The Carbon Sequestration Benefits of Large-Scale Tidal Wetland Restoration in Puget Sound.

A Case Study of the Snohomish Estuary

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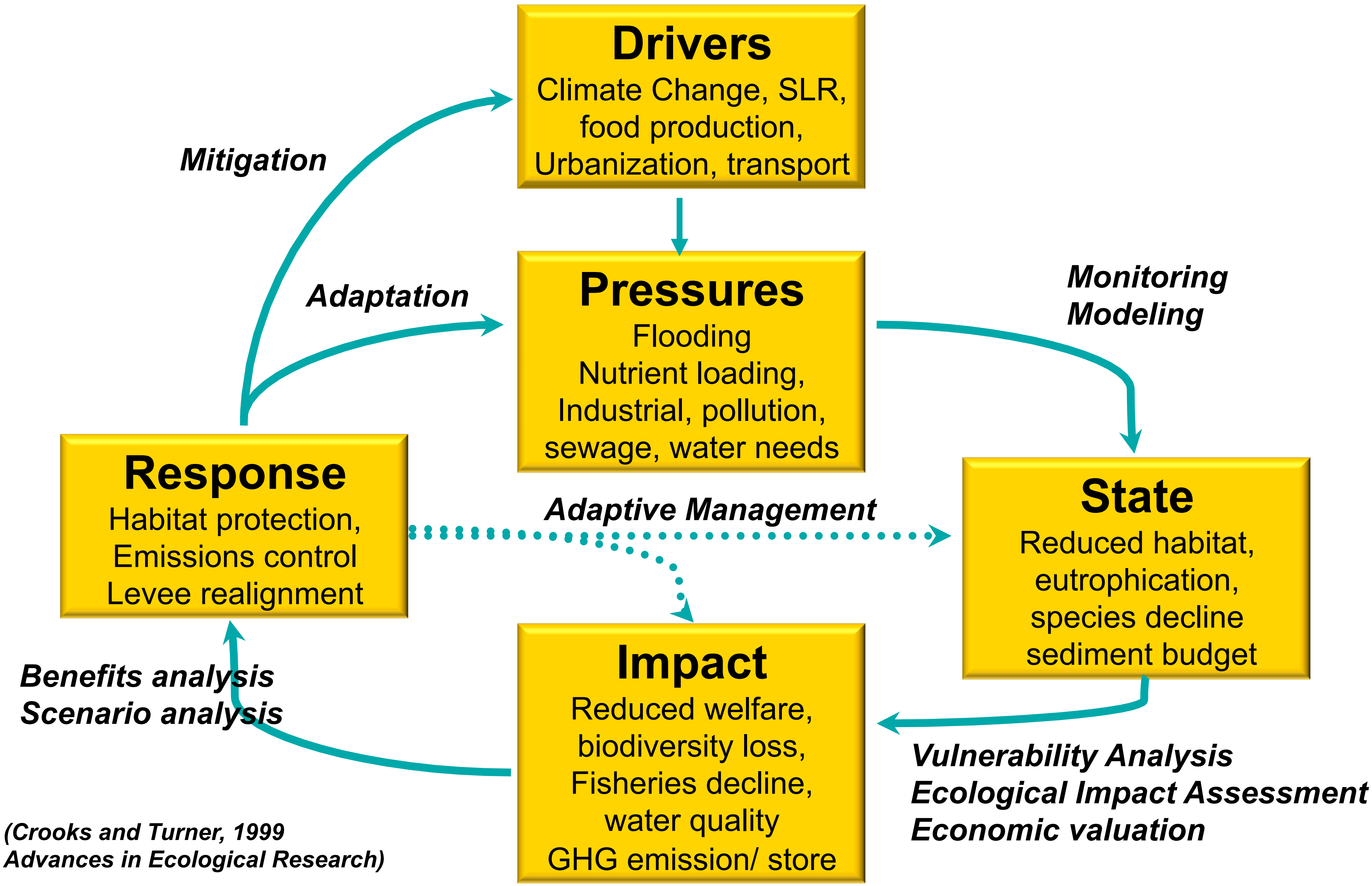
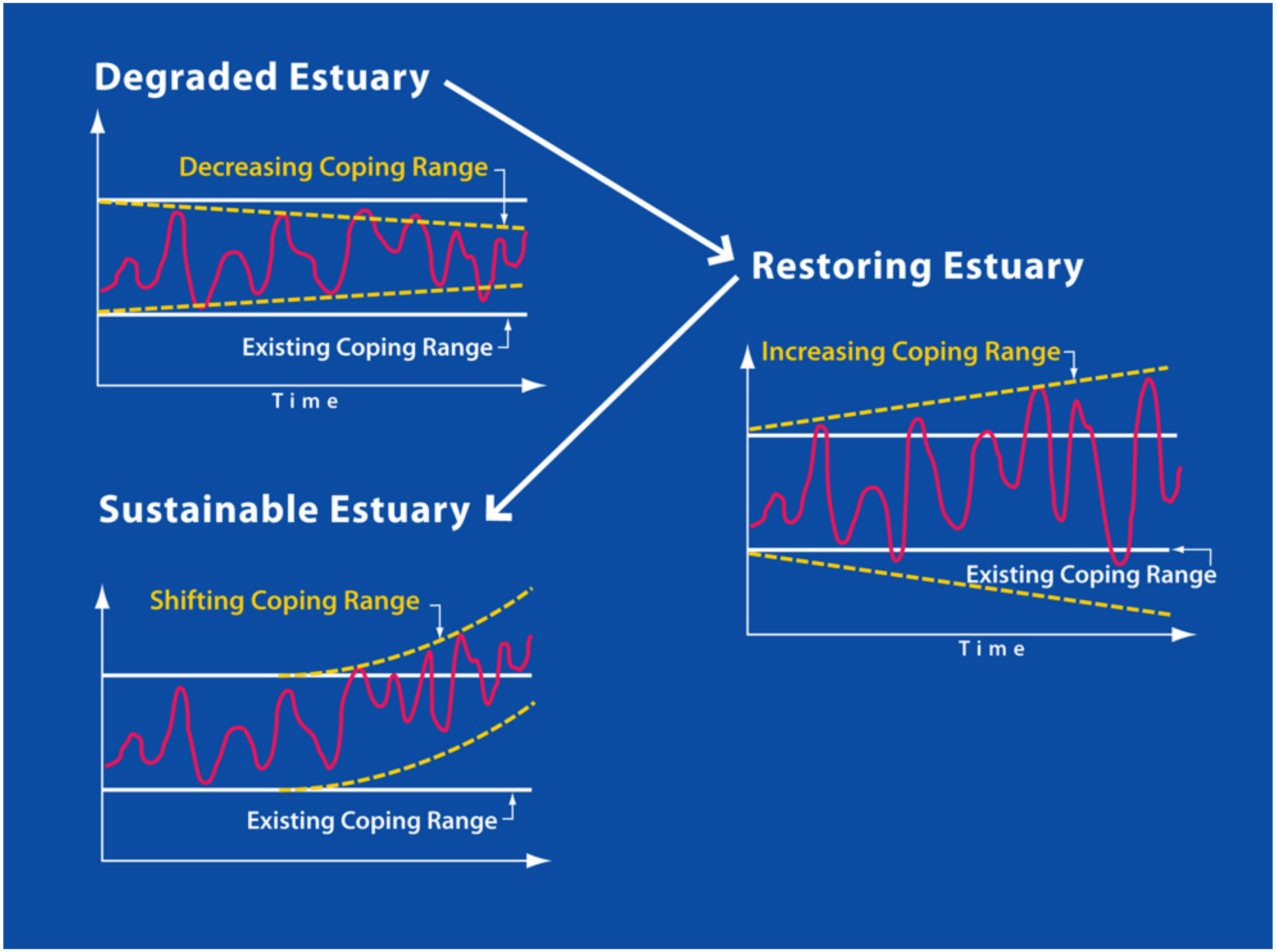
Sustainable Management



