Eklutna Hydroelectric Project

Eklutna River Instream Flow

Year 2 Study Report

DRAFT

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Terms, Acronyms, and Abbreviations

1D	One-Dimensional
2D	Two-Dimensional
ADFG	Alaska Department of Fish and Game
AK	Alaska
AWWU	Anchorage Water and Wastewater Utility
BM	Benchmark
cfs	Cubic Feet per Second
CSI	Combined Suitability Indices
FSP	Final Study Plan
GPS	Global Positioning System
HEC-RAS	U.S. Army Corps of Engineers River Analysis System (HEC-RAS) developed by the Hydrologic Engineering Center
HDF	Hierarchical Data Format
HSC	Habitat Suitability Criteria
HSI	Habitat Suitability Indices
LiDAR	Light Detection and Ranging
MANSQ	Manning's Equation
MJA	McMillen Jacobs Associates
NAD	North American Datum
NAVD	North American Vertical Datum
NMFS	National Marine Fisheries Service
NVE	Native Village of Eklutna
PHABSIM	Physical Habitat Simulation
PME	Protection, Mitigation, and Enhancement
QA	Quality Assurance
QC	Quality Control
QGIS	Quantum Geographic Information System
R	Reach
RMSE	Root Mean Square Error
RTK	Real Time Kinematics
STGQ	Stage-discharge relation or rating curve
TM	Technical Memorandum
TR	Transect
TU	Trout Unlimited
TWG	Technical Work Group
UTM	Universal Transverse Mercator
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAF	Velocity Adjustment Factor
WDFW	Washington Department of Fish and Wildlife
WP	Working Pin
WSE	Water Surface Elevation

WSL	Water Surface Level
WSP	Water Surface Profile
WUA	Weighted Usable Area

1 INTRODUCTION

The 1991 Fish and Wildlife Agreement (1991 Agreement) was executed amongst the Municipality of Anchorage, Chugach Electric Association, Inc., Matanuska Electric Association, Inc. (collectively “Project Owners”), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the State of Alaska as part of the sale of the Eklutna Hydroelectric Project (Project) from the Federal government to the now Project Owners. The 1991 Agreement requires that the Project Owners conduct studies that examine and quantify, if possible, the impacts to fish and wildlife from the Project. The studies must also examine and develop protection, mitigation, and enhancement (PME) measures for fish and wildlife affected by such hydroelectric development. This examination shall consider the impact of fish and wildlife measures on flow in the Eklutna River as well as available means to mitigate these impacts. The Project Owners initiated consultation in 2019 and have implemented studies to inform the development of the future Fish and Wildlife Program for the Project. As part of these studies, the Project Owners contracted Kleinschmidt Associates to describe and evaluate Eklutna River instream flow.

The instream flow study of the Eklutna River was initiated in 2021 in accordance with Section 3.1 of the May 2021 Final Study Plans (FSPs) (McMillen Jacobs Associates [MJA] 2021), which were collectively developed in response to the 1991 Agreement. As noted in the FSP, based on early outreach efforts, the main goals of the agencies and other interested parties is to find a new balance amongst the uses of water in the Eklutna River basin, including power production, potable water supply, and fish habitat. Potential flow related PME measures involve providing a flow regime into the Eklutna River that would accomplish habitat restoration and increase the anadromous fish assemblage of the river. The FSP provides additional background information and context for the instream flow study, with detailed planning, field data collection and surveying occurring in 2021, and data analysis and modeling (both one-dimensional [1D] Hydrologic Engineering Center’s River Analysis System [HEC-RAS] and Physical Habitat Simulation [PHABSIM] Modeling and barrier analysis, and two-dimensional [2D] HEC-RAS and habitat modeling) in 2022.

The 2021 efforts were described in the Year 1 Interim Report (Kleinschmidt Associates [Kleinschmidt] 2022a) with the subsequent data analysis and modeling described in three technical memoranda (TMs) that presented respectively, results of Habitat Suitability Curve (HSC) development (Kleinschmidt 2022b); 1D PHABSIM/HEC-RAS modeling and barrier analysis (Kleinschmidt 2022c): and 2D HEC-RAS and habitat modeling (Kleinschmidt 2022d). This report integrates all of the study elements into one document and therefore represents the final report for the Instream Flow Study as described in MJA (2021). The models that have been developed under this study will be used in subsequent alternatives analysis that will include results from the sediment transport/geomorphology modeling as well as operational considerations.

1.1. Goals and Objectives

As noted in Section 3.1 of the FSP (MJA 2021), the stated goal of the Instream Flow Study is to provide quantitative indices of current and future reach specific fish habitat-flow relationships and utilize those relationships for determining fish habitat under various alternative operational scenarios. Specific objectives included:

1. Mapping current aquatic habitat in the main channel, and where present, side-channels of the Eklutna River affected by Project operations.
2. Collecting data and information that can be used to characterize, quantify, and model Eklutna River fish habitat.
3. Developing a HEC-RAS model (in collaboration with the Geomorphology/Sediment Transport Study) for the length of the river that can be used to:
   a. Estimate water surface elevation and average water velocity along modeling transects on a daily basis under alternative operational scenarios; and
   b. Estimate sediment routing and transport capacities under varying flow conditions.
4. Developing HSC and Habitat Suitability Indices (HSI) for target/selected species and life stages of fish for biologically relevant time periods selected in consultation with the Aquatics Technical Work Group (TWG).
5. Developing fish habitat-flow relationships using the USFWS 1D PHABSIM models[1] that can produce a time series of data for a variety of biological metrics under existing, and future conditions resulting from alternative operational scenarios.
6. Evaluating existing conditions, and potential future conditions based on alternative operational scenarios using a hydrologic database that includes specific years or portions of annual hydrographs for wet, average, and dry years.

Following release of the Year 1 Interim Report and based on discussions with the TWG, the Year 2 studies were expanded to include 2D HEC-RAS and habitat modeling in four reaches (R) R3, R4, R6, and R10 of the Eklutna River that had not been surveyed in 2021. These reaches were not surveyed in part due to accessibility issues during release of the high target flow, susceptibility to channel change due to sediment deposition, tidal influence (R3), and complexity of habitats (braiding and multiple channels) within those reaches. The modeling of these additional reaches focused on complex off-channel and side channel habitats that provide for juvenile rearing habitats.

1.2. Study Area

The study area for the Instream Flow Study included an approximate 10-mile section of the Eklutna River extending from just below the existing dam downstream to just below the railroad bridge. This area is displayed in Figure 1.2-1.

[1] Note that 2D modeling was considered during the early study planning process (MJA 2021), but its potential use was considered most applicable to off-channel and side channel complex habitat areas that provide juvenile salmonid rearing habitat. As a result, the 1D suite of models provided in the Physical Habitat Simulation (PHABSIM) programs, in concert with the 1D HEC-RAS model were the primary set of models applied in the Year 1 Study.

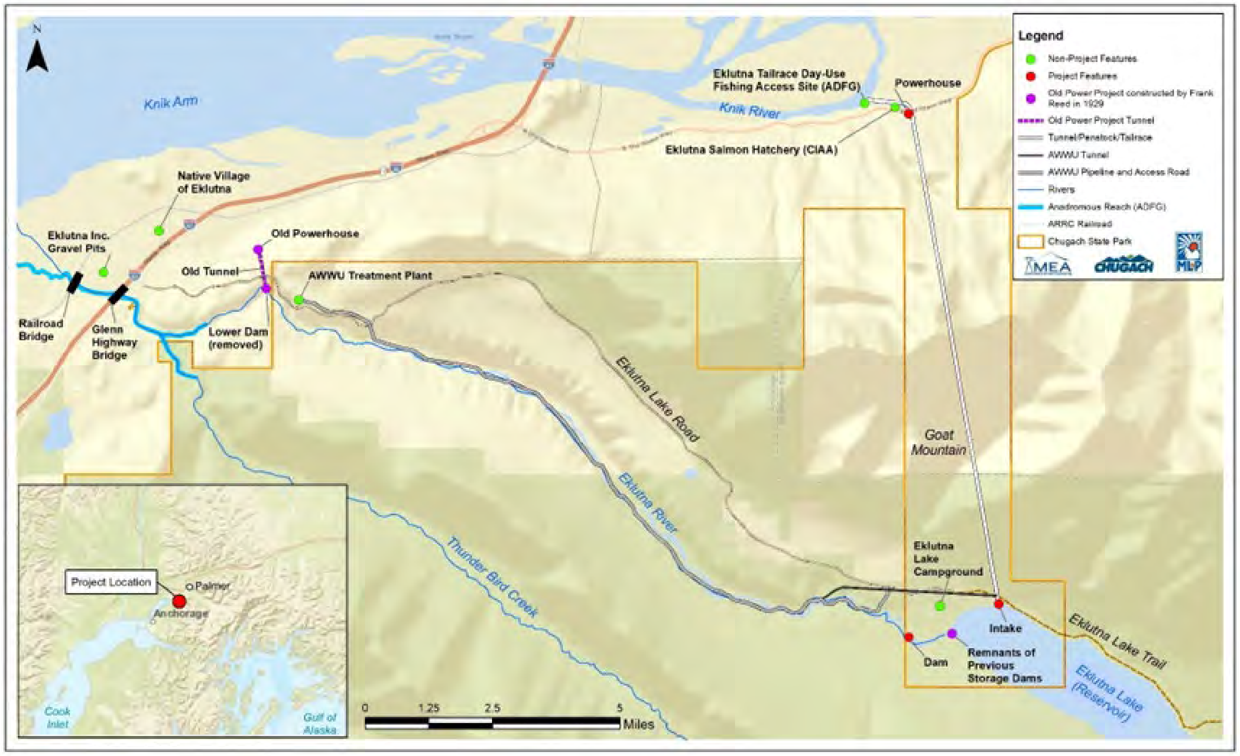


Figure 1.2-1. Eklutna River instream flow study area extending from just below the Eklutna Dam to just below the Railroad Bridge below the Glen Highway. The Instream Flow Study consisting of the one – dimensional HEC-RAS and PHABSIM modeling, two-dimensional HEC-RAS and habitat modeling, and barrier analysis was conducted within this river segment.

1.3. Process Overview

The Instream Flow Study of the Eklutna River was initiated in 2021 in accordance with Section 3.1 of the May 2021 FSPs (MJA 2021). The Year 1 Interim Report (Kleinschmidt 2022a) was completed in January 2022 and described the methods used and summarized the data and information collected during the first year of the Instream Flow Study, covering the period June 2021 through October 2021.

Subsequent data analysis in 2022 resulted in the completion of three modeling efforts for the Eklutna River including: 1) development of a HEC-RAS 1D model; 2) development of PHABSIM models; and 3) barrier analysis for five (named A-E) potential barriers to fish migration within Reach 7. The preliminary results of the PHABSIM and barrier analysis were provided in a Technical Memorandum (Kleinschmidt 2022c) and presented during a TWG meeting on September 28, 2022. A process overview flowchart depicting these three components of the Eklutna River instream flow studies is provided in Figure 1.3-1.

The additional surveying for the 2D modeling was conducted in the summer of 2022, with development of the 2D HEC-RAS and habitat models completed in the fall of 2022. Results of the 2D analysis were presented in a TM (Kleinschmidt 2022d) and provided to the Aquatics

TWG (February 13, 2023). A flowchart depicting the 2D HEC-RAS and habitat modeling process is depicted in Figure 1.3-2.

This report is organized into seven main sections, which in addition to this Introduction (Section 1) include: Section 2 – One-dimensional (1D) HEC-RAS and habitat modeling, Section 3 – Eklutna River Canyon barrier analysis, and Section 4 – Two-dimensional (2D) HEC-RAS and habitat modeling. Each of these sections describes the field data collection and analytical/modeling methods used, modeling results, and general conclusions resulting from each component. Section 5 – Summary Analysis considers the implications of each study component relative to potential flow releases below Eklutna Dam, and how the findings can be applied in an evaluation of flow related alternatives that focus on the provision of productive fish habitats in the Eklutna River. Section 6 – Variances from Final Study Plan lists any modifications or changes in study design from that specified in the original study plan; and Section 7 – References contains a listing of documents cited in the report.

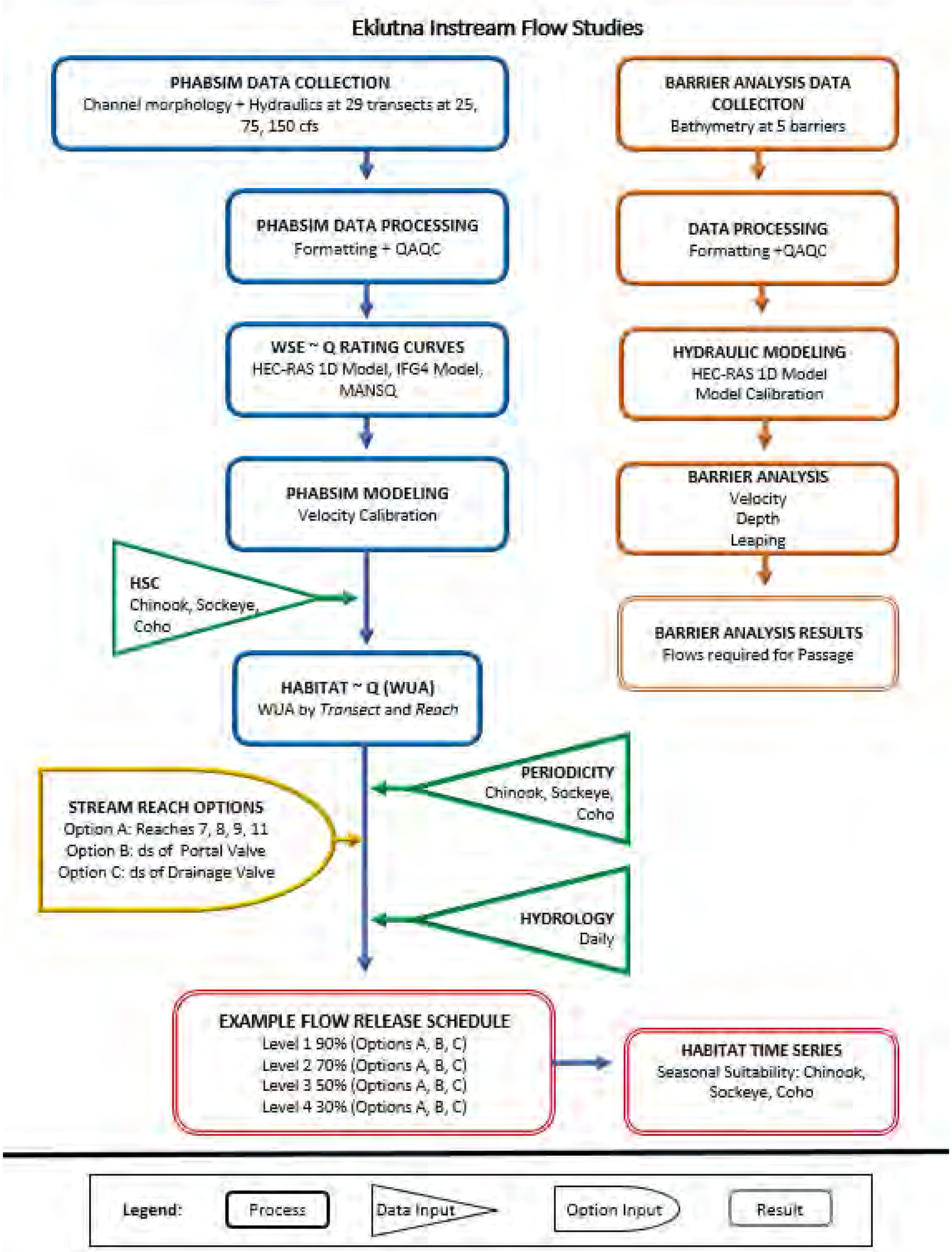


Figure 1.3-1. Flowchart depicting components of the Eklutna River 1D HEC-RAS and PHABSIM process, shown on the left; and barrier analysis, shown on the right.

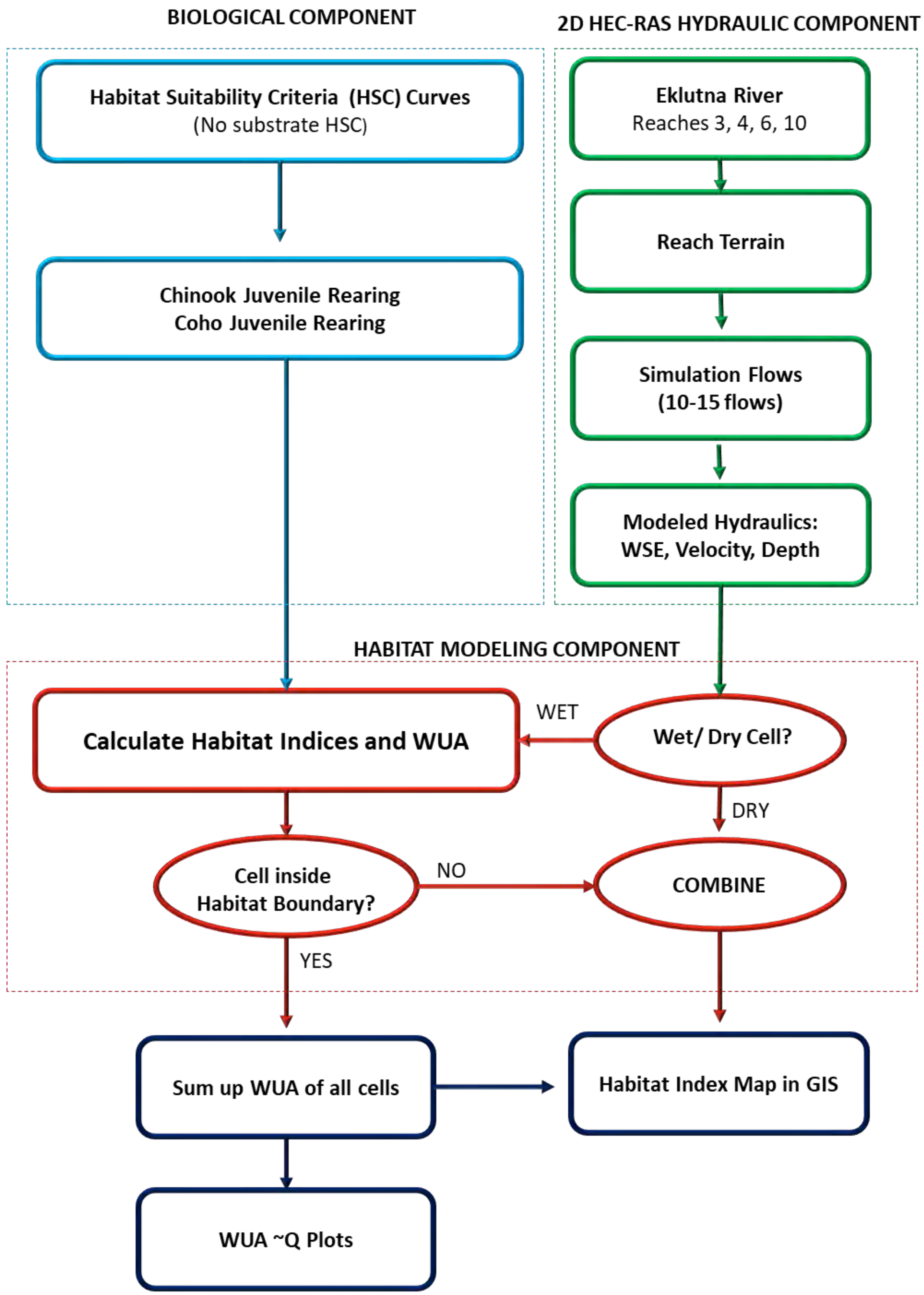


Figure 1.3-2. Flow chart depicting components of the Eklutna River 2D HEC-RAS hydraulic and habitat modeling analysis. The biological components are shown on the left and the 2D HEC-RAS modeling components shown on the right.

2 ONE-DIMENSIONAL (1D) HEC-RAS AND HABITAT MODELING

The 1D HEC-RAS and PHABSIM modeling component of the Instream Flow Study commenced in 2021 with the compilation and review of information and field data collection and surveying, and the majority of data analysis and modeling completed in 2022.

2.1. Existing Information

As part of planning activities, relevant existing information was compiled and summarized to provide an initial assessment of flows, fish species, and sediment conditions in the river, available cross section data, and hydrologic metrics. This included:

- Aerial photographs (1950s to present)
- Light Detection and Ranging (LiDAR) data (2016 and 2020)
- Aerial videography (2020)
- USFWS cross sections and hydraulic analysis (2019)
- Alaska Department of Fish and Game (ADFG) fish habitat monitoring (2018 to present)
- Habitat mapping – Brophil and Lamoreaux (2020) and Prince of Wales Tribal Enterprise Consortium (2007)
- Existing HEC-RAS model of the lower Eklutna River – HDR (2016)
- USGS gage records

This material, combined with on-site observations made during a field reconnaissance of the river in July 2020, provided important background information used in the development and implementation of the Instream Flow Study plan.

2.2. Study Site Selection

In parallel with the compilation of existing information, an initial field reconnaissance survey (completed by D. Reiser – Kleinschmidt; R. Benkert – ADFG; S. Owen – MJA; and S. Padula - HRS) was completed from July 21-22, 2020 of the entire length of the Eklutna River, extending from just below the railroad bridge upstream to the existing dam. The survey provided an initial perspective on potential study reaches and transect locations based primarily on the longitudinal distribution of natural and anthropogenic sediments and meso-habitat diversity. Subsequent dialogue with Kathy Dubé (Lead of Geomorphology-Sediment Transport Study – see Section 3.2 of FSP [MJA 2021]) resulted in the removal of river segments with high levels of silt/sediment deposition from consideration of instream flow surveying (see Section 3.1.4.3 of FSP [MJA 2021]).

The Instream Flow Study relied on the development of a meso-habitat map of the entire length of the river that defined major habitat types (riffle, run, pool, glide, etc.) and features throughout the river. This map was used to finalize fish habitat reach breaks within the geomorphic reaches and to select study sites and locations of transect placement. Review of the processes, methodologies, and results of reach designations and macro- and meso-habitat mapping already completed by Brophil and Lamoreaux (2020) and USFWS (2019) provided a solid foundation of information that factored into the identification and mapping of meso-habitat types, and the selection of study sites.

Because of certain, spatially distinct areas of sediment deposition and access considerations in the river, study sites were only established in fish habitat reaches containing useable habitats that would likely exist post-study flow releases. These included two reaches below Thunderbird Creek, R4 and R5, and four reaches above Thunderbird Creek, R7, R8, R9 and R11 (Figure 2.2-1).

Specifically, because the reach of the Eklutna River within and immediately downstream of the lower dam site is so heavily sedimented, channel morphology changes would likely continue to occur even after the 2021 study flow releases. Therefore, no fish habitat modeling sites were established within that reach (i.e., no sites between the lower dam site and the Thunderbird Creek confluence).

This was discussed further with Kathy Dubé (Geomorphology-Sediment Transport Study Lead) and led to the establishment of the following three segments of the Eklutna River Study Area for the instream flow study (Figure 2.2-1):

- Above the upper Anchorage Water and Wastewater Utility (AWWU) bridge consistent with or proximal to the USFWS 2019 study reach;
- Between the upper AWWU bridge and the lower dam site; and
- Between the Thunderbird Creek confluence and just below the railroad bridge.

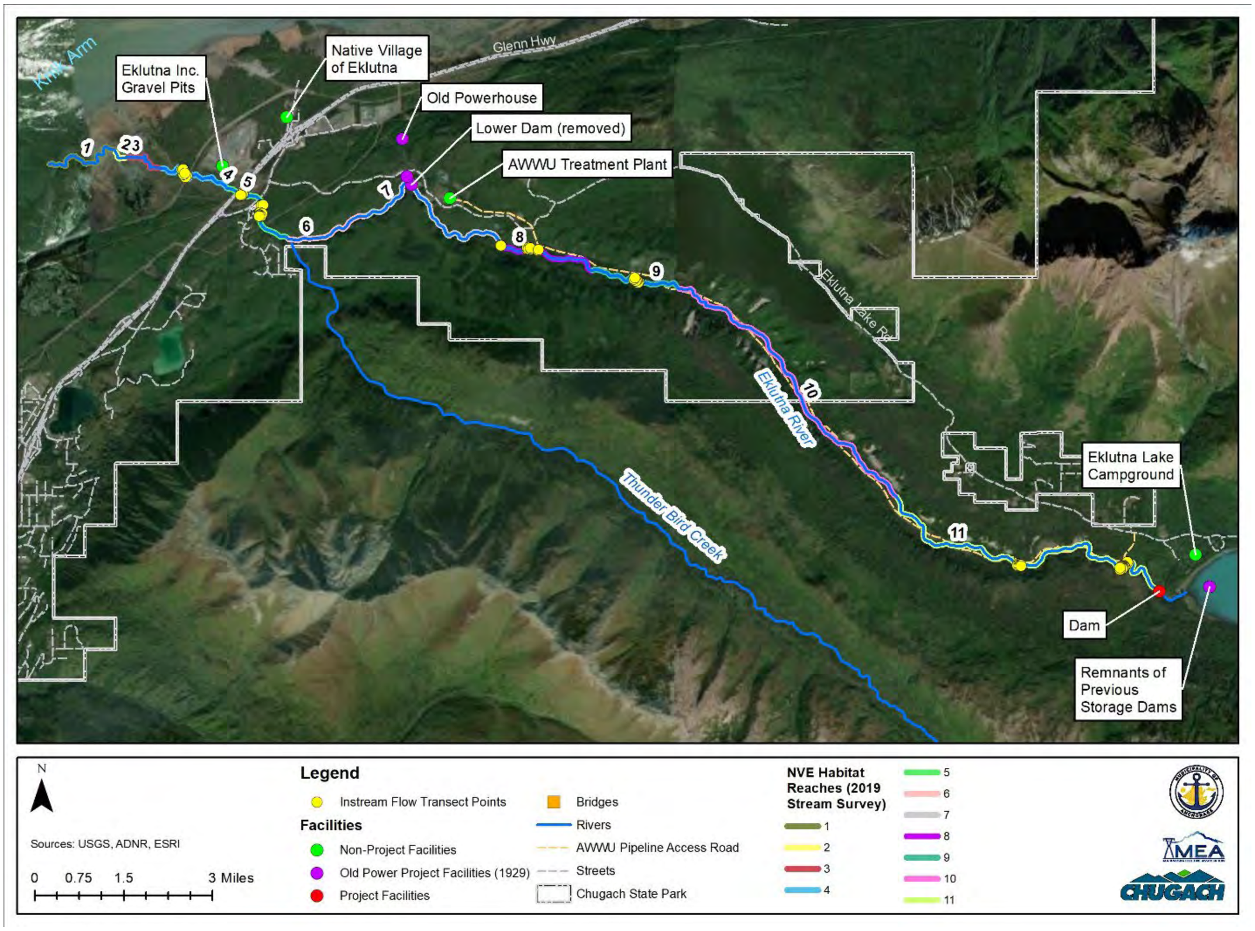


Figure 2.2-1. Eklutna Instream Flow Study Area showing reach designations. PHABSIM transects were located in Reaches 4, 5, 7, 8, 9 and 11.

The selection of exact study sites and transects (see Section 2.3.1) was made in coordination with the Aquatics TWG during a June 9-10, 2021 field reconnaissance and was based on results of the initial July 21-22, 2020 site reconnaissance, the Native Village of Eklutna (NVE) habitat mapping and with consideration of existing sites and transects, including those established by ADFG, NMFS, USFWS, HDR, and NVE. Side channels and slough type habitats were considered during the site selection process

2.3. Field Data Collection

2.3.1. Transect Selection

The overall goal in selecting instream flow study sites and transect locations was to identify areas representative of the hydraulic and physical microhabitat variability and/or that provide critical or unique habitats for the fish species of interest within the Eklutna River.

As an initial step in the transect selection process, the following data sources were reviewed and communications established:

- Eklutna River Salmon Habitat Assessment and Collaboration to Recommend Restoration Flows (Brophil and Lamoreaux 2020);
- Upper Eklutna River Survey – Preliminary Fish Habitat Flow Assessment (Hanson 2019);
- Geomorphology/Sediment Transport Study – 1991 Agreement Implementation Proposed Final Study Plans (MJA 2021);
- Eklutna River Fish Species Composition and Distribution Study – 1991 Agreement Implementation Proposed Final Study Plans (MJA 2021);
- Site photographs compiled from July 21-22, 2020 field reconnaissance; and
- Personal communication with Kathy Dubé (Geomorphology/Sediment Transport Study Lead) Watershed GeoDynamics, May 26, 2021.

Review and consideration of these materials resulted in development of a preliminary set of proposed river reaches, study sites, transect numbers and locations. This process was completed following a stepwise procedure as outlined by Bovee (1982):

- **Step 1**: Partition the river into homologous reaches using such criteria as hydrology, entrenchment, bank-full width, sinuosity, substrate composition, and gradient. This step was completed as part of the NVE Eklutna River habitat assessment (Brophil and Lamoreaux 2020) following procedures outlined in the California Salmonid Stream Habitat Restoration Manual and resulted in the delineation of 11 river reaches (Figure 2.2-1).
- **Step 2**: *Inventory and map each mesohabitat type (e.g., pool, riffle, and run) within the river reaches).* This step was completed as part of the NVE Eklutna River habitat assessment (Brophil and Lamoreaux 2020) following procedures described in the *California Salmonid Stream Habitat Restoration Manual* and resulted in the delineation of 147 mesohabitat units.
- **Step 3**: Utilizing the results of Steps 1 and 2, calculate the percent composition of each mesohabitat type for each of the 11 river reaches (Table 2.3-1).
- **Step 4**: *Select river reaches to be sampled.* Several factors were considered in the selection of river reaches for sampling including channel stability, sediment deposition, habitat diversity, consolidated flow, substrate composition, access, and fish use (Table 2.3-2). An underlying assumption of instream flow studies is that the existing channel bed morphology is stable and will remain that way for the foreseeable future. As stated in Section 2.2, this is clearly not the case for a considerable portion of the Eklutna River and resulted in selection of three river segments consisting of:
    - Above the upper AWWU bridge consistent with or proximal to the USFWS 2019 study site;
    - Between the upper AWWU bridge and the lower dam site; and
    - Between the Thunderbird Creek confluence and just below the railroad bridge.

  Utilizing these criteria, six reaches were selected for sampling – Reaches 4, 5, 7, 8, 9, and 11 (Table 2.3-2). Safety concerns also factored into the final selection of transects with reaches of the river that could not be safely accessed under all test flow releases, and the remaining reaches were eliminated from consideration.

- **Step 5**: *Select representative study sites from within each river reach identified in Step 4.* Study sites were selected to ensure that each major mesohabitat type (>10% composition) was represented at least once and in the same general proportion as in the stream reach. Substrate composition, site access, channel stability, and safety concerns were also considered when defining study sites. Following these guidelines, one representative study site was delineated within each of the six study reaches (Figure 2.2-1).

  One additional, site was added to Reach 11. This site overlaps the sample site established by USFWS in 2019 and was chosen because it is upstream of several alluvial fans which have contributed a large volume of sediment to the channel. Furthermore, it is likely this site provides a channel morphology template of what conditions may look like in other locations absent the high silt/sediment deposits.
- **Step 6**: *Select mesohabitat types for transect placement.* Using the habitat inventory and percent composition information, representative habitat units of each mesohabitat type (e.g., runs, riffles, pools) that represented greater than 10% of the linear distance within each sample site were identified (Table 2.3-3). These were field verified during the June 9-10 field reconnaissance. Representative side channel habitats were also identified and included for potential sampling during the field reconnaissance.
- **Step 7**: *Locate (1-3) transects within mesohabitat units identified in Step 6.* The number, location/positioning of each transect within a mesohabitat type was intended to effectively reflect the hydraulic and physical characteristics present across a wide range of potential flow conditions. The final number and location of mesohabitat transects was selected in consultation with the TWG during the June 8-9, 2021 site visit (Table 2.3-3).

Table 2.3-1. Summary of NVE Eklutna River, Alaska reaches with percent mesohabitat (based on Brophil and Lamoreaux 2020).

Attribute	NVE Reaches										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Length (ft)	1,813	3,282	3,778	4,125	3,781	6,040	4,441	4,780	4,308	10,994	14,050
No. Mesohabitat Units	7	6	16	10	9	14	23	7	14	21	20
No. Off-Channel Units	0	5	15	4	3	0	0	0	0	1	1
Percent Composition[1]											
Run	87	0	33	2	51	67	47	3	14	51	23
Glide	0	32	40	6	0	4	0	8	0	30	5
Riffle	9	0	27	76	46	25	18	86	79	4	2
Cascade	0	0	0	0	0	0	6	1	1	0	0
Mid Channel Pool	0	0	0	0	2	0	14	1	1	7	7
Scour Pool	4	0	0	0	1	4	10	0	0	0	0
Backwater Pool	0	68	0	2	0	0	6	0	5	0	0
Ponded Pool	0	0	0	0	0	0	0	0	0	2	0
Flooded Forest	0	0	0	14	0	0	0	0	0	0	0
Dry	0	0	0	0	0	0	0	0	0	5	62

Notes:
1 Percent composition totals do not always equal 100 due to rounding errors.

Table 2.3-2. Summary of criteria used in selection of sampling reaches in the Eklutna River.

Selection Criteria	NVE Reaches										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Fish Use	H	H	H	H	H	M	Unk	Unk	Unk	Unk	Unk
Habitat Diversity	L	M	H	M	M	M	H	M	M	M	Unk
Access	L	L	H	H	H	M	M	H	H	L	H
Channel Stability	L	L	L	L	M	L	L	M	M	M	M
Consolidated Flow	M	L	L	M	H	H	H	H	H	H	H
Selected for Sampling				✓✓	✓✓		✓✓	✓✓	✓✓		✓✓

Table 2.3-3. Summary of mesohabitat selection and number of transects proposed for 2021 IFS sampling on the Eklutna River, Alaska.

NVE Reach	Representative Sampling Site	Mesohabitat Types	Number of Units	Percent Composition	Selected for Sampling	Selected Unit	Proposed # Transects
4	D/S of railroad bridge (approx. 600 ft)	Run	1	86.8	✓✓	16	1
		Riffle	1	13.2	✓✓	17	2
5	Hwy 1 to Thunderbird Cr. (approx. 3,200 ft)	Run	1	44.2	✓✓	24	2
		Riffle	2	44.1	✓✓	21	3
		HG Riffle	2	10.0	✓✓	25	2
		Pool	1	1.6	Falls Out	NA	0
7	Upstream most extent of canyon just before transition to Reach 8 (approx. 200 ft)	Run	1	47	✓✓	62	1
		Riffle	1	16	Falls Out	NA	0
		HG Riffle	1	2	Falls Out	NA	0
		Cascade	1	6	Falls Out	61	0
		Pool	1	29	✓✓	60	1
8	U/S of canyon and old impoundment sediment storage; near AWWU access road (approx. 1,353 ft)	Run	1	10.7	✓✓	67	1
		Riffle	2	78.1	✓✓	69	3
		HG Riffle	1	9.7	Falls Out	65	0
		Pool	1	1.5	✓✓	NA	1
9	U/S most portion of the reach; bisected by road crossing/ford (approx. 1,372 ft)	Run	2	10.3	✓✓	80	1
		Riffle	1	36.4	✓✓	76	2
		Pocket Water	2	40.3	✓✓	NA	0
11	D/S of first large slides; end of AWWU Road with bridge access (approx. 3,428 ft)	Run	2	23.6	✓✓	117	2
		Riffle	1	8.3	✓✓	118	2
		Pool	2	12.4	Falls Out	NA	0
		Dry	2	55.3	Falls Out	NA	0
11	U/S of AWWU access road (location of USFWS 2019 sampling)	Run	1	56.8	✓✓	123	3
		Pool	1	7.1	Falls Out	NA	0
		Dry	1	36.1	✓✓	122	3
Total Number of Proposed Transects							**30**

This process resulted in the selection of river reaches and associated number of proposed instream flow transects for each reach. A summary of the rationale for selecting certain reaches and the numbers of transects within each reach is presented below.

- **NVE Reach 1 (within Geomorphic Reach 1) –** this is the downstream most reach within the study area and drains directly into Cook Inlet. The reach is tidally influenced and as such, is susceptible to continual change. The gradient is low throughout the reach and channel substrate composition is predominately silt and sand. Fish habitat diversity is low with run habitat comprising over 85 percent of the reach length. It is assumed that fish use is generally limited to adult and juvenile rearing and passage to upstream habitats. For these reasons, NVE Reach 1 was not selected for sampling.
- **NVE Reach 2 (within Geomorphic Reach 1) –**this is the shortest of the study reaches and was heavily impacted by beaver activity (three dams) during the 2019 survey by Brophil and Lamoreaux (2020). Like Reach 1, this reach is low gradient with a high composition of silt/clay and sand substrate. Habitat diversity is directly influenced by beaver dams creating backwater pools and glide habitat. Backwater pools/ponds provide good rearing habitat and a limited amount of spawning activity has been noted in the reach. Due to the extensive beaver activity and connection to off-channel ponds, NVE Reach 2 was not selected for sampling.
- **NVE Reach 3 (within Geomorphic Reach 1) –** this reach is heavily braided with numerous side- and off-channel areas and with a complex array of connection points. For a large portion of the reach, it is difficult to identify the mainstem channel. Mesohabitat types are evenly distributed with riffles, run, and glides present in approximately equal quantities (Brophil and Lamoreaux 2020). Channel substrate is comprised mostly of highly embedded gravels with a high percentage of silt/clay. Due to the complex channel network and unstable nature of the channel, NVE Reach 3 was not selected for sampling.
- **NVE Reach 4 (extending within Geomorphic Reach 2) –** this reach is over 4,000 feet in length and is composed of 10 mesohabitat units. The reach contains a section of flooded forest where stream width varies from 30 ft to over 200 feet and no clear mainstem channel is discernable. Additionally, the reach contains several side channels with poorly defined connections to the mainstem channel. Mesohabitat type in this reach was predominantly riffles (74.5%). Previous gravel mining in the 1980s has disrupted the river path resulting in a complex channel system (Brophil and Lamoreaux 2020). Substrate composition has shifted from highly embedded gravels to predominately small and large cobble. Just downstream of the railroad bridge, the river forms a single channel comprised of riffle and run mesohabitat. Due to the extensive fish use, access, and presence of a single thread channel, a section of NVE Reach 4 was selected for sampling including two mesohabitat types (riffle and glide) with three transects established.
- **NVE Reach 5 (within Geomorphic Reach 3)–** this reach is predominately comprised of a single thread channel that extends from Glenn Highway to Thunderbird Creek. The old and new Glenn Highway bridges create short channelized sections. Mesohabitat complexity is moderate-good with nearly equal quantities of run and riffle habitat (Brophil and Lamoreaux 2020). Under current

conditions, Thunderbird Creek is the major source of flow to the reach. Substrate composition is variable throughout the reach with cobble, boulders, gravel, sand, and silt all present. This reach supports the highest concentration of salmon spawning in the Eklutna River. Recent surveys have documented use by all five Pacific salmon stocks (NVE 2003, unpublished data). Due to the extensive fish use, channel stability, access, and mesohabitat diversity, NVE Reach 5 was selected for sampling including three mesohabitat types (run, riffle, high gradient riffle) represented by seven transects.

- **NVE Reach 6 (within Geomorphic Reach 4) –** this reach contains a single thread channel that has been heavily impacted by fine sediment left behind after removal of Lower Eklutna Dam in 2018. Existing flows have transported a large portion of the remaining sediment to the downstream portion of the reach. For the entire length of the reach, the channel is confined within a steep walled canyon. Mesohabitat is predominately run habitat with highly embedded gravel substrate. A small waterfall that has formed at the previous dam site may limit upstream fish passage under lower flow conditions. Due to the high level of fine sediment and unstable nature of the channel, NVE Reach 6 was not selected for sampling.
- **NVE Reach 7 (within Geomorphic Reaches 4, 5 & 6) –**this reach likewise contains a single thread channel that cuts through the upstream portion of the Eklutna River canyon. Mesohabitat diversity is high with run, riffle, and pool habitat each comprising greater than ten percent of the reach length. Substrate composition is predominately silt/clay as this reach was within the depositional area of the recently removed Lower Eklutna Dam. This material is highly erosive and susceptible to movement in response to high flow events. Numerous colluvial slides are present in the reach with active recruitment of silt/clay and sand material to the channel. Due to the unstable nature of the channel and the active recruitment of fine sediment from the channel margins for most of the reach, only the upstream most portion of Reach 7 was selected for sampling represented by two transects.
- **NVE Reach 8 (within Geomorphic Reaches 7 & 8) -**this reach is located upstream of the Eklutna River canyon and flows through a relatively wide valley bottom. Mesohabitat composition is predominately riffle, but also contains some run, glide, and high gradient riffle units. Channel substrate is coarse dominated by boulder and cobble. The AWWU pipeline road provides access to the reach and parallels the river for most of the upstream portion. The road does not appear to confine or restrain channel meander. Both channel banks are lined with riparian vegetation providing nearly 100 percent canopy coverage. Juvenile Dolly Varden char have been observed in the reach. Higher flows are predicted to remove fine sediment from the reach and provide improved spawning and rearing habitat (Brophil and Lamoreaux 2020). Due to the presence of resident fish species, channel stability, access, and potential to provide spawning habitat, Reach 8 was selected for sampling including three mesohabitat types (run, riffle, and pool) represented by five transects.
- **NVE Reach 9 (within Geomorphic Reach 8) –** this reach is just over 4,300 feet in length with a gentle meander pattern across the valley floor. The AWWU access road runs parallel to the reach but does not appear to constrain or restrict the channel. The reach is composed of 14 units with riffle mesohabitat comprising over 75 percent of the reach. This reach was not continuously wetted during the 2019 NVE survey

(Brophil and Lamoreaux 2020) and several isolated pools (pocket pool) were noted during the survey. Several active colluvial fans enter the river within this reach delivering silt/clay and gravel into the system. Access to this reach is good from the AWWU pipeline road and should be safe during all proposed flow conditions. Due to the potential for providing diverse mesohabitat (riffle, run, and pool) under higher flow conditions, its meandering flow pattern, substrate composition, and safe access during high flow releases, NVE Reach 9 was selected for sampling including three mesohabitat types (run, riffle, and high gradient riffle) represented by three transects.

- **NVE Reach 10 (within Geomorphic Reach 9) –** this reach is the second longest in the study area at just over 2 miles in length. The reach was not continuously wetted during the 2019 NVE survey with just over five percent of the channel dry. Mesohabitat was predominately run (51%) and glide (30%) with several short, cascade habitat units distributed throughout the reach (Brophil and Lamoreaux 2020). Silt/clay was the dominate substrate with gravel and boulders subdominant. Numerous colluvial fans are present within the reach with active recruitment of silt/clay and gravel. The large influx of sediment from the colluvial fans has resulted in a highly variable channel width ranging from just a few feet to over 75 feet. The AWWU pipeline road crossed the channel several times within this reach, but there are no bridges. Access to the reach would be restricted during high flow events**.** Due to the active recruitment and deposition of fine sediment to the channel and limited access, Reach 10 was not selected for sampling.
- **NVE Reach 11 (within Geomorphic Reaches 9 & 10) –** this reach is the longest in the study area at 2.6 miles. During the 2019 NVE survey, over 60 percent of the reach was dry limiting the delineation of mesohabitat types (Brophil and Lamoreaux 2020). For the wetted sections of the reach, run mesohabitat was the dominate habitat type. Channel substrate is highly embedded with silt/clay. Portions of this reach are heavily impacted by recruitment of colluvial material with aggradations of cobble, boulders, and gravels as well as sediments/silts. The AWWU pipeline road runs adjacent to the river and constrains the natural channel meander pattern in several locations. Although the river is channelized within this reach, wetted side channels that are no longer connected to the river were noted during the NVE survey. Access to the reach is good with two bridges providing safe river crossings during high flow events. In 2019, the USFWS established an instream flow sampling site approximately 0.5 miles downstream of the Eklutna Lake dam (Hanson 2019). This site was selected for the purpose of estimating the discharge necessary for fish spawning and incubation and was upstream of the large colluvial fans that are contributing sediment to the reach. Due to the length of the reach, unrestricted access, and presence of the previous USFWS sampling location, two sites were selected for sampling. The first site encompassed the same general location as the 2019 USFWS site represented by six transects. A second site was located downstream of the campground/picnic area but just upstream of the influence of a large beaver pond and was represented by four transects; ten total transects in Reach 11.

Final study sites and transect locations were made based on site-specific conditions and field verification with the TWG during the June 9-10, 2021 study site and transect selection field survey. This survey was a joint effort between the Instream Flow and Geomorphology/Sediment Transport studies and included representatives from NVE, USFWS, NMFS, ADFG and Trout Unlimited (TU). During the survey, instream flow transects were initially flagged and where possible, working pins and temporary benchmarks (BMs) established (Appendix 1 – Instream Flow Transect Data – Eklutna River, Alaska, Figures A.1-2, A.1-12, A.1-34, A.1-41, A.1-57, and A.1-67) depict final reach and approximate transect locations established and surveyed in the Eklutna River. Figure 2.3-1 shows one of the maps indicating the distribution of transects in R8.

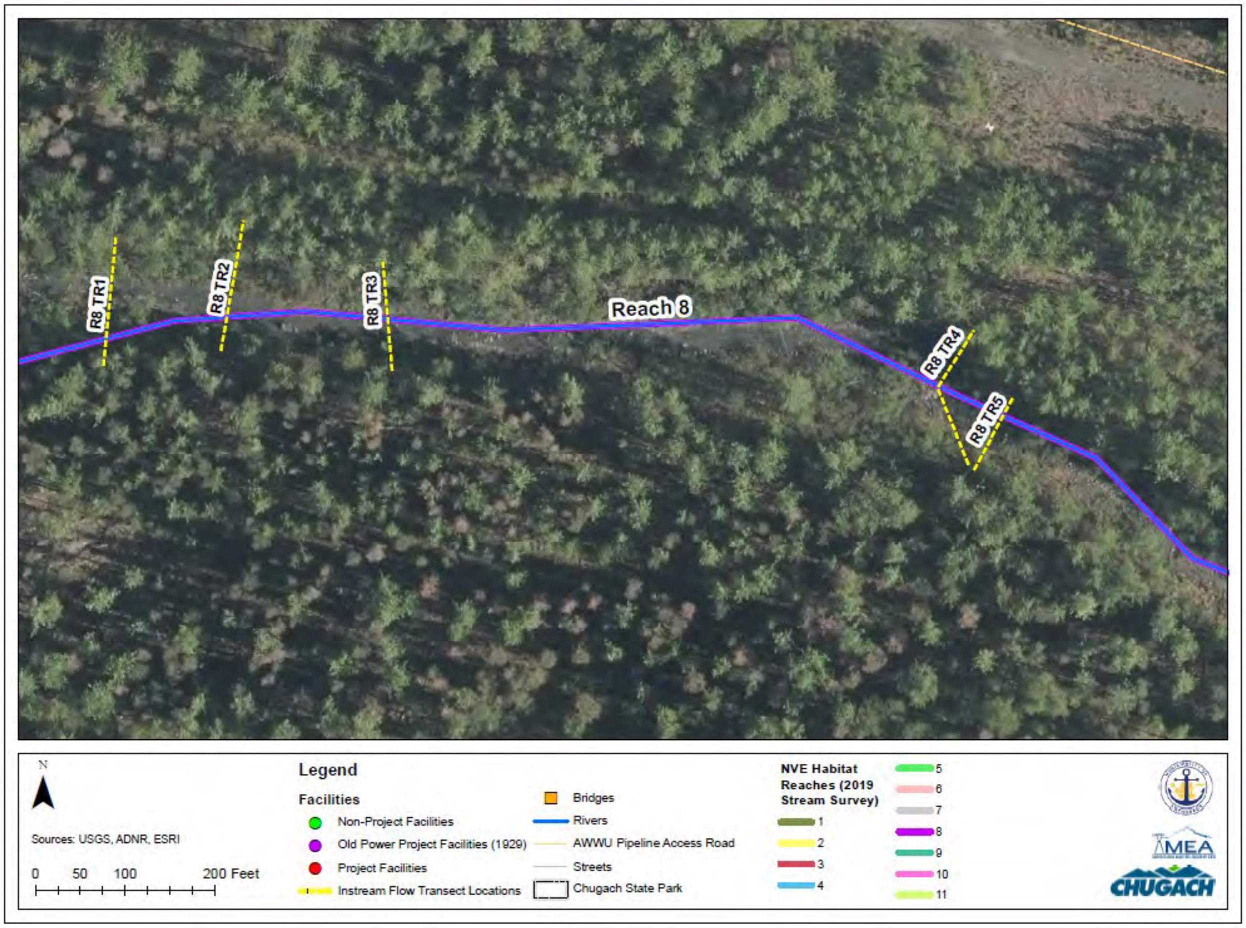


Figure 2.3-1. Map showing locations of transects within mesohabitats in Reach 8 of the Eklutna River.

2.3.2. Selection, Sequence and Release of Target Flows

Development of the PHABSIM and HEC-RAS models requires field data collected at the established transects during several different flows. For the 2021 studies, flows were regulated through a newly installed 30x30-inch drainage outlet gate located at the base of the spillway that could nominally release up to 191 cubic feet per second (cfs) (with the reservoir at the spillway crest). The 2021 studies targeted release flows of 150 cfs, 75 cfs, and 25 cfs as described in Section 3.1.4.5 – Selection of Target Flows and Range of Extrapolation in the FSP (MJA 2021). One set of validation measurements was made on September 9 after gate installation under a low flow release and reported 25.3 cfs.

The PHABSIM modeling is generally governed by a range of extrapolation that reflects 0.4 times the lowest measured field flow to 2.5 times the highest measured field flow. Thus, based on the three target flows, the range of PHABSIM model extrapolation would nominally be from 10 cfs to 375 cfs. However, the HEC-RAS models under development are not constrained by the same limits of extrapolation as the PHABSIM model; HEC-RAS has been widely used to calculate water surface elevations and flood inundation areas at 100-year flood conditions.

The target flows were released in the same sequence, i.e., highest to lowest, to afford the greatest opportunity for sediment transport and channel stabilization over that flow range. Higher flows could not be measured at that time. Flow releases commenced on September 13 and ended on October 6, 2021. Flow adjustments and dates of field surveys were as follows:

- Monday, September 13 – Initiated high target flow (150 cfs) release
- Monday, September 20 – Initiated field surveys of high-flow
- Thursday, September 23 – Completed high-flow field surveys
- Friday, September 24 – Down-ramped to mid-target flow (75 cfs) release
- Saturday, September 25 – Initiated field surveys of mid-flow
- Tuesday, September 28 – Completed mid-flow field surveys
- Wednesday, September 29 – Down-ramped to 25 cfs
- Thursday, September 30 – Initiated field surveys of low-flow
- Saturday, October 2 – Completed low-flow field surveys
- Wednesday, October 6 – Down-ramped to 0 cfs

Overall, the flow release schedule encompassed a 24-day period; 11 days high flow; 5 days mid-flow; 8 days low flow.

The regulation of flows between target flows followed a structured down-ramping schedule designed to prevent or minimize the potential stranding and/or trapping of fish in reaches of the Eklutna River subjected to flow reductions during the controlled flow releases. The schedule followed a down-ramping criterion of 2 inch/hour and was based on Hunter (1992), who concluded that salmonid fry smaller than 50 mm in length are most vulnerable to stranding. Fingerlings, smolts and adults are also vulnerable to stranding, but because of their greater mobility they can withstand down-ramping rates greater than that resulting in the stranding of fry.

The downramping schedule for the Eklutna River was based on a rating curve for USGS Gage 15280000 (Eklutna River downstream from Eklutna Dam). The rating curve (Figure 2.3-2) was developed from measurements performed from 1947 to 1964. The stage-discharge rating curve was used to calculate the reduction in stage for the downramping sequences listed in Table 2.3-4. The average hourly downramping rates were all less than 2 inches/hour and ranged from 1.25 inches to 1.50 inches.

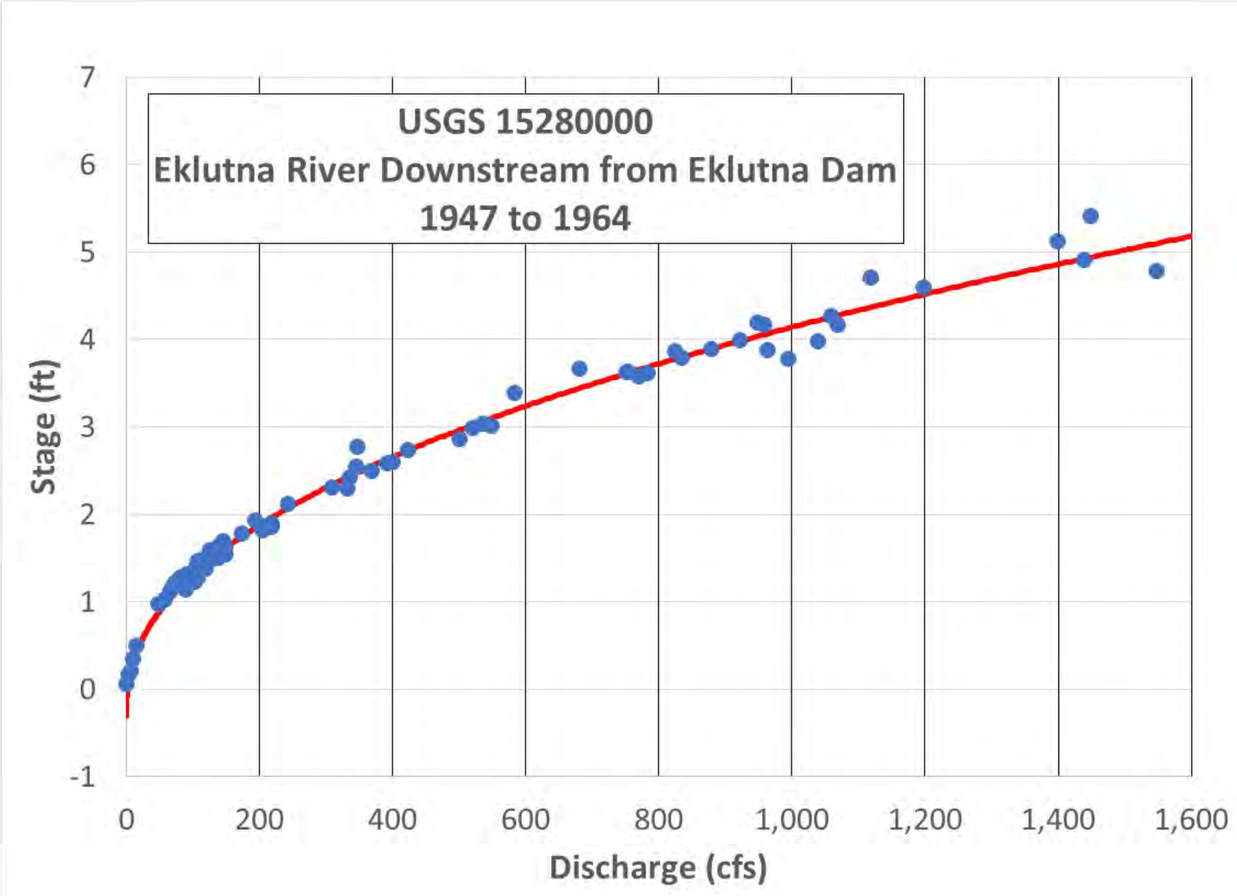


Figure 2.3-2. Stage-discharge rating curve for USGS Gage 1528000, Eklutna River, Alaska, downstream from Eklutna Dam.

Table 2.3-4. Average hourly downramping rates for three flow reductions in the Eklutna River, Alaska.

Downramping Event	Total Stage Reduction (inches)	Number of Hourly Downramping Steps	Average Hourly Downramping (inches)
150 to 75 cfs	5.0	4	1.25
75 to 25 cfs	6.5	4	1.63
25 to zero cfs	7.5	5	1.50

It was determined that converting to an approximate 2 inch/hour down-ramping sequence from 150 cfs to 75 cfs would require four flow adjustments:

1. Hour 0 with existing flow at 150 cfs, make adjustment to 125 cfs
2. Hour 1 (existing flows at 125 cfs) – make adjustment to 105 cfs
3. Hour 2 (existing flows at 105 cfs) – make adjustment to 90 cfs
4. Hour 3 (existing flows at 90 cfs) – make adjustment to 75 cfs and hold for pre-determined time

Converting to an approximate 2 inch/hour down-ramping sequence from 75 cfs to 25 cfs would likewise require four flow adjustments:

1. Hour 0 with existing flow at 75 cfs, make adjustment to 55 cfs
2. Hour 1 (existing flows at 55 cfs) – make adjustment to 40 cfs
3. Hour 2 (existing flows at 40 cfs) – make adjustment to 31 cfs
4. Hour 3 (existing flows at 31 cfs) – make adjustment to 25 cfs and hold for pre-determined time

And finally, converting to an approximate 2 inch/hour down-ramping sequence from 25 cfs to 0 cfs requires five flow adjustments:

1. Hour 0 with existing flow at 25 cfs, make adjustment to 20 cfs
2. Hour 1 (existing flows at 20 cfs) – make adjustment to 15 cfs
3. Hour 2 (existing flows at 15 cfs) – make adjustment to 10 cfs
4. Hour 3 (existing flows at 10 cfs) – make adjustment to 5 cfs
5. Hour 4 (existing flows at 5 cfs) – make adjustment to 0 cfs

These down-ramping requirements were integrated into the gate operations based on the relationships of gate staff gage readings, gate openings and flow. These were then tabulated into three sets of downramping procedures which governed the gate operations during each of the three flow adjustment periods, September 24, September 29, and October 6, 2021.

2.3.3. Transect Setup

The establishment of transects at each sampling location was completed as follows:

- **Survey Preparation** – All field equipment used for collecting transect data was checked and assembled for use. This included a beam check and spin test of calibrated velocity meters, assembly of the top setting wading rod, and testing of the survey level. Stream discharge data for the reach sampled was obtained from direct measurement on the day of the survey.

- **Locations of Transects –** Initial transect placement was completed during field verification with the TWG (June 8 and 9, 2021). General location coordinates were determined using a handheld Global Positioning System (GPS) unit. Wooden stakes containing the number of each transect were positioned on at least one side of the stream and colored survey flagging placed on the stakes and neighboring vegetation to mark the position of each transect.
- **Establishment of Site Benchmarks –** Temporary surveying BMs were established at each site and/or transect grouping. The BMs (e.g., bedrock or boulder point, nail in tree trunk, rebar pounded firmly into the ground) were placed above the active channel and near the bankfull stage, and marked with survey flagging. Temporary BMs served as vertical reference points for water surface and bed elevation measurements. All survey measurements within a site, including water surface elevations and channel cross sectional profiles were referenced to an arbitrary (primary) benchmark elevation of 100.00 feet.
- **Establishment of Working Pins –** Working pins, consisting of wood stakes, a tree stem or branch were established on both sides of the river. The working pins were positioned so that a line connecting these points was perpendicular to the main flow of the stream channel. A survey tape was stretched across the stream channel and connected to the working pins during the collection of instream flow data. Transects that crossed an island often included an intermediate pin, or angle point, on the island around which the survey tape pivoted. These were installed so that the tape was positioned perpendicular to the main flow of each channel along the transect.
- **Survey of Temporary BMs Elevations and Completion of Level Loop –** Following the installation of the temporary BMs (2-3 per site), a level loop survey was completed to establish pin elevations. The elevation data were obtained using an Automatic Level and stadia rod (0.01 ft accuracy). The level loop was considered accurate if closed to within 0.02 ft of the (primary) BM elevation.

2.3.4. PHABSIM Field Data Collection

The surveying and collection of PHABSIM data at the 30 Eklutna River transects was completed in accordance with methods described in the FSP (MJA 2021) (see Section 3.1.4.5 Field Data Collection PHABSIM). These methods followed the general procedures described by Bovee (1982) and Trihey and Wegner (1981). This effort centered around the establishment of a series of transects within representative mesohabitat types (e.g., riffle, run, pool, glide) and the measurement of habitat characteristics (consisting of depth, mean column velocity, and substrate type) at intervals across the transects at each of the three different flows. To ensure consistent data collection, all field data were recorded in either electronic dataloggers or preformatted datasheets. All data were reviewed prior to departing the sample site to check for accuracy and completeness, and to ensure that all measurements had been properly recorded and were legible prior to departure. Each field datasheet was dated and after each field effort, all datasheets were photocopied.

As noted above, three distinct flow levels were targeted corresponding to a high-flow (150 cfs), mid-flow (75 cfs), and low-flow (25 cfs) release from Eklutna Dam. Additional detail regarding the flow release conditions during the three survey periods is provided in *Section 2.3.2 (Selection, Sequencing, and Release of Target Flows).*

One or two field crews consisting of three individuals experienced in Instream Flow Incremental Methodology/PHABSIM field surveying, data collection, and modeling conducted the fieldwork. Prior to initiating data collection, crew members participated in the review of field methods, equipment checks, and quality control check procedures.

The following data were recorded at each transect:

- Reach number, transect number, crew members, and sampling date;
- Velocity meter type, serial number, and calibration check;
- Auto level make and model;
- Water surface elevations (WSEs) – measured to the nearest 0.01 ft at three locations in the channel: near left water edge, center of channel, and near right water edge;
- Photographs – representative photographs were taken of each transect under most of the sampled flow conditions (Appendix 1).

The transect numbering was sequential within each sampling reach from downstream to upstream direction.

2.3.5. Hydraulic and Habitat Measurements

PHABSIM relies on cross sectional measurements to define the channel shape and characterize the hydraulic properties over a range of flow conditions. Field collection of hydraulic and habitat data were consistent with methods described for PHABSIM as noted in Bovee (1982) and Milhous et al. (1984).

Transect depth and velocity measurements were collected at set intervals across each transect at up to three flow conditions (Table 2.3-5). All current meters were tested according to the manufacturers' instructions prior to the first sampling effort and field checked during each subsequent sampling. The velocity meter type, serial number, and calibration number were noted for each transect surveyed.

Table 2.3-5. Instream flow transects by reach, survey site, and habitat type, for 30 PHABSIM transects established in the Eklutna River, 2021.

Reach	Transect	Mesohabitat Type	Measured Flows (cfs)		
			Sep 20-23	Sep 25-27	Sep 30, Oct 1 & 2
4	1	Riffle	177.6	124.4	65.2
	2	Run	154.4	118	66.7
	3	Run	136.5	130.9	64.4
5	1	Run	173.4	119.8	72.5
	2	Riffle	152.2	121.3	65.3
	3	Riffle	165.6	118.7	61.7
	4	Run	NM	114.7	69.2
	5	HG Riffle	146.4	122.6	68.4
	6	HG Riffle	158.1	118.5	60.8
	7	Riffle	175.5	130.1	71.4
7	1	HG Riffle	NM	70.2	22.8
	2	Riffle	101.69	70.5	21
8	1	Run	109.3	66.4	23.4
	2	Riffle	102	69.3	22.8
	3	Riffle	95.2	64.6	23.2
	4	Hydraulic Control	NM	NM	NM
	5	Pool	NM	62.85	20
9	1	Riffle	NM	57.89	20.8
	2	Run	NM	69.75	17.2
	3	Riffle	101.7	60.25	16.4
11	1	Riffle	118.6	81.3	23
	2	Run	112.7	79.2	22.1
	3	Riffle	114.5	89.2	20
	4	Run	111.9	72.2	20.1
	5	Run	NM	79.5	28.1
	6	Riffle	133.6	83.9	28.5
	7	Run	122.3	105.7	25.7
	8	Riffle	141.8	96	30.2
	9	Run	122.3	93.8	24.0
	10	Riffle	119.1	100.4	26.2

Notes:
HG – High gradient
NM – No discharge measurement completed due to sampling hazards or extreme hydraulic conditions.
Discharge measurements within Reaches 7, 8, and 9 appear to represent flow losing conditions. All flow measurements were completed following stringent quality control measures.

Hydraulic data was collected at specified intervals (verticals) across each transect, with the number and spacing of the vertical measurements dependent on transect width and flow pattern. The verticals were spaced such that generally no more than 10% of the channel flow was located between any two verticals. The following data were collected at measurement points across each transect:

- *Water Depth* (to nearest 0.05 foot) – measured using either a 4-foot or 6-foot top setting rod.
- *Bed Elevation* (to nearest 0.05 foot) – determined indirectly from water depth measurements (bed elevation = WSE – water depth); inlet and outlet bed elevations were surveyed in side channels to define side channel connectivity.
- *Channel Profile* (to nearest 0.1 foot) – survey of the entire channel area extending from approximately the bank full water mark on each side of the channel (collected during mid-flow sampling).
- *Mean Column Water Velocity* (to nearest 0.01 ft/sec) – measured using a Sontek FlowTracker2 or Swoffer Model 2100 velocity meter; velocities were measured in accordance with USGS guidance as specified in Turnipseed and Sauer (2010); i.e., at 6/10ths depth in the water column for depth less than 2.5 feet and at 2/10ths and 8/10ths depth for depth greater than 2.5 feet.
- *Substrate* (dominant, subdominant, and percent dominant) – visual classification as described below.

The channel bank and stream bottom substrate composition were visually classified (and by feel when turbidity prevented visual observation) at each station during survey of the detailed channel profile. A gravelometer was used for visual comparison of substrate size classes with field observations. Substrate was classified, according to the dominant, subdominant, and percent dominant grain size category, following the substrate classifications listed in Table 2.3-6.

Table 2.3-6. Modified Wentworth Scale for Substrate Size Classification Eklutna River, Alaska.

Description	Size Class (metric/English)	Code
Fines	< 2 mm/< 0.1 in.	FI
Small Gravel	2-16 mm/0.1-0.6 in.	SG
Large Gravel	16-64 mm/0.6-2.5 in.	LG
Small Cobble	64-128 mm/2.5-5.0 in.	SC
Large Cobble	128-256 mm/5.0-10.0 in.	LC
Boulder	> 256 mm/> 10.0 in.	BO
Bedrock	Bedrock	BR

2.3.6. 1D HEC-RAS Data Collection

The 1D Hydraulic Engineering Center's River Analysis System (HEC-RAS) model relies primarily on LiDAR data collected in 2020. In addition, the model relies on WSEs and cross-sectional data surveyed at each transect as part of the PHABSIM data collection. To be consistent with the LiDAR data, the WSEs and cross-sections were surveyed with respect to the following coordinate system:

- Projection: Universal Transverse Mercator (UTM) Zone 6 North
- Horizontal Datum: North American Datum (NAD)83 (2011)
- Vertical Datum: North American Vertical Datum (NAVD)88 (GEOID12B)
- Units: Meters

Site survey control at each transect was established using the BMs (for elevation control), and the working pin (WP) locations that define the transect alignment. The BMs and WPs were surveyed with Real Time Kinematics (RTK) GPS based on the coordinate system established for the LiDAR.

Additional information from transects established as part of the Geomorphology/Sediment Transport study (Watershed GeoDynamics, Year One Report (2022) was considered and used in the HEC-RAS model development as appropriate.

2.3.7. Data Entry and QA/QC

The data collected during the 2021 field effort were subjected to a rigorous quality control review. Level 1 quality control (QC1) consisted of a review of notes and electronic data in the field for accuracy and completeness. Following each field effort, field notes were photocopied and data were entered into formatted data files (Excel). Following data entry, a line-by-line comparison was made of field data measurements with the computer data file entries, constituting Level 2 quality control (QC2).

After all field efforts were completed, data were subjected to a rigorous quality control review relative to their adequacy for use in developing valid, reliable hydraulic models. The review included an evaluation of field notes and survey data including checks of level loops, cross-sectional data entries (i.e., water depth, velocity, substrate), and water survey elevation data. Cross-sectional profiles were plotted and reviewed to determine whether bed elevations had changed between survey dates. Depth and velocity measurements were used to calculate flows (discharge) for each site visit. In addition, transect photographs were assembled, labeled, and reviewed to provide a visual comparison of flow conditions. This final step constituted Level 3 quality control (QC3). Photographs, bed elevations, and velocity profiles for each transect are provided in Appendix 1.

Additional review was conducted by a hydraulic engineer to assess data adequacy for use in developing valid, reliable hydraulic models. The review included an evaluation of field notes and survey data including checks of level loops and water survey elevation data. Cross-sectional profiles were plotted and reviewed to determine whether stream bed elevation changes occurred between survey dates. Recorded depth and velocity measurements were then used to calculate flows (discharge) for each sampling effort.

The entire review process resulted in the development of transect-specific data sets that were used in the PHABSIM and HEC-RAS hydraulic and habitat modeling.

2.4. Habitat Suitability Curves

HSC are designed for use in a PHABSIM analysis to quantify changes in habitat under various flow regimes (Bovee et al. 1998). Fundamentally, HSC curves represent an assumed functional relationship between an independent variable such as depth, velocity, substrate, and sometimes cover, and the suitability or preference of that variable to a particular fish species and life stage. An example of an HSC curve is shown in Figure 2.4-1 that depicts the actual selected HSC velocity curve applied in the Eklutna River analysis for Coho spawning (purple curve), with curves from other Alaska studies (Kleinschmidt 2022b). In this case, the suitability (preference) for a given velocity is shown on the Y axis, with velocity shown on the X-axis.

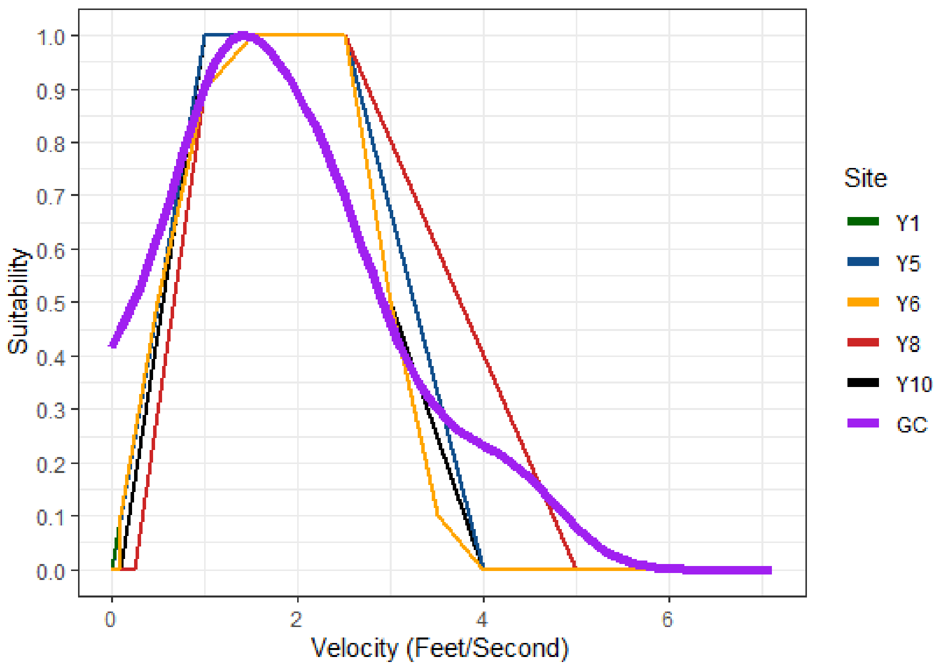


Figure 2.4-1. Example HSC developed for Coho Salmon for the Eklutna River. The purple curve was selected for use in the habitat modeling and was based on data from Grant Creek, Alaska. Other curves considered were from other Alaska streams: Y1=Terror and Kizhuyak rivers; Y5=Cooper Creek; Y6=Wilson River and Tunnel Creek; Y8=Ward Creek; and Y10=Susitna River.

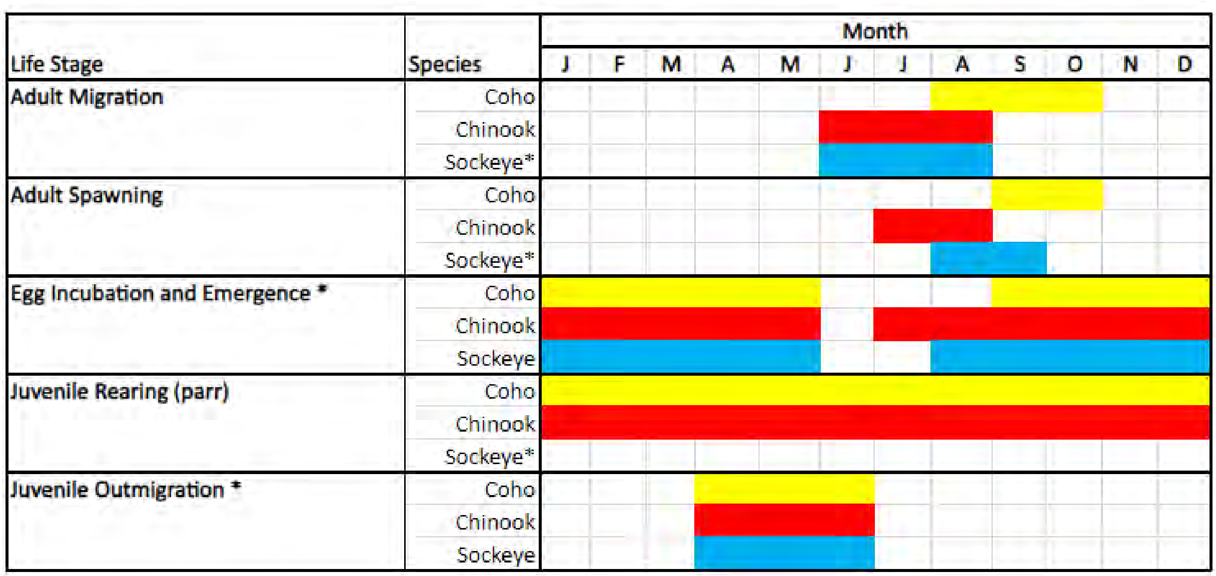
For the Eklutna River analysis, the HSC curve development process involved the following three steps:

- Obtain HSC data or developed HSC curves for target fish species and life stages from streams in the same geographic region;
- Summarize data and information for each candidate HSC curve set focusing on how the curves were constructed, data source(s), location, relative size, and habitat variables; and
- Derive or select a set of recommended HSC curves from this information that would reasonably represent the target fish species and life stages in the Eklutna River.

These steps were followed and resulted in development of HSC curve sets for three species of Pacific salmon (Chinook [*Oncorhynchus tshawytscha*], Coho [*O. kisutch*], and Sockeye [*O. nerka*])[2]. Two life stages were considered for each species, spawning and juvenile rearing, except for Sockeye Salmon; only spawning was considered for sockeye since they generally do not rear in riverine habitats. Recommended HSC curves were developed and provided to the TWG in a draft technical memorandum (Kleinschmidt 2022b) on February 25, 2022. The curves were then discussed with the TWG in a virtual meeting on April 18, 2022, finalized, and used in development of the habitat-flow relationships discussed in this TM.

2.5. Periodicity and Life Stage Priority

Periodicity defines the periods of time that a particular life stage of a species is present or biologically significant to the sustainability of that species. Typical life stages considered include adult migration, spawning (and egg incubation), juvenile rearing, and smolt outmigration. Figure 2.5-1 depicts the species periodicity considered for the Eklutna River including the three species that are the focus of the instream flow assessment, Chinook, Coho, and Sockeye salmon. This figure was based on the estimated periodicities depicted in TU (2018) and USACE (2011) and has been modified slightly based on field observations in 2021 during the Fish Composition and Distribution surveys.



** Not assessed during 2021 River Fish Sampling. Data presented from TU (2018)*

Figure 2.5-1. Summary of seasonal use (periodicity) of the Eklutna River by Chinook Salmon, Coho Salmon and Sockeye Salmon. Figure based on TU (2018), surveys, and observational data from 2021 surveys as presented in the Year 2 Fish Species Composition and Distribution Study Report (2023, in

[2] Although other fish species have been observed in the Eklutna River (MJA 2020), Chinook, Coho, and Sockeye salmon were identified during the Trout Unlimited (TU) 2018 workshop (TU 2018) and are considered "indicator species" due to the variability in their spatial and temporal distribution as well as their diversity in life stage habitat requirements (see Kleinschmidt 2022a).

preparation). *Note: this figure may be updated and applied to future analysis, pending additional information and field observations.*

The timing of the life stage use factors into a prioritization process that was applied in the time series analysis (see Section 2.9.2 and Section 4.5.2). For this, the spawning life stage was considered a higher priority than juvenile rearing, so flow considerations favored spawning habitat during periods when spawning occurred.

2.6. 1D HEC-RAS Model and Results

2.6.1. Model Background

A 1D HEC-RAS (version 6.2) model was constructed as part of this analysis. The purpose of the 1D HEC-RAS model was threefold: develop a model that could closely replicate the observed water surface elevations observed during the three flow releases during the fall of 2021, generate rating curves for the PHABSIM modeling (Section 2.9), and create a model that could be used for the geomorphological study and sediment transport modeling being conducted by Watershed GeoDynamics (2023). The model included a 10.8-mile long reach of the Eklutna River from Eklutna Dam (River Mile 12.3) to River Mile 1.5 (downstream from railroad bridge). Within this model reach, there is one major tributary (Thunderbird Creek) that joins the Eklutna River at River Mile 2.8. The HEC-RAS 1D model included the following three reaches:

1. Upper Eklutna – from Eklutna Dam to the confluence with Thunderbird Creek (9.5 miles)
2. Lower Eklutna – from the confluence with Thunderbird Creek to just downstream from the railroad bridge (1.3 miles)
3. Thunderbird Creek – from the confluence with the Eklutna River to Thunderbird Falls

2.6.2. Model Geometry Setup

The morphology of the HEC-RAS 1D model relied on the following three sources of data:

1. LiDAR data acquired on May 15, 2020
   a. Projection: UTM Zone 6 North
   b. Horizontal Datum: NAD83 (2011)
   c. Vertical Datum: NAVD88 (GEOID12B)
   d. Units: meters
2. Geomorphology study cross sections surveyed in 2021. The bottom profile of each instream flow transect was surveyed using a tape measure and an automatic level. The cross sections were surveyed prior to any flow releases from Eklutna Dam and were then surveyed following each flow release from Eklutna Dam (low = 25 cfs, medium = 86 cfs, and high = 122 cfs).
3. Instream flow study cross sections surveyed in 2021. Horizontal and vertical control was established for each instream flow cross section using RTK GPS. The bottom profile of each instream flow transect was surveyed using a tape measure and an automatic level. Water surface elevations were surveyed, and discharges were measured for three different flow levels (low, medium, and high). These data were used to calibrate hydraulic roughness in the HEC-RAS 1D model. These ground-

based data were collected in 2021 for three different controlled flow releases from Eklutna Dam (low, medium, and high)

A grand total of 241 cross sections were incorporated into the HEC-RAS 1D model. The Upper Eklutna, Lower Eklutna, and Thunderbird Creek had 205, 31, and 5 cross sections, respectively. Of the 241 cross sections, 18 were surveyed for the geomorphology study, 30 were surveyed for the instream flow study, and 193 were cut from the LiDAR dataset. Cross sections cut from the LiDAR were more accurate in the Upper Eklutna and less accurate in the Lower Eklutna because the flows were lower in the Upper Eklutna.

2.6.3. Model Boundary Condition Setup

Boundary conditions, which allow flow to enter and exit the model domain, were applied to the upstream and downstream ends of the Eklutna and Thunderbird model reaches. Steady flow rates were used to define the upstream model boundaries, and the normal depth or channel slope was used to define the downstream model boundaries. Additionally, flows were adjusted at four river stations on the Eklutna River based on flow measurements taken under the Instream Flow field data collection effort during the 2021 flow releases (i.e., within Reaches 11, 9, 7/8, 5, and 4). Thunderbird Creek is estimated as the difference in flows between those measured downstream in Reach 5 and upstream in Reach 7/8. The variations in flow throughout the Eklutna River system are likely a result of attenuation, infiltration, and exfiltration. The final flows and flow adjustments used in the 1D HEC-RAS analysis are displayed in Table 2.6-1.

Table 2.6-1. 1D HEC-RAS Model flows.

HEC-RAS River Station	Project River Mile	River Flows		
		High	Medium	Low
Downstream of Eklutna Dam (Reach 11)	12.24	121.8	86.2	24.7
126992 (Reach 9)	6.62	101.7	62.6	18.1
104923 (Reach 7/8)	5.34	102.0	67.3	22.2
Thunderbird Creek	2.74	59.9	53.5	44.8
59540 (Reach 5)	2.72	161.9	120.8	67.0
38808 (Reach 4)	2.12	166.0	124.4	65.4

2.6.4. Model Calibration

Data collected from the instream flow study were used to calibrate hydraulic roughness in the HEC-RAS 1D model. Measured flows in Table 2.6-1 are relatively low and Manning's n was expected to vary with stage for flows in this range (Keulegan 1938; Limerinos 1970; Hey 1979; Thompson and Campbell 1979; Jarrett 1984; Bathurst 2002; and Rickenmann and Recking 2011). The effective roughness option in HEC-RAS 1D was used to allow Manning's n to vary with stage for flows in the range shown in Table 2.6-1. The model was calibrated to match water surface elevations at the high flow condition by selecting an appropriate effective roughness value.

While the model was calibrated to match conditions observed at the high flow condition in Table 2.6-1, the results did not match the observed condition at the mid and low flow conditions. Separate hydraulic rating curves were developed for the PHABSIM model for each instream flow transect for flows ranging from 10 to 375 cfs as described in Section 2.8 below. For flows less than the high flow, rating curves were based on the STGQ method which uses a stage-discharge regression. For flows between the high flow and 375 cfs, the rating curve was based on the HEC-RAS 1D model. The two rating curves were merged to obtain a smooth transition over the range of flows modeled.

Higher flows (up to 1,500 cfs) were considered in the Geomorphology Study. The 1D HEC-RAS model was used to analyze flow conditions for these higher flows. The effective roughness option allowed Manning’s n to reduce to reasonable levels at 1,500 cfs.

2.6.5. Results

Manning’s n was examined at the geomorphology flow condition (1,500 cfs). At this geomorphology study flow level, Manning’s n in the channel ranged from 0.027 to 0.074 with a median value of 0.040. Manning’s n in the overbank areas ranged from 0.029 to 2.41 with a median value of 0.053. Manning’s n values in the overbank areas were greater than Manning’s n values in the channel as would be expected. Simulated hydraulic conditions at the 1,500 cfs level are expected to be reasonably accurate.

2.7. Habitat Model (PHABSIM) and Results

The PHABSIM analysis began with the original habitat mapping, study site selection, and collection of field and survey data as described in Sections 2.2 through 2.6 above. Thorough data review and quality assurance (QA)/quality control (QC) of model input coupled with the development of HSC curves in 2022 culminated in the development of calibrated hydraulic models and subsequent habitat models for all 29 of the established transects in the Eklutna River. This process is depicted in Figure 1.3-1 including various components of the PHABSIM analysis. A summary of the PHABSIM model setup and results are provided in the sections below.

2.7.1. Setup

Model setup required the selection of modeled flows, modeling of water surface elevations, and velocity modeling and calibrations. Each of these are described in more detail below.

2.7.1.1. Modeled Flows

As noted in Section 2.3.2, the PHABSIM modeling is generally governed by a range of extrapolation that reflects 0.4 times the lowest measured field flow to 2.5 times the highest measured field flow. Thus, based on the three target flows, the range of PHABSIM model extrapolation would nominally be from 10 cfs to 375 cfs. This range of flows was then used to define 30 simulation flows as specified in the PHABSIM model that were applied to all transects with the measured flows in each reach also selected as one of the 30 flows (Table 2.7-1). Measured flows are used for calibration and are automatically selected as one of the 30 flows by the PHABSIM model. Different calibration flows were elected for each transect depending on the measurements within that reach, but it was desirable to have the modeled flows for all transects match such that final habitat curves could merge easily into a composite curve comprising the results from an entire reach or multiple reaches without requiring interpolation between flows. As a result, the 30 modeled flows selected have some flows that are similar (i.e., 65.4 cfs, 67 cfs, and 67.3 cfs as an example), but were selected so that the results would be comparable between transects.

Table 2.7-1. Modeled flows used in the Eklutna River PHABSIM modeling. Calibration flows represent measured flows within different reaches during the flow release tests.

Number	Discharge (cfs)	Type
Q01	10.0	Simulation
Q02	18.1	Calibration
Q03	22.2	Calibration
Q04	24.7	Calibration
Q05	30.0	Simulation
Q06	35.0	Simulation
Q07	40.0	Simulation
Q08	45.0	Simulation
Q09	50.0	Simulation
Q10	55.0	Simulation
Q11	62.6	Calibration
Q12	65.4	Calibration
Q13	67.0	Calibration
Q14	67.3	Calibration
Q15	75.0	Simulation
Q16	80.0	Simulation
Q17	86.2	Calibration
Q18	90.0	Simulation
Q19	101.7	Calibration
Q20	102.0	Calibration
Q21	120.8	Calibration
Q22	121.8	Calibration
Q23	124.4	Calibration
Q24	150.0	Simulation
Q25	161.9	Calibration
Q26	166.0	Calibration
Q27	200.0	Simulation
Q28	250.0	Simulation
Q29	300.0	Simulation
Q30	375.0	Simulation

2.7.1.2. Water Surface Level Modeling

The Water Surface Level (WSL) model within PHABSIM specifies how water level changes with flow rate. There are four options provided in PHABSIM for determining water level including stage-discharge regression (STGQ), Manning's equation (MANSQ), Water Surface Profile (WSP), and User-supplied WSL. STGQ uses a log-log regression between observed stage and discharge pairs to estimate the water surface elevations at all flows of interest. MANSQ utilizes Manning's equation to calculate water surface elevations on a cross section by cross section basis. The WSP program uses a standard step-backwater method to determine water surface elevations on a cross section by cross section basis. For the User supplied WSL, elevation values corresponding to each of the 30-modeled flows are entered in by the user and the model is run by forcing these values. This model type would be used to implement PHABSIM modeling while using a rating curve that was developed under a different program (i.e., using HEC-RAS for example).

For the Eklutna River, each of the transects were set up as individual models and the User supplied WSL model was selected for the simulation. The user supplied rating curves were developed by merging rating curves from the STGQ method and the rating curve extracted from the calibrated HEC-RAS model. Each transect was modeled separately and the merging method applied was specific to each transect. The method of applying a merged rating curve allowed consistency with the geomorphology study which relied on the HEC-RAS model for the mid- to high flows while also meeting the flow, water surface elevation, and velocities measured under the low flow conditions.

Hydraulic output of the water surface level models for each of the 29 PHABSIM transects were compared over the range of modeled flows and were reviewed to ensure values were reasonable and any abrupt changes could be explained. Hydraulic parameters reviewed included the water surface level, average velocity, Froude Number, velocity adjustment factor (VAF), Manning's n, and wetted perimeter as a function of flow.

2.7.1.3. Velocity Modeling and Calibration

Three approaches to velocity modeling were considered; transect based, theoretical profile based, and transect/theoretical composited based. The velocity model within PHABSIM predicts velocities within each cell across the channel at each of the 30-modeled flows. Transect based modeling relies on the measured velocities to predict the velocities at other modeled flows. Theoretical profile-based modeling predicts velocities at the 30-modeled flows as a function of depth and total flow rather than the measured values. This approach uses the same depth and substrate for the habitat model but different predictions of velocities. Each of these two velocity models (i.e., transect based and theoretical) predicts habitat over the full range of modeled flows. The transect/theoretical composited based is a combination of each of these two models that is merged with the other to generate one habitat prediction.

For this study, a transect/theoretical composited model was selected. This approach was applied since channel conditions of the Eklutna River (i.e., steep channel and high velocities) produced unrealistic velocities (i.e., velocity predictions of more than 9 ft/s) at the highest modeled flow if they are based on the measured values. This flow weighted composited approach was considered as providing the most realistic model output. For this approach, the transect based model was applied up to the highest measured flow (i.e., ~100-150 cfs depending on the transect), the theoretical model was used at the highest modeled flow (375 cfs), and a flow weighted composite was used between the two. This approach estimated habitat from predicted velocities within a realistic range for the full range of modeling flows.

Velocity calibration is required for the transect based velocity model to ensure predictions match at the measured values and that predictions at other flows are reasonable. For calibration, Manning's n's can be adjusted in any of the modeling cells across a transect. In general, Manning's n's were typically adjusted at edge areas and areas with peak or low velocities.

2.7.2. Results

Habitat (expressed as weighted usable area [WUA]) versus flow relationships were developed for each of the 29 transects in the 6 different reaches, for the three target fish species and two life stages (Chinook, Coho, and Sockeye salmon spawning; and Chinook and Coho salmon juvenile rearing [Sockeye juveniles generally rear in lake systems]). This resulted in development of 87 spawning habitat vs. flow curves and 58 juvenile rearing vs. flow curves. These curves and supporting data are provided in Appendix 2.

In general, the spawning curves exhibit trends of increasing habitat as flow increases up to some peak (representing habitat maxima), and then decrease as flows continue to increase.[3] The range of the peak habitat flows vary by transect, reach, species, and life stage. In the example shown for Transect 2 in Reach 4 the maximum coho spawning habitat occurs at a flow of approximately 80 cfs; maximum juvenile rearing habitat occurs at 24.7 cfs (Figure 2.7-1). Because of differences in channel morphology and substrate composition (used in defining spawning habitat), these points of habitat maxima can vary substantially between transects (e.g., compare curve shapes for R4, Transect [TR] 1 with R4, TR2 in Figure 2.7-1) and reaches.

Unless individual "Critical"[4] habitats have been identified in a stream, flow analysis based on individual transects is complex. Since no Critical habitats were identified in the Eklutna River, two compositing processes were completed, "reach-based" and "river segment-based." The "reach-based process" involved the compositing of habitat-flow relationships for individual transects <u>by reach</u>, based on habitat types. The second, "river segment – based," combined and weighted these composited curves based on reach lengths to produce habitat-flow relationships representing Above and Below Thunderbird Creek the major tributary to the Eklutna River. The compositing process first served to integrate transect based results across an entire <u>reach</u>, based on the meso-habitat types the transects represent, weighted by the area represented by those

[3] These patterns are typical in many PHABSIM analyses and reflect the sensitivity of the HSC to ever increasing flows. Thus, as flows increase habitat amounts increase since depths and velocities become increasingly more suitable for a particular species life stage. However, at some point the higher flows exceed the range of suitability for a species resulting in a trending decrease in habitat amounts as flows continue to increase.

[4] Critical habitats are defined as specific locations in a stream that represent habitats not represented in other sections of the stream but that are deemed critical to the sustainability of a fish population. An example would be the isolated presence of spawning habitat in one location. The habitat-flow relationships established from transects at that location could be used almost exclusively for evaluating flow needs in the stream.

habitat types.[5] The river segment-based compositing takes it a further step by integrating the reach based analysis again, built on the percentages of the respective segments represented by each reach. The results of both "reach-based" and "river segment-based" habitat vs. flow analysis are presented in Appendix 3.

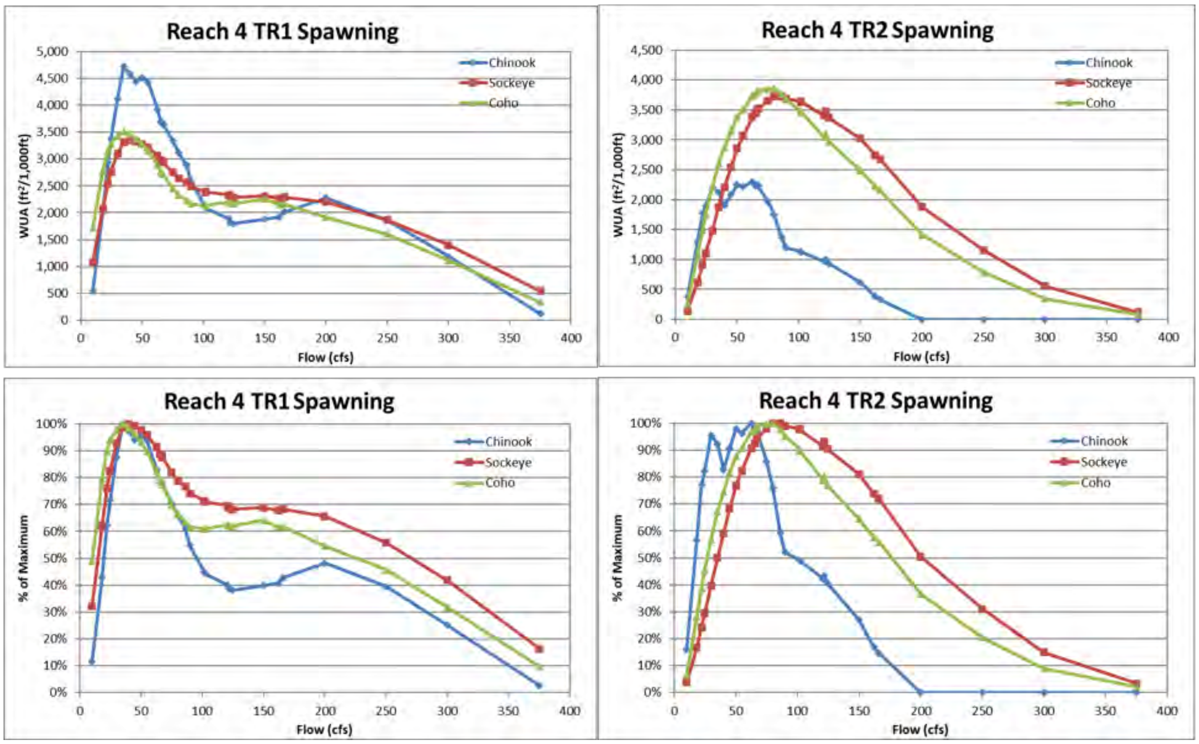


Figure 2.7-1. Example habitat-flow relationships produced via PHABSIM modeling showing general shape characteristics of curves for Chinook (blue), Coho, and Sockeye salmon spawning. These curves are from transects 1 and 2 in Reach 4 of the Eklutna River and show the relationships of habitat area to flow (upper figures) and the same data normalized as a percentage of habitat maximum to flow (lower figures).

As part of the overall analysis (transect, reach, and river based), the habitat vs. flow relationships were normalized to 100%. These normalized curve sets are depicted below each of the habitat vs. flow curves. The curves are transect, reach, and river segment (above and below Thunderbird Creek) specific, and species and life stage specific and do not reflect total habitats for the entire river. They simply represent the results of the upper curves, but depicted as a percentage of the maximum habitat shown for each species and life stage. For example, in the upper panel of Figure 2.7-1 for Reach 4, TR1, the maximum spawning habitat for Chinook is 4,717 ft^2/1,000 ft and for R4, TR2 is 2.300 ft^2/1,000 ft. Those values become 100 % on the lower panels with the rest of the values represented as some percentage of that maximum. The

[5] For example, Reach 5 consists of Runs (51%), Riffles (46%), Mid Channel Pools (2%), and Scour Pools (1%), but only runs and riffles were sampled. Therefore, the analysis assumed run habitats comprised 52.5% of the habitat and riffles 47.5% of the habitat. Since there were three runs and four riffles, each run transect was weighted by 17.5% (for a total of 52.5%) and each riffle by 11.875% (for a total of 47.5%). A similar analysis was used for the other reaches.

same applies to the Coho and Sockeye spawning curves; Coho max spawning habitat for R4, TR1 is 3,508 ft^2/1,000 ft, and 3,851 ft^2/1,000 ft for R4, TR2; Sockeye maximum spawning habitat for R4, TR1 is 3,351 ft^2/1,000 ft, and 3,721 ft^2/1,000 ft for R4, TR2. These values are all expressed as 100% on the lower two panels. The normalized curves and accompanying tables provide a means to explore relative gains in habitat as flows increase. For curves with gradually increasing slopes, percentage gains in habitat are often relatively small compared to flow quantities needed to provide those gains. Inspection of both the curves and tables clearly demonstrate this.

The "river segment-based" WUA analysis combined reaches 4 and 5 to represent the lower Eklutna River (below Thunderbird Creek) and reaches 7, 8, 9, and 11 to represent the upper Eklutna River (above Thunderbird Creek). Weighting of each reach was based on reach length. The results were also normalized and tabularized with notations indicating percentage gains in habitat at different flow intervals.

2.8. 1D Flow Assessment

Historically, some of the earliest flow setting processes in instream flow studies only considered the peaks of the curves representing the maximum habitat, Washington state being a good example. However, that process neglected the stream's hydrology and the periodicity of species and life stage use, which when considered would often demonstrate the maximum habitat flows would never occur under even "average" conditions. Contemporary flow setting methods now consider hydrology and periodicity, and also the relative gains in habitat for flow increases. The percentages of the maximum habitat flow are also typically reviewed as a means to consider tradeoffs between species and life stages.

For this preliminary assessment, the composited "reach-based" and "river segment-based" habitat vs. flow relationships were considered along with the current "baseline" hydrology and periodicity in completing a time series analysis that considered four example flow release levels and three release options described below. The flow levels were selected to demonstrate how the 1D PHABSIM modeling, and in Section 3, the 2D HEC-RAS and habitat modeling can be used in evaluating how different levels of flow may affect spawning and juvenile rearing habitats in the Eklutna River over time. The flow levels should not be considered as recommendations since additional analyses will occur and will undoubtedly result in development of alternative release scenarios.

2.8.1. Example Flow Release Schedule

For this analysis, four (ranging from highest to lowest) example flow levels (1, 2, 3, and 4) and three flow release options (A, B, C) were considered for the provision of habitat. These corresponded to flow levels that would provide 90%, 70%, 50% and 30% of the maximum habitat considering all three species and two life stages. Thus, it was the species that required the highest flow to achieve a given level that would serve as the determinant for that level. The three flow release options were based on three potential flow release locations, Option A – the existing spill gate just below Eklutna Dam; Option B – from the upper AWWU portal located approximately 6,000 ft below the spill gate; and Option C – from the lower AWWU drainage valve located approximately 3,000 ft below the lower extent of Reach 9. The lengths of the

Eklutna River influenced by the flow releases would vary depending on release location. Under Option A, the entire length of river would "see" the flow release from the spill gate. Under Option B, the upper 6,000 ft of the Eklutna River above the upper AWWU portal would not be affected by the flow release and would remain essentially dry. Under Option C, approximately 4 miles of river above the lower AWWU drainage valve would not receive any flow release.

This process is illustrated in Figure 2.8-1 that displays spawning and juvenile rearing habitat and the four flow levels and for the three flow release options. In this case, it is Chinook spawning that sets all four levels since it requires the highest flows to achieve the respective Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30% habitat provision levels. Of note is that there can be two points on a given habitat vs. flow curve that provide the same amounts of habitat, e.g., Sockeye 90% habitat levels at both ~100 cfs and ~25 cfs.

These four flow levels were then used in developing four example monthly flow release schedules for each of the three release options for application in a time series analysis (Table 2.8-1). Using the periodicities shown in Figure 2.5-1, a priority life stage (either spawning or juvenile rearing) was assigned for each month, with spawning having first priority. Since there are only two life stages being considered (spawning and juvenile rearing), the monthly life stage assignments were represented by the juvenile rearing life stage in eight months (November-June), and spawning in four (July-October). The corresponding Level 1 – 90% release schedule[6] (for the Option A release location) would specify 133 cfs during the months of juvenile rearing, and 102 cfs during the spawning months. The Level 2 – 70% release schedules would specify 48 cfs and 30 cfs for juvenile rearing and spawning, respectively; the Level 3 – 50% release schedule 15 cfs and 18 cfs, and the Level 4 – 30% release 7 cfs and 13 cfs (Table 2.8-1). These flow release schedules were then applied to a time series analysis that compared monthly habitats that would occur under each flow release scenario against the habitats afforded by the current/baseline monthly hydrology.

[6] These values are taken from the tabular, normalized results of the habitat versus flow relationships for the river segment-based analysis using 19 transects above Thunderbird Creek. This segment of the Eklutna River would likely benefit the most from flow releases from Eklutna Lake.

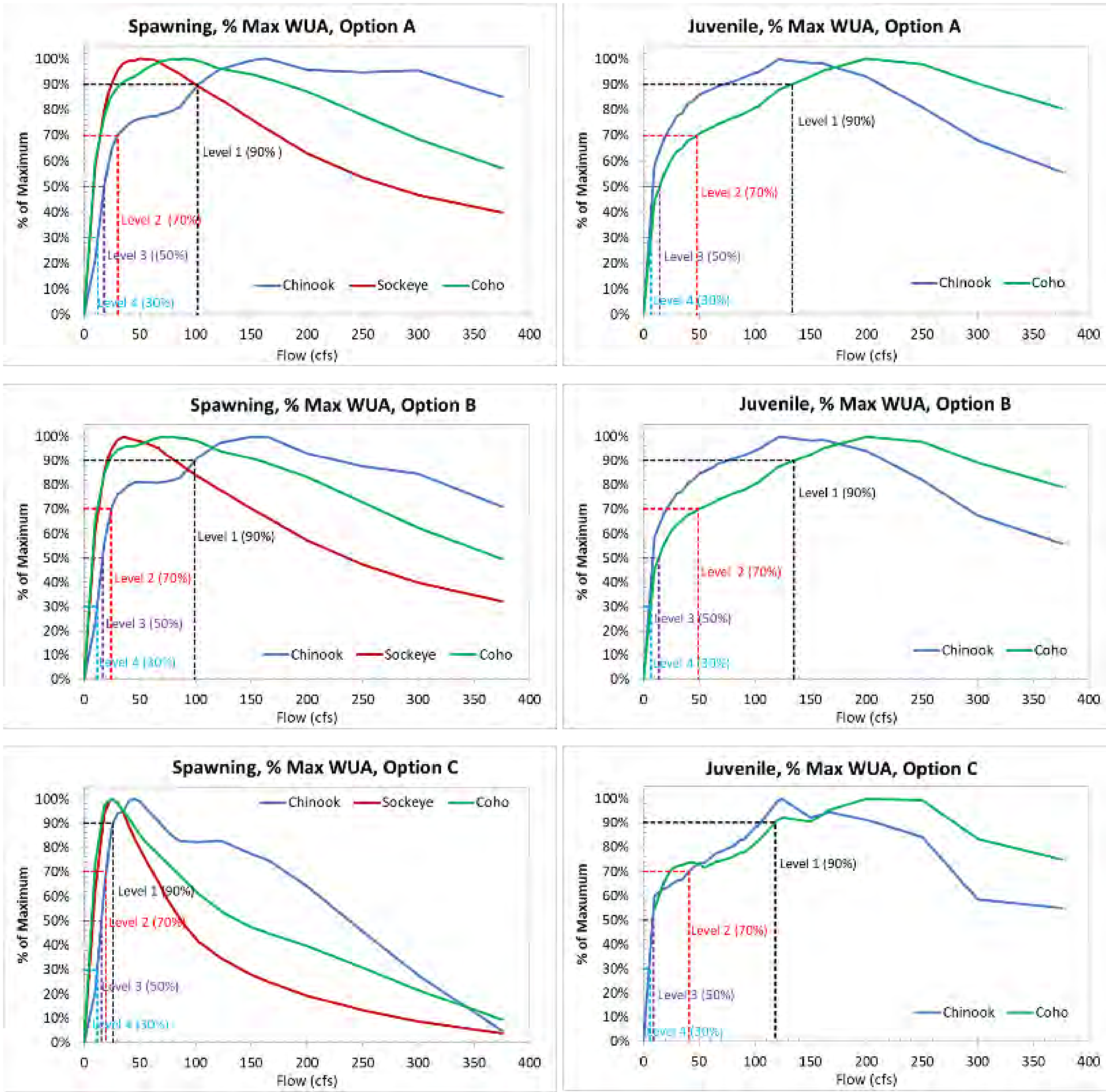


Figure 2.8-1. Normalized Habitat vs. flow relationships for spawning and juvenile rearing showing the Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30% example flow levels identified for the flow release schedules.

Table 2.8-1. Monthly flow releases for four example flow levels (Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30%) and three flow release options (A, B, C) based on adult salmon spawning and juvenile rearing periodicities for the Eklutna River, Alaska. Life stage drivers are Juv-juvenile rearing, and Spwn–spawning. The four flow release levels (1–4) are flows that provide 90%, 70%, 50% and 30% of habitat maxima.

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Life Stage Driver	**Juv**	**Juv**	**Juv**	**Juv**	**Juv**	**Juv**	**Spwn**	**Spwn**	**Spwn**	**Spwn**	**Juv**	**Juv**
OPTION A Flow Release Schedules. All 19 TRs in Reaches 7, 8, 9, and 11 were used in the analysis												
Level 1 = 90% of maximum habitat	133	133	133	133	133	133	102	102	102	102	133	133
Level 2 = 70% of maximum	48	48	48	48	48	48	30	30	30	30	48	48
Level 3 = 50% of maximum habitat	15	15	15	15	15	15	18	18	18	18	15	15
Level 4 = 30% of maximum habitat	7	7	7	7	7	7	13	13	13	13	7	7
OPTION B Flow Release Schedules. All 19 TRs in Reaches 7, 8, 9, and 11 were used. The most upstream 6,000 ft of Reach 11 is located above the upper AWWU portal flow release point and was excluded from the time series analysis												
Level 1 = 90% of maximum habitat	135	135	135	135	135	135	99	99	99	99	135	135
Level 2 = 70% of maximum habitat	49	49	49	49	49	49	25	25	25	25	49	49
Level 3 = 50% of maximum habitat	14	14	14	14	14	14	17	17	17	17	14	14
Level 4 = 30% of maximum habitat	7	7	7	7	7	7	12	12	12	12	7	7
OPTION C Flow Release Schedules. A total of only 6 transects were used, including 2 in Reach 7 and 4 in the lower part of Reach 8. Lower AWWU drainage valve is located about 3,000 ft below Reach 9												
Level 1 = 90% of maximum habitat	118	118	118	118	118	118	26	26	26	26	118	118
Level 2 = 70% of maximum habitat	24	24	24	24	24	24	20	20	20	20	24	24
Level 3 = 50% of maximum habitat	9	9	9	9	9	9	16	16	16	16	9	9
Level 4 = 30% of maximum habitat	6	6	6	6	6	6	12	12	12	12	6	6

2.8.2. Time Series Analysis

Available flow records from the United States Geological Survey (USGS) and the NVE were used to perform time-series analyses of habitat for the four example flow release schedules from Eklutna Lake to the Eklutna River and for various species/life stage combinations of salmonid species. This section describes the daily flows and results of the habitat time series.

The instream flow study reach extends from Eklutna Dam to the zone of tidal influence. Within this reach, Thunderbird Creek is the largest tributary to the Eklutna River, and its confluence is used to divide the Eklutna River into two hydrologic reaches:

1 **Upper Eklutna Reach –** extends from Eklutna Dam to the confluence with Thunderbird Creek. The Upper Eklutna was further divided into the four sub-reaches used for instream flow analyses; R7, R8, R9, and R11. Under baseline conditions, there are no flow releases from Eklutna Dam to these sub-reaches and therefore flows are relatively low.

2 **Lower Eklutna Reach –** extends from the confluence with Thunderbird Creek to the zone of tidal influence. This reach was divided into two sub-reaches used for instream flow analyses; R4 and R5. Under baseline conditions, the flows in these sub-reaches are relatively higher as a result of input from Thunderbird Creek.

Historical daily flow records are available from the Eklutna River at the Old Glenn Highway Bridge (USGS Gage No. 15280200). These continuous daily records extend from May 1, 2002 to September 29, 2007. During this period, there were no flow releases from Eklutna Lake to the Eklutna River. This period of record forms the basis for the time series analyses reported in this section.

During this period, discrete intermittent flow measurements were performed in the Eklutna River just upstream from the confluence with Thunderbird Creek. These records were available from the USGS (Gage No. 15280100) and from the NVE. Monthly median flows were derived from these data and were used to estimate a continuous daily flow hydrograph.

Continuous daily flows in the Eklutna River at the Old Glenn Highway and above the confluence with Thunderbird Creek are shown in Figure 2.8-2 for the period from May 1, 2022 to September 29, 2007. The baseline flows in the Upper Eklutna Reach are relatively low in comparison with the flows in the Eklutna River at the Old Glenn Highway.

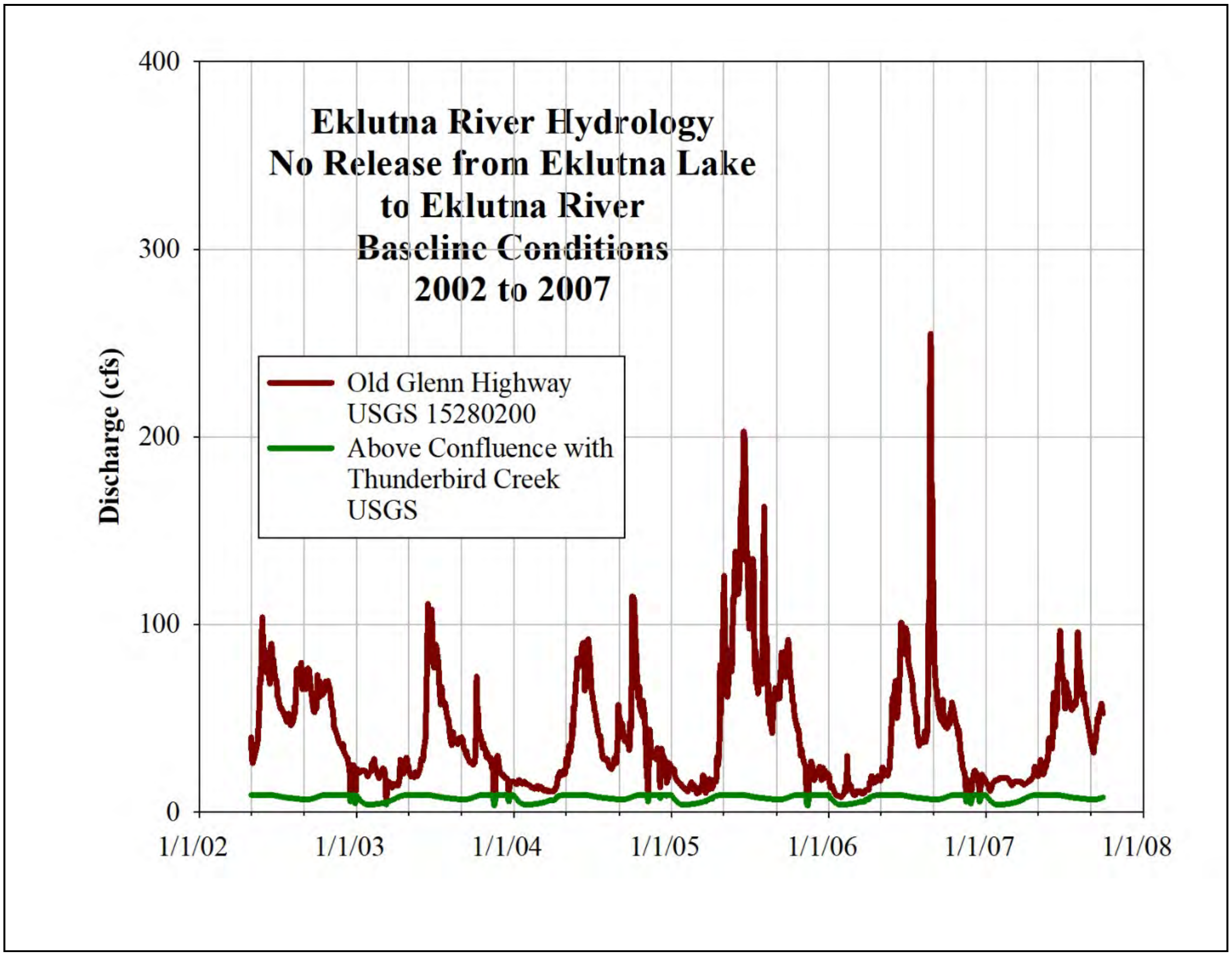


Figure 2.8-2. Daily flows in the Eklutna River at the Old Glenn Highway and above the confluence with Thunderbird Creek from May 1, 2002 to September 29, 2007, with no flow releases from Eklutna Lake to the Eklutna River.

The Upper Eklutna River below Eklutna Dam was visited in late August, 2019 and observations were reported in a site reconnaissance trip report (MJA 2019). The Eklutna River was dry below Eklutna Dam. Measurable flow (1 to 2 cfs) was observed in the Eklutna River about 4 miles downstream from Eklutna Dam (River Mile 8.3). The flow in the Eklutna River above the confluence with Thunderbird Creek (River Mile 2.8) was assumed to be 7 cfs (a typical value for late August). Between these two locations on the Eklutna River, it was assumed that the flow in the Eklutna River was proportional to river mile under baseline conditions. Reach 11 extends for about 2.7 miles downstream from Eklutna Dam. Reach 11 is dry under baseline conditions.

Monthly flow releases from Eklutna Lake to the Eklutna River are listed in Table 2.8-2. Under baseline conditions, no flow would be released to the Eklutna River. Three different options (A, B, and C) were considered for where to release the water downstream from Eklutna Dam. Under Option A, the flow would be released to the Eklutna River just downstream from Eklutna Dam. Under Option B, flow would be released to the Eklutna River about 1.2 miles downstream from Eklutna Dam from the existing AWWU portal. Under Option C, flow would be released to the

Eklutna River about 6.8 miles downstream from Eklutna Dam at a secondary AWWU drainage valve. For each option, the four example flow release levels (Flow Level 1 – 90%, Flow Level 2 – 70%, Flow Level 3 – 50%, and Flow Level 4 – 30%) were considered (see Section 2.9.1) which governed the magnitude of the released flows.

For the time series analysis, six different reaches were analyzed (Reach 4, Reach 5, Reach 7, Reach 8, Reach 9, and Reach 11). As shown in Table 2.8-2, 13 different flow release schedules were considered that included the baseline (no flow release) condition. In addition, 5 different species/life stages were analyzed (Chinook spawning, Chinook juvenile rearing, Coho spawning, Coho juvenile rearing, and Sockeye spawning). With these various permutations, a total of 390 runs were considered and presented herein that represent Options A, B and C.

To illustrate the process of performing a time series analysis, two of the 390 runs were selected. These example runs were for Reach 7, Baseline and Option A, with the Medium (70%) flow release level, and Coho juvenile rearing. Coho juvenile rearing occurs in the river throughout all 12 months of the year and so the analysis was based on the entire year. Other species/life stage combinations might be performed for only part of the year. For example, Chinook spawning occurs in July and August. So, the analysis for Chinook spawning would only be based on those two months of the year.

Table 2.8-2. Monthly flow releases from Eklutna Lake to the Eklutna River under Baseline conditions (zero flow release) and under 12 different flow release schedules. The four flow release levels (1-4) are flows that provide 90%, 70%, 50% and 30% of habitat maxima for Chinook, Coho, and Sockeye salmon.

Scenario		Flow Released from Eklutna Lake to Eklutna River (cfs)											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Baseline		0	0	0	0	0	0	0	0	0	0	0	0
Option A	Flow Level 1	133	133	133	133	133	133	102	102	102	102	133	133
	Flow Level 2	48	48	48	48	48	48	30	30	30	30	48	48
	Flow Level 3	15	15	15	15	15	15	18	18	18	18	15	15
	Flow Level 4	7	7	7	7	7	7	13	13	13	13	7	7
Option B	Flow Level 1	135	135	135	135	135	135	99	99	99	99	135	135
	Flow Level 2	49	49	49	49	49	49	25	25	25	25	49	49
	Flow Level 3	14	14	14	14	14	14	17	17	17	17	14	14
	Flow Level 4	7	7	7	7	7	7	12	12	12	12	7	7
Option C	Flow Level 1	118	118	118	118	118	118	26	26	26	26	118	118
	Flow Level 2	24	24	24	24	24	24	20	20	20	20	24	24
	Flow Level 3	9	9	9	9	9	9	16	16	16	16	9	9
	Flow Level 4	6	6	6	6	6	6	12	12	12	12	6	6

Notes:
Option A – flow released to Eklutna River just downstream from Eklutna Dam
Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam
Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam

The daily flow hydrographs in Reach 7 of the Eklutna River are shown in Figure 2.8-3 for the example runs (Option A, Flow Level 2 – 70% and Baseline conditions). The magnitudes of the Option A Level 2 – 70% flows are several times larger than the magnitudes of the Baseline flows.

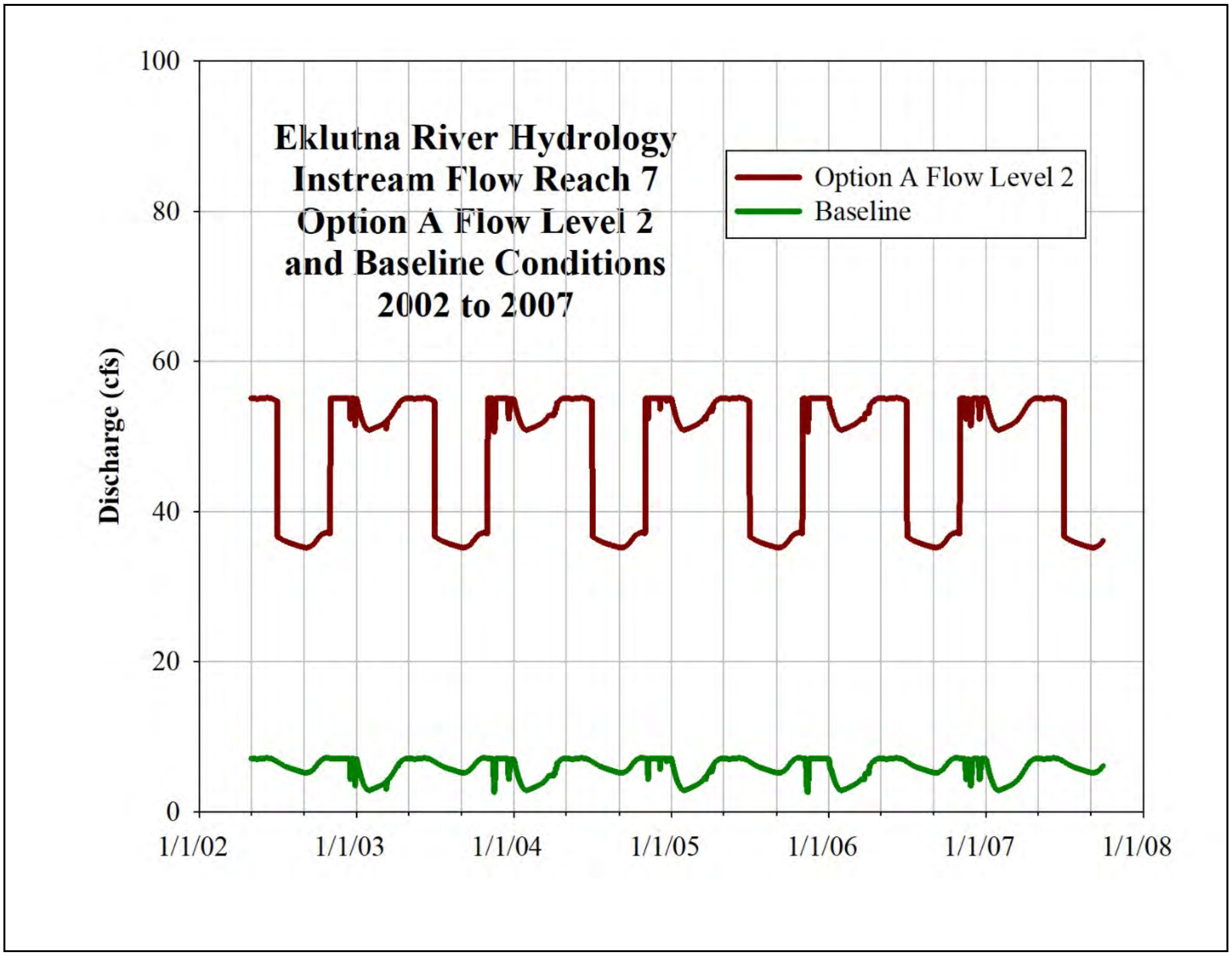


Figure 2.8-3. Daily flows in Reach 7 of the Eklutna River for Option A, Level 2 -70% flow release level and Baseline conditions. Option A – flow released to Eklutna River just downstream from Eklutna Dam.

A habitat area curve defined as WUA for Coho juvenile rearing in Reach 7 is shown in Figure 2.8-4. The curve reaches a peak of about 1.4 acres when the discharge is about 80 cfs.

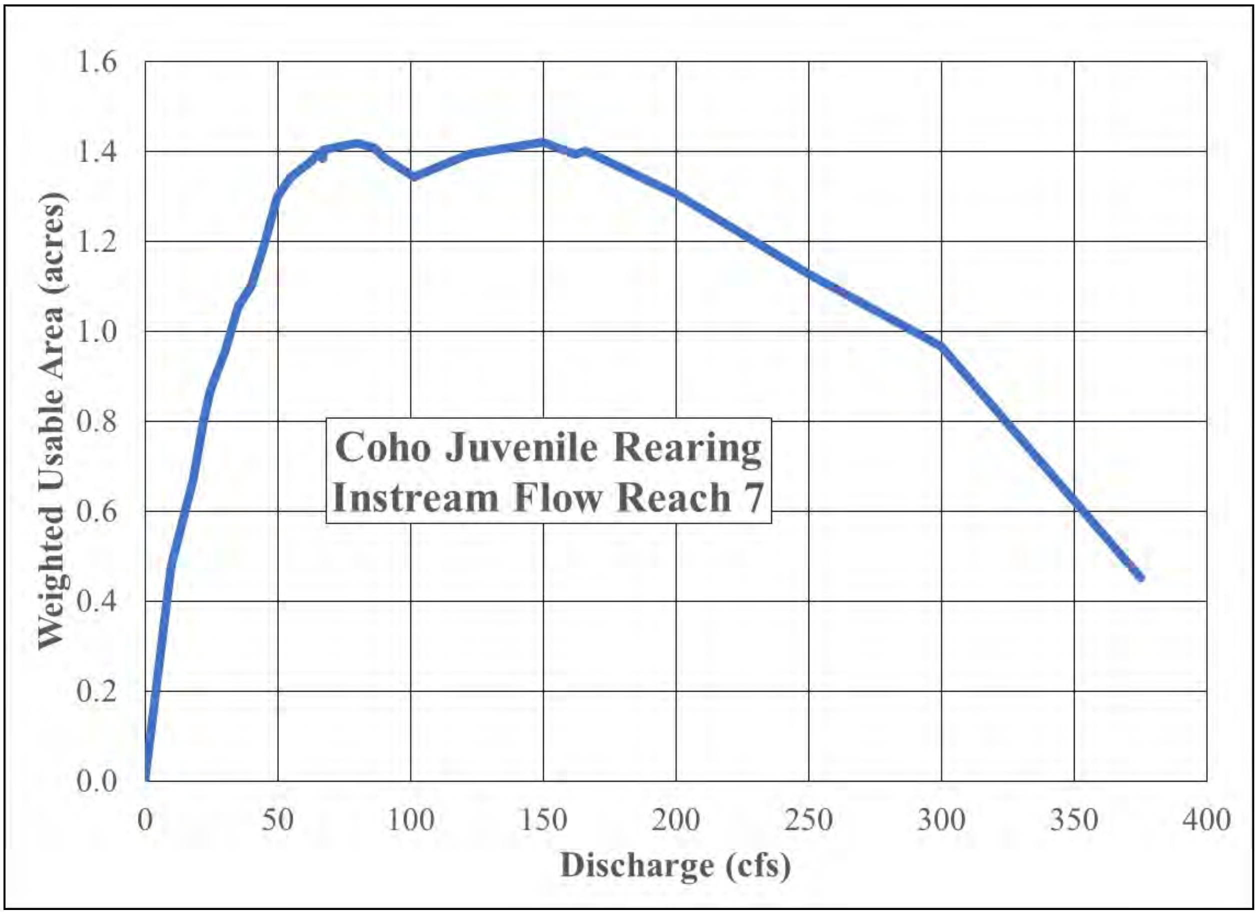


Figure 2.8-4. Habitat area (WUA) in Reach 7 for Coho juvenile rearing as a function of flow in the Eklutna River.

Daily time series of Coho juvenile rearing habitat in Reach 7 are shown in Figure 2.8-5 for Option A Flow Level 2 – 70% and Baseline conditions. The magnitudes of habitat for Option A Flow Level 2 are several times larger than the magnitudes of habitat for Baseline conditions.

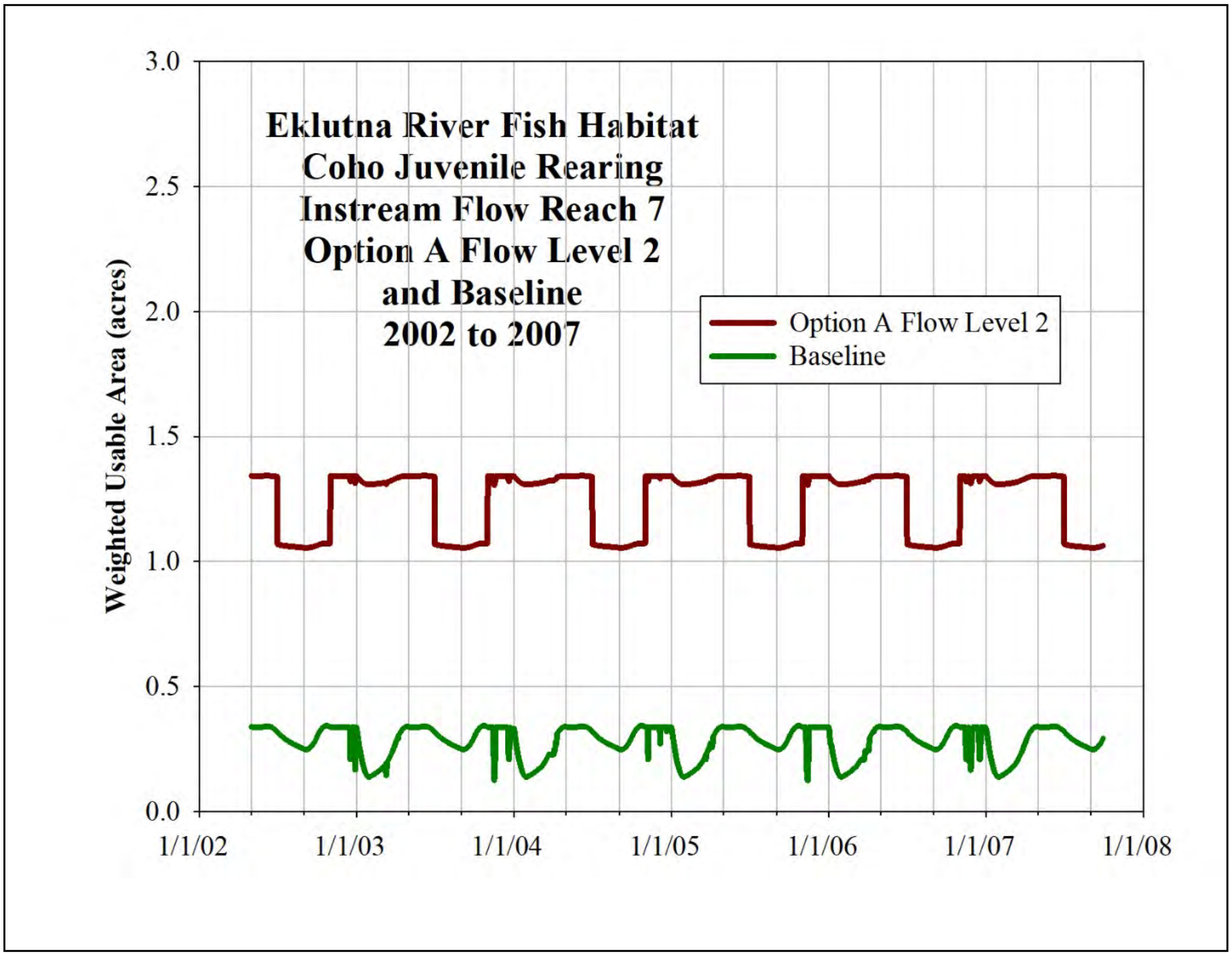


Figure 2.8-5. Daily time series of habitat area (WUA) for Coho juvenile rearing in Reach 7, Option A Medium (upper line) and Baseline conditions (lower line).

These examples were provided just for Reach 7. Final results were based on the combined totals of habitat from all six instream flow reaches (Reach 4 and Reach 5 – below Thunderbird Creek and Reach 7, Reach 8, Reach 9, and Reach 11 – above Thunderbird Creek). Time-averaged habitat areas (WUA) are summarized in Table 2.8-3.

Table 2.8-3. Time-averaged habitat area (WUA) for Chinook spawning, Chinook juvenile rearing, Coho spawning, Coho juvenile rearing, and Sockeye spawning, as determined from four example flow release levels (Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30%) for three flow release location options, A – below Eklutna Dam, B – at upper AWWU portal ~1.2 mile below Eklutna Dam, and C – at AWWU drainage valve about 6.8 miles downstream from Eklutna Dam.

Scenario		Time-Averaged Habitat Expressed as Weighted Usable Area (acres)				
		Chinook		Coho		Sockeye
		Spawning	Juvenile Rearing	Spawning	Juvenile Rearing	Spawning
Baseline		0.51	1.46	1.16	2.48	1.01
Option A	Flow Level 1	1.50	7.94	3.12	12.43	2.50
	Flow Level 2	1.37	6.79	3.07	10.37	2.72
	Flow Level 3	1.18	5.68	2.81	8.53	2.43
	Flow Level 4	0.95	4.58	2.56	6.77	2.16
Option B	Flow Level 1	1.16	5.58	2.44	8.84	2.07
	Flow Level 2	1.13	4.72	2.51	7.51	2.29
	Flow Level 3	1.00	4.03	2.37	6.35	2.13
	Flow Level 4	0.86	3.43	2.21	5.31	1.93
Option C	Flow Level 1	0.65	1.83	1.60	3.20	1.55
	Flow Level 2	0.64	1.69	1.58	3.27	1.51
	Flow Level 3	0.62	1.67	1.56	3.01	1.46
	Flow Level 4	0.60	1.64	1.50	2.90	1.38

Note: The Level 1, Level 2, Level 3, and Level 4 releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

The percent increase (with respect to baseline) of time-averaged habitat area (WUA) is listed in Table 2.8-4. Habitat increases ranged from 10% for Chinook juvenile rearing for Option C Flow Levels 3 and 4 to 440% for Chinook juvenile rearing Option A Flow Level 1.

Table 2.8-4. Percent increase (with respect to baseline) of time-averaged habitat area (WUA) for Chinook spawning, Chinook juvenile rearing, Coho spawning, Coho juvenile rearing, and Sockeye spawning, as determined from four example flow release levels (Flow Level 1 – 90%, Flow Level 2 – 70%, Flow Level 3 – 50% and Flow Level 4 – 30%) for three flow release location options, A – below Eklutna Dam, B – at upper AWWU portal ~1.2 mile below Eklutna Dam and C – at AWWU drainage valve about 6.8 miles downstream from Eklutna Dam (percent rounded to nearest 10%).

Scenario		Time-Averaged Habitat Expressed as Percent Increase above Baseline				
		Chinook		Coho		Sockeye
		Spawning	Juvenile Rearing	Spawning	Juvenile Rearing	Spawning
Baseline		0%	0%	0%	0%	0%
Option A	Flow Level 1	190%	440%	170%	400%	150%
	Flow Level 2	170%	370%	160%	320%	170%
	Flow Level 3	130%	290%	140%	240%	140%
	Flow Level 4	90%	210%	120%	170%	110%
Option B	Flow Level 1	130%	280%	110%	260%	100%
	Flow Level 2	120%	220%	120%	200%	130%
	Flow Level 3	100%	180%	100%	160%	110%
	Flow Level 4	70%	130%	90%	110%	90%
Option C	Flow Level 1	30%	30%	40%	30%	50%
	Flow Level 2	30%	20%	40%	30%	50%
	Flow Level 3	20%	10%	30%	20%	40%
	Flow Level 4	20%	10%	30%	20%	40%

Habitat duration curves for Chinook spawning habitat are shown for Options A, B and C in Figure 2.8-6 and time-averaged habitat areas (WUA) as listed in Table 2.8-3. In all cases, habitat gains were achieved when flows were added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added just downstream from Eklutna Dam (Option A) than when added 1.2 miles downstream (Option B) or 6.8 miles downstream (Option C).

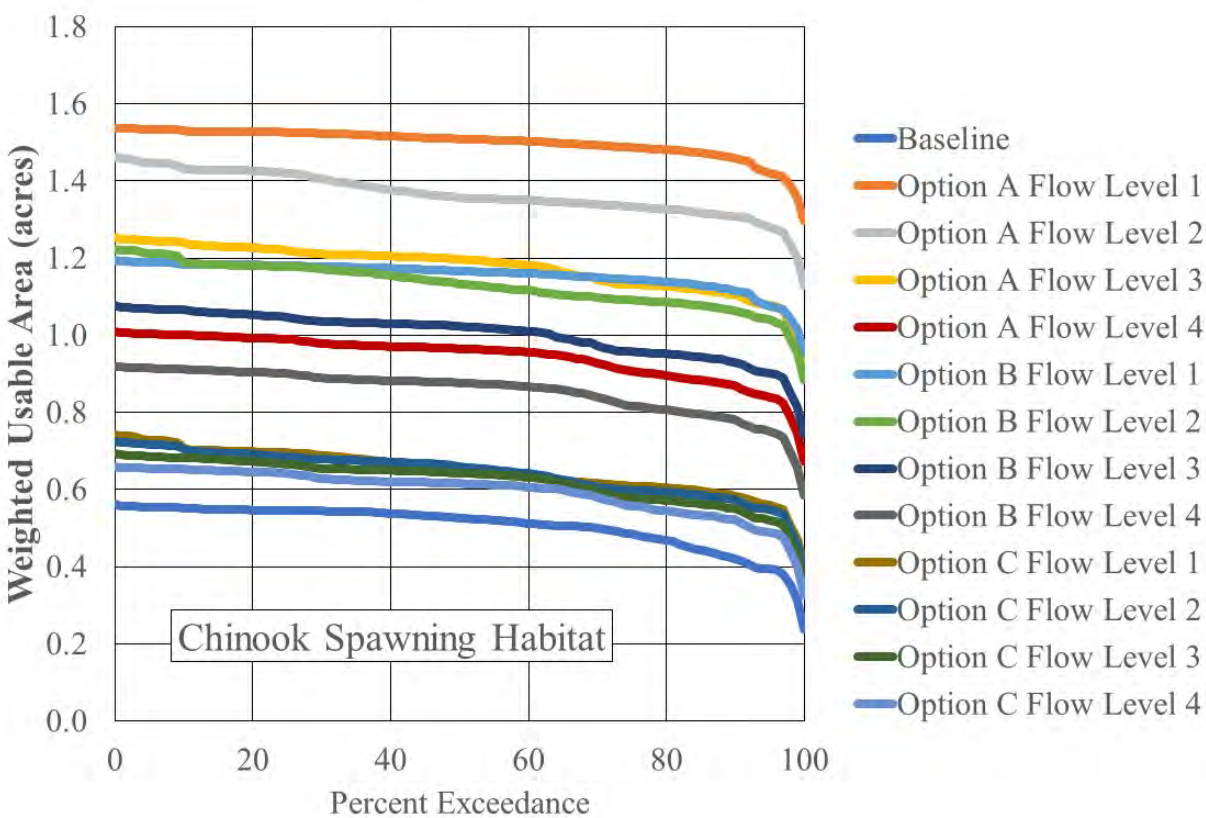


Figure 2.8-6. Chinook spawning habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

Habitat duration curves for Chinook juvenile rearing habitat are shown for Options A, B and C in Figure 2.8-7 and time-averaged habitat area (WUA) as listed in Table 2.8-3. In all cases, habitat gains were achieved when flow was released to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B) or 6.8 miles downstream (Option C).

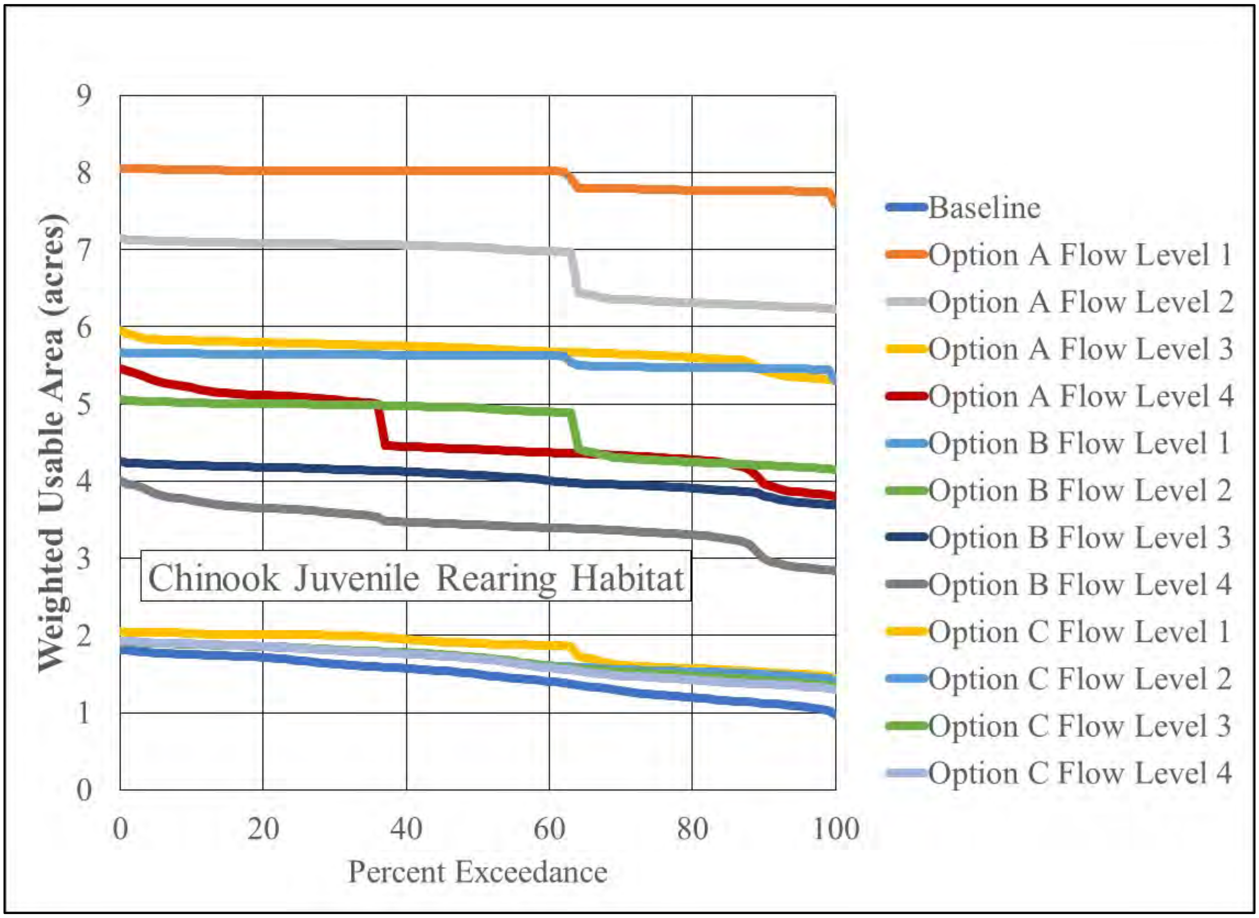


Figure 2.8-7. Chinook juvenile rearing habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

Habitat duration curves for Coho spawning habitat are shown for Options A, B, and C in Figure 2.8-8 and time-averaged habitat areas (WUA) as listed in Table 2.8-3. Similar to above, in all cases, habitat gains were achieved when flow was added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B) or 6.8 miles downstream at the AWWU drainage valve (Option C).

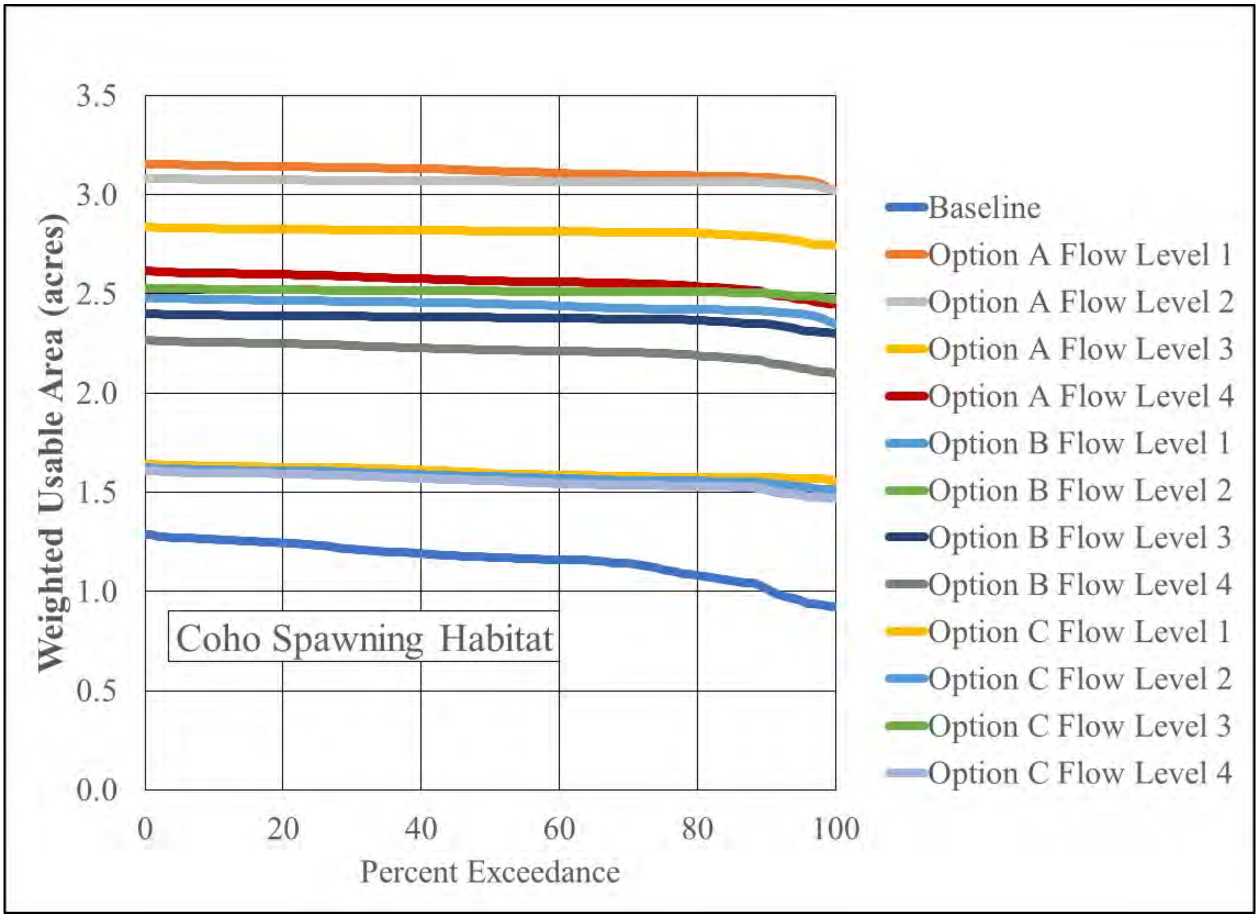


Figure 2.8-8. Coho spawning habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

Habitat duration curves for Coho juvenile rearing habitat are shown for Options A, B and C in Figure 2.8-9 and time-averaged habitat areas (WUA) as listed in Table 2.8-3. In all cases, habitat gains were achieved when flow was added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B) or 6.8 miles downstream at the AWWU drainage valve (Option C).

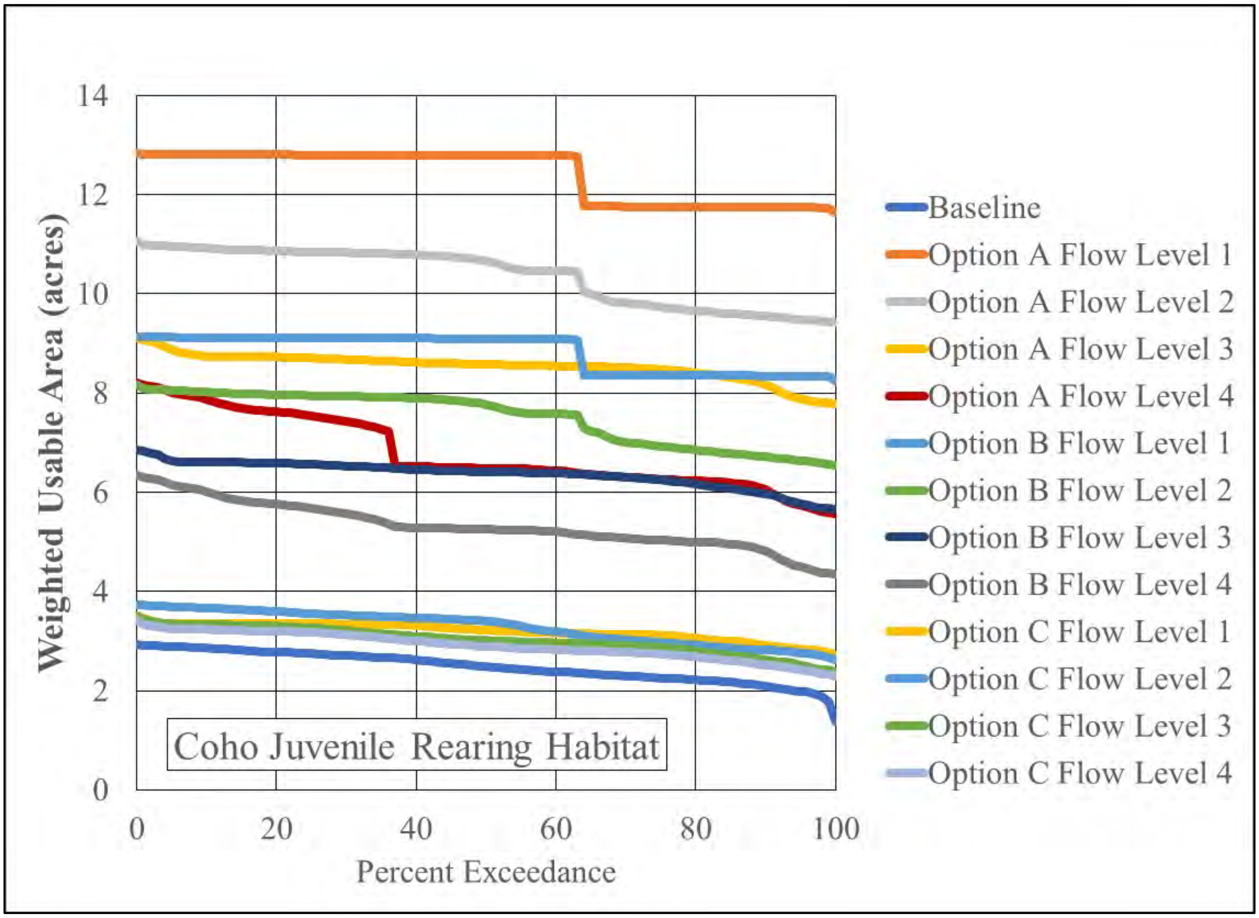


Figure 2.8-9. Coho juvenile rearing habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

Habitat duration curves for Sockeye spawning habitat for Options A, B and C are shown in Figure 2.8-10 and time-averaged habitat areas (WUA) as listed in Table 2.8-3. In all cases, habitat gains were achieved when flow was added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B) or 6.8 miles downstream at the AWWU drainage valve (Option C).

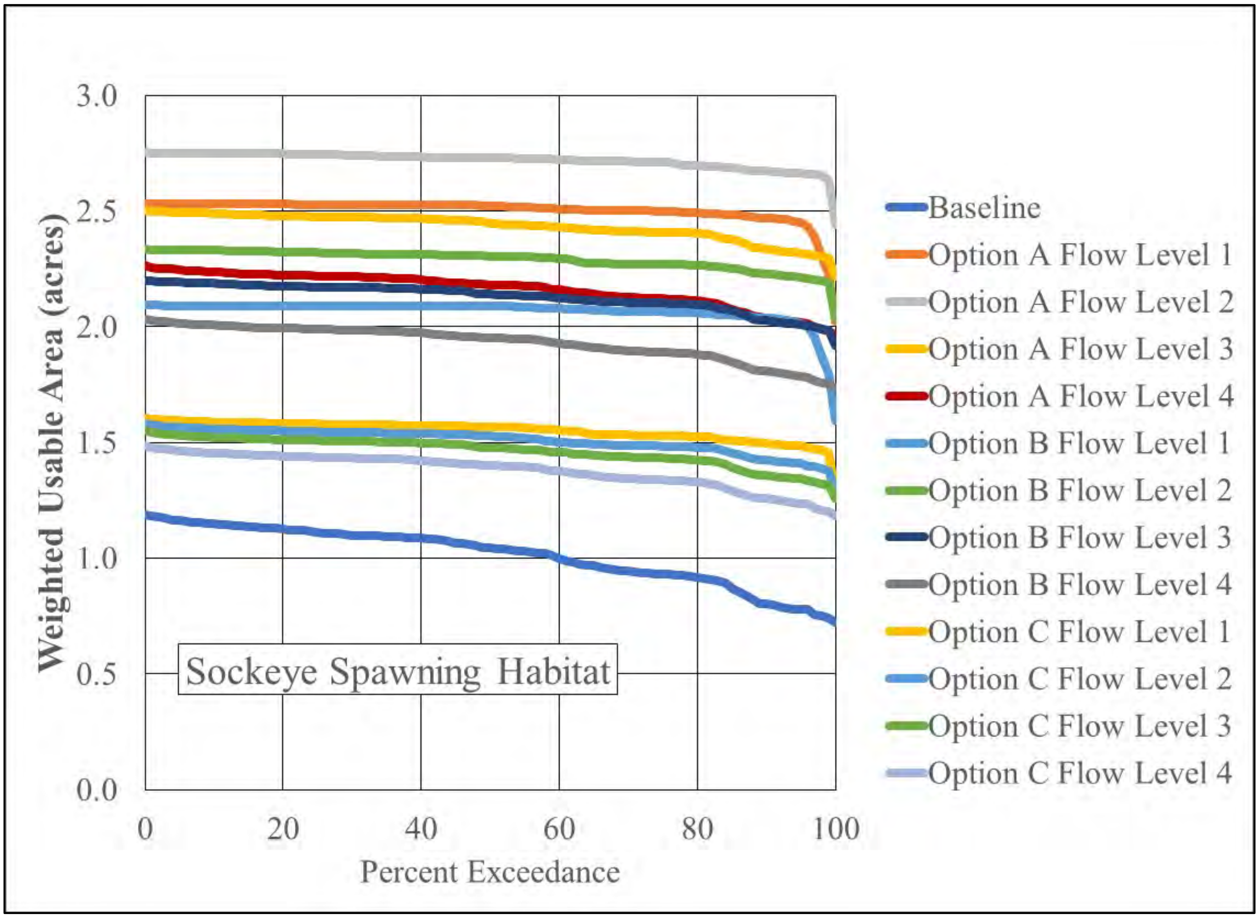


Figure 2.8-10. Sockeye spawning habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

In all cases analyzed, habitat gains (above baseline) were achieved when water was added to the river downstream from Eklutna Dam (all three flow release options, A, B and C). However, the amount of habitat gained varied with location and was the greatest under Option A, followed closely by Option B and then Option C.

