COMBINED AQUATICS WORKING GROUP

CAWG 3-INSTREAM FLOW STUDIES: PHABSIM

TECHNICAL STUDY REPORT

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EXECUTIVE SUMMARY

The CAWG 3 Study Plan, *Determine Flow Related Physical Habitat in Bypass Reaches,* has the primary objective of identifying how flow affects available habitat for fish species in the bypass reaches below Project facilities.

For the purpose of evaluating rearing and spawning habitat, study streams were divided into two groups, those with diversions that are operated throughout the year (mid-sized to large streams), and those with seasonal diversions that are operated only during the runoff season (small streams). The Physical Habitat Simulation Models (PHABSIM) of the Instream Flow Incremental Methodology (IFIM) (Milhous et al. 1989) were used to evaluate flow-related habitat for the continuously diverted streams. The wetted perimeter methodology (Randolph 1984; Nelson 1989; Lohr 1993) was applied to the seasonally diverted smaller streams.

This report describes the methods and results of PHABSIM and passage analyses for streams with year-round diversions. It also provides a description of the process culminating in the development of habitat suitability criteria (HSC) that were used as a part of these studies. The study streams for each of these elements included various reaches of the South Fork San Joaquin and San Joaquin Rivers, as well as Bear, Mono, Big, North Fork Stevenson, and Stevenson Creeks.

The PHABSIM hydraulic models were successfully calibrated for all transects[1] and provide accurate simulations of depths and velocities. When used with appropriate HSC (such as those described below), these models will provide good simulations of habitat as a function of flow and provide reliable results over the full range of simulation flows discussed by the Combined Aquatics Working Group (CAWG), with the exception of the Stevenson Reach of the San Joaquin River (extrapolation beyond about 350-400 cubic feet per second (cfs) is not recommended for this reach).

The Big Creek Alternative Licensing Process (ALP) HSC were developed by CAWG consensus and approved for use in the Big Creek ALP PHABSIM studies in April 2004. These criteria are provided in Section 3.3 of the report and a complete description of their development is provided in Appendix D. The U.S. Fish and Wildlife Service (USFWS) did not agree with the use of the Big Creek ALP velocity criteria for adult and juvenile rainbow and brown trout, but did express concurrence with the remaining criteria. The Big Creek ALP criteria were used to interpret the results of the PHABSIM hydraulic simulations and develop the habitat vs. flow functions that are the primary result of this study. Results of the habitat simulations for each study reach are included in Appendix G.

Passage analyses were conducted to evaluate how flow affects adult trout passage through typical riffles. (Significant passage barriers were also identified in the field

[1] A transect is a cross section placed to represent the hydraulic conditions at a specific location. Measurements are collected along the length of the transect for input into the hydraulic modeling program.

during habitat mapping and reservoir fisheries studies. The results of these barrier identifications are included in the CAWG 1 and CAWG 14 reports.) These flow-related passage analyses were conducted at the riffle transects selected for PHABSIM studies.

Stranding and depth suitability analyses are the two outstanding elements of the CAWG 3 Study Plan not included in this report. These elements will be addressed in a supplemental report.

1.0 INTRODUCTION

As part of the Big Creek Hydroelectric System ALP, Southern California Edison (SCE) has agreed to undertake instream flow studies in various project reaches. The instream flow studies include wetted perimeter studies in applicable smaller streams that are seasonally diverted and PHABSIM studies in larger streams that are diverted throughout the year (SCE 2001). Also undertaken were analyses of passage flows, potential stranding issues, and depth suitability analyses for Rock and Bolsillo creeks (seasonally diverted streams where the wetted perimeter approach could not be applied). The results of the wetted perimeter and passage flow studies conducted in small streams are reported for the upper basin (tributaries of the South Fork San Joaquin River [SFSJR]) in SCE 2003a and for the lower basin (below Mammoth Pool) in SCE 2004a. The results of the PHABSIM and passage studies on larger streams are provided in this report. The results of the stranding analysis and depth suitability studies will be provided in a supplemental report. These studies were developed through extensive consultation with the CAWG, a group that includes the principal stakeholders interested in aquatic issues relating to the Big Creek relicensing process.

This report covers the larger streams that are diverted throughout the year. It provides a description of the study objectives and general approach (Section 2), the methods used in conducting these studies and the discussions and decision points that led to these methods (Section 3), and the results of the analysis (Section 4). The first two sections are important in understanding the scope, nature, and results of the work presented in Section 4, and in identifying their limitations.

The results provided in Section 4 include the basic habitat index (weighted usable area or WUA) vs. flow relationships from the PHABSIM analysis (WUA functions) for each reach. Also included are the flows meeting adult trout passage criteria through typical riffles in each reach. Per the request of the CAWG, we provide some basic descriptions of these curves and note any issues related to the use of the results, but have not provided any conclusions or other interpretation of these results. No assessment of project effects is included in this phase of the study, but will be assessed in consultation with CAWG at a later time.

2.0 STUDY OBJECTIVES AND GENERAL APPROACH

The instream flow study objectives and methods are described in *CAWG 3 Determine Flow-Related Physical Habitat in Bypass Reaches.* This is referred to as the CAWG 3 Study Plan in the remainder of this document.

The CAWG 3 Study Plan identifies the following objectives for these studies:

> *An instream flow study is proposed to evaluate how flow changes resulting from Project operations may affect native fish and aquatic species in the Big Creek system. This study will help address the management goals and objectives outlined by the CAWG. Microhabitat variables, such as velocities and depths, may be altered by changes in flows in the bypass reaches. This may result in alterations in flow-related habitat, which may affect aquatic populations and/or communities. Rapid changes in flow levels may also result in margin areas of the bypass reaches becoming dewatered, without providing sufficient opportunity for fish to move to secure locations, thereby resulting in stranding. To evaluate these potential effects, the following objectives need be addressed:*
>
> 1. *To determine flow-related physical habitat in bypass reaches using:*
>   - *PHABSIM studies for bypass reaches of diversions that operate year-round or*
>   - *Wetted Perimeter studies for diversions that operate primarily during the high flow season.*
> 2. *Determine the potential for stranding for aquatic organisms based on Project operations.*

The reaches and type of study to be performed in each stream reach are identified in Table CAWG 3-1.

This report focuses on the PHABSIM studies conducted on mid-sized to large study streams. These streams include various reaches of the South Fork San Joaquin and San Joaquin rivers, and Bear, Mono, Big, North Fork Stevenson, and Stevenson creeks, as identified in Table CAWG 3-1.

2.1 GENERAL APPROACH

The general approach provided in the CAWG 3 Study Plan included:

- dividing the stream reaches into study segments based on Rosgen channel types and major mesohabitat types
- selecting transects to represent the mesohabitat types in each study segment

- using the PHABSIM models, specifically the IFG4-a hydraulic model, to simulate stream hydraulics and flow related habitat

- reviewing and potentially using PHABSIM models developed as part the BiCEP project

- testing existing habitat suitability criteria for transferability to the Big Creek system and recommending the HSC to be used in the PHABSIM studies.

The objectives of the study and the general approach served as guiding principles throughout the implementation of the studies, both in developing sampling and analytical plans and while conducting the fieldwork and analyses. A more detailed description of the methods employed is provided in Section 3.

2.2 STUDY ELEMENT STATUS

Study elements and their status are identified below.

Study Element	Status	Location of Results
Wetted perimeter studies	Complete	SCE 2003a SCE 2004a
PHABSIM studies	Complete	This report
Passage studies	Complete	SCE 2003a SCE 2004a This report
HSC verification and development studies	Complete	This report
Depth suitability studies for Rock and Bolsillo creeks	In progress	To be presented in a separate report
Stranding studies	In progress	To be presented in a separate report
Limiting factors analysis and impact evaluation (including time series analysis)	To be completed. Need for time series analysis to be determined in consultation with the CAWG	To be completed in coordination with CAWG after approval of relevant CAWG studies

3.0 METHODS

The IFIM was developed by the USFWS's (now part of the U.S. Geological Survey (USGS)) Instream Flow Group (IFG) as a tool to facilitate communication and negotiation between fisheries biologists and water managers. It is used to predict the effects of altered flow regimes on an index of instream habitat (WUA) for fish and other aquatic organisms. As indicated by the name, the IFIM is a complete methodology which contains various sub-models and components. One of the primary components of the IFIM are the PHABSIM models. PHABSIM was selected by the CAWG as the appropriate analytical tool for the large and medium sized streams in the Project area. PHABSIM uses site-specific hydraulic models to simulate microhabitat values (velocity and depth) of a stream over a range of flows. The simulated depths and velocities, as well as static measurements of substrate and sometimes cover, are used with HSC (discussed in Section 3.3) to calculate a WUA value for each simulated flow. The WUA vs. flow relationship is then used to assess the effects of different water management practices on aquatic resources, and to balance or negotiate competing uses for water within a system, such as protection of aquatic resources and out-of-stream uses.

WUA is an index of fish habitat; it does not totally describe the quantity or quality of the habitat. For example, WUA does not consider the proximity of a given area of usable habitat to other areas important to fish (e.g., refuge habitat). When habitat limits fish populations, the WUA may provide an indication of the effect that a given change in streamflow can have on fish habitat and therefore fish populations (Bovee 1982). However, when other limiting factors are in effect, there may be little or no relationship between WUA and fish population size. In these cases, changing the amount of physical habitat may not result in a change in fish population size. It should also be noted that limiting factors are not constant and can change between seasons and years.

Deriving the WUA functions that are the basic output of a PHABSIM analysis requires the collection of field data at transects. These data are used to calibrate a model to represent the hydraulics of the stream over a range of flows. The process is divided into hydraulic modeling and habitat simulation phases. In the discussion that follows, we discuss these two stages in order. The process of selecting appropriate HSC for use in the study is described in Section 3.3. These HSC are used in the habitat simulation phase described in Section 3.2.2.3.

3.1 CONSULTATION

Consultation for CAWG 3 studies has mainly occurred during CAWG meetings, which are held approximately monthly as part of the ALP, and teleconferences, which have been scheduled as needed. Consultation regarding the instream flow studies was initiated in May 2000 when the process of developing specific study plans began and continues through the present. The CAWG and its subgroups were the primary developers of the study plans. Discussions regarding the specific details of the PHABSIM studies commenced in fall 2001. A brief overview of meeting topics is provided in Table CAWG 3-2. Copies of the approved meeting minutes are provided in

Appendix A. All major decisions were made after discussion and approval by the CAWG[2].

3.1.1 BiCEP Model Review and Re-Calibration

A major topic of discussion by the CAWG was the use of PHABSIM models previously developed in the 1980s for the Big Creek Expansion Project (BiCEP) (BioSystems, Inc. 1987). The ALP reaches for which BiCEP PHABSIM models were available were the Mammoth Pool and Stevenson reaches of the San Joaquin River, and upper (Dam 4 to Powerhouse 2) and lower (Dam 5 to Powerhouse 8) Big Creek. The BiCEP study did not place any PHABSIM transects in the Stevenson Reach. The study instead used BiCEP transects from the Mammoth Pool Reach to represent the Stevenson Reach.

The Study Plan called for these models to be reviewed and used in the ALP if they would meet the information needs of the CAWG. A review of these models was conducted and presented to the CAWG in July 2002 and a report was issued (ENTRIX 2002, Appendix B). This review was considered by the CAWG and approved in October 2002. (Please see below for CAWG approach to Stevenson Reach.) In the Mammoth Pool reach, the habitat units in which the transects were placed were relocated using maps and aerial photography. These habitat units were reviewed in the field by the CAWG Transect Selection Team (CTST) for potential utilization within the current Big Creek PHABSIM study. The CTST agreed that the BiCEP transects were representative of the habitat in this reach in general, although the habitat type at BiCEP Transect 16 had changed since the BiCEP study. This transect was dropped from consideration and replaced with a new transect. The CTST selected several additional transects to supplement the BiCEP models. With these additions, the CTST agreed that the combined transects (BiCEP and new) were sufficient for modeling this reach (October 2002).

In the Stevenson Reach of the San Joaquin River, the CTST found highly complex habitat that was generally unsuitable for modeling. Water flowed under and around large boulders, so that the hydraulic regime theory, the underpinning basis for all open-channel hydraulic models, did not apply. The CTST found this reach to be substantially different from the Mammoth Reach, and could not be represented by the transects placed in that reach. An exception to this was for confined deep pool transects in the Mammoth Reach, which the CTST agreed could be used to represent deep pool habitat in the Stevenson Reach. The CTST placed six new transects in this reach to represent habitat, although it was acknowledged that the units where the transects were placed were not typical of the overall stream reach, but were the best available in that reach that could be modeled using PHABSIM.

The BiCEP transects in Big Creek below Dam 4 and Big Creek below Dam 5 could not be relocated from the information available in the BiCEP reports. Consequently, the CTST placed new transects to represent all habitat types in these reaches.

[2] In the rare case where full agreement between CAWG participants was not obtained, the dissenting party is identified in the meeting notes for the meeting in which the decision was reached.

Based on the recommendations in the BiCEP model review (Appendix B) and with the agreement of the CAWG, the BiCEP models for the Mammoth Reach were reconfigured from three-flow models to single-flow models. In reconfiguring these models, the stage-discharge relationship from the original model was retained, but the velocity simulation portion of the model was re-calibrated based on the high-flow velocity set collected at flows of 173 and 178 cfs. This followed the same velocity calibration approach described below for new transects, but was based entirely on the values entered in the BiCEP models and professional judgement, as field data sheets and transect photos were not available.

3.2 PHABSIM METHODS

The following sections provide an overview of the field, model calibration and habitat simulation methods used in the PHABSIM studies. This overview is summarized from the more detailed discussion provided in Appendix C.

3.2.1 TRANSECT PLACEMENT

During consultation, substantial discussion occurred regarding the number of transects required and their placement within the study reaches. These discussions took place between September 2001 and October 2002. The CAWG found the initial approach proposed by ENTRIX, for upper basin streams, to be acceptable in late 2001. In this approach, the study streams were stratified by Project feature or major tributaries and by Rosgen channel type[3]. Rosgen channel types representing less than five percent of the study segment were not sampled. Within each of these strata, transects were placed in each mesohabitat type[4] (riffle, pool, run) that represented more than five percent of the total length of that strata. Two transects were placed in riffles and runs and three transects were placed in deep and shallow pools. This approach was used for transects placed in Bear Creek in fall 2001.

In September 2002, the subject of transect selection was revisited by the CAWG. After extensive discussion a memo with a finalized transect selection protocol was drafted and approved by the CAWG. A copy of this memo is included in Appendix A. Transects were selected in the field by representatives from the CAWG CTST (Table CAWG 3-3) using this revised protocol. The field transect selection was summarized for the CAWG during the January 8, 2003 meeting. At this time, the members of the CTST felt that the transects selected in all reaches were representative of the habitat types

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[3] Rosgen (1996) defined channel types to describe the morphology and likely response pattern of a stream section based on channel shape, level of entrenchment, sinuosity and other factors.

[4] A mesohabitat unit is a hydraulically similar section of stream differentiated from adjoining units by features such as hydraulic controls, gradient, and turbulence. These mesohabitat units are used by aquatic organisms for shelter, feeding, spawning, and rearing. Mesohabitats were identified using methods described by USFS R-5's Fish Habitat Relationships Technical Bulletin (McCain et al. 1990) and Hawkins et al. (1993) as part of CAWG 1 (SCE 2003b). Full descriptions of the mesohabitat types found in each reach can be found in the CAWG 1 report.

present and adequate to meet the needs of the study. The CAWG approved the transects for data collection at this meeting.

PHABSIM transects were placed in each stream reach (Map CAWG 3-1) identified in the CAWG 3 Study Plan, with the exceptions noted below. The number of transects selected for each mesohabitat type is provided, by reach, in Table CAWG 3-4. This table also shows the proportion of the Rosgen channel types in each reach, and the proportion of each mesohabitat type in each Rosgen channel type. This information was used in weighting the transects during habitat simulations as described in Section 3.2.5.

3.2.2 Calibration Flows

The calibration flows at which measurements would be made in each reach were selected with the approval of the CAWG. This topic was initially addressed at the April 17, 2003 CAWG meeting. Calibration flows were selected that would enable the PHABSIM models to span the range between the current minimum flow and the median unimpaired summer flow (as estimated at that time[5]). It was expected that flow negotiations to set minimum flows for the new license would likely fall within this range. The calibration flows agreed upon are presented in Table CAWG 3-5.

3.2.2.1 Collection of Hydraulic Data

Basic input data for the PHABSIM hydraulic models include depth, mean-column velocity, substrate composition, and cover at numerous verticals (measurement points) across each transect. The field data collection procedures and data reduction techniques used in this study followed those described by Trihey and Wegner (1981) and Trihey (1980). For deeper transects in the mainstem rivers, water velocity and depth profile data were collected with an Acoustic Doppler Current Profiler (ADCP).

As agreed to by the CAWG, depth and mean column velocity measurements were collected at each transect at the low and high calibration flows (see Table CAWG 3-5). These measurements were collected at a minimum of 15 to 20 verticals within the low flow portion of the channel at each transect, with additional verticals added at higher flows, as needed. In accordance with the CAWG 3 Study Plan (SCE 2001), velocities were not collected in pools in mid-sized streams that were more than six ft deep.

Substrate and cover conditions were visually assessed for each vertical during low flow, when these elements were most visible. Substrate was coded as dominant particle size, subdominant particle size, and percent of cell with spawnable gravel for trout. Cover was coded as the dominant cover type and the percentage of the cell with cover (Table CAWG 3-6).

[5] At the time the calibration flows were being determined, the hydrology of the project streams had not been fully analyzed. The unimpaired flow values reported at that time may differ somewhat from those presented in CAWG 6 (SCE 2004b).

3.2.2.2 Quality Control/Quality Assurance

Review of field data collected for the Big Creek Instream Flow Study occurred both in the field and office, and was consistent with procedures outlined by Trihey (1980). During field surveys, several conventions were adopted to facilitate the collection of quality data and timely reduction of those data. These include:

- All headpins and water surface elevations (WSLs) were referenced to benchmarks allowing relocation of headpins, staff gages, etc.
- More than two WSLs were surveyed for transects with rapidly varying flow conditions.
- WSLs were checked before and after transect measurements to identify any changes in discharge during the data collection.
- Distance of right headpin was established for each transect and matched in subsequent tape placements to facilitate the collection of point velocity measurements at different calibration flows.

3.2.3 Model Calibration and Development

3.2.3.1 Hydraulic Model Calibration

In the Big Creek ALP, the Riverine Habitat Simulation Model (RHABSIM©) ver. 2.1 programs were used in developing the models (TRPA 1995). This product is an independently developed software package that replicates the algorithms of the original PHABSIM programs (Milhous et al. 1989). While it produces the same results as PHABSIM, RHABSIM substantially adds to the utility of these programs by providing a much improved user interface, facilitating data entry and error checking. The program's enhanced graphical displays also facilitates model calibration and interpretation. In the remainder of this document, we use PHABSIM when referring to a procedural issues or considerations common to all PHABSIM models (PHABSIM, RHABSIM and others) and RHABSIM when referring to some specific element of this particular software.

The goal of using the PHABSIM hydraulic simulation programs was to simulate hydraulic conditions in a stream as a function of stream flow. This was conducted in a two-stage process of calibrating a stage-discharge model and then calibrating a velocity simulation model. The stage-discharge relationship was developed using the IFG-4a method. Data was collected to allow other approaches based on hydraulic theory (ManSQ and WSP) to be used, however the IFG-4a model provided satisfactory results at all transects. After an acceptable stage-discharge relationship had been developed, this relationship was used in conjunction with the bed profile to determine the depth at each vertical across a transect. Velocities were then simulated in the IFG-4a module, based on the estimated discharge and the measured distribution of velocities across the transect at the high calibration flow. During the calibration of the velocity model, the velocity distribution was adjusted to reduce modeling artifacts, and provide a more realistic simulation of velocities across the range of flows to be simulated. This allowed velocity distributions to be developed at each transect for a series of simulated flows.

3.2.4 MODEL CALIBRATION STANDARDS

Several standards were used to evaluate the utility of the models developed during the Big Creek PHABSIM studies. These standards have been developed based on review of the pertinent literature, discussions with experts in hydraulic modeling, and practices developed through many years of experience. Because of the variability of stream conditions to which the PHABSIM models are applied, the IFG no longer recommends specific standards to which models must be calibrated (T. Waddle, USGS May 2004). Historically, however, this group has provided some standards and “rules of thumb” that continue to be applicable. Among the factors considered in evaluating the utility of a model are:

- hydraulic conditions at the specific location of the transect and its immediate vicinity;
- concurrence between the flow at a specific transect and the best estimate of flow for a site;
- ability of the stage-discharge relationship to accurately predict the measured stage at the calibration flows;
- reasonableness of the velocity distribution over the range of flows simulated; and
- range and shape of the Velocity Adjustment Factor (VAF) vs. flow relationship.

The hydraulic conditions at the specific transect location include considerations such as the shape of the bed profile, the complexity of the area, shifting of velocities between one area and another as flow changes, etc. Where there are substantial changes in the bed profile over the range of flows simulated, the stage-discharge relationship may change, which may affect the reliability of this relationship at different flow levels. Channel complexity includes both the shape of the profile and the conditions upstream and downstream of a transect that may cause flow to shift from one area to another.

The concurrence between the measured flow at a transect and the given flow can also affect the reliability of model simulations. Different habitat types have different characteristics, and flows measured at different transects within a site may vary substantially from one transect to the next. If the measured flow at a transect varies from the given flow, the model adjusts for this using a VAF to increase or decrease velocities across the transect so that the simulated flow equals the calibration flow. This results in the simulated velocities differing somewhat from those measured. Trihey (1980) states that transects with a flow measurement error of less than 30 percent are suitable for routine applications of PHABSIM, while errors greater than this will dilute the quality of the analysis (Table CAWG 3-7).

The ability of the stage-discharge relationship to accurately predict WSLs affects the determination of depth at each cell (as this is calculated by subtracting the bed elevation from the simulated WSL) and the flow calculation (as flow is the product of depth, width and velocity). Even small changes in WSL can have a large effect on the calculated flow for some transects, which in turn affects the velocity simulation (see discussion of VAFs above). The strength of the stage-discharge relationship is evaluated both by the absolute difference in the simulated vs. the measured WSLs and by the mean error of the stage-discharge relationship. Ideally, the simulated stage should match the measured stage at the calibration flows as closely as possible (Hardy 2000). Milhous et al. (1989) indicates that a mean error of less than five percent is considered excellent and a mean error of five to 10 percent is considered good.

The shape of the VAF vs. flow relationship should generally increase with flow in a log-linear pattern (Milhous et al. 1989). This is because PHABSIM treats "*n*," the channel roughness coefficient, as a constant, when in fact it generally decreases with increasing depth. Thus when the model predicts velocities for simulation flows less than calibration flow, the roughness will be too low, resulting in velocities that are too high. The model corrects this by reducing the velocities using a VAF that is less than one. Conversely, when the model is predicting velocities for simulation flows higher than the calibration flow, the *n* value is too high, resulting in velocities that are too low, which the model increases with the VAF. Channel roughness can increase with flow for several reasons. These include areas where:

1) channel roughness increases with increasing flow because the channel margins are substantially rougher than the low flow channel, thus reducing conveyance;
2) vegetation becomes inundated at higher flows, increasing roughness and reducing conveyance, or
3) downstream constrictions (narrower channel or flow being squeezed through slots in boulder controls) increase roughness.

Non-ascending VAF patterns were observed at several transects. We investigated each of these instances. In all but one transect, the descending VAF pattern is consistent with physical conditions at the transect location. Attempts were made to eliminate this issue by using MANSQ or WSP to simulate the water surface elevations. In most cases, this did not correct the problem. In the few that it did, it resulted in unacceptable errors in predicted stage. Only one transect was successfully corrected using MANSQ. This was NFS 29-1.

The magnitude of the VAFs is one of the factors that has been used to set boundaries to the range of flows over which the model can be extrapolated (Hardy 2000). There are different opinions about the utility of VAF values for single-flow models. Various practitioners have suggested different standards. Bovee (pers. comm.) has indicated that VAFs between 0.2 and 5 provide good reliability, Milhous (pers. comm.) has suggested that values between 0.1 and 10 are acceptable, and Hardy (2000) states that "there is no rational basis for judging the validity of or efficacy of hydraulic simulations based on some perception of the magnitude of the range in computed VAF values."

Based on this diversity of opinion, we have elected to use Milhous' criteria as the most central of these opinions.

During the velocity calibration process, the magnitude of the predicted velocities are evaluated to determine if they appear to be reasonable. The "reasonableness" of the velocity in a particular cell is specific to the transect and is judged based on the habitat type, velocities in surrounding cells, review of field notes and transect photos, experience, and professional opinion.

These calibration standards were used to evaluate the reliability of model simulations. The model limitations noted in the results section are based on consideration of these standards. Models that meet the calibration standards provide accurate estimates of the habitat variables being modeled and provide for reliable simulation of habitat quantity and quality.

3.2.5 Habitat Modeling

Habitat modeling was conducted using the Habitat Simulation Model (HABSIM) module of the RHABSIM program. In the habitat modeling phase, the simulated depths and velocities from the hydraulic modeling phase were evaluated for their suitability to target species and lifestage using the Big Creek ALP HSC (Section 3.3).

The following options were used when running the habitat simulations. Velocity and depth were used for all species and lifestages. Substrate was used only for spawning rainbow and brown trout where all gravels 0.1 to 3.0 inches in diameter were considered suitable (see Section 3.3). Cover was not used as it was ubiquitous in the Study streams and would not affect WUA. Cells were centered around the measurement verticals to preserve the integrity of the field measurements and decisions made during model calibration.

The transects were weighted based upon the proportional representation of the mesohabitat type and channel type within the stream reach, and the number of transects that were being used to represent that mesohabitat and channel type. These transect weightings are provided in Table CAWG 3-4. These weights were normalized to 100 percent, excluding: 1) channel types that were not modeled because: they represented less than five percent of the total reach length; 2) mesohabitat types representing less than five percent of the habitat in that channel type; and 3) mesohabitat types that do not provide habitat for fish (cascades, bedrock sheet, etc.). For all reaches, but the SJR Mammoth Reach, the transects were weighted within RHABSIM. In the Mammoth Reach, the transects were weighted equally in the RHABSIM model because of the presence of one split channel transect (143-1) in this reach. This transect made it impossible to assign appropriate weights to all transects in the RHABSIM program. WUA was run for each transect individually, including the two channels of transect 143-1. The WUA the two channels of 143-1 were summed at each flow level. WUA values for all transects were then reweighted appropriately to calculate the reach WUA.

For spawning, only transects in habitat types that could potentially be used for spawning were included in the model. Thus transects placed through the center and top of pools were excluded from the spawning models, while pool tailouts were included. All included transects within a reach were weighted equally, to generate the spawning WUA function.

Spawning WUA was calculated using both the actual substrate (those observed in the field) and ideal substrate (all cells considered to have suitable substrate for spawning). The second approach considers only the effects of velocity and depth on spawning habitat. This approach was undertaken at the suggestion of Mike Henry of Federal Energy Regulatory Commission (FERC) as one approach to deal with the patchy nature of suitable spawning gravels in the study streams (M. Henry pers. comm.). The patchy nature of gravels makes it difficult to design a sampling strategy that reflects the true availability of spawning gravel in the study streams or the potential for enhancement given substrate improvement.

3.2.5.1 Habitat Modeling in the SJR - Mammoth Pool Reach

The Mammoth Pool reach was modeled using the BiCEP transects, in combination with new transects placed to supplement those models. Many of the BiCEP transects did not extend far enough up the bank to allow simulation to 500 cfs, as requested by the CAWG, without overtopping the headpins. When the headpins are overtopped, the model creates a vertical wall at the location of the headpin. This allows the WSLs to increase, but the stream cannot spread beyond the headpin. To evaluate the sensitivity of the model to this, the models were run following three different approaches. The first was to let the model run as it normally does, the second was to eliminate individual transects from the WUA analysis as their headpins became overtopped, and the third was to extrapolate the bed upward, using the last two points at the end of the transect. This analysis was performed for adult rainbow trout and Sacramento sucker.

This sensitivity analysis indicated that the first and third methods result in nearly identical results (Figures CAWG 3-1 and 3-2). This occurs because the banks are nearly vertical at ends of most of the transects where the headpins were overtopped. The upward extrapolation of the last two points results in a very similar effect to what the model does with the unaltered bed profile, in that the stream does not spread outward. The approach of eliminating transects from the WUA analysis as the headpins were overtopped resulted less than a 10 percent difference in the WUA values at flows of 300 cfs or more. This difference is insignificant and would not likely affect the selection of appropriate minimum flow levels.

3.2.5.2 Habitat Modeling in the SFSJR downstream of Mono Crossing

Collection of PHABSIM data downstream of Mono Crossing was infeasible because of safety concerns and inability to access these areas at higher flow levels. With CAWG agreement, these areas were modeled based on the transects placed in the SFSJR Mono Creek to Bear Creek Reach. The SFSJR below Mono Creek was divided into two segments at Rattlesnake Crossing. The reach above Rattlesnake Crossing had both B and G channel types, while that below Rattlesnake Crossing was entirely G channel type. SCE does not have any operations that could influence these two reaches differently downstream of Mono Creek, but there is some tributary inflow that may result in different flow levels (SCE 2004b).

3.3 HABITAT SUITABILITY CRITERIA

3.3.1 INTRODUCTION

HSC represent the microhabitat (velocity, depth, substrate, cover) preferences of the target species and lifestages in the PHABSIM model. HSC are mathematical or graphical descriptions of how suitable a particular value of a microhabitat is for a particular organism. Suitability is set to range from zero for microhabitat that is completely unsuitable (e.g., cells that are out of water) to 1.0 for microhabitat values that are optimal (or at least used most frequently when there is a choice) for that organism. These criteria are used within PHABSIM to interpret the values of the hydraulic parameters predicted by the hydraulic simulation programs for the simulated flows. The result of this process is the WUA index of habitat.

The species of interest in the streams where PHABSIM studies were conducted were rainbow and brown trout, hardhead, Sacramento pikeminnow, and Sacramento sucker. The lifestages of interest were adult, juvenile and fry rearing for all species and spawning for the two species of trout.

3.3.2 APPROACH

The CAWG 3 Study Plan (SCE 2001) identified the need to determine which existing HSC were appropriate for use on the Big Creek ALP project steams.

> *Appropriate existing suitability criteria will be tested for transferability within the basin. Potential suitability criteria will be reviewed with the CAWG prior to use. Verified criteria will be used to represent target species and lifestages.*

The general approach for selecting appropriate HSC was described as follows:

> *Habitat criteria suitability testing will include the following steps:*
>
> - *Appropriate habitat suitability criteria for testing will be selected in conjunction with the CAWG.*
> - *Existing criteria will be verified through evaluation of habitat utilization in streams within the Project boundaries.*
> - *Evaluation will be conducted using the Groshens and Orth (1994) testing approach.*

- *Testing will require approximately 50-60 observations of fish habitat use for each species and life stage, and about 200 observations of habitat availability.*

- *Observations of fish habitat utilization will follow standard snorkeling techniques.*

- *Habitat availability will be determined from 10 equally spaced verticals along two transects placed randomly within each habitat unit sampled.*

- *Upon the completion of testing, the results will be presented to the CAWG, along with recommendations for use of criteria or development of site-specific criteria. The decision as to which criteria will be used will be made in concurrence with the CAWG.*

A detailed description of the HSC development process is provided in Appendix D.

3.3.3 SELECTION OF FINAL CRITERIA SETS FOR USE ON THE BIG CREEK ALP

Overlays of the various criteria sets on frequency histograms of habitat use and availability, and the results of transferability testing were presented to the CAWG beginning in October 2003 (Appendix A). Extensive discussions of the merits of the transferability testing and of the various criteria sets considered were conducted over the next several months. These discussions culminated in the development of the Big Creek ALP criteria.

The Big Creek ALP criteria were developed through a consensus of the CAWG, based on their review of the criteria sets reviewed for each species, site-specific use and availability observations, and the combined professional judgement of the CAWG representatives. These criteria were approved for use in the Big Creek ALP PHABSIM studies in April 2004. The USFWS did not agree with the use of the Big Creek ALP criteria for adult rainbow and brown trout, but did express concurrence with the remaining criteria. For these lifestages, the USFWS has developed its own HSC, based on data from the Upper American River Project, that it plans to apply to the Big Creek system. The Big Creek ALP criteria are presented in Figures CAWG 3-3 through 3-7 and Tables CAWG 3-8 through 3-12. These criteria are used to interpret the results of hydraulic modeling as described in Section 3.2.4.

The CAWG reviewed and discussed criteria for macroinvertebrates during the February 2004 CAWG meeting. At that time, the CAWG elected not to model macroinvertebrate habitat, as they did not feel it would add to the analysis of project effects or be used in the flow negotiation process.

The use of winter rearing criteria was also considered and discarded after discussion in February and April 2004. The CAWG felt that winter rearing criteria were unnecessary as flow considerations during the winter would likely be governed by flow needs for spawning and incubation of fish. Meeting the needs of other processes, such as geomorphology and riparian recruitment, would also likely affect selection of winter flows.

3.4 PASSAGE ANALYSIS

One of the study elements identified in the CAWG 3 Study Plan was an evaluation of general passage flows for adult trout through typical riffles in each reach. This analysis was intended to supplement information regarding structural passage barriers identified in CAWG 1 and to be incorporated in an overall analysis of passage issues in CAWG 14. The analysis conducted as part of this study evaluates passage through typical riffles identified in the PHABSIM analysis. This differs from a critical riffle analysis where transects are placed specifically to evaluate passage at the locations most limiting to fish passage because of their shallow depths.

Each riffle was evaluated based on passage criteria for depth and velocity for adult trout from Thompson (1972). These criteria call for a minimum depth of 0.4 ft and a maximum velocity of less than 4 ft/s for a cell to be considered passable. In this analysis, the width of the transect that met these criteria was determined from the PHABSIM output, and the flow that provided at least 25 percent of the wetted width of stream meeting the criteria above was designated as the passage flow. Where the wetted width was less than 10 ft, an additional criterion was added: that the contiguous width meeting the depth and velocity criteria must be at least 10 percent of the total wetted width. The passage flow for each transect was identified in this manner, and the average of these flows for all riffle transects in a reach was selected as the passage flow for the reach. This approach was approved by the CAWG in March 2004.

4.0 RESULTS

4.1 FIELD DATA COLLECTION

PHABSIM data were collected as described in Section 3 at flow levels that closely approximated those proposed and agreed to by the CAWG (Table CAWG 3-13). Depth and velocity measurements were collected at each transect at the high and low calibration flows.

One exception to this occurred in the Stevenson Reach of the San Joaquin River. The narrow channel at this site made it impossible to collect velocity measurements at the high calibration flow due to safety concerns. Velocities were collected at the middle calibration flow instead. In this location, there were difficulties in obtaining a stable flow release from Dam 6. As a result, flows were measured frequently (several times in a day) in the gaging pool just downstream of the study site (the gaging station is no longer operational). The different transects were calibrated based on the flow measurement taken at a time that corresponded best with the time the transect information was collected. Additionally, WSLs were collected at more than three discharge levels for these transects.

4.2 MODEL CALIBRATION

The PHABSIM hydraulic models were successfully calibrated for all transects in all study reaches based on the criteria presented in Section 3.2.4. The PHABSIM models will provide accurate simulations of depths and velocities for all transects, and thus will provide good simulations of habitat. With the exception of the Stevenson Reach of the San Joaquin River, the models provide reliable results over the full range of simulation flows discussed by the CAWG.

All transects, except NFS 29-1,were calibrated using the IFG4-a approach using the stage-discharge regression method. At NFS 29-1, MANSQ was used to correct an anomalous VAF pattern. The measured flows at the transects were generally very similar to the calibration flows at each site. At over 90 percent of the transects, the measured flows at the high calibration flow matched the given flow to within 15 percent, and at only one transect was the measured flow greater than 30 percent from the given flow level (34 percent at one of the BiCEP transects in the SJR Mammoth Reach). At the low calibration flow, 80 percent of the transects had measured flows within 30 percent of the given flow, and only three differed by more than 50 percent. These three transects were each in different stream reaches (Mammoth Reach, Stevenson Creek, and Mono Creek), so the effect of these discrepancies on overall model performance would be small. The difference between the measured flow at the low calibration flow was greater than that at the high calibration flow because of the difficulty of getting a good flow measurement at low flows in complex channels[6]. The difference in the

[6] The difficulty in obtaining an accurate flow measurement under these conditions stems from several factors including the accuracy of the velocity meter, the increased importance of the bed substrate on

proportional error of a discrepancy at low flows vs. high flows, tends to be much greater since the same numerical error is proportionately larger at low calibration flows. Generally, the models had excellent stage-discharge relationships, with mean errors less than five percent. This was exceeded at only five transects, which had mean errors ranging up to 7.4 percent. Mean errors in this range are still considered "good" by the IFG (Milhous et al. 1989). Predicted and measured WSLs generally agreed within +/- 0.04 ft. Differences in predicted and measured WSLs greater than this occurred at six transects, three of which were in the San Joaquin Stevenson Reach transects. Even here, the maximum differential between the observed and simulated WSL was only 0.11 ft. Velocity was successfully calibrated so that the distribution of velocities matched features observed in the field. Excessive velocity spikes (velocities higher than would reasonably be expected in a given location) were reduced, and roughness in edge cells was adjusted to provide reasonable velocities at extrapolated flows (velocities were controlled at the edges to reduce velocity spikes, yet allow water to flow onto the banks at higher simulation flows). VAFs generally ascend with flow, as expected, although some exceptions occur. These were always the result of physical conditions at the transect, where roughness increased with flow due to overhanging vegetation or downstream channel constrictions. The VAF values rarely exceeded the accepted range, and when they did, it was at the lowest flows simulated. The calibration statistics for each model are provided in Appendix E. To further facilitate a review of the models, cross-section plots are provided in Appendix F.

Based on the observed hydraulic conditions at the site, extrapolation of the models for the Stevenson Reach of the San Joaquin River beyond about 350-400 cfs is not recommended. It is likely that conditions at this site may change dramatically as flows begin to substantially exceed the high calibration flow. Additionally, the non-pool transects in this area were calibrated using measurements collected at the middle velocity set, rather than the high velocity set. At a simulation flows of 3 to 350 cfs the models for this reach perform well and are considered reliable for habitat simulation.

4.3 WEIGHTED USABLE AREA VS. FLOW

The different stream reaches identified in the CAWG 3 Study Plan are based on SCE's ability to modify flows from different dams. WUA functions for each of these reaches are described below for each target species and lifestage present in that reach. These functions are presented in tabular form in Appendix G.

4.3.1 SOUTH FORK SAN JOAQUIN RIVER

The SFSJR supports populations of rainbow and brown trout. Brown trout are dominant in the upstream portion of the river, near Florence Lake, while rainbow trout become increasingly dominant with distance downstream from Florence Lake. Rearing and spawning habitat was modeled for both species.

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velocity patterns, the greater proportion of the flow that may travel under substrate (either under a specific particle or in the subsurface of the streambed) where it cannot be measured, etc.

Because the effect of various diversions (Florence, Bear, Mono) influence flow, and thus WUA, in each reach separately, WUA functions are presented for each reach individually. During the impact analysis (to be performed later in cooperation with the CAWG), the effects of flow releases from the various diversions will be assessed for the entire SFSJR.

4.3.1.1 SFSJR - Bear Creek to Florence Lake

4.3.1.1.1 Rainbow Trout

Adult: WUA for adult rainbow trout increases with flow from 10 to 90 cfs, with the most rapid rate of increase occurring between 10 and 25 cfs (Figure CAWG 3-8; CAWG 3 Appendix G Table G-1). The maximum WUA value (21,669 ft^2/1000 ft) occurs at 90 cfs. Twenty five cfs provides about 80 percent of the maximum WUA. WUA declines gradually to approximately 92 percent of the maximum WUA as flow increases between 95 and 175 cfs and remains relatively constant as flow increases further.

Juvenile: Juvenile rainbow trout WUA slightly increases with flow from 10 to 20 cfs. The maximum WUA value of 19,884 ft^2/1000 ft is obtained at 20 cfs. WUA declines with increasing flow between 25 and 175 cfs, providing about 65 percent of maximum WUA at the latter flow. WUA increases slowly with flow again above 175 cfs (Figure CAWG 3-8; CAWG 3 Appendix G Table G-1).

Fry: WUA for rainbow trout fry is at its maximum value (25,747 ft^2/1000 ft) at 10 cfs and decreases with flow to 100 cfs (Figure CAWG 3-8; CAWG 3 Appendix G Table G-1). About 78 percent of maximum WUA is provided at 40 cfs and 60 percent of maximum WUA is available at 100 cfs. WUA then increases slightly as flows increase further.

Spawning: Trout spawning WUA was assessed using actual and ideal (all cells treated as having 100 percent suitable substrate) substrate. The difference in WUA illustrates the extent to which spawning habitat is affected by the availability of suitable substrate as opposed to depth and velocity. The rainbow trout spawning WUA based on the actual substrate was generally very low, with a maximum value of 3,708 ft^2/1000 ft occurring at 35 cfs (Figure CAWG 3-8; CAWG 3 Appendix G Table G-1). WUA increases with flow from 10 to 35 cfs, reaching 80 percent of its maximum value at about 16 cfs. WUA decreases as flow increases above 35 cfs.

The rainbow trout spawning WUA function based on ideal substrate has much higher values, as would be expected given that the entire streambed is assumed to have substrates suitable for spawning. The WUA function increases with flow from 10 to 50 cfs, with the most rapid increase occurring between 10 and 30 cfs (Figure CAWG 3-8; CAWG 3 Appendix G Table G-1). Eighty percent of the maximum WUA value is provided at 25 cfs. WUA decreases by about 15 percent between 50 and 150 cfs and then increases to reach a maximum WUA value (24,668 ft^2/1000 ft) at 300 cfs. This value is about 10 percent higher than that at 50 cfs.

4.3.1.1.2 Brown Trout

Adult: The WUA functions for adult brown trout are quite similar in overall shape to the rainbow trout WUA functions described above (Figure CAWG 3-9; CAWG 3 Appendix G Table G-2). The major differences are that the adult brown trout WUA starts at a higher percentage of its maximum value (74 percent), peaks at a lower flow (40 vs. 90 cfs) and then decreases more rapidly than does the adult rainbow trout WUA function. The maximum WUA value is 20,376 ft^2/1000 ft. Eighty percent of maximum WUA occurs at just over 12 cfs.

Juvenile: For juvenile brown trout, maximum WUA (19,901 ft^2/1000 ft) occurs at 14 cfs, with 10 cfs providing over 98 percent of this value (Figure CAWG 3-9; CAWG 3 Appendix G Table G-2). WUA declines continuously with increasing flows between 14 and 175 cfs, reaching about two thirds of its maximum value at the latter flow. WUA increases by about 5 percent between 200 and 300 cfs.

Fry: The brown trout fry WUA function is quite similar to that for rainbow trout fry WUA (Figure CAWG 3-9; CAWG 3 Appendix G Table G-2). The maximum WUA (25,109 ft^2/1000 ft) occurs at 10 cfs and the function then declines substantially with increasing flows up to 100 cfs. About 58 percent of maximum WUA is provided at this flow. WUA increases again by about 20 percent between 100 and 300 cfs.

Spawning: The values produced by the spawning WUA function based on the actual substrate are quite low, with a maximum value of 3,625 ft^2/1000 ft at 25 cfs. WUA at 10 cfs is about 65 percent of this value, and 80 percent of maximum WUA is obtained at just less than 14 cfs. WUA declines by about 20 percent from its maximum value as flows reach 50 cfs and to about 11 percent of the maximum value at 225 cfs (Figure CAWG 3-9; CAWG 3 Appendix G Table G-2).

The ideal substrate WUA curve for spawning brown trout increases from 64 to 89 percent of its maximum value between 10 and 35 cfs (Figure CAWG 3-9; CAWG 3 Appendix G Table G-2). WUA declines by about 20 percent between 40 and 150 cfs, and then increases to its maximum value at 300 cfs.

4.3.1.2 SFSJR - Mono Creek to Bear Creek

4.3.1.2.1 Rainbow Trout

Adult: Adult rainbow trout WUA increases with flow from 10 to 125 cfs. The rate of increase begins to decline at about 40 to 45 cfs (Figure CAWG 3-10; CAWG 3 Appendix G Table G-3). Maximum WUA is 25,528 ft^2/1000 ft at 125 cfs, with 40 cfs providing about 80 percent of this value. WUA decreases by up to 15 percent with increasing flow above 125 cfs.

Juvenile: Juvenile rainbow trout WUA increases with flow from 84 to 100 percent of its maximum value (21,704 ft^2/1000 ft) from 10 to 30 cfs. It then decreases with increasing flow, reaching 79 percent of its maximum value at 125 cfs, and 52 percent of its maximum value at 300 cfs (Figure CAWG 3-10; CAWG 3 Appendix G Table G-3).

Fry: Fry WUA exceeds 99 percent of its maximum value (28,513 ft^2/1000 ft at 12 cfs) between 10 and 18 cfs and declines rapidly as flows increase above 20 cfs (Figure CAWG 3-10; CAWG 3 Appendix G Table G-3). WUA declines to 80 percent of its maximum value at 60 cfs, and 45 percent of its maximum value at 300 cfs.

Spawning: The amount of spawning gravel available in this reach of the SFSJR is even lower than in the Bear to Florence Reach based on the actual substrate observations. The amount of spawning habitat is at its maximum at 100 cfs (249 ft^2/1000 ft). Spawning WUA based on actual substrate increases most rapidly with flow between 10 and 35 cfs, where it reaches about 71 percent of its maximum value (Figure CAWG 3-10; CAWG 3 Appendix G Table G-3). WUA remains similar between 40 and 55 cfs and then begins to increase again between 60 and 100 cfs. A flow of about 70 cfs provides 81 percent of the maximum WUA value. WUA declines with flow above 100 cfs to about 79 percent of its maximum value.

The ideal substrate WUA function increases rapidly with flow between 10 and 35 cfs. WUA reaches 80 percent of its maximum value at about 22 cfs. Maximum WUA values are obtained at 55 cfs (29,955 ft^2/1000 ft). As flows increase above 60 cfs, WUA declines to about 61 percent of its maximum value at 300 cfs (Figure CAWG 3-10; CAWG 3 Appendix G Table G-3).

4.3.1.2.2 Brown Trout

Brown trout WUA for adults and juveniles shows less response to flow than do the corresponding rainbow trout curves. The shapes of the curves are very similar, but peak WUA values occur at lower flows.

Adult: Adult brown trout WUA increases most rapidly with flow from 10 to 45 cfs and then more gradually from 50 to 75 cfs. WUA reaches 80 percent of its maximum value at 22 cfs, and exceeds 95 percent of its maximum value from 45 to 100 cfs, with a maximum value of 23,730 ft^2/1000 ft at 75 cfs (Figure CAWG 3-11; CAWG 3 Appendix G Table G-4).

Juveniles: Juvenile brown trout WUA increases with flow between 10 and 25 cfs and then decreases with increasing flow, dropping to 48 percent of its maximum value at 300 cfs. The maximum WUA value occurs at 25 cfs (21,946 ft^2/1000 ft). WUA at 10 cfs is 91 percent of the maximum value (Figure CAWG 3-11; CAWG 3 Appendix G Table G-4).

Fry: Maximum brown trout fry WUA (27,865 ft^2/1000 ft) occurs at 12 cfs and exceeds 90 percent of this value at flows up to 30 cfs. WUA declines continuously with flow above 20 cfs, diminishing to 81 percent of its maximum value at about 55 cfs and 44 percent of its maximum value at 300 cfs (Figure CAWG 3-11; CAWG 3 Appendix G Table G-4).

Spawning: Spawning WUA based on actual substrate is very similar in form and magnitude to that of the corresponding rainbow trout curve (Figure CAWG 3-11; CAWG 3 Appendix G Table G-4). The principal differences in the actual substrate WUA function is that it does not decline as much at the lowest flow levels and that the curve peaks at 95 rather than 100 cfs. Eighty percent of the maximum WUA occurs at about 55 cfs.

Spawning WUA based on ideal substrate is also similar to the corresponding rainbow trout curve, but peaks at 40 rather than 55 cfs, with 80 percent of maximum WUA occurring at about 16 cfs. This function declines more rapidly than the corresponding rainbow trout WUA function as flows increase above 40 cfs, creating a narrower peak (Figure CAWG 3-11; CAWG 3 Appendix G Table G-4).

4.3.1.3 SFSJR – Rattlesnake Crossing to Mono Creek

This reach was modeled using the transects from the Rosgen B and G channel types in the SFSJR Mono to Bear reach. These transects were reweighted according to proportion of these channel types and the habitat types within these channel types in the Rattlesnake to Mono reach.

4.3.1.3.1 Rainbow Trout

Adult: The adult rainbow trout WUA function increases most rapidly with flows between 10 and 45 cfs. It continues to increase at a reduced rate as flows continue to increase up to 125 cfs. This flow provides the maximum WUA value of 32,070 ft^2/1000 ft (Figure CAWG 3-12; CAWG 3 Appendix G Table G-5). Eighty percent of the maximum WUA value for adult rainbow trout is provided at about 45 cfs. WUA declines to abut 87 percent of the maximum value at the highest simulation flow.

Juvenile: The lowest simulation flow (10 cfs) provides about 85 percent of the maximum WUA value for juvenile rainbow trout. WUA increases most rapidly from 10 to 20 cfs and is at its maximum value of 26,102 ft^2/1000 ft at 35 cfs (Figure CAWG 3-12; CAWG 3 Appendix G Table G-5). WUA declines with increasing flow above 35 cfs, reaching 77 percent of its maximum value at 125 cfs and 47 percent of the maximum value at 300 cfs.

Fry: Rainbow trout fry WUA is at its maximum at 12 cfs (31,809 ft^2/1000 ft). Flows less than 65 cfs provide more than 80 percent of the maximum WUA for this lifestage (Figure CAWG 3-12; CAWG 3 Appendix G Table G-5). At 300 cfs, the highest flow simulated, WUA is about 42 percent of the maximum value.

Spawning: The amount of spawning habitat available based on the actual substrate values observed in the field was quite low, with a maximum value of 326 ft^2/1000 ft occurring at a flow of 100 cfs. Flows between 75 and 300 cfs provide more than 80 percent of the maximum value (Figure CAWG 3-12; CAWG 3 Appendix G Table G-5).

Spawning WUA based on ideal substrate increases most rapidly with flow between 10 and 35 cfs and reaches its maximum value of 28,536 ft^2/1000 ft at a flow of 55 cfs. Flows between 25 and 125 cfs provide over 80 percent of the maximum WUA.

4.3.1.3.2 Brown Trout

Adults: The adult brown trout WUA function provides about 59 percent of the maximum WUA at 10 cfs, 80 percent at about 25 cfs and reaches its maximum value at 80 cfs (30,210 ft^2/1000 ft) (Figure CAWG 3-13; CAWG 3 Appendix G Table G-6).

Juveniles: WUA for juvenile brown trout reaches its maximum value of 27,310 ft^2/1000 ft at 30 cfs. WUA at 10 cfs is 89 percent of the maximum value (Figure CAWG 3-13; CAWG 3 Appendix G Table G-6). WUA decreases with flow above 30 cfs, reaching a minimum of 42 percent of the maximum value at 300 cfs.

Fry: Fry WUA decreases from its maximum value at 10 cfs (30,880 ft^2/1000 ft) to about 80 percent of this value at 60 cfs. WUA continues to decline with flow, reaching about 41 percent of its maximum value at 300 cfs (Figure CAWG 3-13; CAWG 3 Appendix G Table G-6).

Spawning: Spawning WUA for actual substrate increases slowly with flow, reaching its maximum value of 300 ft^2/1000 ft at 100 cfs. WUA reaches 80 percent of the maximum value at between 65 and 70 cfs. WUA for brown trout spawning based on ideal substrate increases much more quickly with flow, from 66 to 100 percent of the maximum value between 10 and 40 cfs, reaching about 80 percent of the maximum value at 16 cfs. WUA declines with flow above 40 cfs, reaching 80 percent of its maximum value at 95 cfs and 61 percent of its maximum value at 300 cfs (Figure CAWG 3-13; CAWG 3 Appendix G Table G-6).

4.3.1.4 SFSJR – downstream of Rattlesnake Crossing

This reach was modeled using the transects from the Rosgen G channel types in the SFSJR Mono to Bear reach. These transects were reweighted according to proportion of the habitat types within the reach downstream of Rattlesnake Crossing.

4.3.1.4.1 Rainbow Trout

Adult: Adult rainbow trout WUA increases with flow from 10 to 150 cfs. The rate of increase is most rapid between 10 and 45 cfs (Figure CAWG 3-14; CAWG 3 Appendix G Table G-7). Maximum WUA is 38,030 ft^2/1000 ft at 150 cfs, with 45 cfs providing about 80 percent of this value. WUA decreases slightly with increasing flow above 150 cfs.

Juvenile: Juvenile rainbow trout WUA increases with flow from 87 to 100 percent of its maximum value (28,407 ft^2/1000 ft) from 10 to 30 cfs. It then decreases with increasing flow, reaching 80 percent of its maximum value at 95 cfs and 50 percent of its maximum value at 300 cfs (Figure CAWG 3-14; CAWG 3 Appendix G Table G-7).

Fry: Fry WUA is at its maximum value of 32,005 ft^2/1000 ft at 10 cfs. WUA exceeds 95 percent of its maximum value at flows up to 25 cfs (Figure CAWG 3-14; CAWG 3 Appendix G Table G-7). WUA declines to 81 percent of its maximum value at 55 cfs and 48 percent of its maximum value at 300 cfs.

Spawning: The amount of spawning gravel available in this reach of the SFSJR is again quite low based on the actual substrate observations. The amount of spawning habitat is at its maximum at 100 cfs (441 ft^2/1000 ft). Eighty percent of the maximum WUA is provided at all flows greater than 85 cfs (Figure CAWG 3-14; CAWG 3 Appendix G Table G-7).

The ideal substrate WUA function increases rapidly with flow between 10 and 35 cfs. WUA reaches 80 percent of it maximum value at about 20 cfs. Maximum WUA values are obtained at 45 cfs (25,271 ft^2/1000 ft). WUA exceeds 80 percent of the maximum value at all flows between 20 and 300 cfs (Figure CAWG 3-14; CAWG 3 Appendix G Table G-7).

4.3.1.4.2 Brown Trout

Adult: Adult brown trout WUA increases most rapidly with flow from 10 to 45 cfs and then more gradually from 50 to 90 cfs. The maximum WUA of 35,523 ft^2/1000 ft is obtained at 90 cfs. WUA reaches 80 percent of its maximum value at about 25 cfs. As flow increase above 90 cfs, WUA decreases, reaching 78 percent of its maximum value at 300 cfs (Figure CAWG 3-15; CAWG 3 Appendix G Table G-8).

Juveniles: Juvenile brown trout WUA increases with flow between 10 and 30 cfs and then decreases with increasing flow, reaching 46 percent of its maximum value at 300 cfs. The maximum WUA value occurs at 30 cfs (29,850 ft^2/1000 ft). WUA at 10 cfs is 90 percent of the maximum value (Figure CAWG 3-15; CAWG 3 Appendix G Table G-8).

Fry: Maximum brown trout fry WUA (30,791 ft^2/1000 ft) occurs at 10 cfs and declines continuously with increasing flow. WUA exceeds 80 percent of the maximum value at flows up to 50 cfs and declines to about 47 percent of its maximum value at 300 cfs (Figure CAWG 3-15; CAWG 3 Appendix G Table G-8).

Spawning: Spawning WUA based on actual substrate is quite low, with a maximum value of 459 ft^2/1000 ft occurring at 225 cfs (Figure CAWG 3-15; CAWG 3 Appendix G Table G-8). WUA exceeds 80 percent of this value at flows greater than 85 cfs, but there is a slight dip in WUA between 125 and 175 cfs.

Spawning WUA based on ideal substrate peaks at 35 cfs (26,514 ft^2/1000 ft), with 80 percent of maximum WUA occurring at about 14 cfs. This function declines with flow between 35 and 150 cfs and is relatively stable as flows increase further. Flows greater than 90 cfs provide less than 80 percent of the maximum WUA (Figure CAWG 3-15; CAWG 3 Appendix G Table G-8).

4.3.2 BEAR CREEK

No rainbow trout have been observed in Bear Creek downstream of the diversion, so habitat simulations are not reported in this stream for this species.

4.3.2.1 Brown Trout

Adult: Adult brown trout WUA increases most rapidly with flow from 1 to 25 cfs, and then more gradually up to 60 cfs. The maximum WUA of 14,494 ft^2/1000 ft occurs at 60 cfs. WUA reaches 80 percent of its maximum value at just less than 20 cfs. The WUA is relatively constant between 30 and 100 cfs, with only a slight decline at flows above 100 cfs (Figure CAWG 3-16; CAWG 3 Appendix G Table G-9).

Juvenile: The juvenile brown trout WUA function increases rapidly with flow from 1 to 10 cfs and is over 95 percent of its maximum value (13,792 ft^2/1000 ft) from 10 to 40 cfs. As flows increase above 45 cfs, WUA for this lifestage declines to 64 percent of its maximum value at 125 cfs (the highest simulation flow) (Figure CAWG 3-16; CAWG 3 Appendix G Table G-9).

Fry: Fry WUA for brown trout in Bear Creek increases rapidly from 1 to 6 cfs and then more gradually to its maximum value of at 20 cfs (16,721 ft^2/1000 ft). The function attains 81 percent of its maximum value of 2 cfs (Figure CAWG 3-16; CAWG 3 Appendix G Table G-9). WUA declines with flow above 20 cfs, reaching 51 percent of its maximum value at 125 cfs.

Spawning: Brown trout spawning WUA based on actual substrate is again quite low, with a maximum value of 319 ft^2/1000 ft at 17.5 cfs. WUA at 8 cfs is at 81 percent of its maximum value (Figure CAWG 3-16; CAWG 3 Appendix G Table G-9).

Brown trout spawning WUA based on ideal substrate increases most rapidly with flow from 1 to 8 cfs, attaining 80 percent of its maximum value at between 5 and 6 cfs (Figure CAWG 3-16; CAWG 3 Appendix G Table G-9). Maximum WUA occurs at a flow of 25 cfs (10,570 ft^2/1000 ft). WUA declines with increasing flow above 25 cfs, reaching 66 percent of its maximum value at 125 cfs.

4.3.3 MONO CREEK

Habitat simulations were made for rainbow and brown trout in Mono Creek downstream of Mono Diversion, but rainbow trout occur in very low densities (11 fish/km).

4.3.3.1 Rainbow Trout

Adult: Adult rainbow trout WUA increases most rapidly with flow from 5 to 35 cfs (Figure CAWG 3-17; CAWG 3 Appendix G Table G-10). WUA continues to increase at a much reduced rate with flow above 40 cfs. Maximum WUA occurs at a flow of 150 cfs (14,417 ft^2/1000 ft). About 80 percent of the maximum WUA is available at a flow of between 25 and 30 cfs.

Juvenile: Juvenile WUA is similar across the entire range of flows simulated, varying by less than 20 percent. Maximum WUA (11,206 ft^2/1000 ft) for this lifestage is obtained at a flow of 20 cfs. Five cfs provides about 81 percent of the maximum WUA value, while 175 cfs provides about 88 percent of the maximum WUA value (Figure CAWG 3-17; CAWG 3 Appendix G Table G-10).

Fry: Fry WUA increases by about 4 percent from 5 cfs to its maximum value at 9 cfs (14,772 ft^2/1000 ft). WUA declines to 71 percent of its maximum value with increasing flows up to 100 cfs and then begins to increase again (Figure CAWG 3-17; CAWG 3 Appendix G Table G-10).

Spawning: The rainbow trout spawning WUA function with actual substrate increases most rapidly with flow between 5 and 10 cfs, and then continues to increase to its maximum value at 30 cfs (2,827 ft^2/1000 ft) at a slower rate (Figure CAWG 3-17; CAWG 3 Appendix G Table G-10). Eighty percent of maximum WUA is obtained at 13 cfs. The percentage of maximum WUA remains above 80 percent to a flow of nearly 60 cfs.

WUA based on ideal substrate has its maximum value at 50 cfs (15,018 ft^2/1000 ft). WUA exceeds 80 percent of this value at flows from 14 to 125 cfs. WUA increases most rapidly between 5 and 15 cfs (Figure CAWG 3-17; CAWG 3 Appendix G Table G-10).

4.3.3.2 Brown Trout

Adult: Adult brown trout WUA in Mono Creek increases rapidly with flow from 5 to 20 cfs and then increases very gradually as flows increase above 25 cfs, increasing by only another 10 percent at the highest flow simulated (175 cfs), where maximum WUA is 12,234 ft^2/1000 ft. Flows above 14 cfs provide more than 80 percent of the maximum WUA (Figure CAWG 3-18; CAWG 3 Appendix G Table G-11).

Juvenile: Juvenile WUA is very constant over the entire range of simulated flows, varying by less than 10 percent from the maximum value of 10,502 ft^2/1000 ft (Figure CAWG 3-18; CAWG 3 Appendix G Table G-11), which occurs at 13 cfs.

Fry: The lowest simulation flow (5 cfs) provides approximately 96 percent of the maximum WUA (14,524 ft^2/1000 ft) for brown trout fry. The maximum WUA value occurs at 8.5 cfs. WUA for this lifestage begins to decrease as flow increases from 8.5 to 100 cfs, reaching about 68 percent of its maximum value at the latter flow (Figure CAWG 3-18; CAWG 3 Appendix G Table G-11).

Spawning: Maximum WUA for spawning brown trout, based on actual substrate observations occurs at a flow of 25 cfs, with 2,813 ft^2/1000 ft. The most rapid increase occurs between 5 and 20 cfs, and 80 percent of the maximum value occurs at 9.5 cfs. This function declines to a low of 19 percent of maximum WUA as flows increase to 175 cfs. Flows of greater than 50 cfs provide less than 80 percent of maximum WUA for this lifestage (Figure CAWG 3-18; CAWG 3 Appendix G Table G-11).

Spawning WUA based on ideal substrate also increases rapidly between 5 and 20 cfs, and has a broad peak, which extends to about 70 cfs (Figure CAWG 3-18; CAWG 3 Appendix G Table G-11). Flows from 10 to 90 cfs provide greater than 80 percent of the maximum WUA.

4.3.4 San Joaquin River – Mammoth Reach

The Mammoth Reach of the San Joaquin River is used by Sacramento sucker, rainbow trout and brown trout (SCE 2003c). Sacramento sucker are dominant in terms of both abundance and biomass.

4.3.4.1 Rainbow Trout

Adult: WUA for adult rainbow trout increases most rapidly between 10 and 70 cfs, and then continues to increase at a slower rate to its maximum value of 53,930 ft^2/1000 ft at 225 cfs (Figure CAWG 3-19; CAWG 3 Appendix G Table G-12). A flow of 50 cfs provides 80 percent of the maximum WUA for adult rainbow trout. WUA values decline slightly as flows increase from 250 to 500 cfs.

Juvenile: Juvenile rainbow trout WUA is at about 90 percent of the maximum value at 10 cfs and climbs to its maximum value (33,681 ft^2/1000 ft) at 35 cfs (Figure CAWG 3-19; CAWG 3 Appendix G Table G-12). WUA then declines with increasing flows, reaching 80 percent of its maximum value at between 125 and 150 cfs ant 48 percent of its maximum value at 500 cfs.

Fry: Fry WUA is at its maximum value at 11 cfs (39,765 ft^2/1000 ft) and declines with increasing flows (Figure CAWG 3-19; CAWG 3 Appendix G Table G-12). A flow of 80 cfs provides about 80 percent of the maximum WUA while a flow of 500 cfs, provides about 41 percent of the maximum WUA.

Spawning: Rainbow trout spawning WUA based on actual substrate is generally quite low, with a maximum value of 587 ft^2/1000 ft at 500 cfs (Figure CAWG 3-19; CAWG 3 Appendix G Table G-12). WUA climbs continuously with increasing flow over the range of simulated flows, attaining 80 percent of the maximum WUA at between 300 and 350 cfs.

Rainbow trout spawning WUA based on ideal substrate also increases with flow, reaching its maximum value at 400 cfs. The most rapid rate of increase occurs at flows from 10 to 70 cfs. The rate of increase then slows as flows become progressively higher. Eighty percent of maximum WUA is provided at 125 cfs.

4.3.4.2 Brown Trout

Adult: WUA for adult brown trout increases most rapidly between 10 and 50 cfs, and reaches a maximum value of 52,036 ft^2/1000 ft at 150 cfs (Figure CAWG 3-20; CAWG 3 Appendix G Table G-13). A flow of 25 cfs provides about 82 percent of the maximum WUA for adult brown trout. WUA values decline to 83 percent of the maximum value as flows increase from 150 to 500 cfs.

Juvenile: Juvenile brown trout WUA is at its maximum value (37,469 ft^2/1000 ft) at 30 cfs (Figure CAWG 3-20; CAWG 3 Appendix G Table G-13). A flow of 10 cfs provides about 91 percent of the maximum value. WUA then declines with increasing flows above 30 cfs, reaching 80 percent of its maximum value at between 125 and 150 cfs and 49 percent of its maximum value at 500 cfs.

Fry: The shape of the brown trout fry WUA function is very similar to that for rainbow trout fry. Brown trout fry WUA is at its maximum value at 11 cfs (36,369 ft^2/1000 ft) and declines with increasing flows (Figure CAWG 3-20; CAWG 3 Appendix G Table G-13). A flow of 70 cfs provides about 82 percent of the maximum WUA while a flow of 500 cfs, provides about 35 percent of the maximum WUA.

Spawning: Brown trout spawning WUA based on actual substrate is generally quite low, with a maximum value of 671 ft^2/1000 ft at 500 cfs (Figure CAWG 3-20; CAWG 3 Appendix G Table G-13). WUA climbs most rapidly from 0 to 60 cfs, going from 26 to 64 percent of the maximum value. The rate of increase is reduced at flows from 70 to 400 cfs. A flow of 225 cfs provides 81 percent of the maximum WUA.

The maximum WUA for Brown trout spawning WUA based on ideal substrate occurs at 250 cfs, with 80 percent of this value provided at just over 80 cfs. WUA increases most rapidly at flows between 10 and 100 cfs. WUA decreases about 10 percent between 250 and 500 cfs (Figure CAWG 3-20; CAWG 3 Appendix G Table G-13).

4.3.4.3 Sacramento Sucker

Adult: WUA for Sacramento sucker adults increases most rapidly between 10 and 60 cfs and reaches it maximum value of 61,337 ft^2/1000 ft at 300 cfs (Figure CAWG 3-21; CAWG 3 Appendix G Table G-14). A flow of 60 cfs provides about 80 percent of the maximum WUA value.

Juvenile/Fry: WUA for Sacramento sucker juveniles and fry increases slightly with flow from 10 to 18 cfs, which provides the maximum WUA (46,232 ft^2/1000 ft) (Figure CAWG 3-21; CAWG 3 Appendix G Table G-15. WUA declines as flows increase above 18 cfs, reaching 80 percent of the maximum value at 150 cfs and 51 percent of the maximum value at 500 cfs.

4.3.5 San Joaquin River – Stevenson Reach

The Stevenson Reach of the San Joaquin River supports populations of all five species, rainbow and brown trout, hardhead, Sacramento pikeminnow, and Sacramento sucker. The USFS has identified this reach for potential management for the latter three species, and hardhead are listed as a sensitive species by the USFS. The PHABSIM results in this reach are based on models from new transects placed within this reach in combination with deep pool transects from the Mammoth Reach. Because of the extremely turbulent hydraulics in this reach, the models are extrapolated only to 350 cfs, and not the 500 cfs originally proposed.

4.3.5.1 Rainbow Trout

Adult: In the Stevenson Reach of the San Joaquin River, adult WUA increases with flow from 3 to 250 cfs, although WUA is relatively constant once flows exceed 150 cfs.

The maximum WUA value is 54,956 ft^2/1000 ft. The most rapid increase in WUA occurs at flows between 3 and 50 cfs, the upper value of which provides about 75 percent of the maximum WUA observed (Figure CAWG 3-22; CAWG 3 Appendix G Table G-16), while 70 cfs provides about 81 percent of the maximum WUA value.

Juvenile: Juvenile rainbow trout WUA increases most rapidly with flow from 3 to 20 cfs, and then climbs more gradually to its maximum value (28,512 ft^2/1000 ft) at 70 cfs. Eighty percent of maximum WUA is obtained at 6 cfs. WUA decreases with flows above 70 cfs to reach 68 percent of its maximum value at 350 cfs (Figure CAWG 3-22; CAWG 3 Appendix G Table G-16).

Fry: Fry WUA increases with flow between 3 and 30 cfs and then declines with increasing flows above 30 cfs (Figure CAWG 3-22; CAWG 3 Appendix G Table G-16). The WUA at 30 cfs is 33,436 ft^2/1000 ft (maximum value). WUA exceeds 90 percent of the maximum value at flows from 3 to 70 cfs, and drops below 80 percent of the maximum WUA value at just over 125 cfs.

Spawning: Rainbow trout spawning WUA is generally quite low, with a maximum value of 322 ft^2/1000 ft at 80 cfs. WUA is at about 18 percent of the maximum value at 3 cfs, and reaches 80 percent of the maximum WUA value at about 35 cfs (Figure CAWG 3-22; CAWG 3 Appendix G Table G-16).

Rainbow trout spawning WUA based on ideal substrate climbs rapidly between 3 and 50 cfs. WUA declines slightly between 50 and 200 cfs, and then begins to climb again at a moderate rate to the highest flow simulated (Figure CAWG 3-22; CAWG 3 Appendix G Table G-16). The maximum WUA occurs at 350 cfs. The initial peak at 50 cfs provides about 70 percent of this value.

4.3.5.2 Brown Trout

Adult: WUA for adult brown trout climbs most rapidly with flow from 3 to 40 cfs, and then climbs at a more gradual rate to its peak (53,477 ft^2/1000 ft) at 175 cfs (Figure CAWG 3-23; CAWG 3 Appendix G Table G-17). A flow of 35 cfs provides about 80 percent of the maximum WUA value. The WUA function is relatively constant at flows above 100 cfs.

Juvenile: Juvenile WUA increases most rapidly between 3 and 20 cfs, and peaks at 50 cfs (32,728 ft^2/1000 ft). A flow of 5 cfs provides about 80 percent of the maximum WUA value. WUA for juvenile brown trout begins to decline at a moderate rate with increasing flows above 60 cfs, reaching about 67 percent of its maximum value at 350 cfs (Figure CAWG 3-23; CAWG 3 Appendix G Table G-17).

Fry: Fry WUA for brown trout increases by about 8 percent between 3 and 12.5 cfs (12.5 cfs provides the maximum WUA of 30,433 ft^2/1000 ft) and then declines moderately once flows exceed 30 cfs (Figure CAWG 3-23; CAWG 3 Appendix G Table G-17).

Spawning: Spawning WUA for brown trout, based on the substrate observed in the field, is low at all flows, with a maximum value of 350 ft^2/1000 ft occurring at 40 cfs (Figure CAWG 3-23; CAWG 3 Appendix G Table G-17). The most rapid increase occurs between 3 and 40 cfs where WUA increases by 85 percent of the maximum. A flow of 25 cfs provides about 80 percent of maximum WUA. WUA decreases slowly with flow above 40 cfs, reaching about 80 percent of its maximum value at the highest flow simulated.

The spawning WUA based on ideal substrate increases rapidly with flow from 3 to 30 cfs and reaches an initial peak at 40 cfs that is about 73 percent of the maximum value. There is a slight dip in WUA at flows between 50 and 200 cfs, and then WUA begins to increase again with flow to its maximum value of 20,657 ft^2/1000 ft at 350 cfs (Figure CAWG 3-23; CAWG 3 Appendix G Table G-17). Eighty percent of maximum WUA is reached at a flow of 225 cfs.

4.3.5.3 Hardhead

Adult: WUA for adult hardhead increases with flow over the entire range of simulation flows. The rate of increase is most rapid between 3 and 20 cfs and quite gradual at flows between 175 and 350 cfs. A flow of 45 cfs provides about 80 percent of maximum WUA. Maximum WUA is provided at 350 cfs (50,296 ft^2/1000 ft) (Figure CAWG 3-24; CAWG 3 Appendix G Table G-18).

Juvenile: WUA for juvenile hardhead increases most rapidly with flow between 3 and 20 cfs, and then climbs more gradually between 25 and 90 cfs, the latter of which provides the greatest amount of WUA (61,355 ft^2/1000 ft). WUA only varies by about 25 percent over the range of flows simulated and 6 cfs provides 81 percent of the maximum WUA.

4.3.5.4 Sacramento Pikeminnow

Adult: WUA for adult pikeminnow varies by only about 25 percent over the range of flows simulated (Figure CAWG 3-25; CAWG 3 Appendix G Table G-19). WUA increases most rapidly with flow between 3 and 20 cfs, and reaches 81 percent of its maximum value at 6 cfs. The maximum WUA (42,964 ft^2/1000 ft) occurs at 100 cfs.

Juvenile: WUA for juvenile pikeminnow increases most rapidly with flow from 3 to 20 cfs. Thirty cfs provides the maximum WUA for this lifestage of 39,166 ft^2/1000 ft. Three cfs provides nearly 90 percent of the maximum WUA, while a flow of 350 cfs provides about 61 percent of maximum WUA (Figure CAWG 3-25; CAWG 3 Appendix G Table G-19).

4.3.5.5 Sacramento Sucker

Adult: WUA for Sacramento sucker adults increases continuously with flow over the range of flows simulated, attaining a maximum value of 61,756 ft^2/1000 ft (Figure CAWG 3-26; CAWG 3 Appendix G Table G-20). WUA increase most rapidly with flow from 3 to 30 cfs. A flow of 80 cfs provides 81 percent of the maximum WUA.

Juvenile: The maximum WUA (42,644 ft^2/1000 ft) for juvenile sucker occurs at a flow of 40 cfs. Over 90 percent of this value is provided at flows from 3.5 to 100 cfs (Figure CAWG 3-26; CAWG 3 Appendix G Table G-20).

4.3.6 BIG CREEK – DAM 4 TO PH 2

Big Creek below Dam 4 supports populations of rainbow and brown trout. Fish population sampling indicates that these species have approximately equal abundance in this reach (SCE 2003c).

4.3.6.1 Rainbow Trout

Adult: WUA for adult rainbow trout on Big Creek below Dam 4 increases most rapidly with flow from 1 to 20 cfs. WUA continues to increase at a more moderate rate between 20 and 50 cfs. WUA is relatively constant at flows above 60 cfs (Figure CAWG 3-27; CAWG 3 Appendix G Table G-21). The maximum WUA value (14,738 ft^2/1000 ft) occurs at 100 cfs, while a flow of 30 cfs provides 82.2 percent of the maximum WUA.

Juvenile: Juvenile rainbow trout WUA increase rapidly with flow between 1 and 12 cfs, and peaks at 18 cfs with a value of 12,910 ft^2/1000 ft (Figure CAWG 3-27; CAWG 3 Appendix G Table G-21). Six cfs provides about 80 percent of the maximum WUA value.

Fry: Rainbow trout fry WUA increases most rapidly with flow from 1 to 6 cfs, is near its maximum value between 6 and 9 cfs and then declines gradually. All simulated flows except 1 cfs provide more than 80 percent of the maximum WUA value (15,564 ft^2/1000 ft at 8.9 cfs) (Figure CAWG 3-27; CAWG 3 Appendix G Table G-21).

Spawning: Spawning WUA based on actual substrate increases rapidly with flow from 1 to 12 cfs and reaches its peak value of only 186 ft^2/1000 ft at 25 cfs. As flows increase above 25 cfs, WUA decreases relatively rapidly. Greater than 80 percent of the maximum WUA is provided at flows of 10 to 50 cfs (Figure CAWG 3-27; CAWG 3 Appendix G Table G-21).

Spawning WUA, based on ideal substrate, increases rapidly with flow from 1 to 14 cfs. A flow of 12 cfs provides about 81 percent of the maximum WUA. The peak WUA value of 14,251 ft^2/1000 ft occurs at 30 cfs (Figure CAWG 3-27; CAWG 3 Appendix G Table G-21). WUA is generally constant at flows above 18 cfs.

4.3.6.2 Brown Trout

Adult: Adult brown trout WUA increase most rapidly between 1 and 14 cfs, and then more gradually from 14 to its peak value (12,957 ft^2/1000 ft) at 45 cfs (Figure CAWG 3-28; CAWG 3 Appendix G Table G-22). A flow of 14 cfs provides 80 percent of the maximum WUA value. WUA for adult brown trout is constant at flows above 30 cfs.

Juvenile: Juvenile brown trout WUA increases rapidly with flow from 1 to 8 cfs and reaches its maximum value of 12,695 ft^2/1000 ft at 16 cfs. All flows above 4.5 cfs provide more than 80 percent of the maximum WUA cfs (Figure CAWG 3-28; CAWG 3 Appendix G Table G-22). WUA declines moderately between 16 and 40 cfs and is relatively constant from 40 to 100 cfs.

Fry: Brown trout fry WUA increases rapidly with flow from 1 to 5 cfs, with peak values occurring at 8 cfs and a very gradual decline with increasing flows from 35 to 100. A flow of 1.5 cfs provides 80 percent of the maximum WUA value (Figure CAWG 3-28; CAWG 3 Appendix G Table G-22).

Spawning: WUA for spawning brown trout based on actual substrate increases rapidly with flow from 1 to 10 cfs, peaks at 14 cfs (202 ft^2/1000 ft), and then declines rapidly with increasing flows above 20 cfs (Figure CAWG 3-28; CAWG 3 Appendix G Table G-22). Flows of 7 to 35 cfs provide more than 80 percent of the maximum WUA value.

Spawning WUA based on ideal substrate increases rapidly with increasing flow from 1 to 12 cfs and peaks at 20 cfs. A flow of 8 cfs provides 82 percent of the maximum WUA value. WUA is relatively constant at all flows greater than 30 cfs.

4.3.7 Big Creek - Dam 5 to PH 8

Big Creek below Dam 5 supports both rainbow and brown trout. Rainbow trout are numerically dominant, with brown trout populations being about 20 to 60 percent the size of rainbow trout populations, depending on channel type.

4.3.7.1 Rainbow Trout

Adult: WUA for adult rainbow trout on Big Creek below Dam 5 increases most rapidly with flow from 1 to 16 cfs (Figure CAWG 3-29; CAWG 3 Appendix G Table G-23). WUA continues to increase at a more moderate rate between 18 and 50 cfs. WUA is relatively constant at flows above 60 cfs, but the highest WUA value occurs at 80 cfs (16,089 ft^2/1000 ft). A flow of 18 cfs provides about 80 percent of the maximum WUA for adult rainbow trout.

Juvenile: Juvenile rainbow trout WUA increases rapidly with flow between 1 and 4.5 cfs and peaks at 12 cfs (11,005 ft^2/1000 ft) (Figure CAWG 3-29; CAWG 3 Appendix G Table G-23). A flow of 2.5 cfs provides 80 percent of the maximum WUA value. WUA decreases gradually with flow between 25 and 100 cfs.

Fry: Rainbow trout fry WUA increases most rapidly with flow from 1 to 5 cfs, and is at its maximum of 14,017 ft^2/1000 ft at 9 cfs (Figure CAWG 3-29; CAWG 3 Appendix G Table G-23). All flows less than 40 cfs provide more than 80 percent of the maximum WUA value, and a flow of 1 cfs provides 88 percent of the maximum value.

Spawning: Rainbow trout spawning WUA based on actual substrate is more abundant in this reach than the BC4 reach based on the WUA function. However, given the relatively small amount of spawning gravels available, this may reflect a relatively slight increase in the total amount of spawnable gravel observed. WUA increases with flow most rapidly between 1 and 16 cfs, with a flow of 1 cfs providing about 13 percent of the maximum WUA value and 12 cfs providing about 90 percent of the maximum WUA value. The maximum WUA value of 938 ft^2/1000 ft occurs at 16 cfs (Figure CAWG 3-29; CAWG 3 Appendix G Table G-23). WUA declines by about 28 percent as flow increases to 100 cfs.

The spawning WUA function based on ideal substrate increases most rapidly with flow from 1 to 14 cfs, and then continues to climb at a more moderate rate over the rest of the simulation flows. Eighty percent of the maximum WUA value is provided at a flow of 30 cfs.

4.3.7.2 Brown Trout

Adult: Adult brown trout WUA increases rapidly with flow from 1 to 12 cfs. Maximum WUA (15,246 ft^2/1000 ft) occurs at 35 cfs, while a flow of 7 cfs provides about 80 percent of this value (Figure CAWG 3-30; CAWG 3 Appendix G Table G-24).

Juvenile: Juvenile brown trout WUA increases most rapidly with flow from 1 to 6 cfs and peaks at 10 cfs (Figure CAWG 3-30; CAWG 3 Appendix G Table G-24). A flow of 2 cfs provides 81 percent of the maximum WUA (11,683 ft^2/1000 ft). The WUA declines to 70 percent of its maximum value at 100 cfs.

Fry: Brown trout fry WUA increases with flow from 1 to 5 cfs and reaches its peak value at 9 cfs. A flow of 1 cfs provides 90 percent of the maximum WUA value, and all flows less than 40 cfs provide more than 80 percent of the maximum WUA (Figure CAWG 3-30; CAWG 3 Appendix G Table G-24).

Spawning: The maximum spawning WUA based on actual substrate observations (772 ft^2/1000 ft) is provided at a flow of 12 cfs and 80 percent of this value occurs at 7 cfs (Figure CAWG 3-30; CAWG 3 Appendix G Table G-24). Spawning WUA increases most rapidly with flow from 1 to 10 cfs.

The spawning WUA function based on ideal substrate increases most rapidly with flow from 1 to 12 cfs, and then continues to climb at a more moderate rate over the rest of the simulation flows. Eighty percent of the maximum WUA value occurs at 14 cfs.

4.3.8 STEVENSON CREEK

Stevenson Creek below Shaver Lake supports only rainbow trout. No other species have been observed here (SCE 2003b).

4.3.8.1 Rainbow Trout

Adult: The most rapid increase in WUA for adult rainbow trout in Stevenson Creek occurs between flows of 1 and 16 cfs, with a more gradual climb to the peak WUA value of 13,851 ft^2/1000 ft at 45 cfs. WUA declines slightly as flows increase further (Figure CAWG 3-31; CAWG 3 Appendix G Table G-25). A flow of 14 cfs provides about 80 percent of the maximum WUA.

Juvenile: Juvenile rainbow trout WUA increases most rapidly as flows increase from 1 to 6 cfs and peaks at a flow of 8 cfs with 11,739 ft^2/1000 ft. Flows of 2 to 25 cfs provide more than 80 percent of the maximum WUA value (Figure CAWG 3-31; CAWG 3 Appendix G Table G-25).

Fry: Fry WUA is at its maximum (13,677 ft^2/1000 ft) at a flow of 3 cfs and declines rapidly with increasing flows to 60 cfs, which provides 54 percent of the maximum values. WUA then increases again with increasing flow (Figure CAWG 3-31; CAWG 3 Appendix G Table G-25).

Spawning: Spawning WUA based on observed substrate is quite low with a maximum value of 168 ft^2/1000 ft at 20 cfs. WUA increases most rapidly with flow from 2 to 12 cfs, with flows of 9 to 50 cfs providing more than 80 percent of the maximum WUA value (Figure CAWG 3-31; CAWG 3 Appendix G Table G-25).

The spawning WUA function based on the ideal substrate increases rapidly with flow between 2 and 16 cfs. WUA increases by only 8 percent with increasing flows above 16 cfs. A flow of 10 cfs provides 81 percent of the maximum WUA.

4.3.9 NF Stevenson Creek

NF Stevenson Creek supports populations of rainbow trout and brown trout, as well as rainbow/golden trout hybrids. Habitat simulations were performed for rainbow trout and brown trout. No criteria specific to rainbow golden hybrids have been developed, but these fish are behaviorally similar to rainbow trout and thus the rainbow trout simulations would apply to this species as well. Brown trout are dominant in terms of both numbers and biomass in this stream.

A few Sacramento sucker have also been observed in NF Stevenson Creek. These individuals are thought to have been introduced to the creek through Tunnel 7, but are not thought to have a self-sustaining population in the creek (SCE 2003b). Because of this, habitat simulations were not performed for Sacramento sucker in this stream.

4.3.9.1 Rainbow Trout

Adult: Adult rainbow trout WUA in NF Stevenson increases more gradually than was observed in other lower basin small streams. WUA increases most rapidly between 3 and 17.5 cfs and continues to increase more gradually with flow to 60 cfs. WUA is relatively constant at flows above this value, but the maximum WUA of 12,266 ft^2/1000 ft occurs at 60 cfs. Eighty percent of the maximum WUA is provided at 20 cfs (Figure CAWG 3-32; CAWG 3 Appendix G Table G-26).

Juvenile: Juvenile rainbow trout WUA in NF Stevenson Creek varies by only about 25 percent. WUA increases most rapidly with flow from 3 to 9 cfs and peaks at 17.5 cfs with a value of 12,795 ft^2/1000 ft. WUA for this lifestage declines gradually as flows increase above 20 cfs, but all flows between 4 and 80 cfs provide in excess of 80 percent of the maximum WUA value (Figure CAWG 3-32; CAWG 3 Appendix G Table G-26).

Fry: Fry WUA peaks at 6.5 cfs and declines as flows increase above this value (Figure CAWG 3-32; CAWG 3 Appendix G Table G-26). Three cfs, the lowest flow simulated, provides over 95 percent of the maximum WUA value.

Spawning: Rainbow trout spawning WUA based on actual substrate increases rapidly with flow from 3 to 8 cfs and begins to decline gradually as flows increase above 11 cfs. Flows between 4.5 and 30 cfs provide about 80 percent of the maximum WUA value (Figure CAWG 3-32; CAWG 3 Appendix G Table G-26).

The ideal substrate spawning WUA curve increases rapidly with flow from 3 to 20 cfs and then plateaus near its maximum value at about 25 to 70 cfs. Eighty percent of the maximum WUA value is provided by a flow of 15 cfs.

4.3.9.2 Brown Trout

Adult: Adult brown trout WUA increases most rapidly with flow from 3 to 14 cfs, and then more gradually as flows increase to 35 cfs, where the maximum WUA value of 12,059 ft^2/1000 ft occurs (Figure CAWG 3-33; CAWG 3 Appendix G Table G-27). A flow of 10 cfs provides 81 percent of the maximum WUA value. WUA decreases slightly as flows increase further.

Juvenile: WUA for brown trout juveniles increases most rapidly with flow from 3 to 9 cfs and peaks at 15 cfs with a value of 13,053 ft^2/1000 ft. Flows of 3 to 60 cfs provide more than 80 percent of the maximum WUA value (Figure CAWG 3-33; CAWG 3 Appendix G Table G-27).

Fry: Fry WUA increases slightly from 3 to 6 cfs and then declines slowly as flows increase further. Over 95 percent of the maximum WUA is provided by flows from 3 to 15 cfs, while all flows less than 45 cfs provide more than 80 percent of the maximum WUA value (Figure CAWG 3-33; CAWG 3 Appendix G Table G-27).

Spawning: Brown trout spawning WUA based on actual substrate increases about 25 percent with flow from 3 cfs to the maximum WUA value (177 ft^2/1000 ft) at 8 cfs. WUA declines to 39 percent of the maximum value as flow increases to 80 cfs.

The spawning WUA function based on ideal substrates increases most rapidly with flow from 3 to 15 cfs and then more gradually up to its maximum value at 30 cfs. A flow of 10 cfs provides about 80 percent of the maximum WUA value.

4.4 PASSAGE ANALYSIS

The results of the passage analysis are presented by stream reach in Tables CAWG 3-14 and 3-15 for upper basin and lower basin streams, respectively. These results identify the flows that would meet the criteria established for the upstream passage of adult trout through a typical riffle in each reach. The information provided here is discussed in conjunction with structural barriers and information derived from wetted perimeter studies in the CAWG 14 report (SCE 2004d).

4.4.1 SF San Joaquin River – Bear to Florence

Four riffles were sampled in Bear to Florence reach of the SF San Joaquin River (Table CAWG 3-14). At each of these riffles, the lowest simulation flow (8.28 cfs) provided sufficient depth for passage. This flow provided a depth of 0.4 ft over 40 to 68 percent of the wetted stream width, with a passage width of 13 and 42 ft at the four transects.