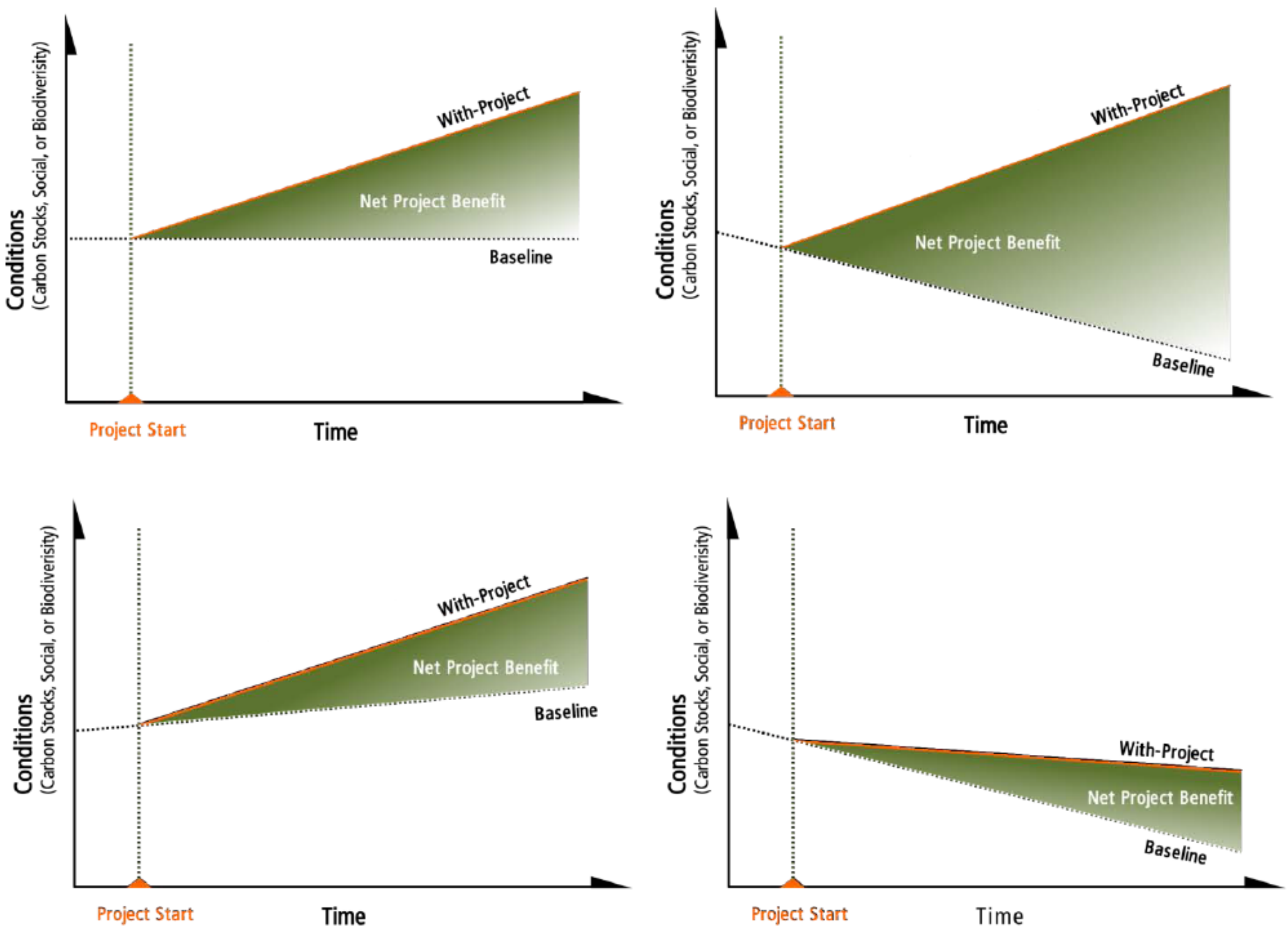
(Crooks and Turner, 1999
Advances in Ecological Research)

