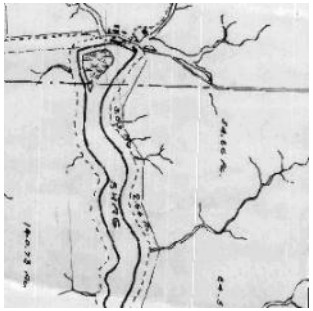






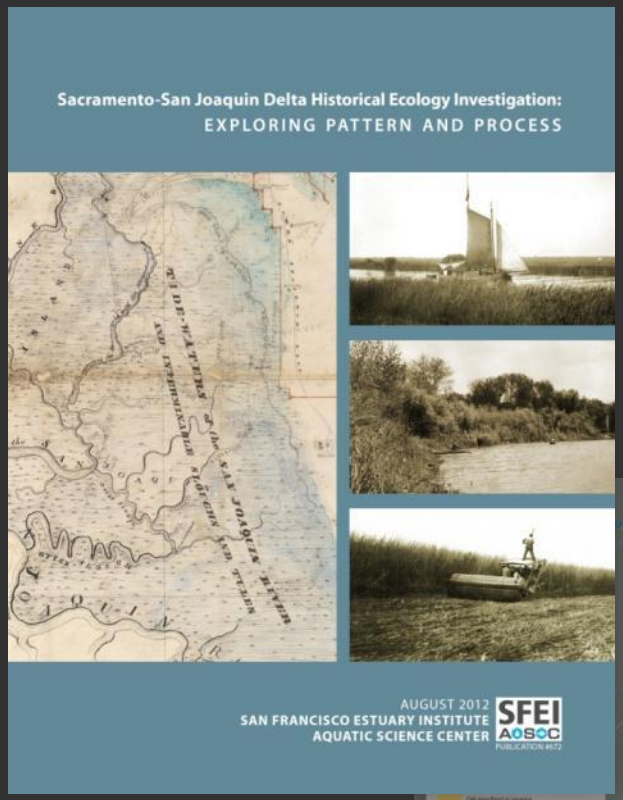



Historical Ecology of Lower Yolo Bypass

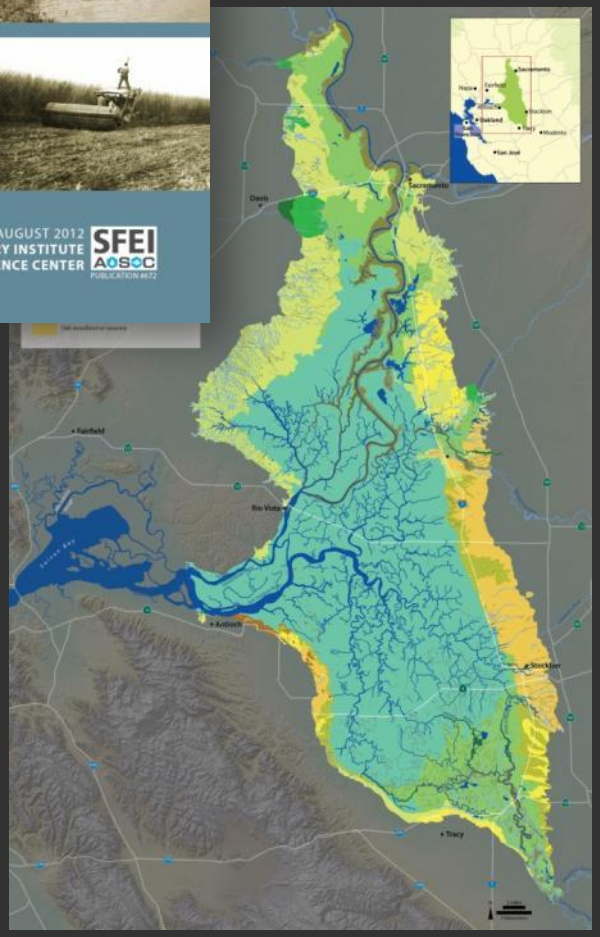
Robin Grossinger
San Francisco Estuary Institute-
Aquatic Science Center

Lower Yolo Restoration Project
Expert Panel Meeting
February 13, 2013

AQUATIC SCIENCE CENTER



Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process



- Funded by Ecosystem Restoration Program (CDFW, NOAA, US FWS)
- Final Report/GIS Available: www.sfei.org/DeltaHEStudy
- Collaboration with KQED QUEST and Stanford's Bill Lane Center for the American West: science.kqed.org/quest/delta-map/

Historical ecology is:

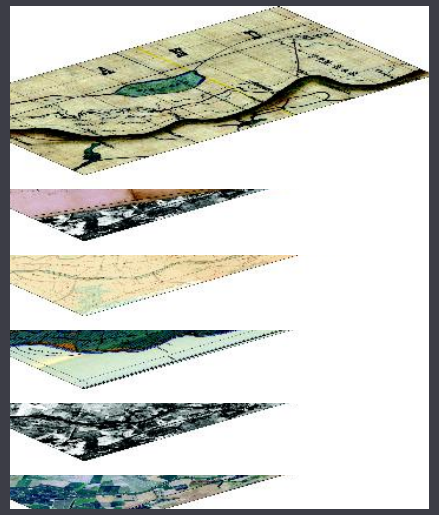
Using the past to understand the present landscape and assess its future potential

- **Links landscape pattern, process, and function**
- **Describes the conditions to which species are adapted**
- **Challenges assumptions about past landscapes**
- **Identifies opportunities and constraints**

Historical ecology is not:

Not about prescriptive management

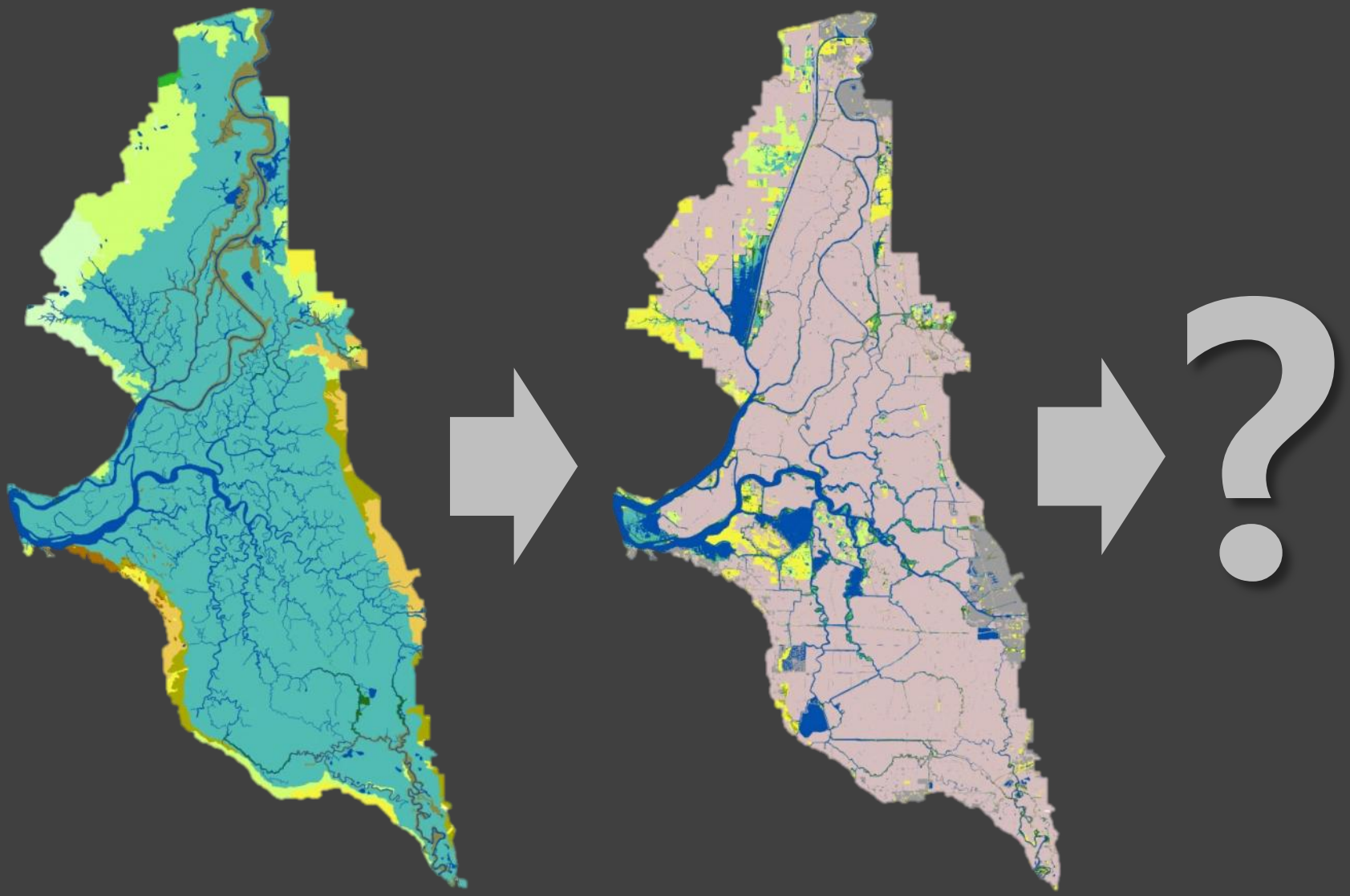
Not about recreating the past!



Not just the “way things were,” but the “way things work” (Safford et al. 2012)

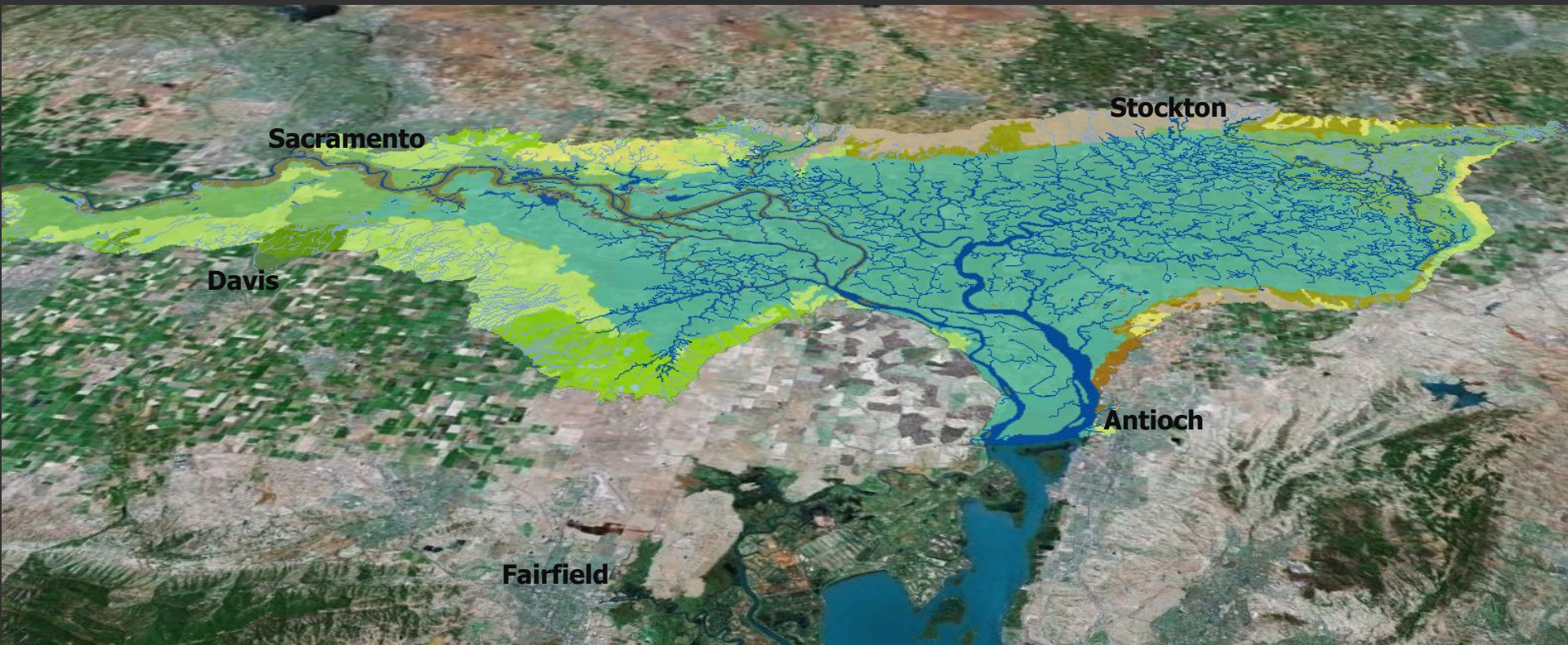
(See also: *“The Growing Importance of the Past in Managing Ecosystems of the Future”* (Safford, Wiens, and Hayward 2012))

How do we create ecologically functional, resilient *landscapes*?

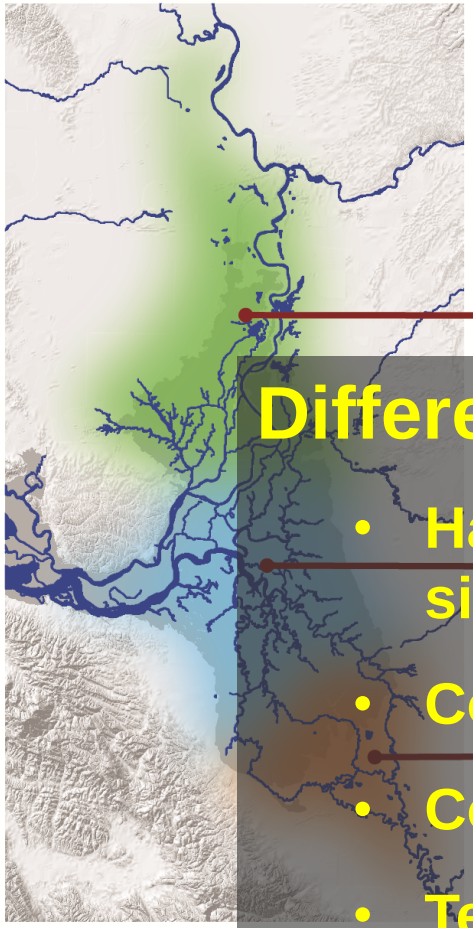


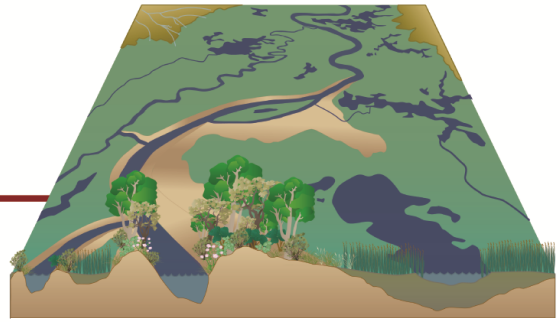
key points

- Multiple landscapes
  - Habitat mosaics arranged in distinct patterns
  - Expressed across broad physical gradients



Conceptual models of historical landscapes



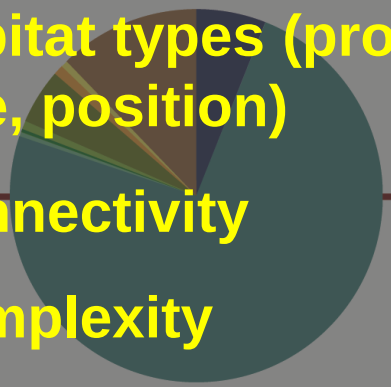


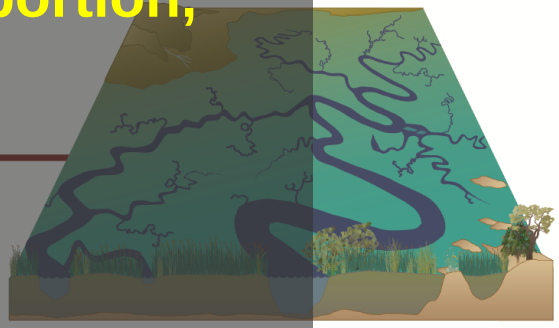
North Delta: where flood basins flank rivers

360,000 acres

Different characteristics

- Habitat types (proportion, size, position)
- Connectivity
- Complexity
- Temporal variability

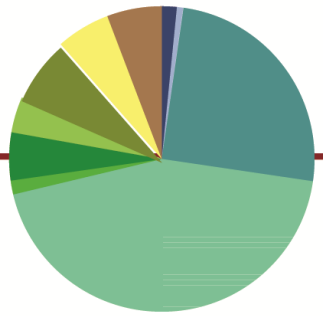




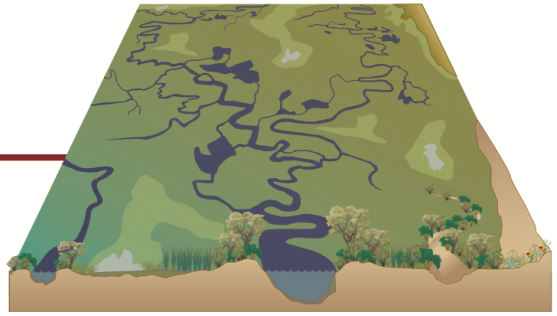
Central Delta: where tides dominate

300,000 acres

- waterway
- pond/lake
- seasonal pond/lake
- tidal freshwater emergent wetland
- nontidal freshwater emergent wetland
- willow
- valley foothill riparian
- wet meadow/seasonal wetland
- vernal pool complex
- alkali seasonal wetland complex
- inland dune scrub
- grassland
- woodland/savanna

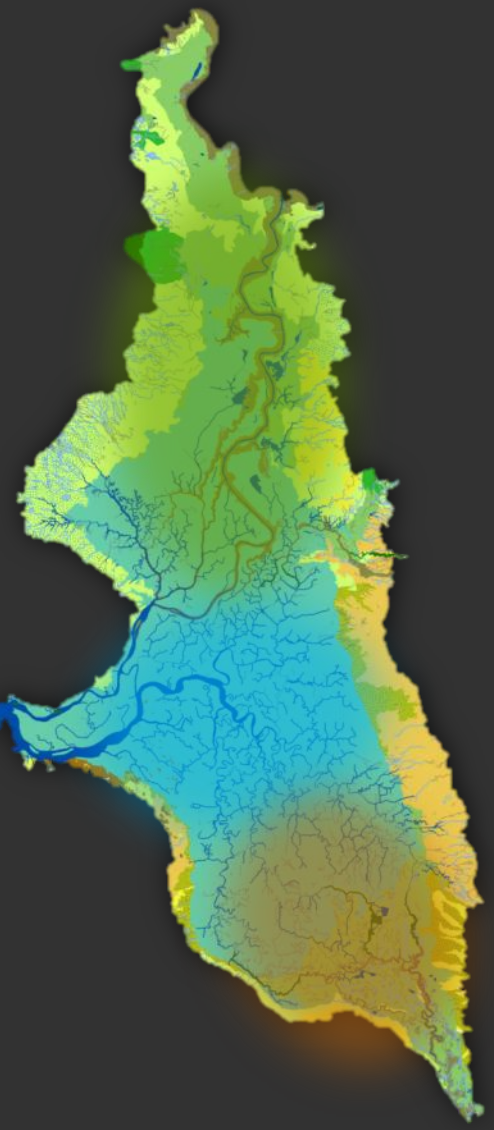


120,000 acres



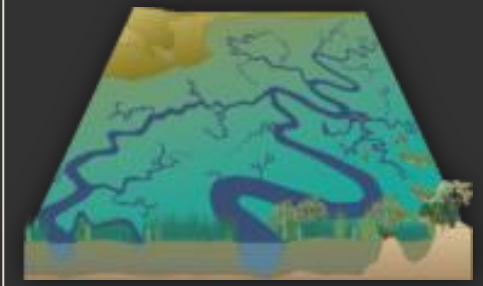
South Delta: where floodplains meet tides

Delta Historical Landscapes summary

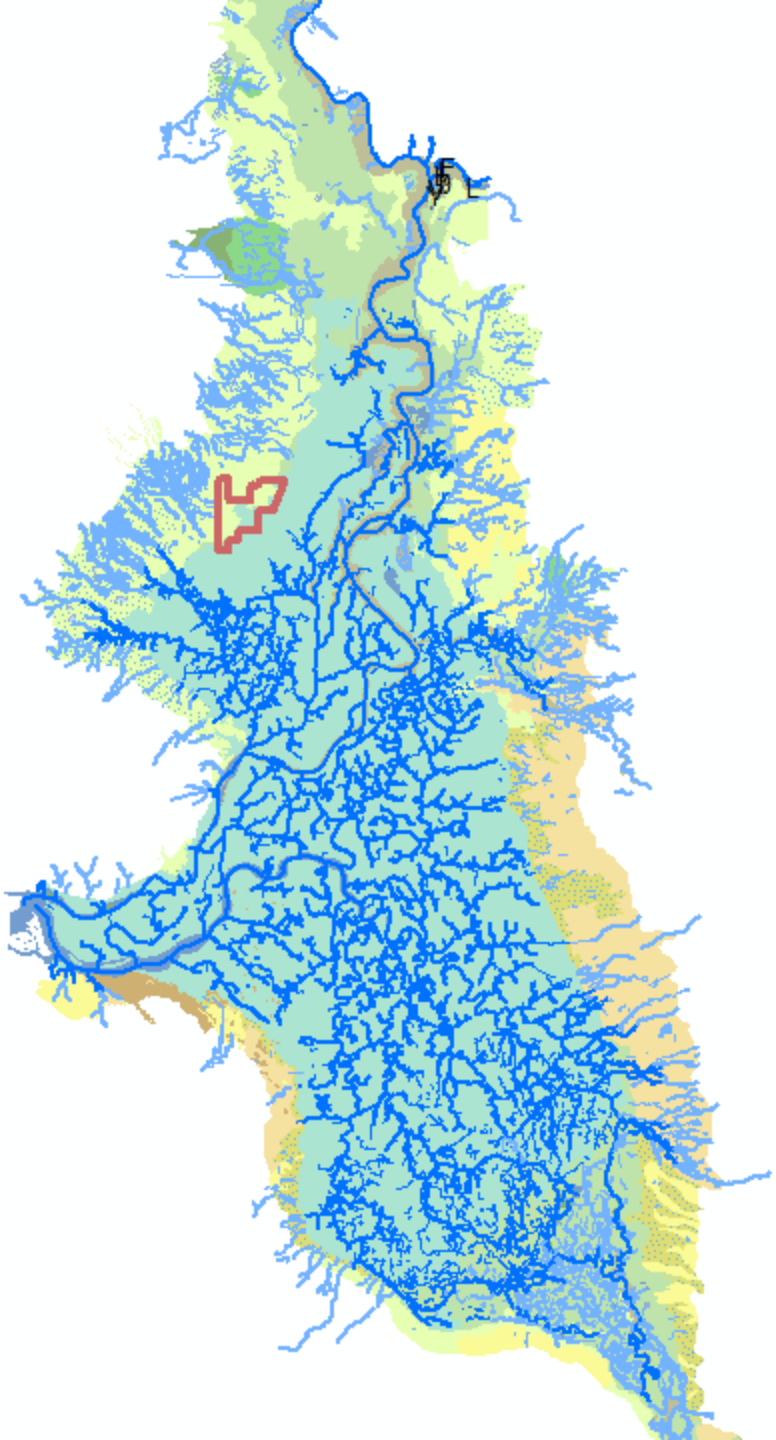


- Floods wetted and connected landscape
- Riparian forest bordering tule basins
- Few channels; diffuse overflow

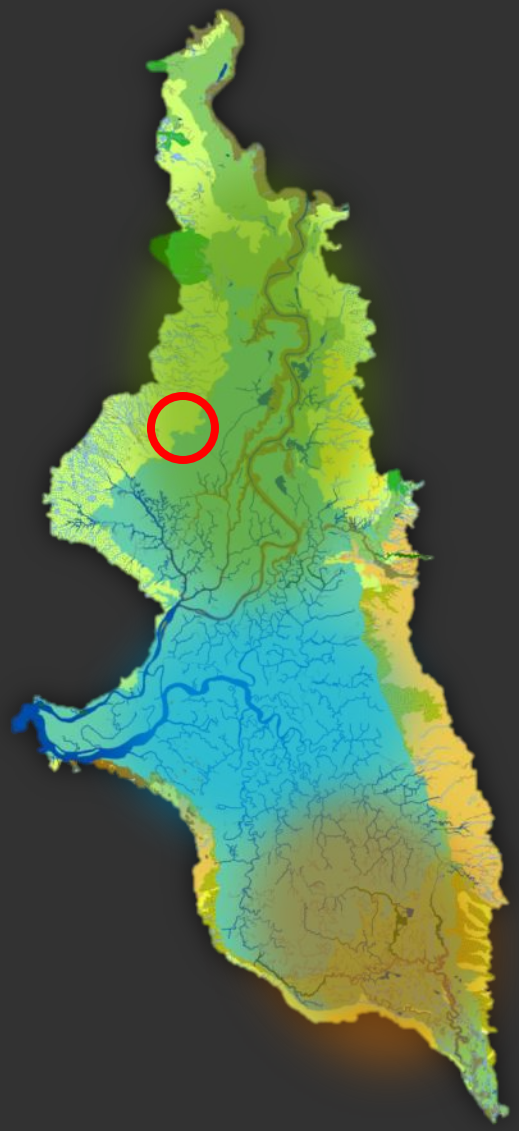
- High degree of tidal influence
- Networks of branching subtidal channels
- Tidal wetland of tule and willow-fern swamp



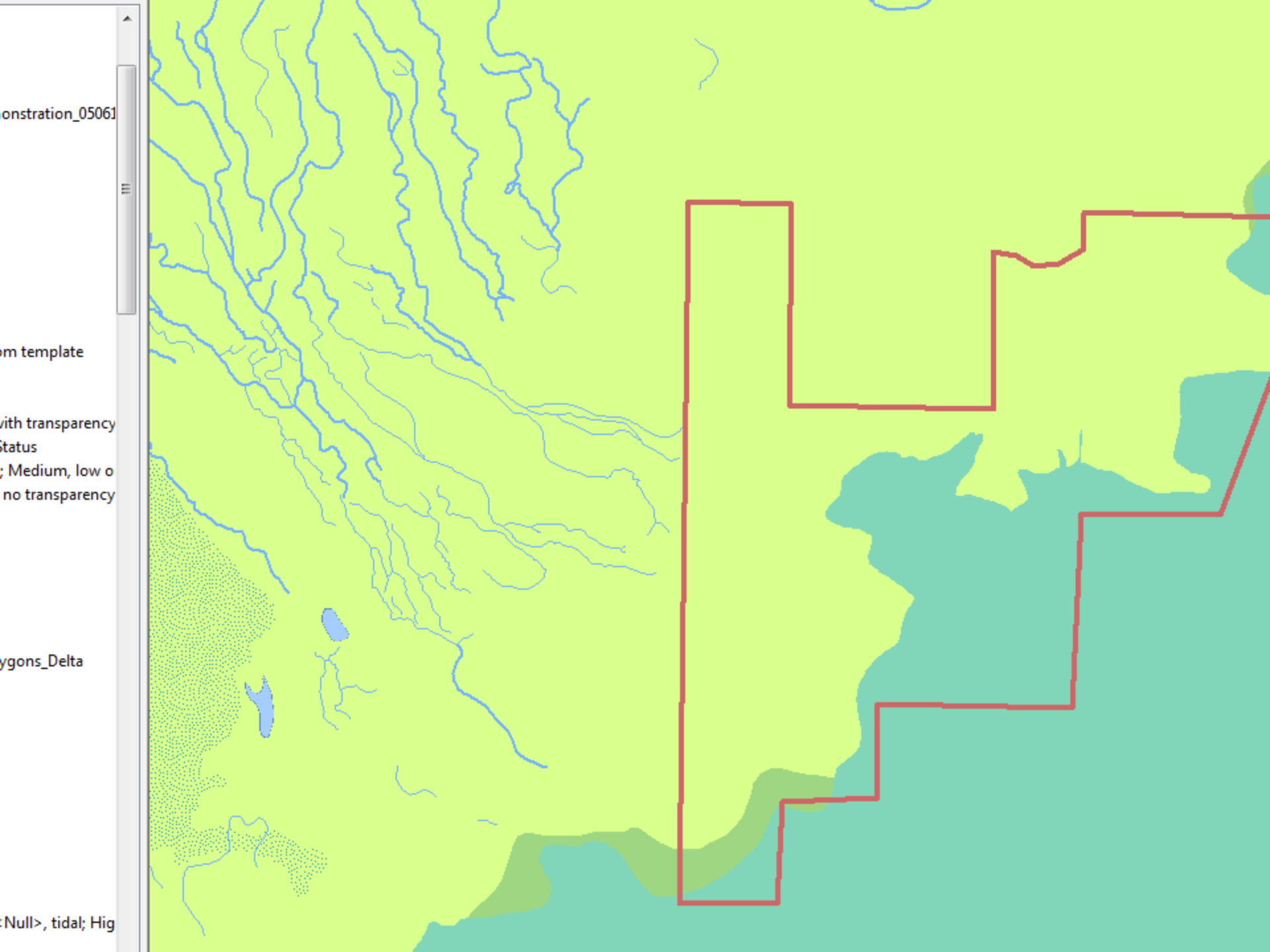
- Floods within a complex landscape meet the tides
- Side-channels connected to rivers
- Habitat type diversity at local scale



