Delta Wetlands Futures: Marsh Resilience and Blue Carbon in the Sacramento-San Joaquin Delta

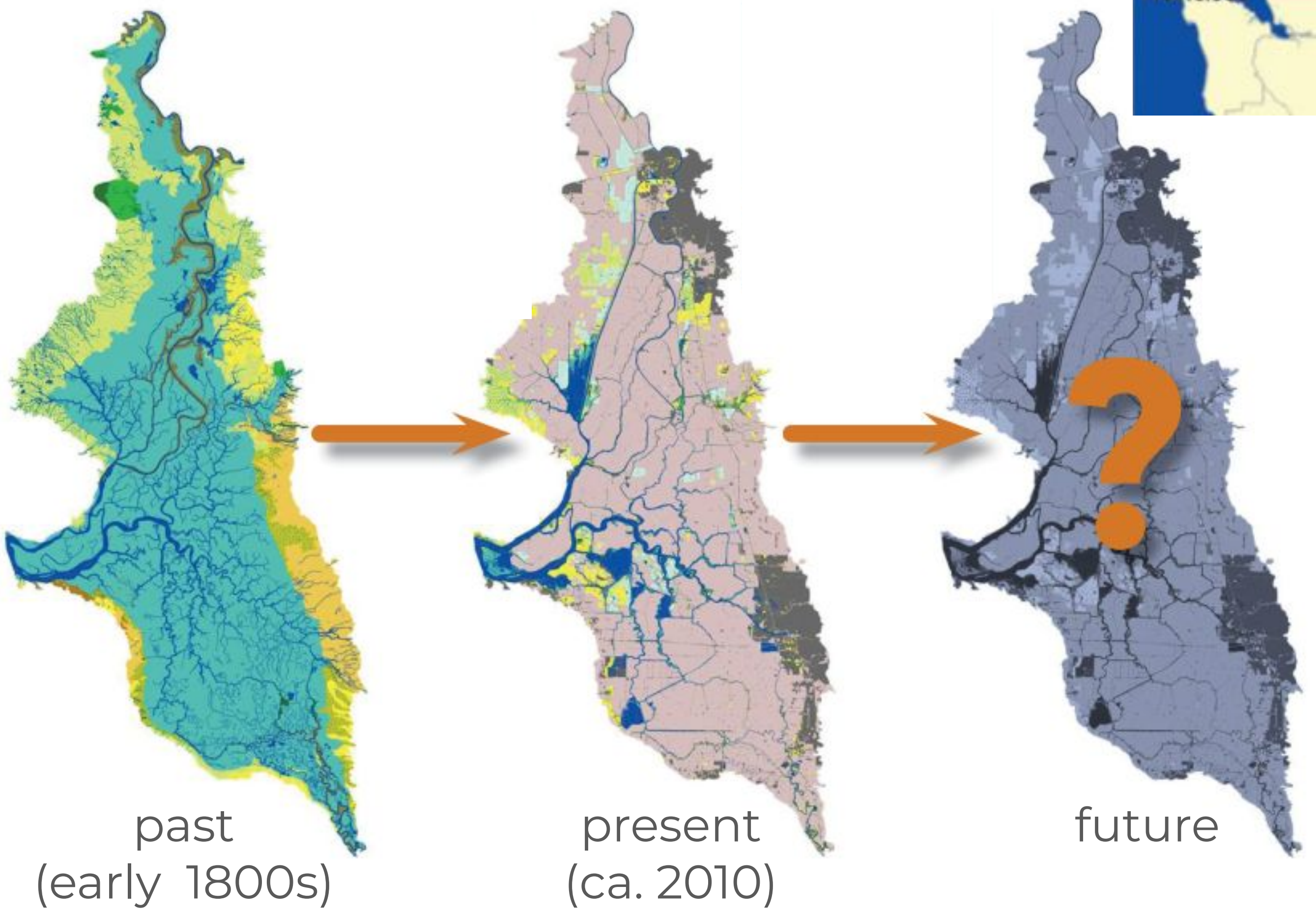
North Bay Watershed Association Board Meeting

June 2, 2023

Background

Land use change, subsidence, and GHG emissions in the Sacramento-San Joaquin Delta

- Once the largest estuarine wetland on the US west coast
- In late 1800s and early 1900s, ~98% drained for agriculture
- Loss of tidal wetland habitat
- Widespread subsidence
- ~21% of California's agricultural GHG emissions
- Future Delta threatened by Sea Level Rise and continued subsidence
    - Extensive land use planning to restore lost functions

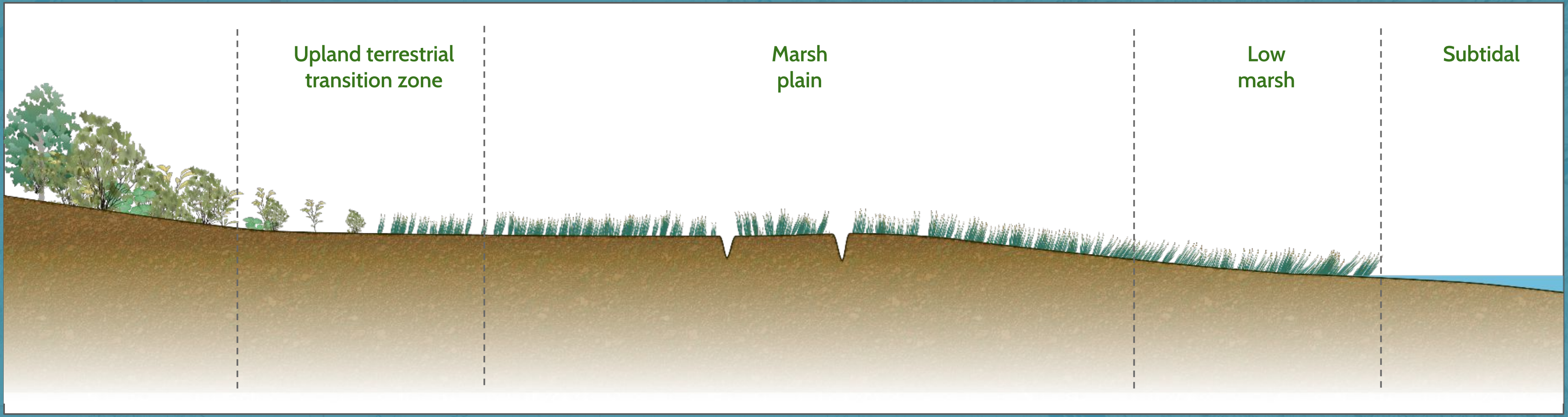


Tidal Marsh Resilience to Sea Level Rise

- **Wetland resilience**: the ability of wetlands to persist as sea levels rise
- **Spatial patterns** are important for restoration and management decisions
- **Our approach**:
  - modeling and mapping with currently available data
  - including existing marshes and areas that could be restored based on elevation
  - SLR definitions based on 2018 OPC report

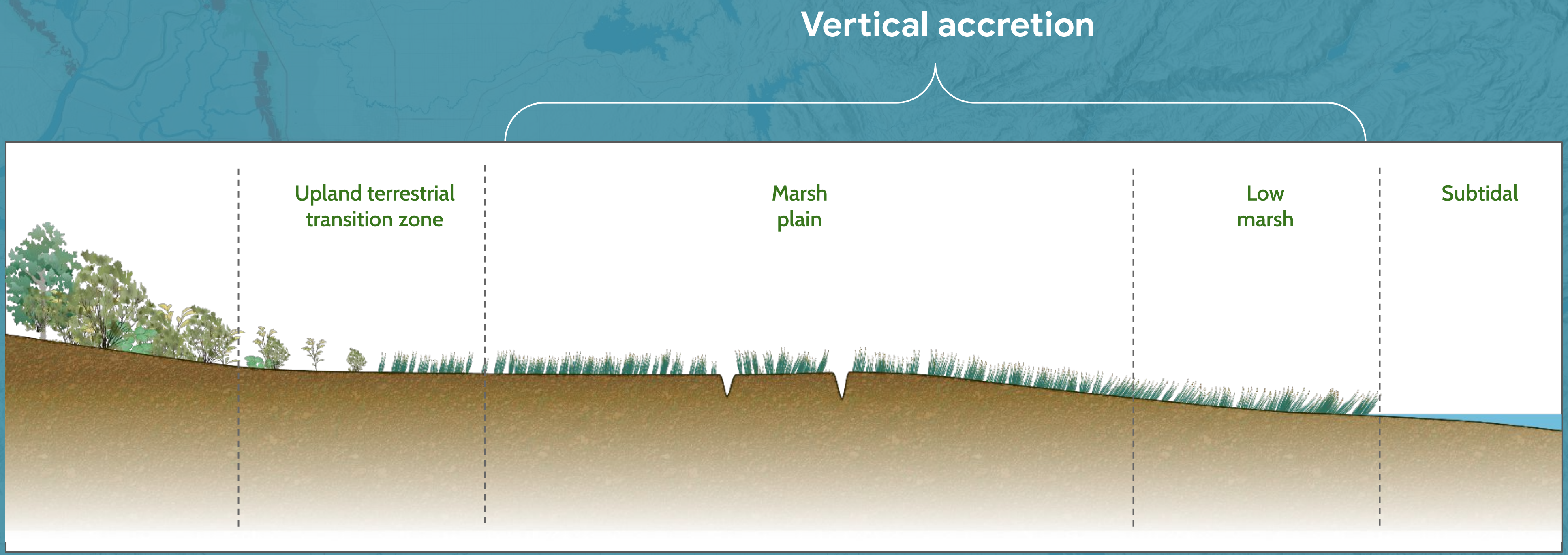
Wetland resilience processes

Key process of tidal wetland evolution	Marsh migration	Vertical accretion	Marsh erosion / progradation



