FINAL TECHNICAL MEMORANDUM

To:	Chugach Electric, Matanuska Electric, and Municipality of Anchorage
From:	Dudley Reiser, Clair Yoder, Chiming Huang, Stuart Beck, Audrey Thompson, and Mike Gagner – Kleinschmidt Associates
Cc:	Samantha Owen – McMillen Jacobs Associates
Date:	October 27, 2022 **Document No.** 2819278.02
Re:	Instream Flow and Fish Barrier Analysis for the Eklutna River – Preliminary Results and Example Flow Release Scenarios

1.0 INTRODUCTION

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 (FSP) (MJA 2021a). The Year 1 Interim Report (Kleinschmidt Associates 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 resulted in the completion of three modeling efforts for the Eklutna River including: 1) development of a Hydrologic Engineering Center's River Analysis System (HEC-RAS) one-dimensional (1D) model; 2) development of Physical Habitat Simulation (PHABSIM) models; and 3) barrier analysis for five (named A-E) potential barriers to fish migration within the canyon. The HEC-RAS 1D model was developed and submitted to Kathy Dubé of Watershed Geodynamics on July 16, 2022 for application in the geomorphological analysis of the river, which will be presented in a separate technical memorandum.

1.1 PURPOSE AND OBJECTIVE

The purpose of this technical memorandum (TM) is to summarize the results of the PHABSIM modeling and barrier flow analyses[1], and to describe how those results were used to formulate several example Eklutna Lake flow release scenarios. The overall objective is to demonstrate the reliability and utility of the data collection and modeling

[1] Details of both the PHABSIM and barrier analysis including hydraulic model calibrations and habitat/passage modeling will be provided in the Year 2 Report. Details regarding the development and selection of the Habitat Suitability Curves applied in the current PHABSIM analysis are provided in a separate Draft TM dated February 25, 2022 (Kleinschmidt Associates 2022b) and were described during the March 25, 2022 TWG meeting.

completed in support of both the Instream Flow Study as further described in the proposed final study plan (MJA 2021a) as well as the Year 1 Report (Kleinschmidt Associates 2022a), and the barrier analysis as presented in the River Fish Phase of the Year 2 Study Plan (MJA 2022).

1.2 OVERVIEW OF THE PHABSIM AND BARRIER ANALYSIS

Fundamentally, PHABSIM modeling provides a means to evaluate how fish habitat[2] may change in response to changes in flow, taking into consideration channel shapes and sizes. For the Eklutna River, this provides a useful tool for comparing incremental habitat gains (or losses) under flow conditions that may vary with flow releases from Eklutna Lake. The analysis produces a series of habitat versus flow curves specific to salmonid species and their life stages including spawning and juvenile rearing. Figure 1-1 depicts one of over 145 weighted useable area (WUA) curve sets generated for the Eklutna River, illustrating the primary output of PHABSIM modeling. WUA curves demonstrate the relationship between available habitat and flow for a specific transect (location). Habitat is defined as the area (ft^2) per length (1,000 ft) of stream and allows the estimation of total habitat by species and life stage within a given length of stream under varying flow conditions. This total habitat estimation provides a comparative framework for evaluating how project operations (scenarios) involving flow releases may affect fish habitat, taking into consideration the timing[3] of when a particular life stage (i.e., spawning) for a species is important. These scenarios are all compared against an existing hydrologic "baseline" condition-- for the Eklutna River, from 1955[4] to the present, a period in which there have been no planned flow releases from Eklutna Lake below the dam aside from the 2021 target flow releases to support the instream flow study and periodic uncontrolled spill.

[2] PHABSIM generates habitat that is termed weighted useable area (WUA) because it is weighted by a given species and life stage preference for selected habitat variables (depth, velocity, substrate) represented by Habitat Suitability Criteria (HSC). In this TM, the terms habitat and WUA are used interchangeably.

[3] The period of time when different life stages are important in a given year is defined as Periodicity. This was initially defined in the Study Plan (MJA 2021a) but has been refined in this TM based on direct observations.

[4] In 1955, the federal government completed construction of a new hydropower project and in 1964 a new storage dam which effectively eliminated any flow releases from Eklutna Lake to the Eklutna River.

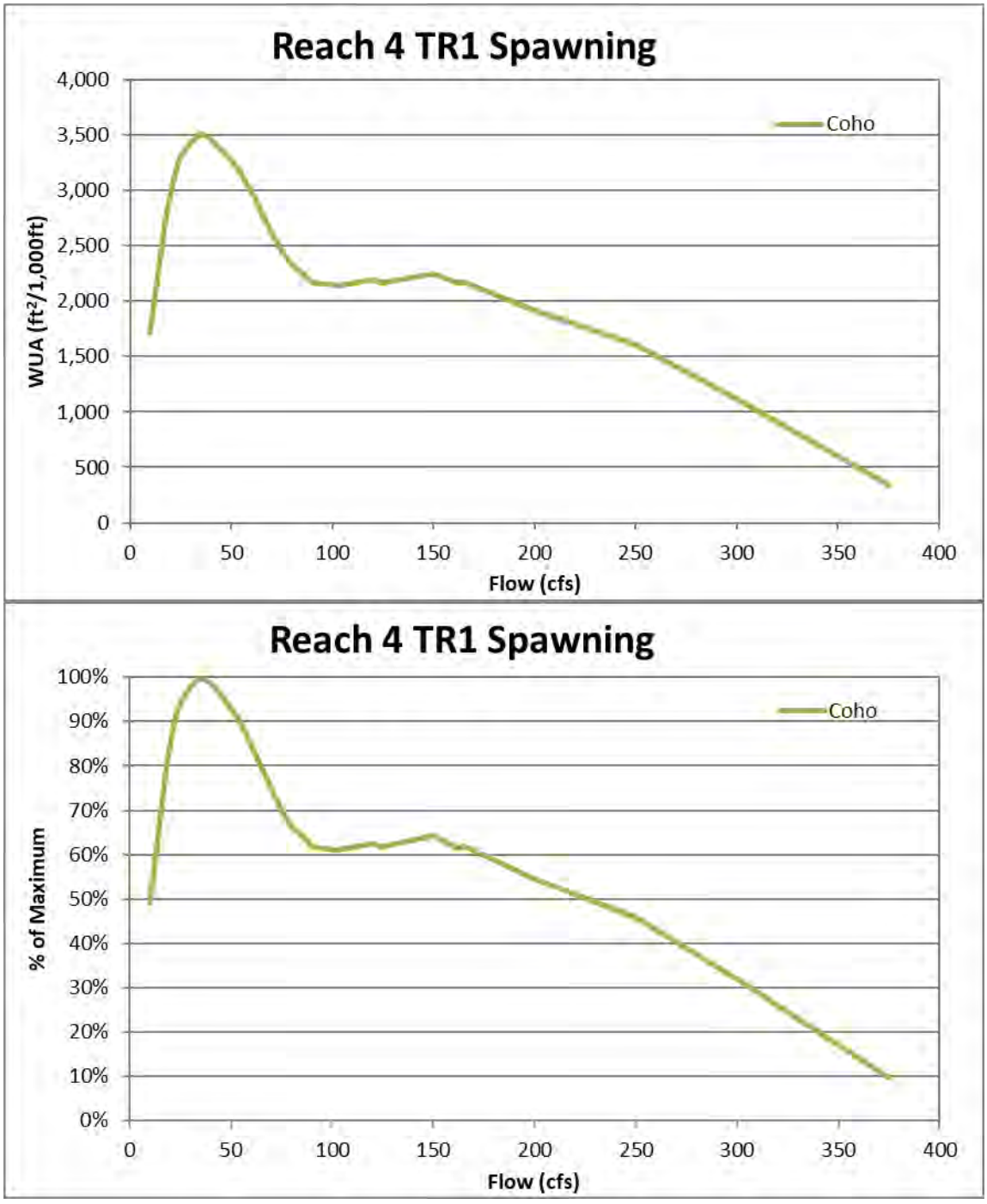


Figure 1-1 Representative habitat-flow relationship produced via PHABSIM modeling. This curve was from Transect 1 in Reach 4 of the Eklutna River and shows how Coho spawning habitat (represented as weighted useable area – WUA) incrementally changes with flow. The lower figure represents the same information normalized and expressed as a percentage of the highest amount of habitat for the curve.

Using similar methodology, the barrier analysis makes a comparative assessment of an assortment of physical and hydraulic parameters attendant to five potential physical barriers located in the Eklutna River. These potential barriers were observed during weekly spawning surveys in 2021 and identified as potential impediments to fish access upstream. The barriers were modeled under different flow conditions and analyzed relative to the swimming and leaping capabilities of adult salmon. Figure 1-2 conceptualizes this analysis and displays both chute and falls type barriers. The potential barriers in the Eklutna River were all chute type. The analysis centered on determining a threshold minimum flow for each of the five potential barriers, below which successful upstream movement of adult salmon may be impeded.

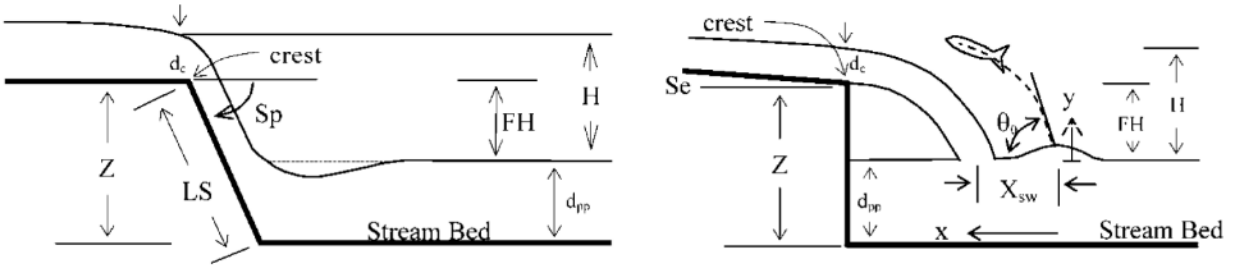


Figure 1-2 Schematics of chute-type (left) and falls-type (right) potential barriers (adapted from Powers and Orsborn 1985, as presented in Reiser et al. 2006). Representative variables include among others, water depth, velocity, slope and height of the structure. The potential barriers in the Eklutna River were all of the chute type.

While acknowledging that additional analysis is underway under the broader Eklutna River Instream Flow Study both in terms of the development of two-dimensional (2D) model coverage for reaches not surveyed in 1D in 2021 (R3, R4, R6, R10)[5] and geomorphology/sediment transport modeling, modeling efforts completed thus far demonstrate that the data collected in 2021 and 2022 and subsequent modeling completed in 2022 are robust and reliable and can be applied in analyzing habitat vs. flow relationships under current conditions of the Eklutna River. The data collection and modeling process followed strict QA/QC procedures and established protocols and guidelines specified in Bovee (1982), Trihey and Wegner (1981), and Milhous et al. (1984) and described in Sections 3.2 and 4.1 of the Year 1 Study Report (Kleinschmidt Associates 2022a). Likewise, the data collected in 2022 relative to potential barriers were collected in

[5] Based on considerations of channel stability, sediment deposition, habitat diversity, consolidated flow, substrate composition, access, fish use, and sampling safety, six of the eleven reaches were selected for sampling in 2021 - R4, R5, R7, R8, R9 and R11. Reaches R3, R4, R6, and R10 were not surveyed. More details regarding reach and study site selection are provided in the Year 1 Report in Sections 2.3 and 2.5.1 (Kleinschmidt Associates 2022a).

accordance with methods described in Section 3.3.4.3 of the Year 2 Study Plan (MJA 2022) with data analysis patterned after Reiser et al. (2006). In combination, the PHABSIM and barrier analyses provide a solid basis for comparing several example flow release scenarios and resulting effects on habitat (WUA) under current conditions of the Eklutna River.

This TM describes the process for the development of flow vs. habitat relationships at a general level, focusing primarily on demonstrating (using examples) the application of PHABSIM habitat modeling and barrier analysis to evaluate potential flow release scenarios against current conditions in the Eklutna River. Necessary steps in the analysis are summarized generally, however, details of the modeling process and related analyses will be provided in full in the final Year 2 Study Report.

2.0 PHABSIM MODEL DEVELOPMENT

The PHABSIM analysis began with the original habitat mapping, study site selection, and collection of field and survey data, completed in 2021. Thorough data review and QA/QC of model input coupled with the development of Habitat Suitability Criteria (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 2-1 including various components of the PHABSIM analysis. A brief summary of the steps involved in this process is provided below.

2.1 MESO-HABITAT MAPPING, AND STUDY SITE AND TRANSECT SELECTION

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 (Figure 2-2). 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).

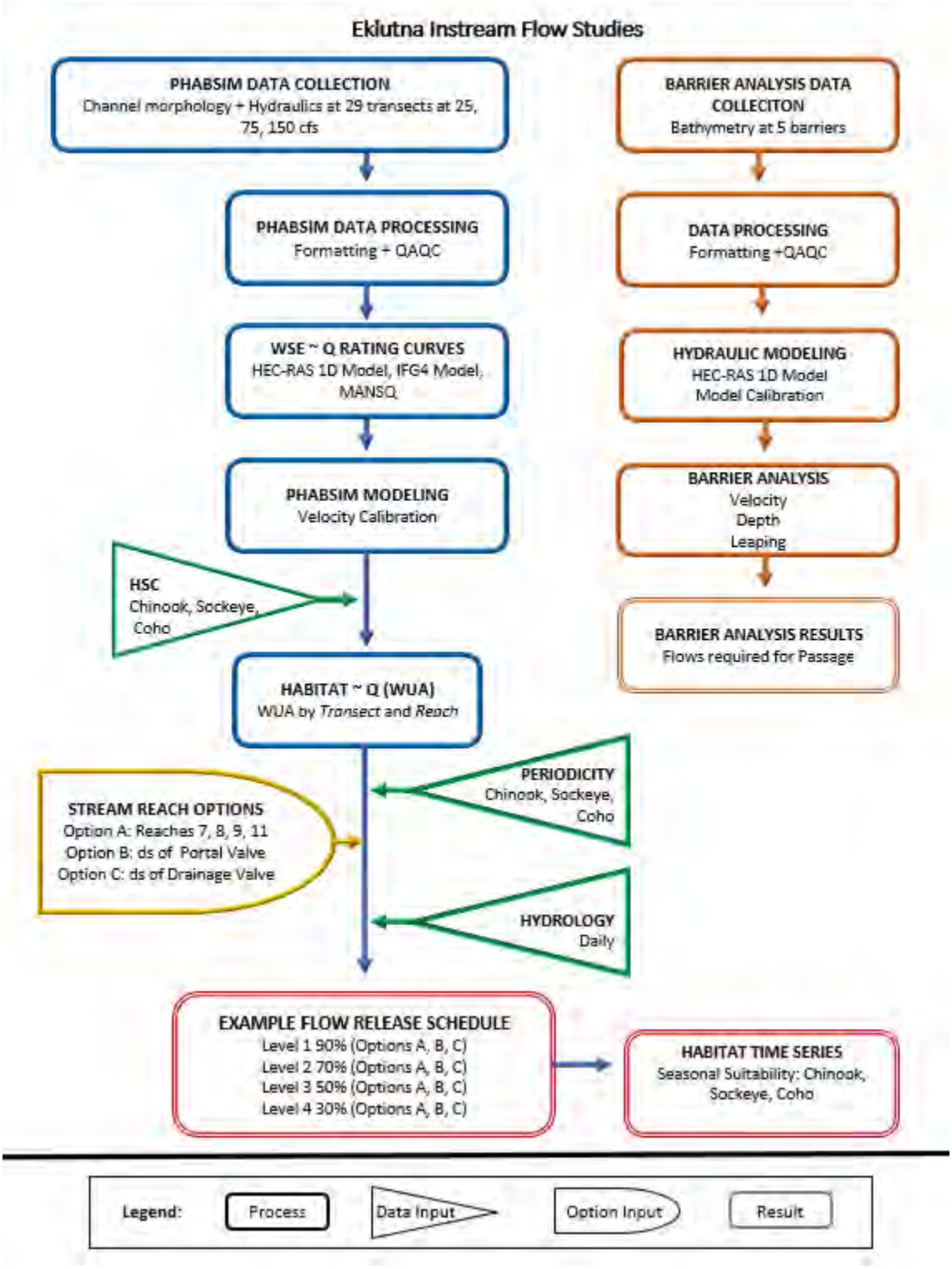


Figure 2-1 Flow chart depicting components of the Eklutna River instream flow studies. The Physical Habitat Simulation (PHABSIM) process is shown on the left; Barrier analysis on the right.

Transect selection within representative mesohabitat types in each reach followed the process described in the Year 1 Interim Report (Kleinschmidt Associates 2022a), and resulted in the selection of 30 transects distributed in the above-mentioned reaches (R-) as follows: R4 – 3, R5 – 7, R7- 2, R8 – 5, R9-3, R11 – 10. However, one of the 30 transects located in Reach 8 (Transect 4) served as a hydraulic control and was not included in the hydraulic and habitat modeling; i.e., 29 transects were used in the modeling. The final selection of transects was made in consultation with the Technical Work Group (TWG) during a field survey on June 9-10, 2021. Maps depicting the distribution of transects in each reach were developed and presented in the Year 1 Report; Figure 2-3 shows one of the maps indicating the distribution of transects in R8.

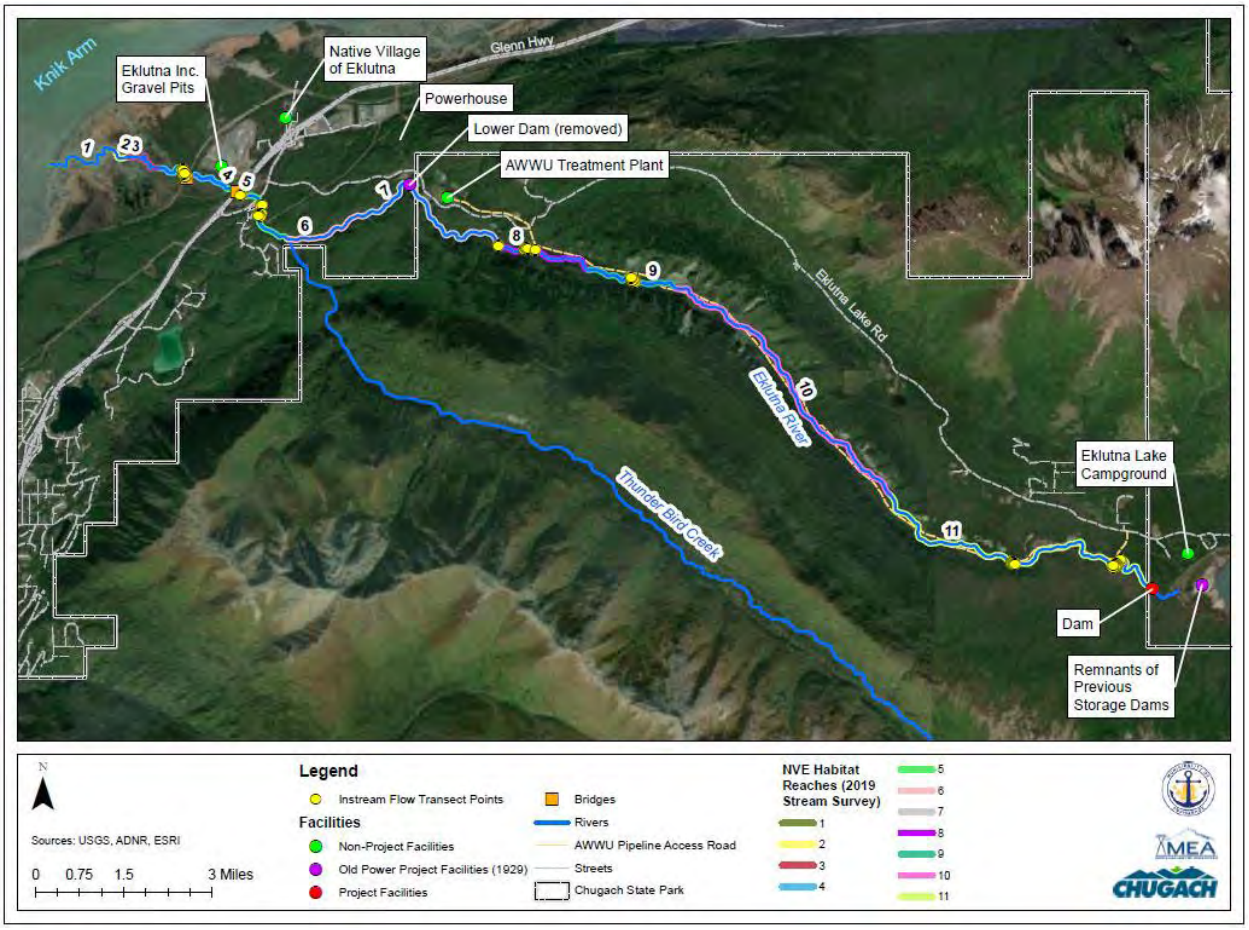


Figure 2-2 Eklutna Instream Flow Study Area showing reach designations. PHABSIM transects were located in reaches 4, 5, 7, 8, 9 and 11.

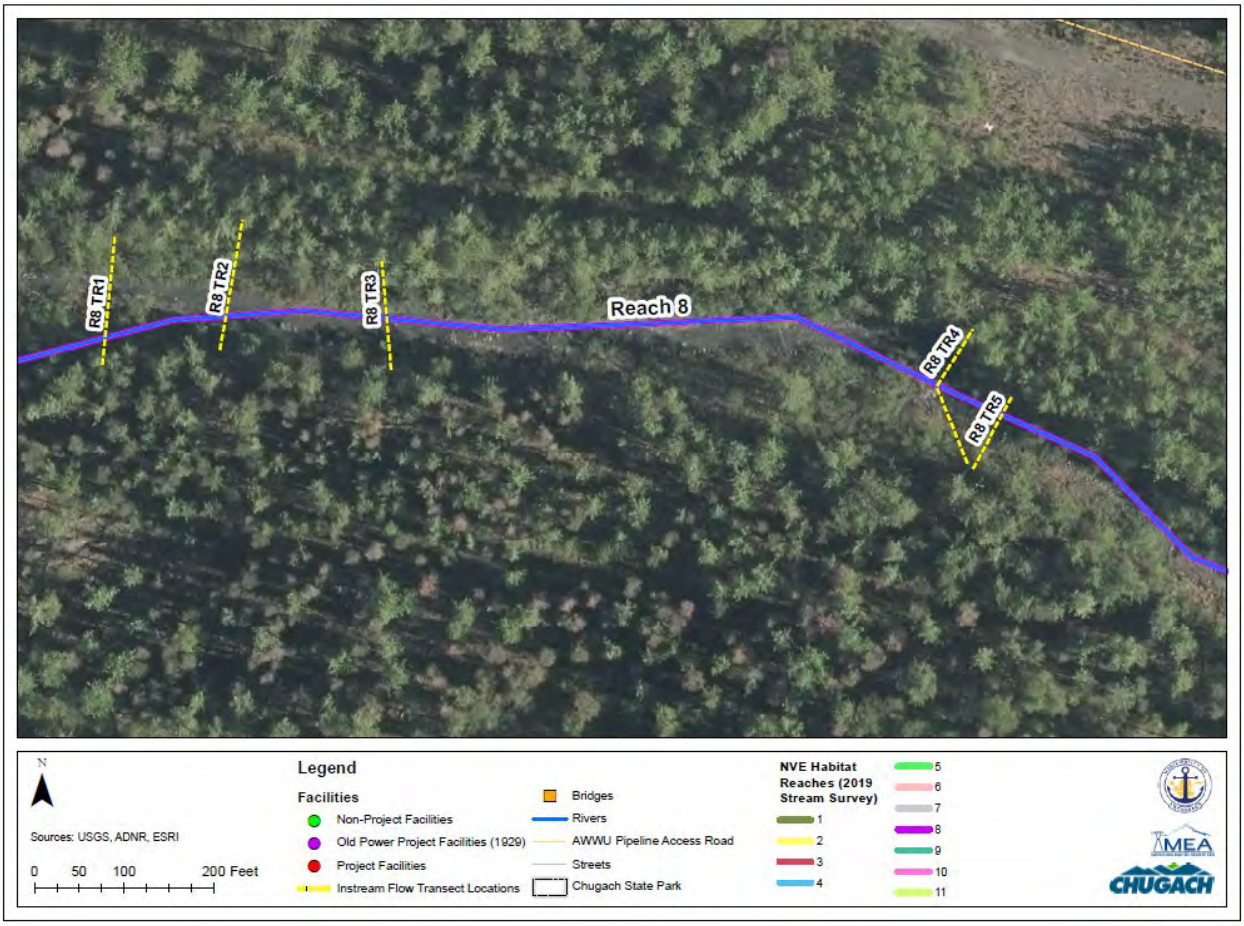


Figure 2-3 Map showing locations of transects within mesohabitats in Reach 8 of the Eklutna River.

2.2 Data Collection and Hydraulic Modeling

Surveying and field data collection for the PHABSIM modeling were collected at 30 transects (29 PHABSIM transects and 1 hydraulic control) under three target flows as described in the FSP (MJA 2021a) and summarized in the Year 1 Instream Flow Study Report (Kleinschmidt Associates 2022a). The field surveys occurred from September 20 through October 2, 2021. Starting with the High flow release (~150 cubic feet per second [cfs]), a combination of physical and hydraulic data were collected across each transect, including water depths and velocity, along with a visual characterization of substrate composition. The process was repeated for the ~75 cfs and ~ 25 cfs flow releases. Water surface elevations were also measured during all flows. Figure 2-4 depicts the set-up and field data collection process. Figure 2-5 illustrates the three flow conditions measured during the field surveys at Transect 1 in R8.

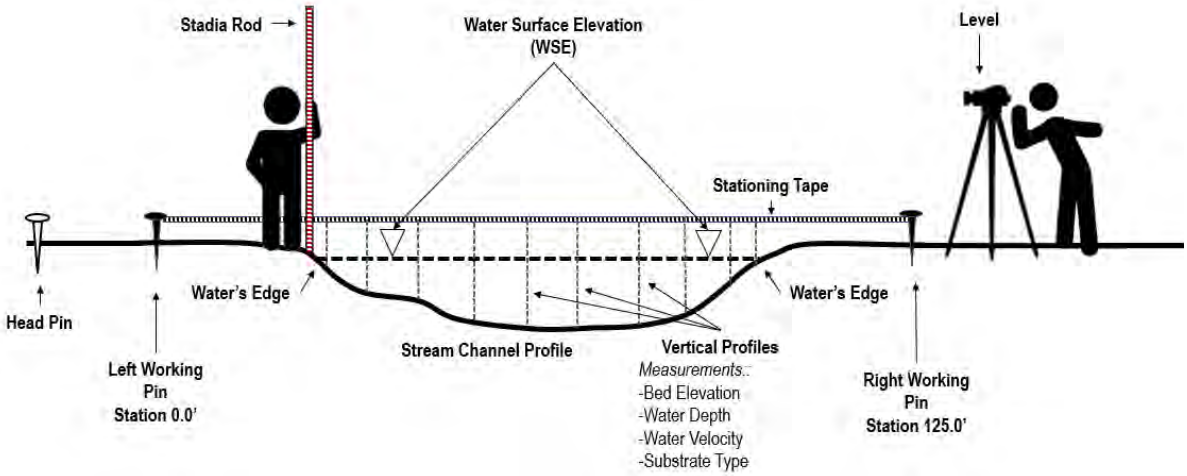


Figure 2-4 Field set-up (looking upstream) for collecting PHABSIM field data for the Eklutna River. Measurements of each of the 30 transects occurred for three separate flow releases from Eklutna Dam, nominally, 150 cfs, 75 cfs, and 25 cfs.

Figure 2-5 Downstream views to Transect 1 in Reach 8 of the Eklutna River during the three flow releases from Eklutna Dam in September 2021; High (upper left), Mid (upper right) and Low (bottom).

The field survey data and information were subjected to Quality Assurance/Quality Control (QA/QC) procedures and then applied in development of detailed hydraulic models for each of the transects. Hydraulic model development and calibration closely followed procedures outlined in Bovee (1982), Bovee et al. (1998), and Milhous et al. (1984) and was based on over 30 years of in-house experience in developing and using hydraulic models for instream flow studies. Details of the model development and calibration will be provided in the Year 2 Report in 2023.

2.3 HABITAT SUITABILITY CURVE DEVELOPMENT

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 2-6 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 Associates 2022b). In this case, the suitability (preference) for a given velocity is shown on the Y axis, with velocity shown on the X-axis.

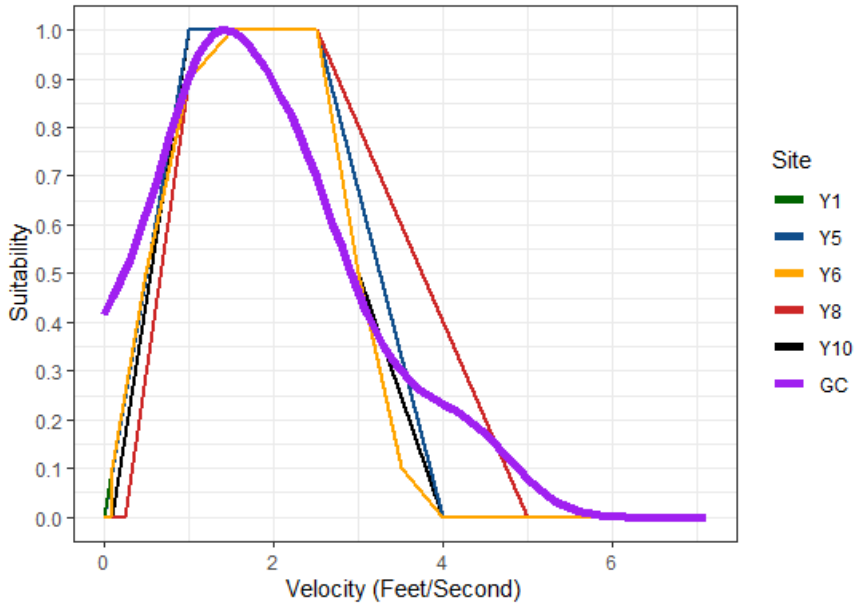


Figure 2-6 Example Habitat Suitability Curve developed for Coho Salmon for the Eklutna River. The purple curve was selected for use in the habitat modeling and was based on data from Grant Creek, Alaska. Other curves considered were from other Alaska streams: Y1=Terror and Kizhuyak rivers; Y5=Cooper 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:

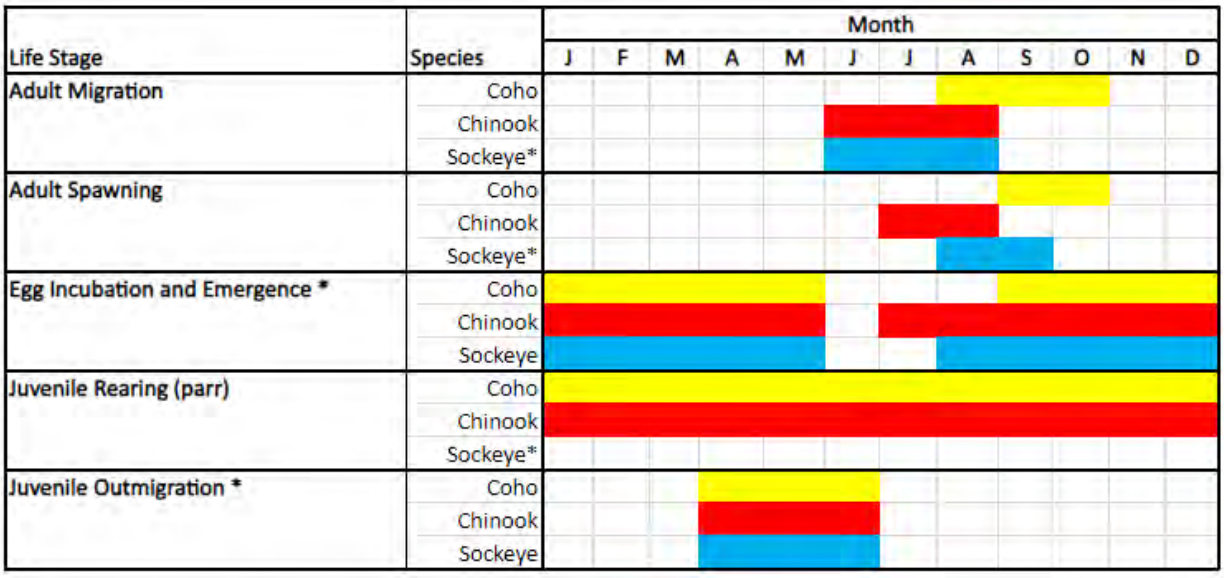
- Obtain HSC data or developed HSC curves for target fish species and life stages from streams in the same geographic region;
- Summarize data and information for each candidate HSC curve set focusing on how the curves were constructed, data source(s), location, relative size, and habitat variables; 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*])[6]. 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 Associates 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.

2.4 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 2-7 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 Trout Unlimited (2018) and USACE (2011), and has been modified slightly based on field observations in 2021 during the Fish Composition and Distribution surveys.

[6] 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 Associates 2022a).



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

Figure 2-7 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 Report (2023, in 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 2.7). 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.

2.5 HABITAT MODELING AND DEVELOPMENT OF HABITAT-FLOW RELATIONSHIPS

Habitat (expressed as weighted usable area) 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 A.

The modeling was completed using a flow weighted composite approach considered as providing the most realistic model output[7]. 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.[8] 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 2-8). 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, T1 with R4, TR2 in Figure 2.8) and reaches.

Unless individual "Critical"[9] habitats have been identified in a stream, flow analysis based on individual transects is complex. As a result, 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 by reach, 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 reach, based on the meso-habitat types the transects represent, weighted by the area represented by those habitat types.[10] 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 B.

[7] Three approaches to modeling were considered; transect based, theoretical profile based, and transect/theoretical composited base. Details of these approaches and the rationale for selection of the composited approach will be provided in the Year 2 Report in 2023.

[8] 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.

[9] 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.

[10] 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.

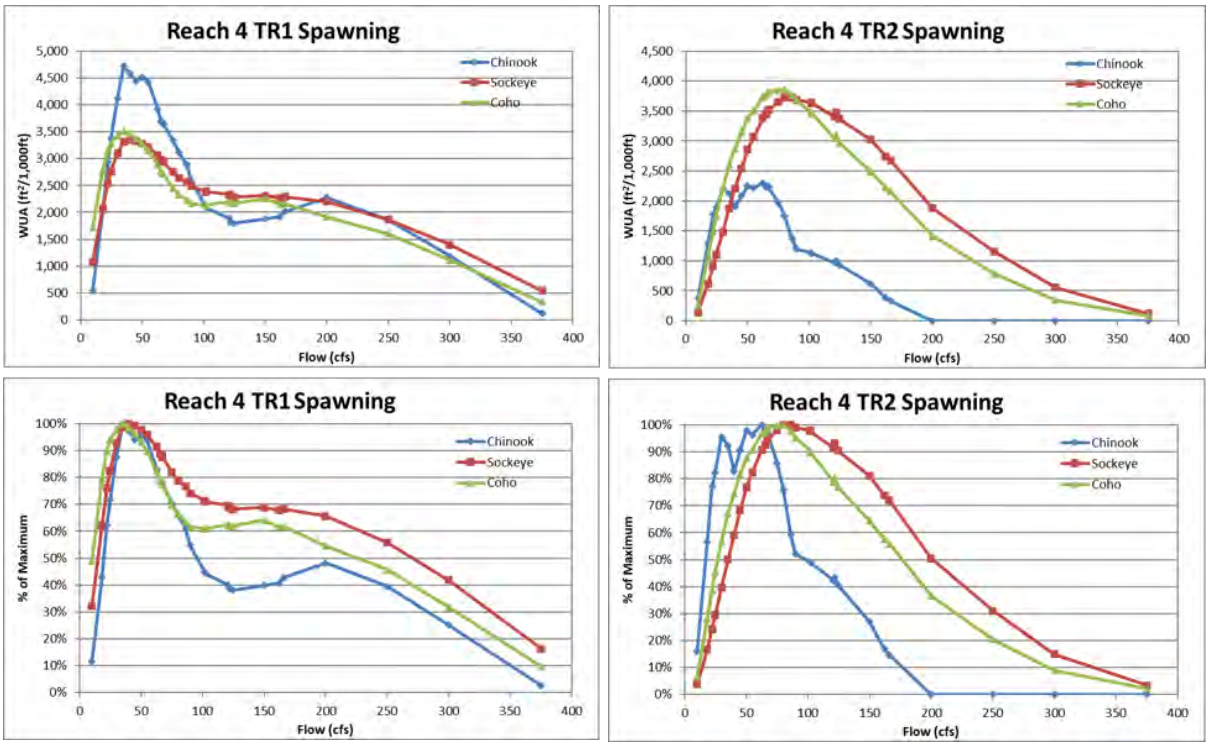


Figure 2-8 Example habitat-flow relationships produced via PHABSIM modeling showing general shape characteristics of curves for Chinook (blue) Coho, and Sockeye salmon spawning. These curves are from transects 1 and 2 in Reach 4 of the Eklutna River and show the relationships of habitat area to flow (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 2-8 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 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.

2.6 PRELIMINARY 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 streams 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 schedules and three release options described below.

2.6.1 EXAMPLE FLOW RELEASE LEVELS AND RELEASE OPTIONS

For this analysis, four (ranging from highest to lowest) example flow levels (1, 2, 3, and 4) and three flow release options 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 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 four 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 Anchorage Water and Wastewater Utility (AWWU) portal located approximately 6,000 ft below the spill gate; and Option C – from the lower AWWU drainage valve located approximately 3000 ft below the lower extent of Reach 9 (see Figure 1-1). 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 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 2-9 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 2-1). Using the periodicities shown in Figure 2-7, 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[11] (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 2-1). 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.

[11] 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.

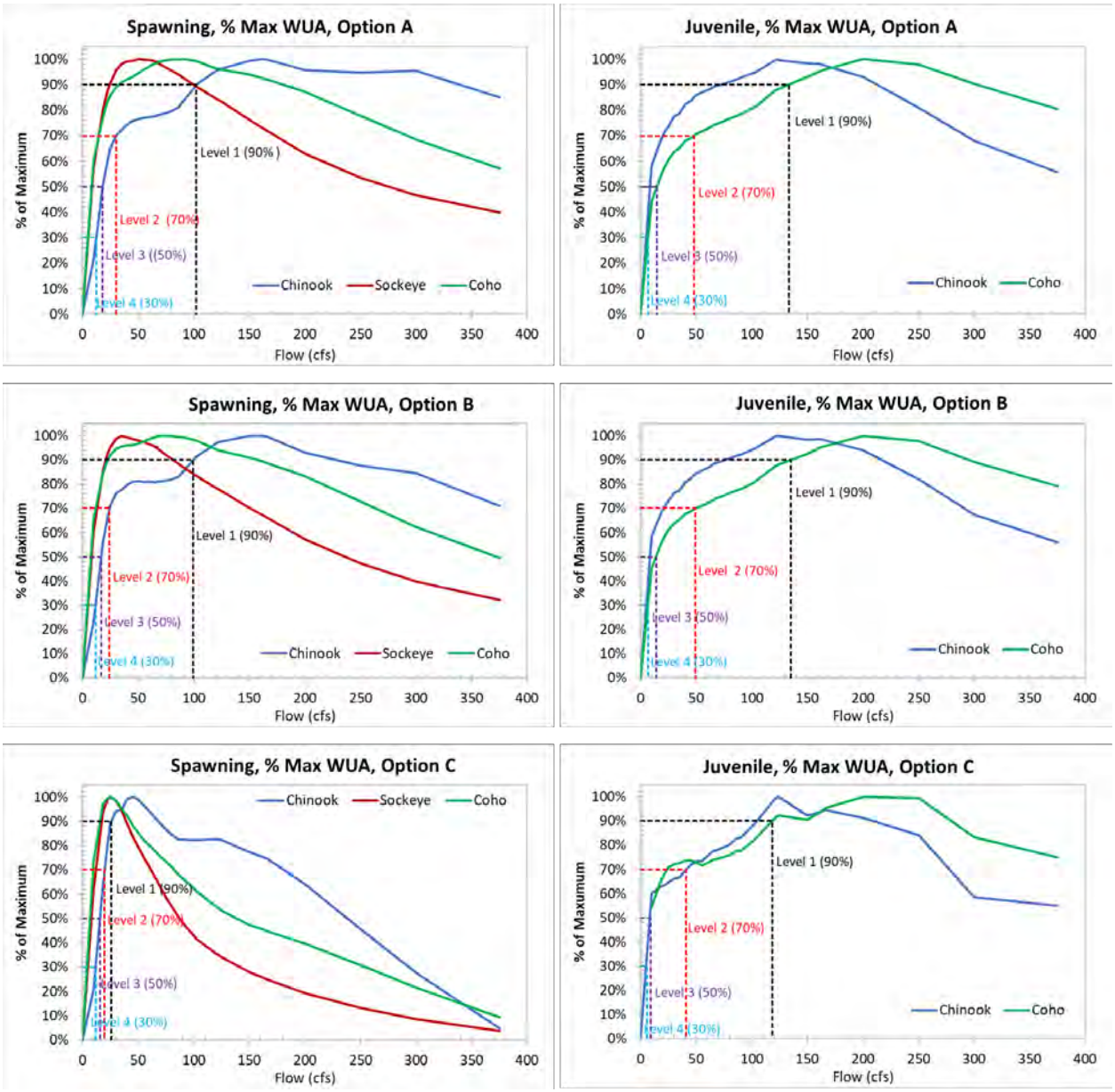


Figure 2-9 Normalized Habitat vs. flow relationships for spawning and juvenile rearing showing the Level 1 – 90%, Level 2 – 70%, Level 3 – 50%, and Level 4 – 30% example flow levels identified for the flow release schedules.

Table 2-1 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.

OPTION A Flow Release Schedules. All 19 TRs in Reaches 7, 8, 9, and 11 were used in the analysis												
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***
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 Anchorage Water and Wastewater Utility 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 Anchorage Water and Wastewater Utility 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

2.6.2 TIME SERIES ANALYSIS

Historical hydrology of the Eklutna River was summarized by McMillen Jacobs and Associates (MJA 2021b). Available flow records from the United States Geological Survey (USGS) and the Native Village of Eklutna (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 2-10 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.

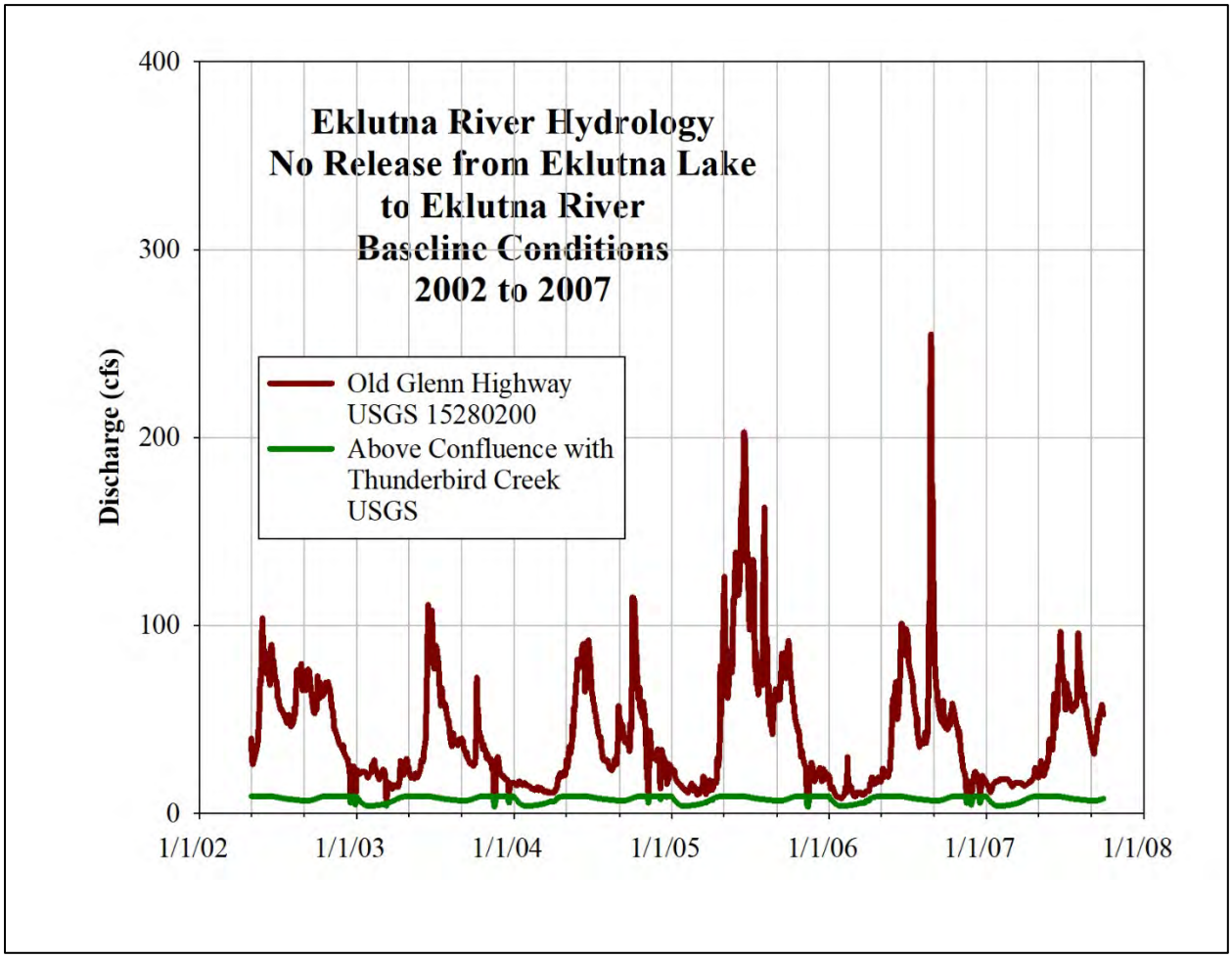


Figure 2-10 Daily flows in the Eklutna River at the Old Glenn Highway and above the confluence with Thunderbird Creek from May 1, 2002 to September 29, 2007, with no flow releases from Eklutna Lake to the Eklutna River.

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 2-2. 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 three example flow release levels (High [90%], Medium [70%], and Low [50%]) were considered (see Section 2.6.1) which governed the magnitude of the released flows. 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 2.6.1) 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 2-2, 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. The results reported herein are based on a total of 270 runs that considered Options A and B. Option C was not quantitatively analyzed because of time constraints but results will be reported in the Year 2 Report. A qualitative assessment of Option C is reported herein.

To illustrate the process of performing a time series analysis, two of the 270 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 2-2 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 2-11 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.