Goal of Restoration (*Adaptation*)



Goal of C Management (Mitigation)

Figure 1. Four Hypothetical Baseline Scenarios that Illustrate the Net Positive Impacts of a Project



Source: Forest Trends

Ecosystems in focus for climate change mitigation

Forest

Peatland

Mangroves

Tidal Marshes

Seagrass

OPEN ACCESS Freely available online

PLOS ONE

Estimating Global "Blue Carbon" Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems

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Table 1. Estimates of carbon released by land-use change in coastal ecosystems globally and associated economic impact.

	Inputs			Results	
Ecosystem	Global extent (Mha)	Current conversion rate (% yr^{-1})	Near-surface carbon susceptible (top meter sediment+biomass, Mg CO_2 ha^{-1})	Carbon emissions (Pg CO_2 yr^{-1})	Economic cost (Billion US$ yr^{-1})
Tidal Marsh	2.2–40 (5.1)	1.0–2.0 (1.5)	237–949 (593)	**0.02–0.24 (0.06)**	**0.64–9.7 (2.6)**
Mangroves	13.8–15.2 (14.5)	0.7–3.0 (1.9)	373–1492 (933)	**0.09–0.45 (0.24)**	**3.6–18.5 (9.8)**
Seagrass	17.7–60 (30)	0.4–2.6 (1.5)	131–522 (326)	**0.05–0.33 (0.15)**	**1.9–13.7 (6.1)**
Total	33.7–115.2 (48.9)			**0.15–1.02 (0.45)**	**6.1–41.9 (18.5)**

Compare to national emissions from all sources

Poland

Japan

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Floodplains Feed Fish
(*floodplain fatties*)

Photo: Jeff Opperman. Research by Carson Jeffres

Wetlands Carbon Management: The Game Plan

- United Nations Framework Convention on Climate Change
  - Brief national climate change negotiators
  - Identify policy opportunities
  - Engage IPCC
  - International demonstration (e.g. GEF project)
- National Governments
  - Establish science research
  - Recognize wetlands in national accounting
  - Agency awareness, action, funding
- Local Demonstration and Activities
  - Landscape level accounting
  - Establish carbon market opportunities
  - Look for synergistic conservation benefits
  - Demonstration projects and public awareness

Recent Activity

- **IUCN and UNEP Reports on Blue Carbon** (2009)
- **Climate Action Reserve** - **Tidal Wetlands Offsets Issues Paper** (PWA and SAIC 2009)
- **RAE Blue Ribbon Panel and Action Plan** US focused 2010
- **NCEAS Working Group –** tidal wetlands carbon model
- **International Blue Carbon Initiative (**2011-onwards)
  - Science Working Group
  - Policy Working Group
- **Reports** (2011)
  - **World Bank, IUCN, ESA PWA –** Global estimates and policy implications
  - **Duke University – Economic Potential**
  - **Climate Focus – international Policy**
- **IPCC Wetlands Supplement for National GHG Accounting** (2011-2013)
- **Voluntary Carbon Standards**
  - Recognizes wetlands activities
  - *Methodology for Tidal Wetlands and Seagrass Restoration* in review
  - *Conservation Methodology in Development*
- **Working Groups**
  - US Federal Agency Blue Carbon Group
  - World Bank Blue Carbon Working Group
  - National groups / programs – Indonesia, Australia, Abu Dhabi, Costa Rica, Oregon, Washington (?)
- **Guidelines for Coastal Wetland Carbon Projects** – in progress

Methodological Guidance for Coastal Wetlands in the
2013 SUPPLEMENT TO THE 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES: WETLANDS