4.4.2 SF San Joaquin River – Mono to Bear

Seven riffle transects were evaluated in the three channel types in the Mono to Bear reach of the SF San Joaquin River (Table CAWG 3-14). The flow meeting the passage criteria at these transects ranged from 10 cfs (at six of the transects) to 30 cfs (at one transect). The percentage of the channel width over which the criteria were met ranged from 26 to 89 percent, but exceeded 39 percent at all but two transects. The width of stream where passage would be possible was between 12 and 24 ft. The average passage flow was about 13 cfs.

4.4.3 Bear Creek

Three riffle transects were evaluated in Bear Creek (Table CAWG 3-14). At each of these transects, the passage criteria were met at the lowest simulation flow (1.1 cfs) over 37 to 75 percent of the channel width, with a passage width of 2.7 to 5.4 ft. Because two of these transects were less than 10 ft wide at this flow, the contiguous width of stream providing passage was evaluated. At these two transects, T5 and T6, the contiguous width of stream was 2.7 and 3.4 ft, respectively.

4.4.4 Mono Creek

Four riffle transects were evaluated for passage in Mono Creek (Table CAWG 3-14). Passage criteria were met at these transects at flows ranging from 3.5 to 10 cfs, with an average of 5.5 cfs. These flows provided passage at 32 to 86 percent of the transect width at these flows, with passage widths of 7 to 13 ft. One transect, 222-2, had a total stream width of less than 10 ft, and the contiguous width of passage at this transect was 2.5 ft.

4.4.5 San Joaquin River – Mammoth Reach

Five transects were evaluated for passage in the Mammoth Reach of the San Joaquin River (Table CAWG 3-15). At four of these transects, the passage criteria were met at a flow of 10 cfs. At the last transect the passage flow was 12 cfs. These flows provided passage at 26 to 60 percent of the transect widths. Passage would be possible over 8 to 28 ft of the transect width.

4.4.6 San Joaquin River – Stevenson Reach

Three transects were evaluated in this reach for passage in the Stevenson Reach of the San Joaquin River (Table CAWG 3-15). At each of these transects, the passage criteria were met at a flow of 6 cfs. This flow provided between 6.5 and 30 ft of passage along the transects, representing between 50 and 83 percent of the total transect widths.

4.4.7 Big Creek – below Dam 4

Five transects were evaluated for passage in Big Creek below Dam 4 (Table CAWG 3-15). Three transects were within the Rosgen A channel and two in the Rosgen B channel type. The flows meeting the passage criteria ranged from 0.29 to 1.75 cfs at these transects, with an average of 0.77 cfs. These flows provided passage over 26 to 55 percent of the transect widths, with the width of the area providing passage ranging from 2.5 to 5.5 ft. Transect 19-1 was only 4.6 ft wide at the passage flow, but a contiguous 2.5 ft of this width met the passage criteria.

4.4.8 Big Creek – below Dam 5

On Big Creek below Dam 5, four transects were evaluated for passage (Table CAWG 3-15). The passage criteria were met at a flow of 2.75 cfs at one transect and 1.5 cfs for the remaining three transects. This resulted in an average passage flow of 1.8 cfs. The percentage of the transect width providing passage ranged from 30 to 94 percent, with the actual width of passage ranging from 2.5 to 10.8 ft. Two transects were less than 10 ft wide. The contiguous width of passage at these transects was 2.5 ft at transect 114-1, and 6 ft at Transect 109-2.

4.4.9 NF Stevenson Creek

Eight transects were evaluated for passage on NF Stevenson Creek (Table CAWG 3-15). The passage criteria were met at flows ranging from 2 to 5.5 cfs. These flows provided passage over 26 to 90 percent of the transect widths, with total passage widths ranging from 1.8 to 21 ft. One transect was less than 10 ft wide (Transect 29-1). At this transect the contiguous width providing passage was 1.35 ft (19 percent of the total width).

4.4.10 Stevenson Creek

Three transects were evaluated on Stevenson Creek (Table CAWG 3-15). At these transects, the flows meeting the passage criteria ranged from 3.9 to 6.0 cfs, averaging 4.75 cfs. The percentage of the transects providing passage was 28 to 32 percent, with total passage widths of 3.9 to 6 ft.

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TABLES

Table CAWG 3-1. Proposed Instream Flow Approach for Project Streams.

SOUTH FORK SAN JOAQUIN RIVER	PHABSIM	WETTED PERIMETER
Tombstone Creek		X
South Slide Creek		X
North Slide Creek		X
Hooper Creek		X
Crater Creek		X
Bear Creek	X	
Chinquapin Creek		X
Camp 62 Creek		X
Bolsillo Creek		X
Camp 61 Creek		X[1]
Mono Creek (Vermilion to Div. Forebay)	X[2]	
Mono Creek (Div. Forebay to San Joaquin River)	X	
Warm Creek		X[2]
SF San Joaquin River	X	
Boggy Meadows Creek		X[2]
Adit #2 Seepage (below Portal Forebay)		X[2]
MAMMOTH REACH		
Rock Creek		X
Ross Creek		X
San Joaquin River (Mammoth Pool Dam to PH)	E[3]	
BIG CREEK REACH		
Rancheria Creek		X
Trib. to Big Creek		X
Big Creek (Dam 1 to PH 1)	X	
Big Creek (Dam 4 to PH 2)	E[4]	
Big Creek (Dam 5 to PH 8)	E[4]	
Pitman Creek		X
Balsam Creek (Dam to Low. Div. Forebay)		X
Balsam Creek (Low. Div. Forebay to Big Creek)		X
Ely Creek		X
STEVENSON CREEK/STEVENSON REACH		
NF Stevenson Creek	X	
Stevenson Creek (Shaver Lake to San Joaquin River)	X	
SJR Stevenson Reach (Dam 6 to PH 3)	E[4]	
SJR Horseshoe Bend (Dam 7 to PH 4)	E[4]	

[1] Study will be performed under the Portal relicensing.
[2] Study will be performed under the Vermilion relicensing.
[3] Study performed in 1984.
[4] Study performed in 1986.
E - Existing model

Table CAWG 3-2. Highlights and Chronology of PHABSIM Related Discussions During the Big Creek ALP Process.

DATE(S)	DESCRIPTION
09-25-01	Discussion of transect selection strategy for upper basin wetted perimeter streams and Bear Creek PHABSIM studies. Work schedule provided for upper basin wetted perimeter transect selection.
02-13-02	Tentative schedule proposed for 2002 upper basin wetted perimeter field data collection.
03-19-02	Updated upper basin wetted perimeter data collection schedule provided. Clarification on HSC verification studies. Discussion of stream stratification approach for HSC studies.
05-08-02	Progress report on wetted perimeter and PHABSIM studies.
07-10-02	Review of BiCEP models. Overview of lower basin transect selection approach. Tentative schedule for transect selection for wetted perimeter and PHABSIM transects discussed.
08-14-02	Additional discussion of BiCEP review with recommendations for additional transects. Discuss peer review of these findings and recommendations.
08-20-02	Proposed transect placement strategy for PHABSIM study reaches. Strategy for stream segmentation by project reach, Rosgen habitat type, and mesohabitat type.
09-12-02	Discussion of what calibration flows the velocity measurements for PHABSIM studies should be collected. Discussion of approaches to addressing spawning habitat. Discussion of the number and placement of transects.
09/23-26/02	Transect selection field trip SF San Joaquin River Bear to Florence and Mono to Bear Reaches, Mono Creek.
09/30/02 – 10/02/02	Transect selection field trip – NF Stevenson Creek, Stevenson Creek, Big Creek above Powerhouse (PH) 1.
10-09-02	Discussion of BiCEP model review and recommendations. Use of models approved with some reservations relating to differences in habitat classification, ability to relocate transects, and what should be done if models cannot be recalibrated. Continuing discussion of PHABSIM transect selection methodology.
10/21-24/02	Transect Selection Field Trip – Big Creek PH2 to Dam 4, Big Creek PH 8 to Dam 5, San Joaquin River Mammoth and Stevenson reaches.
01-08-03	Summary of wetted perimeter and PHABSIM transect selection from 2002 season. Discussion of transect weighting, habitat suitability criteria and protocols for evaluating effects out-of-season of whitewater releases.
03-10-03	Presentation of results of upper basin wetted perimeter studies conducted in 2002.
04-17-03	Rationale for and proposal of calibration flows for PHABSIM studies. Presentation of whitewater stranding study plan. Introductory presentation on HSC transferability testing.
04-28-03	PHABSIM calibration flows approved. Whitewater stranding study protocols approved.
06-12-03	Review of whitewater stranding study field data collection.
07-09-03	Schedule for upcoming PHABSIM fieldwork provided. Update on HSC verification data collection progress.

Table CAWG 3-2. Highlights and Chronology of PHABSIM Related Discussion During the Big Creek ALP Process (cont).

08-19-03	Reviewed comments on CAWG 3 Interim Report. Update on HSC data collection. Decision reached to sample large pools in lower basin large streams to locate hardhead – ignoring study protocol of equal area sampling.
09-11-03	Update on HSC. Field work schedule updated.
10-08-03	Presentation on HSC transferability testing procedure and discussion of HSC to be tested. Presentation and approval of revised approach to assessing habitat in Bolsillo Creek, after proposed food transport modeling proved inappropriate.
12/11 & 12-03	Review of habitat inventory verification on lower Big Creek and agreement that issue was resolved. Review of Altered Flows Preference criteria and extensive discussion of these and other curves.
01-14-04	Discussion of HSC. Proposed modifications to passage analysis presented to group for consideration.
01/28 & 29-04	HSC subgroup meeting. Extensive review and discussion of HSC. Tentative curves developed for consideration and future approval.
02-11-04	Modification to passage analysis presented on 01-14-04 approved. HSC discussion. Macroinvertebrate criteria reviewed. CAWG decides that they are not needed, as they will likely not contribute to setting instream flow requirements. Winter rearing criteria for trout reviewed.
03-11-04	Discussion of winter rearing criteria, including discussion by Ron Campbell HSC discussion and approval of tentative criteria for all lifestages of pikeminnow and sucker and the fry and spawning lifestages for trout, by all parties. Decision still outstanding for adult and juvenile rainbow and brown trout. USFWS offers reanalysis of UARP data using Rubin et al. (1991) methodology.
4-14-04	HSC discussion – CAWG reaches compromise on HSC for adult and juvenile rainbow and brown trout and confirms decision to use Tentative Criteria as approved at last meeting. USFWS does not concur with this decision and says it will develop criteria from the UARP data using the Rubin et al. (1991) approach. CAWG decides to move forward with the Tentative Criteria (now the Big Creek ALP criteria) and will consider the USFWS criteria when they are presented. ENTRIX to move forward with analysis using the agreed upon criteria. CAWG decides use of winter rearing criteria is not necessary.
5-11-04	HSC discussion – USFWS presents new HSC developed from re-analysis of the UARP data. After discussion, CAWG decides that the curves agreed upon in the prior two meetings were most appropriate for use on the Big Creek streams. USFWS disagrees and says it will do an independent analysis using the criteria that they have developed. The USFS requests that an analysis of the sensitivity of WUA to the suitability of low velocity habitat be performed. SCE agrees to undertake this analysis.

Table CAWG 3-3. CTST Participants by Study Reach.

STREAM	REACH	DATE	PARTICIPANTS												
			STEVE ROWAN, SCE	WAYNE ALLEN, SCE	GEOFF RABONE, SCE	PHIL STRAND, USFS	DENNIS SMITH, USFS	CINDY WHELAN, USFS	PAUL DEVRIES, R2	JULIE MEANS, CDFG	CARSON COX, SWRCB	BRITT FECKO, SWRCB	LARRY WISE, ENTRIX	JASON COBURN, ENTRIX	CORALIE DAYDE, ENTRIX
SF SJR	Bear to Florence	*9/23/02*	X			X							X	X	X
SF SJR	Mono to Bear	*9/24/02*	X			X							X	X	X
Mono Creek	BD	*9/26/02*			X	X							X	X	X
NF Stevenson Creek	Below Outlet Reach	*9/30/02*	X			X			X				X	X	X
Stevenson Creek	Below Shaver Lake	*10/1/02 & 10/2/02*		X		X			X				X	X	X
Big Creek	Above PH1	*10/2/01*		X		X			X				X	X	X
Big Creek	PH 2 to Dam 4 *	*10/21/02*	X	X			X	X	X	X	X		X	X	X
Big Creek	PH 8 to Dam 5	*10/22/02*		X			X		X		X		X	X	X
SJR	Mammoth Reach	*10/23/02*		X			X		X	X		X	X	X	X
SJR	Stevenson Reach	*10/24/02*	X	X			X		X	X		X	X	X	X
Rancheria Creek	Above Surge Chamber	*10/24/02*		X			X		X	X		X	X	X	X
Rancheria Creek	Below Surge Chamber	*10/24/02*		X			X			X			X	X	X

Table CAWG 3-4. Number of Transects Selected for Each Stream Reach by Rosgen Channel Type and Mesohabitat Type.

South Fork San Joaquin River - Bear Creek to Florence Lake Reach						
Channel Type	**B**			**C**		
Percent of Reach Length	***71.8%***			***28.2%***		
Habitat Classification	**Percent[1]**	**No. of transects[2]**	**Assigned weight[3]**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	52%	6	6.20%	51%	2	7.17%
Riffle	24%	2	8.53%	0%	0	0.00%
Shallow Pool	0%	0	0.00%	2%	2	0.34%
Deep Pool	24%	3	5.84%	47%	3	4.40%

South Fork San Joaquin River - Mono Crossing to Bear Creek Reach									
Channel Type	**B**			**C**			**G**		
Percent of Reach Length	***58.9%***			***20.4%***			***20.7%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	28%	4	4.14%	19%	2	1.89%	23%	3	1.57%
Riffle	28%	2	8.13%	37%	3	2.53%	26%	2	2.71%
Shallow Pool	0%	0	0.00%	0%	0	0.00%	8%	2	0.79%
Deep Pool	44%	3	8.70%	44%	3	3.00%	43%	3	3.00%

1 Percent of length of Rosgen channel type comprised of this mesohabitat type.

2 Number of transects from transect selection process.

3 Weight assigned to each transect of this mesohabitat type in this reach based on proportional composition of Rosgen channel type, mesohabitat type and number of transect representing a mesohabitat type. Percentages must add to 100 in each reach.

Table CAWG 3-4. Number of Transects Selected for Each Stream Reach by Rosgen Channel Type and Mesohabitat Type (continued).

South Fork San Joaquin River - Rattlesnake Crossing to Mono Crossing						
Channel Type	**B**			**G**		
Percent of Reach Length	***65.36%***			***34.64%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	19%	4	3.02%	12%	3	1.37%
Riffle	33%	2	10.85%	25%	2	4.27%
Shallow Pool	0%	0	-	0%	2	-
Deep Pool	48%	3	10.52%	63%	3	7.33%

South Fork San Joaquin River- Hoffman Creek to Rattlesnake Crossing			
Channel Type	**G**		
Percent Of Reach Length	***100%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	23%	3	7.78%
Riffle	27%	2	13.46%
Shallow Pool	0%	2	-
Deep Pool	50%	3	16.58%

Table CAWG 3-4. Number of Transects Selected for Each Stream Reach by Rosgen Channel Type and Mesohabitat Type (continued).

Bear Creek - below Bear Diversion Reach			
Channel Type	**B**		
Percent Of Reach Length	***100%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	0%	0	-
Riffle	31%	3	10.33%
Shallow Pool	19%	3	6.34%
Deep Pool	50%	3	16.67%

Mono Creek - below Mono Diversion Reach			
Channel Type	**B**		
Percent Of Reach Length	***100%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	50%	5	10.06%
Riffle	12%	4	3.12%
Shallow Pool	6%	5	1.19%
Deep Pool	31%	7	4.47%

Table CAWG 3-4. Number of Transects Selected for Each Stream Reach by Rosgen Channel Type and Mesohabitat Type (continued).

San Joaquin River Reach- Mammoth Reach						
Channel Type	**B**			**G**		
Percent of Reach Length	***54.3%***			***45.7%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	18%	4	2.46%	7%	5	0.59%
Riffle	14%	3	2.47%	15%	2	3.38%
Shallow Pool	0%	0	-	0%	0	-
Deep Pool	68%	7	5.29%	79%	10	3.59%

San Joaquin River - Stevenson Reach			
Channel Type	**G**		
Percent of Reach Length	***100%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	14%	2	7.03%
Riffle	10%	1	10.00%
Shallow Pool	6%	3	1.91%
Deep Pool	70%	4*	17.55%

* Deep Pool transects from SJR- Mammoth Site- BiCEP transects

Table CAWG 3-4. Number of Transects Selected for Each Stream Reach by Rosgen Channel Type and Mesohabitat Type (continued).

Big Creek - Powerhouse 2 to Dam 4 Reach						
Channel Type	**A**			**B**		
Percent of Reach Length	***95.3%***			***4.7%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	7%	3	2.34%	0%	0	-
Riffle	9%	3	2.88%	25%	2	0.60%
Shallow Pool	19%	3	6.03%	0%	0	-
Deep Pool	65%	5	12.31%	75%	3	1.17%

Big Creek - Powerhouse 8 to Dam 5 Reach						
Channel Type	**A**			**Aa+**		
Percent of Reach Length	***70.9%***			***29.1%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	3%	2	1.13%	0%	0	-
Riffle	9%	4	1.59%	0%	0	-
Shallow Pool	18%	3	4.23%	17%	4	1.25%
Deep Pool	70%	4	12.40%	83%	3	8.03%

Table CAWG 3-4. Number of Transects Selected for Each Stream Reach by Rosgen Channel Type and Mesohabitat Type (continued).

North Fork Stevenson Creek - Below Outlet Reach									
Channel Type	**Aa+**			**B**			**C**		
Percent of Reach Length	***57.5%***			***23.0%***			***19.5%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	19%	1	11.10%	0%	0	-	45%	3	2.92%
Riffle	29%	3	5.57%	10%	3	0.77%	13%	2	1.26%
Shallow Pool	18%	2	5.05%	0%	0	-	15%	2	1.46%
Deep Pool	34%	3	6.53%	90%	3	6.91%	27%	2	2.63%

Stevenson Creek- Powerhouse 3 to Dam 6 Reach									
Channel Type	**A**			**Aa+**			**B**		
Percent of Reach Length	***16.3%***			***52.8%***			***30.9%***		
Habitat Classification	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**	**Percent**	**No. of transects**	**Assigned weight**
Flatwater	8%	2	0.69%	22%	2	5.66%	11%	1	3.51%
Riffle	16%	1	2.61%	0%	0	-	7%	2	1.04%
Shallow Pool	27%	2	2.32%	24%	3	4.27%	15%	3	1.54%
Deep Pool	48%	2	3.93%	54%	3	9.55%	67%	2	10.30%

Table CAWG 3-5. Proposed Calibration Flows and Range of Simulation Flows by Stream Reach.

Stream	Proposed Calibration Flow (cfs)			Proposed Range of Simulation Flows	
	Low	Mid	High	Low	High
SF San Joaquin River	27	60	100	10	250
Mono Creek	13	25	50	5	125
Big Creek Below Dam 4	3	15	40	1.2	100
Big Creek Below Dam 5	3	15	40	1.2	100
San Joaquin River - Mammoth Reach	30	80	200	12	500
San Joaquin River - Stevenson Reach	7	35	200	3	500
NF Stevenson Creek	3	10	30	1.5	75
Stevenson Creek	3	10	20	1.2	50
Bear Creek	5	35	50	2	125

Table CAWG 3-6. Substrate and Cover Coding Classification.

SUBSTRATE	SIZE (MM)	CODE	COVER	SIZE (MM)	CODE
Fines	< 4	1	No Cover		1
Small Gravel	4-25	2	Small Object	< 150	2
Large Gravel	25-75	3	Medium Object	150-300	3
Cobble	75-225	4	Large Object	> 300	4
Rubble	225-300	5	Overhanging Vegetation < 450 mm from water surface		5
Small Boulder	300-600	6	Rootwad or Undercut Bank		6
Large Boulder	> 600	7	Surface Turbulence		7
Bedrock	-	8			
Other		9			

Table CAWG 3-7. Criteria for Evaluating the Relative Quality of Velocity Data.

% Variation about Calibration Discharge	Rating	Interaction with Habitat Criteria Curves
less than 5%	Excellent	Suitable for Validation Studies, Criteria Development, R&D
5% to 15%	Good	Suitable for use with the most refined curves without diluting the overall quality of the analysis.
15% to 30%	Fair	Suitable for routine application with most existing curve sets
above 30%	Poor	Will dilute quality of overall analysis; particularly for life history stages with narrow tolerance limits
above 50%	Not recommended for use in definitive analyses	

Table CAWG 3-8. Big Creek ALP Habitat Suitability Criteria for Rainbow Trout.

Adult

Velocity	Suitability	Depth	Suitability
0.00	0.60	0.00	0.00
0.35	1.00	0.10	0.00
1.10	1.00	0.20	0.00
1.80	0.26	0.30	0.02
2.95	0.26	0.40	0.03
3.05	0.00	0.50	0.04
100.00	0.00	0.60	0.05
		0.70	0.06
		0.80	0.07
		0.90	0.10
		1.10	0.38
		1.30	0.60
		1.50	0.76
		1.90	1.00
		3.50	1.00
		10.00	0.50
		100.00	0.50

Juvenile

Velocity	Suitability	Depth	Suitability
0.00	0.73	0.40	0.00
0.05	0.81	0.50	0.24
0.15	1.00	0.70	0.56
0.25	1.00	0.90	1.00
0.35	1.00	1.10	1.00
0.50	1.00	1.30	1.00
0.65	0.82	1.50	1.00
0.75	0.72	1.70	1.00
0.85	0.62	1.90	1.00
0.95	0.52	2.10	1.00
1.05	0.42	2.70	0.51
1.15	0.33	2.90	0.41
1.25	0.25	3.10	0.32
1.35	0.19	3.30	0.25
1.45	0.14	3.50	0.18
1.55	0.11	3.70	0.14
2.25	0.11	3.90	0.11
2.85	0.11	4.90	0.11
2.95	0.00	5.10	0.10
100.00	0.00	5.30	0.09
		5.50	0.06
		100.00	0.06

Fry

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.50	1.00	0.40	1.00
1.00	0.20	1.50	1.00
1.50	0.10	1.60	1.00
3.00	0.00	1.70	0.97
100.00	0.00	1.80	0.93
		1.90	0.86
		2.00	0.79
		2.10	0.71
		2.20	0.62
		2.30	0.53
		2.40	0.45
		2.50	0.37
		2.60	0.30
		2.70	0.23
		2.80	0.18
		2.90	0.14
		3.00	0.10
		100.00	0.10

Spawning

Velocity	Suitability	Depth	Suitability	Substrate	Suitability
0.13	0.00	0.10	0.00	0.00	0.00
0.65	1.00	0.50	1.00	100.00	1.00
1.15	1.00	1.50	1.00		
1.63	1.00	1.77	0.43		
3.00	0.00	5.00	0.43		
100.00	0.00	100.00	0.43		

Table CAWG 3-9. Big Creek ALP Habitat Suitability Criteria for Brown Trout.

Adult

Velocity	Suitability	Depth	Suitability
0.00	0.70	0.00	0.00
0.30	1.00	0.38	0.00
0.75	1.00	1.70	1.00
0.85	0.83	3.50	1.00
0.95	0.73	10.00	0.50
1.05	0.62	100.00	0.50
1.15	0.51		
1.25	0.39		
1.35	0.29		
1.45	0.20		
1.55	0.18		
2.25	0.16		
2.50	0.00		
100.00	0.00		

Juvenile

Velocity	Suitability	Depth	Suitability
0.00	0.73	0.35	0.00
0.15	1.00	0.50	0.39
0.50	1.00	0.70	0.72
0.55	0.80	0.90	1.00
0.65	0.65	1.90	1.00
0.75	0.51	2.00	0.99
0.85	0.37	2.10	0.97
0.95	0.26	2.20	0.95
1.05	0.19	2.30	0.92
1.15	0.11	2.40	0.88
2.75	0.11	2.50	0.84
2.85	0.00	2.60	0.79
100.00	0.00	2.70	0.74
		2.80	0.69
		2.90	0.64
		3.00	0.58
		3.10	0.53
		3.20	0.48
		3.30	0.43
		3.40	0.38
		3.50	0.34
		3.60	0.29
		3.70	0.25
		3.80	0.22
		3.90	0.19
		4.00	0.16
		4.10	0.14
		100.00	0.14

Fry

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.50	1.00	0.40	1.00
1.00	0.20	1.75	1.00
1.50	0.10	2.25	0.30
3.00	0.00	4.00	0.00
100.00	0.00	100.00	0.00

Spawning

Velocity	Suitability	Depth	Suitability	Substrate	Suitability
0.00	0.00	0.10	0.00	0.00	0.00
0.50	1.00	0.50	1.00	100.00	1.00
1.25	1.00	1.50	1.00		
2.25	0.00	1.77	0.43		
100.00	0.00	5.00	0.43		
		100.00	0.43		

Table CAWG 3-10. Big Creek ALP Habitat Suitability Criteria for Hardhead[1].

Adult

Velocity	Suitability	Depth	Suitability
0.00	1.00	1.05	0.00
0.90	1.00	1.30	0.13
1.75	0.08	1.95	0.40
2.50	0.00	2.60	0.66
100.00	0.00	3.30	0.88
		3.60	0.95
		3.95	0.99
		4.20	1.00
		7.33	1.00
		8.00	0.90
		8.67	0.72
		9.33	0.59
		10.00	0.54
		10.67	0.54
		11.33	0.54
		12.00	0.54
		12.67	0.54
		13.33	0.53
		14.00	0.47
		14.67	0.41
		15.33	0.40
		16.00	0.39
		100.00	0.39

Juvenile

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.50	0.00
0.50	0.90	1.00	1.00
1.75	0.25	7.00	1.00
2.60	0.00	12.00	0.15
100.00	0.00	18.00	0.00
		100.00	0.00

Table CAWG 3-11. Big Creek ALP Habitat Suitability Criteria for Pikeminnow.

Adult

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.82	1.00	0.66	0.03
1.15	0.37	1.50	1.00
2.00	0.00	3.28	1.00
100.00	0.00	4.59	0.44
		5.91	0.24
		7.22	0.15
		11.15	0.13
		12.47	0.08
		14.11	0.00
		100.00	0.00

Juvenile

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.19	1.00	0.66	0.71
0.48	0.72	1.00	1.00
0.82	0.42	1.97	1.00
1.14	0.20	3.28	0.76
1.48	0.00	4.59	0.18
100.00	0.00	5.91	0.03
		6.73	0.00
		100.00	0.00

Table CAWG 3-12. Big Creek ALP Habitat Suitability Criteria for Sacramento Sucker.

Adult

Velocity	Suitability	Depth	Suitability
0.00	0.68	0.00	0.00
0.25	0.82	2.25	1.00
0.42	0.90	7.00	1.00
0.58	0.96	10.00	0.75
0.75	1.00	16.00	0.75
0.92	1.00	100.00	0.75
1.08	0.96		
1.25	0.89		
1.42	0.78		
1.58	0.66		
1.75	0.55		
1.92	0.48		
2.08	0.44		
2.25	0.44		
2.42	0.45		
2.58	0.46		
2.75	0.46		
2.92	0.42		
3.08	0.36		
3.25	0.28		
3.42	0.21		
3.58	0.14		
3.75	0.09		
3.92	0.05		
4.08	0.03		
4.25	0.02		
4.50	0.00		
100.00	0.00		

Juvenile

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.25	1.00	0.66	1.00
0.42	0.85	2.00	1.00
0.58	0.69	4.70	0.25
0.75	0.54	8.00	0.00
0.92	0.41	100.00	0.00
1.08	0.30		
1.25	0.23		
1.42	0.19		
1.58	0.17		
3.75	0.00		
100.00	0.00		

Table CAWG 3-13. Model Calibration Flows by Stream Reach and Location.

Stream	Site	Rosgen Channel	Proposed Flow (cfs)			Measured Flows (cfs)		
			Low	Mid	High	Low	Mid	High
SF San Joaquin River	Bear Creek to Florence Lake	C	27	60	100	20.7	41.4	114.2
		B				20.7	49.8	114.2
SF San Joaquin River	Mono Crossing to Bear Creek	C	27	60	100	24.9	53.6	109.2
		B				24.7	51.6	113.1
		G				23.5	51.6	113.1
Mono Creek	Upper Site	B	13	25	50	8.8	19.6	71.9
	Below Mono Diversion	B				13	22.6	70
Upper Big Creek	PH 2 to Dam 4 [1]	A	3	15	40	3.7	14.1	39.3
		A&B				0.73	9.3	39.3
Lower Big Creek	PH 8 to Dam 5	A	3	15	40	3.8	20	46.8
		Aa+				3.2	17.8	51.1
San Joaquin River	Mammoth Reach	B	30	80	200	80.6	152.5	261.8
		G				25	91.1	200
San Joaquin River	Stevenson Reach [2]	G	7	35	200	6	83	242
NF Stevenson Creek	Below Outlet Reach	B	3	10	30	4.7	14.2	30.8
		C				4.8	13.4	30.7
		Aa+				4.6	11.2	27.2
Stevenson Creek	PH 3 to Dam 6	Aa+	3	10	20	4	19	45
		B				4	19	45
		A				4	19	50
Bear Creek	N/A	B	5	35	50	2.8	29	50

[1] The A channel transects in Big Creek below Dam 4 were placed in two sites, one above PH 2 and one near the road crossing between Camp Sierra and Big Creek. The B channel transects were located near the road crossing.

[2] Due to difficulties with flow control at Dam 6, the flow in this reach varied during measurements from transect to transect. The numbers reported here represent the approximate averages of the calibration flows.

Table CAWG 3-14. Passage flows for riffle transects in Big Creek PHABSIM upper basin streams.

Stream	Reach	Transect	Flow	Pass Width	Total Stream Width	Percent Width	Contiguous Width[1]
SF SJR	SSJ-FB	HGR 103-1	8.28	26.2	42	62.33	-
SF SJR	SSJ-FB	HGR 105-1	8.28	13.9	34.1	40.63	-
		Average	8.28				
SF SJR	SSJ-MB	LGR 190-1	30.00	16.2	59.8	27.09	-
SF SJR	SSJ-MB	LGR 190-2	10.00	18	46.7	38.53	-
SF SJR	SSJ-MG	LGR 205-1	10.00	22.6	26.9	84.19	-
SF SJR	SSJ-MG	LGR 205-2	10.00	18	20.2	89.1	-
SF SJR	SSJ-MC	HGR 244-1	10.00	13.5	24.8	54.37	-
SF SJR	SSJ-MC	LGR 244-2	10.00	11.5	44.2	26.03	-
SF SJR	SSJ-MC	LGR 244-3	10.00	24	41.8	57.43	-
		Average	12.86				
Bear Creek	BC-B	T4 RIFF	1.12	5.6	14.8	37.49	-
Bear Creek	BC-B	T5 RIFF	1.12	2.7	5.6	48.71	2.71
Bear Creek	BC-B	T6 RIFF	1.12	3.4	4.6	75.27	3.45
		Average	1.12				
Mono Creek	MC-MDB	LGR 176-1	10.00	8	21	38.13	-
Mono Creek	MC-MDB	LGR 179-1	5.00	6.8	21.1	31.94	-
Mono Creek	MC_UPB	HGR 222-1	3.52	12.8	18.5	69.13	-
Mono Creek	MC_UPB	HGR 222-2	3.52	8.5	9.8	86.11	2.5
		Average	5.51				

[1] Contiguous width identified for transects less than 10 feet wide

Table CAWG 3-15. Passage flows for riffle transects in Big Creek PHABSIM lower basin streams.

Stream	Reach	Transect	Flow	Pass Width	Total Stream Width	Percent Width	Contiguous Width[1]
SJR	SJ-MB	HGR 3-1	10.00	13.6	29.1	46.58	-
SJR	SJ-MB	LGR 9-1	10.00	8	27.6	28.98	-
SJR	SJ-MG	HGR 143-1	10.00	28	46.4	60.29	-
		Average	10.00				
SJR	SJ-SG	HGR 96-1	6.00	6.7	13.5	49.63	-
SJR	SJ-SG	POW 96-2	6.00	30.5	39.1	77.9	-
SJR	SJ-SG	POW 96-3	6.00	14.9	17.9	83.22	-
		Average	6.00				
Big Creek	BC4-A	HGR 19-1	0.29	2.5	4.6	54.74	2.5
Big Creek	BC4-A	HGR 19-2	1.75	5	18.9	26.4	-
Big Creek	BC4-B	HGR 258-1	0.29	5	13.8	36.34	-
Big Creek	BC4-B	HGR 258-2	1.00	5.7	17.4	32.49	-
Big Creek	BC4-A	HGR 273-1	0.50	4.6	15.5	29.98	-
		Average	0.77				
Big Creek	BC5-A	HGR 100-1	3.50	3	10.1	29.79	-
Big Creek	BC5-A	HGR 109-1	1.51	10.8	15.1	71.42	-
Big Creek	BC5-A	HGR 109-2	1.51	8.1	8.6	93.66	6
Big Creek	BC5-A	HGR 114-1	1.51	2.5	8.3	30.08	2.5
		Average	2.01				
NF Stev Creek	NFS-C	LGR 29-1	2.50	2.1	7.1	29.79	1.6
NF Stev Creek	NFS-C	LGR 29-2	5.50	4.5	17.3	25.83	-
NF Stev Creek	NFS-B	HGR 40-1	4.00	5.8	21.9	26.29	-
NF Stev Creek	NFS-B	HGR 40-2	3.25	7	27.1	25.81	-
NF Stev Creek	NFS-B	HGR 40-3	2.00	7	12.1	57.81	-
NF Stev Creek	NFS-Aa	HGR 85-1	2.00	5.7	13.4	42.47	-
NF Stev Creek	NFS-Aa	HGR 85-2	2.00	9	19.1	47.12	-
NF Stev Creek	NFS-Aa	HGR 85-3	2.00	20.8	20.5	14.62	-
		Average	2.91				
Stevenson Creek	SC-A	HGR 40-1	3.25	3.9	13.9	28.19	-
Stevenson Creek	SC-B	HGR 133-1	6.00	6	21.6	27.72	-
Stevenson Creek	SC-B	LGR 131-1	3.50	5.3	16.6	31.89	-
		Average	4.25				

[1] Contiguous width identified for transects less than 10 feet wide

FIGURES

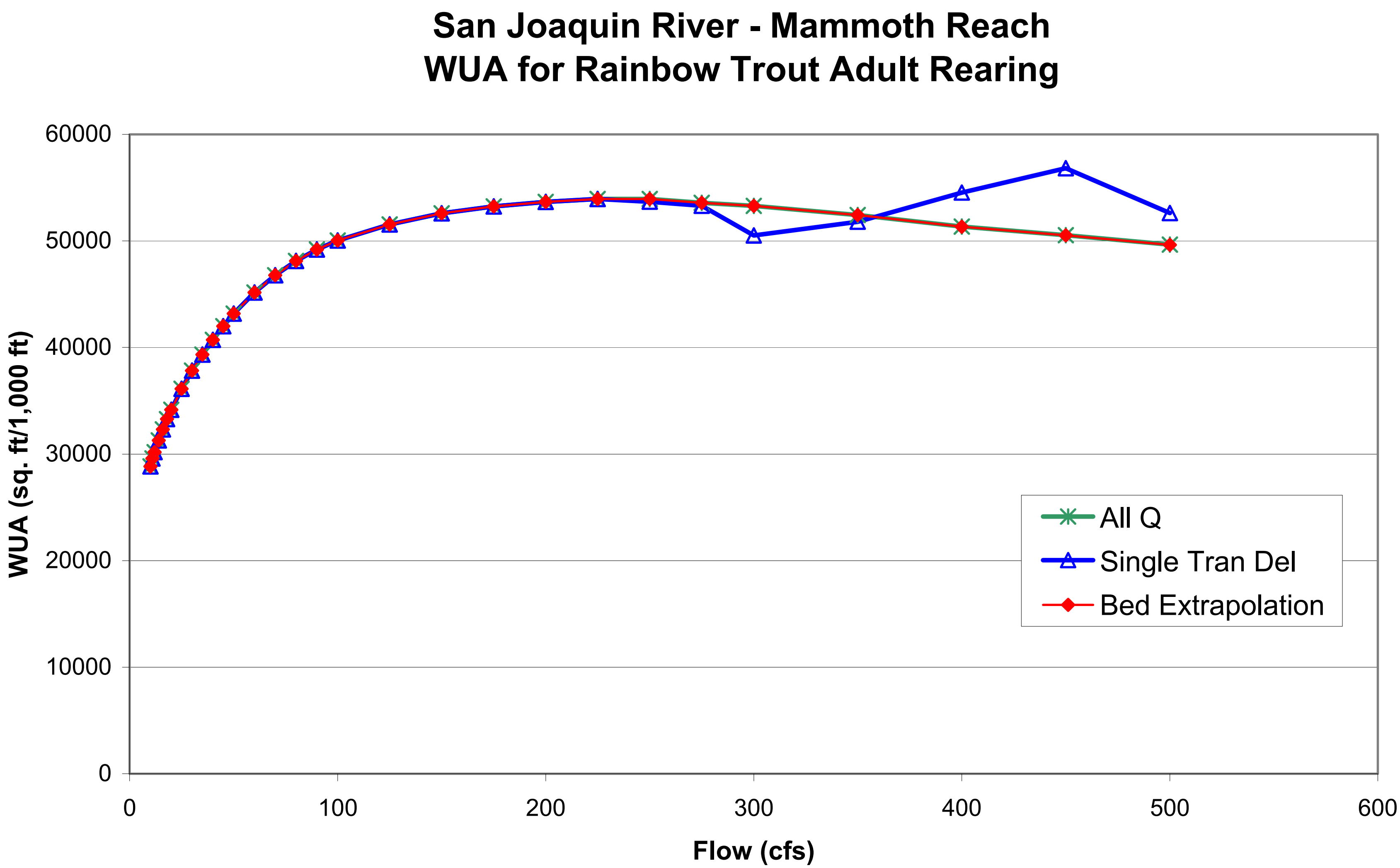


Figure CAWG 3-1. WUA for Rainbow Trout Adult Rearing in San Joaquin River - Mammoth Reach.

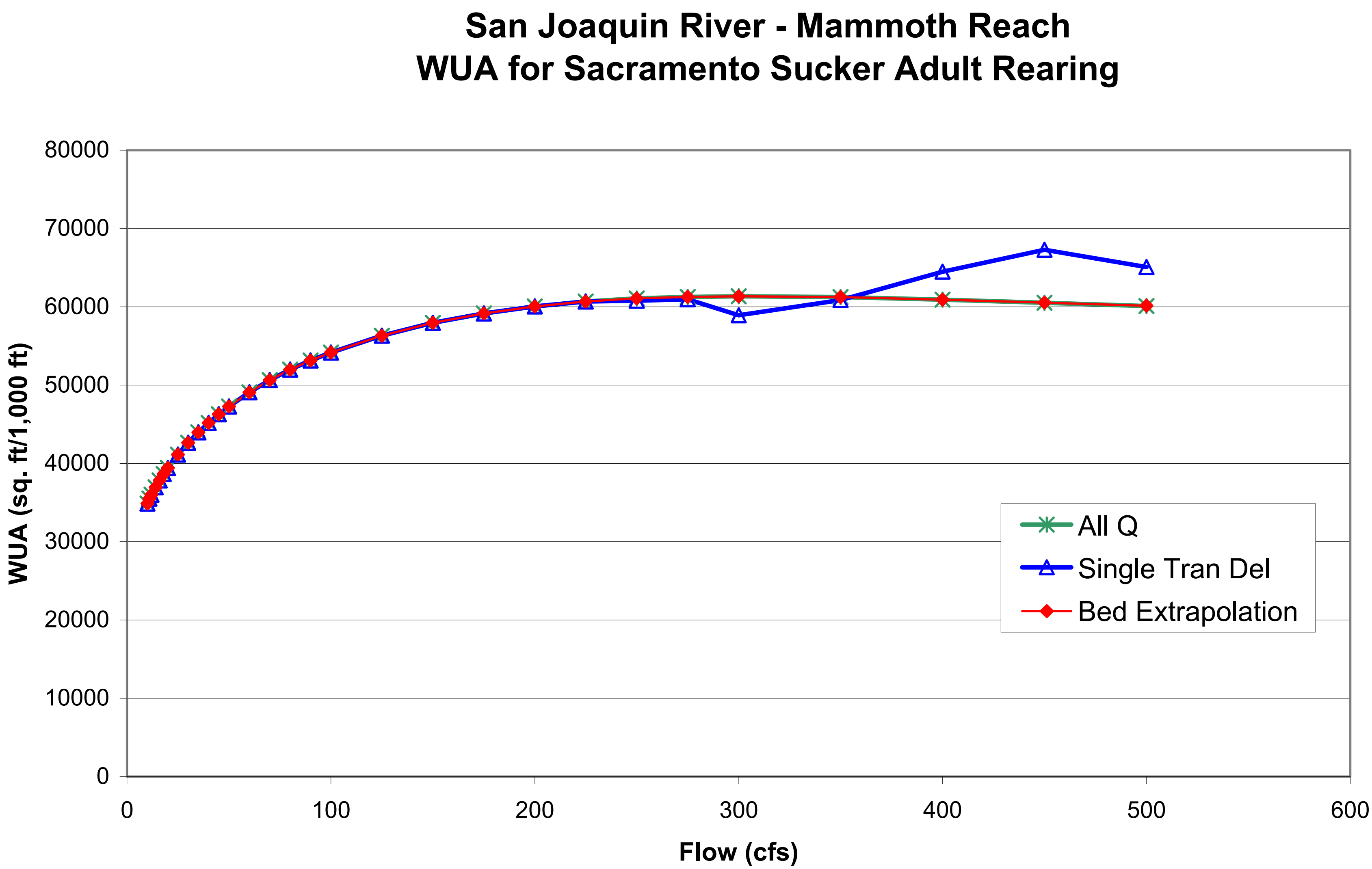


Figure CAWG 3-2. WUA for Sacramento Sucker Adult Rearing in San Joaquin River - Mammoth Reach.

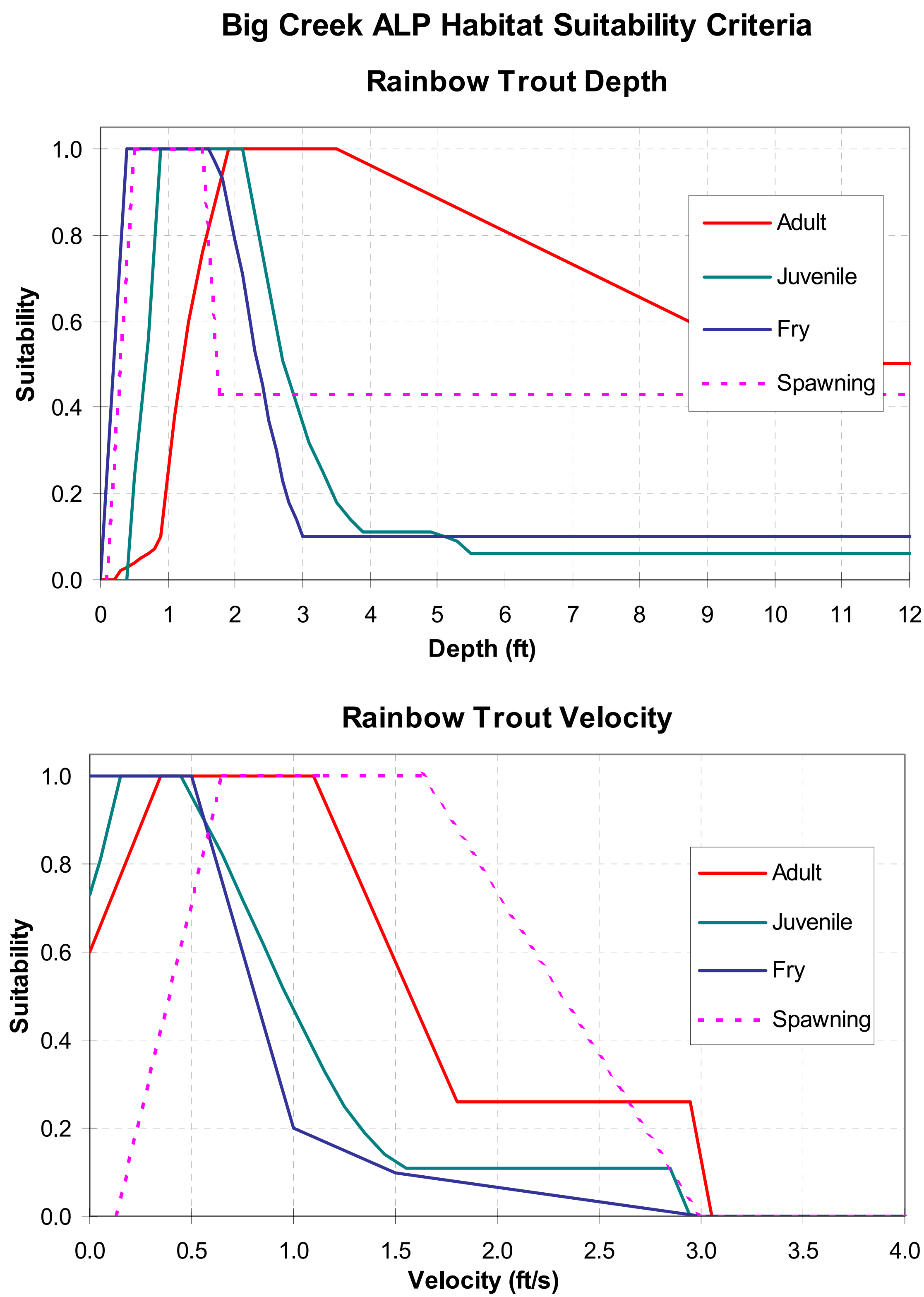
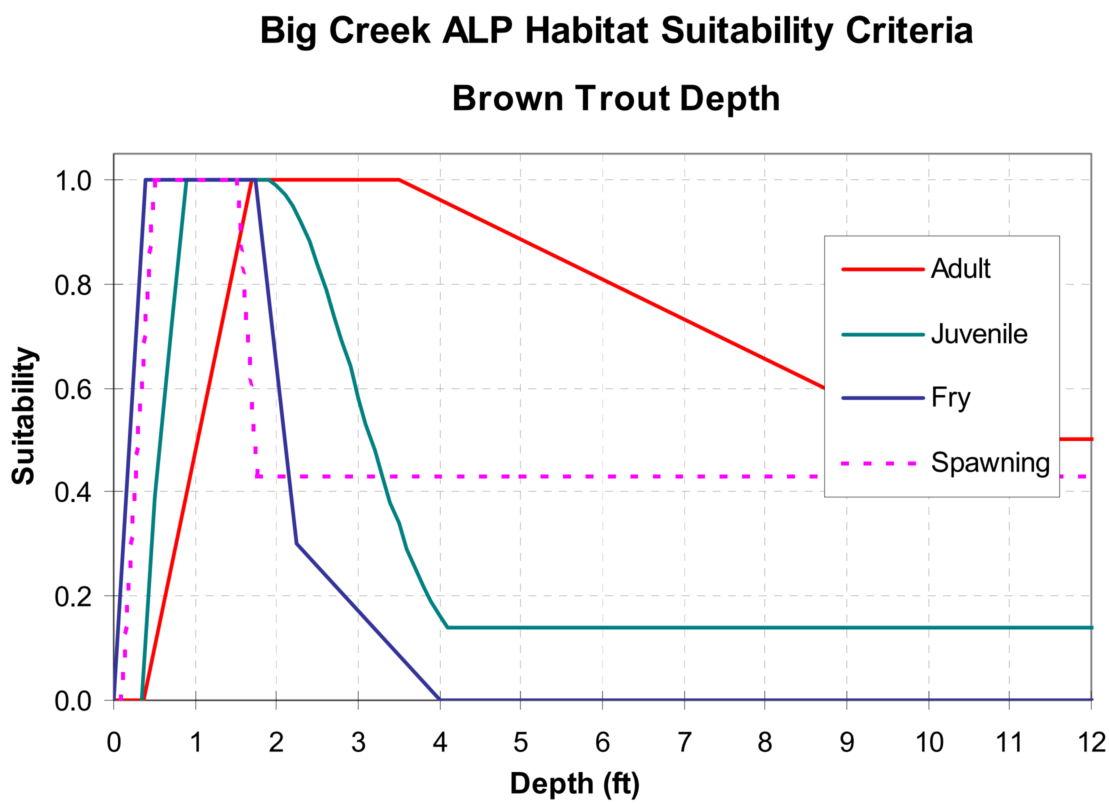


Figure CAWG 3-3. Habitat Suitability Criteria for Rainbow Trout.



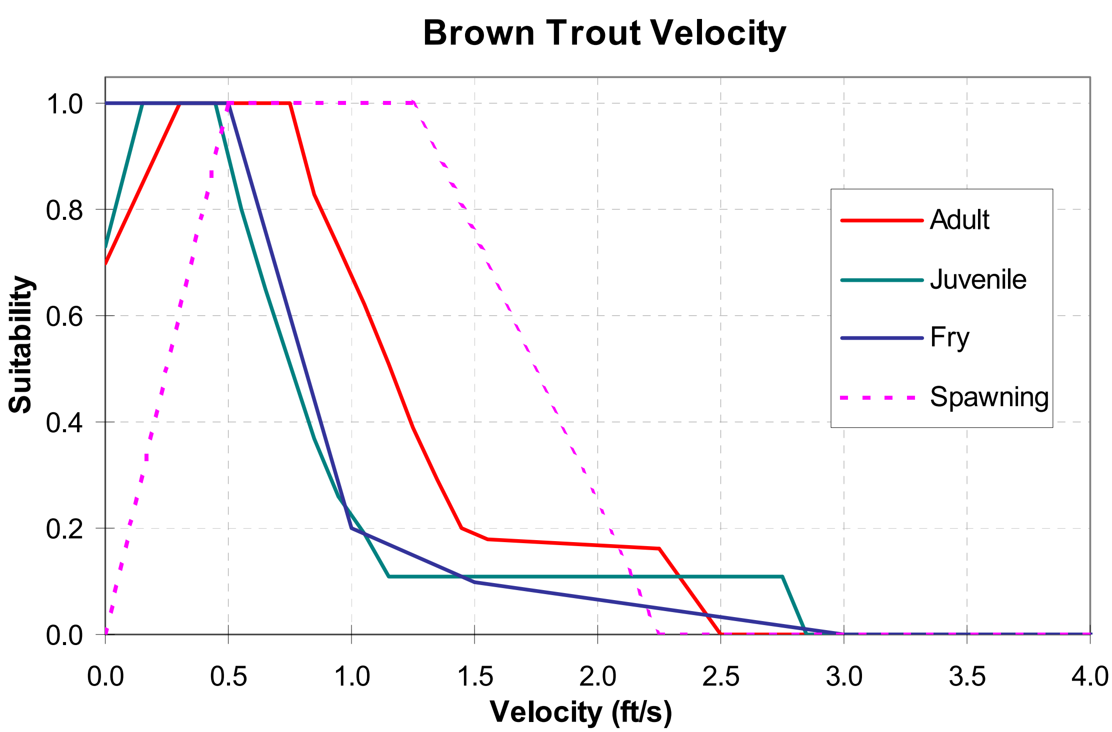


Figure CAWG 3-4. Habitat Suitability Criteria for Brown Trout.

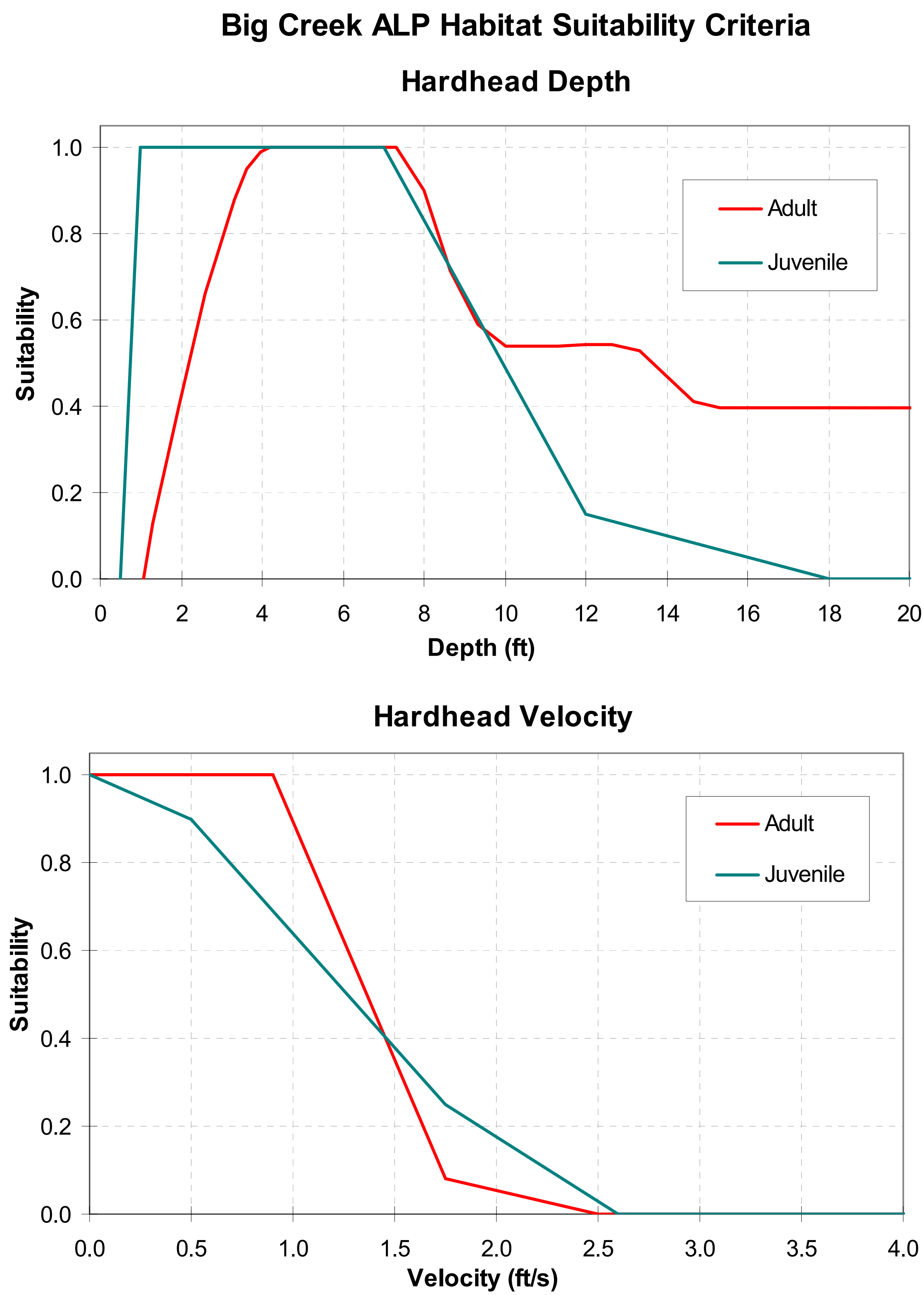


Figure CAWG 3-5. Habitat Suitability Criteria for Hardhead.

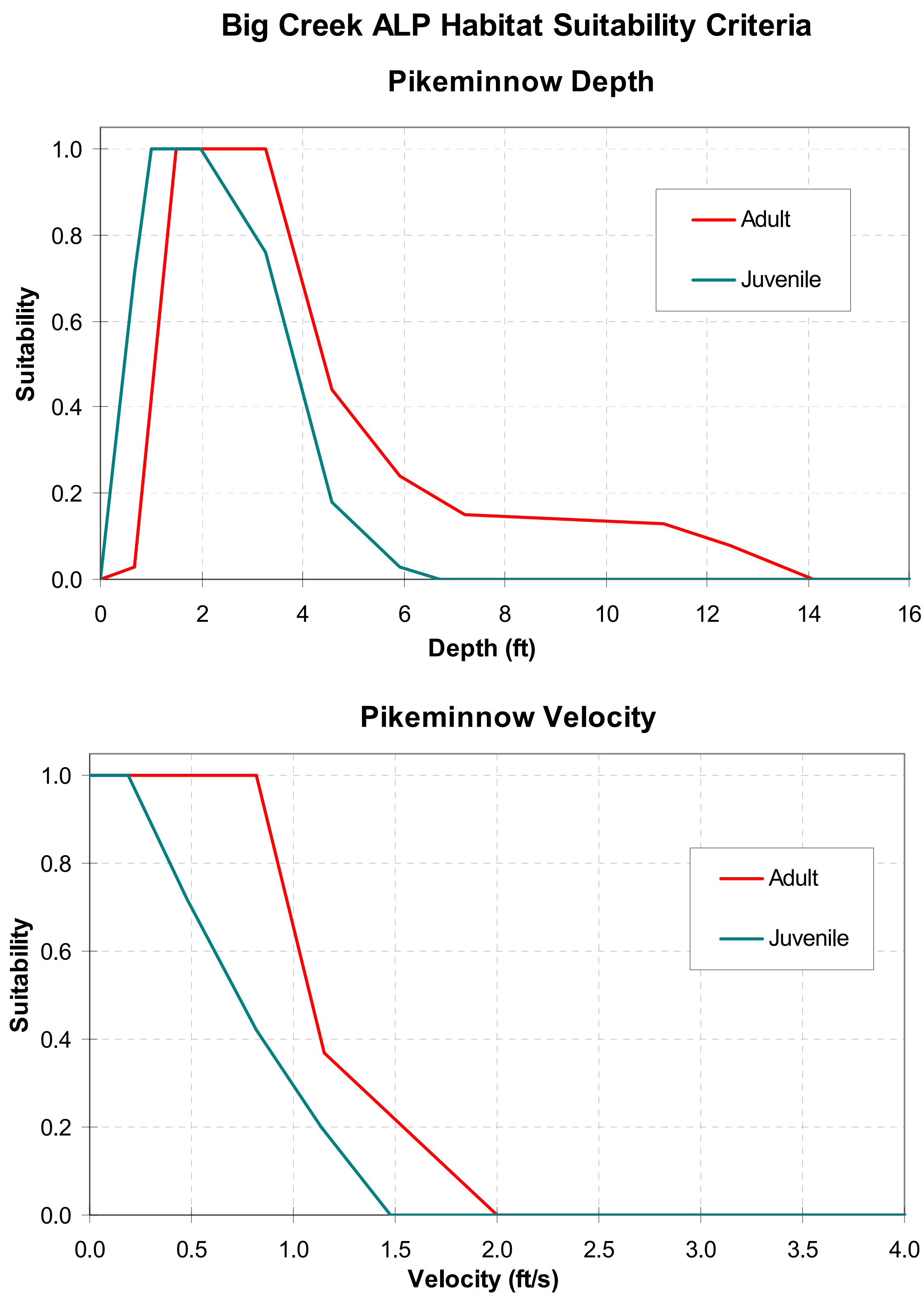


Figure CAWG 3-6. Habitat Suitability Criteria for Sacramento Pikeminnow.

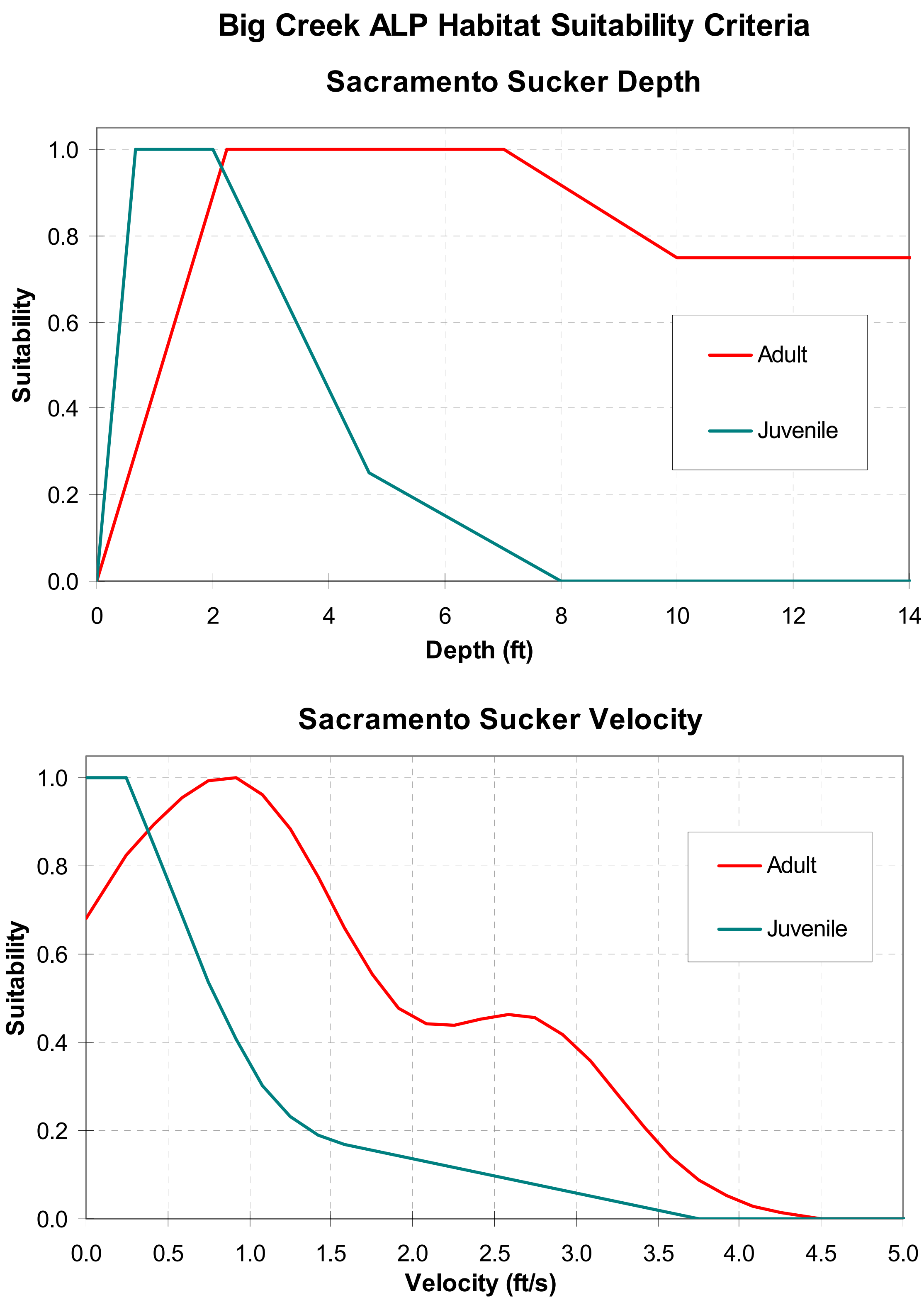
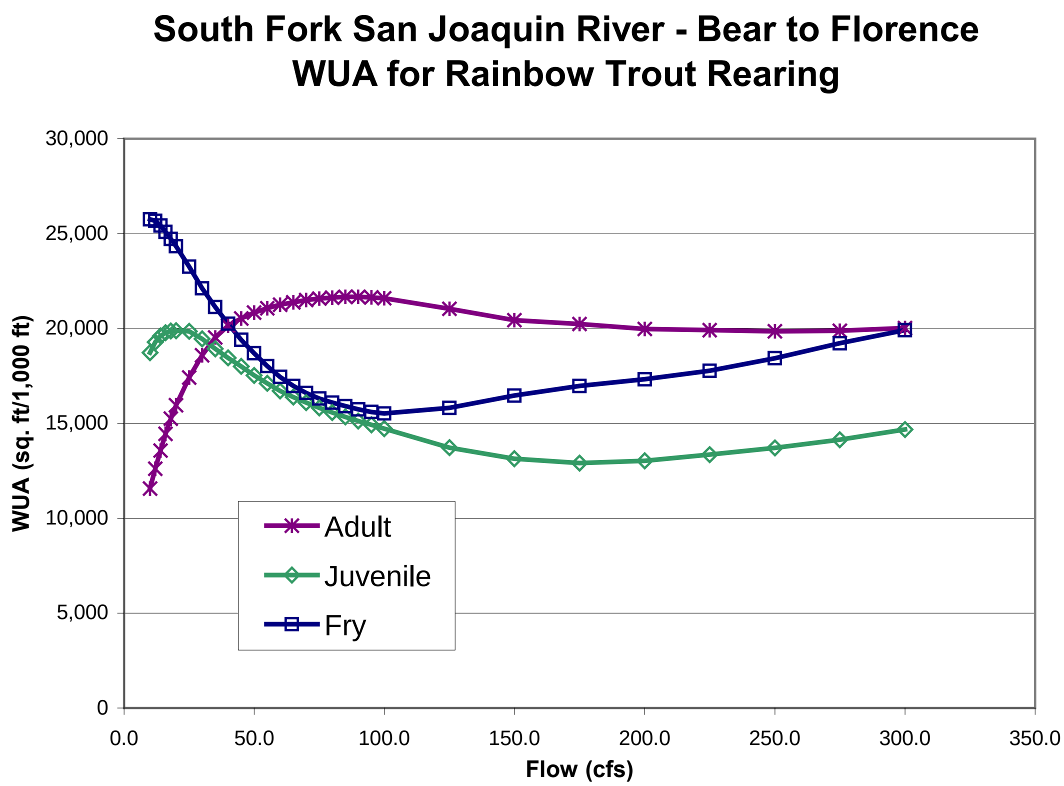


Figure CAWG 3-7. Habitat Suitability Criteria for Sacramento Sucker.



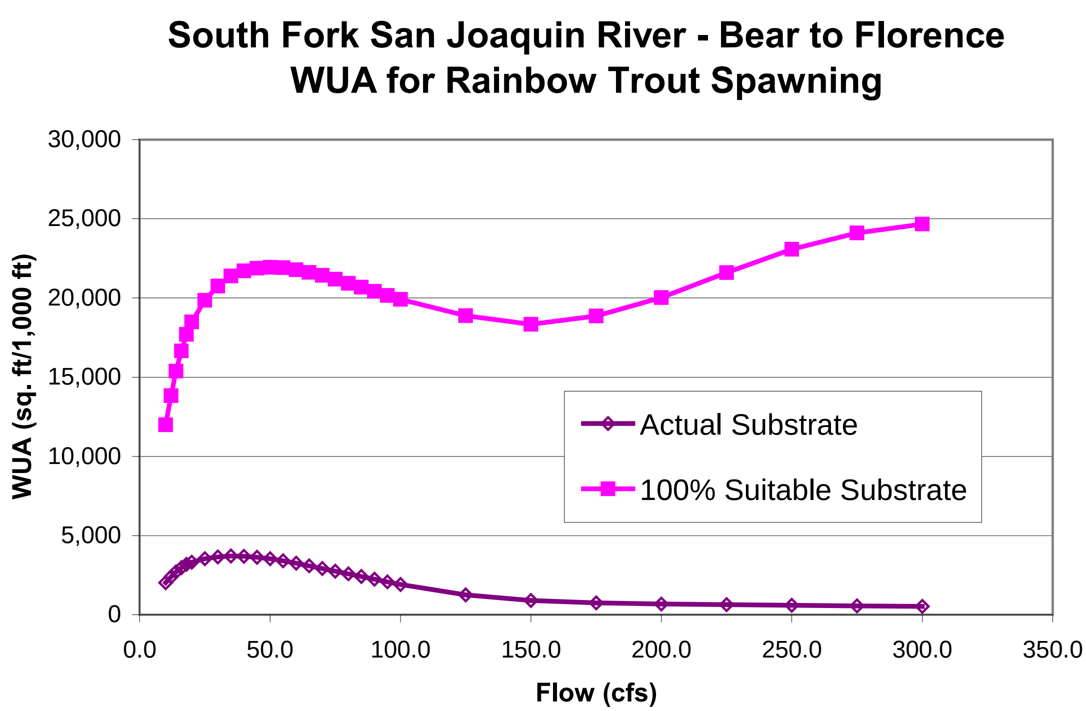
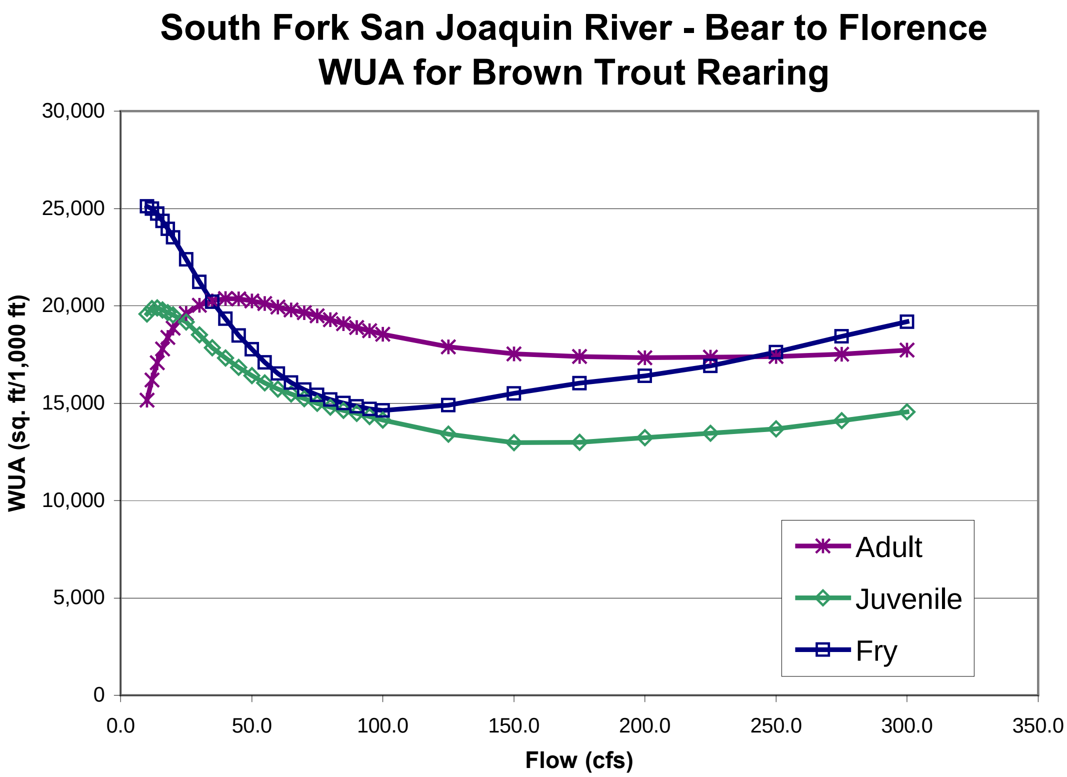


Figure CAWG 3-8. WUA for Rainbow Trout in South Fork San Joaquin River Bear to Florence Reach.



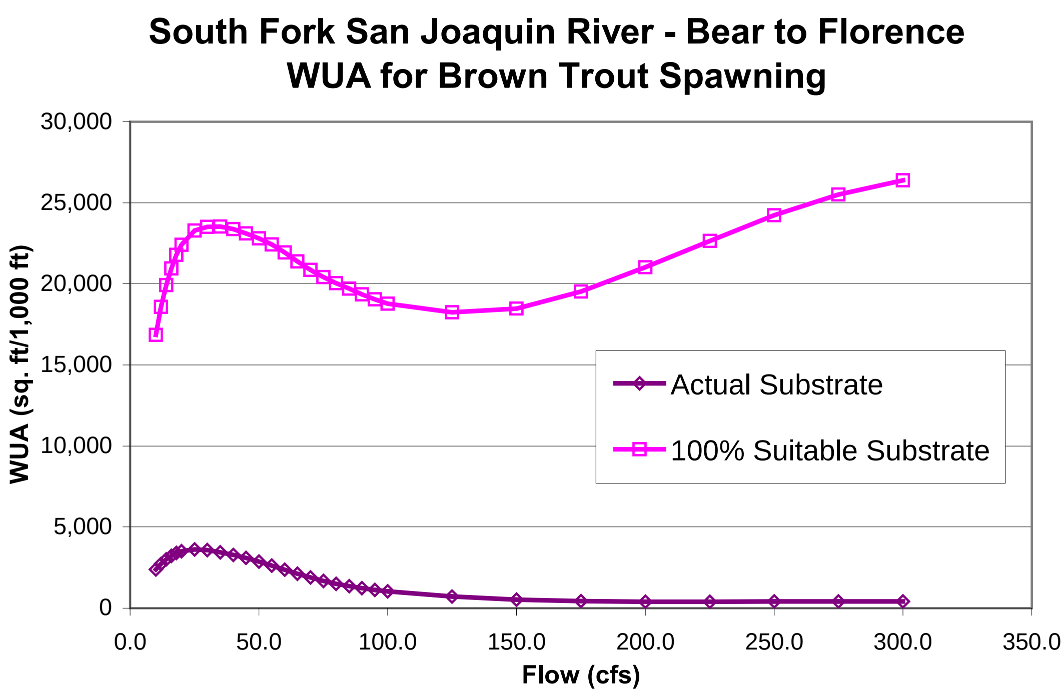
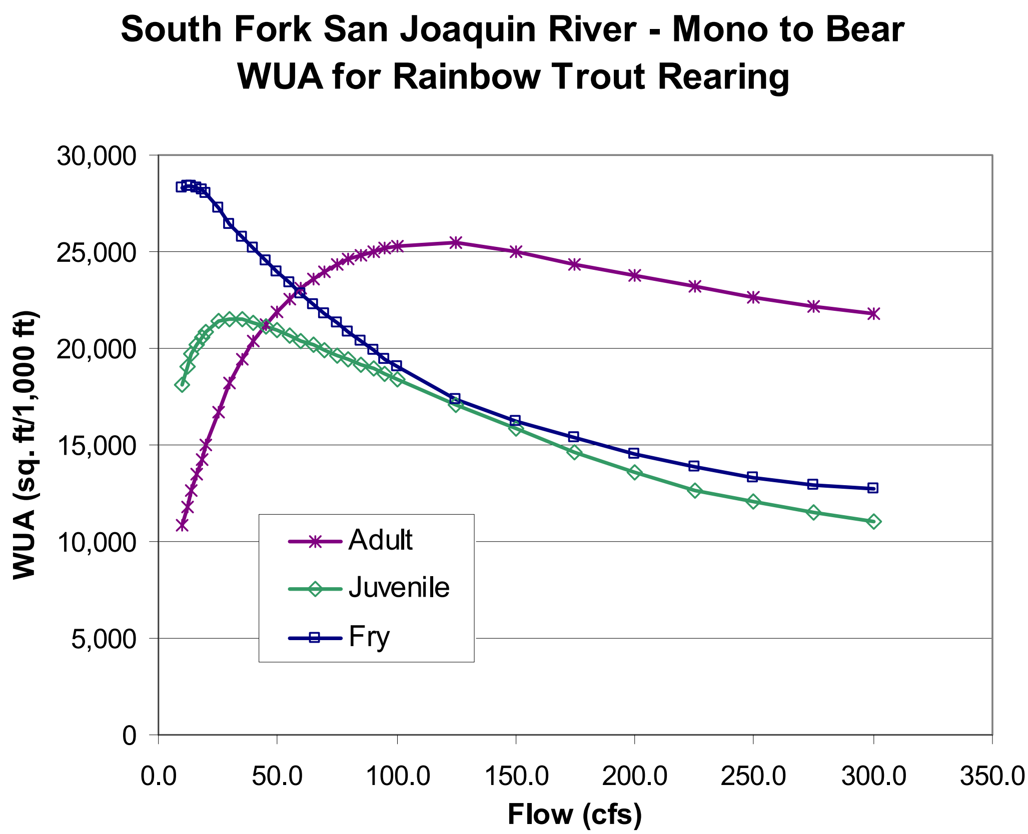


Figure CAWG 3-9. WUA for Brown Trout in South Fork San Joaquin River Bear to Florence Reach.



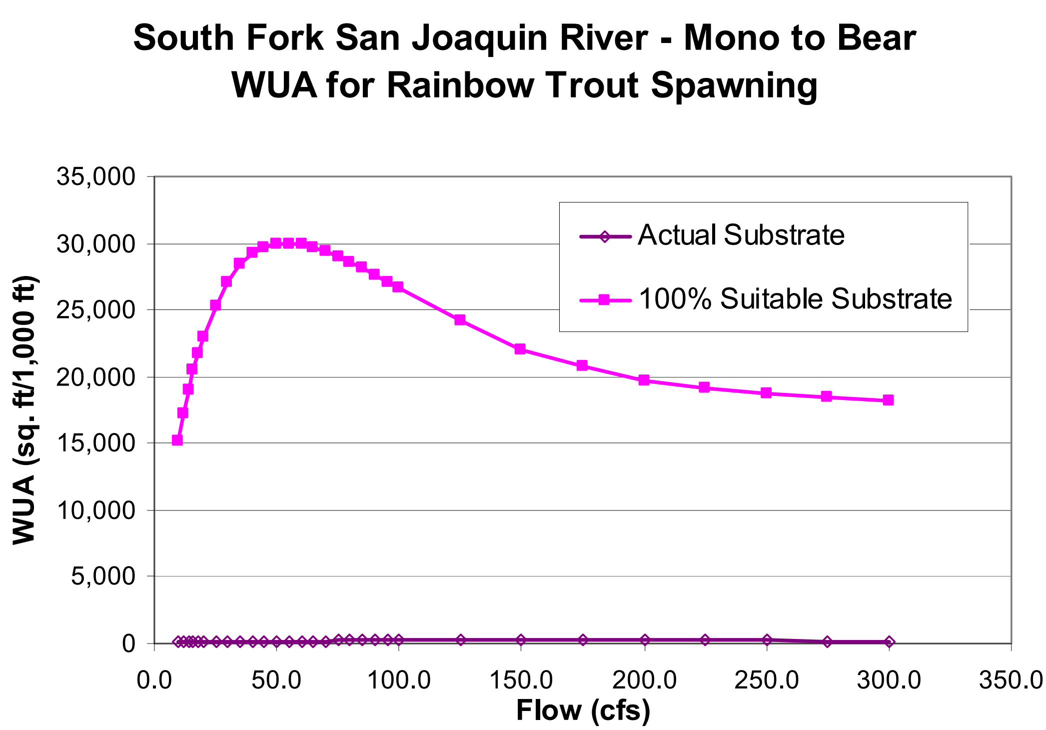
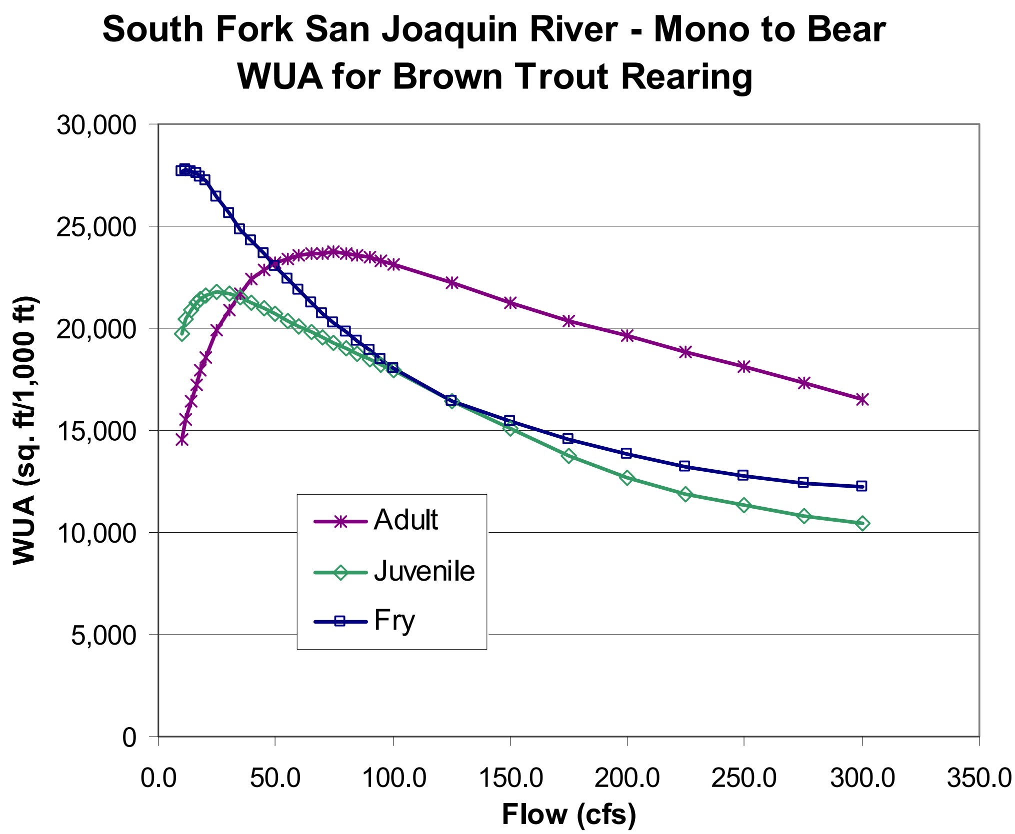


Figure CAWG 3-10. WUA for Rainbow Trout in South Fork San Joaquin River Mono to Bear Reach.



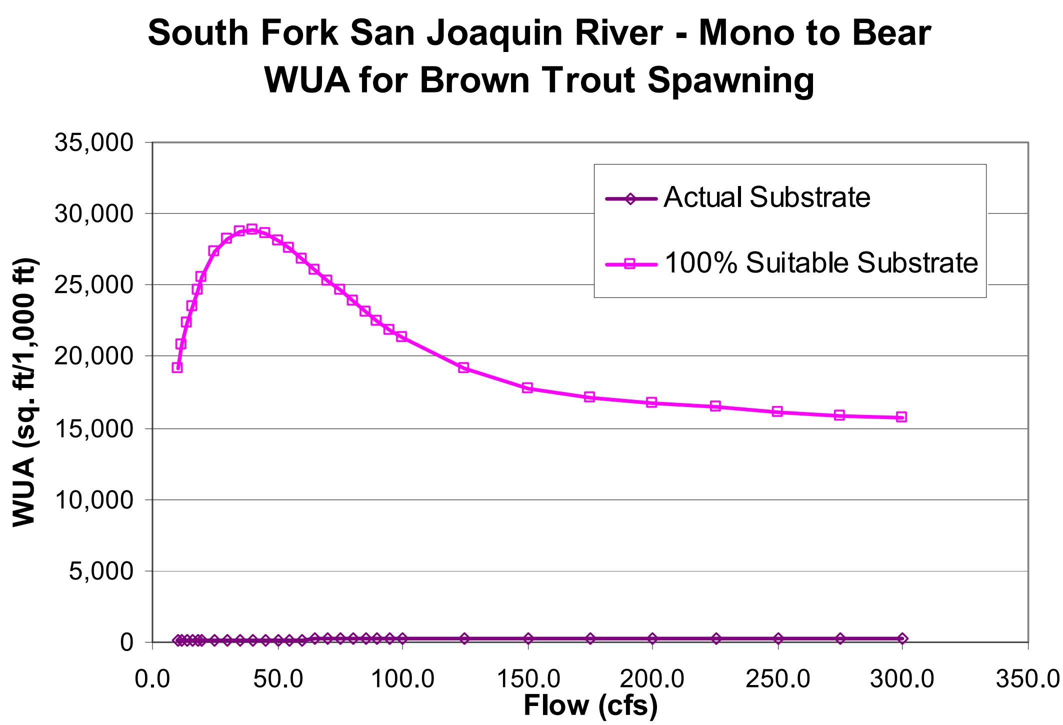
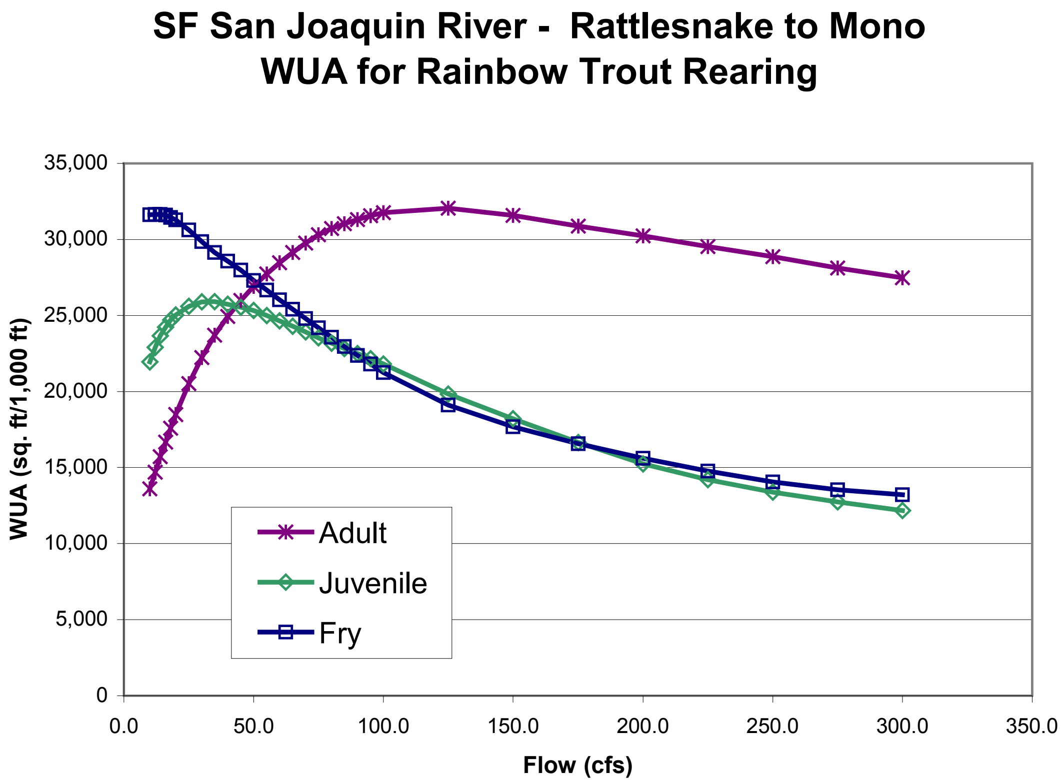


Figure CAWG 3-11. WUA for Brown Trout in South Fork San Joaquin River Mono to Bear Reach.



