

Grant Creek Aquatic Habitat Mapping and Instream Flow Study Results

Aspen Suites Hotel, Anchorage
March 19 - 20, 2014



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In Association with



Fisheries and Aquatics Studies

Grant Creek Studies

- Fish Weir Installation and Monitoring
- Salmon Spawning Distribution and Abundance
- Resident and Rearing Fish Abundance and Distribution
- Baseline Macroinvertebrate Studies
- Baseline Periphyton Studies
- Trail Lake Narrows Study – Fish and Aquatic Habitats
- ***Aquatic Habitat Mapping***
- ***Instream Flow Study***

Grant Creek Aquatic Habitat Mapping – Work Completed

- Field Work
 - Lower Grant Creek (Reaches 1 – 4) mapped key habitats mesohabitat categories in 2009
- Data Analysis by 2010, including spatial fish data from 2009 and 2010
- Reporting
 - Baseline studies report issued in 2009
- Consultation
 - HEA consulted with Work Groups 11 times in 2009

Grant Creek Aquatic Habitat Mapping Completed in 2013

- Ground Truthing of Aquatic Habitats
 - Revisions to existing maps after 2013 field season
- Quantification of Mesohabitats
 - Cascade, glide, pool, etc.
- Quantification of Aquatic Habitats
 - Overhead vegetation, undercut banks, Large Woody Debris

Grant Creek Instream Flow Study Work Completed (2009 – 2010)

- **Field Work**
 - 18 Transects approved by Instream Flow Work Group set up to model the most sensitive Lower Grant Creek areas with following measurements:
 - Middle Flow calibration measurement (175 – 184 cfs) with depth, velocity, water surface elevations (WSE)
 - Low flow WSE (92 – 169 cfs)
 - No High flow WSE
 - Substrate and cover across all transects
 - 18 Transects in lower 0.5 miles of Grant Creek = one every 150 ft
 - HEA consulted with Work Group 11 times in 2009

Grant Creek Instream Flow Study 2013 Field Season

- **Field Work**
 - Verified stability of the 18 existing transects (bed profile, stage of zero flow, substrate and cover)
 - If stable, used existing middle flow measurements taken in 2010 and used as high flow measurement
 - If not stable, redid those transects that had shifted (bed profiles, depth/velocities, WSE, substrate and cover, hydraulic control)
 - Took low/middle flow WSEs and discharges and calibration flows where needed
 - Collected higher WSE and discharges where needed
 - Collected data for site-specific Habitat Suitability Index (HSI) curves

Grant Creek Instream Flow Study 2013 Field Season, cont'd

- Field Work
 - Implemented Connectivity study for Reach 5
- Data Analysis
 - Calibrated each transect
 - Used 3 – 5 WSEs and one velocity set (one flow model) to simulate the range of flows for Grant Creek:
 - WSE and discharges at low, middle, high/very high calibration flows
 - Depths and Velocities from high flow (approximately 200 cfs)

Grant Creek Instream Flow Study

2013 Field Season, cont'd

- HSI Curves: Use site-specific data to develop curves for Grant Creek (Coho and Sockeye Salmon) spawning life history stage
 - Supplemented with literature curves for other species and life history stages
- Added transect weighting
- Calculated Weighted Usable Area
 - Developed for target species and life stages at each transect and reach
- Developed reports

Reach 5 Connectivity

- At what flows are habitats in Reach 5 connected to areas downstream?
- Used Thompson (the Oregon Method). The passage flow is adequate when the depth criteria is met on at least:
 - 25 % of the wetted transect width, and
 - 10 % continuous portion.
- Depth Criteria:
 - Chinook Salmon: 0.8 ft
 - Coho and Sockeye Salmon: 0.6 ft
 - Dolly Varden Char and Rainbow Trout: 0.4 ft

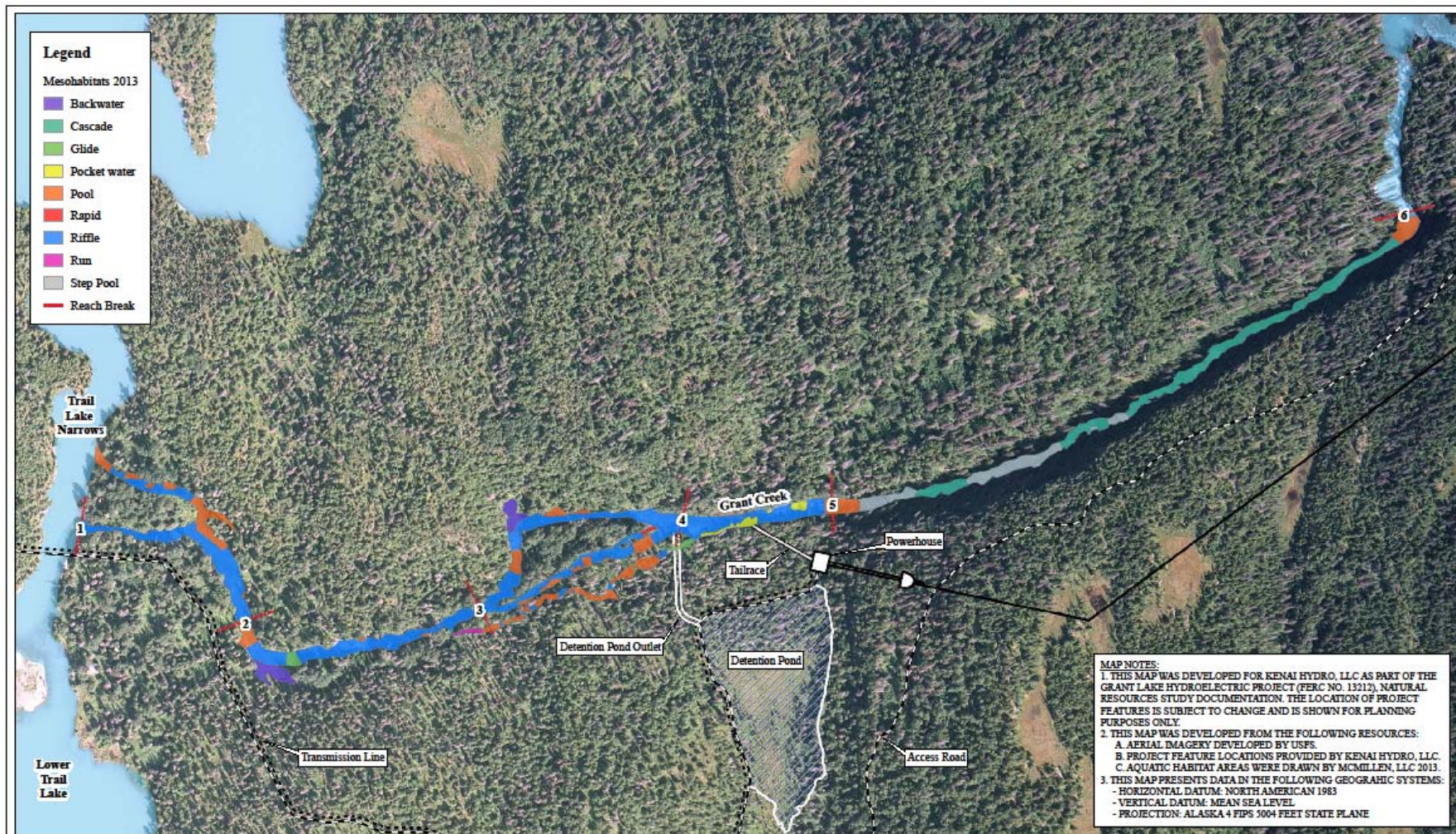
Reach 5 Connectivity, cont'd

- Selected 2 transects which represented the more sensitive types of habitats within the canyon,
- Bed profiles surveyed
- Five WSEs at flows ranging from 17 cfs – 700 cfs
- Developed Stage/Discharge relationships for flows ranging from 7 cfs – 300 cfs. Calculated depths from these data at a range of flows

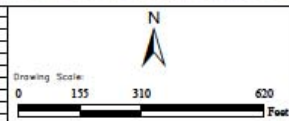
RESULTS

AQUATIC HABITAT MAPPING

- Developed maps for meso-habitat types
- Developed maps for aquatic habitats
- Calculated area per each reach and total