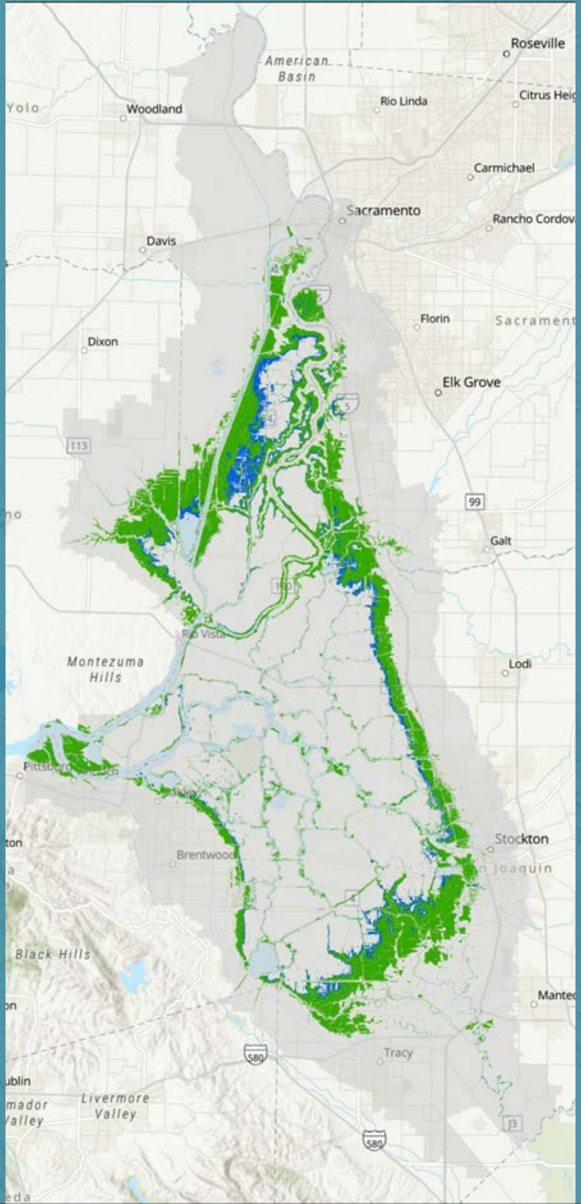
Accretion modeling and mapping

- Coastal Wetland Equilibrium Model (CWEM) with Delta-specific parameter values
- Mapped CWEM results onto Delta using parameters where spatial datasets were available

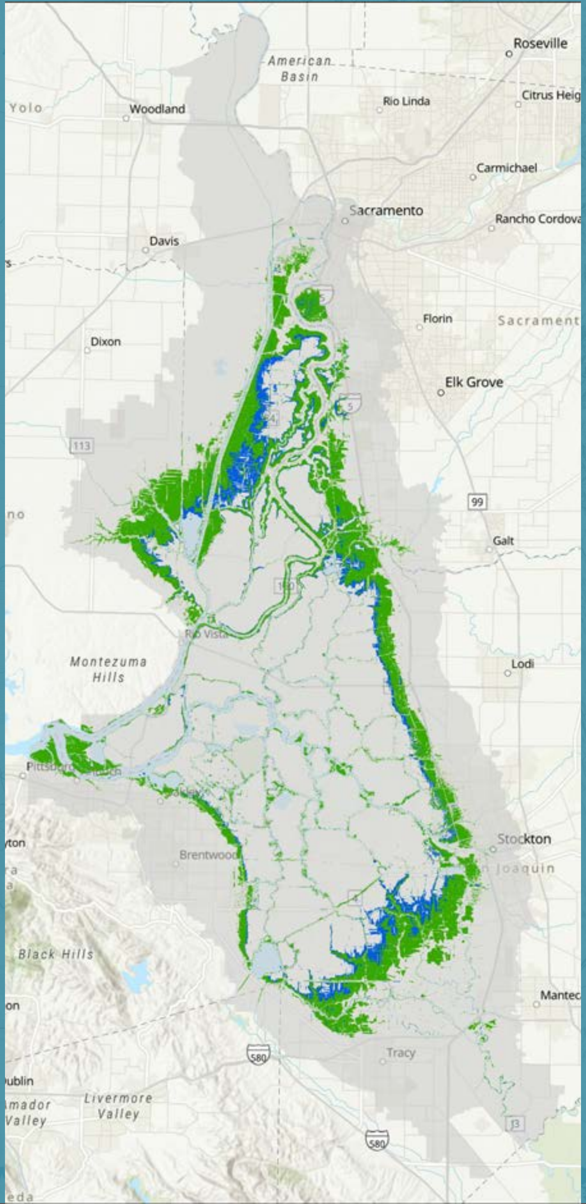


Rising Sea Levels reduce marsh areas

Moderate SLR, 2050



Moderate SLR, 2100



Sea level rise scenarios:

- 0.9 ft by 2050
- 2.5ft by 2100

(Medium sediment)

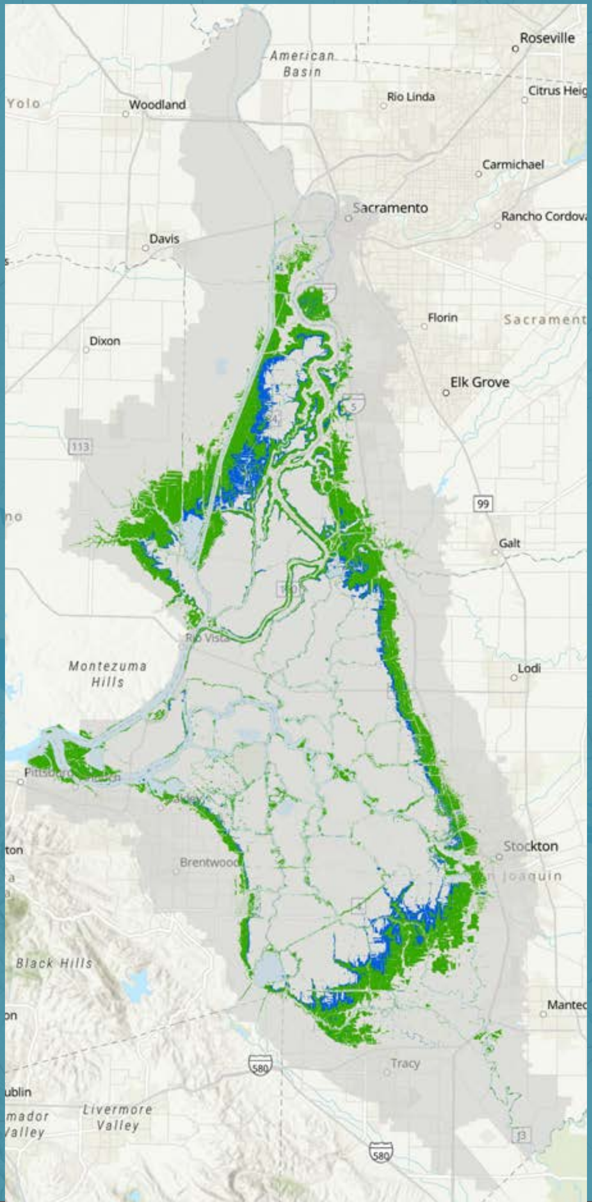
Marsh Persists

Marsh Drowns

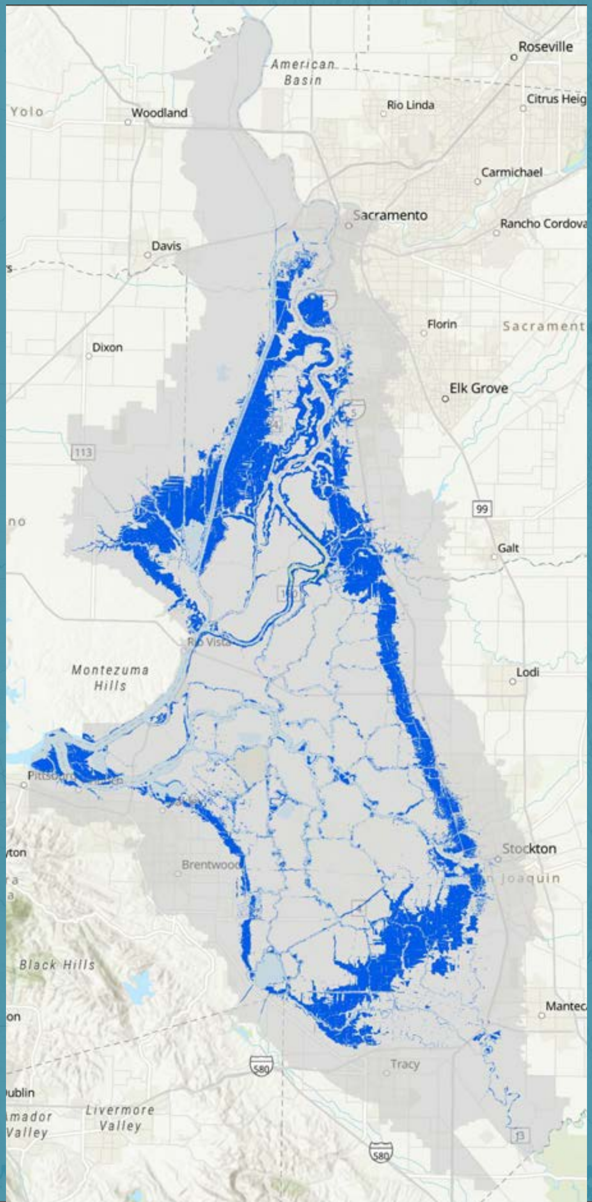
**Maps were developed for conceptual analyses, not planning purposes

Rising Sea Levels reduce marsh areas

High SLR, 2050



High SLR, 2100



Sea level rise scenarios:

