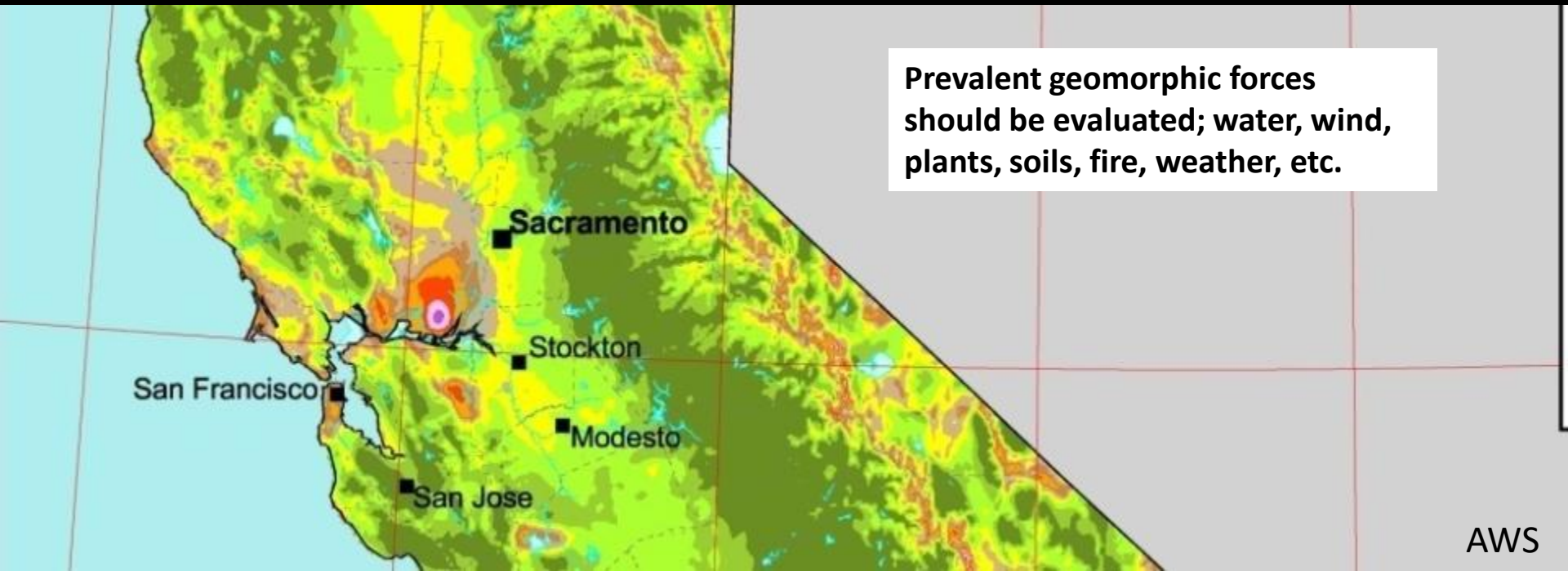
USGS

…What does it mean?

