Tools for Landscape-Scale Restoration Planning in the Delta

Presentation to the Delta Independent Science Board

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San Francisco Estuary Institute-Aquatic Science Center
Funded by the Ecosystem Restoration Program
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Historical ecology is:

Using the past to understand the present landscape and assess its future potential

- Links landscape pattern, process, and function
- Describes the conditions to which species are adapted
- Challenges assumptions about past landscapes
- Identifies opportunities and constraints

Historical ecology is not:

Not about prescriptive management
Not about recreating the past!
Not just the “way things were,” but the “way things work” (Safford et al. 2012)

(See also: “The Growing Importance of the Past in Managing Ecosystems of the Future” (Safford, Wiens, and Hayward 2012))
Historical conditions can no longer be attained...
(ISB 2013)

but need to reestablish historical functions and processes.
How do we create ecologically functional, resilient *landscapes*? (not just nice projects)
“Extensive wide bands or large patches of interconnected valley/foothill riparian forests…”

“Produce sinuous, high-density, dendritic networks of tidal channels through tidal areas…”

“Restore and sustain a diversity of marsh vegetation …”

-- Bay Delta Conservation Plan draft
“Restore large areas of interconnected habitats within the Delta and its watershed by 2100”
- Water Code section 85302

“Restoration of the health of the Delta’s ecological systems by addressing ecological functions and processes at a broad landscape scale”
- Bay Delta Conservation Plan draft

“Management plans and decisions need to be informed by a landscape perspective that recognized interrelationships among patterns of land and water use, patch size, location and connectivity, and species success.”
- Delta Plan draft
• How large is large?

• What should be connected to what? (and how)

• What is the whole that the parts add up to?

• And how does that look in different parts of the Delta?

→ a landscape vision
Central concept

Use an understanding of pattern and process...

to inform landscape scale restoration...

that supports ecological function
Approach is supported in the literature

“… the first step in a river restoration program should be to develop a solid understanding of what the targeted rivers were actually like…”

Montgomery 2008

“Where was habitat historically, and how did that distribution differ from today? What were the geomorphic processes that created the habitat, and how do those processes differ today?”

Collins and Montgomery 2001

Use HE to identify “landscape components” as “building blocks for restoration”

Verhoeven et al. 2008

“Historical understanding” necessary to distinguish “historical,” “hybrid,” and “novel” ecosystems– and associated restoration trajectories.

Hobbs et al. 2009

Use HE “to operationally define concepts like “ecological integrity” and “resilience”…”

Safford et al. 2012

“Knowledge of the past therefore seems to have an impact on preferences for future landscapes.”

Hanley et al. 2008
Background

• **Delta Historical Ecology Investigation** (Whipple et al. 2012)

• **Delta Landscapes Project**
  - *Management Tools for Landscape-Scale Restoration of Ecological Functions*
  - Full Delta
  - 2012-2015 (funded by ERP through DFW)

• **Application of HE to the McCormack-Williamson Tract**
  - Beagle et al. 2012 (funded by TNC)
  - *Landscape Patterns and Processes of the MWT: A framework for restoring at the landscape scale*
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Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process

- Funded by Ecosystem Restoration Program (CDFG, NOAA, US FWS)
- Collaboration with KQED QUEST and Stanford’s Bill Lane Center for the American West: science.kqed.org/quest/delta-map/
key points

- Multiple landscapes
  - Habitat mosaics arranged in distinct patterns
  - Expressed across broad physical gradients
Landscapes reflect physical gradients

**SACRAMENTO RIVER**
5.6-48.4 (21.6 average) MAF/yr
- High sediment
- Rainfall-event driven (high peaks, winter)

**SAN JOAQUIN RIVER**
1.1-19.0 (6.2 average) MAF/yr
- Low sediment
- Snowmelt driven (low peaks, late summer)
Landscapes characterized by:
• Connectivity
• Local complexity
• Temporal variability

Central Delta: where tides dominate
North Delta: where flood basins flank rivers
South Delta: where floodplains meet tides