- 1.9ft by 2050
- 6.9ft by 2100

Marsh Persists
Marsh Drowns

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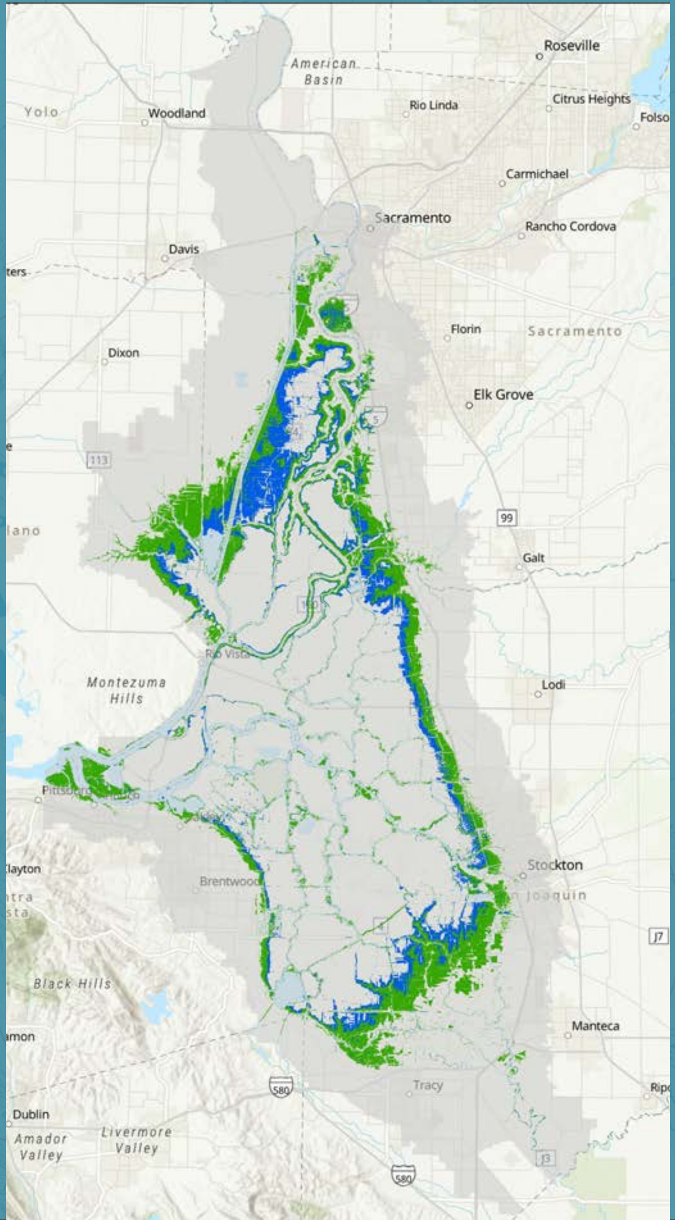
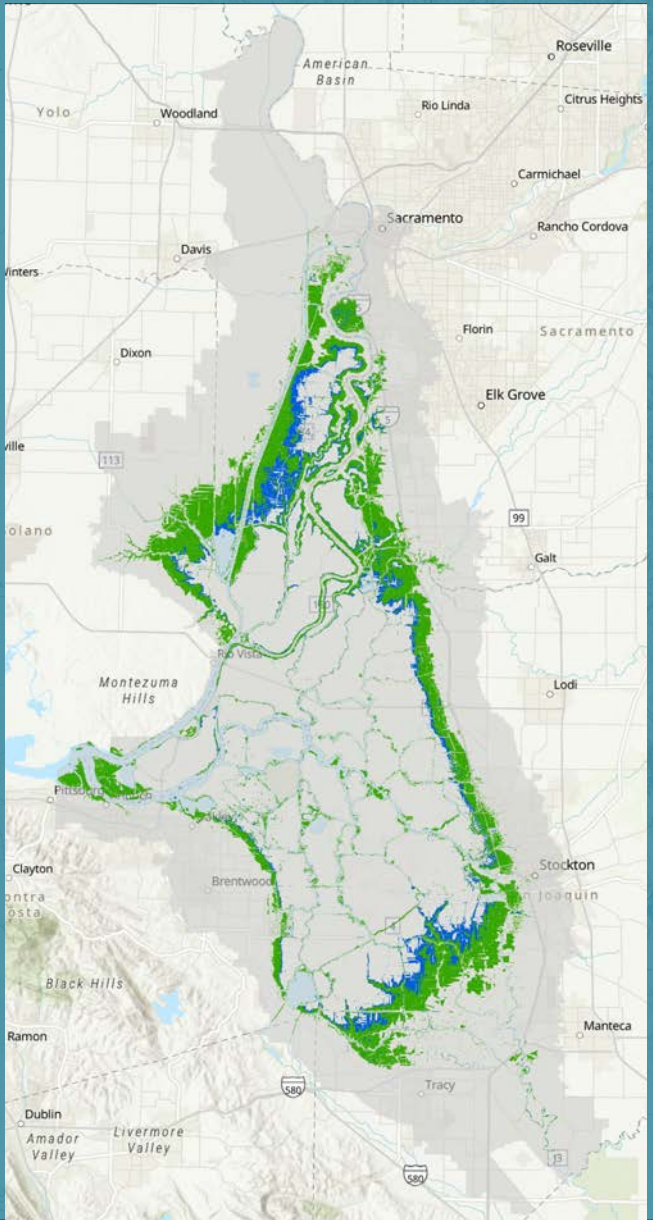
Suspended sediment concentration can reduce marsh susceptibility to rising sea levels

Marsh Drowns
Marsh Persists

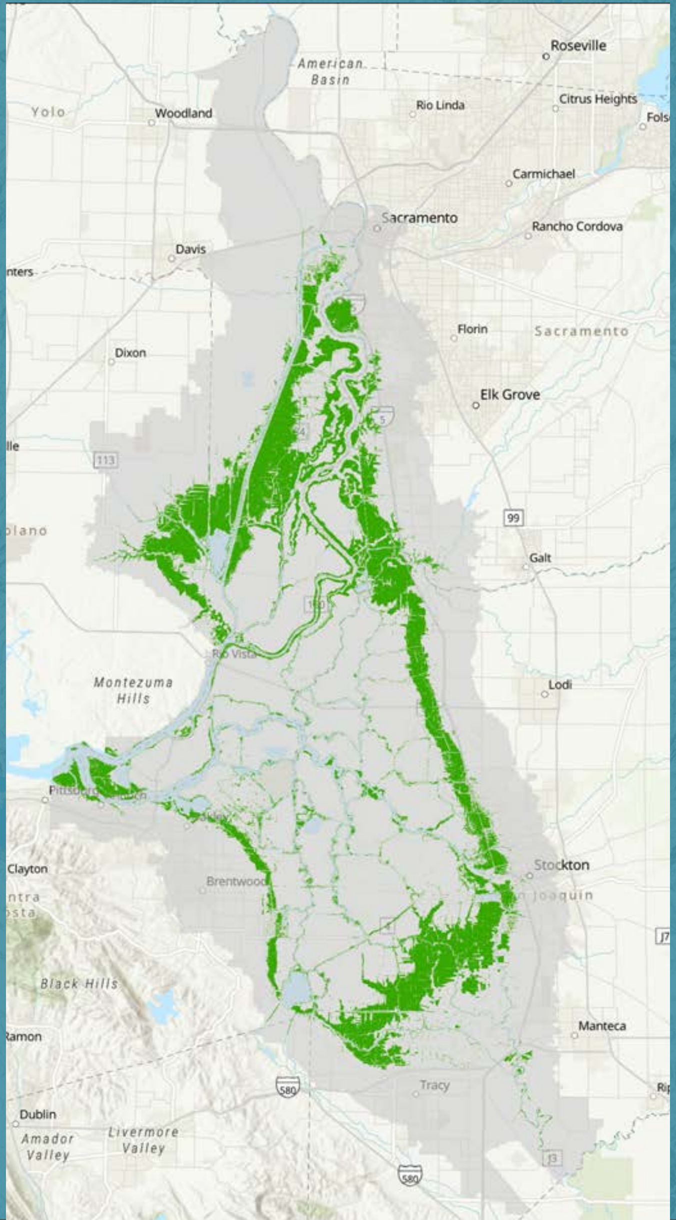
1.9ft SLR by 2100, Low Sed (10mg/l)



1.9ft SLR by 2100, Med Sed (20mg/l)



1.9ft SLR by 2100, High Sed (50mg/l)



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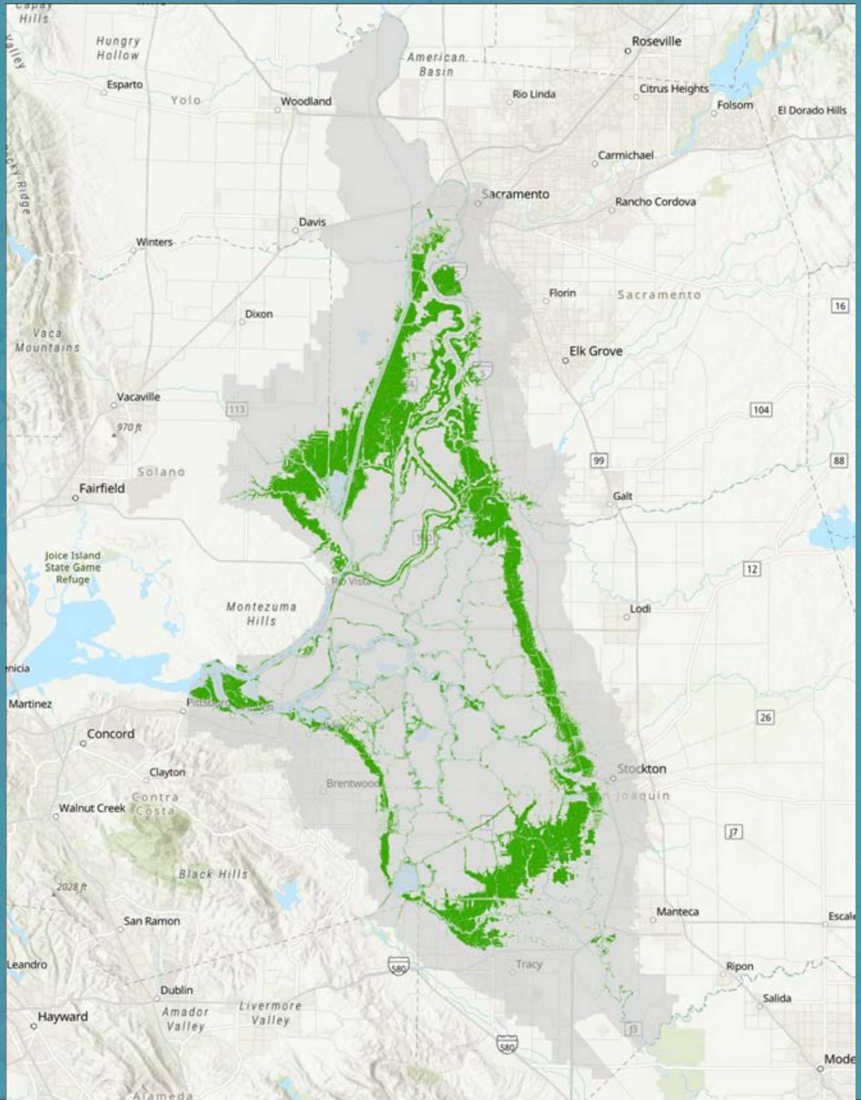
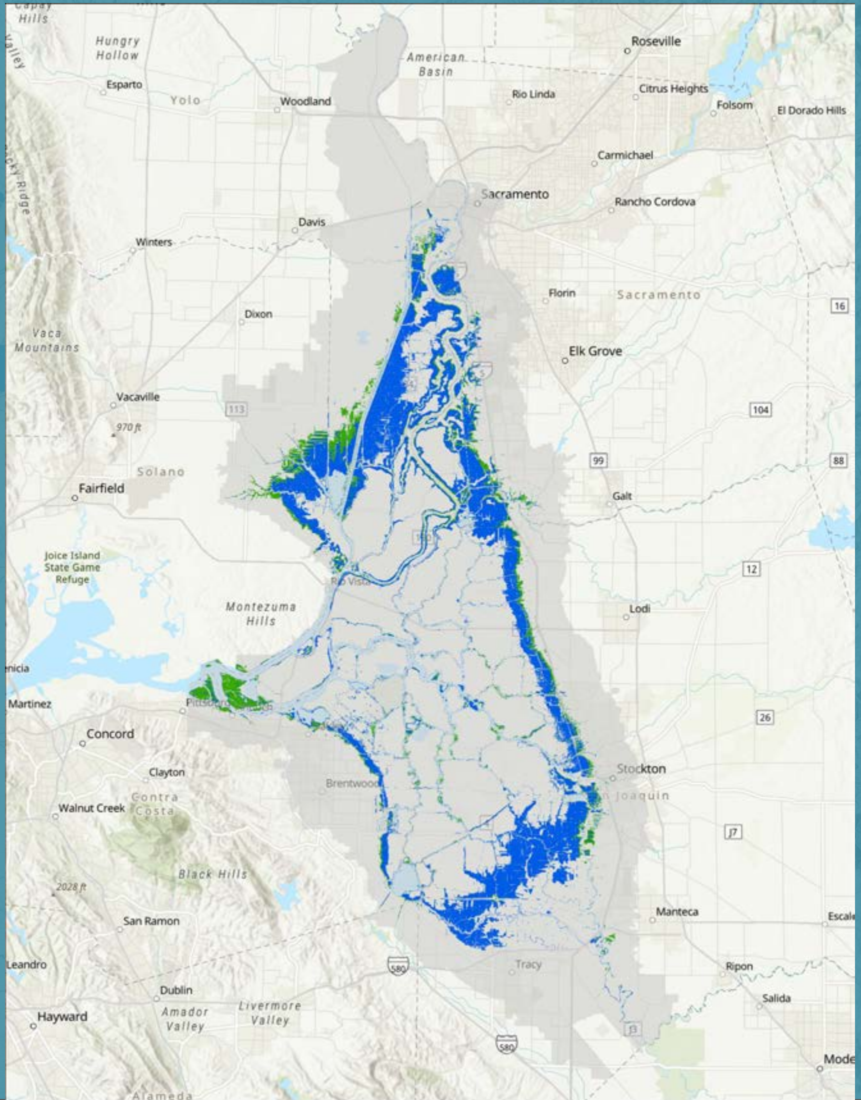
High sediment conditions between 2050 and 2100

