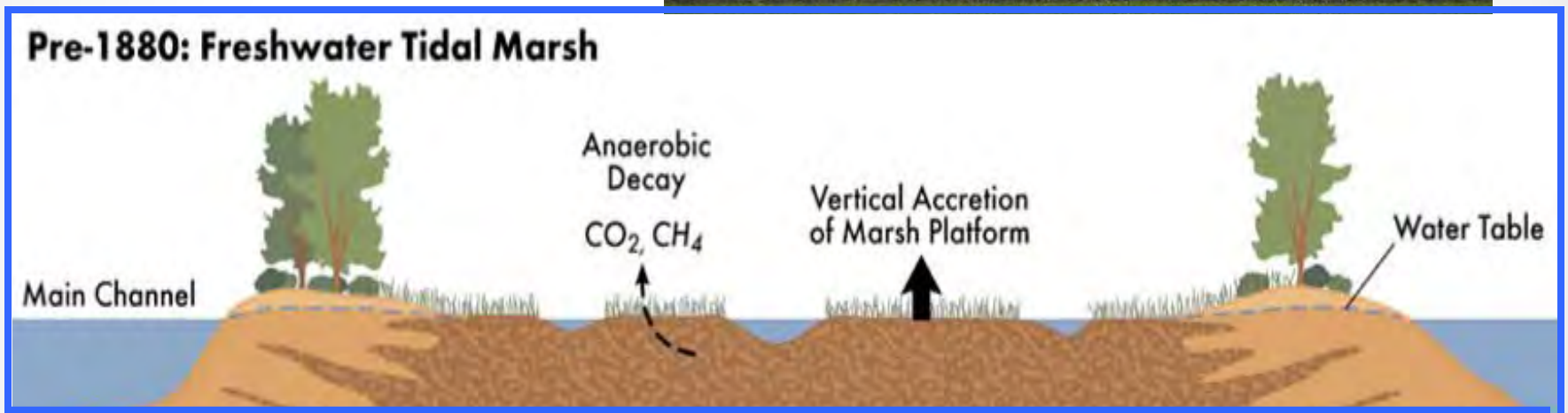
WETLANDS GHG STATE OF THE SCIENCE

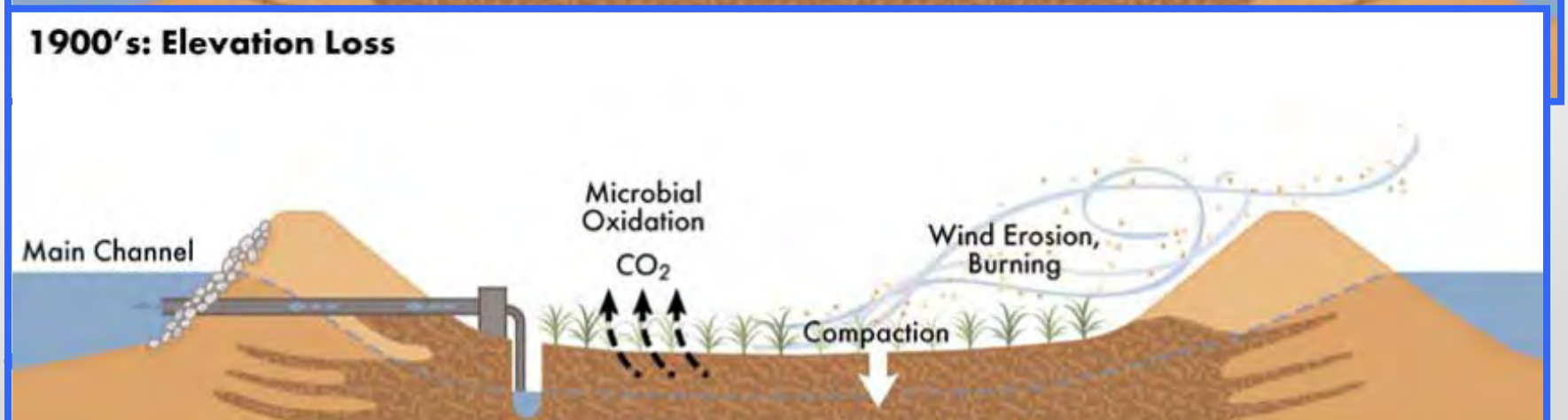
Sacramento-San Joaquin Delta

Water Commission Presentation

May 15, 2013

Subsidence & Carbon Loss





Consequences

Measurements & Modeling

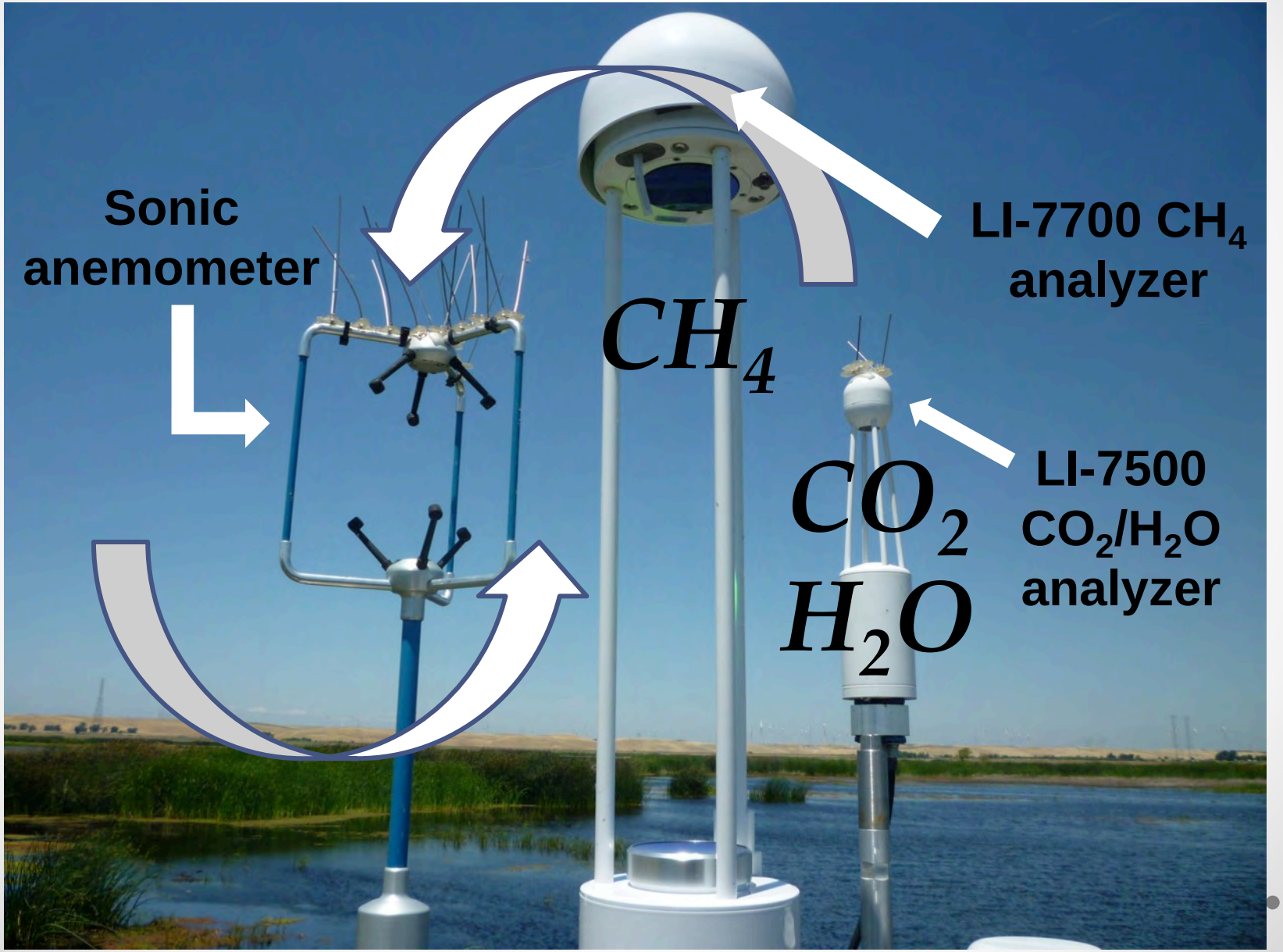
- Measurements began at USGS in 1990 (chambers)[1]
- Eddy covariance, micrometeorological measurements[2]
- Modeled elevation loss and CO_2 emissions[3]

1) Deverel SJ, Rojstaczer S. 1996. Subsidence of agricultural lands in the Sacramento—San Joaquin Delta, California: role of aqueous and gaseous carbon fluxes. Water Resources Research 32(8):2359–23672 Hatala et al., 2012,

2) Jaclyn A. Hatala*, Matteo Detto, Oliver Sonnentag, Steven J. Deverel, Joseph Verfaillie, Dennis D. Baldocchi, 2012, Greenhouse gas (CO2, CH4, H2O) fluxes from drained and flooded agricultural peatlands in the Sacramento-San Joaquin Delta, Agriculture, Ecosystems and Environment , 150,1-18.