REV	DATE	BY	DESCRIPTION



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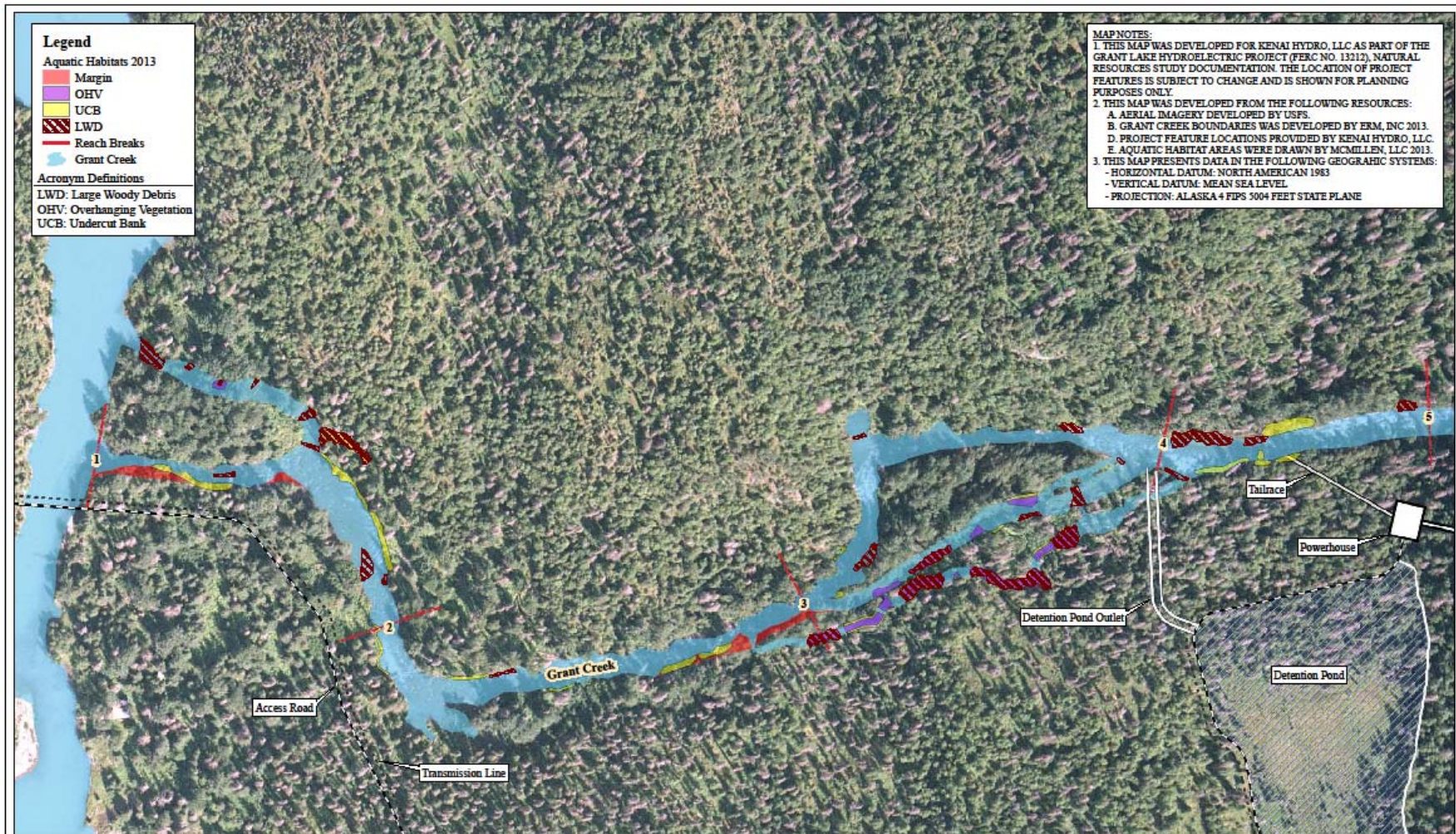
THE KENAI BUILDING
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Developed For:

HEA Homer Electric Association, Inc.
A "GreenSource Energy" Corporation

GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT #P-13212		DESIGNED: J. Woodbury	DRAWING
GRANT LAKE NATURAL RESOURCES STUDY		DRAWN: J. Woodbury	1 of 6
Grant Creek Mesohabitats Reaches 1 - 5		CHECKED: J. Blum	
		ISSUED DATE: 12/6/2013	SCALE: 1:3,300



Legend

Aquatic Habitats 2013

- Margin
- OHV
- UCB
- LWD
- Reach Breaks
- Grant Creek

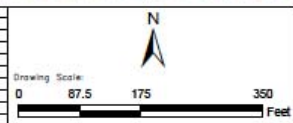
Acronym Definitions

- LWD: Large Woody Debris
- OHV: Overhanging Vegetation
- UCB: Undercut Bank

MAPNOTES:

1. THIS MAP WAS DEVELOPED FOR KENAI HYDRO, LLC AS PART OF THE GRANT LAKE HYDROELECTRIC PROJECT (FERC NO. 13212), NATURAL RESOURCES STUDY DOCUMENTATION. THE LOCATION OF PROJECT FEATURES IS SUBJECT TO CHANGE AND IS SHOWN FOR PLANNING PURPOSES ONLY.
2. THIS MAP WAS DEVELOPED FROM THE FOLLOWING RESOURCES:
 - A. AERIAL IMAGEERY DEVELOPED BY USFS.
 - B. GRANT CREEK BOUNDARIES WAS DEVELOPED BY ERM, INC 2013.
 - C. PROJECT FEATURE LOCATIONS PROVIDED BY KENAI HYDRO, LLC.
 - D. AQUATIC HABITAT AREAS WERE DRAWN BY MCMILLEN, LLC 2013.
3. THIS MAP PRESENTS DATA IN THE FOLLOWING GEOGRAPHIC SYSTEMS:
 - HORIZONTAL DATUM: NORTH AMERICAN 1983
 - VERTICAL DATUM: MEAN SEA LEVEL
 - PROJECTION: ALASKA 4 FIPS 5004 FEET STATE PLANE

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GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212
GRANT LAKE NATURAL RESOURCES STUDY

Aquatic Habitats Grant Creek: Reaches 1-4

DESIGNED: J. Woodbury
DRAWN: J. Woodbury
CHECKED: J. Blum
ISSUED DATE: 12/6/2013

DRAWING
1 of 3
SCALE: 1:1,000

Mesohabitats Found in Grant Creek

[illegible]

Aquatic Habitats Found in Grant Creek

Habitat Type	Total Area (Sq. Ft)	Reach 1 Distributary	Reach 1 Mainstem	Reach 2 Backwater Habitat	Reach 2 Mainstem	Reach 2 Secondary Channel	Reach 3 Backwater Habitat	Reach 3 Mainstem	Reach 3 Primary Side Channel	Reach 3 Secondary Channel	Reach 4 Mainstem	Reach 5 Mainstem
Margin	7,214	0	3,343	0	3,871	0	0	0	0	0	0	0
Overhead Vegetation (OHV)	10,096	302	0	0	0	0	0	0	2,455	7,339	0	0
UCB	12,187	1,513	3,372	0	2,193	0	0	278	110	1,214	3,216	0
Large Woody Debris (LWD)	17,750	3,556	1,894	0	182	0	0	1,142	1,611	6,218	3,040	0

RESULTS

INSTREAM FLOW STUDY

- Affected species and life history stages
- Transects and transect weighting
- Field data collection
- Model calibration
- HSI curves
- WUA

Affected Species and Life History Stages

Species	Spawning	Fry Rearing	Juvenile Rearing	Adult Rearing
Sockeye Salmon	✓			
Coho Salmon	✓	✓	✓	
Chinook Salmon	✓	✓		
Rainbow Trout	✓	✓	✓	✓
Dolly Varden Char	✓	✓	✓	✓

Transects and Transect Weighting

- 18 transects selected in 2009 (~1 every 150 ft)
- Each transect was modeled independently
 - Given equal weighting
 - Were then aggregated by
 - Reach
 - Distributary
 - Side Channel



				 Drawing Scale: 0 95 190 380 Feet	McMILLEN, LLC <small>14100 BAYVIEW DRIVE, SUITE 100, ANCHORAGE, ALASKA 99516 PHONE: 781-451-1111 FAX: 781-451-1112 WWW.MCMILLEN.COM</small>	 Homer Electric Association, Inc. <small>A Townhome Energy Cooperative</small>	GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212		DESIGNED: J. Wic dbury	DRAWN:	
							GRANT LAKE NATURAL RESOURCES STUDY		CHECKED: J. Wic dbury	SCALE: 1:2,000	
				Figure 4.2-1 Grant Creek Instream Flow Transect Locations			CHECKED: J. Blum		DATE: 3/5/04		

