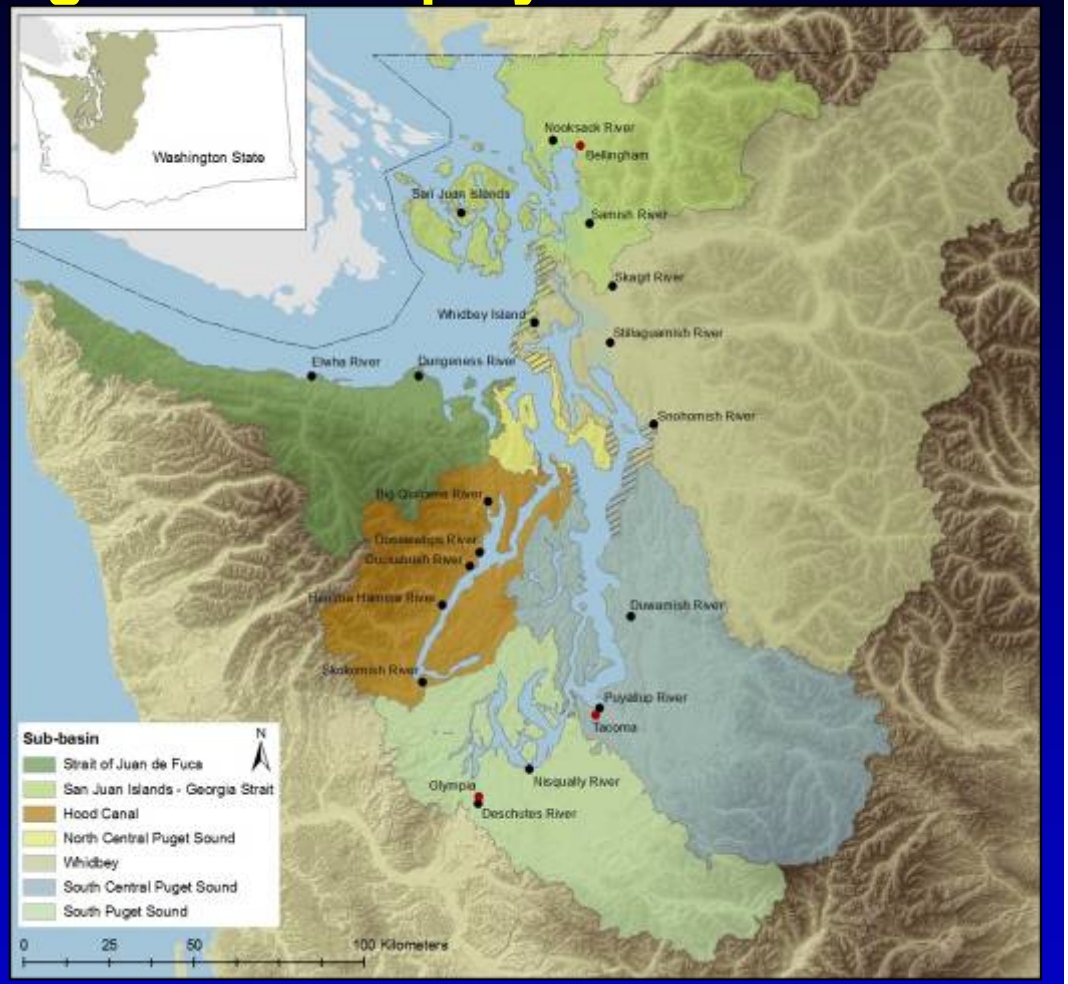
PSNERP CHANGE ANALYSIS

Results Categories & Display

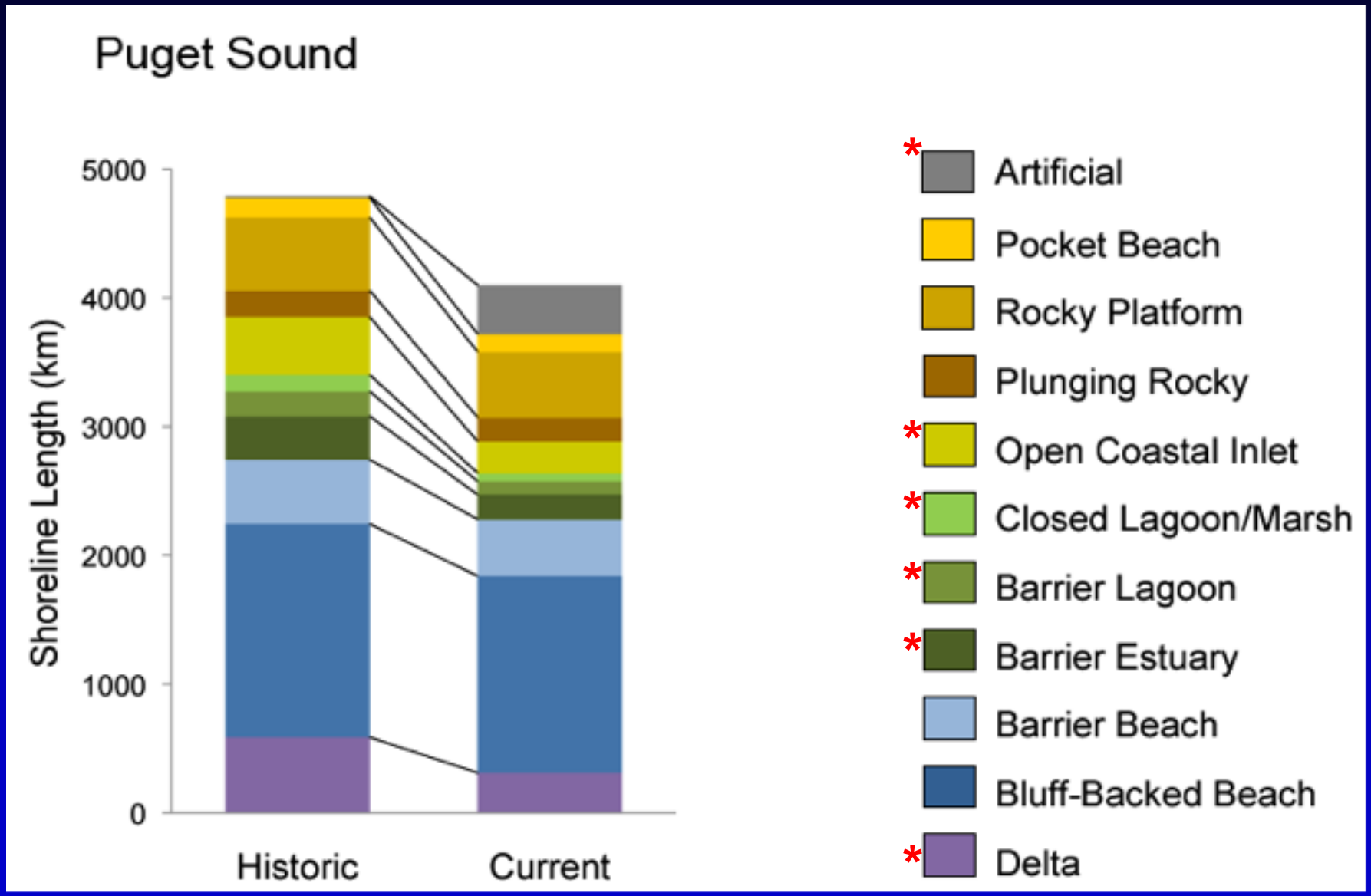
For each of the four categories (tier), we quantify nearshore ecosystem change and rank EFG&S impairment of nearshore ecosystem processes at four scales:

1. Comprehensive, Puget Sound-wide
2. Puget Sound (PSNERP-defined) sub-basins
3. Within process units
4. Among attributes of change within process units



PSNERP CHANGE ANALYSIS

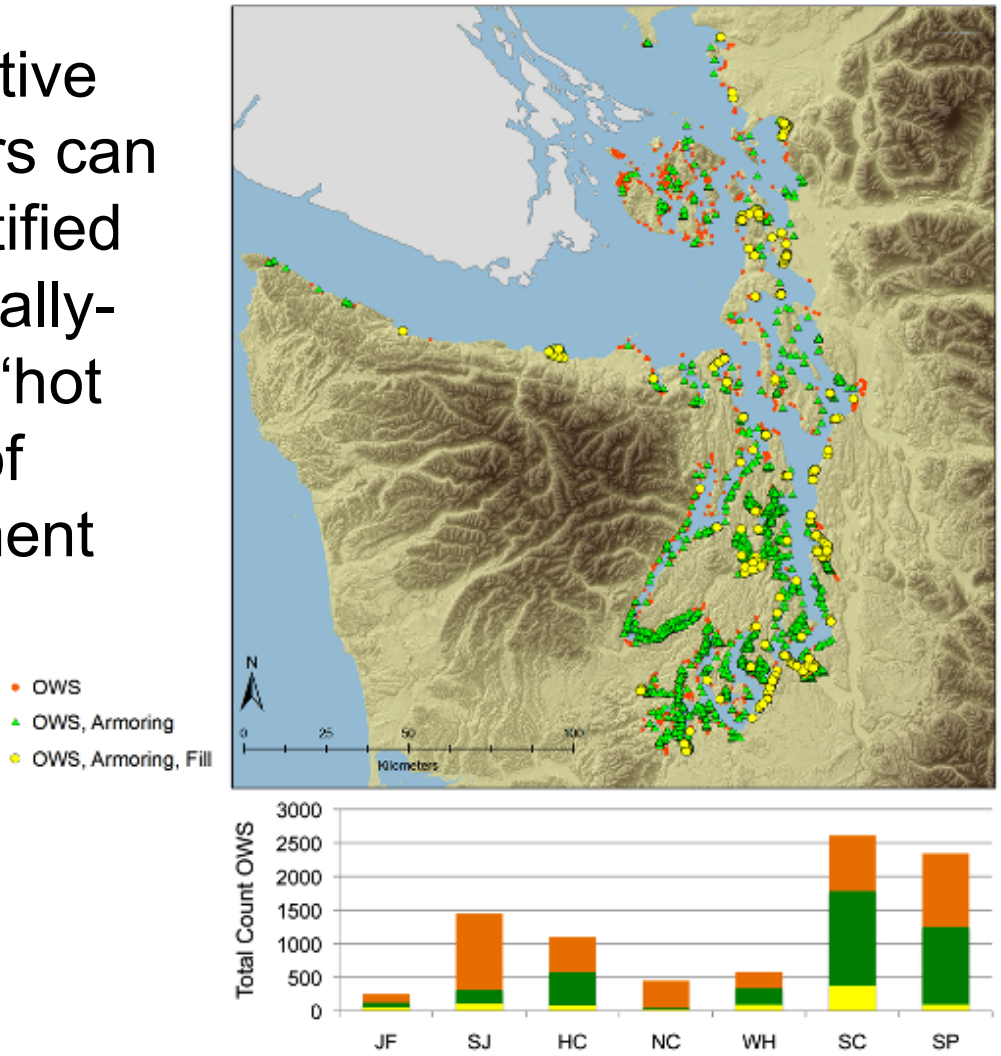
Historic Shoreform Change Sound-Wide



PSNERP CHANGE ANALYSIS

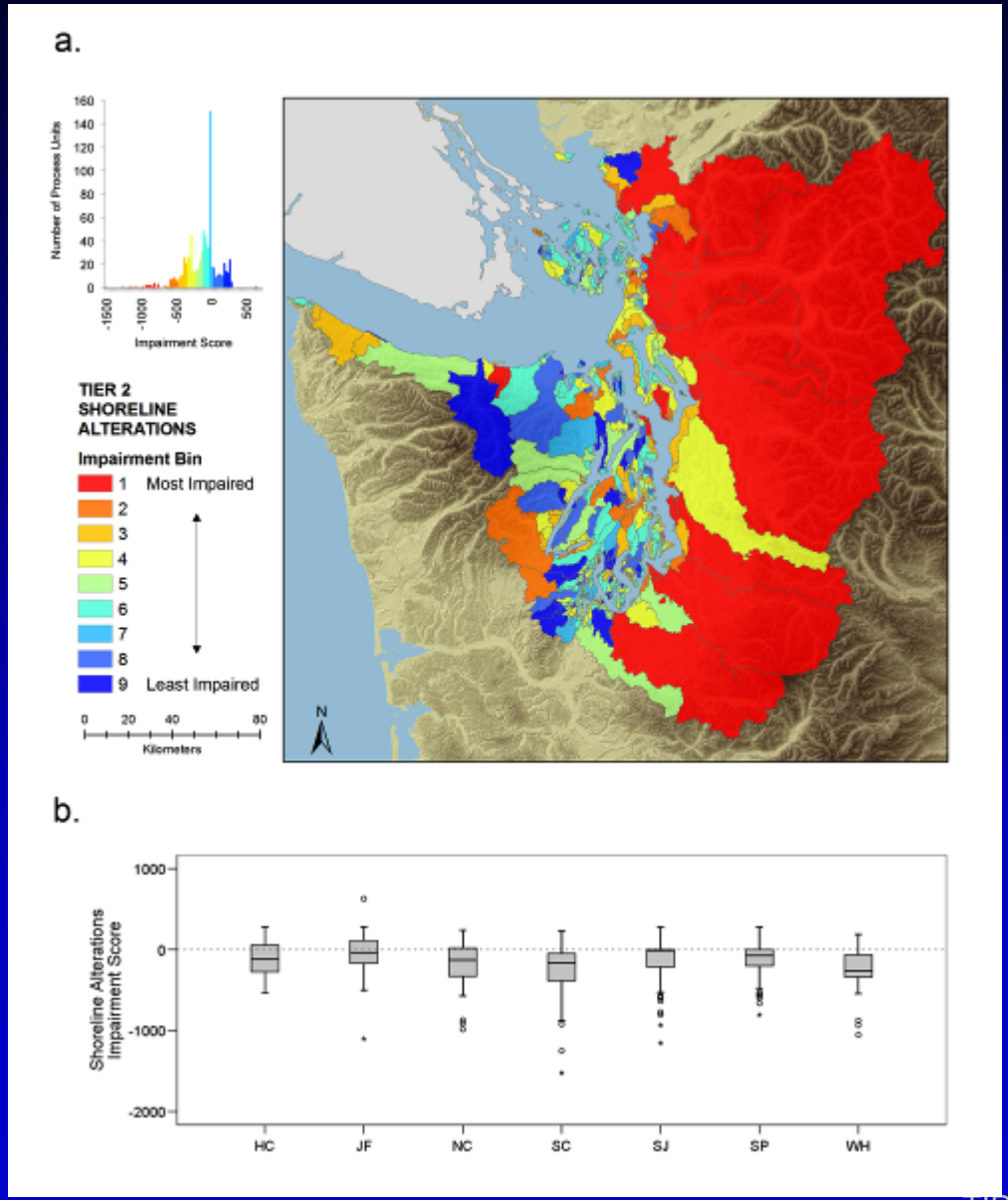
Cumulative Shoreline Alterations

Cumulative stressors can be identified as spatially-explicit “hot spots” of impairment



PSNERP CHANGE ANALYSIS

Impairment due to Shoreline Alteration



Top right: Potential nearshore ecosystem impairment due to shoreline alterations (Tier 2) among Sound-wide process units (PU) symbolized by Impairment Bin.

