Planning Restoration and Rehabilitation of Selected Estuaries of the USA:
Is there time and room left to be strategic?

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Dennis Township Site (212 ha)

THE ESTUARINE RESTORATION PARADIGM?

- "*Build it and they will come*!"
- rapid equivalency to natural ecosystems
- self-maintaining and long-term sustainable ecosystems

Images courtesy of Michael Weinstein

RESTORATION CHALLENGE

- Returning a system to *"a condition similar to the one that existed before it was altered, along with its pre-disturbance functions and related physical, chemical, and biological characteristics. The goal of restoration is to establish a site that is self-regulating and integrated within its landscape, rather than to re-establish an aboriginal condition…."* *Middleton 1999*
- ….futility of trying to re-establish the aboriginal state…Stanford *et al.* 1996
- When resources are limited, ecosystems highly modified, and time may be of essence, is the investment in restoration-challenged landscapes worth it?

Middleton, B. 1999. Wetland Restoration: Flood Pulsing, and Disturbance Dynamics. Wiley. New York.

Stanford, J. A., J. V. Ward, W. J. Liss, C. A. Frissell, R. N. Williams, J. A. Lichatowich, and C. C. Coutant. 1996. A general protocol for restoration of regulated rivers. Regulated Rivers: Research and Management 12:391-413.

DEFINITIONS & DISTINCTIONS

- *restoration* = return ecosystem processes to natural scale and dynamics
- ***rehabilitation* = *manage* natural processes and functions to provide ecosystem functions, goods and services *aka* MEA**

- *passive restoration* = "self design" release of stressors and reintroduction of natural processes
- *active restoration* = human intervention to substitute or accelerate natural processes with engineered solutions

THE CONNUNDRUMS OF RESTORATION IN HEAVILY INDUSTRIALIZED ESTUARIES

- **Historic altered, often irreversibly**
  - structure
  - ecosystem processes
- **Restricted opportunities**
  - conflicts with cost of water-dependent properties
  - derelict properties only available
- **Multiple stressors and disturbances**
  - limited recruitment sources
  - legacy contamination, and recontamination; health risks
  - boat wakes, noise, light
  - exotic species
- **Difficult to attract and maintain public resources**

RESTORATION AND REHABILITATION GOALS NEED TO BE DIFFERENT

Conceptual scheme for identifying restoration ecology and ecological restoration goals and criteria for coastal restoration designs

Weinstein 2007: *Est. & Coasts* 30

STRATEGIC RESTORATION

Strategic restoration **is designed to maximize the contribution of each restoration project to regional, management area, ecosystem, or target species goals, and provide for the greatest contribution to the persistence and/or recovery of populations.**

Takes into account:

- landscape configuration
- restorability of fundamental ecosystem processes
- spatial patterns of demography, dispersion, and dispersal of target species
- barriers to transport and dispersal
- equal weight given to the context (likelihood of site colonization by target species) as well as the content (habitat) of restoration projects

Source: *Scott, T.A., W. Wehtje. and M. Wehtje. 2001. The need for strategic planning in passive restoration of wildlife populations. Restor. Ecol. 9: 262-271.*

INTRODUCTION

- Recognize the many and difficult challenges of restoration in heavily urbanized, industrialized estuaries
- Given such constraints upon the long-term functionality of restoration in these altered systems, is it worth it to restore such dismembered ecosystems?
- If there are convincing arguments, and evidence of restoration performance, how might we approach urban estuarine restoration with:
  - Different expectations
  - Different planning
  - Different performance measures
- West coast USA estuaries: 1. San Francisco Bay; 2. Puget Sound (3. Puyallup; 4. Duwamish)

INSTITUTIONAL AND SOCIAL DRIVERS FOR ESTUARINE RESTORATION

Regulatory mitigation

- River and Harbors Act of 1899 (33 USC §401)
  - gave US Army Corps of Engineers authority to regulate dredging and other projects in navigable waters of the USA
- Fish and Wildlife Coordination Act (16 USC 661-667)
  - first legislation to explicitly mention “mitigation” and consider impacts to natural resources
- National Environmental Policy Act (42 USC §4321-4370)
  - major change in Federal environmental policy, designed primarily as a planning document; mandated Environmental Impact Statement (EIS); involves “major Federal actions” but includes Federal permits for state, local and private projects; resulted in establishment of the Council on Environmental Quality (CEQ)
- Clean Water Act (33 USC §1251-1378)
  - 1977 amendment to Federal Water Pollution Control Act of 1972; administered by US Army Corps of Engineers, in conjunction with (veto authority) US Environmental Protection Agency has ; case law has resulting in emergence of major ‘wetlands’ protection and ‘mitigation’ requirement, especially by regulation of dredging and filling (permits); defines and affords special protection to ‘wetlands’ as well as ‘special aquatic sites’ including ‘mud flats’ and ‘vegetated shallows’

INSTITUTIONAL AND SOCIAL FORCES FOR ESTUARINE RESTORATION

Mitigation

- legal foundation based more on administrative and case law than statue law
- Legal mandate to mitigate is directed to the resource agencies that oversee the projects, rather than at the private project proponent
- Codified definition (CEQ, 40 CFR §1508.2)
  - **1. avoiding the impact altogether** by not taking a certain action or parts of an action;
  - **2. minimizing impacts** by limiting the degree or magnitude of the action and its implementation;
  - **3. rectifying the impact** by repairing, rehabilitating, or restoring the affected environment;
  - **4. reducing or eliminating the impact over time** by preservation and maintenance operations during the life of the action; and,
  - **5. compensating for the impact** by replacing or providing substitute resources or environments.
- 1990 Memorandum of Agreement (MOA guidelines) condensed into Avoid, Minimize and Compensate applied in sequence (but subsequent guidance has relaxed rigorousness of avoidance requirement)

INSTITUTIONAL AND SOCIAL FORCES FOR ESTUARINE RESTORATION

Regulatory Restoration

- US Army Corps of Engineers Restoration under Water Resources Development Act 1986 as amended (WRDA §1135, amended 1996)
  - 1986 authority to carry out aquatic ecosystem restoration on existing or past Corps projects
  - 1996 authority extended to restoration and protection of aquatic habitat and water quality
  - Federal:non-Federal shared costs
- Estuary Restoration Act of 2000 (33 USC §2901)
  - promote the restoration of estuary habitat
  - develop a national estuary habitat restoration strategy for creating and maintaining effective partnerships within the federal government and with the private sector
  - provide federal assistance for and promote efficient financing of estuary habitat restoration projects
  - develop and enhance monitoring, data sharing, and research capabilities
  - establishes Council of representatives NOAA, EPA, USFWS, USDA and USACE to develop and implement a national estuary restoration strategy, designed in part to meet the goal of restoring one million acres of estuarine habitat by 2010
  - cost-shared

INSTITUTIONAL AND SOCIAL FORCES FOR ESTUARINE RESTORATION

Other Regulatory Actions Promoting Restoration

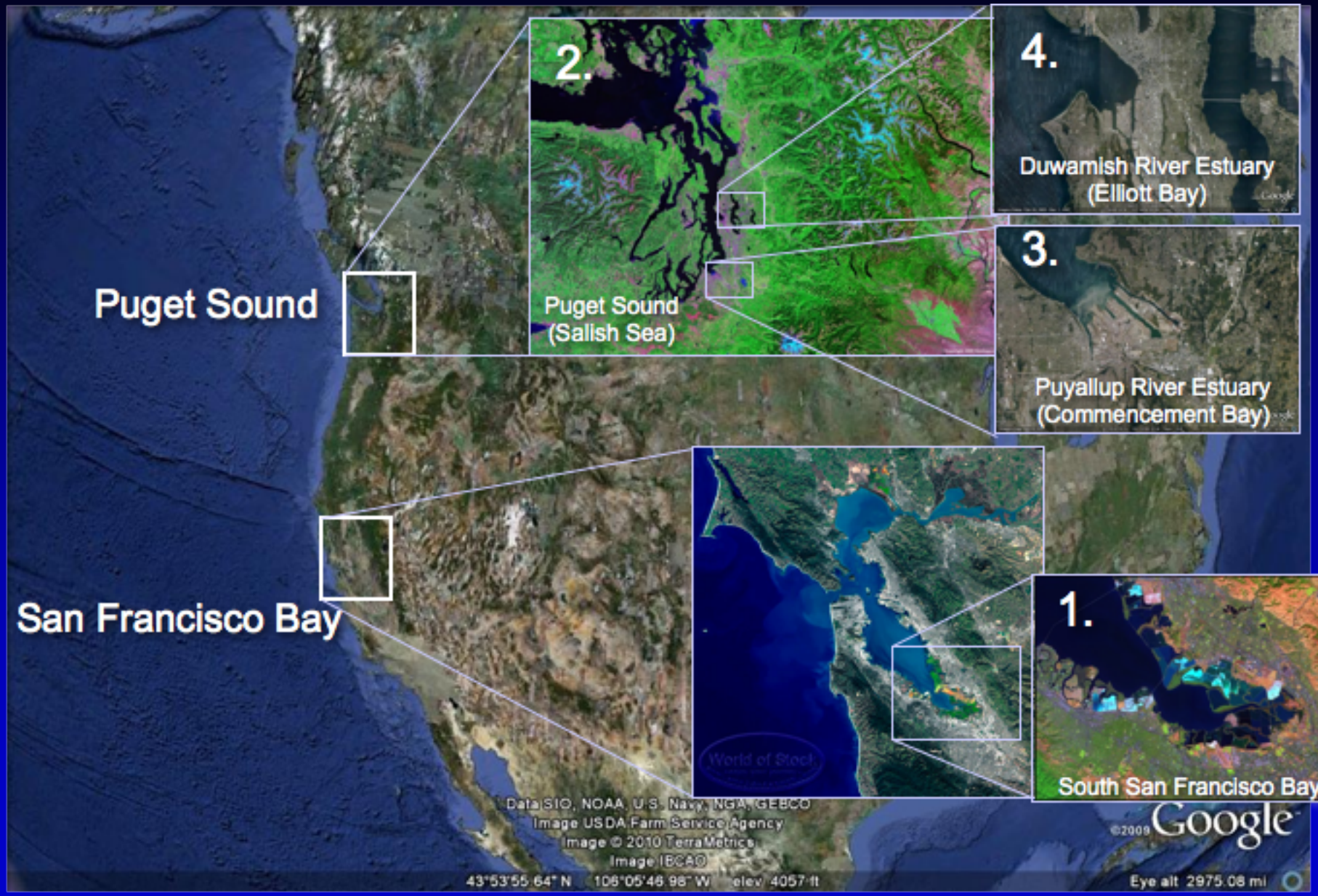
- Endangered Species Act (16 USC 1531-1544)
  - provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend
  - authorizes the determination and listing of species as endangered and threatened;
  - prohibits unauthorized taking, possession, sale, and transport of endangered species;
  - provides authority to acquire land for the conservation of listed species, using land and water conservation funds;
  - authorizes establishment of cooperative agreements and grants-in-aid to States that establish and maintain active and adequate programs for endangered and threatened wildlife and plants;
  - requires Federal agencies to insure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