Field Data Collection

Calibration Flows, 2013

Area	Measured Flows (cfs)					
	17	64	132	182	440	700
Main Channel	✓	✓	✓	✓		✓
Distributary	Dry/Frozen	Dry	Dry	✓	✓	✓
Reach 3 Side Channels	Frozen	✓	✓	✓	✓	✓

Flow Partitioning, Grant Creek Instream Flow Study

Transect	% Flow	r ²	Comments
T100/110	0.99%	0.951	Dry at flows < 190 cfs
Overflow Channel	~ 1.70%	N/A	Activates at ~ 450 cfs; affects Reach 1 main channel transects
T200	8.94%	N/A	% of main channel at calibration measurement
T210/230 Side Channel (SC)	0.00%	N/A	Backwater with no velocity; WSE is dependent upon T200
T300	1.71%	N/A	% of main channel at calibration measurement
T310	GC-T330	N/A	All Reach 2/3 side channels flow represented by T330
T320	15.81%	0.990	
T330-M	15.06%	0.986	Main Channel of T330
T330-2nd	0.0844 xT330-M	0.934	Secondary channel; percent of T330-M flow
T330-3rd	0.0219 xT330-M	0.839	Tertiary channel; percent of T330-M flow

Habitat Suitability Index (HSI) Curves

- Collected site-specific data for the following species and life history stages:
 - Sockeye Salmon spawning (n = 99)
 - Coho Salmon spawning (n = 47)
 - Chinook Salmon spawning (n = 4)

HSI Utilization Data Collection



HSI Habitat Availability Data Collection



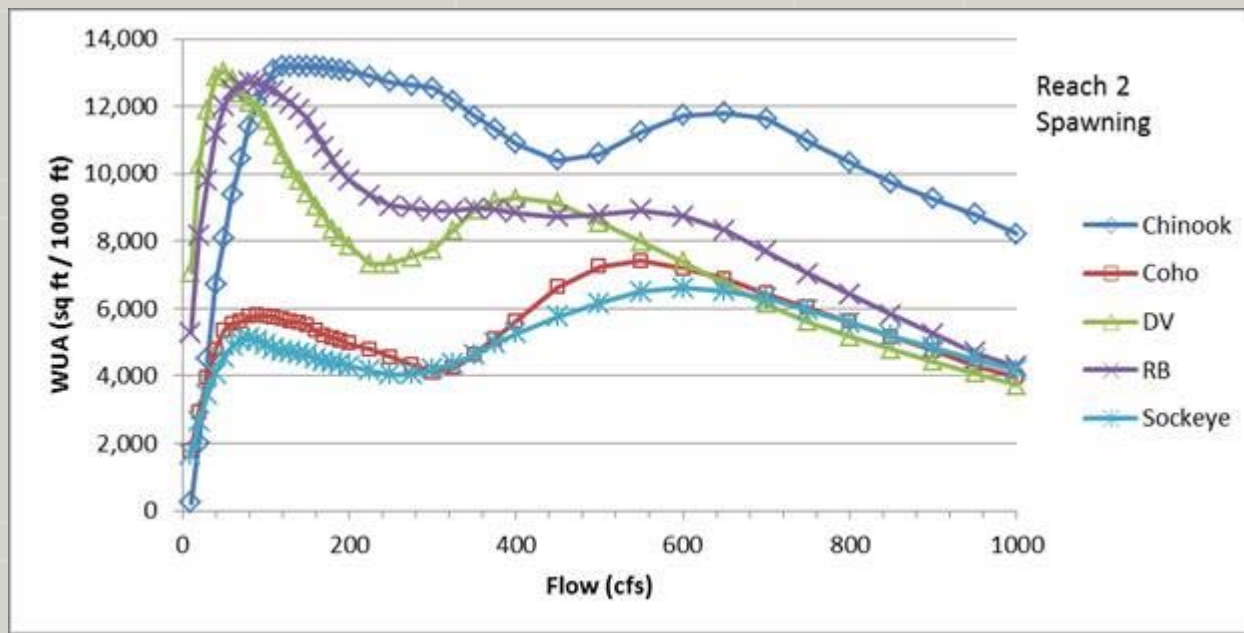
HSI Curves, cont'd.

- Developed site-specific depth and velocity HSI curves for Sockeye and Coho Salmon spawning
- Insufficient numbers of Chinook Salmon spawners to develop site-specific curves
- Literature-based HSI curves used for all other species and life history stages
- Proposed curves sent to AWG on December 18, 2013

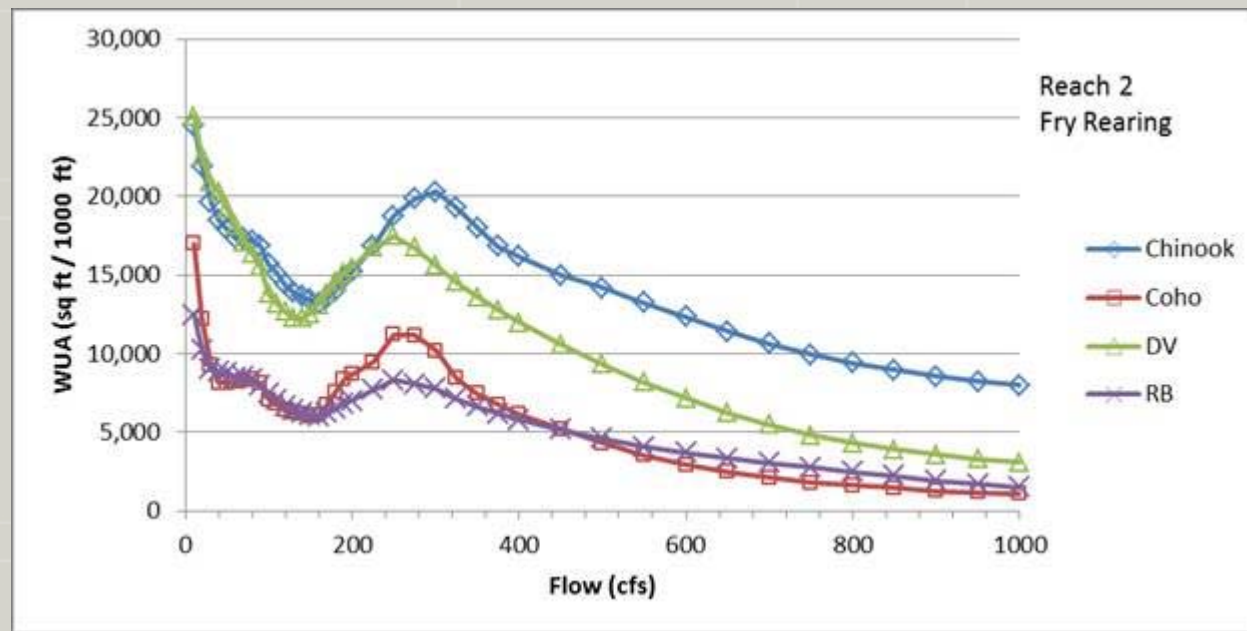
Model Calibration, Grant Creek Instream Flow Study

- Stage/Discharge relationship established for each transect
- Depths and velocities calibrated
- Input transect weighting and HSI curves
- WUA results from the one-velocity and depth calibration models were smoothed and averaged to produce one WUA table for each species and life stage at each transect (from 180 to 200 cfs upwards to 1,000 cfs)
- Transects run independently then aggregated by reach for WUA

