Kenai Hydro, LLC
Grant Lake/Falls Creek Hydroelectric Project
Aquatics Technical Work Group Meeting
USFS Work Center, Kenai, Alaska
September 22-23, 2009 9 am – 3 pm

<u>In Attendance – Site Visit (September 22, 2009)</u>

Jenna Borovansky, Long View Associates (LVA)
Jeff Anderson, U.S. Fish and Wildlife Service (USFWS)
Erin Cunningham, HDR
Gary Fandrei, Cook Inlet Aquaculture Association (CIAA)
Ricky Gease, Kenai River Sportfishing Association (KRSA)
Jason Kent, HDR
Ginny Litchfield, Alaska Department of Fish and Game (ADF&G)
Lee McKinley, ADF&G
Paul McLarnon, HDR
John Morsell, Northern Ecological Services (NES)
Ron Rainey, KRSA
Kim Sager, Alaska Department of Natural Resources (ADNR)
Sue Walker, National Marine Fisheries Service (NMFS)
Brad Zubeck, Kenai Hydro, LLC (KHL)

<u>In Attendance – Technical Workgroup Meeting (September 23, 2009)</u>

Jenna Borovansky, LVA
Jeff Anderson, USFWS
Erin Cunningham, HDR
Gary Fandrei, CIAA
Jim Ferguson, ADF&G
Ricky Gease, KRSA
Eric Johansen, U.S. Forest Service (USFS)
Jason Kent, HDR
Ginny Litchfield, ADF&G
Lee McKinley, ADF&G
Paul McLarnon, HDR
John Morsell, NES
Gary Prokosch, ADNR
Kim Sager, ADNR
Mike Tracy, KHL
Sue Walker, NMFS
Brad Zubeck, KHL

Meeting Summary

Agenda

- September 22, 2009: 10 am – 3 pm, Site Visit to Grant Creek
- September 23, 2009 9 am – 3 pm, Technical Workgroup (TWG) Meeting

Review of September 22, 2009 Grant Creek Field Visit

During the TWG meeting on September 23, Paul McLarnon (HDR) summarized characteristics of Grant Creek, and summarized highlights of the field visit to Grant Creek on September 22, 2009 (Attachment 1). Brad Zubeck (KHL) noted that that there were several questions during the field day about whether Falls Creek was included in the Project proposal; he confirmed that Falls Creek is a part of the Project.

TWG Meeting Summary

Attachment 2 contains the PowerPoint presentation for the day. Brad Zubeck summarized Project features as proposed in the PAD (Attachment 2, slides 4-6). He noted that while a table in the PAD states that the maximum elevation of the Lake under the current operating proposal is 706 feet, that 709 feet is the correct number, reflecting the potential for the lake level to rise 9 feet.

Jason Kent (HDR) summarized hydrology and temperature data collected to date (Attachment 2, slides 8-18).

- *Comment*: Susan Walker (NMFS) asked where the current year's (and available historical flow data) fall relative to the entire historic flow record. She also stated that it would be interesting to determine if El Nino or PDO (Pacific Decadal Oscillation) events occurred in the period of record.
  Response: Jason Kent said that he felt the 2009 hydrology data indicate that this was not the lowest flow on record, but that it is likely a low to average flow year. HDR will review the record of El Nino and PDO event timing.

Jason Kent noted that on slide 14, there is an example of flows around 423 cfs, which HDR noted was the upper limit of safety for hydrologic data collection.

Jason Kent discussed Grant Lake temperature data, highlighting that Grant Creek temperatures in 2009 closely matched the water temperature profile at 1.5 meters depth in Grant Lake. Jason also noted Grant Creek appears to exhibit uniform temperatures longitudinally (upstream to downstream), and differences between surface temperatures and pools measured was slight (maximum difference of about 0.2°C.)

- *Comment:* Gary Fandrei (CIAA) asked whether the temperature data loggers would be left overwinter.
  Response: HDR stated that the surface-level thermistors would be removed prior to ice up, but the thermistors in the deep pools would be left over the winter.

Paul McLarnon provided a summary of data collected in the Fish and Aquatic Habitat Studies through August 31 (Attachment 2, slides 19-32).

Jason Mouw (ADF&G) noted that results of piezometer work done by ADF&G and HDR indicate a simple system with little groundwater influence. Most sites showing neutral or slight downwelling characteristics. Jason noted that the results were consistent with the shallow bedrock characteristics observed in most areas, noting that where there was a shallow colluvium layer over the bedrock, it seemed more likely to find the slight downwelling areas.

Paul McLarnon reviewed spawning foot surveys and minnow trapping data to date. He noted that coho had not been seen spawning in the Creek to date, but that YOY coho were observed, indicating that coho spawning is likely. Surveys would continue into the fall.

Erin Cunningham (HDR) reviewed fish use data from snorkeling surveys (Attachment 2, slides 33-50, and Attachment 3).

- *Comment*: Jason Mouw noted that the shallow backwater areas seen in the field looked to be important habitat, and inquired about sampling effort in these areas.
  Response: Erin Cunningham noted that some of these shallow backwater pocket areas were included in the snorkel surveys. Minnow traps were also placed in these areas, although capture results differed. Erin said the shallow backwater areas are difficult to sample by snorkeling, but some snorkeling was completed, and that future sampling would include these areas.

- *Comment*: Gary Fandrei noted that the timing of the 2009 studies missed sockeye emergence, and that minnow trapping may not be effective for Chinook.
  Response: Paul McLarnon replied that work will begin in May 2010, utilizing electrofishing and/or netting.

- *Comment*: Jeff Anderson (USFWS) stated that sizes of fish observed indicate that there may be overwintering Chinook (greater than 80 mm), and asked if scales had been collected for aging.
  Response: Paul McLarnon stated that scales have not been collected to age fish, but agreed that Chinook sizes indicate overwintering, or fish moving into the system. John Morsell (NES) and Paul noted that data have not shown many juveniles moving into the system yet, and that over-wintering is likely.

- *Comment*: Lee McKinley (ADF&G) asked if any marking was done during resident fish studies.
  Response: Paul McLarnon stated that no marking of juvenile fish was done, but that an informal caudal fin mark was done upon the initial capture of larger fish, and in June there were two or three recaptures during angling surveys. Once new fish began moving into the system later in the summer, no additional recaptures occurred.

Overall HDR found many more fish than historic studies. Paul McLarnon noted that the foot surveys were intense, and that he is confident in the "zeros" recorded at the end of the spawning surveys.

- *Comment*: Gary Fandrei stated that he could look into the timing of weir installation in the 1980s, though he agreed that given the target species at the time was coho, it is likely that the weir did not go in until later in the season.

- *Comment*: Ginny Litchfield (ADF&G) noted that many more fish than expected were seen in Grant Creek, and that the south bank group did not observe any adult fish present or passing into Reach5 during the site visit. She indicated that information on where in the Creek fish use/distribution tapers off would be useful. Jim Ferguson (AD&G) agreed that determining the location where fish use becomes less intensive will be important.
  Response: He indicated that there appears to be a gradient of fish use in the creek, and that use appears to drop off near the reach 4 and 5 break, but this information will need to be confirmed in next year's studies. During field work, crews stopped at the reach break between 4 and 5 for half an hour at the end of each survey, and did not observe any adult fish passage this summer.

- *Comment*: Jim Ferguson asked where anadromy ends.
  Response: Paul McLarnon stated that the current assumption is that there is anadromous use all the way to the currently mapped fish barrier location, but this is not confirmed by data to date. HDR will get further into Reach 5 during next year's study to determine the extent of anadromy.

- *Comment:* Gary Prokosch (ADNR) asked if any recreational fishing was observed during the field season.
  Response: Erin Cunningham noted that she did not see any recreational fishing when she was snorkeling in June. Paul McLarnon stated that other sampling crews saw less than five recreational anglers this season, and that two were seen in the fall last year (2008).

- *Comment:* Jeff Anderson asked if any larger Chinook were observed in June snorkeling.
  Response: Erin Cunningham stated she believed that nearly all of the Chinook were young of the year; although some larger Chinook were observed (> 60 mm). All Chinook had visible parr marks, and the behavior observed did not indicate the fish were on their way out

Instream Flow Study

Jason Kent reviewed information from the historic instream flow study developed for the previous dam proposal (Attachment 2, slides 51-64; Attachment 4).

- *Comment*: Mike Tracy (Kenai Hydro) asked if there was a precipitation gauge near the Project area that may also have historic information that could be reviewed relative to the historic information.
  Response: Eric Johansen (USFS) stated that the USFS keeps some precipitation information for fire monitoring purposes at the Kenai Work Center, but is not sure of the length of the record. The Seward airport may also have data.

- *Comment*: Jason Mouw agreed with the limitations identified in the existing study, notably, he stated that the habitat curves used by Estes and Vincent-Lang did not seem applicable. He also noted that given the other limitations of the study (limited range of flows examined, etc), that examining the historic data with updated habitat curves may not be useful.

- *Response*: Jason Kent stated that the purpose of introducing this study was to provide background information, but that a new instream flow study will be conducted by HDR.

John Morsell and Paul McLarnon noted that in the evaluation of effective spawning habitat, the studies will take into consideration that effective spawning area is only as available as incubation/survivability overwinter. John cited an example of the Bradley River, where spawning habitat was considered in conjunction with incubation criteria developed by participants. Paul noted that if winter flows are a limiting factor in the Grant Creek system, increased winter flows may increase incubation success, and effective spawning area. This will be examined in the studies.

- *Comment*: Jim Ferguson noted that past studies identified temperatures as a concern.
  Response: Jason Kent noted that pool thermistors will be left in over the winter and downloaded when access is available in the spring. Jason also stated that Grant Creek temperatures track the temperature profile of the Grant Lake thermistor at 1.5 meters of depth. Paul McLarnon stated that HDR will leave the thermistor string in the Lake overwinter, but that there will be logistical challenges with maintaining it.

- *Comment*: Jeff Anderson noted that targeting water withdrawal from this area [the top 1.5 m] in the lake would be useful.
  Comment: Susan Walker asked if water would be available from the top 1.5 m of Grant Lake year round.
  Response: Brad Zubeck stated that the engineers on the Project will need to review the feasibility of year round surface withdrawal, if necessary. The current proposal allows for a low level release to maintain canyon flow.

- *Comment*: Lee McKinley asked if gravel recruitment downstream could be impacted by flow regulation at the dam.
  Response: Jason Kent noted on the hydrograph that peak flows greater than 750 cfs could be characterized as flushing flows, though it is unknown if reduced flows would impact spawning gravel recruitment with current information.

- *Comment*: Susan Walker noted that the future precipitation predications may result in more extreme events in the future, and that the Project design should take this into consideration.

- *Comment:* Jim Ferguson asked if the proposed structure could accommodate spill at higher flows.
  Response: Brad Zubeck noted that the preferred operation would be to limit spill, but that flushing flows could be considered based on study results and agency input. The current operations proposal includes operation with up to 350 cfs, with 100 cfs unit running continuously.

John Morsell introduced the instream flow methodology, which was designed to focus on areas of known fish use. Jason Kent explained the elements of the instream flow approach (Attachment 2, slides 66-89). The approach discussed is summarized in Attachment 5.

- *Comment*: Gary Fandrei noted that temperature is a key habitat parameter for many life stages, and that even 1°C change could have a large influence.
  Response: Jason Kent noted that hydrology studies will collect information to determine the thermal regime in the Creek, and potential temperature changes can be assessed later in the instream flow study after baseline data has been collected.

- *Comment*: Jeff Anderson noted that current proposed study locations do not account for coho spawning, and requested that additional study sites be added if coho spawning is observed.
  Response: HDR agreed that if different areas were used for coho spawning, additional study sites would be added.

- *Comment*: Jeff Anderson asked if changes in velocity (higher in winter) due to Project operations would alter fish use.
  Response: Jason Kent noted that the assumption of this method is that since habitat is being used, current velocities are acceptable. Available habitat parameters may be evaluated based on winter conditions and proposed operations, but velocities will not be measured. However, the agencies should have enough information from studies to evaluate effects.

- *Comment*: Ginny Litchfield also noted that if winter use is limiting, habitat areas identified may not be the key winter habitats.
  Response: Jason Kent noted that the instream flow model will be able to predict when areas go dry. John Morsell added that winter habitat can be estimated using the proposed method, and that additional transects could be added if studies show new use areas in the winter. Paul McLarnon added that it may be difficult to get in and look at winter use until after break-up, but noted that potential winter habitat areas could be identified now (e.g., pools), and an effort could be made to look at these areas during the winter.

- *Comment:* Jeff Anderson noted that the operations proposal could provide more winter habitat for fish.

- *Comment:* The group discussed whether it was possible to install thermistor strings in Chinook redds over winter. Jason Mouw noted that the literature supports an average depth of 40 cm for Chinook. This would be too deep for sockeye, but would still provide information on the source of water in the redd.

- *Comment:* The group noted that winter survey (in rearing areas) information, where feasible, may be useful. It was also noted that winter observation of ice presence would be useful.

- *Comment:* Jason Mouw noted he is in support of this instream flow study approach. He stated that a tendency in instream flow studies is to ignore important shoreline and pocket habitats, and this approach allows for considering those areas.

- *Comment:* Susan Walker noted that a sediment transport study would provide useful information.
  Response: Jason Kent stated that a limited sediment transport analysis will be included as a part of the fluvial geomorphology component of the hydrology study.

- *Comment:* Jim Ferguson asked if overwinter temperatures change, availability of food sources, etc should be considered.
  Response: John Morsell noted that temperature data will provide necessary information to evaluate operations proposals, as more information becomes available through the studies to develop the proposal based on resource considerations.

- *Comment:* Lee McKinley asked if there were potential changes to wood recruitment.
  Response: Paul McLarnon noted that the habitat mapping methodology includes the collection of information on wood distribution, and based on observation, wood sources appear plentiful in Grant Creek.

Jason Kent walked through information on slide 75 describing habitats for instream flow consideration, and gathered feedback on priorities.

- *Comment*: Susan Walker noted that the fundamental function of the stream should be considered when designing studies and evaluation effects.
  Response: John Morsell stated that salmonid spawning and incubation, and early life stage refugia for Chinook are important considerations for Grant Creek.

- *Comment*: Gary Prokosch asked if parameters for winter habitat were considered a primary function of the stream.
  Response: Paul McLarnon noted that there is limited winter use, with observations of YOY only.

- *Comment*: Gary Prokosch stated that proposed operations could open up rearing habitat in the winter. Jeff Anderson noted that overwintering habitat is generally the bottleneck for Chinook, so Project could reduce this bottleneck.
  Response: John Morsell noted that the wetted perimeter analysis in the side channel habitat will be an essential index for evaluating this use. Overall, analysis will focus on parameters that are most likely to be impacted by changes in flow.

- *Comment*: Jason Mouw stated that from preliminary data on downwelling, this may not be a key limiting factor of use. He stated that intergravel flow depth may be limited in areas.

- *Comment*: Susan Walker noted that in spawning areas, since current use is known, she does not envision flow changes having a negative effect.

- *Comment*: Jeff Anderson asked the range of flows that could be analyzed with this approach.
- *Response*: Jason Kent noted that staff gages can be read from the bank at any high flow. However, flows in the creek will likely not be measured at flows higher than 450 cfs, so there likely will not be verification of the stage-discharge curve at these flows. On the low end, flow measurements will be taken at low flows when ice impact is minimal. The instream flow method allows extrapolation of 40-60% of the high/low ranges, so the total flow range will depend on measured flows in the hydrology study.

Closing

The agency representatives were offered the opportunity to mark habitat study areas in the field the following day, but no participants chose to attend. The proposed study areas and approach presented in the meeting was generally supported, with feedback recorded in the notes. A full study plan will be presented by HDR in November, and a technical memo outlining the instream flow methodology is provided as Attachment 5.

The meeting adjourned at approximately 3 pm.

Attachments

Attachments are available on the September 22-23, 2009 TWG meeting calendar page at www.kenaihydro.com.

Attachment 1: September 22, 2009 Field Observation Summary and Reach Map
Attachment 2: September 23, 2009 PowerPoint Presentation
Attachment 3: Fish Use by Reach (2009) Figures
Attachment 4: Summary of 1986-1987 Instream Flow Study
Attachment 5: Instream Flow Methodology Technical Memo

Kenai Hydro Instream Flow Technical Working Group Site Visit

Aquatic Habitat and Fish Use Observational Considerations

Tuesday September 22, 2009

Reach 1

- Primarily fastwater riffle habitat
- Large angular substrates
- Spawning at stream margins
- Sockeye spawning aggregate in middle reach area at head of dis-tributary
- Thermistor location on north bank at head of dis-tributary
- Includes dis-tributary
    - Lower flow, juvenile rearing

Reach 2

- Contains old USGS gage station and new gage station
- Primarily fastwater riffle habitat – stream margin spawning
- One large scour pool a upper end of reach
- Isolated areas of undercut bank
- Remnant channel on south bank
    - Large woody debris
    - Overflow channel at head of remnant channel

Reach 3

- Island Complex with side channel on south bank
- Fast water riffle habitat
- Large backwater pool
- Large scour pool
- Side channel is bedrock controlled
- Stream margins with undercut bank
- Stream margin spawning

Reach 4

- Fast water riffle
    - Stream margins with isolated areas of undercut bank
- Large scour pool at top of reach

- Overflow channel on north bank
- Small back water areas – juvenile rearing

Reach 5

- Dominate Habitat is cascade
- large bolder substrate
- Source of substrate input to stream – colluvium inputs to stream from canyon walls
- fish use of this reach has been largely undefined, will be focus of future study efforts


Upper Trail Lake
Grant Lake
1
2
3
4
5
6
ADFG Anadromoust Fish Distribution Limit
This inset provides an overview of the Grant Creek study area and delineated Grant Creek Reaches
Distributary Channel
Grant Creek
REACH 1
REACH 2
Distributary Channel
Grant Creek
Unmapped Remnant Channel
REACH 2
REACH 3
REACH 3
REACH 4
REACH 4
REACH 5
UPSTREAM SURVEY EXTENT
2009 GRANT CREEK
MAJOR HABITAT CATEGORIES
KENAI HYDRO
ENVIRONMENTAL BASELINE STUDIES
ADFG Anadromous Fish Distribution
Large Woody Debris
Cascade Dominated Habitat
Glide Dominated Habitat
Pool Dominated Habitat
Riffle Dominated Habitat
Side or Overflow Channel
N
W
E
S
Feet
140 70 0 140
HDR ALASKA INC.
SEPTEMBER 2009
P. BLAIR

Kenai Hydro, LLC.

Grant Lake Project, Instream Flow Technical Working Group Meeting

Kenai Lake Work Center, Moose Pass Alaska

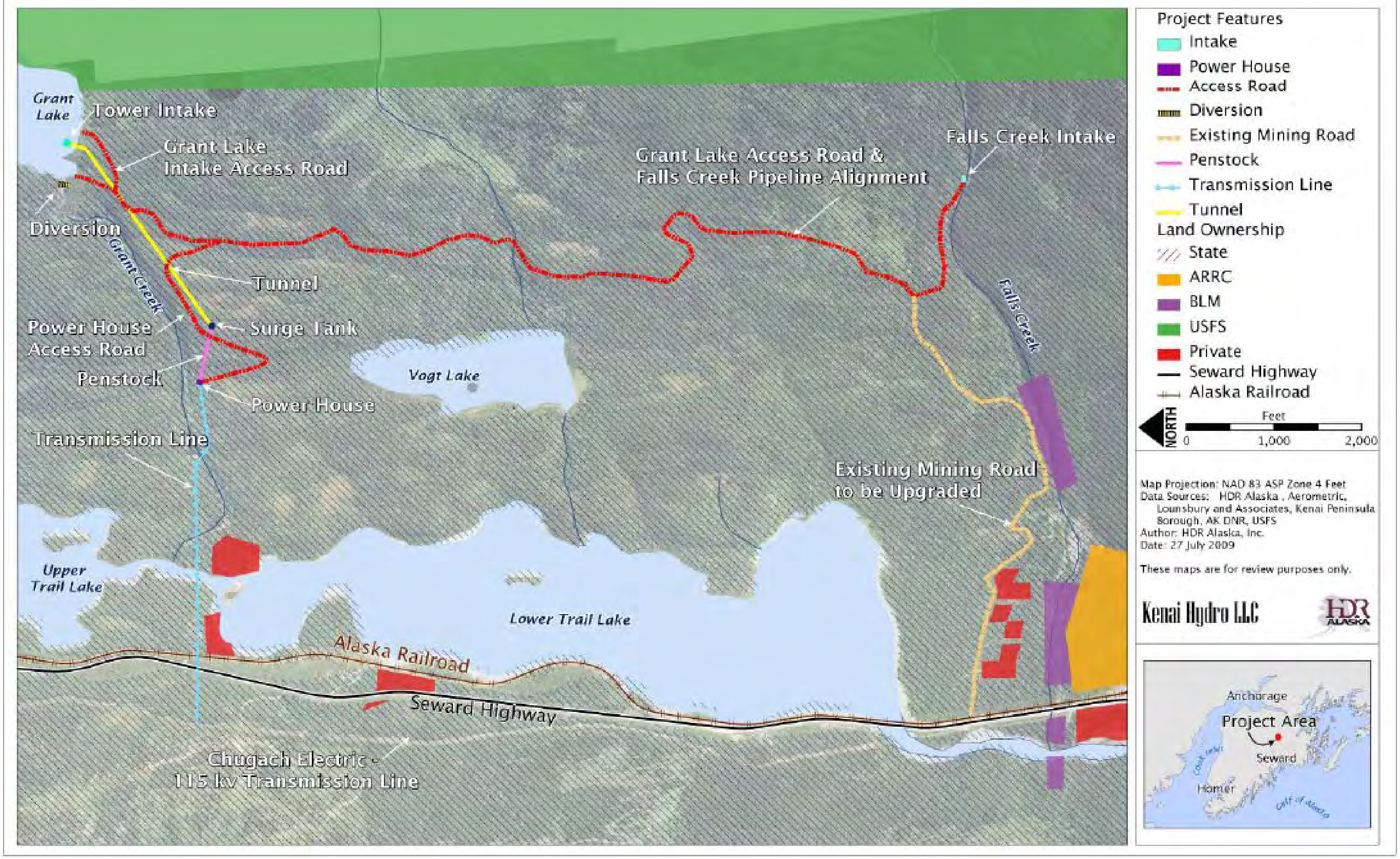
September 22 and 23 2009

QUESTIONS & COMMENTS REGARDING SITE VISIT

Licensing Update

- Filed our NOI & PAD on August 6th
- FERC issued approval of the TLP "with early scoping"
- Next Steps
  - Plan Joint Meeting Nov 10, 2009?
  - Intend to have draft study plans for joint meeting

PROJECT ENGINEERING UPDATE



PROJECT ENGINEERING UPDATE

SUMMARY OF PROJECT FEATURES
Generating Units •2 Francis units (1.2MW 3.3 MW)
Maximum Rated Turbine Discharge •Unit 1 - 100 cfs •Unit 2 - 250 cfs
Normal Maximum Reservoir Elevation Range •675-706 feet – 48,000 acre feet storage
Gross Head •191 feet
Grant Creek Diversion •10 foot high concrete gravity •120 foot crest width •60 foot spillway crest length

PROJECT ENGINEERING UPDATE

Lower Pressure Pipeline •200 lf welded steel, 96 inch diameter
Pressure Tunnel •2,800 lf horseshoe tunnel, 10 foot diameter
Penstock •650 lf welded steel, 66 inch diameter
Falls Creek Diversion •Concrete gravity 10 foot high •50 lf crest length •800 foot crest elevation
Falls Creek Pipeline •13,000 lf welded steel, 42 inch diameter
Powerhouse •Approximate Dimensions 45 feet x 60 feet x 30 feet high
Transmission Line •4,100 lf overhead line, 115kV
Access Roads •3.4 miles single lane gravel surface

AGENDA

- Preliminary results of 2008-2009 hydrology study
- Preliminary results of 2009 fish & aquatic habitat studies
- Review of 1987 instream flow study
- Proposed instream flow study approach

- Not included today: macroinvertebrates, water quality, Grant Lake fish capture results, work completed after August 31st.

Hydrology update

HYDROLOGY UPDATE

Summary of 2009 data collection

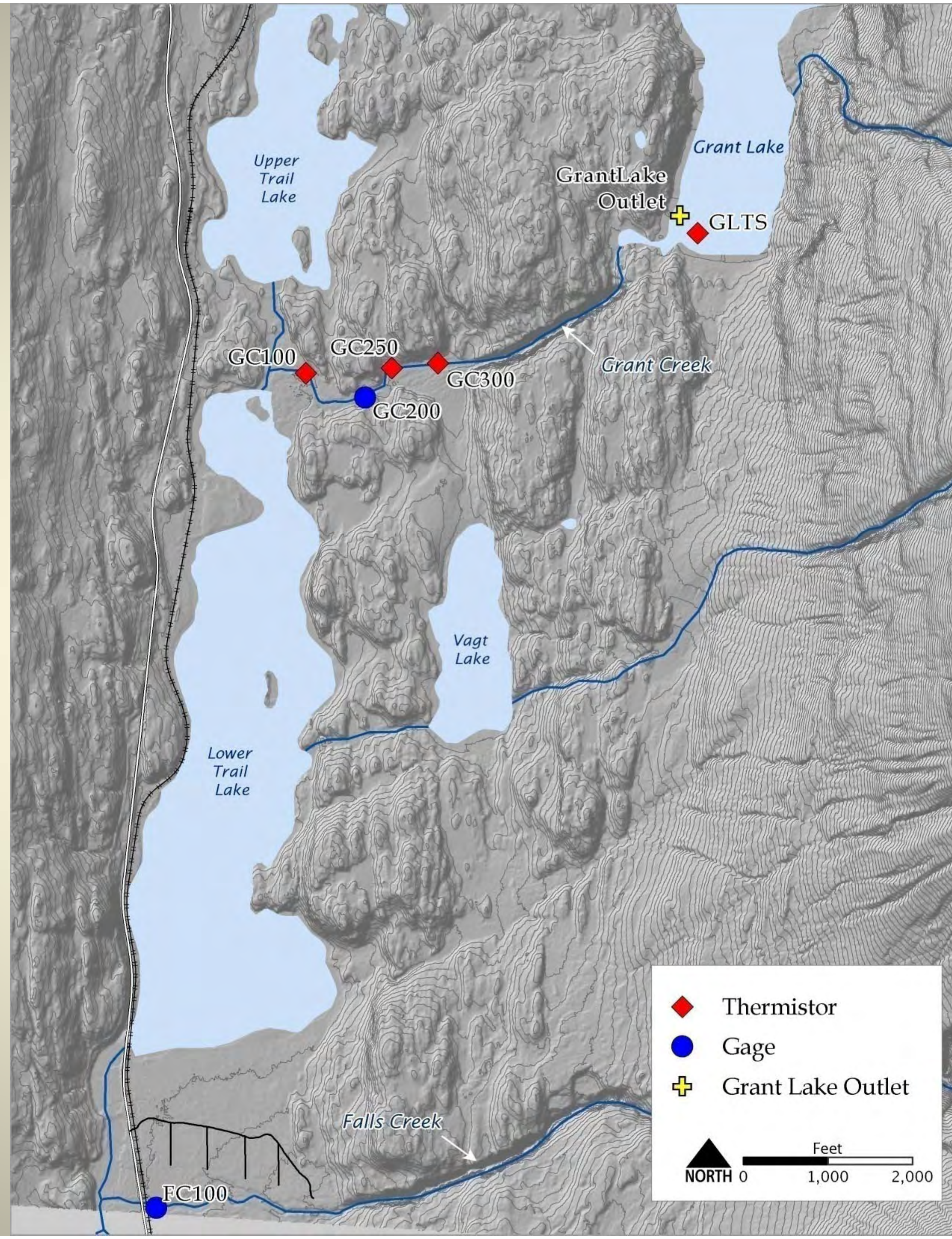
Grant Creek:

- Pressure transducer (stage) loggers at GC200 (old USGS site)
- Thermistor (temperature) loggers at:
  - GC100 (surface and bottom of pool)
  - GC200 (run)
  - GC250 (pool)
  - GC300 (riffle)
- Instantaneous discharge measurements:
  - Four measurements, one in 2009 (422 cfs on 6/22/2009)

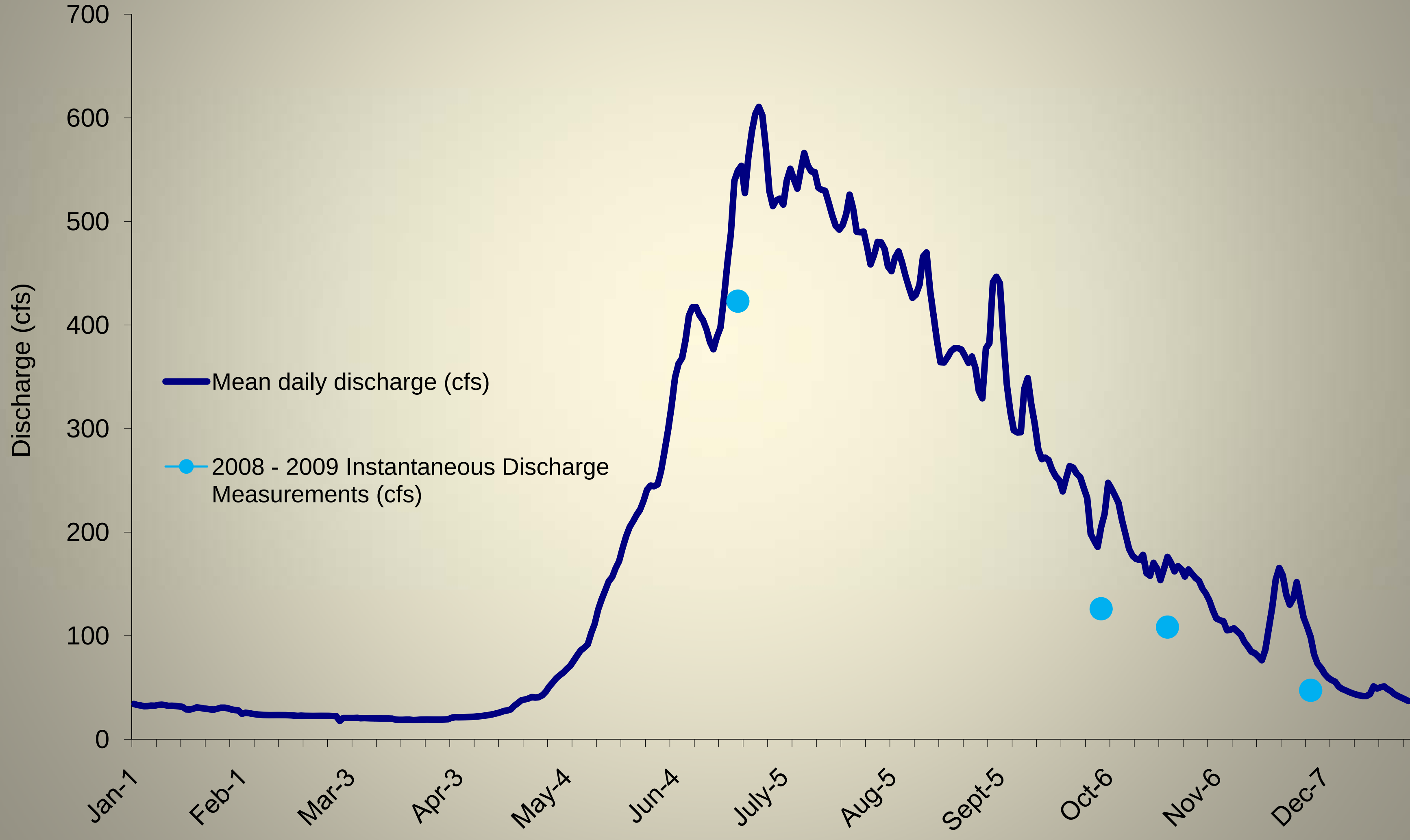
Falls Creek:

- Pressure transducer (stage) logger at FC100
- Thermistor (temperature) logger at FC100 (run)
- Instantaneous discharges (six measurements, two in 2009)