High SLR by 2050 (1.9ft),
High Sed



High SLR by 2100 (6.9ft),
High Sed



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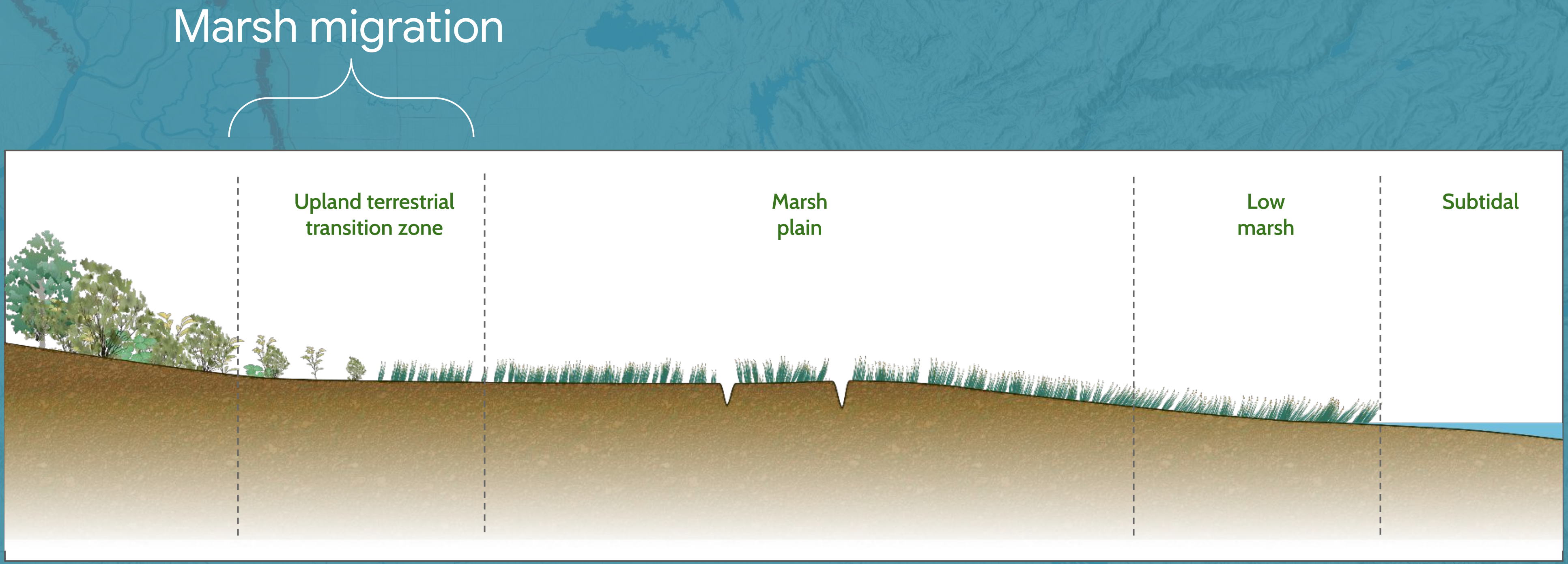
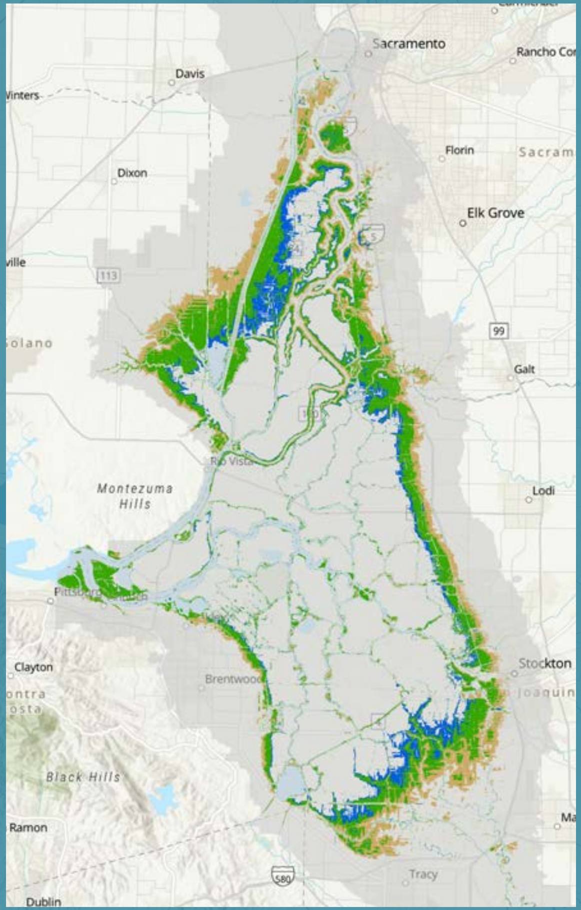
Marsh migration

- Mapped potential migration space based on elevation
- Included areas near existing or potential marsh

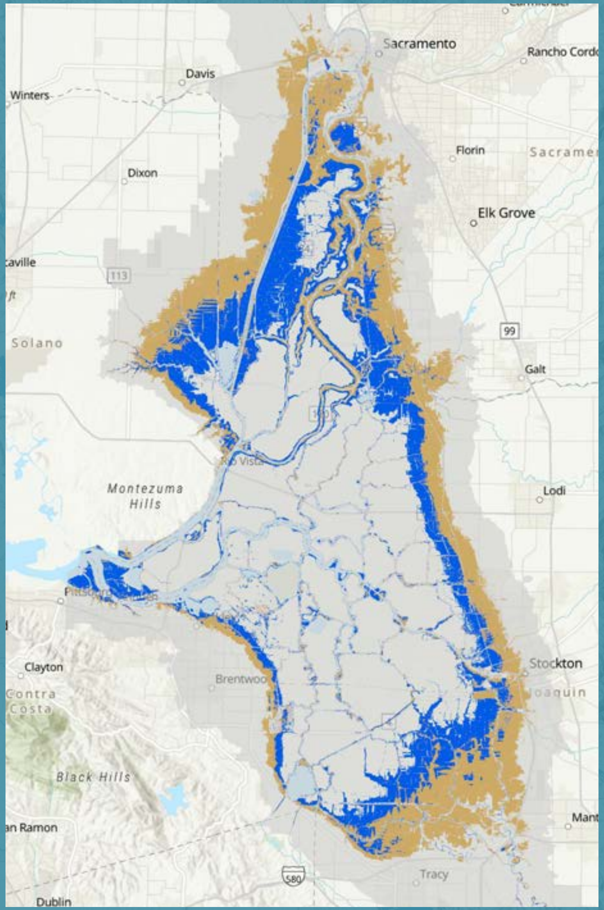


Low lying areas adjacent to emergent marsh are areas for potential marsh migration

Moderate SLR migration
(1.9ft SLR by 2100)



High SLR migration
(6.9ft by 2100)



Marsh Persists

Marsh Drowns

Migration Space

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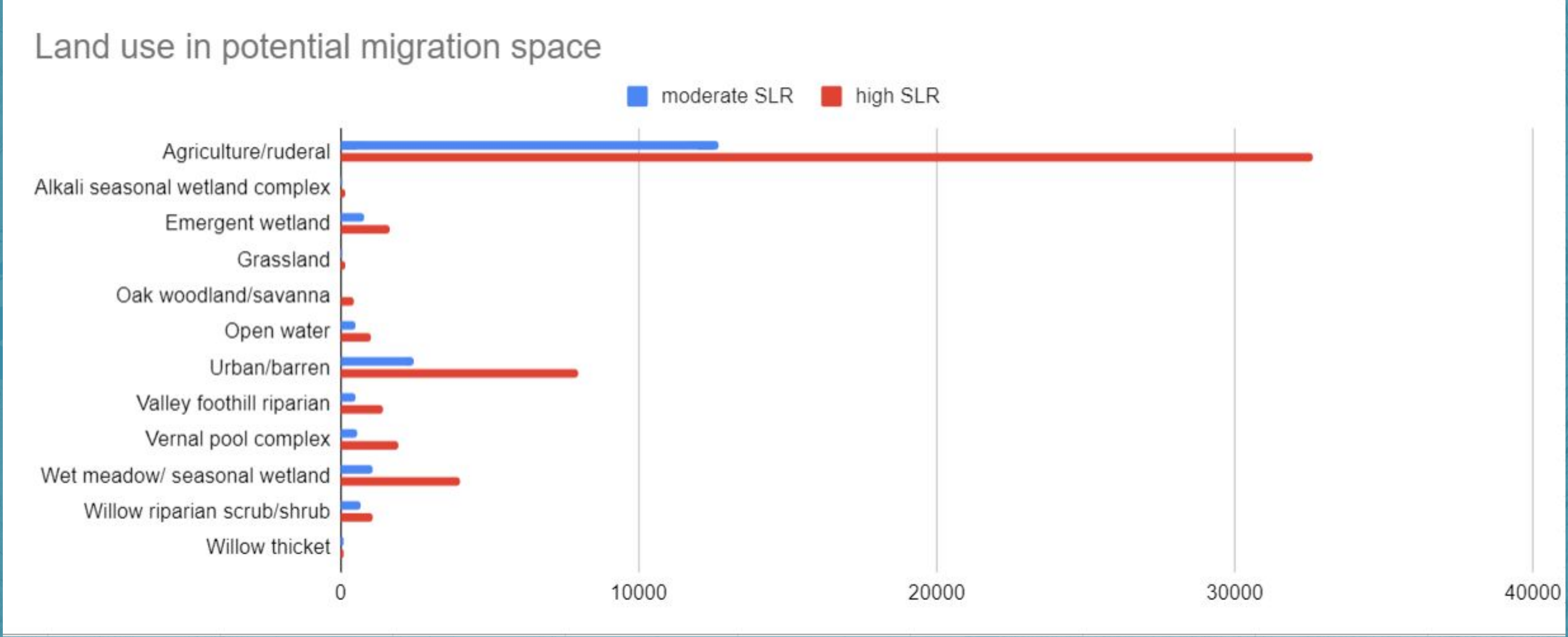
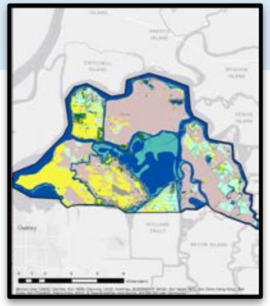
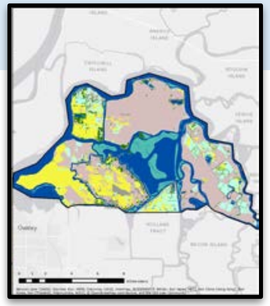
Potential marsh migration space: Land Use

