Delta Wetland Futures:

Blue Carbon & Elevation Change
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## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLUE CARBON IN THE DELTA</td>
<td>vi</td>
</tr>
<tr>
<td>PAST AND PRESENT PEAT CARBON STOCKS</td>
<td>2</td>
</tr>
<tr>
<td>METHODS</td>
<td>2</td>
</tr>
<tr>
<td>RESULTS</td>
<td>3</td>
</tr>
<tr>
<td>FUTURE RESTORATION SCENARIANS</td>
<td>4</td>
</tr>
<tr>
<td>FIVE FUTURE SCENARIOS</td>
<td>4</td>
</tr>
<tr>
<td>SCENARIO ANALYSIS</td>
<td>6</td>
</tr>
<tr>
<td>FUTURE MODELING RESULTS</td>
<td>8</td>
</tr>
<tr>
<td>POTENTIAL TO MITIGATE SUBSIDENCE AND BUILD ELEVATIONS</td>
<td>8</td>
</tr>
<tr>
<td>POTENTIAL TO REDUCE OR REVERSE FUTURE PEAT CARBON LOSSES</td>
<td>9</td>
</tr>
<tr>
<td>HIGH REFERENCE SCENARIO GHG EMISSIONS</td>
<td>10</td>
</tr>
<tr>
<td>LARGE REDUCTIONS IN GHG EMISSIONS IN WETLAND RESTORATION SCENARIOS</td>
<td>11</td>
</tr>
<tr>
<td>MULTIPLE BENEFITS FOR ECOSYSTEMS AND PEOPLE</td>
<td>12</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>14</td>
</tr>
<tr>
<td>RESOURCES &amp; RELATED EFFORTS</td>
<td>15</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>16</td>
</tr>
</tbody>
</table>
BLUE CARBON IN THE
DELTA

Carbon-rich peat deposits lie beneath the farmlands and wetlands of the Sacramento-San Joaquin Delta. Historically up to 60 ft thick, this peat represents roughly 6,700 years of carbon dioxide uptake and carbon sequestration by the Delta’s historical wetlands (Drexler et al. 2009a). Once a blue carbon ecosystem—a tidal freshwater wetland covering ~420,000 acres—the Delta’s historical tidal wetlands accumulated deep carbon stocks as sea levels gradually rose after the last ice age. Ninety-eight percent of those wetlands have since been drained, leading to extensive subsidence, peat carbon losses, and high ongoing greenhouse gas (GHG) emissions. Over the past 200 years, a layer of peat up to ~30 ft thick in some places has disappeared from the Delta (Drexler et al. 2009b; Deverel and Leighton 2010), reversing millennia of climate protection, stressing the Delta’s levees, and threatening California’s water supply (Deverel et al. 2016a).

Ongoing land–surface subsidence and sea level rise present profound challenges for the future Delta. Accordingly, the science, management, and policy arenas have seen an increasing focus on the potential for alternate land uses in the Delta to stop or reverse subsidence, sequester carbon and reduce GHG emissions, and restore natural processes and ecosystems to support imperiled species.

A note about units: A mix of metric and imperial units has been used in this report in order to align with standard practices of the management and science communities. Measures of area, length, and volume are expressed in units of acres, feet and cubic feet—units commonly used by resource managers. Carbon and GHG emissions are expressed as metric tons (MT) or million metric tons (MMT), the standard units used in US and international GHG inventories. Metric units are also used for the density of carbon in peat, in order to facilitate comparisons with other published values. In some cases both metric and imperial units are provided.
This report explores opportunities to protect and restore the Delta’s blue carbon stocks through large-scale land-use changes. Establishing wetlands in drained and subsiding sites can halt carbon losses and build new peat, reducing GHG emissions and rebuilding elevations while providing other benefits for ecosystems and people (Miller et al. 2008; Deverel et al. 2014; Deverel et al. 2016b; Hemes et al. 2019). Tidal wetlands, nontidal “subsidence reversal” wetlands, and rice are three wetland land uses that can each play a role in a sustainable future Delta. To envision a future Delta that supports the climate, native ecosystems, and the region’s agricultural heritage, large-scale scenario analysis can be used to set meaningful restoration targets, define priorities, and identify where management actions offer multiple benefits or entail tradeoffs between objectives.

