Rehabilitation Approaches for Lower Lake Creek

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Lower Lake Creek Goals and Objectives

- Aquatic Goals:
  - Restore and enhance anadromous and resident salmonid habitat in Reach 1 of Lower Lake Creek (RM 0.0 – 1.0)
  - Fish species present or potentially present in this reach are:
    - Chinook Salmon
    - Coho Salmon
    - Steelhead Trout
    - Sea-run Cutthroat Trout
    - Resident Rainbow Trout

Lower Lake Creek Goals, cont'd.

- Species most likely to utilize this reach of Lake Creek (steelhead trout and rainbow trout and coho salmon) are typically rearing limited. The primary goal would be to increase and restore rearing habitat for the species listed above.
- Spawning habitat is also very scarce in this reach of Lake Creek. Energy Northwest proposes to increase spawning habitat for anadromous and resident species through the recreation of pools and pool tailouts.

Lower Lake Creek Objectives

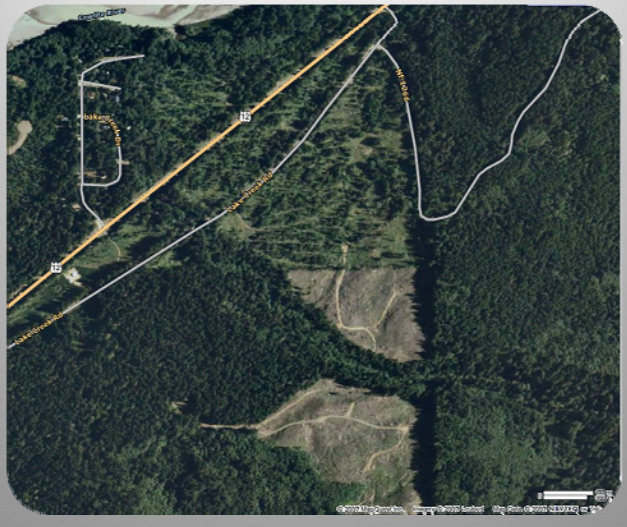
1. Increase salmonid rearing habitat in Lake Creek from RM 0.0 – 1.0 by:
   - Increasing the number of pools in lower Lake Creek to represent 30% of the available habitat.
   - Improving the rearing habitat found in the remaining runs and glides

Lower Lake Creek Objectives, cont'd.

2. Increase salmonid spawning habitat in Lake Creek from RM 0.0 – 1.0. This will be accomplished by:
   - Increasing the number of pools and pool tailouts in the anadromous reach of Lake Creek
   - Placing gravel into the pool tailouts of appropriate size for salmon and trout spawning.

Rehabilitation Approach

- Focus on lower 1 mile of stream



Rehabilitation Approach

Species and Life Stage Focus:

1. Juvenile rearing for steelhead, coho, rainbow, and cutthroat (year-round)
    1. Emphasis on Steelhead and Coho juveniles
2. Spawning for steelhead, coho, rainbow, cutthroat, and Chinook

* Rehabilitation efforts will also provide benefits for other aquatic and terrestrial species

Rehabilitation Approach

- <u>Geomorphic Goals</u>
  - Convert a degraded plane-bed/step-pool system into a wood forced step-pool system
  - Convert current glide habitat into high quality pool habitat
  - Construct pool-forming bedforms (steps) using boulder and wood complexes
  - Increase residual pool depths to increase habitat capacity during low flow periods
  - Increase instream cover and complexity
  - Decrease channel width-to-depth ratios
  - Increase available spawning habitat