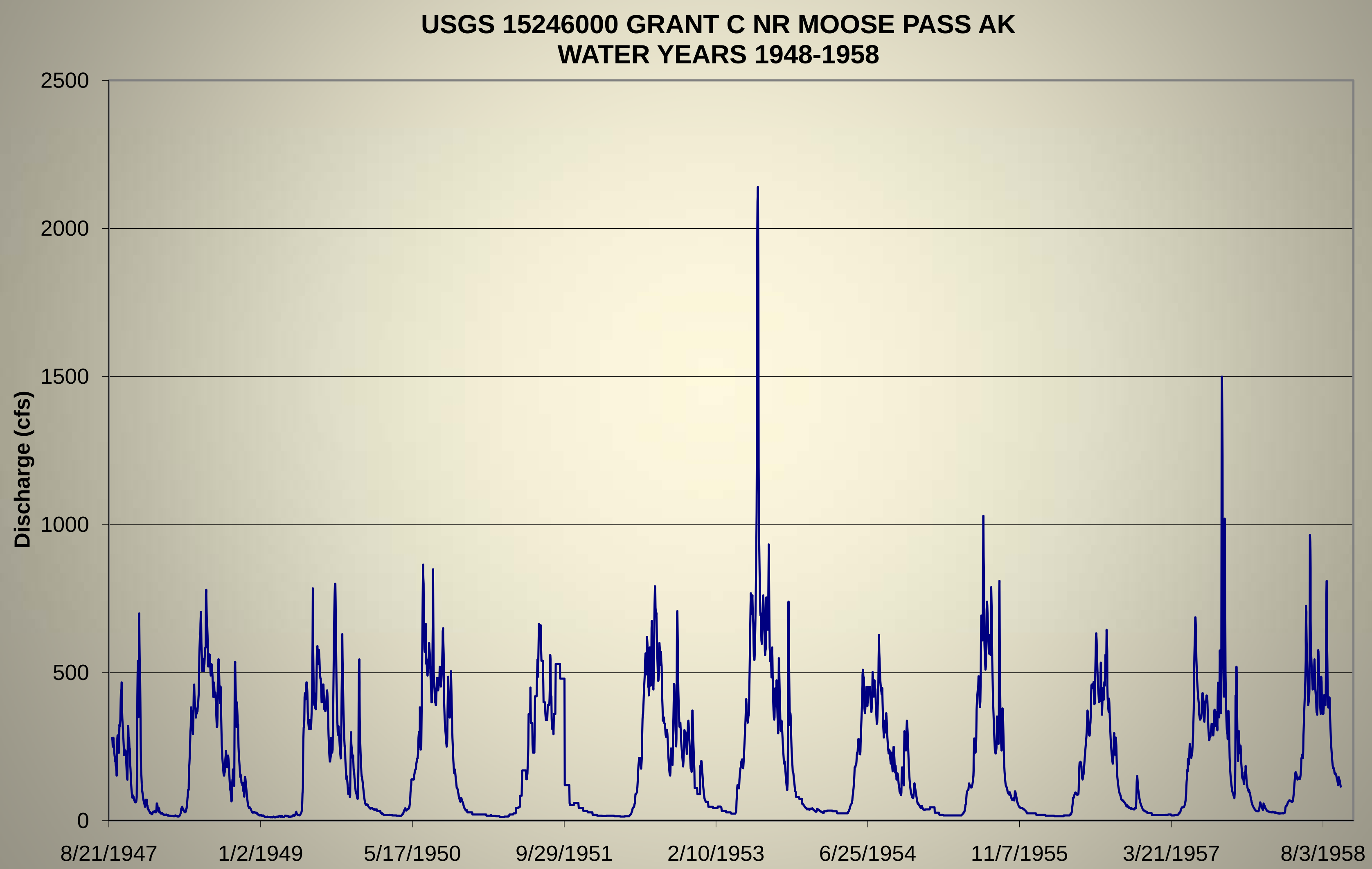
MAP OF GRANT CREEK AND FALLS CREEK SURFACE WATER GAGES AND THERMISTOR LOCATIONS



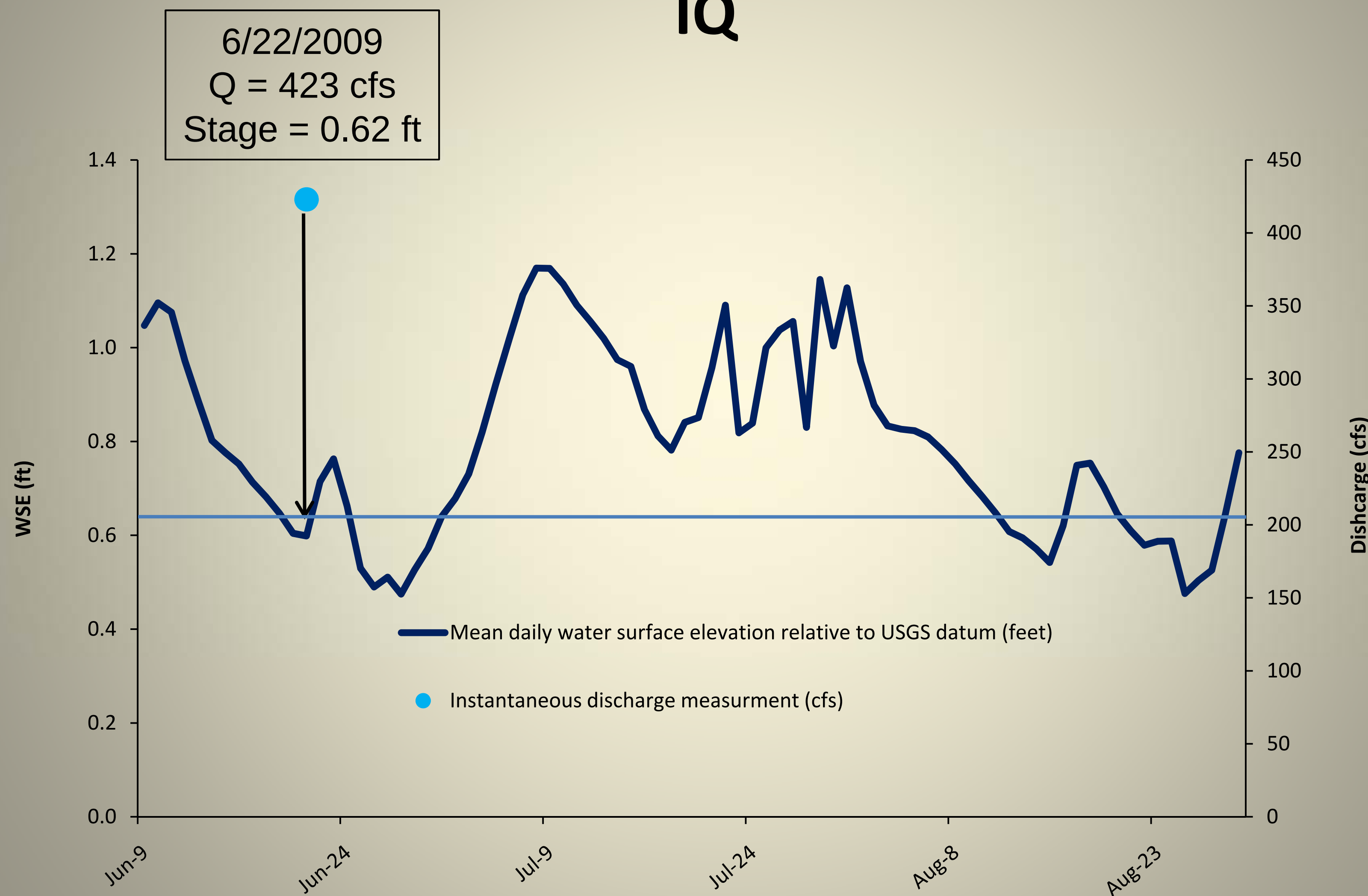
HISTORICAL GRANT CREEK (GC200) HYDROGRAPH (1947 -1958)



HISTORICAL GRANT CREEK (GC200) HYDROGRAPH (1947 -1958)

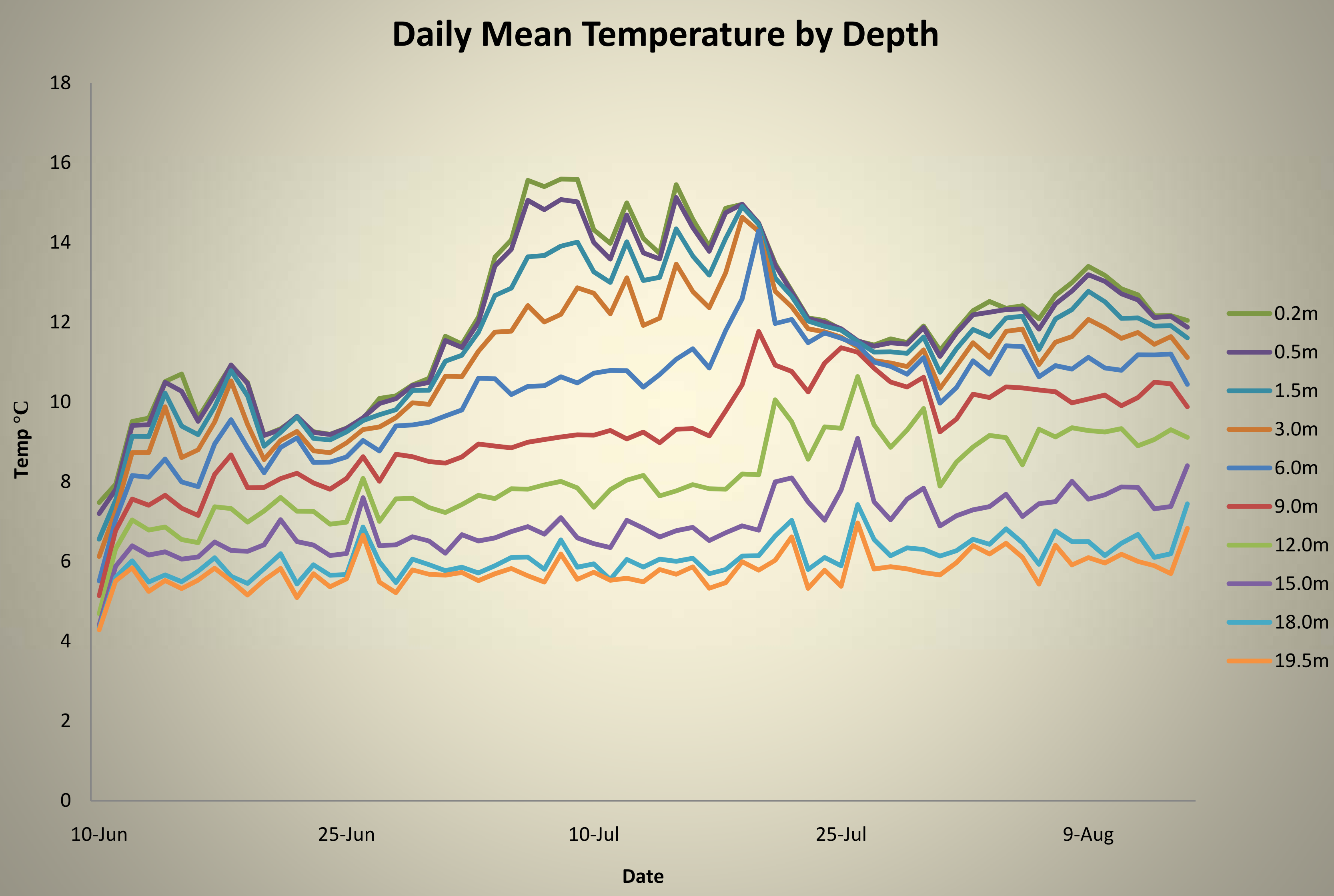


GC200 6/10/2009 – 8/30/2009 WATER SURFACE ELEVATIONS (WSE) AND 6/22/2009 IQ

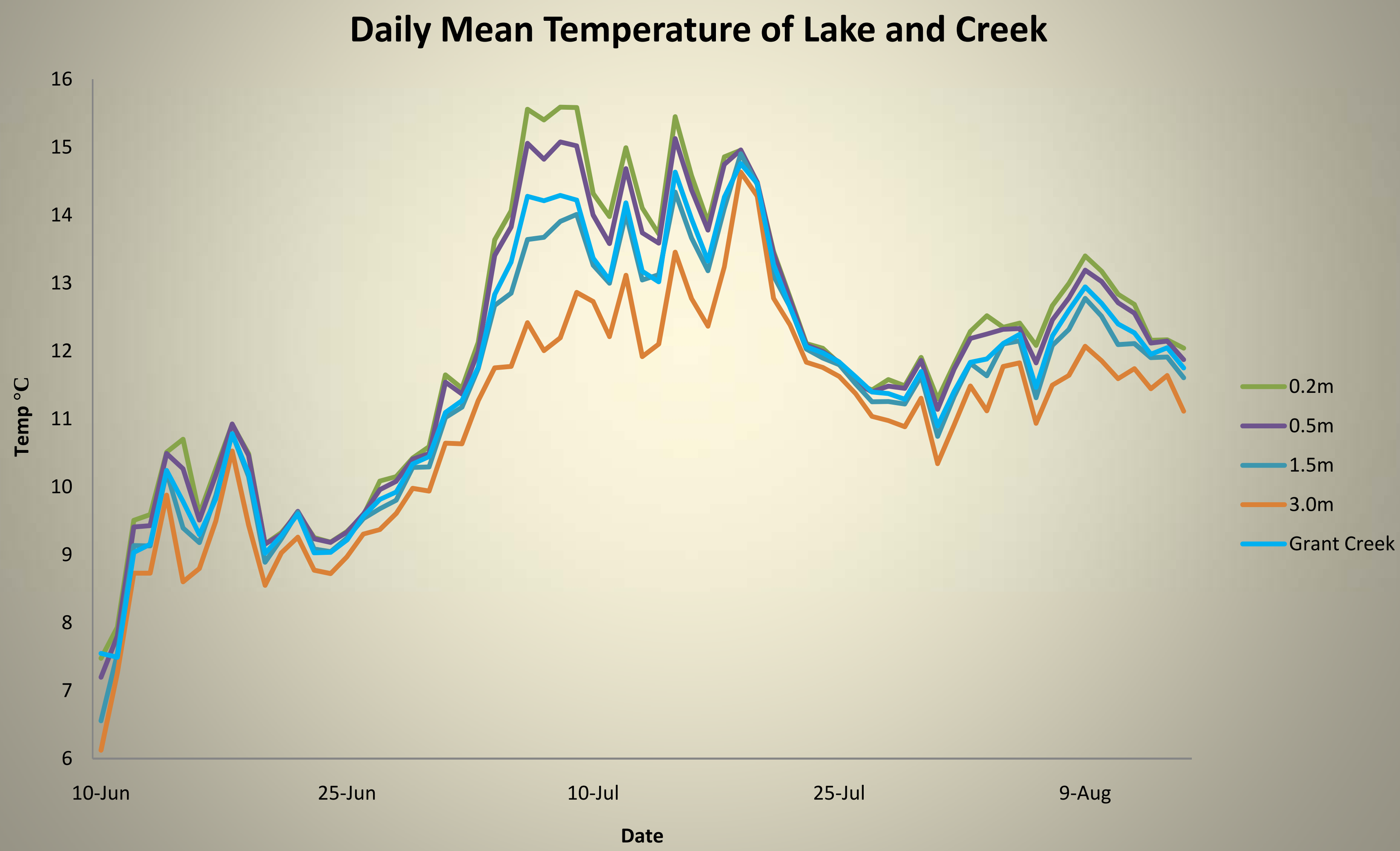


GC200 DATA COLLECTION – JUNE 22, 2009

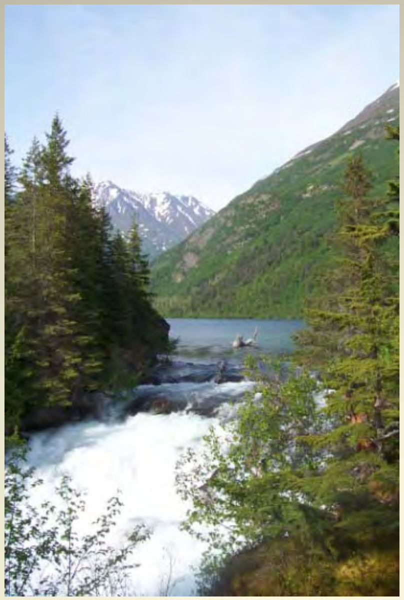
GRANT LAKE TEMPERATURES



GRANT LAKE VS. GRANT CREEK TEMPERATURES



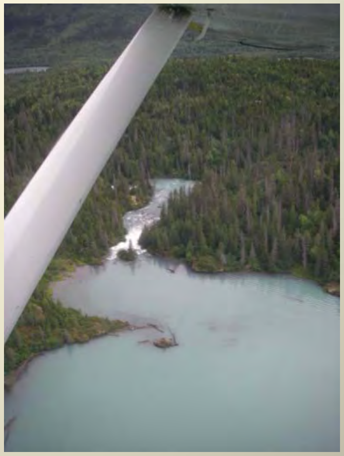
GC200 gage install, 6/09/2009



Grant Lake outlet 6/10/2009

Falls Creek gage 7/24/2009

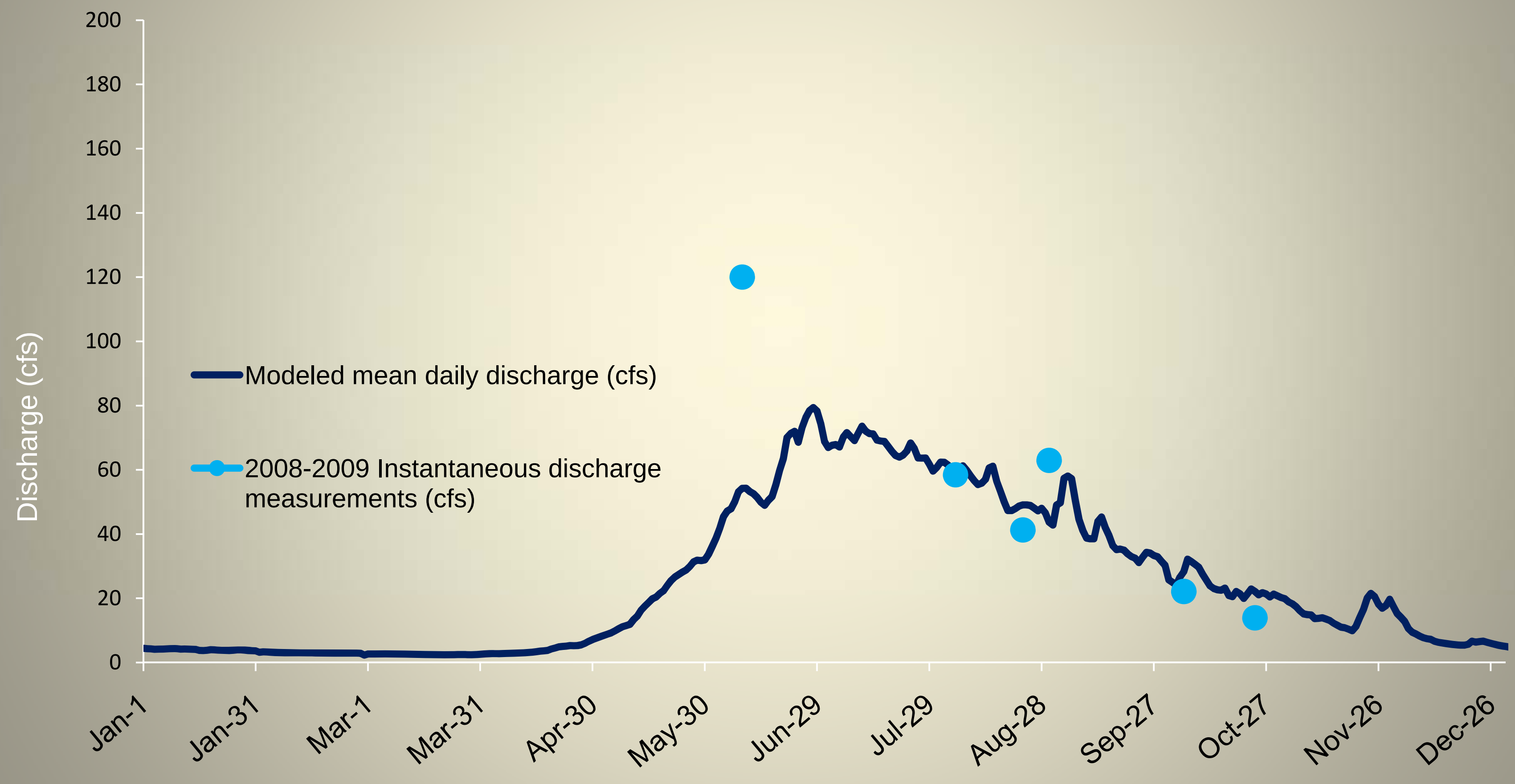
GC200 weather station 8/12/2009



Grant lake outlet aerial view 7/24/2009

MODELED FALLS CREEK (FC100) HYDROGRAPH

(BASED ON USGS GAGE DATA WITH 73.5% BASIN AREA REDUCTION)



RESULTS OF 2009 FISH AND AQUATIC HABITAT STUDIES

Study Purpose – Characterize resident and rearing fish use of aquatic habitats, fish spawning abundance and run timing in Grant Creek.

Five Primary Studies

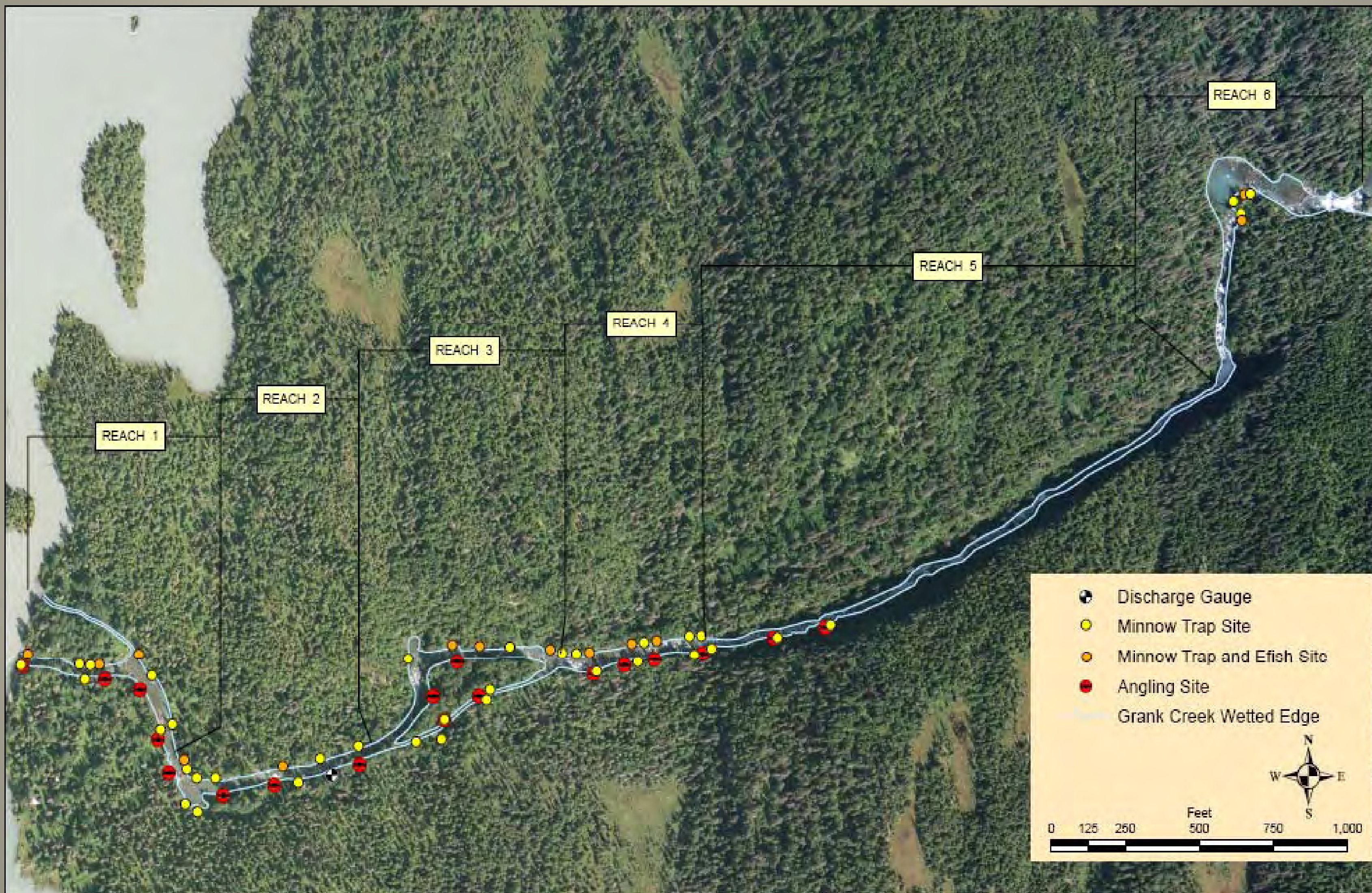
1. Juvenile fish study
2. Resident fish study
3. Salmon spawning foot surveys
4. Aquatic habitat survey
5. Fish use reconnaissance study
    a) Grant Creek
    b) Falls Creek

<u>The following study results are as of August 31, 2009 – studies are ongoing at the time of this presentation.</u>

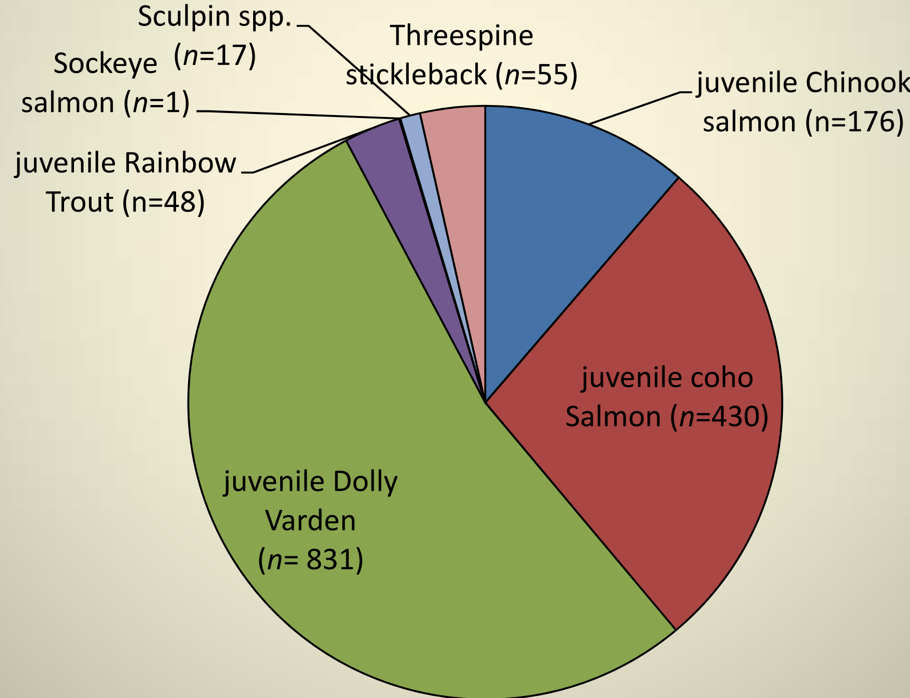
VERTICAL HYDRAULIC GRADIENT RECONNAISSANCE

JUVENILE FISH STUDY, PRELIMINARY RESULTS FOR MINNOW TRAPPING

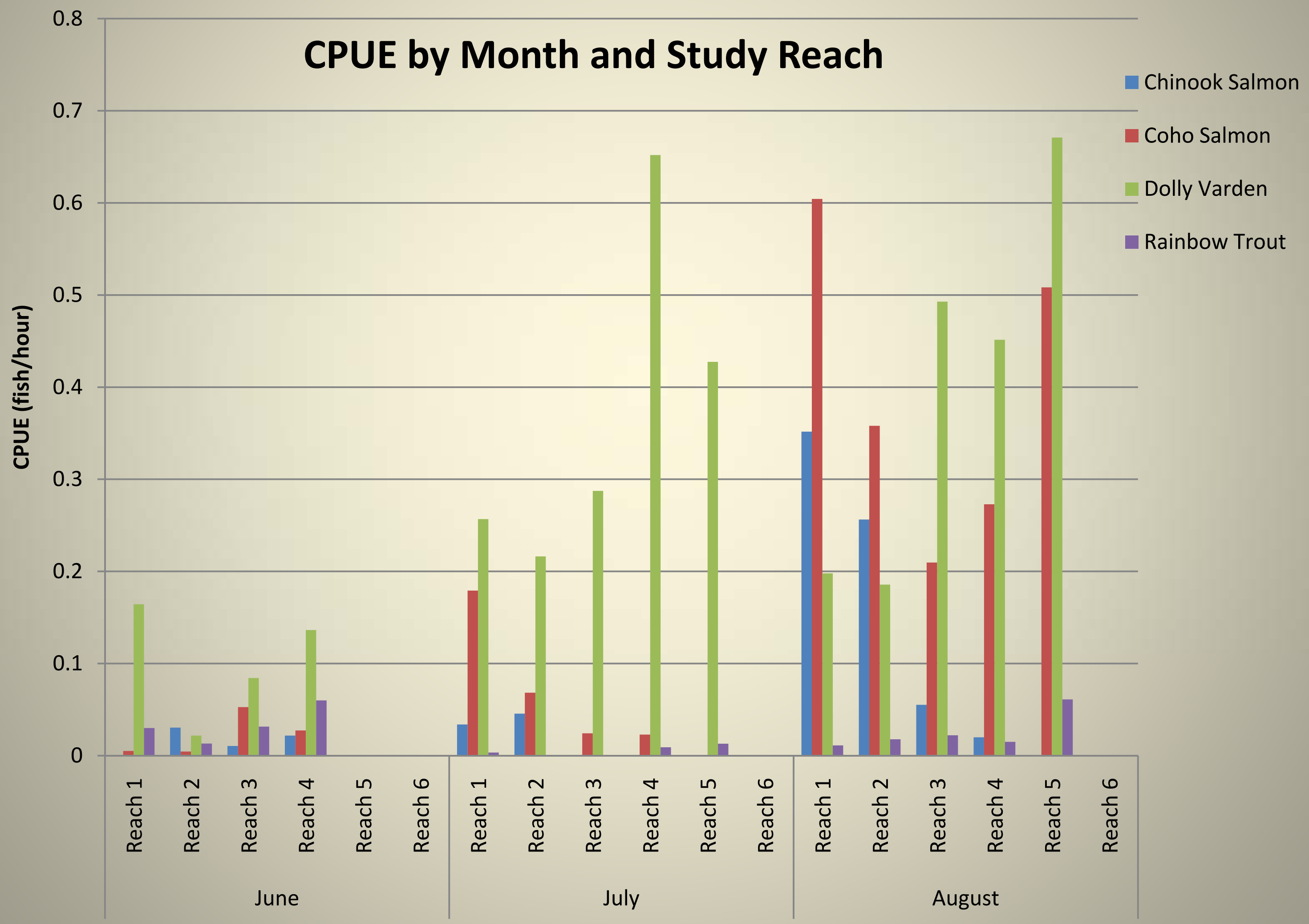
JUVENILE AND RESIDENT FISH STUDY, SAMPLE SITE AND STUDY REACH LOCATIONS



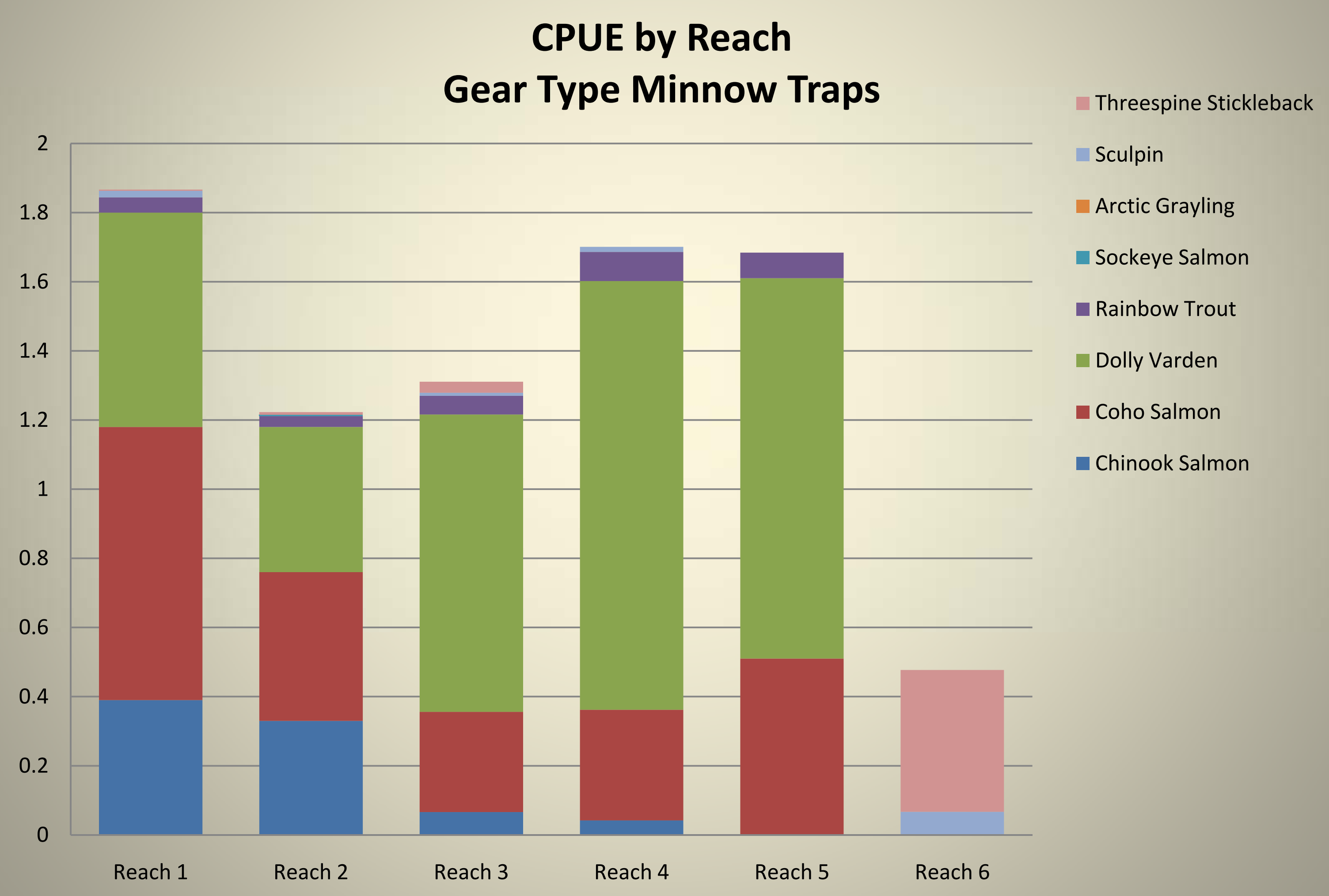
Juvenile Fish Study
Species Composition and Relative Abundance
Gear Type: Minnow Trapping