This study evaluated the effects of Delta land use scenarios on peat carbon stocks, GHG emissions, and other ecosystem functions. We asked the following questions:

1. What mass of blue carbon was stored during the Holocene and lost since the 19th century?
2. What is the potential upper bound for GHG benefits and peat carbon accumulation through wetland restoration and rice cultivation in the Delta?
3. What magnitude of GHG emissions reductions and peat carbon storage could existing Delta wetland restoration and rice farming targets achieve?
4. How can the configuration of wetland restoration and rice cultivation be optimized for GHG mitigation and other restoration goals?

Figure 1. Location map of the Sacramento-San Joaquin River Delta, the area analyzed for this project.

What is blue carbon?

Blue carbon is carbon stored by coastal and marine ecosystems. Although the Delta is now primarily agriculture, it was once the largest freshwater estuarine wetland on the west coast of North America.

Photo by Shira Bezalel, SFEI
What mass of blue carbon was stored during the Holocene and lost since the 19th century?

**METHODS**

**Peat thickness mapping:**
To map peat thickness across the historical and modern Delta, we combined maps of modern peat thickness and surface elevations (Deverel and Leighton 2010; DWR and USGS 2019) with a reconstructed digital elevation model for the early 1800s (Robinson et al. 2014; RMA 2015). We assumed that within the historical extent of the Delta’s tidal wetlands, elevation losses since the early 1800 were due primarily to compaction and microbial oxidation of peat.

**Core data synthesis:**
We synthesized carbon data from 23 peat cores from farmed islands and remnant wetlands in the Delta (Drexler et al. 2009a,b; Callaway et al. 2012; Craig et al. 2017; Anthony and Silver 2020; Drexler et al. 2021). Cores spanned a range of landscape positions and varied in depth from 50 cm (1.6 ft) to 9 m (30 ft) below the soil surface. We looked at patterns in carbon and peat density to identify carbon density values for different land uses and depths.

**Mapping peat carbon:**
We applied carbon density values to mapped peat volumes to estimate the mass of peat stored in the historical (ca. 1800) and modern (2017) Delta.
RESULTS

In the early 1800s, the Delta stored an estimated 280 million metric tons of carbon (MMT C) in its 180 billion cubic feet of peat. (This volume is equal to ~2,000 olympic-size swimming pools.)

Over the past two centuries, approximately half this carbon has been lost to oxidation. The Delta now stores an estimated 99 billion cubic feet of peat and 140 MMT C.

This loss of ~140 MMT C is equivalent to clear-cutting over three and a half million acres of forest or burning half a trillion pounds of coal.

By using a reconstructed historical DEM to map early-1800s peat, we were able to account for areas where there is no remaining peat. This led us to a value for historical peat carbon storage that is 40-90% greater than previous estimates based on subsidence rates and accommodation space within existing peatlands (Mount and Twiss 2005; Deverel and Leighton 2010; Drexler et al. 2019).

Surface soils on Delta farmed islands are over twice as carbon-dense (97 ± 37 kg C m⁻³) as deeper peat layers (46 ± 4.2 kg C m⁻³) or remnant peat in the Delta’s tidal wetlands (37 ± 5.9 kg C m⁻³) due to impacts of compaction and land-surface subsidence.
What is the potential upper bound for GHG benefits and peat carbon accumulation through wetland restoration and rice cultivation in the Delta? What magnitude of GHG emissions reductions and peat carbon storage could existing Delta wetland restoration and rice farming targets achieve?

We developed five future land use scenarios to assess opportunities for peat carbon accumulation, GHG benefits, and subsidence mitigation through wetland restoration and rice cultivation in the Delta.

**FIVE FUTURE SCENARIOS**

1. **Reference**: The reference scenario served as a baseline against which alternative scenarios were compared. In this scenario, the current configuration of land uses were maintained into the future.

2. **Maximum potential**: The maximum potential scenario defined the theoretical potential for tidal restoration and subsidence mitigation. In this scenario, all sites at intertidal elevations were converted to tidal wetland, and all subsided areas were converted to subsidence reversal wetlands. Urban and barren areas were excluded from the analysis.

3. **GHG 1**: Focused primarily on GHG mitigation, GHG 1 places 76,500 acres of wetlands managed for subsidence reversal and rice in sites with the highest potential GHG benefit. GHG 1 is based on additional (above current commitments) acres of freshwater wetland in Scenario 1 from California’s 2022 Scoping Plan For Achieving Carbon Neutrality (CARB 2022).

4. **GHG 2**: This scenario places 38,100 acres of wetlands managed for subsidence reversal and rice in sites with the greatest potential GHG benefit. GHG 2 is based on the extent of additional freshwater wetlands in the Scoping Plan Scenario 3 (CARB 2022).