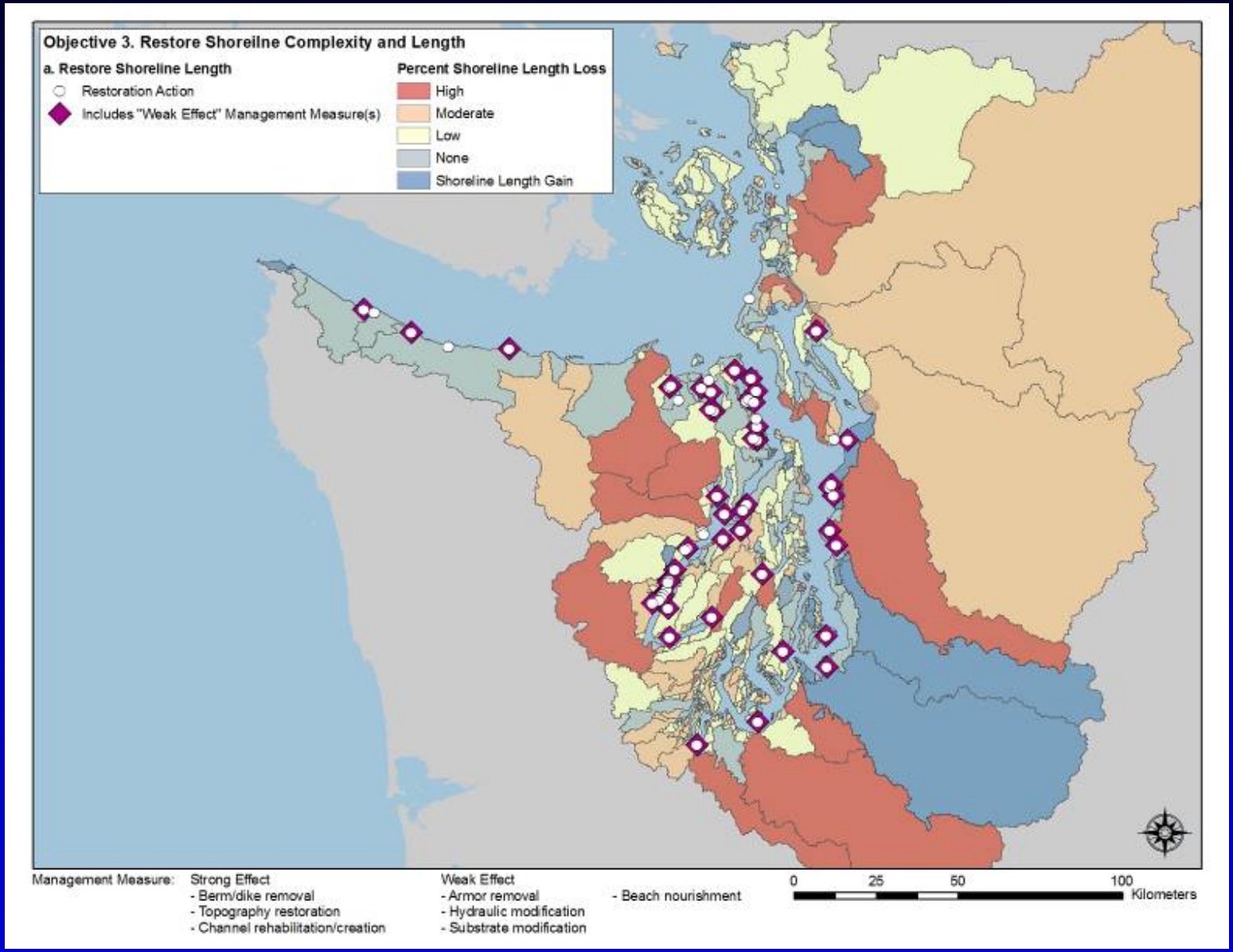
Top left: Frequency distribution of Impairment Scores.

Bottom: Range of Impairment Scores by Sub-basin. Boxplot shows the median, interquartile range (box length), outliers (cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box), and extreme cases of individual variables (cases with values more than 3 box lengths from the upper or lower edge of the box).

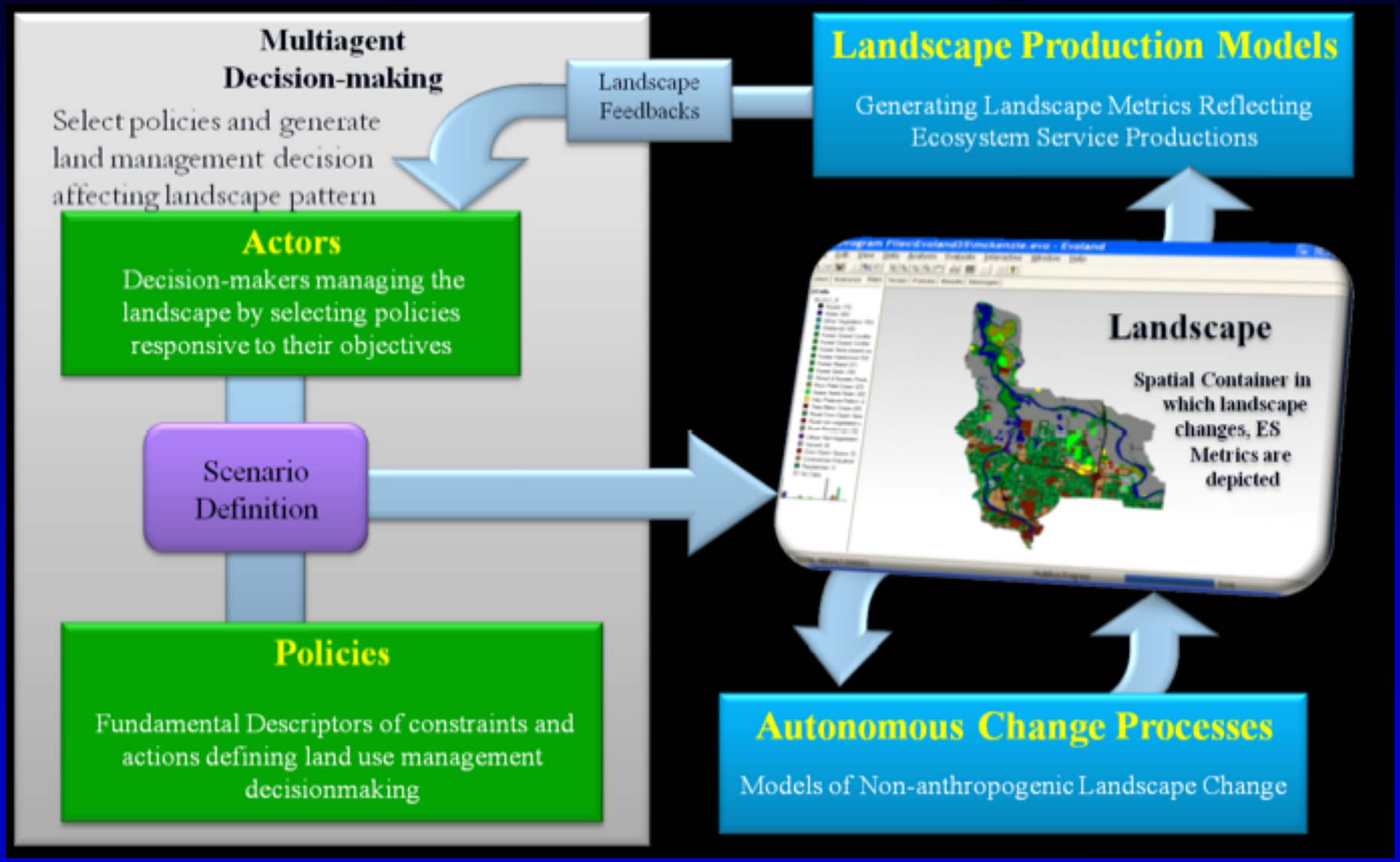
PSNERP Strategic Needs of Puget Sound Nearshore Ecosystems

1. Restore connectivity and size of large river deltas
2. Restore sediment input, transport and accretion processes
3. Restore shoreline complexity and length
4. Enhance landscape heterogeneity and connectivity
5. Protect relatively undegraded processes in large river deltas
6. Protect relatively undegraded sources of sediment
7. Protect relatively undegraded embayments
8. Increase understanding of natural processes restoration to improve effectiveness of project actions

STRATEGIC RESTORATION/PRESERVATION PORTFOLIO DEVELOPMENT

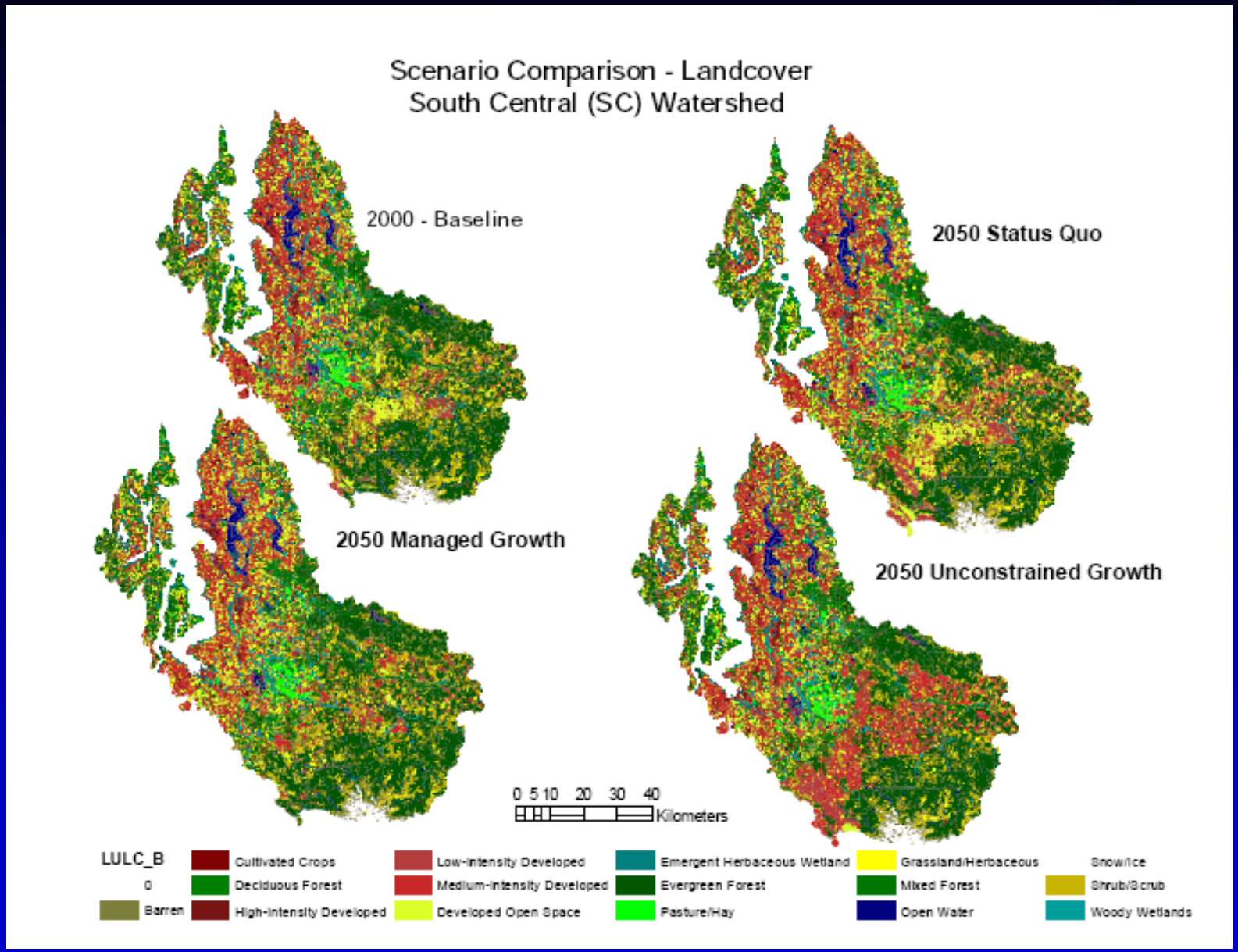


FUTURE RISK ASSESSMENT PROJECT (FRAP)
Puget Sound ENVISION Project



Bolte & Vache; OSU; http://envision.bioe.orst.edu/StudyAreas/PugetSound/index.html