Juvenile Fish Study Results

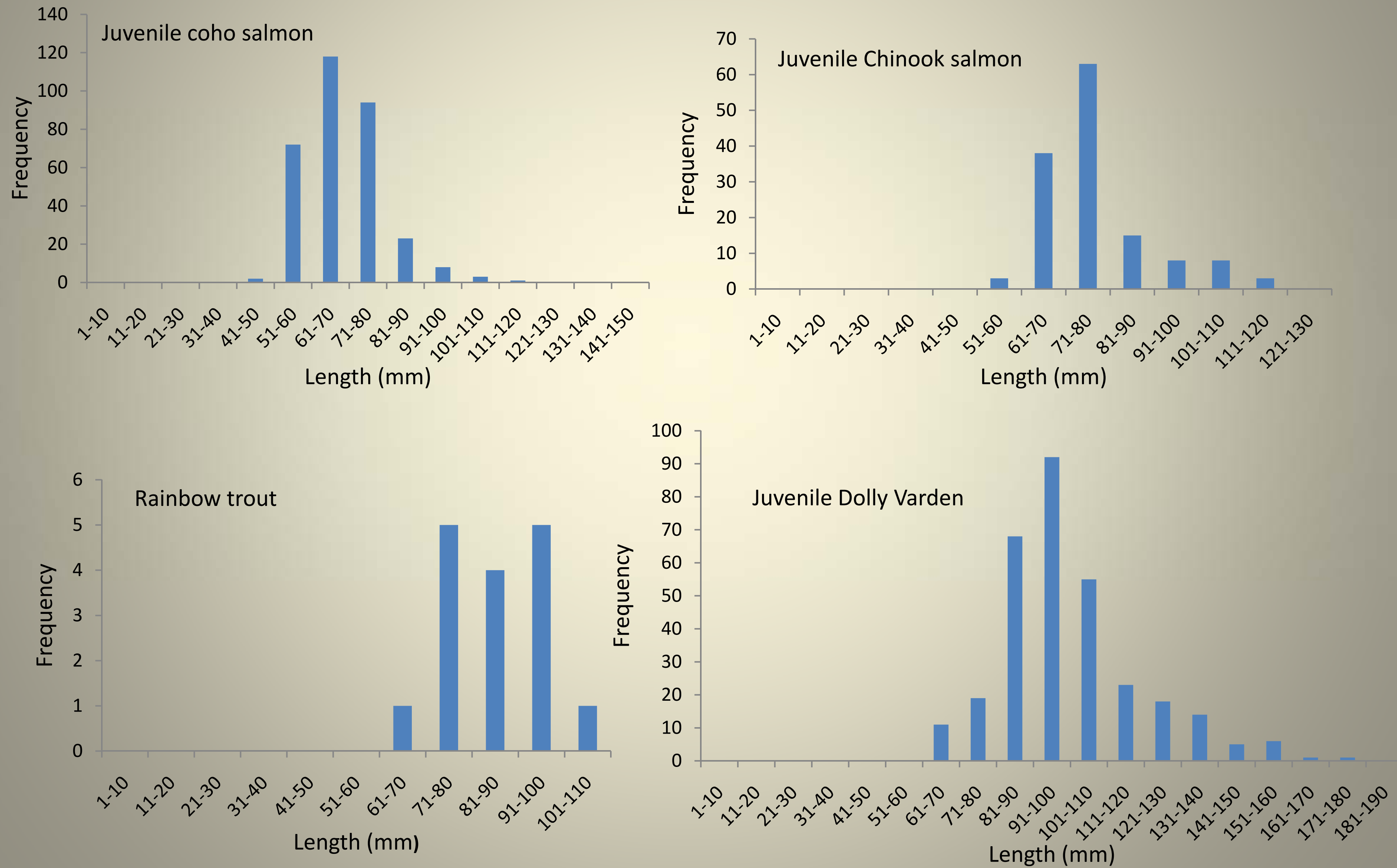


CPUE By Reach – Data Pooled for All Months



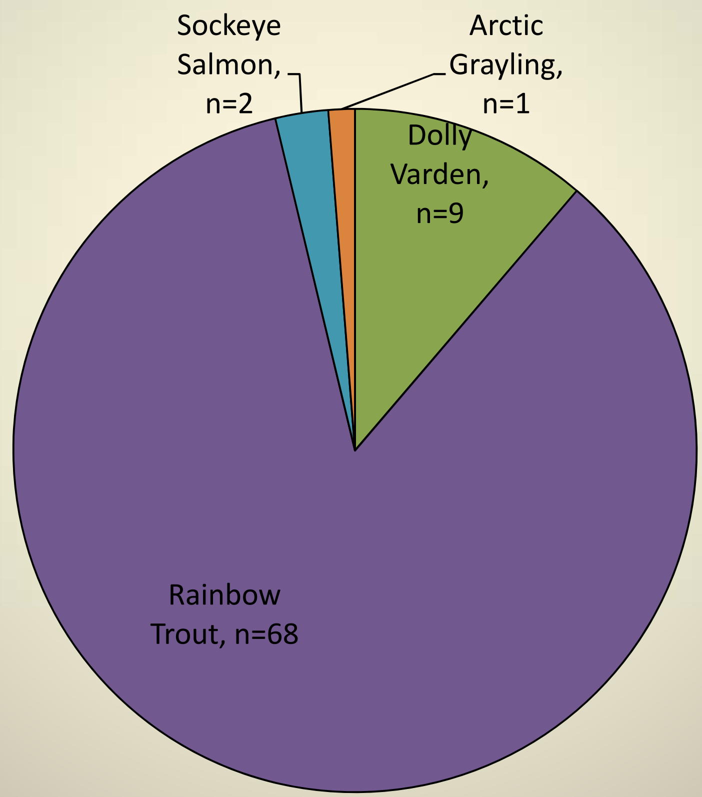
Juvenile Fish Study, CPUE By Habitat Type – All Months

Juvenile Fish Study,
Species Length Frequency – August

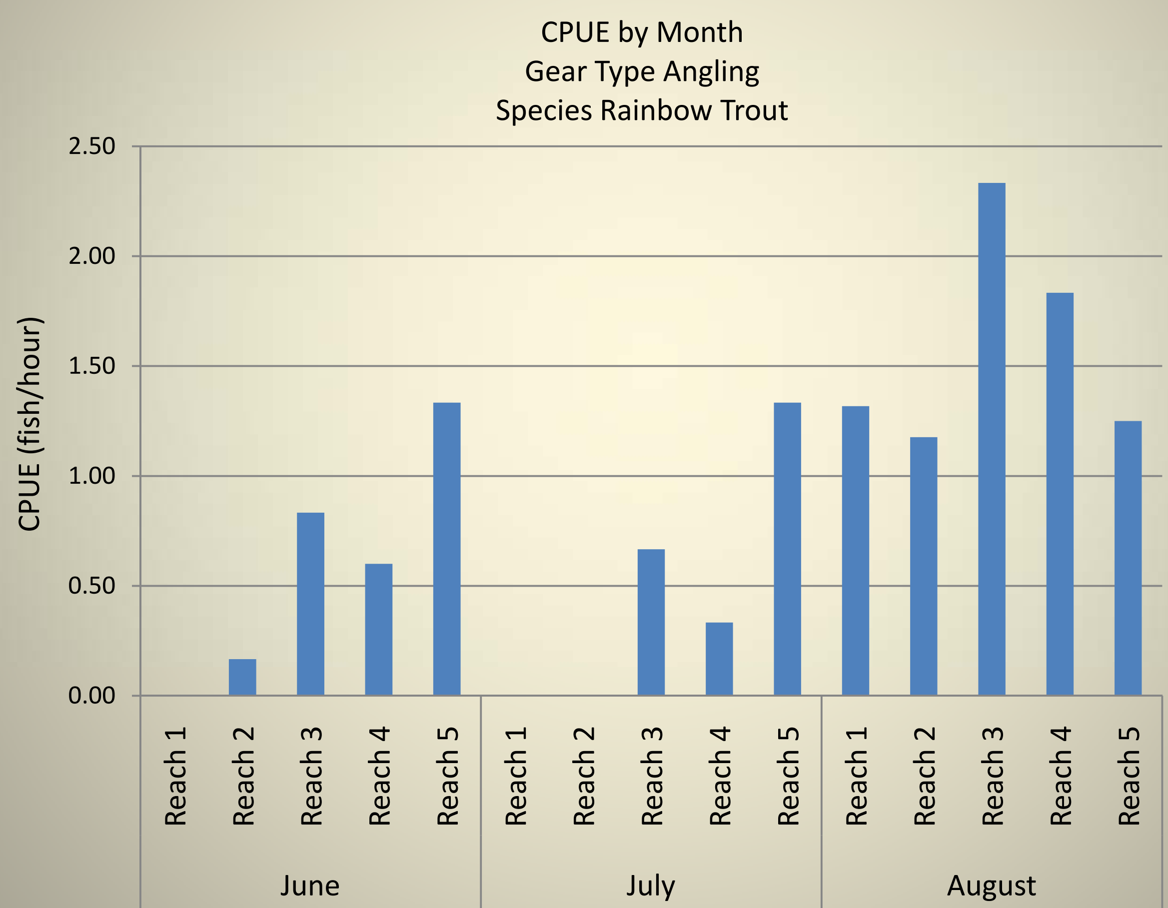


Resident Fish Study

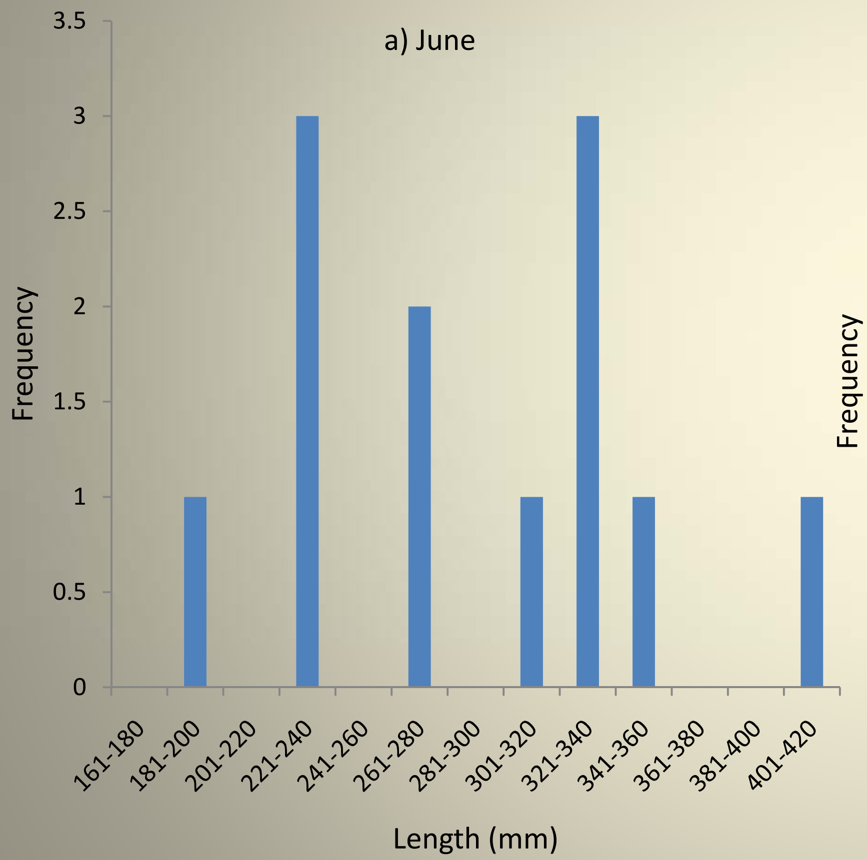
Resident Fish Study,
Species Composition and Relative Abundance
Gear Type: Rod & Reel

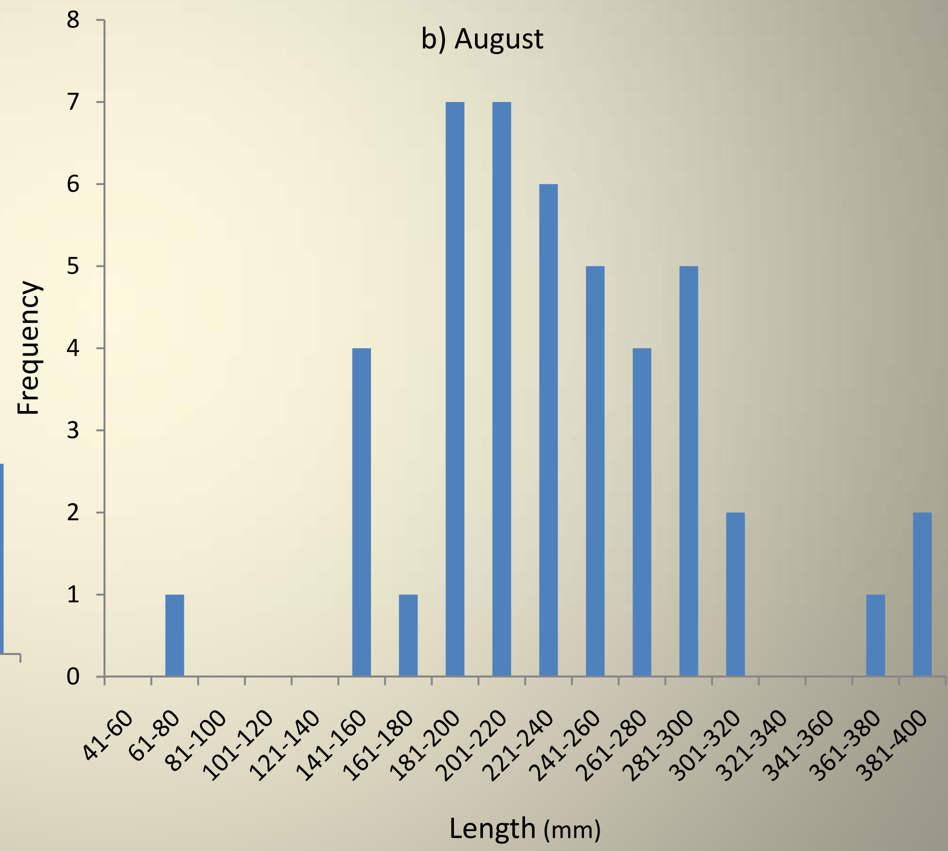


Resident Fish Study CPUE Results, By Reach and Month

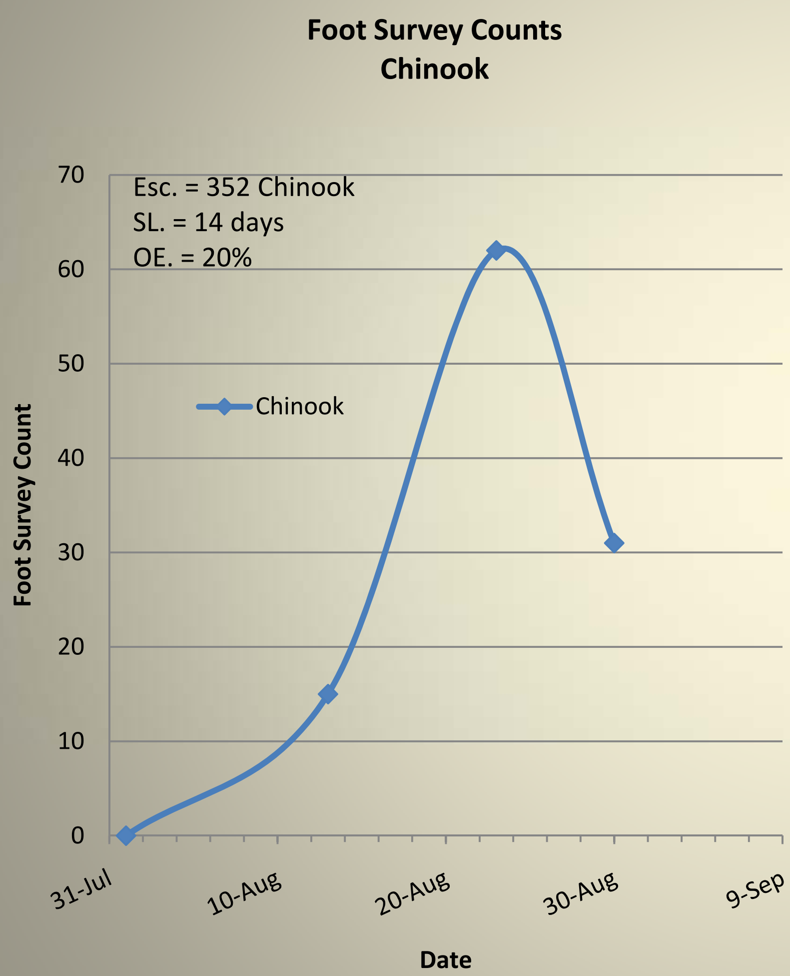


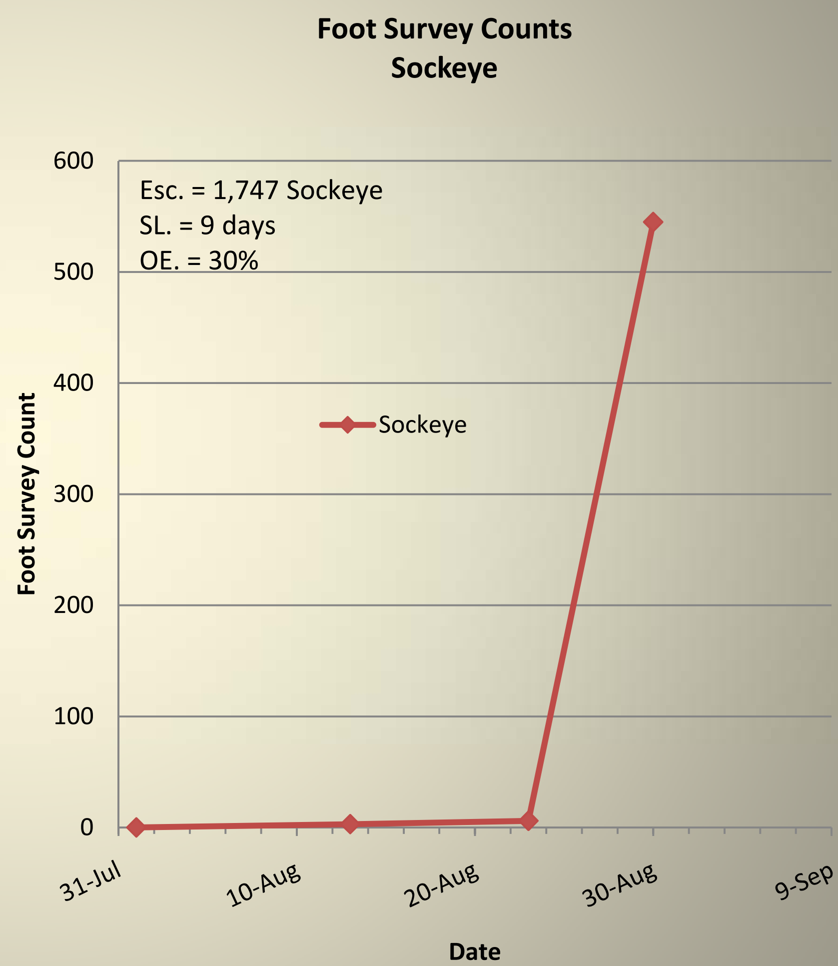
Resident Fish Study, Rainbow Trout Length Frequency Comparison Between June and August





Adult Salmon, Foot Survey Results as of August 31, 2009





FISH HABITAT SELECTION/USE RECONNAISSANCE STUDY GRANT CREEK, 2009

Goal:

Gain insight into the types of aquatic habitats occupied by fish in Grant Creek

Two Primary Components:

1. Juvenile rearing and resident fish

- Chinook, sockeye and coho salmon
- Rainbow trout, Dolly Varden char*

2. Spawning salmon

- Chinook, sockeye, and coho salmon

*Arctic grayling & whitefish have been observed in Grant Creek but were not considered “target” species for this study.

JUVENILE & RESIDENT FISH HABITAT USE RECONNAISSANCE STUDY

Objective:

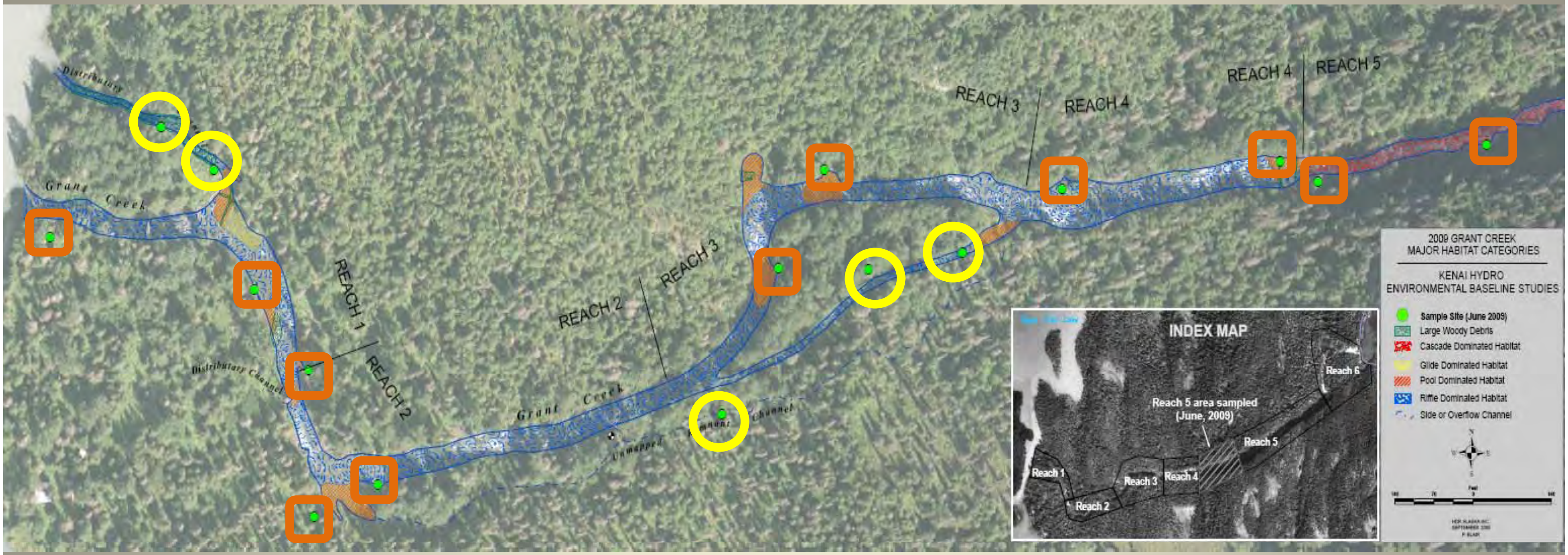
Identify the habitat characteristics/areas that are important for rearing and resident fish, based on those habitats occupied by fish within *representative habitat units* in Grant Creek.

Three Primary Tasks:

1. Establish sample sites "*representative*" of the aquatic habitat in Grant Creek
2. Identify discrete "microhabitat sample areas" based on microhabitat characteristics observed
3. Record fish presence within each "microhabitat sample area"

JUVENILE & RESIDENT FISH HABITAT USE
METHODS/RESULTS

Task 1: Established 16 sample sites in Grant Creek



11 sites in the primary channel

- fast-water: 5 riffles, 1 cascade
- pools: 1 backwater, 1 slough, 2 scour
- variable: 1 small overflow channel

5 sites in secondary channels:

- 2 in distributary channel (Reach 1)
- 2 in secondary channel (Reach 3)
- 1 in tertiary channel (Reach 2/3)

JUVENILE & RESIDENT FISH HABITAT USE

RESULTS

Task 2: Identified "<u>microhabitat sample areas"</u> based on:

- location relative to main channel (margin, midchannel, backwater pocket, etc).
- depth/flow regimes (shallow-Fast, shallow-Slow, deep-Fast, deep-Slow)
- cover (instream: UCB, overhanging veg., large substrate size; or velocity; or no cover)

Sample Site Locations	"Sample Areas"	Typical Characteristics
Main Channel	Pool/fastwater	Deep and fast, typically midchannel
	Riffle/fastwater	Fast, typically michannel and margins
	Margin with undercut bank	Stream margin with undercut bank; typically along fastwater in main channel
	Margin without undercut bank	Stream margin with *no* undercut bank; typically along fastwater in main channel
	LWD dam	LWD creates velocity break (site in Reach 1)
	Margin shelf with LWD	Shallow, wide stream margin with some overhanging vegetation or other instream cover
Backwater / Slough Areas	Backwater pool/ slough	Large backwater/low velocity areas, can be located along stream margin near velocity break
	Backwater pocket	Small backwater/low velocity areas, can be located along stream margin near velocity break
Secondary Channels	Distributary	Variable microhabitat & depth/flow regimes, all microhabitats present (Reach 1)
	Secondary	Typically includes margins with undercut bank, margins without undercut bank, and faster velocity areas in the midchannel. (Reach 3)
	Tertiary	Variable microhabitats (Reach 3)

JUVENILE & RESIDENT FISH HABITAT USE
RESULTS

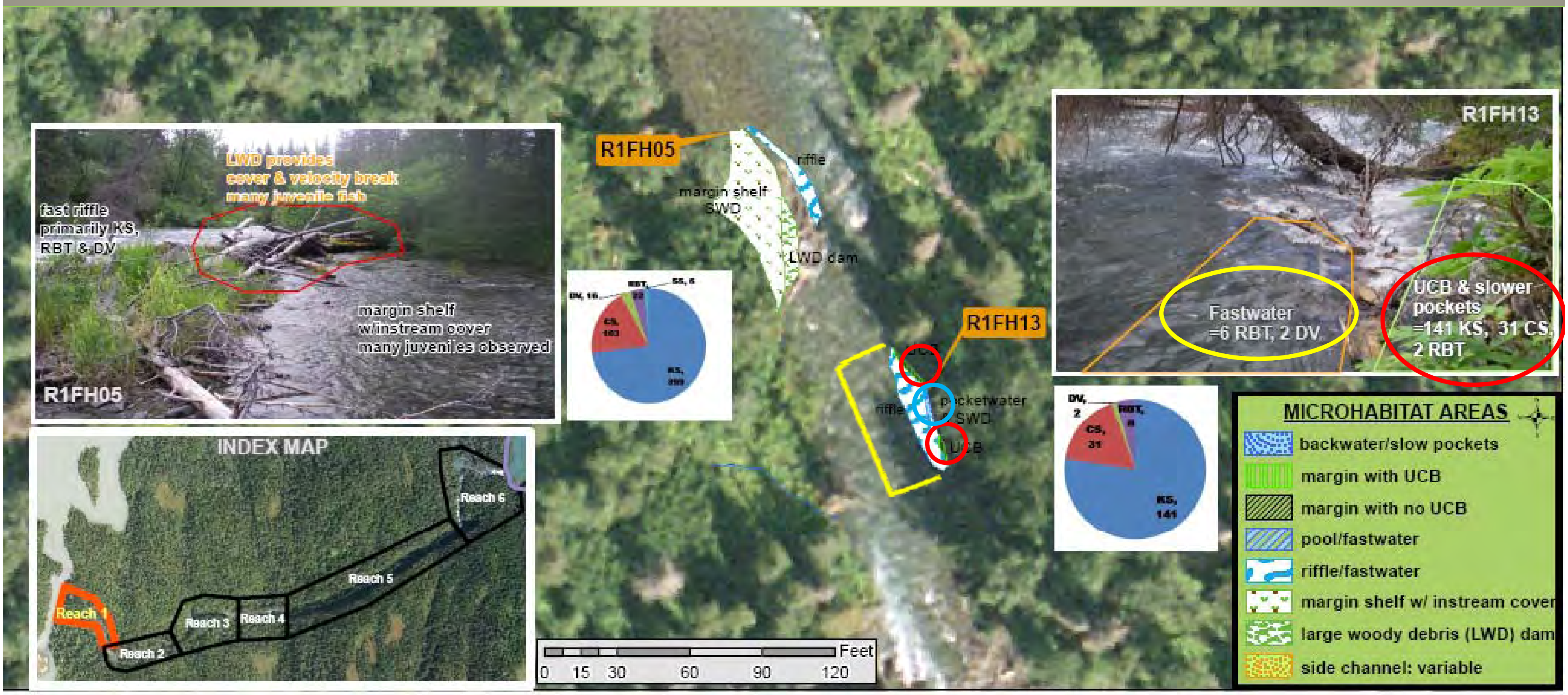
Task 3. Identified fish presence within "<u>microhabitat sample areas"</u>

- identified fish to species
- estimated fork lengths using 20 mm size bins
- recorded cover type and substrate size for each fish observation
- measured depth/velocity where fish were (and were <u>not</u>) observed


Methods:

Snorkeling = primary method (15 sites)
Electrofishing = primarily used to confirm species identification & length estimates (2 sites)

JUVENILE & RESIDENT FISH HABITAT USE
RESULTS - **REACH 1**

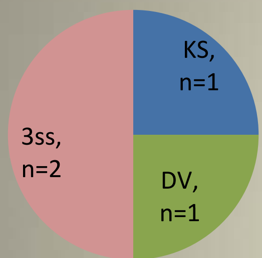


Reach 1: primarily fastwater riffle with few pools (meso-habitat level)

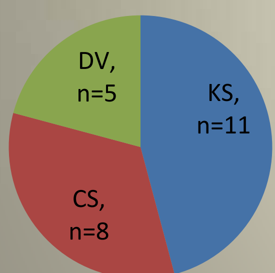
JUVENILE & RESIDENT FISH HABITAT USE

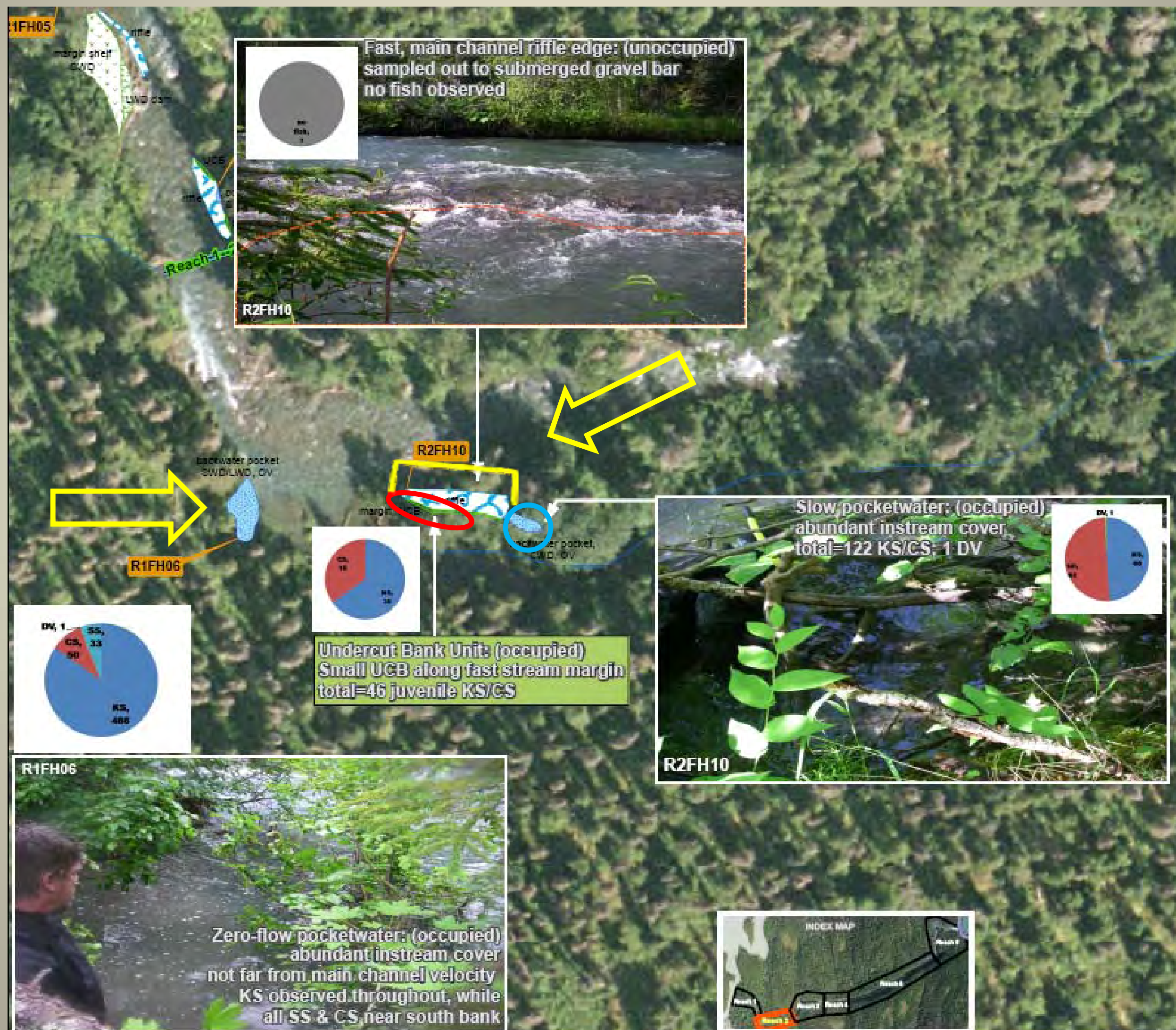
RESULTS - **REACH 2**

Site 2MT-J July



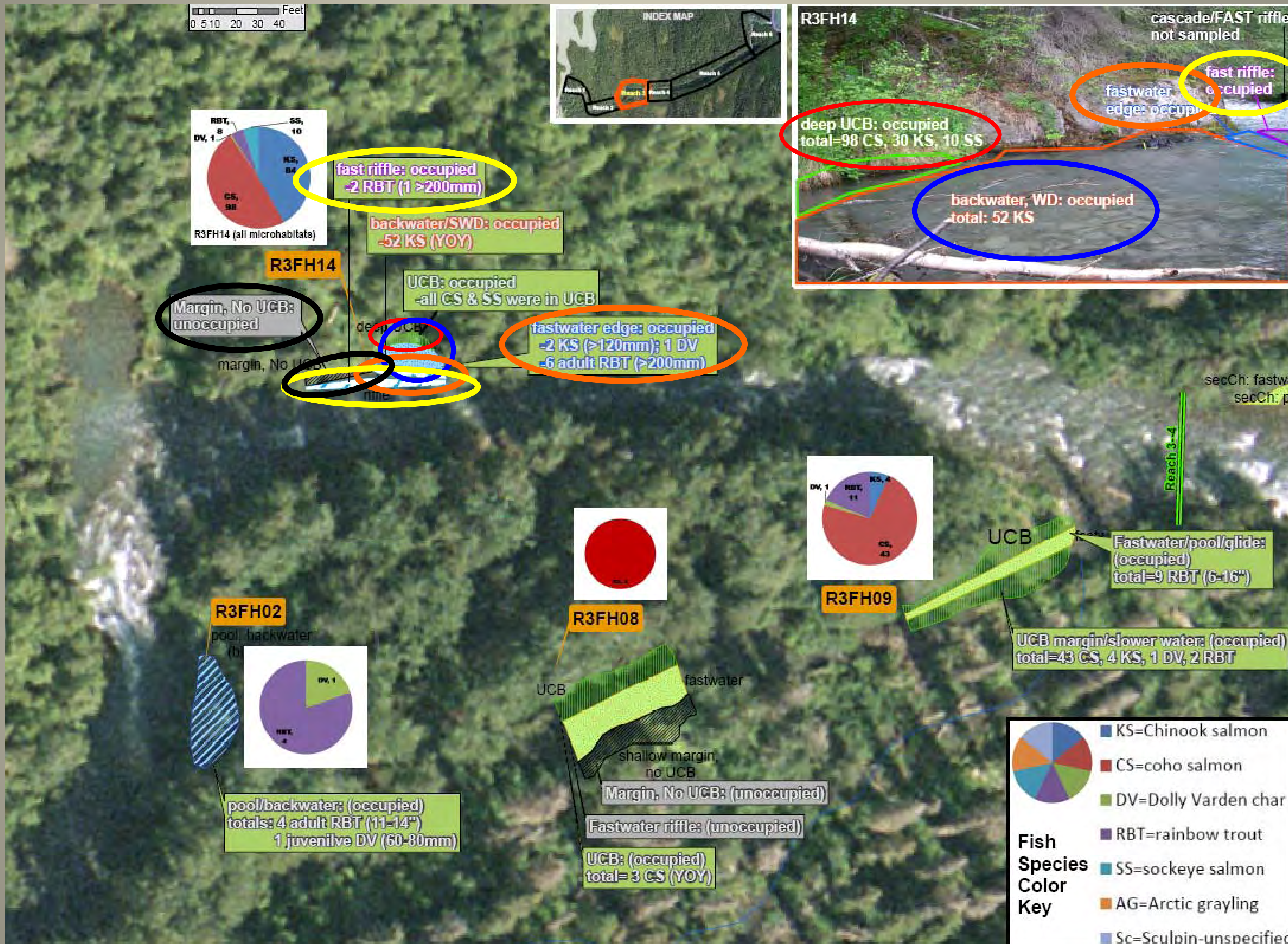
Site 2MT-J August





Reach 2: primarily fastwater riffle with few pools (meso-habitat level)