Interface btw North Delta and Central Delta landscapes



- Historically, part of North Delta Flood Basins landscape
- Occupied the edge of the Yolo Basin
- Also distal end of Putah Creek alluvial fan
- Today, closer to subtidal waters → key interface position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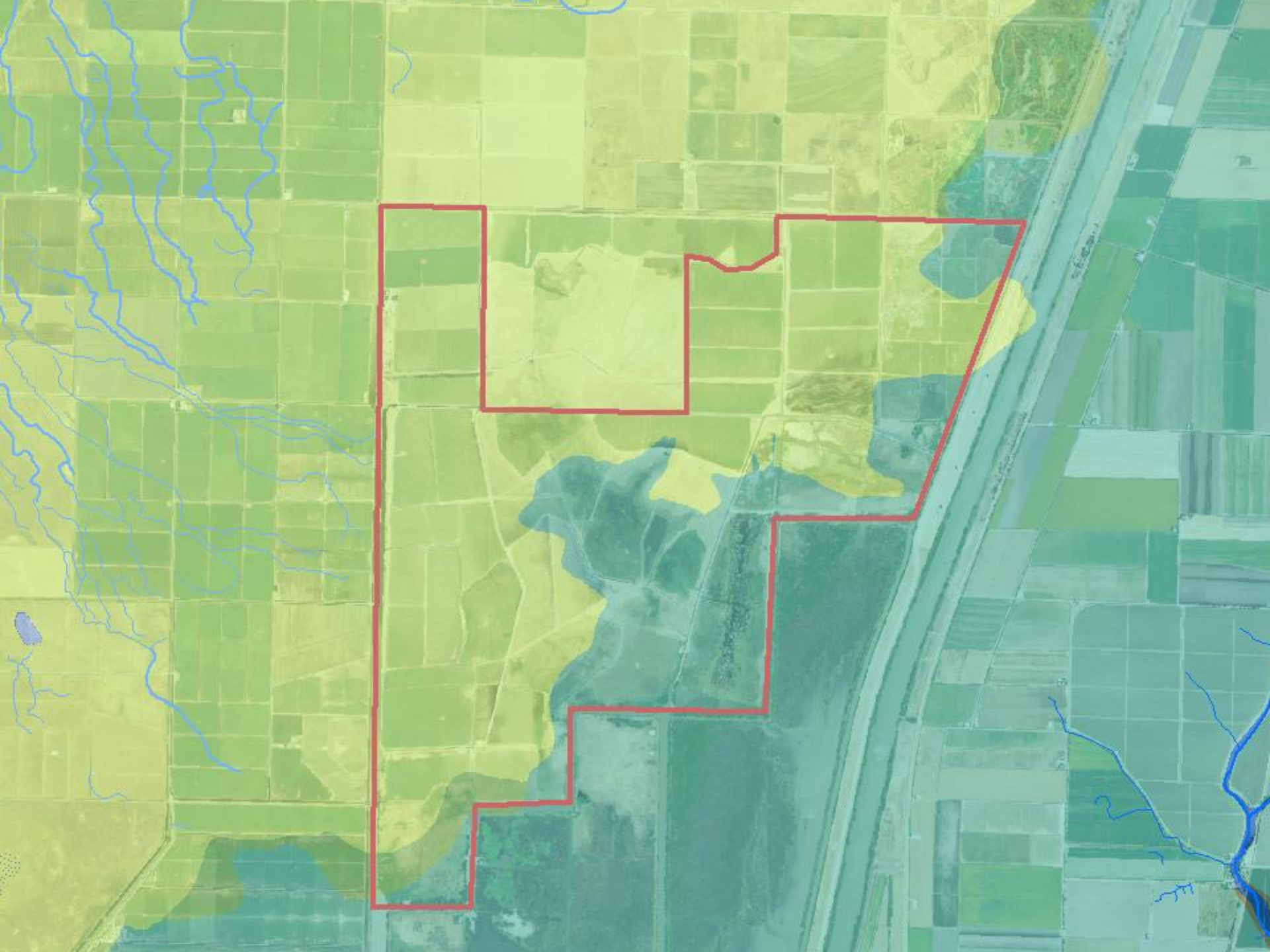

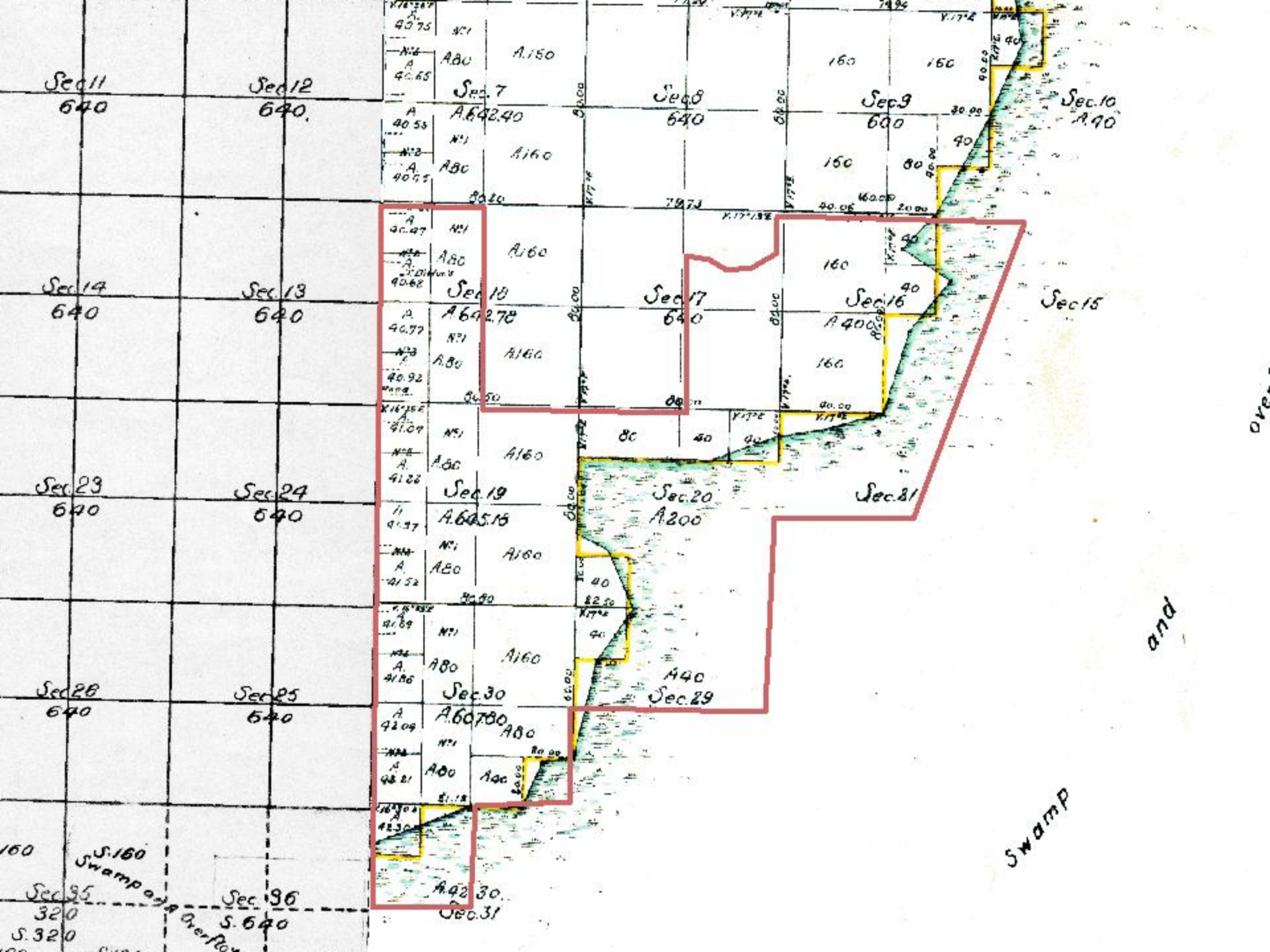
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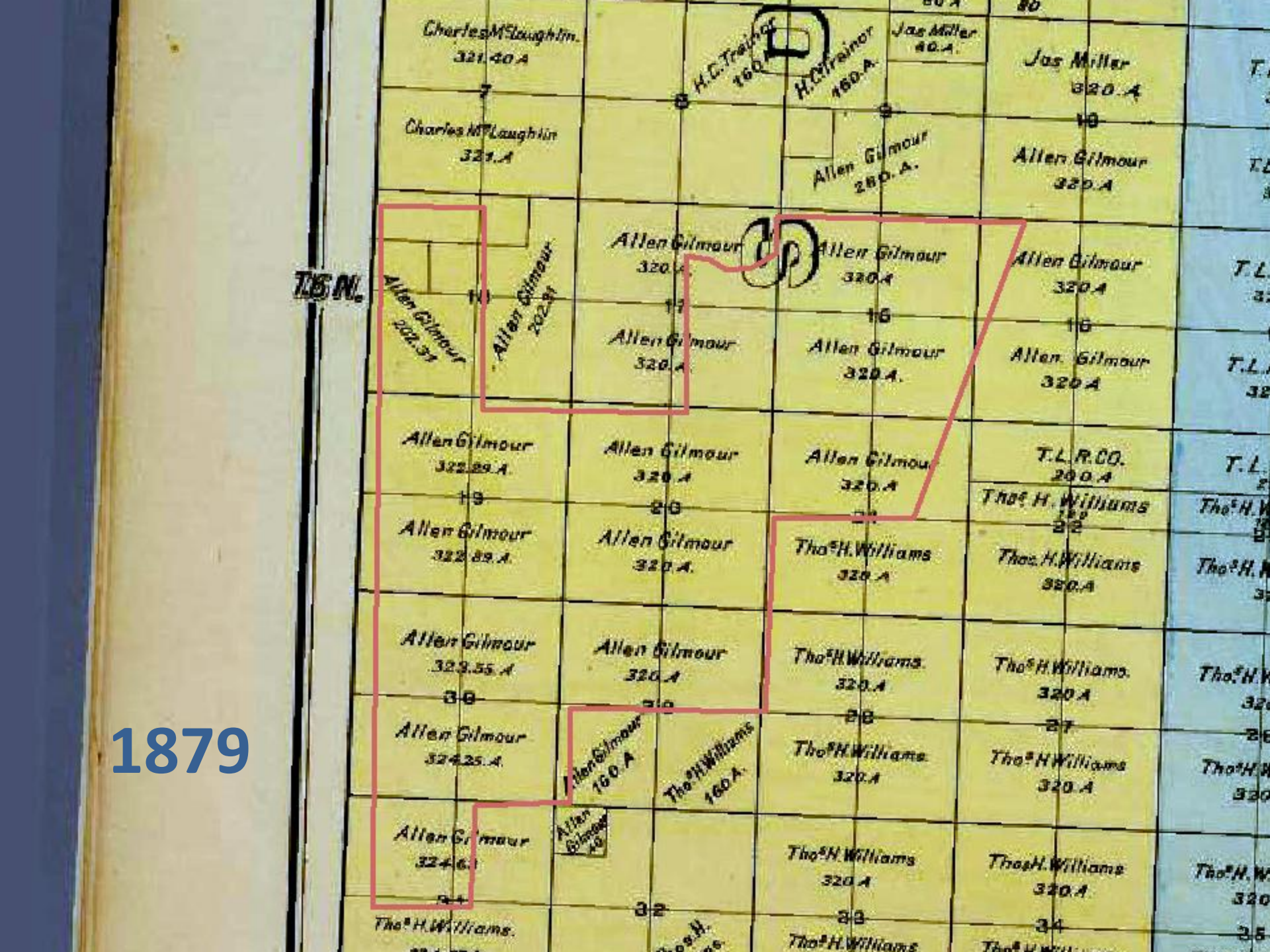
and
Swamp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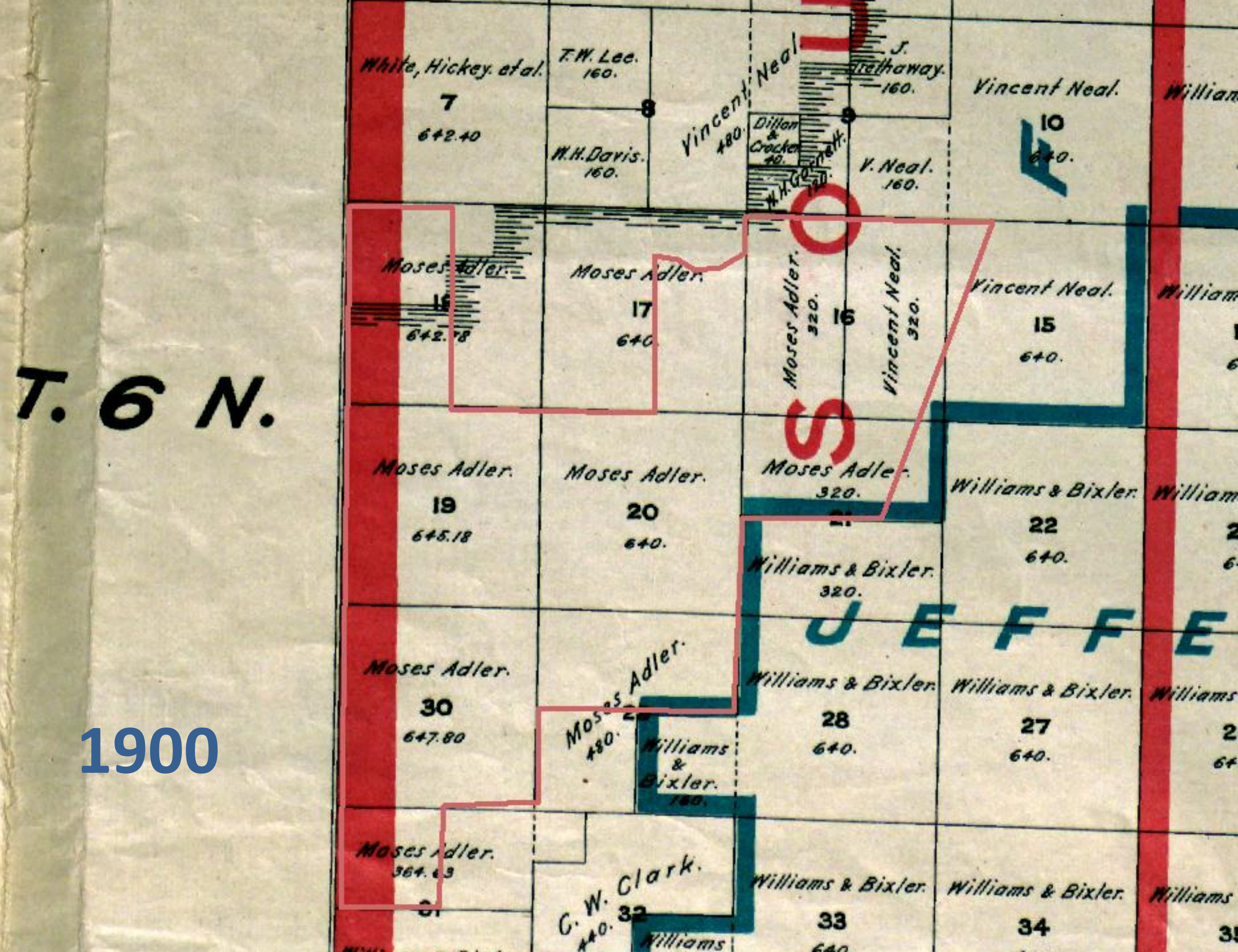
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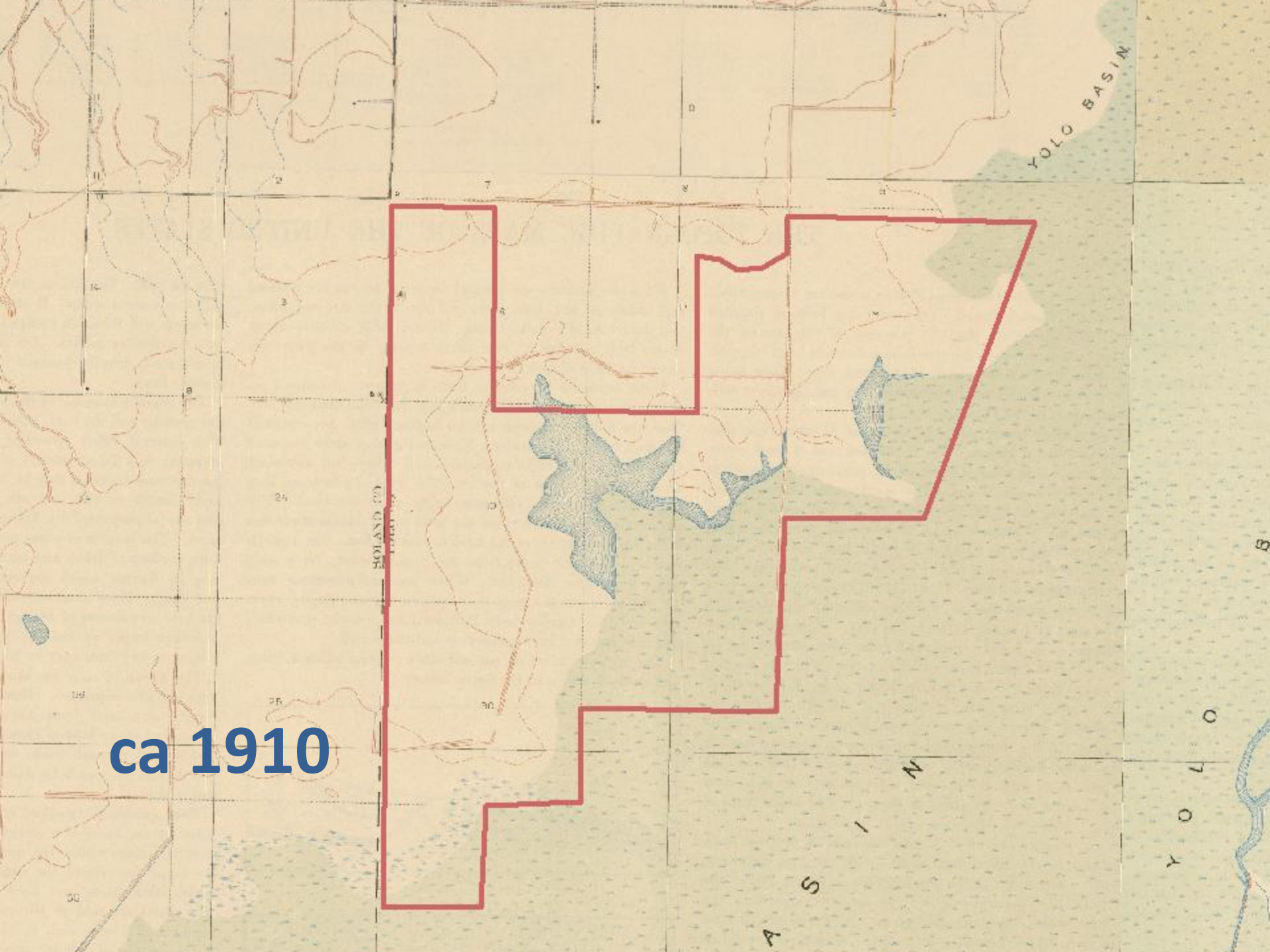
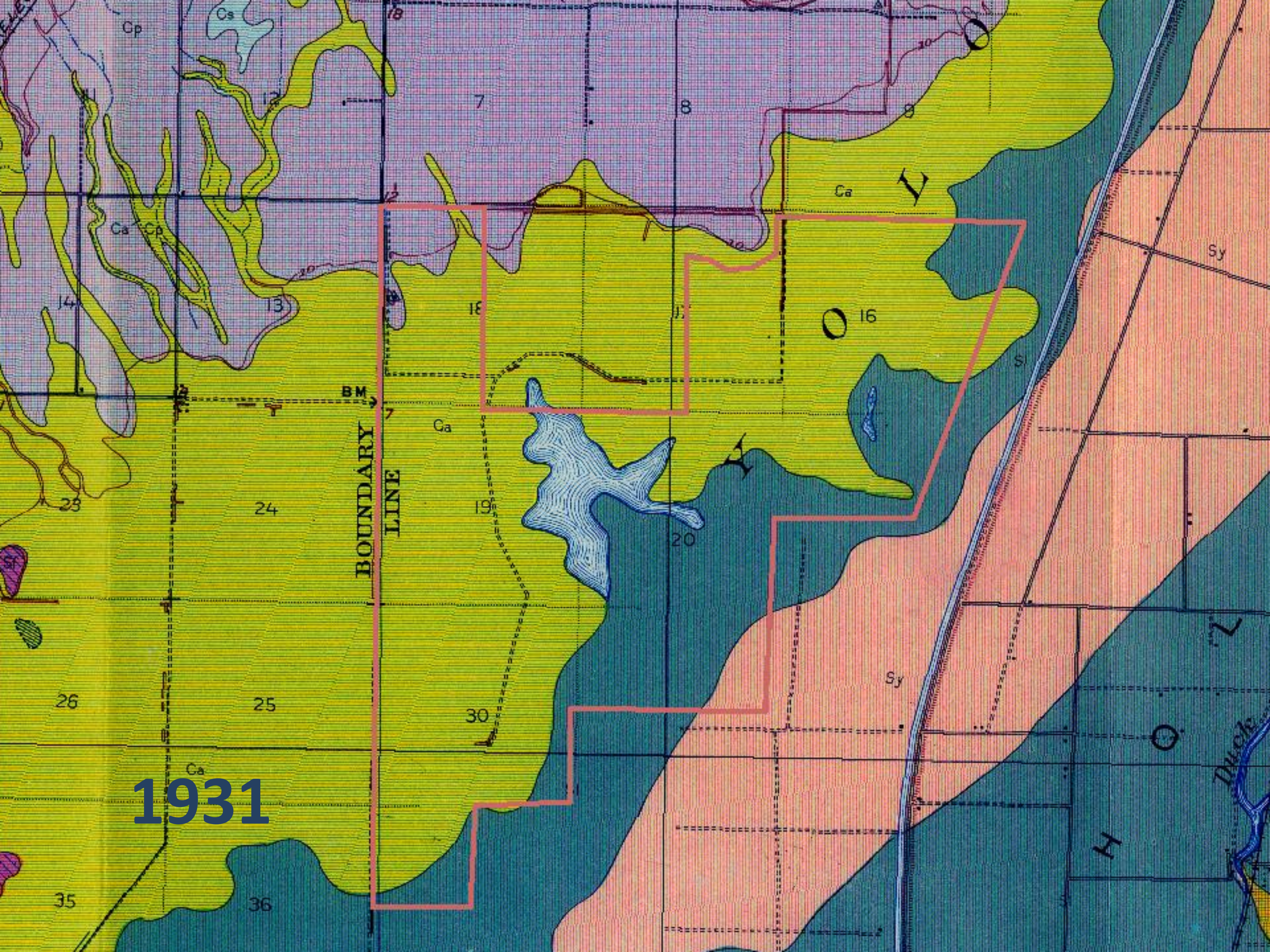