Rehabilitation Approach

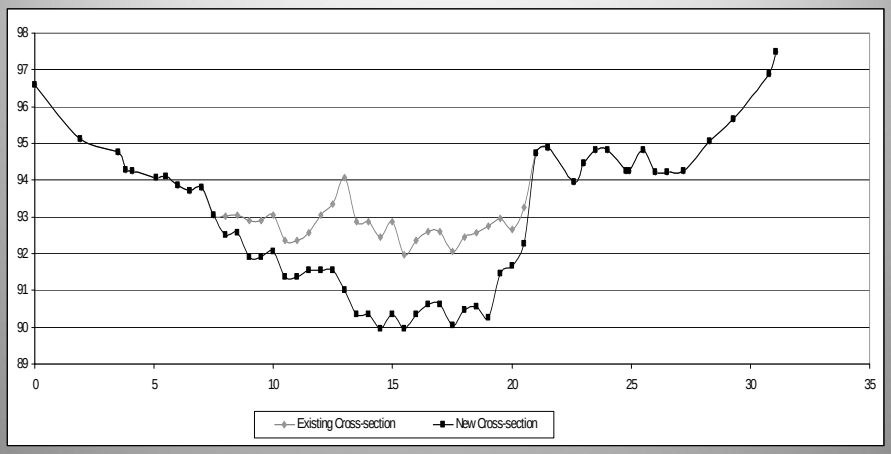
- Geomorphic Objectives
  - Increase wood quantities from 30 pieces/mi to 90-130 pieces/mi (this is within range of upstream reaches and exceeds NOAA PFC criteria)
  - Create 15 large wood / boulder complexes between RM 0.3 and 1.0 (>20 jams/mi, approx 1 jam every 250 ft)
  - Install boulder complexes to enhance pool habitat between RM 0 and 0.3
  - Decrease glide/run habitat to <40% and increase pool habitat to >30%
  - Reduce pool width-to-depth ratios to below 15:1 and possibly below 10:1 (they currently regularly exceed 30:1)
  - Increase spawning area by increasing availability of pool tailouts and through spawning gravel augmentation

Rehabilitation Approach

Calculation of WUA with Enhancement – (December 2007)

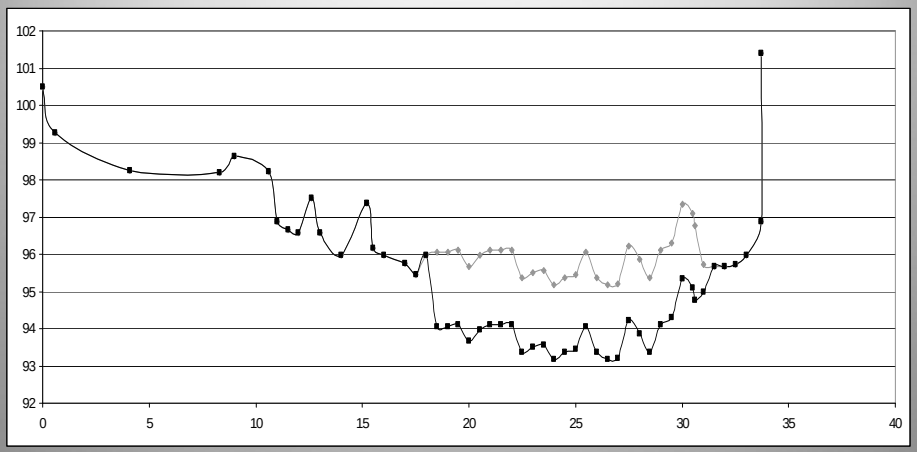
- Pools
  - Transects 5 and 9
  - Increase residual depth
- Pool Tailouts
  - Transect 7
    - Placement of suitable-sized gravel for salmon and trout

Transect 5



Cross-section Data, Transect 7	
Flow (cfs) =	22.9
WSE (ft) =	93.95
Bed elev @ max depth (old) (ft)=	91.96
Bed elev @ max depth (new) (ft)=	89.96
Assumed downstr control depth (ft) =	1.8
residual depth (ft) =	2.2
Max excavation depth (ft) =	2

Transect 9



Cross-section Data, Transect 9	
Flow (cfs) =	25.52
WSE (ft) =	96.69
Bed elev @ max depth (old) (ft)=	95.165
Bed elev @ max depth (new) (ft)=	93.165
Assumed downstr control depth (ft) =	1.8
residual depth (ft) =	1.7
Max excavation depth (ft) =	2

Methods

- The new, modified transects were calibrated using a depth calibration across the range of flows that were modeled in the Lake Creek Instream Flow Study
- The scaling factors for each transect, species and life stage were used to adjust the depth calibration models to be comparable to the velocity regression models.

Results

- Results reflect changes made to pool habitat for rearing and pool tailout habitat for spawning
- Results do not reflect re-engineered glides and runs, which will increase salmonid rearing WUA in these habitats
- Spawning Habitat increased to levels above pre-project and existing operations
- Rearing habitat varied by species and life stage.