INSTITUTIONAL AND SOCIAL FORCES FOR ESTUARINE RESTORATION

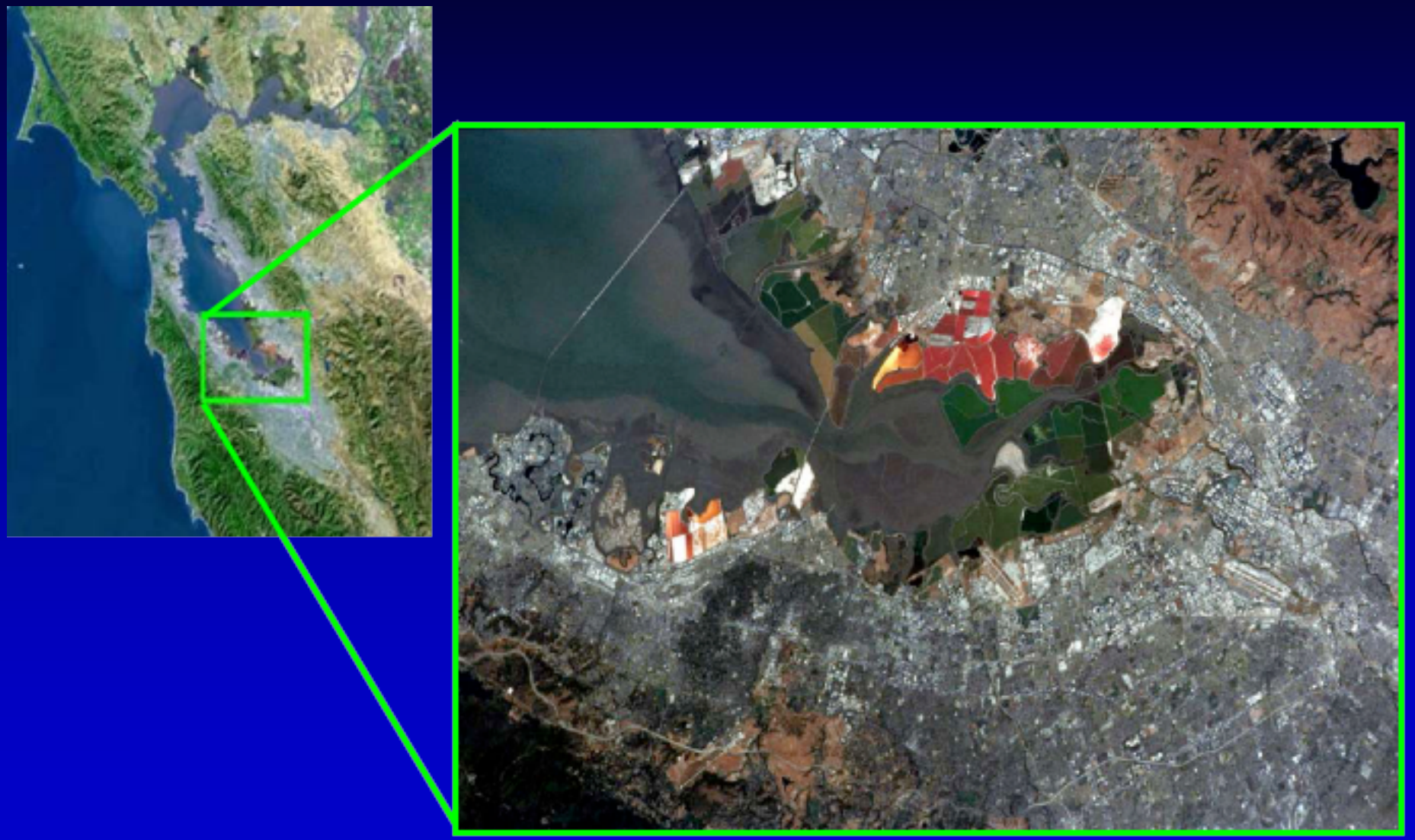
Non-Regulatory Restoration

- **Non-governmental organizations (NGO)**
  - Independent NGS initiatives, e.g., The Nature Conservancy, California Coastal Conservancy
- **Partnerships, such as Coastal America**
  - Established in 1999, partnership of federal agencies, state and local governments, and private organizations; work together to protect, preserve, and restore our nation's coasts
- **Place-Based Restoration Initiatives**
  - E.g., CALFED (Bay-Delta Authority) and South San Francisco Bay Salt Ponds Restoration, which involve unique state-Federal and non-governmental relationships supported by public (Congressional appropriations, local bonds) and private (trusts and foundations) funding

FOUR RESTORATION VIGNETTES

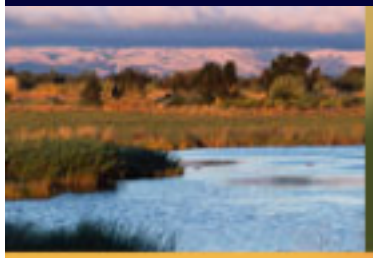


SAN FRANCISCO BAY
SOUTH BAY SALT POND RESTORATION PROJECT



SOUTH SAN FRANCISCO BAY SALT PONDS

SAN FRANCISCO BAY
SOUTH BAY SALT POND RESTORATION PROJECT



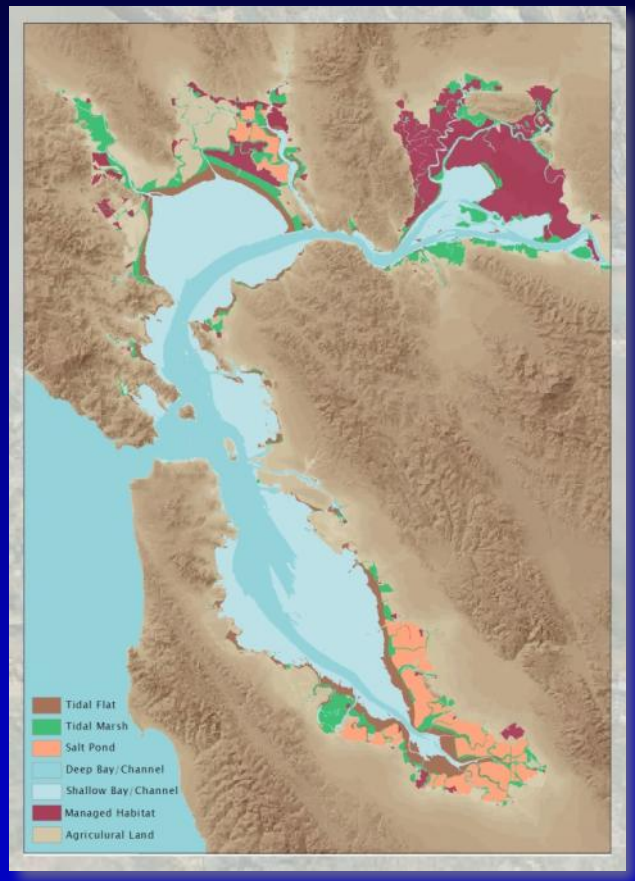
South Bay Salt Pond Restoration Project

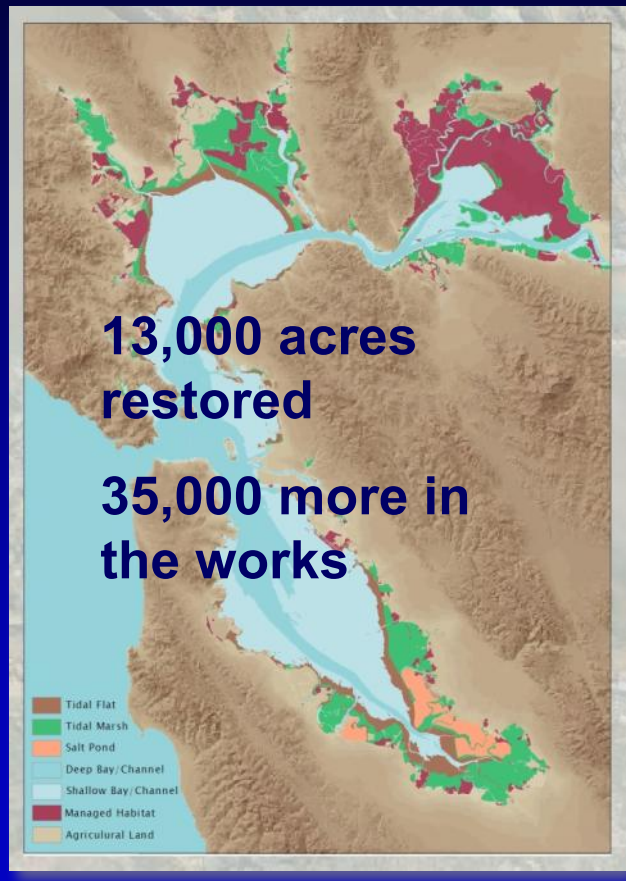
CALIFORNIA DEPARTMENT FISH&GAME

Coastal Conservancy

U.S. FISH & WILDLIFE SERVICE

SAN FRANCISCO BAY
Wetland Loss and Restoration





Past (~1850) Present (~2000) Future (~2030)