YOLO BASIN
ca 1910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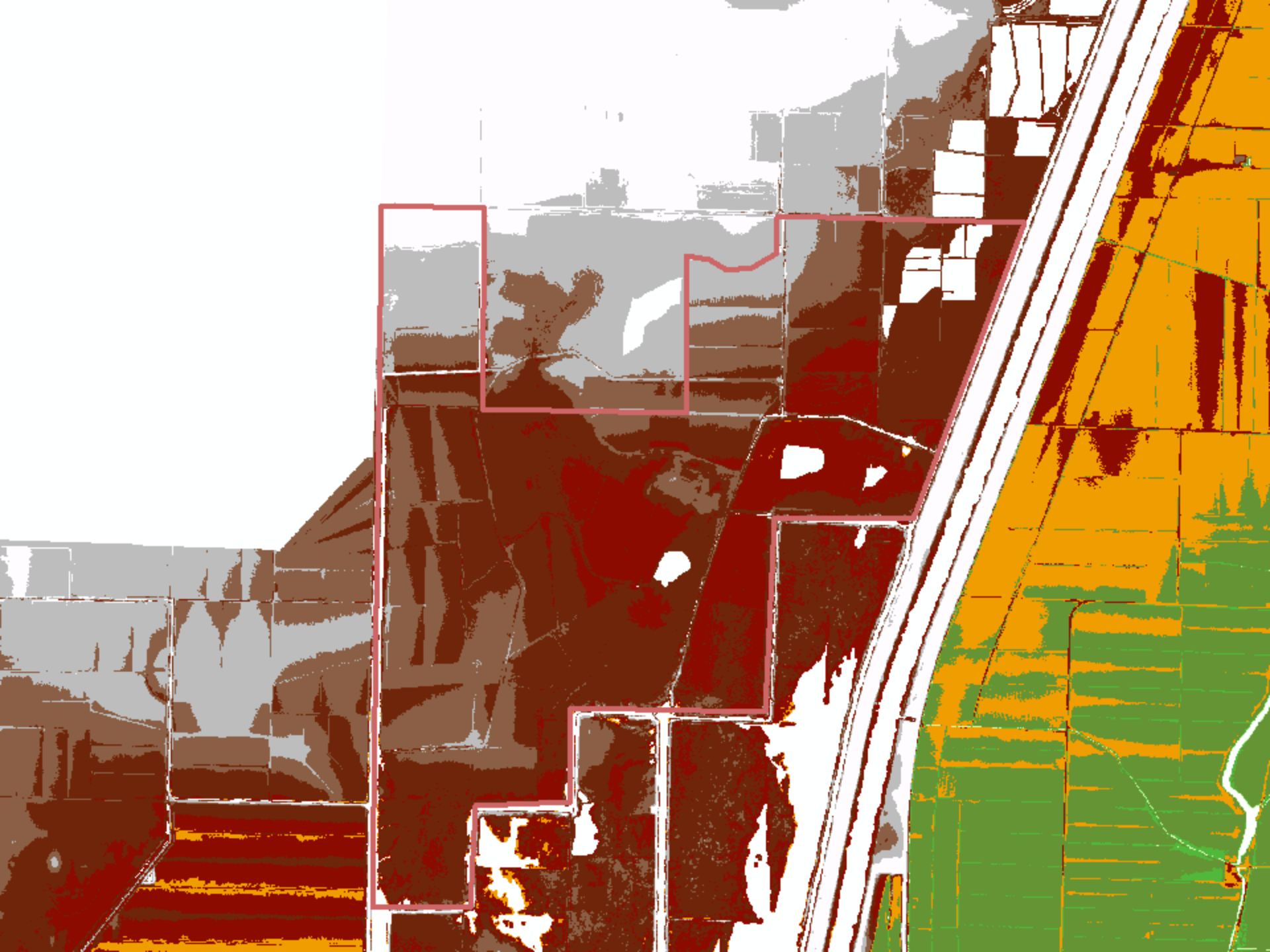
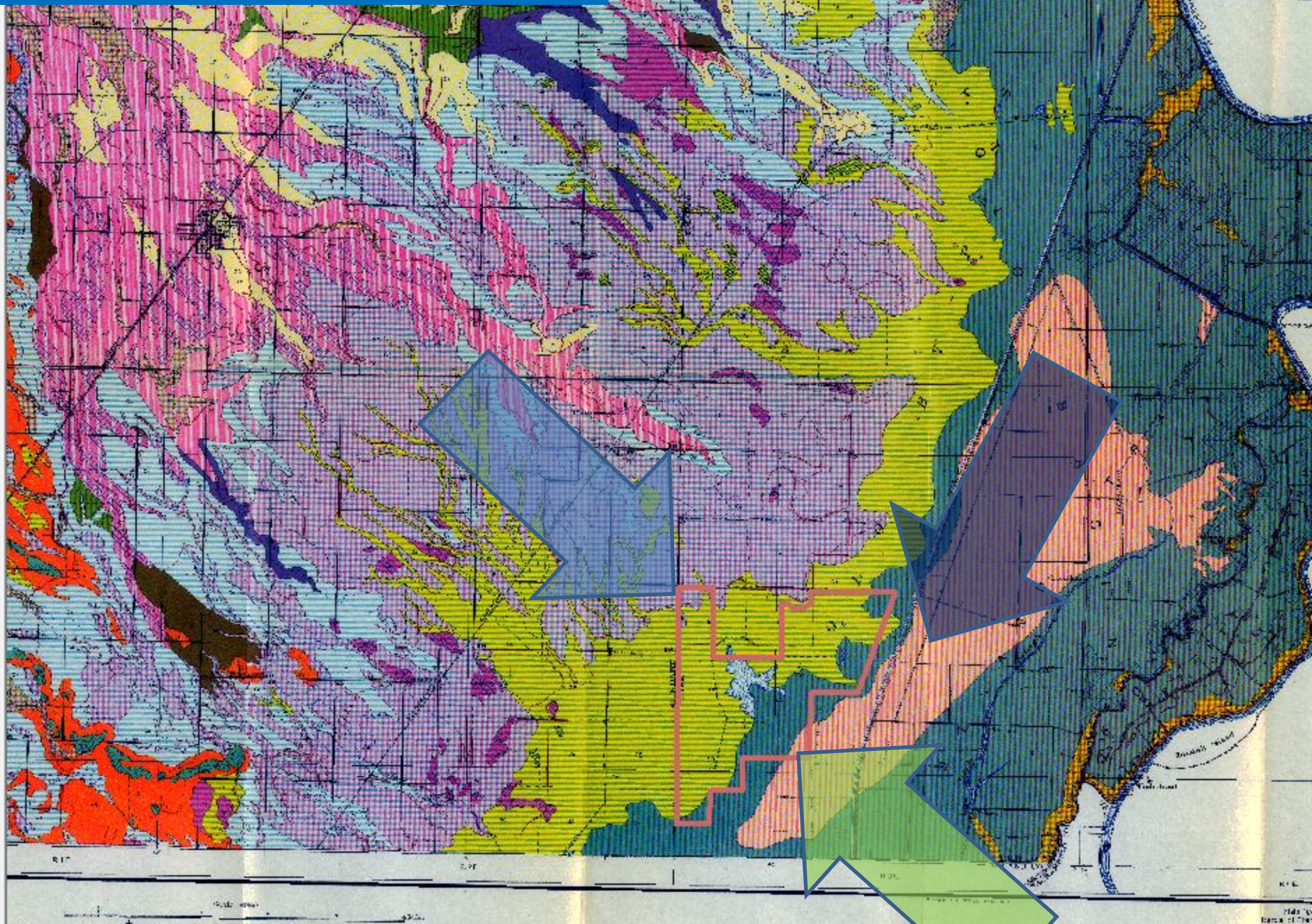
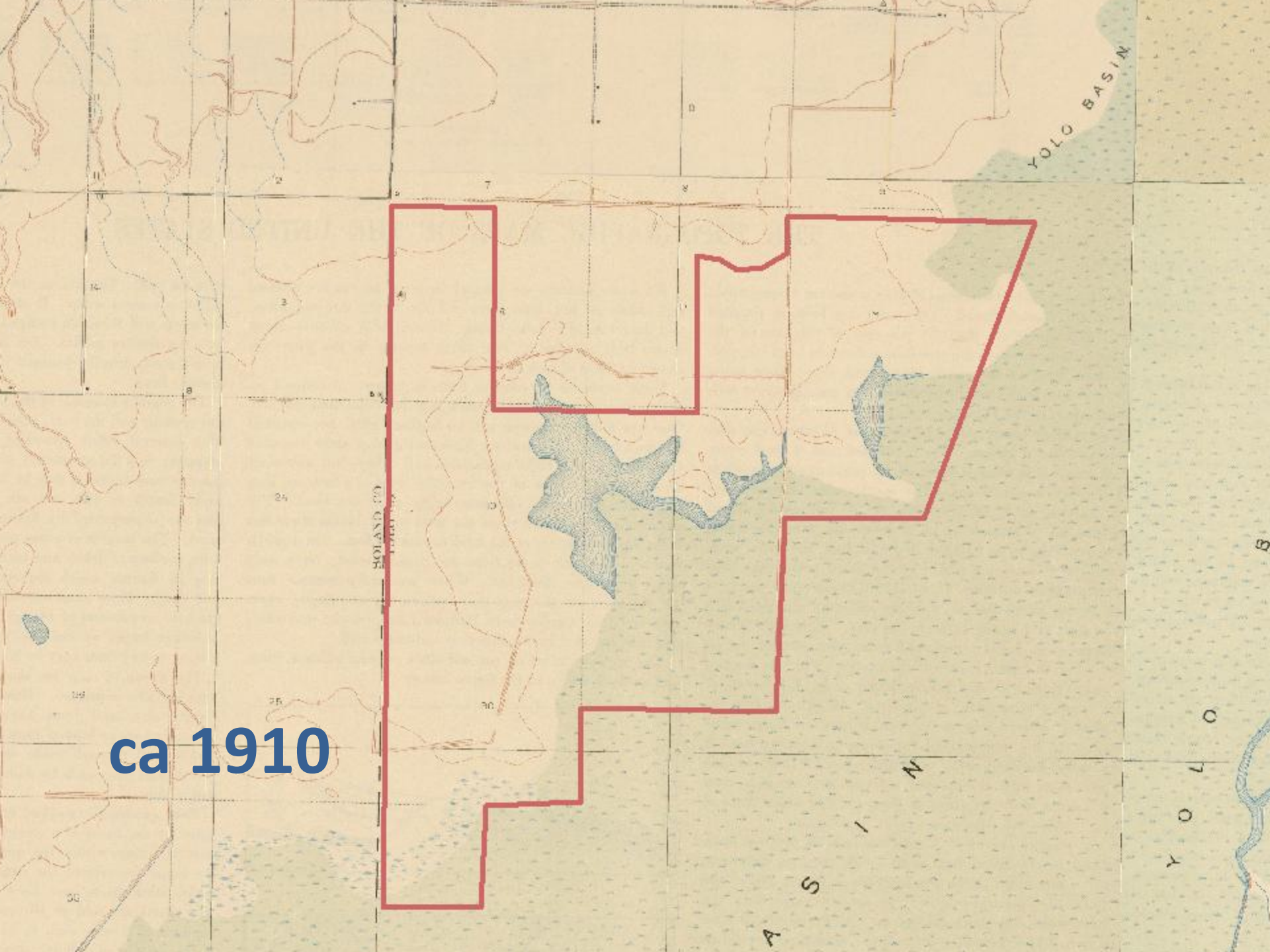
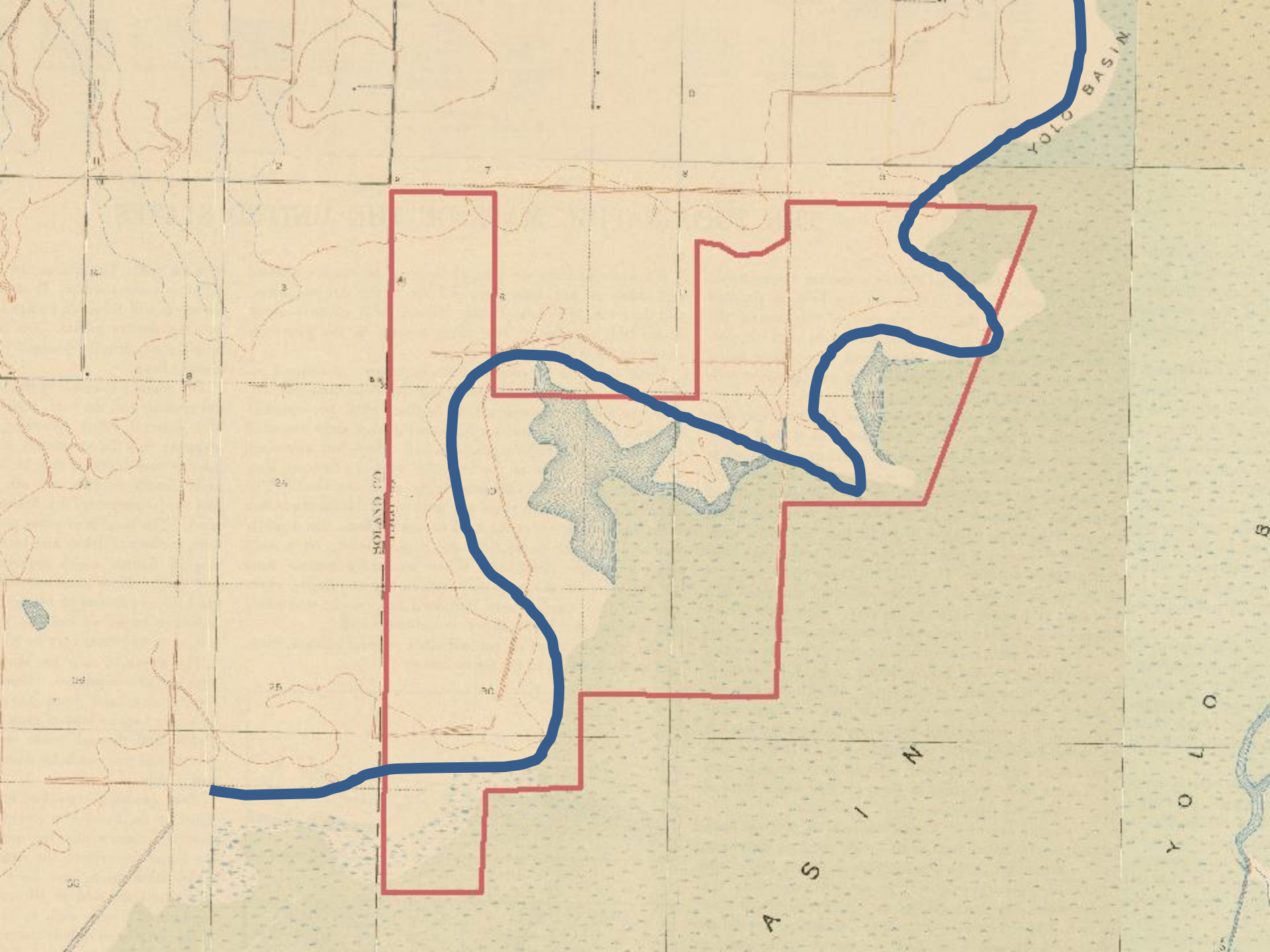


Alluvial topography




YOLO BASIN
ca 1910


YOLO BASIN
SOLANO CO
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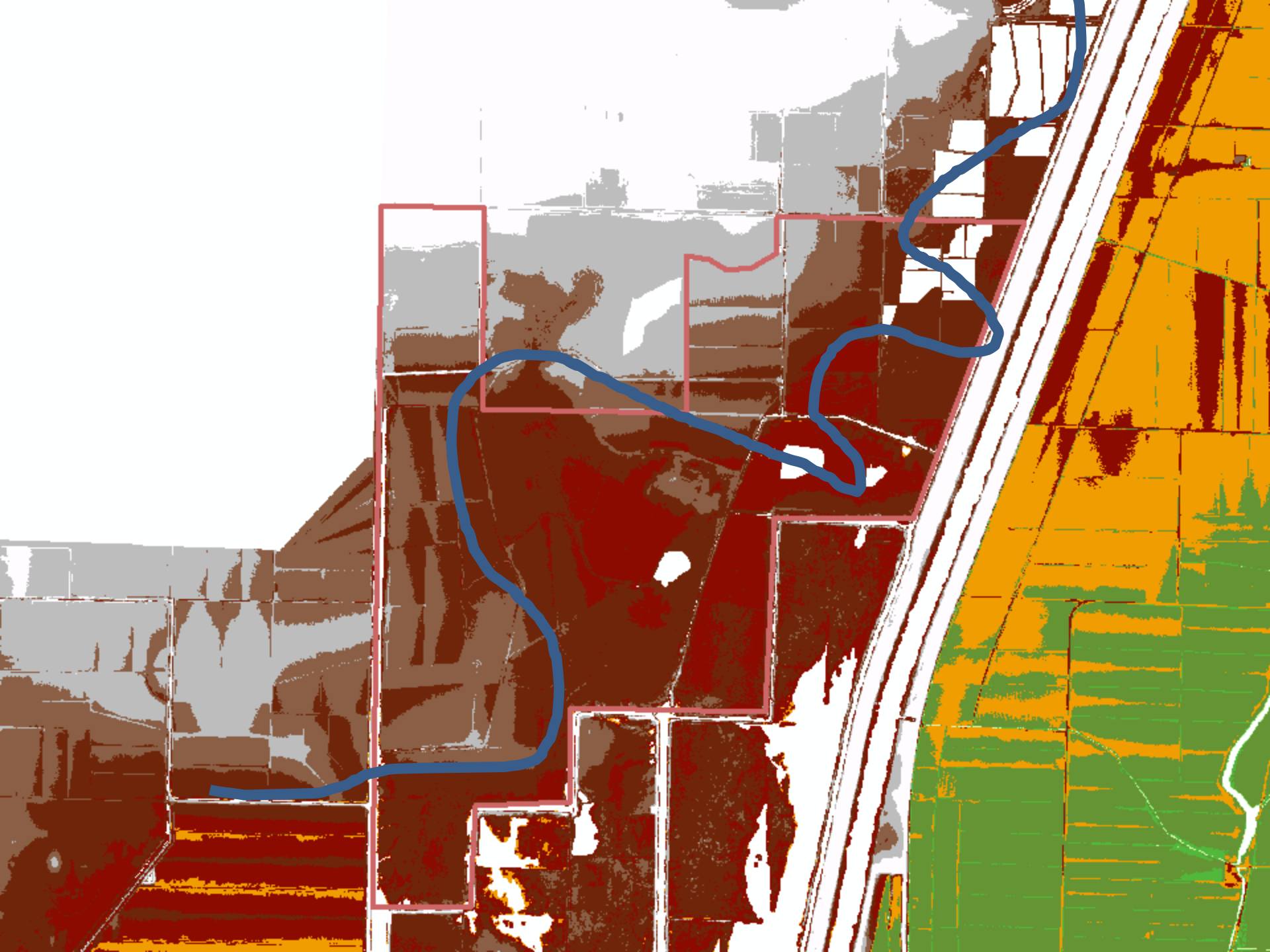
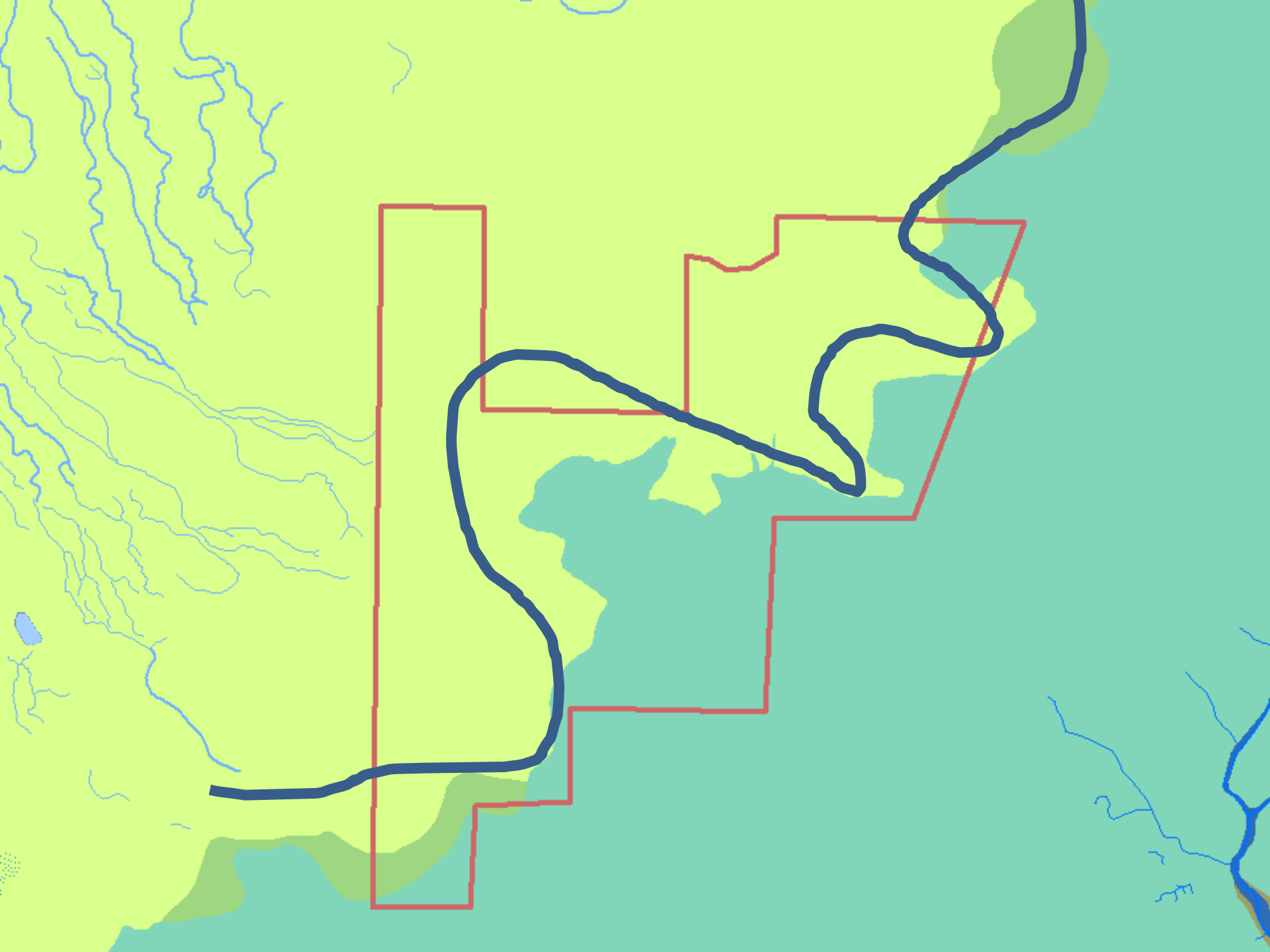
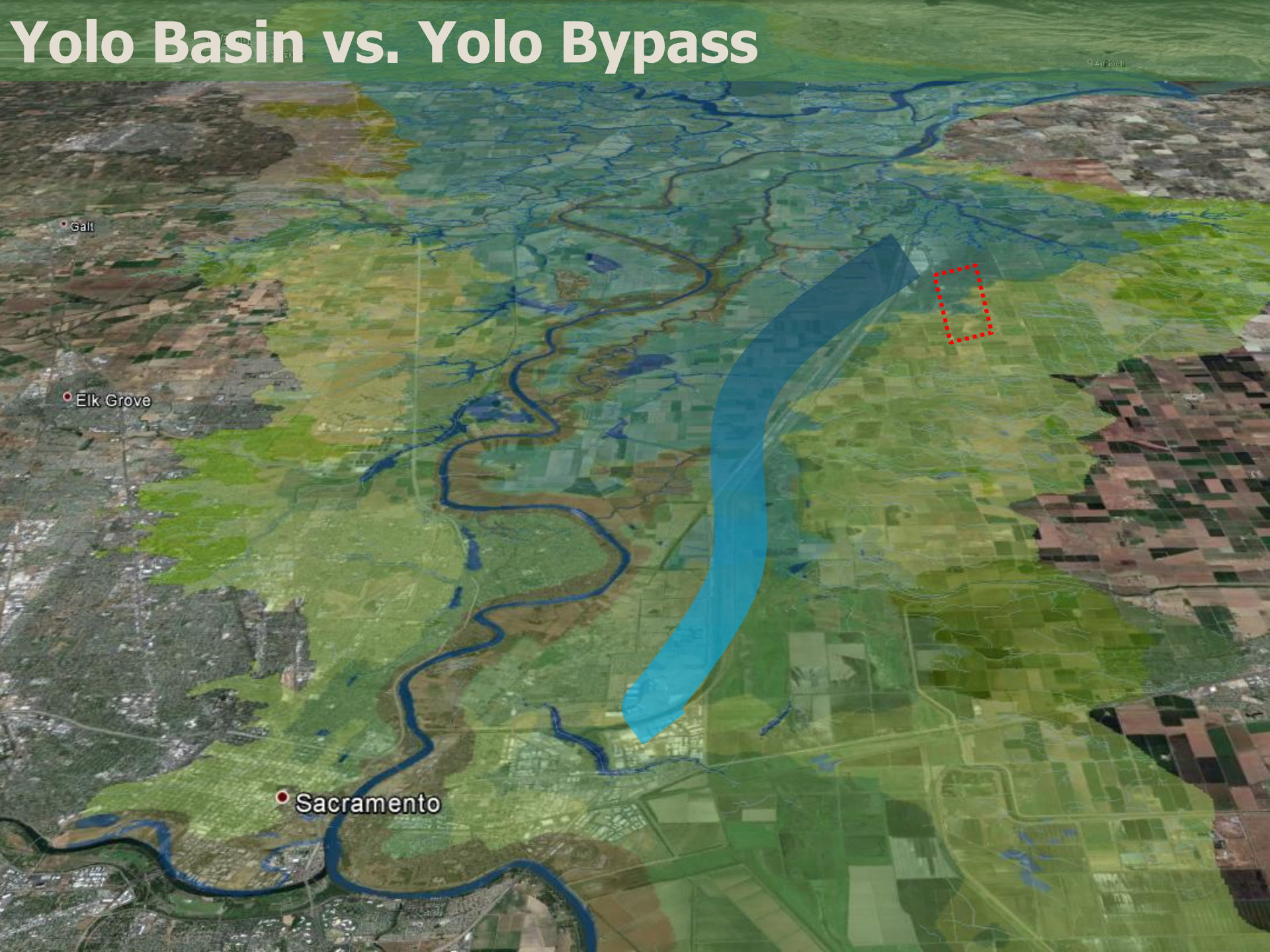
BASIN