3) Deverel, Steven J. & Leighton, David A. 2010. Historic, Recent, and Future Subsidence, Sacramento-San Joaquin Delta, California, USA. San Francisco Estuary and Watershed Science, 8(2), 1-23

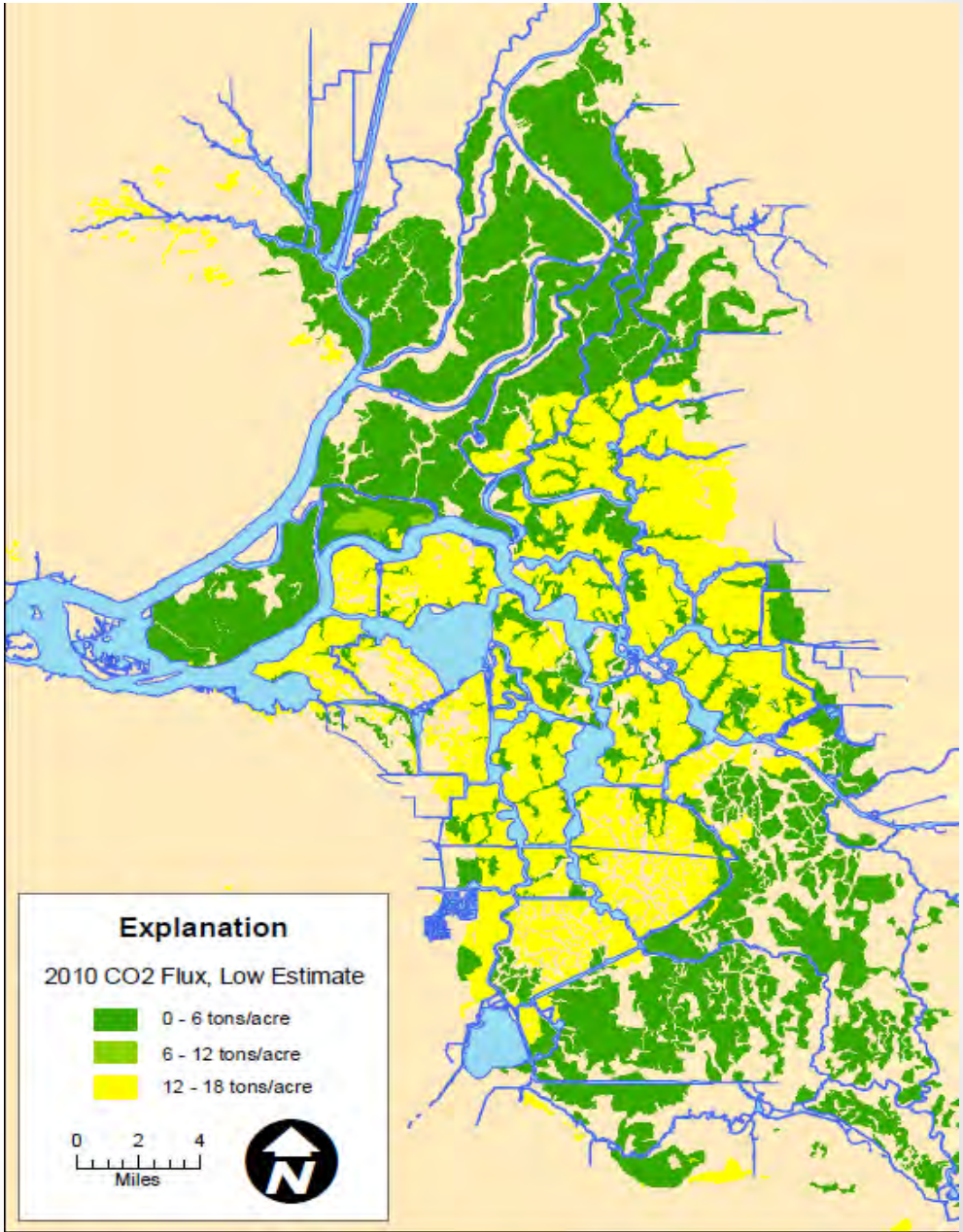
Eddy covariance technique



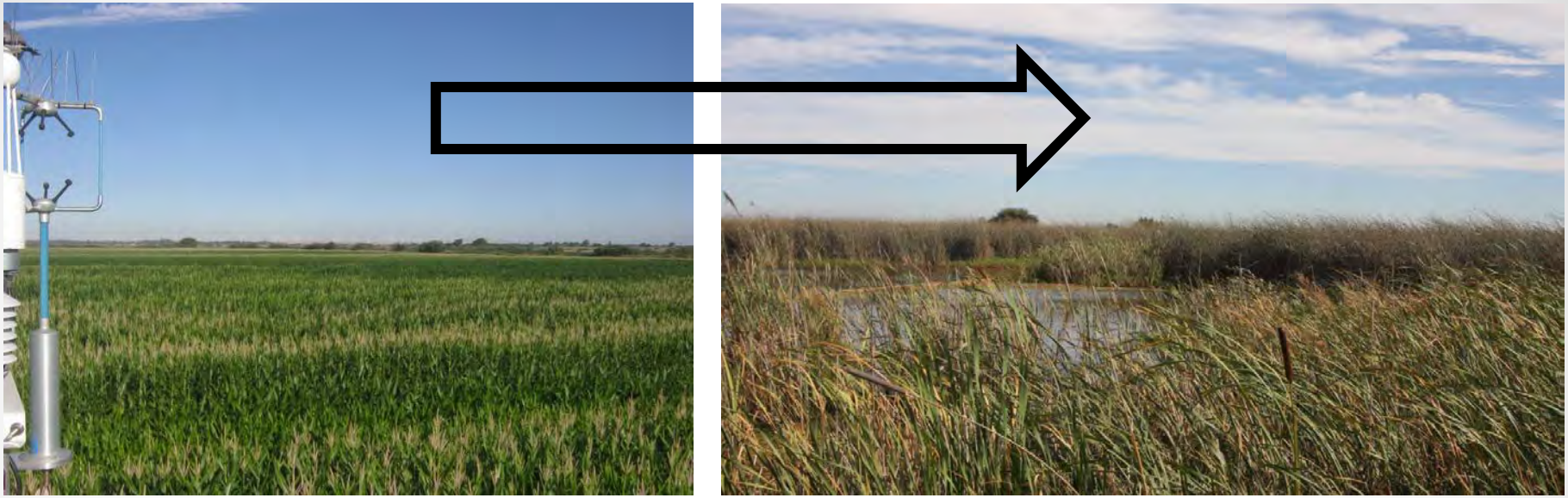
Estimated CO_2 emissions