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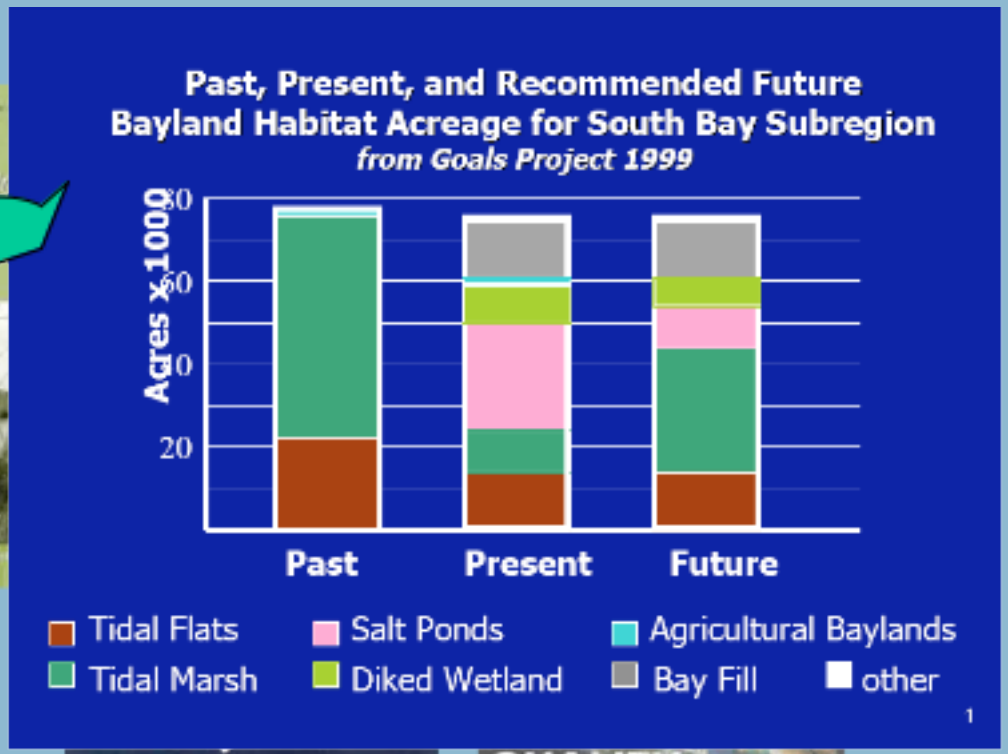
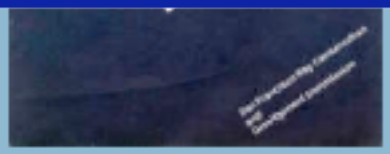
SOUTH BAY SALT POND RESTORATION PROJECT

Regional Planning Efforts





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SAN FRANCISCO BAY
SOUTH BAY SALT POND RESTORATION PROJECT

Cost of Acquisition

(6,683 ha)
- **16,500 total acres**

(6,116 ha)
15,100 in south bay

(567 ha)
1,400 along Napa river

(€72 million)
- **$100 million cost**

(€52 million)
$72M - state of California

(€6 million)
$8M - united states government

(€14 million)
$20M - Packard, Goldman, Hewlett, and Moore foundations

15

Mission:
Prepare a scientifically sound and publicly supported restoration and public access plan that can begin to be implemented in five years.

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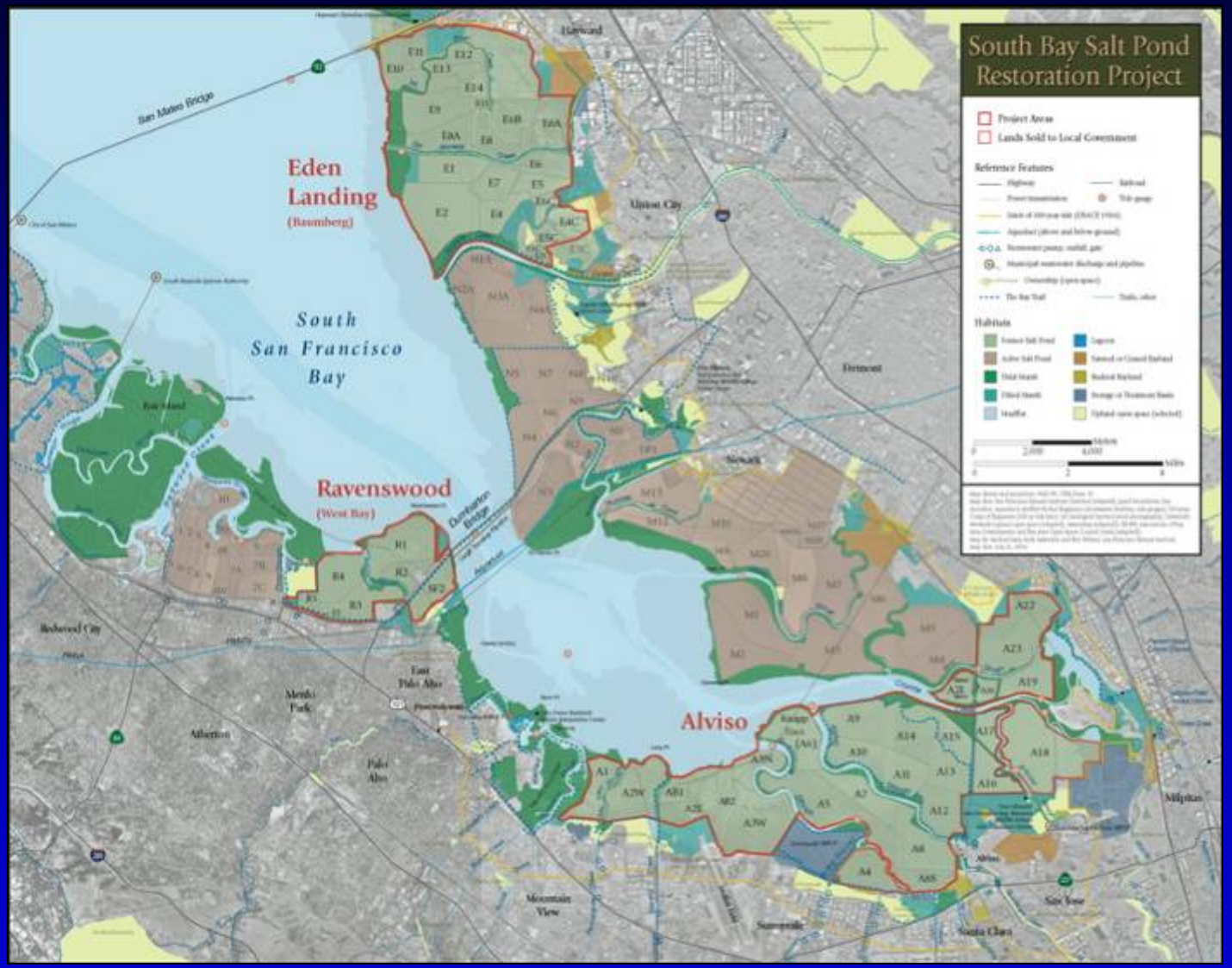
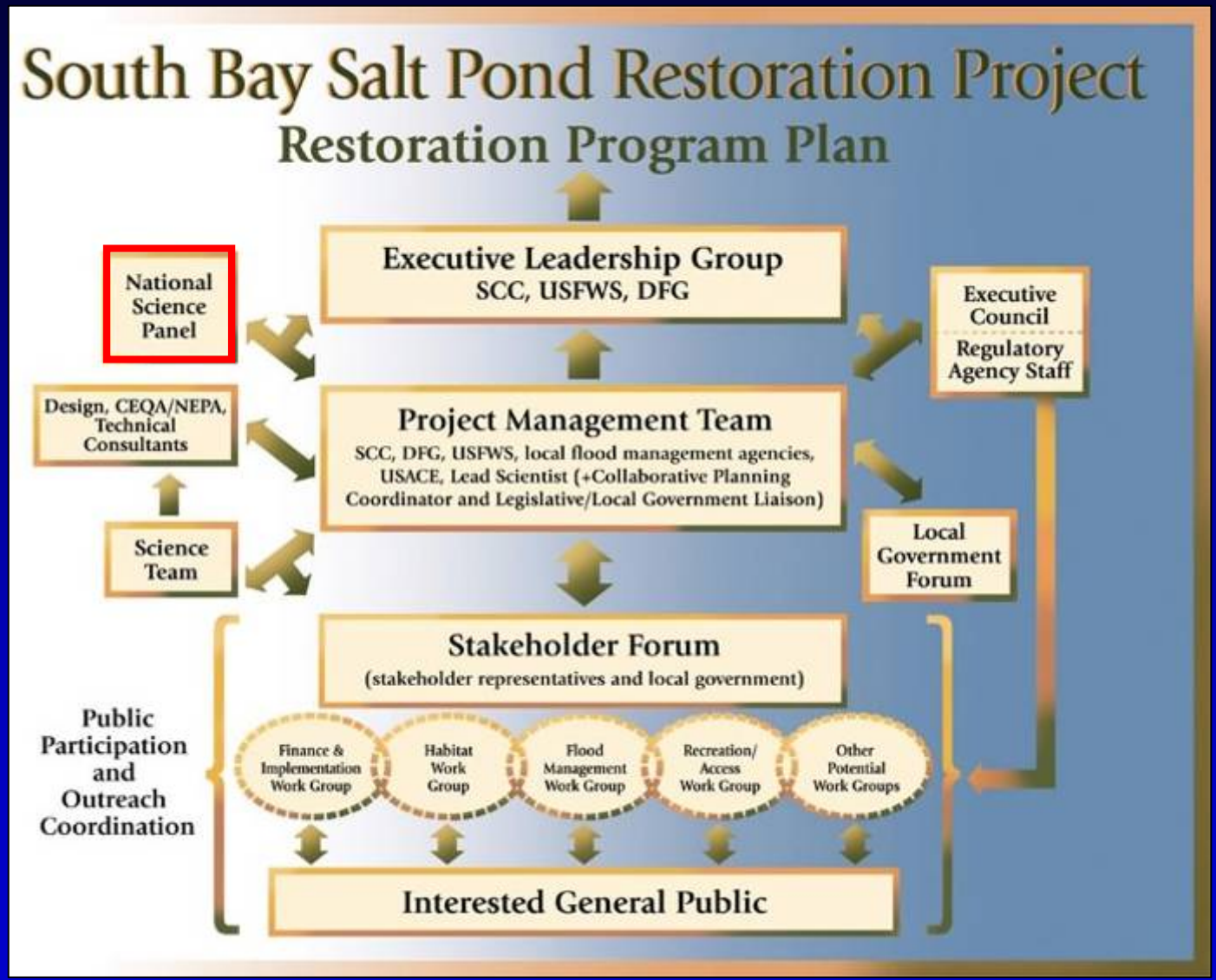
SOUTH BAY SALT POND RESTORATION PROJECT