JUVENILE & RESIDENT FISH HABITAT USE: RESULTS - REACH 3

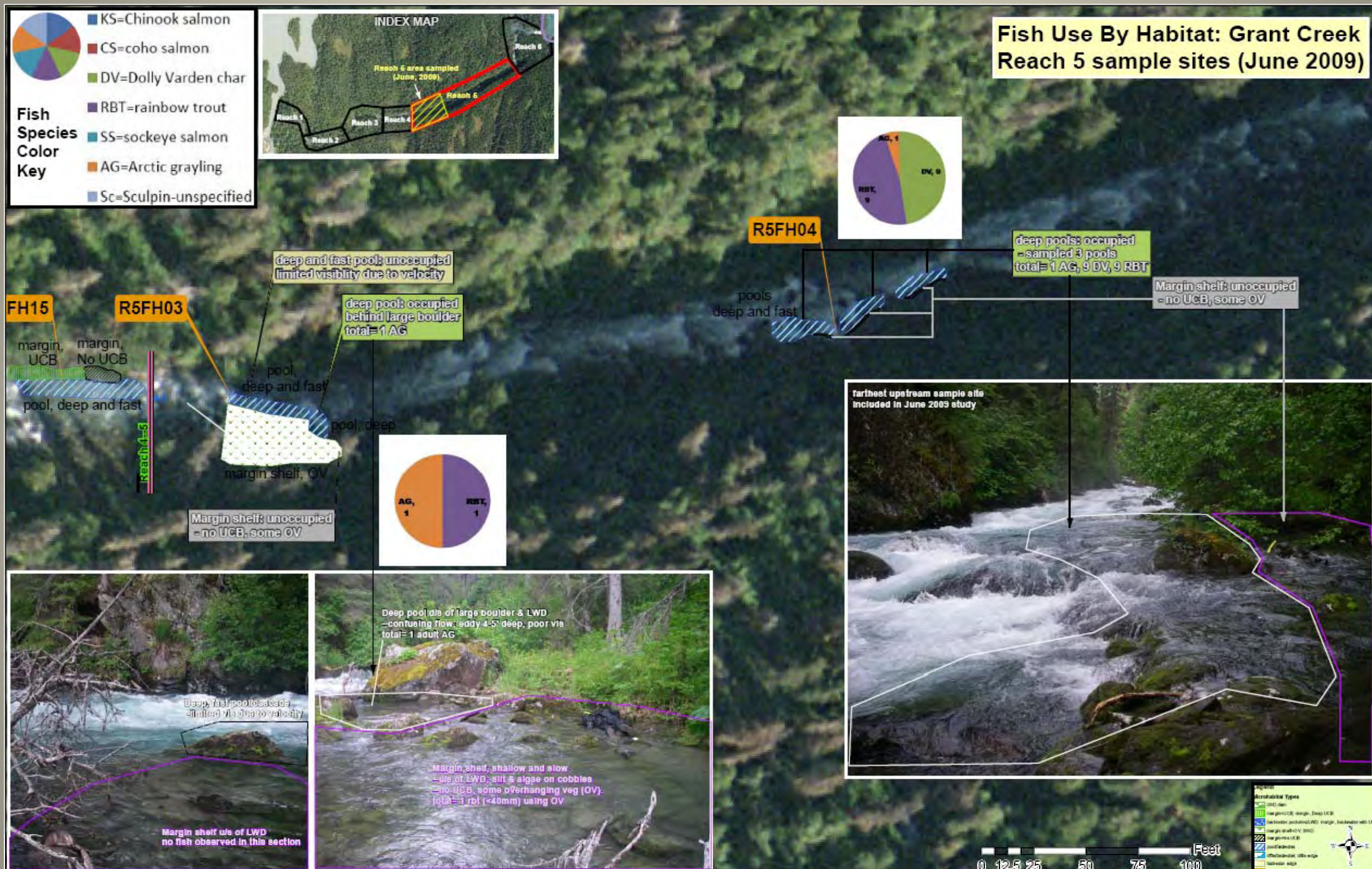


Reach 3: primarily fastwater riffle and pools (meso-habitat); *also has a secondary and tertiary channel*

JUVENILE & RESIDENT FISH HABITAT USE
RESULTS – **REACH 4**

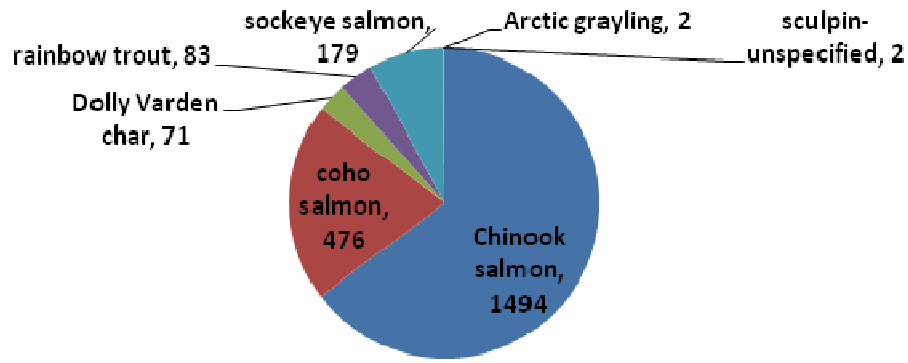
Reach 4: primarily fastwater riffle with few pools (at the meso-habitat level)

JUVENILE & RESIDENT FISH HABITAT USE: RESULTS - REACH 5



Reach 5: primarily fastwater cascade, deep pools also present, note extent of sample area

JUVENILE & RESIDENT FISH HABITAT USE
RESULTS – ALL SAMPLE SITES

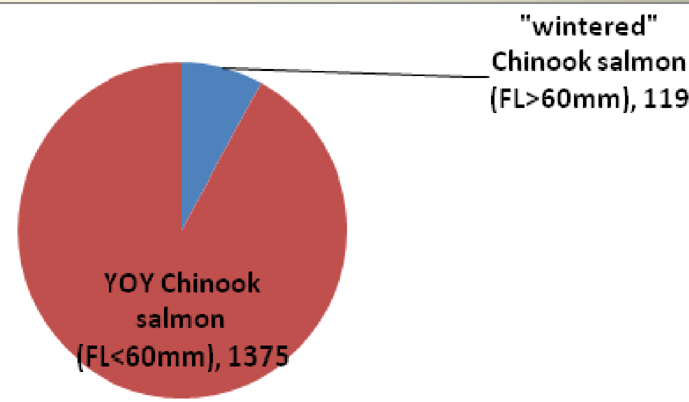


Species Composition and Relative Abundance, June 2009

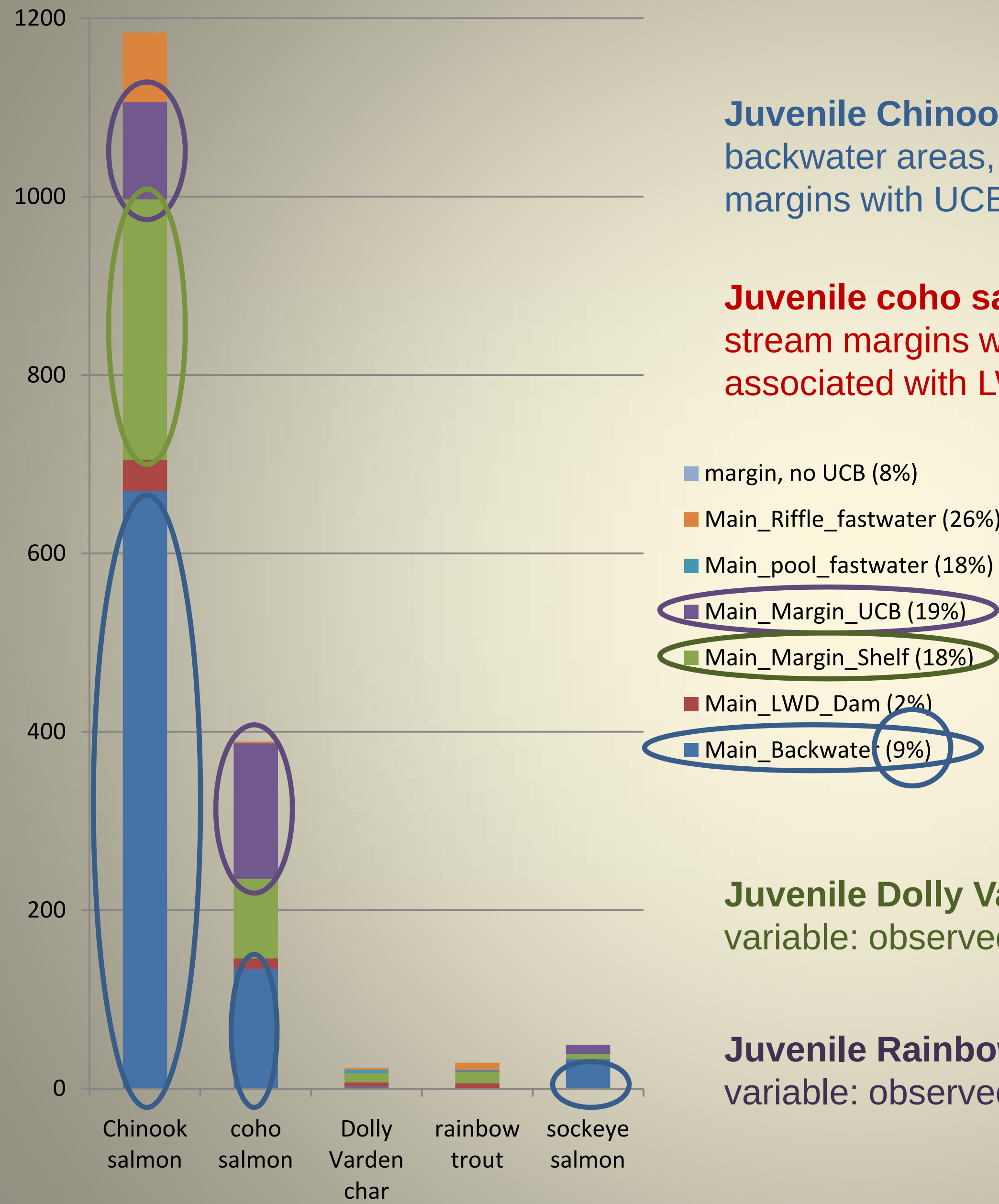
All juvenile salmon were young of the year, except Chinook salmon

Chinook salmon (FL>60mm) likely overwintered in Grant Creek

Chinook salmon ages, June 2009



MICROHABITATS OCCUPIED BY JUVENILE FISH, MAIN CHANNEL, IN JUNE 2009 (PRELIMINARY RESULTS)



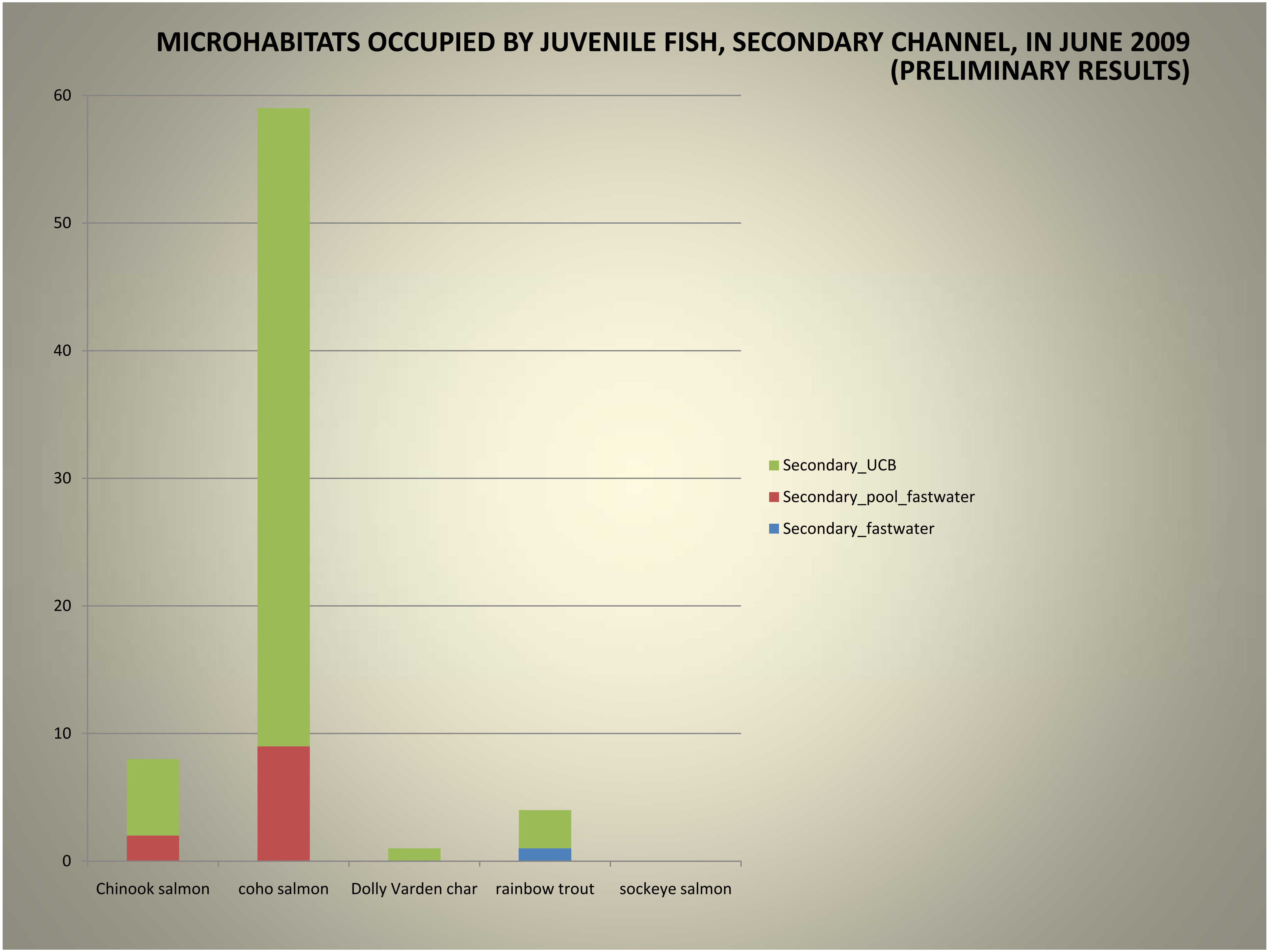
Juvenile Chinook salmon:
backwater areas, margin shelf associated with LWD, stream margins with UCB

Juvenile coho salmon:
stream margins with UCB, backwater areas, margin shelf associated with LWD

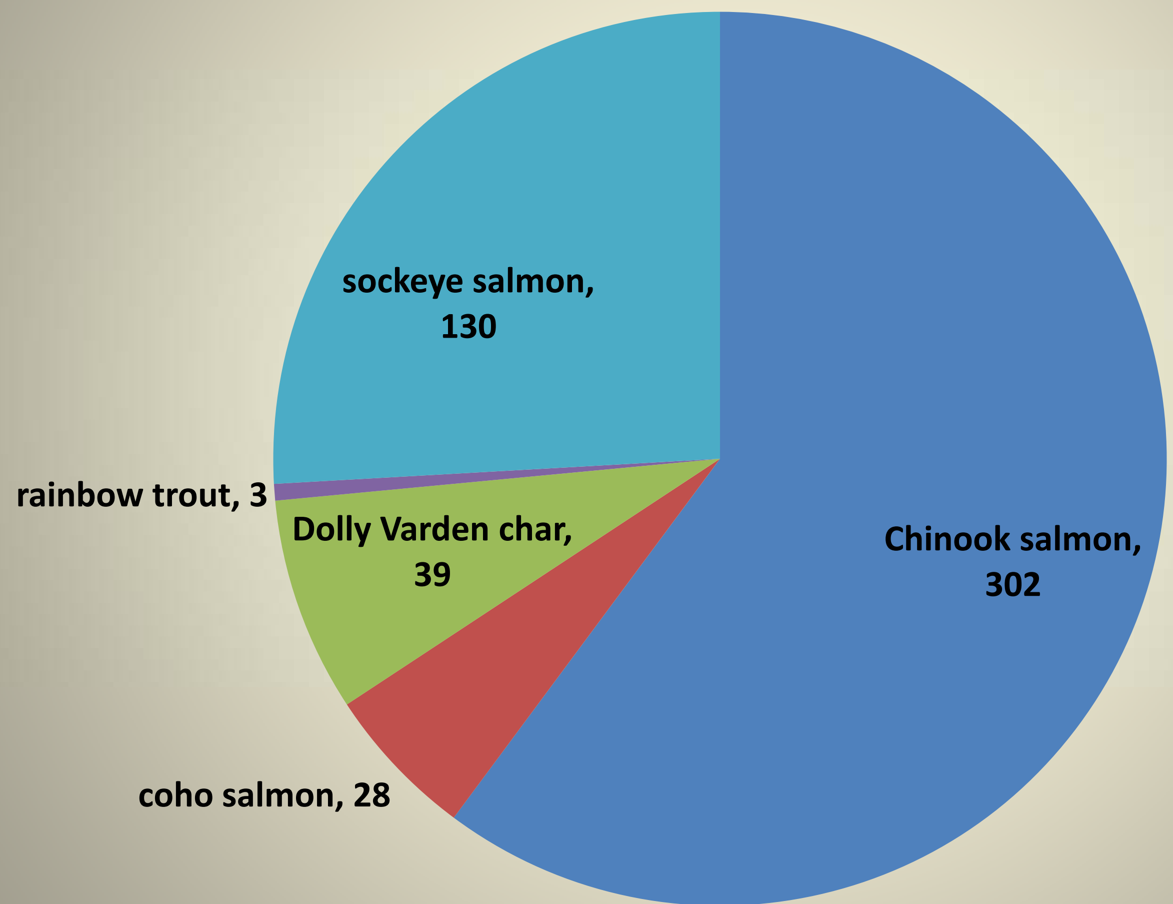
Juvenile sockeye salmon:
backwater areas, stream margins with UCB, margin shelf associated with LWD

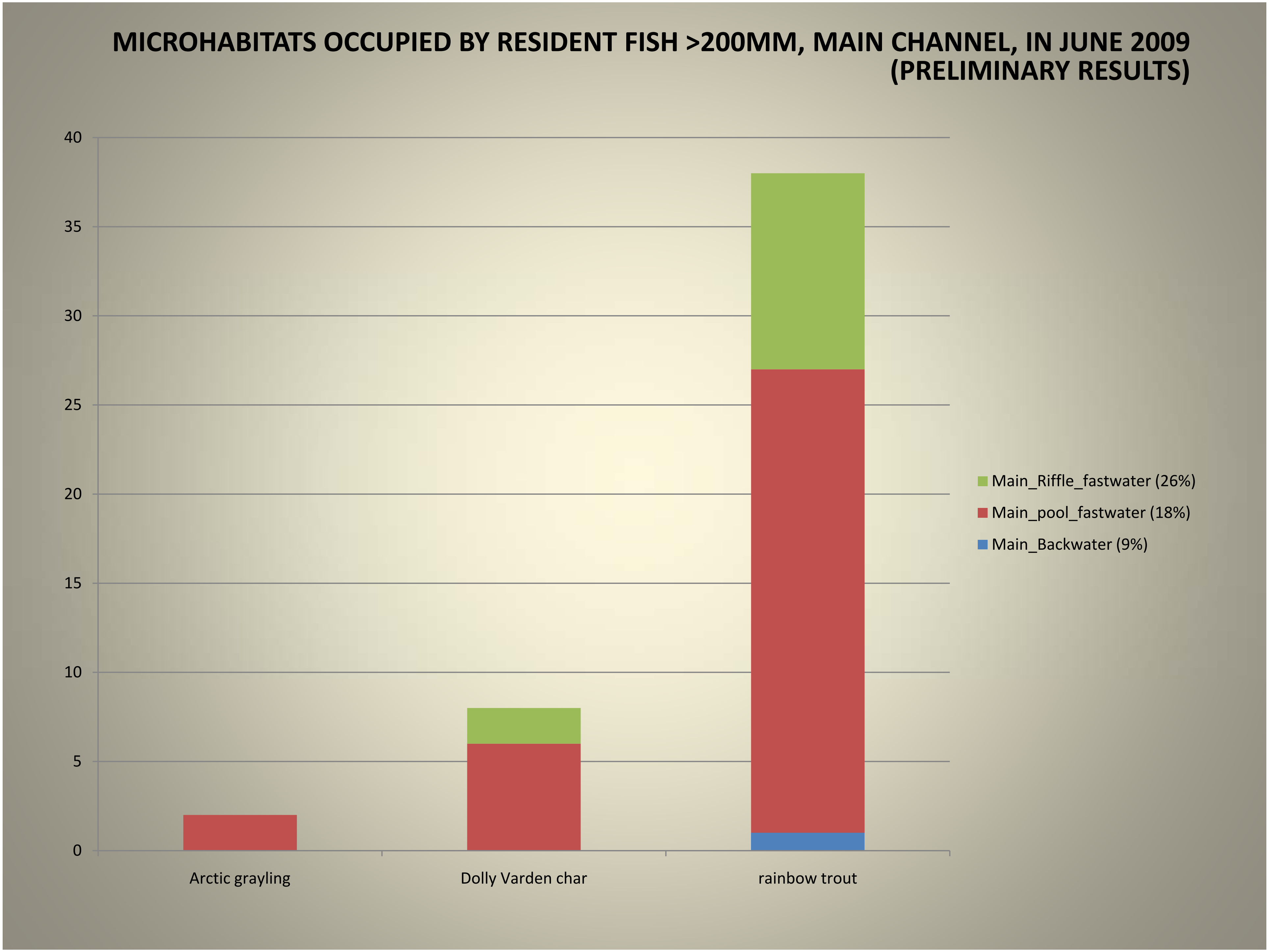
Juvenile Dolly Varden char (<200mm):
variable: observed in 5 of the 7 microhabitats

Juvenile Rainbow Trout (<200mm):
variable: observed in 4 of the 7 microhabitats


MICROHABITATS OCCUPIED BY JUVENILE FISH, SECONDARY CHANNEL, IN JUNE 2009
(PRELIMINARY RESULTS)
60
50
40
30
20
10
0
Chinook salmon
coho salmon
Dolly Varden char
rainbow trout
sockeye salmon
Secondary_UCB
Secondary_pool_fastwater
Secondary_fastwater

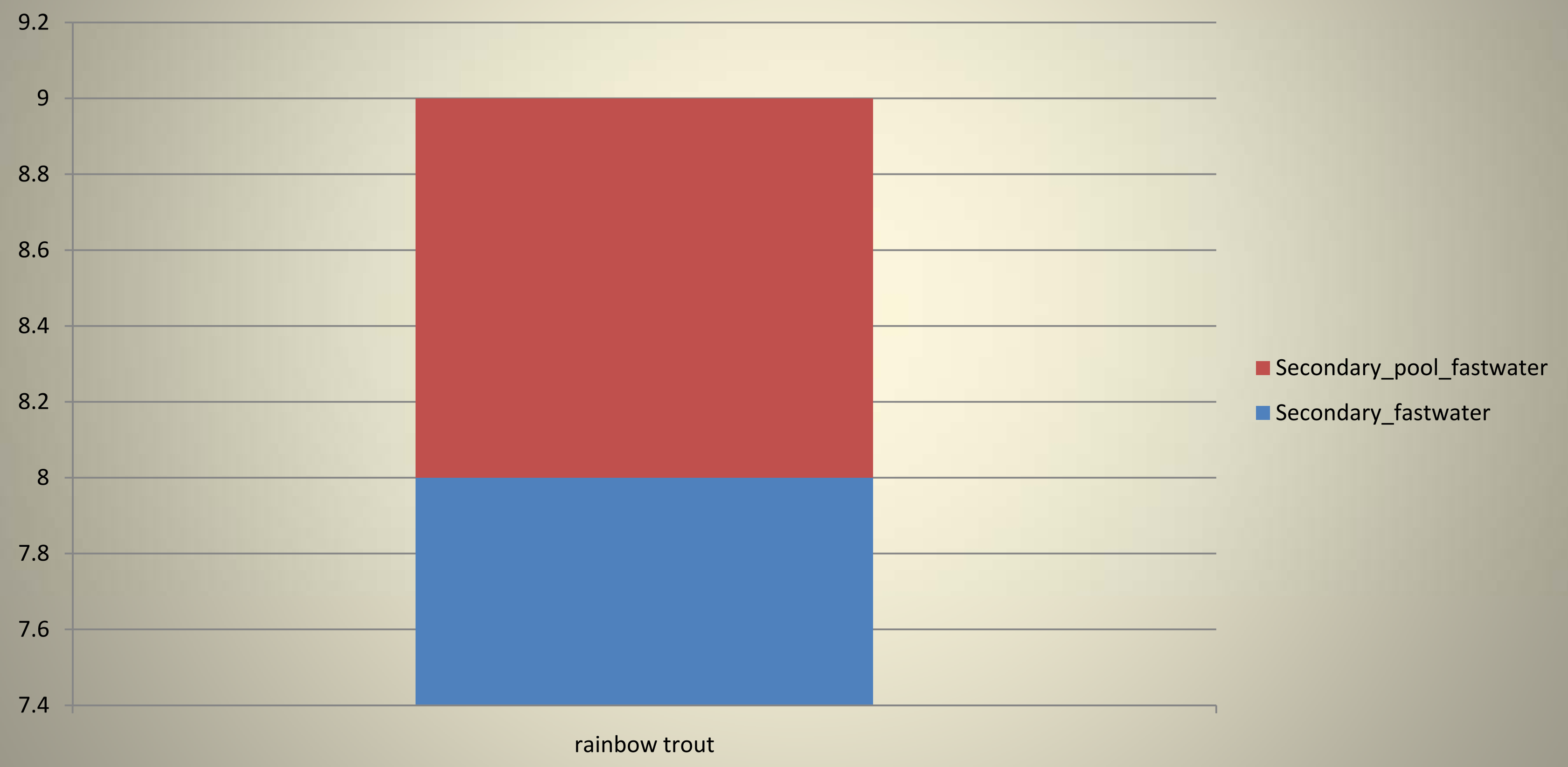
FISH OBSERVED IN DISTRIBUTARY CHANNEL, IN JUNE 2009 (PRELIMINARY RESULTS)





MICROHABITATS OCCUPIED BY RESIDENT FISH >200MM, MAIN CHANNEL, IN JUNE 2009 (PRELIMINARY RESULTS)
40
35
30
25
20
15
10
5
0
Arctic grayling
Dolly Varden char
rainbow trout
Main_Riffle_fastwater (26%)
Main_pool_fastwater (18%)
Main_Backwater (9%)

MICROHABITATS OCCUPIED BY RESIDENT FISH >200MM, SIDE CHANNELS, IN JUNE 2009 (PRELIMINARY RESULTS)



MICROHABITATS OCCUPIED BY REARING AND RESIDENT FISH IN JUNE 2009, (PRELIMINARY RESULTS)

Sample Site Locations	"Sample Areas"	Typical Characteristics
Main Channel	Pool/fastwater	Deep and fast, typically midchannel
	Riffle/fastwater	Fast, typically michannel and margins
	Margin with undercut bank	Stream margin with undercut bank; typically along fastwater in main channel
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	Margin shelf with LWD	Shallow, wide stream margin with some overhanging vegetation or other instream cover
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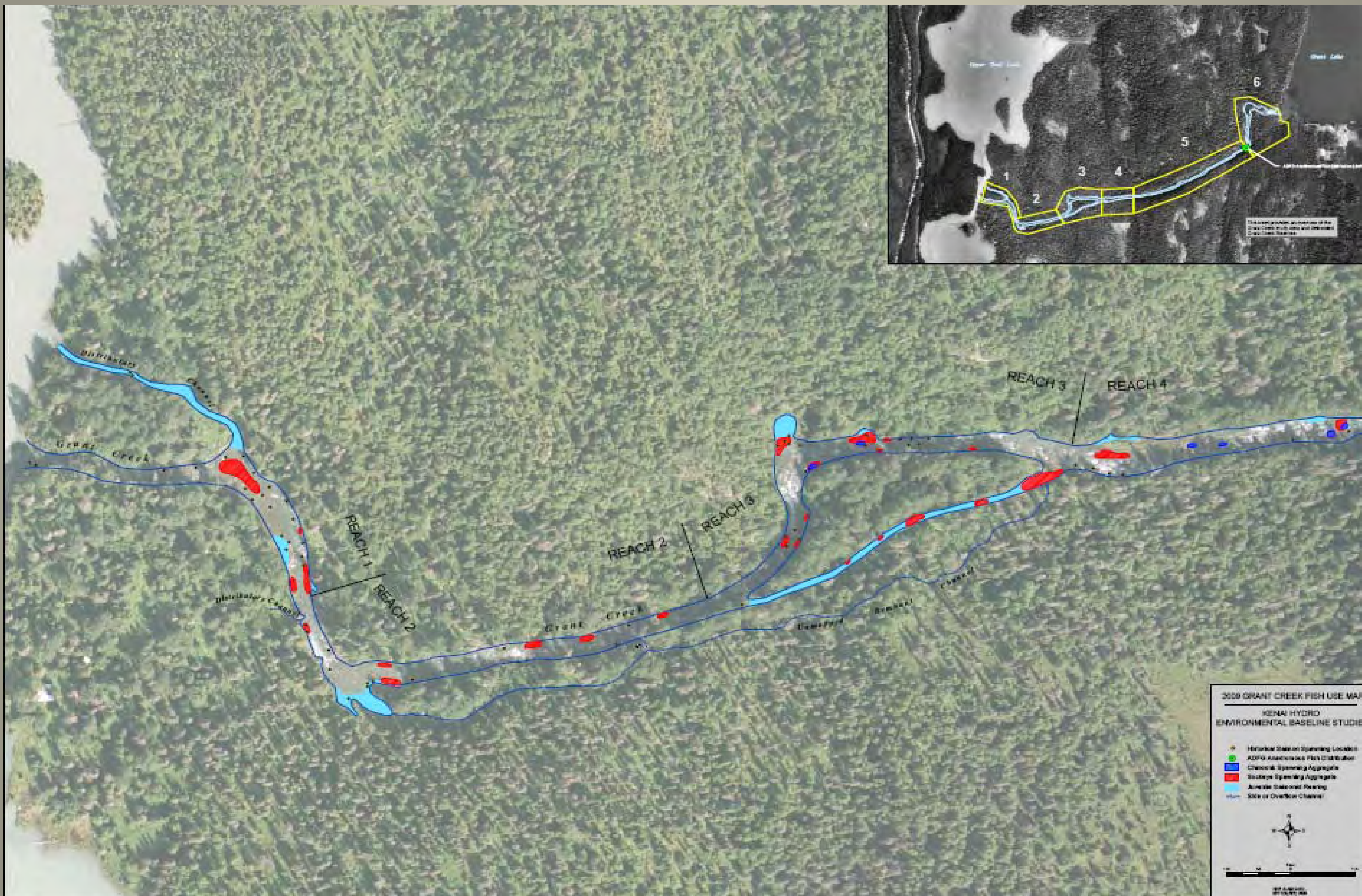
	Backwater pocket	Small backwater/low velocity areas, can be located along stream margin near velocity break
Secondary Channels	Distributary	Variable microhabitat & depth/flow regimes, all microhabitats present (Reach 1)
	Secondary	Typically includes margins with undercut bank, margins without undercut bank, and faster velocity areas in the midchannel. (Reach 3)
	Tertiary	Variable microhabitats (Reach 3)

Grant Creek, Juvenile Rearing and Spawning Use



SYNOPSIS OF 1986-1987 GRANT CREEK INSTREAM FLOW STUDY

KENAI HYDRO, INC.