5. **GHG-habitat**: Based on the Delta Plan Performance Measures for subsidence reversal and tidal wetland (PM 5.2, 4.12, and 4.16; DSC 2013; DSC 2022), this scenario adds 32,500 acres of tidal wetland and 30,000 acres of subsidence reversal and rice, of which 3,500 acres is at shallowly subsided elevations to enable tidal reconnection.
Table 1. Description of future scenarios targets for tidal wetland, subsidence reversal wetland, and rice cultivation. Subsidence reversal wetlands and rice in GHG 1, GHG 2, and the GHG-habitat scenario were sited to optimize GHG emissions reductions.

<table>
<thead>
<tr>
<th>FUTURE SCENARIO</th>
<th>LAND COVER TYPE</th>
<th>SCENARIO TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>Tidal wetland</td>
<td>Maintain existing</td>
</tr>
<tr>
<td></td>
<td>Subsidence reversal wetland</td>
<td>Maintain existing</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Maintain existing</td>
</tr>
<tr>
<td>Maximum potential</td>
<td>Tidal wetland</td>
<td>Expand to all area at intertidal elevations*</td>
</tr>
<tr>
<td></td>
<td>Subsidence reversal wetland</td>
<td>Expand to all area at intertidal elevations*</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Maintain existing</td>
</tr>
<tr>
<td>GHG 1</td>
<td>Tidal wetland</td>
<td>Maintain existing</td>
</tr>
<tr>
<td></td>
<td>Subsidence reversal wetland</td>
<td>Add 42,075 acres (55% of GHG 1 target)</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Add 34,425 acres (45% of GHG 1 target)</td>
</tr>
<tr>
<td>GHG 2</td>
<td>Tidal wetland</td>
<td>Maintain existing</td>
</tr>
<tr>
<td></td>
<td>Subsidence reversal wetland</td>
<td>Add 20,955 acres (55% of GHG 2 target)</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Add 17,145 acres (45% of GHG 2 target)</td>
</tr>
<tr>
<td>GHG-habitat</td>
<td>Tidal wetland</td>
<td>Add 32,500 acres at intertidal elevations</td>
</tr>
<tr>
<td></td>
<td>Subsidence reversal wetland</td>
<td>Add 16,500 acres (55% of GHG-habitat target), 3,500 of which is at shallowly subsided elevations</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Add 13,500 acres (45% of GHG-habitat target)</td>
</tr>
</tbody>
</table>

*Excludes land classified as urban or barren
SCENARIO ANALYSIS

- **Modeling timeframe:** We projected scenarios 40 years into the future assuming 1.1 ft of sea level rise (SLR) by 2060, the 50% probabilistic SLR projection for California from the Ocean Protection Council (OPC 2018).

- **Elevation and carbon analyses:** We used three process-based biogeochemical models to predict future elevations, changes in carbon stocks, and net CO₂ emissions or uptake. The Coastal Wetlands Equilibrium Model (CWEM; Morris et al. 2022) predicts vertical accretion in tidal wetlands, SUBCALT² (Deverel and Leighton 2010; Deverel et al. 2016b) predicts peat oxidation and subsidence in drained organic soils, and SEDCALT (Callaway et al. 1996; Deverel et al. 2014) predicts elevation gains and peat carbon accumulation in subsidence reversal wetlands.

- **Other GHG analyses:** We used GHG emission factors from the literature to predict methane and nitrous oxide emissions, as well as net CO₂ emissions from other land-use types. For a full description of modeling methods and emission factors, see Vaughn et al. (*submitted*).

- **Landscape Scenario Planning Tool:** All analyses were packaged in a new Carbon and Greenhouse Gas module for the Landscape Scenario Planning Tool. This allowed us to evaluate carbon and GHG outcomes alongside other metrics of ecosystem function relevant to land managers and planners.
Figure 4. The Landscape Scenario Planning Tool (LSPT) is a GIS-based platform that allows users to compare the effects of Delta land use scenarios on a variety of ecosystem functions. Users input scenarios as GIS layers, and the tool runs a series of quantitative analyses that are grouped by theme into analysis modules. The new Carbon and Greenhouse Gas module outputs metrics of elevation change, carbon storage, and GHG emissions, facilitating comparisons between alternative scenarios relative to baseline conditions. This module also includes a functionality for users to explore potential revenue from the sale of carbon credits.
**FUTURE MODELING RESULTS:**

**POTENTIAL TO MITIGATE SUBSIDENCE AND BUILD ELEVATIONS**

**Key findings:**

**REFERENCE**

If current land uses continue over the coming four decades, the Delta could see a 19,000-acre increase in deeply subsided land and an 18,000-acre loss of intertidal and tidal-terrestrial elevations due to subsidence and SLR. This shift in elevations would reduce opportunities to restore tidal habitat and increase the risk of levee failures due to increased hydrostatic forces and intensified seepage (Deverel et al. 2016a).