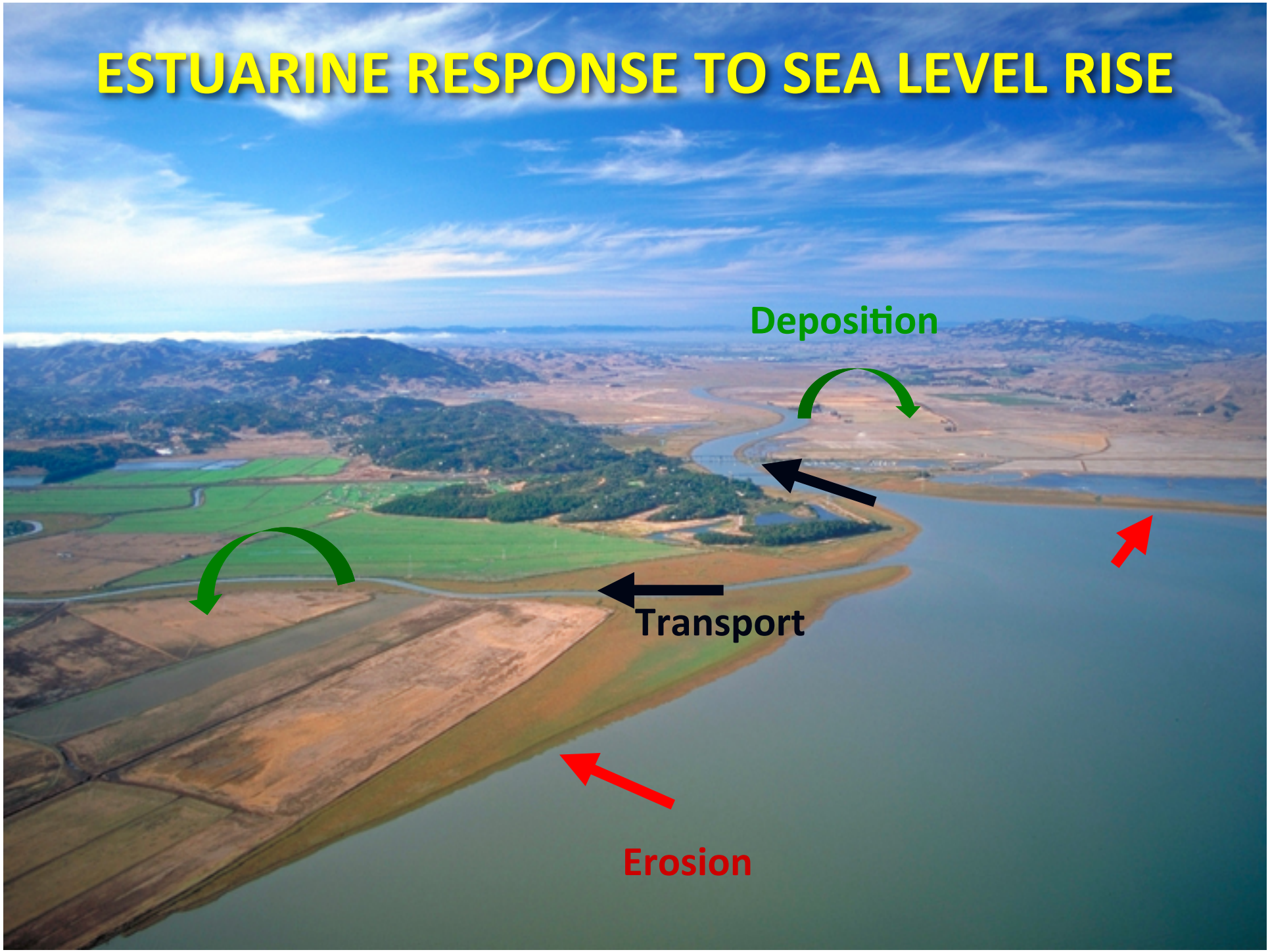
SAN FRANCISCO BAY
SOUTH BAY SALT POND RESTORATION PROJECT



SAN FRANCISCO BAY
SOUTH BAY SALT POND RESTORATION PROJECT

Challenges

- policy:
  - ✓ loss of salt pond birds
- science and engineering:
  - ✓ uncertainties—water quality, mudflat habitat loss, mercury—studies, modeling and adaptive management
  - ✓ strategic deployment of passive restoration and managed habitats over landscape
  - ✓ flood protection and erosion control
- public investment:
  - ✓ balance competing ecosystem goods and services