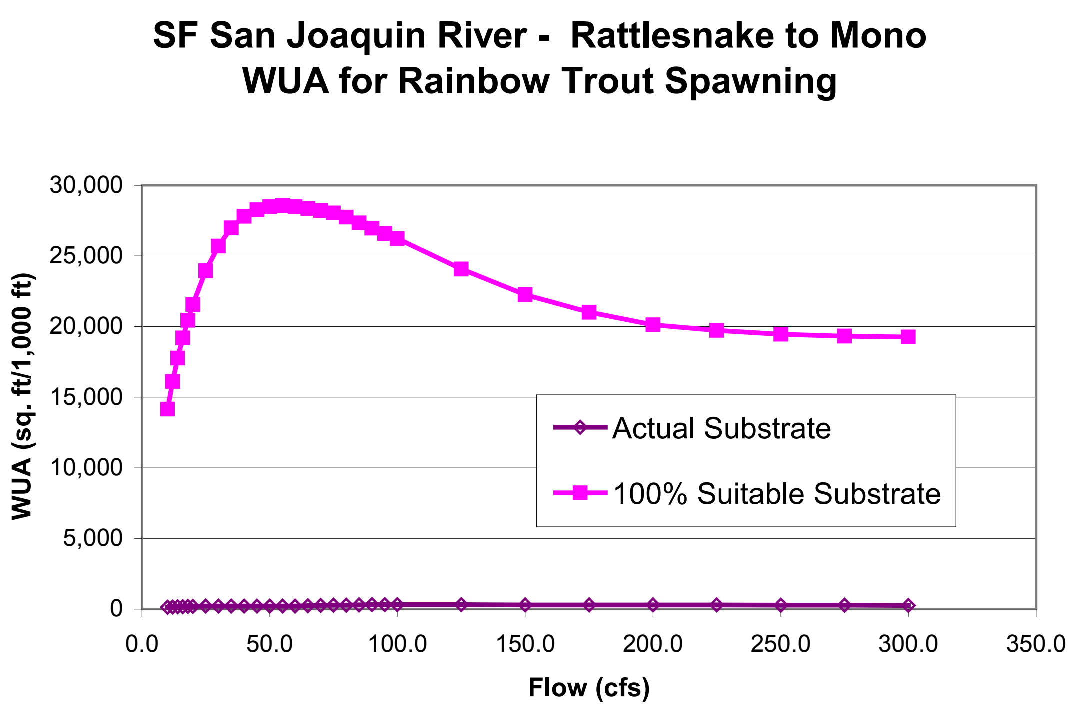
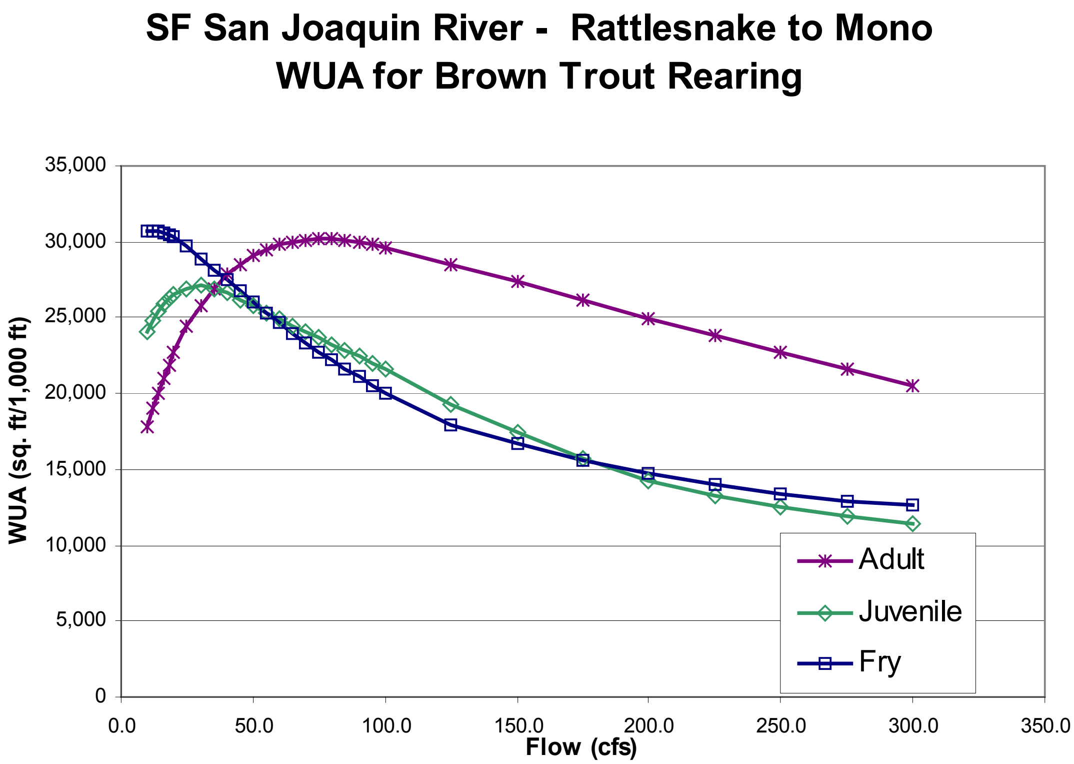


Figure CAWG 3-12. WUA for Rainbow Trout in South Fork San Joaquin River – Rattlesnake Crossing to Mono Crossing Reach.



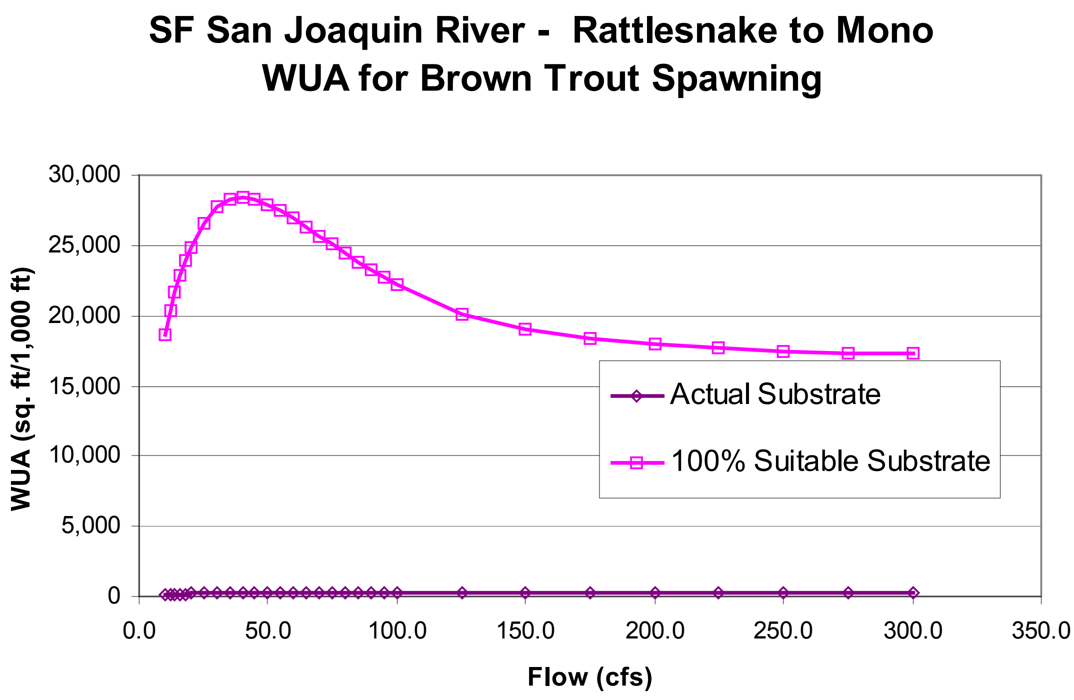
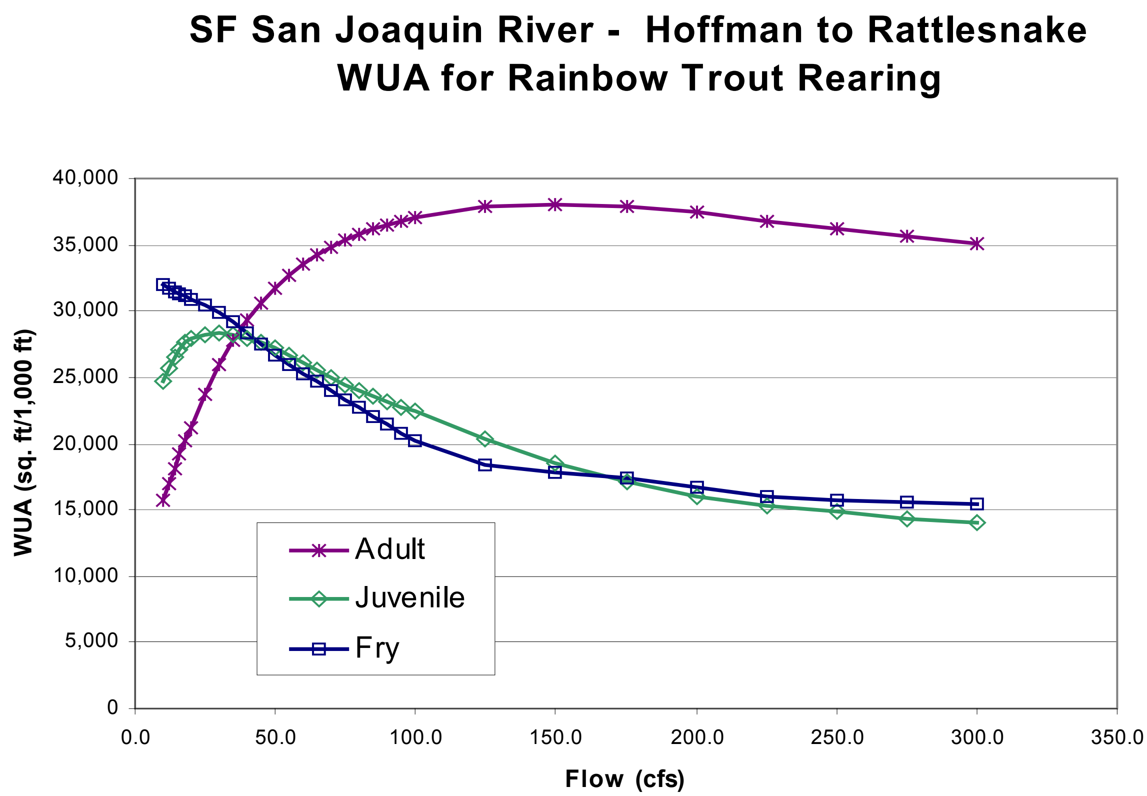


Figure CAWG 3-13. WUA for Brown Trout in South Fork San Joaquin River – Rattlesnake Crossing to Mono Crossing Reach.



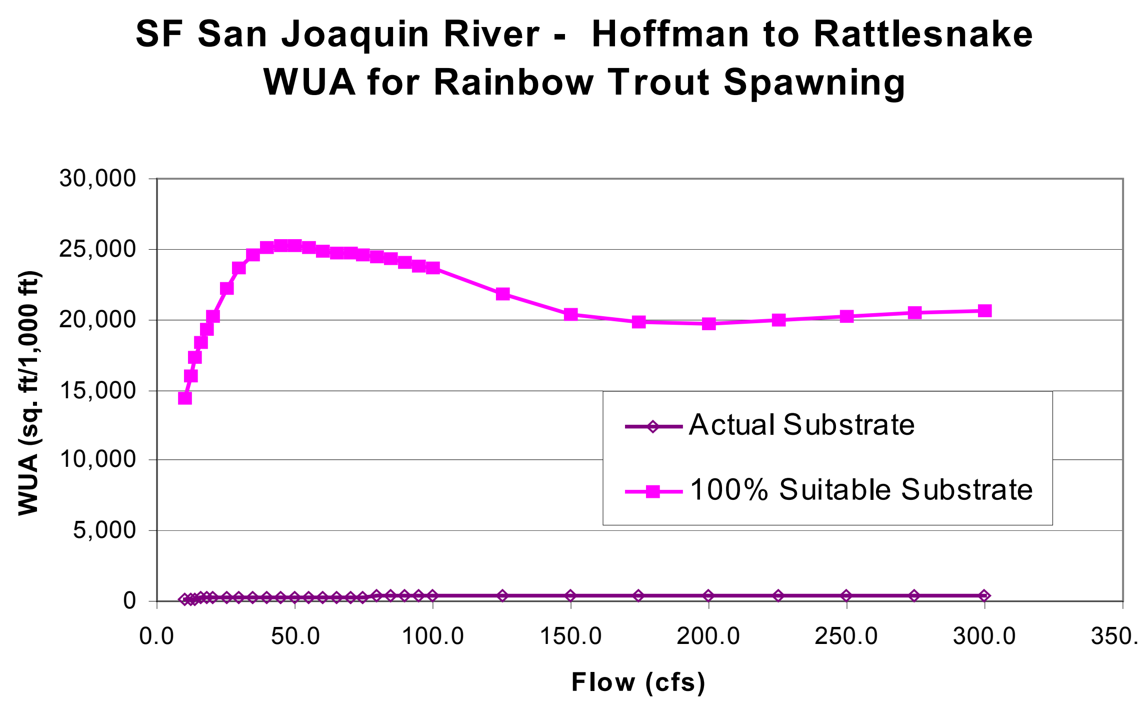
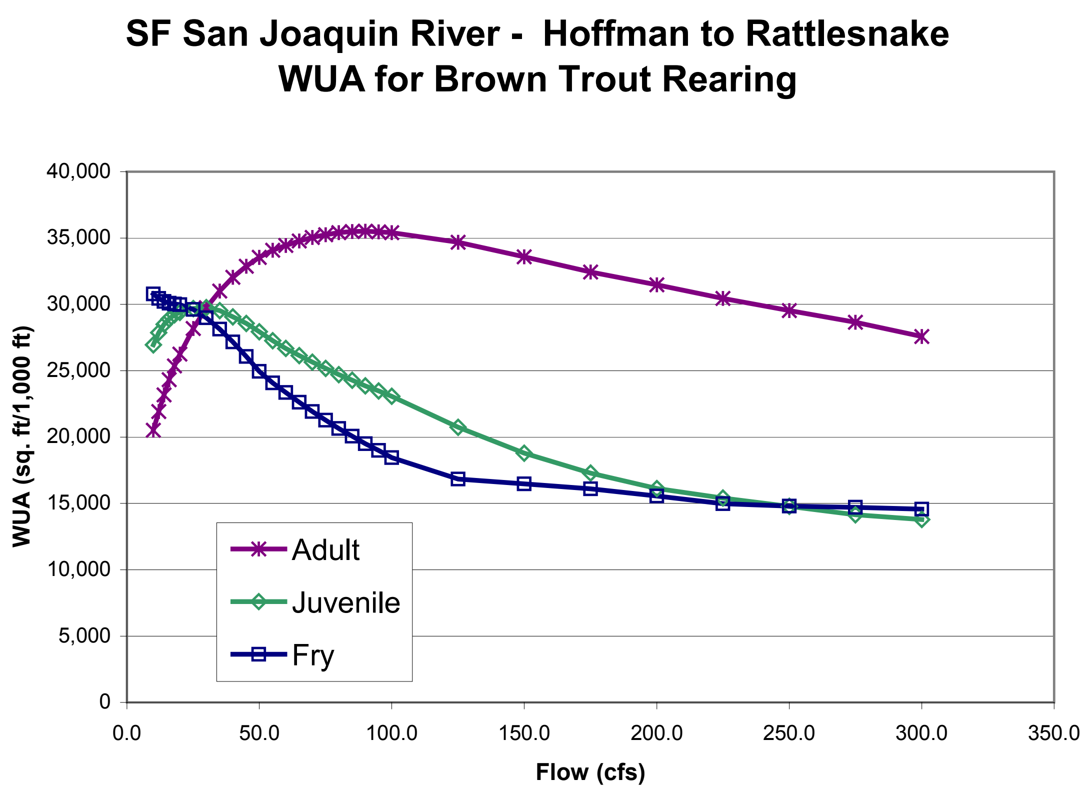


Figure CAWG 3-14. WUA for Rainbow Trout in South Fork San Joaquin River – Hoffman to Rattlesnake Crossing Reach.



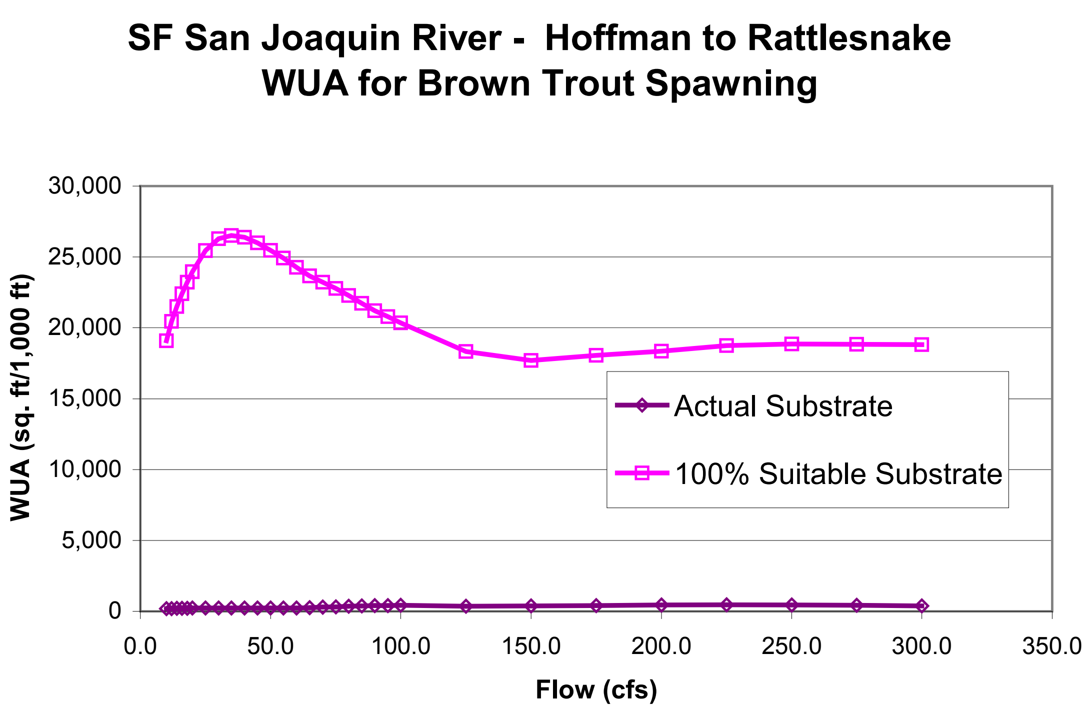
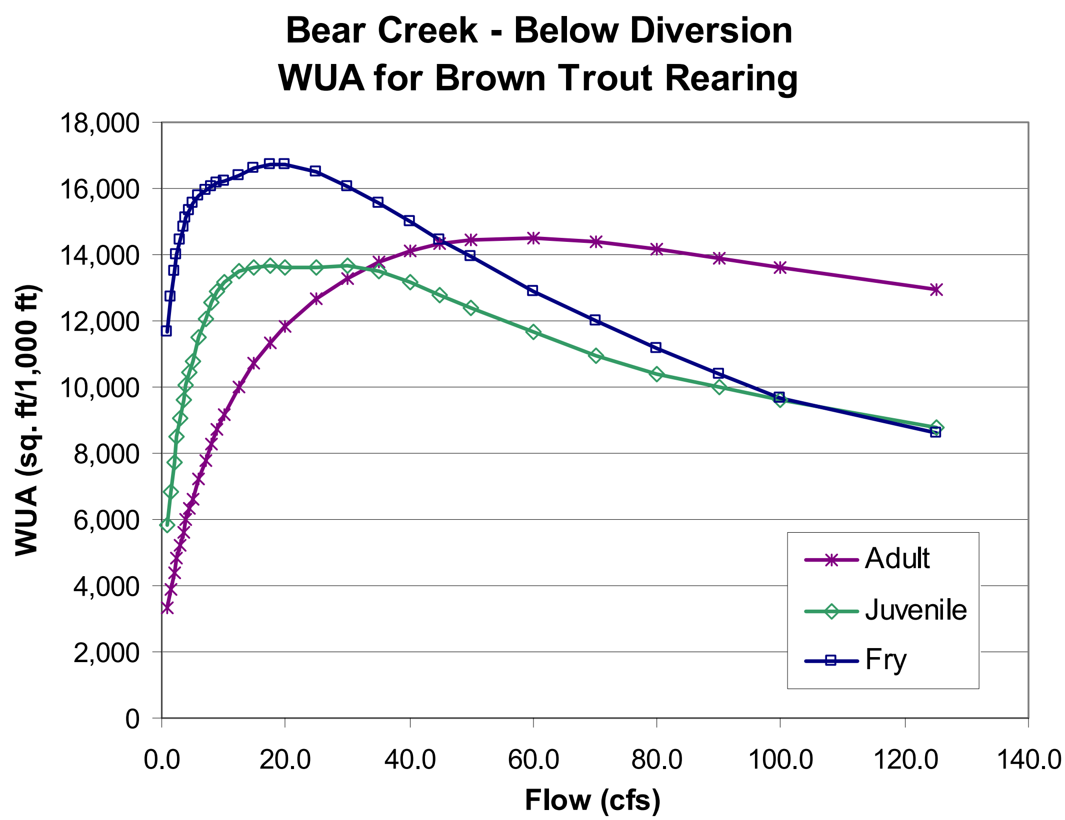


Figure CAWG 3-15. WUA for Brown Trout in South Fork San Joaquin River – Hoffman to Rattlesnake Crossing Reach.



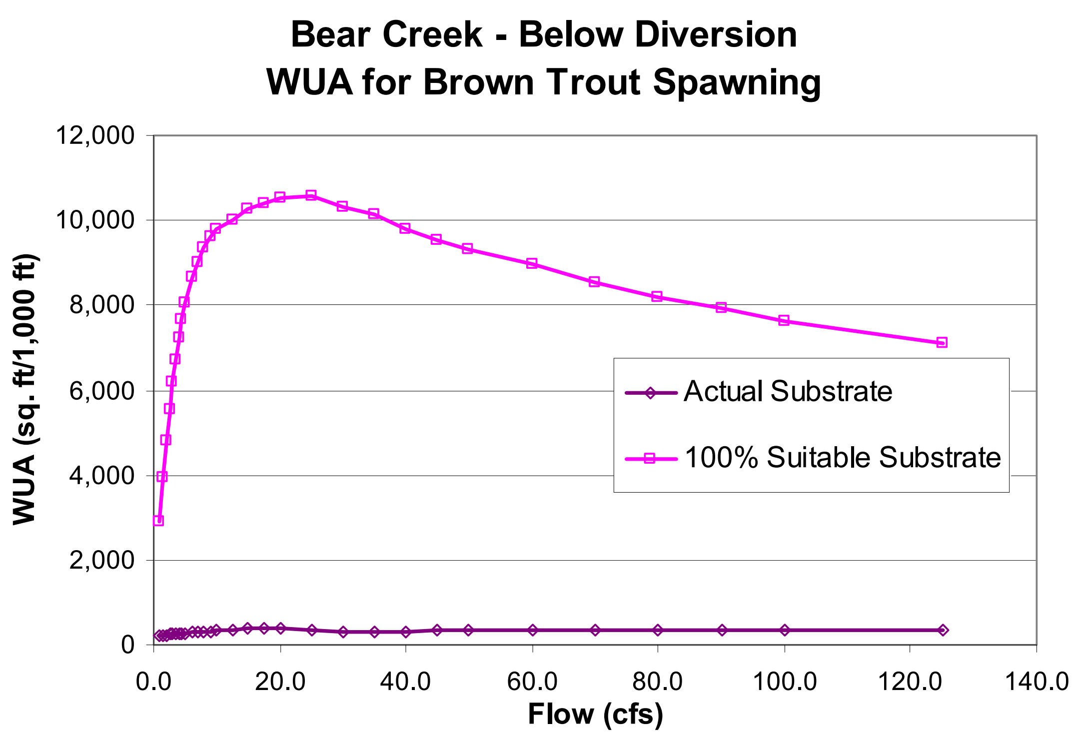
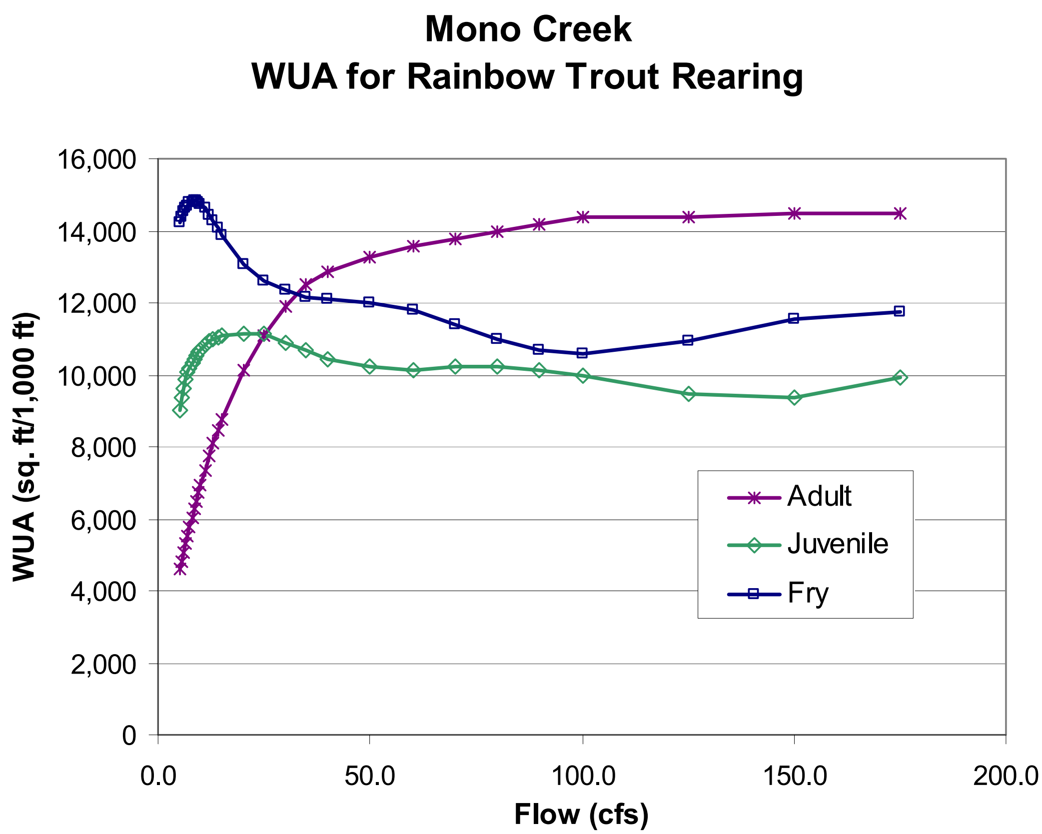


Figure CAWG 3-16. WUA for Brown Trout in Bear Creek.



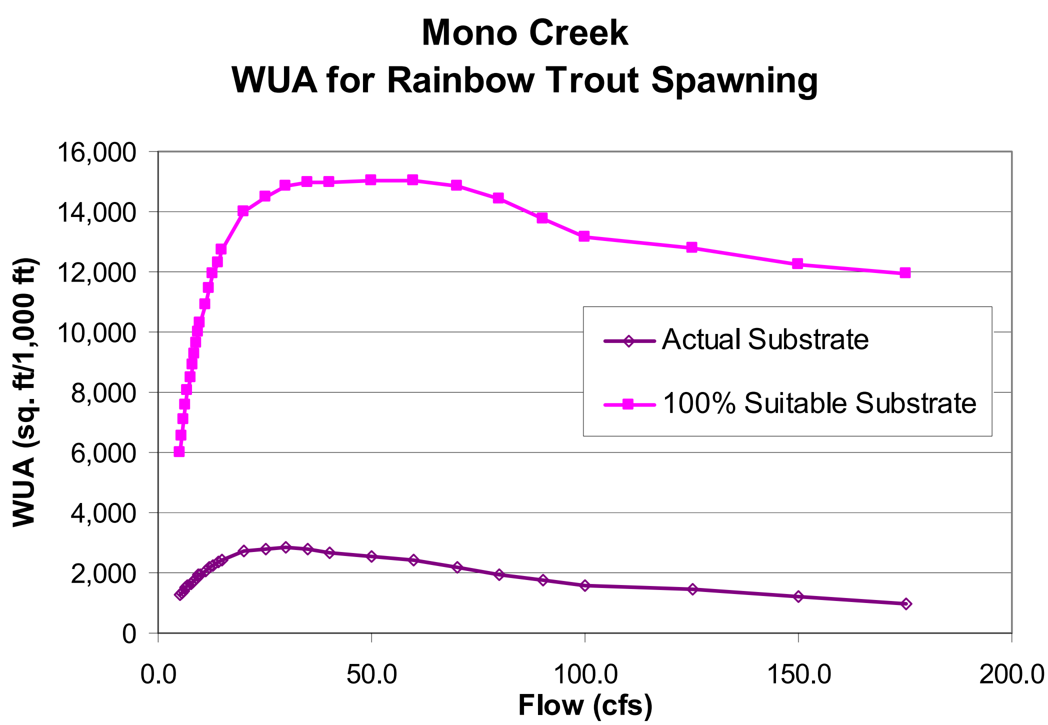
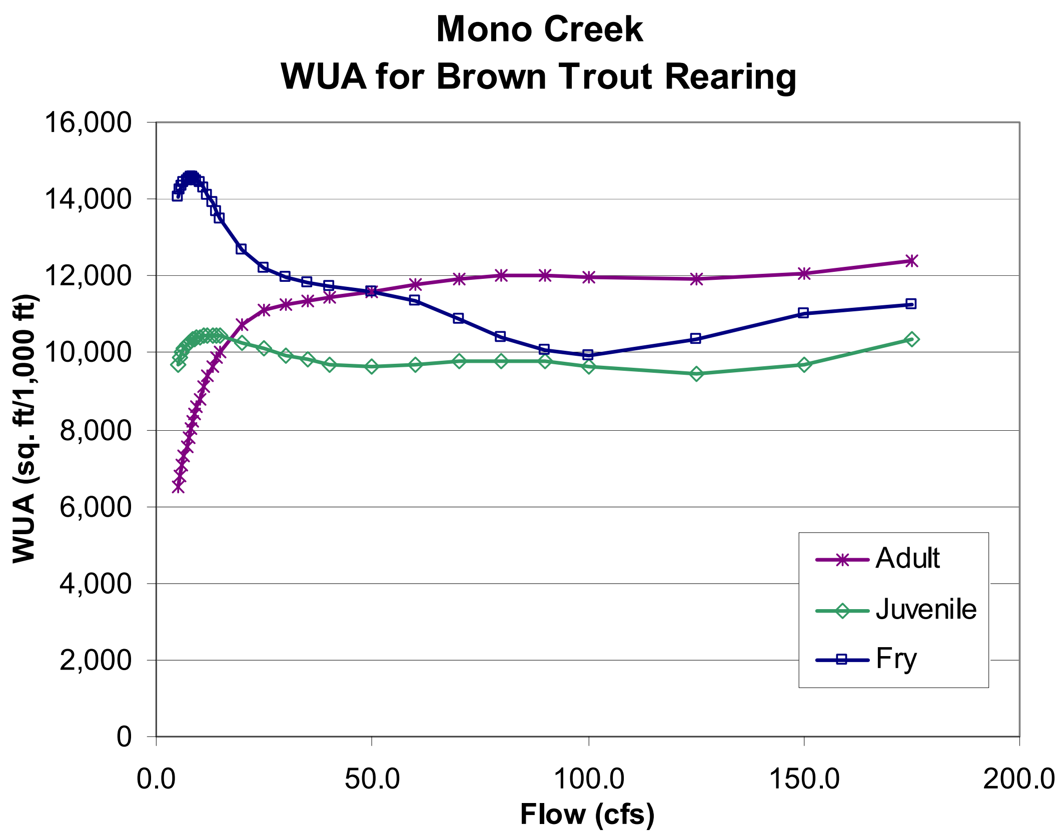


Figure CAWG 3-17. WUA for Rainbow Trout in Mono Creek.



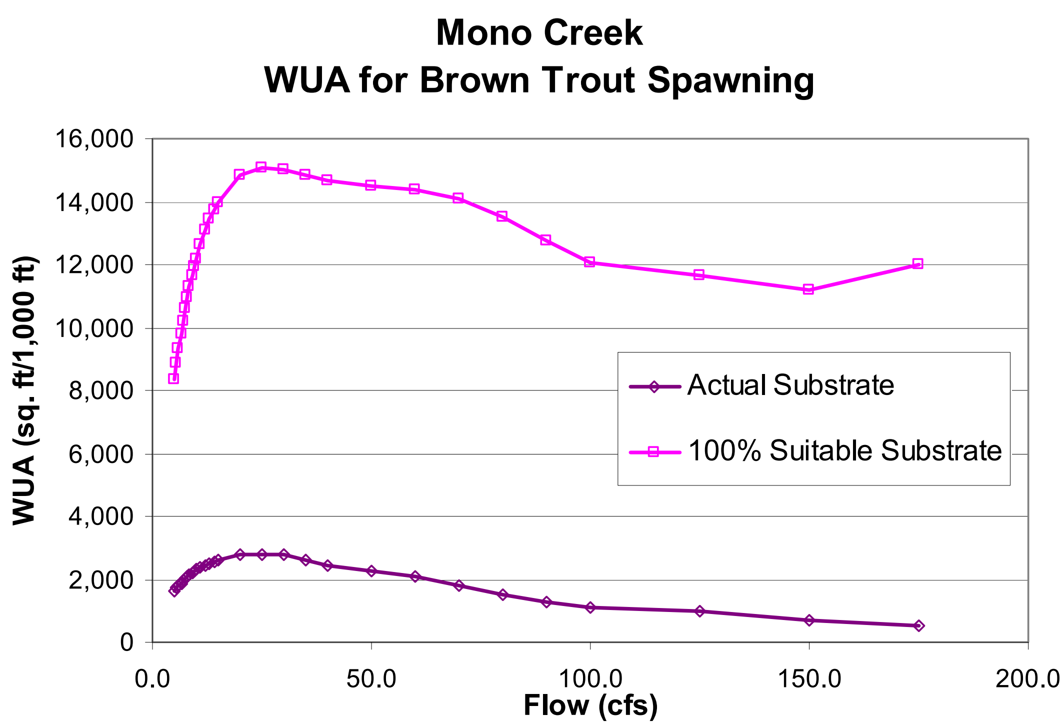
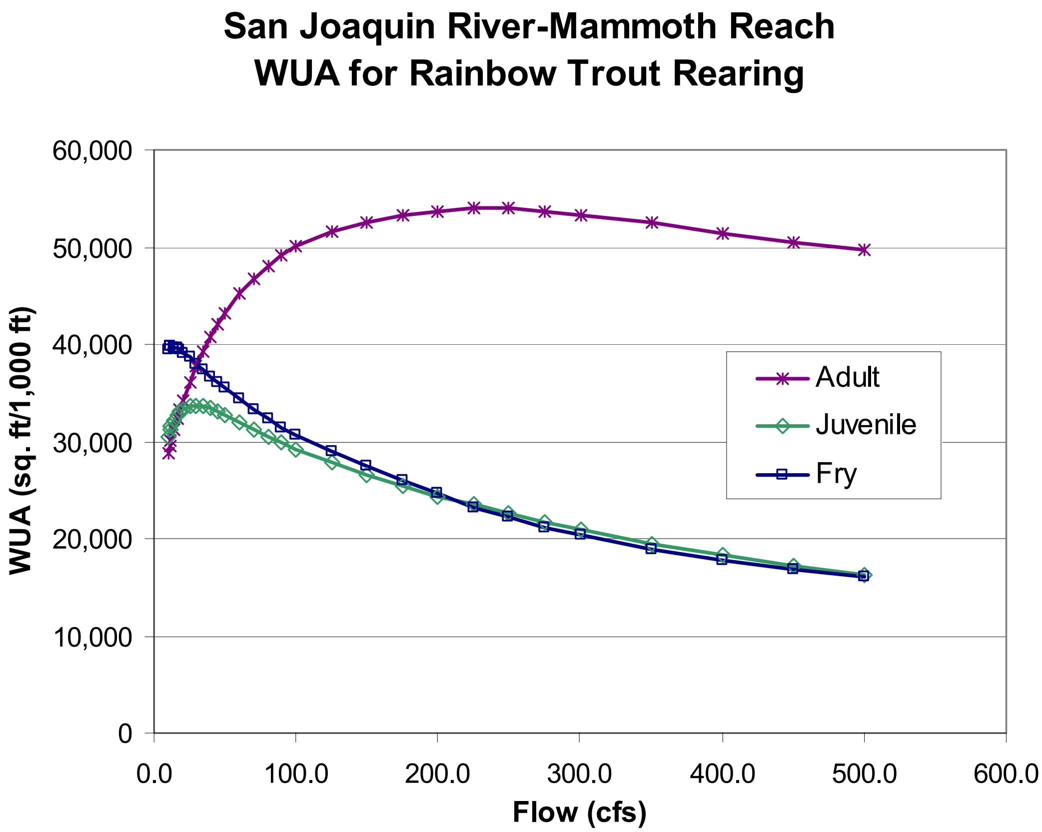


Figure CAWG 3-18. WUA for Brown Trout in Mono Creek.



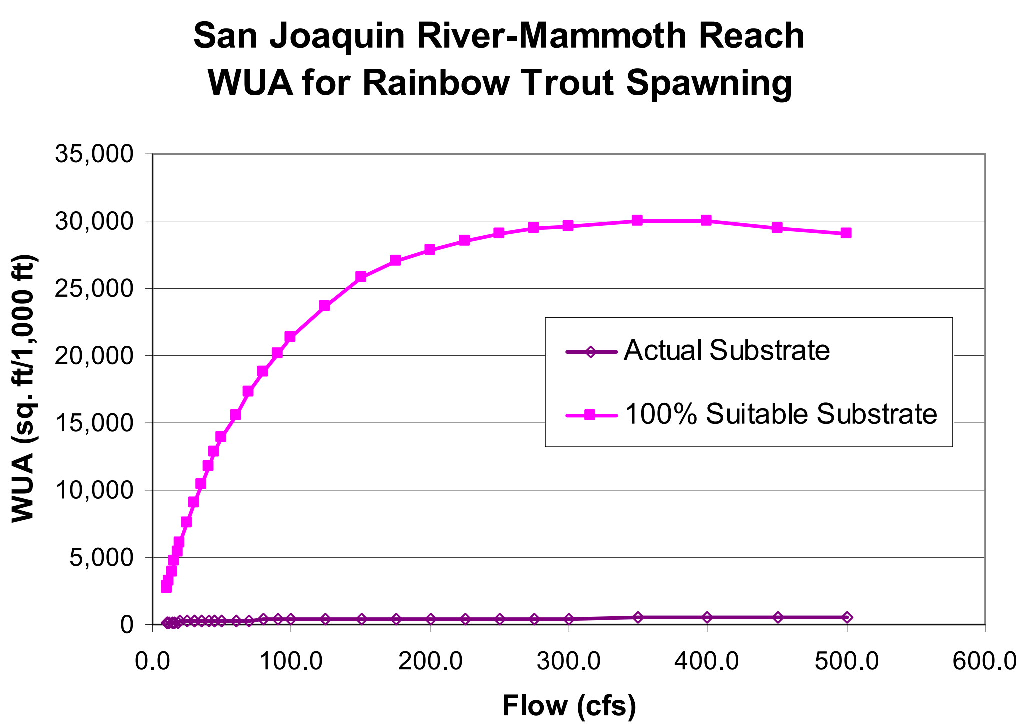


Figure CAWG 3-19. WUA for Rainbow Trout in San Joaquin River Mammoth Reach.

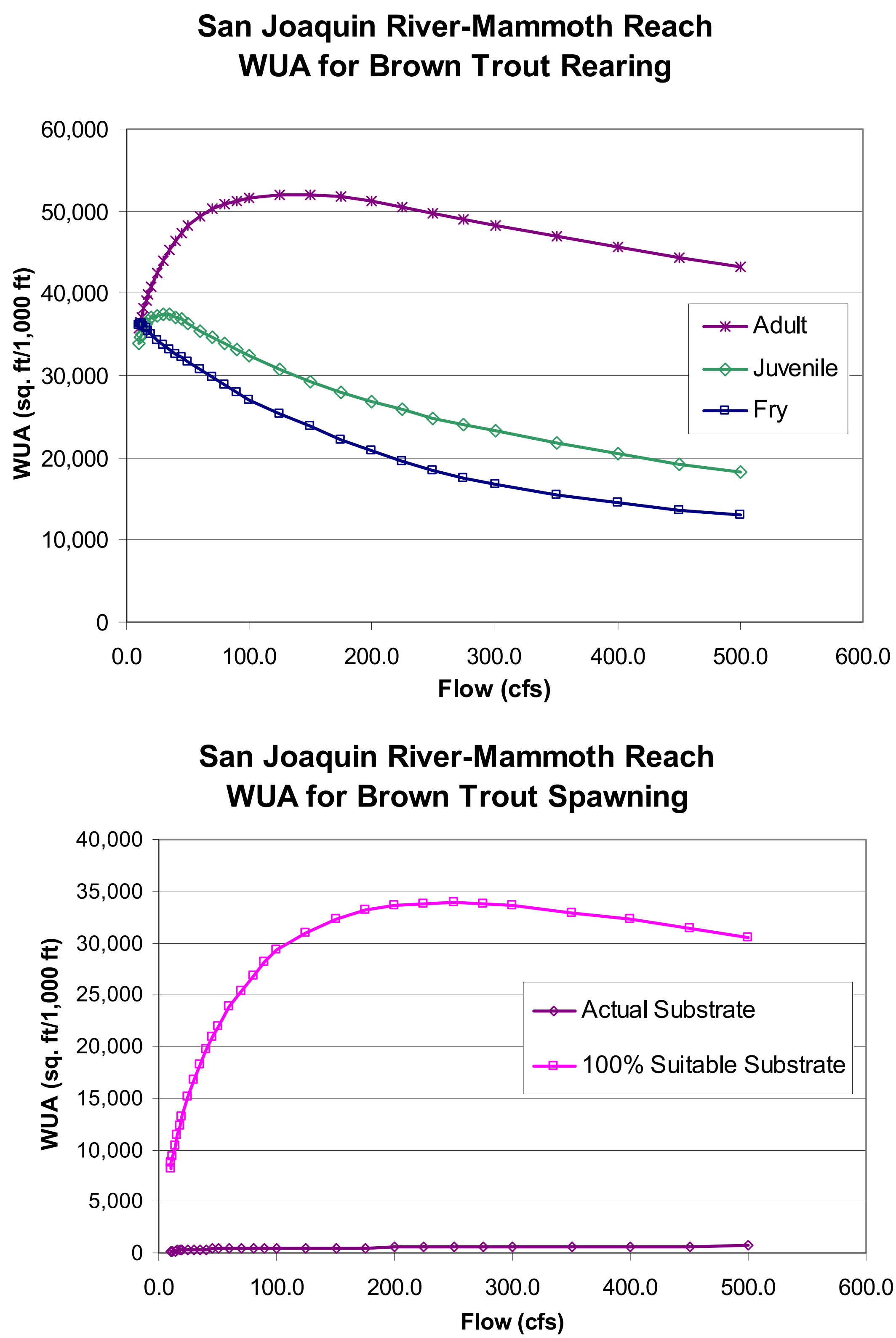


Figure CAWG 3-20. WUA for Brown Trout in San Joaquin River Mammoth Reach.

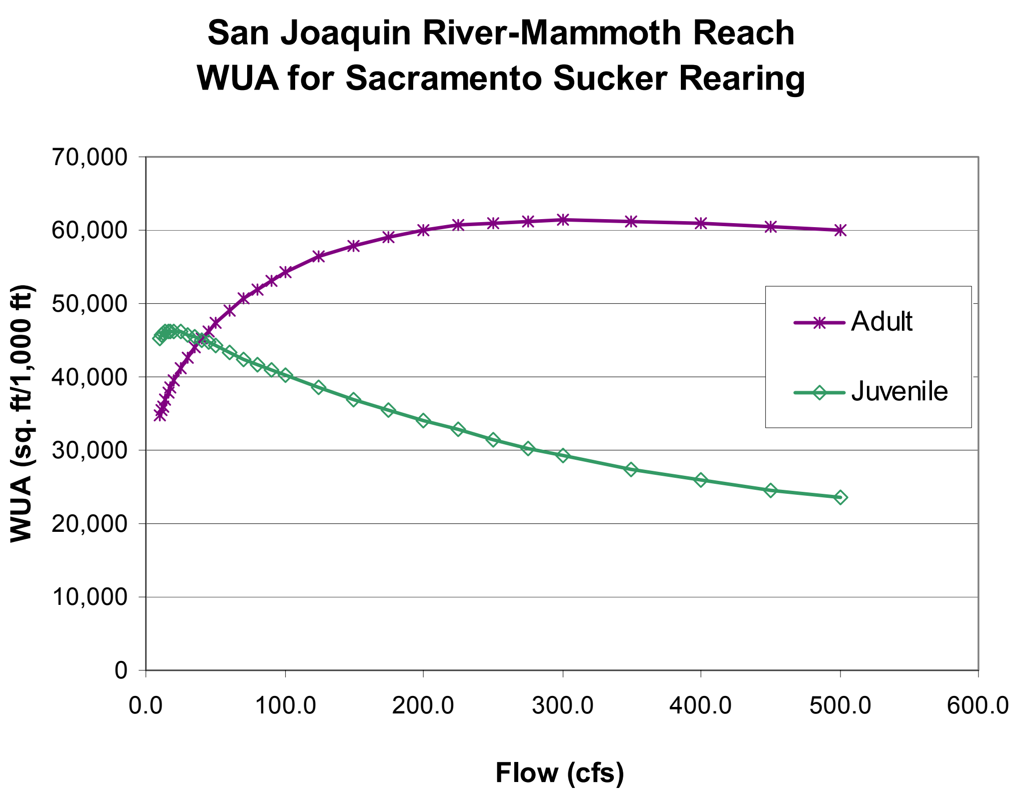
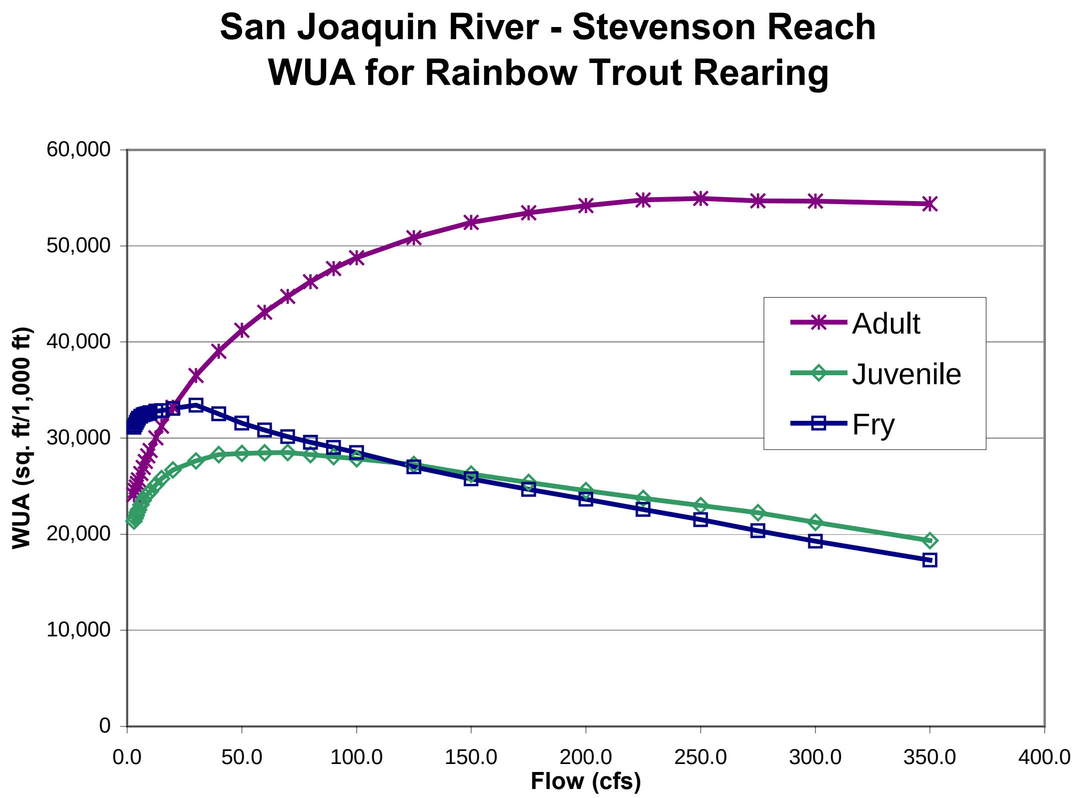


Figure CAWG 3-21. WUA for Sacramento Suckers in San Joaquin River Mammoth Reach.



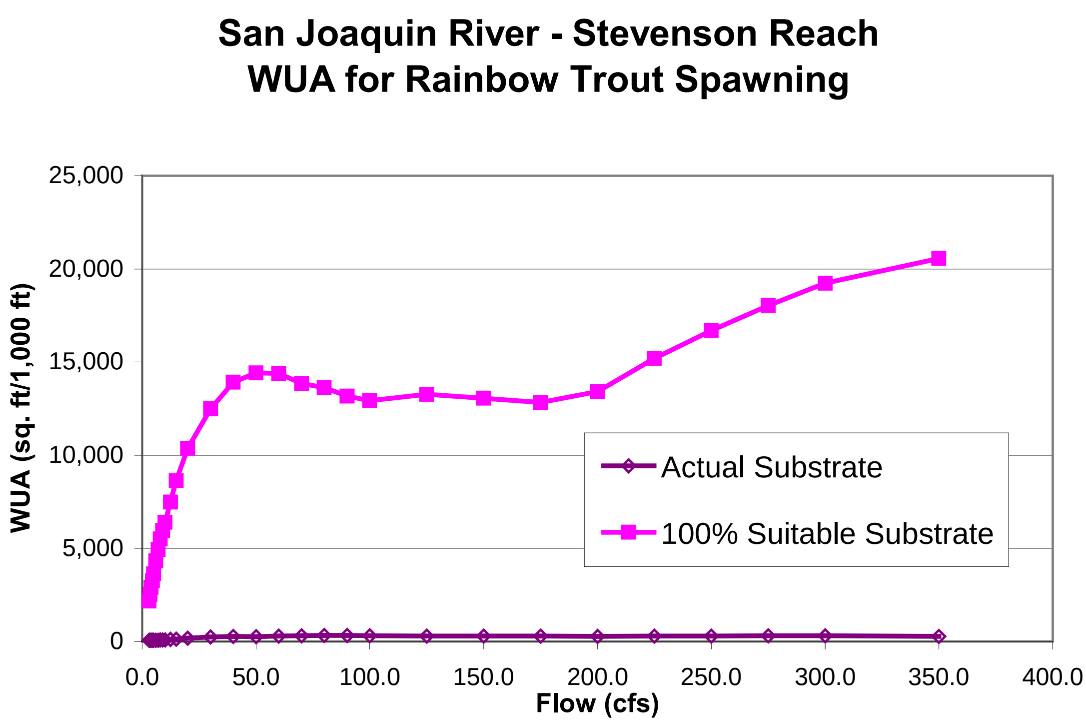
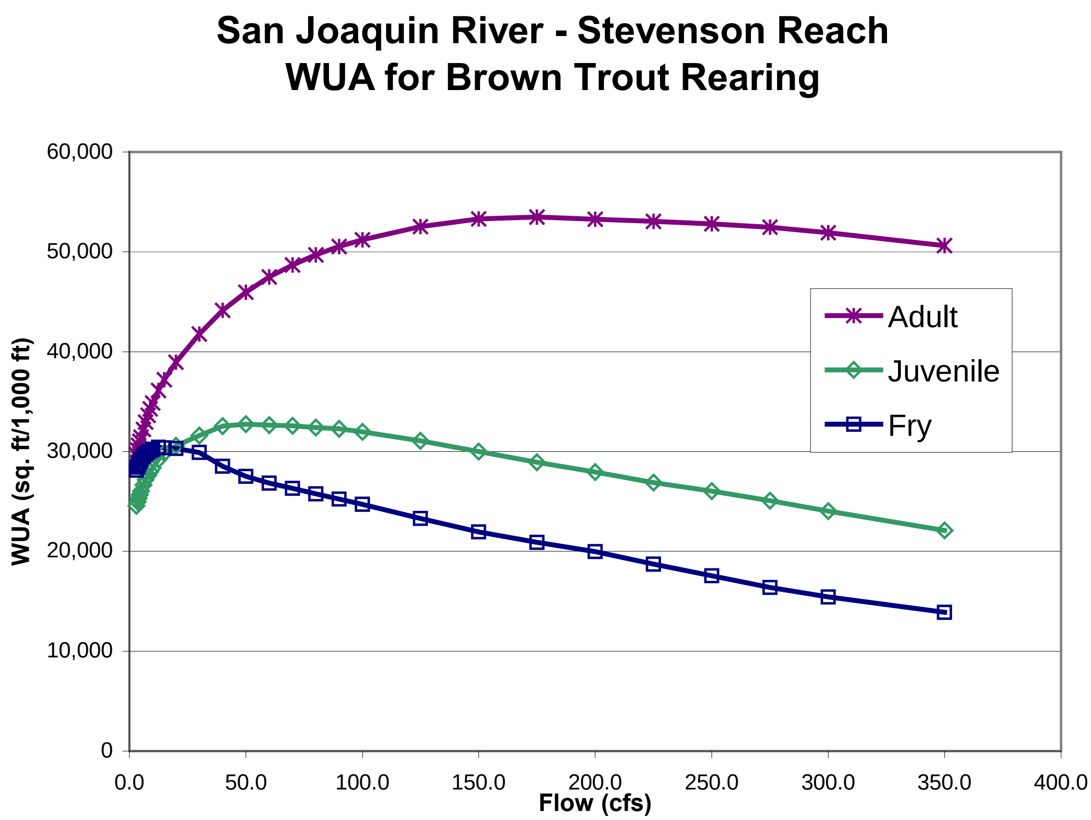


Figure CAWG 3-22. WUA for Rainbow Trout in San Joaquin River Stevenson Reach.



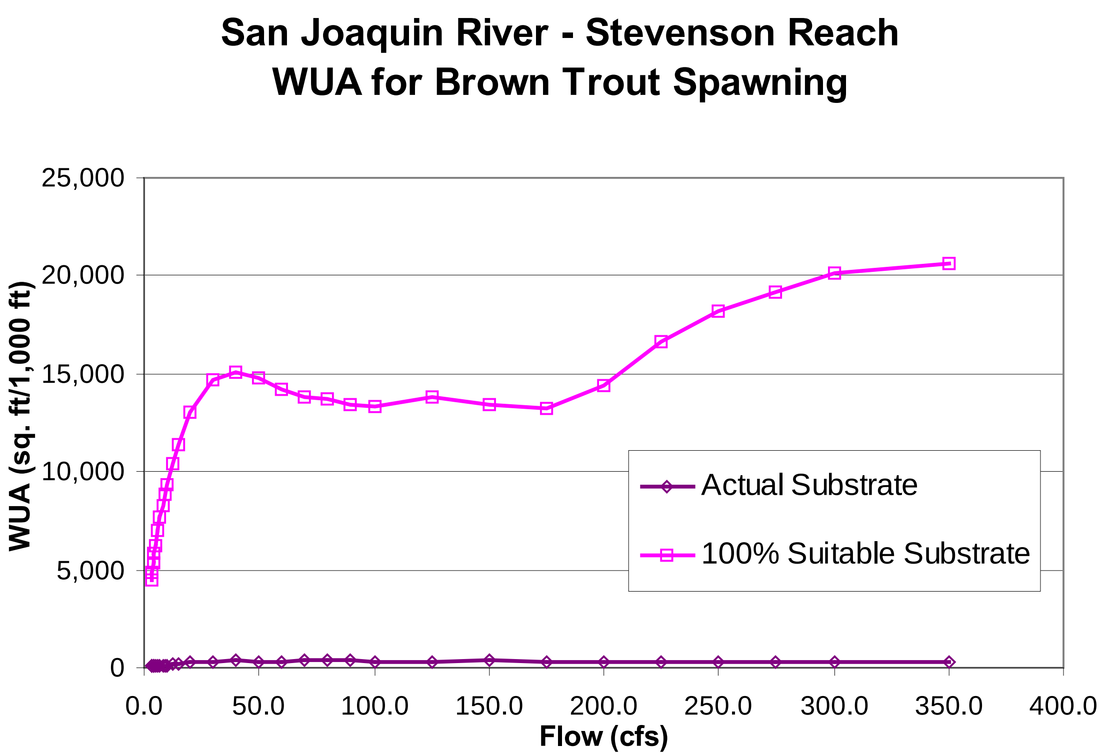


Figure CAWG 3-23. WUA for Brown Trout in San Joaquin River Stevenson Reach.

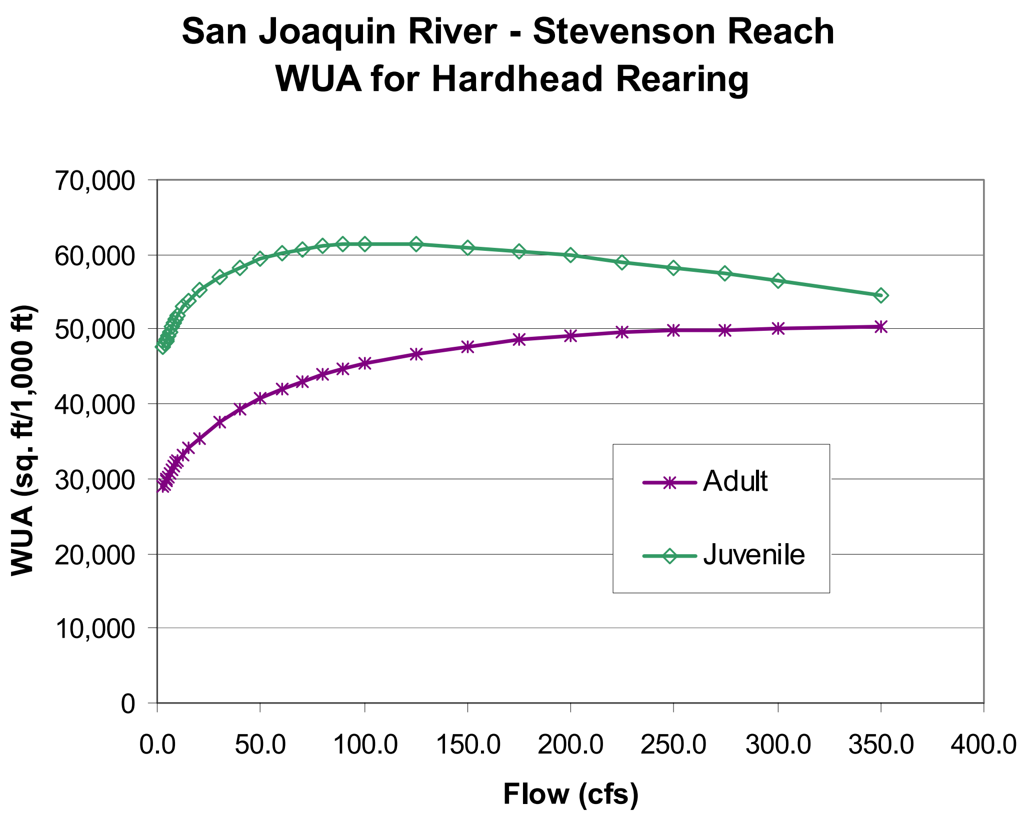


Figure CAWG 3-24. WUA for Hardhead in San Joaquin River Stevenson Reach.

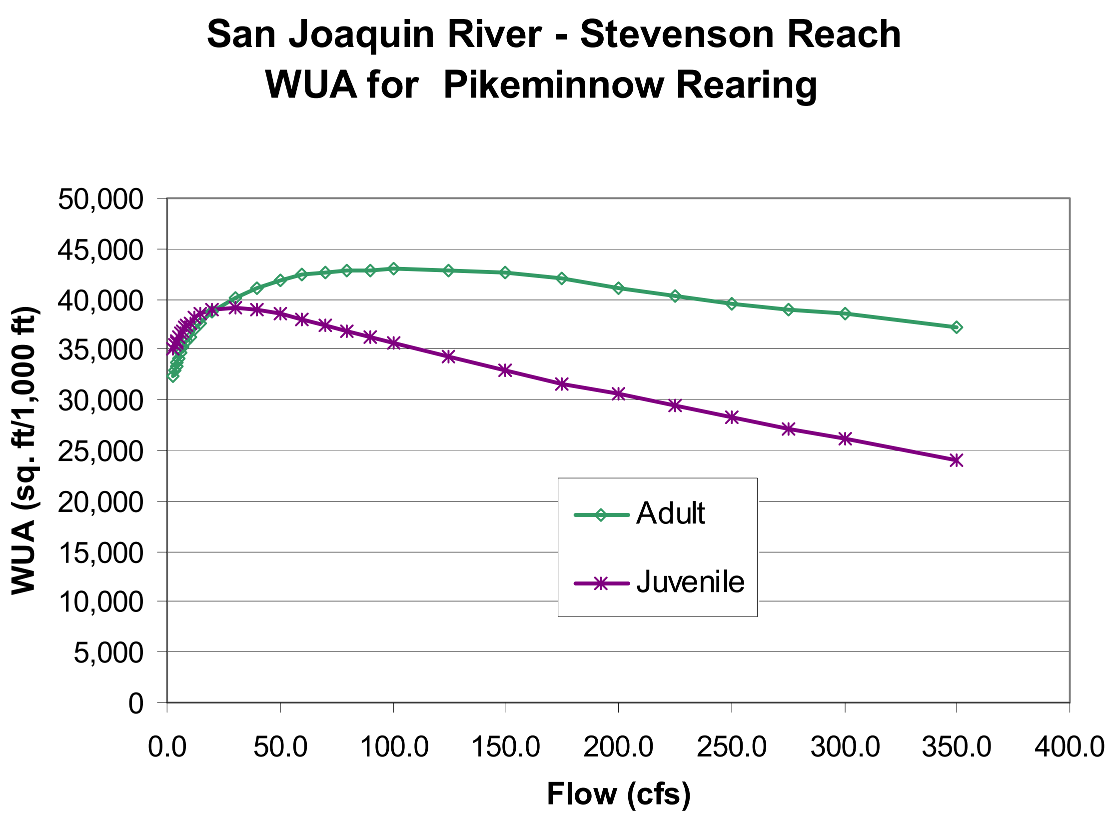


Figure CAWG 3-25. WUA for Pikeminnow in San Joaquin River Stevenson Reach.

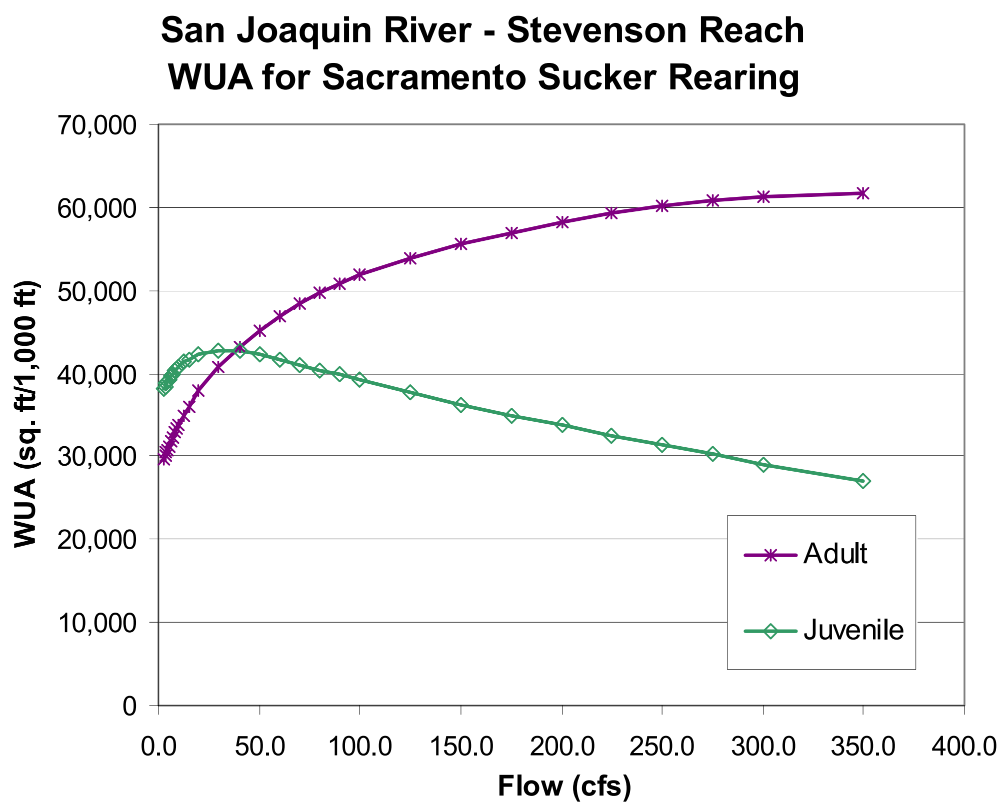
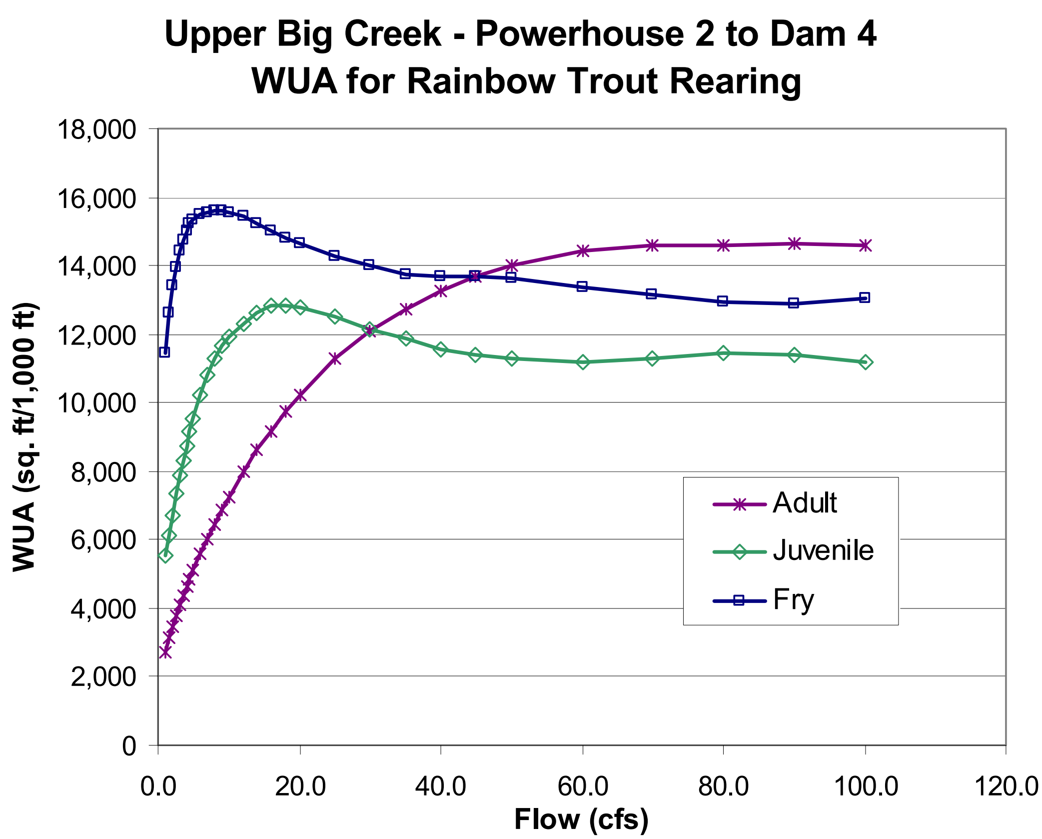


Figure CAWG 3-26. WUA for Sacramento Sucker in San Joaquin River Stevenson Reach.



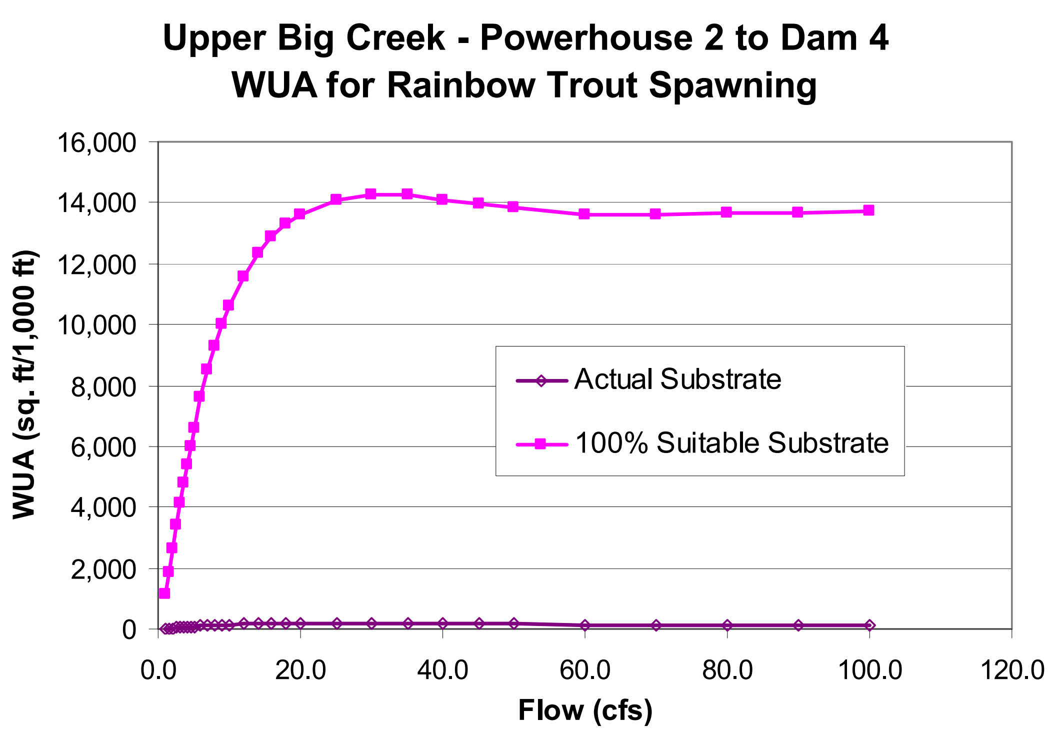
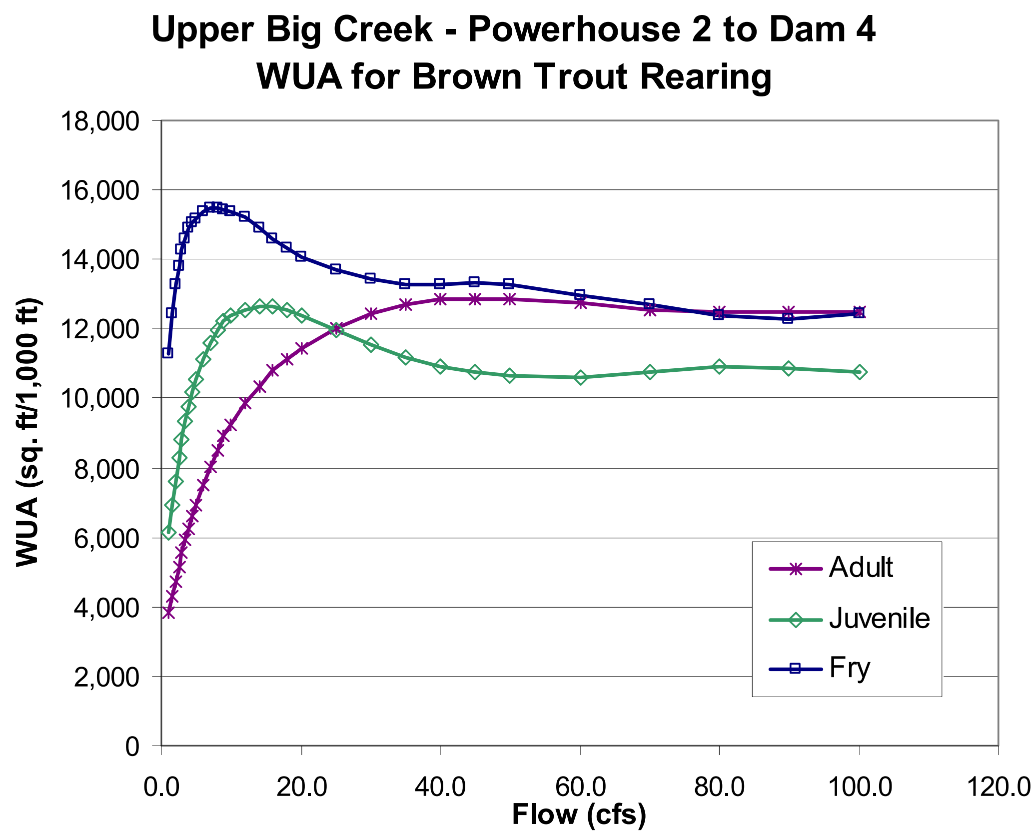


Figure CAWG 3-27. WUA for Rainbow Trout in Upper Big Creek - Powerhouse 2 to Dam 4 Reach.



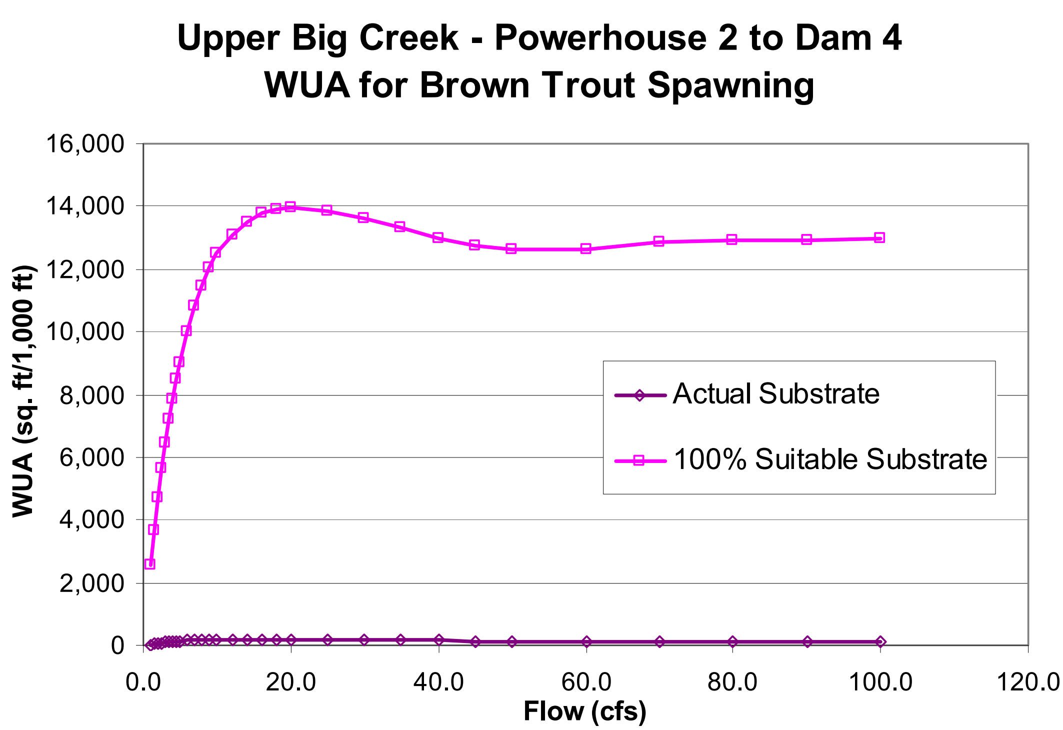
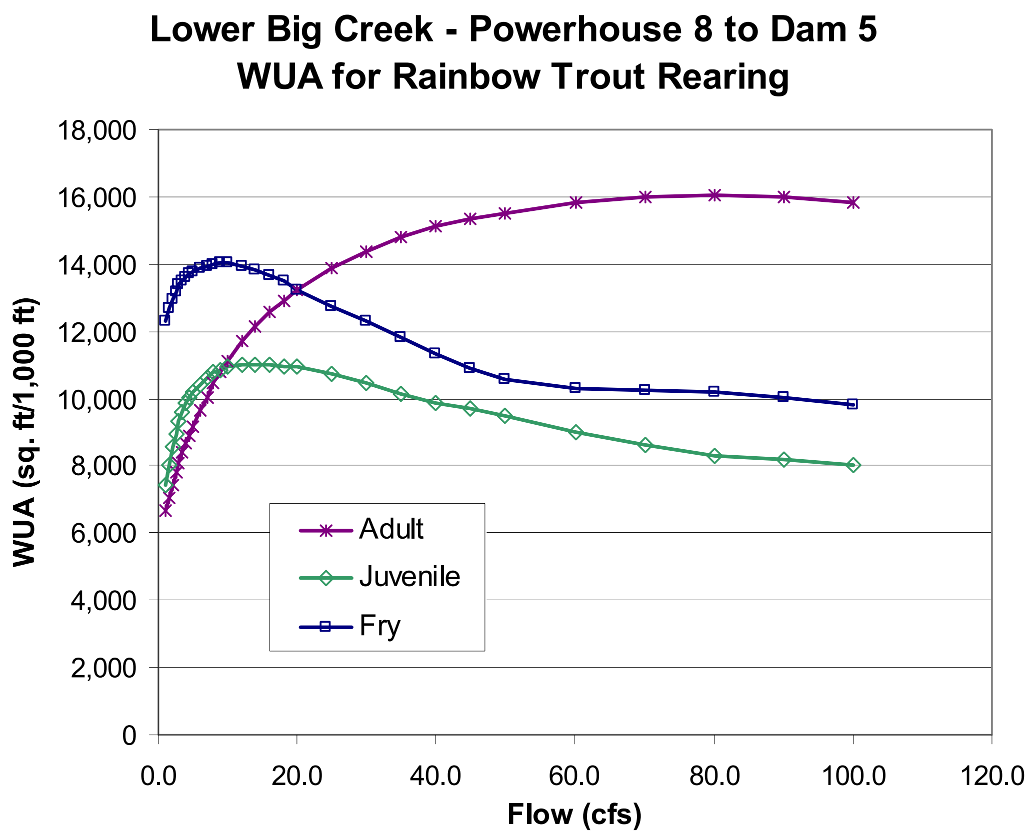


Figure CAWG 3-28. WUA for Brown Trout in Upper Big Creek - Powerhouse 2 to Dam 4 Reach.



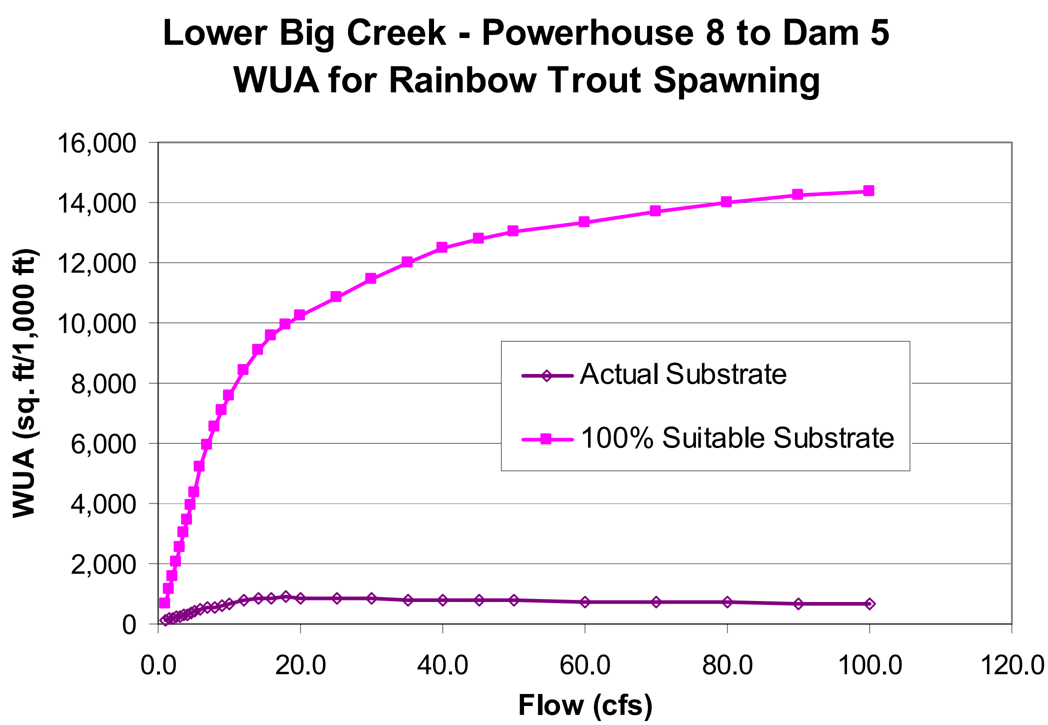
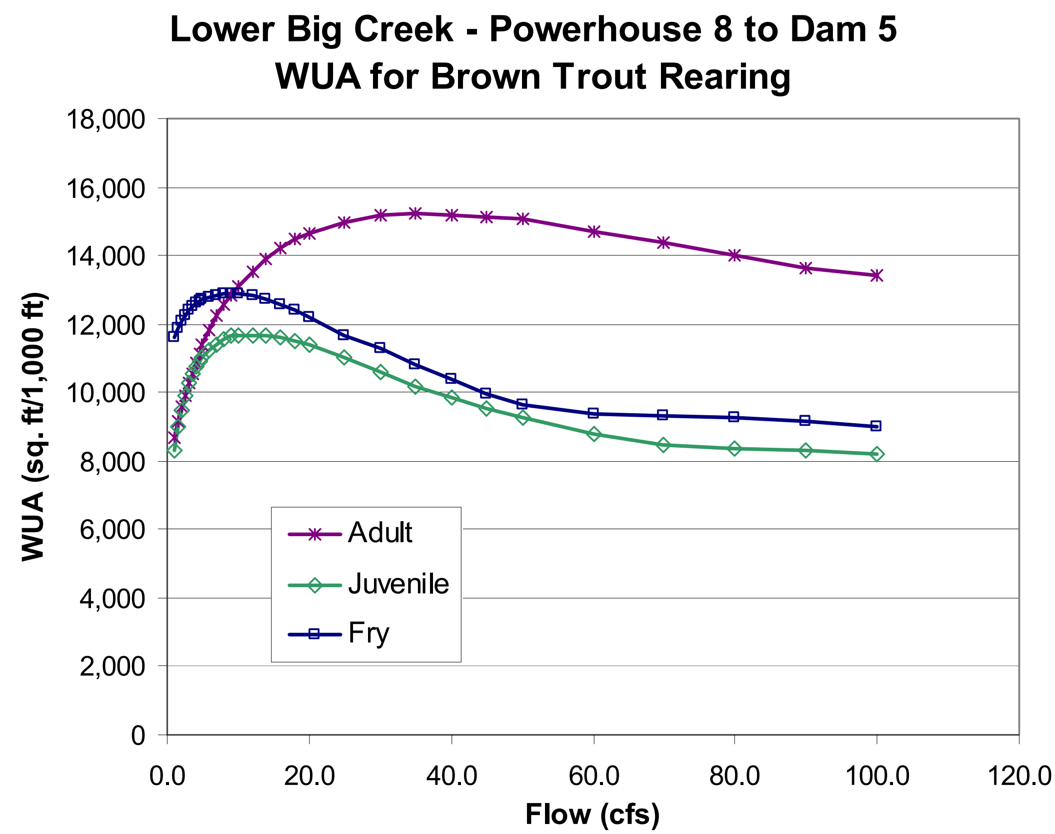


Figure CAWG 3-29. WUA for Rainbow Trout in Upper Big Creek - Powerhouse 8 to Dam 5 Reach.



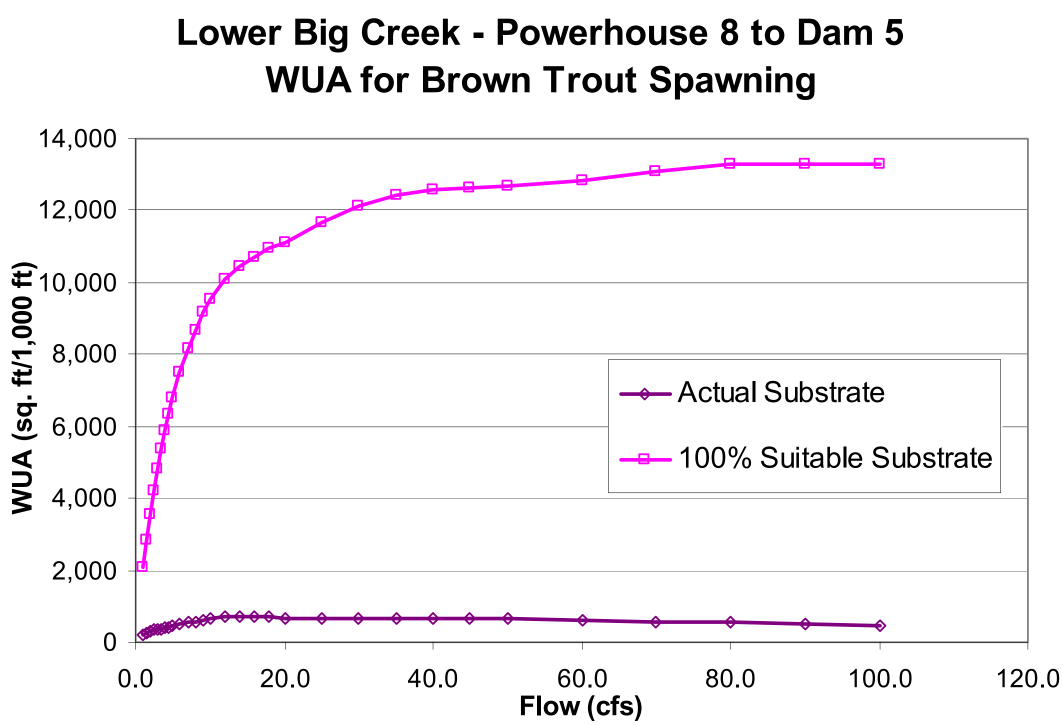
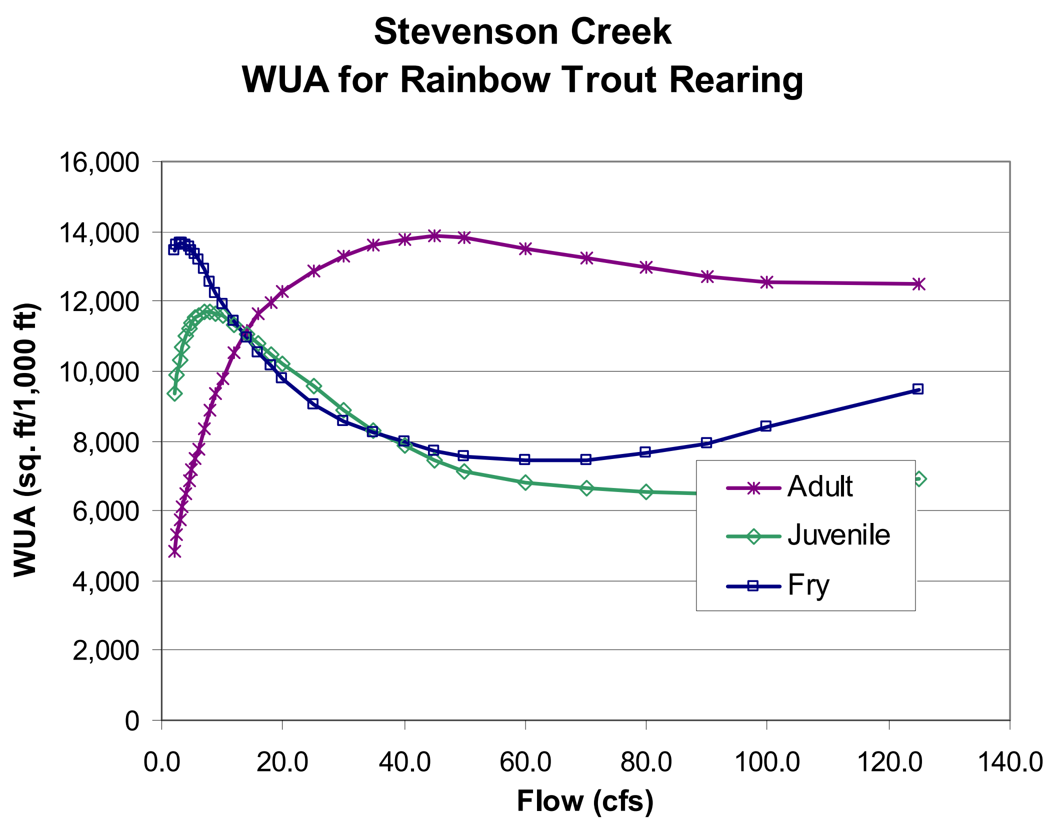


Figure CAWG 3-30. WUA for Brown Trout in Upper Big Creek - Powerhouse 8 to Dam 5 Reach.