3 EKLUTNA RIVER CANYON REACH BARRIER ANALYSIS

Upstream movement of adult salmon can be affected by localized hydraulic and physical conditions, rendering transitory barriers to upstream passage. Five high-gradient, shallow, swift-water stream sections were identified within the "Canyon Reach" in Reach 7 with the potential to impede or obstruct the upstream migration of adult salmon moving into the upper Eklutna River (Figure 3-1). These five potential barriers were surveyed in July 2022 to collect physical and hydraulic data to analyze whether and under what flow conditions they might impede/obstruct upstream movements of salmon.

Figure 3-1. Locations of potential barriers within Reach 7 of the Eklutna River surveyed for passage analysis. Sites A – D were identified during 2021 surveys; Site E was added during the 2022 survey.

3.1. Data Collection and Analysis

Field data were surveyed in mid-July 2022 to collect passage related hydraulics, channel bathymetry, and stream flow measurements. Additionally, site photographs (Figures 3.1-1, 3.1-2, and 3.1-3) and video clips were recorded for each site. The flows experienced during the survey resulted from accretion flow from surface runoff and groundwater sources; no flows were being released from the dam.

Figure 3.1-1. Representative photographs of potential Fish Passage Barriers A (top photo) and B (bottom photo) collected during the August 19-21 survey of the Eklutna River, Alaska (AK) at a flow of 8.8 cfs.

Figure 3.1-2. Representative photographs of potential Fish Passage Barriers C (top photo) and D (bottom photo) collected during the August 19-21 survey of the Eklutna River, AK at a flow of 8.8 cfs.

Figure 3.1-3. Representative photograph of potential Fish Passage Barrier E collected during the August 19-21 survey of the Eklutna River, AK at a flow of 8.8 cfs.

Channel survey data were collected using a Leica Total Station and Data Collector. Depending upon the hydraulic complexity, a different number of cross channel transects (ranging from 9 to 13) were surveyed for each site. The transects were distributed to capture the hydraulic conditions considered critical to evaluating fish passage. A summary of the bathymetric survey information collected at each of the five passage sites is provided in Table 3.1-1.

Table 3.1-1. Summary of bathymetric survey data completed at the five (A-E) potential barrier sites in the Eklutna River. The sites are listed in an upstream sequence; i.e., Site A is lowermost, Site D uppermost.

Site	Site Length (ft)	Number of Transects	Number of Surveyed Points	Survey Date
Site A	156	12	190	7/19/22
Site B	99	9	130	7/20/22
Site E	121	13	207	7/20/22
Site C	105	12	235	7/21/22
Site D	94	10	195	7/21/22

The surveys included measurement of water surface elevations at each site and representative flow measurements made above Site E, and the most upstream site – Site D.; flow was estimated at ~8.8 cfs.

A 1D hydraulic model was set up for each passage site using HEC-RAS 6.2 (USACE 2016). The model setup included the surveyed transects, defining the upper and lower extent of each site for modeling purposes, and the surveyed flow of 8.8 cfs. The hydraulic model was first calibrated to the surveyed WSEs by assigning surface roughness coefficients to each transect. Different channel roughness values were tried until the simulated WSEs were considered satisfactory. Bank stations were assigned based on the field notes and photographs that indicated the portion of the transect through which most of the water would travel. Because of strong turbulence and water surface fluctuations at each site, the model was calibrated to a WSE slightly lower than the surveyed value by 0.25 feet to 0.5 feet to bring the simulated hydraulics as close to the field condition as possible.

After the model was set up and calibrated, it was then applied to simulating the hydraulics (i.e., velocity and depth) for a broad range of flows between 2 cfs and 100 cfs for use in determining the minimum flow for safe fish passage at each of the five fish passage barrier sites.

3.2. Fish Passage Criteria

To determine the flow level necessary to provide fish passage through the five potential barriers, four potential passage barrier types were evaluated: velocity, depth, chute, and falls. The passage criteria used in the analyses were cited in Reiser et al. (2006) and the Washington State Department of Fish and Wildlife (WDFW 2019) (Table 3.2-1). The passage assessment focused on the same three salmon species as the PHABSIM analysis, Chinook, Coho, and Sockeye.

Table 3.2-1. Depth and velocity criteria applied in the Eklutna River barrier assessment; source Reiser et al. (2006) and WDFW (2019).

Species	Swimming Depth (ft)	Body Length (ft)	Burst Velocity (ft/s)
Chinook	0.56	3.0	10.8
Coho	0.56	2.3	10.2
Sockeye	0.56	1.8	10.6

Note: Burst velocities are the lower end values of the range in Reiser et al. (2006).

These criteria were then applied to output from the hydraulic models to define the flow conditions that would allow unobstructed fish passage through each of the five sites. The general guidelines used for determining unobstructed passage are outlined below:

- Velocity within migration pathway that does not exceed the lower end of the range of a species burst velocity;
- Depth within migration pathway that is greater than the fish body depth;
- Chute characteristics (length and prevailing velocities) that would not preclude fish swimming through via burst speed; and

- Falls characteristics (e.g., dimensions – height, slope, velocity, plunge pool depth) that would not exceed a fish's leaping capabilities.[7]

3.3. Results

Over the modeled flow range (2 to 100 cfs), the hydraulic and passage analyses indicated; 1) the top flow velocity at each site was always less than the burst velocity of all three fish species; 2) the falls drops were generally small at all sites and not expected to result in leaping issues; and 3) the chute length and velocity characteristics would not obstruct passage.

Overall, the analyses suggested the major barrier issue at all five sites was the water depth (not velocity) required to allow unobstructed migration of adult salmon. The corresponding minimum flows (considered as flow thresholds) and associated hydraulics to meet the fish passage requirements were determined at each site and are summarized in Table 3.3-1. These flows were considered threshold values below which passage could be impaired.

This preliminary analysis suggests that a minimum flow of 50 cfs (based on Site B characteristics) would be needed in Reach 7 of the Eklutna River during adult salmon upstream migration period (June-October) (Figure 2.5-1) to provide for unobstructed fish passage through all five of these sites. However, the channel morphologies of each site (especially Site B due to the residual sediment deposits and unstable banks; see Figure 3.3-1) are dynamic and may change either naturally or via soft engineering techniques. The associated flow thresholds would likewise change. As a result, the barrier flow analysis was not directly integrated into the time series analysis described in Section 2.9.2.

Table 3.3-1. Flow thresholds required to meet water depth criteria for upstream fish passage at the five potential barriers in the Eklutna River.

	Site A	Site B*	Site C	Site D	Site E
Minimum passage Q (cfs)	40.0	50.0	8.8	40.0	40.0
Velocity at critical transect (ft/s)	8.35	6.25	4.71	4.340	3.76
Depth at critical transect (ft)	0.62	0.57	0.69	0.600	0.43
Froude at critical transect	1.90	1.50	1.00	0.990	1.01
Potential barrier average slope (ft/ft)	0.16	0.14	0.087	0.068	0.12
Passage barrier type	Depth	Depth	Depth	Depth	Depth

* Note -site B resides within a channel segment that contains residual sediment deposits and bank instability and would likely change under varying flow conditions.

[7] Note - The falls features of the five sites have small drops from the top to the plunge pool; the highest drop is about 1.5 feet at Site E, which could be traversed via swimming. As the result, no falls features were analyzed.

4 TWO-DIMENSIONAL (2D) HEC-RAS AND HABITAT MODELING

As noted in Sections 2.2 and 2.3, the 1D PHABSIM study sites were located within five reaches of the Eklutna River – R11, R9, R8, R7, and R4 (Figure 2.2-1). No study sites were established in Reaches 10, 6, 3, 2, and 1 in part due to accessibility issues during release of the high target flow, susceptibility to channel change due to sediment deposition, tidal influence (R3), and complexity of habitats (braiding and multiple channels) within those reaches. These complex areas contain off-channel habitats frequently used by juvenile salmonids for rearing and may also support some spawning habitats. LiDAR based 2D hydraulic modeling can provide a reasonable characterization of these complex habitats under a wide range of flows and is not as constrained as 1D PHABSIM modeling. As a result, four (4) new study sites were identified for 2D HEC-RAS hydraulic modeling in 2022 (MJA 2022). These included:

- Reach 10 to encompass main and side channel complexity in an upper reach of the Eklutna River inaccessible during the 2021 study flow releases;
- Reach 6 to encompass channel characteristics within the canyon reach of the Eklutna River immediately upstream from the confluence with Thunderbird Creek; this reach contained substantial sediment deposits and therefore channel morphologies would have likely changed during the three test flow releases; the reach was likewise inaccessible during the 2021 study flow releases;
- Reach 4 within the section of the Eklutna River between the highway and railroad bridges encompassing the “flooded forest” complex; and
- Reach 3 within a section of the Eklutna River below the railroad bridge containing a braided beaver complex considered as supporting high value juvenile habitats (see Fish Study).

4.1. Site Selection and Model Extent Determination

Study reaches were selected for 2D hydraulic model development due to their habitat and hydraulic complexity (Reaches 4 and 3) and accessibility issues during the 2021 test flow releases (Reaches 10 and 6) (Figure 4.1-1). In general, 2D hydraulic models perform best when the modeled reaches fully contain any split flow paths within the area of interest and have clearly defined inflow and outflow locations. The specific segments of the modeled reaches were adjusted accordingly and contain representative habitat features within each, complete with inflow and outflow features. Nominally, the R3 model was 2,183 ft in length, R4 2,502 ft., R6 1,167 ft, and R10 3,744 ft (Figure 4.1-2).

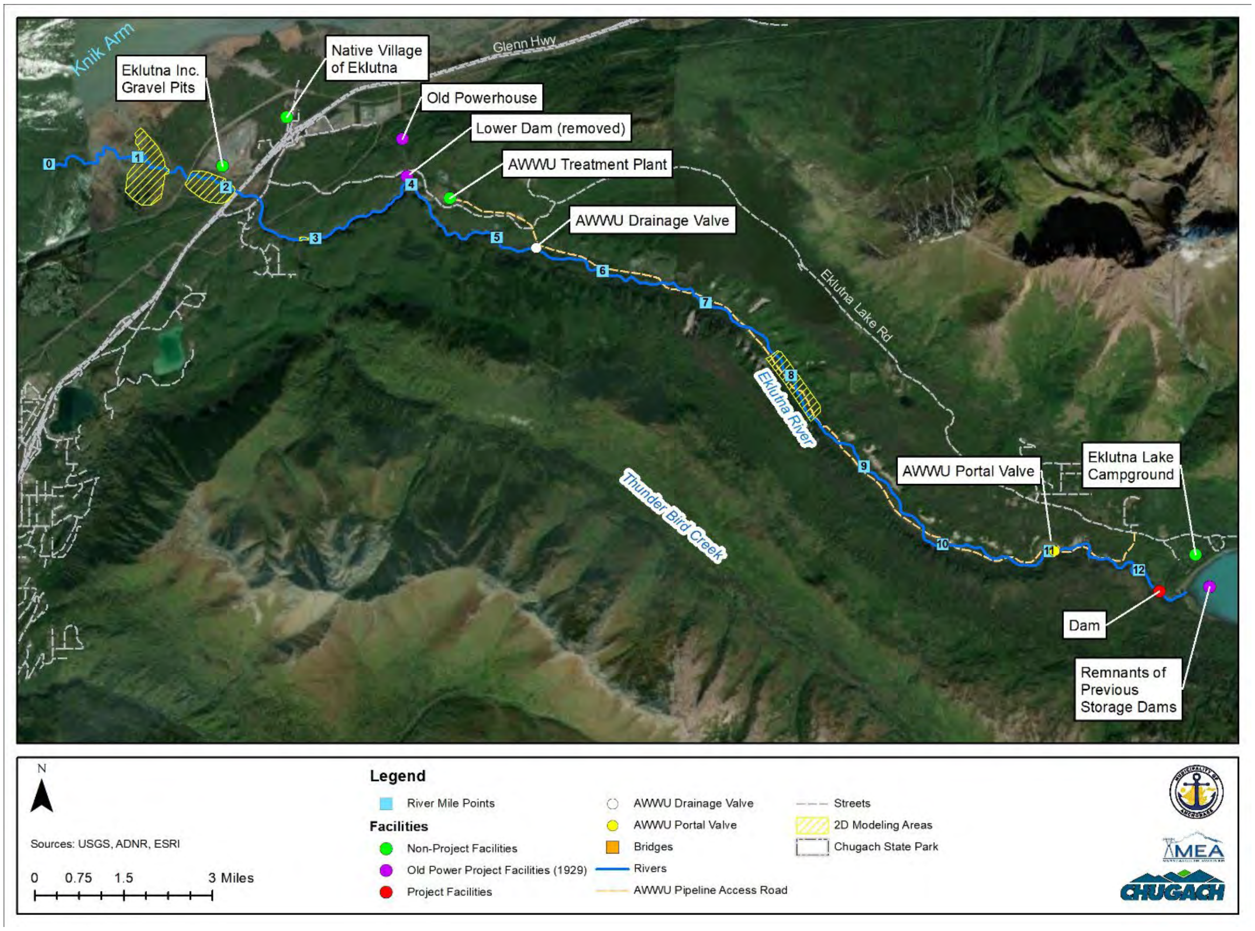


Figure 4.1-1. Eklutna Instream Flow Study Area showing reach designations. Two-dimensional HEC-RAS modeling sections were located in Reaches 10, 6, 4, and 3 and are indicated by areas of yellow cross-hatching. The Reach 6 section is small and located just above the confluence of Thunderbird Creek.

Figure 4.1-2. Model extents for each of the four reaches. The polygon border in orange represents the extent of the hydraulic model and the polygon in light green is the habitat model extent. Nominally, the models for Reaches 3, 4, 6, and 10 were 2,183 ft., 2,502 ft., 1,167 ft, and 3,744 ft in length, respectively. The line passing the middle of each polygon represents the main water course at low flow.

4.2. Data Collection

4.2.1. 2022 Topobathymetric LiDAR Data Collection

In May 2022, NV5 Geospatial was contracted by MJA to collect topobathymetric LiDAR data for the Eklutna River. This data set was the primary source of elevation data of the Eklutna River's floodplain and bathymetric elevations (NV5 Geospatial 2022). The LiDAR (out of channel) portions of this survey had estimated vertical accuracies of 0.101 meters evaluated at a 95% confidence interval. The bathymetric portions of the survey had estimated vertical accuracies of 0.328 meters evaluated at a 95% confidence interval. NV5 Geospatial indicated the differences in vertical accuracy between the out-of-channel and in-channel topography were likely a result of highly turbid and shallow depth stream conditions, combined with the altitude required to safely fly over the river. Based on on-the ground observations during the RTK-GPS data collection effort (Section 4.2.2), Reaches 4 and 3 exhibited the greatest amount of turbidity. Because of the differences in vertical accuracy, using this bathymetric data as the basis for the 2D hydraulic model introduces some uncertainty into the analysis. However, this uncertainty was reduced through model calibration and sensitivity analysis.

4.2.2. RTK-GPS Survey and Additional Data Collection and Comparison with LiDAR

RTK-GPS surveying and field data collection for the 2D hydraulic modeling were collected at each of the four selected reaches (R10, R6, R4, and R3). The RTK-GPS surveys and data collection efforts occurred from August 2 to August 5, 2022, with one full day spent at each of the four reaches. The objective of the surveys was to collect data useable for development of the 2D model. Because of time limitations, the data collection was prioritized as follows:

- Priority 1 data were required and involved collection of a sufficient number of RTK GPS elevation points in each study reach to evaluate the quality of floodplain and in-channel portions of the topobathymetric LIDAR data in those areas;
- Priority 2 data would be useful in the model development and consisted of the collection of water surface elevations under flow conditions present during the site visit; and
- Priority 3 data were considered optional since they were not directly needed for model development but could provide supplemental information including photos, preliminary roughness estimates, dimensions of key hydraulic features, and main channel substrates.

Figure 4.2-1 depicts the set-up and RTK-GPS survey data collection process.

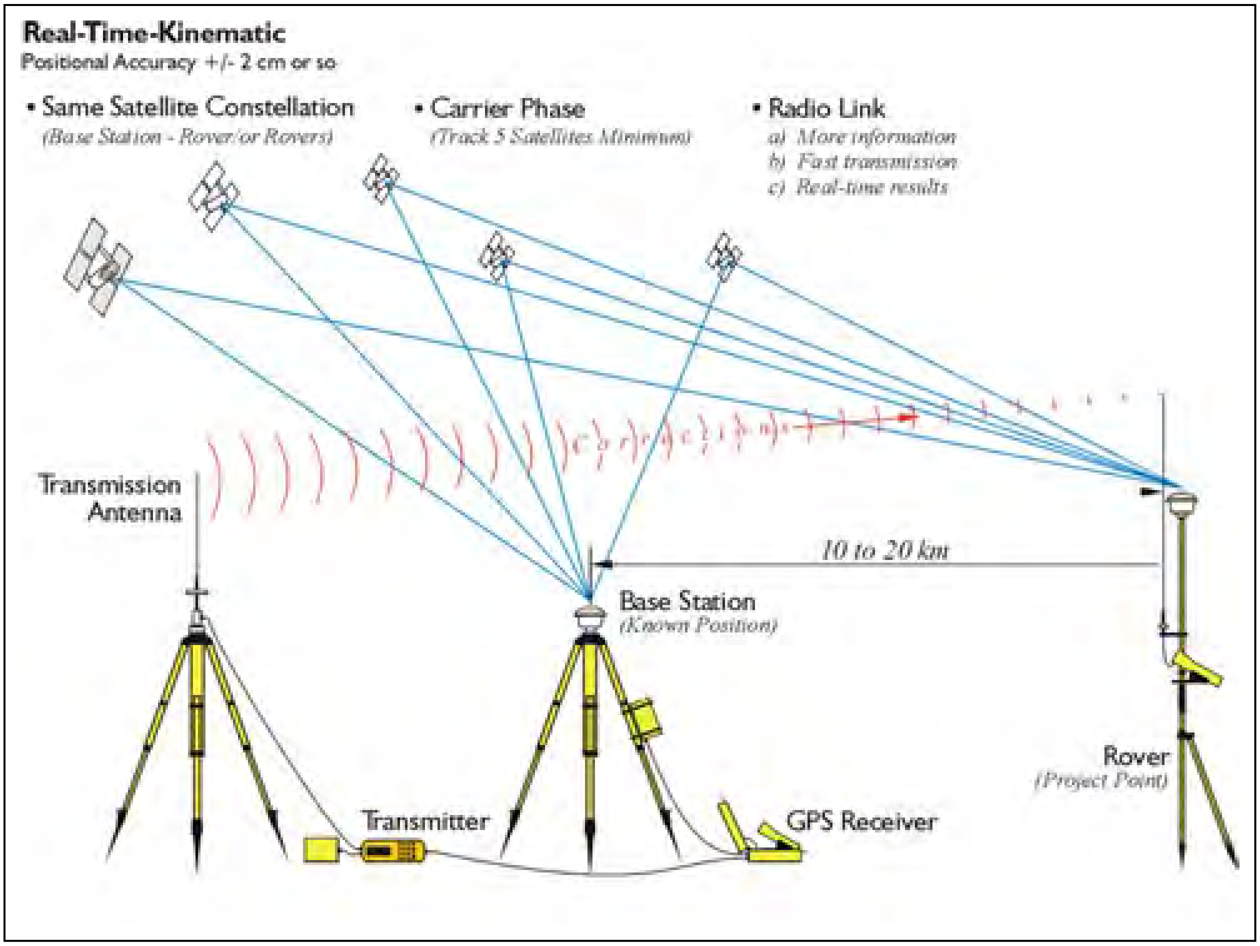


Figure 4.2-1. Example field set-up for collecting RTK-GPS Ground elevation points (*Source: GPS for Land Surveyors*) for the Eklutna River.

The priority 1 data were used to identify areas where the topobathymetric LiDAR data were unable to capture the true channel bottom, while priority 2 data were used for model calibration. Where collected, the priority 3 data were used to improve the model geometry and estimates of available habitat. Substrate data collection was limited and focused on defining Manning's roughness coefficients for use in the 2D model. Time constraints precluded detailed mapping of spawning substrate which would be required for computing 2D derived estimates of spawning habitat. Priority 3 data included channel flow, main channel substrate information, and site photos.

The field survey data and information were subjected to quality assurance/quality control procedures and then used to check the 2022 LiDAR data and calibrate the hydraulic model. Table 4.2-1 lists the flows measured at each of the four sites as well as the number of ground and water surface elevation measurements taken.

Table 4.2-1. RTK-GPS and flow data collection in each of the 2D model sites in Reaches 10, 6, 4, and 3 of the Eklutna River.

Reach	Measured Flow(s) (cfs)	Number of Ground/Channel Measurements	Number of Water Surface Measurements
10	0.57	148	12
6	8.23, 8.55	114	39
4	61.10, 66.70	218	53
3	62.4	175	40

Some limited qualitative substrate data within Reaches 10, 6, and 4 were recorded, but only in the main channel portions of the study areas. R3 was a large and widely distributed study area and appeared to have a uniform substrate composition ranging from fine sediments to large gravels and thus, was not mapped. However, the substrate data collected were not sufficient to use in the evaluation of channel and floodplain spawning habitats as described in this technical memorandum. This would require detailed substrate mapping of each of the 2D Study sites which has not been done.

As described in Section 4.2.1, the LiDAR report provided to Kleinschmidt Associates by NV5 Geospatial noted that in areas with high turbidity, significant vegetation cover, and very shallow depths, the bathymetric elevations have greater uncertainty than the out-of-channel LiDAR elevations.

Kleinschmidt Associates completed a separate analysis of the LiDAR elevation data by comparing the LiDAR elevations to the RTK-GPS survey data that was collected within two months of the LiDAR flight. The comparison revealed that overall, the Root Mean Square Error (RMSE) between the RTK-GPS surveyed elevations and the LiDAR topobathymetry elevations was 0.16 feet and ranged from 0.12 to 0.18 feet. RMSE describes how concentrated data are around the line of best fit between two data sets (low values mean two highly correlated data sets). The RMSE listed for each of the data sets listed in Table 4.2-2 reveals that there is a high correlation between the RTK-GPS survey elevations and the 2022 topobathymetric LiDAR data. Figure 4.2-2 highlights the elevation differences of the two data sets. This analysis revealed that the LiDAR and RTK-GPS elevation data are accurate to within roughly 0.2 meters for the whole data set. Reaches 6 and 4 had greater agreement compared to R3 and R10. Reaches 3 and 10 had the greatest amount of vegetative cover while R3 had the most turbidity of the four reaches.

Table 4.2-2. RMSE for LiDAR vs. RTK-GPS elevation comparison for the four 2D HEC-RAS study reaches of the Eklutna River.

Reach	RMSE (ft)
10	0.18
6	0.12
4	0.15
3	0.18

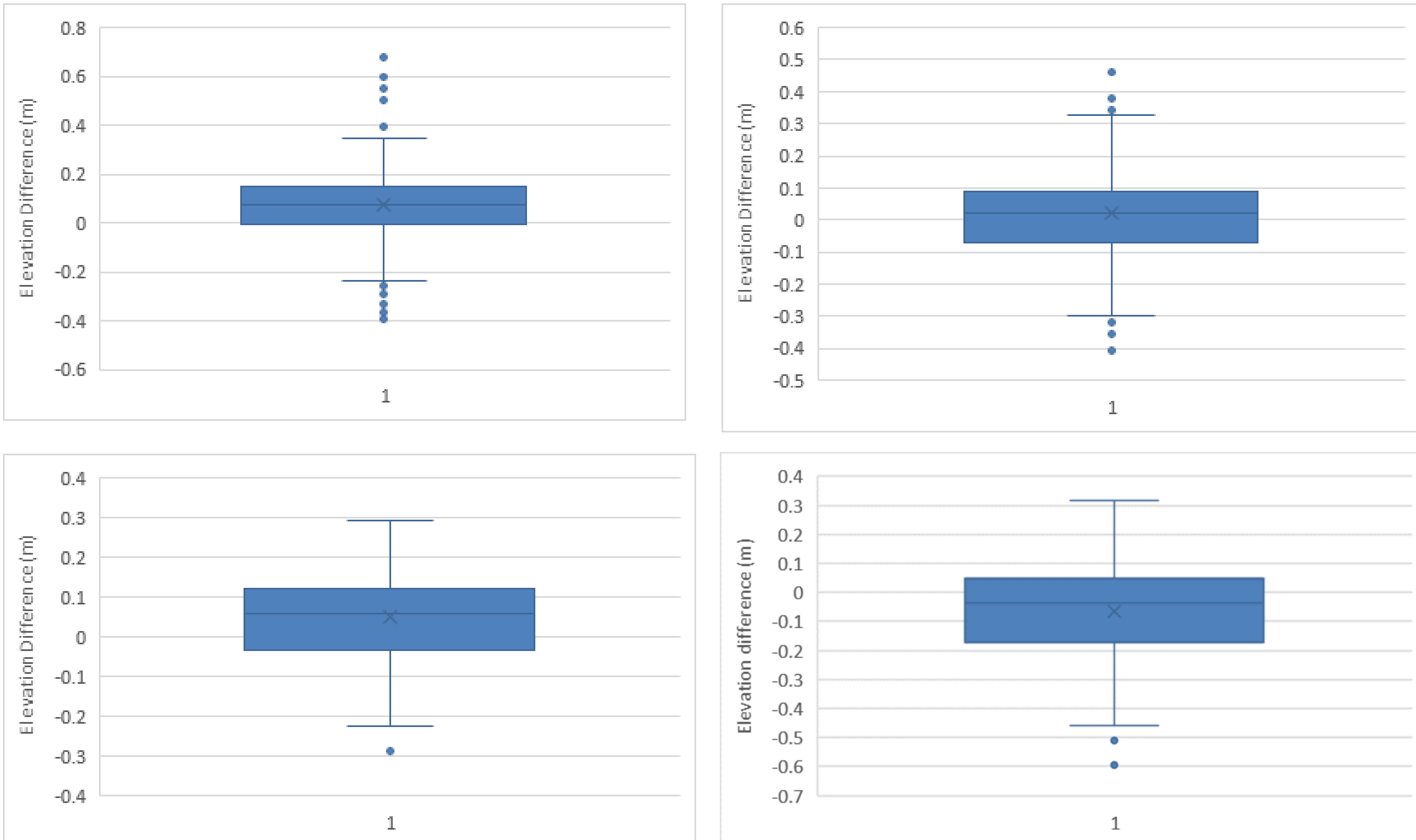


Figure 4.2-2. Elevation differences between the LiDAR data and RTK-GPS survey data for the Eklutna River for Reach 4 (upper left), Reach 3 (upper right), Reach 10 (lower left), and Reach 6 (lower right).

4.3. 2D Model Development

4.3.1. Development of 2D Mesh and Selection of Manning's Roughness Values

HEC-RAS 2D utilizes a gridded computation mesh to compute the direction, velocity, and depth of flow within the model domain. Each 2D mesh is made of computational cells that are sized to capture adequate detail within areas of interest. Typically, areas of higher importance or hydraulic conveyance, such as in-channel areas, will be assigned smaller cells than out-of-channel areas to capture greater hydraulic detail. Table 4.3-1 below summarizes the cell sizes selected for the models in Reaches 10, 6, 4, and 3.

Table 4.3-1. Computational cell sizes utilized for the 2D model for Reaches 10, 6, 4, and 3 in the Eklutna River.

Reach	Floodplain Cell Size (ft)	Channel Cell Size (ft)	Total Number of Cells
10	25	2-3	100,275
6	10	3	6,122
4	25	3	71,282
3	25	3-5	30,383

Initial Manning's roughness coefficients of each site's channel and floodplain was estimated through on the ground observations, review of site photos and channel substrate maps, and guidance provided in the HEC-RAS 2D User's Manual (USACE 2021). These initial Manning's roughness coefficients of each site's channel and floodplain were based on the flow conditions observed at the time of the calibration data collection. The flow channel roughness values used for each site were adjusted to best match the observed data recorded during the site visit (see Section 4.3.3 of this report for discussion on the calibration process). Typically, the Manning's roughness coefficients of a stream's channel and floodplain are higher at lower flows when the frictional forces on the flow are higher. As flow, and subsequently depth increase, these frictional forces decrease and the Manning's roughness coefficients used to model these higher flows also decrease. These effects are more pronounced in river reaches that are confined to a single channel thread and lessened in reaches that are wide and multi-threaded. For this reason, adjustments to Manning's roughness based on flow were made for the R6 and R10 models, given that these reaches are much more confined then R3 and R4. Table 4.3-2 summarizes the final roughness values used for each model at the calibration flow level. Table 4.3-3 and Table 4.3-4 highlight the adjustments to Manning's roughness based on flow for R6 and R10.

Table 4.3-2. Floodplain and Main Channel Manning's n roughness values applied to the 2D HEC-RAS hydraulic models developed for Reaches 10, 6, 4, and 3 of the Eklutna River.

Reach	Floodplain Description	Floodplain Manning's n Roughness Coefficient	Main Channel Description	Main Channel Manning's n Roughness Coefficient
10	Emergent Herbaceous Forest and Shrubs	0.085	Large cobble/boulder bed; cascading pools	0.055
6	Large Cobble/Deciduous Forest	0.065-0.075	Gravel/cobble bed	0.025-0.038
4	Shrub/Scrub	0.07	Gravel/cobble bed	0.032
3	Woody Wetlands	0.065	Incised channel with vegetated banks and small gravel/fine bed	0.04*

*Defined channel not present in majority of study area.

Table 4.3-3. Adjusted Manning's roughness values for Reach 6 of the Eklutna River.

Flow (cfs)	Manning's Roughness		
	Right Floodplain	Left Floodplain	Channel
8.4	0.087	0.134	0.038
25	0.087	0.134	0.032
50	0.087	0.134	0.030
75	0.071	0.098	0.029
150	0.059	0.074	0.028
200	0.056	0.070	0.028
250	0.053	0.065	0.028
375	0.050	0.060	0.027

Table 4.3-4. Adjusted Manning's roughness values for Reach 10 of the Eklutna River.

Flow (cfs)	Manning's Roughness		
	Floodplain	Channel	Roadway
8.4	0.147	0.055	0.050
25	0.147	0.049	0.050
50	0.147	0.046	0.050
75	0.147	0.044	0.050
150	0.147	0.042	0.050
200	0.085	0.042	0.042
250	0.071	0.041	0.039
375	0.060	0.040	0.036

4.3.2. Model Hydrology and Boundary Conditions

Boundary conditions, which allow flow to enter and exit the model domain, were applied to each 2D mesh at the upstream and downstream ends of the model. Flow hydrographs were used to define the upstream model boundaries, and the normal depth or channel slope was used to define the downstream model boundaries. In order to replicate the flows analyzed in the 1D PHABSIM analysis, the flow hydrographs used in the analysis were held constant to achieve a "quasi-steady" state condition within the model domain. This means natural attenuation within the Eklutna River system was not accounted for in this preliminary analysis.

One of the purposes of the 2D HEC-RAS models is to provide hydraulic inputs to the 2D habitat model needed to develop the habitat vs. flow curves described in Section 4.4.5. For this, each of the reaches was modeled with the flow conditions of 10, 25, 50, 75, 100, 150, 200, 250, 300, and 375 cfs. That range of flows proved sufficient for defining the shapes of the curves in R3 and R4 where, because of adjacent and abundantly available floodplain channels, additional flow equates to additional habitat. However, R6 in particular, and R10 to some extent are confined within a narrower floodplain and therefore opportunities for off-channel connectivity are more limited. To better define the habitat – flow relationships in those reaches, an additional five flows (37 cfs, 62 cfs, 87 cfs, 175 cfs, and 225 cfs) intermediate to those for R3 and R4 were modeled (Table 4.3-5). Table 4.3-6 summarizes the flows and normal depth slopes used for each of the four hydraulic models. The selected calibration flow used for Reaches 6 and 4 was an average of the two measured calibration flows recorded during the site visit.

Table 4.3-5. Flows used in the 2D habitat modeling for Reaches 3, 4, 6, and 10 of the Eklutna River. Ten flows were sufficient to define the habitat vs. flow relationships in R3 and R4, but an additional five flows were modeled in R6 and R10 to better define the relationships.

2D Habitat Modeled Flow (cfs)			
Reach 3	**Reach 4**	**Reach 6**	**Reach 10**
10	10	8.4	10
25	25	25	25
50	50	37	37
62.4	63.5	50	50
75	75	62	62
100	100	75	75
150	150	87	87
200	200	100	100
250	250	150	150
300	300	175	175
375	375	200	200
		225	225
		250	250
		300	300
		375	375

Table 4.3-6. Model boundary conditions including calibration flows, and normal depth slope used in defining downstream boundaries for Reaches 10, 6, 4, and 3 of the Eklutna River.

Reach	Calibration Flow	Downstream Normal Depth Slope (ft/ft)**
10	0.57*	0.01198
6	8.4	0.0204
4	63.5	0.00743
3	62.4	0.00136, 0.00321***

* Calibration for Reach 10 was not conducted given how small the measured flow (0.57 cfs) was compared to the modeled habitat flow range (10-375 cfs).
** Normal depth was estimated based on the slope of the terrain through the boundary of the model.
*** Reach 3 contained two distinct outlets for flow and thus, had two normal depth boundary conditions.

4.3.3. Model Calibration

Calibration flows were measured for all four study reaches as described above in Section 4.3.2. However, the measured flow in Reach 10 (0.57 cfs) was too low to use in model calibration given the range of modeled flows (10-375 cfs). Model calibration data was limited to the flows present in the noted reaches at the time of data collection (August 2-5, 2022).

For the other three reaches, Manning's n values were adjusted to best replicate the observed water surface elevations measured during the RTK-GPS survey. For this preliminary analysis, Manning's roughness was determined to be the primary calibration parameter as the other hydraulic model parameters were assumed to be known (flow, ground elevations, bathymetry). The base and adjusted Manning's n values are shown in Table 4.3-7 below.

Table 4.3-7. Manning's calibration used for the Eklutna River 2D HEC-RAS hydraulic model.

Reach	Base Main Channel Manning's n Roughness Coefficient	Adjusted Main Channel Manning's n Roughness Coefficient
10	0.055	0.055**
6	0.045	0.025-0.038
4	0.045	0.032
3	0.045*	0.04*

*Defined channel not observed in majority of study area.
*Not calibrated.

The final calibrated model reported average differences between measured and modeled water surface elevations of -0.35, -0.23, and -0.12 feet for Reaches 6, 4, and 3, respectively. These differences between modeled and measured water surface elevations are adequate for a 2D model of this size. Figure 4.3-1 shows the correlation between measured and modeled water surface elevations for the three reaches. These figures highlight the strong correlation between the predicted and measured water surface elevations in the three calibrated models.

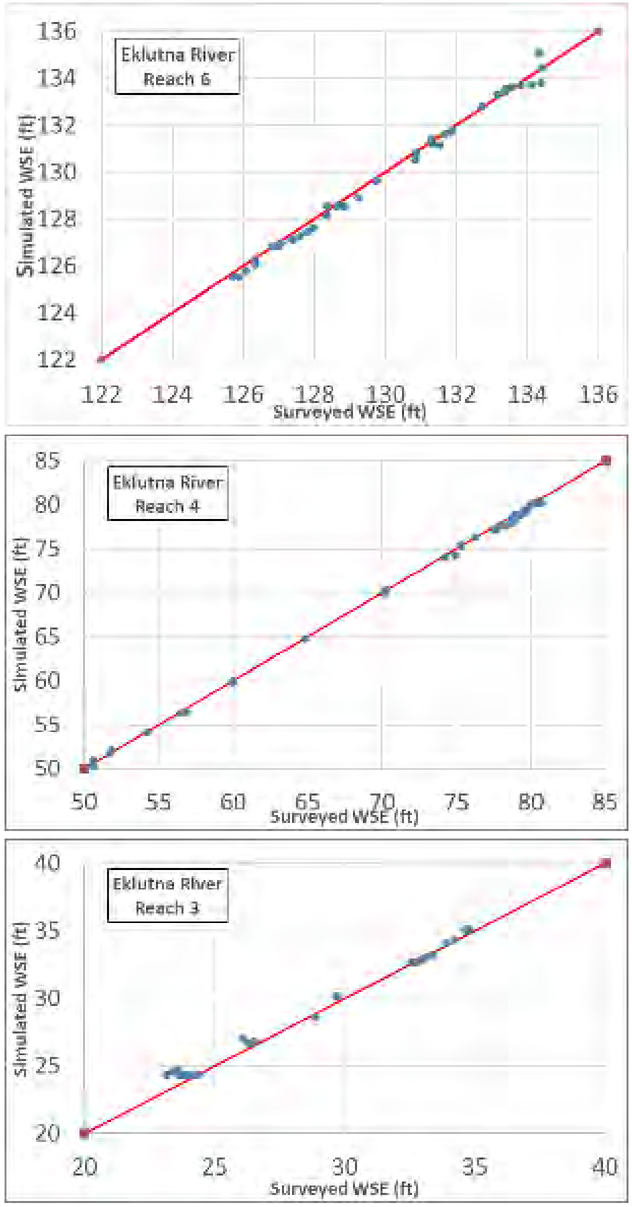


Figure 4.3-1. Reach 6 (top), Reach 4 (middle), and Reach 3 (bottom) water surface elevation calibrations for the 2D HEC-RAS model for the Eklutna River.

Based on the analysis of the LiDAR data (Section 4.2.1), the areas with thicker vegetation canopy and high turbidity levels exhibited greater discrepancy between the LiDAR surface and the RTK-GPS survey points. This conclusion is further supported by the calibration of the hydraulic models, which revealed that the models for reaches with thicker vegetation canopy and high turbidity levels (Reaches 4 and 3) did not calibrate as well as the Reach 6 model which had minimal vegetated canopy and low turbidity.

4.3.4. Interpreting Model Results

The results produced by this hydraulic model represent the depth, velocity, and inundation extents related to specific flow levels within the Eklutna River. Additional sources of flow within the modeled areas such as groundwater, rainfall/runoff, tidal, or snowmelt are not accounted for. This means the areas of inundation, or “wetted areas,” are only shown if they are hydraulically connected to the Eklutna River under the modeled flow levels in the Eklutna River. If the model results indicate that a portion of the channel or floodplain is dry, those areas may still be inundated as a result of other hydrologic sources.

As an example, Reach 3 has numerous ponds that are inundated year-round regardless of the flow level in the Eklutna River (Figure 4.3-2). The source of the water that keeps these ponds full is unknown and not accounted for in the model. The 2D model results for Reach 3 suggest that these ponds are not hydraulically connected to the Eklutna River (dry). However, since these ponds are known to hold water (Figure 4.3-2), it is possible that some hydraulic connections to the Eklutna River and its floodplain do exist, and/or other sources of inflow (i.e., rainfall/runoff, snowmelt, groundwater exfiltration, etc.) are occurring. The aerial images captured in Figure 4.3-2 would suggest that the ponds to the south (clear, darker water), are not connected to the Eklutna River floodplain (light turbid water).

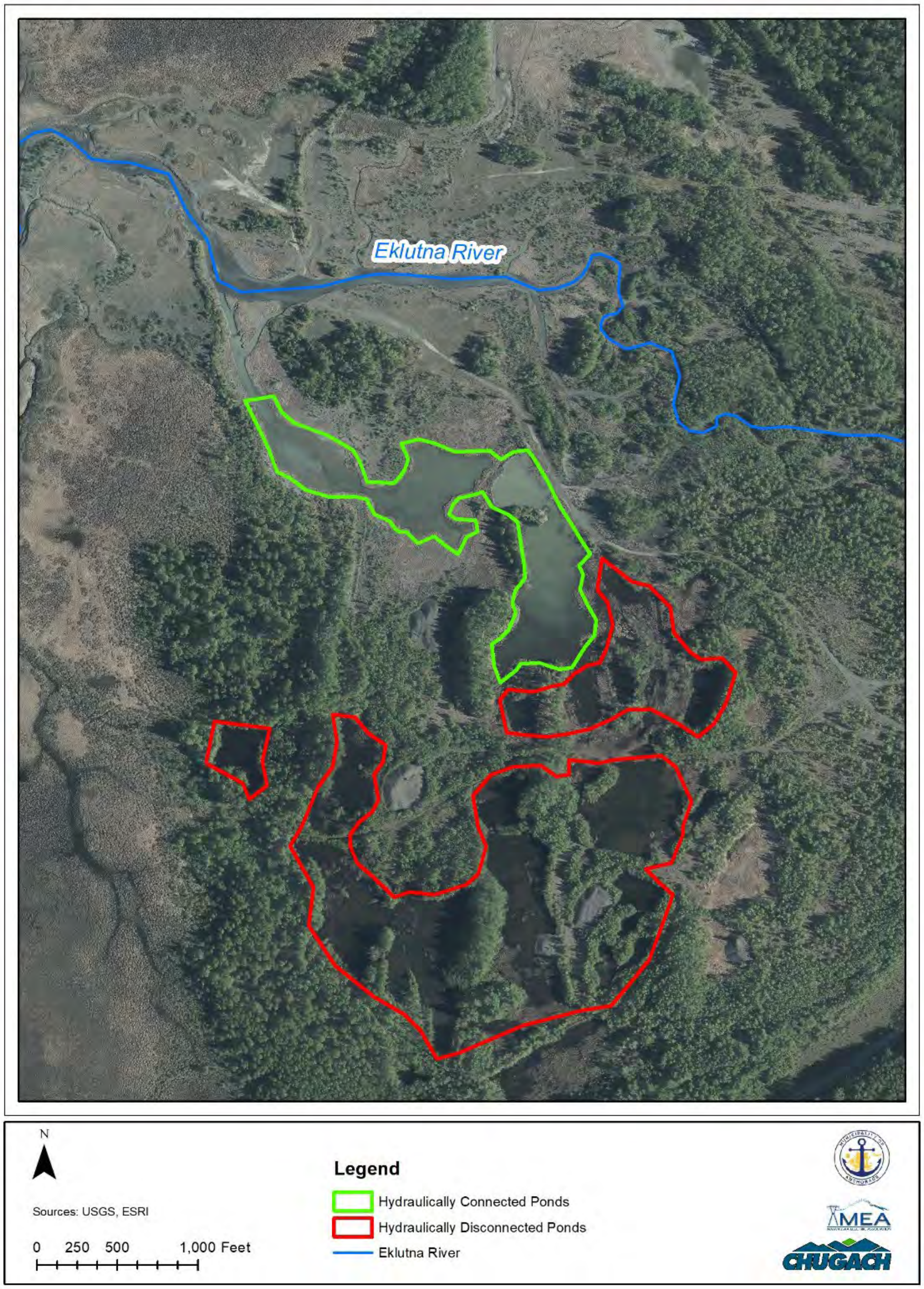


Figure 4.3-2. Off Channel Ponds located in Reach 3 of the Eklutna River. Some of these ponds may become physically connected to the river via surface flows, while others may remain disconnected with water levels influenced by groundwater from other sources or hyporheic underflow from the river.

4.4. 2D Habitat Analysis

The 2D habitat analysis used outputs from the 2D HEC-RAS model for the Eklutna River combined with a python program built within the Quantum Geographic Information System (QGIS), an open-source mapping software that provides services similar to ArcGIS. The program read in the simulated velocity and depth from the hydraulic modeling results and merged the HSC preference curves to calculate weighted usable habitat area for the fish species (Chinook and Coho salmon) and life stages (juvenile rearing) of interest. Figure 1.3-2 illustrates the general steps of the modeling process applied in the 2D analysis, with details described below.

4.4.1. Linkage with the 2D HEC-RAS Model

The 2D habitat modeling used the hydraulics pertinent to the cells defined in the 2D HEC-RAS hydraulic model. Mesh cell sizes varied within the terrain model with larger cells applied in the broad off-channel and floodplain areas (~10 ft to 25 ft) and smaller cells in the main channels (~2 ft to 5 ft.) to capture the more complex habitat features. Figure 4.4-1 through Figure 4.4-4 illustrate the mesh cell sizes applied in the 2D HEC-RAS and 2D habitat modeling. A cell was considered either wet or dry in the habitat model, but only the wet cells were included in the habitat calculations. Different flows will have different WSEs and for one flow, there may be dry cells in one location while cells in other locations may be wetted. Table 4.4-1 summarizes the number of cells in each of the four reaches (R3, R4, R6, and R10) used for both hydraulic simulation and habitat modeling, the latter which are notably less than those for hydraulic simulation. These differences are because of the shorter modeling extents used in the habitat model (Table 4.4-2; Figure 4.1-2) which excluded the less developed hydraulic transition zones near the upstream and downstream boundaries.

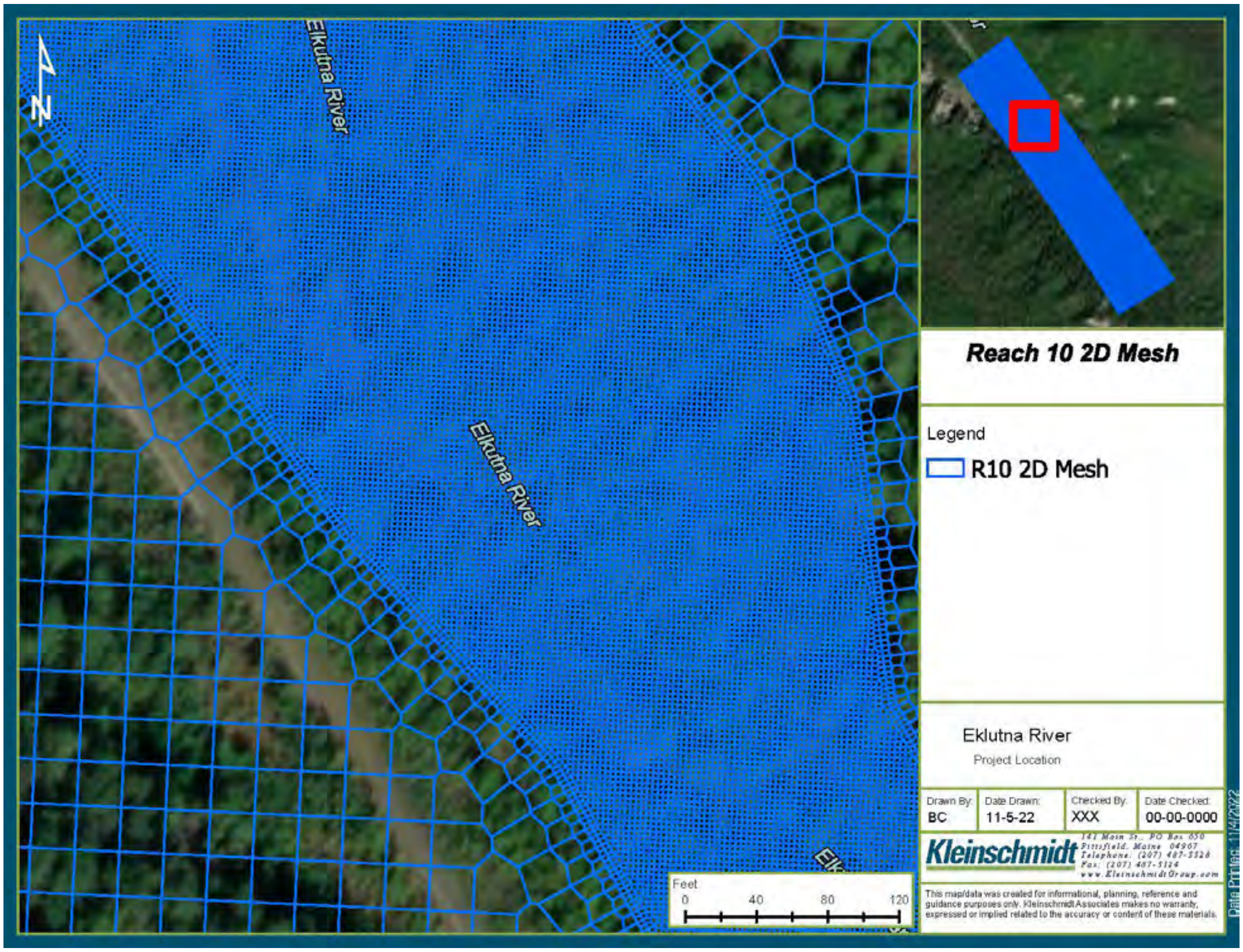


Figure 4.4-1. Subsection of Reach 10 of the Eklutna River illustrating the mesh cell sizes used in main channel and floodplain habitats. Smaller mesh sizes were used in the main channel to define complex habitat features. This segment of R10 was 3,744 ft long and contains representative side channel and off-channel habitats.

Figure 4.4-2. Subsection of Reach 6 of the Eklutna River illustrating the mesh cell sizes used in main channel and floodplain habitats. Smaller mesh sizes were used in the main channel to define complex habitat features. This segment of R6 was 1,167 ft long and contained limited side channel and off-channel habitats.

Figure 4.4-3. Subsection of Reach 4 of the Eklutna River illustrating the mesh cell sizes used in main channel and floodplain habitats. Smaller mesh sizes were used in the main channel to define complex habitat features. This segment of R4 was 2,502 ft long and contains the "flooded forest" complex and other representative side channel and off-channel habitats.

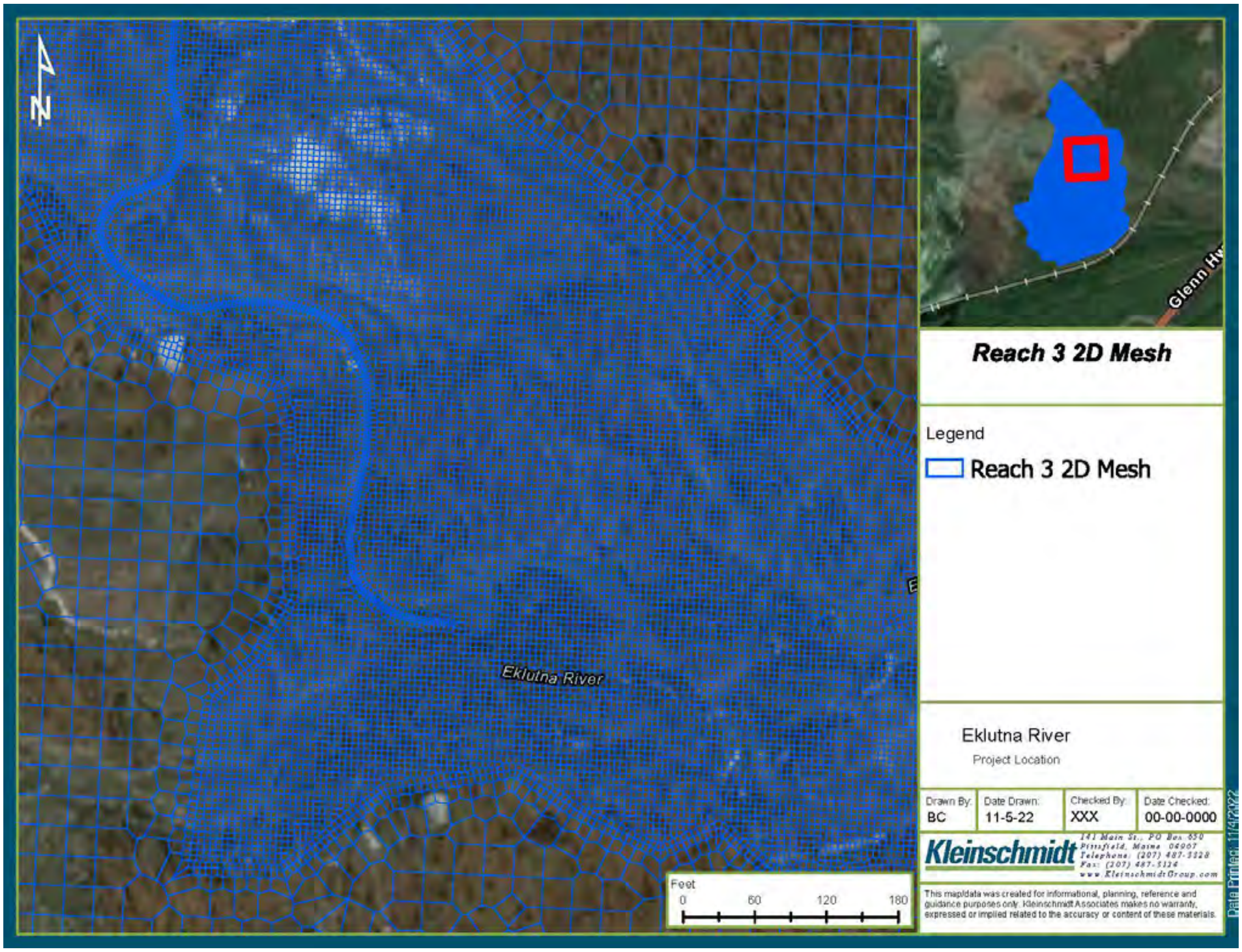


Figure 4.4-4. Subsection of Reach 3 of the Eklutna River illustrating the mesh cell sizes used in main channel and floodplain habitats. Smaller mesh sizes were used in the main channel to define complex habitat features. This segment of R3 was 2,183 ft long and contains a braided beaver complex and other representative side channel and off-channel habitats.

Table 4.4-1. Number of cells (not including boundary cells) in the 2D HEC-RAS hydraulic model and habitat model in reaches R3, R4, R6, and R10 of the Eklutna River.

Reach	Number of cells	
	Hydraulic Model	Habitat Model
R3	30,383	26,677
R4	71,282	69,863
R6	6,122	4,294
R10	100,275	93,055

Table 4.4-2. Approximate length of each stream reach (R3, R4, R6, and R10) of the Eklutna River used in the 2D HEC-RAS hydraulic model and habitat model.

Reach	Reach length (ft)	
	Hydraulic Model	Habitat Model
R3	2,183	2,001
R4	2,502	2,402
R6	1,167	783
R10	3,744	3,443

4.4.2. Defining 2D Habitat Cells

The 2D habitat modeling followed the same PHABSIM guidelines for 1D habitat modeling, but computationally used a different approach for defining habitat cells. In 1D analysis, a computational cell is determined by adjacent verticals in a transect where velocity and depths are measured and reported over a prescribed stream length (usually 1,000 ft). If a cell width is 2 feet, then the computational cell size is 2,000 ft^2 in surface area. In the 2D habitat model, a computational cell is defined by the mesh cell size generated from the hydraulic model. If a cell size is 3 ft wide by 3 ft long, the computational cell size is 9 ft^2 in surface area. In addition, a computational cell in 1D analysis can be partially wet while a 2D cell in the current study is either dry or wet.

The same simulation flows used in the 2D HEC-RAS modeling (Section 4.3.2) were applied in the 2D habitat modeling.

4.4.3. Habitat Suitability Curves

HSC curves are designed for use in an instream flow analysis to quantify changes in habitat under various flow regimes. For the 2D habitat analysis, the same HSC curve sets developed for the 1D PHABSIM analysis (Kleinschmidt 2022b) were considered, but in this case were focused solely on juvenile rearing habitats[8] for Chinook and Coho salmon. The curve sets included the variables of depth and velocity; all substrates are considered suitable for juvenile rearing.

4.4.4. Periodicity and Life Stage Priority

The same periodicity as defined in the 1D HEC-RAS and habitat modeling (see Section 2.5 and Figure 2.5-1) was applied for the 2D habitat modeling. Unlike the 1D PHABSIM analysis (Kleinschmidt 2022c) that focused on both spawning and juvenile rearing life stages, the 2D habitat modeling only considered the juvenile rearing life stage and therefore was the life stage priority for all months. The spawning life stages did factor into the Time Series B analysis (see Section 4.6.2.2).

[8] As noted above and in the Year 2 Study Plan, the 2D habitat analysis was focused on juvenile rearing habitat and specifically to determine to what extent gains in habitat could be achieved if side channel and off channel areas could be connected via flow.

4.4.5. Habitat – Flow Relationships

As noted above, the 2D habitat modeling was facilitated with a python program built within the QGIS platform. However, there is currently no commercially available model for converting 2D HEC-RAS model outputs into habitat-flow relationships. For this, Kleinschmidt developed and applied a separate program utilizing the Python scripts to compute these relationships. This program was subjected to a rigorous QA/QC process to ensure model outputs were accurately representing habitats. This included: exporting detailed simulated hydraulics and habitat indices of each modeled flow to an Excel file for documentation purposes; construction of GIS shape files with attribute tables including hydraulics, geometry, rearing combined suitability indices (CSI), and all other habitat indices of each cell for each flow and each species; comparison of the WSE, velocity, and depths in the shape file attribute tables against those in the Hierarchical Data Format (HDF) designed to store and organize large amounts of data, as a means to QA/QC the hydraulics; and then displaying the modeled WUA vs. flow relationships on a GIS interface to show the habitat modeling results.

Step wise, the computation of habitat vs. flow relationships by species and for each of the modeled flows were derived by first combining the modeled velocities and hydraulic depths of each cell with the HSC curves for rearing to calculate weighted velocity and depth indices, expressed in V_i and D_i, respectively. These were then combined for each cell to calculate a CSI ($CSI = V_i \times D_i$) that incorporated both velocity and depth, and then the area (A) of the cell was determined, and finally total WUA computed by summing up all cells as $WUA = \sum_{all\ cells} CSI \times A$. Figure 4.4-5 illustrates an example of this for the four reaches for a flow of 75 cfs.

These areas were then summed over the entire habitat model boundary to provide an estimate of total habitat for a given flow. Dividing these areas by the stream lengths of each reach provided an estimate of habitat area per 1,000 ft of stream length. This process was applied to all four reaches (R10, R6, R4, and R3) resulting in the derivation of reach-specific Chinook and Coho juvenile rearing habitat vs. flow relationships (Figure 4.4-6 and Figure 4.4-7). These relationships are shown in tabular format in Table 4.4-3 through Table 4.4-6.

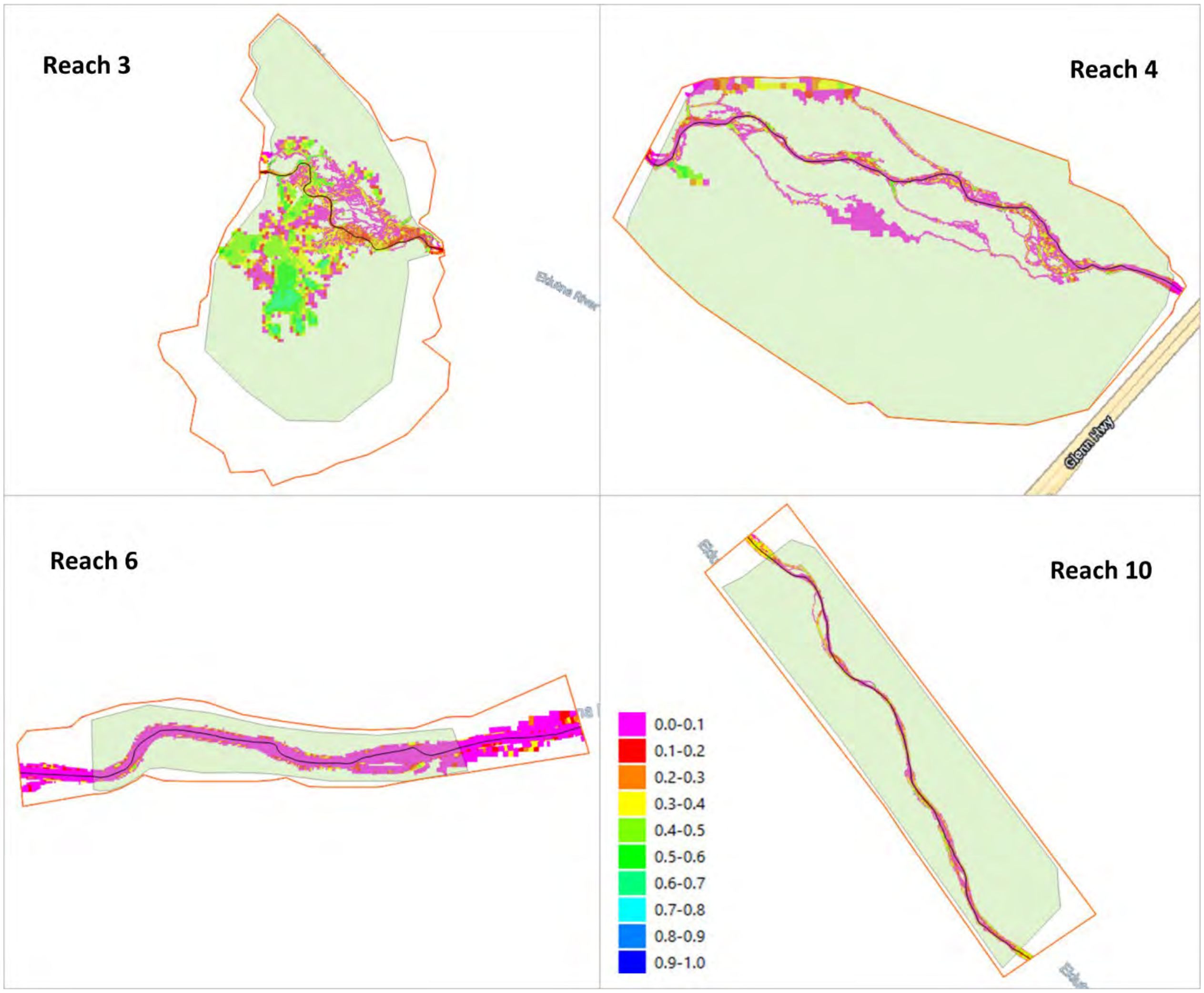


Figure 4.4-5. Combined Suitability Index habitat maps for juvenile rearing habitat in Reach 3 (upper left), Reach 4 (upper right), Reach 6 (lower left), and Reach 10 (lower right) for the 75 cfs modeled flow. The legend in Reach 10, also applies to other reaches, with the scale of habitat suitability ranging from high (blue) to low (purple).

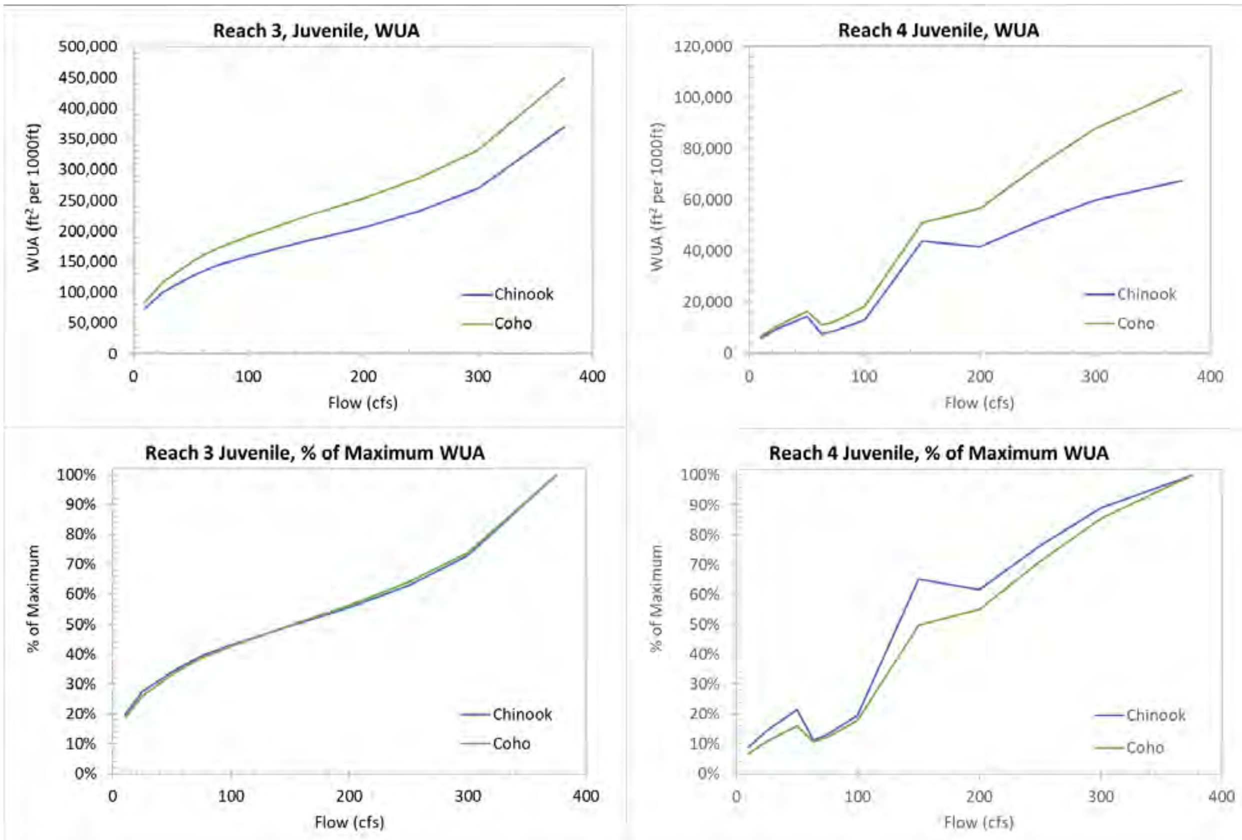


Figure 4.4-6. Habitat-flow relationships for Chinook and Coho juvenile rearing habitat for Reach 3 (left panels) and Reach 4 (right panels) produced from 2D habitat modeling. Relationships of habitat area to flow are shown in the upper figures; lower figures depict the same data normalized as a percentage of habitat maximum to flow.

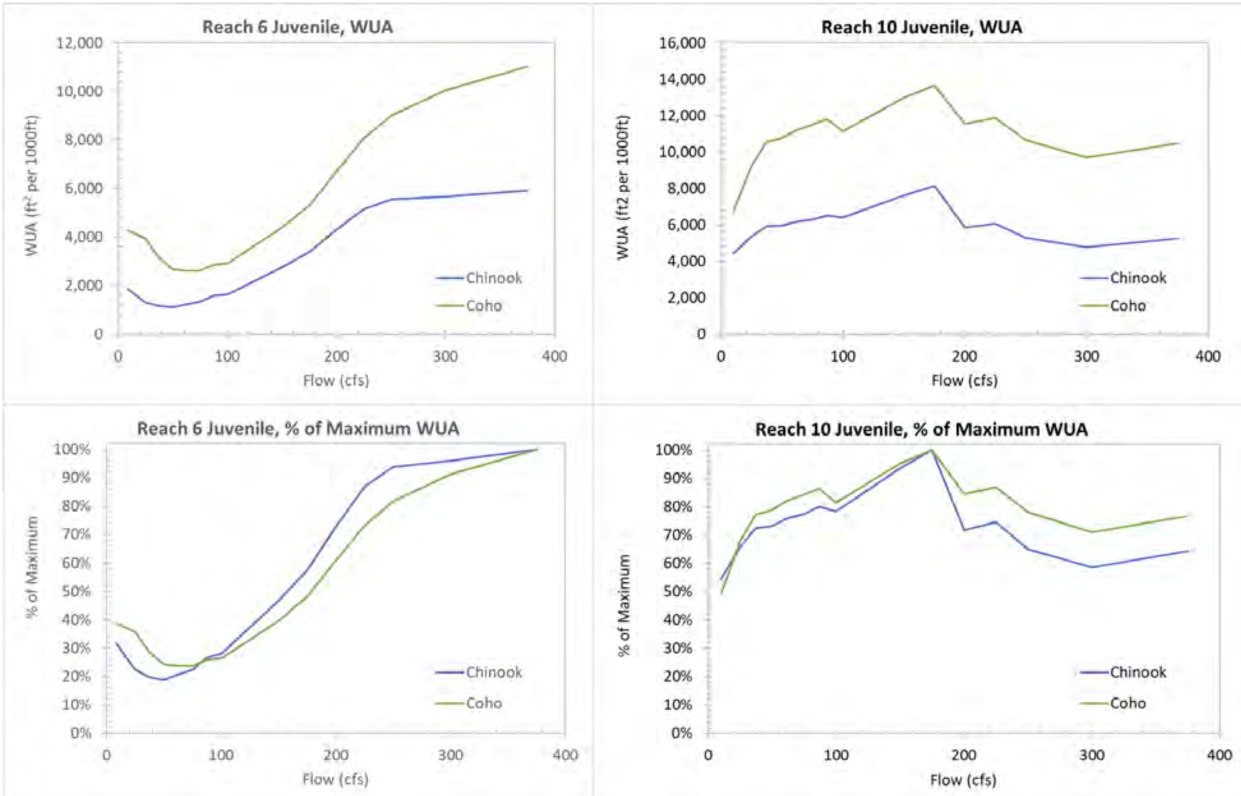


Figure 4.4-7. Habitat-flow relationships for Chinook and Coho juvenile rearing habitat for Reach 6 (left panels) and Reach 10 (right panels) produced from 2D habitat modeling. Relationships of habitat area to flow are shown in the upper figures; lower figures depict the same data normalized as a percentage of habitat maximum to flow.

Table 4.4-3. Tabularized juvenile rearing habitat-flow relationships for Chinook (left two columns) and Coho (right two columns) salmon for Reach 3; the second column in each set depicts the data normalized as a percentage of habitat maximum.

Q (cfs)	Chinook Juvenile		Coho Juvenile	
	WUA (ft^2/1,000 ft)	% Maximum WUA	WUA (ft^2/1,000 ft)	% Maximum WUA
10	73,223	20%	83,674	19%
25	100,780	27%	116,734	26%
50	126,169	34%	148,831	33%
62.4	136,708	37%	162,256	36%
75	145,586	39%	173,698	39%
100	159,224	43%	191,596	43%
150	183,223	50%	223,611	50%
200	205,466	56%	253,289	56%
250	233,100	63%	288,067	64%
300	269,810	73%	332,114	74%
375	369,823	100%	449,527	100%

Table 4.4-4. Tabularized juvenile rearing habitat-flow relationships for Chinook (left two columns) and Coho (right two columns) salmon for Reach 4; the second column in each set depicts the data normalized as a percentage of habitat maximum.

Q (cfs)	Chinook Juvenile		Coho Juvenile	
	WUA (ft^2/1,000 ft)	% Maximum WUA	WUA (ft^2/1,000 ft)	% Maximum WUA
10	5,965	9%	6,812	7%
25	9,688	14%	10,984	11%
50	14,459	21%	16,380	16%
63.5	7,552	11%	11,113	11%
75	8,909	13%	12,565	12%
100	13,226	20%	18,294	18%
150	43,956	65%	51,124	50%
200	41,596	62%	56,727	55%
250	51,486	76%	73,202	71%
300	59,992	89%	87,954	85%
375	67,461	100%	103,061	100%

Table 4.4-5. Tabularized juvenile rearing habitat-flow relationships for Chinook (left two columns) and Coho (right two columns) salmon for Reach 6; the second column in each set depicts the data normalized as a percentage of habitat maximum.

Q (cfs)	Chinook Juvenile		Coho Juvenile	
	WUA (ft^2/1,000 ft)	% Maximum WUA	WUA (ft^2/1,000 ft)	% Maximum WUA
8.4	1,877	32%	4,281	39%
25	1,324	22%	3,941	36%
37	1,171	20%	3,138	28%
50	1,115	19%	2,669	24%
62	1,220	21%	2,627	24%
75	1,327	22%	2,624	24%
87	1,579	27%	2,857	26%
100	1,656	28%	2,908	26%
150	2,766	47%	4,383	40%
175	3,399	57%	5,304	48%
200	4,307	73%	6,700	61%
225	5,150	87%	8,061	73%
250	5,548	94%	9,006	82%
300	5,672	96%	10,051	91%
375	5,912	100%	11,012	100%

Table 4.4-6. Tabularized juvenile rearing habitat-flow relationships for Chinook (left two columns) and Coho (right two columns) salmon for Reach 10; the second column in each set depicts the data normalized as a percentage of habitat maximum.

Q (cfs)	Chinook Juvenile		Coho Juvenile	
	WUA (ft^2/1,000 ft)	% Maximum WUA	WUA (ft^2/1,000 ft)	% Maximum WUA
10	4,455	55%	6,742	49%
25	5,368	66%	9,266	68%
37	5,919	72%	10,553	77%
50	5,973	73%	10,774	79%
62	6,203	76%	11,224	82%
75	6,320	77%	11,517	84%
87	6,535	80%	11,825	87%
100	6,401	78%	11,136	81%
150	7,642	94%	13,004	95%
175	8,166	100%	13,666	100%
200	5,852	72%	11,552	85%
225	6,090	75%	11,885	87%
250	5,309	65%	10,678	78%
300	4,786	59%	9,713	71%
375	5,252	64%	10,484	77%

All the relationships provide insight as to how increasing flows in the respective reaches influence juvenile rearing habitats, as connectivity is provided to side channel and floodplain habitats. Reaches 3 and 4 provide the best illustration of this. For R3, (the lower most reach), the curves exhibit an ever-increasing amount of juvenile habitat as flows increase. This reach contains a broad mosaic of complex channels that can become connected under different flow conditions (Figure 4.4-8); portions of this reach are also tidally influenced. As a result, more flow provides more connections to adjoining floodplain areas and rearing habitat continues to increase. The amounts of juvenile rearing habitat predicted for this reach are the highest of all reaches, ranging from ~73,000 ft^2 per 1,000 ft at 10 cfs to 450,000 ft^2 per 1,000 ft of stream at 375 cfs. Flows even higher than those modeled would still likely provide additional rearing habitat in this reach.

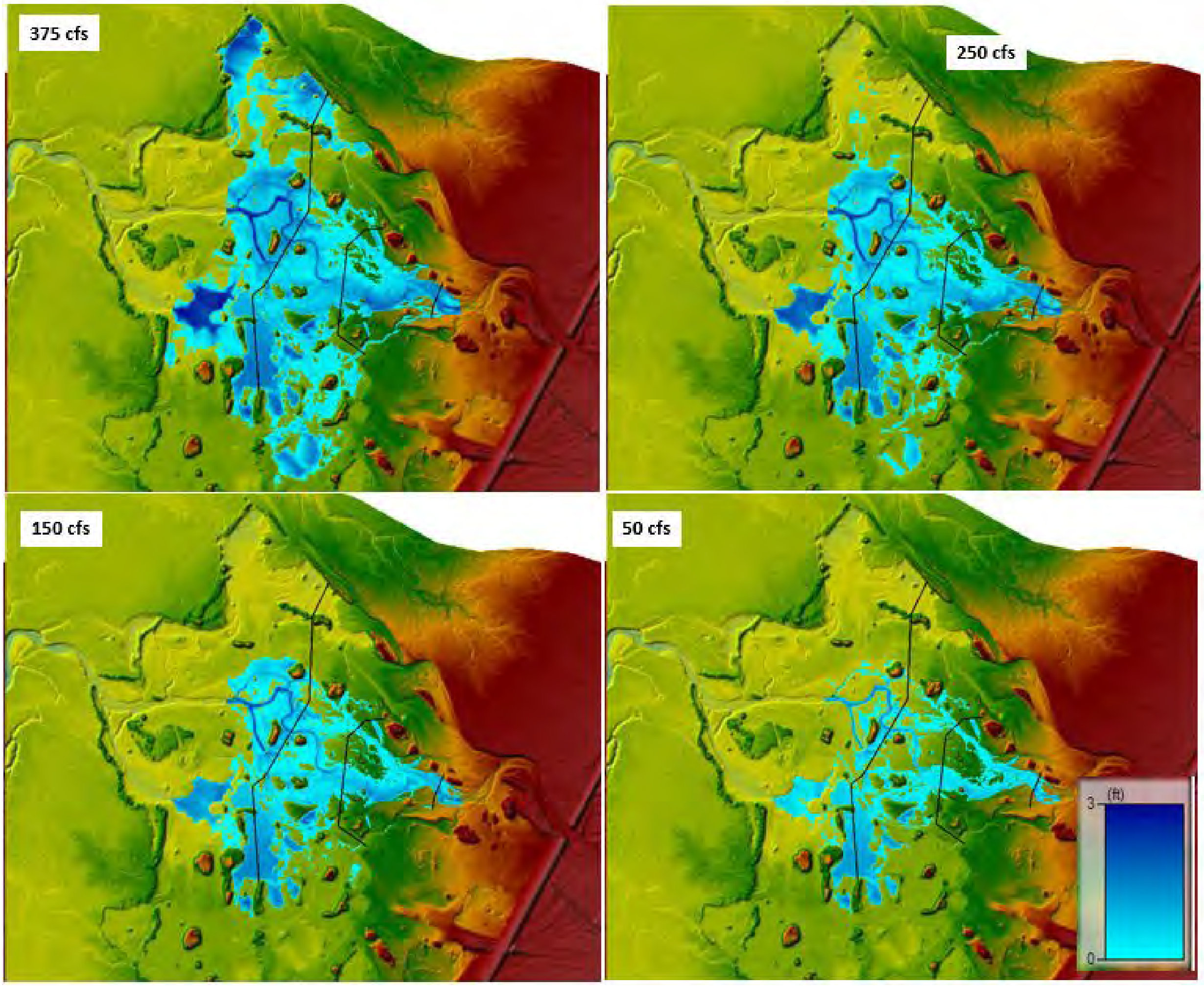


Figure 4.4-8. Example of channel connectivity under flows of 50 cfs, 150 cfs, 175 cfs, and 375 cfs for Reach 3 of the Eklutna River.

As explained in Section 4.3.4, there are known areas of inundation (ponds) within the Reach 3 modeled area that are not captured in the HEC-RAS model and that are shown as dry.

The habitat vs. flow relationship in R4 similarly shows an increasing trend of habitat with flow, but in this case the curve is punctuated by a habitat decrease around 70 cfs and a general leveling of habitat marked by an inflection in the curve at around 150 cfs, before continuing to increase. The decrease around 70 cfs likely occurs as flows in the main channel begin to exceed velocities suitable for juvenile rearing. With higher flows, although the main channels may not provide suitable rearing habitats, side channel and floodplain habitats begin to be engaged and habitat increases. This increase in habitat continues until flows reach about 150 cfs, where there is a leveling off/inflection point again likely marking an exceedance in velocities within some of the floodplain channels connected under those flows. Continued flow increases engage further floodplain channels and rearing habitat again increases. Figure 4.4-9 illustrates habitat connectivity under flows ranging from 50 cfs to 375 cfs. Juvenile rearing habitat amounts predicted in this reach range from ~6,000 ft^2 per 1,000 ft at 10 cfs to 103,000 ft^2 per 1,000 ft at 375 cfs.

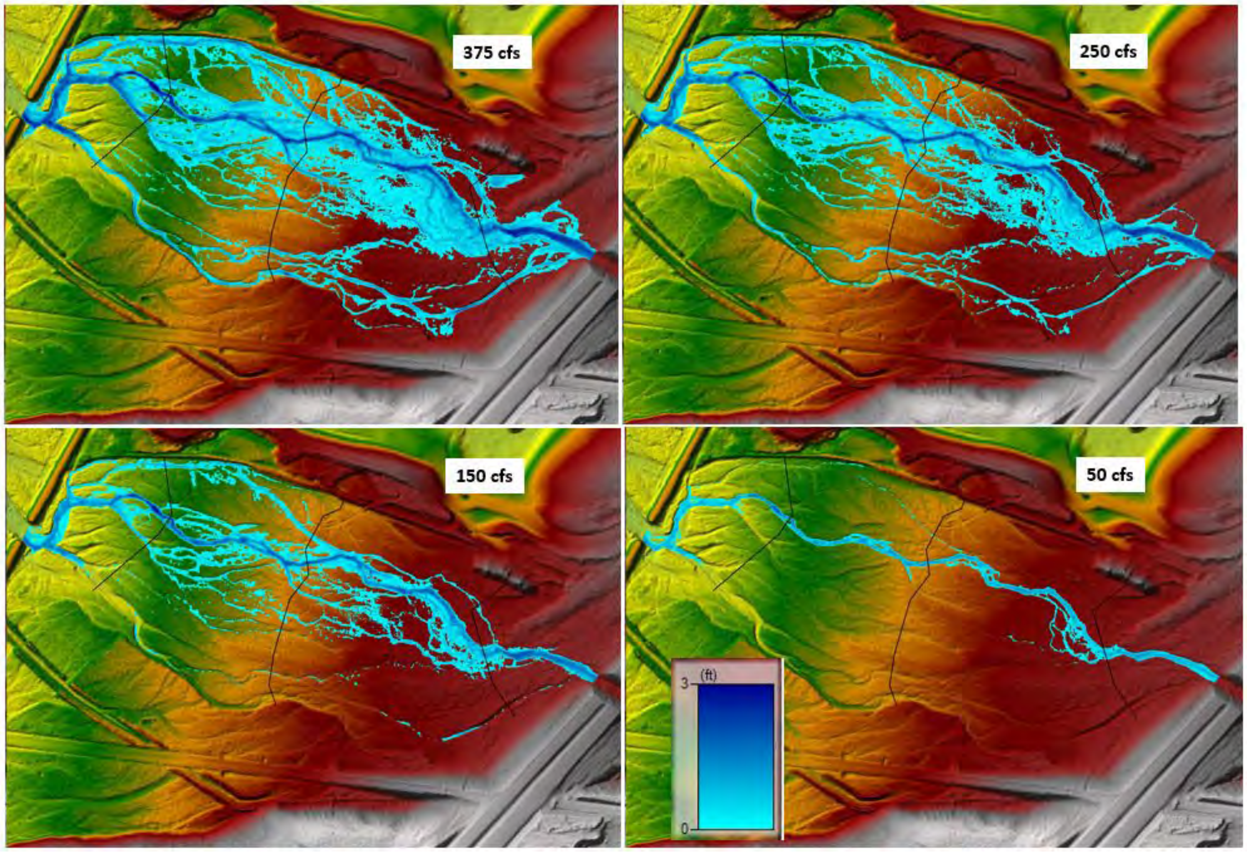


Figure 4.4-9. Example of channel connectivity under flows of 50 cfs, 150 cfs, 175 cfs, and 375 cfs for Reach 4 of the Eklutna River.

Although the habitat vs. flow relationship of R6 appears similar to R3 and R4, there are distinct differences in how this reach of stream responds to flow increases, primarily a function of its channel and floodplain morphology. Reach 6 is confined and flows through a narrow relatively steep canyon that lacks a broad floodplain and complex side-channel and off-channel habitats. As a result, the greatest amount of rearing habitat in the main channel is provided by the lowest flows (~10 cfs) as exhibited on the curve (Figure 4.4-9). R6 is the only reach (of the four reaches) that exhibits this trend. As flows increase to about 50 cfs, habitat amounts in the main channel continue to decrease, before beginning to increase, marking the point where overbank flows occur. However, unlike R3 and R4, the increased flows are not engaging connections with broad floodplain areas but rather with ever increasing adjoining fringe habitats where velocities can still remain suitable for juvenile rearing (Figure 4.4-10). Figure 4.4-11 depicts channel connectivity changes under flows ranging from 25 cfs to 300 cfs. Notably, the amounts of juvenile rearing habitat provided in R6 are relatively small compared to R3 and R4; habitats in R6 range from ~1,100 ft^2 per 1,000 ft at 50 cfs to 11,000 ft^2 per 1,000 ft at 375 cfs. Of note is that R6 contains extensive deposits of sediment and is subject to large changes in channel morphology under varying flows. This channel instability was one of the reasons it was not selected for study for the 1D PHABSIM analysis.

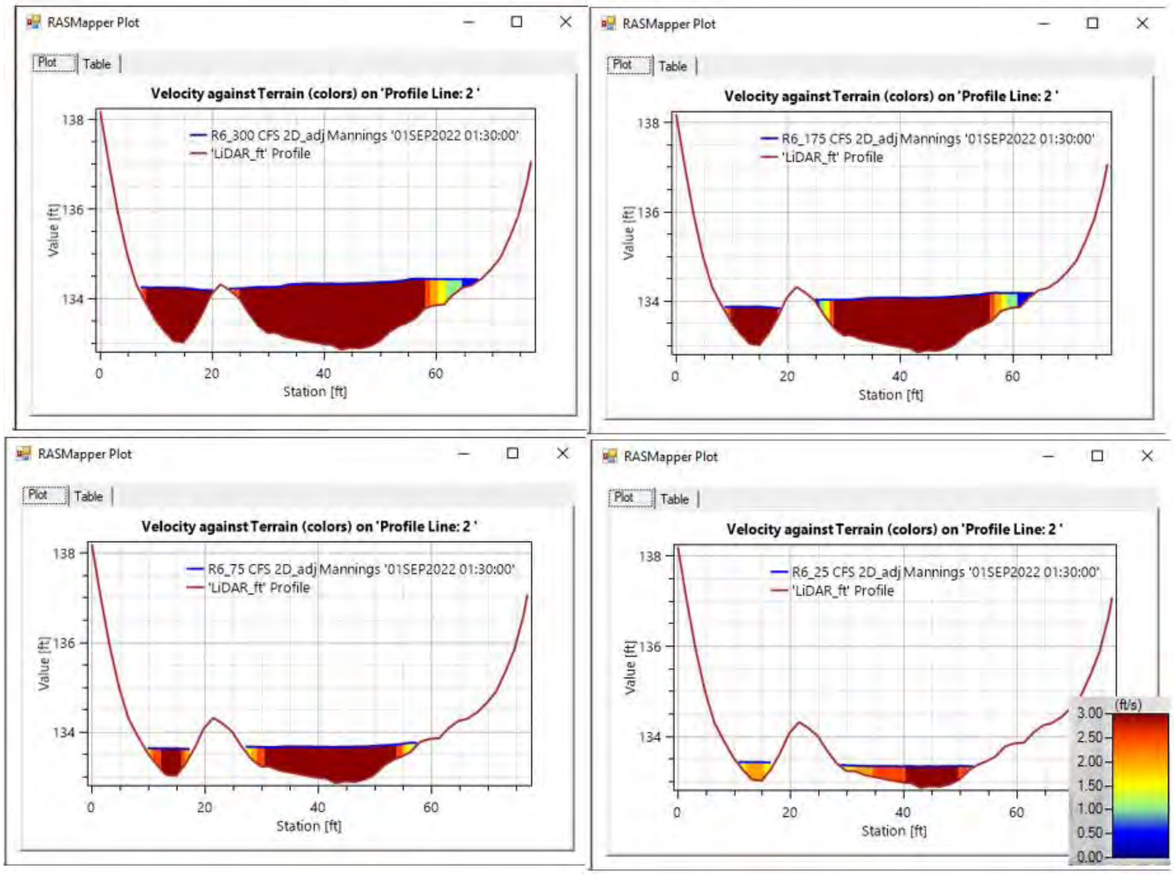


Figure 4.4-10. Variation of velocity under four flow conditions (300 cfs – upper left, 175 cfs – upper right, 75 cfs – lower left, 25 cfs – lower right) for a subsection of R6 of the Eklutna River. As flows increase, velocity in the channel increases. Habitats for juvenile Coho and Chinook are mostly located at the fringes of the channel/floodplain where velocities are lowest.

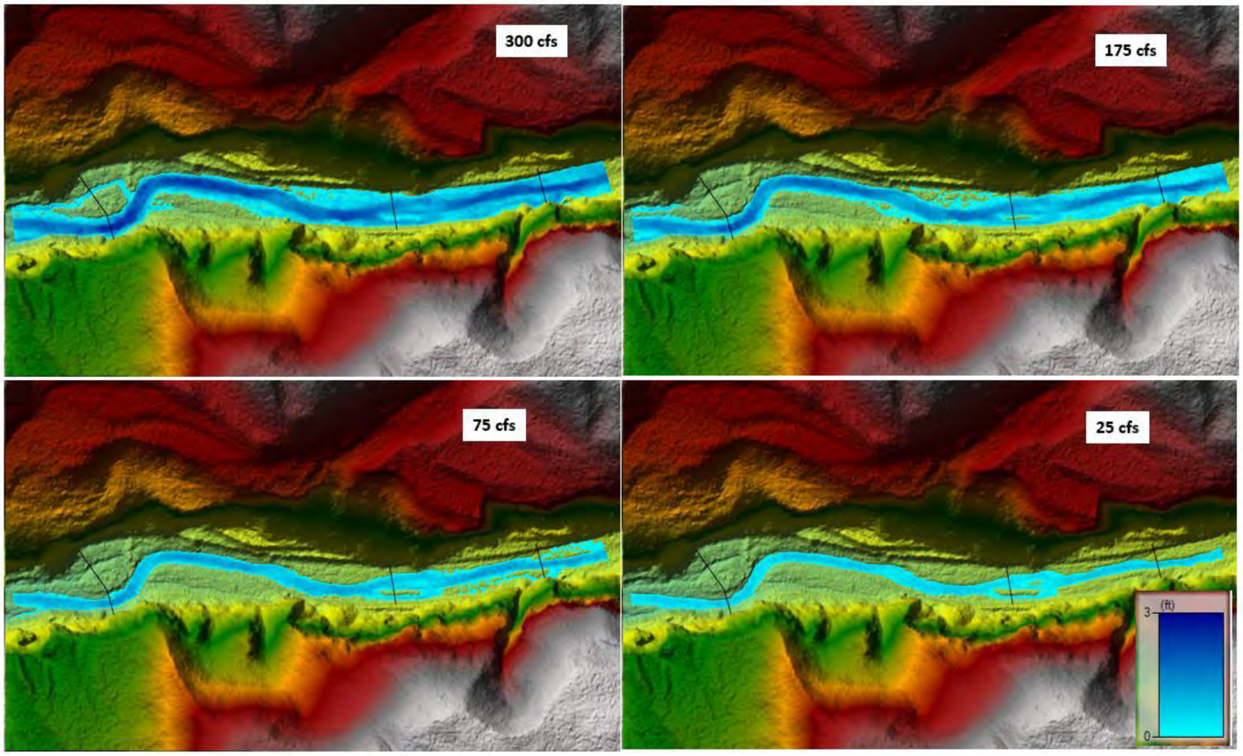


Figure 4.4-11. Example of channel connectivity under flows of 300 cfs (upper left panel), 175 cfs (upper right panel), 75 cfs (lower left panel) and 25 cfs (lower right panel) for Reach 6 of the Eklutna River.

The habitat vs. flow relationship for R10 represents perhaps the best example of how side channel and off-channel habitats would respond in the Eklutna River above Thunderbird Creek. In this case, the shapes of the curves are somewhat jagged with alternating increases and decreases in habitats likely reflective of the channel complexity and the connection with adjacent side and off-channel areas with increases in flow. This is illustrated in Figure 4.4-12 that shows channel connectivity under a range of flows from 25 cfs to 300 cfs. This is further shown in Figure 4.4-13 that shows the variation in water surface elevations across different channel features under a range of flow conditions. As flows increase, more channels become connected, but water surface elevations may differ. The punctuated pattern of the curve demonstrates how habitats can alternately blink in and out with flows owing to changing velocity patterns in the newly engaged channels. There are two minor peaks, one at ~85 cfs and one at 225 cfs, and one well defined peak that occurs at 175 cfs (Figure 4.4-7). Nominally, for the range of flows modeled, R10 provides habitats ranging from ~4,500 ft^2 per 1,000 ft at 10 cfs to ~13,500 ft^2 per 1,000 ft at 175 cfs. This is the only reach where habitats are not maximized at the highest flow (375 cfs) and indicates that the shape of the habitat vs. flow relationship was likely captured within the range of the modeled flows (10-375 cfs).

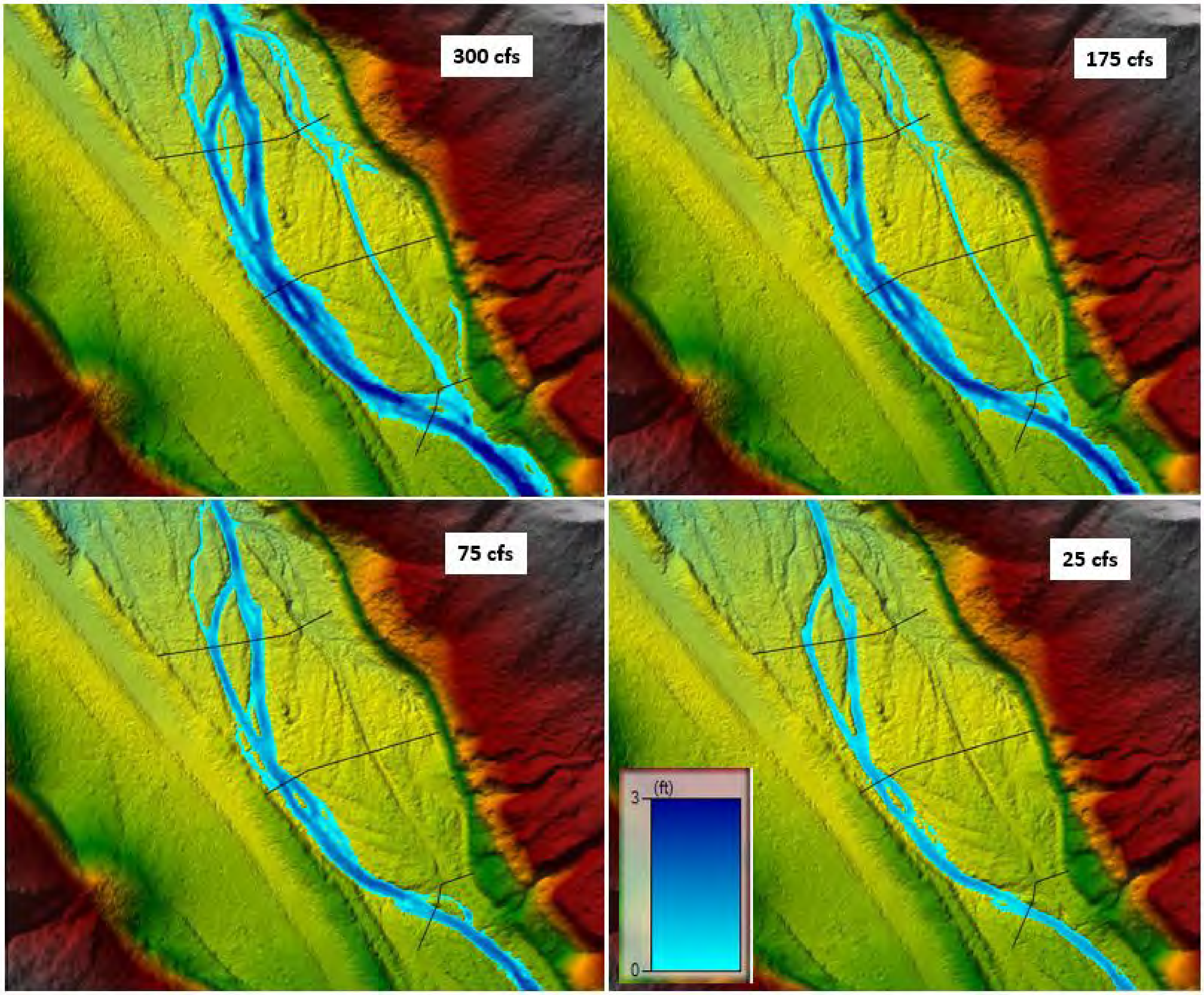


Figure 4.4-12. Example of channel connectivity under flows of 300 cfs (upper left panel), 175 cfs (upper right panel), 75 cfs (lower left panel) and 25 cfs (lower right panel) for Reach 10 of the Eklutna River.

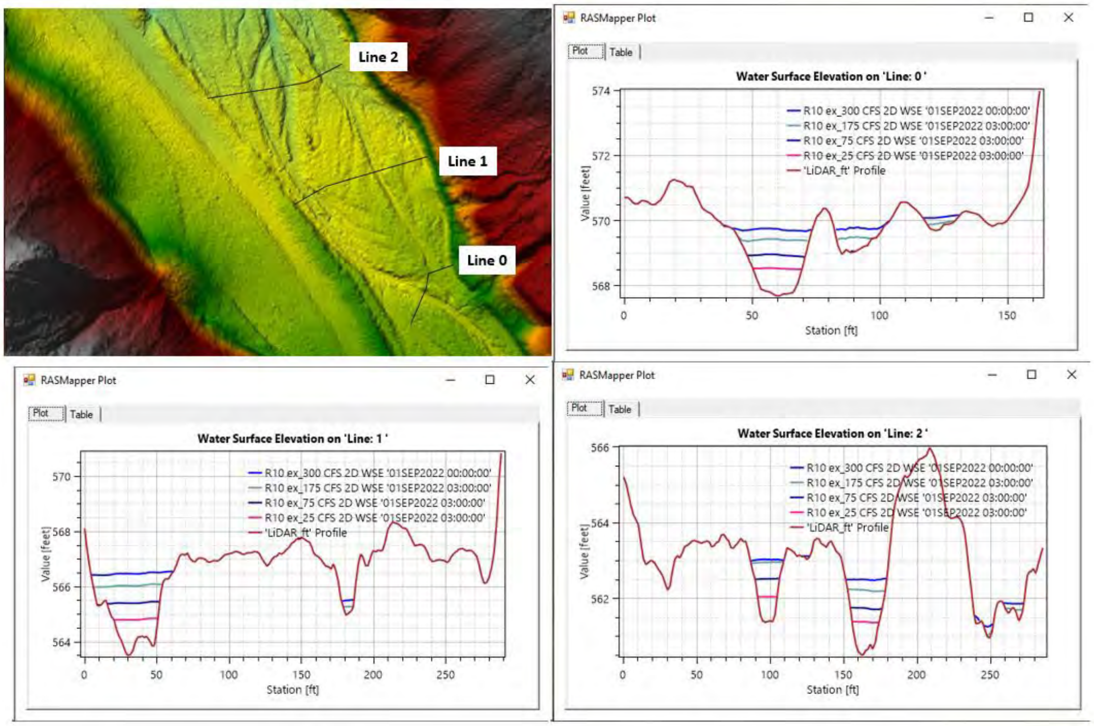


Figure 4.4-13. Variation of WSEs under four flow conditions (25 cfs to 300 cfs) for a subsection of R10 of the Eklutna River. As flows increase, more channels become hydraulically connected, but WSEs may differ between channels.

4.5. Off-Channel Connectivity Analysis

The output from the 2D HEC-RAS model was also used to explore and provide a preliminary assessment of the amount of potential off-channel habitat expressed as connected surface areas under different flow conditions. The analysis focused on determining the amount of area (in acres) within the model boundaries of each respective reach, with depths of at least 0.5 feet[9]. This area was considered "off-channel habitat" independent of the floodplain substrate and HSC criteria, and simply reflected the areas that would be connected under different flows.
An example showing the extent of inundation for the five different flows (10 cfs, 25 cfs, 75 cfs, 150 cfs, and 375 cfs) is depicted in Figure 4.5-1 for R10.

[9] These areas were defined solely using a water depth criterion of 0.5 ft and do not reflect species preference. The 0.5 ft depth was selected as a reasonable basis for defining off-channel habitats.

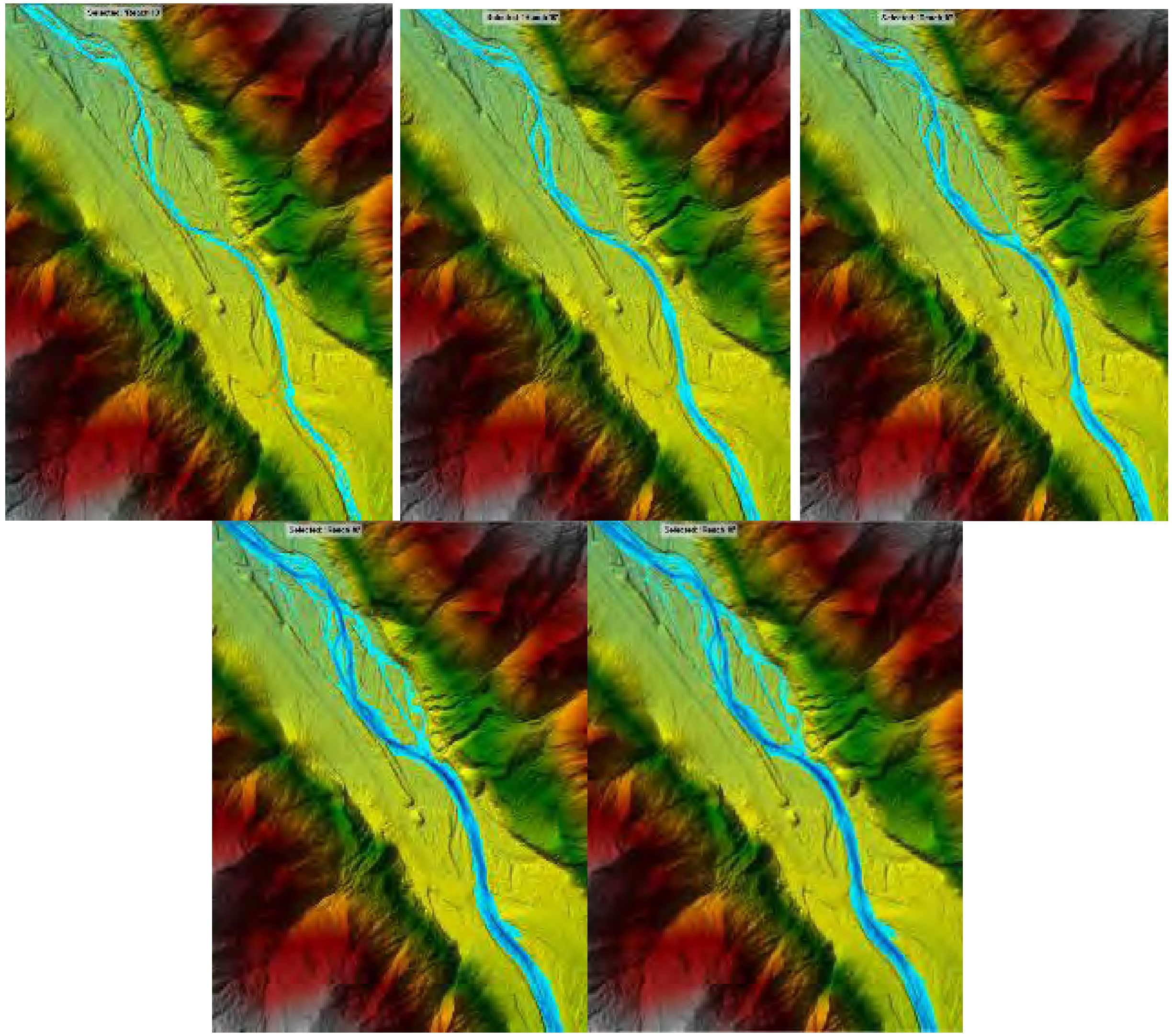


Figure 4.5-1. 2D Model Results for Reach 10 showing extent of inundation and connectivity for flows of 10 cfs (upper left), 25 cfs (upper center), 75 cfs (upper right), 150 cfs (lower left), 375 cfs (lower right).

As defined above, the amount of off-channel habitat estimated for each reach is depicted in Table 4.5-1 and presented as total area (acres) and total acres per mile of main channel stream length. The table shows the relationship between total acres of habitat per stream mile and flow. Figure 4.5-2 and Figure 4.5-3 show the relationship between total acres of habitat per stream mile and flow. The information presented in these charts indicates that for Reaches 10, 6, and 3 there are subtle inflection points of diminishing returns, where the amount of habitat added per cfs of flow is the highest. Reach 4 does not appear to have this same inflection point, likely due to the significant number of braided side channels that are accessible at higher flows. The associated flow rate of this inflection point depends on the scaling used in the chart. The inflection points for Reaches 10, 6, and 3 appear to be between 75-150 cfs, 25-75 cfs, and 75-125 cfs, respectively.

Table 4.5-1. Off-channel habitat areas estimated in Reaches 10, 6, 4, and 3 of the Eklutna River via the 2D HEC-RAS modeling.

Off-Channel Habitat								
Reach	**3**		**4**		**6**		**10**	
Flow (cfs)	**Acres**	**Acres/Mi**	**Acres**	**Acres/Mi**	**Acres**	**Acres/Mi**	**Acres**	**Acres/Mi**
10	2.56	6.25	0.21	0.45	0.01	0.05	0.63	0.90
25	4.02	9.83	0.64	1.37	0.18	0.84	1.22	1.73
75	7.03	17.17	1.25	2.67	0.48	2.21	2.35	3.32
150	10.14	24.76	2.18	4.66	0.67	3.08	3.27	4.64
375	20.85	50.91	5.93	12.67	1.21	5.53	4.43	6.28

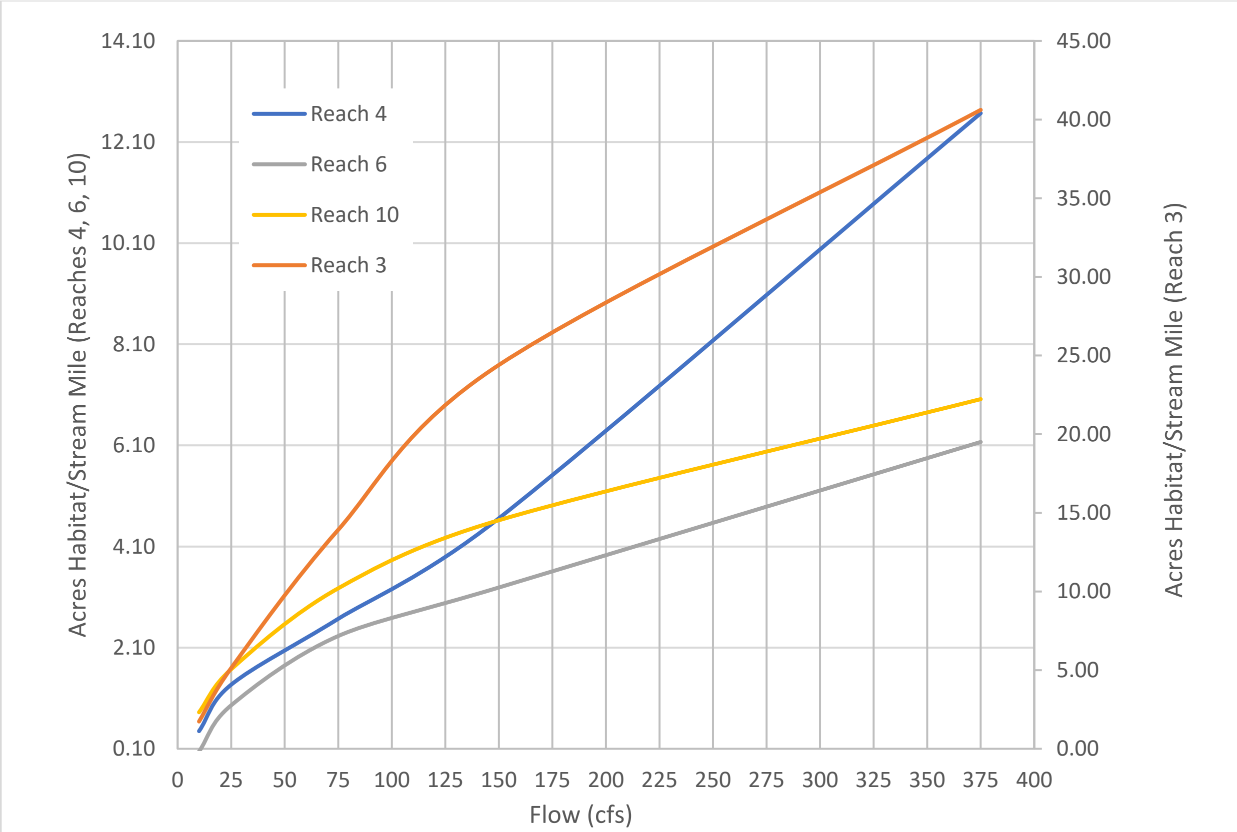


Figure 4.5-2. Estimated off channel habitat per mile of stream vs. flow (standard) for Reach 10, Reach 6, Reach 4, and Reach 3 of the Eklutna River based on the 2D HEC-RAS hydraulic model.

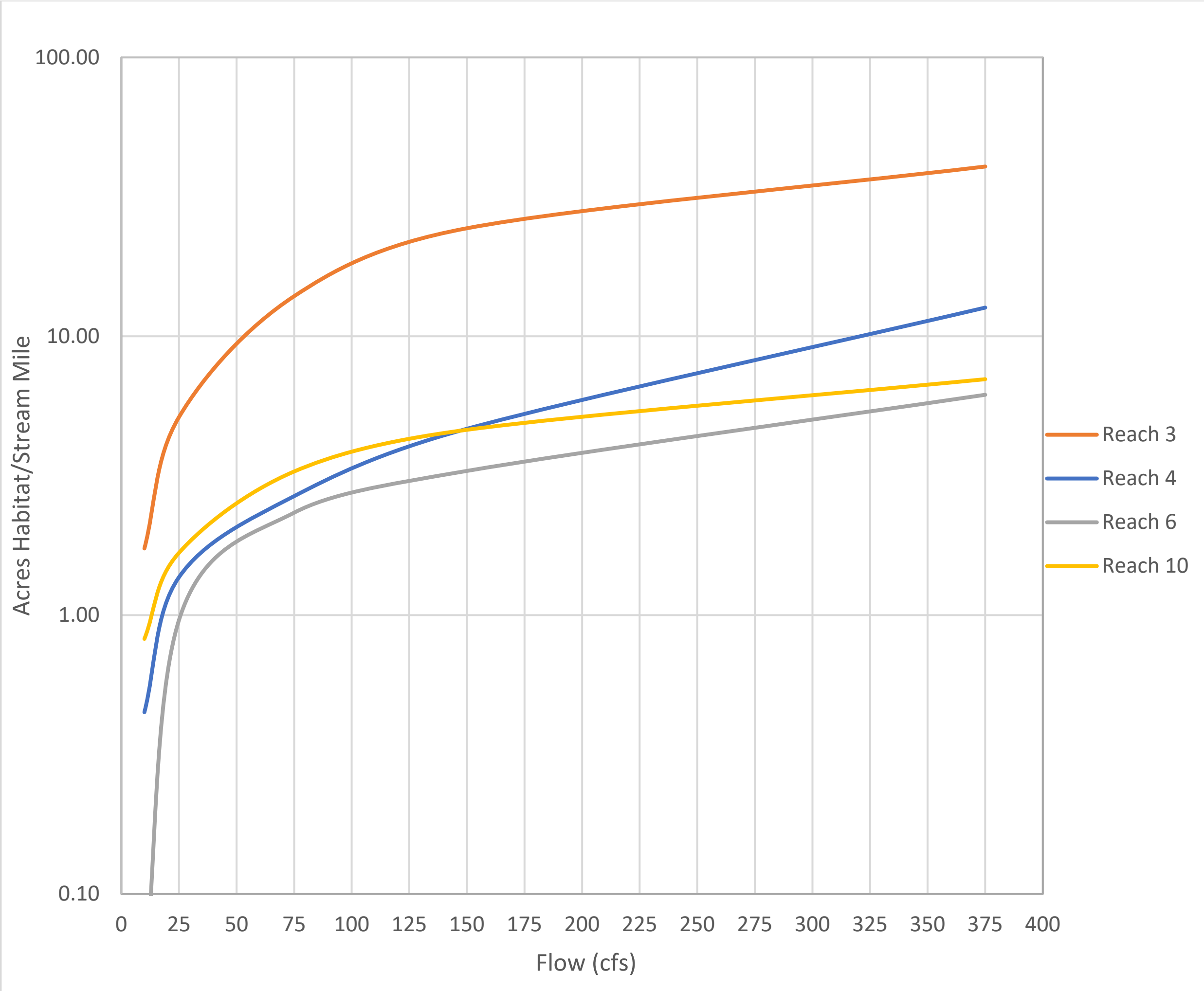


Figure 4.5-3. Estimated off channel habitat per mile of stream vs. flow for Reach 10, Reach 6, Reach 4, and Reach 3 of the Eklutna River based on the 2D HEC-RAS hydraulic model (logarithmic).

4.6. 2D Flow Assessment

Similar to the 1D flow assessment (Section 2.9), the 2D flow assessment used composited "reach-based" habitat vs. flow relationships for deriving four example flow release schedules and three release options. These were then used in a time series analysis that considered the current "baseline" hydrology and periodicity as defined in Section 2.5.

4.6.1. Flow Release Levels and Release Options

There were two separate flow release level schedules developed for this analysis, the first based on the 2D juvenile rearing habitat analysis, and the second based on a combined 2D juvenile rearing and 1D PHABSIM spawning habitat analysis. The same three release options described below were considered for both schedules.

4.6.1.1. 2D Juvenile Rearing Habitat Flow Release Schedule

Like the 1D PHABSIM analysis (Kleinschmidt 2022c), the 2D habitat vs. flow relationships were then used for deriving potential flow release levels based on providing the 90%, 70%, 50%, and 30% of maximum juvenile rearing habitat flows. The release flows were based on a composite of the R6 and R10 habitat vs. flow relationships above Thunderbird Creek, since this is the river segment that would receive the greatest benefit (as a percentage flow increase over baseline) from flow releases from Eklutna Lake. The habitat-flow relationships for R3 and R4 which are below Thunderbird Creek, were not used for developing flow releases from Eklutna Lake but were considered in the time series analysis. Figure 4.6-1 displays the individual based protection flows for R6 and R10, and the composited R6 and R10 curves and protection levels that were used for setting flow release levels. The monthly flows are also depicted in Table 4.6-1. Unlike the 1D PHABSIM analysis that also considered spawning habitat and was the priority life stage during the months of spawning (July-October), the 2D habitat modeling only considered juvenile rearing habitat which occurs in all 12 months.

The four flow release levels were likewise based on three potential flow release locations, Option A – the existing spill gate just below Eklutna Dam; Option B – from the upper AWWU portal located approximately 6,000 ft below the spill gate; and Option C – from the lower AWWU drainage valve located approximately 3,000 ft below the lower extent of Reach 9 (Figure 2.2-1). The lengths of the Eklutna River influenced by the flow releases would vary depending on release location. Under Option A, the entire length of river would “see” the flow release from the spill gate. Under Option B, the upper 6,000 ft (approximately 1.2 miles) of the Eklutna River above the upper AWWU portal would not be affected by the flow release and would remain essentially dry. Under Option C, approximately 6.8 miles of river downstream from the Eklutna Dam would not receive any flow release. For the 2D habitat modeling, Options A and B would be based on the composited R10 and R6 analysis since both would benefit from flow releases from either location. For Option C, only R6 would benefit and therefore flows were initially based only on R6 habitat modeling but adjusted to include R10 for reasons discussed in Section 4.6.2 below.

Table 4.6-1. Monthly flow releases from Eklutna Lake to the Eklutna River under Baseline conditions (zero flow release) and under 12 different flow release schedules. The four flow release levels (1–4) are flows that provide 90%, 70%, 50%, and 30% of habitat maxima for Chinook and Coho juvenile rearing for all 12 months of the year.

Scenario		Flow Released to Eklutna River (cfs)											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Baseline		0	0	0	0	0	0	0	0	0	0	0	0
Option A	Flow Level 1	143	143	143	143	143	143	143	143	143	143	143	143
	Flow Level 2	54	54	54	54	54	54	54	54	54	54	54	54
	Flow Level 3	8	8	8	8	8	8	8	8	8	8	8	8
	Flow Level 4	5	5	5	5	5	5	5	5	5	5	5	5
Option B	Flow Level 1	143	143	143	143	143	143	143	143	143	143	143	143
	Flow Level 2	54	54	54	54	54	54	54	54	54	54	54	54
	Flow Level 3	8	8	8	8	8	8	8	8	8	8	8	8
	Flow Level 4	5	5	5	5	5	5	5	5	5	5	5	5
Option C	Flow Level 1	293	293	293	293	293	293	293	293	293	293	293	293
	Flow Level 2	219	219	219	219	219	219	219	219	219	219	219	219
	Flow Level 3	179	179	179	179	179	179	179	179	179	179	179	179
	Flow Level 4	8	8	8	8	8	8	8	8	8	8	8	8

Notes:
Option A – flow released to Eklutna River just downstream from Eklutna Dam.
Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam.
Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. Note – under the current infrastructure, maximum flow releases from the AWWU Drainage Valve are limited to approximately 110 cfs.

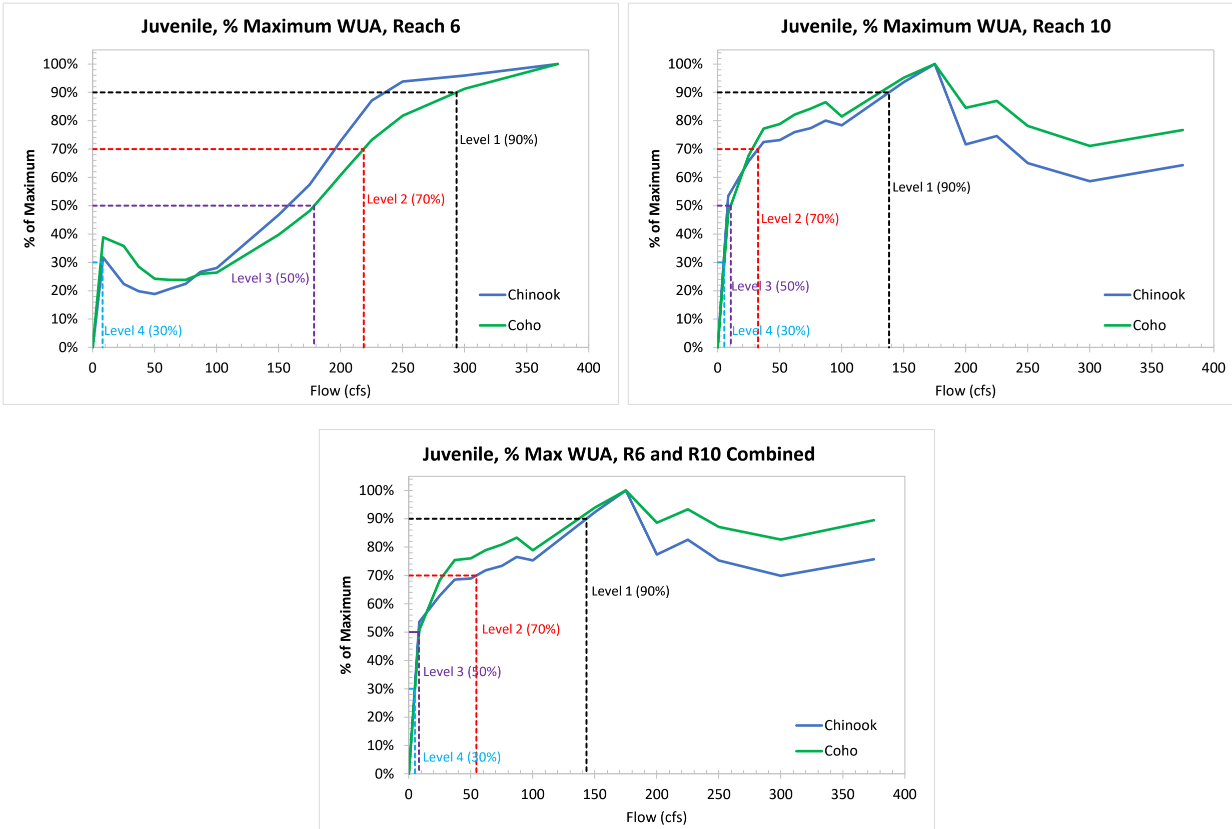


Figure 4.6-1. Normalized habitat vs. flow relationships for juvenile rearing showing the Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30% example flow levels identified for the flow release schedules. Flow levels are displayed separately for R6 and R10 (upper figures) and composited for R6 and R10 (lower figure). The composited curve was used in setting flow release levels.

4.6.1.2. Combined 2D Juvenile Rearing Habitat and 1D Spawning Habitat Flow Release Schedule

A separate flow release level schedule was developed based on the combined 2D juvenile rearing habitat and the 1D PHABSIM spawning habitat vs. flow relationships (Table 4.6-2). This schedule was like that presented in the 1D PHABSIM TM Kleinschmidt 2022c) that showed months prioritized by spawning and rearing, but in this case the juvenile rearing flow releases were based on the 2D habitat modeling results. Like above, the same three flow release locations were considered for each of the four flow release levels.

Table 4.6-2. Monthly flow releases from Eklutna Lake to the Eklutna River under Baseline conditions (zero flow release) and under 12 different flow release schedules. The four flow release levels (1–4) are flows that provide 90%, 70%, 50%, and 30% of habitat maxima for Chinook and Coho juvenile rearing for the months extending from December through June and spawning for the months extending from July through October.

Scenario		Flow Released to Eklutna River (cfs)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline		0	0	0	0	0	0	0	0	0	0	0	0
Option A	Flow Level 1	143	143	143	143	143	143	102	102	102	102	143	143
	Flow Level 2	54	54	54	54	54	54	30	30	30	30	54	54
	Flow Level 3	8	8	8	8	8	8	18	18	18	18	8	8
	Flow Level 4	5	5	5	5	5	5	13	13	13	13	5	5
Option B	Flow Level 1	143	143	143	143	143	143	99	99	99	99	143	143
	Flow Level 2	54	54	54	54	54	54	25	25	25	25	54	54
	Flow Level 3	8	8	8	8	8	8	17	17	17	17	8	8
	Flow Level 4	5	5	5	5	5	5	12	12	12	12	5	5
Option C	Flow Level 1	293	293	293	293	293	293	26	26	26	26	293	293
	Flow Level 2	219	219	219	219	219	219	20	20	20	20	219	219
	Flow Level 3	179	179	179	179	179	179	16	16	16	16	179	179
	Flow Level 4	8	8	8	8	8	8	12	12	12	12	8	8

Notes:
Option A – flow released to Eklutna River just downstream from Eklutna Dam.
Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam.
Option C – flow released to Eklutna River about 6.8 miles downstream from Eklutna Dam. Note – under the current infrastructure, maximum flow releases from the AWWU Drainage Valve are limited to approximately 110 cfs.

4.6.2. Time Series Analysis

The time series analysis followed the same general approach applied for the 1D PHABSIM analysis (Kleinschmidt 2022c) except two different analyses were completed. The time series considered all reaches of the Eklutna River including segments above and below Thunderbird Creek. The first, Time Series A was based on the 2D habitat modeling results for juvenile rearing habitats, and the second, Time Series B based on a combined 1D and 2D habitat results which incorporated both spawning and juvenile rearing habitat. With Time Series A, the analyses were focused on determining rearing habitat in the four 2D reaches (Reaches 10, 6, 4, and 3). With Time Series B, the analyses were focused on determining rearing habitat in a total of nine reaches (2D Reaches 10, 6, 4, and 3 and 1D Reaches 11, 9, 8, 7, and 5). Time Series B also included analyses for spawning habitat in six reaches (1D Reaches 11, 9, 8, 7, 5, and 4) with available substrate information.

Of note is that the Option C flow release schedules depicted in Tables 4.6-1 and 4.6-2 that were based on the R6 habitat modeling results were not analyzed for either series. This was because the flow release levels were solely reliant on the juvenile rearing habitat – flow relationships from R6 since based on that flow release location (AWWU drainage valve; Figure 4.1-1, R6 would be the only reach above Thunderbird Creek affected by flow releases from that location. However, as discussed in Section 4.5, R6 is confined and flows through a narrow relatively steep canyon that generally lacks a broad floodplain and complex side-channel and off-channel habitats. The channel morphology in R6 is unstable with extensive deposits of sediments and loosely consolidated materials residual to the dam removal. Thus, juvenile rearing habitats are primarily associated with fringe areas at channel margins rather than in primary side and off channel areas. As a result, basing flow releases for Option C solely on the juvenile habitat vs. flow relationships for R6 is not biologically justified. Moreover, reliance on that relationship alone (see Figure 4.6-1, Table 4.4-5, and Table 4.5-6) would render flow releases for the 90%, 70%, and 50% of habitat maxima of 293 cfs, 218 cfs, and 178 cfs, respectively. These flows are all higher than the 90% releases when both R10 and R6 are considered together. Nevertheless, to preserve the Option C release location, alternative time series analyses (both for Time Series A and B) were made using the same flow release schedules (based on R10 and R6) used for Option B (Tables 4.6-3 and 4.6-4).

Table 4.6-3. Monthly flow releases from Eklutna Lake to the Eklutna River under Baseline conditions (zero flow release) and under 12 different flow release schedules. The flow release schedule for Option C was adjusted to correspond to the same flow release schedule as Option B. The four flow release levels (1–4) are flows that provide 90%, 70%, 50%, and 30% of habitat maxima for Chinook and Coho juvenile rearing for all 12 months of the year (Time Series A).

Scenario		Flow Released to Eklutna River (cfs)											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Baseline		0	0	0	0	0	0	0	0	0	0	0	0
Option A	Flow Level 1	143	143	143	143	143	143	143	143	143	143	143	143
	Flow Level 2	54	54	54	54	54	54	54	54	54	54	54	54
	Flow Level 3	8	8	8	8	8	8	8	8	8	8	8	8
	Flow Level 4	5	5	5	5	5	5	5	5	5	5	5	5
Option B	Flow Level 1	143	143	143	143	143	143	143	143	143	143	143	143
	Flow Level 2	54	54	54	54	54	54	54	54	54	54	54	54
	Flow Level 3	8	8	8	8	8	8	8	8	8	8	8	8
	Flow Level 4	5	5	5	5	5	5	5	5	5	5	5	5
Option C	Flow Level 1	143	143	143	143	143	143	143	143	143	143	143	143
	Flow Level 2	54	54	54	54	54	54	54	54	54	54	54	54
	Flow Level 3	8	8	8	8	8	8	8	8	8	8	8	8
	Flow Level 4	5	5	5	5	5	5	5	5	5	5	5	5

Table 4.6-4. Monthly flow release schedule for the Eklutna River for Options A, B, and C and for Flow Levels 1, 2, 3, and 4. The flow release schedule for Option C was adjusted to correspond to the same flow release schedule as Option B. The four flow release levels (1–4) are flows that provide 90%, 70%, 50%, and 30% of habitat maxima for Chinook and Coho juvenile rearing for the months extending from December through June and spawning for the months extending from July through October (Time Series B).

Scenario		Flow Released to Eklutna River (cfs)											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Baseline		0	0	0	0	0	0	0	0	0	0	0	0
Option A	Flow Level 1	143	143	143	143	143	143	102	102	102	102	143	143
	Flow Level 2	54	54	54	54	54	54	30	30	30	30	54	54
	Flow Level 3	8	8	8	8	8	8	18	18	18	18	8	8
	Flow Level 4	5	5	5	5	5	5	13	13	13	13	5	5
Option B	Flow Level 1	143	143	143	143	143	143	99	99	99	99	143	143
	Flow Level 2	54	54	54	54	54	54	25	25	25	25	54	54
	Flow Level 3	8	8	8	8	8	8	17	17	17	17	8	8
	Flow Level 4	5	5	5	5	5	5	12	12	12	12	5	5
Option C	Flow Level 1	143	143	143	143	143	143	99	99	99	99	143	143
	Flow Level 2	54	54	54	54	54	54	25	25	25	25	54	54
	Flow Level 3	8	8	8	8	8	8	17	17	17	17	8	8
	Flow Level 4	5	5	5	5	5	5	12	12	12	12	5	5

Notes:

1 These data are based on the modeled habitat-flow relationships developed during 1D and 2D instream flow modeling. There may be limitations of existing or potential-future infrastructure to deliver flows of this magnitude to the river. These limitations will be discussed in the Engineering Feasibility Report.

4.6.2.1. Hydrology

As discussed in Kleinschmidt (2022c), available flow records from the USGS and the NVE were used to perform time-series analyses of habitat for three example flow release schedules from Eklutna Lake to the Eklutna River, and for various species/life stage combinations of salmonid species.

The instream flow study reach extends from Eklutna Dam to the zone of tidal influence. Within this reach, Thunderbird Creek is the largest tributary to the Eklutna River, and its confluence is used to divide the Eklutna River into two hydrologic reaches:

1. **Upper Eklutna Segment –** extends from Eklutna Dam to the confluence with Thunderbird Creek. The Upper Eklutna was further divided into the six reaches used for instream flow analyses: R11, R10, R9, R8, R7, and R6. Under baseline conditions, there are no flow releases from Eklutna Dam to these sub-reaches and therefore flows are relatively low.
2. **Lower Eklutna Segment –** extends from the confluence with Thunderbird Creek to the zone of tidal influence. This segment was divided into three reaches used for instream flow analyses: R5, R4, and R3. Under baseline conditions, the flows in these reaches are influenced by inputs from Thunderbird Creek and are therefore relatively high compared to those in the Upper Eklutna segment.

Historical daily flow records are available from the Eklutna River at the Old Glenn Highway Bridge (USGS Gage No. 15280200). These continuous daily records extend from May 1, 2002 to September 29, 2007. During this period, there were no flow releases or spill events from Eklutna Lake to the Eklutna River. This period of record forms the basis for the time series analyses reported in this section.

During this period, discrete intermittent flow measurements were performed in the Eklutna River just upstream from the confluence with Thunderbird Creek. These records were available from the USGS (USGS Gage No. 15280100) and from the NVE. Monthly median flows were derived from these data and were used to estimate a continuous daily flow hydrograph.

Continuous daily flows in the Eklutna River at the Old Glenn Highway and above the confluence with Thunderbird Creek are shown in Figure 4.6-2 for the period from May 1, 2022 to September 29, 2007. The baseline flows in the Upper Eklutna Reach are relatively low in comparison with the flows in the Eklutna River at the Old Glenn Highway.

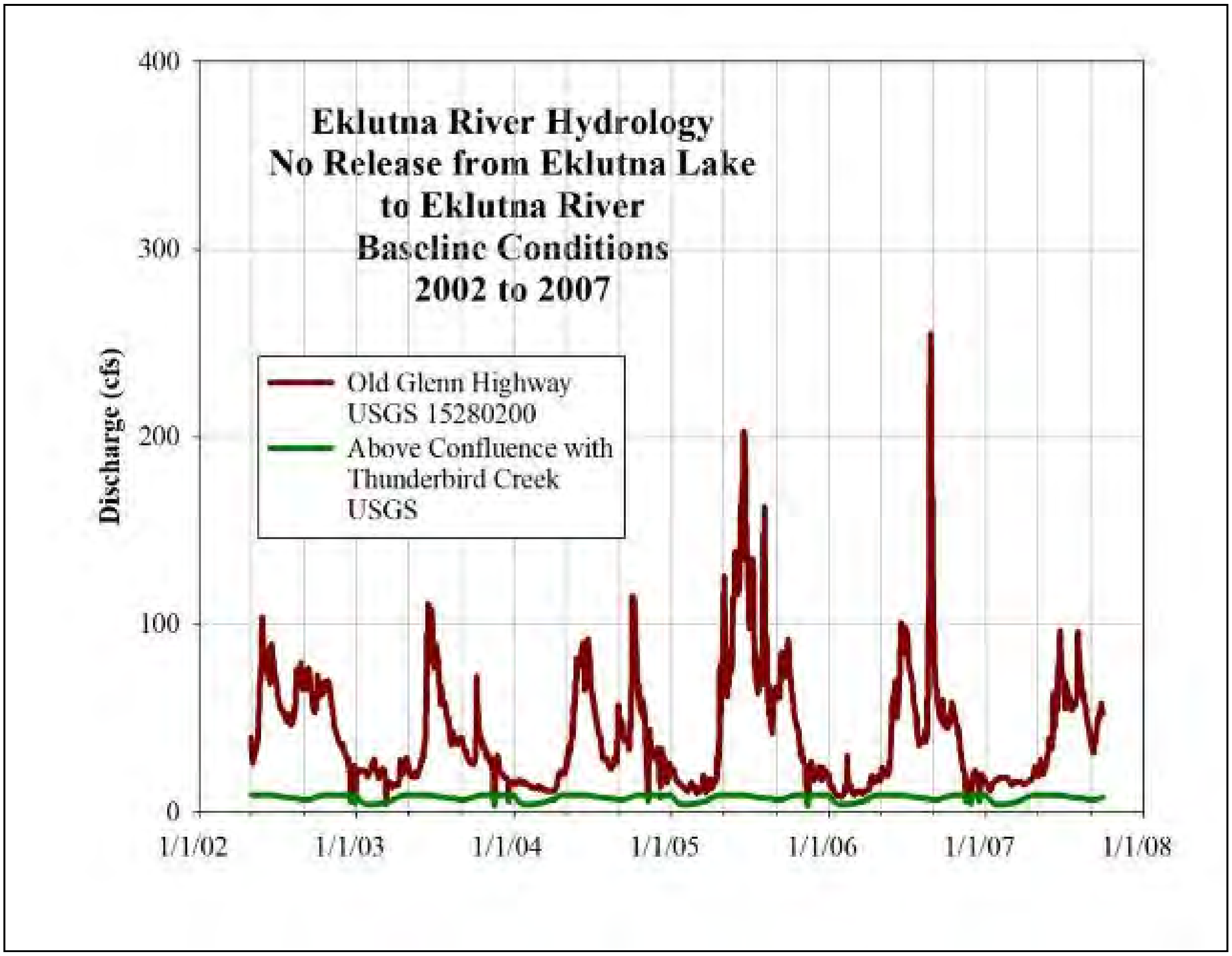


Figure 4.6-2. Daily flows in the Eklutna River at the Old Glenn Highway and above the confluence with Thunderbird Creek from May 1, 2002 to September 29, 2007, with no flow releases from Eklutna Lake to the Eklutna River.

The Upper Eklutna River below Eklutna Dam was visited in late August 2019, and observations were reported in a site reconnaissance trip report (MJA 2019). The Eklutna River was dry below Eklutna Dam. Measurable flow (1 to 2 cfs) was observed in the Eklutna River about 4 miles downstream from Eklutna Dam (River Mile 8.3). This location with noticeable discharge is in R10, and divides R10 into two sub-reaches (Upper Reach 10 and Lower Reach 10). Under baseline conditions, there is no discharge in Upper Reach 10 and there are very small discharges in Lower Reach 10.

The flow in the Eklutna River above the confluence with Thunderbird Creek (River Mile 2.8) was assumed to be 7 cfs (a typical value for late August). Between these two locations on the Eklutna River, it was assumed that the flow in the Eklutna River was proportional to river mile under baseline conditions. Reach 11 extends for about 2.7 miles downstream from Eklutna Dam. Reach 11 is dry under baseline conditions.

4.6.2.2. Flow Releases Applied in the Time Series

The flow releases applied in the two time series varied according to the schedules in Table 4.6-3 (Time Series A) and Table 4.6-4 (Time Series B).

Time Series A – 2D Juvenile Habitat Analysis

Under baseline conditions, no flow would be released to the Eklutna River. Although three different options (A, B, and C) were considered for where to release the water downstream from Eklutna Dam, only Options A and B were analyzed for reasons noted above. Under Option A, the flow would be released to the Eklutna River just downstream from Eklutna Dam. Under Option B, flow would be released to the Eklutna River about 1.2 miles downstream from Eklutna Dam from the existing AWWU portal valve. For each option, the four example flow release levels (Flow Level 1 – 90%, Flow Level 2 – 70%, Flow Level 3 – 50%, and Flow Level 4 – 30%) were considered (see Section 4.5.1.2) which governed the magnitude of the released flows. The magnitudes of the discharges listed in Table 4.6-3 were derived from weighted useable area curves for Chinook and Coho juvenile rearing. All three options (Options A, B, and C) were based on habitat in Reaches 10 and 6[10]. In Time Series A, the discharge magnitudes were based on rearing habitat only (for all 12 months of the year).

Time Series B – 2D Juvenile and 1D Spawning Habitat Analysis

Under baseline conditions, no flow would be released to the Eklutna River. The magnitudes of the discharges listed in Table 4.6-4 were derived from weighted usable area curves for Chinook and Coho juvenile rearing for the months extending from December through June, and for spawning for months July through October. All three options (Options A, B, and C) for the juvenile rearing months were based on habitat in R10 and R6, while the flow releases for the spawning months were based on the 1D PHABSIM reaches above Thunderbird Creek; the Option C analysis applied the same flow release schedule as for Option B.

4.6.2.3. Example Analysis Based on Time Series B

To illustrate the process of performing a time series analysis, two runs were selected. These example runs focused on Coho juvenile rearing habitat and were for Time Series B Upper Reach 10, Baseline and Option A, with the Level 2 (70%) flow release. Coho juvenile rearing occurs in the river throughout all 12 months and so the analysis was based on the entire year. In Time Series B, spawning habitat was also analyzed but not presented in this example; results that include spawning habitat are shown in tabular formats in Section 4.5.2.4.2.

The daily flow hydrographs in Reach 10 of the Eklutna River are shown in Figure 4.6-3 for the example runs (Option A, Flow Level 2 – 70% and Baseline conditions). The magnitudes of the Option A Level 2 – 70% flows are several times larger than the magnitudes of the Baseline flows.

[10] The release flows were based on a composite of the R6 and R10 habitat vs. flow relationships above Thunderbird Creek, since this is the river segment that would receive the greatest benefit (as a percentage flow increase over baseline) from flow releases from Eklutna Lake. The habitat-flow relationships for R3 and R4 which are below Thunderbird Creek, were not used for developing flow releases from Eklutna Lake but were considered in the time series analysis.

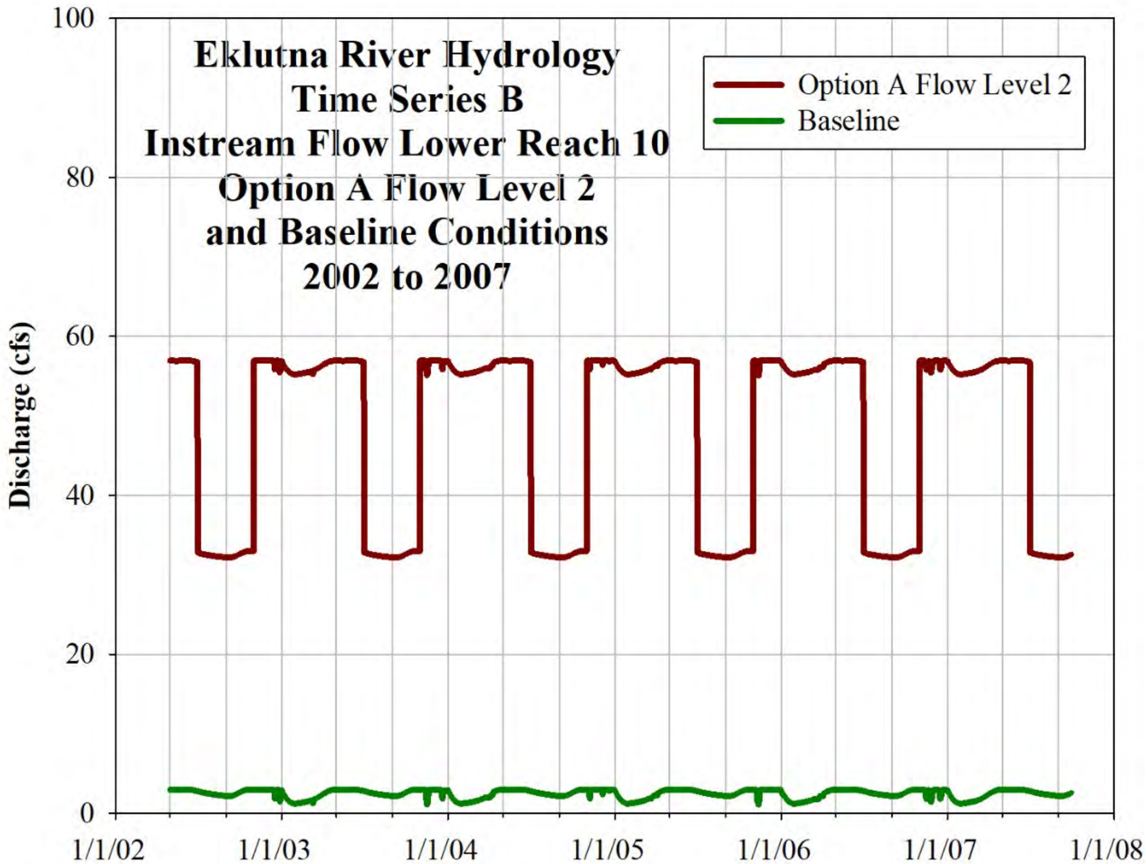


Figure 4.6-3. Daily flows in Upper Reach 10 of the Eklutna River for Option A, Level 2 – 70% flow release level and Baseline conditions, Time Series B. Option A – flow released to Eklutna River just downstream from Eklutna Dam.

A habitat area curve defined as WUA for Coho juvenile rearing in Lower Reach 10 is shown in Figure 4.6-4. The curve reaches a peak of about 2.1 acres when the discharge is about 175 cfs.

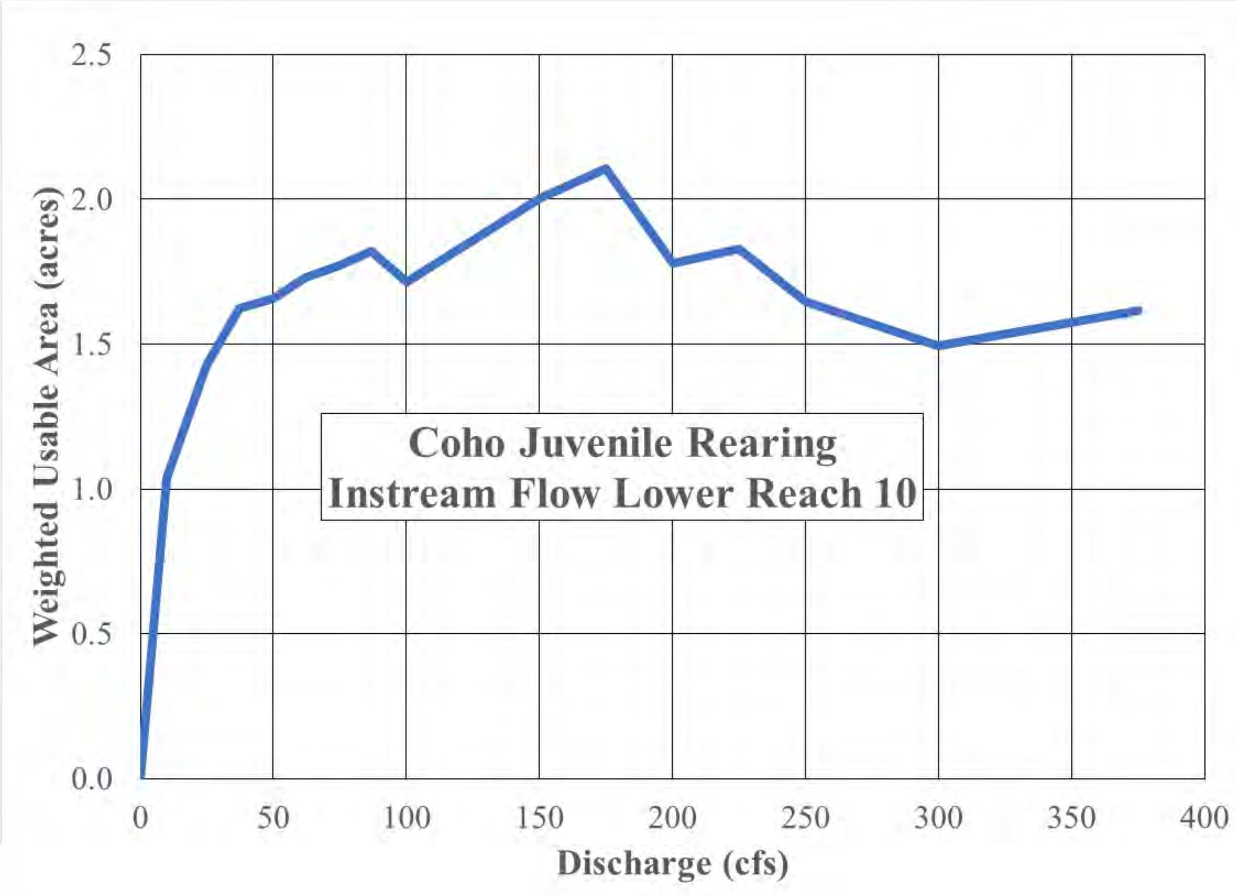


Figure 4.6-4. Habitat area (WUA) in Lower Reach 10 for Coho juvenile rearing as a function of flow in the Eklutna River.

Applying the habitat vs. flow relationship defined in Figure 4.6-4 to the hydrology data in Figure 4.6-3 provides a daily time series of Coho juvenile rearing habitat over the same time period (Figure 4.6-5). The magnitudes of habitat for Option A Flow Level 2 are several times larger than the magnitudes of habitat for Baseline conditions.

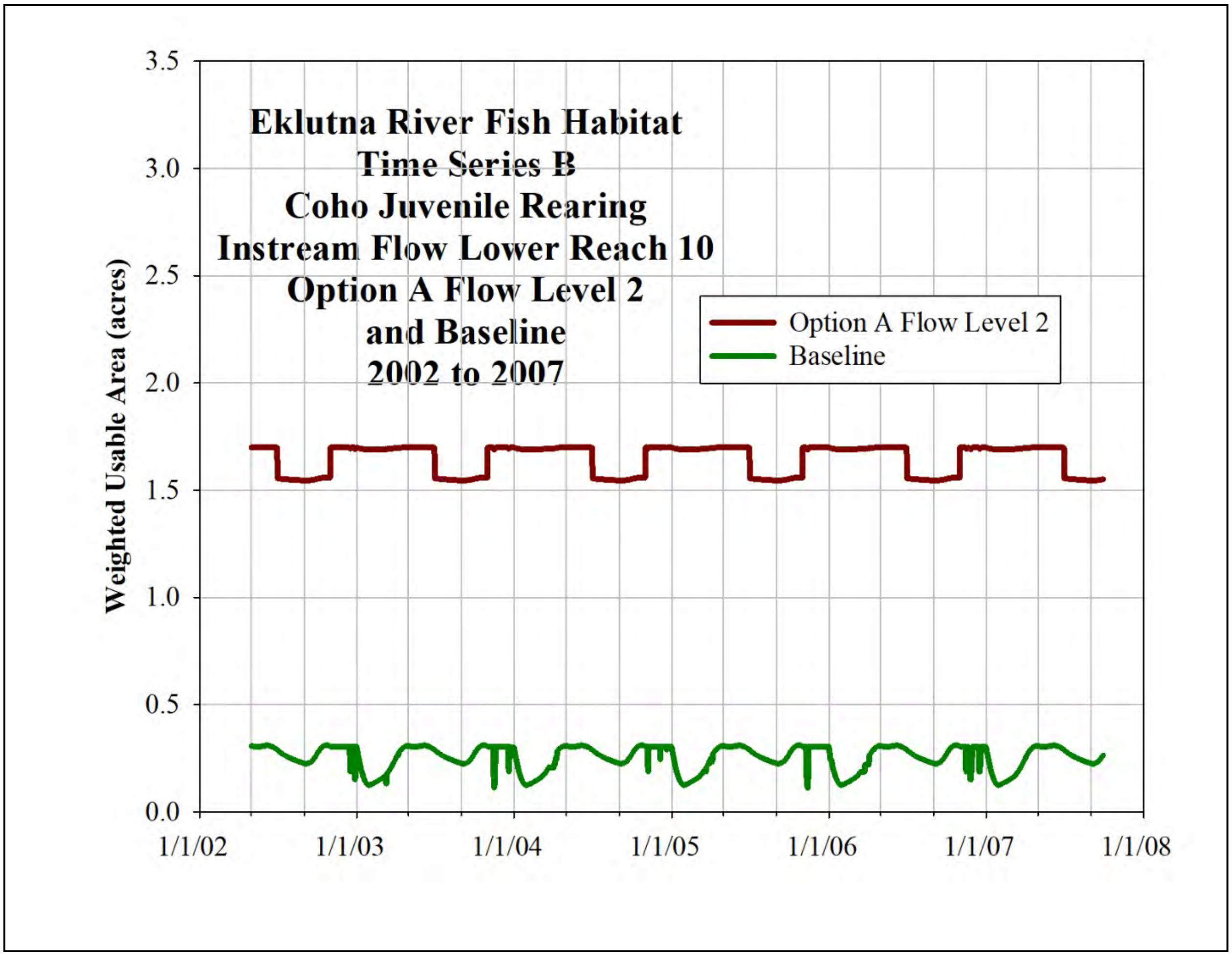


Figure 4.6-5. Daily time series of habitat area (WUA) for Coho juvenile rearing in Lower Reach 10, Option A, Flow Level 2 (70%) (upper line) and Baseline conditions (lower line).

These examples were provided just for Lower Reach 10. Final results for Time Series B were based on the combined totals of juvenile rearing habitat from nine instream flow reaches (Reaches 11, 10, 9, 8, 7, and 6 – above Thunderbird Creek and Reaches 5, 4, and 3 – below Thunderbird Creek). Spawning habitat was also computed based on the 1D PHABSIM analysis for Reaches 11, 9, 8, 7, 5, and 4.

4.7. Summary of Time Series Analysis

4.7.1. Time Series A

Time-averaged habitat areas (WUA) for Time Series A are summarized in Table 4.7-1. These areas represent the combined total of juvenile rearing habitat from 2D Reaches 3, 4, 6, and 10.

Table 4.7-1. Time-averaged habitat area (WUA) for Time Series A for Chinook and Coho juvenile rearing, as determined from four example flow release levels (Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30%) for three flow release location options, A – below Eklutna Dam, Option B – AWWU portal, and Option C – AWWU drainage valve. The flow release schedule for Option C was made the same as for Option B.

Scenario		Time-Averaged Habitat Expressed as Weighted Usable Area (acres)	
		Juvenile Rearing	
		Chinook	Coho
Baseline		11.0	13.3
Option A	Flow Level 1	23.8	30.5
	Flow Level 2	16.8	21.4
	Flow Level 3	12.8	15.8
	Flow Level 4	12.2	15.0
Option B	Flow Level 1	23.8	30.5
	Flow Level 2	16.8	21.4
	Flow Level 3	12.8	15.8
	Flow Level 4	12.2	15.0
Option C	Flow Level 1	22.0	27.5
	Flow Level 2	15.4	18.9
	Flow Level 3	12.0	14.5
	Flow Level 4	11.7	14.1

Note: The Level 1, Level 2, Level 3, and Level 4 releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook and Coho salmon.

The percent increase (with respect to baseline) of time-averaged habitat area (WUA) is listed in Table 4.7-2. Habitat increases ranged for Chinook from 120% (Flow Level 1 to 10% for Level 4; for Coho, from 130% to 10%.

Table 4.7-2. Percent increase (with respect to baseline) of time-averaged habitat area (WUA) Time Series A for Chinook and Coho juvenile rearing as determined from four example flow release levels (Flow Level 1 – 90%, Flow Level 2 – 70%, Flow Level 3 – 50% and Flow Level 4 – 30%) for three flow release location options, A – below Eklutna Dam, B – at upper AWWU portal, and C at AWWU drainage valve. The flow release schedule for Option C was made the same as for Option B. Percentages were rounded to nearest 10%.

Scenario		Time-Averaged Habitat Expressed as Percent Increase above Baseline	
		Juvenile Rearing	
		Chinook	Coho
Baseline		0%	0%
Option A	Flow Level 1	120%	130%
	Flow Level 2	50%	60%
	Flow Level 3	20%	20%
	Flow Level 4	10%	10%
Option B	Flow Level 1	120%	130%
	Flow Level 2	50%	60%
	Flow Level 3	20%	20%
	Flow Level 4	10%	10%
Option C	Flow Level 1	100%	110%
	Flow Level 2	40%	40%
	Flow Level 3	10%	10%
	Flow Level 4	10%	10%

Habitat duration curves for Chinook juvenile rearing habitat are shown for Time Series A in Figure 4.7-1. In all cases, habitat gains were achieved when flows were added to the river downstream from Eklutna Dam. For a given level, similar gains in habitat would occur for Options A and B because the release points for both of these options are above Reaches 10, 6, 4, and 3.