- Delta = ~ 1.5 to 2 MMT CO_2e/year

- Est. statewide ag N_2O emission = ~5 MMT CO_2 e/year

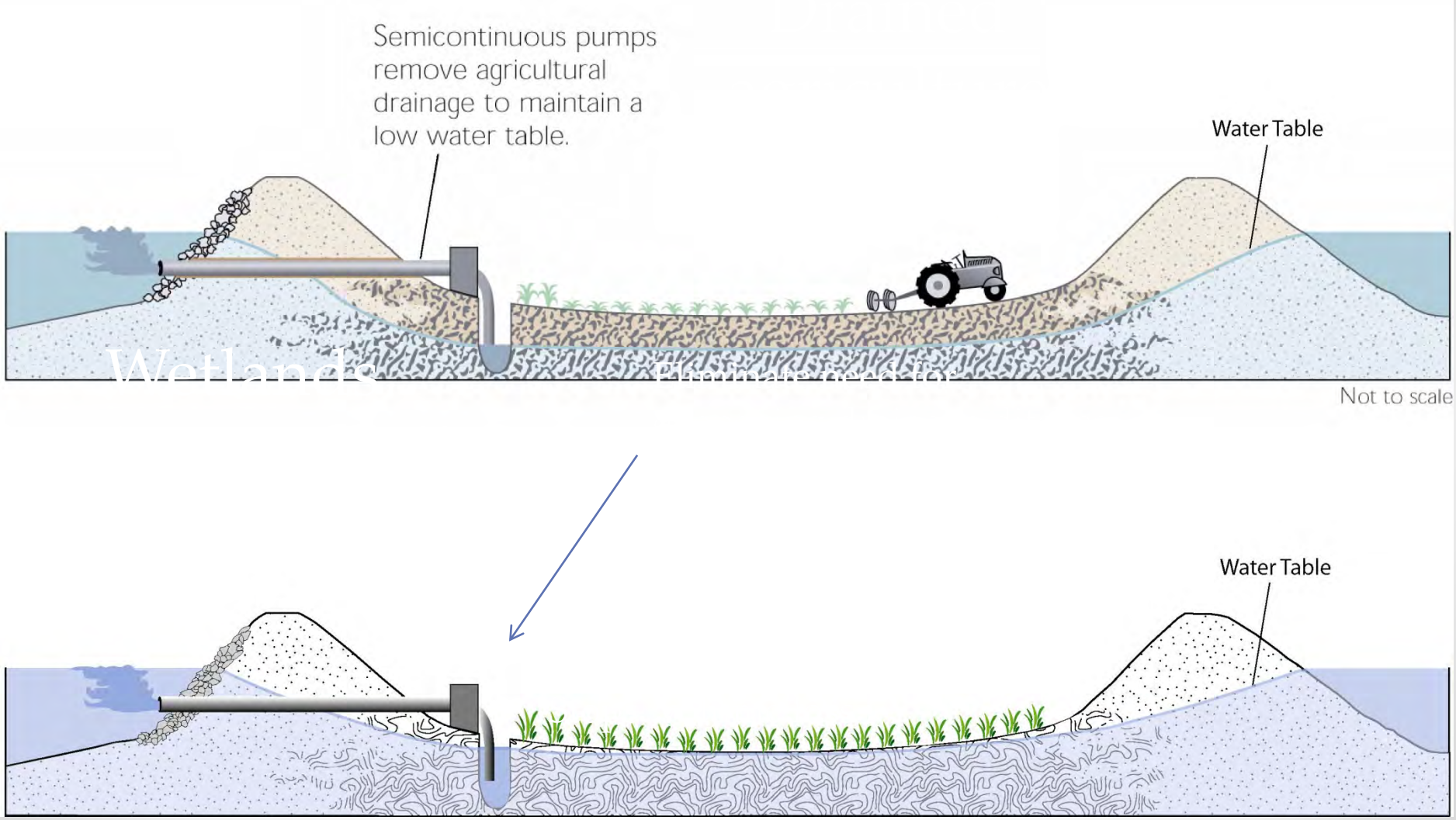


Future?

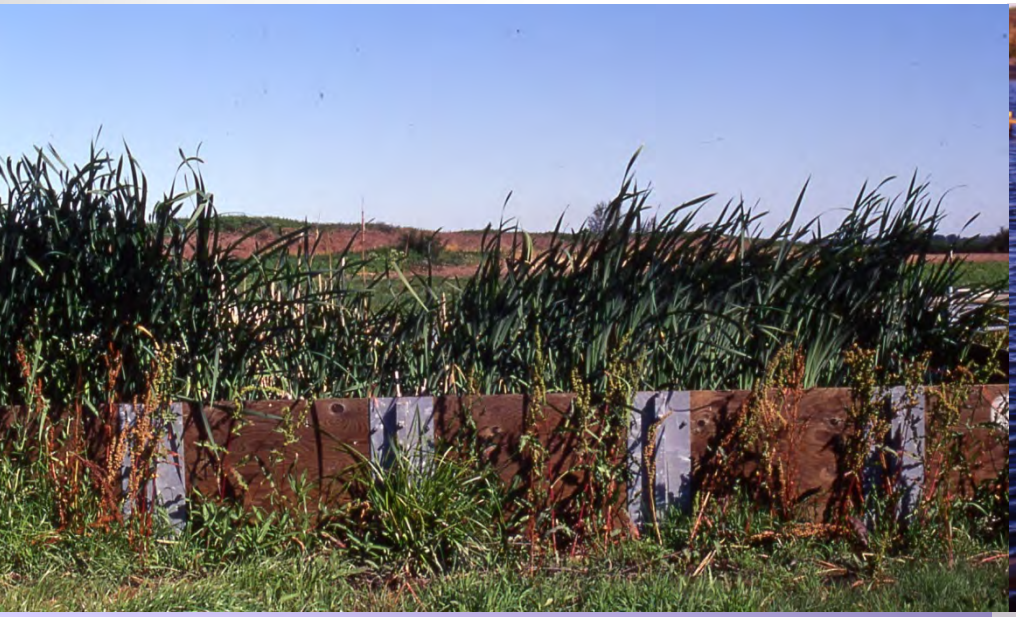


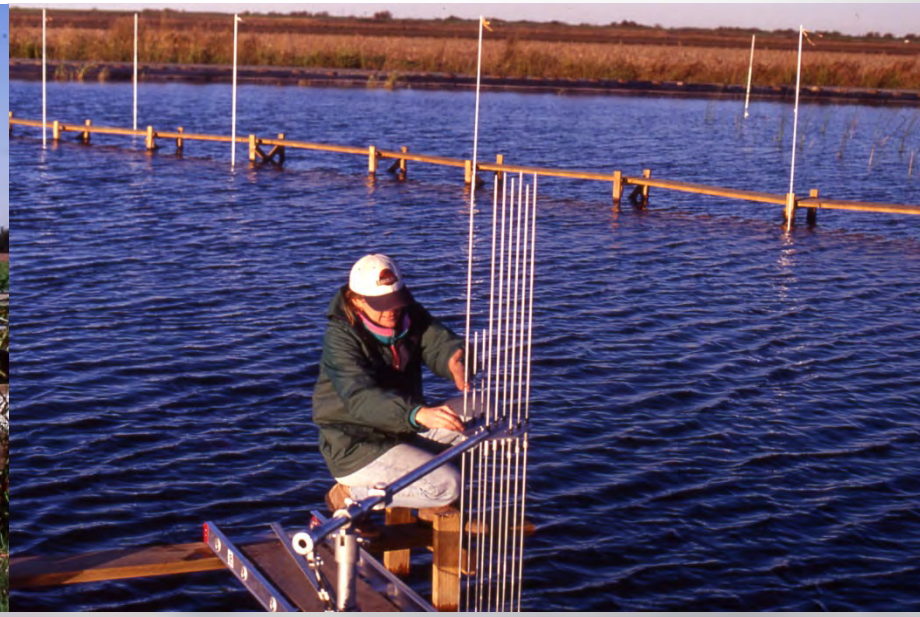
Flooding to create wetlands, reduce further carbon loss and sequester carbon

