Locating Ideal Juvenile Chinook Salmon Habitat in the Columbia River Estuary using a Multi-criteria Evaluation Method

Scott Swenson, Jeremy Krueger, Haley Dillon
GEOG 592 Final Project
Winter 2011

Introduction

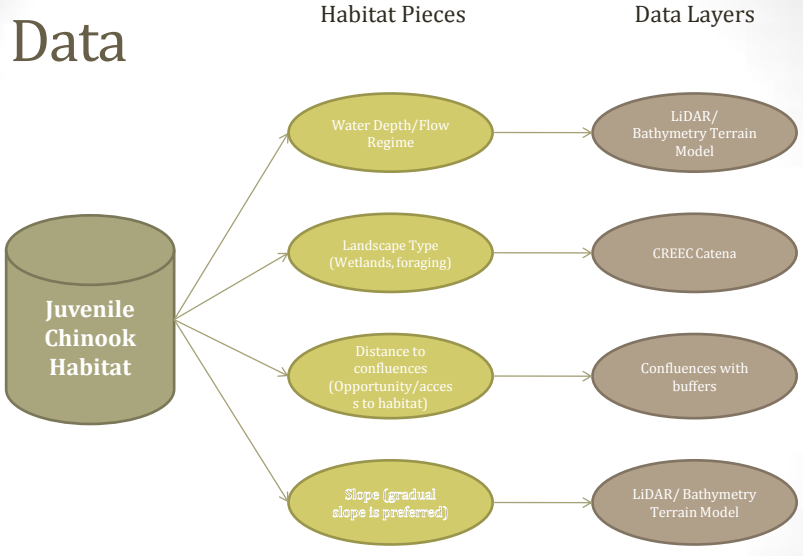
- Importance
  - Ecosystem
  - Historic
  - Cultural
  - Economy
  - Lacking current data (GIS data is line data and mapped at a very coarse scale)

- Disappearing Habitat
  - Development
  - Dams, diking, water control
  - Water quality
  - Endangered species list
  - Government, conservationist restoring/preserving habitat
- Species: Juvenile Chinook Salmon (spring run)
  - Specific habitat needs

Study Area

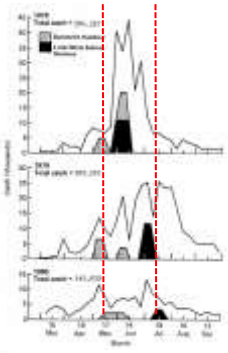
- From river mile 86-105 of the Columbia River
- Extent of Columbia/Willamette River Floodplain (UW/USGS)
- Tidally affected

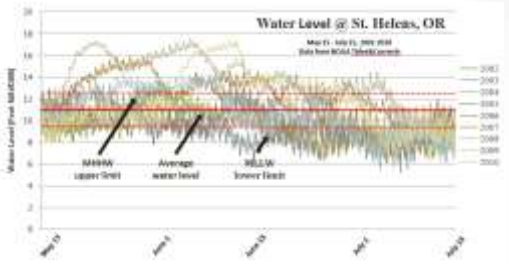
Data



Data – Flow Regime

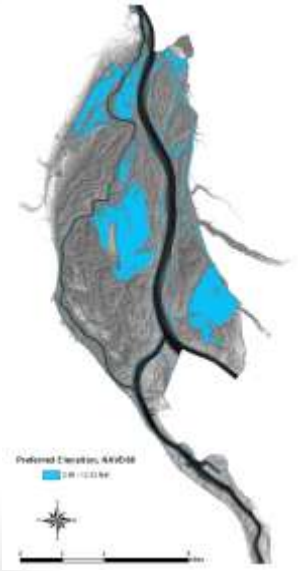
- Migration window – roughly May - July
- Flow regime during this period shows opportunity to access habitat





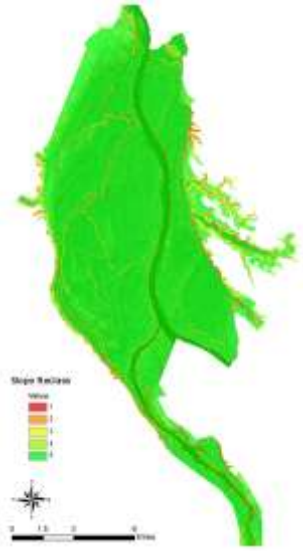
- Calculated average of flow over this time period from 2002-2010
- Our study area is tidally affected so we buffered the average with the tidal range in order to represent MHHW and MLLW.
- Preferred depth is .1 – 2 meters beneath the surface.