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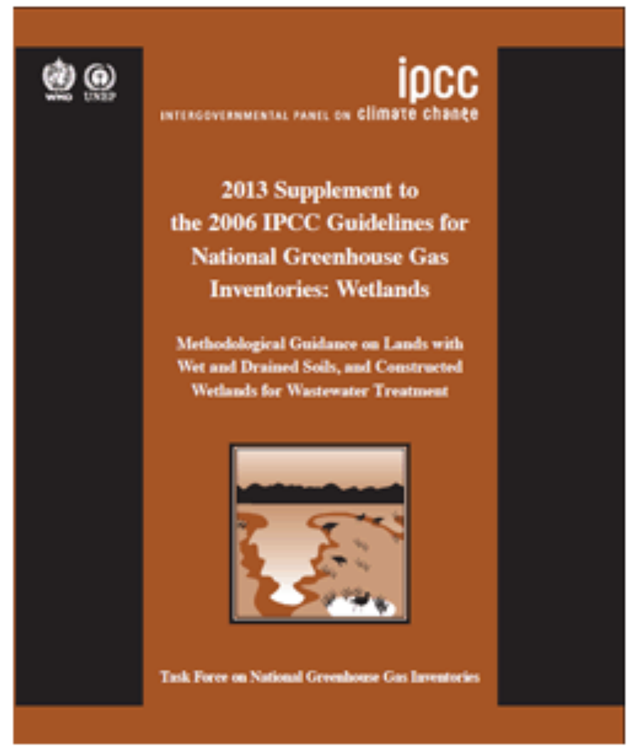
2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

1. Introduction
2. Cross cutting guidance on organic soils
3. Rewetting and restoration of organic soils
4. Coastal wetlands
5. Other freshwater wetlands
6. Constructed wetlands
7. Good practice and implications for reporting



Adopted by IPCC Oct 2013, Published Feb 2014
http://www.ipcc-nggip.iges.or.jp/

Wetlands Restoration and Conservation (WRC)

Adopted into Standard Oct 4, 2012

http://v-c-s.org/wetlands_restoration_conservation

Other Categories:

•Afforestation, Reforestation, Revegetation (ARR)
•Agricultural Land Management (ALM)
•Improved Forest Management IFM)
•Reduced Emissions from Deforestation and Degradation (REDD)

Example Project Activities Likely to be Covered by VCS Coastal Wetlands Restoration Methodology

- Rewetting of drained wetlands (dike breach, managed wetlands)
- Subsidence reversal (managed reed beds soil building)
- Restoring sediment supply
- Lowering of water levels on impounded wetlands
- Raising soil surfaces with dredged material
- Restoring salinity conditions
- Improving water quality
- Revegetation (marsh / forest)
- Combinations of the above

<u>Methodology in review</u>
<u>Expected early 2015!</u>

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More coming…

- To be released at the Climate Negotiations, Lima, 2014.
- One of a raft of guidance to be released over coming months.

COASTAL BLUE CARBON OPPORTUNITY ASSESSMENT
FOR THE SNOHOMISH ESTUARY

THE CLIMATE BENEFITS OF ESTUARY RESTORATION

- 4749 ha of drained wetlands
- 29% of wetland loss in Puget Sound
- 1353 ha of restoration planned.

