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

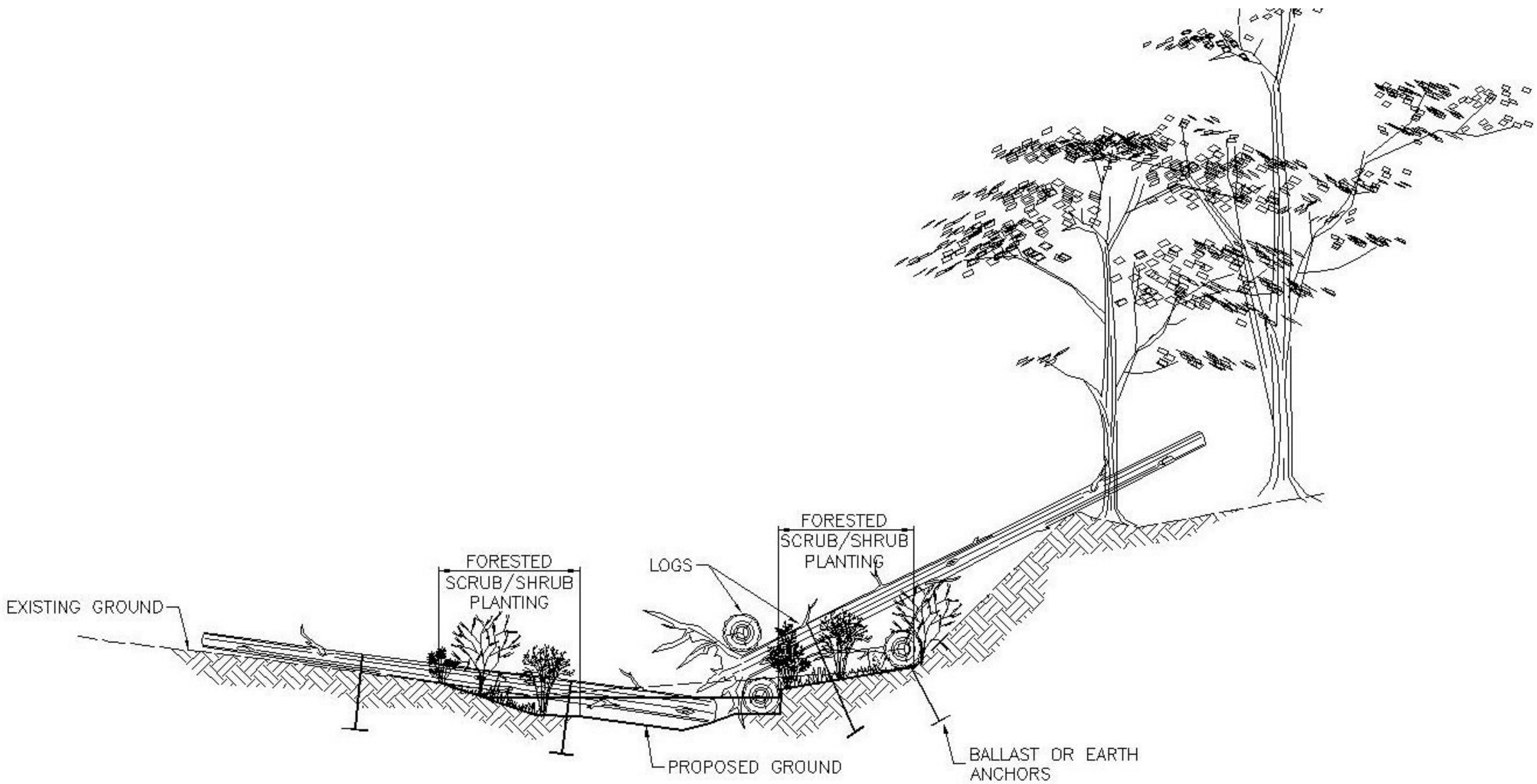
Rehabilitation Approach

- Geomorphic Goals
  - 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



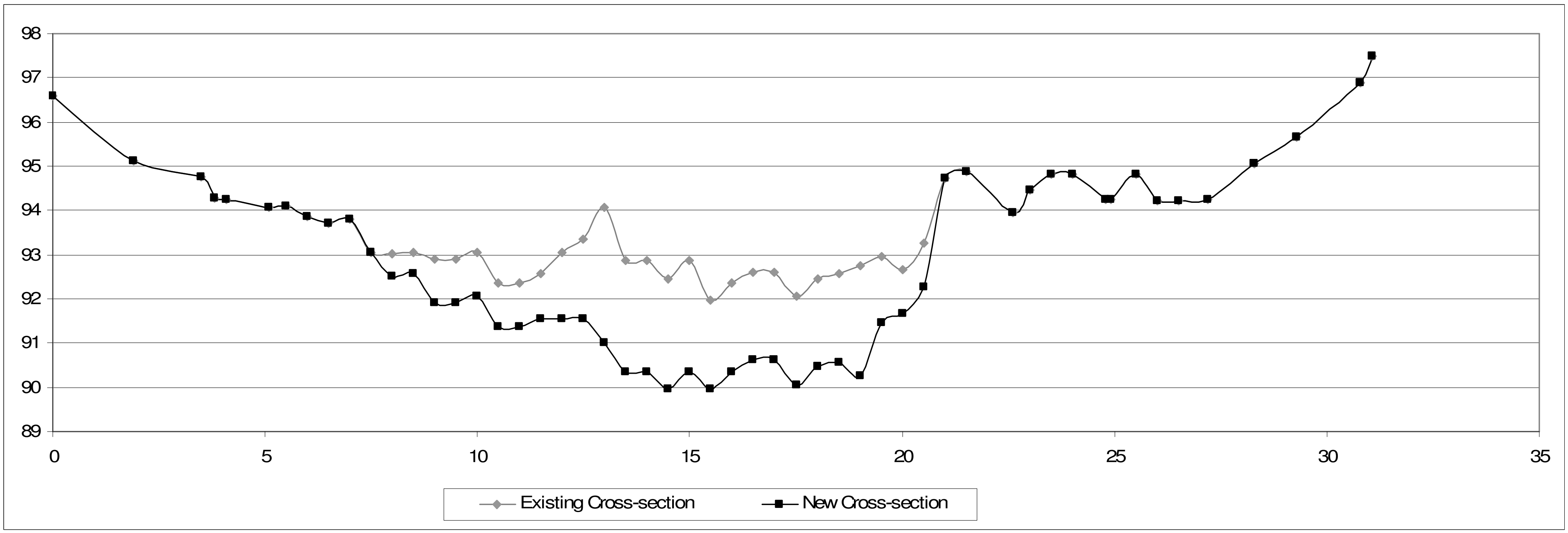
Rehabilitation Approach

Calculation of WUA with Enhancement

- Pools
  - Transects 5 and 9
  - Increase residual depth

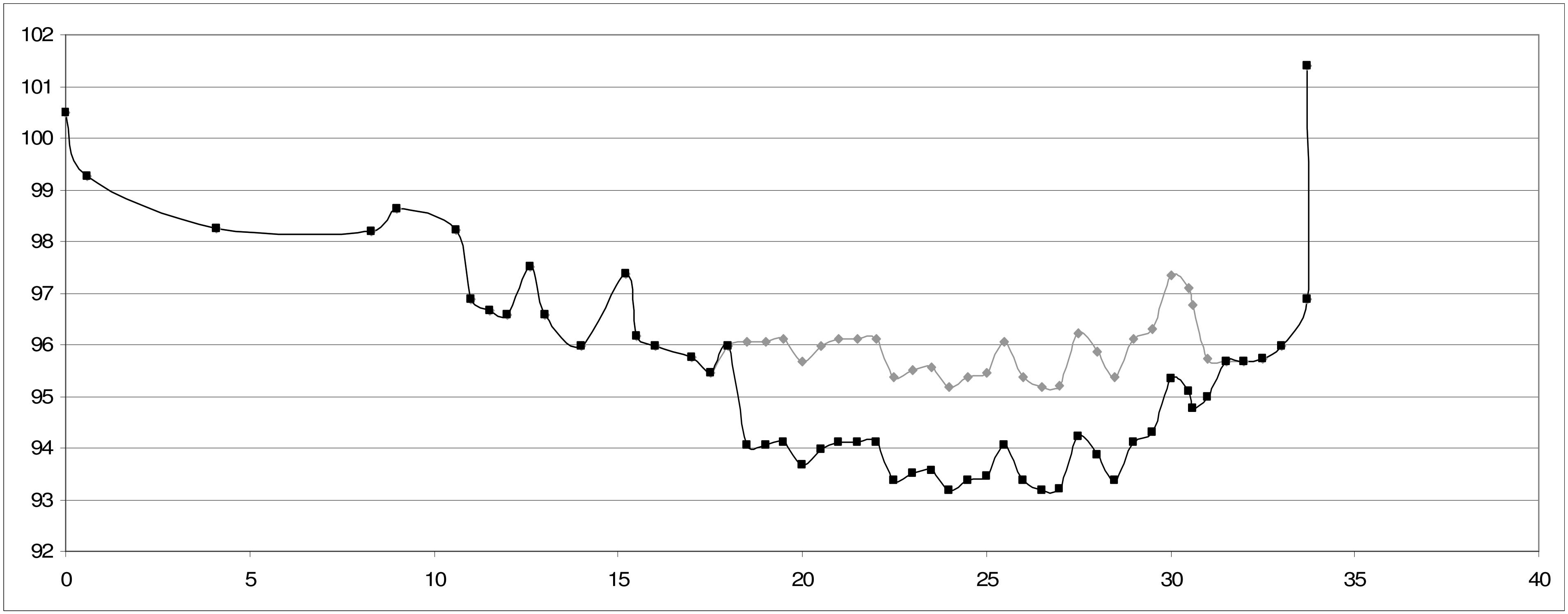
- Pool Tailouts
  - Transect 7
    - Placement of suitable-sized gravel for salmon and trout

Transect 5


98
97
96
95
94
93
92
91
90
89
0
5
10
15
20
25
30
35
Existing Cross-section
New Cross-section

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

Calculation of WUA with Enhancement, cont'd

- Run Pool Transects 5 and 7 as approved, calibrated transects
  - As 3-velocity set models (lower flows)
  - As 1 velocity set models (higher flows)
- This is considered the benchmark
- Run these same transects using the depth calibration method

What is the Depth Calibration Method?