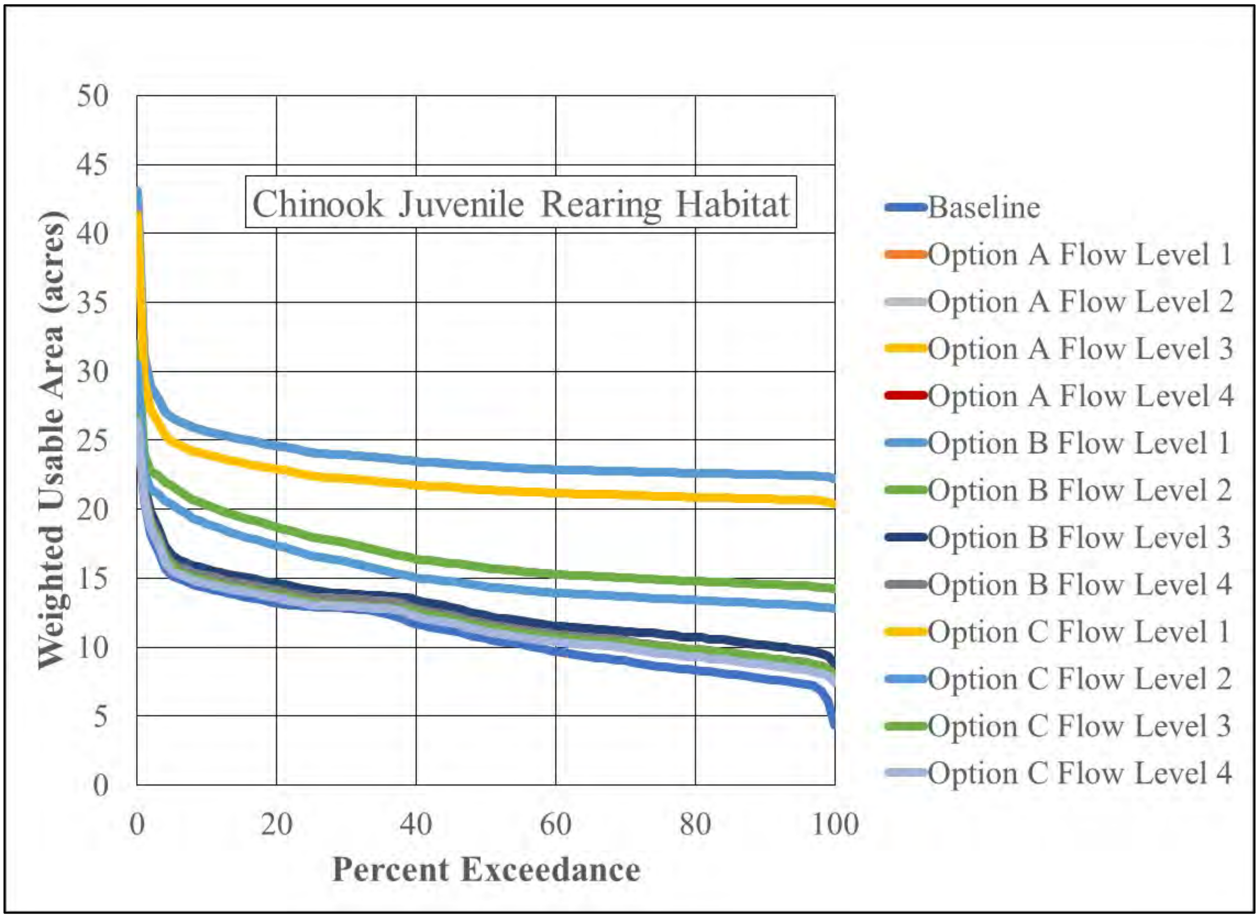


Figure 4.7-1. Chinook juvenile rearing habitat duration curves derived from the total habitat from Reaches 3, 4, 6, and 10. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

Habitat duration curves for Coho juvenile rearing habitat are shown for Time Series A in Figure 4.7-2. In all cases, habitat gains were achieved when flows were added to the river downstream from Eklutna Dam. For a given level, similar gains in habitat would occur for Options A and B because the release points for both of these options are above Reaches 10, 6, 4, and 3.

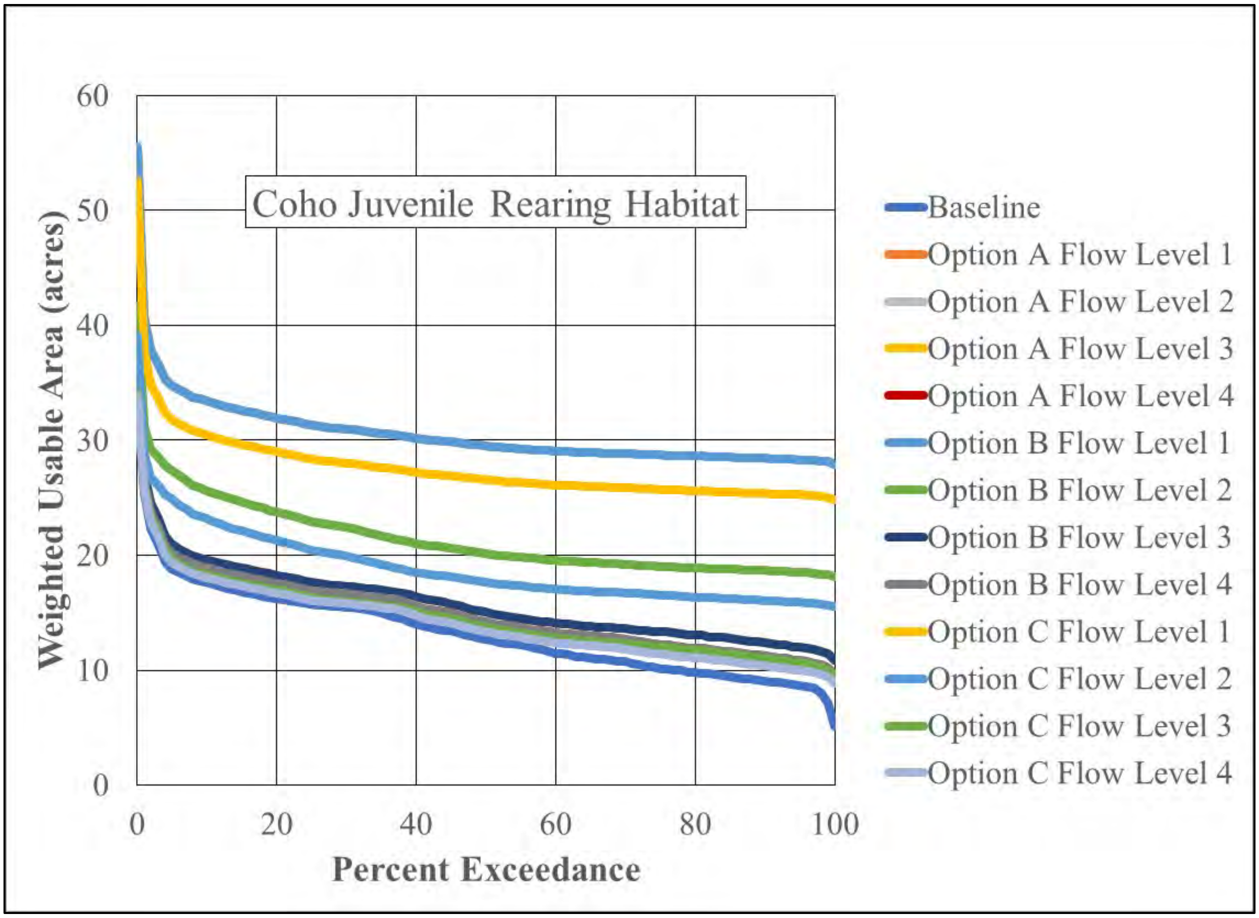


Figure 4.7-2. Coho juvenile rearing habitat duration curves derived from the total habitat from Reaches 3, 4, 6, and 10. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

4.7.2. Time Series B

Time-averaged habitat areas (WUA) for Time Series B are summarized in Table 4.7-3. These areas represent the combined totals of juvenile rearing habitat from Reaches 3, 4, 5, 6, 7, 8, 9, 10, and 11 (combined 2D and 1D analysis) and for spawning, Reaches 4, 5, 7, 8, 9, and 11 (1D analysis) spawning habitat.

The percent increase (with respect to baseline) of time-averaged habitat area (WUA) for Time Series B is listed in Table 4.7-4. Habitat increases ranged for Chinook rearing from 160% for Option A Level 1 to 10% for Option C Level 4; 180% to 10% for Coho. Spawning habitat increases ranged from for Chinook, 200% for Option A, Level 1 to 0% for Option C Level 1; 170% for Option A, Level 1 to 20% for Option C, Level 1 for Coho; and 170% for Option A, Level 2 to 30% for Option C, for Level 4 for Sockeye.

Table 4.7-3. Time-averaged habitat expressed as weighted usable area (acres) for Chinook and Coho juvenile rearing and for Chinook, Coho, and Sockeye spawning. Time-averaged habitat is reported for the Eklutna River for Options A, B, and C and for Flow Levels 1, 2, 3, and 4. Flows are driven by 2D juvenile rearing habitat from November through June and by 1D spawning habitat for July through October (Time Series B). The flow release schedule for Option C was made the same as the flow release schedule for Option B.

Scenario		Time-Averaged Habitat Expressed as Weighted Usable Area (acres)				
		Chinook		Coho		Sockeye
		Spawning	Juvenile Rearing	Spawning	Juvenile Rearing	Spawning
Baseline		0.5	11.9	1.2	14.8	1.0
Option A	Flow Level 1	1.5	30.6	3.1	41.3	2.5
	Flow Level 2	1.4	22.6	3.1	30.4	2.7
	Flow Level 3	1.2	17.6	2.8	22.8	2.4
	Flow Level 4	1.0	16.2	2.6	20.8	2.2
Option B	Flow Level 1	1.2	28.1	2.4	37.5	2.1
	Flow Level 2	1.1	20.4	2.5	27.2	2.3
	Flow Level 3	1.0	16.3	2.4	21.0	2.1
	Flow Level 4	0.9	15.2	2.2	19.4	1.9
Option C	Flow Level 1	0.5	22.9	1.4	29.0	1.3
	Flow Level 2	0.6	16.0	1.6	20.6	1.5
	Flow Level 3	0.6	13.3	1.6	16.9	1.5
	Flow Level 4	0.6	12.9	1.5	16.3	1.5

Note: The Level 1, Level 2, Level 3, and Level 4 releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon.

Table 4.7-4. Time-averaged habitat expressed as percent increase above baseline for Chinook and Coho juvenile rearing and for Chinook, Coho, and Sockeye spawning. Time-averaged habitat increases are reported for the Eklutna River for Options A, B, and C and for Flow Levels 1, 2, 3, and 4. Flows are driven by 2D juvenile rearing habitat from November through June and by 1D spawning habitat for July through October (Time Series B). The flow release schedule for Option C was made the same as the flow release schedule for Option B.

Scenario		Time-Averaged Habitat Expressed as Percent Increase above Baseline				
		Chinook		**Coho**		**Sockeye**
		Spawning	**Juvenile Rearing**	**Spawning**	**Juvenile Rearing**	**Spawning**
Baseline		0%	0%	0%	0%	0%
Option A	Flow Level 1	200%	160%	170%	180%	150%
	Flow Level 2	170%	90%	160%	110%	170%
	Flow Level 3	130%	50%	140%	50%	140%
	Flow Level 4	100%	40%	120%	40%	110%
Option B	Flow Level 1	130%	140%	110%	150%	100%
	Flow Level 2	120%	70%	120%	80%	130%
	Flow Level 3	100%	40%	100%	40%	110%
	Flow Level 4	70%	30%	90%	30%	90%
Option C	Flow Level 1	0%	90%	20%	100%	30%
	Flow Level 2	30%	30%	40%	40%	50%
	Flow Level 3	20%	10%	30%	10%	50%
	Flow Level 4	20%	10%	30%	10%	50%

Habitat duration curves for Time Series B for Chinook spawning habitat are shown in Figure 4.7-3. In all cases, habitat gains were achieved when flows were added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added just downstream from Eklutna Dam (Option A) than when added 1.2 miles downstream (Option B), or 6.8 miles downstream (Option C).

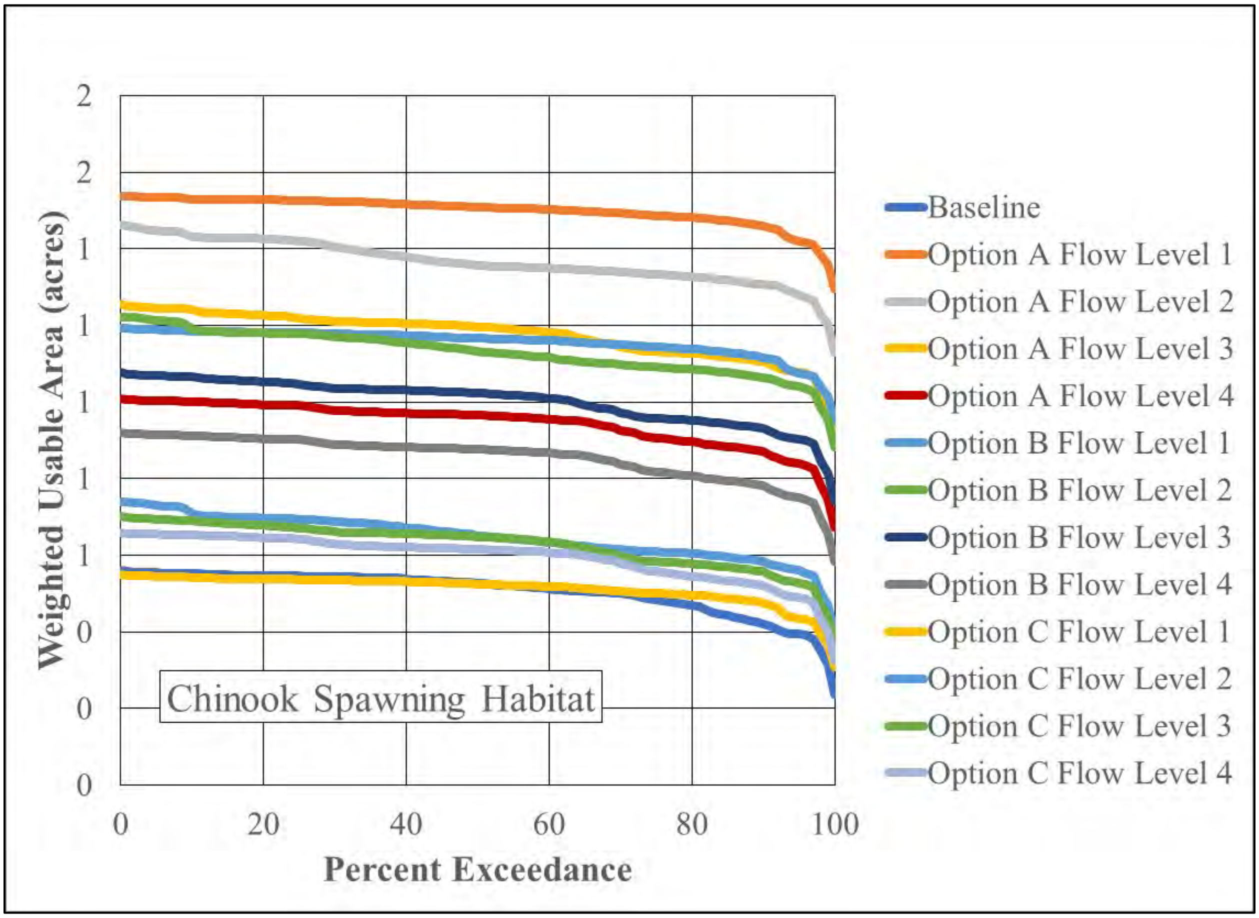


Figure 4.7-3. Chinook spawning habitat duration curves derived from the total habitat from Reaches 11, 9, 8, 7, 5, and 4. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

Habitat duration curves for Time Series B Chinook juvenile rearing habitat are shown in Figure 4.7-4. In all cases, habitat gains were achieved when flow was released to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B), or 6.8 miles downstream (Option C).

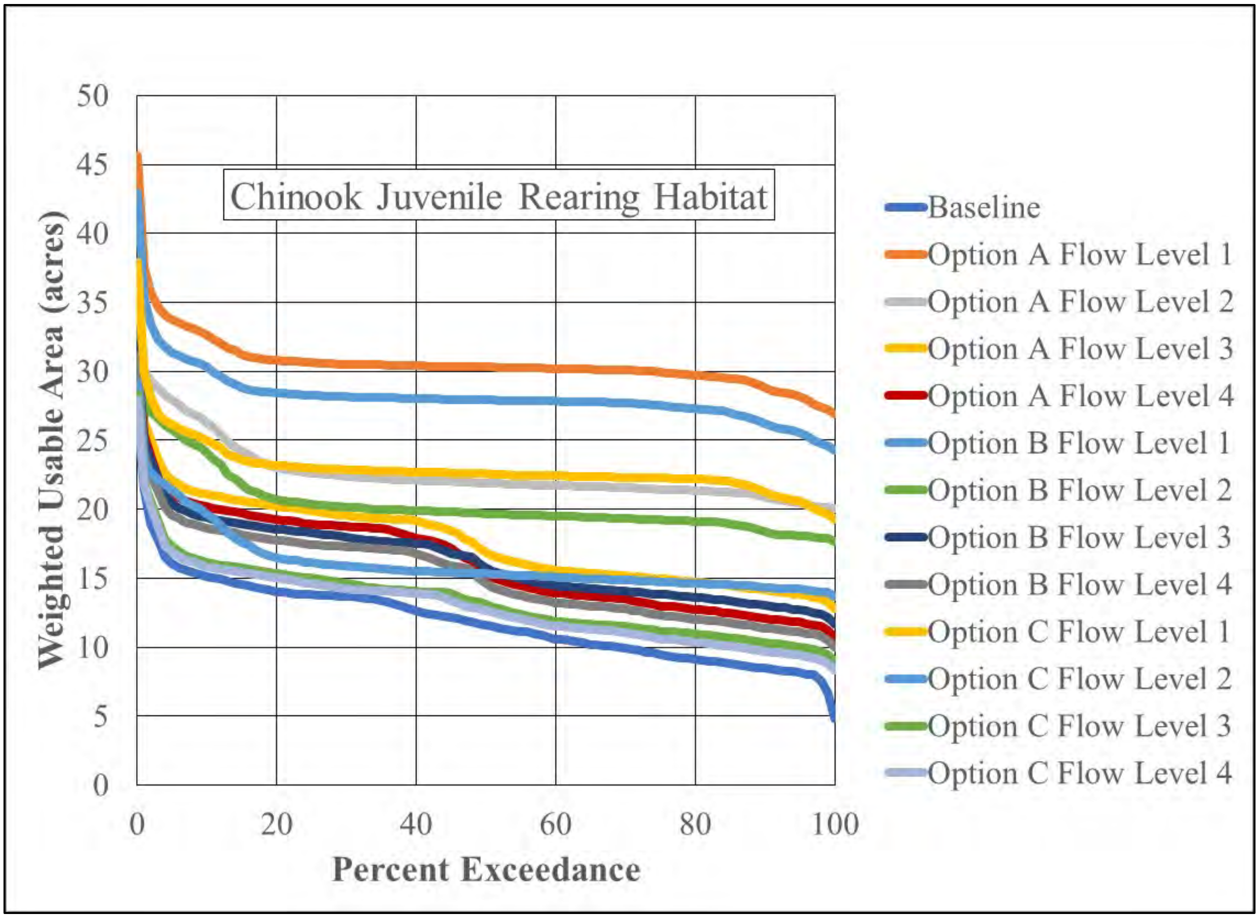


Figure 4.7-4. Chinook juvenile rearing habitat duration curves derived from the total habitat from Reaches 11, 10, 9, 8, 7, 6, 5, 4, and 3. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

Habitat duration curves for Time Series B for Coho spawning habitat are shown in Figure 4.7-5. Similar to above, in all cases, habitat gains were achieved when flow was added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B), or 6.8 miles downstream (Option C).

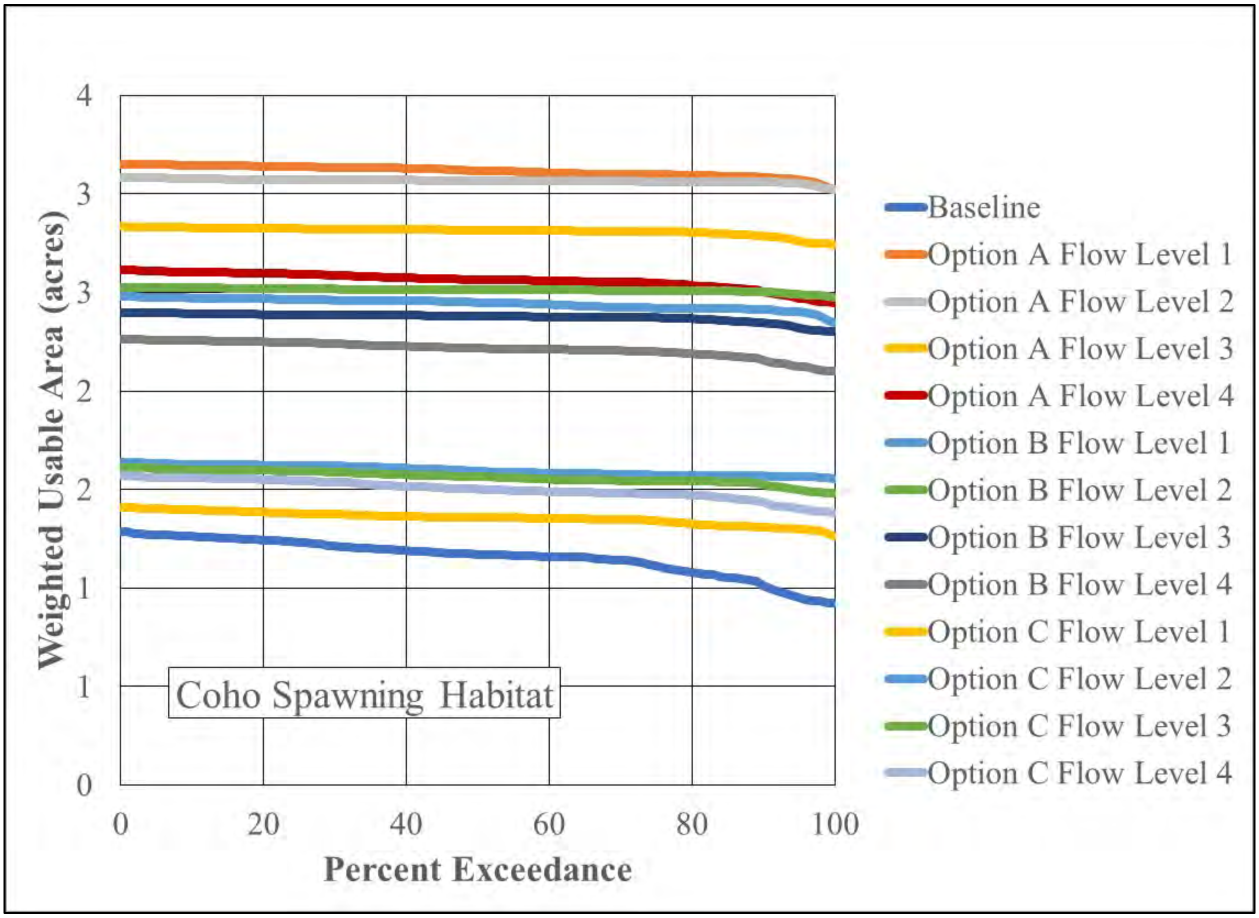


Figure 4.7-5. Coho spawning habitat duration curves derived from the total habitat from Reaches 11, 9, 8, 7, 5, and 4. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

Habitat duration curves for Time Series B for Coho juvenile rearing habitat are shown in Figure 4.7-6. In all cases, habitat gains were achieved when flow was added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B), or 6.8 miles downstream (Option C).

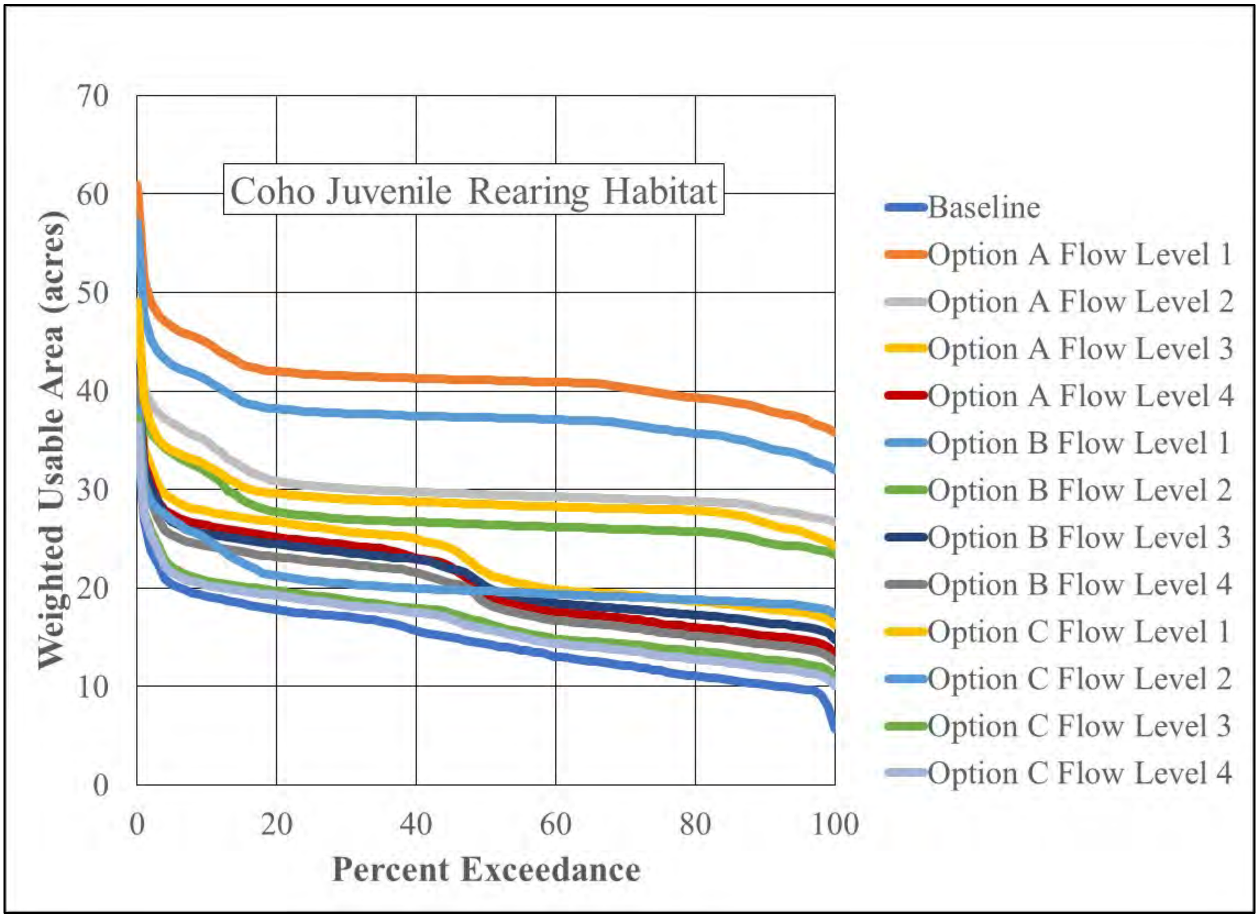


Figure 4.7-6. Coho juvenile rearing habitat duration curves derived from the total habitat from Reaches 11, 10, 9, 8, 7, 6, 5, 4, and 3. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

Habitat duration curves for Time Series B Sockeye spawning habitat are shown in Figure 4.7-7 and time-averaged habitat areas (WUA) as listed in Table 4.7-3. In all cases, habitat gains were achieved when flow was added to the river downstream from Eklutna Dam. Larger gains in habitat were achieved when flow was added to the river just downstream from Eklutna Dam (Option A) than when flow was added to the river 1.2 miles downstream from Eklutna Dam (Option B), or 6.8 miles downstream (Option C).

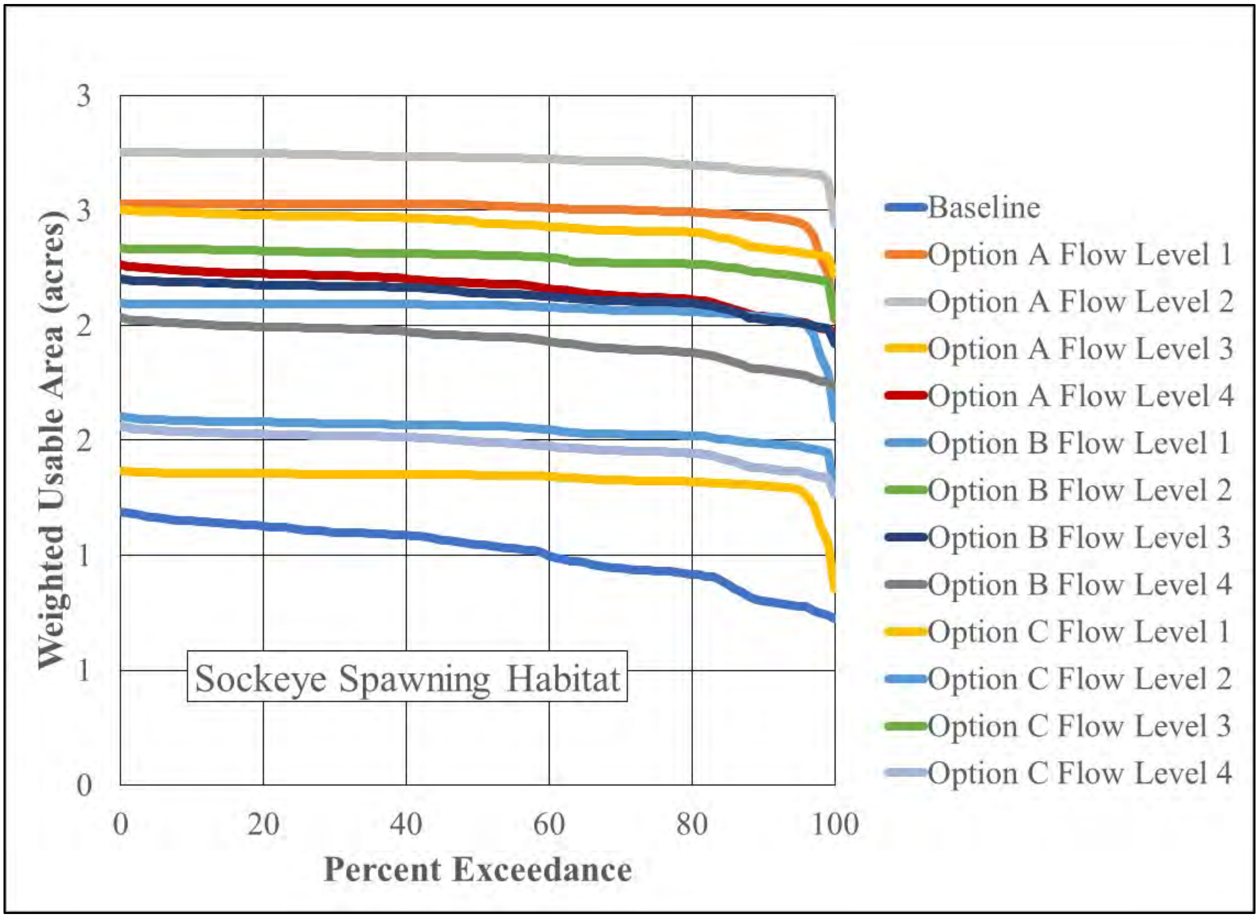


Figure 4.7-7. Sockeye spawning habitat duration curves derived from the total habitat from Reaches 11, 9, 8, 7, 5, and 4. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. Option C – flow released to the Eklutna River in Reach 8. The Level 1, Level 2, Level 3, and Level 4 flow releases represent flows that provide 90%, 70%, 50%, and 30% of the maximum habitat as determined from the habitat vs. flow relationships for Chinook, Coho, and Sockeye salmon. The flow releases for Option C were assumed to be the same as the flow releases for Option B.

In all cases and for all release options (A, B, and C) analyzed, habitat gains (above baseline) were achieved when water was added to the river downstream from Eklutna Dam. The greatest overall gains occurred under release options A followed closely by B since they affected the most river miles. The Option C release point is ~6.8 miles below the dam and therefore fewer river miles would be affected and habitat gains were overall less than gains for Options A and B.

For illustration purposes, the results of the Time Series B analysis were analyzed for both spawning and rearing habitats on a reach basis and then cumulatively summarized for reaches above and below Thunderbird Creek. These tables are presented in Appendix 4 into two series of tables. The first series depicts the results for Chinook juvenile habitat for the three flow release options (A, B, and C) followed by Coho juvenile habitat. The second series depicts spawning habitats for the three flow release options presented for Chinook, Coho and then

Sockeye. Appendix 4 also contains a series of tables that summarize habitat amounts into upper Eklutna River, consisting of Reaches R6, R7, R8, R9, R10 and R11, and lower Eklutna River, consisting of R3, R4 and R5. Thunderbird Creek represents the largest contributor to flow to the Eklutna River, but it only affects the lower reaches (R3, R4 and R5).

Table 4.7-5 represents a simplified example of this analysis and depicts a reach based comparative assessment of the apportionment of Chinook juvenile rearing habitat under baseline and for Option A, Level 1 flow conditions. On an overall reach basis and under existing baseline conditions (no flow releases from Eklutna Lake with flows resulting from accretion and tributary flow [primarily Thunderbird Creek]), Reach 3 would account for about 81 percent (9.7 acres) of the total estimated juvenile rearing habitat of the entire Eklutna River (Table 4.7-5). This would be followed by R4 (8%), and R5 (3%) which are both below Thunderbird Creek with all reaches above Thunderbird Creek (R6 through R11) cumulatively providing about 7% (0.9 acres) of the baseline habitat totals. Under Option A and based on Time Series B) and with a flow Level 1 release of 143 cfs, the Chinook juvenile rearing habitat amounts in R3 would increase to 16.7 acres that would represent 55% of the total. The next largest increase in habitats would occur in decreasing order: R11 with 5.4 acres (18%), followed by R4 with 4.1 acres (13%), R10 with 1.8 acres (6%), R7 with 0.9 acres (3%), R8 with 0.7 acres (3%) and then R5 and R6 each with 0.3 acres (1%). These habitat amounts and percentages will differ based on flow release levels from Eklutna Lake. A more comprehensive comparison of all flow levels and for both spawning and juvenile rearing is provided in Appendix 4.

Table 4.7-5. Comparison of juvenile rearing habitat in the Eklutna River by reach under baseline (no flow releases from Eklutna Lake) and Option A-Level 1 flow release (143 cfs). Habitats expressed as acres and percent of total for the entire river. Results from Time Series B analysis.

Chinook Juvenile Rearing - Time Series B				
	Baseline		Option A – Level 1	
	Acres	Percent of Total	Acres	Percent of Total
Reach 3	9.7	81%	16.7	55%
Reach 4	1.0	8%	4.1	13%
Reach 5	0.4	3%	0.3	1%
Reach 6	0.2	2%	0.3	1%
Reach 7	0.2	2%	0.9	3%
Reach 8	0.2	2%	0.7	2%
Reach 9	0.1	1%	0.4	1%
Reach 10	0.2	1%	1.8	6%
Reach 11	0.0	0%	5.4	18%
Lower Eklutna	11.0	93%	21.1	69%
Upper Eklutna	0.9	7%	9.5	31%
Total	11.9	100%	30.6	100%

5 FLOW ASSESSMENT SUMMARY

The Fish and Wildlife Agreement (1991) states that:

> *"The Purchasers agree to fund studies to examine, and quantify, if possible, the impacts to fish and wildlife from the Eklutna and Snettisham Projects. The studies will also examine and develop proposals for the protection, mitigation, and enhancement of fish and wildlife affected by such hydroelectric development. This examination shall consider the impact of fish and wildlife measures on electric rate payers, municipal water utilities, recreational users and adjacent land use, as well as available means to mitigate these impacts."*

The Instream Flow Study was commissioned to develop a set of models and analytical tools that could be applied in formulating an initial understanding of how the provision of flows in the Eklutna River influence the amount of productive fish habitats (of different species and life stages) in different reaches of the river. Building on this understanding, as well as results from other resource studies, including Geomorphology/Sediment Transport, Fish Species Composition and Distribution, Macroinvertebrates, Water Quality, and Hydrology (Stream Gaging) Studies, it should be possible to derive a series of flow release prescriptions that are focused on restoring habitat to productive levels, but at the same time and in accordance with the 1991 Agreement can be balanced with the needs of other water resource users in the basin (e.g., wildlife, electric rate payers, municipal water utilities, recreation and others).

As described above, the Instream Flow Study has developed and successfully tested a suite of models and analyses that can be used in formulating and evaluating alternative flow release schedules that support the development and sustainment of productive fish habitats in the Eklutna River. However, the development of these schedules will need to be closely coordinated with the Geomorphology/Sediment Transport study so that channel changes and habitat forming flows can be factored into their development. Some specific thoughts related to the study follow.

First off, the time series analysis completed for both the 1D and 2D modeling provides an effective means for comparing habitat gains between various flow release scenarios and release location options with those provided by baseline conditions. However, the scenarios presented in this analysis were for example purposes only and primarily serve to illustrate the process used and sample outputs that can be provided via a time series assessment. Importantly, the analysis confirms the utility of the both the 1D PHABSIM modeling described in Section 2 and the 2D modeling described in Section 4 as two of several models that can be used for considering and balancing fish habitat needs amongst other uses of water in the Eklutna River basin.

Importantly, all of the instream flow analysis and modeling completed to date has the most direct applicability to the current conditions and channel morphologies of the Eklutna River. The 1D study sites and reaches were selected in consultation with Watershed Geodynamics to represent those deemed most likely to remain geomorphologically stable over the range of the target flow releases. Results of cross-sectional profiling before and after the flow releases confirmed the overall stability of the sites; 29 of the 30 transect profiles showed little variation between measurement periods. Although shifts in channel features are inevitable and will continue to occur in the Eklutna River, to the extent the conditions as measured during the PHABSIM modeling remain generally the same (some shifts in mesohabitat types and amounts are expected) the model should continue to be a useful tool for evaluating flow release options. The 2D study sites included those susceptible to channel changes but their selection was more targeted on understanding the relationships of flow and habitat on juvenile rearing habitats in side-channel and off-channel areas outside of the main channel. The barrier analysis clearly focused on current conditions and as noted, the results could vary substantially if channel characteristics at the respective barriers changed.

6 VARIANCES FROM FINAL STUDY PLAN AND PROPOSED MODIFICATIONS

Section 3.1.4.4 of the Instream Flow Final Study Plan states, “In addition, a 1D HEC-RAS model will be developed for the entire length of the Eklutna River to develop stage/discharge rating curves at PHABSIM transects and also for estimating channel changes due to sediment transport as determined in the Geomorphology/Sediment Transport Study (Section 3.2).” Section 3.1.4.6 states in reference to the PHABSIM data analysis and modeling, “Stage-discharge relationships will be developed using the WSE model in the PHABSIM program. The MANSQ (channel geometry and roughness) option will be used to calculate WSE.” Slightly different methods than those outlined above were used to calculate the rating curve and WSEs used within PHABSIM.

As stated in Section 2.7.4 the 1D HEC-RAS model was calibrated to match conditions observed at the high flow condition. The results did not match the observed condition at the mid and low flow conditions. Separate hydraulic rating curves were developed for the PHABSIM model for each instream flow transect for flows ranging from 10 to 375 cfs to match the mid and low flow conditions. For flows less than the high flow, the rating curves were based on the STGQ method which uses a stage-discharge regression. For flows between the high flow and 375 cfs, the rating curve was based on the HEC-RAS 1D model. The two rating curves were merged to obtain a smooth transition over the range of flows modeled.

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Appendix 1: Instream Flow Transect Data – Eklutna River, Alaska

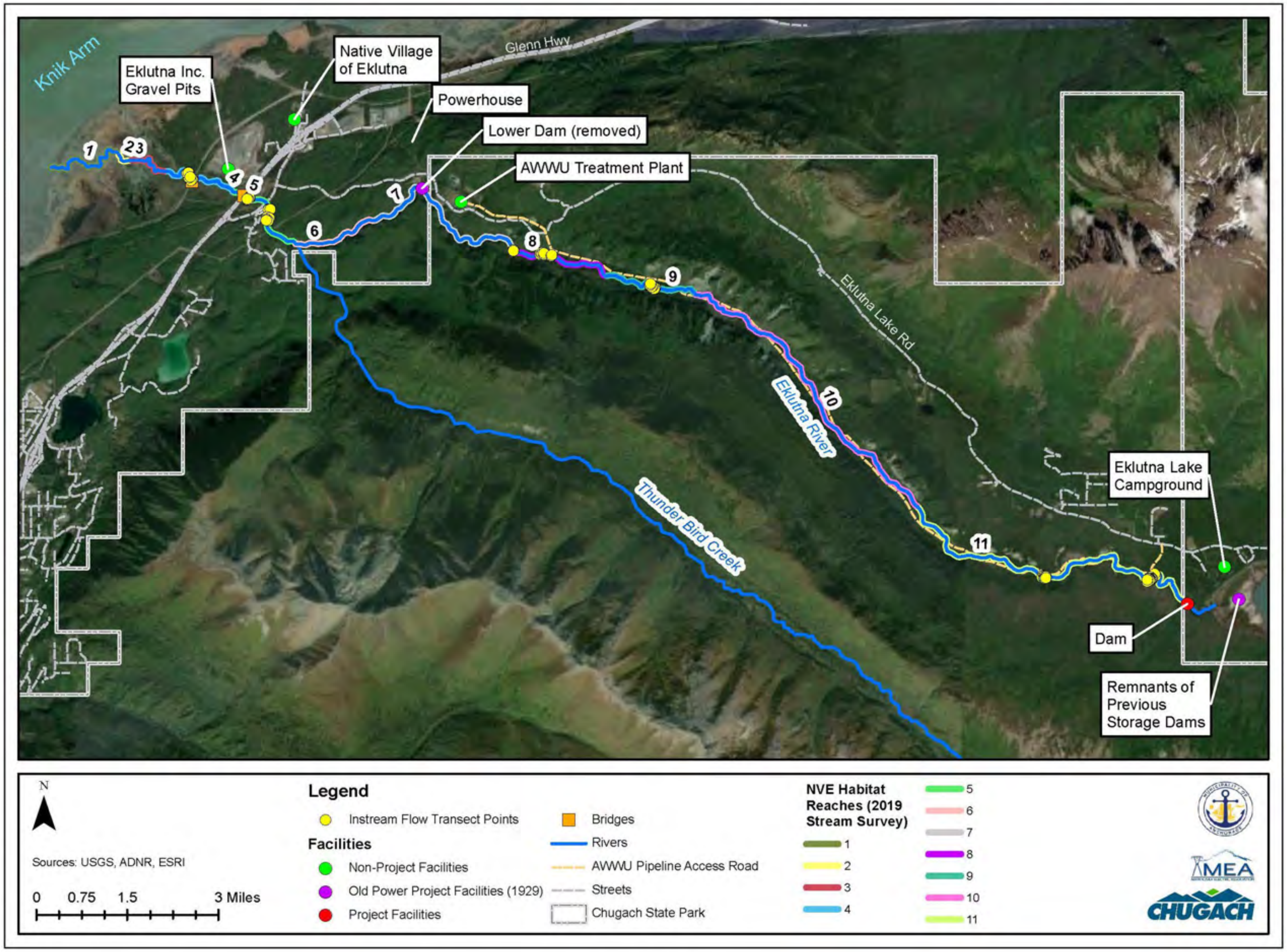


Figure A.1-1. Eklutna River, Alaska instream flow study area, fish habitat reaches, and sample sites.

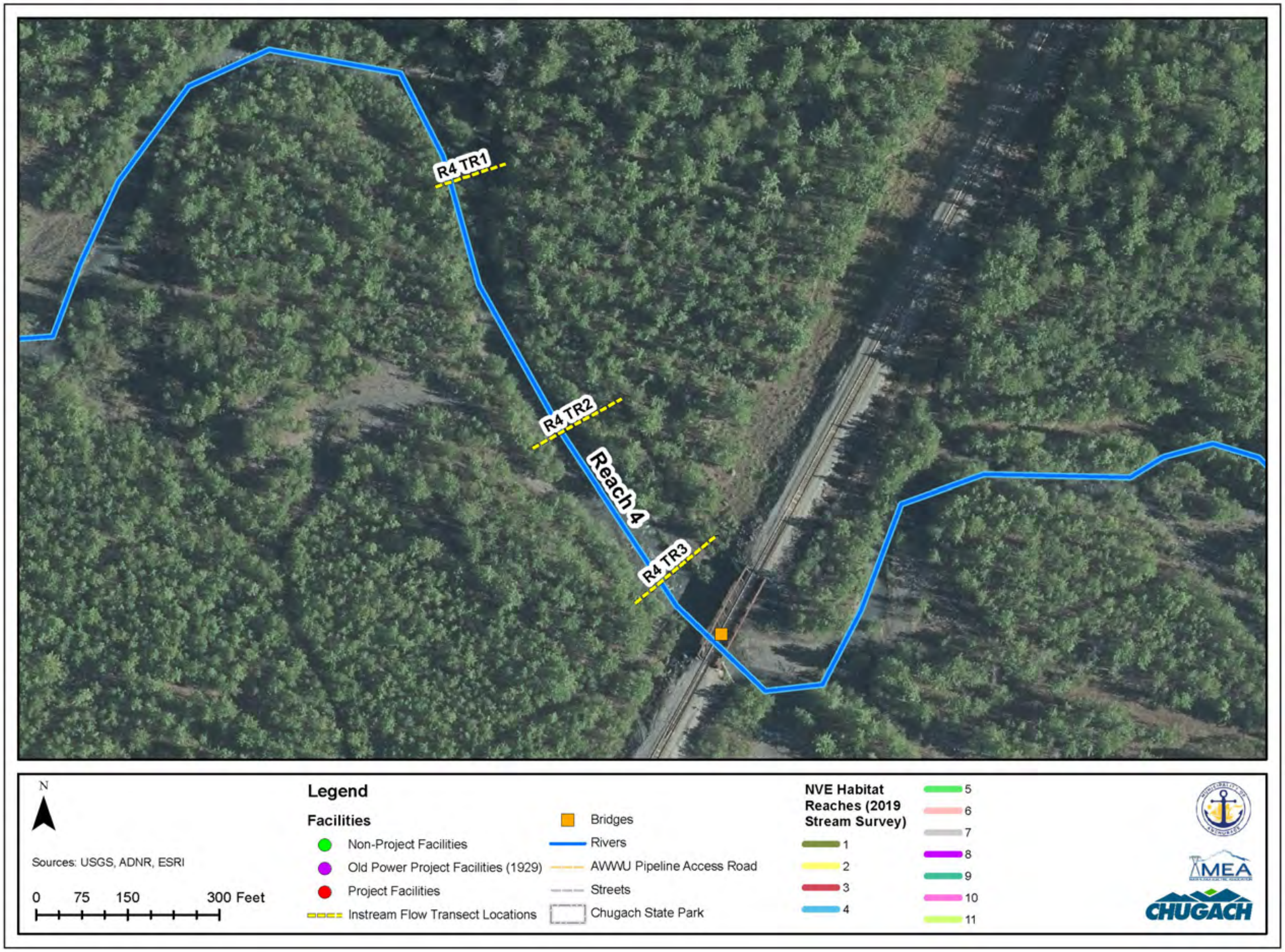
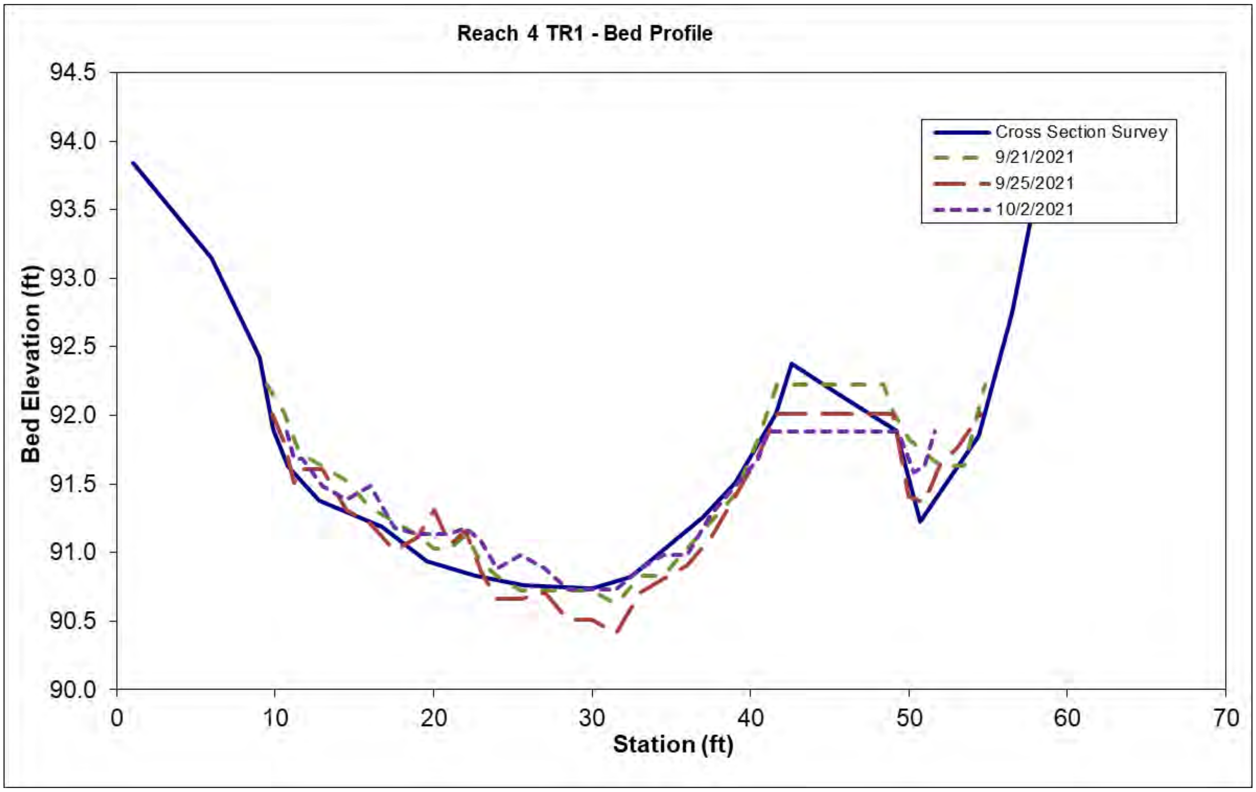


Figure A.1-2. Eklutna River, Alaska, Reach 4 transect location map (Transects 1-3).



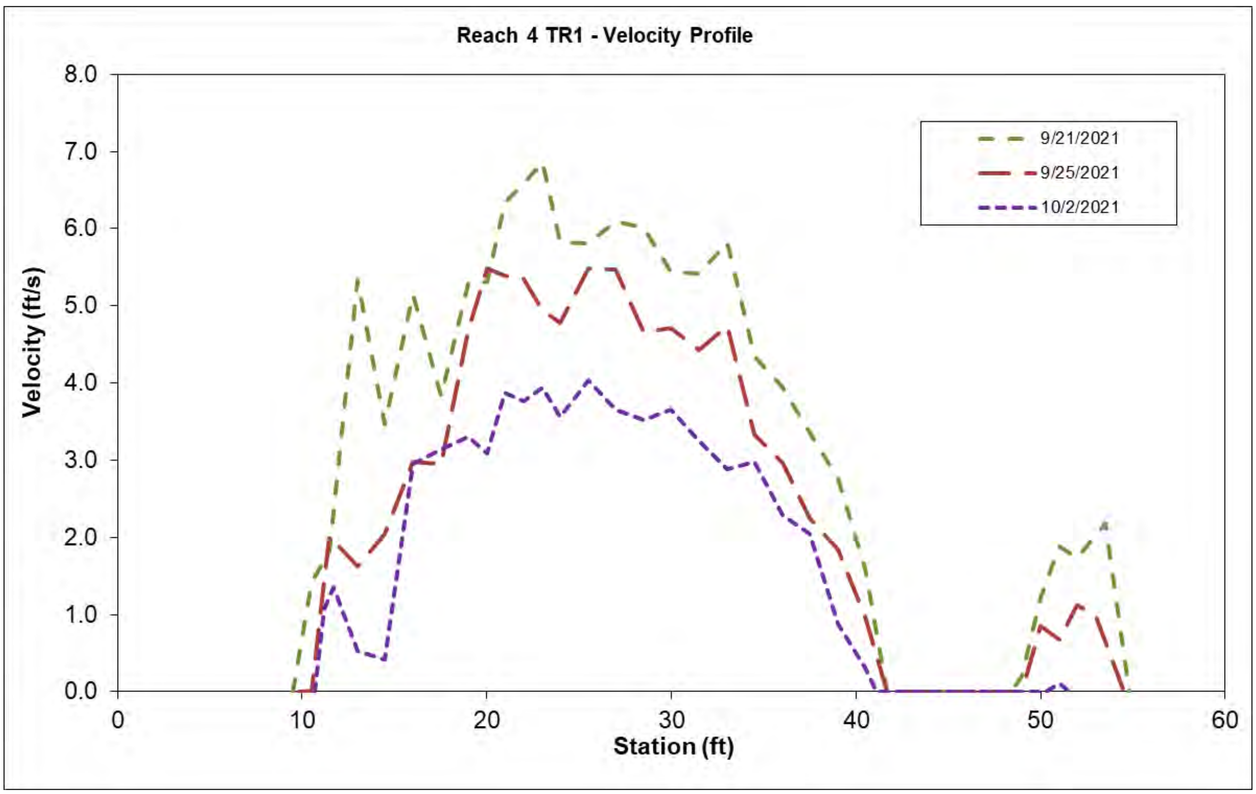
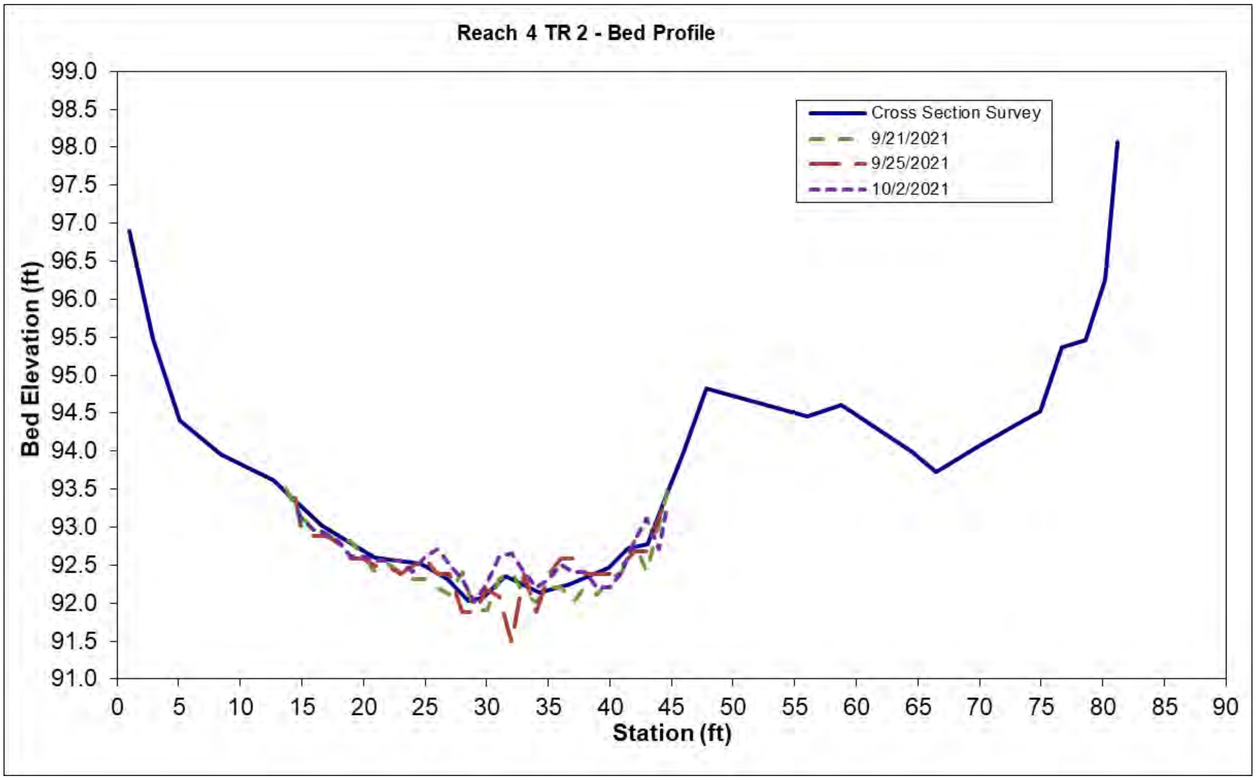


Figure A.1-3. Eklutna River, Alaska, Reach 4 Tr-1 bed profile (upper) and velocity profile (lower).

Figure A.1-4. Eklutna River, Alaska, Reach 4 Tr-1 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	(ft, RTK Datum)
1	93.84		0.0	74.27
6	93.15		5.0	73.58
9	92.42		8.0	72.85
9.9	91.90		8.9	72.33
10.8	91.63		9.8	72.06
12.8	91.38		11.8	71.81
16.7	91.19		15.7	71.62
19.6	90.94		18.6	71.37
22.7	90.83		21.7	71.26
25.7	90.76		24.7	71.19
30	90.74		29.0	71.17
32.4	90.82		31.4	71.25
37	91.26		36.0	71.69
39	91.51		38.0	71.94
41.6	92.01		40.6	72.44
42.6	92.38		41.6	72.81
45.4	92.16		44.4	72.59
49.2	91.89		48.2	72.32
50.7	91.23		49.7	71.66
54.4	91.85		53.4	72.28
56.5	92.75		55.5	73.18
58.9	94.12		57.9	74.55

Figure A.1-5. Eklutna River, Alaska, Reach 4 Tr-1 HEC-RAS survey data.



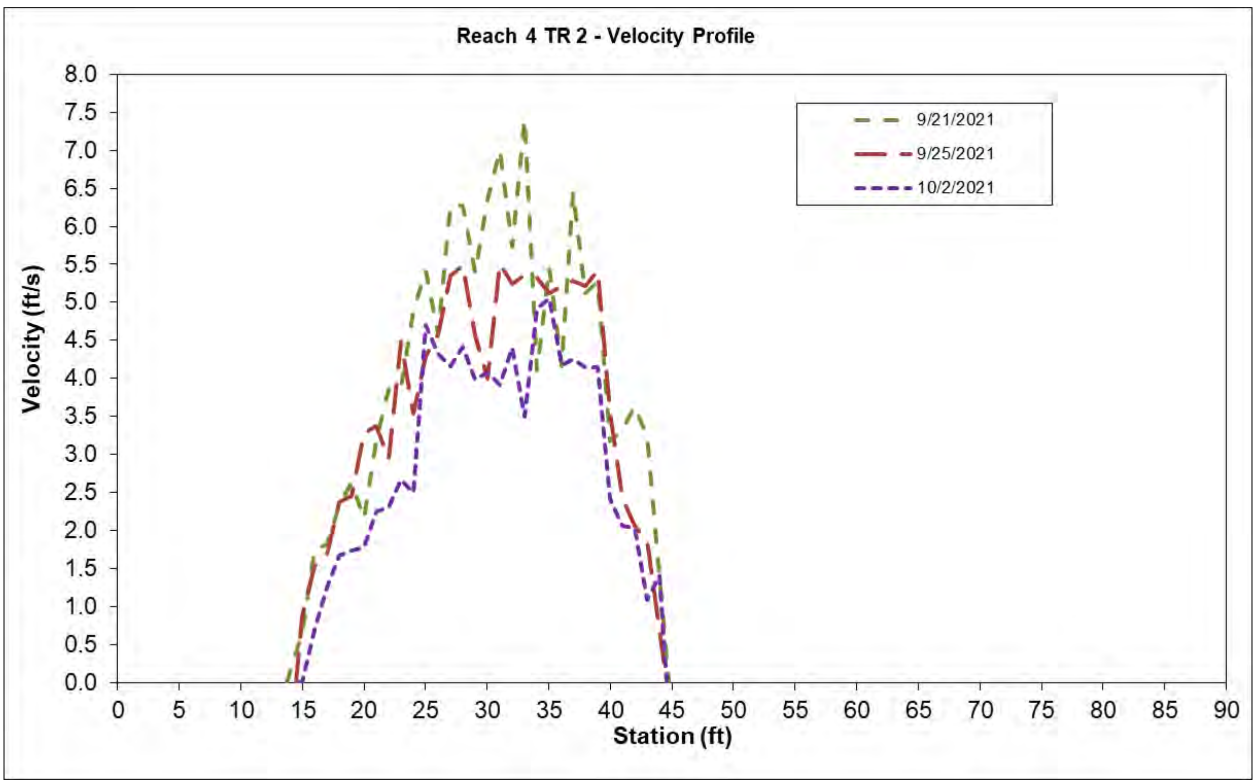
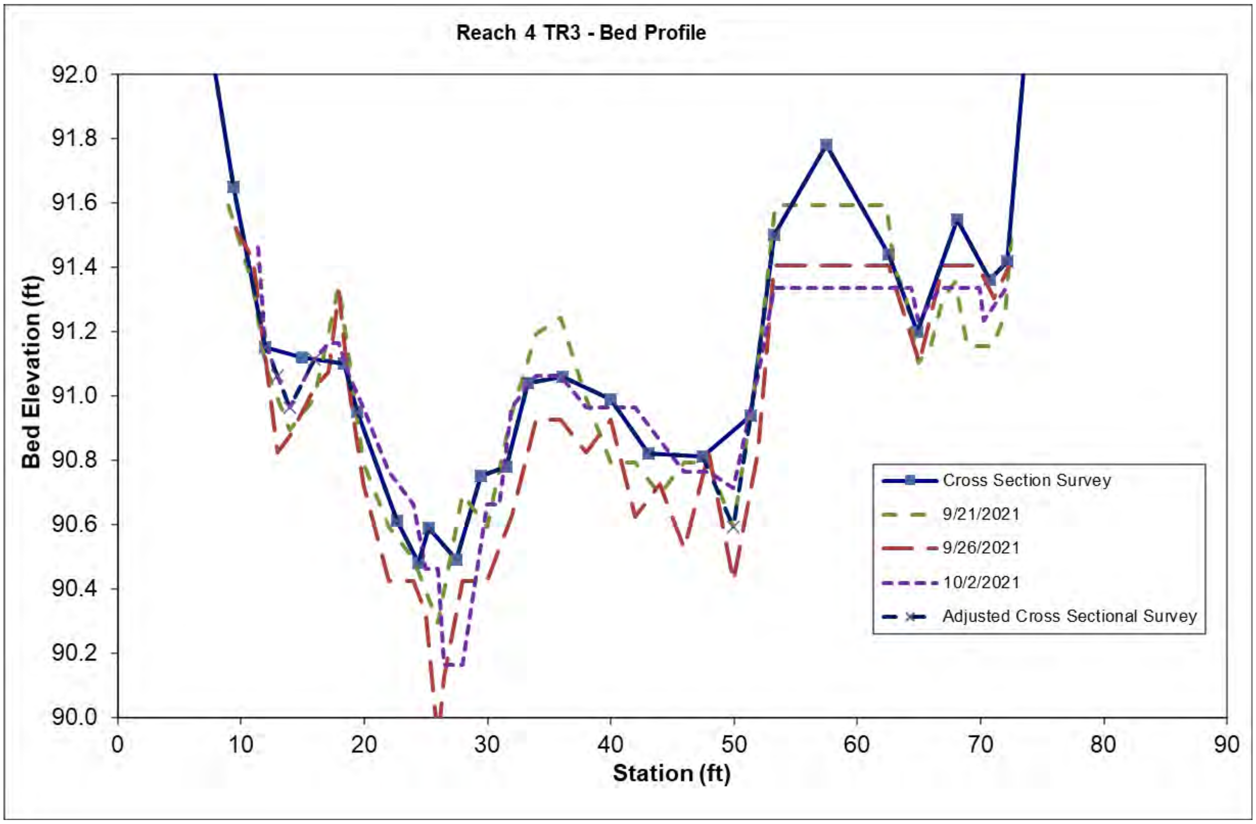


Figure A.1-6. Eklutna River, Alaska, Reach 4 Tr-2 bed profile (upper) and velocity profile (lower).

Figure A.1-7. Eklutna River, Alaska, Reach 4 Tr-2 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1.0	96.90		0.0	78.53
2.9	95.48		1.9	77.11
5.1	94.41		4.1	76.04
8.4	93.96		7.4	75.59
12.7	93.62		11.7	75.25
14.4	93.36		13.4	74.99
16.6	93.02		15.6	74.65
20.9	92.60		19.9	74.23
24.7	92.52		23.7	74.15
26.8	92.31		25.8	73.94
28.5	92.03		27.5	73.66
29.7	92.07		28.7	73.70
31.5	92.36		30.5	73.99
34.3	92.14		33.3	73.77
36.7	92.25		35.7	73.88
39.9	92.47		38.9	74.10
41.5	92.72		40.5	74.35
43.1	92.77		42.1	74.40
44.4	93.35		43.4	74.98
45.9	93.96		44.9	75.59
47.8	94.82		46.8	76.45
56.0	94.46		55.0	76.09
58.8	94.61		57.8	76.24
64.5	94.00		63.5	75.63
66.5	93.72		65.5	75.35
69.9	94.07		68.9	75.70
72.8	94.34		71.8	75.97
74.9	94.52		73.9	76.15
76.7	95.36		75.7	76.99
78.6	95.46		77.6	77.09
80.2	96.26		79.2	77.89
81.2	98.06		80.2	79.69

Figure A.1-8. Eklutna River, Alaska, Reach 4 Tr-2 HEC-RAS survey data.



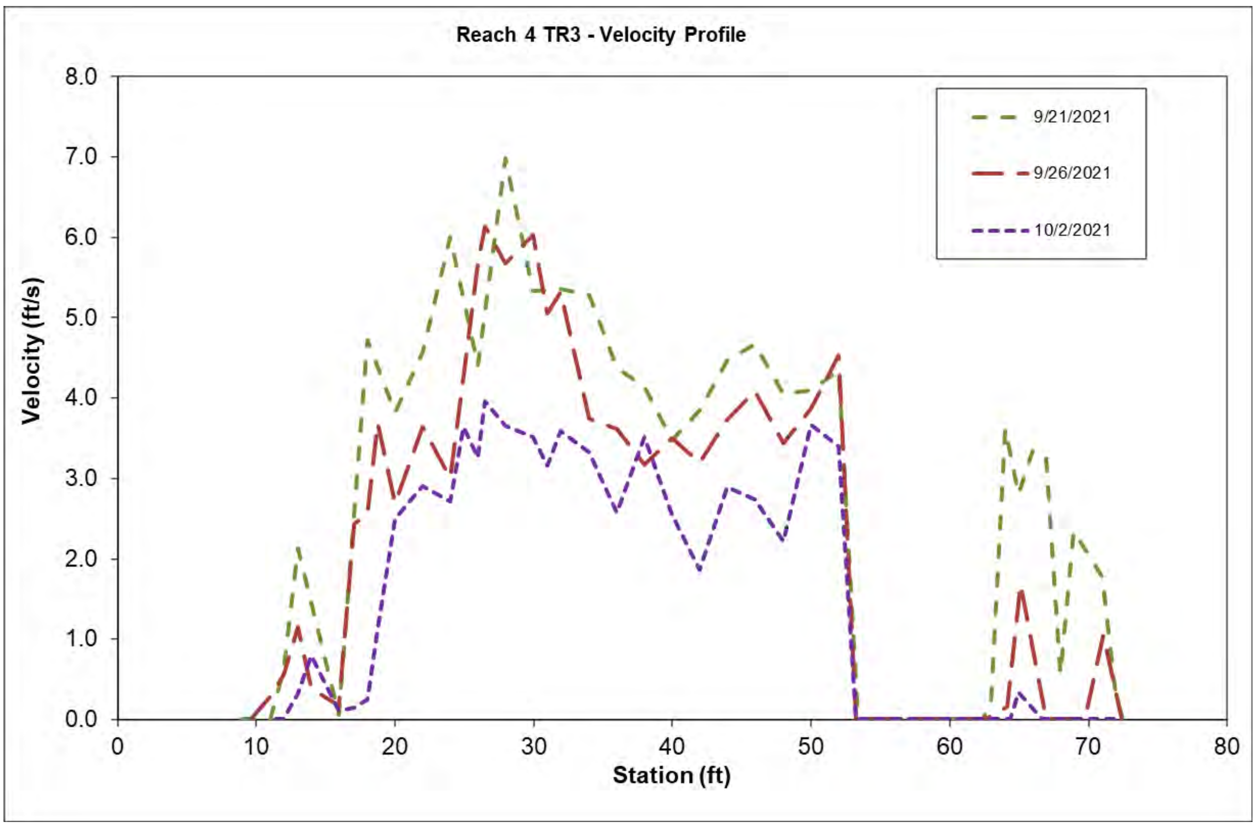


Figure A.1-9. Eklutna River, Alaska, Reach 4 Tr-3 bed profile (upper) and velocity profile (lower).

Figure A.1-10. Eklutna River, Alaska, Reach 4 Tr-3 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1.0	94.71		0.0	81.16
4.3	93.09		3.3	79.54
6.3	92.40		5.3	78.85
9.4	91.65		8.4	78.10
12.0	91.15		11.0	77.60
13.0	91.06		12.0	77.51
14.0	90.96		13.0	77.41
16.0	91.11		15.0	77.56
18.4	91.10		17.4	77.55
19.5	90.95		18.5	77.40
22.7	90.61		21.7	77.06
24.4	90.48		23.4	76.93
25.3	90.59		24.3	77.04
27.5	90.49		26.5	76.94
29.5	90.75		28.5	77.20
31.6	90.78		30.6	77.23
33.3	91.04		32.3	77.49
36.1	91.06		35.1	77.51
40.0	90.99		39.0	77.44
43.1	90.82		42.1	77.27
47.5	90.81		46.5	77.26
50.0	90.59		49.0	77.04
51.4	90.94		50.4	77.39
53.3	91.50		52.3	77.95
57.5	91.78		56.5	78.23
62.6	91.44		61.6	77.89
64.9	91.20		63.9	77.65
68.1	91.55		67.1	78.00
70.8	91.36		69.8	77.81
72.2	91.42		71.2	77.87
73.6	92.05		72.6	78.50
79.0	92.19		78.0	78.64
81.7	93.85		80.7	80.30
83.9	94.80		82.9	81.25

Figure A.1-11. Eklutna River, Alaska, Reach 4 Tr-3 HEC-RAS survey data.

Figure A.1-12. Eklutna River, Alaska, Reach 5 transect location map (Transects 1-2).

Figure A.1-13. Eklutna River, Alaska, Reach 5 transect location map (Transect 3).

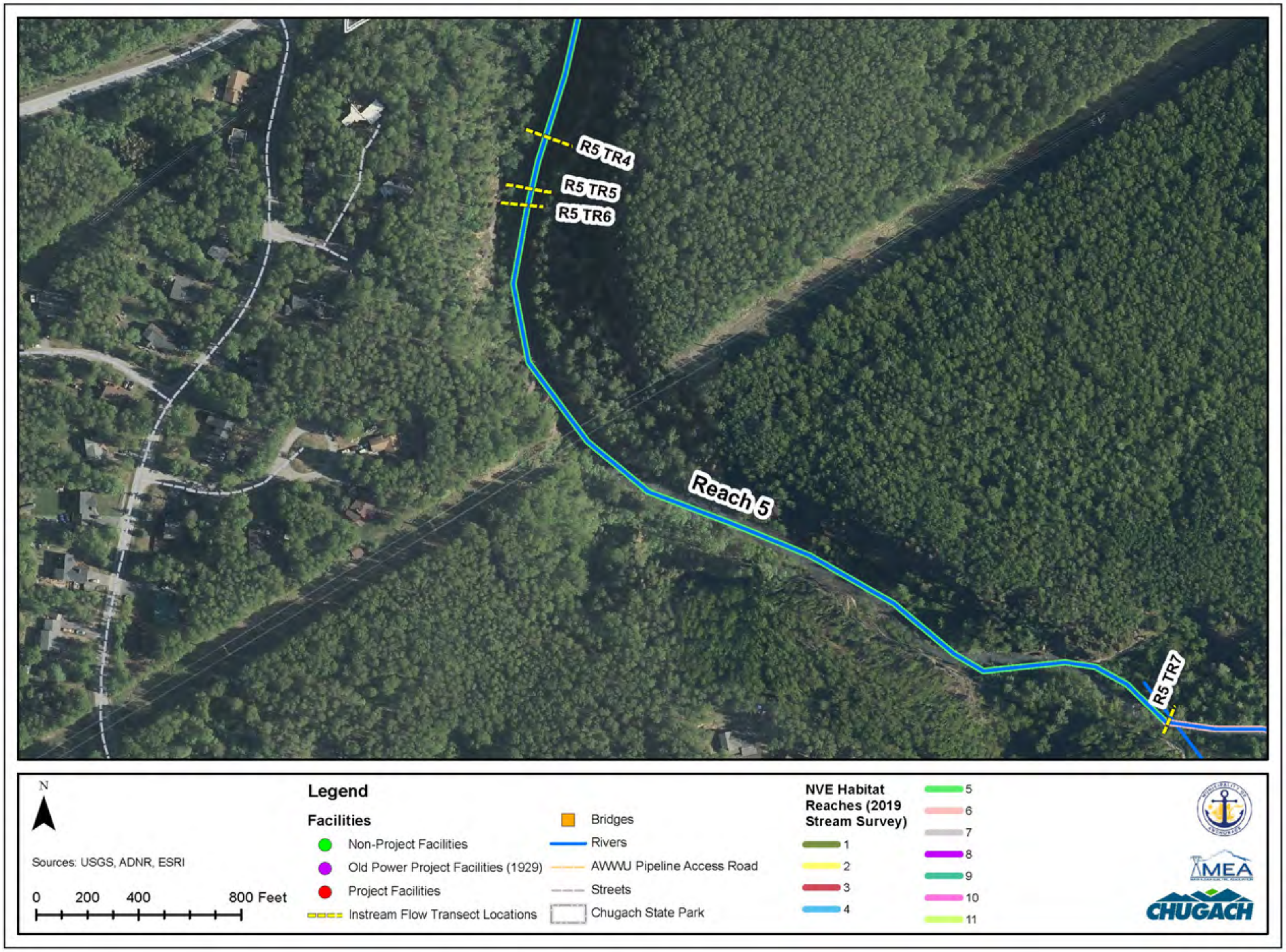
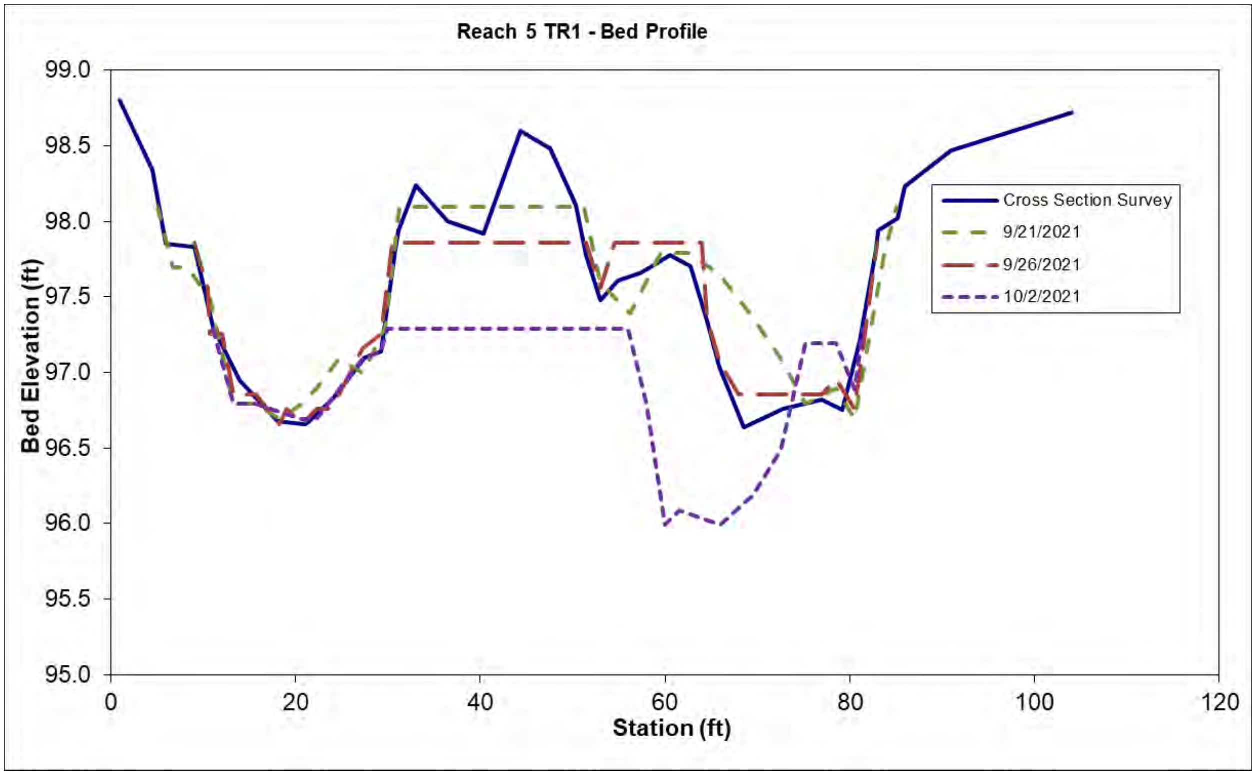


Figure A.1-14. Eklutna River, Alaska, Reach 5 transect location map (Transects 4-7).



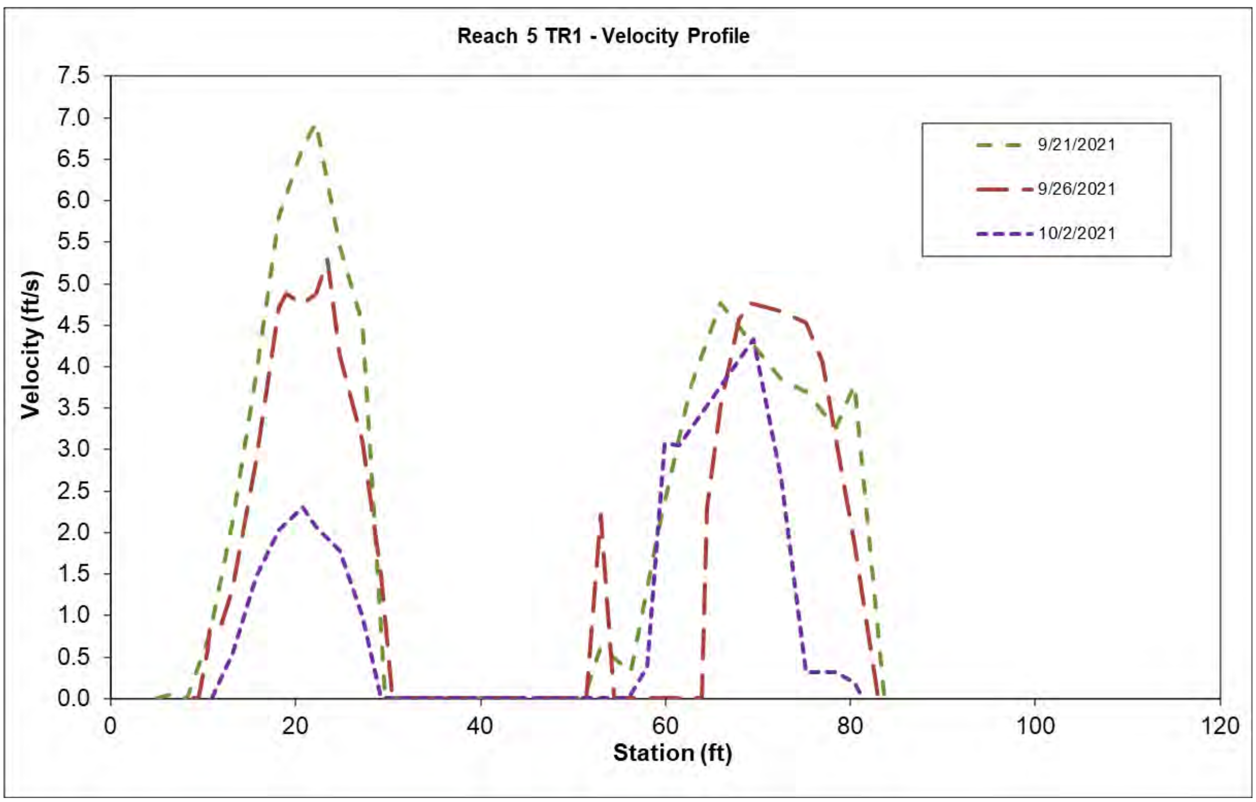


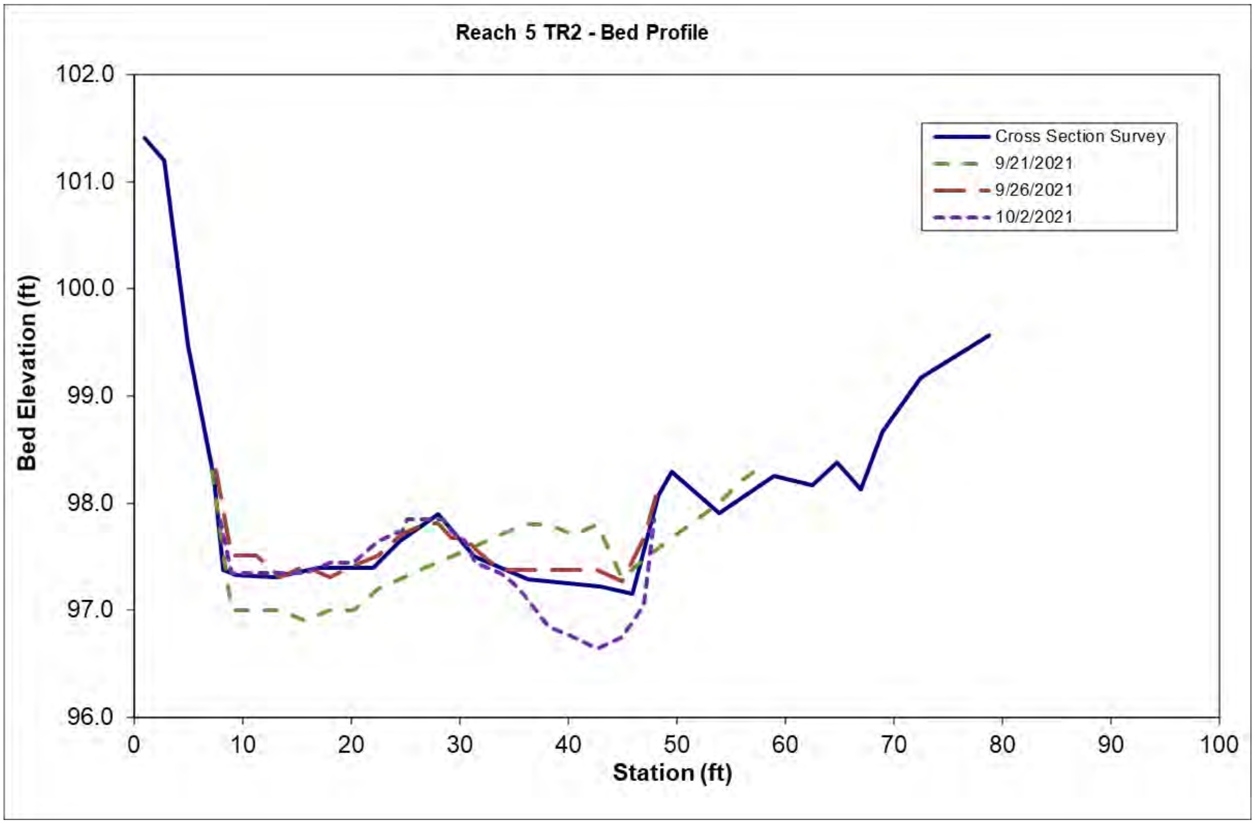
Figure A.1-15. Eklutna River, Alaska, Reach 5 Tr-1 bed profile (upper) and velocity profile (lower).

Figure A.1-16. Eklutna River, Alaska, Reach 5 Tr-1 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	98.80		0	112.81
4.5	98.34		3.5	112.35
6	97.85		5	111.86
9.1	97.83		8.1	111.84
11	97.30		10	111.31
13.9	96.95		12.9	110.96
18	96.68		17	110.69
21	96.66		20	110.67
21.5	96.68		20.5	110.69
24	96.83		23	110.84
27.5	97.10		26.5	111.11
29.2	97.14		28.2	111.15
30.8	97.82		29.8	111.83
31.1	97.94		30.1	111.95
33	98.24		32	112.25
36.5	98.00		35.5	112.01
40.4	97.92		39.4	111.93
44.3	98.60		43.3	112.61
47.6	98.48		46.6	112.49
50.3	98.11		49.3	112.12
51.5	97.78		50.5	111.79
53	97.48		52	111.49
54.9	97.61		53.9	111.62
57.4	97.66		56.4	111.67
60.5	97.78		59.5	111.79
62.8	97.70		61.8	111.71
64.5	97.34		63.5	111.35
65.9	97.04		64.9	111.05
68.5	96.64		67.5	110.65
72.7	96.76		71.7	110.77
77	96.82		76	110.83
79.2	96.75		78.2	110.76
81.1	97.21		80.1	111.22
82.8	97.82		81.8	111.83
83.1	97.94		82.1	111.95
85.2	98.02		84.2	112.03
86	98.23		85	112.24
91	98.47		90	112.48
104	98.72		103	112.73

Figure A.1-17. Eklutna River, Alaska, Reach 5 Tr-1 HEC-RAS survey data.



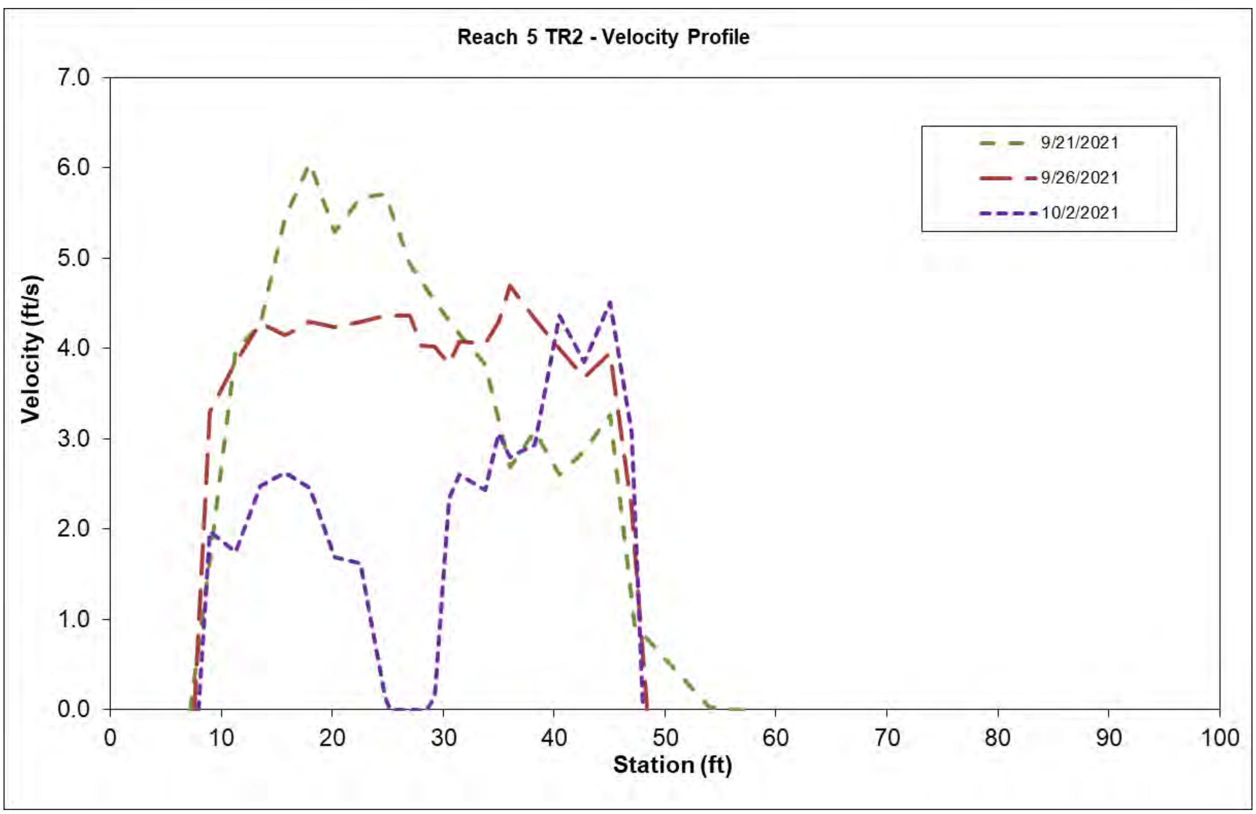


Figure A.1-18. Eklutna River, Alaska, Reach 5 Tr-2 bed profile (upper) and velocity profile (lower).

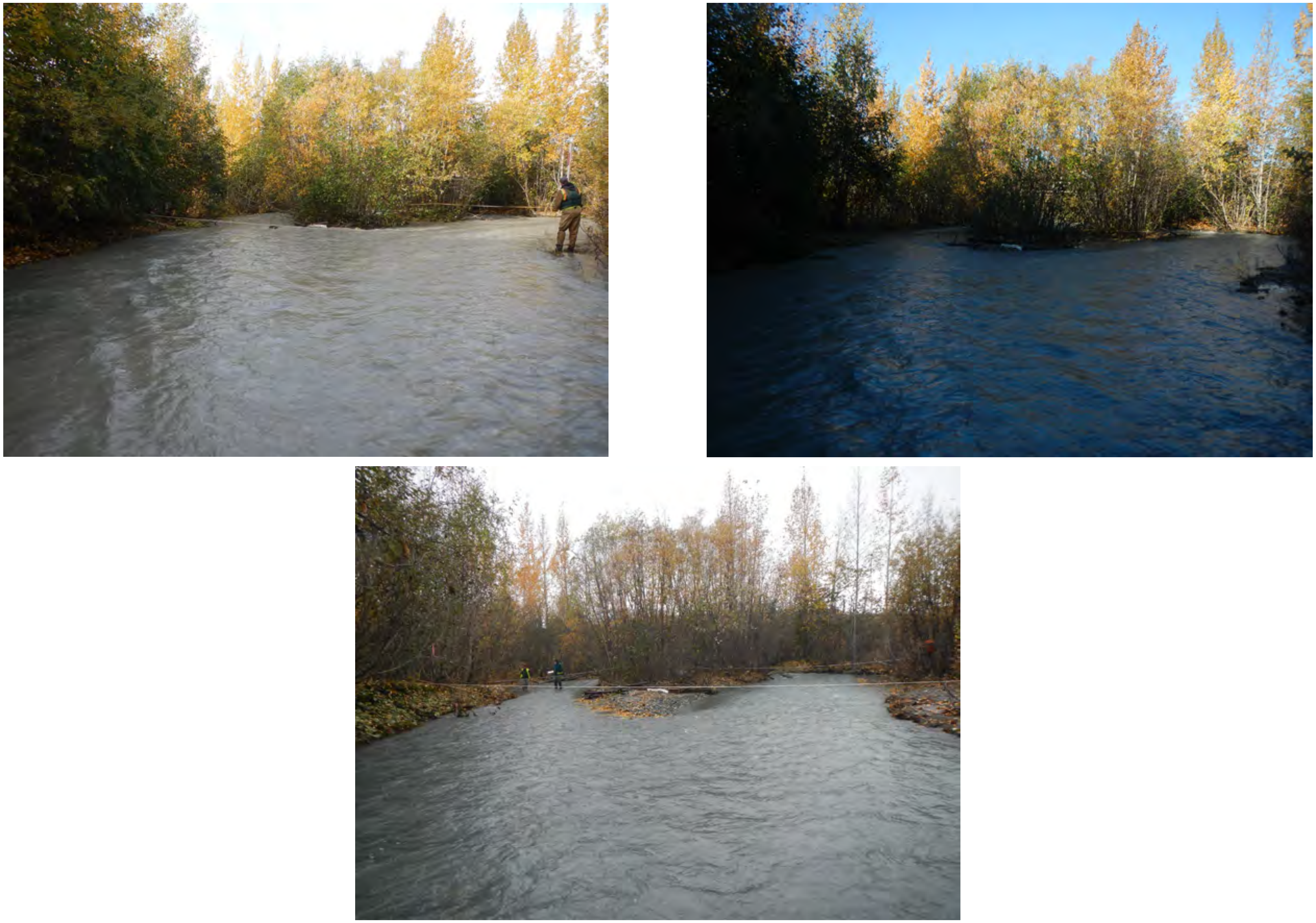
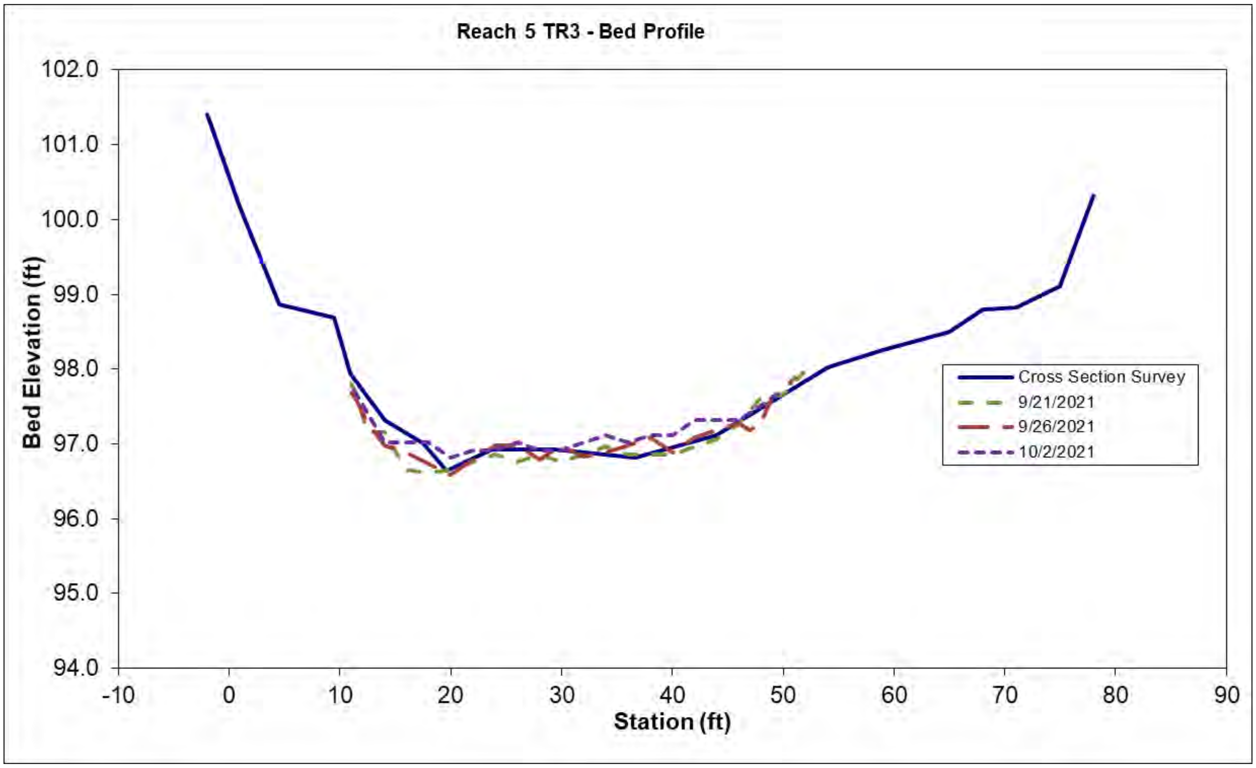


Figure A.1-19. Eklutna River, Alaska, Reach 5 Tr-2 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	101.41		0	115.37
2.8	101.19		1.8	115.15
5	99.47		4	113.43
7.4	98.23		6.4	112.19
8.2	97.37		7.2	111.33
9.5	97.33		8.5	111.29
13	97.31		12	111.27
17	97.39		16	111.35
22	97.39		21	111.35
24.5	97.64		23.5	111.60
28	97.89		27	111.85
31.4	97.50		30.4	111.46
36.3	97.29		35.3	111.25
43	97.22		42	111.18
46	97.15		45	111.11
48.3	98.07		47.3	112.03
49.6	98.29		48.6	112.25
54	97.90		53	111.86
59	98.25		58	112.21
62.5	98.16		61.5	112.12
64.8	98.38		63.8	112.34
67	98.13		66	112.09
69	98.67		68	112.63
72.5	99.17		71.5	113.13
78.8	99.56		77.8	113.52

Figure A.1-20. Eklutna River, Alaska, Reach 5 Tr-2 HEC-RAS survey data.



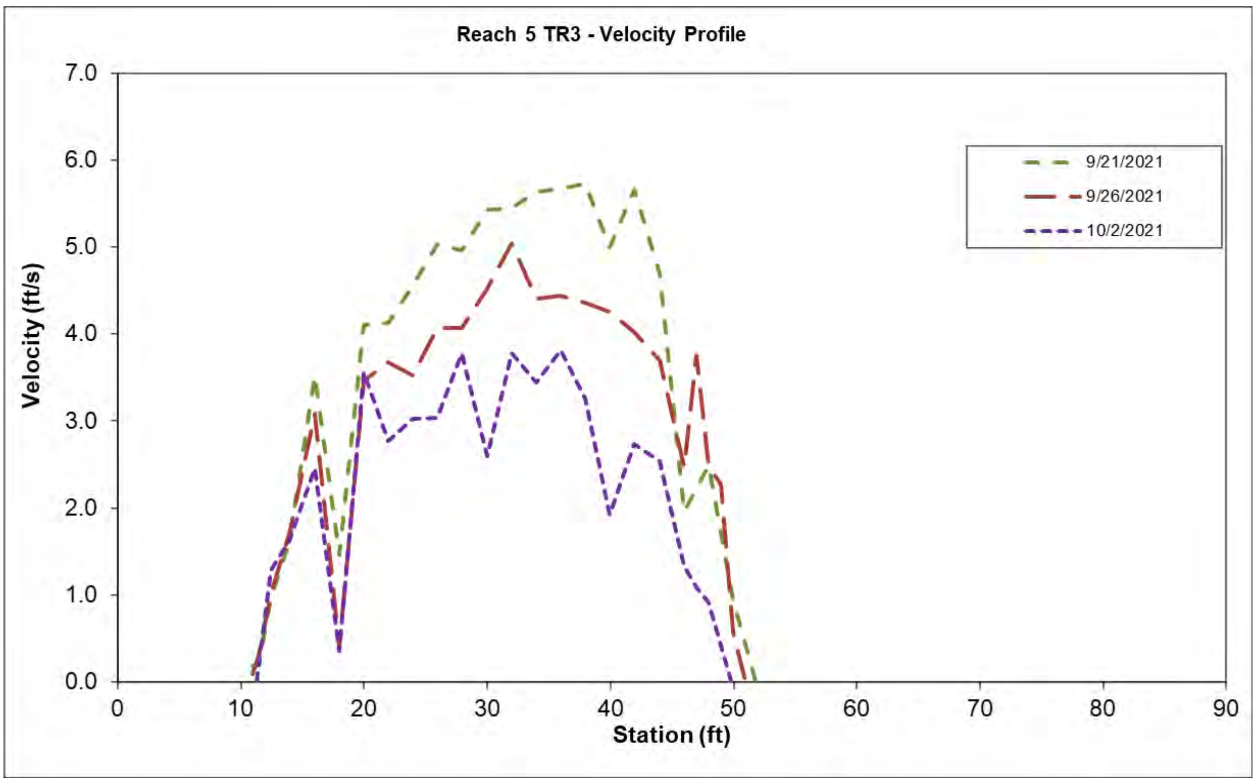
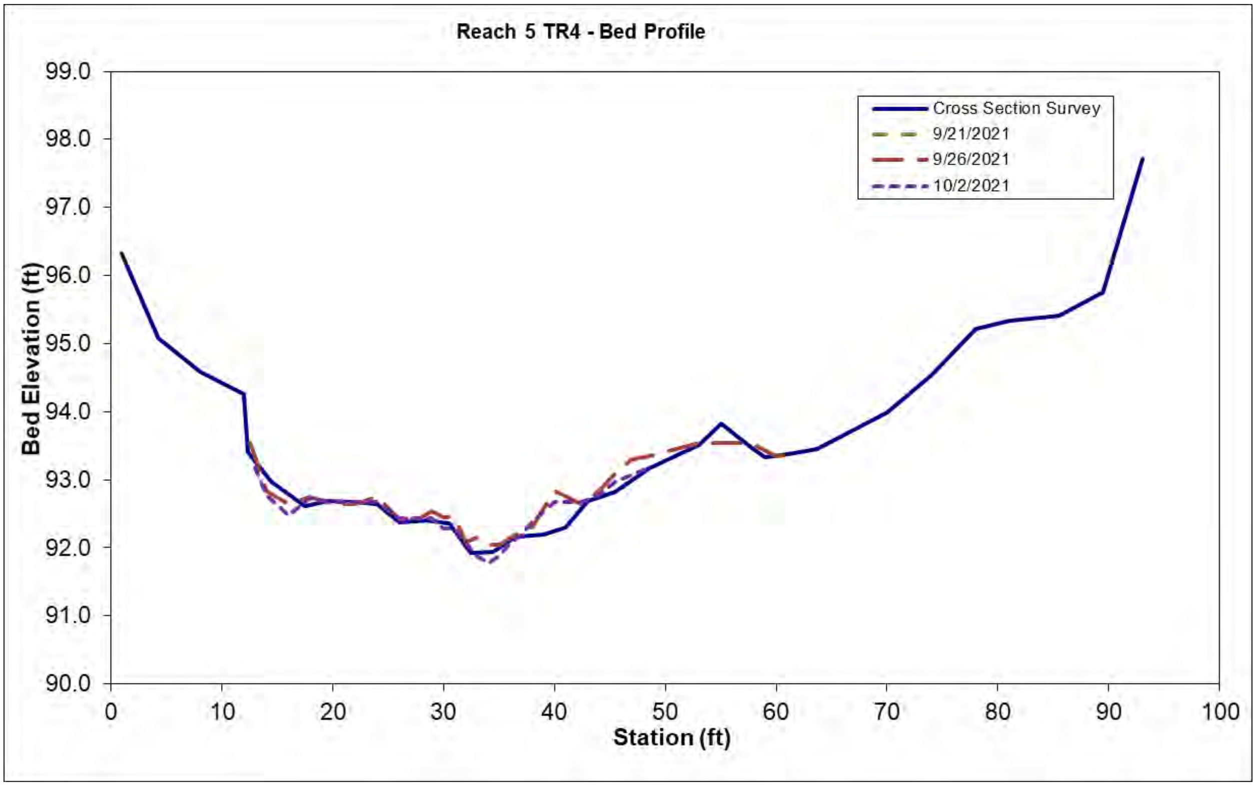


Figure A.1-21. Eklutna River, Alaska, Reach 5 Tr-3 bed profile (upper) and velocity profile (lower).

Figure A.1-22. Eklutna River, Alaska, Reach 5 Tr-3 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
-2	101.40		-3	128.43
1	100.17		0	100.17
4.5	98.86		3.5	98.86
9.5	98.69		8.5	98.69
10.9	97.94		9.9	97.94
14	97.32		13	97.32
17.5	97.01		16.5	97.01
19.6	96.64		18.6	96.64
21.5	96.78		20.5	96.78
23.7	96.92		22.7	96.92
29.5	96.92		28.5	96.92
36.6	96.82		35.6	96.82
44	97.11		43	97.11
50.7	97.73		49.7	97.73
54	98.02		53	98.02
59	98.26		58	98.26
65	98.50		64	98.50
68	98.80		67	98.80
71	98.82		70	98.82
75	99.11		74	99.11
78	100.31		77	100.31

Figure A.1-23. Eklutna River, Alaska, Reach 5 Tr-3 HEC-RAS survey data.



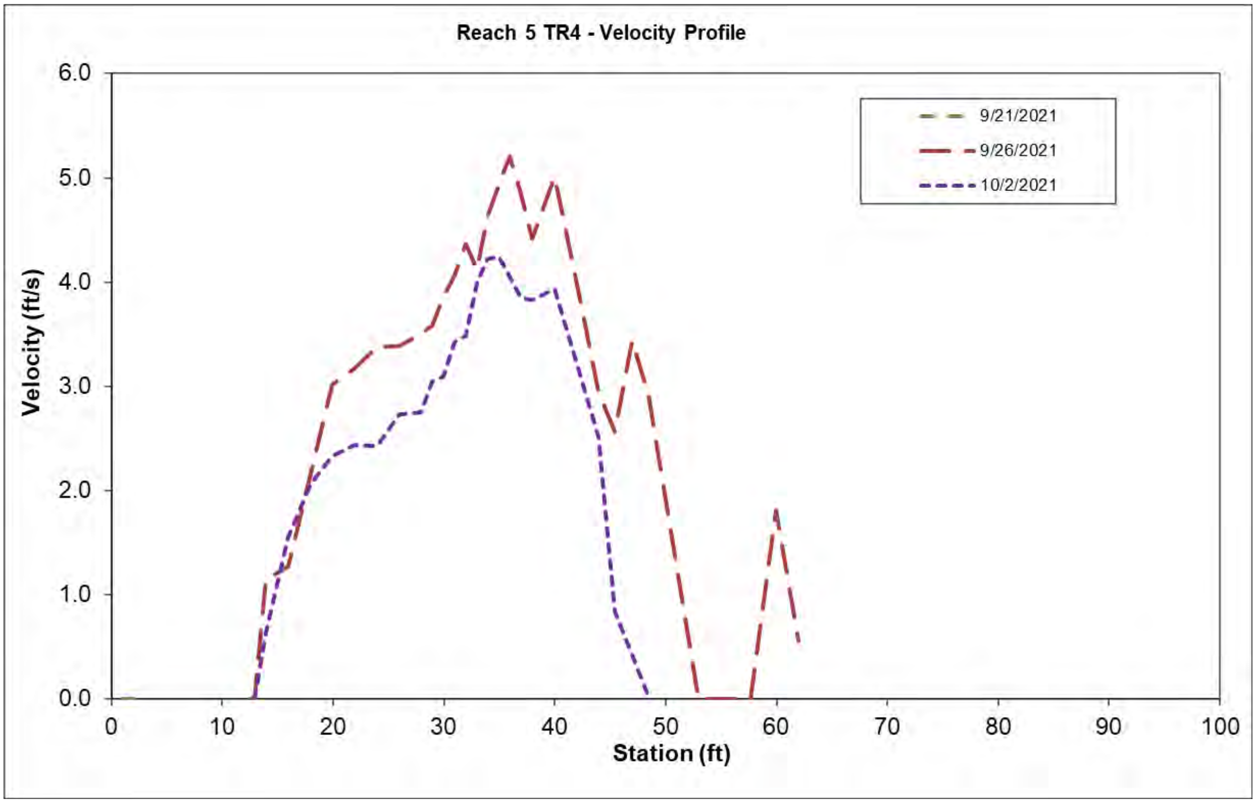


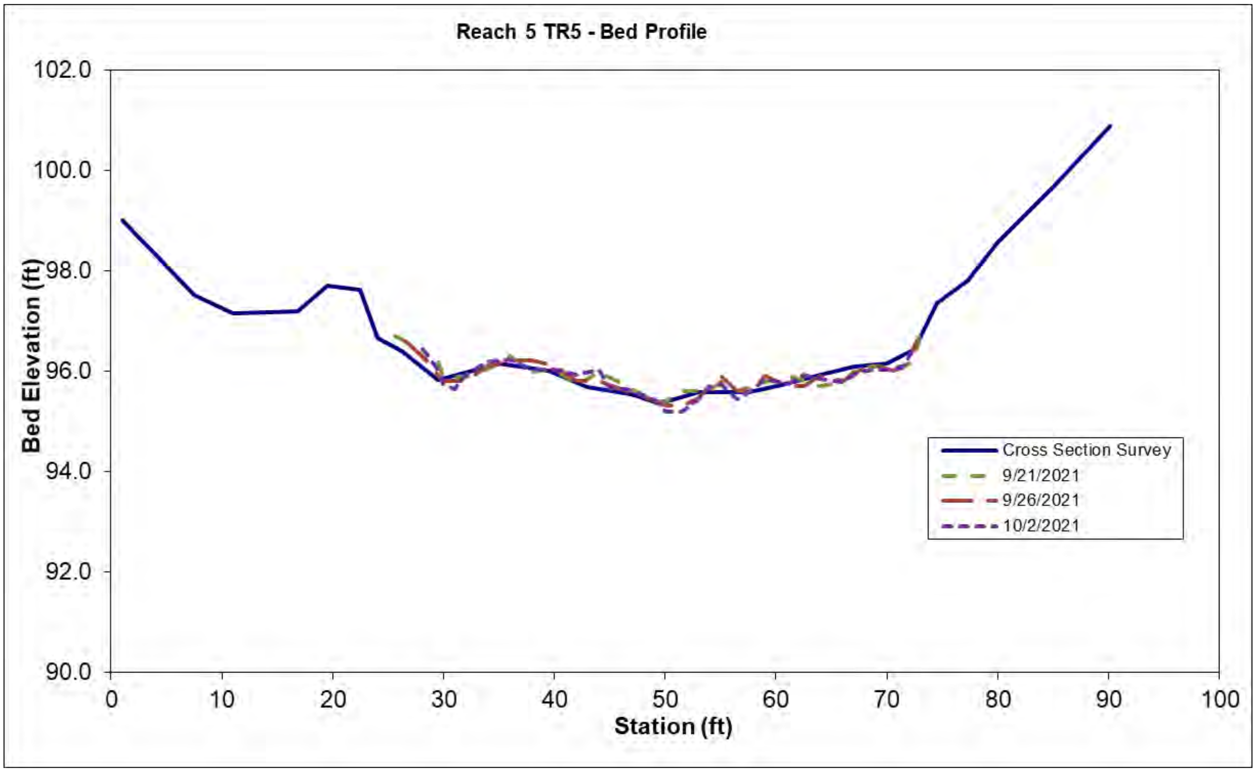
Figure A.1-24. Eklutna River, Alaska, Reach 5 Tr-4 bed profile (upper) and velocity profile (lower).

Figure A.1-25. Eklutna River, Alaska, Reach 5 Tr-4 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	96.33		0	131.48
4.3	95.08		3.3	130.23
8	94.58		7	129.73
12	94.26		11	129.41
12.4	93.41		11.4	128.56
14.5	92.97		13.5	128.12
17.5	92.61		16.5	127.76
19.5	92.69		18.5	127.84
22	92.67		21	127.82
24	92.64		23	127.79
26	92.37		25	127.52
28.5	92.40		27.5	127.55
30.5	92.36		29.5	127.51
32.5	91.93		31.5	127.08
34.5	91.94		33.5	127.09
36.5	92.17		35.5	127.32
39	92.19		38	127.34
41	92.30		40	127.45
43	92.69		42	127.84
45.5	92.82		44.5	127.97
48.5	93.17		47.5	128.32
53	93.51		52	128.66
55	93.83		54	128.98
57.7	93.48		56.7	128.63
59	93.33		58	128.48
61	93.38		60	128.53
63.7	93.45		62.7	128.60
70	93.99		69	129.14
74	94.54		73	129.69
78	95.22		77	130.37
81	95.33		80	130.48
85.5	95.41		84.5	130.56
89.5	95.76		88.5	130.91
93	97.71		92	132.86

Figure A.1-26. Eklutna River, Alaska, Reach 5 Tr-4 HEC-RAS survey data.



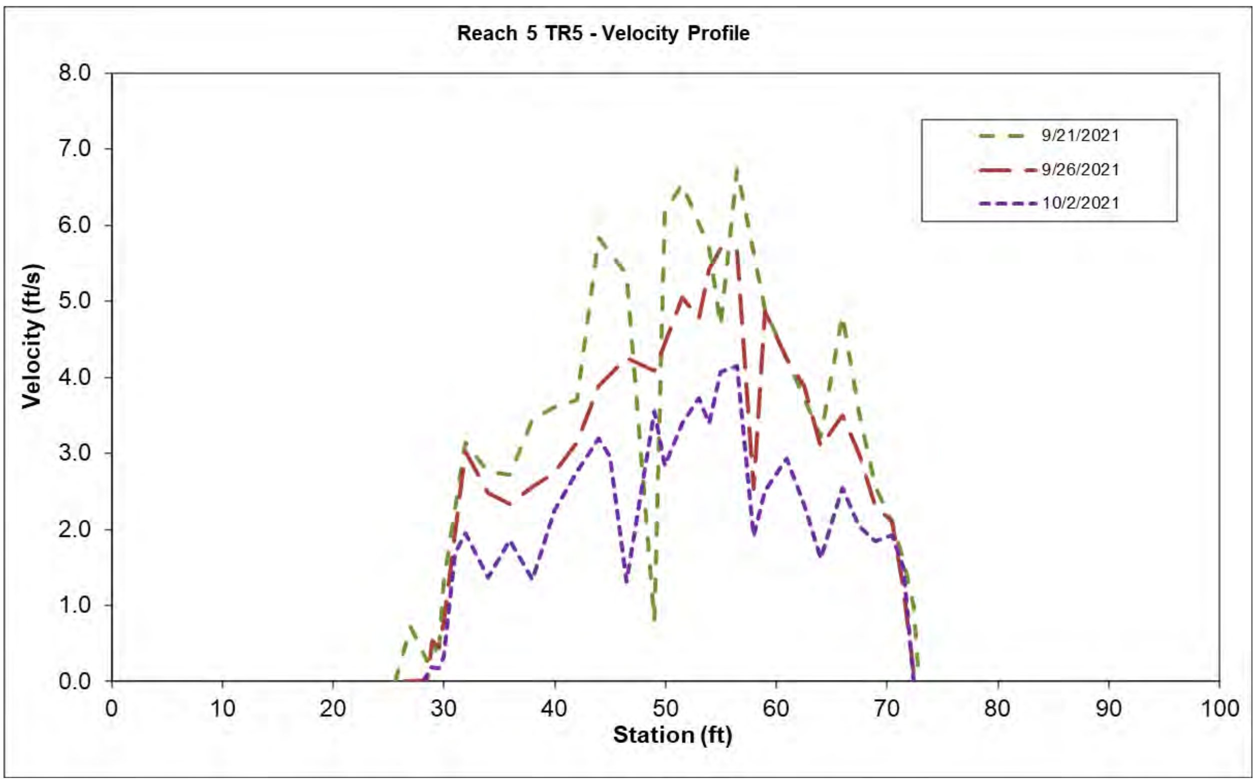
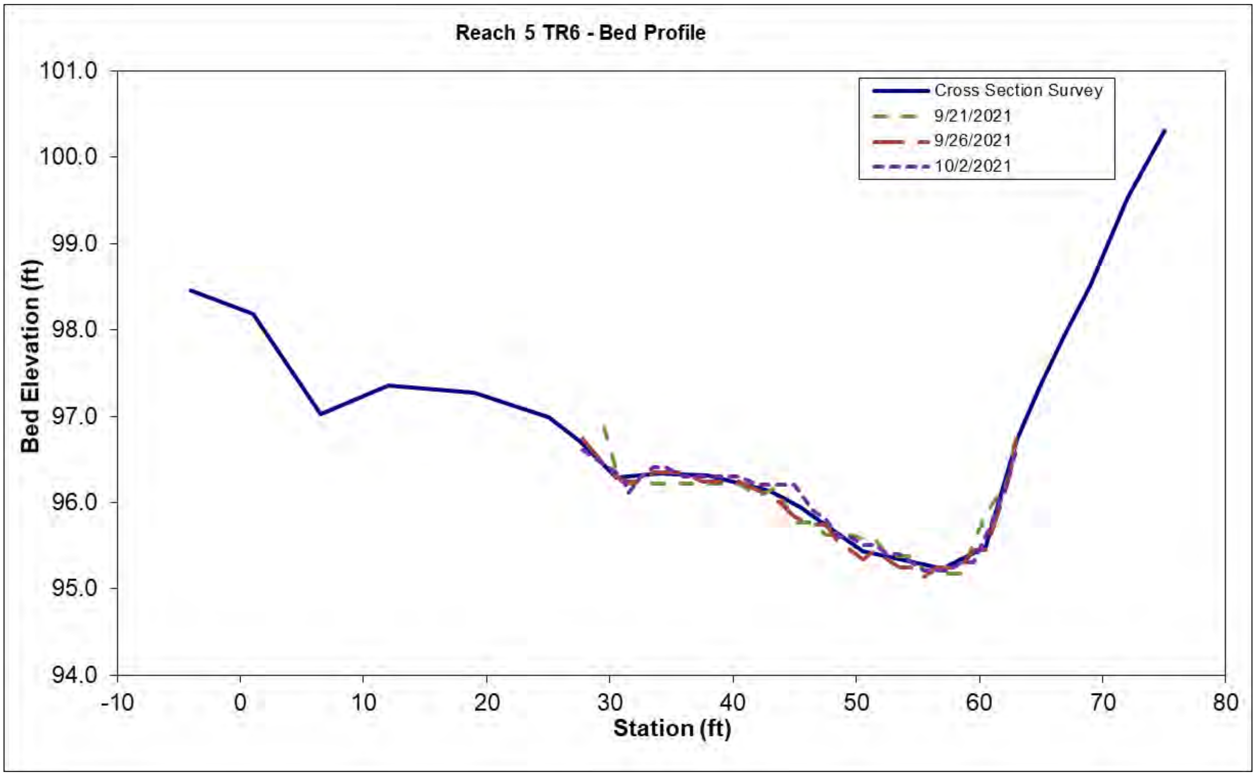


Figure A.1-27. Eklutna River, Alaska, Reach 5 Tr-5 bed profile (upper) and velocity profile (lower).

Figure A.1-28. Eklutna River, Alaska, Reach 5 Tr-5 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	99.01		0	132.89
7.5	97.53		6.5	131.41
11	97.15		10	131.03
16.8	97.19		15.8	131.07
19.5	97.71		18.5	131.59
22.5	97.62		21.5	131.50
24	96.67		23	130.55
26.3	96.41		25.3	130.29
29.5	95.83		28.5	129.71
35	96.15		34	130.03
39.5	96.01		38.5	129.89
43	95.68		42	129.56
47	95.54		46	129.42
49.5	95.37		48.5	129.25
53	95.59		52	129.47
57.5	95.58		56.5	129.46
60.5	95.73		59.5	129.61
64	95.94		63	129.82
67	96.10		66	129.98
70	96.15		69	130.03
72.5	96.44		71.5	130.32
74.5	97.37		73.5	131.25
77.3	97.82		76.3	131.70
80	98.57		79	132.45
85	99.67		84	133.55
90.1	100.89		89.1	134.77

Figure A.1-29. Eklutna River, Alaska, Reach 5 Tr-5 HEC-RAS survey data.



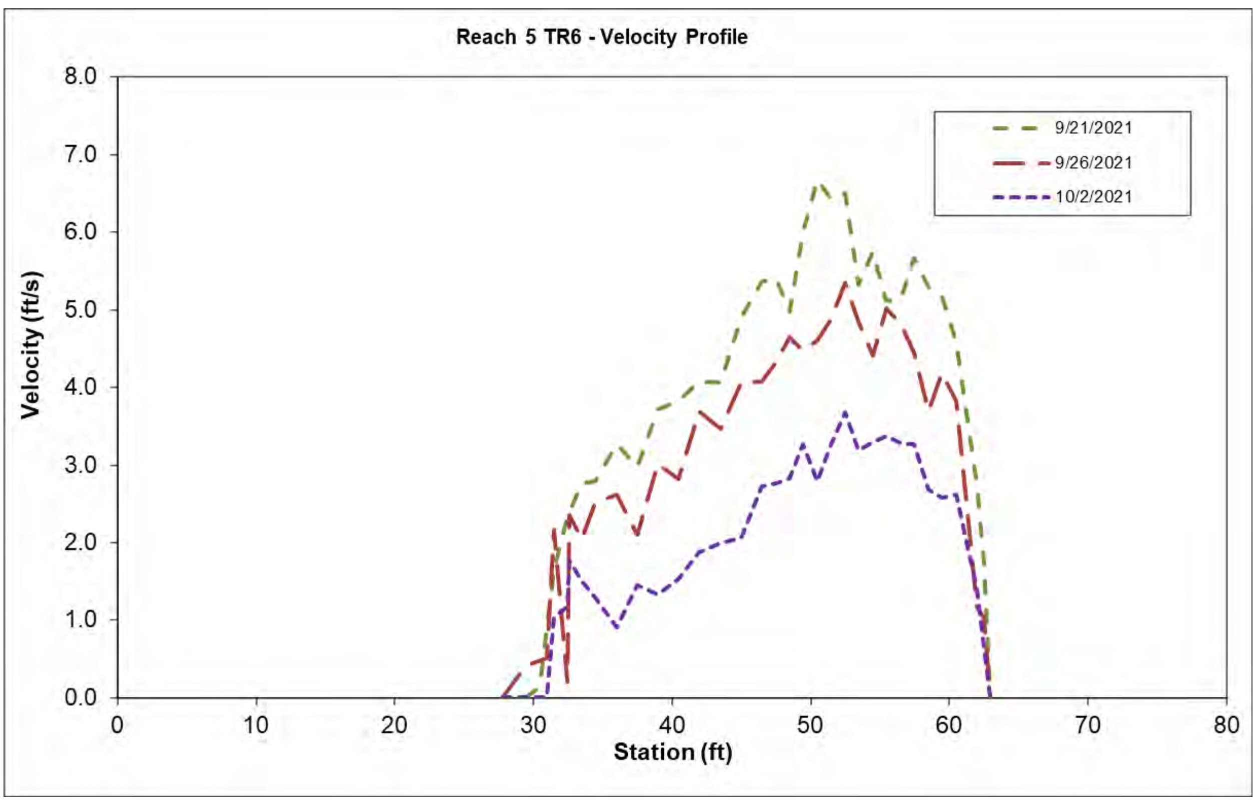
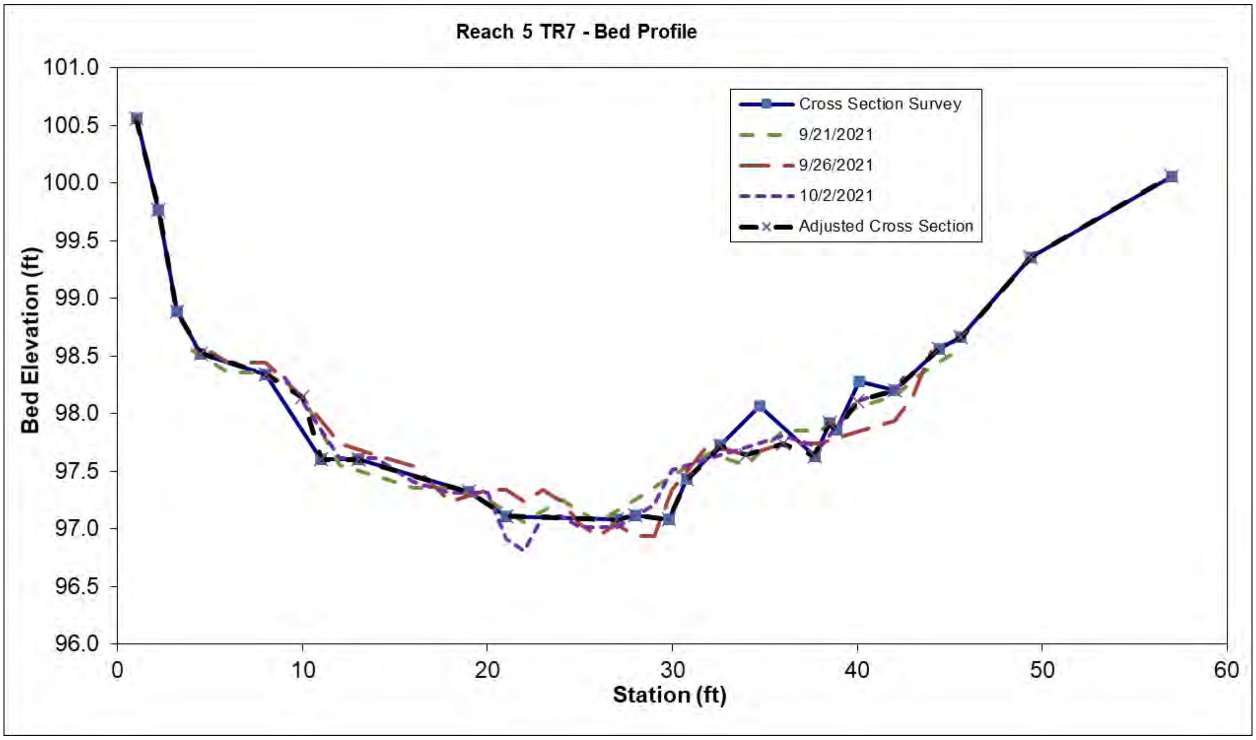


Figure A.1-30. Eklutna River, Alaska, Reach 5 Tr-6 bed profile (upper) and velocity profile (lower).

Figure A.1-31. Eklutna River, Alaska, Reach 5 Tr-6 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
-4	98.46		-5	132.34
1	98.19		0	132.07
6.5	97.02		5.5	130.90
12	97.36		11	131.24
19	97.27		18	131.15
25	96.99		24	130.87
27.6	96.70		26.6	130.58
30.5	96.29		29.5	130.17
34	96.34		33	130.22
38	96.31		37	130.19
43	96.13		42	130.01
45.5	95.95		44.5	129.83
48	95.69		47	129.57
50.5	95.44		49.5	129.32
57	95.24		56	129.12
60.5	95.48		59.5	129.36
63.1	96.74		62.1	130.62
65	97.37		64	131.25
67	97.96		66	131.84
69	98.50		68	132.38
72	99.53		71	133.41
75	100.30		74	134.18

Figure A.1-32. Eklutna River, Alaska, Reach 5 Tr-6 HEC-RAS survey data.



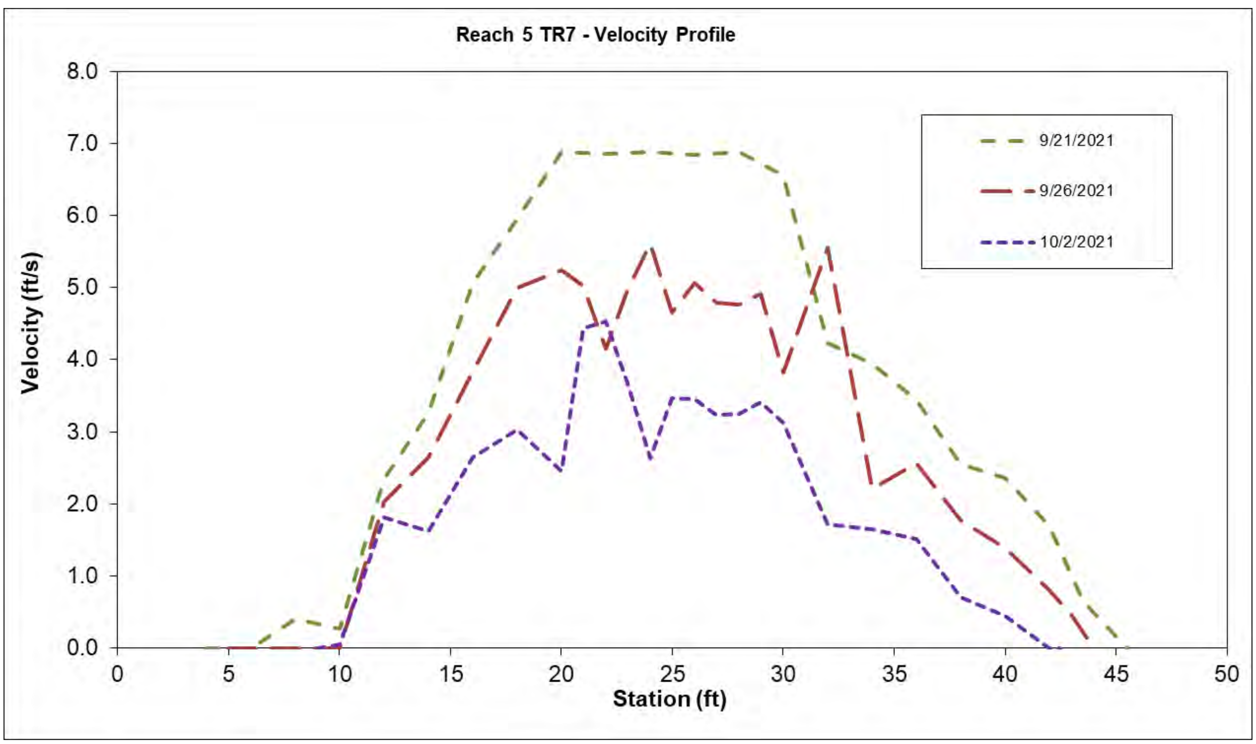


Figure A.1-33. Eklutna River, Alaska, Reach 5 Tr-7 bed profile (upper) and velocity profile (lower).

Figure A.1-34. Eklutna River, Alaska, Reach 5 Tr-7 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	100.56			
2.2	99.77		No RTK Survey	
3.2	98.89		Poor Satellite Reception	
4.5	98.52			
8	98.34			
10	98.14	Added station		
11	97.60			
13	97.60			
19	97.32			
21	97.11			
27	97.08			
28	97.12			
29.8	97.08			
30.8	97.43			
32.6	97.72			
34	97.64	removed 34.7 and replace with 34 from 9/26		
36	97.74			
37.7	97.63			
38.5	97.92			
38.9	97.86			
40	98.11	Removed station 40.1 and replaced with station 40 from 10/2 survey		
42	98.20			
44.4	98.56			
45.6	98.66			
49.4	99.36			
57	100.06			

Figure A.1-35. Eklutna River, Alaska, Reach 5 Tr-7 HEC-RAS survey data.

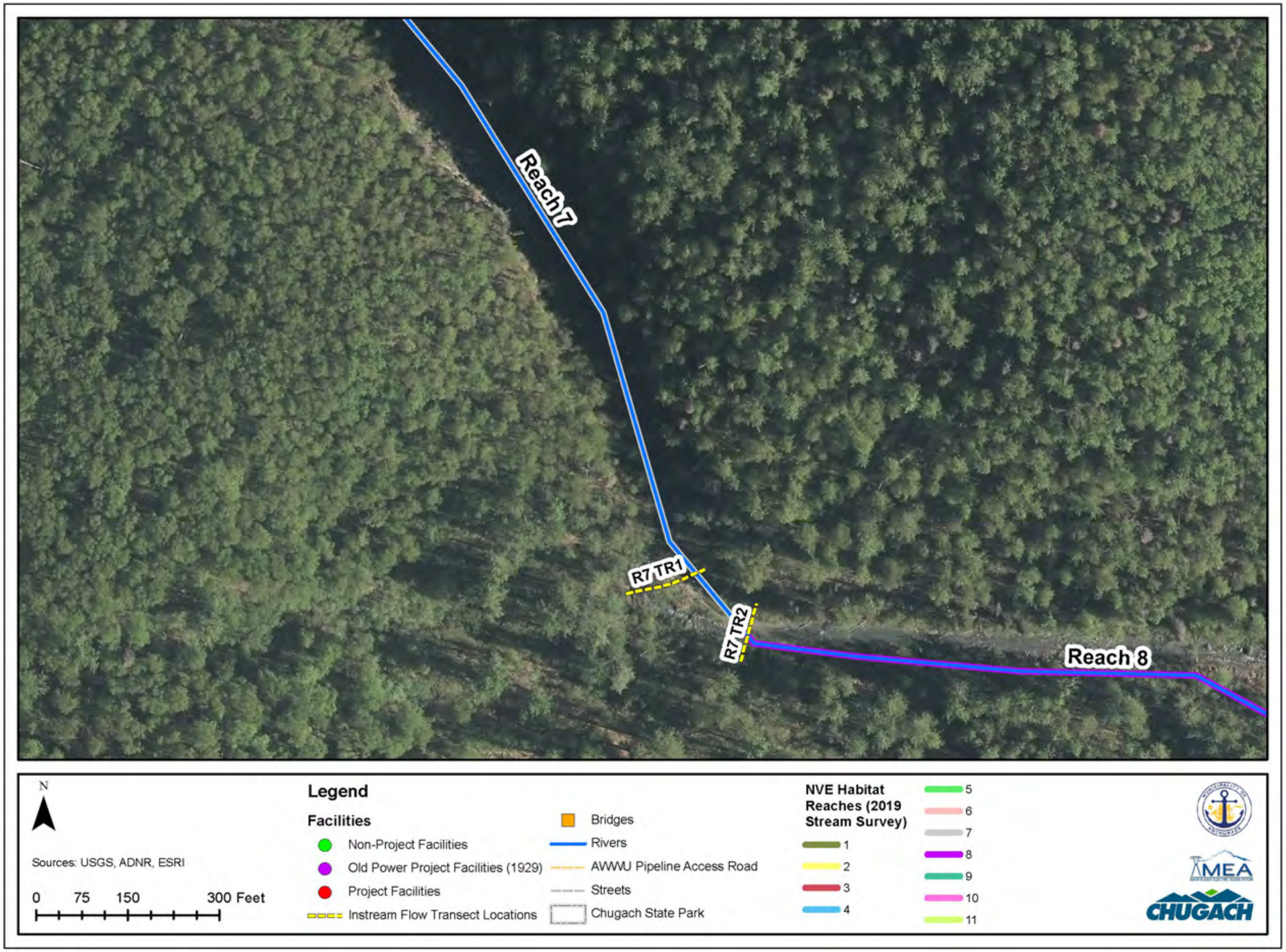
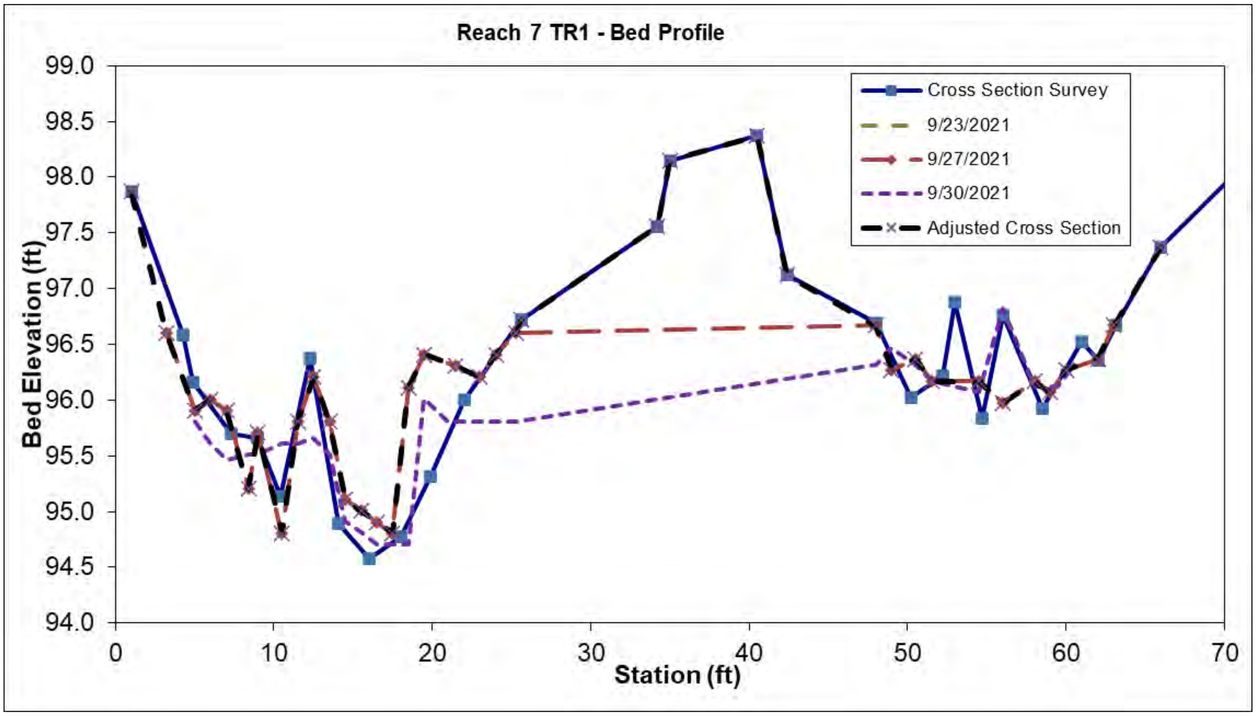


Figure A.1-36. Eklutna River, Alaska, Reach 7 transect location map (Transects 1-2).



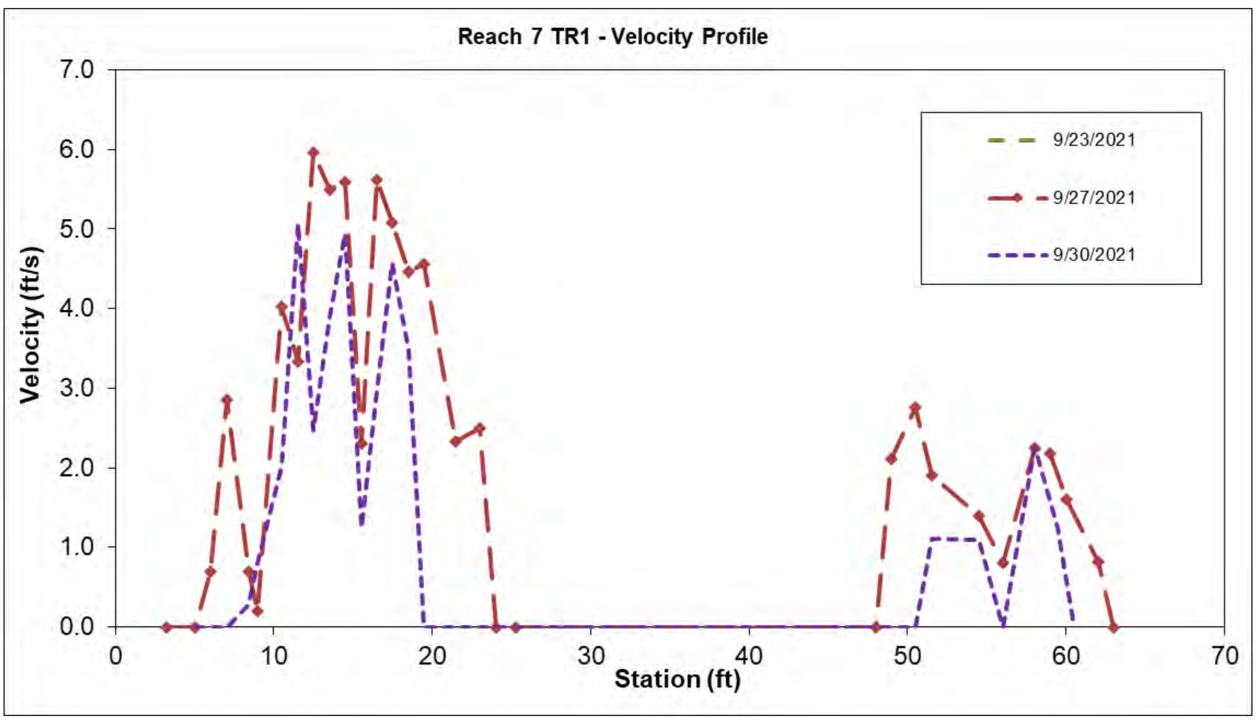


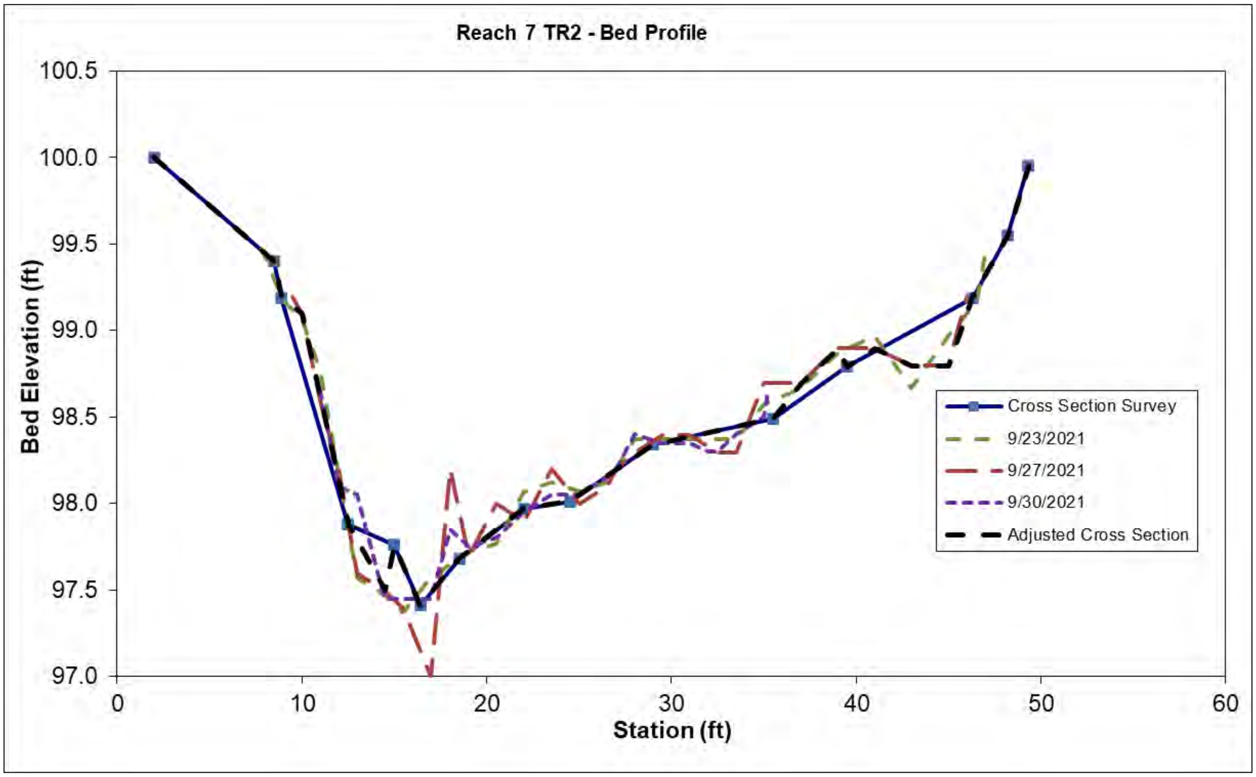
Figure A.1-37. Eklutna River, Alaska, Reach 7 Tr-1 bed profile (upper) and velocity profile (lower).

Figure A.1-38. Eklutna River, Alaska, Reach 7 Tr-1 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	97.87		0	359.05
3.2	96.61		2.2	357.79
5	95.91		4	357.09
6	96.01		5	357.19
7	95.91		6	357.09
8.4	95.21		7.4	356.39
9	95.71		8	356.89
10.5	94.81		9.5	355.99
11.5	95.81		10.5	356.99
12.5	96.21		11.5	357.39
13.5	95.81		12.5	356.99
14.5	95.11		13.5	356.29
15.5	95.01		14.5	356.19
16.5	94.91		15.5	356.09
17.5	94.81		16.5	355.99
18.5	96.11		17.5	357.29
19.5	96.41		18.5	357.59
21.5	96.31		20.5	357.49
23	96.21		22	357.39
24	96.41		23	357.59
25.3	96.61		24.3	357.79
25.6	96.72		24.6	357.90
34.2	97.56		33.2	358.74
35	98.15		34	359.33
40.5	98.37		39.5	359.55
42.4	97.12		41.4	358.30
48	96.67		47	357.85
49	96.27		48	357.45
50.5	96.37		49.5	357.55
51.5	96.17		50.5	357.35
54.5	96.17		53.5	357.35
56	95.97		55	357.15
58	96.17		57	357.35
59	96.07		58	357.25
60	96.27		59	357.45
62	96.37		61	357.55
63	96.67		62	357.85
66	97.37		65	358.55

Figure A.1-39. Eklutna River, Alaska, Reach 7 Tr-1 HEC-RAS survey data.



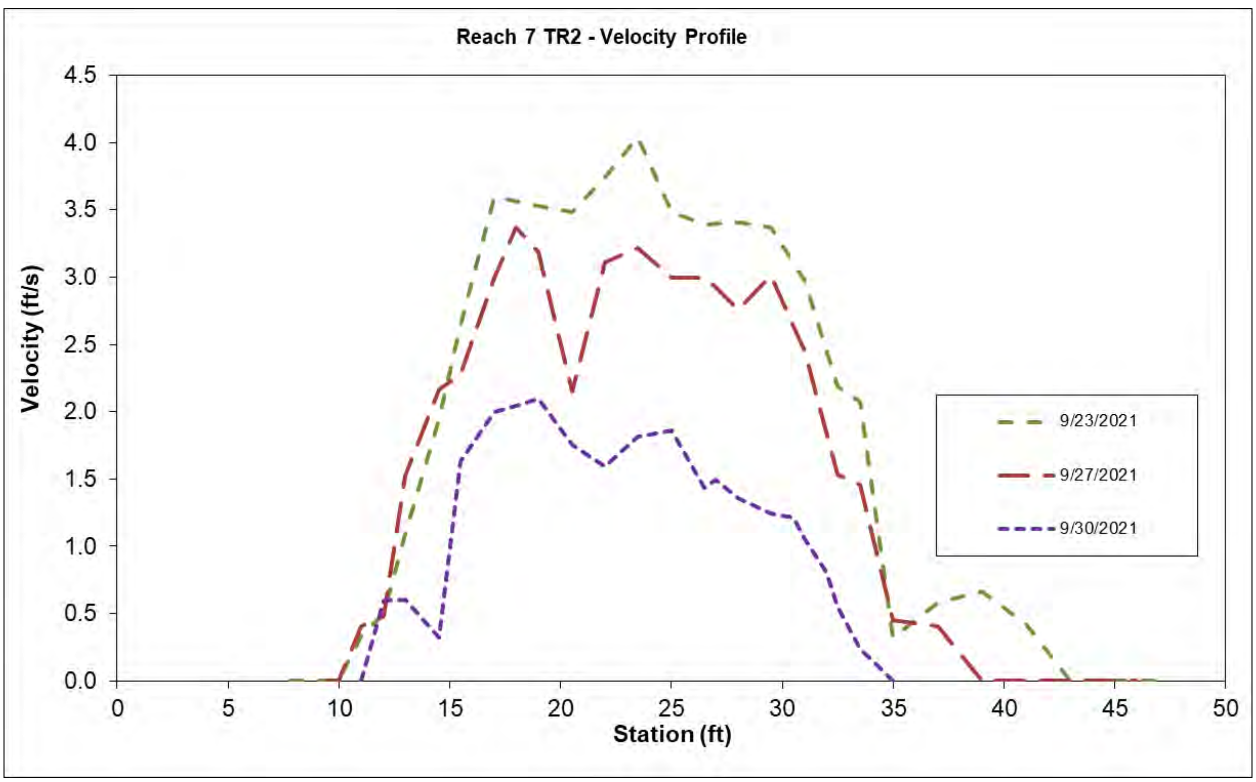


Figure A.1-40. Eklutna River, Alaska, Reach 7 Tr-2 bed profile (upper) and velocity profile (lower).

Figure A.1-41. Eklutna River, Alaska, Reach 7 Tr-2 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
2	100.00		0	361.18
8.5	99.40		6.5	360.58
8.9	99.19		6.9	360.37
10	99.10	Added point	8	360.28
12.5	97.88		10.5	359.06
14.5	97.50		12.5	358.68
15	97.76		13	358.94
16.4	97.41		14.4	358.59
18.5	97.68		16.5	358.86
22	97.97		20	359.15
24.5	98.01		22.5	359.19
29	98.34		27	359.52
35.5	98.49		33.5	359.67
37	98.70	Added point	35	359.88
39	98.90	Added point	37	360.08
39.5	98.79		37.5	359.97
41	98.90	Added point	39	360.08
43	98.80	Added point	41	359.98
45	98.80		43	359.98
46.3	99.19		44.3	360.37
48.2	99.55		46.2	360.73
49.3	99.95		47.3	361.13

Figure A.1-42. Eklutna River, Alaska, Reach 7 Tr-2 HEC-RAS survey data.