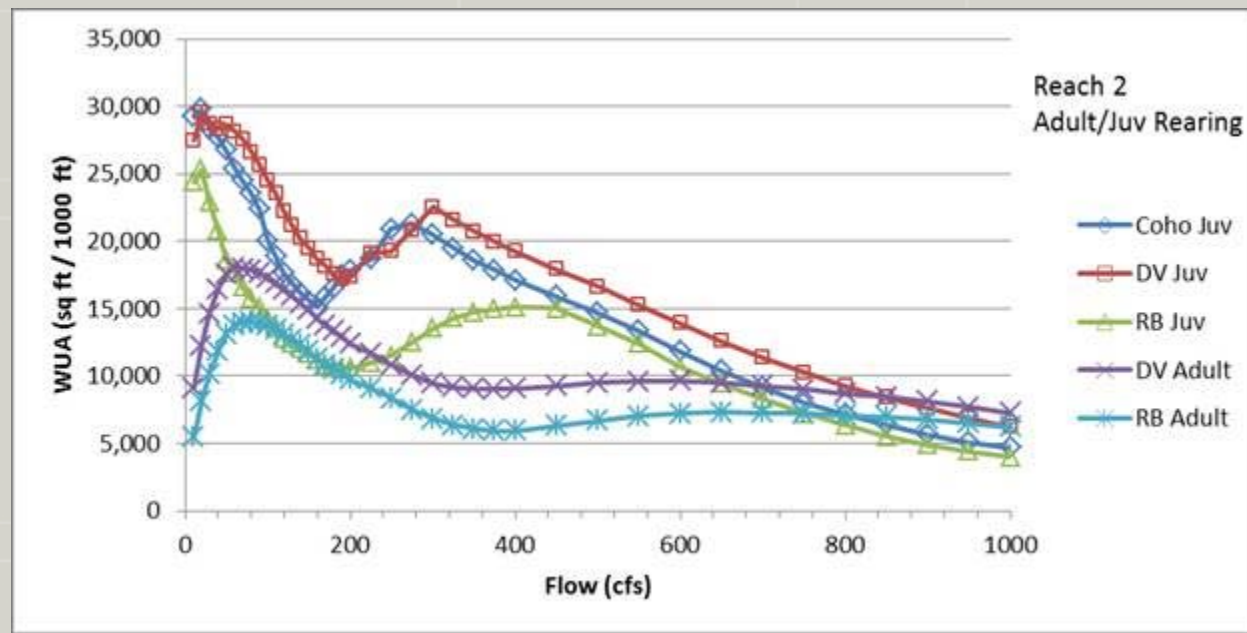
Reach 2, Spawning WUA



Reach 2 Fry Rearing WUA

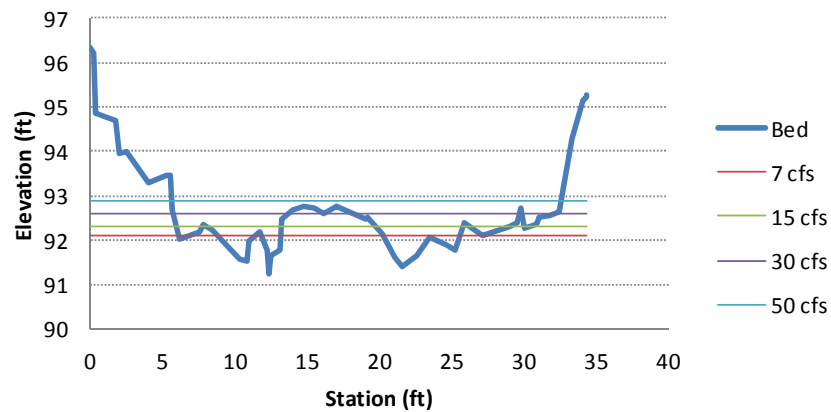


Reach 2 Juvenile/Adult Rearing WUA

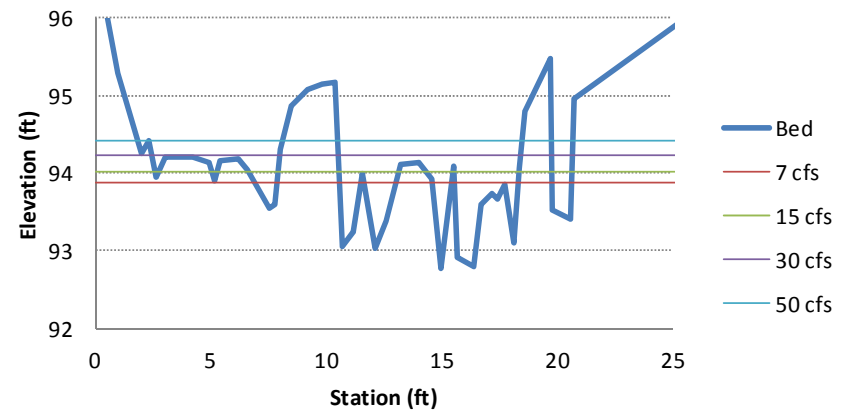


Connectivity of Habitats in Reach 5

T510 Connectivity Transect



T520 Connectivity Transect



Transects 510 and 520



Transects 510 and 520



Connectivity in Reach 5

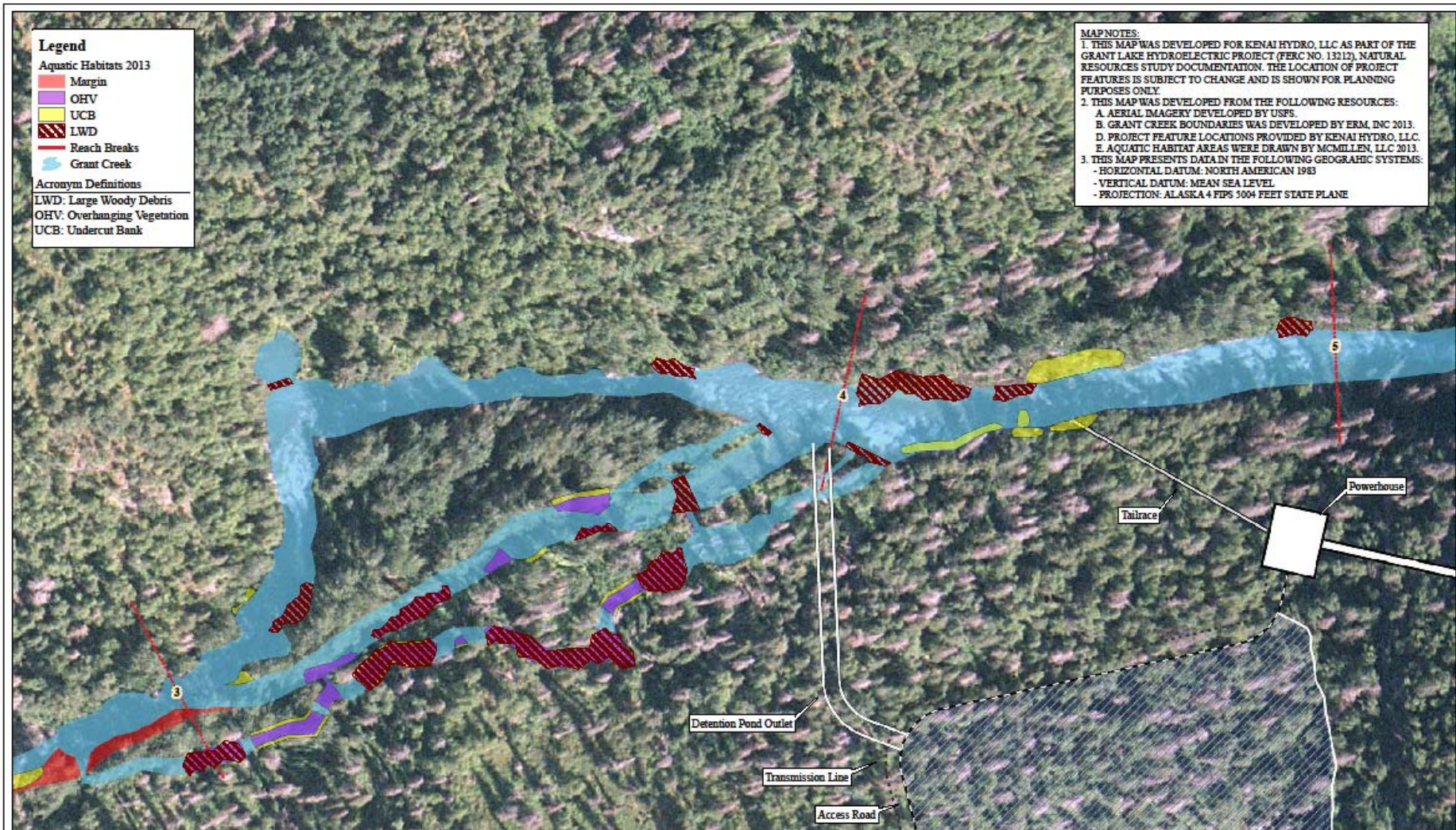
Species	Passage Criteria	Flow (cfs)		
		T510	T520	Average
Trout/Char	Total (25%)	7	7	7
	Continuous (10%)	7	7	7
	Both Criteria	7	7	7
Coho/Sockeye	Total (25%)	15	7	10
	Continuous (10%)	10	7	10
	Both Criteria	15	7	10
Chinook	Total (25%)	30	7	30
	Continuous (10%)	25	7	25
	Both Criteria	30	7	30