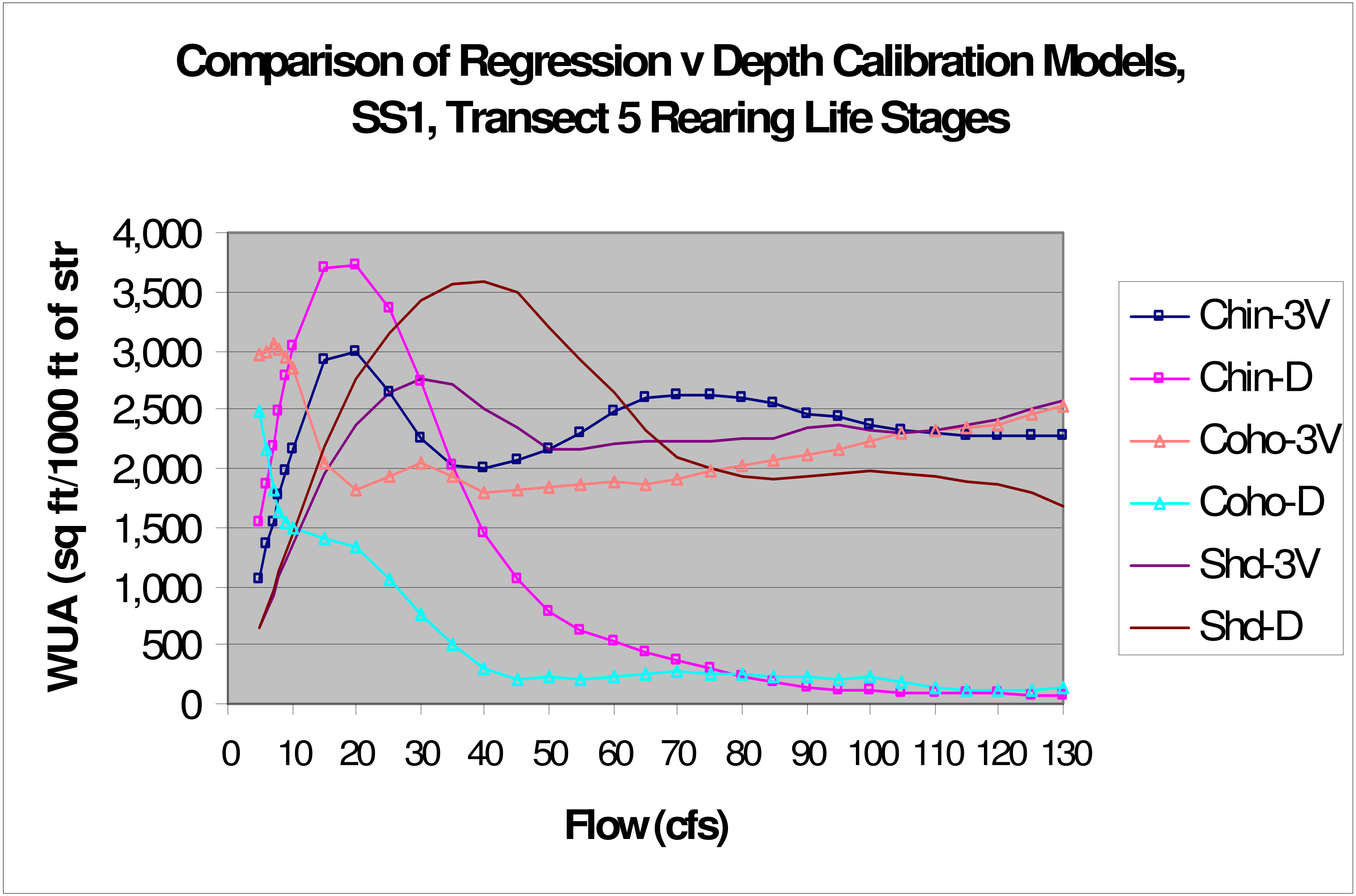
- Model uses the following existing information:
  - Bed Profile
  - Depths
  - Substrate and Cover
  - Slope
  - Stage/Discharge Relationship