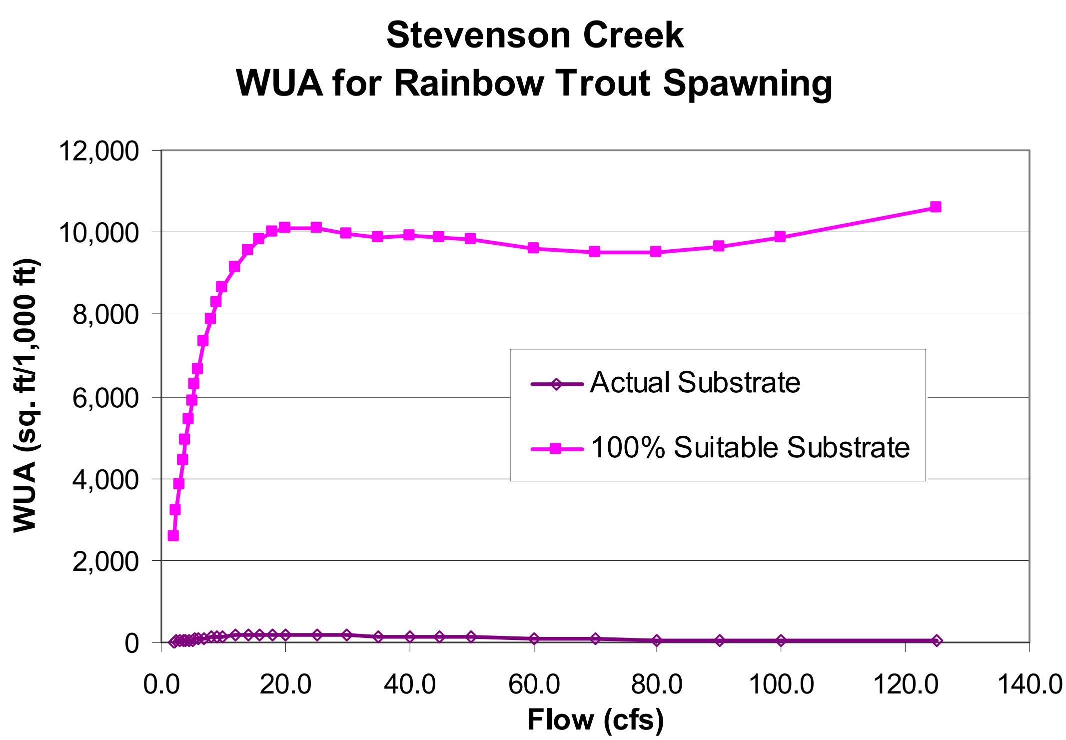
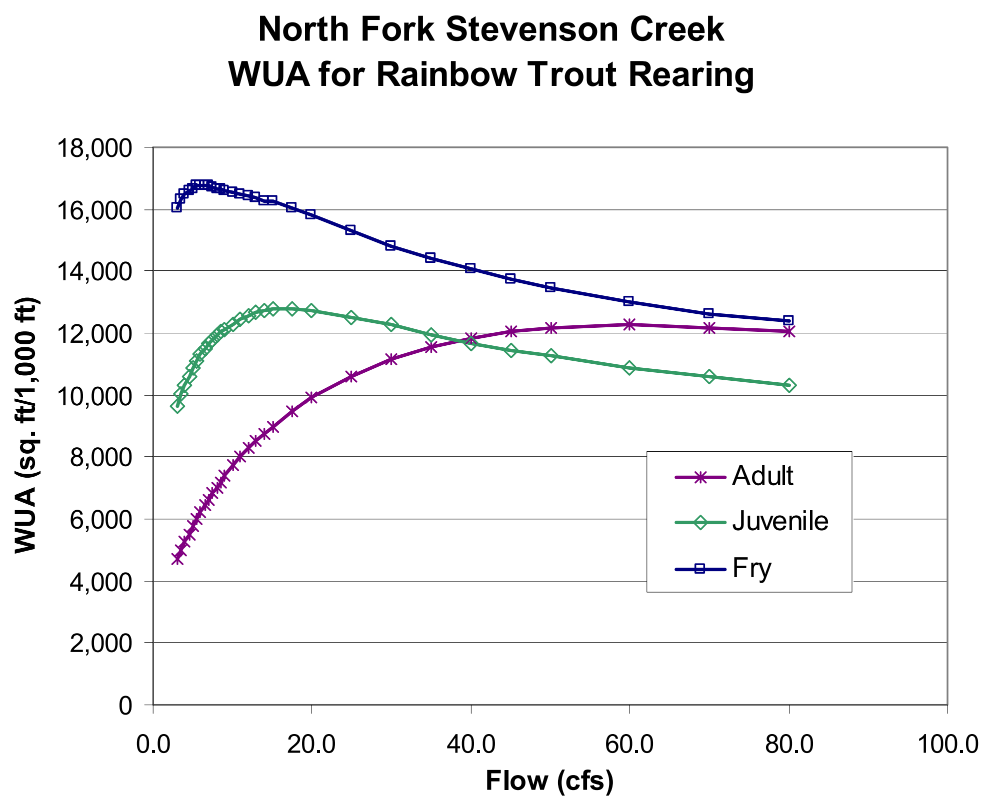


Figure CAWG 3-31. WUA for Rainbow Trout in Stevenson Creek.



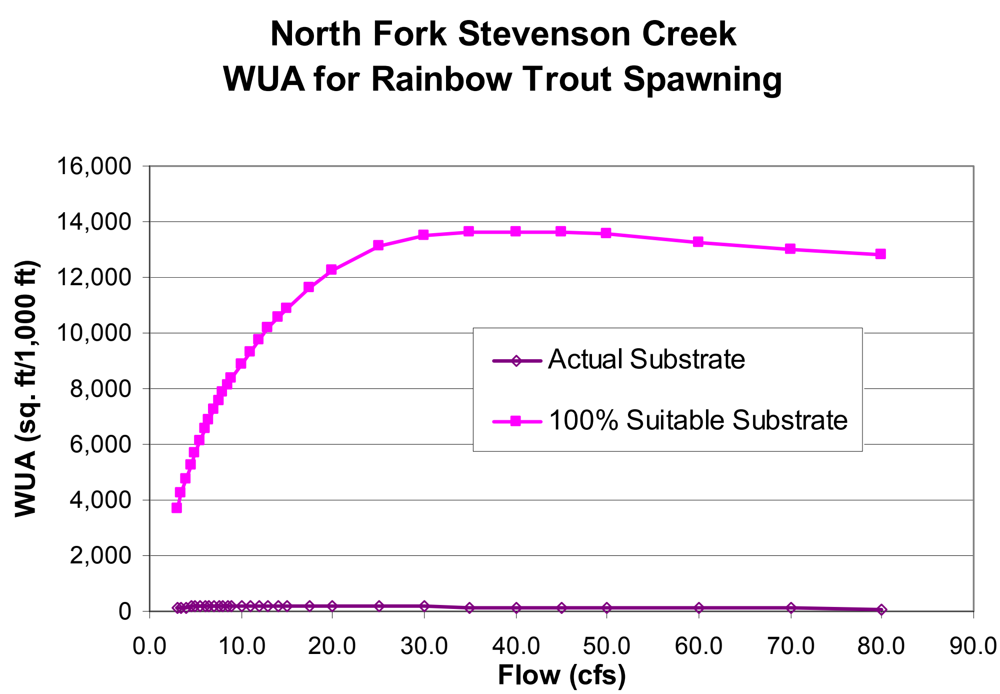
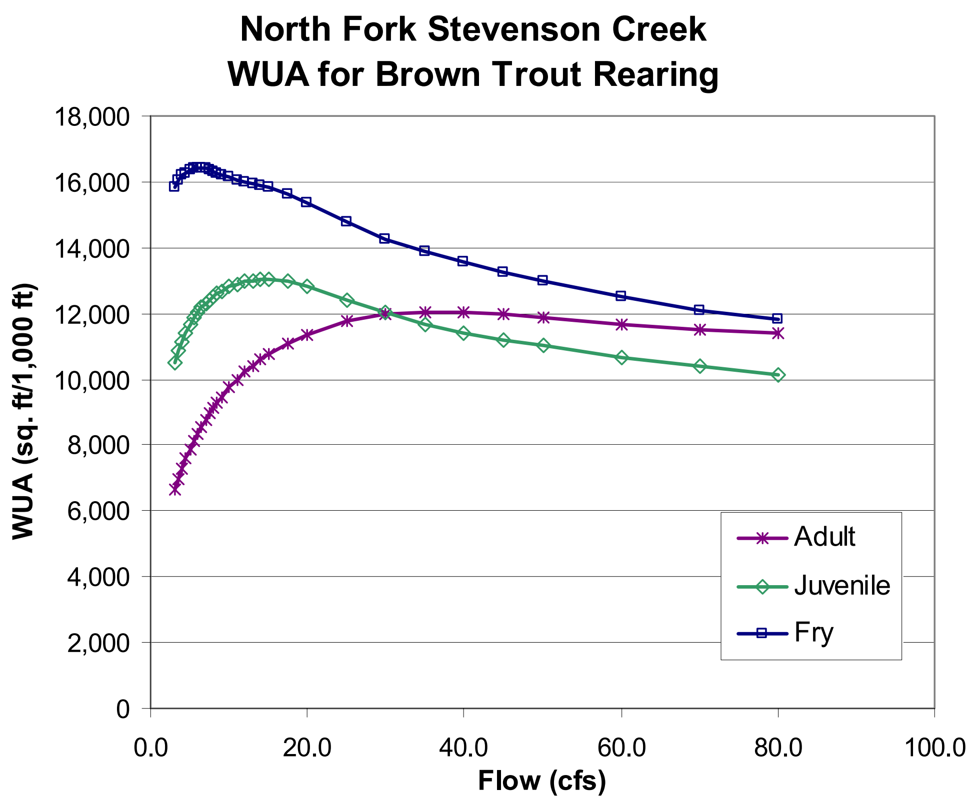


Figure CAWG 3-32. WUA for Rainbow Trout in North Fork Stevenson Creek.



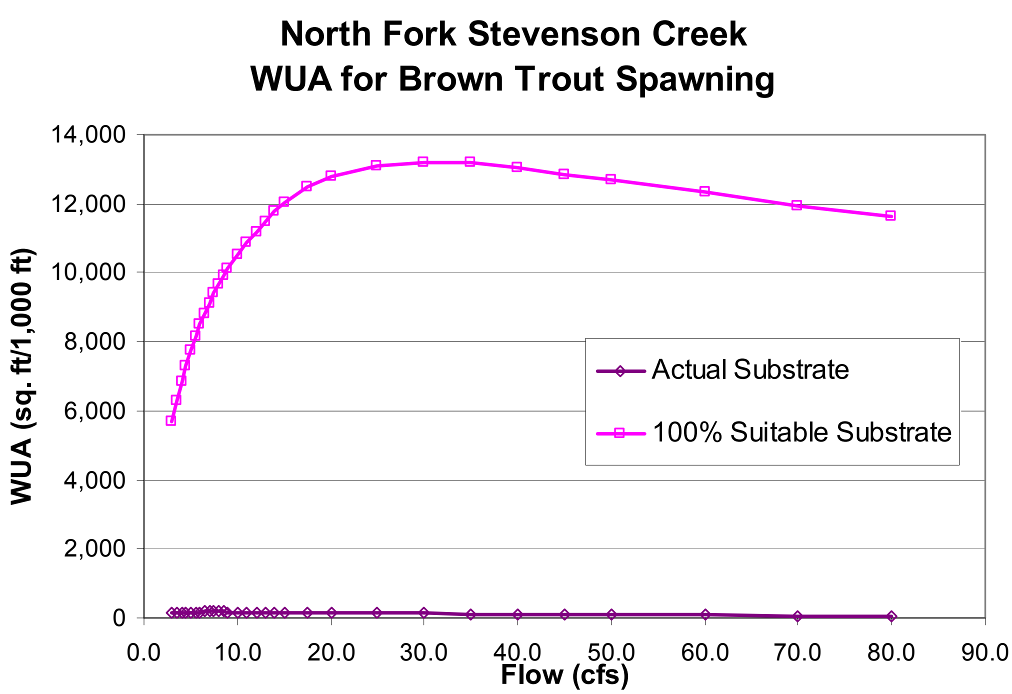


Figure CAWG 3-33. WUA for Brown Trout in North Fork Stevenson Creek.

MAP

Map (Figure) CAWG 3-1. PHABSIM Study Sites (Overview Map-Overall Map of Study Area)

Non-Internet Public Information

This Map has been removed in accordance with the Commission regulations at 18 CFR Section 388.112.

This Map is considered Non-Internet Public information and should not be posted on the Internet. This information is provided in Volume 4 of the Application for New License and is identified as "Non-Internet Public" information. This information may be accessed from the FERC's Public Reference Room, but is not expected to be posted on the Commission's electronic library, except as an indexed item.

APPENDIX A

AGENCY CONSULTATION DOCUMENTS

Big Creek Collaborative
Combined Aquatic Resources Working Group

September 25, 2001

Meeting Notes

Time:	10:00 AM to 4:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Office Clovis, CA	**Facilitator**:	Anna West
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Wayne Lifton	ENTRIX, Inc.
Anna West	Kearns & West
Martin Ostendorf	ENTRIX, Inc (Recorder)
Geoff Rabone	SCE
Ed Bianchi	ENTRIX, Inc.
Holly Eddinger	USFS-SNF
Steve Rowan	SCE
Larry Wise	ENTRIX, Inc.
Rick Hopson	USFS-SNF
Wayne Thompson	Fresno Flyfishers for Conservation
Julie Means	CDFG
Julie Tupper	USFS - RHAT
Debbie Giglio	USFWS

Telephone Participants:

Chuck Bonham	Trout Unlimited
Janelle Nolan-Summers	ENTRIX, Inc.

Open Meeting, Make Introductions, Review Agenda

The meeting was opened with introductions and review of the meeting agenda.

Review and Approve Meeting Minutes/Notes

Meeting minutes need to be reviewed and approved so that they can be posted on the SCE Hydro website and submitted to the FERC as part of the six month ALP status report.

<u>July 2, 2001 Meeting Notes</u>

Page 4, Reference to the USFS Stream Conditioning Inventory (SCI) process. This should be changed to say: “This is a quantitative evaluation”. Strike out the following: “Not quantitative, but systematic”.

In the next paragraph beginning with Proper Functioning Condition (PFC) add the following sentence as the first sentence; "This is not a quantitative, but systematic process.

A previous action item was to obtain the most recent version of Stream Conditioning Inventory. **Action Item**: The USFS indicated that they would find the most recent version of the SCI and provided it to the CAWG.

The meeting minutes were approved with the above changes.

July 10, 2001 Meeting Notes

The meeting minutes were approved.

July 11, 2001 Meeting Notes

Attendance list change Steve Rowans affiliation to SCE.

The meeting minutes were approved by the CAWG.

Discussion of Over-winter Temperature Measurements for Amphibians

The CAWG-5 study plan describes water temperature monitoring. Part of the CAWG-5 study is over-winter water temperature monitoring proposed in pools of Bear Creek, Mono Creek and Camp 61 Creek.

The CAWG-8 study plan indicated that year-round water temperature monitoring data would be collected in location of known foothill yellow-legged frog populations at lower elevations in the basin. Data will be collected as described in the CAWG-5 study plan.

The USFS indicated that water temperature probes should be placed in Jose Creek (Jose Basin), and Willow Creek.

Does the Project have an effect on Jose Creek? No, but the Project may have an effect on the amphibian population in the creek.

The lower end of Stevenson Creek was also recommended for year round water temperature monitoring. It was pointed out that this region is a 1,000-foot waterfall. Everyone agreed not to include Lower Stevenson Creek.

Have populations of Foothill-yellow-legged frogs been seen in Willow Creek? No, but this area is prime habitat. There is a recorded observation in North Fork Willow Creek by Peter Moyle about 20 years age. The USFS indicated that there was a sighting this summer by PG&E's consultation on the Crane Valley Project. This sighting is being confirmed, and such populations can move downstream.

Where in Willow Creek would you place the temperature probe? Two probes should be placed, one in the main channel and one in the side habitat. There is a big temperature difference between the main channel and the side habitat areas.

It was recommended that the USFS should go along for the selection of the water temperature monitoring location. The USFS agreed. **Action item**: Janelle will coordinate (schedule) site visit with USFS in the next few weeks to find locations for temperature recorders. Phil Strand will likely go on behalf of the USFS (Holly Eddinger will be included on the list although she can not attend). Julie Means with CDFG asked to participate on this site selection.

USFS suggested that a temperature recorded also be installed at the end of Big Creek 3 Project reach. This is where the powerhouse discharges into Redinger Lake.

Would these temperature readings be the daily maximum, minimum and mean? The USFS suggested that readings be taken every 30 minutes, all the way through mid-June. Hourly readings were suggested to preserve the electronic memory in the temperature probes. We will install two probes; the second will be a back up in case the first is lost. We will use hourly recording interval.

The USFS has been doing temperature monitoring; will they continue to do temperature monitoring? They want the relicensing process to do it. The USFS want temperature monitoring in the big pool below the bridge and downstream in some side habitats.
Action Item: The USFS (Holly Eddinger) to provide an electronic photo of Foothill Yellow-legged Frog and tadpoles to the CAWG members who requested it.

Summary of meeting with USFWS Regarding ESA Consultation requirements for the Studies.

SCE and ENTRIX met with the USFWS to discuss ESA consultation requirements for the study plans.

USFWS has concerns on five study plans, (CAWG-7, REC-3, CUL-1, CUL-2, and CAWG-3), and would require informal consultation as follows:

<u>CAWG-7 Characterize Fish Populations</u>

The USFWS expressed concern regarding the effects of electrofishing fish population surveys on amphibians. SCE prepared a letter that was sent to the USFWS explaining the methods and number of personnel that will be used for these surveys. The USFWS approved what we want to do; their only condition was to disinfect the equipment to prevent spread of fungus. We are waiting for the USFWS ESA section to provide protocols on disinfecting/cleaning of equipment (USFWS ESA section wants to use the USGS protocol). **Action Item**: USFWS and CDFG requested a copy of the consultation correspondence between SCE and USFWS.

The consultation letter sent to USFWS stated that we will: (1) do a walk through, visual scan of the electrofishing site for frogs and tadpoles, if we see frogs or tadpoles of the listed or proposed groups, we will move the site; (2) avoid/reduce disturbance of the site, and (3) during electrofishing, stop if we encounter a frog, remove it to a safe holding container, and return it to the site after work at the site is complete. We will use a 5 percent bleach solution to disinfect the equipment.

<u>CUL-1 Prehistoric Cultural Resources and CUL-2 Historic Era (Pre-1954) Cultural Resources</u>

Concern was expressed that excavation could effect Mariposa Pussy Pod. Excavation work was approved for the Vermilion and Portal studies since these locations are above the elevation range of the species. At lower elevations, we will need to do pre-surveys. However, we will have completed our vegetation mapping before the cultural people go out to do more studies at the lower elevations. The result of the vegetation studies will be provided to the cultural group.

<u>CAWG–3 Determine Flow-Related Physical Habitat in Bypass Reaches and REC-3 Whitewater Recreation Assessment Study</u>

Concern was expressed regarding the put in and put out locations for the whitewater rafting runs and the effects on VELB, nesting eagles and amphibian habitat at these locations.

The USFS asked if the USFWS was concerned regarding the effects of controlled flow releases on biota in the bypassed reaches. The USFWS feels that the Sierra Nevada Framework (Framework) would not allow this type of release, and the USFWS assumes we will be using only natural spill events. The USFS does not agree with the USFWS interpretation of the Framework. There is a disconnect regarding the interpretation of the Framework. Additional consultation will be needed to follow up on this issue.

Action Item: Distribute the SCE letter on electrofishing to the CAWG. Distribute USFWS and SCE meeting notes to CAWG once reviewed and approved by USFWS.

A proposal was made that we create a discrete subgroup between CAWG and REC to get everyone on the same page on this controlled flow release issue. There are several people that participate in both working groups and can report back to working groups, as needed. A separate group is not needed.

SCE proposed to do single flow studies with natural spill the first season. During the second season we will address the timing of controlled releases for the controlled flow studies (out of season flow studies), if needed.

We should begin to work now with USFWS on high flow studies for whitewater flows. And plan on doing out of season studies. We need to develop a plan to do the work and if we decide later that controlled releases are not needed, then we need not do them.

As we develop this plan, we will need an adaptive management component. In case the objectives change before the USFWS service approves the plan.

What is the issue of out of season flows? The whitewater interest groups want to enhance their opportunities for whitewater recreation through out the summer. Therefore, there would be a need for controlled releases after the natural spill period to determine the viability and characteristics of the whitewater runs. The other issue concerns the biological effects to fish, amphibians, reptiles, and macroinvertebrates if there are controlled releases in the summer months. Bald eagles were an issue on Pit River release flow studies.

IFIM work will also require flow releases and will have similar effects and concerns as recreation controlled flow releases.

The USFWS is also concerned regarding the ramping for controlled releases. We will be preparing a memo describing the natural ramping rates. The issue associated with ramping rates is stranding of amphibians in backwaters after the flows a ramped down. (e.g. induce spawning amphibians deposit egg masses, flows decrease and egg mass are stranded). There is potential for this to happen on some small tributaries where wetted perimeter studies are proposed, if listed or candidate amphibians are present. However, this is mainly an issue for the IFIM streams.

There is also a conflict between fisherman and whitewater boaters. We should collect data on fishability of waters during a controlled release. We would need this information for the negotiation phase of the settlement.

The USFS stated that the USFWS is mistaken, the Framework does not provide a restriction of out of season flow releases.

Action Item: Follow up with USFWS and USFS on Framework and controlled flow releases.

Discussion of the False Color IR Aerial Photography

EMERGE, Inc has flown all of the Category 1 areas (high priority areas in back country). This is the high elevation stuff (Vermilion, Edison, Portal, etc.) and we have received the digital images from these areas.

They are currently processing the lower elevation stuff and will be flying this soon. Delay due to FAA restrictions after September 11. We should have everything in the next week or two.

ENRTIX is currently doing the vegetation mapping in preparation of field vegetation and wildlife studies.

Review of Information Regarding Site and Transect Selection for CAWG-3 Studies

Handout – CAWG Stream Transect Information Packet

Does this presentation include a discussion on geomorphology transects? No, a geomorphologist will likely be participating during the field transect selection. They will be there to initiate discussion and take advantage of site select for transects that will also satisfy geomorphology transect selection, (if we can move a transect to meet objectives of both IFIM and geomorphology, we may).

This presentation and transect selection is focusing on wetted perimeter transect selection so that we catch the run off period next spring.

Slide presentation on wetted perimeter transect selection (Wayne Lifton and Larry Wise)

Action Item: Distribute electronic version of wetted perimeter transect selection presentation to the CAWG members requesting it. Presentation is basically the same materials in handouts that were emailed.

The transect selection for wetted perimeter is focused on the upper tributaries of the South Fork San Joaquin Rivers. One stream is being reviewed for IFIM PHABSIM transect selection (Bear Creek). Bear Creek has limited storage, so flow study is somewhat dependent on natural flow availability.

SCE has limited ability to manipulate flow on these small streams, therefore we need to catch natural run-off for the wetted perimeter analysis.

Adit No. 2 is listed as one of the streams, however, it is not a diverted stream it is leakage from the Ward Tunnel. Both Camp 61 Creek and Adit No. 2 are part of the Portal traditional relicensing process.

Tombstone Creek may be removed from the list of streams. SCE may elect to take it out of service. If it is taken out of service then there is no reason to do studies on this creek. **Action Item:** Get resolution from USFS on Tombstone Creek. Is it in the Project Area?

North and South Slide Creeks are not in operation now; we need to determine if SCE will re-operate these.

The wetted perimeter method is used for small streams with no storage, which are diverted only during run-off period.

What about PHABSIM on the South Fork San Joaquin River? The South Fork San Joaquin is being deferred until next year since we have Florence Lake upstream, which contains stored water.

How will we monument the stage discharge relationship? This fall when we select the transects we will only be putting in head pins and the holders for the staff gages. We will place the staff gages and survey the transects next spring during the study.

The rest of the presentation reviewed the Rosgen Level 1 analysis and habitat mapping information for the upper tributaries. Data for each stream was presented individually.

North Slide Creek

General questions regarding the Rosgen level one channel type. Where the stream type is indicated as A+/A is A+, is the dominant channel type with some sections of A? Yes it is. Then we should always denote this by placing a slash"/" between the channel types.
Holly suggests a bar chart with the percentages of the habitat types. We will need to see what kind of presentation of the information we can provide quckly

We will place transects in riffles. If there are no riffles then we will go to runs for transects. The USFS requested a breakdown of the habitats before they agree with this approach. **Action Item**: ENTRIX to provide R-5 Habitat types, before we go out to select transects.

South Slide Creek

There is a lot more flatwater than N. Slide Creek. This is a location where we may place transects in runs.

We did not habitat map above the diversion due to safety concerns (very steep rugged terrain). We will take another look now that the flows are low.

South Slide Creek Data was missing from the handout.

Action Item: Email South Slide Creek information to the CAWG.

Tombstone Creek

Two reaches, transects in both reaches. Pie charts in handout and slide do not match.

Action Item: Redistribute Tombstone Creek pie chart by email to the CAWG.

Hooper Creek

No comments.

Crater Creek

Two reaches, upstream steep channel. No matching habitat type above and below the diversion. How will you handle that? We will look at comparative runs upstream and downstream. We will determine this in the field when we select transects

Crater Creek Diversion Channel.

This is an unnamed ephemeral stream that is flow augmented

Bolsillo Creek

No comments.

Camp 62 creek

No comments.

Chinquapin Creek

Only mapped 500 feet upstream, need to look at his one in more detail, not all pool habitat.

What are you going to do there? Since you don't have comparative upstream habitat.

Can't we cross reference with another stream? Yes, but we would all need to discuss and agree on it in the field.

Camp 61 creek

Three reaches, mostly pool habitat with lots of runs.

East Fork Camp 61 Creek

No comments.

West Fork Camp 61 Creek

No comments.

Adit No. 2

Is this a flow that is augmented or is the flow there because of the leakage from the Ward Tunnel?

Is this a flow augmented stream or is it created by the project?

It would be hard to tell. There are lots of springs in the area.

PHABSIM Bear Creek

Two reaches.

Reach 2 flatter may provide spawning habitat for trout living in the SFSJR.

For the table of stream channel type percentages that you are going to provide, will it also include information by habitat type by percentage? The USFS will eventually want to get the tabular data? We will try to get the percentage information together, in electronic format to the CAWG.

Discussion of Field Schedule for Transect Selection.

We are proposing the weeks beginning October 8th and 15th.

Who will be participating:
- Julie Means
- Rick Hopson
- Phil Strand
- R2 - Dudley Reiser or Paul DeVries
- USFWS

How many days do we need? We have constraint now that we have short days.

We will be looking at pre-flagged candidate sites

The USFS prefers that we do the Bear Creek on Oct. 9, 10 or 11, so Dudley Rieser (R2) can be there. Bear Creek on the 9th and maybe the 10th (may need two days).
Follow with wetted perimeter.

The USFS wants to make sure of the utility of the transect selection.

Action Item: ENTRIX will develop a schedule and send it to the CAWG for review. We will set the schedule this coming Friday. Where to meet and what time.

On the first day we need to start a little later, on the 9th.

Action Item: Julie Tupper to find out what R2 can schedule and timing when they can be here.

General comments on transect selection. We need to do the best we can so that we do not have reopeners two years down the road.

Summary of Action Items

Action Item: The USFS indicated that they would find the most recent version of the SCI and provided it to the CAWG.

Action Item: Janelle coordinate (schedule) site visit with USFS in the next to week to find locations for temperature recorders for amphibian habitat temperature monitoring in the lower system.

Action Item: The USFS (Holly Eddinger) to provide an electronic photo of Foothill Yellow legged Frog and tadpoles to the CAWG members requesting them.

Action Item: USFWS and CDFG requested a copy of the consultation correspondence between SCE and USFWS.

Action Item: Follow up with USFWS and USFS on Sierra Nevada Framework and controlled flow releases.

Action Item: Distribute the USFWS and SCE consultation meeting notes to CAWG once they are reviewed and approved by USFWS.

Action Item: Distribute electronic version of Wetted Perimeter transect selection presentation to the CAWG (to CAWG members requesting it).

Action Item: Get resolution from SCE and USFS on Tombstone Creek, is it in the Project Area.

Action Item: ENTRIX to provide R-5 Habitat types early next week, before we go out to select transects.

Action Item: Email South Slide Creek information to the CAWG.

Action Item: Redistribute Tombstone Creek pie chart by email to the CAWG.

Action Item: ENTRIX will develop a field schedule for transect selection and send it to the CAWG for review. We will set the schedule this coming Friday. Where to meet and what time.

Action Item: Julie find out what R2 schedule and timing when can they be here.

Adjourn meeting

Big Creek Collaborative
Combined Aquatic Working Group

February 13, 2002

Final Meeting Notes

Time:	10:00 – 3:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Supervisors Office Clovis, CA	**Coordinator**:	Wayne Lifton
Teleconference No.:	1-800-556-4976	**Recorder**:	Martin Ostendorf
Teleconference Name:	Combined Aquatic Working Group		

Attended By	Ed Bianchi	ENTRIX
	Mike Henry	FERC
	Wayne Lifton	ENTRIX
	Julie Means	CDFG
	Janelle Nolan-Summers	ENTRIX
	Martin Ostendorf	ENTRIX
	Bill Pistor	K&W
	Geoff Rabone	SCE
	Steve Rowan	SCE
	Phil Strand	USFS-SNF
	Wayne Thompson	Fresno Flyfishers
	Julie Tupper	USFS-RHAT
Phone Participants	Carson Cox	SWRCB
	Jen Carville	Friends of the River
	Holly Eddinger	USFS-SNF
	Britt Fecko	SWRCB
	Rick Hopson	USFS-SNF

Introductions and Review Agenda

The following Handouts were provided to the group:

- February 13, 2002 Meeting Agenda
- Draft Meeting Notes January 9, 2002
- Aerial Photography Estimate Request
- Aerial Photography Metadata
- CNDDB Forms for Aquatic Species
- Amphibian and Reptile Habitat Ground Survey Data for Low Elevations
- Amphibian and Reptile Habitat Characteristics Criteria

The meeting was opened with everyone making introductions followed by a review of the agenda. No comments were received on the agenda.

Review Previous Action Items

- Develop and email out schedule for subgroup meetings and the next CAWG. We will review a schedule during today's meeting.

- Send out a proposed schedule for fall 2003 IFIM transect selection. A schedule will be presented during today's meeting.

- Get a copy of the Mono Lake night snorkeling survey. The SWRCB will look into this and get back to the group.

- Compile metadata for the aerial photography. A handout with this data is provided in today's handout package.

- Is Tombstone Creek in the Project Area? It is marginally economical, SCE is doing an economic analysis. The same thing applies to Slide Creek.

Review January 9, 2002 Draft Meeting Minutes

Page 3, Last sentence, should be relictual salamander.

Page 5, Geomorphology, third bullet, change qualitative to quantitative

Page 6, 2003 Activities, Geomorphology, change qualitative to quantitative

Meeting minutes were approved with the above three changes.

Overview of vegetation community mapping (Presentation)

A copy of this slide presentation is included in Attachment A.

Sometime at the end of February, we will be distributing a compact disk containing data for use in identifying sites for amphibian and reptile surveys (this is for elevations below 4,500 feet).

We will use CD-ROMs because all of the files are too large to email.

We will be going through data that will be used to ID reference sites for amphibians and reptiles. This data includes:

- Species life history
- Vegetation community mapping
- Helicopter data reconnaissance (including photographs with GPS points)
- Amphibian/habitat mapping and reptile groundtruthing data
- Mesohabitat types
- Downed woody debris
- Hydrology
- Water quality
- Water temperature
- Rosgen Level 1 data

All these data sets will be evaluated together to determine the location of potential habitat for the amphibians and reptiles.

Species life history and distribution.

- Yosemite Toad, 6,400 to 11,300 feet

- Western Pond Turtle, <6000 feet
- Mountain Yellow-legged Frog, 4,500 to 12,000 feet
- Foothill Yellow-legged Frog, <4,500 feet (we may want to look below 5,000 feet)

If you have overlap in species distribution so you would look for both species in the overlap areas.

Salamanders: the USFS still has not made a determination on the species that they may consider Forest Service Sensitive. We need to be aware of the forth-coming species status.

When will we know the USFS determination? We may not know in the short term.

At the next subgroup meeting we need to identify survey methodology for these species and see how they can be integrated into surveys that are already proposed as part of the project.

We need to know how the subgroup will deal with this species. We are trying to do this by keeping it on the table.

Species life history and distribution

The presentation in Attachment A summarizes the life history parameters for the following species. The discussion for each of these species is summarized below:

Yosemite Toad

The USFS is focused on the tadpole lifestage.

We need to keep in mind potential habitat sites to account for the USFWS needs. This comes back to the hydrology, since we could create habitat by changing flows.

We are still taking a habitat-based approach, but we will do some presence absence surveys.

Mountain Yellow-Legged Frog

We don't know when egg-laying occurs we only know of the tolerances. They prefer streams that do not a have a high canopy cover.

What is your definition of a deep pool? It is based on a width to depth ratio. Recent publication puts the ratio at 40%.

The USFS hasn't heard of the depth requirement for this species. **Action Item No. 1:** Provide the paper describing the depth requirement for MYLF ration approach for the identification of deep pool to the group.

Foothill Yellow-Legged Frog

Who provided the temperature range? **Action Item No. 2:** Provide references to publications identifying the temperature ranges for FYLF.

Typically, the FYLF is found in gravel bars at the confluence with tributaries. However, in our system they are found in bedrock pools. This may or may not be an anomaly. This may be a characteristic habitat for this species in the Big Creek system. Preferred habitat in the Southern Sierra may be different.

A helicopter reconnaissance was conducted, data collected from the flight includes:
- Habitat data
- Substrate
- Presence of riparian habitat
- Gradient (qualitative)
- Surrounding vegetation community

Mesohabitat gradient data is also provided within the mesohabitat data.

We find that the Rosgen level 1 over-estimates the gradient. IT relies on valley slope rather than stream slope. We do not want to eliminate a potential site based on the Rosgen 1 data only.

Amphibian and reptile groundtruthing
Potential amphibian and reptile habitats were ranked during groundtruthing as follows:

0 = is not suitable
1 = potential habitat
2 = moderate
3 = high probability

Does the rank take into account that some streams dry up in the summer, for instance, Ely Creek? The ranking is based on conditions last August, there were pools that had not dried up

Everyone will receive the data CD for the sample site selection. It will contain a lot of data for the low elevation areas, below 4,500 feet. Once everyone has the data CD, then we should have a subgroup meeting to review it. The subgroup will need to review the ranking system criteria that were provided in the habitat criteria data sheet.

Decisions from the subgroup come back to the CAWG for approval. The subgroup will go through the technical details and bring their decisions and conclusions back to the CAWG for review and approval.

Mesohabitat data, does the reported cover include woody debris? We have canopy type and separate woody debris listed.

We have taken a first cut at ranking the mesohabitat types, based on the following scale:

O = is not suitable
1 = moderate
2 = high

It was noted that this is different from the amphibian habitat ranking scale. It was recommended that we use the same ranking system. **Action Item No. 3:** Make the ranking scales for the mesohabitat consistent with the system that was used to rank the amphibian habitat.

Ranking evaluation, should we do additive or multiplicative ranking? The subgroup will need to think how to use the ranking system. When using the multiplication approach a 0 ranking value will knock out an unsuitable habitat.

You might be able to give different weights for the different ranks. We want to be sure that we don't disregard secondary habitats.

We need to develop a stratified sampling approach.

We can stratify across all types of habitat. We can then sample a subset of the stratified secondary habitat.

A second CD containing data for the entire project area is being developed and will be distributed. This second CD will include data for both the low elevation and high elevation streams.

The low elevation streams will be the first group to be surveyed (April). Therefore, there is a time constraint to get the data for these streams out to the working group so we can select survey locations.

Action Item No 4: Amphibian and Reptile Subgroup meeting to review CD data. March 1 at the USFS Clovis office from 1 PM to 4 PM.

Demonstration on how to use the data CD

A demonstration on how to use the amphibian, reptile and riparian CD was provided.

The files on the CD are all Adobe Acrobat files that are linked together. The Adobe Acrobat reader program is free and can be downloaded from the Adobe website on the Internet. It is recommend that you have the latest version of Adobe Acrobat (version 5.05) to view the contents of the slides.

Can we get more copies of the CD? Once you receive your version of the CD you are free to copy it.

The distribution of the CD is the easiest way to present the large volume of data necessary to select the amphibian/reptile and riparian sampling sites.

Riparian Subgroup

Action Item No. 5: Riparian subgroup meeting on March 19th from 1 PM at the USFS Clovis Office.

The objective of this meeting is to go through a methodology to select the riparian sites.

Riparian subgroup participants: Joanna Clines, Julie Means, Rick Hopson, Carson Cox, Geoff Rabone, Julie Tupper, Wayne Lifton (and potentially Mitchell Katzel).

Survey Schedule

There was a handout of the schedule at the last CAWG meeting.

ESA Consultation Update

We are still trying to get USFWS involved in the process. We are emailing, faxing and calling them on a consistent basis. Gary Taylor, Debbie Giglio, and Jesse Wild have been included in the Amphibian, Reptile, and Riparian subgroups.

Next CAWG meeting is planned for March 13th.

Aquatics Studies Schedule Presentation

A slide of the tentative schedule for the aquatics studies was projected for group. A copy of this slide is included in Attachment B.

Fish populations start in mid-June and will likely run through August. The locations where the studies will start are dependent on the snowmelt run off timing.

Macroinvertebrate Studies will be conducted during August through September.

Wetted perimeter and IFIM transect selection is proposed to be preformed beginning August 5 and September 9. The will extend through the first two weeks of August, and early September. We will be selecting transect locations for the 2003 studies.

This year's wetted perimeter and IFIM/PHABSIM studies will be conducted in April/May and May/June respectively.

Geomorphology studies will be conducted on Camp 61 Creek July 15 through July 19 (for the Portal relicensing). The remaining streams will be studied during July through September.

Have you made a first cut as to where the transects will be selected? We will develop this data and have a subgroup meeting to review the data prior to going into the field.

Distribution of the CD-ROM: The CD is going to the Subgroup, if other CAWG members want a copy they should let us know. Geoff to send a copy to Carla, Mike Henry, and Britt Fecko.

Review of Action Items:

Action Item No. 1: Provide the paper describing the depth requirement for MYLF ration approach for the identification of deep pool to the group.

Action Item No. 2: Provide references to publications identifying the temperature ranges for FYLF

Action Item No. 3: Make the ranking scales for the mesohabitat consistent with the system that was used to rank the amphibian habitat.

Action Item No 4: Amphibian and Reptile Subgroup meeting to review CD data. March 1 at the USFS Clovis office from 1 PM to 4 PM.

Action Item No. 5: Riparian subgroup meeting on March 19th from 1 PM at the USFS Clovis Office.

Adjourn

Attachment A

Overview of vegetation community mapping distributed on February 1st (Presentation)

Attachment B

Aquatics Studies Schedule

Big Creek Collaborative

Combined Aquatic Working Group

March 19, 2002

Final Meeting Notes

Time:	10:00 – 2:15 PM	**Moderator:**	Wayne Lifton
Location:	USFS Supervisors Office Clovis, CA	**Coordinator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Cody Fleece
Teleconference Name:	Combined Aquatic Working Group		

Attended By	Wendy Van Dyke	North Fork Rancheria
	Steve Rowan	SCE
	Phil Strand	USFS-SNF
	Bill Pistor	Kearns & West
	Janelle Nolan-Summers	ENTRIX
	Lonnie Schardt	Huntington Lake Association
	Sara Yarnell	ENTRIX
	Rick Hopson	USFS-SNF
	Darrin Doyle	ENTRIX
	Geoff Rabone	SCE
	Larry Lockwood	Huntington Lake Association
	Julie Means	CDFG
	Britt Fecko	SWRCB
	Wayne Lifton	ENTRIX
	Cody Fleece	ENTRIX
	Mitchell Katzel	ENTRIX

Phone Participants

<u>Introductions and Review Agenda</u>

The following Handouts were provided to the group:

- March 19, 2002 Meeting Agenda
- Draft Meeting Notes February 13, 2002
- Final Meeting Notes January 9, 2002
- Draft Meeting Notes August 1, 2001
- 2002 Field Schedule
- Depth Requirements Reference for Mountain Yellow-legged Frogs

The meeting was opened with everyone making introductions followed by a review of the agenda.

Review Previous Action Items

Action Item No. 1: Provide the paper describing the depth requirement for MYLF rationale approach for the identification of “deep pool” to the group. **COMPLETED**

Action Item No. 2: Provide references to publications identifying the temperature ranges for FYLF. **COMPLETED**

Action Item No. 3: Make the ranking scales for the mesohabitat consistent with the system that was used to rank the amphibian habitat. **COMPLETED**

Action Item No 4: Schedule Amphibian and Reptile Subgroup meeting to review CD data. March 1 at the USFS Clovis office from 1 PM to 4 PM. **COMPLETED**

Action Item No. 5: Riparian subgroup meeting on March 19th from 1 PM at the USFS Clovis Office. **ON AGENDA**

Action Item No. 6: Provide copy of USFWS meeting notes. **COMPLETED**

USFWS meeting notes passed out.

Review February 13, 2002 Draft Meeting Minutes

Approved by all.

Amphibian and Reptile Subgroup Meeting

PowerPoint presentation by Janelle Nolan-Summers

- Refine Mesohabitat queries
- Run Mesohabitat queries
- Prepare preliminary habitat map
- Determine highest ranking reaches
- Cross-reference with other data (ground survey, helicopter, etc.)
- Identify sub-basin Geomorphology
- Select sample sites
- Complete queries for areas where special-status species are found
- Prepare map of potential habitats

Presentation by Sarah Yarnell
Mesohabitats considered as part of stream habitat criteria
Gradient
Substrate
Cover type
Canopy (% as quartiles)

Habitat Criteria
0 = Poor
1 = Moderate
2 = Good
3 = Very Good (Just for substrate for FHYL frog)
N/A = Not Available

Criteria Weighting
FYLF – Substrate

% Coarse = Gravel + 2 Cobble + 2 Boulder + Bedrock
0-35 Coarse = 1
35-75 Coarse = 2
75-100 Coarse = 3
FYLF Cover
Any cover = 2
No cover = 1

Summed each habitat unit
Component = 0
Score = 0

Next step will be to look at Histograms for reaches, compare scores and look at scores of adjacent mesohabitats.
Conditional sum = if any score = 0 then mesohabitat score is 0 except FYLF.

Action Item 1: Request for PowerPoint presentation. Will send via E-mail.

Survey Protocols
Presentation by Janelle

- FYLF – Lind 1997 (high ranking habitat types); Fellers and Freel (other types)
- MYLF – Fellers and Freel
- Yosemite Toad – Fellers and Freel modified zigzag transect
- Western Pond Turtle – Reese (undated)

Reference Site Selection

Why is Jose Creek identified as a potential reference reach, as well as Willow Creek?
For Jose Creek:
Population present on Jose Creek
Want non-project impaired reaches
Jose Creek is more information gathering than true referencing
Problems with use of Willow Creek:
Bullfrogs – Willow Creek
Fish – Willow Creek
Diversions – Willow Creek

Action Item 2: Request sub-group review of issue. Willow Creek in or out?

Action Item 3: Include Mill Creek as a reference?

Action Item 4: Does the CAWG agree on approach? Perhaps time is needed to reflect and submit comments. Comments to be submitted to Janelle by 3/27.

1. Areas above Diversion
2. Non-Project affected reaches

The Subgroup will further evaluate how to use Jose Creek and Willow Creek.

Willow Creek not dropped at this time, despite alterations and presence of Bullfrogs.

Action Item 5: <u>The Subgroup will evaluate if Willow Creek should be removed from the potential Reference Reach list.</u>

Reference Reach selection
Similar Geomorphology

Next steps
3/22 Amphibian, Reptile, Riparian CD available for distribution.

Create preliminary Habitat map based on stream habitat criteria 3/29.

Conduct mesohabitat typing of Jose Creek 3/25.

USFWS meeting 3/29.

Janelle – Handouts
Amphibian/ Reptile helicopter survey data for high elevation on streams
Amphibian/Reptile ground survey data for high elevation streams

Action Item 6: Wayne distributed info regarding angling opportunities to the subgroup. Notify prior to 3/21 if interested in participating (Martin Ostendorf).

Action Item 7: Rick will check with Julie Tupper re: status of SCI Protocol.

Action Item 8: Request Mitchell's PowerPoint presentation.

Geomorphic Assessment
Presentation by Mitchell Katzel
Goals
Inventory Geomorph condition
Characterize effect of Project operations
Flow regime
Channel Geomorphology
Sediment recruitment
Sediment transport
Riparian function
Discuss significance of Project effects
Link with other technical studies: riparian and wildlife

Technical Objectives
Pre- and Post-project hydrology: timing, magnitude, duration

Sediment Recruitment
Identify process
Magnitude of supply
Project facility and operational effects particle size in reservoir.

Basin Stratification
Rosgen Level II
Guidance for reference reach selections

Existing Data
Photos – recent and historic
Identify sediment sources

Characterize Flow Regime

Sediment and Woody Debris Management

Roads Assessment as Sediment Source

Aerial Survey
Level I and II classification
- Entrenchment
- Pattern and Form
- Materials
- Bedform
- Floodplain Presence

Snowmelt Runoff Observations
Bankfull indicators
Focus on C and E Channel types most likely connected to floodplain

Geomorphology Field Surveys
Focus on sensitive channels B, C, E, F, G. A and B less responsive
- Validate channel type
- Compare particle size upstream and downstream of diversions

Does sediment supply relate to soil information? Yes, but will not use soil information unless it is available in a format that assists with evaluating sediment supply conditions. Probably greater emphasis on Geologic conditions such as bedrock lithology.

Sediment Transport
Determine effective discharge
- Peak flows
- Estimate bankfull discharge – defined as flow that moves sediment. Does work.

Map sediment deposits, fine sediment accumulations
Compare unimpaired and regulated channels

Project Effects
Inventory channel morphology
Stability
- Degrading, aggrading

Riparian Habitat Functionality
Floodplain connectivity (hydrology, sediment deposition))
Vegetation encroachment

General Approach Geomorphic Assessment

2002 Technical Studies
- Review and analyze existing data
- Qualitative Reconnaissance Survey
- Data Reduction, Synthesis and Interpretation
- Select Quantitative study sites for 2003 (CAWG Participation)
- CAWG Consults on Impacted Areas and Reference Locations for Further Study

Field Inventories
- Identify transition between geomorphic types.

What about diversion locations? Often located at transitions between channel types.

Does this affect ability to identify useful reference?
Yes – need to consider if important indicators are similar up and downstream of diversions. May not have suitable reference areas upstream of diversions, must consider:

- Bankfull indicators (type quality)
- Entrenchment and floodplain connectivity
- Bed particle size
- Slope
- Geology

Provide Level II map? Yes, perhaps Level "1.5" classification is best description of work product for 2002.

- Identify aggradation degradation – braiding
- Classify channel bedform
- Categorize recruitment processes
- Presence of woody debris and function
- Reservoirs – visually estimate volume and particle size
- Road inventory
    - Will submit classification system to CAWG
    - Which roads? Only SCE roads?
    - Possibly identify non-project sources if impacting streams

Action Item 9: Group can provide forms for road assessment to Mitchell. Identify non-project roads that are sediment sources. Study only project roads.

<u>Data Synthesis and Interpretation</u>

- Reference reach
    - Compare channel morphology to quantify Project effects
- Reference reach screening
    - Basin stratification
        Drainage Area Elevation
        Valley slope Etc.
    - Field verification and observations
        Project effected and non-effected must be similar for valid comparison
    - CAWG review and approval
- Indicators of altered channel morphology
    Aggradation/Degradation
    Lateral instability
    Longitudinal comparison (e.g. particle size)
        How does character change with distance along stream?

Action Item No. 10: Regional curves available for hydraulic geometry. USFS has data available (possibly use?). Use to predict channel dimensions based on drainage area.

End of this year select quantitative study sites
Field inspections with study groups

Review existing data March-May
Qualitative reconnaissance
    CAWG approves data sheets June
    Field inventor May-September
Synthesize data In September
Select sites in October

Hydrology study should feed into geomorphology study

Analysis of Indicators of Hydrologic Alteration up front would be a good idea

Scheduling

Identify opportunities for CAWG to participate

Wetted Perimeter Data collection

High flow	4/23-4/27
Mid Q	5/29-6/2
Low Q	7/9-7/13

Action Item No. 11: Steve needs to run IFIM flows by generation folks to discuss timing.

Bear Creek 6/3-6/6

Select wetted perimeter PHABSIM transects

Wetted perimeter	8/5-8/15
PHABSIM	8/19-8/23
	9/9-9/13
	9/23-9/26

We'll try to be sensitive to notification issues

HSC Verification

50 Observations/Species and lifestage

Streams will be stratified in upper and lower basins for streams used for PHABSIM.

Action Item No. 12 Presentation on how HSC criteria comparison. Possibly fall 2002 Action Item.

Water Quality Sampling

Spring snowmelt	5/6-5/24
30 day fecal	7/24-7/26
Fall baseflow	(Dates?)

Reservoir Profile

Each month

Mammoth Pool only. Yes concern about mine waste bioaccumulation.

Geomorphology

May helicopter reconnaissance weather dependent

June – general reconnaissance

Field crew – start up July

Big Creek – end July

August – work toward higher elevation streams. Reference last so they will know if those chosen are adequate compared to Project.

Fish population studies must wait for flows to come down.

Entrainment – Bi-monthly

Macros – Cross comparison of labs will be implemented to ensure quality of results

Amphibians – (input from Janelle)

Western Pond	May – select sites
FYFL	June
MYLF	Start in late May –June also YT. Site selection late April
Red-legged	Site assessment

Action Item No. 13: Revise Amphibian schedule and e-mail.

Review of Action Items:

Action Item No. 1: Request for PowerPoint presentation. Will send via E-mail.

Action Item No. 2: Request sub-group review of issue. Willow Creek in or out?
Action Item No. 3: Include Mill Creek as a reference?

Action Item No. 4: Does the CAWG agree on approach? Perhaps time is needed to reflect and submit comments. Comments to be submitted to Janelle by 3/27.

Action Item 5: The Subgroup will evaluate if Willow Creek should be removed from the potential Reference Reach list.

Action Item 6: Wayne distributed info regarding angling opportunities subgroup. Notify prior to 3/21 (Martin Ostendorf).

Action Item No. 7: Rick will check with Julie Tupper re: SCI Protocol.

Action Item No. 8: Request Mitchell's PowerPoint presentation.

Action Item No. 9: Group can provide forms for road assessment to Mitchell. Identify non-project roads that are sediment sources. Study only project roads.

Action Item No. 10: Regional curves available for hydraulic geometry. USFS has data available (possibly use?). Use to predict channel dimensions based on drainage area.

Action Item No. 11: Steve needs to run IFIM flows by generation folks to discuss timing.

Action Item No. 12: Presentation on how HSC criteria comparison. Possibly fall 2002 presentation.

Action Item No. 13: Revise Amphibian schedule and e-mail.

Adjourn

Big Creek Collaborative
Combined Aquatic Working Group

May 8, 2002

Final Meeting Notes

Time:	1:00 – 4:00 PM	**Moderator:**	Wayne Lifton
Location:	Picadilly Inn - Fresno	**Facilitator**:	
Teleconference No.:	1-800-556-4976	**Recorder**:	Wayne Lifton
Teleconference Name:	Combined Aquatic Working Group		

Attended By	Julie Means	CDFG
	Larry Lockwood	SAMS
	Phil Strand	USFS-SNF
	Britt Fecko	SWRCB
	Carson Cox	SWRCB
	Janelle Nolan-Summers	ENTRIX
	Mitchell Katzel	ENTRIX
	Martin Ostendorf	ENTRIX
	Wayne Lifton	ENTRIX
	Geoff Rabone	SCE
	Woody Trihey	ENTRIX

Phone Participants		
	Jesse Wilde	USFWS

<u>Introductions and Review Agenda</u>

Review actions items.
All action items done – except to resolve:
Provide consistent river stationing system by June 12th CAWG meeting

<u>Updates: Water Quality Sub-group</u>

- Add sampling location – PH 8 tailrace near Dam 6
- Completing sampling location map now
- Reviewing samples and protocols

- Two sampling events for spring and fall 2002 as follows:

Spring and Fall Sampling Events

Small diversions to be sampled during high flow and near end of run off period, because after run off, no diversions are made, therefore, no Project effects. Sampling to be performed in late June – early July. This applies to the small diversions. All other locations to be sampled in late fall.

Approval: Upon recommendation of the Water Quality Subgroup the CAWG approved proposed locations and timing, for spring and fall sampling events.

Fecal coliform <u>(5 sample/30 days)</u>
Several stakeholders expressed an interest to add additional sample locations for the fecal coliform (5-sample/30 day) sampling program.

Approval: Locations were added as follows:

- Three locations in Line, Billy and Bear Creeks that flow into Huntington Lake, (these will be sampled to assess potential fecal coliform sources upstream of cabins at Huntington Lake).
- A location on Balsam Creek upstream of Camp Sierra

The 5 sample/30 day sampling event will straddle 4^{th} of July holiday weekend.

The spring sampling locations will be sampled for fecal coliform Basin Plan standards. If the Basin Plan standard is exceeded at any of the sampling locations then these locations will be added to the 5-sample/30 day locations for fecal coliform.

Fecal coliform has 6-hour hold time, and this may not be feasible to collect and transports some of the water samples to the laboratory in this timeframe. Several sites have access issues. For instance the confluence of the SFSJR and SJR is a location where we may not be able to meet the six hour hold time.

We will strive to meet the 6-hour hold time for as many samples as possible. However, some of the samples may not meet the 6-hour holding time.

<u>Analytical Methods</u>

The subgroup reviewed analytical methods and associated detection limits (Need to make sure hardness dependent metals are sufficiently low).

A comparison of methods indicated that the laboratories have updated methods from those originally proposed. These methods are EPA approved and the laboratory that will be used is a state certified laboratory. Approval: Upon recommendation by the subgroup the CAWG approved the analytical methods for the water quality samples.

Chlorophyll α – analysis, we are identifying several laboratories that are can complete these analysis..

Propose to begin sampling on May 20. It will take 3-4 weeks to get results. After that, we will reconvene group to discuss results.

Action Item 1: Prepare and distribute maps of the approved water quality locations. These will be distributed electronically on a compact disk.

Amphibian/Reptiles

Janelle will provide Jesse Wild of USFWS an update on sample and reference/habitat verification segment methodology.

Janelle's Presentation

1 Finalized stream habitat criteria for Foothill Yellow-legged frogs, Mountain Yellow-legged frogs, Yosemite Toad and Western Pond Turtle approved by the U.S. Fish and Wildlife Service.

2 Working with the U.S. Fish and Wildlife Service to finalize the California red-legged frog stream habitat criteria.

3 Janelle provided two handouts on Foothill Yellow-legged frogs: 1) Proposed .Foothill Yellow-legged Frog sample and reference/habitat verification segments and 2) Habitat Suitability of Stream Segments including Geomorphic Description for Foothill Yellow-legged Frog.

Ranked stream segments by based on Stream Habitat Criteria query results. . Completed calculations of mean, weighted mean, standard deviation for each segment. Ranked segments as good, moderate, or poor based on Sub-group approved criteria.

- Subgroup completed an overlay of geomorphic features of each stream segment
- Stratified selection of sample and reference/habitat verification segments by Rosgen Level 1
- Completed geomorphology field verification of proposed sample and reference/habitat verification segments

Sample and reference/habitat verification sites were selected based on channel type (geomorphology), segment quality, spatial distribution within the watershed and access.

Overview of Process

In subgroup, reviewed sample segment for foothill yellow legged frog
Habitat components ranked, assigned scores to value of each component.

Scoring of quality	Mean	Weighted Mean
Good	≥ 7	≥ 7.25
Moderate	4-6.99	4-7.24
Poor	< 3.99	< 3.99

Prepared plots of segment quality by distance and reviewed geomorphology of each segment. Completed geomorphology verification of site visit at proposed sample and reference/habitat verification sites. Stratified sample and reference/habitat verification segments across Rosgen types, segment quality, spatial distribution, and accessibility.

Subgroup has identified and approved Foothill yellow-legged frog sample and reference/habitat verification.

18 sample and reference/habitat verification segments have been selected. During surveys, sample a minimum of 1,000 ft segment will be surveyed in accordance with the subgroup approved ~~modified~~ Lind protocol (SWRCB STAFF AND THE SUBGROUP DID NOT AGREE TO A "MODIFIED" LIND PROTOCOL, NOR WAS A "MOIDIFIED" LIND PROTOCOL SUBMITTED TO THE CAWG FOR ITS APPROVAL). Greater than 1,000 ft segment will likely be surveyed at each sample and reference/habitat verification

segment.

Good quality habitats – use ~~modified~~ Lind approach to see if they are there
Moderate – poor quality habitats –use Fellers and Frehl, if frogs are found switch to ~~modified~~ Lind site methodology to gather more detailed data.

14 sampling sites
3 habitat verification sites
1 reference site

Poor segments were only identified in Aa+ channel types.

Action Item 2: Janelle Nolan-Summers to send out presentation to CAWG.

While sampling poor habitats are there opportunities to identify mitigation opportunities? Yes.

Will you get adequate information on frogs? If found in moderate and poor habitats, we will collect more detailed data on habitats with the Lind site methodology~~. This is consistent with the modified Lind approach~~. This will allow us to be able to compare data between segments.

CAWG approved approach and sample and reference/habitat verification segments selected for foothill yellow-legged frog. Janelle will provide Jesse Wild of USFWS an overview of approach and sample and reference/habitat verification sites selected for foothill yellow-legged frog at a separate meeting.

Other species provided to sub-group, similar data to Foothill Yellow-legged frog.

Is there something driving Yosemite toad poor habitat? Will be cross-referenced with meadows where they breed.

Sub-group meeting on May 24 at ENTRIX office in Sacramento from 9 am to 3 pm. Verify with Geoff Rabone on 5/27/02. Conference call on Monday 10 am to 12 pm. Janelle Nolan-Summers with U.S. Fish and Wildlife Service from 1 pm to 4 pm.

Action Item 3: Janelle Nolan-Summers to send agenda for May 24 meeting on Friday.

Next Steps

- Start sampling on Friday for foothill yellow-legged frog.
- Start geomorphology verification for Yosemite toad and Mountain Yellow-legged frog following selection of sample and reference/habitat verification segments.
- Once sample and reference/habitat verification sites area selected by the subgroup they will bring segments to the CAWG for approval.

Stream habitat queries will be run for western pond turtle and California red-legged frog.

Riparian Sub-group

Group will list methods. Defer riparian work until Rosgen 1.5 is ready after this year. Need to have more definitive information than Rosgen 1.

Will collect microhabitat data on riparian with geomorphology.

Is data collection season dependent? No, work to be done in spring and summer. Data will be collected during 2003. Geomorphology data sheets and protocols to CAWG in June.

CAWG approved deferring implementation of the Riparian study plan until 2003, after Rosgen Level 1.5 data is collected and more geomorphology data is available.

Geomorphology
Two handouts.
Reference reach selection.
Mitchell's presentation
Prefer as first choice for reference reach use same stream, different reach.

Geomorphology Presentation
Consider putting landmarks on profile plots such as tributaries
What is secondary aspect? How determined?

Above diversion reference for eight Project streams.
Why Ross and not Rock? Rock has a radical slope change downstream of the diversion, but Ross does not. Ross has an orchard with private property that diverts water. NF Stevenson Creek used as a conduit for water to Shaver Lake.

Was Fish Creek considered? Yes.
44 possible reference reaches considered. Each Project reach has at least one candidate reference reach except San Joaquin River downstream of Mammoth Pool.

North Fork and Middle Fork have different mix of geologic types than mainstem San Joaquin, including volcanic material in addition to granite rock.
Could historical aerial photography be used if suitable? Yes, if the photos have sufficient detail.

Candidate Reference Reaches and Geomorphic watershed characterization reviewed.

Action Item 4: Mitchell to provide explanation of codes used in geomorphology table then revised geomorphologic reach parameter. Provide CAWG with write-up of the guidelines used for determining the + or – ratings

For reference reaches, similarity based on a variety of characteristics.

Action Item 5: Provide reference reach comparison characterizations to Project-affected streams.
Action Item 6: Provide candidate reference list. Provide CAWG with map or profile with landmarks showing location of reference and project reaches

Mitchell – we will need to do this after stationing is decided. Profile plots should have stream confluences, other landmarks.

How are you weighting comparisons between the parameters evaluated for the reference streams and the corresponding project-affected streams? No set formula, need to interpret how the + or – assigned to each parameter that was evaluated, based on our criteria, add up as a whole.
Woody – need to keep in mind what the purpose of the reference reach is, in order to decide if it is a good match to a Project-affected reach. Purposes include biology, and geomorphology
No final "call" on reference reaches and Project-affected reach comparisons are being made.

Primary and secondary aspect. What does this mean? Basin aspect comparison is based on primary aspect only.

Example on SF San Joaquin candidate reach upstream of Florence Lake.

Example for Rock Creek comparison between Jose and Jackass Creeks.

Action Item 7: Wayne to get last geomorphology presentation on CD ROM to CAWG.

<u>PHABSIM/Wetted Perimeter Update Presentation</u>
We are currently reviewing the existing PHABSIM models. IF models are adequate, we will present to CAWG and not select transects for modeling those reaches. If the models are good and need to be extended, we may need to relocate transects used. If models are not good, we won't look for the BICEP transects
We may need to evaluate the potential for extending the models at higher flows for whitewater or other purposes. This may involve using existing transects or selecting some additional ones. We will report to the CAWG in July.

<u>Review of Action Items:</u>

Action Item 1: Prepare and distribute maps of the approved water quality locations. These will be distributed electronically on a compact disk.

Action Item 2: Janelle Nolan-Summers to send out presentation to CAWG.

Action Item 3: Janelle Nolan-Summers to send agenda for May 24 meeting on Friday.

Action Item 4: Mitchell to provide codes used in geomorphology table then revised geomorphologic reach parameter.

Action Item 5: Get comparison characterizations for reference reach comparison to groups. Provide candidate reference list.

Action Item 6: Provide CAWG with map or profile with landmarks showing location of reference and Project reaches

Action Item 7: Wayne to get last geomorphology presentation on CD ROM to CAWG.

Adjourn

Big Creek Collaborative
Combined Aquatic Working Group

July 10, 2002

Final Meeting Notes

Time:	10:00 – 3:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Offices – Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Wayne Lifton/Mitchell Katzel
Teleconference Name:	Combined Aquatic Working Group		

Attended By	Mitchell Katzel	ENTRIX
	Mike Henry	FERC
	Geoff Rabone	SCE
	Mark Newquist	SCE
	Wayne Allen	SCE
	Steve Rowan	SCE
	Wayne Lifton	ENTRIX
	Phil Strand	USFS
	Bill Pistor	Kearns & West
	Britt Fecko	SWRCB
	Lonnie Schardt	HLA
	Julie Means	CDFG
	Carson Cox	SWRCB

Phone Participants None

<u>Handouts</u>

- Agenda
- June meeting notes
- Carson Cox's comments on May Meeting Notes
- Larry Wise's map package
- Mitchell Katzel's aerial Overflight Forms
- Wayne Lifton's Candidate Fish Site and Macroinvertebrate Site Selection tables

Action Items Discussed

- CD-ROM identification still needs to be completed.
- Other materials went out
- Lind versus modified Lind still under discussion in subgroup.

It was suggested that all future meeting notes be more of a summary and a record of agreements/disagreements rather than pseudo transcriptions.
Need to avoid attributions unless someone wants to go formally on the record.

Geomorphology Update

Mitchell Katzel:
Verification of Rosgen Types and collection of other data.
NF Stevenson Creek outlet is Tunnel 7, Gate 2.
Stevenson Creek, review of changes based on ground.
Further clarification will be provided as work continues.

Did you see much woody debris? Not a lot. Not much geomorphic function.

Fish and Macroinvertebrate Sampling

Wayne Lifton's Presentation
We are only identifying sampling sites for those streams where we know the Rosgen stream typing. As we verify the Rosgen types from the Level I classification, we will stratify and identify the sampling locations.

Fish Sampling
Objective: determine fish abundance, growth, (etc based on CAWG-7) to be sampled in representative manner based on channel geomorphic type and habitat type (CAWG-1, -2).

Electrofishing sampling

Snorkeling surveys – habitats too deep for electrofishing

Stratification – sample one of each major Rosgen type, use Hawkins/collapsed habitat types that are representative based on habitat mapping. 100 meter sites per plan.

Reference sites – one site in comparable channel type upstream of Project diversion for small and medium size diversions. Upstream of diversions are not always the same Rosgen types as downstream. Larger streams – may not have good references to survey. Example is Stevenson Reach of San Joaquin River; Mammoth Pool Reach is upstream. It is not an adequate reference.

Discussion of streams and habitats to be sampled based on handout and slides. These included:
Adit No. 8, Balsam Creek, Ely Creek, NF Stevenson Creek, Stevenson Creek, Rock Creek, Ross Creek, Camp 62 Creek, Chinquapin Creek, North and South Slide Creeks, Crater Creek, Crater Creek Diversion, Hooper Creek, and Tombstone Creek.

Can you tell the difference between wild and hatchery fish in streams that are stocked? Usually yes, by appearance. Scales can be definitive if there is doubt.
Comment: Stratification approach is a good approach. Stratification procedure may help explain number differences between locations. In the past, stratification was just based

on visual observation and access.

Stevenson Creek – is above the Lake a suitable reference reach? We will need to evaluate.

Mammoth Pool Reach, San Joaquin River, SF San Joaquin River, Mono Creek, and Bolsillo Creek are waiting for Rosgen type verifications before determining fish sampling locations. Plan to present these to CAWG at next meeting.

No objections to proposed fish sampling sites.

Action Item 1: Copy of letter to USFWS for SWRCB electrofishing sampling.
It may be on website, otherwise will bring to next meeting.

Macroinvertebrate Sampling

Based on CAWG-10 Plan - focus is on water quality not macroinvertebrate community *per se.* Slide presentation.

Discussion of streams and habitats to be sampled based on handout and slides. These included:
Adit No. 8, Balsam Creek, Ely Creek, NF Stevenson Creek, Stevenson Creek, Rock Creek, Ross Creek, Camp 62 Creek, Chinquapin Creek, North and South Slide Creeks, Crater Creek, Crater Creek Diversion, Hooper Creek, and Tombstone Creek.

Comment: Macroinvertebrate sampling has been controversial; methodology is based on effects of toxics in the stream, not diversions.

Factors affecting macroinvertebrate sampling

Stratification – reduce variability due to channel type, substrate, and habitat type, in order to identify Project effects. Use reference sites that do not contribute additional variability or confounding comparisons. We have found that substrate size influences benthic community. Sample only one Rosgen Level I Channel type per study plan.

One sampling site at the upstream and downstream ends of each bypass reach.

RBP methodology specifies sampling riffle habitat. Some sites have no riffles. Runs are a potential substitute, but some sites have no runs.

Comment: Sampling should be representative of the reach.
We will visually estimate substrate particle size at sampling site. We probably won't have many choices for where we sample. RBP used as a water quality component.

Comment: Does study give any meaningful data if it's not done in a riffle or run?
Pools can be sampled, but we need to use different methods than for riffle/run.
Cascades not practical to sample. Taxa and metrics from other habitat types may not be comparable, may confound use of metrics.

Comment: How are we considering tributary inputs?
We are not considering tributaries in these streams. We may want to give some thought to tributary influences in deciding where we sample. This is not a big issue on the streams we are discussing today, but sampling location on the larger streams have not yet been determined; we should consider tributary influences on the larger streams (**Action Item for August meeting**).

Decisions: There are three choices for sampling macroinvertebrates above and below diversions in a given stream type given the lack of riffles and runs in some reaches.

Proposal:
(1) If riffles are present in bypass reach but not above diversion, sample riffles – no reference site used above diversion.
(2) Where riffles are not available in bypass reach, but runs are, sample runs. Sample runs if available above diversion.
(3) If neither riffle nor run available, do not sample.

Discussion of potential approaches.
Suggest we sample riffles, stays closer to protocol. Better for diagnosing impacts to use riffles. Riffles tend to have greater diversity than runs. Larger rivers, runs can be more productive; on smaller streams riffles are more productive.

Concern expressed about not having an upstream reference, even if you use runs as a reference for riffles downstream. Concern for confounding results. Is sampling the riffle below diversion going to tell us anything about the Project diversion effect if there is no reference riffle upstream of the diversion? It will tell us something about the health of the stream, but you can't attribute anything to Project effects without the upstream reference.

Wayne – A way to address this is to compare runs above and below diversion, only the one run station immediately below the diversion. Riffles below the diversion would also be sampled including at the end of the reach, and intermediate station in long reaches. Only one channel type would be sampled per study plan. This would allow both a comparison above and below the diversion, and a comparison of changes along the bypass reach.

SWRCB – Would like to check with Russ Kanz before making a final decision on sampling protocol decisions. Will get back to the group, if any concerns.

List of streams with appropriate reference sites. **No objections to Wayne's proposal for sites and approach.**

Need reference sites for Stevenson Creek, if any. Will discuss with Geomorphologists.

Comment: Is there an example of instream flow release requirement for macroinvertebrates? None was identified.

<u>Short Lunch Break</u>

<u>Review of BiCEPs Instream Flow Studies</u>

After lunch, Larry Wise presented BiCEP PHABSIM studies done in mid-1980's.

The BiCEP project, conducted in the 1980's, evaluated the potential environmental effects associated with increasing the generation capacity of the Big Creek System. As part of these studies, an evaluation of fish habitat as a function of flow was undertaken in Big Creek, and the San Joaquin River below Mammoth Pool.

Reaches included:

Lower Big Creek (Big Creek Powerhouse 8 to Dam 5)
Upper Big Creek (Big Creek Powerhouse 2 to Dam 4)
Mammoth Reach (Mammoth Pool to Mammoth Pool Powerhouse)
Stevenson Reach (Powerhouse 3 to Dam 6)

Objectives of BiCEP PHABSIM Model Review:

1. Review of BiCEPs PHABSIM models to determine their utility in the ALP process and in meeting the informational needs of the CAWG
2. Provide recommendations regarding their use and their limitations

Review Criteria:

Is the habitat type identified in each of the models?
Do the model statistics for mean error and velocity adjustment factors fall within acceptable boundaries?
Do the range of flows in these models meet those needed for the current study or can they be extended to meet this range?
At what Flow are the headpins overtopped?
Are the transects representative of channel-types and mesohabitat types?
Have channel changes occurred that would affect the validity of the use of the models?

Explanation of PHABSIM model.

What's the probability of potential for significant change in channel type since 1984 when BiCEP transects were surveyed? Geomorphology will have to consider the potential for channel change since 1984.

Lower Big Creek Conclusions/Recommendations

- Habitat types identified in models, riffle not represented
- Calibration statistics within recommended tolerances
- Range of simulations limited by extent of channel profile survey, but may be extended to 75 cfs
- Re-weight habitat models to reflect recent habitat mapping

Upper Big Creek Conclusions/Recommendations:

- Habitat types identified in models
- Calibration statistics for most transects within recommended tolerances
- Range of simulations limited by extent of channel profile survey
- Upper range of simulations may be limited to 20 to 33 cfs at 5 of 15 transects
- Solutions for extending simulation range
    - Obtain additional transect measurements
    - Apply Lower Big Creek models to Upper Big Creek Reach

Mammoth Reach Conclusions/Recommendations:

- Habitat types identified in models
- Stage Discharge Relationships acceptable
- Velocity calibrations for most transects acceptable for some flows based on VAFs for a three flow model
- Re-weight habitat models to reflect recent habitat mapping
- Recommend attempting re-calibration using IFG-4A method
- Upper range of simulations limited to 375 cfs at 9 transects based on headpin elevations
- Additional transects needed to simulate whitewater flows (600 - 1,500 cfs)

Stevenson Reach – are Mammoth transects appropriate for Stevenson Reach? Need to complete channel geomorphology Rosgen Level I assessment.

If Mammoth Reach conclusions are applicable:

- Appropriate simulation range insufficient for whitewater flows (500 - 800 cfs), will need to add transects to simulate whitewater flows
- Re-weight habitat models to reflect recent habitat mapping

Need to select for any supplementary transects in September. Measurements to be made in Spring 2003. Hope to get report out in about two weeks, depends upon receiving geomorphology results.

Other Project reaches where IFIM needs to be performed but are not included in the BiCEP work:

- SF San Joaquin River
- Mono Creek
- Stevenson Creek
- NF Stevenson Creek

WETTED PERIMETER

Small tributaries with no storage
Diverted only during run-off period
Habitat bottlenecks likely to occur during base flow period
Sample reach upstream and bypass reach downstream of diversions
Studies dependent upon the presence of run-off due to lack of storage
Select sites and transects this fall

Measure 3 riffles (runs where riffles are not available)
Measure Stage-Q relationship
Determine flow needed to reach inflection point (where channel bottom fills with water)
Determine passage conditions

Seven tributaries for WP studies to be considered during field trip:
Ross Creek, Rock Creek, Adit 8 Creek (break in pipe is source of water), Ely Creek, Balsam Creek, and Pitman Creek.

Adit 8 Creek has 4 riffles for review by CAWG
Ely Creek has 5 riffles suitable for CAWG review below diversion
Rock Creek - 3 sites above diversion suitable for review; 2 sites below diversion

Comment - Consider plunge pool approach for Rock Creek and Bolsillo Creek? Consider amount of flow needed to transport food through pools. Look at velocity distribution through pools – literature suggests you need 0.3 ft/sec to move food through pools.

Field trip to select WP transects to begin July 29.

IFIM Transect Selections
Aug 19-23 - SF San Joaquin River
Sep 23-27 - Mono Creek, Stevenson Creek, NF Stevenson Creek, Big Creek below Huntington Lake

Geomorphology Subgroup

Vegetation Encroachment included:
Aerial Survey Reconnaissance Data Sheet
CAWG agrees on Aerial Survey data forms – with one modification:
(1) Add Active or Inactive to Tributary Recruitment conditions

Ground Survey Forms to be finalized via Phone Conference.

Report from Amphibian Subgroup

Phil Strand reviewed work by subgroup and recommendations.
Yosemite toad methodology– handout

Yosemite toad methodology approved

Mountain Yellow-legged frog

Handout

Geographical and geomorphic stratification

Changes in sites:
Keep SFSJR Mono Xing to Rattlesnake, drop South Slide
Mono Creek above Lake Edison in place of Bear to be explained.

Approved MYLF site selection and methodology

Western Pond turtle pools are found in cascade/high gradient streams

Use Reese methodology for WPT, as discussed in subgroup. **No objections.**

Modifying approach based on fish and Foothill Yellow-Legged Frog surveys.
Focus surveys to look for them where they haven't been found.

Use both geographic and geomorphic stratification. Habitat quality (based on suitability analysis) is variable. Species is very mobile. Surveys need to be done by the end of July. Another meeting may be needed, probably next week to address sites and pool definition.

List of Action Items

1. Incorporate Carson's comments into 6/12 CAWG meeting summary

2. Meeting summary – Format improvement – July notes as model – Review in August meeting

3. SCE – USFWS letter Re: amphibians and electrofishing. Copy to Britt Fecko

4. August meeting topic – Tributary inputs for macroinvertebrates – S. Fork San Joaquin River in particular

5. Call Re: Wayne proposal on Run/Run reference and Riffle BD. Britt/Carson to check with Russ. Call With Russ and others, if needed

6. Remaining Geomorphology verification – remaining stream sample sites identified at August CAWG

7. Report on BiCEP transect use in ALP—discuss in August meeting

8. Transect selection: Field trip 7/29 – 8/02, 8/19 SFSJR, 9/23 Mono, Stevenson, NF Stevenson, Big Creek below Huntington Lake

9. Combine 7/10/02 presentations (Larry and Wayne) onto CD ROM and distribute

10. Teleconference – Geomorphology ground survey forms

Approvals/Concurrence

1. Fish Sampling sites

2. Macroinvertebrate Sampling Sites and Proposed Approach (Pending feedback from SWRCB regarding use of runs in upstream reference sites and immediately below the diversion for those streams with runs, but without riffles upstream of diversion, and having riffles present in bypass reach. Riffles in bypass reach would be sampled per study plan.)

3. Yosemite Toad Methodology as recommended by Amphibian Subgroup.

4. Mountain Yellow-legged Frog methodology as recommended by Amphibian Subgroup.

5. Reese Western Pond Turtle Methodology as recommended Amphibian Subgroup.

Big Creek Collaborative
Combined Aquatic Working Group

August 14, 2002

FINAL Meeting Notes

Time:	10 AM to 4 PM	**Moderator:**	Wayne Lifton
Location:	USFS Offices in Clovis	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Wayne Lifton/ Mitchell Katzel/ Larry Wise
Teleconference Name:	Combined Aquatic Working Group		

Attended By	Larry Wise	ENTRIX
	Lonnie Schardt	HLA
	Julie Means	CDFG
	Wayne Allen	SCE
	Bill Pistor	Kearns & West
	Britt Fecko	SWRCB
	Phil Strand	USFS
	Steve Rowan	SCE
	Wayne Lifton	ENTRIX
	Carson Cox	SWRCB
	Mitchell Katzel	ENTRIX
	Julie Tupper	USFS

Phone Participants	**For Amphibian Portion**	
	Laurraine Tigas	ENTRIX
	Kathy Little	ENTRIX
	John Hale	

<u>Review Previous Action Items</u>

- Discuss Run sampling for BMI
- May meting notes approved
- CD ROM of July presentations distributed
- July meeting notes approved
- SCE letter to USFWS re: electrofishing and amphibians. Copy sent to Britt.
- Brief discussion – EPA protocol uses runs. ENTRIX has call into Jim Harrington, will report results. Britt and Carson checked with Russ Kanz- he said runs OK and move forward or check with Harrington.

- September plenary meeting moved to Wednesday September 12
- CAWG Thursday September 13
- Recreation meeting Tuesday September 11
- Bill to follow up on September meeting schedule with group.
- Other action items to be addressed during today's meeting

Geomorphology Verification Presentation:

Rosgen reach breaks for San Joaquin River, SF San Joaquin River, Big Creek, Mono Creek
Review of Rosgen reach breaks Level 1.5.
CD-ROM passed out to subgroup 2 weeks ago. Will be revised later based on evaluation of field data.

SF San Joaquin River starting from confluence B and G, mostly G2 highly entrenched and confined becomes B at Rattlesnake Crossing. B2 and B3 based on substrate, C at Mono Hot Springs. B and G upstream. CS/B5 – near Jackass Meadow. Candidate for quantitative study lots of sand with gravel.

Macroinvertebrate and Fish Study Sites Presentation

Fish and Macroinvertebrate site selection
Review objectives
Streams to be discussed listed in handouts for fish and macroinvertebrates
Stratification strategy presented again from July presentation
For fish will sample all Rosgen Level I channel types representing >5% of a reach.
100 m sites with all major habitat types will be used for fish sampling.

Sampling sites to be selected for sites not previously approved. Waited for verification of channel types by geomorphology team. Sampling Sites based on Rosgen Channel Types from Level I and then verified from the Level 1.5 channel typing from aerial surveys and ground surveys. Includes additional reaches due to increased number of stream types than originally delineated from just Level I typing.
Streams include:

- SF SJR
- Mono Creek
- Bolsillo Creek
- Mammoth Pool Reach SJR
- Stevenson Reach of SJR
- Big Creek
- Pitman Creek

Fish Sampling

South Fork San Joaquin River:

- Primarily Rosgen Level I: B and G Channel Types with small areas of C.
- B Channel Type dominant downstream of Florence Lake
- G Channel Type dominant downstream of Hoffman Creek
- Sampling of Channel Types constituting >5% of length in each reach
- Sampling in reaches identified in CAWG-7.

Handout of fish sampling sites lists reaches and candidate sites.
SFSJR:
Florence to Bear – sample B and C not G type. Look at potential reference sites upstream of Florence.
Bear to Mono – sample B, C, and G
Rattlesnake to Mono – Sample B type channel
Rattlesnake to Confluence – very inaccessible. G-type channel One site identified upstream of Hoffman.

Description of potential reference reach sampling units (B and G channel types) upstream of Florence Lake to compare with SF San Joaquin River below Florence Lake for fish. No reference available for C type channel. References mostly valid for upper end of project reach – lower end is substantially lower in elevation.

Mono Creek- all B channel. One site below diversion. No adequate channel reference for Mono Creek above diversion because above is another bypass reach.

Bolsillo Creek-B channel above and below diversion, Aa+ channel also present below diversion. One site in each of these reaches.

Fish sampling in Mammoth Pool reach of SJR – B and G channel types, one site in each. No upstream reference, but this will be discussed later in presentation.

Stevenson Reach-all G channel type. Access can be challenging.
Sample two sites, one each in upper and lower portions of reach

Big Creek Dam 4 to PH 2 (Upper Big Creek Reach). Almost all A Channel type. No suitable reference upstream due to bypassed reach. One sampling site in A channel type.

Dam 5 to PH 8 (Lower Big Creek Reach). Primarily A channel, with Aa+ section in lower ½ mile. One sampling site in each channel type.

Big Creek below Huntington Lake Reach-Big Creek two miles below the dam to be verified by geomorphology team on the ground for next CAWG meeting. Will present potential fish sampling sites at that time.

Pitman Creek-Two channel types present B and Aa+. Only B present upstream of the diversion. We propose to sample three sites: B-above the diversion, B and Aa+ below the diversion.

Clarify that we are sampling representative reaches vs individual habitat units. We are sampling sites containing representative habitat types by channel type and stream reach. A stakeholder raised a concern that we may not be sampling large pools. Pools in candidate sites are selected to be representative of types for channel and reach type. Bigger, deeper pools will be snorkeled. Prefer to sample contiguous habitat types.

A question was asked as to how the group will address fishing pressure?
Will integrate data at some point in the future to tell the whole story regarding fish population issues; consider temperature, water quality, recreation take, stocking, hydrology, geomorphology, etc.

Macroinvertebrate Sampling

Macroinvertebrate sampling protocols described. If riffles are not present above diversion, but run is and is present below diversion, we will sample run above and immediately below the diversion and riffles throughout the bypass reach.
Are we taking into account the CSBP suggested alternate methodology if you don't have riffles? Spot sampling vs. Best available habitat discussion. Original EPA methodology was based on sampling cobble, and was not meant for pools or cascades. ENTRIX has called Jim Harrington at CDFG, but we have not talked with him at this time. Will discuss with him and adopt suggestions, as applicable.

South Fork San Joaquin River. Mostly B and G channel types. B channel dominant type below Florence Lake and in the vicinity of the diverted tributaries. G channel dominant in lower portion of reach including inaccessible areas. Both types are present at the bottom of the reach. Propose to sample B channel type, all candidate sites are riffles. Sample eight sites between Florence Lake and confluence with San Joaquin River.

Description of potential reference reach sampling units (B channel types) upstream of Florence Lake to compare with SF San Joaquin River below Florence Lake for macroinvertebrates.
Mono Creek downstream of Mono Diversion

- Rosgen Level I: B Type Channel
- Riffles Present
- Upstream reach is below Vermilion Valley Dam
- Reach upstream of Lake Edison sampled for Vermilion relicensing, may represent a potential reference

Four sites to be sampled in Mono Creek. Sampling will be conducted in similar substrate types – we don't want to sample sand in one location and gravel in another because this will confound the study results.

Bolsillo Creek. Bolsillo will be sampled above and below the diversion.
B channel type AD, B and Aa+ channel types BD
Sample B channel type AD and BD.

Mammoth Pool Reach. B and G channel types, B channel is the majority.
Propose to sample B type channel. There are riffles present in each of the B channel segments. Unclear as to whether the San Joaquin River section below the Mainstem San Joaquin River and SF San Joaquin River confluence could be used as a partial reference. It has upstream diversions on the South Fork, but also a major unregulated drainage area input. Subject of discussion for today, as well.

Can we sample B and G channel type instead of just the B channel type? Is this a change in the study plan? G channel type macroinvertebrate results are likely to be different than the B channel type results.

How do we sample every 2 miles and still consistently sample the same channel type? It seems like we are mixing and matching methodologies. We are using two approaches, point source (i.e., for example the Rock Creek spoils pile) and then comparing longitudinally above and below diversion ("ambient water quality" approach).

It is to our advantage to hold channel types constant to compare type B to type B. It may be difficult to sample across channel types and interpret the results. Try to reduce the factors that influence the results. Comparing above and below the diversion, you must hold the channel type constant. However, there are reasons to sample across channel types because this is considering things at a bigger scale to get at the overall stream aquatic health- longitudinal change issues. Concerns over the sediment input from the Rock Creek spoils pile and measuring effect on BMIs.

Proposed wording that stakeholders would like to have information across different channel types, sampling approximately every two miles to address issue of overall health of aquatic ecosystem, in addition to following the existing Study Plan which holds channel types constant above and below Project facilities to specifically addresses effect of diversions. State Board staff expressed that the proposal to have information across different channel types and sampling approximately every two miles is already a part of the study plan and is not an addition.

Channel type was over-riding factor in deciding where to put sampling locations according to existing Study Plan. We are reducing the variability by sticking to one channel type. State Board staff believe according to the existing study plan that channel type should only be one factor in deciding where to put sampling locations and see value in comparing CSVP information across channel types.

It is valuable to sample both types, but comparing across is adding too much variability and will confound results. Important to factor out this variability. Other factors such as temperature and elevation already contribute a lot of variability. State Water Board staff do not agree with this statement and see value in analyzing CSVP information both within and between channel types.

Proposal to sample B and G but treat as two "reaches" in Mammoth Reach:

Two sites in G type

Two sites in B type

Samples will likely come up with differences in BMIs. Must have an understanding that comparisons between channel types are likely to be confounded by differences. Move Site 3 upstream of Shakeflat Creek from the B into the G channel section. Put a site above Rock Creek in the G channel section. Proposed sites will address here spoils pile issue concerns. This provides data for longitude of reach and provides data also for within channel type comparisons. Stakeholders will have information to make comparisons either way. Seems agreeable group move on.

Discussion of reach from top of Mammoth Pool and NF-SF Confluence, one site will be sampled for reference placed in the first appropriate riffle upstream of inundation zone of Mammoth Pool.

Stevenson Reach - Only G type channel in this reach, which will be sampled at four locations. Access can be a problem in this reach. Riffles are available at each candidate site.

Big Creek

Big Creek Dam 4 to PH 2 (Upper Reach). Mainly A type channel. Riffles present at candidate sites. Sample three sites. No adequate reference, reach upstream is diverted.

Big Creek Dam 5 to PH 8 (Lower Reach). Mainly A type channel. Riffles present at candidate sites. Sample two sites. No adequate reference, reach upstream is diverted.

Pitman Creek. Two Rosgen channel types present: B and Aa+. Upstream of diversion B Channel Type with run habitat. Small section of B below diversion, but no riffles or runs. Aa+ below the diversion contains run habitat. B Channel run above diversion may lead to confounded comparisons. Propose to sample Aa+ channel only.

Would like to sample B channel AD to use as a reference to B channel BD on other sites without other references. The Aa+ channel section below the diversion can be compared with other Aa+ channel type reference sites on other streams, where the variability due to flow, altitude, drainage area, etc. is minimized.

Proposal to take one sample in the B-channel section above the diversion. SCE agrees to include this sample for reference reach purposes, not for comparison with the Aa+ channel section.

Next Steps:

Verify geomorphology for Rancheria Creek and for Big Creek between Huntington Lake and PH 1. Bring candidate sites to September CAWG meeting.

Does CAWG want sampling site in the lower South Fork Near Hoffman confluence? Access would require a 2-3 day commitment of time. There is a site near confluence. No, don't think this is worth the time for one site.

Channel Type	A		B	
Percent of Reach Length	***95.3%***		***4.7%***	
Habitat Classification	Percent	No. of transects	Percent	No. of transects
FLATWATER	6%	1	4%	3
RIFFLE	7%	2	15%	0 (+2)
SHALLOW POOL	15%	5	5%	0
DEEP POOL	51%	4	45%	0 (+2)

BiCEP Model Review (*Larry Wise: BiCEP presentation)*
Presentation of conclusions of Hydraulic Review
Recommend re-calibration of model using IFG4-A
Re-cap of last time. Conclusions of hydraulic review. Stage – discharge relationships look good.
Add transects as suggested.

Big Creek Reach
Lower Big Creek
Aa+ - type channel not represented in BiCEP models. Major habitat types are deep pools, cascade and shallow pools. CAWG recommended adding transects to represent deep and shallow pools (3 transects each). No transects in cascades as they don't provide substantial habitat. How important is it to pick three additional transects for Shallow Pool when it represents only 12% of a reach length that represents 29% of the reach length (i.e., 3% of the channel length)? It could be important because it may be the only significant area of fish production.

A-type channel represented in BiCEP model, except riffles. Recommend adding two transects to represent riffles.

Upper Big Creek
A-type channel: Information provided at meeting regarding habitats represented by existing transects was incorrect. Correct habitat representation provided below.

Original Information:

Corrected Information:

Based on this corrected information, we would recommend that one transect be added to better represent flatwater habitat. The initial proposed addition of transects to riffles and deep pools is now unnecessary.