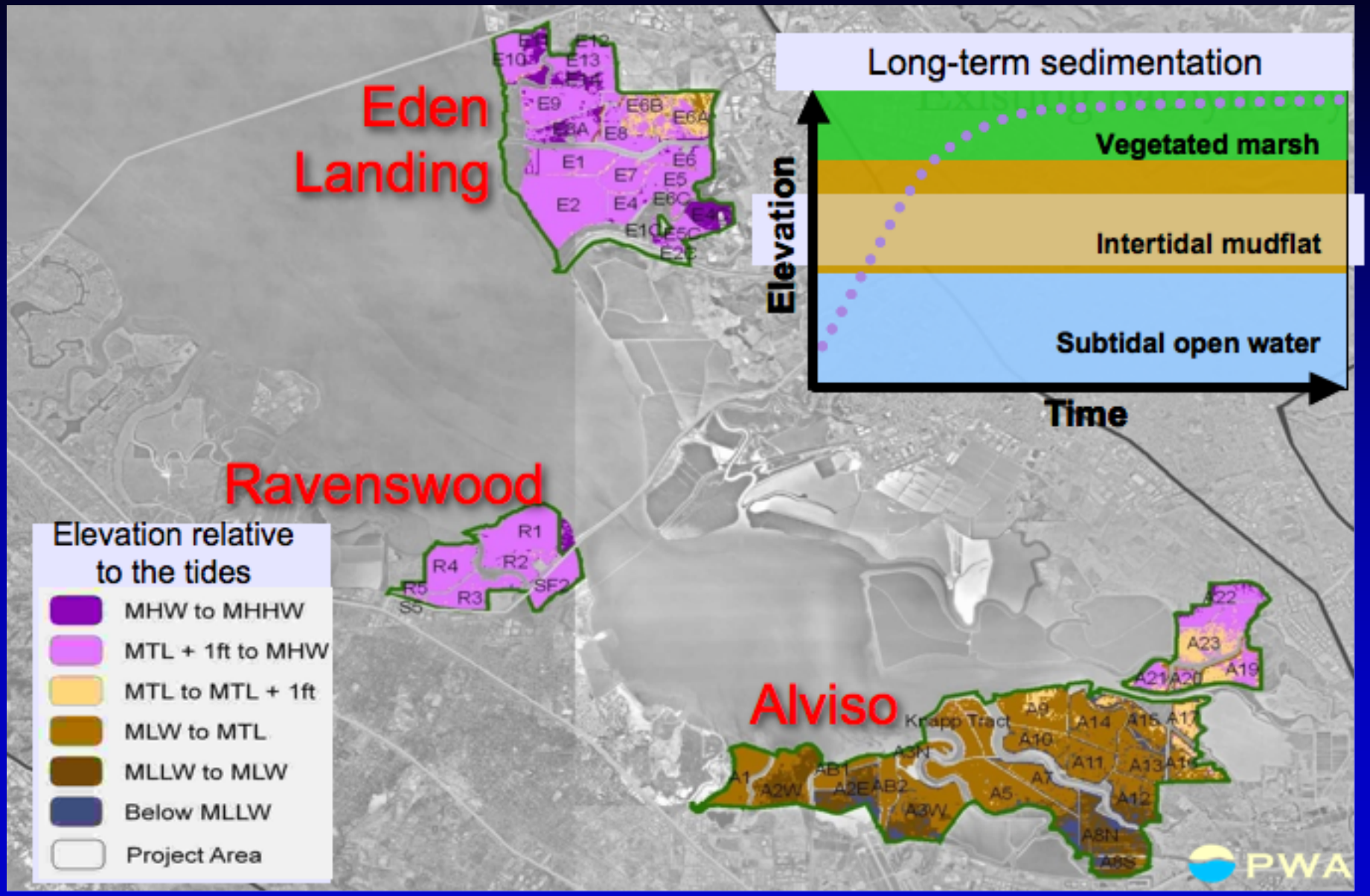

ESTUARINE RESPONSE TO SEA LEVEL RISE
Deposition
Transport
Erosion

BENEFICIAL RE-USE OF DREDGED MATERIAL

MARSH CREATED WITH DREDGED MATERIAL

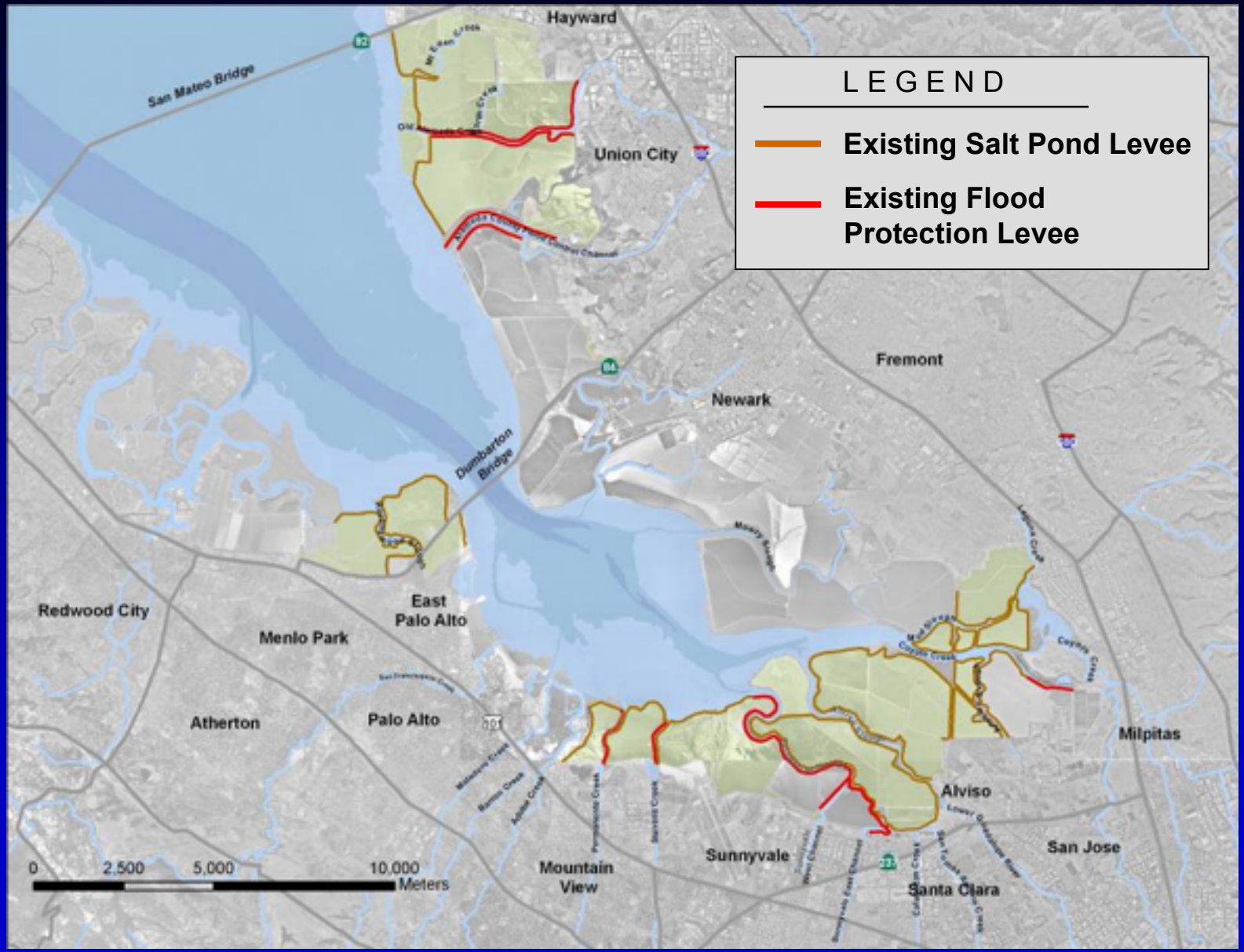
RAINBOW DREDGING

PLANNING FOR SEA LEVEL RISE



INCREASE RESILIENCE BY MAKING ROOM FOR TRANSGRESSION

EXISTING LEVEES



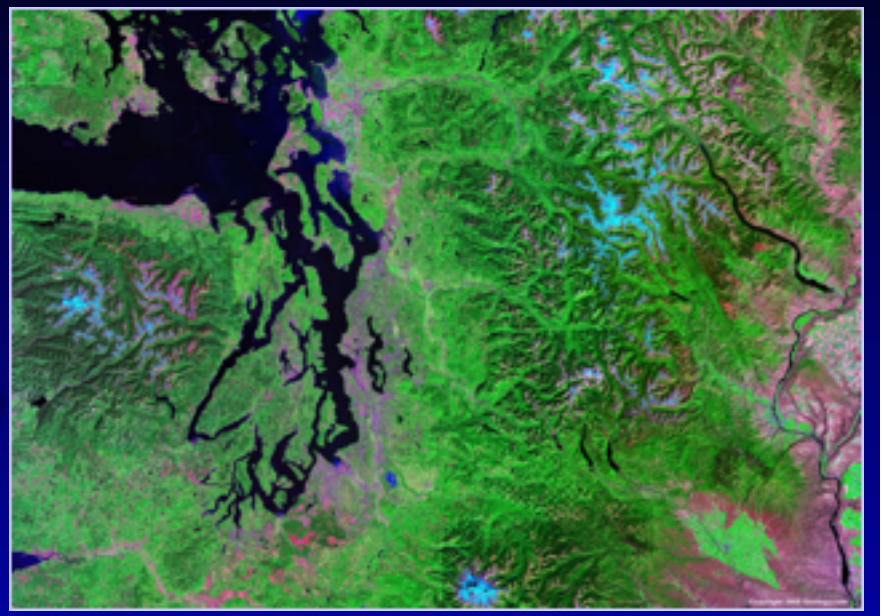
PROPOSED FLOOD PROTECTION LEVEES

SUMMARY:
South San Francisco Bay Salt Pond Restoration

1. Anything's possible! …..one person's constraints is another person's opportunity;
2. system's response to restoration may alter the present, and accepted structure and composition of ecosystems;
3. monitoring and science (particularly modeling) to predict pattern and rate of restoration is required to be adaptive, but also helps in communication; and,
4. peer review and stakeholder involvement from the beginning is invaluable.

NEARSHORE PUGET SOUND

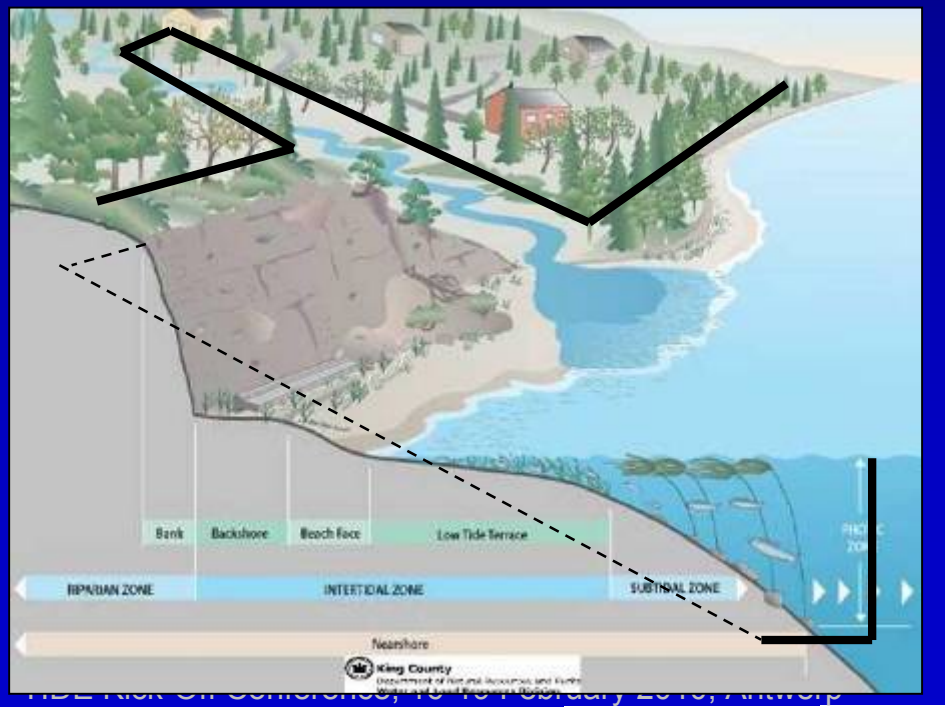
Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)…



- …is a large-scale initiative to ***protect and restore natural processes and functions of nearshore ecosystems***
- …is a General Investigation, jointly sponsored by Army COE and WDFW
  - began in 2001, completion in 2011
  - may result in USACE constriction authority and appropriation
- …is the nearshore component of the Puget Sound Partnership's strategy to restore Puget Sound
- …does not address contaminants and excess nutrient-eutrophication issues (PSP does)

NEARSHORE PUGET SOUND

The shallow water of estuarine deltas & marine shorelines, from the top of the coastal bank to water depths where light supports plant growth and up rivers to the end of tidal influence



