PLANNING ESTUARY RESTORATION IN THE USA

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STRATEGIC RESTORATION

Rehabilitation of ecosystems in extensively developed estuaries is difficult enough given the legacy of historic modifications and contamination, but restoration of ecosystem processes and recovery of at least some of the goods and services provided by natural estuarine ecosystems is particularly challenging. I provide here four vignettes of restoration planning and implementation in extensively developed estuaries of the West Coast USA that provide some potential 'lessons learned' about the need to be more strategic, as time and opportunity to achieve some level of rehabilitation, much less restoration, diminish in the face of continued development pressures and external forces such as climate change.

While there are many examples of complete or near-complete restoration of estuarine ecosystems and the fundamental processes that support them, extensively developed coastal landscapes often constrain our capability to accomplish the »build it and they will come« goals of most restoration projects. Rapidly achieving equivalency to natural (»reference«) ecosystems that will be self-sustaining in the long term is often futile given the limited opportunities to fully recover natural ecosystem processes, conditions and functions required at the watershed scale. Rather than seeking to re-create original conditions, the only feasible goal we can strive to attain is thus to establish sites that are self-regulating and integrated within their landscapes.

In this context, rehabilitation (managing natural processes and functions to provide ecosystem functions, goods and services) often is the only option. Thus, in most circumstances we should accept active restoration – human intervention to substitute or accelerate natural processes with engineered solutions – instead of the more preferable passive 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. This requires taking into account limiting factors such as:

- Landscape configuration
- Restorability of fundamental ecosystem processes
- Spatial patterns of demography, dispersion, and dispersal of key species
- Barriers to transport and dispersal of energy, organisms and important resources
- Equal weight given to the landscape context as well as the content of restoration projects.

LESSONS LEARNED

Based on personal experience with restoration initiatives in four west coast North American (USA) estuaries, (1) South San Francisco Bay, (2) Puget Sound, (3) Puyallup River estuary, and (4) Duwamish River estuary – I suggest that, while there are convincing arguments for rehabilitation in these highly altered systems, we need to approach it strategically with different expectations, planning and performance measures.

While there are many differences in the historic, cultural and, particularly legal/regulatory drivers for restoration between the USA and comparable situations in Northern Europe, the motivations are often the same: mitigation for lost resource and ecosystem function from on-going development and recovery of ecosystem goods and services that have been lost or degraded by prior activities. In the USA, comprehensive restoration actions in large, developed estuaries such as the TIDE estuaries has been driven by a combination of regulatory mitigation (e.g. US Clean Water Act), recovery of threatened or endangered species (e.g. US Endangered Species Act) or non regulatory restoration initiated by local governments, non governmental organizations and private citizens.

The following are lessons from the restoration initiatives in these four west coast estuaries.

1. South San Francisco Bay (South Bay Salt Ponds Restoration Project)

- Anything is possible, e.g. one person's constraints is another person's opportunity, where what was once considered to be unfeasible has turned into the potential of over 6,600 ha of restored estuarine wetland (Figure 26).
- The estuary's response to restoration may alter the structure and composition of component ecosystems in a way that may not be part of the historic template.

Figure 26.

A salt pond (#3, West Bay) currently being planned for restoration under the South Bay Salt Pond Restoration Project, San Francisco Bay, California, USA. Credit: Charles Simenstad, University of Washington.

- Monitoring and science (particularly modeling) to predict pattern and rate of restoration is required to be adaptive, but also helps in communication with stakeholders.
- Peer review and stakeholder involvement from the beginning of the process is invaluable.

2. Puget Sound (Pudget Sound Nearshore Ecosystem Restoration Project

- Change Analysis and Strategic Needs Assessment guidance documents helped identify the greatest need/benefit for restoration and preservation along the ~4,000 km of Puget Sound's shoreline.
- Analyses of a geospatial database facilitated inference about:
  - Relationships between nearshore ecosystem structure and the processes that create and sustain shoreline geomorphology and function
  - Landscape analysis of adjacent and cumulative effects among stressors and restoration actions
  - Planning restoration and preservation portfolios
  - Exploration of future change effects on alternative restoration and preservation strategies.

3. Puyallup River Estuary

Extensive industrial and urban development of this estuary (Commencement Bay) suggests that:

- Although you can't restore historic estuary structure, it is possible to strategically enhance function for target species such as endangered Pacific salmon (*Oncorhynchus* spp.) if ecosystem processes (e.g., river flow, sedimentation) are still intact.
- Spatially-explicit identification of salmon habitat needs can lead to new, more strategic restoration and rehabilitation targets (Figure 27) .
- Legacy contaminants will continue to be a stressor vis-a-vis recontamination of rehabilitation sites.

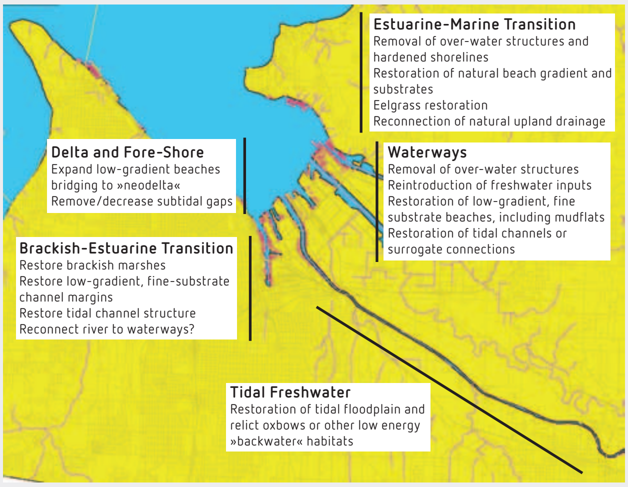

Figure 27.