B-type channel: very short reach of channel, but flatwater (run) represented in BiCEP

Channel Type	A		B	
Percent of Reach Length	***95.3%***		***4.7%***	
Habitat Classification	Percent	No. of transects	Percent	No. of transects
FLATWATER	6%	5	4%	3
RIFFLE	7%	1 (+1)	15%	0 (+2)
SHALLOW POOL	15%	6	5%	0
DEEP POOL	51%	0 (+3)	45%	0 (+2)

model by three transects. CAWG recommended adding two transects to riffles and two to deep pools to round out representation of habitat in this channel type. No transects would be placed in shallow pools.

SJR Mammoth Pool Reach
Mammoth – recommend recalibration using IFG 4A to extend range of flow simulation.

G-type channel: All habitat types adequately represented in G-type channel. No additional transects recommended for modeling usual range of flows.
B-type channel: Riffles not represented and deep pools underrepresented. Recommended adding two transects to each of these two habitat types.

Stevenson Reach
No BiCEP transect in Stevenson Reach. In BiCEP, Mammoth transects were used to represent Stevenson Reach.

Mammoth and Stevenson Reach have similar channel type, habitat type composition, and similar widths and depths. Recommend accepting use of Mammoth G-channel transects in Stevenson Reach.

State Board would like to see the BiCEP transect models peer reviewed. Some CDFG staff in the Region were involved in the BiCEP model. Gary Smith – CDFG can do the review. USFS would also like to peer review of the report. They will contact R2. SCE would like to see the peer reviewers consider if the additional transects proposed are necessary and cost-effective. Potential peer reviewers list: Gary Smith, Craig (?Chris) Hunter (State Board recommendation), Mark Gard (USFWS), Dudley Reiser (from R2). Wayne Lifton to ask USFWS (Gary Taylor) about possible Mark Gard peer review.
Get it out quickly
Reviews must be back before September CAWG meeting.

Need review completed by CAWG meeting on September 12. Report done by August 26 for peer review. Let Bill Pistor know by 26th who will be reviewing report.

Postpone IFIM transect selection presentation due to lack of time. Reschedule to Tuesday 20th from 3:00-5:00 PM - Meeting to review Larry's presentation. Meeting to be facilitated.

<u>Amphibians Study Discussion</u>
Proposed pool definition for Western Pond Turtles. No objections to language in hand-out. Approval from CAWG.

Riparian Study Discussion
Substrate Size characteristics data collection is a concern in conjunction with the riparian vegetation. What is riparian vegetation nexus with particle size data?
Discussion of riparian data collection sheet, concern about what substrate data are being collected, especially out of channel/microhabitat.
Concern with field crews already out there doing geomorphology surveys. If this isn't decided may miss opportunity. Riparian info important for designing qualitative studies with PFC, SCI. How important is it?

Add to Riparian Data Collection Form information on Substrate at specific sites where riparian vegetation is growing. Data Sheet to now include:
Left Bank Dominant Particle Size Subdominant Particle Size

Right Bank Dominant Particle Size Subdominant Particle Size
Data Sheet approved with modifications.

Riparian Data to be collected by Riparian/Botanist (John Hale for week of August 19).

Geomorphology
A reminder to everyone that the CD-ROM is mislabeled, it should indicate that the material represents the Rosgen "Level 1.5" classification and not Level I. We will do something about the labels.

Everyone has reviewed the memo material on CD-ROM, candidate study reaches for quantitative not to be sampled. There are 28 miles to be ground-truthed.

What if we feel there are holes in qualitative surveys? CAWG approves the list of ground survey sites for qualitative study.

Mitchell wants a concurrence from group on locations of ground survey sites for qualitative study. Approved.

Candidate sites for quantitative sites. Do not collect qualitative data at these locations. Mitch and Woody will be prepared to initiate first discussions regarding quantitative studies for the CAWG meeting on September 12th.

IFIM Transect Selection Schedule:
Upper Basin Sept 23-27
Sept 30 - Oct 4

Wayne to take care of CSBP question follow-up.

Agreement Actions:

1. CAWG agrees to fish and macroinvertebrate sampling sites as modified during the meeting today.

2. CAWG agrees on adding a macroinvertebrate site in G1/G2 section above Mammoth Pool since there is an added G sampling site below Mammoth Pool. The sampling will need to be done quickly since the elevation of Mammoth is dropping quickly.

3. CAWG approves list of Geomorphology Ground Survey Sites for Qualitative Study.

4. Western Pond Turtle pool definition approved.

5. Riparian forms approved with modification.

6. Geomorphology ground level qualitative study sites approved.

List of Action Items

Action Item 1: Kearns & West to finalize and distribute September meeting schedule.

Action Item 2: South Fork San Joaquin River - field for electrofishing, snorkeling, fish and macroinvertebrates (Sept). Let group (Britt) know when scheduled.

Action Item 3: Question: CSBP – alternatives for dealing w/ when a riffle is not available – i.e. spot sampling. Issue: can you compare a spot sampled riffle in reference reach with a "normal" riffle in BD reach?

Action Item 4: BiCEP PHABSIM Report and proposed additional transects:

- USFS/R2 review – Julie Tupper to contact Dudley Riser
- CDFG background and reviewers – Julie Means to contact Gary Smith and Dale Mitchell
- Carson verify from Canaday – Craig Hunter or Chris ? and proceed from there
- USFWS – Wayne Lifton to contact USFWS (Gary Taylor) to see if Mark Gard or other reviewer available
- Larry – report out quickly target date: 8/26/02

Group check with experts and report on Tuesday
* Fast review – concluded by September 12, 2002

Action Item 5: New transect selection - schedule meeting/call for next week – Tuesday 8/20/02 from 3 to 5 PM at USFS office in Clovis.

Action Item 6: Geomorphology data sheet needs substrate (dominant; subdominant; left and right bank (looking down); setting; comment and location).

Action Item 7: John Hale (or other riparian person) to go with geomorphology crew to help identify plants and locations.

Big Creek Collaborative
Combined Aquatic Working Group

August 20, 2002

FINAL Meeting Notes

Time:	3 PM to 5 PM	**Moderator:**	Wayne Lifton
Location:	USFS Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Wayne Lifton
Teleconference Name:	IFIM Combined Aquatic Working Group		

Attended By	Wayne Lifton	ENTRIX
	Phil Strand	USFS
	Bill Pistor	Kearns & West
	Wayne Allen	SCE
	Larry Wise	ENTRIX
	Julie Means	CDFG
Phone Participants	Carson Cox	SWRCB
	Britt Fecko	SWRCB

Instream Flow Transect Allocation
Larry Wise Presentation
Discussion of transect selection, stratification

Reaches typically based on Project features, hydrological features. We use this, but then stratify by Rosgen channel type. Representative mesohabitats are selected within Rosgen channel types to account for variability in how channel types affect characteristics of mesohabitats. This generally results in as many or more transects than in other types of transect allocation.

Concerns expressed by some about not understanding the approach and that the CAWG has approved an approach yet. Details had been discussed in the preparation of the CAWG-3 Study Plan, but were reduced in later versions. The last version was moved to an appendix to the plan, during final CAWG approval process, it was decided to leave the appendix out of the plan.

Can appendix or details be found and provided to those not involved in plan development. ENTRIX will look for document. Can Larry explain process? He will provide information.

Some not familiar with information, want to review before making a decision.

Question about access downstream of Rattlesnake Crossing. Difficult to access area, requires a lot of time to get in and out, as well as collect data. Access time in excess of what was considered reasonable access time per plan. Larry to analyze G channel mesohabitats downstream of Rattlesnake to see if sites there would be needed and report back.

Bear to Florence C and B channel

Number of transects to be placed SF San Joaquin River: Bear Creek to Florence Lake

Channel Type	**B**		**C**		G	
Percent of Reach Length	***69.8%***		***27.4%***		***2.8%***	
Habitat Classification	Percent	No. of transects	Percent	No. of transects	Percent	No. of transects
FLATWATER	50%	2	50%	2	50%	0
RIFFLE	23%	2	1%	0	0%	0
SHALLOW POOL	1%	0	2%	0	0%	0
DEEP POOL	23%	3	46%	3	38%	0

Reach
G channel not included <5 percent.

Bear to Mono

Number of transects to be placed SF San Joaquin River Mono Crossing to Bear Creek Reach

ChannelType	**B**		**C**		**G**	
PercentofReach Length	***58.9%***		***20.4%***		***20.7%***	
HabitatClassification	Percent	No.of transects	Percent	No.of transects	Percent	No.of transects
FLATWATER	25%	2	19%	2	23%	2
RIFFLE	25%	2	37%	2	26%	2
SHALLOW POOL	8%	3	0%	0	8%	3
DEEP POOL	40%	3	44%	3	43%	3

Mammoth Pool
B and G channel types
BiCEPs transects in both
G = 46% deep pool, riffle, flatwater
B = 54% deep pool, flatwater, riffle

Number of transects to be placed in San Joaquin River Mammoth Reach

Channel Type	B		G	
Percent of Reach Length	*54.3%*		*45.7%*	
Habitat Classification	Percent	No. of transects	Percent	No. of transects
FLATWATER	18%	4	6%	3
RIFFLE	14%	0 (+2)	14%	2
SHALLOW POOL	0%	3	2%	2
DEEP POOL	68%	2 (+2)	75%	7

Number of transects represent those from BiCEPs study with additional transect recommendation in parentheses

Stevenson Reach
G channel Type
Deep pool, flatwater, riffle – Use BiCEP transect only

Mono Creek
All B channel type
Flatwater, riffle, deep pool, shallow pool

Number of transects to be placed Mono Creek Below Mono Diversion Reach

Channel Type	B	
Percent of Reach Length	*100%*	
Habitat Classification	Percent	No. of transects
FLATWATER	45%	2
RIFFLE	11%	2
SHALLOW POOL	5%	3
DEEP POOL	28%	3

Big Creek
Dam 4 to PH 2
B and A channel types
Some BiCEP transects in B

Number of transects to be placed Big Creek – Dam 4 to PH 2 Reach
Number of transects represent those from BiCEPs study with additional transect recommendation in parentheses

Channel Type	**A**		**B**	
Percent of Reach Length	***95.3%***		***4.7%***	
Habitat Classification	Percent	No. of transects	Percent	No. of transects
FLATWATER	6%	1	4%	3
RIFFLE	7%	2	15%	0 (+2)
SHALLOW POOL	15%	5	5%	0
DEEP POOL	51%	4	45%	0 (+2)

Dam 5 to PH 8
A and Aa+ channel type

Number of transects to be placed Big Creek – Dam 5 to PH 8 Reach
Number of transects represent those from BiCEPs study with additional transect recommendation in parentheses

Channel Type	**A**		**Aa+**	
Percent of Reach Length	***70.9%***		***29.1%***	
Habitat Classification	Percent	No. of transects	Percent	No. of transects
FLATWATER	3%	4	4%	0
RIFFLE	8%	0 (+2)	3%	0
SHALLOW POOL	16%	2	12%	0 (+3)
DEEP POOL	62%	2	60%	0 (+3)

Would like alternative approach in writing if use of BiCEP models is not approved. List as Action Item.

NF Stevenson Enhanced Reach

Number of transects to be placed North Fork Stevenson
Don't sample A
Will sample G

Stevenson Creek

Channel Type	A		Aa+		B		C		G	
Percent of Reach Length	*4.3%*		*50.4%*		*20.2%*		*17.1%*		*8.1%*	
Habitat Classification	Percent	No. of transects	Percent	No. of transects	Percent	No. of transects	Percent	No. of transects	Percent	No. of transects
FLATWATER	20%	0	9%	2	4%	0	44%	2	37%	2
RIFFLE	0%	0	13%	2	10%	2	12%	2	5%	2
SHALLOW POOL	10%	0	8%	3	0%	0	15%	3	0%	0
DEEP POOL	0%	0	15%	3	86%	3	26%	3	57%	3

Shaver Lake to SJR

Number of transects to be placed Stevenson Creek

28 transects
G channel type < 5%, will not be modeled

Channel Type	A		Aa+		B		G	
Percent of Reach Length	*15.8%*		*51.2%*		*29.9%*		*3.2%*	
Habitat Classification	Percent	No. of transects	Percent	No. of transects	Percent	No. of transects	Percent	No. of transects
FLATWATER	7%	2	11%	2	9%	2	4%	0
RIFFLE	13%	2	3%	0	6%	2	4%	0
SHALLOW POOL	23%	3	12%	3	12%	3	0%	0
DEEP POOL	40%	3	27%	3	55%	3	65%	0

Brief discussion of transects and habitat types
Number of stations per cross-section. ~20 in low flow channel usually 25-40 across transect

Need to find old appendix that was removed after discussion prior to approval of CAWG 3 Plan

Description of selection of habitat clusters / sequences - need review of approach.

Whitewater Studies
Objective- needs to be clearly defined
Approach to be used depends on objectives

Single flow – three reaches from Recreation Group
1. Mammoth Reach
2. Stevenson Reach
3. Below Florence to Rattlesnake

<u>Other Possibilities</u>
Mono Creek
Bear Creek
Big Creek Dam 4 to PH 2
Big Creek Dam 5 to PH 8
North Fork Stevenson

Need to consult with Gangemi, Martinez, and Martzen after August 27 to identify whitewater flows and reaches.

Concern about transition-zone fish community in Stevenson Reach.
Stevenson Reach not being considered for augmental flow release at present.
Field work issues at higher flows: 600-1200 cfs-safety, difficulty of taking measurements, difficulties of gaining access.

Maybe focus on edge cells, critical habitats. Need to select sites where we can get access and work at high flows.

Objectives
Native cyprinids and catastomids, more of an issue with Stevenson rather than Mammoth out of season flows, effects on amphibian, reptiles.

Stranding and ramping-fry rearing and spawning locations, sensitive species areas that need to be sampled.
Use habitat suitability of amphibian habitats from Janelle's work to identify amphibian sites.

Wayne Lifton to find technical appendix material. Get out by next CAWG meeting.

List of Action Items

Action Item 1: Larry - Write-up an overview of transect allocation approach.
Channel type
Transects per channel type
Transects per mesohabitat

Action Item 2: Teleconference to discuss the above, if needed. Otherwise discuss, if needed, at CAWG meeting.

Action Item 3: Larry - South Fork San Joaquin – G channel. Hoffman/Rattlesnake – prepare presentation re: mesohabitat types.

Action Item 4: Larry - Write-up proposed approach for transects if the current BiCEP transects are NOT approved by CAWG (combine with write-up from Action Item 1).

Action Item 5: With Action Items 1 and 4, find study plan details – i.e. Appendix that was ultimately pulled out of study plan and redistributed to group.

Action Item 6: Add to write-up:

- How to come up with random areas for transect selection

Action Item 7: Re: Whitewater flows to be considered for IFIM. Check with Martzen, et al. re: appropriate flows (Aug. 27 Flight). Mono, Bear, Big Creek, and NF Stevenson Creek.

Action Item 8: Out of Season whitewater flows –

- Bring in amphibian sub-group
- Bring in amphibian experience from Pit (Britt to discuss with Russ Kanz and make sure Julie Tupper provides input)-for next CAWG meeting
- Identify species of interest in selecting transects
- Geomorphology re: spawning gravel
- Larry to take group's Site/Species concerns and recreation group's recommended flows (Aug 27) and develop straw man proposal for new whitewater transects.

FINAL

Big Creek Collaborative Relicensing
Combined Aquatics Working Group
Meeting Summary
September 12, 2002
10:00 AM – 3:00PM

Attendees:

Present:	Julie Means	CDFG
	Larry Wise	Entrix
	Wayne Lifton	Entrix
	Wayne Thompson	Federation of Fly Fishers
	Mike Henry	FERC
	Roger Robb	Friant Water Users Authority
	Lonnie Schardt	Huntington Lake Association
	Bill Pistor (Facilitator)	Kearns & West
	Bryan Harland (Notetaker)	Kearns & West
	Larry Lockwood	SAMS Coalition
	Geoff Rabone	Southern California Edison
	Wayne Allen	Southern California Edison
	Carson Cox	SWRCB
	Britt Fecko	SWRCB
	Rick Hopson	US Forest Service
	Cindy Whelan	US Forest Service
	Phil Strand	US Forest Service

Phone: [none]

Introduction, Ground rules, Agenda – Bill Pistor (Facilitator, Kearns & West) proposed ending the meeting at 3 today so that CRWG members can make it to the Cultural Resources Working Group meeting at 4PM at the Prather Forest Service Office. He then distributed and reviewed the meeting agenda with the group, which approved the agenda with the change in meeting time **[Attachment A: CAWG September 12, 2002 Meeting Agenda]**. Bill reviewed the groundrules from the Big Creek Collaborative Communications Protocol.

Review Previous Action Items – The CAWG reviewed action items from the Aug 14 and 20th meetings. Below are any action items from either of those meetings that are not yet completed (all actions are completed if not listed below):

- BICEP PHABSIM Report and proposed transect selection peer review
  - Julie Tupper contact Dudley Riser
  - Carson verify from Canaday
  - Julie Means has not heard back from Gary Smith and Dale Mitchell, by the end of the week she should hear from them.
  - Wayne Lifton to contact USFWS, has not heard back from them yet.

- Mike asked about the range of low to high flows Entrix is looking at in the middle range velocity measurements. Mike drew diagrams on flip chart to explain his issue. Suggested using the low flow and high flow velocities only and not the middle set of velocities to measure the IFG4. Whitewater flows are too high to extrapolate down to these flows. The group agreed.
- Britt to contact Russ Kanz RE: Pit amphibian experience (8/20 - Action Item 8).
- Check in with Recreation group after their walk through (8/20 - Action Item 8).

Mike Henry (FERC) asked about the reference to spawning gravel with Geomorphology. Wayne Lifton (Entrix) stated that the Stevenson Creek is a self contained creek that will need to be looked at for spawning gravel. Phil Strand (USFS) said that it might have been him that made the reference.

Schedule Riparian & Amphibian SubGroup Meetings – members were asked if they could make a combo Riparian (2 hrs) & Amphibian (3hrs) subgroup meeting on Oct 28th from 10AM to 4PM (10AM to 12PM for Riparian / 1PM to 4PM for Amphibian). **Action:** Julie Means (CDFG) will check availability of CDFG office for that day, if not available, **Action:** Phil Strand (USFS) will check the availability of the Clovis USFS office. **Action:** Janelle Nolan-Summers (Entrix) will provide meeting materials and agenda in advance to subgroup members.

Review and Approve Meeting Notes – Bill moved to postpone approving the meeting summaries due to a comment that needs to be addressed in the August 14th summary. **Action:** The revised meeting notes will be sent out to CAWG members at a later date for approval. **Agreement:** The group agreed.

ID Stream Sampling Locations for Fish and Macroinvertebrates for Rancheria Creek and Big Creek Downstream of Huntngton Lake

Wayne Lifton (Entrix) provided handouts to the group with sampling site locations RE: CAWG 7 & CAWG 10 **[Attachment B: CAWG September 12, 2002 PowerPoint Slides]**.

CAWG-7: Fish

Wayne reviewed Channel Types and characteristics for Big Creek and Rancheria Creek (cascade, riffle, pool habitats). Question was asked if the dog legged section that creates an artificial channel needs to be sampled. Are we trying to sample above and below the energy dissipation structure, which created an artificial channel, to see the impacts vs. the natural channel?

A suggestion was made to stay with the natural channels and the project effects to those and not sample the unnatural channels. Wayne proposed sampling above and below the channel and an extra sample in the artificial affected channel. **Agreement:** The group agreed.

Bill asked if the group approves the proposed approach for fish. The group agreed.

CAWG-10: Macroinvertebrates
Wayne reviewed sampling sites for CAWG-10 (channel types and characteristics). Rancheria Creek and Big Creek. Wayne asked if, based on the CAWG-7 discussion, does the group want to do a spot sample in the artificial channel as well? **Agreement:** The group agreed.

A question was raised as to whether the CAWG will be sampling above and below the dam on Big Creek? Wayne said that the group will have to make that decision because there are no good reference sites. Balsam, and Stevenson might be good references. A stakeholder stated that he would prefer more samplings in the B channel types. Wayne suggested taking an extra B channel sample. **Agreement:** The group agreed to adding a B channel sample between the two proposed B channel sample sites.

Instream Flow/Wetted Perimeter – Larry Wise (Entrix) reviewed the topics for discussion of Instream Flow / Wetted Perimeter studies with a PowerPoint Presentation**.**

Raionale for Number of Transects by Channel and Habitat Type
Larry gave the reasons for transect selections for PHABSIM studies and an overview of the ALP PHABSIM and wetted perimeter studies. Larry explained how streams were categorized for the study plan development by using Rosgen channel types. By placing transects in each major habitat type within each Rosgen channel type, variability is reduced. The number of transects used in other relicensing studies –Lower Tule, Pit, and Stanislaus– done by different environmental engineering firms show that the number of proposed transects for the Big Creek Relicensing are equal to or greater than the number of transects being used for other current relicensings.

A comment was made that the number of transects that have been selected are within the protocols he's read. Another stakeholder said that Gary Smith likes the rule of 3 (3 within each habitat and 3 replicates). A proposal was made that the group agree to an established process for transect selection in writing.

The group discussed that it would be difficult to decide at a working group meeting on what the rules of transects selections should be, since it's often a decision that is made in the field based on the channels and similarity to other channels.

A stakeholder suggested a meeting between the experts for the transects selection process. Bill proposed a conference call with the SWRCB, the CDFG and Gary Smith to review the proposed transect methodology. The CDFG agreed to participating in a conference call/meeting to go over the transect selection to give the SWRCB a comfort level with the transects selection.

Bill asked if there was a consensus on the proposed approach on the number of transects selections. The CAWG, with the exception of the SWRCB, agreed on the protocol for transect selection. The SWRCB would like to consult with Gary Smith who works in an advisory capacity for the SWRCB and CDFG before agreeing to the approach. The CDFG agreed to participate in the consultation meeting with Gary Smith, who is working for both the CDFG and SWRCB.

Bill proposed the following process for review and approval of the transect selection (see below)

Proposed approach to resolve the number of transects question:

1.) Immediately following today's CAWG meeting: Julie, Carson, Britt, and Larry Meet Re: number of transect selection
2.) Blurb on 2, 2, 3 rationale explained by Larry emailed to the group on September 13.
3.) SWRCB and CADFG call w/Gary Smith Friday September 13th.
4.) Follow-Up with Wayne, if necessary on Monday September 16th.
5.) Decision Mid-Next Week. Kearns & West will make calls to the SWRCB and CADFG to get the decision.

Agreement: The group agreed to this process and will be provided with an update on the process before the next working group meeting.

Major Habitats for the South Fork San Joaquin River by Channel Type
Larry gave a presentation on the Rosgen channel types on the South Fork San Joaquin River.

Larry explained that it would be extremely dangerous and difficult to do samples in the South Fork San Joaquin below Rattlesnake Crossing. Larry suggested that since the data can be replicated elsewhere, that the CAWG not sample the inaccessible reach and instead use data from comparable reaches with similar channel types. **Agreement:** The group also agreed to not do samples in the G channels and use the G channel near Florence dam to represent the inaccessible G channel downstream.

South Fork San Joaquin B Channel Summary

- Place new transects in riffles and runs in area below Mono Crossing
- 2 transects per habitat type
- Use transects in upstream B-type channel to represent pools in this area

Bill asked for a consensus on the proposed channel selection for B channel types. **Agreement:** The group agreed, pending the decision on the approach to the numbers of transects, per the earlier action item with SWRCB and CDFG consultation with Gary Smith.

Transect Placement in Non BiCEP Reaches (IFIM Reaches)
Rancheria Creek and Big Creek Wetted Perimeter Studies. The proposal is to put three transects in the riffles of B-Channel types in Rancheria Creek. Proposal to put transects in each of the major habitat types in each of the channel types (four sets) within this reach, except for channel types that are less than 5%.

(Please see PowerPoint Presentation for detailed analysis of Channel types and number of transects)

Agreement: The group agreed on the locations of the transects, with the pending discussion with Gary Smith on the numbers of transects.

BiCEP Review
Bill asked if there has been enough peer review for a discussion on the BiCEP review. The group said that they needed more time to review the documents that were distributed and would like to postpone the discussion for a later date.

Wayne Lifton asked if the group could schedule a meeting to discuss the BiCEP Review on October 3rd at Big Creek in person and conference call from 8AM to 10AM. **Action:** Wayne will distribute an agenda with call-in information to CAWG members. **Agreement:** The group agreed.

<u>Geomorphology-Approach to Quantitative Studies</u> – Mitch gave presentation on the framework for identifying project effects and quantitative studies.
[Attachment C: Montgomery-Buffington Approach to Channel Classification PowerPoint Presentation]

Mitch explained the different categorizations for channels based on the Montgomery-Buffington approach and described the characteristics of each channel type (see Attachment E for further details).

Mitch explained that the different channel types influence the potential responses to change in flow or sediment regime. The intensity of disturbance is an important factor in the channel responses. The further downstream from the disturbance, the more the channel asserts its' natural form.

Montgomery and Buffington categorized different channel types possible response to changing conditions. Bedrock channels are not very likely to respond to change in transport. Riffles have the highest probability to change, but they are the smallest percentage of channel types in the Big Creek Project.

When the group looks at project affects, they should keep in mind how likely these channel types are affected by the project. Also, when developing PM&E measures, these differences in channel types and responses to change are a major factor in deciding where the most effect will be.

There was a brief discussion on the suitability of studies based on differing channel types. The group agreed to discuss that issue at a later date.

A question was asked if there is an instance in the Big Creek Project where the channel type changed entirely. Mitch stated that North Fork Stevenson is probably the best example.

Due to a lack of time, the Geomorphology presentation will be continued at the October CAWG meeting. **Action:** CAWG members also asked Mitch to email copies of this PowerPoint presentation to the group before the October meeting. Mitch agreed.

Agreements

1. The CAWG agreed to Riparian and Amphibian SubGroup meetings on October 28 from 10AM to 4PM (10 to 12: Riparian / 1 to 4 Amphibian).
2. CAWG agreed to postpone approving the Aug 14 and 20 meeting summaries until revised versions have been sent to members for review.
3. CAWG agreed to an extra sample in the “artificial channel” on Rancheria Creek for CAWG-7 and CAWG-10.
4. CAWG agreed to the proposed B channel samples on Big Creek for CAWG-10 and adding another B channel sample between the two B channels.
5. CAWG, with the exception of Britt Fecko, Carson Cox, and Julie Means, agreed to the transect selection rationale proposed by Entrix. Britt, Carson, and Julie will contact Gary Smith on September 13 and report back to CAWG (see action item 3 below).
6. CAWG agreed to not do samples in G channel types on the South Fork San Joaquin, due to inaccessibility. CAWG agreed to use the G channel type near Florence Dam to represent the inaccessible G channel downstream instead.
7. CAWG agreed, pending the SWRCB/CDFG Gary Smith review of transect selection methodology, to the proposed B channel sampling approach on the South Fork San Joaquin River.
8. CAWG agreed, pending the SWRCB/CDFG Gary Smith review of transect selection methodology, to the proposed transect placement in Non BiCEP Reaches.
9. CAWG agreed to a meeting/conference call on October 3 from 8AM to 10AM RE: BiCEP Review.

Unfinished Actions from Previous Meetings

- BICEP PHABSIM Report and proposed transect selection peer review (8/14 - Action Item 4)
  - Julie Tupper contact Dudley Riser
  - Carson verify from Canaday
  - Wayne Lifton to contact USFWS, has not heard back from them yet.
- Britt to contact Russ Kanz RE: Pit amphibian experience (8/20 - Action Item 8).
- Check in with Recreation group after their walk through (8/20 - Action Item 8).

List of Actions from September 12, 2002 Meeting

Action 1: Riparian & Amphibian SubGroup meeting scheduled on October 28 from 10AM to 4PM (10 to 12: Riparian / 1 to 4 Amphibian).. Julie Means will check meeting room availability at the CDFG office in Fresno. If CDFG meeting room is not available, Phil Strand will check meeting room availability at the USFS Clovis Office.

Action 2: The August 14, 2002 CAWG meeting summary will be revised and distributed to CAWG members for final approval.

Action 3: *CDFG & SWRCB secondary review of transect selection methodology*

- Immediately following the September 12, 2002 CAWG meeting, Julie Means (CDFG), Carson Cox (SWRCB), Britt Fecko (SWRCB), and Larry Wise (Entrix) meet to discuss the rationale for transect selection. Larry to give memo to SWRCB & CDG for meeting with Gary Smith.
- Larry to email transect selection memo to CAWG on September 13, 2002.
- SWRCB and CDFG conference call with Gary Smith on September 13, 2002 RE: transect selection.
- On September 16, 2002, SWRCB and CDFG call Wayne Lifton with any questions from Gary Smith call, if necessary. Wayne to relay any questions to Larry; give answers to CDFG & SWRCB by September 18, 2002.
- SWRCB and CDFG to give Wayne Lifton decision if agree with transect select methodology or not by September 19, 2002.

Action 4: CAWG to hold a meeting to discuss the BiCEP review on October 3, 2002 from 8AM to 10AM. Wayne Lifton will distribute agenda and conference call information to CAWG members.

Action 5: Mitch (Entrix) will email the Geomorphology PowerPoint presentation on the Montgomery-Buffington Approach to Channel Classification to CAWG members.

Attachments

Attachment A: CAWG September 12, 2002 Meeting Agenda
Attachment B: CAWG September 12, 2002 PowerPoint Presentation
Attachment C: Montgomery-Buffington Approach to Channel Classification PowerPoint Presentation

Big Creek Collaborative
Combined Aquatic Working Group

October 9, 2002

FINAL Meeting Notes

Time:	10 AM to 4 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn, Fresno, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Teleconference Name:	Combined Aquatic Working Group		

Attended By	Bill Pistor	Kearns & West
	Bryan Harland	Kearns & West
	Jean Baldrige	ENTRIX
	Carson Cox	SWRCB
	Steve Rowan	SCE
	Rick Hopson	USFS
	Phil Strand	USFS
	Ed Bianchi	ENTRIX
	Wayne Lifton	ENTRIX
	Geoff Rabone	SCE
	Wayne Allen	SCE
	Mitchell Katzel	ENTRIX
	Julie Means	CDFG
	Cindy Whelan	USFS
	Britt Fecko	SWRCB
Phone Participants	Paul Devries	R2
	Julie Tupper	USFS
	Mike Henry	FERC
	Larry Wise	ENTRIX

Introductions
Stakeholders introduced themselves and reviewed and approved the day's agenda.

Review of Previous Action Items
Outstanding action items:

- BiCEP review meeting postponed until today.
  - A revised Geomorphology presentation will be provided to the CAWG by M. Katzel.

Review and Approve Meeting Notes
Meeting Summaries for Aug. 14 (w/ edits), Aug. 20 (w/ edits) and Sept. 12 (no edits) were approved.

Geomorphology-Approach to Quantitative Studies [NO DECISIONS]
M. Katzel (ENTRIX) resumed and concluded the geomorphology presentation begun at the September 12 CAWG meeting.

M. Katzel also distributed the Montgomery-Buffington paper to the CAWG *(Channel-reach morphology in mountain drainage basins)*.
Stakeholders asked if project effects could alter a reach significantly enough to change its Montgomery-Buffington classification reach type. Katzel said that, overall, reach types haven't appeared to change but that more subtle changes in sediment storage, particle size and thickness of alluvial veneer within reach types are more likely to have occurred. These more subtle changes, according to Katzel, are difficult to measure.

The CAWG expressed its interest in discussing options/methods for trying to measure the more subtle changes within reach types. Katzel agreed to do so at a future date.

Action Item 1: Katzel will provide GIS maps with the Montgomery-Buffington channel classification and bedform types laid out over the Rosgen channel types in this years study report. Katzel will put together a graphic detailing the differences and similarities between the Rosgen and Montgomery Buffington classification types.

Instream Flow – BiCEP Models
W. Lifton (ENTRIX) reviewed the slide presentation presented by L. Wise (ENTRIX) at the August 14 CAWG meeting, which proposed using a combination of existing BiCEP transects and new transects for Mammoth reach (Mammoth Pool to Mammoth Pool PH), Stevenson reach (PH 3 to Dam 6), upper Big Creek (PH 2 to Dam 4) and Big Creek (PH8 to Dam 5). The CAWG was asked to approve the approach recommended in this presentation.

In reviewing the transect recommendations for the various reaches, the following topics/issues were raised and responded to:

> BiCEP model re-calibration: Concern with the 90% certainty that the model can be recalibrated to today's IFG4A standard. If unsuccessful, new transects will be selected.
>
> Comparison of HSC curves: When HSC curves are collected they will be provided to Paul Devries and interested CAWG participants.
>
> Difference in detail of BiCEP channel type classification: Concern that use of aerial photography and early habitat typing standards in BiCEP produced less detail in habitat classification making comparisons difficult. The CAWG transect selection team will visit the various reaches and the BiCEP transects will be compared to the channel type today to determine if that unit is consistent with our current habitat criteria. If not, new transects will be selected. Where BiCEP is known to be inadequate, such as with runs and other complex habitats, new transects will be selected.
>
> Lost Data / Records: Where transect locations from the BiCEP work cannot be found due to lost records, then new transects will be selected.
>
> Justification for selection of BiCEP and new transects: Transect Selection Team's work in the field on BiCEP and new transects will be documented through a memo to the group and a video of Team describing their decisions. In addition, each transect location was photographed. This approach has and will be used for all transect selection fieldwork.

Consistent approach for selection of new transects: Stakeholders agreed that whatever approach is used for selecting new BiCEP related transects it should be consistent with the methodology the CAWG approves for selecting the other PHABSIM transects.

Agreement: The group agreed to the existing BiCEP transects, the recommended supplemental transects and new transects for runs and complex habitats proposed (detail to be provided with slide presentation) by ENTRIX with final decisions being made in the field by the CAWG transect selection team. The methodology for selecting BiCEP supplemental and new transects will be consistent with the overall methodology on transect methodology still to be approved by the CAWG.

Action Item 2:

- Field visit to Mammoth sites to verify habitats (Week of October 21: 4 to 5 days. Start on Monday at Noon at either Mammoth or Big Creek. Will let working group members know ASAP)
    - Schedule on the day to day activities, Larry will draft and distribute to the group.
    - Select supplemental and replacement transects in field
    - Determine specific whitewater objectives
    - Select specific transects for inclusion in whitewater study

Other Sub-Group Updates
Wayne gave an update on the subgroup activities. Riparian and Amphibian SubGroup Meetings will be held on October 28th at the CDFG Shaw office in the main conference room from 10:00-12:00 (Riparian) and 1:00-4:00 (Amphibian). Terrestrial Working Group will meet on October 24 at the Clovis Forest Service Office.

Next CAWG Meeting
November 13th from 10 AM to 4 PM. Julie Means will be unavailable, but will send someone in her place.

Upcoming Activities

- Macroinvertebrate program finished in September with all stations visited and spot samples complete.
- Crayfish sampling complete in Mammoth Pool and Shaver Lake.
- Fisheries surveys were conducted on Mammoth using electrofishing and hydro-acoustics. The CAWG will need to coordinate with Native Americans for the traditional collection sites for freshwater mollusks for 2003.
- Fish program is still going along according to plan. Personnel will be in field through the end of the month.
- Water quality is complete except for tissue sampling. Need to do gill nets at Redinger Lake for fish tissues.
- Hydroacoustics being done at the intakes of the major reservoirs.
- All on-ground geomorphology surveys are complete. In process of compiling and reducing data. ENTRIX will produce maps to present the information. Wayne and Mitchell will get together next week to prepare data for presentation to the group.
- Steve Rowan (SCE) said the hydrology work is 75% complete. Once all data is entered, we will be able to model.
- The Recreation Working Group has conducted a single flow study on Vermilion. Mono Creek, Bear Creek, and North Fork Stevenson Creek have all been eliminated from further consideration. The Recreation Group will keep Big Creek:

in for further consideration. Mammoth and Stevenson are still in for single flow with the potential for controlled flows.

PHABSIM Transect Selection Methodology

The group resumed its discussion from the September 12 CAWG meeting on transect selection methodology. The group reviewed an off-line effort by CDFG, SWRCB and SCE to modify the approach proposed by L. Wise in his original memo. The effort attempted to address concerns raised by the SWRCB at the September 12 CAWG meeting regarding numbers of transects selected (advocating the "rule of 3") and the need to consult G. Smith (CDFG), currently serving as a technical advisor to the SWRCB on IFIM. The resulting document, not agreed to off-line by SCE, was presented to the group. The following were the key concerns and points of discussion on the proposed modified approach:

Concern that proposed approach does not adequately capture variability within mesohabitat. Although the number of transects that are selected for PHABSIM may change based on the methodology by which they are selected, SWRCB staff were not specifically concerned about the number of transects selected. Instead, SWRCB staff were interested in determining the basis of L. Wise's approach, and were concerned that the proposed transect placement methodology would not adequately capture the variability that occurs within a mesohabitat unit as well as between mesohabitat units. The "rule of 3" is a methodology supported by Gary Smith, CDFG Biologist and PHABSIM technical expert, which SWRCB staff believe would capture between and within mesohabitat variability.

<u>Concern that new approach would unnecessarily increase number of transects.</u> SCE and ENTRIX expressed concern that it would triple the number of transects currently established by the study plan and already selected by the team in fieldwork to date. The goal should not be to adhere to a rigid numerical goal but rather to make sure that the number and placement of the transects selected adequately represent the habitat and that this should be accomplished in the field.

<u>Approach meets needs of the state while providing flexibility to CAWG</u>. The SWRCB view is that the proposed approach would advance their goal of adequately capturing variability between mesohabitats and meet their need to incorporate the evolving state standard approach for IFIM transect selection. The SWRCB emphasized, however, that the approach continues to assign final decision-making discretion for transect selection to the CAWG transect selection team.

<u>CAWG should make final transect selection decisions.</u> Some participants pointed out that while the originally proposed methodology takes a bottom up approach in selecting the location and number of transects and the modified methodology proposes a top down approach, both vest final selection with the CAWG so that the outcome of either approach would likely be similar. USFS indicated that in its view, the most important point is that transect selection should be done in the field. FERC stated that from their experience, there is no established methodology for establishing a set number of transects - the idea is to get a representative sample of the channel types and this should be accomplished by the CAWG transect selection team in the field.

<u>Is transect selection to-date adequate?</u> SCE expressed concern that the field work and CAWG transect selection to-date would be re-opened. FERC asserted that if the CAWG transect selection team approved these transects then they are

likely adequate. This was affirmed by the SWRCB. Participants in the CAWG's past transect selection efforts present at the meeting indicated that they are satisfied with transect selection to date. USFS did say that if they were following the new proposed methodology, they may have flagged more potential sites but that the outcome would probably have been similar. It also was pointed out by ENTRIX and USFS that in the past, three random sites are flagged for inspection, anyway. Other unflagged locations are often viewed and discussed when walking between sites.

While no agreement was achieved, the group decided to continue working on the methodology document to attempt and reach consensus.

Action Item 3: SCE will come up with a counterproposal. Would like the back and forth to be sent to the CAWG for review. Have an exchange next week before the field trip on October 21.

Action Item 4: Wayne will send Julie's revised memo (informal proposal) to the CAWG members for review.

Action Item 5: SCE will have a revised version of the proposal to the CAWG by October 17, 2002.

Review of Action Items

Action Item 1: Katzel will provide GIS maps with the Montgomery-Buffington channel classification and bedform types laid out over the Rosgen channel types in this year's study report. Katzel will put together a graphic detailing the differences and similarities between the Rosgen and Montgomery Buffington classification types.

Action Item 2:

- Field visit to Mammoth sites to verify habitats (Week of October 21: 4 to 5 days. Start on Monday at Noon at either Mammoth or Big Creek. Will let working group members know ASAP)
    - Schedule on the day to day activities, Larry will draft and distribute to the group.
    - Select supplemental and replacement transects in field
    - Determine specific whitewater objectives
    - Select specific transects for inclusion in whitewater study

Action Item 3: SCE will come up with a counterproposal. Would like the back and forth to be sent to the CAWG for review. Have an exchange next week before the field trip on October 21.

Action Item 4: Wayne will send Julie's revised memo (informal proposal) to the CAWG members for review.

Action Item 5: SCE will have a revised version of the proposal to the CAWG by October 17, 2002.

Big Creek Collaborative
Combined Aquatics Working Group

January 8, 2003

FINAL Meeting Notes

Time:	12:30 PM to 4:00 PM	**Moderator:**	Larry Wise
Location:	Piccadilly Inn, Fresno, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor	Kearns & West
	Bryan Harland	Kearns & West
	Kelly Catlett	Friends of the River
	Wayne Thompson	Federation of Fly Fishers
	Ed Bianchi	ENTRIX
	Geoff Rabone	Southern California Edison
	Mike Henry	FERC
	Cindy Whelan	USFS – Sierra National Forest
	Phil Strand	USFS – Sierra National Forest
	Rick Hopson	USFS – Sierra National Forest
	Julie Means	CDFG
	Jean Baldrige	ENTRIX
	Wayne Allen	Southern California Edison
	Larry Wise	ENTRIX
	Larry Lockwood	SAMS
	Brandi Bradford	National Park Service
	Roger Robb	Friant Water Users Authority
Phone Participants:	Carson Cox	SWRCB
	Britt Fecko	SWRCB
	Wayne Lifton	ENTRIX

Introductions
Stakeholders introduced themselves and the organization they represent, then reviewed and approved the day's agenda.

Action Item 1: Check mailing list for accuracy:
-W. Lifton will add Cindy Whelan to the CAWG mailing list, E. Bianchi will make sure she is added to all ENTRIX working group mailing lists.
-W. Lifton will check if Lonnie Schardt is on the CAWG email distribution list.

Review of Previous Action Items
Bill reviewed action items from the October 9, 2002 CAWG meeting. All had been addressed. There were no outstanding actions.

Review and Approve October 9, 2002 CAWG Meeting Notes

Bill reviewed edits submitted by the SWRCB with the group and asked for any other comments or edits. No additional edits were offered. The meeting summary was approved with the SWRCB edits.

Review of 2002 Field Activities
W. Lifton (ENTRIX) reviewed the 2002 Field Activities for the group:

- Habitat inventory work completed.
- Water Quality program executed.
- Additional temperature monitoring was completed on Balsam Creek in 2002, the creek was diverted during 2002, but not 2000 or 2001.
- All identified amphibian sampling completed.
- All fish sampling completed.
- Riparian sampling delayed to 2003.
- Macroinvertebrate sampling completed.
- Phase I of geomorphology study.

W. Lifton and L. Wise briefly summarized field work yet to be completed in 2003:

- Entrainment preliminary work for site selection.
- Anadromous fish and passage
- Water use and hydrology.
- Geomorphology quantitative studies.
- Riparian
- Decisions to be made regarding additional amphibian work.
- Data collection for PHABSIM sites and remaining WP sites.

Wetted Perimeter and PHABSIM Transect Selection
L. Wise gave a presentation on Wetted Perimeter and PHABSIM transects selected during the 2002 field season. P. Strand (USFS), B. Fecko (SWRCB), P. DeVries (USFS), Dennis Smith (USFS), Julie Means (CDFG) and C. Cox (SWRCB) were present for portions of the transect selection. There were 193 transects selected for the IFIM studies and 32 for the Wetted Perimeter studies. The presentation is attached to this meeting summary in its entirety, highlights listed below. Due to the extremely technical nature of the transect selection field discussions, and the fact that few CAWG members were present throughout the transect selection period, the presentation has been recorded in more detail for these meeting notes than is customary. It is intended to provide a record of what decisions were made in the field and why.

Action Item 2: Ed Bianchi (ENTRIX) to send Britt Fecko a copy of this presentation.

Wetted Perimeter

Seven seasonally diverted streams in the Lower Basin were considered for wetted perimeter transect placement. These included Adit 8, Ross, Rock, Ely, Balsam, Pitman, and Rancheria Creeks. Transects were placed on six of these creeks during a CAWG field visit conducted between July 29 and August 2, 2002. The CAWG Transect Selection Team (CTST) decided not to place transects in Ross Creek, because it goes dry in the summer and does not provide suitable habitat for fish or amphibians. No transects were placed in Adit 8 Creek above the diversion as this stream, which starts from a leaking pipe, essentially starts at the diversion, which is no longer used.

Habitat in Rock Creek below the diversion was largely composed of cascade/pool habitat, with few riffles or runs. The wetted perimeter approach was considered inappropriate for application here by the CTST. The CTST decided a food transport approach would be more appropriate. Two appropriate locations for food transport transects were located above the diversion on Rock Creek and one appropriate location was located below the diversion.

PHABSIM

PHABSIM transects were placed in each stream reach identified in the CAWG-3 study plan with the exception of reaches of the South Fork San Joaquin River downstream of Mono Crossing. These reaches were excluded because of safety concerns and inability to access these areas at higher flow levels. Each stream reach was sub-divided by Rosgen habitat type. Within each major Rosgen sub-reach (>5 percent), transects were placed to represent all major habitat types representing more than 5 percent of that stream reach. Transects were placed to capture the diversity of the habitats present within each major habitat type.

In each Rosgen sub-reach, the CTST visited three sites or walked a long section of stream to access the sites reviewed prior to placing transects. The objective was for the CTST to review in the field the habitats present and their characteristics prior to placing transects. The CTST recommended holding off on PHABSIM studies on Big Creek below Huntington Lake until decisions were made with regard to riparian and geomorphic concerns.

SF San Joaquin River – Bear Creek to Florence Lake

In the B-channel sub-reach three sites were visited and transects were placed in two of them to capture the range of variability in pocket water and run habitats. In the C-channel, nearly the entire reach was walked by the CTST. This reach was very homogenous with lots of pool and run habitat. Transects were placed to represent these habitats. Additionally, two transects were placed in a unique riffle section where exceptionally good spawning gravel was observed. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

SF San Joaquin River – Mono Crossing to Bear Creek

Transects were placed in each of the three Rosgen channel types present in this stream reach: B, C and G. Transect placement followed the protocols and the number of transects placed met or exceeded the number of transects proposed during previous CAWG meetings. The CTST did not install transects in shallow pool (172), located in the B-channel section, but instructed ENTRIX to do so when returning to this area in Spring 2003. The shallow pool selected to represent the G channel was relatively uniform and required only two transects to represent the habitat type. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

Mono Creek below Mono Diversion

CTST visited two sites and walked about 1 mile of stream in Mono Creek (Rosgen Level 1 B-Channel). The CTST observed that the two sites were different in terms of gradient and structure and spawning gravel was present. CTST put a complete set of transects in both sites to capture the range of variability in these habitat types. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

San Joaquin River – Mammoth Reach

CTST revisited the BiCEP study sites and a few headpins that were found in these areas. The majority of the BiCEP transects appeared to be representative of habitat types identified in the BiCEP models. Some channel changes had occurred, which required some transects to be replaced. CAWG had previously identified uncertainty about flatwater habitat types identified in the BiCEP study. Additional transects were placed in run and pocket water habitat types to address this.

In the G channel (near Shakeflat Creek), CTST accepted 13 of the 14 BiCEP transects. They discarded one of the riffle transects as inappropriate and replaced it with a new transect in a different habitat unit. Two new transects were placed in pocket water habitat and a new transect was placed to capture pool tail habitat, which did not appear to be represented in the BiCEP transects.

In the B channel (above Mammoth Pool powerhouse), CTST accepted eight of nine existing BiCEP transects as appropriate, although some channel changes were observed. The CTST replaced one pocket water transect with a new transect. Two BiCEP shallow pool transects were observed to be deep now. CTST decided to re-measure these transects to represent deep pool habitat (the BiCEP version would still be used to represent shallow pool habitat). Two new transects were installed in this area to represent riffle habitat, which was not represented in the BiCEP model. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

San Joaquin River – Stevenson Reach

CTST drove along a substantial portion of this reach where they had a clear view of the channel. The reach was quite different than the Mammoth Reach in that it was more confined and had larger substrates. CTST felt that new transects were appropriate for all but deep pool habitats. Confined Mammoth reach deep pool transects could be used to represent deep pools in the Stevenson Reach, as well. New transects were placed in flatwater, riffle, and shallow pool habitats. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

Big Creek – PH1 to Huntington Lake

This section of the stream was heavily overgrown with riparian vegetation that will have a significant effect on the PHABSIM models. In the view of the CTST, the CAWG needs to make a decision about the management objectives for this reach and about riparian and geomorphic issues before deciding if a PHABSIM study is appropriate here. If a PHABSIM study were to be implemented at this time, and then the riparian and geomorphic conditions altered, the results of the PHABSIM study would probably be invalidated. Preliminary transects were placed pending the CAWG's decision on this recommendation. Transect locations were selected in the A and B channel types, no transects were placed in the G channel type as it was described as being intermediate in terms of habitat characteristics to the others. Because releases must be made from Huntington Lake for this study, there is flexibility for the CAWG to evaluate these issues without compromising the schedule. The potential need to look at these channels with a multi-disciplined approach was discussed and the possible formation of a subgroup. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

Action Item 3: CAWG to discuss (w/ geomorphology and riparian vegetation info) management and future studies needed for Big Creek between PH1 and Huntington Lake. A decision must be reached by August to allow PHABSIM work to be done in 2003. (BIN ITEM)

Big Creek –PH2 to Dam 4

Transect selection was made to supplement existing BiCEP models and to replace flatwater transects. In the B-channel section, the CTST walked nearly the entire length of the channel type sub-reach. The CTST supplemented the BiCEP transects with three deep pool transects and 2 riffle transects. No new transects were added in flatwater habitat, as the habitat inventory identified only one trench chute. This unit would not provide suitable habitat for fish and amphibians, under even moderate flows. In the A-channel type, uncertainty about the BiCEP transects led the CTST to place transects in all habitat types – a total of 14 new transects. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

Big Creek –PH8 to Dam 5

Transects were placed to supplement BiCEP transects in the A channel type. The Aa+ channel type was not represented in the BiCEP models. In the A-channel type, new transects were placed in all major habitat types, for a total of 13 transects. The CTST felt that these transects, in combination with those from the BiCEP models should adequately represent the habitat in this reach.

In the Aa+ channel the only habitat types that can be modeled that composed more than 5 percent of the stream length were shallow pools and deep pools. Transects were placed through both of these habitat types. There was some misunderstanding about categorization of cascade habitats in this reach. The

CTST observed that in one cascade unit, some riffle and run habitat were lumped with a downstream cascade, leading to the question of whether the riffle and run habitats were adequately represented.

Dennis Smith (USFS) and Larry Wise (ENTRIX) went back and reviewed the habitat inventory in the lower half of this reach to ascertain the extent of the problem. This review indicated that the habitat inventory was generally accurate. There may be a minor amount of usable habitat in some cascades. Dennis and Larry discussed giving shallow pools a slightly higher proportion of the overall habitat to account for these small pockets of habitat.

Larry relayed the results of discussions he had had with the habitat inventory crew regarding this. The habitat inventory crew indicated that if they were in a cascade and found pockets of habitat which were not as long as the stream was wide they were not broken out separately. Additionally, they reported that if it appeared that fish would be washed out of this small piece of habitat at higher flows, then that piece was not broken out as a separate habitat unit.

NF Stevenson Creek – below Outlet Reach

In this reach the CTST felt that some of the pool transects in the Aa+ and C channel types could be adequately represented by 2 transects. One of the riffle transects in the Aa+ channel type, was placed in a run-like section. Additionally the CTST, elected not to put transects in the G-channel type. While this channel type comprised eight percent of the stream, it consisted of only 5 habitat units and was only 1,500 feet long. Two of the habitat units were affected by the gage weir and bridge footings. The CTST felt the remaining units would be adequately represented by transects placed elsewhere. A summary of transects selected by channel type is provided in the accompanying copy of the presentation.

CTST selected transects in all appropriate channel types in this reach according to the protocols and previous CAWG presentations. The CTST felt that the transects selected were representative of what was present in the stream and would do a good job of characterizing the response of the stream to different flows. Only one section of B channel was available for transect selection. The CTST walked most of this section prior to placing transects. The second section of B channel is located immediately below the dam and is heavily influenced by the dam and Highway 168. Both the Aa+ and A channel types in this stream reach are difficult to access. The CTST walked a long section of A-channel in visiting the three sites. This section was generally steep and most riffles were on the verge of being cascades with super-critical flow. This type of habitat cannot be modeled using PHABSIM. The CTST therefore placed only one transect in riffle habitat in this channel type. A summary of transects selection by channel type is provided in the accompanying copy of the presentation.

Summary of Transect Placement

Transects were placed in all stream reaches and Rosgen sub-reaches
The CTST felt that the transect placements were representative of the range of habitat conditions observed for each habitat type.
BiCEP transects in the Mammoth Reach of the SJR were generally representative and acceptable with some supplementation.
CTST recommends that PHABSIM in Big Creek below Huntington Lake be held aside pending consideration of observed riparian and geomorphic issues.

Follow up on Issues Identified during Transect Selection Presentation
Habitat Characterization

Concern was expressed regarding habitat characterization in the Big Creek reach between Powerhouse 8 and Dam 5 (discussed above). Specifically the concern focused on habitat characterization in cascade habitats and the presence of small pockets of other habitats and excessive lumping of habitats. Some stakeholders expressed concerns that habitats are not adequately characterized,. Although D. Smith and L. Wise (ENTRIX) re-walked a portion of this reach, and while they found some minor inconsistencies at current flows, they felt that the habitat inventory was generally appropriate.

The group discussed the importance of habitat characterization in the final models and ways to address this.

M. Henry (FERC) suggested that during the analysis phase the WUA functions could be developed by habitat type and for each transect to determine how different habitat types respond to changes in flow. This could be used in conjunction with the composite WUA function (all habitat types together) in evaluating alternative flow regimes. By looking at the functions in this way, the response of habitats that are less available are not swamped out by those that are more available.

Others suggested that some reaches could be flown to see if what we have on paper matches the mapping. Ed Bianchi indicated that this would not be feasible due to heavy canopy in this reach. Mike suggested doing QA/QC checks on habitat maps when in the field, which was done in other reaches. It was suggested that ground truthing, with CAWG oversight would work. The Group did not resolve this issue and opted to form a subgroup to address this issue.

Action Item 4: Convene group/subgroup to discuss potential actions to verify habitat designations and bring a recommendation back to the CAWG (BIN ITEM)

PHABSIM Memo
B. Pistor (Kearns & West) reviewed the latest version of the memo on transect selection methodology drafted by SCE, SWRCB and the CDFG with the first paragraph removed. Bill moved for approving this version of the memo. A copy of this memo is attached to these meeting minutes.
AGREEMENT: The Group Agreed.

Scheduling
Transect Weighting
The CAWG will need to make a decision on Transect weighting, as pertaining to how the sub-habitat types within major habitat types will be treated in the final models by early this fall. This will be needed to develop composite weighted usable area functions for the analysis of PHABSIM model results.

Habitat Suitability Criteria
Data were collected for testing the transferability of HSC to the project area. SCE is proposing to use the Altered Flow Criteria for rainbow and brown trout and the Pit River criteria for Sacramento sucker, hardhead and Sacramento pikeminnow. The Altered Flow criteria were developed as regional criteria for southern Sierra Nevada streams by SCE and PG&E. These criteria were based upon observations from several local streams including Big Creek and NF Stevenson Creek. These criteria have been verified for use on Big Creek and NF Stevenson Creek. This study will evaluate whether these criteria can be transferred to larger streams in both the lower and upper basin and to smaller streams in the supper basin. Larry will give a presentation in March on the progress of this validation study. Depending on the results of the validation, a discussion of next steps will be needed and a decision regarding the need for additional data. The decision will be needed by May/June to enable additional data to be collected if necessary.

Whitewater Study Protocols
Need to look at in Feb/March. P. DeVries (USFS) will forward protocols to Larry.

Action Item 5: Once L. Wise (ENTRIX) receives whitewater study protocols examples from P. DeVries (USFS) he will forward to the CAWG.

E. Bianchi (ENTRIX) provided some clarification regarding the whitewater studies. He said there has been some whitewater work done with the Recreation Working Group, namely single flow studies. The recreation group is currently discussing the need to do more single flow studies, as well as controlled flow studies. Currently, single flow studies are being planned contingent on spill from project facilities. Ed will communicate to the CAWG as planning progresses. ID of reaches has been passed on to the group and protocols for the whitewater studies have been agreed upon. F&WS has agreed to protocols for in-season whitewater studies. If Rec. decides out-of-season flow releases are needed, F&WS will need to readdress. Ed stressed that PHABSIM studies during whitewater type flows are contingent upon spill and will be piggy-backed on whitewater studies. There are no plans for controlled flow releases in the whitewater range of flows for PHABSIM studies. No opportunity to collect data for PHABSIM after the whitewater studies are completed.

Geoff Rabone notes F&WS gave approval for the flow studies if they are performed within spill season. However, F&WS wanted to limit the number of people participating in the study.

Wayne – depending on whether using natural hydrograph or controlled flows, differing strategy will be used to collect required information.

Julie Tupper – Requested that people conducting field work record general ecological data (species observations, habitat, etc) while conducting the field work (FEB/MAR).

Review of Action Items
Action Item 1: Check mailing list for accuracy:
-W. Lifton will add Cindy Whelan to the CAWG mailing list, E. Bianchi will make sure she is added to all ENTRIX working group mailing lists.
-W. Lifton will check if Lonnie Schardt is on the CAWG email distribution list.
Action Item 2: Ed Bianchi (ENTRIX) to send Britt Fecko a copy of the Transect Selection presentation.
Action Item 3: CAWG to discuss (w/ geomorphology and riparian vegetation info) management and future studies needed for Big Creek between PH1 and Huntington Lake. A decision must be reached by August to allow PHABSIM work to be done in 2003. (BIN ITEM)
Action Item 4: Convene group/subgroup to discuss potential actions to verify habitat designations and bring a recommendation back to the CAWG. (BIN ITEM)
Action Item 5: Once L. Wise (ENTRIX) receives whitewater study protocols examples from P. DeVries (USFS) he will forward to the CAWG.

Big Creek Collaborative
Combined Aquatics Working Group

March 10, 2003

Final Meeting Notes

Time:	11:00 AM to 5:00 PM	**Moderator:**	Wayne Lifton
Location:	CDFG Office, Fresno, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bryan Harland	Kearns & West
	Bill Pistor	Kearns & West
	Julie Means	CDFG
	Lonnie Schardt	Kokanee Power
	Steve Rowan	SCE
	Geoff Rabone	SCE
	Wayne Allen	SCE
	Rick Hopson	USFS
	Julie Tupper	USFS
	Wayne Thompson	Federation of Fly Fishermen
	Ed Bianchi	ENTRIX
	Phil Strand	USFS
	Cindy Whelan	USFS
Phone Participants:	Wayne Lifton	ENTRIX

Introductions

Stakeholders introduced themselves and the organization they represent. Bill Pistor (Facilitator, Kearns & West) proposed approving the meeting agenda as distributed to the group. Ed suggested adding an item on the FERC Critical Energy Infrastructure Information (CEII) Rulemaking.

Action Item #1: Check distribution lists for accuracy with ENTRIX. Lonnie Schardt did not receive the last distribution add ldschardt@aol.com.

Critical Energy Infrastructure Information

Geoff Rabone (SCE) explained the final rule adopted by FERC on Critical Energy Infrastructure Information and the classifications of information. A copy of the FERC summary of the new rule is available online at www.ferc.gov. FERC has created four categories of information: Public; Non-Internet Public; Critical Energy Infrastructure Information (Confidential); and Privileged. The distribution of each category of information is as follows:

- *Public* – Maintained in FERC Public Reference Room and on FERRIS.
- *Non-Internet Public (NIP)* – Maintained in Public Reference Room but not on FERRIS, except as an indexed item. Not to be posted on the internet.
- *CEII (Nonpublic)* – Not maintained in Public Reference Room, but is maintained as an indexed item on FERRIS.
- *Privileged* – Not Maintained in Public Refernce Room or on FERRIS, except as an indexed item.

Action Item #2: Geoff to supply the CAWG the FERC summary of the final rulemaking RE: CEII. He will get clarification from Nino on its implications for the Big Creek Relicensing and get an email out to the group.

Review Action Items from February Meeting

Outstanding action items from the February CAWG meeting are listed below with comments.

- ENTRIX to add photo examples to CAWG-2. ENTRIX to add table of contents to all CAWG DTSRs. (There has not been another distribution of the CAWG DTSRs at this time. Future versions of the reports will contain tables of contents.)

- Larry Wise to distribute the whitewater study protocols from the Forest Service to the group after he has reviewed. (protocols are for controlled flow studies only)

- **HABITAT CLASSIFICATION SUBGROUP** (Continuing action item) - An initial subgroup meeting hasn't been convened yet, will take place during low-flow time of year. This item will be added to the CAWG-3 Habitat Classification time sensitive element.

Hydrology Subgroup Update

Steve gave the group an update on the Hydrology subgroup meeting. The Hydrology Subgroup met on March 6th at the USFS Clovis Office. There is a meeting summary available for interested stakeholders. The subgroup will meet next on April 10, 2003 9AM to 12Noon at the Clovis Forest Service Office.

Jan Meeting Summary

Action Item #3: Cindy asked that the meeting summaries be placed on the web as soon as approved. Jan notes were approved.

Feb Meeting Summary

Feb meeting summary was approved without edits.

CAWG-3: Determine Flow-Related Physical Habitat in Bypass Reaches Presentation (Larry Wise)

Larry Wise (ENTRIX) gave a PowerPoint Presentation *(Attachment A: 03-10-03 CAWG Presentation)* on the CAWG-3: Flow-Related Physical Habitat in Bypass Reaches Draft Technical Study Report. Larry reviewed the CAWG-3 objectives, study elements completed and outstanding as well as the results for upper basin seasonally diverted streams.

Study Elements Completed:

- Wetted Perimeter
  - Measurements and analysis completed at Wetted Perimeter transects selected in Fall 2001.
  - Transects selected for all remaining Wetted Perimeter streams.
- PHABSIM
  - BiCEP models reviewed.
  - Transects selected for PHABSIM studies on all candidate reaches.
- HSC observations collected for verification.

Outstanding Study Elements:

- CAWG approval of PHABSIM target flows
- Scheduled 2003 data collection.
- Modeling of remaining transects.
- BiCEP model revisions with additional transects.
- HSC transferability testing and presentation to CAWG
- Whitewater studies.
- Decision on habitat time series analysis.

Results for upper basin small streams - Wetted Perimeter and Food Transport Analysis
Larry summarized the results for the upper basin small streams (Bolsillo, Camp 62, Chinquapin, Crater, North Slide, South Slide, Tombstone, and Hooper creeks). Wetted perimeter analysis was used for all streams except Bolsillo Creek, where a Food Transport analysis was used.

Measurement flows for these streams typically ranged between less than a tenth of CFS to more than 30. Ed Bianchi (ENTRIX) asked if there are higher flows below the diversions than above due to accretion. This was the case for some streams. Larry reported that there were no runs or riffles above the Chinquipin diversion, and therefore there is no reference site here. Additionally the CAWG Transect Selection Team (CTST) did not place transects above North and South Slide Creek diversions as habitat was dissimilar and these diversions are no longer operational.

Larry stated that the model calibrations using IFG4a or MANSQ were highly successful. MANSQ was used on four of the 30 transects. Most of the simulated water surface elevations were within three hundredths of a foot of the measured water surface elevation. At two transects, simulated water surface elevations differed from measured water surface elevations by as much as six one-hundredths of a foot.

Larry next reviewed the Wetted Perimeter vs. Discharge Relationship results with the group. Flows at the inflection points above and below the diversions ranged from 0.4 to 1.5 CFS. The results on each stream were very similar above and below diversions. Camp 62 creek is a good example with a 0.7 cfs inflection point above the diversion and 0.8 cfs below. All inflection points occurred within range of measured flows, which increases the confidence in the results as the model is interpolating between known point rather than extrapolating. Larry informed the group that ENTRIX feels confident in the results' accuracy.

ENTRIX field crews also conducted food transport analysis on Bolsillo Creek last field season. The concept of these analyses was to look at velocities through pools and look at what flows would provide food transport across a third of the width of the pool. Food transport results for Bolsillo Creek are as follows:

- **Low Flow (0.2cfs)** – Food transport limited.
- **Mid Flow (2.3cfs)** – Initiation at all transects. Sustained transport at one transect, nearly attained at other two transects.
- **High Flow (7.2cfs)** – Initiation and sustained transport attained at two transects. Initiation and sustained transect not attained at the transect where sustained transport was attained at middle flow.

The group discussed whether the Bolsillo Creek food transport results were giving the group the information they needed in terms of fish habitat and the possible need to use a different approach for future food transport studies. The group agreed to explore alternatives to the proposed food transport methodology used on Bolsillo Creek.

Action Item #4: Larry to identify alternative approaches for Bolsillo Creek for food transport for group consideration at a future CAWG meeting.

A stakeholder asked what the assumed food is for this study. Larry answered that drifting larval life stages of aquatic insects are the assumed food. Follow up question: Do we know what they're eating? Larry answered that although stomach pumping on trout has not been done, it is safe to say that trout are opportunistic and will eat whatever is around. Other studies have indicated that trout will use non-drift benthos. Ed stated that there will be a discussion of the usability of this approach in the report and Food Transport will be carried over as an outstanding study element for CAWG-3.

Action Item #5: ENTRIX to put the discussion on the suitability of the proposed methodology in the CAWG-3 Draft Technical Study Report. This item will also be identified as time-sensitive for CAWG review.

Fish Passage Analysis
Larry next gave a summary of the Fish Passage Analysis done as part of the CAWG-3 study. Fish passage studies were conducted on Camp 62, Chinquapin, Crater, Hooper, Bolsillo, North Slide, South Slide and Tombstone Creeks. Objective is to provide an estimate of the flow required for adult migration through typical wide, shallow habitats. Larry reviewed the criteria used for analyzing fish passage (Thompson's Criteria) and the minimum passage flows above and below the diversions.

Ed asked if there is a seasonality or time period associated with the criteria. Larry stated that the time period is during the spawning season, when trout are typically moving up or down stream looking for suitable spawning areas. Wayne Lifton (ENTRIX) added that most of the trout in the tributaries are fall spawners, which means they are moving upstream at low flow times of year.

Passage flows generally ranged from 0.2 to 3.6 cfs, which typically fell within measured flows. High velocities might be affecting passage opportunities at Hooper, but velocities across portions of each transect were low enough to allow passage. On South Slide Creek the 3.6 cfs average flow was affected by one transect that had a 7.5 cfs reading. Since that creek is not currently in operation, it shouldn't affect the results.

A stakeholder asked why passage flows for Hooper Creek below diversion is so much higher than above. Larry answered that there is a different channel type above and below. The channel above the diversion is narrower and steeper than it is below the diversion. Passage flows are based on a strict interpretation of the Thompson criteria. There are places where passage criteria are not quite met, but passage is still likely possible.

Another stakeholder asked if there are other barriers in place that can make this information moot (i.e., structures). Larry responded that those are noted in the habitat survey. When instream flow work is completed all information pertinent to fish passage will be summarized in CAWG 14.

Next Steps for CAWG-3:
- Determination of target flows for 2003 PHABSIM studies.
- Determine whitewater protocols.
- HSC verification presentation.
- Collection of data at transects selected in 2002.
- Decision on habitat time series analysis.
- Modeling and analysis of 2003 data.
- BiCEP model revisions with additional transects.

A stakeholder asked when will the CAWG have geomorphic information to look at in terms of fish passage. Wayne responded that the information has been mapped out and barriers noted. Ed added that the first step in approving the Draft Technical Study Reports is getting the basic information and then as we move on to the project effects analysis stage, we need to collect data from multiple plans and put together in one spot –summary tables, etc. Once the CAWG reaches a consensus on the data that has been presented in each study plan the group will begin to look at data across multiple studies.

Report Review Schedule
The Forest Service asked how to submit comments on the draft study reports? Bill responded that all working groups will use the single text protocol from the Big Creek Relicensing Communications Protocol.

Ed explained the proposed DTSR review schedule. From the time working group members receive the study report, they'll have 30 days (the schedule) to review and submit comments to Kearns & West. Then, Kearns & West will have 7 days to incorporate the comments and redistribute to the group for review and consideration for approval at the next working group meeting.

Bill asked if the group agrees with the proposed deadlines.

Agreement: The group agreed to the proposed DTSR review schedule.

Action Item #6: Kearns & West and ENTRIX will make a table of release dates, review dates, with the time sensitive elements listed in the order which they should be addressed by stakeholders and distribute to the Plenary group.

Water Quality Report

Lonnie Schardt (Kokanee Power) asked where the coliform samples were taken for Huntington lake? The maps included don't show enough resolution to know exactly where the samples were taken. ENTRIX will look at the maps again and see if they can better describe where the locations are in relation to Bear and Line Creeks.

Action Item #7: ENTRIX will check the Water Quality maps for resolution problems and report back to the group.

Review of Action Items

Action Item #1: Check distribution lists for accuracy with ENTRIX. Lonnie Schardt did not receive the last distribution add ldschardt@aol.com. (WAS MISSING the 'd' in the middle)
Action Item #2: Geoff to supply the CAWG the FERC summary of the final rulemaking RE: CEII. He will get clarification from Nino on its implications for the Big Creek Relicensing and get an email out to the CAWG.
Action Item #3: Cindy asked that the meeting summaries be placed on the web as soon as approved. January notes were approved.
Action Item #4: Larry to ID alternative approaches for Bolsillo Creek for food transport for group consideration at a future CAWG meeting.
Action Item #5: ENTRIX to put the discussion on the suitability of the proposed methodology in the CAWG-3 Draft Technical Study Report. This item will also be identified as time-sensitive for CAWG review.
Action Item #6: Kearns & West and ENTRIX will make table of release dates, review dates, with the time sensitive elements listed in the order which they should be addressed by stakeholders and distribute to the Plenary group.
Action Item #7: ENTRIX will check the Water Quality maps for resolution problems and report back to the group.

Big Creek Collaborative
Combined Aquatics Working Group

April 17, 2003

Final Meeting Notes

Time:	9:00 AM to 3:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Forest Supervisors Office, Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Phil Strand	USFS
	Bill Pistor (Facilitator)	Kearns & West
	Larry Wise	ENTRIX
	Roger Robb	Friant Water Users Authority
	Steve Rowan	Southern California Edison
	Martin Ostendorf	ENTRIX
	Britt Fecko	SWRCB
	Kelly Catlett	Friends of the River
	Rick Hopson	USFS
	Wayne Thompson	Federation of Fly Fishers
	Julie Means	CDFG
	Cindy Whelan	USFS
	Mitchell Katzel	ENTRIX
Phone Participants:	Intern from OPEC	
	Julie Tupper	USFS-RHAT

Introductions

Stakeholders introduced themselves and the organization they represent. Bill Pistor (Facilitator, Kearns & West) proposed approving the REVISED meeting agenda distributed to the group this morning. The group agreed to the revised agenda.

Review previous meeting action items

Outstanding action items listed below:

- **Action Item #2:** Geoff Rabone to send out CEII information as related to the Big Creek ALP.
- **Action Item #4:** Larry to identify alternative approaches for the food transport study on Bolsillo Creek for the CAWG review.
- **Habitat Classification Subgroup Meeting**

Britt suggested the group holding a conference call to discuss issues related to the 2003 Field Season.

Approve Meeting Summary

No comments to the CAWG March 10, 2003 Meeting Summary. The group approved the summary.

Big Creek Operations Update

Steve Rowan (SCE) gave an overview of water storage for this year. According to SCE's April 16, 2003 projections, runoff is expected to be 66% of normal this water year. Due to the projected water year and the fact that the PHABSIM studies use a significant amount of water, Steve proposed postponing the Mono Creek and South Fork San Joaquin studies to next field season. Steve acknowledged that April has been an above normal month for precipitation, but the moisture has been offsetting the dryer months, so the net result is still below normal.

Britt asked if the moisture forecasted for the end of this month would offset the current water year forecast. Steve said that in all likelihood it will not make a big enough difference to change the generation and runoff forecast.

Study Flows for CAWG-3

Larry Wise (ENTRIX) gave a PowerPoint presentation on the proposed target flows for the CAWG-3 PHABSIM studies. In the Mammoth Reach of the San Joaquin River. ENTRIX is hoping to do the measurements in the second half of May to avoid any potential conflicts with amphibian egg masses or, because of the below normal water year, ISO may declare “no touch days,” in which case SCE would not be able to change their operations. (Please see Appendix A: CAWG-3 PHABSIM Calibration Flows PowerPoint Presentation)

The methodology for conducting PHABSIM studies has been approved by the CAWG at previous meetings. Transects for PHABSIM studies were selected in coordination with the CAWG in 2002. The next step is to select the calibration (target) flows for each reach, which must be approved by this working group.

The Hydrology sub-group is currently working on developing flow information for the various Project streams. This information will not be available in time to be used for the PHABSIM studies to be conducted this year. Because of this, ENTRIX has developed proposed target flows using the USGS pre-project flow information from the San Joaquin River at Mammoth; Stevenson Creek above Shaver Lake; and all available information for Bear Creek above the diversion. This information has been supplemented and corroborated with information from other sources (specifically Barre 1925 and the USBR USAN model for the San Joaquin River. Theproposed target flows meet the stated objective for flow simulations stated in CAWG-3, and leave room for adjustments that may be needed based on the results of the Hydrology Subgroup work, which are not completed at this time.

Bear Creek above Diversion

Based on USGS records at USGS gaging station 11230500, the flows above the diversion are 36, 16, and 11 cfs in the months of August, September and October respectively. This is based on an 80-year period of record.

SCE proposes target flows of 5, 25, and 50 cfs, which would provide an extrapolation range of 2 to 125 cfs, based on the generally accepted PHABSIM modeling rule-of-thumb. According to this rule PHABSIM model simulation flows can be reliably extrapolated from 0.4 times the measured low flow to 2.5 times the measured high flow. The actual range of acceptable simulation depends on the model calibration statistics – sometimes the range can be extended – in other situations, the model may not be extrapolated that far. ENTRIX has had very good success in meeting and often being able to exceed the rule-of-thumb extrapolation range.

San Joaquin River – Mammoth

Based on available information, the median unimpaired flows for this reach are 425, 226, and 157 cfs in the months of August, September and October respectively.

Proposed target flows are 200, 80, and 30 cfs, which would give an extrapolation range of 5 to 500 cfs.

San Joaquin River – Stevenson Reach

There are no USGS flow records available for this reach., Unimpaired flows were estimated based on information available for the Mammoth Pool Reach and Big Creek to estimate the flowentering the Stevenson Reach. These flows ranged from which measured 440 cfs in August to 175 cfs in October.

The proposed target flows are 7, 35, and 200 cfs, which should give a range of extrapolation of 3 to 500 cfs. These calibration flows differ from the Mammoth Pool Reach because of the lower current minimum flow requirements for the Stevenson Reach. This range of measurement flow will cover the range of summer unimpaired flows.

A stakeholder asked why Larry picked the months of August, September and October. Larry answered that while November flows are often lower than those in October, in November water starts to cool down, fish change habitat and feeding behaviors and require less habitat due to lower metabolic requirements.

Big Creek
There are no USGS unimpaired flow numbers for Big Creek, so information from AH Barre in 1924 to estimate unimpaired summer flows. The numbers are the sum of Pitman Creek and Huntington Lake flows. These flows ranged from 9 cfs in September to 18 cfs in October. Proposed target flows are 3, 15, 40 cfs, which would providean extrapolation range from 1 to 100 cfs.

Stevenson Creek above Shaver
These unimpaired flows are also taken from Barre. Unimpaired flows range from 2 to 5 cfs during the August through October timeframe. Proposed target flows are 3, 10, 20 cfs. Higher measurement flows are proposed for this creek because the minimum flow requirement is currently greater than the unimpaired flow in some months. A range of proposed measurement flows higher than the summer unimpaired flow was required to allow a robust stage-discharge relationship to be developed. The proposed flows should allow for an extrapolation range of 1 to 50 cfs.

Larry gave the group an update on the North Fork Stevenson Creek Flows. The group held a conference call on March 20, 2003 and agreed to target flows of 15 and 30 cfs for the North Fork Stevenson Creek. ENTRIX did go out in the field and measured flows of 28 and 13 cfs. They will go back out to take the low flow measurements in the summer.

A stakeholder asked if the evaluation of the hydrology information could cause this study to change in any way? Larry answered that it might change slightly, but ENTRIX left a margin of error in these numbers for that purpose.

The stakeholders requested some time to review the proposed target flows.

Action Item #1: The CAWG plans to hold a conference call on April 28, 2003 at 8:30AM to discuss and approve the proposed target flows.

A stakeholder asked if the San Joaquin – Mammoth Reach is more time sensitive than the other reaches. Larry answered only in terms of whitewater. All the flows will require SCE to open a valve. The later in the summer the greater the probability that SCE will not be allowed to do releases due to the previously mentioned restraints.

The group discussed the timing of conducting these studies. Bill suggested scheduling the studies to coincide with the whitewater study releases, which will most likely take place in mid-May. The Recreation Working Group has not yet selected a date as of this meeting, but will be working offline to finalize dates in April.

The Forest Service and USFWS have expressed concerns about affecting amphibian spawning and conducting the flows in mid-May may help reduce the risk of affecting egg masses.

Martin informed the group that ENTRIX is trying to schedule a conference call to discuss whitewater study scheduling as well. Britt Fecko (SWRCB) expressed interest in participating in that call.

Action Item #2: Martin to inform Britt of any scheduled whitewater conference call.

Action Item #3: Larry to email the proposed target flows presentation to the CAWG no later than Friday the 18th.

Whitewater Stranding Study Protocol
Larry next gave a presentation on the Whitewater Stranding Study Protocol, which will be completed in coordination with the whitewater study. The focus of the study will be the Mammoth reach. This proposed protocol stems from field discussions held while reviewing the BiCEP PHABSIM transects in the Mammoth Reach and R2's suggested study approach. The goal of this discussion is to agree on the proposed methodology. (Please see Appendix B: Whitewater Stranding Study Protocol PowerPoint Presentation)

The study objective is to analyze the potential effects of a single, in season whitewater test flow on fish populations. The study focus will be on the stranding and trapping of fish during flow recessions following the whitewater release. The group will use this information to obtain insight into potential measures that may be needed to provide recreational flow releases, while providing adequate protection for fish populations.

A stakeholder asked for clarification of the terms "stranding" and "trapping." Stranding occurs when a fish is left out of the river in an unwatered area as flows recede. Trapping occurs when a pool forms on the side of the channel (on a bank or bar) during higher flows and a fish is trapped in the isolated pool, once the water recedes.

Larry explained that the results of the study will not be quantitative, but the emphasis will be on the mechanisms rather than on population information impacts. Main area of concern is when whitewater releases are done during times of year when fish aren't used to seeing higher flows.

Larry explained that the will be conducted the study in areas where PHABSIM transects are placed. These areas can be accessed at the proposed whitewater flow levels. These areas also contain features conducive to trapping or stranding fish, including bars, high flow channels and backwater pools.

Depth and velocity measurements must be done when flows are at peak. Due to the travel time of the water from top to bottom of 8-9 miles, the flow duration could be as long as 24 hours. This is a longer duration than what whitewater boaters would be asking for.

The group discussed ramping rates for the study. ENTRIX proposed a ramping rate of 200 cfs an hour. Some stakeholders requested information regarding the ramping rates for consideration of the proposed methodology.

Action Item #4: Larry to send out information (BiCEP, stage discharge level, 15min data, etc.) and the proposed study methodology and ramping rates for stakeholder review before the April 28th call.

The group agreed that it would help in their review to receive materials at least one business week in advance of the meetings.

HSC for Use in Instream Flow (PowerPoint)
Larry gave a presentation introducing the Habitat Suitability Criteria (HSC) verification process. This was a presentation only, with no proposal for approval at this meeting. (please see Appendix C: Intro to HSC Verification PowerPoint Presentation)

Selected criteria were developed from stream observations in the immediate study area (Big Creek and NF Stevenson Creek, as well asthe Tule River, and Willow Creek, and all observations were taken together to generate regional criteria sets for rainbow and brown trout for central Sierra streams. Those criteria are based on numerous observations and have been tested on the Tule. The criteria were also tested for rainbow trout in Big Creekand found to be valid for use there, as well.

A stakeholder asked if the criteria were developed in regulated streams. Larry said yes and that observations were collected at different flow s, as well. This was followed by a discussion of the number of observations made to date on various streams and within various stream strata. Streams were divided into upper and lower basin streams and into large streams and mid-sized streams. These strata were based on the physical characteristics of the various reaches including consideration of flow, structural and temperature aspects. Larry mentioned that different species will be observed in different areas. For example, it is difficult to get a lot of observations for adult trout in the Stevenson Reach of the San Joaquin River. The CAWG will need to address in the group at a later date **(Bin Item).**

A stakeholder asked if the criteria were created in the Big Creek area does that mean they have already been tested. Larry answered that for rainbow trout yes, because they have been tested. There are not enough observations to verify all lifetages of brown trout. Because the criteria were developed in the area, they do seem transferable, but because observations from other streams also were used to develop the criteria, there may be differences between observed utilization in a single stream and the composite utilization function.

The HSC verification will utilize the Groshens and Orth (1984) approach. In using this approach threshold suitability values will need to be selected to differentiate between suitable and unsuitable habitat and optimal and usable habitat. These values will be selected in during a future CAWG meeting. The approach calls for testing two null hypotheses:

- H_0: Suitable habitat is not used more than unsuitable.
- H_a: Suitable habitat is used more than unsuitable.

- H_1: Optimal habitat is not used more than marginal.
- H_a: Optimal habitat is used more than marginal.

Both null hypotheses should be rejected for a criteria set to transfer.

Larry outlined the methods for data collection for the ALP and the sampling locations and stream categories. The CAWG can discuss next steps at a future meeting.

A stakeholder asked in what months and year types were these samples taken. Larry said they were taken in the summer (July, August, and September) during normal, dry and wet years. Larry said sampling during these months may limit habitat availability, but that we will try to maximize habitat availability in sampling design, by sampling across all habitat types equally and sampling at different flow levels..

Bill asked for the timing of the HSC work. Larry does not expect to get through this in one or two meetings. Bill said that often an HSC subgroup is formed for this. A stakeholder asked when the CAWG can expect to have a validation report from ENTRIX. Larry answered that in July or August they will bring back preliminary results for group review.

Amphibian Egg Mass Monitoring / USFWS Consultation

Janelle spoke with Jesse Wild today and sent a consultation letter describing the methodology for the implementation of the Recreation whitewater study. Jesse gave verbal approval today for surveys through mid-May.

Action Item #5: The Amphibian Subgroup will hold a conference call on April 22 at 1PM to discuss issues related to this study.

Geomorphology and the Whitewater Release
A stakeholder asked Mitchell if the 800 cfs release would be enough for geomorph sub-group to obtain useful information on gravel transport and painted gravel study. Mitch didn't know if it will be enough. A follow-up question was asked if the 800 cfs could be a preliminary study and could lead to further study. Mitch said that unless you do the study over a range and increments of flows, it's hard to track when gravel moved. Doing the study as proposed would only give you an answer of whether the flow is enough to move or not and not give any graded information.

Mitch asked what the objective of the 800 cfs study would be. Martin explained that the work could be supplemental to the information we hope to get from the formal study. Mitchell said what might be of interest would be sand transport for the pools.

Action Item #6: Mitchell to consider/propose to the group geomorphic work that could be conducted in coordination with the Whitewater study.

Review Comments on CAWG-2: Geomorphology
The group reviewed comments received from the USFS and SWRCB on the CAWG-2 Draft Technical Study Report. Bill walked through comment by comment. Comments will be noted in the revised draft of the study report and not in this meeting summary. This meeting summary will capture any disagreement or actions that result from the discussion.

Agreement: Continue to have same structure, but within the completed elements all study elements will be listed with the status of each listed in parenthesis. Then, in the study elements not completed section, the elements not completed will be listed again.

The group discussed the need for a timeline on the study elements yet to be completed. ENTRIX explained that a timeline will be produced separately from the DTSRs. The group agreed.

Action Item #7: ENTRIX to produce timeline separate from the DTSR's on the study elements yet to be completed.

Mitchell explained that ENTRIX fully documented (photographically) the field surveys and that the photos will be incorporated as an Appendix.

DTSR Edit: Add Photo document Appendix.

Bin Item: CAWG to address the unregulated/regulated stream length question at a later date after Mitch, Rick and Britt hold offline meeting to discuss.

DTSR Edit: Mitchell to provide field data sheets in an appendix (section 5.0)

Action Item #8: Bryan to send out May 6th Amphib (8-12) and CAWG (1-5) meeting agenda. Bryan check with Julie Means for the CDFG meeting room.

Action Item #9: Geomorph Subgroup meeting May 7th 8AM to 1PM.

Action Item #10: K&W to call CAWG members regarding a separate Water Quality DTSR meeting?

<u>Review of Action Items</u>
Action Item #1: The CAWG to hold a conference call on April 28, 2003 at 8:30AM to discuss and approve the proposed target flows.
Action Item #2: Martin to inform Britt of any scheduled whitewater conference call.
Action Item #3: Larry to email the proposed target flows presentation to the CAWG no later than Friday the 18th.

Action Item #4: Larry to send out information (BiCEP, stage discharge level, 15min data, etc.) and the proposed study methodology and ramping rates for stakeholder review before the April 28th call.
Action Item #5: The Amphibian Subgroup will hold a conference call on April 22 at 1PM to discuss issues related to this study.
Action Item #6: Mitchell to consider/propose to the group geomorphic work that can be conducted in coordination with the Whitewater study.
Action Item #7: ENTRIX to produce timeline separate from the DTSR's on the study elements yet to be completed.

Action Item #8: Bryan to send out May 6th Amphib (8-12) and CAWG (1-5) meeting agenda. Bryan check with Julie Means for the CDFG meeting room.
Action Item #9: Geomorph Subgroup meeting May 7th 8AM to 1PM.
Action Item #10: K&W to call CAWG members regarding a separate Water Quality DTSR meeting?

Action Items From Previous Meetings
(March 10, 2003) Action Item #2: Geoff Rabone to send out CEII information as related to the Big Creek ALP.
(March 10, 2003) Action Item #4: Larry to identify alternative approaches for the food transport study on Bolsillo Creek for the CAWG review.
Habitat Classification Subgroup Meeting

Appendices
Appendix A: CAWG-3 PHABSIM Calibration Flows
Appendix B: Whitewater Stranding Study Protocol PowerPoint Presentation
Appendix C: Intro to HSC Verification PowerPoint Presentation

Big Creek Collaborative

Combined Aquatics Working Group
Conference Call

April 28, 2003

Final Meeting Notes

Time:	8:30 AM to 9:30 PM	**Moderator:**	
Location:	Conference Call	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Ryan Bricker
Name:	Combined Aquatics Working Group		
	Bill Pistor	Kearns & West	
Phone Participants:			
	Geoff Rabone	SCE	
	Larry Wise	ENTRIX	
	Larry Lockwood	SAMS	
	Phil Strand	Forest Service	
	Brit Fecko	SWRCB	
	Rick Hopson (FS)	Forest Service	
	Paul Martzen	San JoaquinPaddlers Club	
	Ryan Bricker	Kearns & West	
	Julie Means	CDFG	
	Mitchell Katzel	ENTRIX	

Big Creek April 28 CAWG Meeting

Stakeholders introduced themselves and the organization they represent, then reviewed and approved the day's agenda.

There was a brief discussion on scheduling dates in relation to the May 15th Whitewater study.

PHABSIM Calibration Flows

Larry talked about calibration flows and it was noted that the types of flows will be based on hydrographs and safety and are summarized in line 17 of the presentation. Bill suggested further review offline

It was asked if there is an underline strategy. The underline strategy is determining what hydrologic info is available; picking calibration to cover a full range; all with a consideration for safety - Taken from CAWG 3.

It was asked if flows can go up to 500 cfs. The answer was yes.

Whitewater Protocol

Larry said that Paul had the protocol right before the last meeting and days later distributed a revision describing the approach. The plan will be to go out and collect depth and velocity data to take back into the office and apply criteria and assess risks. Data will be collected pretty early (in-season river flow) but it is not certain how ramping rates will be assessed. In order to validate observations it would be ideal to create the best environment to strand fish. Bisect studies will be used to get information on ramping rates – they go to about 450 cfs – banks are vertical around our area at about 450.

Whitewater Study Ramping Rates

There were still concerns with ramping rates and the possible need for a second study. Larry replied that they are not anticipating another study being needed. It was mentioned again that there is a desire to have high ramping rates to create the best conditions for catching fish for validity of the studies. At this time they are looking for it to be a worst case scenario. This would create stronger verification. It must also be kept in mind that observation only tells us about the fish at the point of observation and does not tell us anything about other areas. It was mentioned that other elements such as temperature will also have an effect.