- Does Not Use Measured Velocities

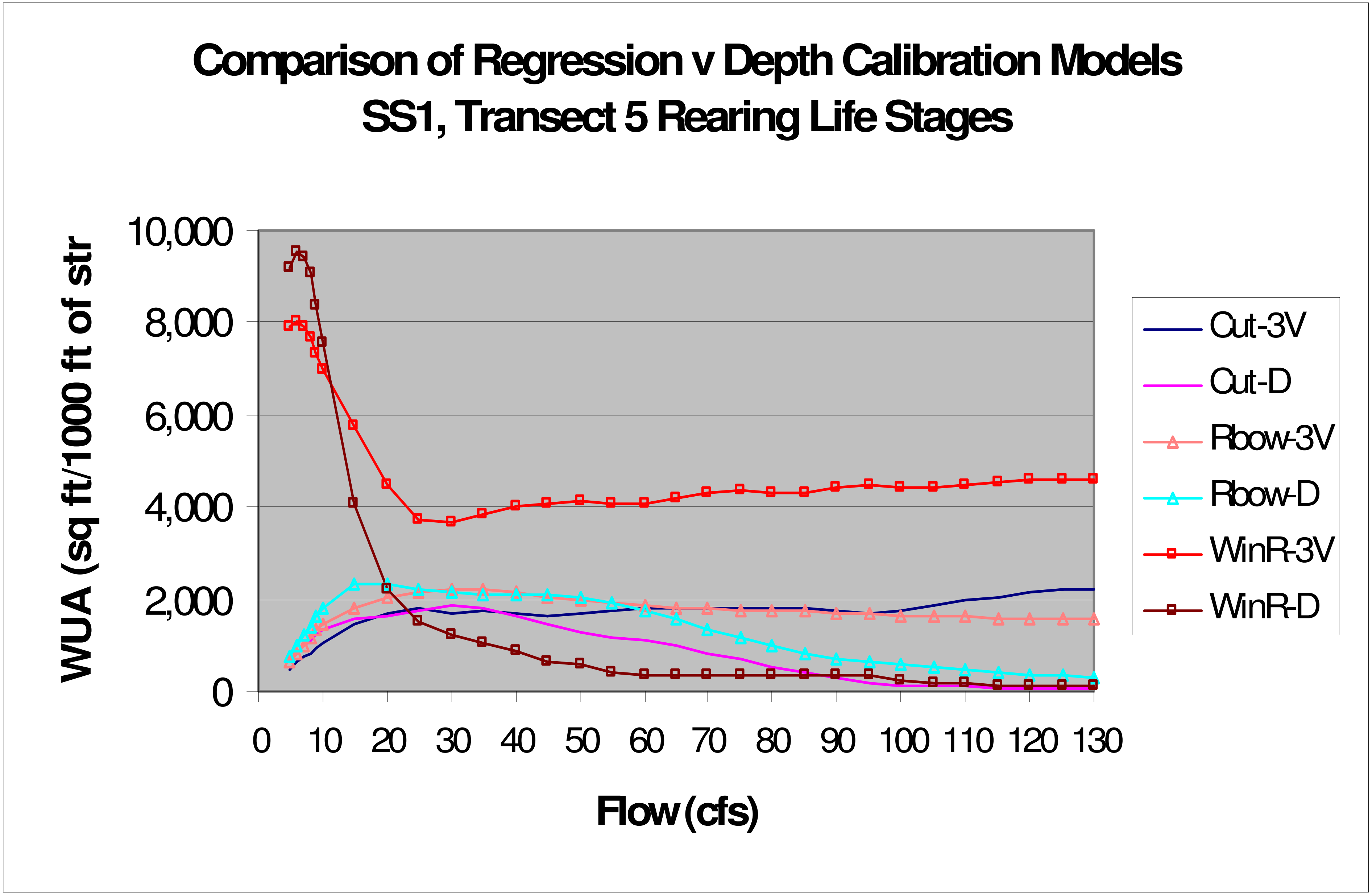
How does it work?

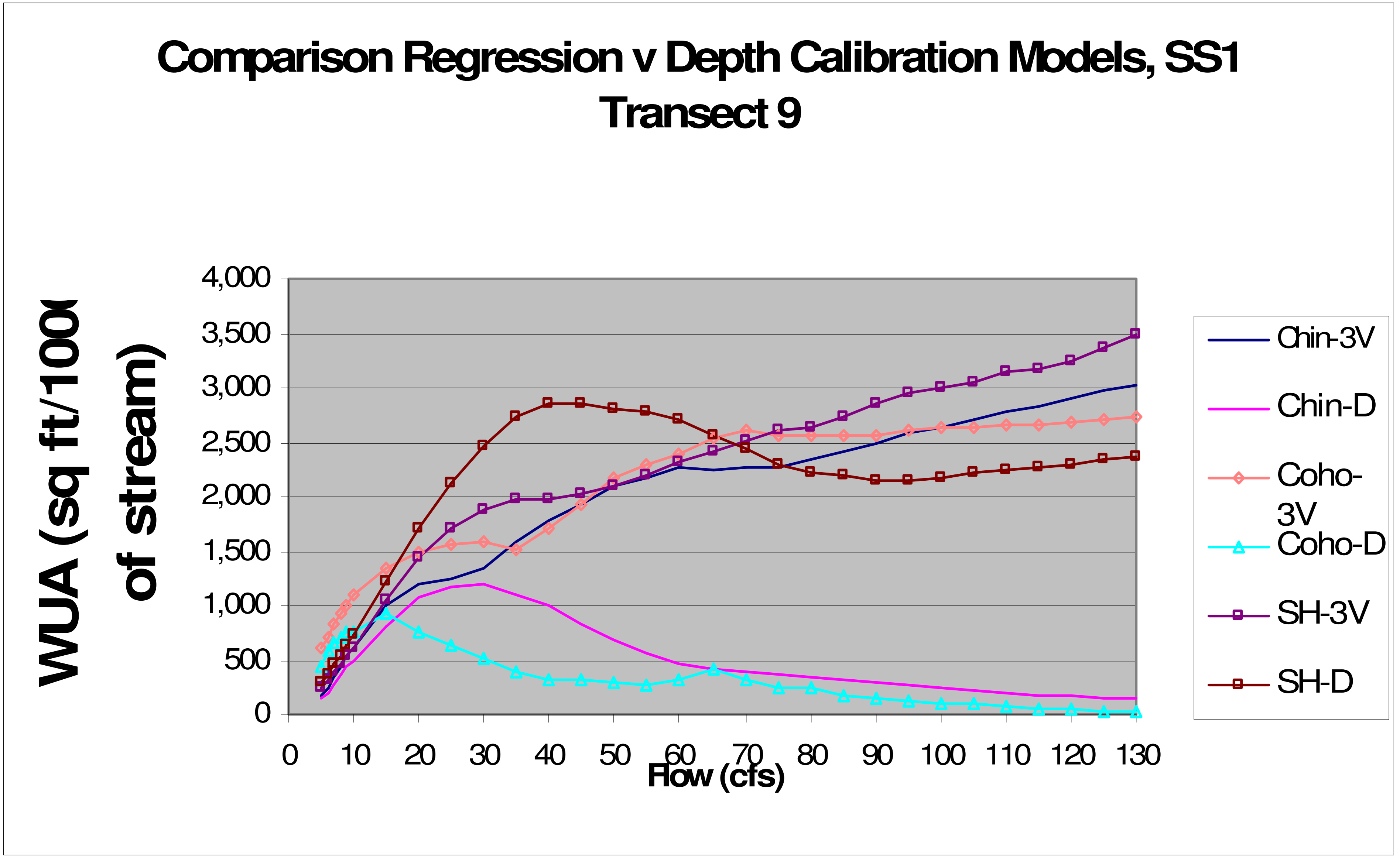
- Model works with the premise that the deepest part of the channel (thalweg) is usually the fastest part of the channel
- Velocities are more equally distributed across the channel
- Tends to “smooth out” velocities across the channel.
- THE ONLY THING DIFFERENT IN THE TWO APROACHES IS THE SIMULATION OF VELOCITIES – EVERYTHING ELSE REMAINS THE SAME