Grant Lake
Hydroelectric
Project
FERC No. 7633-002

Additional Information
Final Report
with

Agency License Terms and Conditions
for
Selected Alternative I
and

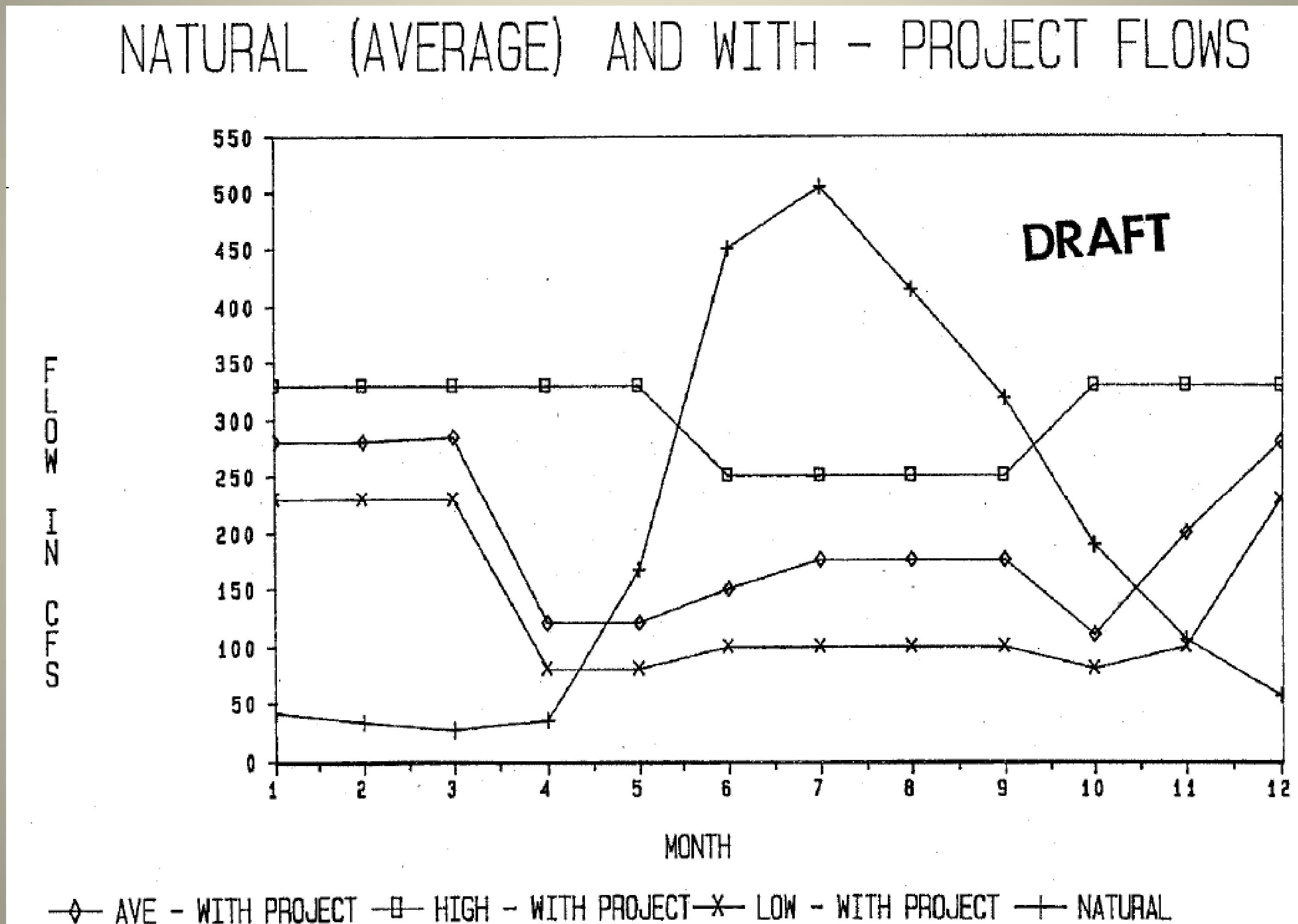
Power Contract Information

September 4, 1987

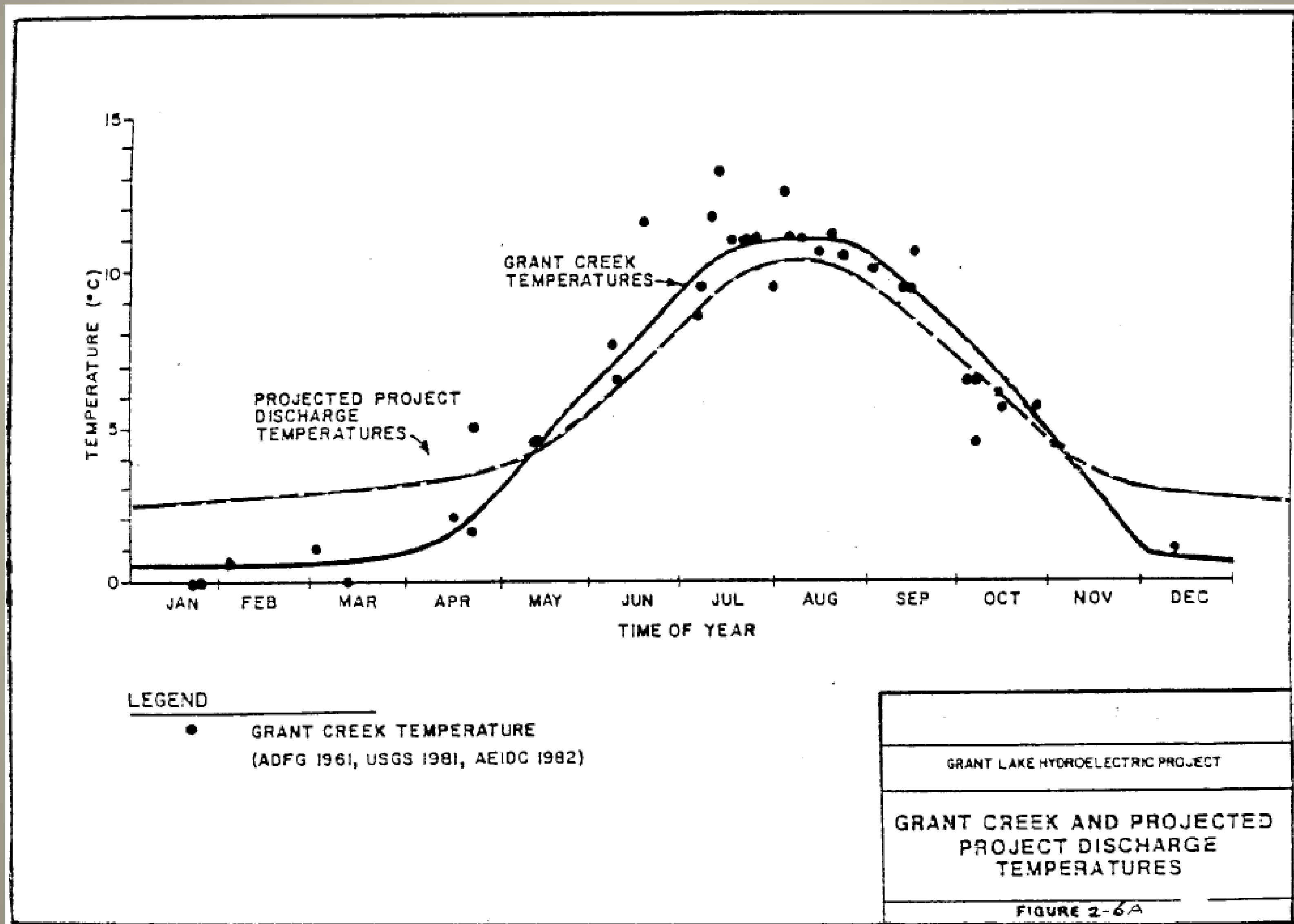
SUMMARY OF 1987 GRANT CREEK INSTREAM FLOW STUDY

- Description of Proposed Project
  - Kenai Hydro Inc. in the 1980’s (no relation to current Kenai Hydro , LLC)
  - Proposed powerhouse at bottom of canyon reach
  - Multi-level intake, load following
- Negotiated MIF and ramping rates with Agencies
  - MIF ranging from 50 cfs Nov through April to 100 cfs June through mid-October
  - Ramping rates to minimize stranding of juveniles
  - Multi-level intake structure and temperature monitoring to mitigate for temperature impacts

PROPOSED HYDROLOGIC IMPACT



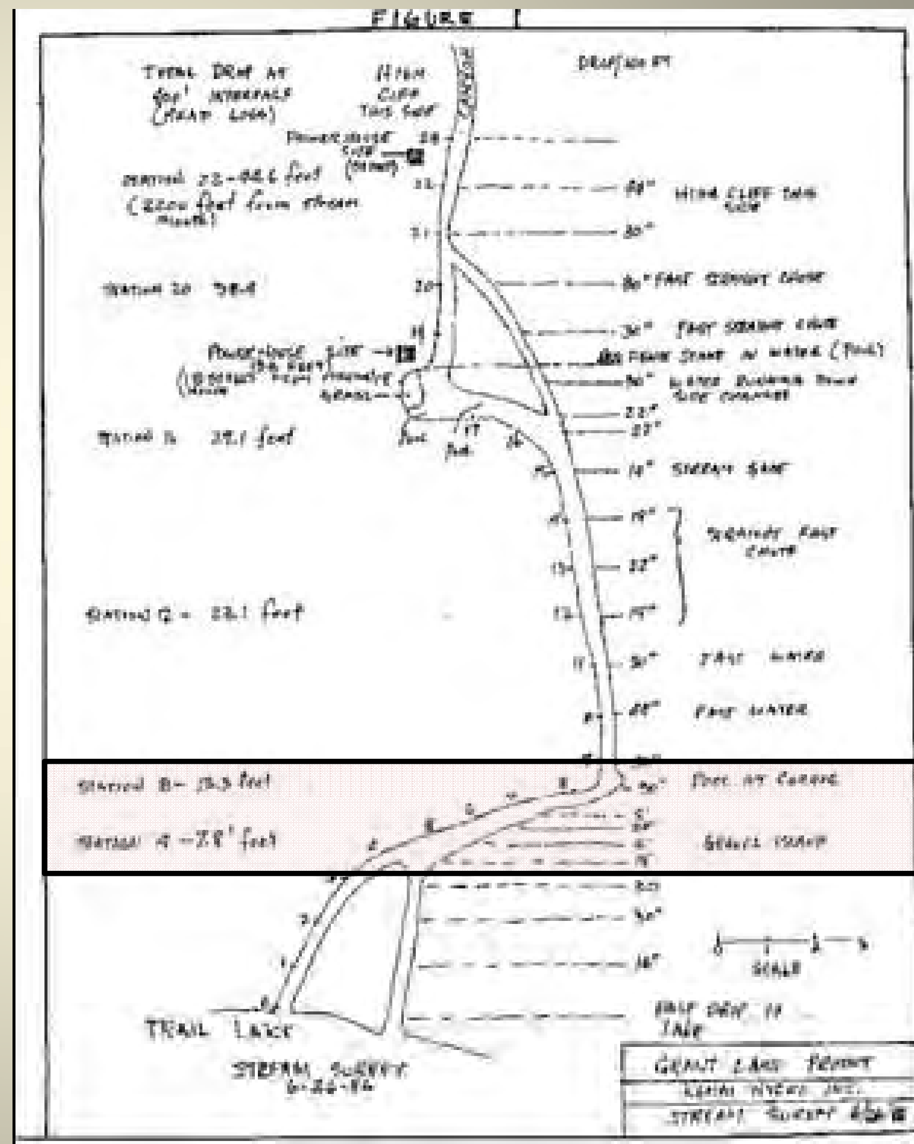
PROPOSED TEMPERATURE IMPACT



1987 GRANT CR. INSTREAM FLOW STUDY

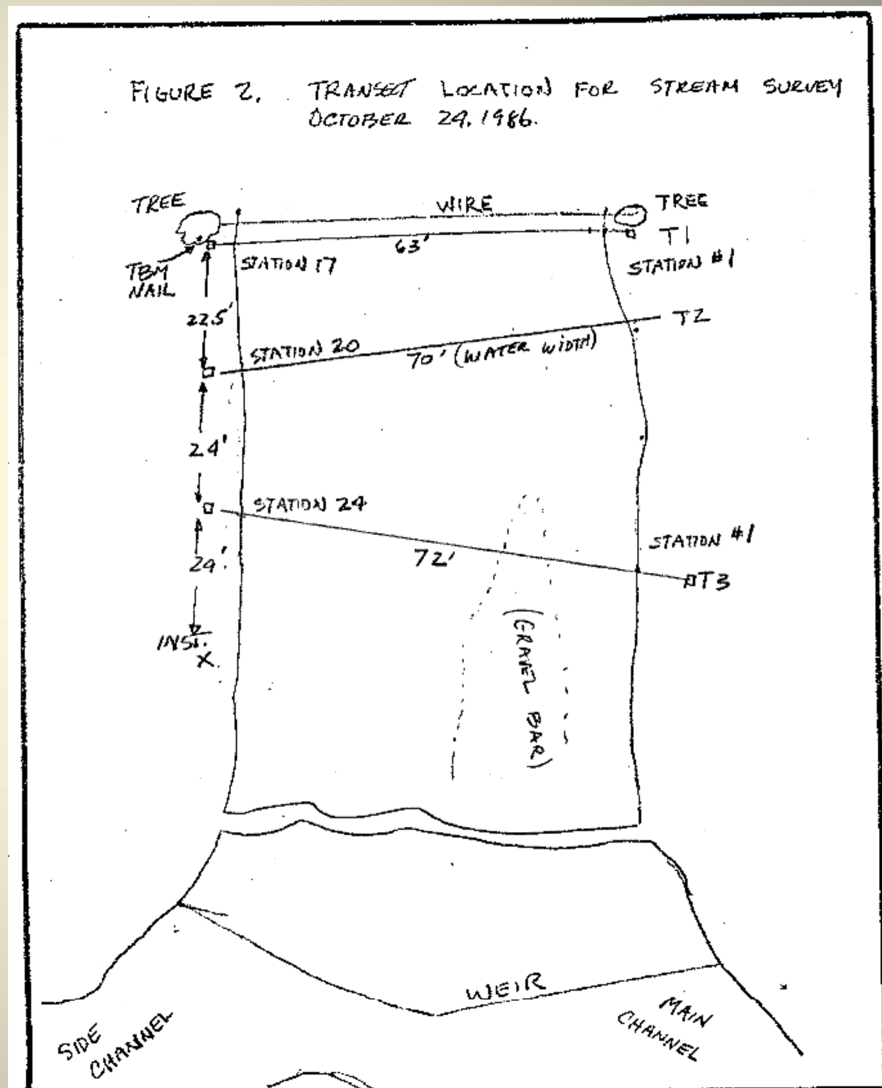
- KHI conducted stream habitat survey in June 1986

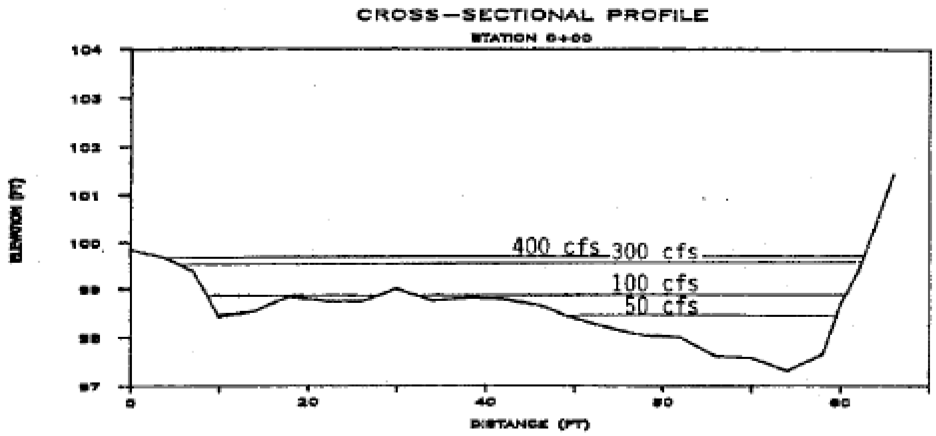
- Work Group of agency staff (ADFG, USFWS, NMFS) determined Stations 4-8 were “most critical reach of the stream” due to spawning activity

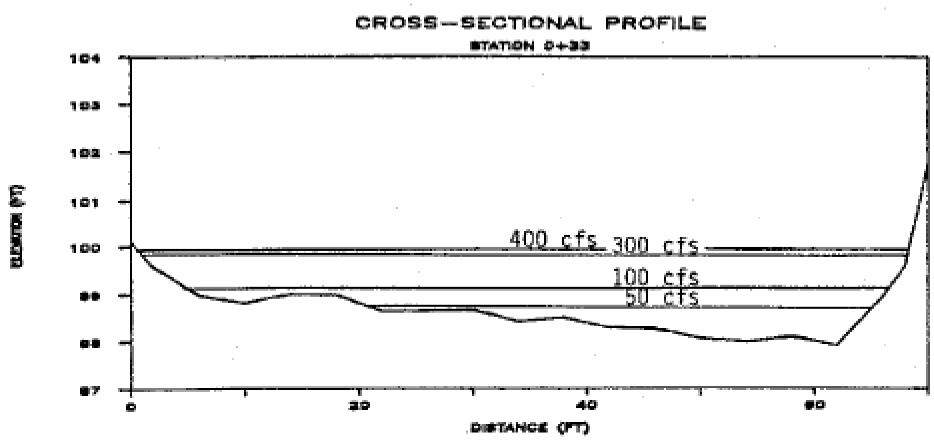


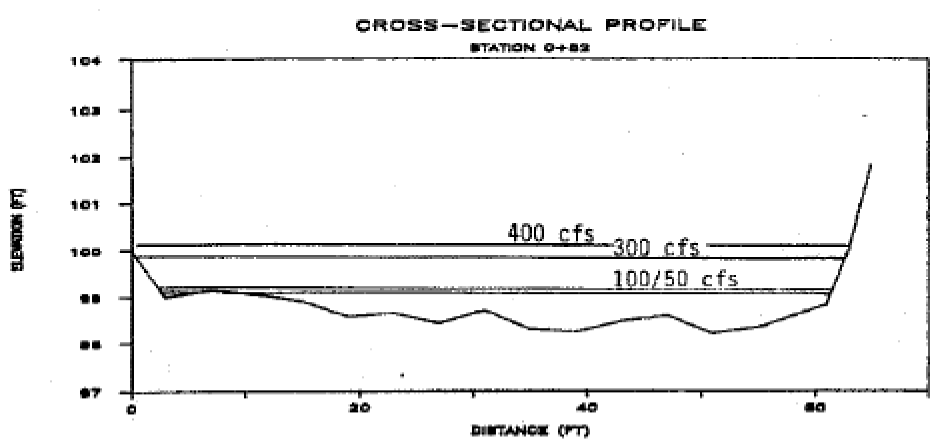
1987 GRANT CR. INSTREAM FLOW STUDY

- October 1986, three cross sections measured using PHABSIM-type methodology.
- Targeted spawning habitat
- Measured flow ~ 250 cfs
- Used WSP/HABTAT models – components of modern PHABSIM
- Simulated 50-450 cfs




CROSS—SECTIONAL PROFILE
STATION 0+00
ELEVATION (FT)
DISTANCE (FT)
400 cfs
300 cfs
100 cfs
50 cfs
104
103
102
101
100
99
98
97
0
20
40
60
80


CROSS—SECTIONAL PROFILE
STATION 0+33
ELEVATION (FT)
DISTANCE (FT)
400 cfs
300 cfs
100 cfs
50 cfs
104
103
102
101
100
99
98
97
0
20
40
60


CROSS—SECTIONAL PROFILE
STATION 0+82
ELEVATION (FT)
DISTANCE (FT)
400 cfs
300 cfs
100/50 cfs
104
103
102
101
100
99
98
97
0
20
40
60

1987 GRANT CR. INSTREAM FLOW STUDY

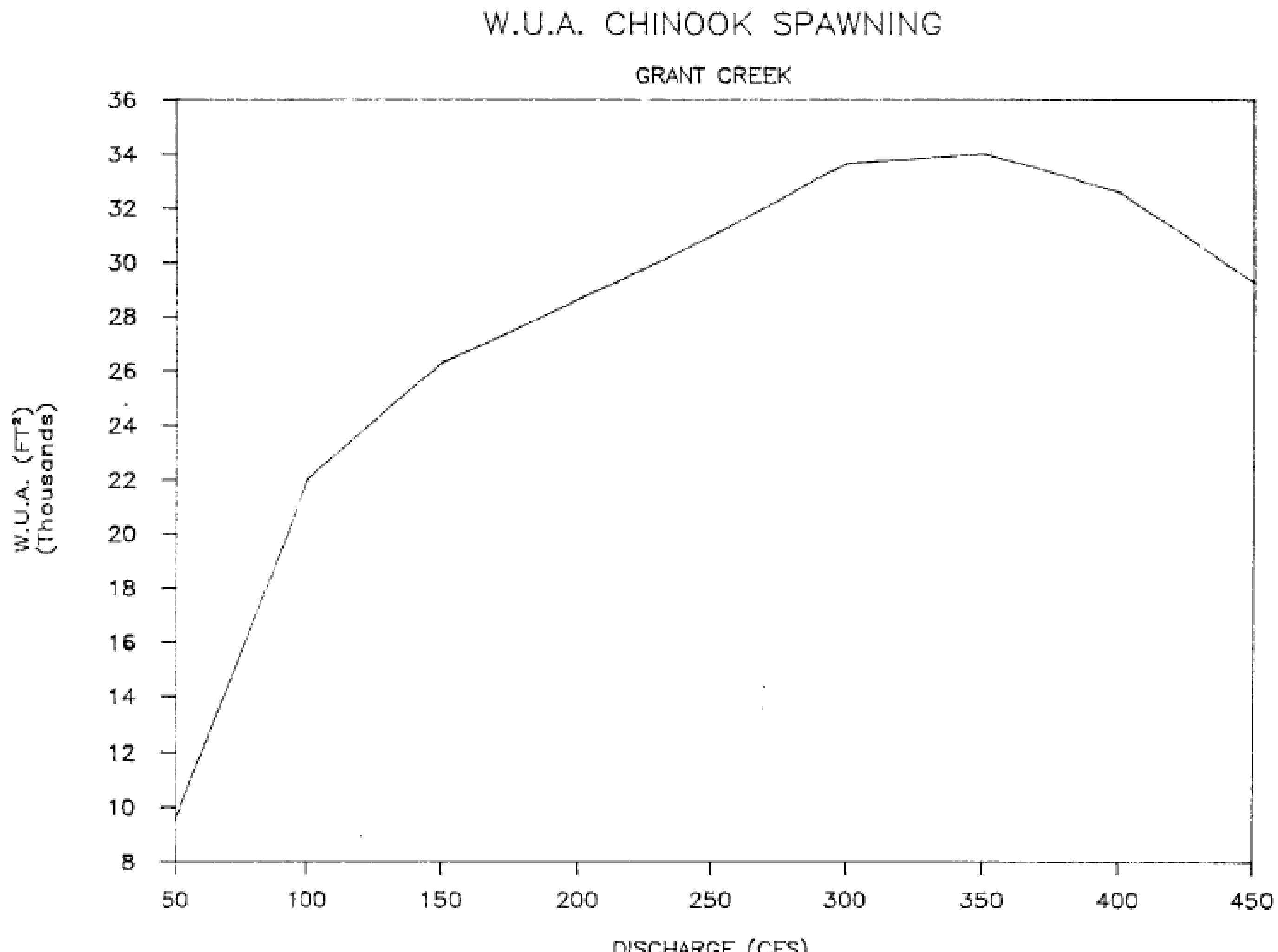
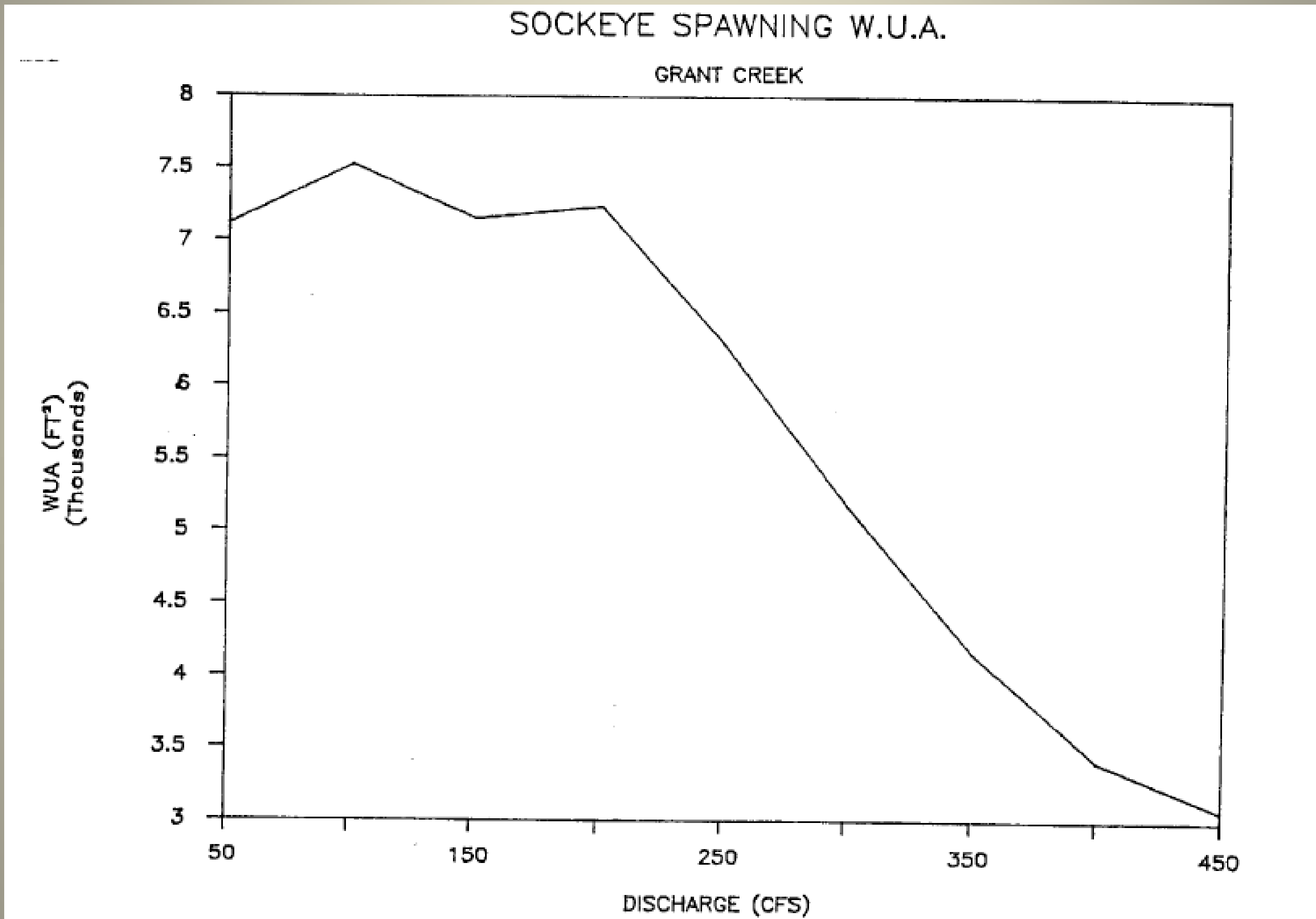
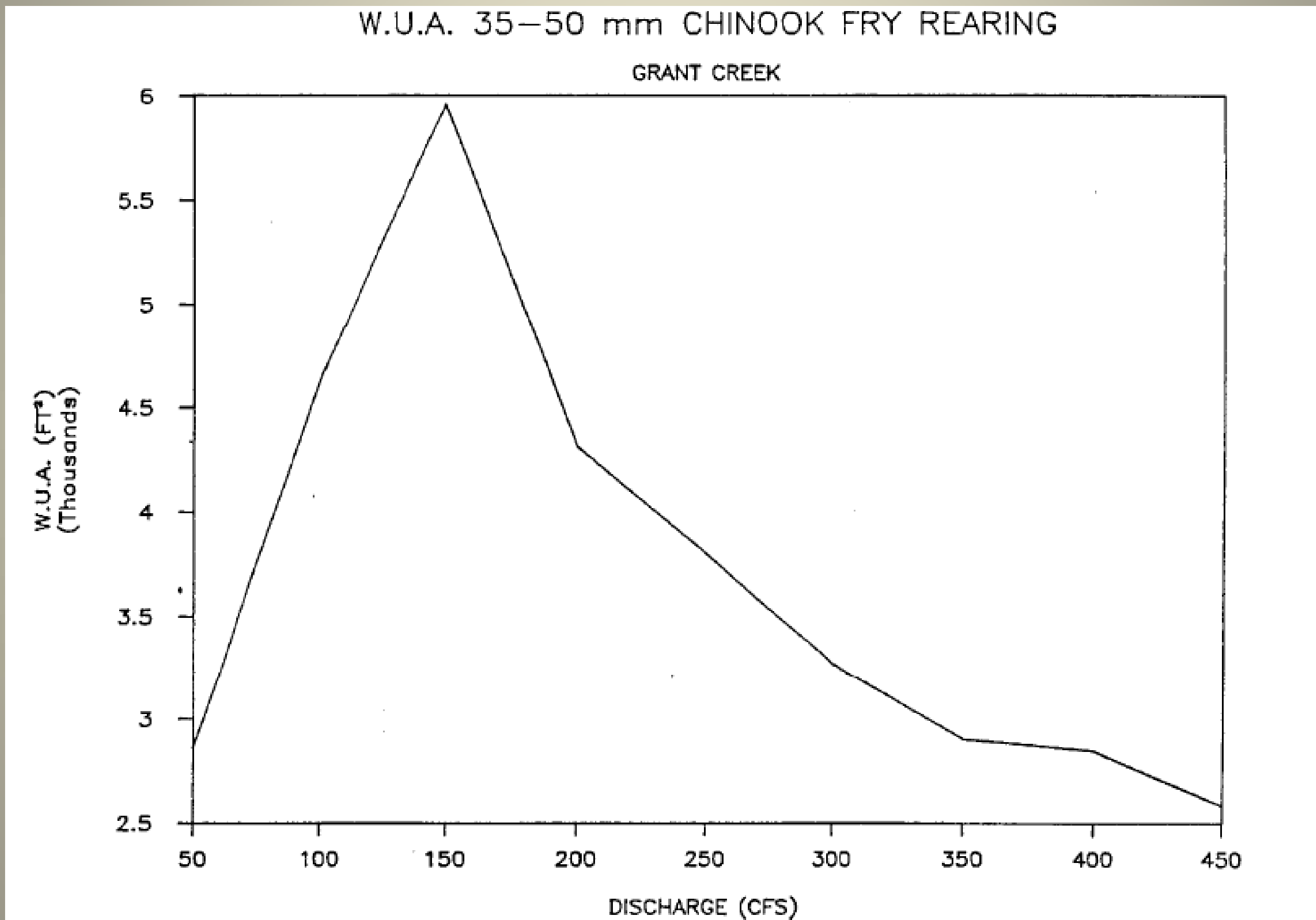


FIGURE 6. WEIGHTED USABLE AREA (WUA) FOR SPAWNING CHINOOK SALMON IN GRANT CREEK

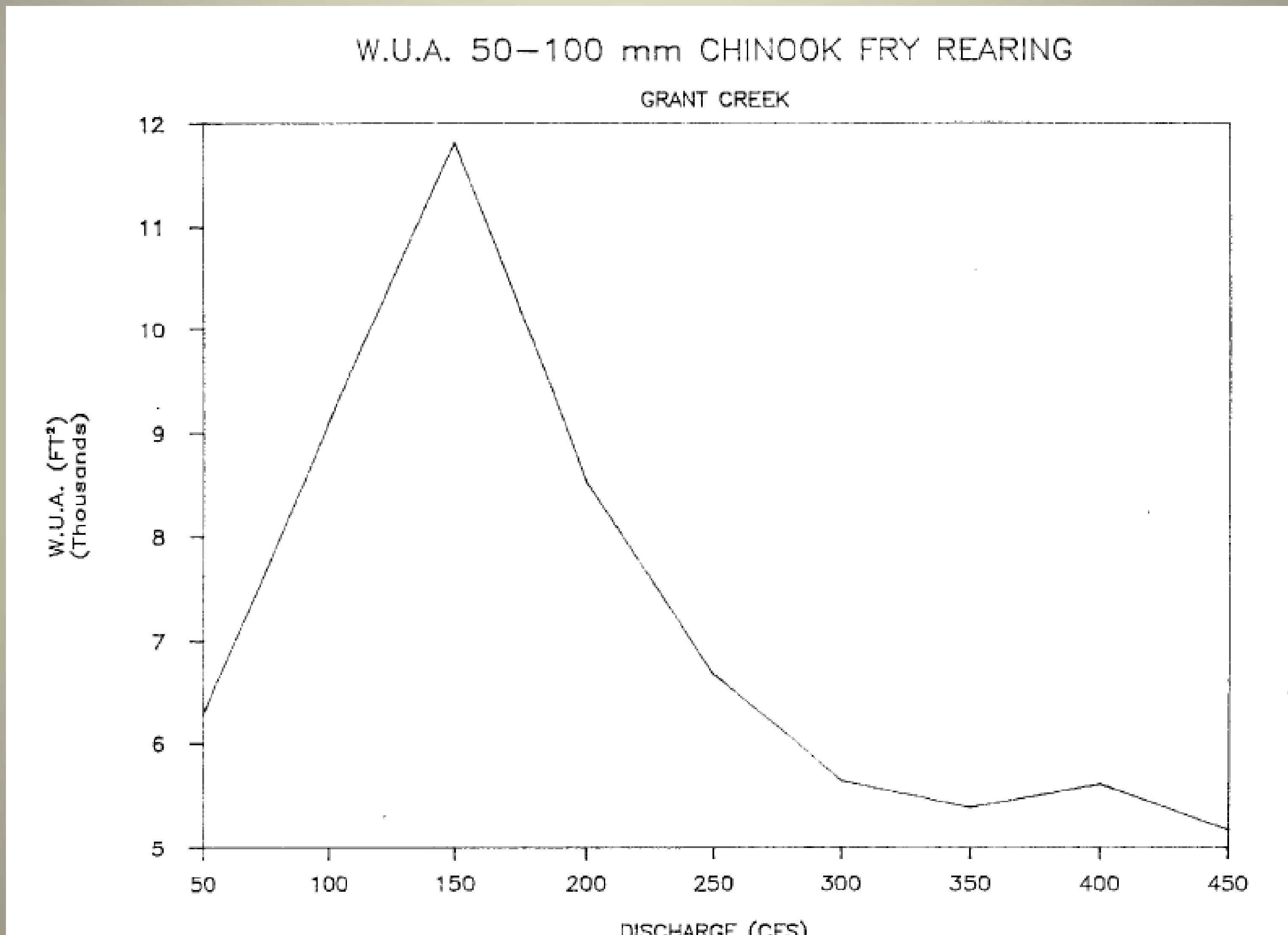
1987 GRANT CR. INSTREAM FLOW STUDY



1987 GRANT CR. INSTREAM FLOW STUDY



1987 GRANT CR. INSTREAM FLOW STUDY



1987 GRANT CR. INSTREAM FLOW STUDY

- Conclusions
  - Chinook spawning – peaks at 350 cfs; 70% at 150 cfs
  - Sockeye spawning – peaks 50-175 cfs
  - <50 mm fry – peaks at 150 cfs; sharp drop <100 cfs
  - 50-100 mm fry – peak 100-350 cfs; sharp drop <100 cfs

  - Study targeted spawning habitat only
  - Included low-level stranding analysis

LIMITATIONS OF 1987 GRANT CR. INSTREAM FLOW STUDY

- 3 cross sections measured at key spawning habitat – does not directly address utilized rearing habitat units
- Flow rate dropped 21% during measurements or error in collection of velocities
- One flow rate measured at 250 cfs – too high for applying to low flow conditions
- Study cannot be extrapolated upward because bank geometry was not surveyed

LIMITATIONS OF 1987 GRANT CR. INSTREAM FLOW STUDY

- Habitat Suitability Criteria
  - Derived primarily from Burger et al. (1983)[1] and Estes and Vincent-Lang (1984)[2] on Kenai River system, with modifications based on other regional habitat suitability studies
  - Spawning depth 1 ft vs. 2 ft
  - Stratification for spawning substrate size
  - Chinook fry surrogate for all salmonid species (RBT, DV, sockeye)

[1] – Burger, C.U., D.B. Wangaard, R.L. Wilmot, and A.N. Palmisano. 1983. Salmon investigations in the Kenai River, Alaska, 1979-1981. USFWS, Nat. Fish. Res. Center, Seattle, Alaska Field Station. Anchorage, AK. 178 pp.

[2] – Estes, C. and D.S. Vincent-Lang, eds. 1984. Report No. 3. Aquatic Habitat and instream flow investigations (May-October 1983). Chapters 7 and 9. Susitna Hydro Aquatic Studies, Alaska Dept. of Fish and Game. Report to the Alaska Power Authority. Anchorage, AK.