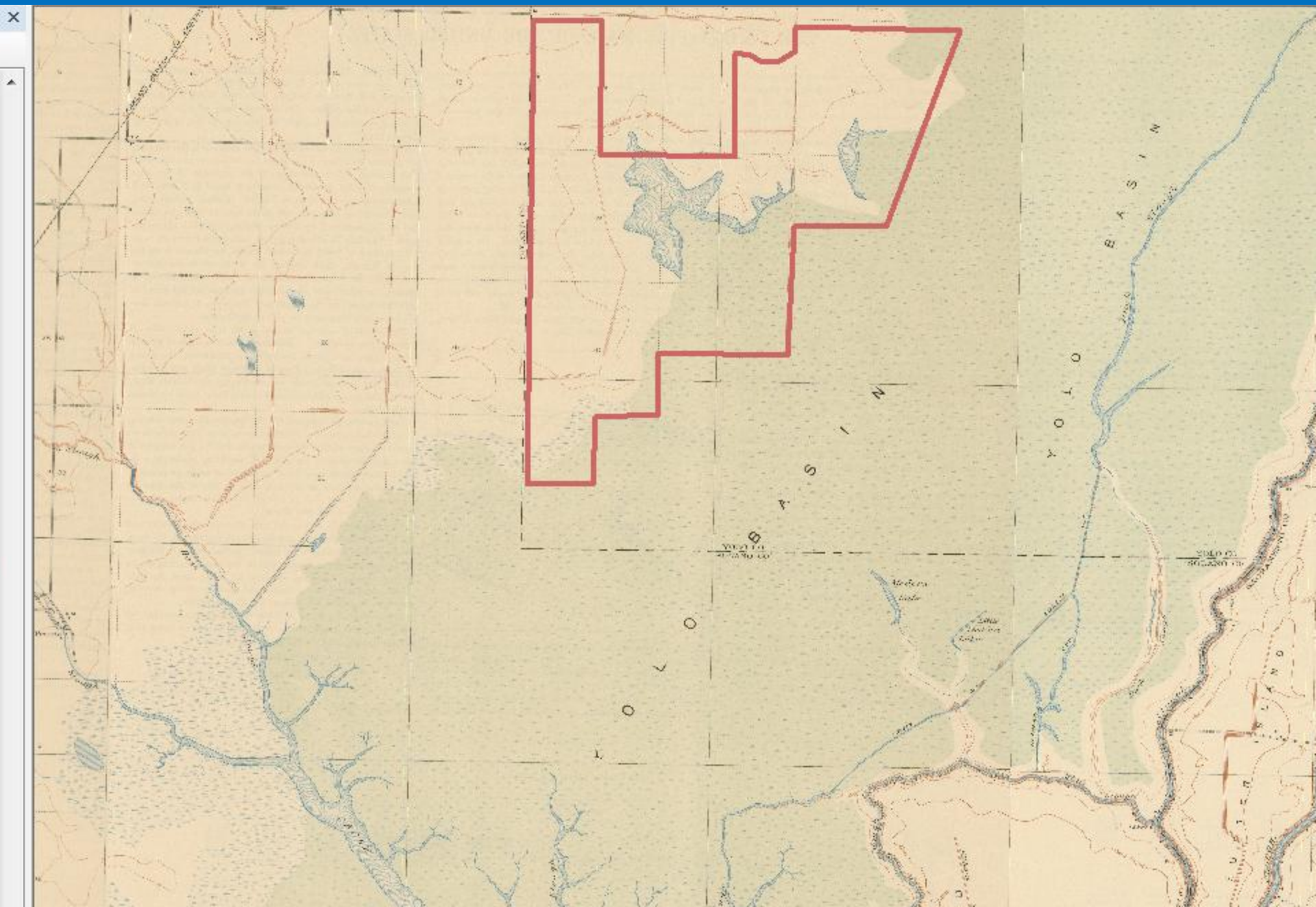


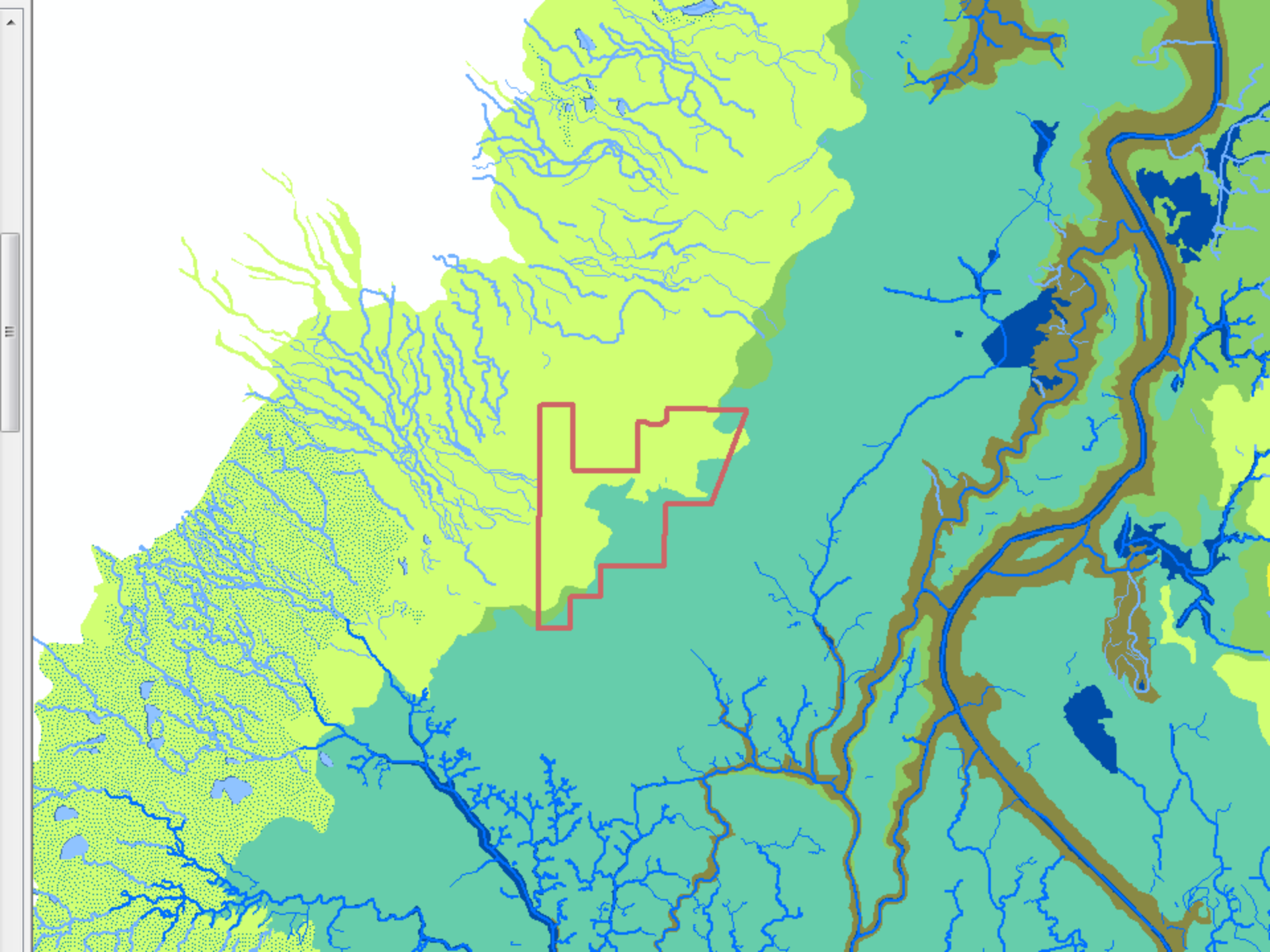


Yolo Basin vs. Yolo Bypass

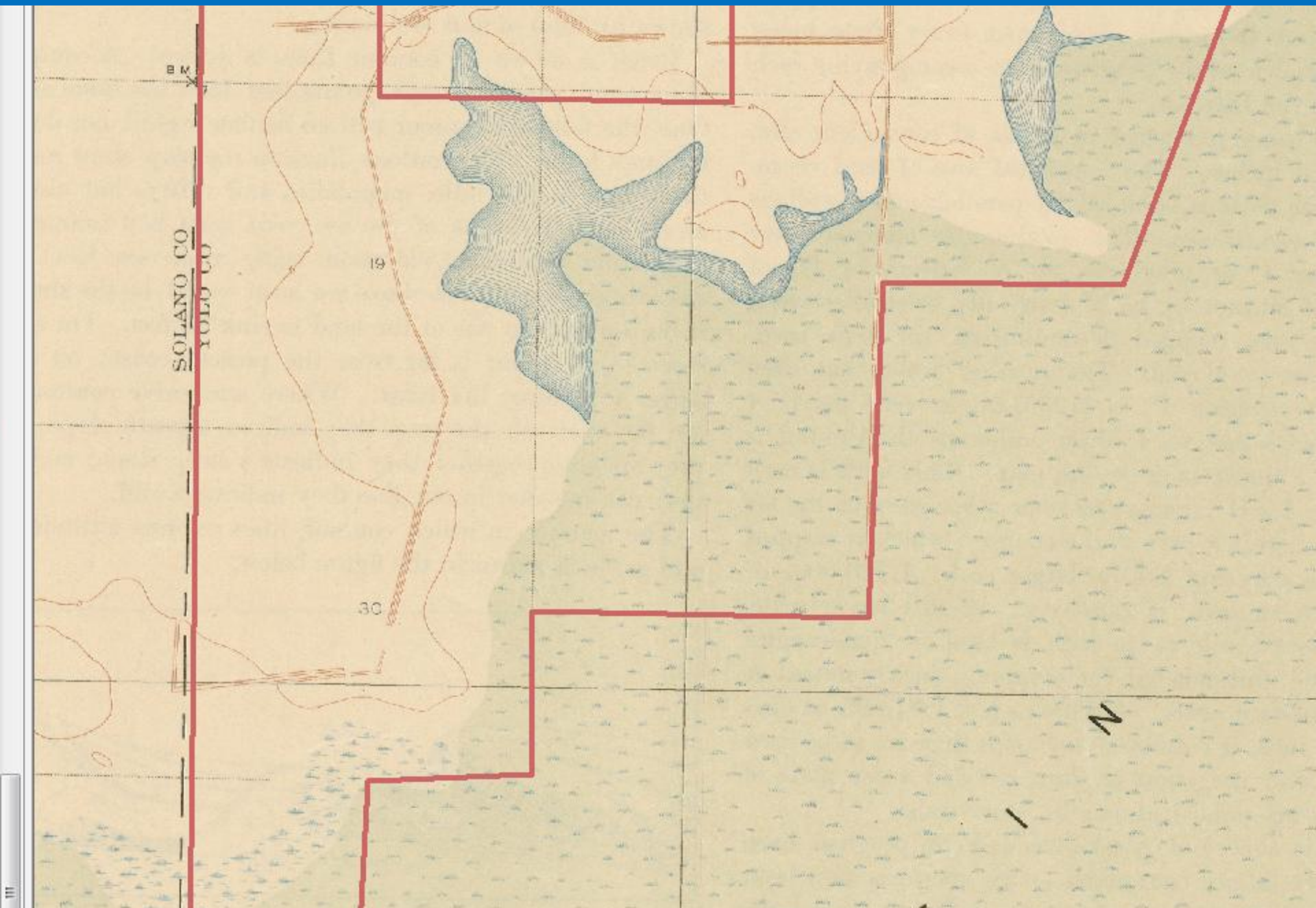


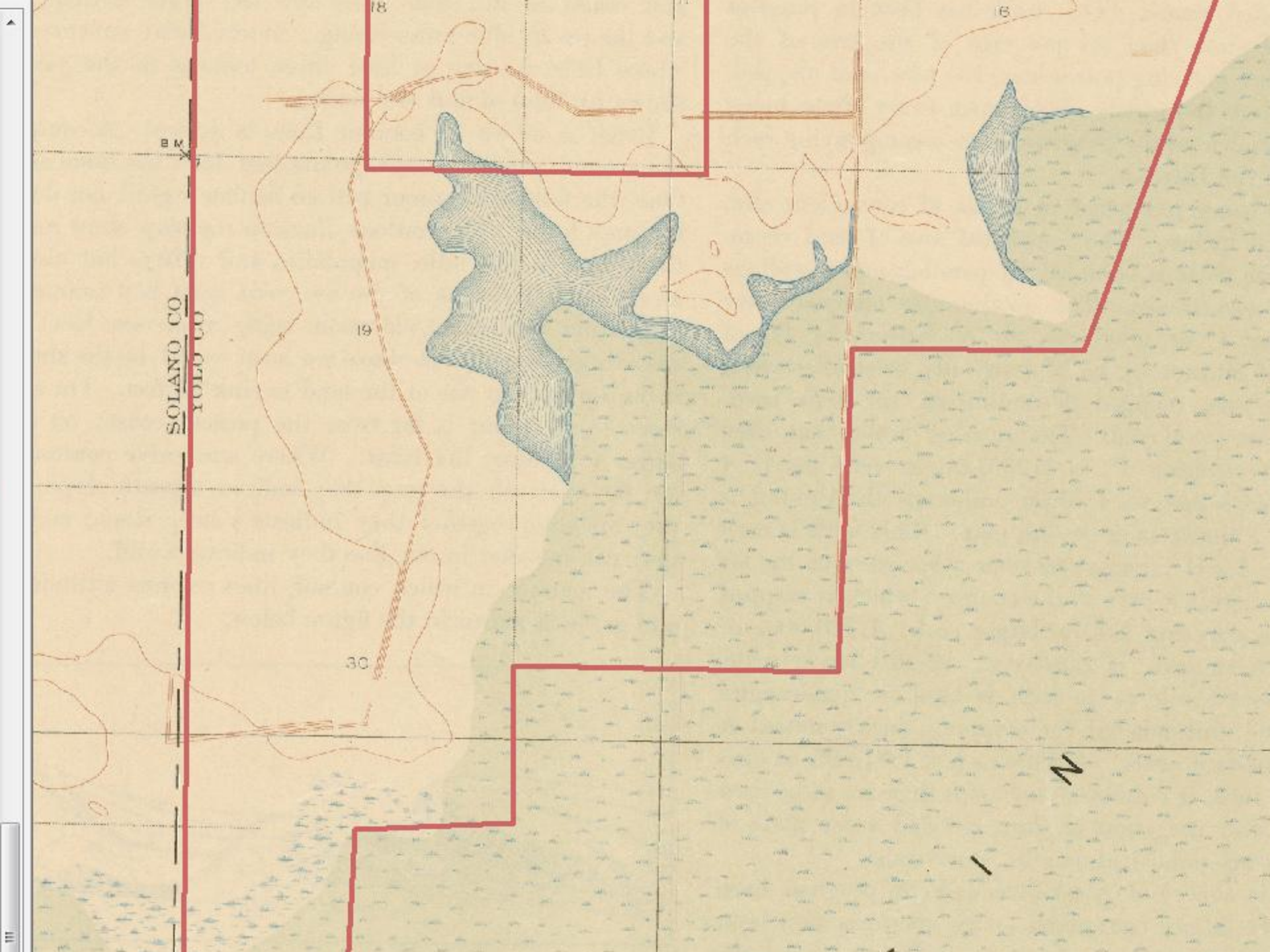
Distance from tidal channel networks





Seasonal ponds along marsh transition zone

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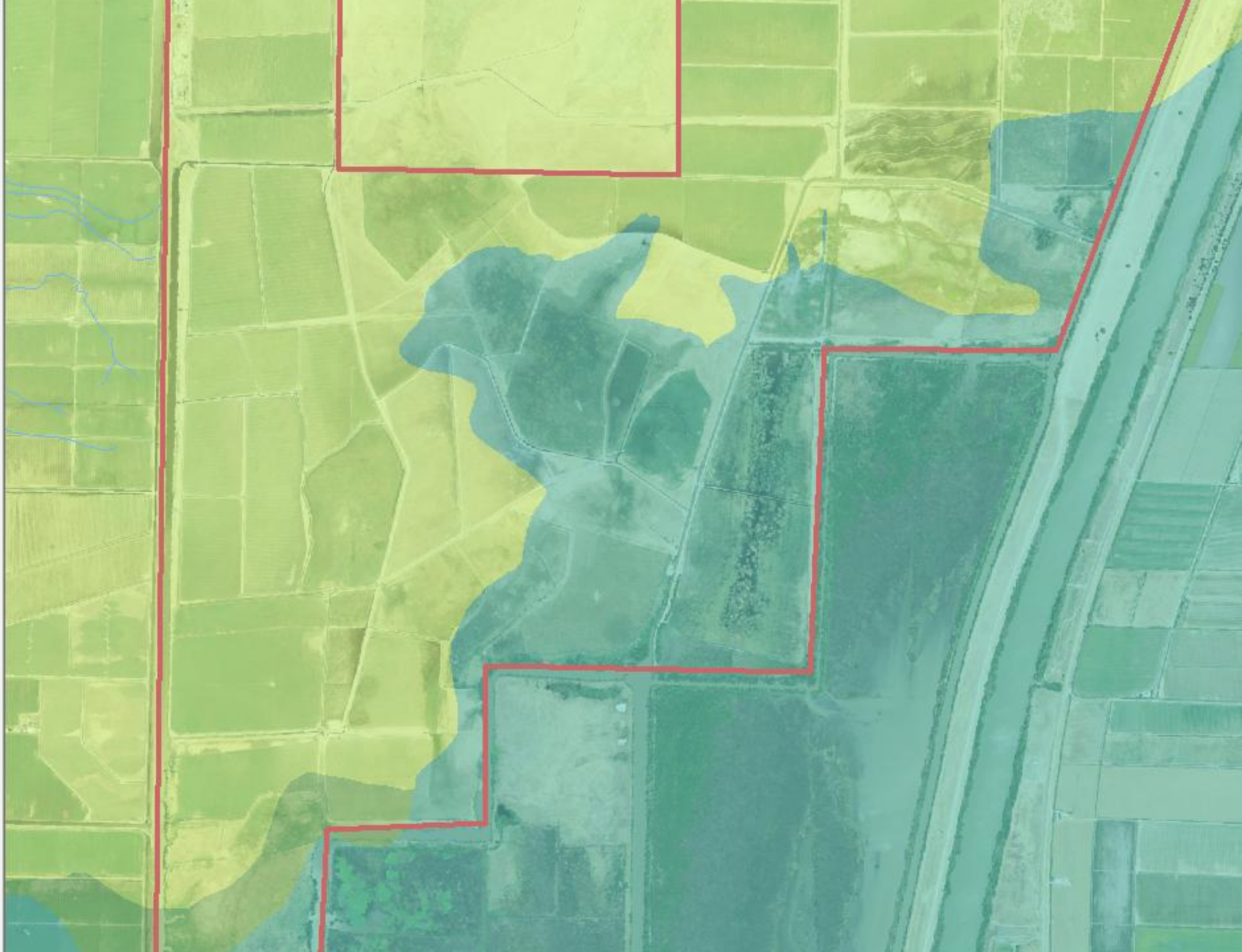
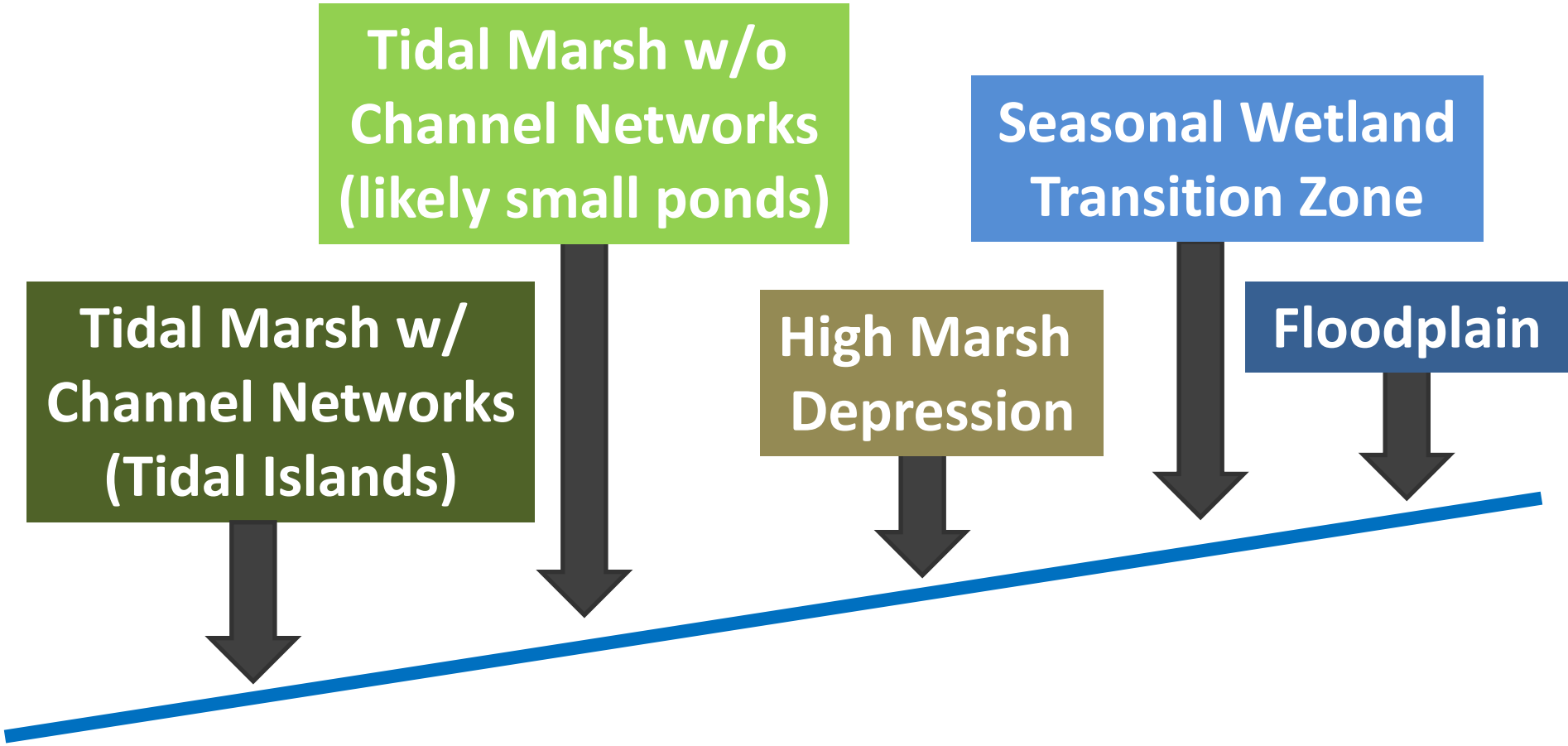
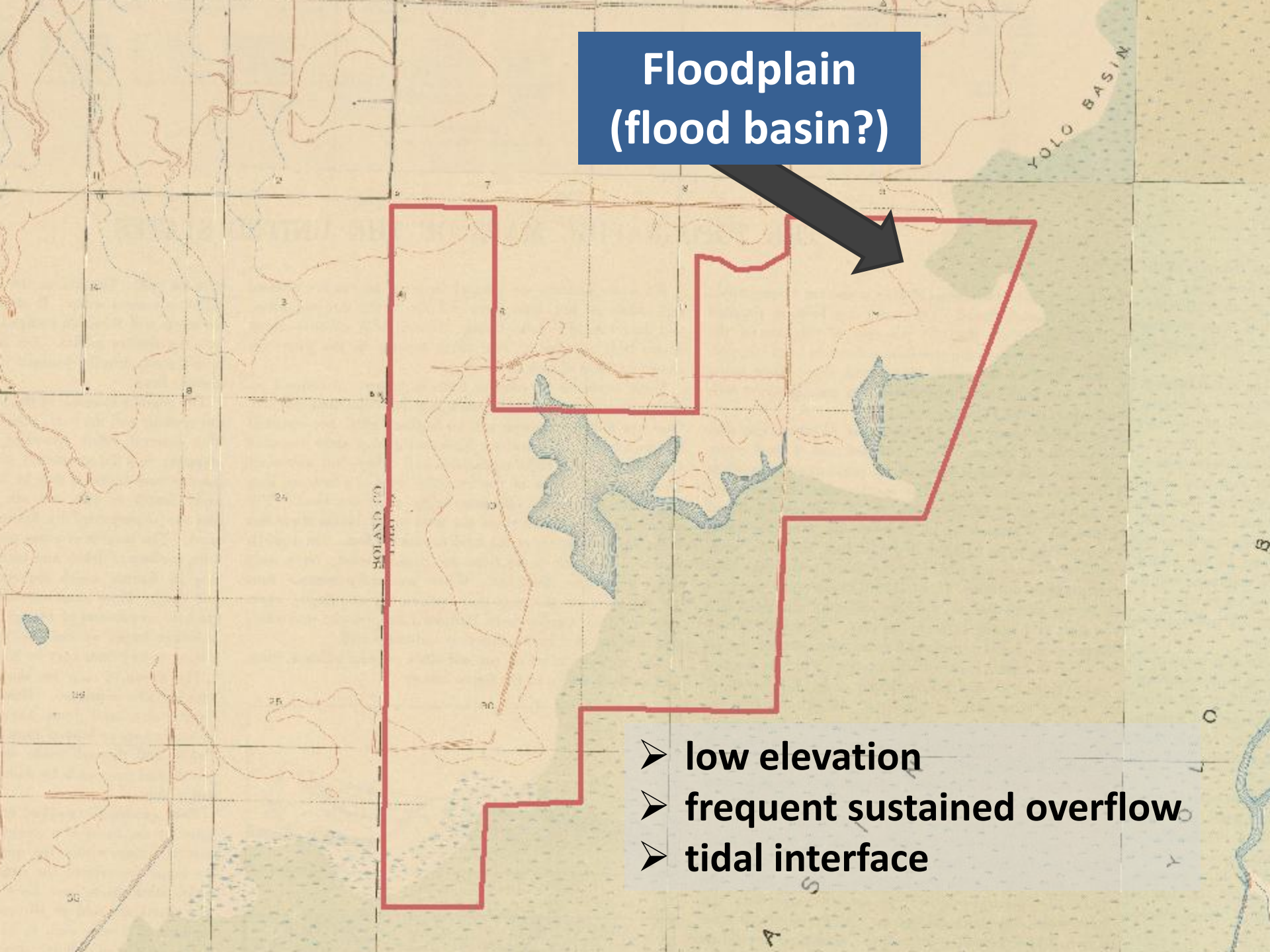
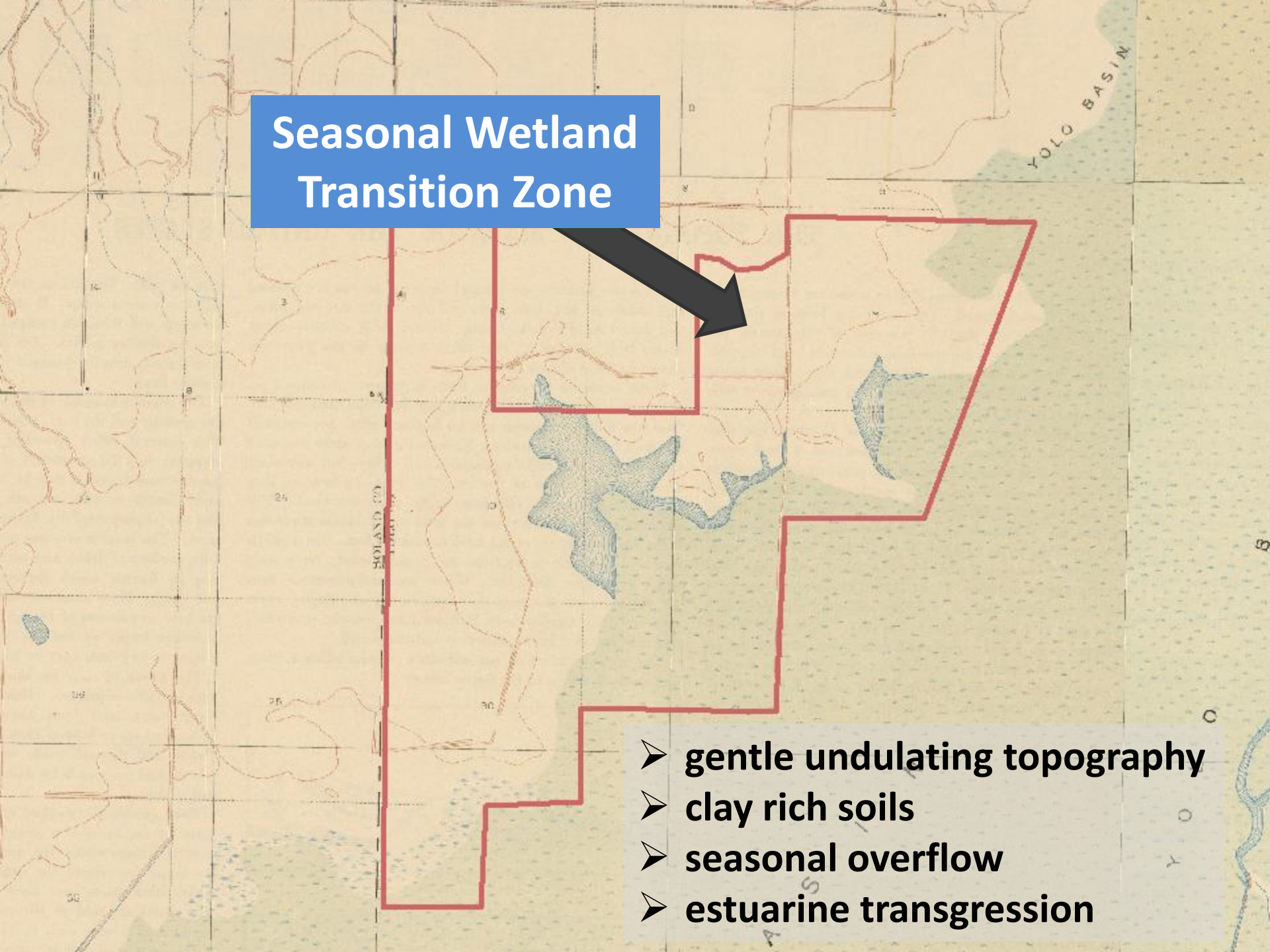
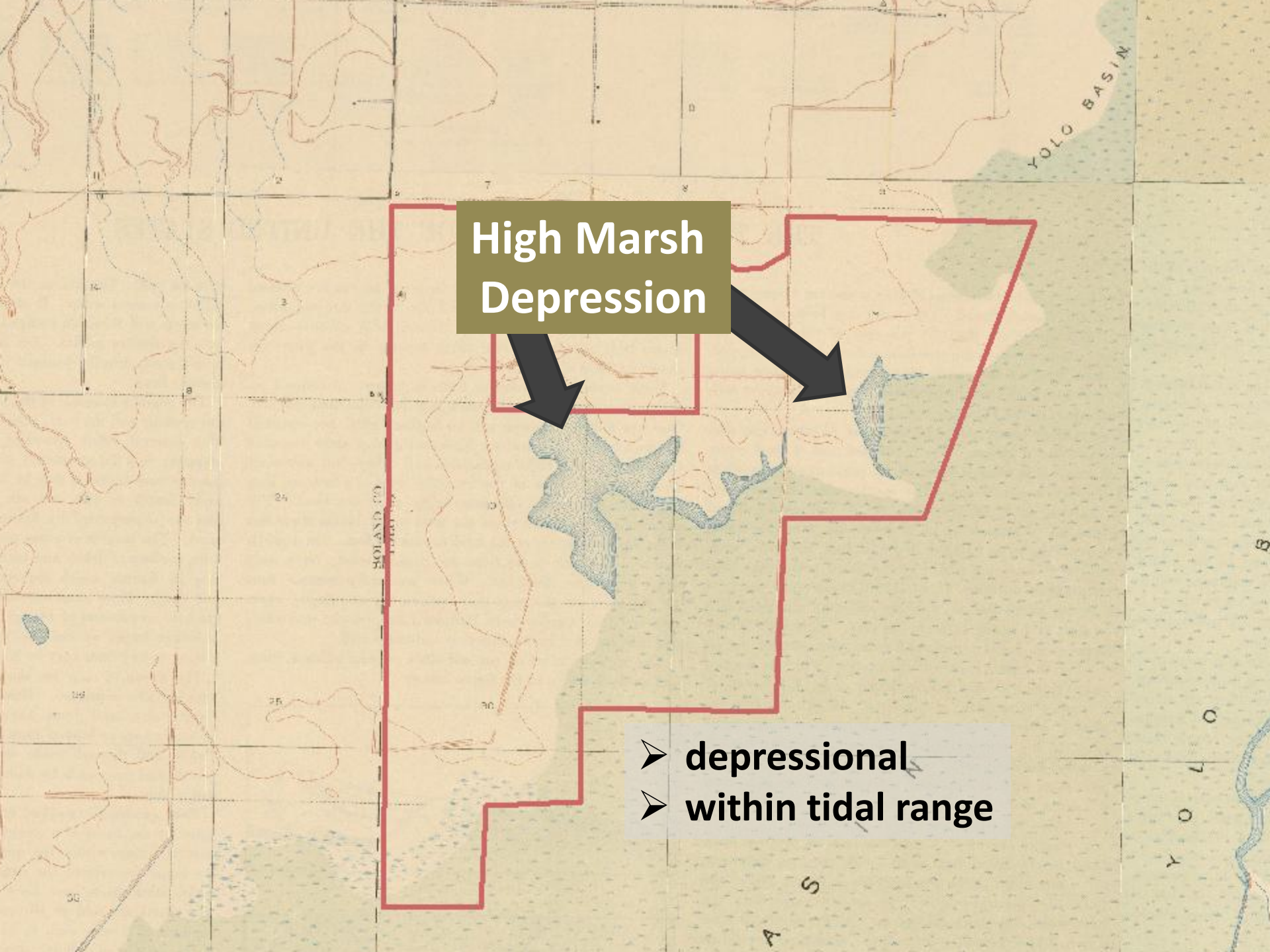
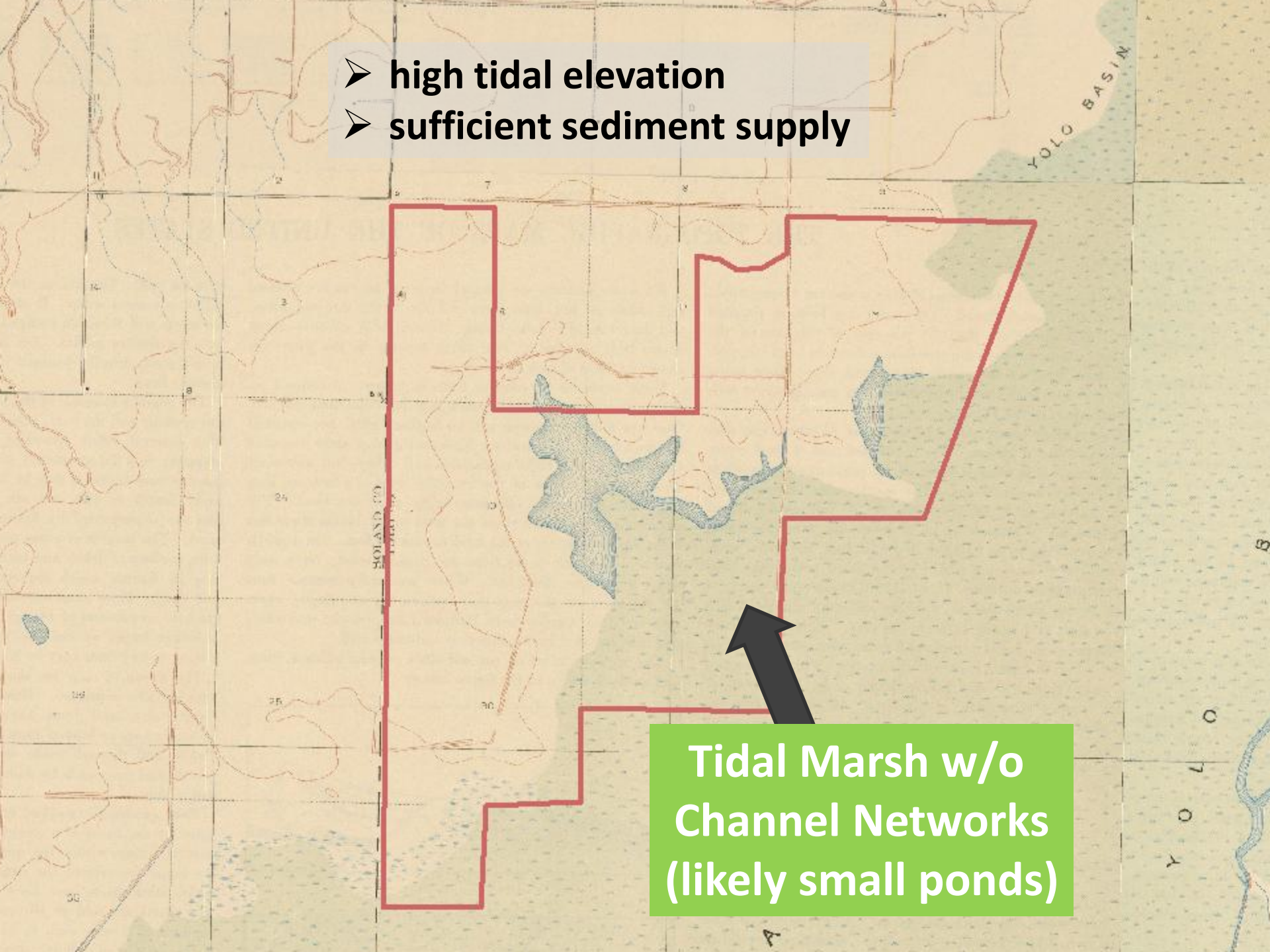