Phil was asked if he could live with the ramping rate for the purpose of mapping. Phil replied that he was uncomfortable with the plan in terms of fish.

Brit wanted clarification that a ramping rate of 6 inches/hour will be solely used for this study with the understanding that this is not used as future ramping rate. For the study they will be mapping higher flow and will be trying to have the flow come down to evaluate if any fish are trapped. We are looking for indication that what we think traps fish does trap fish. They would like to have biological verification of measurements.

Phil said he could live with the current situation with the understanding that if we see an effect on fish, actions need to be taken.

Bill asked if the group would agree to adopt Larry's protocol. There was a general agreement.

There were concerns regarding the time it would take to see downramping downstream. It is estimated to take 12-24 hours for the water's travel time (about 9 miles). There are too many problems with making observations at night so timing is important. 6-8 hour was another rough estimate of travel time. Marking stakes with times would be possible, but is probably not an option because it would require someone standing out there all night

Possible Geomorphologic Methodology

The group waited to get Mitchell on the phone

It was asked if Larry had a chance to talk to Janelle about additional sites. He did and told the group that it will be possible to access the upper site (Mammoth Lakes?).

The use of pressure translucent gauges was suggested, and will be looked into further. It might be useful to have one upstream and one downstream. Could think about putting it across transects and recording data every 15 minutes.

Julie means joins call

Mitchell joins call

Mitchell explained the need to look at potential transport of spotting site gravel. Boundaries will be created if spills are not enough to move gravel. The possibility of using tracer gravel was brought up. Mitchell will participate with Larry and Wayne for locations to place gravel.

There were questions and a discussion about the use of shields criteria and whether the information can be verified using this approach. This can be done and they will need to survey in at least one cross-section and use a hydraulic model to calibrate the water surface elevation at release and use shields criteria bed sheer stress to look at forces.

Different natural elements may have an effect on gravel flows and readings, and it is not likely that smooth flows will be found to apply shields criteria. However, it is still possible to give good estimates and caparison of tracers by using different locations. Ways to help studies - look for smooth lavender non-turbulent flows, estimate how much gravel you would expect to see there in the first place and compare. We could also throw out lager particles and if they move assume the smaller particles would to.

It was asked if scour chains could be used. Mitchell said it would be possible, but what we want to know is if spawning gravel will move and it is probably more efficient to use tracer gravel. Another method might be to use multiple layers of tracers with different colors. In order to do this, pockets deep enough to separate surface form subsurface will need to be located. Opportunities will be looked for.

A stakeholder asked Mitchell if this was the most useful place to use shields and if it would still be used it if we were not in the collaborative. Mitchell said there is nothing else better out there, but would be open to using something other than shield if there are suggestions.

The group discussed the possibility of shooting some cross sections. Larry suggested about 6 cross-sections in each reach. A concern was brought up regarding measuring velocity when shooting at 800 cfs. Mitchell said we can measure water elevation but probably not velocity. To see if this will work, we need to go out, get cross sections, and when 800 cfs release occurs, use the model and compare with shields criteria to determine force on cross-section. It is hard to know if we will come up with useful information and determine if shields is useful.

There was discussion on sites to be used since gravel is distributed in different locations and some gravel reaches will be difficult to locate. We may only use locations near the dam and powerhouse where we have access. Safety is number one and locations in between might not be an option. Some of these spots are pretty remote and can not easily be accessed. The best gravel reaches are down by the powerhouse so this might be what is used.

There was still some discomfort with shields and whether or not it would give you a number you could rely on. The possibility of shooting water elevations and not using tracers was discussed. Mitchell responded that if we did not put out tracer we have no way to calibrate an appropriate shields criterion and that the accuracy will be different for each case. Pulling out a shields number and hoping it works is more affective in some places than others and there is no way to know for sure how accurate the numbers will be.

It was brought up that the readings are not indicating whether shields info is working or not. Shields is not a fixed set number, the shields parameter is a fluid number. What it takes to move gravel will be different in channels with different roughness and different elements. Rick asked Mitchell how close he has been getting. Mitchell's answer was that we will know how close we get after it's been done. The greater the size of bed elements decreases the confidence in shields. Smoother beds give a better chance for finding level through literature.

Discussion changed to suspended sediment transport. As long as it is safe, a depth integrated technique can be used to look at what flows get sand transport and total suspended sediment transport. There was interest in the use of tag lines. As of now, they are not planning to have a bunch of tag lines, probably one at each site. There would probably be two sampling cross sections.

End of agenda –

A stakeholder asked about the Methodology Protocol timeline.
Mitchell was not anticipating distributing a timeline, but will document all steps taken.

No other matters. Meeting adjourned

Big Creek Collaborative
Combined Aquatic Working Group

June 12, 2003

Final Meeting Notes

Time:	9AM to 3 PM	**Moderator:**	Wayne Lifton
Location:	USFS Clovis Office 1600 Tollhouse Rd. Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatic Working Group		

Attended By	Bill Pistor	Kearns & West
	Bryan Harland	Kearns & West
	Wayne Allen	SCE
	Geoff Rabone	SCE
	Phil Strand	USFS
	Wayne Thompson	Federation of Fly Fisherman
	Wayne Lifton	ENTRIX
	Cathy Little	ENTRIX
	Janelle Nolan-Summers	ENTRIX
	Katy	ENTRIX
	Rick Hopson	USFS
	Julie Means	CDFG
	Debbie Giglio	USF&WS
Phone Participants:	Britt Fecko	SWRCB
	Mitchel Katzel	ENTRIX
	Kelly Catlett	Friends of the River

Introductions

Bill Pistor (Kearns & West) began the meeting by having stakeholders introduce themselves and the organization they represent, then reviewed and approved the day's agenda. The agenda was approved with no edits.

Action Item #1: Kearns & West will distribute the April 17, May 6, and May 19th CAWG meeting summaries to the group for review.

Action Item #2: Wayne Lifton will edit the CAWG-1 DTSR to include SCE large woody debris operations protocols.

Fieldwork Update

Wayne Lifton (ENTRIX) gave the group and update on the recent fieldwork that has taken place in the field. Please see the PowerPoint presentation for the full details.

Action Item #3: The fieldwork update PowerPoint presentation to be sent to the group.

Single Flow Whitewater Stranding Studies
A stakeholder asked if the field crew walked to the sites. Wayne said they helicoptered in, but the storms prevented them from completing the depth and velocity measurements.

A stakeholder asked if there were any tributaries entering upstream of the upper and lower sites. Wayne Allen answered no for the upper and yes for the lower. Hooper was turned out north and south slide and tombstone. The estimated CFS of those combined would be about 20—25 cfs accretion coming in.

For the South Fork San Joaquin River near Jackass Meadow - five very small fry (20 mm or less) found in residual pools. Two fish were isolated; three in a pool that was still connected to the river at base flows. For the South Fork San Joaquin River above the gage, five brown trout about 95 to 180 mm long. Four deceased, one rescued. One brown trout observed in side channel, flow still present but fish likely could not move back. One dead 150 mm long rainbow.

Remaining work: topographic data collection for SFSJR sites. Reduce data and prepare overlays of topography, depths and velocities. Select depth and velocity thresholds with CAWG concurrence, and then complete evaluation.

A stakeholder asked what the ramping down rate was. Wayne Allen did not know, will pull the card and get the data.

Action Item #4: Wayne Allen to find out the ramp-down rate for the spill flows on the South Fork San Joaquin River

A stakeholder asked if there will be another spill event. Wayne A answered that the temperature has cooled off, so it has slowed the flow. He says there probably won't be one.

Small Diversion Entrainment Sampling
A stakeholder asked how close the velocities were measured to the intake. Wayne Lifton answered that they took several readings at different distances and the measurement reported is the maximum velocity measured.

Another stakeholder asked where the net was set up. Wayne said fairly close to the stream inlet to the diversion impoundment.

A stakeholder asked why they chose Balsam over other diversions. Wayne answered that the two tributaries are Ely and Balsam. Balsam is bigger and has more fish, so it seemed like a better location to take a representative sample. The stakeholder asked about Pitman diversion. Wayne said that it is far upstream and is diverted into Balsam Meadow Fore bay and not into a turbine.

The stakeholder asked if there is any mortality information on fish being entrained to forebays. Wayne said he wasn’t aware of any, there was no likely source of direct mortality associated with such a diversion and the focus of this study is to measure turbine mortality.

A stakeholder asked if there was any progress on the food study. Wayne said that he and Larry have talked about it and Larry is coming up with an alternative approach to addressing flow analysis for Bolsillo Creek. (Continuing Action Item).

A stakeholder asked if they will sample Balsam again. Wayne said they will go out again and do an additional 48-hour sample. Balsam Creek contains primarily rainbow trout. The stakeholder asked if they would do a study in the fall also. Wayne said the CAWG can discuss that option, but none was planned.

A stakeholder asked for a picture of a trawl with a live car. Wayne showed a picture of the trawl used in the Pit 4 study. He said that they used a larger trawl for the Pit project than would be used for the small diversions. Wayne explained the trawl device and how the live car reduces the potential for further fish injury by blocking the high velocity flow.

Entrainment Monitoring Discussion

Wayne explained that at the last meeting, the group did not get to a decision on the medium and large reservoirs.

Proposal: Powerhouse 1, 2A (high-head, impulse turbines, which are known for high mortality), Mammoth Pool Powerhouse (good representative of high head Francis). Bimonthly during summer and quarterly during other months.
The group discussed the proposal and several options for obtaining the information needed for entrainment on medium and large reservoirs. The group reached an agreement on sampling:

Agreement: ENTRIX will conduct entrainment sampling at the tailraces of Big Creek Powerhouses 1 and 2A, Mammoth Powerhouse, and Eastwood Powerhouse. Samples will be taken bi-monthly during the warm months and quarterly during the winter months. Eastwood will not be sampled during the winter months.

A stakeholder asked if the pumpback of water is a factor. Wayne said that pumpback occurs separately and that in general, fish mortality can be high during pump back cycle, due to pressure and turbulence. This has been studied.

A stakeholder asked what the percentage of survival would be at the higher mortality turbines. Wayne said no more than about 20% based on literature values.

The State Water Board expressed a concern that the entrainment information collected for the Portal Project is not sufficient to base a management decision on and that the group cannot conclude that entrainment isn't taking place at Portal. Wayne said that they can extrapolate the information gathered at Portal for the time of year and type of operation at Portal.

Geoff stated that the FERC position is that we don't have to prove that there isn't a problem, only that there is a problem. Geoff went on to say that if there is no fish population deficiency, then it would be difficult to conclude that there was an entrainment problem.
Wayne suggested looking at the Portal operations in terms of the entrainment samples and general operations.

Action Item #5: Wayne Allen will collect Portal Powerhouse operations data and entrainment sampling dates and times; distribute to the CAWG before the next meeting; the CAWG will compare sampling with operational modes to determine if sampling is representative for normal operations.

A stakeholder said that since she hasn't seen the diversions directly she has trouble conceptualizing how the fish might be entrained. She would like to see one at low flow for clarification. Geoff suggested Bolsillo and small diversions with vertical drops. She stated that she would like velocity measurements.

Action Item #6: Wayne Allen to research if there is any velocity information for diversions with vertical drops, specifically Bolsillo Creek Diversion.

Wayne L. said the study they conducted on Mokelumne is indicative of what might be expected of trout entrainment in the relation to the pattern of the Sierra Nevada hydrograph.

Action Item #7: Wayne Lifton to provide citations for Mokelumne entrainment study and for relevant literature on trout movement and provide to the CAWG for review.

A stakeholder asked if SCE has a fishing license or something similar that allows them to take fish. Geoff said that if you look at the CDFG code, it's the operator's responsibility to keep fish pops in good condition downstream from the project, but this begs the question: What constitutes good population? And: What is a significant impact?

A stakeholder asked what the protocol would be for determining the level of entrainment during the winter time. Wayne Lifton answered that they are going to do bimonthly sampling in the summer and quarterly in the winter.

Meeting Adjourned

Summary of Action Items

Action Item #1: Kearns & West will distribute the April 17, May 6, and May 19th CAWG meeting summaries to the group for review.
Action Item #2: Wayne Lifton will edit the CAWG-1 DTSR to include SCE large woody debris operations protocols.
Action Item #3: The fieldwork update PowerPoint presentation to be sent to the group.
Action Item #4: Wayne Allen to find out the ramp-down rate for the spill flows on the South Fork San Joaquin River
Action Item #5: Wayne Allen will collect Portal Powerhouse operations data and entrainment sampling dates and times; distribute to the CAWG before the next meeting; the CAWG will compare sampling with operational modes to determine if sampling is representative for normal operations.
Action Item #6: Wayne Allen to research if there is any velocity information for diversions with vertical drops, specifically Bolsillo Creek Diversion.
Action Item #7: Wayne Lifton to provide citations for Mokelumne entrainment study and for relevant literature on trout movement and provide to the CAWG for review.

Big Creek Collaborative
Combined Aquatics Working Group

July 9, 2003

Final Meeting Notes

Time:	10:00 AM to 4:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Forest Supervisors Office, Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor (Facilitator)	Kearns & West
	Bryan Harland (Notetaker)	Kearns & West
	Wayne Lifton	ENTRIX
	Wayne Allen	SCE
	Phil Strand	USFS
	Geoff Rabone	SCE
	Cindy Whelan	USFS
	Rick Hopson	USFS
	Wayne Thompson	Federation of Fly Fishermen
	Martin Ostendorf	ENTRIX
	Julie Means	CDFG
	Julie Tupper	USFS - RHAT
	Ed Bianchi	ENTRIX
Phone Participants:	Britt Fecko	SWRCB
	Kelly Catlett	Friends of the River
	Larry Wise	ENTRIX

Introductions

Stakeholders introduced themselves and the organization they represent. Bill Pistor (Facilitator, Kearns & West) proposed approving the REVISED meeting agenda distributed to the group this morning. The group agreed to the revised agenda.

Kearns & West distributed the summaries from the April 17th, May 6th, and May 19th CAWG meetings. The summaries were approved with slight revisions.

Review Previous Meeting Action Items

Outstanding action items listed below:

- **Action Item:** Geoff Rabone to send out FERC's Critical Energy Infrastructure Information (CEII) guidelines as they relate to the Big Creek ALP.
- **Action Item:** Bryan to send PowerPoint presentation on fieldwork to the CAWG.
- **Action Item:** Wayne Lifton to provide citations for Mokelumne entrainment study and for relevant literature on trout movement and provide to the CAWG for review.
- **Action Item:** Geomorphology subgroup will schedule a fieldtrip at the July 10 Geomorphology subgroup meeting.

Action Item #1: Timeline for outstanding study elements in the DTSRs will be developed on a group by group basis. ENTRIX will provide an initial draft of the timeline, then discussed in the groups. The CAWG will need to make decisions before the outstanding study elements timeline can be fully developed. Two weeks from today.

South Fork San Joaquin Single Flow Study

Action Item #2: Bryan to send the South Fork San Joaquin Single Flow Study ramping down rate PowerPoint slide to the CAWG.

Bolsillo Diversion Downward Flow

Wayne Lifton (ENTRIX) gave a presentation on the Bolsillo Diversion down ramping flows per an action item from the June 12 CAWG meeting. He explained that information provided by Wayne Allen was used to prepare velocity calculations. At lower flows, water passes through the grating at the side of the intake or overflows the upper lip. Velocity is proportional to the height of the flow and when the water surface elevation is higher, the surface area for intake is larger. Velocity increases are related to the flow passing through the area formed by the depth of flow and the circumference of the intake. At larger flows, water passes through the entire upper surface of the intake, as well as the side resulting in lower velocities. Velocities were presented for average, maximum, and minimum monthly flows for 2001 and 2002. Velocities ranged from 0.19 to 1.06 ft/s for the flows evaluated.

Geoff Rabone (SCE) said that there is surface flow and an orienting flow going downstream when the diversion is diverting water. He thinks that smaller fish will be towards the shallower areas.

A stakeholder asked what time period has the highest downward velocities. Wayne L. answered that May is consistently the highest daily average velocities. The stakeholder asked if the other diversions are similar structures. Wayne Allen said yes. Geoff said the only difference in other diversions is that the bore hole is at more of an angle.

Fieldwork Schedule

Wayne explained the process for the study timeline and fieldwork schedule. ENTRIX does not have a master schedule yet because the CAWG needs to make decisions in other meetings before the schedule can be set. Martin gave a brief overview of the scheduled events as of today.

Entrainment

Last week did small diversions. Next week will do BC1, 2A, Mammoth and Eastwood. Wayne explained that the work is contingent on operations constraints and that the ISO may issue a “no touch day” especially with the hot weather. During September, we will do a second round of entrainment sampling.

Instream Flow

PHABSIM for SFSJR and Bear Creek being done this week.
Wetted perimeter and PHABSIM on Big Creek Stevenson Creek and NF Stevenson in August.
Supplementary Habitat mapping in August.
Habitat Suitability Criteria in August.

Native American Mollusk Sampling will be conducted at the end of September near Big Creek 4.

No further scheduled activities at this time, but shifts in the schedule are possible. There will be entrainment sampling in November.

Action Item #3: Wayne Allen will notify members of the CAWG when he receives fieldwork notifications. Kearns & West and Wayne Allen will coordinate on the CAWG distribution list. CAWG members interested in attending fieldwork can contact Wayne Allen to coordinate logistics.

A stakeholder asked about the Supplemental Habitat Mapping work. Wayne Lifton said that there is an area that needs to be mapped and the Big Creek QC work as well. Woody debris work also may take place, depending upon CAWG decisions regarding need and geomorphology studies. Mitchell will discuss where there will be additional mapping with the Geomorphology group.

Overview of CAWG-4: Chemical Water Quality Draft Technical Study Report
Martin reviewed the CAWG-4 with the group. The CAWG-4 DTSR is not up for approval at this meeting. Martin will be presenting the report and the comments simultaneously. After Martin reconciles the stakeholder comments into the report it will be up for approval at a future meeting. References to stakeholder comments are included in this summary along with the group's decision on addressing those comments.

DTSR Comment: Page 1-2: SWRCB
Samples not taken in 2002 should be taken in 2003. Martin explained that they are tracking to see if they can get them. Flows too high, inaccessible areas stand in the way. ENTRIX will try to take those samples.

DSTR Comment: Page 2: SWRCB
Martin explained that the intent was not to try to interpret, but compare to the CA Toxic rule, the national rule and Basin Plan. Needs further discussion with the SWRCB and SCE. Britt explained that for compliance with the CWA, they need to use the strictest standards available.
DSTR Edit: ENTRIX will change language to be less interpretive.

DTSR Comment: Page 2: SWRCB
DTSR Edit: ENTRIX will add a discussion of those samples.

DTSR Comment: Page 3: SWRCB
DTSR Edit: ENTRIX will provide edits to the text. The justification of eliminating reservoirs will be included.

DTSR Comment: Page 3: SWRCB
DTSR Edit: The reservoirs and impoundments need to be listed. ENTRIX will provide the justification for not sampling all reservoirs.

DTSR Comment: Page 4: SWRCB
DTSR Edit: ENTRIX will make changes to address the beneficial uses. Martin said that the study element can be kept and the SWRCB comment on beneficial uses will be provided in the text. State that it may meet standards and include more detailed discussion below.

DTSR Comment: Page 5: SWRCB
DTSR Edit: ENTRIX will incorporate references to proper tables, figures, etc.

Action Item #4: Martin to send the preliminary results of In-situ gas saturation at mammoth pool during a spill event.

DTSR Comment: Pg 5: SWRCB
Arsenic will be evaluated.

DTSR Comment: Pg 6: SWRCB
DTSR Edit: Comments on the most controlling values and beneficial uses. Will be made a footnote to the report. Another paragraph will be added regarding a water quality subgroup being formed to decide which standards will be used.

DTSR Comment: Pg 7: SWRCB
DTSR Edit: ENTRIX will add an explanation on justifications.

DTSR Comment: Pg 8: SWRCB

DTSR Edit: Martin will address the explanation developed by subgroup.

DTSR Comment: Pg 8: SWRCB
Fecal sampling will be completed.

DTSR Comment: Pg 8: SWRCB
DTSR Edit: Tombstone diversion mention will be fixed.

DTSR Comment: Pg 8: SWRCB
DTSR Edit: ENTRIX will add language on why some samples cannot be taken due to safety issues.

DTSR Comment: Pg 8 (bottom paragraph): SWRCB
DTSR Edit: ENTRIX will add the dates when diversions were turned out. ENTRIX will explain the Hooper Creek diversion.
North Slide, South Slide and Tombstone samples will be explained.

DTSR Comment: Pg 9: SWRCB
DTSR Edit: 4.3.3 ENTRIX will add paragraph on fish tissue sampling.

DTSR Comment: Pg 11: SWRCB
DTSR Edit: Appendix A will add discussion on methyl mercury.

DTSR Comment: Pg 11: SWRCB
DTSR Edit: ENTRIX will include a paragraph that will address the J-values limit.

DTSR Comment: Pg 13: SWRCB
DTSR Edit: ENTRIX will strike the reference to USFS.

DTSR Comment: Pg 14: USFS
DTSR Edit: ENTRIX will correct statement Re: Shaver Lake Tributaries.

DTSR Comment: Pg 15: SWRCB
DTSR Edit: ENTRIX fix

DTSR Comment: Pg 17: SWRCB
DTSR Edit: ENTRIX will define water quality goals

DTSR Comment: Pg 17: USFS
DTSR Edit: ENTRIX will add % of pH

DTSR Comment: Pg 19: SWRCB
DTSR Edit: ENTRIX will incorporate turbidity standard.

DTSR Comment: Pg 29: SWRCB
DTSR Edit: Will be addressed in Appendix J

DTSR Comment: Pg 29: SWRCB
DTSR Edit: Referred to in Appendix A comments

DTSR Comment: Pg 31: USFS
DTSR Edit: Edit will be incorporated. Partial sentence will be fixed

DTSR Comment: Pg A3: SWRCB
DTSR Edit: Will be incorporated.

DTSR Comment: Pg A4: SWRCB
DTSR Edit: Edit will be incorporated. Geoff suggested "when the hardness is high…" be added to the sentence before the comment.

DTSR Comment: Pg A8: SWRCB
DTSR Edit: Edit will be incorporated

DTSR Comment: Pg A9: SWRCB
DTSR Edit: Edit will be incorporated

DTSR Comment: Pg A10: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A10: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A11: SWRCB
DTSR Edit: Will be addressed in Appendix J

DTSR Comment: Pg A12: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A14: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A21: SWRCB
DTSR Edit: Edit will be incorporated

A stakeholder asked why the study was analyzing Silver. Ed Bianchi explained that the Cloud seeding study is a cross reference to this and will be referenced in the DTSR. (Silver Iodide) CAWG-12: Water Use addresses cloud seeding.

Action Item #5: ENTRIX will make the edits necessary and Kearns & West will redistribute the CAWG-4 to the group. The group will review and then approve at future meeting.

CAWG-7: Characterize Fish Populations
Wayne reviewed the CAWG-7 DTSR with the group. Comments from stakeholders on CAWG-7 will be due on August 3, 2003. The group will discuss comments at the next CAWG meeting.

Hydroacoustics
Wayne explained that when sampling with hydroacoustics, the beam of the device starts narrow and widens as it gets farther from the boat. This results in a smaller sampled volume for shallower water, when compared to deeper water.

A stakeholder asked if ENTRIX lumped hatchery and wild rainbow trout. Wayne L. said they did not. They did not age hatchery rainbow trout because their scales do not allow adequate aging.

Action Item #6: Wayne Lifton will check the condition factors reported in the CAWG-7 DTSR to confirm that hatchery trout were not included with wild rainbow trout.

Portal Entrainment Monitoring Discussion
Wayne L. showed the group a chart of information provided by Wayne Allen and USGS with the generation, total flow, ISO no touch days and ISO emergency days and the entrainment sampling for 2001-2002. When

the HB valve is open, sampling cannot take place. When the ISO issues no touch or emergency days, there can be no outages to set up a net or retrieve a sample. The net was damaged in August 2002 due to HB valve operation, so no samples could be taken at that time.

Wayne L. showed the group the exceedance flows for Portal. Most water is moved between the months of May to August. Wayne pointed out that there appeared to be adequate numbers of samples in the winter months when operations are generally decreased due to decreased flow availability, but the summer months were represented by few samples.

The State Water Board said that the problems of having inadequate sampling are due to sampling during the wrong part of the year. The Board referenced the Portal Application which states that for the December 12th period sampling started at 12 o'clock, and went for 24 hours. The Water Board stated that this is not enough info. The second sample was in January, there was no information on the volume of water when a Kokannee carcass was caught. The application says you did not catch any fish in the summer months, but that there were portions of fish that were caught in the net.

Agreement: The CAWG agreed that additional entrainment sampling will be taken at Portal to represent the higher flow period. Sampling will focus on flows of over 400 cfs. ENTRIX will coordinate with SCE operations to find the window of opportunity and go take the samples.

Review of Habitat Suitability Data Collection

Wayne L. reviewed the HSC Verification Update with the group. Focus will be on testing the altered flows preference criteria for trout and the Pit River criteria developed by Peter Moyle and Don Baltz for Sacramento sucker, Sacramento pikeminnow, and hardhead.

Wayne explained that there are two components in using PHABSIM to analyze habitat at different flows. A hydraulic model such as IFG4a is used to simulate velocities and depths for a range of flows at each transect. The other is to evaluate these results in terms of fish microhabitat. The PHABSIM HABTAT, HABTAV, and HABTAE models interpret hydraulic model results using habitat suitability criteria to interpret the suitability of habitat for different species and lifestages.

Suitability goes from 0 to 1. Zero is unsuitable habitat and 1 is completely suitable habitat. Wayne drew some sample curves and explained what they meant. Suitability of velocity multiplied by suitability of depth for an area of stream equals the weighted usable area for that location in the example shown.

A stakeholder asked how we know that a fish is "happy" in a habitat. Wayne said that "happy" fish is determined by how many fish are observed in certain microhabitat conditions. We observe where the fish are in relation to the availability of habitat choices. Geoff added that there's a different set of suitability for different fish and different lifestages.

The habitat suitability curves that we will be using are based on large data sets of habitat availability and fish habitat use observations. The first step in this study is to see if the existing curves can be used for our purposes. The specific approach will be to use the Groshens and Orth testing approach to compare HSC to observations of habitat availability and use by fish in the study streams. If HSC pass the test then they will be adequate for use in PHABSIM.

A stakeholder asked what the timeframe for developing site specific curves is. Wayne said that the first order of business is to determine whether existing curves are adequate, then we will assess what information we have and don't have, then see where we stand.

A stakeholder asked if they are using any of the snorkeling results to develop suitability curves. Wayne said they need about 50 snorkeling observations of fish habitat use to test a HSC. However, these are not the same observations collected for CAWG-7.

A stakeholder explained that on the Pit River, recent observations of juvenile suckers were different from the curves they had developed there. Wayne said that the HSC would be tested prior to use. In addition, there are ways to adjust curves to reflect actual habitat use, otherwise site-specific curves would need to be developed.

Wayne gave a summary of the sampling locations and years and numbers of observations collected, so far. He then outlined the data gaps for each fish species. Wayne said they tried not to take observations where they stock fish to avoid having hatchery fish from influencing the HSC decisions.

A stakeholder asked if the adequate sample numbers have been verified. Larry Wise (ENTRIX) said they are ready to do the QC work, and then will run through the various tests for information available. Larry said they will come back to the August CAWG meeting with the tests where there are sufficient numbers of observations.

Ed Bianchi asked about the latest time they can continue to make observations this year. Larry said until October. The CAWG will need to decide soon whether to do site-specific models or to use existing data. Ed said that they need to put together a schedule for collecting the data and bring back to the group with the decision whether to go site specific.

Action Item #7: ENTRIX will develop a schedule for making a decision on whether existing habitat suitability criteria (HSC) for fish, to be used in PHABSIM, can be verified and used or whether they will need to be adjusted or site specific HSC will need to be developed. Schedule will be incorporated into field work schedule to be distributed to the CAWG by July 23.

Schedule
CAWG is behind on approving study reports. Bill proposed having multiple CAWG meetings next month. The CAWG will meet on August 19, 20, 21. No Plenary in August.

The USFS said the hydrology information will affect every study we have right now. Ed recognized that and said that SCE and ENTRIX are working on a solution to get the information to the group as soon as possible. The USFS that they are concerned that if the hydrology data comes out and makes the group have to revisit the DTSRs.

Action Item #8: Per the USFS's request, SCE and ENTRIX will get the Hydrology Information out to the group, soon.

<u>Meeting Adjourned</u>

<u>Summary of Action Items</u>
Action Item #1: Timeline for outstanding study elements in the DTSRs will be developed on a group by group basis. ENTRIX will provide an initial draft of the timeline, then discussed in the groups. The CAWG will need to make decisions before the outstanding study elements timeline can be fully developed. Two weeks from today.
Action Item #2: Bryan to send the South Fork San Joaquin Single Flow Study ramping down rate PowerPoint slide to the CAWG.
Action Item #3: Wayne Allen will notify members of the CAWG when he receives fieldwork notifications. Kearns & West and Wayne Allen will coordinate on the CAWG distribution list. CAWG members interested in attending fieldwork can contact Wayne Allen to coordinate logistics.
Action Item #4: Martin to send the preliminary results of In-situ gas saturation at mammoth pool during a spill event.
Action Item #5: ENTRIX will make the edits necessary and Kearns & West will redistribute the CAWG-4 to the group. The group will review and then approve at future meeting.
Action Item #6: Wayne Lifton will check the condition factors reported in the CAWG-7 DTSR to confirm that

hatchery trout were not included with wild rainbow trout.
Action Item #7: ENTRIX will develop a schedule for making a decision on whether existing habitat suitability criteria (HSC) for fish, to be used in PHABSIM, can be verified and used or whether they will need to be adjusted or site specific HSC will need to be developed. Schedule will be incorporated into field work schedule to be distributed to the CAWG by July 23.
Action Item #8: Per the USFS's request, ENTRIX will get the Hydrology Information out to the group, soon.

Big Creek Collaborative
Combined Aquatics Working Group

August 19, 2003

Final Meeting Notes

Time:	10:00 AM to 4:00 PM	**Moderator:**	Wayne Lifton
Location:	CDFG Office Fresno, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Britt Fecko	SWRCB
	Geoff Rabone	SCE
	Wayne Allen	SCE
	Wayne Lifton	ENTRIX
	Ed Bianchi	ENTRIX
	Phil Strand	USFS
	Rick Hopson	USFS
	Wayne Thompson	Federation of Fly Fishers
	Julie Tupper	USFS-RHAT
	Cindy Whelan	USFS
	Larry Wise	ENTRIX
	Julie Means	CDFG
Phone Participants:	Mitchel Katzel	ENTRIX

Introductions
Stakeholders introduced themselves and the organization they represent. Bill Pistor (Facilitator, Kearns & West) proposed approving the REVISED meeting agenda distributed to the group last week. The group agreed to the revised agenda.

The CAWG reviewed the June 12 and July 9 CAWG meeting summaries. The group changed the July 9 summary to include the SWRCB's support of the USFS's request for hydrology information.

Agreement: The June 12 and July 9 meeting summaries were approved with that edit.

Review previous meeting action items (Incomplete Actions Listed Below):
- **Action Item**: Timeline for outstanding study elements to be developed by ENTRIX and distributed to the CAWG.
- Fieldwork participation email notifications will no longer be an outstanding action item as it is ongoing.
- **Action Item**: Per the USFS's request, ENTIRX will get the Hydrology information to the group soon.

Ed Bianchi (ENTRIX) explained that there has been a change in how the hydrology information is being developed for the group. Since Wayne Allen (SCE) has been dealing with the fieldwork, he has had little time to complete the compilation of the information. ENTRIX has taken over the responsibility for compiling the information and will be presenting a strategy for dealing with the unimpaired hydrology information to the Hydrology subgroup at the next subgroup meeting.

The group discussed the period of record for the data. The SWRCB and CDFG agreed that 25 years is a sufficient period of record, but more would be useful.

The SWRCB stated that the raw hydrology data may be helpful. Geoff Rabone (SCE) stated that providing the raw data would take manpower away from compiling the information from the hydrology subgroup. Wayne Allen (SCE) stated that the raw information can be accessed from the USGS website. The CDFG stated that they would be willing to supply the SWRCB with copies of the historical data that they posses.

Action Item: Julie Means (CDFG) to provide hardcopies of the historical hydrology data to Britt Fecko (SWRCB).

Several stakeholders expressed that the hydrology information is needed to understand the context of the other CWAG study results.

The CDFG requested a Hydrology subgroup meetings for an update on the information by held before the October CAWG meeting.

Action Item #2: Hydrology Subgroup meeting scheduled for 10AM on September 30 at the CDFG Office.

CAWG-1: Habitat Overview of Comments and revisions

Wayne Lifton (ENTRIX) explained that ENTRIX sent the CD to the CAWG with the revised versions of CAWG-1 and CAWG-4 along with a table detailing the revisions made based on stakeholder comments. Wayne L. reviewed the CAWG-1: Habitat DTSR and stakeholder comments with the group.

Action Item #3: Wayne Lifton (ENTRIX) will remind the Sacramento office that Britt needs to be called for document distributions, so she can pick up from the ENTRIX office.
Action Item #4: Julie Means (CDFG) will send an email with her interim contact information during the CDFG move to Carla Anthony (SCE) and Bryan Harland (Kearns & West).
Action Item #5: Any member of the CAWG should contact either Bryan Harland (Kearns & West), Carla Anthony (SCE), or Martin Ostendorf (ENTRIX) with their new information. Those three will coordinate information.

The SWRCB asked how the group will reconcile the lack of information on SCE's Large Woody Debris (LWD) management and inventory, specifically the small tributaries. The USFS reviewed the CAWG-2 Study Objectives and explained that they are trying to find out what impact the project has had on LWD. Wayne L asked if the group can defer this to CAWG-2 and consider the CAWG-1 part of LWD being complete. The group agreed and the information would be provided in the CAWG-2 2003 Study Report.

Action Item #6: ENTRIX will specify a date for a PHABSIM Dam 5 to Powerhouse 8 fieldtrip and distribute to the CAWG. Martin Ostendorf (ENTRIX) will call Britt once the trip is scheduled.

The USFS asked if the group will find out how much gravel movement occurred during this summer's spill event. Mitchell Katzel (ENTRIX) said ENTRIX will be providing that information to the group at a future meeting.

Bill asked the group if they can approve CAWG-1. The USFS said that the QC in the Dam 5 to Powerhouse 8 needs to be resolved. Wayne L. suggested approving the report as is and the QC then be included as an outstanding study element, which will be provided in the 2003 report. The USFS agreed.

The USFS asked what the status of the reservoirs bathymetric surveys that are noted in CAWG-1 as an outstanding element. These also are identified in CAWG-2. It was explained that some work was done, but the work was to be completed under CAWG 2.The CDFG stated that they had fisheries people look at the report and they did not have any edits.

Agreement: CAWG-1 DTSR was approved.

Action Item #7: Bryan Harland (Kearns & West) will remove Holly Eddinger from all Big Creek Relicensing mailing lists. She is no longer involved with the relicensing.

CAWG-2: Geomorphology, Review Stakeholder Comments

Mitchell reviewed the remaining stakeholder comments to the CAWG-2 DTSR, which was not completely reviewed at the April CAWG meeting. He suggested that he and the SWRCB and USFS stakeholders hold a meeting regarding their request for the information on the total length of unregulated and regulated streams and watershed area.

Action Item #8: Mitchell Katzel (ENTRIX), Rick Hopson (USFS) and Britt Fecko (SWRCB) will hold a conference call on the request for information on stream reaches. Will report back to the CAWG on the results. Bryan Harland (Kearns & West) will help coordinate the call.

Discussion of incomplete GIS portions of work. Wayne L asked if the GIS item can be included in the 2003 report and moved to the outstanding study elements section. The group agreed.

The USFS explained their reference to the Grant research paper. He explained that it proposes a new methodology for examining sediment transport. Mitchell said that he reviewed the paper and the methodology relies on having real sediment load data and we cannot use it here since no such data exists for the ALP streams. The USFS said that he doesn't think you need that data, but only hydrology data. The USFS requested that the group to take a look at this data using the Grant as a concept.

The SWRCB said the Grant methodology would be helpful for dealing with the sediment budget component of the CAWG-2 study. Mitchell said when he read the paper it seemed to him that you need the sediment info, but he will go back and look. Another stakeholder said that she thinks what Grant is proposing is an approach at looking at how you have tributary contributions. This would be considered for 2003 report.

Action Item #9: Geomorphology Subgroup will discuss the Grant research paper and it's relation to the CAWG-2 study.

Mitchell then reviewed the rest of the stakeholder comments and stated that he will take the comments and draft a revised CAWG-2 DTSR, which will be distributed to the CAWG.

Agreement: The group approved the study report, if the changes are made as requested in the stakeholder comments.

CAWG-3 Instream Flow, Review Stakeholder Comments and Responses

Larry Wise (ENTRIX) reviewed a table detailing comments received on CAWG 3 and the responses to those comments. The group discussed and agreed on proposed changes which Larry will make to the CAWG-3 DTSR and then redistribute to the group. .

The USFS stated that if they have an issue with the HSC, they will contact Larry within a week. If not, they approve the report.

Agreement: The group approved CAWG-3 with those changes. Kearns & West will contact stakeholder to obtain approval offline

HSC Verification Update

Larry gave a presentation on the HSC Verification Update. See PowerPoint presentation for further details on the approach and fieldwork update.

The SWRCB asked if snorkeling will bias the results. Larry answered that the technique is to look as far forward as they swim up and observe the fish. If you come up on a fish and they dart under a rock that doesn't count as an observation. The visibility is very good in the project area too. Habitat is assessed whether or not there are fish. The SWRCB asked if sampling at base flows will bias the results. Larry said it would if not taken into account, to do this they are looking at different reaches at different flows. When they are at ungaged reaches, they make a note of the flow.

Larry said that the next step is to look at the relationships of the microhabitat variables for independence or correlation and which the test is appropriate. Ed asked if with additional work will there be something to present to the group for the fish to pass the test. He pointed out that the information needs to come to the group soon for a decision.

Action Item #10: Larry Wise (ENTRIX) to send Bryan the HSC PowerPoint presentation, Bryan to send to the CAWG.

Ed asked what will happen if they are unable to collect enough observations. The group will have to decide on how to handle. Possibly use different criteria or adjust the criteria to account for actual habitat use.

The USFS asked Larry if they have avoided looking for hardheads in deep pools due to trying to sample equal areas. Larry said yes, but they are going to change that and go looking.

Larry will summarize the HSC results and bring the approach to be used based on testing to the CAWG for approval. If HSC pass test, they will be used, if not Larry will propose what should be done.

CAWG-5: Water Temperature, Overview

Wayne L reviewed the PowerPoint presentation on the CAWG-5: Temperature Monitoring DTSR. See CAWG-5 DTSR for details.

The SWRCB stated that they are the ultimate decision maker for the criteria for beneficial uses. The stakeholder representative can provide advice to the CAWG on what the SWRCB will decide. They can provide suggestions and references. When the SWRCB looks at temperature, they only look at peer reviewed, published references. Ed asked if the SWRCB can bring references information on how they've dealt with temperature criteria in other relicensings for the group to discuss.

Action Item #11: Britt Fecko (SWRCB) will provide examples of SWRCB criteria for water temperature from other relicensings to Bryan Harland (Kearns & West), who will distribute to the CAWG.

The SWRCB asked if 24°C is considered the LD 50. Larry said no. They asked where the hardhead reference of 28°C came from. Larry said it's in Peter Moyle's new textbook.

A stakeholder asked if ENTRIX has information on the sampling sites from the 2000 field season, which occurred before the study plan was approved. Wayne L said they are in there and where the data collection differed from the final study plan, it is noted.

Another stakeholder asked how Wayne interpreted the 5°F increase. Wayne answered that they looked at the difference in temperature. If the difference in temperature was greater than 5°F, then they flag it. In the summary, the report notes if the increase occurs, when the flow was being diverted

The SWRCB asked if they looked at temps above the diversion. Wayne said that they didn't take the temperature above the diversion at all sites, primarily at the diversion. Most diversions being very small.

CAWG-10 Macroinvertebrates Overview

Wayne went over the CAWG-10 DTSR. Please see the CAWG-10 DTSR for further details.

The USFS stated that Midden areas have been used to determine historic presence of Mollusks.

Action Item #12: Geoff Rabone (SCE) to talk to Tom Taylor (SCE) regarding Cultural Midden sites and the identification of historic Mollusks collection points.

Meeting Adjourned

Review Action Items

Action Item #1: Julie Means (CDFG) to provide hardcopies of the historical hydrology data to Britt Fecko (SWRCB).

Action Item #2: Hydrology Subgroup meeting scheduled for 10AM on September 30 at the CDFG Office.

Action Item #3: Wayne Lifton (ENTRIX) will remind the Sacramento office that Britt needs to be called for document distributions, so she can pick up from the ENTRIX office.

Action Item #4: Julie Means (CDFG) will send an email with her interim contact information during the CDFG move to Carla Anthony (SCE) and Bryan Harland (Kearns & West).

Action Item #5: Any member of the CAWG should contact either Bryan Harland (Kearns & West), Carla Anthony (SCE), or Martin Ostendorf (ENTRIX) with their new information. Those three will coordinate information.

Action Item #6: ENTRIX will specify a date for a PHABSIM Dam 5 to Powerhouse 8 fieldtrip and distribute to the CAWG. Martin Ostendorf (ENTRIX) will call Britt once the trip is scheduled.

Action Item #7: Bryan Harland (Kearns & West) will remove Holly Eddinger from all Big Creek Relicensing mailing lists. She is no longer involved with the relicensing.

Action Item #8: Mitchell Katzel (ENTRIX), Rick Hopson (USFS) and Britt Fecko (SWRCB) will hold a conference call on the request for information on stream reaches. Will report back to the CAWG on the results. Bryan Harland (Kearns & West) will help coordinate the call.

Action Item #9: Geomorphology Subgroup will discuss the Grant research paper and it's relation to the CAWG-2 study.

Action Item #10: Larry Wise (ENTRIX) to send Bryan the HSC PowerPoint presentation, Bryan to send to the CAWG.

Action Item #11: Britt Fecko (SWRCB) will provide examples of SWRCB criteria for water temperature from other relicensings to Bryan Harland (Kearns & West), who will distribute to the CAWG.

Action Item #12: Geoff Rabone (SCE) to talk to Tom Taylor (SCE) regarding Cultural Midden sites and the identification of historic Mollusks collection points.

Big Creek Collaborative
Combined Aquatics Working Group

September 11, 2003

Final Meeting Notes

Time:	3:00 PM to 5:00 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University Fresno, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor (Facilitator)	Kearns & West
	Bryan Harland (Note Taker)	Kearns & West
	Janelle Nolan-Summers	ENTRIX
	Sarah Yarnel	ENTRIX
	Rick Hopson	USFS
	Julie Tupper	USFS
	Britt Fecko	SWRCB
	Phil Strand	USFS
	Wayne Lifton	ENTRIX
	Wayne Allen	SCE
	Geoff Rabone	SCE
	Ed Bianchi	ENTRIX
	Cindy Whelan	USFS
	Ken Voos	ENTRIX
Phone Participants:	Julie Means	CDFG
	Paul Martzen	San Joaquin Paddlers

Introductions

Stakeholders introduced themselves and the organization they represent. Bill Pistor (Facilitator, Kearns & West) reviewed the agenda. The meeting agenda was changed so that the discussion on CAWG-3 will take the place of CAWG-7, which was covered at the September 10 CAWG meeting. Bill also proposed removing the "approval" part of the CAWG-5 to just a discussion. The agenda was approved by the group with these changes.

Agreement: The group agreed to hold a Riparian Subgroup conference call on September 22 at 8AM. The purpose of the call will be to cover the PFC methodology and an update on the preliminary results of the field studies. Janelle Nolan-Summers (ENTRI X) will send out materials for the call within the next week.

CAWG-8 Amphibians and Reptiles

Bill explained where we were in the CAWG-8 report. The group left off with peer review of the queries approach by Amy Lind and Sarah Kupferburg and began drafting language for the outstanding study elements for the CAWG-8 DTSR.

Britt Fecko (SWRCB) explained that Sarah Kupferburg has sent a hardcopy of her comments on the queries to her via regular mail.

Action Item (follow-up): Britt Fecko (SWRCB) will forward comments on the Amphibian and Reptile Queries methodology from Sarah Kupferburg to Bryan Harland (Kearns & West), who will forward to the CAWG.

Action Item (follow-up): Janelle will contact Julie Tupper (USFS) to have Amy Lind review the Amphibian Reptiles queries methodology. The goal will be to have Amy's review by October 17.

The group developed draft language for the CAWG-8 DTSR, the text of which will be included in the revised CAWG-8 DTSR. Bill asked for approval on the language. The SWRCB asked if they can have Jim Canaday's review before approving. Bill asked if the SWRCB would agree to the CAWG approving the language on the condition that Jim Canaday will review and approve offline. The SWRCB agreed and said Jim Canaday will review by September 26.

Agreement: The CAWG approved the CAWG-8 DTSR for distribution to the Plenary and general public with the exception of the SWRCB, who will review during the public and plenary comment period. The group agreed.

Bill said if the SWRCB submitted any approval or comments before the reports go out, it will be incorporated.

CAWG-3

The Group reviewed the CAWG-3 DTSR Revised version and the response to comments table. Geoff proposed adding "during that season" to the end of the last sentence on page nine end of the third paragraph. Geoff also wanted to remove any excess hyphenation. The group agreed.

Update on HSC

Larry Wise (ENTRIX) gave the group an update on the HSC work. He said crews are out of the field and have indicated which data is desirable for testing. Right now, ENTRIX is in the process of getting the last three weeks of observation into the database. They will send out a list of counts for all observations next week.

Action Item #1: Larry Wise (ENTRIX) to send out counts of observations for the HSC to the CAWG.

A stakeholder asked if the data being collected will allow the group to look at other criteria. Larry said that the data being collected will allow the group to evaluate almost any criteria for the species studied. Larry said that the CAWG will be able to do many things with the information being collected. The stakeholder indicated that the CAWG needs to discuss criteria as a group.

The stakeholder asked when the group will be at that point where they can look at criteria. Larry said that they can put together criteria proposed for evaluation and can send them around for people to take a look at. Larry said they can have out in a couple of weeks.

Action Item #2: Larry Wise (ENTRIX) will send a variety of HSC criteria to the CAWG for review by September 26. The group will address at the CAWG meeting on October 8.

Wayne L explained that the study plan set up criteria for initial testing. He said that if the observations don't fit, then the group will look at other criteria for use in development of specific criteria. Larry agreed and said that in instances where things aren't fitting quite right then they should look at other criteria.

The USFS indicated that they would like another step in the process before the group begins the modeling process.

A stakeholder suggested forming a separate subgroup for HSC and asked Larry when the validation of the data collected will be completed. Larry answered that by the beginning of the week following next he will have it completed.

Wayne L asked the USFS if they know of any other curves for trout that are applicable to the upper Big Creek system. The USFS said that the American River might be an example for the group to look at.

Action Item #3: Larry Wise (ENTRIX) will contact R2 and Tom Payne regarding HSC for fish from the upper American River to ascertain availability and appropriateness for potential use at Big Creek.

A stakeholder suggested having a subgroup meeting instead of holding offline meetings between experts. The group will address HSC at the next CAWG meeting.

Updates on Other CAWG Fieldwork

Larry and Wayne L. will be working on a schedule for fieldwork for the next few weeks and Wayne Allen will let people know when and where field crews will be doing work.

A stakeholder asked Larry if Mitchell is planning on doing any geomorph work in the reaches where Larry is working. Ed said that he's pretty sure that they are doing something out there, but not sure. Ed suggested that anyone interested in fieldwork schedules contact Martin Ostendorf (ENTRIX) or Carla Anthony (SCE).

Action Item #4: Mitchell Katzel (ENTRIX) and Janelle Nolan-Summers (ENTRIX) will send a Riparian and Geomorphology fieldwork update and schedule to the CAWG.

A stakeholder asked what flow levels will be sent down Stevenson creek. Wayne Allen said that they will be sending 80 and 30 CFS. Mono: 50, 25 and 7 CFS.

Action Item #5: Larry Wise (ENTRIX) will send an email with the schedule for remaining instream flow work to Bryan Harland (Kearns & West), who will forward to the CAWG.

CAWG-5 Water Temperature Modeling (PowerPoint Presentation)

Ken Voos (ENTRIX) gave a presentation on the CAWG-5 water temperature model. The report is a review of the existing temperature models that might be applicable to Big Creek Relicensing. For the details of the presentation, please see the PDF, which will be distributed to the CAWG.

Action Item #6: Wayne Lifton (ENTRIX) will send a PDF version of the September 11, 2003 CAWG-5 presentations to Bryan Harland (Kearns & West), who will forward to the CAWG.

Models selected for review:
SNTEMP (USGS)
Hear Source (Oregon DEQ)
CE-QUAL-R2 (USACE)
CE-QUAL_RIV1 (USACE)
RMA-11 (Resource Management Associates)
QUAL-2e (USEPA)

A stakeholder asked if you can reduce instability of models by reduce the size of the reach? Can you use the two dimensional model for a piece of the project area. Ken said yes and if we use a simple model and find areas that we want to focus on, then the group can use a more complex model.

Wayne L. said that can be done depending upon the level of detail. If you haven't collected data at the level of detail you want to model, it's hard to retrofit information and that additional information collection would be very time-consuming (could result in need for another year of data at a different scale). He said that the model would also need to include appropriate hydraulic data at an appropriate scale. Geoff said that there may be other ways to get at the more complex information.

A stakeholder asked if you would know if you are getting unstable, unreliable results from a dynamic model. Ken said no, you will not be able to tell in most cases except in the cases when the results are so far off that they are noticed by the person running the model.

A stakeholder asked if the results from the dynamic models will be more accurate representation of what's going on. Ken said no.

A stakeholder said that it may be interesting to look at the rate at which the heating occurs during the day, which is what the dynamic models do. Ken said both models can do that. She asked if dynamic models will give more detailed information on the fluctuations throughout the day. Ken said that is true.

A question was asked about whether conditions could be simulated that were not observed in the field. Wayne L explained that the models selected are physical models that simulate physical factors that correspond to real conditions and can be used to extrapolate. Ken said that the models will predict what is going to change. A regression model shouldn't be extrapolated. A regression model will not be representative, if some factor is not accountable for.

A stakeholder asked who at Oregon State University worked on the Heat Source model. Ken said he didn't know. The stakeholder said that the problem is that it's new and we don't know how reliable it is. Ken agreed and said that there's a website set up by the author. Ken said a model needs to be used numerous times to know the bugs.

The SWRCB said one of their concerns about SNTEMP is that it simulates maximum temperatures and that one of her major objectives is maximum temps. Ken said that he has used the SNTEMP many times and that there have been some issues with past versions of the maximum temperature models, which can be .75 to 1 degree off. The latest version Ken is using provides a better calibration. He said maximum temperature prediction largely depend on the mean daily temperatures.

Wayne said you can have problems with both dynamic and steady-state models and that modeling is a simplification of reality and not reality. Sometimes things happening in the real world are different from the model. Sometimes dynamic models can go off on you in reaching a solution and can have major problems with calibration and prediction.

A stakeholder said that during those times when the temperature is critical (low flow) would that increase the variation around the mean? Ken said that nice thing about the stable model is you can get a great simulation of the mean daily temperatures. If something's wrong, it can be easily identified. After calibration, you can find the differences. In the end, when you know where the error occurs with your results. You can get very confident with the mean dailies at any flow and then add the maximums on to that.

The stakeholder said that you're only using meteorological information to get the maximums and not the stream conditions. You're going to have differing levels of confidence depending on different conditions of the stream. Ken said that one way to account for that is that in calibrating. Ed said that you come up with calibration statistics that can give you level of confidence. So depending on the flow level, you can know how confident you are. Wayne said that all these models are especially affected by how you structure the model. This has a major effect on results.

Recommendation: Ken suggested that the CAWG use the SNTEMP model for most of the data, using Heat Source and CE-QUAL-W2 to supplement the information, if necessary. The group will discuss the recommendation at the October CAWG meeting.

A stakeholder asked how the group would decide on using certain models. Ken said that the group would have to look at the data at a later date and decide for the a specific use.

The SWRCB commented that there is a process that the SWRCB goes through for determining if streams are in compliance with beneficial uses criteria. She said they will be looking at both Maximum and Mean daily temperatures for deciding what model to use.

Julie Means (CDFG), who was on the phone, asked for a hardcopy of the presentations.

Action Item #7: Bryan Harland (Kearns & West) will drop off a hardcopy of the CAWG-5 Model report at the CDFG office for Julie Means (CDFG).

<u>Selection of Bypass Reaches for Stream Temperature Modeling (PowerPoint Presentation)</u>
Wayne gave a presentation to the group on the bypass reaches to be modeled as a part of the CAWG-5 study. He gave the reasons for Temperature Modeling.

The SWRCB said that there is a problem with the CAWG-5 report. Generally, the SWRCB measures the above diversion and below diversion. We would be comparing the tributaries to the reservoir to the bottom of the reach. Wayne said he can provide the information the SWRCB wants in the report, but the reach selection will most likely remain the same. The SWRCB agreed. Wayne said that he doesn't think that different comparisons would change things in terms of reach selection based on water temperatures. Release of cold water from Project lakes came up. That piece of the modeling picture isn't really necessary for this relicensing because the outlets for the large lakes are located near the bottom in stratified lakes, and release flows from those outlets provide cold water during the summer.

Wayne L. continued the presentation and reviewed the approach to reach selection.

Stakeholders asked for the information on the days the diversions were in operation to be included in the report. Wayne agreed.

The SWRCB explained their criteria for water temperature and said that if you have a situation where you have fish and are dealing with 19°C, the maximum warming cannot go beyond 2.78°C. If you have a water temperature upstream that is at the maximum, then downstream you cannot exceed it. Britt explained that the 2.78°C is the assumed natural warming. Wayne said that he had understood that the 2.78°C was for the warming of the project on top of the natural warming. The SWRCB explained that unless a reference reach is available you cannot go beyond the 2.78°C in total warming. Wayne L. said that was one of the purposes for which you might use a model.

The SWRCB stated that they asked for thermographs on unimpaired reaches for this reason. Geoff said they did not ask for that information. Wayne said the group discussed placement during the development of the study plan. If you're modeling a reach and it has 5°F degrees of warming, then you can determine the difference of with the project and without the project. Using the models we can determine how much is of the warming is due to the diversion and how much is not. Wayne said that they discussed using the model to parse out the project effects.

Bill suggested moving on from this topic since it is essentially a project affects analysis discussion. The group agreed.

Wayne continued on with the presentation. A stakeholder asked if the 24°C temperature was decided by the CAWG. Wayne said it was in the literature. Another stakeholder said he doesn't remember the CAWG agreeing on 24°C, but just using it as a conservative estimate. Ed explained that stakeholders can submit comments on the threshold in the DTSR.

Wayne explained that the CAWG will have to agree on a threshold, but in the meantime, we are using conservative numbers to identify reaches to model. He went on to explain that the 19°C number came from Trout Unlimited and the SWRCB, adding that CDFG had stated that they were considering using 19°C for the statewide criteria. The 24°C number came from extremely conservative criteria in the literature. A stakeholder asked if the literature is cited in the report. Wayne said some of it is , but there is a great deal of literature on the subject.

Wayne reviewed the table with the number of days the reach went over 19°C. Then gave numbers of days monitored versus the temps.

Ross Creek was a problem because it went dry and there is a non-project diversion for the apple orchard upstream.

Wayne gave the considerations for warming. When diversion is turned out, warming is natural.
A stakeholder asked if Wayne believes that the structure of the diversion doesn't cause warming. Wayne said basically yes. The stakeholder said we should examine that to determine if that's true. The group agreed.

Wayne recommended not modeling the reaches that exceed the 5°F warming, but do not exceed the mean daily or maximum daily temperature criteria. The SWRCB asked about a other reasons for modeling the reaches. Wayne said the Board will have to decide what their needs are.

Action Item #8: Britt Fecko (SWRCB) will check on the diversion allotment for the upstream non-SCE diverter on Ross Creek and report back to the CAWG.

<u>Next steps and timing:</u>
The CAWG needs to determine which reaches to model. ENTRIX will touch base with CAWG members try to approve stream reach proposal and modeling proposal on September 22, 3:30 conference call. At the next CAWG meeting the group will talk about which things to simulate.

<u>Summary of Action Items</u>
Action Item #1: Larry Wise (ENTRIX) to send out counts of observations for the HSC to the CAWG.
Action Item #2: Larry Wise (ENTRIX) will send a variety of HSC criteria to the CAWG for review by September 26. The group will address at the CAWG meeting on October 8.
Action Item #3: Larry Wise (ENTRIX) will contact R2 and Tom Payne regarding HSC for fish from the upper American River to ascertain availability and appropriateness for potential use at Big Creek.
Action Item #4: Mitchell Katzel (ENTRIX) and Janelle Nolan-Summers (ENTRIX) will send a Riparian and Geomorphology fieldwork update and schedule to the CAWG.
Action Item #5: Larry Wise (ENTRIX) will send an email with the schedule for remaining instream flow work to Bryan Harland (Kearns & West), who will forward to the CAWG.
Action Item #6: Wayne Lifton (ENTRIX) will send a PDF version of the September 11, 2003 CAWG-5 presentations to Bryan Harland (Kearns & West), who will forward to the CAWG.
Action Item #7: Bryan Harland (Kearns & West) will drop off a hardcopy of the CAWG-5 Model report at the CDFG office for Julie Means (CDFG).
Action Item #8: Britt Fecko (SWRCB) will check on the diversion allotment for the upstream non-SCE diverter on Ross Creek and report back to the CAWG.

Big Creek Collaborative

Combined Aquatics Working Group

October 8, 2003

Final Meeting Notes

Time:	9:00 AM to 5:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Clovis Office	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group - Geomorphology/Hydrology Subgroups		

Attended By:	Phil Strand	USFS
	Bill Pistor	Kearns & West
	Bryan Harland	Kearns & West
	Wayne Lifton	ENTRIX
	Wayne Allen	SCE
	Roger Robb	Friant Water Users Authority
	Phil Strand	USFS
	Larry Wise	ENTRIX
	Julie Means	CDFG
	Geoff Rabone	SCE
Phone Participants:	Britt Fecko	SWRCB
	Ken Voos	ENTRIX
	Paul Devries	R2 – USFS
	Dudley Reiser	R2 – USFS

Introductions and Agenda

Bill Pistor (Kearns & West) began the meeting by having stakeholders introduce themselves and the organizations they represent. He then reviewed the day's agenda. Wayne Lifton (ENTRIX) suggested adding the approval of the pebble count methodology, the group approved the revised agenda.

Review Action Items

Outstanding action items listed below:

Action Item: Britt Fecko (SWRCB) will provide Wayne Lifton (ENTRIX) with the list of literature cited in the CAWG-7 DTSR she would like copies of. There was no commitment to provide the references, however. ENTRIX will check with SCE for direction.
Action Item: Larry Wise (ENTRIX) will send an e-mail with the scheduled flows for the PHABSIM work to Bryan Harland (Kearns & West), who will forward to the CAWG.

A stakeholder asked if there will be a schedule of fieldwork activities sent to the CAWG. Mitchell Katzel (ENTRIX) said that they are finishing up next week.

Action Item #1: Mitchell Katzel (ENTRIX) will send a fieldwork schedule for geomorphology to Bryan Harland (Kearns & West), who will forward to the CAWG.

Approve Meeting Summaries

The SWRCB submitted comments on the September 11 CAWG meeting. Geoff (SCE) said that he thinks the SWRCB edits should be added to this meeting summary and not to those of Sept 11th. Bill proposed adding a footnote to the Sept 11 notes and adding the clarification language to this meeting summary. Bill suggested putting into the meeting note "The SWRCB gave a demonstration on temperature parameters at the meeting; a follow up e-mail was submitted at a later date, which is presented in the October meeting notes." Then, the full text of the e-mail will be presented in these notes. The group agreed.

Action Item #2: Britt Fecko will send the SWRCB water temperature criteria e-mail to Bryan Harland (Kearns & West), who will forward to the CAWG and attach to the September 11 CAWG meeting summary.

With that edit, the meeting summaries were approved.

Geomorphology Methodology

Bill reviewed the revised methodology for pebble counts for the CAWG and asked for the CAWG's approval.

Agreement: The revised pebble count methodology was approved.

Instream Flow

Discussion of Habitat Suitability Criteria

Larry Wise (ENTRIX) gave a presentation on the results of the HSC testing analysis. He reviewed management goals and objectives from the CAWG-3 Study Plan as well as the general and specific approaches. He then gave a PowerPoint presentation on HSC (for further details, please see the attached presentation).

Larry reviewed the Groshens and Orth method, which provides a statistical evaluation of whether a set of HSC is appropriate for use on a given stream. This approach compares the frequency of utilization of depth and velocity with the availability of these parameters within the stream. The values of depth and velocity are divided into "suitable" vs. "unsuitable" and "optimal" vs. "marginal" categories based upon the criteria being tested and threshold suitability values (in this case 0.5 and 0.1). He provided an example showing a curve with lines depicting the threshold values that divide suitable from unsuitable, and optimal from marginal. In CAWG 3 the threshold values were defined as 0.1 and 0.5. The Groshens and Orth test compares the utilization and availability within these categories in two one-tailed chi-square tests; one for suitable vs. unsuitable and one for optimal vs. marginal. The null hypothesis being tested is that both categories are being used to the same extent based on their relative availability within each test. The alternate hypothesis is that suitable habitat is used more than unsuitable habitat and optimal habitat is used more than marginal habitat. Both null hypotheses must be rejected for the criteria to pass for a given parameter.

The values of depth available may influence the way in which a fish selects velocities and vice versa. Where depth and velocity are not being selected independently, a simultaneous test of both parameters is indicated. This is termed a "joint" test. Larry discussed testing for such interactions and considering a criteria set to pass where there is an interaction and the joint test passes. When there is no interaction, then depth and velocity may be considered to be independent and would both need to pass for a criteria set to be accepted for use..

Larry reviewed, basin by basin, the observations for each fish species. Larry sent out the curves for each fish species before this meeting, and indicated that some have already passed. For those that didn't pass, he sought recommendations from the CAWG as to how to move forward.

A stakeholder asked if Larry can provide a curve depicting the ratio of use to availability from the verification data. Larry replied that in most cases there are not enough observations to develop a reliable relationship in this manner. Such a curve would be badly skewed if there was a low number of utilization observations available. Additionally, this is beyond the scope of what was agreed to in CAWG-3. Wayne L. said that ENTRIX would need to ask SCE if they should do the extra work of attempting to prepare such curves. Geoff added that the altered flows are preference curves and included in their development were observations collected on streams within the Big Creek system, as well as from adjacent watersheds (i.e., Willow Creek).

Action Item #3: Britt Fecko (SWRCB) to contact Larry Wise (ENTRIX) regarding her request for additional curves. They will report back to the group with any further related actions.

Larry showed examples of HSC that didn't pass and some overlays of different criteria curves. Paul Devries questioned the narrow peaks of the curves and said that he thought that the AF Preference velocity curve needed to be shifted to the right and that a preferred velocity of zero did not reflect trout's use of feeding lanes.

Wayne L. stated that the velocity criteria reflected the actual mean column velocities being used by the fish. Therefore, adjusting criteria that reflect actual habitat use is not appropriate.
For the Juvenile rainbow trout, Larry suggested using the S&A criteria. He asked the group for approval and/or opinions on a future conference call.

The group discussed the study methodology and the use of Altered Flows criteria. Larry said that the study plan called for the testing of Altered Flows Preference Criteria for trout and the Pit River Criteria for non-trout species. If these passed, then they would be used. If they didn't pass, then other criteria would be sought and tested, such as the Smith and Aceituno Criteria for trout. The USFS representative said he looked at the study plan and it does specify what Larry said. He has concerns regarding the criteria, but wishes he looked at the criteria when the study plan was approved. Dudley asked if there will not be a chance to go back. This issue will be addressed at a future HSC meeting.

Some stakeholders said they wanted the opportunity to look at the other curves.

A stakeholder said that he's not sure that the Altered Flows (AF) curves will be applicable if they don't reflect feeding lanes. He said that S&A provide criteria for areas where cover is available and a second set where cover is absent. Larry used the S&A criteria with-cover for this study, as cover is abundant in the Big Creek system.

Wayne L said he has problems using criteria that incorporate velocities for feeding, as trout are not necessary drift feeding only. Larry looked into the feeding lane issue as far as criteria sets. Larry said there is only one criterion he knows of which was developed by the Fish and Wildlife service of Colorado. The feeding lane criteria are separate from the normal velocity HSC and represent the use of a modeling option in HABTAE or HABTAV, the PHABSIM habitat models.

A stakeholder suggested that there needs to be some time for the group to digest this and then hold a conference call or a meeting to discuss the curves. He thinks that the goal really needs to be getting agreement before moving on because we don't want to revisit this in the future.
The stakeholder asked if Larry would provide a short summary of the background information on the different sets of HSC curves that we are being asked to consider, so that we can make better decisions about their use.

Action Item #4: Larry Wise (ENTRIX) to prepare a memo providing a background on the different HSC criteria and send to Bryan Harland (Kearns & West), who will forward to the CAWG.

Agreement: The group proposed forming a HSC subgroup. The group agreed.

The group discussed adding all the curves to all the plots of the observed data sets, rather than just the AF if it passes.

Action Item #5: Julie Means (CDFG) to provide Gary Smith's rationale for not using the Raleigh HSC criteria to the CAWG.

Action Item #6: 6A-Larry Wise (ENTRIX) will send plots with all HSC curves overlain on utilization histograms out to the CAWG by Tuesday (10/14). The CAWG will review, then hold a meeting on October 27 and 28 (10AM to 4PM each day) in Modesto to discuss further.
6B-Paul Devries (R2) will check into getting the UARP criteria data to Larry by Friday (10/10).

The group discussed potential agenda items for the HSC subgroup meeting.

Potential HSC subgroup agenda items:

- Review Gary Smith's rationale for not preferring the Raleigh curve.
- Discussion of correlation between depth and velocity selection.
- Paul DeVries proposed not spending a lot of time on the YOY, and only focusing on the Adult and Juvenile, since the fry are not typically used in any decision making process in relicensing for trout.
- Cover in relation to the HSC.

Larry showed a table summarizing which habitat suitability criteria had passed the transferability test, and were therefore acceptable for use in the PHABSIM studies, as outlined in the CAWG-3 study plan.

Recommendation on Approach for Bolsillo Creek Habitat Analysis

Larry explained that at a previous meeting, the group decided that the food transport analysis was inconsistent with the observed conditions. The group asked that Larry come up with an alternate approach, which he presented.

Larry explained that in the Vermilion Relicensing, they used flows required to maintain depth suitability in pools. Results were presented as the percentage of stream width with suitable depths as a function of flow.

A stakeholder asked if this was the same approach used in Portal. Larry said no. This is focused on pools, while portal was focused on riffles.

Action Item #7: Larry Wise (ENTRIX) will copy the pool evaluation methodology from the Vermilion report and send to Bryan, who will forward to the CAWG.

Larry said that since people were comfortable with the approach in the Vermilion relicensing he recommends the same approach for Bolsillo Creek. He also proposes using this approach on Rock Creek.

A stakeholder asked why the methodology doesn't work. Larry explained that the answer obtained during the first analysis didn't relate to reality, it was suggesting a flow of 7 cfs when there is only a flow of 10 cfs for a maximum of a couple of days during peak runoff. The new method will give the group a better idea of habitat rather than a flow that doesn't exist in the stream, except for a short period of time.

Agreement: The group agreed to use the Vermilion method on Bolsillo and Rock Creeks.

Temperature Modeling Decision: Approval of Model to be Used

Action Item #8: Bryan Harland (Kearns & West) will send PDF versions of the slide presentations from today's meeting to the CAWG.

Wayne Lifton and Ken Voos (ENTRIX) reviewed the recommended model for temperature to the group. The proposal is to use SNTEMP, using Heat Source or CE-QUAL-W2 to supplement the information, if necessary.

Wayne reviewed the language from CAWG-5 discussing the use of existing models. He also gave the results of BiCEP Model calibration check.

A stakeholder asked what “bias” referred to in the presentation. Wayne explained that the Maximum Error is the biggest deviation at any time of any day. Ken explained “bias” as the average difference between the predicted temperature and actual temperature. The probable error is the 50% confidence interval, which means that 50% of the time, the model predictions will be within the actual temperature (plus/minus) the probable difference.

Wayne gave the status of the model reaches. The fourth model needs some additional work, but the others are ready to go. Wayne asked for approval of the proposed models.

A stakeholder asked what the improved maximum temperature algorithm referred to. Ken explained that the prediction in the original SNTEMP model for the maximum daily temperature was not very accurate downstream from dams. He has modified the code to improve maximum temperature predictions by accounting for upstream conditions. This has proven to be very satisfactory in use.

The stakeholder asked what “looks upstream” means. Ken said that the new version considers dams and tributaries, so it retrieves the actual recorded value from that point downstream and takes the packet downstream under daylight conditions.

A stakeholder asked if there was any chance that the methodology be provided in writing to the CAWG.

Action Item #9: Ken Voos and Wayne Lifton (ENTRIX) will provide a written description of the maximum temperature methodology of the modified SNTEMP to Bryan Harland (Kearns & West), who will forward to the CAWG.

A stakeholder asked if they have any areas in mind right now that they might want to use CE-QUAL-W2. Wayne said no, but they wanted to be clear that if SNTEMP doesn’t work, they will have a backup in mind that may be appropriate.

The USFS said that Julie Tupper felt that there would be a need to compare SNTEMP to other dynamic models in some reaches. Wayne said that the idea is that they will run the SNTEMP to the actual data set, then the group will be able to see whether it can accurately predict actual temperatures. He said that there is a lot of set up work involved in running these models. The USFS requested giving a tentative approval of the SNTEMP, then if Julie T. has a problem, to discuss later.

Action Item #10: Ken Voos, Wayne Lifton (ENTRIX), Geoff Rabone, Wayne Allen (SCE), and Julie Tupper (USFS) to hold a conference call to discuss her issues related to the SNTEMP model. Bryan Harland (Kearns & West) will help to coordinate the call and inform members of the CAWG when it will take place.

Agreement: The group agreed to use SNTEMP, using Heat Source or CE-QUAL-W2 to supplement the information, if necessary with the above caveat.

<u>Follow-up discussion of reaches to be modeled</u>
The group discussed the reaches to be modeled for temperature and developed a proposed methodology, which is listed below:

A stakeholder asked if Mono and Bear creeks could be modeled to see what the effect of additional flow releases would be on the SFSJR.

PROPOSAL: Perform a sensitivity analysis to game out a range of flows for Mono and/or Bear, then if the ability to evaluate the effect on the SFSJR is too close to call, then in the PME phase, the CAWG will decide whether to model. Sensitivity analysis includes looking at the effect of increased flows from the creeks at water temperatures representative of both the diversion (coolest temperature available) and near the confluence with the SFSJR. The results would be the effect on SFSJR temperatures.

Wayne proposed supplying the proposal in writing so stakeholders can review, then revisit at the next CAWG meeting, or a later date.

Action Item #11: Ken Voos and Wayne Lifton (ENTRIX), will write up an approach (phased) for dealing with analyzing the effect of Bear Creek and Mono Creek flow releases on the South Fork San Joaquin River and deciding whether modeling of those creeks is necessary. This will be sent to Bryan Harland (Kearns & West) to send to the CAWG.

The SWRCB said that they don't have a problem with the proposed reaches, just the exclusion of the other reaches. Wayne asked that the group approve the reaches now as a starting point and then revisiting at a later date the other reaches. The group agreed.

Simulation Conditions
Simulation Output will include the predicted water temp based on numerous variables.

Wayne proposed modeling the same flows as considered in PHABSIM modeling for that reach. And average and 20% exceedance meteorology and normal hydrology for summer months: June, July, and August and including September for SJR downstream of Mammoth Pool and Stevenson Reach.

A stakeholder asked what normal hydrology means. As a conservative estimate, can't the group look at a hot and dry year? Wayne Allen (SCE) said that they have two different operations: normal and dry. Wayne said that they can simulate for average and dry. The group agreed. Phil asked if we can include the month of May as well for the lower reaches only (Mammoth, Stevenson and Big Creek).

Simulation from the point of discharge to the end of the reach with the results reported at 0.5-km intervals along the stream was proposed and accepted by the group as the simulation framework. ENTRIX will take the results and put into table of reach, month, meteorology and flow of stream temps by location for daily mean and maximum temp. They will provide figures of temperature along stream longitude for each flow by month and meteorology as well as percent of stream length exceeding certain temperatures.

A stakeholder asked if Wayne can write up the simulation proposal as well. He said that he could provide the presentation slides to her as modified by the group today.

Action Item #12: Wayne Lifton (ENTRIX) will modify the slides on modeling conditions and send to Bryan Harland (Kearns & West), who will send to the CAWG.

CAWG-5 and CAWG-10 Revised DTSRs
The group received the revised editions of CAWG-5 and 10 as well as a table detailing the response to comments. The group decided to discuss and approve the DTSRs at a later date.

Meeting Adjourned

Summary of Action Items
Action Item #1: Mitchell Katzel (ENTRIX) will send a fieldwork schedule for geomorphology to Bryan Harland (Kearns & West), who will forward to the CAWG.
Action Item #2: Britt Fecko will send the SWRCB water temperature criteria e-mail to Bryan Harland (Kearns & West), who will forward to the CAWG and attach to the September 11 CAWG meeting summary.
Action Item #3: Britt Fecko (SWRCB) to contact Larry Wise (ENTRIX) regarding her request for additional curves. They will report back to the group with any further related actions.
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criteria to the CAWG.
Action Item #6: 6A-Larry Wise (ENTRIX) will send plots with all provided HSC curves overlain on utilization histograms out to the CAWG by Tuesday (10/14). The CAWG will review, then hold a meeting on October 27 and 28 (10AM to 4PM each day) in Modesto to discuss further.
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Action Item #12: Wayne Lifton (ENTRIX) will modify the slides on modeling conditions and send to Bryan Harland (Kearns & West), who will send to the CAWG.

Big Creek Collaborative
Combined Aquatics Working Group

December 10, 2003

Meeting Notes

Time:	10:00 AM to 4:30 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor (Facilitator)	Kearns & West
	Bryan Harland (Note Taker)	Kearns & West
	Wayne Lifton	ENTRIX
	Larry Wise	ENTRIX
	Ryan Bricker	Kearns & West
	Jean Baldrige	ENTRIX
	Rick Hopson	USFS
	Julie Means	CDFG
	Roger W. Robb	Friant Water Users Authority
	Dudley Reiser	R2
	Phil Strand	USFS
	Wayne Thompson	Federation of Fly Fisherman
	A. Britt Fecko	SWRCB
	Russ Kanz	SWRCB
	Julie Tupper	USFS – RHAT
	Geoff Rabone	SCE
	Wayne Allen	SCE
Phone Participants:	Brian Caruso	ENTRIX

Introductions and Agenda

Bill Pistor began the meeting by having stakeholders introduce themselves and indicate the organizations they represented. Bill reminded the group that Bryan Harland will be leaving Kearns & West and that all future correspondences should be sent to Ryan Bricker of Kearns & West at rbricker@kearnswest.com. The group reviewed and approved the agenda.

A stakeholder requested that meeting summaries and materials be sent in a timelier manner. Bill explained that with the transition of Bryan to Ryan, there has been some delay, but Kearns & West will make every effort to get materials to stakeholders in a timely manner.

Review Action Items

Outstanding action items from previous meetings are listed below:

Action Item: Mitchell Katzel (ENTRIX) will revise the October 2, 2003 SCI, Rosgen Level II and PFC Memo according to the approved edits from stakeholders and send to Bryan Harland (Kearns & West) to send to the CAWG.

Action Item : Britt Fecko (SWRCB) will send the SWRCB water temperature criteria email to Bryan

Harland (Kearns & West), who will forward it to the CAWG and attach it to the September 11 CAWG meeting summary.

Julie Means (CDFG) asked that all materials be distributed to her on a CD through the mail.

CAWG-6: Hydrology
Brian Caruso (ENTRIX) gave the group a status update on the hydrology study. He told the group that he had gone back over the tables and QC'd for any errors. Those tables were distributed to the CAWG before this meeting. Rick Hopson (USFS) said that he still had errors on his copies.

Action Item #1: Ryan Bricker (Kearns & West) to contact Rick Hopson (USFS) regarding the hydrology tables distributed to the CAWG.

Brian said that they have plotted diversion flow hydrographs and are currently evaluating them for adequacy, accuracy and usability for the group.

Since Camp 61 is not diverted, Brian suggested that Camp 61 flow information can be used to represent the unaltered flow.

A stakeholder asked if ENTRIX will be estimating data for the gaps. Brian answered that he is not sure how that can be done since missing data can mean that there was no water being diverted at the time of measurement. For unaltered flow, he said that synthesis is more appropriate. ENTRIX will use a methodology for synthesizing based on runoff and area, as well as the Forest Service's regression curves.

A stakeholder asked how the fact that information only being available for a few months out of the year will factor into the IHA analysis. Brian said that they can use monthly information to develop the mean annual flow.

Brian said they are in the process of characterizing spill events, where data is available, by plotting hydrographs and estimating summary statistics, including flow percentiles/exceedance probabilities. The information will be presented when the analysis of diversion and other data is complete.

Brian asked the group what people were interested in, in terms of spill events. The State Water Board, US Forest Service and San Joaquin Paddlers have all expressed an interest in the information to get an idea of which diverted streams are receiving spills and what the magnitude and frequency of those spills are. Brian stated that ENTRIX is in the process of preparing that information and can address those needs when the information is presented to the group.

Brian said they have the hourly data, but are not sure about the availability of the 15-minute data. Wayne Allen (SCE) said that they have the 15-minute data for the USGS sites operated by SCE going back to the 1990/91 water year. However, SCE does not have the 15-minute data for the water rights stations.

A stakeholder suggested that the USGS might have the information buried in an archive somewhere. Brian said that might be the case and ENTRIX would investigate this (Continuing Action Item).

Brian next addressed Action Item #3 to "define adequate data." He said that the goal right now was to try to summarize the rationale behind the decision making process and that when the group gets the actual diversion data, they can go through station by station to define what constitutes "adequate." Brian then gave a summary of the decision making process, which can be found in the PowerPoint presentation attached to this summary.

Brian said that the Terrestrial Working Group is currently working on the cloud seeding study and will be presenting the findings at a future meeting.

Rick asked if he could get the right tables sent to him and also if high flow data is normal for critically dry years from time to time. Brian answered that the way that the water years are estimated doesn't always reflect what is happening in the sub-basin. In some cases, higher flows are seen in particular locations even though it's a dry year. Wayne L. suggested that the timing of precipitation can affect the information too. Brian agreed and added that sometimes you will see higher peak flows earlier in the snow melt season. As information is interpreted, they will have to look at why higher flows were observed.

The group was told that often times in a dry year, the operator will keep the reservoir high, then a big storm will come along and they will have to spill and that could account for the higher flows.

A stakeholder asked Geoff Rabone (SCE) if SCE was going to make information available electronically. Geoff answered that once Brian finishes, they will readdress the issue.

Wayne L. (ENTRIX) told the group that in a couple of weeks they will see if some of the information will be ready for January. Britt requested holding a hydrology subgroup meeting in late January.

CAWG-3: Instream Flow (HSC Discussion)
Larry Wise (ENTRIX) gave an update on the habitat inventory field trip. He told the group that they tracked through the habitat mapping up to the point where the transects were selected. Their conclusion was that the habitat inventory was done correctly, but found that during the initial PHABSIM transect selection the flagging crew had referenced the wrong units (pool 26 was actually pool 21). A stakeholder said that there were a couple of units that were short units that they were separated out into their own units, but could have been lumped together. These were riffles that were shorter than bankfull widths.

Larry said that they have not done a good job at previous meetings of explaining what the Altered Flows (AF) Project was and where the criteria came from. Jean Baldrige (ENTRIX) was present and gave the group a presentation on the Altered Flows Project and preference criteria. She described the history of the project to the group. In order to ensure that the AF group had proper guidance, a technical advisory committee was established that consisted of experts including well-known scientists, members of the Instream Flow Group, and resource agency technical experts. The committee helped to validate predictions and identify limiting factors. The goal of this project was to look at fish populations' response to altered flow regimes and determine if PHABSIM could be used to predict population changes, when other limiting factors are accounted for. They had the opportunity to look at the influence of different habitat suitability criteria as well as study different methods. Jean went on to describe the contents of the study to the group including fish population sampling in the spring and fall, monitoring flows to understand changes, evaluating food production, fishing pressure, water quality and other factors, and finally manipulating flows to see if a population response could be predicted.

Jean went on to explain the study design, study variables, and the three levels of analysis.

She then discussed the process of making and testing predictions. For each test, they estimated the population under the altered flow conditions. Abundance and biomass were predicted for each year and each site, based on such indices as weighted usable area from PHABSIM models and based on different HSC. For each, they evaluated the accuracy. Dr. Bob Smith set up the statistical analysis.

Next, Jean went over the results with the group. All tests resulted in positive correlation. However, the best statistical relationship was with the WUA resulting from the AFP criteria. Combining rainbow and brown trout criteria to represent niche overlap to predict total trout with PHABSIM gave the best statistical fit.

Geoff asked if the new license was granted for the Tule. Jean said that everything except a higher flow that they proposed for a certain time of year was written into the license.

Dudley asked what the number of years for the study was at the altered flow and the answer was three at the higher flow with one transition year.

A stakeholder asked what they attributed the increase in population to. Jean answered that there was an improvement in water quality and habitat. A different stakeholder asked if there were any changes to the geomorphology that contributed to the improved habitat and asked if there was a bigger flow. The answer was no.

Larry took over the presentation and told the group that the Altered Flows criteria were developed using some observations from the Big Creek system. He told the group that they had input from the technical advisory committee throughout the development of the Altered Flows project. They also held a workshop that was hosted by the IFG in 1995 and what came out of that was the desire to develop generic transferable criteria that could be used for PHABSIM studies in many streams. He went on to describe the stratification of the sampling effort. Samples were done in the NFMF Tule, SFMF Tule, Big Creek, North Fork Stevenson, Stevenson, and SF Willow Creek. The samples were taken between July and October with temperatures in excess of 12 degrees Celsius. For curve development they used numerous observations collected over a range of geomorphic and hydraulic stream conditions. They evaluated transferability testing techniques such as Goshen's and Orth and Thomas and Bovee and found that the Groshens and Orth method worked better.

A stakeholder asked if they used the Thomas and Bovee approach. The answer was yes, it was tested extensively. They used one vertical, two verticals and all combos to represent utilization and availability, but it didn't help. They found that Thomas and Bovee did not do a good job of predicting the microhabitat at the location of the fish. The variability of the bottom of the stream means that if you are not measuring the velocity at the location of the fish, you are measuring something different than what the fish is selecting for.

Larry explained that at different thresholds they found that Altered Flows transferred, using Groshens and Orth. He added that the results of the curves were approved by the panel of experts. The curves were robust when using different densities and were applicable to different streams. The Altered Flows did and excellent job.

Next, Dudley Reiser (R2) gave a presentation on the UARP (Upper American River Project) relicensing. He told the group that the UARP is on a parallel path to Big Creek. The UARP might be a little ahead. They have approved the rainbow curves, but the verdict on hardheads is still "out." He told the group that the process used in the development of the UARP curves is not unlike what is going on here. Their data sets came from Tom Payne from observations collected on the American River. He told the group that he collected a lot of site specific data with the intention of developing transferable curves for other sites. He also told the group that a lot of data was collected. When they went through all of the transferability analyses, it turned out that some of the curves that had passed did not match the observations. Because of this, it was recommended that site specific criteria be used. The biggest issue had to do with the curve fitting program used that resulted in single peaks.

The group was told that Mark Allen helped guide everyone through the curve development and transferability process for the UARP. When they first presented the curve sets, Dudley and the USFS were skeptical because the polynomial set had one peak. He told the group that fish do not respond in a single peak, but are more opportunistic.

The UARP group ended up approving sets for the large, medium, and small channel types. The collective thinking was that fish are not that sensitive and curve maxima need to be spread out. The largest changes made were associated with the tops of the curves and, in the end, none of the agreed to curves were exactly like what Mark Allen presented or what the data revealed.

The UARP did not have an abundance of data for brown trout, so they ended up pulling some information from the literature and published information. Jean asked how the group came up with medium streams and the answer was that they extrapolated between small and large streams. Dudley told the group that he was not a proponent of the large, medium, and small curves. When Dudley was originally working with Bob and

Dennis, they brought forward the notion of regionalization of curve sets. He suspects that everyone here would like to head in that same direction.

Russ told the group that they just went through a similar process in the Stanislaus relicensing. He told the group that as he sees it, he thinks a fish is a fish is a fish. He also told the group that there is a full write up on the Stanislaus relicensing website (www.stanrelicensing.com). Dudley told the group that the Stanislaus information was used on the UARP. Russ asked if the data was from the North Fork, because that data was older. Dudley said that he would check on that.

Action Item #2: Wayne Lifton (ENTRIX) to obtain Stanislaus HSC curves for comparison.

Jean told the group that the issue with drawing curves is that they are arbitrary and that the group needs to be able to use an objective test for determining what curves to use. Russ said that it might take too much time and money and thought that the group needed to discuss many different variables.

Geoff asked if they came up with multiple curves or just one for the Stanislaus relicensing. Russ said that they came up with two because the licensee and the agencies couldn't agree.

Geoff asked if the group could review the curves again and Dudley told the group that one of the things to think about was when to limit depth. Dudley added that he did not think that adult rainbow trout were really not going to use streams that are 7 feet deep if given the opportunity. With that in mind, the group might not want to limit the depth. Geoff asked how, philosophically, did they decide on the broadness of the curve and then extrapolate to the other streams. Dudley said that it was done by looking at the original polynomial and then just drawing them. They did not use any mathematical equations. He said that it was more about looking at it from a biological perspective and using professional judgment. There was no mathematical extrapolation made. It was a discussion among biologists.

Russ said that drawing your own curves would bias your time series and said that he thought that it would be a mistake. He added that the group should look at time series in the future. Russ also told the group that there were some good real time series spreadsheets used in the Stanislaus that he can not reveal because they are proprietary of Divine Tarbell and Associates.

A stakeholder asked if Peter Moyle was still working on the hardhead curves for the UARP. Dudley answered that, as far as he knows, yes.

Dudley said that for the UARP they were not comfortable with limiting the depth. He told the group that he personally doesn't want to get hung up on the depth curve. He is more concerned with the velocity. Larry agreed that the velocities affect fish behavior more than depth.

Next, Larry gave a presentation on the results of the testing and covered the following topics: determining weighted useable area; HSC selections; transferability studies; decision pathway; and criteria considered.

Next, Larry showed the group the transferability testing results.

Britt asked Larry if they could include the sample size on the slides for future distributions.

Action Item #4: Larry Wise (ENTRIX) to include the sample size (N) of each species on the revised HSC charts.

Larry reviewed the new plots that included the UARP curves. Britt asked if graphs existed where the suitability and the availability were overlapped. Larry answered that they had gotten rid of them.

Russ asked if the flows at the time of observation could be added to the graphs.

Action Item #5: Larry Wise (ENTRIX) to add a reference chart on the flows at the time observations were made.

Action Item #6: ENTRIX to provide cloud seeding study results to the CAWG, when available.

The meeting was adjourned.

Actions from December 10, 2003 Meeting

Action Item #1: Ryan Bricker (Kearns & West) to contact Rick Hopson (USFS) regarding the hydrology tables distributed to the CAWG. Will redistribute correct tables.

Action Item #2: Wayne Lifton (ENTRIX) to obtain Stanislaus HSC curves for comparison.

Action Item #3: Wayne Lifton and Larry Wise (ENTRIX) to incorporate the Altered Flows total trout curves to the current charts.

Action Item #4: Larry Wise (ENTRIX) to include the sample size (N) of each species on the revised HSC charts.

Action Item #5: Larry Wise (ENTRIX) to add a reference chart on the flows at the time observations were made.

Action Item #6: ENTRIX to provide cloud seeding study results to the CAWG, when available.