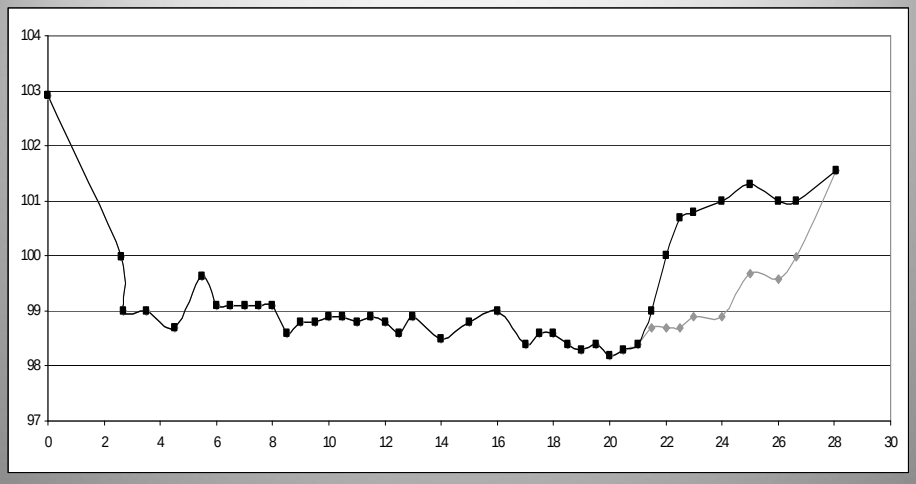
Next Steps

- Interfluve to modify glide/run habitat to be run in the model
- Modifications to lower Reach 2
- Interfluve to survey and design structures within the lower anadromous zone (RM 0.0 – 1.03)
  - Conditioned upon agreement that enhancement will mitigate for flows

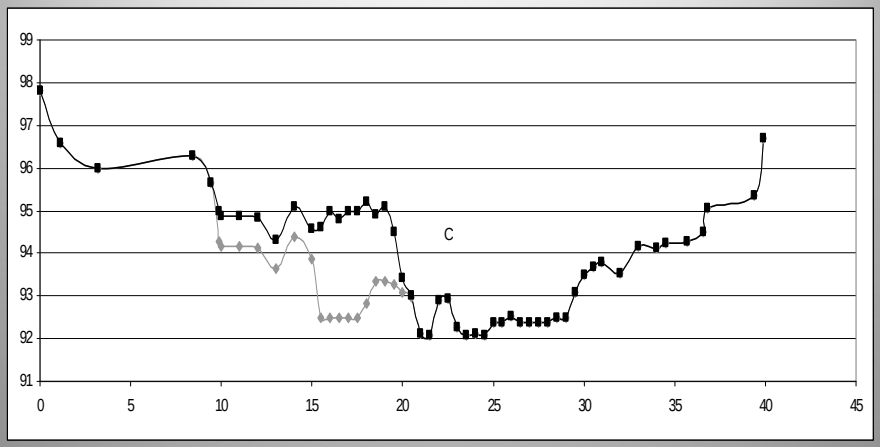
Additional Analysis

- Study Site 1
  - Transect 2 (Run) Channel narrowed by about 20% of wetted width at the middle calibration flow using log and boulder structures
  - Transect 6 (Run) Channel narrowed by about 25% of wetted width at the middle calibration flow using log and boulder structures