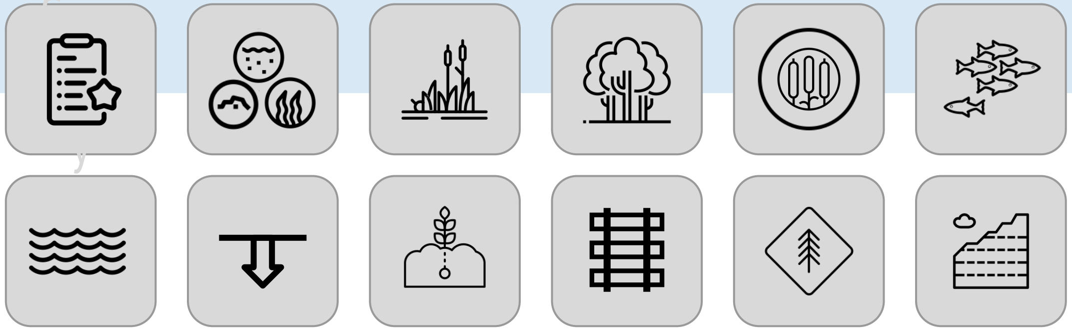


LANDSCAPE SCENARIO PLANNING TOOL

https://www.sfei.org/projects/landscape-scenario-planning-tool







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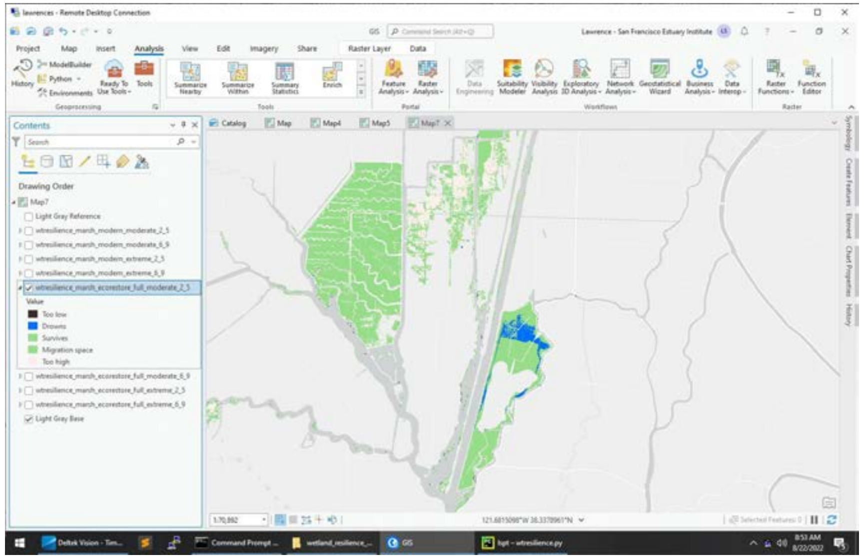
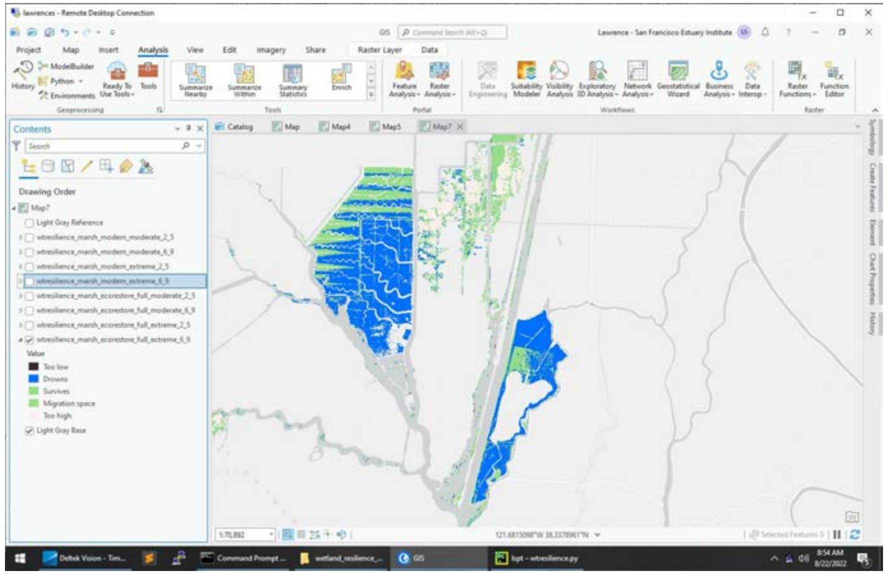
New wetland resilience module

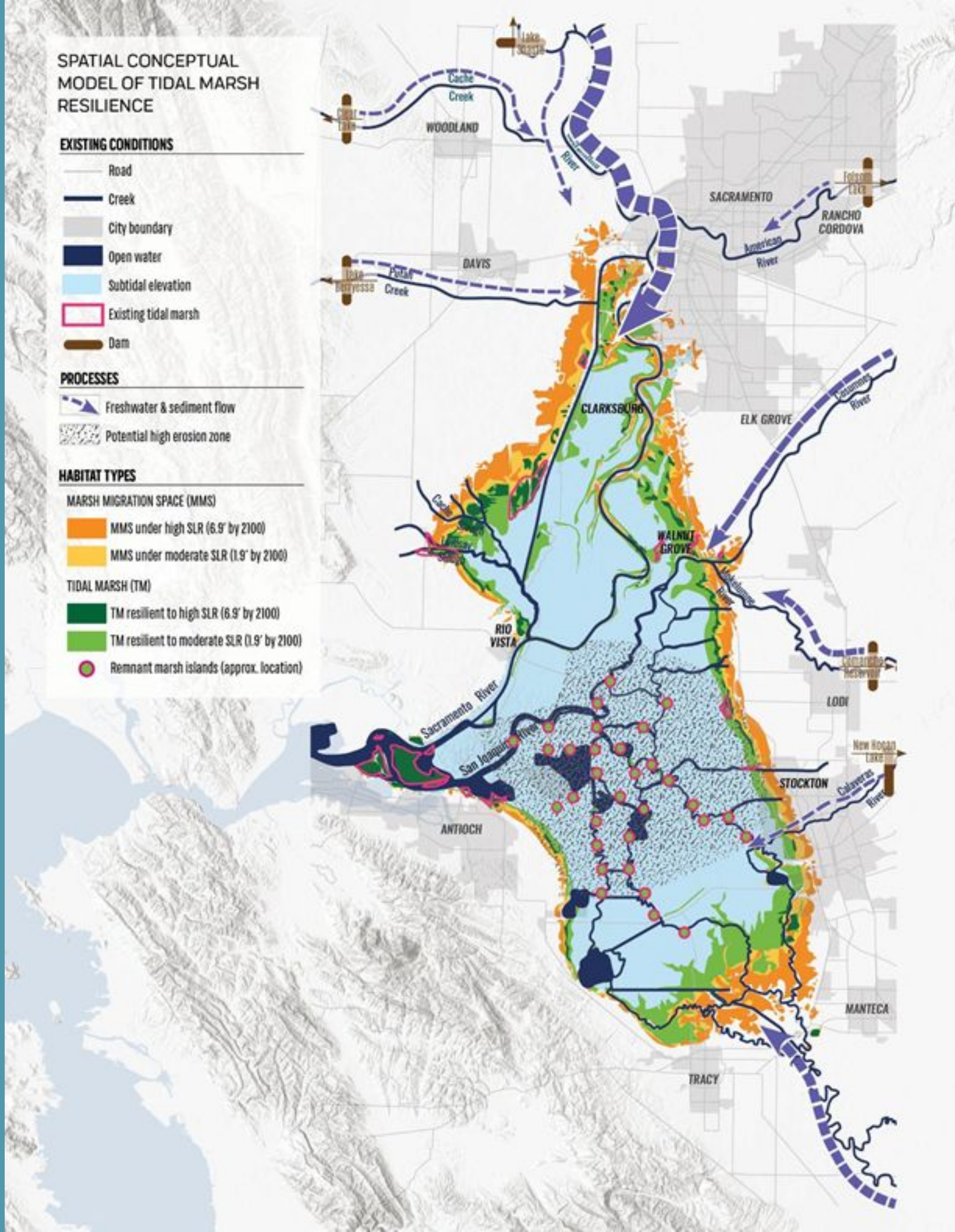




- Uses mapping from this effort to determine:
  - If tidal wetlands in the user scenario are likely to persist to 2100
  - If wetland planning includes actions in areas of potential migration space
- Allows users to apply this data to their own projects
- Module built with appropriate caveats and discussion of uncertainties and unknowns