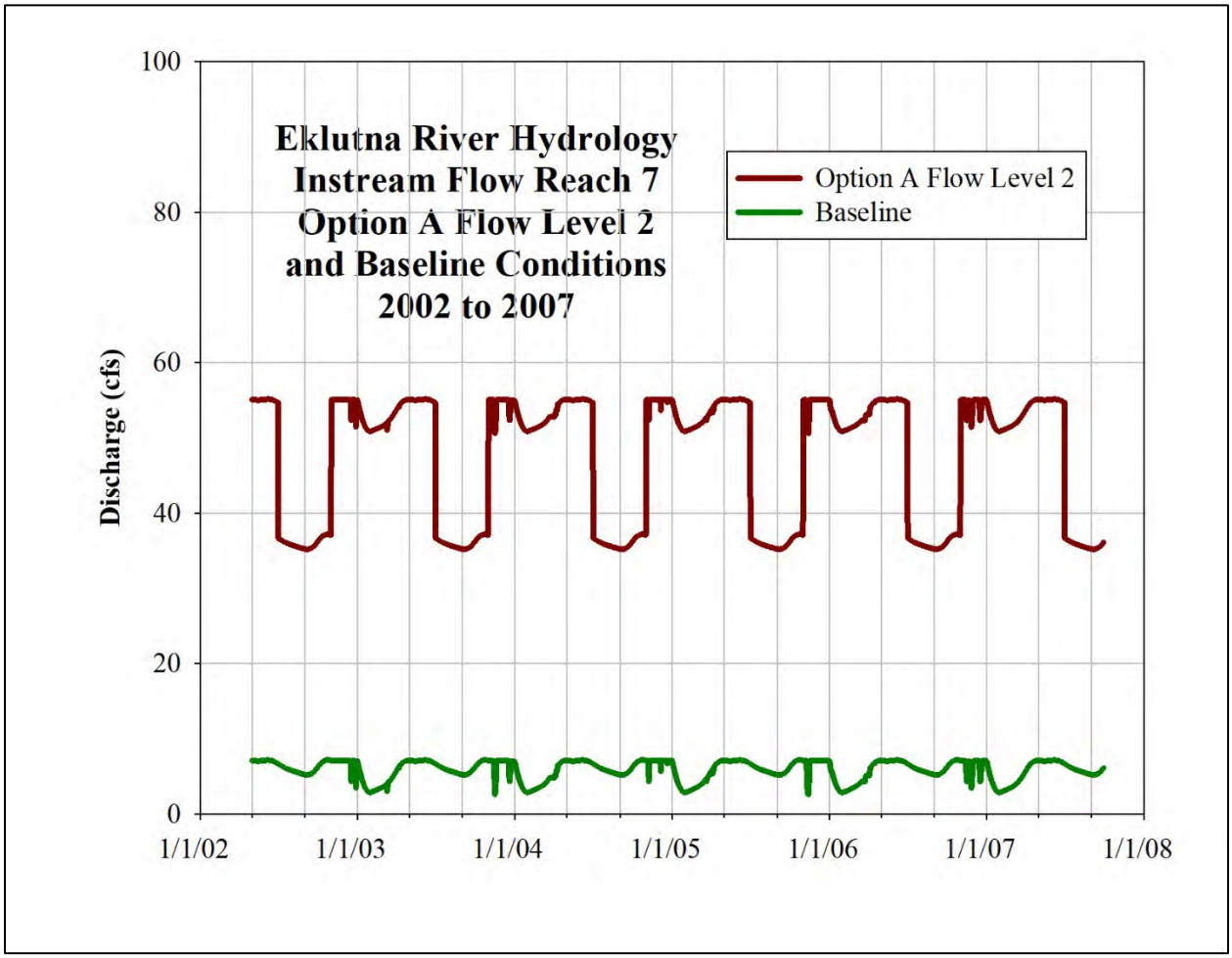


Figure 2-11 Daily flows in Reach 7 of the Eklutna River for Option A, Level 2 -70% flow release level and Baseline conditions. Option A – flow released to Eklutna River just downstream from Eklutna Dam

A habitat area curve defined as WUA for Coho juvenile rearing in Reach 7 is shown in Figure 2-12. The curve reaches a peak of about 1.4 acres when the discharge is about 80 cfs.

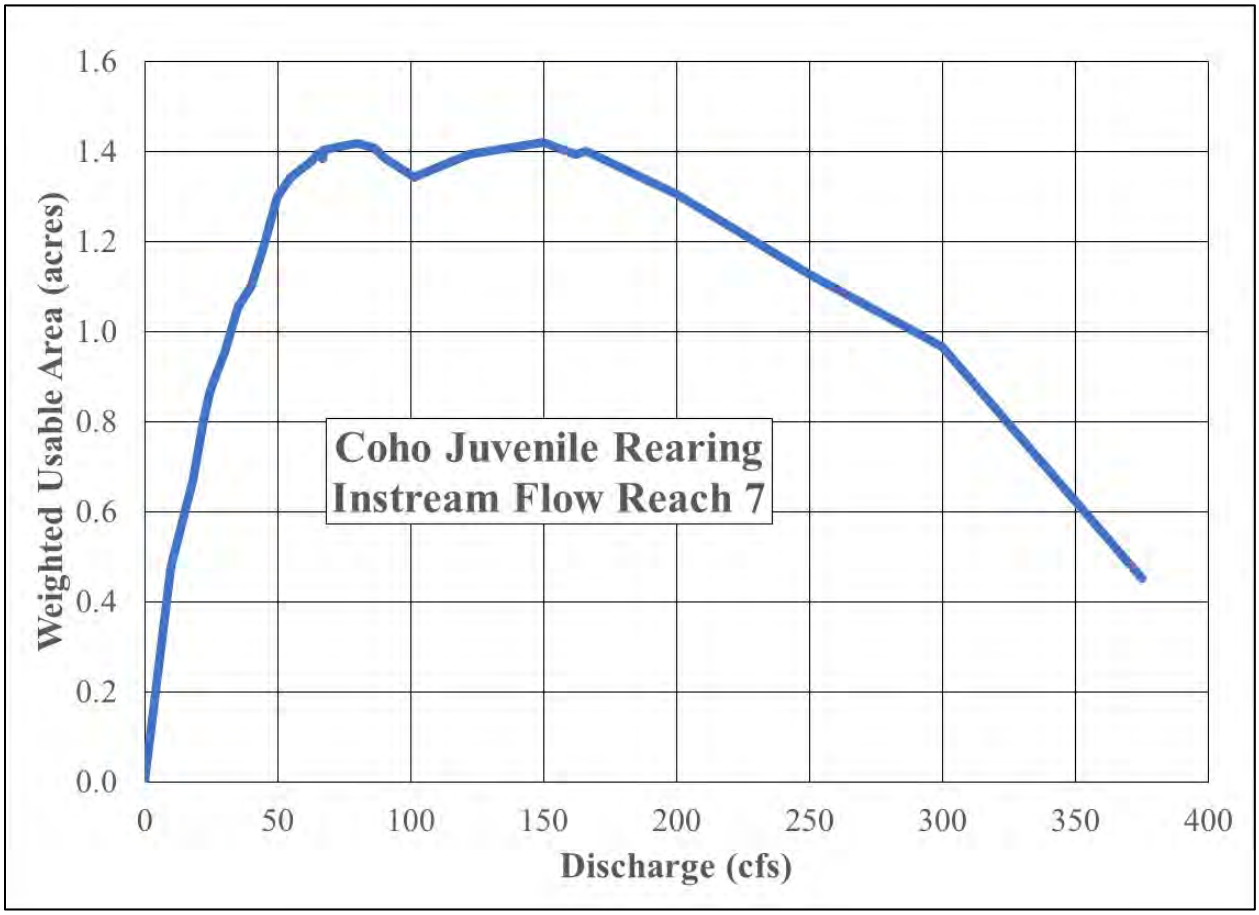


Figure 2-12 Habitat area (weighted usable area) in Reach 7 for Coho juvenile rearing as a function of flow in the Eklutna River.

Daily time series of Coho juvenile rearing habitat in Reach 7 are shown in Figure 2-13 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.

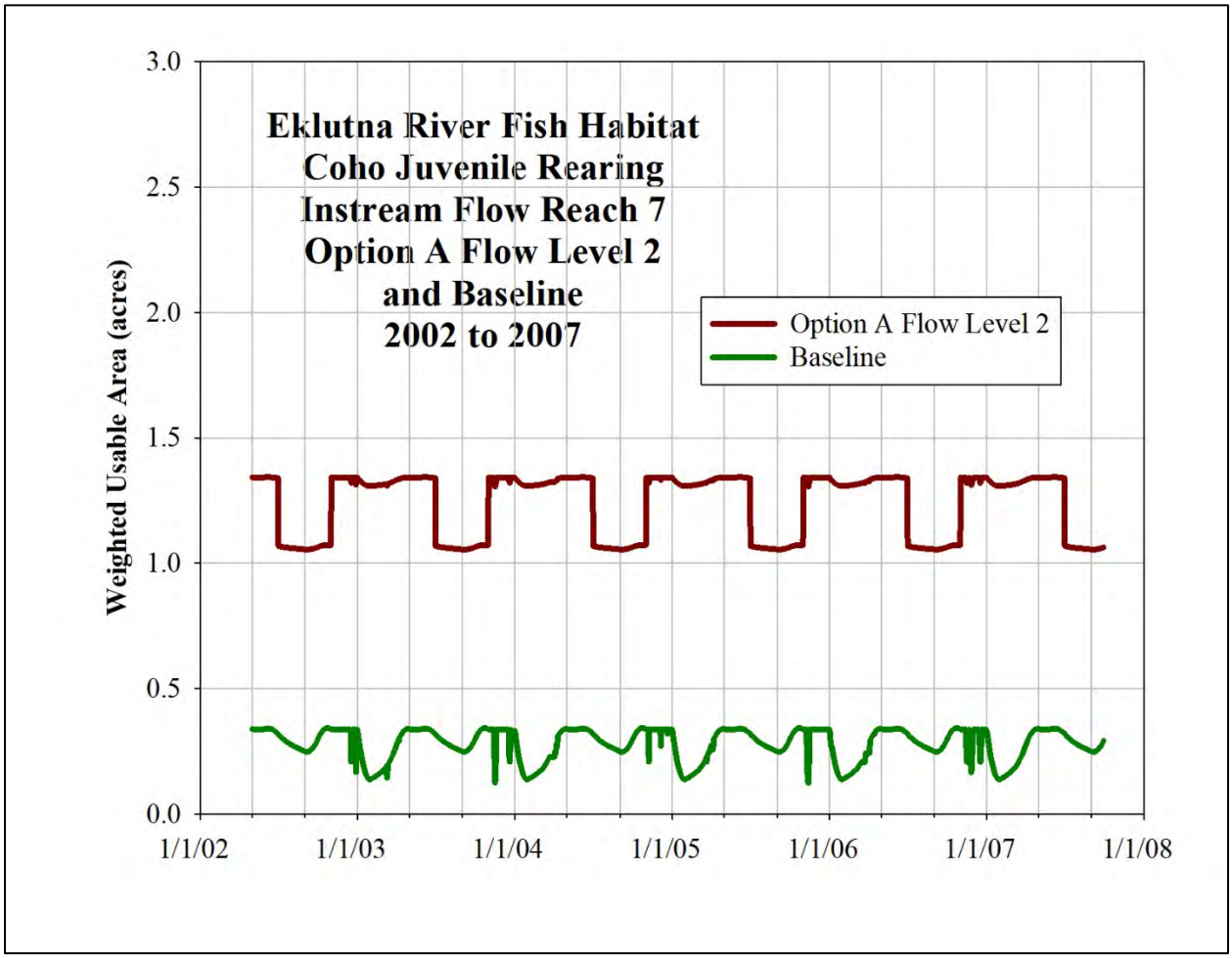


Figure 2-13 Daily time series of habitat area (weighted usable area) for Coho juvenile rearing in Reach 7, Option A Medium (upper line) and Baseline conditions (lower line).

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 2-3.

Table 2-3 Time-averaged habitat area (weighted usable area) 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 two flow release location options, A – below Eklutna Dam and B – at upper AWWU portal ~1.2 mile below 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

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 (weighted usable area) is listed in Table 2-4. Habitat increases ranged from 70% for Chinook spawning Option B Flow Level 4 to 440% for Chinook juvenile rearing Option A Flow Level 1.

Table 2-4 Percent increase (with respect to baseline) of time-averaged habitat area (weighted usable area) 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 two flow release location options, A – below Eklutna Dam and B – at upper AWWU portal ~1.2 mile below Eklutna Dam. Percent rounded to nearest 10%.

Scenario		Percent Increase of Time-Averaged Habitat with Respect to Baseline Habitat				
		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%

Habitat duration curves for Chinook spawning habitat are shown in Figure 2-14 and time-averaged habitat areas (WUA) as listed in Table 2-3. 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).

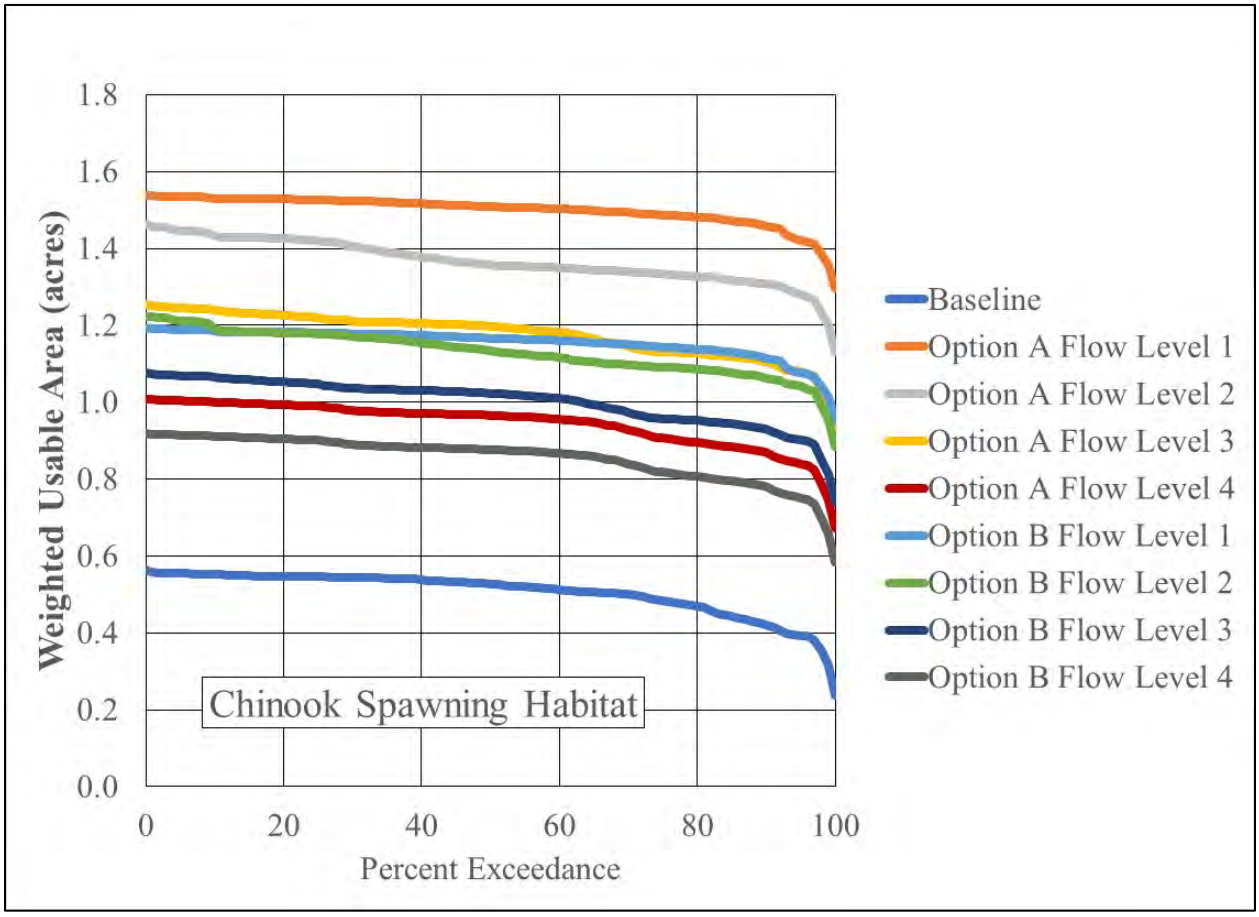


Figure 2-14 Chinook spawning habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. The Level 1, Level 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 in Figure 2-15 and time-averaged habitat area (WUA) as listed in Table 2-3. 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).

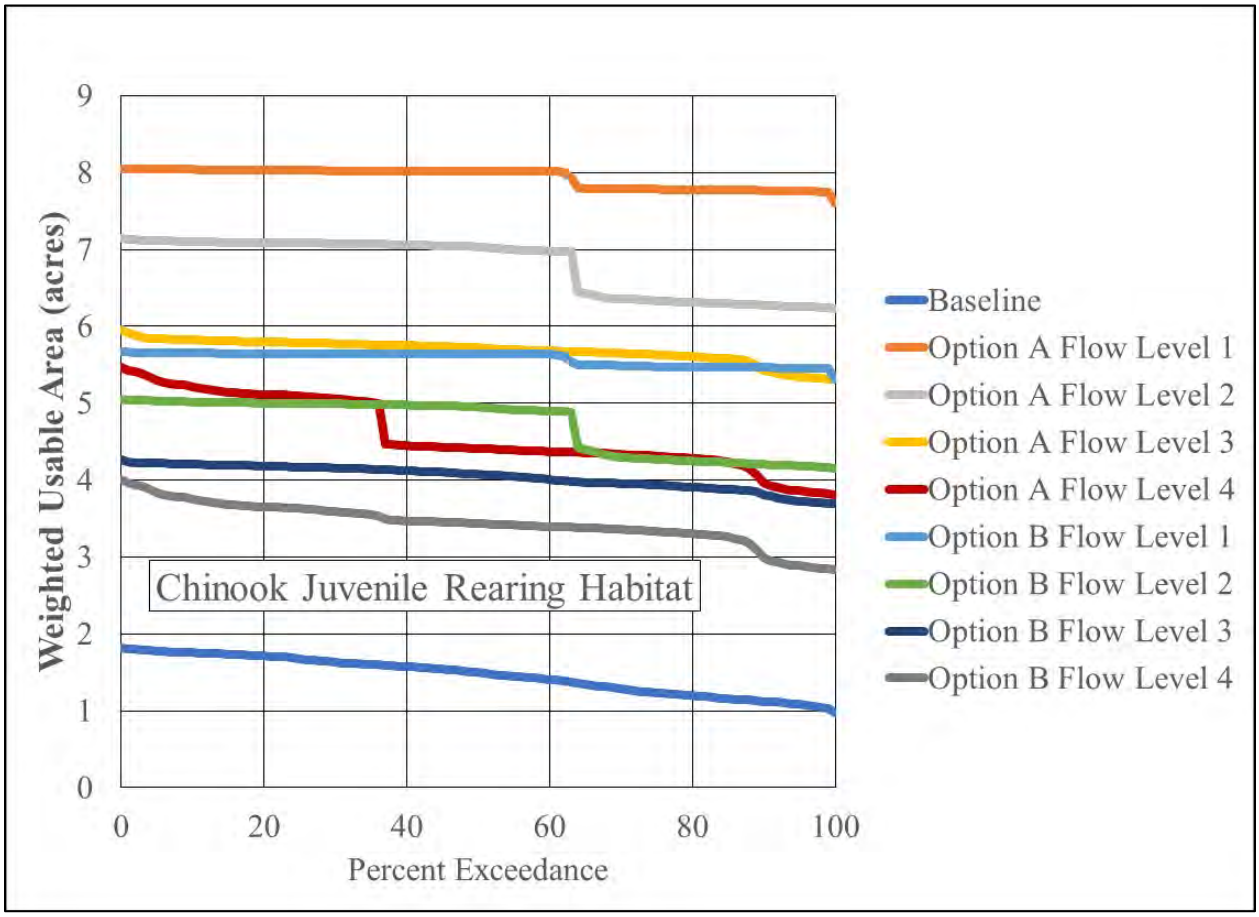


Figure 2-15 Chinook juvenile rearing habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. The Level 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 in Figure 2-16 and time-averaged habitat areas (WUA) as listed in Table 2-3. 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).

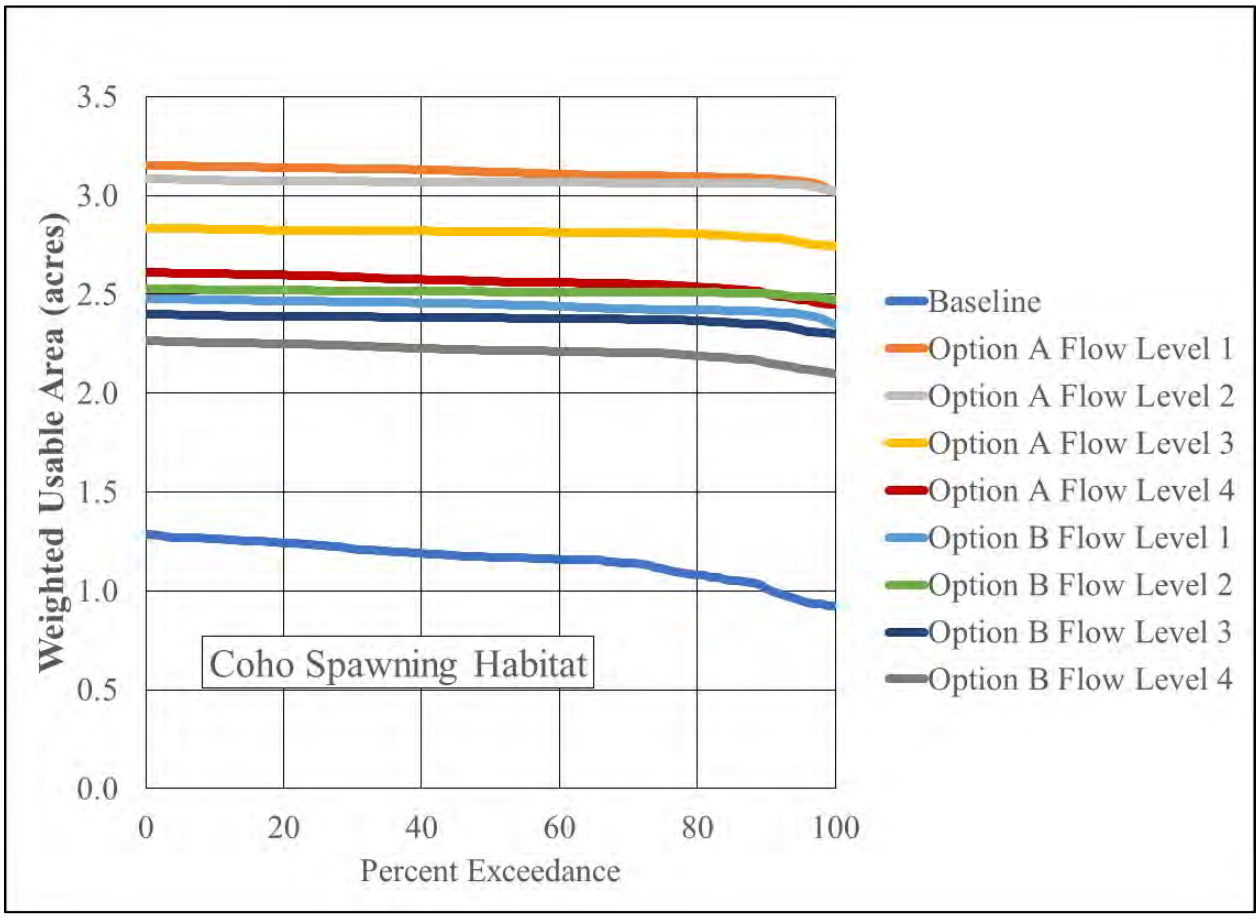


Figure 2-16 Coho spawning habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. The Level 1, Level 2, 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 in Figure 2-17 and time-averaged habitat areas (WUA) as listed in Table 2-3. 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).

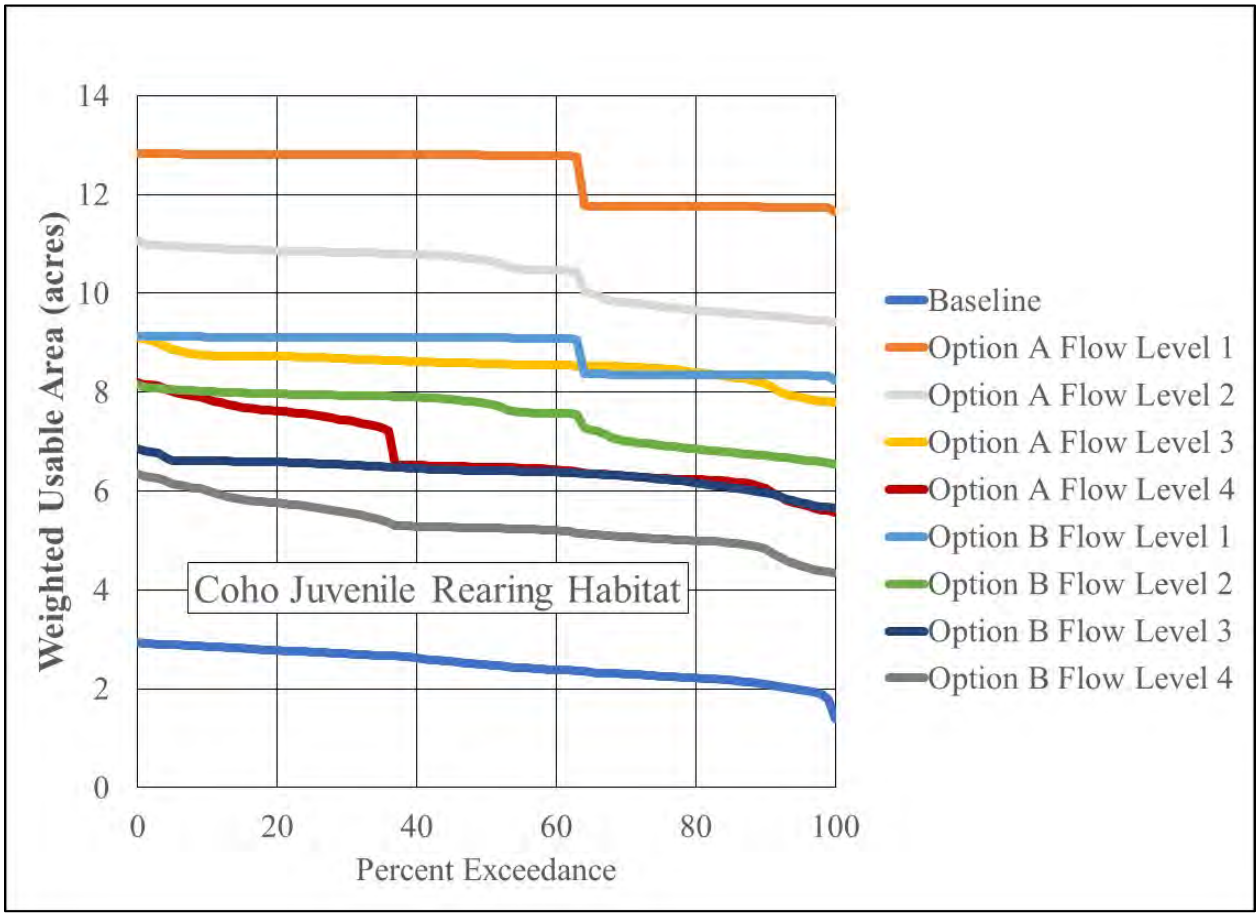


Figure 2-17 Coho juvenile rearing habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. The Level 1, 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 are shown in Figure 2-18 and time-averaged habitat areas (WUA) as listed in Table 2-3. 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).

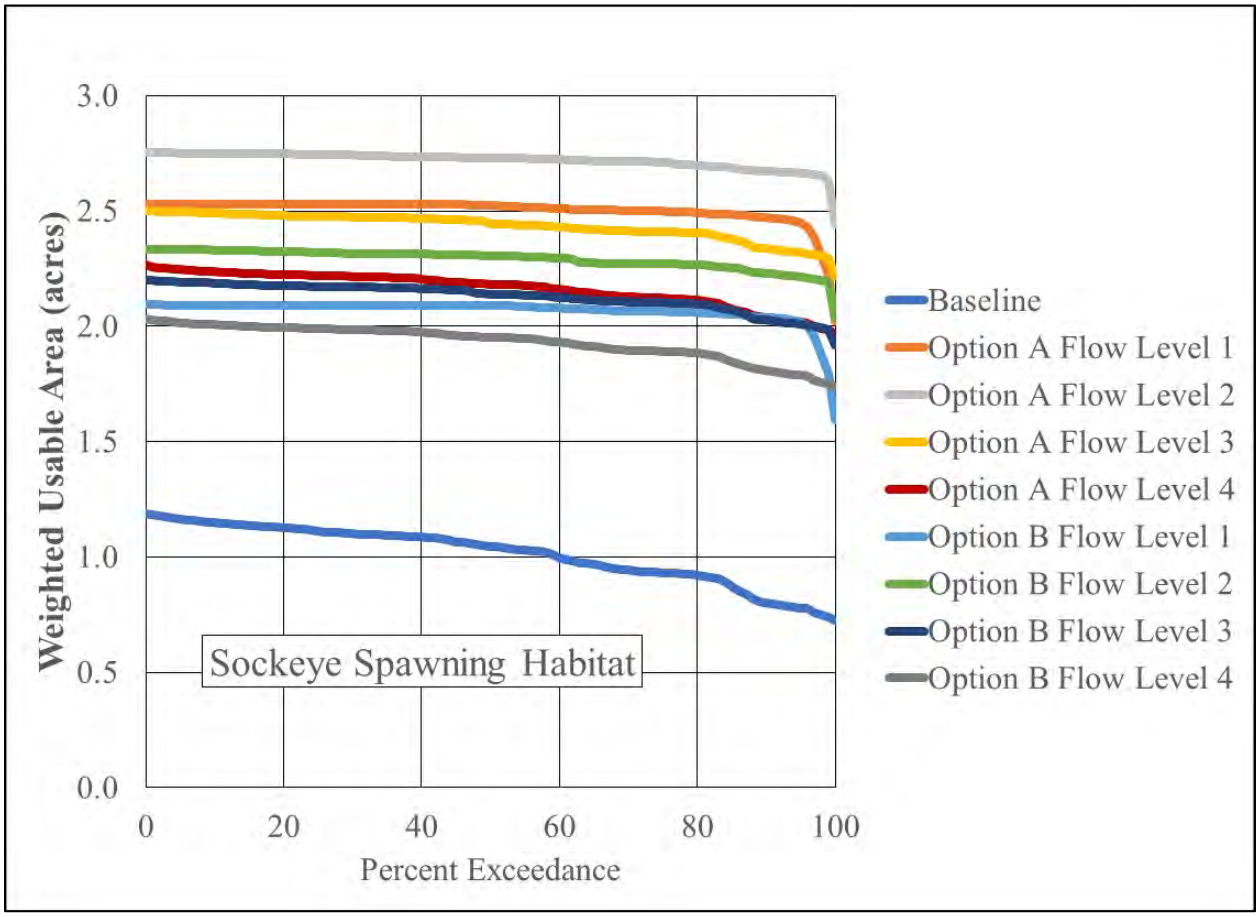


Figure 2-18 Sockeye spawning habitat duration curves derived from the total habitat from Reaches 4, 5, 7, 8, 9, and 11. Option A – flow released to Eklutna River just downstream from Eklutna Dam. Option B – flow released to Eklutna River about 1.2 miles downstream from Eklutna Dam. The Level 1, Level 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 (Options A and B). While Option C was not analyzed, it is likely that habitat gains (above baseline) would also occur for Option C. However, the flow release point is ~ 6.8 miles below the dam and therefore fewer river miles would be affected and habitat gains would be less than gains for Options A and B.

2.7 FURTHER CONSIDERATIONS AND STUDY LIMITATIONS

The time series analysis (see Section 2.6.2) 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 PHABSIM modeling described in Section 2.5 that has been completed to date and that represents one of several models that can be used for considering and balancing fish habitat needs amongst other uses of water in the Eklutna River basin, including power production, and potable water supply. The results of the geomorphology and sediment transport modeling, and the 2D HEC-RAS habitat analysis will certainly factor into this analysis, as will results from other studies, e.g., fisheries, water quality, etc.

Importantly, the analysis has the most direct applicability to the current conditions and channel morphologies of the Eklutna River. The study sites were selected in consultation with Watershed Geodynamics to represent those deemed most likely to remain geomorphically 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 under the Fish and Wildlife Program.

3.0 EKLUTNA RIVER CANYON REACH FISH 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 3-2, 3-3, and 3-4 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 3-2 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, AK at a flow of 8.8 cfs.

Figure 3-3 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 3-4 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.

Table 3-1 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 WSE's by assigning surface roughness coefficients to each transect. Different channel roughness values were tried until the simulated WSE's 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). The passage assessment focused on the same three salmon species as the PHABSIM analysis, Chinook, Coho, and Sockeye.

Table 3-2 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 leaping capabilities.[12]

3.3 PRELIMINARY 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). 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 2-7) to provide for unobstructed fish passage through all five of these sites. However, the channel morphologies of each site (especially Site B) 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 2.6.2.

Table 3-3 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

[12] 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.

4.0 REFERENCES

Bovee, K.D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology (IFIM). Instream Flow Information Paper No. 12. USFWS Report FWS/OBS-82-26.

Bovee, K.D., B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor, and J. Henriksen. 1998. Stream habitat analysis using the instream flow incremental methodology. U.S. Geological Survey, Biological Resources Discipline Information and Technology Report USGS/BRD-1998-0004. Viii + 131 pp.

Brophil, A.C. and M. Lamoreaux. 2020. Eklutna River Salmon Habitat Assessment and Collaboration to Recommended Restoration Flows. Native Village Eklutna.

Kleinschmidt Associates. 2022a. Year 1 Interim Report. Prepared by D. Reiser and M. Gagner and prepared for Chugach Electrical Association, Matanuska Electric Association, and Municipality of Anchorage. January 2022.

Kleinschmidt Associates. 2022b. Habitat Suitability Criteria (HSC) Curves for the Eklutna River, Alaska. Prepared by D. Reiser, A. Shelly, and M. Gagner for Chugach Electric Association, Matanuska Electric Association, and Municipality of Anchorage. 61 pp.

McMillen Jacobs Associates (MJA). 2019. Eklutna Hydroelectric Project, Fish & Wildlife Program Development, Site Reconnaissance Trip Report.

McMillen Jacobs Associates (MJA). 2020. Final Initial Information Package. Eklutna Hydroelectric Project 1991 Fish and Wildlife Agreement Implementation. Prepared for Chugach Electrical Association, Matanuska Electric Association, and Municipality of Anchorage.

McMillen Jacobs Associates (MJA). 2021a. Proposed Final Study Plans. Eklutna Hydroelectric Project 1991 Fish and Wildlife Agreement Implementation. Prepared for Chugach Electrical Association, Matanuska Electric Association, and Municipality of Anchorage.

McMillen Jacobs Associates (MJA). 2021b. Historical hydrology of the Eklutna River, Draft Technical Memorandum, prepared by Samantha Owen (MJA) for Mike Brodie, Chugach Electrical Association. Prepared for Chugach Electrical Association, Matanuska Electric Association, and Municipality of Anchorage. November 8, 2021.

McMillen Jacobs Associates (MJA). 2022. Year 2 Study Plan. Prepared for Chugach Electrical Association, Matanuska Electric Association, and Municipality of Anchorage. January 2022.

Milhous, R.T., D.L. Wegner, and T. Waddle. 1984. Users guide to the physical habitat simulation system (PHABSIM). Instream Flow Information Paper No. 11. Washington, DC: U.S. Fish and Wildlife Service (FWS/OBS-81/43). Revised.

Reiser, D.W., C. Huang., S. Beck., M. Gagner., and E. Jeanes. 2006. Defining flow windows for upstream passage of adult anadromous salmonids at cascades and falls. Transactions of the American Fisheries Society. 135:668-679.

Trihey, E.W. and D.L. Wegner. 1981. Field data collection procedures for use with the physical habitat simulation system of the instream flow group, U.S. Fish and Wildlife Service, Natl. Ecol. Res. Center, Fort Collins, CO: 139 pp.

Trout Unlimited (TU). 2018. Eklutna River Workshop, Summary of Outcomes, Recommendations, and Future Needs. June 2018.

United States Army Corps of Engineers (USACE). 2011. Eklutna River Aquatic Ecosystem Restoration Technical Report. Joint Base Elmendorf-Richardson, Alaska. November 2011.

United States Army Corps of Engineers (USACE). 2016. HEC-RAS River Analysis System User's Manual Version 5.0, US Army Corps of Engineers, Institute for Water Resource, Hydrologic Engineering Center, Davis, CA, Report CPD-68.

United States Fish and Wildlife Service (USFWS). 2019. Upper Eklutna River Survey. Preliminary Fish Habitat Flow Assessment. Heather Hanson, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Washington Department of Fish and Wildlife (WDFW). 2019. Fish passage inventory, assessment, and prioritization manual. Olympia, Washington.