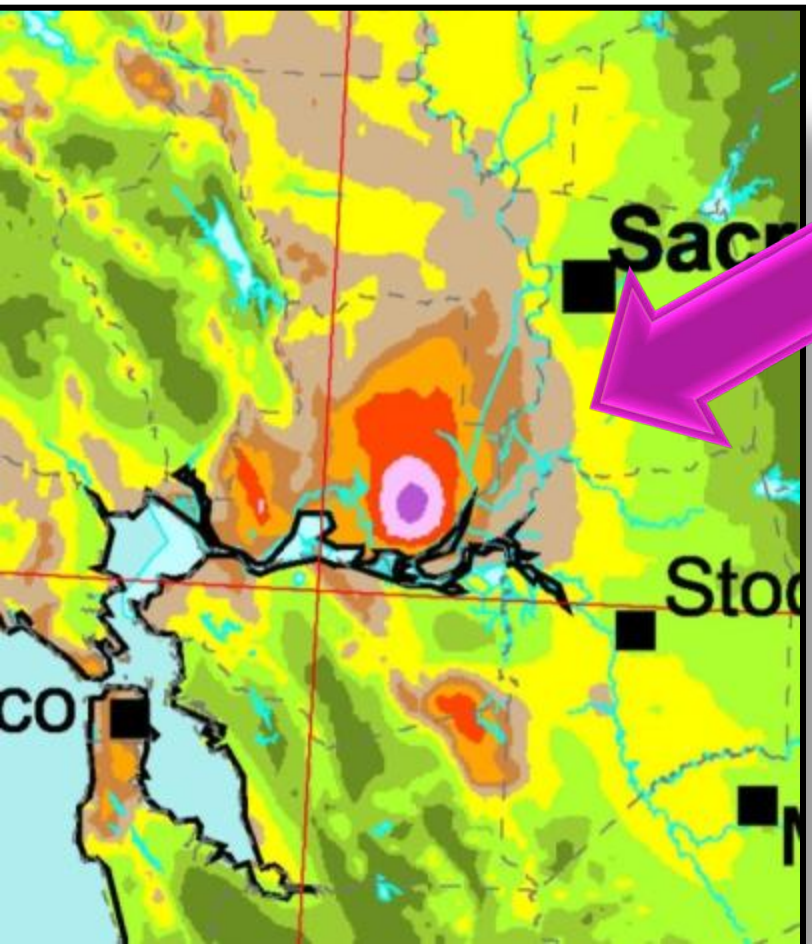


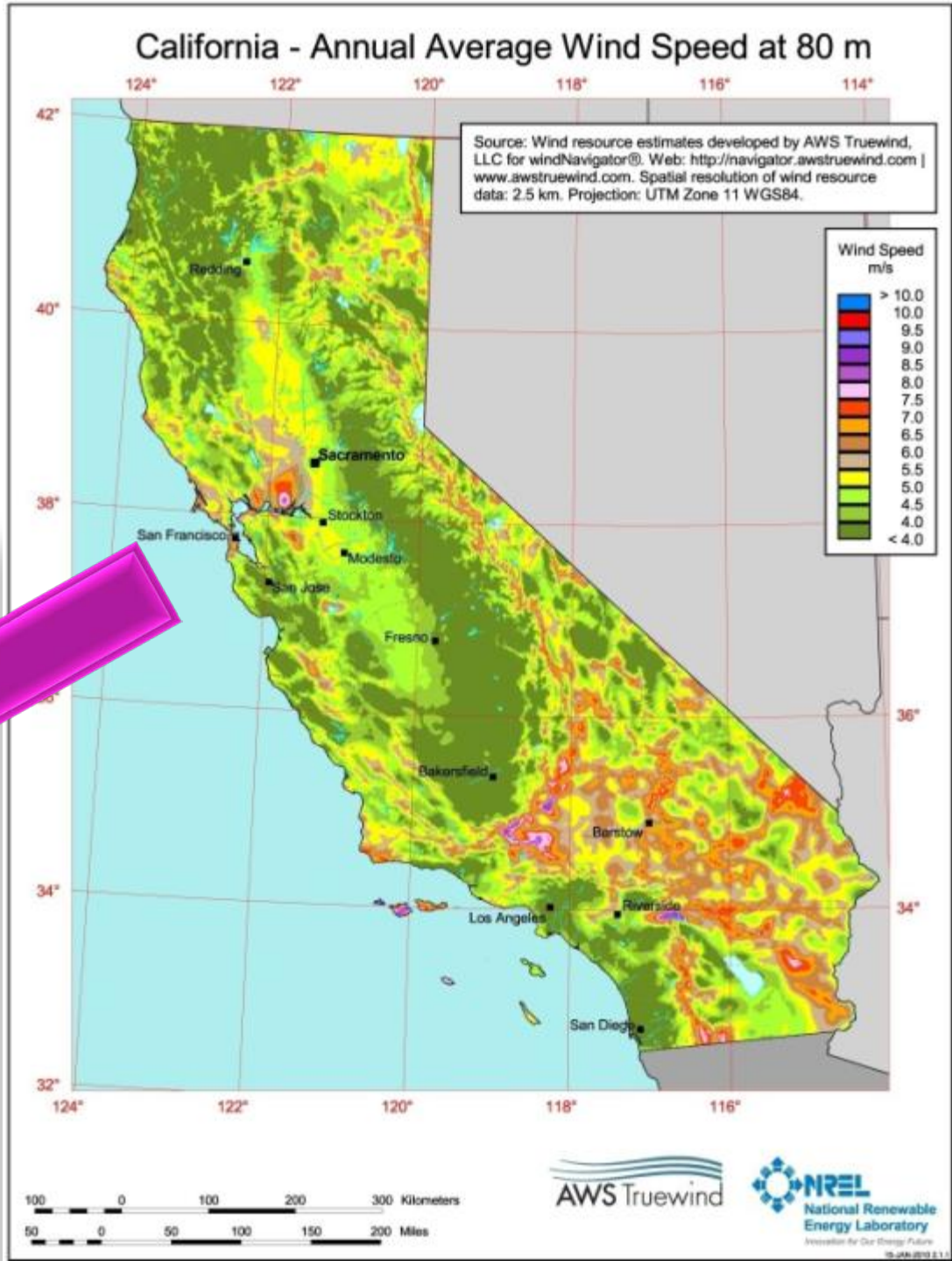
3. Futurecasting 101

1. Track change
2. Look for patterns