Wetland benefits



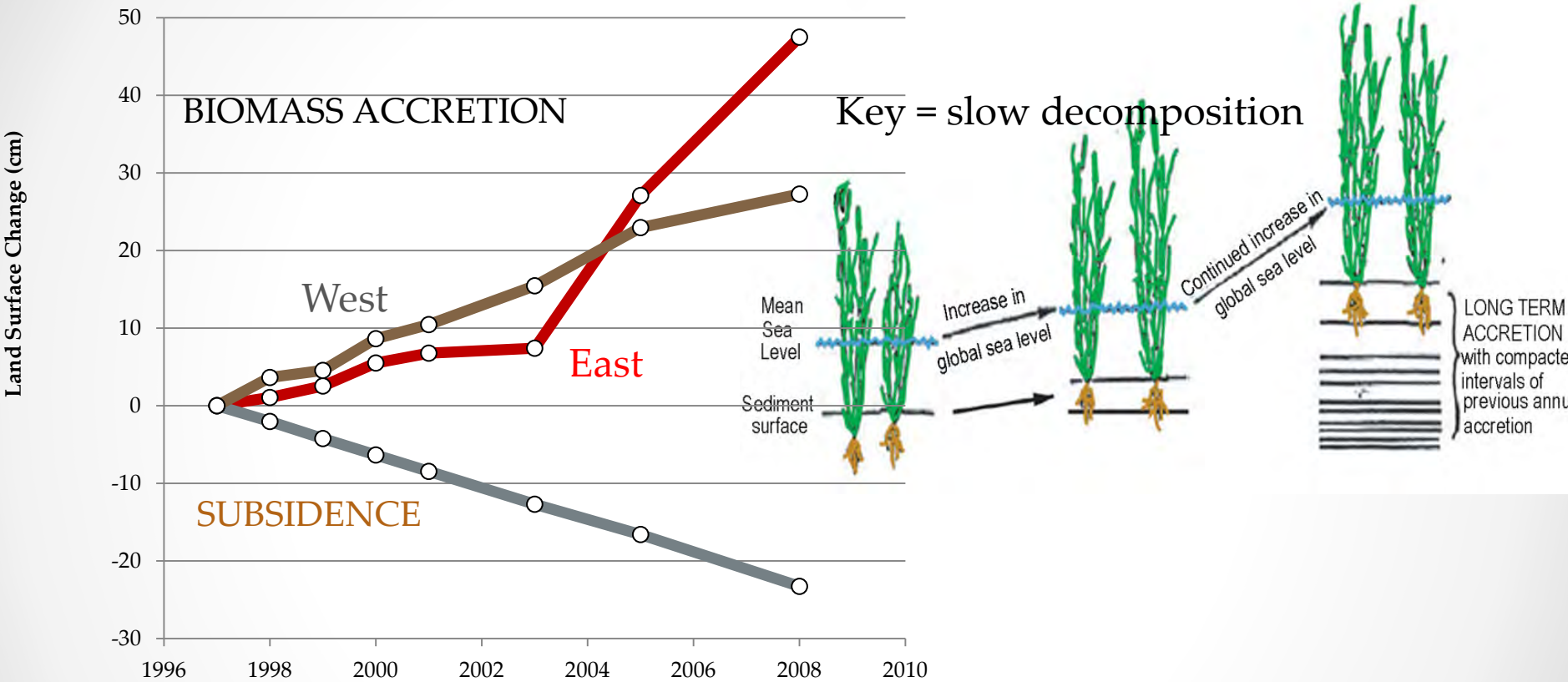
Carbon capture wetlands - Twitchell Island





Accreted biomass

Wetland accretion



Miller, R.L., Fram, M.S., Wheeler, G., Fujii, R., 2008. Subsidence reversal in a re-established wetland in the Sacramento-San Joaquin Delta, California, USA. *San Francisco Estuary and Watershed Science*, 6(3): 1-24.

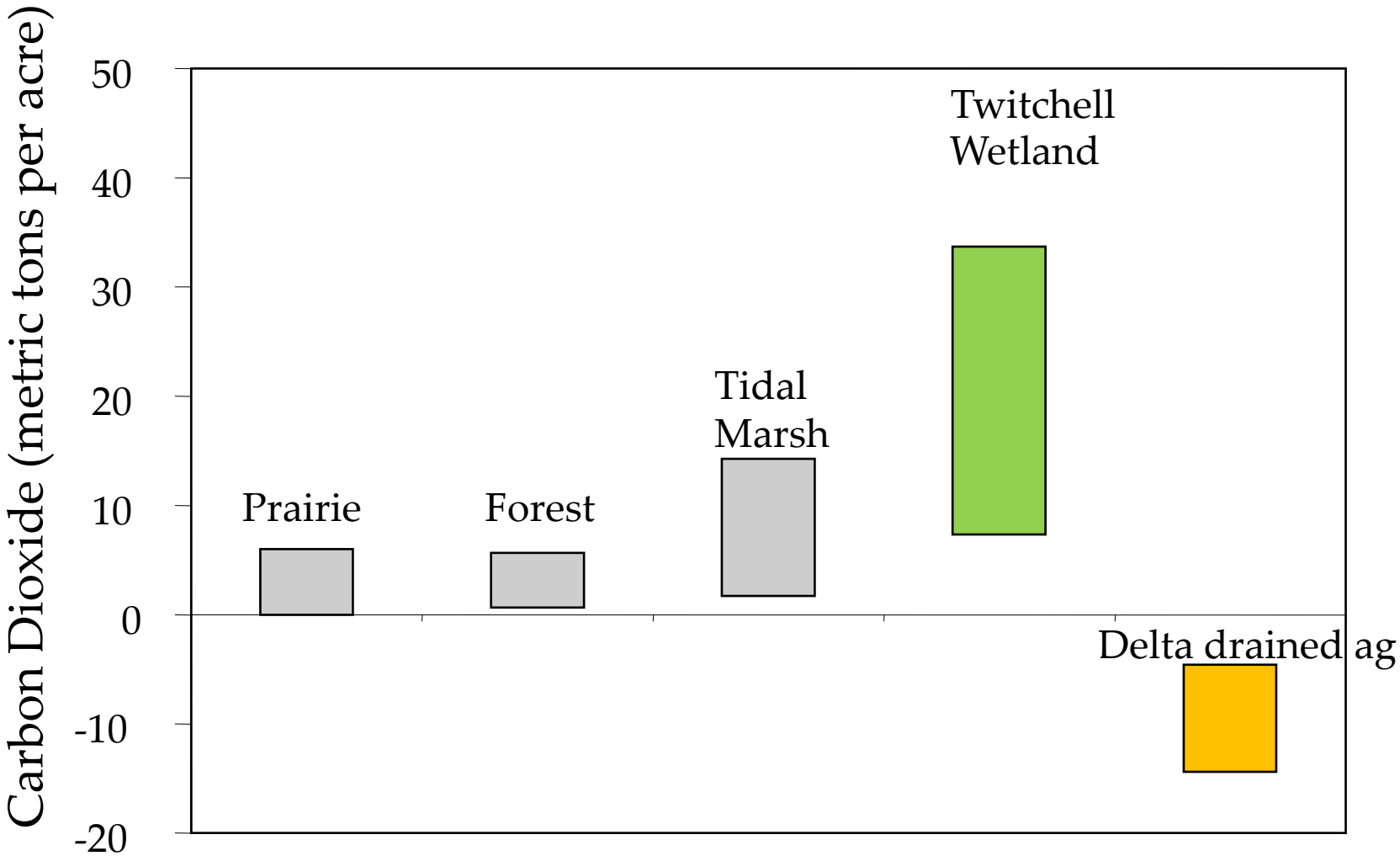
Estimated Net GHG Benefit

	MT CO_2 equivalent per acre-year
Average carbon sequestration from cores	16
Methane emission[4]	-10 (0.5 ton CH4/A-yr x 21)
Current CO_2 loss due to soil oxidation	9
Net benefit (16 – 10 + 9)	15

Range: 9 to 35 MT CO_2 per acre-year

4) Miller, Robin L., 2011 Carbon Gas Fluxes in Re-Established Wetlands on Organic Soils Differ Relative to Plant Community and Hydrology, Wetlands DOI 10.1007/s13157-011-0215-2

Productivity comparison



Benefit

14 MT CO2 per acre per year, varying initial price, 5% increase per year

Initial price ($/ton)	Break even at	Net revenue ($/acre)
$12	38 years	$56
$15	25 years	$183
$20	16 years	$ 108
$25	10 years	$ 209