Big Creek Collaborative
Combined Aquatics Working Group

December 11, 2003

Meeting Notes

Time:	8:00 AM to 3:30 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor (Facilitator)	Kearns & West
	Bryan Harland (Note Taker)	Kearns & West
	Wayne Lifton	ENTRIX
	Larry Wise	ENTRIX
	Ryan Bricker	Kearns & West
	Jean Baldrige	ENTRIX
	Rick Hopson	USFS
	Julie Means	CDFG
	Roger W. Robb	Friant Water Users Authority
	Dudley Reiser	R2
	Phil Strand	USFS
	Wayne Thompson	Federation of Fly Fishermen
	A. Britt Fecko	SWRCB
	Russ Kanz	SWRCB
	Julie Tupper	USFS – RHAT
	Geoff Rabone	SCE
	Wayne Allen	SCE

Introductions and Agenda

Bill initiated the meeting and the group picked up with the overlay curves from the previous day.

A stakeholder asked where all this was leading and how the subgroup's decisions would potentially affect projects operations. Geoff Rabone (SCE) told the group that SCE does have some points that do not have current instream requirements, and the group is trying to determine if existing instream release requirements are appropriate or whether they need to be adjusted. It was said that this was just first step of the process, and the group was being asked to approve curves without knowing what the effects will be on the project. Wayne Lifton (ENTRIX) replied that the group wants to make sure that the HSC is representative of fish use and he said that the power issues are more negotiation-related items. A stakeholder added that the real decision here was to figure out the best science and to apply the best tool.

The group then discussed the use of professional judgment when determining curve shapes. Geoff told the group that in the past, people used a method nicknamed BOGSAR (Bunch Of Guys Standing Around Stream), whereby experts just stood by a stream and "estimated" appropriate flows. Now, they have modeled the biology and PHABSIM process is a more scientifically based process.

A stakeholder told the group that they should not be looking at the criteria and how they affect SCE operations and influence flow. He added that the goal should not be to look at it economically, but, rather to look at it biologically.

A stakeholder asked if they had looked at the 2-D modeling yet and told the group about some tools that Pit River used. He said that it was amazing how close the results were. A different stakeholder added that they did 2-D modeling, 1-D modeling, and habitat mapping for the UARP and said that it was interesting how close they all were.

Geoff told the group that if they expect Larry Wise (ENTRIX) to go back and analyze more curves, they need to identify exactly what they expected him to do. Wayne L. added that all tools must be in place before they do the PHABSIM.

A stakeholder asked if all the data sets had been collected. Wayne L. answered yes and said that there will be a 2003 report coming out soon that will contain all the information. It was added that the hope was to get through the negotiations by the end of 2004. The PDEA will have to be filed by the end of 2005. Bill said that the schedule mentioned would be ideal, but thought that negotiations would probably continue through 2005.

A stakeholder asked if the hydrology information would be out soon. Wayne L. said that the schedule is to have the 2003 reports out in mid-February and Bill added that Brian Caruso (ENTRIX) is hoping to have the hydrology information ready by January 2004.

A stakeholder suggested that if an agreement was not reached on the HSC, the group could still go forward on the calibration issues. Bill asked if the Altered Flows curves and the UARP curves were different enough that they would take a massive effort to resolve the differences between them. Dudley Reiser (R2) thought that the biggest differences had to do with velocity. He also added that he thought that the UARP curves fit the data better. Bill asked Russ Kanz (SWRCB) if he agreed or if he thought that the Stan curves were better. Russ said he agrees with what Dudley was saying, but could not remember the Stan curves. He thought that they were similar to UARP's.

The group then discussed fish velocity preference and Russ told the group that he does not think that fish prefer zero velocity. He referenced a video by Craig Adley of a fish feeding behind a rock, not expending much energy except to go out from behind the rock and grab a bug. Dudley said that it's hard to judge this because the fish is in zero velocity, but the food is coming by with a velocity of the water. He added that the group needed to think about what is really important to the fish. Wayne said that there are other factors to take into account for the PHABSIM modeling. Dudley asked for the display of the curves and told the group that he thinks the observational data fits UARP criteria better.

The group examined the overlaid curves.

Geoff told the group that his worry was that changing curves would make it impossible to keep the science in mind. Britt Fecko (SWRCB) said that when you adjust the curves you do keep the science in mind.

A stakeholder asked if you would get a lot of zero velocity preference data if you're at low velocities to begin with. Larry responded that there are a number of velocities at higher levels. A stakeholder said that fish in a reservoir do like the zero velocity so he has a problem with saying that fish don't prefer zero velocity. Russ replied that reservoir and river fish are different issues.

Wayne told the group that everyone needs to assume that fish are doing both benthic and drift feeding. In some streams and times, benthic feeding may be dominant. Geoff added that fish are complex and no model will adequately capture everything.

Russ told the group that the problem he had with the UARP curves was the top was not broad enough. Wayne L. told the group that the Altered Flows curves were based on observations that have been checked against reality. Russ responded by saying that he had a lot of heartburn around when the Altered Flows observations were made and thought that the Stan curves do the best job. Roger Robb (Friant Water Users Authority) told the group that he thought the altered flows curves fit the raw data. Russ replied that you have to be careful because you have to keep in mind what the flow was when the observations were made.

A stakeholder asked what the flow was at the time of the AFP observations. Larry answered that the flow was between 3 and 38 cfs depending on the reach. Dudley said that part of his heartburn with the Altered Flows is that if you look at the other curve sets for adult rainbow and adult brown you just do not see that sort of suitability curve for anything else. He added that he did not think that the curve should start out at zero and trail straight down. This suggests that the best velocity is zero and then everything from there is downhill. He said maybe for brown trout but not for a rainbow trout. Russ thought that .25 to .5 could be equally suitable and said that velocities are very important.

Wayne L. pointed out to the group that Jean Baldrige showed in her presentation that the biology (fish populations) did respond to flows resulting from these curves very well.

Larry presented a table that showed the electivity index for shear zones in non-pool habitats. Observations were divided into three ranges: less than one meter, one to two meters, and more than two meters. He told the group that anything more than .25 is significant based on work by Moyle. It was asked how it was measured and Larry said that after they observed the fish they would go back and look for the nearest shear zone and measure the distance to the nearest area of higher velocity. A fish within an area of high velocity water would be considered to be less than 1 meter from shear. The overall conclusion from the table is that trout were not selecting to be selecting for velocity shears, even though those were readily available. Rather, the fish appeared to be using velocities as they were available, regardless of whether a shear zone was located nearby or not. By looking only at non-pool habitats, we are focusing on those areas where fish are most likely to be utilizing shears.

Russ asked for an explanation of the availability percentage use. Larry explained that his overall conclusion was that the fish are not selecting to be in shear zones. The group then discussed the possibility of using a feeding model, but most felt that this method would not be necessary.

Russ told that group that if the flow is low then the results will vary and he added that, to him, the results were almost inconclusive. Larry said that he thought that the results were saying that the fish are using what is out there.

The group then discussed fry and spawning habitat. For the Upper American process, fry were considered but not included. Russ said the public does not scream for trophy fry programs. Wayne L told the group that because of the low number of fry observed, they will have to rely on a fallback. Dudley said they did address spawning in the UARP.

Russ told the group that he was in favor of radio tagging fish to measure spawning. He said that it is a cost effective tool that is not used enough. Wayne L. told the group that there are access issues when rainbow are spawning, which make radio tagging difficult.

Larry had put together spawning curves and presented them to the group. There was a brief discussion on the importance of depth. Some believed that the right combination of velocity and gravel will allow fish to spawn at any depth. The group was told that the size of the fish is of particular importance when it comes to spawning and Dudley asked if ENTRIX had any spawning observations. The answer was no, only incidental observations. Larry showed a spawning gravel graph. He told the group that he thought that everyone could agree that spawning takes place in small and large gravel.

Next, the group reviewed the brown trout spawning velocity curves. Russ told the group that he had heartburn thinking that was not enough information on the spawning. It was asked if there is any more fieldwork planned and the answer was no, not on spawning. The problem is finding access and tracking the fish. If they get into bedrock canyon areas, you'll know they're down there, but you will not be able to get to them. Another severe difficulty is in getting a sufficient number of observations to elicit any meaningful information from the effort. Even for some of the more abundant species and lifestages, we were unable to get enough observations, even under good conditions. For spawning, conditions would be poor for making observations, and the fish could only be counted if they were actively creating a redd, so it would be very difficult to collect more than a few observations.

Britt asked how accessible the North Fork Stevenson was and the answer was that it is the most accessible. Larry told the group that even if they go through the effort to find spawning, they will only get 20 to 30 observations on a few reaches and that may not be very useful. Britt said that it can be helpful for the geomorphology work.

Dudley told the group that the main interest is in the depth and velocity in the spawning area with the best gravel and agreed with Larry in thinking that you wouldn't have much of a data set with the observations. He also added that there are lots of spawning curves out there to use. Russ said that since rainbow trout typically spawn in higher flows, the information is important.

The group moved on to discuss juvenile life stage curves. Dudley told the group that there are no channel distinctions for the UARP curves and that the assumption is that a juvenile is a juvenile is a juvenile. There was a brief discussion about fish size and sexual maturity after which the group moved on to discuss hardhead, pikeminnow and suckers.

Larry gave a presentation on transition zone species, discussed the different criteria that were looked at, and gave statistics on where the criteria came from.

Larry went on to give the results of the criteria testing.

Action Item #1: Larry Wise (ENTRIX) will provide a revised packet of HSC presentations to Ryan Bricker (Kearns & West), who will distribute to the CAWG and burn a CD for Julie Means (CDFG).

Julie Tupper (USFS) told the group that they could never reach an agreement on the Pit River. Some of the fish people say that there was a debate in the Pit process that the juvenile and the fry do not hang out together. Julie T asked how long the juveniles are juveniles. Larry said approximately four years.

Larry went on to review the hardhead lower basin large stream velocity and depth curves with the group. Larry told the group that the West Sierra passed on all joint, depth and velocity tests, so he recommends starting there. Dudley asked if they have the UARP curves. Larry answered that the UARP curves have not been finalized yet.

Russ asked if they collected a bunch of information on the UARP. Dudley and Wayne L. looked up the UARP curves and told the group that they resemble the Pit curves and go horizontal, then up again at an angle and did not seem, to fit this project's data.

Dudley says he has a problem with any curves that go up and down. Larry agreed. Russ told the group that in the Klamath they do have an up and down curve.

Wayne asked Dudley if they can get the curves from him.

Action Item #2: Dudley Reiser (R2) to supply the UARP hardhead, pikeminnow and sucker curves to ENTRIX.

Dudley suggested engaging Peter Moyle for this process and the group agreed it could be beneficial.

Action Item #3: Wayne Lifton and Larry Wise (ENTRIX) to contact Peter Moyle regarding hardhead.

Russ told the group that we need to be very careful what we ask Peter for because there's a lack of information on hardhead.

Julie T. asked about overlap on fry and juvenile and if there are predation problems. Larry said that there are.

Larry told the group that the next step is to take a look at other criteria for trout and the total trout and then get revised plots out to everybody.

Julie asked if they are planning on getting PHABSIM done by January and the answer was no.

In January we can look at all this stuff and get into the details of sorting through the information.

Russ told the group that one of the things to keep in mind from the agency's perspective was that there has been a willingness to not require site specific curves and in exchange for that, there should be leeway for professional judgment and "drawing" to some degree for the curves.

Geoff asked for information on what curves passed to be included in the legend.

Action Item #4: Larry Wise (ENTRIX) to add a reference on which curves passed on the charts.

Action Item #5: Debbie Giglio (USFWS) to check on the USFWS position on using HABTAE for addressing shear zones.

Next meeting: January 28 and 29th in Modesto.

The meeting was adjourned.

Summary of Action Items

Action Item #1: Larry Wise (ENTRIX) will provide a revised packet of HSC presentations to Ryan Bricker (Kearns & West), who will distribute to the CAWG and burn a CD for Julie Means (CDFG).
Action Item #2: Dudley Reiser (R2) to supply the UARP hardhead, pikeminnow and sucker curves to ENTRIX.
Action Item #3: Wayne Lifton and Larry Wise (ENTRIX) to contact Peter Moyle regarding hardhead.
Action Item #4: Larry Wise (ENTRIX) to add a reference on which curves passed on the charts.
Action Item #5: Debbie Giglio (USFWS) to check on the USFWS position on using HABTAE for addressing shear zones.

Big Creek Collaborative
Combined Aquatics Working Group

January 14, 2004

Meeting Notes

Time:	10:00 AM to 4:30 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Ryan Bricker
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor (Facilitator)	Kearns & West
	Ryan Bricker (Note Taker)	Kearns & West
	Andrew Wyckoff	Kearns & West
	Wayne Lifton	ENTRIX
	Julie Means	CDFG
	Geoff Rabone	SCE
	Wayne Thompson	Federation of Fly Fisherman
	Rick Hopson	USFS
	Julie Tupper	USFS
	A. Britt Fecko	SWRCB
	Phil Strand	USFS
	Lonnie Schardt	Huntington Lake Association
	Monty Schmidt	NRDC
	Roger W. Robb	Friant Water Users Authority
	Larry Wise	ENTRIX
	Wayne Allen	SCE
Phone Participants:	Brian Caruso	ENTRIX
	Debbie Giglio	USFWS
	Mitchell Katzel	ENTRIX
	Woody Trihey	ENTRIX
	Paul Devries	R2 Resource Consultants

Introductions and Agenda

Bill initiated the meeting by introducing Ryan Bricker (Kearns & West) and Andrew Wyckoff (Kearns & West) and then asked for everyone to introduce themselves and the organizations they represent.

Review Action Items/Meeting Notes

The group reviewed and approved the November Meeting Summary and went through the Action Items from the December CAWG meeting.

Action Item #1: Geoff Rabone (SCE), Phil Strand (USFS), and others to check for an email from Jim Canaday (SWRCB) regarding the SWRCB water temperature criteria (from late September or October). If not found, Britt Fecko (SWRCB) to re-craft and provide to Kearns & West for distribution to the CAWG.

Action Item #2: Brian Caruso (ENTRIX) to correct the hydrology table error identified by Rick Hopson (USFS) and provide new Hydrology Packet on CD.

The group then discussed the 2004 CAWG meeting schedule. The group was informed that SCE is considering having all meetings held regularly at the Piccadilly Inn and that it is safe to say that we will be having more meetings this year than in the past.

Action Item #3: CAWG meeting currently scheduled for February 12, 2004 to be adjusted due to State Holiday.

Monty Schmitt (NRDC) was new to the group and asked if he could be given a brief update on the CAWG 12 and CAWG 13 studies. Wayne Lifton (ENTRIX) responded that CAWG 12 "Water Use" is still a little further out. The hydrology must be completed as well as the water routing modeling before "Water Use" can be wrapped up. Right now they are shooting for March for the distribution of CAWG 12 "Water Use." Wayne L. also added that they are just entering the impact analysis phase and they might be a little behind of where they would like to be. CAWG 13 "Anadromous Fish" is one of the 2004 reports coming out in the next month or two and there will be the normal comment period.

Action Item #4: Add NRDC (Monty Schmitt) to CAWG Distribution Lists and Kearns & West to provide contact info to Carla Anthony (SCE).

Britt Fecko (SWRCB) asked for a negotiations scheduling estimate. Negotiations are expected to kick off in March along with a Mutual Gains training session. The goal is to wrap-up settlement in December 2004.

Rick Hopson (USFS) asked if the routing models will be a CAWG decision point. Wayne L. replied that it is in the study plan that CAWG consensus is required.

Britt brought to the group's attention that the February CAWG meeting is currently scheduled for the 12th which is a state holiday and will need to be rescheduled.

The group reviewed past Action Items.

<u>CAWG 6 Hydrology Update</u>:
Wayne L. displayed a PowerPoint presentation on the Big Creek Hydrology Study to the group while Brian Caruso (ENTRIX) narrated from the phone. Brian talked the group through the slides and explained how to read the various graphs and informed the group of the sources of various data. It was mentioned that the graphs presented are going to be distributed on CD with updates made. As they go through the streams and diversions, the spreadsheet has constantly been updated.

Brian continued explaining the data summary tables and what the columns and symbols represented. Rick asked why they were choosing to use twenty year records rather than the entire records. Brian replied that they are looking at the entire record, but in many cases some stations only have data going back to the 80s. In addition, the conditions from the last 20 years may be more valid for the group's purposes than data from the 30s or 40s, because of additional project facilities being constructed since then. Wayne L. added that the reason for looking at the 20 year records is to have "apples to apples" comparison. Brian agreed, but added that there are still some cases where we don't even have 20 years of data, so the data is not entirely consistent, but they are trying to be as consistent as possible.

Brian went on to further explain the data summary sheet. Britt asked if the tunnel numbers could also be added as well as the names. In other documents and data sheets, sites are referenced by their tunnel numbers. Brian answered that they have found some inconsistency in names from different documents but they can add tunnel numbers.

Action Item #5: Brian Caruso (ENTRIX) to correct Eastwood table, add tunnel numbers to conduit names, and provide annotations to the small diversion hydrographs.

Brian continued to explain the data summary table for small diversions. Rick had a question about Crater Creek and why there was only one gauge. Wayne Allen (SCE) explained the location of the gauge to the group and Wayne L. added for clarification that these are diverted flows. It was explained that it is impossible to tell by just looking at it. It was decided that as an Action Item that Wayne A. would look into this issue.

Action Item #6: Wayne Allen (SCE) to look into why there is only one gauge value for Crater Diversion.

Brian went on to explain why flat peaks were excluded from the statistics while their values were included on the table. He explained that the flat peaks value tells us that it was at least a certain value. He also told the group that in the end less than 2 percent of the data was excluded from analysis. However, even though these are small percentages, the values tended to be located at the extreme ends of the highs and lows and therefore could have an impact on the final results, so this should be talked about in the future.

Where they did see peaks flatten out, they checked for streams below the diversion to look for increased flows there as well. From this they can look to see if measurement devices were working properly. Rick thought that the next step might be to throw the numbers back in and see how sensitive the analysis would be.

Wayne Allen told the group that at Camp 62, where they had flat peaks, vertical shafts were drilled into the tunnel in 2001-2002 and Camp 62 had experienced a problem. It would not accept the water. Wayne A. then suggested that it be added as an Action Item for him to look into this issue further.

Action Item #7: Wayne Allen (SCE) to look into issues regarding Camp 62 and the vertical shafts that were drilled in 2000-2001.

Rick added that this would not explain Hooper or Bolsillo.

Bill asked Brian if the sensitivity analysis suggested by Rick was something that they would already do or if the group should make it an Action Item. Brian responded that it is not something that they would do. Julie Tupper (USFS) added that it is more important to understand the hydrology of the main streams. She thought that the group should figure out if there are more important things that need to be done first. Geoff Rabone (SCE) agreed with Julie and suggested it be added to the bin list.

Bin Item: Brian Caruso (ENTRIX) to consider sensitivity analysis for excluded data for small diversions.

Brian continued with the presentation. One of the slides showed hydrographs for each year at Chinquapin. It was pointed out that there was no data for the years 1996-1997 when the station was knocked out by a flood. Geoff asked if Chinquapin was the one with the flat peak and wanted to look at that. Brian answered that it didn't have a flat peak, but did have a series of low flows very close to 0 (looking at 1992). The graph excluded September which included some of the data they wanted to look at and Brian told the group that it could be included in the final version.

Brian continued to explain the hydrograph slides and data gaps for 1972 through the early 80's. Rick asked if they were planning on doing an unimpaired analysis for these streams. Brian responded that right now the goal is to estimate the unimpaired flows where we have gauges. There are requests for data at flows where there are no gauges and they are looking at those by a case by case basis. Geoff asked if it would be possible to add the vertical lines to the graphs for ease of viewing. Brian answered that they could.

Action Item #8: Brian Caruso (ENTRIX) to add appropriate vertical lines to hydrographs for ease of viewing.

Britt asked if the Bear Creek conduit was just for Bear Creek. Wayne A. answered that it is.

Brian went on to explain the exceedance tables. Julie T. asked when the minimum pool went into effect in Florence Lake. The answer was 1979. Julie T. suggested that it might be nice to use that as our cut-off date.

Action Item #9: Brian Caruso (ENTRIX) to use 1979 (when minimum pool went into effect) as the beginning of modern period for exceedance tables for Florence storage (minimum storage requirement estimates).

Geoff wanted to confirm that the plan was to distribute these graphs on CD. He brought up that it would be difficult to read these graphs in black and white and wanted to make sure it was acceptable to the group if the graphs were in color on CD instead. It was agreed that for now the graphs will continue to be in color and that all stakeholders will have an opportunity to receive a CD.

Brian continued with the presentation. Julie T. brought up that the group has piles of data - so much that it becomes complicated figuring the whats, wheres, and whys of everything that is going on and suggested that a summary be provided to the Working Group.

Action Item #10: Brian Caruso (ENTRIX) to produce a summary list (which, where, and what) for the large volume of data.

Rick mentioned that a table for IHA and Summary Statistics locations was previously provided to the group, but there was never any resolution on what will be done and at which locations. It would be unfortunate if later in the process people started asking for additional information.

Action Item #11: Brian Caruso (ENTRIX) to present rationale with examples for doing different levels of IHA in different cases. To present at February CAWG.

Phil Strand (USFS) asked about the possibility of making all the data for discharge stations available to the CAWG. Wayne A. answered that all the data used is on the USGS website. Julie T. added that some SCE data was also used and believes that it would helpful if the CAWG could at least be provided with the information that is not on the USGS website

Action Item #12: Brian Caruso (ENTRIX) and Wayne Allen (SCE) to identify what data is being used that is not USGS data.

CAWG 2 Geomorphology Review of Field Notes

Mitchell Katzel (ENTRIX) and Woody Trihey (ENTRIX) joined the meeting by telephone to discuss their responses to the USFS's field inspection draft summary comments. Mitchell told the group that one of the points discussed was that Big Creek below Huntington has undergone a great deal of change. He believes that they will need to work with the channel as it is (currently first order status) rather than attempt to change it to a fourth order channel, which is probably what it used to be. But for Big Creek below Huntington, if the group is not happy with the first order status maybe it will have to be changed to a fourth order channel. Rick replied that the Forest Service was not proposing a fourth order channel, but thought that there needs to be a discussion on whether a fourth order channel was needed. Phil added that they did have a discussion out in the field and it was suggested there to think about it as a first order channel, but no decisions were made.

Mitchell asked the group if they thought that it needs to be added to the memo that further discussion is needed. Rick replied that he thought so. He also added that Mitchell and Woody should also include this as one of their recommendations, but maybe present it as a decision point. It was also suggested that the memo be revised using a single text technique. Julie T. added that everyone needs to be cautious when writing these memos to make sure they are presenting data rather than making decisions. Someone who wasn't involved in this discussion could pick this up and think that a decision had been made. It was agreed that it would be better to phrase the memo as a proposal.

Action Item #13: Mitchell Katzel (ENTRIX) to revise field trip memo as recommendations rather than a decision and distribute for approval by the CAWG. (Future Decision Point)

Rick asked when the quantitative data and would be available. Mitchell answered that it will be coming out, but he couldn't give a date. But it will be part of the 2003 DTSR.

Britt said that, referring to Mitchell's response on measuring the channel, she thought it might be necessary to evaluate the quantitative results then reevaluate on whether it will be necessary to make measurements based on what the channel naturally was. Mitchell agreed that the current study plan will provide some information but may not have all the information that the CAWG needs to make decisions. This means that sometimes additional information gathering will be needed. We may need hard data with test flows.

Woody told the group that if they are going to work with the existing channel they could look at the type of movement from the fine sediment in the channel. If they were thinking of changing the channel type, there are some considerations that need to be taken into account. Information could be used from cross-sections for determining what the channels used to be like and if it was decided to release water, think of the debris that would flow down to dam one. There are lots of other factors to look at and the group might not even want to go there. They have got a lake and a first order flow regime and might want to work with what currently exists rather than what used to be there. Bill added that it sounded like the discussion was important, but might be needed later in the PM&E stage. Wayne L. agreed that this is a discussion for down the road after the reports have been distributed.

The Group took a lunch break.

CAWG 3 Instream Flow – HSC Update

Larry Wise (ENTRIX) went through the Stanislaus River HSC with the group and discussed what they will be using for the meeting on the 28th and 29th. He explained that on the Stanislaus River, they took their observations and developed a generic trout criteria similar in concept to the total trout criteria (adults + juveniles) the CAWG discussed at their previous meeting. The original intent had been to verify criteria using transferability testing, as we were doing here. They were unable to verify curves and ended up developing site specific curves from the smaller transferability data set. Generally substantially more observations are required to develop site specific criteria. The group began to review the different curve sets.

Phil asked about the difference between the Stan 1 and Stan 2 curves. Larry replied that they ran two different sets of criteria in the Stanislaus relicensing process. He added that for adult trout velocity, one of the things they looked at was bioenergetics when they developed Stan 1. Phil asked to know how they arrived at that and if they used habitat runs. Larry replied that he talked to Mark Allen to get his information and beyond that he didn't have all the answers. Britt told the group that Russ Kanz might be able to fill everyone in. Julie T. told the group that they might be able to get Craig Addley to come talk to the group about the Stanislaus River Criteria.

Geoff noted that the Stan curves were developed on a fairly low number of observations compared to SCE's. Larry agreed that those numbers would be considered low if you were developing criteria. Julie M. said that she could get a copy of the final report for everyone.

A stakeholder asked about UARP criteria. Larry responded that they had already talked about the UARP. Geoff asked about information on the hardhead specifically, but this information was not on the slides. Larry went on to explain the UARP hardhead criteria to the group. He added that the UARP hardhead criteria have not been approved by Peter Moyle yet so everything should be considered preliminary. UARP only had adult hardhead criteria. They couldn't find any criteria for juvenile hardhead.

Action Item #14: Britt Fecko (SWRCB), Julie Tupper (USFS), and Julie Means (CDFG) to give Larry Wise (ENTRIX) a copy of the SPLAT Validation Study Report. ENTRIX to distribute to the CAWG.

The group moved on to Passage Analysis. It was proposed that 10 percent contiguous width criterion be dropped from the analysis. Larry explained to the group that by the time you get to your 25 percent total you almost always get your 10 percent contiguous. The 10 percent contiguous width requires a substantial amount of work, as is not output directly by the RHABSIM or PHABSIM programs. Rather you have to manually go through reams of output to determine the flow at which the 10 percent contiguous width is met.

It was asked if this was separate from barrier analyses and the answer was yes. In PHABSIM there are transects in representative riffles. There are physical barriers (falls, culverts, etc.) identified in CAWG 1 that will be included in the barrier report, along with the typical passage flows from the passage analysis described above. Wayne continued to explain that what Larry was suggesting has been done on many larger rivers. It's hard to get the 10 percent contiguous values from the data and it is very labor intensive

Geoff said that he would say to go ahead, because it seems like the Thompson's 0.4 foot depth criteria is based on the physical dimensions of a trout, velocity on swimming speed, and width would be based on the physical dimensions of a trout as well. Ten percent of the width of most streams is much larger than the typical width of an adult trout.

Britt asked what exactly they are trying to get at with this study. The answer was that they are trying to identify the flows in the larger streams in which passage may be obstructed. They are picking representative riffles and calculating a representative passage flow. For each transect they look to see what flow is needed to achieve the minimum passage criteria over at least 25 percent of the stream width. Britt asked what they are trying to get at with the contiguous. It was Larry's opinion that the contiguous is supposed to be big enough for the fish to find and the 25 percent is intended to allow the fish to find its way from one area of passage within a unit to another, as the thalweg of the channel is not always contiguous. Paul asked if this was going to be applied to both high and low flows? Larry replied that it would be applied mostly to low flows. Phil concluded that this meant that they are mostly going to be looking at depth as the main issue.

It was stated that they are not asking for approval at this point but will likely ask for approval at the next meeting. The CAWG was asked to please forward questions to Kearns & West and they will forward them to ENTRIX. It would be nice to get a sense from everyone if this seems like an acceptable approach.

Future Decision Point: Use of Thompson's Criteria for Passage Analysis.

Larry handed out a packet that included the Stanislaus and UARP criteria in addition to what was handed out at the previous meeting. He went through the tables with the group and explained what the codes meant. Larry agreed to provide the group with a legend to accompany the packet.

Action Item #15: Larry Wise (ENTRIX) to produce page of glossary keys/legend for abbreviations, symbols, line width, etc.

Action Item #16: Ryan Bricker (Kearns & West) to email location info for Modesto HSC meeting to the CAWG.

Action Item #17: ENTRIX to distribute HSC meeting agenda to the CAWG early next week.

Phil asked if the background materials from Julie M. could be provided to the group before the next meeting. Julie M. answered that if it was small enough she could make copies.

There was no more business on HSC and the group moved on to discuss responses to CAWG 5.

Discussion of CAWG 5 Report Comments and Responses

All comments received on CAWG 5 have been entered into the table accompanied by the response.

Referring to her comment that included replacing the words “warm” and “cold” in the report with numeric values, Britt said that she agrees that it is easier to read “warm” and “cold” and can live with it, even though it is a technical report.

Britt’s next issue had to do with natural warming in comparison to warming resulting from the diversion of flows. She stated that the EPA is very specific about what natural waters are and suggested that rather than saying increase temperatures “due to natural warming” it may be better to say “warming is due to absence of flow.” She also offered to provide Geoff with the EPA definition that the SWRCB follows.

Action Item #18: Britt Fecko (SWRCB) to provide Geoff Rabone (SCE) with citation for the EPA’s definition of natural warming, anthropogenic effect, etc.

Britt also had a concern with the data gap for Big Creek Upstream of Huntington Lake resulting from vandalism. The following year experienced a dramatic temperature jump. She said that there has to be some other reference stream in comparison to Big Creek Downstream. Wayne L. replied that they do have some. Home Creek and Line Creek are examples. Britt added that it may be helpful to provide comments or footnotes where there are data gaps or jumps in the graphs. Wayne L. replied that they have been modifying the text and it will be footnoted on the graphs.

Phil had a comment regarding using the 24 degree Celsius criteria as a baseline before the CAWG has accepted what the effects might be. Wayne L. replied that they also have data for 22 degrees Celsius and 23 degrees Celsius. The main reason for using 24 was to conservatively identify reaches for modeling. All the data for different temperatures will be appended to the report. A stakeholder told the group that there was NOAA fisheries temperature data that they could use. Wayne L. told the group that they have referred to the EPA issue paper #5. Jim Canaday pointed this out when it first came out and they have been watching it. There is a lot of good stuff that they have compiled, but there are also many differences in the species and strains of fish that are being evaluated in the Pacific Northwest as opposed to what we find in California, the southern portion of the range for many of these species.

Wayne L. told the group that the rewrite will be significant in terms of edits with all the tables being entered in. The executive summary table will have the reference streams that Britt wanted to see. He added that they will try to make it as painless as possible, but with all the changes it will be pretty complex

Monty said that while looking at the 2001 study plans, one of the things that he was interested in was trying to understand how the issue of restoration of Anadromous fish downstream was being looked at. It has been unclear for years how to look at water temperature as a connected element. Wayne L. replied that temperature and other variables downstream of the Project area are only addressed in terms of biological effects in the Anadromous fish report and only as they have been identified to date. It is a summary of project potential effects and proposed projects (in addition to Big Creek) that may affect this project in terms of cumulative impacts. Potential downstream effects of the Big Creek system will be noted in the report, but basically no actions will be suggested until something is proposed as a suitable project or PM&E.

Monty told the group that he was still trying to figure out what it would take to restore Anadromous fish below Friant dam. He is looking at anything that would have to do with timing of flows and providing suitable temperatures downstream at different times of the year. There is a draft restoration study in the works. The SCE studies are further along than their research downstream, but they are just trying to get a handle on it to see if temperature is an issue.

Monty told the group that it would help to look at some of SCE's data. Bill suggested that Monty talk to Wayne L. Monty asked if there was a modeling of outflows as part of Big Creek No. 4. Temperature models would be helpful since it is the end of the SCE project. Wayne L. and Geoff responded that it was a long time ago, but that they could look at the Big Creek No. 4 license application.

Action Item #19: Geoff Rabone (SCE) to provide Monty Schmitt (NRDC) with a copy of the Big Creek 4 temperature portion of the license application.

Geoff brought up a comment made by Britt where she talked about the effects of temperatures and "species of concern". He told Britt that when he thinks about "management species," he thinks of things like trout or frogs, but when he read in her comments about "species of concern," he was a bit troubled. He wanted to know if she was looking at something else that was not being currently considered in the study plans. Britt responded that it was just a generic term that she used.

There were no further issues and the Group Reviewed Action Items and adjourned.

Action Item #1: Geoff Rabone (SCE), Phil Strand (USFS), and others to check for an email from Jim Canaday (SWRCB) regarding the SWRCB water temperature criteria (from late September or October). If not found, Britt Fecko (SWRCB) to re-craft and provide to Kearns & West for distribution to the CAWG.
Action Item #2: Brian Caruso (ENTRIX) to correct the hydrology table error identified by Rick Hopson (USFS) and provide new Hydrology Packet on CD.

Action Item #3: CAWG meeting currently scheduled for February 12, 2004 to be adjusted due to State Holiday.
Action Item #4: Add NRDC (Monty Schmitt) to CAWG Distribution List and Kearns & West to provide contact info to Carla Anthony (SCE).
Action Item #5: Brian Caruso (ENTRIX) to correct Eastwood table, add tunnel numbers to conduit names, and provide annotated hydrographs to the data summary tables.
Action Item #6: Wayne Allen (SCE) to look into why there is only one gage value for Crater Diversion.
Action Item #7: Wayne Allen (SCE) to look into issues regarding Camp 62 and the vertical shafts that were drilled in 2000-2001.
Action Item #8: Brian Caruso (ENTRIX) to add appropriate vertical lines to hydrographs for ease of interpreting.
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Action Item #11: Brian Caruso (ENTRIX) to present rationale with examples for doing different levels of IHA in certain cases. Present at February CAWG.
Action Item #12: Brian Caruso (ENTRIX) and Wayne Allen (SCE) to identify what data is being used that is not USGS data.
Action Item #13: Mitchell Katzel (ENTRIX) to revise field trip memo to sound like a record of the trip with recommendations rather than decisions and distribute for approval by the CAWG. (Future Decision Point)
Action Item #14: Britt Fecko (SWRCB), Julie Tupper (USFS), and Julie Means (CDFG) to give Larry Wise (ENTRIX) a copy of the SPLAT Validation Study Report. ENTRIX to distribute to the CAWG.
Action Item #15: Larry Wise (ENTRIX) to produce page of glossary keys/legend for abbreviations, symbols, line width, etc.
Action Item #16: Ryan Bricker (Kearns & West) to email location info for Modesto HSC meeting to the CAWG.
Action Item #17: ENTRIX to distribute HSC meeting agenda to the CAWG early next week.
Action Item #18: Britt Fecko (SWRCB) to provide Geoff Rabone (SCE) with citation for the EPA's definition of natural warming, anthropogenic effects, etc.
Action Item #18: Geoff Rabone (SCE) to provide Monty Schmitt (NRDC) with a copy of the Big Creek No. 4 temperature portion of the license application.

Bin Items and Future Decision Points
Bin Item: Brian Caruso (ENTRIX) to consider sensitivity analysis for excluded data for small diversions.
Future Decision Point: Use of variation of Thompson's Criteria for Passage Analysis.

Big Creek Collaborative
Combined Aquatics Working Group

February 11, 2004

Meeting Notes

Time:	10:00 AM – 4:00 PM	**Moderator:**	Wayne Lifton, ENTRIX
Location:	Broadmoor Room Piccadilly Inn, Fresno, CA	**Facilitator:** **Recorder:**	Bill Pistor, K&W Andrew Wyckoff, K&W

Teleconference No.: 1-800-556-4976

Attended by:
Bill Pistor, K&W
Andrew Wyckoff, K&W
Geoff Rabone, SCE
Wayne Allen, SCE
Roger Robb, FWUA
Wayne Thompson, FFF
Debbie Giglio, USFWS
Phil Strand, USFS
Rick Hopson, USFS
A. Britt Fecko, SWRCB
Kelly Catlett, FOTR
Wayne Lifton, ENTRIX
Julie Tupper, FS-RHAT
Geoff Rabone, SCE
Paul Martzem, SJP

Phone Participants:
Julie Means, CDFG
Larry Wise, Entrix
Brian Caruso, Entrix
Paul DeVries, R2

Introductions
The meeting was initiated and stakeholders introduced themselves and specified which organization they represented. Bill Pistor (Facilitator, Kearns & West) introduced Andrew Wyckoff (Kearns & West) and indicated that Andrew would now be the K&W contact person/liaison for the CAWG and for the Terrestrial Working Group.

Review of Action Items
A number of the Action Items had been assigned to Brian Caruso (ENTRIX). Since Brian was not joining the meeting until the afternoon, via phone, the group agreed to pass over Brian's Action Items for the morning and revisit them in the afternoon after Brian joined the meeting.

Following are the updates on the rest of the Action Items covered on the morning of 2/11/04.

Ongoing Action Items

- **Action Item:** Mitchell Katzel (ENTRIX) will revise the October 2, 2003 SCI, Rosgen Level II and PFC Memo according to the approved edits from stakeholders and send to Ryan Bricker (Kearns & West) to send to the CAWG.
  Response: Wayne Lifton (Entrix) to contact Mitchell for resolution
- **Action Item:** Larry Wise (ENTRIX) to add a reference chart on the flows at the time observations were made.
  Response: Completed
- **Action Item:** ENTRIX to provide cloud seeding study results to the CAWG when applicable studies are concluded.
  Response: This Action Item is still ongoing
- **Action Item:** Dudley Reiser (R2) to supply the UARP hardhead, pikeminnow and sucker curves to ENTRIX.
  Response: Completed
- **Action Item:** Wayne L and Larry Wise (ENTRIX) to continue their efforts to contact Peter Moyle regarding hardhead.
  Response: Wayne and Larry are still working on contacting Peter
- **Action Item:** Debbie Giglio (USFWS) to check on the USFWS position in using HABTAE for addressing shear zones.
  Response: This Action Item was marked as a Bin item by the group.

Actions from January 14, 2004 Meeting

- **Action Item #1:** Geoff Rabone (SCE), Phil Strand (USFS), and others to check for an email from Jim Canaday (SWRCB) regarding the SWRCB water temperature criteria (from late September or October). If not found, Britt Fecko (SWRCB) to re-craft and provide to Kearns & West for distribution to the CAWG.
  Response: Britt will take care of this Action Item
- **Action Item #3:** CAWG meeting currently scheduled for February 12, 2004 to be adjusted due to State Holiday.
  Response: Completed
- **Action Item #4:** Add NRDC (Monty Schmitt) to CAWG Distribution Lists and Kearns & West to provide contact info to Carla Anthony (SCE).
  Response: Completed
- **Action Item #6:** Wayne Allen (SCE) to look into why there is only one gauge value for Crater Diversion.
  Response: Completed and Wayne discussed with Brian Caruso
- **Action Item #7:** Wayne Allen (SCE) to look into issues regarding Camp 62 and the vertical shafts that were drilled in 2000-2001.
  Response: Completed
- **Action Item #13:** Larry Wise (ENTRIX) to produce page of glossary keys/legend for abbreviations, symbols, line width, etc.
  Response: Completed
- **Action Item #14:** Ryan Bricker (Kearns & West) to email location info for Modesto HSC meeting to the CAWG.
  Response: Completed
- **Action Item #15:** ENTRIX to distribute HSC meeting agenda to the CAWG early next week.
  Response: Completed
- **Action Item #16:** Britt Fecko (SWRCB) to provide Geoff Rabone (SCE) with citation for the EPA's definition of natural warming, anthropogenic effect etc.
  Response: Ongoing—Britt will contact Geoff when she had the information
- **Action Item #17:** Geoff Rabone (SCE) to provide Monty Schmitt (NRDC) with a copy of the Big Creek 4 temperature portion of the license application.
  Response: Completed

- **Action Item #18:** Mitchell Katzel (ENTRIX) to revise field trip memo to sound like a recommendation rather than a decision and distribute for approval by the CAWG. (Future Decision Point)
  Response: Ongoing—Wayne to contact Mitchell for resolution
- **Action Item #19:** Britt Fecko (SWRCB), Julie Tupper (USFS), and Julie Means (CDFG) to give Larry Wise a copy of the SPLAT Validation Study Report. ENTRIX to distribute to the CAWG.
  Response: Britt, Julie T and Julie M provided their documents to Larry. Entrix will distribute the materials.

HSC Subgroup Action Items from January 28-29, 2004 Meetings

- **Action Item #1:** Britt Fecko (SWRCB) to send out Stan curves and additional background information regarding various Stan tools to the CAWG.
  Response: Completed
- **Action Item #2:** Larry Wise to contact Mark Allen (TRPA) to get information regarding the Upper North Fork Feather River and Lower North Fork Feather River and whether there are two sets of curves.
  Response: Larry talked with Mark and discovered there were two curves used. Britt said she would contact Russ (SWRCB) to discuss his interest in this matter.
- **Action Item #3:** CAWG members to continue seeking Peter Moyle's (DWFCB) review for Hardhead curves.
  Response: Ongoing
- **Action Item #4:** Larry Wise (ENTRIX) to look into what is driving the failure of the Pit Hardhead criteria on transferability tests.
  Response: Larry will continue
- **Action Item #5:** Dudley Reiser (R2) to send the TRPA UARP data report to Ryan Bricker (Kearns & West) to distribute to Julie Means (DFG). (Presentation might be on the web or Larry Wise might have it.)
  Response: Completed

<u>Additional Analysis Actions</u>

- **Action Item #6:** SCE to assess the SWRCB's request for Use to Availability Analysis.
  Response: Ongoing

Britt said that observations were taken at low flows. She wanted to find out if the observations were biased. Wayne L explained that there are mathematical problems in performing Use to Availability analysis when many of the higher velocity (and depth) bins are unoccupied. Furthermore, the observations the SWRCB are asking for this analysis on were performed for transferability, not curve development, not curve development, He continued to tell the group that when doing criteria development one needs a huge number of observations. Britt agreed, then asked what the maximum flows were during the test. Wayne L said that velocities are not considered within the test. Transferability testing is not the same as criteria development. Britt then asked if the observations were limited to a lower range of flows and habitats. Wayne said there was not a terribly wide range of flows but that velocities went out to 2 feet per second, and that most observations of positions occupied by fish were at the lower velocities. .

Britt then expressed that it would be easier for everyone to discuss this matter if copies of the Stan E-3 Appendix were in each person's hands. Wayne L asked for Britt to tag the relevant page numbers. It was agreed that these pages numbers would be identified when the report gets distributed (on CD) to the group.

Julie M mentioned concerns that Gary Smith had regarding the flow levels used on the Stan. She added they had made requests for a habitat time series on the Stan. She said that she had notes from the conversation and that she would distribute them in Memo form to the CAWG. Debbie wanted Mark Gard (USFWS) to look at them as well.

- **Action Item #7:** Wayne Allen (SCE) to create a table indicating the flows existing during PHABSIM fish observations and distribute to CAWG by February 11, 2004.
  Response: Completed
- **Action Item #8:** CRWG to review and make better assessment of the Stan data, TRPA analysis, and Validation Report.
  Response: Ongoing. Wayne L said the tools were still being gathered for this effort
- **Action Item #9:** Re-distribute the Altered Flows paper.
  Response: Wayne L to distribute copies to Geoff, Julie M, Paul Devries, and Wayne Allen
- **Action Item #10:** ENTRIX to make data available to stakeholders.
  Response: Ongoing. Geoff is still working on it.
- **Action Item #11:** CAWG to review UARP presentations.
  Response: Ongoing
- **Action Item #12:** SCE to assess possibility of running sensitivity analysis for curves using different asymptotes, as well as on tentatively agreed to adult rainbow and adult brown trout velocities.
  Response: Wayne mentioned that Dudley and Julie T. suggested running PHABSIM on other stream data with the HSC. Britt felt this was premature. Wayne agreed and suggested that this be marked as a Bin item. The group agreed—Bin.
- **Action Item #13:** Larry Wise (ENTRIX) and Kearns & West to distribute the new tentatively agreed to curves by February 4, 2004 for discussion at the February 11, 2004 CAWG meeting.
  Response: Completed
- **Action Item #14:** Wayne L (ENTRIX) and others to acquire, look at and distribute winter use curves.
  Response: Larry had a number of winter criteria for his presentation but was unable to make it in person due to illness. Wayne L told CAWG members if they find the information applicable then ENTRIX can distribute to the group.

Review Agenda
Bill ran through the day's meeting agenda and then explained how the December CAWG meeting notes were temporarily lost on Bryan Harland's computer due to a crashed server. He apologized for the delay and said K&W is working to improve efficiency in this matter.

Break 11:00 – 11:15

Upon returning from a break, CAWG members reintroduced themselves.

Passage Analysis Approach Discussion
Larry began by reviewing with the group the discussion in CAWG 3 re: general flows needed for fish migration. He said the CAWG elected to use a modification of Thompson's method using the PHABSIM riffle transects. This was intended to provide an idea of the flow required to pass a fish through typical shallow habitat types, but was not a critical riffle analysis as described by Thompson. Thompson's criteria for adult trout migration are 0.4 feet depth and 4 feet per second velocity. The Thompson methodology requires that these minimum passage requirements be met at 25 percent of the total transect width and 10 percent of the contiguous width cannot be automatically generated by the PHABSIM program and is labor intensive. In addition, it has been ENTRIX's experience that the 10 percent contiguous criterion is almost always met when the 25 percent total width criterion is. Because calculation of the 10 percent contiguous is labor intensive and very rarely changes the estimated passage flow for a transect, SCE was requesting approval to drop the 10 percent contiguous criterion and proceed with only the 25 percent criterion. Britt asked for clarification on the 10% and 25% requirements and asked if this has not been used in critical riffles where transects are). Larry said the passage analysis is done in riffles. The criteria are set up for gravel bottom streams as opposed to the bedrock and boulder dominated streams in the project area. Thus the criteria would tend to be more conservative, due

to the greater roughness and hydraulic complexity in the project streams. Britt asked if there were any differences arising on account of doing passage analysis along the same transects as PHABSIM. Larry responded that the primary difference was in the objective: in this study we are attempting to determine a passage flow through typical riffles, whereas in Thompson's approach, the intent was to determine passage flows for critical riffles – those that are most limiting to migration.

The results of the analysis would be presented by reach, with the passage flow for each transect and the average for the reach. Paul (R2) mentioned doing a similar study along transects. Paul mentioned that the 25% was good to a certain stream width. He asked Larry if any of the transects were less than 10 feet wide. Larry said at least 90% were greater than this width.

Caveat: Paul asked that for transects less than 10 feet wide, Entrix should look to see if a sufficient contiguous width was available that would provide a reasonable passage opportunity for adult trout. His concern is for the fish to get through comfortably. Bill affirmed that the **CAWG approves the suggested modification of the Thompson passage criteria with the *caveat* of additional analysis for transects less than 10 feet in width**.

<u>Review of HSC Criteria from January 28 & 29, 2004 HSC Meetings</u>

Adult Rainbow Trout Depth

After Larry introduced the topic and showed the slide depicting the curve, Britt clarified that the criteria/curves about to be reviewed were **tentatively agreed to by the HSC subgroup *without* the consent of the State Water Board***.* Bill then asked the group if the slide and curve were what they remembered and had in their notes. The group said yes.

Julie T said a lot of the discussion among the fish biologists is that when looking at availability you just don't know if the fish are simply using what is there because that is what is currently available. She said the fish biologists incorporated their expertise into the discussion during the last HSC meeting.

Adult Rainbow Trout Velocity

Larry showed the slide with the curve agreed to by the HSC subgroup *without* the consent of the State Water Board. Bill asked everyone if this was the curve they remembered. Debbie said, with her fish expert's (M. Gard) input, that they support shifting the curve over to the right to match the Stan curve. The expert in her office thought it would be a more appropriate curve for trout. Britt Fecko asked if this was related to Thomas Payne's work. Debbie thought it might be. Britt said the SWRCB was comfortable with the Stan curve because they worked with use to availability curves.

Julie T confirmed that the group was not in agreement on the adult rainbow trout curves. She stated that five fish biologists are not going to have the same answer. Britt then asked if the curves should be shifted to the right and if the data was biased. Julie T reminded Larry that she had asked him to provide a count for each class. Larry said he had not had time to get to that.

Bill asked Debbie for her thoughts on the tentatively agreed to curve. She said she no longer had tentative agreement on the curve developed at the last HSC meeting. Geoff mentioned he was hesitant to run two curves. He said it gets too political. Bill then asked the group if they were in tentative agreement that this was the slide established in Modesto (last HSC meeting). The group said yes.

Juvenile Rainbow Trout Depth

Wayne L showed the slide depicting the curve and Bill asked the group if it was what they had tentatively agreed to. The group said yes (with the exception of the State Water Board).

Juvenile Rainbow Trout Velocity
Wayne L showed the slide and Paul asked for a differentiation to be made between fry and juvenile. Bill asked him if this would be an adjustment when the fry were discussed and Paul said yes. Bill asked the group if the slide and curve were what they had tentatively agreed to. The group said yes (with the exception of the State Water Board).

Fry Rainbow Trout Depth
Wayne L showed the slide depicting the curve and Bill asked the group if it was what they had tentatively agreed to. The group said yes (with the exception of the State Water Board).

Fry Rainbow Trout Velocity
Wayne L showed the slide depicting the curve and Bill asked the group if it was what they remembered. Paul requested a change to 0.5 feet of velocity, pointing out the fry criteria reach peak suitabilities at slightly higher velocities than the juvenile criteria. He recommended changing the juvenile velocity criteria to match the peak of the fry velocity criteria. Bill asked everyone if they could live with the change. They said yes. Bill then asked the group if they had tentative agreement. The group said yes (with the exception of the State Water Board).

Rainbow Trout Spawning Depth
Wayne L showed the slide depicting the curve and Larry said it followed the UARP curve. Bill asked the group if it was what they had tentatively agreed to. The group said yes (with the exception of the State Water Board).

Rainbow Trout Spawning Velocity
Wayne L showed the slide depicting the curve. Bill asked the group if it was what they had tentatively agreed to. The group said yes (with the exception of the State Water Board). Wayne L told Paul that he remembered Dudley saying this particular curve is not the final one, considering the fish size we are dealing with.

Break for lunch—12:30-1:30

Adult Brown Trout
Wayne L showed the slide depicting the curves. Bill asked the group if it was what they had tentatively agreed to. Debbie G. said she no longer had agreement with the adult brown trout depth curve. The USFWS now supported the use of the Stan-1 generic criteria for the Big Creek studies. The rest of the group said yes (with the exception of the State Water Board)

Juvenile Brown Trout
Wayne L showed the slide depicting the velocity and depth curves and Bill asked the group if it was what they had tentatively agreed to. The group said yes (with the exception of the State Water Board). Phil, in concert with Paul, asked for the curve to be adjusted so there was a suitability of 1.0 at 0.5 feet of velocity. The group agreed to this adjustment.

Fry Brown Trout
Wayne L showed the slide depicting the velocity and depth curves and Bill asked the group if it was what they had tentatively agreed to. The group was still in agreement (with the exception of the State Water Board).

Brown Trout Spawning
Wayne L showed the slide depicting the velocity and depth curves and Bill asked the group if it was what they had tentatively agreed to. The group was still in agreement (with the exception of the State Water Board).

Adult Hardhead

Wayne L showed the slide depicting the velocity and depth curves and Paul said that there was still no resolution yet on the Upper American hardhead curve. Bill asked the group if it was what they had tentatively agreed to. The group was still in agreement.

Juvenile Hardhead
Wayne L showed the slide depicting the velocity and depth curves and Bill asked the group if it was what they had tentatively agreed to. The group was still in agreement.

Adult Sacramento Sucker
Wayne L showed the slide depicting the velocity and depth curves and Larry said he was not sure about the swale at 2.25 feet. He said he would modify it to a straight line. Bill asked the group they were fine with "straightlining" the swale. The group said yes.

Juvenile Sacramento Sucker
Wayne L showed the slide depicting the velocity and depth curves and Bill asked the group if it was what they had tentatively agreed to. The group was are still in agreement.

Adult Pikeminnow
Wayne L showed the slide depicting the curve and Bill asked the group if it was what they had tentatively agreed to. The group was still in agreement.

Juvenile Pikeminnow
Wayne showed the slide depicting the curve and Bill asked the group if it was what they had tentatively agreed to. The group was still in agreement.

To summarize these HSC curve discussions Bill restated that there were some adjustments made to some juvenile curves and that there was a non-agreement from Debbie and Mark Gard on the rainbow and brown trout adult criteria. Additionally, the SWRCB has not tentatively agreed to any of the trout criteria. Otherwise, he said we still have tentative agreement on the curves. Debbie said she needed to have a discussion with Mark about the brown trout adults too. She requested a placeholder so she could check in with him.

<u>Macroinvertebrate Criteria Discussion</u>
After some discussion, the group decided to not look at macroinvertebrate criteria. It was mentioned that since it has not been used in other relicensings and it had previously not been a factor in determining instream flow regimes, that the group could live with not investigating further. Bill confirmed asking the group if they could live with not doing it. They answered yes.

<u>Winter Criteria Discussion</u>
Larry said that at the HSC meeting people expressed interest in seeing some winter criteria for trout habitat. He said there was some California criteria but not local to Big Creek. Paul asked whether there was discussion about the fish residing in gravel and added that they are not keying in on flow too much in the research. Paul feels it is worth looking at.

Adult Trout Velocity Winter
Wayne L brought up the first slide and Larry explained the myriad of curves. He said the criteria indicated that trout are inactive and hunkering down. Wayne L stated that the group needs to consider the varying snow and ice conditions which affect the winter criteria.

Adult Trout Depth Winter
Wayne L brought up the first slide and iterated that the curves are dependent upon the stream habitat where the data was collected. He asked Larry if a summary could be developed for the winter criteria, like the summary for the summer criteria. Larry said yes.

Juvenile Trout Velocity & Depth Winter

Finally, curves were shown for Juvenile Trout Velocity and Depth Winter. Wayne L indicated that they would get the information out so people could review it for the next meeting.

Hydrology Discussion

Brain Caruso joined the group via conference call. He wanted to address the Action Items from January and to discuss the next steps.

Action Item 2: Completed. Brian had corrected the error highlighted by Rick. He had replaced the critically dry year flow and fixed it. He also indicated that zeros meant there was no data for low water level years.

Action Item 8 and part of 5: Completed. The vertical lines were inserted. Brian said the slides will all be provided on CD in the near future. Re: Action Item 5: Bill asked the group if Brian's annotations were what they were looking for. The group said yes.

Action Item 9: Completed.

Action Item 5: The correction was made to the Eastwood table.

Action Item 10: Ongoing. The table has been continuously updated; this is the current version.

Action Item 12: Ongoing. Now shows which data is USGS data and which is not. Shows all except for Rock Creek and Ross Creek—smaller creeks.

Action Item 11: Brian explained that the methodology recommends 20 years of data so we are only doing it where we do have 20 years of data. He continued recommending that at other gauged locations we should calculate mean, annual one day minimum, mean annual flood, and annual 7-day minimum.

Britt said that she would like to wait before agreeing with these recommendations. Rick told Brian that for Action Item 11 he felt like the same information was still being presented. He asked if the data were robust to a single data set. He asked why some statistics from IHA work but others do not. Brian responded saying that other parameters could be added and shorter data sets could be used, but that the confidence in the results would be correspondingly lower. The rationale is to use data from those with over 20 years of information—which leaves the four we have been using. That is not to say we wouldn't have synthetic data to use.

A discussion regarding synthetic data ensued. Brian felt it might not be as reliable even though they were coming up with it for all gauges. Julie T. mentioned that it had been used at other relicensings. Rick said he would be more comfortable having IHA done on the full suite of parameters. Brian said he could present IHA results at the locations he recommended and go over the synthesized data at the unimpaired locations. Julie T. also expressed seeing this data to see the timing of the flows and to get a better idea of when peaks probably occur.

Wayne L. asked Brian to redistribute documents for the next Hydrology Subgroup meeting scheduled for 9:00 AM – 12:00 PM on February 26th. During this meeting Brian will address Action Item 11. He will also go through each site and provide what kind of data he has, the degree of confidence he has, and sites with less data and why ENTRIX has recommended not addressing these with IHA but using a simpler methodology..

Next HSC Meeting

The topic for the next meeting will be what additional analysis needs are there?

Actions from February 11, 2004 Meeting

Action Item #1: Wayne Lifton (SCE) to send the relevant Hal Beecher article on adjacent cell velocity to CAWG.

Action Item #2: Britt Fecko (SWRCB) to tell Jim Canaday (SWRCB) to redo the email on SWRCB temperature approach.

Action Item #3: Larry Wise (ENTRIX) to distribute the following:

- 2002 validation report
- CD with Stanislaus Appendix E-36 from Britt Fecko; relevant page numbers will be identified.

- Winter curves
- Macroinvertebrate criteria

Action Item #4: Larry Wise (ENTRIX) to distribute the Altered Flow Report to: Geoff Rabone (SCE), R2, Julie Means (CDFG), and Wayne Allen (SCE).
Action Item #5: Britt Fecko (SWRCB) to check with Russ regarding whether we need to bring the Lower North Fork Feather River criteria into our discussions.
Action Item #6: Julie Means (CDFG) will provide a memo to CAWG regarding Gary Smiths' concerns about Stanislaus HSC.
Action Item #7: Julie Means (CDFG) will give Mark Gard's memos on Stanislaus HSC to Kearns and West to distribute.
Action Item #8: Larry Wise (ENTRIX) will check the colors on the PDF for the new HSC subgroup curves: adult rainbow depth, fry rainbow depth, and adult brown depth.
Action Item #9: Larry Wise (ENTRIX) will prepare a document on origin and background regarding winter curves.
Action Item #10: Brian Caruso (ENTRIX) will provide a table indicating the varying levels of confidence with the synthetic hydrographs.
Action Item #11: Brian Caruso (ENTRIX) will present a proposal in two weeks on IHA data where only the synthetic unimpaired flows are available.
Action Item #12: Brian Caruso (ENTRIX) will fix the errors in the IHA/Data Table and redistribute to Kearns and West.
Action Item #13: Brian Caruso (ENTRIX) will prepare a summary of methods used for estimating unimpaired flow.

Bin Items and Future Decision Points

Bin Items:

- HABTAE—adjacent cell velocity won't be used
- Sensitivity analysis for curves using synthetic data

Big Creek Collaborative
Combined Aquatics Working Group

March 11, 2004

Meeting Notes

Time:	9:00 AM to 3:00 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Andrew Wyckoff
Access Code:	271911		

Attended By:	Bill Pistor	Kearns & West
	Andrew Wyckoff	Kearns & West
	Wayne Lifton	ENTRIX
	Julie Means	CDFG
	Geoff Rabone	SCE
	Wayne Thompson	Federation of Fly Fisherman
	Deb Giglio	USFWS
	Mark Gard	USFWS
	Phil Strand	USFS
	Larry Wise	ENTRIX
	Wayne Allen	SCE
Phone Participants:	Jim Canaday	SWRCB
	Paul Devries	R2 Resource Consultants
	Ron Campbell	R2 Resource Consultants

Introductions and Agenda
The meeting was initiated and stakeholders introduced themselves and specified which organization they represented. Bill Pistor (K&W) then laid out the meeting agenda. Geoff (SCE) reminded meeting participants about the Big Creek 4 TRG invitation.

Winter Criteria Discussion
Larry Wise (Entrix) began the discussion by indicating the watersheds for which winter criteria have been previously developed. While discussing the West Cascades Criteria it was requested that the Campbell & Neuner report be sent to the HSC subgroup.

Action Item: Larry Wise (Entrix) to distribute Campbell & Neuner paper to HSC subgroup.

After describing the individual watersheds, Larry then projected composite winter curves. The first set of slides referenced rainbow trout, both adult and juvenile. Discussion ensued regarding what to do with the criteria, if anything. Those who feel the winter curves are not necessary indicate that there are too few observations to provide reliable data and that fish are sedentary during the winter and won't react as much to flows. Considerations, other than available physical habitat, are probably more limiting during the winter.

After a break, Larry showed a slide of all the winter curves with the tentatively agreed upon CAWG adult rainbow trout curves superimposed on top. Paul Devries (R2) then located Ron Campbell (R2) who talked to the group about his rainbow trout winter study. Ron indicated that the curves were deemed reconnaissance curves due to the limited number of observations. The study was conducted in high-gradient Cascade-Pool streams with no ice cover and temperatures less than 3 degrees Celsius. Geoff (SCE) asked Ron if he used winter curves in other situations and he responded that he did if temperatures dropped below the three degree mark. The group then decided to take a break and revisit the winter curve discussion later in the afternoon.

Review of Stanislaus Criteria

Larry described what went into developing the Stan criteria. Mark Gard (USFWS) indicated that it was difficult to find fast deep water during the study and that because of the this the SPLAT had not been able to reach resolution on a single set of criteria. Some member felt that the velocity curves did not adequately reflect the use of higher velocities. Phil Strand (USFS) stated that because the evaluation of the microhabitat delineations was estimated visually it led to results that were more qualitative than quantitative. The group then briefly touched upon the differences between the Stan and Big Creek habitats. Julie Means (CDFG) restated her four concerns with the Stanislaus Criteria, those being that the criteria were 1) generic trout curves – combined brown and rainbow trout; 2) relied extensively on freehand drawing that did not reflect existing curves or the data collected as part of the study, 3) the use of visual estimates when stratifying the sampling areas, and 4) the flows data were collected at and used in preparing the criteria.

Additional Analyses Discussion

Mesohabitat Types

Larry projected slides for velocity and depth for rainbow and brown trout in riffle, flat water and pool habitats, respectively.

Utilization and Availability Contour Plots

Larry first projected slides for rainbow trout. The four slides covered availability and utilization of habitat by rainbow trout for all habitat types, flat water, pools and riffles, respectively. Wayne L. suggested that the fish were selecting more for depth than velocity.

Larry next projected slides for brown trout. The four slides covered availability and utilization of habitat by brown trout for all habitat types, flat water, pools and riffles, respectively.

Mark felt that the rainbow and brown trout were favoring higher velocities and higher depths. Mark and Paul both asked for scatter plots to be generated along with the contours.

Action Item: Larry Wise (Entrix) to make scatter plots of the observations (related to the contour plots).

Habitat Use by Fish Size

Larry projected slides of confidence interval plots and box and whisker plots for rainbow and brown trout depth and velocity utilization.

Utilization to Availability Ratios

First, Larry described past reports involving utilization to availability ratios. He mentioned that the Instream Flow Group (IFG) who developed the utilization to availability ratios no longer recommends using them. Paul also mentioned that there is no mathematical expression, which adequately accounts for availability. Larry then continued, describing the requested calculation of utilization to availability on Big Creek. He projected slides that detailed rainbow and brown trout velocity and depth. Larry said that utilization to availability is strongly driven by outlying data representing limited habitats being used by a small proportion of the observed fish.

Additional Discussion of Stanislaus Criteria

Larry projected a scatter plot slide from the Stan Appendix E-3, illustrating use versus availability based on the four habitat types designated in that process before data was collected: slow-shallow, fast-shallow, slow-deep, and fast-deep. After some discussion, Larry said this stratification system did not work because the values selected to differentiate between fast and slow and deep and shallow habitats were arbitrary and must reflect the availability in the stream being sampled. It was mentioned that both low and high flows were used but that the majority of the observations were collected at low flows. There was concern among stakeholders regarding the use of generic trout (as opposed to separating rainbows and browns) and the use of freehand drawing for the curves. Mark mentioned that he thought that the methodology used on the North Fork of the Feather was more sound. He then reiterated that he felt the availability was limiting the use.

Upper American River Criteria

The Upper American River Criteria were discussed. Larry provided an overview of these criteria, which are predominantly utilization curves, with some professional adjustment. Flows ranged up to 154 cfs in large streams. Mark discussed that he did not like these criteria, but that the data was collected in a manner that might allow the Rubin method to be used to develop new criteria. He volunteered to do this. Larry asked for further discussion of the Rubin report and Julie asked to receive a copy of it for her review.

Action Item: Larry Wise (Entrix) to distribute copies of Rubin, et al report to the HSC subgroup.

More conversation ensued about the Upper North Fork of the Feather. Mark then mentioned the Butte Creek report and some HSC members asked for copies of it.

Action Item: Mark Gard (USFWS) to distribute, via Kearns & West, the Butte Creek report to the HSC subgroup.

Altered Flows Criteria

Larry described the study and its parameters. It is one of the few studies that showed that the results of the criteria used with PHABSIM were highly correlated with actual fish population responses. He added that the report has yet to be published but that it has been distributed to those who have asked for it.

Review of CAWG HSC Curves

Wayne Lifton (Entrix) recapped where the curves currently stood and suggested taking the ones with total agreement from the group off of the list so that Larry Wise could start working with them. The group agreed.

The SWRCB (Jim Canaday) stated that they could live with the adult, juvenile and fry curves for both rainbow and brown trout. This was a change from the SWRCB's earlier comments. He then said he did not have agreement with the Hardhead curves, but would like to see them forwarded to Peter Moyle for his comments.

Phil (USFS) said he would also like to look into the Hardhead upon Peter Moyle's input. Paul said if the hardhead were doing so well in the Pit then something good must be going on there. Jim asked if Peter would look at the Hardhead issue.

Action Item: Larry Wise and Wayne Lifton (Entrix) to send Peter Moyle a copy of the Hardhead curves for his review.

The conversation then returned to the rainbow and brown trout curves. The USFWS (Mark Gard & Debbie Giglio) stated that they could not live with the rainbow and brown trout adult and juvenile CAWG curves for velocity and depth. Mark added that his concern revolved around strictly seeing things based upon the available velocity when transferability observations were made. He said his comfort level was more with the Stan criteria.

The group then discussed the need to distribute the above mentioned reports in timely fashion and decided to have a conference call prior to the April CAWG meeting.

Action item: An HSC subgroup conference call will be held on Tuesday March 30th from 2-4 PM. Group members are expected to have reviewed the distributed reports prior to the conference call.

Decision:
The group agreed that the tentative criteria agreed to on January 28 and 29 were acceptable and approved for use.for all lifestages of Sacramento Sucker and Sacramento Pikeminnow, and rainbow and brown trout fry and spawning. Still outstanding were decisions regarding adult and juvenile rainbow and brown trout. The group would like Peter Moyle's input on the hardhead criteria before these are approved.

Return to Winter Curve Discussion
Bill asked the group if they were comfortable using the North Umpqua curves. Julie Means (CDFG) said she wanted more time to review and think about this. Geoff (SCE) said he was on the fence for using the winter curves/criteria. The rest of the meeting participants felt there was no need to use the winter curves/criteria.

Bill then reviewed the meeting's action item with the group.

March 11, 2002 Action Items
Action item: Larry Wise (Entrix) to make a scatter plot of observations to go along with the contours.
Action item: Mark Gard (USFWS) to distribute, via Kearns & West, the Butte Creek report to the HSC subgroup.
Action item: Larry Wise (Entrix) to distribute copies of Rubin, et al report to the HSC subgroup.
Action item: Larry Wise (Entrix) to distribute copies of Campbell and Neuner report to the HSC subgroup.
Action item: Larry Wise and Wayne Lifton (Entrix) to send Peter Moyle a copy of the Hardhead curves for his review.
Action item: An HSC subgroup conference call will be held on Tuesday March 30th from 2-4 PM. Group members are expected to have reviewed the distributed reports prior to the conference call.

Bin Items
Decision on winter curves/criteria

The meeting adjourned.

Big Creek Collaborative
Combined Aquatics Working Group

April 14, 2004

Meeting Notes

Time:	10:00 AM to 2:00 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Andrew Wyckoff
Access Code:	271911		

Attended By:	Bill Pistor	Kearns & West
	Andrew Wyckoff	Kearns & West
	Wayne Lifton	ENTRIX
	Julie Means	CDFG
	Geoff Rabone	SCE
	Wayne Thompson	Federation of Fly Fisherman
	Roger Robb	FWUA
	Chuck Bonham	Trout Unlimited
	Monty Schmitt	NRDC
	Phil Strand	USFS
	Rick Hopson	USFS
	Larry Wise	ENTRIX
	Wayne Allen	SCE
Phone Participants:	Deb Giglio	USFWS
	Paul Devries	R2 Resource Consultants
	Julie Tupper	USFS

Introductions and Agenda

The meeting was initiated and stakeholders introduced themselves and specified which organization they represented. Bill Pistor (Kearns &West) then laid out the meeting agenda. Geoff Rabone (SCE) asked meeting participants if they were planning on attending the Endangered Species conference May 12th & 13th in Sacramento hosted by the FERC, NOAA and the FWS. Some stakeholders said they were attending the conference and it was suggested that the May CAWG meeting be moved to May 11th.

Action Item: K&W to check with CAWG stakeholders whether May 11th is a workable date for next month's meeting.

Water Year Update

Wayne Allen (SCE) gave the group a brief update on the status of the water year and snow pack. He said that the SCE snow surveys had been completed and that the snow pack is 74% of normal. Considering the recent spell of cooler weather, Wayne said that Mammoth Pool has a 30-40% chance of spilling.

March Action Item Review
The group then reviewed the action items from the March 10th & 11th CAWG meetings. All action items had been completed with the exception of the following two, which are ongoing:

Action item: Larry Wise (Entrix) and Wayne Lifton (Entrix) to send Peter Moyle a copy of the Hardhead curves for his review.
Action item: Jim Canaday (SWRCB) to address temperature issues (past conversations with Britt Fecko) at April CAWG meeting.

The group then reviewed the action items from the Hydrology Subgroup conference call on March 15th. Three of the four action items had been completed, with most being incorporated into the CAWG 6 Hydrology Report. The fourth action item indicated below was still in progress:

Action Item: Rick Hopson (USFS) to email the USGS "URL" for Miller's Crossing to the Hydrology subgroup.

Previous Meeting Notes Discussion
With the inclusion of Phil Strand's (USFS) and Rick's comments, the group approved the meeting notes from the March 10th & 11th CAWG meetings.

CAWG Draft Study Report Update
Wayne Lifton indicated that the CAWG 1, 10 and 13 draft study reports were distributed to the group on April 5, 2004. He said that all comments on these reports must be submitted to Kearns & West by May 5, 2004.

The group was then reminded of the comment protocol procedures. They are to make comments in Microsoft Word and send them to Andrew Wyckoff (Kearns & West). Kearns & West will then consolidate the submitted comments into one comment table which will subsequently be distributed to the group for review.

General Discussion
Wayne Thompson (Fly Fishers) expressed concern as to whether macroinvertebrate studies scheduled to be conducted both before and after the whitewater studies had been conducted. He felt that forgetting the study plan for macroinvertebrates would be a mistake. Geoff said that the ALP single-flow whitewater studies were done when spill was occurring in 2003, and that if controlled flow studies were deemed necessary by the Recreation Working Group, that they would coordinate with the CAWG to do the macroinvertebrate studies. Also, the Big Creek 4 Technical Review Group (TRG) will address this issue in any test flows it performs as part of the Adaptive Management Program for the new license. He mentioned that no flow studies were done for Big Creek 4 during relicensing and that in the license issued by the FERC, it was mandated that this issue be addressed.

Chuck Bonham (TU) stated that he wanted to closely examine the relationship between CAWG reports 6, 12 & 13. He asked if the timing and outflow of Friant are the responsibility of the Bureau of Reclamation or SCE and what relationship existed between the upstream and downstream projects. He then asked that CAWG 13 be placed on the May 11th agenda as a topic of discussion.

Action Item: The CAWG 13 study report will be placed on the May 11th agenda as a discussion item. (Entrix)

Monty Schmitt (NRDC) asked whether there was a connection between the Big Creek system and downstream anadromous fish. He feels this issue should be discussed at greater depth. He also requested to be placed on ENTRIX's CD report distribution list.

Action Item: Eileen Dessaso (Entrix) will place Monty Schmitt on the Entrix CAWG CD report distribution list.

BREAK

HSC Curves and PHABSIM Discussion

The group was reminded that they, { had reached agreement on the curves for all life stages of the Sacramento Sucker and the Sacramento Pikeminnows; for rainbow and brown trout fry and spawning; and for rainbow and brown trout adult depth. Still outstanding were decisions regarding adult and juvenile rainbow and brown trout velocity and hardhead. The CAWG, with the exception of the USFWS was in agreement on using the tentative CAWG criteria for juvenile rainbow and brown trout as well. Regarding hardhead, the SWRCB, the USFS, and the USFWS would like to hear Peter Moyle's input prior to moving ahead with a final decision on the choice of hardhead criteria.

Debbie Giglio (USFWS) said that Mark Gard (USFWS) was planning on completing a re-analysis of UARP curves using his modification of the Rubin *et al* approach. She also indicated that, based on the scatter plots distributed to the group, Mark felt there was limited fast, deep habitat during the data collection at Big Creek. Finally, Debbie said that Mark felt that there were three ways to satisfy his objections: 1) collect data at higher flows; 2) use the Rubin et al methodology; or, 3) use the Stanislaus Alt 1 curves.

Larry Wise and Paul DeVries then briefly discussed a prior conversation they had regarding the CAWG HSC curves. Their conversation is further fleshed out as represented by the footnote below.[1]

Debbie and Geoff then had a discussion regarding HSC curves and Mark's outlook. Geoff felt that using the collected data was the best approach, as opposed to using mathematical regressions. Debbie stated that Mark's model may provide flows above existing conditions. She then said that the collaborative approach was not to move ahead without the entire group. Julie Tupper (USFS) asked Geoff if he was opposed to having ENTRIX run two sets of curves. Geoff said that he was, because that could lead to picking the answer one liked and then working backwards to the curve set that produced those pre-decided flows. Julie pointed out that this is what usually happens, anyway, to some degree, because people can guess at the effects of different curve sets on flow recommendations. Geoff maintained that it would be better to have the group agree on one set of curves, while remembering that these fisheries models have a degree of uncertainty, and that the recommendations they produce are only one of several sets of information that will go into making final recommendations on flows.

Bill said that it sounds like Mark is going to run his curves, which he can subsequently bring to the group. Wayne Lifton asked if Mark's analysis could be distributed to the CAWG at least two weeks prior to the next CAWG meeting. Wayne also asked for specific information to accompany

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[1] In my referenced conversation prior to the meeting with Larry, I did not feel that Mark's approach "would not be helpful", just that we at R2 thought the UARP/CAWG curves were a reasonable representation of adult and juvenile rainbow and brown trout habitat needs, so that any revised curves based on Mark's analysis would not necessarily result in dramatic changes from what we have currently or lead to major differences in flow recommendations. Even if they did, I noted that there is no single best way to 'correct' for availability, on a cell-by-cell or other basis, because the resulting curves are only as 'good' as the mathematical abstraction used to infer the relation between availability and use. It then comes to deciding whose mathematical representation of preference is more 'accurate' or 'realistic', and determining whether we ended up confusing precision with either. In the end, we believe the present "CAWG curves" capture the major essence of depth and velocity needs in streams affected by the Big Creek project.
(P. DeVries; R2)

Mark's curves, so that the CAWG could interpret what Mark's output means and compare it to what the group is already considering. Two action items arose from Wayne's requests.

Action item: Debbie Giglio (USFWS) will talk with Mark Gard to find out what his timeframe is for his UARP re-analysis.

Action item: Wayne Lifton (Entrix) will email Debbie Giglio re: what information would be helpful in his report, if USFWS develops new criteria based on the UARP data. This would include the methodology, choices made during the curve development process, the effects of those choices on the shape of the final curves, and the results.

LUNCH BREAK

Bill reiterated that all CAWG members (except the USFWS) were in agreement and would proceed with trying to come to agreement on the outstanding details of the so-far agreed upon CAWG HSC curves.

Decision: The group will go ahead with the agreed upon CAWG curves. The USFWS may conduct further analyses on the UARP curve set independently. The CAWG will decide whether or not they want to consider the work of USFWS after they see the results, but will expect ENTRIX to continue on with the CAWG curves in the meantime.

Discussion then turned toward to the ascending limbs (front end) of the adult and juvenile rainbow and brown trout velocity curves. Bill indicated that the group needed to determine appropriate suitability intercepts for zero velocity. Larry projected the velocity curves so the group could refresh their collective memory.

Adult Rainbow Trout Velocity

Discussion ensued around the previously suggested intercepts 0.13, 0.5, 0.65 and 1.0. After talking about the merits of various intercepts, 0.6 was selected as a suitable compromise intercept. Bill then asked the group if everyone could live with the 0.6 suitability intercept at 0 velocity. Everyone except the USFWS said they were OK with this intercept. Julie Means (CDFG) suggested that having a drafted rationale for this suitability intercept would be helpful.

Action item: Larry Wise (Entrix) to email Andrew Wyckoff the written rationale statement for the 0.6 suitability intercept at 0 velocity for adult rainbow trout.

Adult Brown Trout Velocity

Discussion ensued around the previously suggested intercepts 0, 0.5, 0.65 and 1.0. After talking about the merits of various intercepts, 0.7 was selected as a suitable intercept. Bill then asked the group if everyone could live with the 0.7 suitability intercept at 0 velocity. Everyone except the USFWS said they were OK with this intercept. As with the rainbow trout, Julie Means (CDFG) suggested that having a drafted rationale for this suitability intercept would be helpful as the CAWG continues on in the process.

Action item: Larry Wise (Entrix) to email Andrew Wyckoff the written rationale statement for the 0.7 suitability intercept at 0 velocity for adult brown trout.

Winter Curves Discussion

Bill reminded the group that the winter curves discussion had been deemed a Bin item at the previous CAWG meeting. Phil (USFS) said he did not feel compelled to use winter curves. Julie Means (CDFG) said that she initially brought up winter curves because she felt it would be helpful to have a rationale for the winter flows. She said that as long as there was a rationale provided for the winter flows, and then she was comfortable not using the winter curves.

Action item: Larry Wise (Entrix) to email Andrew Wyckoff the rationale for not using winter HSC, but determining winter flow requirements based on other factors, such as not dewatering redds.

Bill then reviewed the meeting's action items with the group.

April 14, 2004 Action Items

Action item: Andrew (K&W) will check with agencies to see if the tentative Tuesday May 11th CAWG meeting date works with their schedules.
Action item: Terrestrial and Land Management working groups will have to be rescheduled as a result of the CAWG switch to Tuesday May 11th. (Entrix)
Action item: Chuck Bonham (Trout Unlimited) will forward a copy of the Communications Protocol to Monty Schmitt.
Action item: The CAWG 13 study report will be placed on the May 11th agenda as a discussion item. (Entrix)
Action item: Eileen Dessaso (Entrix) will place Monty Schmitt on the CAWG CD report distribution list.
Action item: Wayne Lifton (Entrix) will email Debbie Giglio re: what information would be desired in the report if USFWS develops new criteria based on the UARP data. This would include the methodology, choices made during the curve development process, the effects of those choices on the shape of the final curves, and the results.
Action item: Debbie Giglio (USFWS) will talk with Mark Gard to find out what his timeframe is for his UARP re-analysis.
Action item: Larry Wise (Entrix) to email Andrew Wyckoff the written rationale statement for the 0.6 suitability intercept at 0 velocity for adult rainbow trout and the 0.7 suitability intercept at 0 velocity for brown trout.
Action item: Larry Wise (Entrix) to send revised adult rainbow and brown trout velocity curves agreed upon by the CAWG (with the exception of the USFWS) to Andrew Wyckoff for distribution to the CAWG.
Action item: Larry Wise (Entrix) to email Andrew Wyckoff the rationale for not using winter HSC, but determining winter flow requirements based on other factors, such as not dewatering redds.

The meeting adjourned.

Final Approach to Transect Selection and Placement

Rationale for the number of transects to be placed for PHABSIM studies within each Rosgen Level 1 channel type and description of transect placement in the field.

The CAWG 3 Study Plan listed the specific reaches where PHABSIM studies would be conducted. These reaches were defined by stream, Project features and hydrological features. The study plan also specified that each of these reaches would be further stratified by Rosgen Level I channel type, with transects to be placed to represent all major habitat types (pool, riffle, run) within each channel type. Using this approach, the variability associated within a habitat type is not only partitioned by reach, but it is also partitioned into Rosgen Level I channel types within each reach, a level of stratification not usually undertaken in transect placement for PHABSIM studies. Through this approach, the CAWG study plan addresses the range of variability within habitat types in a manner that has not typically been addressed in other PHABSIM studies by providing additional transects selected to specifically account for a source of variability.

Early in the process of developing the CAWG 3 Study Plan, the group discussed placing 10 to 12 transects per Rosgen Level I channel type within each reach. This number of transects was based on the group's cumulative experience in conducting instream flow studies, the types of habitat present in the study reaches, and the stratification of the study area into streams, reaches, and Rosgen Level I channel types. It was thought that an average of 10 to 12 transects per Rosgen Level I channel type would provide coverage of all the major habitat types with replication in the habitat types that are most responsive to changes in flow. The group felt that this number of transects within each of the Rosgen Level I channel types would capture the range of habitat variability within each reach and provide a good understanding as to how flow affects habitat in the reach as a whole. However, the final decision as to the placement and number of transects would be based on a determination in the field by a CAWG transect selection team, which would evaluate potential study sites and select mesohabitat units and transects that will best represent habitat features within the study area.

In placing these transects, study sites would be selected from each Rosgen Level I channel types in accordance with the procedures outlined in the September 4 memo in the section titled "***The random selection process used to select sites for the instream flow studies***". Transects would then be placed in the different habitat types by a CAWG transect selection team during a field visit. Within each Rosgen Level I channel type sub-reach, the approach would be to flag a minimum of three of each of the following habitat types (if they occur within the individual sub-reach): riffle, run, shallow pool, and deep pool habitats, for consideration by the CAWG transaction field team. The field team would visit these flagged habitat units, make a determination in the field as to the number of habitat units that will be needed to represent the subreach, and place transects, as follows:

Representative habitat units of both deep pools (three feet or more in depth) and shallow pools (maximum depth of three feet or less) as they occur within each Rosgen channel type sub-reach, would be evaluated by the CAWG transaction selection team. After a determination by the CAWG team as to the number of habitat units needed to best represent the sub-reach, transects would be placed. For pools, the approach would be to place a transect at the head of the pool (where water enters the pool), the tail of the pool (where water leaves the pool), and through the deepest, slowest part of the pool. In small pools, the transect through the deep, slow part of the pool may be omitted where this area is not very different from the areas represented by the other transects in that pool. Controls for each pool would be measured, but are not counted among the total for habitat transects. Rationale for any selections made by the CAWG transect selection team will be fully documented.

Three mesohabitat units (of both run and riffle) within each Rosgen channel type sub-reach would initially be flagged to allow the CAWG selection team to evaluate areas with different characteristics. As discussed above for pools, the CAWG transect selection team would first determine the number of mesohabitat units needed to represent the sub-reach. Then three transects would be initially be considered by the CAWG transect selection team for placement in each mesohabitat unit selected. The actual number of transects placed will be determined by the team, based on conditions observed in the field. In addition, if the team determines that inclusion of additional subclasses are needed to adequately represent riffles or runs, additional transects may be assigned to these habitat types, with adequate justification. Rationale for any selections made by the CAWG transect selection team will be fully documented.

In addition to placing transects in representative habitat types, the CAWG transect selection team may elect to place additional transects to capture some specific feature (i.e., spawning areas), or to place fewer transects if some feature does not warrant representation in that reach. The actual number of transects within each habitat type, and the number of habitat units selected within each subreach may be altered in the field by the CAWG transect selection team to reflect the conditions observed. The primary consideration of the team is that the numbers of mesohabitat units chosen, and numbers of transects placed, will adequately represent important features of the habitat in the study area.

This approach, which partitions individual project reaches into subreaches based on Rosgen Level 1 channel type, and which requires the field evaluation of three representative units of each major mesohabitat type within these subreaches by the CAWG transect selection team prior to transect placement, will allow for a better representation of habitat features within the study area than occurs in the majority of PHABSIM studies. In addition this approach will address the variability between the mesohabitat units, both within each sub-reach, and between sub-reaches, because the stratification of sampling and placement of transects specifically address the geomorphic factors that shape the channel in each reach. It is these factors that create the channel types and result in the largest amount of variability observed in the specific habitat types.

APPENDIX B

BiCEP MODEL REVIEW

BiCEP PHABSIM MODEL REVIEW

Prepared for:

SOUTHERN CALIFORNIA EDISON
Big Creek, CA

Prepared by:

ENTRIX, INC.
Walnut Creek, CA

Project No. 506637

August 28, 2002

BiCEP PHABSIM MODEL REVIEW

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The Instream Flow Incremental Methodology (IFIM) and its associated Physical Habitat Simulation (PHABSIM) models are typically used to evaluate fish habitat as a function of flow in streams and rivers. The use of instream flow models is included in the studies described in the Combined Aquatics Working Group (CAWG) Study Plan CAWG-3 "Determine Flow-Related Physical Habitat in Bypass Reaches." One of the objectives of that study was to review and evaluate the applicability of instream flow models developed as part of the Big Creek Expansion Project (BiCEP) during the 1980s (SCE 2001). Data and instream flow models were available from the BiCEP studies for several of the Project bypass reaches. These include Upper Big Creek (Big Creek Powerhouse 2 to Dam 4), Lower Big Creek (Big Creek Powerhouse 8 to Dam 5), and the San Joaquin River (the Mammoth and Stevenson Reaches). The Mammoth Reach transects were measured and used for that reach. Those same transects were re-weighted to reflect the habitat composition of the Stevenson Reach and used to model this reach, as well.

This review is confined to the evaluation of the hydraulic simulation models developed for the BiCEP study and their coverage of the major channel and habitat types present in the study reaches. These hydraulic simulations were used in conjunction with habitat suitability criteria (HSC) to produce weighted usable area (WUA) as a function of flow. The selection of the appropriate HSC is a part of the CAWG-3 study that is being conducted separately from this review. The purpose of this evaluation is to determine if the BiCEP hydraulic models will fulfill, in whole or in part, the information needs of the CAWG in describing how flow affects aquatic habitat in these reaches.

If the hydraulic models are considered appropriate and applicable, then these models will be used in conjunction with HSC approved by the CAWG to generate new WUA functions for these reaches. The CAWG-3 Plan identifies a series of specific questions to be answered for each set of models. These questions are:

1. Have channel changes occurred that would affect the validity of the use of the models?

2. Is the habitat type identified for each transect included in the models?

3. Do the transects provide an accurate representation of the habitat types currently found in the reaches?

4. Are the transects representative of channel-types and mesohabitat types?

5. Do the model statistics for mean error and velocity adjustment factors fall within acceptable boundaries?

6. Does the range of acceptable simulation flows in these models meet those needed for the current study or can they be extended to meet this range?

This evaluation relied on review of available documentation from the BiCEP study, including reports and copies of field data sheets and field notes where available. In most cases, model calibration statistics and habitat types were presented in the BiCEP reports (BSAI 1985, 1987). This report information also identified the general location of the BiCEP transects within the study reaches. This location was sufficient to allow a comparison to geomorphic channel types (Rosgen 1994) identified during the ALP process. This comparison facilitated the evaluation of whether all appropriate channel and habitat types had been represented in the BiCEP study.

This report communicates the results of this review and provides recommendations for the potential future use of this information. Each BiCEP bypass reach model is discussed in terms of the six issues identified, above. Recommendations are made with respect to how these models may be applied to provide the CAWG with appropriate information in the Big Creek ALP process and lists any supplemental information or modifications needed.

2.1 HABITAT REPRESENTATION

2.1.1 HABITAT TYPES

The first four questions from the CAWG-3 plan (see page 1-1 of this report), address the issue of whether the BiCEP models adequately represent the major habitat types currently present in the study reaches. This includes evaluating whether the models could be used in their present form to represent current habitat conditions, and if not, whether sufficient information is available to adjust the models for changes in habitat or in how habitats are classified. To address these questions, it is necessary to understand how habitats were classified for the BiCEP work and how that classification relates to current approaches.

In the BiCEP study, prior to the application of the USGS Instream Flow and Aquatic Systems Group's (IFG) PHABSIM models, habitats in each reach were classified to assist in transect selection and transect weighting (BSAI 1987). Habitats in Big Creek reaches were evaluated through ground surveys. Habitats in the San Joaquin River were evaluated using aerial photographs. The habitat classification approach used for the BiCEP studies was developed by BSAI. The BiCEP classification approach has similarities and differences from current habitat classification approaches. Mesohabitats were classified into generally recognized types such as riffles, run/flatwater, pools, and cascades. In the BSAI approach, pools were classified by pool depth. In addition, a separate category was based on whether the pool was a plunge pool associated with a cascade.