**MAXIMUM POTENTIAL**

Delta-wide wetland restoration has the potential to dramatically reduce the extent of deeply subsided land and increase opportunities for tidal reconnection by building elevations in shallowly subsided sites.

**Table 2. Extent of land-surface subsidence at the end of the 40-year modeling period**

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>DEEPLY SUBSIDED LAND AREA (&gt;10 ft below MTL) [acres]</th>
<th>SHALLOWLY SUBSIDED LAND AREA (between MLLW and MTL – 10 ft) [acres]</th>
<th>INTERTIDAL LAND AREA [acres]</th>
<th>TIDAL-TERRESTRIAL LAND AREA (above MHHW) [acres]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modern Delta (2017)</td>
<td>161,400</td>
<td>130,700</td>
<td>44,200</td>
<td>28,100</td>
</tr>
<tr>
<td>Reference</td>
<td>180,100</td>
<td>127,400</td>
<td>38,700</td>
<td>15,900</td>
</tr>
<tr>
<td>Maximum potential</td>
<td>129,100</td>
<td>134,400</td>
<td>80,300</td>
<td>18,000</td>
</tr>
<tr>
<td>GHG 1</td>
<td>171,700</td>
<td>135,300</td>
<td>39,100</td>
<td>15,900</td>
</tr>
<tr>
<td>GHG 2</td>
<td>177,000</td>
<td>130,300</td>
<td>38,700</td>
<td>15,900</td>
</tr>
<tr>
<td>GHG-habitat</td>
<td>178,200</td>
<td>127,700</td>
<td>40,100</td>
<td>15,900</td>
</tr>
</tbody>
</table>

Notes: modern scenario reflects the current elevation distribution as of 2017. Intertidal zone approximated using a mean tidal range of 3.6 ft. Maximum potential extent excludes 217 acres for which model-based subsidence or accretion values were unavailable.

**GHG 1, GHG 2, GHG-HABITAT**

The GHG 1, GHG 2, and GHG-habitat scenarios offer elevation benefits relative to Reference-scenario conditions. Given ongoing subsidence in non-wetland sites, however, the extent of deeply subsided land is expected to increase over time in all three scenarios. Similar opportunities and challenges exist at intertidal elevations. By restoring 32,500 acres at intertidal or near-intertidal elevations the GHG-habitat scenario increases intertidal land area relative to the Reference scenario. However, even this scenario sees an absolute loss of area at intertidal elevations over the coming 40 years due to accelerating SLR.
**POTENTIAL TO REDUCE OR REVERSE FUTURE PEAT CARBON LOSSES**

**REFERENCE**

If existing land uses are maintained, the Delta could lose an estimated 8.3 MMT carbon over four decades due to ongoing subsidence, with as much as 1m of elevation loss on the most rapidly subsiding islands. This loss of 8.3 MMT of C is comparable to clear-cutting more than 100,000 acres of U.S. forest (EPA 2021).

**MAXIMUM POTENTIAL**

We found that as much as 24 MMT of carbon could theoretically be sequestered with Delta-wide wetland restoration.

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**Table 2. Extent of land-surface subsidence at the end of the 40-year modeling period**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>40-year change in peat carbon storage (MMT C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>-8.3</td>
</tr>
<tr>
<td>Maximum potential</td>
<td>+24</td>
</tr>
<tr>
<td>GHG 1</td>
<td>-2.7</td>
</tr>
<tr>
<td>GHG 2</td>
<td>-3.4</td>
</tr>
<tr>
<td>GHG-Habitat</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 5. Future scenario cumulative change in peat carbon storage over the 40-year modeling period. Error bars represent standard errors propagated from error ranges from SUBCALC®, CWEM, and peat core data.**
Under reference scenario conditions, we found that the Delta will emit an estimated 1.2 MMT CO₂ equivalents (CO₂e) per year to the atmosphere. Modeled per-acre GHG emissions depended on land use type, water table depth, soil organic matter content, and other site-specific factors. Across the Delta, sites ranged from a weak net sink for GHGs to a net source as high as ~25 MT CO₂e per acre per year.