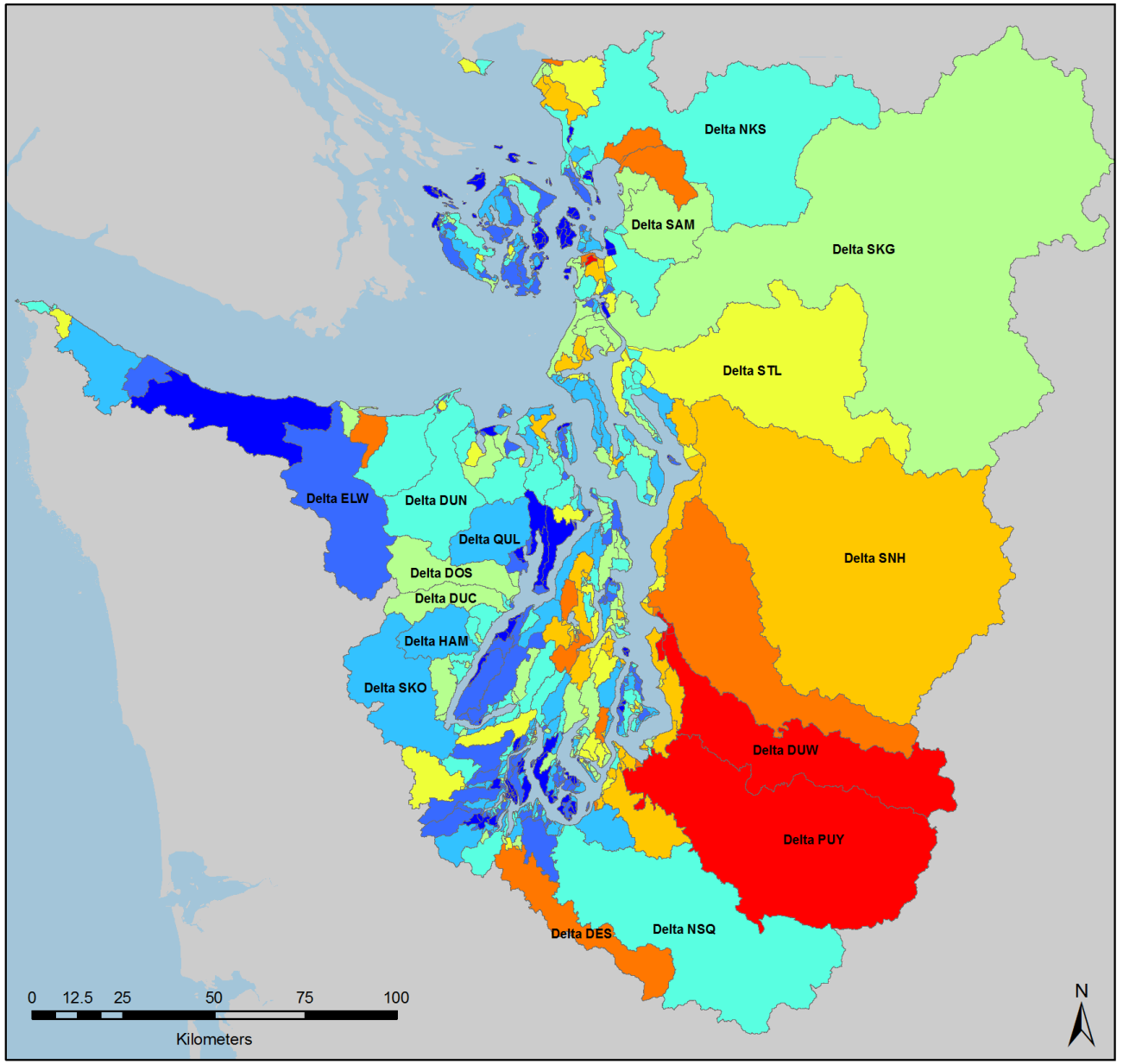
FUTURE RISK ASSESSMENT PROJECT (FRAP)



Bolte & Vache; OSU; http://envision.bioe.orst.edu/StudyAreas/PugetSound/index.html

FUTURE IMPAIRMENT?

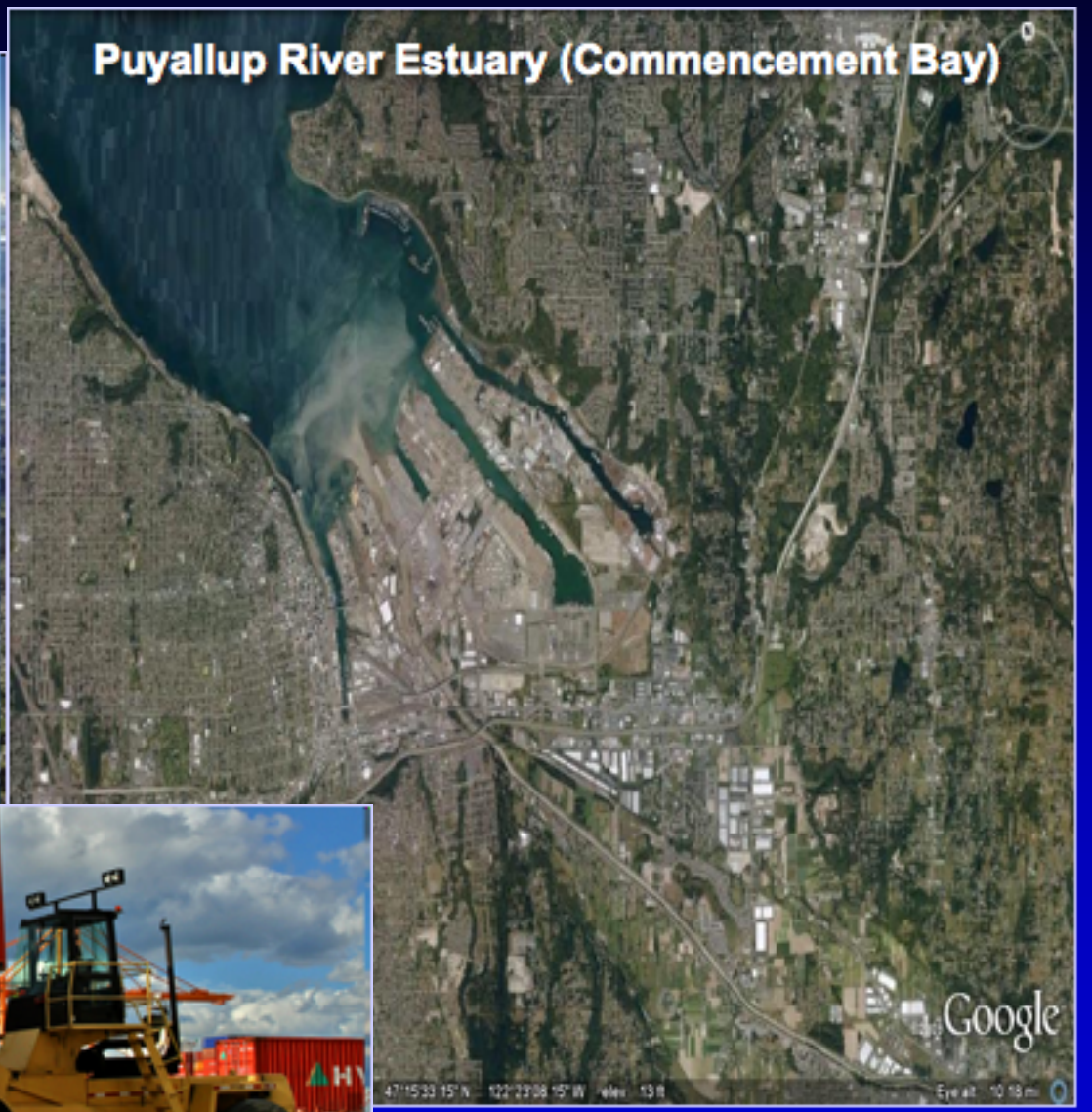
Potential Changes in <u>Adjacent Upland</u> (Tier 3) Impairment under FRAP *Status Quo* Scenario



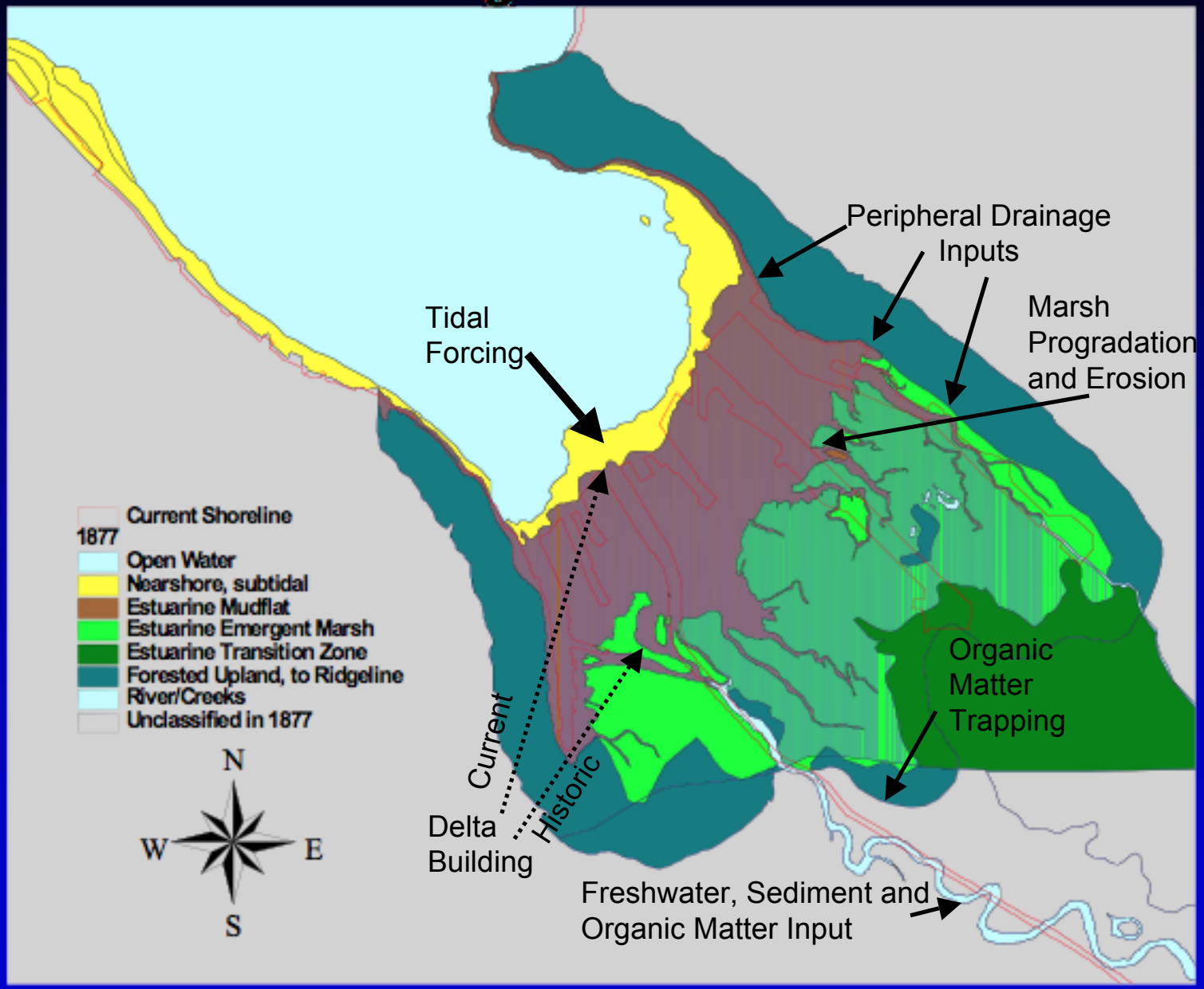
SUMMARY:
Puget Sound Nearshore Ecosystem Restoration

- PSNRP Change Analysis and Strategic Needs Assessment documents historical change in geomorphic structure of deltas, beaches and embayments of Puget Sound, and the greatest need/benefit for restoration and preservation
- Geospatial database and analyses facilitate:
  - **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