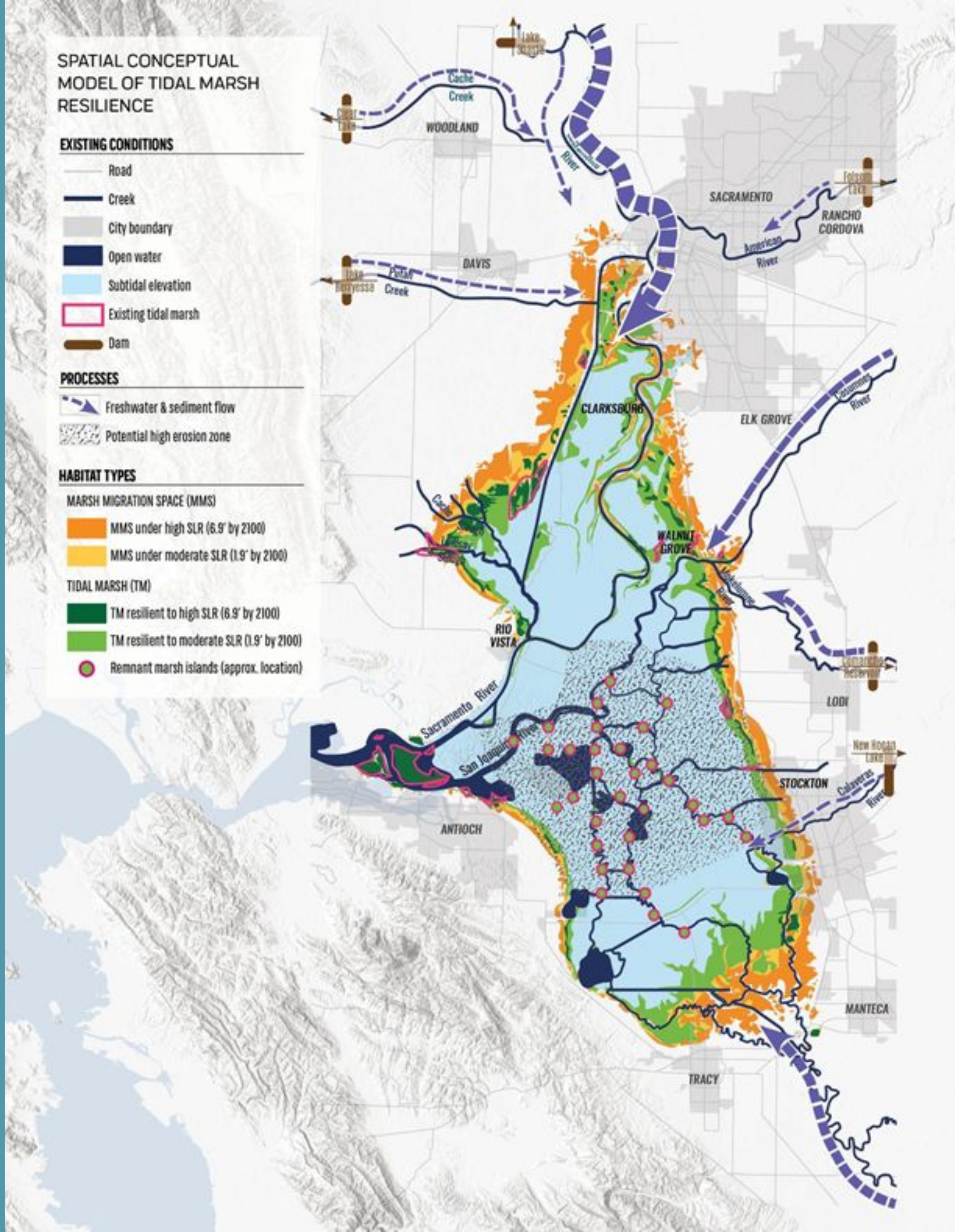
Conclusions

- Many existing, planned, and potential future tidal marshes are resilient to moderate SLR (Delta periphery)
- Few marshes are resilient to high SLR (NW and West Delta)
- Sediment is important for wetland resilience (high N. Delta inputs)
- Most existing marshes are resilient, including Central Delta marshes



Conclusions

- Migration space will be very important for maintaining marshes under high SLR conditions
- Competing land use priorities in migration space areas
- SLR will increase after 2050, so actions taken now are important.



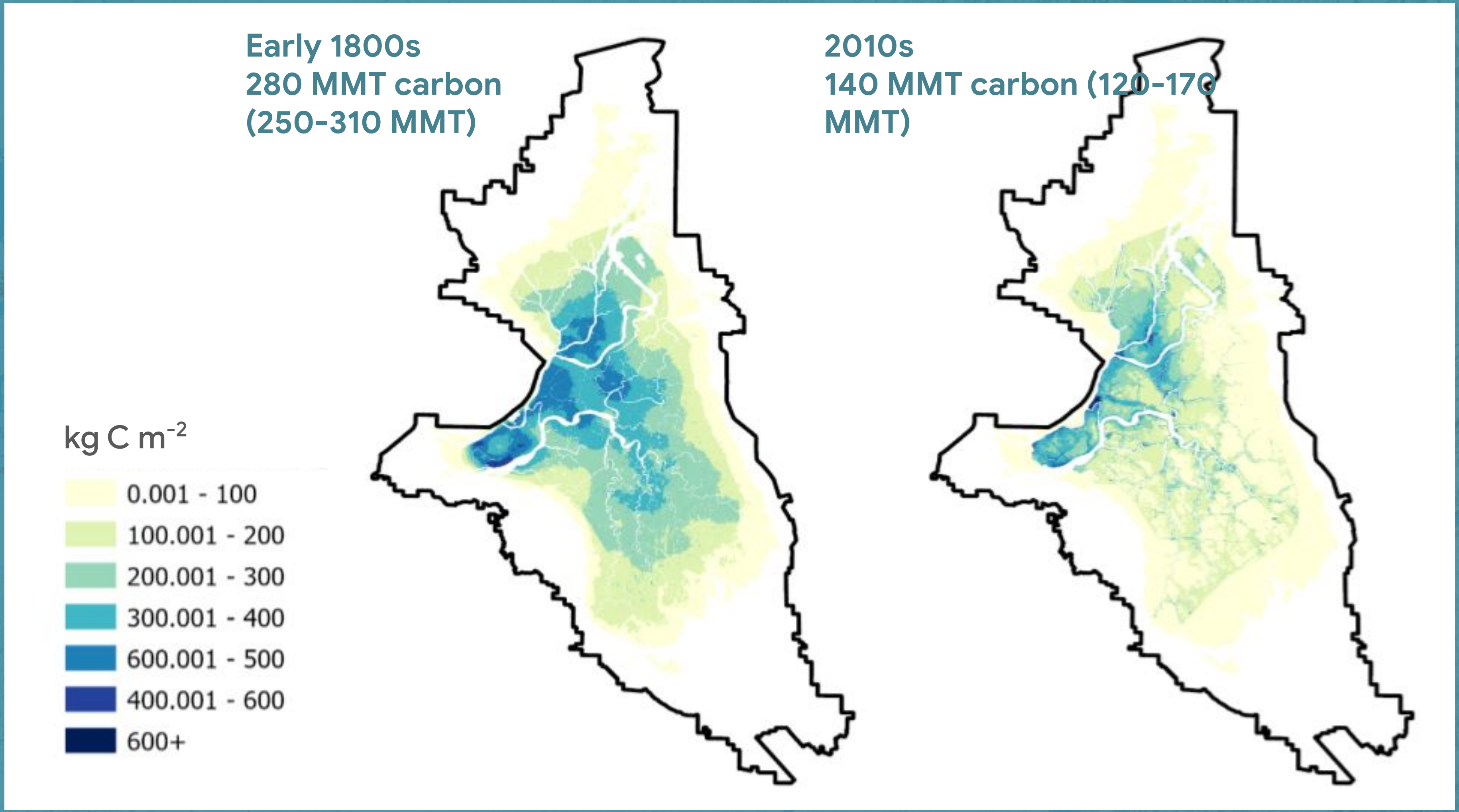
Blue Carbon and Elevation Change

- **Past and present:** how much carbon has been lost from Delta peat due to subsidence?
- **Future:** what magnitude of carbon and greenhouse gas benefit could wetland restoration and rice farming achieve?
    - Ecological upper bound?
    - Existing restoration and rice farming targets?
    - Co-benefits and tradeoffs?

Past and Present

- New peat maps from peat thickness and elevation models
- New synthesis of carbon density from 23 Delta peat cores

⇒ ~140 million metric tons (MMT) of carbon lost from Delta peat since the early 1800s

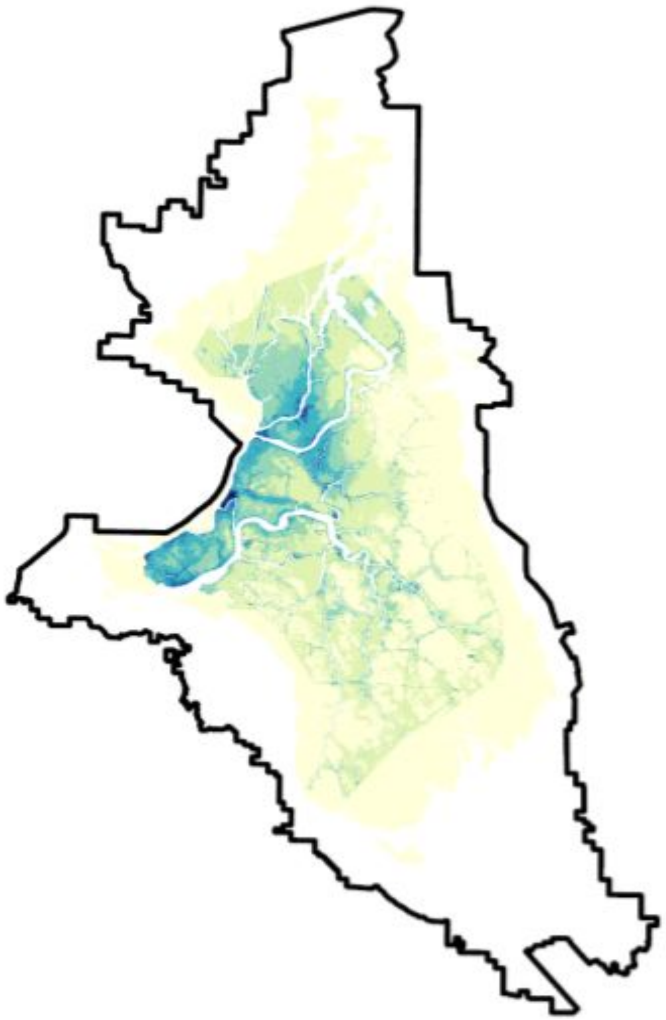


Future

Modeled elevation change, carbon storage, and greenhouse gas emissions

5 future scenarios

- **Reference** – current landscape configuration
- **Maximum potential** – maximize subsidence mitigation and tidal habitat
- **GHG 1** – +76,500 acres of subsidence and GHG mitigation (45% rice)
- **GHG 2** – +38,100 acres of subsidence and GHG mitigation (45% rice)
- **GHG-habitat** – +32,500 acres of tidal habitat and 30,000 acres subsidence mitigation (45% rice, 3,500 acres near intertidal)