Operational Enhancements Reach 2/3 Side Channels

- Large amount of high quality/diverse habitat
- Currently have low to no flows during the winter and other low flow periods
- Currently subject to freezing/snow/ice and drying out during low flow periods
- More stable flows with proposed project operation create opportunity for sustainable habitat in side channels

Reach 2/3 Side Channels

- Consists of two main channels that begin at the Reach 3/4 break
- Side channels constitute 21% of total length of Grant Creek, but contain:
 - 97% - OVH
 - 44% - LWD
 - 50% - Glide
 - 34% - Pool



Legend

Aquatic Habitats 2013

- Margin
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- Grant Creek

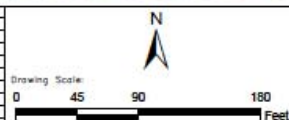
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REV	DATE	BY	DESCRIPTION



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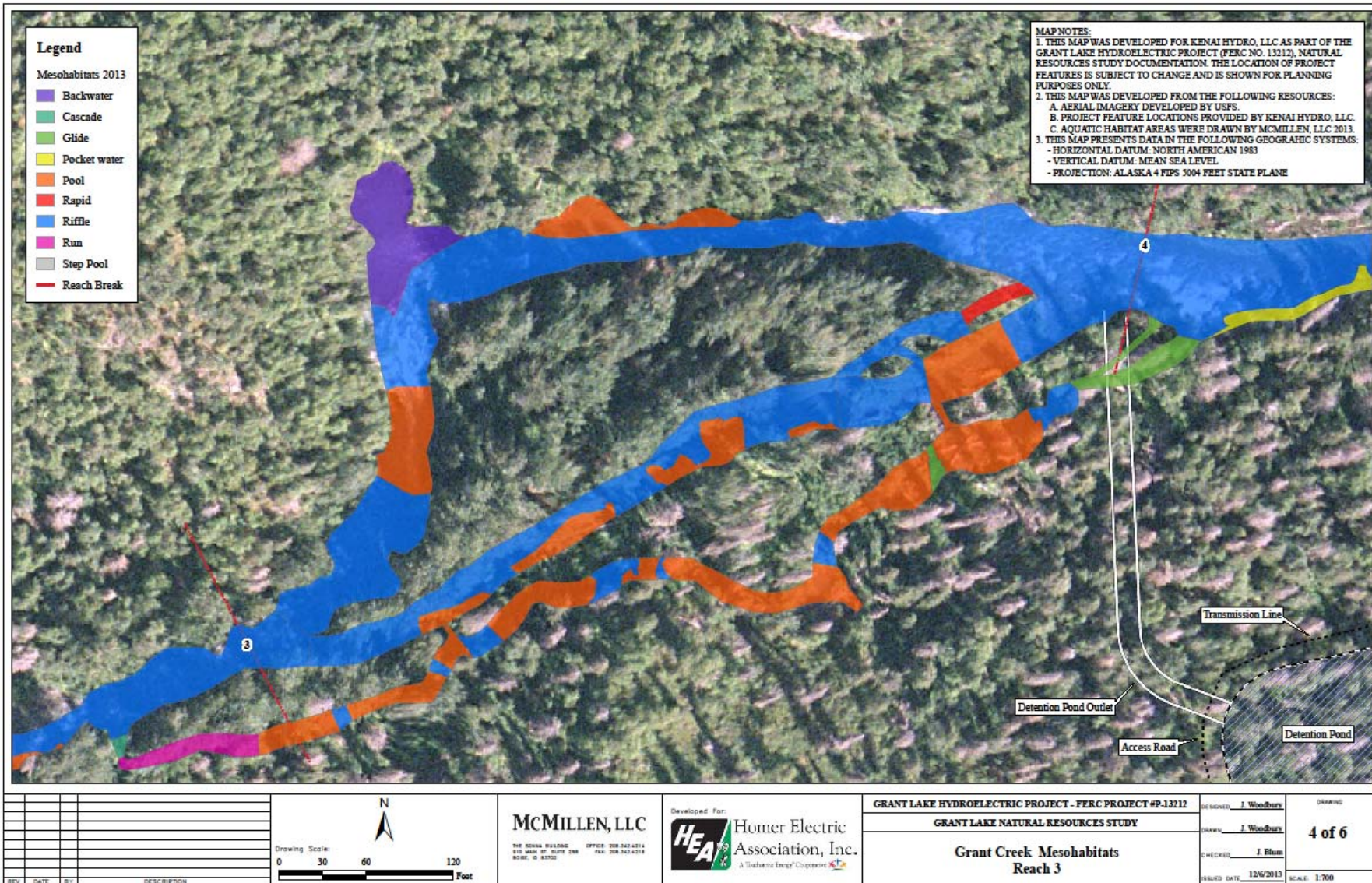
GRANT LAKE HYDROELECTRIC PROJECT - FERC PROJECT NO. 13212

GRANT LAKE NATURAL RESOURCES STUDY

Aquatic Habitats
Grant Creek: Reaches 3 & 4

DESIGNED: J. Woodbury
DRAWN: J. Woodbury
CHECKED: J. Blum
PRINTED DATE: 12/6/2013