NEARSHORE ECOSYSTEM PROCESSES

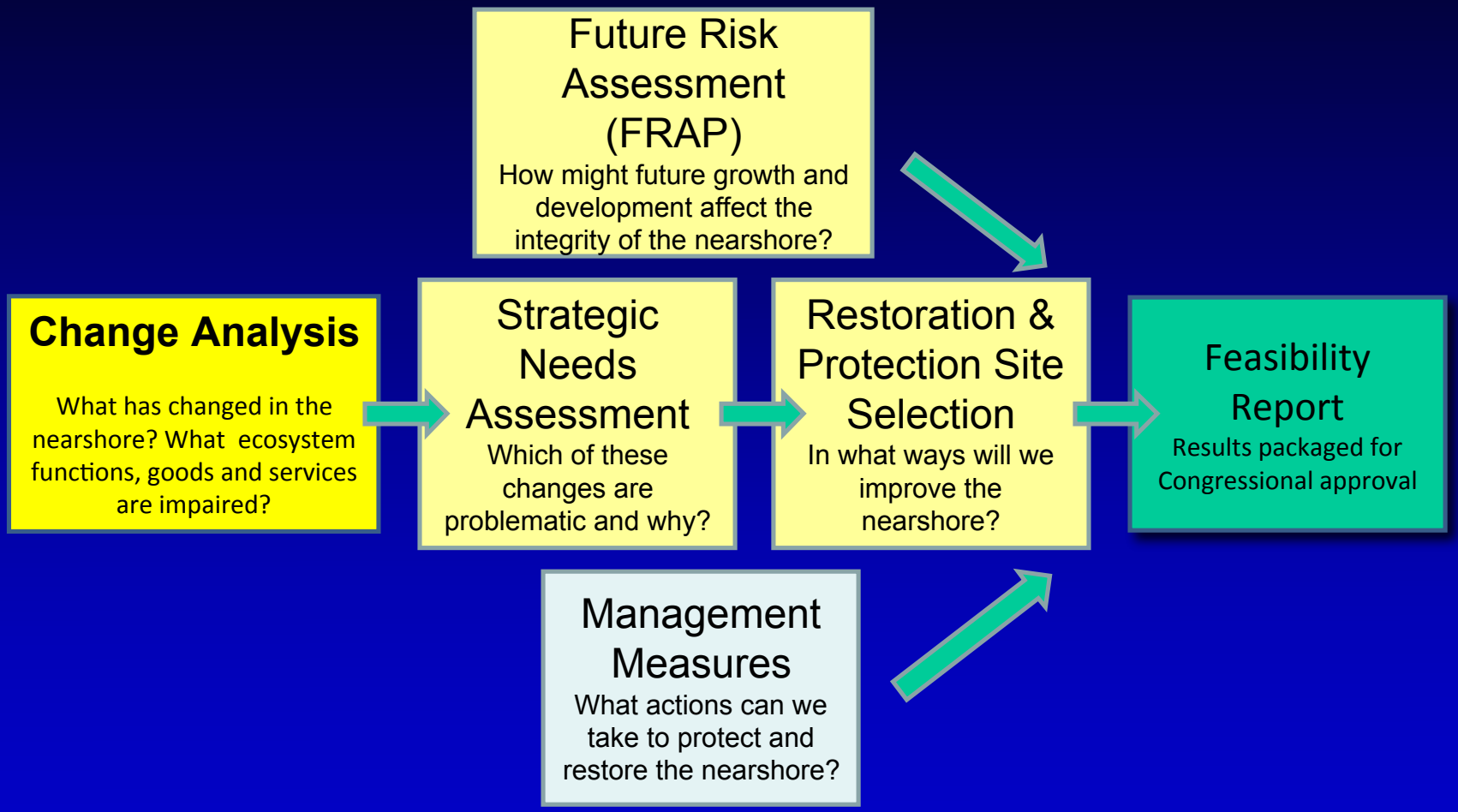
Examples of 'local' ecosystem processes:

- **Sediment Supply and Transport:** supply (from bluff, stream and marine sources) and transport of sediments and other matter by water and wind
- **Beach Erosion and Accretion:** erosion and deposition (accretion) of sediments and mineral particulate material by water, wind and other forces
- **Tidal Hydrology:** localized tidal movements, differing from regional tidal regime mostly in tidal freshwater and estuarine ecosystems
- **Localized Wind and Wave Inputs to the Shoreline:** exposure to wind-driven waves
- **Distributary Channel Migration:** combined freshwater and tidal flow influences on distributary channel form and location
- **Tidal Channel Formation and Maintenance:** geomorphic processes, primarily tidally driven, that form and maintain tidal channel geometry
- **Freshwater Input:** freshwater inflow from surface (streamflow) and groundwater (seepage) and mixing with seawater
- **Detritus Recruitment and Retention:** import and deposition of particulate (dead) organic matter
- **Exchange of Aquatic Organisms:** organism transport and movement
- **Solar Radiation:** exposure to solar radiation and resulting effects (e.g., radiant heat)

SHORELINE ALTERATIONS (PSNERP Tier 2) IN PUGET SOUND

PSNERP CHANGE ANALYSIS

Process and Products



PSNERP CHANGE ANALYSIS

Objective: *Detect and describe* ***differences between the physical structure of Puget Sound nearshore environment in the past and the physical structure of the present****, that is consistent with our conceptual model of the* ***relationships among nearshore ecosystem processes, structure and function****.*

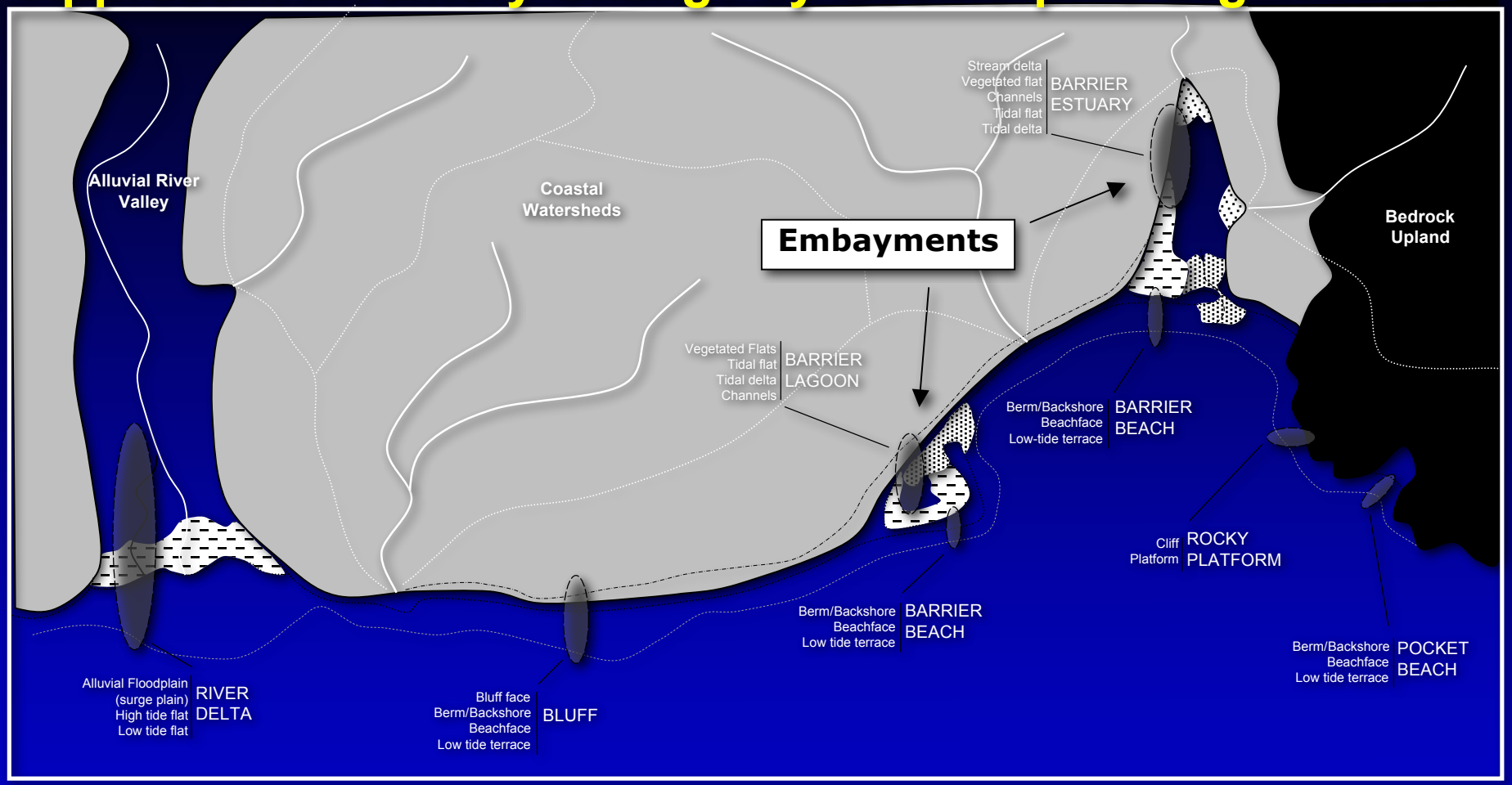
Approach: Assess change in ***types and magnitude of changes that have altered the historic functions, goods and services of natural nearshore ecosystems of Puget Sound*** over last ~125 yr

Scope and Focus:

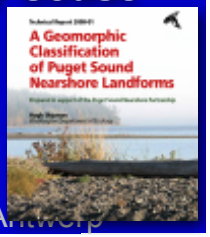
- ***nearshore ecosystem processes related to hydrogeomorphic structure***
- ***spatially explicit***
- ***landscape/ecosystem organization***
- ***comprehensive, Sound-wide***