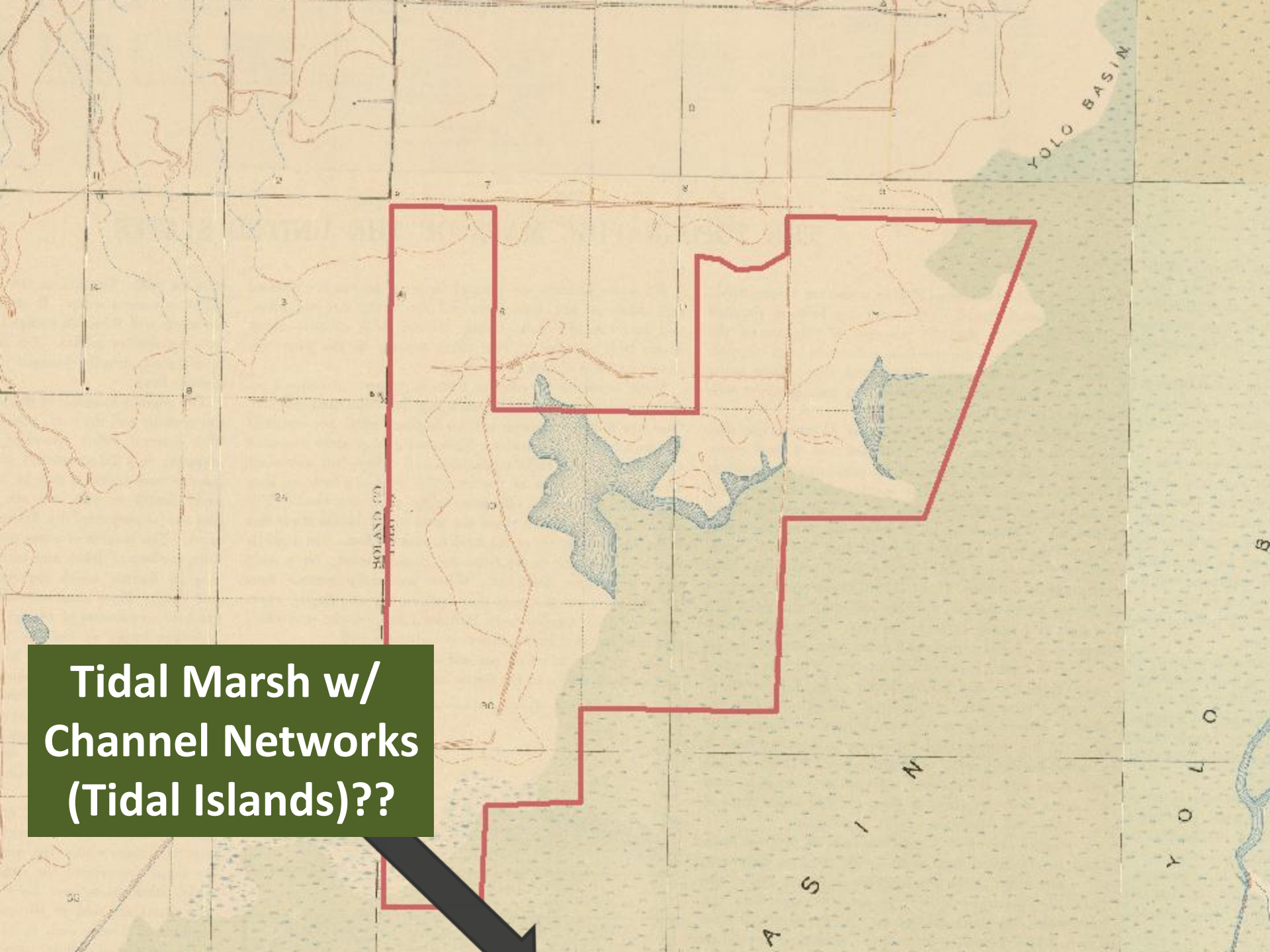

Tidal Marsh w/o Channel Networks (likely small ponds)
Seasonal Wetland Transition Zone
Tidal Marsh w/ Channel Networks (Tidal Islands)
High Marsh Depression
Floodplain

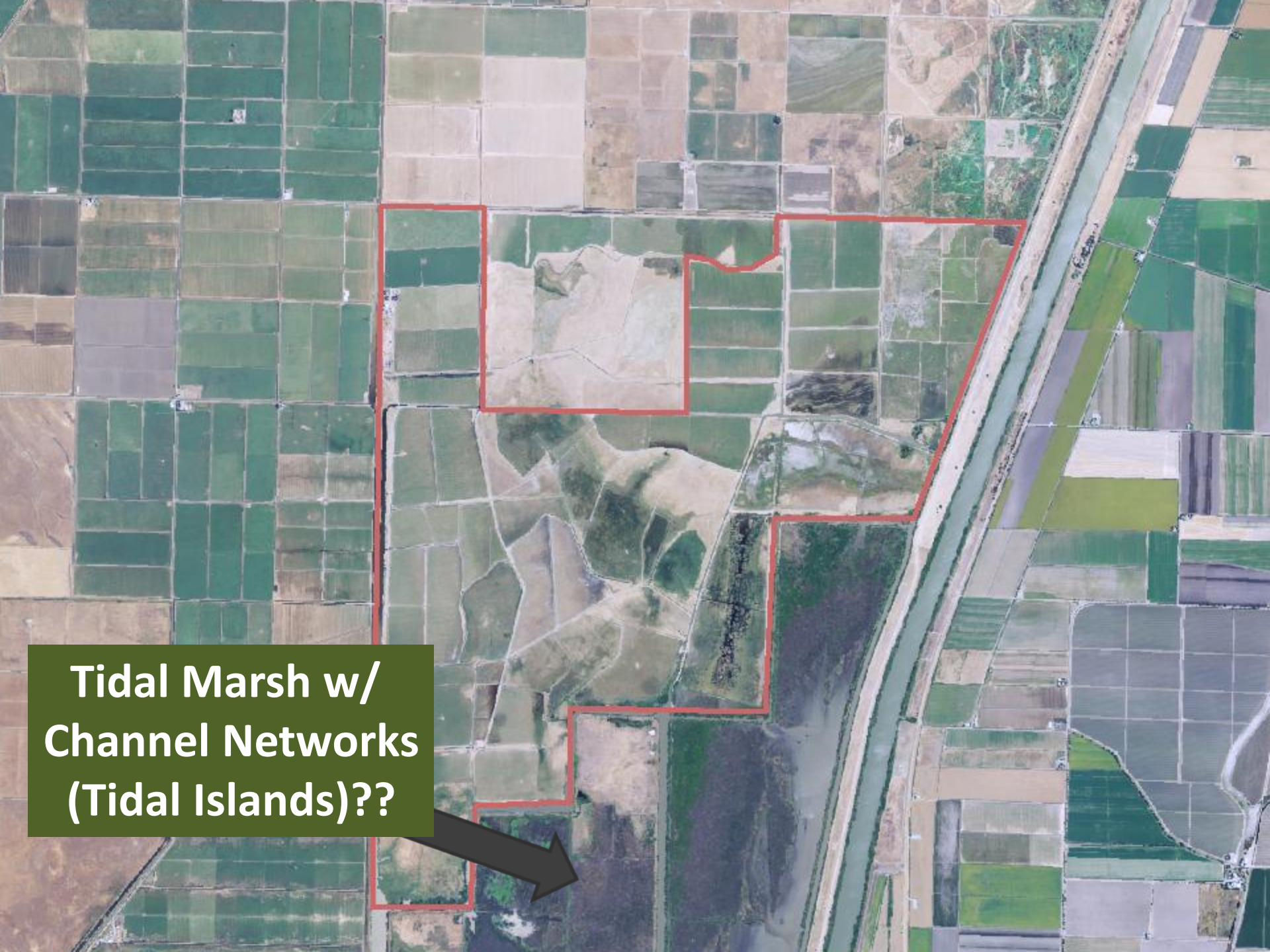

Floodplain
(flood basin?)
YOLO BASIN
SOLANO CO.
low elevation
frequent sustained overflow
tidal interface


Seasonal Wetland Transition Zone
YOLO BASIN
gentle undulating topography
clay rich soils
seasonal overflow
estuarine transgression


High Marsh Depression
YOLO BASIN
depressional
within tidal range


high tidal elevation
sufficient sediment supply
YOLO BASIN
Tidal Marsh w/o Channel Networks (likely small ponds)

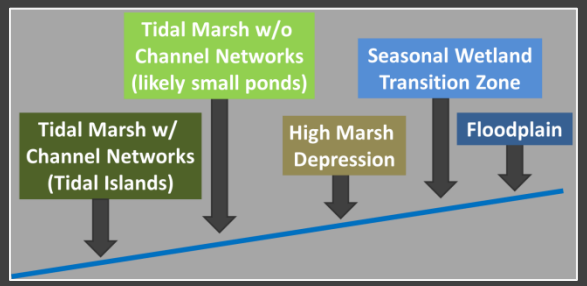

YOLO BASIN
Tidal Marsh w/ Channel Networks (Tidal Islands)??


Tidal Marsh w/
Channel Networks
(Tidal Islands)??

Historical conditions are not prescriptive;

they help identify opportunities and constraints

- variable topography, complex transition zone
- flood and highest-tide inundation
- ideal estuarine transgression
- unlikely to form tidal channels
- proximity to subtidal interface
- part of a larger functional or operational landscape unit?

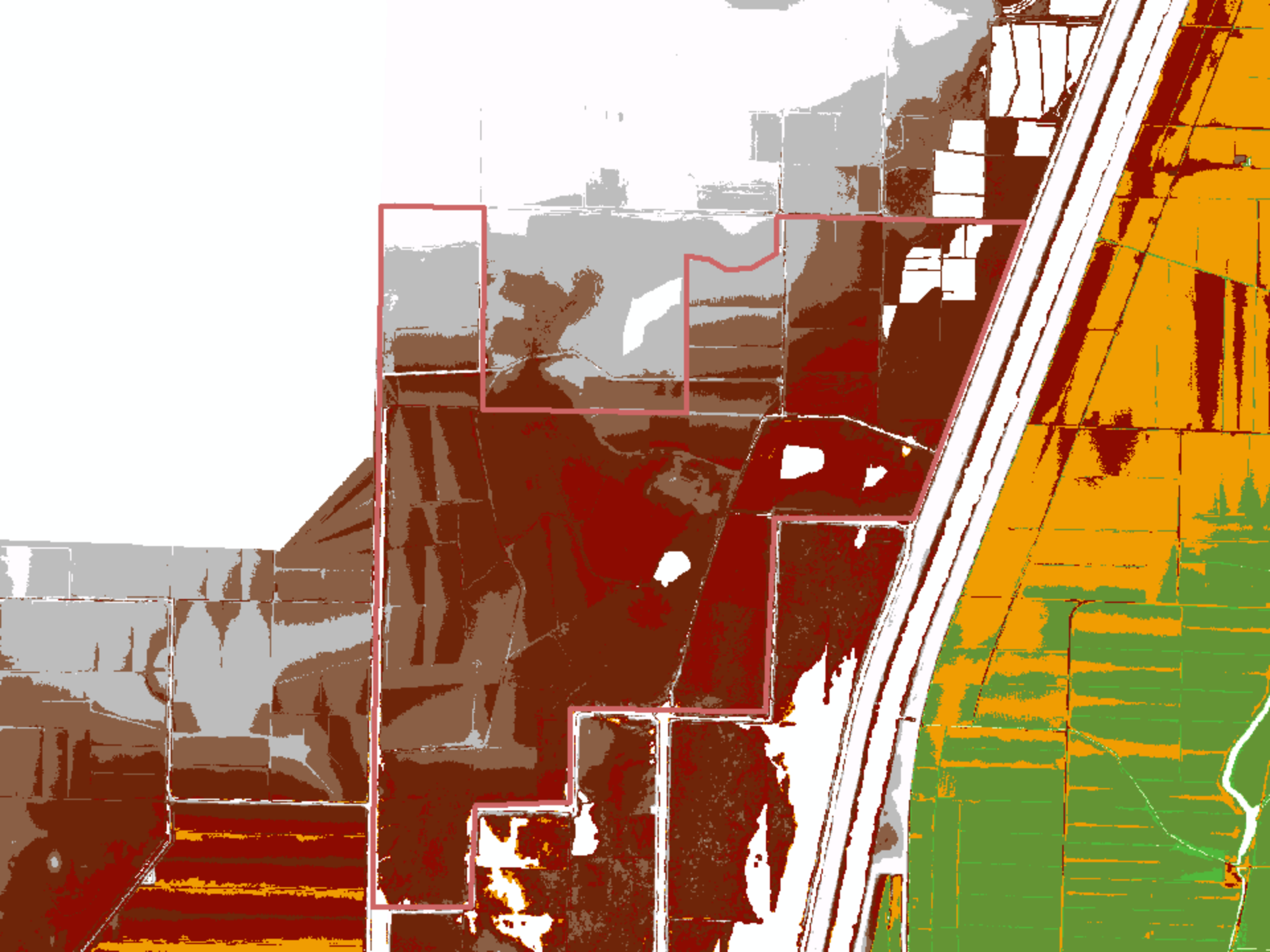


THANK YOU

www.sfei.org/HEP

robin@sfei.org

Courtesy of The Center for Sacramento History



Approach is supported in the literature

"… the first step in a river restoration program should be to develop a solid understanding of what the targeted rivers were actually like…

Montgomery 2008

"Where was habitat historically, and how did that distribution differ from today? What were the geomorphic processes that created the habitat, and how do those processes differ today?" **Collins and Montgomery 2001**

Use HE to identify "landscape components" as "building blocks for restoration"

Verhoeven et al. 2008

"Historical understanding" necessary to distinguish "historical," "hybrid," and "novel" ecosystems– and associated restoration trajectories.

Hobbs et al. 2009

Use HE "to operationally define concepts like "ecological integrity" and "resilience"…" **Safford et al. 2012**

"Knowledge of the past therefore seems to have an impact on preferences for future landscapes." **Hanley et al. 2008**

Background

- **Delta Historical Ecology Investigation** (Whipple et al. 2012)

- **Delta Landscapes Project**
  - *Management Tools for Landscape-Scale Restoration of Ecological Functions*
  - Full Delta
  - 2012-2015 (funded by ERP through DFW)

- **Application of HE to the McCormack-Williamson Tract**
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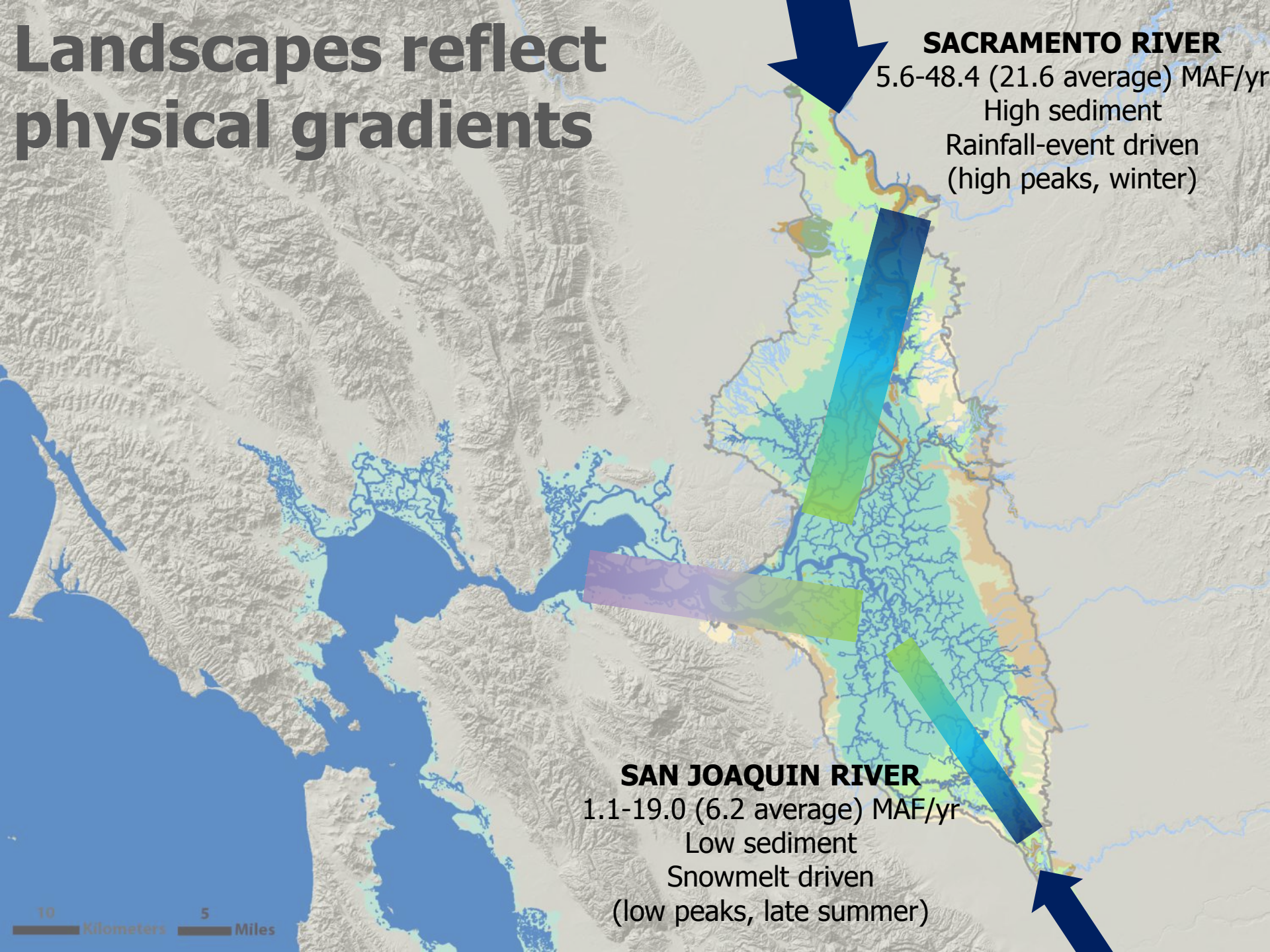
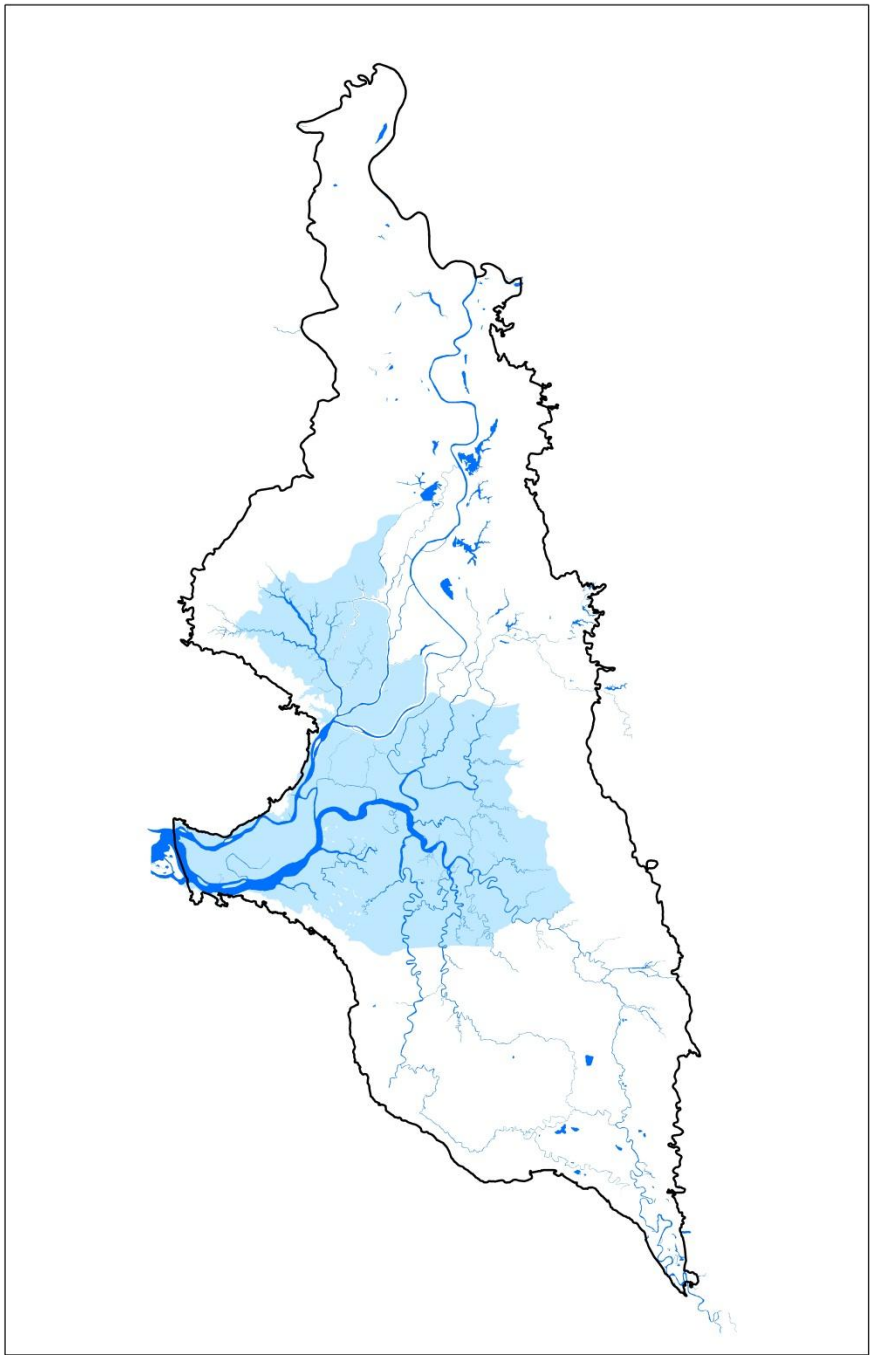
Landscapes reflect physical gradients