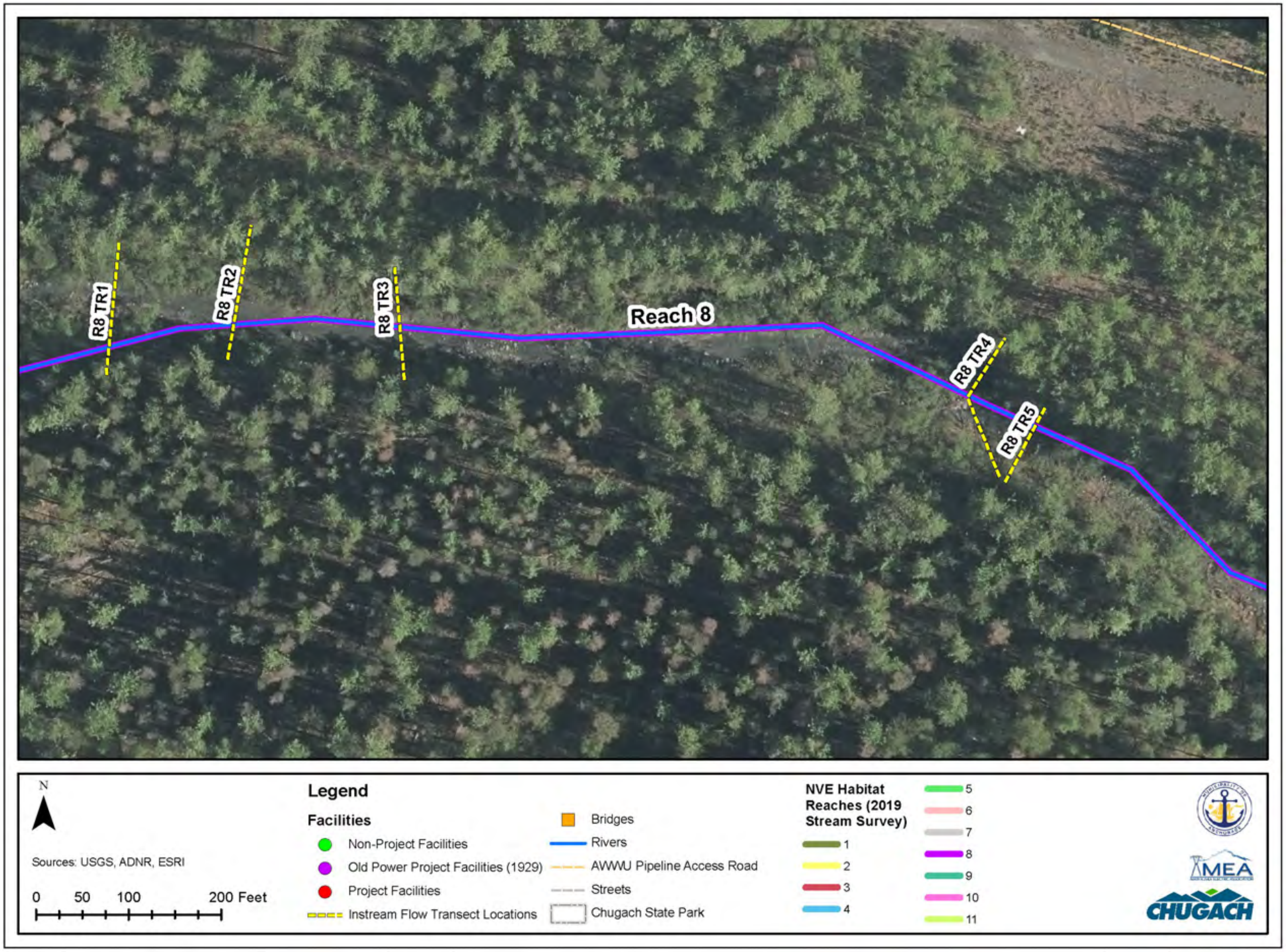
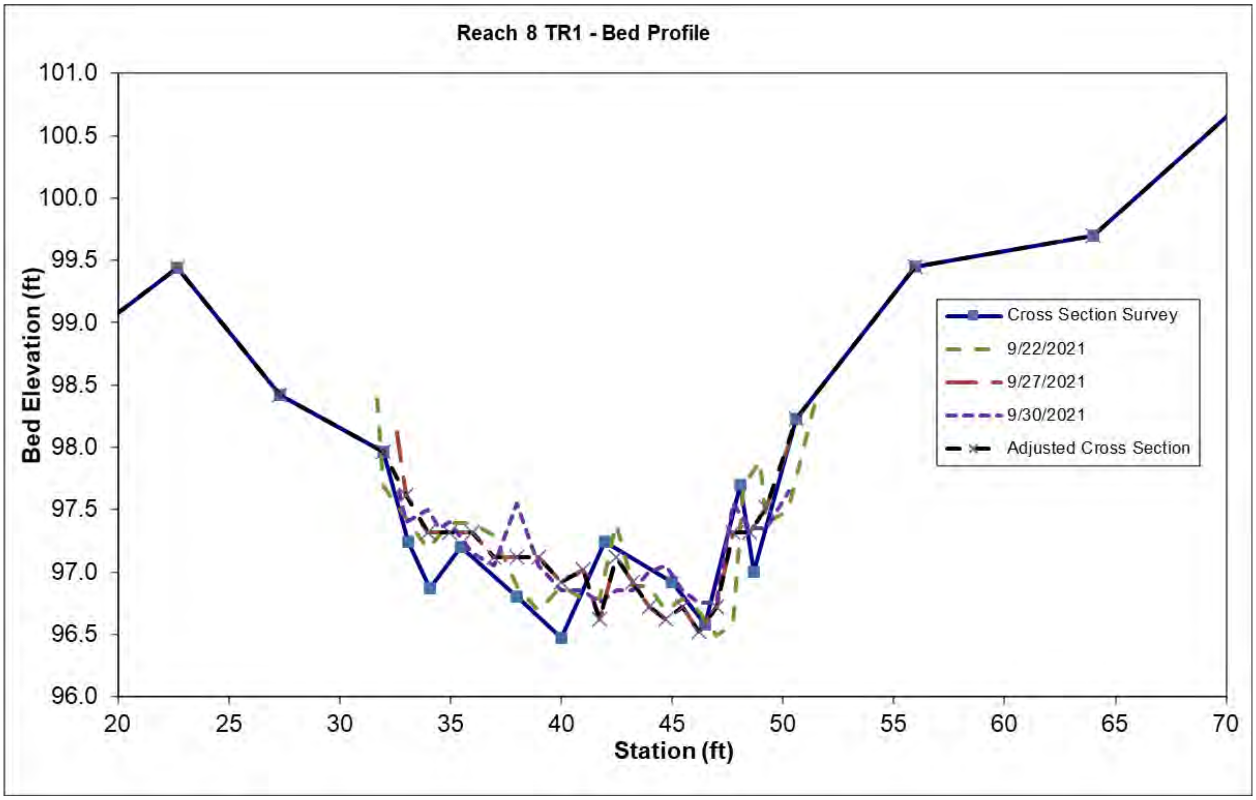


Figure A.1-43. Eklutna River, Alaska, Reach 8 transect location map (Transects 1-5).



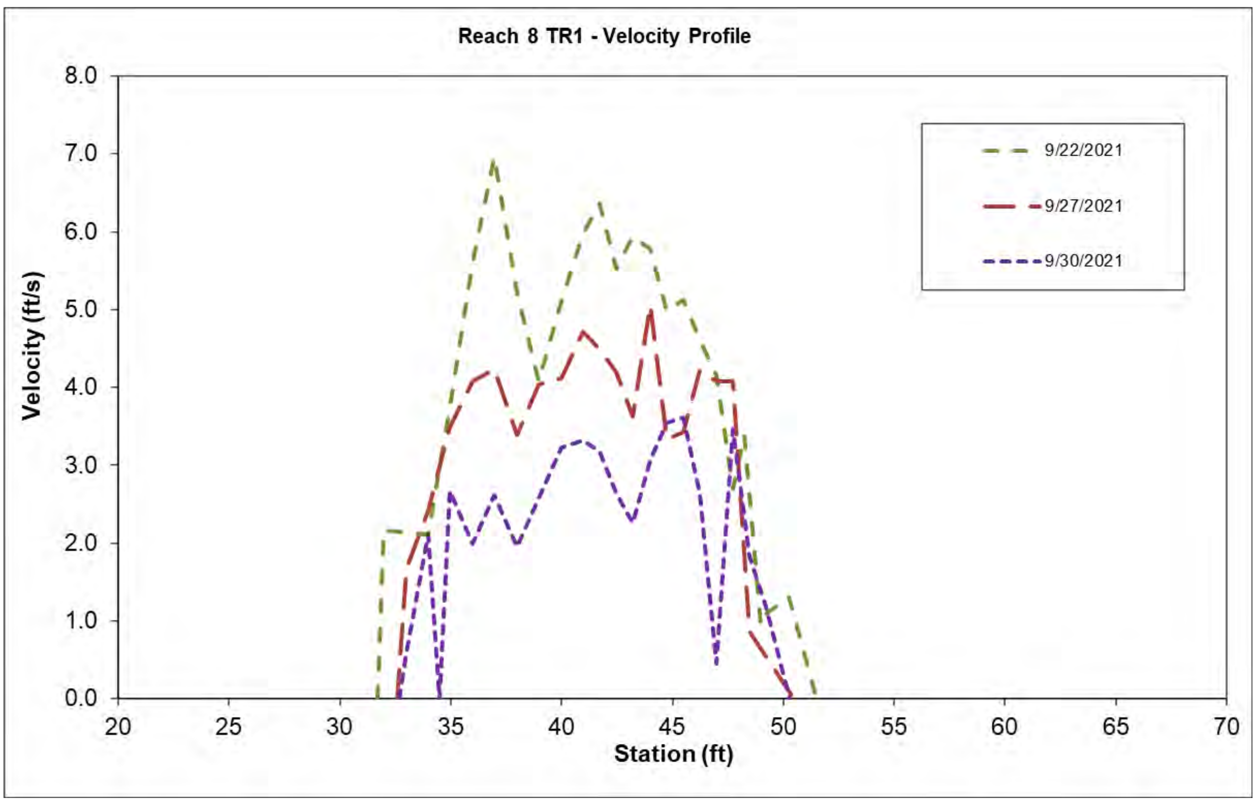


Figure A.1-44. Eklutna River, Alaska, Reach 8 Tr-1 bed profile (upper) and velocity profile (lower).

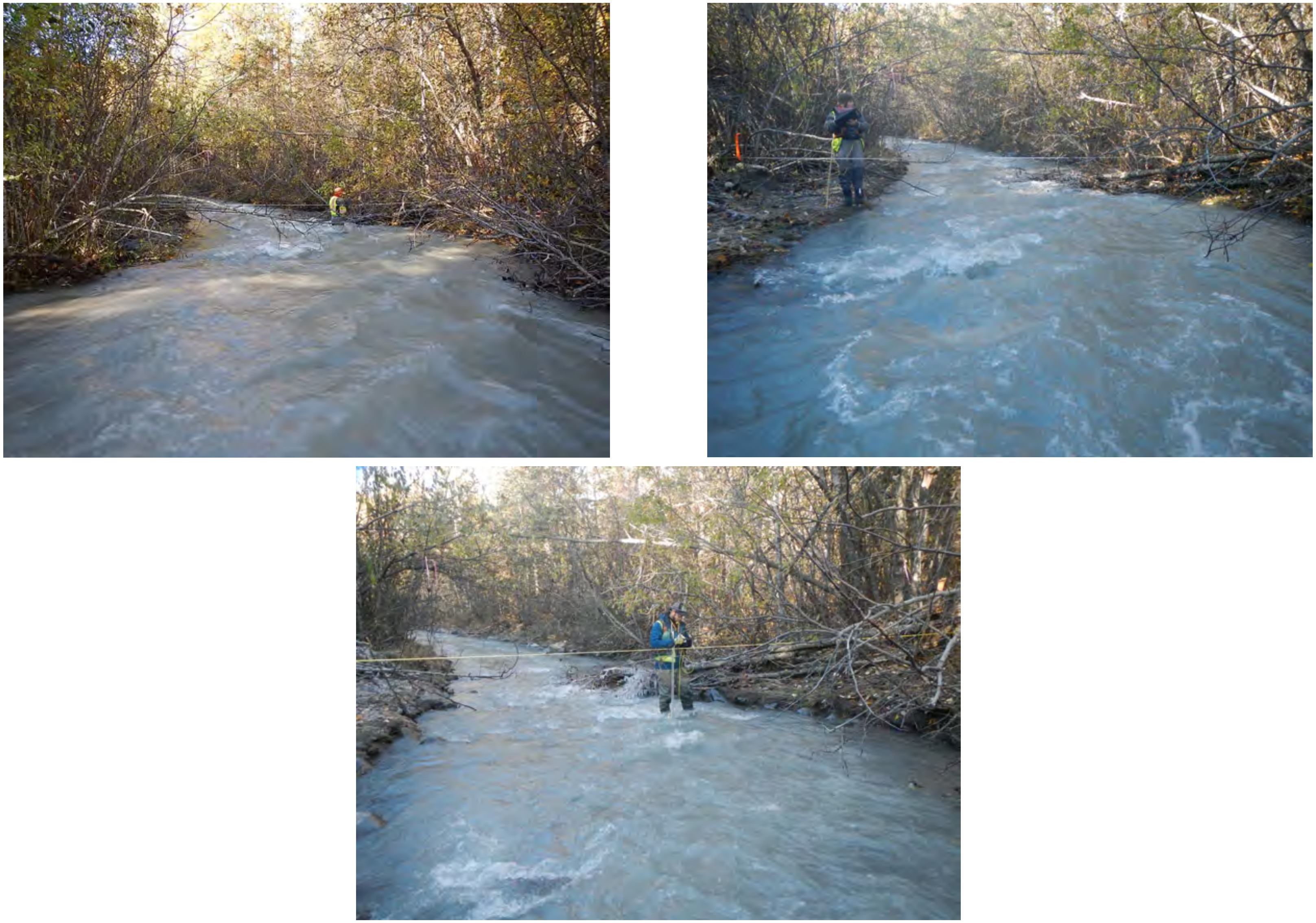
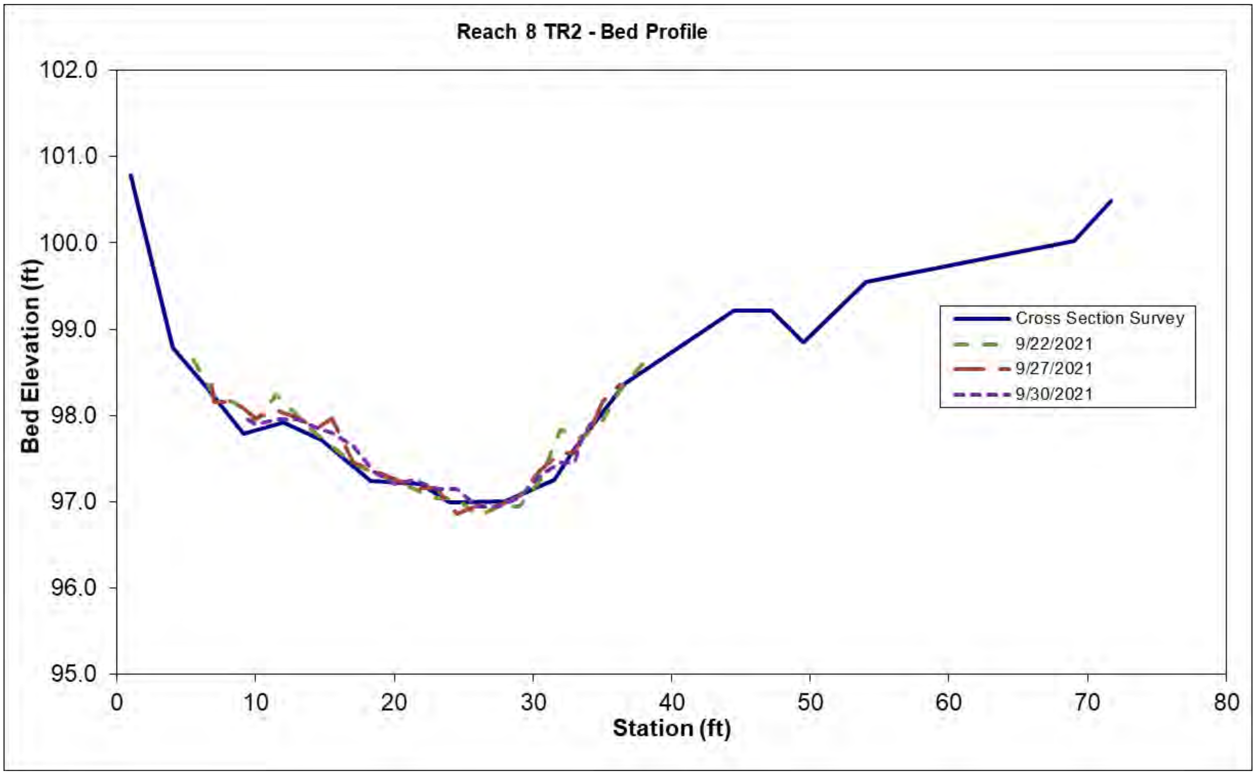


Figure A.1-45. Eklutna River, Alaska, Reach 8 Tr-1 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
-3.9	104.14	From channel profile survey	-4.9	384.33
1	100.30	From channel profile survey	0	380.49
3.9	98.76	From channel profile survey	2.9	378.95
4.5	98.62	From channel profile survey	3.5	378.81
10	98.95	From channel profile survey	9	379.14
14.5	98.50	From channel profile survey	13.5	378.69
16.8	98.64	From channel profile survey	15.8	378.83
22.7	99.44	From channel profile survey	21.7	379.63
27.3	98.42	From channel profile survey	26.3	378.61
32	97.96	From channel profile survey	31	378.15
33	97.62	From 9/26 WSE/depth calc	32	377.81
34	97.32	From 9/26 WSE/depth calc	33	377.51
35	97.32	From 9/26 WSE/depth calc	34	377.51
36	97.32	From 9/26 WSE/depth calc	35	377.51
37	97.12	From 9/26 WSE/depth calc	36	377.31
38	97.12	From 9/26 WSE/depth calc	37	377.31
39	97.12	From 9/26 WSE/depth calc	38	377.31
40	96.92	From 9/26 WSE/depth calc	39	377.11
41	97.02	From 9/26 WSE/depth calc	40	377.21
41.75	96.62	From 9/26 WSE/depth calc	40.75	376.81
42.5	97.12	From 9/26 WSE/depth calc	41.5	377.31
43.25	96.92	From 9/26 WSE/depth calc	42.25	377.11
44	96.72	From 9/26 WSE/depth calc	43	376.91
44.75	96.62	From 9/26 WSE/depth calc	43.75	376.81
45.5	96.72	From 9/26 WSE/depth calc	44.5	376.91
46.25	96.52	From 9/26 WSE/depth calc	45.25	376.71
47	96.72	From 9/26 WSE/depth calc	46	376.91
47.75	97.32	From 9/26 WSE/depth calc	46.75	377.51
48.5	97.32	From 9/26 WSE/depth calc	47.5	377.51
49.25	97.52	From 9/26 WSE/depth calc	48.25	377.71
50.6	98.23	From channel profile survey	49.6	378.42
56	99.45	From channel profile survey	55	379.64
64	99.70	From channel profile survey	63	379.89
70.6	100.74	From channel profile survey	69.6	380.93

Figure A.1-46. Eklutna River, Alaska, Reach 8 Tr-1 HEC-RAS survey data.



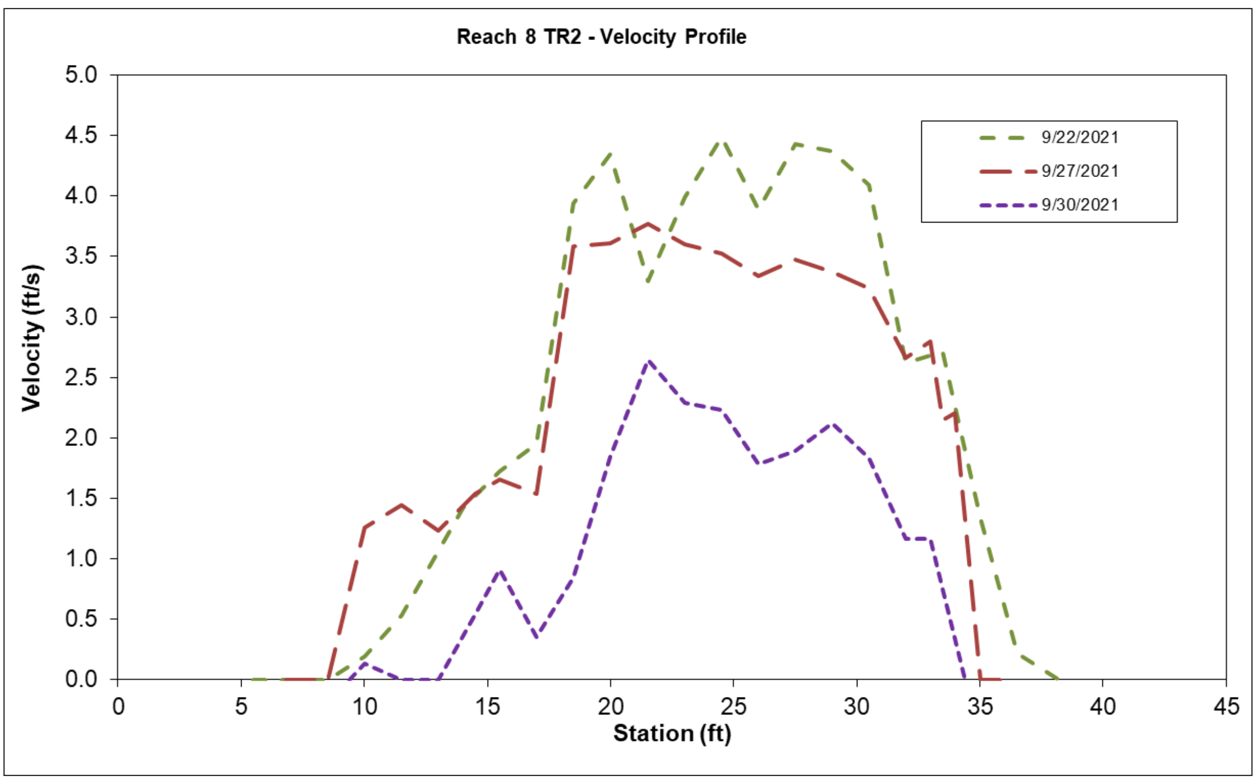


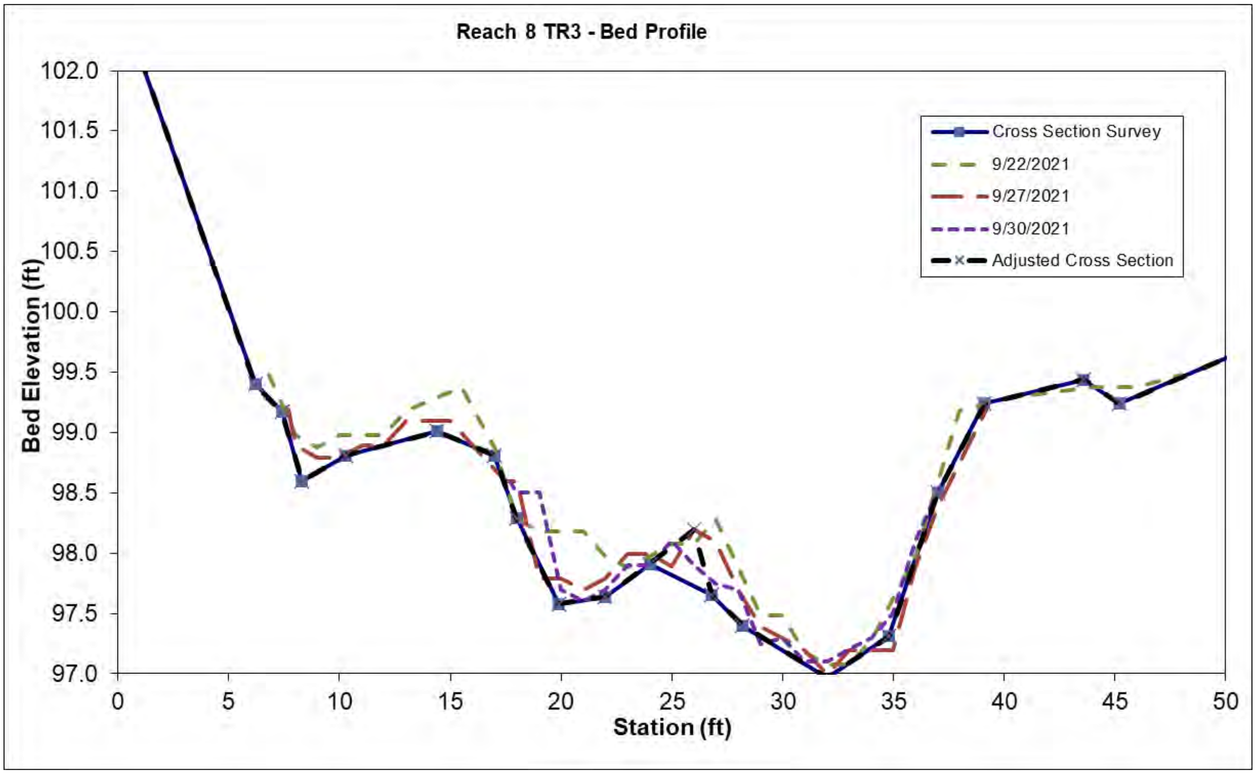
Figure A.1-47. Eklutna River, Alaska, Reach 8 Tr-2 bed profile (upper) and velocity profile (lower).

Figure A.1-48. Eklutna River, Alaska, Reach 8 Tr-2 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	100.78		0	380.97
4	98.79		3	378.98
6.5	98.31		5.5	378.50
9.1	97.79		8.1	377.98
12	97.92		11	378.11
14.7	97.72		13.7	377.91
18.3	97.24		17.3	377.43
21.9	97.21		20.9	377.40
24	97.00		23	377.19
28	97.01		27	377.20
31.5	97.25		30.5	377.44
33.1	97.63		32.1	377.82
36.6	98.37		35.6	378.56
44.5	99.21		43.5	379.40
47.2	99.21		46.2	379.40
49.5	98.85		48.5	379.04
54	99.55		53	379.74
69	100.02		68	380.21
71.7	100.49		70.7	380.68

Figure A.1-49. Eklutna River, Alaska, Reach 8 Tr-2 HEC-RAS survey data.



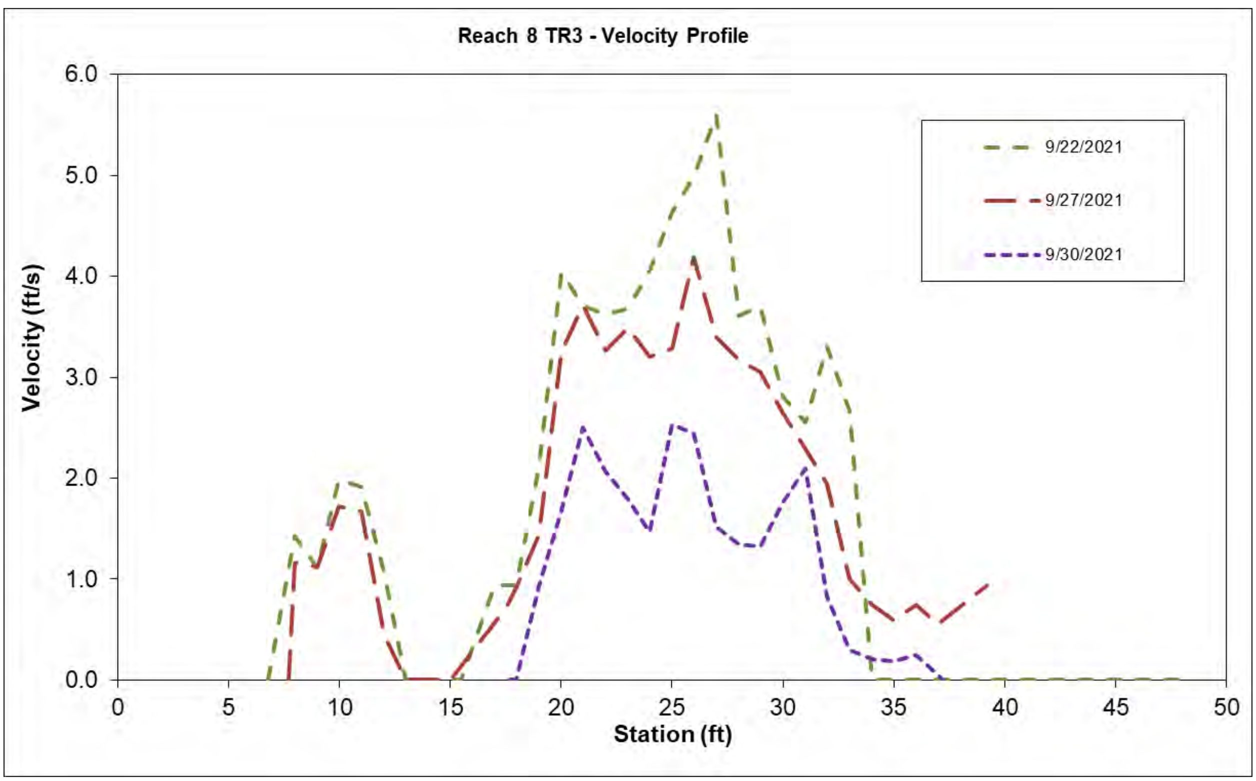


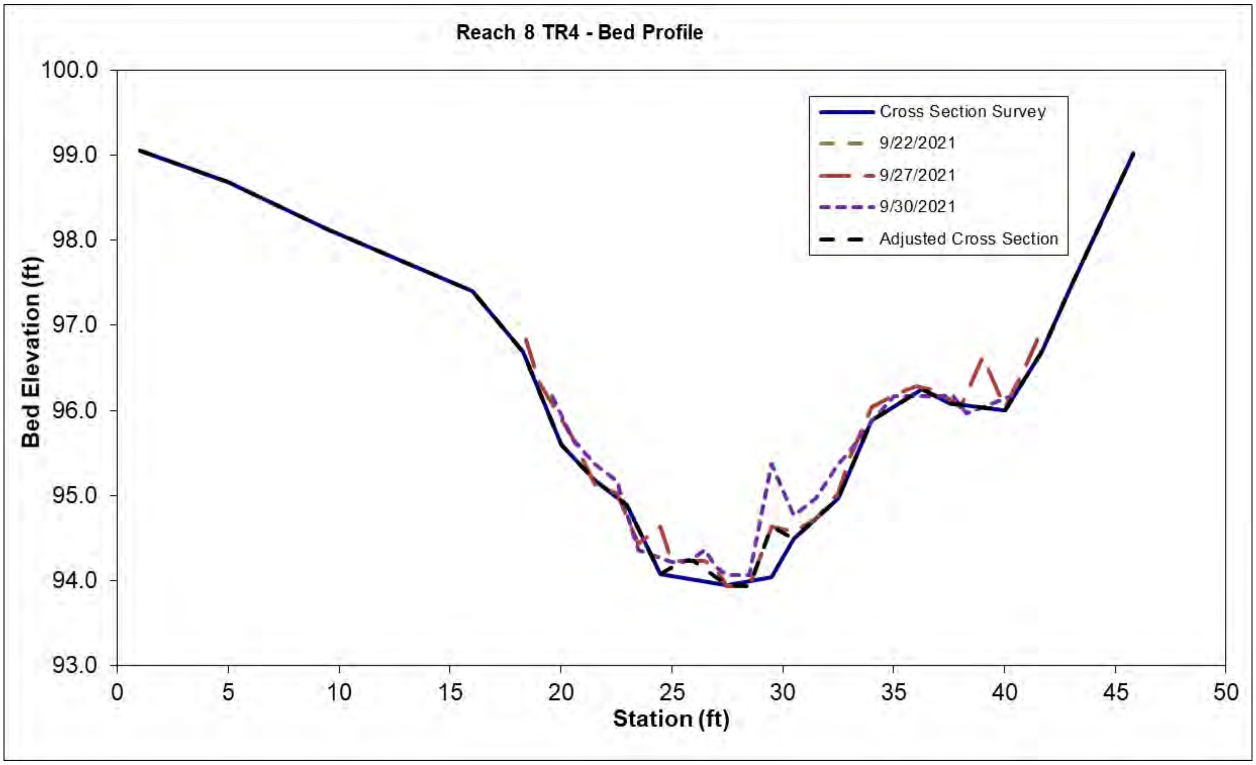
Figure A.1-50. Eklutna River, Alaska, Reach 8 Tr-3 bed profile (upper) and velocity profile (lower).

Figure A.1-51. Eklutna River, Alaska, Reach 8 Tr-3 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	102.11		0	381.37
6.2	99.40		5.2	378.66
7.4	99.17		6.4	378.43
8.3	98.60		7.3	377.86
10.3	98.81		9.3	378.07
14.4	99.01		13.4	378.27
17	98.81		16	378.07
18	98.29		17	377.55
19.9	97.58		18.9	376.84
22	97.64		21	376.90
24	97.91		23	377.17
26	98.19	Added point	25	377.45
26.8	97.65		25.8	376.91
28.2	97.40		27.2	376.66
32	96.97		31	376.23
34.8	97.31		33.8	376.57
37	98.50		36	377.76
39.1	99.24		38.1	378.50
43.6	99.44		42.6	378.70
45.2	99.24		44.2	378.50
52.7	99.83		51.7	379.09
60	100.49		59	379.75

Figure A.1-52. Eklutna River, Alaska, Reach 8 Tr-3 HEC-RAS survey data.



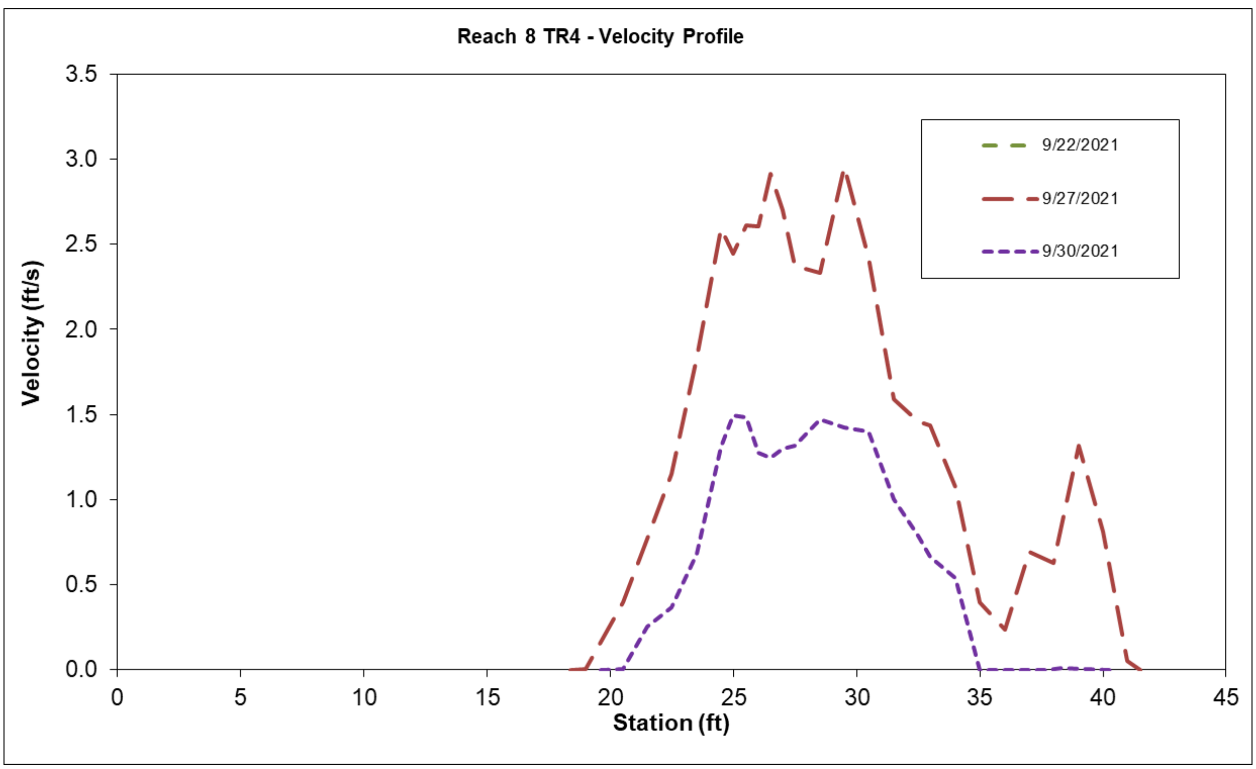


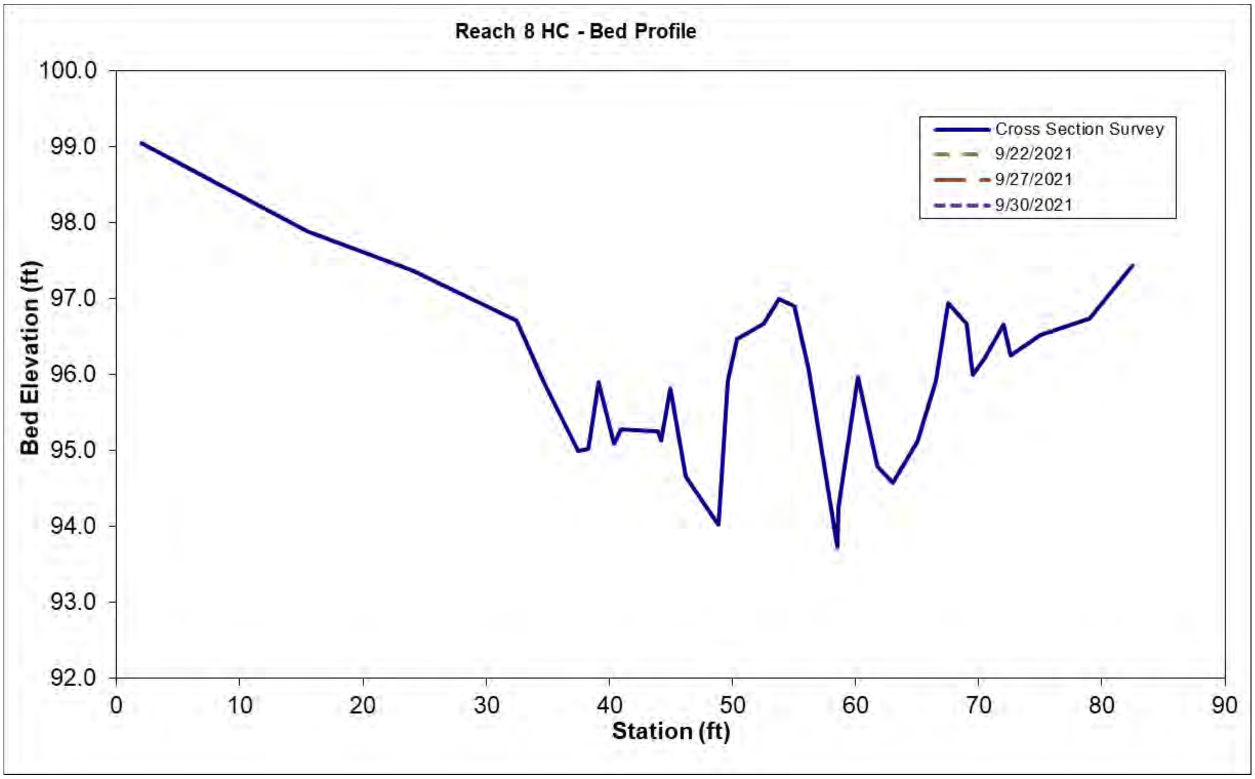
Figure A.1-53. Eklutna River, Alaska, Reach 8 Tr-4 bed profile (upper) and velocity profile (lower).

Figure A.1-54. Eklutna River, Alaska, Reach 8 Tr-4 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	99.05		0	388.18
5	98.68		4	387.81
9.5	98.13		8.5	387.26
16	97.40		15	386.53
18.3	96.69		17.3	385.82
20	95.60		19	384.73
21.5	95.18		20.5	384.31
23	94.88		22	384.01
24.5	94.08		23.5	383.21
25.5	94.23	*New Point from 9/27 WSE/depth data	24.5	383.36
26	94.23	*New Point from 9/27 WSE/depth data	25	383.36
27.5	93.94		26.5	383.07
28.5	93.93	*New Point from 9/27 WSE/depth data	27.5	383.06
29.5	94.63	*replaced surveyed reading with 9/27 data	28.5	383.76
30.5	94.49		29.5	383.62
32.5	94.97		31.5	384.10
34	95.88		33	385.01
36.3	96.25		35.3	385.38
37.5	96.08		36.5	385.21
40	96.00		39	385.13
41.7	96.70		40.7	385.83
43	97.45		42	386.58
45.8	99.02		44.8	388.15

Figure A.1-55. Eklutna River, Alaska, Reach 8 Tr-4 HEC-RAS survey data.



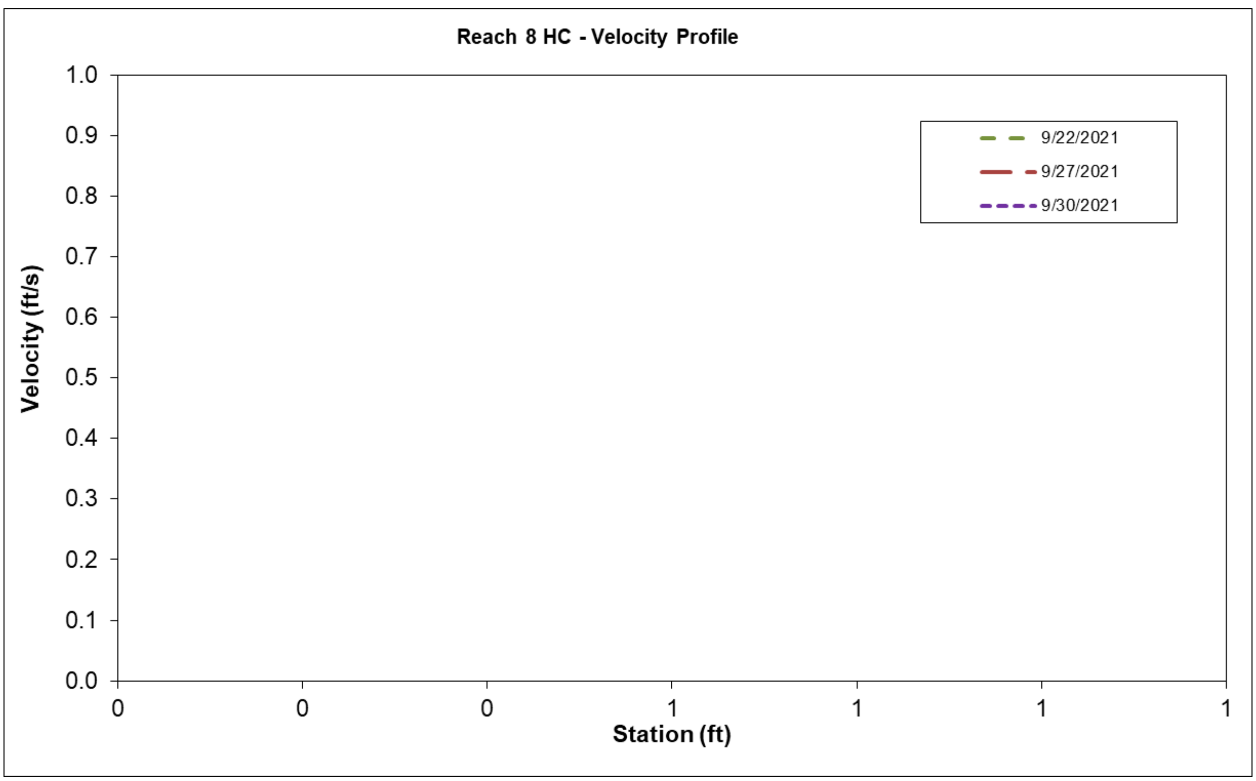


Figure A.1-56. Eklutna River, Alaska, Reach 8 HC bed profile (upper) and velocity profile (lower).

Figure A.1-57. Eklutna River, Alaska, Reach 8 HC representative photographs for high (upper left), mid (upper right) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
2	99.05		0	388.18
15.5	97.88		13.5	387.01
24	97.37		22	386.50
32.5	96.70		30.5	385.83
34.7	95.88		32.7	385.01
37.5	94.99		35.5	384.12
38.3	95.01		36.3	384.14
39.1	95.90		37.1	385.03
40.4	95.08		38.4	384.21
41	95.27		39	384.40
44	95.24		42	384.37
44.2	95.13		42.2	384.26
45	95.81		43	384.94
46.2	94.65		44.2	383.78
48	94.23		46	383.36
48.9	94.02		46.9	383.15
49.6	95.91		47.6	385.04
50.4	96.46		48.4	385.59
52.5	96.66		50.5	385.79
53.8	96.99		51.8	386.12
55	96.90		53	386.03
56.2	96.06		54.2	385.19
58.5	93.72		56.5	382.85
58.6	94.24		56.6	383.37
60.2	95.96		58.2	385.09
61.8	94.78		59.8	383.91
63	94.57		61	383.70
65	95.11		63	384.24
66.5	95.91		64.5	385.04
67.5	96.94		65.5	386.07
69	96.66		67	385.79
69.5	95.99		67.5	385.12
70.5	96.22		68.5	385.35
72	96.65		70	385.78
72.6	96.25		70.6	385.38
75	96.52		73	385.65
79	96.73		77	385.86
82.5	97.44		80.5	386.57

Figure A.1-58. Eklutna River, Alaska, Reach 8 HC HEC-RAS survey data.

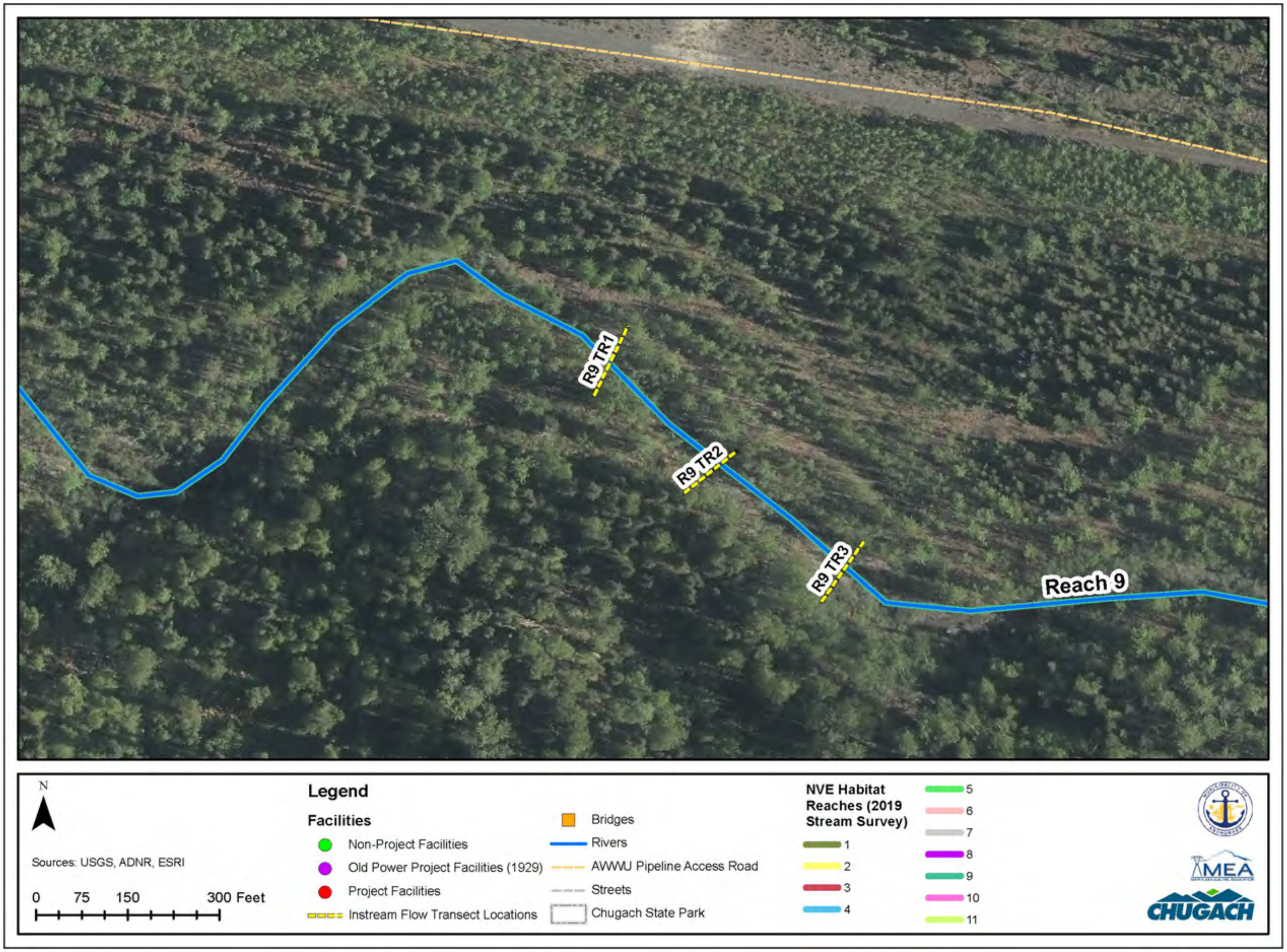
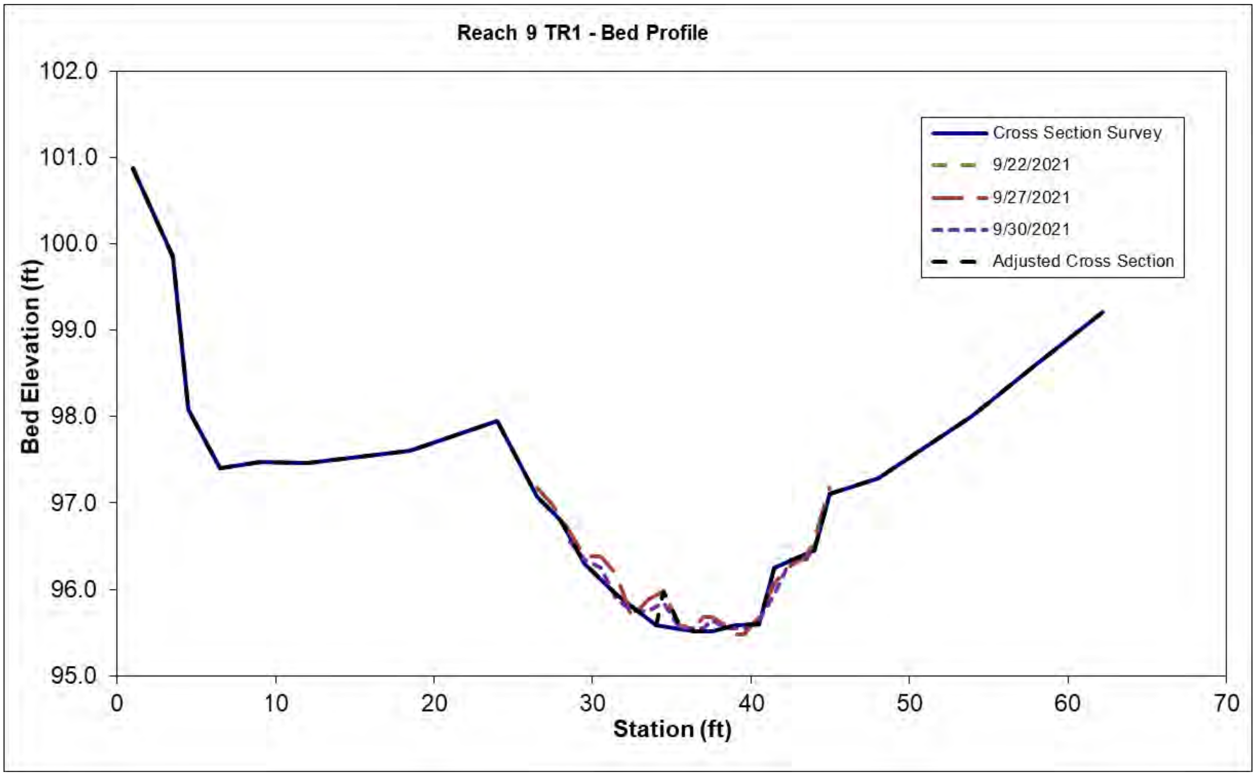


Figure A.1-59. Eklutna River, Alaska, Reach 9 transect location map (Transects 1-3).



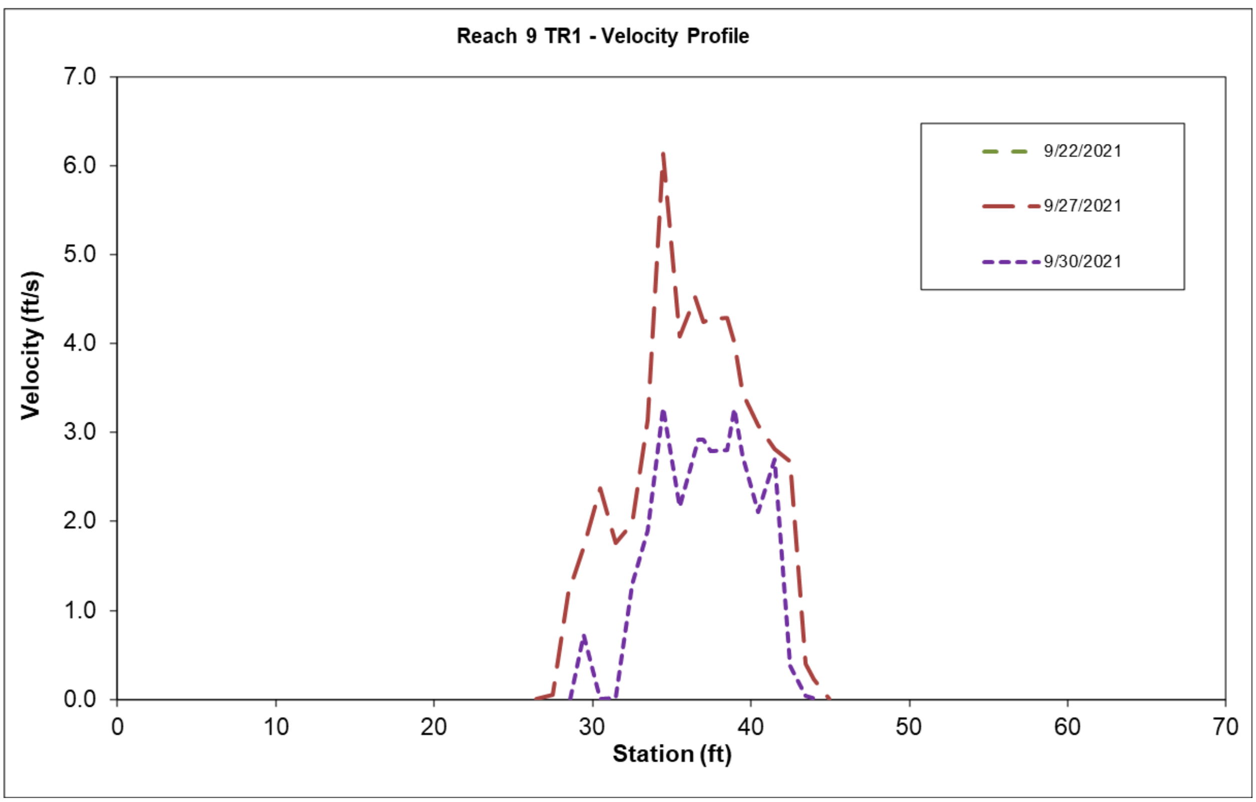


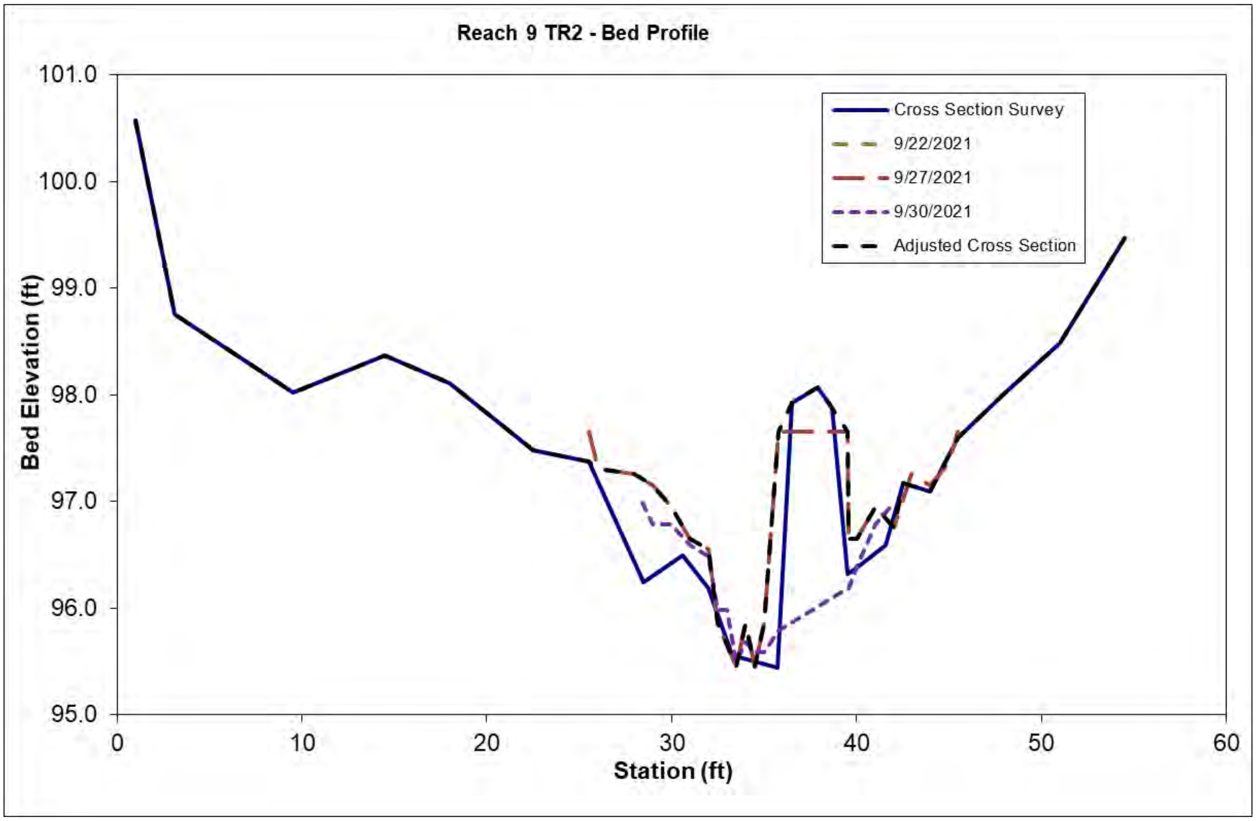
Figure A.1-60. Eklutna River, Alaska, Reach 9 Tr-1 bed profile (upper) and velocity profile (lower).

Figure A.1-61. Eklutna River, Alaska, Reach 9 Tr-1 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100ft Datum)	Notes	Adj Station (ft)	Ground (ft, RTK Datum)
1	100.87		0	466.96
3.5	99.85		2.5	465.94
4.5	98.08		3.5	464.17
6.5	97.40		5.5	463.49
9	97.47		8	463.56
12	97.46		11	463.55
18.5	97.60		17.5	463.69
24	97.95		23	464.04
26.5	97.07		25.5	463.16
28	96.80		27	462.89
29.5	96.30		28.5	462.39
31.5	95.94		30.5	462.03
34	95.59		33	461.68
34.5	95.98	*Added point from 9/27 WSE/depth profile	33.5	462.07
35.5	95.58	*Added point from 9/27 WSE/depth profile	34.5	461.67
36.5	95.51		35.5	461.60
37.5	95.51		36.5	461.60
39	95.59		38	461.68
40.5	95.60		39.5	461.69
41.5	96.25		40.5	462.34
44	96.45		43	462.54
45	97.11		44	463.20
48	97.28		47	463.37
54	98.01		53	464.10
58	98.60		57	464.69
62.2	99.21		61.2	465.30

Figure A.1-62. Eklutna River, Alaska, Reach 9 Tr-1 HEC-RAS survey data.



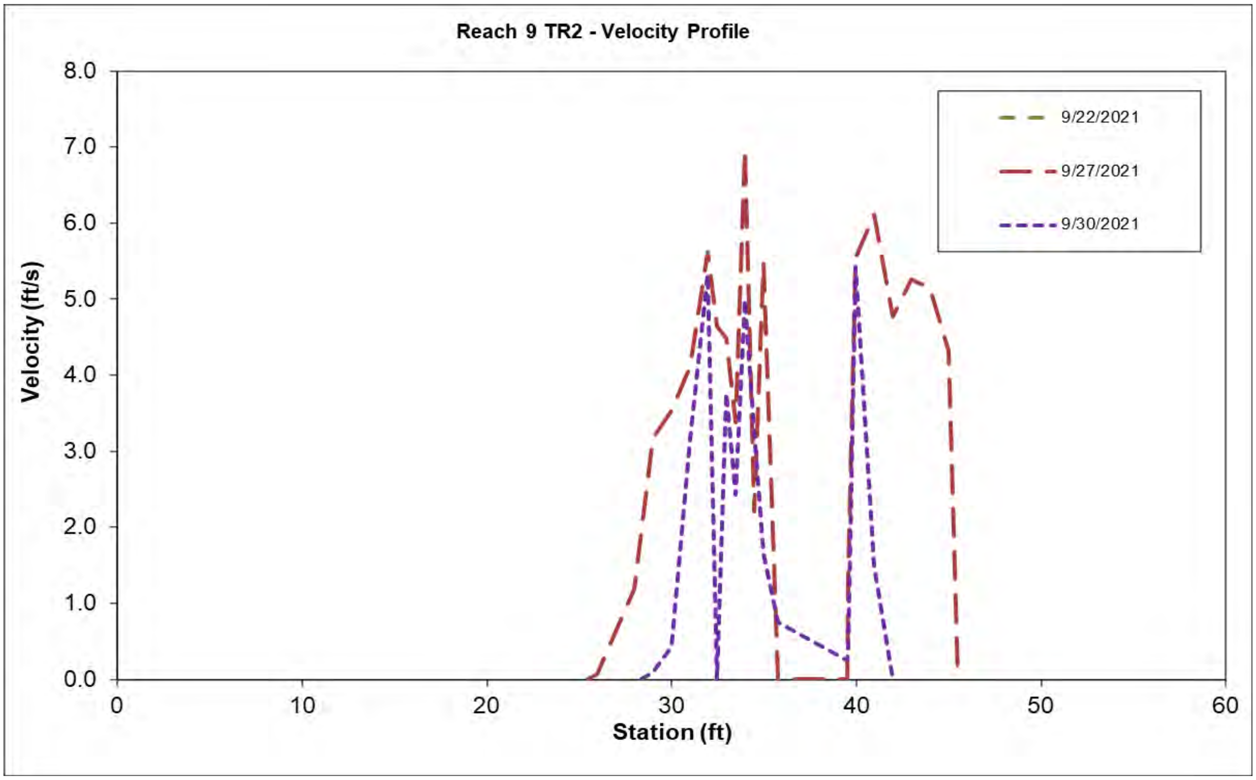
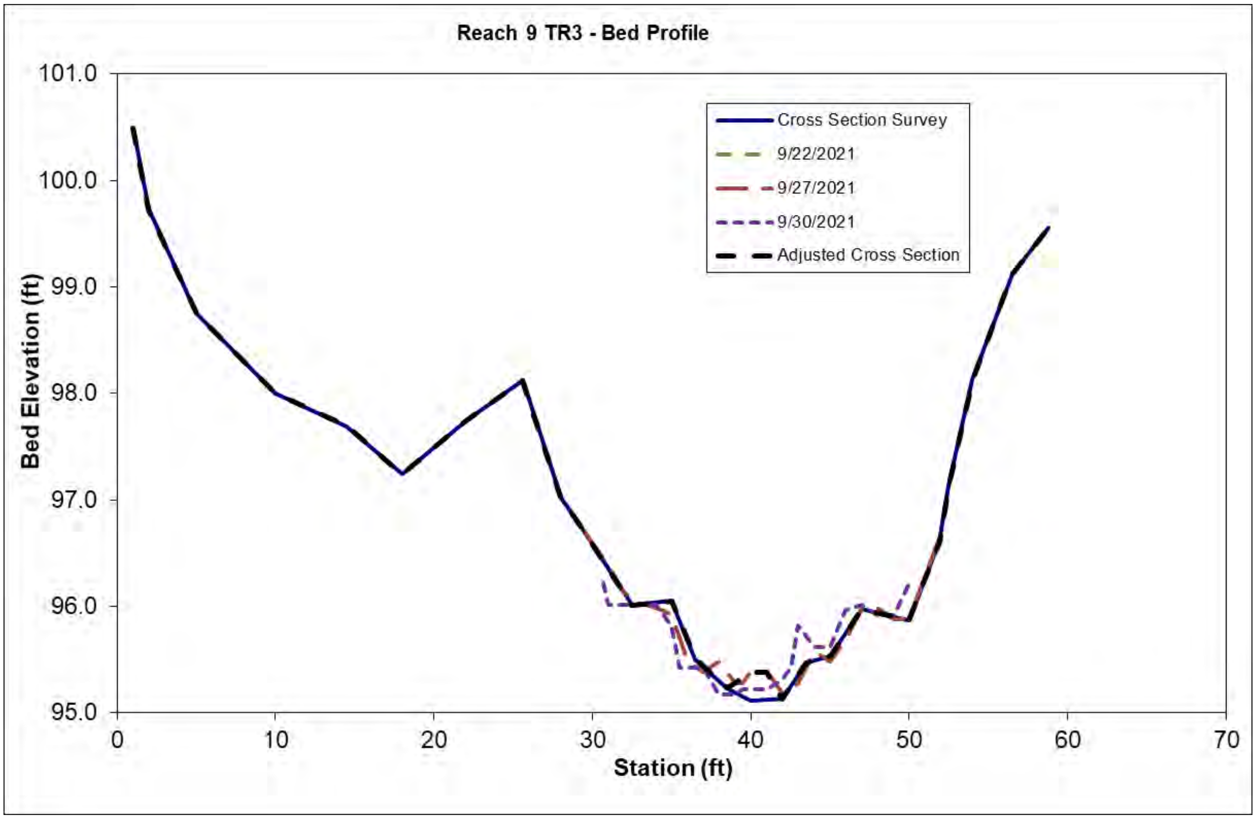


Figure A.1-63. Eklutna River, Alaska, Reach 9 Tr-2 bed profile (upper) and velocity profile (lower).

Figure A.1-64. Eklutna River, Alaska, Reach 9 Tr-2 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Sta (ft)	Channel Profile from Survey Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	100.57	channel profile survey	0.0	467.81
3.1	98.75	channel profile survey	2.1	465.99
9.5	98.02	channel profile survey	8.5	465.26
14.5	98.37	channel profile survey	13.5	465.61
18	98.11	channel profile survey	17.0	465.35
22.5	97.48	channel profile survey	21.5	464.72
25.5	97.37	channel profile survey	24.5	464.61
26	97.30	9/27 WSE/depth profile	25.0	464.54
28	97.25	9/27 WSE/depth profile	27.0	464.49
29	97.15	9/27 WSE/depth profile	28.0	464.39
30	96.95	9/27 WSE/depth profile	29.0	464.19
31	96.65	9/27 WSE/depth profile	30.0	463.89
32	96.55	9/27 WSE/depth profile	31.0	463.79
32.5	95.85	9/27 WSE/depth profile	31.5	463.09
33	95.65	9/27 WSE/depth profile	32.0	462.89
33.5	95.45	9/27 WSE/depth profile	32.5	462.69
34	95.85	9/27 WSE/depth profile	33.0	463.09
34.5	95.45	9/27 WSE/depth profile	33.5	462.69
35	95.85	9/27 WSE/depth profile	34.0	463.09
35.8	97.65	9/27 WSE/depth profile	34.8	464.89
36.5	97.92	channel profile survey	35.5	465.16
37.9	98.07	channel profile survey	36.9	465.31
38.7	97.88	channel profile survey	37.7	465.12
39.5	97.65	9/27 WSE/depth profile	38.5	464.89
39.6	96.65	9/27 WSE/depth profile	38.6	463.89
40	96.65	9/27 WSE/depth profile	39.0	463.89
41	96.95	9/27 WSE/depth profile	40.0	464.19
42	96.75	9/27 WSE/depth profile	41.0	463.99
42.5	97.17	channel profile survey	41.5	464.41
44	97.09	channel profile survey	43.0	464.33
45.5	97.60	channel profile survey	44.5	464.84
48	98.01	channel profile survey	47.0	465.25
51	98.48	channel profile survey	50.0	465.72
54.5	99.47	channel profile survey	53.5	466.71

Figure A.1-65. Eklutna River, Alaska, Reach 9 Tr-2 HEC-RAS survey data.



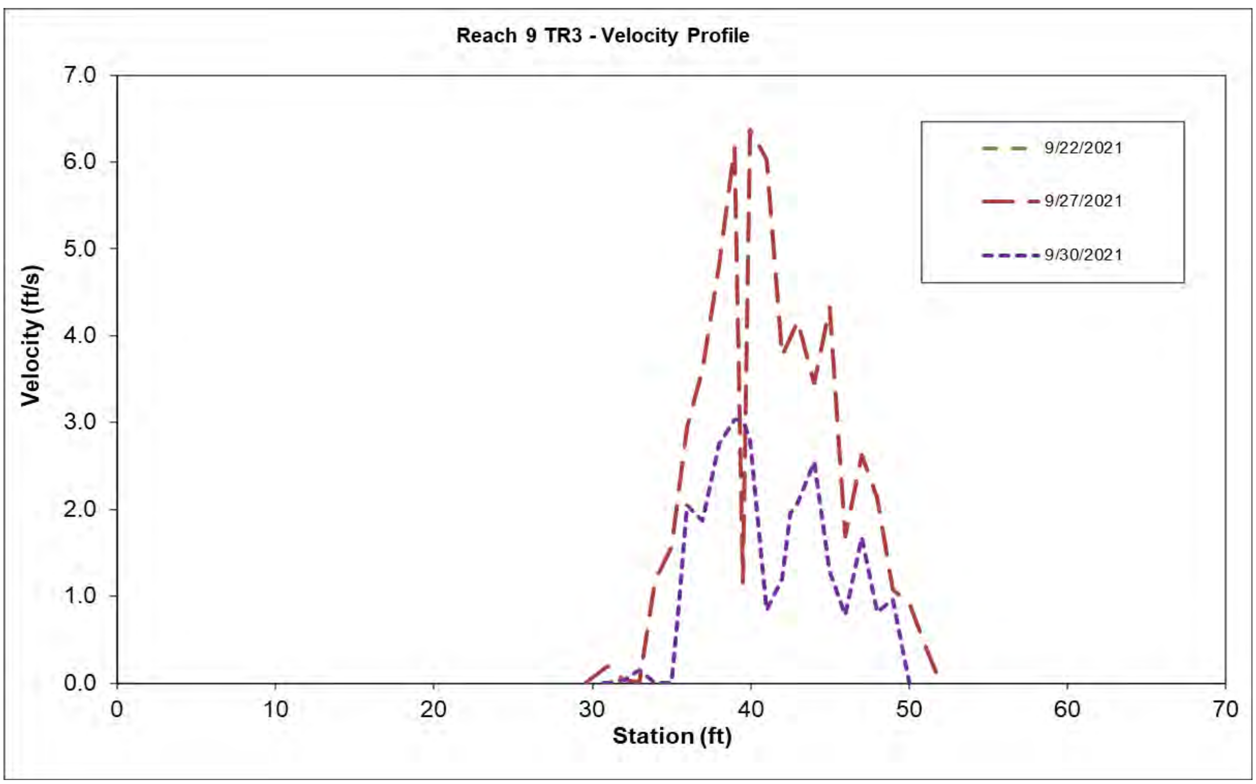


Figure A.1-66. Eklutna River, Alaska, Reach 9 Tr-3 bed profile (upper) and velocity profile (lower).

Figure A.1-67. Eklutna River, Alaska, Reach 9 Tr-3 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	100.49		0	470.05
2	99.73		1	469.29
5	98.75		4	468.31
10	98.00		9	467.56
14.5	97.69		13.5	467.25
18	97.24		17	466.80
22	97.74		21	467.30
25.6	98.12		24.6	467.68
28	97.02		27	466.58
29.3	96.74		28.3	466.30
32.5	96.01		31.5	465.57
35	96.05		34	465.61
36.5	95.50		35.5	465.06
38.5	95.23		37.5	464.79
40	95.38	9/27 WSE/depth profile	39	464.94
41	95.38	9/27 WSE/depth profile	40	464.94
42	95.13		41	464.69
43.5	95.47		42.5	465.03
45	95.53		44	465.09
47	95.97		46	465.53
48.5	95.92		47.5	465.48
50	95.87		49	465.43
51.9	96.61		50.9	466.17
52.5	97.14		51.5	466.70
54	98.13		53	467.69
56.5	99.12		55.5	468.68
58.8	99.56		57.8	469.12

Figure A.1-68. Eklutna River, Alaska, Reach 9 Tr-3 HEC-RAS survey data.

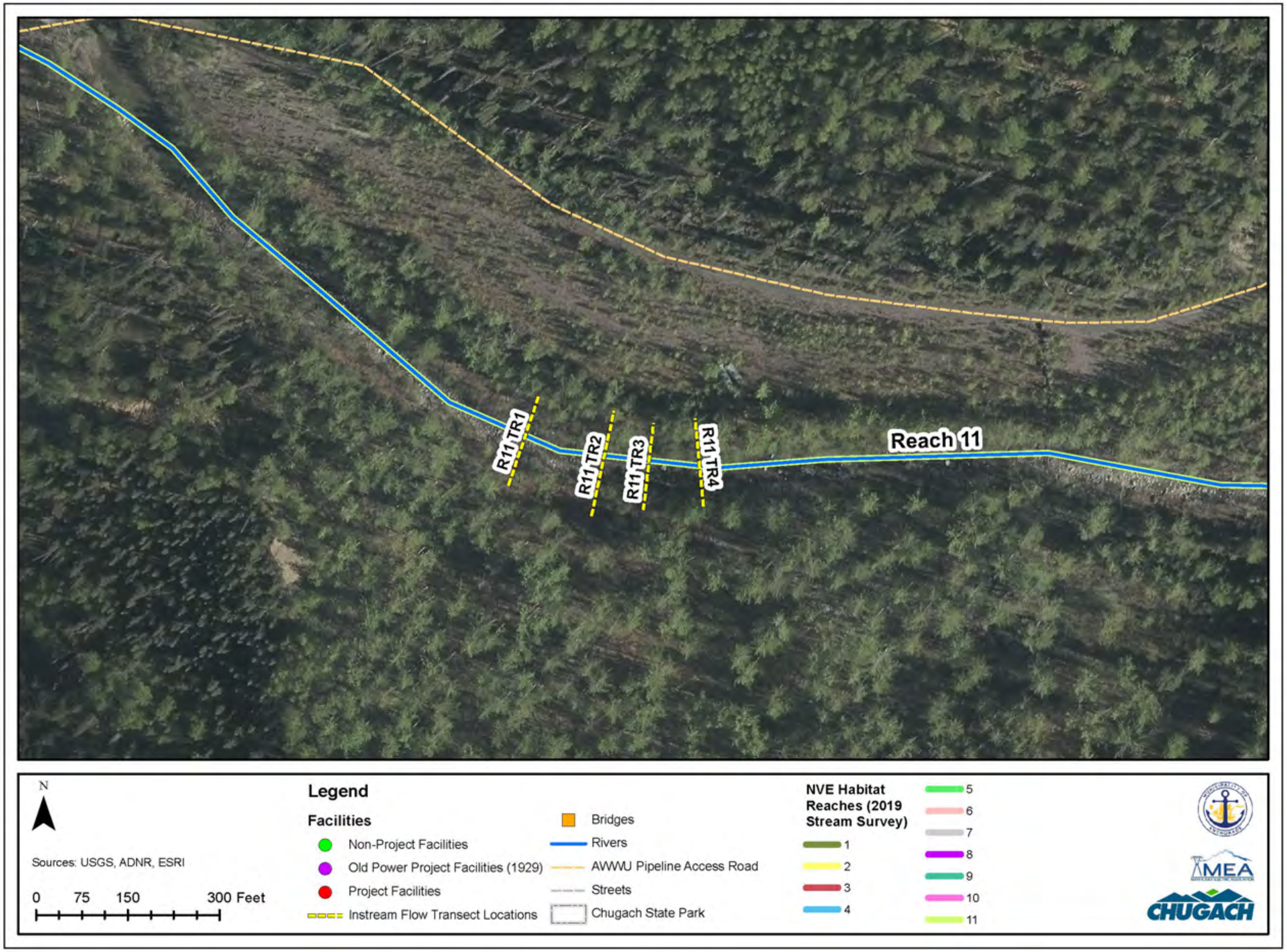


Figure A.1-69. Eklutna River, Alaska, Reach 11 transect location map (Transects 1-4).

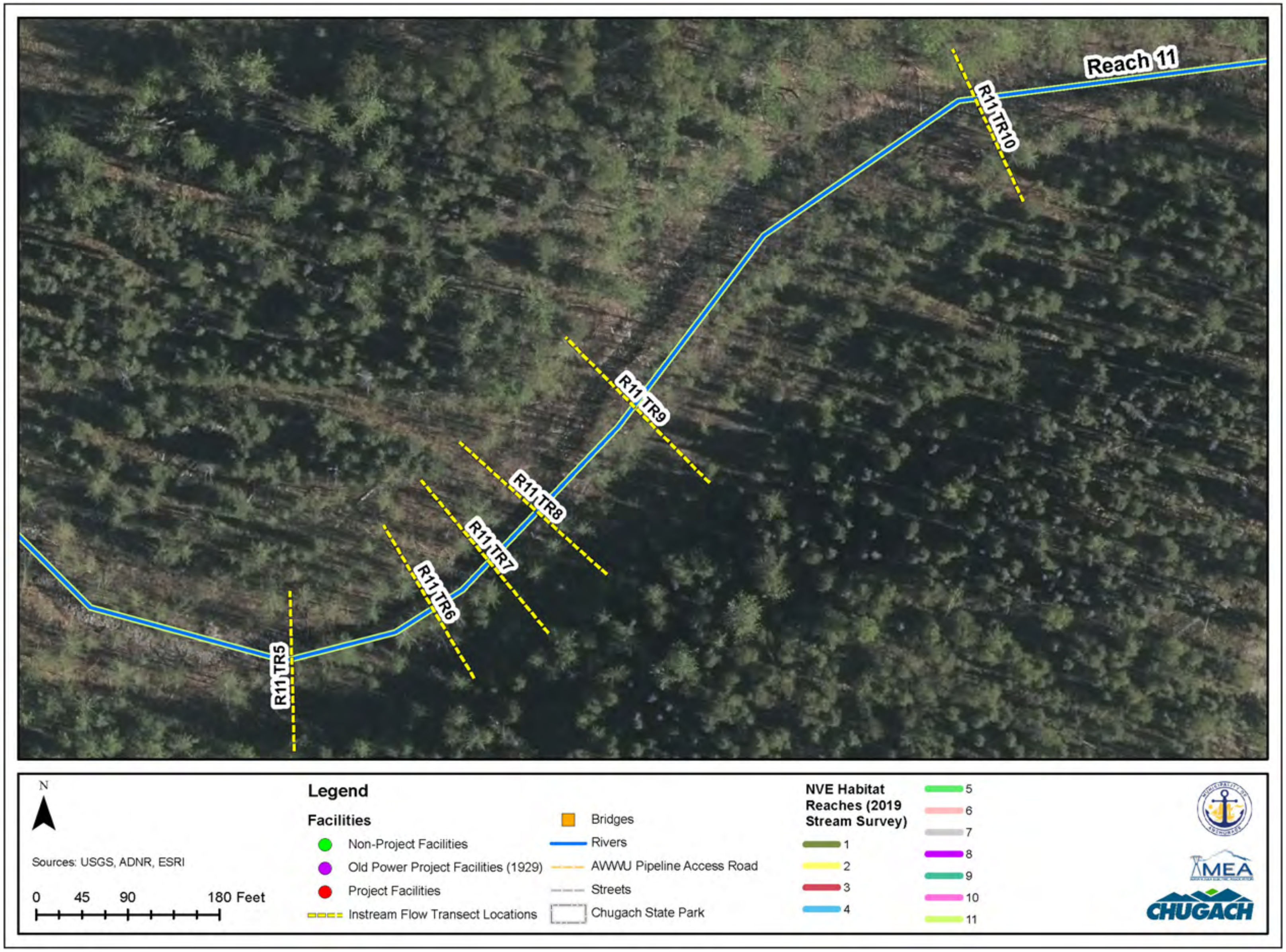
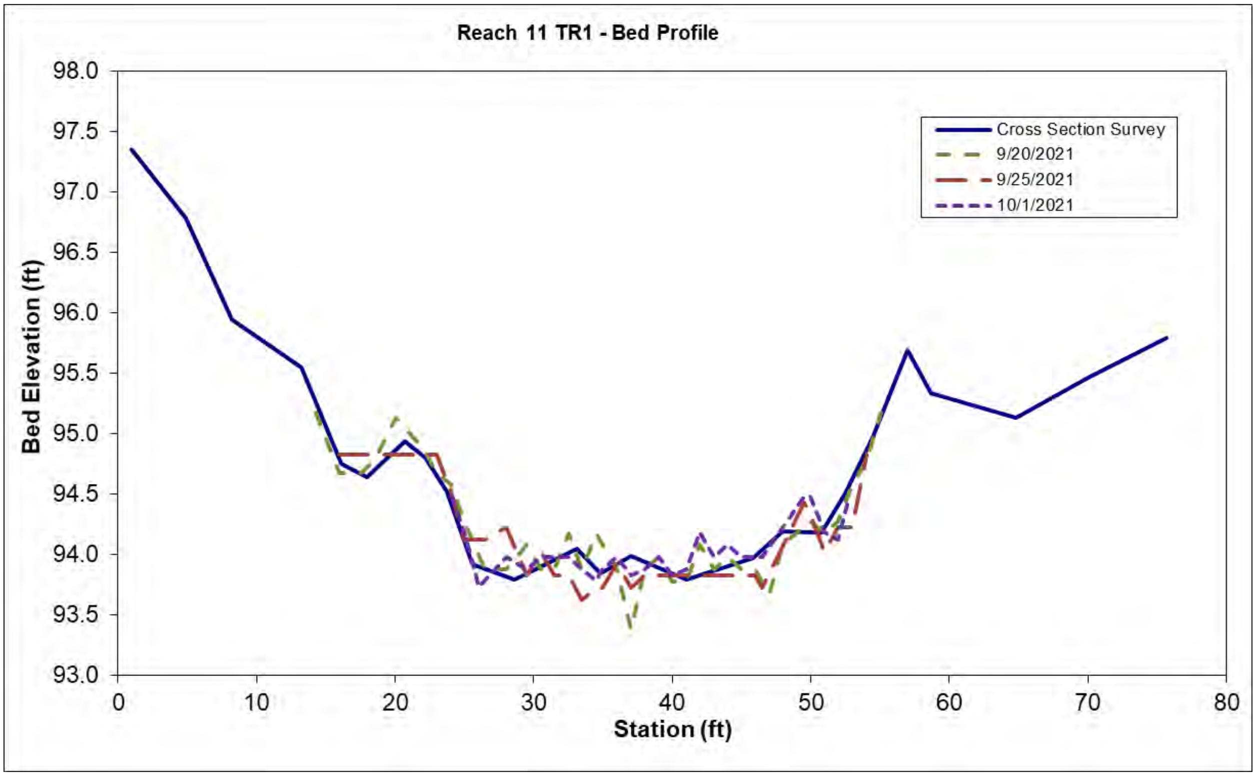


Figure A.1-70. Eklutna River, Alaska, Reach 11 transect location map (Transects 5-10).



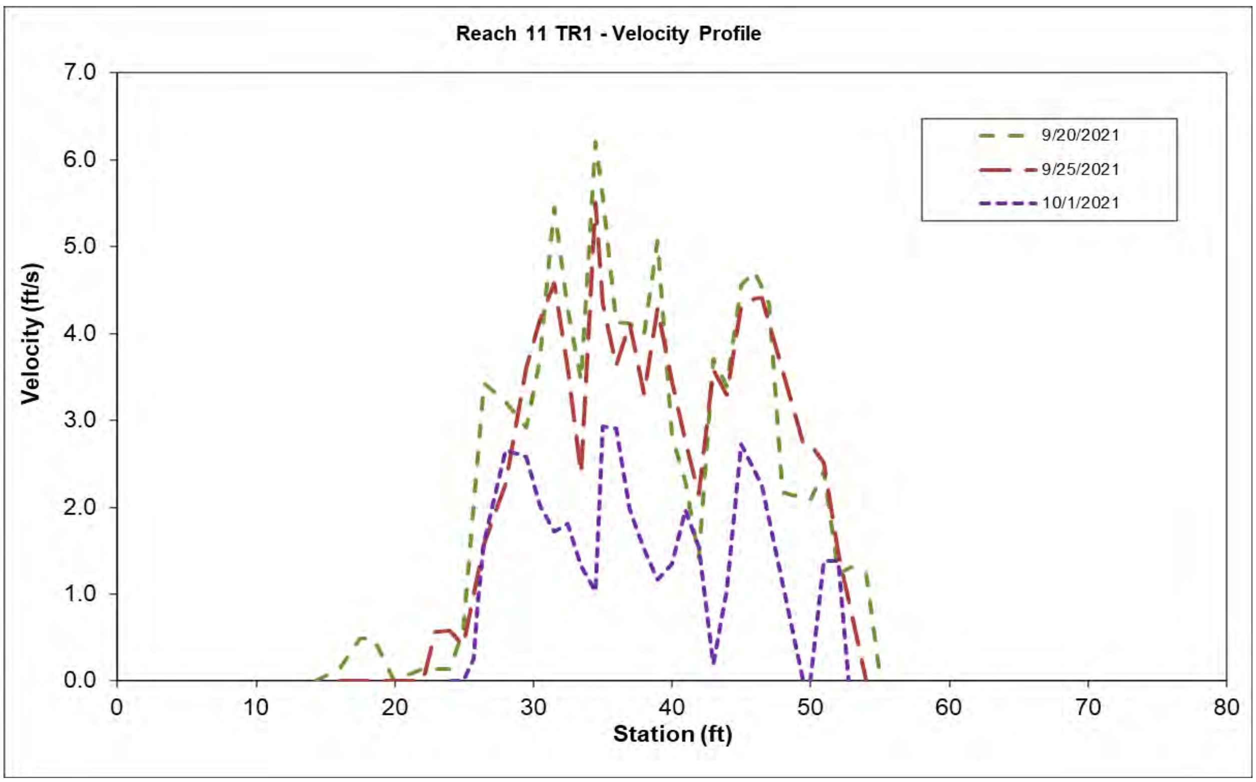


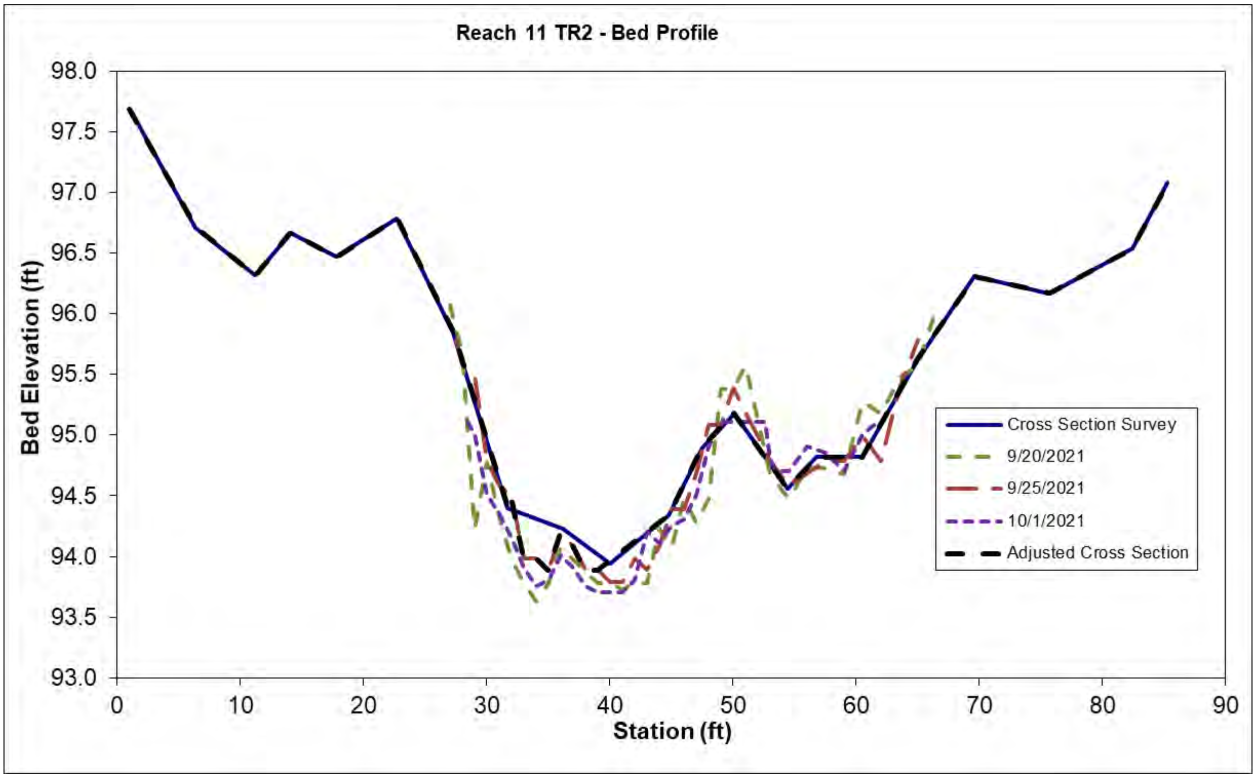
Figure A.1-71. Eklutna River, Alaska, Reach 11 Tr-1 bed profile (upper) and velocity profile (lower).

Figure A.1-72. Eklutna River, Alaska, Reach 11 Tr-1 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	97.35		0	800.51
4.9	96.78		3.9	799.94
8.2	95.94		7.2	799.10
13.2	95.55		12.2	798.71
16.1	94.75		15.1	797.91
18	94.64		17	797.80
20.7	94.94		19.7	798.10
22.2	94.80		21.2	797.96
23.7	94.52		22.7	797.68
25.6	93.92		24.6	797.08
28.6	93.79		27.6	796.95
33.1	94.05		32.1	797.21
34.8	93.84		33.8	797.00
37	93.99		36	797.15
41	93.79		40	796.95
45.8	93.97		44.8	797.13
48	94.19		47	797.35
50.8	94.18		49.8	797.34
52.5	94.50		51.5	797.66
54.5	94.97		53.5	798.13
57	95.69		56	798.85
58.7	95.33		57.7	798.49
64.8	95.13		63.8	798.29
70	95.46		69	798.62
75.7	95.79		74.7	798.95

Figure A.1-73. Eklutna River, Alaska, Reach 11 Tr-1 HEC-RAS survey data.



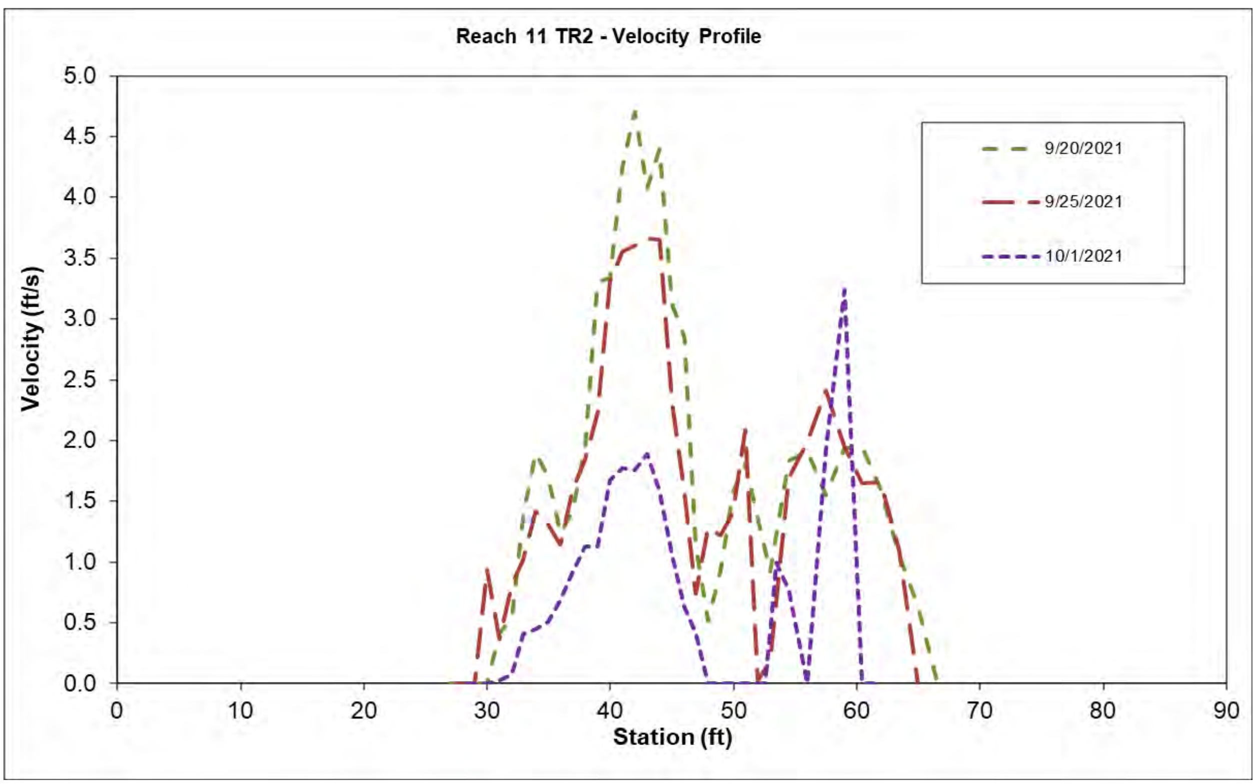


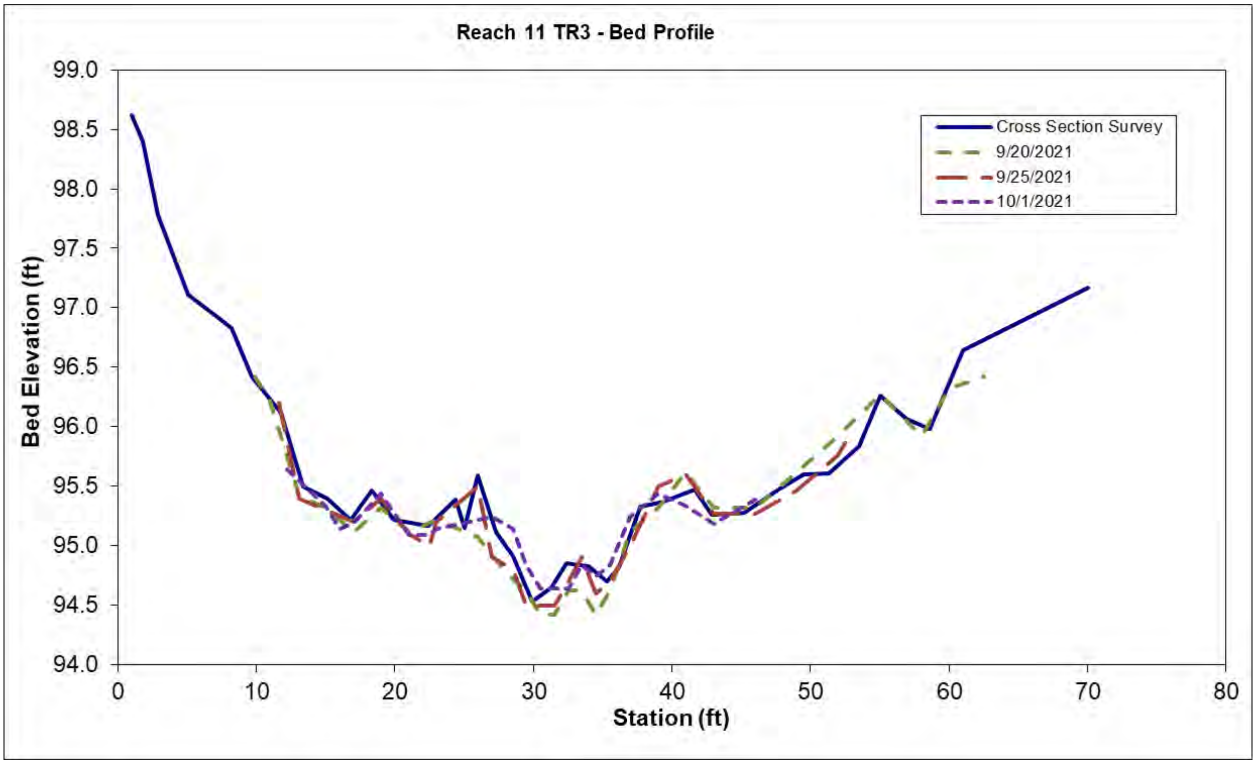
Figure A.1-74. Eklutna River, Alaska, Reach 11 Tr-2 bed profile (upper) and velocity profile (lower).

Figure A.1-75. Eklutna River, Alaska, Reach 11 Tr-2 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	97.69		0	800.85
6.4	96.71		5.4	799.87
11.2	96.32		10.2	799.48
14.1	96.67		13.1	799.83
17.8	96.47		16.8	799.63
22.7	96.79		21.7	799.95
27.3	95.85		26.3	799.01
31.7	94.40		30.7	797.56
32	94.49	*9/27 profile from WSE/depth	31	797.65
33	93.99	*9/27 profile from WSE/depth	32	797.15
34	93.99	*9/27 profile from WSE/depth	33	797.15
35	93.89	*9/27 profile from WSE/depth	34	797.05
36	94.19	*9/27 profile from WSE/depth	35	797.35
37	94.09	*9/27 profile from WSE/depth	36	797.25
38	93.89	*9/27 profile from WSE/depth	37	797.05
39	93.89	*9/27 profile from WSE/depth	38	797.05
44.8	94.34		43.8	797.50
47.5	94.90		46.5	798.06
50.1	95.18		49.1	798.34
54.4	94.56		53.4	797.72
56.8	94.82		55.8	797.98
60.5	94.82		59.5	797.98
65	95.63		64	798.79
69.6	96.31		68.6	799.47
75.7	96.17		74.7	799.33
82.4	96.54		81.4	799.70
85.3	97.08		84.3	800.24

Figure A.1-76. Eklutna River, Alaska, Reach 11 Tr-2 HEC-RAS survey data.



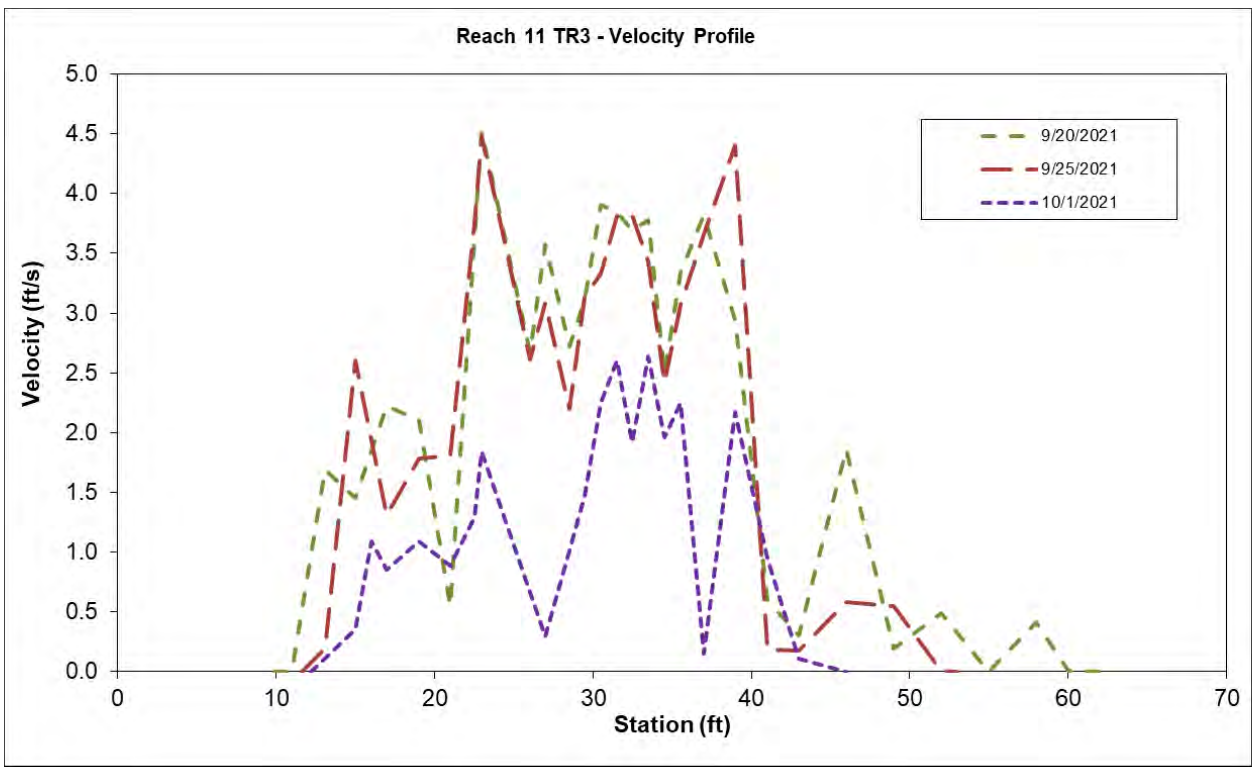


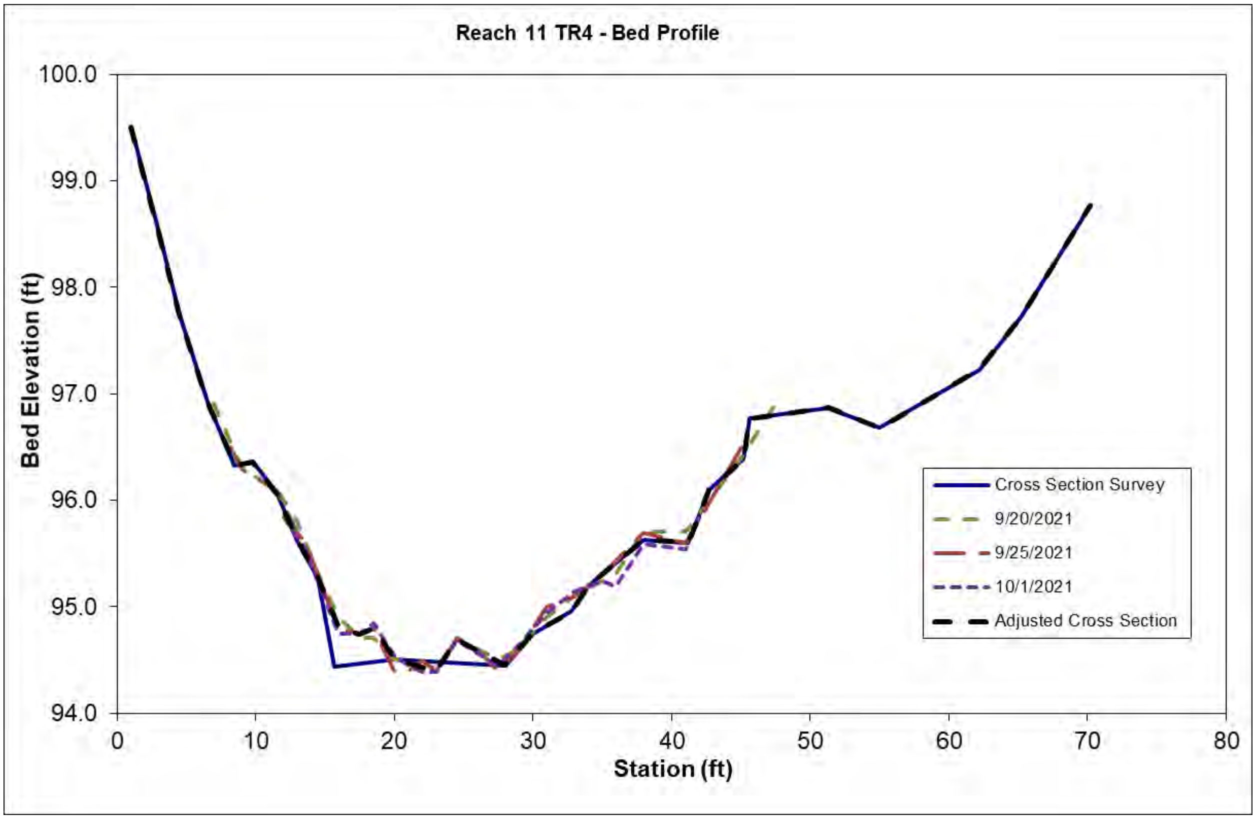
Figure A.1-77. Eklutna River, Alaska, Reach 11 Tr-3 bed profile (upper) and velocity profile (lower).

Figure A.1-78. Eklutna River, Alaska, Reach 11 Tr-3 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	98.62		0	801.78
1.8	98.40		0.8	801.56
2.9	97.78		1.9	800.94
5.1	97.11		4.1	800.27
6.9	96.95		5.9	800.11
8.2	96.83		7.2	799.99
9.7	96.42		8.7	799.58
11.8	96.12		10.8	799.28
13.4	95.50		12.4	798.66
15.1	95.40		14.1	798.56
16.8	95.22		15.8	798.38
18.3	95.46		17.3	798.62
19.9	95.22		18.9	798.38
22.4	95.17		21.4	798.33
24.4	95.39		23.4	798.55
25	95.15		24	798.31
26	95.59		25	798.75
27.3	95.12		26.3	798.28
28.5	94.91		27.5	798.07
29.9	94.53		28.9	797.69
31.3	94.65		30.3	797.81
32.4	94.85		31.4	798.01
34	94.83		33	797.99
35.3	94.70		34.3	797.86
36.2	94.82		35.2	797.98
37.7	95.33		36.7	798.49
39.4	95.37		38.4	798.53
41.6	95.47		40.6	798.63
42.9	95.26		41.9	798.42
45.2	95.28		44.2	798.44
47.7	95.47		46.7	798.63
49.5	95.60		48.5	798.76
51.3	95.61		50.3	798.77
53.5	95.84		52.5	799.00
55	96.26		54	799.42
56.9	96.07		55.9	799.23
58.6	95.98		57.6	799.14
61	96.64		60	799.80
70	97.17		69	800.33

Figure A.1-79. Eklutna River, Alaska, Reach 11 Tr-3 HEC-RAS survey data.



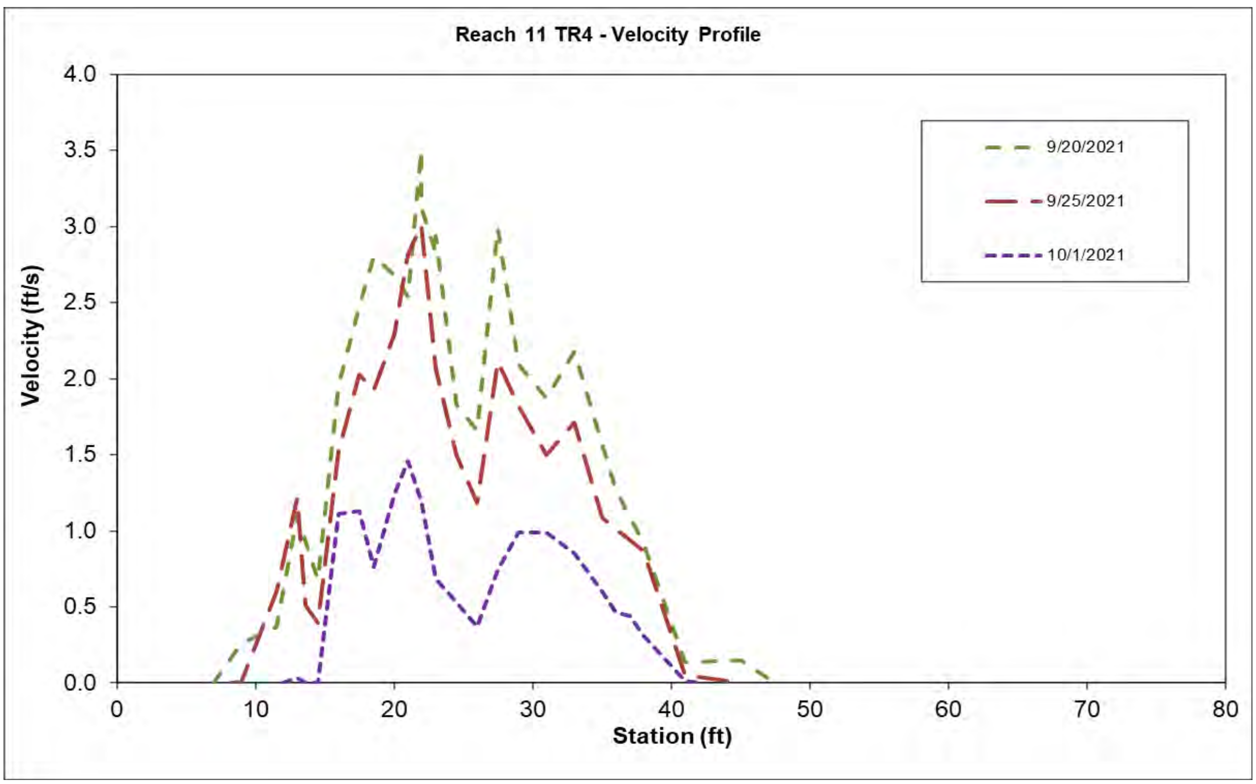
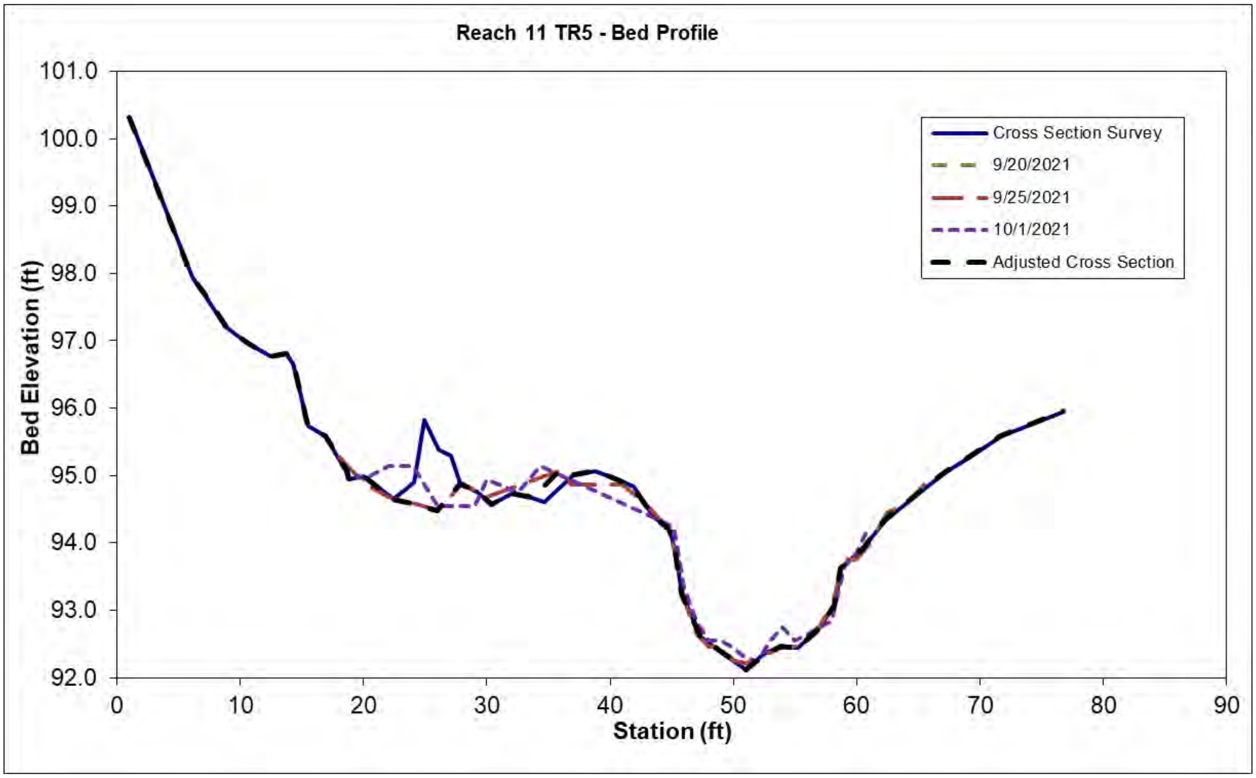


Figure A.1-80. Eklutna River, Alaska, Reach 11 Tr-4 bed profile (upper) and velocity profile (lower).

Figure A.1-81. Eklutna River, Alaska, Reach 11 Tr-4 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	99.50		0	802.66
3	98.51		2	801.67
4.5	97.74		3.5	800.90
6.5	96.93		5.5	800.09
8.5	96.33		7.5	799.49
9.8	96.36		8.8	799.52
11.5	96.07		10.5	799.23
13	95.62		12	798.78
14.5	95.27		13.5	798.43
16	94.80	*From 9/25 WSE/depth profile	15	797.96
17.5	94.75	*From 9/25 WSE/depth profile	16.5	797.91
18.5	94.80	*From 9/25 WSE/depth profile	17.5	797.96
20	94.51		19	797.67
23	94.40	*From 9/25 WSE/depth profile	22	797.56
24.5	94.70	*From 9/25 WSE/depth profile	23.5	797.86
28	94.45		27	797.61
30	94.75		29	797.91
32.8	94.96		31.8	798.12
34	95.20		33	798.36
38	95.63		37	798.79
41.2	95.60		40.2	798.76
42.7	96.10		41.7	799.26
45.2	96.39		44.2	799.55
45.6	96.77		44.6	799.93
51.3	96.87		50.3	800.03
55	96.68		54	799.84
62.2	97.23		61.2	800.39
65.2	97.72		64.2	800.88
70.2	98.77		69.2	801.93

Figure A.1-82. Eklutna River, Alaska, Reach 11 Tr-4 HEC-RAS survey data.



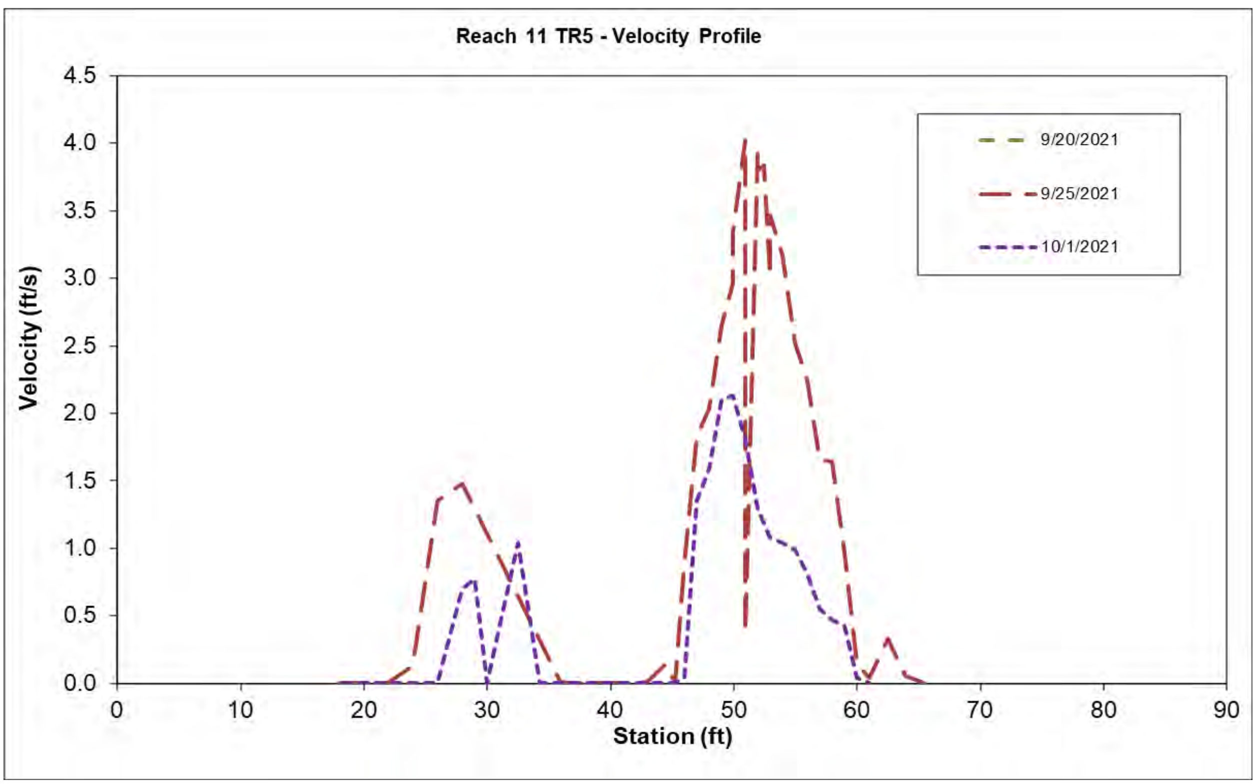
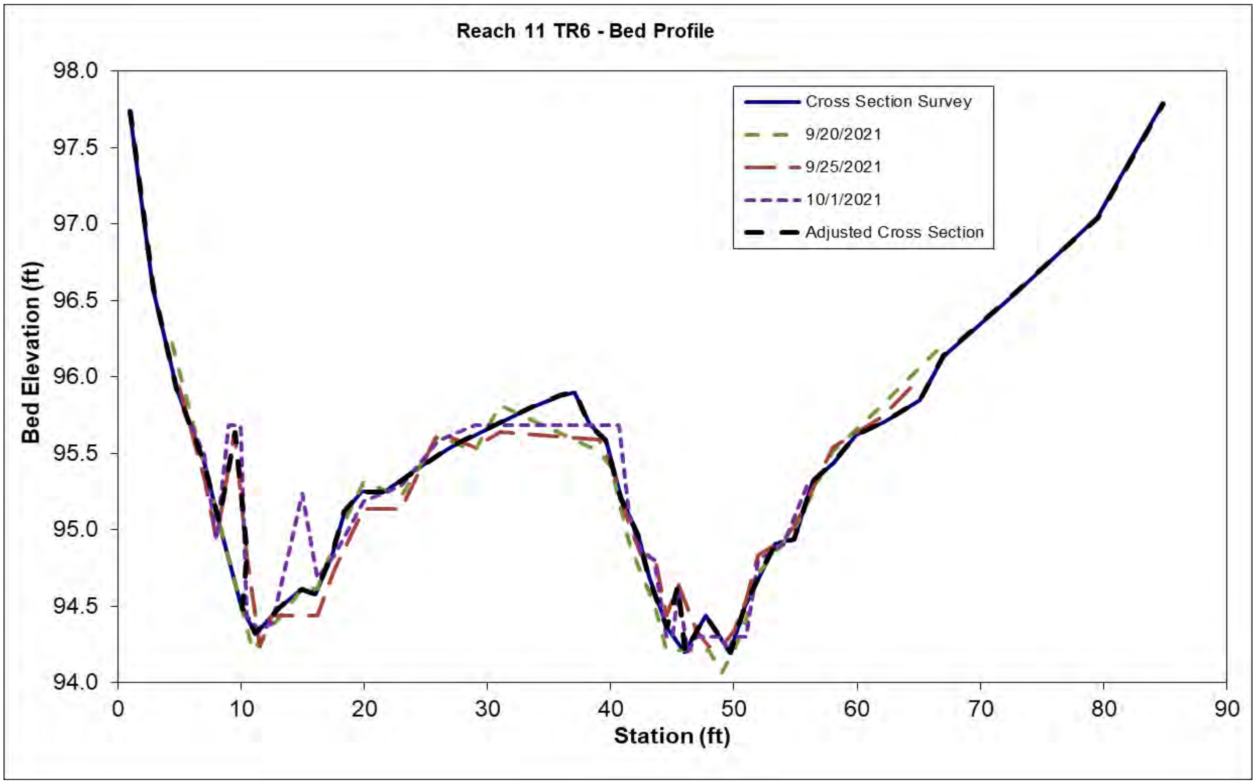


Figure A.1-83. Eklutna River, Alaska, Reach 11 Tr-5 bed profile (upper) and velocity profile (lower).

Figure A.1-84. Eklutna River, Alaska, Reach 11 Tr-5 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	100.31		0	868.39
6.1	97.95		5.1	866.03
7.2	97.66		6.2	865.74
8.8	97.22		7.8	865.30
10.4	96.99		9.4	865.07
12.4	96.77		11.4	864.85
13.7	96.81		12.7	864.89
14.3	96.67		13.3	864.75
15.5	95.73		14.5	863.81
16.9	95.59		15.9	863.67
17.7	95.34		16.7	863.42
18.6	95.07		17.6	863.15
18.8	94.94		17.8	863.02
20	94.99		19	863.07
22.4	94.65		21.4	862.73
24	94.59	*9/25 WSE/depth profile	23	862.67
26	94.49	*9/25 WSE/depth profile	25	862.57
27.8	94.88		26.8	862.96
29.2	94.76		28.2	862.84
30.4	94.57		29.4	862.65
32	94.73		31	862.81
33.7	94.67		32.7	862.75
36	95.09	*9/25 WSE/depth profile	35	863.17
37	95.01		36	863.09
38.8	95.07		37.8	863.15
41	94.91		40	862.99
41.9	94.83		40.9	862.91
43.5	94.39		42.5	862.47
44.8	94.20		43.8	862.28
45.3	93.85		44.3	861.93
45.8	93.24		44.8	861.32
47.4	92.59		46.4	860.67
49.1	92.37		48.1	860.45
51	92.12		50	860.20
52.6	92.36		51.6	860.44
53.9	92.46		52.9	860.54
55.2	92.44		54.2	860.52
56.8	92.70		55.8	860.78
58.2	93.08		57.2	861.16
58.7	93.63		57.7	861.71
60.4	93.89		59.4	861.97
62.3	94.34		61.3	862.42
65.7	94.84		64.7	862.92
67.2	95.05		66.2	863.13
69.2	95.28		68.2	863.36
71.7	95.59		70.7	863.67
76.8	95.95		75.8	864.03

Figure A.1-85. Eklutna River, Alaska, Reach 11 Tr-5 HEC-RAS survey data.



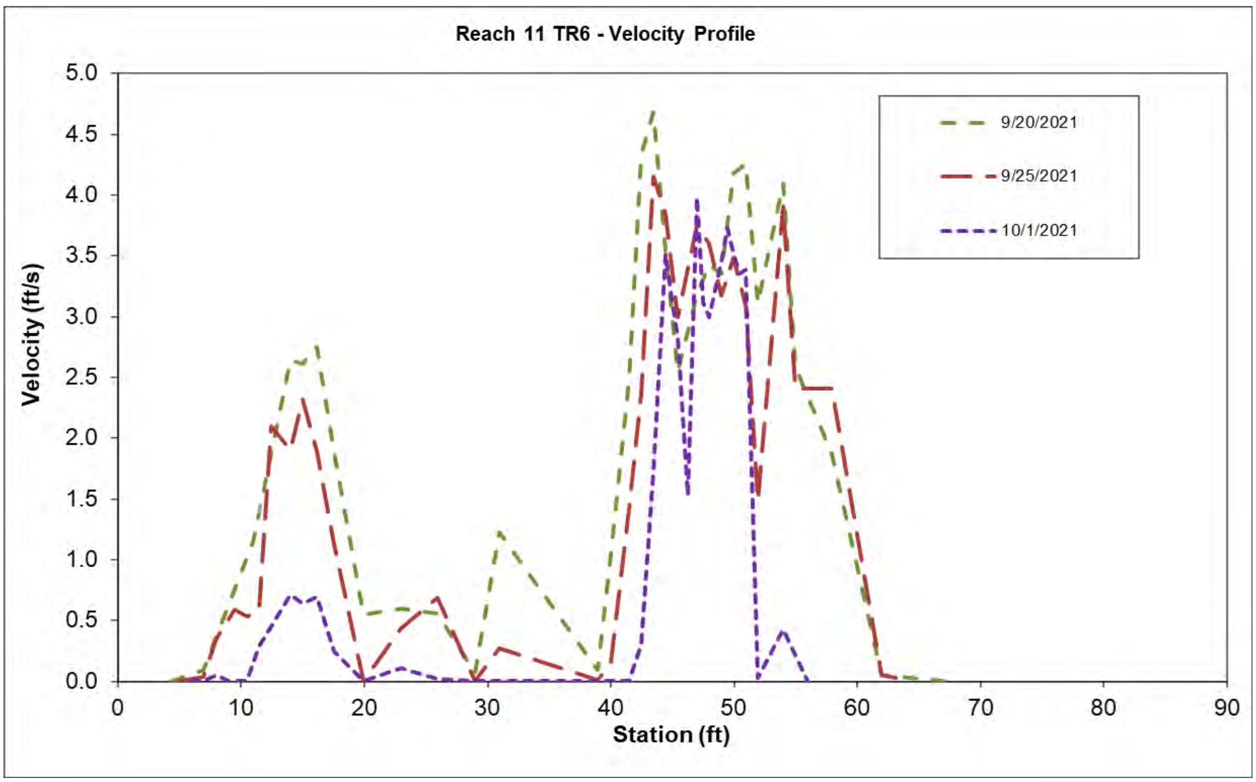


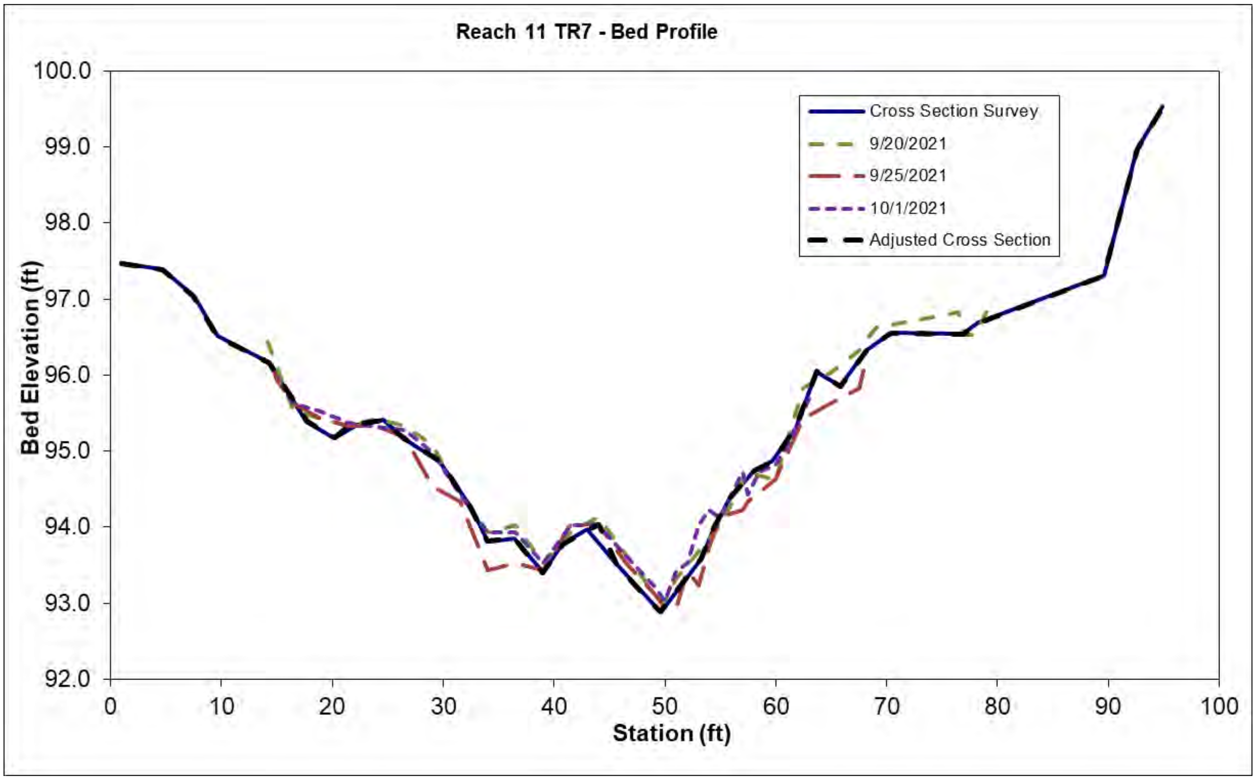
Figure A.1-86. Eklutna River, Alaska, Reach 11 Tr-6 bed profile (upper) and velocity profile (lower).

Figure A.1-87. Eklutna River, Alaska, Reach 11 Tr-6 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	97.74		0	865.82
2.9	96.58		1.9	864.66
4.8	95.92		3.8	864.00
7	95.44		6	863.52
8.2	95.06		7.2	863.14
9.5	95.64	*9/25 WSE/depth profile	8.5	863.72
10.5	94.84	*9/25 WSE/depth profile	9.5	862.92
10.1	94.49		9.1	862.57
11.2	94.32		10.2	862.40
13.1	94.49		12.1	862.57
14.9	94.61		13.9	862.69
16	94.58		15	862.66
17.4	94.84		16.4	862.92
18.4	95.12		17.4	863.20
19.8	95.25		18.8	863.33
21.7	95.25		20.7	863.33
24	95.38		23	863.46
27	95.54		26	863.62
33.5	95.80		32.5	863.88
36	95.88		35	863.96
37.1	95.90		36.1	863.98
38.3	95.69		37.3	863.77
39.6	95.59		38.6	863.67
40.8	95.21		39.8	863.29
42.2	94.97		41.2	863.05
43.1	94.69		42.1	862.77
44.6	94.36		43.6	862.44
45.5	94.64	*9/25 WSE/depth profile	44.5	862.72
46	94.20		45	862.28
47.7	94.44		46.7	862.52
49.7	94.20		48.7	862.28
50.9	94.50		49.9	862.58
52.7	94.80		51.7	862.88
53.4	94.91		52.4	862.99
54.9	94.94		53.9	863.02
56.4	95.32		55.4	863.40
58.1	95.44		57.1	863.52
59.9	95.62		58.9	863.70
62.3	95.71		61.3	863.79
65.1	95.85		64.1	863.93
67	96.14		66	864.22
73	96.56		72	864.64
79.5	97.04		78.5	865.12
84.8	97.79		83.8	865.87

Figure A.1-88. Eklutna River, Alaska, Reach 11 Tr-6 HEC-RAS survey data.



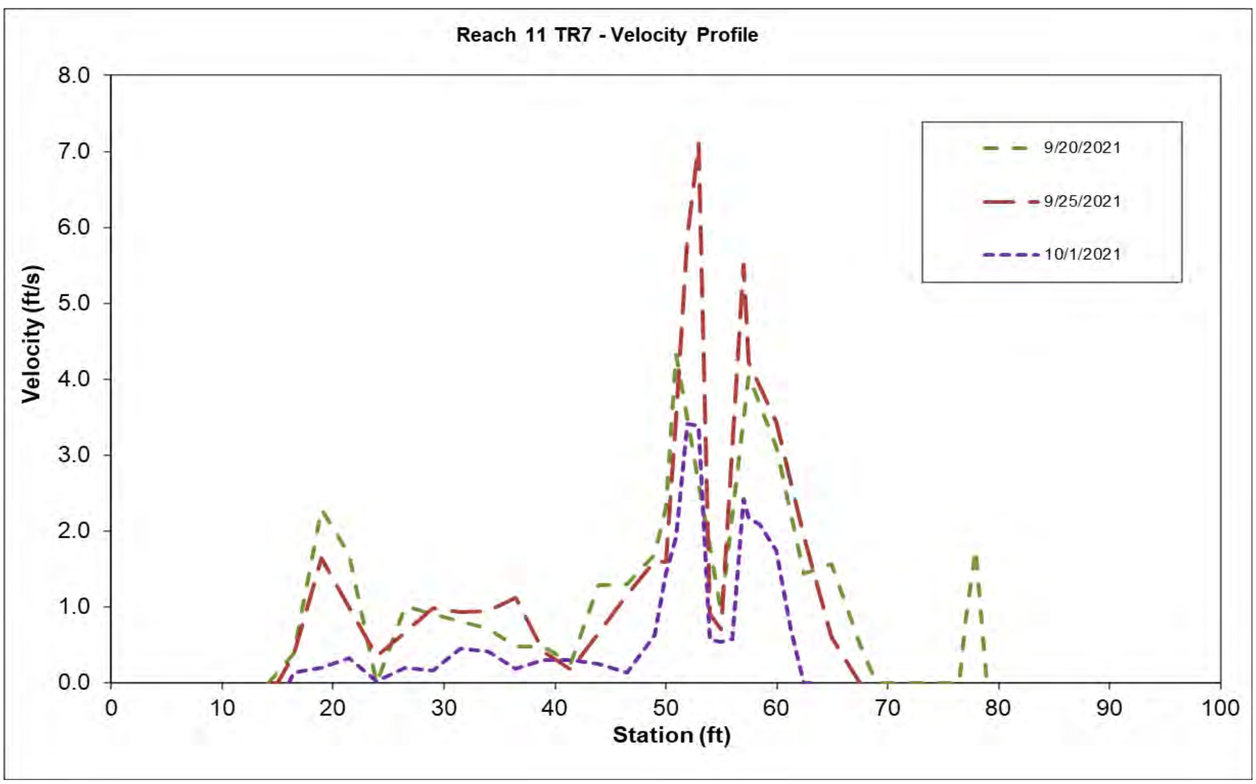


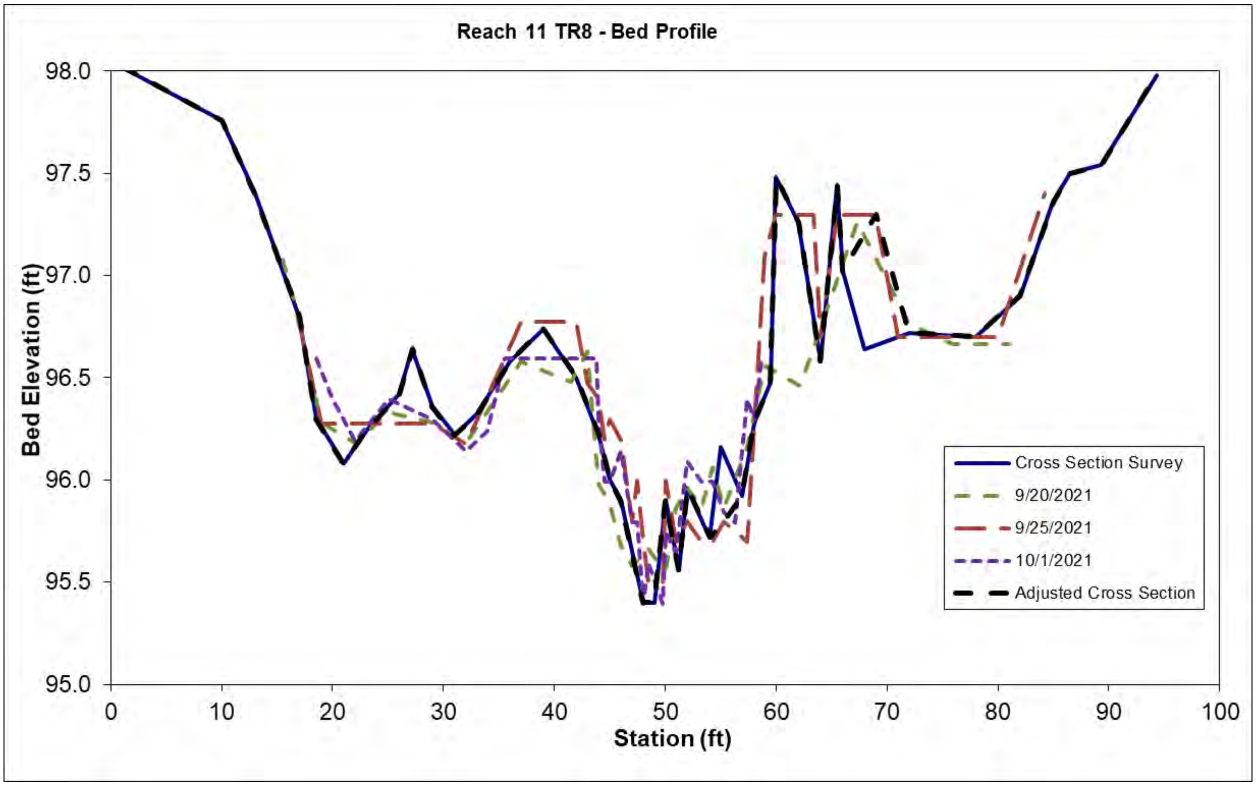
Figure A.1-89. Eklutna River, Alaska, Reach 11 Tr-7 bed profile (upper) and velocity profile (lower).

Figure A.1-90. Eklutna River, Alaska, Reach 11 Tr-7 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	97.47		0	865.55
4.7	97.39		3.7	865.47
7.5	97.04		6.5	865.12
9.6	96.51		8.6	864.59
14.3	96.16		13.3	864.24
17.7	95.39		16.7	863.47
20.2	95.17		19.2	863.25
21.5	95.33	*9/25 WSE/depth profile	20.5	863.41
22.2	95.35		21.2	863.43
24.6	95.41		23.6	863.49
26.5	95.16		25.5	863.24
29.7	94.86		28.7	862.94
32.5	94.25		31.5	862.33
34	93.81		33	861.89
36.4	93.85		35.4	861.93
39	93.40		38	861.48
40.8	93.78		39.8	861.86
43	93.97		42	862.05
44	94.03	*9/25 WSE/depth profile	43	862.11
45.6	93.52		44.6	861.60
47.5	93.21		46.5	861.29
49.6	92.88		48.6	860.96
53.3	93.59		52.3	861.67
54.2	93.93		53.2	862.01
55.8	94.37		54.8	862.45
57.9	94.73		56.9	862.81
59.7	94.87		58.7	862.95
61.8	95.31		60.8	863.39
63.7	96.05		62.7	864.13
65.8	95.85		64.8	863.93
68.2	96.33		67.2	864.41
70.4	96.55		69.4	864.63
76.9	96.54		75.9	864.62
78.3	96.69		77.3	864.77
89.6	97.31		88.6	865.39
92.6	98.97		91.6	867.05
94.9	99.53		93.9	867.61

Figure A.1-91. Eklutna River, Alaska, Reach 11 Tr-7 HEC-RAS survey data.



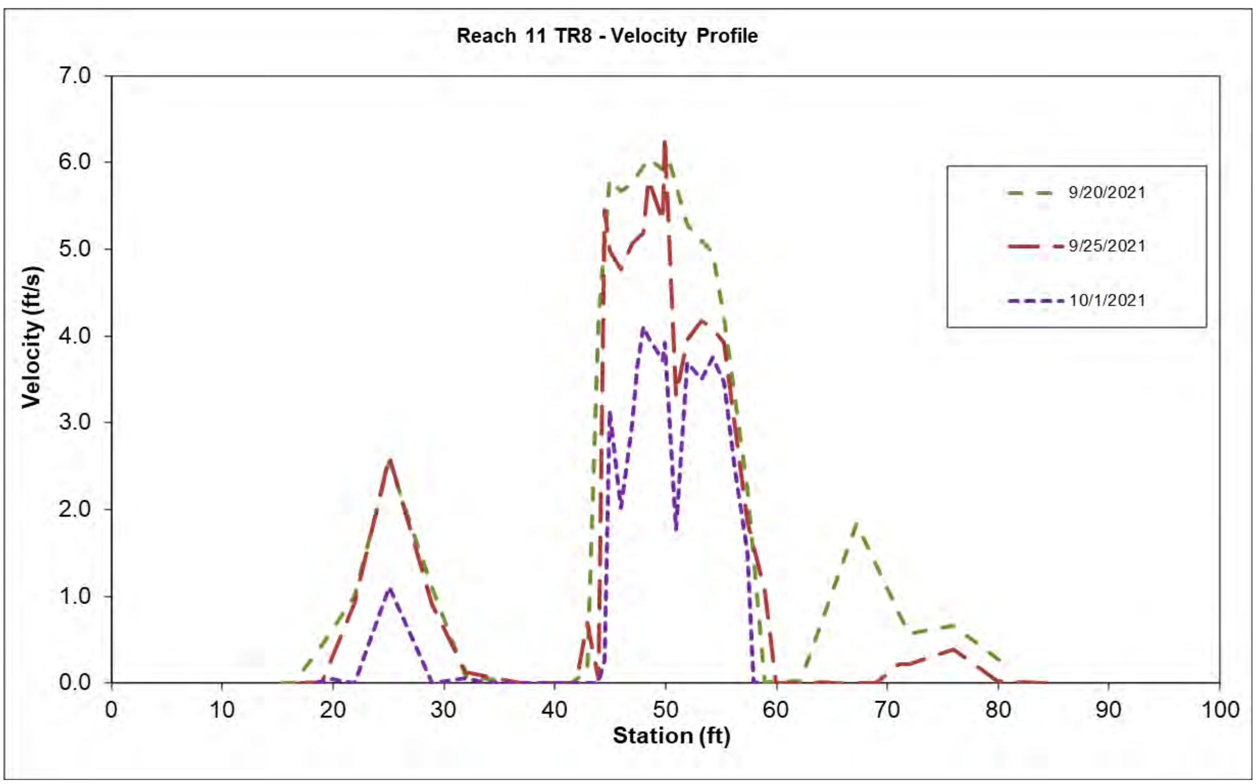
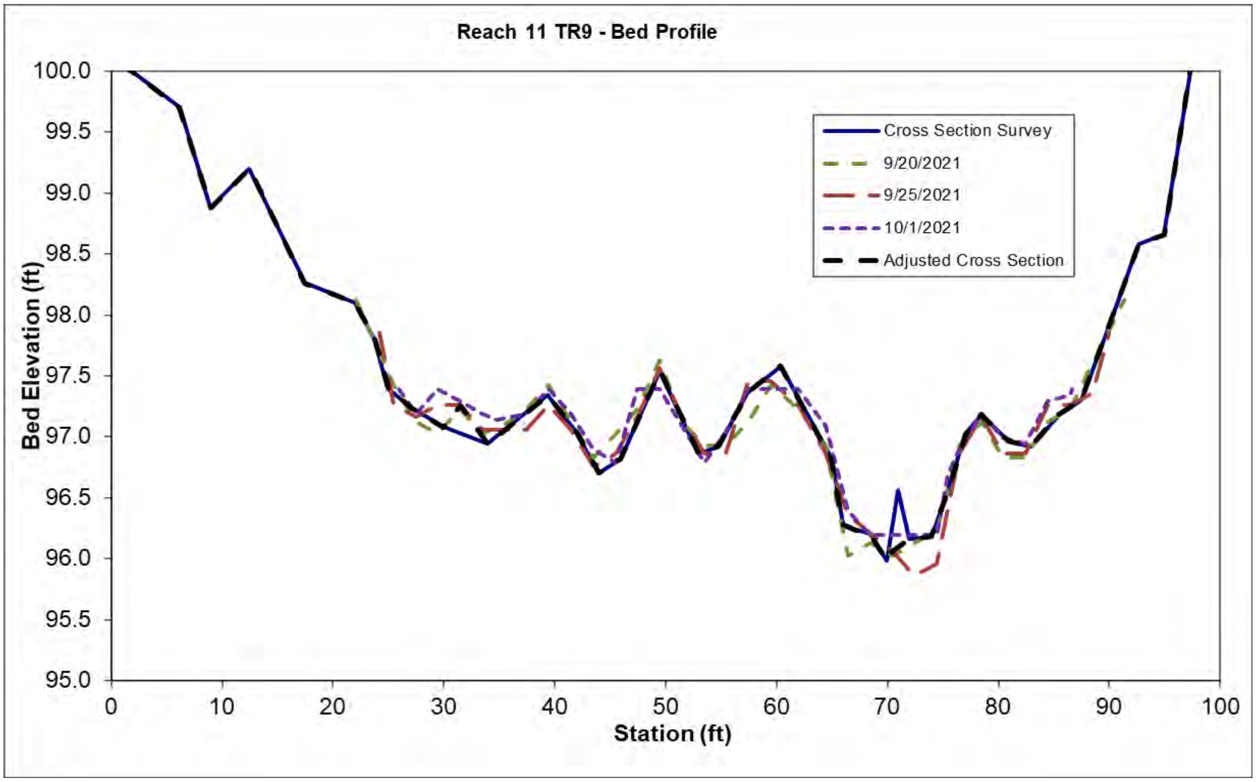


Figure A.1-92. Eklutna River, Alaska, Reach 11 Tr-8 bed profile (upper) and velocity profile (lower).

Figure A.1-93. Eklutna River, Alaska, Reach 11 Tr-8 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	98.02		0	866.10
10	97.76		9	865.84
13	97.40		12	865.48
17	96.80		16	864.88
18.5	96.30		17.5	864.38
21	96.08		20	864.16
23	96.24		22	864.32
26	96.42		25	864.50
27.2	96.64		26.2	864.72
29	96.36		28	864.44
31	96.22		30	864.30
33	96.32		32	864.40
36	96.58		35	864.66
39	96.74		38	864.82
42	96.50		41	864.58
44	96.22		43	864.30
45	96.00		44	864.08
46	95.90		45	863.98
48	95.40		47	863.48
49	95.40		48	863.48
50	95.90		49	863.98
51.2	95.56		50.2	863.64
52	95.96		51	864.04
54	95.72		53	863.80
55.3	95.80	*9/25 WSE/depth profile, removed sta 55	54.3	863.88
56.9	95.92		55.9	864.00
58	96.28		57	864.36
59.5	96.48		58.5	864.56
60	97.48		59	865.56
62	97.26		61	865.34
64	96.58		63	864.66
65.5	97.44		64.5	865.52
66	97.02		65	865.10
69	97.30	*9/25 WSE/depth profile, removed sta 68 from channel profile	68	865.38
72	96.72		71	864.80
78	96.70		77	864.78
82	96.90		81	864.98
85	97.36		84	865.44
86.5	97.50		85.5	865.58
89.3	97.54		88.3	865.62
94.3	97.98		93.3	866.06

Figure A.1-94. Eklutna River, Alaska, Reach 11 Tr-8 HEC-RAS survey data.



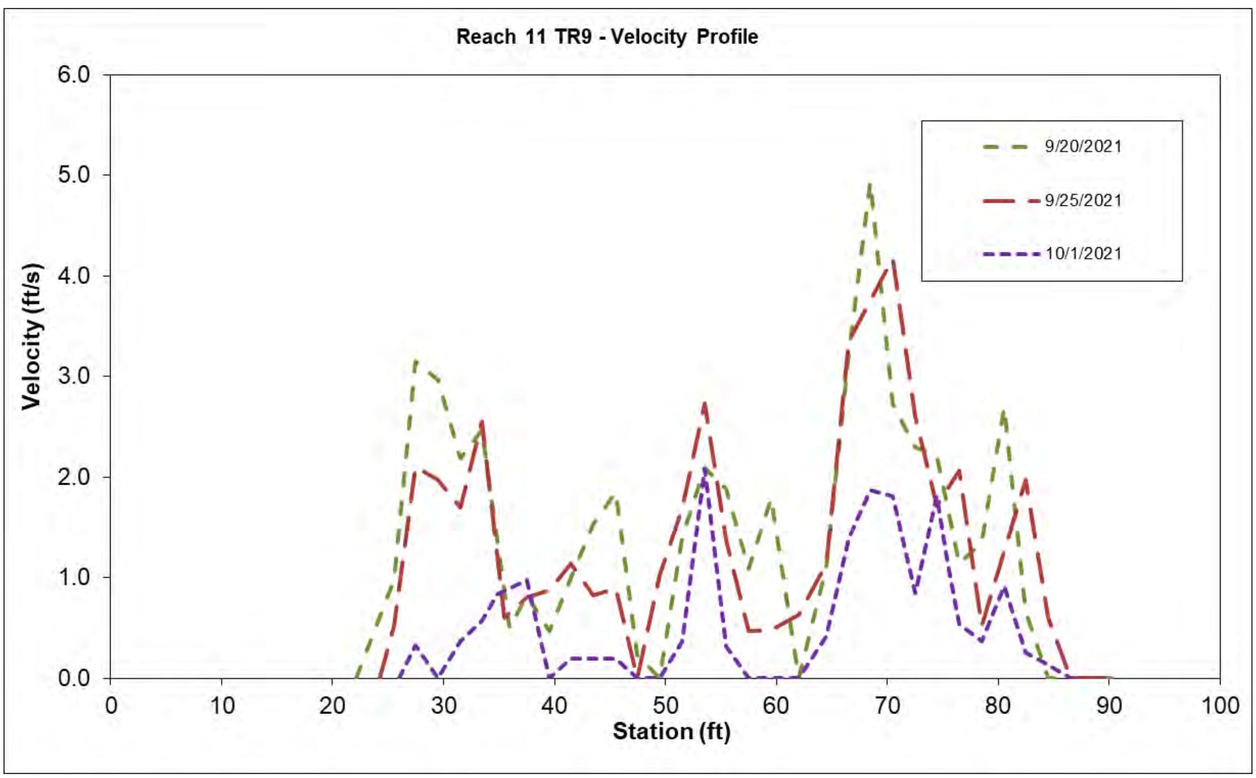
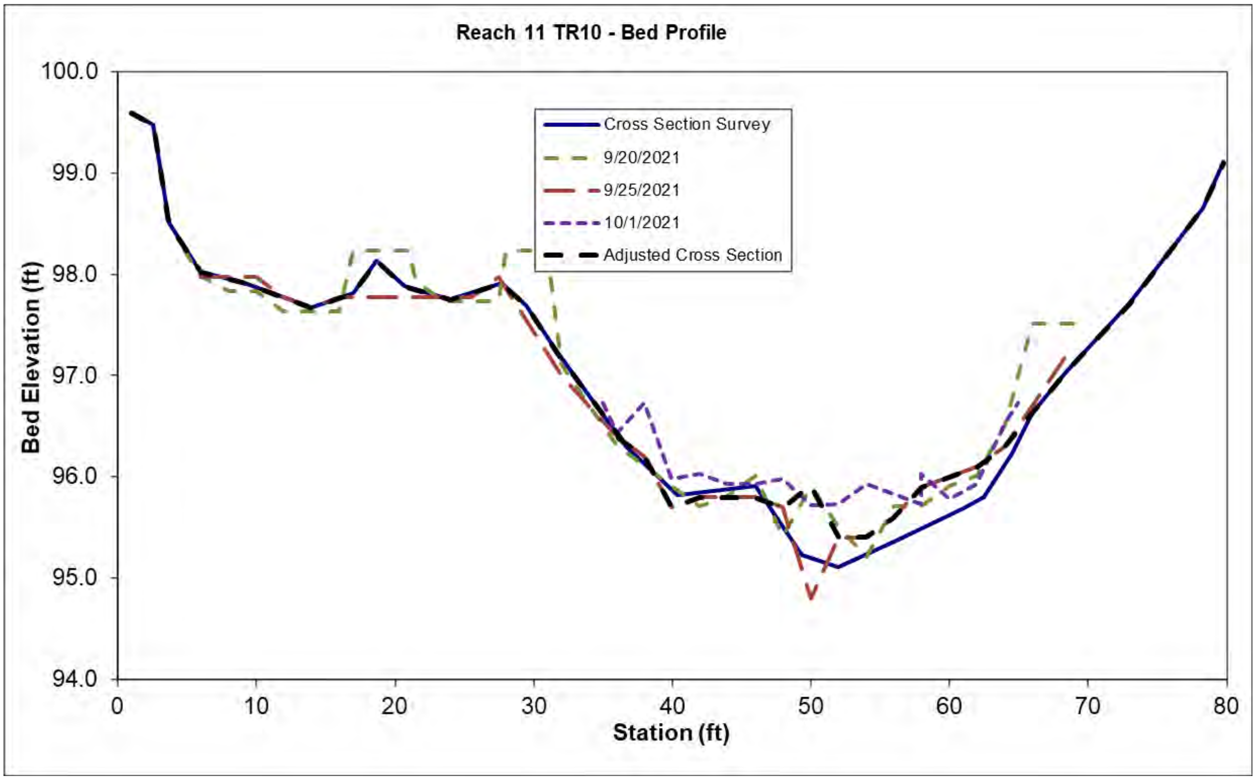


Figure A.1-95. Eklutna River, Alaska, Reach 11 Tr-9 bed profile (upper) and velocity profile (lower).