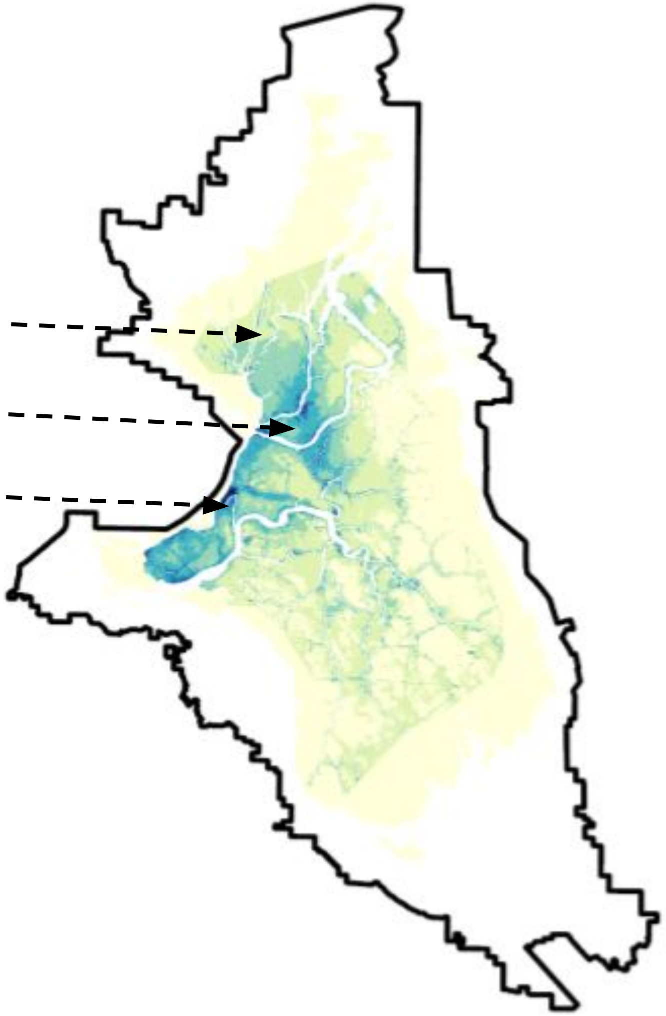


Future

Modeled elevation change, carbon storage, and greenhouse gas emissions

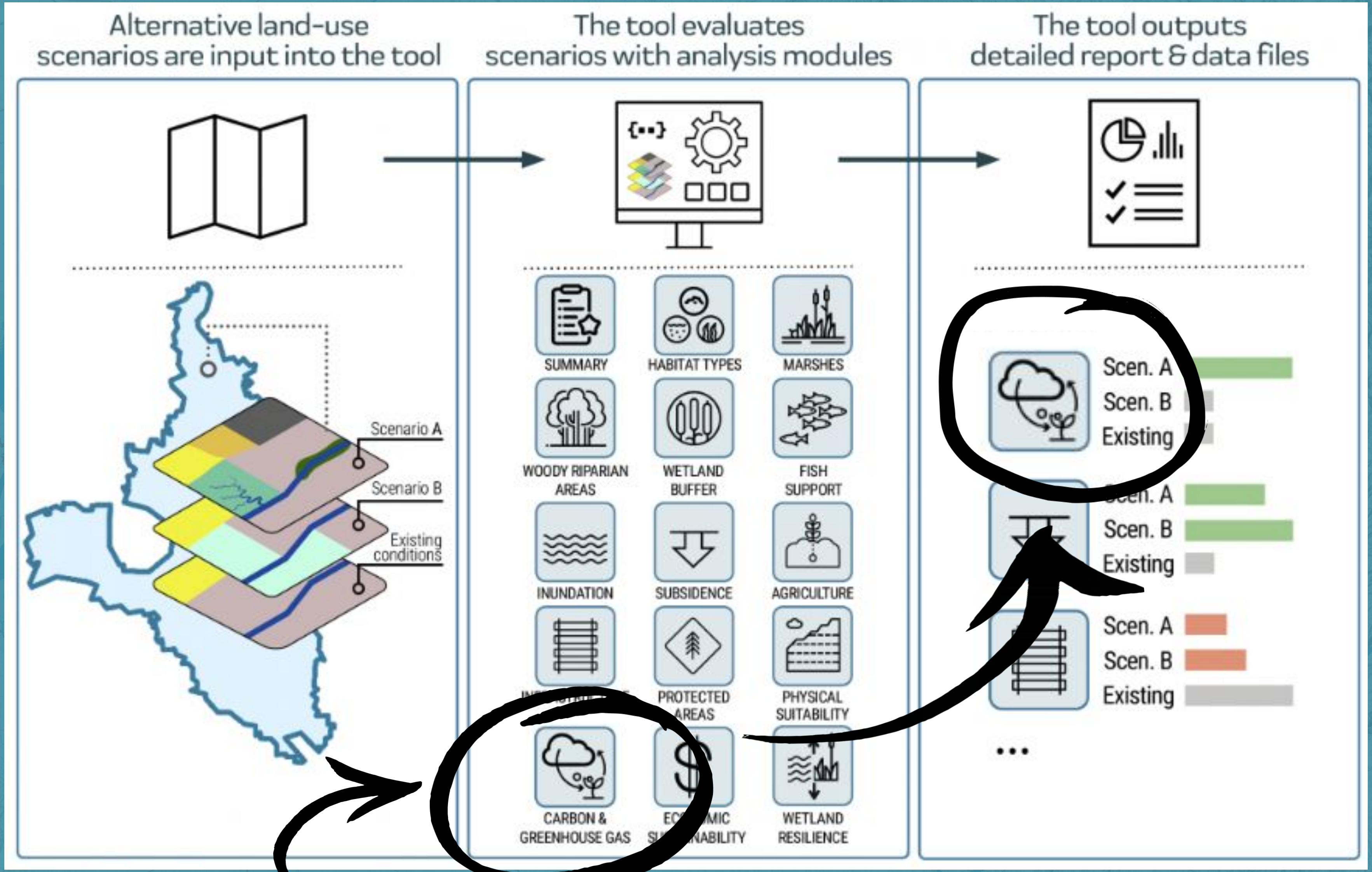
Scenario analysis: +40 years, 1.1’ sea level rise by mid-century

- Elevation, carbon, and CO_2
  - Tidal wetland: CWEM
  - Subsiding areas: SUBCALC
  - Managed wetland: SEDCALC
- Methane, nitrous oxide, and CO_2 in other land use types: emission factors



Modeling platform: Landscape Scenario Planning Tool

https://www.sfei.org/projects/landscape-scenario-planning-tool



- elevation
- carbon
- GHG emissions
- potential carbon revenue

...

- other module results

SUBCALC, CWEM, SEDCALC, other values and models

funded by
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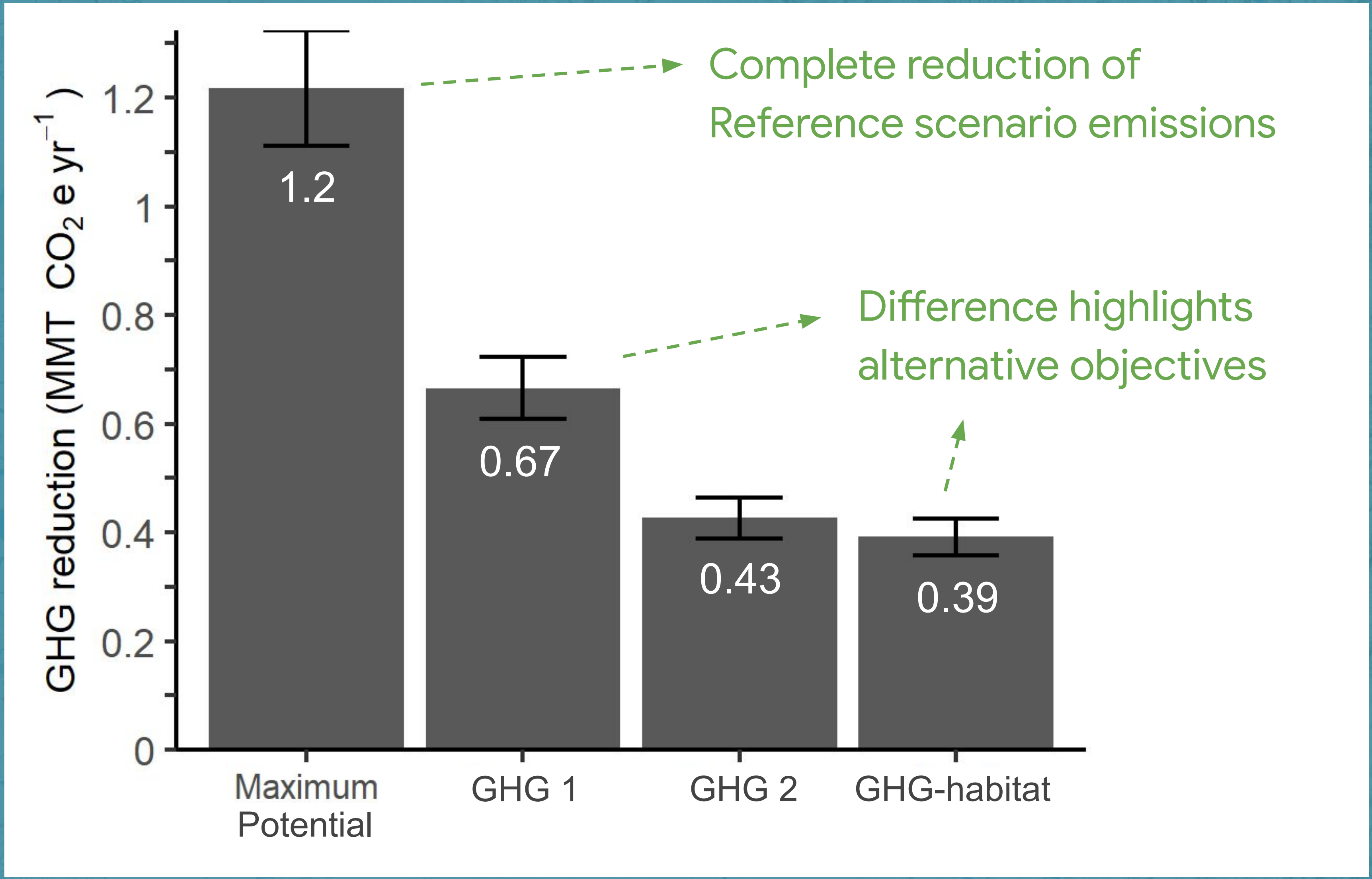
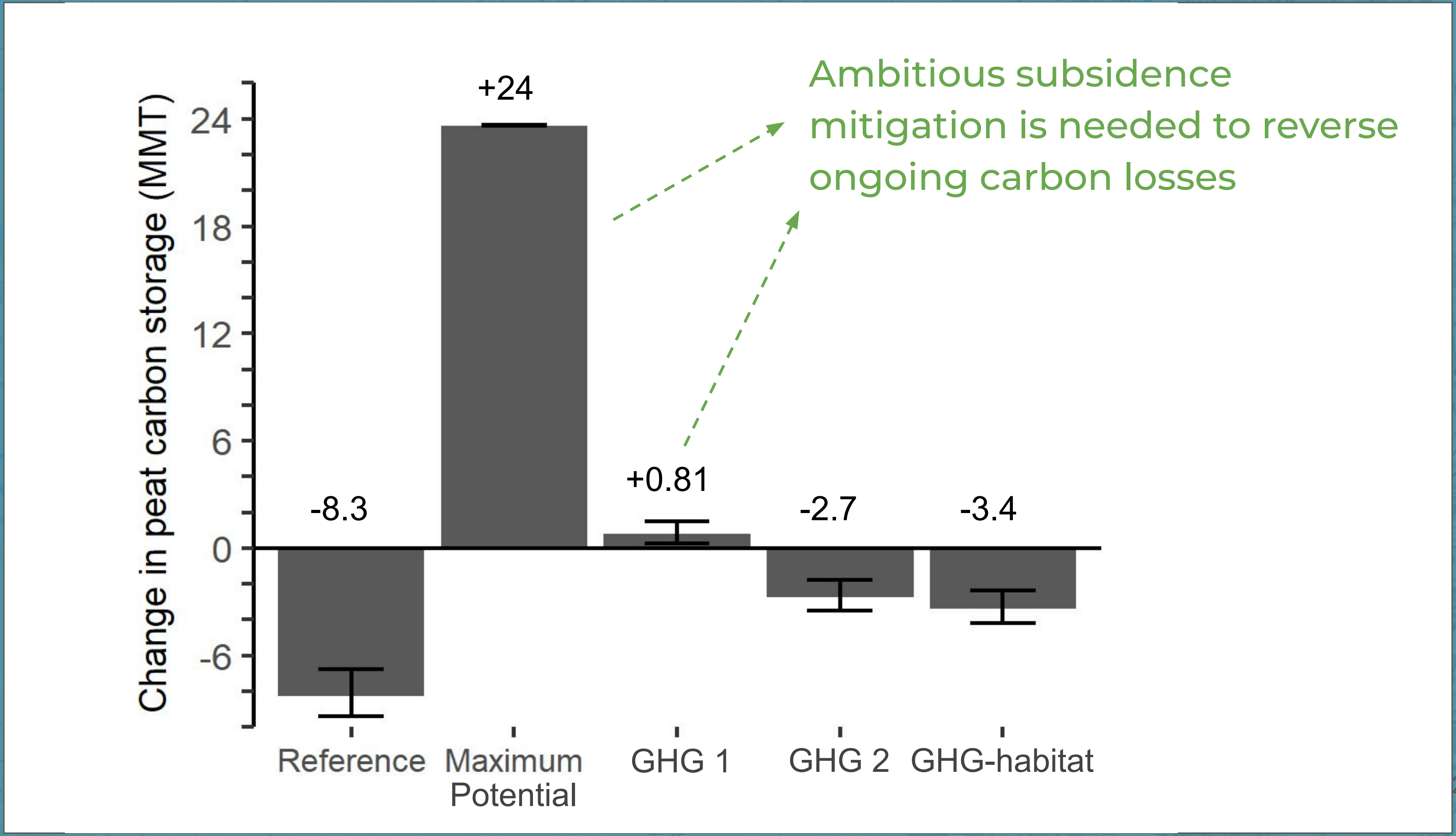
Results: large potential reductions in greenhouse gas emissions