3. Identify drivers



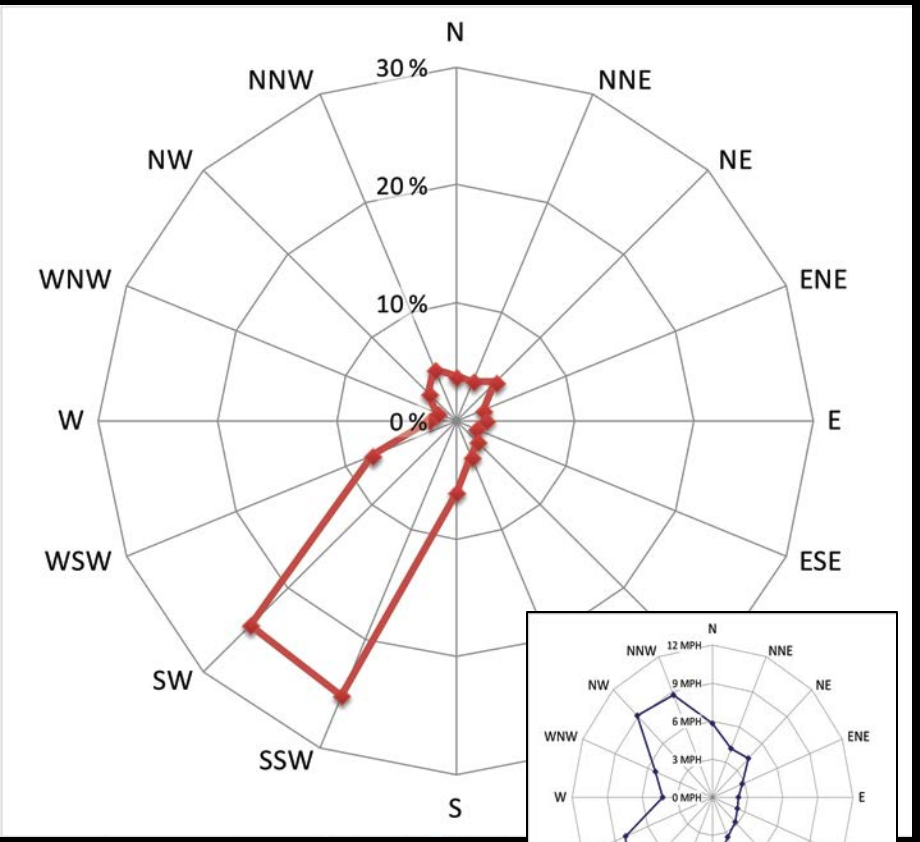
…Suisun Marsh next to the 4th windiest place in California