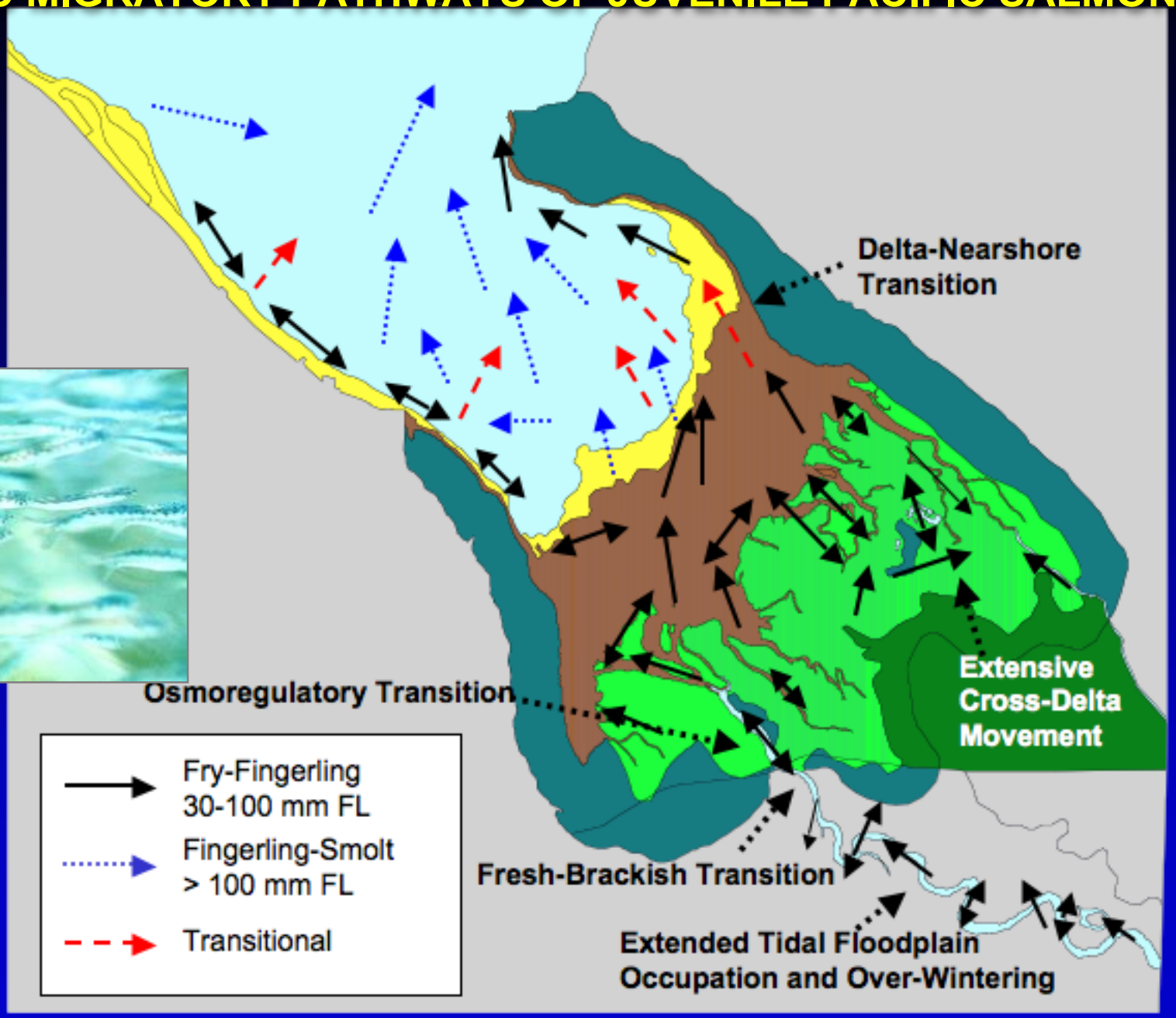
PUYALLUP RIVER ESTUARY



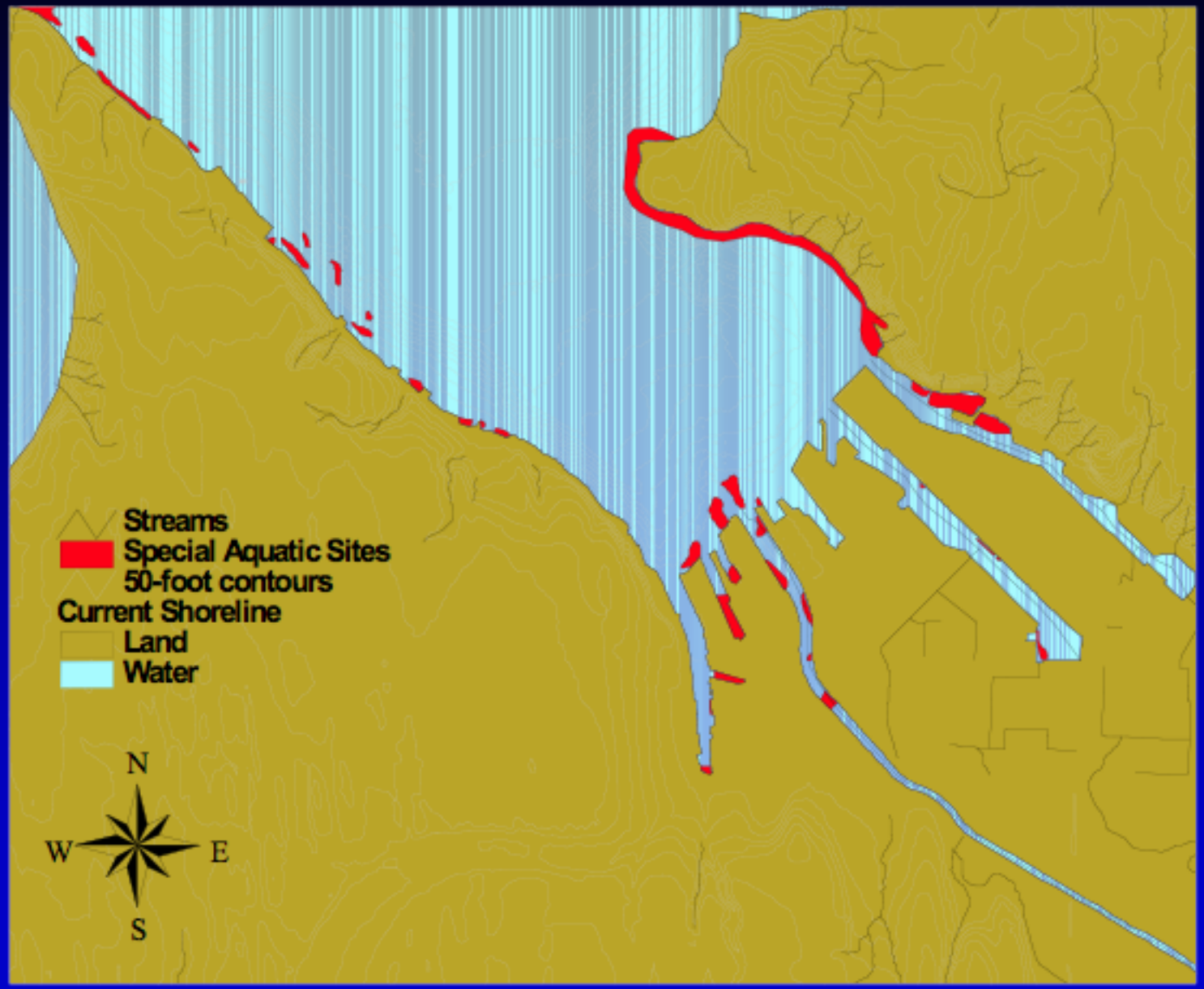
HISTORIC ECOSYSTEM STRUCTURE AND PROCESSES



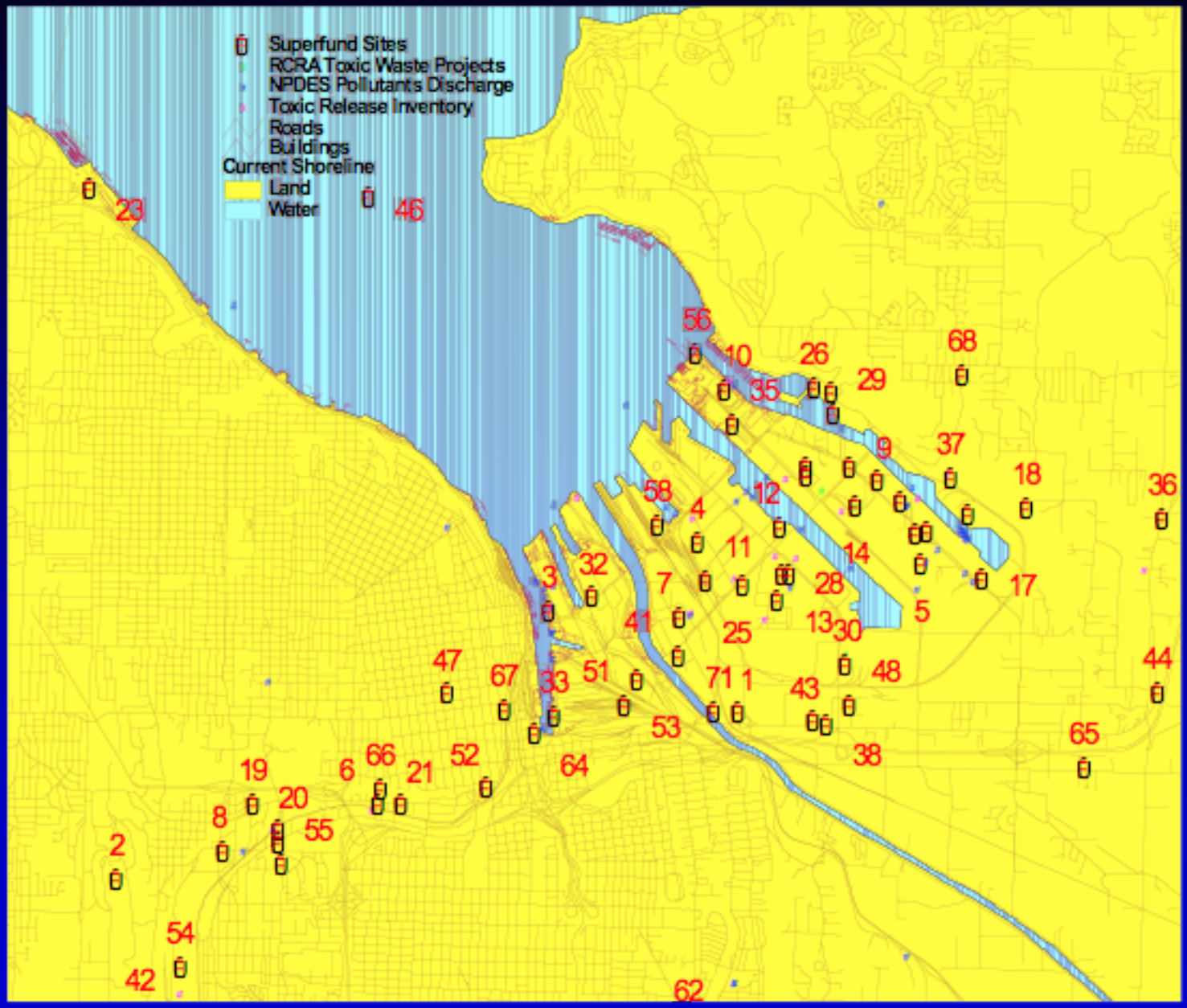
HISTORIC MIGRATORY PATHWAYS OF JUVENILE PACIFIC SALMON



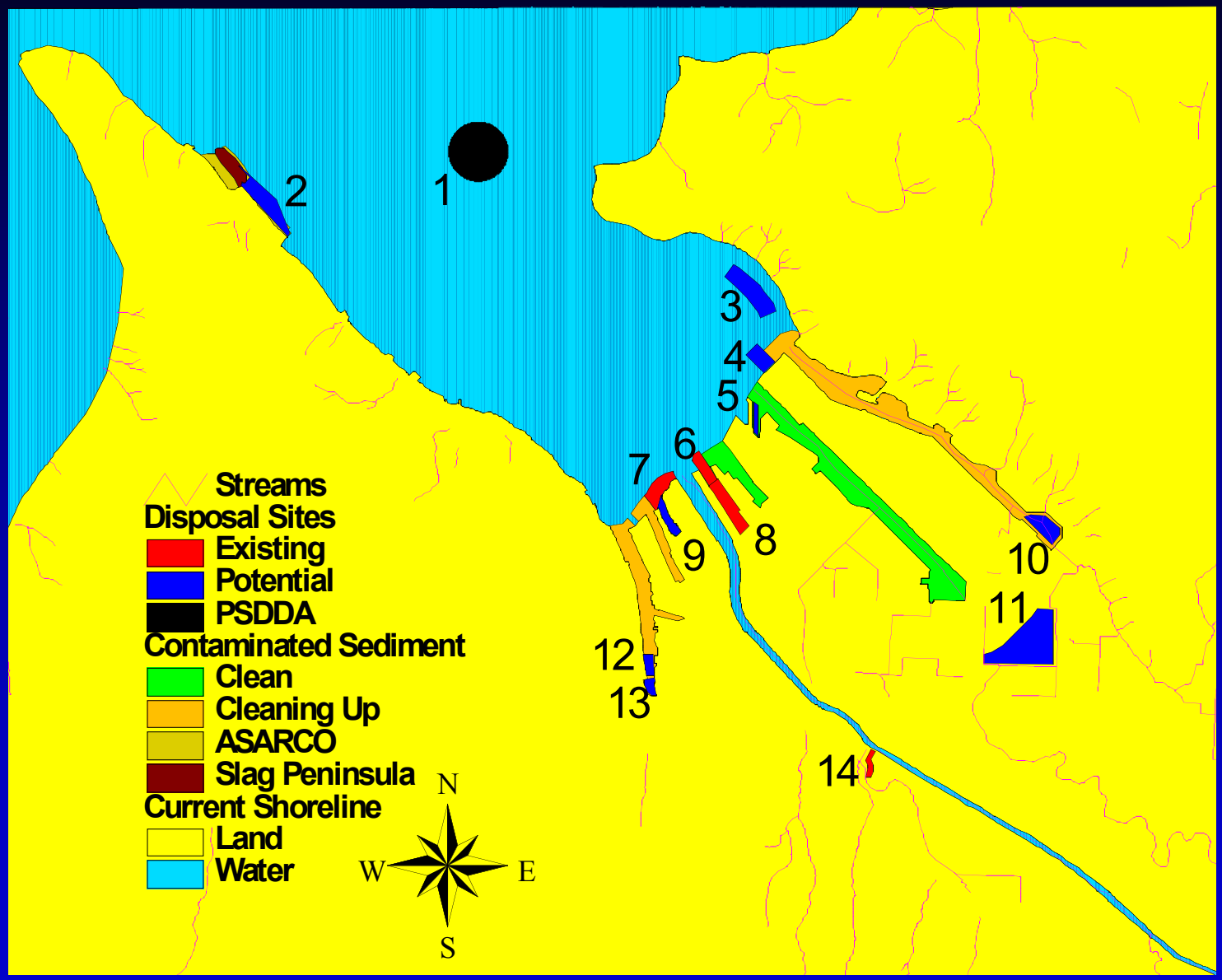
SPECIAL AQUATIC SITES



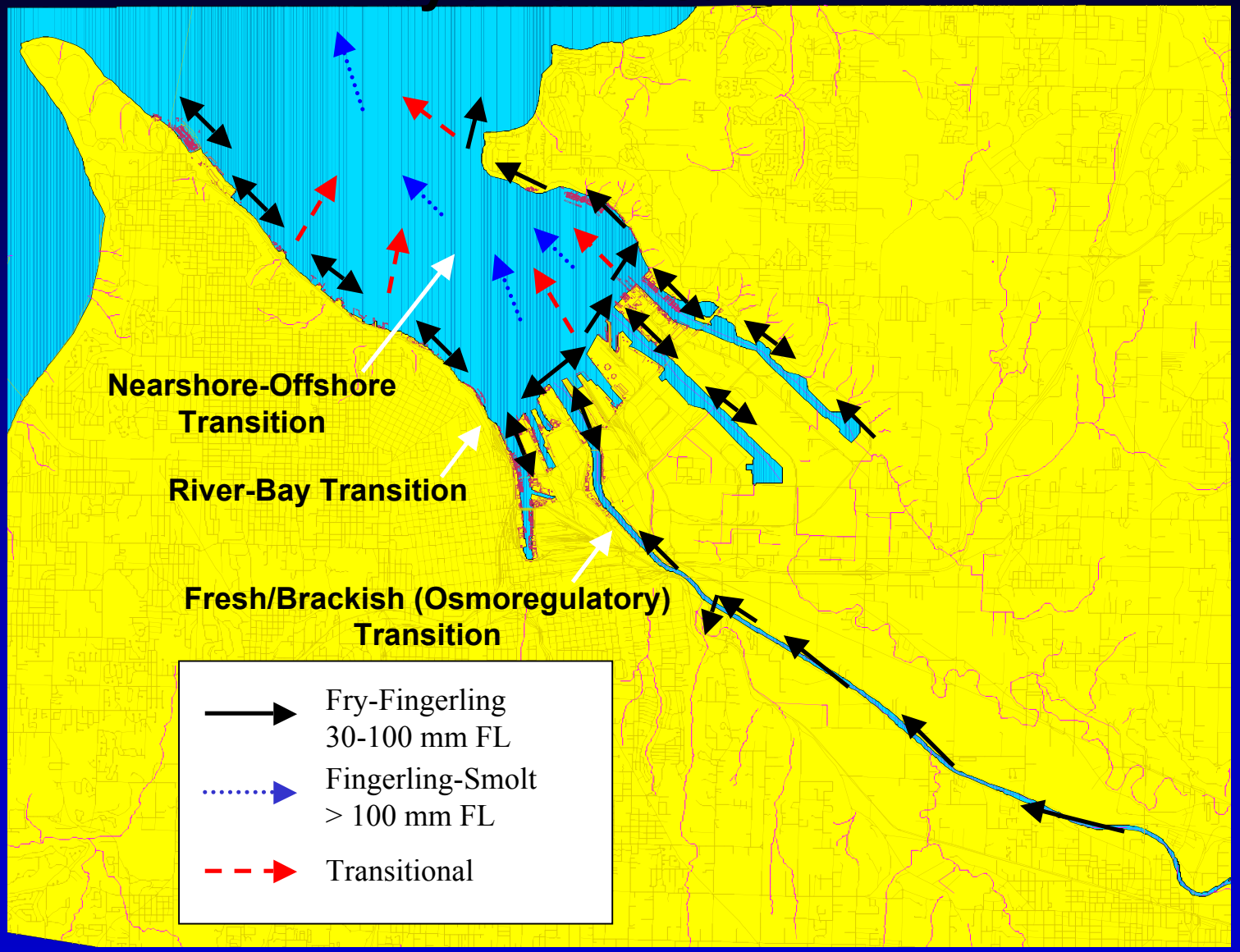
EPA SUPERFUND & OTHER PROBLEM SITES



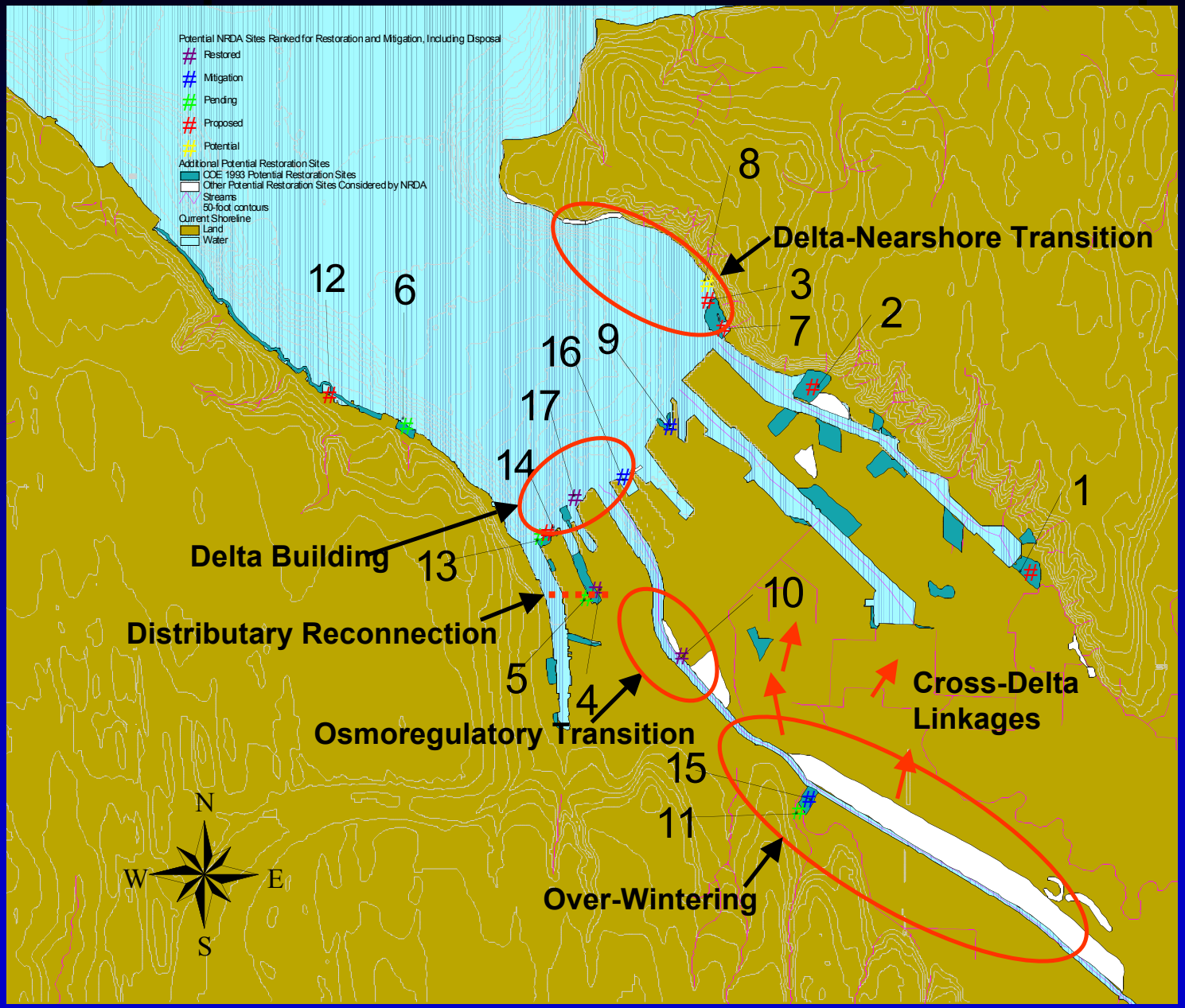
DISPOSAL SITES & CONTAMINATED SEDIMENTS



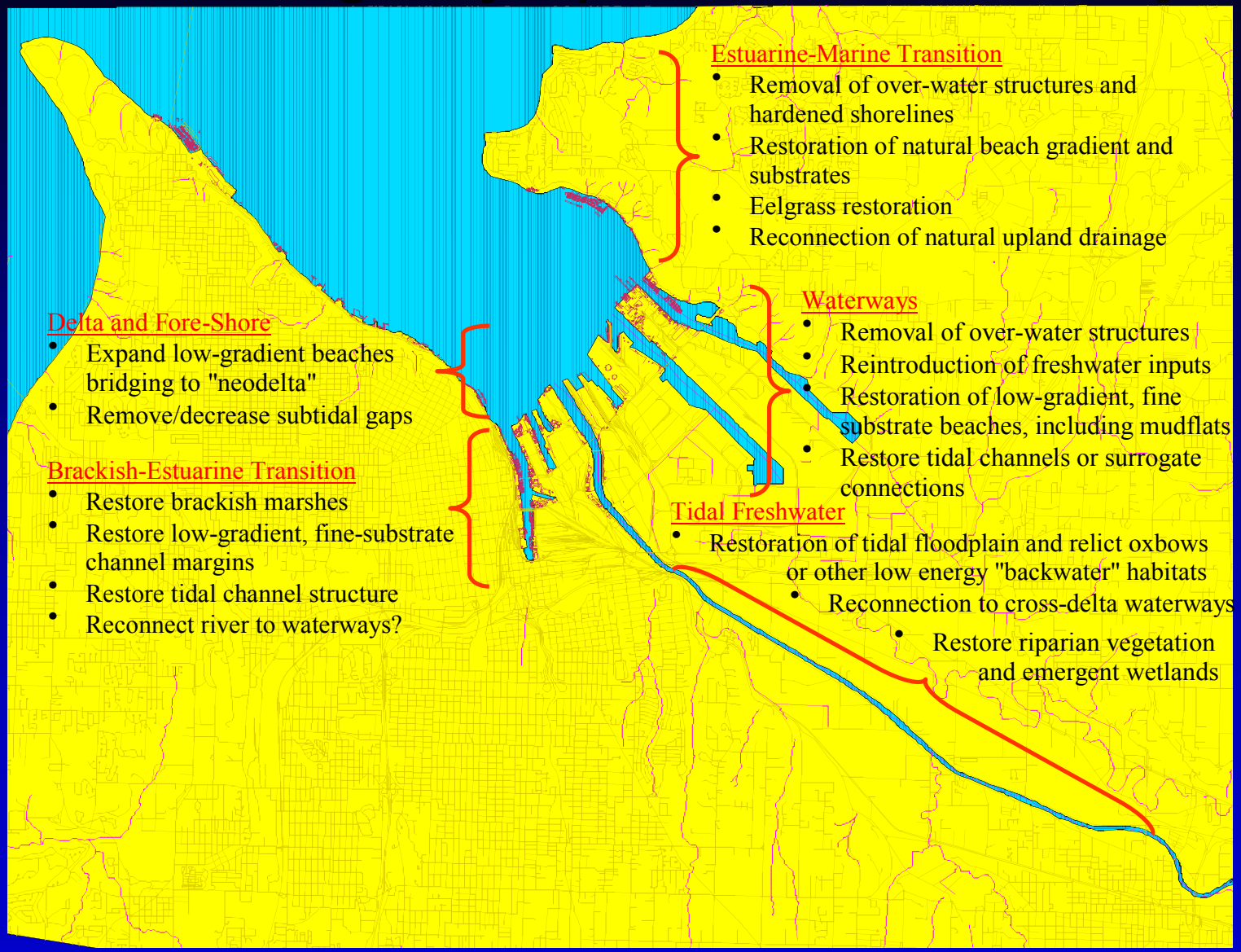
MODERN MIGRATORY PATHWAYS OF JUVENILE PACIFIC SALMON