(DRAWING)
3 of 3
SCALE: 1:1,000



Side Channel Habitat, Reach 3



Pools in Side Channels, Reaches 2/3

Immediately upstream of gage

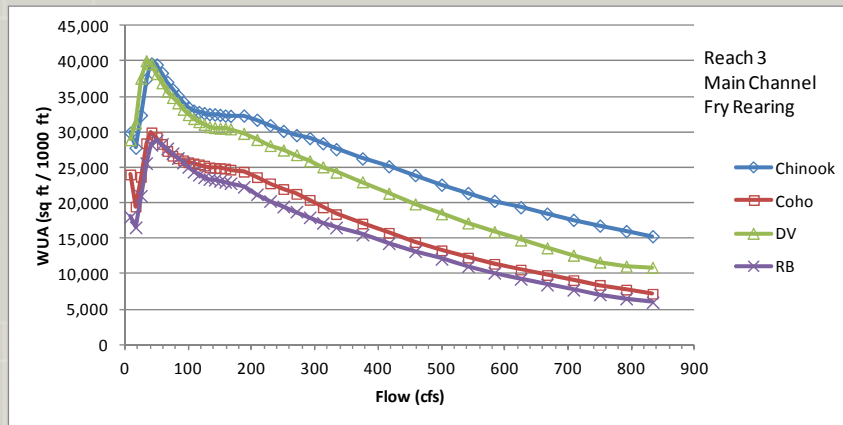


Reach 2/3 Side Channel

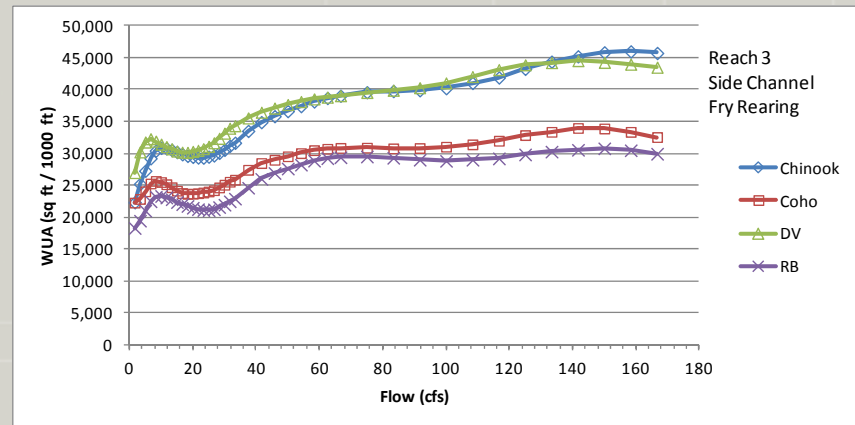


Reach 3 Mainstem vs. Side Channel WUA

R3 Mainstem – Fry WUA

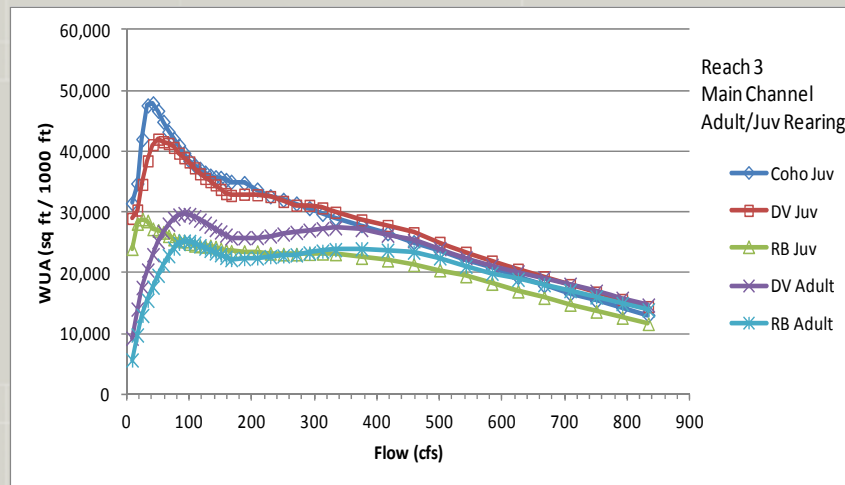


R3 Side Channel – Fry WUA

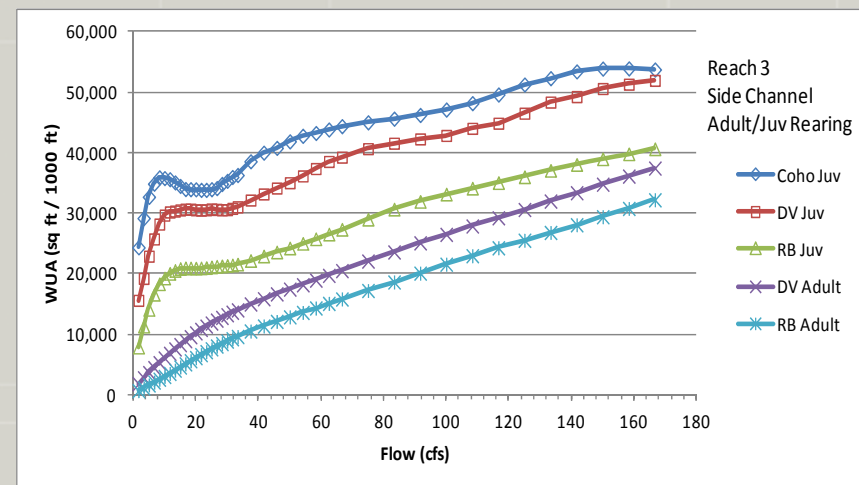


Reach 3 Mainstem vs. Side Channel WUA

R3 Mainstem – Juv/AD Rearing WUA

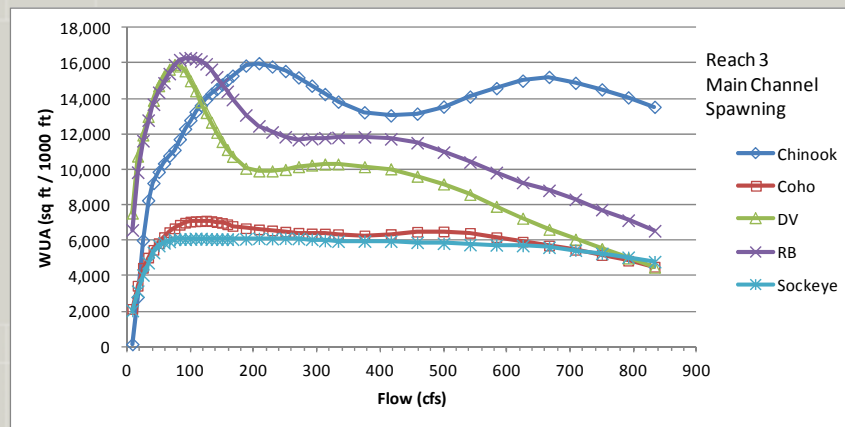


R3 Side Channel – Juv/AD Rearing WUA

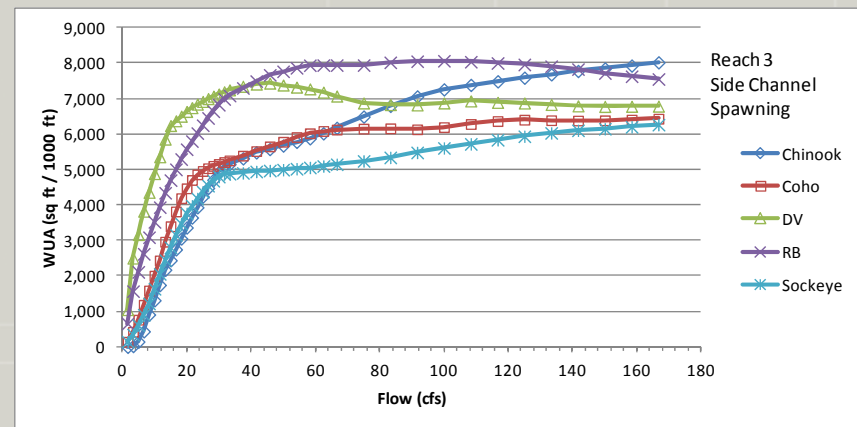


Reach 3 Mainstem vs. Side Channel WUA

R3 Mainstem – Spawning WUA



R3 Side Channel – Spawning WUA



Side Channel and Canyon Photos @ 132 cfs

Reach 3 Side Channel



Reach 5



Side Channel and Canyon Photos @ 700 cfs

Reach 3 Side Channel



Reach 5

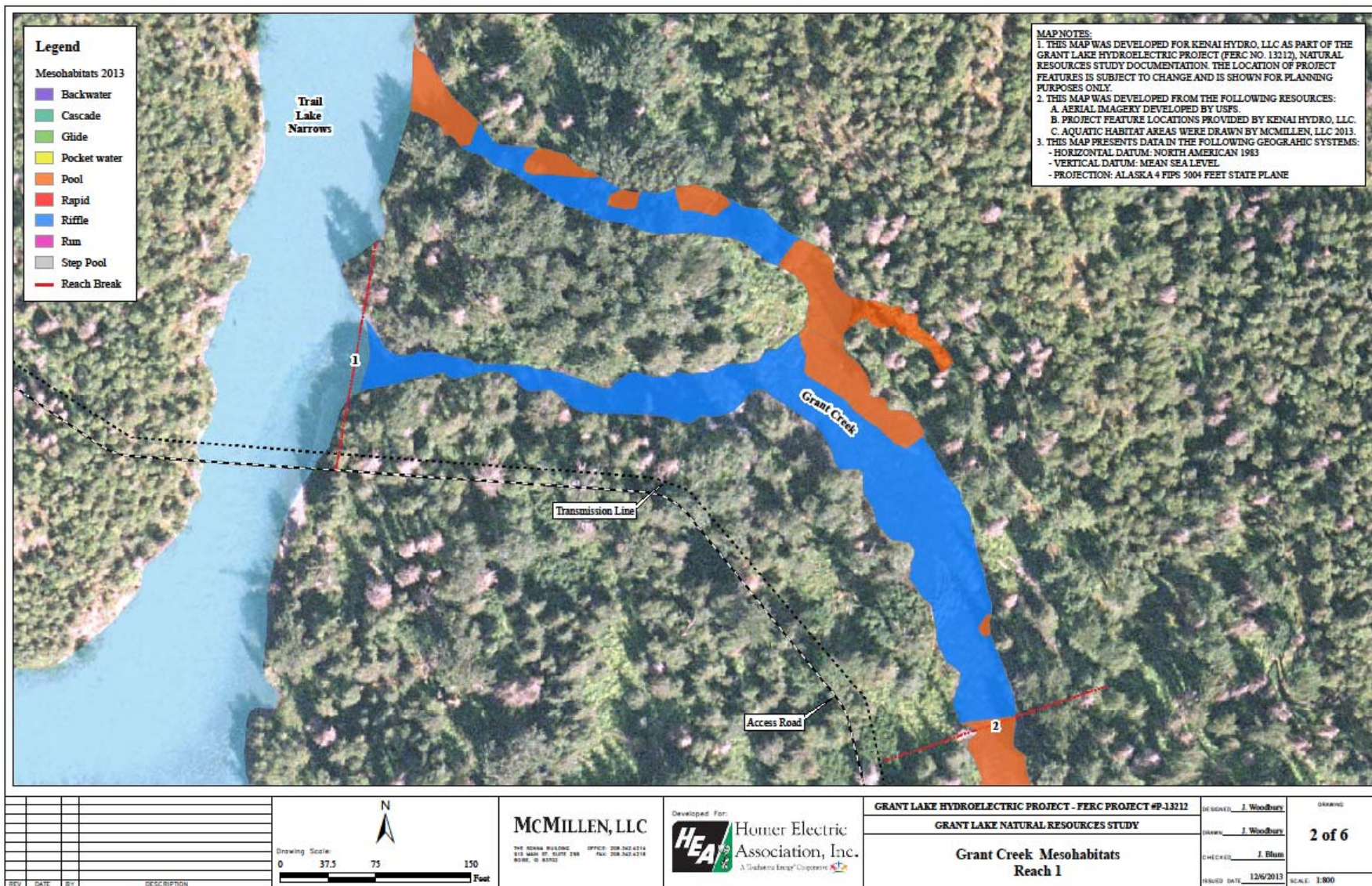


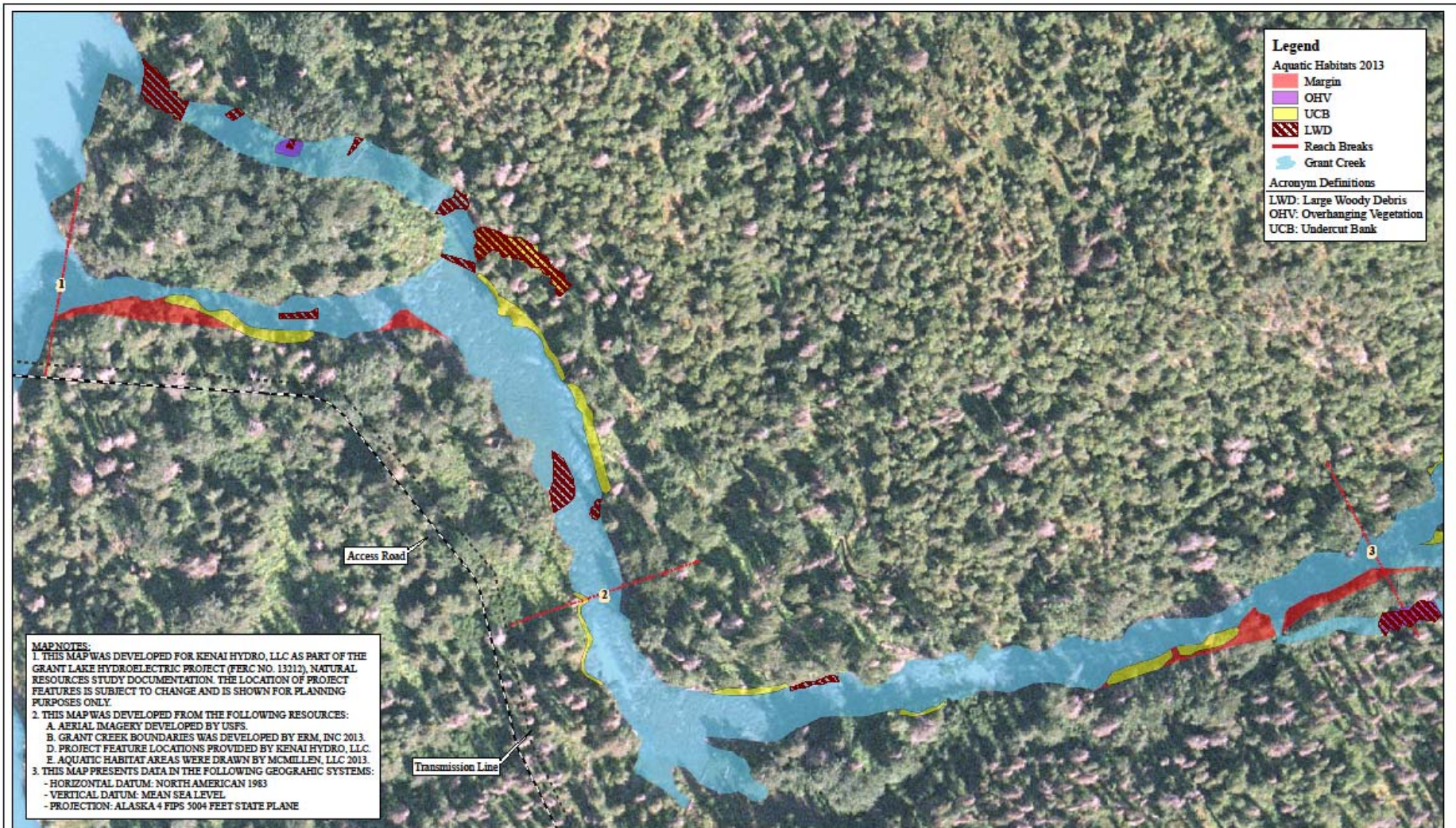
Potential Enhancement Opportunity - Reach 1 Distributary