Figure A.1-96. Eklutna River, Alaska, Reach 11 Tr-9 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey				
Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	100.06		0	868.14
6.2	99.70		5.2	867.78
9	98.88		8	866.96
12.5	99.20		11.5	867.28
17.5	98.26		16.5	866.34
22	98.10		21	866.18
23.8	97.80		22.8	865.88
25	97.40		24	865.48
27	97.24		26	865.32
30	97.08		29	865.16
31.5	97.26	*9/25 WSE/depth profile	30.5	865.34
34	96.94		33	865.02
36.4	97.12		35.4	865.20
39.4	97.34		38.4	865.42
42	97.04		41	865.12
44	96.70		43	864.78
46	96.82		45	864.90
49.5	97.54		48.5	865.62
53	96.86		52	864.94
54.8	96.92		53.8	865.00
57.4	97.36		56.4	865.44
60.4	97.58		59.4	865.66
65	96.82		64	864.90
66	96.28		65	864.36
67	96.24		66	864.32
68.5	96.20		67.5	864.28
70	95.98		69	864.06
70.5	96.06	*9/25 WSE/depth profile, removed station 71 from channel profile	69.5	864.14
72	96.16		71	864.24
74	96.18		73	864.26
75.5	96.56		74.5	864.64
77.1	97.02		76.1	865.10
78.5	97.18		77.5	865.26
81	96.96		80	865.04
83	96.92		82	865.00
85.5	97.18		84.5	865.26
87.5	97.30		86.5	865.38
90	97.90		89	865.98
92.7	98.58		91.7	866.66
95	98.66		94	866.74
97.5	100.10		96.5	868.18

Figure A.1-97. Eklutna River, Alaska, Reach 11 Tr-9 HEC-RAS survey data.



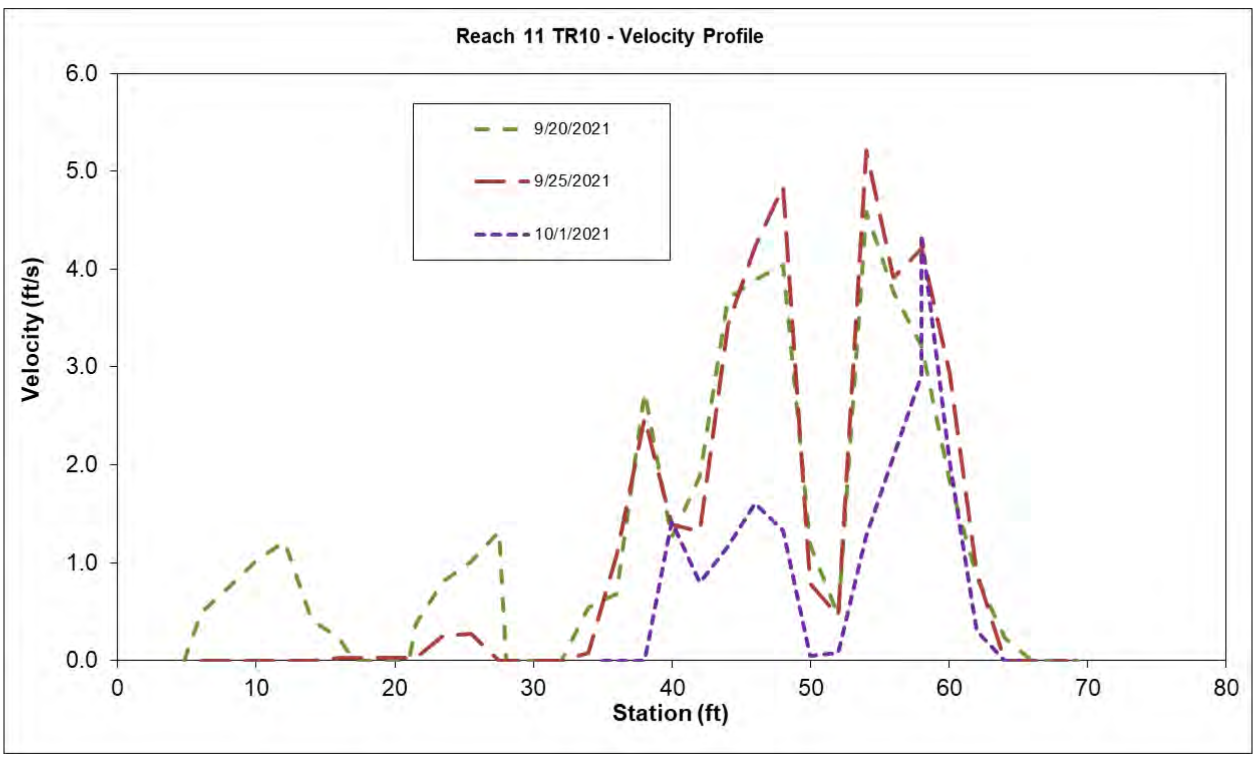


Figure A.1-98. Eklutna River, Alaska, Reach 11 Tr-10 bed profile (upper) and velocity profile (lower).

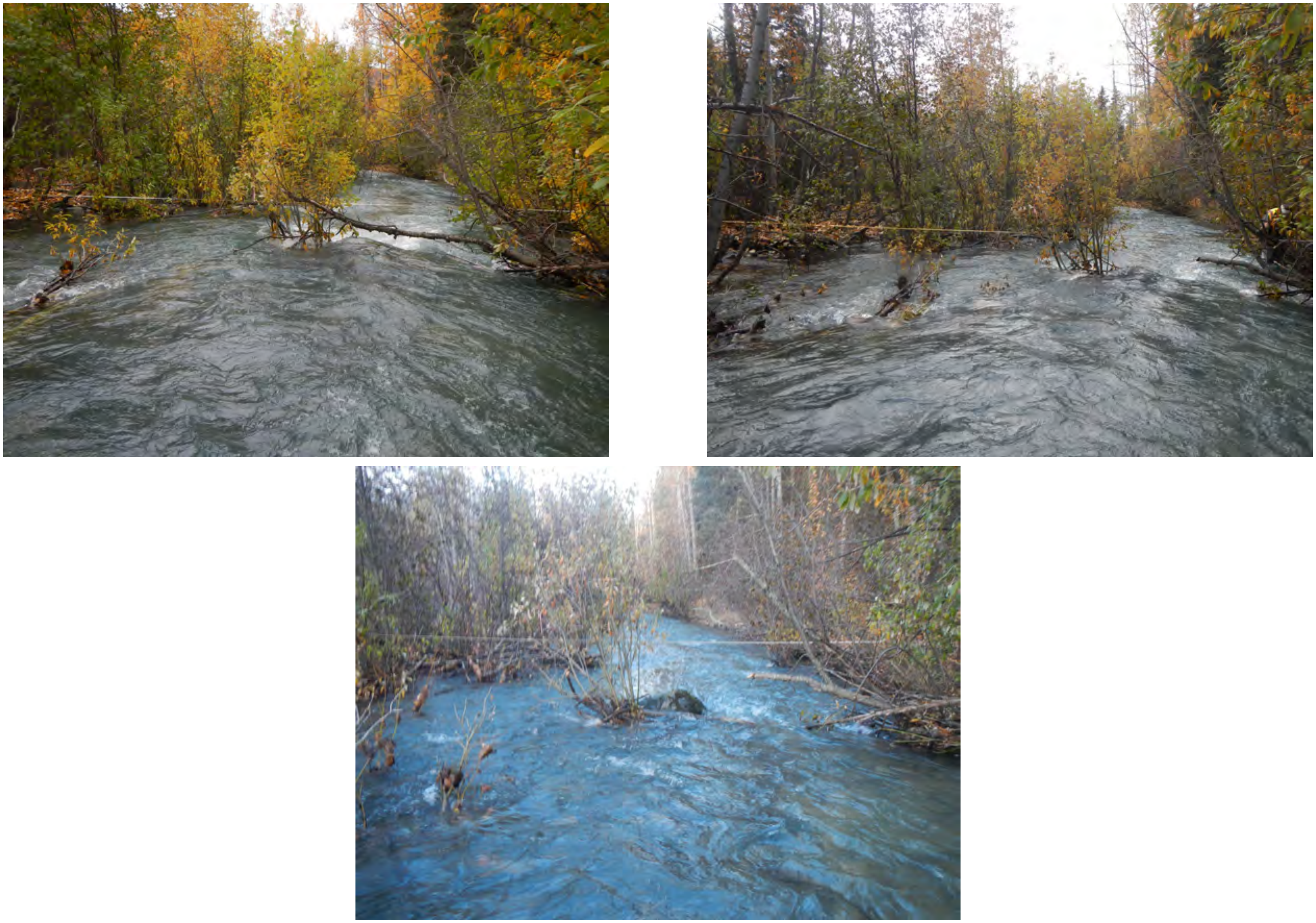


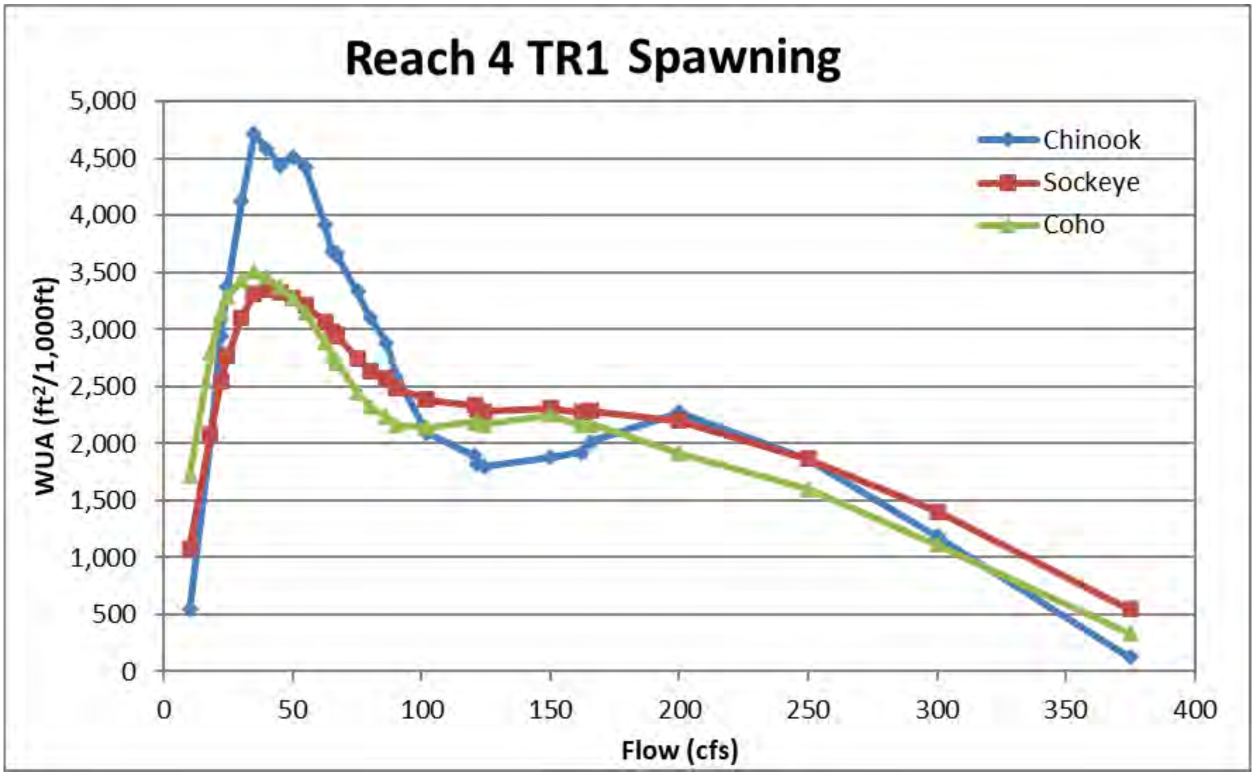
Figure A.1-99. Eklutna River, Alaska, Reach 11 Tr-10 representative photographs for high (upper left), mid (upper right), and low (bottom) flow sampling.

Channel Profile from Survey

Sta (ft)	Ground (ft, 100 ft datum)	Notes	Adj Station (ft)	Ground (ft, RTK)
1	99.59		0	870.72
2.6	99.47		1.6	870.60
3.7	98.50		2.7	869.63
6	98.02		5	869.15
9	97.92		8	869.05
14	97.67		13	868.80
17	97.81		16	868.94
18.7	98.13		17.7	869.26
20.7	97.88		19.7	869.01
24	97.75		23	868.88
27.7	97.91		26.7	869.04
29.5	97.69		28.5	868.82
31.7	97.23		30.7	868.36
36.7	96.30		35.7	867.43
36	96.40	*9/25 WSE/depth profile	35	867.53
38	96.20	*9/25 WSE/depth profile	37	867.33
40	95.70	*9/25 WSE/depth profile	39	866.83
42	95.80	*9/25 WSE/depth profile	41	866.93
44	95.80	*9/25 WSE/depth profile	43	866.93
46	95.80	*9/25 WSE/depth profile	45	866.93
48	95.70	*9/25 WSE/depth profile	47	866.83
50	95.91	*9/20 WSE/depth profile	49	867.04
52	95.40	*9/25 WSE/depth profile	51	866.53
54	95.40	*9/25 WSE/depth profile	53	866.53
56	95.60	*9/25 WSE/depth profile	55	866.73
58	95.90	*9/25 WSE/depth profile	57	867.03
60	96.00	*9/25 WSE/depth profile	59	867.13
62	96.10	*9/25 WSE/depth profile	61	867.23
64	96.30	*9/25 WSE/depth profile	63	867.43
66	96.63		65	867.76
68.5	97.04		67.5	868.17
73	97.71		72	868.84
78.3	98.65		77.3	869.78
79.8	99.10		78.8	870.23

Figure A.1-100. Eklutna River, Alaska, Reach 11 Tr-10 HEC-RAS survey data.

Appendix 2: Transect Based Habitat vs. Flow Relationships



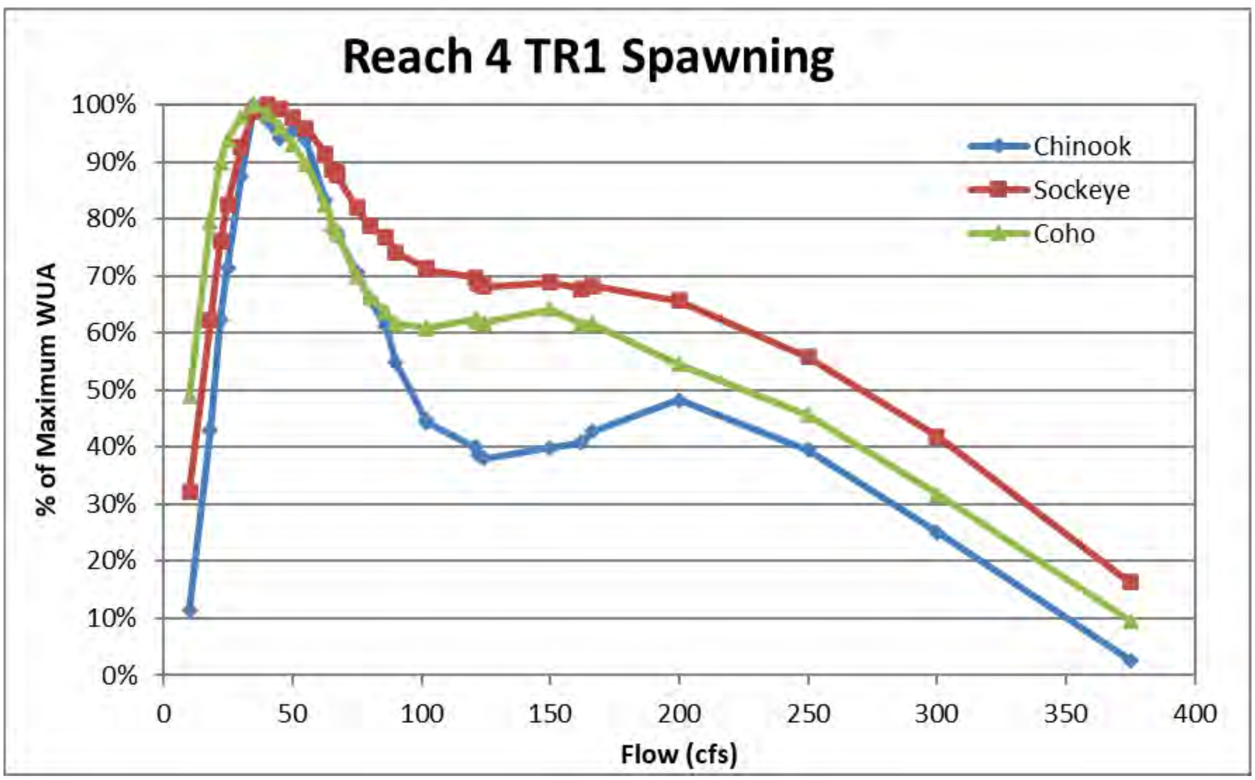


Figure A.2-1. Reach 4 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

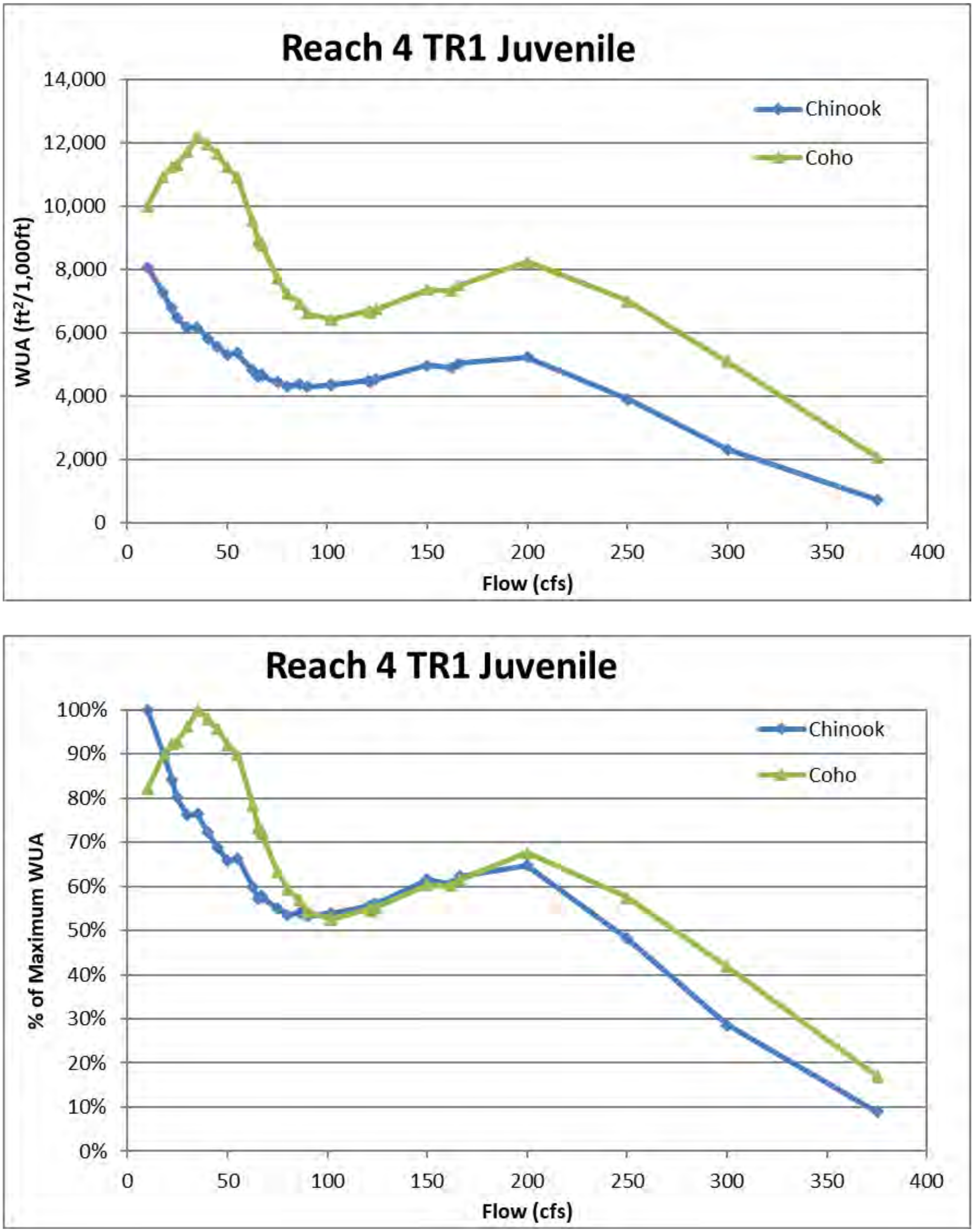
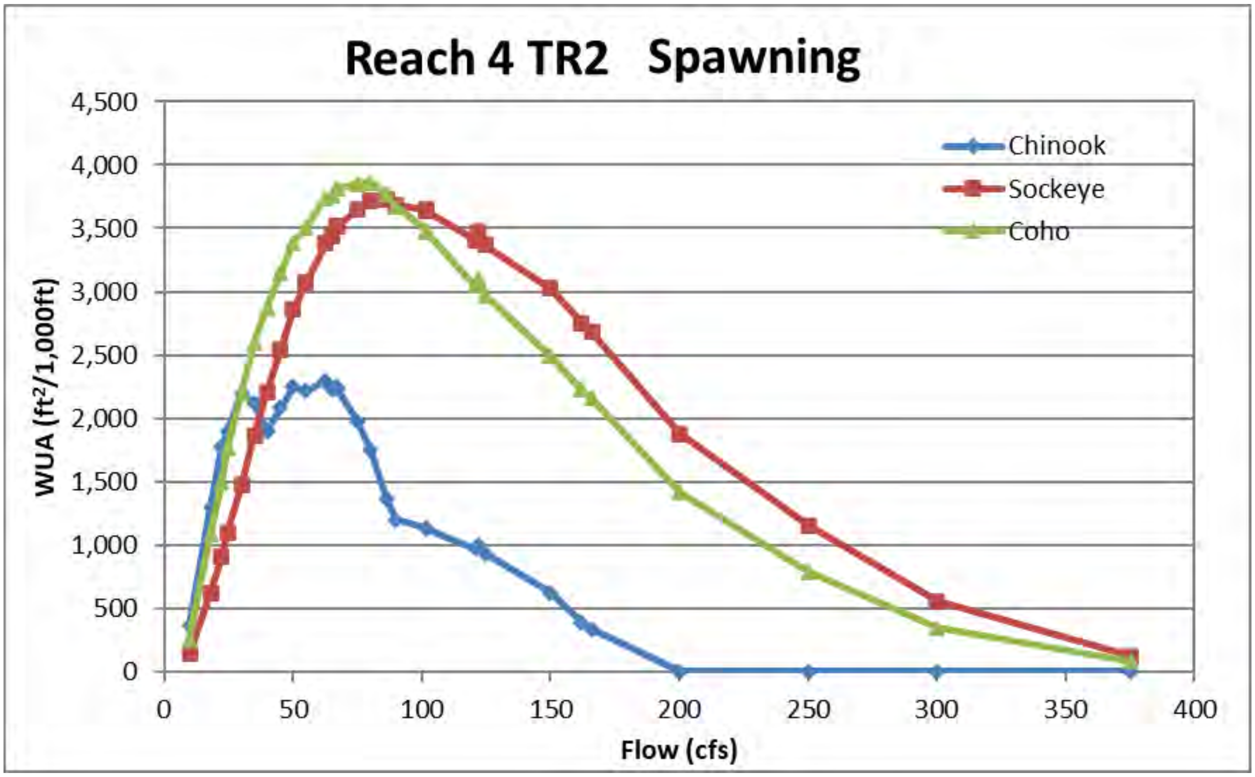


Figure A.2-2. Reach 4 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



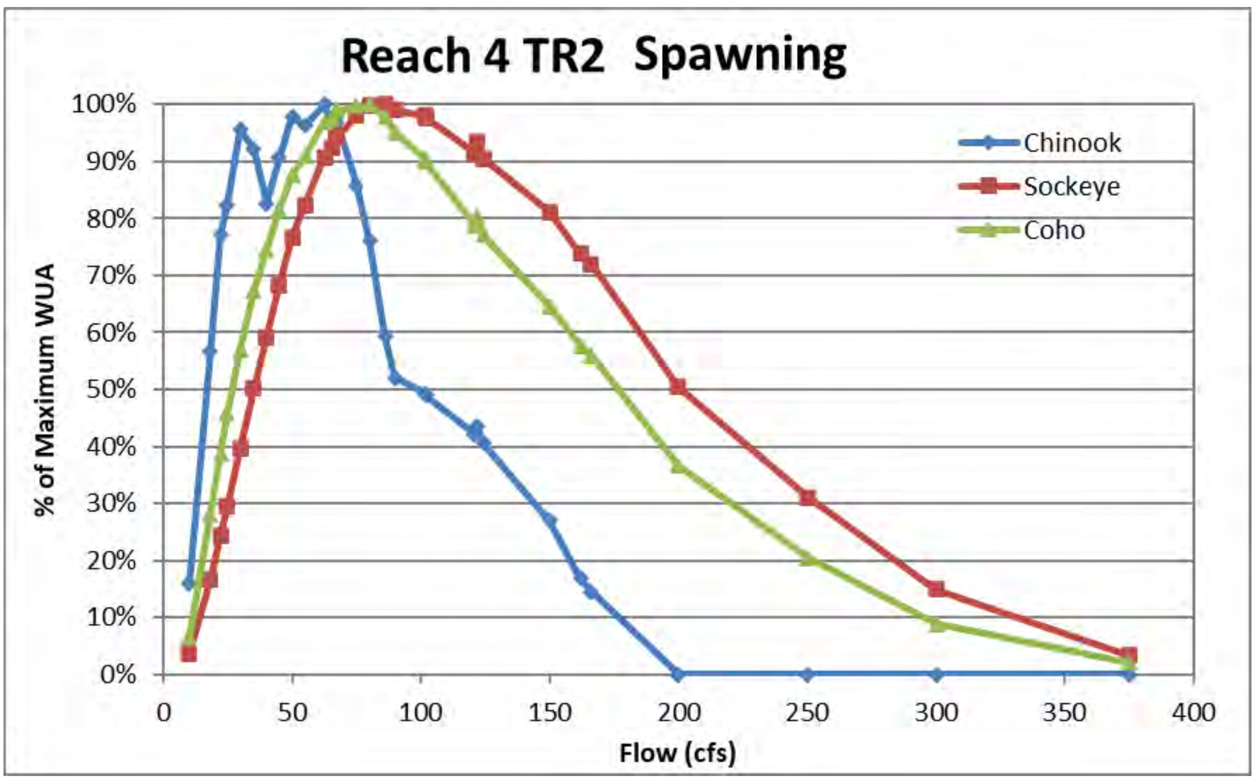
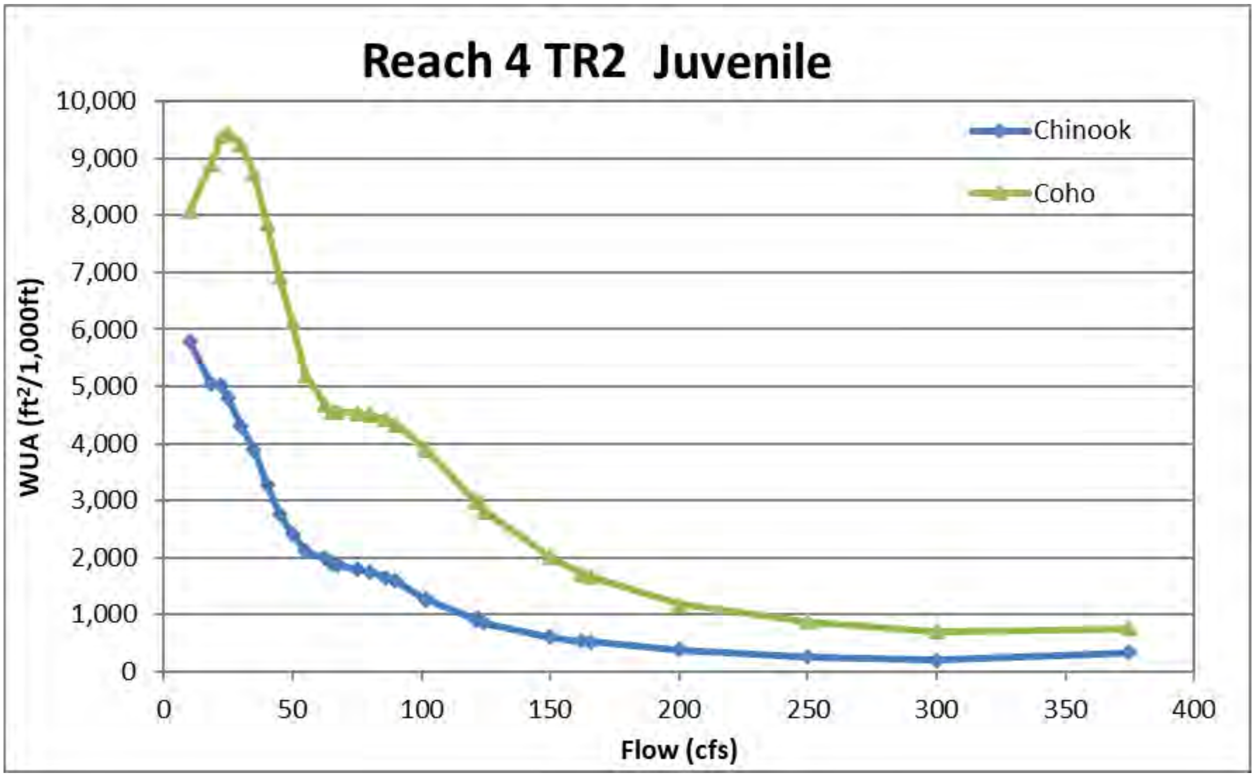


Figure A.2-3. Reach 4 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



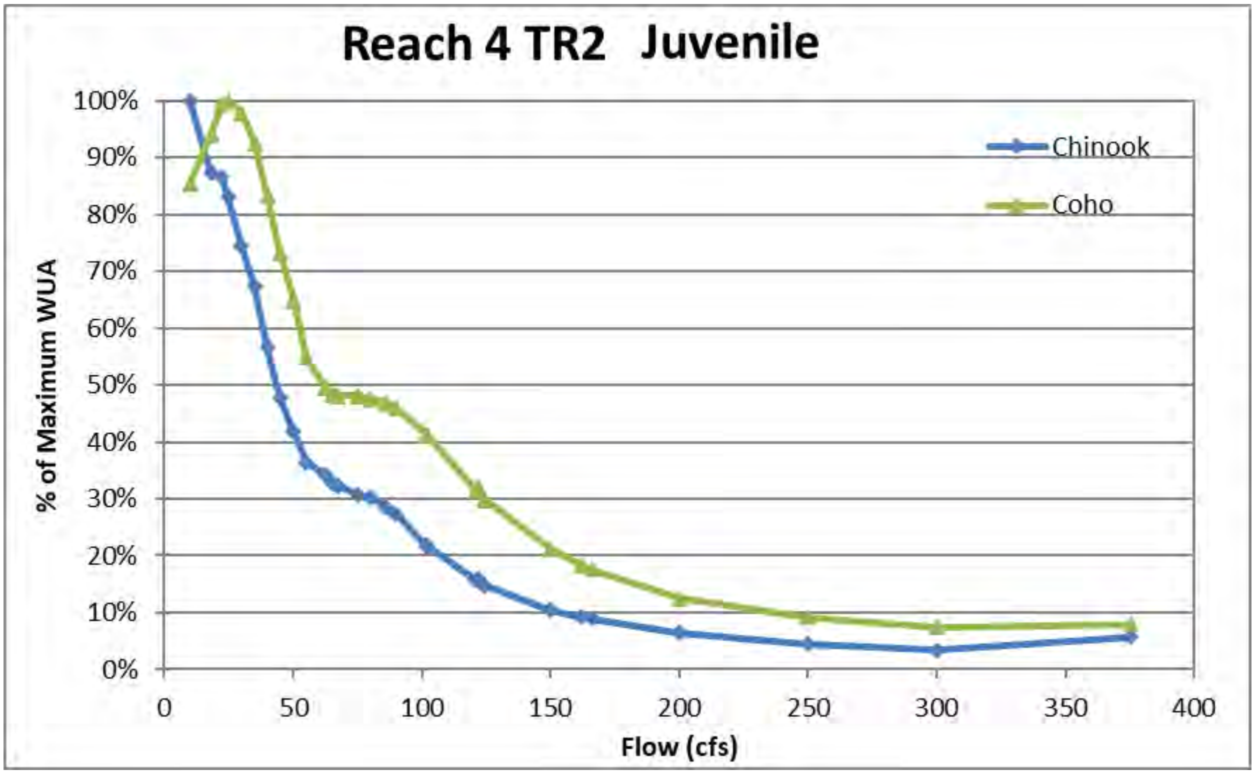
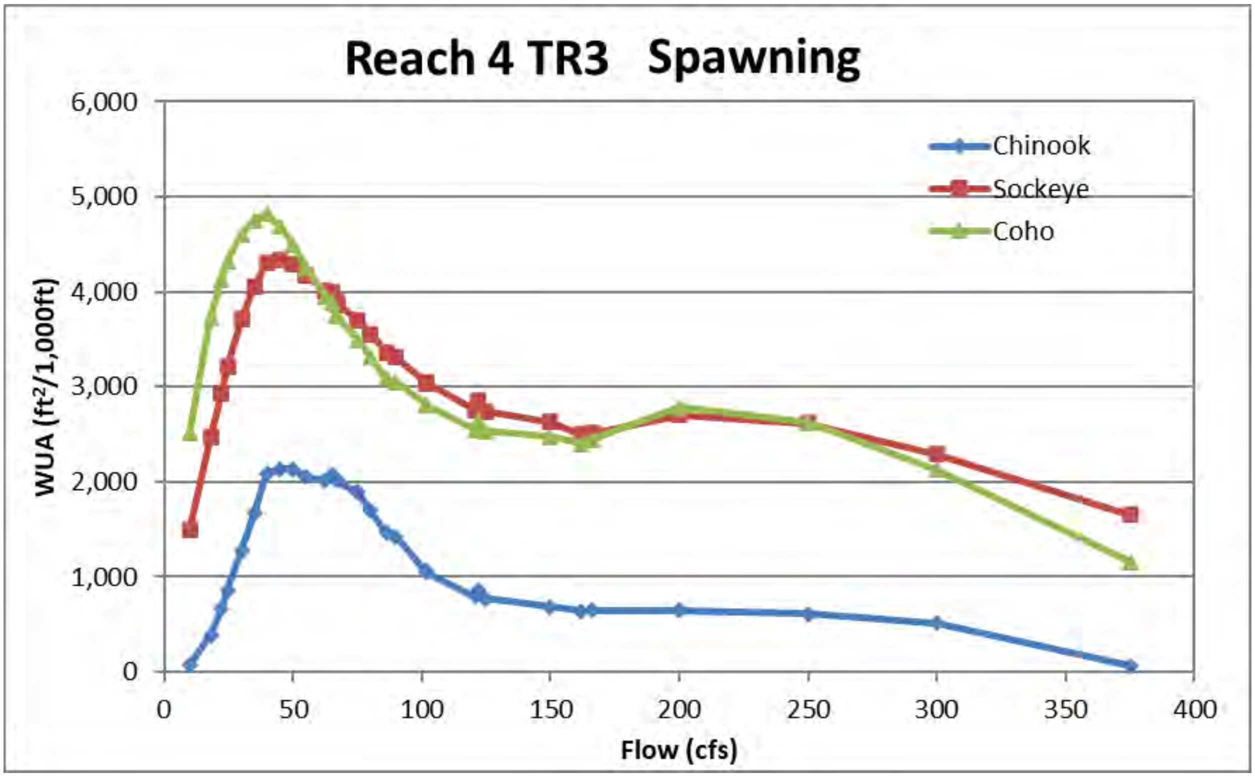


Figure A.2-4. Reach 4 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



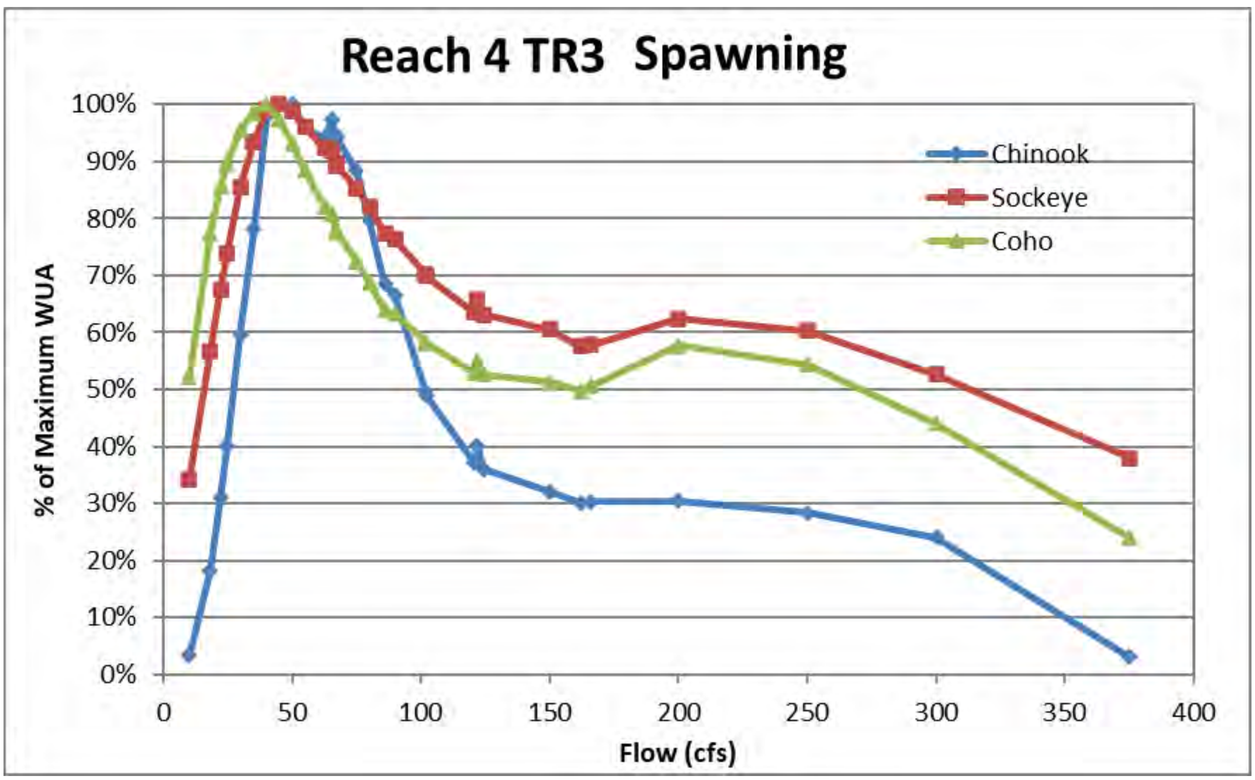
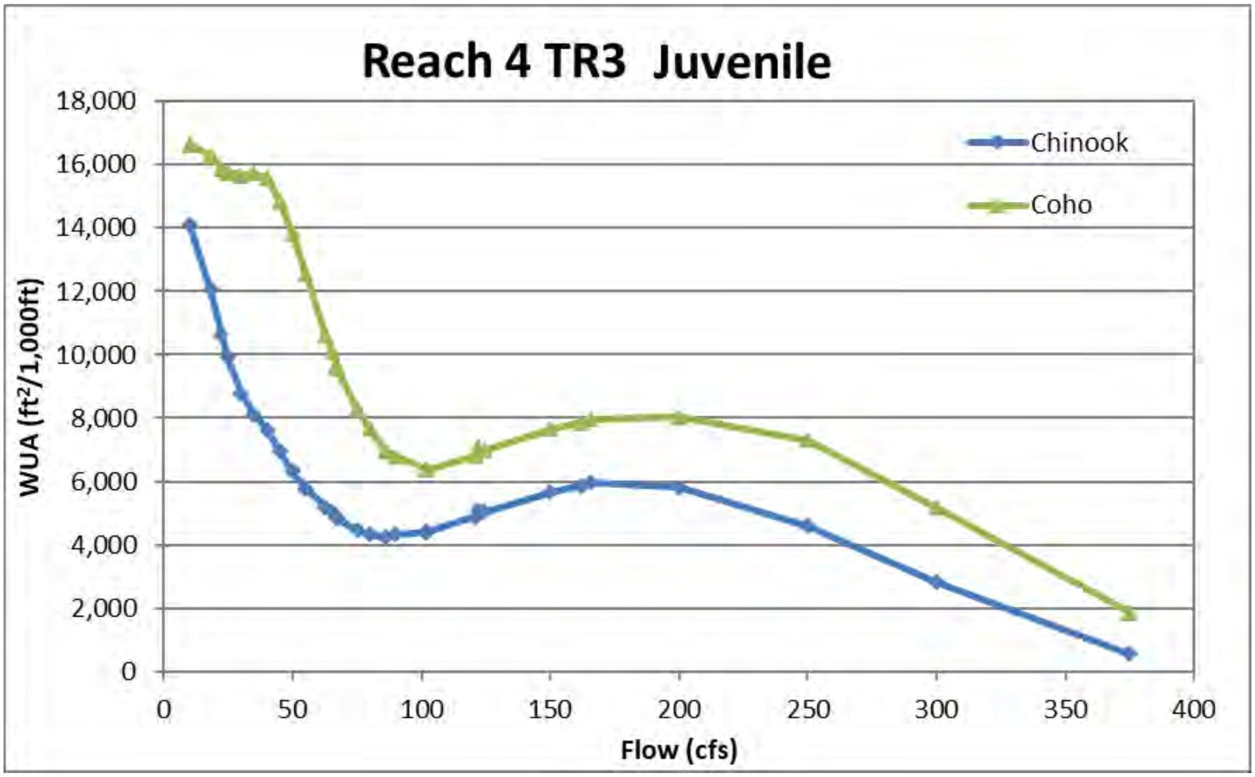


Figure A.2-5. Reach 4 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



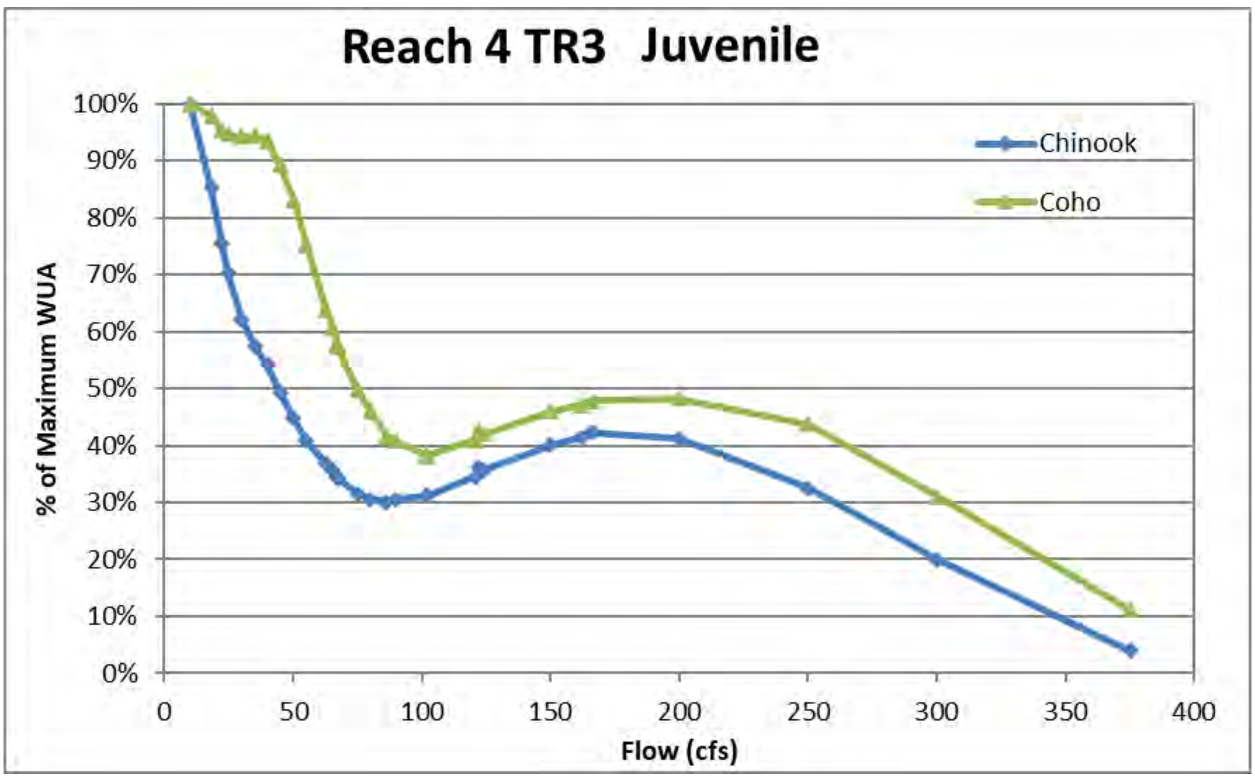


Figure A.2-6. Reach 4 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

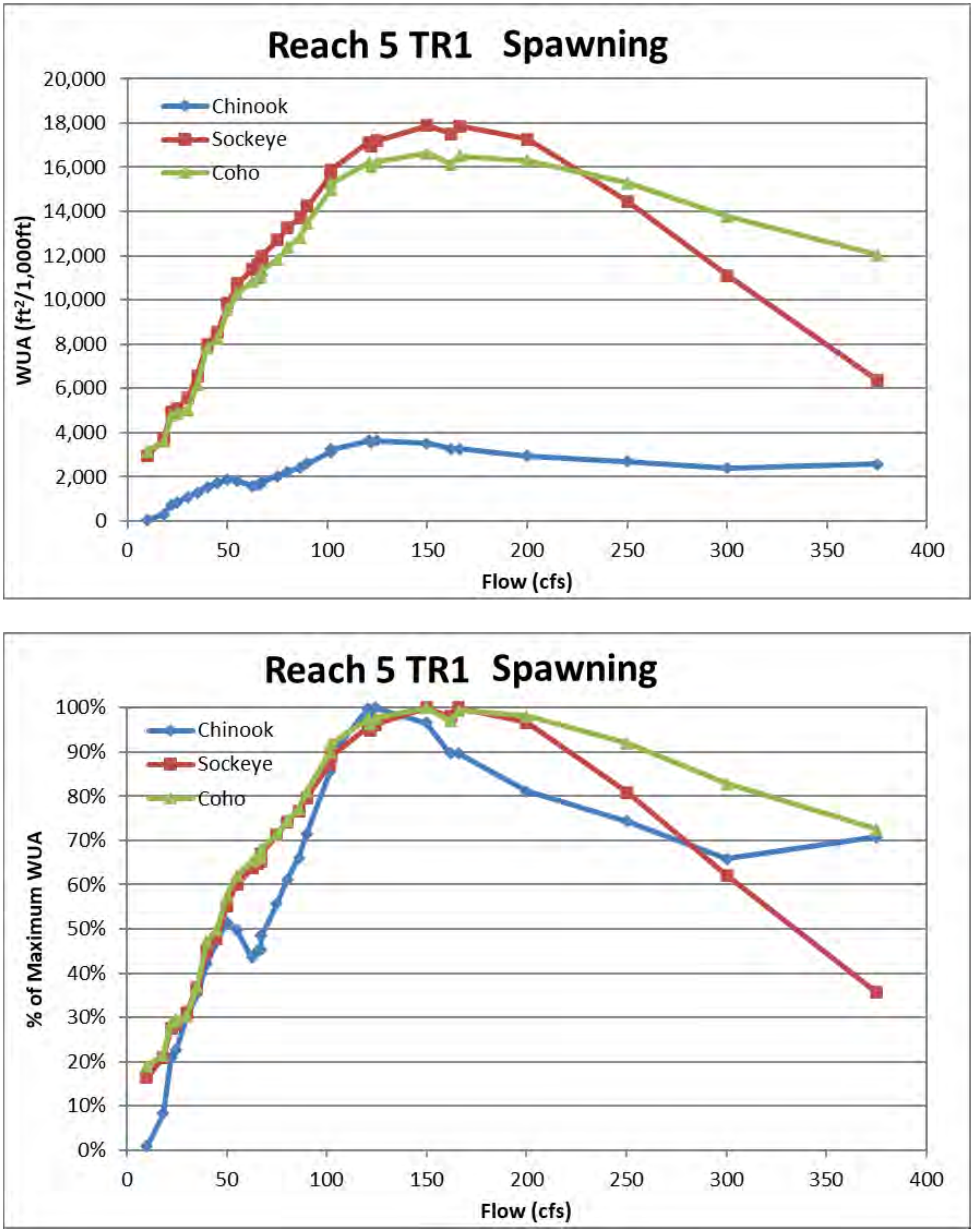


Figure A.2-7. Reach 5 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

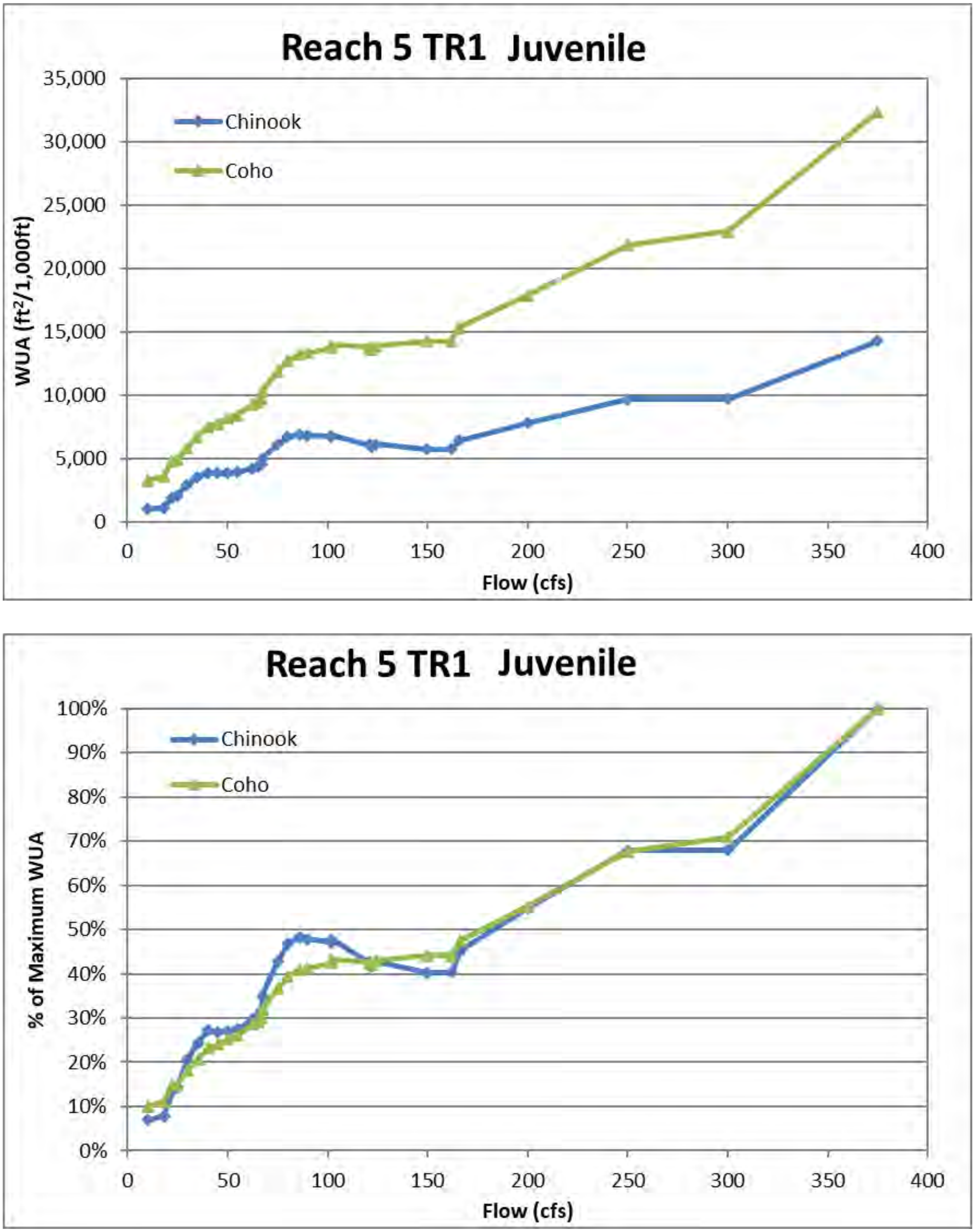
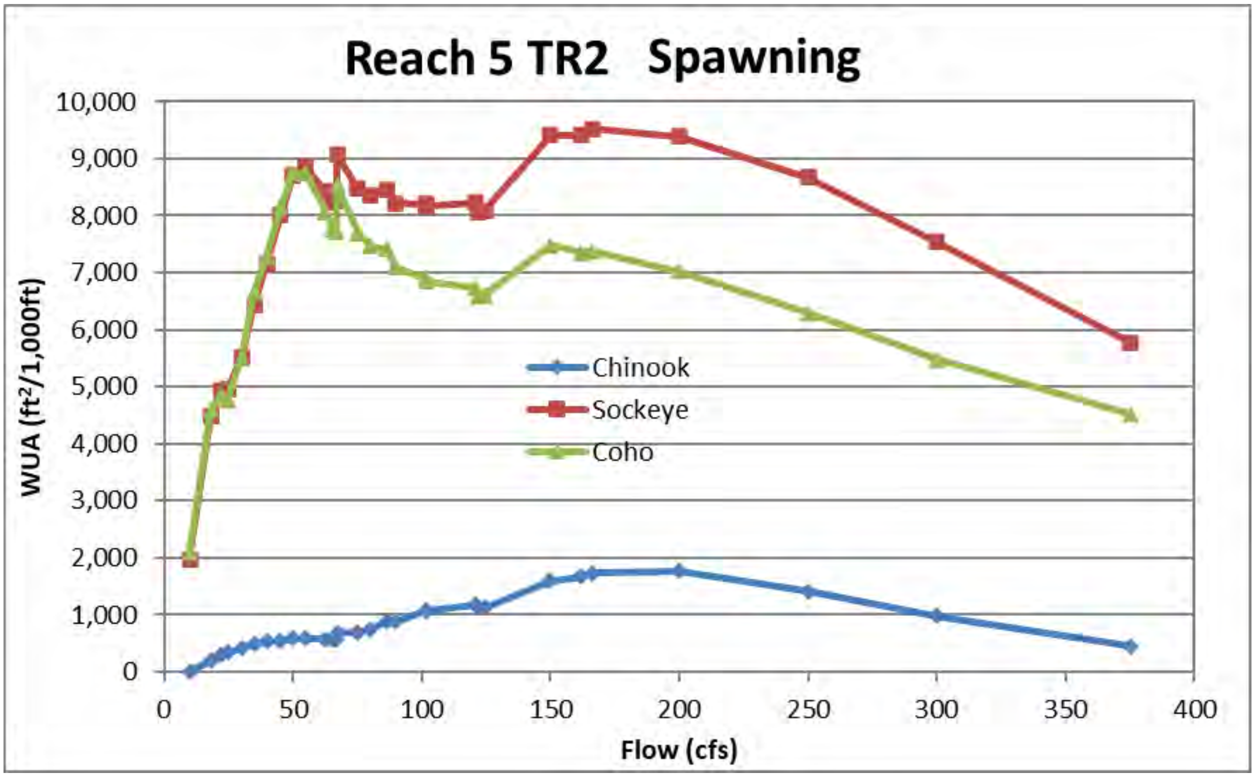


Figure A.2-8. Reach 5 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



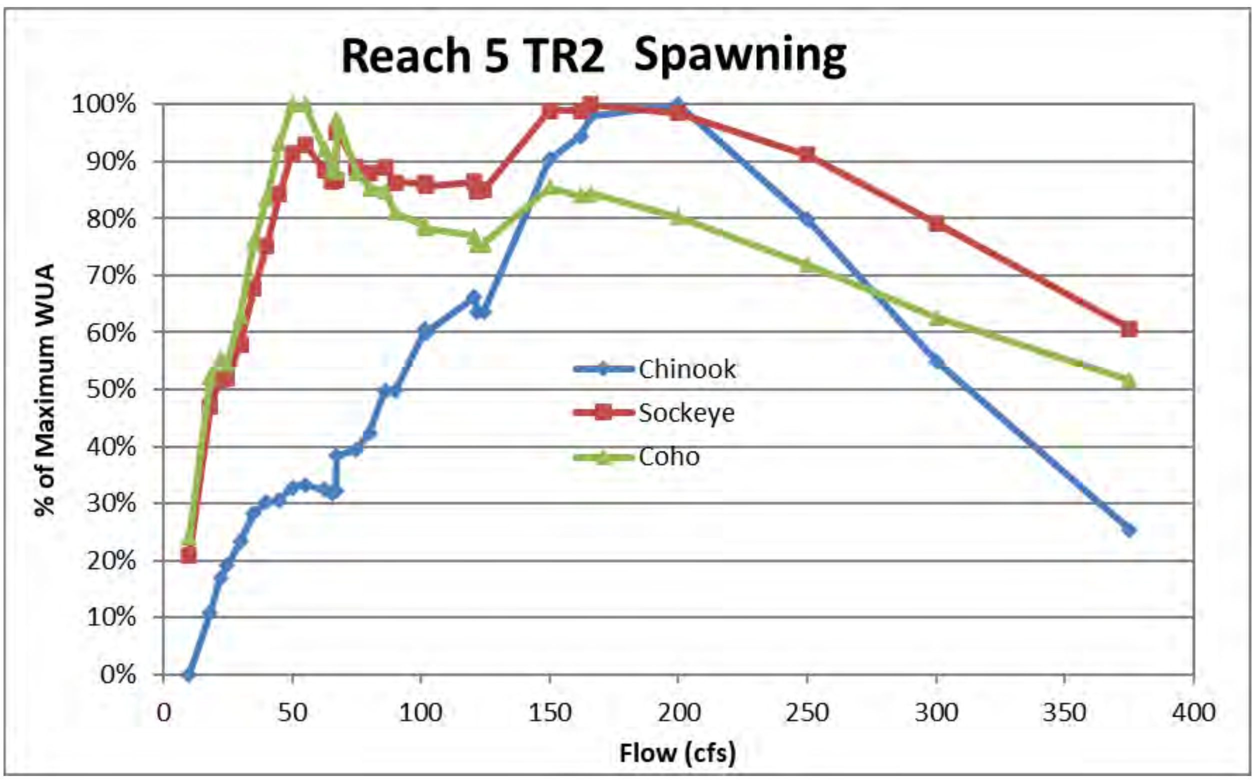
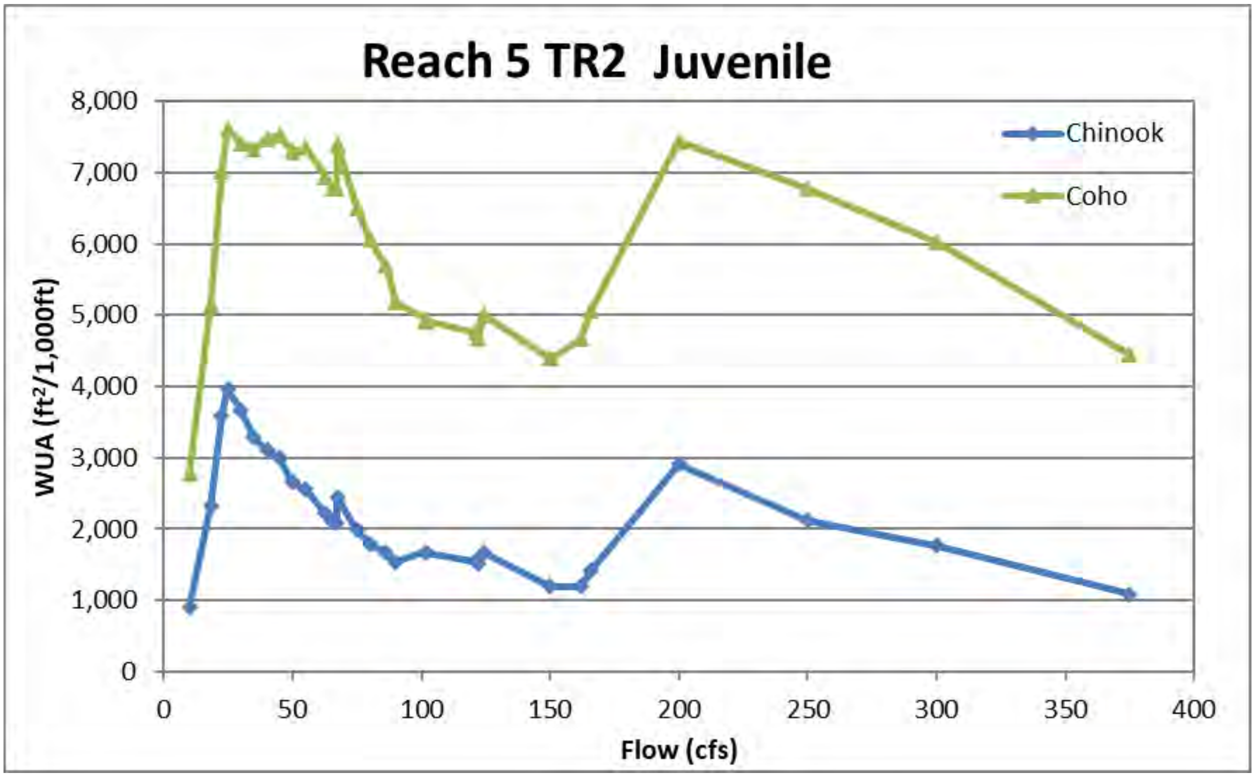


Figure A.2-9. Reach 5 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



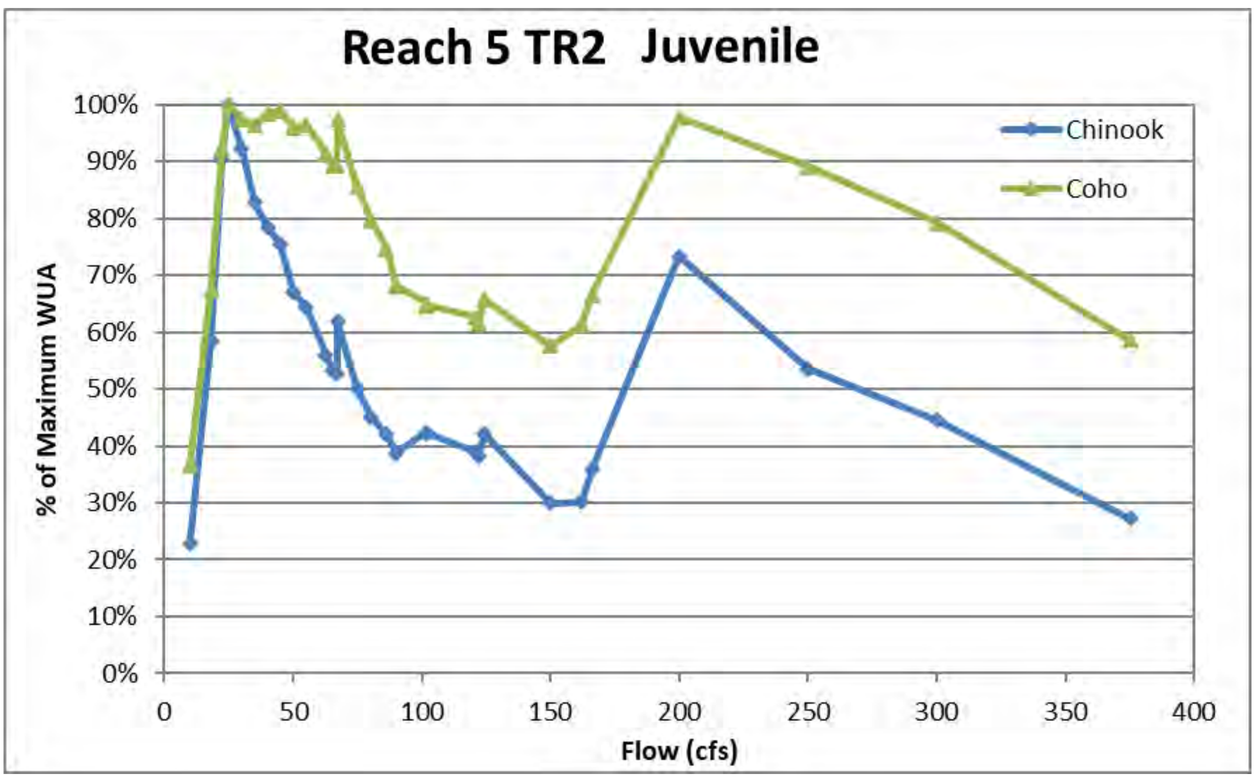


Figure A.2-10. Reach 5 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

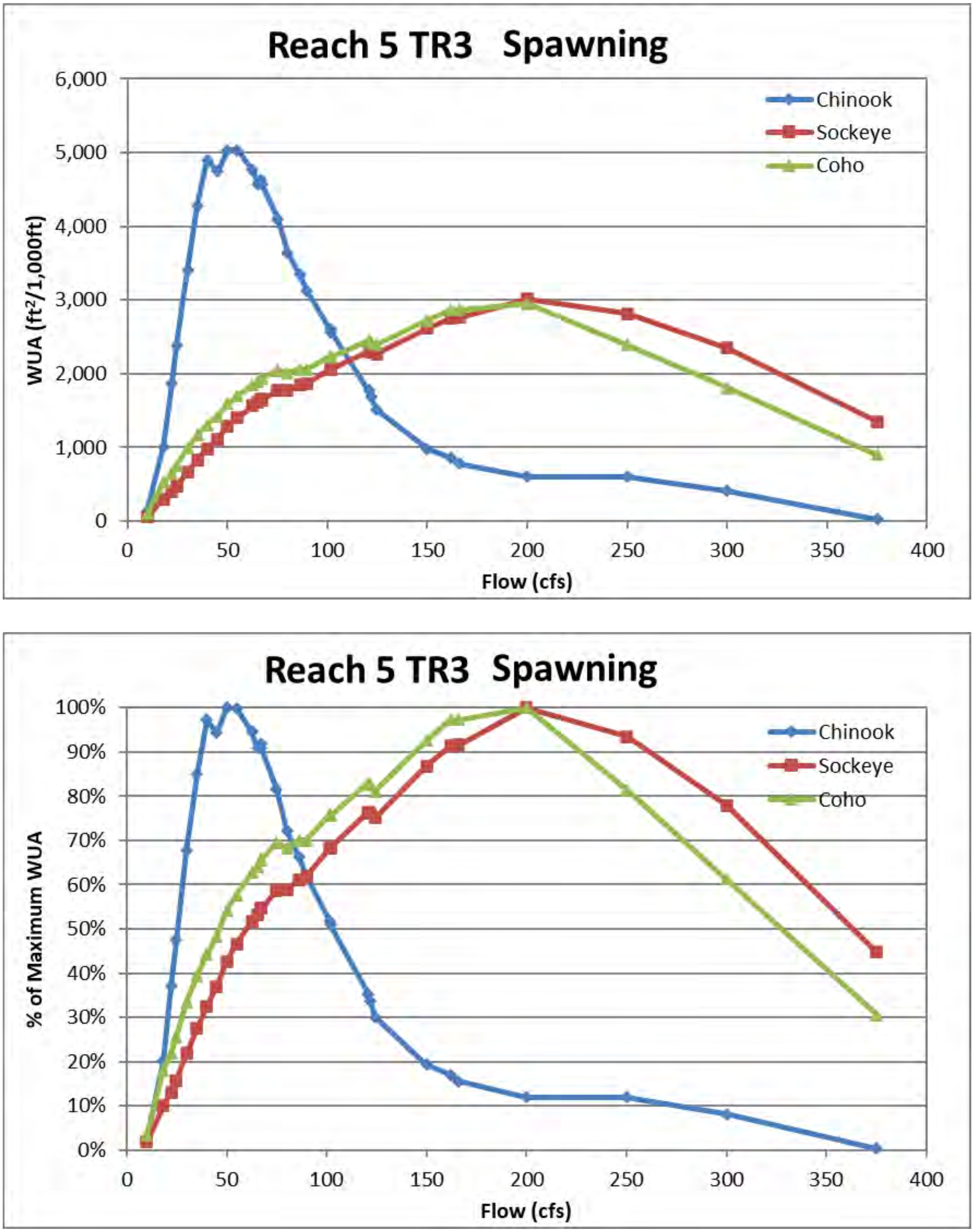


Figure A.2-11. Reach 5 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

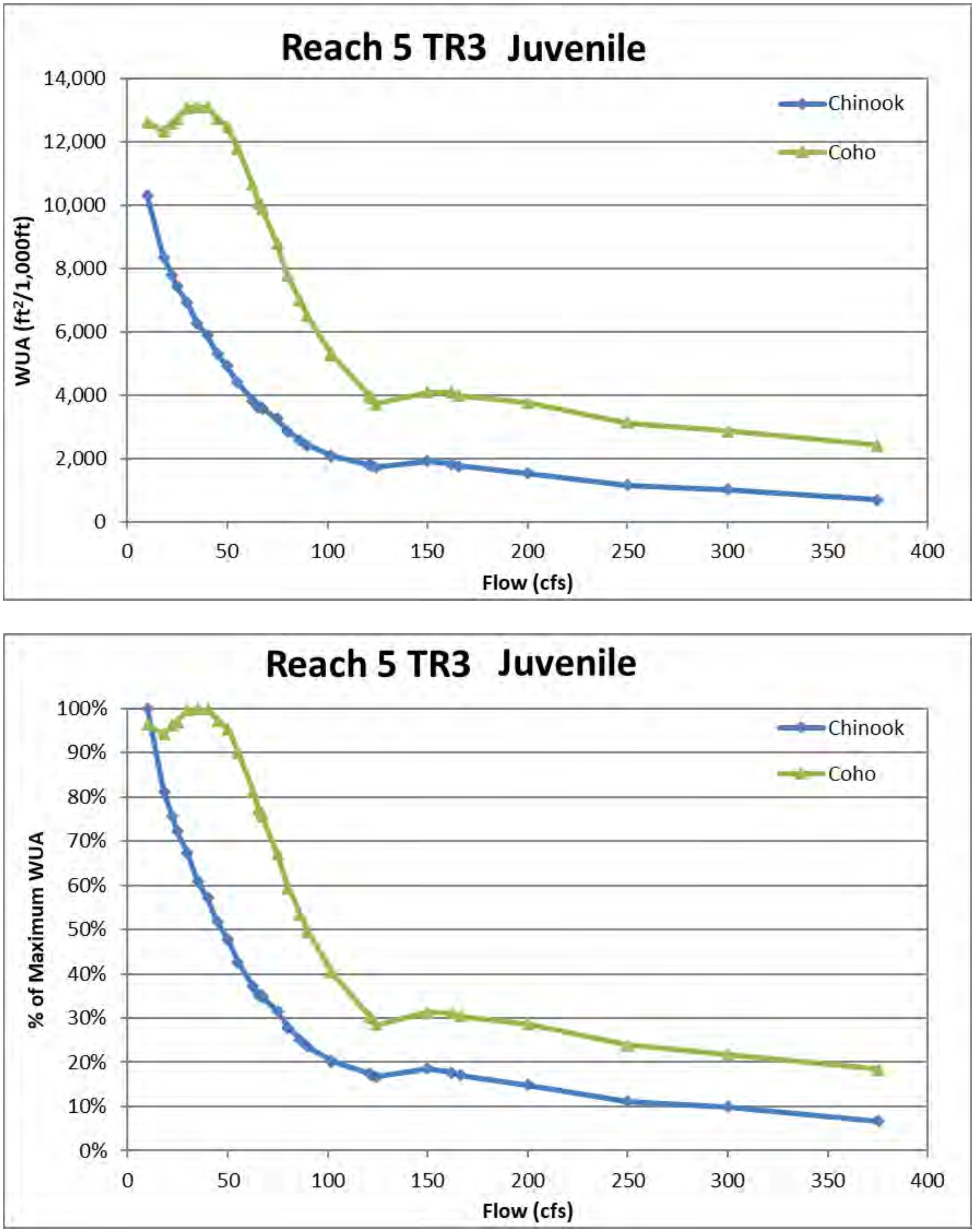
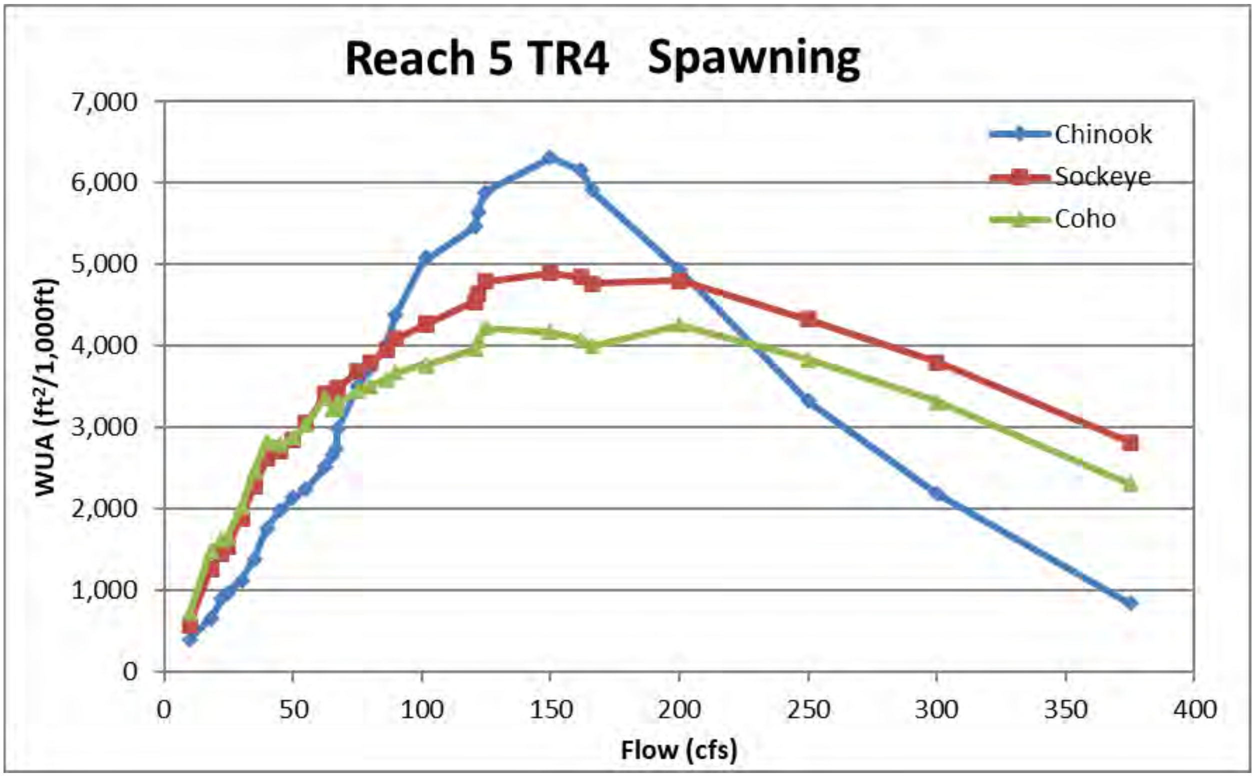


Figure A.2-12. Reach 5 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



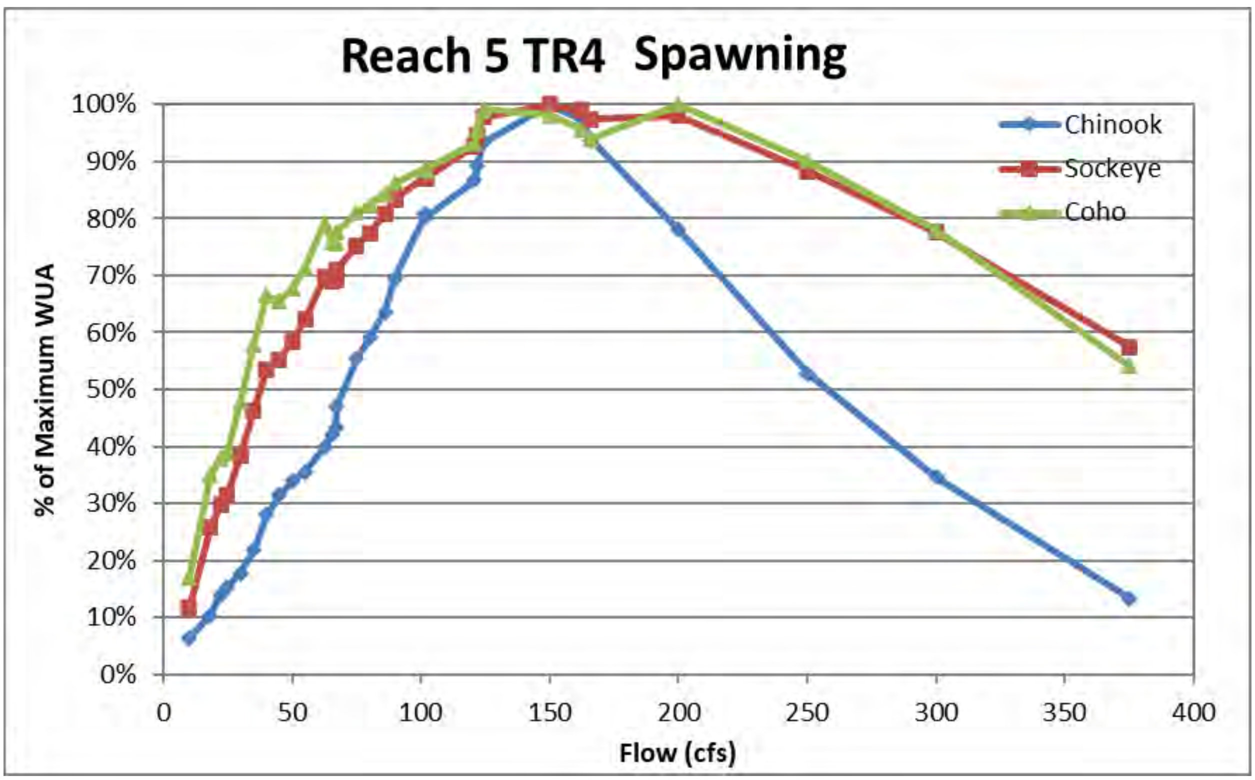
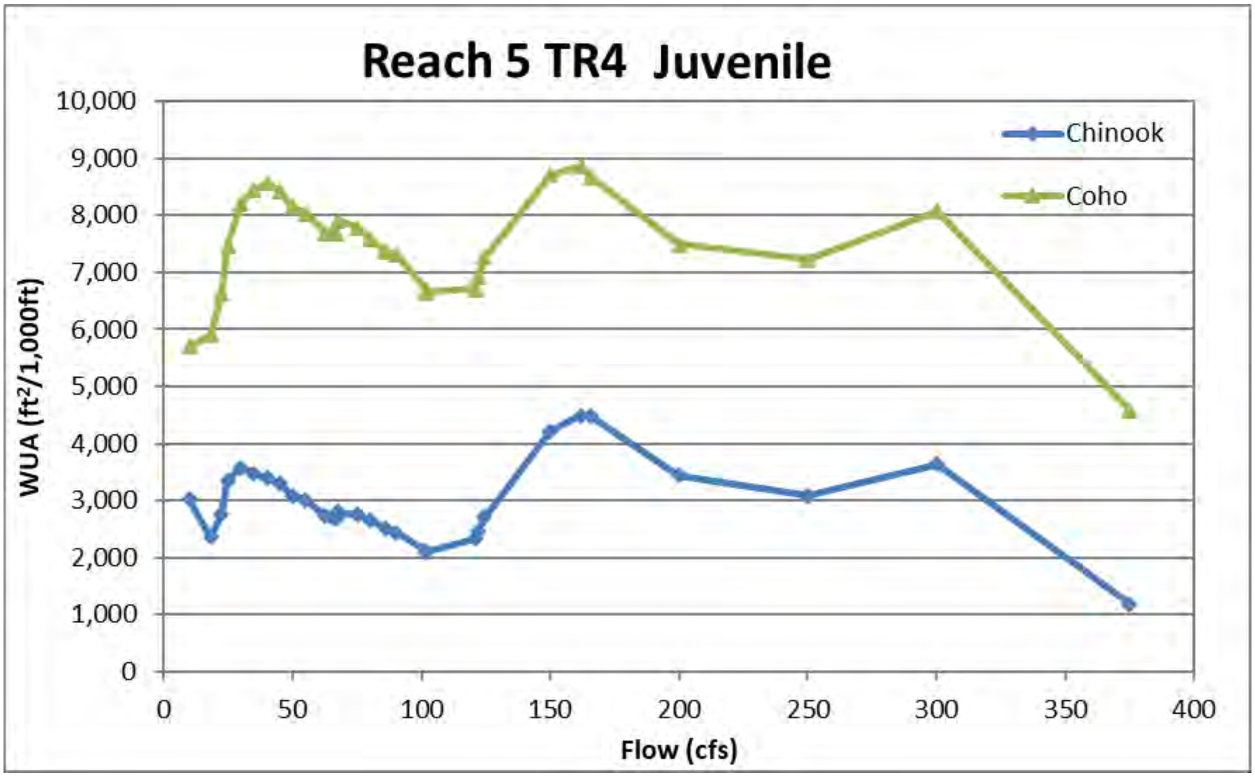


Figure A.2-13. Reach 5 Transect 4 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



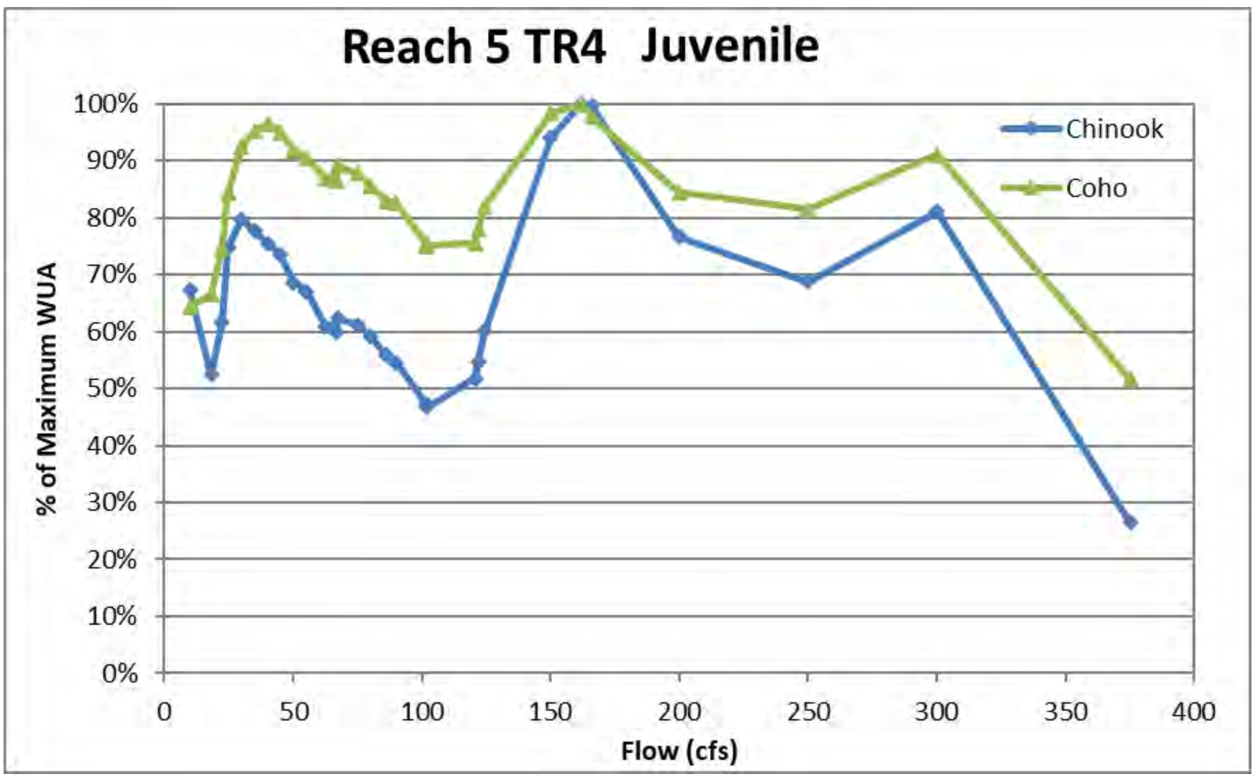
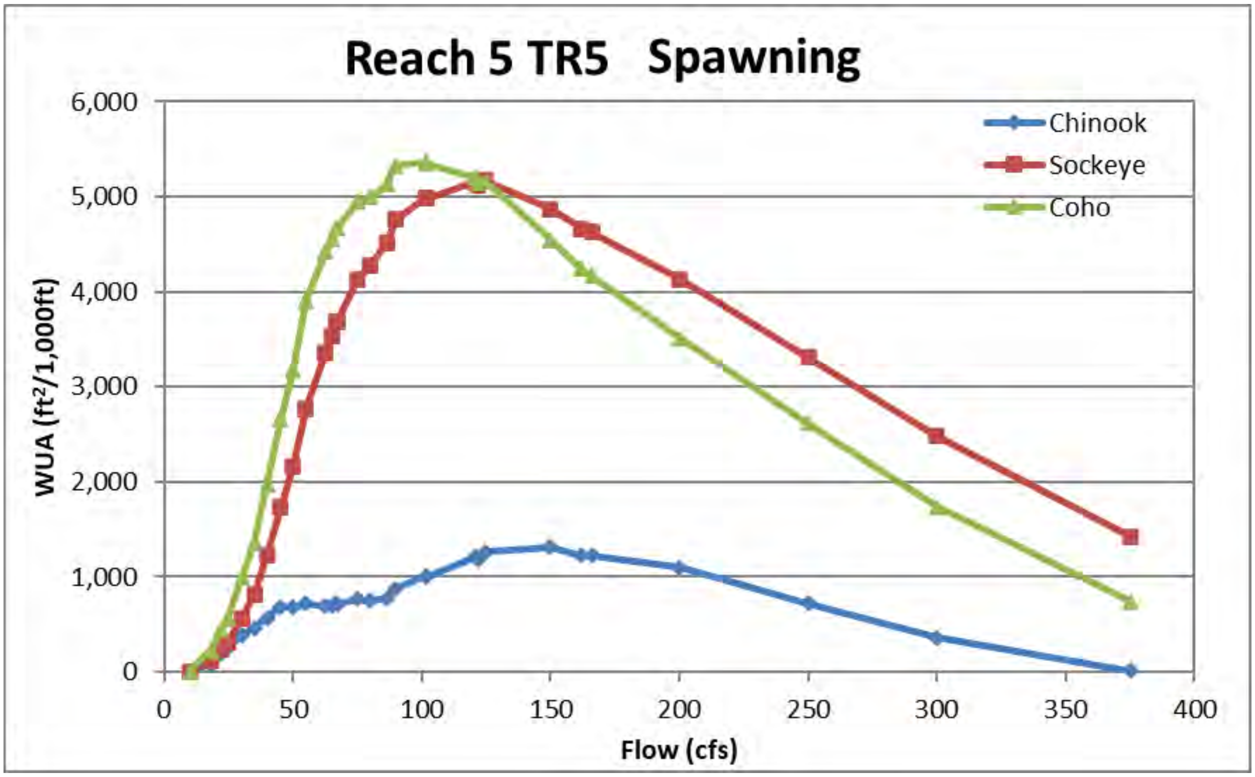


Figure A.2-14. Reach 5 Transect 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



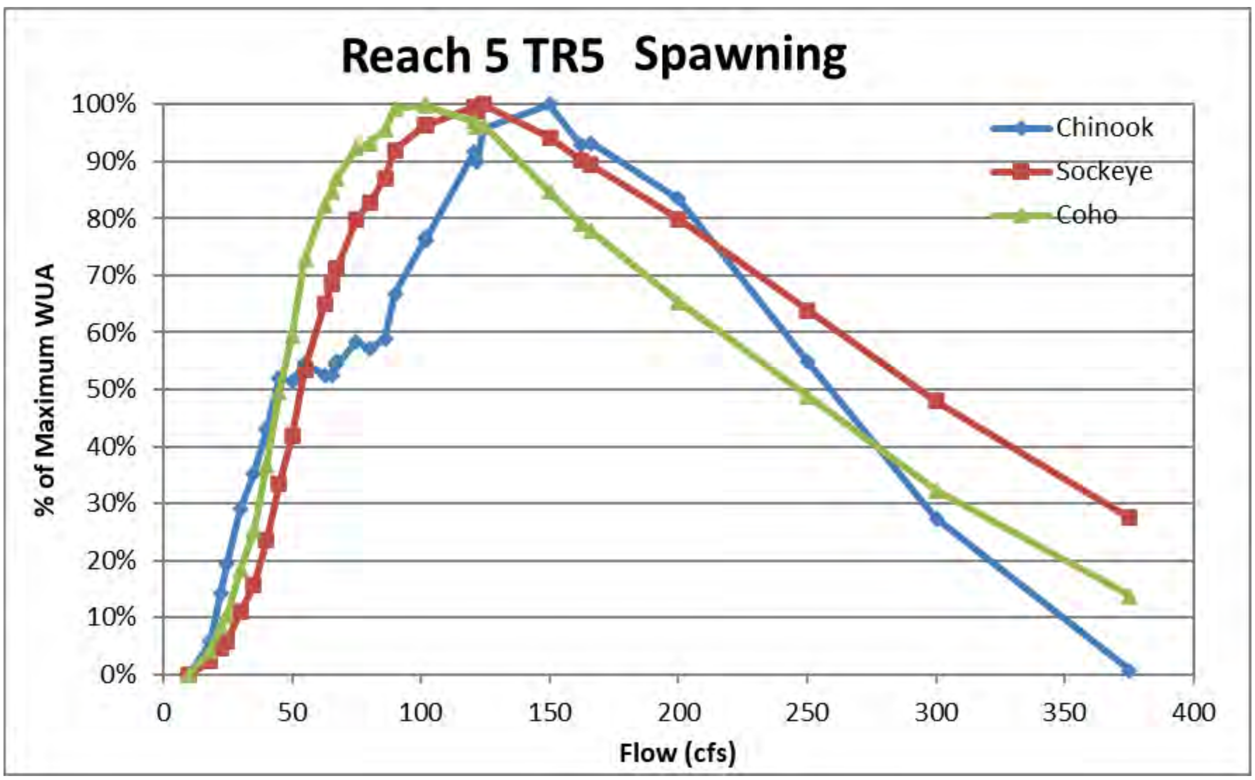
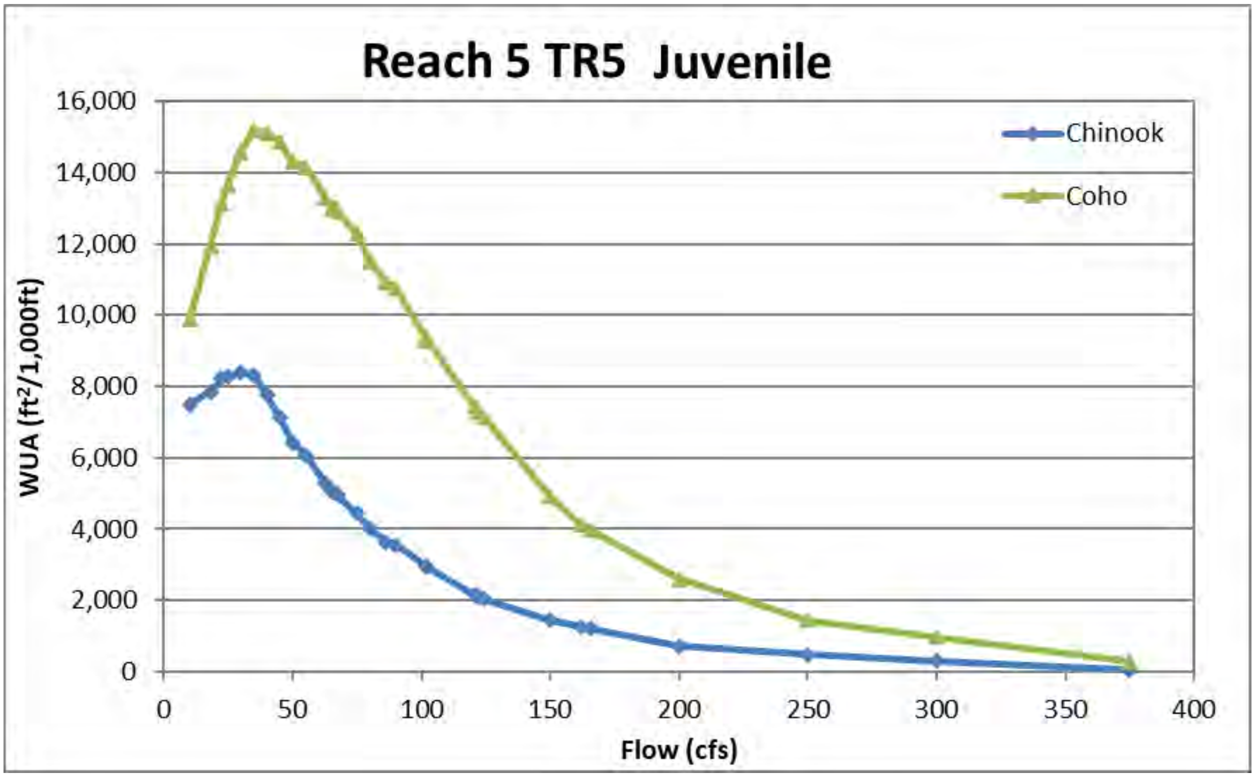


Figure A.2-15. Reach 5 Transect 5 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



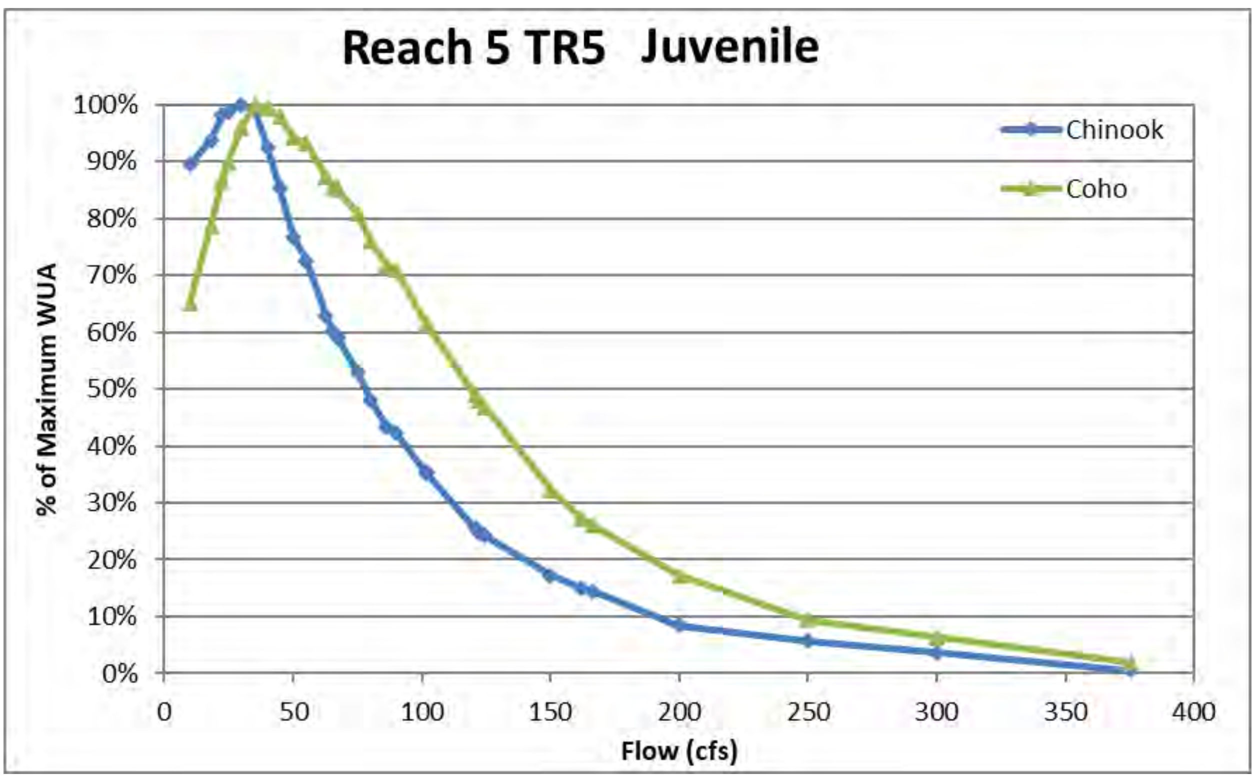
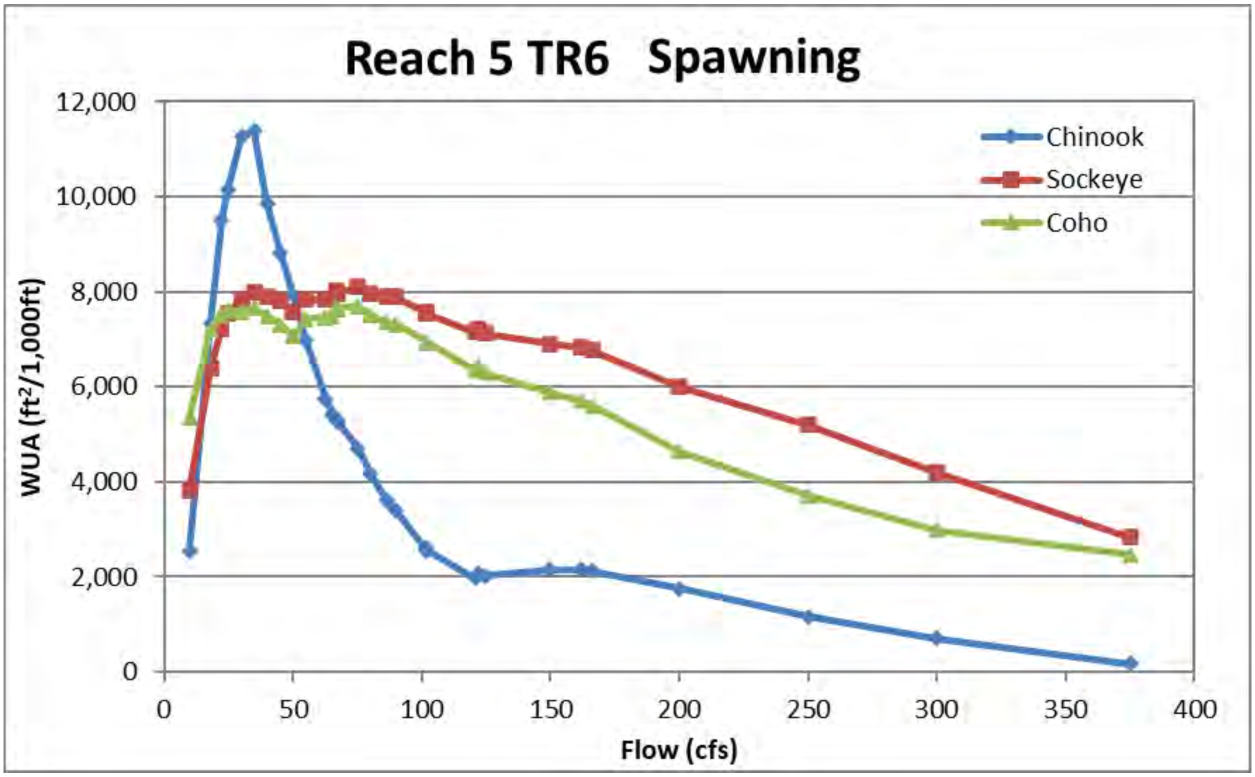


Figure A.2-16. Reach 5 Transect 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



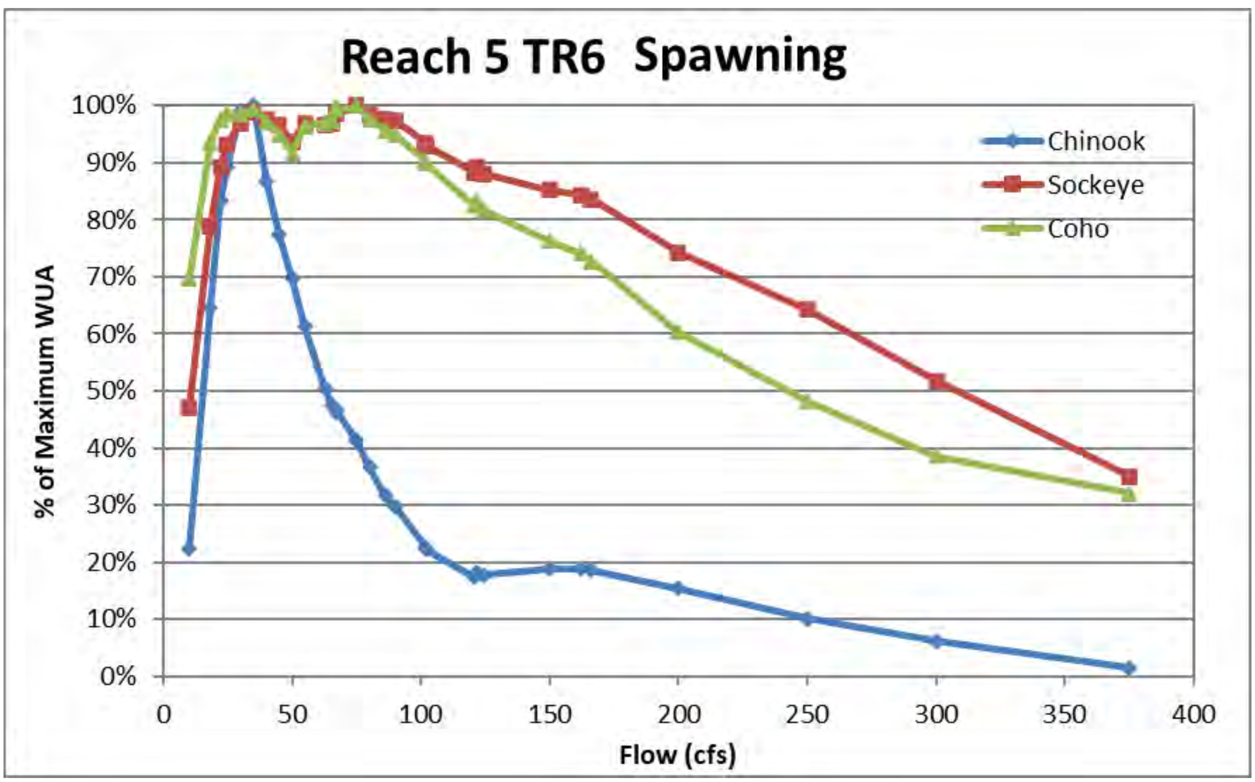
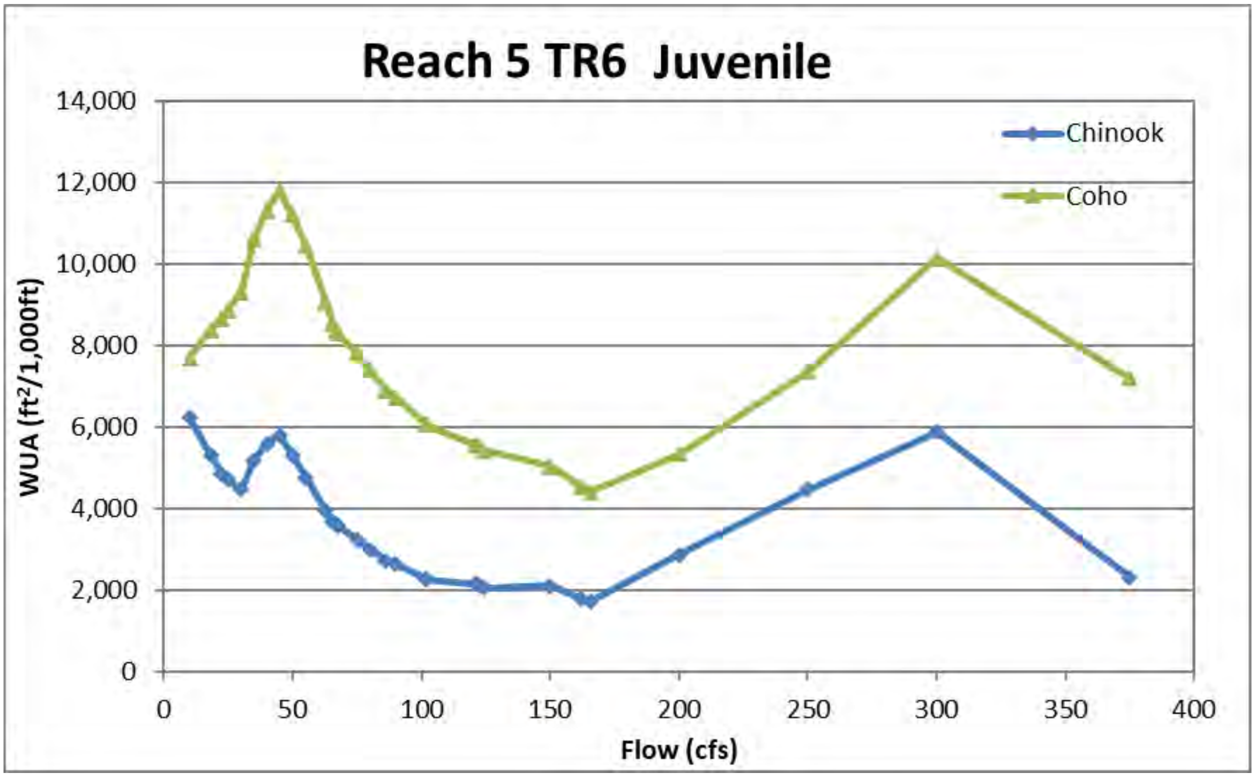


Figure A.2-17. Reach 5 Transect 6 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



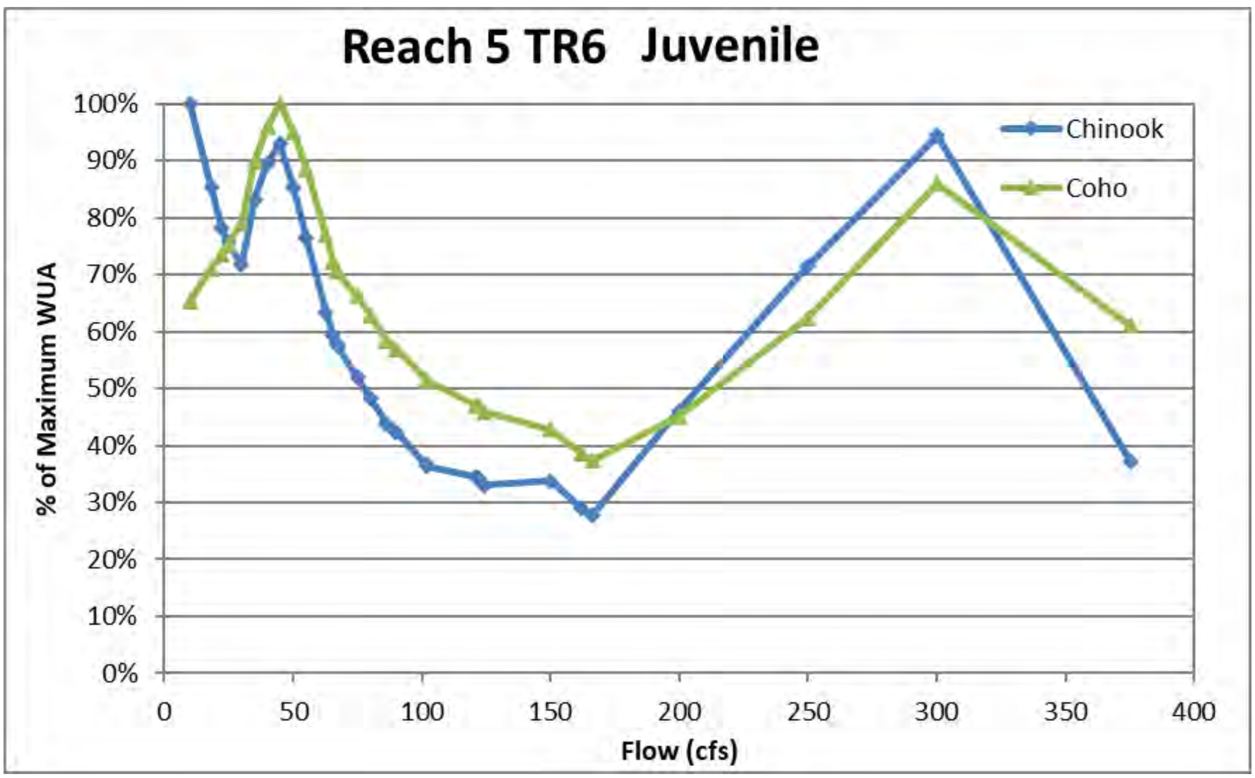


Figure A.2-18. Reach 5 Transect 6 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

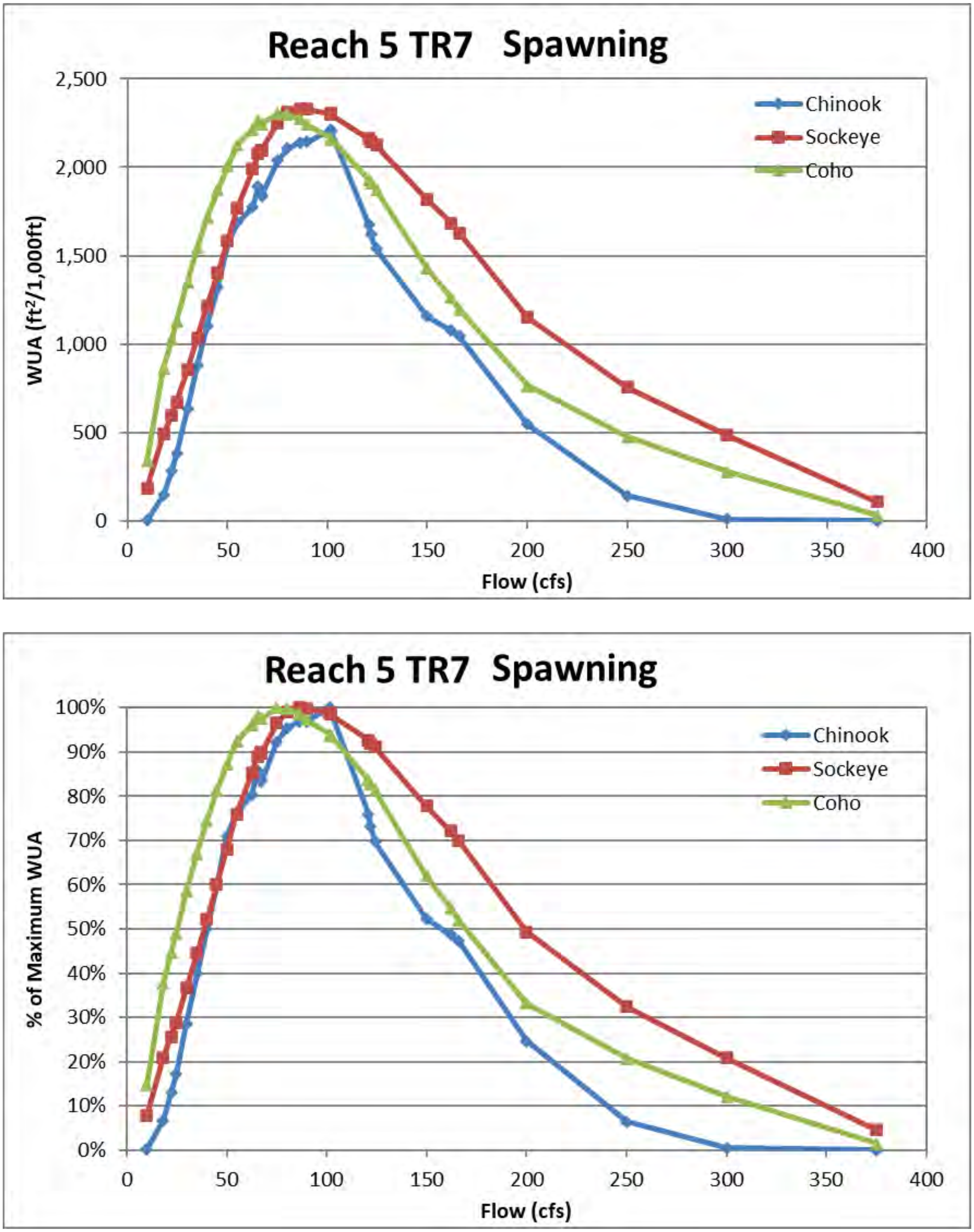
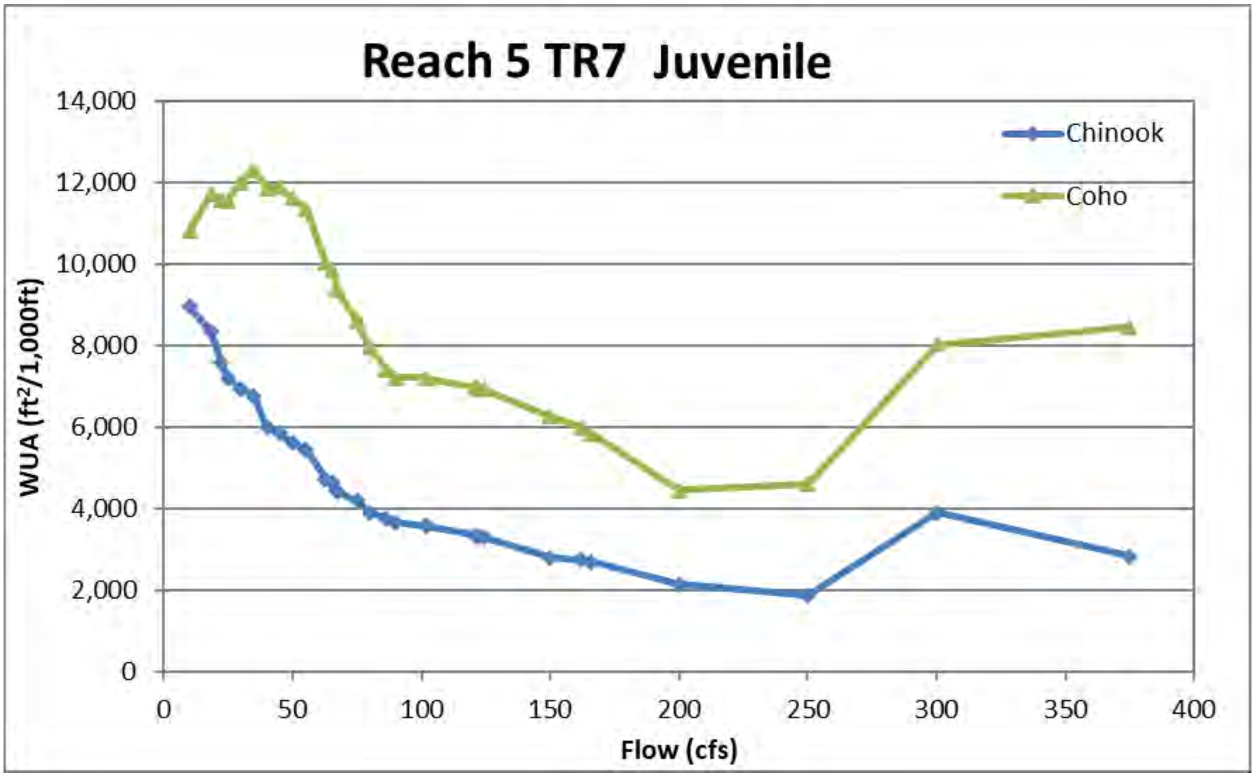


Figure A.2-19. Reach 5 Transect 7 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



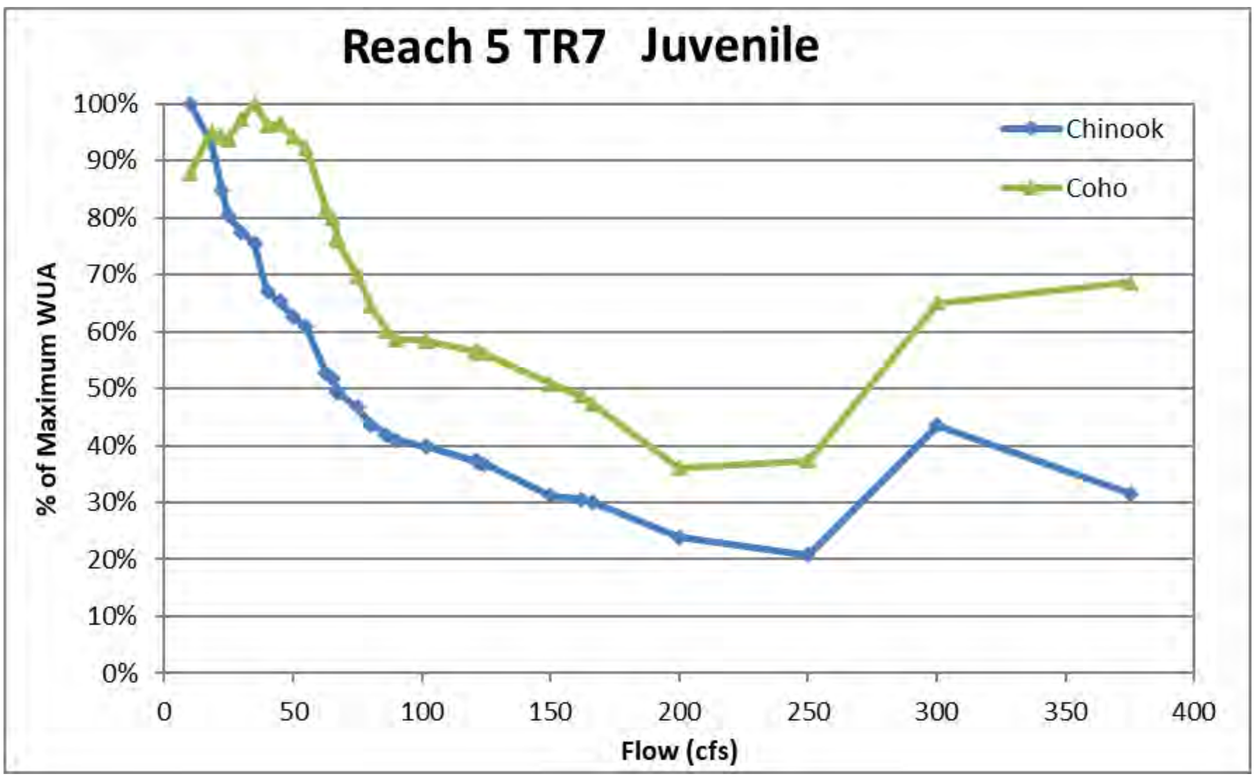
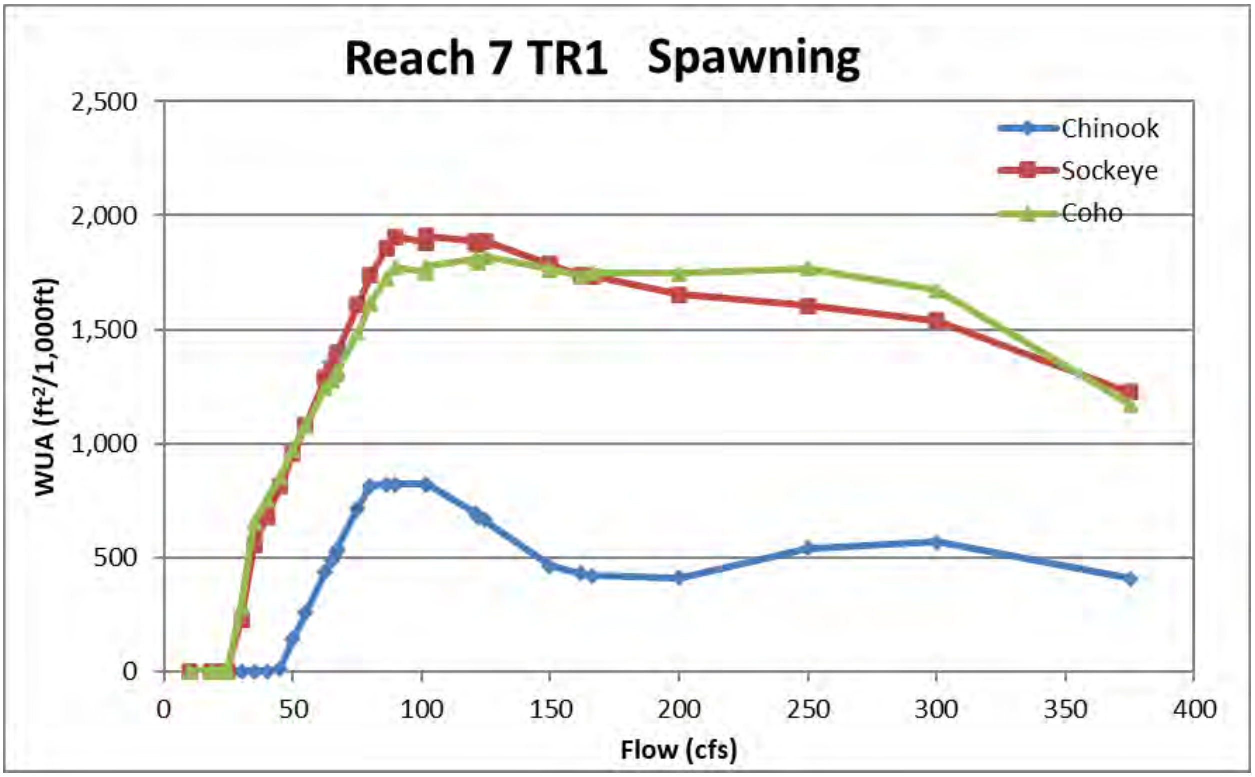


Figure A.2-20. Reach 5 Transect 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



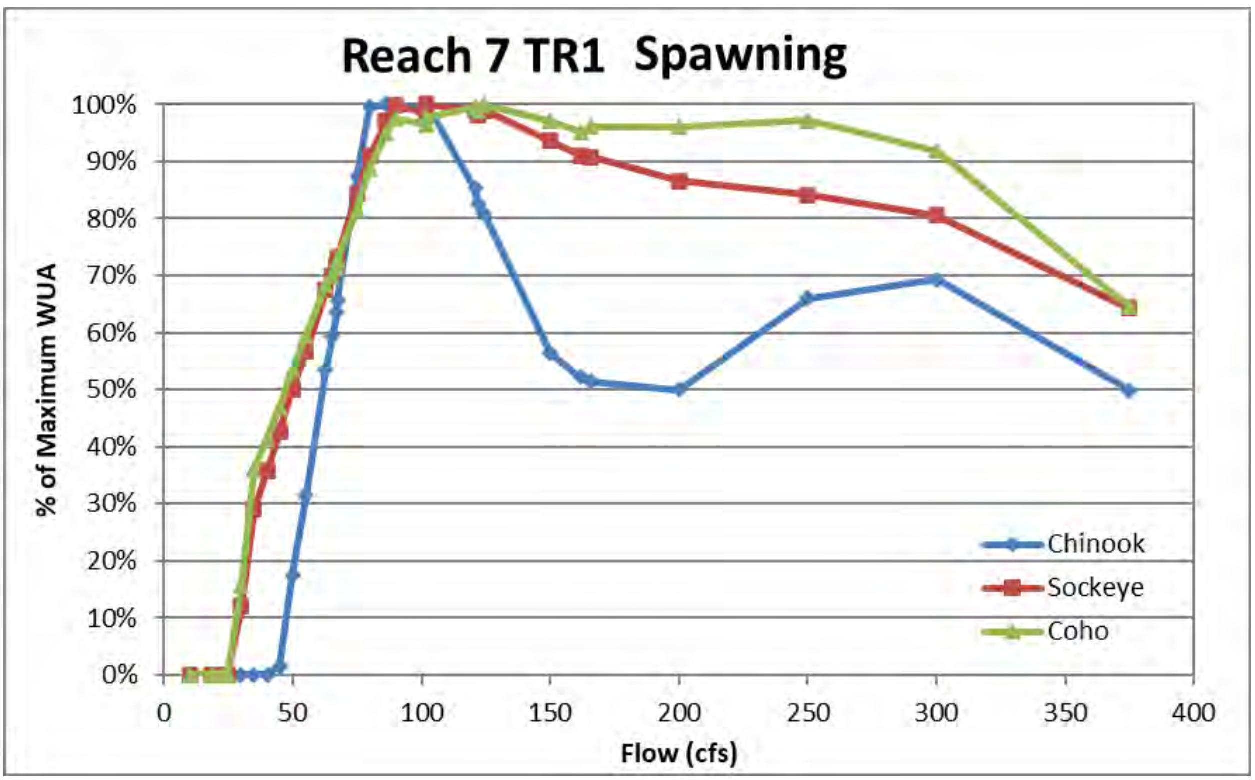


Figure A.2-21. Reach 7 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

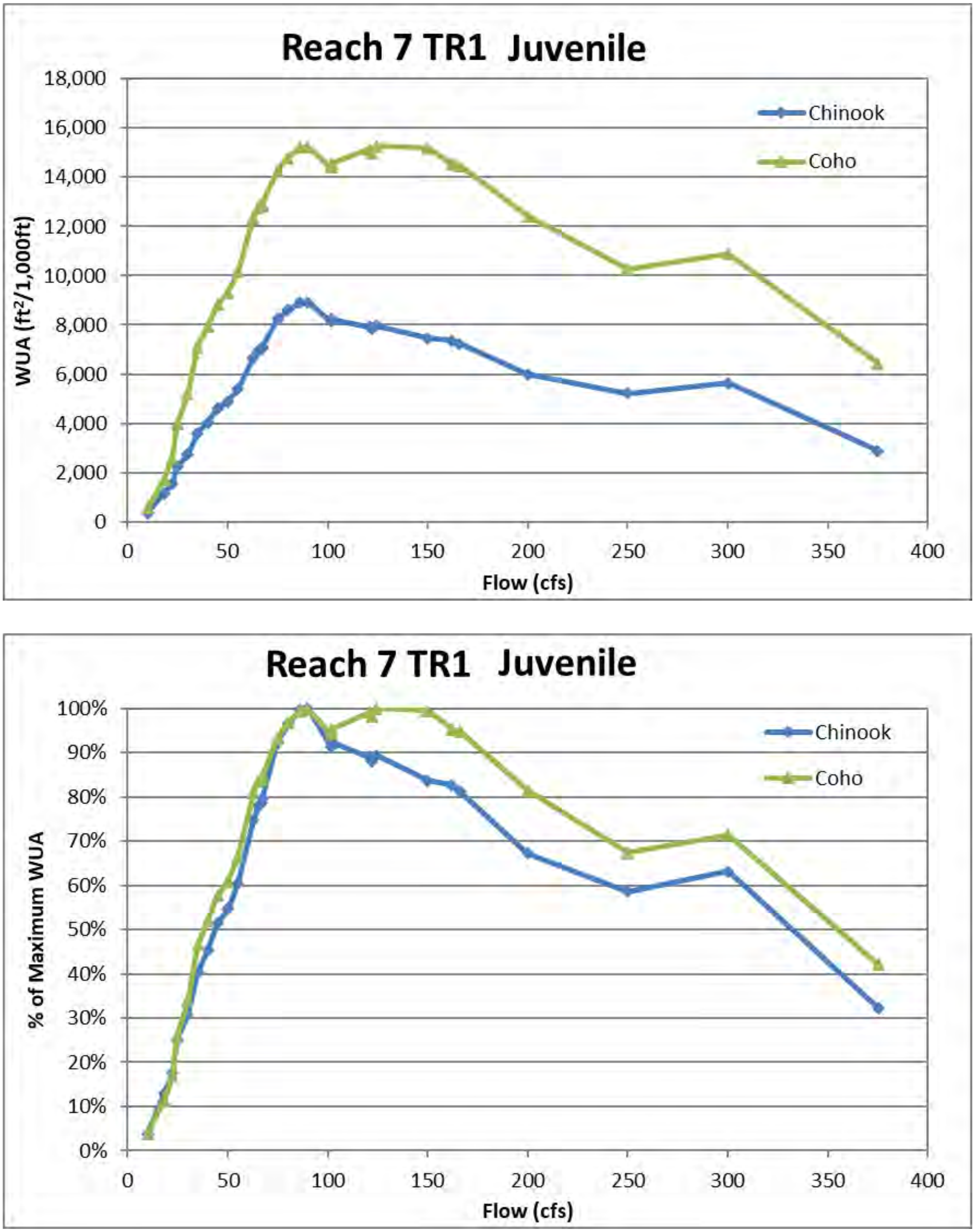
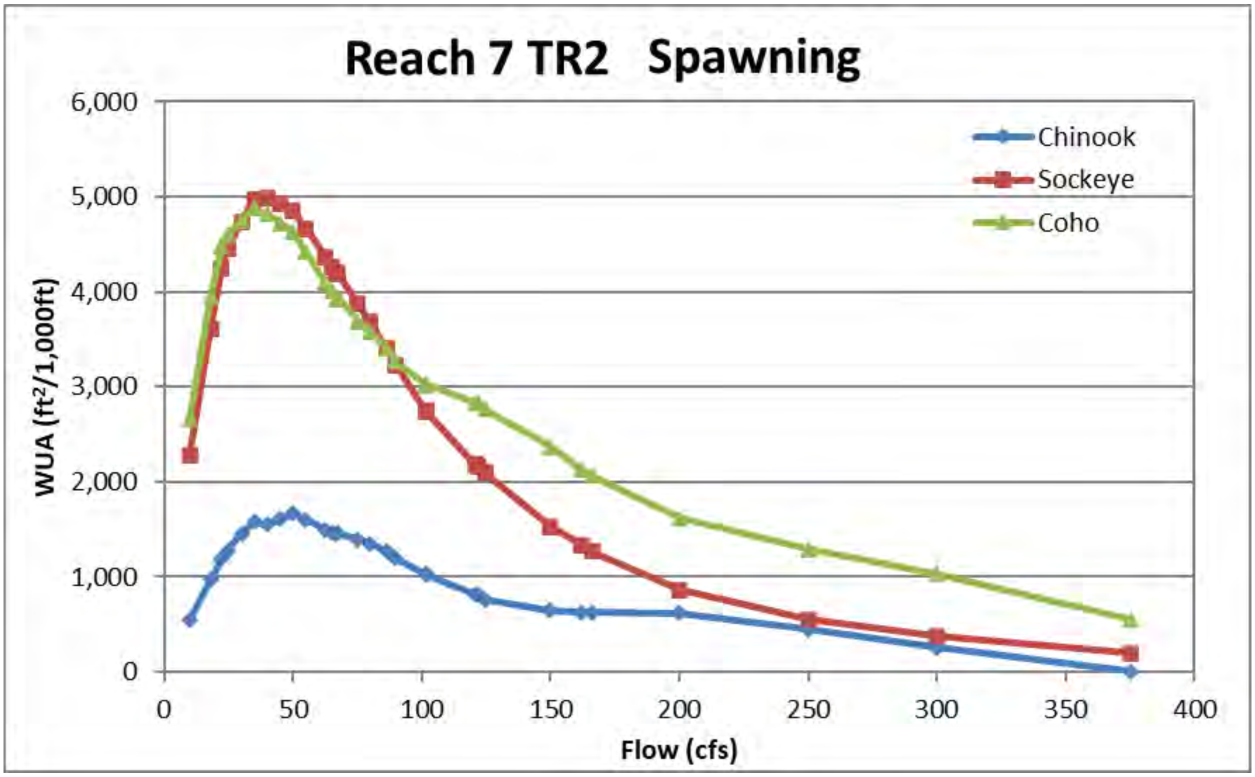


Figure A.2-22. Reach 7 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



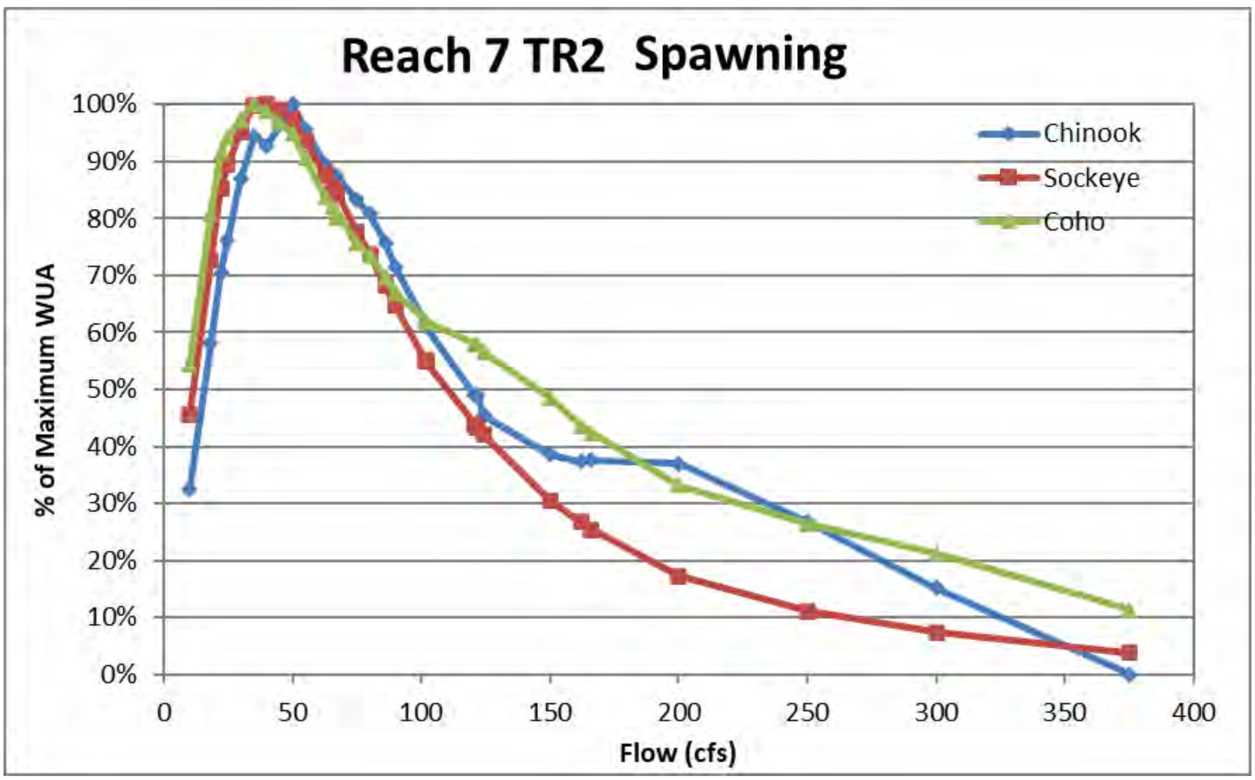
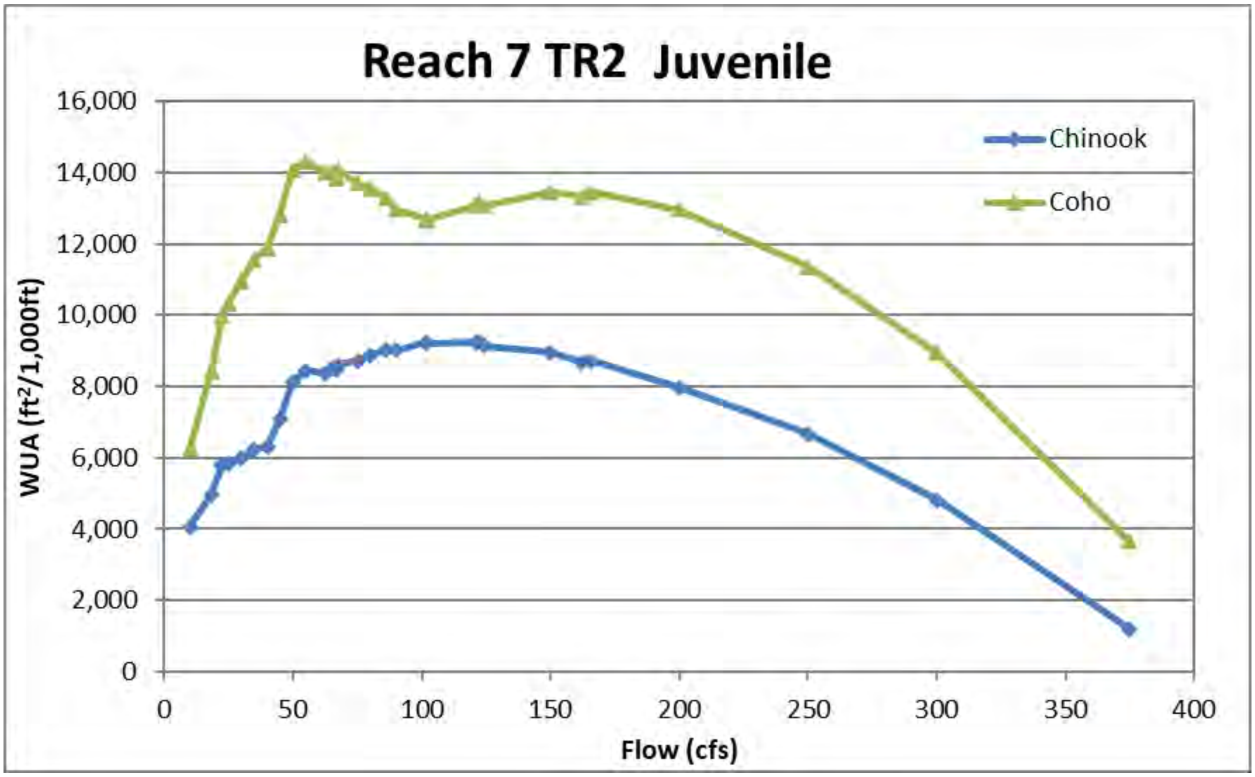


Figure A.2-23. Reach 7 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



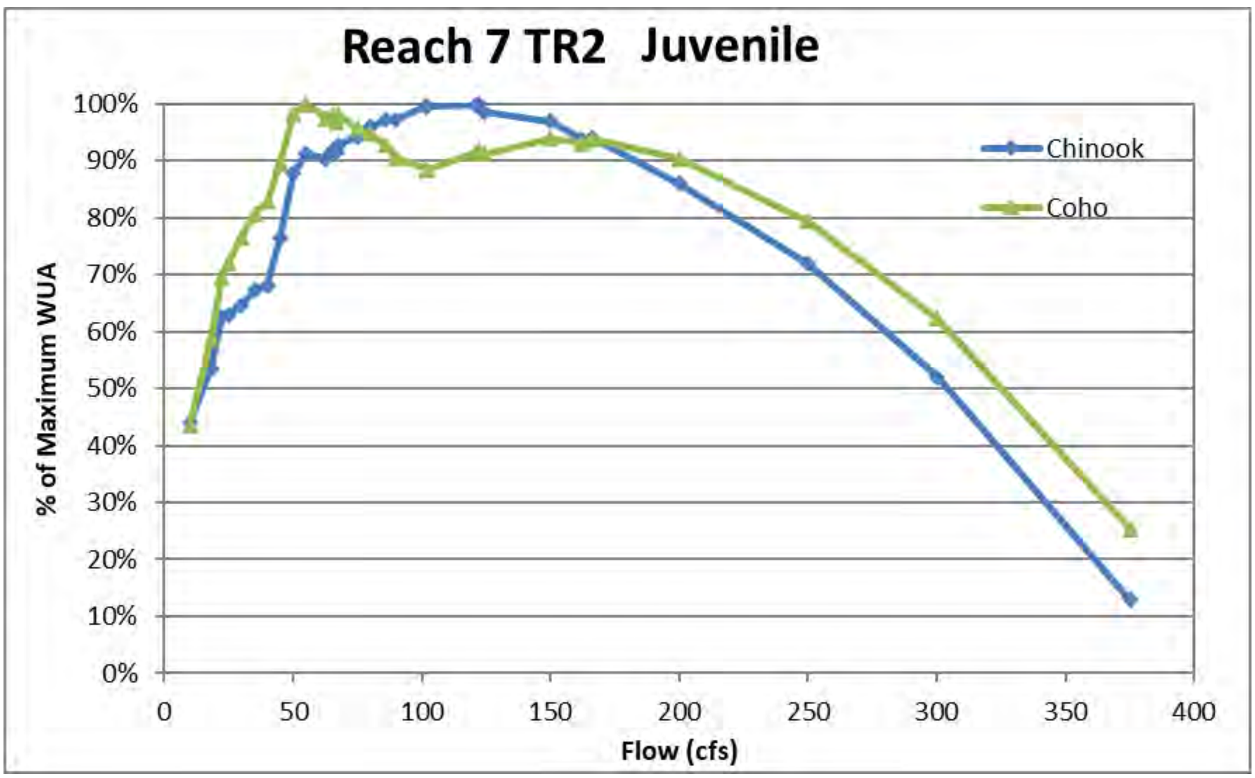
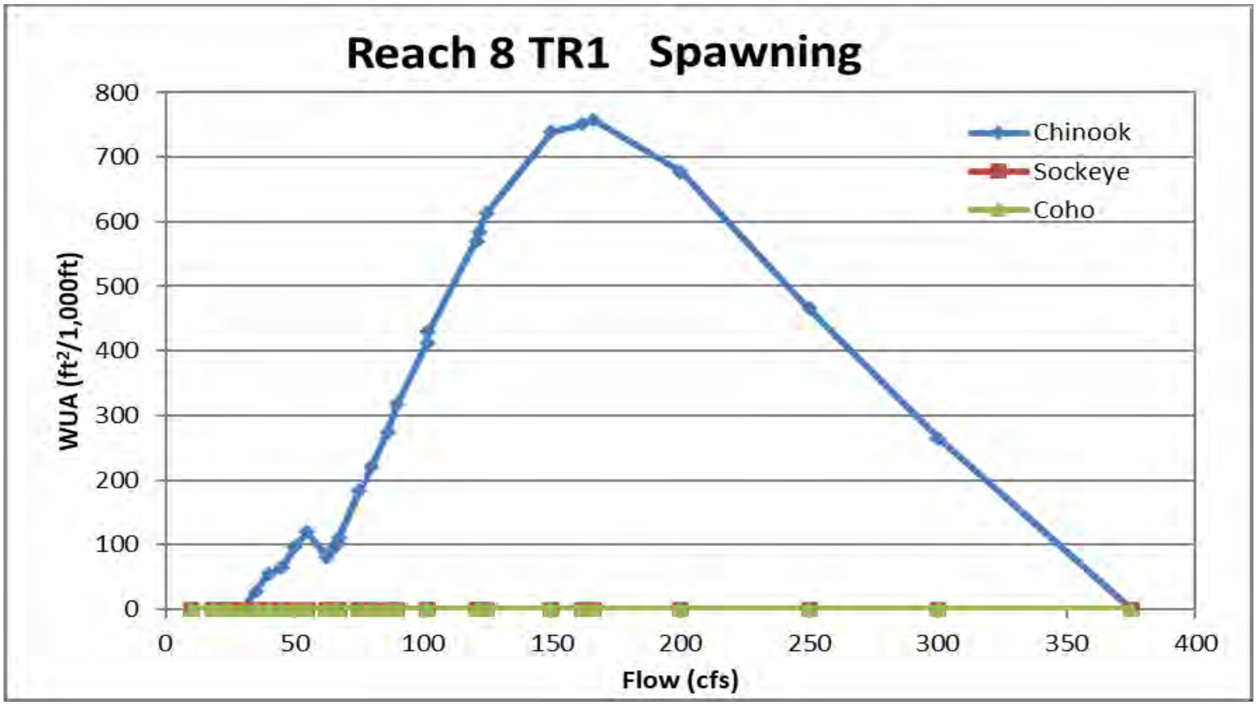


Figure A.2-24. Reach 7 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



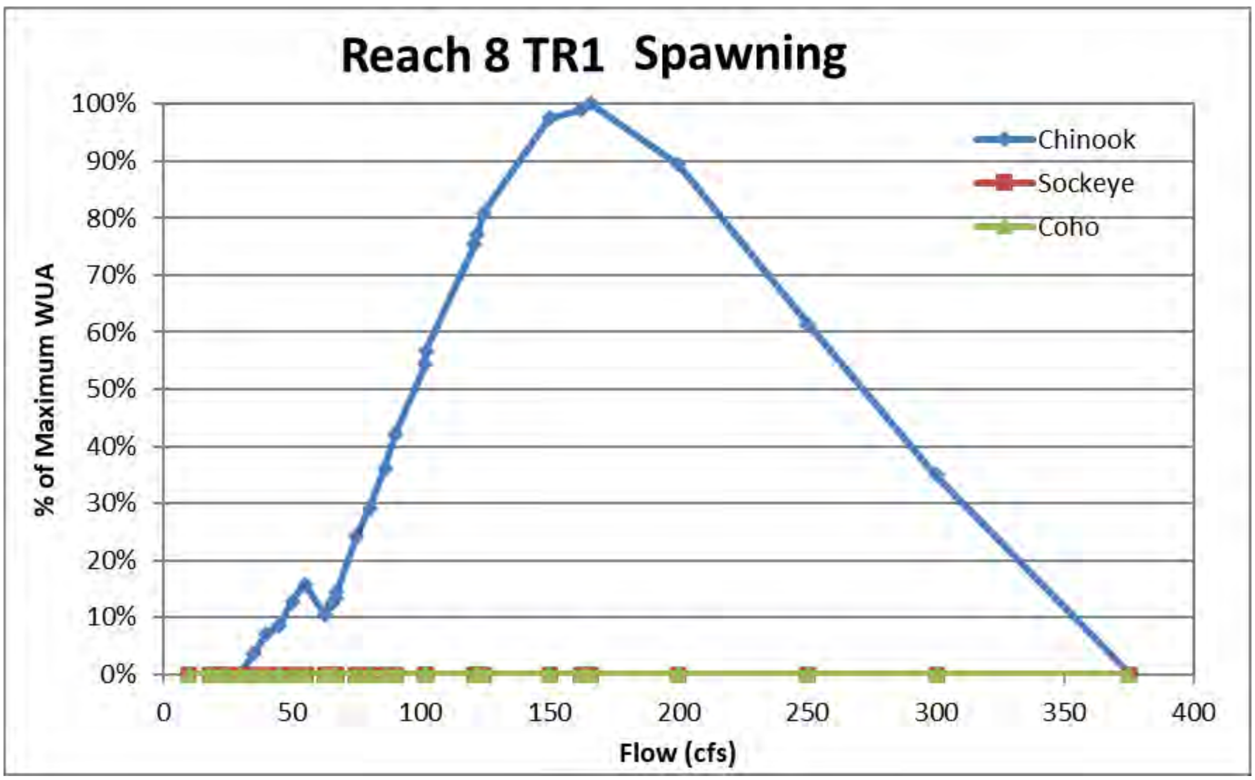


Figure A.2-25. Reach 8 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

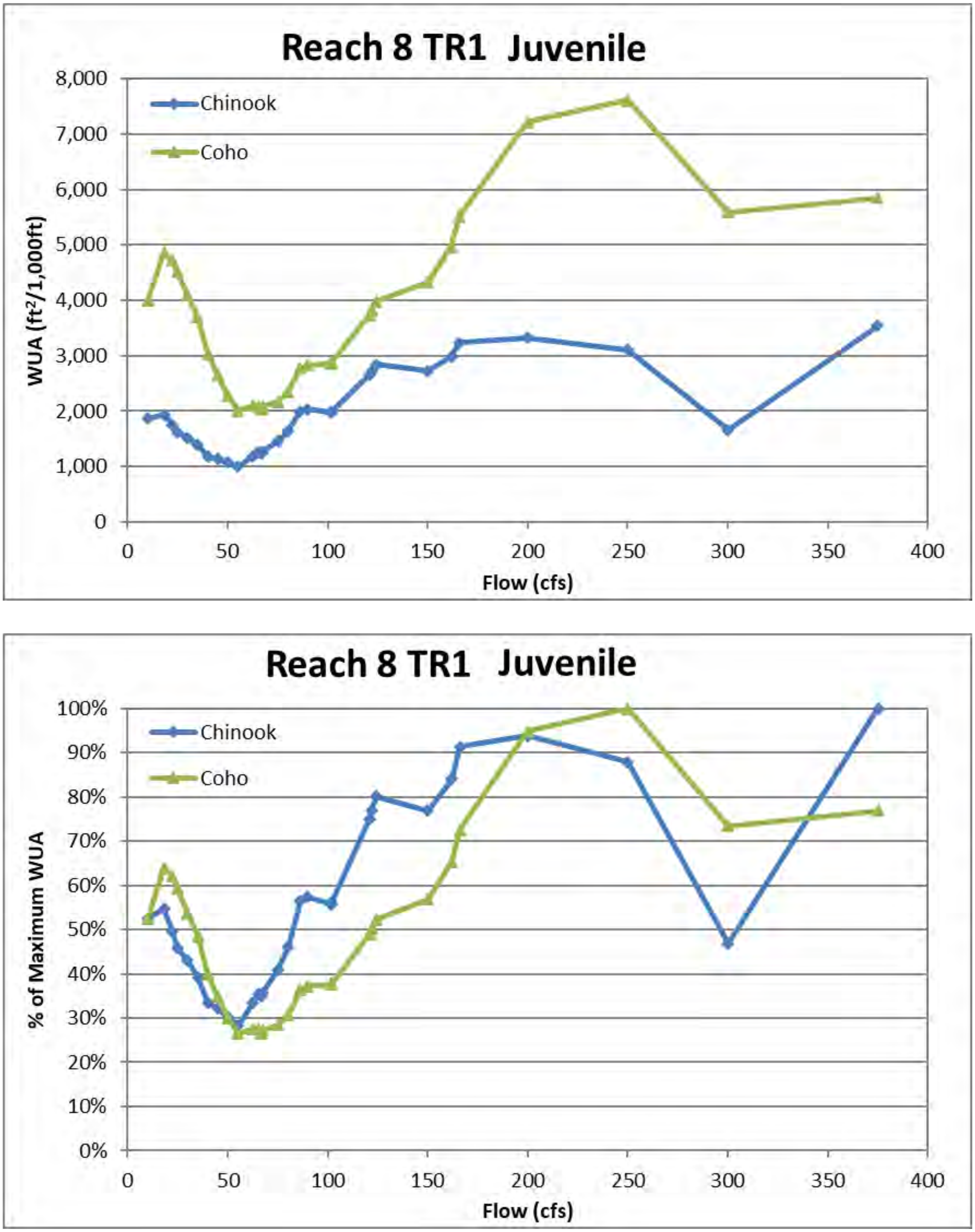
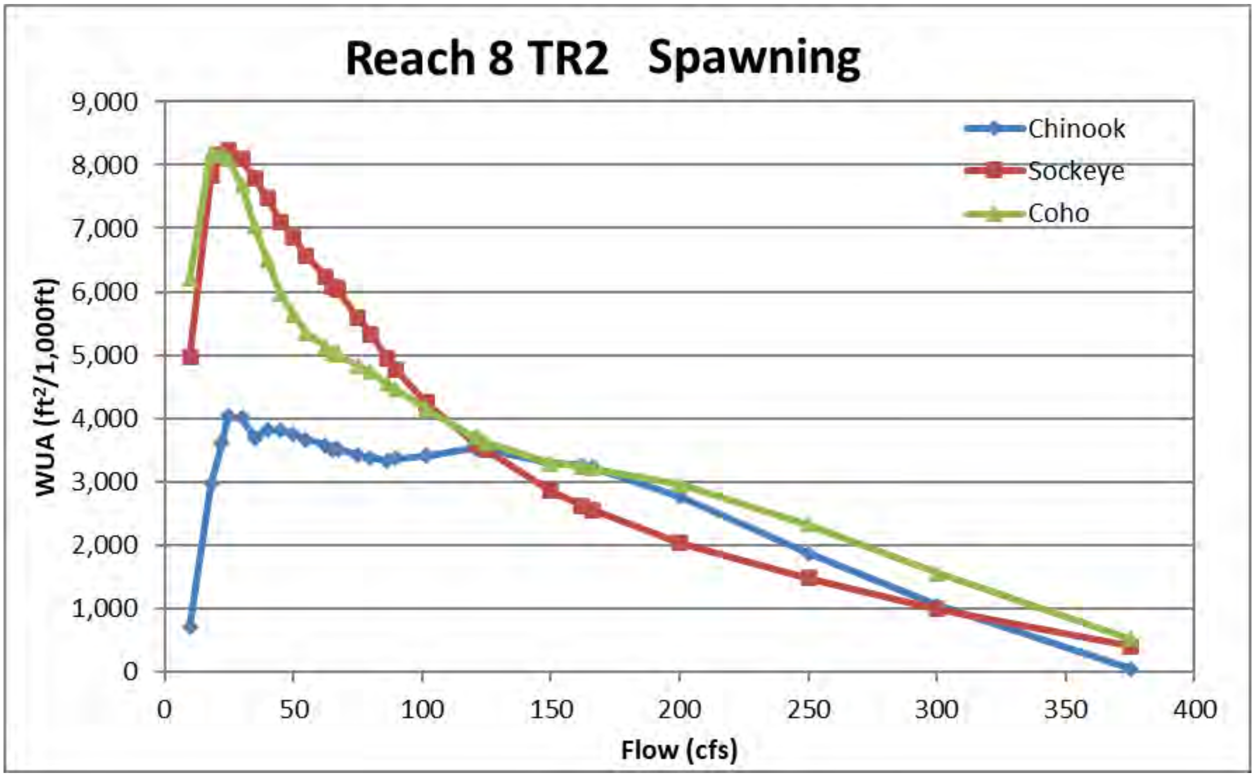