RESTORATION & REHABILITATION FOCUS AREAS



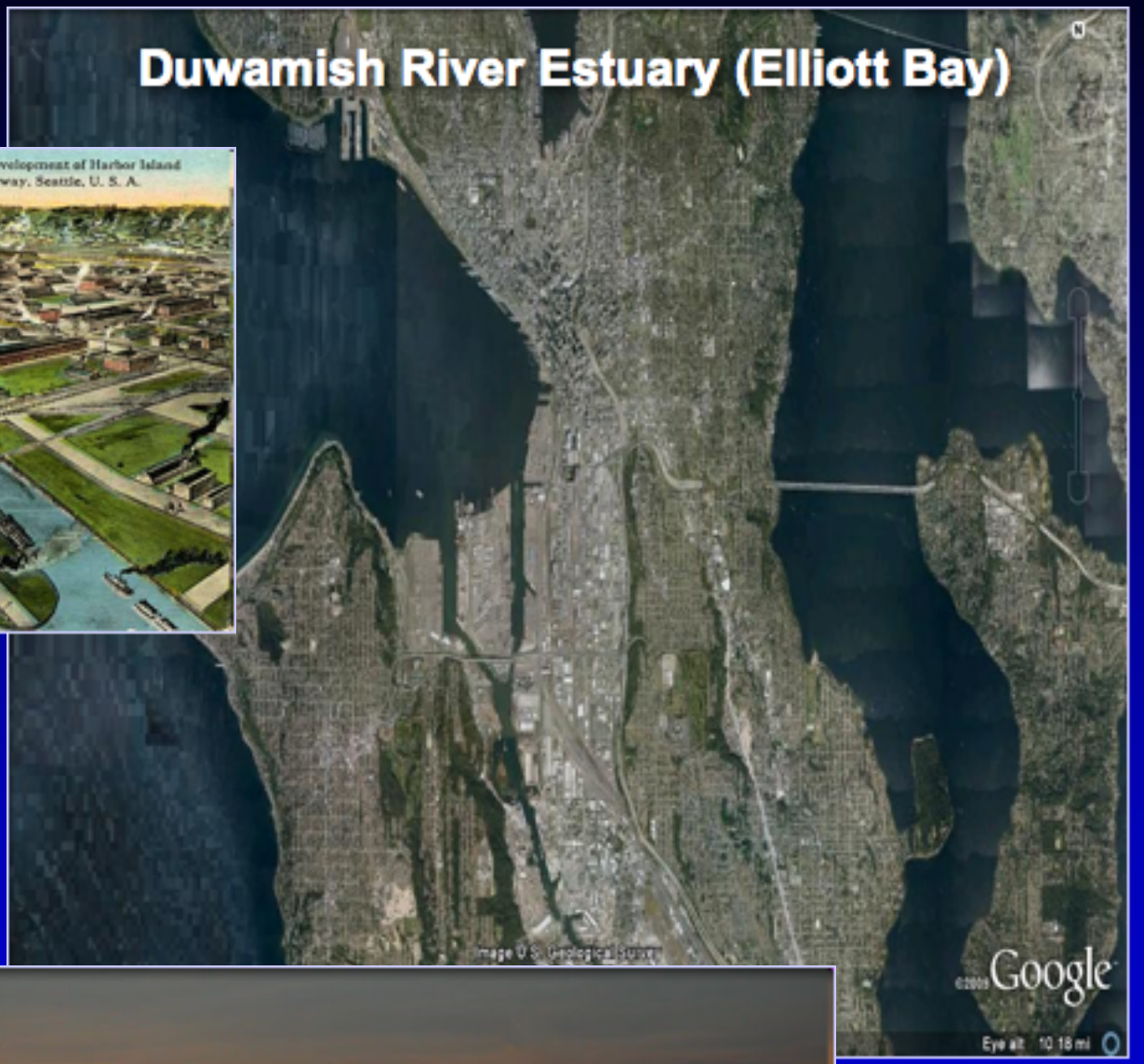
APPROPRIATE ACTIONS FOR ENHANCEMENT OF JUVENILE SALMON REARING HABITAT IN COMMENCEMENT BAY

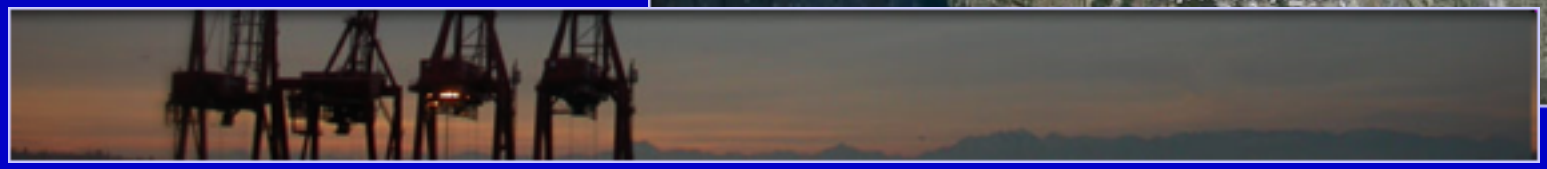


SUMMARY:
Puyallup River Estuary Restoration

1. Can't *restore* historic estuary structure, but can enhance function for juvenile salmon;
2. Spatially-explicit identification of salmon habitat needs likely increases new, more strategic restoration and rehabilitation targets; but,
3. legacy contaminants will continue to be stressor *vis a vis* recontamination of rehabilitation sites.