APPENDIX A
TRANSECT BASED HABITAT VS. FLOW RELATIONSHIPS

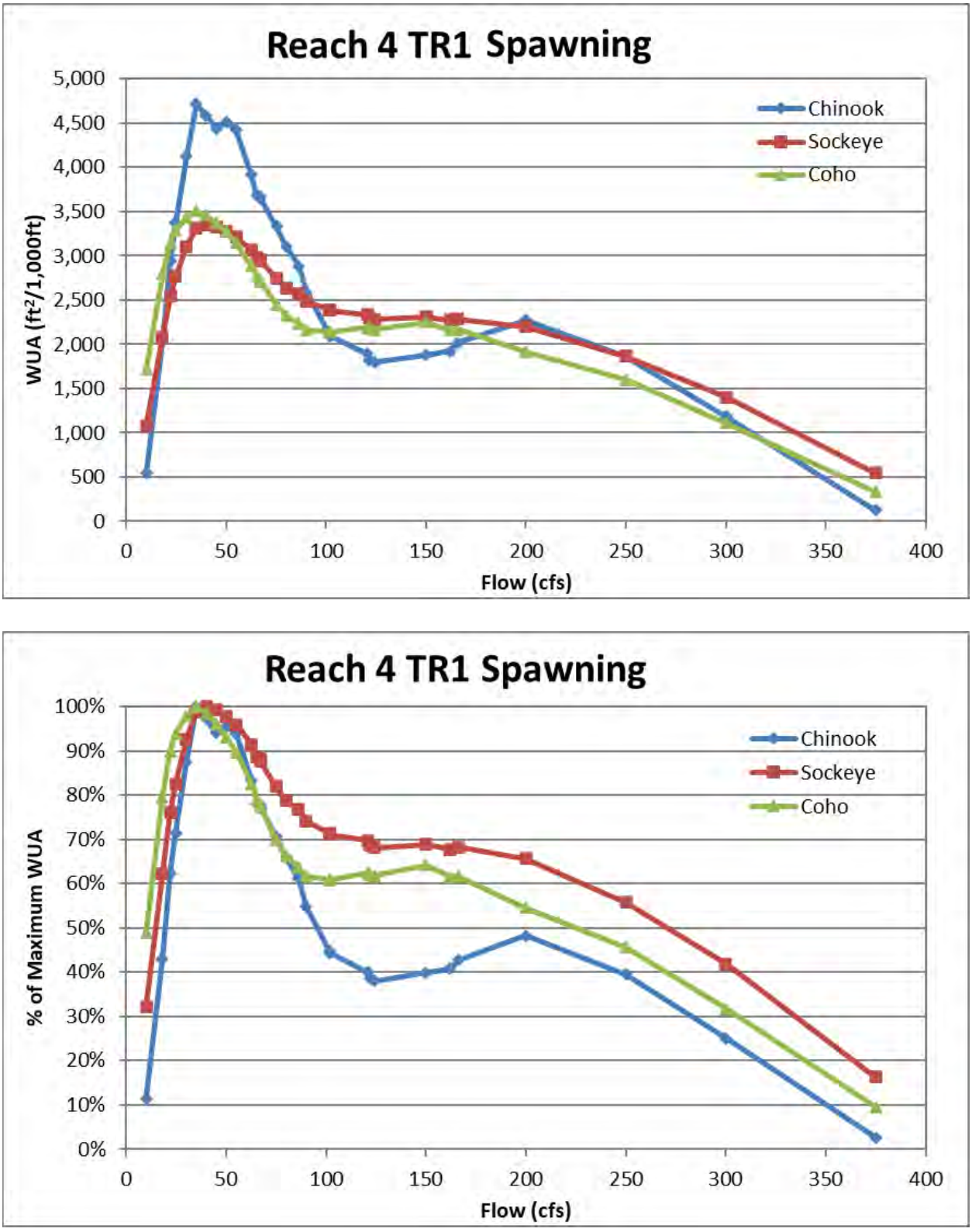


Figure A-1 Reach 4 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

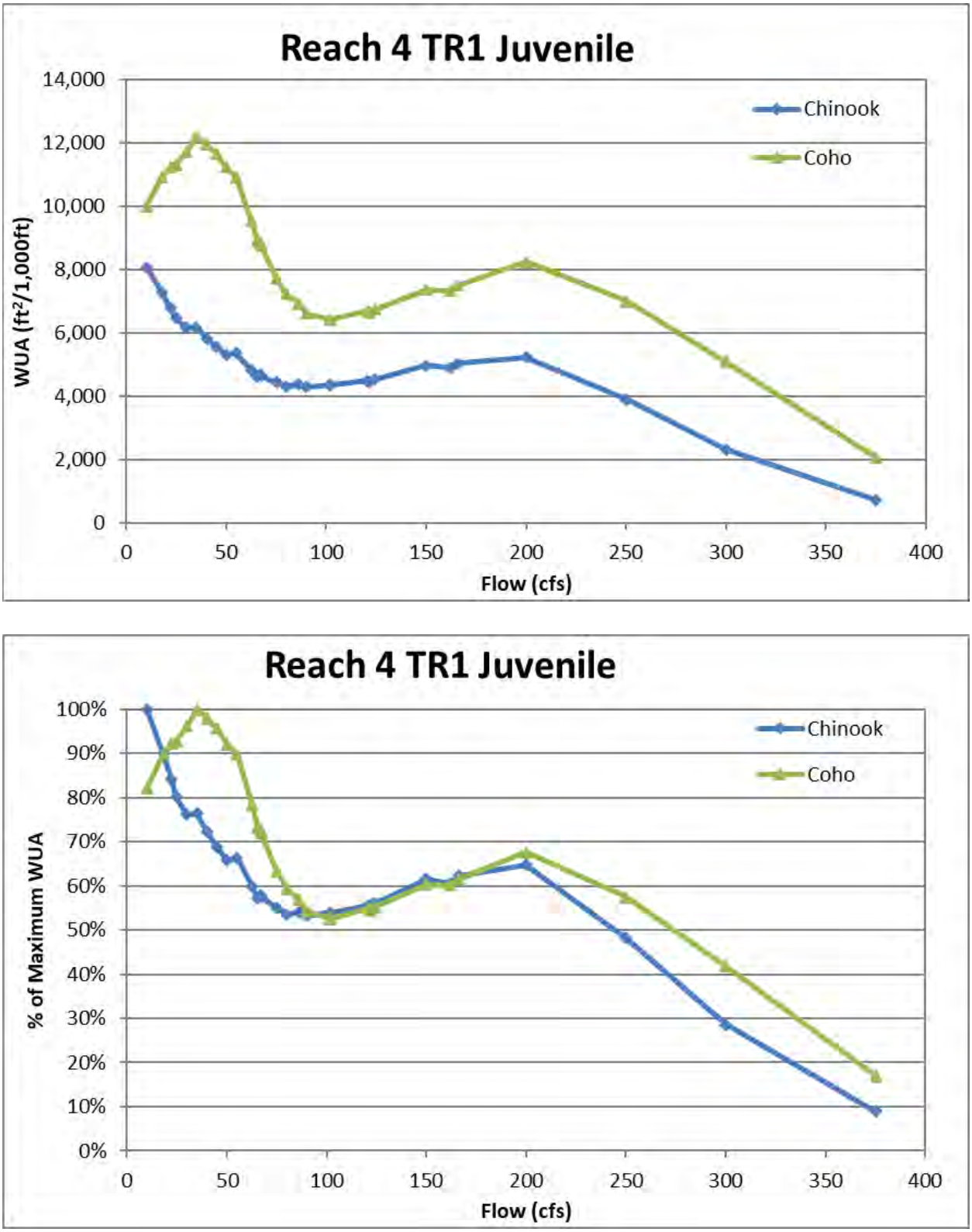


Figure A-2 Reach 4 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

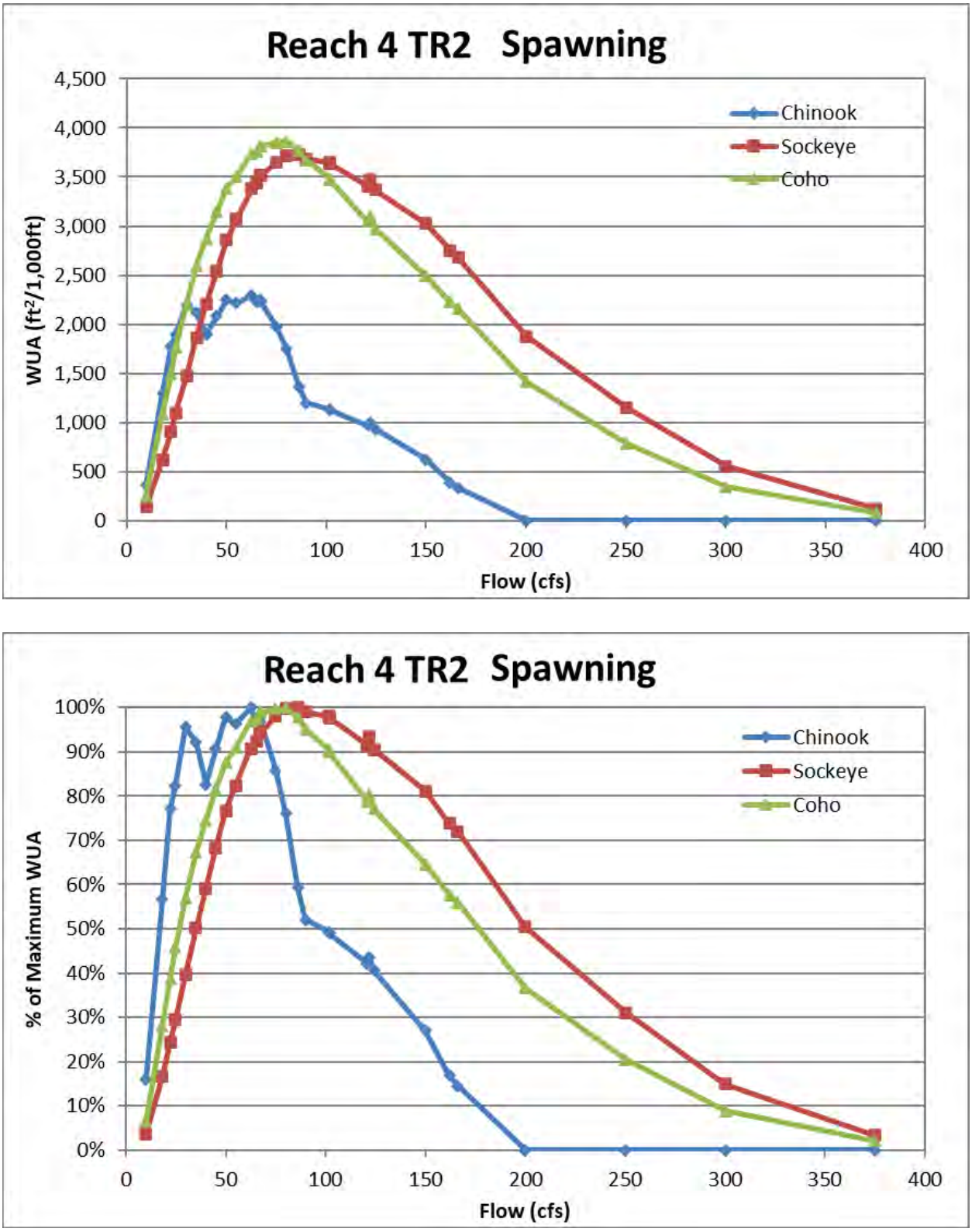


Figure A-3 Reach 4 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

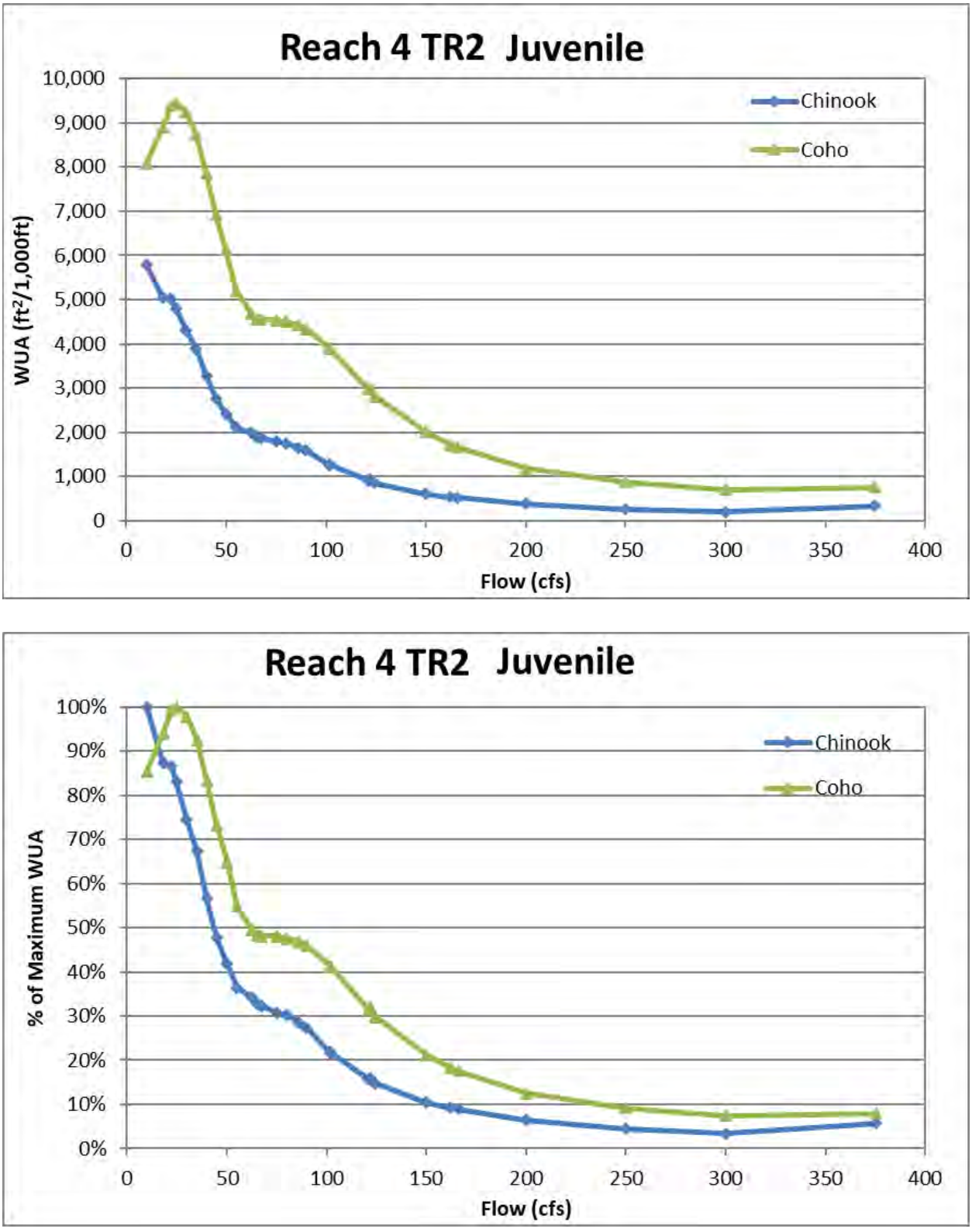


Figure A-4 Reach 4 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

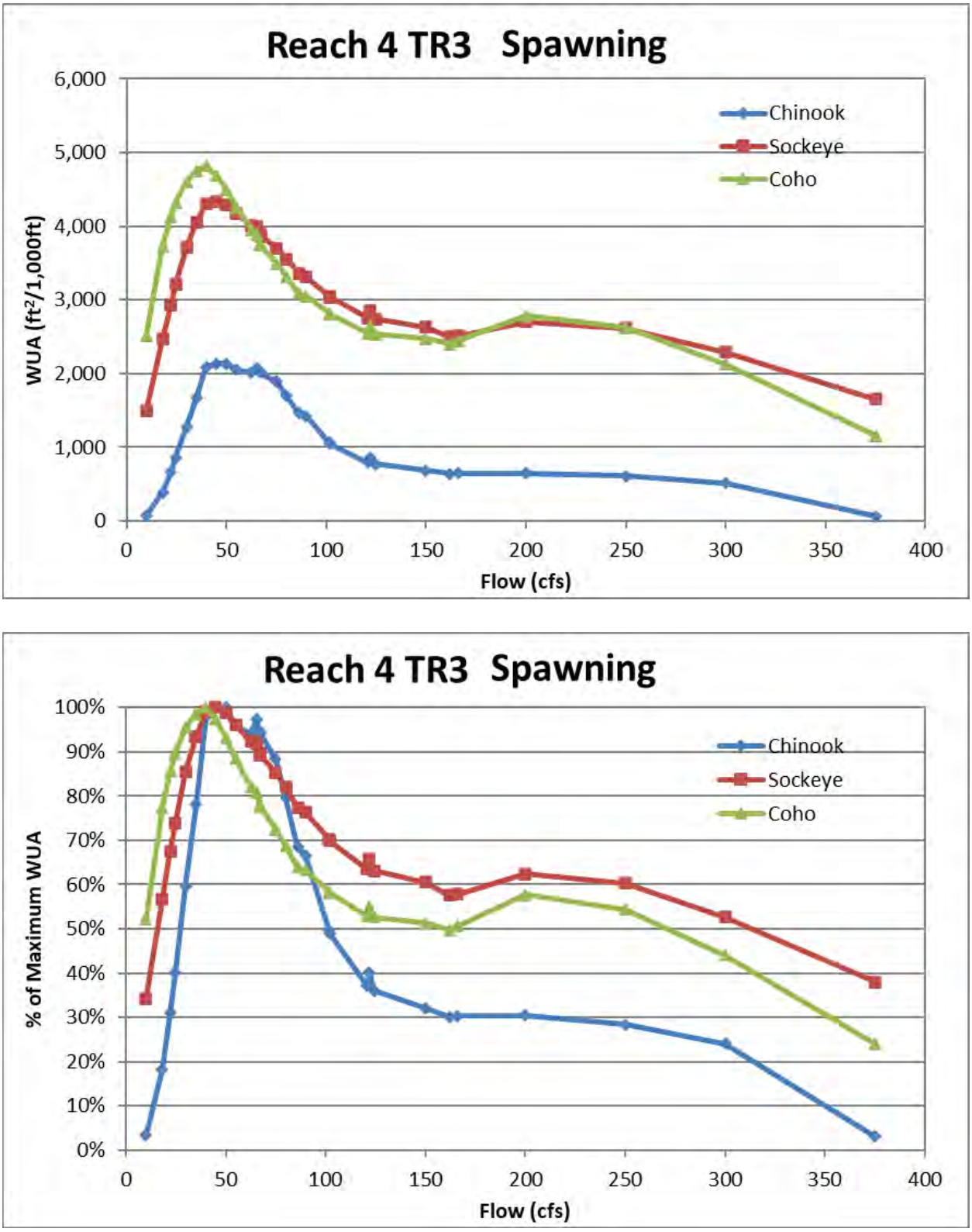


Figure A-5 Reach 4 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

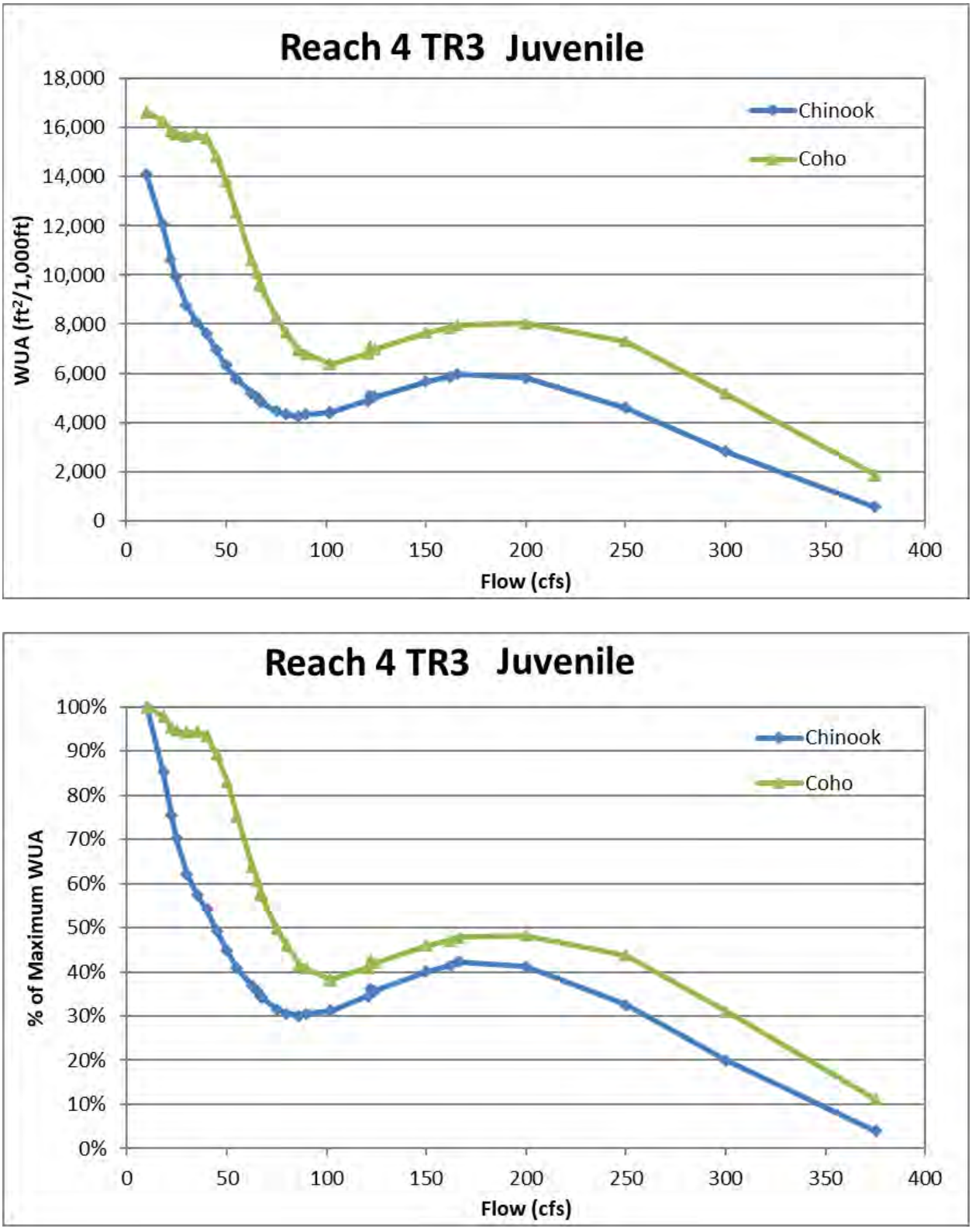


Figure A-6 Reach 4 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

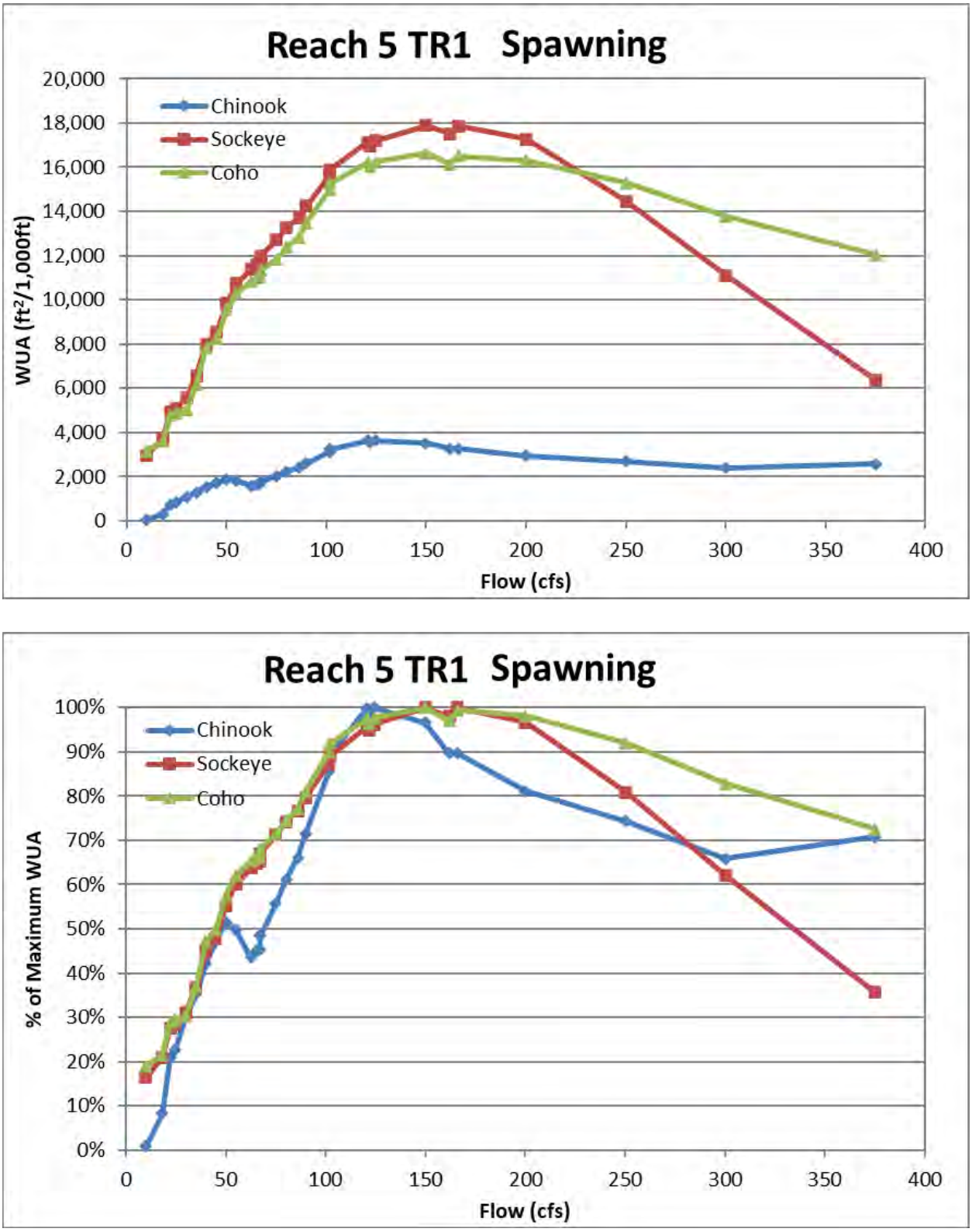


Figure A-7 Reach 5 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

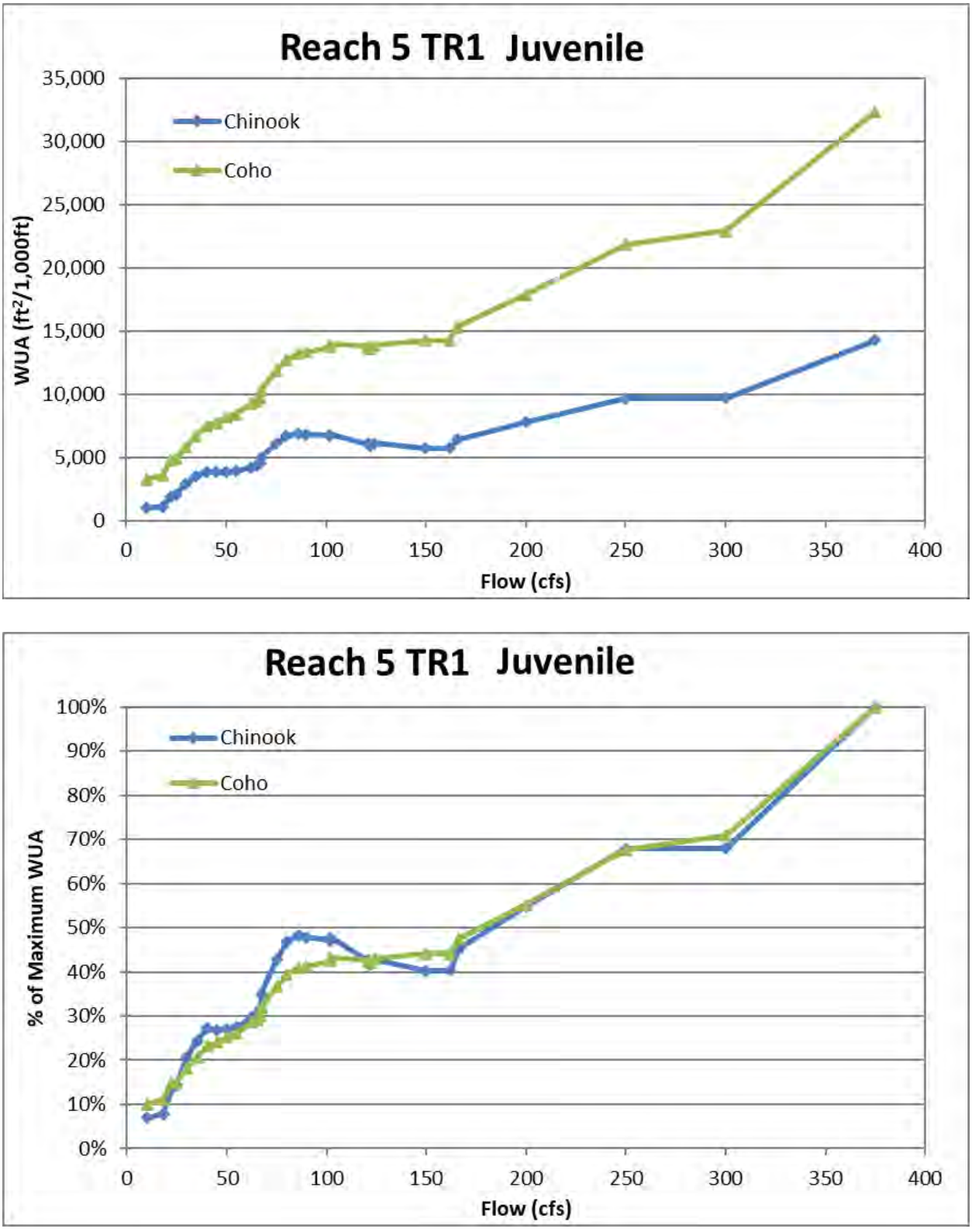


Figure A-8 Reach 5 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

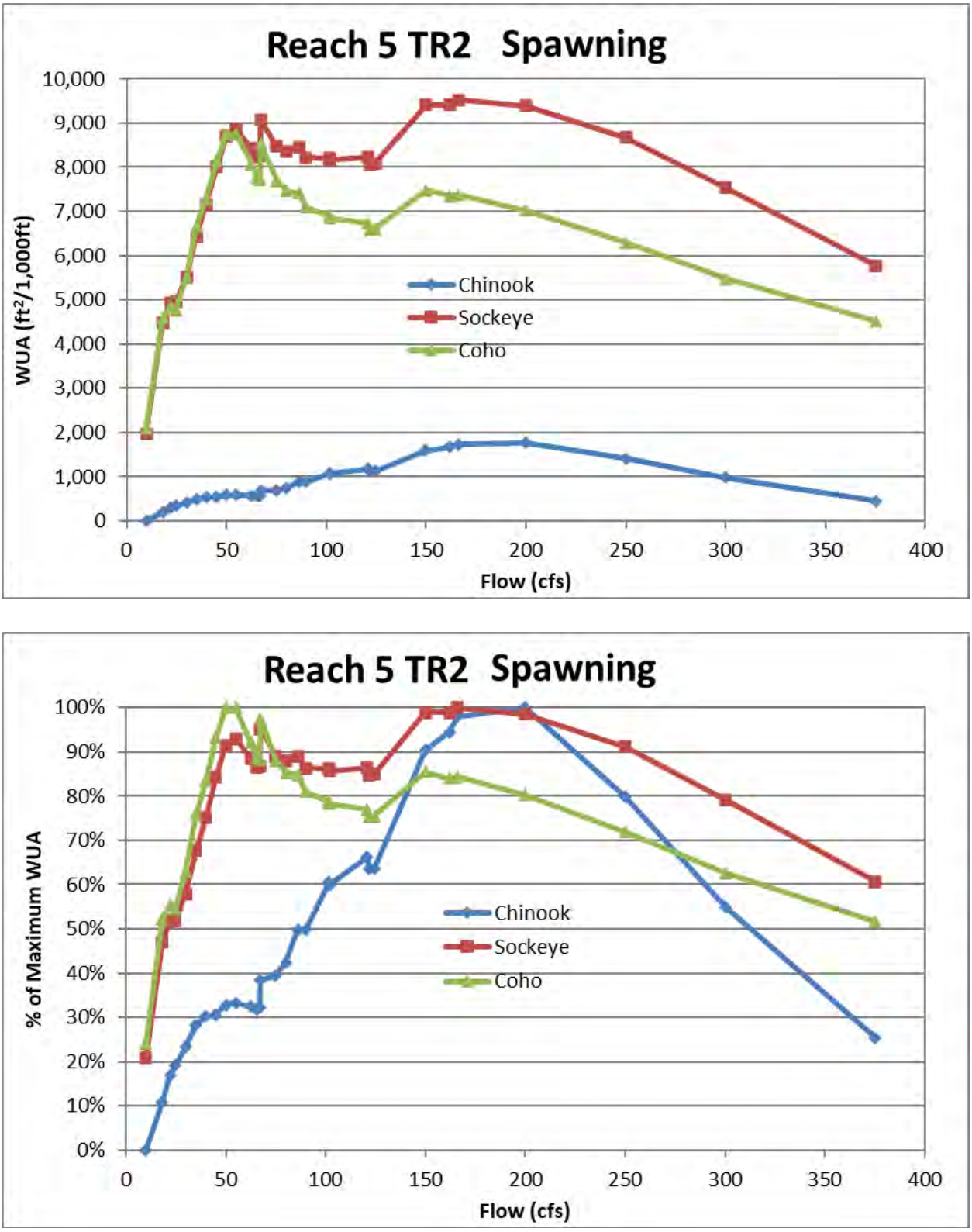


Figure A-9 Reach 5 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

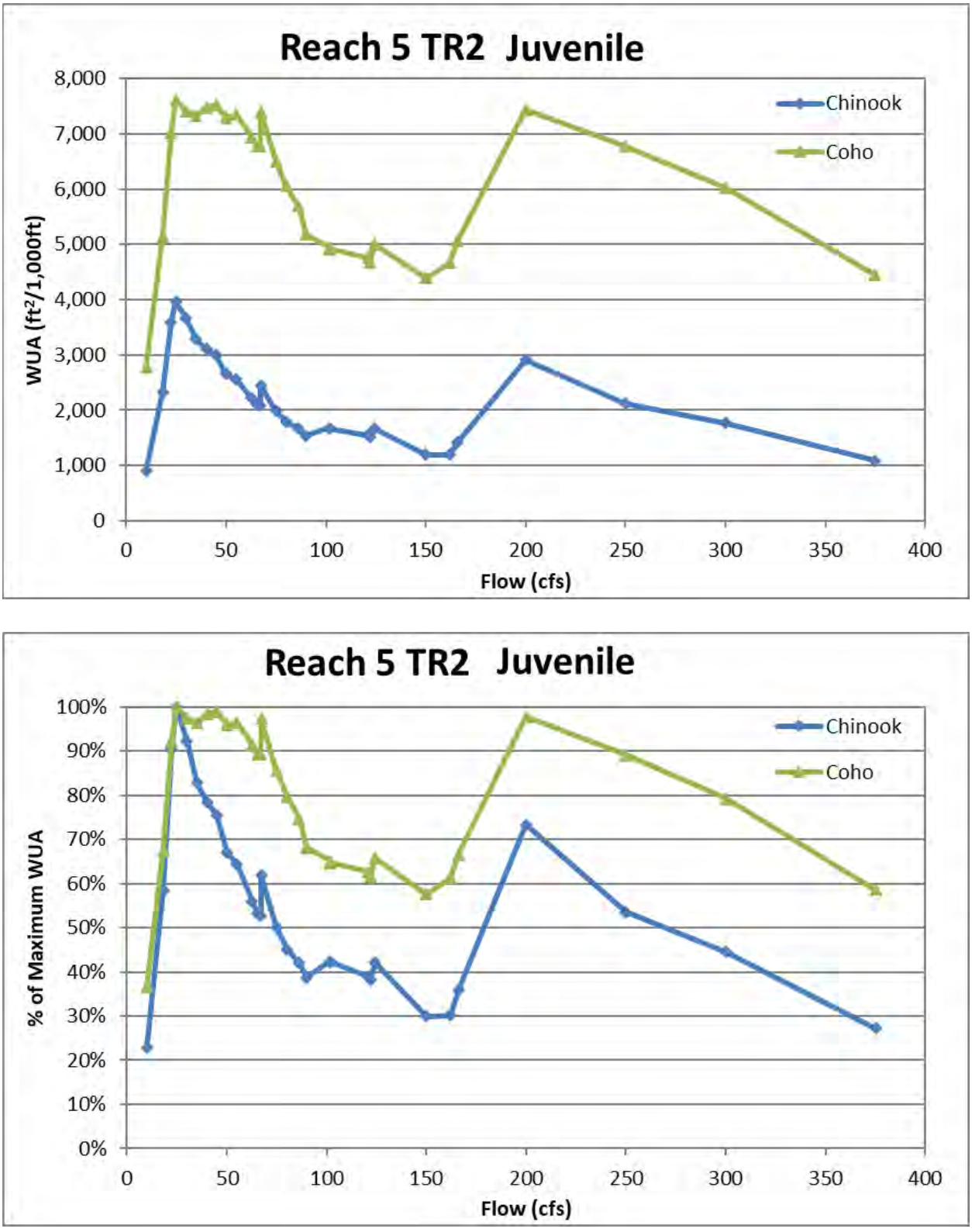


Figure A-10 Reach 5 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

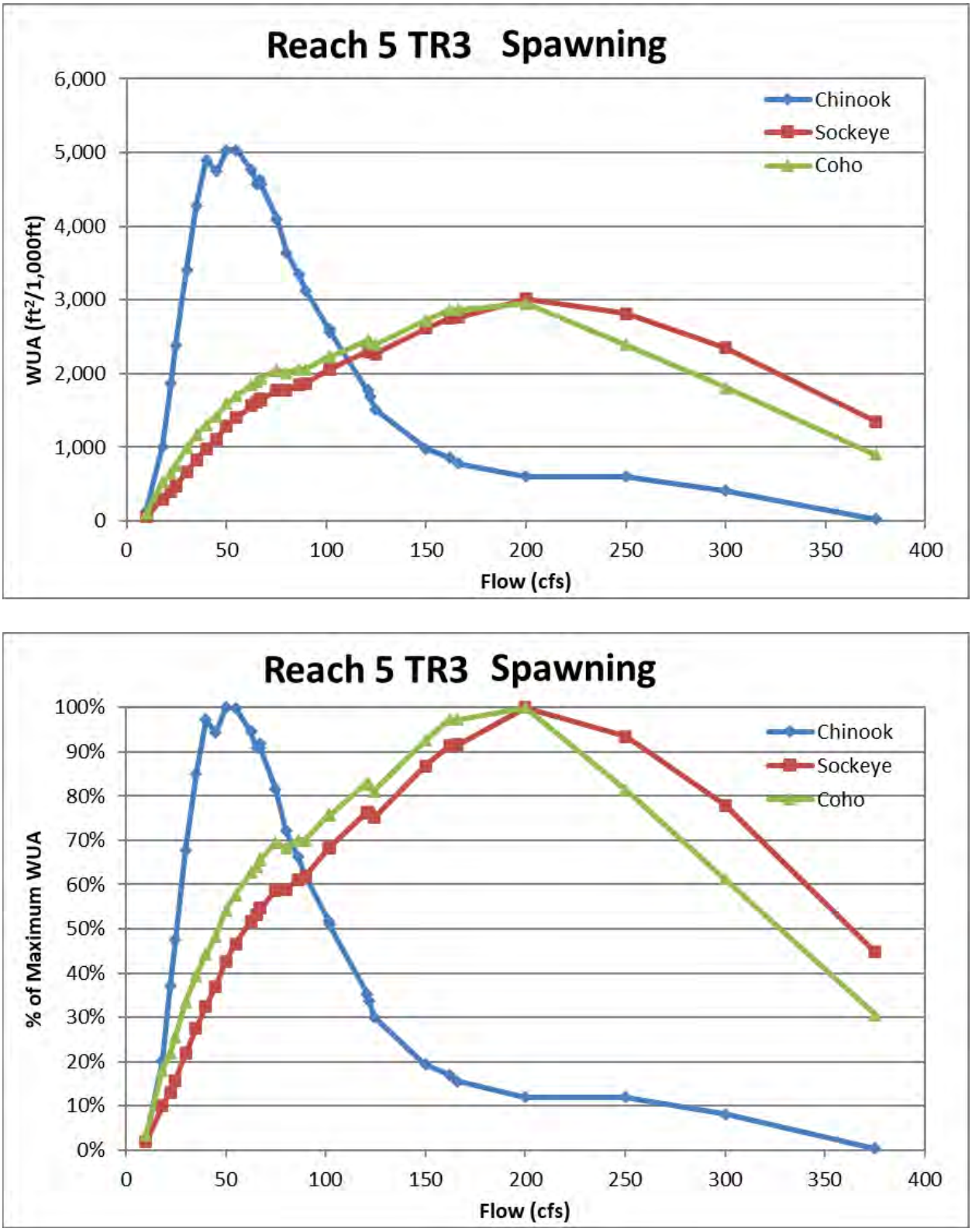


Figure A-11 Reach 5 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

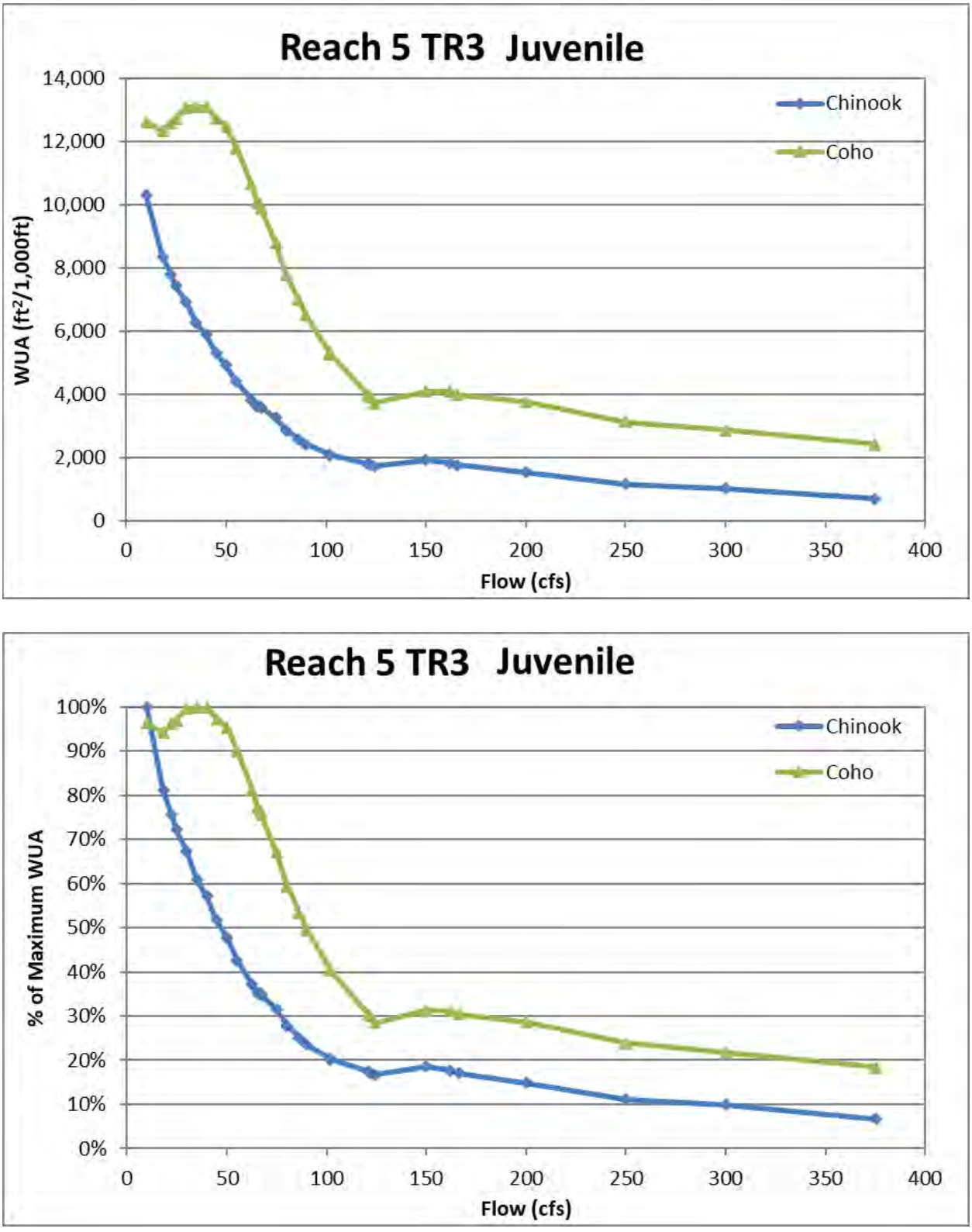


Figure A-12 Reach 5 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

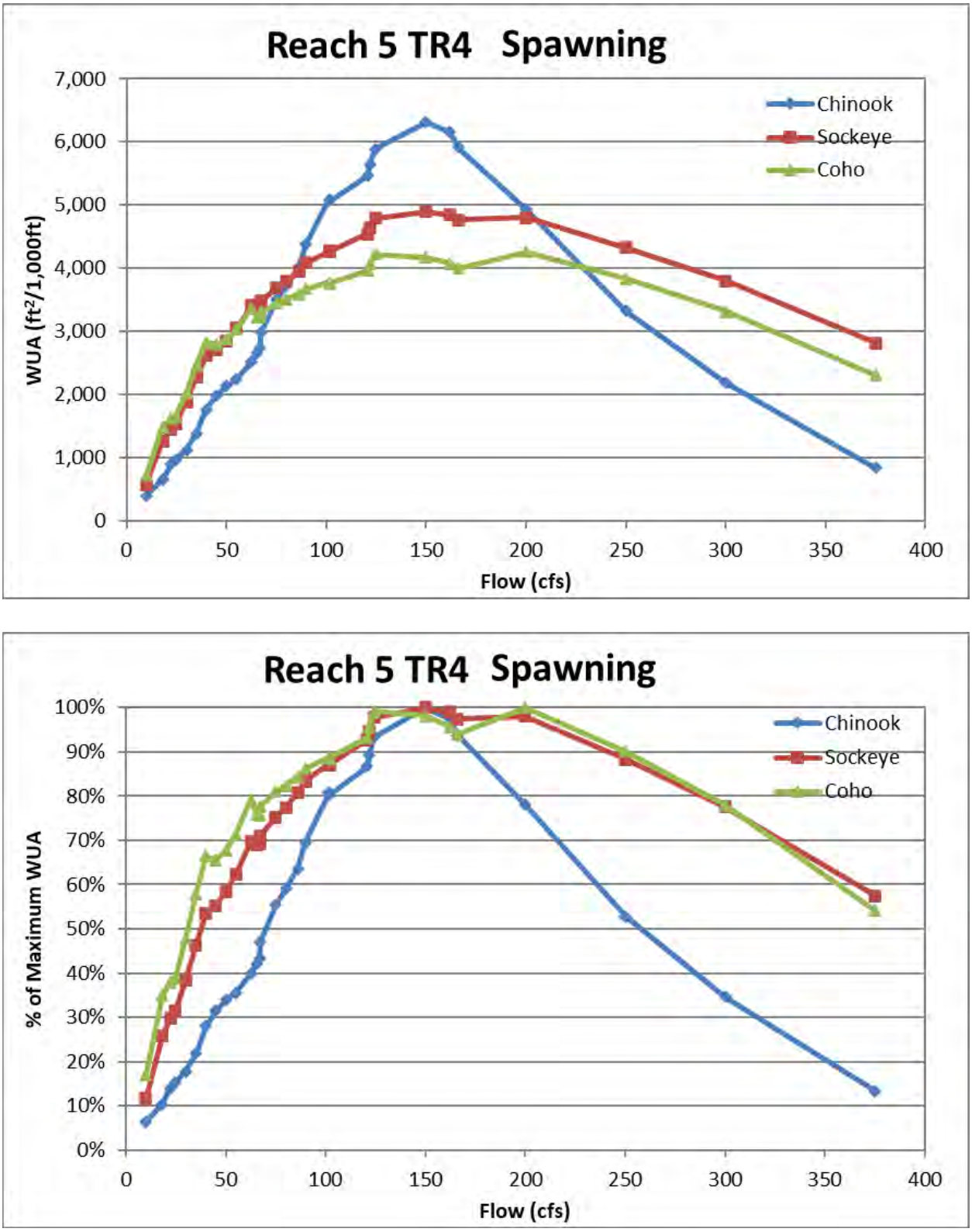


Figure A-13 Reach 5 Transect 4 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

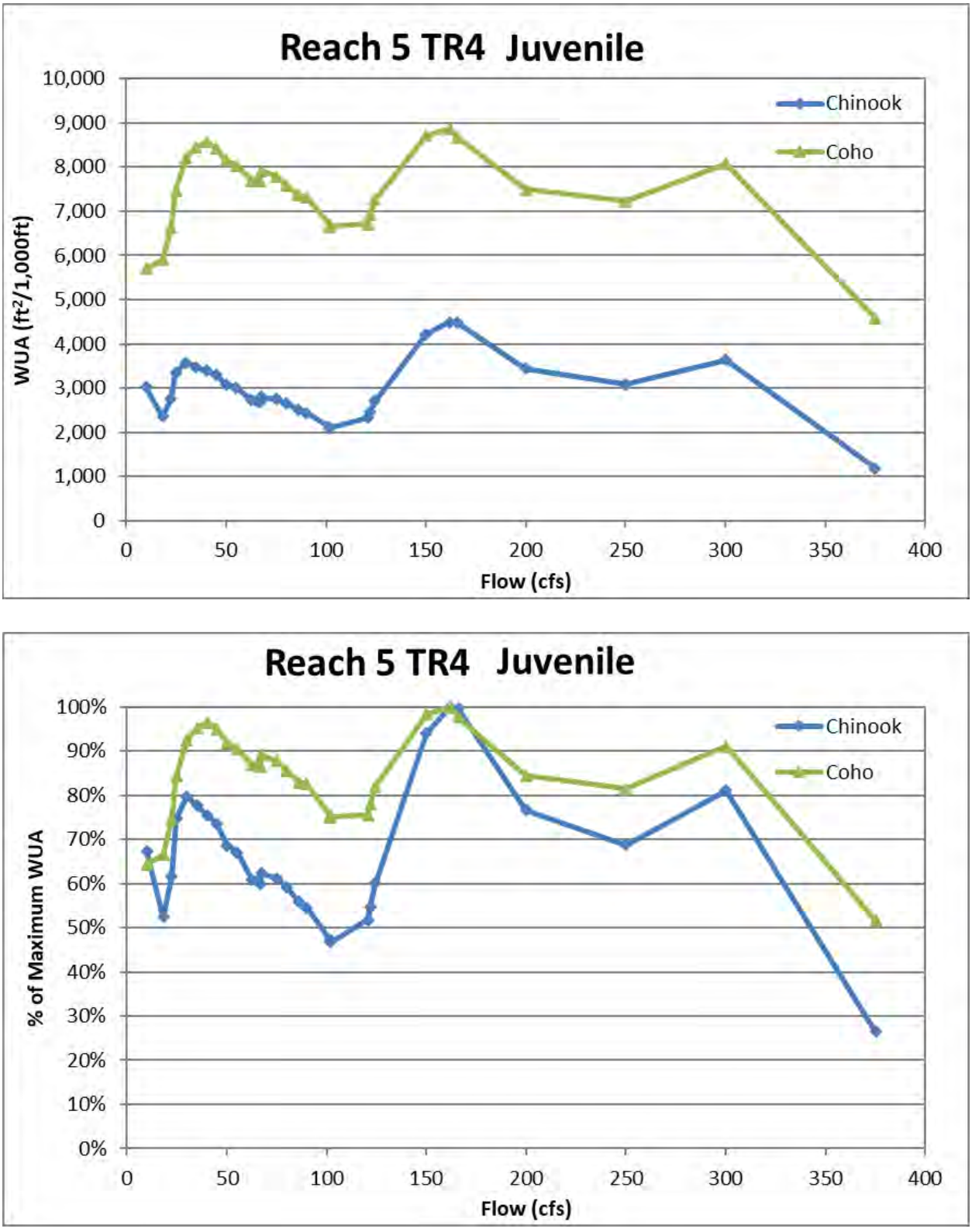


Figure A-14 Reach 5 Transect 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

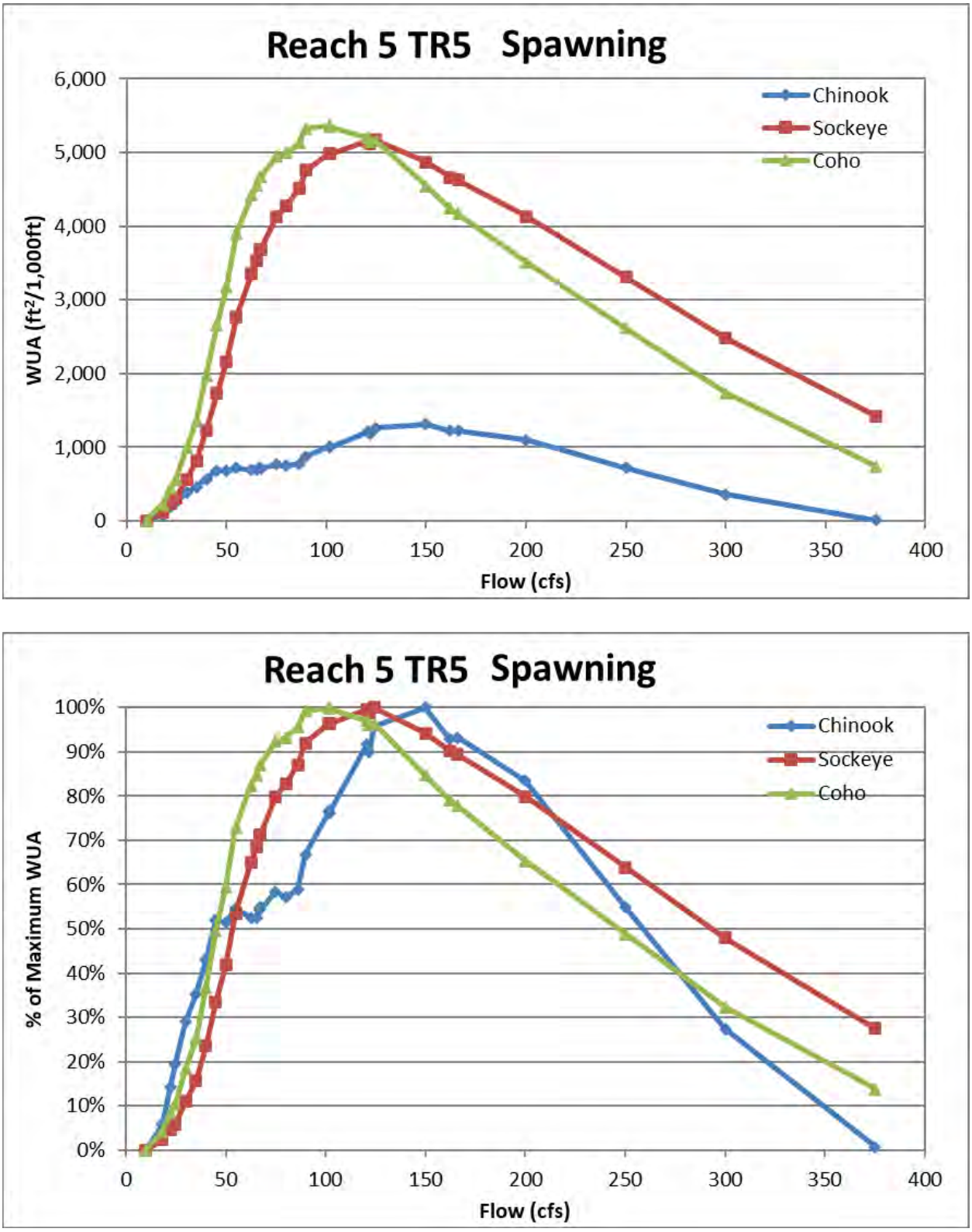


Figure A-15 Reach 5 Transect 5 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

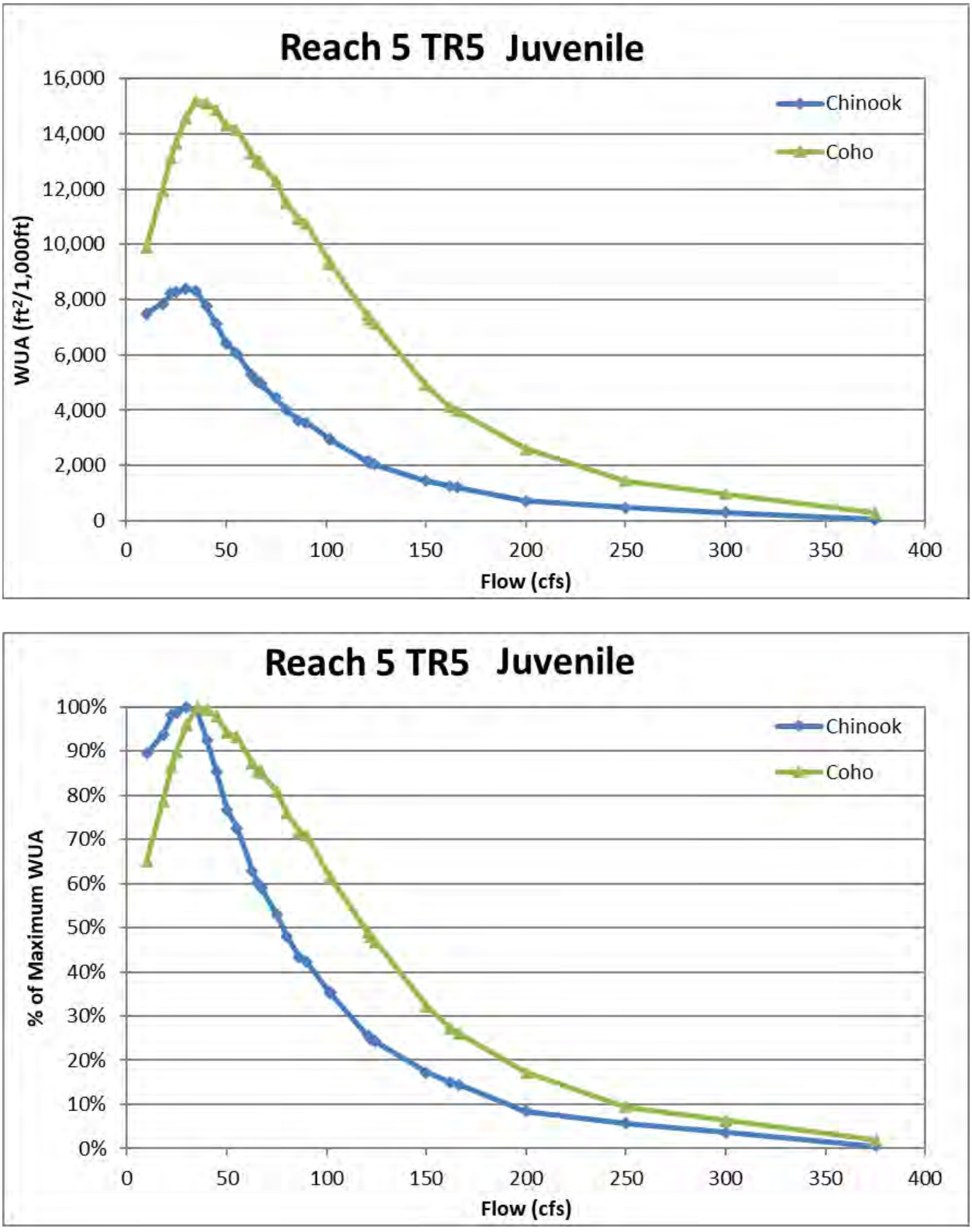


Figure A-16 Reach 5 Transect 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