Figure 6. Modeled future net annual GHG emissions for the Reference scenario
LARGE REDUCTIONS IN GHG EMISSIONS IN WETLAND RESTORATION SCENARIOS

MAXIMUM POTENTIAL

The maximum potential scenario would provide GHG emissions reductions of 1.2 MMT CO$_2$e yr$^{-1}$, converting the Delta from a large GHG source to roughly carbon neutral. Achieving an equivalent GHG benefit by planting trees would require planting roughly more than 2 million trees each year, year after year (EPA 2022).

GHG 1 & GHG-HABITAT

GHG 1 and GHG-habitat restore similar acres of wetlands, but provide substantially different GHG emissions reductions. This difference highlights the impact of alternative objectives. GHG 1 focused exclusively on GHG benefits, with all wetlands placed in sites with the highest baseline emissions. GHG-habitat, in contrast, prioritized both GHG benefits and tidal habitat, with over half the additional wetlands at intertidal or near-intertidal elevations where baseline GHG fluxes are lower.

GHG 1, GHG 2, GHG-HABITAT

All restoration scenarios offer high GHG benefits ranging from roughly a third to a half of the maximum potential.

Figure 7. Future scenario greenhouse gas emissions reductions. Net GHG emissions reductions were calculated as the mean annual difference in GHG emissions between the Reference scenario and each alternative scenario over the 40-year modeling period. Units of CO$_2$ equivalents (CO$_2$e) incorporate net exchanges of CO$_2$, methane, and nitrous oxide.
How can the configuration of wetland restoration and rice cultivation be optimized for GHG mitigation and other restoration goals?

In addition to carbon and GHG benefits, the scenarios we analyzed offer a variety of other benefits for ecosystems and people. Restoring wetlands in the Delta supports fish, birds, and other wildlife populations, particularly when configured in large marsh patches that enhance connectivity between wetlands and open water. Creation of wetlands for subsidence mitigation also protects the region’s infrastructure and economy. Without such measures, elevation losses due to continued subsidence and rising sea levels will exacerbate strain on levees, increasing pumping costs and the risk of catastrophic levee failures (Deverel et al. 2016a). At the same time, however, implementing scenario land use changes presents financial challenges and may entail tradeoffs with existing land uses. Because the majority of deeply subsided land in the central Delta is in private ownership, there is a need to identify near-term solutions that can mitigate subsidence while providing reasonable income. Converting drained agriculture to rice is one such solution, as rice offers sustained farm income while reducing GHG emissions and halting subsidence by maintaining saturated soils for much of the year (Hatala et al. 2012; Knox et al. 2015; Deverel et al. 2016b). Impounded nontidal wetlands can also provide income on the voluntary carbon market.

Table 3 shows examples of metrics evaluated by the LSPT, enabling comparisons among scenarios across a number of different functions.

Key takeaways:

- Subsidence mitigation reduces the likelihood of future levee failures (Deverel and Leighton 2010). In the most rapidly subsiding sites, we modeled elevation benefits of as much as 2 m relative to the reference scenario. This could be particularly relevant in areas that are becoming too wet to farm (Deverel et al. 2015).

- Wetland restoration increases wildlife habitat extent and habitat quality, for instance by creating large patches that are likely to develop complex channel networks (Robinson et al. 2014).

- Connectivity between water and wetlands is particularly important for fish such as salmonids (SFEI-ASC 2020). By increasing tidal wetland area, the GHG-habitat scenario in particular improves metrics of habitat connectivity.

- Wetland creation presents tradeoffs with existing agricultural uses, but rice cultivation and the sale of carbon credits have the potential to replace lost income while reducing subsidence and GHG emissions (Whipple et al. 2022). Using a conservative carbon price of $10/ton, we estimated about three million dollars in potential carbon revenue for the GHG-habitat scenario.
Table 3. Additional metrics of ecosystem function and land use associated with future scenarios. The Reference and Maximum potential scenarios bracket the range of potential values for each metric (row) in the table. Green highlighting indicates which of the three other future scenarios, GHG 1, GHG 2, and GHG-habitat, performs best for a given metric.