Different characteristics
• Habitat types (proportion, size, position)
• Connectivity
• Complexity
• Temporal variability
Delta Historical Landscapes summary

- Floods wetted and connected landscape
- Channels to lakes along gradient
- Riparian forest bordering tule basins

- High degree of tidal influence
- Networks of branching channels
- Tidal wetland of tule and willow-fern swamp

- Floods within a complex landscape meet the tides
- Side-channels connected to rivers
- Habitat type diversity at local scale
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Goals and Objectives

- Metrics (past and present)
  - Synthesis of historical landscape pattern and process
  - Physical landforms

- Maps, memo on change
  - Relationship to provided ecological functions
  - Contemporary data and research

- Conceptual models, restoration principles, possible scenarios memos
  - Landscape perspective in planning and management
  - Expected future physical template

- Visuals, website, journal article
  - Social and economic considerations
  - Collective future vision and new directions
Landscape Interpretation Team

Stephanie Carlson (UC Berkeley)
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Steve Lindley (NMFS)
Jeff Mount (UC Davis)
Peter Moyle (UC Davis)
Anke Mueller-Solger (IEP and Delta Science Program)
Eric Sanderson (Wildlife Conservation Society)
Dave Zezulak (CDFG)
Ecological Functions framework (Task 3)

**Level**

**Theme**

Ecological functions

Wildlife groups

**Population Level**

- **Life History Support**
  - Provide habitat and connectivity for native resident species
  - Provide habitat connectivity for native migratory species
  - Maintain connectivity for fragmented populations
  - Maintain genetic and phenotypic variability for natural selection

**Biocomplexity**

- All wildlife (animals and plants)
- All wildlife (animals and plants)

**Community Level**

- **Food**
  - Gross food supply
  - Net food supply
  - Aquatic wildlife
  - Terrestrial wildlife at marsh edge
  - All wildlife (animals and plants)

- **Biodiversity**
  - Movement and recycling of nutrients to fuel the bottom of the food web
  - All wildlife (animals and plants)
  - All wildlife (animals and plants)
  - Maintain diverse native communities
## Ecological Functions list (Task 3)

<table>
<thead>
<tr>
<th>Category</th>
<th>Function</th>
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<td>Habitat and connectivity</td>
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<td>for pelagic fish</td>
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<td>Habitat and connectivity</td>
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<td>for demersal fish</td>
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<td>Habitat and connectivity</td>
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<td>for littoral fish</td>
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<td>and connectivity</td>
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<td>for resident mammals</td>
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<td>for marsh birds</td>
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<td>for anadromous fish</td>
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<td>for migratory waterfowl</td>
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<td>Maintain connectivity</td>
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<td>for fragmented populations</td>
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<td>Maintain diverse native</td>
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<td>communities</td>
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<td>Nutrient movement and</td>
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<td>recycling</td>
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<td>Gross food supply</td>
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<td>Net food supply</td>
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</tbody>
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# Landscape Metrics list (Task 3)

## Associated ecological functions

### Quench
- Sinuosity
- Density (by depth class)
- Total length (by width class and depth class)
- Total area (by depth class and season)
- Ratio of flow-through to blind channels

### Riparian
- Total riparian forest area
- Number of riparian forest patches
- Riparian forest patch length (by type and width class)
- Gap-absence
- Linear extent adjacent to wetlands (by type)
- Total length of wetland/upland or wetland/riparian edge

### Habitat metrics
- Patch size distribution (for select habitat types)
- Edge to area ratio (for select habitat types)
- Nearest neighbor distance (for select habitat types)
- Patch adjacency diversity
- Patch type richness

### Lnodation
- Area of wetland habitat (by depth class and season)
- Ponded area in summer (by depth class and duration)
- Wetted area in winter (by type)

### Marsh Productivity
- Estimated annual primary production (by habitat)
- Volumes of net auto- vs. net hetero-trophic habitat
- Area of marsh (by type)
Background