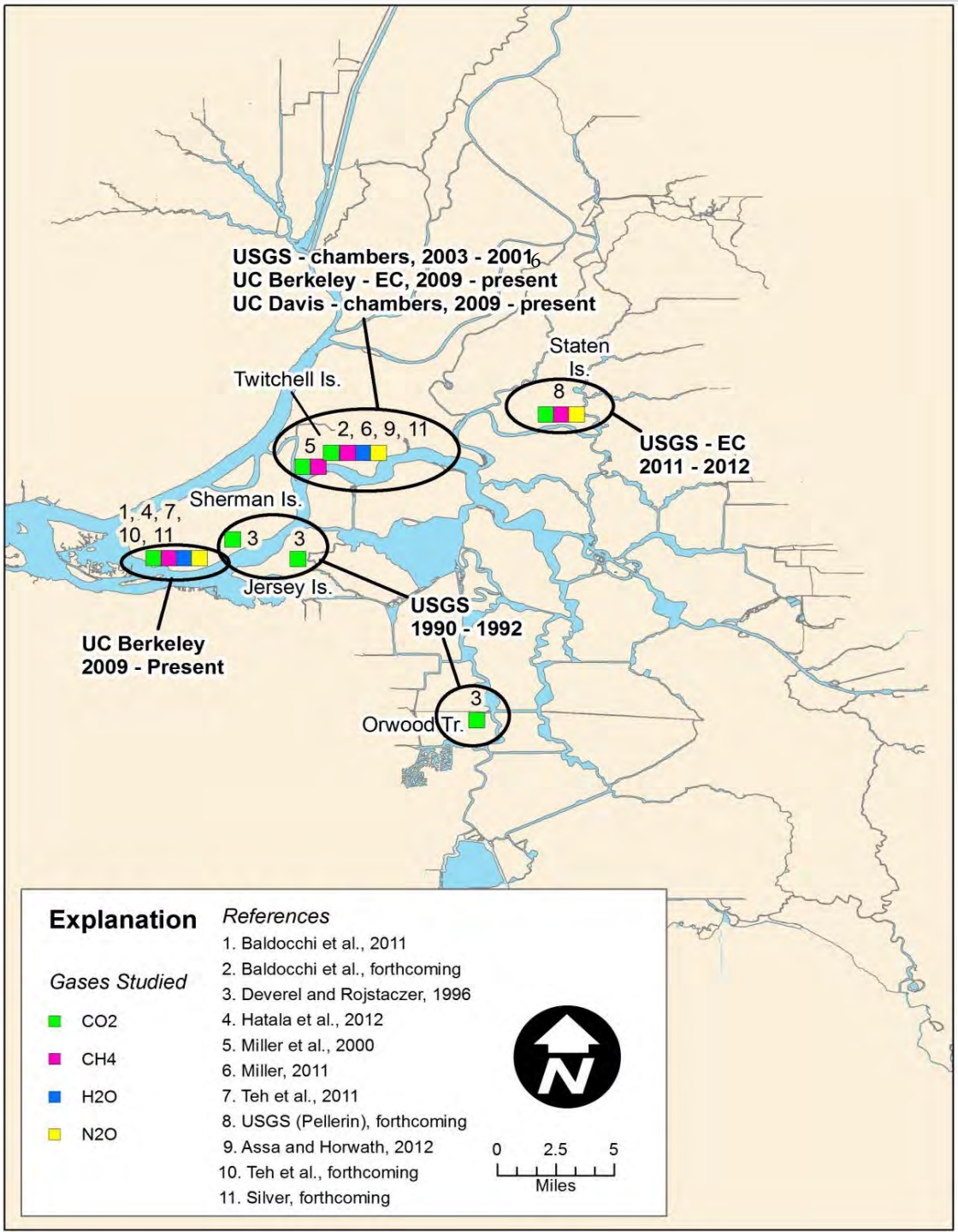
Recent net revenue for Delta corn ~ $190/acre

Bates and Lund , *Delta Subsidence Reversal, Levee Failure, and Aquatic Habitat – A Cautionary Tale* (SFEWS, March 2013)

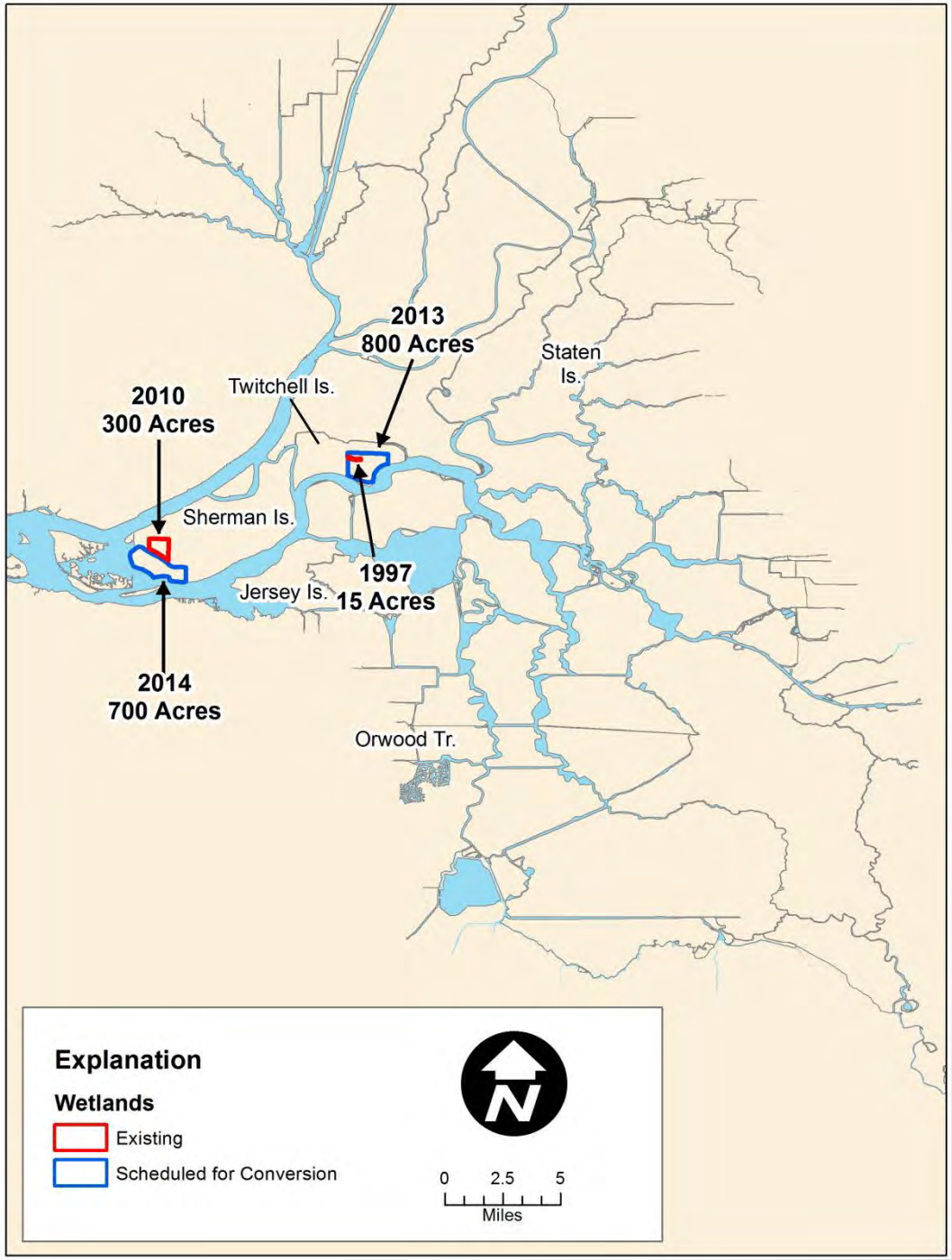
"…even limited elevation gains for ecological or other benefit can be useful."
"….subsidence reversal seems likely to be a useful part of a successful Delta solution."