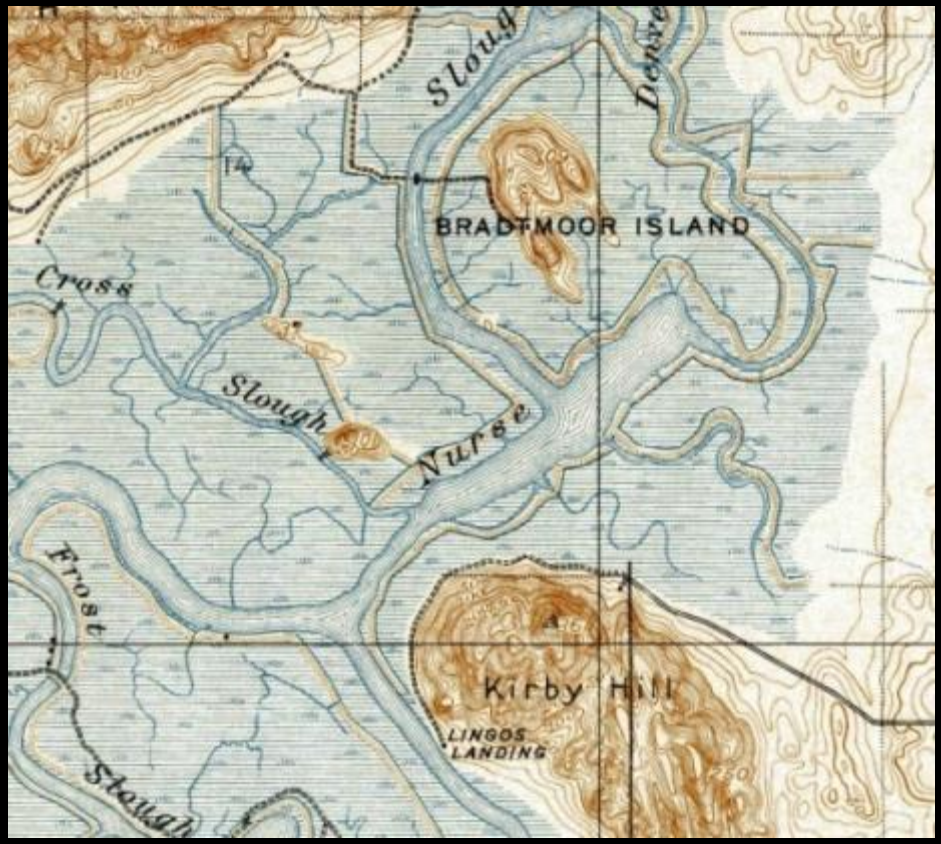
Processes pair with land forms

Percent of wind from each direction



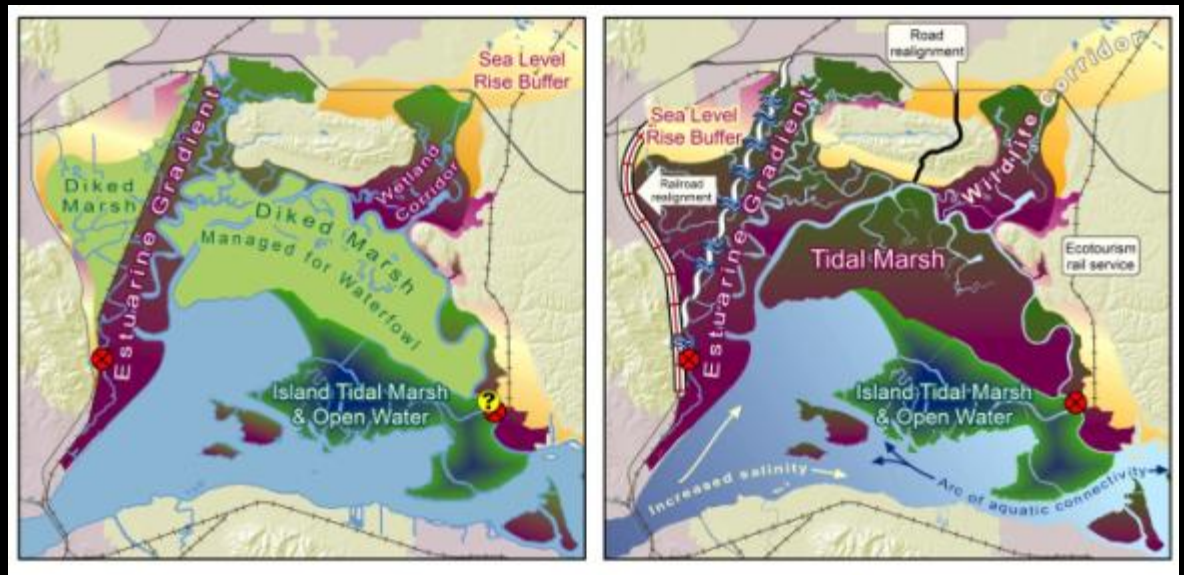
Avg windspeed

Driver echoed in landform shape



3. Futurecasting 101

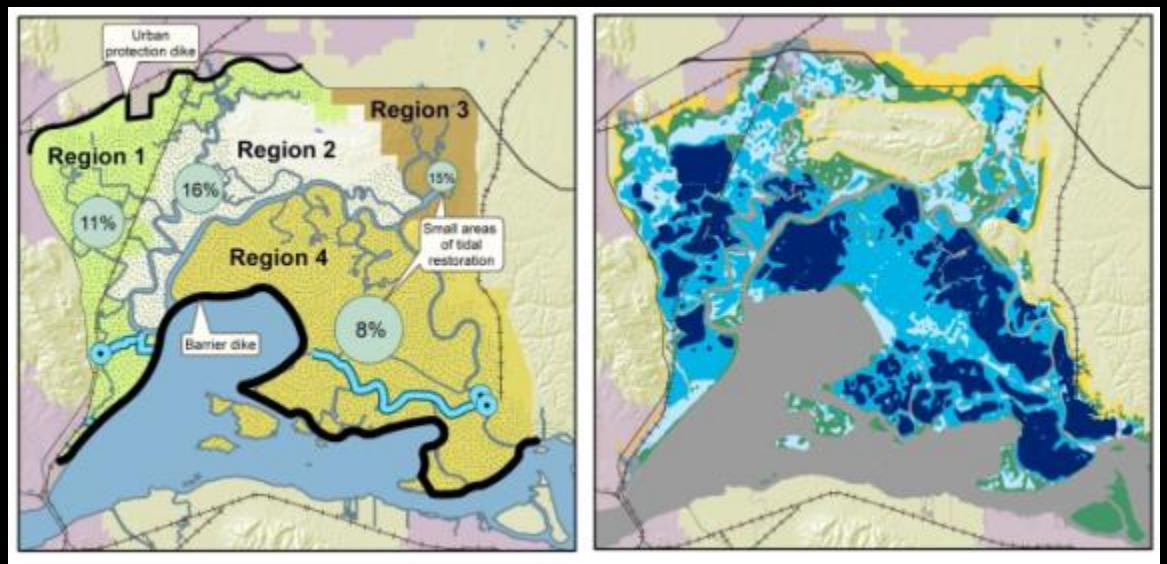
1. Track change
2. Look for patterns
3. Identify drivers
4. Describe a few reasonable trajectories



Amber Manfree

3. Futurecasting 101

1. Track change
2. Look for patterns
3. Identify drivers
4. Describe a few reasonable trajectories
5. Bookend with extreme cases