Strategic actions to restore and rehabilitate juvenile Pacific salmon habitats in Commencement Bay, Puget Sound, Washington, USA. Credit: Charles Simenstad, University of Washington.

4. Duwamish River Estuary

In an estuary that has lost ~98 % of its tidal wetlands over a century of development, rehabilitation of less than 7 ha of tidal ecosystems by 13 projects since 1988 has provided some important lessons:

- Small but strategic changes can produce significant ecosystem benefits if positioned appropriately in the estuarine landscape and designed to maximize landscape linkages, as evidenced by the documented functional response by fish and wildlife (Figure 28).
- The developed landscape can offer an experimental tableau for testing alternative restoration approaches, performance standards and monitoring.
- Initiatives in urban estuaries offer the opportunity for expansion of public understanding, appreciation and even direct involvement in restoration
- As is the case with some resources, such as at-risk anadromous salmon, we cannot afford NOT to ensure that watershed restoration and all other measures toward salmon recovery are not compromised by failure to rehabilitate their estuarine habitat.

A MESSAGE FOR THE TIDE PROJECT

Figure 28.

Main intertidal basin of Herrings House restoration site shortly after reinundation by tide, lower Duwamish River estuary, Puget Sound, Washington, USA. Credit: Curtis Tanner, USFWS.

Integrating over these experiences, some important »take home messages« should be applicable to the TIDE project:

- The need to acknowledge system constraints and understand and work with extant ecosystem processes.
- The value in being strategic in approach and deployment of restoration and rehabilitation actions that maximize environmental benefit.
- Planning and designing rehabilitation and restoration for landscape connectivity, both proximally as well as at regional scale.
- Being more innovative, integrating both active and passive restoration.
- Deploying and managing adaptively.

- Looking to the future for both constraints as well as opportunities (e.g., climate change, population growth, development).
- Employing interdisciplinary science and engineering teams to confront the complex issues of rehabilitating highly developed landscapes.
- The importance of employing models – conceptual to hydrodynamic, sedimentological, and ecological – to test hypotheses responses and support adaptive management.

Ultimately, the challenges of rehabilitating estuarine ecosystems in urbanized and industrial estuaries in the USA and northern Europe are the same: managing expectations and using the best scientific and technical tools to ensure that the results are strategic. We should be encouraged to optimize the credibility and dissemination of efforts in this direction by: using external peer review and other ›lessons learned‹ mechanisms; producing white papers and other guidance documents that provide timely dissemination of results to the broader restoration community; contributing to applied science publications; and, collaborating in international forums at all scales through workshops and international meetings.

A NEW VISION FOR THE LOIRE RIVER ESTUARY

Pierre Bona – GIP Loire Estuaire

THE LOIRE ESTUARY

The Loire River extends over 1000 km with a catchment covering a fifth of France. Its flows varies dramatically from 150 to 6200 m^3/s. Its estuary extends over 100 km and passes through the city of Nantes, located some 55 km away from the sea and built on high ground, and through areas of unprotected low-lying agricultural land, mainly used for cattle grazing (Figure 29).

Figure 29.
Upstream view of the Loire estuary. Credit: Gerpho.

RIVER ALTERATIONS

For the past two centuries, the Loire estuary has undergone a series of major public works to maintain safe shipping conditions to the Port of Nantes. Initially, the estuary was shallow with a multi-channel and island system. It was deepened and transformed into a single channel to help the tide propagate upstream more efficiently.

However this has resulted in an alteration of estuary hydrosedimentological processes, with some negative impacts on the various users of the Loire River:

- Low water levels have dropped dramatically, which has resulted in an increase in the tidal range in Nantes from 3 m to more than 6 m within the past 100 years
- The salt intrusion has progressed upstream
- Turbidity has developed in extent and concentration

RESTORATION PLAN

Faced with such problems, it was decided in the 1990s to initiate an ambitious study and monitoring programme, as part of the ›Plan Loire‹, to improve the understanding of the estuarine processes, set common objectives for the future of the estuary and define a possible restoration scheme.

The stakeholders decided on a new common vision for the estuary, based on more balanced objectives between economy, urban development, environment and amenities. The study programme has shown that it is possible to restore the hydrosedimentological processes by modifying the estuary morphology, while providing better conditions for its users.

The proposed restoration scheme is based on two main actions: the recreation of mudflats along the downstream part of the estuary and the filling up of deep sections in the navigation channel, downstream of Nantes. Both will reduce the tendency of the Loire to trap fine sediments in its internal estuary while restoring key ecological functions.

PILOT PROJECT

The GIP Loire Estuaire, who is the project manager for this restoration programme, is a partnership organisation created by the main estuary stakeholders in 1998 to advance and capitalize on knowledge in the downstream part of the Loire river. The GIP Loire Estuaire is now considering the creation of a 100 ha mudflat in the estuary, as part of a pilot project, before implementing this type of intervention in a larger scale (500 ha). The new mudflat will be created by digging into areas of unprotected low-lying agricultural land, used for cattle grazing, and/or reed beds of high ecological value (Figure 30).