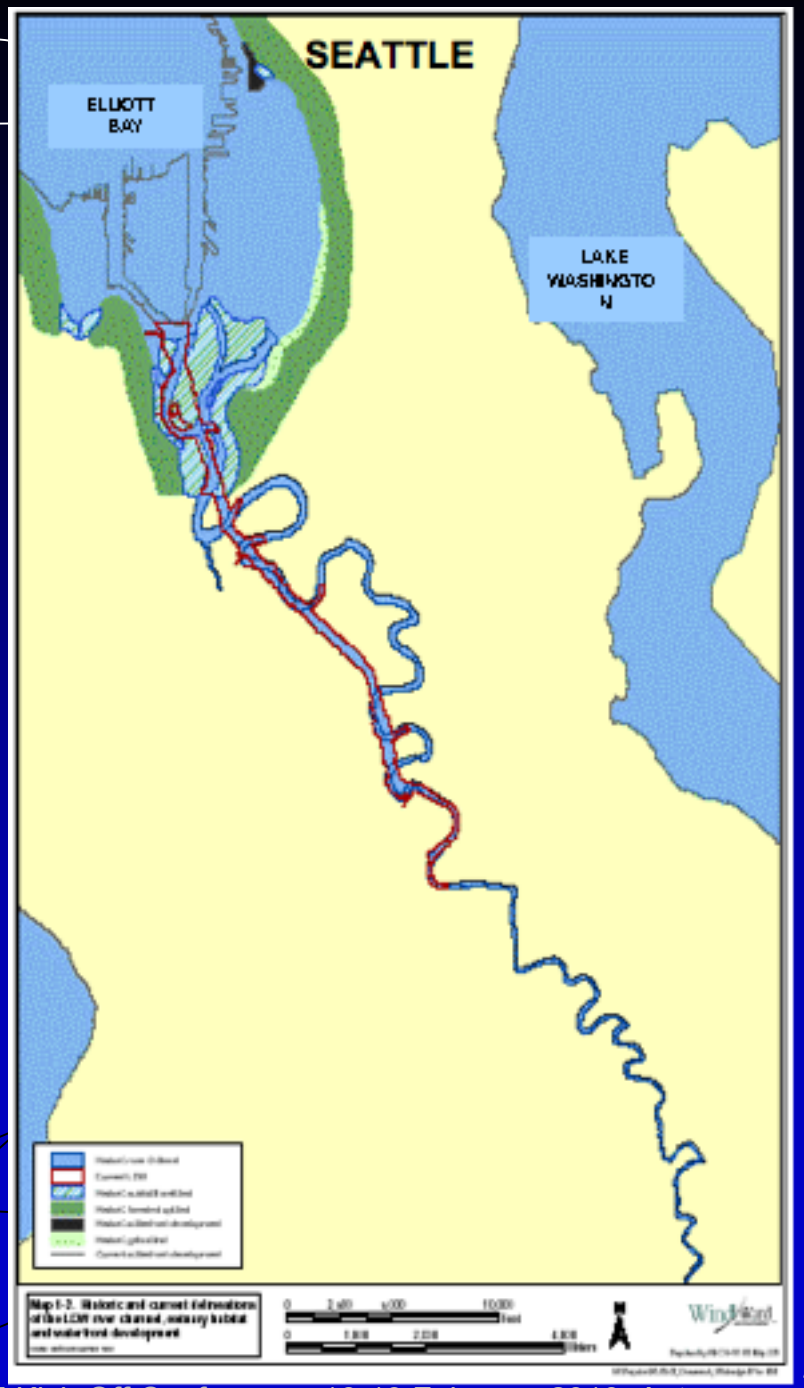
DUWAMISH RIVER ESTUARY



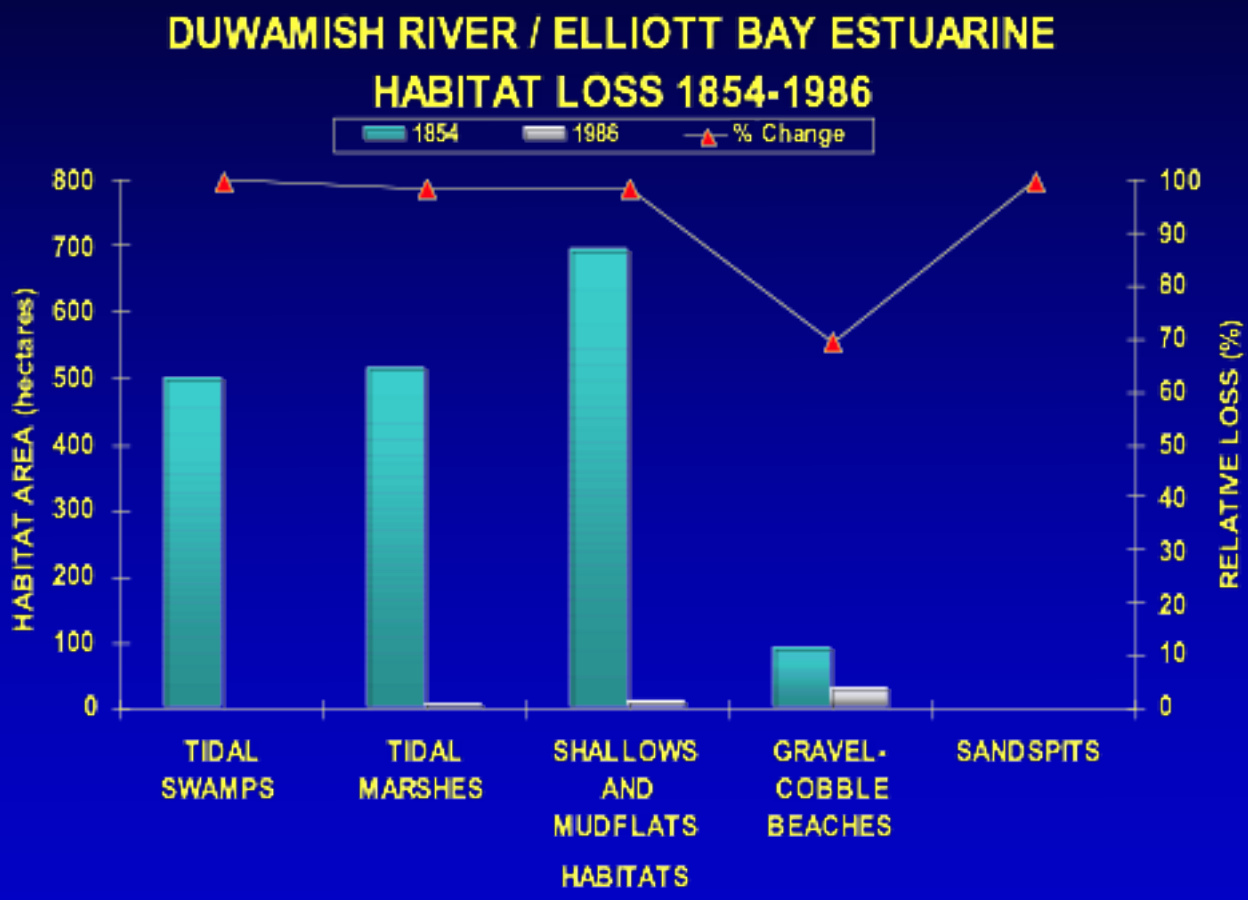


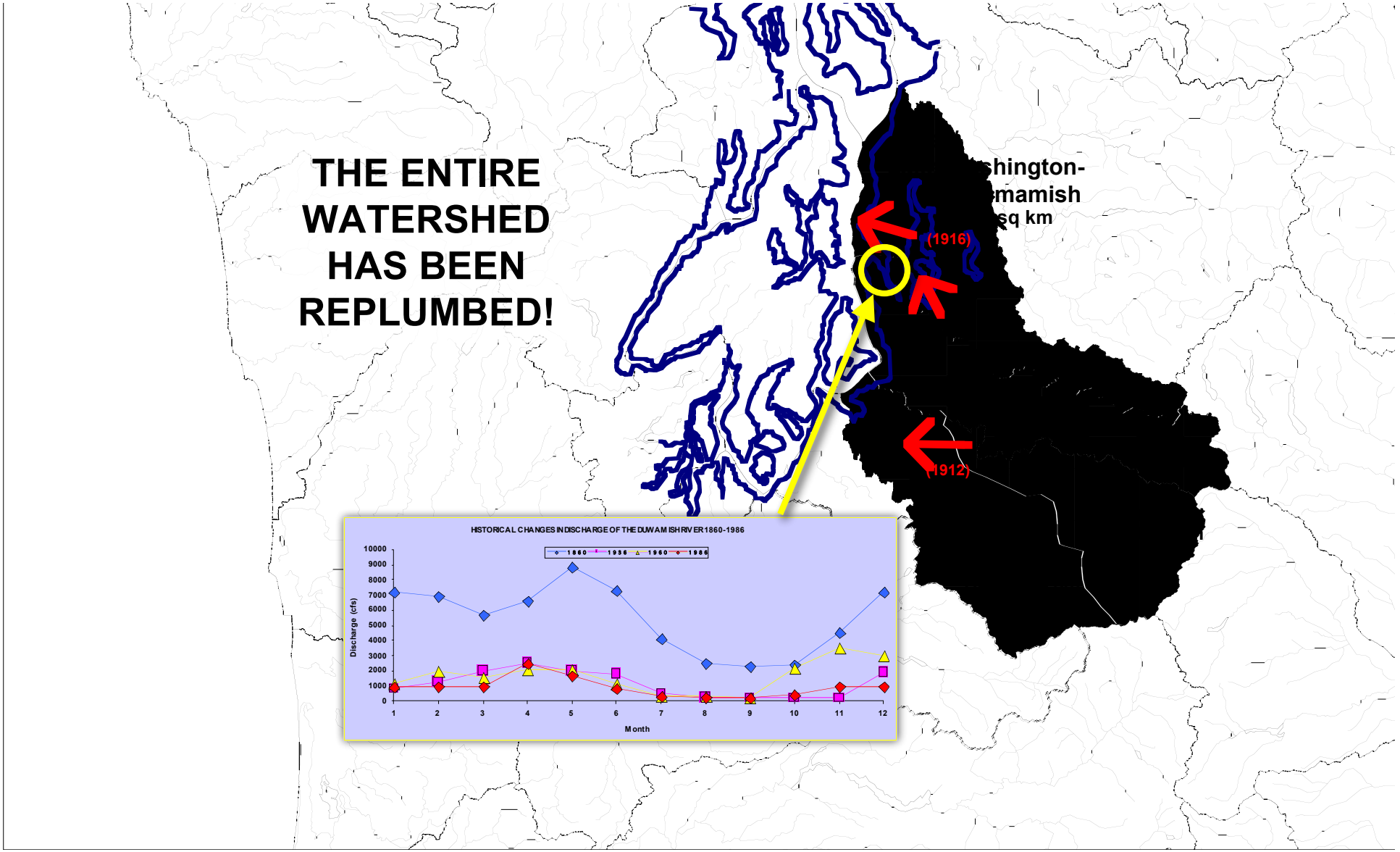

Seattle


Elliot Bay
Lake Washington
Today
0 0.5 1 1.5 Miles


SEATTLE
ELLIOTT BAY
LAKE WASHINGTO N

HISTORIC DREDGING AND FILLING OF THE DUWAMISH RIVER ESTUARY





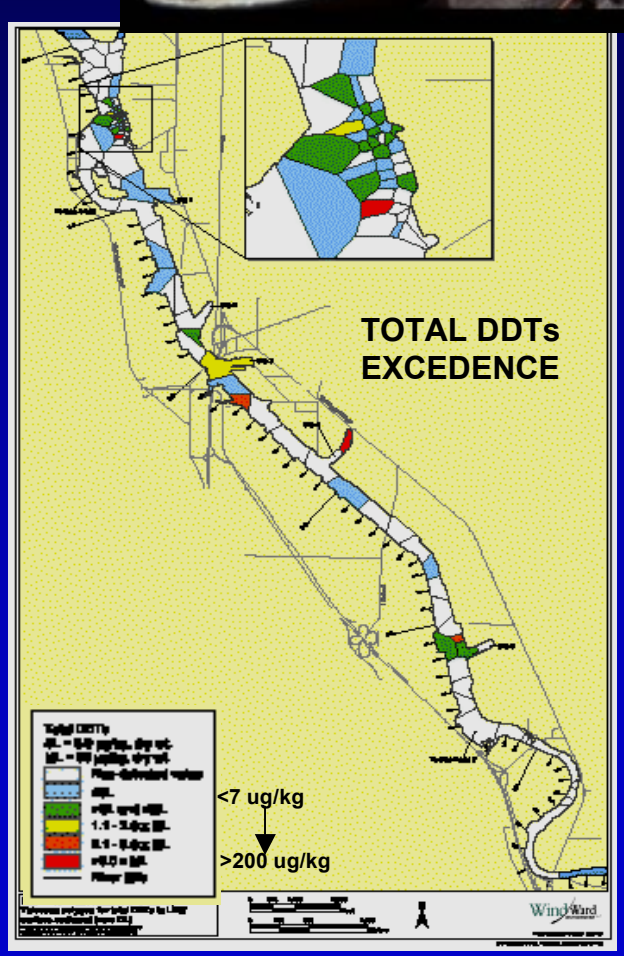
Changes in Duwamish River Watershed:

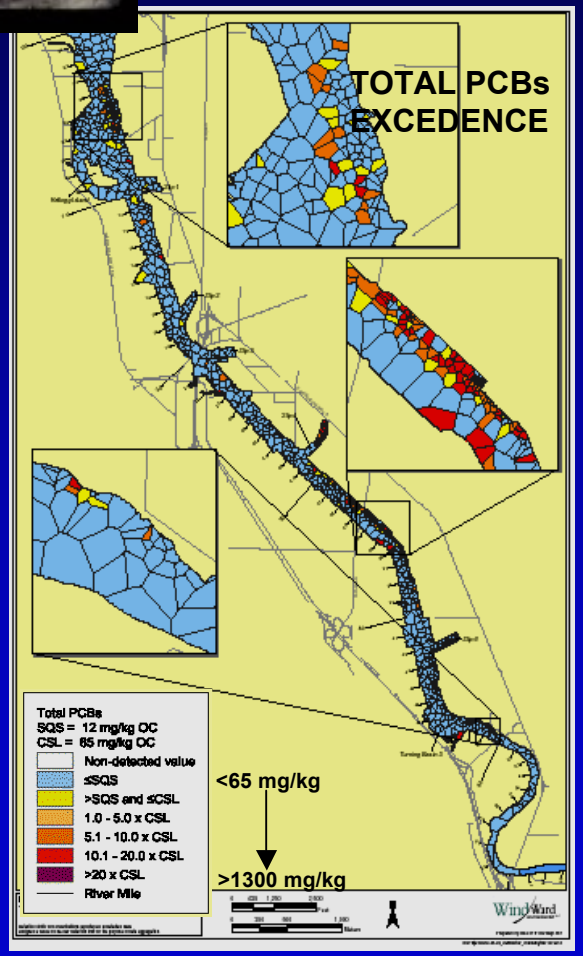
1912 Diversion of White River to Puyallup River watershed (-25.2%)