PSNERP CHANGE ANALYSIS

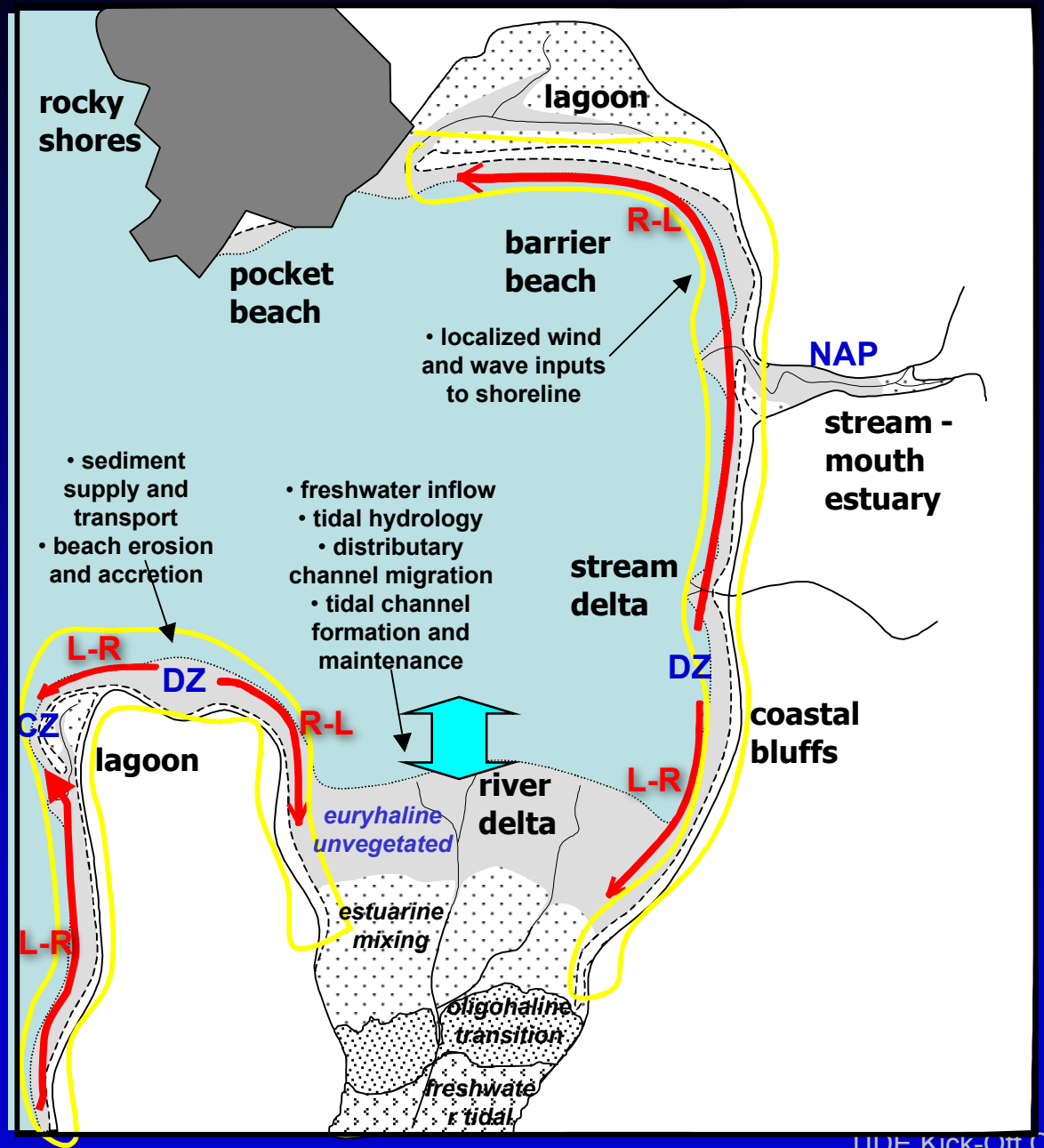
Approach: Inventory Change by Geomorphic Organization



Typical coastal shoreforms in Puget Sound (from *Shipman et al.* 2008)



NEARSHORE ECOSYSTEM PROCESSES



Nearshore Ecosystem Process Domains

Drift cell processes

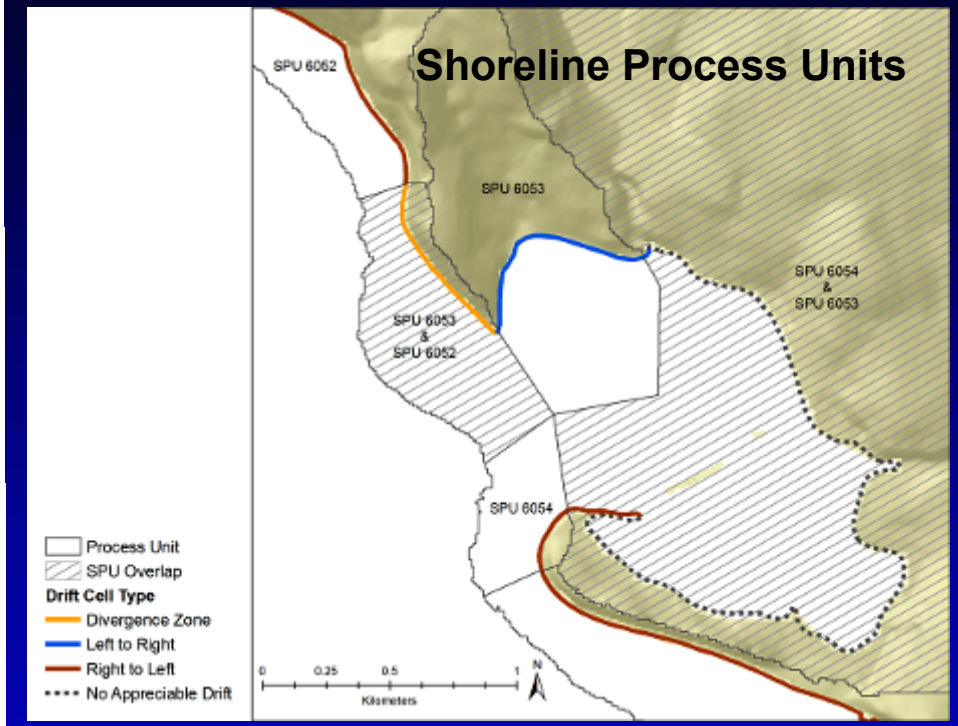
- **DZ**: Divergence Zone sediment delivery
- **R-L**: Right to Left sediment transport
- **L-R**: Left and Right sediment transport
- **CZ**: Convergence Zone sediment accretion/sink
- **NAP**: No Appreciable Drift

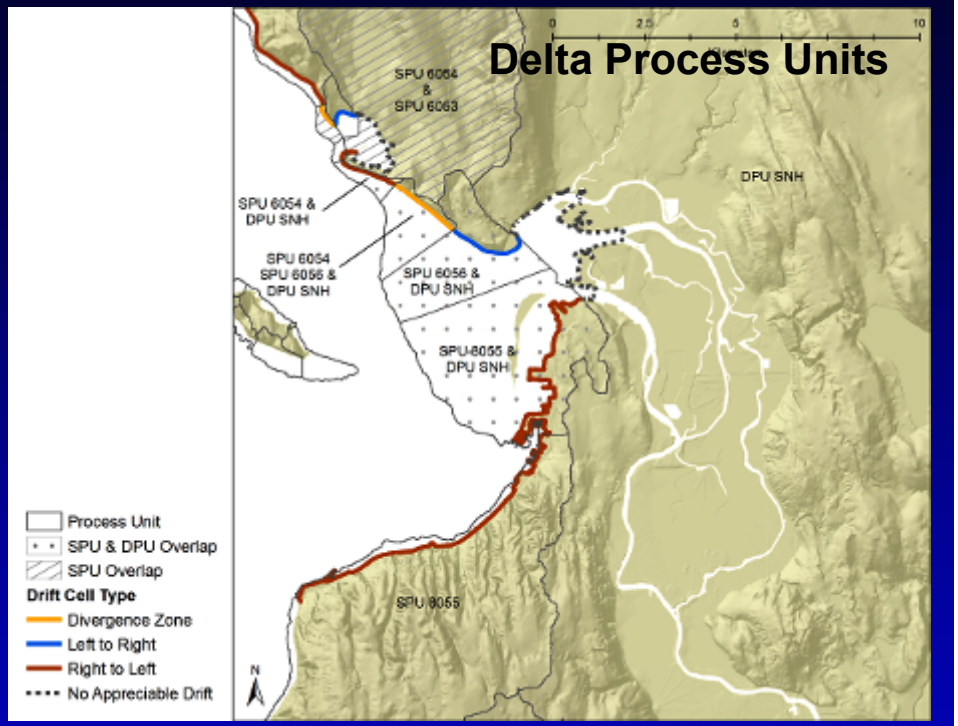
Delta processes

- **EU**: euryhaline unvegetated
- **EM**: estuarine mixing
- **OT**: oligohaline transition
- **FT**: freshwater tidal

PSNERP CHANGE ANALYSIS

Geospatial Units





Example of hierarchical organization of PSNERP geographic scale units (GSU) for shoreline process units (SPU; left) and delta process unit (DPU) in the Whidbey Basin, indicating components of littoral drift cells (Drift Cell Type). Note that SPUs overlap (cross-hatching) in the Divergence Zone and where there is No Appreciable Drift, and where SPU and DPU overlap (stippling).