- Currently distributary does not get wetted until Grant Creek flows reach ~ 180 - 190 cfs
- Analysis indicates T100 and T110 currently receive only about 1% of the water in Grant Creek once the distributary is activated
- Modeling of higher flows indicates that significant increases in WUA are possible with additional flow

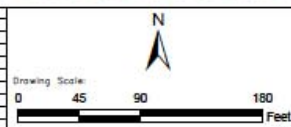
Reach 1 Distributary, cont'd

- Reach 1 distributary constitutes only 5.6% of the stream length of Grant Creek, but has:
 - 17.6% of the pool habitat
 - 20% of the LWD
 - 12% of the undercut banks





REV	DATE	BY	DESCRIPTION



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Aquatic Habitats
Grant Creek: Reaches 1 & 2

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PUBLISHED DATE: 12/6/2013

(DRAWING)
2 of 3
SCALE: 1:1,000

Reach 1 Distributary

Distributary mouth @ Grant Creek
flow of 131 cfs



Distributary mouth @ Grant Creek
flow of 700 cfs



Distributary – Reach 1

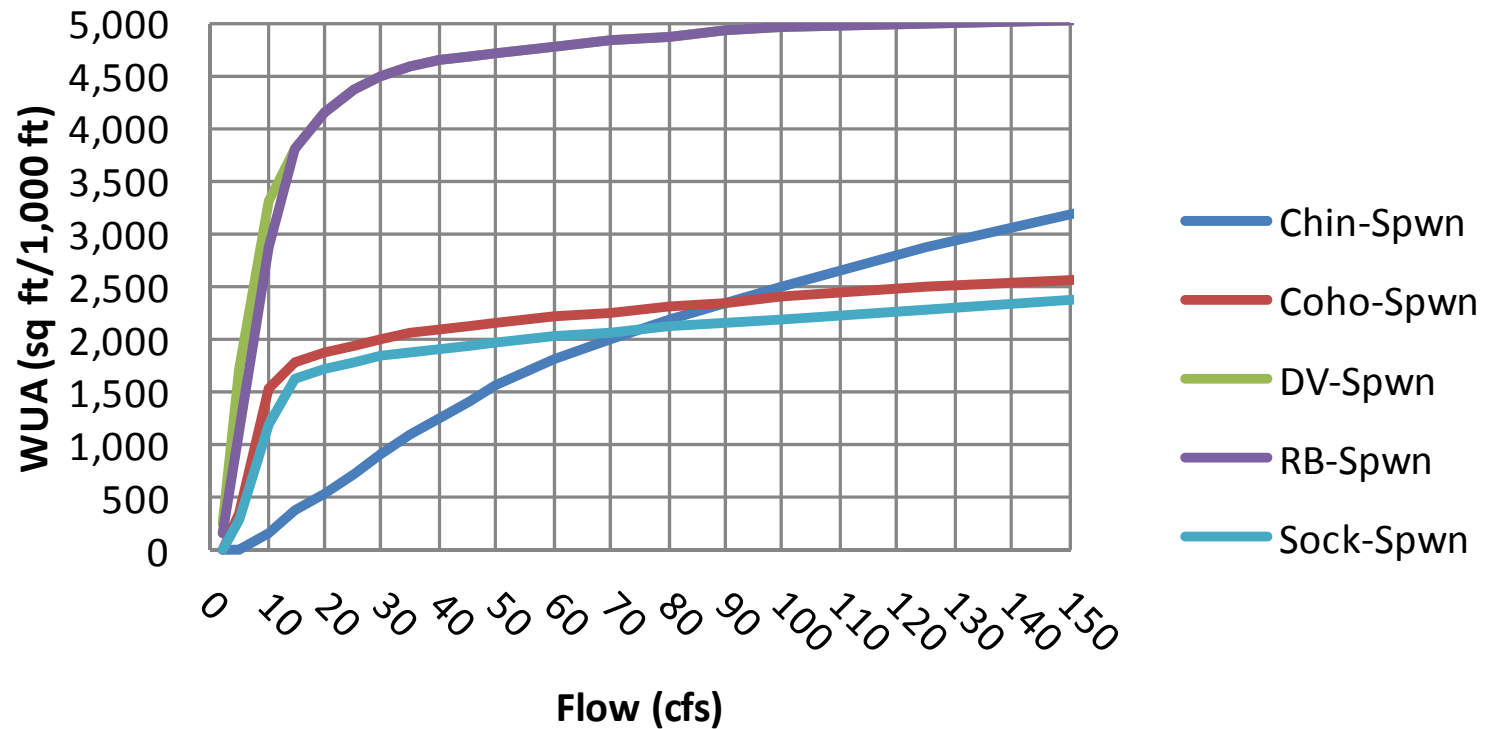
LWD @ Grant Creek flow of 64 cfs



Distributary @ Grant Creek flow of 700 cfs (7 cfs in distributary)