How do they compare?

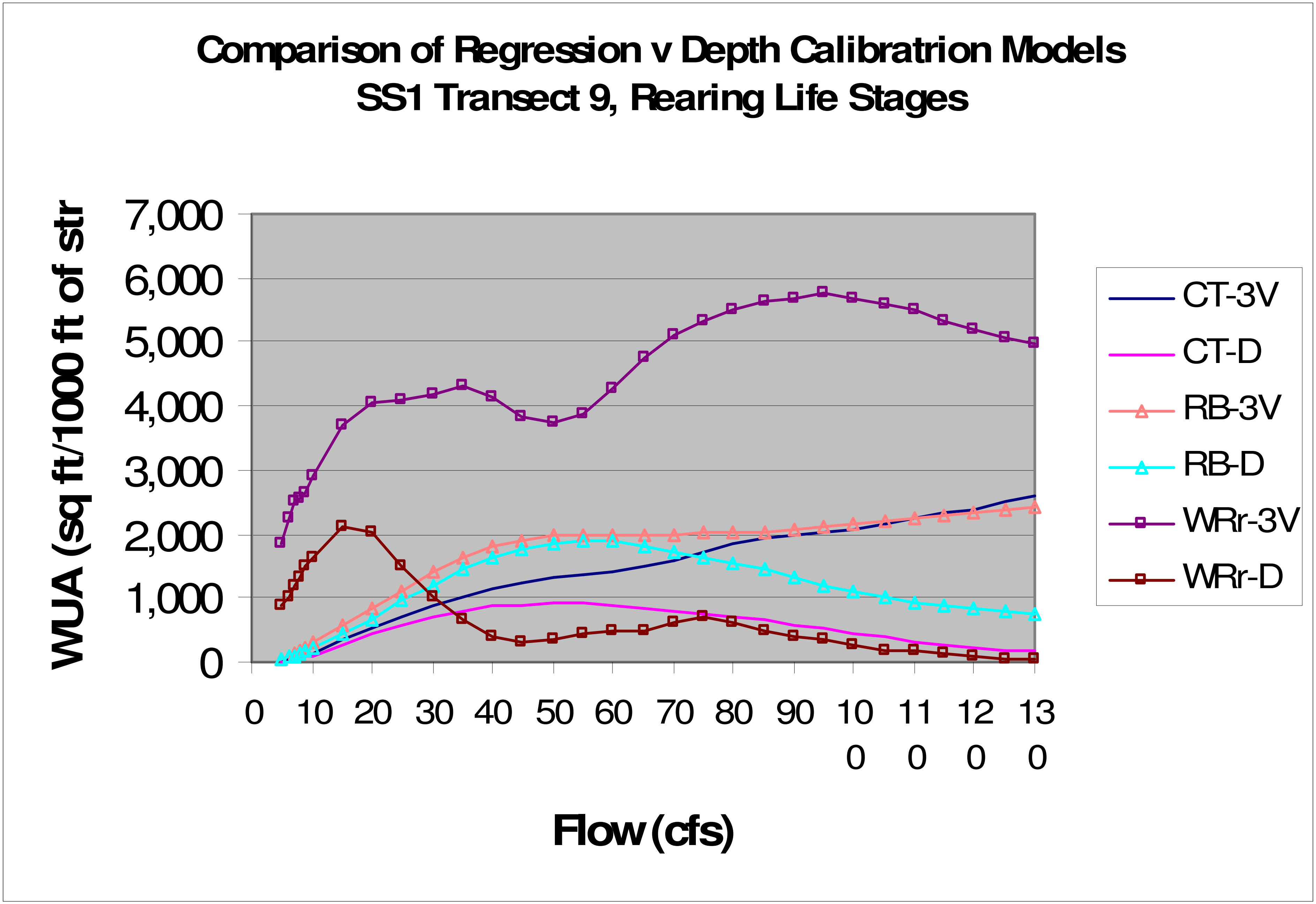


Comparison of Regression v Depth Calibration Models,
SS1, Transect 5 Rearing Life Stages
WUA (sq ft/1000 ft of str
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Flow (cfs)
Chin-3V
Chin-D
Coho-3V
Coho-D
Shd-3V
Shd-D


Comparison of Regression v Depth Calibration Models
SS1, Transect 5 Rearing Life Stages
WUA (sq ft/1000 ft of str
10,000
8,000
6,000
4,000
2,000
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Flow (cfs)
Cut-3V
Cut-D
Rbow-3V
Rbow-D
WinR-3V
WinR-D



Comparison Regression v Depth Calibration Models, SS1
Transect 9
WUA (sq ft/100
of stream)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Flow (cfs)
Chin-3V
Chin-D
Coho-3V
Coho-D
SH-3V
SH-D


Comparison of Regression v Depth Calibratrion Models
SS1 Transect 9, Rearing Life Stages
WUA (sq ft/1000 ft of str
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
10
20
30
40
50
60
70
80
90
10
0
11
0
12
0
13
0
Flow (cfs)
CT-3V
CT-D
RB-3V
RB-D
WRr-3V
WRr-D

Results

- Varies
  - Some life history stages model similarly, with curves of similar shape and amplitude
  - Some life history stages do not model in a similar fashion

How to Make These Methods Comparable?