RESTORE AMERICA'S ESTUARIES ESA WESTERN WASHINGTON UNIVERSITY EARTH CORPS

WILDLIFE FOREVER FUND BOEING NOAA

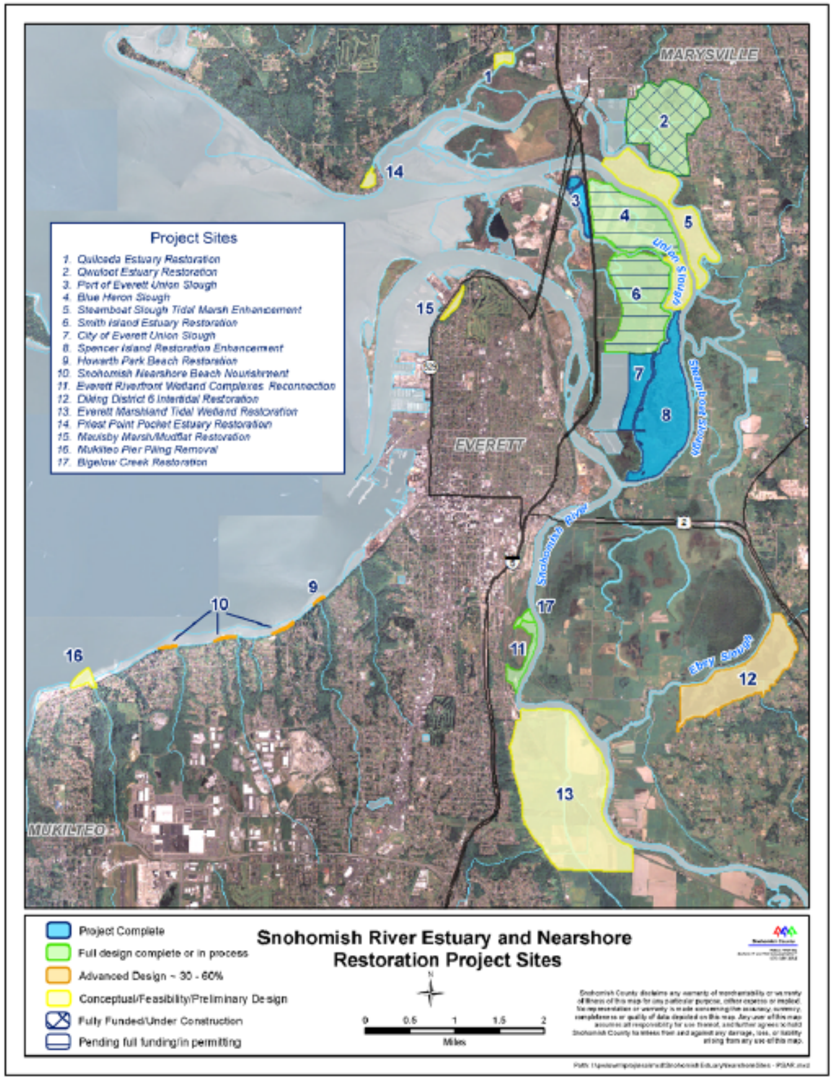

Figure 2 Snohomish Estuary nearshore restoration sites (Snohomish County, 2013).

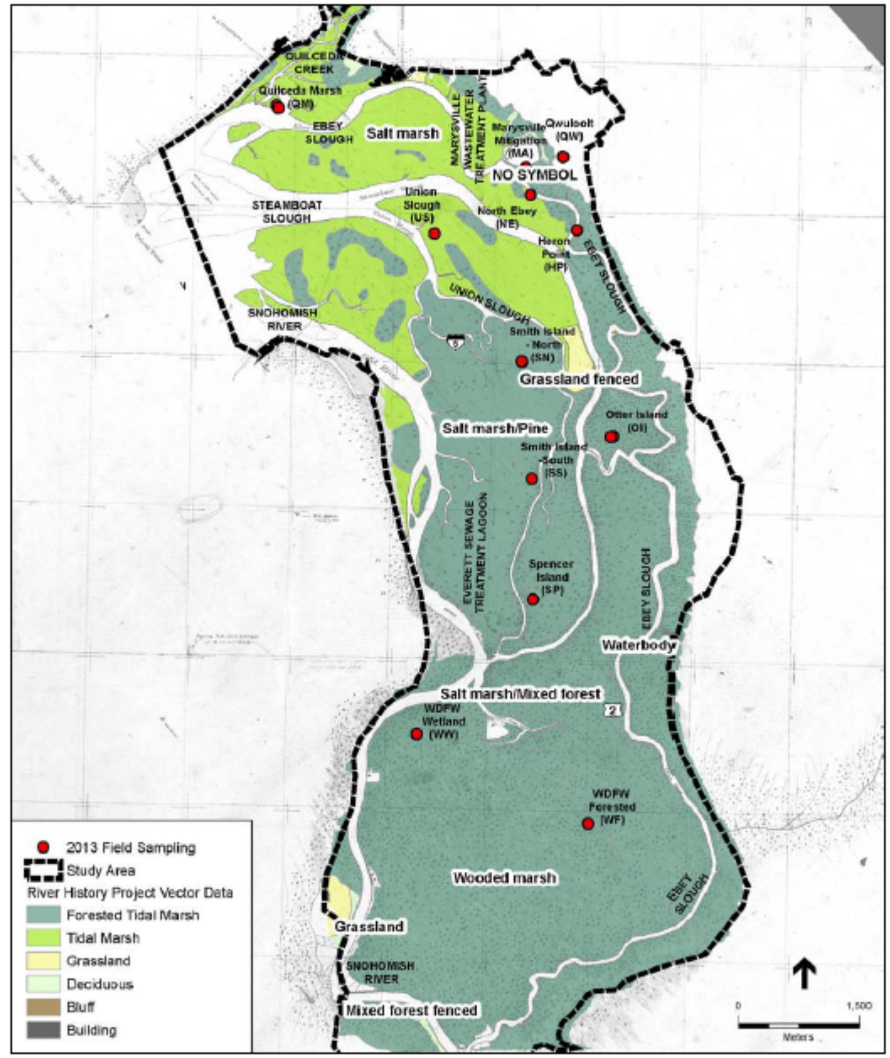

Figure 8 Historic habitats of the Lower Snohomish Estuary based on River History Project (Geomorphological Research Group, Quaternary Research Center, 2005) and Haas and Collins (2001) and 2013 soil core and vegetation plot locations.

Project Area

- Includes floodplain inundated with 1m sea level rise.