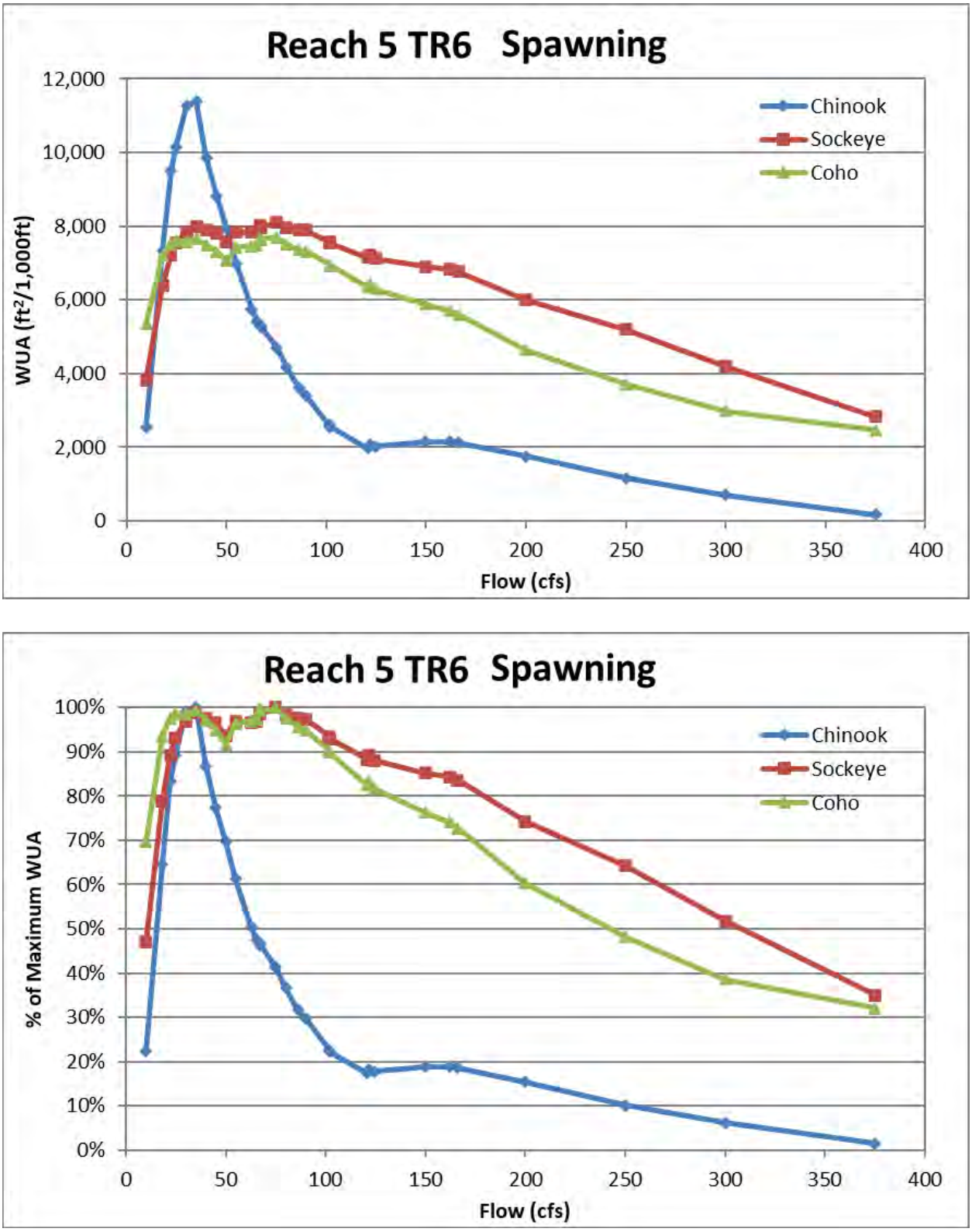


Figure A-17 Reach 5 Transect 6 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

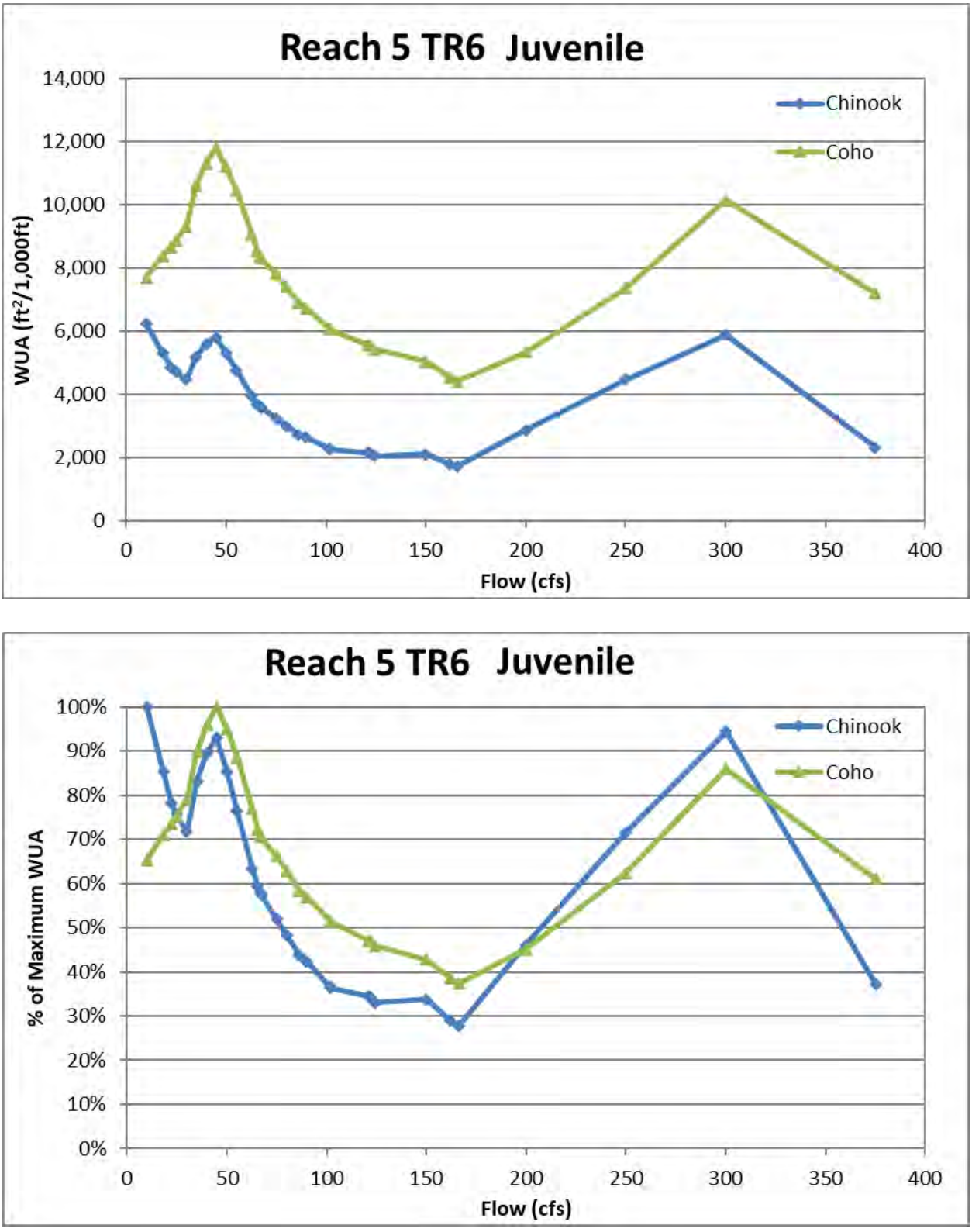


Figure A-18 Reach 5 Transect 6 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

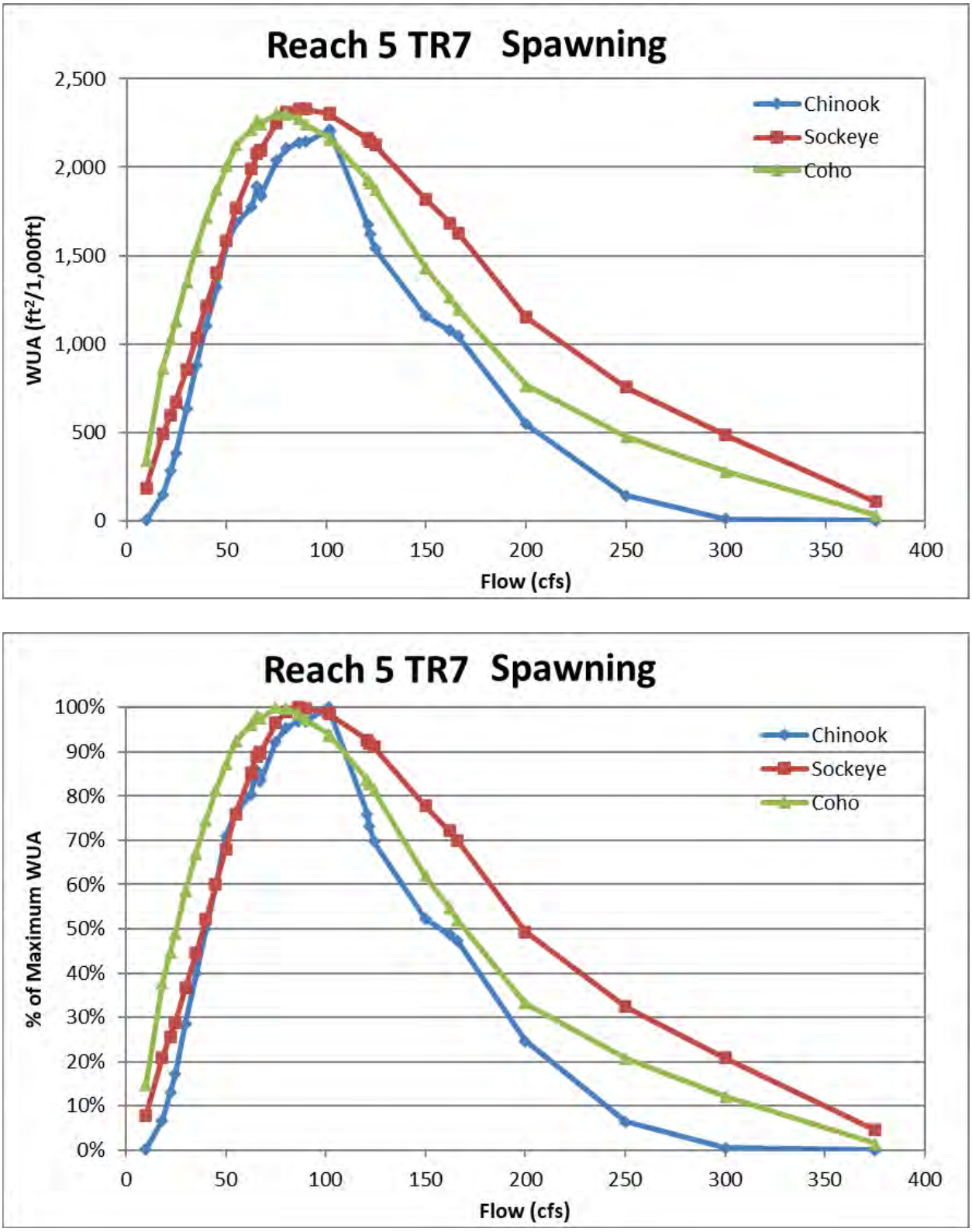


Figure A-19 Reach 5 Transect 7 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

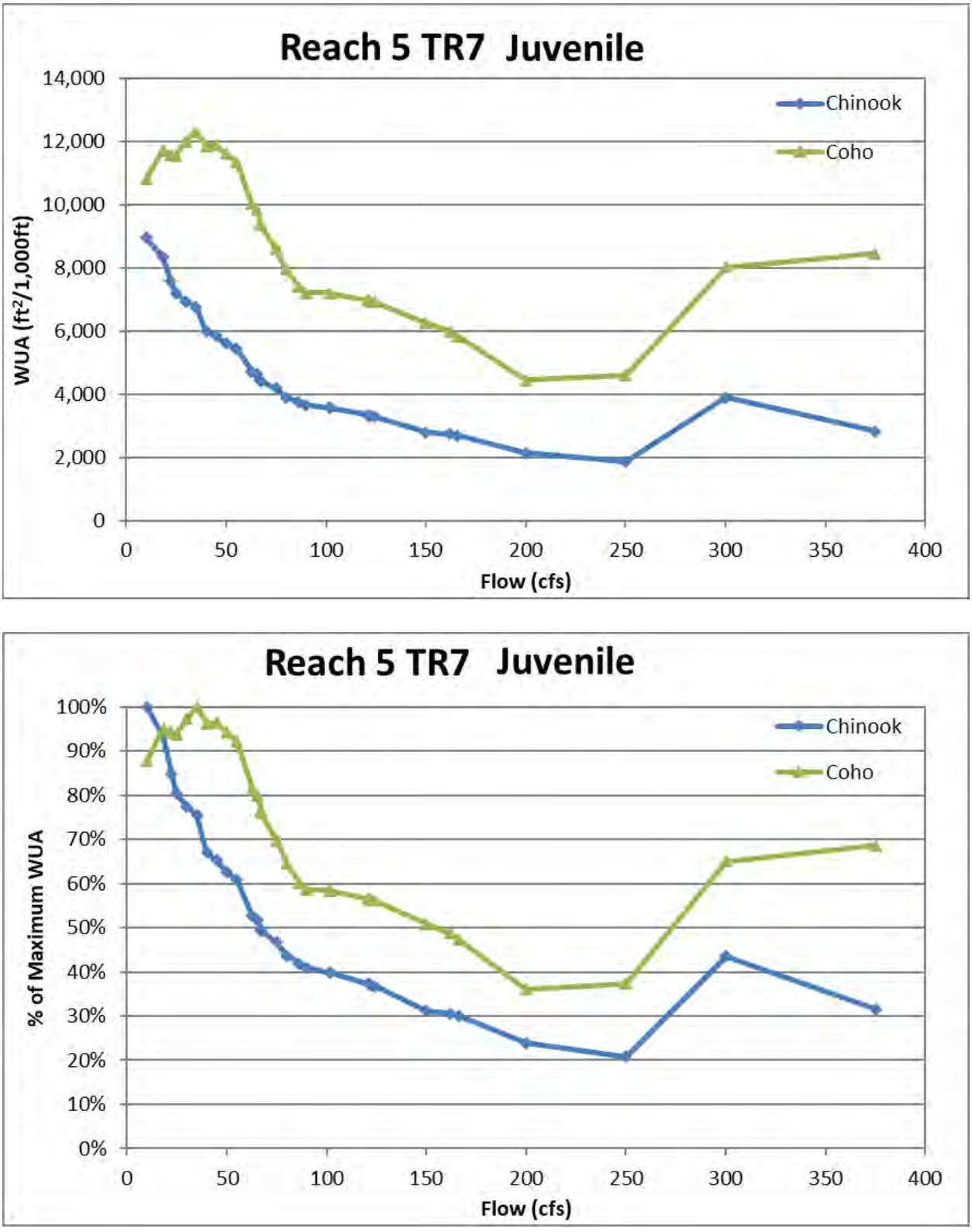


Figure A-20 Reach 5 Transect 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