RELEVANCY OF 1987 GRANT CR. INSTREAM FLOW STUDY

- Provides generic look at habitat availability as a function of flow
- Provides a check on our assumptions for spawning habitat use and preference
  - Chinook and sockeye run timing align with peaks of spawning WUA curves

RATIONALE FOR PROPOSED INSTREAM FLOW APPROACH

FACTORS INFLUENCING METHOD CHOICE

- Short Length of Stream and Useable Fish Habitat

  No need for sub-sampling or extrapolation

  Specific fish use areas can be feasibly identified

  Allows direct sampling of known fish use areas

- Desire expressed by TWG to focus on fish use limiting factors that are specific to Grant Creek and relate flow alterations to the availability of those factors

- General criticism of traditional methods

  Studies of IFIM/PHABSIM show that results are only weakly related to fish use or biological productivity – labor intensive and expensive

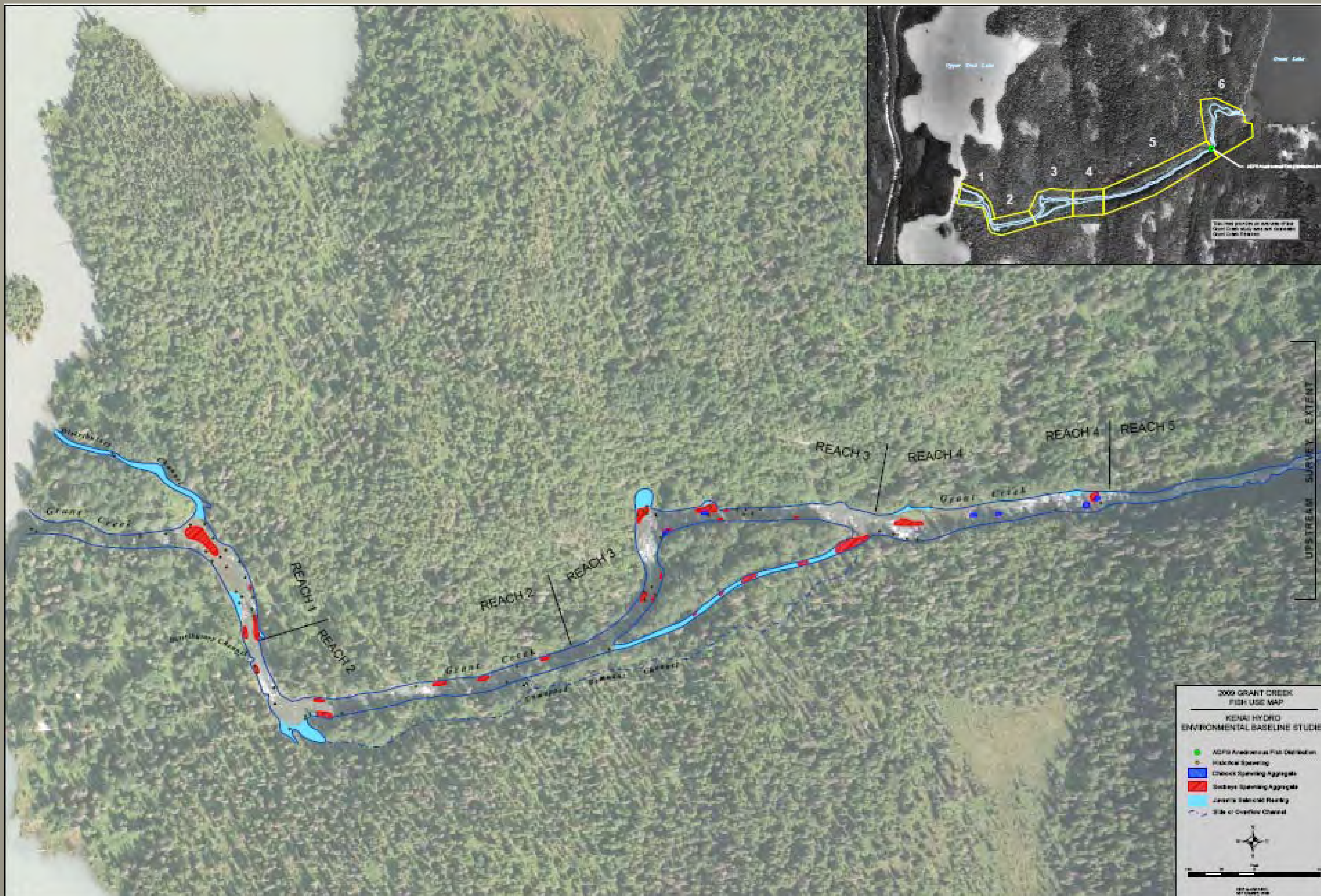
  Expert habitat mapping and habitat criteria mapping subjective and poorly reproducible – cannot predict habitat changes for the full range of flows

FACTORS INFLUENCING METHOD CHOICE (CONT.)

- Difficult working conditions in Grant Creek
  - Steep terrain prevents sub-sampling of all habitat types
  - Not wadeable for much of the year
    - Habitat mapping techniques work best if stream can be waded over a range of flows
    - IFIM depends on repeated measurements at wide range of flows – difficult to accomplish
  - Water turbid much of the year
    - Habitat mapping techniques are most applicable to clear streams

- Most fish use areas in Grant Creek are well defined and limited in surface area

Grant Creek, Juvenile Rearing and Spawning Use



OVERVIEW OF SELECTED APPROACH

- Emphasizes the identification of specific factors driving fish use within known use areas in Grant Creek

- Looks at the potential changes that might occur to fish use factors at each use area under various flow regimes

- In most cases changes are modeled using a single transect to define stream geometry, combined with flow measurements collected as part of the hydrology program

- Additional transects or other specialized measurements may be employed depending on the requirements of the sample site

METHOD COMPONENTS

- Study fish use of Grant Creek – identify use areas and probable site-specific limiting factors affecting that use
- Select key habitat types/fish use categories for consideration
- Select key criteria to be analyzed for each fish use area
- Select range of suitability for each criteria
- Select field sites suitable for analysis for each of the key fish use categories

METHOD COMPONENTS (CONT.)

- Select transect locations within field site
- Collect field data
- Integrate with measured stream flows
- Model changes to key criteria for a range of altered flows

KEY HABITATS FOR INSTREAM FLOW CONSIDERATION

KEY HABITATS FOR INSTREAM FLOW CONSIDERATION

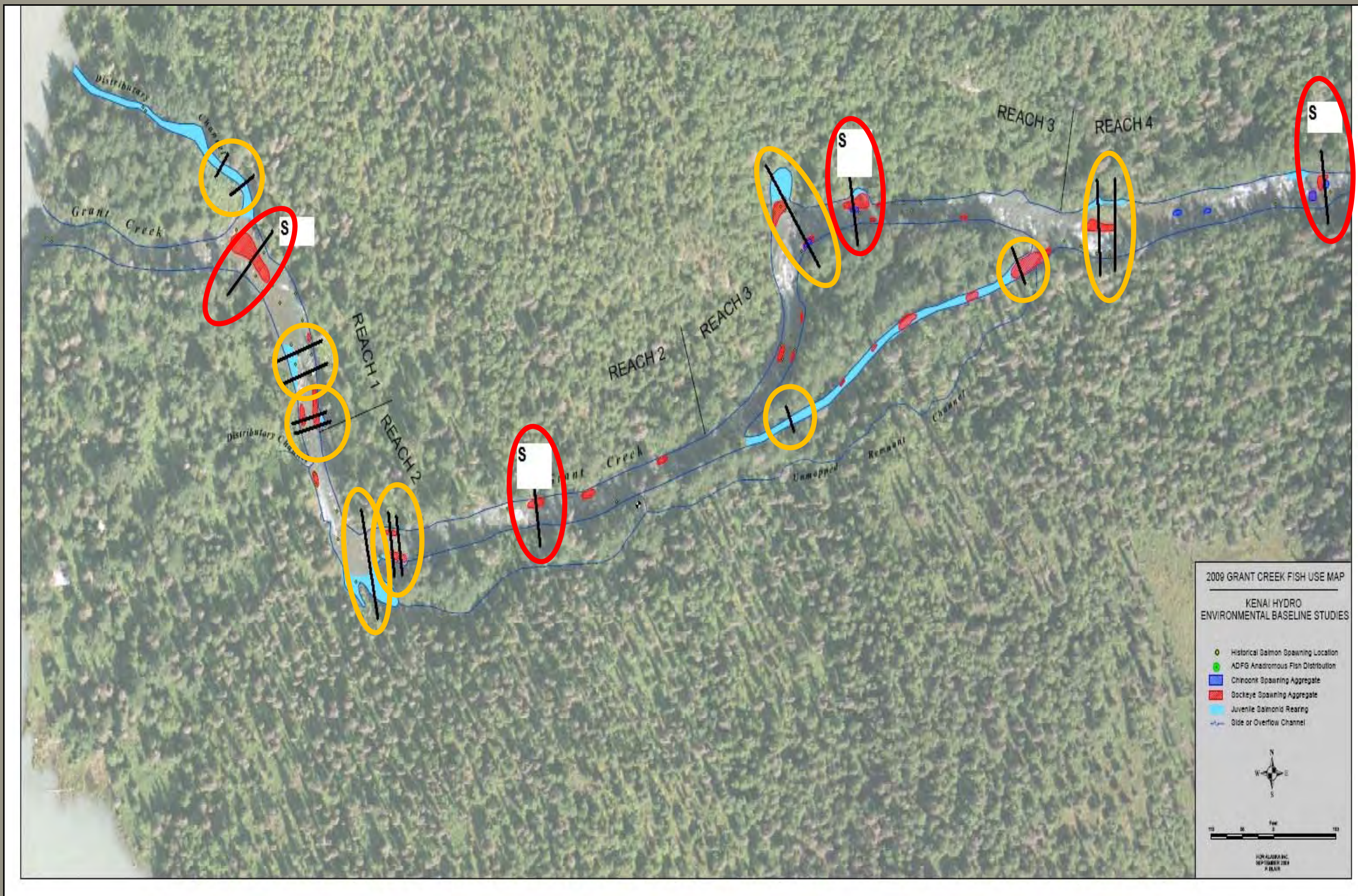
Assumptions

- Individual fish tend to select the most favorable microhabitat conditions from the total range of habitat present
- Fish will use less favorable habitat conditions to a lesser frequency and will eventually leave the area before habitat conditions become lethal
- Individual fish will use more favorable habitats at a greater frequency and are more likely to be observed with those favorable habitats

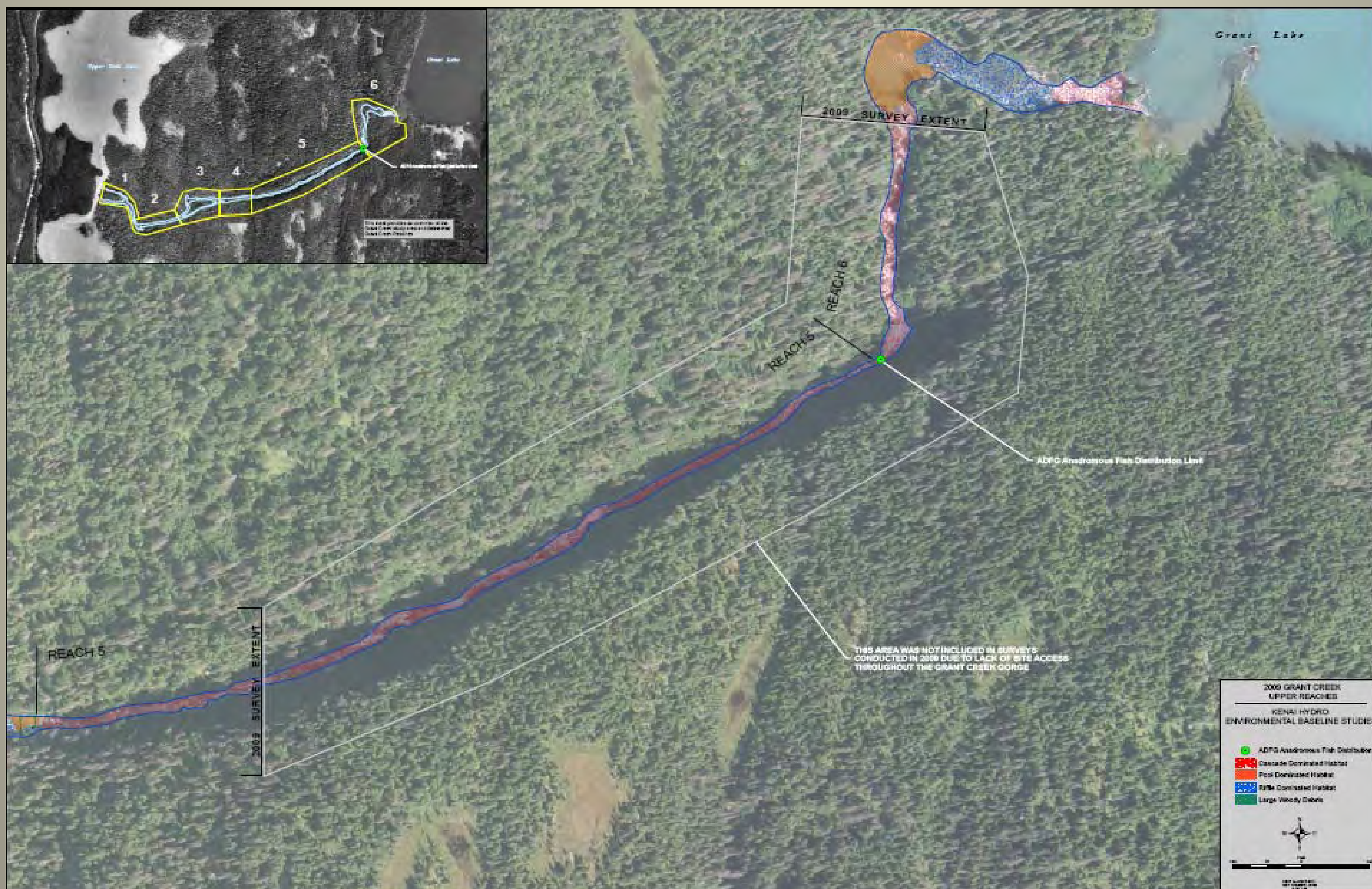
HABITATS FOR INSTREAM FLOW CONSIDERATION

Species & Life Stage	Periodicity	Key Habitat Parameters
Rainbow Trout Spawning	May to early June	Pending additional field study results
Chinook Spawning	Early August to Early September	Depth, Velocity, Substrate Size, Vertical Hydraulic Gradient
Sockeye/Coho Salmon Spawning	Mid August through October	Depth, Velocity, Substrate Size, Vertical Hydraulic Gradient
Adult Resident Feeding	May through November	Pool tail-outs, Riffles
Incubation (salmon)	August through May of following year	Lateral Connectivity, Depth, Substrate Size, Vertical Hydraulic Gradient
Incubation (RBT)	May through July	Lateral Connectivity, Depth, Substrate Size, Vertical Hydraulic Gradient
Juvenile rearing - Side Channel	May through November	Lateral Connectivity, Depth, Velocity , Cover
Juvenile rearing - Backwater Pools	May through November	Lateral Connectivity, Depth, Velocity, Cover
Juvenile rearing - Main Channel	January through December - likely very low in winter months because of reduced flow	Access to undercut bank, instream cover/velocity refugia

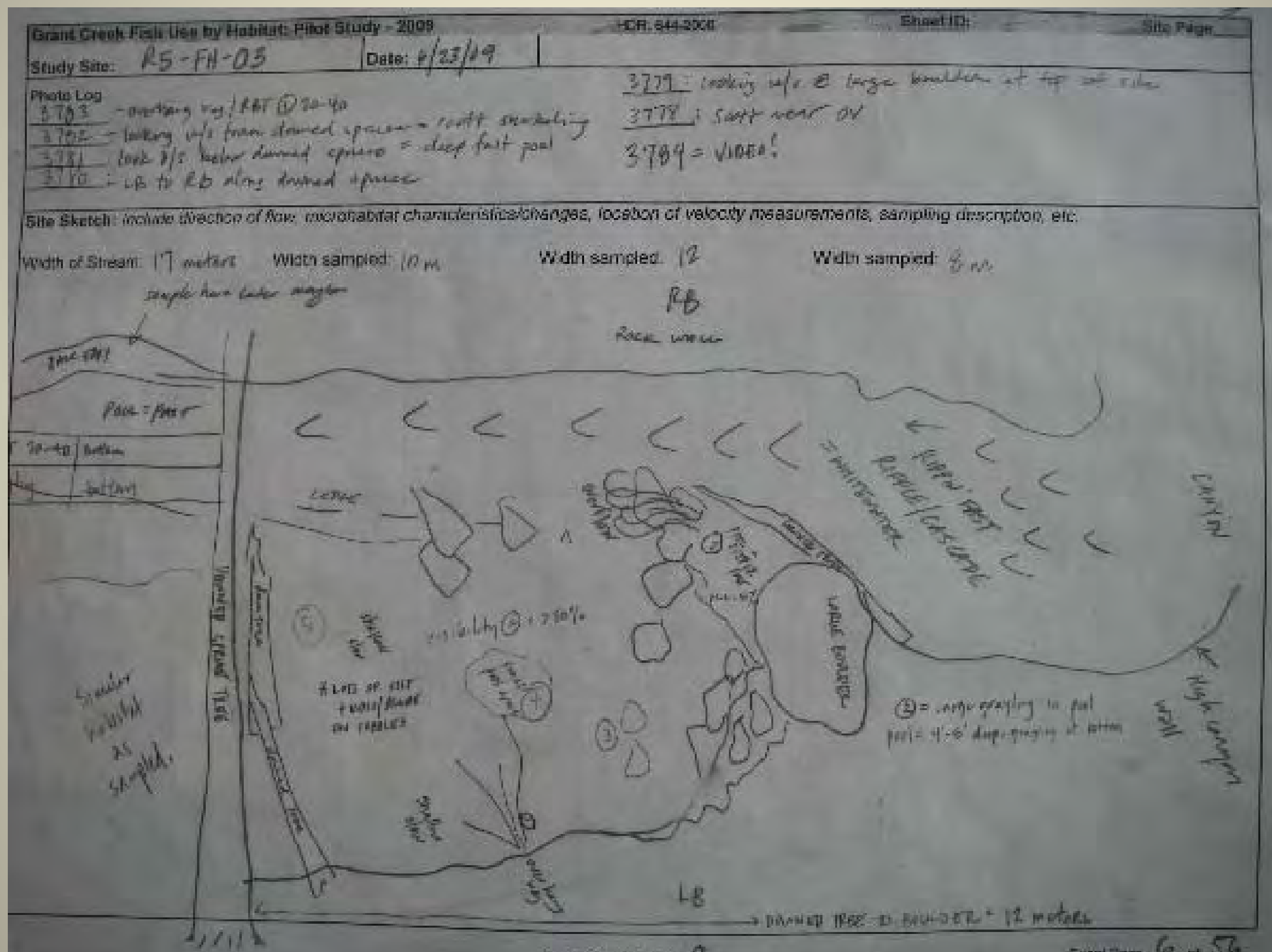
KEY HABITATS FOR INSTREAM FLOW CONSIDERATION
POTENTIAL CROSS SECTION LOCATIONS



REACHES 5 AND 6



DETAILS OF INSTREAM FLOW APPROACH



DETAILS OF INSTREAM FLOW APPROACH

- 4-element approach
  - Lateral habitat connectivity
  - Selection of key microhabitats
  - Spawning bed thermistor strings
  - Lake & stream temperature monitoring

DETAILS OF INSTREAM FLOW APPROACH

Element 1 – Lateral Habitat Connectivity

- Similar to Wetted Perimeter Method
- Targets utilized habitat with known use
- One survey, multiple water surface elevation observations

DETAILS OF INSTREAM FLOW APPROACH

Proposed cross section locations (preliminary)

DETAILS OF INSTREAM FLOW APPROACH

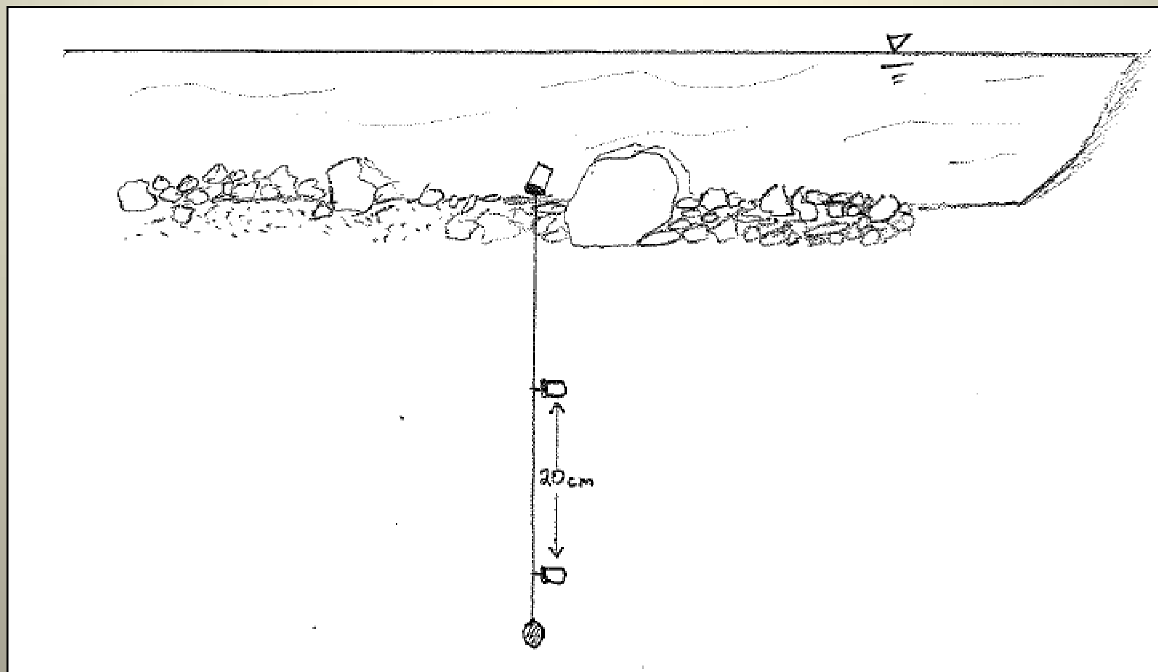
Element 2 – Selection of key microhabitats

- To determine which microhabitat factors are selected by fish in Grant Creek
- Preference curves not required in this approach
- Observations at locations in Element 1

DETAILS OF INSTREAM FLOW APPROACH

Element 3 – Spawning bed thermistor strings

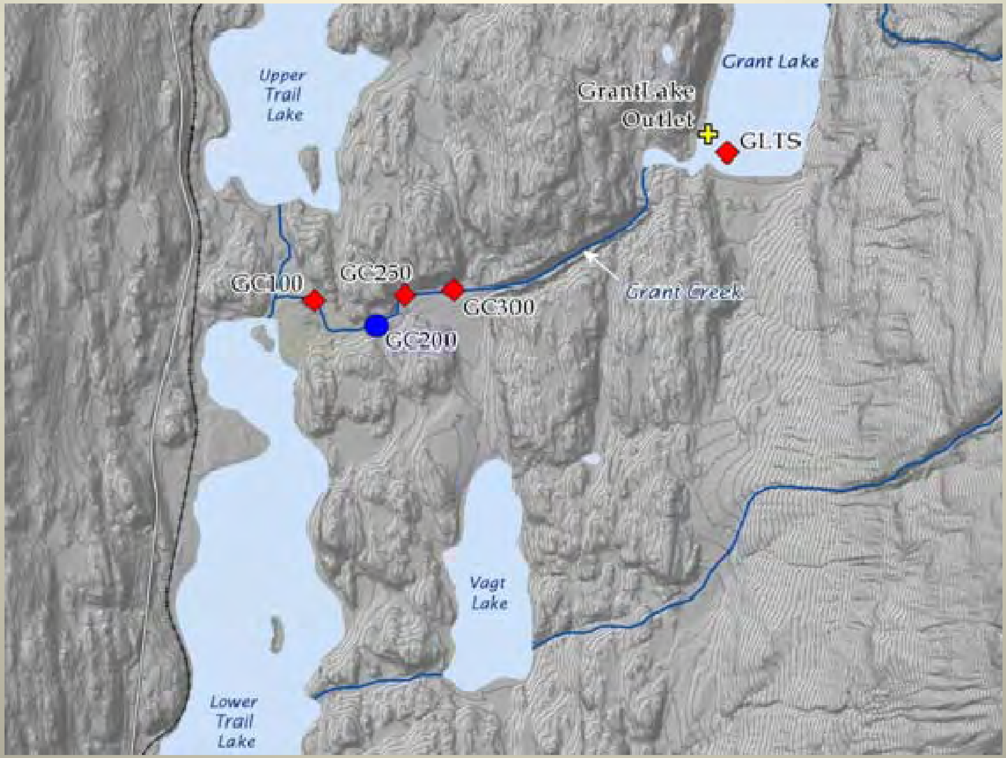
- 3 thermistors per string, spaced 20 cm apart
- 3 strings at known redds (utilized habitat)
- 3 strings at suitable habitat without known spawning activity (unutilized habitat)
- Measures temperature "tracer" as surrogate for upwelling or downwelling



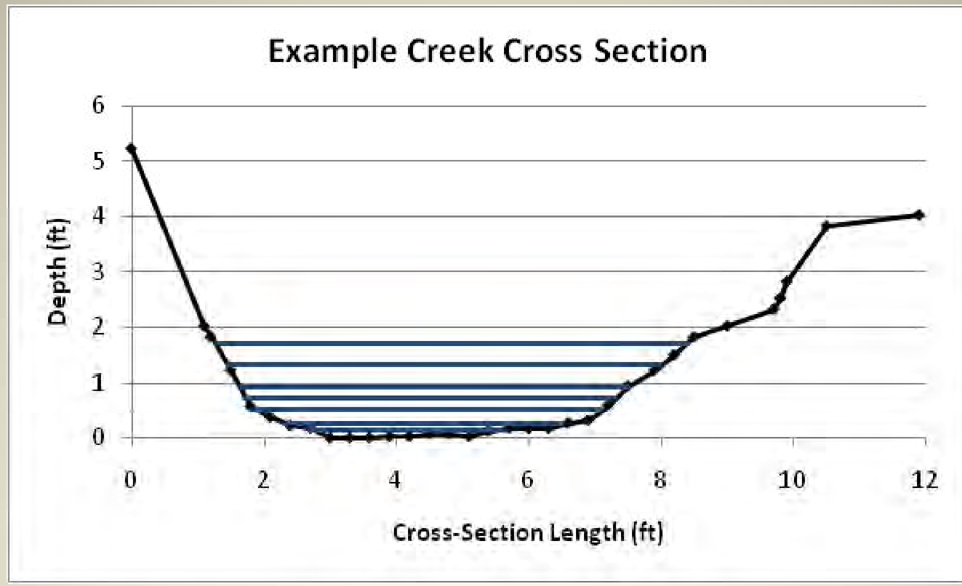
DETAILS OF INSTREAM FLOW APPROACH

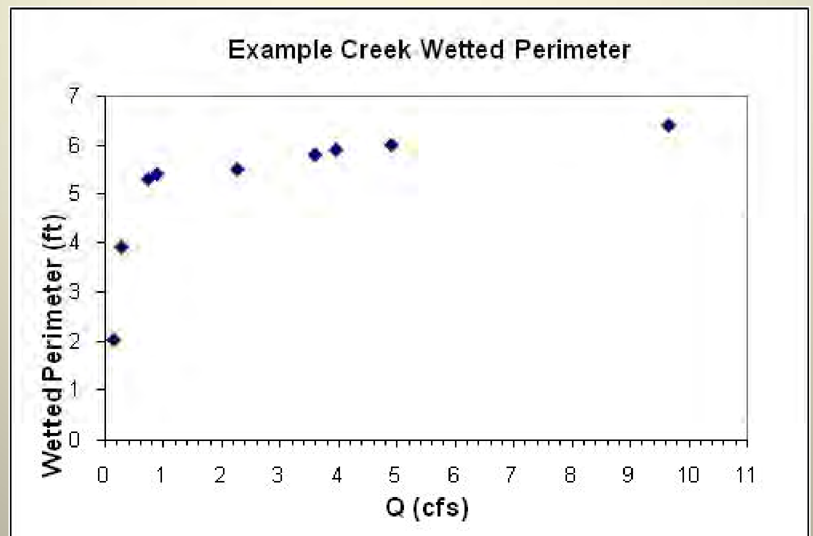
Element 4 – Stream flow & temperature monitoring

- Continues 2009 program
- Continuous flow monitoring at USGS gage site
- Temperature monitoring at multiple locations in Grant Creek

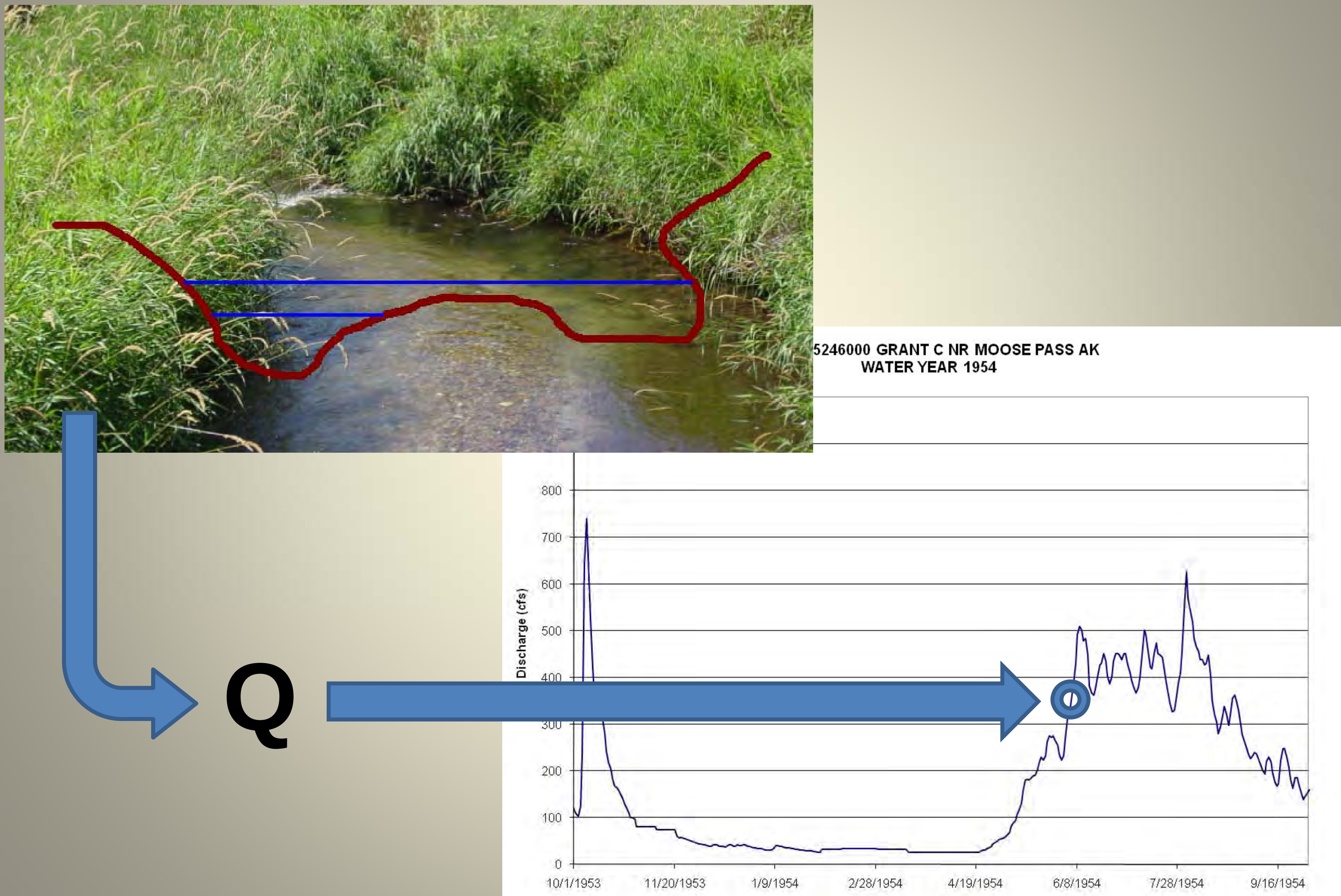


EXAMPLE OF INSTREAM FLOW ANALYSIS





EXAMPLE OF INSTREAM FLOW APPROACH



DETAILS OF INSTREAM FLOW APPROACH

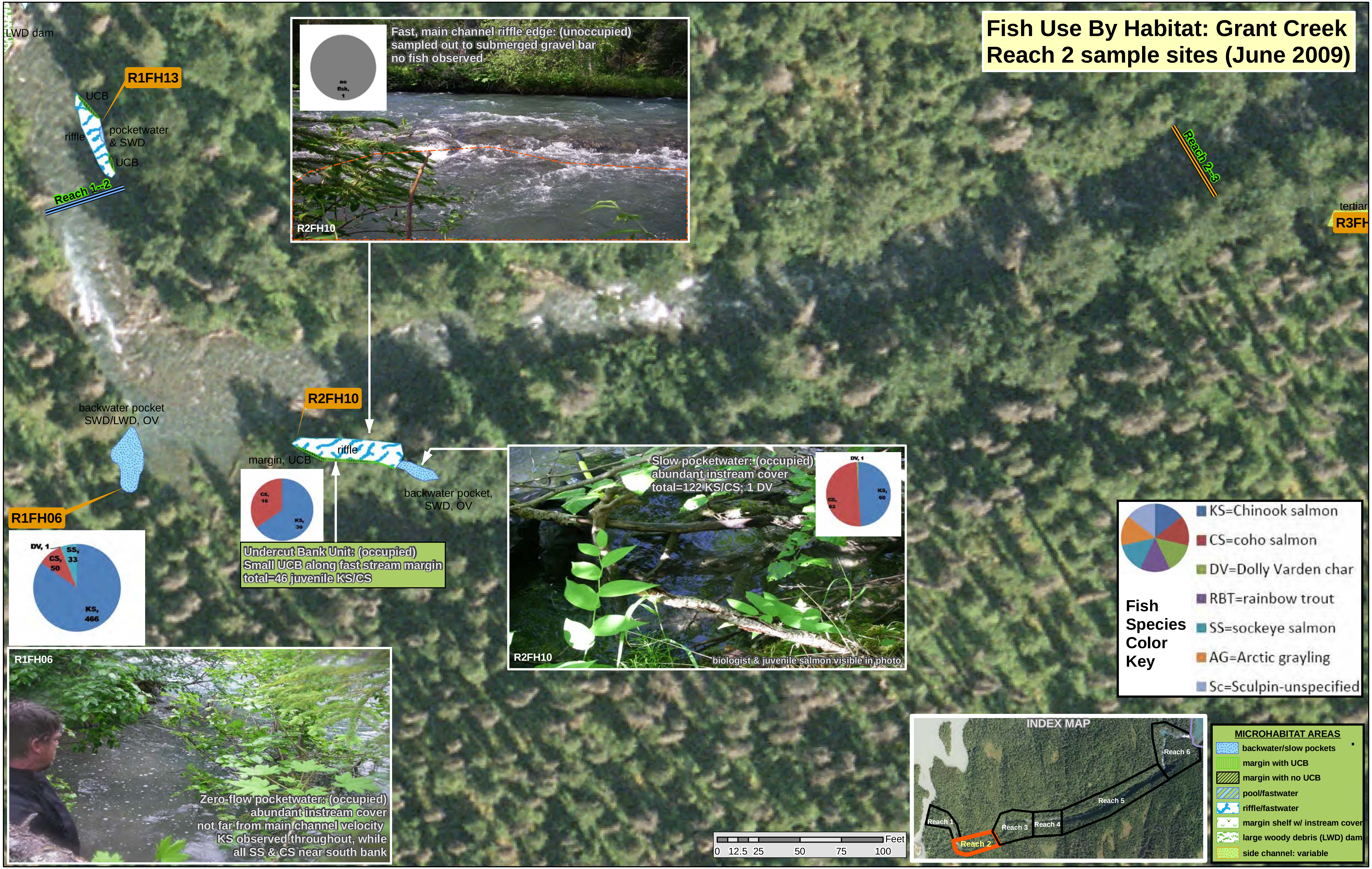
Analysis & Synthesis

- Represents an in-depth analysis of utilized habitat areas
- Lateral connectivity study allows estimation of flows at which the habitat unit is no longer available; flexible (i.e. depth)
- Habitat data and fish use data are spatially and temporally connected to flow and temperature measurements
- Conclusions compared to historic hydrograph
- Intragravel temperature study goes beyond typical PHABSIM-type analysis of spawning microhabitat parameters