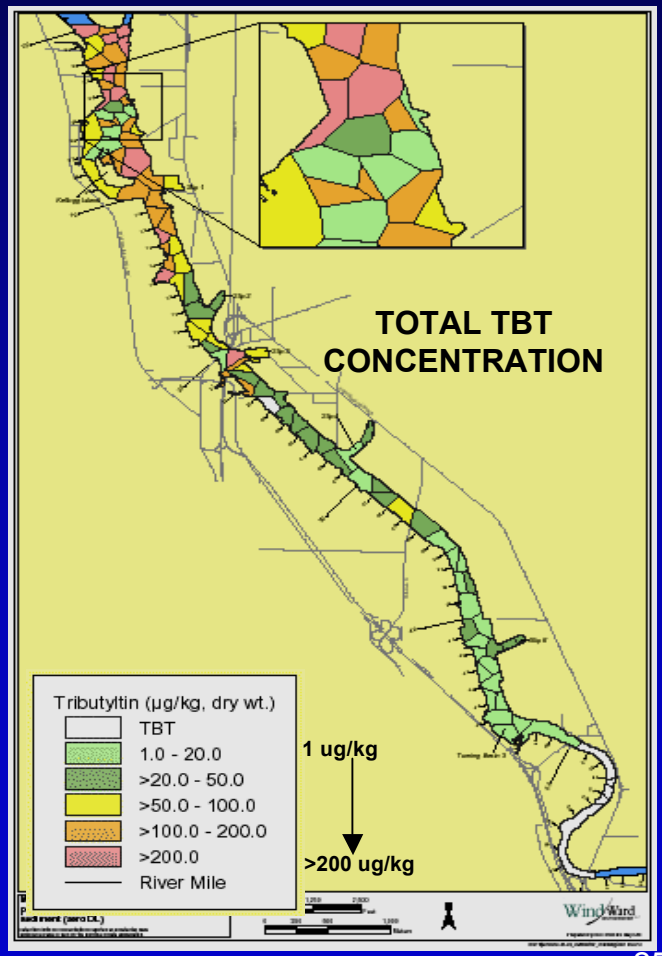
1916 Diversion of Cedar and Lake Washington-Lake Sammamish watersheds to Lake Washington Ship Canal (-40.6%)

= 70-75% reduction in freshwater inflow to estuary

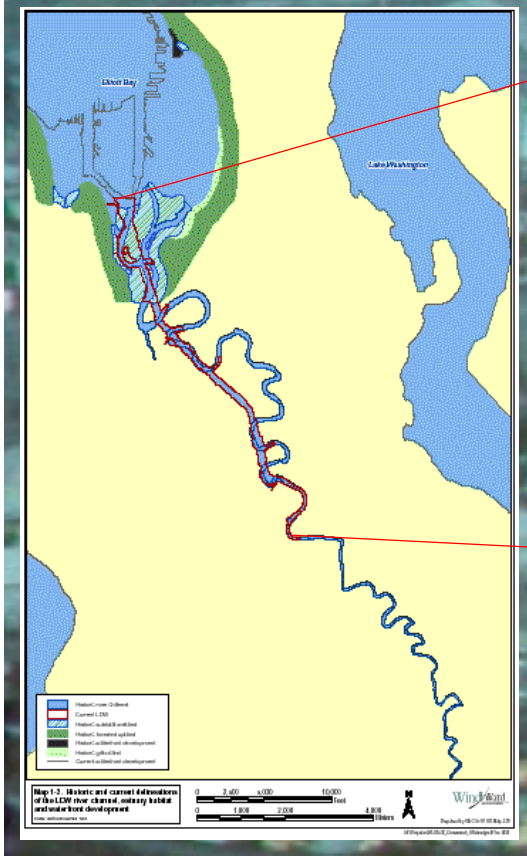
A LEGACY OF CONTAMINATION





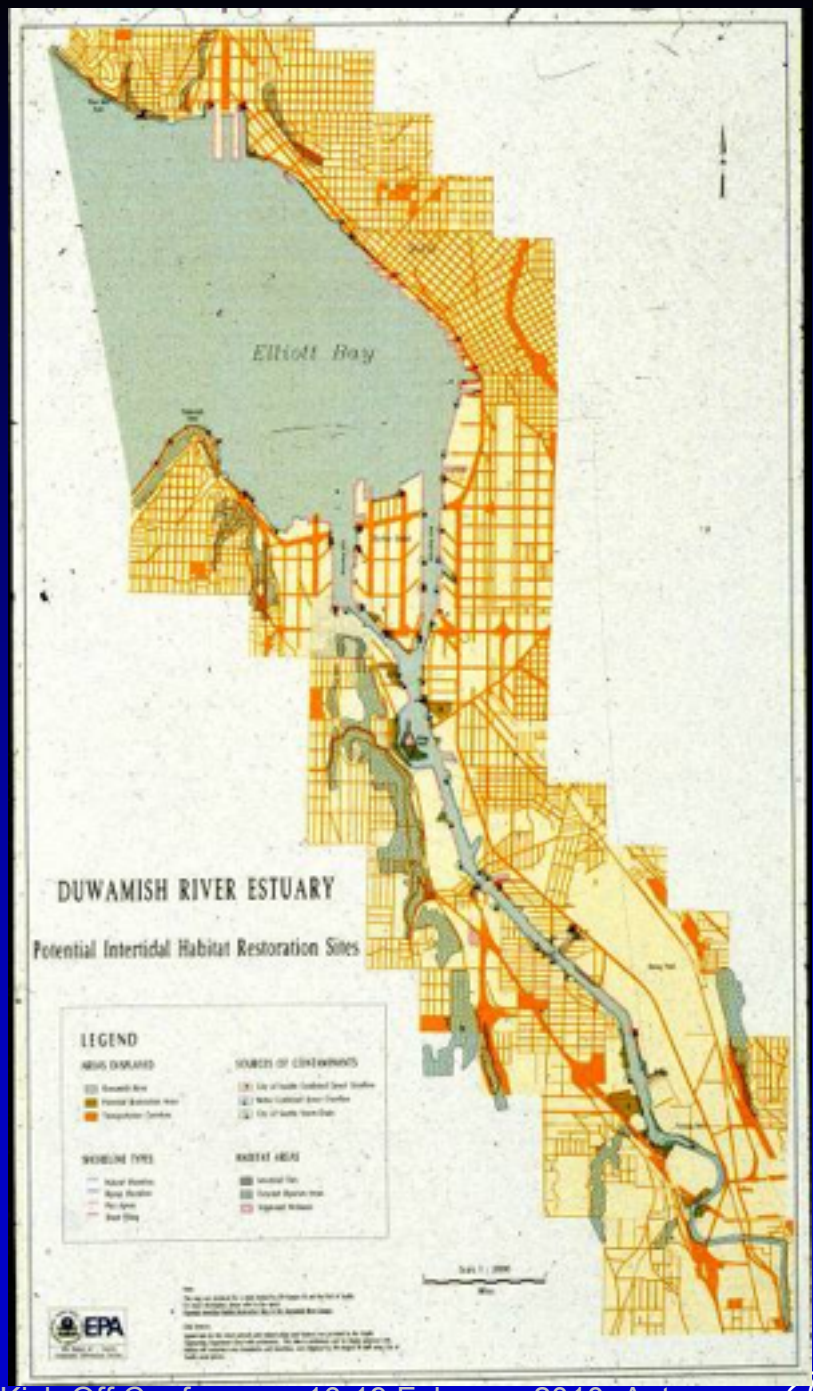


CAN ESTUARINE ~~RESTORATION~~ REHABILITATION BE EFFECTIVE IN A PIECEMEAL APPROACH?.....e.g., recovery by a thousand band-aids?



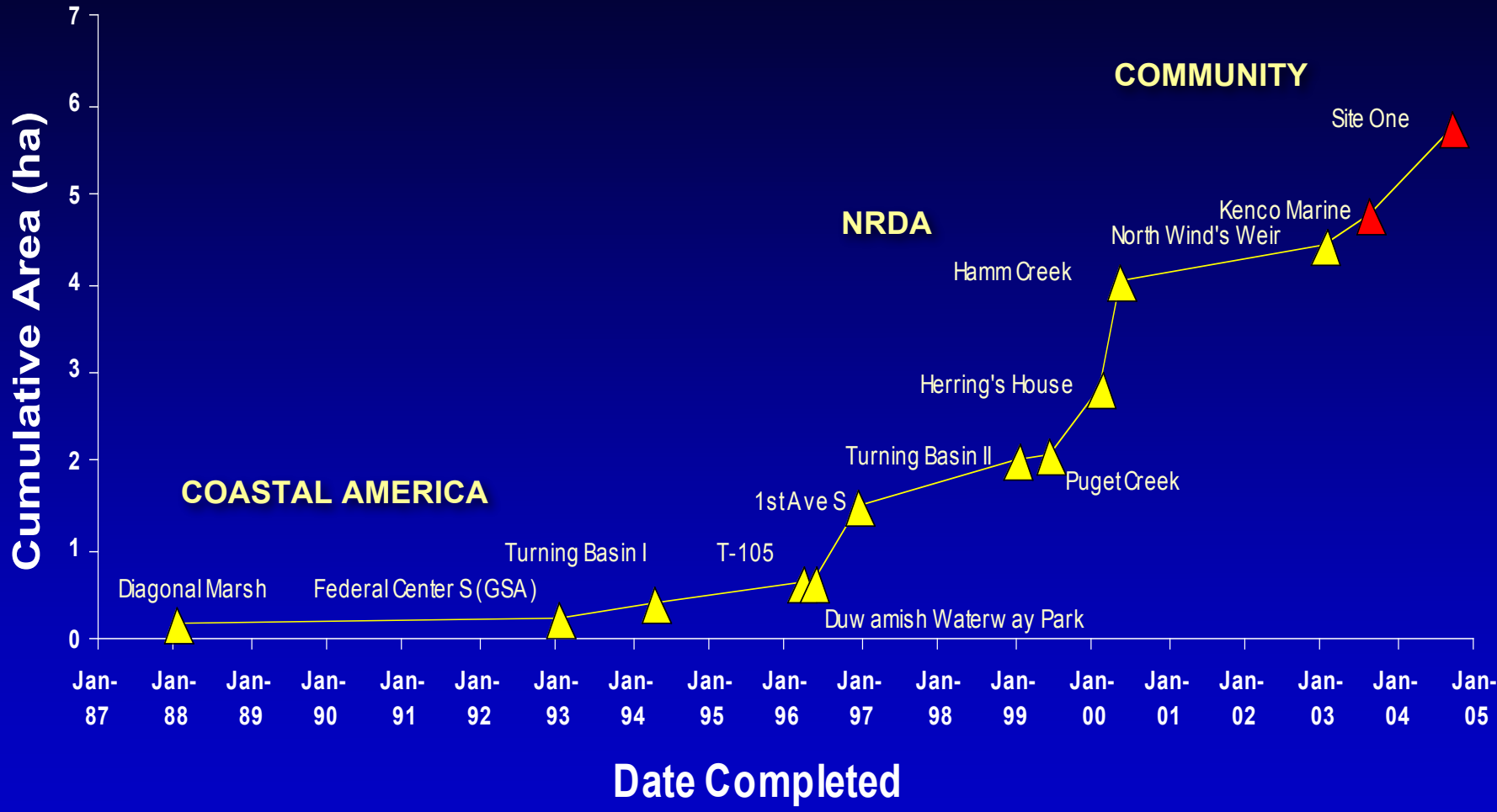
THE EMERGENCE OF A RESTORATION STRATEGY FOR THE DUWAMISH RIVER / ELLIOTT BAY

- Port of Seattle mitigation
- Coastal America
- NRDA
- non-regulatory restoration



COMPLETE AND IN-PROGRESS DUWAMISH RIVER ESTUARY PROJECTS

DUWAMISH RIVER ESTUARY RESTORATION SINCE 1988



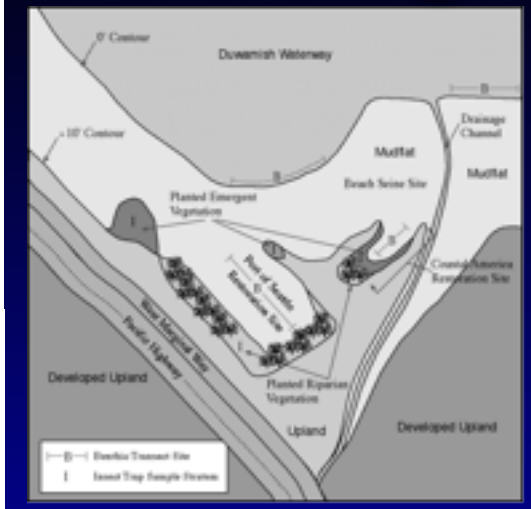
ADDRESSING THE CHALLENGES OF RESTORATION IN URBANIZED / INDUSTRIALIZED ESTUARIES

- creative, inventive approaches
  - ✓ excavation of fill to intertidal elevations
  - ✓ removal of over-water structures
  - ✓ creating littoral “bench” habitat
  - ✓day-lighting streams and estuarine channels
- acceptance of some unaesthetic, if not less than ecologically natural, alternatives to counter disturbances
- costs $$$$

GSA


Existing Vegetation
Planned Emergent Vegetation
Developed upland
+9' Contour
Planned Riparian Vegetation
0' Contour
Duwamish Waterway
Sediment Bench

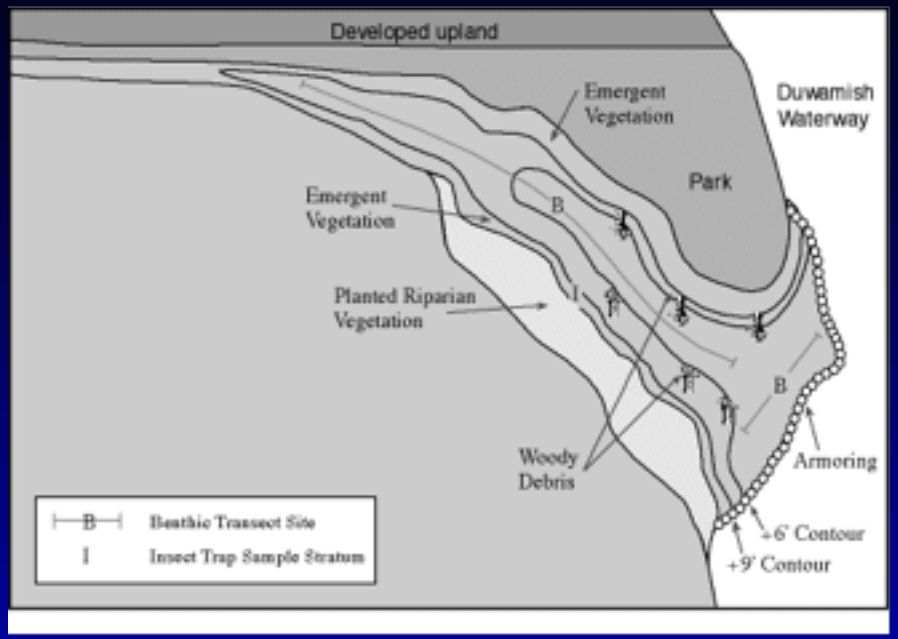
Turning Basin



Habitats Being Restored

Estuary Upland

T-105


Developed upland
Emergent Vegetation
Duwamish Waterway
Park
Emergent Vegetation
B
Planted Riparian Vegetation
I
B
Woody Debris
Armoring
B Benthic Transect Site
I Insect Trap Sample Stratum
+6' Contour
+9' Contour