delta inundation

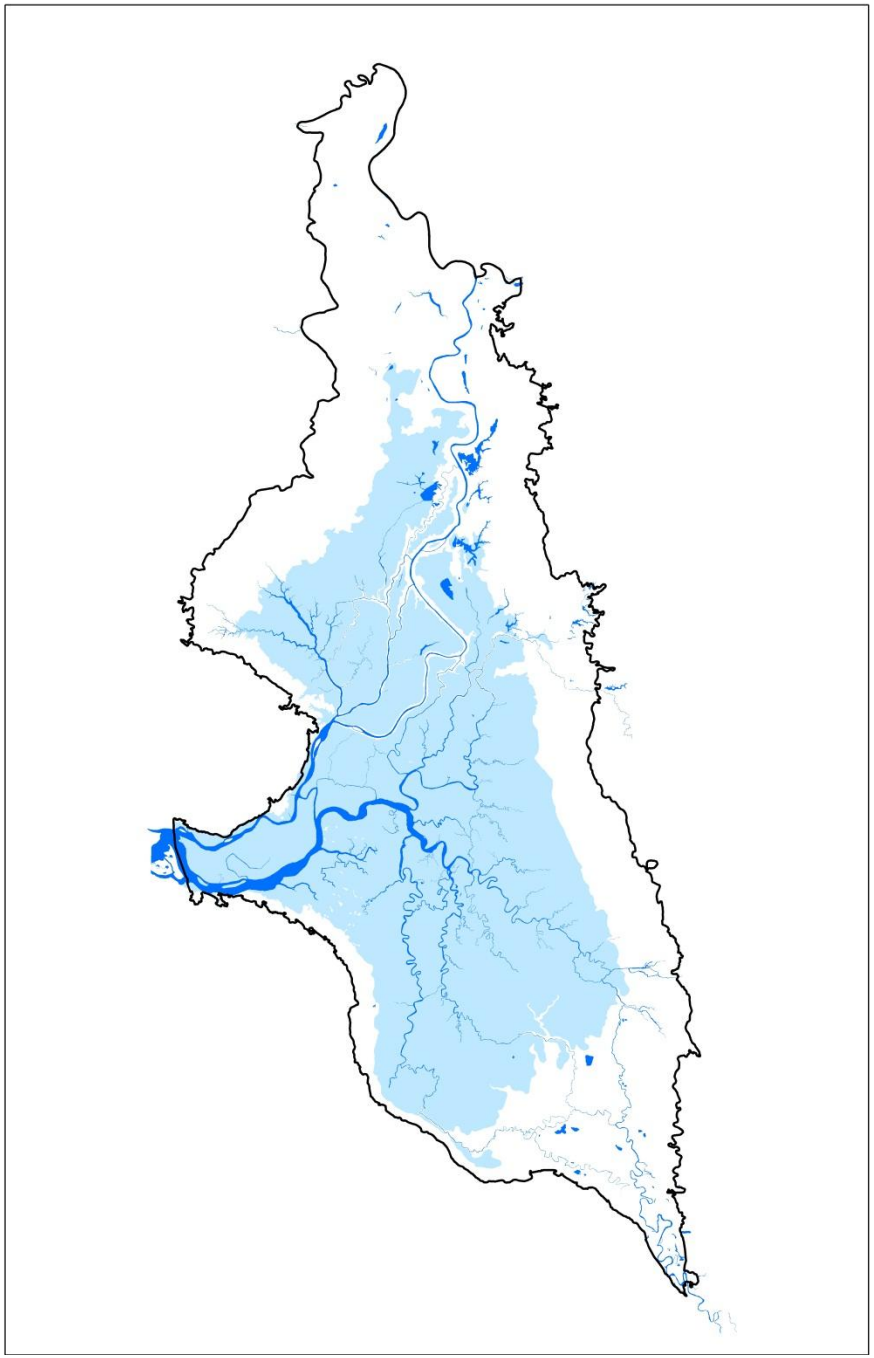
Tidal- daily

- 1 inch
- Twice daily



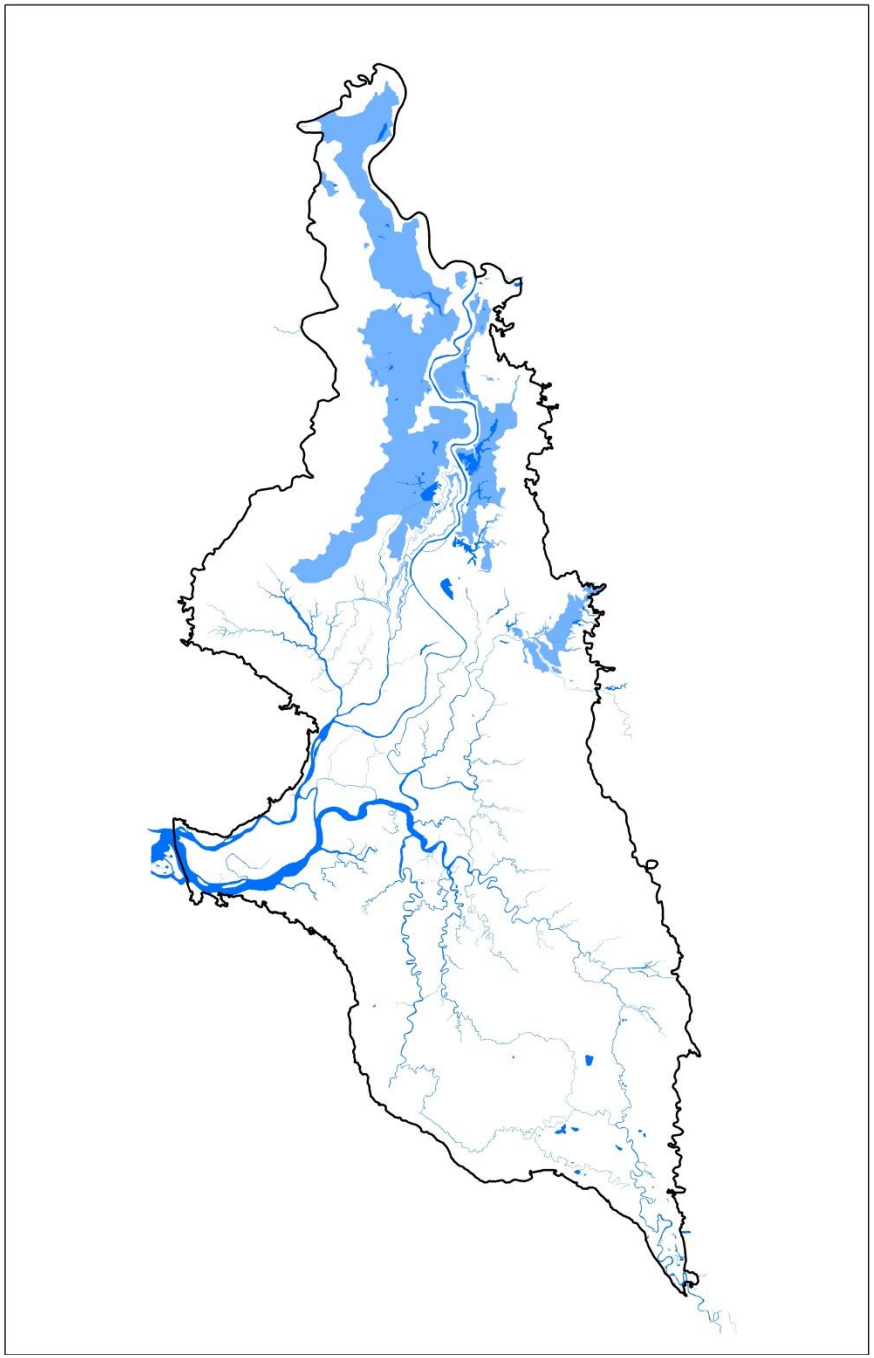
Tidal- Spring tides

- 1.5 feet
- ~3 days per month



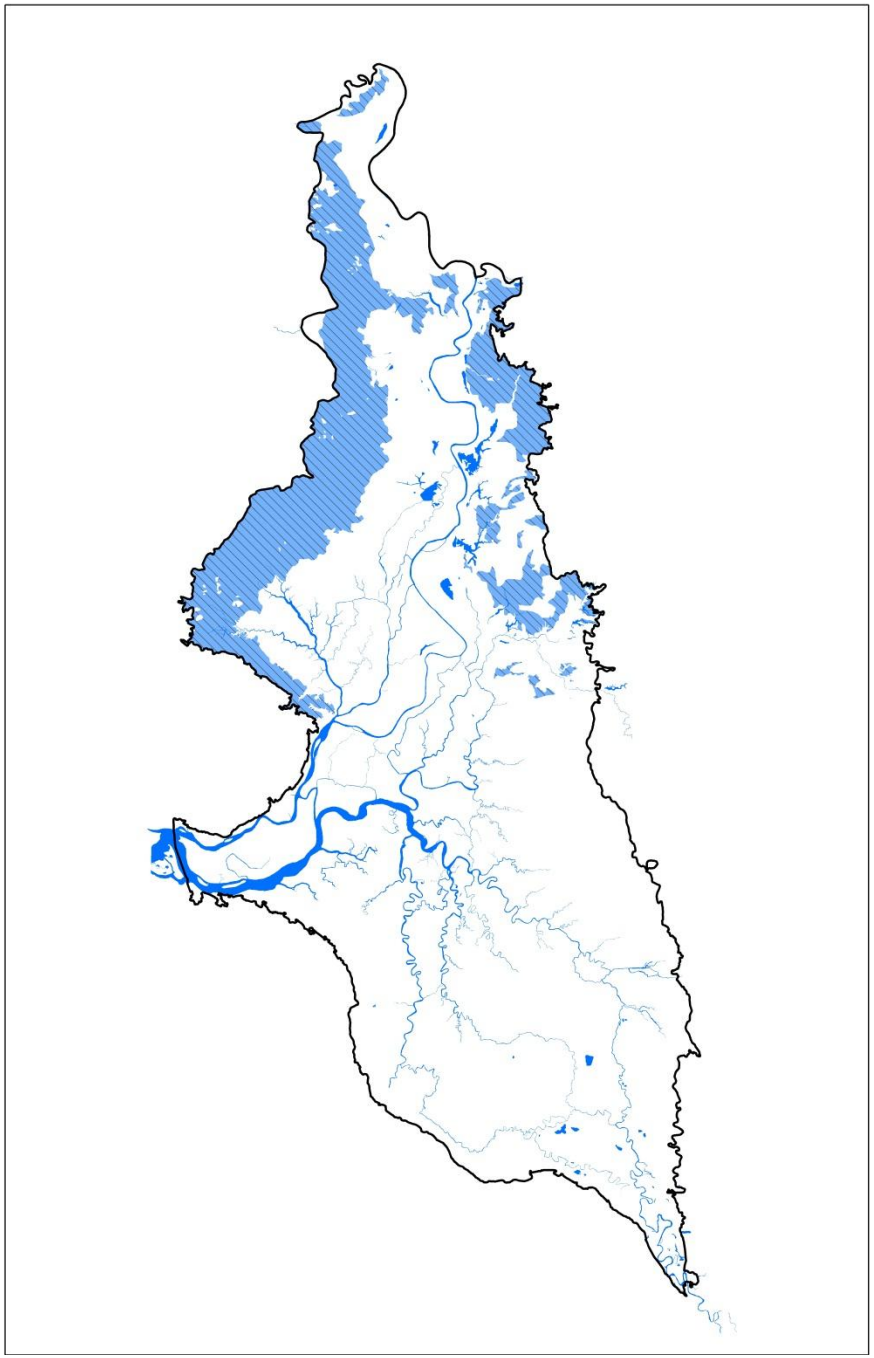
Fluvial- Sacramento

- 4 ft.
- December - May



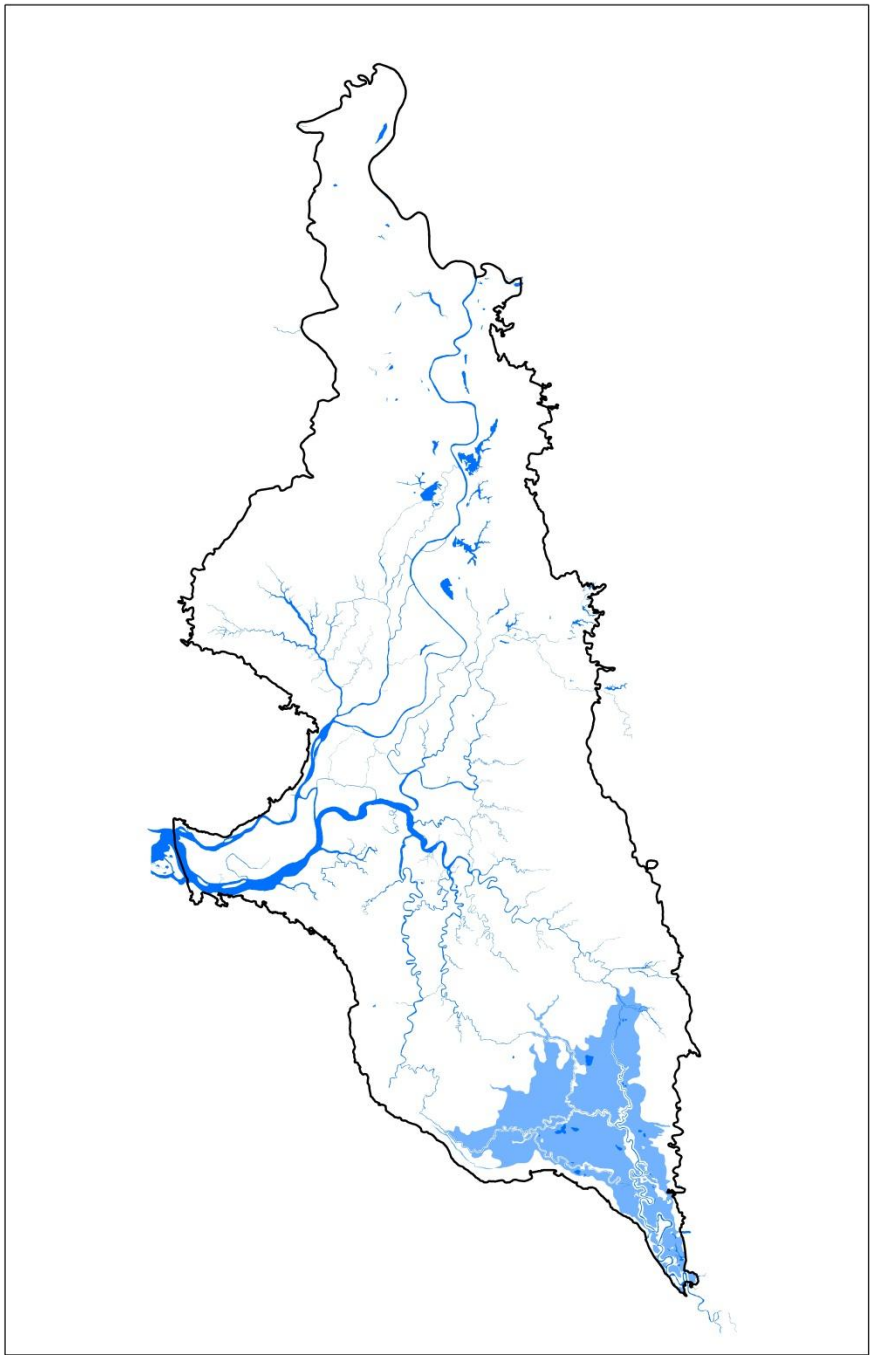
Fluvial- seasonal wetlands

- 1 inch
- Short lived events (~1-2 days each) during winter



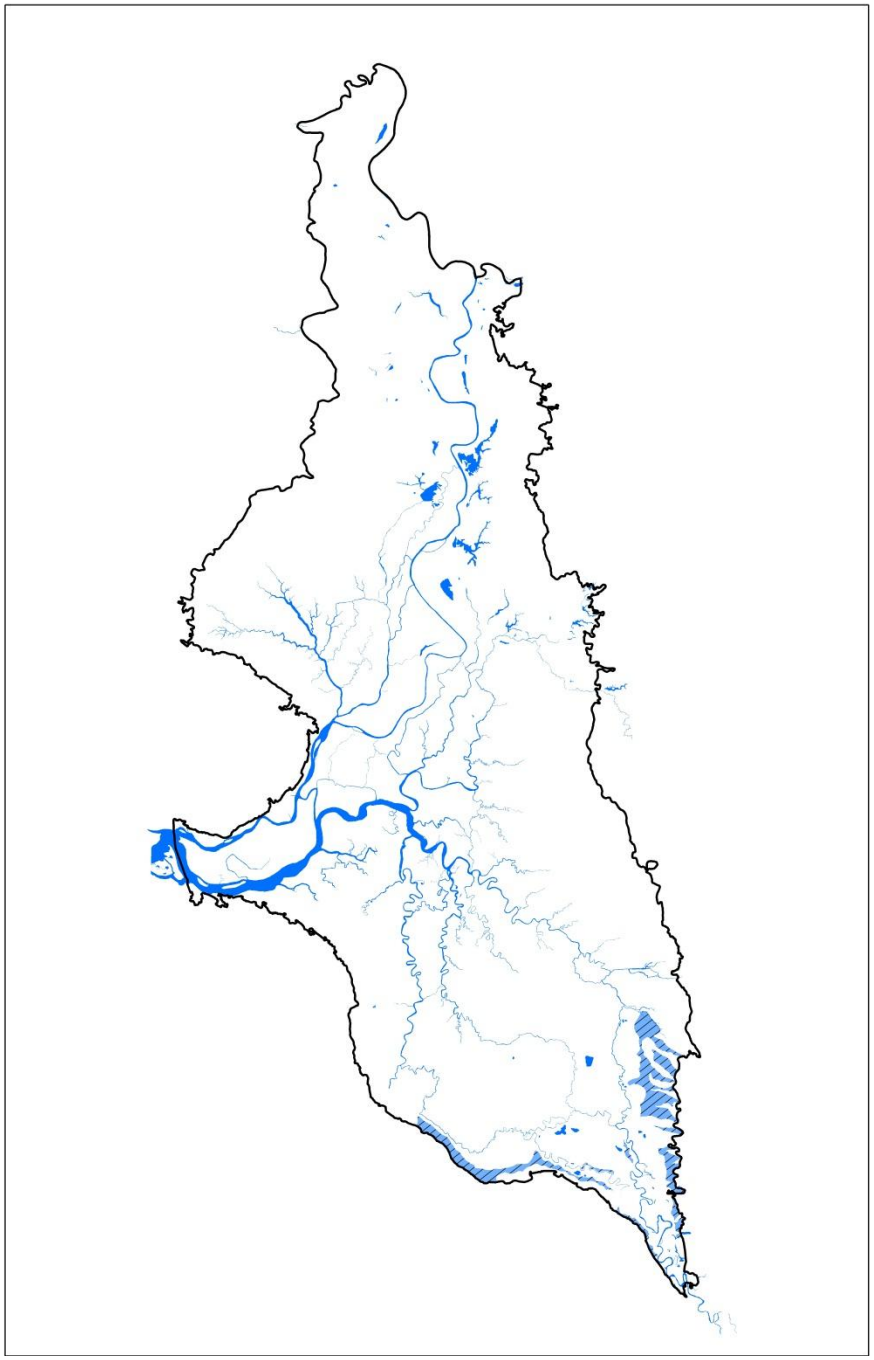
Fluvial- San Joaquin

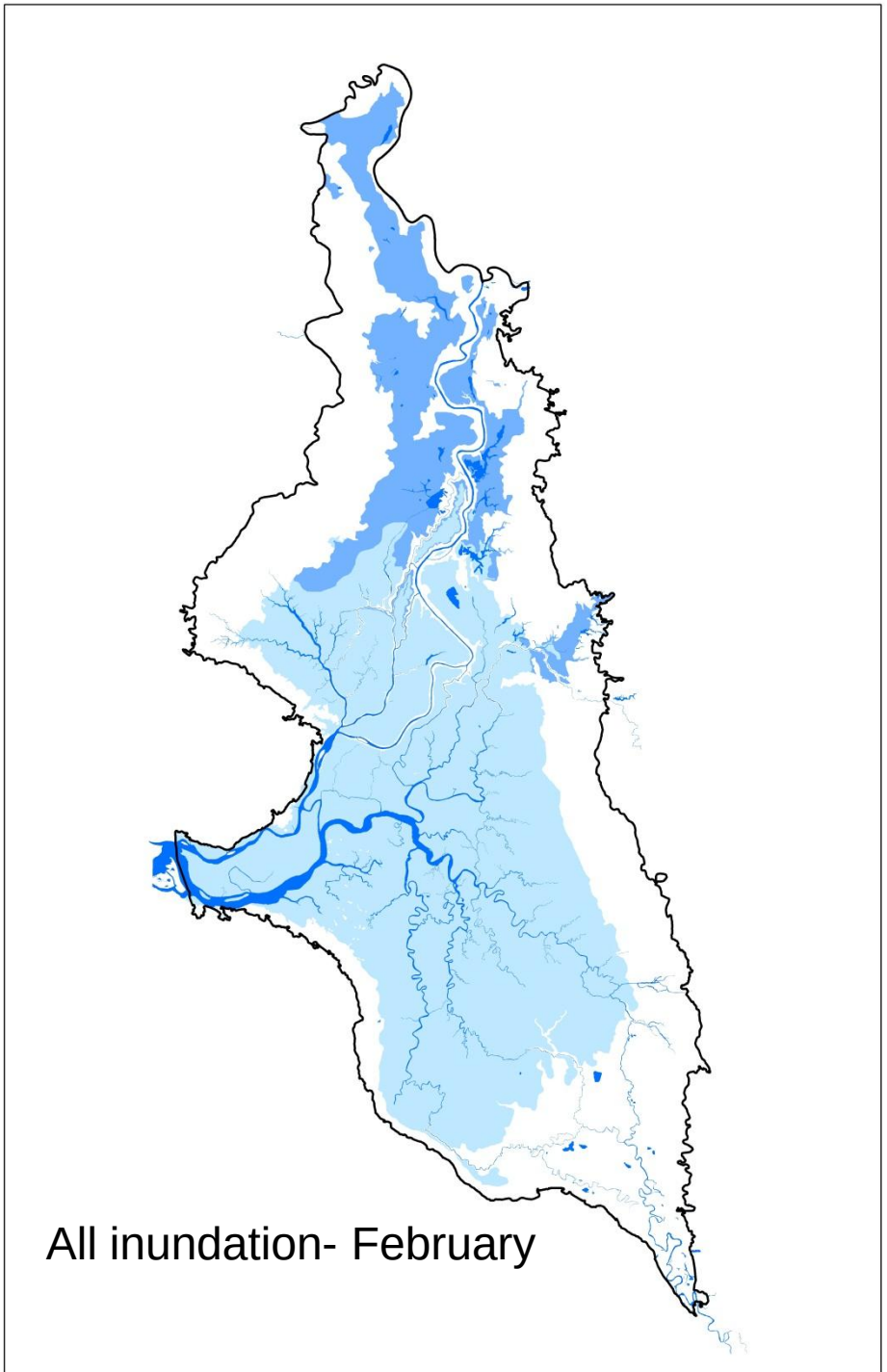
- 4 ft.
- April - July



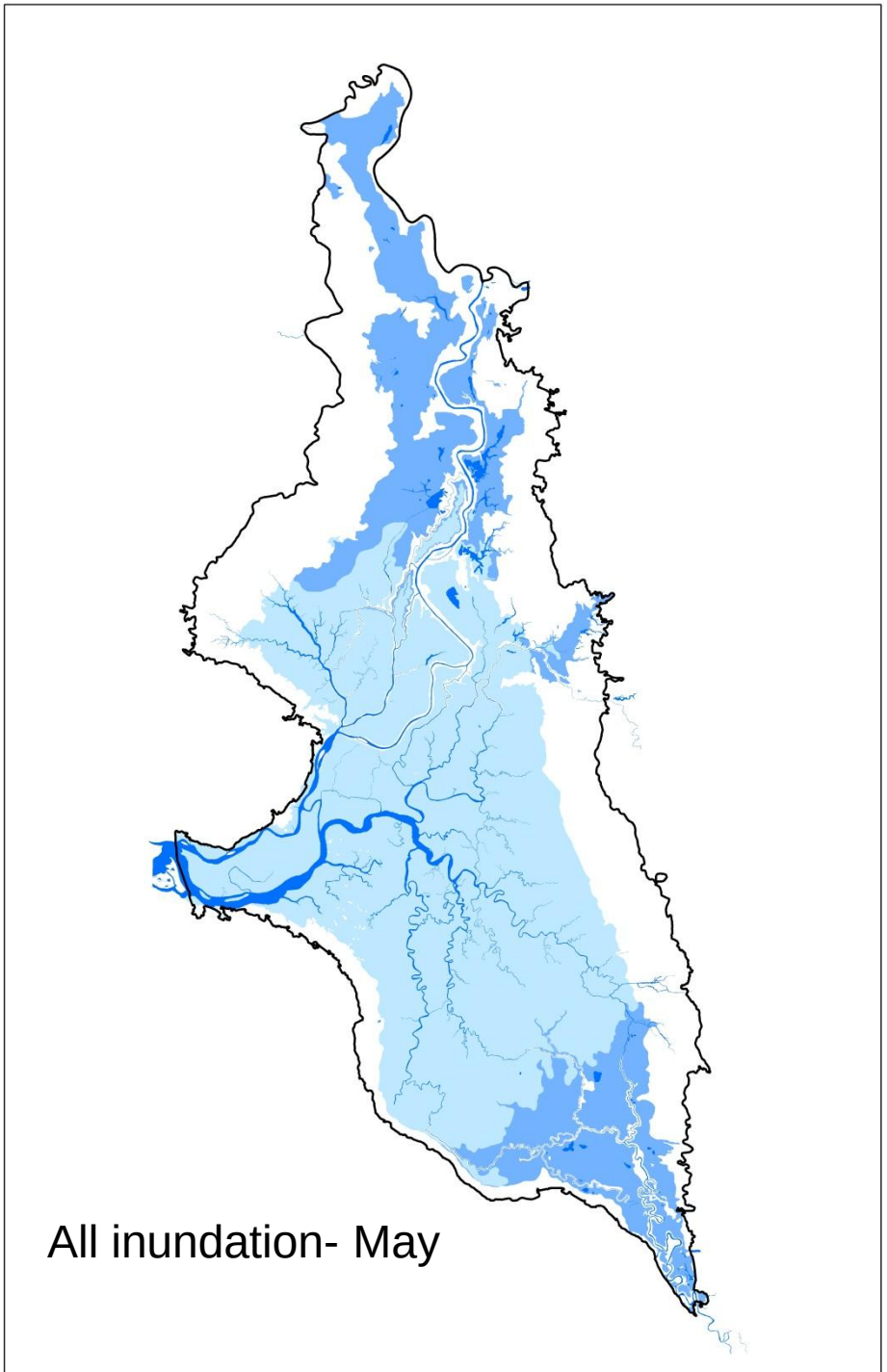
Fluvial- seasonal wetlands

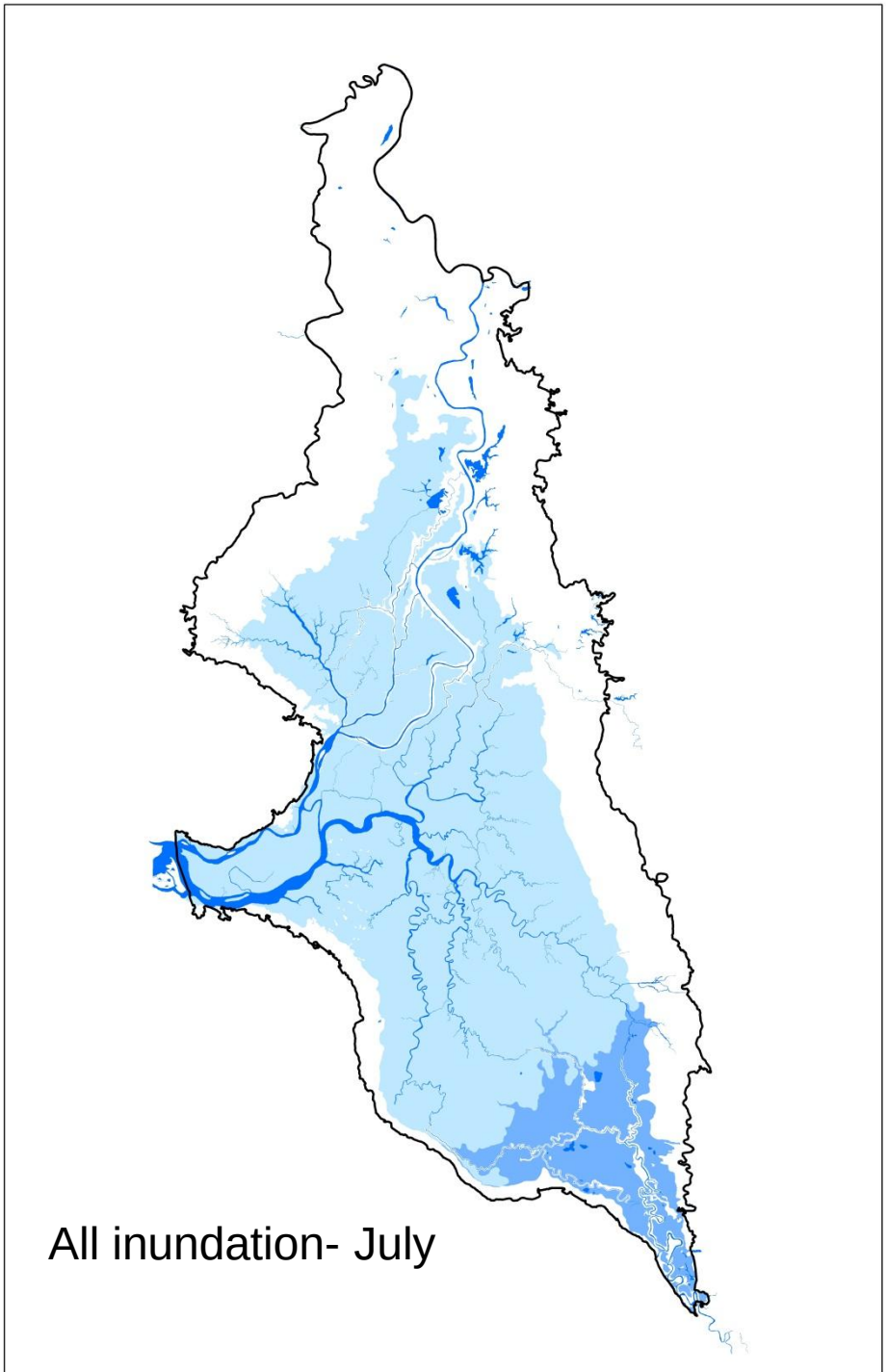
- 1 inch
- Short lived events (~1-2 days each) during summer

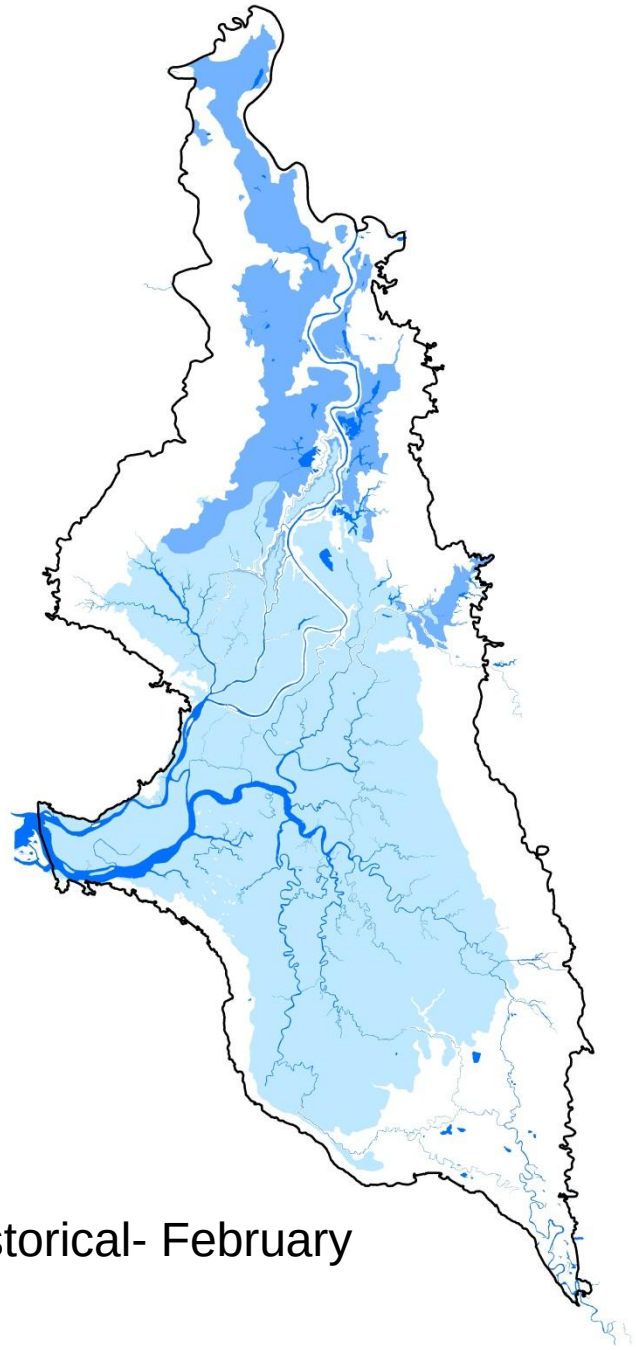




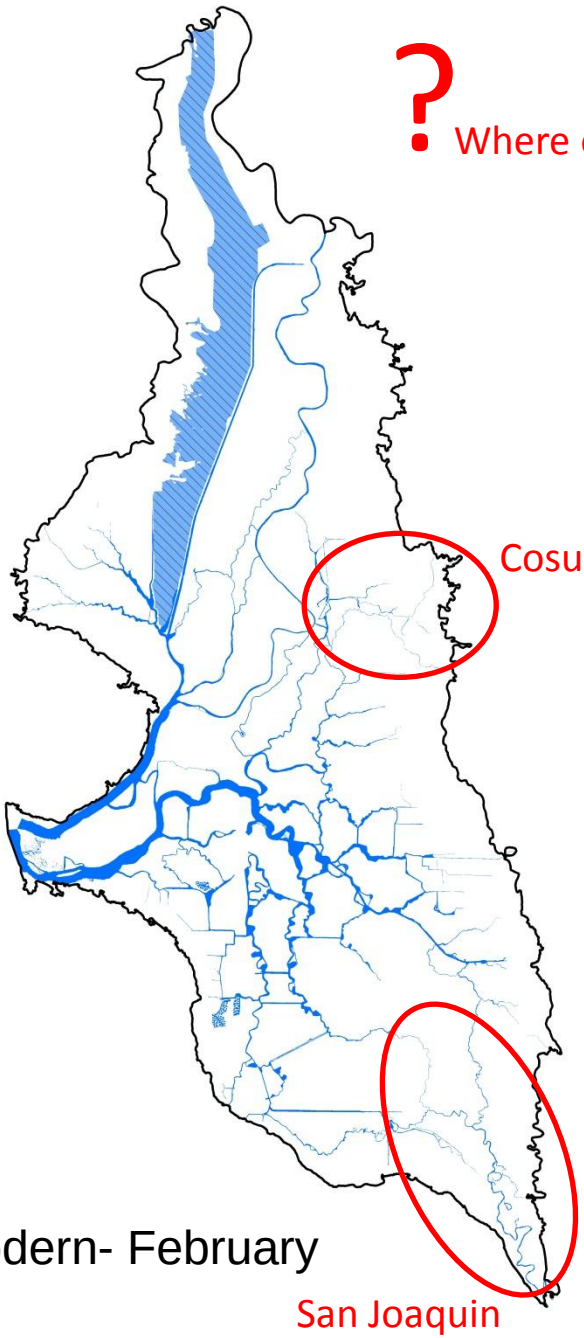
All inundation- February


All inundation- May


All inundation- July



Historical- February



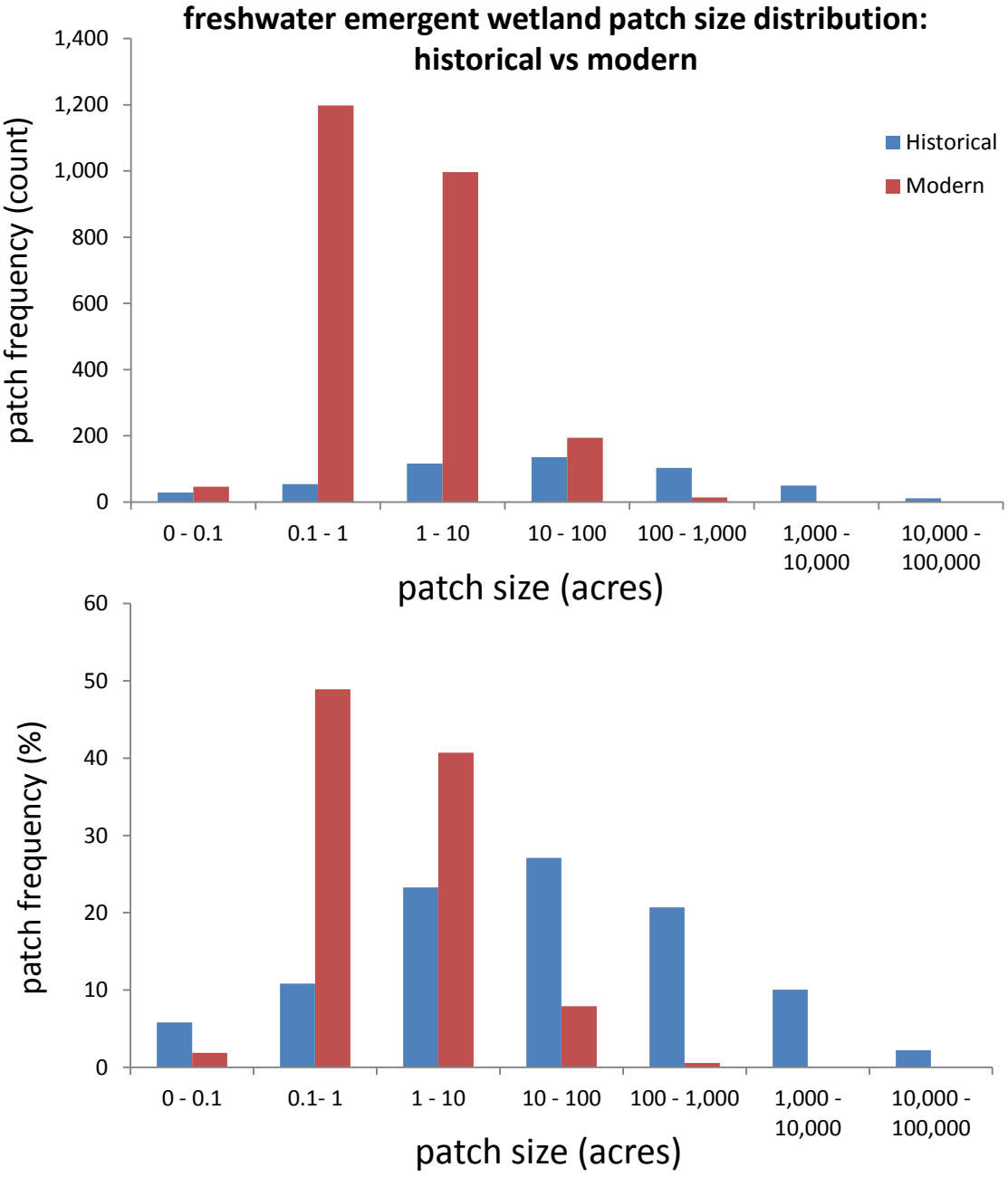
Modern- February

Metric Example

- Channel width
- Channel density
- Channel depth
- Blind channels
- Delta inundation
- Delta volume (hypsometric curves)
- Riparian width

- Patch size distribution and richness

- Patch adjacency
- Nearest neighbor distance


freshwater emergent wetland patch size distribution:
historical vs modern
patch frequency (count)
1,400
1,200
1,000
800
600
400
200
0
Historical
Modern
0 - 0.1
0.1 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100,000
patch size (acres)
patch frequency (%)
60
50
40
30
20
10
0
0 - 0.1
0.1- 1
1 - 10
10 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100,000
patch size (acres)

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Ecofunction Metrics

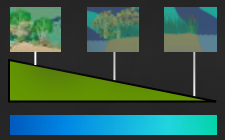
+

Physical Drivers & Gradients

Conceptual Landscape Models

+

Existing & Projected Physical Settings



Operational Landscape Units
with specific Landscape Metrics and associated Ecological Functions at Regional and Subregional scale