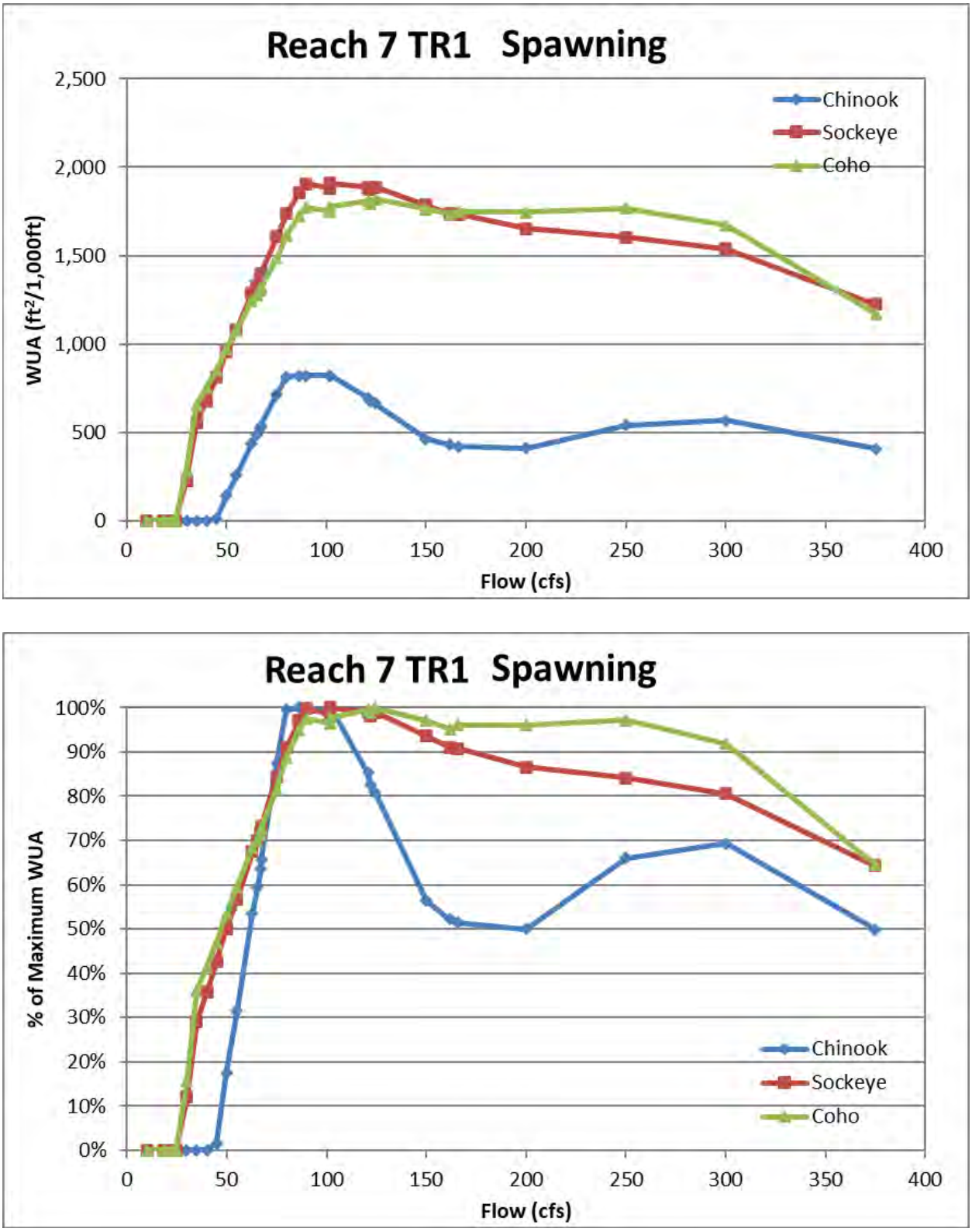


Figure A-21 Reach 7 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

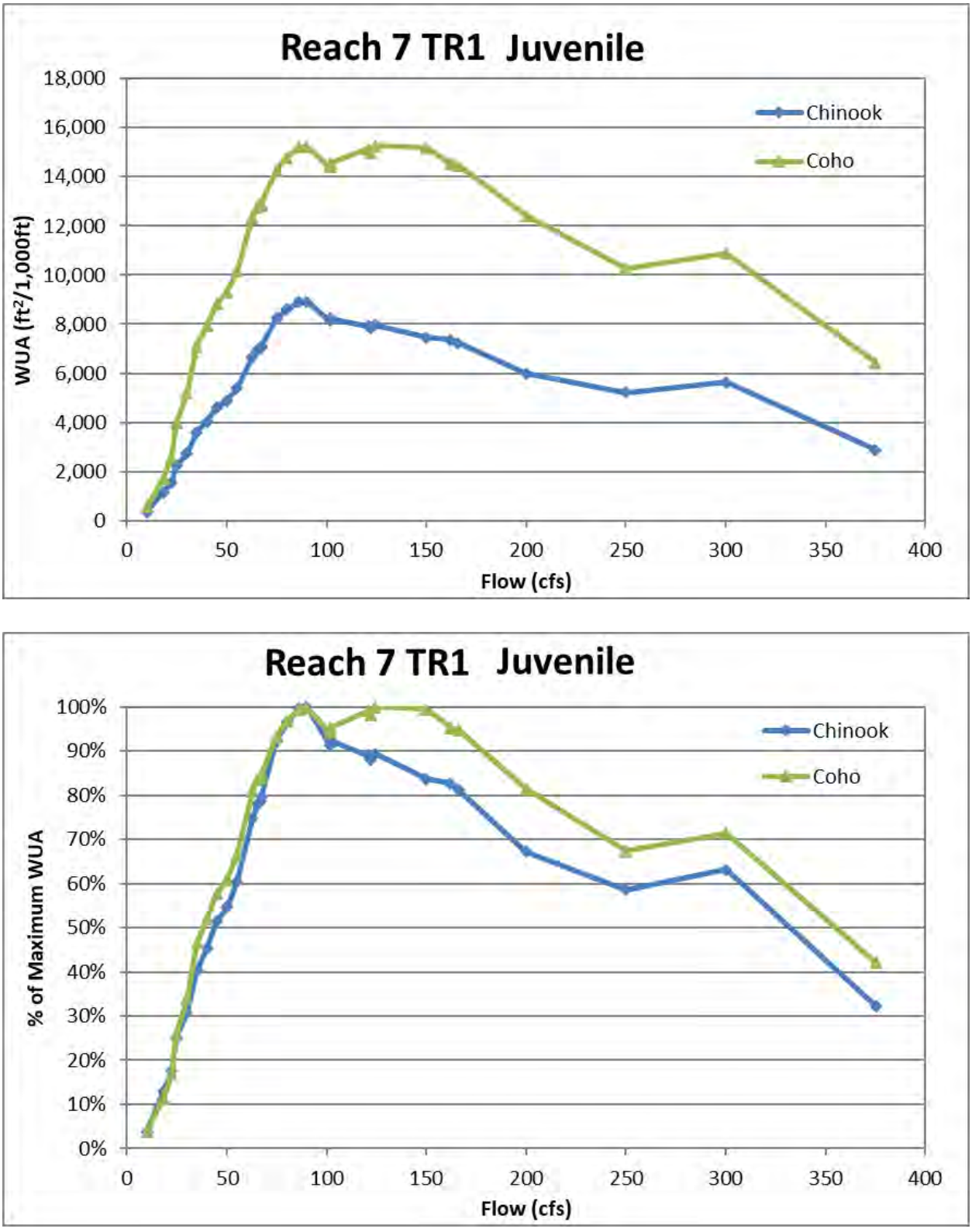


Figure A-22 Reach 7 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

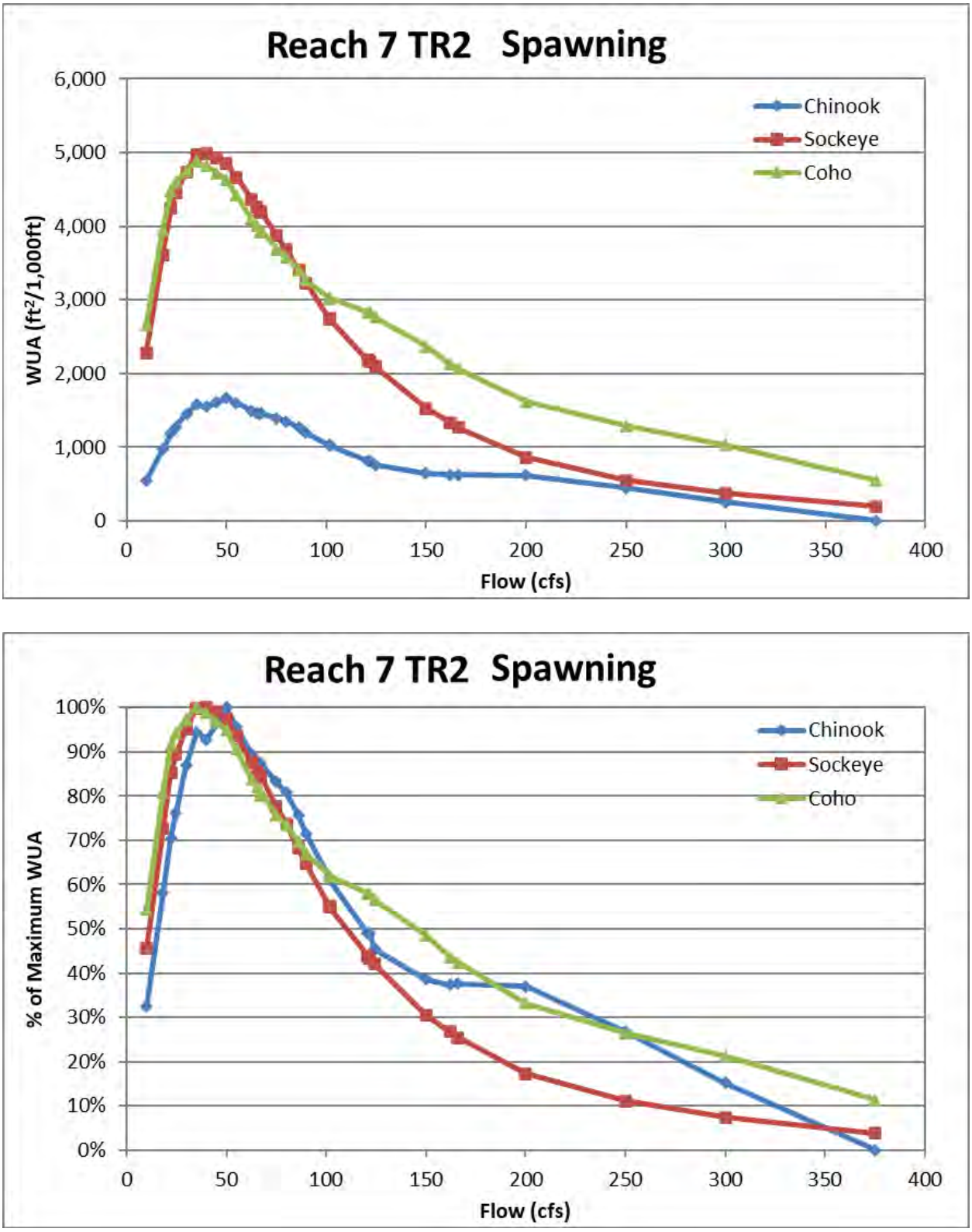


Figure A-23 Reach 7 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

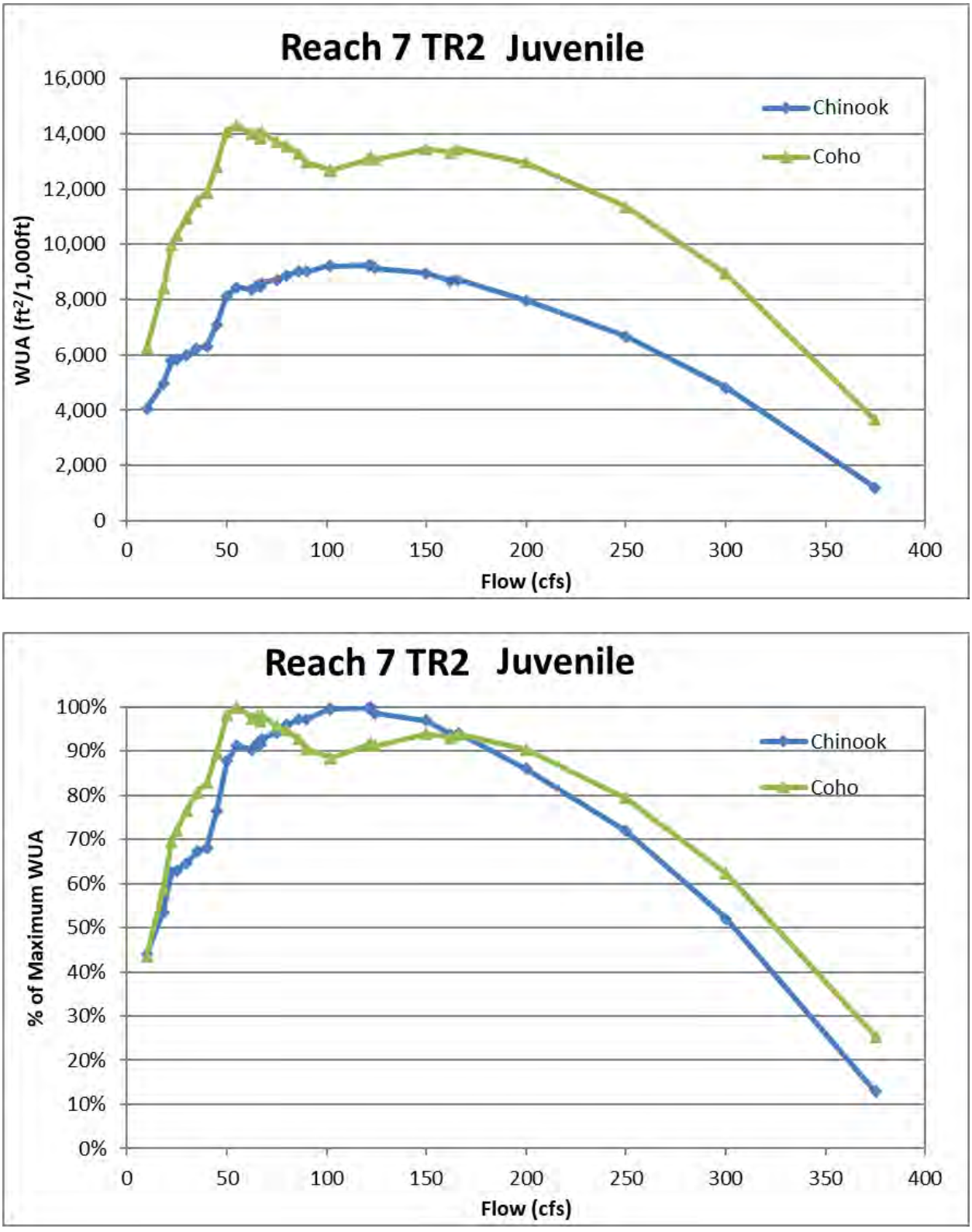


Figure A-24 Reach 7 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

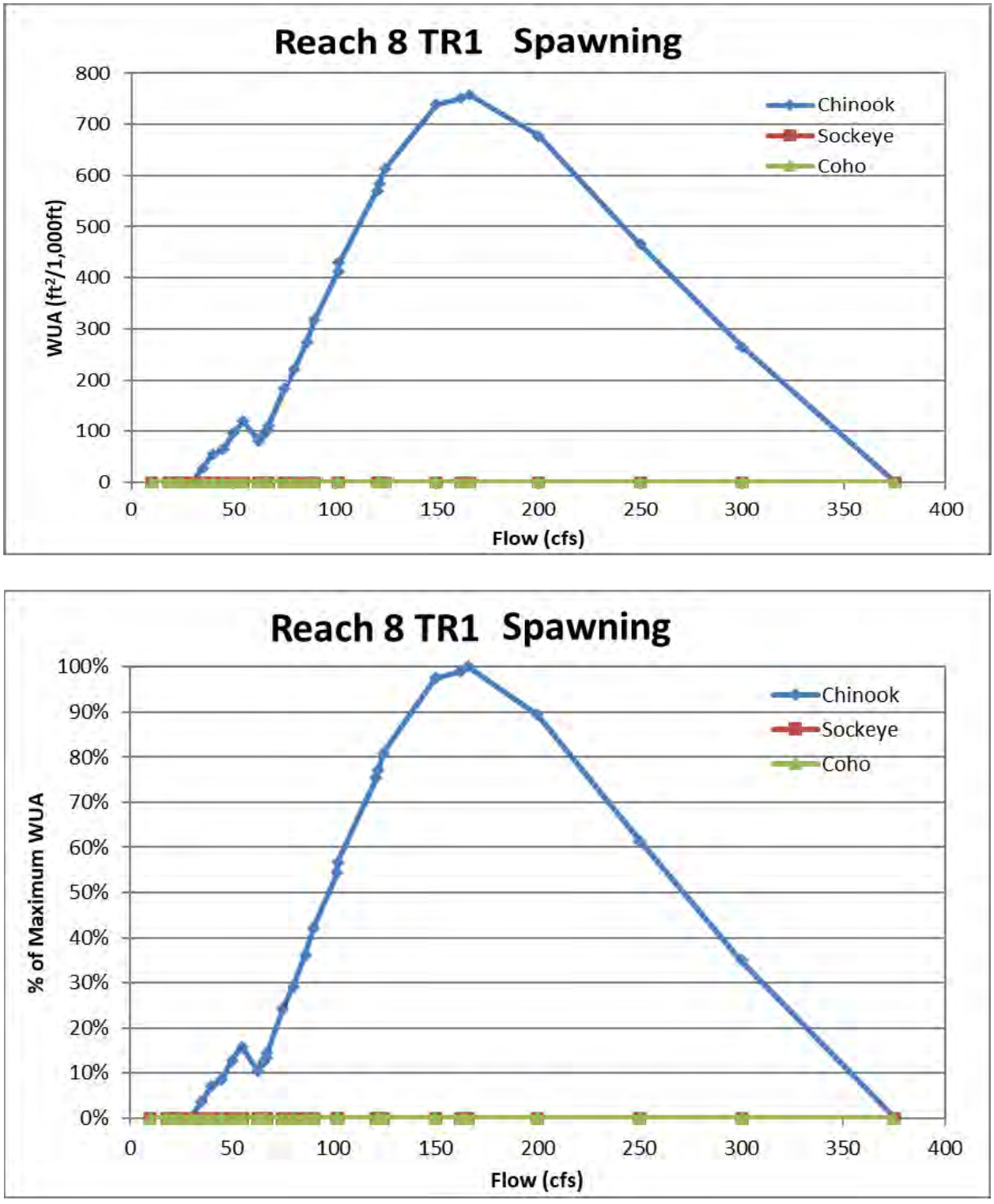


Figure A-25 Reach 8 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

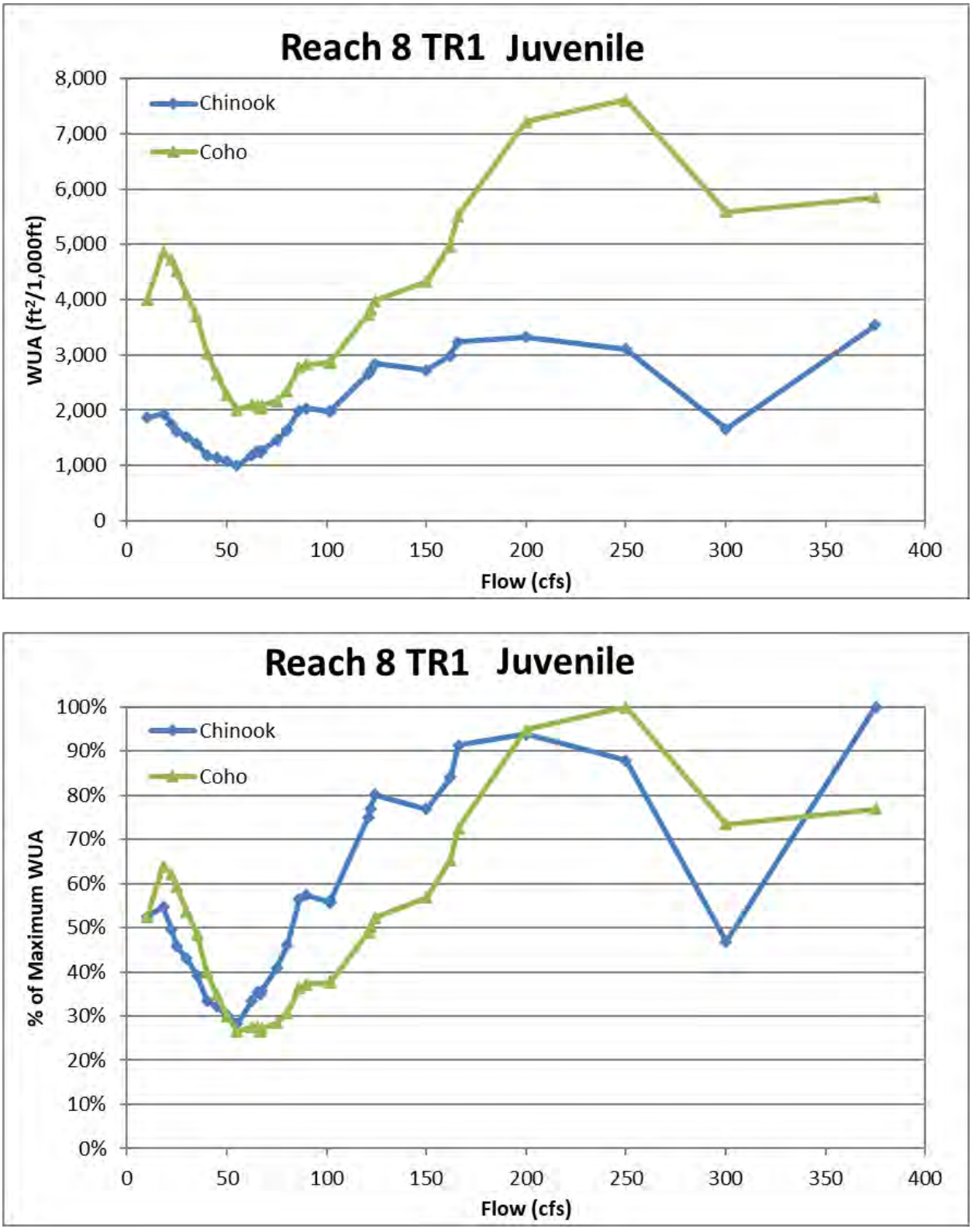


Figure A-26 Reach 8 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

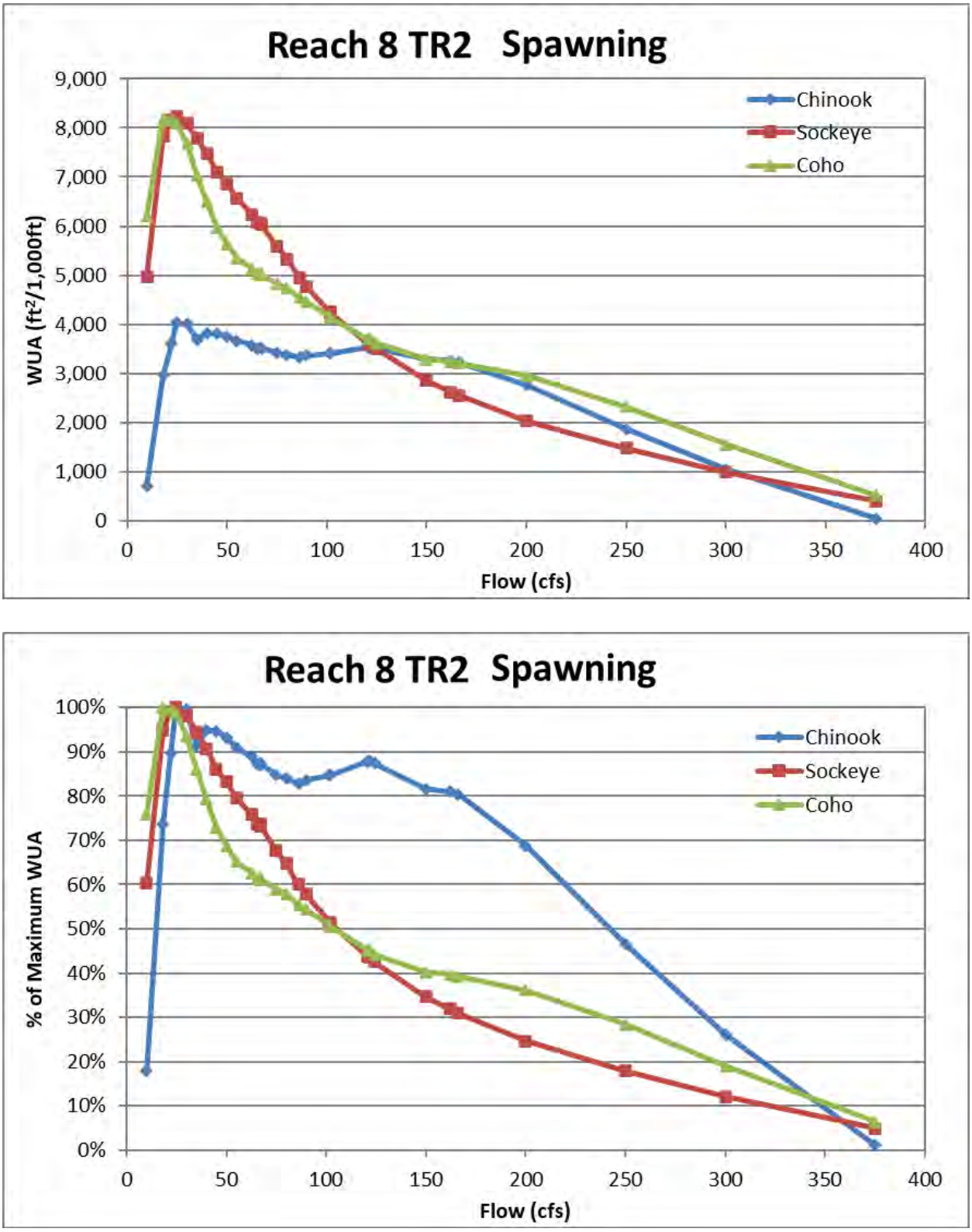


Figure A-27 Reach 8 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

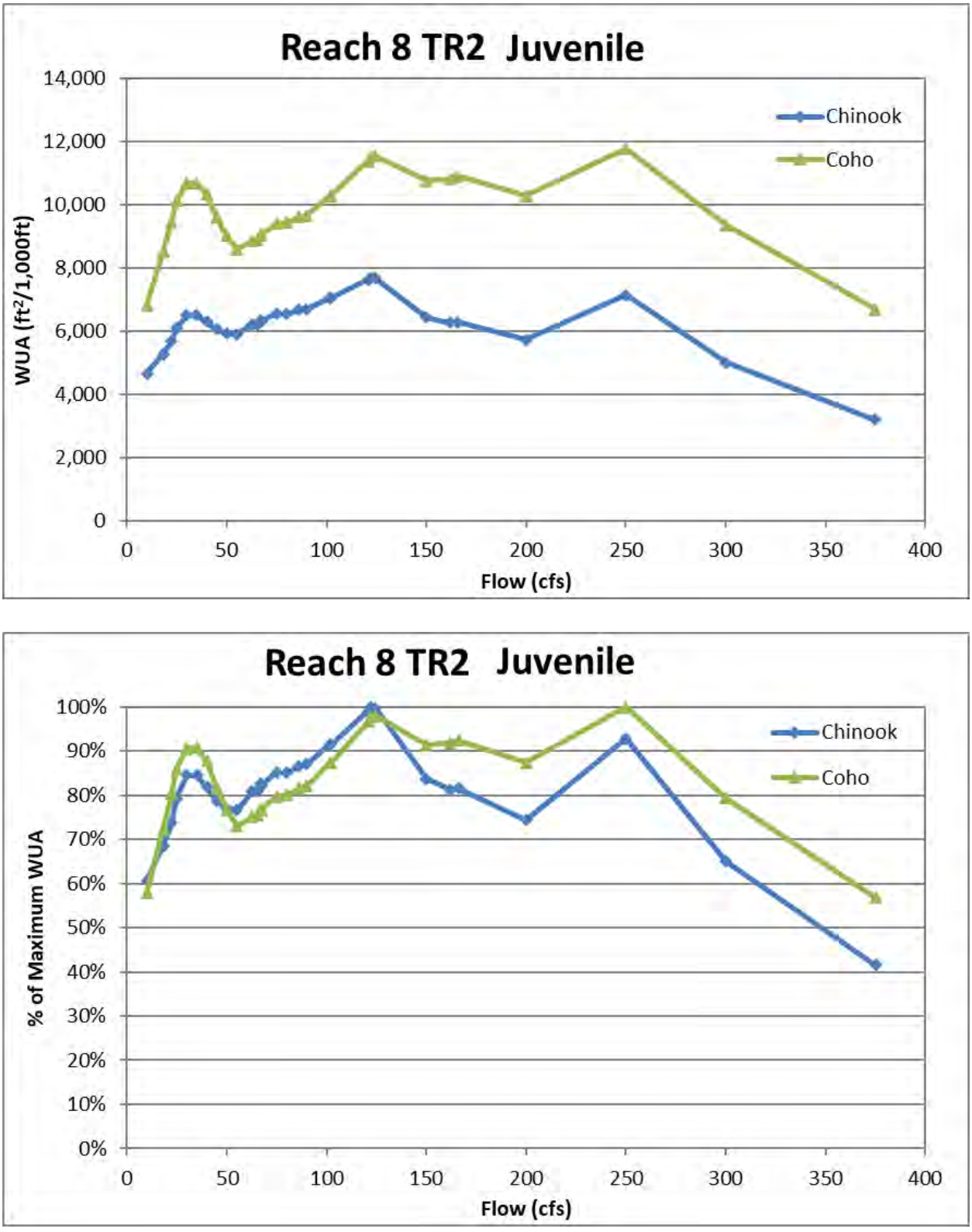


Figure A-28 Reach 8 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

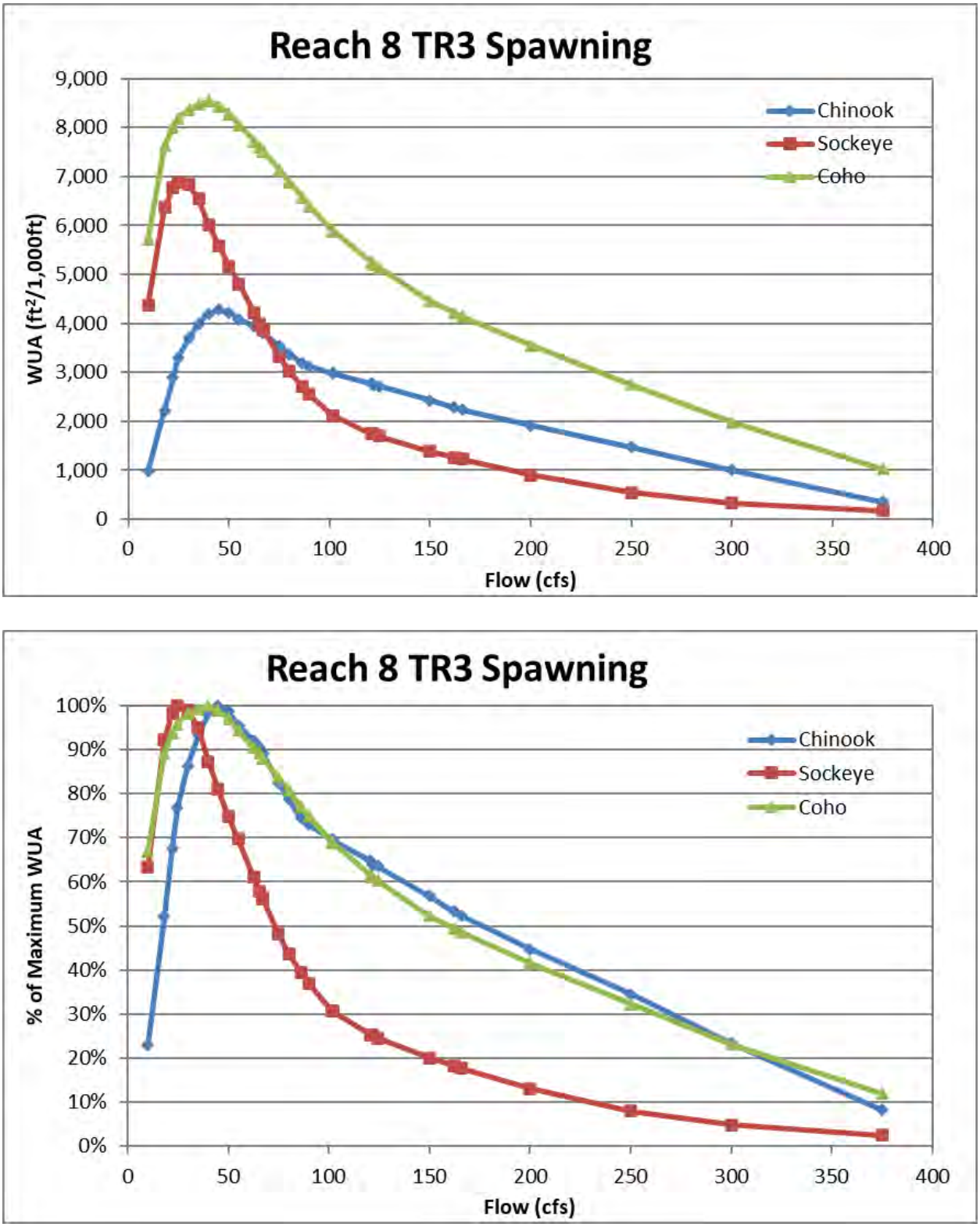


Figure A-29 Reach 8 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

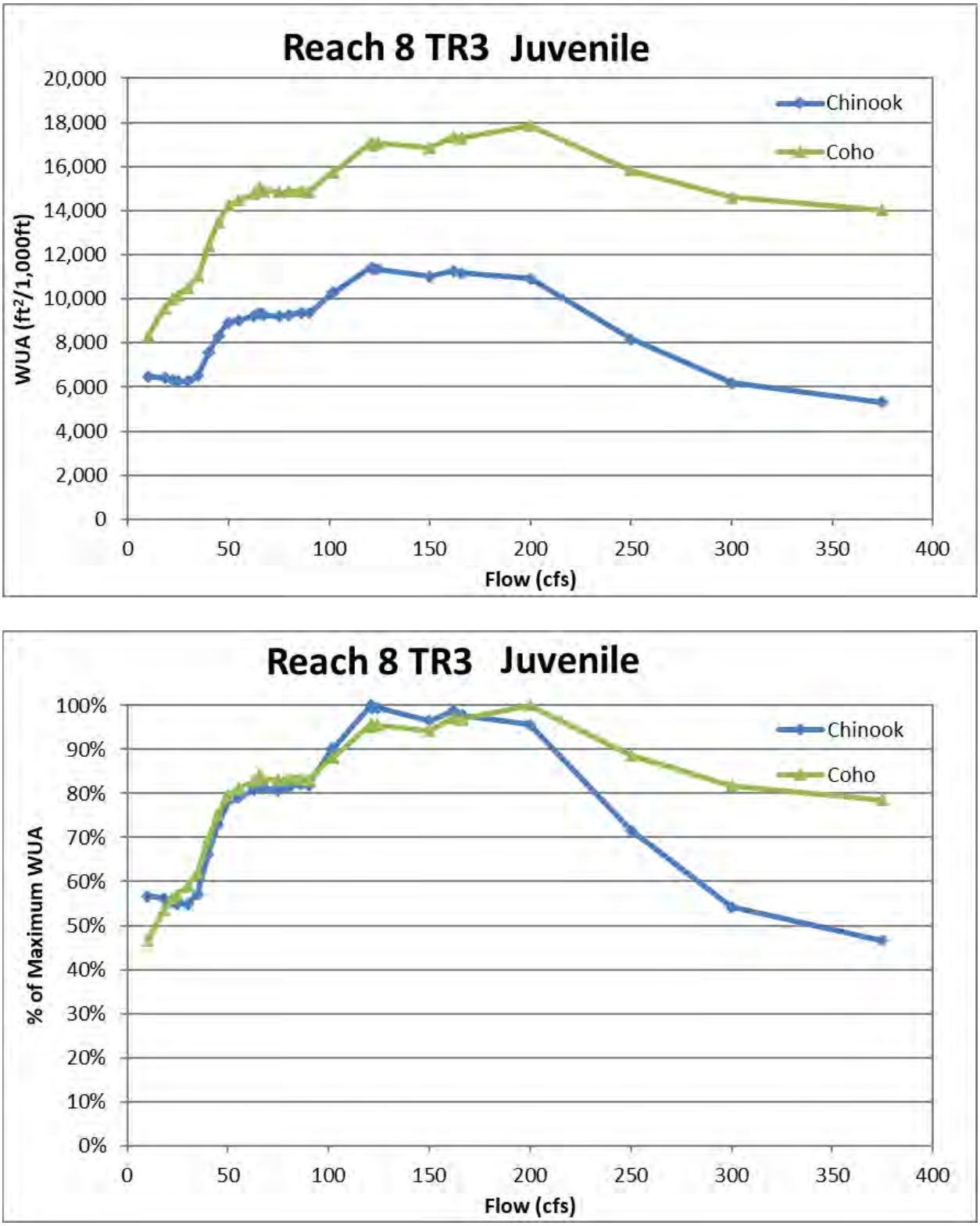


Figure A-30 Reach 8 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

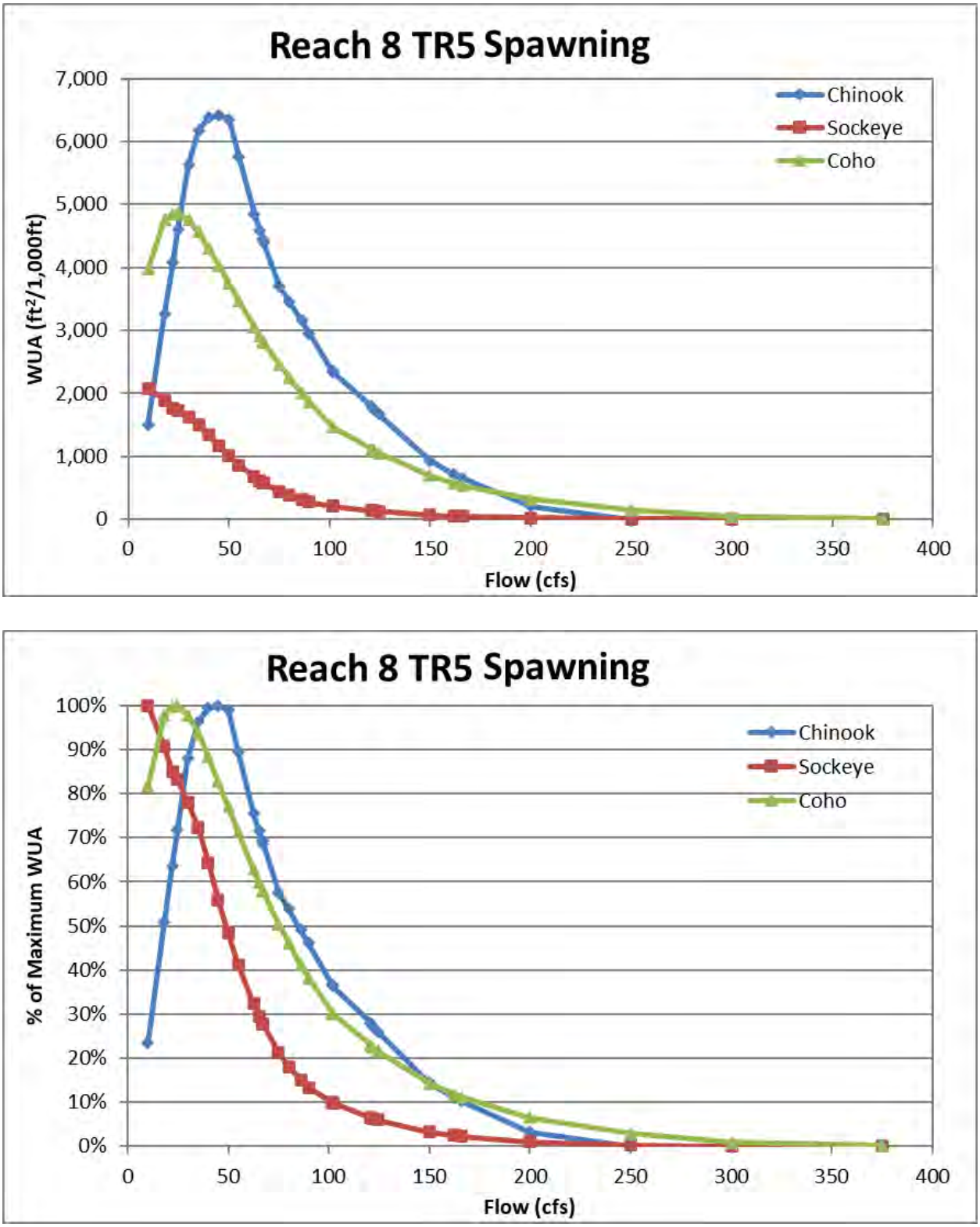


Figure A-31 Reach 8 Transect 5 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

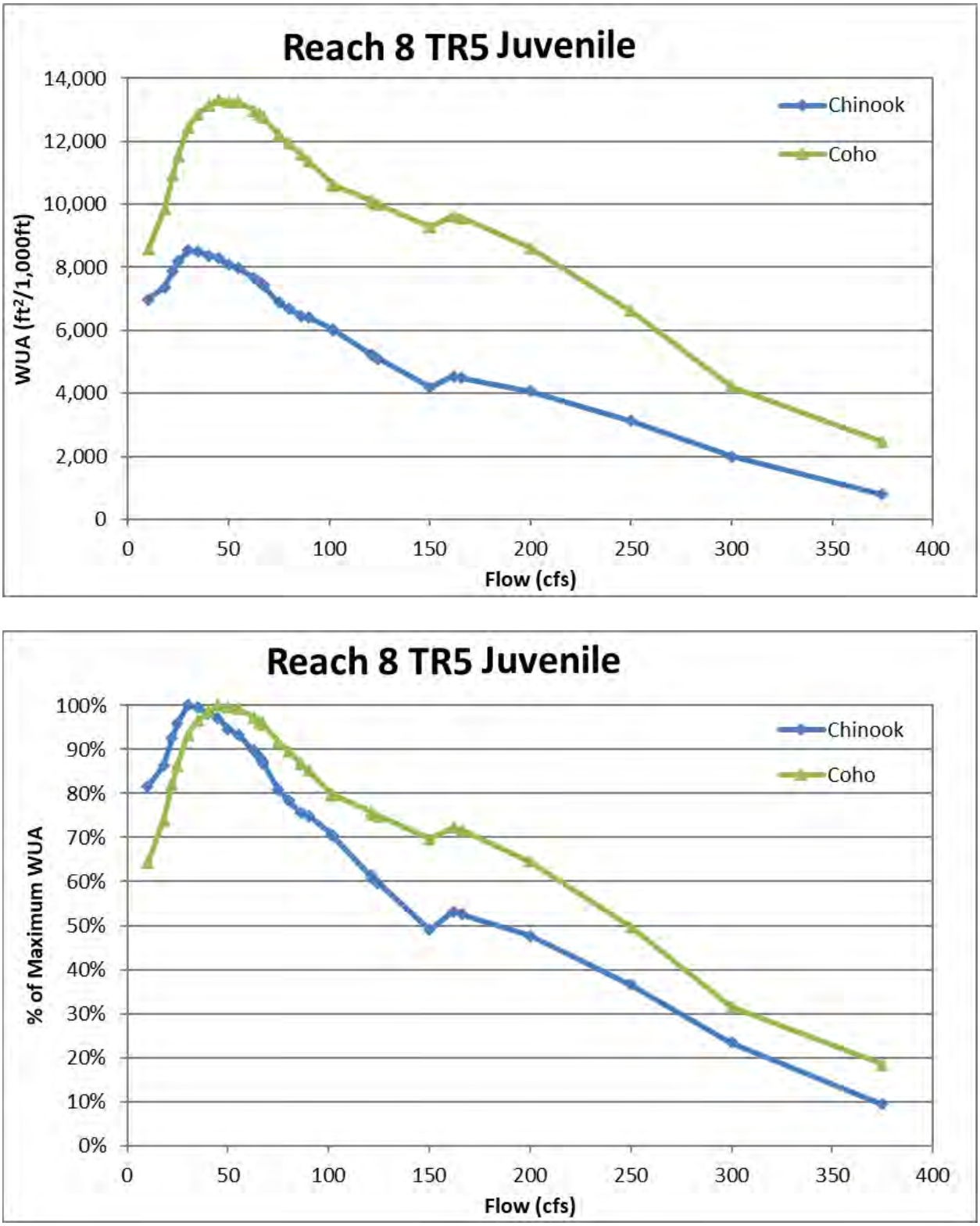


Figure A-32 Reach 8 Transect 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

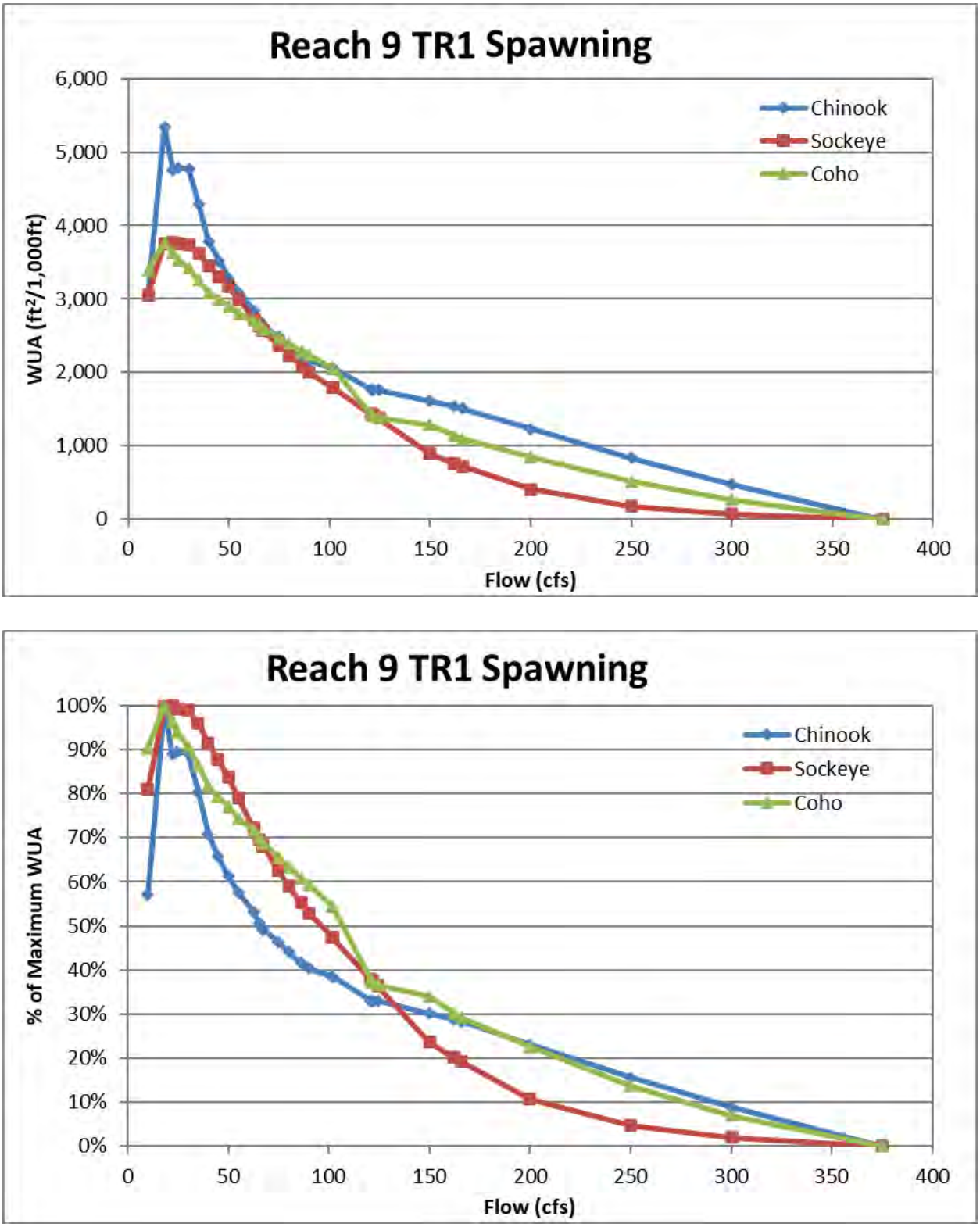


Figure A-33 Reach 9 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

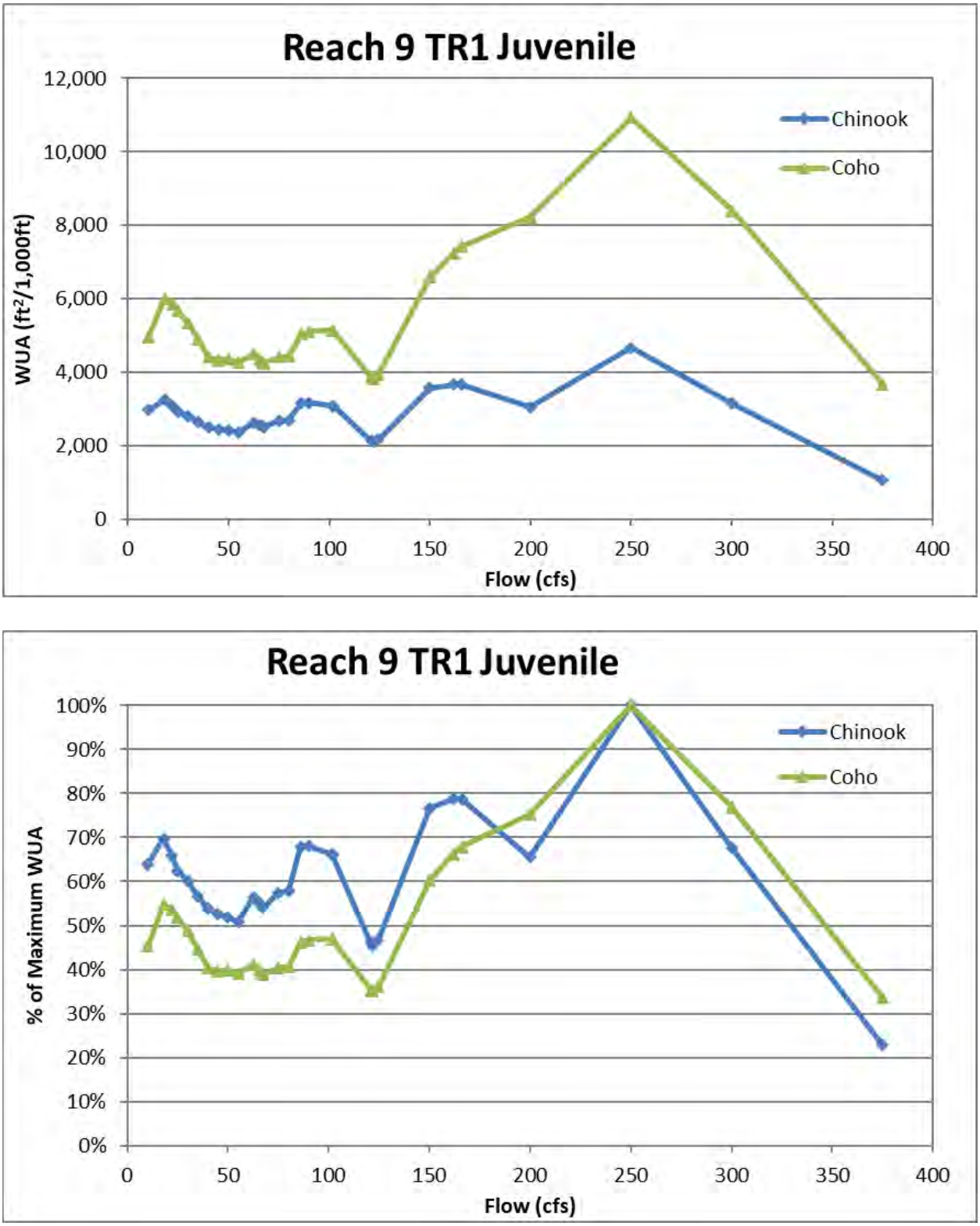


Figure A-34 Reach 9 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

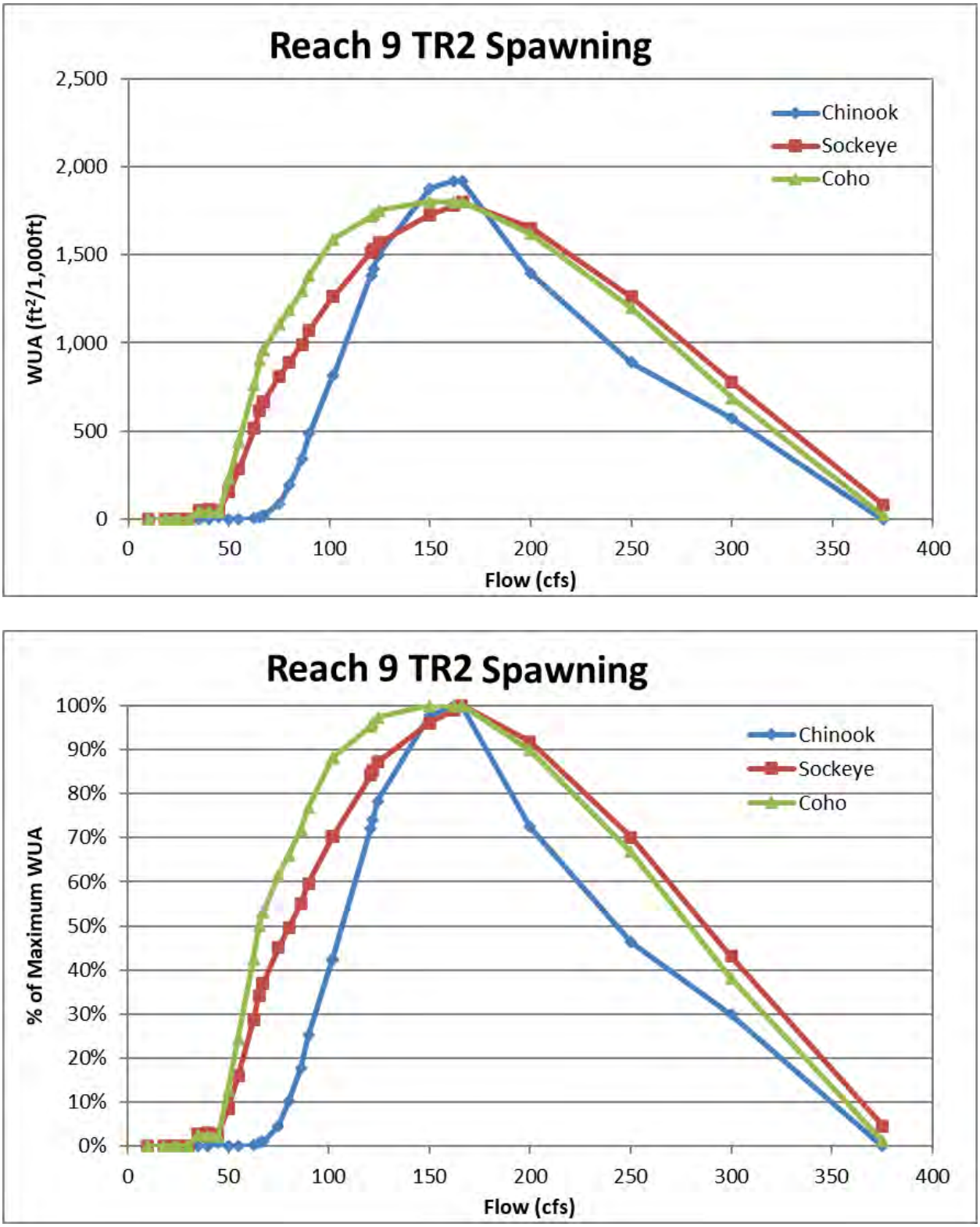


Figure A-35 Reach 9 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

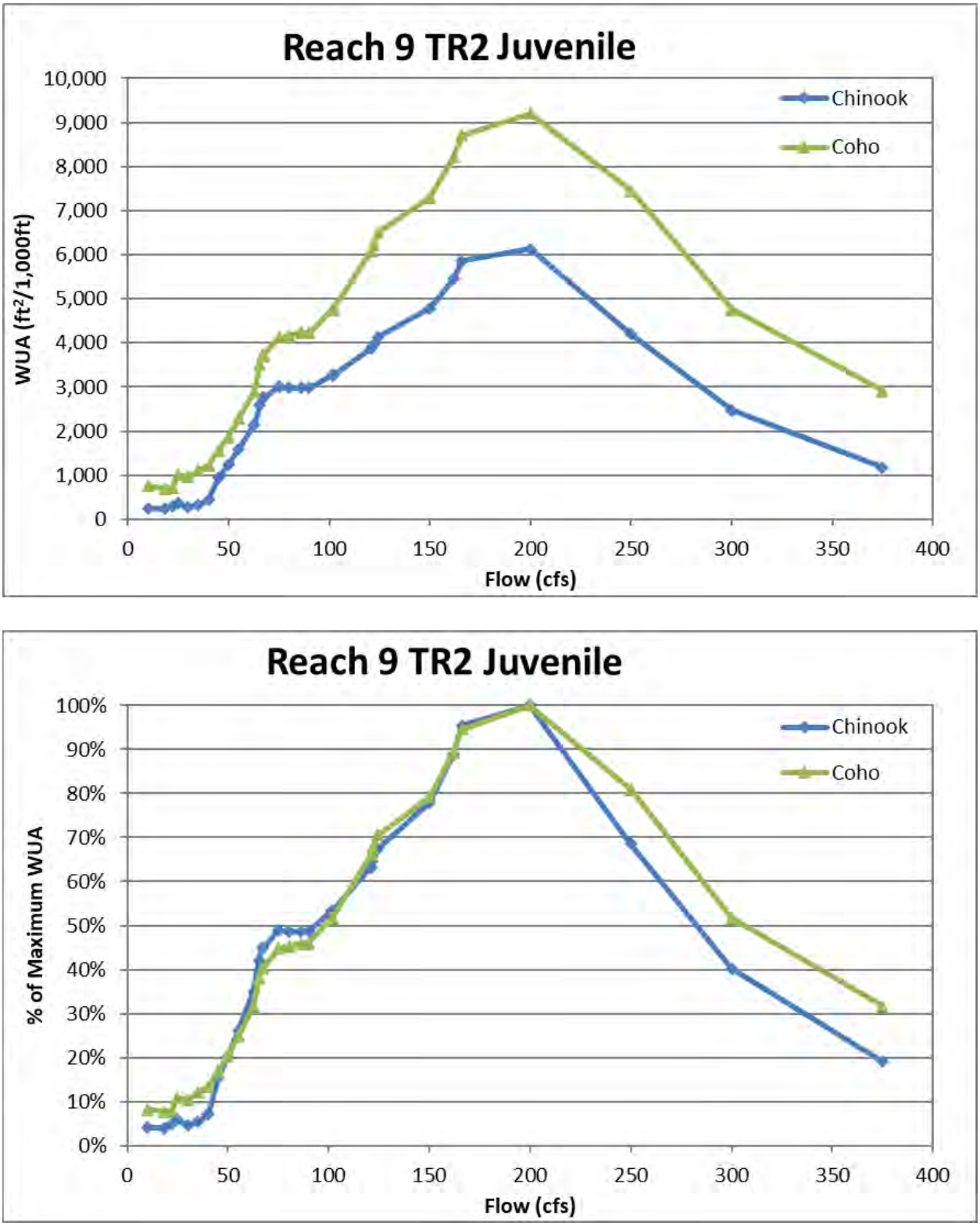


Figure A-36 Reach 9 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

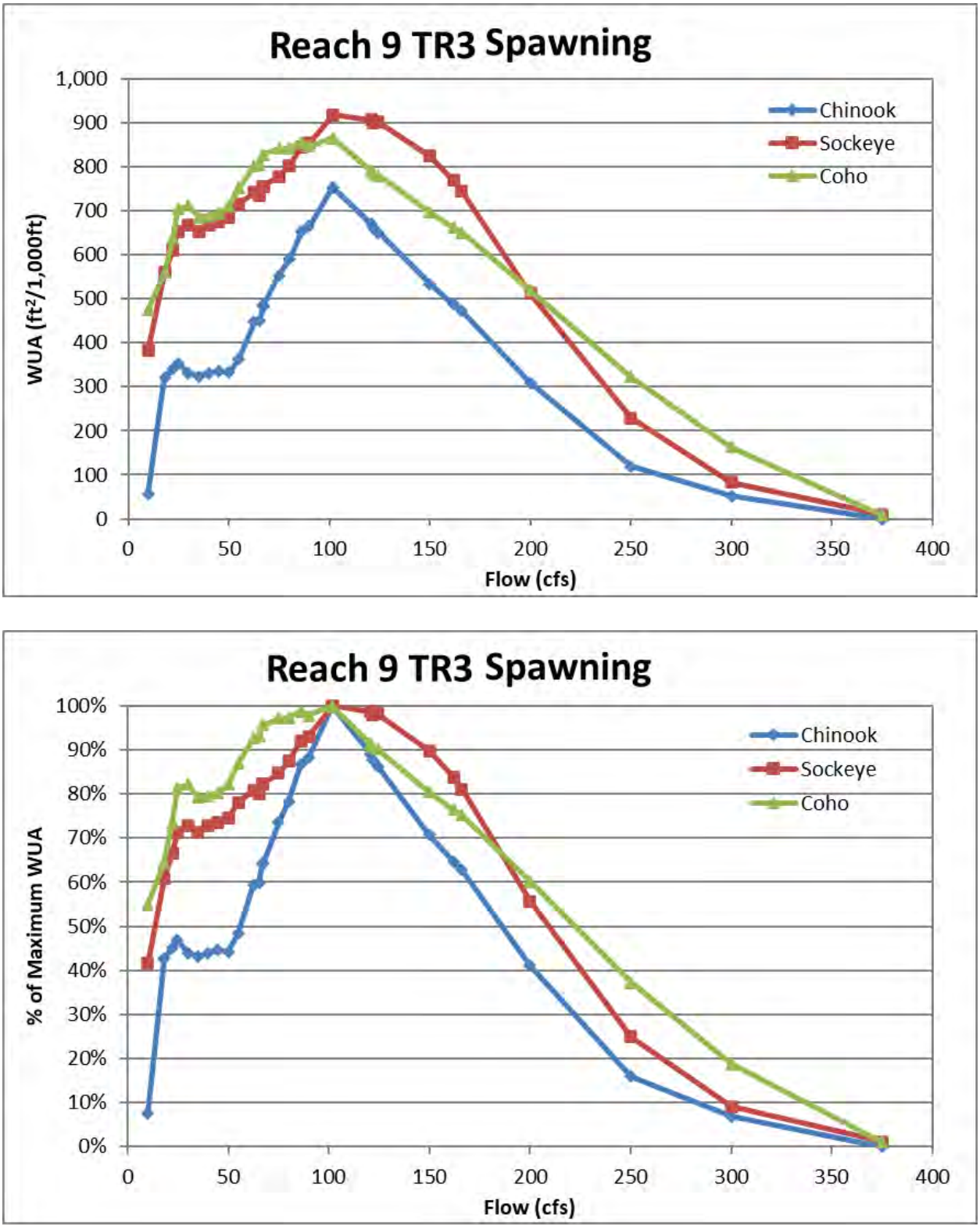


Figure A-37 Reach 9 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

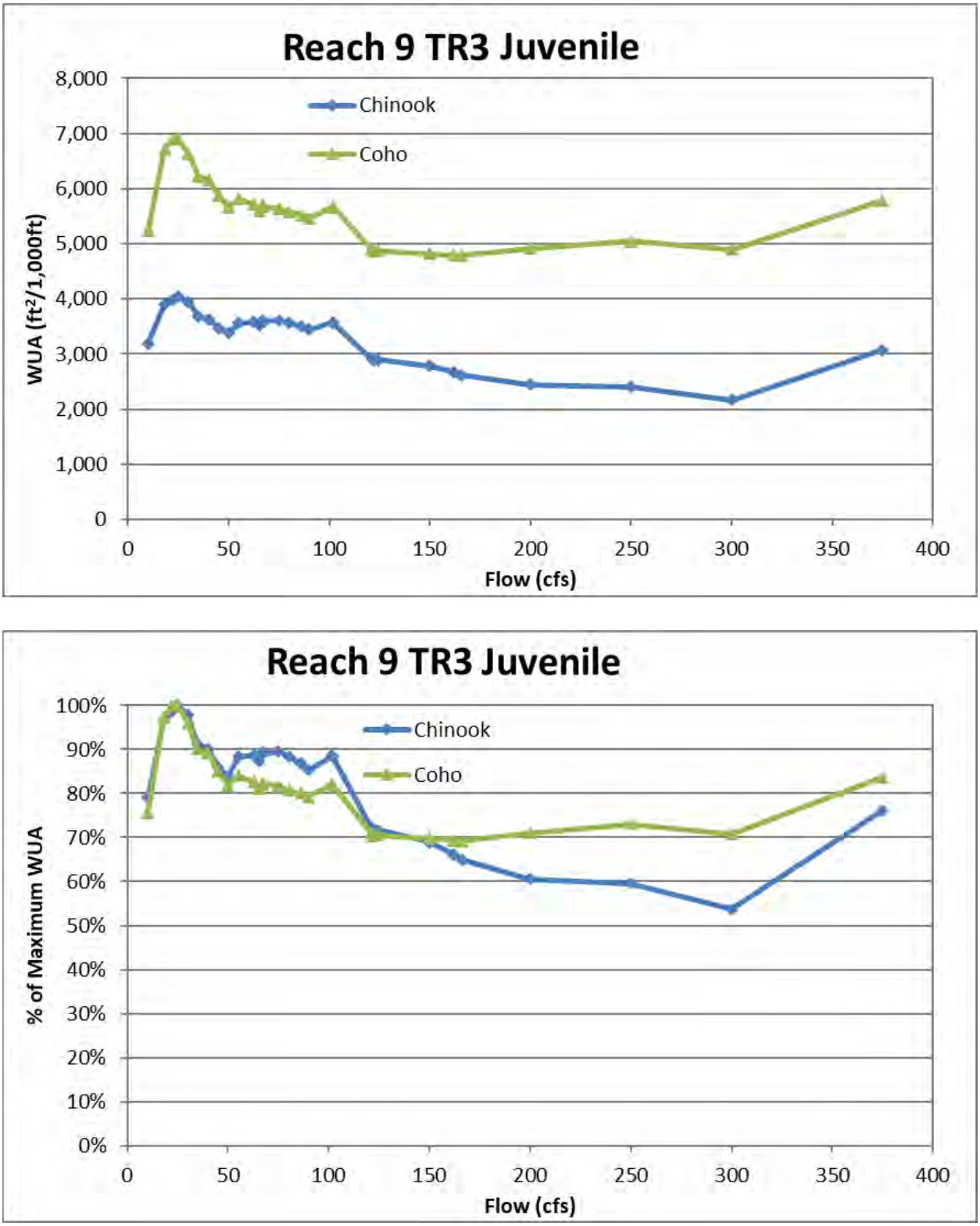
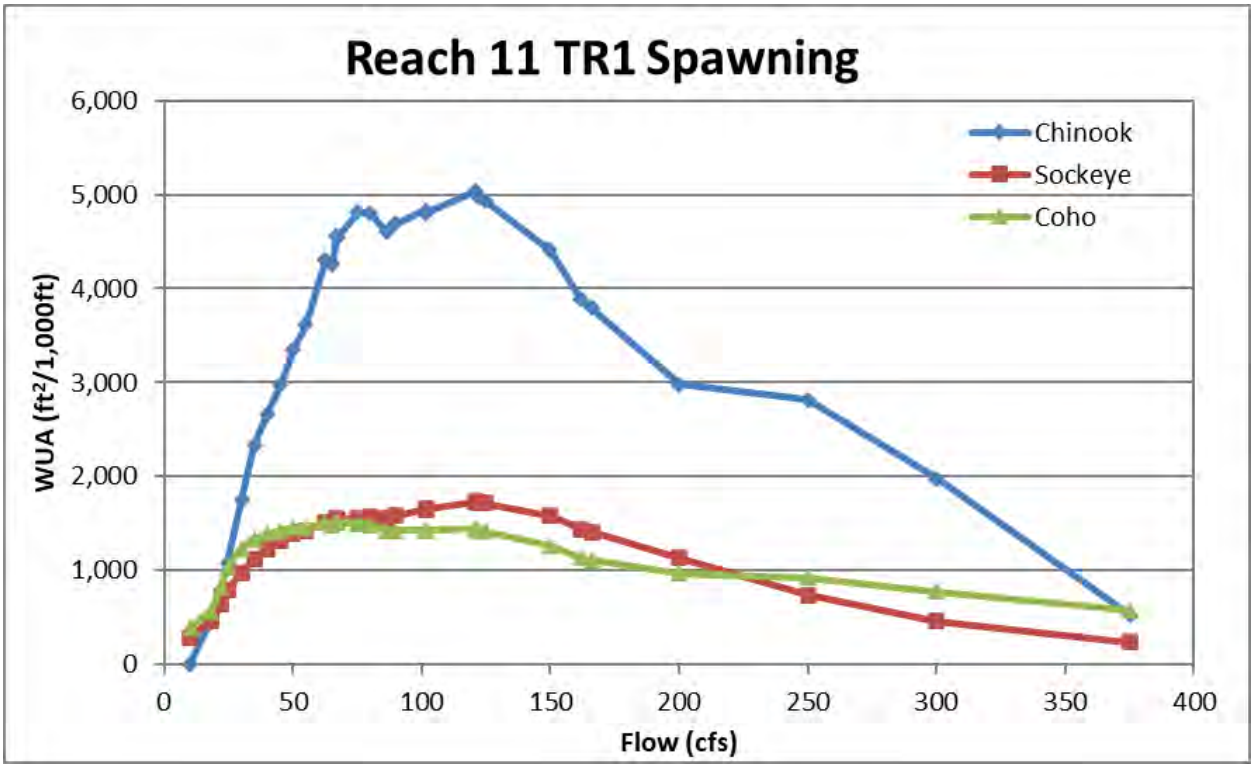


Figure A-38 Reach 9 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



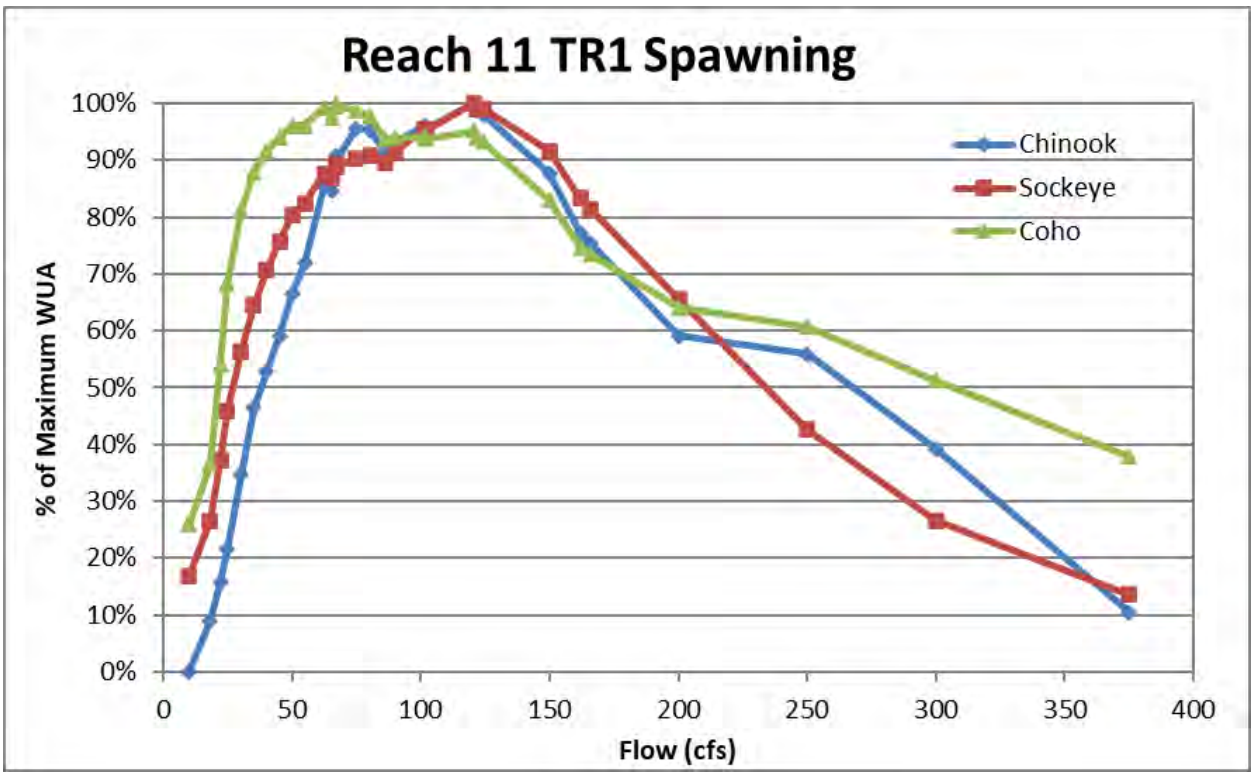


Figure A-39 Reach 11 Transect 1 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

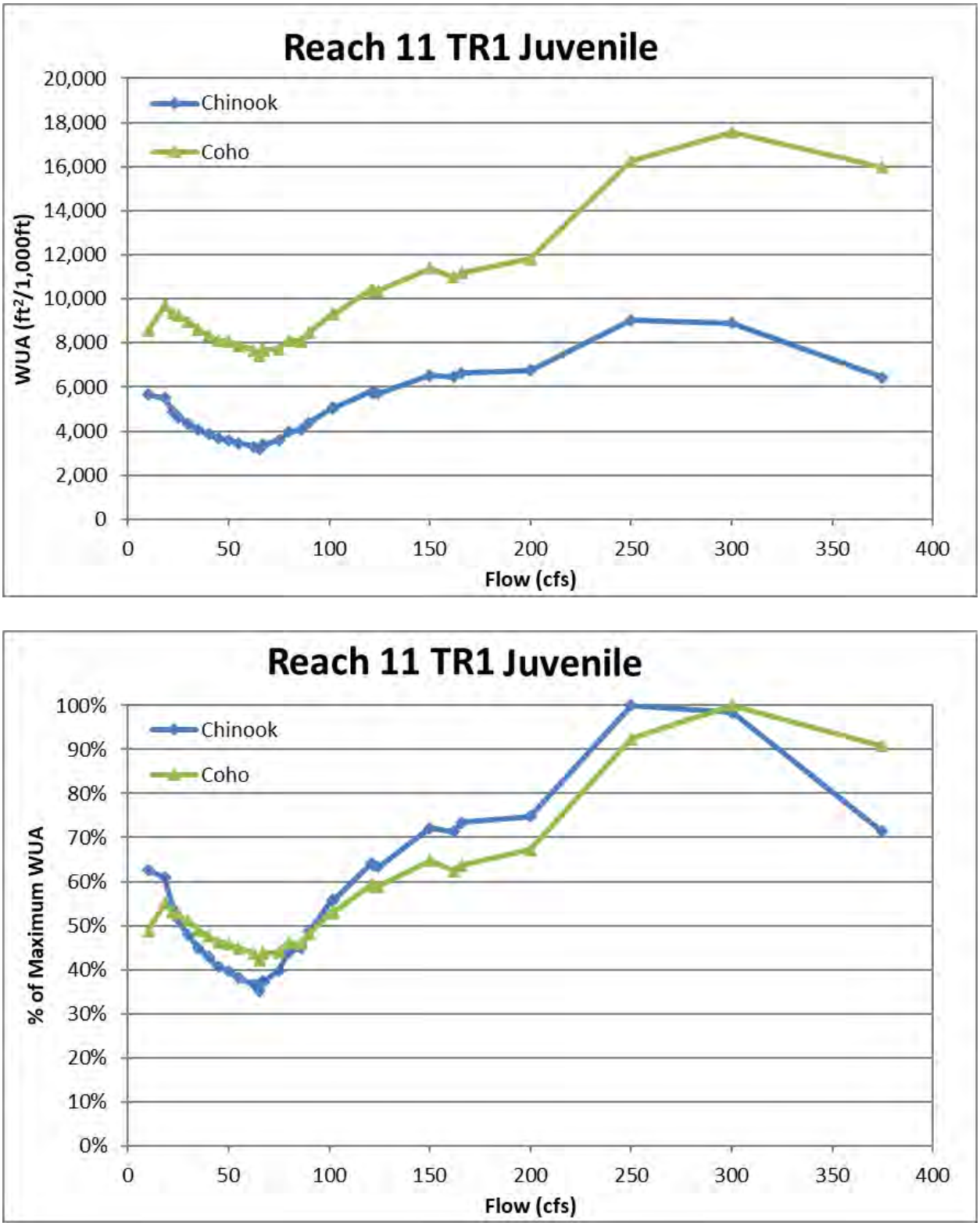
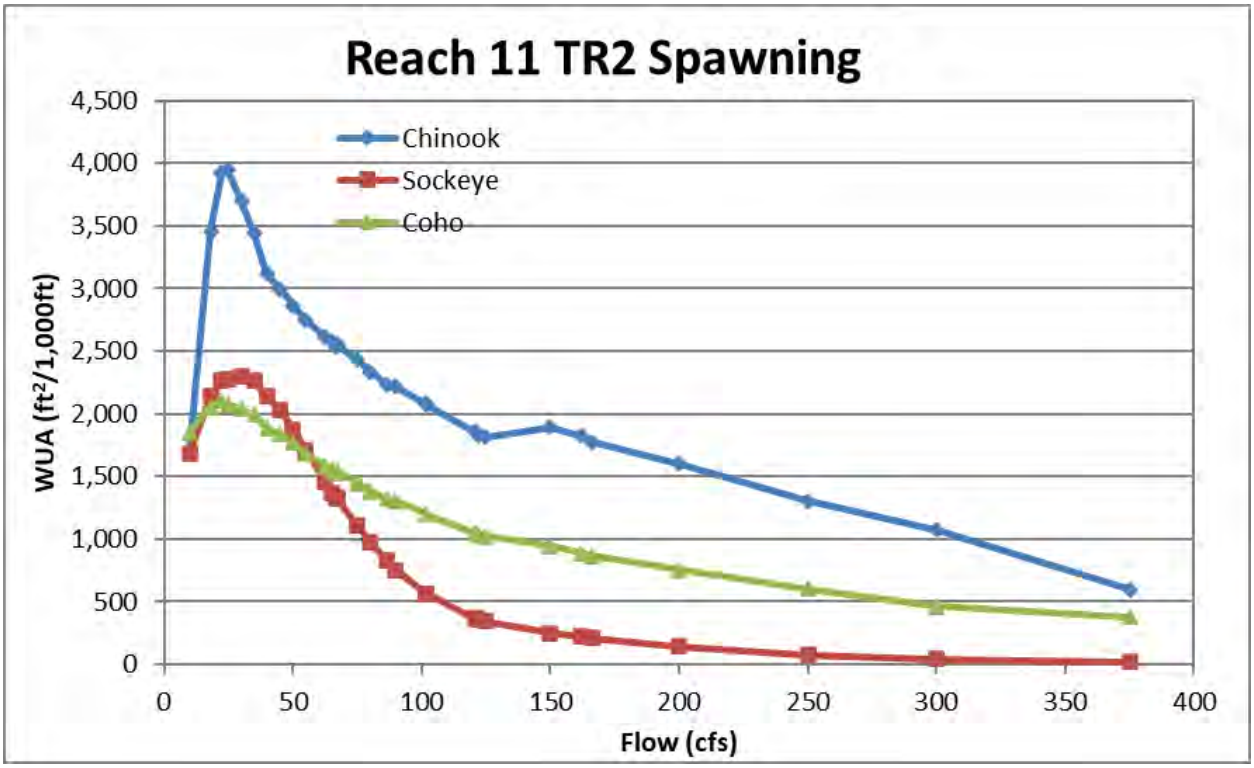