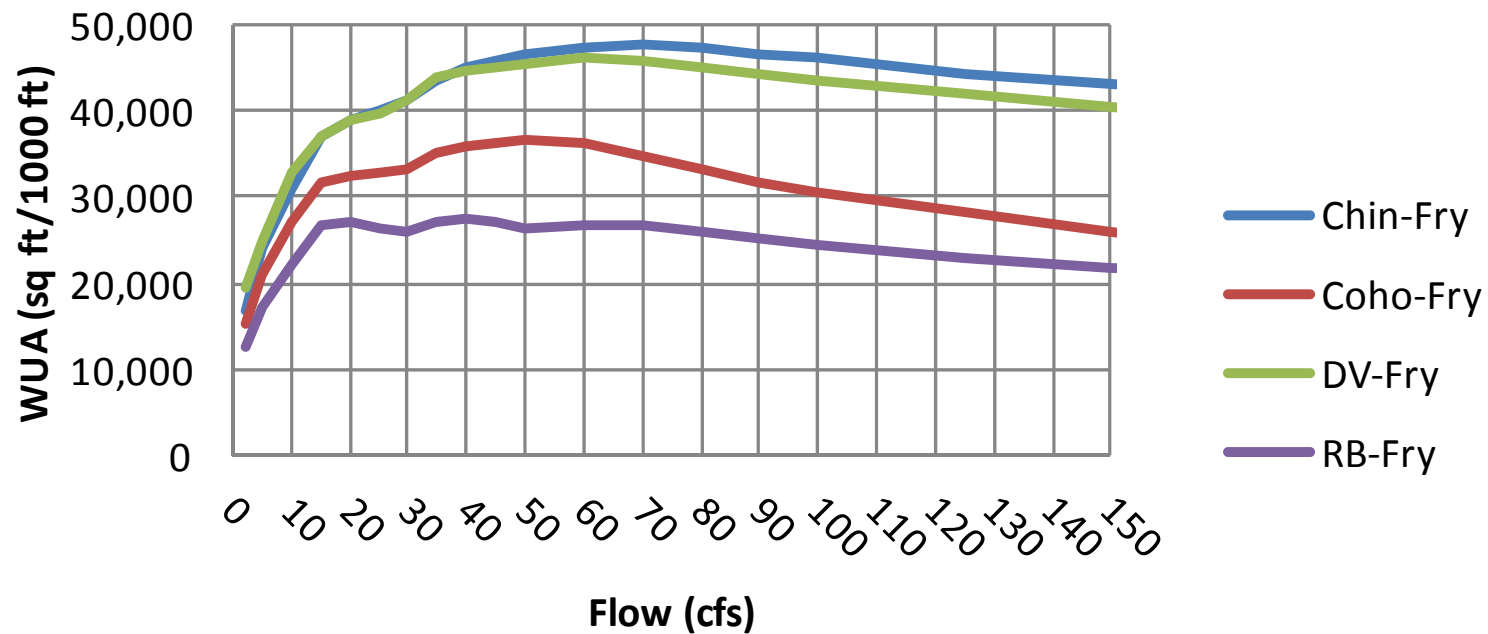


Reach 1 Distributary Spawning WUA



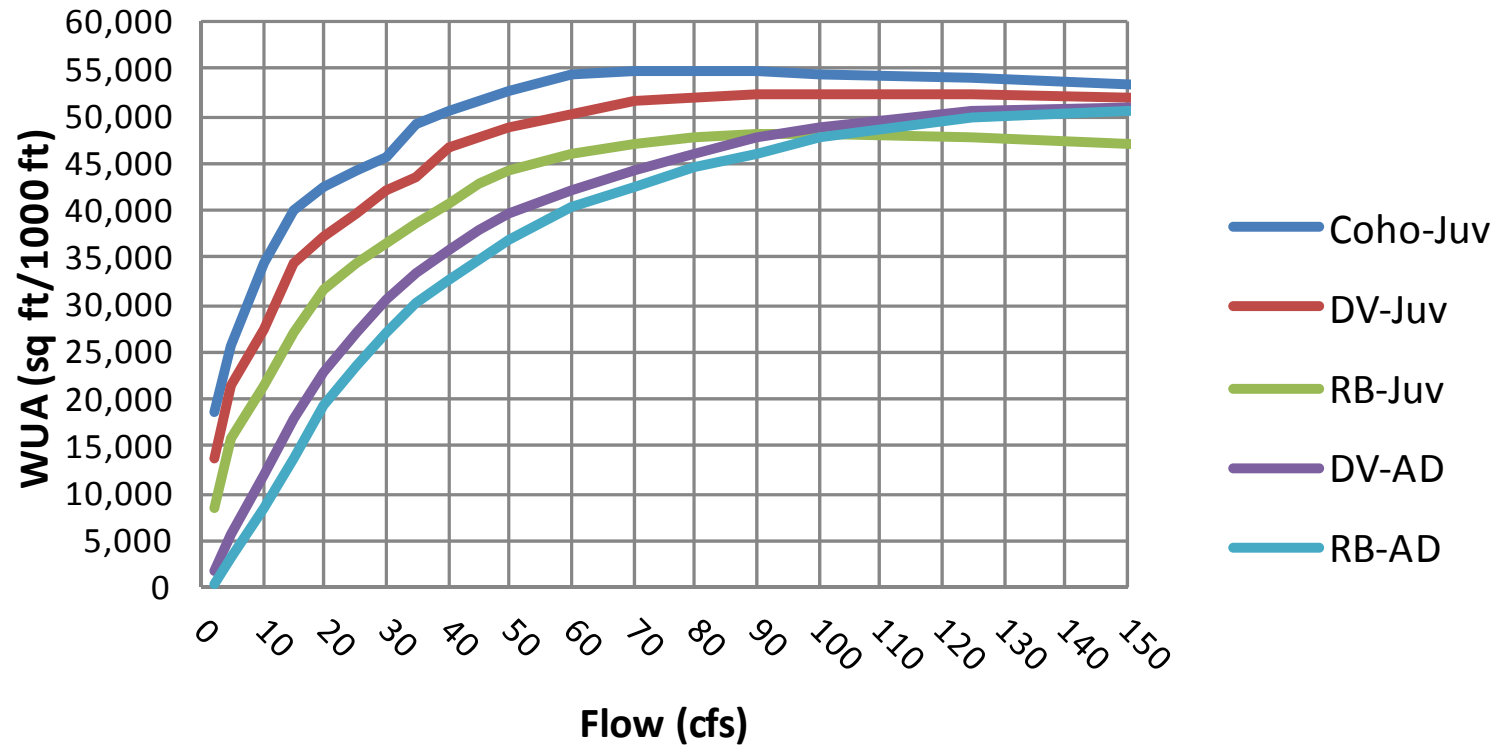
16 – 300 ***TIMES*** more spawning habitat at 35 cfs than 2 cfs (flow in distributary when approximately 200 cfs in Grant Creek main channel)

Reach 1 Distributary Fry Rearing WUA



2.2 – 2.6 ***TIMES*** more fry rearing habitat at 35 cfs than 2 cfs (flow in distributary when approximately 200 cfs in Grant Creek main channel)

Reach 1 Distributary Juv/AD Rearing WUA



2.7 – 75 **TIMES** more juvenile and adult rearing habitat at 35 cfs than 2 cfs (flow in distributary when approximately 200 cfs in Grant Creek main channel)

Where Do We Go From Here?

Aquatic Work Group to determine:

- Periodicity of species and life history stages
- Critical path(s) for species/life history stages/
months
- Determination of priority transects/reaches
- Integrate the hydrology, aquatic studies,
geomorphology and engineering
- Development of PM&E measures