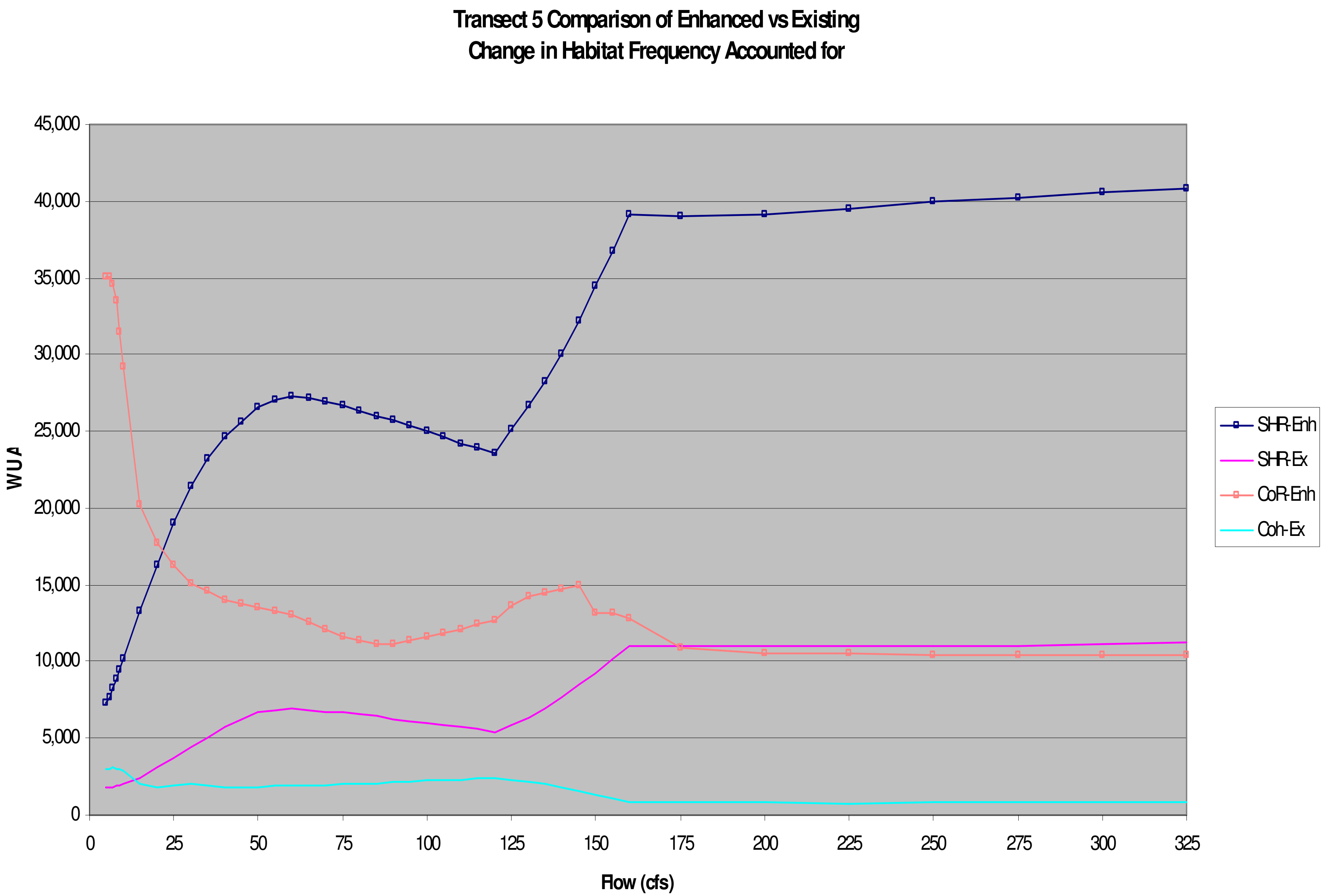
- Scaling Factors
  - The calibrated, 3-velocity and 1-velocity set models are considered a "true" representation of velocity response over a range of flows
  - Depth Calibrations results were "scaled" to modify them to reflect regression model results
  - Each transect, species and life stage for each of these transects would be individually scaled at each flow modeled.