Figure A-40 Reach 11 Transect 1 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



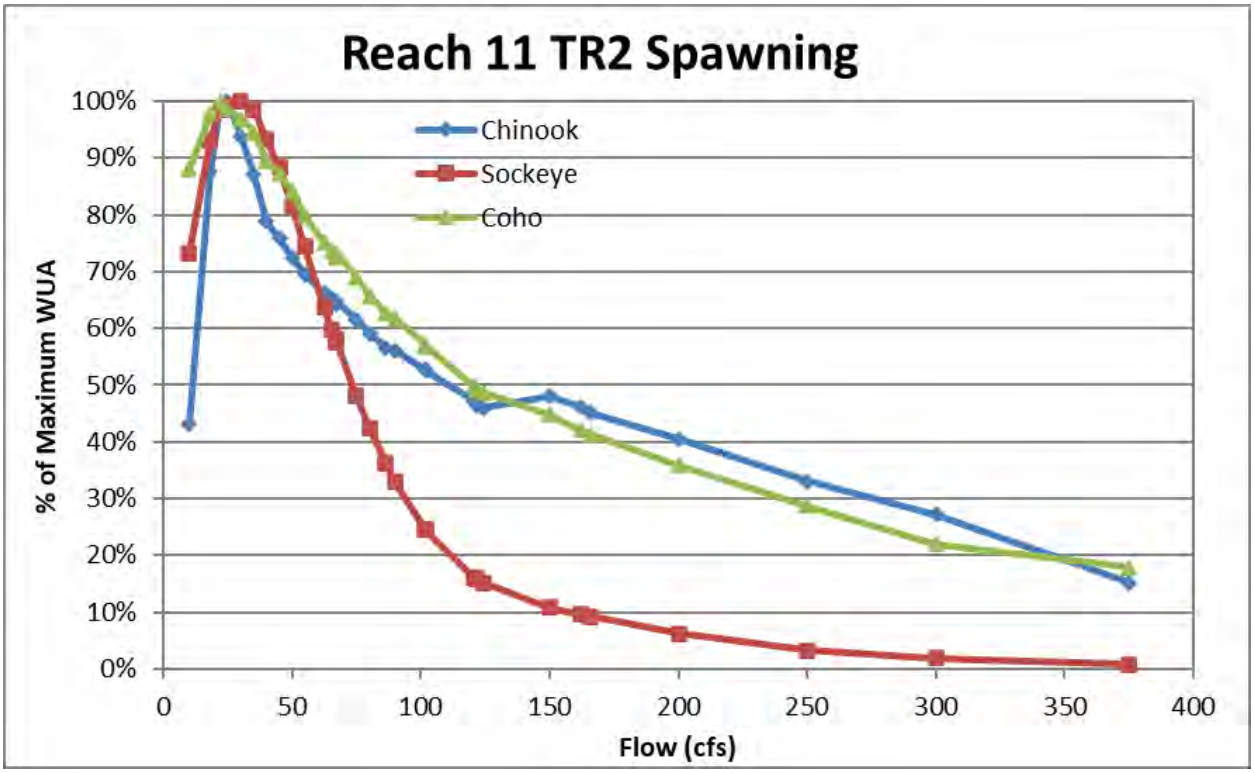


Figure A-41 Reach 11 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

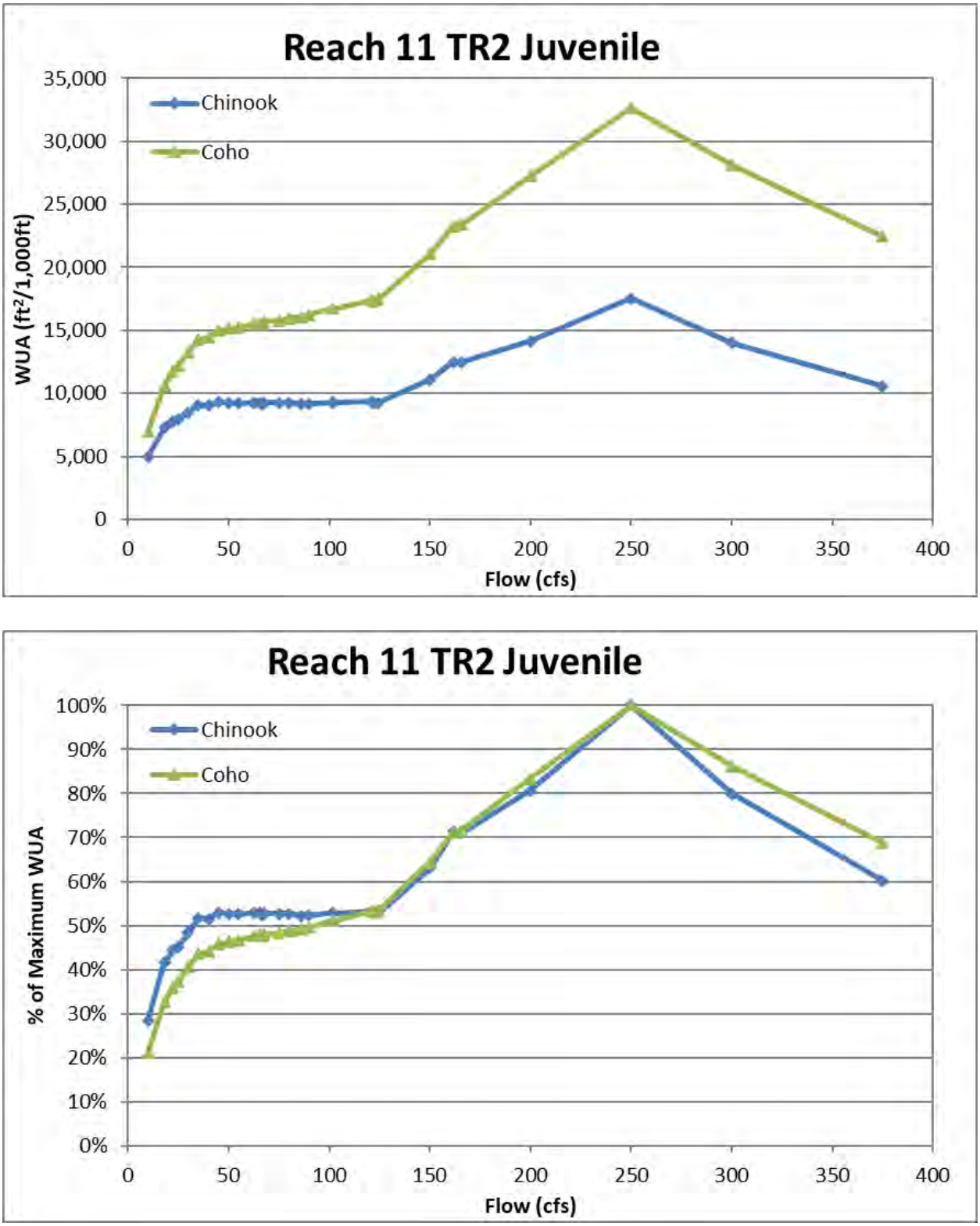


Figure A-42 Reach 11 Transect 2 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

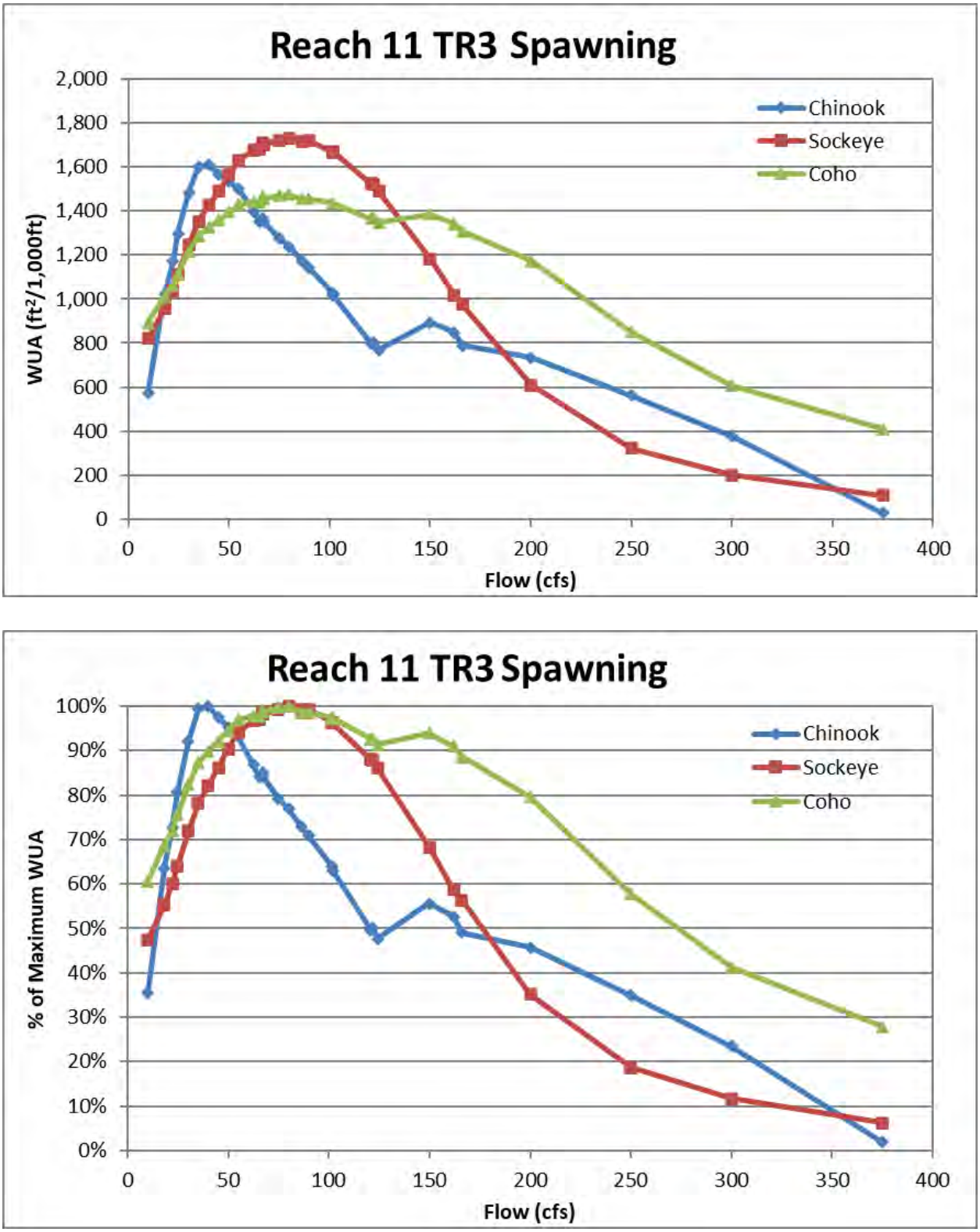


Figure A-43 Reach 11 Transect 3 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

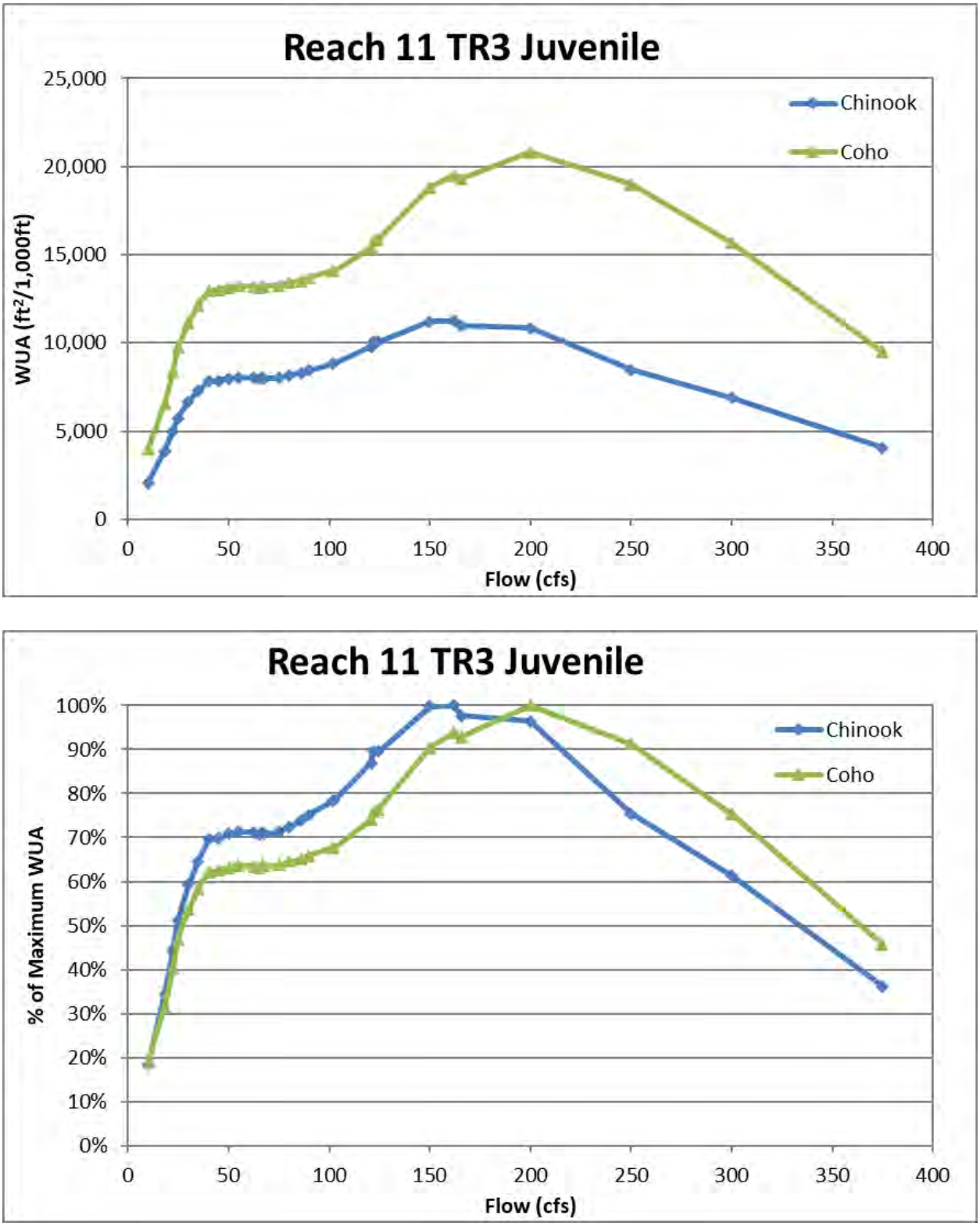
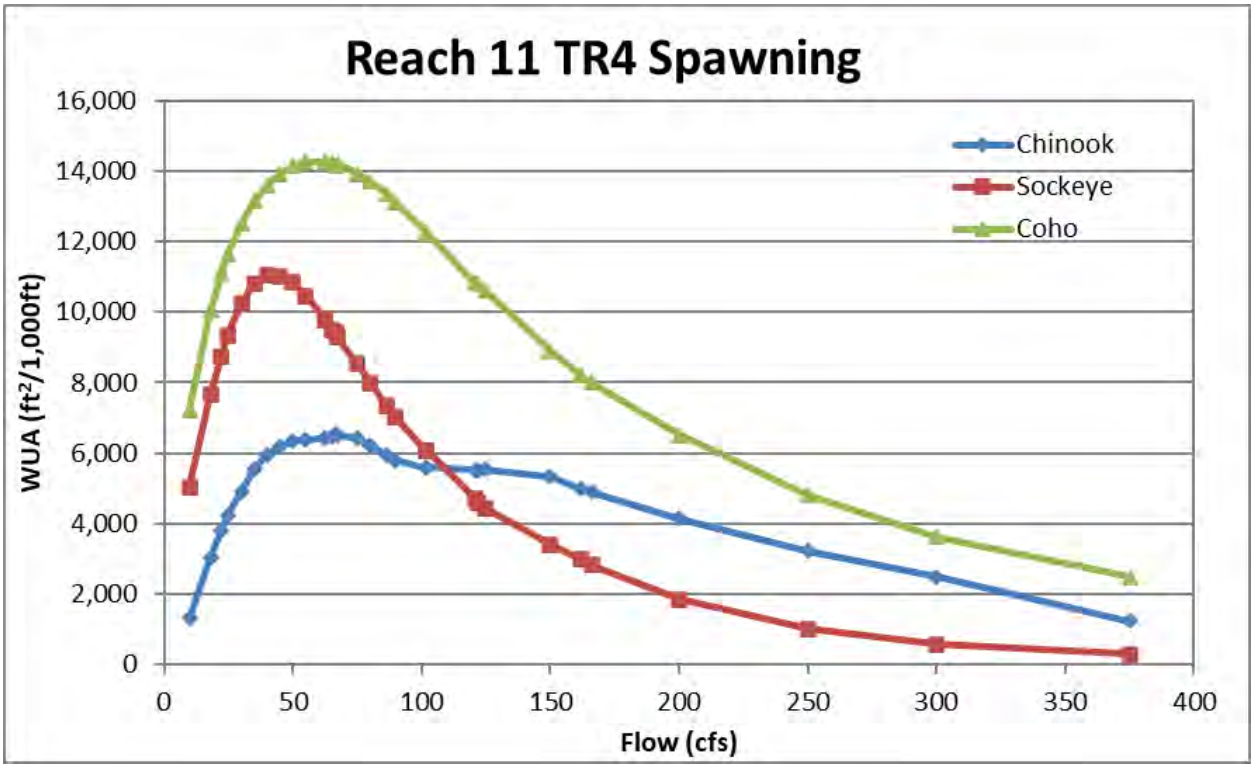


Figure A-44 Reach 11 Transect 3 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.



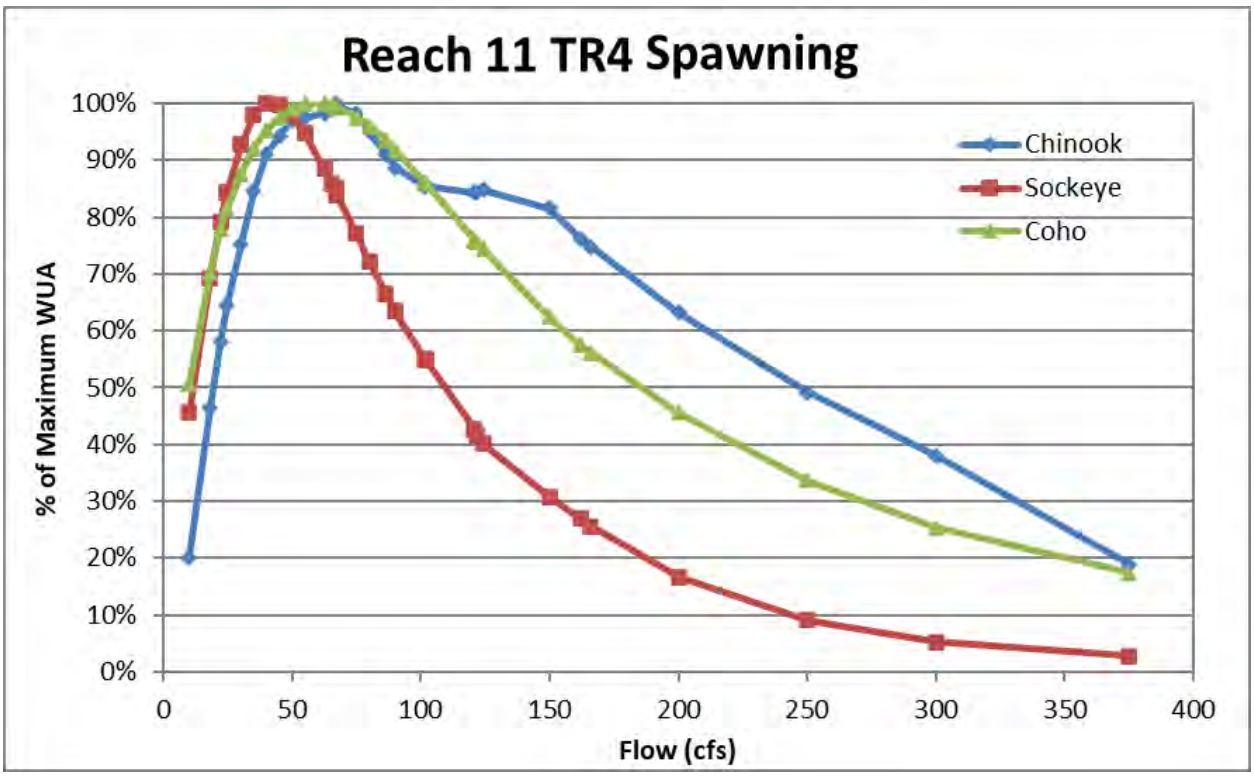


Figure A-45 Reach 11 Transect 4 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

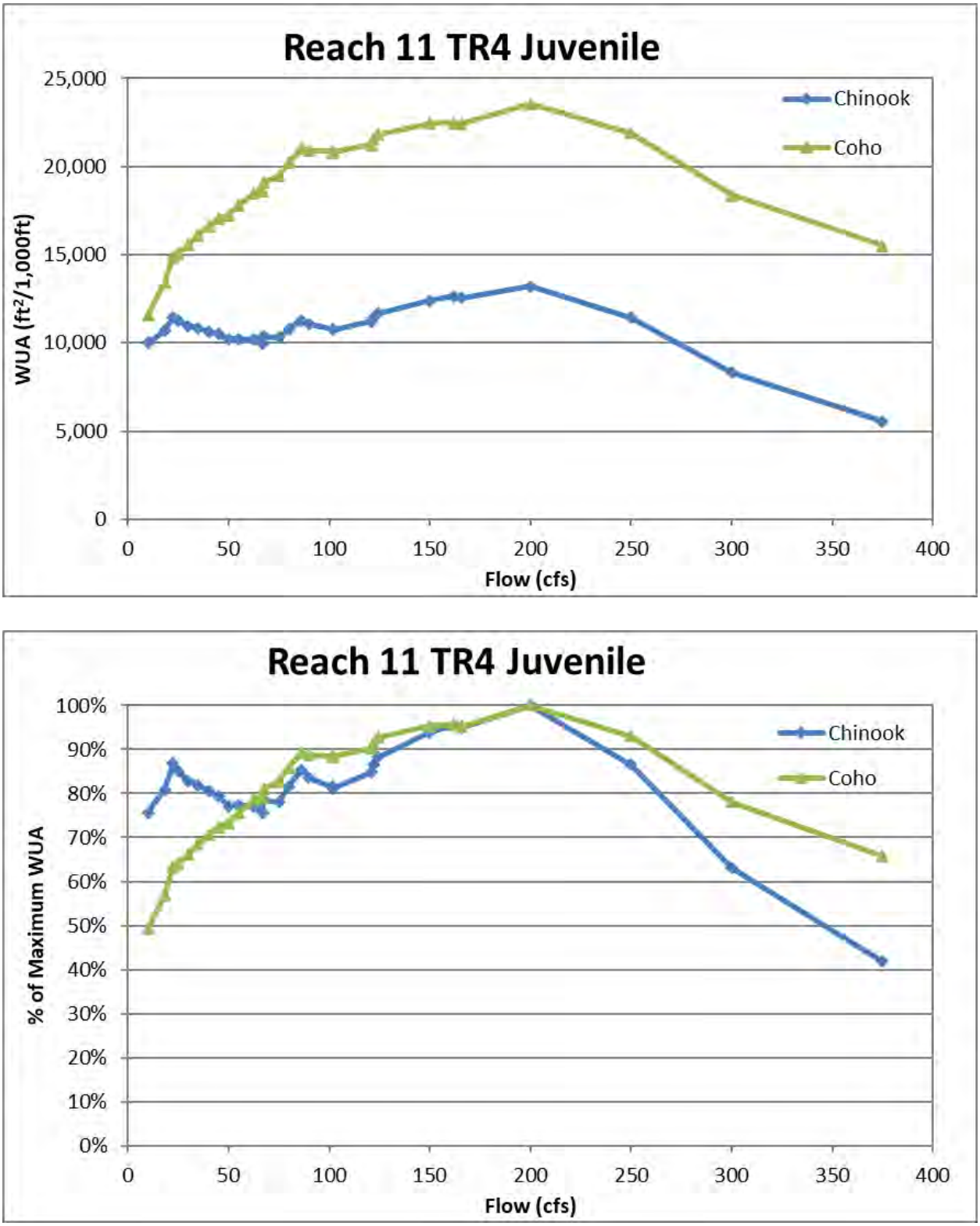


Figure A-46 Reach 11 Transect 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

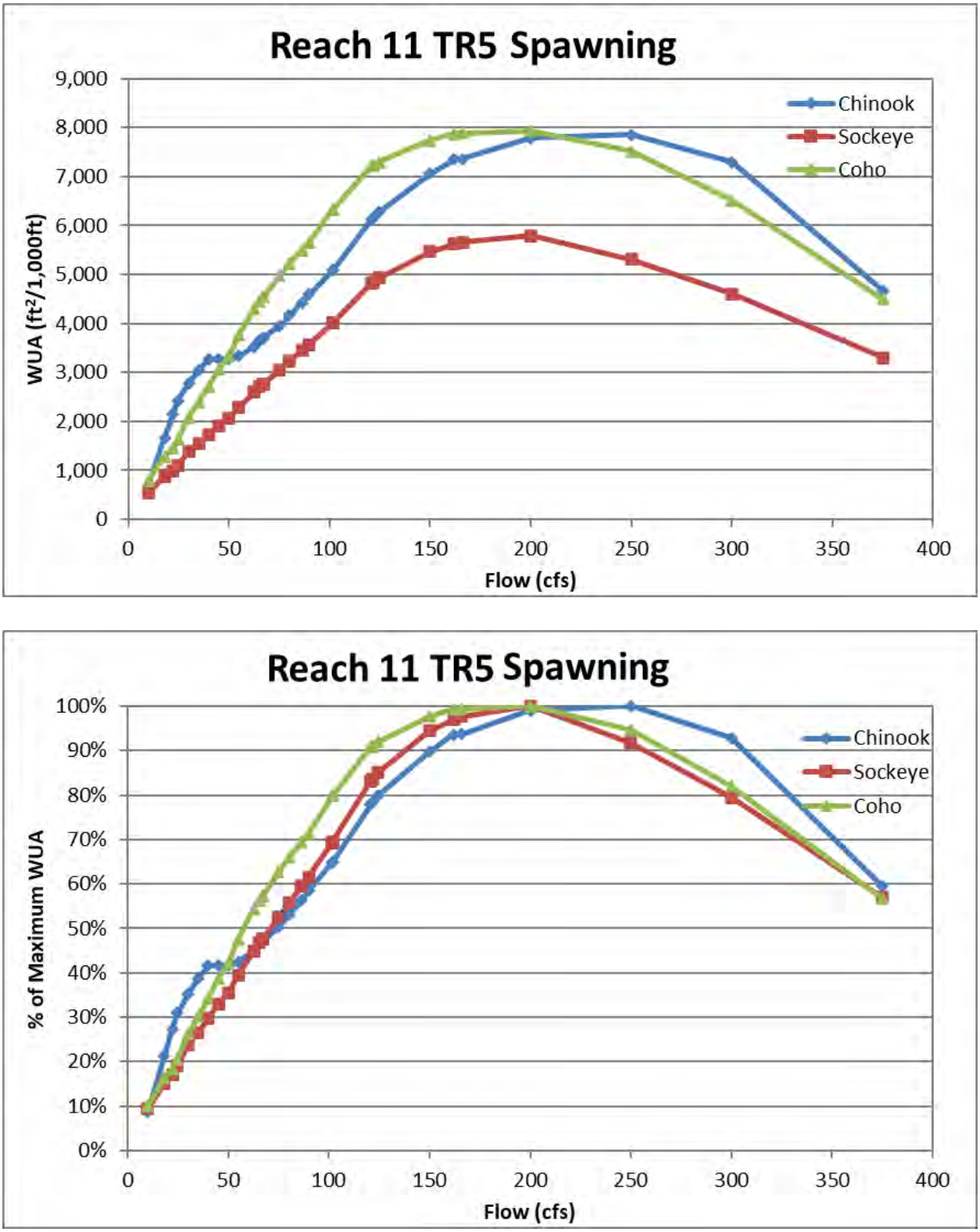


Figure A-47 Reach 11 Transect 5 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

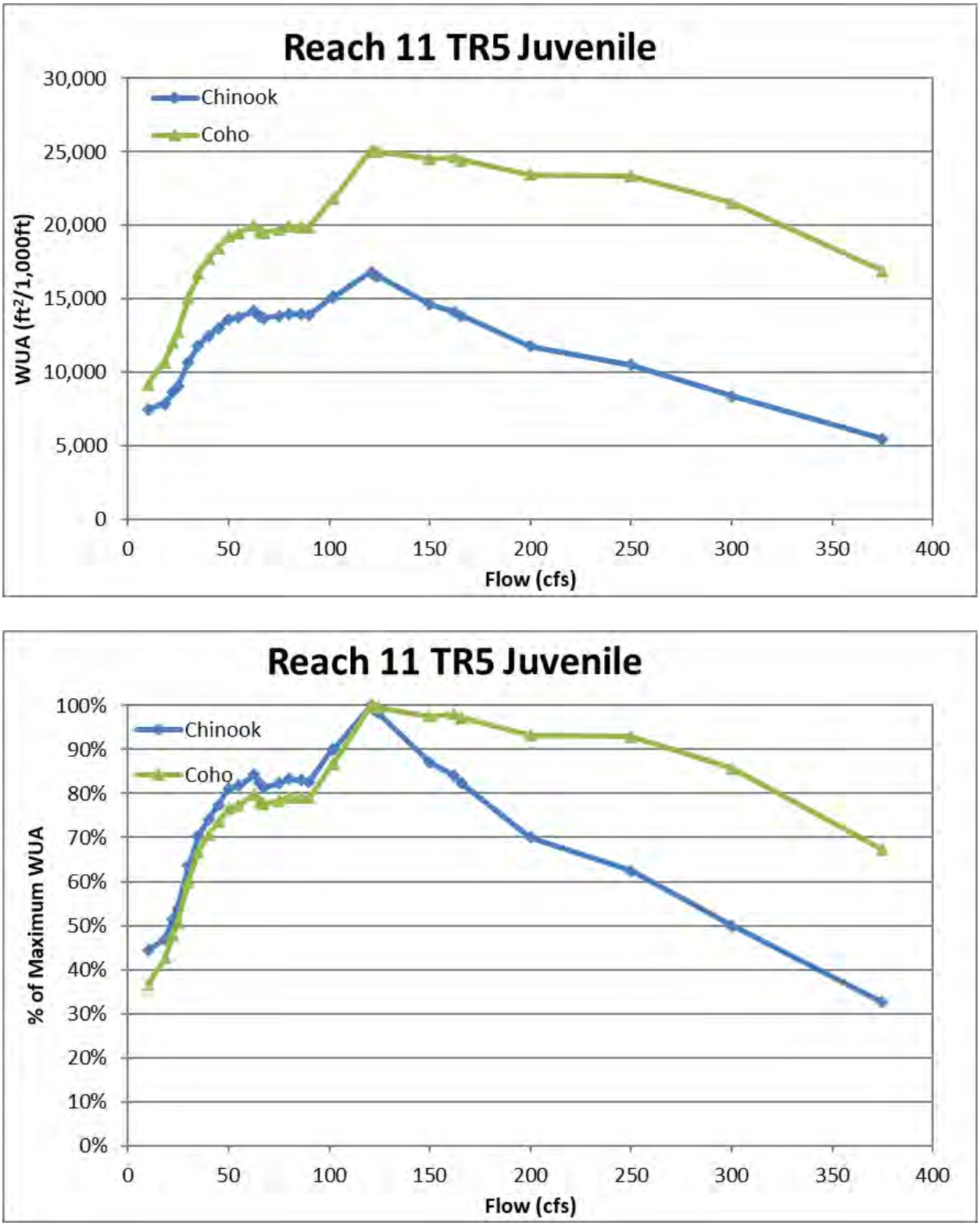


Figure A-48 Reach 11 Transect 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

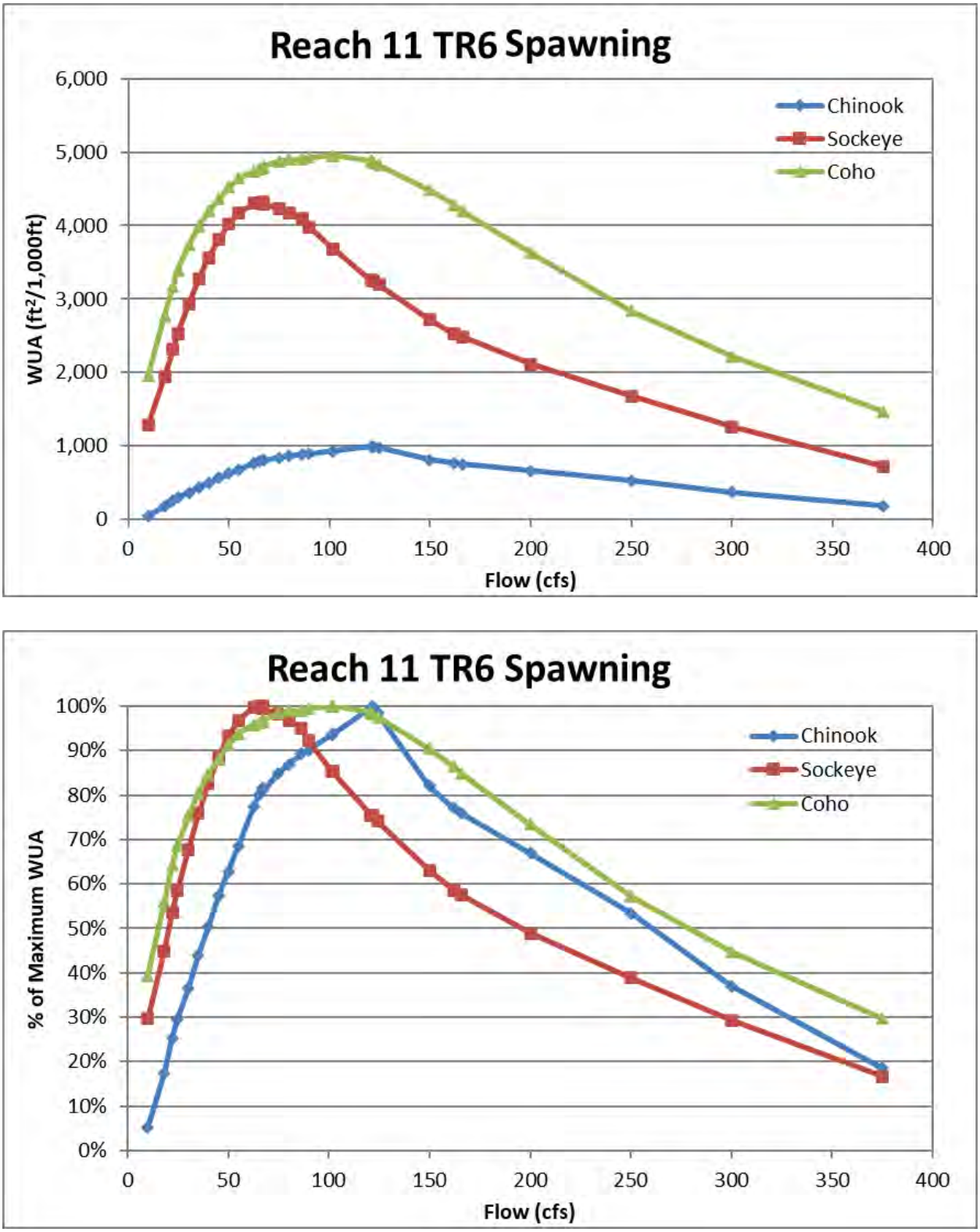


Figure A-49 Reach 11 Transect 6 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

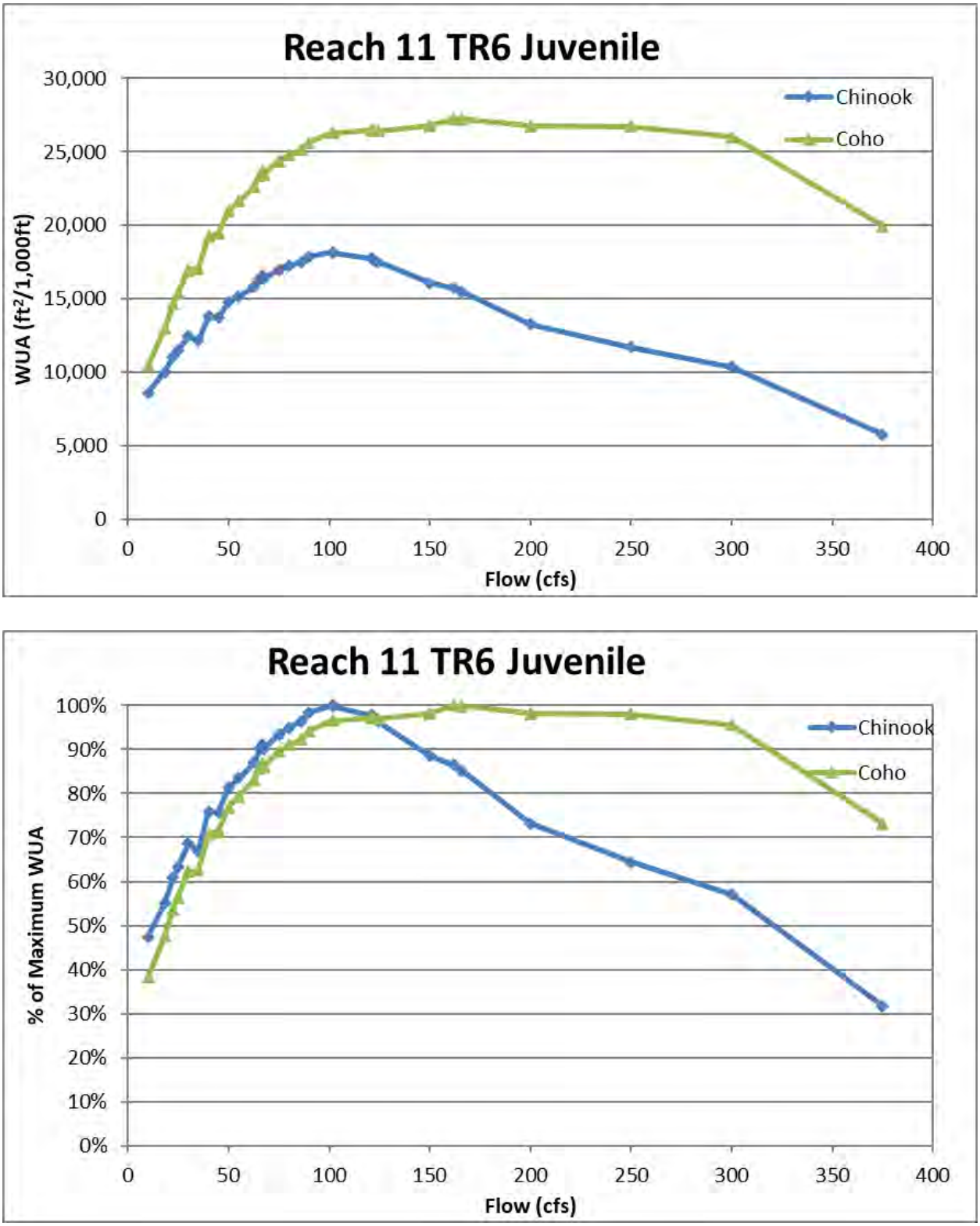


Figure A-50 Reach 11 Transect 6 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

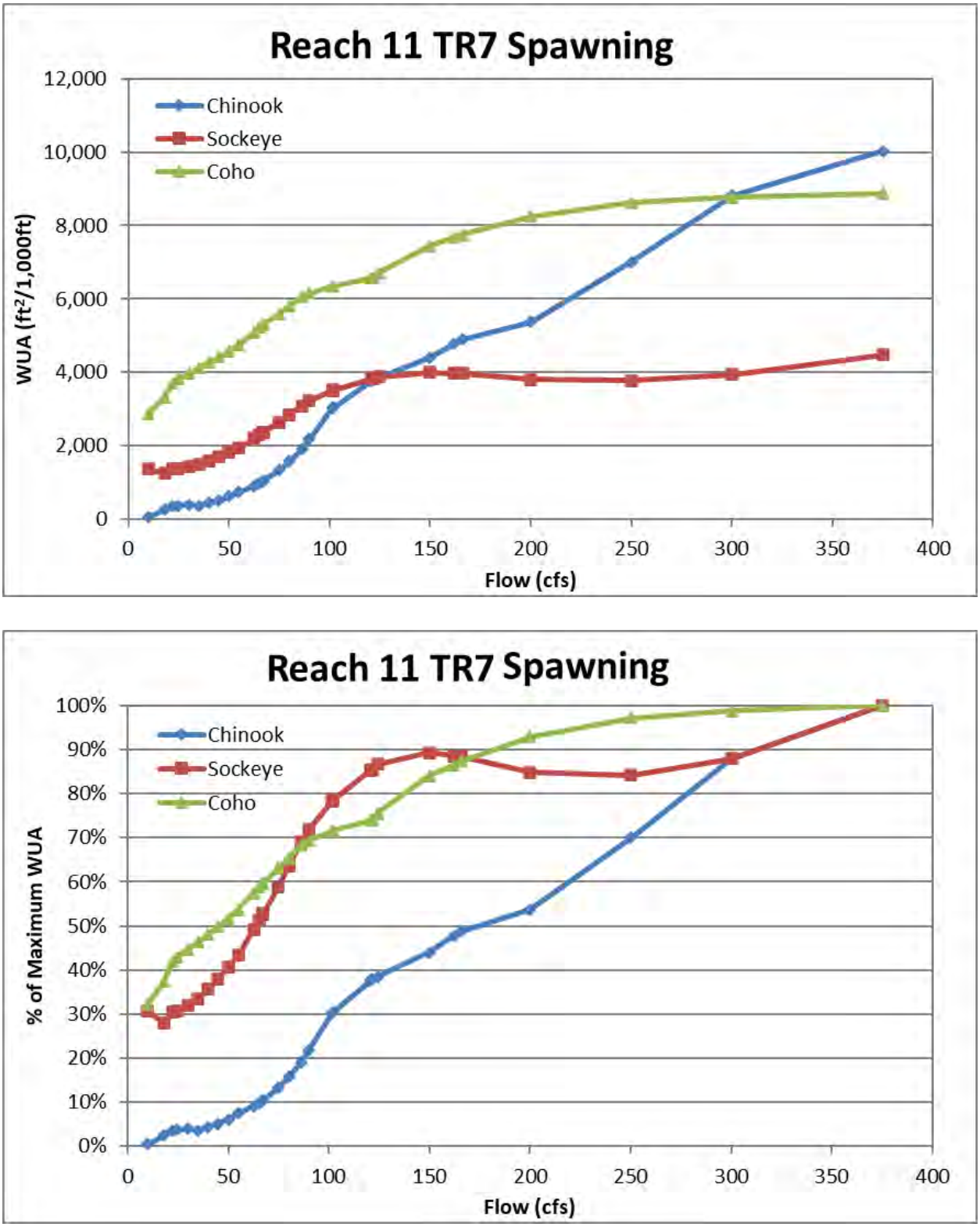


Figure A-51 Reach 11 Transect 7 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

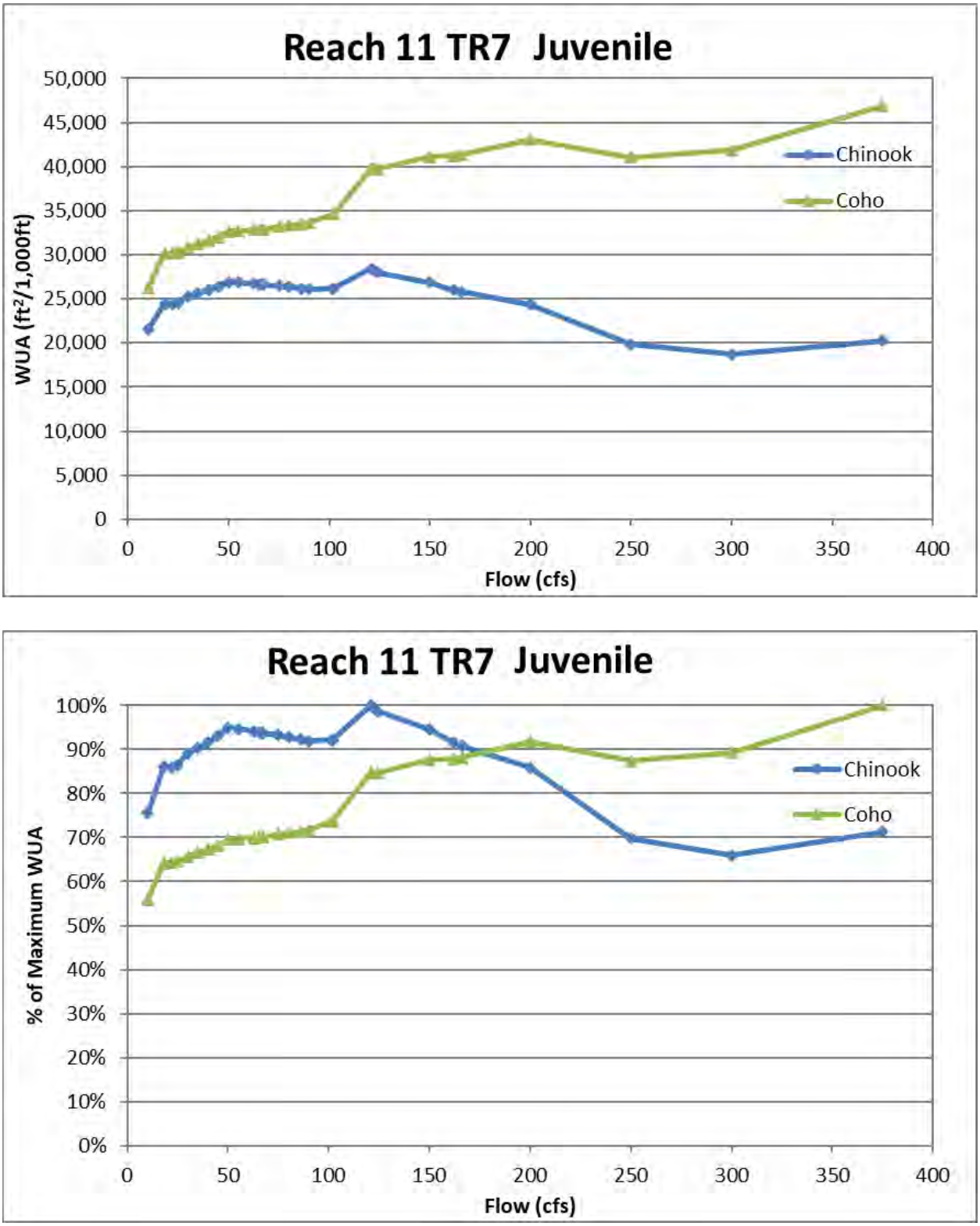


Figure A-52 Reach 11 Transect 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