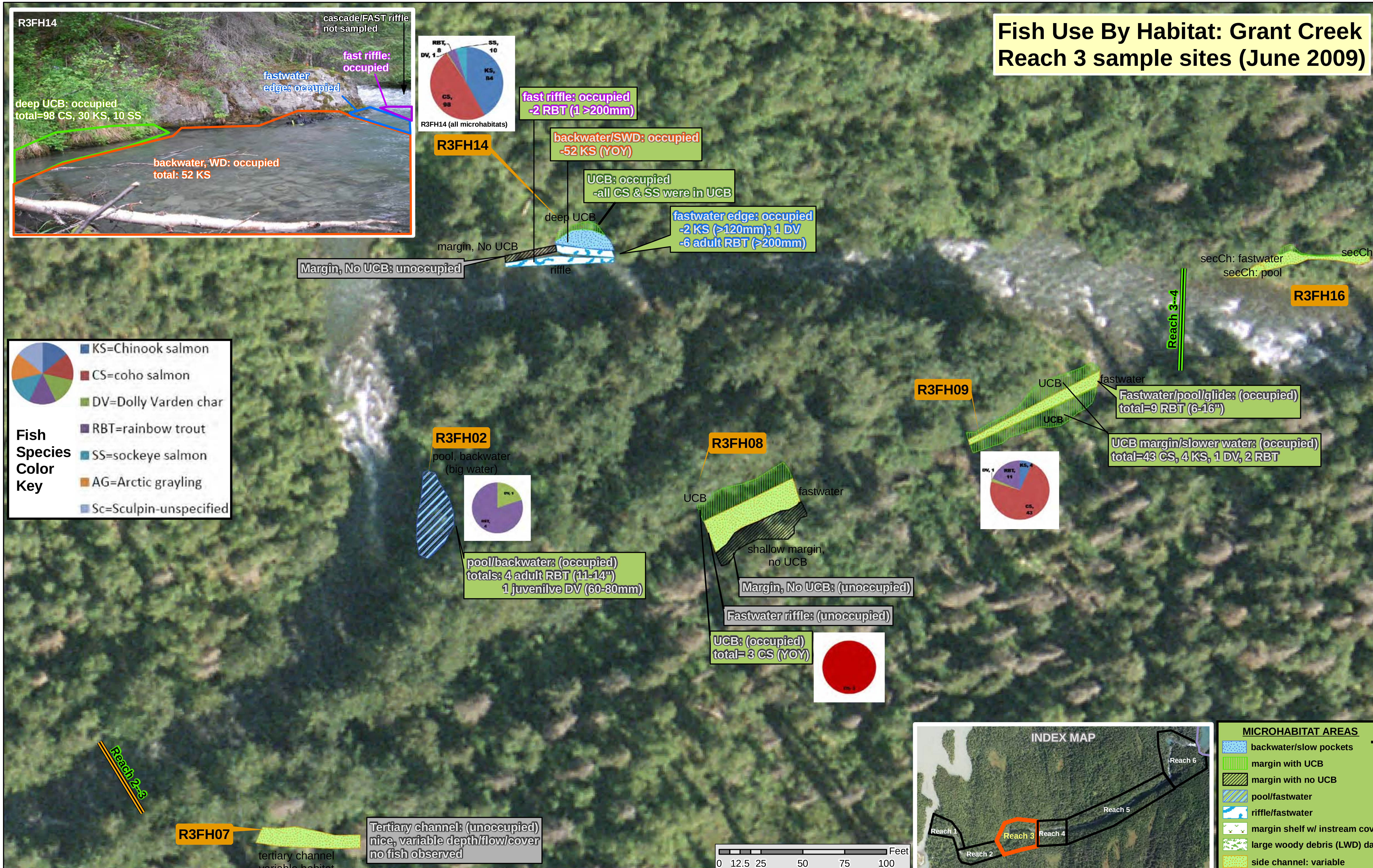
DISCUSSION AND ACTION ITEMS

End

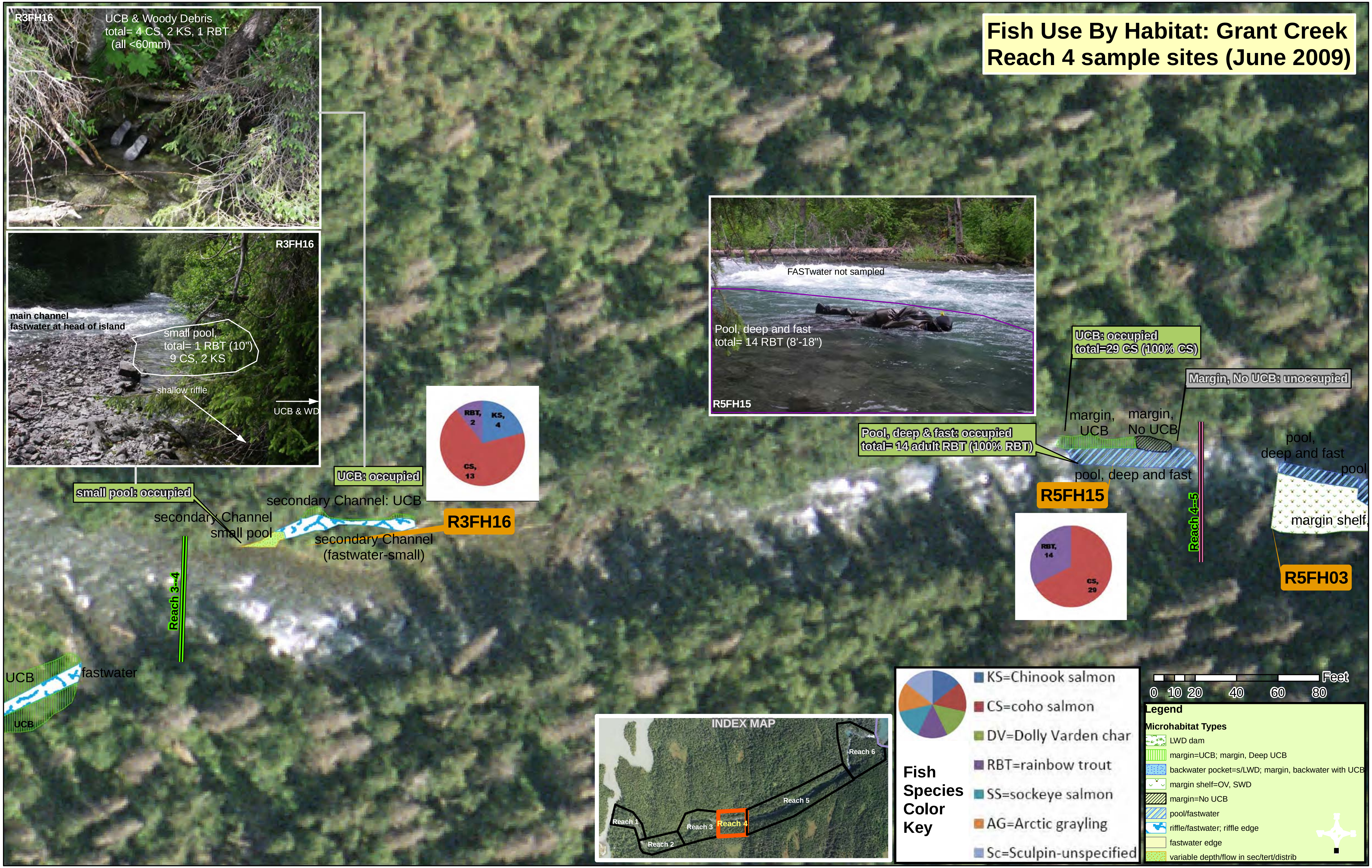
Fish Use By Habitat: Grant Creek
Reach 1 sample sites (June 2009)
Fish Species Color Key
KS=Chinook salmon
CS=coho salmon
DV=Dolly Varden char
RBT=rainbow trout
SS=sockeye salmon
AG=Arctic grayling
Sc=Sculpin-unspecified
Trail Lake
Grant Creek (distributary channel)
Grant Creek (primary channel)
SS, 70
KS, 54
DV, 25
CS, 2
RBT, 3
DV, 14
SS, 60
CS, 26
KS, 248
R1FH11
R1FH12
variable microhabitats available and occupied in distributary.
R1FH11
FH11&12 combined
distributary: variable depth/flow regimes instream cover
R1FH12
variable microhabitats available and occupied in distributary.
R1FH01
riffle_fastwater
margin shelf, SWD
fast riffle no cover no fish observed
SWD instream cover total= 4 KS, 1 RBT, 2 Sc
R1FH01
Sc, 2
KS, 4
RBT, 1
LWD provides cover & velocity break many juvenile fish
fast riffle primarily KS, RBT & DV
margin shelf w/instream cover many juveniles observed
R1FH05
R1FH05
riffle
margin shelf SWD
LWD dam
DV, 16
RBT, 22
SS, 6
CS, 103
KS, 399
R1FH13
UCB
riffle
pocketwater & SWD
UCB
R1FH13
Fastwater =6 RBT, 2 DV
UCB & slower pockets =141 KS, 31 CS, 2 RBT
DV, 2
RBT, 8
CS, 31
KS, 141
INDEX MAP
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Feet
0 15 30 60 90 120
MICROHABITAT AREAS
backwater/slow pockets
margin with UCB
margin with no UCB
pool/fastwater
riffle/fastwater
margin shelf w/ instream cover
large woody debris (LWD) dam
side channel: variable



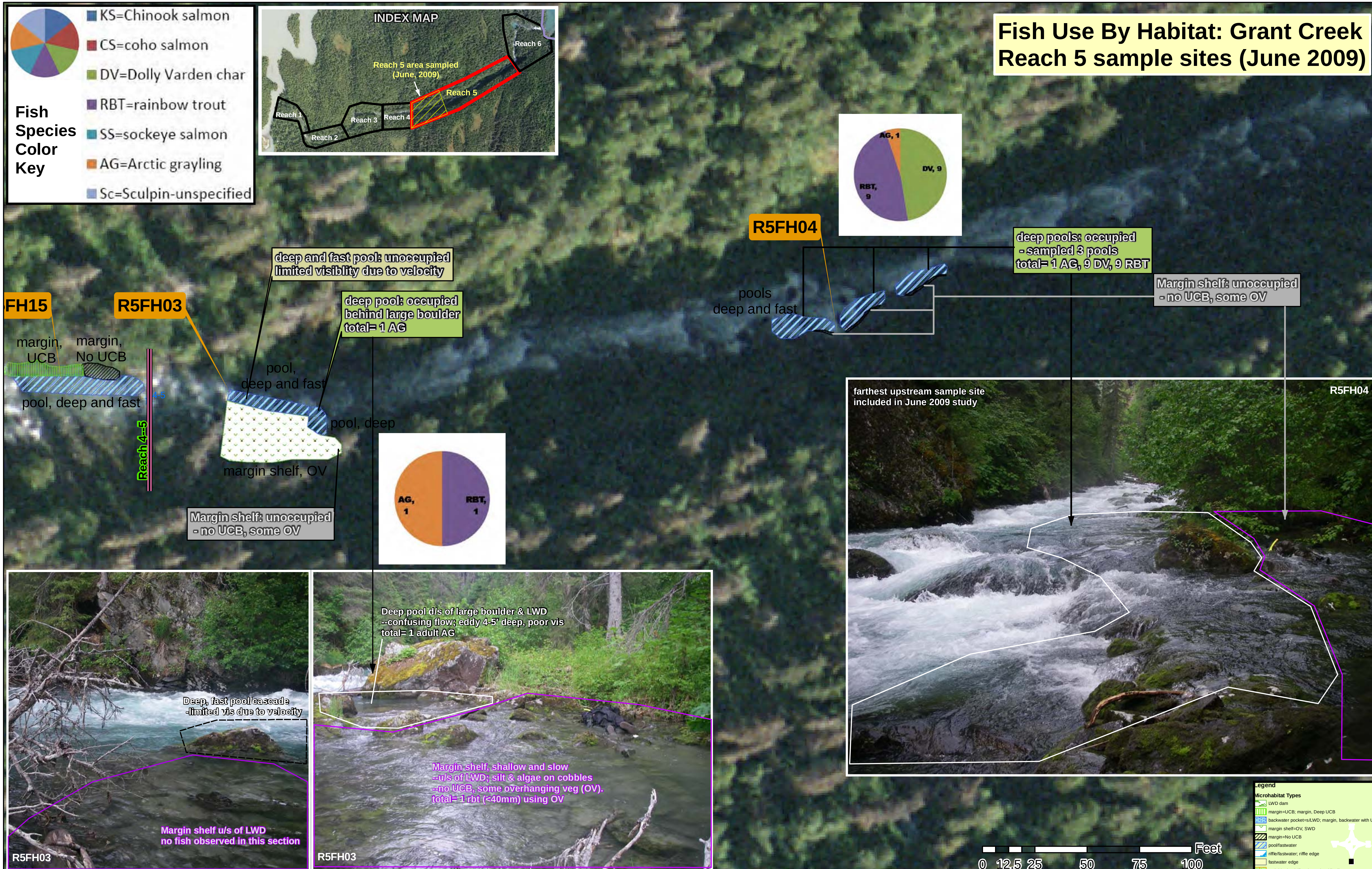
Fish Use By Habitat: Grant Creek
Reach 2 sample sites (June 2009)
LWD dam
R1FH13
UCB
riffle
pocketwater & SWD
UCB
Reach 1--2
Reach 2--3
tertiar
R3FH
Fast, main channel riffle edge: (unoccupied)
sampled out to submerged gravel bar
no fish observed
no fish, 1
R2FH10
R2FH10
backwater pocket
SWD/LWD, OV
margin, UCB
riffle
backwater pocket,
SWD, OV
CS, 16
KS, 30
Undercut Bank Unit: (occupied)
Small UCB along fast stream margin
total=46 juvenile KS/CS
R1FH06
DV, 1
SS, 33
CS, 50
KS, 466
Slow pocketwater: (occupied)
abundant instream cover
total=122 KS/CS; 1 DV
DV, 1
CS, 62
KS, 60
R2FH10
biologist & juvenile salmon visible in photo
R1FH06
Zero-flow pocketwater: (occupied)
abundant instream cover
not far from main channel velocity
KS observed throughout, while
all SS & CS near south bank
Fish Species Color Key
KS=Chinook salmon
CS=coho salmon
DV=Dolly Varden char
RBT=rainbow trout
SS=sockeye salmon
AG=Arctic grayling
Sc=Sculpin-unspecified
INDEX MAP
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Feet
0 12.5 25 50 75 100
MICROHABITAT AREAS
backwater/slow pockets
margin with UCB
margin with no UCB
pool/fastwater
riffle/fastwater
margin shelf w/ instream cover
large woody debris (LWD) dam
side channel: variable



Fish Use By Habitat: Grant Creek
Reach 3 sample sites (June 2009)
R3FH14
cascade/FAST riffle not sampled
fast riffle: occupied
fastwater edge: occupied
deep UCB: occupied
total=98 CS, 30 KS, 10 SS
backwater, WD: occupied
total: 52 KS
R3FH14 (all microhabitats)
fast riffle: occupied
-2 RBT (1 >200mm)
backwater/SWD: occupied
-52 KS (YOY)
UCB: occupied
-all CS & SS were in UCB
fastwater edge: occupied
-2 KS (>120mm); 1 DV
-6 adult RBT (>200mm)
deep UCB
margin, No UCB
riffle
Margin, No UCB: unoccupied
secCh: fastwater
secCh: pool
R3FH16
Reach 3--4
KS=Chinook salmon
CS=coho salmon
DV=Dolly Varden char
RBT=rainbow trout
SS=sockeye salmon
AG=Arctic grayling
Sc=Sculpin-unspecified
Fish Species Color Key
R3FH09
UCB
fastwater
Fastwater/pool/glide: (occupied)
total=9 RBT (6-16")
UCB margin/slower water: (occupied)
total=43 CS, 4 KS, 1 DV, 2 RBT
R3FH02
pool, backwater (big water)
pool/backwater: (occupied)
totals: 4 adult RBT (11-14")
1 juvenilve DV (60-80mm)
R3FH08
UCB
fastwater
shallow margin, no UCB
Margin, No UCB: (unoccupied)
Fastwater riffle: (unoccupied)
UCB: (occupied)
total= 3 CS (YOY)
Reach 2--3
R3FH07
tertiary channel variable habitat
Tertiary channel: (unoccupied)
nice, variable depth/flow/cover
no fish observed
0 12.5 25 50 75 100 Feet
INDEX MAP
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
MICROHABITAT AREAS
backwater/slow pockets
margin with UCB
margin with no UCB
pool/fastwater
riffle/fastwater
margin shelf w/ instream cover
large woody debris (LWD) dam
side channel: variable



Fish Use By Habitat: Grant Creek
Reach 4 sample sites (June 2009)
R3FH16
UCB & Woody Debris
total= 4 CS, 2 KS, 1 RBT
(all <60mm)
R3FH16
main channel
fastwater at head of island
small pool,
total= 1 RBT (10")
9 CS, 2 KS
shallow riffle
UCB & WD
FASTwater not sampled
Pool, deep and fast
total= 14 RBT (8'-18")
R5FH15
UCB: occupied
total=29 CS (100% CS)
Margin, No UCB: unoccupied
margin,
UCB
margin,
No UCB
Pool, deep & fast: occupied
total= 14 adult RBT (100% RBT)
pool,
deep and fast
pool
pool, deep and fast
R5FH15
margin shelf
Reach 4–5
R5FH03
RBT, 14
CS, 29
RBT, 2
KS, 4
CS, 13
UCB: occupied
small pool: occupied
secondary Channel: UCB
secondary Channel
small pool
R3FH16
secondary Channel
(fastwater-small)
Reach 3–4
UCB
fastwater
UCB
INDEX MAP
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Fish
Species
Color
Key
KS=Chinook salmon
CS=coho salmon
DV=Dolly Varden char
RBT=rainbow trout
SS=sockeye salmon
AG=Arctic grayling
Sc=Sculpin-unspecified
Feet
0 10 20 40 60 80
Legend
Microhabitat Types
LWD dam
margin=UCB; margin, Deep UCB
backwater pocket=s/LWD; margin, backwater with UCB
margin shelf=OV, SWD
margin=No UCB
pool/fastwater
riffle/fastwater; riffle edge
fastwater edge
variable depth/flow in sec/tert/distrib



Fish Use By Habitat: Grant Creek
Reach 5 sample sites (June 2009)
KS=Chinook salmon
CS=coho salmon
DV=Dolly Varden char
RBT=rainbow trout
SS=sockeye salmon
AG=Arctic grayling
Sc=Sculpin-unspecified
Fish Species Color Key
INDEX MAP
Reach 5 area sampled (June, 2009)
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
FH15
margin, UCB
margin, No UCB
pool, deep and fast
Reach 4--5
R5FH03
deep and fast pool: unoccupied limited visiblity due to velocity
deep pool: occupied behind large boulder total= 1 AG
pool, deep and fast
pool, deep
margin shelf, OV
Margin shelf: unoccupied - no UCB, some OV
AG, 1
RBT, 1
R5FH04
AG, 1
DV, 9
RBT, 9
pools deep and fast
deep pools: occupied - sampled 3 pools total= 1 AG, 9 DV, 9 RBT
Margin shelf: unoccupied - no UCB, some OV
farthest upstream sample site included in June 2009 study
R5FH04
Deep, fast pool/cascade -limited vis due to velocity
Margin shelf u/s of LWD no fish observed in this section
R5FH03
Deep pool d/s of large boulder & LWD --confusing flow; eddy 4-5' deep, poor vis total= 1 adult AG
Margin shelf, shallow and slow --u/s of LWD; silt & algae on cobbles --no UCB, some overhanging veg (OV). total= 1 rbt (<40mm) using OV
R5FH03
0 12.5 25 50 75 100 Feet
Legend
Microhabitat Types
LWD dam
margin=UCB; margin, Deep UCB
backwater pocket=s/LWD; margin, backwater with UCB
margin shelf=OV, SWD
margin=No UCB
pool/fastwater
riffle/fastwater; riffle edge
fastwater edge
variable depth/flow in sec/tert/distrib

Memo

To:	Grant Lake/Falls Creek Hydroelectric TWG		
From:	Jason Kent	Project:	Grant Lake/Falls Creek Hydroelectric
Copy:	Brad Zubeck, Kenai Hydro LLC		
Date:	September 9, 2009	Job No:	91437
Re:	**Review of 1986-1987 Grant Lake FERC Application Documents for Instream Flow Considerations**		

Introduction

During drafting of the Pre-Application Document (PAD), Kenai Hydro, LLC conducted due diligence contacts to agencies and Tribes to collect existing information. During this information gathering effort, some additional instream flow and environmental analysis conducted in the 1980s by Kenai Hydro, Inc. (unrelated to Kenai Hydro, LLC) in support of a license application for hydropower development on Grant Creek was provided to KHL.

The documents are an assemblage of reports and written communications between Kenai Hydro Inc. (KHI) and state and federal agencies in 1986 and 1987 relative to a Federal Energy Regulatory Commission (FERC) license application for the proposed Grant Lake Hydroelectric Project (FERC No. 7633-002). The documents include draft and final reports of a limited but complete IFIM investigation and negotiated minimum instream flows (MIF) and ramping rates.

Summary of Kenai Hydro Inc. Documents

Originally, KHI's proposal was to route flow from Grant Lake to a powerhouse off Grant Creek, effectively removing a large portion of the flow from the creek. An initial license application included an instream flow proposal that was based on a Tennant Method book analysis and negotiated with the agencies in 1982. The proposal was based on Tennant's classification system and the assumption that "base flows of 40-60% would be outstanding and the optimum range would be 60-100% of average flow."

After two years of negotiations with the agencies, Kenai Hydro Inc. determined that the resulting loss of habitat would be considered unacceptable by the agencies and went forward with a new alternative that returned water to the creek at the downstream end of the "canyon reach." This new alternative was investigated in the 1987 instream flow study, and is similar to the approach being proposed by Kenai Hydro LLC today.

KHI suggested the following proposed MIF regime:

October – May	50 cfs
May - October	100 cfs

The agencies (led by USFWS) countered with a proposal favorable to both parties that featured a step increase with the purpose of limiting potential stranding.

November 1 – April 30	50 cfs
May 1-31	75 cfs
June 1 – October 15	100 cfs
October 16-31	75 cfs

The KHI proposal included load following as an important component. To offset the potential impacts of load following on redd dewatering and stranding of fish, the USFWS suggested the following ramping rate:

Increasing flow	• Not to exceed 100 cfs/hr
Decreasing flow	• 10%/hr at flows above 100 cfs • 10 cfs/hr at flows below 100 cfs

KHI anticipated that the project would impart a temperature effect on Grant Creek. The maximum expected change would be -1°C in the summer and +2°C in the winter. The USFWS stated that this change in temperature regime would impact fisheries by increasing the time to button-up stage for chinook fry. To mitigate these impacts, USFWS asked KHI to construct a a multi-level intake structure in Grant Lake and operate the structure to draw water from the uppermost levels of the lake.

In addition, USFWS recommended monitoring of post-operation thermal regime in Grant Creek and evaluation of the changes from the pre-project conditions for a minimum of 6 years after commencement of project operations. NMFS requested a verification study of the instream flow study that included a weekly census of adult chinook and sockeye salmon in August and September during construction and for a ten-year period thereafter.

Report Details

Document 1. Kenai_Hydro_Inc_Grant_Lake_Hydro_Project_Addtl_Info_2-15-1987.pdf

The revised project, with the powerhouse at the bottom of the canyon reach and flows diverted from Grant Lake, is discussed in this document. Proposed project flows are presented in Figure 1.

On October 21-23, 1986, a meeting and site visit was held at the USFWS office in which an alternate analysis method was selected. The discussion was centered on results of a stream survey conducted by Kenai Hydro Inc. (KHI) on June 26, 1986 (Figure 2). The work group determined the “most critical reach of the stream” that contained the highest amount of spawning activity was near the mouth of Grant Creek between stations 4-8 as shown on Figure 2. The work group selected a method that included the collection of 3 transects at stations 5 and 6 (Figure 3), and analysis using the computer model WSP/IFG-2, a precursor to the PHABSIM suite of models that is used today. Later that month, a consulting firm collected the stream surveys. The work group attendees included:

KHI – Dick Poole, Jonathan Hanson
ADFG – Don McKay, Christopher Estes
USFWS – Lenny Corin, Steven Lyons, George Elliott
NMFS – Brad Smith

The work group determined that “spawning is the most critical factor since rearing occurs mainly in the associated lakes.” This assumption led to a study design that included one transect flow measurement at three transects. KHI determined that one set of measurements was justified because “conflicts are low and the stream is a simple stable channel.” KHI characterized Grant

Creek as “a simple stream with steep gradients, minimal side channels, few pools, and a rough bottom with a minimum of spawning gravel.” The selected study area where spawning was determined to occur the most, stations 4-8, was considered the “the most sensitive to changes in stream flow due to the elevated gravel bar and riffles that are present.” Typical PHABSIM-style transect measurements were taken during the field work conducted on October 24, 1986 (Figure 3).

KHI provides the following information regarding icing and winter flows:

“On a month by month basis, flows are lowest in the months of January, February, March and April. During this period minimum daily flows of 11 cfs occur with the stream icing up. Flows across the ice affecting stage-discharge relationships are recorded indicating anchor ice and solid freezing are occurring.

“During this period egg incubation is occurring and for the four month period the eggs are essentially in a holding phase due to the low temperatures which limit development. Stream flow is restricted to the bottom of the channel and eggs which have been spawned on the upper gravel bars freeze or depend on the availability of ground water for survival. Juvenile rearing would be restricted to the channel and limited pools during winter. Ice cover may or may not occur to protect the exposed eggs. Dewatering of alevins would of course cause 100 percent mortality.”

The original KHI proposal included reservoir management regimes (reservoir filling in off-peak months for use during the peak energy demand months of November through February) and proposed ramping rates. KHI reports daily changes of 185 cfs/day were observed during the period of record. KHI proposed a 100 cfs/hr rate of change for Grant Creek.

Figure 4 presents the projected project temperature discharges in Grant Creek. The project was projected to slightly flatten the temperature curve, warming the discharged water in the winter and cooling it in the summer. The reason for this difference is that the water intake in Grant Lake is below the surface, and the natural discharge is surface water that is exposed to ambient air temperatures. Due to this impact, USFWS asked KHI to include a multi-level intake structure in Grant Lake (this is discussed in the details of Document 3).

<u>Details of Envirosphere’s February 1987 Instream Flow Study Report</u>

The objectives of Envirosphere’s instream flow study were to quantify the relationship between habitat and flow for trout and salmon, to identify the physical habitat type that is limiting production in Grant Creek, and to determine how daily flow fluctuations from load following may potentially strand juvenile fish.

The report included a summary of existing data including fish resources of Grant Creek. Summary of that summary:

- Chinook
    - Adults
        - spawn in August and September.
        - Based on surveys (ADFG 1952-1981 and APA 1984), average peak salmon spawning ground count was 19 fish. Weir counts by Cook Inlet Aquaculture Association indicated that this number may be somewhat larger but generally less than 50 returning adults each year.
    - Juveniles
        - Age 1+ observed year round (APA 1984), but low numbers observed during March, May & June suggest they are either inactive or migrated elsewhere.
        - Natural emergence may be later than June because no observation in minnow traps until August (APA 1984). Some were observed during electrofishing in May, but may have been stimulated from the gravel.

- Sockeye
  - Adults
    - Spawn in August and September.
    - Based on surveys (ADFG 1952-1981 and APA 1984), average peak salmon spawning ground count was 61 fish. Weir counts by Cook Inlet Aquaculture Association show higher numbers – 400 in 1985 and 675 in 1986.
  - Juveniles
    - Likely rear in the downstream lake system and not in Grant Creek.
- Coho
  - Adults
    - No observations (ADFG 1952-1981 and APA 1984). However, very small (<40 mm) coho fry were trapped in August 1984 (APA 1984), indicating some natural spawning.
    - Returns were observed in 1985 and 1986 by CIAA weir counts; these fish were returns from the coho introduction program in Grant Lake that has since been discontinued.
  - Juveniles
    - Previous studies (APA 1984) show some coho rear in the lower reaches of Grant Creek but were less abundant and not as widely distributed as juvenile chinook.
- Rainbow Trout
  - Spawning
    - No spawning adults were observed, but small juveniles (45-50 mm) were observed in October 1982, indicating some natural spawning (APA 1984).
  - Rearing
    - RBT are evenly distributed in Grant Creek, and are found in most habitat types. RBT captured in 1982 ranged in length from 43-106 mm (APA 1984).
- Dolly Varden
  - Spawning
    - No spawning adults were observed (APA 1984).
  - Rearing
    - Larger fish may move into Grant Creek during the late summer to feed and avoid the high turbidity of the Trail Lakes.
    - DV observed ranged in length from 55-300 mm.

Envirosphere analyzed the data and determined that "as a result of the similarities among the salmonid species present in Grant Creek…an analysis of chinook and sockeye salmon will provide a relatively good indicator of the habitat relationships for coho, rainbow trout, and Dolly Varden char...therefore the stranding analysis in this study can be broadly applied, even though it is targeted on chinook." They selected as the evaluation species for the instream flow study the spawning and rearing lifestages of chinook and the spawning lifestage of sockeye.

Suitability curves "were developed from information found in the literature. This was believed to be a reasonable approach because a considerable amount of information is available in Alaska on suitability and some is directly available from the Kenai River system (e.g., Burger et al. 1982)." The HSC used for this study are presented in Figures 5 through 7. Details on the studies used to develop these criteria are given on pages 10-16 of the Envirosphere report.

Timing of life history phases for chinook and sockeye are presented in Table 1. Envirosphere characterizes the incubation phase as "somewhat more difficult; however, inferences have been made from observations of the appearance of small juveniles (less than 50 mm) in the summer."

Table 1. Life history phases of chinook and sockeye salmon in Grant Creek.

Stage	When Present
Chinook	
Adults	August-September
Egg incubation and early intragravel	August-May/June
Juveniles	All year
Sockeye	
Adults	August-September
Egg incubation and early intragravel	August-May/June
Juveniles	Move downstream and rear elsewhere

Field data were collected on October 24, 1986 by KHI. Information collected on three transects included depth, velocity, and substrate. Vertical intervals were 2-4 feet, and velocities were measured at 0.2, 0.6, and 0.8 * depth. The calibration flow was approximately 246 cfs.

The model was calibrated and flow simulations were run for 50-450 cfs using WSP (Bovee and Milhous 1978). Stranding potential was examined using the methodology described by Prewitt and Whitmus (1986). This methodology uses information on cross slope, substrate, and discharge to determine stranding potential.

Results of Weighted Usable Area (WUA) are presented in Figures 8 through 11. In general, flows greater than 100 cfs cover a majority of the stream bed. Chinook spawning area peaks around 350 cfs, with about 70% of maximum spawning area available at 150 cfs. Sockeye spawning area peaks between 50 and 175 cfs and drops off sharply at flows greater than 175 cfs.

Chinook <50mm fry rearing peaks around 150 cfs, and for chinook 50-100mm fry the peak habitat is somewhat steady between 100 and 350 cfs. For both sizes of chinook juveniles, habitat drops sharply at flows less than 100 cfs.

The change in rate of stranding is relatively steady throughout the simulated flow range of 50-450 cfs with the exception of the range 50-120 cfs; in this flow range, stranding area rate was very high. Incremental changes in flow greater than 350 cfs impart a large increase in stranding area; the effect is lower for increments smaller than 350 cfs.

Document 2. Kenai_Hydro_Inc_Grant_Lake_Hydro_Project_FERC_No_7633-002_Instream_Flow_Study_5-4-1987.pdf

This document includes the final instream flow report and comments from the resource agencies (USFWS, ADFG, NMFS) on the draft report.

Three agencies – ADFG, USFWS, and NMFS, provided KHI technical comments and concerns with the instream flow study. These comments are summarized below relative to the limitations of the study.

- The model (WSP) assumes steady flow during data collection. Flow measurements show that the flow rate dropped 51.5 cfs (21%) during the field study.
- USFWS applied a rule of thumb that flow simulations should not be applied to flows less than 40% of the lowest calibration flow. In this case, 40% of 246 cfs is 98 cfs.
- The study would be more credible if data had been collected at flows between 100-125 cfs.
- The model cannot be extrapolated upwards if the end of the cross sections were at the water's edge.

- Habitat suitability criteria are questionable (multiple concerns – see original letter).
- Stranding analysis is unclear because the method used is unpublished and unknown.
- The Tennant Method was presented improperly and it is unclear how it fits into the report.

Document 3. Kenai_Hydro_Inc_Grant_Lake_Hydro_Project_Addtl_Info_Final_Report_with_Agency_T_Cs_9-4-1987.pdf

This document includes the communication between KHI and the agencies regarding negotiated minimum instream flows and ramping rates. The key documents are letters to KHI Vice President Richard Poole dated July 14, 1987 from USFWS and July 1, 1987 from NMFS. The letters suggest modifications to KHI's proposed minimum instream flows, thermal impacts, and ramping rates.

Instream Flows

USFWS determined the instream flow study "inadequate for the purpose of evaluating the fishery habitat currently available in Grant Creek, and the impacts (both positive and negative) which would result from the current proposal. The basic and most important concern with the study is poor data." USFWS interpreted the raw velocity data for transect T1 as having errors of greater than 20% for 8 of 16 verticals. Considering this error, they questioned the ability of the model to extrapolate to 100 cfs and beyond.

USFWS and NMFS suggested the following MIF regime:

November 1 – April 30	50 cfs
May 1-31	75 cfs
June 1 – October 15	100 cfs
October 16-31	75 cfs

USFW also suggested installing a continuous flow recording gage at or downstream of the tailrace.

Ramping Rates

Although the USFWS doubted the validity of the instream flow model, they acknowledged the increased potential for stranding at flows below 100 cfs. To address this concern, they recommended the following ramping rates:

Increasing flow	• Not to exceed 100 cfs/hr
Decreasing flow	• 10%/hr at flows above 100 cfs • 10 cfs/hr at flows below 100 cfs

Temperature

KHI anticipated that the project would impart a temperature effect on Grant Creek. The maximum expected change would be -1°C in the summer and +2°C in the winter (Figure 4). USFWS voiced concern that the change in the project temperature regime would affect the time for chinook fry to reach the button-up stage. "In consideration of temperature-related concerns, Kenai Hydro, Inc., has agreed to utilize a multi-level intake structure. To minimize adverse impacts to the fishery resources we recommend that the intake structure be operated to draw water from the uppermost levels of Grant Lake."

Monitoring

USFWS also recommended monitoring of post-operation thermal regime in Grant Creek and evaluation of the changes from the pre-project conditions for a minimum of 6 years after commencement of project operations.

NMFS requested a verification study of the instream flow study that included a weekly census of adult chinook and sockeye salmon in August and September during construction and for a ten-year period thereafter.