Results: potential to reduce or reverse carbon losses



Results: multiple benefits for ecosystems and people

Metric	Reference	Maximum potential	GHG 2	GHG 1	GHG-habitat
Area of deeply subsided land (>3m below MTL)	72,882 ha	52,246 ha	71,647 ha	69,474 ha	72,110 ha
Area of marsh patches greater than 100 ha	4,806 ha	158,181 ha	10,276 ha	16,674 ha	17,836 ha
Average distance to nearest marsh patch greater than 100 ha	14 km	1.4 km	6.0 km	3.9 km	3.0 km
Area of hydrologically connected wetland and riparian habitat within 2 km of open water	8,925 ha	54,923 ha	8,925 ha	8,925 ha	9,342 ha
Loss of agriculture	–	114,814 ha	8,001 ha	15,719 ha	18,244 ha

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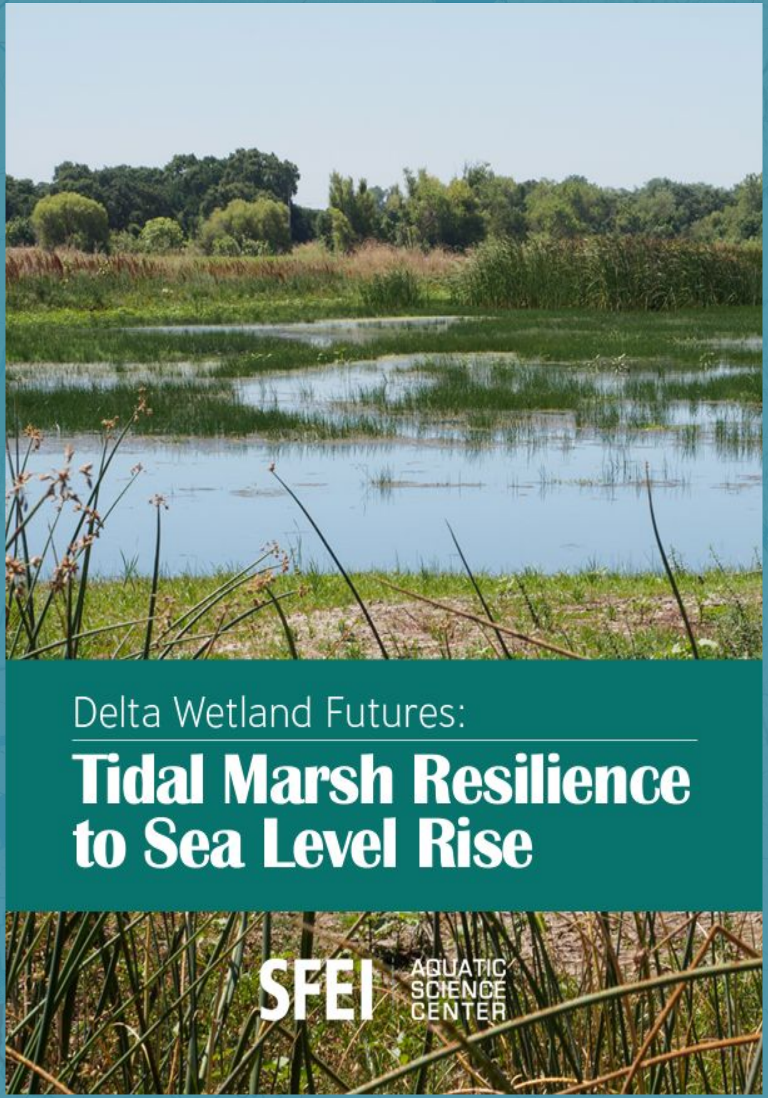

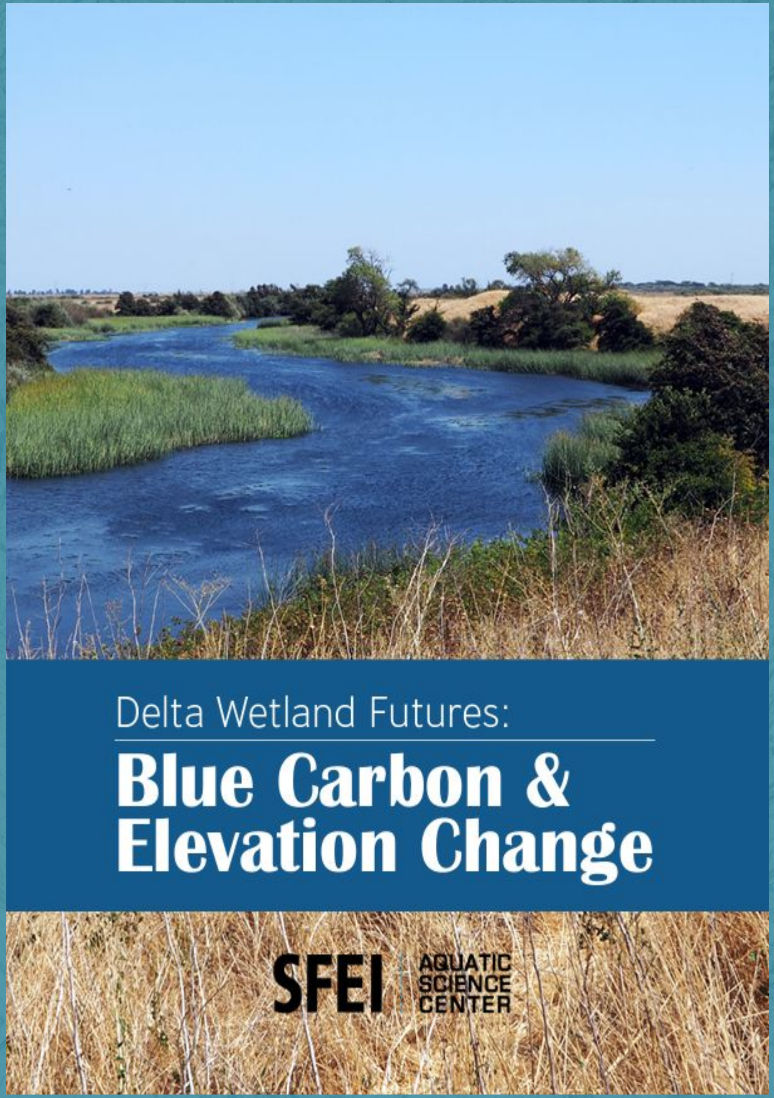

https://www.sfei.org/projects/delta-wetlands-and-resilience-blue-carbon-and-marsh-accretion

Conclusions

- *Many existing, planned, and potential future tidal marshes are resilient to moderate SLR.*
- *Few existing tidal marshes are resilient to high SLR; Migration space will be highly important for maintaining tidal marshes under high SLR conditions.*
- *Large-scale wetland creation/restoration has the potential to mitigate subsidence, reduce or reverse peat carbon losses, and reduce GHG emissions.*
- *The scale of opportunity for GHG mitigation is LARGE (1.2 MMT CO_2e/yr), setting the context for ambitious land-use planning.*
- *Competing priorities in restoration planning call for a balanced portfolio:*
  - *maintain current tidal marsh and restore in areas resilient to moderate SLR*
  - *mitigate subsidence and GHG emissions through rice and managed wetland*
  - *plan for future tidal restoration in migration space zone.*

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Thanks!

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