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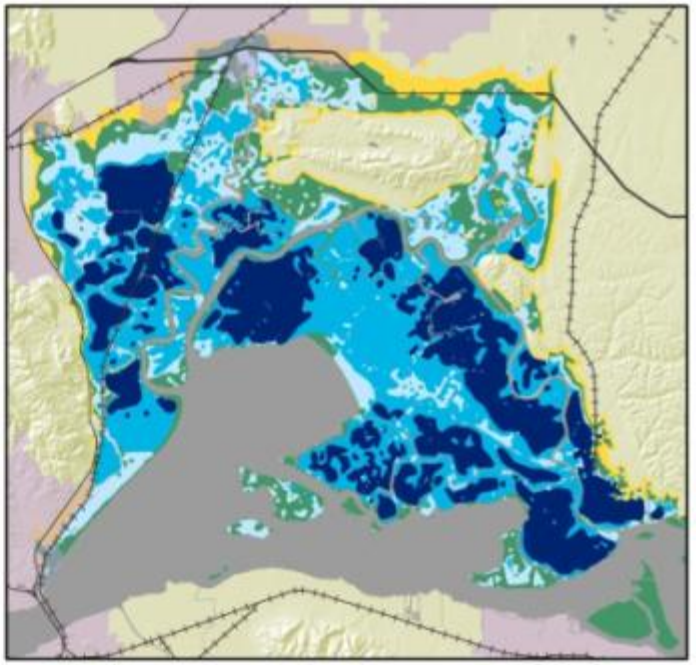
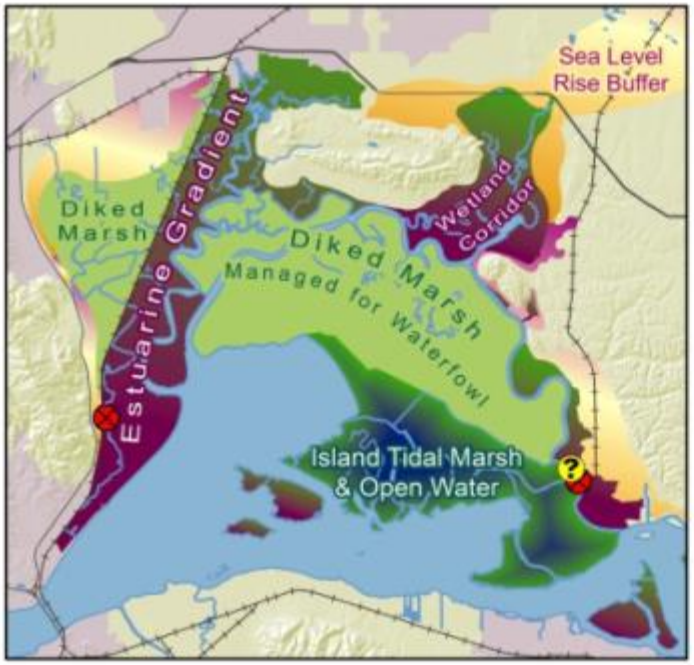
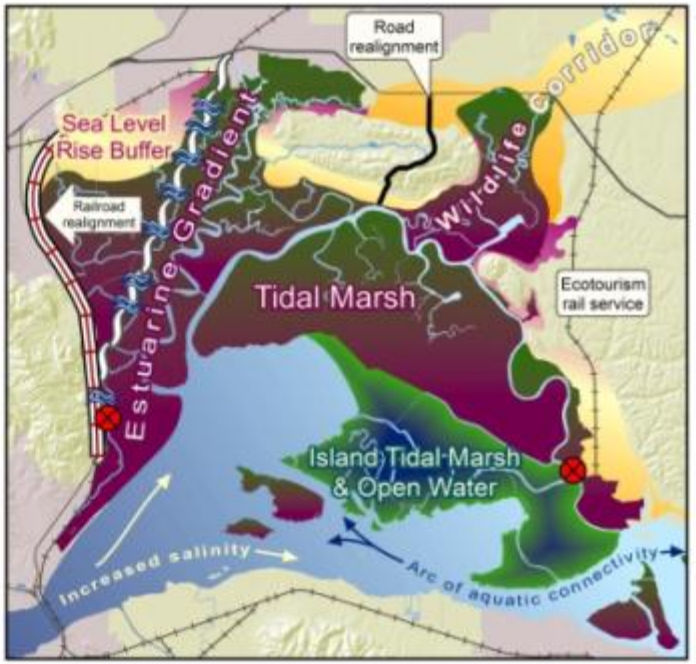
Aggressive hardening of the landscape



Continue current use with no adaptive controls

Hybrid human use - environmental management





Aggressive greening of the landscape

Concluding remarks

- Change is not the enemy!
- Think like a landscape
- Attitude matters
  - Balance human and ecosystem needs
  - Possibly mobilize like WWII?
    https://newrepublic.com/article/135684/declare-war-climate-change-mobilize-wwii
- Making room for processes can make extreme environmental events less frequent and less damaging

Thank you!

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EXTRA SLIDES

“Not all streams are created equal—some streams are disproportionately important for supporting biological diversity. Be strategic in conserving places that matter most. “

- Ted Grantham

2015 Estimated Agricultural Drought Impacts

Description	Impact	Base year	Percent
Drought water shortage (million acre-ft)	8.7	26.4	33%
Groundwater replacement (million acre-ft)	6.0	8.4	72%
Net water shortage (million acre-ft)	2.7	26.4	10%
Drought-related idle land (acres)	540,000	9 million*	6%
Crop revenue losses ($)	$900 million	$40 billion	2.3%
Dairy and livestock revenue losses ($)	$350 million	$13 billion	2.7%
Costs of additional pumping ($)	$590 million	$780 million	75.5%
Net revenue losses ($)	$1.8 billion	54 billion rev.	3.3%
Total economic impact ($)	**$2.7 billion**	NA	NA
Direct job losses (farm seasonal)	10,100	200,000#	5.1%
Total job losses	**21,000**	NA	NA

* NASA-ARC estimate of normal Central Valley idle land is 1.2 million acres.

Total agriculture employment is about 412,000, of which 200,000 is farm production.

Dr. Josue Medellin-Azuara