- Conceptual design for restoration projects
- Performance measures
- Regional vision products
- Test thru research (field, modeling, experiments)

(Verhoeven et al. 2008)

Case study: McCormack-Williamson Tract

- **Opportunities**
- Large restoration opportunity
- Variable topography
- Connection to uplands and tides
- Remnant historical features

Case study:
McCormack-Williamson Tract

- **Constraints**
- Short term constraints
  - *Flooding bottleneck*
  - *$, process*
- Long term constraints
  - *Radio tower, access*
  - *Land ownership*

Translating historical ecology to landscape scale restoration

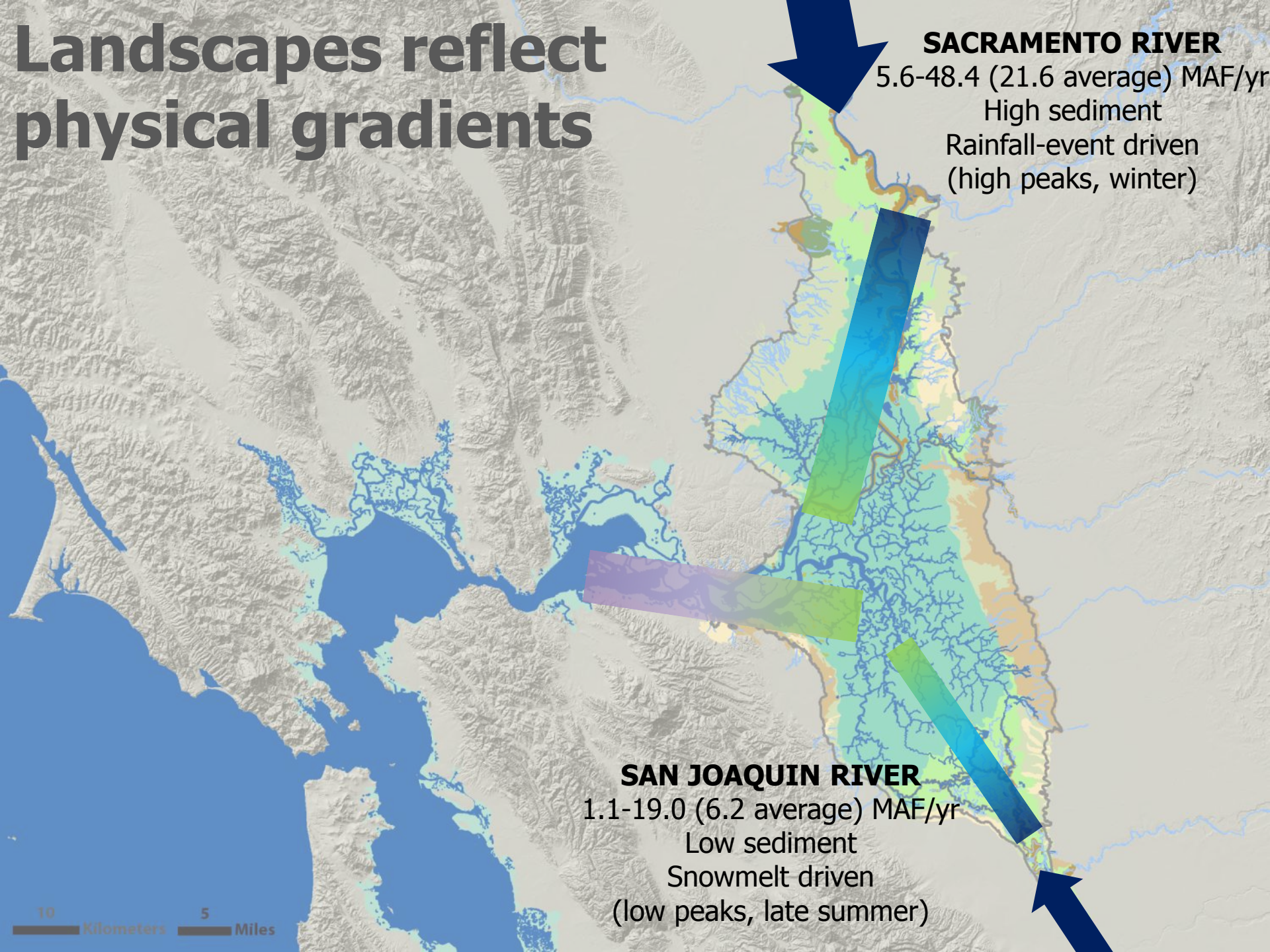
1) It is important to know how we got here:

- How the formation of the tract underlies “constraints”
- What are the physical drivers of this landscape?
  - Transition between tidal/non-tidal, transition to upland habitat types etc.

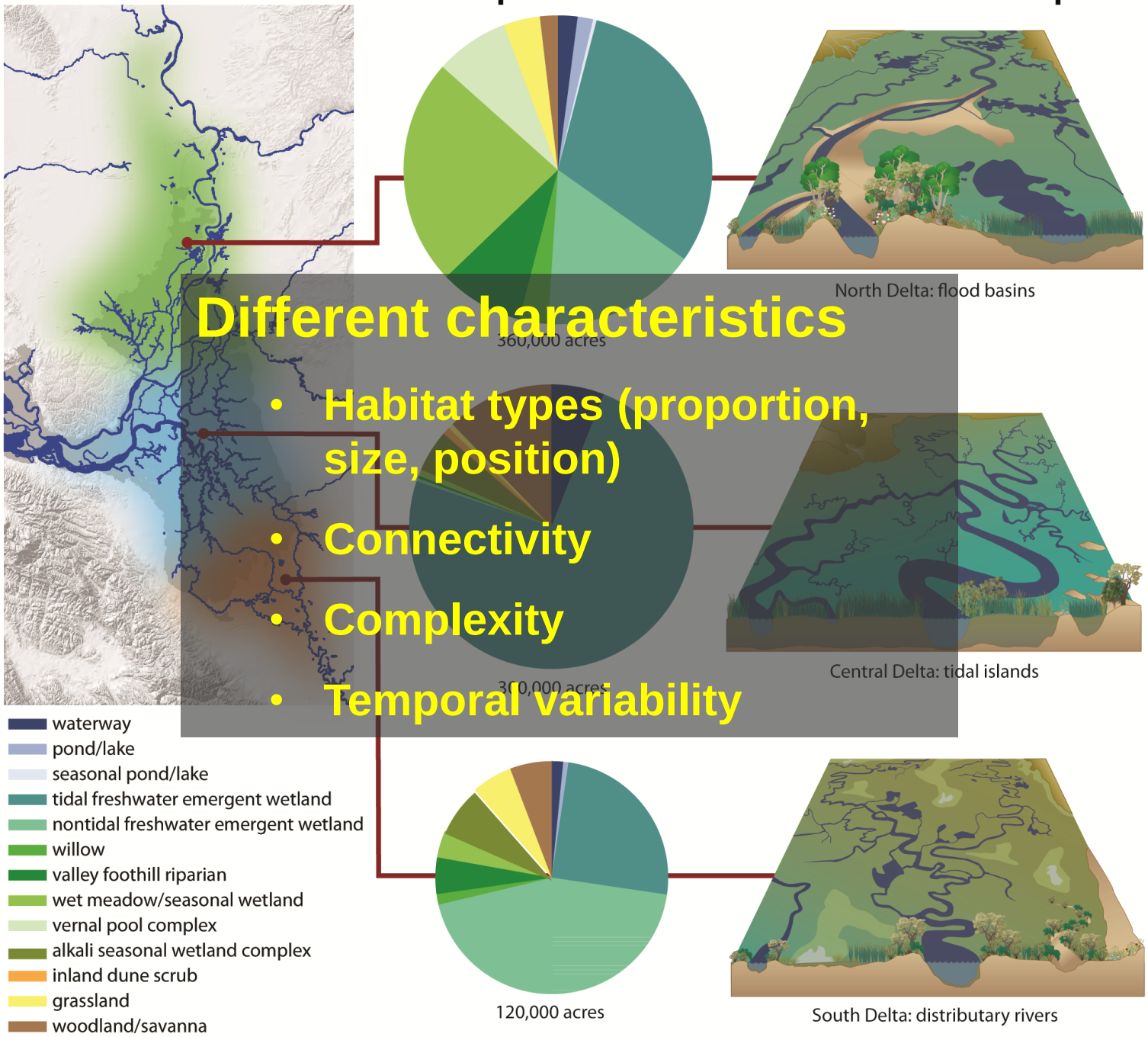
2) How do these drivers influence restoration potential?


Tidal channel
Fluvial channel
Tidal or Fluvial channel
(lower confidence level)
Water
Intermittent pond or lake
Tidal freshwater emergent wetland
Non-tidal freshwater emergent wetland
Willow thicket
Willow riparian scrub or shrub
Valley foothill riparian
Wet meadow and seasonal wetland
Vernal pool complex
Alkali seasonal wetland complex
Stabilized interior dune vegetation
Grassland
Oak woodland or savanna

Landscapes reflect physical gradients



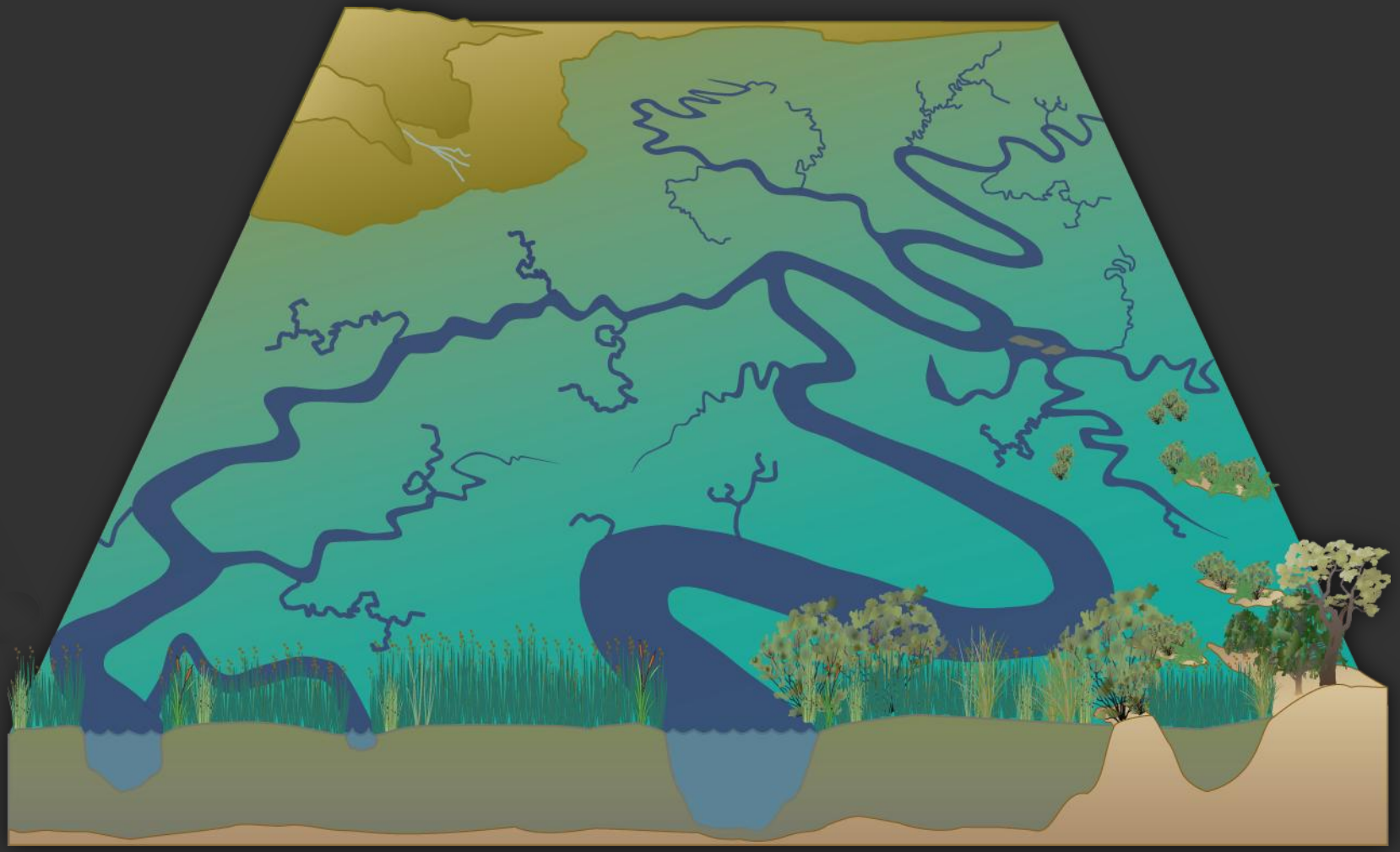
Conceptual models of historical landscapes



Different characteristics

- Habitat types (proportion, size, position)
- Connectivity
- Complexity
- Temporal variability

Central Delta: where tides dominate

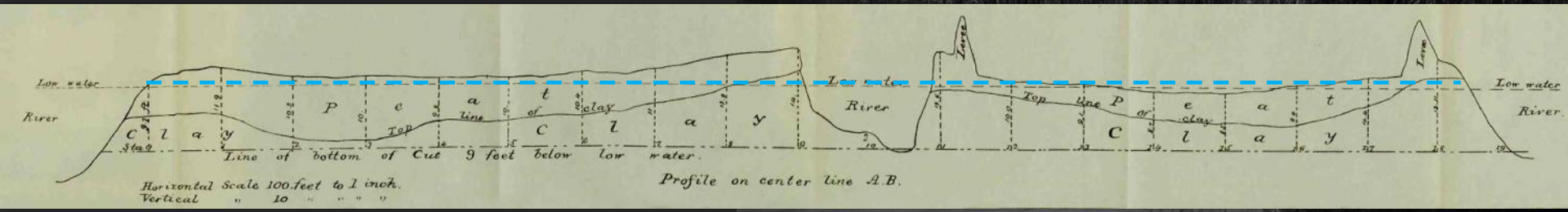


Central Delta: where tides dominate

- Low banks
- Frequent tidal inundation
- High connectivity between land and water