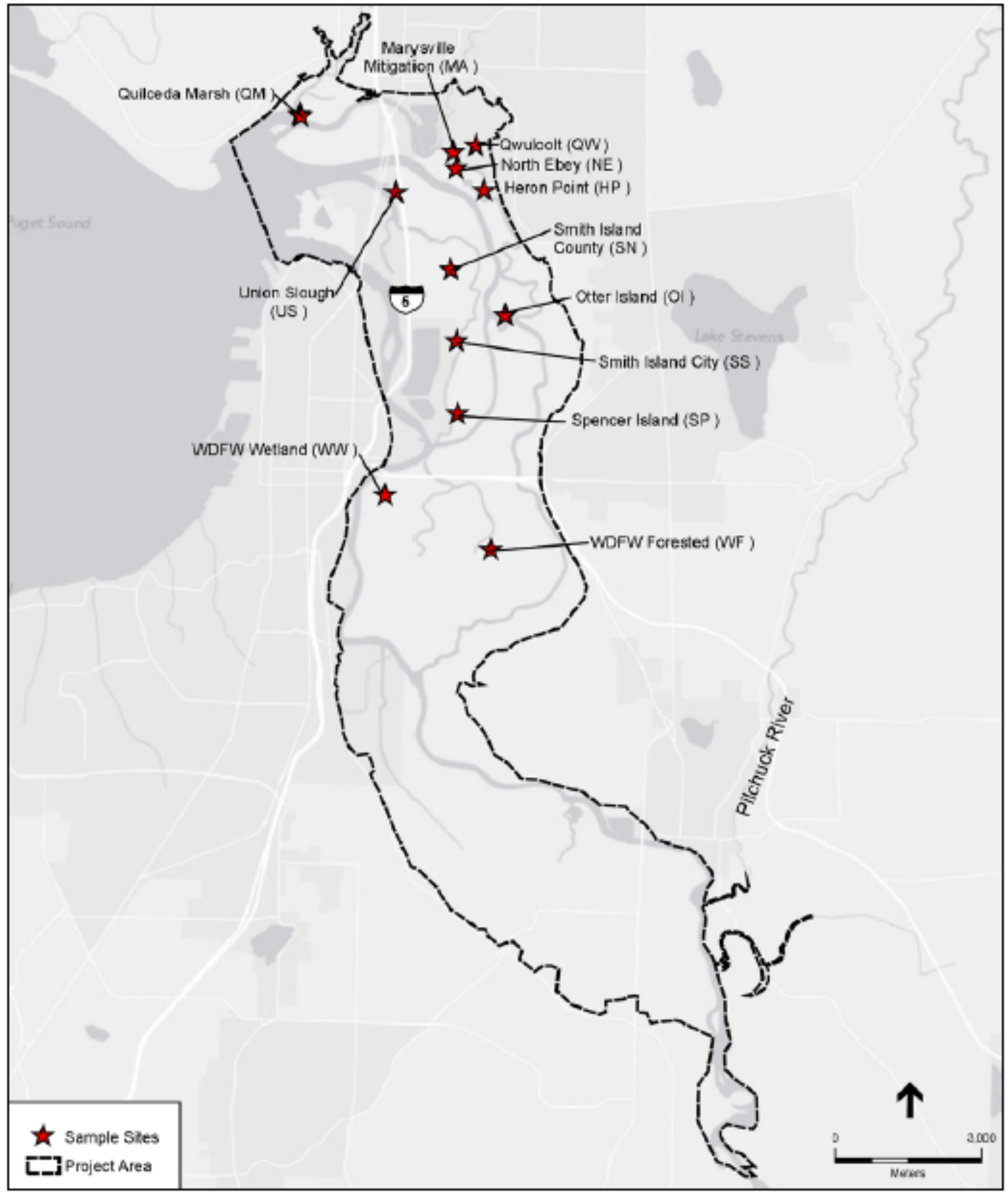

Figure 6 Study Area (dashed black line) and 2013 field sampling sites (red star).