<table>
<thead>
<tr>
<th>METRIC</th>
<th>RANGE OF POTENTIAL VALUES (Reference - Maximum potential)</th>
<th>GHG 1</th>
<th>GHG 2</th>
<th>GHG-HABITAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of deeply subsided land (&gt;10 ft below MTL)</td>
<td>180,120 - 129,846 acres</td>
<td>171,058</td>
<td>176,790</td>
<td>177,982</td>
</tr>
<tr>
<td>Area of tidal and nontidal marsh patches greater than 100 ha (247 acres)</td>
<td>11,876 - 390,873 acres</td>
<td>41,201</td>
<td>25,392</td>
<td>44,079</td>
</tr>
<tr>
<td>Area of tidal and nontidal marsh patches greater than 500 ha (1,236 acres)</td>
<td>2,116 - 389,791 acres</td>
<td>12,792</td>
<td>7,037</td>
<td>17,169</td>
</tr>
<tr>
<td>Average distance to nearest tidal and nontidal marsh patch greater than 100 ha (247 acres)</td>
<td>8.0 - 0.84 miles</td>
<td>2.4 miles</td>
<td>3.5 miles</td>
<td>1.9 miles</td>
</tr>
<tr>
<td>Area of tidal marsh within 2 km (1.24 mi) of open water</td>
<td>11,457 - 23,223 acres</td>
<td>11,457</td>
<td>11,457</td>
<td>12,486</td>
</tr>
<tr>
<td>Average distance to nearest large connected wetland</td>
<td>4.3 - 0.027 miles</td>
<td>4.3 miles</td>
<td>4.3 miles</td>
<td>4.2 miles</td>
</tr>
<tr>
<td>Loss of agriculture</td>
<td>0 - 283,712 acres</td>
<td>38,841</td>
<td>19,771</td>
<td>45,082</td>
</tr>
<tr>
<td>Loss of prime farmland</td>
<td>0 - 241,337 acres</td>
<td>33,044</td>
<td>18,143</td>
<td>36,725</td>
</tr>
</tbody>
</table>

Notes: metrics presented here were quantified with the LSPT, using the Carbon and Greenhouse Gas, Marshes, Fish Support, and Agriculture analysis modules. Marsh patches are defined as contiguous regions of tidal and non-tidal emergent wetland. Hydrologically connected wetlands are defined as contiguous with the channel network. Prime farmland grade is defined by the California Department of Conservation’s Farmland Mapping and Monitoring Program’s 2018 database (https://www.conservation.ca.gov/dlrp/fmmp)
CONCLUSIONS

• The sooner action is taken to mitigate subsidence, restore ecosystems, and reduce ongoing GHG emissions from Delta soils, the greater the opportunities for a resilient Delta ecosystem, economy, and water supply, and the greater the Delta’s contributions to California’s climate change mitigation goals.

• Large-scale wetland creation/restoration and rice fields have 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 CO₂e per year), setting the context for ambitious land-use planning in the Delta.

• Competing priorities in restoration planning call for a balanced portfolio that considers stressors to the climate, wildlife, and the Delta’s infrastructure and economy. Such a balanced portfolio should mitigate subsidence and GHG emissions through rice and managed wetlands, and maintain current tidal marsh and restore tidal habitat in areas resilient to moderate SLR.

• Subsidence mitigation calls for both near-term and long-term solutions. In the near term, conversion to rice in the most rapidly subsiding areas can mitigate elevation losses while providing sustained income. Over the longer term, projected increases in carbon prices and the financial benefits of reducing the risk of levee failure may be sufficient to incentivize larger scale conversion to subsidence reversal and tidal wetlands.

• Multi-benefit tools like the Landscape Scenario Planning Tool can help land use planners evaluate large-scale opportunities, impacts, and tradeoffs across a range of critical ecosystem functions.
RESOURCES & RELATED EFFORTS

**Download the Landscape Scenario Planning Tool (LSPT):** The maps created in this effort are available for conservation planners to use in the LSPT. The LSPT is a set of resources to assist users with developing, analyzing, and evaluating different land use scenarios in California’s Suisun-Delta region. The tool is designed to inform ongoing and future restoration planning efforts by assessing how proposed projects will affect a suite of landscape metrics relating to desired ecosystem functions and services. Maps from this study are incorporated into the newly added wetland resilience module.

**Access the full report:** More details on the methods and findings of this study can be found in the published journal article (manuscript submitted for publication).


**Read the other reports from the Blue Carbon and Wetland Resilience Project:** This study is part of a larger project that looked at carbon sequestration and wetland resilience in the Delta. The following resources provide more information on the other studies in this project.

**Published journal articles:**


**Summary report of Robinson et al. (2022):**

REFERENCES


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