SS1 Transect 2



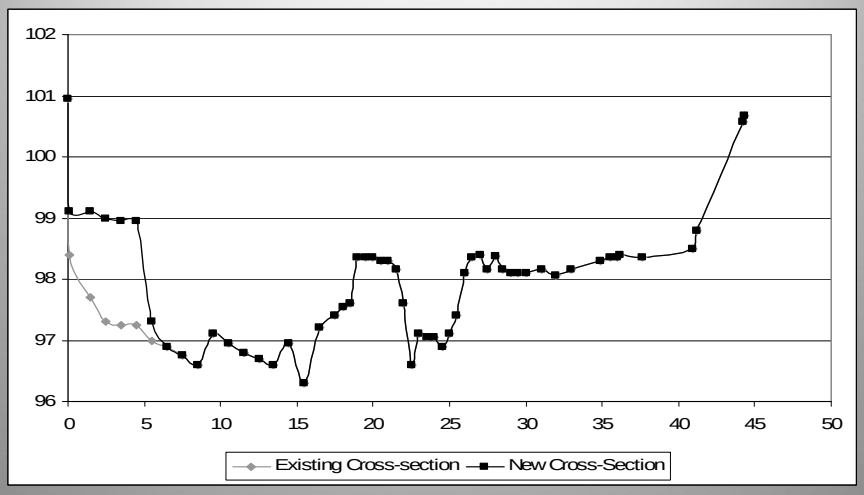
SS1 Trans 6



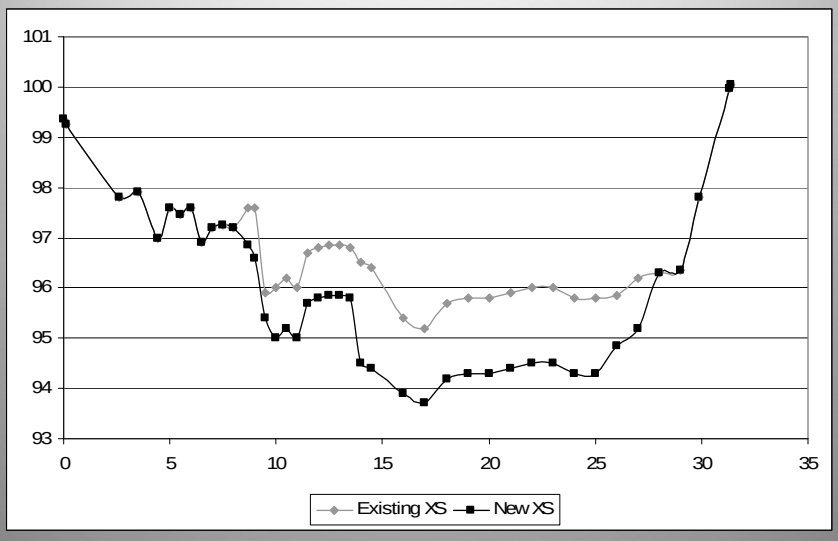
Additional Analysis (cont'd)

- Study Site 2
  - Transect 1 (Run) Channel narrowed by about 20% of wetted width at the middle calibration flow using log and boulder structures
  - Transect 3 (Pool)
  - Transect 6 (Run) Channel narrowed by about 20% of wetted width at the middle calibration flow using log and boulder structures
  - Transect 7 (Pool)

SS2 Trans 1

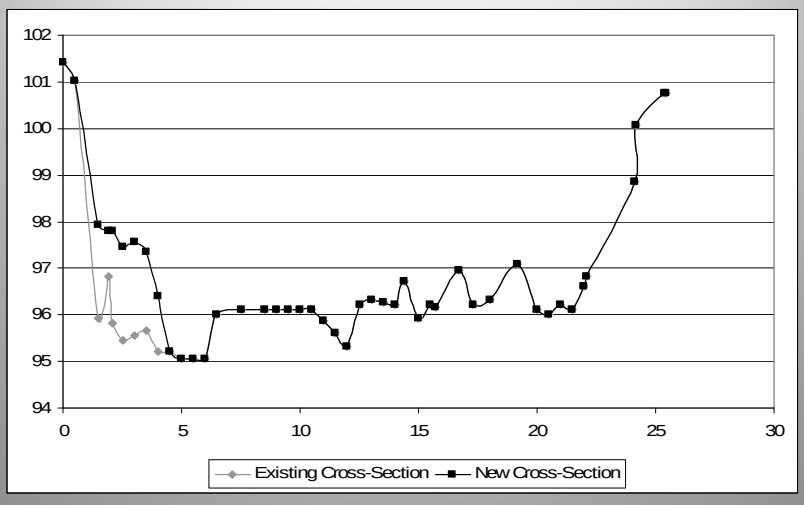


SS2 Transect 3

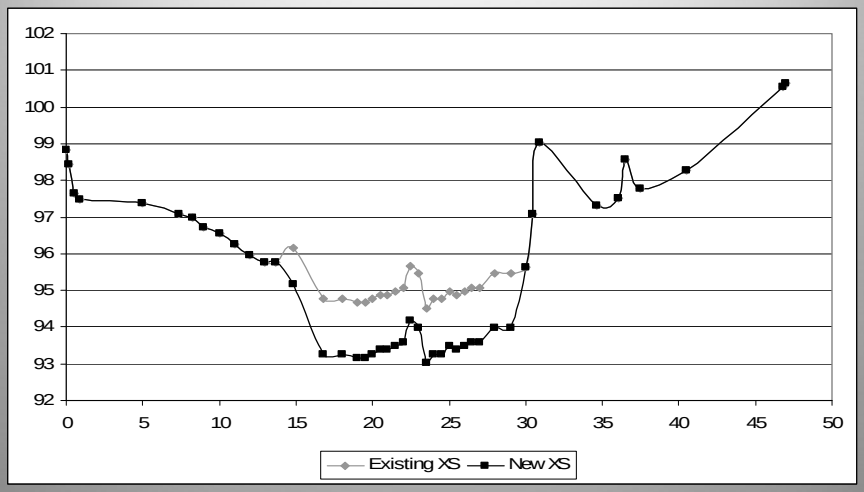


Cross-section Data, Study Site 2 Transect 3	
Flow (cfs) =	26.95
WSE (ft) =	97.65
Bed elev @ max depth (old) (ft)=	95.2
Bed elev @ max depth (new) (ft)=	93.7
Assumed downstr control depth (ft) =	1.8
residual depth (ft) =	2.2
Max excavation depth (ft) =	1.5