Restoration and carbon sequestration potential

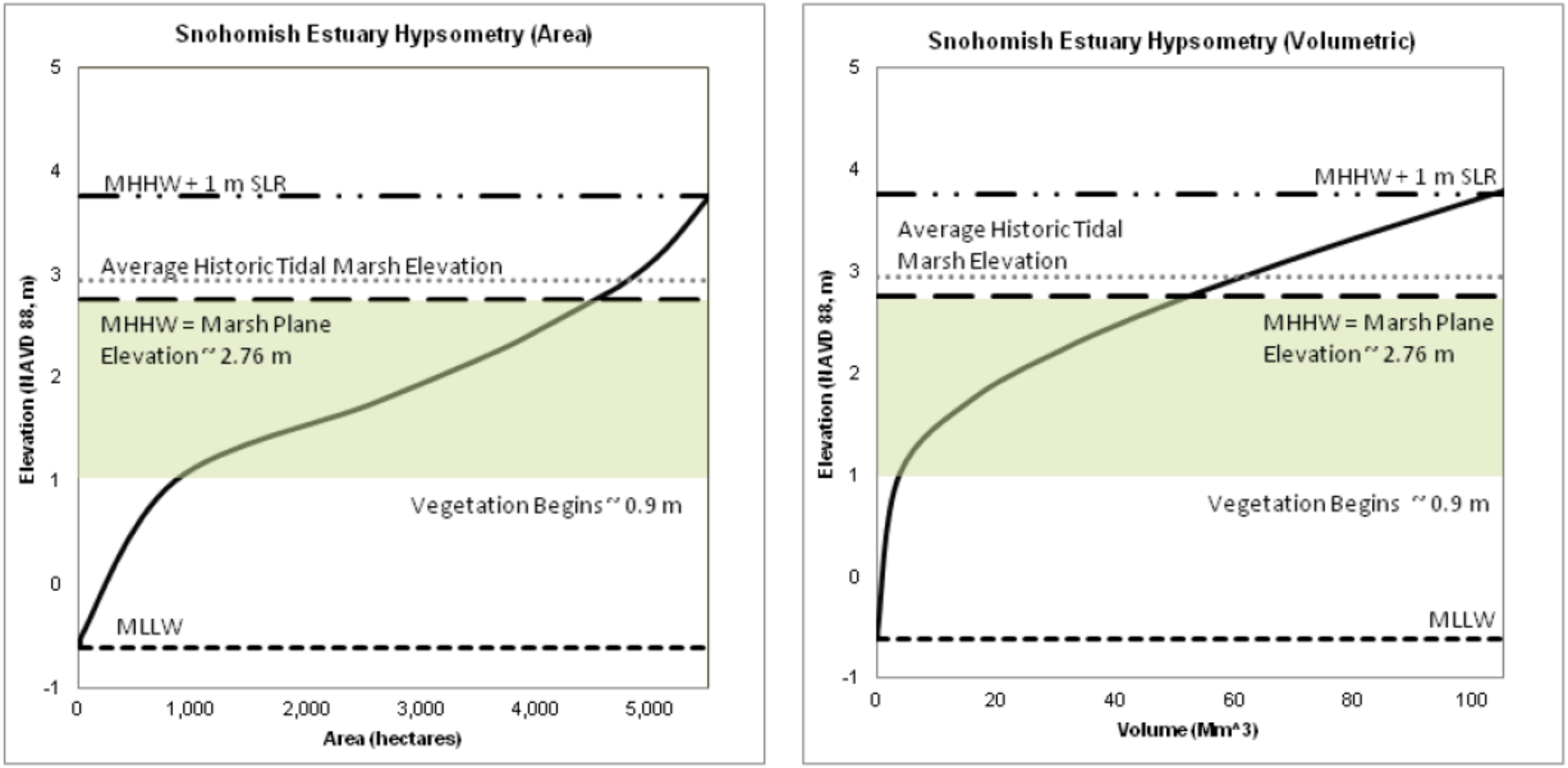

Figure 18 Hypsometric analysis of entire project area (ha).

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Site	Site Name	Sediment accretion rate (cm yr^{-1})	Carbon accumulation rate (g C m^{-2} yr^{-1})	Mineral accumulation rate (g m^{-2} yr^{-1})
QM	Quilceda Marsh	0.43	110.2	2134
HP	Heron Point	0.18	58.0	484
OI	Otter Island	0.58	173.1	2543
NE	North Ebey	1.61	352.1	7585
SP	Spencer Island	0.35	91.4	2148

Table 11. Rates of sediment accretion, carbon accumulation, and mineral accumulation for five sites. Accretion rates were determined from the distribution of excess ^{210}Pb activity with depth using one core from each site. Carbon and mineral accumulation rates were calculated from the accretion rates

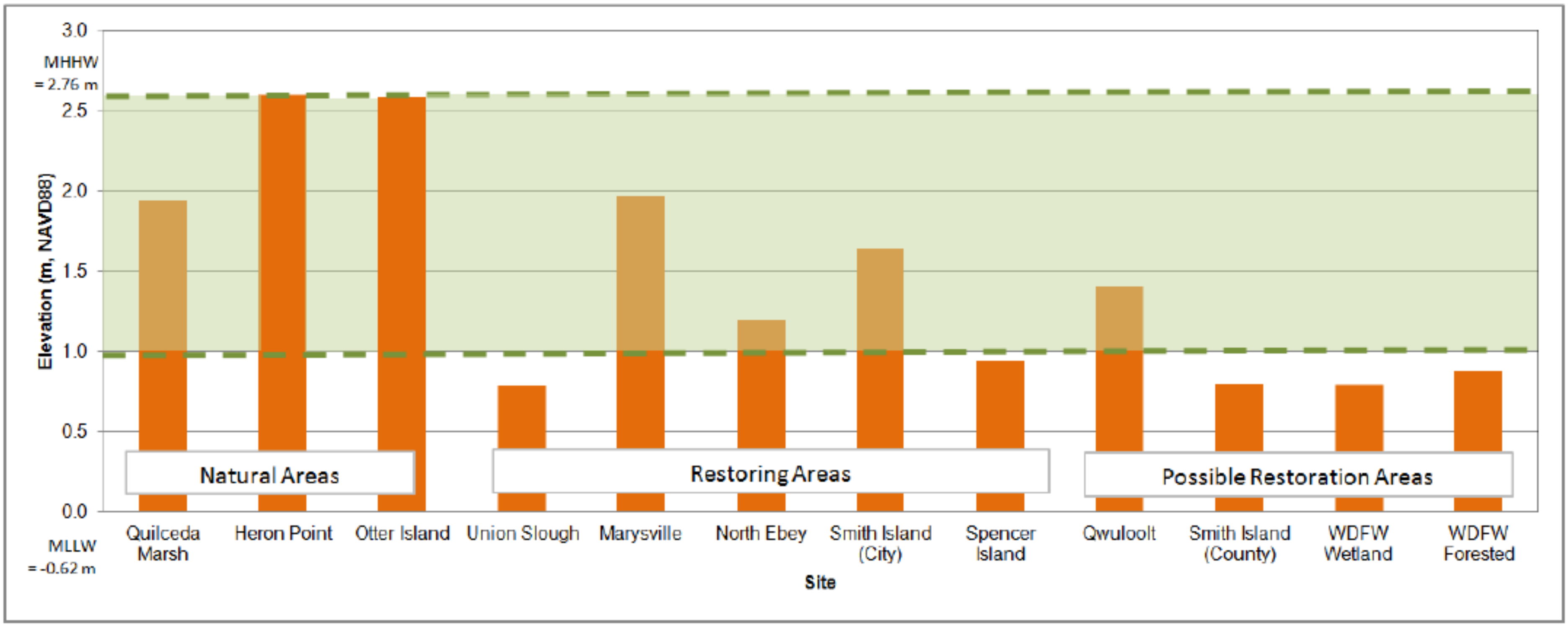
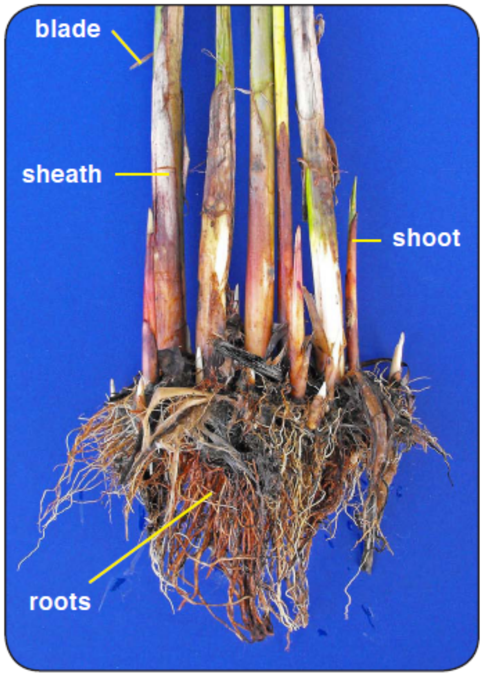
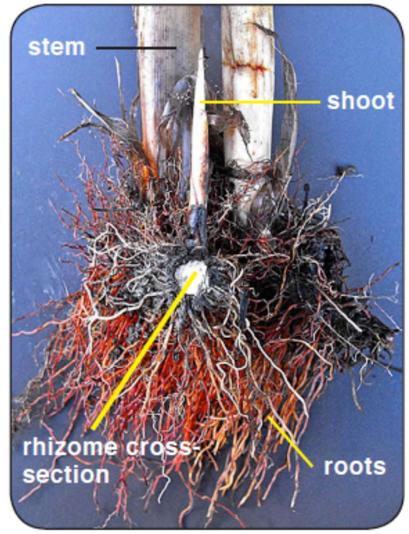