Figure A.2-26. Reach 8 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



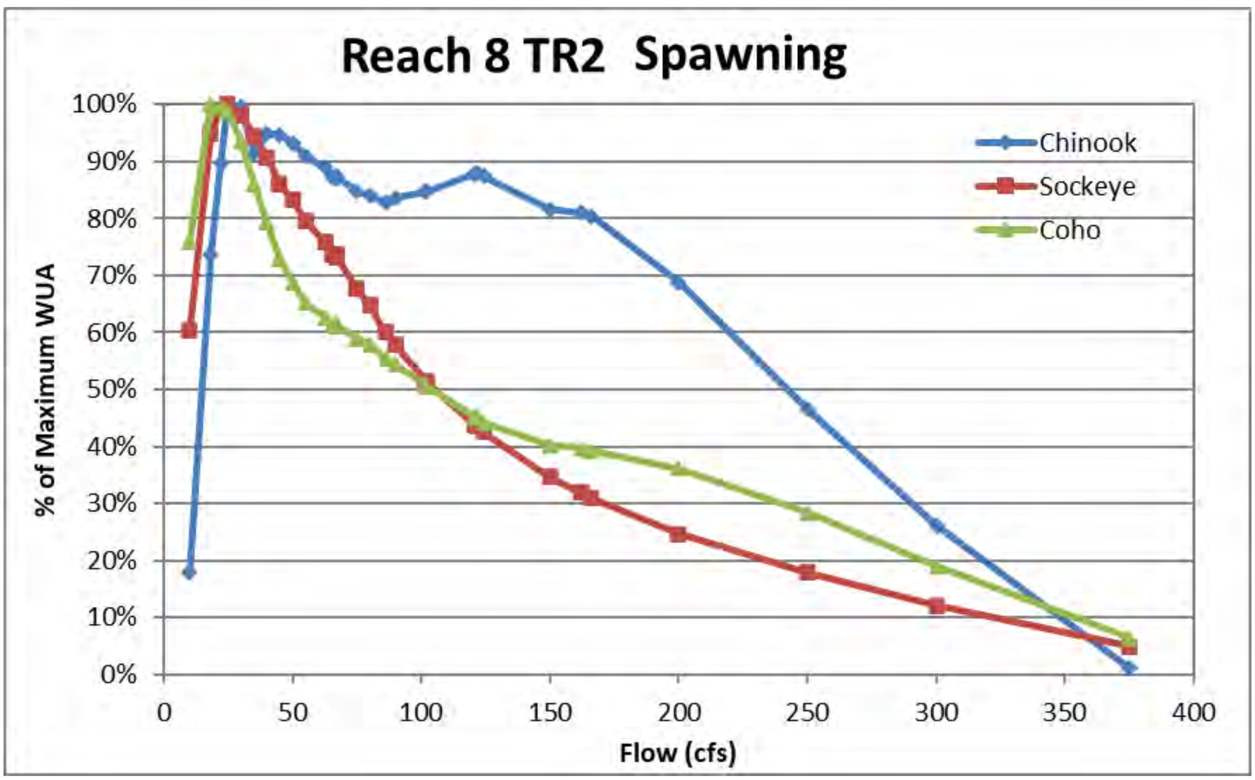
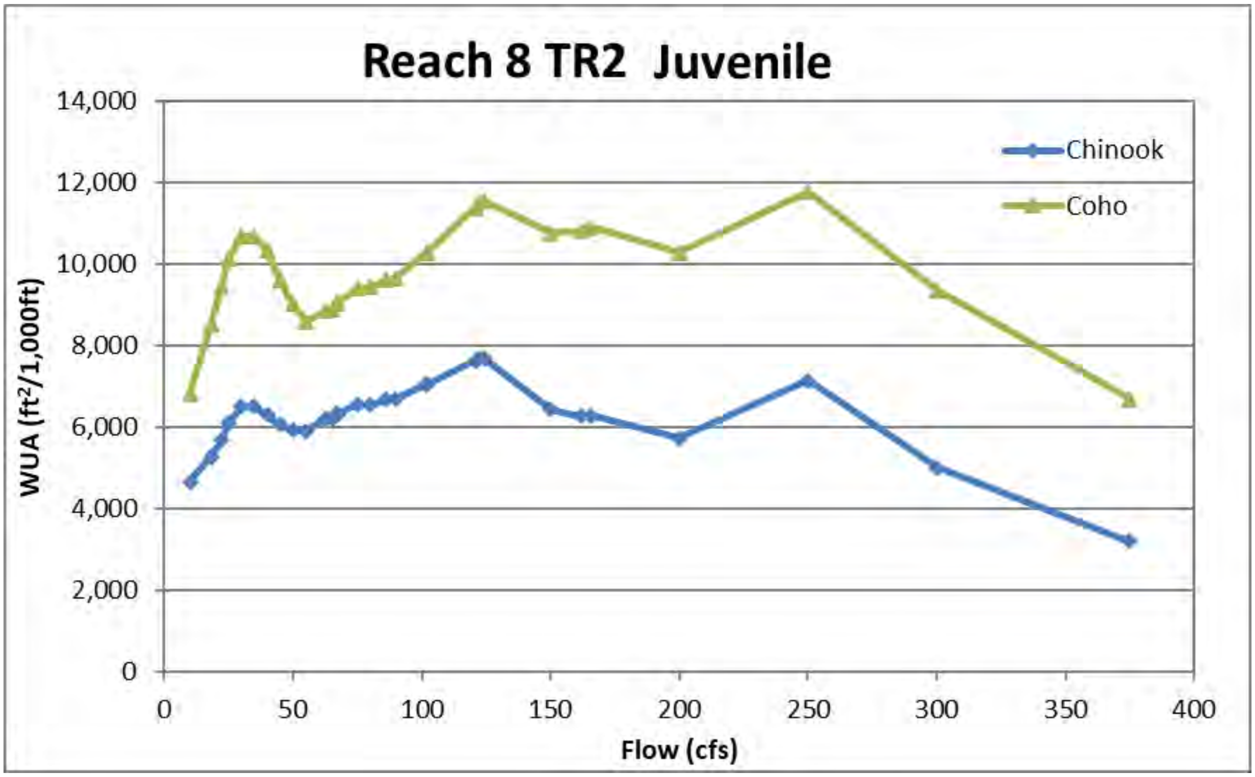


Figure A.2-27. Reach 8 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



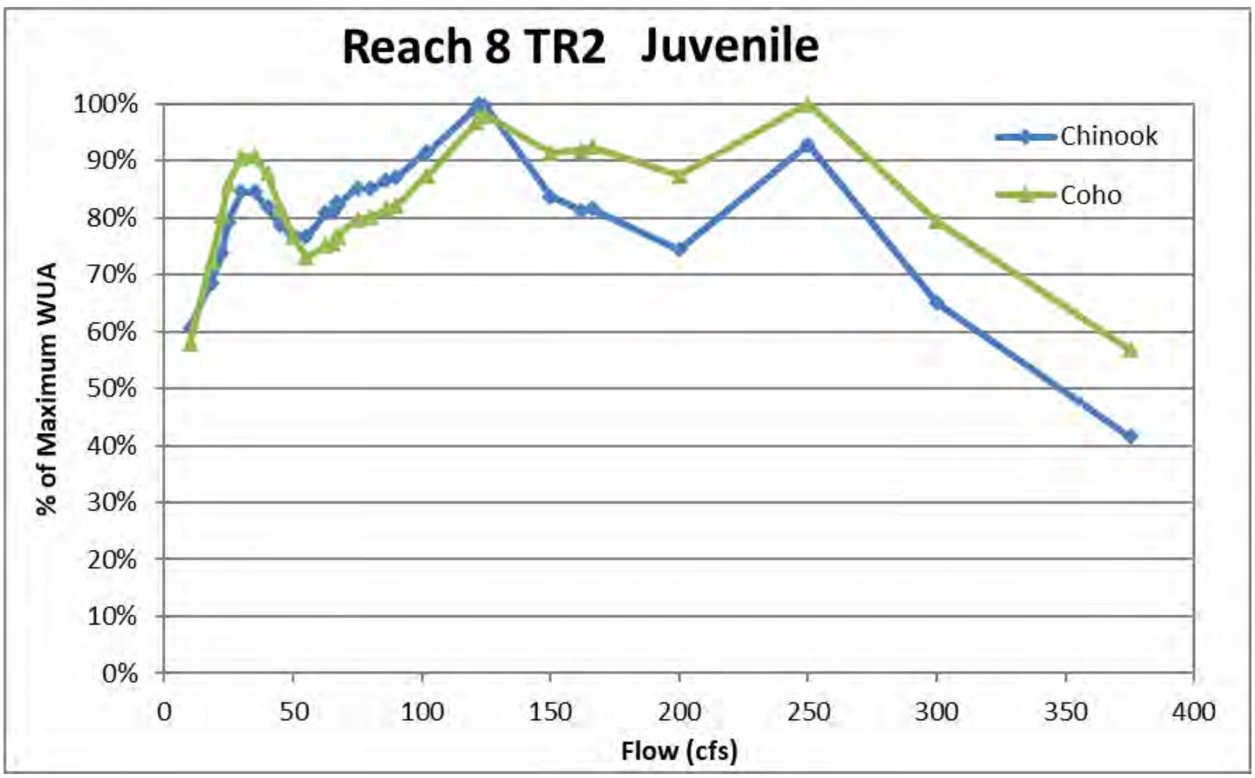
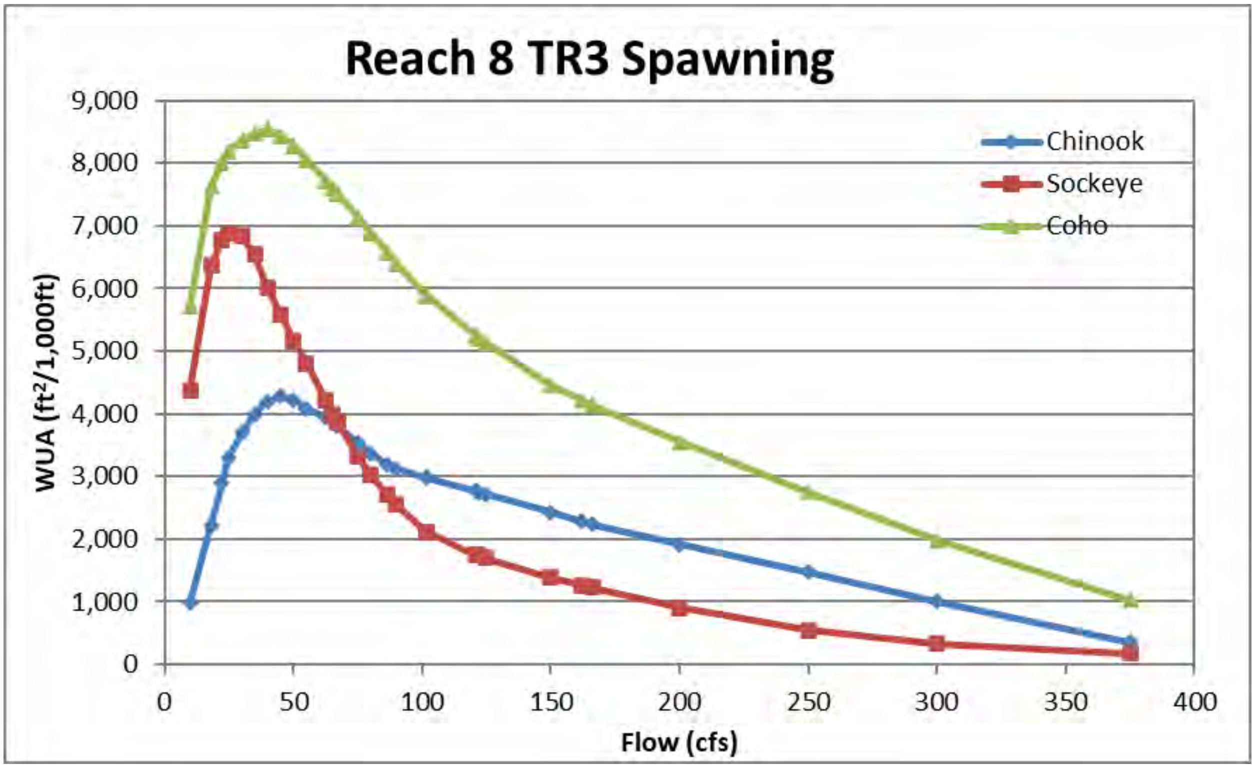


Figure A.2-28. Reach 8 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



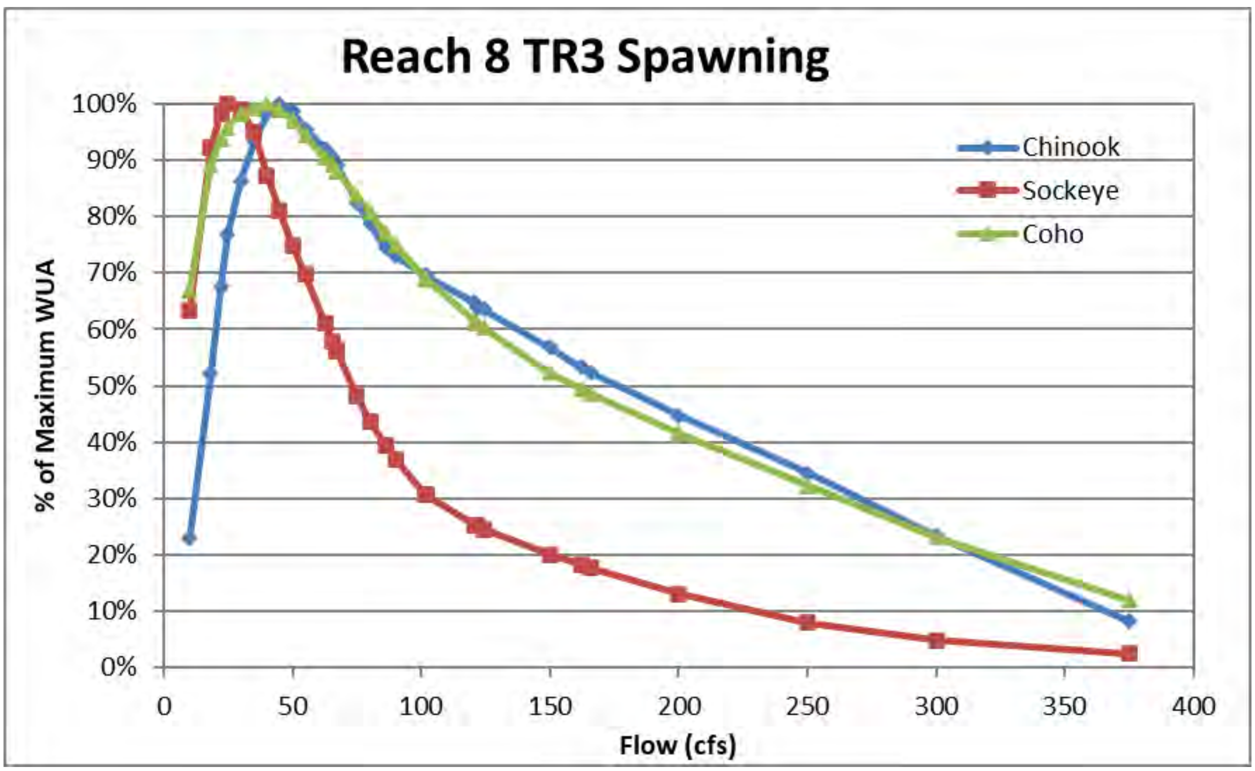
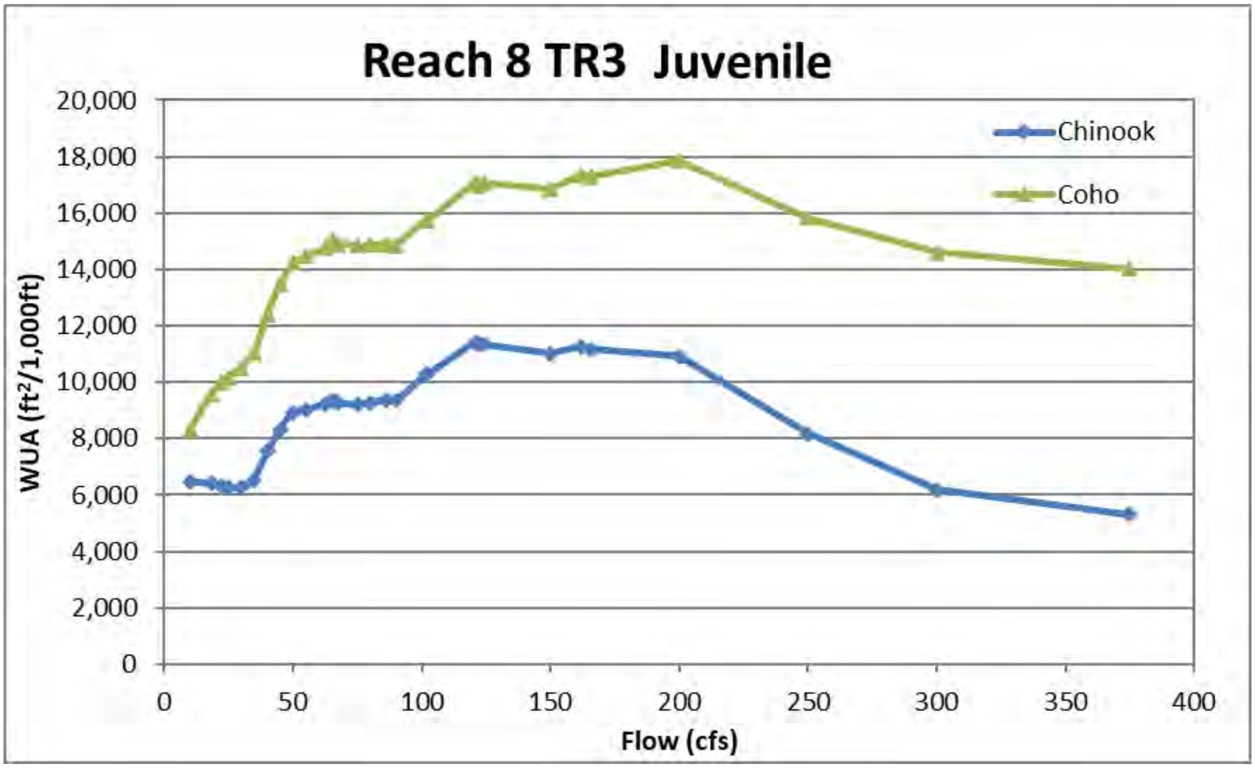


Figure A.2-29. Reach 8 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



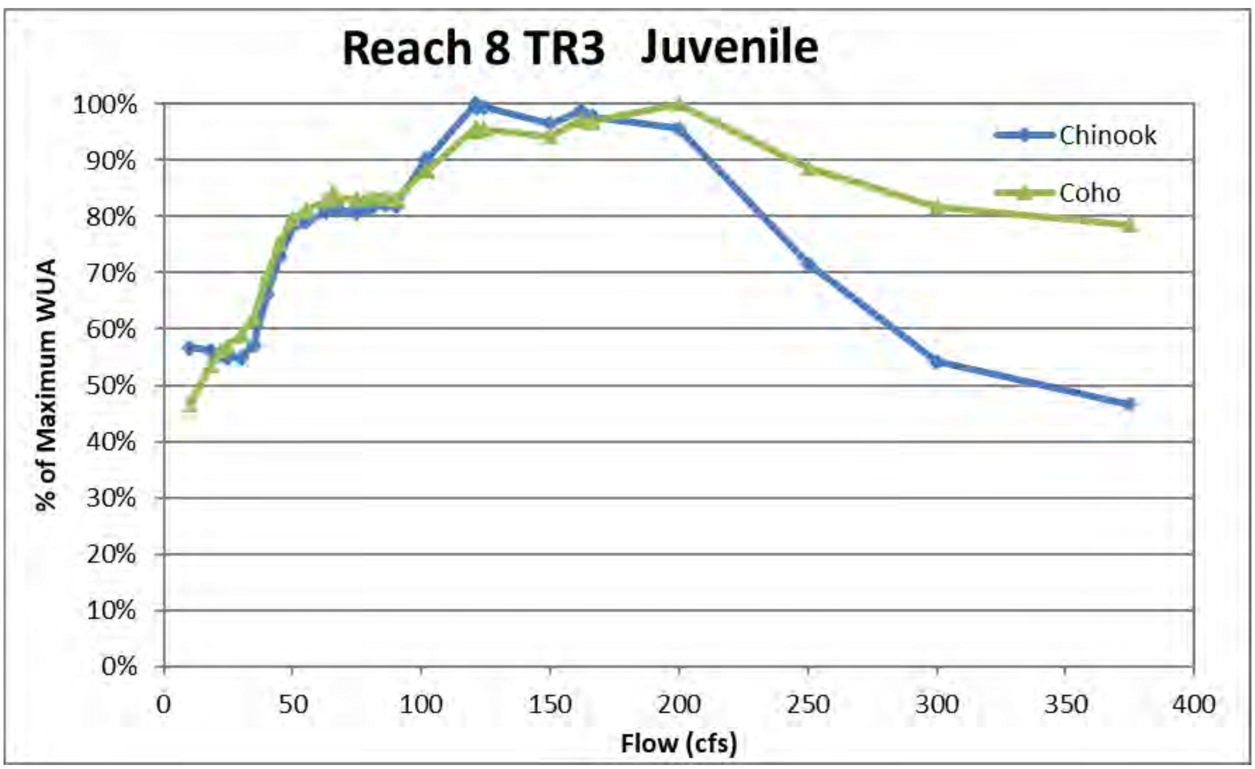
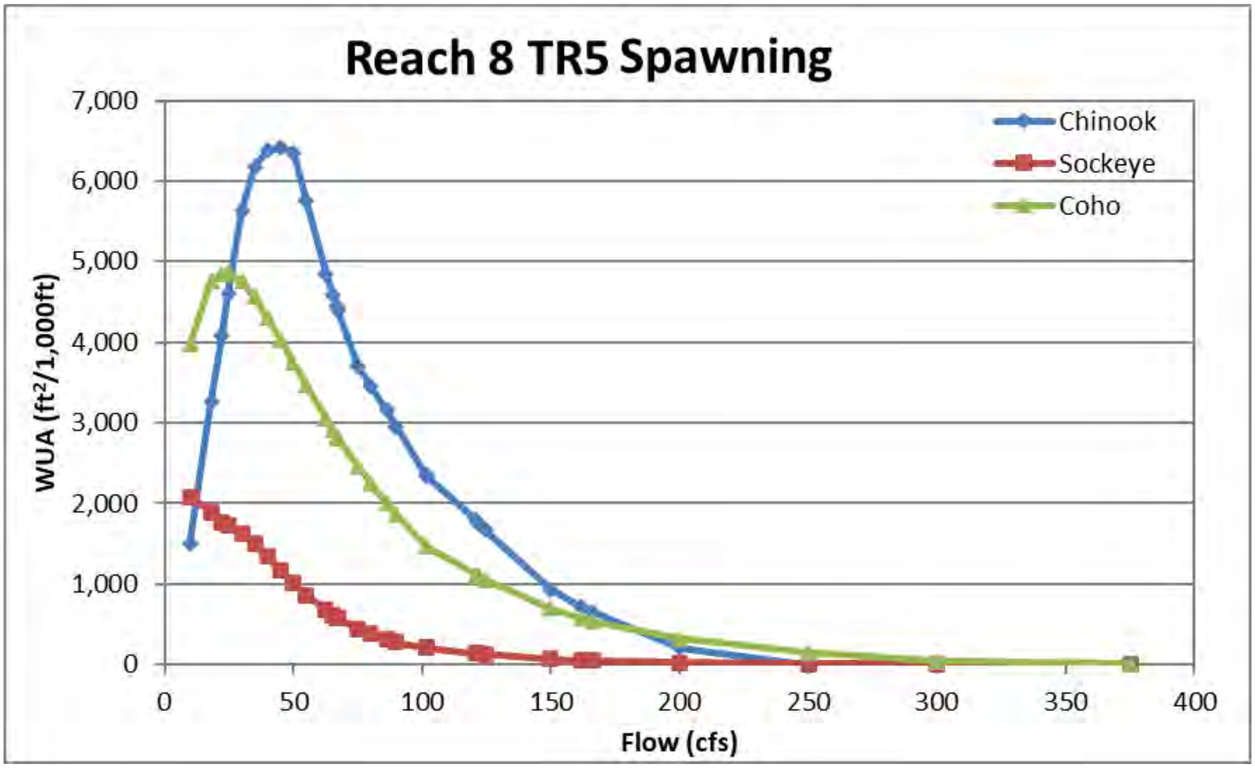


Figure A.2-30. Reach 8 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



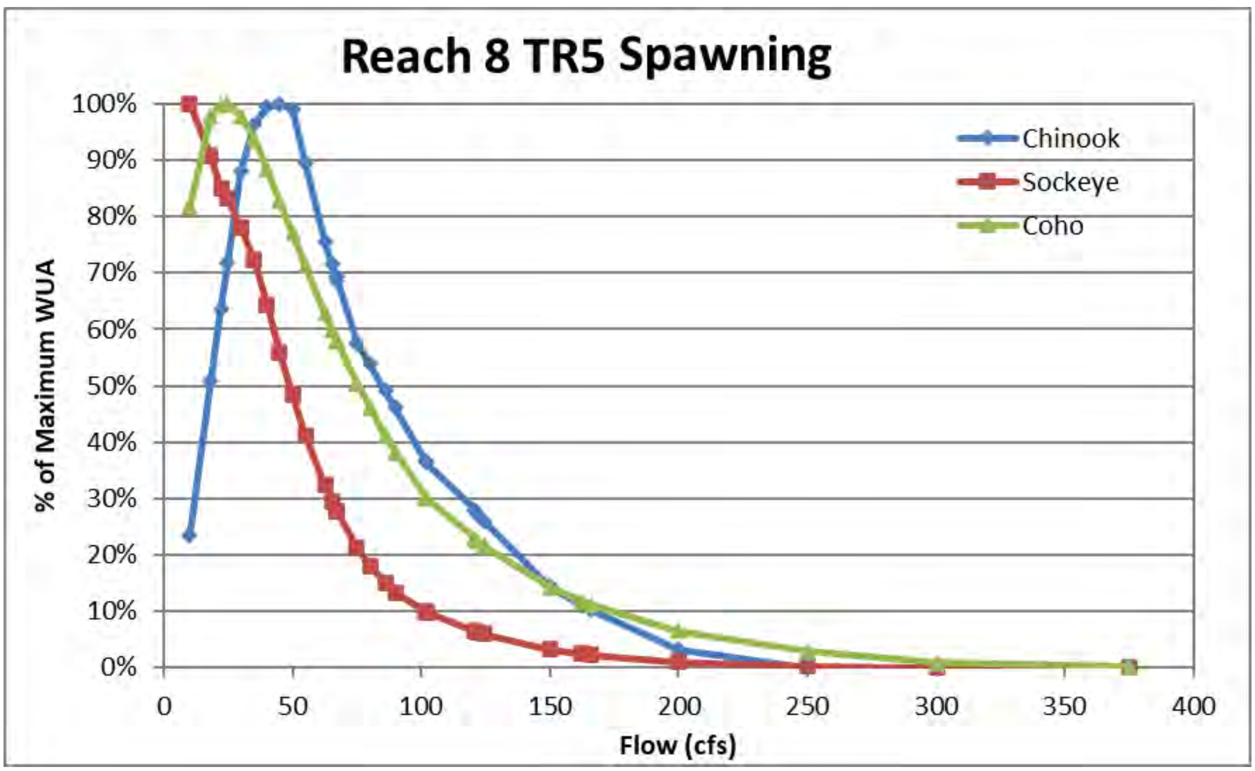
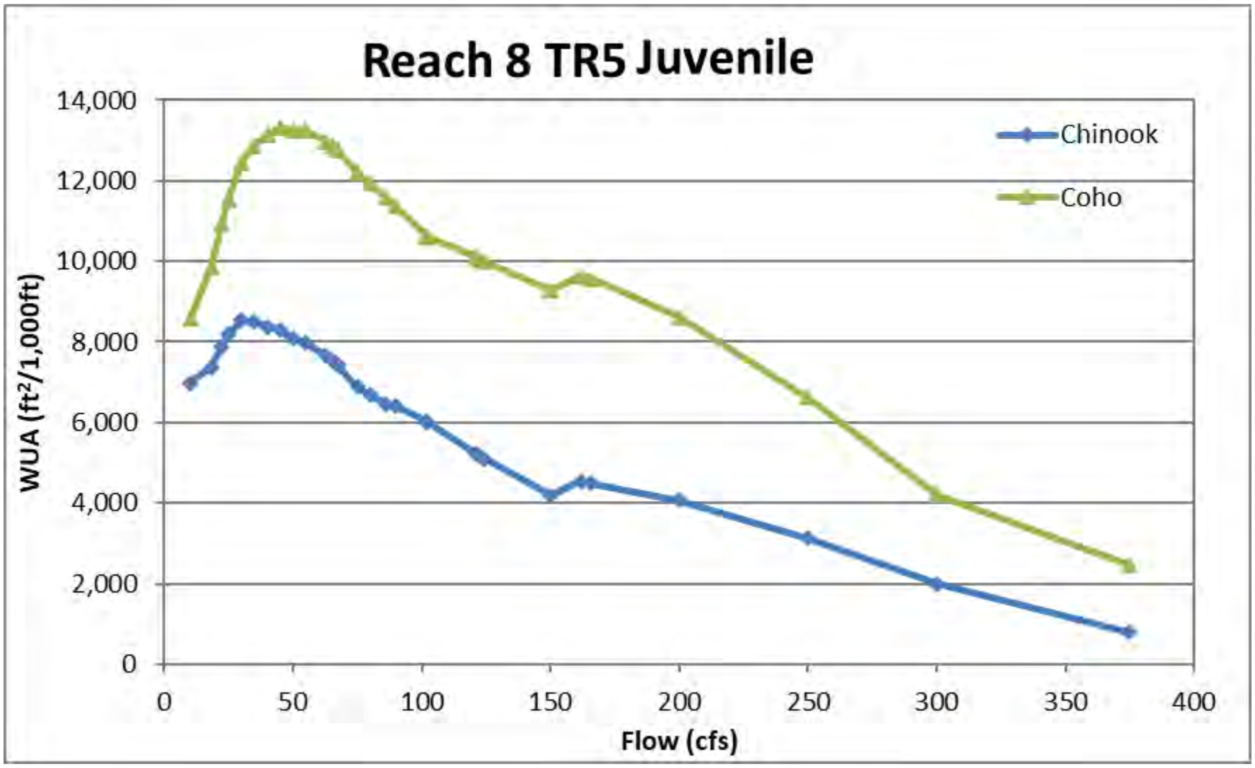


Figure A.2-31. Reach 8 Transect 5 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



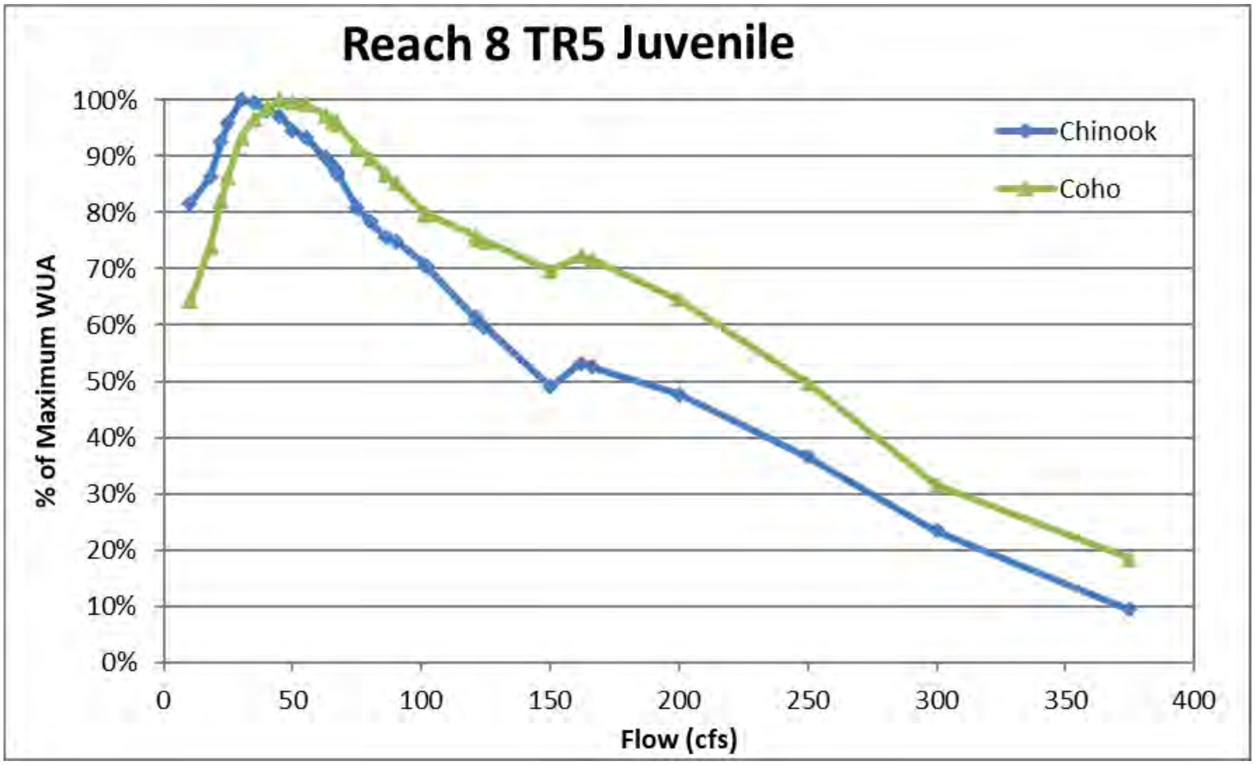
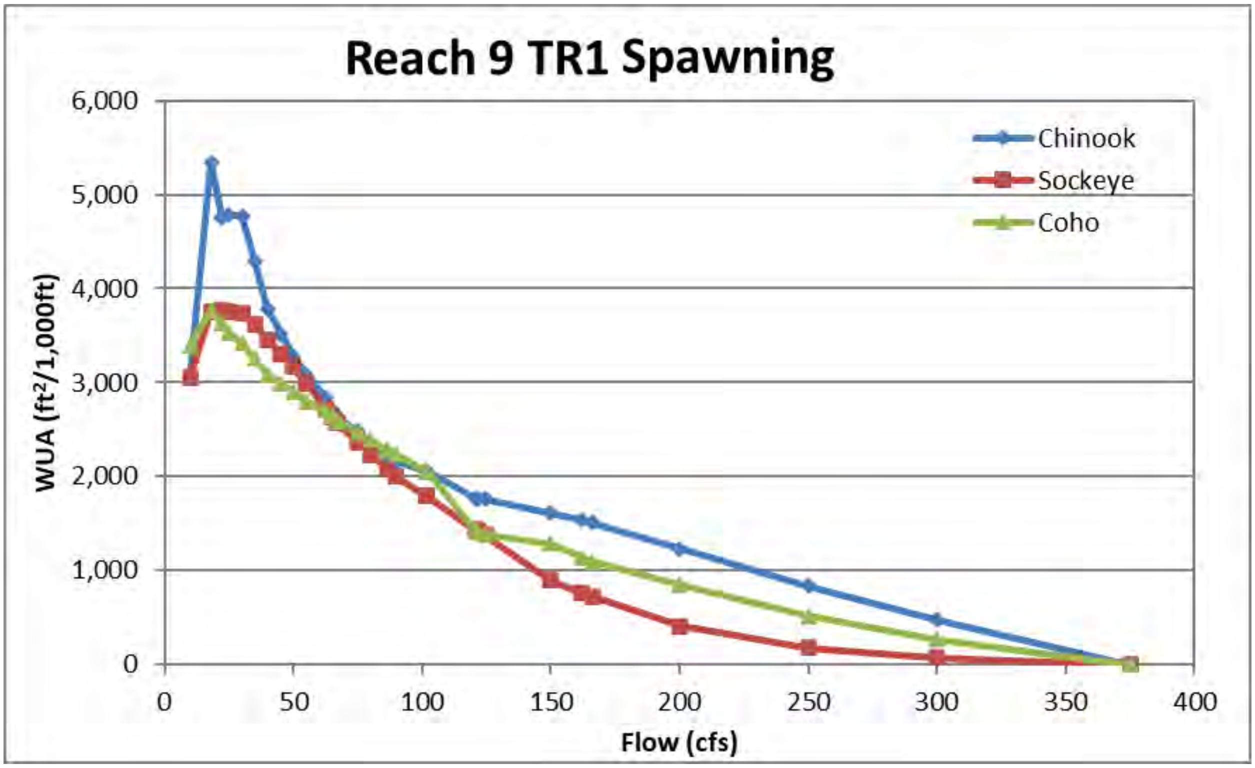


Figure A.2-32. Reach 8 Transect 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



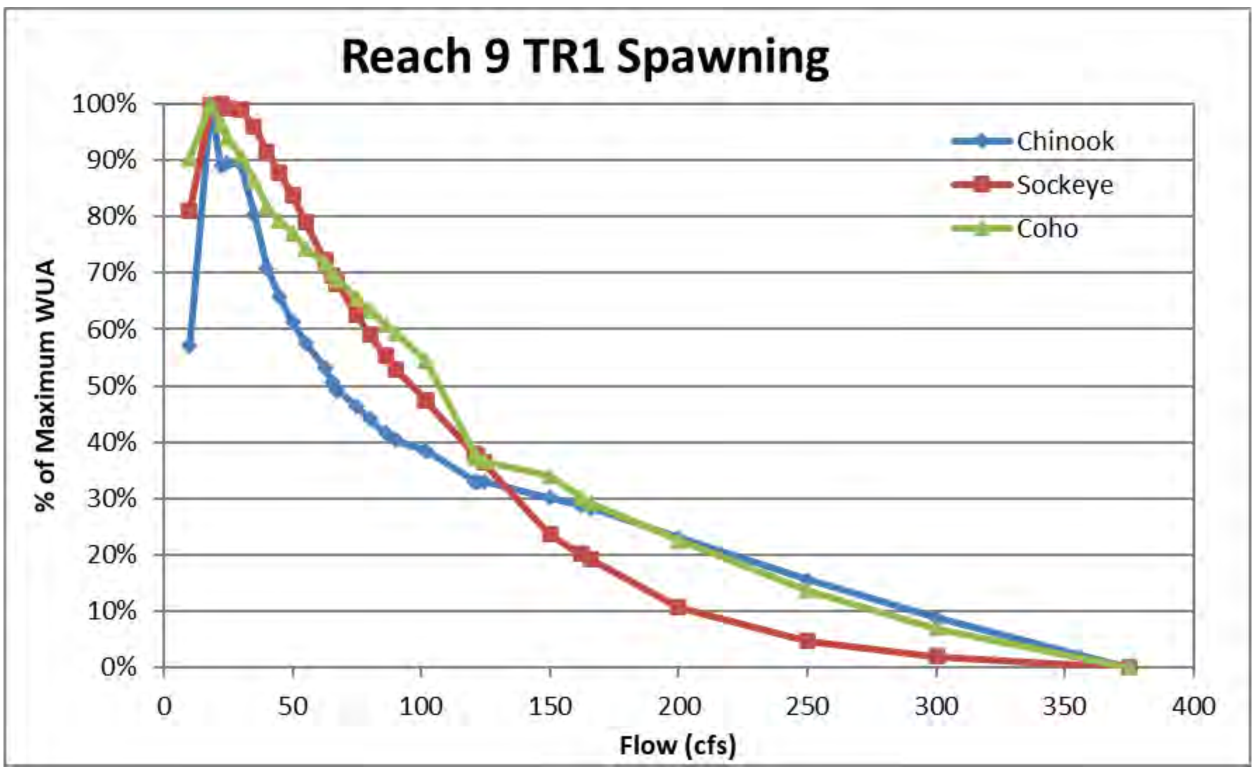


Figure A.2-33. Reach 9 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

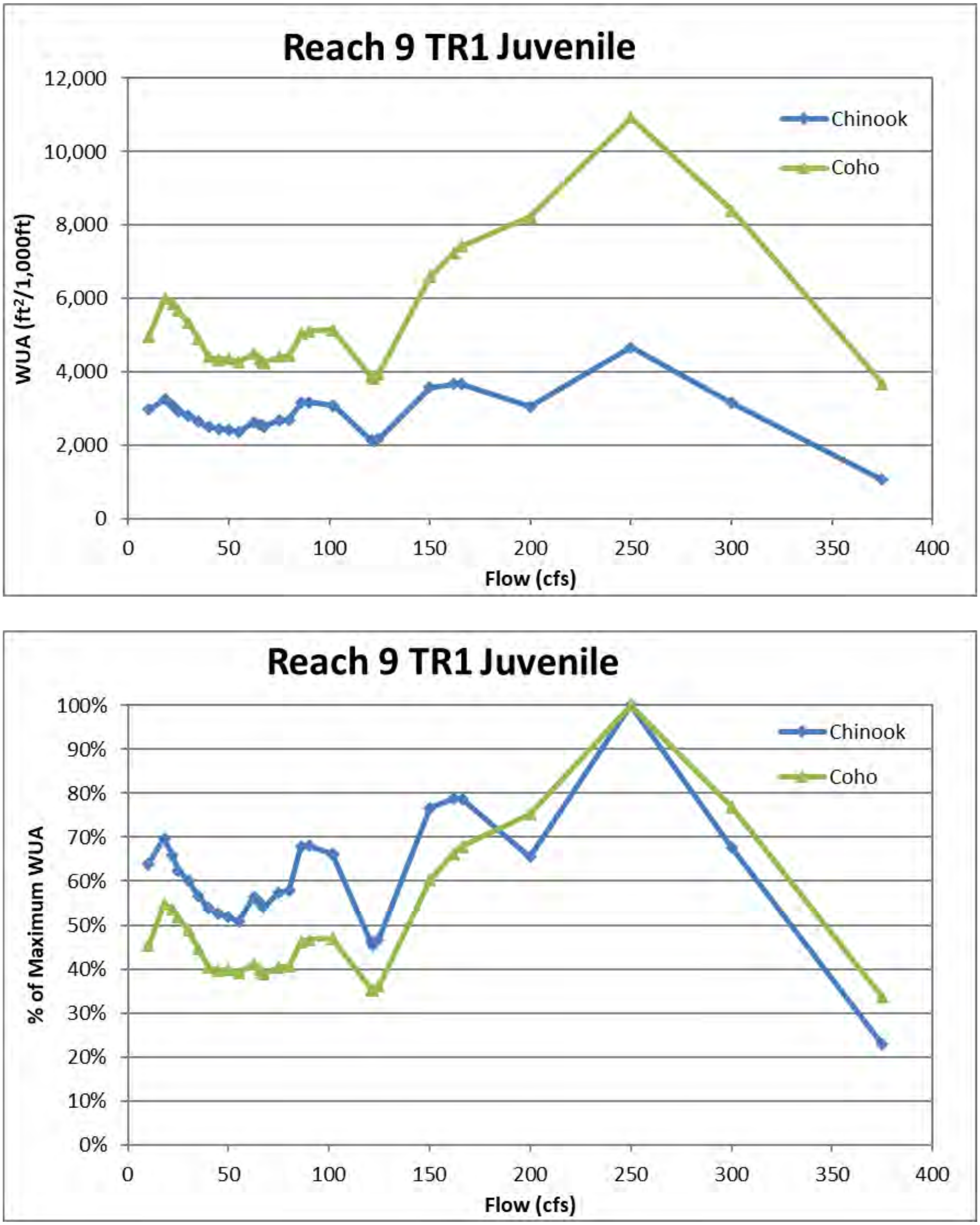
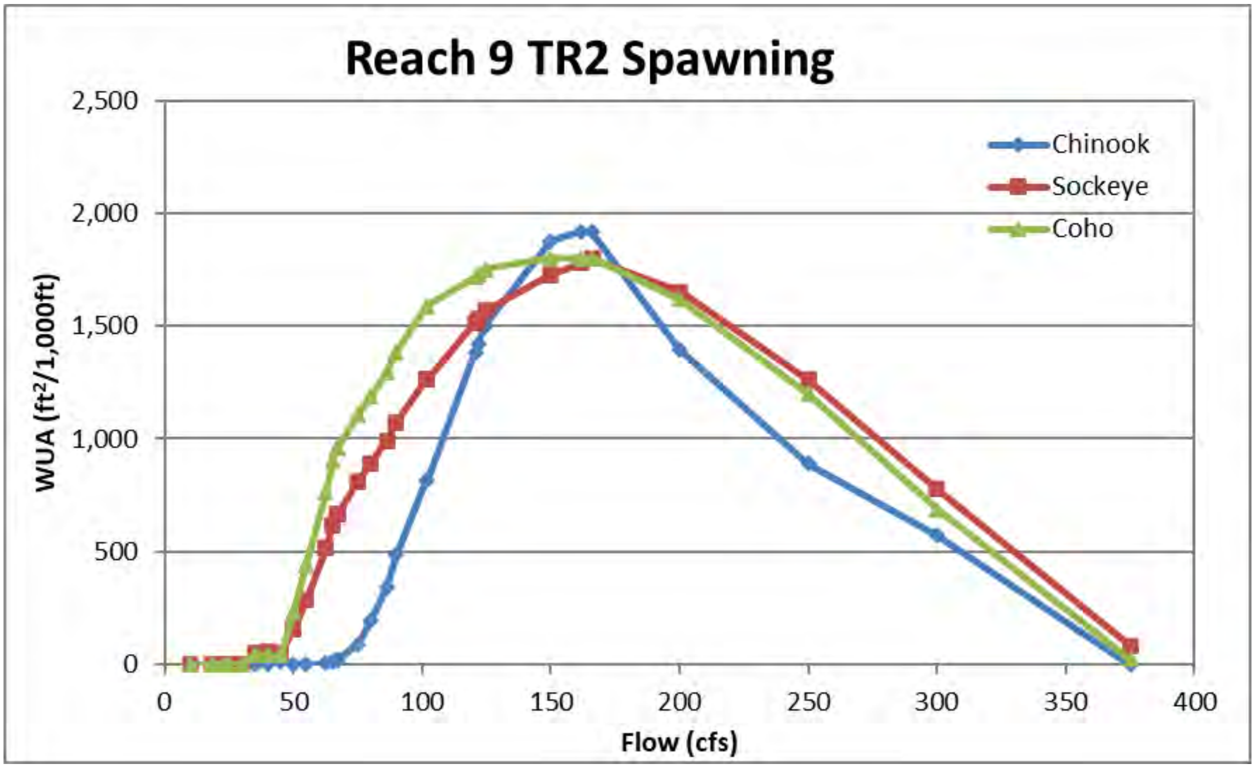


Figure A.2-34. Reach 9 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



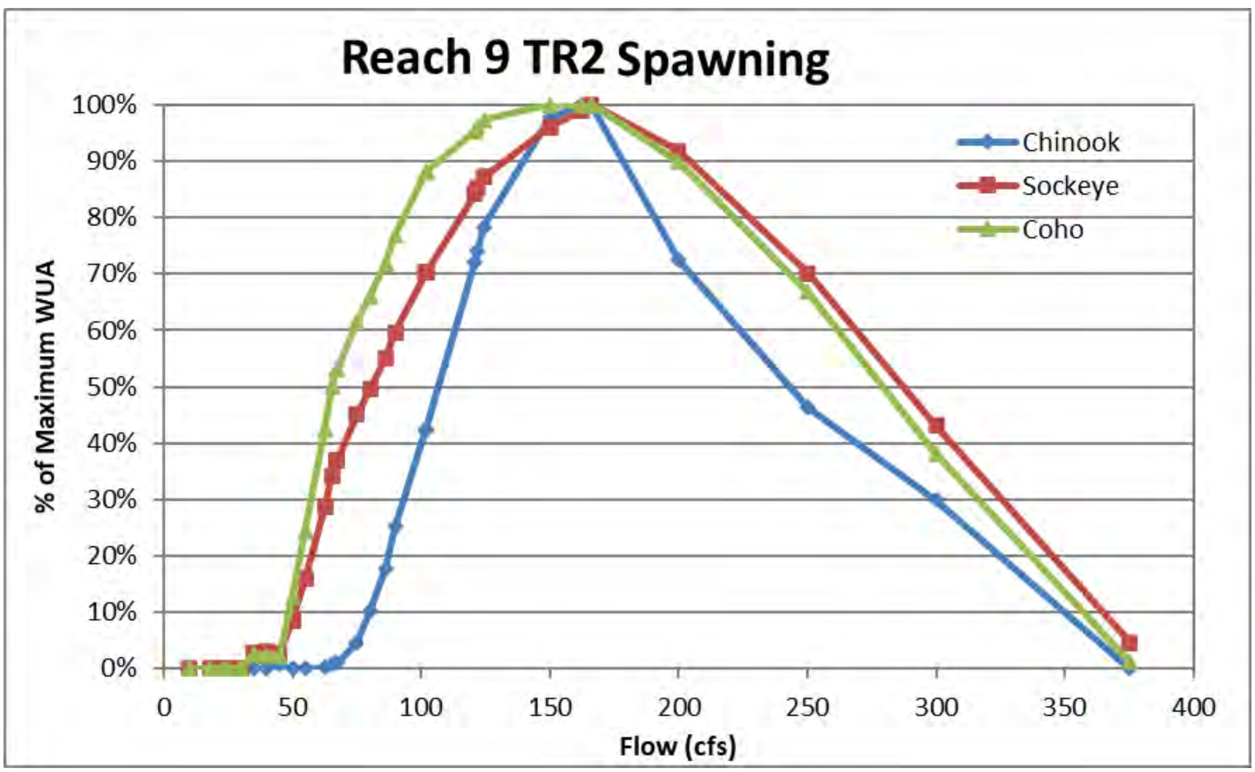
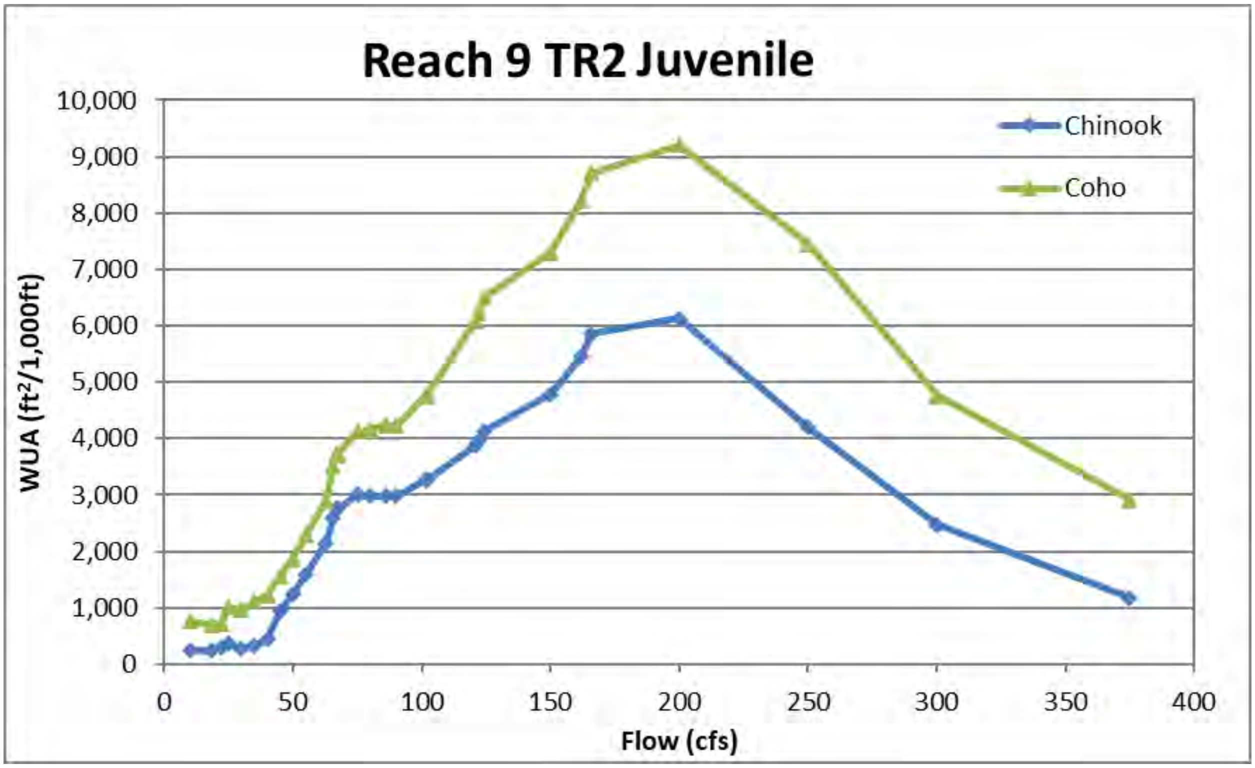


Figure A.2-35. Reach 9 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



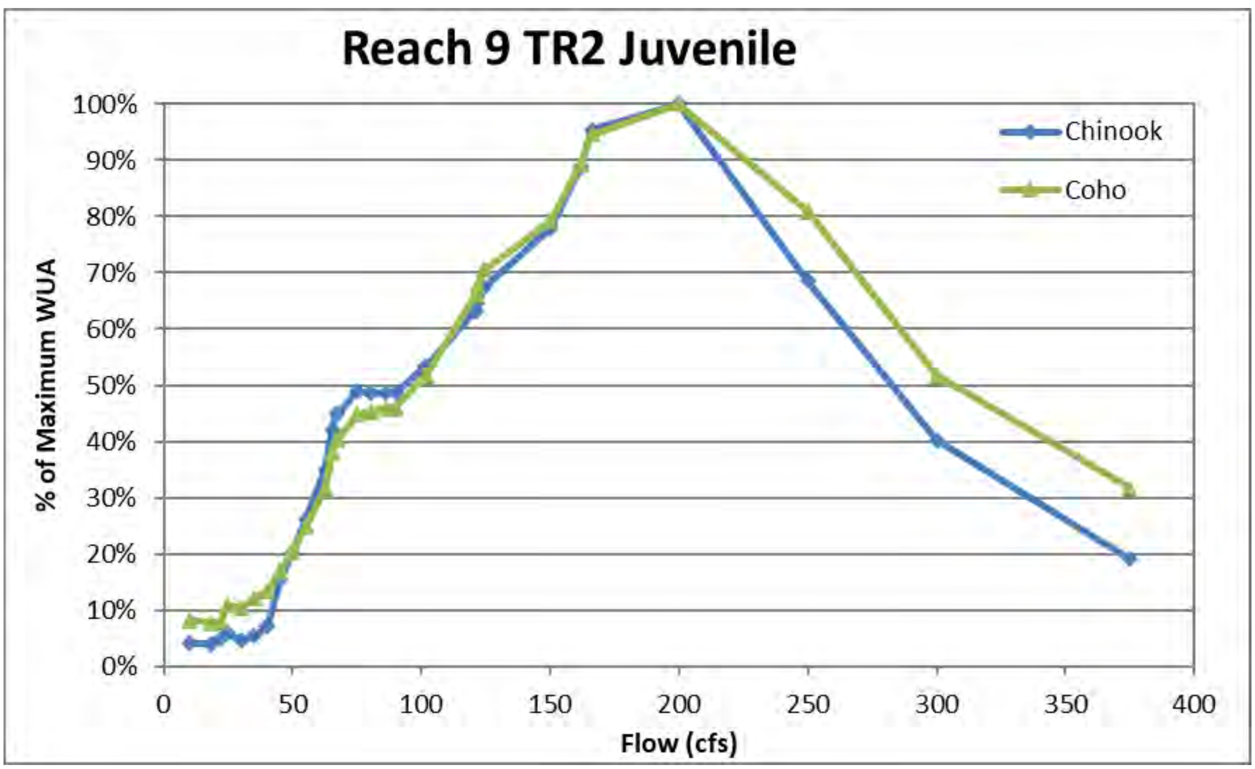
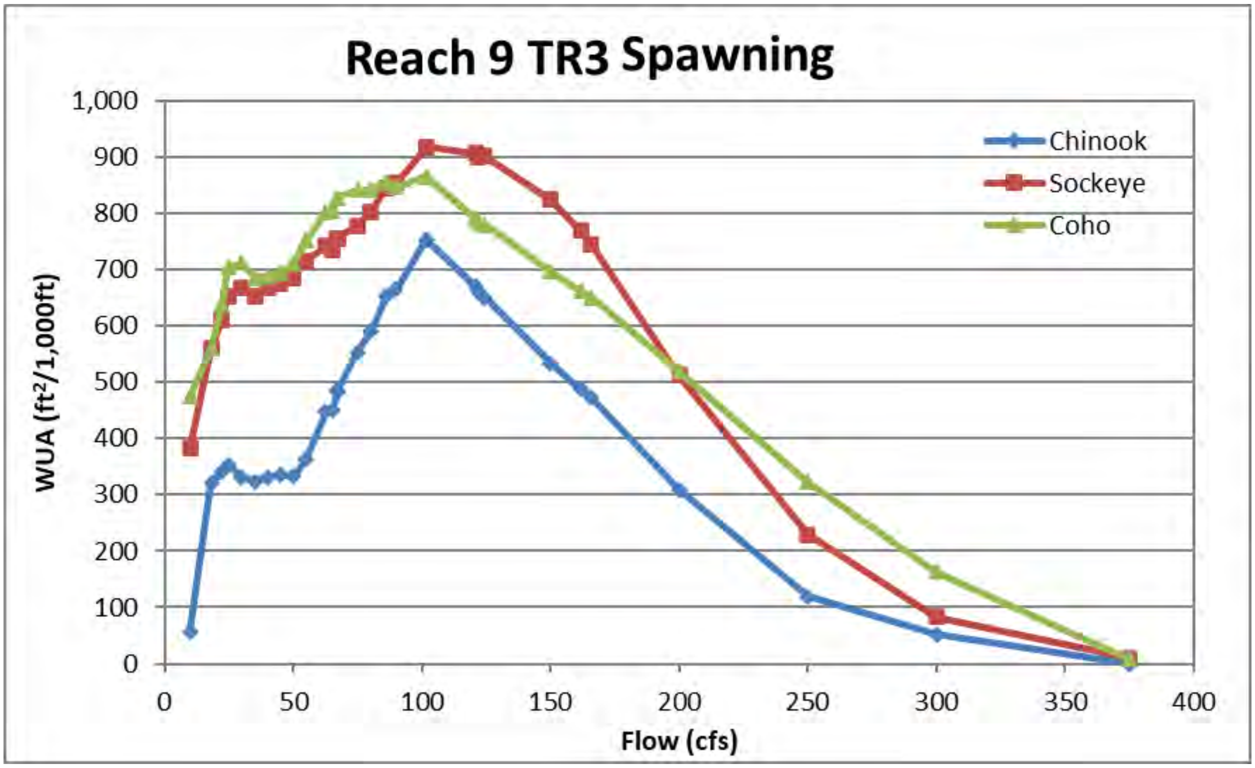


Figure A.2-36. Reach 9 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



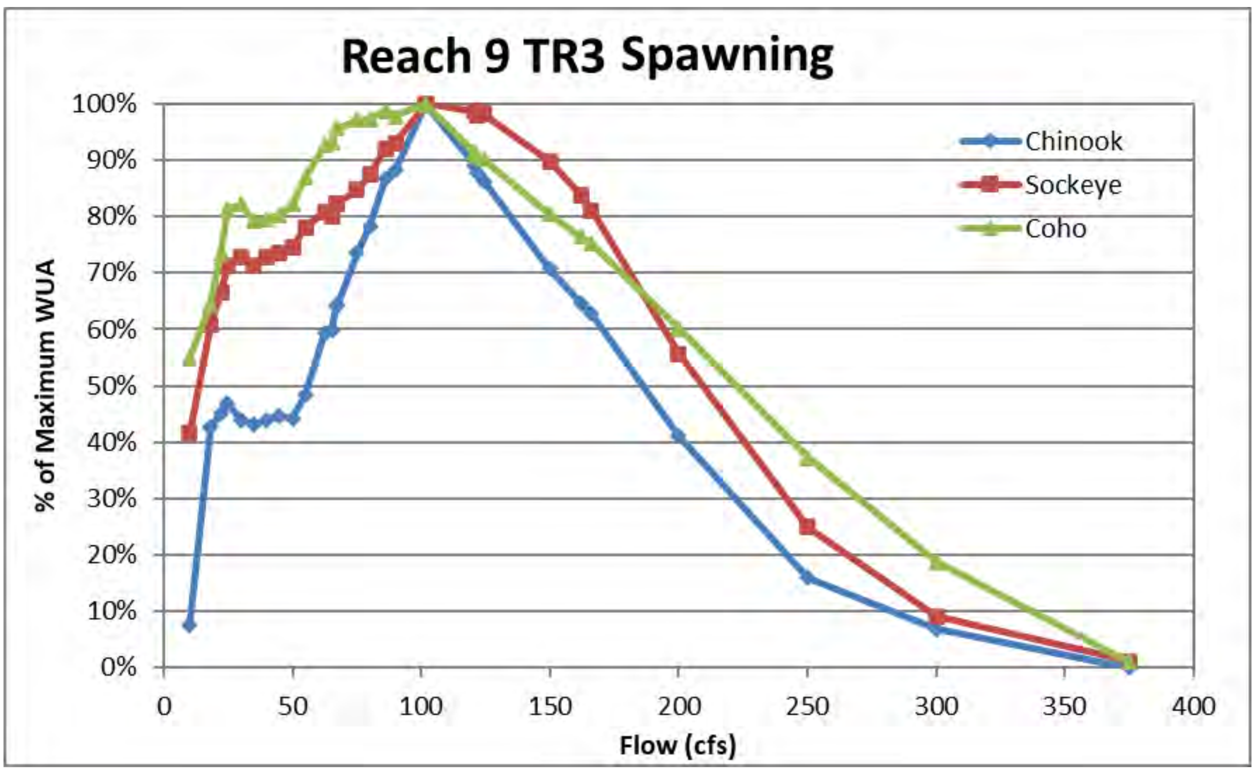
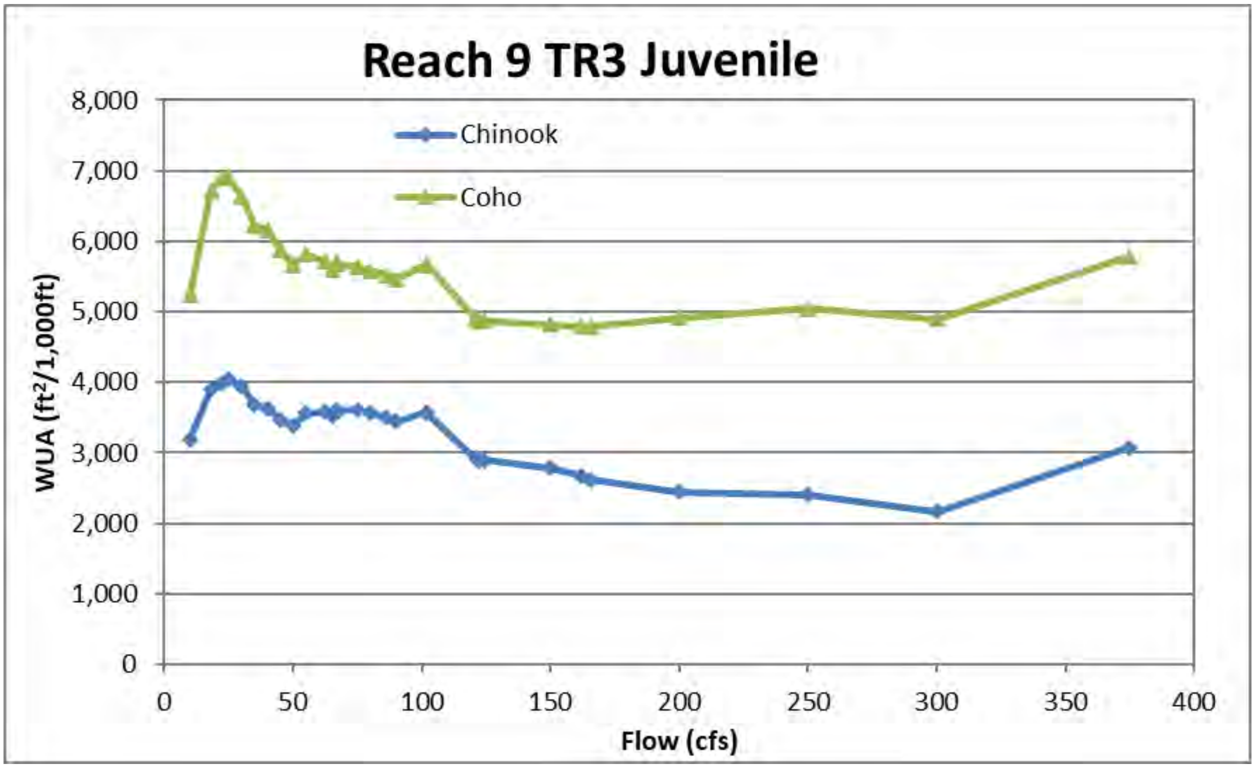


Figure A.2-37. Reach 9 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



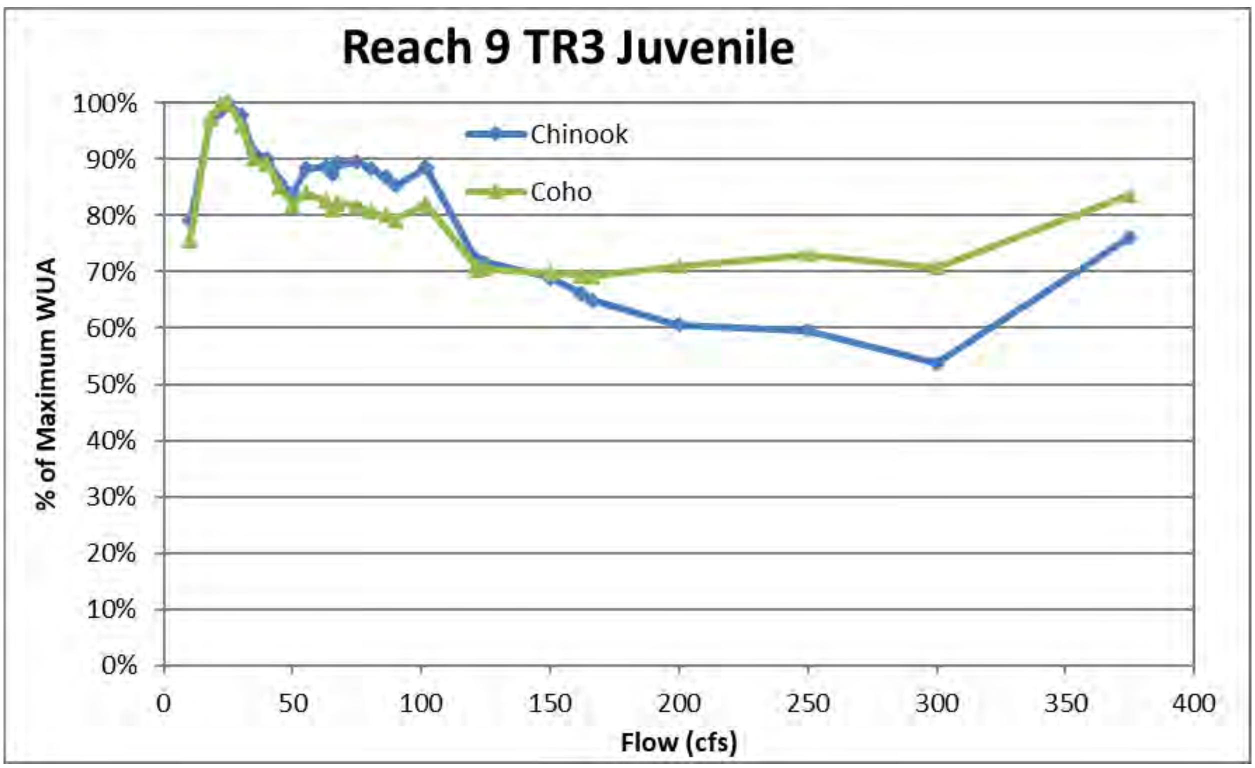
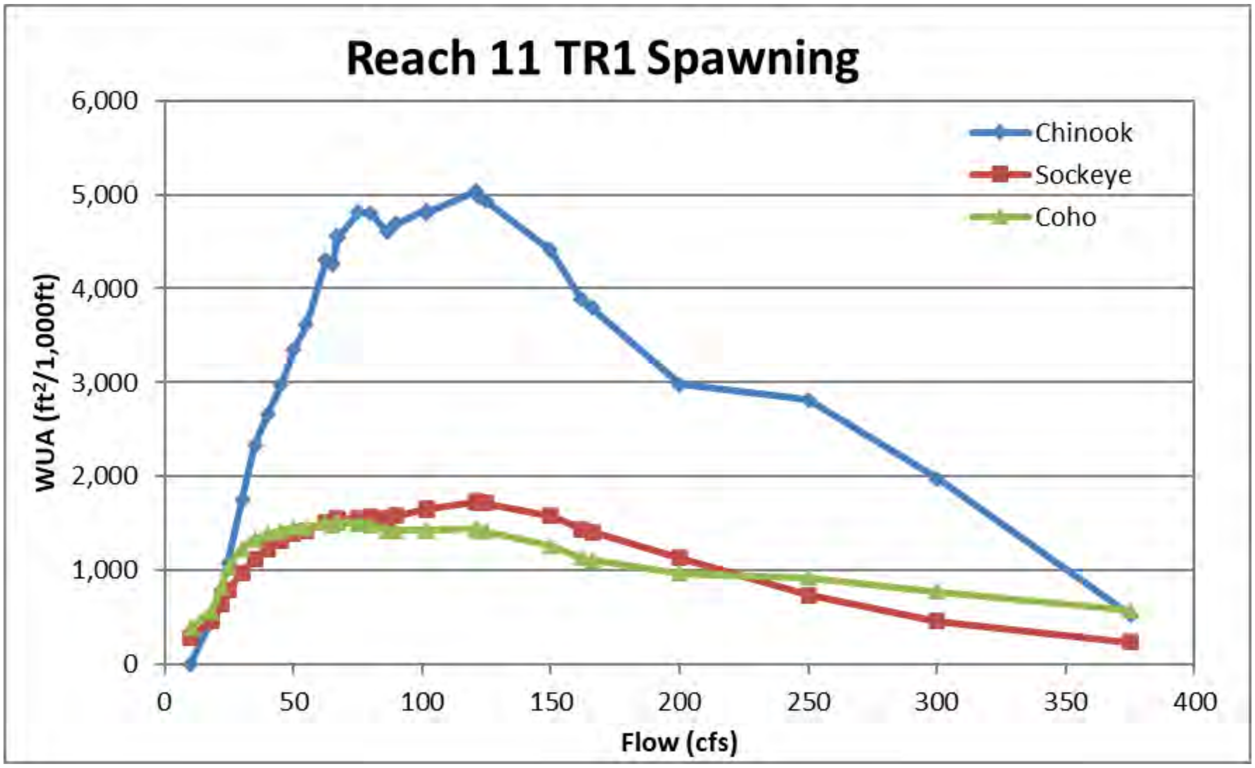


Figure A.2-38. Reach 9 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



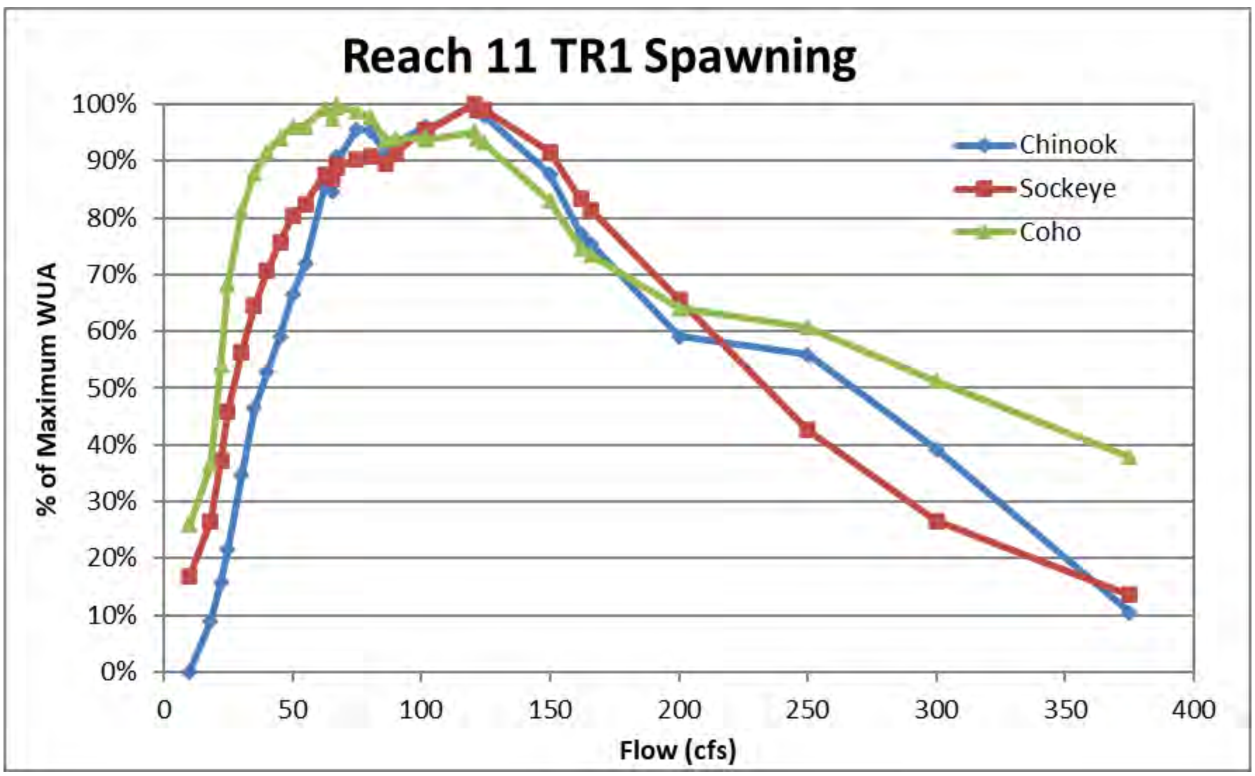
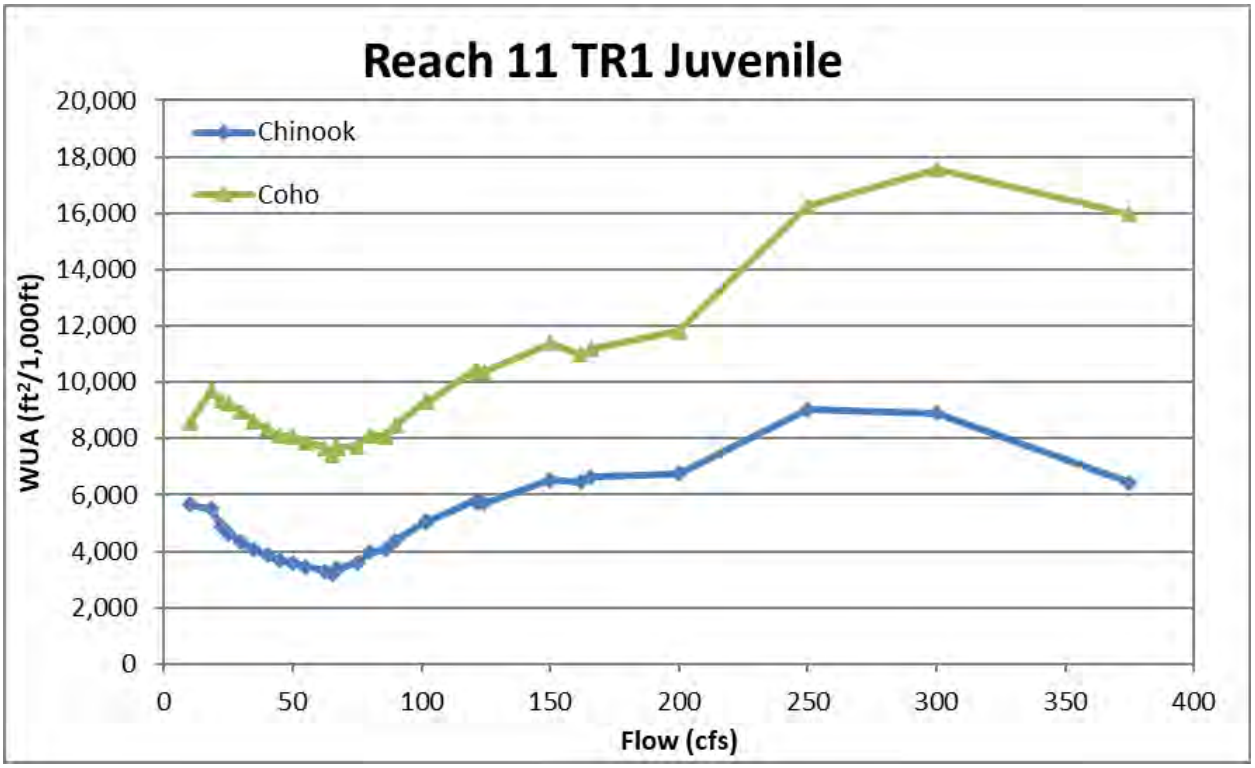


Figure A.2-39. Reach 11 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



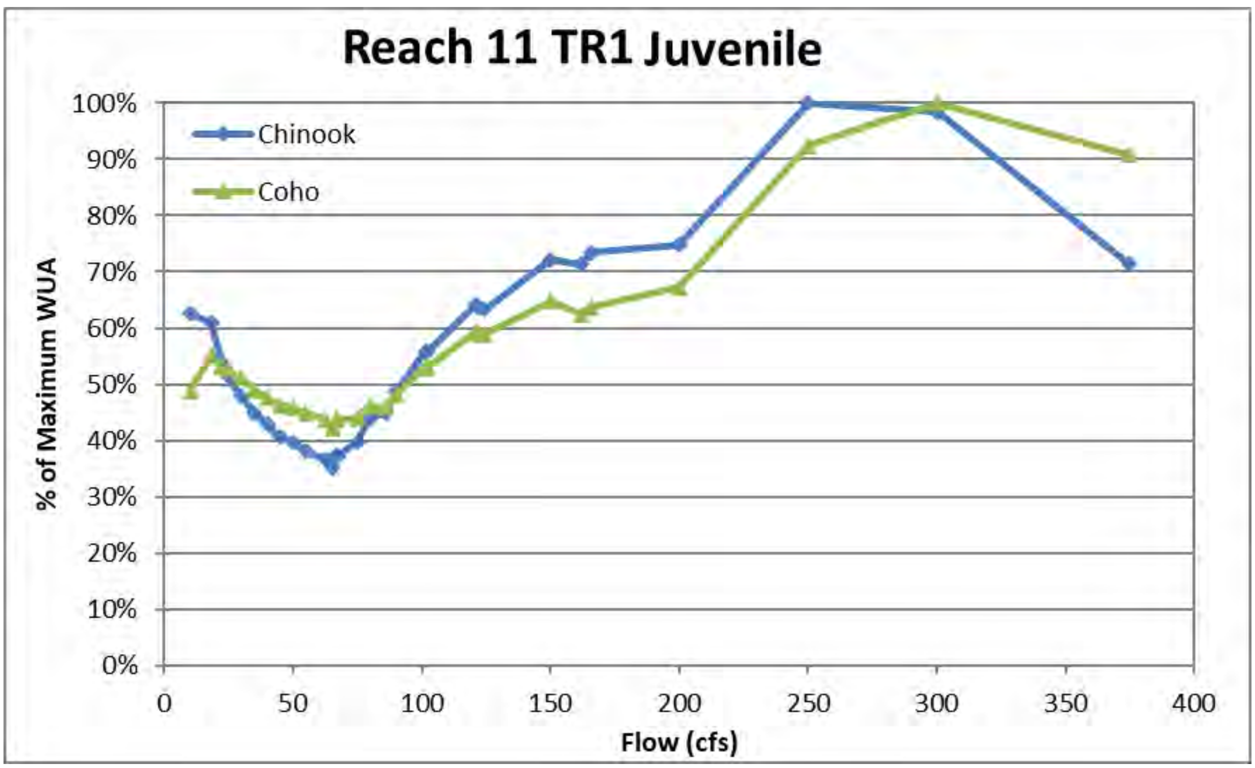
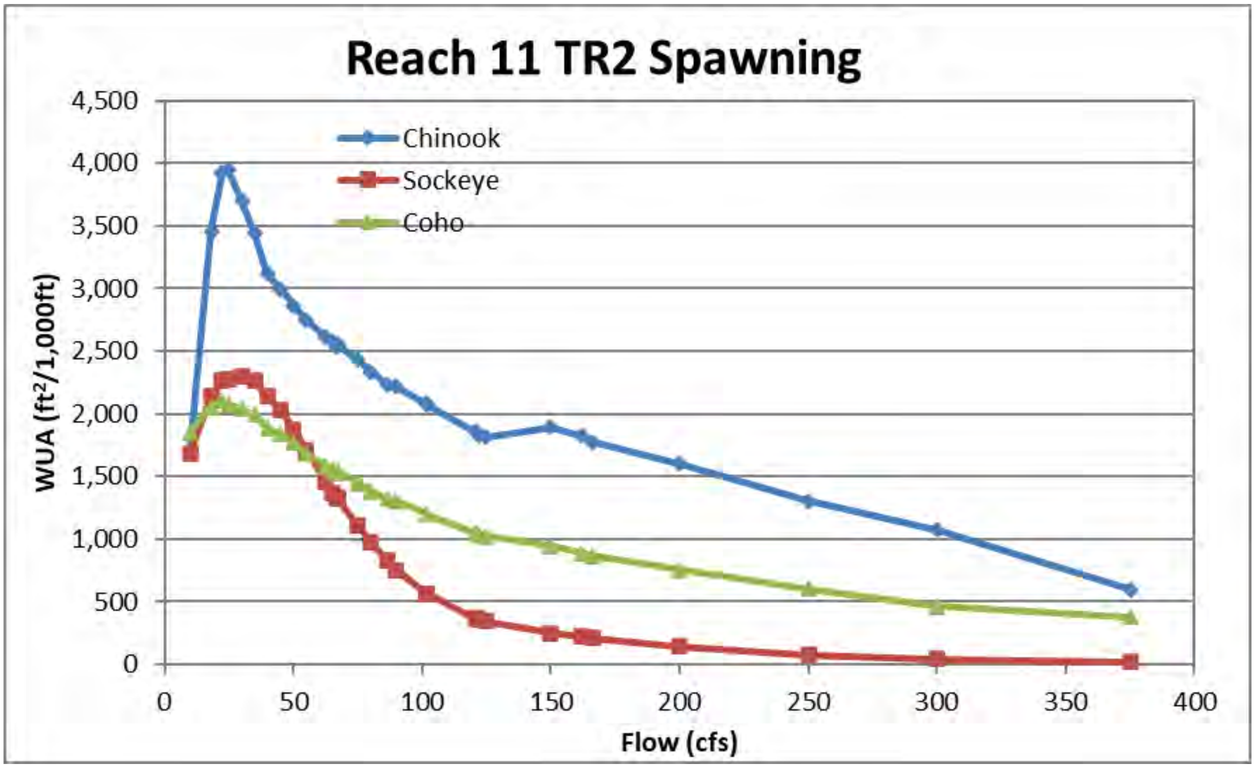


Figure A.2-40. Reach 11 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



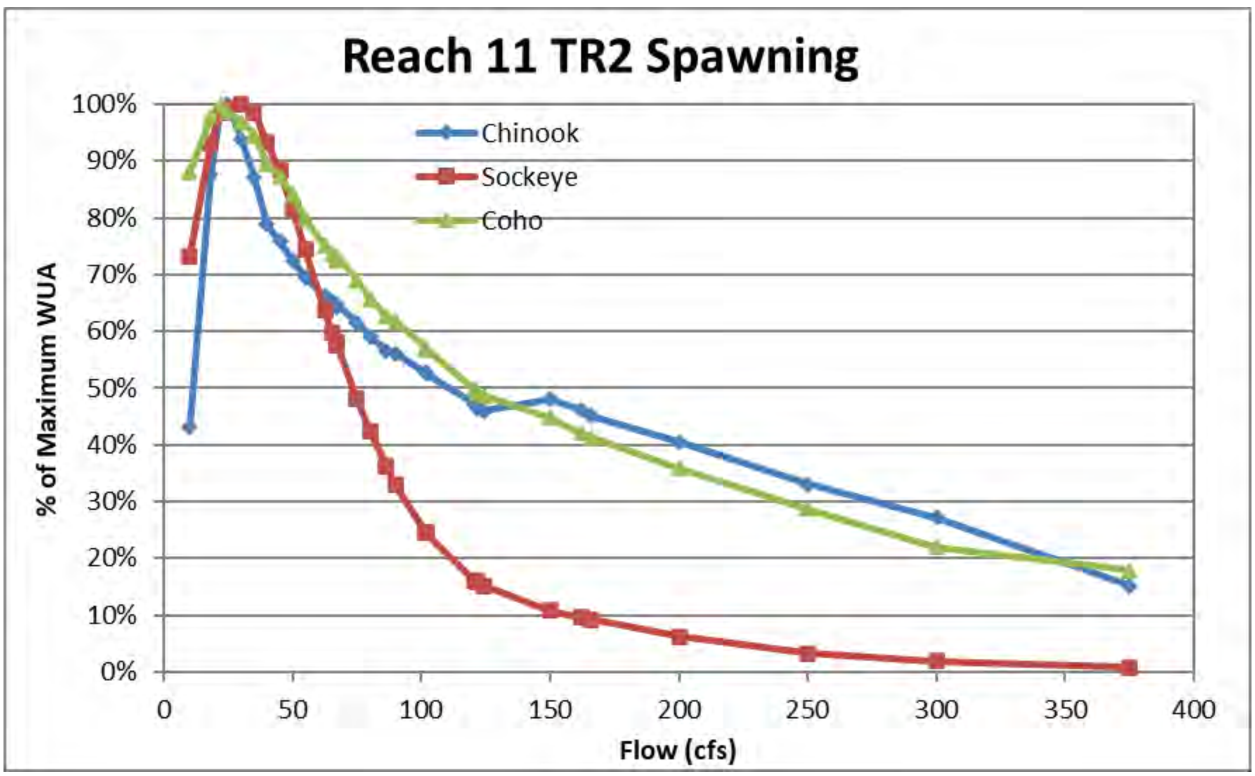


Figure A.2-41. Reach 11 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

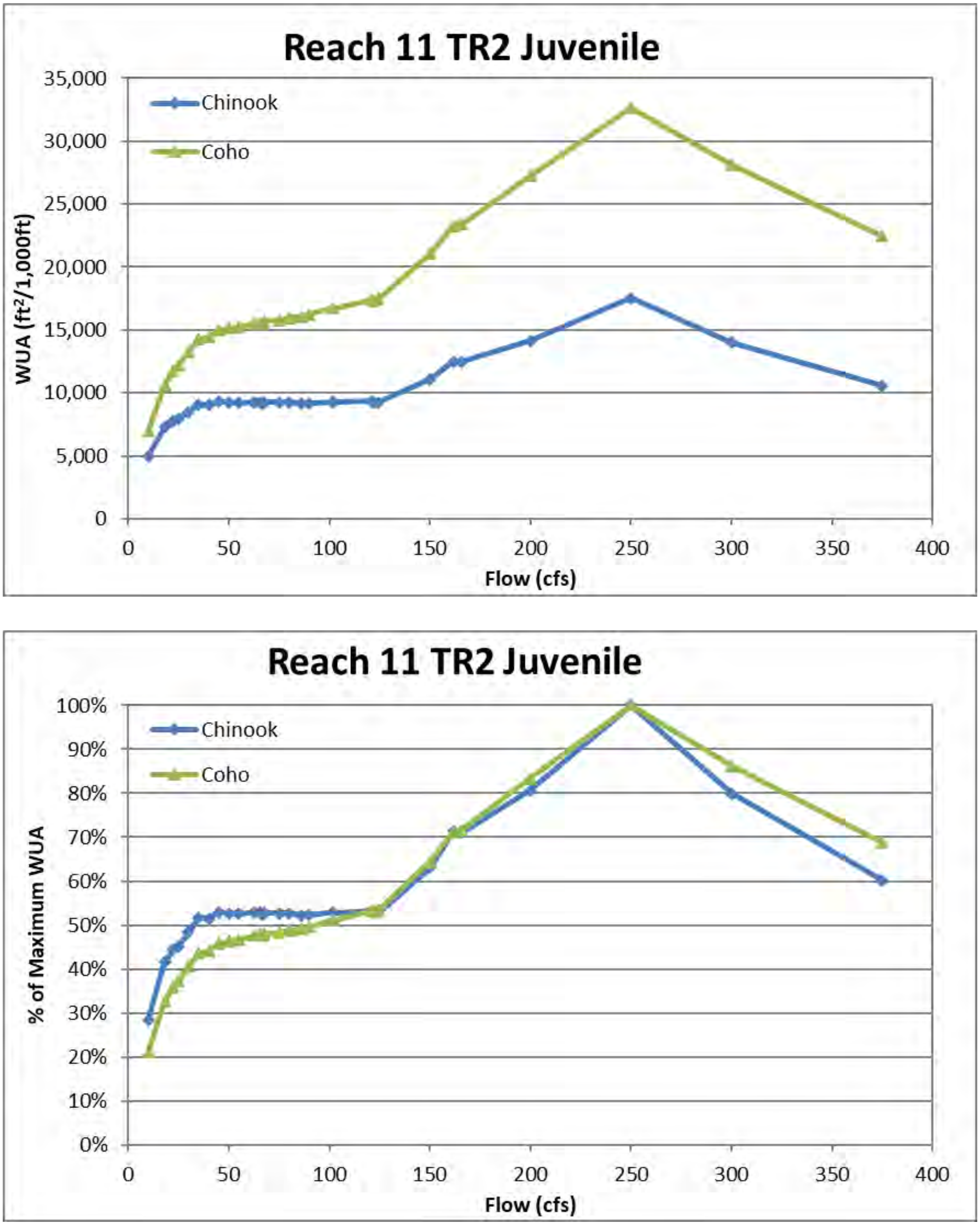
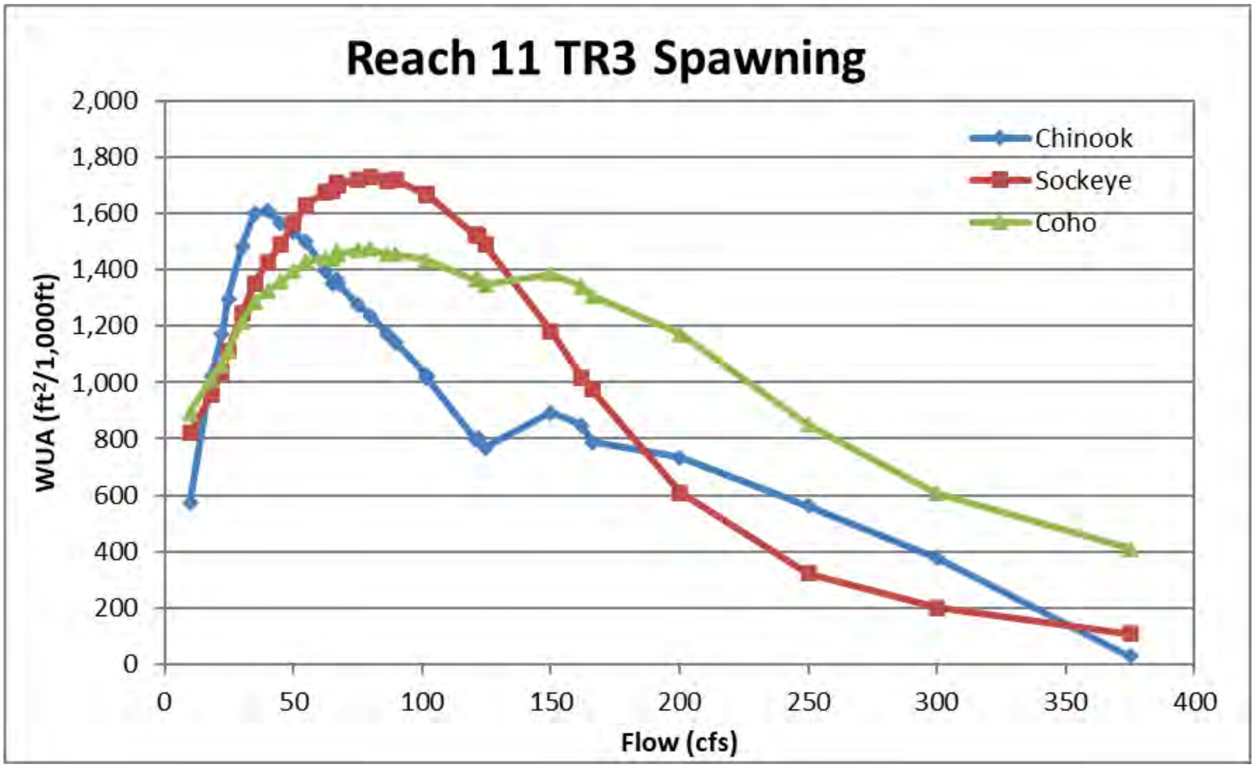


Figure A.2-42. Reach 11 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



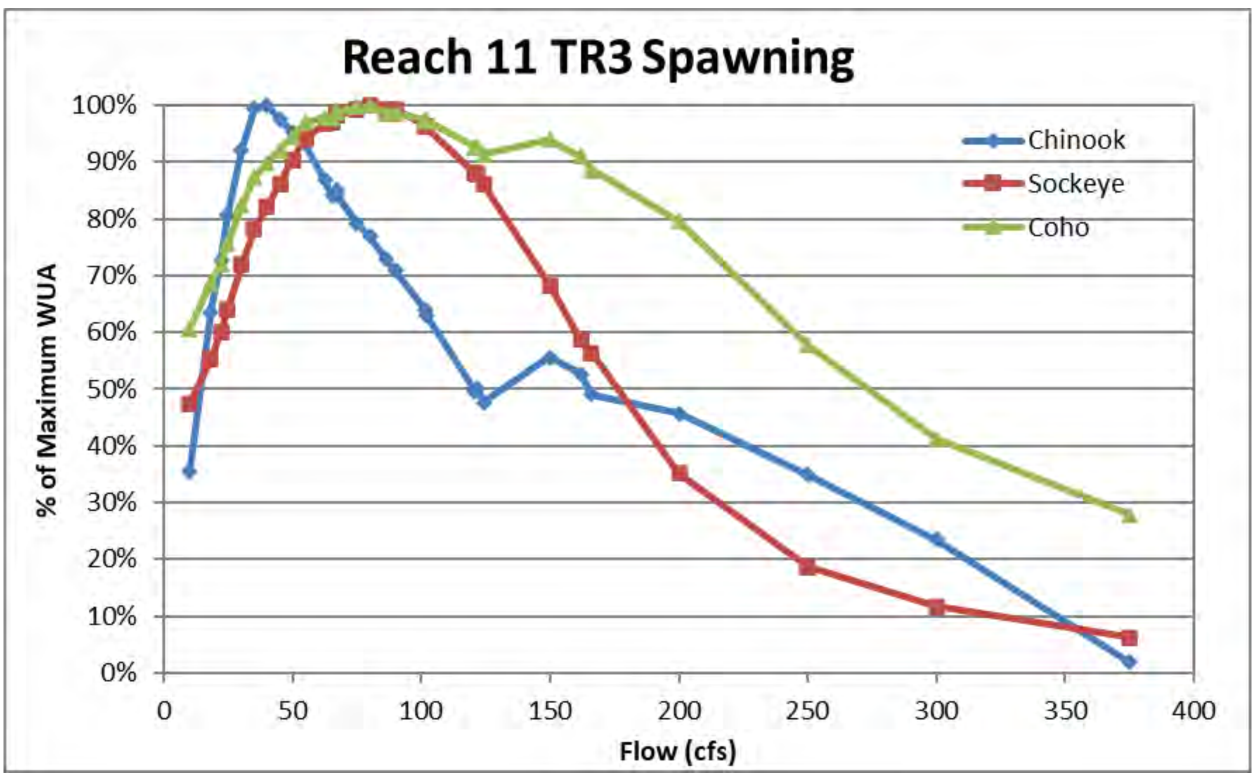
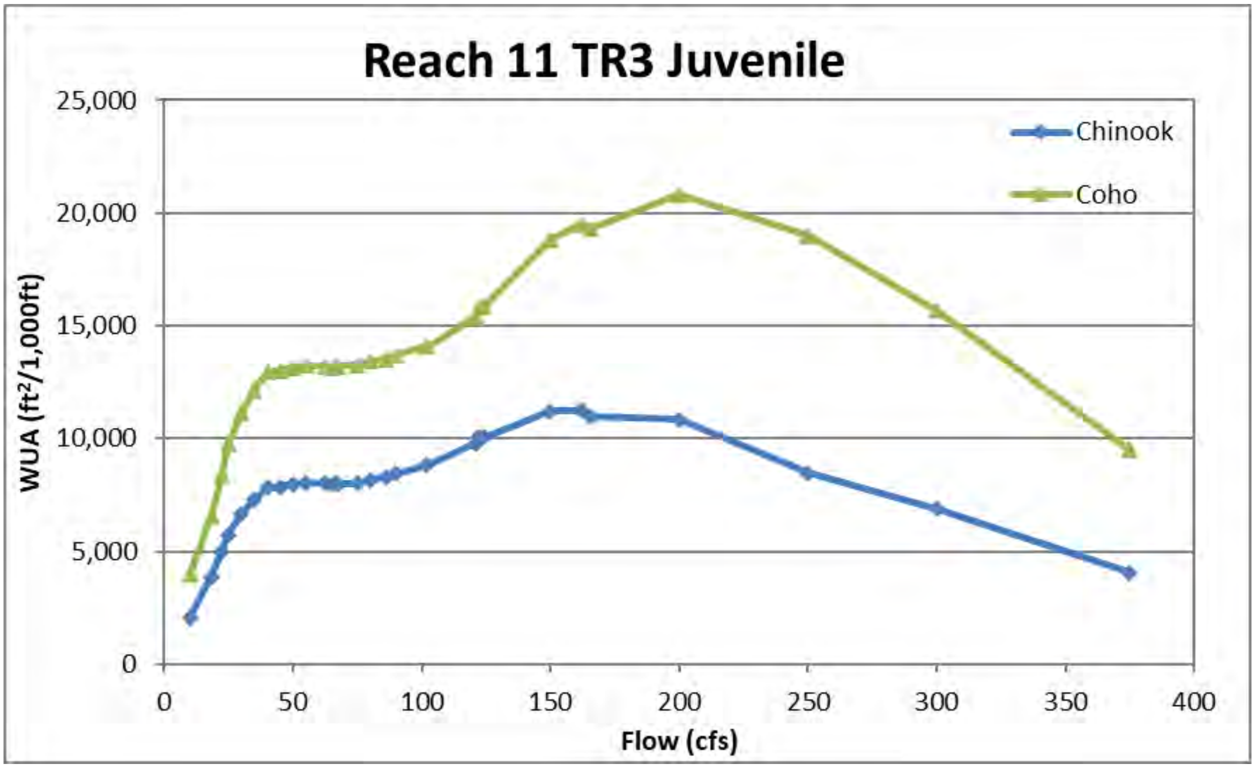


Figure A.2-43. Reach 11 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



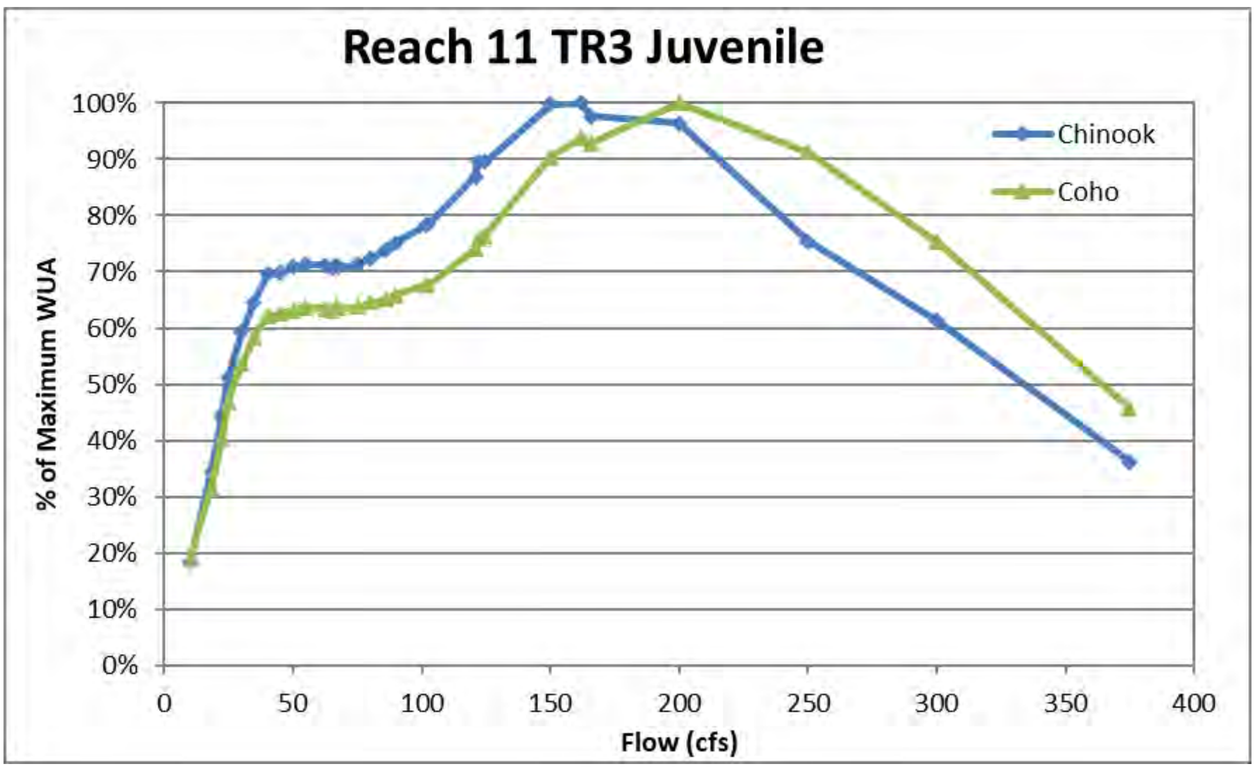
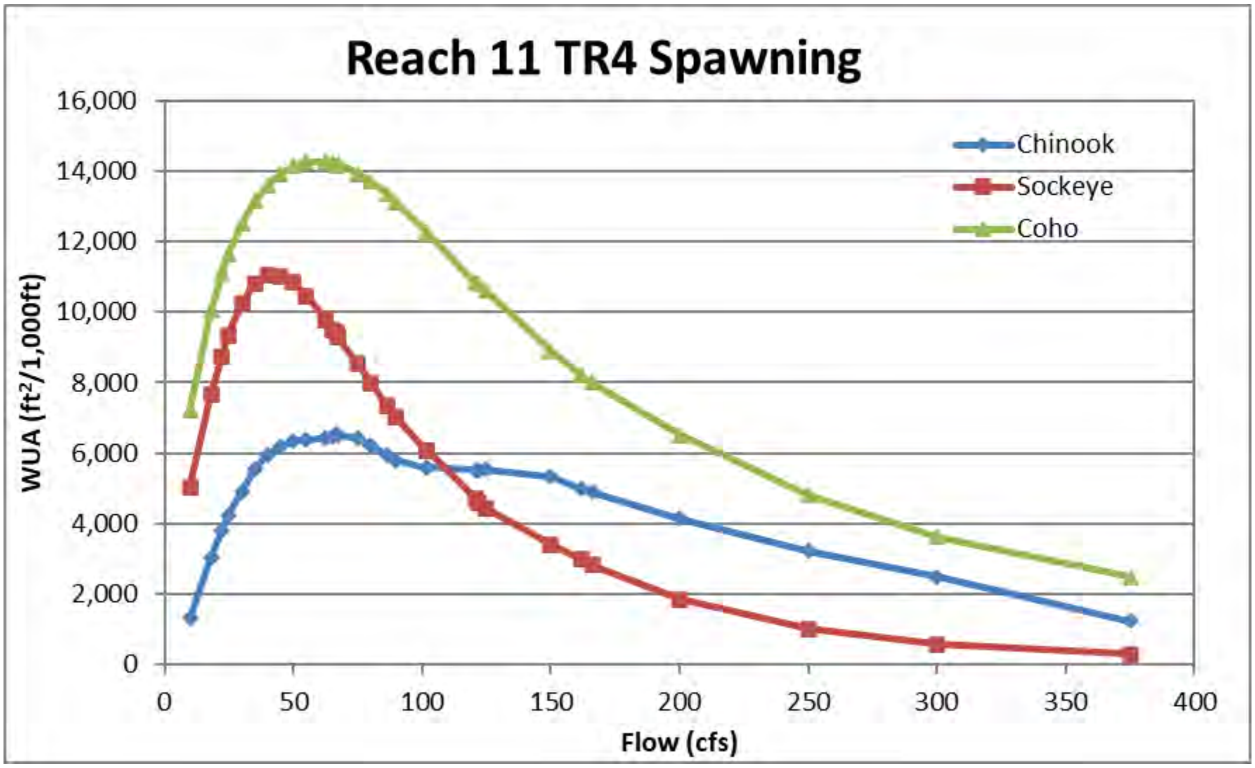


Figure A.2-44. Reach 11 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



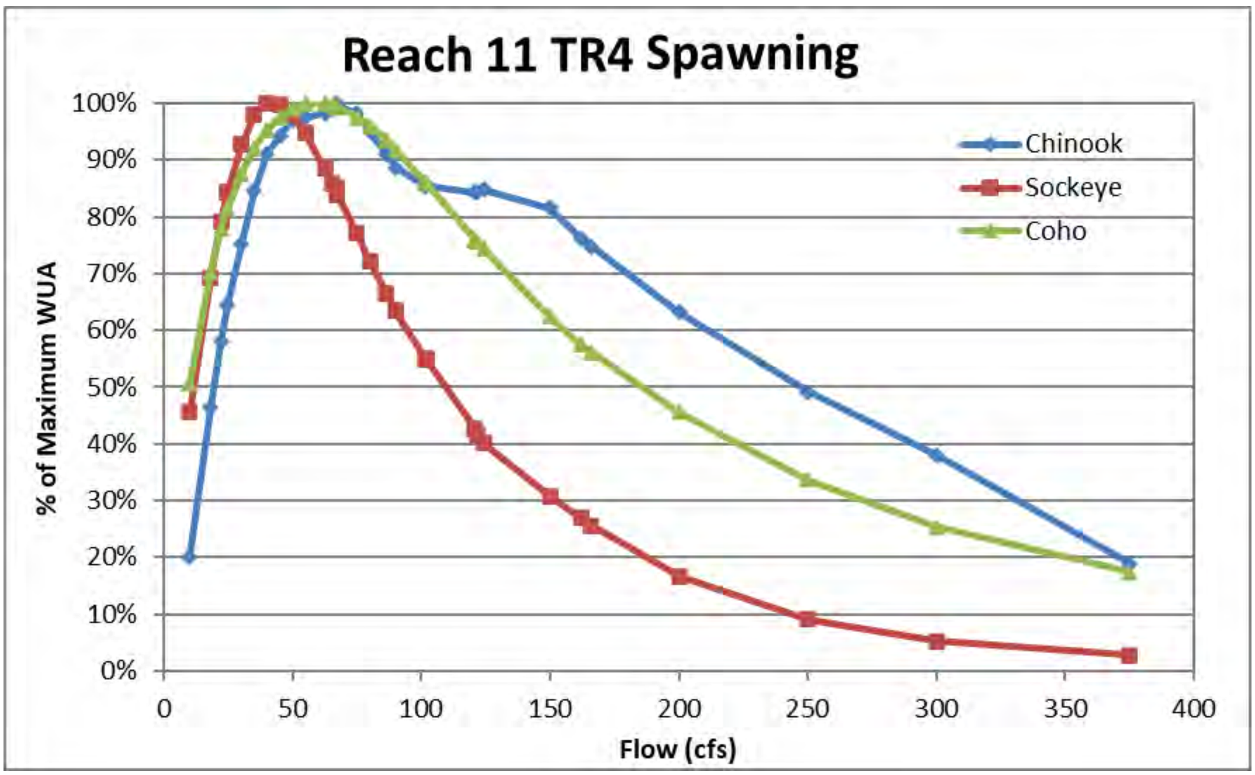
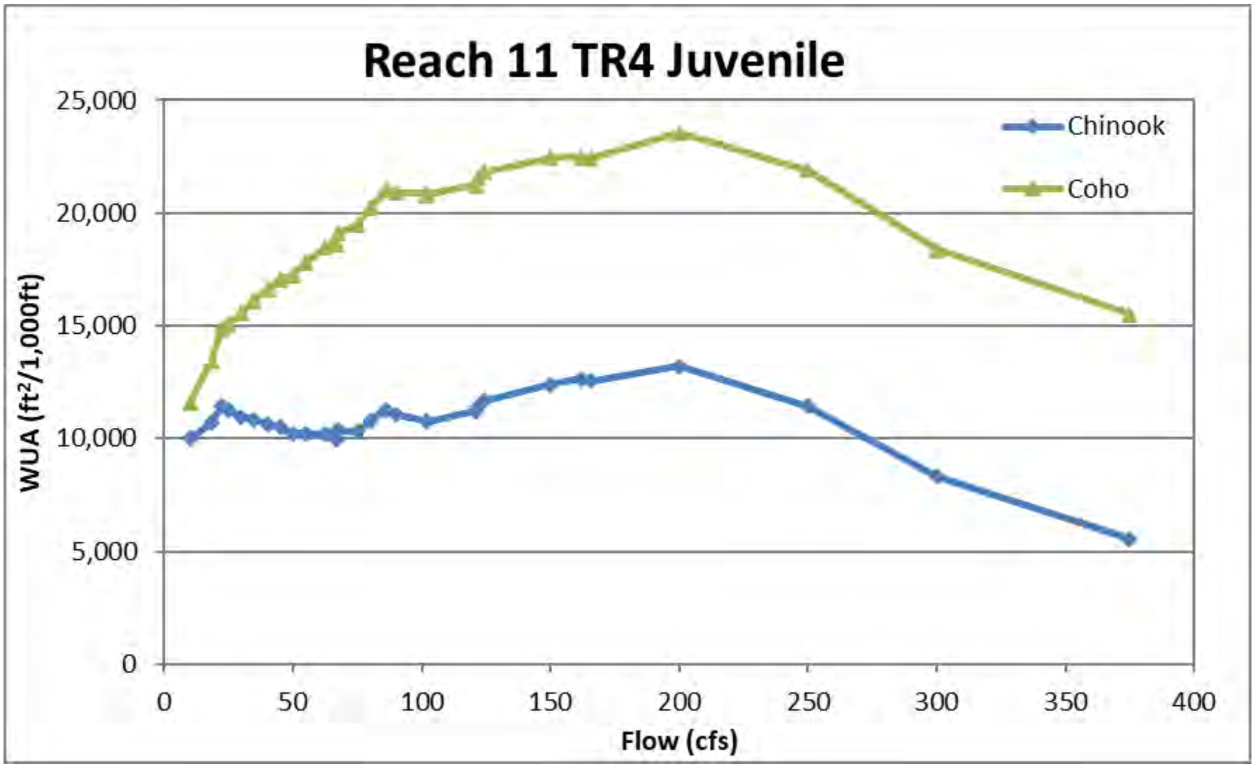


Figure A.2-45. Reach 11 Transect 4 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



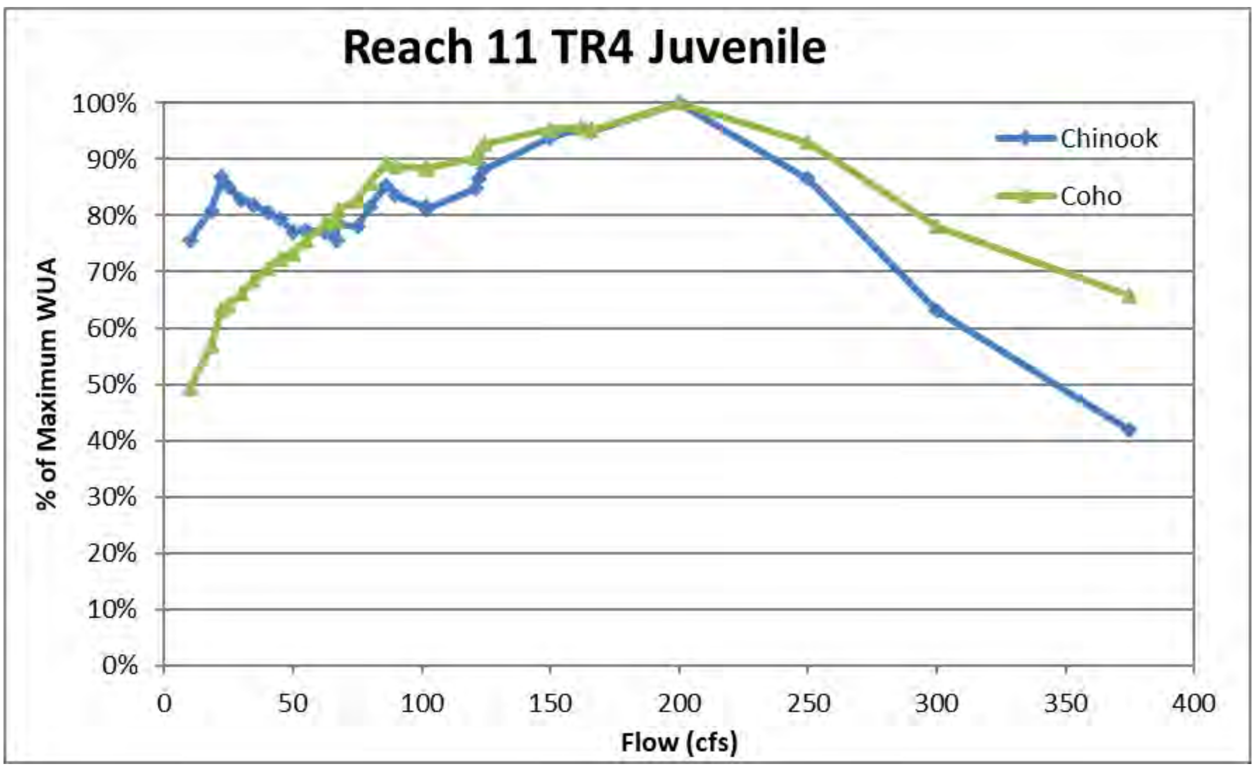
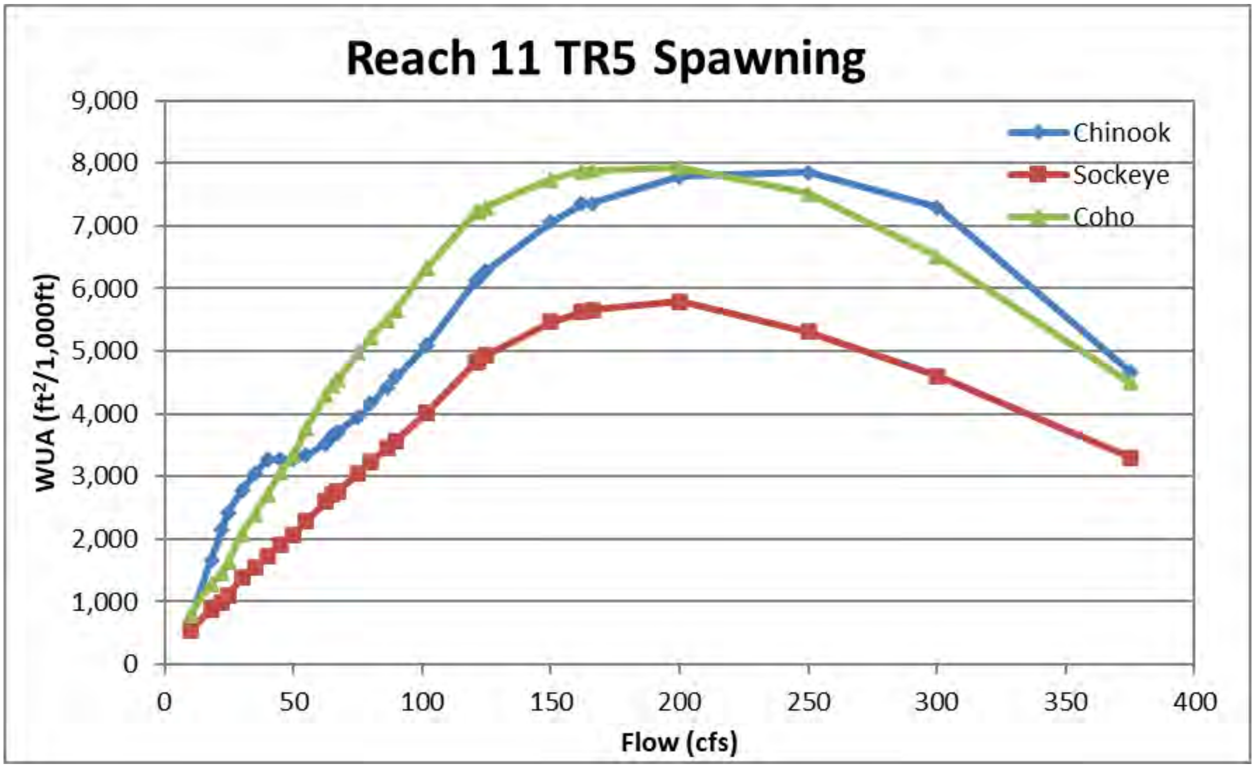


Figure A.2-46. Reach 11 Transect 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



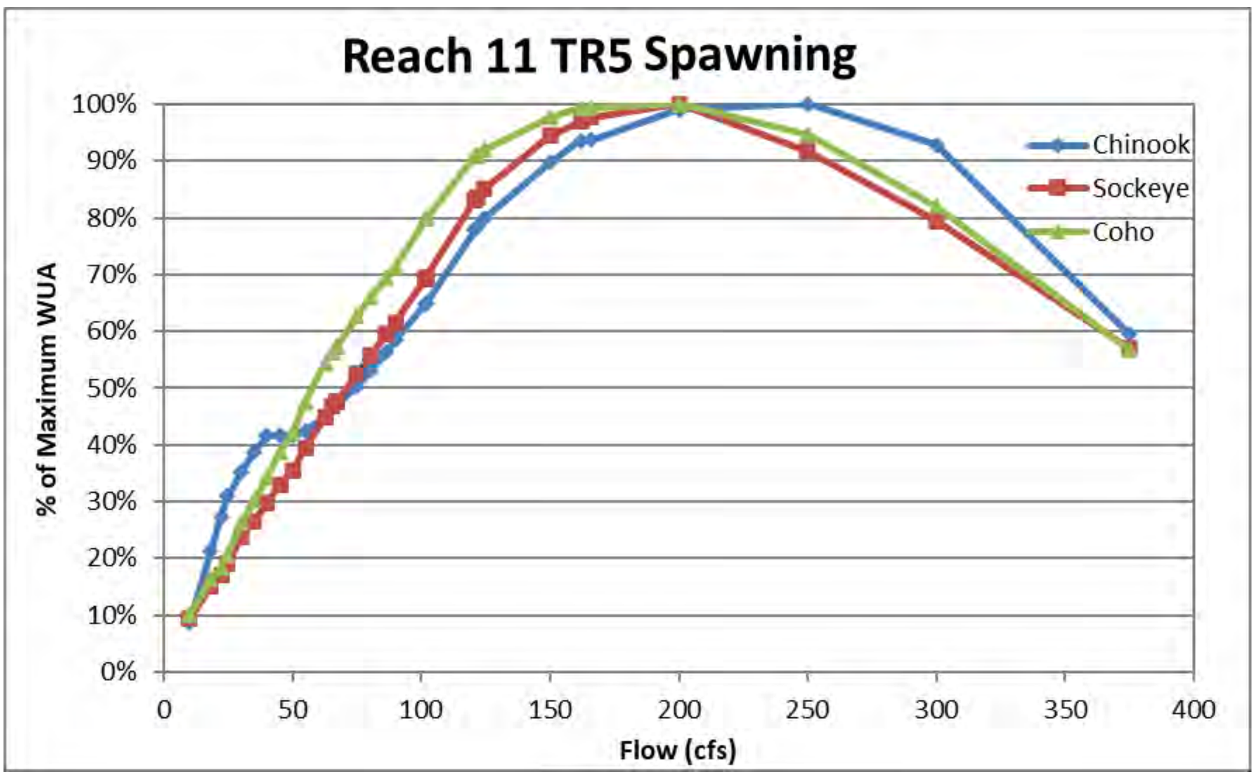
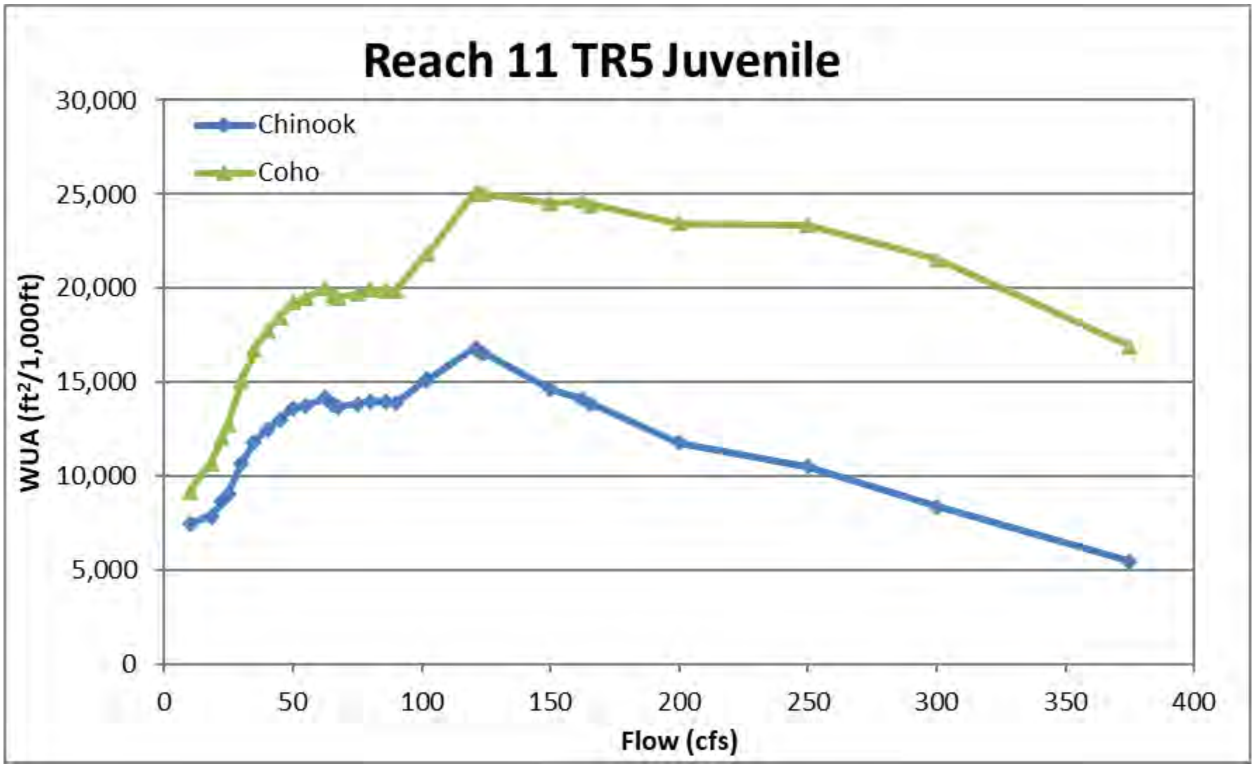


Figure A.2-47. Reach 11 Transect 5 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



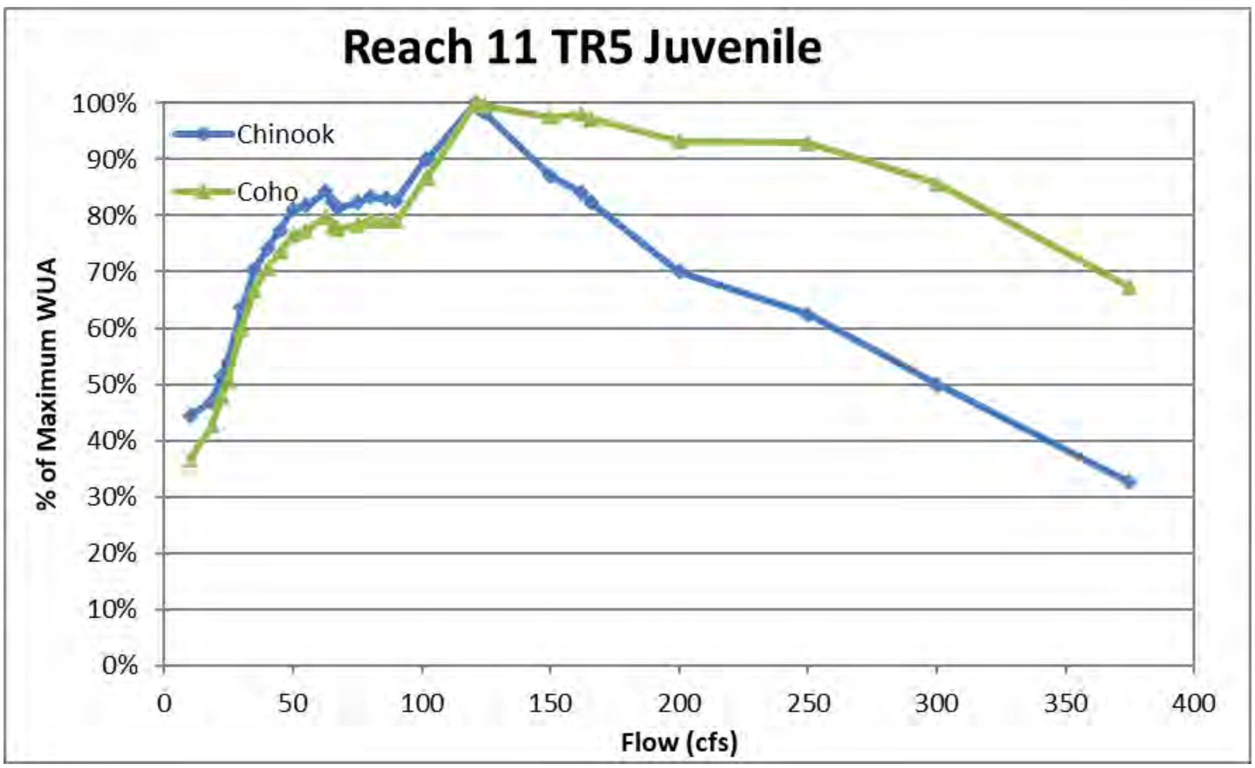
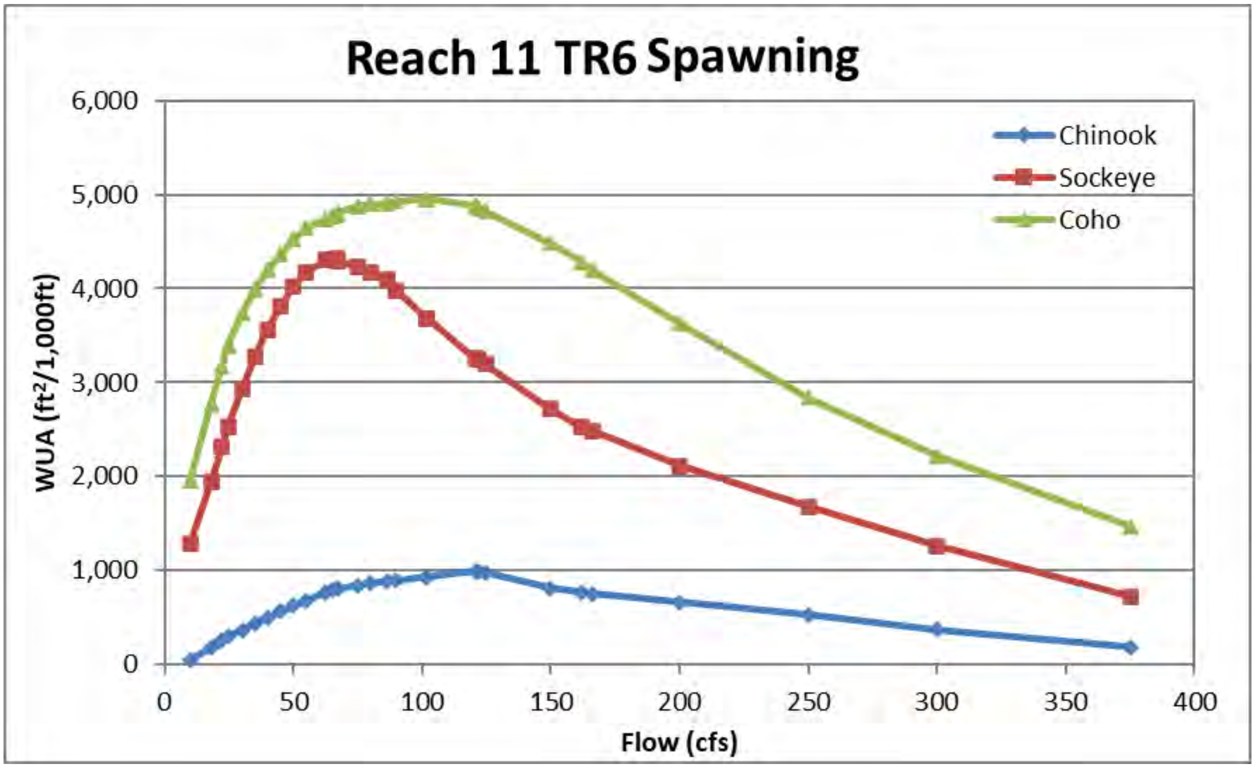


Figure A.2-48. Reach 11 Transect 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



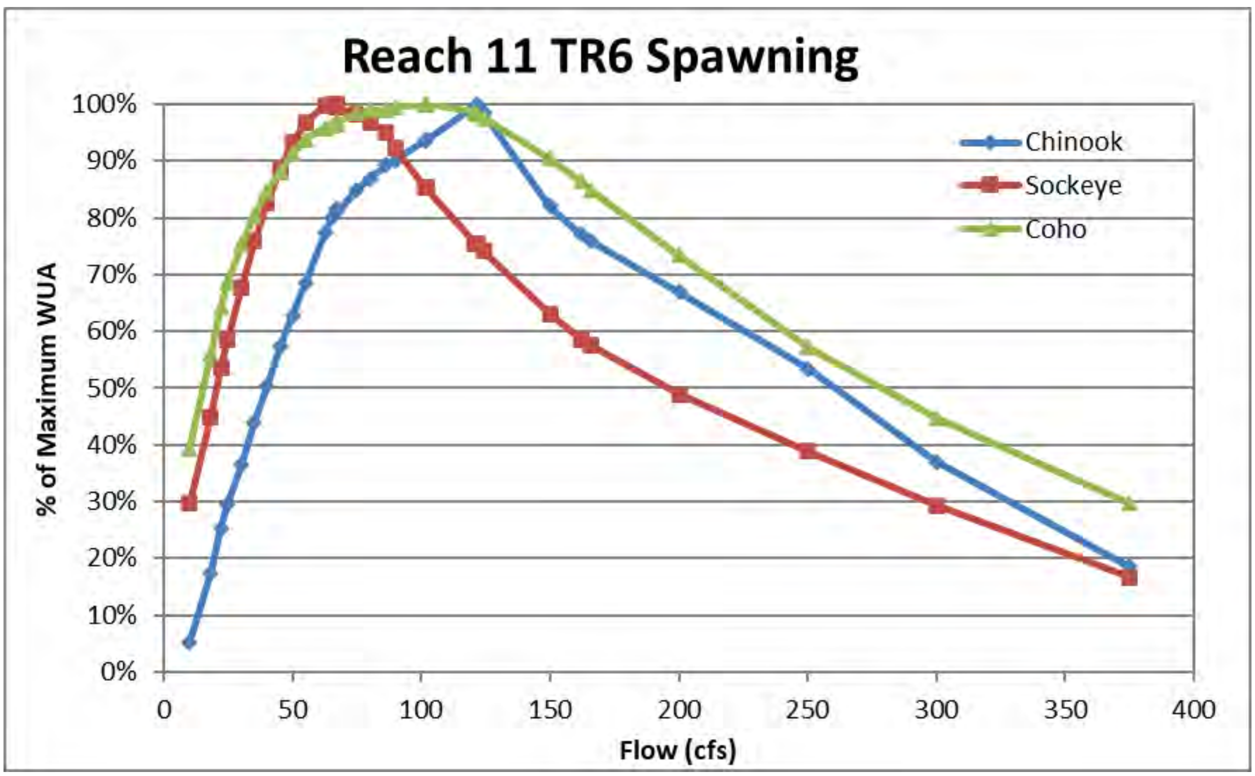
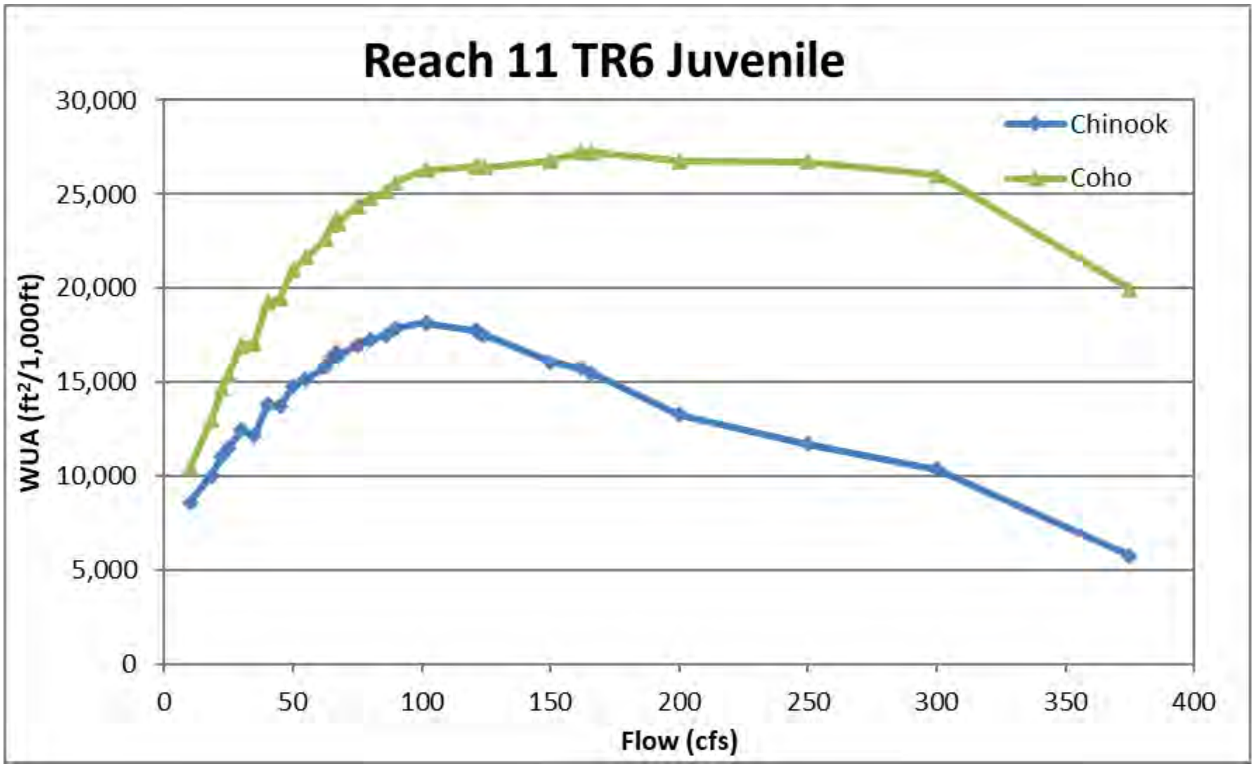


Figure A.2-49. Reach 11 Transect 6 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



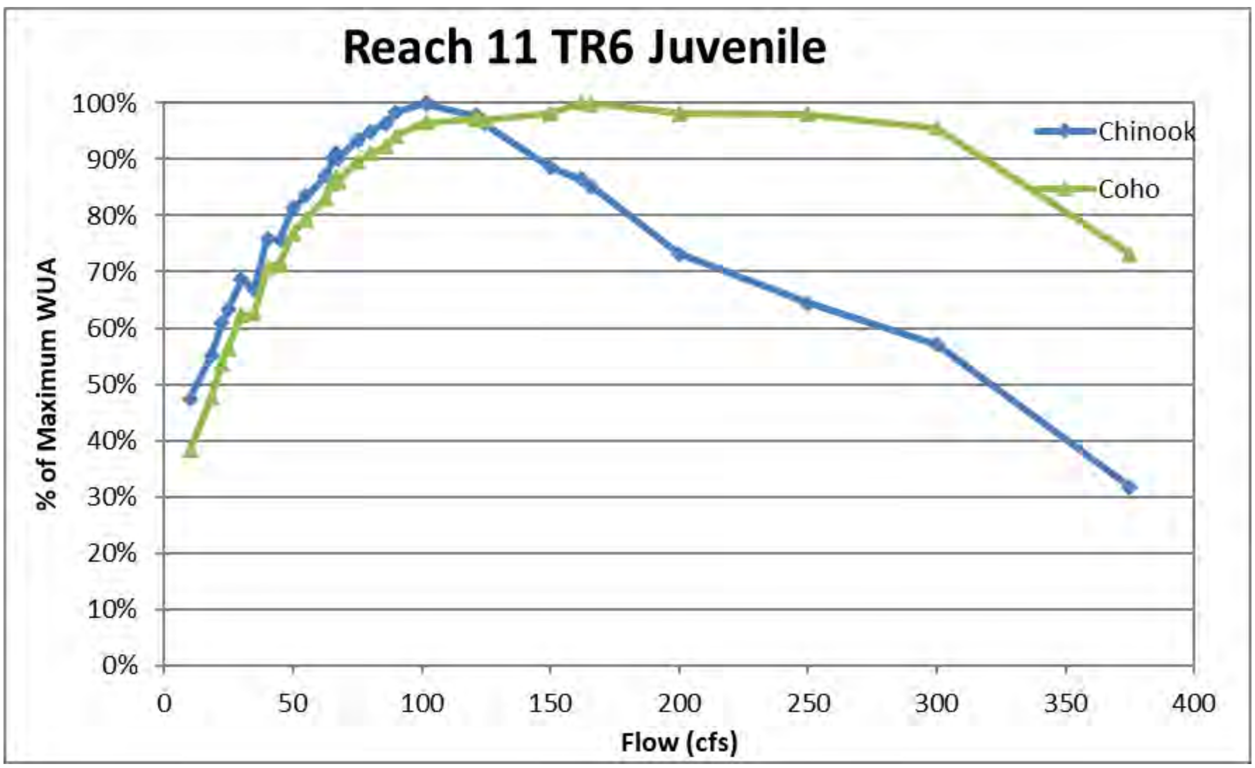
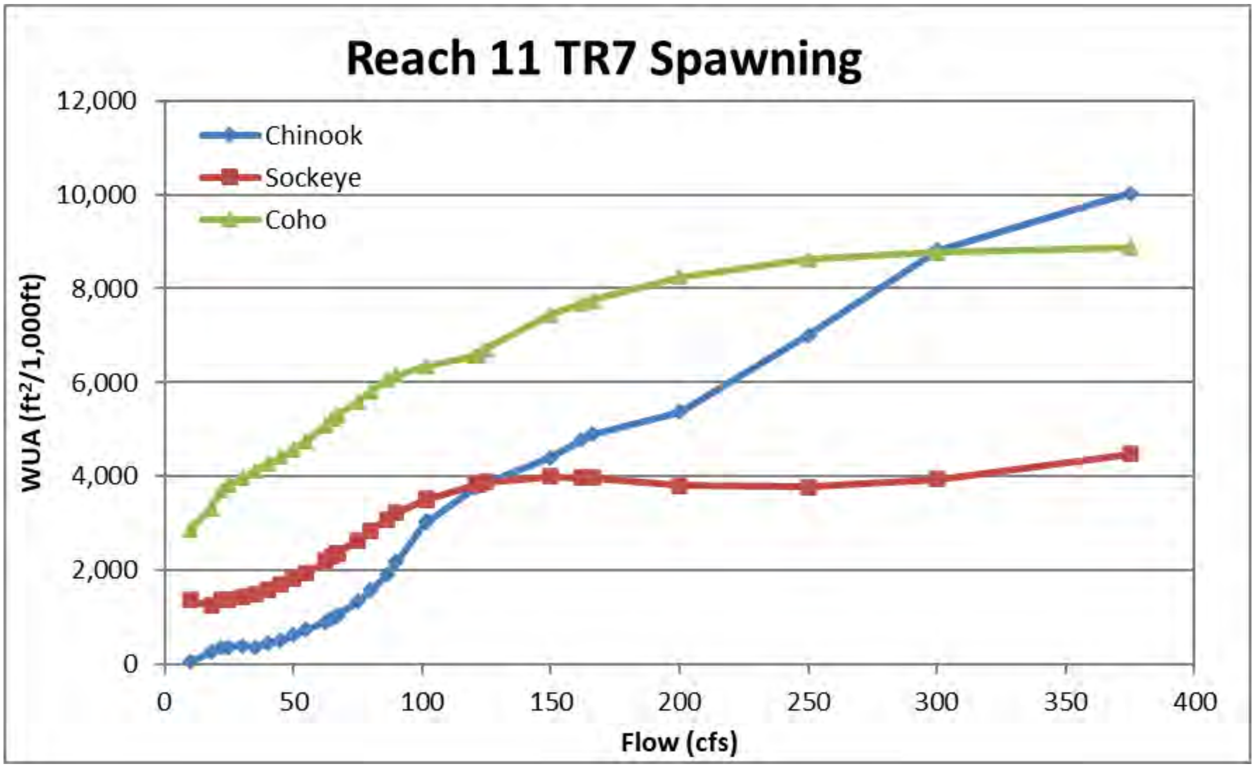


Figure A.2-50. Reach 11 Transect 6 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



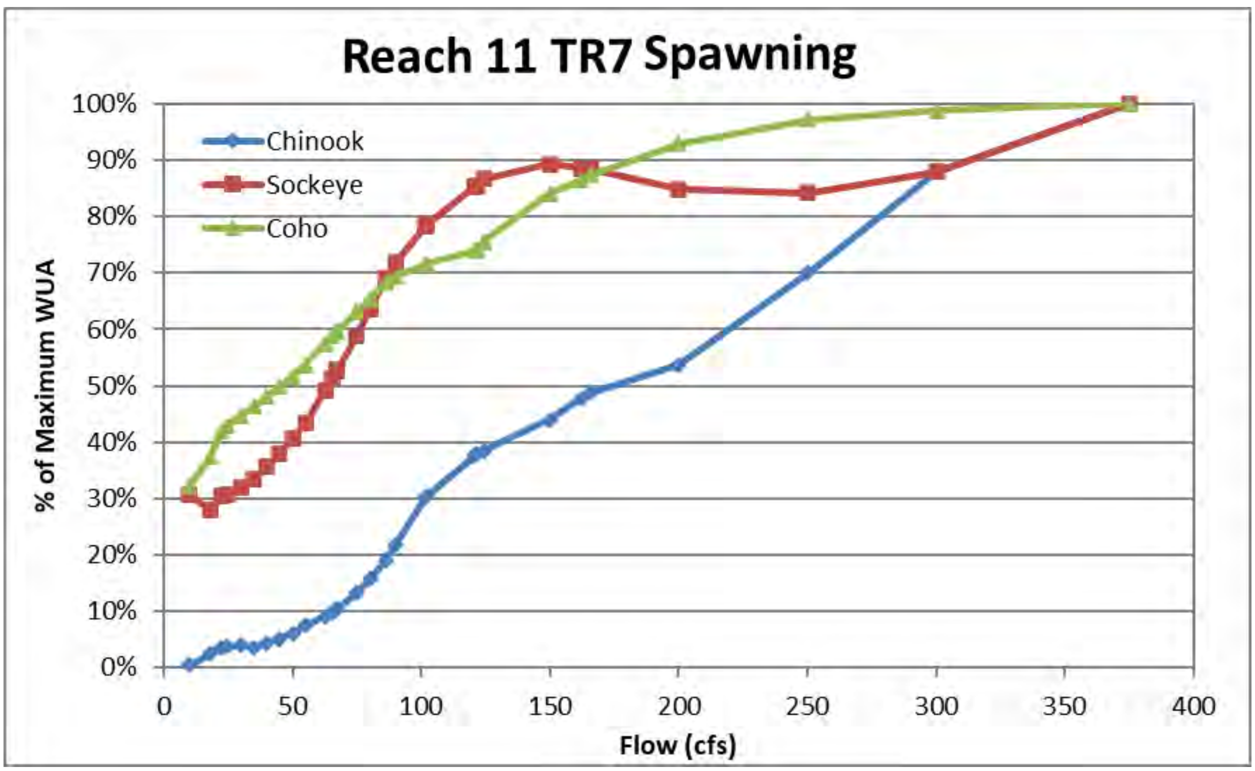
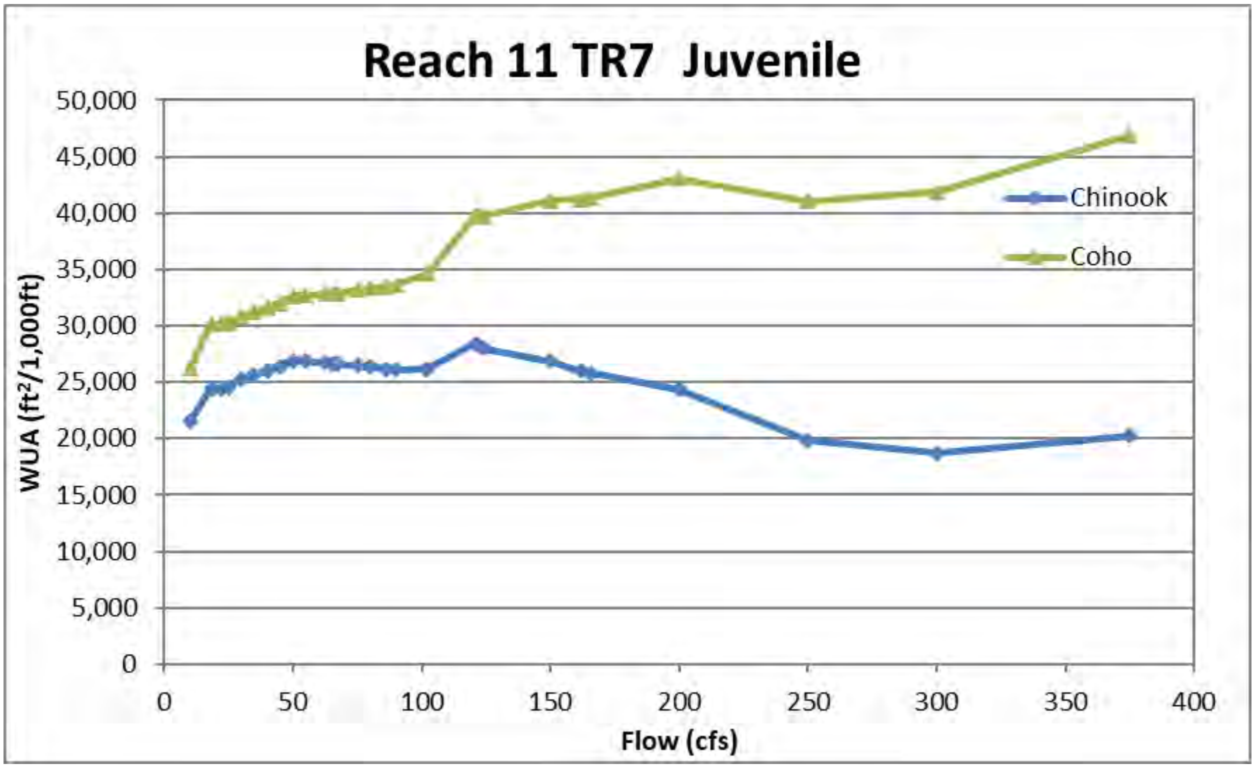


Figure A.2-51. Reach 11 Transect 7 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