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Ecofunction Metrics

Physical Drivers & Gradients

Conceptual Landscape Models

Existing & Projected Physical Settings

Operational Landscape Units
with specific Landscape Metrics
and associated Ecological Functions
at Regional and Subregional scale

- Conceptual design for restoration projects
- Performance measures
- Regional vision products
- Test thru research (field, modeling, experiments)

(Verhoeven et al. 2008)
Case study: McCormack-Williamson Tract

- **Opportunities**
  - Large restoration opportunity
  - Variable topography
  - Connection to uplands and tides
  - Remnant historical features
Case study: McCormack-Williamson Tract

**Constraints**

- **Short term constraints**
  - Flooding bottleneck
  - $, process

- **Long term constraints**
  - Radio tower, access
  - Land ownership
1) It is important to know how we got here:
   ✤ How the formation of the tract underlies “constraints”
   ✤ What are the physical drivers of this landscape?
     ✤ Transition between tidal/non-tidal, transition to upland habitat types etc.

2) How do these drivers influence restoration potential?
WALNUT GROVE
GALT
HWY 5
LAMBERT ROAD
LAKES
CRAVASSE SPLAYS
TIDAL ISLANDS
SNODGRASS SLOUGH
COSUMNES SINK
SACRAMENTO RIVER
MOKELUMNE RIVER
Topographic Variability

Legend
Elevation (meters)

-0.5
-0.5-1
0-0.5
0.5-1
1-1.5
1.5-2
2-2.5
2.5-3
3-5
5-10

Map showing topographic variability with color-coded elevation ranges and specific areas marked as natural levees and lake/low spots.
Potential Operational Landscape Unit for MWT Area

- Based on position within historical and projected future Delta landscapes
- Not yet using landscape metrics and fully developed conceptual landscape models
CONCEPTUAL DIAGRAM
Habitat and Connectivity for Native Species

<table>
<thead>
<tr>
<th>Tidal Marsh Area</th>
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<tbody>
<tr>
<td>Riparian Width</td>
<td></td>
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</tbody>
</table>
### Connectivity for Fragmented Populations

<table>
<thead>
<tr>
<th></th>
<th>MWT proposed</th>
<th>MWT as part of OLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riparian Forest Connectivity</td>
<td></td>
<td></td>
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<tr>
<td>Tidal Marsh Patch Size</td>
<td></td>
<td></td>
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<tr>
<td>NND (to marsh for fish)</td>
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</tr>
</tbody>
</table>
### Biocomplexity/Adaptation Potential

<table>
<thead>
<tr>
<th>Habitat richness</th>
<th>MWT proposed</th>
<th>MWT as part of OLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous natural topo gradient (to 15m)</td>
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<tr>
<td>Marsh area in 2100</td>
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</table>
Long term opportunities

- 35 year lease on radio tower
- Lake reconnection
- Enhance lateral and longitudinal connectivity
- Acquire land between MWT and Cosumnes Preserve
- Degrade levees, tidal channels
- Acquire Dead Horse Island

Short term opportunities

- MWT
Scaling up to Full Delta: multiple, linked OLUs
Lessons from a historical perspective

- Large and interconnected habitats may mean different things for different places.
- Manage and plan with current and future expected physical gradients in mind.
- Think at the large scale and in the long term.
- The future will be different from both the present and the past, but emphasizing certain patterns and processes over others may yield a healthier ecosystem.
## Timeline and products

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
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<tbody>
<tr>
<td>2.0</td>
<td>Historical and contemporary landscape analysis</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>3.0</td>
<td>Description and comparison of past and present ecological function</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>4.0</td>
<td>Development of conceptual models, landscape-level restoration principles, and target metrics</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
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<tr>
<td>5.0</td>
<td>Communication and outreach</td>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
</tr>
</tbody>
</table>

- **Metrics (past and present)**
- **Maps, memo on change**
- **Conceptual models, restoration principles, possible scenarios memos**
- **Visuals, website, peer-reviewed paper**
THANKS

SFEI
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Jamie Kass
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The LIT

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