Previous, Ongoing and Planned:

Baseline and wetland emissions measurements



Wetlands for Subsidence Reversal, Habitat & Carbon Sequestration



Protocol Monitoring

- Baseline
  - Emission measurements (Eddy covariance/ chambers)
  - Calibrated model results

- Project
  - Measurement of elevation change (sedimentation erosion table)
  - Cores for determination of carbon accumulation
  - Model results
  - Emissions measurements

Summary

Current state of the science for the Delta includes:

- Model estimates and measurements for CO_2 emissions for baseline conditions
- Measurements of emissions and carbon sequestration potential for managed wetlands
- Estimated potential for implementation
- Understanding spatial variances

Comparison

	SSJ Delta	Suisun Marsh	California Tidal
Baseline emissions data and estimates	5 islands	none	In progress, 12 sites
Wetlands emissions and C sequestration data	Sherman & Twitchell	none	Calloway and others, 2012
Estimated net sequestration (tons CO2/A-year)	15 (9 -35)	Likely similar to Delta	1-5 (does not include baseline)
Accommodation space below sea level (acre-feet)	1.9 Million	5,800	~50,000
Potential acreage (near term)	~20,000	unknown	~40,000
Additional considerations	Risk to current land use	Potential tidal habitat within 50 yr	Protection of current marsh

Next Steps & Key Questions

Key questions:

- Spatial and temporal variability and variance consideration for methodology development
- N_2O
- Optimal management and monitoring
- Potential for credit stacking

Next Steps:

- Protocol development
  - Voluntary and Regulatory Markets
- Pilot projects on private land

Restoration of Degraded Deltaic Wetlands of the Mississippi Delta Protocol Development for Voluntary Market

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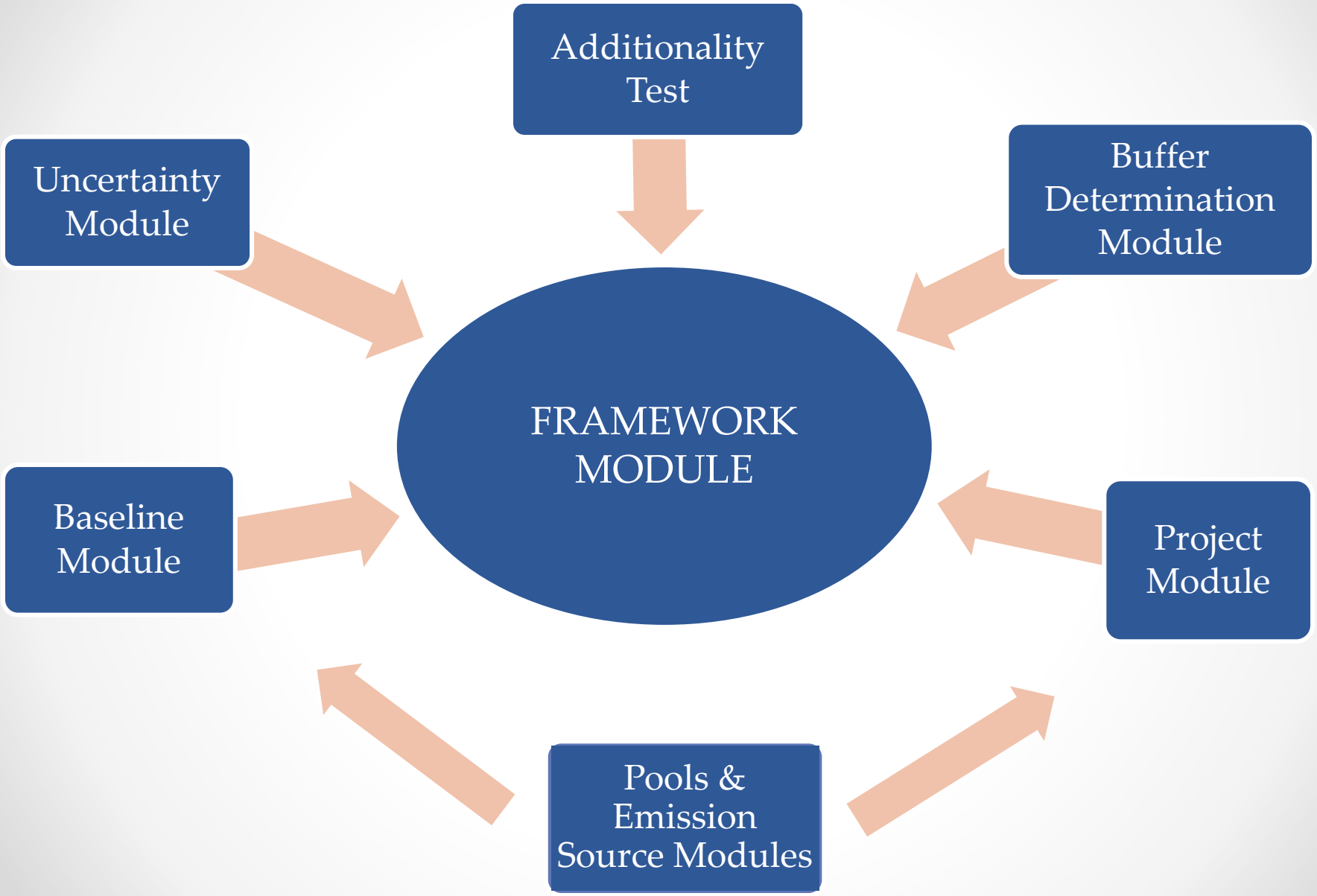
American Carbon Registry

Methodological Procedure

1. Identification of the most plausible project activity baseline
2. Definition of the project boundaries
3. Demonstration of additionality
4. Development of monitoring plan
5. Estimation of baseline carbon stock changes and GHG emissions
6. Estimation of total net GHG emissions reductions (project minus baseline and leakage)
7. Calculation of uncertainty
8. Assessment of reversal risk
9. Calculation of ERTs


Additionality Test
Uncertainty Module
Buffer Determination Module
FRAMEWORK MODULE
Baseline Module
Project Module
Pools & Emission Source Modules

Modules

Determination of when module/tool use is mandatory (M), conditional (C), or optional (O).

Determination	Module/Tool	Wetland Restoration	Wetland Restoration with Hydrologic Management
Always Mandatory	WR-MF	M	M
	T-DEG	M	M
	T-RISK / T-PERM	M	M
	X-UNC	M	M
Baselines	BL-WR	M	N/A
	BL-WR-WL	O	N/A
	BL-WR-HM	N/A	M
	BL-WR-HM – WL	N/A	O
Pools	CP-TB	C	C
	CP-S	O	O
Emissions	E-E	N/A	C
	E-FFC	C	C
Project Scenario	PS-WR	M	N/A
	PS-WR-HM	N/A	M

Structure of Each Module

Each module has three key sections:

1. Scope, applicability and output parameters
   - Gives users immediate upfront information on purpose and outputs of module
2. Procedure
   - Methodological steps and calculations
3. Parameters
   - Gives parameters used in the methodology and where they are derived from