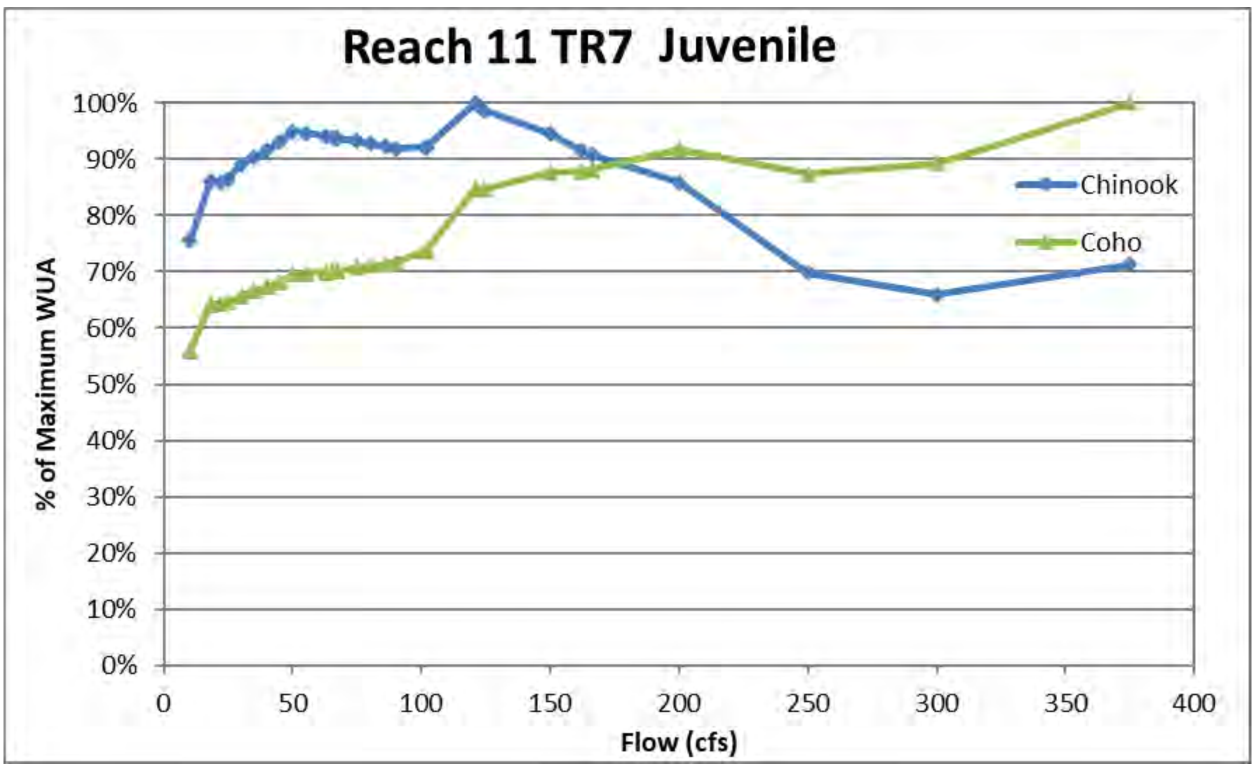
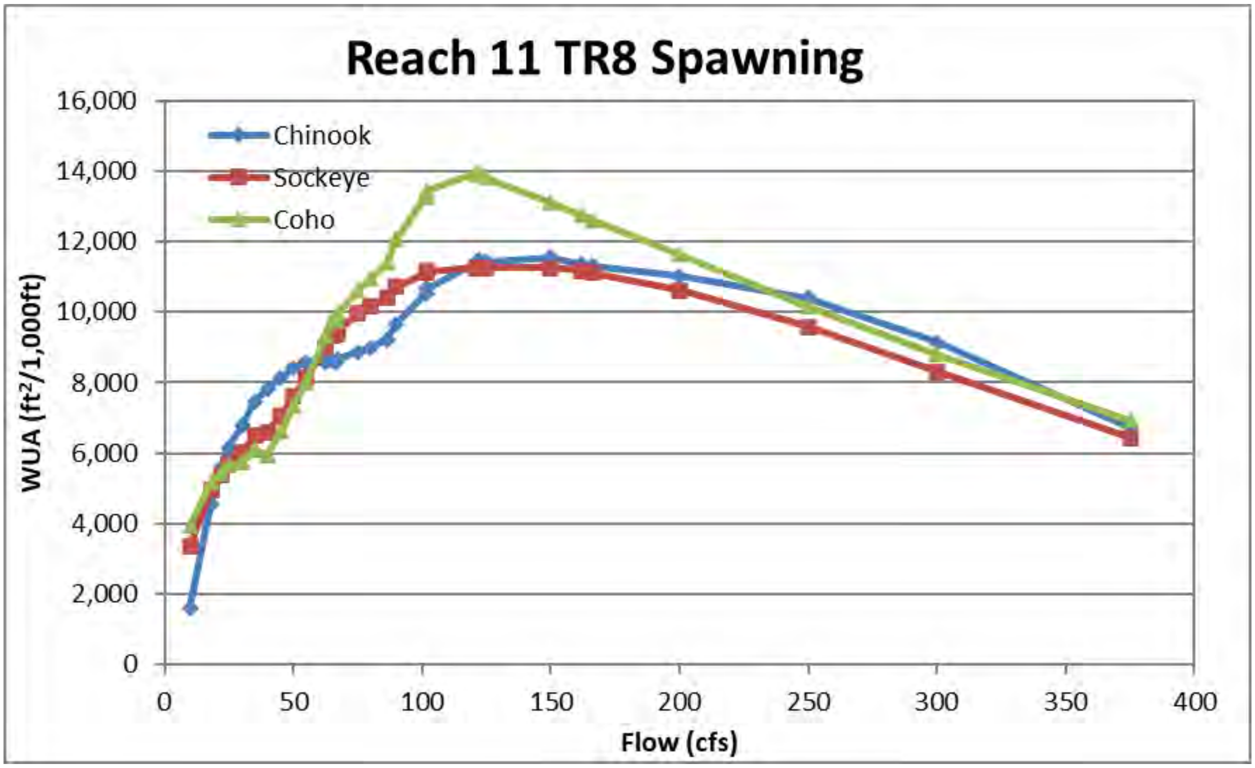


Figure A.2-52. Reach 11 Transect 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



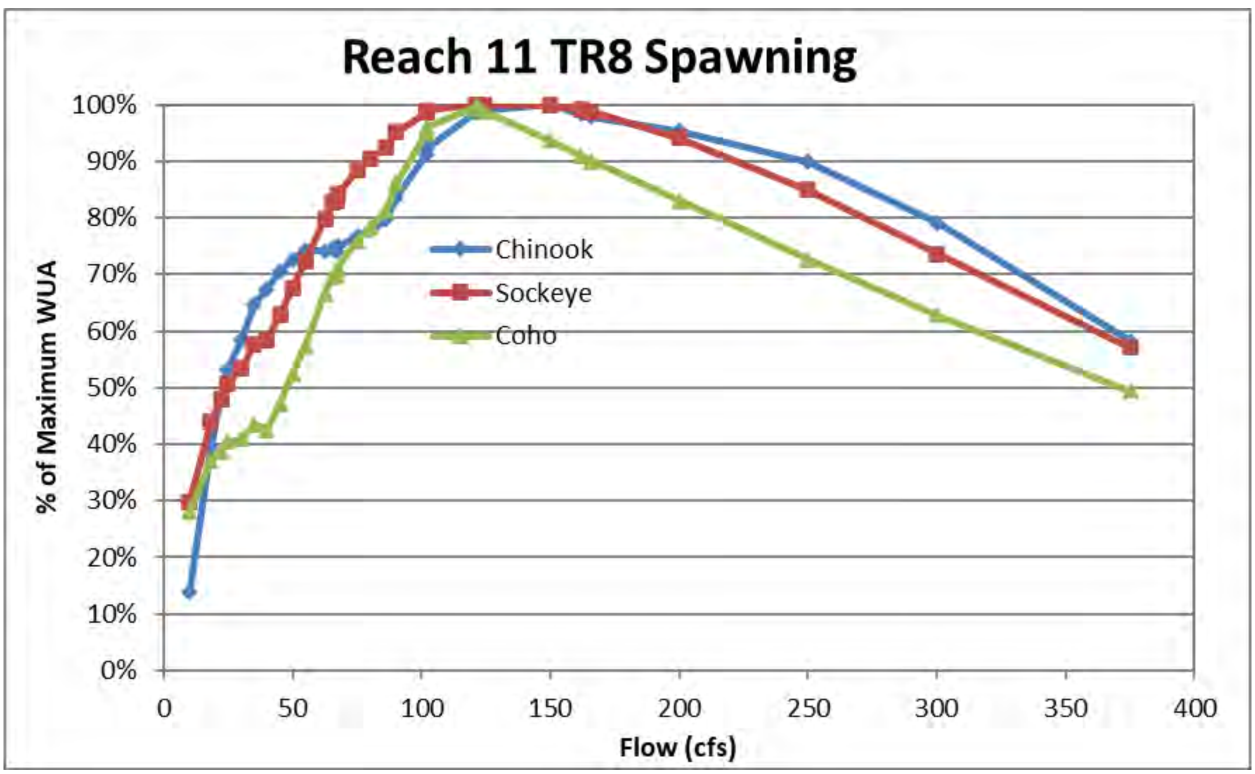
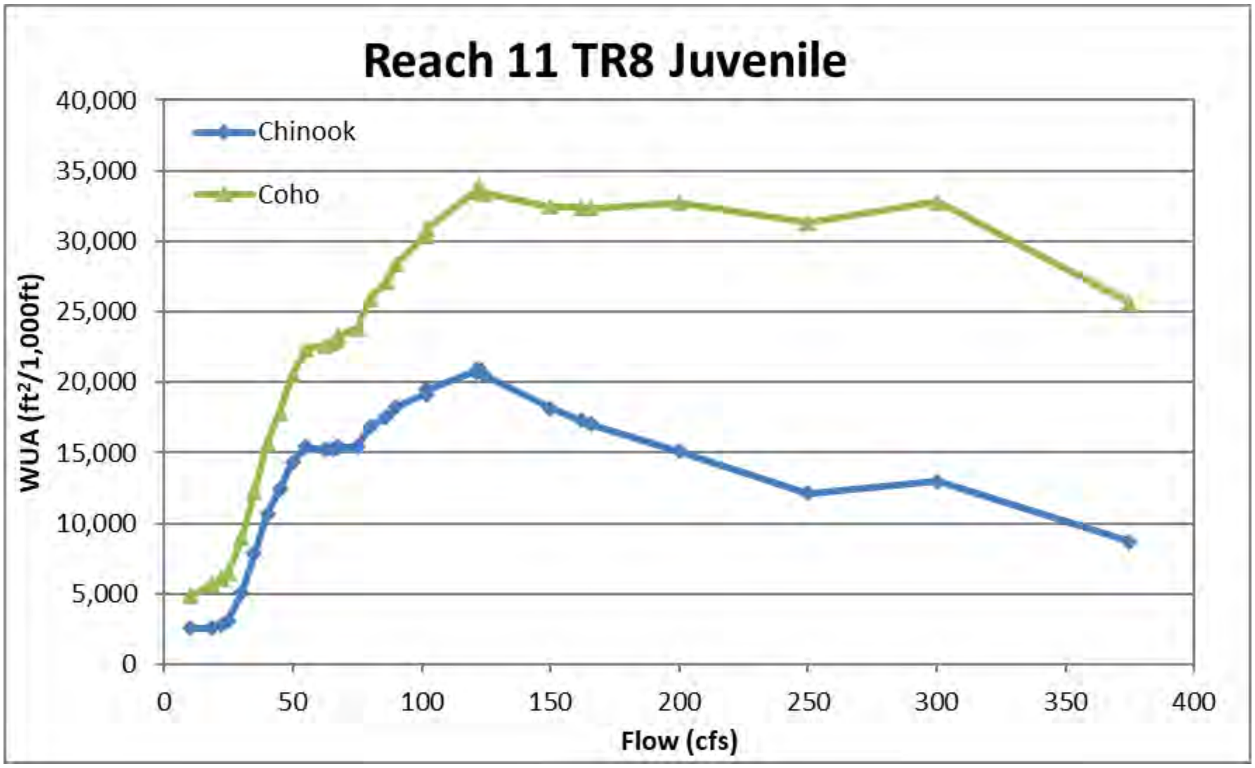


Figure A.2-53. Reach 11 Transect 8 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



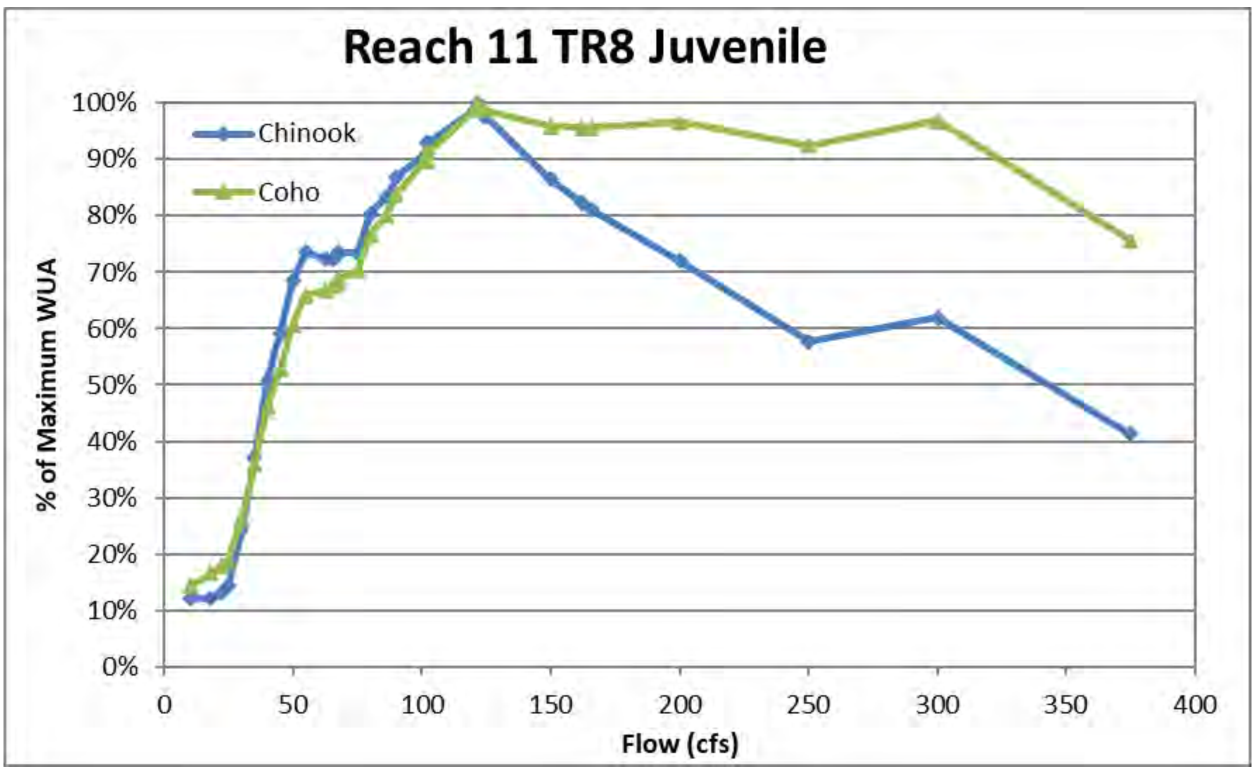


Figure A.2-54. Reach 11 Transect 8 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

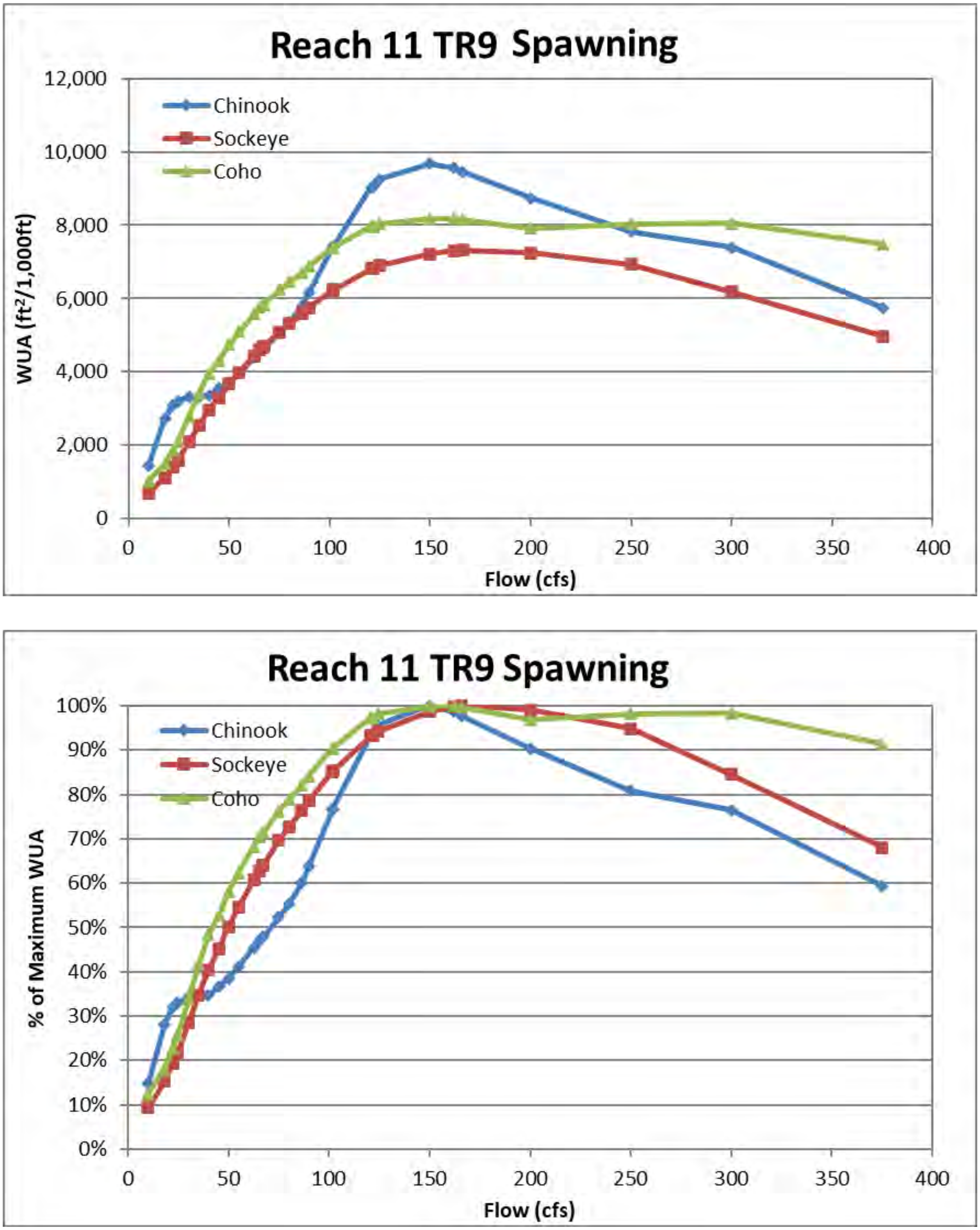
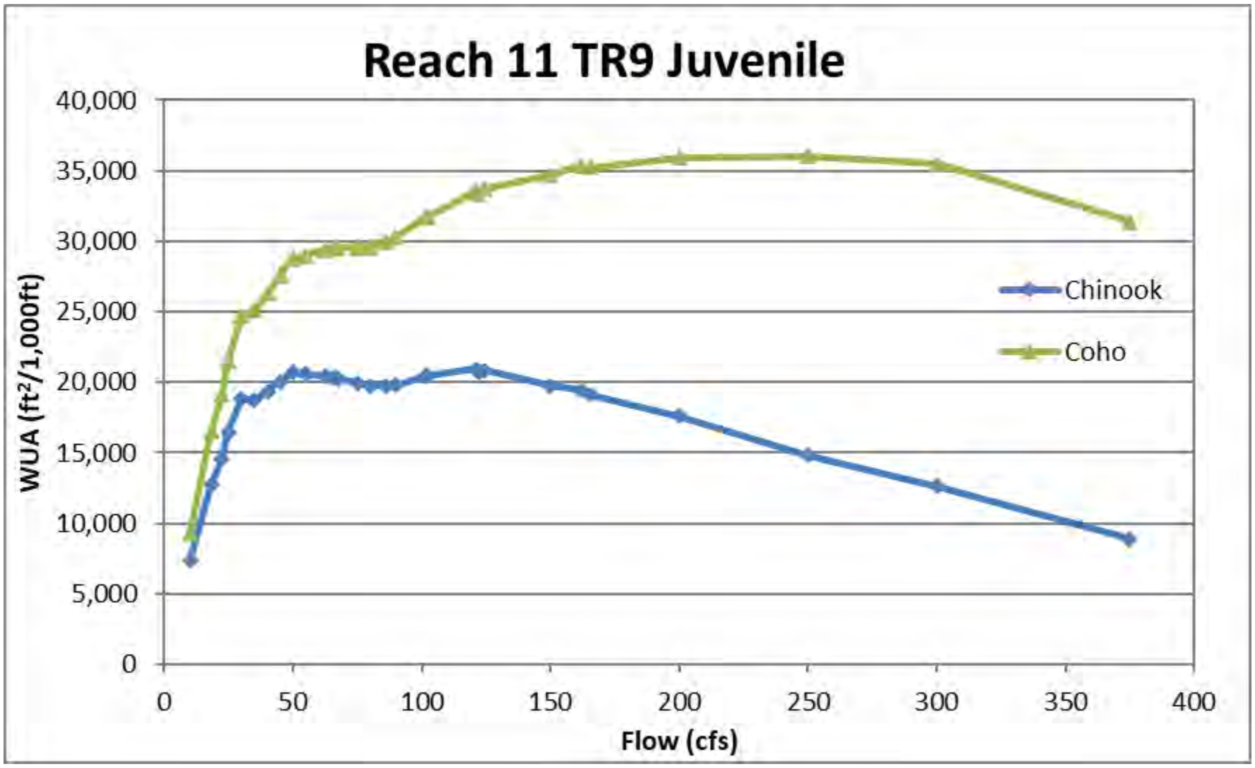


Figure A.2-55. Reach 11 Transect 9 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



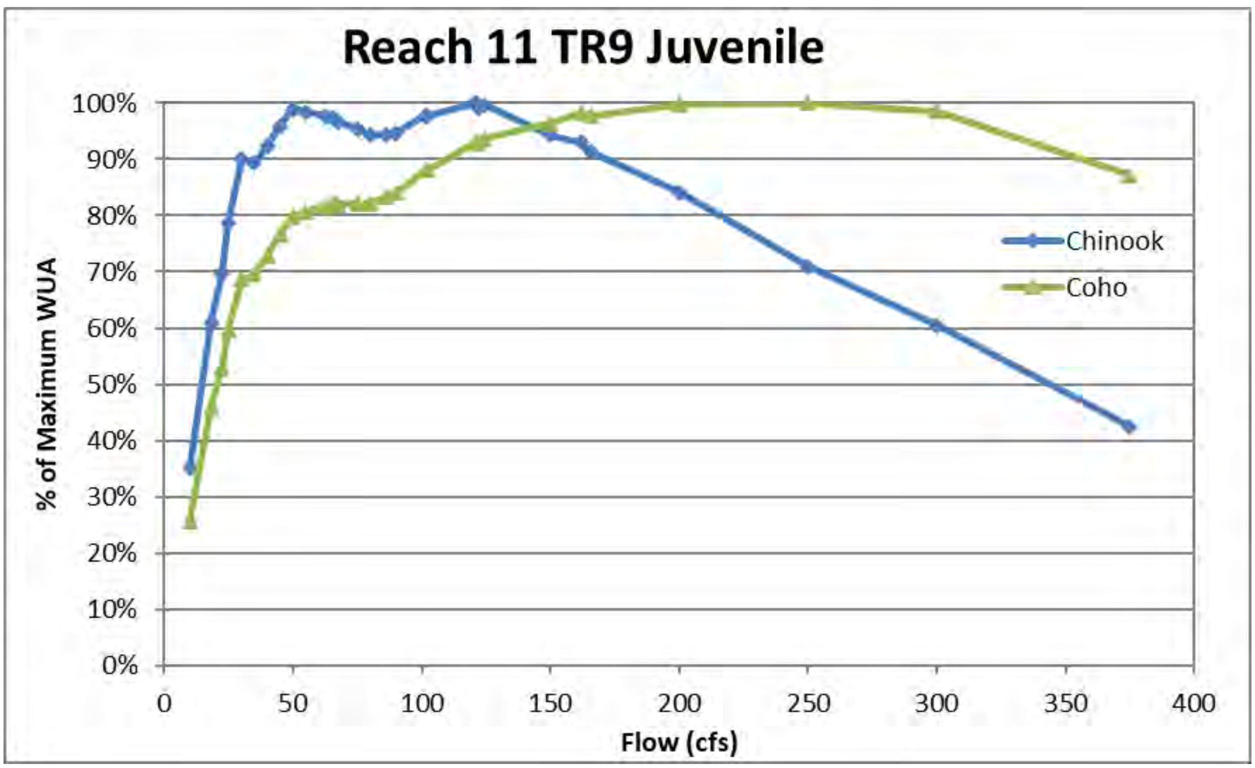
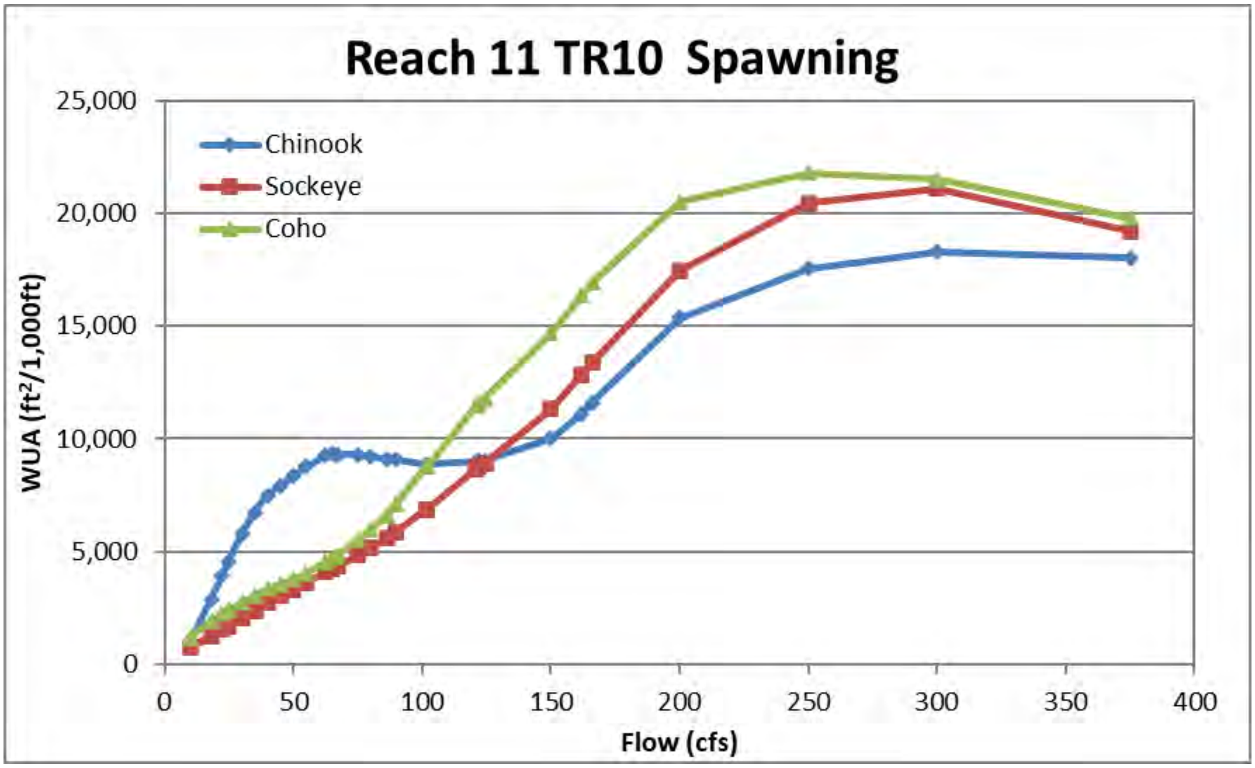


Figure A.2-56. Reach 11 Transect 9 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



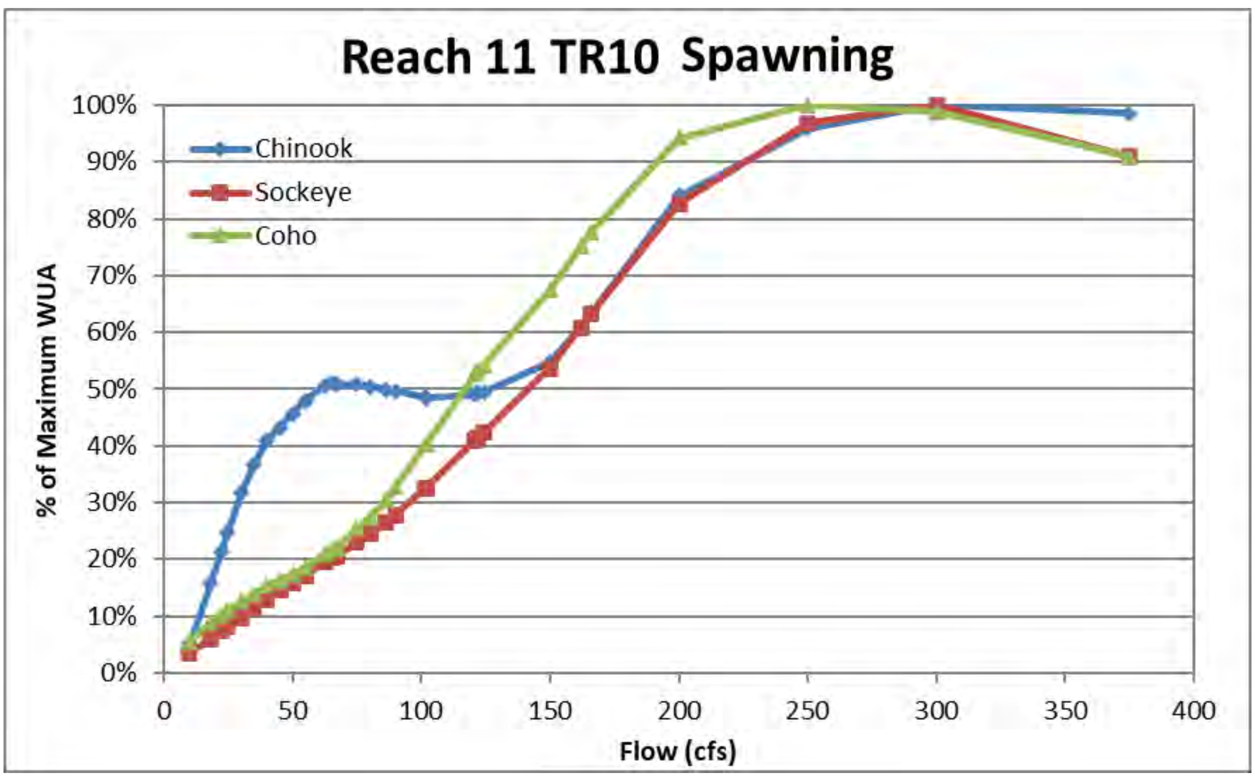
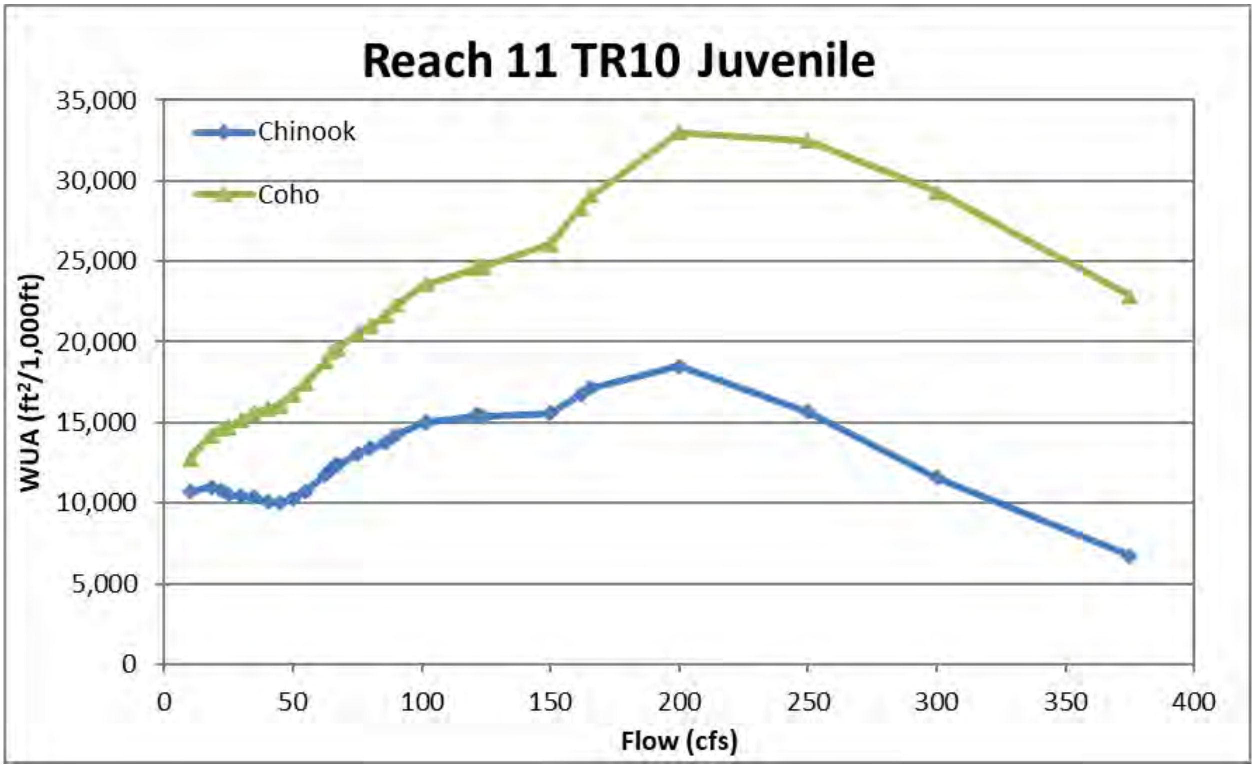


Figure A.2-57. Reach 11 Transect 10 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



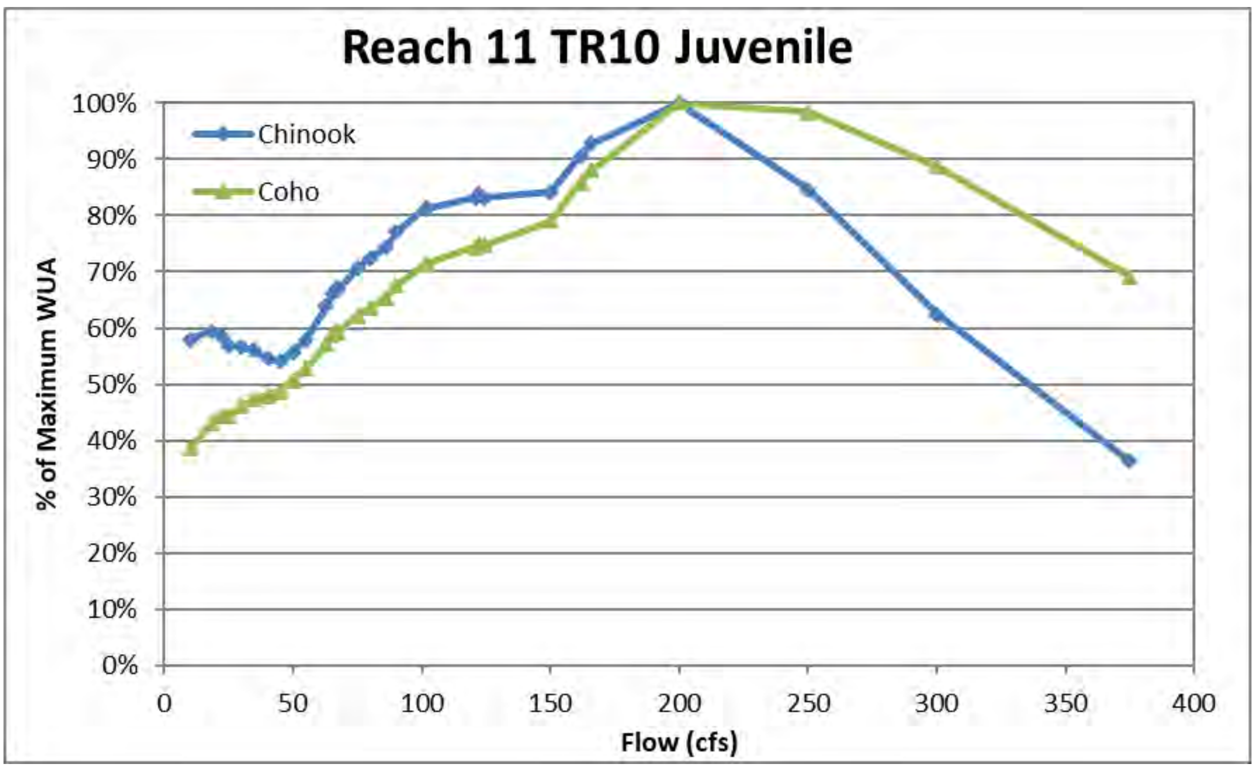


Figure A.2-58. Reach 11 Transect 10 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

Table A.2-1. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 1 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	546	8066	12%	100%
	18.1	2030	7257	43%	90%
	22.2	2941	6781	62%	84%
	24.7	3371	6464	71%	80%
	30	4126	6146	87%	76%
	35	4717	6165	100%	76%
	40	4589	5833	97%	72%
	45	4437	5558	94%	69%
	50	4510	5308	96%	66%
	55	4428	5354	94%	66%
	62.6	3922	4828	83%	60%
	65.4	3685	4605	78%	57%
	67	3677	4671	78%	58%
	67.3	3642	4639	77%	58%
	75	3334	4434	71%	55%
	80	3109	4316	66%	54%
	86.2	2886	4362	61%	54%
	90	2587	4290	55%	53%
	101.7	2115	4356	44.8%	54%
	102	2093	4340	44%	54%
	120.8	1889	4486	40%	56%
	121.8	1824	4451	39%	55%
	124.4	1796	4531	38%	56%
	150	1879	4969	40%	62%
	161.9	1924	4888	41%	61%
	166	2018	5030	43%	62%
	200	2276	5227	48%	65%
	250	1865	3892	40%	48%
	300	1186	2311	25%	29%
	375	124	725	3%	9%

Table A.2-2. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 1 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1082	NA	32%	
	18.1	2083	NA	62%	
	22.2	2548	NA	76%	
	24.7	2768	NA	83%	
	30	3106	NA	93%	
	35	3312	NA	99%	
	40	3351	NA	100%	
	45	3328	NA	99%	
	50	3275	NA	98%	
	55	3213	NA	96%	
	62.6	3066	NA	92%	
	65.4	2974	NA	89%	
	67	2954	NA	88%	
	67.3	2937	NA	88%	
	75	2748	NA	82%	
	80	2640	NA	79%	
	86.2	2573	NA	77%	
	90	2486	NA	74%	
	101.7	2392	NA	71%	
	102	2382	NA	71%	
	120.8	2336	NA	70%	
	121.8	2306	NA	69%	
	124.4	2282	NA	68%	
	150	2310	NA	69%	
	161.9	2273	NA	68%	
	166	2289	NA	68%	
	200	2199	NA	66%	
	250	1869	NA	56%	
	300	1401	NA	42%	
	375	546	NA	16%	

Table A.2-3. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 1 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1719	10000	49%	82%
	18.1	2793	10930	80%	90%
	22.2	3158	11229	90%	92%
	24.7	3293	11307	94%	93%
	30	3431	11710	98%	96%
	35	3508	12181	100%	100%
	40	3458	11944	99%	98%
	45	3374	11661	96%	96%
	50	3271	11219	93%	92%
	55	3147	10936	90%	90%
	62.6	2893	9543	82%	78%
	65.4	2771	8913	79%	73%
	67	2734	8856	78%	73%
	67.3	2714	8759	77%	72%
	75	2453	7729	70%	63%
	80	2324	7225	66%	59%
	86.2	2234	6931	64%	57%
	90	2163	6609	62%	54%
	101.7	2141	6420	61%	53%
	102	2136	6404	61%	53%
	120.8	2193	6682	63%	55%
	121.8	2175	6641	62%	55%
	124.4	2170	6739	62%	55%
	150	2250	7352	64%	60%
	161.9	2160	7318	62%	60%
	166	2166	7506	62%	62%
	200	1914	8245	55%	68%
	250	1603	6998	46%	57%
	300	1114	5086	32%	42%
	375	336	2070	10%	17%

Table A.2-4. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 2 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	367	5789	16%	100%
	18.1	1301	5050	57%	87%
	22.2	1773	5019	77%	87%
	24.7	1894	4812	82%	83%
	30	2197	4307	96%	74%
	35	2123	3895	92%	67%
	40	1901	3280	83%	57%
	45	2085	2766	91%	48%
	50	2251	2421	98%	42%
	55	2216	2111	96%	36%
	62.6	2300	1980	100%	34%
	65.4	2227	1889	97%	33%
	67	2253	1882	98%	33%
	67.3	2230	1870	97%	32%
	75	1973	1786	86%	31%
	80	1750	1746	76%	30%
	86.2	1365	1657	59%	29%
	90	1198	1586	52%	27%
	101.7	1133	1265	49.3%	22%
	102	1126	1252	49%	22%
	120.8	971	912	42%	16%
	121.8	1001	919	44%	16%
	124.4	933	856	41%	15%
	150	622	601	27%	10%
	161.9	389	529	17%	9%
	166	336	520	15%	9%
	200	0	377	0%	7%
	250	0	263	0%	5%
	300	0	192	0%	3%
	375	0	329	0%	6%

Table A.2-5. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 2 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	138	NA	4%	
	18.1	622	NA	17%	
	22.2	906	NA	24%	
	24.7	1100	NA	30%	
	30	1475	NA	40%	
	35	1868	NA	50%	
	40	2207	NA	59%	
	45	2545	NA	68%	
	50	2858	NA	77%	
	55	3069	NA	82%	
	62.6	3381	NA	91%	
	65.4	3443	NA	92%	
	67	3520	NA	94%	
	67.3	3515	NA	94%	
	75	3651	NA	98%	
	80	3721	NA	100%	
	86.2	3725	NA	100%	
	90	3687	NA	99%	
	101.7	3649	NA	98%	
	102	3637	NA	98%	
	120.8	3407	NA	91%	
	121.8	3477	NA	93%	
	124.4	3370	NA	90%	
	150	3023	NA	81%	
	161.9	2752	NA	74%	
	166	2684	NA	72%	
	200	1879	NA	50%	
	250	1158	NA	31%	
	300	557	NA	15%	
	375	124	NA	3%	

Table A.2-6. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 2 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	257	8071	7%	85%
	18.1	1087	8883	28%	94%
	22.2	1496	9383	39%	99%
	24.7	1764	9443	46%	100%
	30	2200	9232	57%	98%
	35	2597	8739	67%	93%
	40	2876	7863	74%	83%
	45	3149	6920	82%	73%
	50	3385	6133	88%	65%
	55	3506	5190	91%	55%
	62.6	3740	4677	97%	50%
	65.4	3764	4551	97%	48%
	67	3822	4560	99%	48%
	67.3	3813	4546	99%	48%
	75	3851	4541	100%	48%
	80	3860	4495	100%	48%
	86.2	3772	4422	98%	47%
	90	3677	4342	95%	46%
	101.7	3487	3909	90%	41%
	102	3470	3885	90%	41%
	120.8	3045	2981	79%	32%
	121.8	3100	3013	80%	32%
	124.4	2973	2811	77%	30%
	150	2493	2004	65%	21%
	161.9	2229	1729	58%	18%
	166	2162	1665	56%	18%
	200	1416	1179	37%	12%
	250	788	870	20%	9%
	300	345	699	9%	7%
	375	83	755	2%	8%

Table A.2-7. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 3 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	71	14120	3%	100%
	18.1	389	12051	18%	85%
	22.2	662	10654	31%	75%
	24.7	860	9923	40%	70%
	30	1274	8781	60%	62%
	35	1669	8125	78%	58%
	40	2088	7640	98%	54%
	45	2134	6962	100%	49%
	50	2137	6318	100%	45%
	55	2052	5764	96%	41%
	62.6	2011	5200	94%	37%
	65.4	2077	5051	97%	36%
	67	2023	4879	95%	35%
	67.3	2010	4847	94%	34%
	75	1888	4455	88%	32%
	80	1700	4323	80%	31%
	86.2	1463	4244	68%	30%
	90	1422	4317	67%	31%
	101.7	1063	4406	49.7%	31%
	102	1049	4400	49%	31%
	120.8	792	4871	37%	34%
	121.8	858	5093	40%	36%
	124.4	770	5045	36%	36%
	150	686	5658	32%	40%
	161.9	642	5850	30%	41%
	166	649	5965	30%	42%
	200	650	5819	30%	41%
	250	607	4587	28%	32%
	300	514	2811	24%	20%
	375	66	564	3%	4%

Table A.2-8. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 3 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1489	NA	34%	
	18.1	2462	NA	57%	
	22.2	2932	NA	68%	
	24.7	3209	NA	74%	
	30	3706	NA	85%	
	35	4057	NA	94%	
	40	4300	NA	99%	
	45	4338	NA	100%	
	50	4286	NA	99%	
	55	4169	NA	96%	
	62.6	4009	NA	92%	
	65.4	3989	NA	92%	
	67	3887	NA	90%	
	67.3	3867	NA	89%	
	75	3702	NA	85%	
	80	3557	NA	82%	
	86.2	3357	NA	77%	
	90	3309	NA	76%	
	101.7	3048	NA	70%	
	102	3036	NA	70%	
	120.8	2753	NA	63%	
	121.8	2854	NA	66%	
	124.4	2741	NA	63%	
	150	2626	NA	61%	
	161.9	2496	NA	58%	
	166	2511	NA	58%	
	200	2705	NA	62%	
	250	2614	NA	60%	
	300	2286	NA	53%	
	375	1650	NA	38%	

Table A.2-9. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 3 of Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	2512	16646	52%	100%
	18.1	3731	16296	77%	98%
	22.2	4127	15887	86%	95%
	24.7	4323	15764	90%	95%
	30	4604	15672	96%	94%
	35	4755	15724	99%	94%
	40	4819	15578	100%	94%
	45	4688	14858	97%	89%
	50	4493	13843	93%	83%
	55	4259	12530	88%	75%
	62.6	3956	10624	82%	64%
	65.4	3897	10115	81%	61%
	67	3764	9653	78%	58%
	67.3	3737	9555	78%	57%
	75	3493	8300	72%	50%
	80	3310	7662	69%	46%
	86.2	3086	6938	64%	42%
	90	3049	6792	63%	41%
	101.7	2815	6383	58%	38%
	102	2803	6371	58%	38%
	120.8	2551	6809	53%	41%
	121.8	2651	7103	55%	43%
	124.4	2535	6992	53%	42%
	150	2470	7663	51%	46%
	161.9	2398	7847	50%	47%
	166	2443	7962	51%	48%
	200	2783	8037	58%	48%
	250	2621	7293	54%	44%
	300	2123	5175	44%	31%
	375	1157	1864	24%	11%

Table A.2-10. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 1 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	32	991	1%	7%
	18.1	300	1118	8%	8%
	22.2	758	1916	21%	13%
	24.7	825	2053	23%	14%
	30	1090	2948	30%	21%
	35	1280	3475	35%	24%
	40	1532	3885	42%	27%
	45	1711	3838	47%	27%
	50	1875	3857	52%	27%
	55	1811	3919	50%	27%
	62.6	1583	4249	44%	30%
	65.4	1635	4352	45%	31%
	67	1652	4521	45%	32%
	67.3	1763	4989	48%	35%
	75	2023	6100	56%	43%
	80	2221	6681	61%	47%
	86.2	2402	6888	66%	48%
	90	2594	6827	71%	48%
	101.7	3111	6717	85.6%	47%
	102	3237	6831	89%	48%
	120.8	3632	6068	100%	43%
	121.8	3559	5949	98%	42%
	124.4	3636	6107	100%	43%
	150	3510	5742	97%	40%
	161.9	3259	5744	90%	40%
	166	3259	6445	90%	45%
	200	2950	7815	81%	55%
	250	2703	9672	74%	68%
	300	2394	9697	66%	68%
	375	2572	14262	71%	100%

Table A.2-11. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 1 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	2943	NA	16%	
	18.1	3741	NA	21%	
	22.2	4941	NA	28%	
	24.7	5101	NA	29%	
	30	5563	NA	31%	
	35	6566	NA	37%	
	40	7994	NA	45%	
	45	8551	NA	48%	
	50	9855	NA	55%	
	55	10740	NA	60%	
	62.6	11394	NA	64%	
	65.4	11601	NA	65%	
	67	11675	NA	65%	
	67.3	11985	NA	67%	
	75	12711	NA	71%	
	80	13262	NA	74%	
	86.2	13703	NA	77%	
	90	14247	NA	80%	
	101.7	15616	NA	87%	
	102	15891	NA	89%	
	120.8	17108	NA	96%	
	121.8	16967	NA	95%	
	124.4	17195	NA	96%	
	150	17879	NA	100%	
	161.9	17523	NA	98%	
	166	17870	NA	100%	
	200	17273	NA	97%	
	250	14461	NA	81%	
	300	11102	NA	62%	
	375	6370	NA	36%	

Table A.2-12. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 1 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	3155	3269	19%	10%
	18.1	3573	3603	21%	11%
	22.2	4797	4839	29%	15%
	24.7	4898	4865	29%	15%
	30	5027	5864	30%	18%
	35	6149	6668	37%	21%
	40	7857	7514	47%	23%
	45	8250	7752	50%	24%
	50	9548	8170	57%	25%
	55	10301	8450	62%	26%
	62.6	10858	9279	65%	29%
	65.4	10990	9487	66%	29%
	67	11033	9724	66%	30%
	67.3	11323	10319	68%	32%
	75	11843	11860	71%	37%
	80	12354	12750	74%	39%
	86.2	12823	13234	77%	41%
	90	13464	13352	81%	41%
	101.7	14971	13745	90%	42%
	102	15276	13985	92%	43%
	120.8	16201	13794	97%	43%
	121.8	16008	13602	96%	42%
	124.4	16232	13913	98%	43%
	150	16622	14284	100%	44%
	161.9	16129	14301	97%	44%
	166	16509	15379	99%	48%
	200	16312	17875	98%	55%
	250	15293	21895	92%	68%
	300	13778	22960	83%	71%
	375	12046	32348	72%	100%

Table A.2-13. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 2 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	0	904	0%	23%
	18.1	192	2317	11%	58%
	22.2	302	3583	17%	90%
	24.7	339	3962	19%	100%
	30	413	3656	23%	92%
	35	501	3280	28%	83%
	40	535	3110	30%	79%
	45	542	2994	31%	76%
	50	580	2657	33%	67%
	55	589	2551	33%	64%
	62.6	575	2221	32%	56%
	65.4	564	2108	32%	53%
	67	571	2087	32%	53%
	67.3	680	2447	38%	62%
	75	698	1982	39%	50%
	80	750	1791	42%	45%
	86.2	882	1668	50%	42%
	90	879	1534	50%	39%
	101.7	1072	1679	60.5%	42%
	102	1060	1671	60%	42%
	120.8	1172	1546	66%	39%
	121.8	1124	1514	63%	38%
	124.4	1125	1665	64%	42%
	150	1600	1189	90%	30%
	161.9	1671	1196	94%	30%
	166	1736	1420	98%	36%
	200	1770	2905	100%	73%
	250	1413	2120	80%	53%
	300	974	1766	55%	45%
	375	449	1080	25%	27%

Table A.2-14. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 2 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1979	NA	21%	
	18.1	4483	NA	47%	
	22.2	4926	NA	52%	
	24.7	4943	NA	52%	
	30	5515	NA	58%	
	35	6439	NA	68%	
	40	7161	NA	75%	
	45	8019	NA	84%	
	50	8705	NA	91%	
	55	8843	NA	93%	
	62.6	8426	NA	89%	
	65.4	8230	NA	86%	
	67	8255	NA	87%	
	67.3	9062	NA	95%	
	75	8471	NA	89%	
	80	8365	NA	88%	
	86.2	8466	NA	89%	
	90	8218	NA	86%	
	101.7	8206	NA	86%	
	102	8161	NA	86%	
	120.8	8225	NA	86%	
	121.8	8066	NA	85%	
	124.4	8090	NA	85%	
	150	9415	NA	99%	
	161.9	9413	NA	99%	
	166	9518	NA	100%	
	200	9382	NA	99%	
	250	8671	NA	91%	
	300	7535	NA	79%	
	375	5778	NA	61%	

Table A.2-15. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 2 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	2107	2785	24%	37%
	18.1	4579	5140	52%	68%
	22.2	4858	7010	56%	92%
	24.7	4768	7601	54%	100%
	30	5506	7418	63%	98%
	35	6649	7330	76%	96%
	40	7300	7479	83%	98%
	45	8149	7524	93%	99%
	50	8750	7293	100%	96%
	55	8747	7343	100%	97%
	62.6	8063	6942	92%	91%
	65.4	7756	6788	89%	89%
	67	7712	6788	88%	89%
	67.3	8525	7401	97%	97%
	75	7700	6507	88%	86%
	80	7465	6064	85%	80%
	86.2	7419	5686	85%	75%
	90	7087	5182	81%	68%
	101.7	6891	4949	79%	65%
	102	6850	4916	78%	65%
	120.8	6730	4764	77%	63%
	121.8	6592	4679	75%	62%
	124.4	6608	4999	76%	66%
	150	7480	4384	85%	58%
	161.9	7346	4665	84%	61%
	166	7381	5069	84%	67%
	200	7021	7432	80%	98%
	250	6286	6776	72%	89%
	300	5479	6022	63%	79%
	375	4517	4453	52%	59%

Table A.2-16. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 3 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	139	10309	3%	100%
	18.1	1011	8355	20%	81%
	22.2	1865	7804	37%	76%
	24.7	2387	7439	47%	72%
	30	3408	6929	68%	67%
	35	4275	6273	85%	61%
	40	4896	5886	97%	57%
	45	4747	5323	94%	52%
	50	5033	4921	100%	48%
	55	5029	4403	100%	43%
	62.6	4762	3825	95%	37%
	65.4	4576	3616	91%	35%
	67	4622	3621	92%	35%
	67.3	4573	3583	91%	35%
	75	4104	3254	82%	32%
	80	3639	2871	72%	28%
	86.2	3340	2595	66%	25%
	90	3118	2425	62%	24%
	101.7	2598	2100	51.6%	20%
	102	2565	2078	51%	20%
	120.8	1773	1794	35%	17%
	121.8	1692	1773	34%	17%
	124.4	1513	1719	30%	17%
	150	976	1918	19%	19%
	161.9	854	1829	17%	18%
	166	783	1763	16%	17%
	200	604	1535	12%	15%
	250	601	1152	12%	11%
	300	407	1026	8%	10%
	375	22	696	0%	7%

Table A.2-17. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 3 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	55	NA	2%	
	18.1	301	NA	10%	
	22.2	393	NA	13%	
	24.7	477	NA	16%	
	30	658	NA	22%	
	35	829	NA	28%	
	40	981	NA	33%	
	45	1114	NA	37%	
	50	1287	NA	43%	
	55	1405	NA	47%	
	62.6	1561	NA	52%	
	65.4	1606	NA	53%	
	67	1650	NA	55%	
	67.3	1647	NA	55%	
	75	1768	NA	59%	
	80	1772	NA	59%	
	86.2	1844	NA	61%	
	90	1863	NA	62%	
	101.7	2059	NA	68%	
	102	2057	NA	68%	
	120.8	2304	NA	76%	
	121.8	2292	NA	76%	
	124.4	2264	NA	75%	
	150	2613	NA	87%	
	161.9	2754	NA	91%	
	166	2760	NA	92%	
	200	3013	NA	100%	
	250	2814	NA	93%	
	300	2349	NA	78%	
	375	1349	NA	45%	

Table A.2-18. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 3 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	103	12632	3%	96%
	18.1	530	12337	18%	94%
	22.2	643	12596	22%	96%
	24.7	756	12713	26%	97%
	30	983	13079	33%	100%
	35	1164	13104	40%	100%
	40	1306	13099	44%	100%
	45	1422	12740	48%	97%
	50	1597	12489	54%	95%
	55	1698	11806	58%	90%
	62.6	1850	10650	63%	81%
	65.4	1888	10105	64%	77%
	67	1937	10021	66%	76%
	67.3	1933	9912	66%	76%
	75	2047	8778	70%	67%
	80	2013	7791	68%	59%
	86.2	2062	7010	70%	53%
	90	2062	6499	70%	50%
	101.7	2236	5332	76%	41%
	102	2227	5281	76%	40%
	120.8	2448	4007	83%	31%
	121.8	2430	3930	82%	30%
	124.4	2390	3727	81%	28%
	150	2726	4097	93%	31%
	161.9	2867	4084	97%	31%
	166	2866	3995	97%	30%
	200	2945	3764	100%	29%
	250	2395	3123	81%	24%
	300	1806	2860	61%	22%
	375	899	2410	31%	18%

Table A.2-19. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 4 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	402	3019	6%	67%
	18.1	651	2353	10%	52%
	22.2	892	2763	14%	62%
	24.7	969	3350	15%	75%
	30	1121	3576	18%	80%
	35	1380	3482	22%	78%
	40	1768	3389	28%	76%
	45	1985	3302	31%	74%
	50	2138	3081	34%	69%
	55	2243	3011	36%	67%
	62.6	2512	2728	40%	61%
	65.4	2661	2718	42%	61%
	67	2740	2693	43%	60%
	67.3	2977	2798	47%	62%
	75	3499	2746	55%	61%
	80	3726	2655	59%	59%
	86.2	4019	2510	64%	56%
	90	4389	2445	70%	54%
	101.7	5098	2123	80.8%	47%
	102	5070	2097	80%	47%
	120.8	5469	2327	87%	52%
	121.8	5638	2457	89%	55%
	124.4	5890	2698	93%	60%
	150	6313	4221	100%	94%
	161.9	6153	4488	97%	100%
	166	5916	4469	94%	100%
	200	4930	3439	78%	77%
	250	3328	3086	53%	69%
	300	2191	3638	35%	81%
	375	838	1187	13%	26%

Table A.2-20. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 4 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	576	NA	12%	
	18.1	1262	NA	26%	
	22.2	1453	NA	30%	
	24.7	1538	NA	31%	
	30	1881	NA	38%	
	35	2270	NA	46%	
	40	2620	NA	53%	
	45	2703	NA	55%	
	50	2855	NA	58%	
	55	3049	NA	62%	
	62.6	3412	NA	70%	
	65.4	3377	NA	69%	
	67	3389	NA	69%	
	67.3	3479	NA	71%	
	75	3684	NA	75%	
	80	3794	NA	77%	
	86.2	3953	NA	81%	
	90	4085	NA	83%	
	101.7	4277	NA	87%	
	102	4262	NA	87%	
	120.8	4544	NA	93%	
	121.8	4638	NA	95%	
	124.4	4790	NA	98%	
	150	4898	NA	100%	
	161.9	4848	NA	99%	
	166	4769	NA	97%	
	200	4803	NA	98%	
	250	4323	NA	88%	
	300	3800	NA	78%	
	375	2815	NA	57%	

Table A.2-21. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 4 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	723	5714	17%	64%
	18.1	1486	5900	35%	67%
	22.2	1618	6620	38%	75%
	24.7	1659	7475	39%	84%
	30	2032	8216	48%	93%
	35	2470	8444	58%	95%
	40	2831	8563	67%	97%
	45	2793	8431	66%	95%
	50	2881	8148	68%	92%
	55	3034	8039	71%	91%
	62.6	3368	7693	79%	87%
	65.4	3235	7707	76%	87%
	67	3225	7678	76%	87%
	67.3	3309	7916	78%	89%
	75	3449	7788	81%	88%
	80	3506	7592	82%	86%
	86.2	3592	7362	84%	83%
	90	3669	7326	86%	83%
	101.7	3786	6711	89%	76%
	102	3769	6656	89%	75%
	120.8	3968	6702	93%	76%
	121.8	4069	6918	96%	78%
	124.4	4221	7266	99%	82%
	150	4176	8722	98%	98%
	161.9	4072	8870	96%	100%
	166	3999	8663	94%	98%
	200	4257	7490	100%	84%
	250	3836	7222	90%	81%
	300	3316	8078	78%	91%
	375	2306	4580	54%	52%

Table A.2-22. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 5 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	0	7499	0%	89%
	18.1	76	7857	6%	94%
	22.2	186	8221	14%	98%
	24.7	256	8273	19%	99%
	30	381	8380	29%	100%
	35	464	8320	35%	99%
	40	566	7760	43%	93%
	45	684	7146	52%	85%
	50	677	6423	51%	77%
	55	719	6084	55%	73%
	62.6	691	5275	53%	63%
	65.4	690	5033	52%	60%
	67	722	4985	55%	59%
	67.3	716	4946	54%	59%
	75	768	4448	58%	53%
	80	751	4017	57%	48%
	86.2	774	3638	59%	43%
	90	878	3544	67%	42%
	101.7	1007	2964	76.6%	35%
	102	1001	2942	76%	35%
	120.8	1206	2141	92%	26%
	121.8	1183	2089	90%	25%
	124.4	1258	2029	96%	24%
	150	1315	1443	100%	17%
	161.9	1222	1259	93%	15%
	166	1225	1211	93%	14%
	200	1098	707	83%	8%
	250	722	479	55%	6%
	300	361	306	27%	4%
	375	11	46	1%	1%

Table A.2-23. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 5 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	0	NA	0%	
	18.1	121	NA	2%	
	22.2	242	NA	5%	
	24.7	306	NA	6%	
	30	566	NA	11%	
	35	811	NA	16%	
	40	1220	NA	24%	
	45	1728	NA	33%	
	50	2164	NA	42%	
	55	2767	NA	53%	
	62.6	3360	NA	65%	
	65.4	3539	NA	68%	
	67	3678	NA	71%	
	67.3	3685	NA	71%	
	75	4131	NA	80%	
	80	4277	NA	83%	
	86.2	4504	NA	87%	
	90	4756	NA	92%	
	101.7	4987	NA	96%	
	102	4978	NA	96%	
	120.8	5153	NA	100%	
	121.8	5116	NA	99%	
	124.4	5172	NA	100%	
	150	4869	NA	94%	
	161.9	4665	NA	90%	
	166	4623	NA	89%	
	200	4129	NA	80%	
	250	3306	NA	64%	
	300	2479	NA	48%	
	375	1424	NA	28%	

Table A.2-24. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 5 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	0	9888	0%	65%
	18.1	226	11953	4%	79%
	22.2	446	13144	8%	87%
	24.7	557	13654	10%	90%
	30	986	14590	18%	96%
	35	1358	15187	25%	100%
	40	1974	15111	37%	100%
	45	2662	14874	50%	98%
	50	3186	14302	59%	94%
	55	3905	14155	73%	93%
	62.6	4419	13280	82%	87%
	65.4	4552	12997	85%	86%
	67	4667	12990	87%	86%
	67.3	4667	12924	87%	85%
	75	4953	12291	92%	81%
	80	4998	11526	93%	76%
	86.2	5127	10910	96%	72%
	90	5325	10772	99%	71%
	101.7	5363	9360	100%	62%
	102	5348	9307	100%	61%
	120.8	5202	7434	97%	49%
	121.8	5152	7293	96%	48%
	124.4	5168	7124	96%	47%
	150	4545	4911	85%	32%
	161.9	4242	4131	79%	27%
	166	4170	3962	78%	26%
	200	3507	2614	65%	17%
	250	2616	1432	49%	9%
	300	1732	966	32%	6%
	375	739	282	14%	2%

Table A.2-25. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 6 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	2553	6231	22%	100%
	18.1	7350	5324	65%	85%
	22.2	9488	4866	83%	78%
	24.7	10146	4714	89%	76%
	30	11262	4469	99%	72%
	35	11382	5182	100%	83%
	40	9865	5585	87%	90%
	45	8805	5791	77%	93%
	50	7925	5317	70%	85%
	55	6973	4759	61%	76%
	62.6	5750	3955	51%	63%
	65.4	5413	3701	48%	59%
	67	5336	3610	47%	58%
	67.3	5277	3583	46%	58%
	75	4708	3237	41%	52%
	80	4166	3009	37%	48%
	86.2	3613	2733	32%	44%
	90	3392	2643	30%	42%
	101.7	2590	2282	22.8%	37%
	102	2546	2269	22%	36%
	120.8	1976	2150	17%	35%
	121.8	2071	2136	18%	34%
	124.4	2023	2061	18%	33%
	150	2153	2104	19%	34%
	161.9	2155	1803	19%	29%
	166	2115	1728	19%	28%
	200	1753	2873	15%	46%
	250	1157	4462	10%	72%
	300	697	5887	6%	94%
	375	171	2317	1%	37%

Table A.2-26. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 6 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	3816	NA	47%	
	18.1	6384	NA	79%	
	22.2	7227	NA	89%	
	24.7	7542	NA	93%	
	30	7849	NA	97%	
	35	7999	NA	99%	
	40	7898	NA	98%	
	45	7815	NA	97%	
	50	7586	NA	94%	
	55	7839	NA	97%	
	62.6	7827	NA	97%	
	65.4	7838	NA	97%	
	67	8006	NA	99%	
	67.3	7970	NA	98%	
	75	8094	NA	100%	
	80	7965	NA	98%	
	86.2	7903	NA	98%	
	90	7887	NA	97%	
	101.7	7563	NA	93%	
	102	7529	NA	93%	
	120.8	7149	NA	88%	
	121.8	7226	NA	89%	
	124.4	7125	NA	88%	
	150	6893	NA	85%	
	161.9	6826	NA	84%	
	166	6766	NA	84%	
	200	6004	NA	74%	
	250	5197	NA	64%	
	300	4191	NA	52%	
	375	2837	NA	35%	

Table A.2-27. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 6 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	5363	7704	70%	65%
	18.1	7207	8382	94%	71%
	22.2	7521	8662	98%	73%
	24.7	7595	8877	99%	75%
	30	7585	9318	98%	79%
	35	7651	10608	99%	90%
	40	7484	11318	97%	96%
	45	7308	11798	95%	100%
	50	7068	11195	92%	95%
	55	7428	10451	96%	89%
	62.6	7464	9074	97%	77%
	65.4	7487	8539	97%	72%
	67	7685	8394	100%	71%
	67.3	7643	8315	99%	70%
	75	7701	7823	100%	66%
	80	7510	7412	98%	63%
	86.2	7365	6907	96%	59%
	90	7311	6724	95%	57%
	101.7	6955	6091	90%	52%
	102	6922	6053	90%	51%
	120.8	6349	5566	82%	47%
	121.8	6416	5559	83%	47%
	124.4	6294	5415	82%	46%
	150	5879	5042	76%	43%
	161.9	5708	4555	74%	39%
	166	5601	4410	73%	37%
	200	4643	5329	60%	45%
	250	3709	7369	48%	62%
	300	2975	10146	39%	86%
	375	2466	7202	32%	61%

Table A.2-28. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 7 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	5	8956	0%	100%
	18.1	147	8359	7%	93%
	22.2	286	7602	13%	85%
	24.7	381	7199	17%	80%
	30	633	6939	29%	77%
	35	881	6757	40%	75%
	40	1104	5997	50%	67%
	45	1321	5846	60%	65%
	50	1566	5603	71%	63%
	55	1686	5451	76%	61%
	62.6	1773	4723	80%	53%
	65.4	1894	4641	86%	52%
	67	1847	4444	84%	50%
	67.3	1839	4418	83%	49%
	75	2038	4190	92%	47%
	80	2106	3909	95%	44%
	86.2	2141	3756	97%	42%
	90	2143	3665	97%	41%
	101.7	2210	3572	100.0%	40%
	102	2198	3566	99%	40%
	120.8	1679	3346	76%	37%
	121.8	1619	3306	73%	37%
	124.4	1540	3292	70%	37%
	150	1157	2792	52%	31%
	161.9	1078	2742	49%	31%
	166	1045	2689	47%	30%
	200	546	2136	25%	24%
	250	143	1861	6%	21%
	300	11	3898	1%	44%
	375	0	2822	0%	32%

Table A.2-29. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 7 of Reach 5 expressed as area (ft²/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft²/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	186	NA	8%	
	18.1	490	NA	21%	
	22.2	600	NA	26%	
	24.7	674	NA	29%	
	30	856	NA	37%	
	35	1037	NA	44%	
	40	1216	NA	52%	
	45	1402	NA	60%	
	50	1587	NA	68%	
	55	1771	NA	76%	
	62.6	1988	NA	85%	
	65.4	2075	NA	89%	
	67	2093	NA	90%	
	67.3	2096	NA	90%	
	75	2252	NA	97%	
	80	2308	NA	99%	
	86.2	2333	NA	100%	
	90	2329	NA	100%	
	101.7	2304	NA	99%	
	102	2298	NA	99%	
	120.8	2162	NA	93%	
	121.8	2145	NA	92%	
	124.4	2124	NA	91%	
	150	1815	NA	78%	
	161.9	1684	NA	72%	
	166	1629	NA	70%	
	200	1150	NA	49%	
	250	757	NA	32%	
	300	485	NA	21%	
	375	108	NA	5%	

Table A.2-30. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 7 of Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	341	10822	15%	88%
	18.1	866	11724	38%	95%
	22.2	1027	11605	45%	94%
	24.7	1129	11561	49%	94%
	30	1350	12011	59%	97%
	35	1544	12326	67%	100%
	40	1715	11866	74%	96%
	45	1871	11889	81%	96%
	50	2008	11612	87%	94%
	55	2128	11361	92%	92%
	62.6	2214	10041	96%	81%
	65.4	2261	9863	98%	80%
	67	2249	9431	98%	77%
	67.3	2245	9363	97%	76%
	75	2303	8608	100%	70%
	80	2299	7956	100%	65%
	86.2	2272	7427	99%	60%
	90	2241	7220	97%	59%
	101.7	2164	7213	94%	59%
	102	2157	7198	94%	58%
	120.8	1929	6986	84%	57%
	121.8	1908	6935	83%	56%
	124.4	1871	6920	81%	56%
	150	1428	6262	62%	51%
	161.9	1262	6004	55%	49%
	166	1197	5834	52%	47%
	200	765	4451	33%	36%
	250	476	4607	21%	37%
	300	280	8021	12%	65%
	375	33	8451	1%	69%

Table A.2-31. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 1 of Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	0	348	0%	4%
	18.1	0	1148	0%	13%
	22.2	0	1565	0%	18%
	24.7	0	2237	0%	25%
	30	0	2735	0%	31%
	35	0	3590	0%	40%
	40	0	4036	0%	45%
	45	12	4589	2%	51%
	50	144	4873	18%	55%
	55	258	5385	32%	60%
	62.6	439	6659	53%	75%
	65.4	488	6958	59%	78%
	67	521	7018	64%	79%
	67.3	537	7104	65%	80%
	75	718	8236	88%	92%
	80	816	8593	100%	96%
	86.2	820	8891	100%	100%
	90	820	8916	100%	100%
	101.7	820	8146	100.0%	91%
	102	820	8241	100%	92%
	120.8	699	7932	85%	89%
	121.8	676	7848	82%	88%
	124.4	662	7968	81%	89%
	150	462	7463	56%	84%
	161.9	428	7371	52%	83%
	166	422	7243	51%	81%
	200	410	5998	50%	67%
	250	541	5225	66%	59%
	300	569	5638	69%	63%
	375	409	2878	50%	32%

Table A.2-32. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 1 of Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	0	NA	0%	
	18.1	0	NA	0%	
	22.2	0	NA	0%	
	24.7	0	NA	0%	
	30	228	NA	12%	
	35	554	NA	29%	
	40	680	NA	36%	
	45	812	NA	43%	
	50	956	NA	50%	
	55	1081	NA	57%	
	62.6	1288	NA	67%	
	65.4	1334	NA	70%	
	67	1370	NA	72%	
	67.3	1396	NA	73%	
	75	1606	NA	84%	
	80	1736	NA	91%	
	86.2	1853	NA	97%	
	90	1904	NA	100%	
	101.7	1881	NA	99%	
	102	1908	NA	100%	
	120.8	1887	NA	99%	
	121.8	1874	NA	98%	
	124.4	1887	NA	99%	
	150	1786	NA	94%	
	161.9	1737	NA	91%	
	166	1732	NA	91%	
	200	1653	NA	87%	
	250	1605	NA	84%	
	300	1538	NA	81%	
	375	1225	NA	64%	

Table A.2-33. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 1 of Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	0	563	0%	4%
	18.1	0	1717	0%	11%
	22.2	0	2577	0%	17%
	24.7	0	3963	0%	26%
	30	285	5169	16%	34%
	35	655	7102	36%	47%
	40	753	7943	41%	52%
	45	852	8801	47%	58%
	50	975	9296	54%	61%
	55	1081	10145	59%	66%
	62.6	1244	12337	68%	81%
	65.4	1274	12761	70%	84%
	67	1300	12816	72%	84%
	67.3	1322	12905	73%	85%
	75	1483	14239	82%	93%
	80	1615	14775	89%	97%
	86.2	1724	15195	95%	100%
	90	1775	15232	98%	100%
	101.7	1753	14404	96%	94%
	102	1778	14548	98%	95%
	120.8	1810	15128	100%	99%
	121.8	1795	15009	99%	98%
	124.4	1818	15265	100%	100%
	150	1765	15188	97%	99%
	161.9	1732	14550	95%	95%
	166	1748	14476	96%	95%
	200	1746	12432	96%	81%
	250	1767	10278	97%	67%
	300	1670	10901	92%	71%
	375	1173	6445	65%	42%

Table A.2-34. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 2 of Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	544	4070	33%	44%
	18.1	970	4951	58%	53%
	22.2	1177	5799	71%	63%
	24.7	1273	5826	76%	63%
	30	1452	5982	87%	65%
	35	1577	6226	94%	67%
	40	1548	6310	93%	68%
	45	1609	7075	96%	76%
	50	1670	8132	100%	88%
	55	1598	8442	96%	91%
	62.6	1495	8362	90%	90%
	65.4	1466	8506	88%	92%
	67	1445	8469	87%	91%
	67.3	1460	8593	87%	93%
	75	1390	8720	83%	94%
	80	1348	8874	81%	96%
	86.2	1265	9005	76%	97%
	90	1194	9007	72%	97%
	101.7	1028	9223	61.6%	100%
	102	1020	9210	61%	100%
	120.8	818	9229	49%	100%
	121.8	818	9256	49%	100%
	124.4	761	9123	46%	99%
	150	644	8965	39%	97%
	161.9	624	8687	37%	94%
	166	628	8709	38%	94%
	200	619	7969	37%	86%
	250	448	6662	27%	72%
	300	253	4821	15%	52%
	375	0	1188	0%	13%

Table A.2-35. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 2 of Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	2275	NA	46%	
	18.1	3616	NA	73%	
	22.2	4250	NA	85%	
	24.7	4451	NA	89%	
	30	4740	NA	95%	
	35	4975	NA	100%	
	40	4982	NA	100%	
	45	4932	NA	99%	
	50	4846	NA	97%	
	55	4666	NA	94%	
	62.6	4365	NA	88%	
	65.4	4261	NA	86%	
	67	4183	NA	84%	
	67.3	4202	NA	84%	
	75	3872	NA	78%	
	80	3676	NA	74%	
	86.2	3396	NA	68%	
	90	3225	NA	65%	
	101.7	2744	NA	55%	
	102	2731	NA	55%	
	120.8	2186	NA	44%	
	121.8	2160	NA	43%	
	124.4	2094	NA	42%	
	150	1526	NA	31%	
	161.9	1331	NA	27%	
	166	1264	NA	25%	
	200	859	NA	17%	
	250	554	NA	11%	
	300	371	NA	7%	
	375	194	NA	4%	

Table A.2-36. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 2 of Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	2657	6260	54%	44%
	18.1	3946	8429	81%	59%
	22.2	4476	9965	92%	70%
	24.7	4593	10306	94%	72%
	30	4753	10971	97%	77%
	35	4878	11568	100%	81%
	40	4815	11874	99%	83%
	45	4724	12823	97%	90%
	50	4622	14082	95%	98%
	55	4420	14326	91%	100%
	62.6	4091	13979	84%	98%
	65.4	4003	14049	82%	98%
	67	3912	13851	80%	97%
	67.3	3953	14075	81%	98%
	75	3687	13710	76%	96%
	80	3579	13570	73%	95%
	86.2	3406	13280	70%	93%
	90	3265	12965	67%	90%
	101.7	3029	12696	62%	89%
	102	3018	12659	62%	88%
	120.8	2826	13086	58%	91%
	121.8	2828	13166	58%	92%
	124.4	2764	13074	57%	91%
	150	2371	13455	49%	94%
	161.9	2128	13331	44%	93%
	166	2069	13443	42%	94%
	200	1615	12949	33%	90%
	250	1287	11362	26%	79%
	300	1035	8935	21%	62%
	375	554	3642	11%	25%

Table A.2-37. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 1 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	0	1861	0%	53%
	18.1	0	1935	0%	55%
	22.2	0	1756	0%	50%
	24.7	0	1622	0%	46%
	30	0	1524	0%	43%
	35	28	1387	4%	39%
	40	54	1186	7%	34%
	45	64	1139	8%	32%
	50	97	1071	13%	30%
	55	120	998	16%	28%
	62.6	80	1188	11%	34%
	65.4	95	1256	13%	35%
	67	103	1236	14%	35%
	67.3	110	1262	15%	36%
	75	183	1446	24%	41%
	80	221	1627	29%	46%
	86.2	275	1997	36%	56%
	90	318	2032	42%	57%
	101.7	412	1975	54.3%	56%
	102	429	1991	57%	56%
	120.8	571	2653	75%	75%
	121.8	584	2724	77%	77%
	124.4	613	2838	81%	80%
	150	739	2722	98%	77%
	161.9	751	2976	99%	84%
	166	758	3235	100%	91%
	200	677	3319	89%	94%
	250	465	3110	61%	88%
	300	265	1660	35%	47%
	375	0	3540	0%	100%

Table A.2-38. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 1 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	0	NA	0%	
	18.1	0	NA	0%	
	22.2	0	NA	0%	
	24.7	0	NA	0%	
	30	0	NA	0%	
	35	0	NA	0%	
	40	0	NA	0%	
	45	0	NA	0%	
	50	0	NA	0%	
	55	0	NA	0%	
	62.6	0	NA	0%	
	65.4	0	NA	0%	
	67	0	NA	0%	
	67.3	0	NA	0%	
	75	0	NA	0%	
	80	0	NA	0%	
	86.2	0	NA	0%	
	90	0	NA	0%	
	101.7	0	NA	0%	
	102	0	NA	0%	
	120.8	0	NA	0%	
	121.8	0	NA	0%	
	124.4	0	NA	0%	
	150	0	NA	0%	
	161.9	0	NA	0%	
	166	0	NA	0%	
	200	0	NA	0%	
	250	0	NA	0%	
	300	0	NA	0%	
	375	0	NA	0%	

Table A.2-39. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 1 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	0	3994	0%	52%
	18.1	0	4863	0%	64%
	22.2	0	4726	0%	62%
	24.7	0	4520	0%	59%
	30	0	4094	0%	54%
	35	0	3702	0%	49%
	40	0	3042	0%	40%
	45	0	2661	0%	35%
	50	0	2288	0%	30%
	55	0	2012	0%	26%
	62.6	0	2099	0%	28%
	65.4	0	2094	0%	28%
	67	0	2022	0%	27%
	67.3	0	2076	0%	27%
	75	0	2166	0%	28%
	80	0	2341	0%	31%
	86.2	0	2768	0%	36%
	90	0	2834	0%	37%
	101.7	0	2859	0%	38%
	102	0	2879	0%	38%
	120.8	0	3731	0%	49%
	121.8	0	3824	0%	50%
	124.4	0	3984	0%	52%
	150	0	4329	0%	57%
	161.9	0	4975	0%	65%
	166	0	5523	0%	73%
	200	0	7218	0%	95%
	250	0	7614	0%	100%
	300	0	5588	0%	73%
	375	0	5851	0%	77%

Table A.2-40. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 2 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	719	4669	18%	61%
	18.1	2963	5284	74%	69%
	22.2	3612	5672	90%	74%
	24.7	4027	6096	100%	79%
	30	4005	6510	99%	85%
	35	3685	6505	91%	85%
	40	3819	6304	95%	82%
	45	3815	6062	95%	79%
	50	3753	5917	93%	77%
	55	3666	5899	91%	77%
	62.6	3580	6221	89%	81%
	65.4	3512	6220	87%	81%
	67	3524	6353	88%	83%
	67.3	3505	6325	87%	82%
	75	3418	6558	85%	85%
	80	3380	6546	84%	85%
	86.2	3336	6673	83%	87%
	90	3366	6700	84%	87%
	101.7	3412	7054	84.7%	92%
	102	3413	7043	85%	91%
	120.8	3536	7622	88%	99%
	121.8	3540	7698	88%	100%
	124.4	3520	7676	87%	100%
	150	3288	6442	82%	84%
	161.9	3261	6257	81%	81%
	166	3238	6281	80%	82%
	200	2770	5730	69%	74%
	250	1870	7149	46%	93%
	300	1053	5004	26%	65%
	375	47	3199	1%	42%

Table A.2-41. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 2 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	4970	NA	60%	
	18.1	7824	NA	95%	
	22.2	8172	NA	99%	
	24.7	8240	NA	100%	
	30	8087	NA	98%	
	35	7785	NA	94%	
	40	7478	NA	91%	
	45	7096	NA	86%	
	50	6862	NA	83%	
	55	6564	NA	80%	
	62.6	6245	NA	76%	
	65.4	6076	NA	74%	
	67	6066	NA	74%	
	67.3	6025	NA	73%	
	75	5580	NA	68%	
	80	5332	NA	65%	
	86.2	4947	NA	60%	
	90	4765	NA	58%	
	101.7	4252	NA	52%	
	102	4231	NA	51%	
	120.8	3611	NA	44%	
	121.8	3586	NA	44%	
	124.4	3508	NA	43%	
	150	2856	NA	35%	
	161.9	2628	NA	32%	
	166	2554	NA	31%	
	200	2036	NA	25%	
	250	1478	NA	18%	
	300	995	NA	12%	
	375	405	NA	5%	

Table A.2-42. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 2 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	6217	6832	76%	58%
	18.1	8187	8528	100%	72%
	22.2	8159	9462	100%	80%
	24.7	8100	10129	99%	86%
	30	7670	10676	94%	91%
	35	7034	10691	86%	91%
	40	6495	10338	79%	88%
	45	5962	9625	73%	82%
	50	5636	9026	69%	77%
	55	5338	8600	65%	73%
	62.6	5132	8856	63%	75%
	65.4	5026	8895	61%	75%
	67	5036	9070	62%	77%
	67.3	5008	9047	61%	77%
	75	4826	9402	59%	80%
	80	4747	9441	58%	80%
	86.2	4538	9609	55%	82%
	90	4448	9669	54%	82%
	101.7	4170	10294	51%	87%
	102	4139	10281	51%	87%
	120.8	3698	11395	45%	97%
	121.8	3705	11514	45%	98%
	124.4	3618	11545	44%	98%
	150	3294	10770	40%	91%
	161.9	3248	10819	40%	92%
	166	3214	10899	39%	92%
	200	2955	10295	36%	87%
	250	2319	11784	28%	100%
	300	1556	9355	19%	79%
	375	529	6702	6%	57%

Table A.2-43. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 3 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	983	6472	23%	57%
	18.1	2227	6410	52%	56%
	22.2	2888	6328	68%	55%
	24.7	3289	6267	77%	55%
	30	3691	6263	86%	55%
	35	3999	6528	93%	57%
	40	4200	7547	98%	66%
	45	4279	8323	100%	73%
	50	4223	8913	99%	78%
	55	4090	9021	96%	79%
	62.6	3937	9217	92%	81%
	65.4	3875	9380	91%	82%
	67	3820	9299	89%	81%
	67.3	3808	9262	89%	81%
	75	3534	9206	83%	81%
	80	3371	9278	79%	81%
	86.2	3188	9375	75%	82%
	90	3122	9351	73%	82%
	101.7	2982	10285	69.7%	90%
	102	2975	10271	70%	90%
	120.8	2771	11414	65%	100%
	121.8	2737	11334	64%	99%
	124.4	2721	11349	64%	99%
	150	2429	11020	57%	97%
	161.9	2284	11270	53%	99%
	166	2237	11157	52%	98%
	200	1913	10925	45%	96%
	250	1477	8180	35%	72%
	300	1005	6189	23%	54%
	375	354	5320	8%	47%

Table A.2-44. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 3 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	4375	NA	63%	
	18.1	6358	NA	92%	
	22.2	6775	NA	98%	
	24.7	6895	NA	100%	
	30	6831	NA	99%	
	35	6544	NA	95%	
	40	6020	NA	87%	
	45	5583	NA	81%	
	50	5165	NA	75%	
	55	4806	NA	70%	
	62.6	4215	NA	61%	
	65.4	3991	NA	58%	
	67	3880	NA	56%	
	67.3	3864	NA	56%	
	75	3317	NA	48%	
	80	3018	NA	44%	
	86.2	2723	NA	39%	
	90	2550	NA	37%	
	101.7	2116	NA	31%	
	102	2109	NA	31%	
	120.8	1746	NA	25%	
	121.8	1739	NA	25%	
	124.4	1697	NA	25%	
	150	1384	NA	20%	
	161.9	1265	NA	18%	
	166	1225	NA	18%	
	200	901	NA	13%	
	250	548	NA	8%	
	300	335	NA	5%	
	375	171	NA	2%	

Table A.2-45. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 3 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	5713	8323	67%	47%
	18.1	7620	9567	89%	54%
	22.2	8009	10004	94%	56%
	24.7	8178	10178	96%	57%
	30	8372	10531	98%	59%
	35	8471	11053	99%	62%
	40	8533	12411	100%	69%
	45	8435	13473	99%	75%
	50	8279	14238	97%	80%
	55	8060	14474	94%	81%
	62.6	7721	14780	90%	83%
	65.4	7608	15029	89%	84%
	67	7516	14941	88%	84%
	67.3	7502	14899	88%	83%
	75	7140	14841	84%	83%
	80	6894	14890	81%	83%
	86.2	6573	14900	77%	83%
	90	6402	14846	75%	83%
	101.7	5893	15752	69%	88%
	102	5878	15724	69%	88%
	120.8	5250	17104	62%	96%
	121.8	5214	16994	61%	95%
	124.4	5145	17063	60%	96%
	150	4462	16841	52%	94%
	161.9	4221	17351	49%	97%
	166	4145	17304	49%	97%
	200	3546	17861	42%	100%
	250	2753	15836	32%	89%
	300	1981	14611	23%	82%
	375	1027	14038	12%	79%

Table A.2-46. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 5 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	1501	6972	23%	82%
	18.1	3269	7362	51%	86%
	22.2	4084	7894	64%	92%
	24.7	4598	8186	72%	96%
	30	5640	8536	88%	100%
	35	6177	8492	96%	99%
	40	6375	8377	99%	98%
	45	6413	8297	100%	97%
	50	6354	8077	99%	95%
	55	5748	7977	90%	93%
	62.6	4852	7667	76%	90%
	65.4	4588	7531	72%	88%
	67	4448	7467	69%	87%
	67.3	4401	7416	69%	87%
	75	3697	6895	58%	81%
	80	3449	6679	54%	78%
	86.2	3150	6464	49%	76%
	90	2953	6399	46%	75%
	101.7	2352	6034	36.7%	71%
	102	2331	6010	36%	70%
	120.8	1798	5232	28%	61%
	121.8	1743	5176	27%	61%
	124.4	1668	5093	26%	60%
	150	927	4185	14%	49%
	161.9	711	4539	11%	53%
	166	652	4487	10%	53%
	200	206	4067	3%	48%
	250	0	3121	0%	37%
	300	0	1990	0%	23%
	375	0	794	0%	9%

Table A.2-47. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 5 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	2078	NA	100%	
	18.1	1885	NA	91%	
	22.2	1766	NA	85%	
	24.7	1730	NA	83%	
	30	1624	NA	78%	
	35	1501	NA	72%	
	40	1338	NA	64%	
	45	1164	NA	56%	
	50	1004	NA	48%	
	55	857	NA	41%	
	62.6	674	NA	32%	
	65.4	613	NA	30%	
	67	577	NA	28%	
	67.3	574	NA	28%	
	75	442	NA	21%	
	80	377	NA	18%	
	86.2	313	NA	15%	
	90	277	NA	13%	
	101.7	206	NA	10%	
	102	205	NA	10%	
	120.8	134	NA	6%	
	121.8	132	NA	6%	
	124.4	123	NA	6%	
	150	67	NA	3%	
	161.9	52	NA	2%	
	166	47	NA	2%	
	200	21	NA	1%	
	250	5	NA	0%	
	300	1	NA	0%	
	375	0	NA	0%	

Table A.2-48. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 5 of Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	3976	8572	82%	64%
	18.1	4760	9861	98%	74%
	22.2	4853	10933	100%	82%
	24.7	4865	11525	100%	86%
	30	4757	12457	98%	93%
	35	4562	12875	94%	97%
	40	4302	13127	88%	98%
	45	4023	13330	83%	100%
	50	3744	13263	77%	100%
	55	3471	13236	71%	99%
	62.6	3053	12986	63%	97%
	65.4	2909	12855	60%	96%
	67	2831	12803	58%	96%
	67.3	2815	12751	58%	96%
	75	2455	12210	50%	92%
	80	2250	11944	46%	90%
	86.2	2000	11571	41%	87%
	90	1860	11363	38%	85%
	101.7	1474	10643	30%	80%
	102	1462	10615	30%	80%
	120.8	1119	10116	23%	76%
	121.8	1098	10034	23%	75%
	124.4	1056	9994	22%	75%
	150	697	9281	14%	70%
	161.9	574	9635	12%	72%
	166	539	9556	11%	72%
	200	316	8611	7%	65%
	250	143	6620	3%	50%
	300	41	4204	1%	32%
	375	4	2460	0%	18%

Table A.2-49. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 1 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	3051	2984	57%	64%
	18.1	5344	3247	100%	70%
	22.2	4751	3069	89%	66%
	24.7	4780	2911	89%	62%
	30	4770	2807	89%	60%
	35	4291	2645	80%	57%
	40	3790	2507	71%	54%
	45	3514	2451	66%	53%
	50	3276	2424	61%	52%
	55	3082	2368	58%	51%
	62.6	2840	2630	53%	56%
	65.4	2709	2570	51%	55%
	67	2636	2533	49%	54%
	67.3	2628	2520	49%	54%
	75	2476	2679	46%	57%
	80	2360	2698	44%	58%
	86.2	2225	3167	42%	68%
	90	2158	3175	40%	68%
	101.7	2057	3087	38.5%	66%
	102	2056	3077	38%	66%
	120.8	1766	2147	33%	46%
	121.8	1763	2119	33%	45%
	124.4	1764	2178	33%	47%
	150	1612	3575	30%	77%
	161.9	1535	3671	29%	79%
	166	1510	3666	28%	79%
	200	1232	3057	23%	66%
	250	831	4663	16%	100%
	300	474	3155	9%	68%
	375	0	1065	0%	23%

Table A.2-50. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 1 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	3056	NA	81%	
	18.1	3760	NA	100%	
	22.2	3774	NA	100%	
	24.7	3747	NA	99%	
	30	3737	NA	99%	
	35	3618	NA	96%	
	40	3457	NA	92%	
	45	3310	NA	88%	
	50	3165	NA	84%	
	55	2984	NA	79%	
	62.6	2726	NA	72%	
	65.4	2630	NA	70%	
	67	2576	NA	68%	
	67.3	2570	NA	68%	
	75	2359	NA	62%	
	80	2229	NA	59%	
	86.2	2086	NA	55%	
	90	1998	NA	53%	
	101.7	1790	NA	47%	
	102	1789	NA	47%	
	120.8	1431	NA	38%	
	121.8	1418	NA	38%	
	124.4	1373	NA	36%	
	150	892	NA	24%	
	161.9	761	NA	20%	
	166	723	NA	19%	
	200	407	NA	11%	
	250	179	NA	5%	
	300	74	NA	2%	
	375	0	NA	0%	

Table A.2-51. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 1 of Reach 9 expressed as area (ft²/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	3398	4954	90%	45%
	18.1	3764	5998	100%	55%
	22.2	3629	5867	96%	54%
	24.7	3536	5663	94%	52%
	30	3416	5341	91%	49%
	35	3252	4886	86%	45%
	40	3082	4405	82%	40%
	45	2985	4344	79%	40%
	50	2901	4351	77%	40%
	55	2800	4276	74%	39%
	62.6	2704	4502	72%	41%
	65.4	2641	4366	70%	40%
	67	2602	4277	69%	39%
	67.3	2591	4248	69%	39%
	75	2466	4416	66%	40%
	80	2388	4441	63%	41%
	86.2	2286	5046	61%	46%
	90	2236	5109	59%	47%
	101.7	2056	5139	55%	47%
	102	2051	5125	54%	47%
	120.8	1426	3876	38%	35%
	121.8	1404	3834	37%	35%
	124.4	1381	3945	37%	36%
	150	1282	6594	34%	60%
	161.9	1141	7242	30%	66%
	166	1095	7429	29%	68%
	200	851	8231	23%	75%
	250	515	10936	14%	100%
	300	263	8405	7%	77%
	375	0	3674	0%	34%

Table A.2-52. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 2 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	0	250	0%	4%
	18.1	0	245	0%	4%
	22.2	0	300	0%	5%
	24.7	0	360	0%	6%
	30	0	281	0%	5%
	35	0	331	0%	5%
	40	3	438	0%	7%
	45	15	942	1%	15%
	50	1	1238	0%	20%
	55	0	1598	0%	26%
	62.6	6	2145	0%	35%
	65.4	14	2587	1%	42%
	67	20	2758	1%	45%
	67.3	20	2750	1%	45%
	75	90	3001	5%	49%
	80	196	2975	10%	49%
	86.2	340	2983	18%	49%
	90	484	2981	25%	49%
	101.7	815	3277	42.5%	53%
	102	816	3270	43%	53%
	120.8	1385	3875	72%	63%
	121.8	1422	3969	74%	65%
	124.4	1503	4133	78%	67%
	150	1875	4780	98%	78%
	161.9	1919	5443	100%	89%
	166	1916	5852	100%	95%
	200	1392	6133	73%	100%
	250	889	4203	46%	69%
	300	573	2467	30%	40%
	375	0	1172	0%	19%

Table A.2-53. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 2 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	0	NA	0%	
	18.1	0	NA	0%	
	22.2	0	NA	0%	
	24.7	0	NA	0%	
	30	0	NA	0%	
	35	49	NA	3%	
	40	54	NA	3%	
	45	51	NA	3%	
	50	154	NA	9%	
	55	286	NA	16%	
	62.6	515	NA	29%	
	65.4	617	NA	34%	
	67	666	NA	37%	
	67.3	666	NA	37%	
	75	810	NA	45%	
	80	891	NA	50%	
	86.2	991	NA	55%	
	90	1073	NA	60%	
	101.7	1263	NA	70%	
	102	1264	NA	70%	
	120.8	1516	NA	84%	
	121.8	1533	NA	85%	
	124.4	1568	NA	87%	
	150	1728	NA	96%	
	161.9	1779	NA	99%	
	166	1799	NA	100%	
	200	1652	NA	92%	
	250	1262	NA	70%	
	300	776	NA	43%	
	375	83	NA	5%	

Table A.2-54. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 2 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	0	759	0%	8%
	18.1	0	705	0%	8%
	22.2	0	730	0%	8%
	24.7	0	1011	0%	11%
	30	0	958	0%	10%
	35	44	1116	2%	12%
	40	42	1227	2%	13%
	45	43	1566	2%	17%
	50	232	1877	13%	20%
	55	443	2292	25%	25%
	62.6	764	2892	42%	31%
	65.4	901	3507	50%	38%
	67	957	3724	53%	40%
	67.3	957	3710	53%	40%
	75	1111	4128	62%	45%
	80	1189	4158	66%	45%
	86.2	1294	4236	72%	46%
	90	1383	4226	77%	46%
	101.7	1587	4768	88%	52%
	102	1589	4758	88%	52%
	120.8	1717	6080	95%	66%
	121.8	1729	6227	96%	68%
	124.4	1752	6499	97%	71%
	150	1801	7297	100%	79%
	161.9	1800	8217	100%	89%
	166	1800	8706	100%	95%
	200	1619	9209	90%	100%
	250	1202	7451	67%	81%
	300	686	4762	38%	52%
	375	23	2920	1%	32%

Table A.2-55. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 3 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	57	3186	8%	79%
	18.1	322	3896	43%	97%
	22.2	340	3980	45%	99%
	24.7	353	4034	47%	100%
	30	331	3948	44%	98%
	35	324	3677	43%	91%
	40	332	3634	44%	90%
	45	336	3475	45%	86%
	50	333	3377	44%	84%
	55	364	3560	48%	88%
	62.6	448	3578	59%	89%
	65.4	450	3525	60%	87%
	67	484	3600	64%	89%
	67.3	483	3590	64%	89%
	75	554	3609	74%	89%
	80	590	3565	78%	88%
	86.2	653	3503	87%	87%
	90	664	3442	88%	85%
	101.7	753	3572	100.0%	89%
	102	751	3564	100%	88%
	120.8	670	2924	89%	72%
	121.8	661	2891	88%	72%
	124.4	650	2893	86%	72%
	150	533	2781	71%	69%
	161.9	487	2670	65%	66%
	166	473	2617	63%	65%
	200	309	2441	41%	61%
	250	120	2401	16%	60%
	300	52	2166	7%	54%
	375	0	3073	0%	76%

Table A.2-56. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 3 of Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	382	NA	42%	
	18.1	559	NA	61%	
	22.2	611	NA	67%	
	24.7	653	NA	71%	
	30	668	NA	73%	
	35	653	NA	71%	
	40	668	NA	73%	
	45	675	NA	74%	
	50	685	NA	75%	
	55	715	NA	78%	
	62.6	742	NA	81%	
	65.4	734	NA	80%	
	67	755	NA	82%	
	67.3	755	NA	82%	
	75	778	NA	85%	
	80	802	NA	87%	
	86.2	845	NA	92%	
	90	854	NA	93%	
	101.7	916	NA	100%	
	102	918	NA	100%	
	120.8	906	NA	99%	
	121.8	899	NA	98%	
	124.4	901	NA	98%	
	150	824	NA	90%	
	161.9	769	NA	84%	
	166	744	NA	81%	
	200	511	NA	56%	
	250	229	NA	25%	
	300	83	NA	9%	
	375	10	NA	1%	

Table A.2-57. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 3 of Reach 9 expressed as area (ft²/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft²/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	475	5232	55%	76%
	18.1	560	6721	65%	97%
	22.2	637	6893	74%	100%
	24.7	704	6909	81%	100%
	30	712	6640	82%	96%
	35	685	6221	79%	90%
	40	688	6158	80%	89%
	45	694	5878	80%	85%
	50	711	5659	82%	82%
	55	752	5808	87%	84%
	62.6	802	5716	93%	83%
	65.4	806	5595	93%	81%
	67	827	5692	96%	82%
	67.3	827	5676	96%	82%
	75	841	5638	97%	82%
	80	841	5580	97%	81%
	86.2	854	5527	99%	80%
	90	846	5467	98%	79%
	101.7	865	5675	100%	82%
	102	863	5661	100%	82%
	120.8	791	4920	91%	71%
	121.8	784	4865	91%	70%
	124.4	780	4876	90%	71%
	150	697	4820	81%	70%
	161.9	662	4794	76%	69%
	166	650	4781	75%	69%
	200	520	4912	60%	71%
	250	322	5046	37%	73%
	300	163	4892	19%	71%
	375	9	5784	1%	84%

Table A.2-58. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 1 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	0	5653	0%	63%
	18.1	452	5506	9%	61%
	22.2	792	4864	16%	54%
	24.7	1084	4641	22%	51%
	30	1743	4324	35%	48%
	35	2332	4057	46%	45%
	40	2656	3867	53%	43%
	45	2973	3660	59%	41%
	50	3346	3587	66%	40%
	55	3618	3439	72%	38%
	62.6	4298	3301	85%	37%
	65.4	4257	3165	85%	35%
	67	4567	3385	91%	37%
	67.3	4538	3363	90%	37%
	75	4811	3584	96%	40%
	80	4799	3968	95%	44%
	86.2	4598	4059	91%	45%
	90	4690	4396	93%	49%
	101.7	4833	5054	96.0%	56%
	102	4805	5035	95%	56%
	120.8	5032	5787	100%	64%
	121.8	4974	5736	99%	64%
	124.4	4937	5713	98%	63%
	150	4408	6522	88%	72%
	161.9	3886	6446	77%	71%
	166	3792	6631	75%	73%
	200	2977	6753	59%	75%
	250	2813	9032	56%	100%
	300	1978	8890	39%	98%
	375	525	6440	10%	71%

Table A.2-59. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 1 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	292	NA	17%	
	18.1	461	NA	27%	
	22.2	642	NA	37%	
	24.7	793	NA	46%	
	30	977	NA	56%	
	35	1115	NA	64%	
	40	1224	NA	71%	
	45	1312	NA	76%	
	50	1391	NA	80%	
	55	1426	NA	82%	
	62.6	1516	NA	88%	
	65.4	1502	NA	87%	
	67	1548	NA	89%	
	67.3	1539	NA	89%	
	75	1563	NA	90%	
	80	1570	NA	91%	
	86.2	1550	NA	90%	
	90	1581	NA	91%	
	101.7	1654	NA	96%	
	102	1646	NA	95%	
	120.8	1731	NA	100%	
	121.8	1715	NA	99%	
	124.4	1715	NA	99%	
	150	1585	NA	92%	
	161.9	1442	NA	83%	
	166	1408	NA	81%	
	200	1134	NA	66%	
	250	737	NA	43%	
	300	461	NA	27%	
	375	234	NA	14%	

Table A.2-60. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 1 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	394	8559	26%	49%
	18.1	556	9685	37%	55%
	22.2	820	9340	54%	53%
	24.7	1034	9238	68%	53%
	30	1231	8971	81%	51%
	35	1334	8612	88%	49%
	40	1390	8355	92%	48%
	45	1426	8113	94%	46%
	50	1458	8076	96%	46%
	55	1457	7877	96%	45%
	62.6	1508	7691	99%	44%
	65.4	1479	7423	97%	42%
	67	1518	7724	100%	44%
	67.3	1508	7670	99%	44%
	75	1499	7720	99%	44%
	80	1482	8126	98%	46%
	86.2	1422	8068	94%	46%
	90	1426	8479	94%	48%
	101.7	1430	9343	94%	53%
	102	1422	9304	94%	53%
	120.8	1445	10438	95%	59%
	121.8	1426	10345	94%	59%
	124.4	1414	10358	93%	59%
	150	1260	11402	83%	65%
	161.9	1134	10980	75%	62%
	166	1113	11189	73%	64%
	200	972	11805	64%	67%
	250	921	16244	61%	92%
	300	778	17581	51%	100%
	375	575	15969	38%	91%

Table A.2-61. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 2 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	1702	4994	43%	28%
	18.1	3459	7303	88%	42%
	22.2	3920	7782	99%	44%
	24.7	3947	7916	100%	45%
	30	3698	8483	94%	48%
	35	3437	9073	87%	52%
	40	3113	9017	79%	51%
	45	2996	9287	76%	53%
	50	2860	9245	72%	53%
	55	2746	9230	70%	53%
	62.6	2614	9274	66%	53%
	65.4	2574	9273	65%	53%
	67	2533	9182	64%	52%
	67.3	2555	9273	65%	53%
	75	2429	9236	62%	53%
	80	2334	9245	59%	53%
	86.2	2235	9161	57%	52%
	90	2216	9167	56%	52%
	101.7	2085	9295	52.8%	53%
	102	2074	9266	53%	53%
	120.8	1861	9358	47%	53%
	121.8	1827	9270	46%	53%
	124.4	1814	9263	46%	53%
	150	1895	11068	48%	63%
	161.9	1823	12498	46%	71%
	166	1777	12464	45%	71%
	200	1598	14140	40%	81%
	250	1302	17536	33%	100%
	300	1072	14017	27%	80%
	375	597	10549	15%	60%

Table A.2-62. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 2 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1681	NA	73%	
	18.1	2137	NA	93%	
	22.2	2264	NA	99%	
	24.7	2277	NA	99%	
	30	2297	NA	100%	
	35	2262	NA	99%	
	40	2140	NA	93%	
	45	2027	NA	88%	
	50	1877	NA	82%	
	55	1708	NA	74%	
	62.6	1462	NA	64%	
	65.4	1374	NA	60%	
	67	1331	NA	58%	
	67.3	1320	NA	57%	
	75	1105	NA	48%	
	80	975	NA	42%	
	86.2	833	NA	36%	
	90	756	NA	33%	
	101.7	565	NA	25%	
	102	563	NA	25%	
	120.8	368	NA	16%	
	121.8	363	NA	16%	
	124.4	348	NA	15%	
	150	248	NA	11%	
	161.9	221	NA	10%	
	166	212	NA	9%	
	200	144	NA	6%	
	250	75	NA	3%	
	300	43	NA	2%	
	375	18	NA	1%	

Table A.2-63. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 2 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1851	6922	88%	21%
	18.1	2057	10646	98%	33%
	22.2	2105	11739	100%	36%
	24.7	2077	12181	99%	37%
	30	2039	13250	97%	41%
	35	1992	14247	95%	44%
	40	1885	14421	90%	44%
	45	1838	14971	87%	46%
	50	1769	15124	84%	46%
	55	1680	15243	80%	47%
	62.6	1582	15545	75%	48%
	65.4	1553	15624	74%	48%
	67	1522	15532	72%	48%
	67.3	1541	15691	73%	48%
	75	1452	15771	69%	48%
	80	1385	15965	66%	49%
	86.2	1319	16043	63%	49%
	90	1301	16213	62%	50%
	101.7	1202	16730	57%	51%
	102	1198	16695	57%	51%
	120.8	1049	17422	50%	53%
	121.8	1035	17338	49%	53%
	124.4	1024	17477	49%	53%
	150	944	21049	45%	64%
	161.9	887	23277	42%	71%
	166	867	23420	41%	72%
	200	756	27249	36%	83%
	250	603	32676	29%	100%
	300	462	28144	22%	86%
	375	376	22474	18%	69%

Table A.2-64. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 3 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	572	2058	36%	18%
	18.1	1022	3866	64%	34%
	22.2	1171	4998	73%	44%
	24.7	1298	5742	81%	51%
	30	1481	6665	92%	59%
	35	1600	7281	99%	65%
	40	1608	7831	100%	70%
	45	1567	7857	97%	70%
	50	1534	7970	95%	71%
	55	1499	8026	93%	71%
	62.6	1395	8002	87%	71%
	65.4	1352	7938	84%	71%
	67	1368	7996	85%	71%
	67.3	1352	7968	84%	71%
	75	1274	8014	79%	71%
	80	1237	8152	77%	72%
	86.2	1171	8299	73%	74%
	90	1140	8456	71%	75%
	101.7	1029	8815	64.0%	78%
	102	1015	8806	63%	78%
	120.8	799	9782	50%	87%
	121.8	805	10093	50%	90%
	124.4	768	10073	48%	90%
	150	894	11230	56%	100%
	161.9	847	11248	53%	100%
	166	790	10981	49%	98%
	200	734	10847	46%	96%
	250	562	8484	35%	75%
	300	377	6899	23%	61%
	375	30	4070	2%	36%

Table A.2-65. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 3 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	821	NA	47%	
	18.1	956	NA	55%	
	22.2	1037	NA	60%	
	24.7	1110	NA	64%	
	30	1244	NA	72%	
	35	1352	NA	78%	
	40	1423	NA	82%	
	45	1490	NA	86%	
	50	1564	NA	90%	
	55	1630	NA	94%	
	62.6	1674	NA	97%	
	65.4	1680	NA	97%	
	67	1708	NA	99%	
	67.3	1700	NA	98%	
	75	1720	NA	99%	
	80	1731	NA	100%	
	86.2	1717	NA	99%	
	90	1718	NA	99%	
	101.7	1668	NA	96%	
	102	1665	NA	96%	
	120.8	1524	NA	88%	
	121.8	1521	NA	88%	
	124.4	1488	NA	86%	
	150	1182	NA	68%	
	161.9	1018	NA	59%	
	166	976	NA	56%	
	200	609	NA	35%	
	250	324	NA	19%	
	300	202	NA	12%	
	375	108	NA	6%	

Table A.2-66. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 3 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	893	3955	61%	19%
	18.1	1014	6544	69%	31%
	22.2	1061	8392	72%	40%
	24.7	1114	9758	76%	47%
	30	1214	11137	82%	54%
	35	1286	12147	87%	58%
	40	1324	12926	90%	62%
	45	1358	13019	92%	63%
	50	1394	13148	95%	63%
	55	1429	13239	97%	64%
	62.6	1442	13201	98%	63%
	65.4	1441	13129	98%	63%
	67	1463	13256	99%	64%
	67.3	1455	13206	99%	64%
	75	1469	13261	100%	64%
	80	1474	13423	100%	65%
	86.2	1453	13537	99%	65%
	90	1453	13717	99%	66%
	101.7	1437	14073	97%	68%
	102	1435	14037	97%	68%
	120.8	1365	15400	93%	74%
	121.8	1368	15795	93%	76%
	124.4	1346	15881	91%	76%
	150	1384	18805	94%	90%
	161.9	1342	19514	91%	94%
	166	1306	19328	89%	93%
	200	1173	20793	80%	100%
	250	851	18993	58%	91%
	300	608	15671	41%	75%
	375	411	9514	28%	46%

Table A.2-67. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 4 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	1313	10008	20%	76%
	18.1	3033	10704	46%	81%
	22.2	3790	11476	58%	87%
	24.7	4222	11252	65%	85%
	30	4922	10972	75%	83%
	35	5525	10836	85%	82%
	40	5957	10650	91%	81%
	45	6160	10500	94%	79%
	50	6345	10210	97%	77%
	55	6373	10236	97%	77%
	62.6	6425	10185	98%	77%
	65.4	6476	10118	99%	77%
	67	6537	9986	100%	76%
	67.3	6507	10390	100%	79%
	75	6418	10323	98%	78%
	80	6207	10795	95%	82%
	86.2	5959	11295	91%	85%
	90	5798	11049	89%	84%
	101.7	5580	10791	85.4%	82%
	102	5589	10742	85%	81%
	120.8	5512	11218	84%	85%
	121.8	5521	11455	84%	87%
	124.4	5539	11673	85%	88%
	150	5329	12415	82%	94%
	161.9	4980	12635	76%	96%
	166	4888	12546	75%	95%
	200	4129	13225	63%	100%
	250	3212	11448	49%	87%
	300	2484	8334	38%	63%
	375	1232	5539	19%	42%

Table A.2-68. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 4 of Reach 11 expressed as area (ft²/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft²/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	5034	NA	46%	
	18.1	7659	NA	69%	
	22.2	8748	NA	79%	
	24.7	9332	NA	84%	
	30	10245	NA	93%	
	35	10817	NA	98%	
	40	11051	NA	100%	
	45	11014	NA	100%	
	50	10832	NA	98%	
	55	10463	NA	95%	
	62.6	9785	NA	89%	
	65.4	9485	NA	86%	
	67	9392	NA	85%	
	67.3	9276	NA	84%	
	75	8521	NA	77%	
	80	7976	NA	72%	
	86.2	7352	NA	67%	
	90	7014	NA	63%	
	101.7	6072	NA	55%	
	102	6066	NA	55%	
	120.8	4724	NA	43%	
	121.8	4597	NA	42%	
	124.4	4439	NA	40%	
	150	3398	NA	31%	
	161.9	2978	NA	27%	
	166	2830	NA	26%	
	200	1842	NA	17%	
	250	1004	NA	9%	
	300	575	NA	5%	
	375	300	NA	3%	

Table A.2-69. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 4 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	7226	11595	51%	49%
	18.1	10029	13415	70%	57%
	22.2	11111	14893	78%	63%
	24.7	11625	15070	81%	64%
	30	12511	15549	88%	66%
	35	13139	16135	92%	69%
	40	13590	16596	95%	71%
	45	13930	17039	98%	72%
	50	14138	17271	99%	73%
	55	14260	17805	100%	76%
	62.6	14270	18483	100%	79%
	65.4	14228	18626	100%	79%
	67	14172	18617	99%	79%
	67.3	14195	19088	99%	81%
	75	13919	19470	98%	83%
	80	13703	20213	96%	86%
	86.2	13358	21028	94%	89%
	90	13104	20887	92%	89%
	101.7	12283	20856	86%	89%
	102	12252	20803	86%	88%
	120.8	10835	21255	76%	90%
	121.8	10801	21579	76%	92%
	124.4	10614	21843	74%	93%
	150	8904	22466	62%	95%
	161.9	8210	22483	58%	96%
	166	8001	22414	56%	95%
	200	6500	23536	46%	100%
	250	4811	21898	34%	93%
	300	3617	18382	25%	78%
	375	2479	15502	17%	66%

Table A.2-70. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 5 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	687	7471	9%	44%
	18.1	1668	7869	21%	47%
	22.2	2149	8641	27%	51%
	24.7	2431	9059	31%	54%
	30	2775	10686	35%	64%
	35	3047	11829	39%	70%
	40	3270	12474	42%	74%
	45	3275	13009	42%	77%
	50	3264	13626	42%	81%
	55	3331	13749	42%	82%
	62.6	3522	14166	45%	84%
	65.4	3650	13834	46%	82%
	67	3710	13705	47%	82%
	67.3	3709	13677	47%	81%
	75	3952	13842	50%	82%
	80	4161	14002	53%	83%
	86.2	4421	13965	56%	83%
	90	4594	13899	58%	83%
	101.7	5086	15161	64.8%	90%
	102	5098	15113	65%	90%
	120.8	6117	16810	78%	100%
	121.8	6164	16680	78%	99%
	124.4	6273	16516	80%	98%
	150	7053	14629	90%	87%
	161.9	7347	14148	94%	84%
	166	7364	13833	94%	82%
	200	7785	11767	99%	70%
	250	7854	10499	100%	62%
	300	7288	8394	93%	50%
	375	4667	5474	59%	33%

Table A.2-71. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 5 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	538	NA	9%	
	18.1	877	NA	15%	
	22.2	993	NA	17%	
	24.7	1111	NA	19%	
	30	1385	NA	24%	
	35	1539	NA	27%	
	40	1717	NA	30%	
	45	1913	NA	33%	
	50	2054	NA	35%	
	55	2289	NA	40%	
	62.6	2595	NA	45%	
	65.4	2710	NA	47%	
	67	2763	NA	48%	
	67.3	2765	NA	48%	
	75	3045	NA	53%	
	80	3230	NA	56%	
	86.2	3443	NA	59%	
	90	3570	NA	62%	
	101.7	4013	NA	69%	
	102	4025	NA	69%	
	120.8	4816	NA	83%	
	121.8	4845	NA	84%	
	124.4	4924	NA	85%	
	150	5469	NA	94%	
	161.9	5619	NA	97%	
	166	5662	NA	98%	
	200	5793	NA	100%	
	250	5313	NA	92%	
	300	4605	NA	79%	
	375	3305	NA	57%	

Table A.2-72. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 5 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	796	9185	10%	37%
	18.1	1288	10710	16%	43%
	22.2	1453	12009	18%	48%
	24.7	1634	12745	21%	51%
	30	2090	15080	26%	60%
	35	2399	16757	30%	67%
	40	2718	17760	34%	71%
	45	3070	18487	39%	74%
	50	3334	19255	42%	77%
	55	3776	19475	48%	77%
	62.6	4316	20053	54%	80%
	65.4	4473	19683	56%	78%
	67	4551	19548	57%	78%
	67.3	4551	19513	57%	78%
	75	4975	19697	63%	78%
	80	5227	19909	66%	79%
	86.2	5501	19883	69%	79%
	90	5652	19885	71%	79%
	101.7	6327	21818	80%	87%
	102	6333	21785	80%	87%
	120.8	7210	25137	91%	100%
	121.8	7229	25030	91%	100%
	124.4	7293	25015	92%	100%
	150	7746	24531	98%	98%
	161.9	7878	24637	99%	98%
	166	7889	24436	99%	97%
	200	7930	23441	100%	93%
	250	7514	23359	95%	93%
	300	6504	21522	82%	86%
	375	4498	16913	57%	67%

Table A.2-73. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 6 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	52	8620	5%	47%
	18.1	173	10006	17%	55%
	22.2	252	11047	25%	61%
	24.7	293	11497	30%	63%
	30	362	12438	36%	69%
	35	437	12152	44%	67%
	40	500	13795	50%	76%
	45	568	13732	57%	76%
	50	624	14762	63%	81%
	55	679	15164	68%	84%
	62.6	769	15799	77%	87%
	65.4	797	16356	80%	90%
	67	811	16560	82%	91%
	67.3	805	16348	81%	90%
	75	844	16962	85%	93%
	80	863	17235	87%	95%
	86.2	887	17504	89%	96%
	90	895	17866	90%	98%
	101.7	929	18155	93.6%	100%
	102	931	18124	94%	100%
	120.8	989	17753	100%	98%
	121.8	993	17654	100%	97%
	124.4	978	17483	98%	96%
	150	815	16083	82%	89%
	161.9	766	15723	77%	87%
	166	753	15469	76%	85%
	200	665	13276	67%	73%
	250	531	11696	53%	64%
	300	368	10372	37%	57%
	375	185	5764	19%	32%

Table A.2-74. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 6 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1279	NA	30%	
	18.1	1941	NA	45%	
	22.2	2310	NA	54%	
	24.7	2530	NA	59%	
	30	2924	NA	68%	
	35	3272	NA	76%	
	40	3562	NA	83%	
	45	3819	NA	89%	
	50	4025	NA	93%	
	55	4175	NA	97%	
	62.6	4304	NA	100%	
	65.4	4311	NA	100%	
	67	4315	NA	100%	
	67.3	4288	NA	99%	
	75	4237	NA	98%	
	80	4177	NA	97%	
	86.2	4096	NA	95%	
	90	3981	NA	92%	
	101.7	3678	NA	85%	
	102	3682	NA	85%	
	120.8	3258	NA	76%	
	121.8	3251	NA	75%	
	124.4	3199	NA	74%	
	150	2720	NA	63%	
	161.9	2526	NA	59%	
	166	2482	NA	58%	
	200	2112	NA	49%	
	250	1679	NA	39%	
	300	1264	NA	29%	
	375	721	NA	17%	

Table A.2-75. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 6 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1958	10428	40%	38%
	18.1	2771	12976	56%	48%
	22.2	3176	14617	64%	54%
	24.7	3400	15379	69%	56%
	30	3731	16979	75%	62%
	35	3985	17053	80%	63%
	40	4195	19271	85%	71%
	45	4360	19466	88%	71%
	50	4525	20954	91%	77%
	55	4646	21629	94%	79%
	62.6	4745	22662	96%	83%
	65.4	4768	23385	96%	86%
	67	4782	23662	97%	87%
	67.3	4802	23480	97%	86%
	75	4874	24389	98%	90%
	80	4896	24799	99%	91%
	86.2	4903	25139	99%	92%
	90	4928	25648	100%	94%
	101.7	4949	26329	100%	97%
	102	4951	26294	100%	97%
	120.8	4883	26494	99%	97%
	121.8	4863	26427	98%	97%
	124.4	4828	26426	98%	97%
	150	4480	26752	90%	98%
	161.9	4282	27247	86%	100%
	166	4197	27221	85%	100%
	200	3631	26748	73%	98%
	250	2835	26714	57%	98%
	300	2214	26031	45%	96%
	375	1471	19948	30%	73%

Table A.2-76. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 7 of Reach 11 expressed as area (ft²/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft²/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	51	21503	1%	76%
	18.1	257	24425	3%	86%
	22.2	346	24404	3%	86%
	24.7	375	24552	4%	86%
	30	396	25302	4%	89%
	35	361	25649	4%	90%
	40	438	25988	4%	92%
	45	515	26437	5%	93%
	50	619	26942	6%	95%
	55	748	26883	7%	95%
	62.6	909	26740	9%	94%
	65.4	985	26672	10%	94%
	67	1026	26641	10%	94%
	67.3	1048	26587	10%	94%
	75	1342	26474	13%	93%
	80	1572	26341	16%	93%
	86.2	1901	26193	19%	92%
	90	2171	26114	22%	92%
	101.7	3029	26181	30.2%	92%
	102	3047	26158	30%	92%
	120.8	3766	28395	38%	100%
	121.8	3808	28279	38%	100%
	124.4	3853	28001	38%	99%
	150	4407	26845	44%	95%
	161.9	4777	26012	48%	92%
	166	4894	25776	49%	91%
	200	5379	24386	54%	86%
	250	7011	19834	70%	70%
	300	8816	18717	88%	66%
	375	10020	20243	100%	71%

Table A.2-77. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 7 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1372	NA	31%	
	18.1	1250	NA	28%	
	22.2	1362	NA	30%	
	24.7	1376	NA	31%	
	30	1428	NA	32%	
	35	1502	NA	34%	
	40	1599	NA	36%	
	45	1703	NA	38%	
	50	1819	NA	41%	
	55	1944	NA	43%	
	62.6	2201	NA	49%	
	65.4	2301	NA	51%	
	67	2357	NA	53%	
	67.3	2366	NA	53%	
	75	2644	NA	59%	
	80	2848	NA	64%	
	86.2	3094	NA	69%	
	90	3218	NA	72%	
	101.7	3511	NA	78%	
	102	3517	NA	78%	
	120.8	3825	NA	85%	
	121.8	3830	NA	85%	
	124.4	3887	NA	87%	
	150	4002	NA	89%	
	161.9	3973	NA	89%	
	166	3964	NA	88%	
	200	3805	NA	85%	
	250	3778	NA	84%	
	300	3942	NA	88%	
	375	4483	NA	100%	

Table A.2-78. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 7 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	2862	26243	32%	56%
	18.1	3327	30135	38%	64%
	22.2	3714	30202	42%	64%
	24.7	3813	30286	43%	65%
	30	3970	30840	45%	66%
	35	4113	31240	46%	67%
	40	4265	31570	48%	67%
	45	4416	32001	50%	68%
	50	4582	32621	52%	70%
	55	4762	32690	54%	70%
	62.6	5093	32843	57%	70%
	65.4	5220	32859	59%	70%
	67	5283	32898	60%	70%
	67.3	5301	32867	60%	70%
	75	5594	33237	63%	71%
	80	5807	33331	65%	71%
	86.2	6061	33443	68%	71%
	90	6155	33616	69%	72%
	101.7	6349	34564	72%	74%
	102	6350	34555	72%	74%
	120.8	6564	39793	74%	85%
	121.8	6564	39744	74%	85%
	124.4	6704	39760	76%	85%
	150	7455	41138	84%	88%
	161.9	7672	41228	86%	88%
	166	7757	41370	87%	88%
	200	8245	43064	93%	92%
	250	8624	41050	97%	87%
	300	8761	41898	99%	89%
	375	8871	46929	100%	100%

Table A.2-79. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 8 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	1610	2563	14%	12%
	18.1	4559	2558	39%	12%
	22.2	5585	2758	48%	13%
	24.7	6156	3029	53%	14%
	30	6762	5100	58%	24%
	35	7474	7814	65%	37%
	40	7797	10687	67%	51%
	45	8144	12421	70%	59%
	50	8395	14375	73%	68%
	55	8577	15428	74%	73%
	62.6	8562	15190	74%	72%
	65.4	8631	15190	75%	72%
	67	8557	15290	74%	73%
	67.3	8669	15424	75%	73%
	75	8862	15399	77%	73%
	80	8982	16865	78%	80%
	86.2	9215	17517	80%	83%
	90	9663	18235	84%	87%
	101.7	10541	19129	91.2%	91%
	102	10665	19513	92%	93%
	120.8	11398	20753	99%	99%
	121.8	11483	20993	99%	100%
	124.4	11440	20482	99%	98%
	150	11559	18160	100%	87%
	161.9	11362	17303	98%	82%
	166	11310	17004	98%	81%
	200	11021	15110	95%	72%
	250	10397	12099	90%	58%
	300	9146	12989	79%	62%
	375	6727	8677	58%	41%

Table A.2-80. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 8 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	3366	NA	30%	
	18.1	4943	NA	44%	
	22.2	5397	NA	48%	
	24.7	5718	NA	51%	
	30	6012	NA	53%	
	35	6495	NA	58%	
	40	6586	NA	58%	
	45	7076	NA	63%	
	50	7615	NA	68%	
	55	8137	NA	72%	
	62.6	8996	NA	80%	
	65.4	9315	NA	83%	
	67	9359	NA	83%	
	67.3	9476	NA	84%	
	75	9950	NA	88%	
	80	10173	NA	90%	
	86.2	10422	NA	93%	
	90	10718	NA	95%	
	101.7	11110	NA	99%	
	102	11146	NA	99%	
	120.8	11257	NA	100%	
	121.8	11261	NA	100%	
	124.4	11261	NA	100%	
	150	11248	NA	100%	
	161.9	11169	NA	99%	
	166	11116	NA	99%	
	200	10605	NA	94%	
	250	9571	NA	85%	
	300	8296	NA	74%	
	375	6431	NA	57%	

Table A.2-81. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 8 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	3940	4846	28%	14%
	18.1	5169	5643	37%	17%
	22.2	5439	6033	39%	18%
	24.7	5669	6430	40%	19%
	30	5731	8919	41%	26%
	35	6095	12222	44%	36%
	40	5957	15638	43%	46%
	45	6606	17869	47%	53%
	50	7344	20535	52%	61%
	55	8031	22319	57%	66%
	62.6	9338	22609	67%	67%
	65.4	9750	22855	70%	68%
	67	9784	23046	70%	68%
	67.3	9956	23292	71%	69%
	75	10614	23806	76%	70%
	80	10957	25941	78%	77%
	86.2	11391	27124	81%	80%
	90	12066	28397	86%	84%
	101.7	13289	30407	95%	90%
	102	13445	30899	96%	91%
	120.8	13925	33506	99%	99%
	121.8	14003	33852	100%	100%
	124.4	13826	33409	99%	99%
	150	13112	32452	94%	96%
	161.9	12748	32376	91%	96%
	166	12604	32368	90%	96%
	200	11624	32725	83%	97%
	250	10162	31291	73%	92%
	300	8792	32801	63%	97%
	375	6920	25613	49%	76%

Table A.2-82. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 9 of Reach 11 expressed as area (ft²/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft²/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	1432	7331	15%	35%
	18.1	2722	12735	28%	61%
	22.2	3089	14573	32%	70%
	24.7	3203	16436	33%	79%
	30	3315	18836	34%	90%
	35	3327	18686	34%	89%
	40	3351	19323	35%	92%
	45	3551	20063	37%	96%
	50	3721	20698	38%	99%
	55	3974	20588	41%	98%
	62.6	4398	20438	45%	98%
	65.4	4557	20341	47%	97%
	67	4622	20265	48%	97%
	67.3	4627	20221	48%	97%
	75	5056	19948	52%	95%
	80	5352	19718	55%	94%
	86.2	5807	19757	60%	94%
	90	6161	19800	64%	95%
	101.7	7410	20470	76.5%	98%
	102	7430	20418	77%	98%
	120.8	9044	20916	93%	100%
	121.8	9061	20752	94%	99%
	124.4	9249	20838	96%	100%
	150	9680	19733	100%	94%
	161.9	9555	19460	99%	93%
	166	9458	19085	98%	91%
	200	8742	17601	90%	84%
	250	7824	14827	81%	71%
	300	7399	12639	76%	60%
	375	5743	8877	59%	42%

Table A.2-83. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 9 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	681	NA	9%	
	18.1	1122	NA	15%	
	22.2	1412	NA	19%	
	24.7	1594	NA	22%	
	30	2086	NA	29%	
	35	2541	NA	35%	
	40	2964	NA	41%	
	45	3299	NA	45%	
	50	3672	NA	50%	
	55	3985	NA	54%	
	62.6	4437	NA	61%	
	65.4	4596	NA	63%	
	67	4680	NA	64%	
	67.3	4683	NA	64%	
	75	5089	NA	70%	
	80	5311	NA	73%	
	86.2	5583	NA	76%	
	90	5750	NA	79%	
	101.7	6230	NA	85%	
	102	6237	NA	85%	
	120.8	6813	NA	93%	
	121.8	6824	NA	93%	
	124.4	6892	NA	94%	
	150	7215	NA	99%	
	161.9	7300	NA	100%	
	166	7313	NA	100%	
	200	7247	NA	99%	
	250	6935	NA	95%	
	300	6178	NA	84%	
	375	4972	NA	68%	

Table A.2-84. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 9 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1023	9267	12%	26%
	18.1	1482	16527	18%	46%
	22.2	1869	19071	23%	53%
	24.7	2104	21472	26%	60%
	30	2785	24705	34%	69%
	35	3400	25061	42%	70%
	40	3957	26270	48%	73%
	45	4317	27619	53%	77%
	50	4747	28758	58%	80%
	55	5099	29033	62%	81%
	62.6	5584	29422	68%	82%
	65.4	5759	29527	70%	82%
	67	5845	29536	71%	82%
	67.3	5842	29500	71%	82%
	75	6237	29608	76%	82%
	80	6447	29609	79%	82%
	86.2	6712	30009	82%	83%
	90	6892	30283	84%	84%
	101.7	7396	31757	90%	88%
	102	7397	31713	90%	88%
	120.8	7971	33525	97%	93%
	121.8	7968	33405	97%	93%
	124.4	8040	33750	98%	94%
	150	8174	34708	100%	96%
	161.9	8185	35387	100%	98%
	166	8153	35238	100%	98%
	200	7921	35955	97%	100%
	250	8033	36010	98%	100%
	300	8048	35480	98%	99%
	375	7476	31409	91%	87%

Table A.2-85. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Transect 10 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	945	10705	5%	58%
	18.1	2881	10977	16%	59%
	22.2	3900	10844	21%	59%
	24.7	4529	10530	25%	57%
	30	5823	10448	32%	57%
	35	6734	10358	37%	56%
	40	7492	10087	41%	55%
	45	7914	9990	43%	54%
	50	8351	10295	46%	56%
	55	8770	10717	48%	58%
	62.6	9265	11797	51%	64%
	65.4	9330	12237	51%	66%
	67	9308	12387	51%	67%
	67.3	9299	12356	51%	67%
	75	9312	13052	51%	71%
	80	9211	13389	50%	72%
	86.2	9123	13745	50%	74%
	90	9090	14232	50%	77%
	101.7	8873	15046	48.5%	81%
	102	8864	15014	48%	81%
	120.8	8979	15379	49%	83%
	121.8	9036	15480	49%	84%
	124.4	9050	15375	49%	83%
	150	10018	15556	55%	84%
	161.9	11120	16758	61%	91%
	166	11612	17144	63%	93%
	200	15374	18482	84%	100%
	250	17552	15659	96%	85%
	300	18293	11550	100%	62%
	375	18029	6717	99%	36%

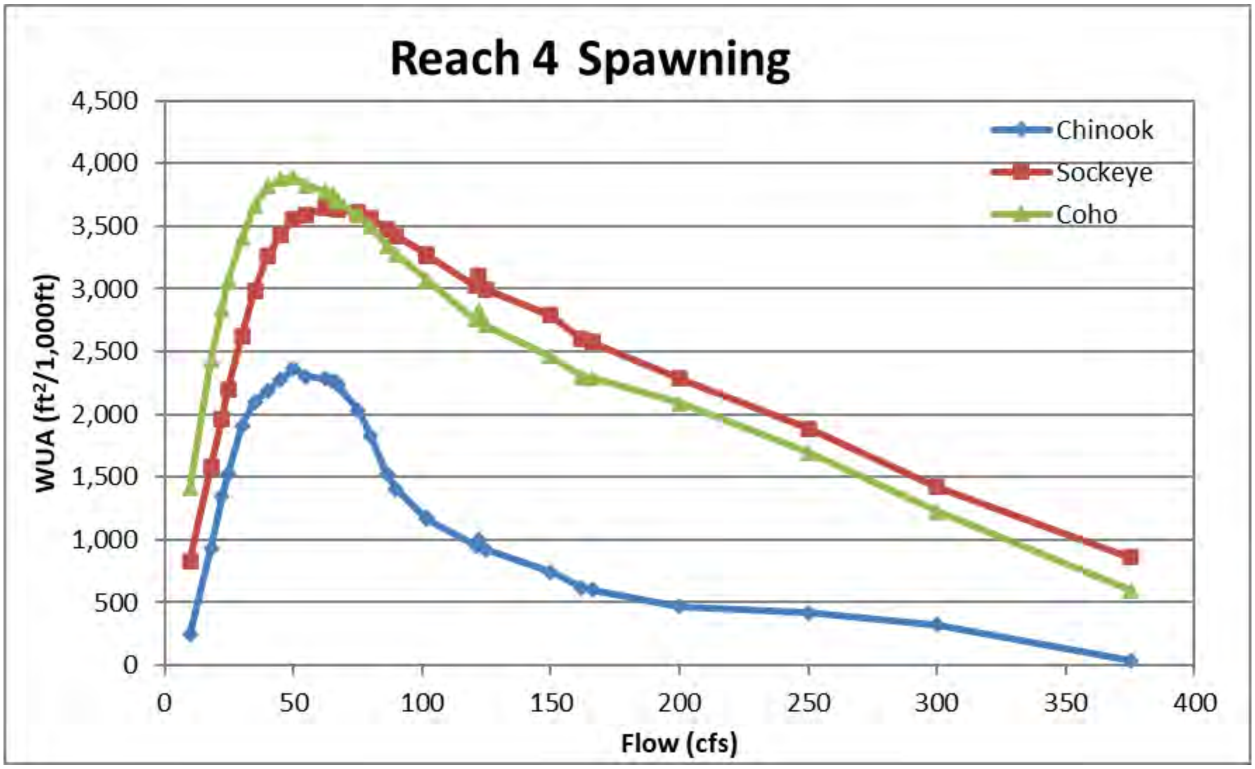
Table A.2-86. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Transect 10 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	749	NA	4%	
	18.1	1277	NA	6%	
	22.2	1549	NA	7%	
	24.7	1703	NA	8%	
	30	2054	NA	10%	
	35	2381	NA	11%	
	40	2738	NA	13%	
	45	3062	NA	15%	
	50	3333	NA	16%	
	55	3623	NA	17%	
	62.6	4112	NA	19%	
	65.4	4267	NA	20%	
	67	4342	NA	21%	
	67.3	4356	NA	21%	
	75	4858	NA	23%	
	80	5156	NA	24%	
	86.2	5583	NA	26%	
	90	5885	NA	28%	
	101.7	6862	NA	33%	
	102	6868	NA	33%	
	120.8	8648	NA	41%	
	121.8	8764	NA	42%	
	124.4	8933	NA	42%	
	150	11319	NA	54%	
	161.9	12846	NA	61%	
	166	13371	NA	63%	
	200	17450	NA	83%	
	250	20439	NA	97%	
	300	21098	NA	100%	
	375	19199	NA	91%	

Table A.2-87. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Transect 10 of Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1201	12750	6%	39%
	18.1	1924	14227	9%	43%
	22.2	2235	14661	10%	44%
	24.7	2402	14687	11%	44%
	30	2740	15202	13%	46%
	35	3037	15629	14%	47%
	40	3339	15818	15%	48%
	45	3584	16065	16%	49%
	50	3776	16741	17%	51%
	55	4040	17445	19%	53%
	62.6	4568	18842	21%	57%
	65.4	4732	19414	22%	59%
	67	4815	19611	22%	59%
	67.3	4819	19566	22%	59%
	75	5558	20524	26%	62%
	80	5963	20986	27%	64%
	86.2	6625	21615	30%	65%
	90	7121	22308	33%	68%
	101.7	8756	23634	40%	72%
	102	8758	23587	40%	71%
	120.8	11441	24561	53%	74%
	121.8	11609	24735	53%	75%
	124.4	11795	24677	54%	75%
	150	14687	26083	67%	79%
	161.9	16362	28358	75%	86%
	166	16917	29085	78%	88%
	200	20513	33009	94%	100%
	250	21771	32470	100%	98%
	300	21521	29314	99%	89%
	375	19788	22857	91%	69%

Appendix 3: Reach Based and River Based Habitat vs. Flow Relationships



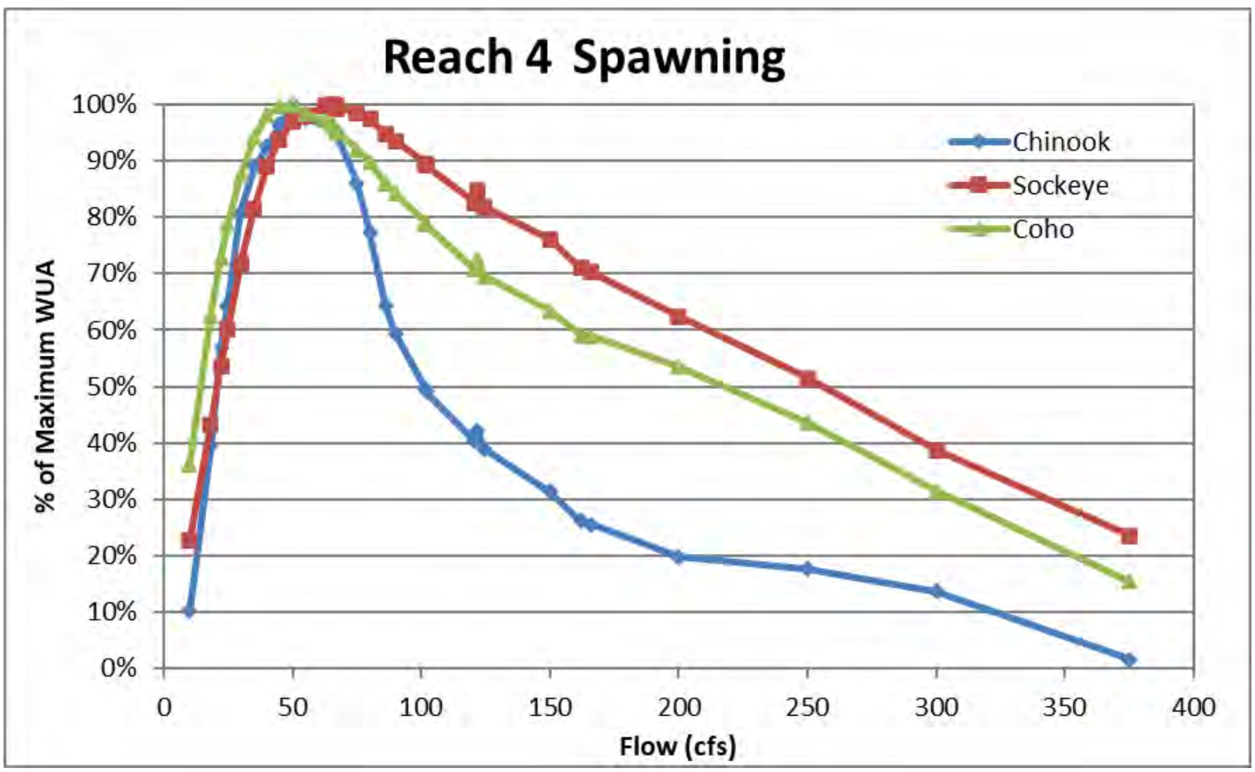
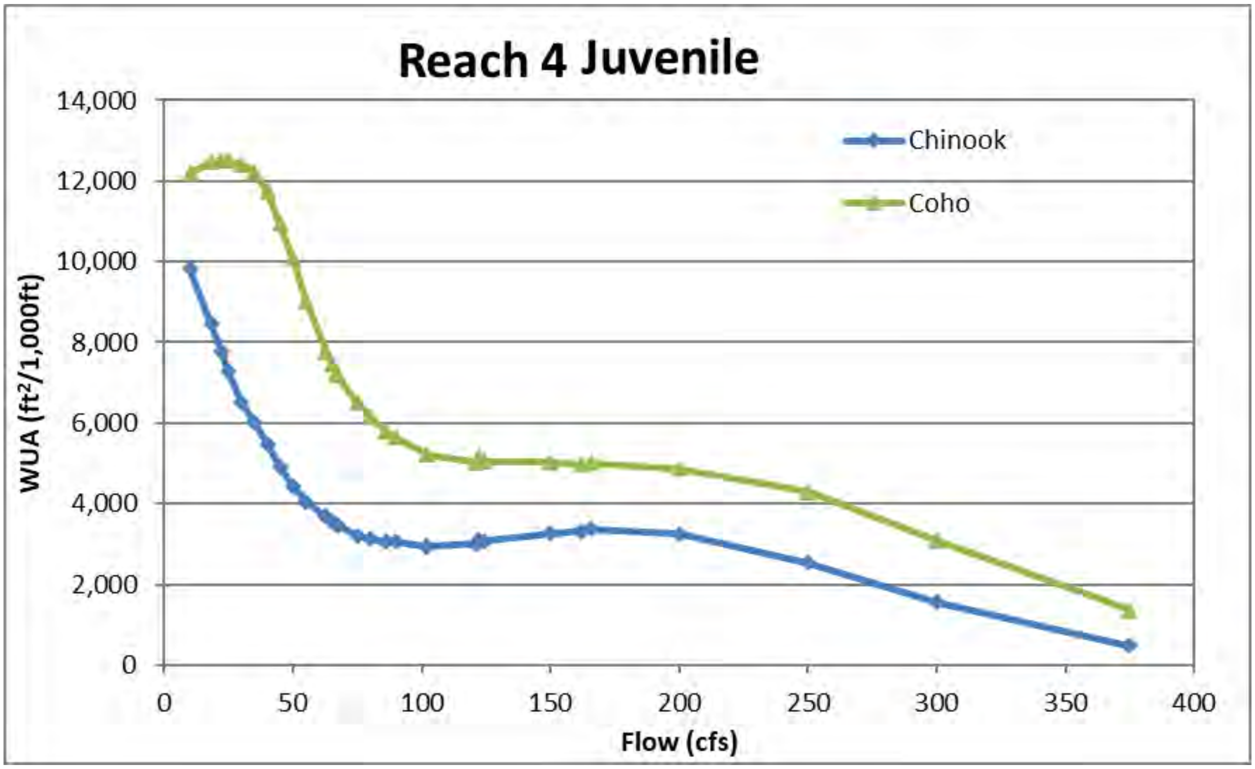


Figure A.3-1. Reach 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



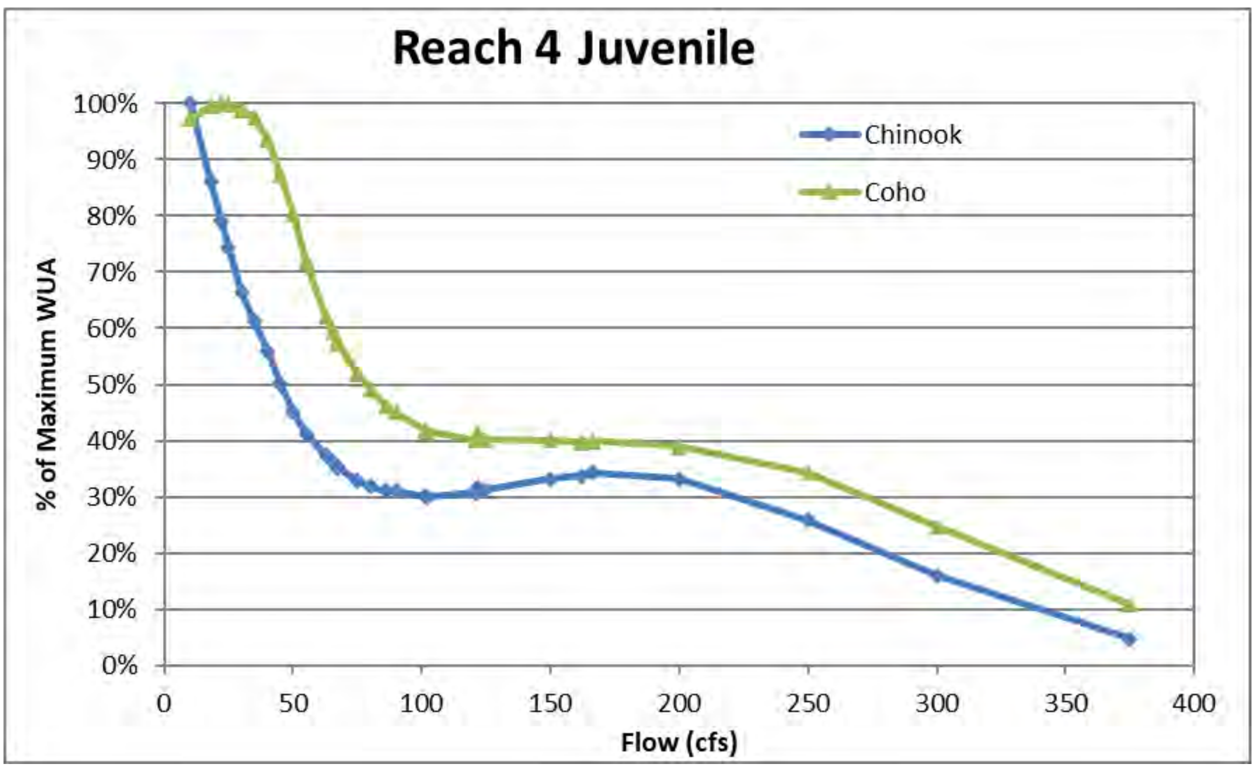
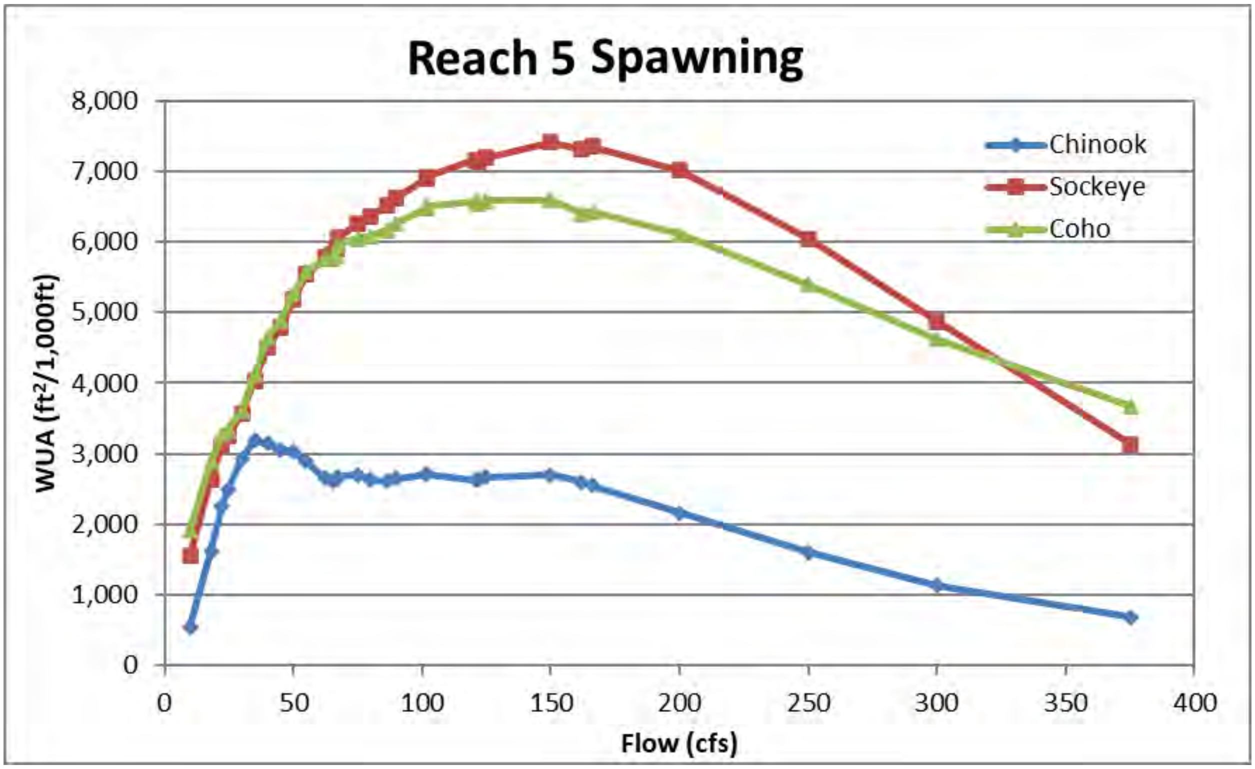


Figure A.3-2. Reach 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



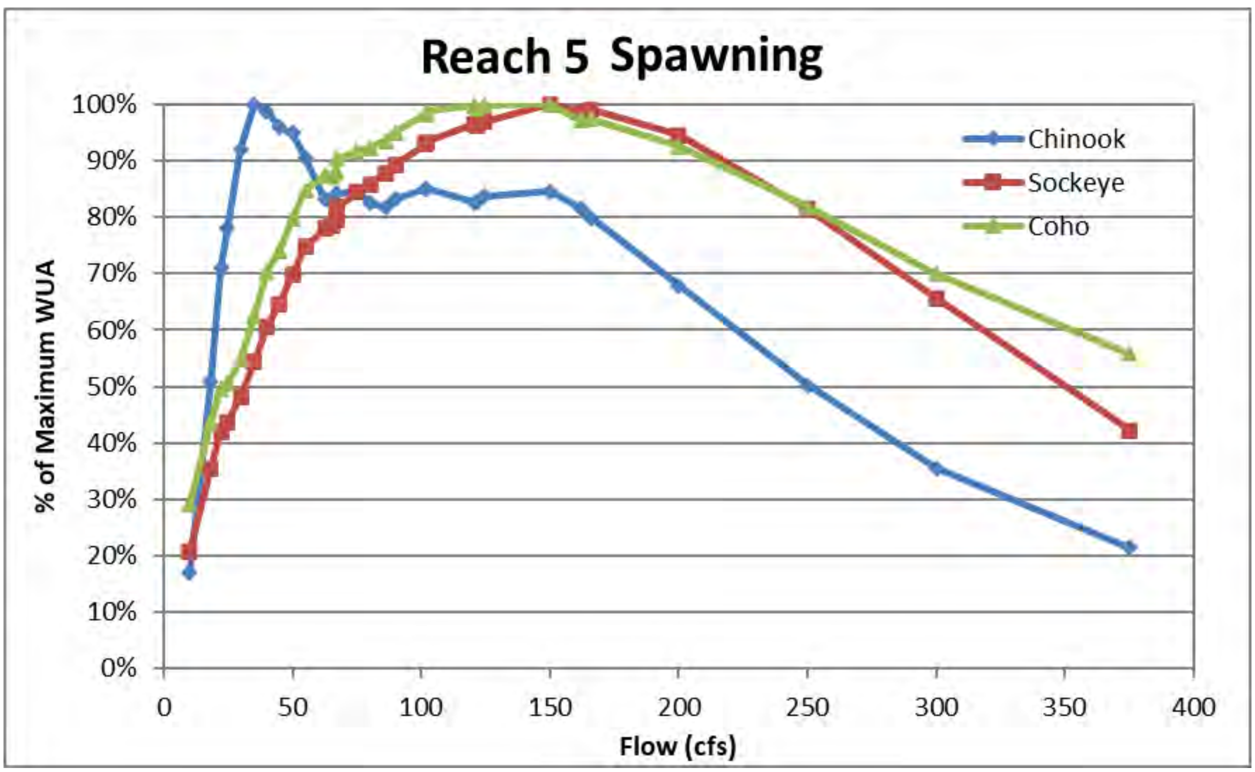
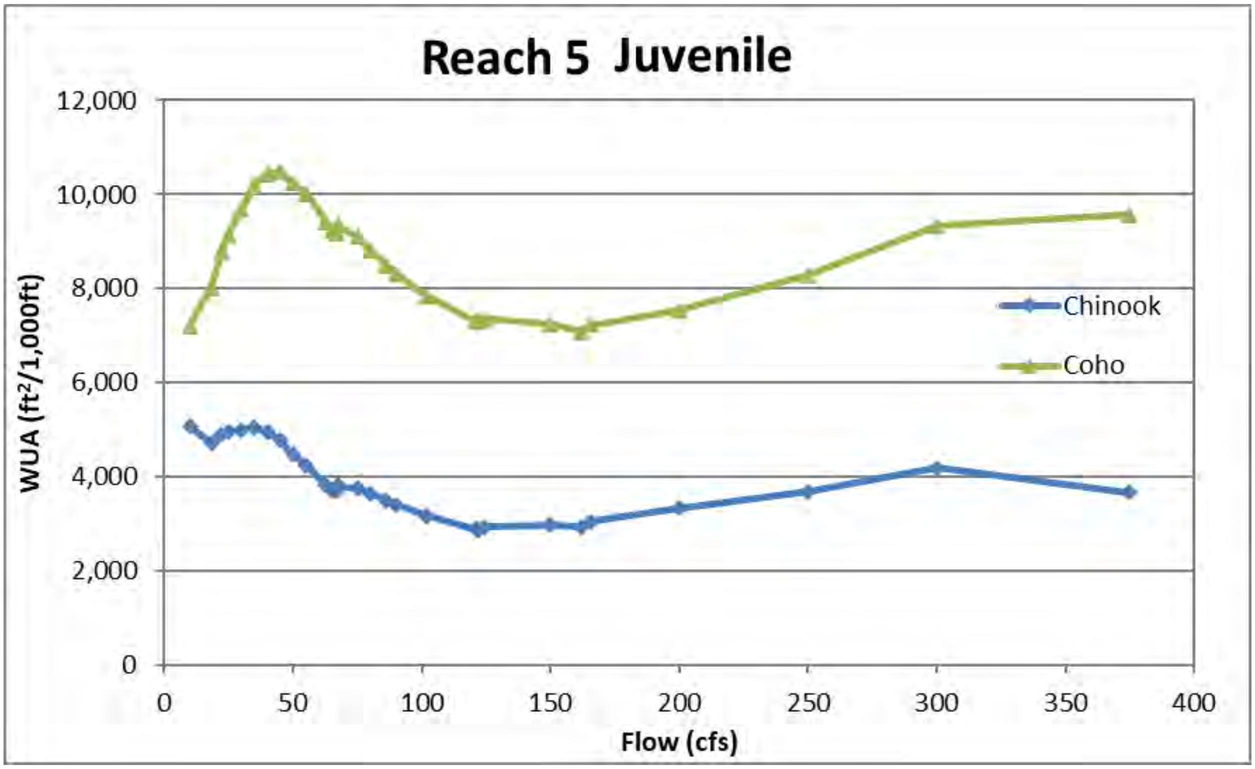


