# Can Nearshore Ecosystems Function in Urbanized Ecosystems?

Charles ("Si") Simenstad University of Washington School of Aquatic and Fishery Sciences Wetland Ecosystem Team simenstd@u.washington.edu http://www.fish.washington.edu/research/wet/



**Definition of nearshore**: downstream from the upstream limits of tidal influence of any river or stream entering Puget Sound, to the western limit of the Strait of Juan de Fuca, including those adjacent uplands that directly affect nearshore processes, and encompassing intertidal and subtidal areas, extending to the depth limits of the photic zone



# THE ESTUARINE-NEARSHORE CONTINUUM OF PHYSICS, CHEMISTRY AND ECOLOGY=<u>MOSAIC</u>





















# **SCALES OF SHORELINE FUNCTION**

Internal

- > Within marine riparian ecosystem
- Ecosystem
  - > Exchanges between ecosystems
- Ecotone-Landscape
  - > Across land-margin
  - > Landscape element

Cultural

- > Traditional use
- Recreational/aesthetic
  - > Anthropogenic value



# ROLE OF ESTUARIES IN SALMON EARLY LIFE HISTORY = "nursery function"

- Juveniles of "ocean-type" salmon, rather than "stream-type" and typical hatchery races, e.g., are the most estuarine dependent on habitat integrity (and frequently in jeopardy?)
- Physiological transition during migration
- Significant shift in feeding and predation regimes
- Site of rapid growth
- Buffer freshwater rearing during extreme events

# ORGANIC MATTER AND INSECT PRODUCTION

Puget Sound shorelines provide the food web sources and processes, prey production and the habitat for juvenile salmon





### PUGET SOUND NEARSHORE ECOSYSTEMS: Ghosts of Habitat Past?



- extensive loss of estuarine rearing habitat
- reduced connectivity
- forced transport to marine environments

Is the marine nearshore acceptable replacement for estuarine habitat of ocean-type juvenile salmon?



Challenges Of Habitat Restoration In A Heavily Urbanized Estuary: "Restoring" the Duwamish River estuary

photo by C. Tanner, USFWS

### **RESTORATION CHALLENGE**

- Returning a system to "a condition similar to the one that existed before it was altered, along with its predisturbance 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 reestablish an aboriginal condition...." Middleton 1999
- ....futility of trying to re-establish the aboriginal state....Stanford *et al.* 1996
- When resources are limited, 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.



Fall 1996, following restoration construction



# THE ESTUARINE RESTORATION PARADIGM?

- build it and they will come
- rapid equivalency to natural ecosystems
  self-maintaining and sustainable



Images courtesy of M. Weinstein

# THE CHALLENGES OF RESTORATION IN HEAVILY INDUSTRIALIZED ESTUARIES



- Structure
- Ecosystem processes
- Restricted opportunities
  - Conflicts with cost of water-dependent properties
  - Derelict properties only available
- Multiple stressors and disturbances
  - Limited recruitment sources
  - Contamination, and recontamination; health risks
  - Boat wakes, noise, light
  - Exotic species
- Difficult to attract and maintain public resources





#### HISTORIC CHANGES IN THE DUWAMISH RIVER ESTUARY



WET/SAFS/UW figure by J. Burke

### HISTORIC DREDGING AND FILLING OF THE DUWAMISH RIVER ESTUARY



photo by C. Tanner, USEWS







## A LEGACY OF CONTAMINATION





Unspawned adult coho salmon doing "the Jesus walk" in the process of dying in Longfellow Creek, tributary to the Duwamish River estuary



#### 



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

Port of Seattle mitigation
Coastal America
NRDA
non-regulatory restoration



#### NOTE: 10 ha line



#### **DUWAMISH RIVER ESTUARY RESTORATION SINCE 1988**

#### **COMPLETED DUWAMISH RIVER ESTUARY PROJECTS**



Lake

COMPLETE AND ANTICIPATED DUWAMISH RIVER ESTUARY PROJECTS



Lake Washington

> Site One 2.5 ac

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 \$\$\$\$











# **Turning Basin**









Upland









# **T-105**





photo courtesy of C. Tanner, USFWS



# **Herring's House**



photo courtesy of C. Tanner, USFWS



### Hamm Creek







### **EXOTIC SPECIES**



### **AVERAGE HEIGHT OF ESTAURINE PLANTS BY GOOSE EXCLUDER CONDITION, 2001**



#### **ATTRIBUTES OF PROTECTED AND GRAZED Carex lyngbyei**



PROTECTED

### IS URBAN ESTUARY RESTORATION WORTH THE COST?

#### **DUWAMISH RIVER ESTUARY RESTORATION COSTS**



SITE

# 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 SALMON TELL THE DIFFERENCE?







WET/SAFS/UW photo by J. Cordell

### Juvenile Chinook—Duwamish Estuary, 1997



Percentage of Diet by Weight

#### JUVENILE SALMON PREY DENSITY— BENTHIC CORES







**Duwamish Waterway** 

**Snohomish Estuary** 

#### JUVENILE SALMON PREY DENSITY— INSECT TRAPS







Density, No. m<sup>-2</sup>

**Duwamish Waterway** 

### EARLY INTERPRETATION OF JUVENILE SALMON HABITAT REHABILITATION

- 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 sitespecific levels

#### **Boeing volunteers at Turning Basin**

#### CITIZENS CAN MAKE THE DIFFERENCE!

**Bruce Clifton leading Weed Team** 



pugetsound.org

Jeff Walker (in blue vest) led crew on Earth Day Volunteers for People for Puget Sound provide stewardship



Matt Wells and daughter Emma enjoy Earth Day working together

# VOLUNTEER STEWARDSHIP CAN ALSO CONTRIBUTE TO RESTORATION SCIENCE!



pugetsound.org

### **DESPITE THE CHALLENGES**

#### • 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</li>
 ✓ evidence of functional response by fish and wildlife

 experimental tableaux for testing alternative restoration approaches, performance standards and monitoring in challenging systems

 if we can accomplish something here......!
 extensive expansion of public understanding, appreciation and involvement in restoration
 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



#### But, we must:

- be realistic in our expectations... this is not your average restoration... it is rehabilitation at best
- 2. acknowledge system constraints... understand and work with extant processes
- 3. explore innovative approaches
- 4. learn more from what's already in place... <u>intensively</u> monitor and experiment
- 5. be adaptive
- 6. understand how to use the landscape connectivity, both proximally and at regional scale
- 7. expand social and cultural connections, and institutional commitments



# **TAKE-HOME MESSAGE**

- consider nearshore landscape....from watershed to nearshore marine
- <u>anything</u> will contribute.....the challenge will be how to cumulatively make a difference
- be strategic.....where are the gaps (literally and figuratively)?
- provide a "habitat ecoscape" with integrity and sustainability
- not only incorporate human dimensions (can't avoid it in urban setting) but take advantage of it!

Will we leave anything left of Puget Sound nearshore ecosystems......for our grandchildren, not to mention the fish?