Baseline Scenarios

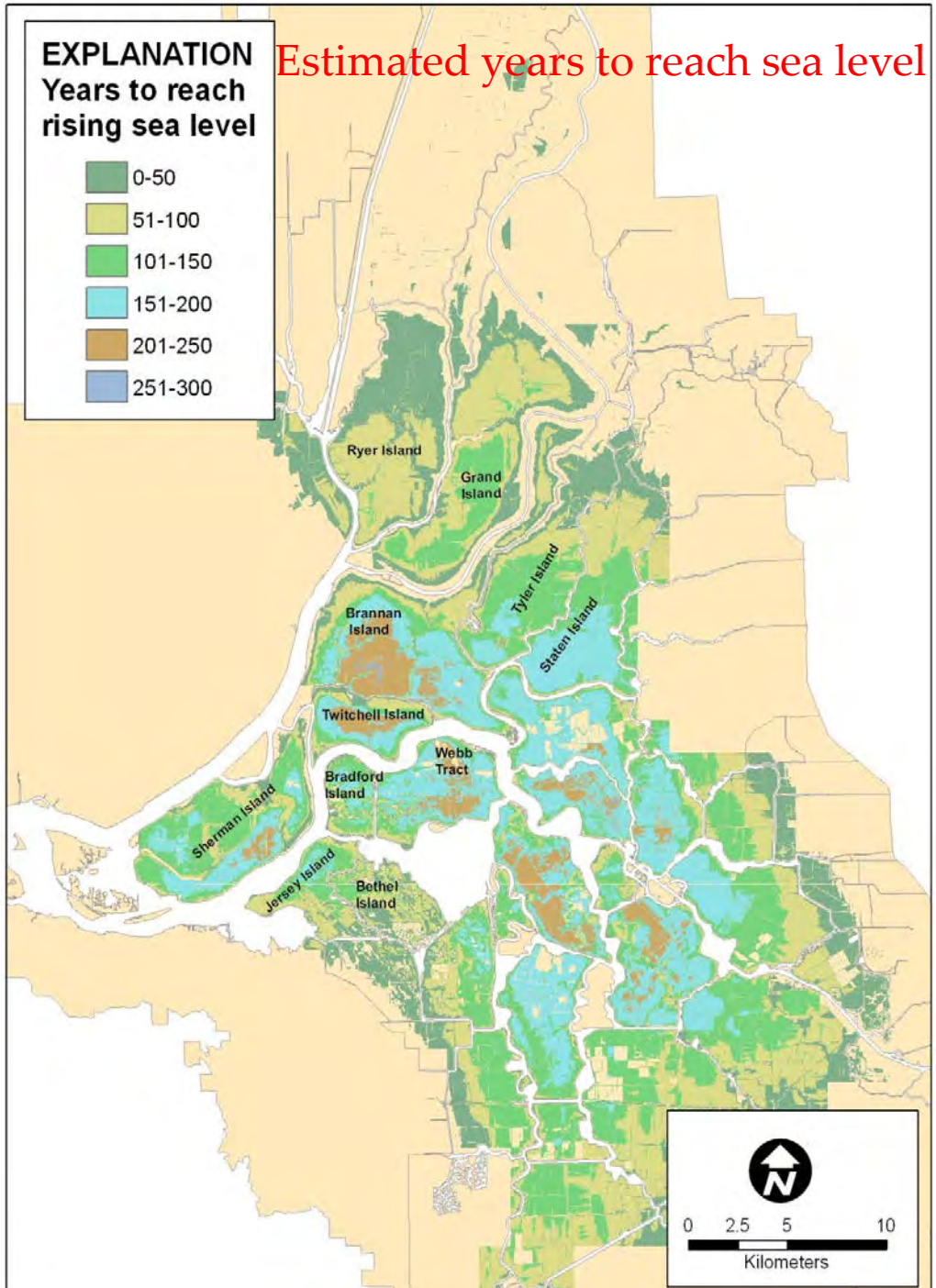
- **Conservative baseline scenario:**
  - Uses the degraded carbon sequestration rate determined prior to Start Date or that would have occurred in the absence of the project activity
  - Constant wetland project area in baseline
- **Projected wetland loss scenario:**
  - Uses the degraded carbon sequestration rate determined just prior to Start Date or that would have occurred in the absence of the project activity, and also incorporates a projected reduction of total wetland project area due to wetland loss that would occur over a 40-year Crediting Period if no activity were to take place.

Key Equation

Net emission reduction = Project - Baseline

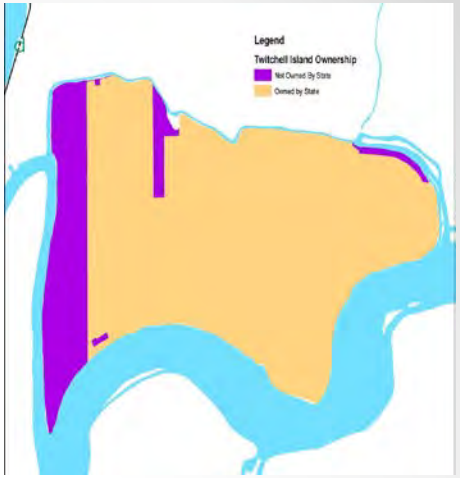
Carbon Credit = ERT = $(\Delta C_{ACTUAL} - \Delta C_{BSL})*(1\text{-}LK)*(1 - UNC)*(1\text{-}BUF)$

Subsided islands = "accommodation space" for carbon sequestration



Land Owner Representation (Sherman and Twitchell

Twitchell Island



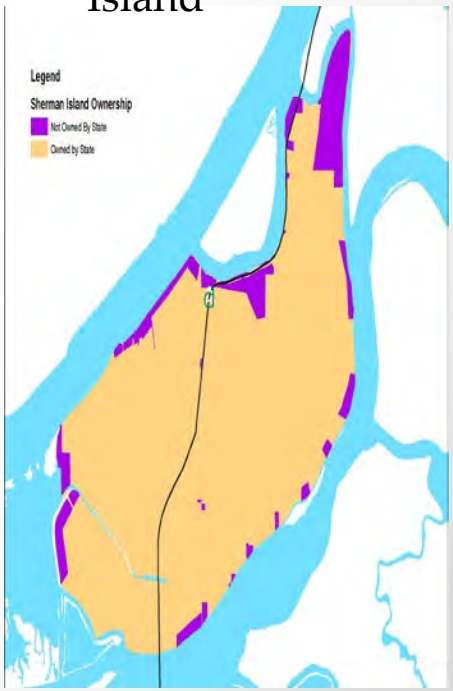
Program Description

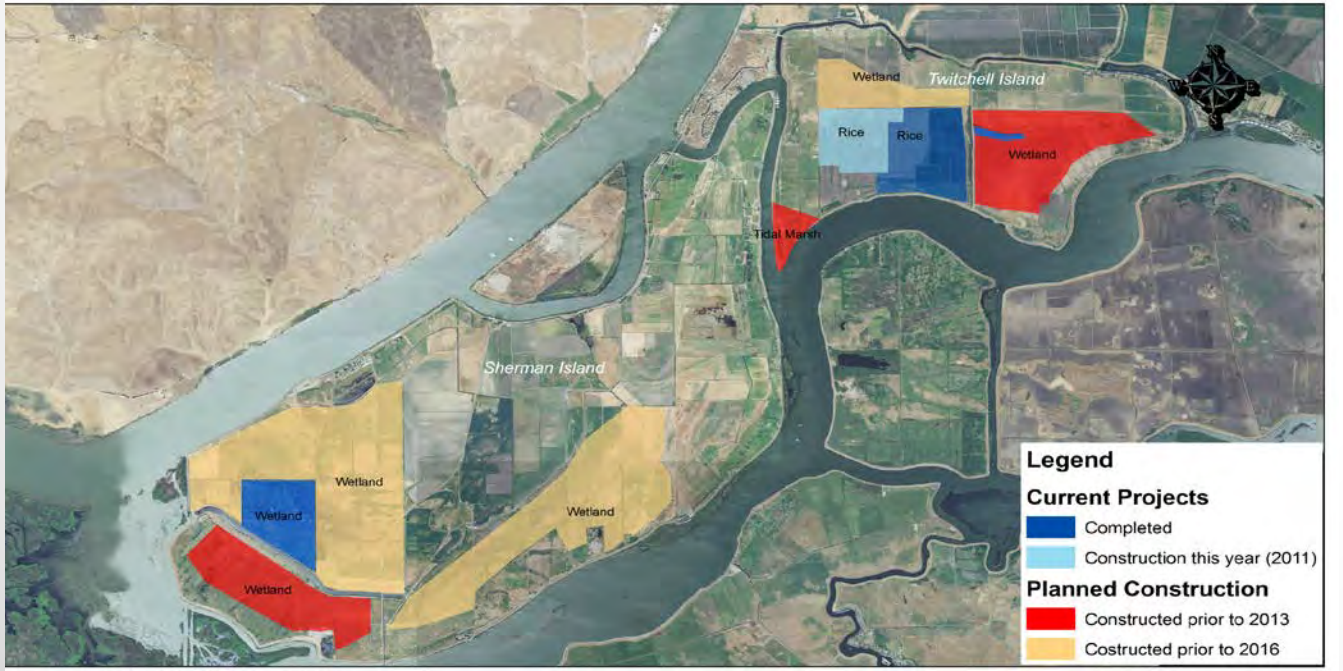
Work with local Reclamation Districts and contractors that perform work on Delta Lands owned by the State

Projects

Twitchell Island – Ownership ~97% of 3500 acres
Sherman Island – Ownership ~90% of 10,000 acres