Data – Water depth



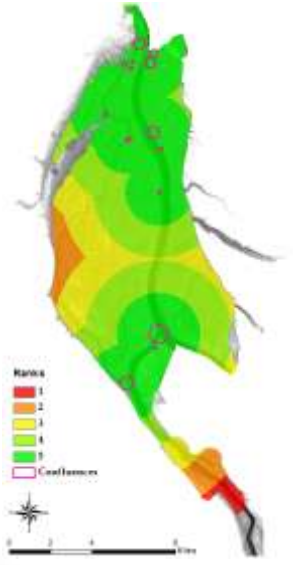
- Layer: Terrain Model, Bathymetry and LiDAR merge 2010
- Source: Army Corps of Engineers
- Importance to habitat: water is habitat and shallow depth is important to juveniles
- Layer created by:
  - Reclass terrain raster (2.89 – 12.32) = 1, all other values = 0
  - Convert to vector, select all connecting polygons, export
  - Convert back to raster

Data - Slope



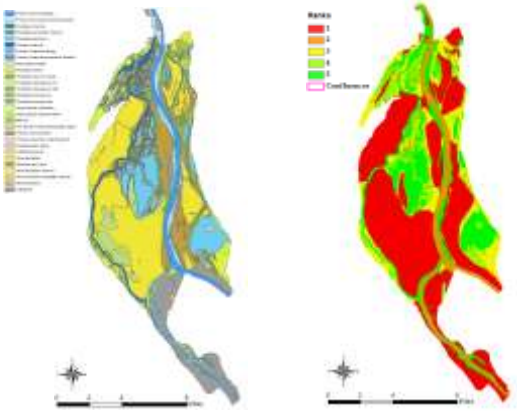
- Layer: Terrain Model, Bathymetry and LiDAR merge 2010
- Source: Army Corps of Engineers
- Importance to habitat: Juvenile Chinook salmon prefer gently sloping bottom surfaces
- Layer created by: Slope tool was applied to DEM. Raster then reclassified into 5 classes. With 5%, 10%, 15% and 20% as break points.

Data - Confluences



- Layer: Confluences
- Importance to habitat: confluence areas represent an opportunity to access more habitat
- Layer created by:
  - Digitized confluences with buffers based on channel width
  - Euclidean Distance tool
  - Reclassified into 5 classes, 2,500m intervals
- Method for weighting: 5 classes – closer to confluence = higher rank

Data – Landscape (catena)



- Layer: CREEC geomorphic catena, 2009 (currently under development)
- Source: UW/USGS
- Importance to habitat: shallow water habitat descriptor, food source (aquatic invertebrates) are found in specific landscape classes
- Layer created by:
  - Converting feature to raster
  - Reclassify classes 1-5
- Method for weighting:
  - Reclass/rank important classes (i.e. floodplain channels, low marsh…) higher than classes that inhibit habitat (i.e. artificial/diked areas).

5 (Water features)	4 (Wetland features, food input)	3 (Possibly wetland)	2 (Too deep or too high)	1 (Artificial/diked features)
Columbia river beach/shallow	Floodplain lake island	Floodplain herbaceous high	Primary channel thalweg	Artificial - diked
Floodplain secondary channel	Trib/secondary channel island	Columbia Floodplain	Tributary thalweg	Artificial - diked (bar and scroll)
Floodplain channel	Floodplain herbaceous low	Floodplain (bar and scroll)	Floodplain forest high	Artificial - diked channel
Floodplain lake/pond	Floodplain forest low	Willamette Floodplain		Artificial - diked lake/pond
Primary channel permanently flooded				Artificial - fill
Tributary permanently flooded				Artificial lake/pond
Tributary channel				Bedrock
Willamette river beach/shallow				Terrace