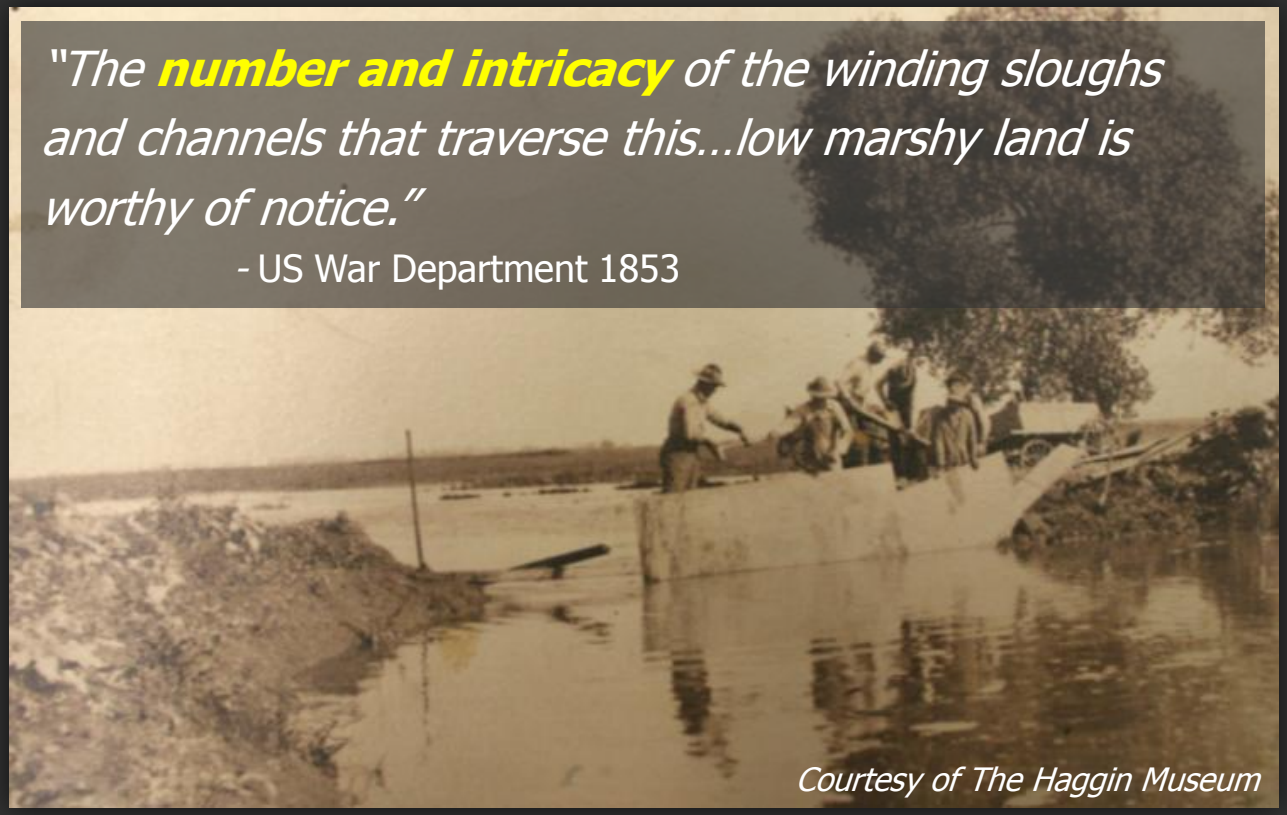
"The water reached our blankets at the turn of the tide"

- October 1811, Abella and Cook 1960



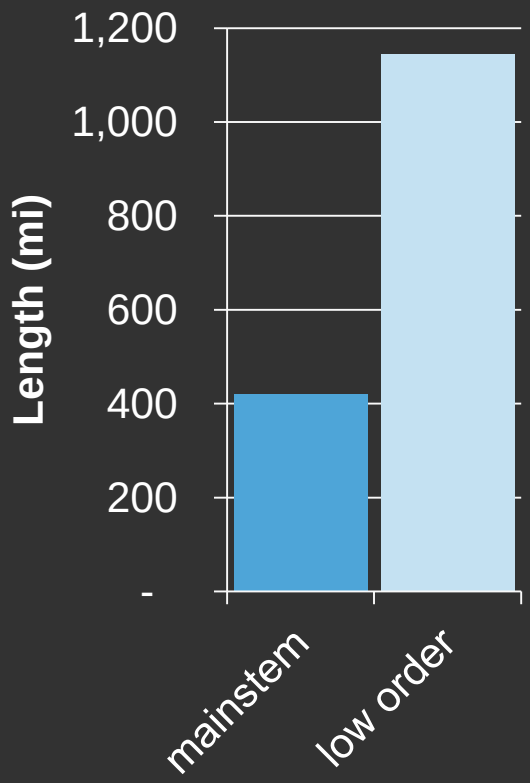
Central Delta: where tides dominate

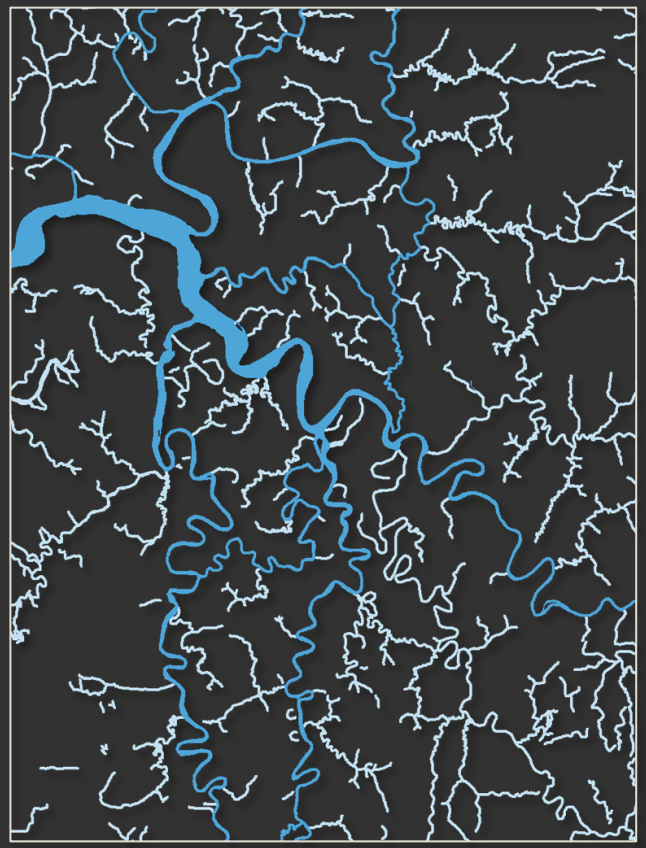
- Numerous sinuous tidal channels of different sizes



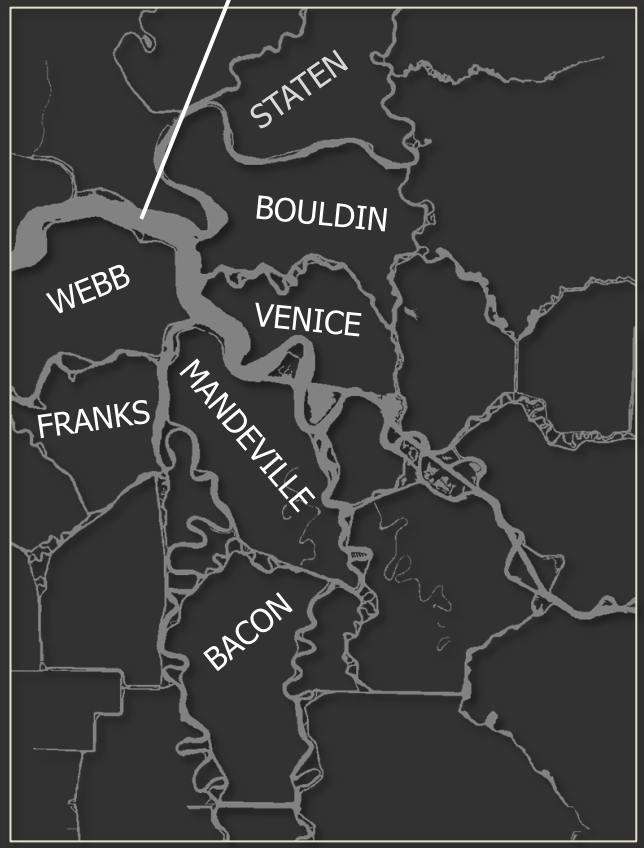
Central Delta: where tides dominate

- Numerous sinuous tidal channels of different sizes
- Organized into networks branching into wetland





early 1800s



early 2000s

Central Delta: where tides dominate

- Diverse vegetation community including willow-fern swamp

Courtesy of The Haggin Museum

Central Delta: where tides dominate

- Diverse vegetation community including willow-fern swamp

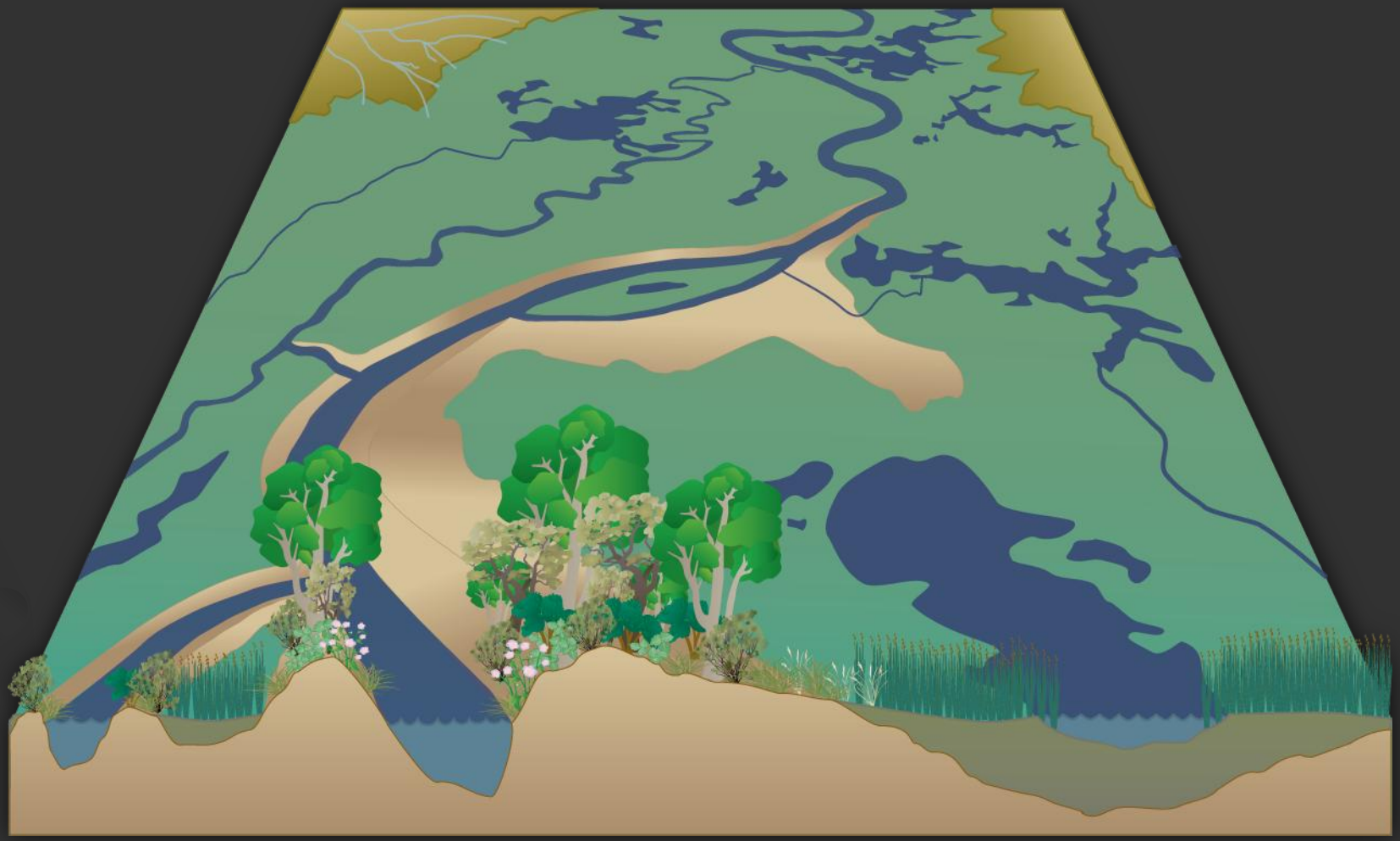
*"Their edges are not so elevated, nor are they so covered with vegetation, while their interior parts the **tule** is thinner and shorter. **Willows** here grow **in bunches**."*

- USDA 1874

Daniel Burmester

Courtesy of The Haggin Museum

North Delta: where flood basins flank rivers



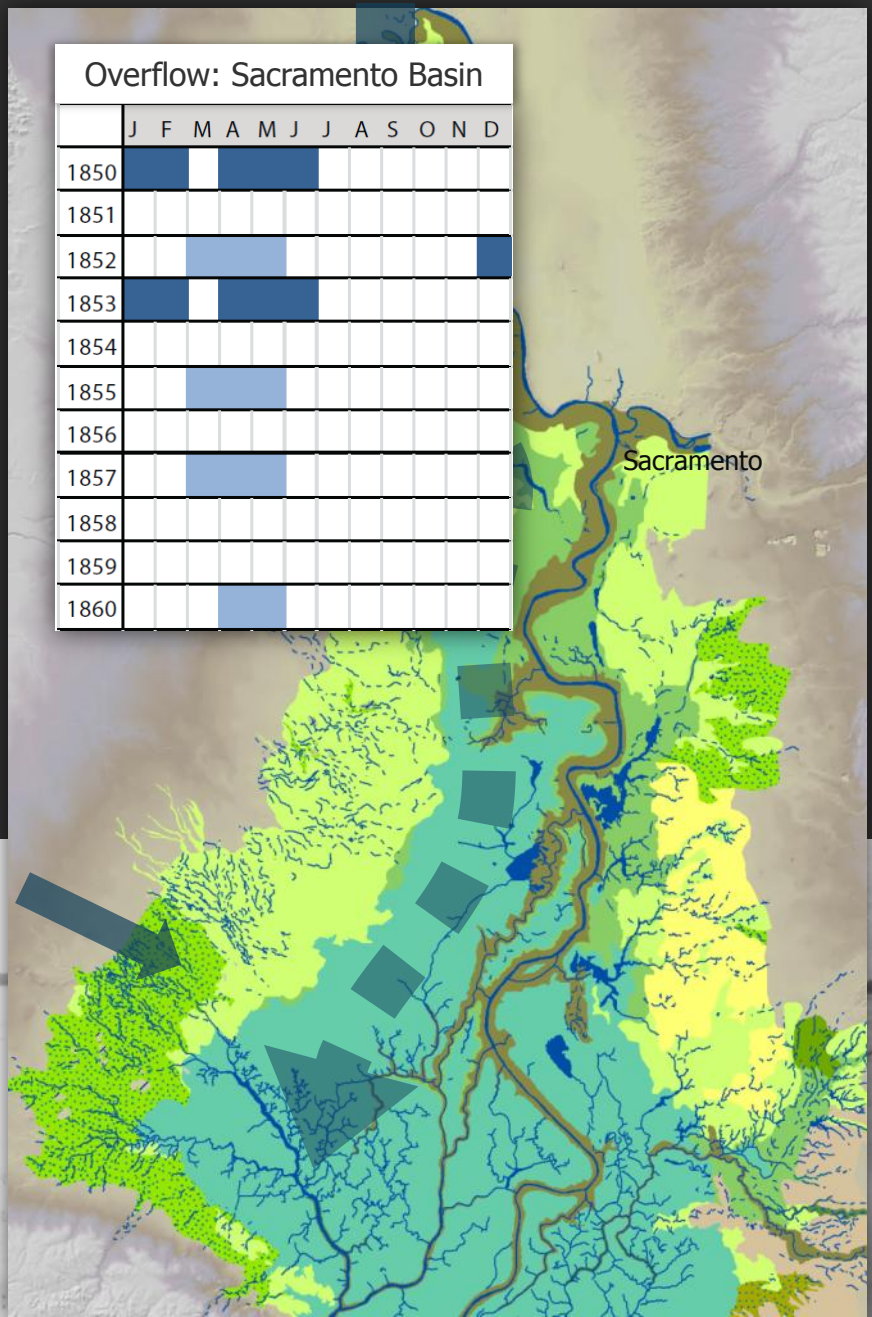
Yolo Basin vs. Yolo Bypass

North Delta: where flood basins flank rivers

- Floods connected components
- Seasonal and inter-annual variability

*"the great basins…act as **enormous regulating reservoirs**…to cut down the crest of the great flood waves"*

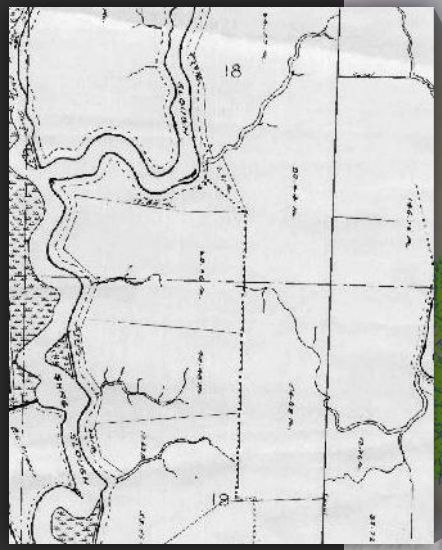
- Dabney Commission 1905



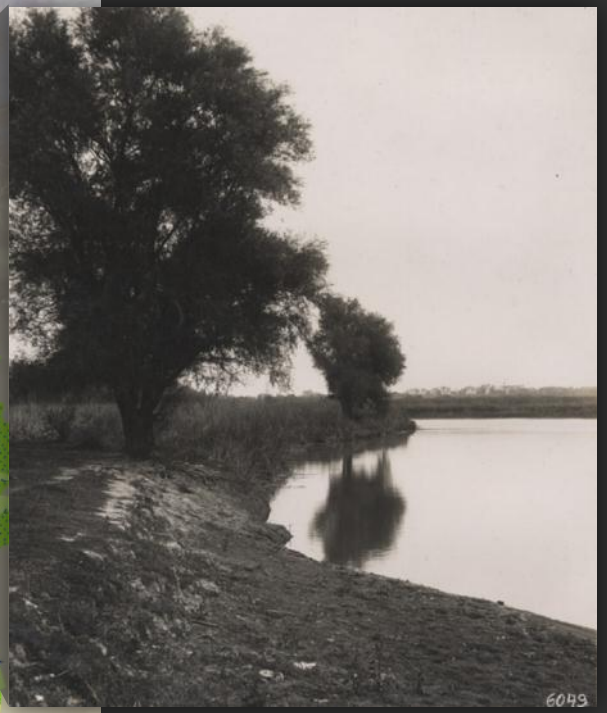
North Delta: where flood basins flank rivers

- Different features depending on position along gradients

Courtesy of UC Davis Special Collections



Courtesy of Solano County Surveyor



Courtesy of California State Library

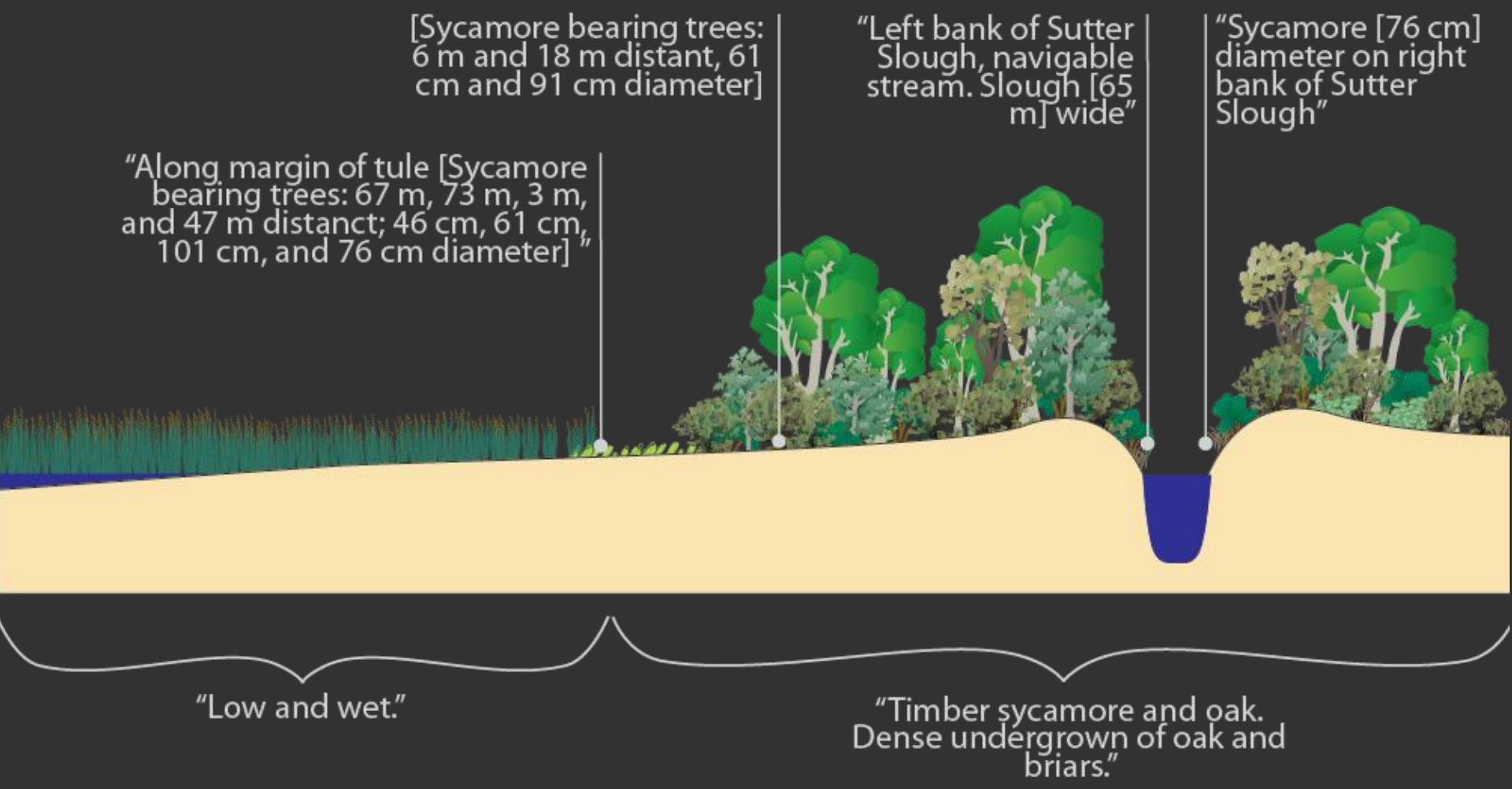
North Delta: where flood basins flank rivers

- Dense and structurally complex riparian forest

Courtesy of The Bancroft Library

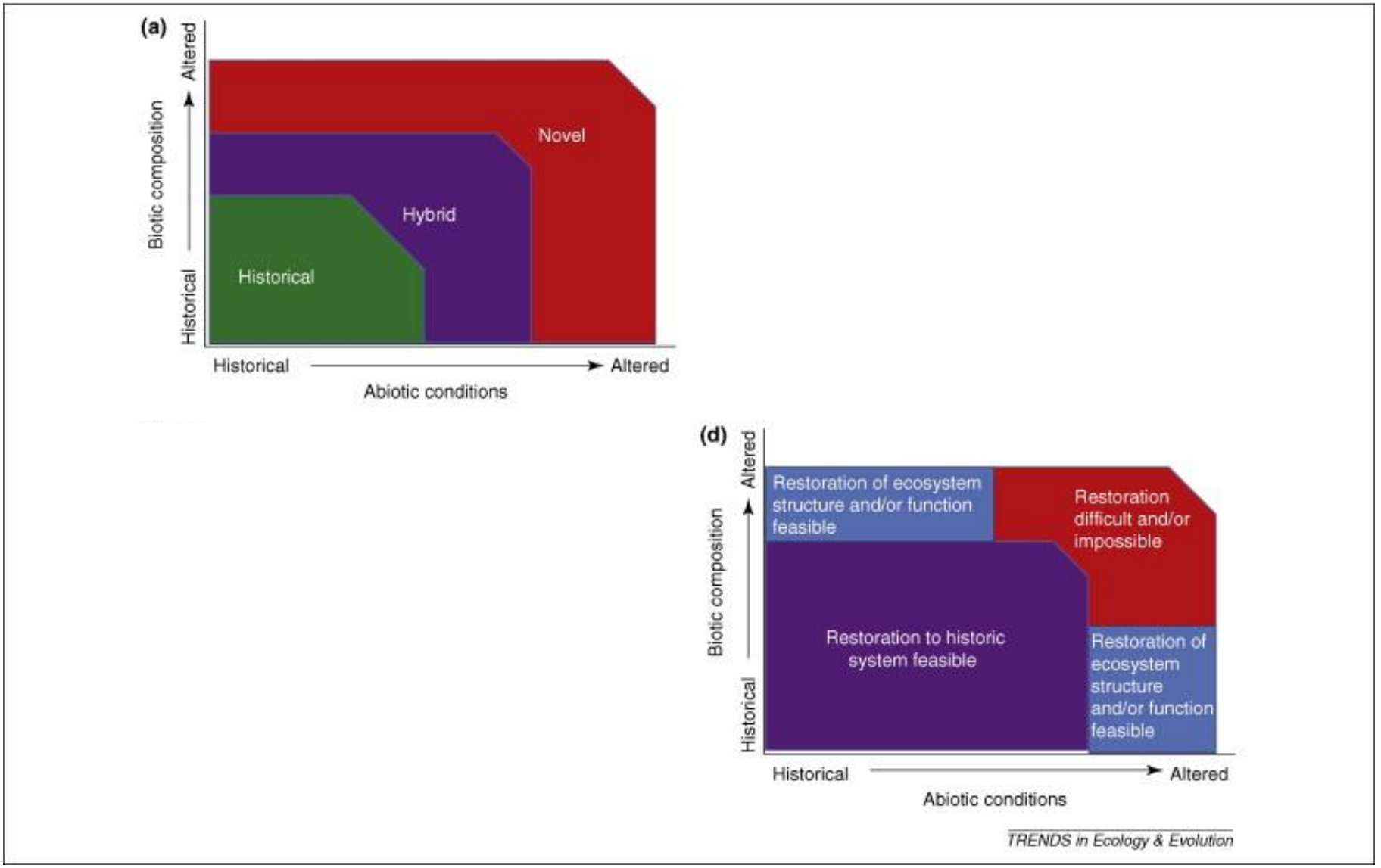
North Delta: where flood basins flank rivers

- Riparian forest on natural levees bounded flood basins



William J. Lewis, November 1859

- **Transition zone between tidal tule marsh and wet meadow**



Hobbs et al. 2009