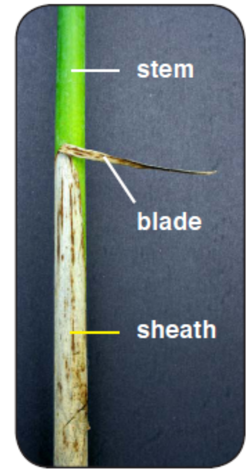
Figure 19 Existing and approximate targeted restoration elevations by site as of 2013. Units are in meters (m), NAVD88.



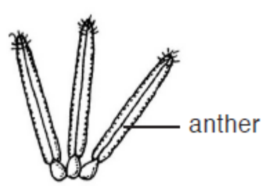
Great Bulrush stems, roots and new shoots in autumn



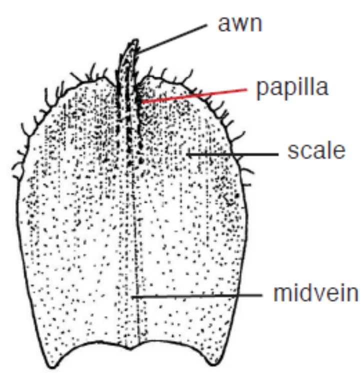
Cross-section of rhizome 7 mm thick with roots and new white shoot 5 cm tall



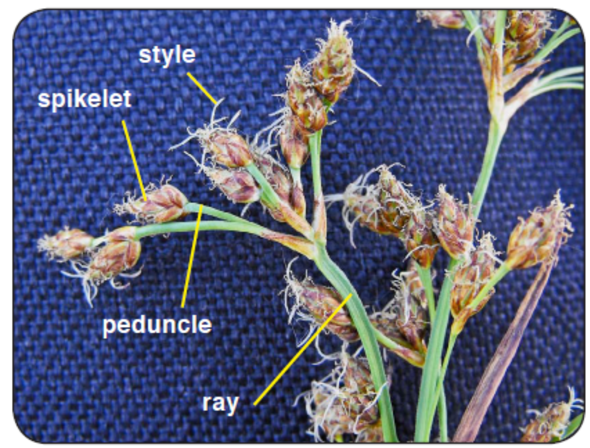
Lower stem 12 mm wide with leaf blade shorter than sheath



Young stamens x10; each c. 2 mm long



Fertile scale x15; dorsal side



Inflorescence with green rays, peduncles and brown spikelets c. 8 mm long with exserted styles

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Key Results – Existing Projects

1. *Planned* restoration of 1,353 ha would yield 1,176,000 tons CO_2 sequestration at current sea level

2. Planned restoration would yield additional 1,377,000 tons CO_2 sequestration to future sea level

3. Total CO_2 sequestration of 2,553,000 tons

4. This is equivalent to the emissions from 500,000 cars in one year, or 5,000 cars/year for 100 years

Key Results – Expanded Restoration

1. *Full* restoration of 4,393 ha would yield 4,495,000 tons CO_2 sequestration at current sea level

2. Full restoration would yield additional 4,485,000 tons CO_2 sequestration to future sea level

3. Total CO_2 sequestration of 8,980,000 tons

4. This is equivalent to the emissions from 1.76 million cars in one year, or 17,600 cars/year for 100 years

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EAD Involvement