Methods

- Analytical Hierarchy Process
- Pairwise Comparison of 5 criteria
  - Depth
  - Slope
  - Vegetation/Landcover
  - Proximity to conflunces

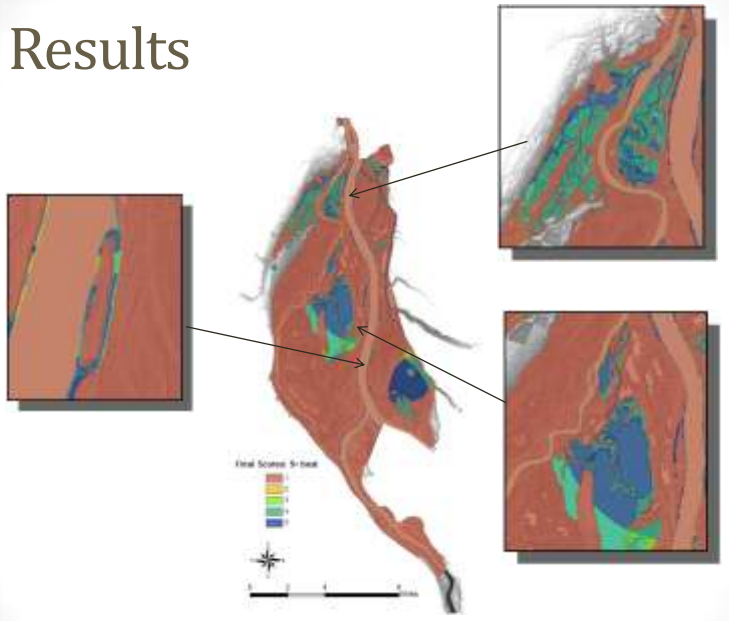
			A	B	C	D	E	Geometric Mean	Weight
A	Slope	A	1.0000	5.0000	1.0000	5.0000	0.1429	1.289937	0.15566
B	Distance to Confluence	B	0.2000	1.0000	5.0000	3.0000	0.1111	0.802742	0.096869
C	Landcover/Vegetation	C	1.0000	0.2000	1.0000	5.0000	0.1429	0.677611	0.081769
E	Depth	E	7.0000	9.0000	7.0000	9.0000	1.0000	5.244888	0.632913
							Sum of Geometric Means	8.286908	1

Methods

- Add and/or multiply layers using the raster calculator

(.632913 * finaldepth) *
(.15566 * slope_rcl1) *
(.096869 * confluences) *
(.081769 * catreclass2) *

Results



Conclusion

- Importance of this study:
  - Our output is a more robust dataset than what we were able to find online (coarse scale line data)
  - Data could be provided to government/conservationists for environmental planning purposes – prioritize valuable habitat protection sites
- Future Considerations…
  - Apply constraining datasets to results : Land ownership, openspace acquisition by bond measures, historical wetlands, water temperature, water quality, predation, etc…
  - Add a restoration component – compare current opportunity with historic to find what is missing today and what could be restored.
  - Apply to the rest of the Columbia River Estuary

Questions???

References

1. Daniel L. Bottom, Charles A. Simenstad, Jennifer Burke, Antonio M. Baptista, David A. Jay, Kim K. Jones, Edmundo Casillas, and Michael H. Schiewe. “Salmon at River’s End: The Rold of the Estuary in the Decline and Recovery of Columbia River Salmon”. NOAA Technical Memorandum NMFS-NWFSC-68 (August 2005).

2. Ayesha Gray, Charles A. Simenstad, Daniel L. Bottom, Trevan J. Cornwell. “Salmon Habitat in Recovering Wetlands of the Salmon River Estuary, Oregon, U.S.A.”. *Restoration Ecology Vol. 10 No. 3*, pp. 514–526 (September 2002)

3. Charles Simenstad, Jason Toft, Melora Haas, Michele Koehler, and Jeff Cordell. “Investigations of the juvenile Salmon Passage and Habitat Utilization”. *USACE – Seattle District 2001 Lake Washington and Hiram M. Chittenden Locks Juvenile Salmon Passage and Habitat Utilization. (2001)*