PSNERP CHANGE ANALYSIS

Shoreform Transition (Tier 1)

- Historic shoreforms (A)
- Current shoreforms (B)

Shoreline Alterations (Tier 2)

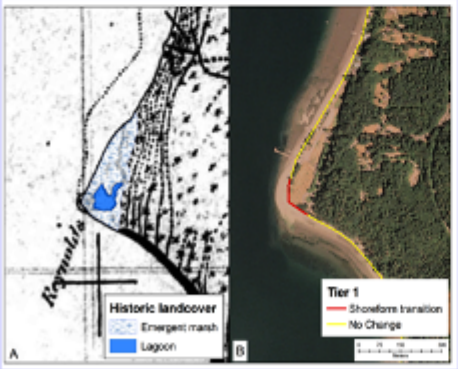
- Loss/gain intertidal classes
- Armoring
- Tidal barriers
- Breakwaters/jetties
- Overwater structures
- Nearshore fill
- Marinas
- Roads
- Railroads active
- Railroads abandoned

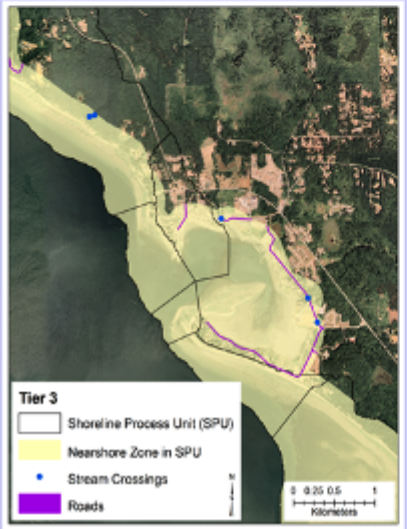
Adjacent Upland Change (Tier 3)

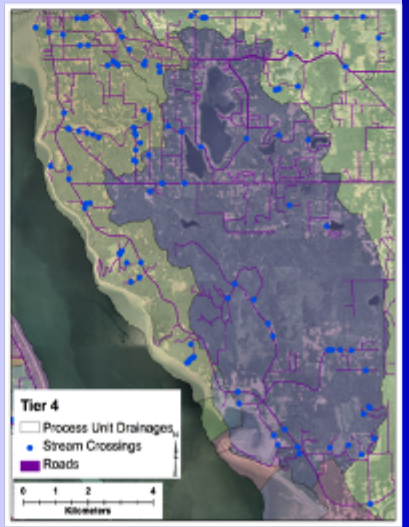
- Roads
- Railroads active
- Railroads abandoned
- Land cover
- Impervious surface
- Stream crossings

Watershed Area Change (Tier 4)

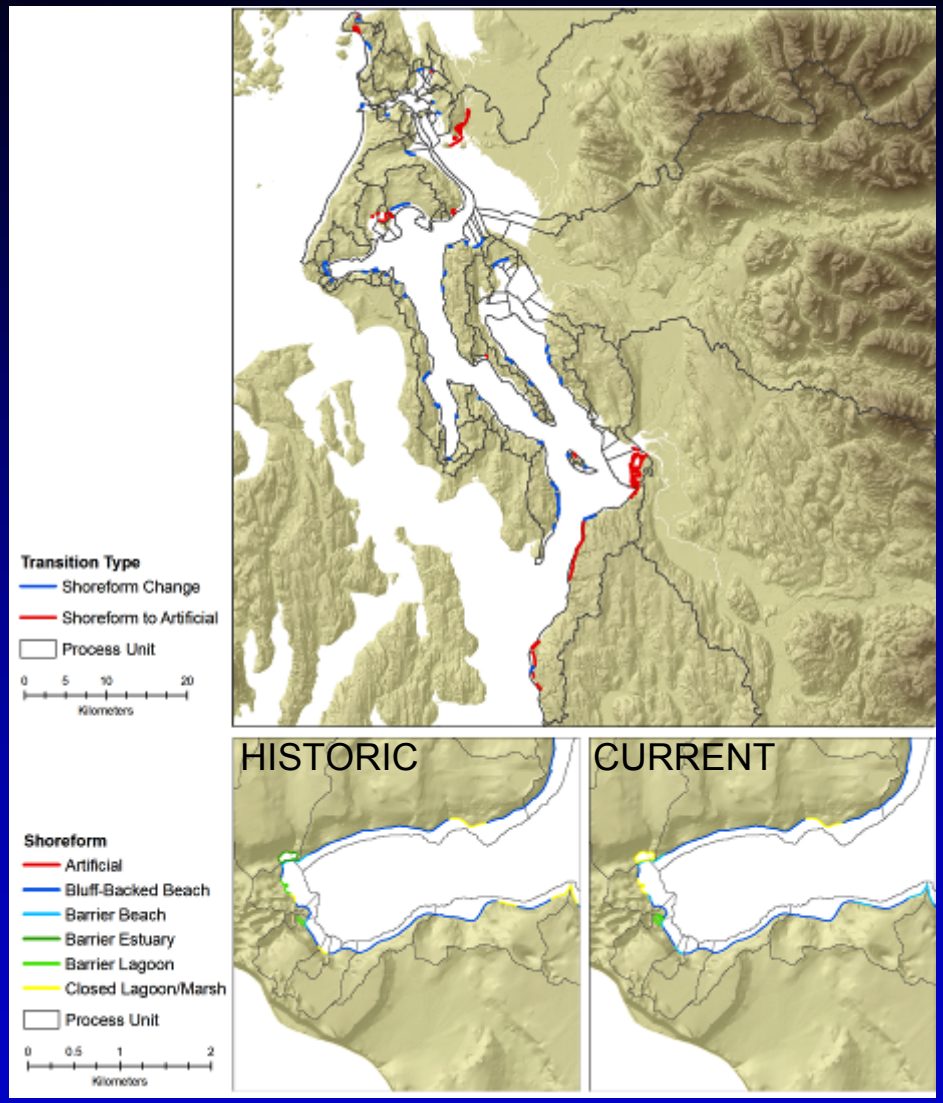
- Roads
- Railroads active
- Railroads abandoned
- Land cover
- Impervious surface
- Stream crossings
- Impounded drainage area (dams)
- Current drainage extent based on historic drainage extent







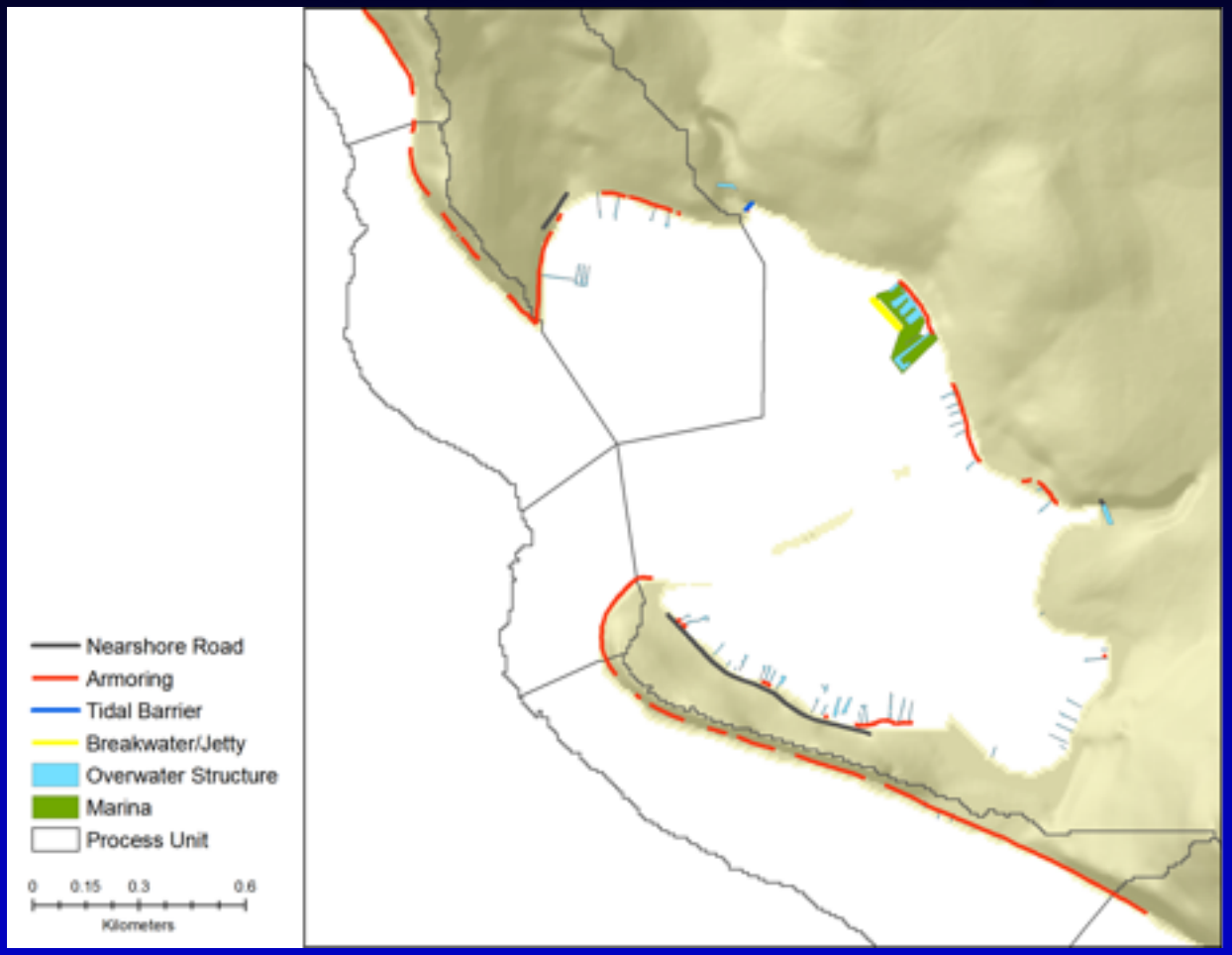
PSNERP CHANGE ANALYSIS



Example of transitions in shoreform type to Artificial shoreform in the Whidbey Sub-basin (top) and from historic (left) to current (right) of different natural shoreforms (bottom).

PSNERP CHANGE ANALYSIS

Shoreline Alterations (Tier 2)



Examples of shoreline alterations (Tier 2) changes mapped for a segment of the Whidbey Sub-Basin; other features analyzed in this category of the Change Analysis included nearshore fill, nearshore railroads (active and abandoned), and percent change in wetland classes.