Figure A.3-3. Reach 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



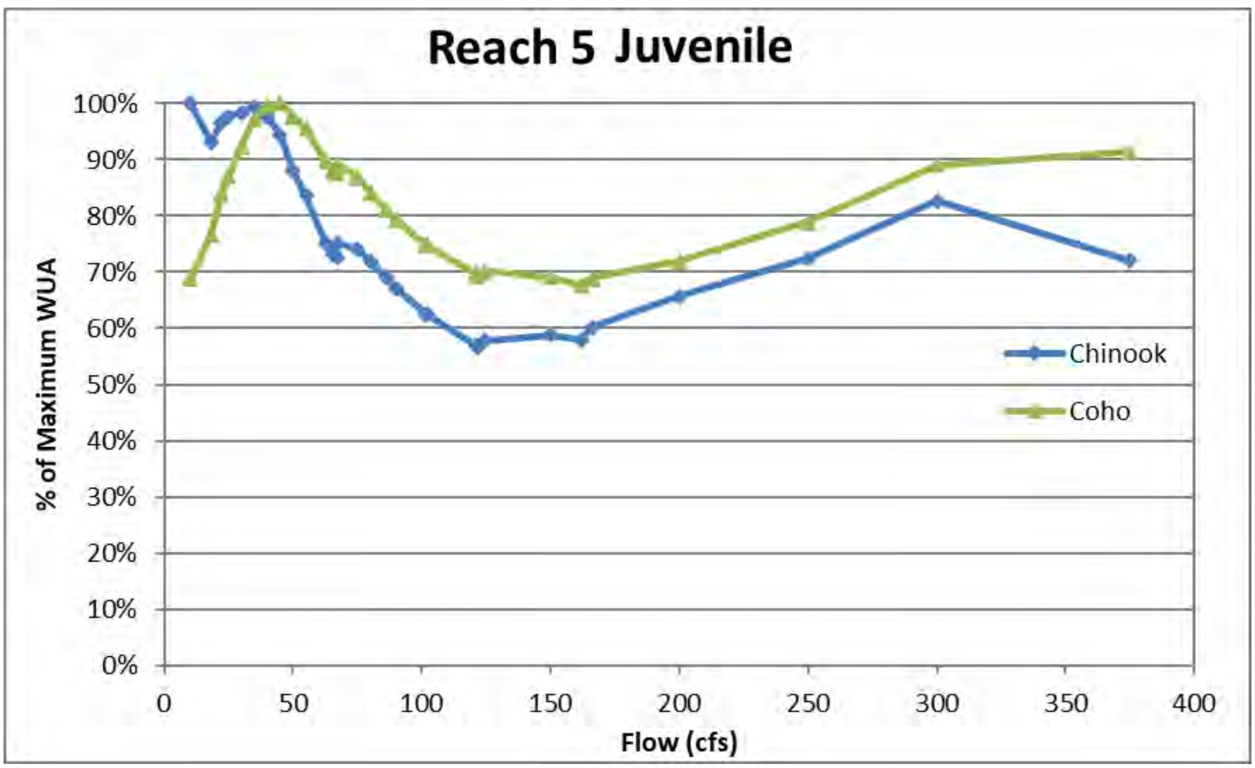
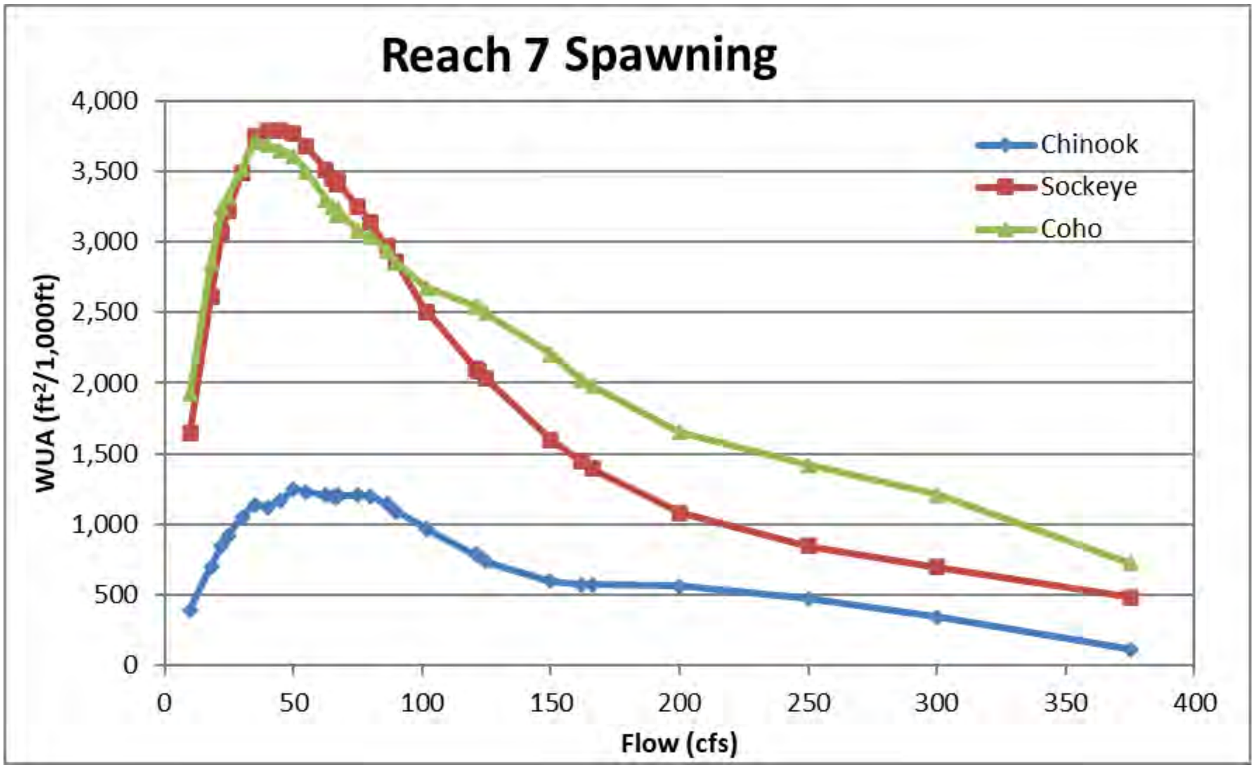


Figure A.3-4. Reach 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



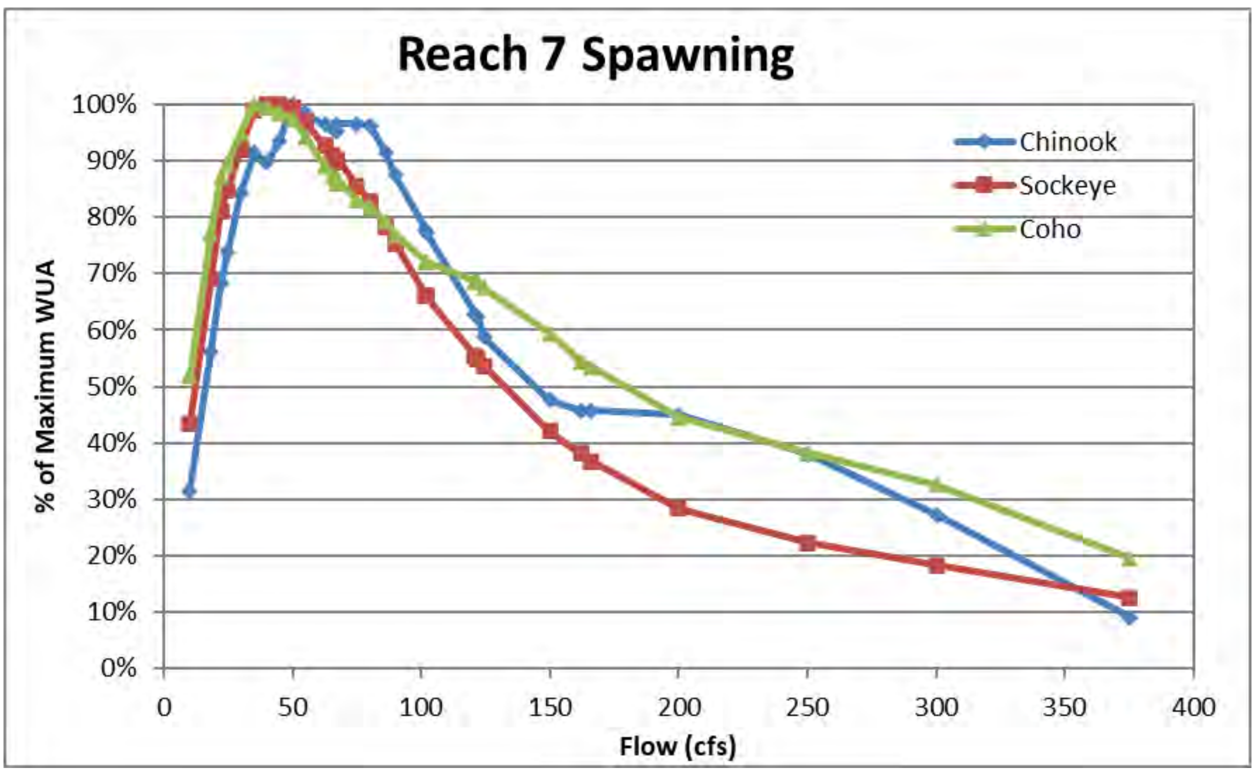
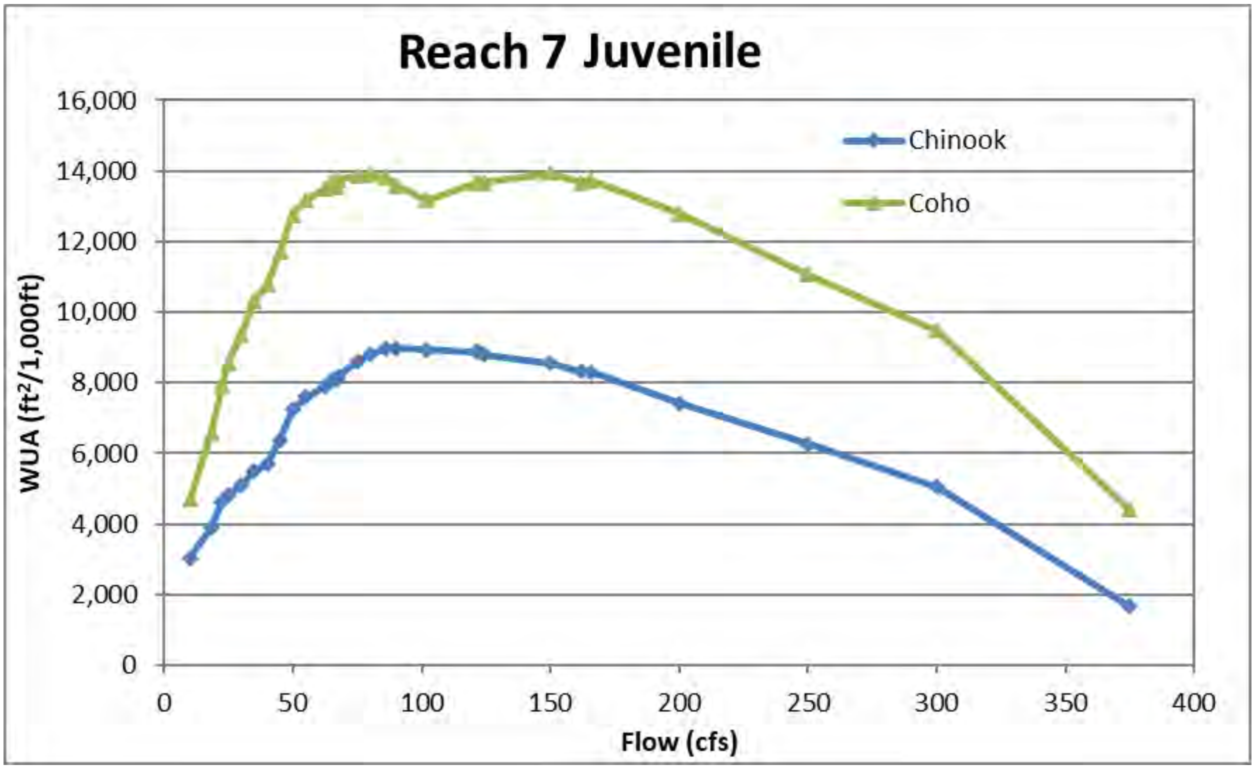


Figure A.3-5. Reach 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



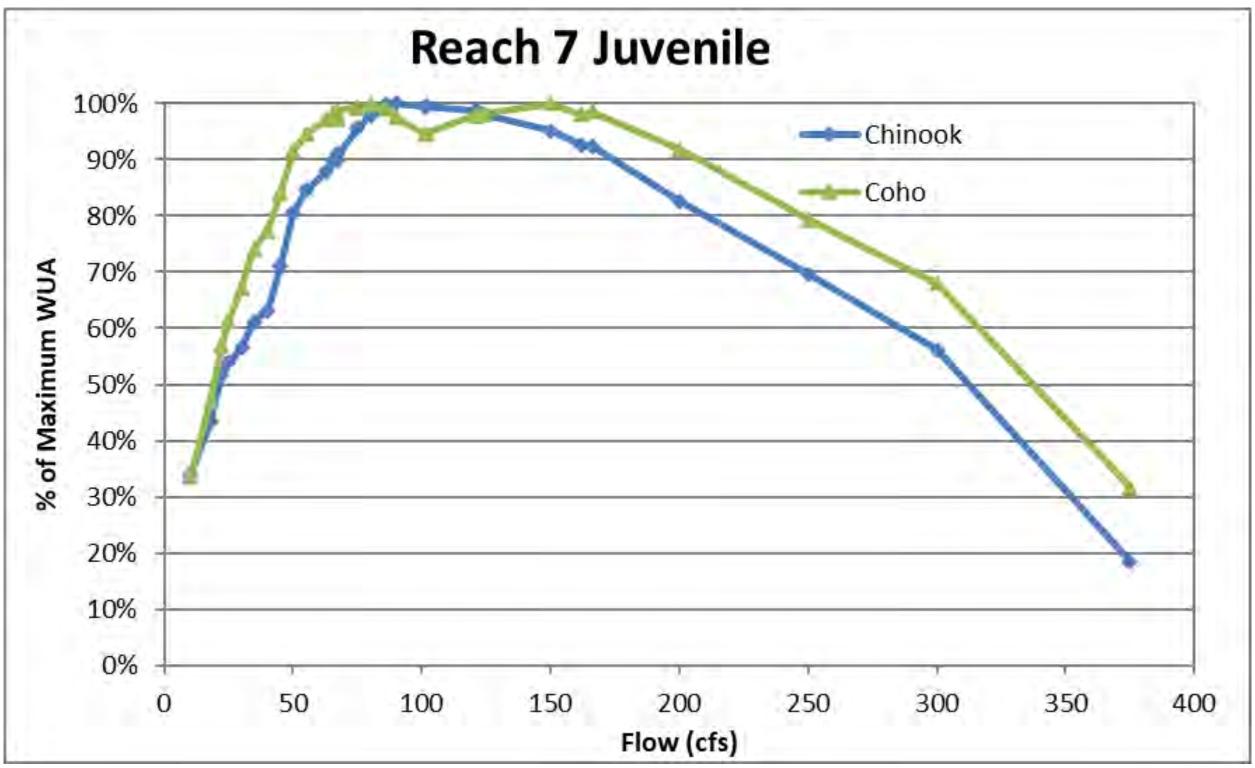
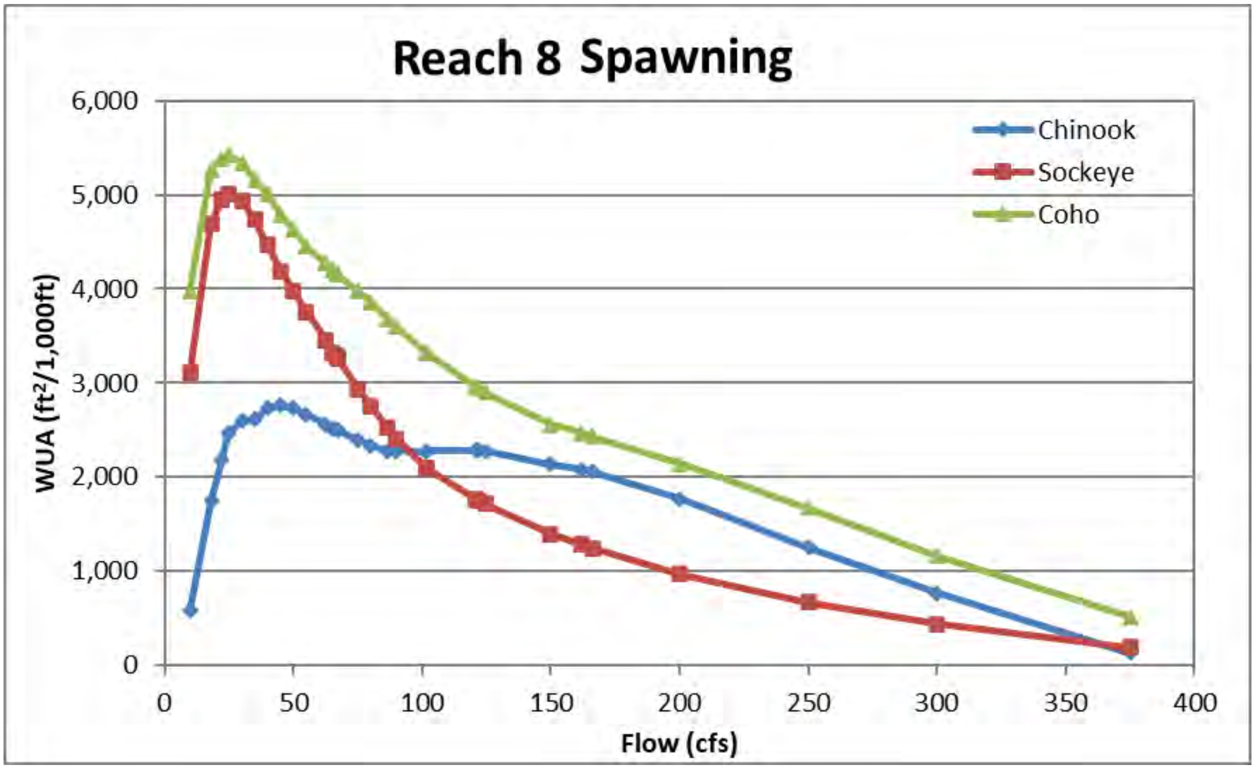


Figure A.3-6. Reach 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



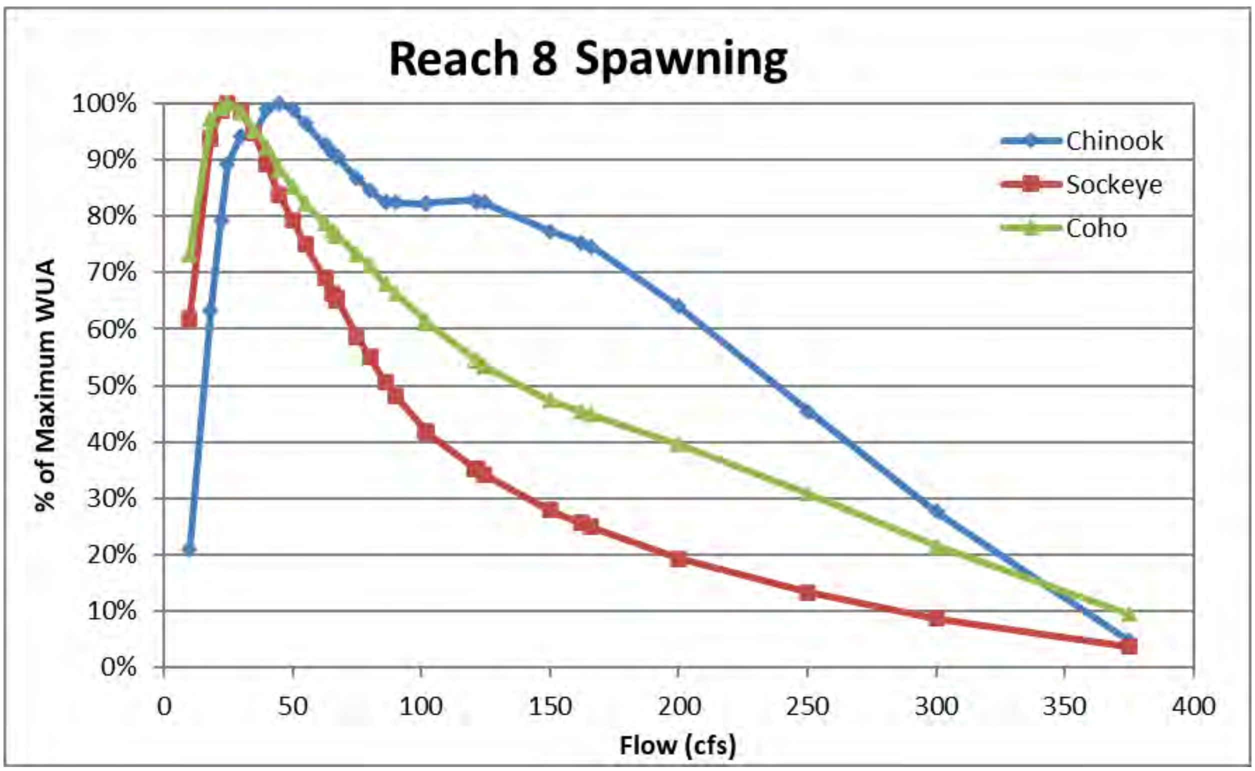
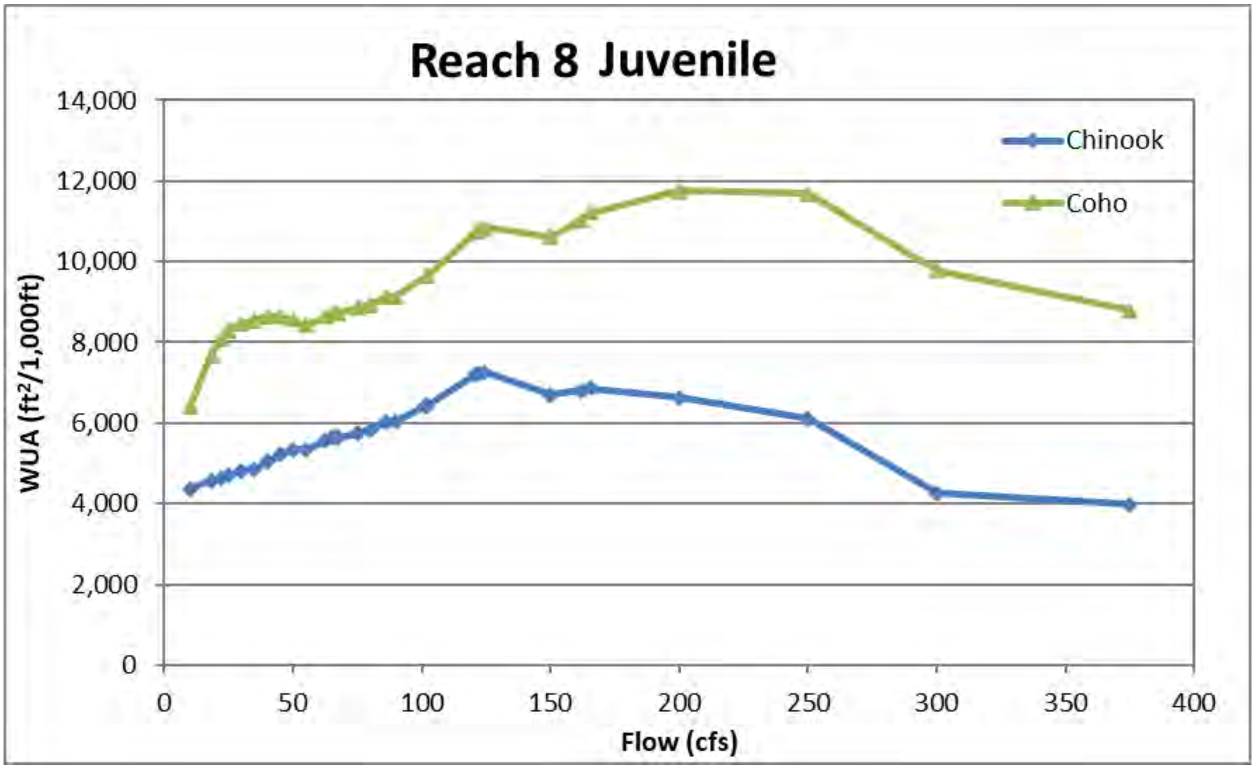


Figure A.3-7. Reach 8 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



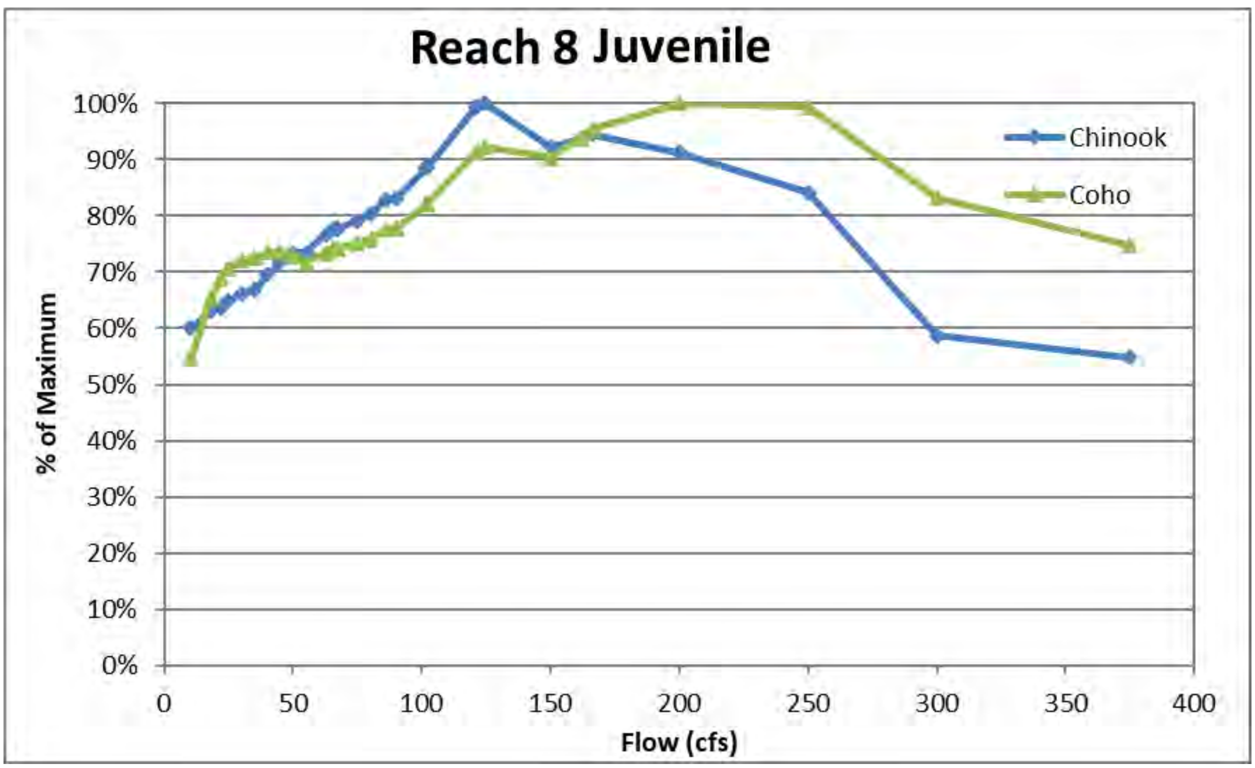
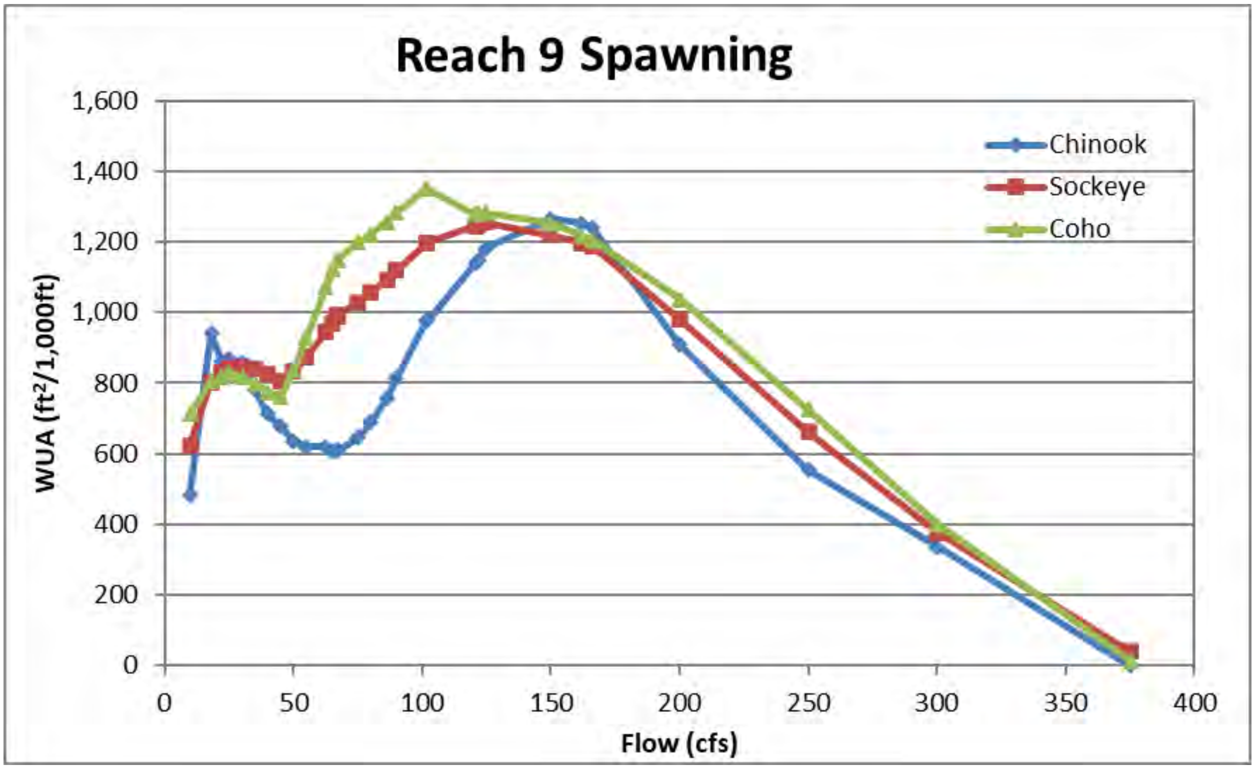


Figure A.3-8. Reach 8 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



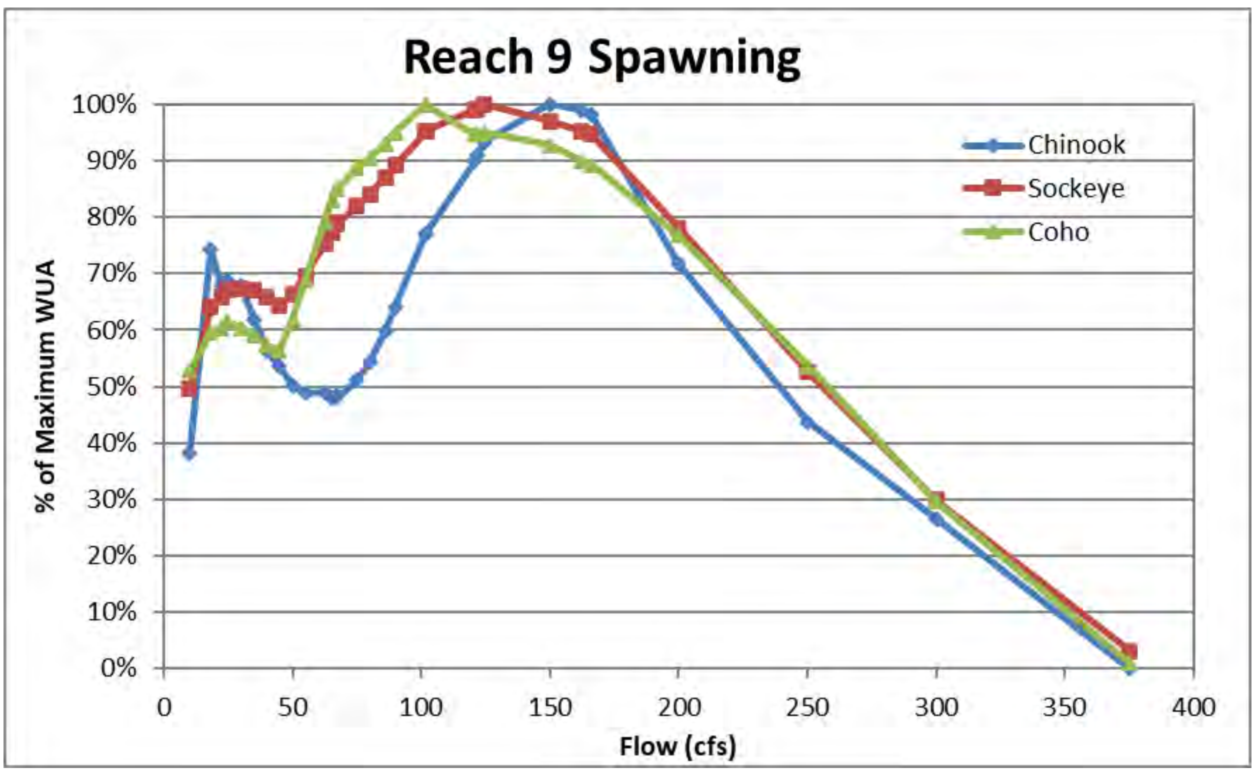
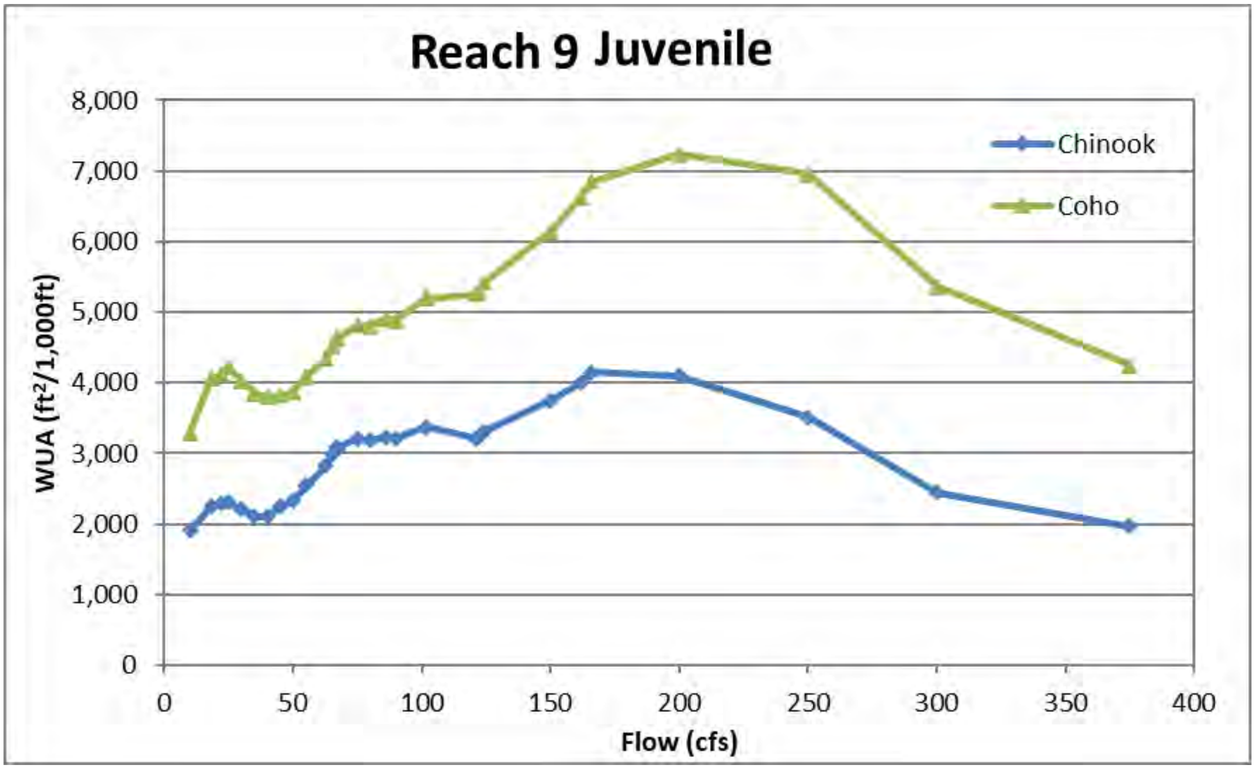


Figure A.3-9. Reach 9 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



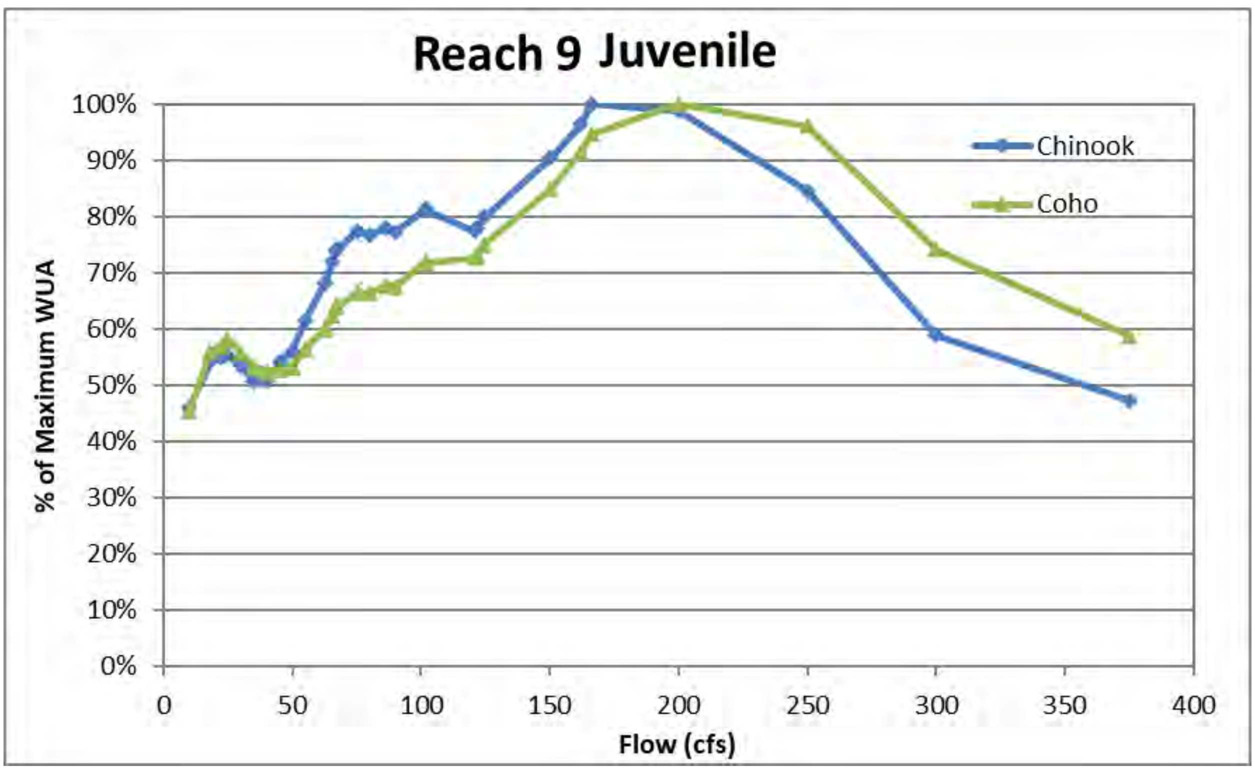
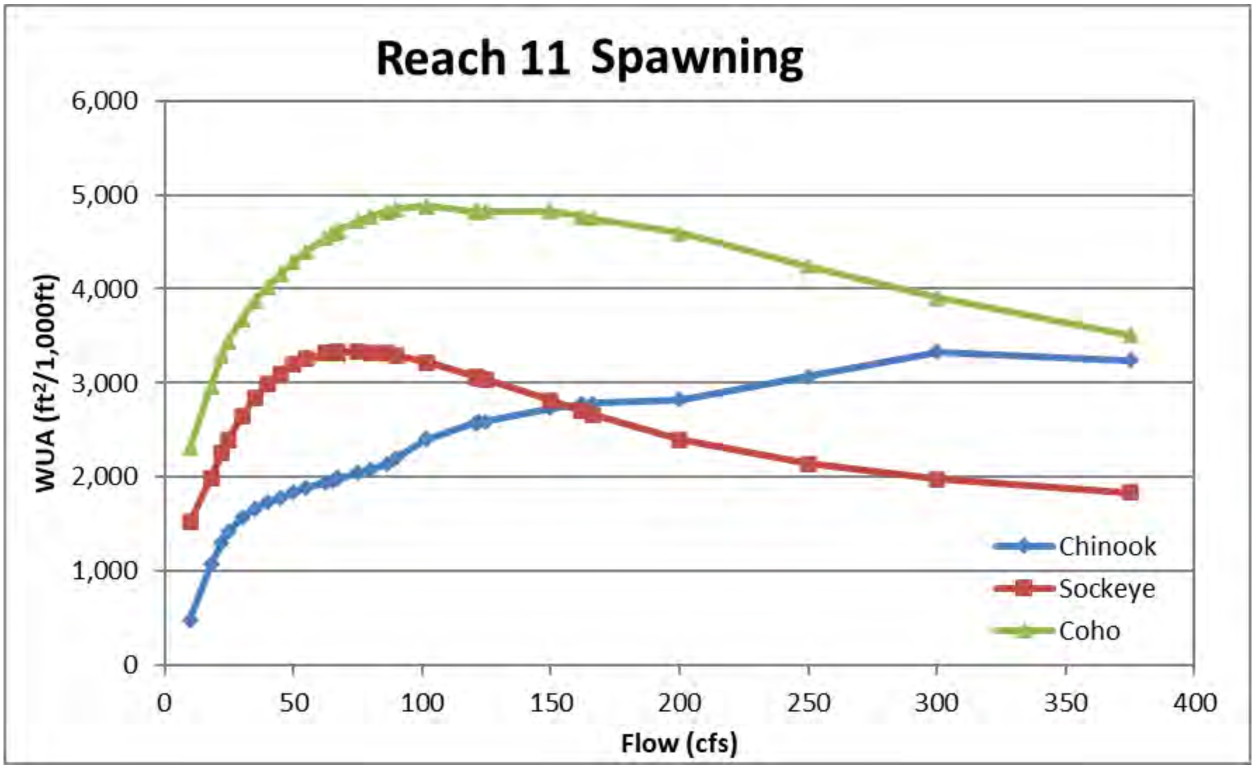


Figure A.3-10. Reach 9 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



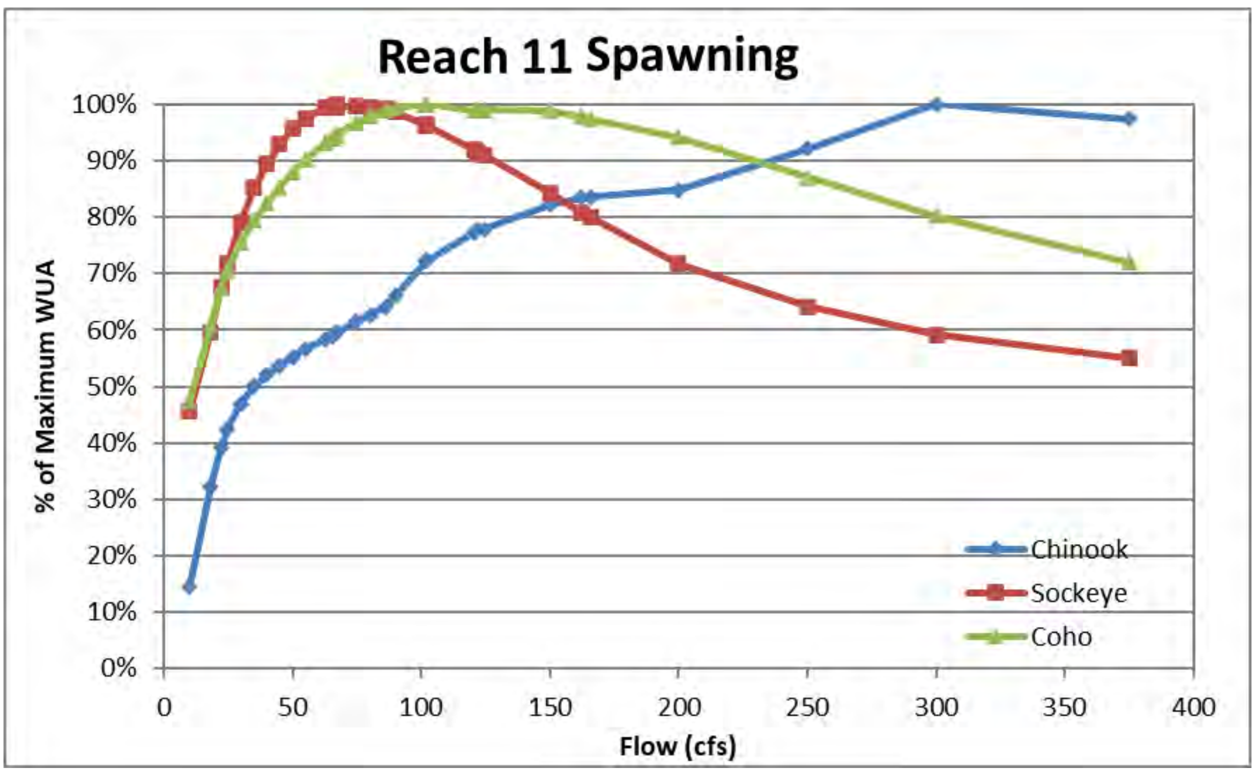
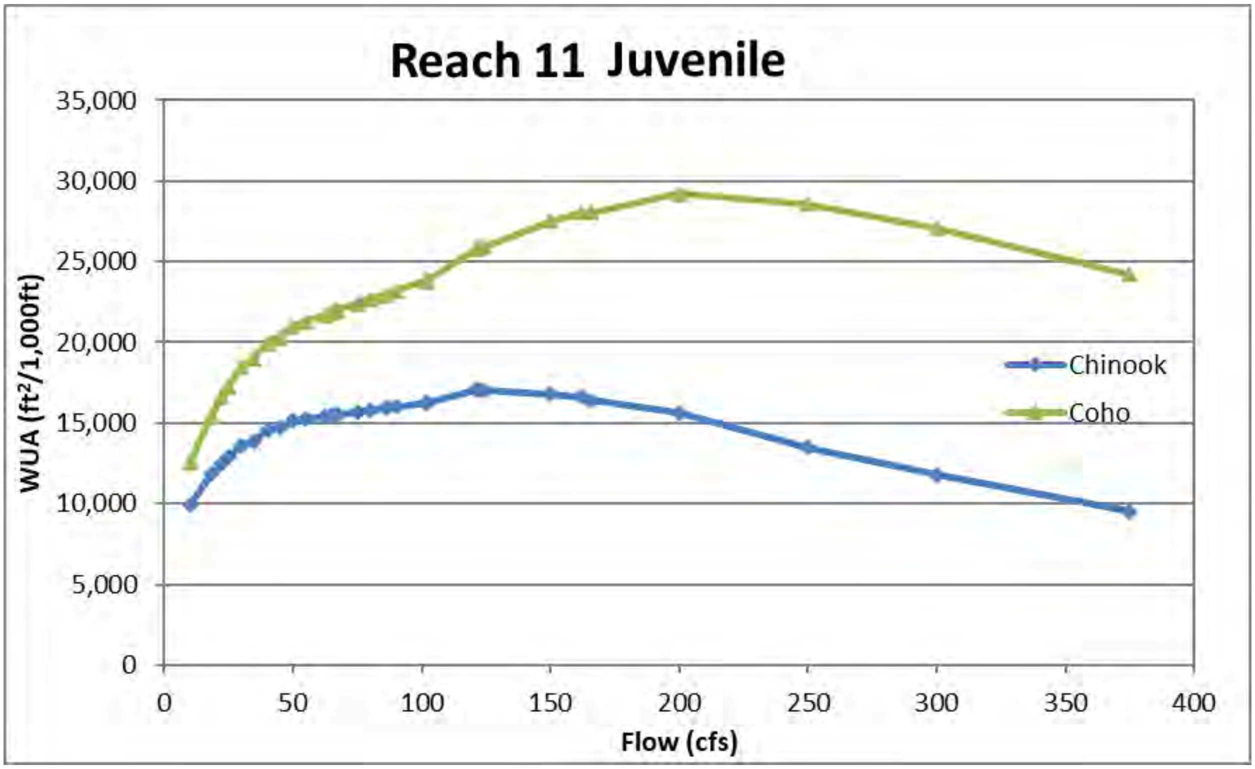


Figure A.3-11. Reach 11 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



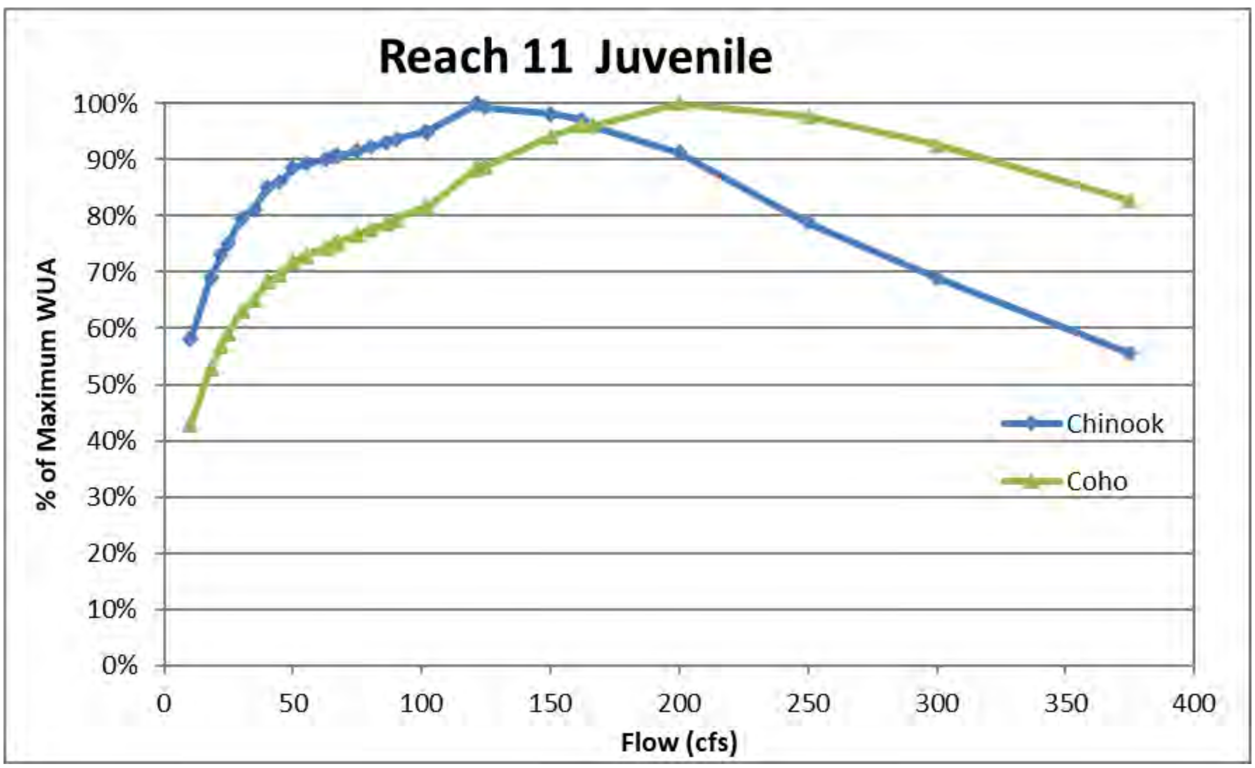
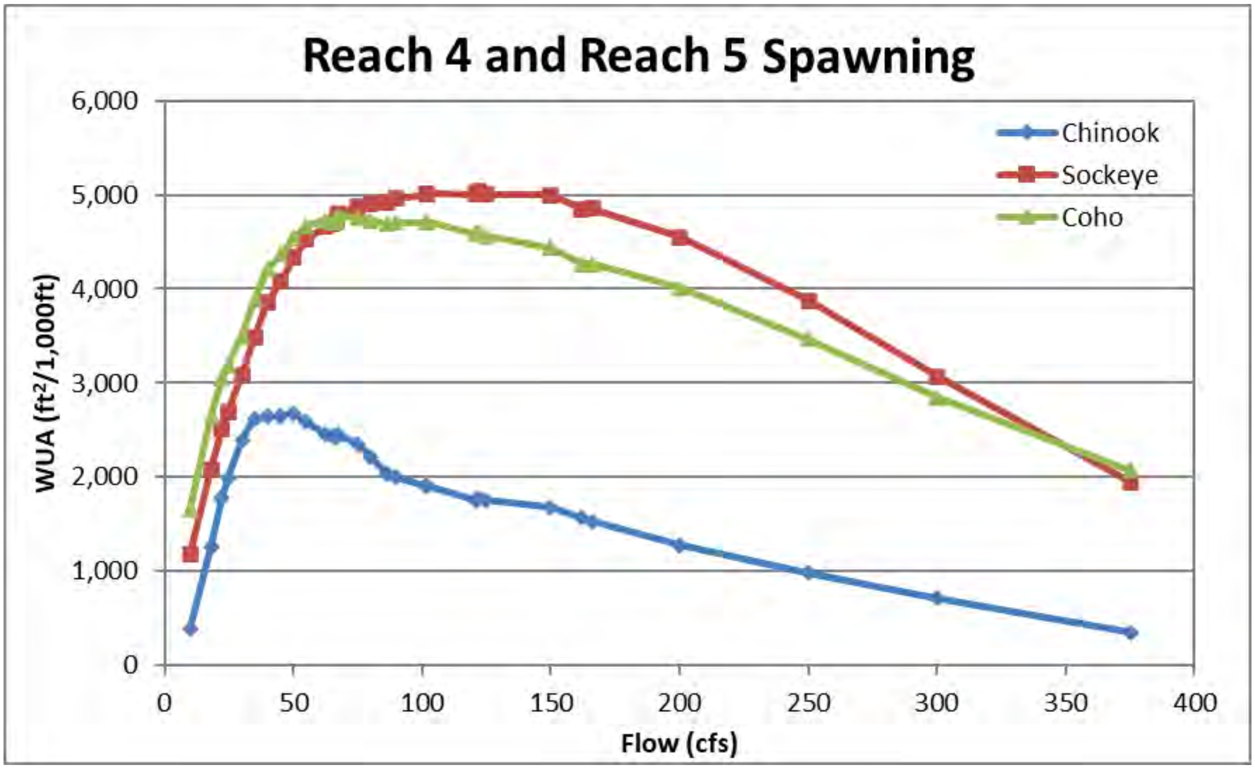


Figure A.3-12. Reach 11 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



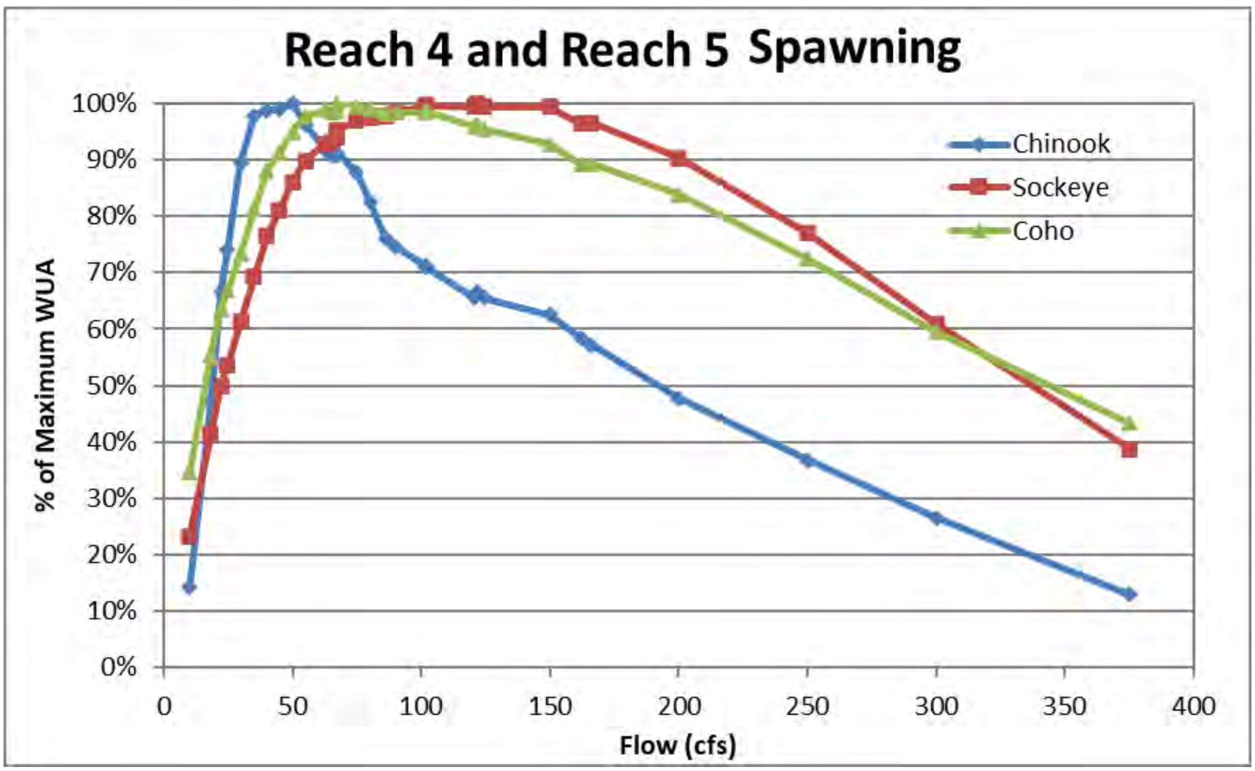
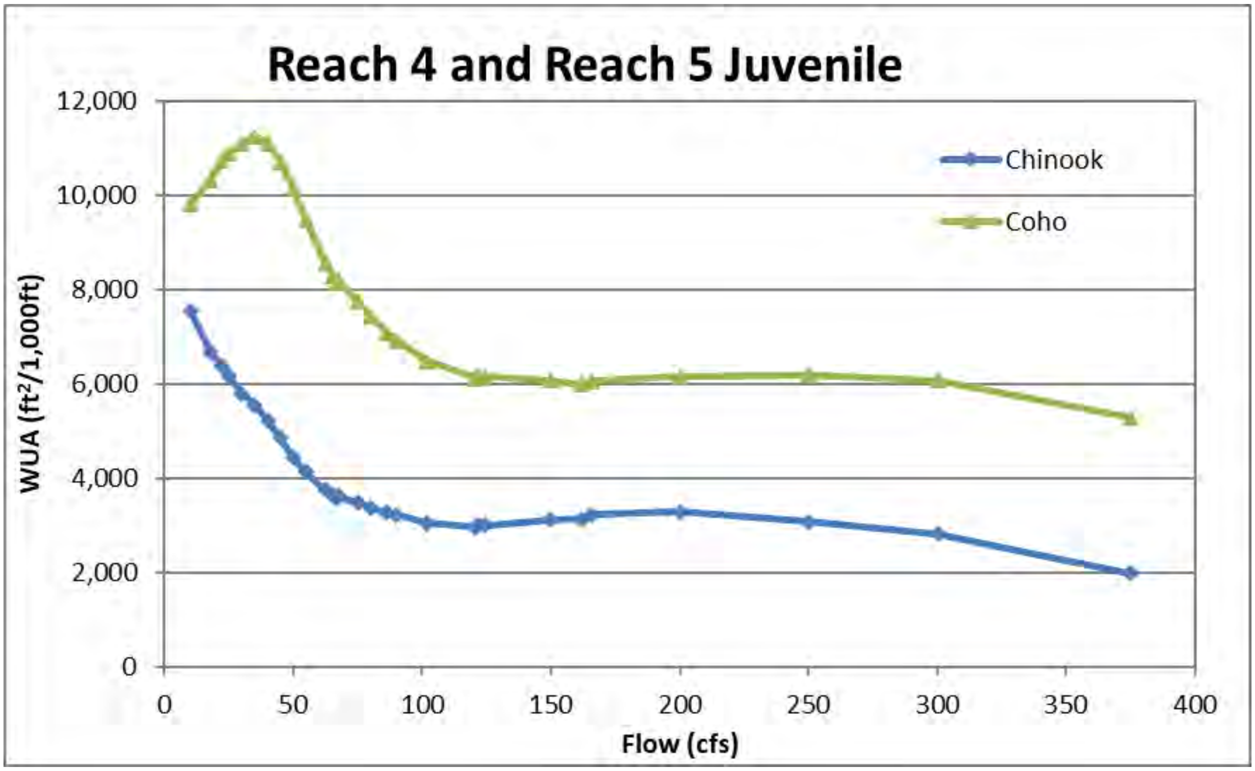


Figure A.3-13. Below Thunderbird Creek total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



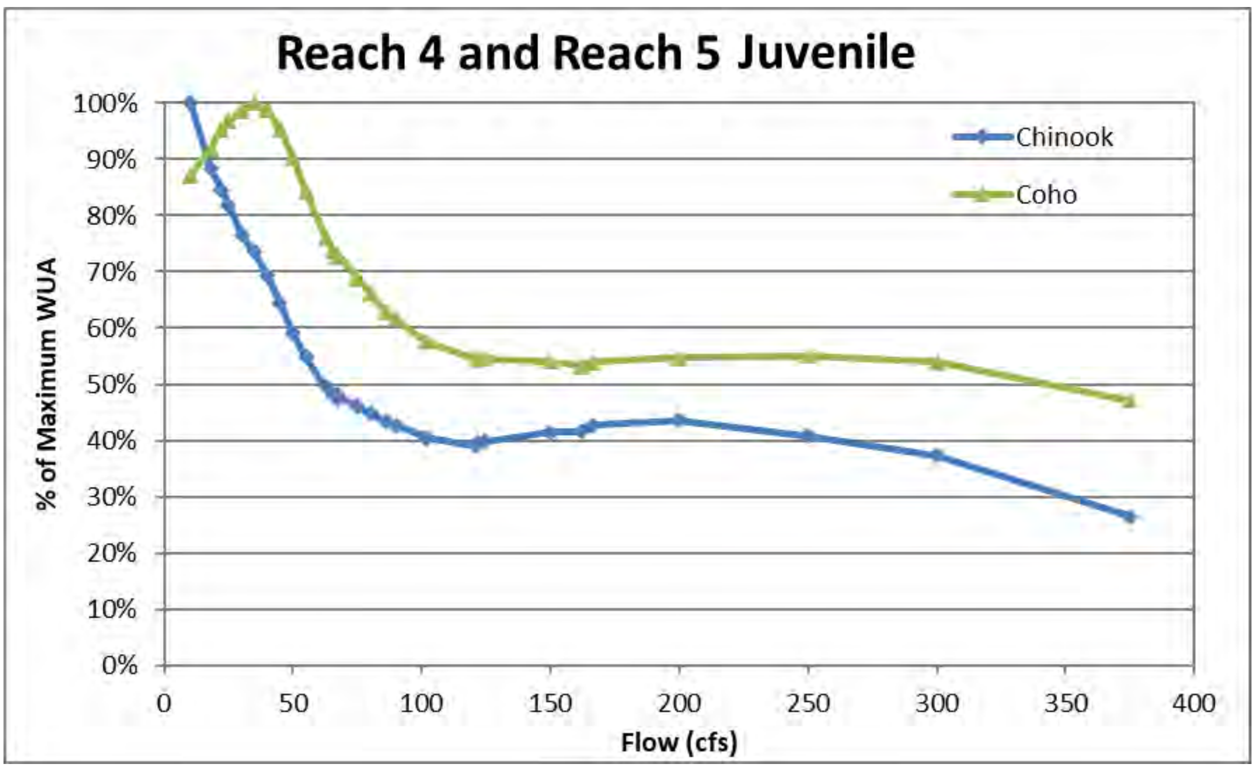
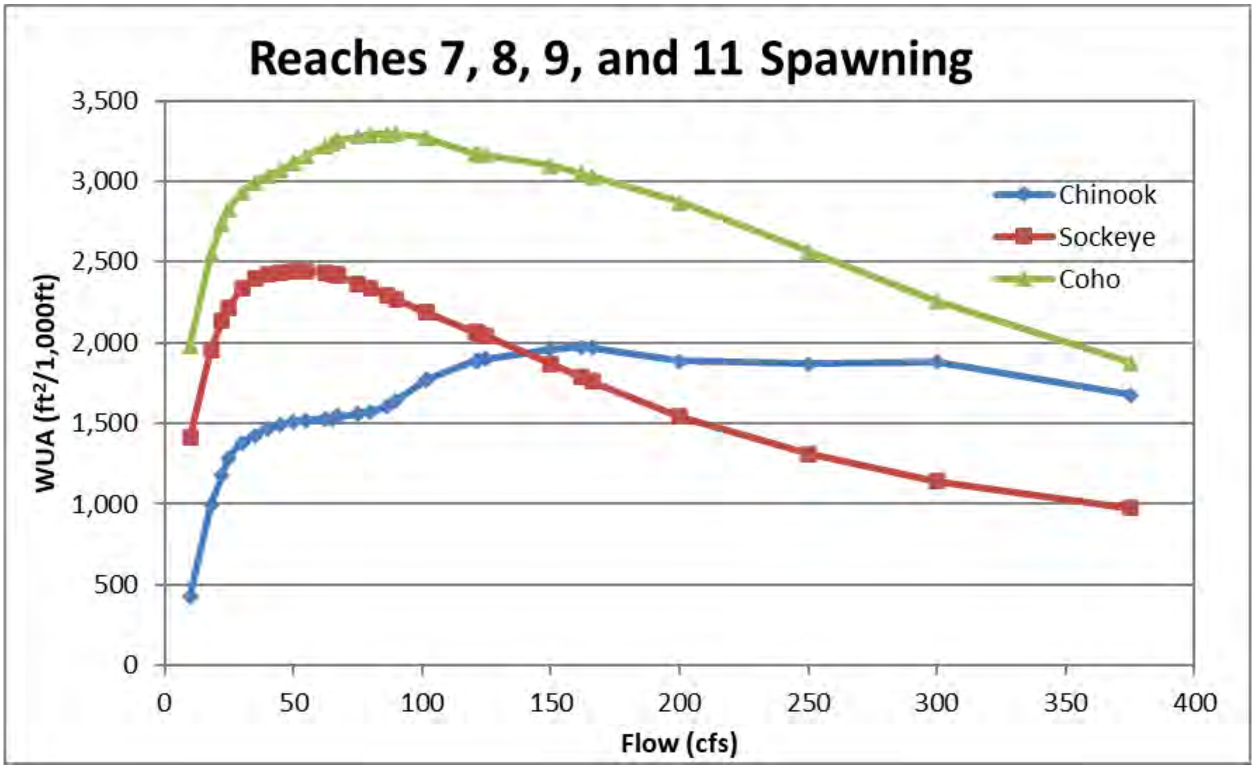


Figure A.3-14. Below Thunderbird Creek weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



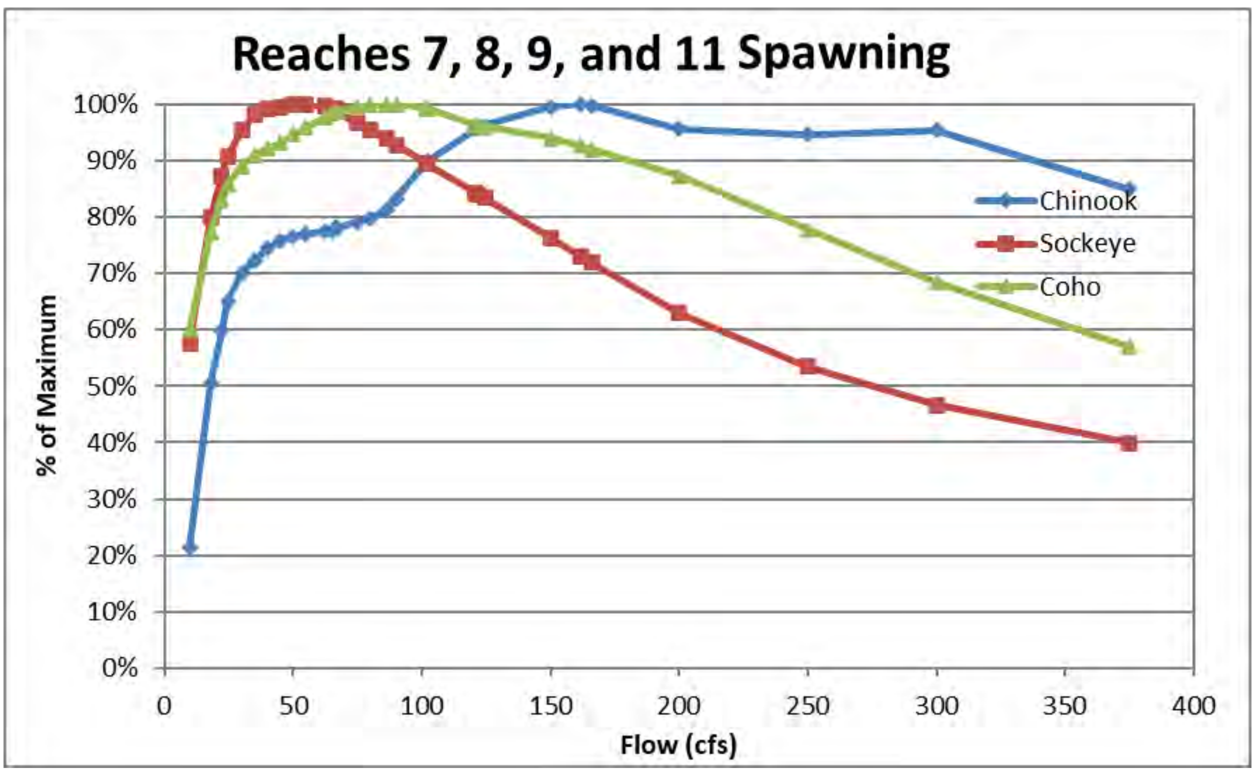
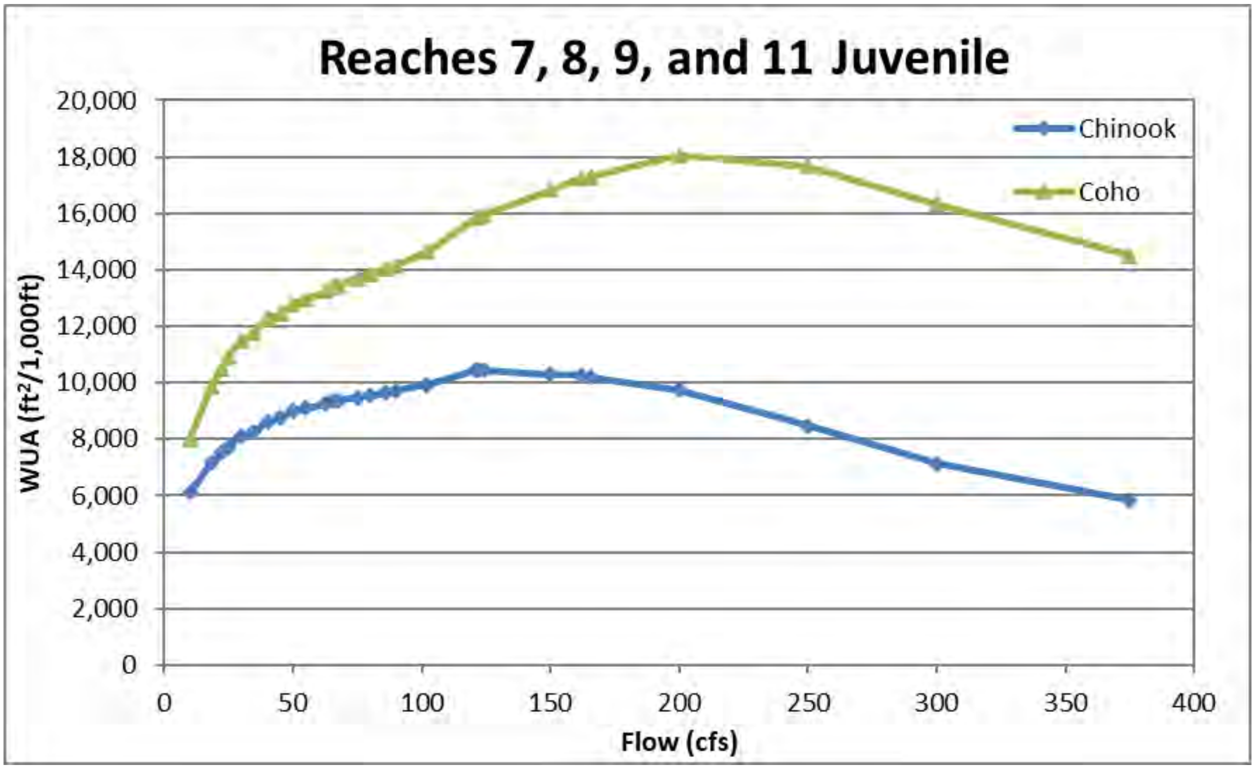


Figure A.3-15. Above Thunderbird Creek total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.



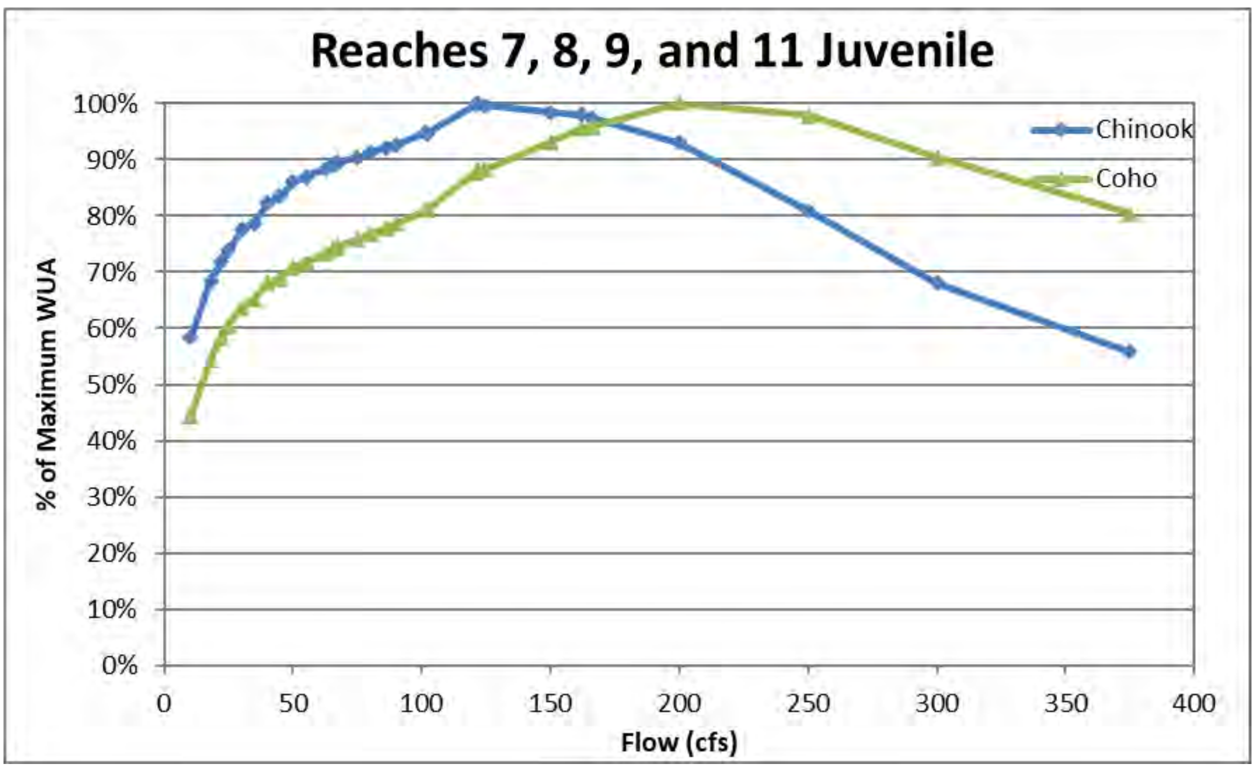


Figure A.3-16. Above Thunderbird Creek weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

Table A.3-1. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	243	9816	10%	100%
	18.1	932	8456	39%	86%
	22.2	1343	7759	57%	79%
	24.7	1523	7301	64%	74%
	30	1911	6515	81%	66%
	35	2102	6021	89%	61%
	40	2185	5487	92%	56%
	45	2280	4915	96%	50%
	50	2364	4438	100%	45%
	55	2302	4041	97%	41%
	62.6	2285	3680	97%	37%
	65.4	2264	3553	96%	36%
	67	2251	3475	95%	35%
	67.3	2231	3452	94%	35%
	75	2033	3217	86%	33%
	80	1826	3128	77%	32%
	86.2	1522	3054	64%	31%
	90	1404	3050	59%	31%
	101.7	1172	2947	49.6%	30%
	102	1161	2936	49%	30%
	120.8	955	3008	40%	31%
	121.8	995	3112	42%	32%
	124.4	921	3066	39%	31%
	150	743	3264	31%	33%
	161.9	619	3314	26%	34%
	166	604	3373	26%	34%
	200	468	3254	20%	33%
	250	418	2532	18%	26%
	300	325	1561	14%	16%
	375	39	467	2%	5%

Table A.3-2. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	833	NA	23%	
	18.1	1582	NA	43%	
	22.2	1965	NA	54%	
	24.7	2200	NA	60%	
	30	2628	NA	72%	
	35	2988	NA	82%	
	40	3260	NA	89%	
	45	3433	NA	94%	
	50	3550	NA	97%	
	55	3589	NA	98%	
	62.6	3649	NA	100%	
	65.4	3662	NA	100%	
	67	3649	NA	100%	
	67.3	3636	NA	99%	
	75	3608	NA	99%	
	80	3566	NA	97%	
	86.2	3470	NA	95%	
	90	3424	NA	94%	
	101.7	3279	NA	90%	
	102	3267	NA	89%	
	120.8	3025	NA	83%	
	121.8	3103	NA	85%	
	124.4	2999	NA	82%	
	150	2787	NA	76%	
	161.9	2598	NA	71%	
	166	2575	NA	70%	
	200	2285	NA	62%	
	250	1885	NA	51%	
	300	1420	NA	39%	
	375	862	NA	24%	

Table A.3-3. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Reach 4 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1409	12186	36%	97%
	18.1	2437	12468	63%	99%
	22.2	2837	12532	73%	100%
	24.7	3062	12509	79%	100%
	30	3404	12398	88%	99%
	35	3664	12228	94%	98%
	40	3819	11737	98%	94%
	45	3879	10945	100%	87%
	50	3890	10078	100%	80%
	55	3829	9012	98%	72%
	62.6	3778	7789	97%	62%
	65.4	3753	7449	96%	59%
	67	3715	7235	96%	58%
	67.3	3697	7175	95%	57%
	75	3582	6516	92%	52%
	80	3493	6162	90%	49%
	86.2	3342	5772	86%	46%
	90	3275	5643	84%	45%
	101.7	3077	5239	79%	42%
	102	3063	5221	79%	42%
	120.8	2753	5026	71%	40%
	121.8	2825	5174	73%	41%
	124.4	2711	5036	70%	40%
	150	2465	5018	63%	40%
	161.9	2302	4973	59%	40%
	166	2292	5011	59%	40%
	200	2086	4874	54%	39%
	250	1697	4295	44%	34%
	300	1225	3095	31%	25%
	375	599	1365	15%	11%

Table A.3-4. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	540	5078	17%	100%
	18.1	1622	4732	51%	93%
	22.2	2263	4902	71%	97%
	24.7	2489	4962	78%	98%
	30	2932	5000	92%	98%
	35	3184	5049	100%	99%
	40	3147	4952	99%	98%
	45	3054	4793	96%	94%
	50	3022	4473	95%	88%
	55	2882	4241	91%	84%
	62.6	2649	3818	83%	75%
	65.4	2616	3713	82%	73%
	67	2624	3692	82%	73%
	67.3	2680	3818	84%	75%
	75	2694	3762	85%	74%
	80	2630	3655	83%	72%
	86.2	2604	3507	82%	69%
	90	2649	3411	83%	67%
	101.7	2708	3171	85.0%	62%
	102	2710	3178	85%	63%
	120.8	2631	2894	83%	57%
	121.8	2639	2876	83%	57%
	124.4	2667	2935	84%	58%
	150	2695	2983	85%	59%
	161.9	2597	2941	82%	58%
	166	2544	3053	80%	60%
	200	2163	3337	68%	66%
	250	1600	3680	50%	72%
	300	1133	4195	36%	83%
	375	684	3661	21%	72%

Table A.3-5. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1547	NA	21%	
	18.1	2633	NA	36%	
	22.2	3115	NA	42%	
	24.7	3242	NA	44%	
	30	3578	NA	48%	
	35	4029	NA	54%	
	40	4496	NA	61%	
	45	4793	NA	65%	
	50	5184	NA	70%	
	55	5541	NA	75%	
	62.6	5782	NA	78%	
	65.4	5827	NA	79%	
	67	5899	NA	80%	
	67.3	6059	NA	82%	
	75	6260	NA	84%	
	80	6365	NA	86%	
	86.2	6509	NA	88%	
	90	6627	NA	89%	
	101.7	6890	NA	93%	
	102	6922	NA	93%	
	120.8	7159	NA	97%	
	121.8	7138	NA	96%	
	124.4	7190	NA	97%	
	150	7415	NA	100%	
	161.9	7308	NA	99%	
	166	7346	NA	99%	
	200	7013	NA	95%	
	250	6043	NA	82%	
	300	4867	NA	66%	
	375	3132	NA	42%	

Table A.3-6. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Reach 5 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1920	7210	29%	69%
	18.1	2883	8017	44%	76%
	22.2	3267	8788	50%	84%
	24.7	3333	9120	51%	87%
	30	3611	9687	55%	92%
	35	4119	10195	63%	97%
	40	4640	10441	70%	100%
	45	4886	10481	74%	100%
	50	5257	10241	80%	98%
	55	5590	10018	85%	96%
	62.6	5760	9416	87%	90%
	65.4	5754	9224	87%	88%
	67	5807	9173	88%	88%
	67.3	5961	9349	90%	89%
	75	6043	9104	92%	87%
	80	6082	8816	92%	84%
	86.2	6166	8498	94%	81%
	90	6263	8319	95%	79%
	101.7	6477	7835	98%	75%
	102	6513	7842	99%	75%
	120.8	6577	7315	100%	70%
	121.8	6546	7276	99%	69%
	124.4	6585	7358	100%	70%
	150	6590	7242	100%	69%
	161.9	6401	7095	97%	68%
	166	6423	7219	97%	69%
	200	6103	7540	93%	72%
	250	5395	8278	82%	79%
	300	4616	9329	70%	89%
	375	3678	9575	56%	91%

Table A.3-7. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	394	3039	32%	34%
	18.1	701	3897	56%	43%
	22.2	851	4626	68%	52%
	24.7	920	4832	74%	54%
	30	1050	5083	84%	57%
	35	1140	5496	91%	61%
	40	1119	5680	90%	63%
	45	1167	6386	94%	71%
	50	1247	7229	100%	80%
	55	1227	7596	98%	85%
	62.6	1202	7890	96%	88%
	65.4	1195	8077	96%	90%
	67	1189	8067	95%	90%
	67.3	1205	8180	97%	91%
	75	1204	8586	97%	96%
	80	1201	8797	96%	98%
	86.2	1142	8973	92%	100%
	90	1091	8982	87%	100%
	101.7	971	8925	77.8%	99%
	102	964	8941	77%	100%
	120.8	785	8870	63%	99%
	121.8	779	8866	62%	99%
	124.4	733	8803	59%	98%
	150	594	8549	48%	95%
	161.9	570	8323	46%	93%
	166	571	8303	46%	92%
	200	561	7423	45%	83%
	250	474	6264	38%	70%
	300	340	5047	27%	56%
	375	113	1656	9%	18%

Table A.3-8. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1645	NA	43%	
	18.1	2614	NA	69%	
	22.2	3073	NA	81%	
	24.7	3218	NA	85%	
	30	3490	NA	92%	
	35	3751	NA	99%	
	40	3790	NA	100%	
	45	3790	NA	100%	
	50	3768	NA	99%	
	55	3673	NA	97%	
	62.6	3513	NA	93%	
	65.4	3450	NA	91%	
	67	3404	NA	90%	
	67.3	3425	NA	90%	
	75	3245	NA	86%	
	80	3138	NA	83%	
	86.2	2969	NA	78%	
	90	2859	NA	75%	
	101.7	2505	NA	66%	
	102	2503	NA	66%	
	120.8	2103	NA	55%	
	121.8	2081	NA	55%	
	124.4	2037	NA	54%	
	150	1598	NA	42%	
	161.9	1444	NA	38%	
	166	1394	NA	37%	
	200	1079	NA	28%	
	250	845	NA	22%	
	300	694	NA	18%	
	375	480	NA	13%	

Table A.3-9. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Reach 7 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1921	4682	52%	34%
	18.1	2853	6570	77%	47%
	22.2	3236	7918	87%	57%
	24.7	3321	8549	90%	61%
	30	3515	9363	95%	67%
	35	3708	10331	100%	74%
	40	3690	10785	100%	77%
	45	3652	11709	98%	84%
	50	3612	12756	97%	92%
	55	3495	13168	94%	94%
	62.6	3302	13524	89%	97%
	65.4	3247	13692	88%	98%
	67	3189	13564	86%	97%
	67.3	3225	13751	87%	99%
	75	3077	13857	83%	99%
	80	3035	13904	82%	100%
	86.2	2940	13811	79%	99%
	90	2852	13593	77%	98%
	101.7	2675	13169	72%	95%
	102	2674	13183	72%	95%
	120.8	2545	13652	69%	98%
	121.8	2542	13677	69%	98%
	124.4	2502	13681	67%	98%
	150	2203	13935	59%	100%
	161.9	2019	13668	54%	98%
	166	1980	13729	53%	99%
	200	1652	12806	45%	92%
	250	1420	11062	38%	79%
	300	1211	9480	33%	68%
	375	725	4418	20%	32%

Table A.3-10. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	578	4364	21%	60%
	18.1	1748	4575	63%	63%
	22.2	2189	4623	79%	64%
	24.7	2464	4702	89%	65%
	30	2600	4809	94%	66%
	35	2612	4849	95%	67%
	40	2734	5051	99%	70%
	45	2762	5210	100%	72%
	50	2733	5332	99%	73%
	55	2661	5337	96%	73%
	62.6	2559	5566	93%	77%
	65.4	2518	5641	91%	78%
	67	2505	5650	91%	78%
	67.3	2497	5637	90%	78%
	75	2394	5750	87%	79%
	80	2337	5827	85%	80%
	86.2	2277	6020	82%	83%
	90	2277	6032	82%	83%
	101.7	2270	6433	82.2%	89%
	102	2273	6430	82%	89%
	120.8	2287	7207	83%	99%
	121.8	2281	7228	83%	100%
	124.4	2278	7262	82%	100%
	150	2138	6699	77%	92%
	161.9	2083	6808	75%	94%
	166	2061	6863	75%	95%
	200	1768	6628	64%	91%
	250	1256	6112	45%	84%
	300	765	4258	28%	59%
	375	132	3982	5%	55%

Table A.3-11. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	3103	NA	62%	
	18.1	4695	NA	94%	
	22.2	4945	NA	99%	
	24.7	5007	NA	100%	
	30	4934	NA	99%	
	35	4738	NA	95%	
	40	4463	NA	89%	
	45	4191	NA	84%	
	50	3974	NA	79%	
	55	3756	NA	75%	
	62.6	3454	NA	69%	
	65.4	3324	NA	66%	
	67	3284	NA	66%	
	67.3	3265	NA	65%	
	75	2937	NA	59%	
	80	2756	NA	55%	
	86.2	2531	NA	51%	
	90	2413	NA	48%	
	101.7	2101	NA	42%	
	102	2092	NA	42%	
	120.8	1767	NA	35%	
	121.8	1756	NA	35%	
	124.4	1716	NA	34%	
	150	1398	NA	28%	
	161.9	1283	NA	26%	
	166	1246	NA	25%	
	200	968	NA	19%	
	250	668	NA	13%	
	300	438	NA	9%	
	375	190	NA	4%	

Table A.3-12. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Reach 8 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	3977	6409	73%	55%
	18.1	5263	7678	97%	65%
	22.2	5383	8097	99%	69%
	24.7	5419	8313	100%	71%
	30	5341	8480	99%	72%
	35	5162	8532	95%	73%
	40	5001	8649	92%	74%
	45	4790	8641	88%	74%
	50	4628	8572	85%	73%
	55	4455	8418	82%	72%
	62.6	4270	8629	79%	73%
	65.4	4196	8721	77%	74%
	67	4168	8725	77%	74%
	67.3	4154	8721	77%	74%
	75	3971	8842	73%	75%
	80	3862	8926	71%	76%
	86.2	3684	9121	68%	78%
	90	3596	9142	66%	78%
	101.7	3333	9647	61%	82%
	102	3317	9640	61%	82%
	120.8	2961	10736	55%	91%
	121.8	2951	10769	54%	92%
	124.4	2900	10854	54%	92%
	150	2563	10631	47%	90%
	161.9	2468	11032	46%	94%
	166	2431	11223	45%	95%
	200	2146	11755	40%	100%
	250	1673	11686	31%	99%
	300	1166	9786	22%	83%
	375	513	8790	9%	75%

Table A.3-13. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	483	1909	38%	46%
	18.1	941	2248	74%	54%
	22.2	859	2280	68%	55%
	24.7	869	2304	69%	56%
	30	859	2219	68%	53%
	35	783	2100	62%	51%
	40	712	2107	56%	51%
	45	678	2245	54%	54%
	50	635	2325	50%	56%
	55	618	2547	49%	61%
	62.6	620	2827	49%	68%
	65.4	605	2983	48%	72%
	67	611	3081	48%	74%
	67.3	609	3072	48%	74%
	75	646	3211	51%	77%
	80	689	3184	54%	77%
	86.2	757	3232	60%	78%
	90	812	3206	64%	77%
	101.7	975	3373	77.1%	81%
	102	975	3366	77%	81%
	120.8	1139	3211	90%	77%
	121.8	1150	3233	91%	78%
	124.4	1180	3312	93%	80%
	150	1265	3750	100%	90%
	161.9	1253	3998	99%	96%
	166	1242	4149	98%	100%
	200	908	4102	72%	99%
	250	554	3507	44%	85%
	300	337	2443	27%	59%
	375	0	1963	0%	47%

Table A.3-14. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	622	NA	50%	
	18.1	803	NA	64%	
	22.2	827	NA	66%	
	24.7	841	NA	67%	
	30	846	NA	67%	
	35	843	NA	67%	
	40	827	NA	66%	
	45	806	NA	64%	
	50	833	NA	66%	
	55	874	NA	70%	
	62.6	944	NA	75%	
	65.4	970	NA	77%	
	67	991	NA	79%	
	67.3	990	NA	79%	
	75	1029	NA	82%	
	80	1055	NA	84%	
	86.2	1094	NA	87%	
	90	1119	NA	89%	
	101.7	1195	NA	95%	
	102	1196	NA	95%	
	120.8	1244	NA	99%	
	121.8	1246	NA	99%	
	124.4	1255	NA	100%	
	150	1218	NA	97%	
	161.9	1197	NA	95%	
	166	1189	NA	95%	
	200	980	NA	78%	
	250	660	NA	53%	
	300	376	NA	30%	
	375	40	NA	3%	

Table A.3-15. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Reach 9 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	713	3290	53%	45%
	18.1	804	4057	60%	56%
	22.2	817	4121	60%	57%
	24.7	831	4216	62%	58%
	30	816	4031	60%	56%
	35	799	3852	59%	53%
	40	774	3800	57%	53%
	45	762	3815	56%	53%
	50	837	3855	62%	53%
	55	929	4084	69%	56%
	62.6	1072	4334	79%	60%
	65.4	1122	4523	83%	63%
	67	1149	4643	85%	64%
	67.3	1148	4626	85%	64%
	75	1200	4813	89%	67%
	80	1222	4805	90%	66%
	86.2	1257	4906	93%	68%
	90	1283	4886	95%	68%
	101.7	1351	5209	100%	72%
	102	1350	5197	100%	72%
	120.8	1280	5256	95%	73%
	121.8	1279	5288	95%	73%
	124.4	1283	5425	95%	75%
	150	1254	6139	93%	85%
	161.9	1217	6616	90%	91%
	166	1206	6847	89%	95%
	200	1037	7237	77%	100%
	250	725	6954	54%	96%
	300	400	5365	30%	74%
	375	13	4250	1%	59%

Table A.3-16. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	486	9923	15%	58%
	18.1	1076	11816	32%	69%
	22.2	1301	12497	39%	73%
	24.7	1416	12859	43%	75%
	30	1563	13628	47%	80%
	35	1665	13883	50%	81%
	40	1734	14559	52%	85%
	45	1785	14710	54%	86%
	50	1838	15150	55%	89%
	55	1885	15270	57%	89%
	62.6	1939	15402	58%	90%
	65.4	1961	15503	59%	91%
	67	1985	15548	60%	91%
	67.3	1986	15514	60%	91%
	75	2048	15655	62%	92%
	80	2084	15795	63%	92%
	86.2	2137	15913	64%	93%
	90	2199	16025	66%	94%
	101.7	2403	16254	72.2%	95%
	102	2406	16235	72%	95%
	120.8	2575	17069	77%	100%
	121.8	2588	17106	78%	100%
	124.4	2590	16994	78%	99%
	150	2735	16791	82%	98%
	161.9	2777	16622	83%	97%
	166	2781	16413	84%	96%
	200	2822	15606	85%	91%
	250	3067	13469	92%	79%
	300	3328	11786	100%	69%
	375	3244	9509	97%	56%

Table A.3-17. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1522	NA	46%	
	18.1	1992	NA	60%	
	22.2	2255	NA	68%	
	24.7	2395	NA	72%	
	30	2642	NA	79%	
	35	2843	NA	85%	
	40	2985	NA	89%	
	45	3101	NA	93%	
	50	3193	NA	96%	
	55	3254	NA	97%	
	62.6	3317	NA	99%	
	65.4	3323	NA	100%	
	67	3338	NA	100%	
	67.3	3322	NA	100%	
	75	3327	NA	100%	
	80	3323	NA	100%	
	86.2	3313	NA	99%	
	90	3293	NA	99%	
	101.7	3215	NA	96%	
	102	3217	NA	96%	
	120.8	3068	NA	92%	
	121.8	3057	NA	92%	
	124.4	3040	NA	91%	
	150	2815	NA	84%	
	161.9	2699	NA	81%	
	166	2669	NA	80%	
	200	2396	NA	72%	
	250	2141	NA	64%	
	300	1976	NA	59%	
	375	1839	NA	55%	

Table A.3-18. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Reach 11 expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	2315	12520	47%	43%
	18.1	2964	15452	61%	53%
	22.2	3291	16632	68%	57%
	24.7	3441	17295	71%	59%
	30	3685	18438	76%	63%
	35	3876	19021	80%	65%
	40	4021	19998	83%	68%
	45	4157	20322	85%	70%
	50	4285	20995	88%	72%
	55	4397	21300	90%	73%
	62.6	4541	21708	93%	74%
	65.4	4585	21901	94%	75%
	67	4607	22013	95%	75%
	67.3	4621	22000	95%	75%
	75	4717	22403	97%	77%
	80	4770	22694	98%	78%
	86.2	4819	22942	99%	79%
	90	4847	23200	99%	79%
	101.7	4874	23849	100%	82%
	102	4874	23825	100%	82%
	120.8	4824	25794	99%	88%
	121.8	4819	25887	99%	89%
	124.4	4826	25945	99%	89%
	150	4824	27503	99%	94%
	161.9	4773	28055	98%	96%
	166	4750	28051	97%	96%
	200	4592	29212	94%	100%
	250	4242	28577	87%	98%
	300	3909	27064	80%	93%
	375	3509	24190	72%	83%

Table A.3-19. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Below Thunderbird Creek expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	385	7550	14%	100%
	18.1	1262	6675	47%	88%
	22.2	1783	6393	67%	85%
	24.7	1985	6182	74%	82%
	30	2399	5790	90%	77%
	35	2620	5556	98%	74%
	40	2645	5231	99%	69%
	45	2650	4857	99%	64%
	50	2678	4455	100%	59%
	55	2579	4137	96%	55%
	62.6	2459	3746	92%	50%
	65.4	2433	3630	91%	48%
	67	2429	3579	91%	47%
	67.3	2446	3627	91%	48%
	75	2349	3477	88%	46%
	80	2211	3380	83%	45%
	86.2	2039	3271	76%	43%
	90	1999	3223	75%	43%
	101.7	1907	3054	71.2%	40%
	102	1902	3052	71%	40%
	120.8	1757	2953	66%	39%
	121.8	1781	2999	67%	40%
	124.4	1756	3004	66%	40%
	150	1677	3130	63%	41%
	161.9	1565	3135	58%	42%
	166	1532	3220	57%	43%
	200	1278	3294	48%	44%
	250	983	3081	37%	41%
	300	711	2821	27%	37%
	375	348	1994	13%	26%

Table A.3-20. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Below Thunderbird Creek expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1175	NA	23%	
	18.1	2085	NA	41%	
	22.2	2515	NA	50%	
	24.7	2698	NA	54%	
	30	3083	NA	61%	
	35	3486	NA	69%	
	40	3851	NA	77%	
	45	4084	NA	81%	
	50	4331	NA	86%	
	55	4522	NA	90%	
	62.6	4669	NA	93%	
	65.4	4697	NA	93%	
	67	4725	NA	94%	
	67.3	4795	NA	95%	
	75	4876	NA	97%	
	80	4904	NA	97%	
	86.2	4924	NA	98%	
	90	4956	NA	98%	
	101.7	5006	NA	99%	
	102	5015	NA	100%	
	120.8	5002	NA	99%	
	121.8	5032	NA	100%	
	124.4	5003	NA	99%	
	150	5000	NA	99%	
	161.9	4851	NA	96%	
	166	4857	NA	97%	
	200	4546	NA	90%	
	250	3874	NA	77%	
	300	3069	NA	61%	
	375	1947	NA	39%	

Table A.3-21. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Below Thunderbird Creek expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1653	9806	35%	87%
	18.1	2650	10339	55%	92%
	22.2	3043	10742	64%	95%
	24.7	3191	10888	67%	97%
	30	3503	11102	73%	99%
	35	3882	11255	81%	100%
	40	4211	11117	88%	99%
	45	4361	10723	91%	95%
	50	4544	10156	95%	90%
	55	4671	9493	98%	84%
	62.6	4726	8567	99%	76%
	65.4	4710	8298	99%	74%
	67	4716	8162	99%	73%
	67.3	4780	8215	100%	73%
	75	4759	7754	100%	69%
	80	4731	7431	99%	66%
	86.2	4692	7076	98%	63%
	90	4704	6923	98%	62%
	101.7	4703	6480	98%	58%
	102	4713	6475	99%	58%
	120.8	4582	6121	96%	54%
	121.8	4604	6179	96%	55%
	124.4	4564	6146	95%	55%
	150	4437	6082	93%	54%
	161.9	4262	5988	89%	53%
	166	4268	6067	89%	54%
	200	4007	6149	84%	55%
	250	3466	6200	73%	55%
	300	2847	6076	60%	54%
	375	2072	5291	43%	47%

Table A.3-22. Habitat vs. flow relationship for Chinook Salmon spawning and juvenile rearing for Above Thunderbird Creek expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Chinook	10	423	6110	21%	58%
	18.1	998	7164	51%	68%
	22.2	1177	7524	60%	72%
	24.7	1284	7726	65%	74%
	30	1381	8123	70%	78%
	35	1424	8241	72%	79%
	40	1469	8622	74%	82%
	45	1494	8748	76%	84%
	50	1509	9005	77%	86%
	55	1518	9102	77%	87%
	62.6	1528	9253	78%	88%
	65.4	1530	9342	78%	89%
	67	1541	9381	78%	90%
	67.3	1540	9360	78%	89%
	75	1559	9474	79%	90%
	80	1574	9554	80%	91%
	86.2	1602	9655	81%	92%
	90	1642	9710	83%	93%
	101.7	1770	9923	89.8%	95%
	102	1772	9911	90%	95%
	120.8	1886	10447	96%	100%
	121.8	1894	10473	96%	100%
	124.4	1898	10434	96%	100%
	150	1961	10301	99%	98%
	161.9	1971	10273	100%	98%
	166	1968	10199	100%	97%
	200	1886	9740	96%	93%
	250	1866	8469	95%	81%
	300	1881	7124	95%	68%
	375	1675	5841	85%	56%

Table A.3-23. Habitat vs. flow relationship for Sockeye Salmon spawning and juvenile rearing for Above Thunderbird Creek expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Optimal	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Sockeye	10	1410	NA	58%	
	18.1	1954	NA	80%	
	22.2	2135	NA	87%	
	24.7	2219	NA	91%	
	30	2333	NA	95%	
	35	2401	NA	98%	
	40	2423	NA	99%	
	45	2432	NA	99%	
	50	2446	NA	100%	
	55	2445	NA	100%	
	62.6	2436	NA	100%	
	65.4	2420	NA	99%	
	67	2424	NA	99%	
	67.3	2413	NA	99%	
	75	2365	NA	97%	
	80	2335	NA	95%	
	86.2	2297	NA	94%	
	90	2271	NA	93%	
	101.7	2189	NA	89%	
	102	2188	NA	89%	
	120.8	2063	NA	84%	
	121.8	2056	NA	84%	
	124.4	2042	NA	83%	
	150	1867	NA	76%	
	161.9	1784	NA	73%	
	166	1761	NA	72%	
	200	1542	NA	63%	
	250	1309	NA	54%	
	300	1141	NA	47%	
	375	976	NA	40%	

Table A.3-24. Habitat vs. flow relationship for Coho Salmon spawning and juvenile rearing for Above Thunderbird Creek expressed as area (ft^2/1,000 ft of stream length) and as a percentage of maximum habitat for a given life stage.

		WUA (ft^2/1,000ft)		% Maximum	
	Q (cfs)	Spawn	Juv	Spawn	Juv
Coho	10	1980	8003	60%	44%
	18.1	2548	9836	77%	54%
	22.2	2737	10520	83%	58%
	24.7	2822	10910	86%	60%
	30	2931	11492	89%	64%
	35	2994	11771	91%	65%
	40	3036	12281	92%	68%
	45	3067	12447	93%	69%
	50	3116	12784	95%	71%
	55	3157	12948	96%	72%
	62.6	3221	13232	98%	73%
	65.4	3238	13375	98%	74%
	67	3249	13452	99%	75%
	67.3	3253	13442	99%	74%
	75	3279	13697	100%	76%
	80	3290	13859	100%	77%
	86.2	3290	14035	100%	78%
	90	3293	14167	100%	78%
	101.7	3272	14636	99%	81%
	102	3269	14620	99%	81%
	120.8	3171	15822	96%	88%
	121.8	3166	15881	96%	88%
	124.4	3162	15946	96%	88%
	150	3098	16813	94%	93%
	161.9	3050	17238	93%	96%
	166	3030	17305	92%	96%
	200	2873	18050	87%	100%
	250	2564	17670	78%	98%
	300	2256	16322	69%	90%
	375	1879	14511	57%	80%

Appendix 4: Reach Based Habitat Areas and Percentages of Total Habitat for the Different Flow Release Options and Flow Levels

Table A.4-1. Time Series A reach-based estimates of Chinook juvenile rearing habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Juvenile Rearing – Time Series A – Option A										
	Baseline		Option A – Level 1		Option A – Level 2		Option A – Level 3		Option A – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	9.7	88%	17.3	73%	13.5	81%	10.5	82%	10.2	84%
Reach 4	1.0	9%	4.2	18%	1.5	9%	1.1	8%	1.0	9%
Reach 5	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 6	0.2	2%	0.4	2%	0.2	1%	0.2	2%	0.2	2%
Reach 7	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 8	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 9	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 10	0.2	2%	1.9	8%	1.5	9%	1.0	8%	0.7	6%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	10.6	96%	21.5	90%	15.0	90%	11.6	90%	11.3	92%
Upper Eklutna	0.4	4%	2.3	10%	1.7	10%	1.3	10%	1.0	8%
Total	**11.0**	**100%**	**23.8**	**100%**	**16.8**	**100%**	**12.8**	**100%**	**12.2**	**100%**

Table A.4-2. Time Series A reach-based estimates of Chinook juvenile rearing habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Juvenile Rearing – Time Series A – Option B										
	Baseline		Option B – Level 1		Option B – Level 2		Option B – Level 3		Option B – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	9.7	88%	17.3	73%	13.5	81%	10.5	82%	10.2	84%
Reach 4	1.0	9%	4.2	18%	1.5	9%	1.1	8%	1.0	9%
Reach 5	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 6	0.2	2%	0.4	2%	0.2	1%	0.2	2%	0.2	2%
Reach 7	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 8	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 9	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 10	0.2	2%	1.9	8%	1.5	9%	1.0	8%	0.7	6%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	10.6	96%	21.5	90%	15.0	90%	11.6	90%	11.3	92%
Upper Eklutna	0.4	4%	2.3	10%	1.7	10%	1.3	10%	1.0	8%
Total	**11.0**	**100%**	**23.8**	**100%**	**16.8**	**100%**	**12.8**	**100%**	**12.2**	**100%**

Table A.4-3. Time Series A reach-based estimates of Chinook juvenile rearing habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Juvenile Rearing – Time Series A – Option C										
	Baseline		**Option C – Level 1**		**Option C – Level 2**		**Option C – Level 3**		**Option C – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	9.7	88%	17.3	79%	13.5	88%	10.5	88%	10.2	88%
Reach 4	1.0	9%	4.2	19%	1.5	10%	1.1	9%	1.0	9%
Reach 5	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 6	0.2	2%	0.4	2%	0.2	1%	0.2	2%	0.2	2%
Reach 7	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 8	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 9	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 10	0.2	2%	0.2	1%	0.2	1%	0.2	1%	0.2	1%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	10.6	96%	21.5	97%	15.0	98%	11.6	97%	11.3	96%
Upper Eklutna	0.4	4%	0.6	3%	0.3	2%	0.4	3%	0.4	4%
Total	**11.0**	**100%**	**22.0**	**100%**	**15.4**	**100%**	**12.0**	**100%**	**11.7**	**100%**

Table A.4-4. Time Series A reach-based estimates of Coho juvenile rearing habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Juvenile Rearing – Time Series A – Option A										
	Baseline		**Option A – Level 1**		**Option A – Level 2**		**Option A – Level 3**		**Option A – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	11.4	85%	21.3	70%	16.2	76%	12.4	78%	12.0	80%
Reach 4	1.2	9%	5.3	18%	2.0	9%	1.3	8%	1.3	8%
Reach 5	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 6	0.5	4%	0.6	2%	0.4	2%	0.6	4%	0.6	4%
Reach 7	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 8	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 9	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 10	0.3	2%	3.2	11%	2.8	13%	1.6	10%	1.1	7%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	12.5	94%	26.6	87%	18.2	85%	13.7	86%	13.3	89%
Upper Eklutna	0.8	6%	3.8	13%	3.1	15%	2.1	14%	1.7	11%
Total	**13.3**	**100%**	**30.5**	**100%**	**21.4**	**100%**	**15.8**	**100%**	**15.0**	**100%**

Table A.4-5. Time Series A reach-based estimates of Coho juvenile rearing habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Juvenile Rearing – Time Series A – Option B										
	Baseline		Option B – Level 1		Option B – Level 2		Option B – Level 3		Option B – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	11.4	85%	21.3	70%	16.2	76%	12.4	78%	12.0	80%
Reach 4	1.2	9%	5.3	18%	2.0	9%	1.3	8%	1.3	8%
Reach 5	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 6	0.5	4%	0.6	2%	0.4	2%	0.6	4%	0.6	4%
Reach 7	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 8	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 9	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 10	0.3	2%	3.2	11%	2.8	13%	1.6	10%	1.1	7%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	12.5	94%	26.6	87%	18.2	85%	13.7	86%	13.3	89%
Upper Eklutna	0.8	6%	3.8	13%	3.1	15%	2.1	14%	1.7	11%
Total	**13.3**	**100%**	**30.5**	**100%**	**21.4**	**100%**	**15.8**	**100%**	**15.0**	**100%**

Table A.4-6. Time Series A reach-based estimates of Coho juvenile rearing habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Juvenile Rearing – Time Series A – Option C										
	Baseline		**Option C – Level 1**		**Option C – Level 2**		**Option C – Level 3**		**Option C – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	11.4	85%	21.3	77%	16.2	86%	12.4	85%	12.0	85%
Reach 4	1.2	9%	5.3	19%	2.0	11%	1.3	9%	1.3	9%
Reach 5	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 6	0.5	4%	0.6	2%	0.4	2%	0.6	4%	0.6	4%
Reach 7	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 8	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 9	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Reach 10	0.3	2%	0.3	1%	0.3	1%	0.3	2%	0.3	2%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	12.5	94%	26.6	97%	18.2	97%	13.7	94%	13.3	94%
Upper Eklutna	0.8	6%	0.9	3%	0.6	3%	0.8	6%	0.8	6%
Total	**13.3**	**100%**	**27.5**	**100%**	**18.9**	**100%**	**14.5**	**100%**	**14.1**	**100%**

Table A.4-7. Time Series B reach-based estimates of Chinook juvenile rearing habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Juvenile Rearing – Time Series B – Option A										
	Baseline		Option A – Level 1		Option A – Level 2		Option A – Level 3		Option A – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	9.7	81%	16.7	55%	13.1	58%	10.7	61%	10.4	64%
Reach 4	1.0	8%	4.1	13%	1.3	6%	1.1	6%	1.0	6%
Reach 5	0.4	3%	0.3	1%	0.3	1%	0.4	2%	0.4	2%
Reach 6	0.2	2%	0.3	1%	0.2	1%	0.2	1%	0.2	1%
Reach 7	0.2	2%	0.9	3%	0.7	3%	0.4	2%	0.3	2%
Reach 8	0.2	2%	0.7	2%	0.6	3%	0.5	3%	0.5	3%
Reach 9	0.1	1%	0.4	1%	0.2	1%	0.2	1%	0.2	1%
Reach 10	0.2	1%	1.8	6%	1.5	7%	1.1	6%	0.9	6%
Reach 11	0.0	0%	5.4	18%	4.7	21%	3.0	17%	2.3	14%
Lower Eklutna	11.0	93%	21.1	69%	14.7	65%	12.2	69%	11.8	73%
Upper Eklutna	0.9	7%	9.5	31%	7.9	35%	5.4	31%	4.4	27%
Total	**11.9**	**100%**	**30.6**	**100%**	**22.6**	**100%**	**17.6**	**100%**	**16.2**	**100%**

Table A.4-8. Time Series B reach-based estimates of Chinook juvenile rearing habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Juvenile Rearing – Time Series B – Option B										
	Baseline		**Option B – Level 1**		**Option B – Level 2**		**Option B – Level 3**		**Option B – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	9.7	81%	16.7	59%	13.0	64%	10.7	66%	10.4	68%
Reach 4	1.0	8%	4.1	14%	1.3	6%	1.1	7%	1.0	7%
Reach 5	0.4	3%	0.3	1%	0.3	2%	0.4	2%	0.4	3%
Reach 6	0.2	2%	0.3	1%	0.2	1%	0.2	1%	0.2	2%
Reach 7	0.2	2%	0.9	3%	0.7	3%	0.4	2%	0.3	2%
Reach 8	0.2	2%	0.7	3%	0.6	3%	0.5	3%	0.5	3%
Reach 9	0.1	1%	0.4	1%	0.2	1%	0.2	1%	0.2	1%
Reach 10	0.2	1%	1.8	6%	1.5	7%	1.1	7%	0.9	6%
Reach 11	0.0	0%	3.0	11%	2.6	13%	1.7	10%	1.3	8%
Lower Eklutna	11.0	93%	21.0	75%	14.6	72%	12.2	75%	11.8	78%
Upper Eklutna	0.9	7%	7.1	25%	5.8	28%	4.1	25%	3.4	22%
Total	**11.9**	**100%**	**28.1**	**100%**	**20.4**	**100%**	**16.3**	**100%**	**15.2**	**100%**

Table A.4-9. Time Series B reach-based estimates of Chinook juvenile rearing habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Juvenile Rearing – Time Series B – Option C										
	Baseline		Option C – Level 1		Option C – Level 2		Option C – Level 3		Option C – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	9.7	81%	16.7	73%	13.0	81%	10.7	80%	10.4	80%
Reach 4	1.0	8%	4.1	18%	1.3	8%	1.1	8%	1.0	8%
Reach 5	0.4	3%	0.3	1%	0.3	2%	0.4	3%	0.4	3%
Reach 6	0.2	2%	0.3	1%	0.2	1%	0.2	2%	0.2	2%
Reach 7	0.2	2%	0.9	4%	0.7	4%	0.4	3%	0.3	3%
Reach 8	0.2	2%	0.4	2%	0.4	2%	0.3	2%	0.3	2%
Reach 9	0.1	1%	0.1	0%	0.1	0%	0.1	1%	0.1	1%
Reach 10	0.2	1%	0.2	1%	0.2	1%	0.2	1%	0.2	1%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	11.0	93%	21.0	92%	14.6	91%	12.2	91%	11.8	91%
Upper Eklutna	0.9	7%	21.0	92%	14.6	91%	12.2	91%	11.8	91%
Total	**11.9**	**100%**	**22.9**	**100%**	**16.0**	**100%**	**13.3**	**100%**	**12.9**	**100%**

Table A.4-10. Time Series B reach-based estimates of Coho juvenile rearing habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Juvenile Rearing – Time Series B – Option A										
	Baseline		Option A – Level 1		Option A – Level 2		Option A – Level 3		Option A – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	11.4	77%	20.5	50%	15.7	52%	12.7	56%	12.3	59%
Reach 4	1.2	8%	5.1	12%	1.7	6%	1.3	6%	1.3	6%
Reach 5	0.8	5%	0.6	2%	0.8	2%	0.8	3%	0.8	4%
Reach 6	0.5	3%	0.5	1%	0.4	1%	0.6	2%	0.6	3%
Reach 7	0.3	2%	1.4	3%	1.3	4%	0.7	3%	0.6	3%
Reach 8	0.3	2%	1.1	3%	0.9	3%	0.8	4%	0.7	3%
Reach 9	0.1	1%	0.6	1%	0.4	1%	0.4	2%	0.3	2%
Reach 10	0.3	2%	3.1	7%	2.7	9%	1.8	8%	1.4	7%
Reach 11	0.0	0%	8.4	20%	6.5	21%	3.9	17%	2.9	14%
Lower Eklutna	13.3	90%	26.2	63%	18.2	60%	14.8	65%	14.3	69%
Upper Eklutna	1.5	10%	15.1	37%	12.2	40%	8.0	35%	6.4	31%
Total	**14.8**	**100%**	**41.3**	**100%**	**30.4**	**100%**	**22.8**	**100%**	**20.8**	**100%**

Table A.4-11. Time Series B reach-based estimates of Coho juvenile rearing habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Juvenile Rearing – Time Series B – Option B										
	Baseline		**Option B – Level 1**		**Option B – Level 2**		**Option B – Level 3**		**Option B – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	11.4	77%	20.4	54%	15.6	57%	12.6	60%	12.2	63%
Reach 4	1.2	8%	5.0	13%	1.7	6%	1.3	6%	1.3	7%
Reach 5	0.8	5%	0.6	2%	0.8	3%	0.8	4%	0.8	4%
Reach 6	0.5	3%	0.5	1%	0.4	1%	0.6	3%	0.6	3%
Reach 7	0.3	2%	1.4	4%	1.2	4%	0.7	3%	0.6	3%
Reach 8	0.3	2%	1.1	3%	0.9	3%	0.8	4%	0.7	4%
Reach 9	0.1	1%	0.6	2%	0.4	2%	0.4	2%	0.3	2%
Reach 10	0.3	2%	3.1	8%	2.6	10%	1.7	8%	1.4	7%
Reach 11	0.0	0%	4.7	13%	3.6	13%	2.1	10%	1.6	8%
Lower Eklutna	13.3	90%	26.1	70%	18.0	66%	14.8	70%	14.3	74%
Upper Eklutna	1.5	10%	11.4	30%	9.2	34%	6.3	30%	5.1	26%
Total	**14.8**	**100%**	**37.5**	**100%**	**27.2**	**100%**	**21.0**	**100%**	**19.4**	**100%**

Table A.4-12. Time Series B reach-based estimates of Coho juvenile rearing habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Juvenile Rearing – Time Series B – Option C										
	Baseline		**Option C – Level 1**		**Option C – Level 2**		**Option C – Level 3**		**Option C – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	11.4	77%	20.4	70%	15.6	76%	12.6	75%	12.2	75%
Reach 4	1.2	8%	5.0	17%	1.7	8%	1.3	8%	1.3	8%
Reach 5	0.8	5%	0.6	2%	0.8	4%	0.8	5%	0.8	5%
Reach 6	0.5	3%	0.5	2%	0.4	2%	0.6	3%	0.6	4%
Reach 7	0.3	2%	1.4	5%	1.2	6%	0.7	4%	0.6	3%
Reach 8	0.3	2%	0.6	2%	0.6	3%	0.5	3%	0.5	3%
Reach 9	0.1	1%	0.1	0%	0.1	1%	0.1	1%	0.1	1%
Reach 10	0.3	2%	0.3	1%	0.3	1%	0.3	2%	0.3	2%
Reach 11	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Lower Eklutna	13.3	90%	26.1	90%	18.0	88%	14.8	88%	14.3	88%
Upper Eklutna	1.5	10%	2.9	10%	2.6	12%	2.1	12%	2.0	12%
Total	**14.8**	**100%**	**29.0**	**100%**	**20.6**	**100%**	**16.9**	**100%**	**16.3**	**100%**

Table A.4-13. Time Series B reach-based estimates of Chinook spawning habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Spawning – Time Series B – Option A										
	Baseline		Option A – Level 1		Option A – Level 2		Option A – Level 3		Option A – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.19	38%	0.06	4%	0.15	11%	0.18	15%	0.18	18%
Reach 5	0.25	48%	0.22	15%	0.23	17%	0.24	20%	0.24	24%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.02	5%	0.09	6%	0.12	8%	0.09	8%	0.07	7%
Reach 8	0.03	6%	0.25	17%	0.29	21%	0.24	21%	0.18	18%
Reach 9	0.02	3%	0.10	7%	0.08	6%	0.09	7%	0.09	9%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.78	52%	0.50	37%	0.34	29%	0.23	23%
Lower Eklutna	0.44	86%	0.28	19%	0.38	28%	0.41	35%	0.42	43%
Upper Eklutna	0.07	14%	1.22	81%	0.99	72%	0.77	65%	0.57	57%
Total	**0.51**	**100%**	**1.50**	**100%**	**1.37**	**100%**	**1.18**	**100%**	**0.99**	**100%**

Table A.4-14. Time Series B reach-based estimates of Chinook spawning habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Spawning – Time Series B – Option B										
	Baseline		Option B – Level 1		Option B – Level 2		Option B – Level 3		Option B – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.19	38%	0.07	6%	0.16	14%	0.18	18%	0.18	22%
Reach 5	0.25	48%	0.22	19%	0.23	21%	0.24	24%	0.24	28%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.02	5%	0.10	8%	0.11	10%	0.09	9%	0.07	8%
Reach 8	0.03	6%	0.25	22%	0.28	25%	0.23	23%	0.17	20%
Reach 9	0.02	3%	0.10	8%	0.09	8%	0.09	9%	0.08	9%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.43	37%	0.26	23%	0.18	18%	0.11	13%
Lower Eklutna	0.44	86%	0.29	25%	0.39	35%	0.41	41%	0.42	50%
Upper Eklutna	0.07	14%	0.87	75%	0.74	65%	0.59	59%	0.43	50%
Total	**0.51**	**100%**	**1.16**	**100%**	**1.13**	**100%**	**1.00**	**100%**	**0.86**	**100%**

Table A.4-15. Time Series B reach-based estimates of Chinook spawning habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Chinook Spawning – Time Series B – Option C										
	Baseline		**Option C – Level 1**		**Option C – Level 2**		**Option C – Level 3**		**Option C – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.19	38%	0.07	13%	0.16	25%	0.18	28%	0.18	31%
Reach 5	0.25	48%	0.22	43%	0.23	36%	0.24	38%	0.24	40%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.02	5%	0.10	19%	0.11	17%	0.09	14%	0.07	12%
Reach 8	0.03	6%	0.11	22%	0.13	20%	0.11	17%	0.08	14%
Reach 9	0.02	3%	0.02	3%	0.02	3%	0.02	3%	0.02	3%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Lower Eklutna	0.44	86%	0.29	56%	0.39	61%	0.41	66%	0.42	71%
Upper Eklutna	0.07	14%	0.23	44%	0.25	39%	0.22	34%	0.17	29%
Total	**0.51**	**100%**	**0.51**	**100%**	**0.65**	**100%**	**0.63**	**100%**	**0.60**	**100%**

Table A.4-16. Time Series B reach-based estimates of Coho spawning habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Spawning – Time Series B – Option A										
	Baseline		Option A – Level 1		Option A – Level 2		Option A – Level 3		Option A – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.35	30%	0.23	7%	0.32	10%	0.34	12%	0.34	13%
Reach 5	0.45	39%	0.56	18%	0.53	17%	0.51	18%	0.50	19%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.12	10%	0.27	9%	0.38	12%	0.34	12%	0.30	12%
Reach 8	0.21	18%	0.35	11%	0.57	18%	0.59	21%	0.57	22%
Reach 9	0.03	2%	0.13	4%	0.08	3%	0.08	3%	0.08	3%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	1.57	50%	1.19	39%	0.95	34%	0.82	32%
Lower Eklutna	0.80	69%	0.79	25%	0.85	28%	0.85	30%	0.84	32%
Upper Eklutna	0.36	31%	2.33	75%	2.21	72%	1.96	70%	1.77	68%
Total	**1.16**	**100%**	**3.12**	**100%**	**3.07**	**100%**	**2.81**	**100%**	**2.62**	**100%**

Table A.4-17. Time Series B reach-based estimates of Coho spawning habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Spawning – Time Series B – Option B										
	Baseline		Option B – Level 1		Option B – Level 2		Option B – Level 3		Option B – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.35	30%	0.23	9%	0.33	13%	0.34	14%	0.35	16%
Reach 5	0.45	39%	0.56	23%	0.52	21%	0.51	21%	0.49	22%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.12	10%	0.27	11%	0.36	14%	0.33	14%	0.29	13%
Reach 8	0.21	18%	0.36	15%	0.59	23%	0.59	25%	0.56	25%
Reach 9	0.03	2%	0.13	5%	0.08	3%	0.08	3%	0.08	3%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.89	36%	0.63	25%	0.52	22%	0.45	20%
Lower Eklutna	0.80	69%	0.79	32%	0.85	34%	0.85	36%	0.84	38%
Upper Eklutna	0.36	31%	1.65	68%	1.66	66%	1.53	64%	1.37	62%
Total	**1.16**	**100%**	**2.44**	**100%**	**2.51**	**100%**	**2.37**	**100%**	**2.21**	**100%**

Table A.4-18. Time Series B reach-based estimates of Coho spawning habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Coho Spawning – Time Series B – Option C										
	Baseline		Option C – Level 1		Option C – Level 2		Option C – Level 3		Option C – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.35	30%	0.23	17%	0.33	21%	0.34	22%	0.35	23%
Reach 5	0.45	39%	0.56	42%	0.52	33%	0.51	32%	0.49	33%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.12	10%	0.27	20%	0.36	23%	0.33	21%	0.29	19%
Reach 8	0.21	18%	0.26	19%	0.35	22%	0.35	23%	0.34	23%
Reach 9	0.03	2%	0.03	2%	0.03	2%	0.03	2%	0.03	2%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Lower Eklutna	0.80	69%	0.79	59%	0.85	53%	0.85	54%	0.84	56%
Upper Eklutna	0.36	31%	0.56	41%	0.74	47%	0.72	46%	0.66	44%
Total	**1.16**	**100%**	**1.36**	**100%**	**1.60**	**100%**	**1.56**	**100%**	**1.50**	**100%**

Table A.4-19. Time Series B reach-based estimates of Sockeye spawning habitats provided under Option A flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Sockeye Spawning – Time Series B – Option A										
	Baseline		**Option A – Level 1**		**Option A – Level 2**		**Option A – Level 3**		**Option A – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.31	31%	0.25	10%	0.33	12%	0.33	14%	0.33	15%
Reach 5	0.44	44%	0.63	25%	0.55	20%	0.52	21%	0.50	23%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.09	9%	0.24	10%	0.38	14%	0.32	13%	0.27	12%
Reach 8	0.15	14%	0.22	9%	0.52	19%	0.54	22%	0.50	22%
Reach 9	0.02	2%	0.12	5%	0.08	3%	0.08	3%	0.08	3%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	1.04	41%	0.85	31%	0.64	26%	0.55	25%
Lower Eklutna	0.75	74%	0.88	35%	0.88	32%	0.85	35%	0.83	37%
Upper Eklutna	0.26	26%	1.62	65%	1.84	68%	1.59	65%	1.39	63%
Total	**1.01**	**100%**	**2.50**	**100%**	**2.72**	**100%**	**2.43**	**100%**	**2.22**	**100%**

Table A.4-20. Time Series B reach-based estimates of Sockeye spawning habitats provided under Option B flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Sockeye Spawning – Time Series B – Option B										
	Baseline		Option B – Level 1		Option B – Level 2		Option B – Level 3		Option B – Level 4	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.31	31%	0.26	12%	0.33	14%	0.33	15%	0.33	17%
Reach 5	0.44	44%	0.63	30%	0.54	24%	0.52	24%	0.50	26%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.09	9%	0.25	12%	0.36	16%	0.31	15%	0.26	13%
Reach 8	0.15	14%	0.23	11%	0.54	24%	0.54	25%	0.48	25%
Reach 9	0.02	2%	0.12	6%	0.08	4%	0.08	4%	0.07	4%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.59	28%	0.44	19%	0.35	16%	0.30	15%
Lower Eklutna	0.75	74%	0.88	43%	0.87	38%	0.85	40%	0.83	43%
Upper Eklutna	0.26	26%	1.18	57%	1.42	62%	1.28	60%	1.11	57%
Total	**1.01**	**100%**	**2.07**	**100%**	**2.29**	**100%**	**2.13**	**100%**	**1.93**	**100%**

Table A.4-21. Time Series B reach-based estimates of Sockeye spawning habitats provided under Option C flow release location for the baseline condition and the four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) expressed as acres and percentages of total habitat amounts. Amounts and percentages noted for Upper Eklutna include amounts in R11, R10, R9, R8, R7, and R6; for Lower Eklutna River – R5, R4, and R3.

Sockeye Spawning – Time Series B – Option C										
	Baseline		**Option C – Level 1**		**Option C – Level 2**		**Option C – Level 3**		**Option C – Level 4**	
	Acres	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Reach 3	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 4	0.31	31%	0.26	19%	0.33	21%	0.33	22%	0.33	24%
Reach 5	0.44	44%	0.63	47%	0.54	35%	0.52	35%	0.50	36%
Reach 6	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 7	0.09	9%	0.25	19%	0.36	23%	0.31	21%	0.26	19%
Reach 8	0.15	14%	0.17	13%	0.30	19%	0.30	20%	0.27	20%
Reach 9	0.02	2%	0.02	2%	0.02	1%	0.02	1%	0.02	2%
Reach 10	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Reach 11	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Lower Eklutna	0.75	74%	0.88	66%	0.87	56%	0.85	57%	0.83	60%
Upper Eklutna	0.26	26%	0.45	34%	0.68	44%	0.63	43%	0.56	40%
Total	**1.01**	**100%**	**1.33**	**100%**	**1.55**	**100%**	**1.48**	**100%**	**1.38**	**100%**

Table A.4-22. Time Series A - Comparative summary of Chinook juvenile time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Chinook Juvenile Rearing – Time Series A						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Baseline		Lower Eklutna	10.6	96%	0.00	0%
		Upper Eklutna	0.4	4%	0.00	0%
		Total	**11.0**	**100%**	0.00	**0%**
Option A	Flow Level 1	Lower Eklutna	21.5	90%	10.84	100%
		Upper Eklutna	2.3	10%	1.89	490%
		Total	23.8	**100%**	12.74	**120%**
	Flow Level 2	Lower Eklutna	15.0	90%	4.40	40%
		Upper Eklutna	1.7	10%	1.32	340%
		Total	16.8	**100%**	5.72	**50%**
	Flow Level 3	Lower Eklutna	11.6	90%	0.93	10%
		Upper Eklutna	1.3	10%	0.88	230%
		Total	12.8	**100%**	1.80	**20%**
	Flow Level 4	Lower Eklutna	11.3	92%	0.60	10%
		Upper Eklutna	1.0	8%	0.59	150%
		Total	12.2	**100%**	1.19	**10%**
Option B	Flow Level 1	Lower Eklutna	21.5	90%	10.84	100%
		Upper Eklutna	2.3	10%	1.89	490%
		Total	23.8	**100%**	12.74	**120%**
	Flow Level 2	Lower Eklutna	15.0	90%	4.40	40%
		Upper Eklutna	1.7	10%	1.32	340%
		Total	16.8	**100%**	5.72	**50%**
	Flow Level 3	Lower Eklutna	11.6	90%	0.93	10%
		Upper Eklutna	1.3	10%	0.88	230%
		Total	12.8	**100%**	1.80	**20%**
	Flow Level 4	Lower Eklutna	11.3	92%	0.60	10%
		Upper Eklutna	1.0	8%	0.59	150%
		Total	12.2	**100%**	1.19	**10%**

Chinook Juvenile Rearing – Time Series A						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Option C	Flow Level 1	Lower Eklutna	21.5	97%	10.84	100%
		Upper Eklutna	0.6	3%	0.17	40%
		Total	22.0	**100%**	11.01	**100%**
	Flow Level 2	Lower Eklutna	15.0	98%	4.40	40%
		Upper Eklutna	0.3	2%	-0.05	-10%
		Total	15.4	**100%**	4.35	**40%**
	Flow Level 3	Lower Eklutna	11.6	97%	0.93	10%
		Upper Eklutna	0.4	3%	0.01	0%
		Total	12.0	**100%**	0.94	**10%**
	Flow Level 4	Lower Eklutna	11.3	96%	0.60	10%
		Upper Eklutna	0.4	4%	0.02	10%
		Total	11.7	**100%**	0.63	**10%**

Table A.4-23. Time Series A- Comparative summary of Coho juvenile time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Coho Juvenile Rearing – Time Series A						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Baseline		Lower Eklutna	12.5	94%	0.00	0%
		Upper Eklutna	0.8	6%	0.00	0%
		Total	**13.3**	**100%**	**0.00**	**0%**
Option A	Flow Level 1	Lower Eklutna	26.6	87%	14.09	110%
		Upper Eklutna	3.8	13%	3.09	410%
		Total	**30.5**	**100%**	**17.17**	**130%**
	Flow Level 2	Lower Eklutna	18.2	85%	5.71	50%
		Upper Eklutna	3.1	15%	2.38	320%
		Total	**21.4**	**100%**	**8.09**	**60%**
	Flow Level 3	Lower Eklutna	13.7	86%	1.15	10%
		Upper Eklutna	2.1	14%	1.39	190%
		Total	**15.8**	**100%**	**2.55**	**20%**
	Flow Level 4	Lower Eklutna	13.3	89%	0.75	10%
		Upper Eklutna	1.7	11%	0.94	120%
		Total	**15.0**	**100%**	**1.68**	**10%**
Option B	Flow Level 1	Lower Eklutna	26.6	87%	14.09	110%
		Upper Eklutna	3.8	13%	3.09	410%
		Total	**30.5**	**100%**	**17.17**	**130%**
	Flow Level 2	Lower Eklutna	18.2	85%	5.71	50%
		Upper Eklutna	3.1	15%	2.38	320%
		Total	**21.4**	**100%**	**8.09**	**60%**
	Flow Level 3	Lower Eklutna	13.7	86%	1.15	10%
		Upper Eklutna	2.1	14%	1.39	190%
		Total	**15.8**	**100%**	**2.55**	**20%**
	Flow Level 4	Lower Eklutna	13.3	89%	0.75	10%
		Upper Eklutna	1.7	11%	0.94	120%
		Total	**15.0**	**100%**	**1.68**	**10%**

Coho Juvenile Rearing – Time Series A						
			Time-Averaged Habitat		Increase Above Baseline	
			Acres	Percent of Total	Acres	Percent
Option C	Flow Level 1	Lower Eklutna	26.6	97%	14.09	110%
		Upper Eklutna	0.9	3%	0.11	10%
		Total	**27.5**	**100%**	**14.20**	**110%**
	Flow Level 2	Lower Eklutna	18.2	97%	5.71	50%
		Upper Eklutna	0.6	3%	-0.13	-20%
		Total	**18.9**	**100%**	**5.58**	**40%**
	Flow Level 3	Lower Eklutna	13.7	94%	1.15	10%
		Upper Eklutna	0.8	6%	0.08	10%
		Total	**14.5**	**100%**	**1.23**	**10%**
	Flow Level 4	Lower Eklutna	13.3	94%	0.75	10%
		Upper Eklutna	0.8	6%	0.08	10%
		Total	**14.1**	**100%**	**0.83**	**10%**

Table A.4-24. Time Series B- Comparative summary of Chinook juvenile time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Chinook Juvenile Rearing – Time Series B						
			Time-Averaged Habitat		Increase Above Baseline	
			Acres	Percent of Total	Acres	Percent
Baseline		Lower Eklutna	11.0	93%	0.00	0%
		Upper Eklutna	0.9	7%	0.00	0%
		Total	**11.9**	**100%**	**0.00**	**0%**
Option A	Flow Level 1	Lower Eklutna	21.1	69%	10.04	90%
		Upper Eklutna	9.5	31%	8.62	1000%
		Total	**30.6**	**100%**	**18.66**	**160%**
	Flow Level 2	Lower Eklutna	14.7	65%	3.66	30%
		Upper Eklutna	7.9	35%	7.06	820%
		Total	**22.6**	**100%**	**10.73**	**90%**
	Flow Level 3	Lower Eklutna	12.2	69%	1.15	10%
		Upper Eklutna	5.4	31%	4.57	530%
		Total	**17.6**	**100%**	**5.72**	**50%**
	Flow Level 4	Lower Eklutna	11.8	73%	0.78	10%
		Upper Eklutna	4.4	27%	3.51	410%
		Total	**16.2**	**100%**	**4.29**	**40%**
Option B	Flow Level 1	Lower Eklutna	21.0	75%	9.97	90%
		Upper Eklutna	7.1	25%	6.27	730%
		Total	**28.1**	**100%**	**16.24**	**140%**
	Flow Level 2	Lower Eklutna	14.6	72%	3.55	30%
		Upper Eklutna	5.8	28%	4.92	570%
		Total	**20.4**	**100%**	**8.48**	**70%**
	Flow Level 3	Lower Eklutna	12.2	75%	1.12	10%
		Upper Eklutna	4.1	25%	3.24	380%
		Total	**16.3**	**100%**	**4.37**	**40%**
	Flow Level 4	Lower Eklutna	11.8	78%	0.76	10%
		Upper Eklutna	3.4	22%	2.50	290%
		Total	**15.2**	**100%**	**3.26**	**30%**

Chinook Juvenile Rearing – Time Series B						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Option C	Flow Level 1	Lower Eklutna	21.0	92%	9.97	90%
		Upper Eklutna	1.9	8%	1.02	120%
		Total	**22.9**	**100%**	**10.99**	**90%**
	Flow Level 2	Lower Eklutna	14.6	91%	3.55	30%
		Upper Eklutna	1.5	9%	0.60	70%
		Total	**16.0**	**100%**	**4.15**	**30%**
	Flow Level 3	Lower Eklutna	12.2	91%	1.12	10%
		Upper Eklutna	1.2	9%	0.31	40%
		Total	**13.3**	**100%**	**1.44**	**10%**
	Flow Level 4	Lower Eklutna	11.8	91%	0.76	10%
		Upper Eklutna	1.1	9%	0.26	30%
		Total	**12.9**	**100%**	**1.02**	**10%**

Table A.4-25. Time Series B - Comparative summary of Coho juvenile time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Coho Juvenile Rearing – Time Series B						
			Time-Averaged Habitat		Increase Above Baseline	
			Acres	Percent of Total	Acres	Percent
Baseline		Lower Eklutna	13.3	90%	0.00	0%
		Upper Eklutna	1.5	10%	0.00	0%
		Total	**14.8**	**100%**	**0.00**	**0%**
Option A	Flow Level 1	Lower Eklutna	26.2	63%	12.89	100%
		Upper Eklutna	15.1	37%	13.63	920%
		Total	**41.3**	**100%**	**26.52**	**180%**
	Flow Level 2	Lower Eklutna	18.2	60%	4.87	40%
		Upper Eklutna	12.2	40%	10.71	720%
		Total	**30.4**	**100%**	**15.59**	**110%**
	Flow Level 3	Lower Eklutna	14.8	65%	1.49	10%
		Upper Eklutna	8.0	35%	6.53	440%
		Total	**22.8**	**100%**	**8.02**	**50%**
	Flow Level 4	Lower Eklutna	14.3	69%	1.02	10%
		Upper Eklutna	6.4	31%	4.95	330%
		Total	**20.8**	**100%**	**5.97**	**40%**
Option B	Flow Level 1	Lower Eklutna	26.1	70%	12.80	100%
		Upper Eklutna	11.4	30%	9.95	670%
		Total	**37.5**	**100%**	**22.75**	**150%**
	Flow Level 2	Lower Eklutna	18.0	66%	4.73	40%
		Upper Eklutna	9.2	34%	7.74	520%
		Total	**27.2**	**100%**	**12.46**	**80%**
	Flow Level 3	Lower Eklutna	14.8	70%	1.46	10%
		Upper Eklutna	6.3	30%	4.80	320%
		Total	**21.0**	**100%**	**6.26**	**40%**
	Flow Level 4	Lower Eklutna	14.3	74%	0.99	10%
		Upper Eklutna	5.1	26%	3.64	250%
		Total	**19.4**	**100%**	**4.63**	**30%**

Coho Juvenile Rearing – Time Series B						
			Time-Averaged Habitat		Increase Above Baseline	
			Acres	Percent of Total	Acres	Percent
Option C	Flow Level 1	Lower Eklutna	26.1	90%	12.80	100%
		Upper Eklutna	2.9	10%	1.47	100%
		Total	**29.0**	**100%**	**14.27**	**100%**
	Flow Level 2	Lower Eklutna	18.0	88%	4.73	40%
		Upper Eklutna	2.6	12%	1.08	70%
		Total	**20.6**	**100%**	**5.81**	**40%**
	Flow Level 3	Lower Eklutna	14.8	88%	1.46	10%
		Upper Eklutna	2.1	12%	0.63	40%
		Total	**16.9**	**100%**	**2.09**	**10%**
	Flow Level 4	Lower Eklutna	14.3	88%	0.99	10%
		Upper Eklutna	2.0	12%	0.50	30%
		Total	**16.3**	**100%**	**1.49**	**10%**

Table A.4-26. Time Series B - Comparative summary of Chinook spawning time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Chinook Spawning – Time Series B						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Baseline		Lower Eklutna	0.44	86%	0.00	0%
		Upper Eklutna	0.07	14%	0.00	0%
		Total	**0.51**	**100%**	**0.00**	**0%**
Option A	Flow Level 1	Lower Eklutna	0.28	19%	-0.15	-40%
		Upper Eklutna	1.22	81%	1.15	1640%
		Total	**1.50**	**100%**	**0.99**	**200%**
	Flow Level 2	Lower Eklutna	0.38	28%	-0.06	-10%
		Upper Eklutna	0.99	72%	0.92	1310%
		Total	**1.37**	**100%**	**0.86**	**170%**
	Flow Level 3	Lower Eklutna	0.41	35%	-0.03	-10%
		Upper Eklutna	0.77	65%	0.70	990%
		Total	**1.18**	**100%**	**0.67**	**130%**
	Flow Level 4	Lower Eklutna	0.42	43%	-0.01	0%
		Upper Eklutna	0.57	57%	0.50	710%
		Total	**0.99**	**100%**	**0.49**	**100%**
Option B	Flow Level 1	Lower Eklutna	0.29	25%	-0.15	-30%
		Upper Eklutna	0.87	75%	0.80	1140%
		Total	**1.16**	**100%**	**0.65**	**130%**
	Flow Level 2	Lower Eklutna	0.39	35%	-0.04	-10%
		Upper Eklutna	0.74	65%	0.67	950%
		Total	**1.13**	**100%**	**0.62**	**120%**
	Flow Level 3	Lower Eklutna	0.41	41%	-0.02	-10%
		Upper Eklutna	0.59	59%	0.52	740%
		Total	**1.00**	**100%**	**0.50**	**100%**
	Flow Level 4	Lower Eklutna	0.42	50%	-0.01	0%
		Upper Eklutna	0.43	50%	0.36	520%
		Total	**0.86**	**100%**	**0.35**	**70%**

Chinook Spawning – Time Series B						
			Time-Averaged Habitat		Increase Above Baseline	
			Acres	Percent of Total	Acres	Percent
Option C	Flow Level 1	Lower Eklutna	0.29	56%	-0.15	-30%
		Upper Eklutna	0.23	44%	0.16	230%
		Total	**0.51**	**100%**	**0.01**	**0%**
	Flow Level 2	Lower Eklutna	0.39	61%	-0.04	-10%
		Upper Eklutna	0.25	39%	0.18	260%
		Total	**0.65**	**100%**	**0.14**	**30%**
	Flow Level 3	Lower Eklutna	0.41	66%	-0.02	-10%
		Upper Eklutna	0.22	34%	0.15	210%
		Total	**0.63**	**100%**	**0.12**	**20%**
	Flow Level 4	Lower Eklutna	0.42	71%	-0.01	0%
		Upper Eklutna	0.17	29%	0.10	150%
		Total	**0.60**	**100%**	**0.09**	**20%**

Table A.4-27. Time Series B - Comparative summary of Coho spawning time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Coho Spawning – Time Series B						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Baseline		Lower Eklutna	0.80	69%	0.00	0%
		Upper Eklutna	0.36	31%	0.00	0%
		Total	**1.16**	**100%**	**0.00**	**0%**
Option A	Flow Level 1	Lower Eklutna	0.79	25%	-0.01	0%
		Upper Eklutna	2.33	75%	1.97	550%
		Total	**3.12**	**100%**	**1.96**	**170%**
	Flow Level 2	Lower Eklutna	0.85	28%	0.06	10%
		Upper Eklutna	2.21	72%	1.85	520%
		Total	**3.07**	**100%**	**1.91**	**170%**
	Flow Level 3	Lower Eklutna	0.85	30%	0.05	10%
		Upper Eklutna	1.96	70%	1.60	450%
		Total	**2.81**	**100%**	**1.65**	**140%**
	Flow Level 4	Lower Eklutna	0.84	32%	0.04	10%
		Upper Eklutna	1.77	68%	1.42	400%
		Total	**2.62**	**100%**	**1.46**	**130%**
Option B	Flow Level 1	Lower Eklutna	0.79	32%	-0.01	0%
		Upper Eklutna	1.65	68%	1.29	360%
		Total	**2.44**	**100%**	**1.29**	**110%**
	Flow Level 2	Lower Eklutna	0.85	34%	0.06	10%
		Upper Eklutna	1.66	66%	1.30	360%
		Total	**2.51**	**100%**	**1.36**	**120%**
	Flow Level 3	Lower Eklutna	0.85	36%	0.05	10%
		Upper Eklutna	1.53	64%	1.17	330%
		Total	**2.37**	**100%**	**1.22**	**110%**
	Flow Level 4	Lower Eklutna	0.84	38%	0.04	10%
		Upper Eklutna	1.37	62%	1.02	280%
		Total	**2.21**	**100%**	**1.06**	**90%**

Coho Spawning – Time Series B						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Option C	Flow Level 1	Lower Eklutna	0.79	59%	-0.01	0%
		Upper Eklutna	0.56	41%	0.20	60%
		Total	**1.36**	**100%**	**0.20**	**20%**
	Flow Level 2	Lower Eklutna	0.85	53%	0.06	10%
		Upper Eklutna	0.74	47%	0.39	110%
		Total	**1.60**	**100%**	**0.44**	**40%**
	Flow Level 3	Lower Eklutna	0.85	54%	0.05	10%
		Upper Eklutna	0.72	46%	0.36	100%
		Total	**1.56**	**100%**	**0.41**	**40%**
	Flow Level 4	Lower Eklutna	0.84	56%	0.04	10%
		Upper Eklutna	0.66	44%	0.30	80%
		Total	**1.50**	**100%**	**0.34**	**30%**

Table A.4-28. Time Series B - Comparative summary of Sockeye spawning time-averaged habitat expressed in acres and percent of total for three flow release options (A – spill gate; B – AWWU portal; C – AWWU drainage valve) and four flow release levels (Level 1 through Level 4 that provide 90%, 70%, 50%, and 30% of maximum habitat) between upper Eklutna (Reaches R11, R10, R9, R8, R7, and R6) and Lower Eklutna (R5, R4 and R3) River with amounts expressed as increases above baseline.

Sockeye Spawning – Time Series B						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Baseline		Lower Eklutna	0.75	74%	0.00	0%
		Upper Eklutna	0.26	26%	0.00	0%
		Total	**1.01**	**100%**	**0.00**	**0%**
Option A	Flow Level 1	Lower Eklutna	0.88	35%	0.13	20%
		Upper Eklutna	1.62	65%	1.36	520%
		Total	**2.50**	**100%**	**1.49**	**150%**
	Flow Level 2	Lower Eklutna	0.88	32%	0.12	20%
		Upper Eklutna	1.84	68%	1.58	610%
		Total	**2.72**	**100%**	**1.71**	**170%**
	Flow Level 3	Lower Eklutna	0.85	35%	0.09	10%
		Upper Eklutna	1.59	65%	1.33	510%
		Total	**2.43**	**100%**	**1.42**	**140%**
	Flow Level 4	Lower Eklutna	0.83	37%	0.08	10%
		Upper Eklutna	1.39	63%	1.13	440%
		Total	**2.22**	**100%**	**1.21**	**120%**
Option B	Flow Level 1	Lower Eklutna	0.88	43%	0.13	20%
		Upper Eklutna	1.18	57%	0.92	360%
		Total	**2.07**	**100%**	**1.05**	**100%**
	Flow Level 2	Lower Eklutna	0.87	38%	0.11	20%
		Upper Eklutna	1.42	62%	1.16	450%
		Total	**2.29**	**100%**	**1.28**	**130%**
	Flow Level 3	Lower Eklutna	0.85	40%	0.09	10%
		Upper Eklutna	1.28	60%	1.02	390%
		Total	**2.13**	**100%**	**1.11**	**110%**
	Flow Level 4	Lower Eklutna	0.83	43%	0.07	10%
		Upper Eklutna	1.11	57%	0.85	330%
		Total	**1.93**	**100%**	**0.92**	**90%**

Sockeye Spawning – Time Series B						
			Time-Averaged Habitat		**Increase Above Baseline**	
			Acres	**Percent of Total**	**Acres**	**Percent**
Option C	Flow Level 1	Lower Eklutna	0.88	66%	0.13	20%
		Upper Eklutna	0.45	34%	0.19	70%
		Total	**1.33**	**100%**	**0.32**	**30%**
	Flow Level 2	Lower Eklutna	0.87	56%	0.11	20%
		Upper Eklutna	0.68	44%	0.42	160%
		Total	**1.55**	**100%**	**0.53**	**50%**
	Flow Level 3	Lower Eklutna	0.85	57%	0.09	10%
		Upper Eklutna	0.63	43%	0.37	140%
		Total	**1.48**	**100%**	**0.46**	**50%**
	Flow Level 4	Lower Eklutna	0.83	60%	0.07	10%
		Upper Eklutna	0.56	40%	0.30	110%
		Total	**1.38**	**100%**	**0.37**	**40%**