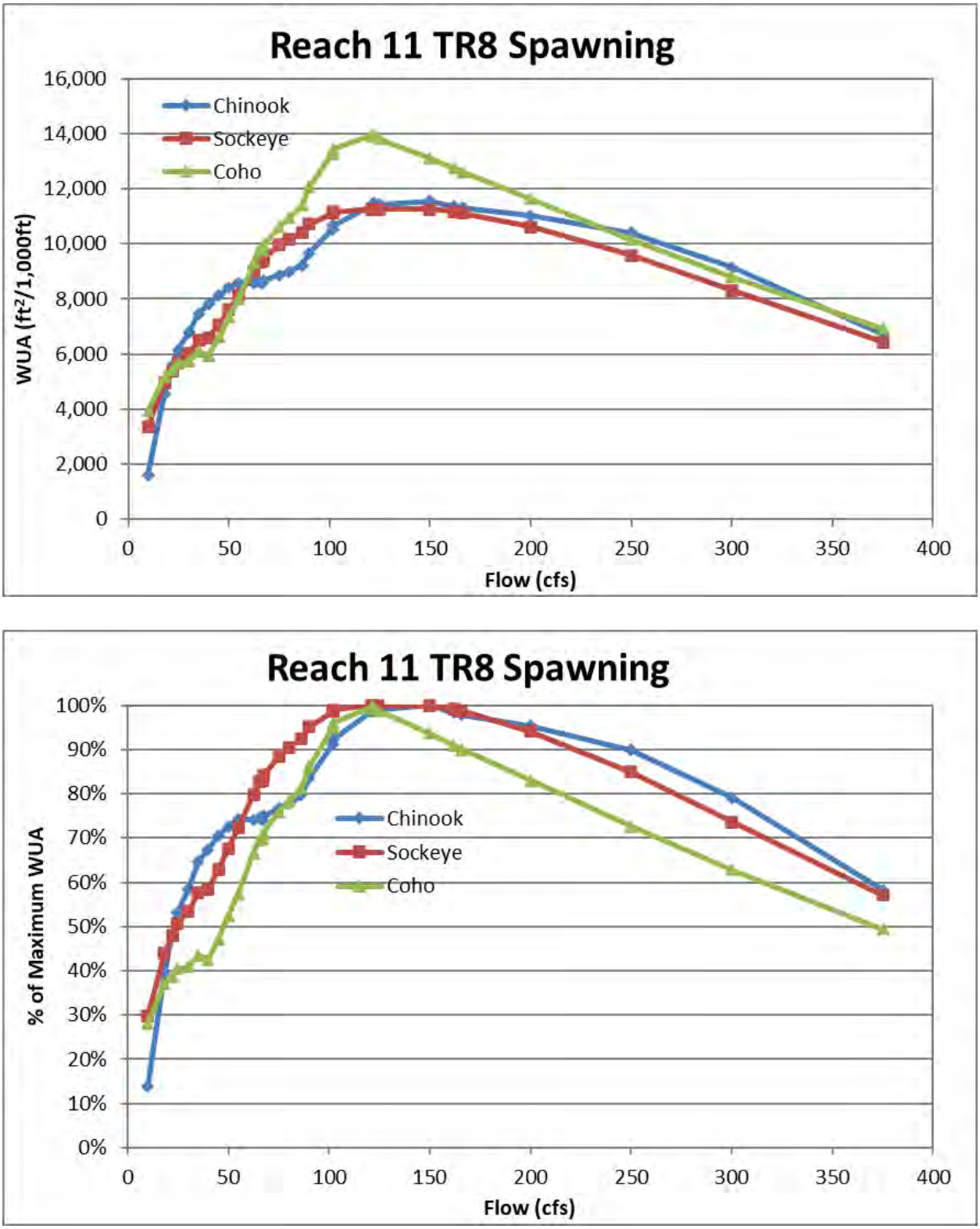


Figure A-53 Reach 11 Transect 8 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

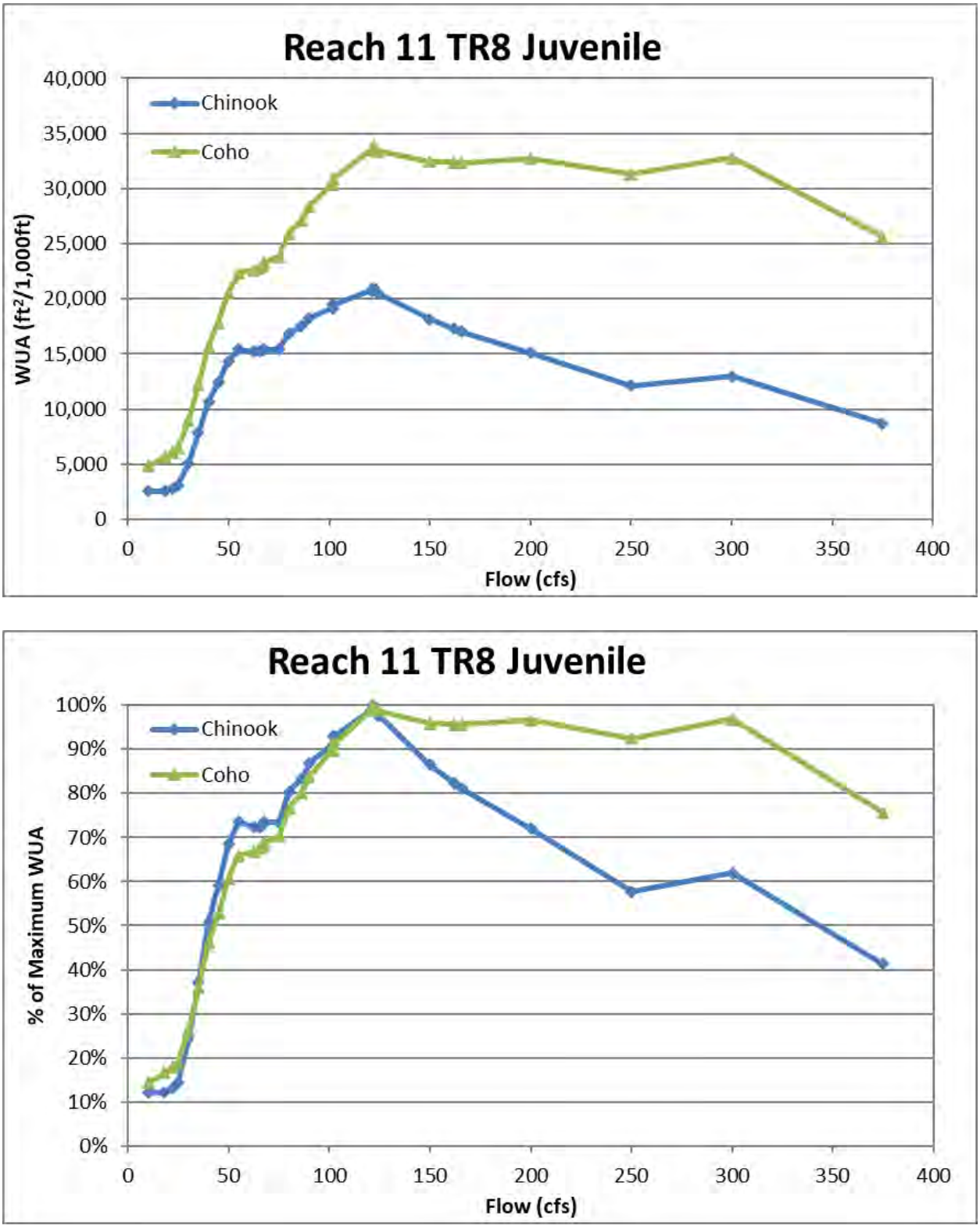


Figure A-54 Reach 11 Transect 8 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

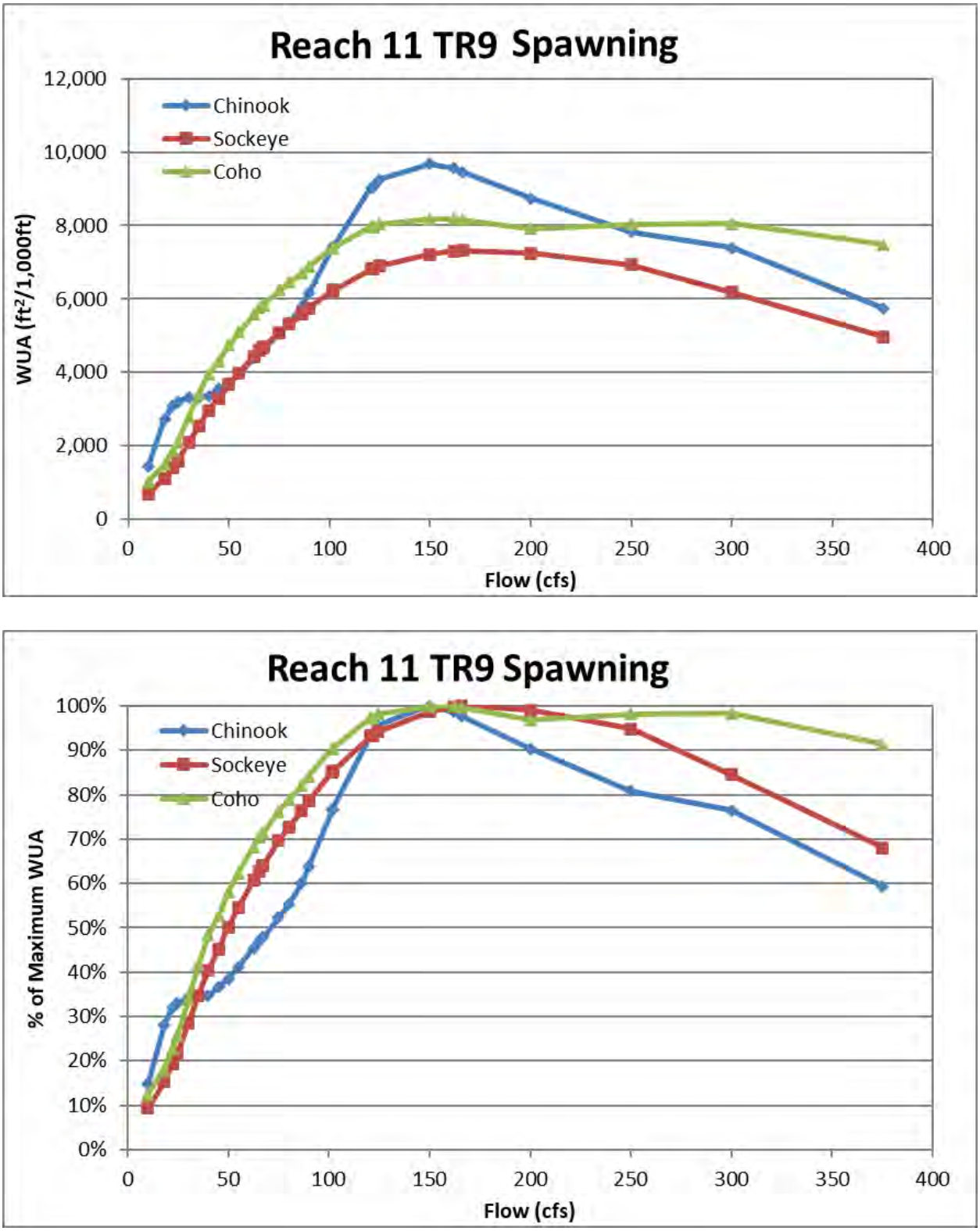


Figure A-55 Reach 11 Transect 9 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

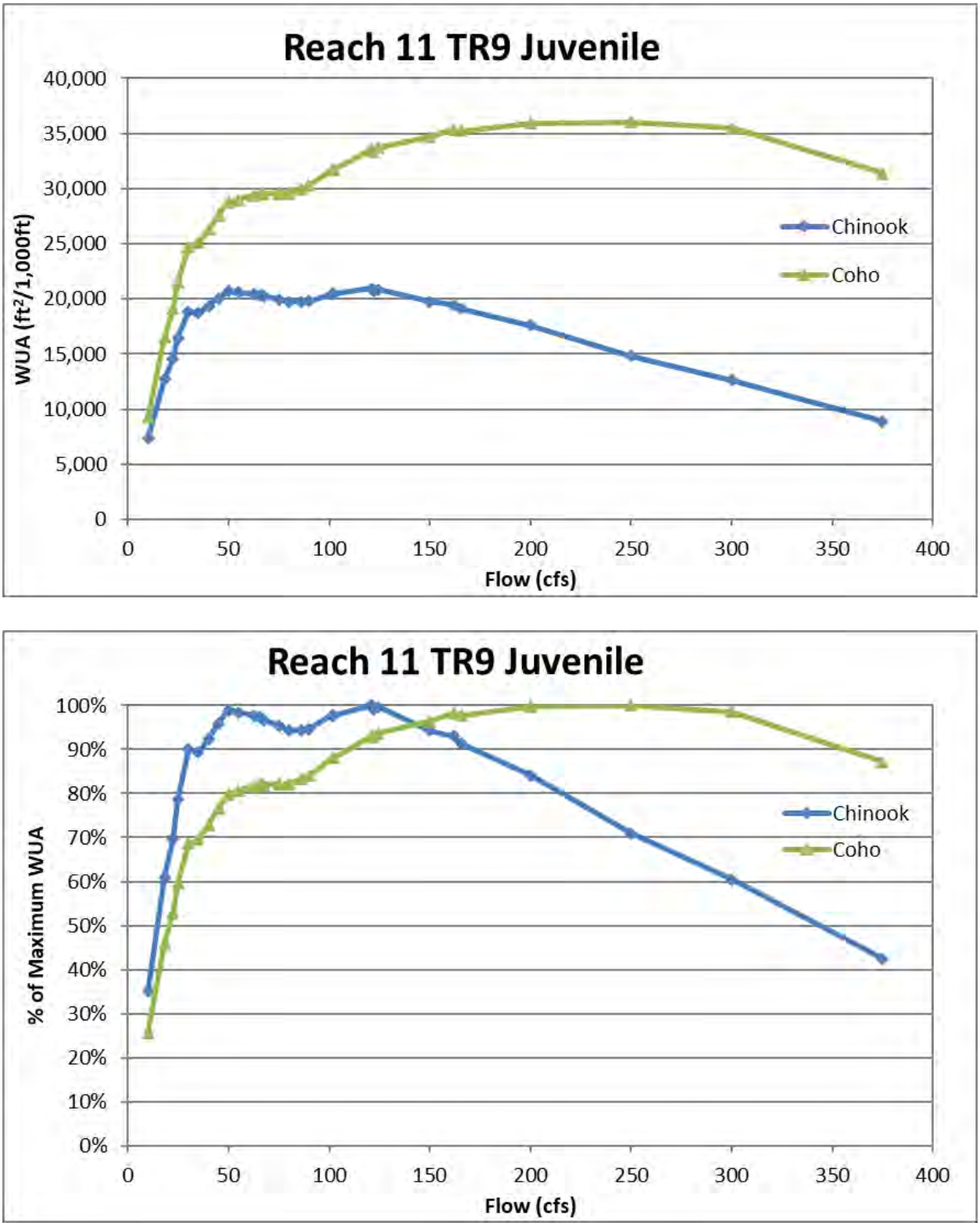


Figure A-56 Reach 11 Transect 9 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

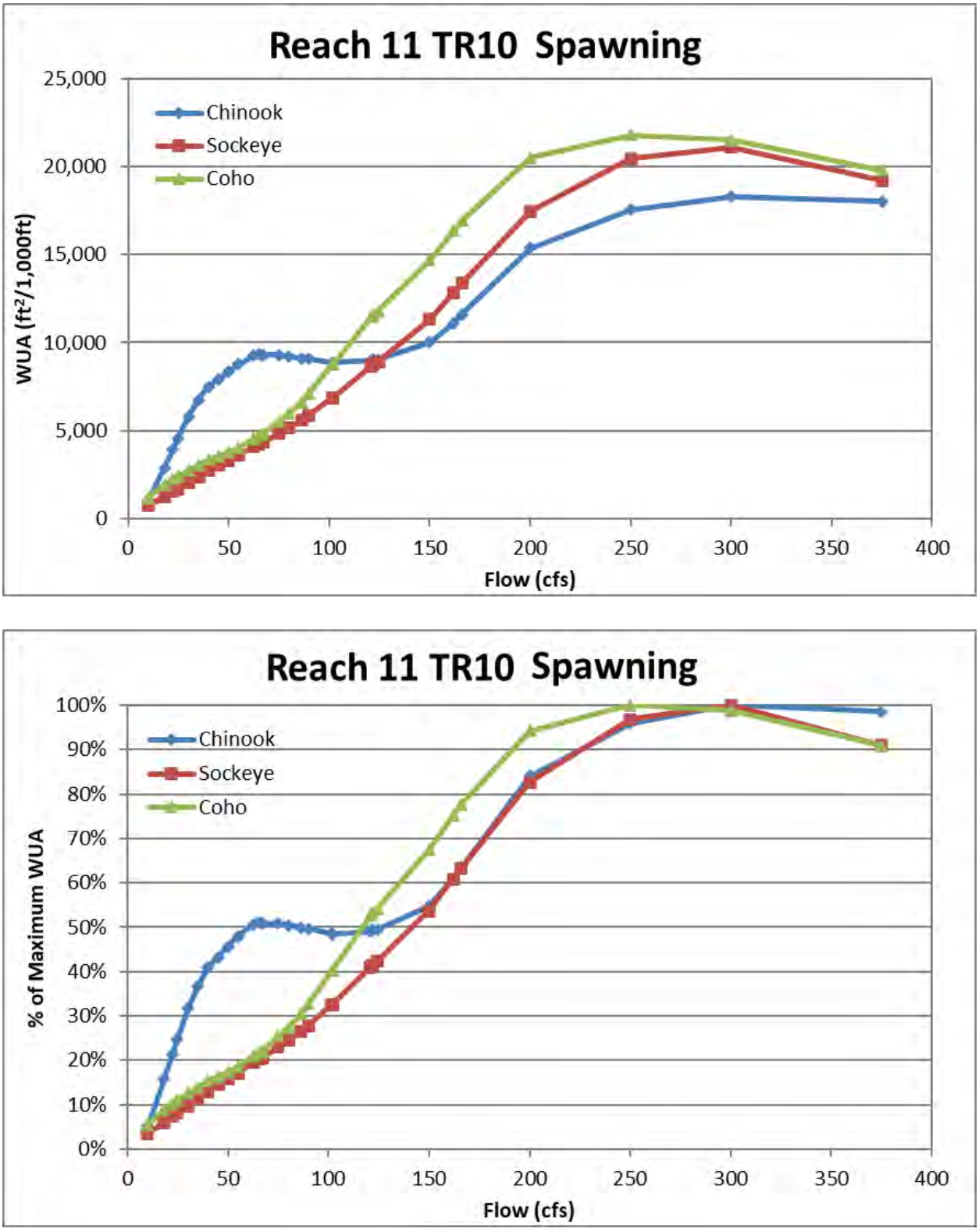


Figure A-57 Reach 11 Transect 10 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

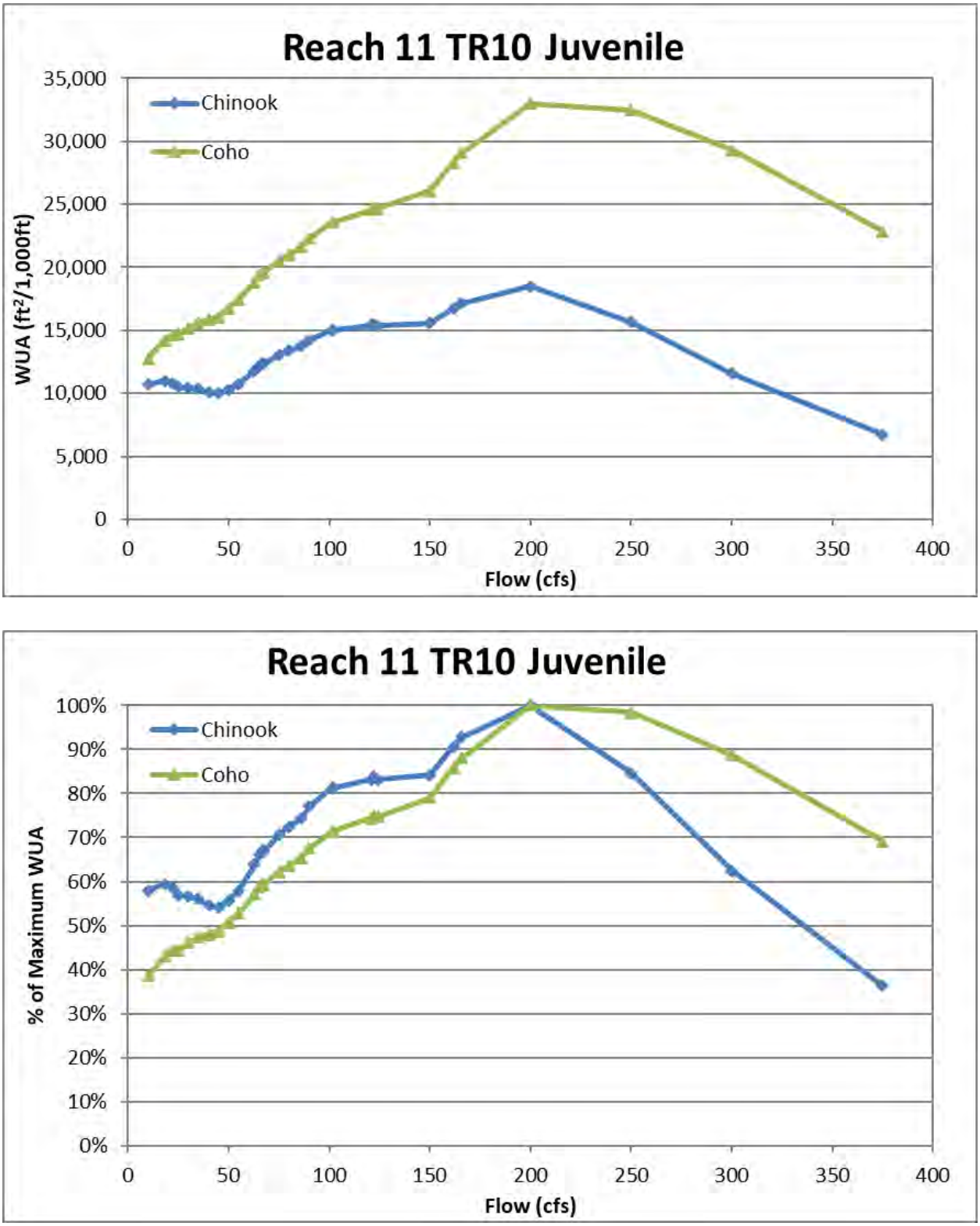


Figure A-58 Reach 11 Transect 10 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

Table A-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 **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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-29 Habitat vs. flow relationship for Sockeye 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)		% 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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-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-51 Habitat vs. flow relationship for Coho 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
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-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-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-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-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-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-57 Habitat vs. flow relationship for Coho 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
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-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-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-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-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-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-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-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-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-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-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-68 Habitat vs. flow relationship for Sockeye 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)		% 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-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-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-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-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-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-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-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-76 Habitat vs. flow relationship for Chinook 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
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-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-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-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-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-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-82 Habitat vs. flow relationship for Chinook 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
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-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-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-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-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-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 B
REACH BASED AND RIVER BASED HABITAT VS. FLOW RELATIONSHIPS