Sherman Island





SELECTED WEST DELTA SUBSIDENCE REVERSAL CARBON SEQUESTRATION PROJECTS

MAP PREPARED SEPTEMBER 16, 2011

0 12500 25000 Fee

Rice Farming on Twitchell

Subsidence Reversal- rice as a way of gaining elevation and land mass

Carbon Storage- rice as a way of sequestering carbon

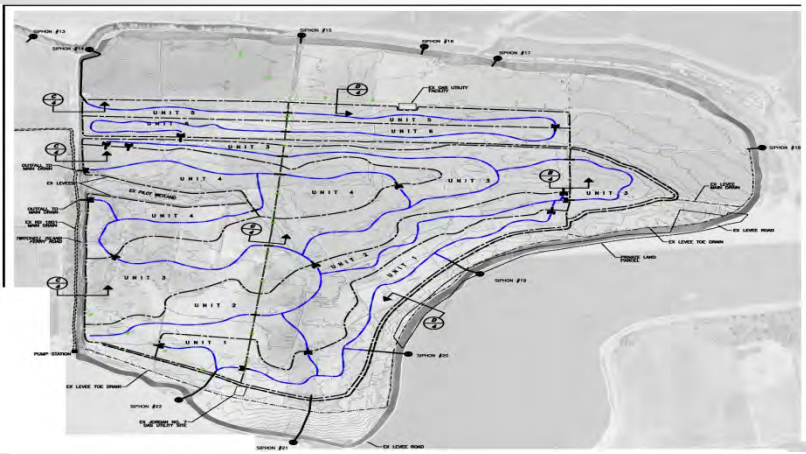
Economics- crop income and carbon market trading

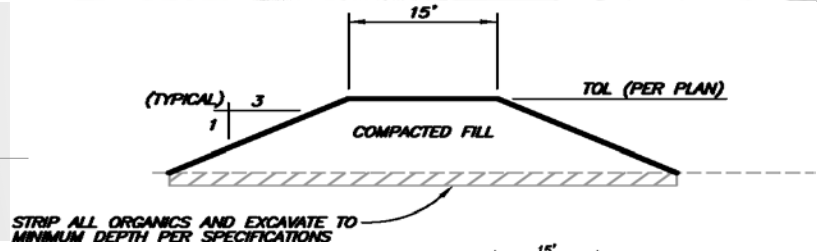
Mayberry Farms Subsidence Mitigation

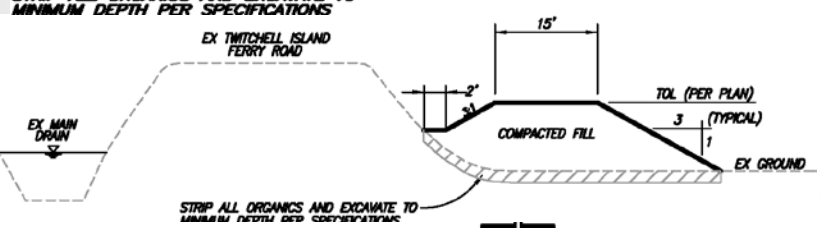
Twitchell East End Restoration Project

± 750 acres of Wetland

± 50 acres of Riparian Forrest







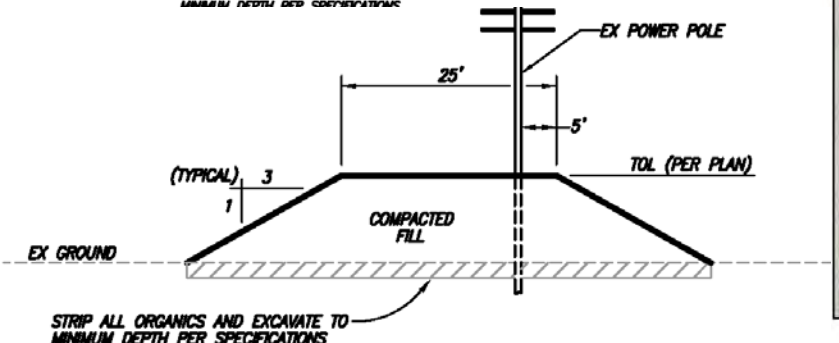
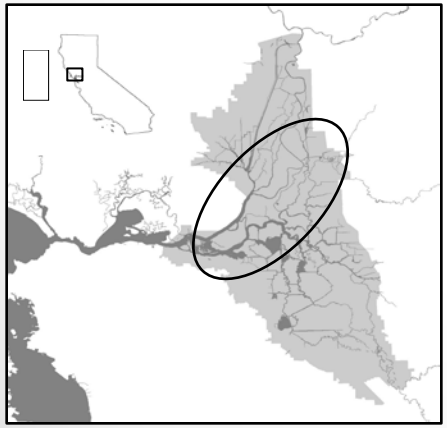


Figure 3. Twitchell Island East End Restoration Project: Concept Restoration Plan

Avian community response to restoration in the Delta

- Quantitative bird and vegetation surveys (n = 117) were conducted at 18 of DWR's project sites in 2011 & 2012.
- Sites consisted of restored riparian or wetland, pasture, cropland, and ruderal weedy habitats.
- Species richness, diversity, and, abundance were assessed using both fine scale vegetation information and land cover types



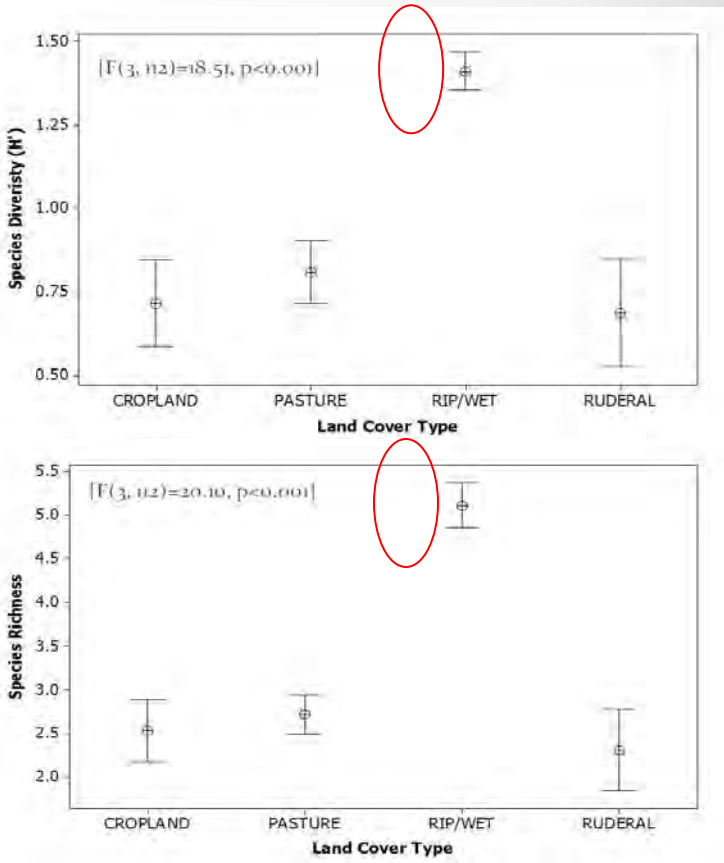
Survey area within the Sacramento-San Joaquin Delta.

Avian community response to restoration in the Delta

- 95 species were detected during bird surveys, including State Threatened Swainson's hawk, Willow Flycatcher, Yellow-breasted Chat, and Northern Harrier, and 6 non-native species.

- **At sites where cropland, pasture, or ruderal land cover had been restored to riparian and wetland, species richness, diversity and abundance (for many species) were significantly higher.**

- Within restoration sites, regression models indicate that vegetation structure and type varied in their importance and direction of effect on community measures and species abundance.



Summary of the predictor variables included in the most supported regression models ($AIC_c < 2.0$) and their direction of effect on Song Sparrow, Marsh Wren and Common Yellowthroat abundance, and Species Richness and Diversity (Shannon).

	Tree Species Richness	Shrub Cover	Non Native Shrub Cover	Emergent Cover	Willow Spp Cover	Cottonwood Cover
Song Sparrow	-	+	+	+	+	+
Marsh Wren	-	-	-	+	-	-
Common Yellowthroat		+			+	-
Species Richness	+	+	+	-	+	
Species Diversity (H')	+	+	+	+	+	

Questions?