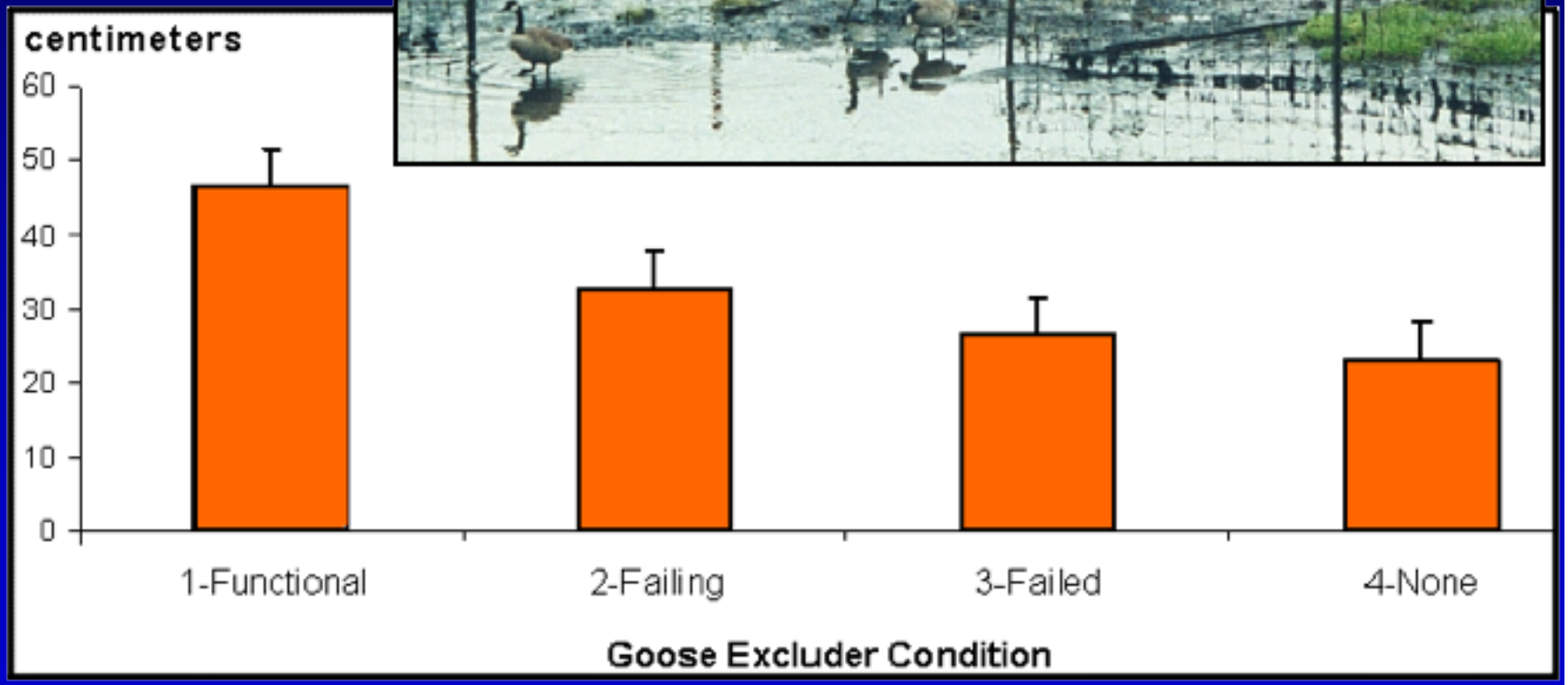
Herring's House

Hamm Creek


0 150 300 Feet
N
Habitats Being Restored
Estuary
Upland
Creek

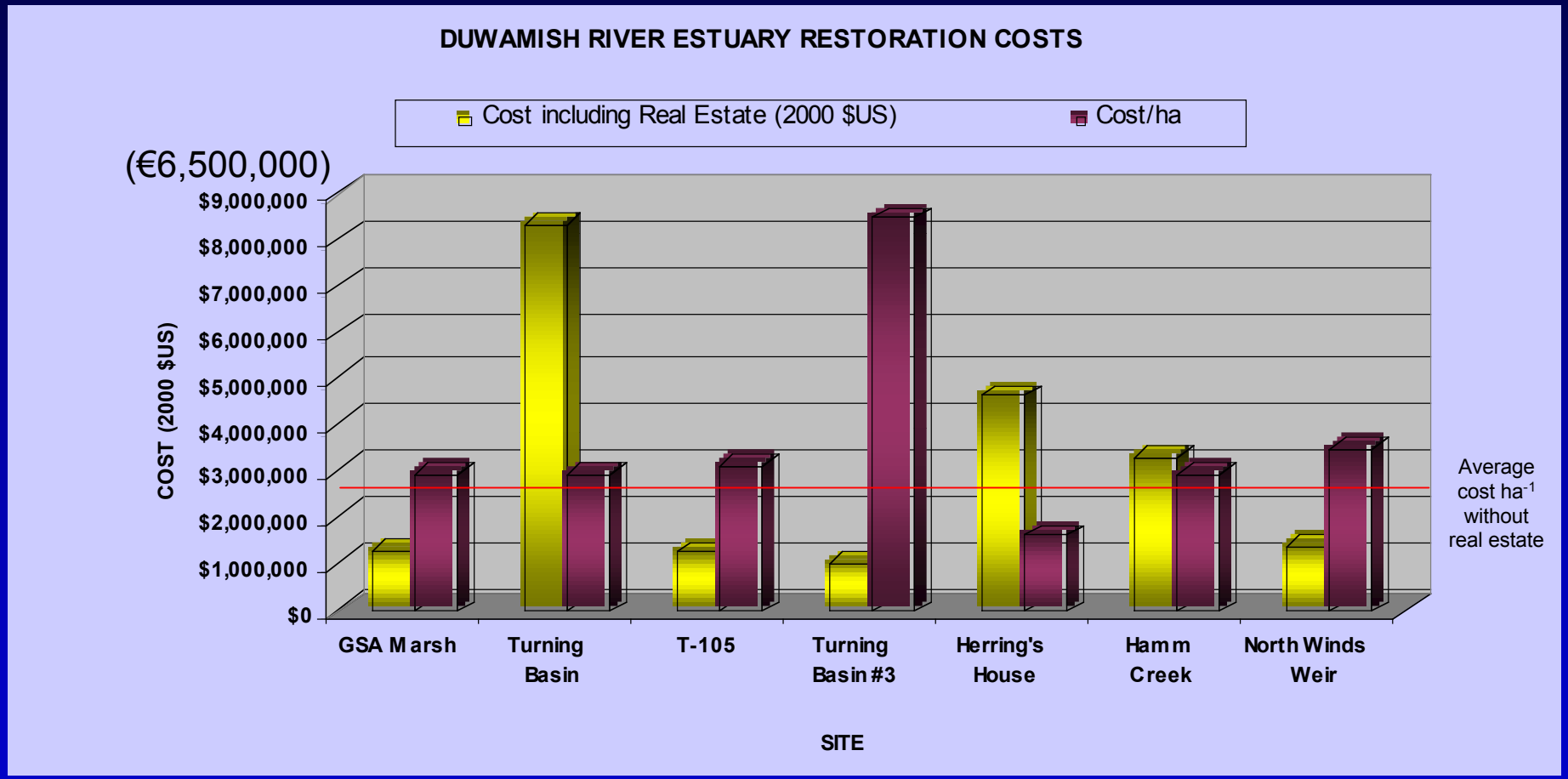

Volunteer Salmon Habitat Restoration and Monitoring Project
Estuary View
Hamm Creek - Site Map
July 2001

AVERAGE HEIGHT OF ESTAURINE PLANTS BY GOOSE EXCLUDER CONDITION, 2001



PEOPLE FOR PUGET SOUND
pugetsound.org

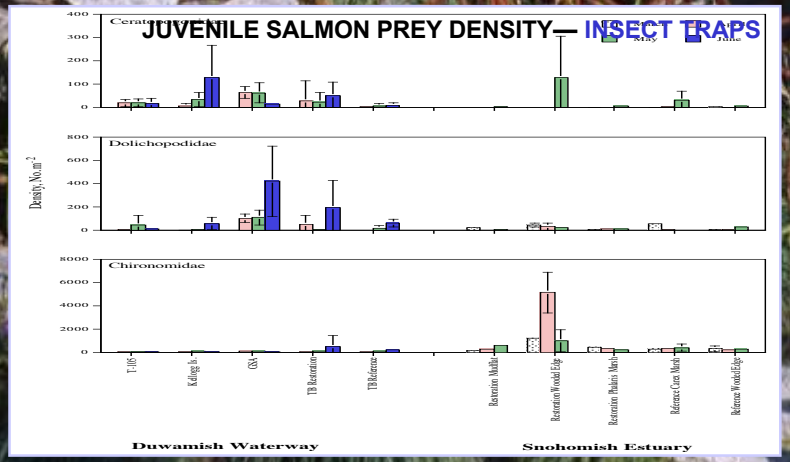
IS URBAN ESTUARY RESTORATION WORTH THE COST?



WHEN ISTHE INVESTMENT WORTHWHILE, DESPITE THE CHALLENGES?

- regulatory/legal mandate and obligation
  - mitigation (CWA)
  - compensation (NRDA)
  - native treaty rights
- endangered species recovery
  - habitat restoration (ESA)
- landscape (re)connectivity
  - optimize efforts in other parts of watershed-coast
- citizen involvement and investment in restoration
- urban revitalization
- cultural healing that taps historical, social, political, aesthetic and moral, as well as scientific, contexts

CAN THE FISH TELL THE DIFFERENCE?



CAN THE FISH TELL THE DIFFERENCE?

Response of Juvenile Salmon to Habitat Restoration in the Duwamish River Estuary

- Although the diet of juvenile salmon migrating through the Duwamish River estuary includes prey that are not typical of less-altered estuaries, they are utilizing organisms colonizing restoration sites
- Some functions, such as refuge from predation (shallow water habitat) and vegetation-associated prey resources, develop rapidly
- Cumulative restoration projects may provide habitat linkages that will create a landscape-scale habitat function for migrating salmon that exceeds site-specific levels

SUMMARY:
Duwamish River Estuary Restoration

1. little change = significant difference?
   - ✓ potentially huge signal:noise response: despite the small increment, habitat area and quality has expanded from a comparatively minor, and continually degrading base <1970's
   - ✓ evidence of functional response by fish and wildlife
2. experimental tableaux for testing alternative restoration approaches, performance standards and monitoring in challenging systems
   - ✓ if we can accomplish something here.....!
3. extensive expansion of public understanding, appreciation and involvement in restoration
4. in case of 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 thoroughly compromised by failure to rehabilitate their estuarine habitat

TAKE-HOME MESSAGES (1)

1. Acknowledge system constraints …..understand and work with extant ecosystem processes
2. Be strategic in approach and deployment of restoration and rehabilitation actions
3. Use the landscape connectivity, both proximally and at regional scale
4. Be more innovative, integrating both active and passive restoration
5. Deploy and manage adaptively
6. Look to future for both constraints and opportunities (e.g., SLR)
7. Develop interdisciplinary science and engineering …..teams

TAKE-HOME MESSAGES (2)

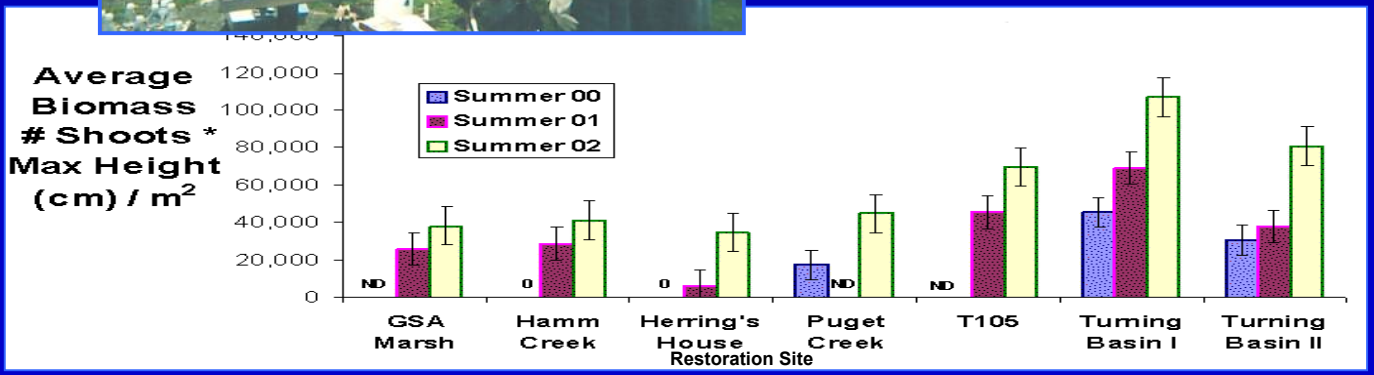
8. Employ models ……conceptual to hydrodynamic, sedimentological, and ecological
9. Manage expectations
10. Use external peer review and other 'lessons learned' mechanisms
11. Contribute to applied science (publications)
12. Collaborate in international forums at all scales
    - workshops
    - white papers and other guidance documents
    - international meetings, e.g.,
      - ✓ Restore America's Estuaries (RAE)
        November 13-17, 2010; Galveston, TX
        (see: https://www.estuaries.org/conference/)
      - ✓ National Conference on Ecosystem Restoration (NCER)
        August 1-5, 2011; Baltimore, MD
        (see: http://www.conference.ifas.ufl.edu/NCER2011/)

DON'T FORGET HUMAN DIMENSION!

Ordinary citizens can become a valuable constituency!

PEOPLE FOR PUGET SOUND

pugetsound.org



THANK YOU

Contact:

Charles (“Si”) Simenstad
1-206-543-7185
simenstd@u.washington.edu

Further information:

- South San Francisco Bay Salt Pond Restoration
  http://www.southbayrestoration.org/
- Puget Sound Nearshore Ecosystem Restoration Project
  http://pugetsoundnearshore.com
- Duwamish River estuary restoration
  http://yosemite.epa.gov/r10/cleanup.nsf/sites/LDuwamish
- Puyallup River estuary restoration
  http://www.darrp.noaa.gov/northwest/cbay/restore.html