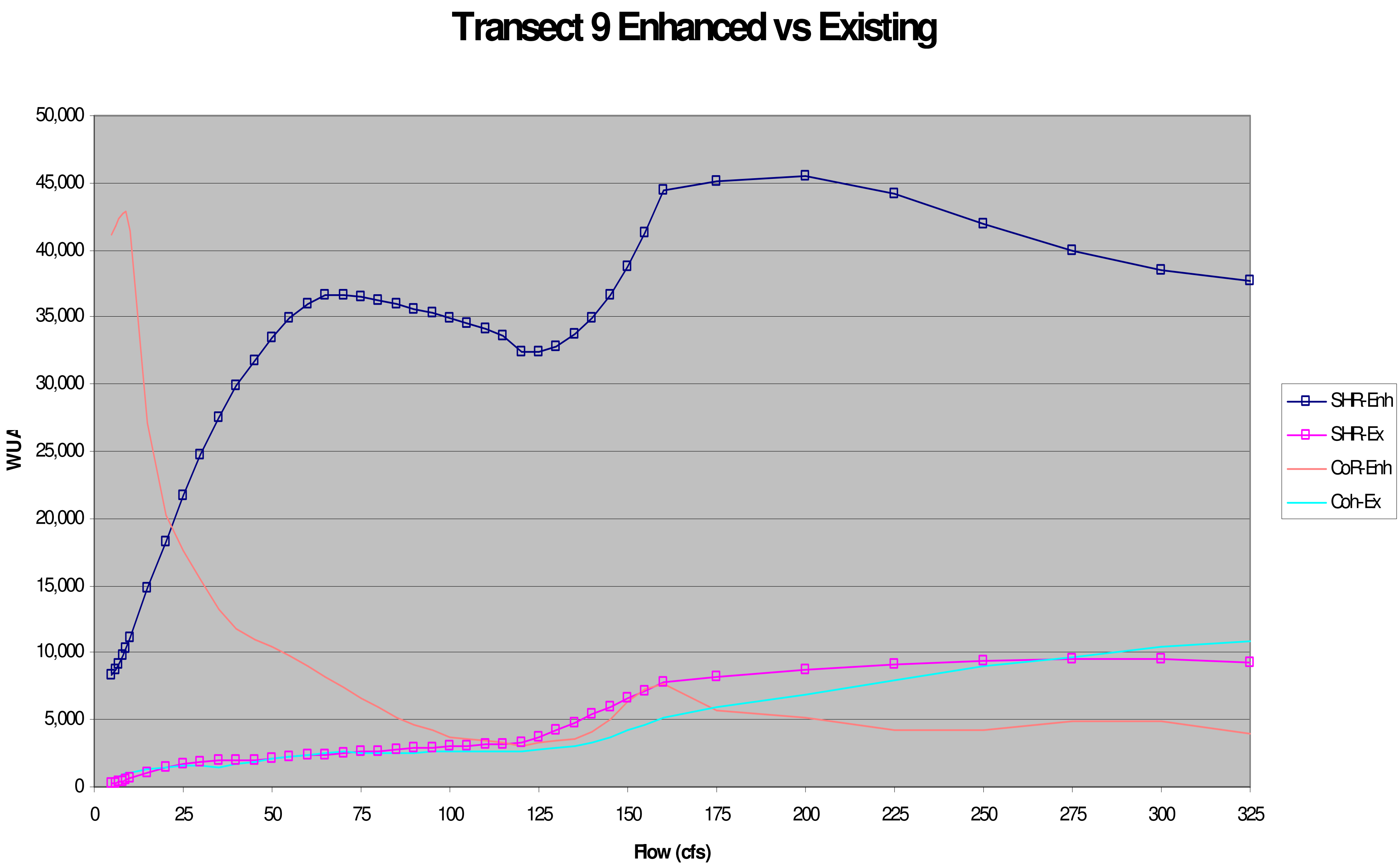
Scaling, Cont'd

- Assumption:
  - *The modified transects will respond to changes in velocity and flow similarly to the original, calibrated transects*
  - *There fore, depth calibration model results fro the modified cross sections can use the same scaling factors as the original transects.*
- *Different scaling factors by:*
  - *Transect*
  - *Life History Stage*
  - *Species*
  - *Flow*

Methods

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


Transect 5 Comparison of Enhanced vs Existing
Change in Habitat Frequency Accounted for
WUA
Flow (cfs)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
25
50
75
100
125
150
175
200
225
250
275
300
325
SHR-Enh
SHR-Ex
CoR-Enh
Coh-Ex



