Simulating Streams Through Culverts in Mat-Su, Alaska

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The Team Approach

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National Marine Fisheries
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The Location

Objectives

- Results of Mat-Su Culvert Survey
- Present Stream Simulation Methodology
- Describe the Culvert Replacement Approach in Mat-Su
- Present a Series of Culvert Replacements
- Future Efforts and Needs
The Problem

- WA: 33,000 culvert barriers
- OR: 30,000 culvert barriers

1999/2004 Culvert Surveys
- 289 culverts surveyed
- Median OHW width: 7 ft.
- 30% creeks <3 feet wide
- 200-300 miles of creek

The Problem

Tongass Survey 2000

Mat-Su Surveys 1999/2004 Streams
Improperly Sized Culverts

- Barriers to Aquatic/Wildlife Movement
- Decrease Habitat

- Change Stream Processes

Improperly Sized Culverts

- Increase Flooding Risk
- Increase Infrastructure Maintenance Costs
Project Objectives – What is Success?

Stream Simulation
- Pass Game Fish (hydraulic design)
- Range of culvert designs
- Better
- Range of ecological functions
- Floodplain Continuity
- Pass adult salmon
- Pass sediment, debris, all aquatic organisms
- Floodplain Process Permitted (meander migration)
- Make the Road Crossing “Invisible”

The Current Solution

- Aquatic Barrier
- Significant Function Effects
- Habitat Value
- Cost
- Stream/Floodplain
- Timing
- Culvert Replacement
- Funding
  - Borough
  - USFWS
  - NRCS
  - NMFS
- Bridge
- CIP Process

Worse
- Flood Capacity
- Pass Game Fish
- Range of culvert designs
Stream Simulation

- “Simulate” adjacent natural channel
- Premise: channel inside culvert should present no more of an obstacle to movement of organisms than adjacent natural channel.

Well-graded native streambed sediment – and withstands 50-year event.

Rockbands: Based on slope and distance.

Culvert bed width = Varies

30-50% of culvert rise.
Alaska DOT/ F&G Simulation Definition

- Culvert width at OHW = 0.9 x channel OHW width
- Slope within 1% of natural grade
- Slope greater than 6% requires additional analysis
- Bed “dynamically stable” up to Q50
- Embed minimum 40% (arch pipes 20%)
- No further hydraulic analysis needed to support fish passage

Good Flood Width
Meadow Creek
Width ratio = 1.5
Slope = 0.9%

Note: Rockband keeps channel form
Natural Streambed
Flow Isolated from Culvert Walls
Crooked Lake System

Culvert Design/Construction

Culvert 1:
- 48-inch Culvert with 2 Relief Culverts
- Design Slope 1.2%
- Fish Passage Event: 10 cfs
- Streambed with 1.5 foot Gravel/Cobbles
- Streambed D50= 3 inches/ D100 = 6 inches
- 100-Year Event: 41 cfs
Crooked Lake System

Culvert Design/Construction

**Culvert 2 & 3:**
- 48-inch Culverts
- Design Slope 2.5% and 0.5%
- Fish Passage Event: 3.6 cfs
- Streambed D50= 3 inches/ D100 = 6 inches
- Streambed with 1.6 foot Gravel/Cobbles
- 100-Year Event: 28 cfs

**Culvert 1**
- Culvert too Steep
- DS Invert Too Low
- Shallow Bed US
- Passes Juveniles
- Better Function

**Crooked Lake System**

Culvert 2 & 3:
- 48-inch Culverts
- Design Slope 2.5% and 0.5%
- Fish Passage Event: 3.6 cfs
- Streambed D50= 3 inches/ D100 = 6 inches
- Streambed with 1.6 foot Gravel/Cobbles
- 100-Year Event: 28 cfs
Crooked Lake System

- Changed Bed Material
- Streambed 3.2% not 2.2%
- Needed Channel in Culvert

- Changed Bed Material
- Streambed 3.4% not 0.5%
- Needed More Fill over Culvert
- Needed Streambed Shaped

Meadow Creek Culvert

Big Lake Watershed: ~90 sq. miles
Culvert Drainage: ~7 sq. miles
Meadow Creek Culvert

Design:
- 7 by 14 foot Arch
- Design Slope 0.75%
- Fish Passage Event: 24 cfs
- Streambed D50= 3 inches/ D100 = 6 inches
- Streambed 2-foot Gravel/Cobbles
- 100-Year Event: 150 cfs

More Bed Material Needed
- Streambed 0.9%
- Did not Form Main Channel
- Rockbands
- Beaver Control
Lucy Lake Tributary

Old Culverts:
- 36-inch Culverts
- Slopes 1.3-5.2%
- Perch: 0.3-2.4 ft.

Lucy Lake System

Culverts:
- 54-inch Culverts for Stream
- Design Slope 1.1-2.0%
- Fish Passage Event: 3 cfs
- Streambed with 1 foot Gravel/Cobbles
- Streambed D50= 0.5 inches/ D100 = 4 inches
- 100-Year Event: 27 cfs
Results

• Eight Culverts Replaced in 2004
• 3.5 miles US Habitat Accessed
• Key Main Stem Culvert Replaced

• CIP Process Initiated
• Prioritization Begun

Future Challenges

• Prioritization
• Education

• Replacement of Key Culverts Under Pavement
• Replacement of Culverts With Bridges