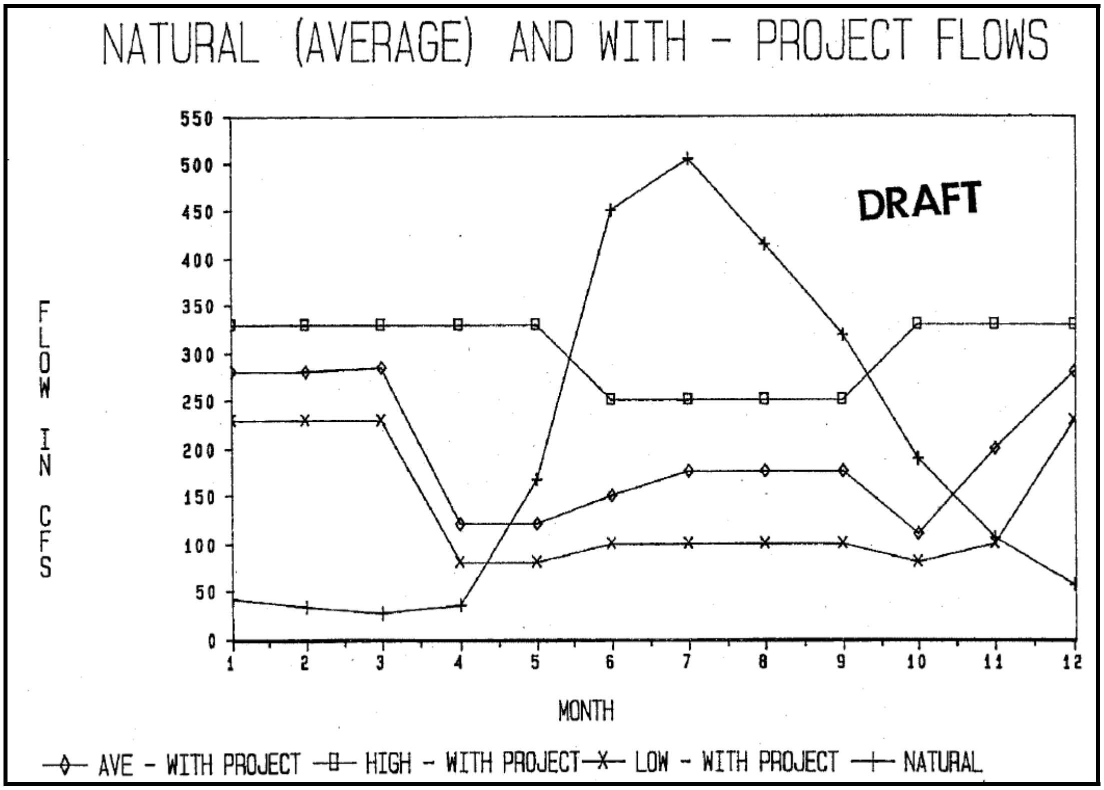


Figure 1. Proposed project flows in Grant Creek

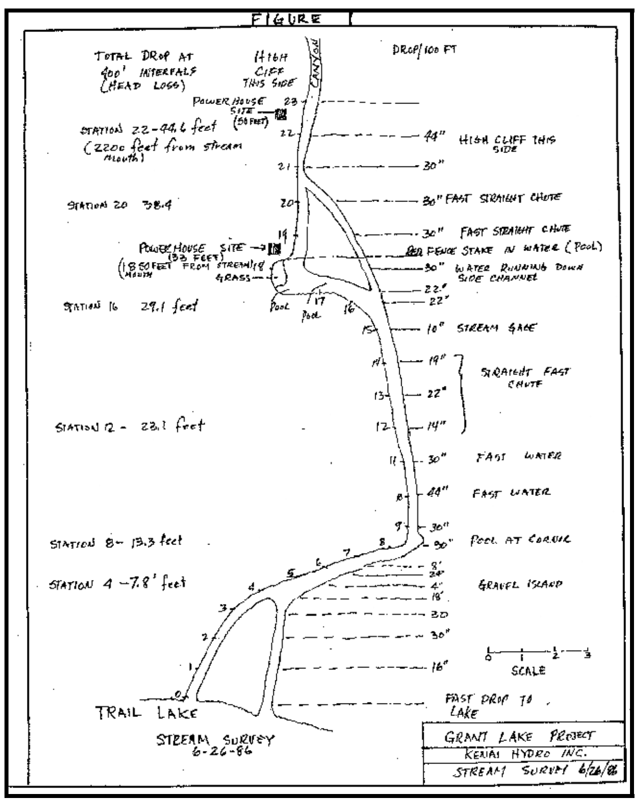


Figure 2. KHI stream survey June 26, 1986

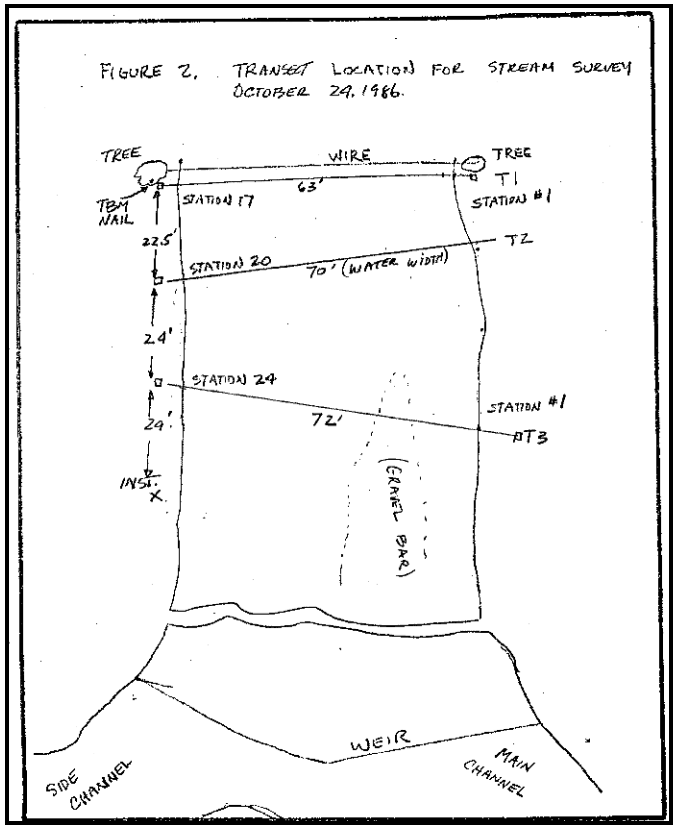


Figure 3. Transect locations for KHI stream survey, October 24, 1986

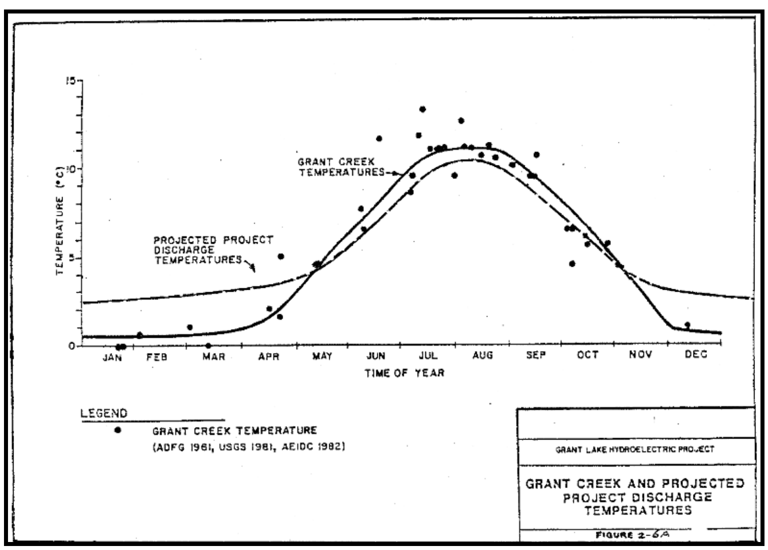


Figure 4. Anticipated post-project temperature regime in Grant Creek

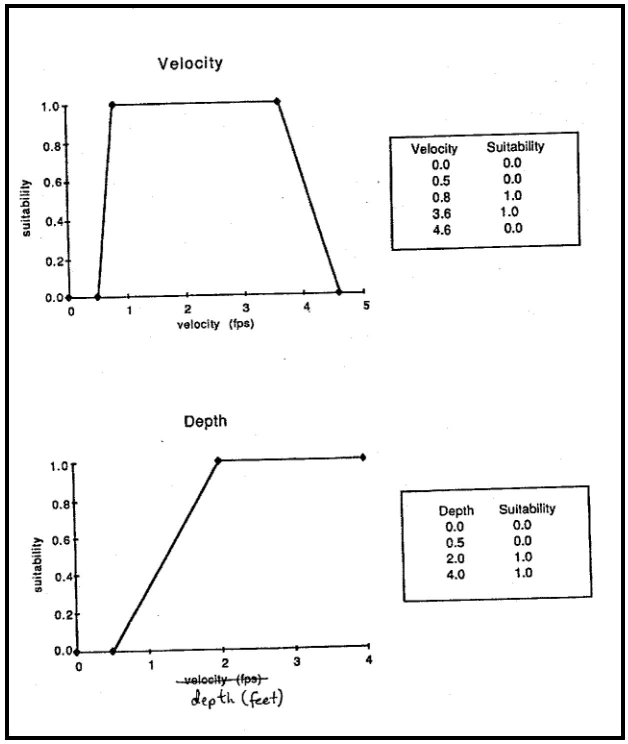


Figure 5. Habitat Suitability Criteria for adult chinook salmon

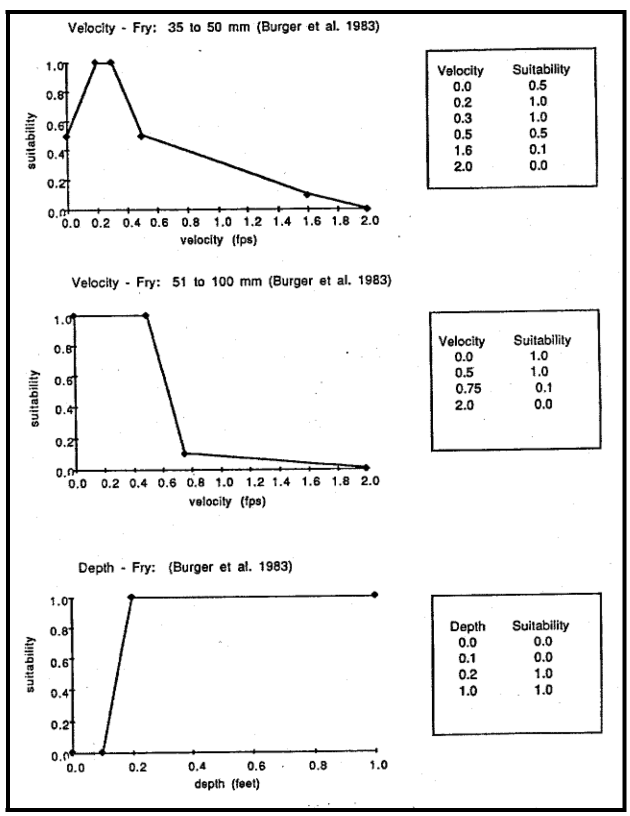


Figure 6. Habitat Suitability Criteria for juvenile chinook salmon

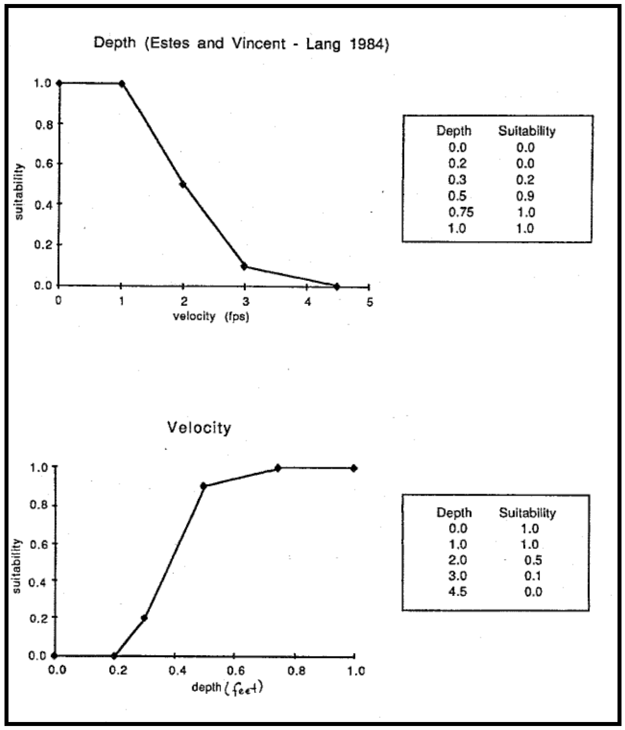


Figure 7. Habitat Suitability Criteria for adult sockeye salmon

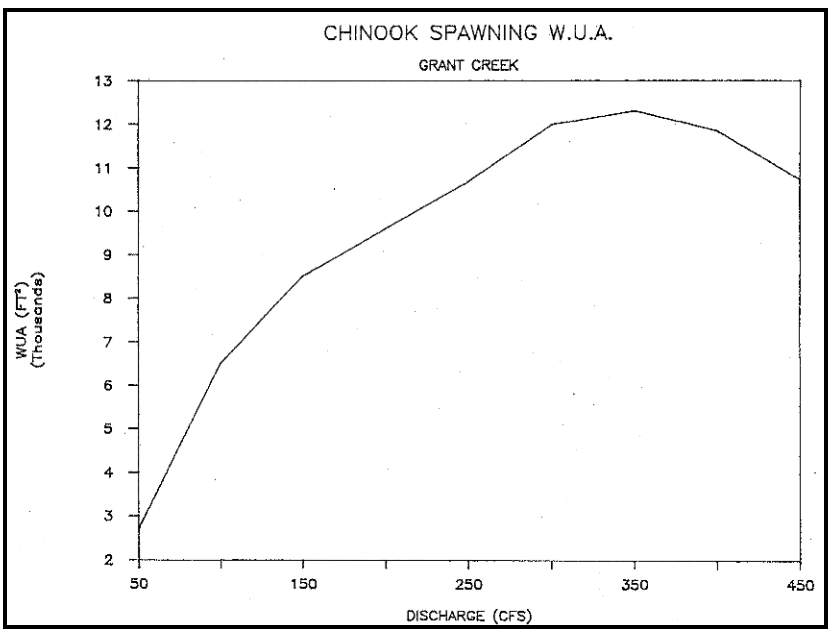


Figure 8. Weighted Usable Area for spawning adult chinook salmon

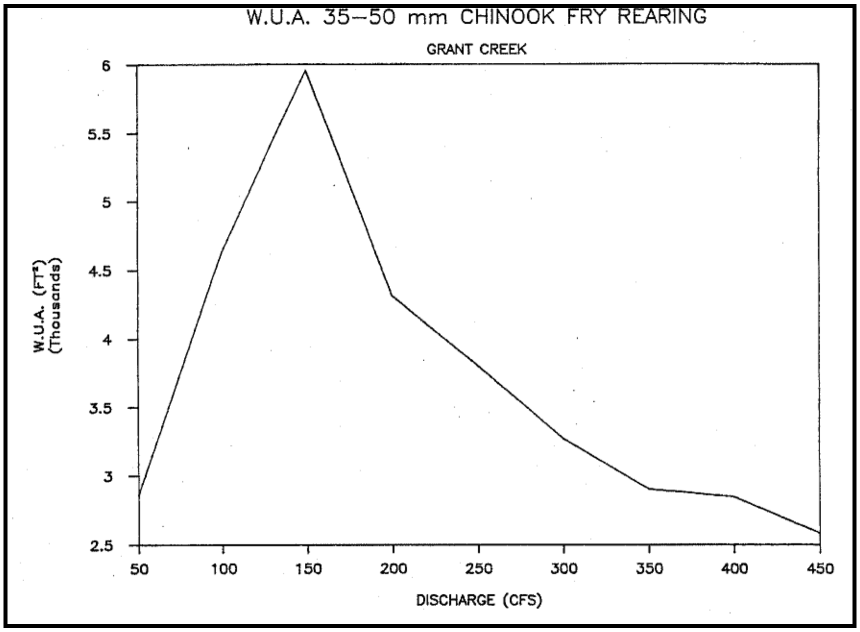


Figure 9. Weighted Usable Area for juvenile rearing chinook salmon 35-50 mm

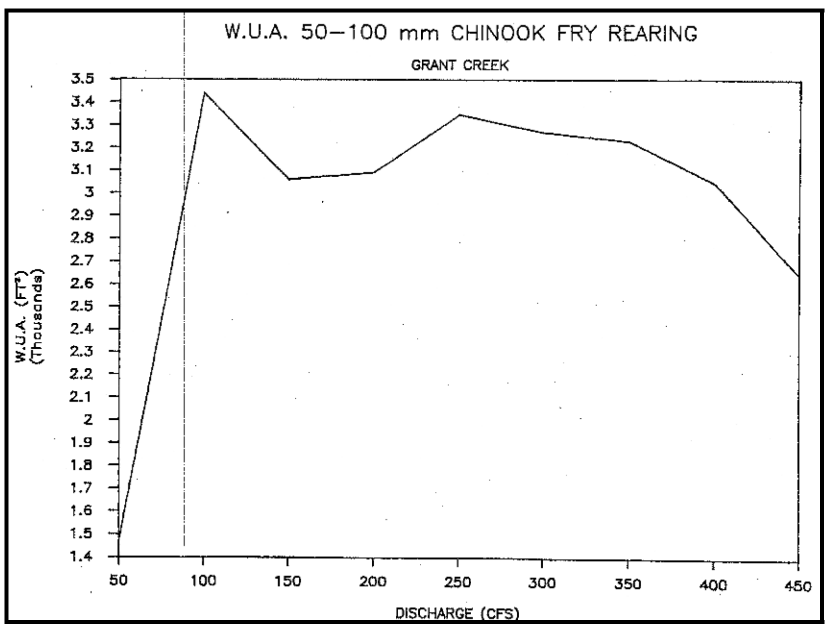


Figure 10. Weighted Usable Area for juvenile rearing chinook salmon 50-100 mm

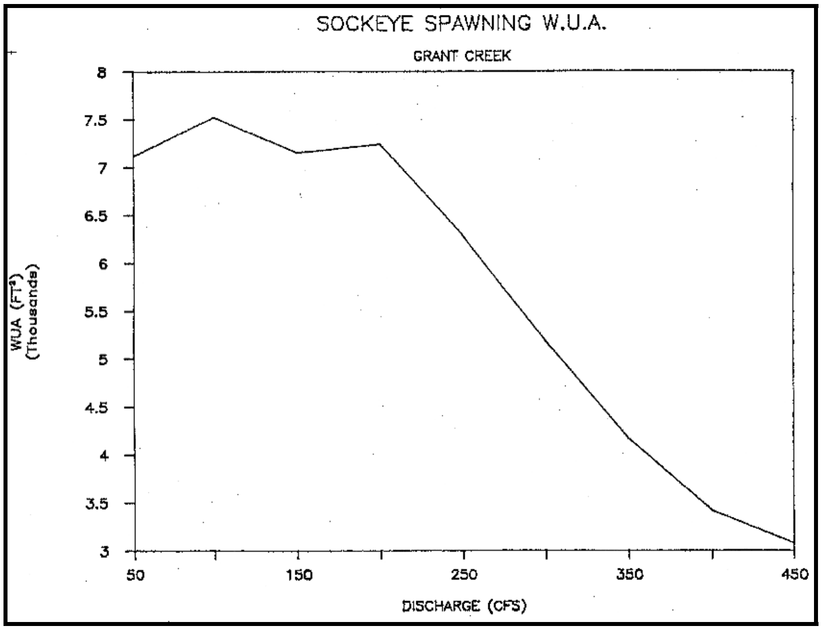


Figure 11. Weighted Usable Area for adult spawning sockeye salmon

Technical Memorandum

Project Name: Grant Creek Hydroelectric Project

Task: Grant Creek, Aquatic Biology and Instream Flow

Tech Memo Title: Study Approach for 2010 Instream Flow Study

To: Grant Lake/Falls Creek Project Instream Flow Technical Work Group

From: HDR Alaska, Inc.

Primary Author: Jason Kent (HDR)

Date: October 9, 2009

Introduction

The proposed methodology for the Grant Creek Instream Flow Study was presented September 22-23, 2009 at a site visit and meeting in Moose Pass. In the meeting held at the Kenai Lake Work Center on September 23, HDR staff presented to the Instream Flow Technical Working Group (TWG) members the methods and results of Grant Creek data collection in late 2008 and 2009 including the hydrology, fish presence, and fish habitat studies. Following these presentations, Jason Kent and Paul McLarnon of HDR and John Morsell of Northern Ecological Services presented the proposed instream flow approach. TWG discussion of the study approach followed.

During the discussion of the instream flow study approach, TWG members asked questions and provided feedback, including suggestions on winter use, spawning gravel recruitment, and food sources. These suggestions were added to the instream flow approach as described in this technical memorandum. The TWG also collaboratively selected habitat use parameters to be studied.

This technical memorandum describes the technical approach for the 2010 Grant Creek instream flow study that will be further described in the Grant Creek Aquatics Study Plan to be provided in November 2009.

Background

Several instream flow study approaches for the Grant Creek study were discussed in TWG meetings held in April 2009 in Kenai, and May 2009 on a conference call. Comments from the TWG at those meetings suggested that a focused, site-specific approach might be appropriate for this system. These comments combined with the short length of Grant Creek make it feasible to directly address the potential effect of flow changes on specific areas of known fish use.

For an instream flow study in Grant Creek, we propose an integrated effort that provides an efficient way of obtaining information to most directly address questions the TWG members have raised regarding the effects of the proposed project on fish habitat in Grant Creek. The approach includes: 1) a series of single transect analyses with each transect going through a known fish use area such as high use spawning or rearing areas; 2) fish studies that help identify microhabitat factors that affect fish use within each key habitat type; 3) measuring vertical water temperature differences at spawning locations to identify areas of upwelling or downwelling; and 4) monitoring temperature and flows at multiple locations on Grant Creek to determine downstream flow accretion and temperature changes. These four components will be analyzed and compared to historical flow data (USGS gage 15246000, water years 1948-1958) to determine effects of different flow regimes on several factors that are important in the lifestages of Grant Creek resident and anadromous fish.

We believe this approach, which focuses on the specific needs of fish that use Grant Creek, addresses the specific analysis needs of TWG members as expressed at the April meeting in Kenai and the subsequent conference call in May. The more traditional approaches such as IFIM and habitat mapping have been subjected to substantial criticism in recent years. The proposed approach overcomes some of the limitations of IFIM and other approaches. Specifically, it does not require extensive data collection to determine "habitat suitability" as required for IFIM/PHABSIM. The proposed approach does require documentation of the rationale for the habitat use criteria selected.

Description of technical approach

1. Lateral Habitat Connectivity

Cross sections will be measured using methods developed for the Wetted Perimeter method. The method provides a graphical plot of wetted perimeter versus discharge, on which the range of flows at which a designated habitat area is unavailable can be determined visually. Site-specific flows are not collected at each cross-section; neither are vertical hydraulic measurements such as depth and velocity. Each site will include staff gages which will be read at multiple times during the field season. The date, time, and gage height will be recorded in order to correlate cross-section stage to the continuous gage. A one-time cross section survey will be conducted to determine channel and overbank geometry and to tie the staff gage to the monument to the continuous gage.

Proposed sites:

- Reach 1
  - 2 sites on the Distributary channel in rearing habitat
  - 4 sites on the main channel in rearing habitat
  - 1 site on the main channel in spawning habitat
- Reach 2
  - 2 sites on the main channel in rearing habitat
  - 2 sites in off-channel pool rearing habitat

    - 1 site on the main channel in spawning habitat
- Reach 3
    - 1 site in off-channel pool rearing habitat
    - 2 sites in secondary channel rearing habitat
    - 1 site in tertiary channel rearing habitat
    - 1 site in main channel spawning habitat
- Reach 4
    - 3 sites in main channel rearing habitat
    - 1 site in main channel spawning habitat

Proposed cross sections were located during a site visit September 24. The locations were set based on presence of physical microhabitat (i.e. undercut bank, overhead cover, bedrock outcrops, pocket water) and observations of fish during the site visit and during snorkeling studies (Figure 1). The site locations will be refined and cross section geometry will be collected in late spring 2010.

2. Microhabitat Selection Study

The purpose of the study is to learn what microhabitat factors the fish in Grant Creek select in order to assess whether proposed Grant Lake/Falls Creek Hydroelectric Project operations would have an effect on instream habitat. In order to maximize the knowledge of habitat selection factors for fish in Grant Creek, the observations would be made at the locations of the lateral habitat connectivity studies as described in section 1 of this memorandum.

Fish spawning and rearing microhabitat values will be recorded in 2010 at programmatically-selected sites (described in the Lateral Habitat Connectivity component of this study approach) in Study Reaches 1, 2, 3, and 4. Measured microhabitat use parameters will vary by habitat units. In the TWG meeting on September 23, the following table of parameters and life stages of interest was developed with input from TWG members.

Habitat use function by life history	Habitat use parameters to measure
Salmon rearing	Depth, cover, habitat connectivity
Salmon spawning	Substrate, depth, temperature, vertical hydraulic gradient
Rainbow trout spawning	TBD
Incubation	Depth, temperature
Resident rearing and spawning	Salmon rearing will be used as a surrogate

Use observations will be made from the bank for the spawning lifestage, and measurements will be recorded from the left side, right side, and head of the observed redd as site conditions allow. Snorkeling will be the method of observation of juvenile fish. Species, number, and estimated size/age classes will be recorded at each observation, and microhabitat measurements will be recorded at each location. During the high flow period in the stream (typically July through mid-September), snorkeling would be limited to the stream margins.

Fish use of winter habitats will be characterized by sampling Grant Creek in late March or early April and again in November or early December in 2010. Sample methods will include the use of baited minnow traps and the use of an underwater camera to observe fish in suspected overwinter habitat. Sample site selection will target suspected overwinter fish habitats such as deep pools, and backwater areas that appear to contain suitable overwinter flow conditions.

For this exercise, site-specific Habitat Suitability Criteria will not be developed. HSC are not required in the proposed assessment approach; however, the numbers of observations and subsequent analysis will proceed to the level sufficient to determine selection factors for each of the measured microhabitat variables. Since transects will, by definition, be within areas that are known to be suitable for fish use, those factors that are most likely to be influenced by flow changes will be emphasized.

The microhabitat selection study will be described in detail in the Fish Resources Study Plan.

3. Spawning bed thermistor strings

Spawning locations that have upwelling of groundwater or downwelling of surface water may be highly selected by fish. However, this microhabitat variable is difficult to identify and measure in the field. Since the temperature of groundwater is typically constant and surface water temperature is highly variable, temperature is usually an effective water quality “tracer” that can indicate the presence of groundwater upwelling areas.

Identifying the difference in water temperatures may be accomplished by the use of thermistor strings buried in the substrate. Three strings will be deployed at known spawning locations observed in the 2009 field season, and three strings will be deployed at spawning-appropriate locations that were observed in 2009 to <u>not</u> have spawning activity.

Each thermistor string will include three HOBO Pendant-type temperature data loggers spaced 20 cm apart. The top thermistor will be on the substrate surface, the middle thermistor will be at 20 cm depth, and the bottom thermistor will be at 40 cm depth. The thermistor strings will be deployed in the spring when flows are at their lowest, and will be recovered about one year later in order to record temperatures for a full spawning and incubation cycle. Subsequent analyses of the temperature will identify if temperature differentials between surface and subsurface water indicate if upwelling or downwelling is occurring at each location.

Proposed sites:

- 3 sites suitable for spawning with known use in 2009

- 3 sites suitable for spawning with no observed use in 2009

4. Flow and temperature monitoring

Continuous flow and temperature monitoring stations that were set in 2009 will be continued and/or reestablished in 2010. The data loggers will be downloaded at regular intervals to contribute to analysis during the 2010 field season.

Site Locations:

- Flow – one site at the location of the USGS station (assumes no flow accretion between Grant Lake outlet and mouth of Grant Creek)
- Temperature – four locations on Grant Creek, including near the proposed powerhouse location, the USGS gage, and two near the mouth of the creek.

Analysis

The components of the instream flow study will tie utilized rearing and feeding habitat units with hydrologic cycles to determine the periods of lateral connectivity for juvenile salmon and resident trout. It will also include a study of vertical temperature differences at known utilized and unutilized spawning sites to determine if upwelling or downwelling is a factor in redd selection. The results of the instream flow study will be integrated with data and results of other studies, including the hydrology, fluvial geomorphology, and aquatic biology studies.

- **Hydrology Study.** The lateral connectivity study includes measurement of staff gages that are tied in elevation to the same benchmark as the continuous discharge gage near the former USGS station. The date and time of the staff gage readings will tie the observed depths to flows measured at the continuous gage. The observed flows can then be connected to the historical hydrographs measured at the USGS gage to determine availability of habitat as a function of depth and flow over the 11 year history. The temperatures recorded in the intragravel module will also be analyzed against recorded discharges.

- **Fluvial Geomorphology Study.** The availability of spawning habitat can be affected by the proposed project if spawning gravel is not transported to downstream spawning beds. The results of the spawning gravel recruitment module of the fluvial geomorphology study will be analyzed with the lateral connectivity study at known spawning locations to evaluate how a potential change in flow regime can affect the availability of spawning habitat.

- **Aquatic Biology Study.** The presence, timing, and relative abundance of fish in Grant Creek is evaluated in the fish resources study. These data are used in analysis of the microhabitat module. The analysis of the instream flow study will be applied to the fish community in Grant Creek.

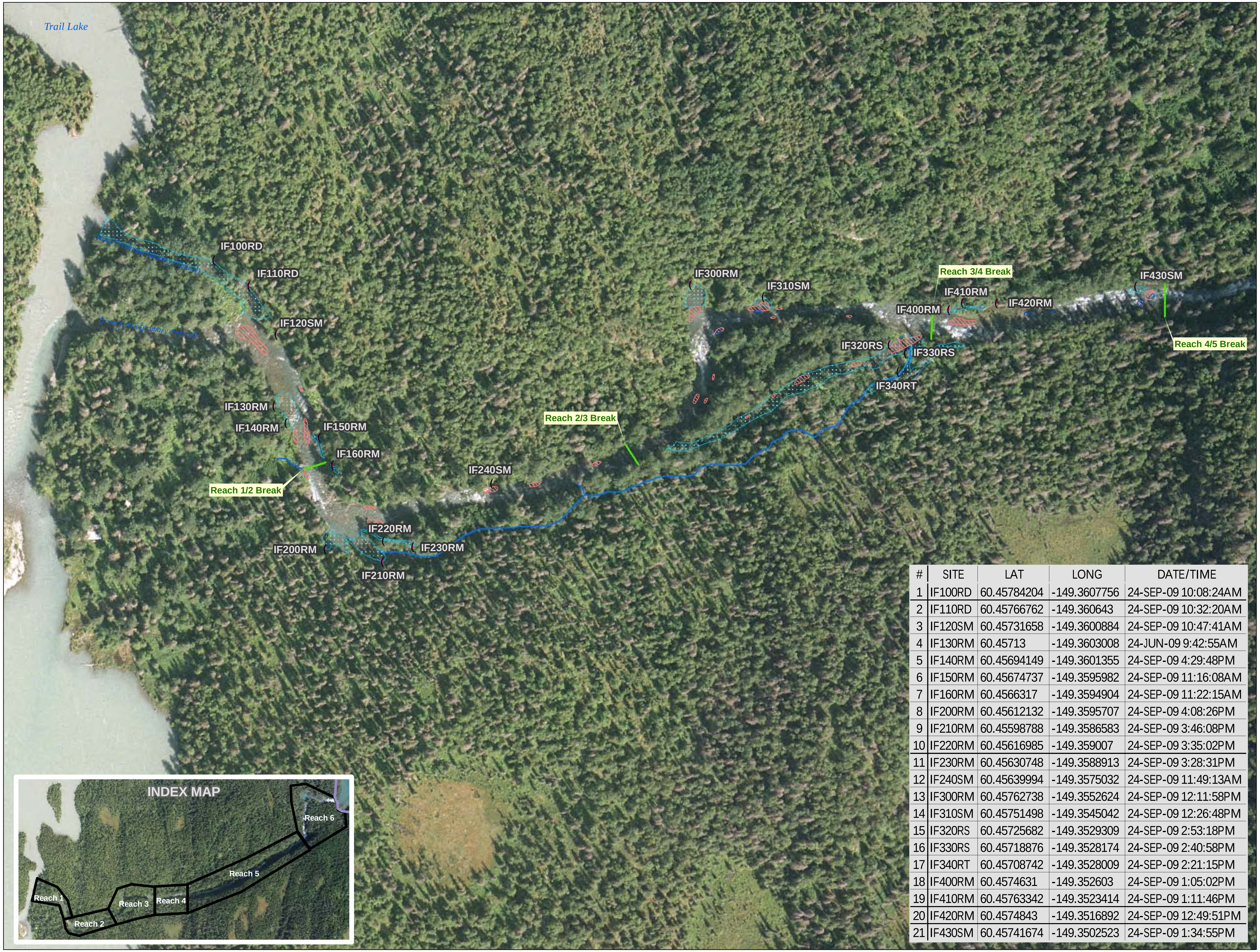
Conclusion

The Grant Creek instream flow study approach was collaboratively developed based on input from the Technical Work Group. Public meetings of the TWG were held in April and September, 2009, and a conference call was held in May 2009; input and suggestions were solicited during these meetings and also through email and phone communications with the TWG and TWG members.

The instream flow study approach represents a detailed study of utilized habitat types, and addresses the desire of the TWG to examine how important individual habitat units may be affected by changes in flow due to the operation of the project. Rather than applying a typical quantitative habitat study that generalizes mesohabitat units in a study reach, this approach uses several techniques to tie physical microhabitat to flow and timing, and applies *in situ* knowledge of fish habitat use in Grant Creek as tools to determine potential effects of the Grant Lake Hydroelectric Project.

Kenai Hydro Environmental Baseline Studies

Figure 1



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2	IF110RD	60.45766762	-149.360643	24-SEP-09 10:32:20AM
3	IF120SM	60.45731658	-149.3600884	24-SEP-09 10:47:41AM
4	IF130RM	60.45713	-149.3603008	24-JUN-09 9:42:55AM
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6	IF150RM	60.45674737	-149.3595982	24-SEP-09 11:16:08AM
7	IF160RM	60.4566317	-149.3594904	24-SEP-09 11:22:15AM
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14	IF310SM	60.45751498	-149.3545042	24-SEP-09 12:26:48PM
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21	IF430SM	60.45741674	-149.3502523	24-SEP-09 1:34:55PM

Instream Flow Study

Proposed Transect Locations

Legend

- Proposed Transect Location
- Sockeye salmon spawning observed
- Chinook salmon spawning observed
- Rearing habitat (delineation approximate)

N

Feet

0 200 400

Map Projection: NAD 83 Alaska State Plane Zone 4 Feet
Data Sources: HDR Alaska, Inc.; APA 1984
Author: HDR Alaska, Inc.
Date: October 2009

This map represents a conceptual level of utility, detail,and accuracy.
The information displayed here is for planning purposes only.
Base information shown constitutes data from various federal, state, public, and private sources.
These maps are for review purposes only.

Kenai Hydro LLC

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