SS2 Transect 6



SS2 Transect 7



Cross-section Data, Study Site 2 Transect 7	
Flow (cfs) =	24.89
WSE (ft) =	96.91
Bed elev @ max depth (old) (ft)=	94.52
Bed elev @ max depth (new) (ft)=	93.02
Assumed downstr control depth (ft) =	1.8
residual depth (ft) =	2.1
Max excavation depth (ft) =	1.5

Rearing Habitat WUA

- SS1: Study Site 1 habitat WUA after enhancements averaged 126.8% of Pre-Project WUA
  - Ranged from 95.3% (Steelhead) to 155.5% (Chinook)
- Lake Creek Overall: Lake Creek habitat WUA after enhancement averaged 124.2% of Pre-Project WUA
  - Ranged from 78.1% (Steelhead) to 200.4% (Coho)
- Every Month showed net increase in WUA over Pre-Project conditions

Table 1. All Sites Lake Creek Habitat Duration Analysis, 50% Exceedence Values

Rearing Habitat (sq ft/1000 ft)							
Month/Period	Chinook	Coho	Steelhead	Rainbow	Cutthroat	Winter Trout	Mean
August							
Pre-Project	4,960	3,439	**5,161**	3,675	4,093		4,265
Current	3,158	4,601	1,686	1,746	1,994		2,637
Proposed	**6,907**	**6,916**	4,181	**3,877**	**5,162**		**5,409**
September							
Pre-Project	4,984	3,470	4,624	3,367	4,018		4,093
Current	2,938	4,641	1,540	1,649	1,842		2,522
Proposed	**7,550**	**5,997**	**4,722**	**4,285**	**5,498**		**5,611**

Table 2. Study Site 1. Lake Creek Habitat Duration Analysis, 50% Exceedence Values

	Rearing Habitat (sq ft/1000 ft)						
Month/Period	Chinook	Coho	Steelhead	Rainbow	Cutthroat	Winter Trout	Mean
August							
Pre-Project	4,448	3,092	**4,777**	3,371	3,640		3,866
Current	2,905	4,229	1,615	1,800	1,707		2,451
Proposed	**7,406**	**4,631**	4,473	**4,997**	**5,122**		**5,326**
September							
Pre-Project	4,692	2,945	4,531	3,367	3,706		3,848
Current	2,711	4,278	1,499	1,698	1,607		2,359
Proposed	**7,703**	**4,210**	**5,117**	**5,522**	**5,367**		**5,584**

Lake Creek Habitat Duration Analysis, 50% Exceedence Values

	Rearing Habitat (sq ft/1000 ft)						
Location	Chinook	Coho	Steelhead	Rainbow	Cutthroat	Winter Trout	Mean
Lake Creek	140.5%	200.4%	78.1%	98.3%	128.6%	133.2%	124.2%
SS1	155.5%	144.7%	95.3%	135.7%	130.2%	115.9%	126.8%

Spawning Habitat

- SS1: Site habitat WUA after enhancements averaged 485.3% of Pre-Project WUA
  - Ranged from 283.9% (Chinook) to 9,707.7% (Rainbow)
- Lake Creek Overall: Lake Creek habitat WUA after enhancement averaged 213.3% of Pre-Project WUA
  - Ranged from 118.8% (Rainbow) to 1190% (Cutthroat)
- Every Month showed net increase in WUA over Pre-Project conditions

Lake Creek Habitat Duration Analysis, 50% Exceedence Values Spawning Habitat. Measured as Percentage of Pre-Project WUA.

Location	Chinook	Coho	Steelhead	Rainbow	Cutthroat	Mean
Lake Creek	283.9%	286.0%	353.5%	2226.5%	9707.7%	485.3%
SS1	180.1%	224.2%	150.6%	1189.9%	118.8%	213.3%

Next Steps

- Develop Monitoring and Evaluation Plan
  - Develop cooperatively with natural resource agencies and tribes
  - FERC requires draft plan in the FLA
- Survey RM 0.0 – 1.0 to design enhancement structures
  - To be added as a PME

Month	Agency Suggested
January	4
February	4
March	4
April	7
May	15
June	10
July	15
August	15
September	20
October	10
November	7
December	4