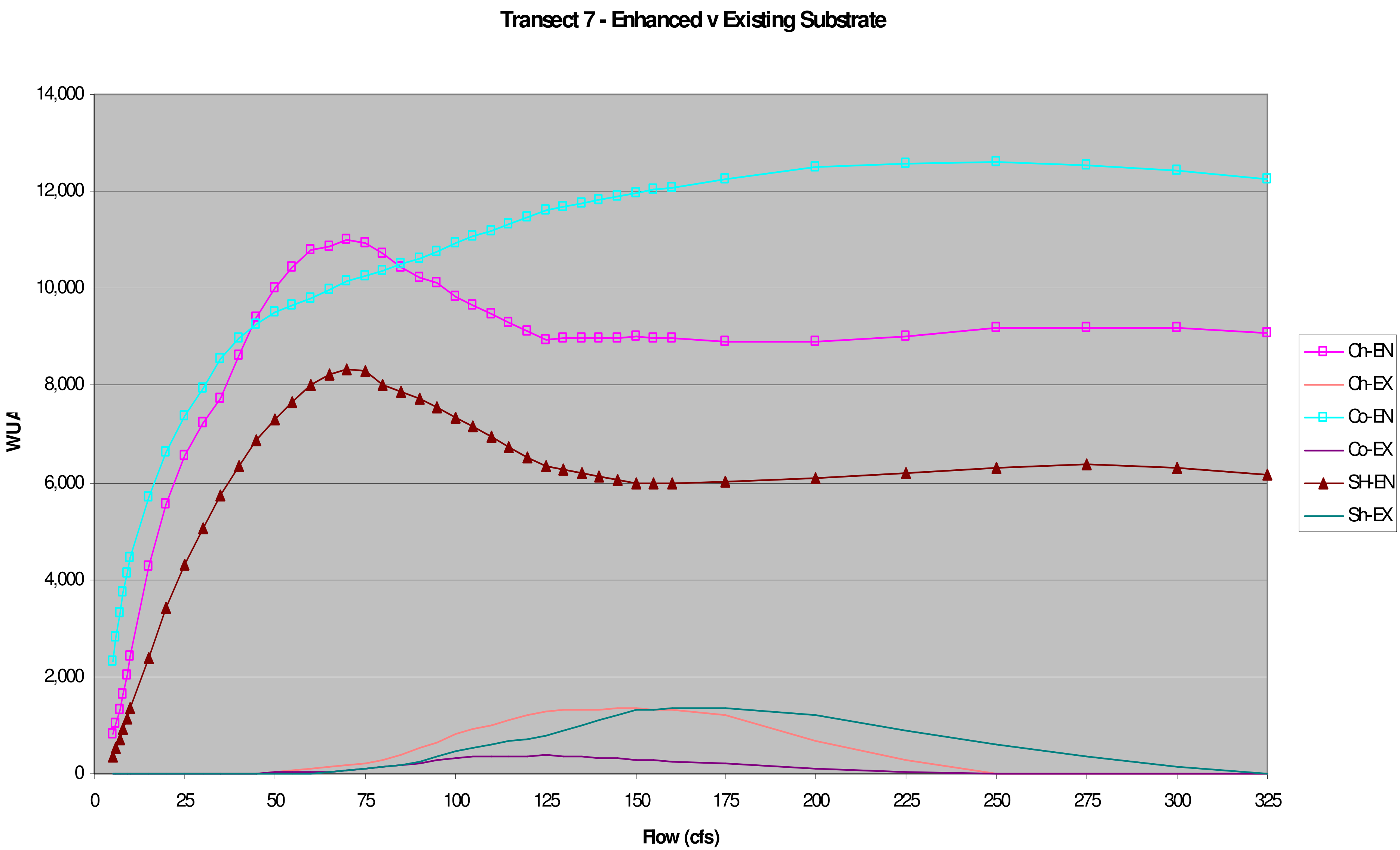
Transect 9 Enhanced vs Existing
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
WUA
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Flow (cfs)
SHR-Enh
SHR-Ex
CoR-Enh
Coh-Ex

Results

- Transect 5: Increases in WUA
  - 254% - 440% (mean 316%) increase in steelhead rearing habitat
  - 415% - 1483% (mean 779%) increase in coho rearing habitat
- Transect 9: Increases in WUA
  - 354%-540% (mean 416%) increase in steelhead rearing habitat
  - 515% - 1583% (mean 879%) increase in coho rearing habitat

Transect 7

- Pool Tailout
  - Substrate was modified to reflect high quality spawning gravels
  - Transect weighting was modified to reflect habitat in the pool/pool tailout complexes.


Transect 7 - Enhanced v Existing Substrate
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
WUA
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Flow (cfs)
Ch-EN
Ch-EX
Co-EN
Co-EX
SH-EN
Sh-EX

Results

- Chinook Spawning Habitat increased from an average of 477 ft^2 to 8,066 ft^2
- Coho Spawning habitat increased from an average of 136 ft^2 to 9,648 ft^2 .
- Steelhead Spawning habitat increased from an average of 411 $ft^2$to 5,704 ft^2.

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

	Rearing Habitat (sq ft/1000 ft)					
Month/Period	**Chinook**	**Coho**	**Steelhead**	**Rainbow**	**Cutthroat**	**Winter Trout**
August						
Pre-Project	**4,960**	3,439	**5,161**	**3,675**	**4,093**	
Current	3,158	4,601	1,686	1,746	1,994	
Proposed	4,362	***4,967***	2,671	2,725	2,979	
September						
Pre-Project	**4,984**	3,470	**4,624**	**3,367**	**4,018**	
Current	2,938	4,641	1,540	1,649	1,842	
Proposed	4,283	***4,982***	2,635	2,679	2,923	

Table 3. All Sites Lake Creek Habitat Duration Analysis, 50% Exceedance Values

	Spawning Habitat (sq ft/1000 ft)				
Month/Period	Chinook	Coho	Steelhead	Cutthroat	Rainbow
August					
Pre-Project	158				
Current	9				
Proposed	**220**				
January					
Pre-Project		293		28	
Current		199		17	
Proposed		**541**		**272**	

Table 2. Study Site 1. Lake Creek Habitat Duration Analysis, 50% Exceedance Values						
Rearing Habitat (sq ft/1000 ft)						
Month/Period	Chinook	Coho	Steelhead	Rainbow	Cutthroat	Winter Trout
November						
Pre-Project	4,439	3,096	4,810	3,369	3,636	5,992
Current	3,948	3,992	2,362	2,397	2,333	8,385
Proposed	***6,742***	***6,648***	**5,140**	***5,148***	***5,093***	**10,954**
December						
Pre-Project	4,626	3,064	5,228	3,710	3,687	6,064
Current	4,722	3,152	3,494	3,022	3,235	7,125
Proposed	***7,445***	***5,775***	**6,237**	***5,726***	***5,955***	**9,710**

Table 4. Study Site 1. Lake Creek Habitat Duration Analysis, 50% Exceedance Values

Month/Period	Chinook	Coho	Steelhead	Cutthroat
September				
Pre-Project	247			
Current	4			
Proposed	***292***			
November				
Pre-Project		167		21
Current		156		52
Proposed		**472**		**449**

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