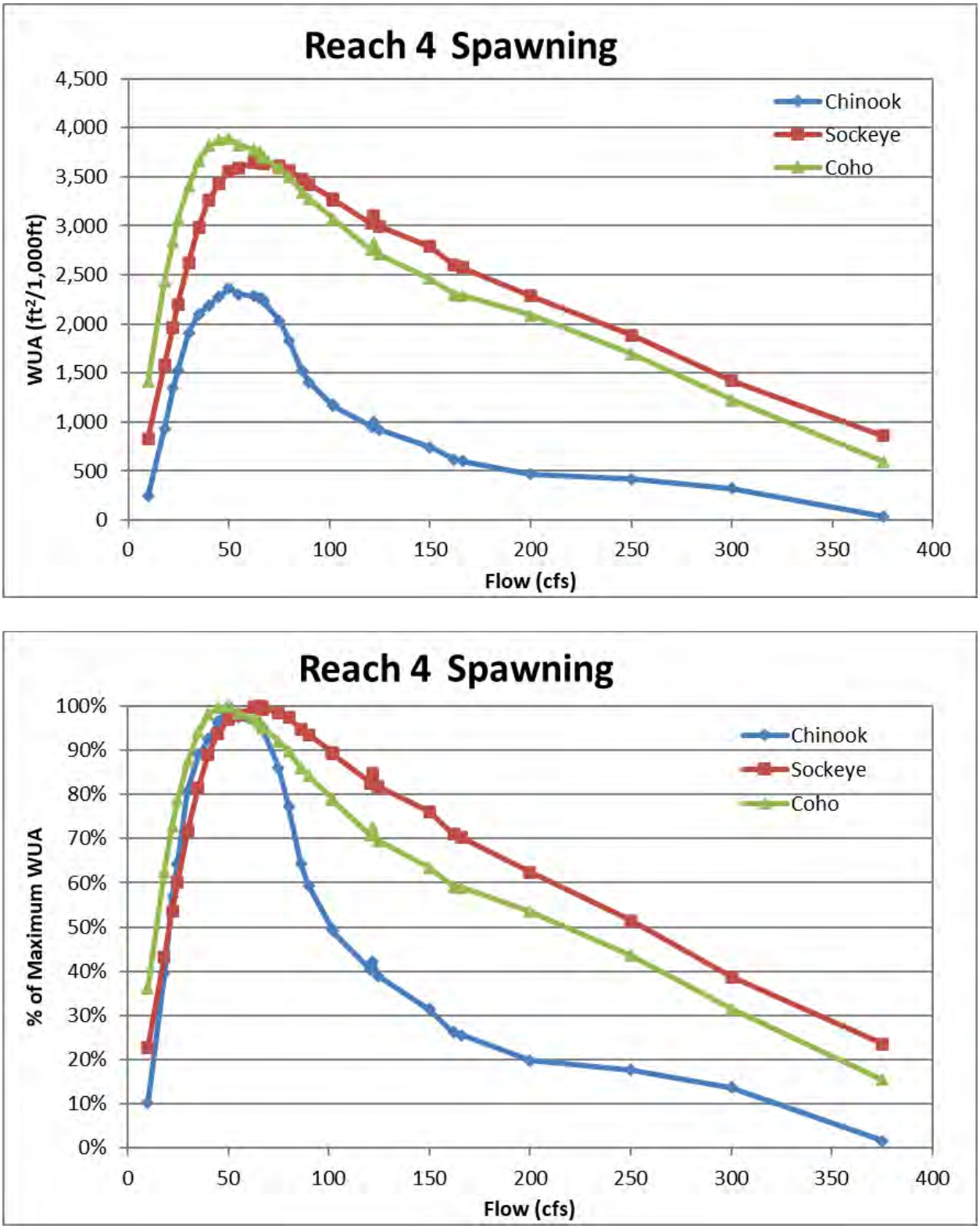


Figure B-1 Reach 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

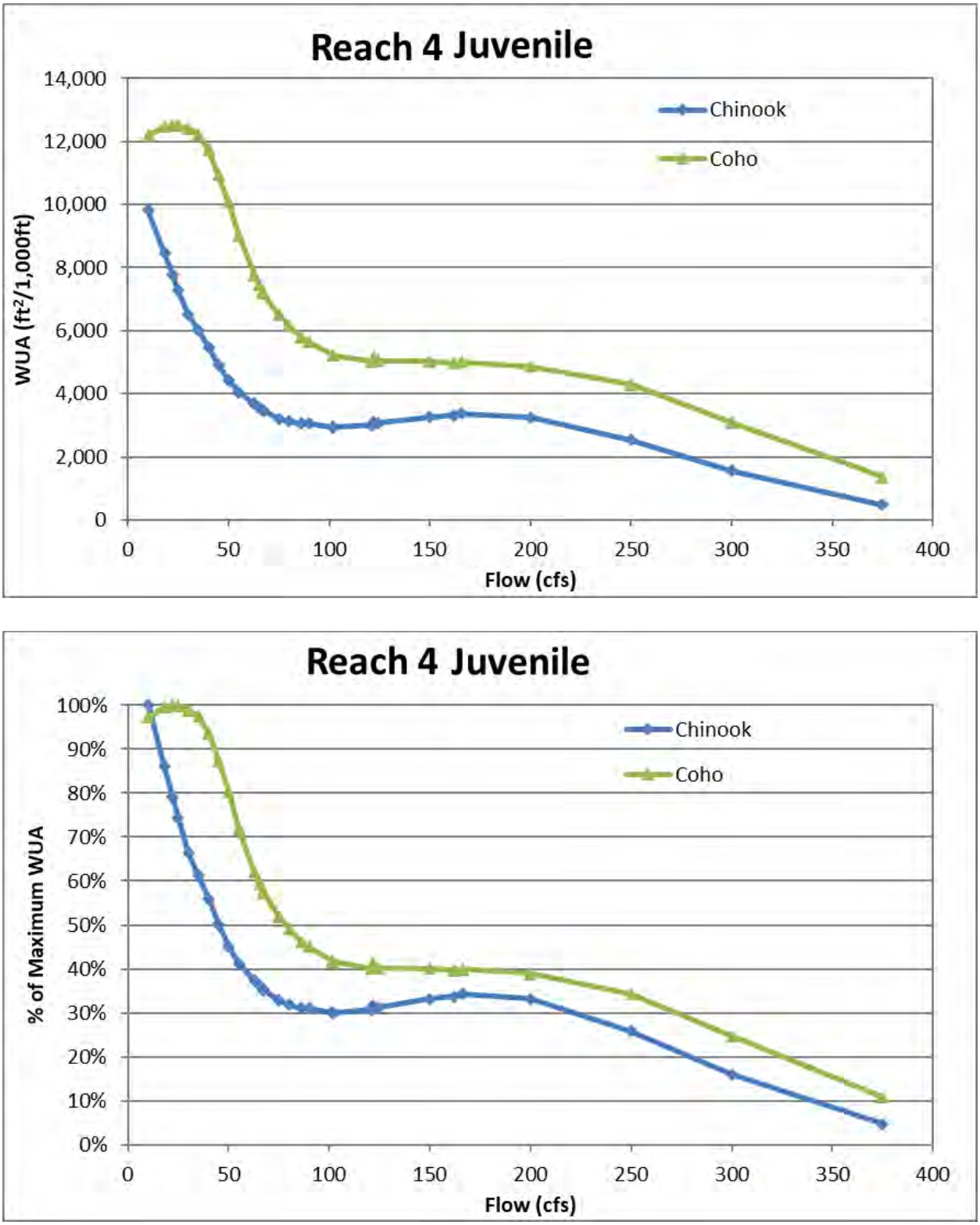


Figure B-2 Reach 4 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

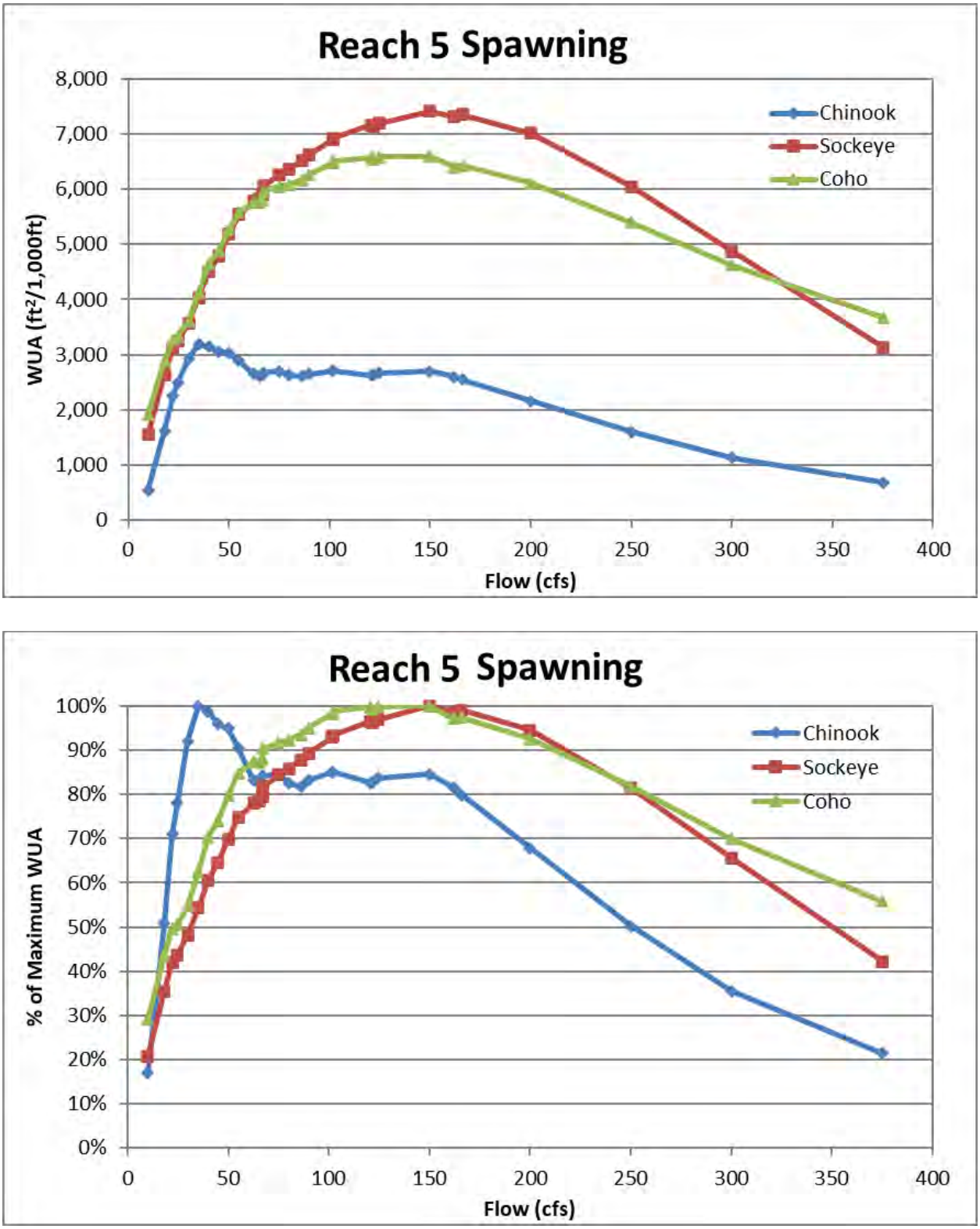


Figure B-3 Reach 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

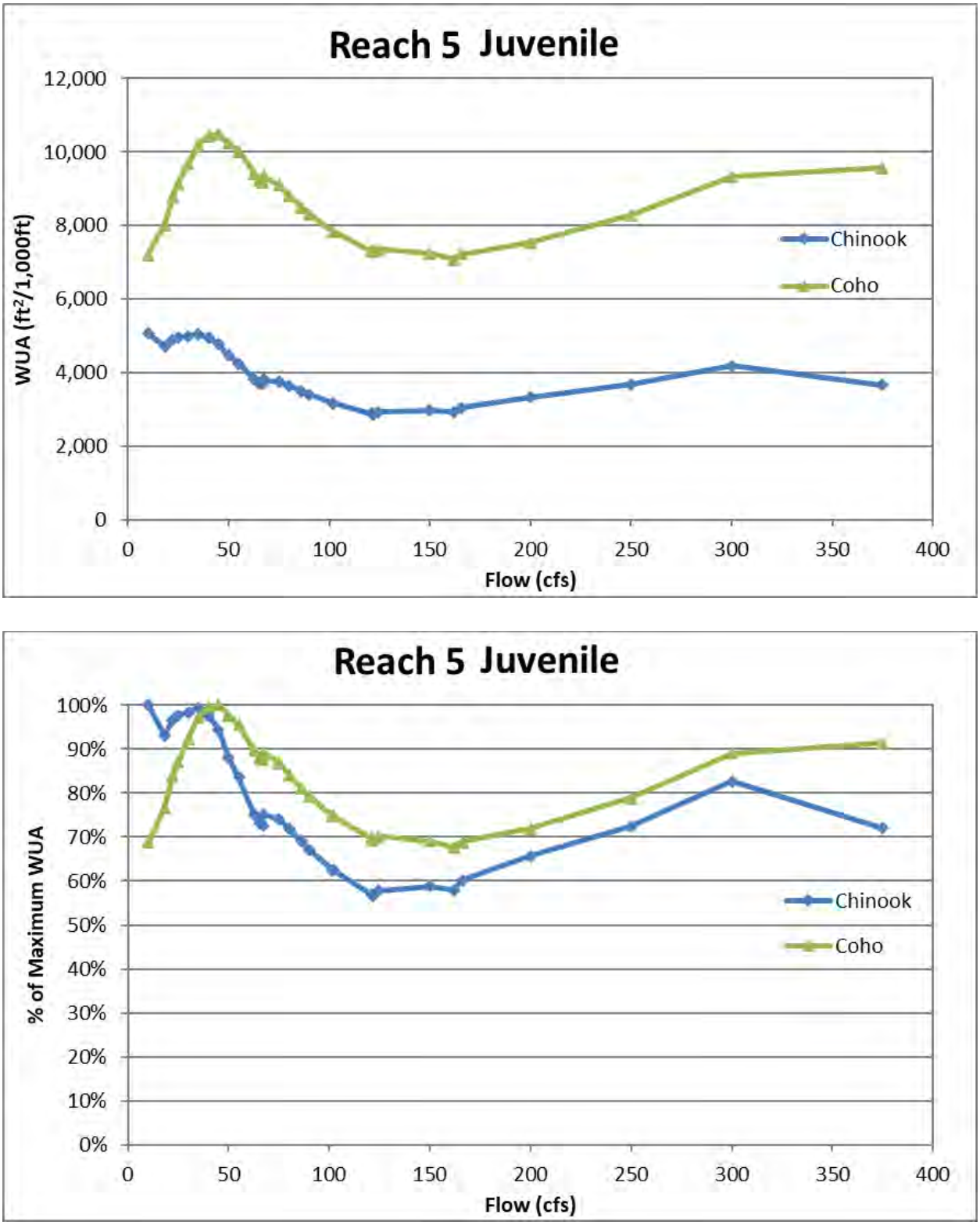


Figure B-4 Reach 5 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

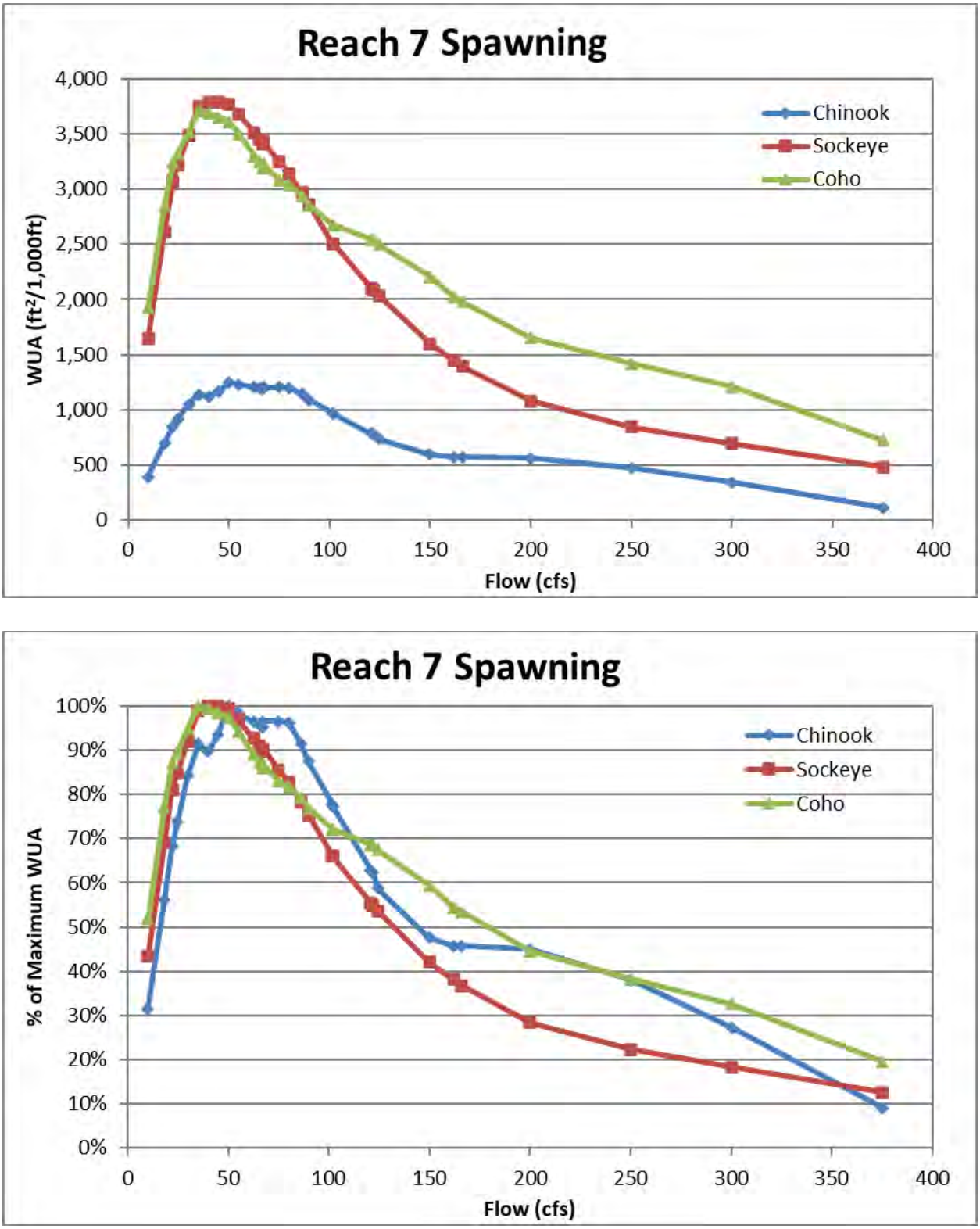


Figure B-5 Reach 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

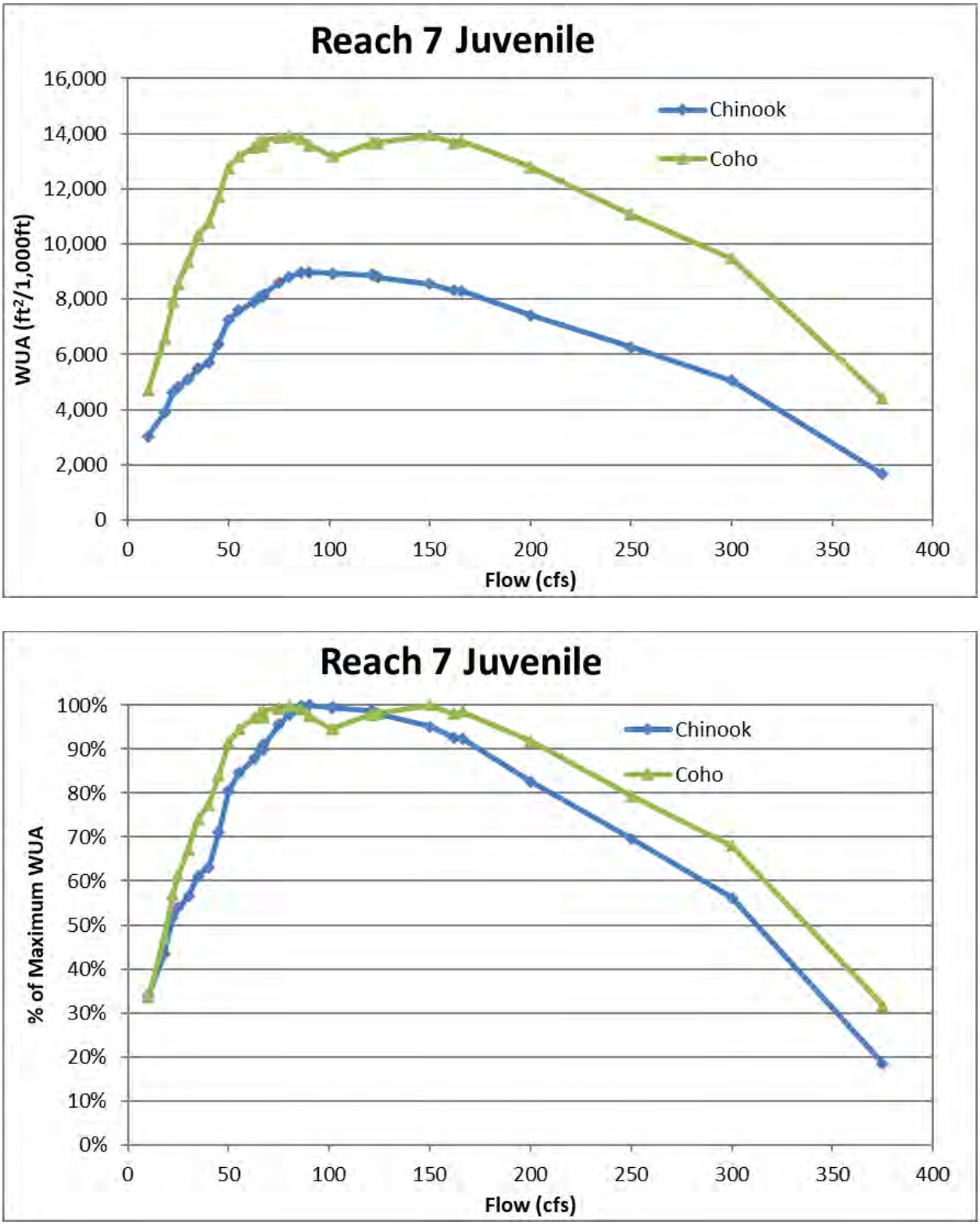


Figure B-6 Reach 7 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

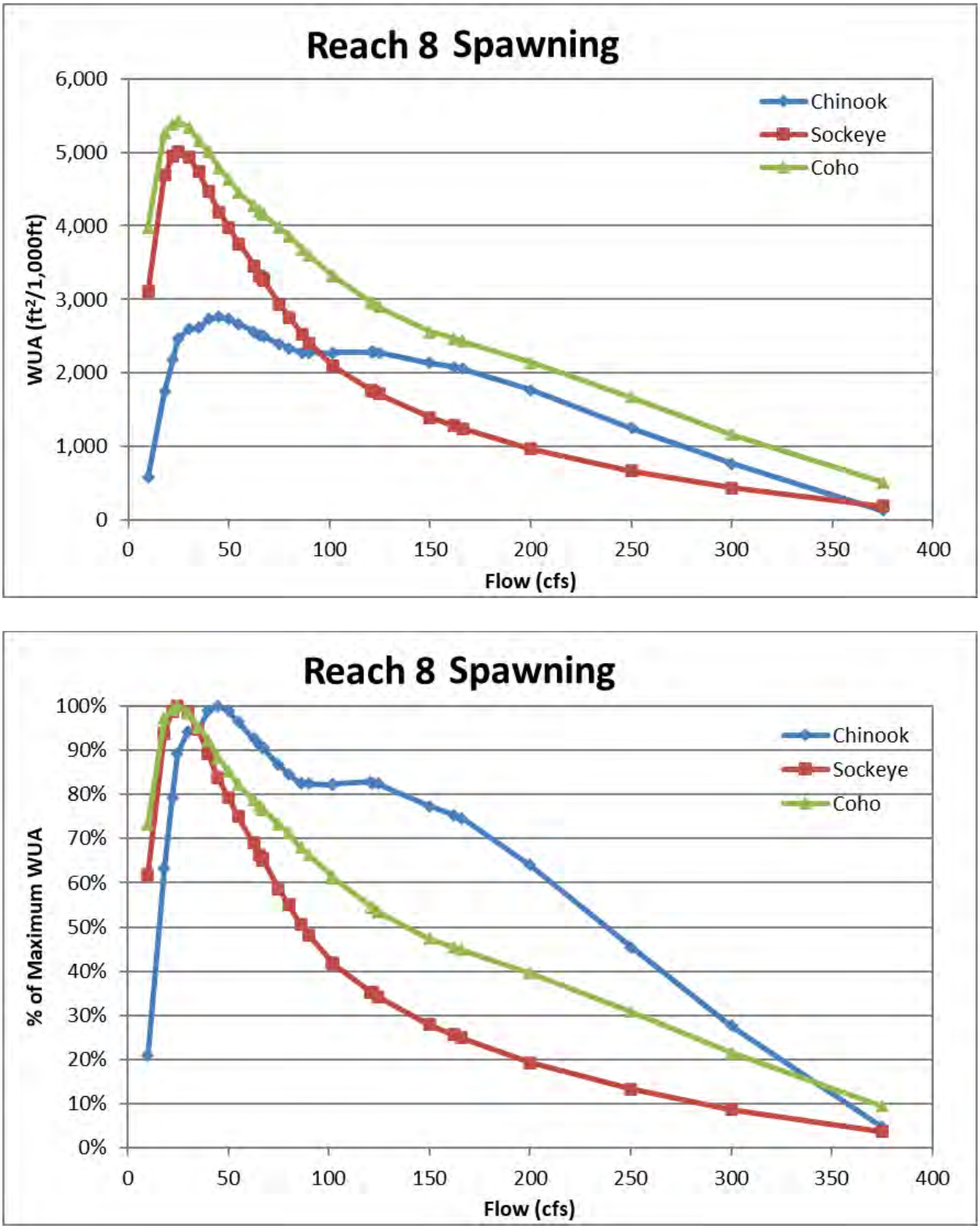


Figure B-7 Reach 8 weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

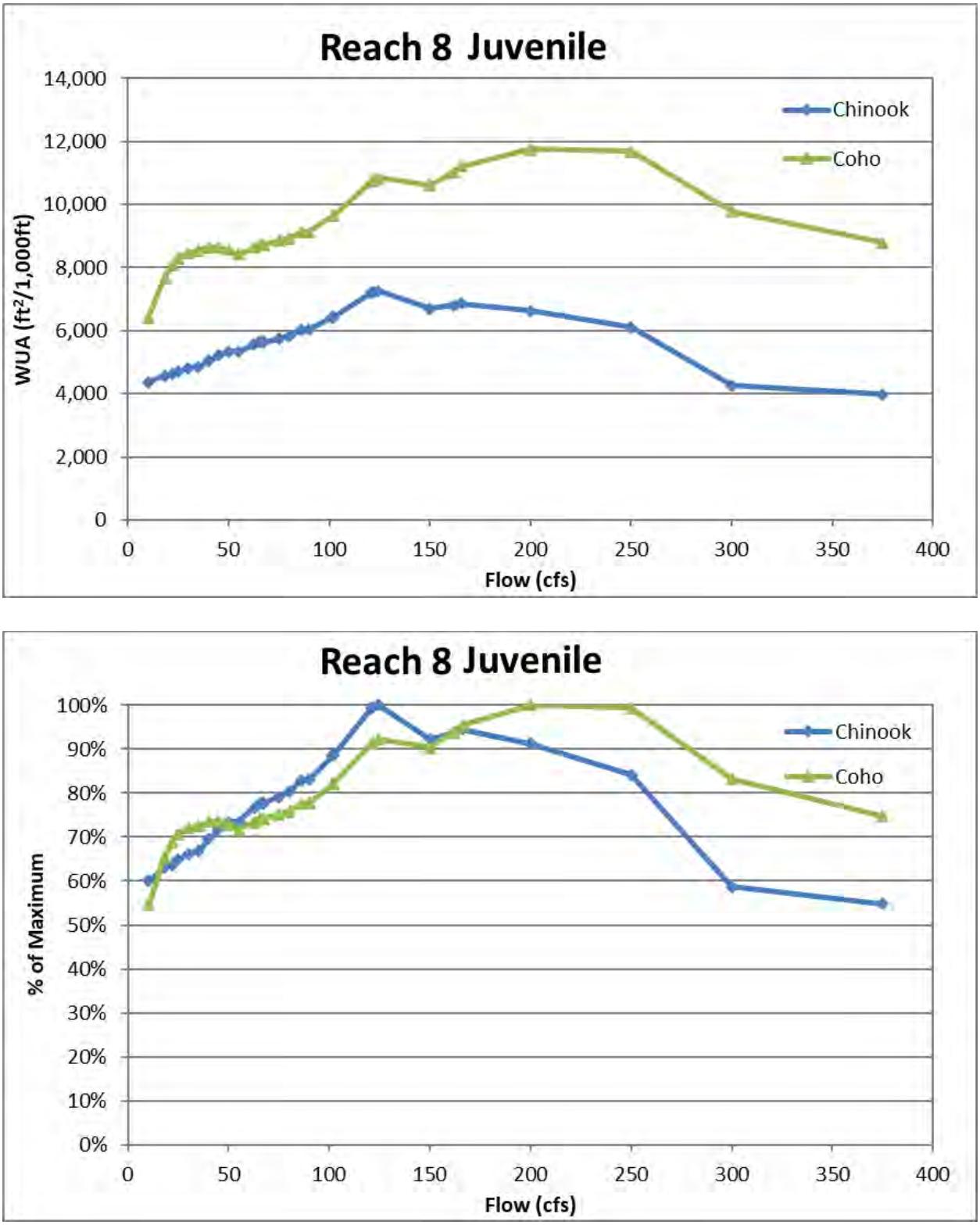


Figure B-8 Reach 8 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

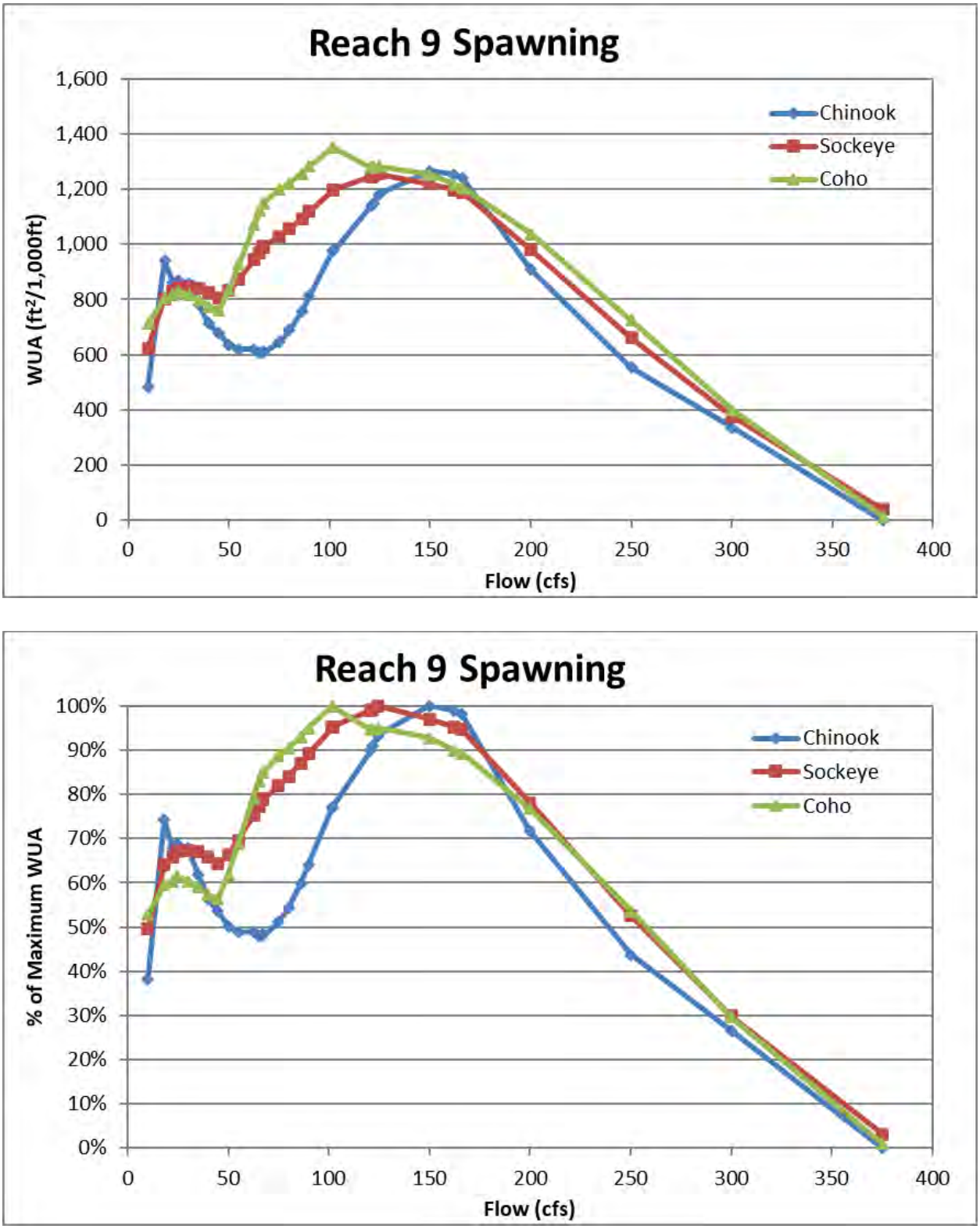


Figure B-9 Reach 9 Transect 2 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

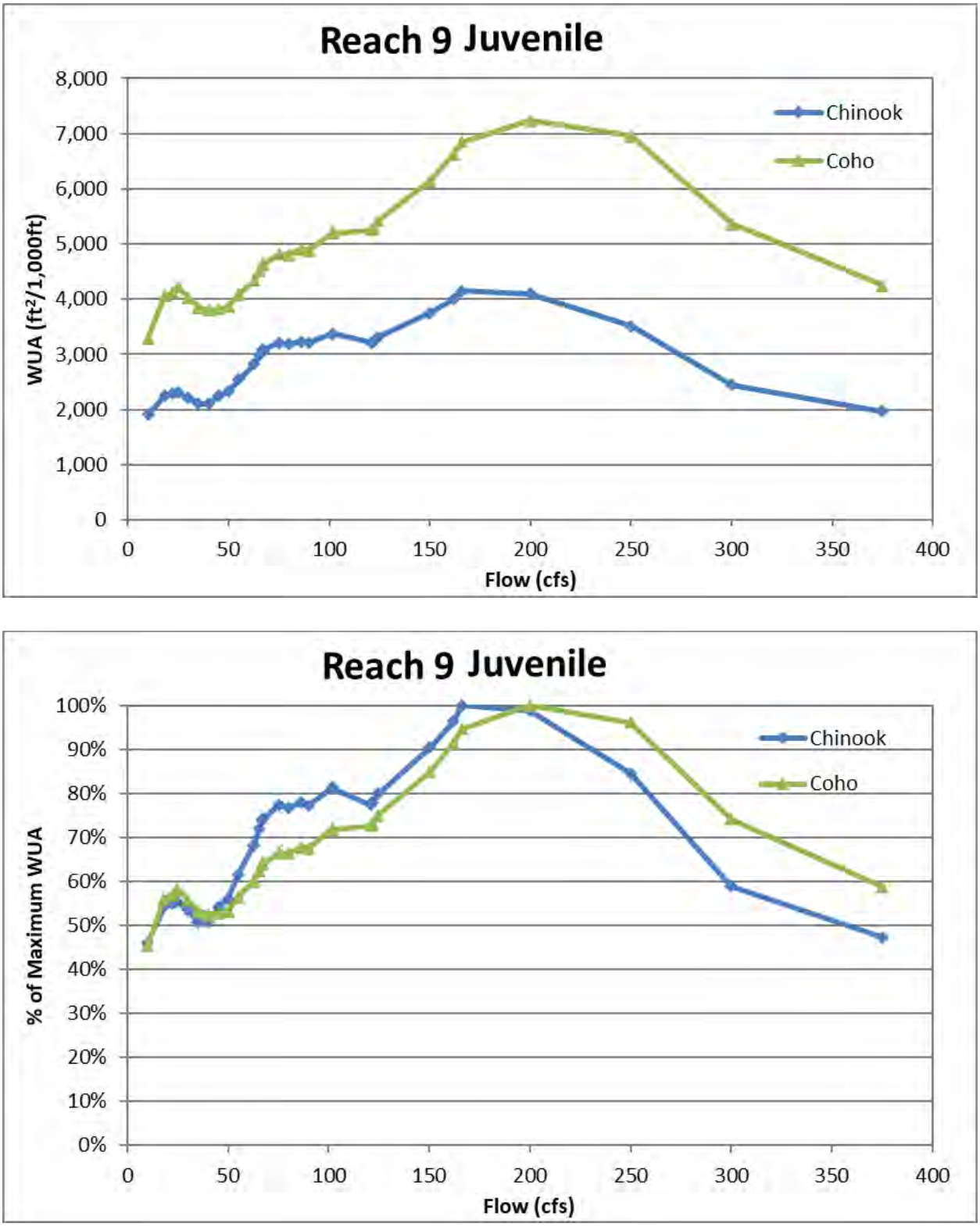


Figure B-10 Reach 9 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

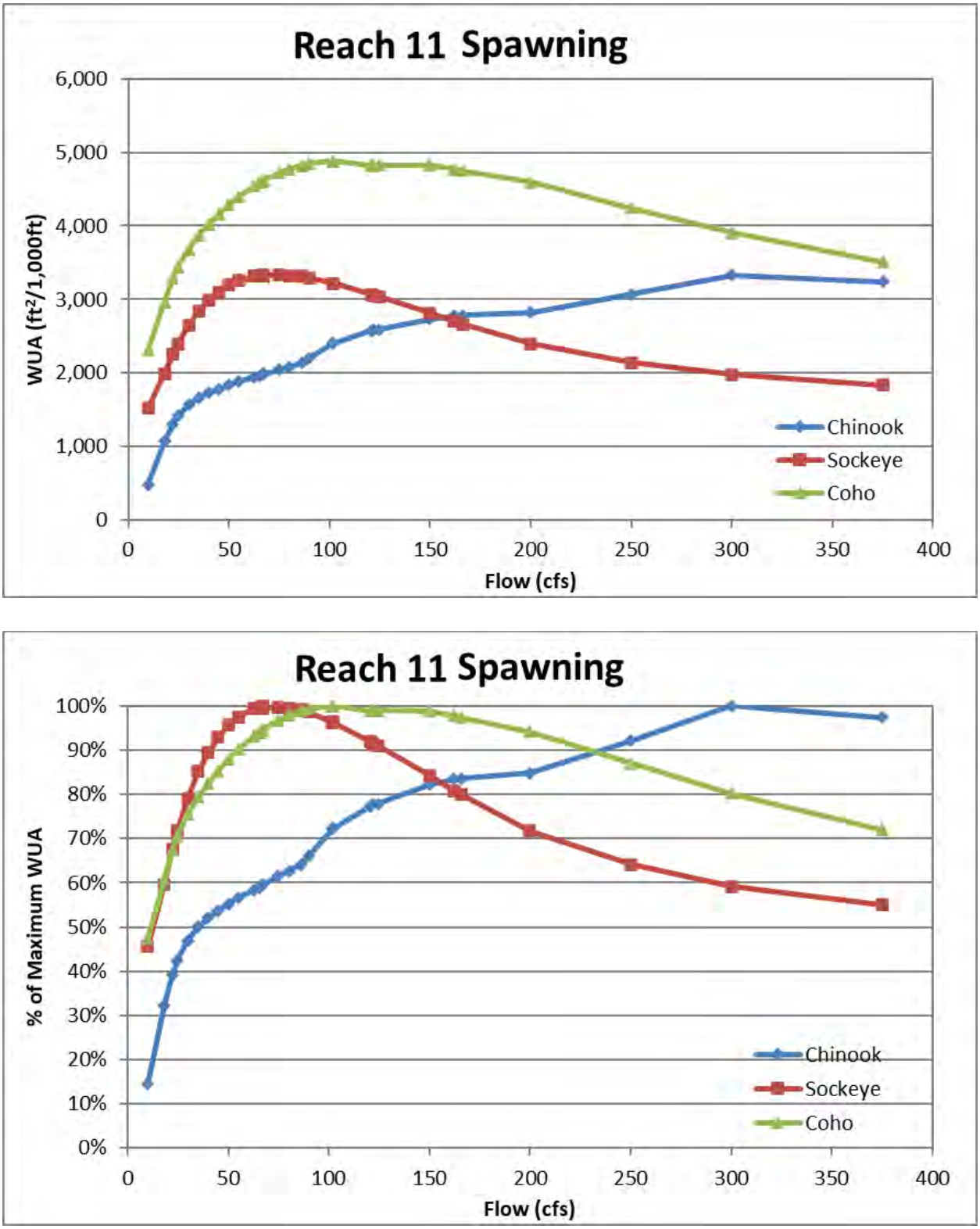


Figure B-11 Reach 11 total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

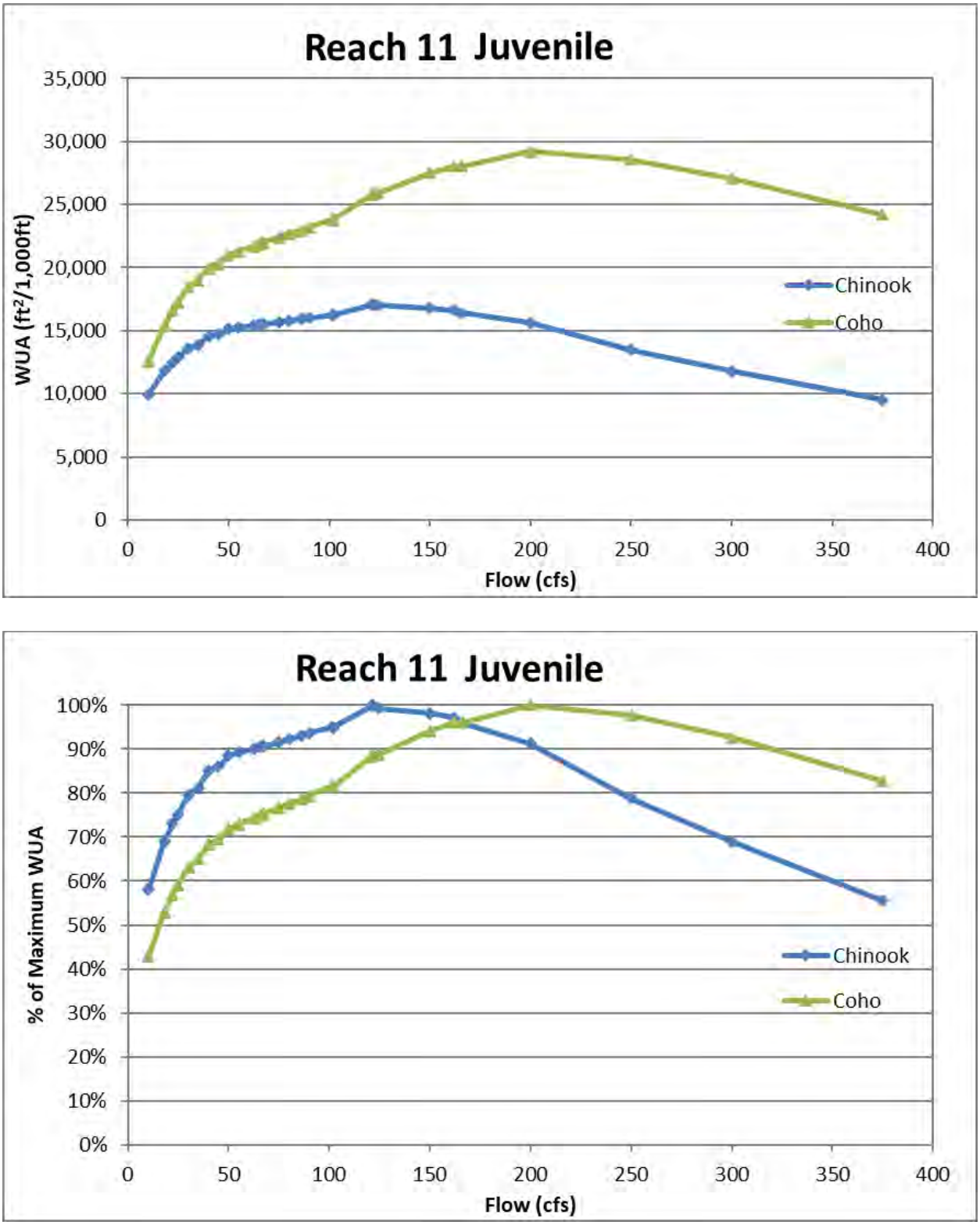


Figure B-12 Reach 11 weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

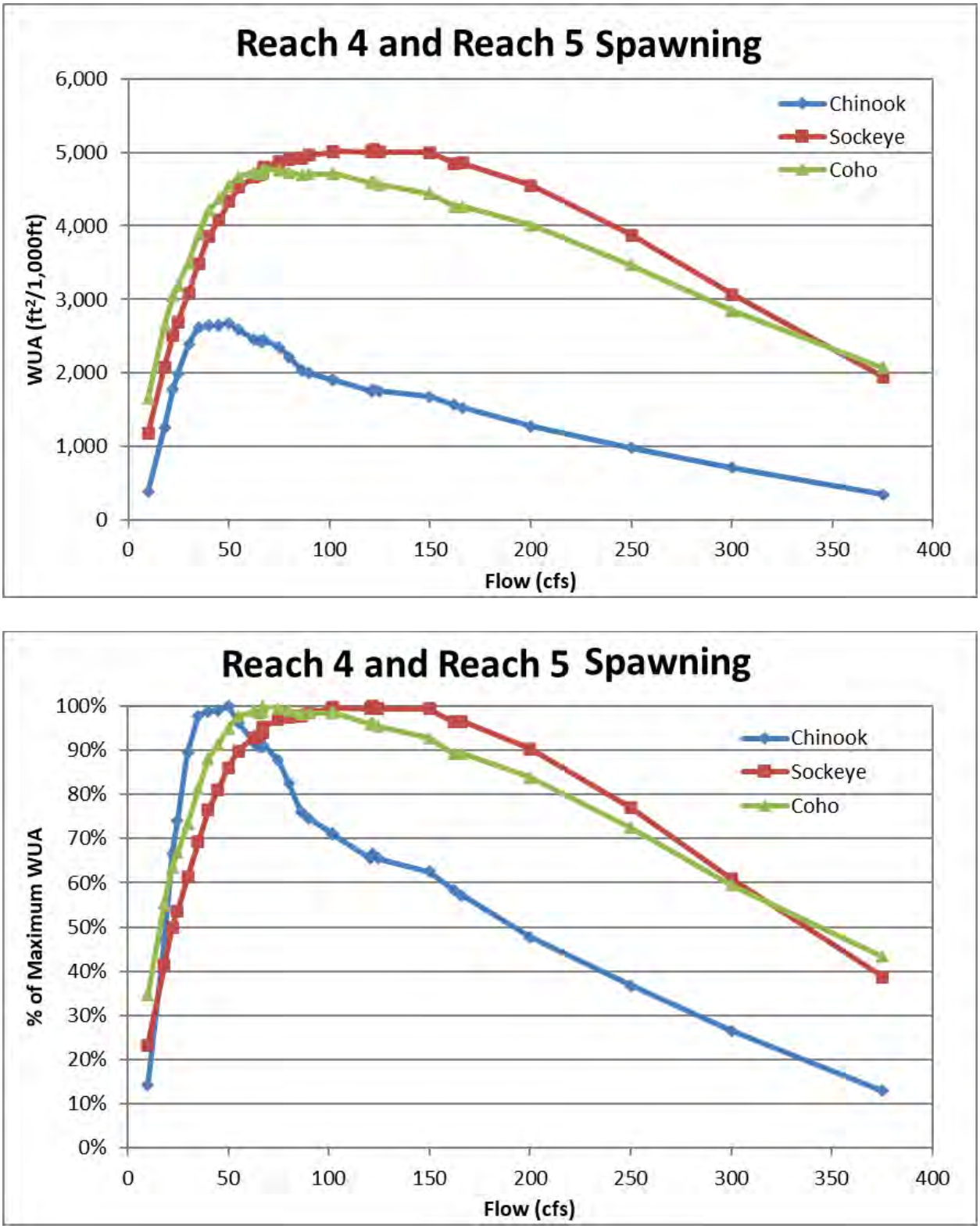


Figure B-13 Below Thunderbird Creek total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

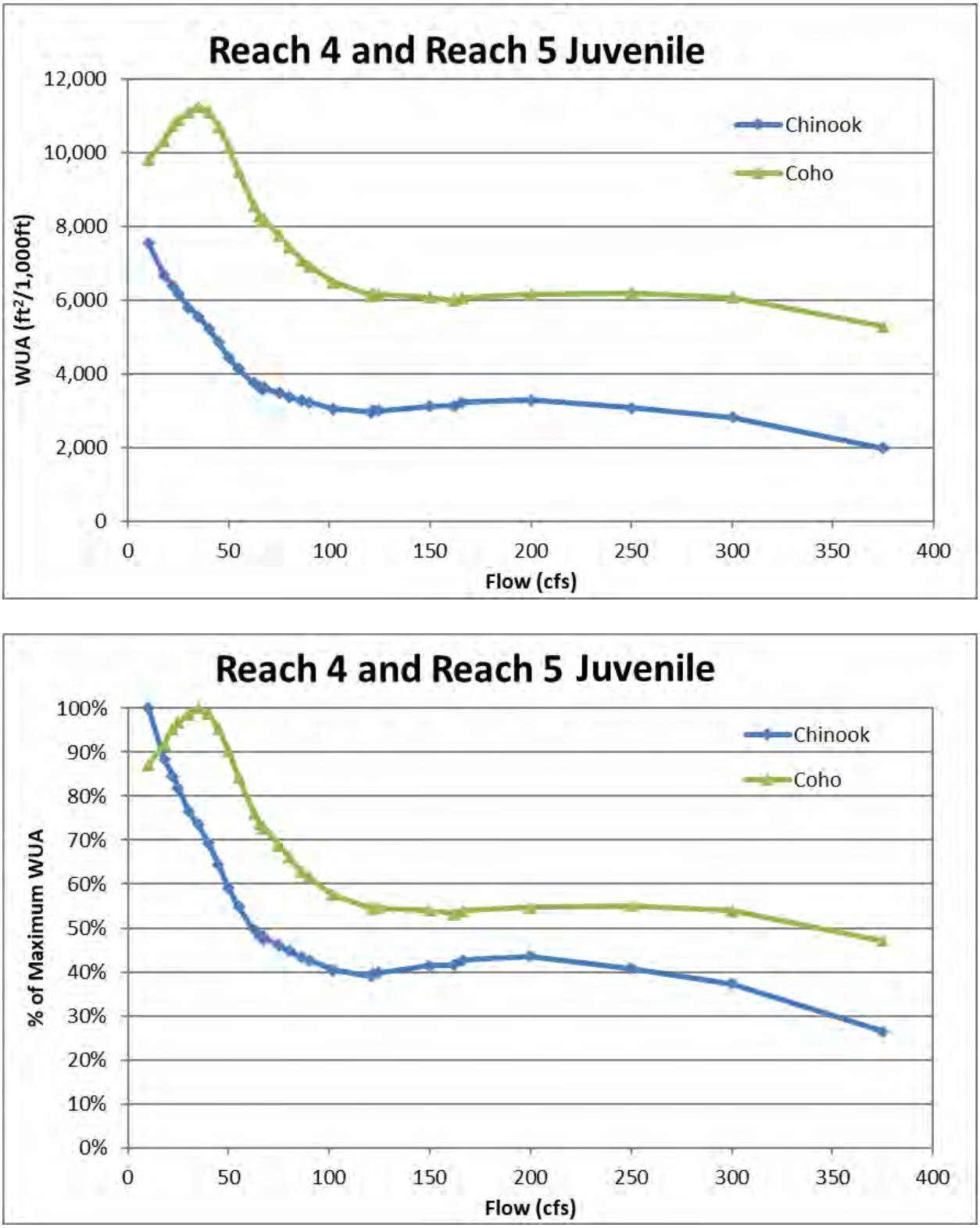


Figure B-14 Below Thunderbird Creek weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

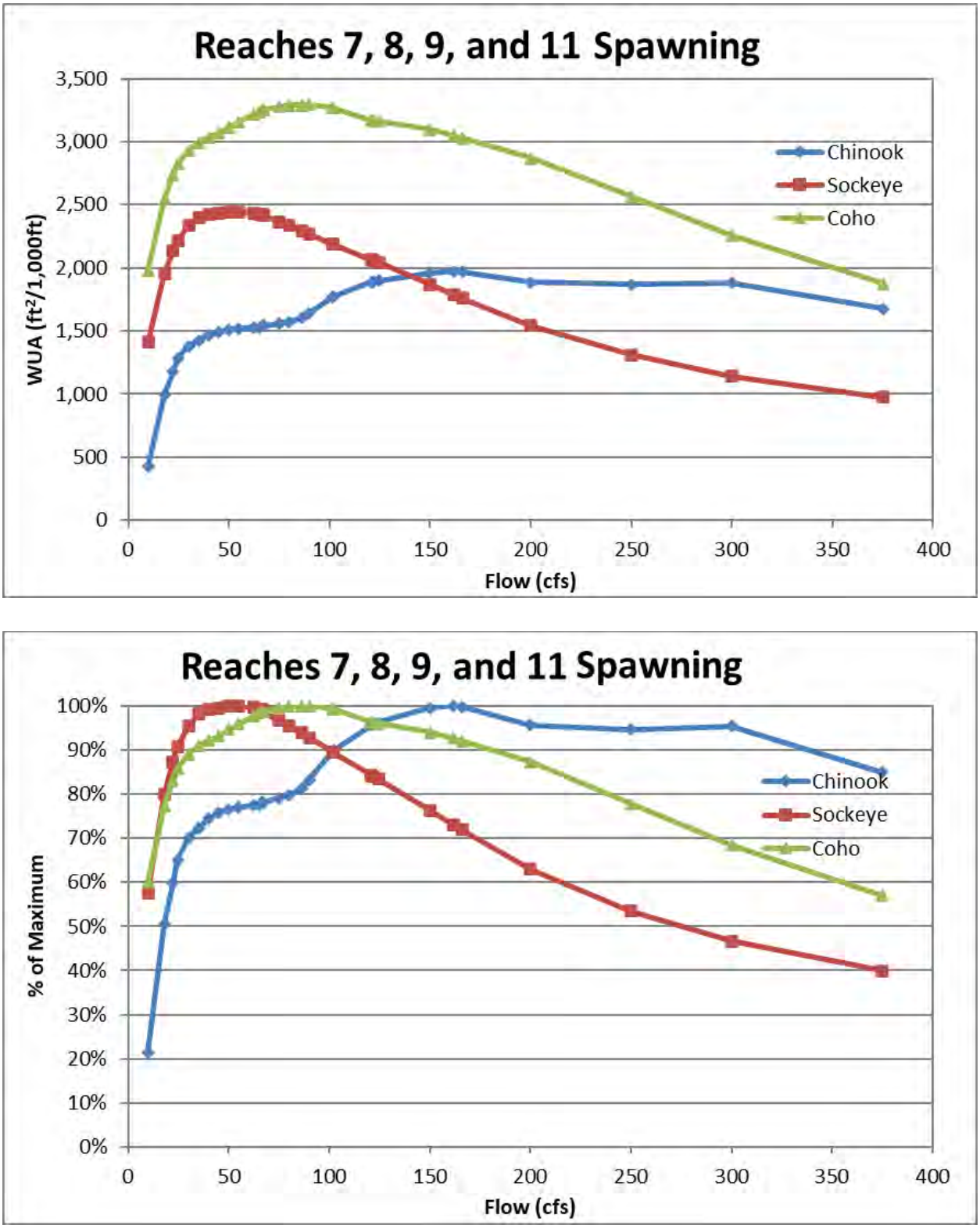


Figure B-15 Above Thunderbird Creek total weighted usable area (top) and percent of maximum weighted usable area (bottom) for spawning life stage of Chinook, Sockeye, and Coho Salmon Eklutna River, Alaska.

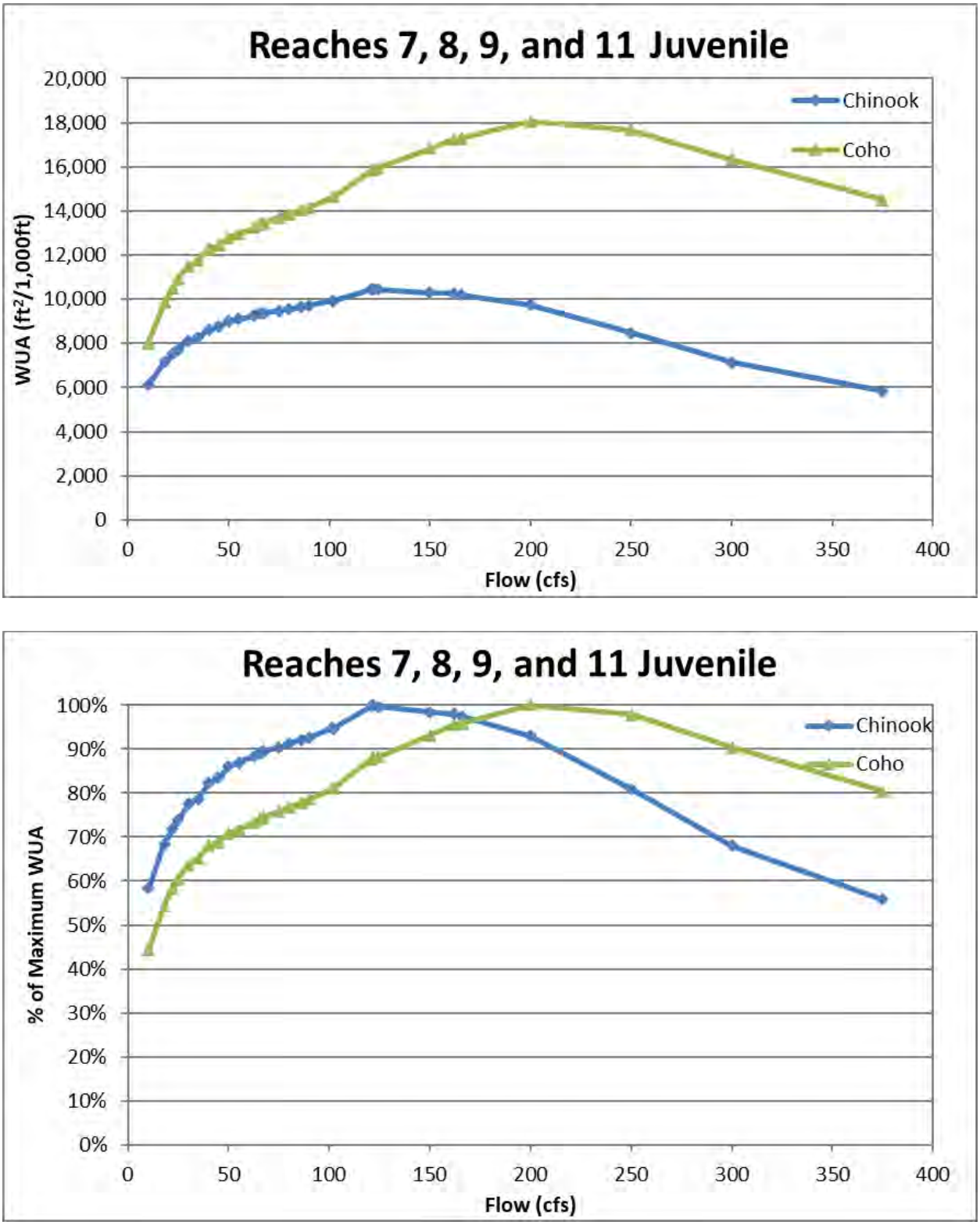


Figure B-16 Above Thunderbird Creek weighted usable area (top) and percent of maximum weighted usable area (bottom) for juvenile life stage of Chinook and Coho Salmon Eklutna River, Alaska.

Table B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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%

Technical Memo Comment-Response Table

Comment #	Agency/Interested Party	Draft Instream Flow and Fish Barrier Analysis Technical Memo Section (Page) *"Text"*	Comment	Response
Section 2.1 Meso-Habitat Mapping, and Study Site and Transect Selection				
1	ADFG	Section 2.21 Meso-Habitat Mapping, and Study Site and Transect Selection (page 5)	Meso-habitat mapping is a robust sampling strategy for instream flow/hydrologic studies.	Thank you for your comment.
2	ADFG	Section 2.21 Meso-Habitat Mapping, and Study Site and Transect Selection (pages 7-8)	Appears an appropriate number of transects were used that should provide a good representation of hydraulic conditions.	Thank you for your comment.
Section 2.4 Periodicity and Life Stage Priority				
3	USFWS	Figure 2-7: Summary of seasonal use (periodicity) of the Eklutan River by Chinook Salmon, Coho Salmon and Sockeye Salmon. Figure based on TU (2018), surveys, and obervational data from 2021 surveys as presented in Year 2 Report (2023, in preparation). (page 12)	Figure 2-7 on page 11 [sic] shows the seasonal use of Eklutna River by Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), and Sockeye Salmon (*O. nerka*) based on the estimated periodicities depicted in Trout Unlimited (2018) and U.S. Army Corps of Engineers (USACE 2011). However, during the TWG meeting we learned that field crews observed discrepancies with these timing windows. We request this new information be used to update the periodicity chart and any subsequent analysis.	Thank you for the comment. This issue has been discussed with NVE and a solution developed that is pending feedback from NVE. Any changes made to the periodicity in Figure 2-7 will be applied in subsequent analysis.
4	ADFG	Section 2.4 Periodicity and Life Stage Priority (page 12)	Agree w report to give spawning life stages higher preference for result interpretations. There is greater variability with juvenile results and thus results/interpretations should account for this uncertainty.	Thank you for the comment and your acknowledgement of the approach applied in assigning a higher prioritization for spawning versus rearing life stage when deriving the monthly flow level options. We have used this on other assessments with the understanding that for any given month in which spawning is known to occur, then priority should be given to the provision of flows to support spawning habitats.
Section 2.5 Habitat Modeling and Development of Habitat-Flow Relationships				
5	ADFG	Section 2.5 Habitat Modeling and Development of Habitat-Flow Relationships (page 14)	Concur w decision to normalize Flow-habitat results; makes it more straightforward to review, compare, and discuss results.	Thank you for your comment.
Section 2.6 Preliminary Flow Assessment				
6	USFWS	Figure 2-9: 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 and Table 2.1: 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, and 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. (pages 17 and 18)	Figure 2-9, Table 2.1, the PHABSIM extrapolation range is 10 to 375 cubic feet per second (cfs) based on test flow releases of 25 to 150 cfs (MJA 2021). Most of the habitat-flow relationship curves produced via PHABSIM modeling, in Appendix A, show a distinct peak within the extrapolation range, but four transect-based curves (Reach 5 TR1 Juvenile, Reach 8 TR 1 Juvenile for Chinook, Reach 11 TR7 Spawning, Reach 11 TR7 Juvenile) and one reach-based curve (Reach 11 Spawning for Chinook) do not. When these specific curves are normalized, 90 percent of maximum weighted useable area is based on the maximum of the extrapolation range (375 cfs) instead of maximum gains for the species and life stage. Given that the peaks would likely be higher if the extrapolation range could have been larger, we request clarification of how these curves were integrated into the information presented in Figure 2-9 and the flow levels in Table 2-1. If larger calibration flows had been possible, how much different could these values have been?	The habitat-flow curves that showed a continuous rise in habitat out to the highest modeled flow were integrated along with the others that had more defined habitat maxima to produce a composite curve for that reach. Habitat-flow relationships can vary widely by transect (as we noted in the TM) which is why compositing of transects is used to provide a blending of the individual relationhips. Because the majority of the curves were well defined within the range of modeled flows, we wouldn't expect there to be a major change in the composited curves if higher calibration flows were possible.

Technical Memo Comment-Response Table

Comment #	Agency/Interested Party	Draft Instream Flow and Fish Barrier Analysis Technical Memo Section (Page) *"Text"*	Comment	Response
7	USFWS	Section 2.6.1 Example Flow Release Levels and Release Options (page 15)	During the engineering portion of the TWG, and in section 2.6.1, four flow release levels and three flow release locations (with two additional modifications) were provided as examples for the model: 1) releasing flows at the dam through the current spillway; 2) releasing flows at the dam through the current spillway, but also excavating a channel through the upstream pond to lower the lake levels required to reach the spillway; 3) tying into Anchorage Water and Wastewater Utility (AWWU) infrastructure, creating a bypass at river mile 11; 4) tying into AWWU infrastructure, creating a bypass further downstream near river mile 5.5; and 5) diverting Lach Q'atnu Creek. Of these five example scenarios, only two (items 1 and 2) provide continuous surface flows from the lake. We would like to see more scenarios that include returning flows to all river reaches, and we look forward to working together to develop these scenarios.	In addition to the dam release methods presented in the 9/28 meeting, additional flow release methods being investigated include a siphon connecting the lake with the plunge pool downstream of the dam, gated spillway releases, and releases at a proposed fish ladder. The gated spillway release was discussed at the 10/17 meeting, and fish passage alternatives will be discussed at the 11/9 meeting. If additional flow release methods at the dam are being discussed, please inform the engineering team and they will be added to the list of PME measures investigated.
8	ADFG	Section 2.6.1 Example Flow Release Levels and Release Options (page 15)	Use of 4 flow levels w 3 release options provide good range for evaluation of alternatives by decision makers.	Thank you for your comment.
9	ADFG	Section 2.6.2 Time Series Analysis (pages 19 - 33)	Good to see Time Series Analysis and Habitat Duration Curves (not always done) – this can provide important insights and comparison w baseline conditions.	Thank you for your comment.

Technical Memo Comment-Response Table

Comment #	Agency/Interested Party	Draft Instream Flow and Fish Barrier Analysis Technical Memo Section (Page) *"Text"*	Comment	Response
Section 2.7 Example Flow Release Levels and Release Options				
10	USFWS	Section 2.7 Further Considerations and Study Limitations (page 33)	Section 2.7, while we recognize that flushing flows and channel geomorphology will be discussed in subsequent meetings, we reiterate that PHABSIM model results are predicated on the assumption of channel maintenance. Maximum weighted useable areas reflect the proportion of modeled available habitat by species and life stage across the range of flows. However, in the absence of channel-forming flow events, or if channels are restored or otherwise physically altered, the amount of salmon habitat available within the study reach will change over time and the model results may longer be applicable. We therefore request that PHABSIM model results be revisited as decisions are made regarding flushing flows. Due to the lack of flow over the last decades, we expect major changes throughout the river. We are concerned that taking a single snapshot in time will not forecast potential habitat in the Eklutna River system. The information should be used in conjunction with the sediment transport model, channel alterations, and a restoration plan.	Thank you for your comment. We recognize that channel changes will occur and may necessitate some refinements in the PHABSIM modeling depending on the extent of channel change. See page 52 of the Revised Draft Study Plan (MJA 2021) "Flow Releases and Channel Changes - The proposed release of target flows to the Eklutna River downstream from Eklutna Dam as part of the IFS will likely cause some changes in channel morphology at different locations in the river. These changes will in part be occurring in the short-term during 2021 field measurements and to some extent will be integrated into the development of the current conditions modeling." The study plan acknowledges that if higher flows were subsequently released, depending on the extent of channel change, the fish habitat results derived from the current channel morphology may need to be modified. During the September 28th TWG meeting it was stated that "To the extent conditions remain generally the same (some shifts in mesohabitat types and amounts are expected), the models *(e.g. current conditions models*) should continue to be a useful tool for evaluating flow release options under the Fish and Wildlife Program". We also agree that the habitat modeling based analysis represents but one of several studies that will be used in evaluatling flow release alternatives. As stated in the conclusions during the September 28th TWG meeting - "Other studies (geomorphology/sediment transport modeling, and 2D modeling) (are) needed to balance fish habitat and other water uses in the Eklutna Basin".
11	USFWS	Section 2.7 Further Considerations and Study Limitations (page 33)	Section 2.7 of the technical memo says the scenarios presented in the analysis should only be used for example purposes to illustrate that the PHABSIM model could work. We agree and would not want the example inputs to be viewed as options or alternatives.	Thank you for the comment and you are correct as stated in the draft TM, "The purpose of this technical memorandum (TM) is to summarize the results of the PHABSIM modeling and barrier flow analyses , and to describe how those results were used to formulate several example Eklutna Lake flow release scenarios. The overall objective is to demonstrate the reliability and utility of the data collection and modeling completed in support of both the Instream Flow Study as further described in the proposed final study plan (MJA 2021a) as well as the Year 1 Report (Kleinschmidt Associates 2022a), and the barrier analysis as presented in the River Fish Phase of the Year 2 Study Plan (MJA 2022)." The flows used in the TM should not be viewed as proposed flow release options or alternatives.

Technical Memo Comment-Response Table

Comment #	Agency/Interested Party	Draft Instream Flow and Fish Barrier Analysis Technical Memo Section (Page) *"Text"*	Comment	Response
General Comments				
12	USFWS	General Discussion	Hydroelectric development has impacted the entire length of Eklutna River, and the study plans have been examining those impacts on fish and wildlife (including spawning grounds and habitat) to inform options for protection, mitigation, and enhancement measures. We understand that a variety of alternatives need to be considered so the impacts to fish and wildlife, electric rate payers, municipal water utilities, recreational users, and adjacent land uses can be analyzed and compared. The AWWU release example captured options for minimal cost to rate payers and utilities while still offering some improvement to habitat over current condition; however, we are concerned this type of scenario would not address habitat at the upper reaches of the river or fish passage into the lake. We would like to see scenarios analyzed that capture maximum improvements for fish habitat over the current condition so that those costs and benefits can also be documented and considered. For example, we recommend including scenarios with modified or new infrastructure that could accommodate year-round flows, flushing flows, and fish passage. We look forward to discussions about ideas and their feasibility.	Thank you for the comment. PME measures to address flushing flows and fish passage into the lake are being investigated. The flushing flows and gated infrastructure at the dam were discussed at the 10/17 TWG meeting and fish passage will be discussed at the 11/9 meeting.

Technical Memo Comment-Response Table

Comment #	Agency/Interested Party	Draft Instream Flow and Fish Barrier Analysis Technical Memo Section (Page) *"Text"*	Comment	Response
13	USFWS	General Discussion	Recognizing the importance of maintaining owner investments and instream habitat gains, we also look forward to future discussions of flushing flows. Preliminary barrier analysis results are impossible to discuss without a consideration of channel geomorphology, local geology, and flushing flows. Cross sections taken at existing fish passage barriers in geologically unstable reaches with high colluvial sediment inputs do not represent permanent river characteristics. A functioning river has a flow regime that is in balance with sediment inputs. Current Eklutna River flows are not in balance with sediment inputs; the river requires more instream flow to route the sediment it receives from the watershed. The surveyed barrier reaches represent sediment aggradation. Marginal releases to maintain a prescribed minimum depth throughout these reaches will provide short term fish passage gains. In the absence of flushing flows, however, continued sediment inputs will increase aggradation and produce additional barriers. As opposed to modeling various flow releases over an existing ephemeral cross section, a sediment transport analysis should be conducted to explore the amount of water and stream power necessary to route the native sediment at a rate that maintains fish passage and habitat over time. Sediment transport analysis will inform decisions regarding the magnitude and timing of flushing flows necessary for channel maintenance.	Thank you for your comment and we agree with your discussion regarding the need for consideration of sediment transport and channel changes with respect to potential barriers. The barrier analysis was completed to provide some estimate of the flow levels that could be problematic for upstream fish passage at the six potential barriers identified under existing conditions. We recognize these conditions may change at some of the locations in the future due to sediment transport and/or tectonic shedding of colluvial material into the channel. Some of the barriers are composed of large boulders bounded by bedrock walls and likely these boulders would not move substantially even under very high flow conditions. More detailed discussions of specific barriers will be included in the Year 2 geomorphology reporting.
14	ADFG	General	Accepted data collection and modeling techniques were cited and used.	Thank you for your comment.