HANSEN CREEK ALLUVIAL FAN AND WETLAND RESTORATION PROJECT

Hydrogeomorphic Changes of a Re-activated Alluvial Fan (Poster #1)

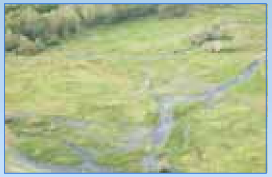
Ian Mostrenko[1], Christina Avolio[1], Chris Brummer[1], Kris Lepine[1], Lauren Rich[2]

1. Herrera Environmental Consultants
2. Upper Skagit Indian Tribe

Project Overview

Hansen Creek, a tributary to the Skagit River, was the site of an alluvial fan and wetland restoration project that began in 2009 within Skagit County's Northern State Recreation Area park (726 acres).

- Project Objectives
  - Restore floodplain connectivity and natural geomorphic processes.
  - Enhance fish habitat for steelhead, Chinook, coho, chum, and pink.
  - Restore native riparian vegetation community.
  - Eliminate need for downstream dredging and reduce downstream flooding.
- Key Project Components
  - Geomorphic Design (Poster #1)
  - Habitat / Riparian (Poster #2)
  - Habitat / Aquatic (Poster #3)
- Project Summary
  - Construction: $2,400,000
  - 140 acres
  - 87 acres wetland
  - 60 acres RCG removed
  - 12 acres Blackberry removed
  - 200,000 CY excavation
  - 302 log structures
  - 105,000 plants

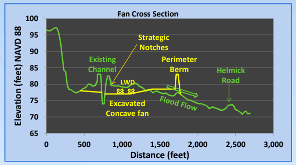


Design and Performance

Design Objectives and Strategies

- Fan functionality must fit within overall geomorphic context (i.e. sediment supply, hydrologic inputs, gradient) of the watershed.
- Use passive approach to engage alluvial fan floodplain:
  - Encourage natural geomorphic processes to activate alluvial fan.
  - Place LWD (channel roughening) to aggrade the existing incised channel.
  - Notch and partially remove existing levees to preserve existing vegetation and initiate connection between the channel and floodplain at strategic locations.
  - Design channel roughening and notches using bedload influx estimates with an avulsion target of 2 to 5 years to allow vegetation establishment.
- Use holistic restoration strategy:
  - Place berms along perimeter to protect adjacent properties and allow natural floodplain processes to occur.
  - Add structure and physical complexity (LWD) and aggressive riparian plantings to accelerate floodplain recovery.
  - Combine strategic placement (density) of LWD with strategic concave re-grading of the floodplain to minimize project construction costs and maximize probability of complex channel evolution given limited construction funding, LWD supply, and existing vegetation.
  - Create a mosaic of habitat types using LWD roughening structures in the fan and wetland to encourage natural evolution of channels.

Mosaic of LWD placed in Hansen Creek alluvial fan to encourage flow deflection, scour, deposition, and physical complexity



Schematic of design cross-section with levee notching, grading, and wood placement to encourage passive fan activation

Estimating Bedload Influx to Fan

Basin	Basin area (km^2)	Total Annual average sediment input (tonnes/year)	Total Annual average sediment input (m^3/year)	Total Annual average bedload flux (tonnes/year)	Total Annual average bedload flux (m^3/year)
Hansen	19.41	47,700	30,300	4,700	3,000

Source: Herrera, based on Syvitski et al. 2005

Geomorphic Changes (photo-point #3)

Pre-Project (2007)

Post Construction (2009)

Fall (2009)

Spring (2010)

Summer (2010)

Summer (2011)

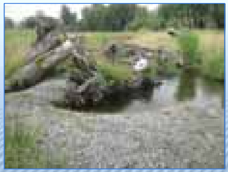
Results – Large Woody Debris (LWD)

Channel Roughening

- Deep scour pools and large bars.
- Significant deposition.
- Passive activation (avulsion) into upper alluvial fan in first year.
- Flow complexity = habitat complexity.

Fan Roughening

- Scour pool formation.
- Debris accumulation and cover.
- Gravel sorting.
- Flow deflection = increased sinuosity and channel length.

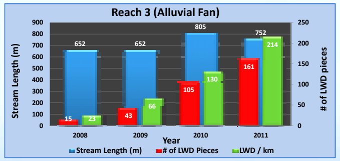


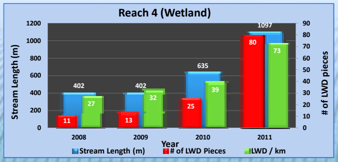
Wetland Roughening

- Scour pool formation.
- Sediment deposition.
- Gravel sorting.
- Flow bifurcation = multiple channels, increased channel length, and meandering.

LWD Monitoring (TFW Protocol)

- Monitored LWD engaged at 10 cfs.
- Stream channel lengthened at 10 cfs.
- Significant increase in the number of engaged LWD pieces and LWD/km.



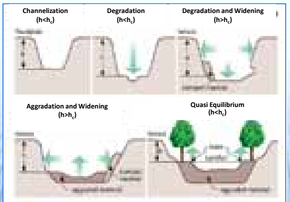


Results – Sediment

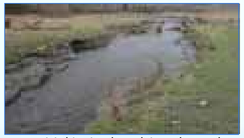
Reach 3 (Alluvial Fan) – Large gravel bars in fan floodplain and side-channels

Reach 4 (Wetland) – Sand splays, gravel splays, and sediment lobes forming patch mosaic in ephemeral side-channels

Fan channels demonstrated channel evolution process



Stages of channel evolution (modified from Simon and Hupp, 1986; Simon and Rinaldi 2006).
h_c = critical bank height



Initial incised avulsion channel

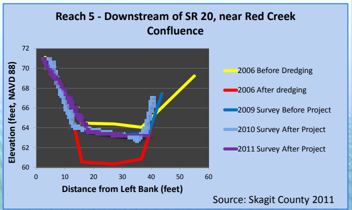
Channel widening and deposition of coarse bedload

Observed Sedimentation on Fan

- Partial avulsion into fan – 2009.
- Full avulsion into fan – 2010.
- 95% of bedload and more suspended sediment depositing than expected.
- Fan sedimentation in lobes or splays as transport capacity decreases across fan.
- Fan depositional grain size decreases in downstream direction.

Downstream Benefits

- Reach 5 historically dredged to reduce flooding impacts to adjacent properties.
- The Reach 5 channel bed has remained stable even after several significant floods depositing more than the average annual bedload in the project area.



Source: Skagit County 2011

Contacts:
Ian Mostrenko, Herrera Environmental Consultants
Associate Engineer: imostrenko@herrerainc.com
Chris Brummer, Herrera Environmental Consultants
Associate Geomorphologist: cbrummer@herrerainc.com