In addition to those commonly used habitat types, a different habitat type called "boulder strewn" was identified. This habitat designation is not used in current habitat typing systems. For the "boulder strewn" habitat type, two different categories were recognized. These were generally classified by bed element size occurring in complex step pool/pocket water types of habitats. The bed elements that were the focus of this classification were large boulders. In this classification approach, large bed elements generally were of more importance to classification than hydraulic considerations. Application of the specific boulder strewn criteria appeared to differ among streams.

Table 2-1 presents definitions of the habitat types used in the BiCEP studies. In determining habitat composition, the BiCEP study classified habitat by individual habitat units in some cases and by groups of habitat units in others. In the latter case, the length of a group of habitat units was measured or estimated and then a relative percentage assigned to major types by visual estimation (i.e. unit 13 was 30 percent pool, 50 percent boulder strewn, and 20 percent run). This appeared to result in some "lumping" of groups of habitats and consequent loss of resolution.

As part of the Big Creek Alternative Licensing Process (ALP), habitat inventory studies were again conducted for these reaches during 2000-2002 using USFS R5 (McCain *et al.*

Table 2-1. Habitat Type Definitions used for BiCEP Habitat Mapping and PHABSIM Models (BSAI 1987).

	Type	Definition
A	Pool	Habitat which has slower water velocity; water surface elevation gradient near zero and would hold significant amounts of water at zero flow.
A_1	Pool	Shallow pool: 4 feet or less.
A_2	Pool	Moderate depth pool: 4 to 8 feet.
A_3	Pool	Deep pool: greater than 8 feet.
B	Run	Habitat is characterized by minimum depths and rapid non-turbulent flows. Runs are typically too deep to be riffles, and too fast to be pools, and have few large boulders.
C	Riffle	Water velocity fast, stream depths shallow, water surface gradient moderate. Stream bed elements are small, and water flows over their surface.
D	BS Type II*	Many large boulders (6 ft. to 30 ft.) throughout stream channel with water flowing around and underneath them. Water pockets can be quite deep and extensive. Boulders form major source of both instream and overhead cover.
E	BS Type I	Small to medium boulders (1 ft. to 6 ft.) scattered throughout habitat, with water mostly flowing around them. Boulders form mostly instream cover, little overhead cover.
F	Cascade	Very steep channel gradient (usually greater than 10 percent) over a short horizontal distance.
PP	Plunge Pool	Moderately deep water pockets form below some cascades; water swirls around the pool then spills into downstream habitats. Substrate is predominantly bedrock
BS	Boulder Strewn	Habitat which is broken and dissociated because of boulders in the water column. Water can be less than 3 feet deep and can display moderate velocity and change in water surface elevation. This habitat can be very heterogeneous, comprising runs, riffles, pocket waters, and cascades.

1990) and Hawkins *et al.* (1993) classifications (CAWG-1 Characterize Stream and Reservoir Habitats Study Plan). In the case of the ALP studies, all inventories were conducted through ground surveys. Individual habitat units were measured by hip chain. Where habitats were inaccessible, lengths were estimated from areas parallel to the stream or from GPS coordinates (in the case of waterfalls or other inaccessible areas).

In order to determine whether the habitat types modeled as part of the BiCEP Project were representative or if they had changed, the habitat classifications for the two studies were compared. As part of this comparison, it was necessary to combine or summarize habitat types within each classification system to a common basis, so that habitat types and their relative contribution to each reach could be compared. To accomplish this, the results of both approaches were summarized to a reduced set of types based on that used in the BiCEP studies. In this summarization all step pools and pocket water types in the ALP studies were classified as "boulder strewn" (with the exception of Stevenson Reach, see below), and the two BiCEP "boulder strewn" types were combined into a single category. Similarly all pools and run type habitats were summarized to pools and runs, respectively, and high and low gradient riffles were combined to form a single riffle category. Table 2-2 presents habitat types that are used for comparison in this review.

2.2 PHABSIM MODELS

2.2.1 MODEL STATISTICS

Documentation of the PHABSIM models in the BiCEP report and its appendices (BSAI 1987), and other available information were reviewed for model performance statistics including velocity adjustment factors (VAFs), and the mean error of the stage-discharge relationship (Milhous *et al*. 1989). Where model outputs were not available, but the PHABSIM model computer files were available, the model decks were run using the RHABSIM version of PHABSIM to obtain the appropriate statistics. Decks were run without calibration or adjustment. According to the Instream Flow and Aquatic Systems Group (IFG), hydraulic simulation models with a mean error of the stage discharge relationship are considered "good" if the mean error is less than ten percent and "excellent" if less than five percent (Milhous *et al*. 1989). In this review, a model was considered unacceptable if its mean error was greater than ten percent. The IFG has also established acceptable tolerance levels for VAFs. These values range from 0.8 to 1.2 for three-flow velocity regression models (IFG4) (Milhous *et al*. 1989), and 0.2 to 5.0 for single flow models (IFG4a) (Bovee pers. comm. 1998). These values were used to help determine the appropriate range of flows for model extrapolation in this review.

2.2.2 MODEL FLOW RANGES

In general, well-calibrated PHABSIM models can be used to extrapolate from 0.4 of the lowest calibration flow to 2.5 times the maximum calibration flow. However, the actual reliable range may be less than or greater than this range depending on model statistics. The appropriate range of extrapolation for each model was determined based on two

Table 2-2. Comparison of BiCEP Habitat Classifications and Equivalent Big Creek ALP Summarized Habitat Types.

BiCEP Habitat Types[1]	Big Creek ALP (Summarized[2])
Pool (including A1, A2, A3, Plunge Pool)	Mid channel pool, Lateral scour pool, Plunge Pool, Dammed Pool
Run	Run, Step Run, Trench Chute, Bedrock Sheet
Boulder-Strewn (including BS, BS I and BS II)[3]	Step Pool, Pocket Water,
Riffle	High Gradient Riffle, Low gradient riffle
Cascade	Cascade

Note:
[1]-Summarized from BioSystems, Inc. 1987.
[2]-Summarized from CAWG-1 Study Plan and McCain *et al*. 1990.
[3]-Specific classifications based on size of boulder and water depth.

criteria. The first was the range of flows at which the model had appropriate VAF values. The second criterion was the flow at which the water surface elevation overtopped the endpins. Discharges that result in elevations that substantially exceed endpin elevations can result in erroneous representation of overbank flows. Discharges that result in such overbank flows should not be used without careful consideration of the potential consequences of the effect of such artifacts.

To use the BiCEP transects placed in boulder strewn habitat types in the ALP studies, it will be necessary to classify these transects into one of the ALP habitat types. While step pools and pocket waters have been identified as the likely constituents of boulder strewn habitat, these habitats are complex and may exhibit a variety of hydraulic features. In order to classify these transects into one of the ALP habitat types, we evaluated the channel profiles, stage of zero flow, water surface elevations (and depths), and the magnitude and distribution of velocities across each transect at the calibration flows. Through this evaluation, each of the boulder strewn transects was assigned to one of the ALP habitats. This classification is provided in the model results table for each reach.

3.1 LOWER BIG CREEK

The Lower Big Creek reach extends from Big Creek Powerhouse 8 upstream to Dam 5 (Figure 3-1). Channel types identified at Rosgen Level I (Rosgen 1996) during the ALP geomorphic study in this reach (CAWG-2) include a high gradient section of Aa+ channel in the lower 0.5 miles of the reach and A channel from there to Dam 5, a distance of 1.8 miles (Figure 3-2). Because of the channel morphology, the bedrock and large boulder controls, and flow regime, the basic channel type is not expected to have changed between the time of the original study and the current time

3.1.1 TRANSECT LOCATION

We were unable to determine the specific location of any of the transects in the Lower Big Creek PHABSIM study. However, based on the maps presented in the BiCEP report (BSAI 1987), the transect data were collected sufficiently far upstream to be located in the A-type channel portion of the reach (Figure 3-2). This channel type represented 71 percent of the length of the reach. Without the specific location of the transects, it is not possible to determine if channel changes occurred at the specific habitat units selected for the BiCEP study, or to take additional measurements to extend the range of any transect model. It does not appear that any transects were placed in the Aa+ portion of the reach. The Aa+-type channel was predominantly pool and cascade, which comprised 93 percent of the length of that channel type.

3.1.2 HABITAT REPRESENTATION

Based on the summarized habitat types presented in Table 2-2, habitat typing from the BiCEP study was compared to that for the ALP study. The proportion of the total length of the reach comprised by each habitat type was determined for both the BiCEP and the ALP studies. The results are presented in Table 3-1.

Table 3-1 indicates that there was reasonable agreement between the two studies based on percentage composition of the summarized habitat classifications. Most habitat types percentages agreed to within five percent. Larger differences occurred among the run and boulder strewn categories. These differences are likely due to differences in the measurement and detail of classification of individual habitat units during the BiCEP study, as well as differences in the emphasis of classification techniques during the two habitat inventory studies. The proportions of major habitat types summarized from the ALP habitat inventory are provided in Figure 3-3.

Data were collected at eight transects on Lower Big Creek for the BiCEP study. The habitat types identified for these transects were pools (n = four), runs (n = two), and "boulder-strewn" (n = two) units. The boulder-strewn classification used in the BiCEP report encompasses complex habitats such as pocket water and step pools. No transects

Figure 3-1. Map of Lower Big Creek Reach

Non-Internet Public Information

This Map has been removed in accordance with the Commission regulations at 18 CFR Section 388.112.

This Map is considered Non-Internet Public information and should not be posted on the Internet. This information is provided in Volume 4 of the Application for New License and is identified as "Non-Internet Public" information. This information may be accessed from the FERC's Public Reference Room, but is not expected to be posted on the Commission's electronic library, except as an indexed item.

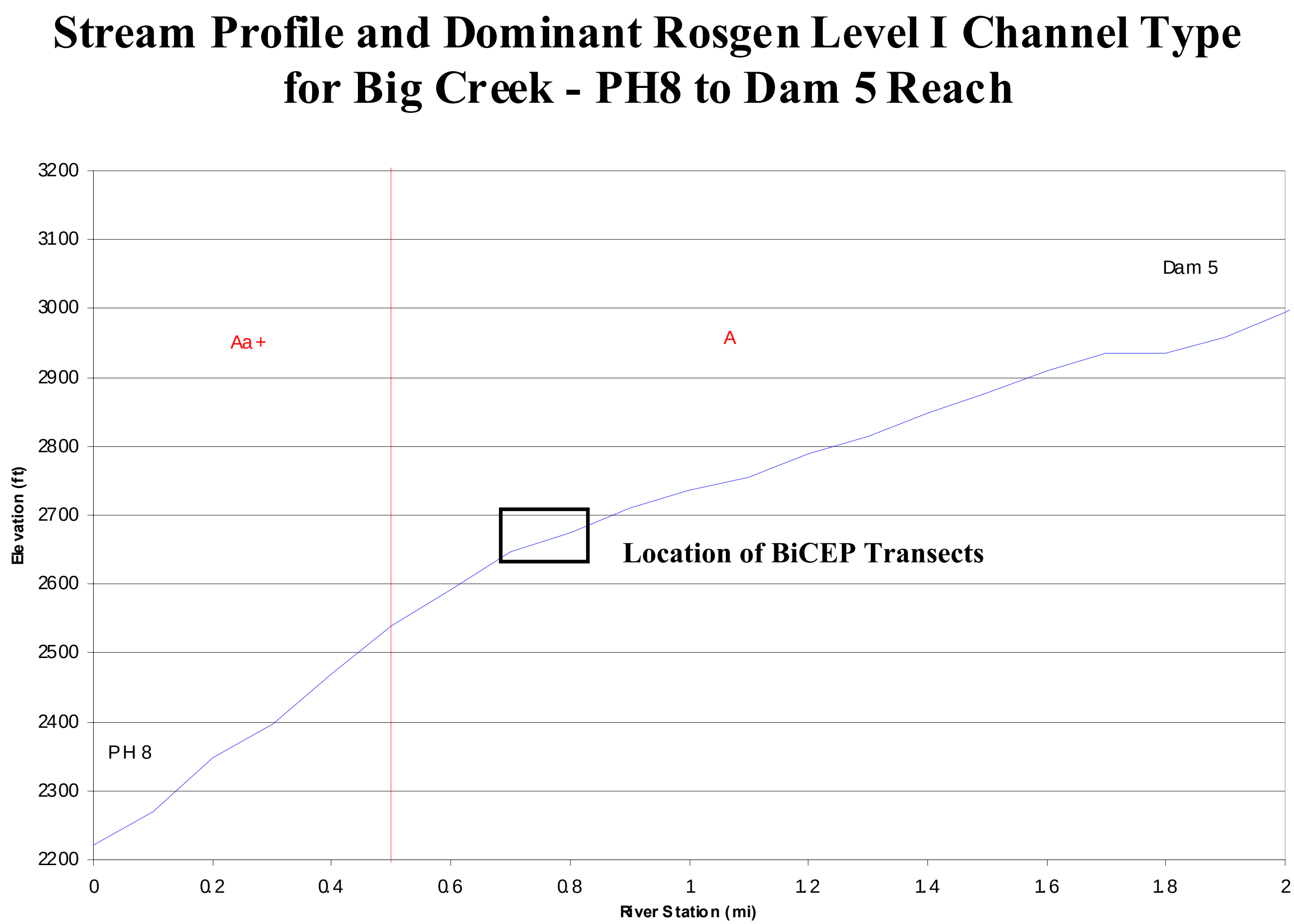
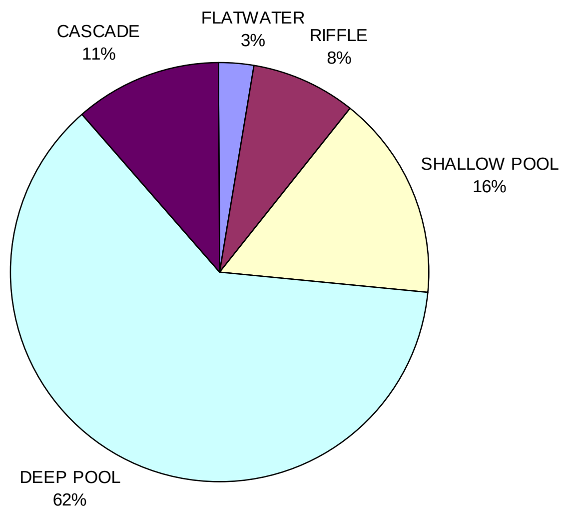


Figure 3-2. Rosgen Channel types for Lower Big Creek – Powerhouse 8 to Dam 5.

Table 3-1. Comparison of Observed Habitat Type Proportions Lower Big Creek Reach for BiCEP (1987) and ALP Habitat Typing (2000-2001).

BiCEP Habitat Type Classifications	BiCEP % Total	Big Creek ALP % Total
Pool	28.2	29.9
Run / Flatwater	19.8	6
Boulder Strewn Total	36.0	46.3
Riffle	2.2	6.4
Cascade	14.0	11.3
Other		
Total	100	100

Big Creek- PH8 to Dam 5 Reach
Channel type: A



Big Creek- PH8 to Dam 5 Reach
Channel type: Aa+

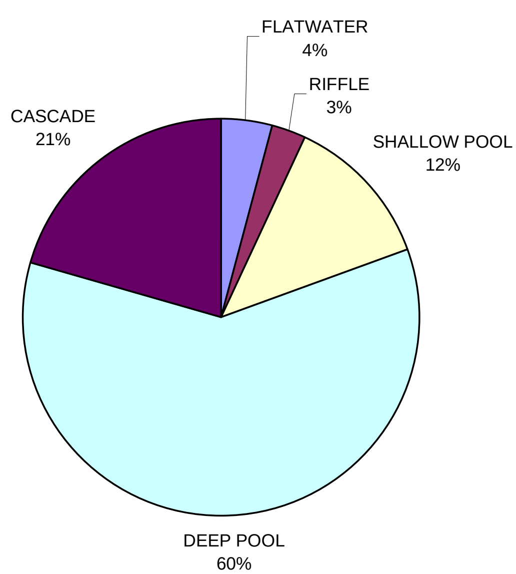


Figure 3-3. Proportion of Habitat Types by Channel Type Observed during the ALP Habitat Inventory in Lower Big Creek.

were placed in cascades due to their limited potential to provide living space for fish. No riffles were specifically represented.

In the BiCEP study, a smaller proportion of the reach was classified as riffles than in the ALP study. This was likely due to the BiCEP classification scheme, which may have included riffles within other habitat types or habitat complexes. We reviewed the channel profile of the boulder-strewn and run transects in the PHABSIM model to determine if any of those could be used to represent riffles and concluded they could not. Riffles currently represent less than 10 percent of the habitat in this reach. If riffles are needed to adequately represent the response of habitat with flow, additional transects will be needed to represent this habitat type.

3.1.3 Model Calibration Statistics and Flow Range

The calibration discharges used in the PHABSIM study ranged from 3.7 to 38.5 cfs (Table 3-2). The simulation discharges ranged from 2 to 60 cfs. At least three stage-discharge pairs and two velocity sets were collected for each transect. The IFG4 regression method was used to develop the stage-discharge relationship for each transect in this reach. This model establishes the stage-discharge relationship by regressing the log of the measured discharge against the log of the stage (minus the stage of zero flow). The mean error of the transects' stage-discharge relationships, an assessment of the strength of the stage-discharge relationship, were within recommended tolerances for all transects.

Velocity simulations in this reach were made using the IFG4a single velocity model. This is the model currently recommended by the IFG. This model uses a single set of calibration velocities and Manning's equation to simulate the distribution of velocities at alternate flow levels. One measure of the strength of the velocity simulation is the Velocity Adjustment Factors (VAFs) at each simulation flow. A VAF is the ratio of the desired simulation discharge to the calculated discharge. The calculated discharge is derived from the predicted water surface elevation and an initial set of simulated velocities. VAFs are used to adjust the initial simulated velocities so that the simulated discharge matches the measured discharge. In most cases, the (VAFs) fell within recommended tolerances for IFG4A models (0.2 to 5.0) (Bovee personal communication 1998). A few discharges at the lower range of simulations for some transects had VAFs less than 0.2 (Table 3-2). All of the discharges at the upper end of the simulation range had VAFs within recommended tolerances. Based on the available simulations and statistics, each of the transects appears to be capable of providing extrapolations to flows of 50 to 60 cfs. Consequently, based on VAFs alone, we may be able to use these models to simulate discharges higher than those used in the BiCEP study (see Hardy 2002 for additional information regarding these calibration parameters).

One factor that must be considered when determining the range of appropriate discharge simulations is the elevation of the surveyed channel profile. With few exceptions, it is not valid to simulate water surface elevations that exceed the elevation of the end points of the bed profile for a transect. We used the stage-discharge equation and the known elevation of the lowest endpoint on the channel profile to calculate this discharge. The run transects had the lowest overtopping discharge which was roughly 94 cfs. This discharge would represent the largest flow that could be reliably modeled, given acceptable statistics for VAFs and stage-discharge relationships.

Table 3-2. Transect Description and Calibration Parameters for the BiCEP PHABSIM Study on Lower Big Creek.

Calib. Velocity Set	BiCEPs Habitat Type	Transect Number	Number Stage / Discharge Pairs	Calibration Flow Range	Stage / Discharge Model Used	Stage / Discharge Model Mean Error	Low Simulation Discharge	High Simulation Discharge	Low Velocity Adjustment Factor	High Velocity Adjustment Factor	Range of Simulation Discharges w/acceptable VAFs	Q Exceeds Minimum Headpin Elevation	Successful Calibration ?	ALP Habitat Type
Hi	A1	8	3	3.7-38.5	IFG4a	1.23	12	60	0.46	1.12	12-60	291.9	Y	SP
Hi	A1	7	3	3.7-38.5	IFG4a	9.30	12	60	0.39	1.23	12-60	916.4	Y	SP
Med	A1	8	3	3.7-38.5	IFG4a	2.89	2	25	0.22	1.41	2-25	291.9	Y	SP
Med	A1	7	3	3.7-38.5	IFG4a	4.52	2	25	0.18	1.59	4-25	916.4	Y	SP
Hi	B	2	3	2.7-35.6	IFG4a	4.67	2	50	0.31	1.07	2-50	94.3	Y	FW
Hi	B	3	3	3.8-38.3	IFG4a	2.19	2	50	0.40	0.78	2-50	107.9	Y	FW
Med	B	2	3	3.7-38.5	IFG4a	0.91	2	50	0.51	1.49	2-50	94.3	Y	FW
Med	B	3	3	3.7-34.5	IFG4a	1.39	2	50	0.54	1.32	2-50	107.9	Y	FW
Lo	B	2	3	3.7-38.5	IFG4a	0.91	2	50	0.97	2.91	2-50	94.3	Y	FW
Lo	B	3	3	3.7-34.5	IFG4a	1.39	2	50	0.89	2.36	2-50	107.9	Y	FW
Hi	A2	5	4	3.7-38.5	IFG4a	6.13	2	50	0.10	1.29	5-50	172.1	Y	DP
Hi	A2	6	4	3.7-38.5	IFG4a	6.25	2	50	0.19	0.62	3.7-12	192.5	Y	DP
Med	A2	5	4	3.7-38.5	IFG4a	6.13	2	50	0.28	2.89	2-50	172.1	Y	DP
Med	A2	6	4	3.7-38.5	IFG4a	6.25	2	50	0.50	2.76	2-50	192.5	Y	DP
Hi	BS	1	3	3.7-34.5	IFG4a	0.06	2	50	0.54	1.19	2-50	154.1	Y	FW
Hi	BS	4	3	2.93-35.5	IFG4a	4.93	2	50	0.20	1.11	4.0-50	74.16	Y	SP
Med	BS	1	3	3.7-34.5	IFG4a	0.06	2	60	0.68	1.74	2-60	154.1	Y	FW
Med	BS	4	3	2.93-35.5	IFG4a	4.93	2	60	0.20	1.11	2-60	74.16	Y	SP

A1 = Pool < 4ft
A2 = Pool 4-8 ft
A3 = Pool > 8ft
B = Run
BS = Boulder Strewn
C = Riffle
D = Boulder Strewn with 6-30 ft Boulders
E = Boulder Strewn with 1-6 ft Boulders
X = Unacceptable across entire range (X<0.2; X>5.0)
UT = Unacceptable VAF Trend

3.1.4 Conclusions and Recommendations

- We do not believe that channel changes of sufficient magnitude were likely to have occurred in the Lower Big Creek reach that would invalidate the use of the BiCEP PHABSIM Models.
- Transects were placed in A-type channel. The habitat type could be identified for each transect. Each habitat type is represented in the model, with the exception of riffles. If necessary for meeting the objectives of the CAWG-3 Study, it would be feasible to model one to two representative riffle transects to represent this habitat type. It also may be feasible to utilize the riffle transect measured in the same channel type in the Upper Big Creek Reach (See below) to represent riffle habitat in this reach.
- No transects were placed in the Aa+ channel type which includes the lowest 0.5 miles of the reach. As this channel type represents nearly 30 percent of the reach, it is important for it to be represented in the models. We recommend placing three transects each in shallow pools and deep pools to represent the habitat in this channel type. Riffles and runs each comprise less than 5 percent of the total length of habitat and we do not recommend placing transects in these habitat types.
- The Lower Big Creek PHABSIM models, as modified by our recommendations, should be able to fulfill the data needs of the CAWG for characterizing flow related habitat in this reach. We believe that the range of hydraulic simulations could be expanded to approximately 85 cfs.
- We recommend that the weighting factors for the habitat models be adjusted to reflect the more recent habitat mapping observations.

3.2 Upper Big Creek

The Upper Big Creek reach extends from Big Creek Powerhouse 2 to Dam 4 (Figure 3-4). The channel type for this reach was classified as types A and B using Rosgen Level I criteria (Rosgen 1996) with B-type channel comprising less than five percent of the total reach length (Figure 3-5). The length of this reach is approximately 4.4 miles.

3.2.1 Transect Location

There were three study sites included in the Upper Big Creek study. The maps in the BiCEP report (BSAI 1987) provided the locations of these sites within the reach with sufficient detail that we were able to determine their location with respect to the Rosgen channel types identified as part of the ALP studies (Figure 3-5). Two sites were located in A-type channel and one site was located in B-type channel. The BiCEP report did not provide sufficient information to allow the relocation of the specific habitat units or the individual transects. Because we were unable to determine the exact location of the Upper Big Creek transects, it was not possible to determine if channel changes occurred at the specific habitat units selected for the BiCEP study or to re-measure or extend the range of any transect model.

Figure 3-4. Map of Upper Big Creek Reach

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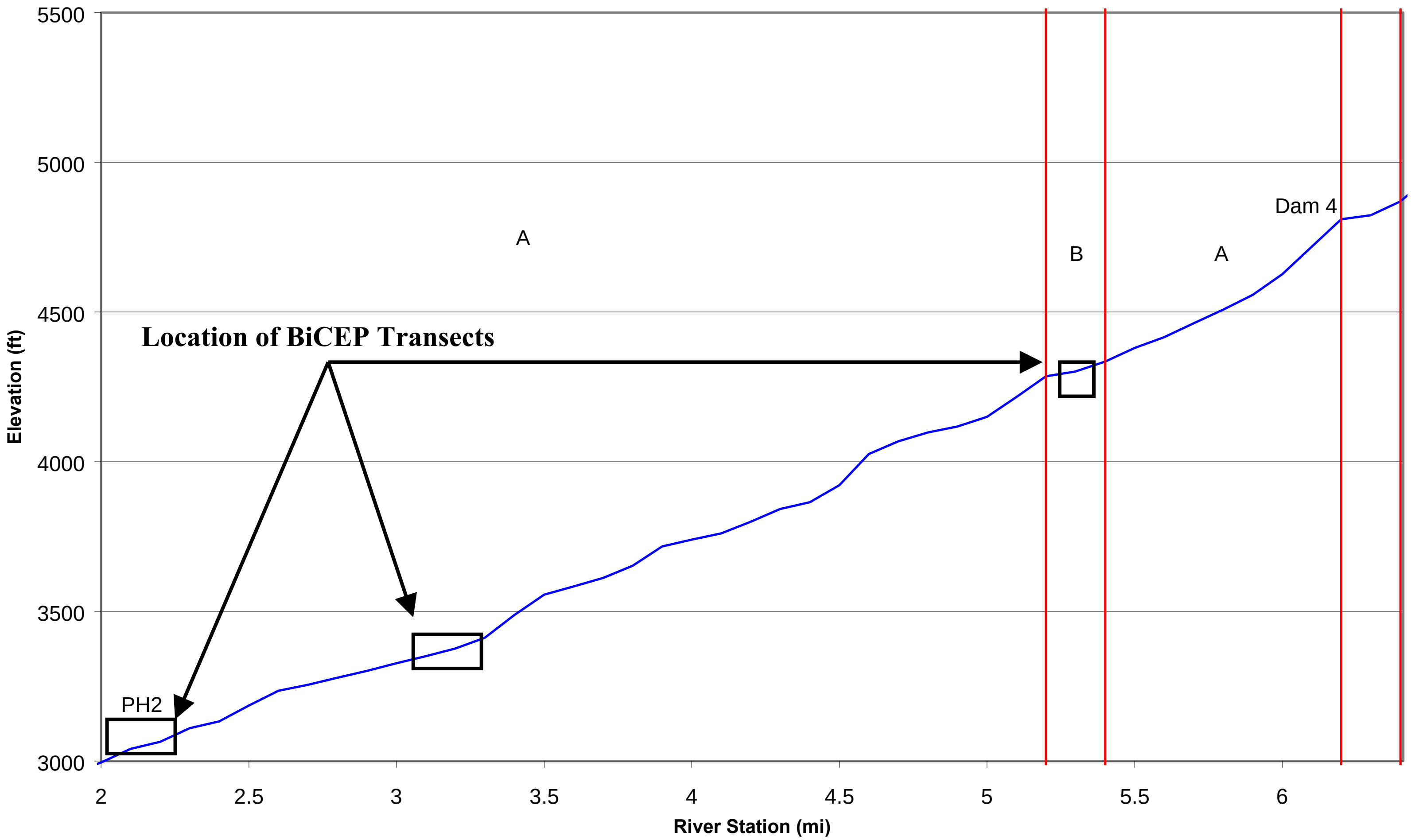


Figure 3-5. Rosgen Channel types for Upper Big Creek – Powerhouse 2 to Dam 4.

3.2.2 HABITAT REPRESENTATION

Based on the summarized habitat types presented in Table 2-2, habitat typing from the BiCEP study was compared to that for the ALP study. The proportion of the reach comprised by each habitat type was determined for both the BiCEP and the ALP studies. The results are presented in Table 3-3.

Table 3-3 indicates that there were some general similarities among the relative proportion of habitat types and some differences between the two studies. While the percentage composition of pools is similar, there were major differences in runs and lesser differences in boulder strewn, cascades and riffles. These differences are likely due to differences in the approach to measurement, as well as reduced detail of classification of individual habitat units during the BiCEP study, as well as differences in classification technique between the two surveys. The proportion of habitats observed during the ALP studies are provided in Figure 3-6.

Fifteen PHABSIM transects were installed in three sites. PHABSIM models were prepared for pools (n = eight), boulder-strewn (n = three), runs (n = three), and riffle (n = one). No transects were placed in cascades due to their limited potential to provide living space for fish. Twelve transects were placed in A-type channels and three transects (all placed in run habitat) were placed in B-type channel. Channel type was not a consideration of the BiCEP study.

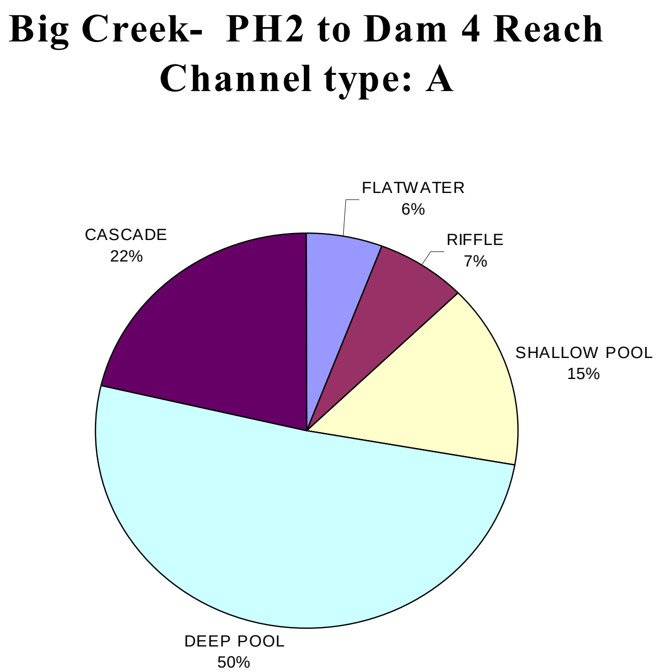
3.2.3 MODEL CALIBRATION STATISTICS AND FLOW RANGE

Three stage-discharge pairs were collected for eight of the transects and four stage-discharge pairs were collected for the remaining seven transects (Table 3-4). The IFG4 regression was used to develop the stage-discharge relationship for each transect in this reach. The IFG4A method was used to develop velocity simulation models. One velocity set was collected for each transect at the high calibration flow. The PHABSIM calibration discharges ranged between 3.3 and 21.55 cfs at Site A, 2.3 and 26.22 cfs at Site B, and 2.77 and 26.92 cfs at Site C. Simulation discharges ranged between 0.92 and 53.88 cfs. The stage-discharge regression mean errors were within acceptable ranges for all transects.

In some cases, VAFs for some transects at some flows, fell outside the range of recommended values (0.2 to 5.0) (Table 3-4). For example, the VAFs for transect A2 were below 0.2 for simulated discharges of up to 22 cfs. Transect A3 had unacceptable values for every simulation discharge. These transects represented shallow pool habitat and the IFG4A hydraulic model may not have been appropriate. Unless additional calibration can bring these VAFs within the acceptable range, transect A2 would not be considered acceptable for use at flows less than 22 cfs, and transect A3 would not be considered acceptable for use at any flow. The range of extrapolation for several other transects was limited by VAF values. These included the range of acceptable simulations for transect A5 below 8 cfs, B1 and B4 below 4 and above 35 cfs, and B3 below 12 and above 35 cfs. Limitations on the range of simulation flows for these transects would also apply, unless additional re-calibration corrected the problems. For the remaining nine transects, VAFs indicated an acceptable range of extrapolation ranging from 3 to 54 cfs.

Table 3-3. Comparison of Observed Habitat Type Proportions Upper Big Creek Reach for BiCEP (1987) and ALP Habitat Typing (2000-2001).

BiCEP Habitat Type Classifications	BiCEP % Total	Big Creek ALP % Total
Pool Total	28.3	22.7
Run / Flatwater	20.8	6.3
Boulder Strewn Total	36.0	44.3
Riffle	2.2	7.5
Cascade	12.7	19.2
Other		
Total	100	100



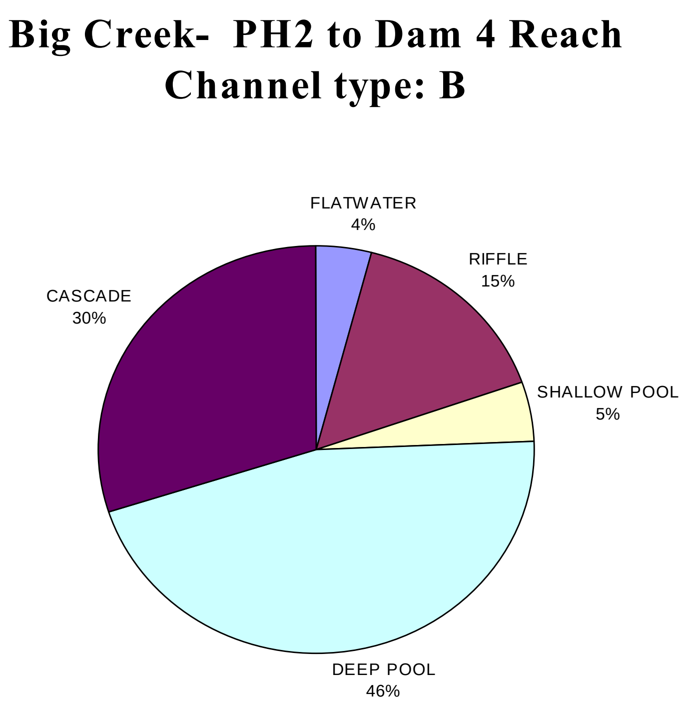


Figure 3-6. Proportion of Habitat Types by Channel Type Observed during the ALP Habitat Inventory in Upper Big Creek.

Table 3-4. Transect Description and Calibration Parameters for the BiCEP PHABSIM Study on Upper Big Creek.

BiCEPs Habitat Type	Transect Number	Number Stage / Discharge Pairs	Calibration Flow Range	Stage / Discharge Model Used	Stage / Discharge Model Mean Error	Low Simulation Discharge	High Simulation Discharge	Low Velocity Adjustment Factor	High Velocity Adjustment Factor	Range of Simulation Discharges w/acceptable VAFs	Q Exceeds Minimum Headpin Elevation	Successful Calibration?	ALP Habitat
A-type Channel													
A1	A1	3	3.3-21.55	IFG4a	2.27	3.3	21.55	0.12	1.65	3-53.88	19.4	Y	SP
A1	A2	3	3.3-21.55	IFG4a	1.19	3.3	21.55	0.03	0.35	22-53.88	43.1	Y	SP
A1	A3	3	3.3-21.55	IFG4a	5.76	3.3	21.55	0.02	0.16	X	108.1	N	-
A1	A4	3	3.3-21.55	IFG4a	6.18	3.3	21.55	0.31	1.67	1.3-53.88	70.1	Y	SP
BS	A5	3	3.3-21.55	IFG4a	0.03	3.3	21.55	0.08	0.62	8-53.88	44.6	Y	
BS	A6	3	3.3-21.55	IFG4a	6.57	3.3	21.55	0.37	1.07	1.3-53.88	24.0	Y	
BS	A7	3	3.3-21.55	IFG4a	4.36	3.3	21.55	0.21	1.32	1.3-53.88	3327.3	Y	
C	A8	3	3.3-21.55	IFG4a	6.24	3.3	21.55	0.51	1.26	1.3-53.88	1559.6	Y	RF
A2	B1	4	2.3-26.22	IFG4a	8.54	0.92	35	0.05	0.88	5.43-35	26.4	Y	DP
A2	B2	4	2.3-26.22	IFG4a	8.20	0.92	35	0.06	0.99	4-35	59.8	Y	DP
A3	B3	4	2.3-26.22	IFG4a	5.08	0.92	35	0.02	0.50	12-35	918.7	Y	DP
A3	B4	4	2.3-26.22	IFG4a	8.62	0.92	35	0.07	0.90	4-35	36.6	Y	DP
B-type Channel													
B	C1	4	2.77-26.92	IFG4a	7.88	0.92	35	0.77	1.07	1.11-67	41.6	Y	FW
B	C2	4	2.77-26.92	IFG4a	9.89	0.92	35	0.67	0.8	1.11-67	111.2	Y	FW
B	C3	4	2.77-26.92	IFG4a	6.17	0.92	35	0.14	1	2.0-67	54.7	Y	FW

A1 = Pool < 4ft
A2 = Pool 4-8 ft
A3 = Pool > 8ft
B = Run
BS = Boulder Strewn
C = Riffle
D = Boulder Strewn with 6-30 ft Boulders
E = Boulder Strewn with 1-6 ft Boulders
X = Unacceptable across entire range (X<0.2; X>5.0)
UT = Unacceptable VAF Trend

The stage-discharge equation and the elevation of the lowest endpoint on the channel profile were used to calculate the discharge at which the stage overtopped the endpoint. The extents of the Upper Big Creek channel profiles were very limited. Four of the transects, A1, A6, B1, and B4, had stages higher than the endpoint elevations at discharges of less than 37 cfs. The stage for transect A1 exceeds the endpoint elevation at 19 cfs, which was less than the high flow calibration discharge.

3.2.4 CONCLUSIONS AND RECOMMENDATIONS

- Based on available information regarding geomorphology and channel characterization, we do not believe that channel changes have occurred in the Upper Big Creek reach that would invalidate the use of the BiCEP PHABSIM Models.

- In the Rosgen Level I Analysis, the Upper Big Creek reach was classified as Type A and B and most transects were placed in the A-type channel which represented over 95 percent of the reach. Pools are represented by 9 transects, riffles by 2 transects, and runs by 1 transect. In the A-type channel, pool and riffle habitats are adequately represented, but there is only one run transect. Placing an additional run transect in this channel type is recommended.

- B channel represented less than 5 percent of the reach, but three transects were placed in runs in this channel type. Pools and riffles were not represented in the B-type channel. The need to represent these habitat types is uncertain, but as this channel type does not appear elsewhere in Big Creek the placement of two riffle and two pool transects within this channel type is recommended.

- Several transects may need additional calibration or re-calibration so that they can be used over the entire range of desired simulated flows. If acceptable VAFs cannot be obtained, we would recommend dropping transects A3 and A2 from the final models, and restricting the downward range of extrapolation to 4 cfs.

- The Upper Big Creek PHABSIM models with recommended modifications should fulfill the data needs of the CAWG for characterizing flow related habitat within a range of discharges from 3 to 50 cfs. Where simulations are needed for discharges greater than 20 cfs, it is recommended that several transects be removed from the simulation. However, there would still be transects remaining in all habitat types. Additionally, since transects in both the Upper and Lower Big Creek reaches were collected from the same channel type and from reaches subject to similar geomorphic influences, it may be possible to apply models of Lower Big Creek Reach transects to the Upper Big Creek Reach to extend the range of simulated flows.

- If the CAWG determines that the models are appropriate for use, it is recommended that the weighting factors for the habitat models be adjusted to reflect the more recent habitat mapping observations.

3.3 SAN JOAQUIN RIVER (MAMMOTH REACH)

The Mammoth Reach of the San Joaquin River extends from Mammoth Pool Dam to Mammoth Pool Powerhouse (Figure 3-7). In the Rosgen Level I analysis (Rosgen 1996), it was determined that the channel types present in this reach are B and G (Figure 3-8).

Figure 3-7. Map of the Mammoth Pool Reach of the San Joaquin River

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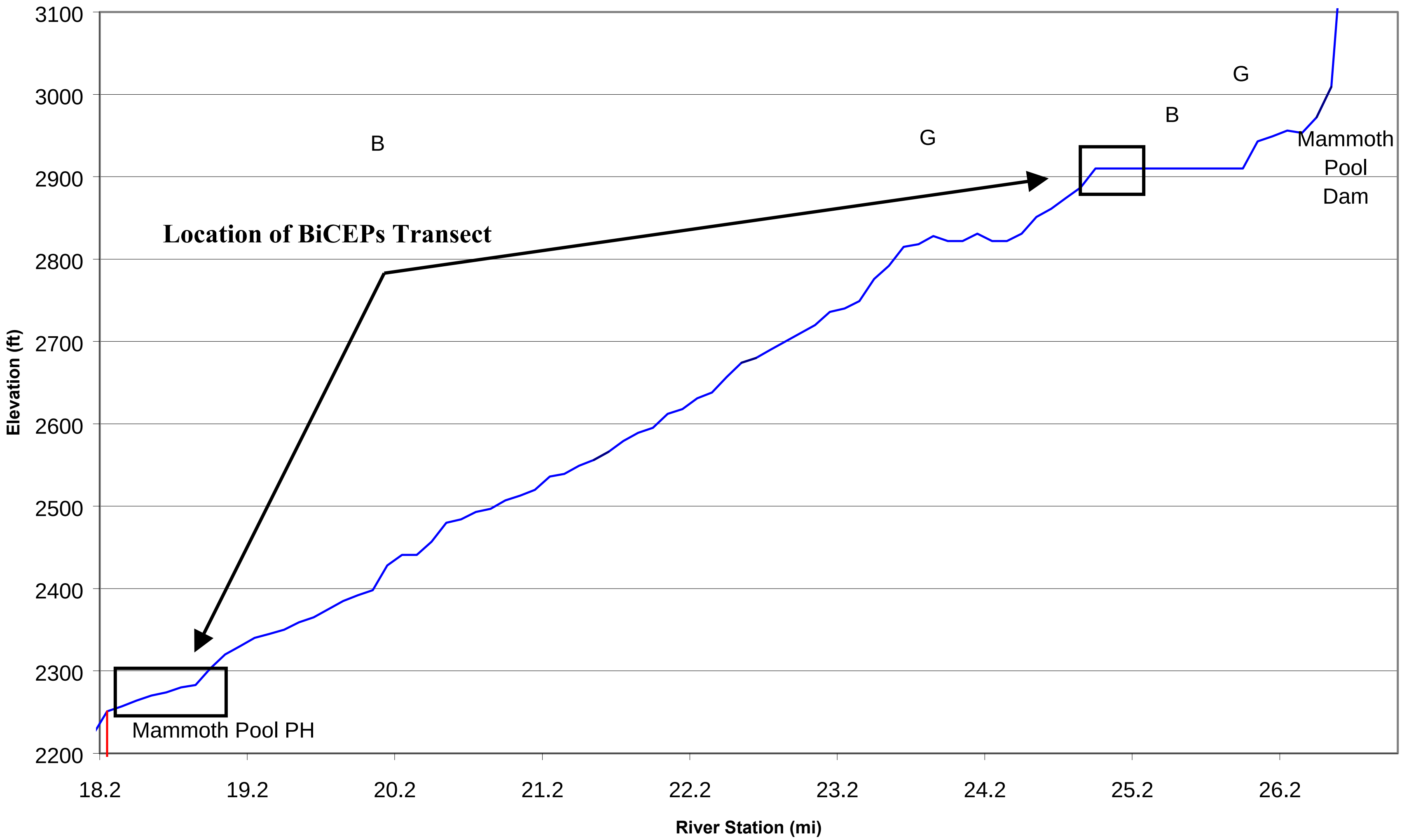


Figure 3-8. Rosgen Channel Types for the Mammoth Pool Reach San Joaquin River.

The reach is approximately 5.8 miles long with about 54 percent of the reach length being B channel.

3.3.1 Transect Location

The Mammoth Pool report (BSAI 1985) provided fairly detailed maps of the location of the transect sites, including the specific habitat units in which the transects were located. These maps indicate the transects were placed in two sites. One site with ten transects was placed in the B-type channel and the other site with fourteen transects was located in the G-type channel. The specific habitat units in which the transects were placed could be relocated and revisited if the CAWG finds this necessary.

The nature and substrate composition of the channel makes it unlikely that substantial changes in channel form or structure would have occurred since the BiCEP studies were completed. The similarity of the two sets of habitat information (discussed below) suggests that the proportions of habitat types did not change significantly. The level of detail in the report was not sufficient to allow relocation of the individual transects, however. Therefore it is not possible to determine if changes occurred at the specific transects modeled for the BiCEP study.

3.3.2 Habitat Representation

Based on the habitat types in Table 2-2, habitat typing from the BiCEP study was compared to that for the ALP study. Unlike the Big Creek reaches previously discussed, the BiCEP habitat typing in the Mammoth Pool and Stevenson reaches was based on aerial photography, rather than ground-level typing. These habitat types were summarized based on the proportion of total length in Table 3-5, where they are compared with the more recent habitat inventory conducted as part of the ALP process.

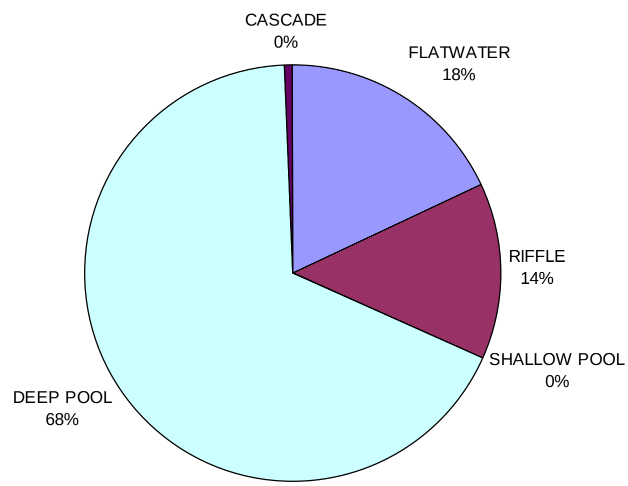
Table 3-5 indicates that a similar relative proportion of each habitat type was observed during the two studies. The principal differences between the two studies lie in the proportional abundance of riffles and cascades. The proportional abundance of these two habitat types essentially was reversed between the two studies. This difference is likely due to the use of aerial photography in the BiCEP study rather than the ground measurement approach used in the ALP study. The proportional representation of the habitat types in the ALP study is provided in Figure 3-9.

For the Mammoth Reach PHABSIM study, transects were installed on pools (n = 14), runs (n = three), riffles (n = two), and boulder strewn units (n = four) (BioSystems Analysis, Inc. 1987)(Table 3-6). Transect 10, which was shown on the maps for the more downstream BiCEP site, was not included in the models available for that site. In the B-type channel there were five (5) pool transects, two (2) run transects, and two (2) boulder-strewn transects. Review of the channel profile and calibration velocities and water surface elevations indicates that the one of the boulder strewn habitat types likely represents run habitat and that the other represents riffle habitat. In the G-type channel there were 9 pool transects, 2 riffle

Table 3-5. Comparison of Observed Habitat Type Proportions Mammoth Reach for BiCEP (1987) and ALP Habitat Typing (2000-2001).

BiCEP Habitat Type Classifications	BiCEP % Total	Big Creek ALP % Total
Pool	47.4	42.1
Run / Flatwater	7.9	7.1
Boulder Strewn	30.3	35.7
Riffle	3.4	13.8
Cascade	11	1.2
Other		
Total	100	100

San Joaquin River- Mammoth Reach
Channel type: B



San Joaquin River- Mammoth Reach
Channel type: G

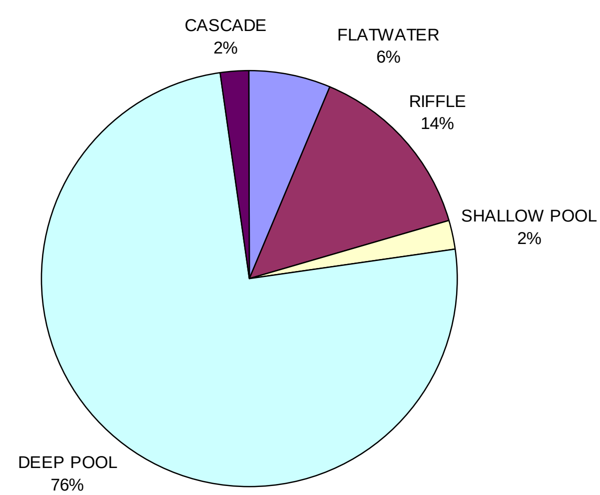


Figure 3-9. Proportion of Habitat Types by Channel Type for the Mammoth Pool Reach based on ALP Studies.

Table 3-6. Transect Description and Calibration Parameters for the BiCEP PHABSIM Study on the Mammoth and Stevenson Reaches of the San Joaquin River.

Habitat Type	Transect Number	Number Stage / Discharge Pairs	Calibration Flow Range	Stage / Discharge Model Used	Stage / Discharge Model Mean Error	Low Simulation Discharge	High Simulation Discharge	Low Velocity Adjustment Factor	High Velocity Adjustment Factor	Range of Simulation Discharges w/acceptable VAFs	Q Exceeds Minimum Headpin Elevation	Successful Calibration?	ALP Habitat
B-type Channel													
E	1	3	28.2-178.5	IFG4	1.68	10	450	0.57	1.28	10-450	670.7	Y	RF
E	2	3	28.2-178.5	IFG4	0.04	10	450	0.68	1.06	10-450	368.4	Y	RN
B	3	3	28.2-178.5	IFG4	1.78	10	450	0.11	0.66	40-450	662.1	Y	FW
A1	4	3	28.2-178.5	IFG4	0.56	10	450	0.04	0.44	120-450	294.8	Y	SP
A1	5	3	28.2-178.5	IFG4	0.64	10	450	0.10	0.84	40-450	580.2	Y	SP
B	6	3	28.2-178.5	IFG4	2.25	10	450	0.19	0.89	15-450	643.0	Y	FW
A3	7	3	28.2-178.5	IFG4	2.78	10	450	0.01	0.27	15-450	323.6	Y	DP
A3	8	3	28.2-178.5	IFG4	2.31	10	450	0.02	0.54	120-450	354.1	Y	DP
A1	9	3	28.2-178.5	IFG4	7.03	10	450	0.17	1.18	15-450	399.9	Y	SP
G-type Channel													
A3	11	3	23.2-173.5	WSP	0.27	10	450	0.00	0.03	350-450	1558.3	Y	DP
A3	12	3	23.2-173.5	WSP	0.27	10	450	0.00	0.11	X	1558.3	N	DP
A3	13	3	23.2-173.5	WSP	0.27	10	450	0.00	0.10	X	1558.3	N	DP
A2	14	3	23.2-173.5	IFG4	1.85	10	450	0.08	0.72	60-450	445.7	Y	DP
A1	15	3	23.2-173.5	IFG4	1.85	10	450	0.06	0.73	60-450	445.7	Y	SP
C	16	3	23.2-173.5	IFG4	1.60	10	450	1.29	2.12	10-450	487.5	Y	RF
A1	17	3	23.2-173.5	IFG4	0.15	10	450	0.15	1.30	15-450	436.9	Y	SP
A2	18	3	23.2-173.5	WSP	0.15	10	450	0.01	0.19	X	224.9	N	DP
A2	19	3	23.2-173.5	WSP	0.15	10	450	0.01	0.20	X	319.5	N	DP
A2	20	3	23.2-173.5	WSP	1.01	10	450	0.04	0.84	80-450	392.4	Y	DP
D	21	3	23.2-173.5	IFG4	0.61	10	450	0.86	2.68	10-450	324.2	Y	FW
D	22	3	23.2-173.5	IFG4	2.57	10	450	0.53	1.64	10-450	362.8	Y	FW
B	23	3	23.2-173.5	IFG4	3.28	10	450	0.26	0.86	10-450	327.1	Y	FW
C	24	3	23.2-173.5	IFG4	6.62	10	450	3.31	2.68	UT	290.0	N	RF

A1 = Pool < 4ft
A2 = Pool 4-8 ft
A3 = Pool > 8ft
B = Run
BS = Boulder Strewn
C = Riffle
D = Boulder Strewn with 6-30 ft Boulders
E = Boulder Strewn with 1-6 ft Boulders
X = Unacceptable across entire range (X< 0.2; X>5.0)
UT = Unacceptable VAF Trend

transects, 1 run transect and 2 boulder strewn transects. These boulder strewn transects would likely be used to represent run habitat based on channel profile, and calibration velocities and water surface elevations.

The pool transects used in the BiCEP study appear to be uncharacteristically wide, ranging from 73 to 100 feet at a flow of about 25 cfs. During the ALP habitat inventory, the pools appeared to have a bimodal distribution of widths, with modes at 40 to 50 feet and the other at the 70 to 80 feet. The BiCEP model appears to capture only the large pool widths. We therefore recommend adding four transects in pools with widths of about 40 to 50 feet.

Based on this review, we conclude that all of the summarized habitat types present in the reach in 2001 were represented in the BiCEP study. If these models are used for future analyses, "weighting factors" for the habitat types will need to be adjusted to represent the proportions measured in the ALP study.

3.3.3 Model Calibration Statistics and Flow Range

Three stage-discharge pairs and three sets of velocity measurements were collected for each of the 23 transects in this reach (Table 3-6). The calibration flows ranged from 23.2 to 178.5 cfs. Simulation discharges at these transects ranged from 10 to 450 cfs. The IFG4 regression method (Milhous *et al.* 1989) was used to develop a stage-discharge model for all but 6 transects. The Step Backwater method (Water Surface Profile model, WSP) was used for the remaining pool transects (11, 12, 13, 18, 19, and 20). Mean errors for all of the models were within acceptable limits.

The IFG4 velocity regression method was used to simulate velocities for the Mammoth Pool transects. In this method, the measured velocities within each cell at the calibration flows are regressed against the calibration flow to develop velocity predictions at simulated flows. When using this method, the IFG recommends that the range of simulated flows be limited to those where the VAFs fall between 0.8 and 1.2. Based upon this criterion, several transects (12, 13, 18, and 19) had unacceptable VAFs across the entire range of simulations. For transect 24 the trend for VAF values did not increase with discharge as recommended by the Instream Flow Group. For many other transects, the range of simulation flows was constrained by unacceptable VAF values.

The three-flow IFG4 model is no longer recommended by the IFG. The extrapolations obtained from this model are considered less reliable than the currently recommended IFG4A approach. If the IFG4 model were to be used, three transects would be unacceptable for use at any flow, sixteen transects would be constrained at lower flows, and four transects would be constrained at higher flows. Only six transects would be acceptable over the entire range of flows used in the BiCEP study. We recommend recalibrating those transects using the IFG4A model to determine if better velocity simulations can be obtained.

The stage-discharge equation and the elevation of the lowest endpoint on the channel profile were used to calculate the discharge for which the stage elevation was greater than the endpoint. The stage for transect 18 exceeds the elevation of the endpoint at about 225 cfs and the headpins of two other transects are inundated at a flow of less than 300 cfs. Ten of the 23 transects exceed the lowest endpoint at discharges less than 375 cfs. It is common, in PHABSIM models, to simulate discharges up to a least 2.5 times the high flow calibration measurement (in this case 435 cfs). Depths and velocities at flows this high may not be reliably simulated for these ten transects. However, the highly incised nature of much of the reach may allow for some additional extrapolation after inspection of locations in the field.

The Mammoth reach of the San Joaquin River has been identified as having potential value for whitewater boating. Whitewater boating flows have been identified as being in the range of 600-1,500 cfs. Flows of this magnitude occur regularly in this reach and would be of concern, only if releases were proposed during times of year when they would not normally occur. In order to evaluate the effects of out of season whitewater flows on fish habitat, it will be necessary to add additional transects, given the range of extrapolation possible for the existing models. Any new transects placed should consider the potential need to collect information to address whitewater flows from the standpoint of accessibility, feasibility of collecting information and safety.

3.3.4 Conclusions and Recommendations

- The proportion of summarized habitat types observed in the BiCEP study is similar to the types recorded in the ALP study. This, coupled with the geomorphology of the reach lead us to believe that channel changes have not occurred in the Mammoth reach that would invalidate the use of the BiCEP PHABSIM Models.

- Transects were placed in both channel types present in the reach (Types B and G). All habitat types were represented in the G-type channel. However, the pool transects appear to represent wide pools. We recommend the placement of four transects in narrower pools to represent these more common pool elements. In the B-type channel, riffle habitat was not represented and therefore it is proposed that two transects be added to represent this habitat type. Deep pools in this channel type represent 70 percent of the habitat, but are represented by only two transects. It is therefore proposed to add two transects to this habitat type, to improve its representation.

- We recommend attempting re-calibrating the models as IFG4A. This would likely improve the utility of most transects. The transects in this reach were modeled using the IFG4 modeling approach which is no longer recommended by the IFG. As a result, many transects had unacceptable VAFs over some range of flows. The BiCEP report noted that an IFG4A method might perform better than the three-flow regression IFG4 method used in that study.

- The extent of the channel profile surveys for transects in this reach constrains the upper limit of appropriate discharge simulations for many of them. Based on current information, the upper limit of extrapolation should be limited to 350 cfs to avoid the need to eliminate too many transects.

- We believe that the Mammoth reach PHABSIM models will fulfill the data needs of the CAWG for characterizing flow related habitat at a more limited range of discharges than those used in the BiCEP study. If simulations are needed for discharges greater than 350 cfs, field inspection of habitat units and, potentially, additional transects may be necessary to represent habitats at those flows.

- The upper range for simulation discharges is insufficient to model flow related habitat under potential out of season whitewater flow releases (600 to 1,500 cfs for this reach, based on information provided from the ALP Recreation Group). Supplemental transects would be needed to study habitat conditions under those flows. However, the number of transects would probably not need to be as numerous and the range of flows to be studied could be restricted to the potential out of season whitewater flow release range. We would recommend placing five to eight transects for this purpose. Those transects would be used to investigate specific concerns of the CAWG with respect to high flows.

- We recommend that the weighting factors for the habitat models be adjusted to reflect the more recent habitat mapping observations.

3.4 San Joaquin River (Stevenson Reach)

The Stevenson Reach of the San Joaquin River extends from Powerhouse 3 to Dam 6 (Figure 3-10). In the Rosgen Level I analysis it was determined that the channel type for this reach was G.

3.4.1 Habitat Representation

Based on the summarized habitat types presented in Table 2-2, habitat typing from the BiCEP study was compared to that for the ALP study. The proportion of the total length of the reach comprised of each habitat type was determined for both the BiCEP and the ALP studies. The results are presented in Table 3-7.

In this reach it appears that in the BiCEP study, the habitat units the ALP study categorized as step pools were classified as pools rather than as boulder strewn habitats. This may be the result of the larger channel size in relation to the boulders in this reach relative to smaller streams like Big Creek and Stevenson Creek. This difference is reflected in Table 3-7. With the step pools shifted to the pool category, the proportional abundance of habitat types is similar between the two studies. The largest discrepancy was an 8 percent difference in flatwater habitat. The proportional representation by habitat type for the ALP study is presented in Figure 3-11.

No transects were installed in the Stevenson Reach of the San Joaquin River (BSAI 1987). The Mammoth Pool Reach transects were re-weighted to reflect the habitat composition of the Stevenson reach and used to calculate WUA the Stevenson Reach. This approach appears to be reasonable from a geomorphic perspective as the two reaches were shaped by the same events in the same type of geology. As discussed above, the Mammoth Pool transects were located in both G and B Rosgen channel types. To represent habitat in the Stevenson Reach, all of the Mammoth Pool transects from both channel types were used. We would recommend not using the transects from the B-type channel to represent the Stevenson Reach, which is G-type channel.

All of the habitat types present in the Stevenson reach were represented in the Mammoth Reach transects located in the G-type channel. Therefore models could be created from the Mammoth transects without the placement of additional transects, providing other factors were similar.

Figure 3-10. Map of Stevenson Reach – San Joaquin River

Non-Internet Public Information

This Map has been removed in accordance with the Commission regulations at 18 CFR Section 388.112.

This Map is considered Non-Internet Public information and should not be posted on the Internet. This information is provided in Volume 4 of the Application for New License and is identified as "Non-Internet Public" information. This information may be accessed from the FERC's Public Reference Room, but is not expected to be posted on the Commission's electronic library, except as an indexed item.

Table 3-7. Comparison of Observed Habitat Type Proportions in the Stevenson Reach for BiCEP (1987) and ALP Habitat Typing (2000-2001) with Step Pools Classified as Pool Habitat.

BiCEP Habitat Type Classifications	BiCEP % Total	Big Creek ALP % Total
Pool Total	69.9	73.4
Run / Flatwater	9.0	0.2
Boulder Strewn Total	15.0	13.4
Riffle	4.0	9.7
Cascade	2.0	3.3
Other	-	-
Total	100	100

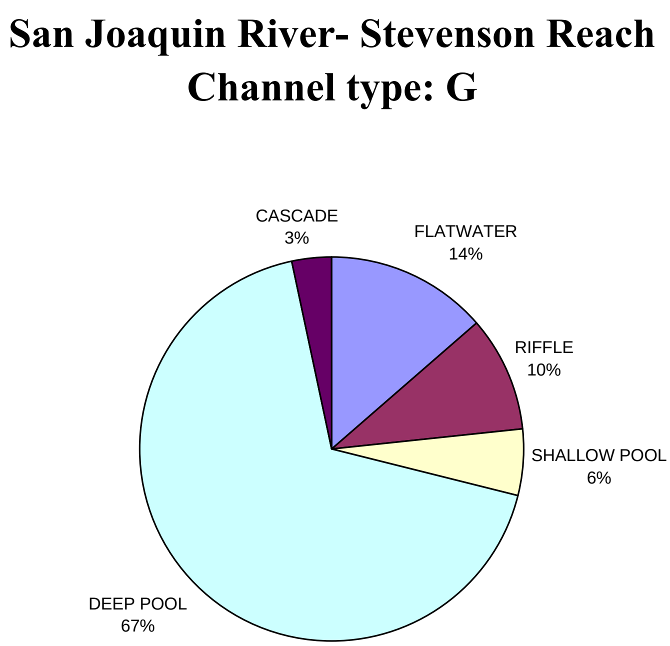


Figure 3-11. Proportion of Habitat Types by Channel Type for the Stevenson Reach based on ALP Studies.

Both reaches had G-type channel, indicating similar gradient, level of confinement, sinuosity, and substrate. The habitat composition of the two reaches are also similar (Table 3-8). To verify that the channel dimensions were similar, the widths and depths of the different habitat types (from the ALP habitat inventory) were compared to those of the Mammoth Pool transects. This indicated that the average width and depth of flatwater and riffle transects were similar to the values indicated in the habitat inventory. For pools, the transect depths were similar to average depths from the habitat inventory, but the average widths were substantially wider. In the Stevenson Reach the large majority of pools were less than 45 feet wide. The addition of transects in the narrow pools in the Mammoth Pool reach would allow better representation of pools in the Stevenson Reach as well.

Based on the similarity in channel type (gradient, entrenchment, substrate size), average width, average depth, and maximum depth it appears that the two reaches are quite comparable. Therefore, it appears that the using the 14 Mammoth Reach G-type channel transects represent the Stevenson Reach of the San Joaquin River is appropriate.

All recommendations made for the Mammoth Reach transects would apply to the specific models used to represent the Stevenson Reach as well. The “weighting factors” for habitat types should be adjusted to represent the proportional representation recorded in the present ALP studies. The Stevenson Reach is also being considered for whitewater rafting flows. This portion of the river is home to hardhead, a USFS and CDFG sensitive species, as well as a community of native transition zone fish whose range has been greatly diminished. If whitewater flows are to be implemented in this area, then the impacts of these flows would need to be addressed.

Table 3-8. Habitat Composition of Stevenson and Mammoth Reaches of the San Joaquin River based upon Habitat Inventories Conducted in 2000-2002.

Channel Type	Stevenson	Mammoth
Habitat Classification	**Percent**	**Percent**
Flatwater	14	6
Riffle	10	14
Shallow Pool	6	2
Deep Pool	68	75

This report has provided a review of the PHABSIM models developed as part of the BiCEP project. The purpose of this evaluation was to determine if these models could be used to address the informational needs of the CAWG for the Big Creek ALP. This review evaluated the representation of the geomorphic channel types and habitat types of the BiCEP models in relation to current information regarding these characteristics in the ongoing ALP. It also evaluated the hydraulic simulations of the models and evaluated their performance based on several commonly accepted standards.

The CAWG plan provided several specific questions to be answered with regard to each of the BiCEP models. These included:

1. Have channel changes occurred that would affect the validity of the use of the models?

    The geomorphic characteristics of the project reaches make it unlikely that there have been channel changes of such magnitude that they would invalidate the use of the models. While it was impossible to revisit and measure transects to confirm that the channel profiles were the same, a comparison of habitat inventories conducted as part of the BiCEP and ALP studies indicates that the proportion of habitat types is quite similar.

2. Is the habitat type identified for each transect included in the models?

    The habitat type of each transect was explicitly provided. For transects in boulder strewn habitat types, a review of the transect cross section, water surface elevation, stage of zero flow, and velocity distribution allowed us to categorize these transects with in the habitat types used in the ALP.

3. Do the transects provide an accurate representation of the habitat types currently found in the reaches?

    The BiCEP transects generally represented the habitat types present in the project reaches. In a few cases, a specific habitat type or channel type was not represented or under-represented and we have recommended the addition of transects to remedy this situation.

4. Are the transects representative of channel-types and mesohabitat types?

    With some additional transects, the BiCEP transects provide representation of all the major channel and mesohabitat types.

5. Do the model statistics for mean error and velocity adjustment factors fall within acceptable boundaries?

With the exception of Mammoth Pool, the models generally meet commonly accepted performance standards. We have recommended the recalibration of the Mammoth Pool transects using the IFG4a methodology that is now recommended by the IFG. A few other transects may need additional calibration to increase the range of flows that they can simulate.

6. Does the range of acceptable simulation flows in these models meet those needed for the current study or can they be extended to meet this range?

    The models appear to be capable of representing habitat over the range of flows most likely to be of interest to the CAWG. The exception would be if out-of-season whitewater recreation flows are proposed. If such releases are contemplated, then additional transects would need to be added to represent habitat conditions at these flows. The current models would be unreliable at that range of flows.

Based on this review, it appears that the BiCEP transects will meet the informational needs of the CAWG, although some transects must be added to represent channel types and habitat types that were not represented in the BiCEP study. A list of proposed transect additions is presented in Table 4-1.

In addition to the addition of these transects, this review provided several other recommendations. The more important of these include:

- Re-calibrating the Mammoth Pool Reach transects using the IFG4a approach, which is now recommended by the IFG.
- Conducting additional calibration of several transects in the Upper Big Creek Reach to bring VAFs to acceptable levels.
- Limiting the upper range of flow simulation to 35 cfs for the Upper Big Creek transects and to 350 cfs for the Mammoth Pool transects. If necessary flows higher than 35 cfs in Upper Big Creek could be simulated through the removal of some transects, through the use of the Lower Big Creek transects, or some combination of these techniques. Simulation of higher flows in the Mammoth Pool reach will require additional transects.
- Accepting the use of the Mammoth Pool transects in G-type channel to represent habitat in the Stevenson Reach, as was done for the BiCEP study.
- Re-weighting the transects in all reaches to reflect the results of the current habitat inventory conducted as part of the ongoing Big Creek ALP.

Table 4-1. Recommended New Transects to Supplement BiCEP PHABSIM Study.

Rosgen Channel Type	Habitat Type	Number of New Transects
Lower Big Creek		
A	Riffle	2
Aa+	Shallow Pool Deep Pool	3 3
Upper Big Creek		
A	Riffle Deep Pool	1 3
B	Riffle Deep Pool	2 2
Mammoth Pool		
B	Riffle Deep Pool	2 2
G	Deep Pool (40 to 50' wide)	4

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APPENDIX C

PHABSIM METHODS

APPENDIX C - PHABSIM METHODS

1.1 INTRODUCTION

This appendix provides a more detailed description of the methods used for the PHABSIM studies, including field data collection and model calibration. Each of the tables and figures referred to in this appendix appear in the main document. The reader should refer to the cited figure or table there. The more important elements of the PHABSIM Methods are provided both here and in the main text of the report.

1.2 CONSULTATION

Consultation for CAWG 3 studies has mainly occurred during CAWG meetings, which are held approximately monthly as part of the ALP. Consultation regarding the instream flow studies was initiated in May 2000 when the process of developing specific study plans was initiated and continues through the present. The CAWG and its subgroups were the primary developers of the study plans. Discussions regarding the specific details of the PHABSIM studies commenced in fall 2001. A brief overview of meeting topics is provided in Table CAWG 3-2. Copies of the approved meeting minutes are provided in Appendix A. All major decisions were made after discussion and approval by the CAWG[1].

1.2.1 TRANSECT PLACEMENT

During consultation, substantial discussion occurred regarding the number of transects required and their placement within the study reaches. These discussions took place between September 2001 and October 2002. The CAWG found the initial approach proposed by ENTRIX, for upper basin streams, to be acceptable in late 2001. In this approach, the study streams were stratified by Project feature or major tributaries and by Rosgen channel type[2]. Rosgen channel types representing less than five percent of the study segment were not sampled. Within each of these strata, transects were placed in each mesohabitat type[3] (riffle, pool, run) that represented more than five percent of the total length of that strata. Two transects were placed in riffles and runs and three transects were placed in deep and shallow pools. This approach was used for transects placed in Bear Creek in fall 2001. In September 2002, the subject of

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[1] In the rare case where full agreement between CAWG participants was not obtained, the dissenting party is identified in the meeting notes for the meeting in which the decision was reached.

[2] Rosgen (1996) defined channel types to describe the morphology and likely response pattern of a stream section based on channel shape, level of entrenchment, sinuosity and other factors.

[3] A mesohabitat unit is a hydraulically similar section of stream differentiated from adjoining units by features such as hydraulic controls, gradient, and turbulence. These mesohabitat units are used by aquatic organisms for shelter, feeding, spawning, and rearing. Mesohabitats were identified using methods described by USFS R-5's Fish Habitat Relationships Technical Bulletin (McCain et al. 1990) as part of CAWG 1 (SCE 2003b) and Hawkins et al. (1993). Full descriptions of the mesohabitat types found in each reach can be found in the CAWG 1 report.

transect selection was revisited by the CAWG. After extensive discussion a memo with a finalized protocol was drafted and approved by the CAWG. A copy of this memo is included in Appendix A. The field transect selection was summarized for the CAWG during the January 8, 2003 meeting. At this time, the members of the CAWG Transect Selection Team (CTST) expressed that they felt that in all reaches the transects selected were representative of the habitat types present and adequate to meet the needs of the study and the CAWG approved the transects for data collection.

1.2.2 BiCEP Model Review

A second major topic of the discussion by the CAWG was the use of PHABSIM models previously developed in the 1980s for the Big Creek Expansion Project (BiCEP)(BioSystems, Inc. 1987). The ALP reaches for which BiCEP PHABSIM models were available were the Mammoth Pool and Stevenson reaches of the San Joaquin River, and upper (Dam 4 to Powerhouse 2) and lower (Dam 5 to Powerhouse 8) Big Creek. In the BiCEP study, the Stevenson Reach of the San Joaquin River was modeled using the transects from the Mammoth Pool Reach. The BiCEP study did not place any PHABSIM transects in the Stevenson Reach.

The Study Plan called for these models to be reviewed and used in the ALP if they would meet the information needs of the CAWG. A review of these models was conducted and presented to the CAWG in July 2002 and a report was issued (ENTRIX 2002, Appendix B). This review was considered by the CAWG and approved in October 2002. In the Mammoth Pool reach, the habitat units in which the transects were placed were relocated using maps and aerial photography. These habitat units were reviewed in the field by the CTST for potential utilization within the current Big Creek PHABSIM study. The CTST agreed that the BiCEP transects were representative of the habitat in this reach in general, although the habitat type at BiCEP transect 16 had changed since the BiCEP study. This transect was dropped from consideration and replaced with a new transect. The CTST selected several additional transects to supplement the BiCEP models. With these additions, the CTST agreed that the combined transects (BiCEP and new) were sufficient for modeling this reach (October 2002).

In the Stevenson Reach of the San Joaquin River, the CTST found highly complex habitat that was generally unsuitable for modeling. Water flowed under and around large boulders, so that the hydraulic regime theory, the underpinning basis for all open-channel hydraulic models, did not apply. The CTST found this reach to be substantially different from the Mammoth Reach, and that it could not be represented by the transects placed in that reach. An exception to this was for confined deep pool transects in the Mammoth Reach, which the CTST agreed could be used to represent deep pool habitat in the Stevenson Reach. The CTST placed six new transects in this reach to represent habitat, although it was acknowledged that the units where the transects were placed were not typical of the overall stream reach, but were the best available in that reach that could be modeled using PHABSIM.

The BiCEP transects in Big Creek below Dam 4 and Big Creek below Dam 5 could not be relocated from the information available in the BiCEP reports. Consequently, the CTST placed new transects to represent all habitat types in these reaches.

1.2.3 Calibration Flows

A third major topic of discussion with the CAWG was the selection of the calibration flows at which measurements would be made in each reach. This topic was initially addressed at the April 17, 2003 CAWG meeting. The basic approach for selecting flows considered current minimum flow requirements and unimpaired summer flows in each reach. Calibration flows were then selected that would enable the PHABSIM models to span the range between the current minimum flow and the median unimpaired summer flow (as estimated at that time[4]) as it was expected that flow negotiations would likely fall within this range in setting minimum flows for the new license.

1.2.4 Habitat Suitability Criteria

The final major topic of discussion with the CAWG was the selection of habitat suitability criteria (HSC). This discussion occurred between October 2003 and the present. While agreement has been reached on most of the criteria by all parties, the USFWS has developed its own HSC, based on data from the Upper American River Project, that it plans to apply in the Big Creek system. All of the other parties have agreed to the Big Creek ALP Criteria presented in Section 3.3 of this document[5].

1.3 PHABSIM

The Instream Flow Incremental Methodology (IFIM) was developed by the U. S. Fish and Wildlife Service's (now part of the U.S. Geological Survey) Instream Flow Group (IFG) as a tool to facilitate communication and negotiation between fisheries biologists and water managers. It is used to predict the effects of altered flow regimes on an index of instream habitat (WUA) for fish and other aquatic organisms. One of the primary components of the IFIM are the PHABSIM models. PHABSIM was selected by the CAWG as the appropriate analytical tool for the large and medium sized streams in the Project area. PHABSIM uses site-specific hydraulic models to simulate microhabitat values (velocity and depth) of a stream over a range of flows. The simulated depths and velocities, as well as static measurements of substrate and sometimes cover, are used with HSC (discussed in Section 3.3) to calculate a WUA value for each simulated flow. The WUA vs. flow relationship is then used to assess the effects of different water management practices on aquatic resources, balance competing uses for water within a system, and negotiate flows to protect aquatic resources and the amount of water available for out-of-stream uses.

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[4] At the time the calibration flows were being determined, the hydrology of the project streams had not been fully analyzed. The unimpaired flow values reported at that time may differ somewhat from those presented in CAWG 6 (SCE 2004b).

[5] As of this writing, there is still some ongoing discussion of the sensitivity of simulations to suitability values for velocities near 0 ft/s for adult rainbow and brown trout.

WUA is an index of fish habitat; it does not totally describe the quantity or quality of the habitat. For example, WUA does not consider the proximity of a given area of usable habitat to other areas important to fish (e.g., refuge habitat). When habitat limits fish populations, the WUA may provide an indication of the effect that a given change in streamflow can have on fish habitat and therefore fish populations (Bovee 1982). However, when other limiting factors are in effect, there will be no relationship between WUA and fish population size. In these cases, changing the amount of physical habitat may not result in a change in population size. It should also be noted that limiting factors are not constant and can change between seasons and years.

Deriving the WUA functions that are the basic output of a PHABSIM analysis requires the collection of field data at transects. These data are used to calibrate a model to represent the hydraulics of the stream over a range of flows. The process is divided into hydraulic modeling and habitat simulation phases. In the discussion that follows, we discuss these two stages in order. The process of selecting appropriate HSC for use in the study is described in Section 3.3. These HSC are used in the habitat simulation phase described in Section 3.2.2.3.

1.3.1 Field Data Collection

1.3.1.1 Transect Selection

Prior to collecting field data for developing hydraulic models, transects must be selected that represent the types of habitat present in the target streams. This was done in close consultation with the CAWG, using the approach described in the Transect Selection Memo in Appendix A. A summary of the field transect selection was presented to the CAWG at the January 2003 meeting. The notes from this meeting are included in Appendix A and additional information regarding the transect selection process can be found there.

As outlined in the CAWG 3 Study Plan (SCE 2001), the preliminary Rosgen Level I evaluation (August 2001) and mesohabitat typing conducted in 1999-2001 were used as the basis for selecting the channel segments and habitat units to be represented in the PHABSIM studies. Each stream reach identified in the Study Plan (see Table CAWG 3-1) was divided into sub-reaches based on their Rosgen channel type. Within each Rosgen subreach that represented more than five percent of the reach length, transects were placed to represent all mesohabitat types (riffle, run, pool) representing more than five percent of that Rosgen channel-type in that stream reach, as described below.

Three preliminary sites were selected for CAWG review based upon a random selection of the most limited mesohabitat type present in the Rosgen channel type. Units that could not be accessed within a reasonable amount of time (approximately one-hour walk from the car) were excluded. Once the most limiting units had been identified, units of the more abundant mesohabitat types were selected around each of these units to complete a site. Transects were clustered in this manner both to expedite data collection and because linking data collected at nearby transects provides information that can be used to check the reliability of the hydraulic models.

The CTST toured each of the preliminary study sites (Table CAWG 3-3) to gain an impression of the stream characteristics. During the site review, large sections of the stream were usually walked and examined enroute to and between the preliminary sites. This review gave the CTST a familiarity with the types of habitat present and their characteristics within each subreach prior to placing transects. After the candidate sites were inspected, the group then selected specific mesohabitat units for sampling. Transects were placed such that the location was representative of the characteristics of the unit (e.g., pool tails, specific riffle hydraulics) and to capture the diversity of microhabitats (depth, velocity, habitat complexity) present within each mesohabitat type. Each transect selected by the CTST was marked with headpins using rebar driven into the ground, nails in trees, or metal clips drilled into the rock face. Where possible, transects were placed to avoid areas where hydraulic models do not perform as well (e.g., areas with numerous water surface elevations (WSLs), multiple braids, side channels). Transects were not placed in areas not utilized by target species (e.g., cascades and bedrock sheets). The locations of sampling sites selected by the CTST are shown on Map CAWG 3-1.

In this manner, PHABSIM transects were placed in each stream reach identified in the CAWG 3 Study Plan with the exceptions noted below. The number of transects selected for each mesohabitat type is provided by reach in Table CAWG 3-4. This table also shows the proportion of the Rosgen channel types in each reach and the proportion of each mesohabitat type in each Rosgen channel type. This information is used in weighting the transects during habitat simulations as described in Section 3.2.5.

Exceptions to Transect Placement

In a few areas, transect placement did not follow the protocols described above. These exceptions occurred on the SF San Joaquin River (SFSJR), in the San Joaquin River (SJR) and in Big Creek below Huntington Lake.

The SFSJR was divided into four reaches based on Project features and the inflow of major tributaries. From downstream to upstream, these reaches were the SJR confluence to Rattlesnake Creek, from Rattlesnake Creek to Mono Creek, from Mono Creek to Bear Creek, and from Bear Creek to Florence Lake. These reaches were divided based on the influence of different project features and geomorphic changes. In the Bear to Florence reach, flow is largely controlled by releases from Florence Lake. In the Mono Crossing to Bear Creek, flow is controlled by releases from both Florence Lake and Bear Creek diversion. Below Mono Crossing, flow releases from the Mono Creek Diversion is also a factor. There are no further Project operations affecting stream flow downstream of Rattlesnake Creek. There are several small tributary streams to each of these reaches, but the diversions on these streams are operated seasonally, and thus do not affect summer flows.

The area below Mono Creek (encompassing the first two reaches described above) is difficult to access and safety concerns at the high flow levels required by this study precluded sampling in this area. The CAWG agreed to represent this area using transects placed in similar Rosgen channel types above Mono Creek. These transects were weighted according to the habitat proportions present in the downstream reaches. As these proportions are quite similar (Table CAWG 3-4), the two reaches were combined and are presented as a single reach in Section 4.

As previously described, the CAWG elected to use transects from the BiCEP models (BioSystems 1987) to represent habitat in the Mammoth Pool and Stevenson (deep pools only) reaches of the SJR. In these areas, new transects were placed to supplement the existing models. In Big Creek, where the CTST elected to not use the BiCEP transects, a complete suite of new transects were selected following the protocol.

The CTST did not place transects on Big Creek below Huntington Lake, which was identified as a target reach in the CAWG 3 Study Plan. The stream in this area was heavily encroached upon by riparian vegetation with willows and alders growing down into the streambed and completely overhanging the channel immediately above the water surface. The CTST recommended holding off on PHABSIM studies in this location until decisions were made with regard to riparian and geomorphic concerns that would substantially affect the outcome of the PHABSIM studies.

1.3.1.2 Collection of Hydraulic Data

Basic input data for the PHABSIM hydraulic models include depth, mean-column velocity, substrate composition, and cover at numerous verticals (measurement points) across each transect. For each transect, the following measurements were taken:

- bed profile
- water surface elevation
- stage of zero flow
- velocity and depth
- substrate and cover
- discharge

The field data collection procedures and data reduction techniques used in this study followed those described by Trihey and Wegner (1981) and Trihey (1980). For deeper transects in the mainstem rivers, water velocity and depth profile data were collected with an Acoustic Doppler Current Profiler (ADCP). Procedures for use of this instrument are described after the discussion of the standard field techniques.

Transect headpins, stream bank profiles, WSLs (water surface elevation), and stage of zero flow (STZ) were surveyed relative to a locally established benchmark using standard surveying techniques. WSLs were surveyed at each calibration flow (Table CAWG 3-5), with multiple points surveyed across the channel for each transect. The STZ is the elevation at which water would pool at a transect when flow is decreased to zero. In riffles and some runs, this is the lowest point of the bed profile (the thalweg). In pools, this is usually the highest low point of the streambed at a downstream hydraulic control (Hardy 2000). The STZ was surveyed at the lowest calibration flow.

As agreed to by the CAWG, depth and mean column velocity measurements were collected at each transect at the low and high calibration flows (see Table CAWG 3-5). These measurements were collected at a minimum of 15 to 20 verticals within the low flow portion of the channel at each transect. Additional verticals were added at higher flows as needed. The spacing and number of verticals per transect depended on the cross-section profile and complexity of the velocity distribution. The horizontal distance to each vertical relative to the left bank headpin was measured with a fiberglass measuring tape. Depths were measured to the nearest 0.1 feet (ft) and velocity to the nearest 0.05 feet per second (ft/s). If depth at a vertical was less than 2.5 ft, one velocity measurement was taken at 0.6 of the total depth. If the depth exceeded 2.5 ft, measurements were taken at 0.2 and 0.8 of the total depth and averaged to determine the mean column velocity. The velocity correction angle also was noted at each vertical.

In accordance with the CAWG 3 Study Plan (SCE 2001), velocities were not collected in pools in mid-sized streams that were more than six ft deep. Measuring velocities in deep pools (> 6 ft) often presents a substantial problem. Water velocities in these pools are very often below the precision limitation of the velocity meter. The IFG-4a programs offer a method by which velocity is determined based on the depth of the cell and the flow level to be simulated. This option was used for pools in mid-sized streams over 6 ft deep.

During data collection, the field crew rated each transect with regard to its suitability for making accurate flow determinations based on the bed structure, channel complexity, and flow patterns. In some areas, where conditions at all transects were poor for measuring flow, a separate location was identified where flow was measured. Discharge was computed at each site at each of the three calibration flows (Table CAWG 3-5).

For deep pools and some shallower units in the mainstem rivers, velocity and depth profiles were collected using an ADCP as described below. The ADCP was not used in the smaller streams where only one or two transects exceeded wadeable depths.

Substrate and cover conditions were visually assessed for each vertical during low flow, when these elements were most visible. Substrate was coded as dominant particle size, subdominant particle size, and percent of cell with spawnable gravel for trout. Cover was coded as the dominant cover type and the percentage of the cell with cover (Table CAWG 3-6). Cells extended halfway to each adjacent vertical and one meter up- and downstream of the transect line.

ADCP Data Collection

Water velocity and depth profile data were collected along deeper transects in the main river channel with an ADCP mounted in an OceanScience fiberglass trimaran. Operation of the ADCP was controlled by radio frequency modem from a laptop computer set up on the riverbank, which initialized, started, and stopped data collection. An ADCP functions by sending a series of short-burst acoustic pulses through transducer heads facing down in the water column. Echoes from the pulses are detected and analyzed by ADCP software to determine water depth and velocity (from the Doppler effect). Data are collected at a high rate of speed and compiled into data packets approximately every second for transmittal to the computer, where the data are displayed in real time and reviewed for quality. Stationing was determined using the bottom tracking feature of the ADCP, and known starting and stopping points along the transect.

Use of an ADCP to collect PHABSIM field data requires a few additional steps for data reduction and computer file building compared with standard velocity measurement methods. The high rate of data collection, for example, can generate more stations across a transect than the PHABSIM model is capable of processing. Also, the bin velocities (the vertical distribution of velocities at a single measurement point) must be consolidated into mean column velocities. The program ADCPtoRHB (Thomas R. Payne and Associates [TRPA]) was used to consolidate the data into stations appropriate for input into the hydraulic modeling program. The ACDPtoRHB program allowed review of all measured data points and selective consolidation into discrete stations at specified intervals. Depth and velocity data in between the intervals was averaged and assigned to the intervals. This interval corresponded to that used for edge cell measurements (collected using standard techniques) and substrate/cover coding.

The ADCP was configured for each individual transect, taking into account maximum depth and velocity, substrate complexity, and water surface dynamics. Several measurements were usually completed before the optimum configuration was obtained. When the ADCP ASCII data is analyzed in the ADCPtoRHB program, the bottom profile is compared to the elevation profile imported from RHABSIM. The surveyed bottom profile is generally used in the final analysis.

1.3.1.3 Quality Control/Quality Assurance

Review of field data collected for the Big Creek Instream Flow Study occurred both in the field and office, and was consistent with procedures outlined by Trihey (1980). During field surveys, several conventions were adopted to facilitate the collection of quality data and timely reduction of those data. These include:

- All headpins and WSLs were referenced to benchmarks allowing relocation of headpins, staff gages, etc.

- More than two WSLs were surveyed for transects with rapidly varied flow conditions.

- WSLs were checked before and after transect measurements to identify any change in discharge during the data collection.

- Distance of right headpin was established for each transect and matched in subsequent tape placements to facilitate the collection of point velocity measurements at different calibration flows.

1.3.2 MODEL CALIBRATION AND DEVELOPMENT

1.3.2.1 Approach to Hydraulic Model Calibration

The goal of using the PHABSIM hydraulic simulation programs was to simulate hydraulic conditions in a stream as a function of stream flow. This was conducted in a two-stage process. The field data collected was used to develop a relationship between WSL (WSL, also referred to as the "stage") and discharge (i.e., the volume of water flowing past a given point per unit time, in this study measured in cubic feet per second, or cfs). This stage-discharge relationship was developed based on either an empirical relationship (the IFG-4 method) or approaches based on hydraulic theory (ManSQ and WSP). After an acceptable stage-discharge relationship had been developed, this relationship was used in conjunction with the bed profile to determine the depth at each vertical across a transect. Velocities were then simulated in the IFG-4a module based on the estimated discharge and the measured distribution of velocities across the transect at the high calibration flows. During the calibration of the velocity model, the velocity distribution was adjusted to reduce modeling artifacts, and provide a more realistic simulation of velocities across the range of flows to be simulated. This allowed velocity distributions to be developed at each transect for a series of simulated flows. The details of model calibration are described in the following sections.

In the Big Creek ALP, the RHABSIM vs. 2.1 programs were used in developing the models (TRPA 1995). This product is an independently developed software package that replicates the algorithms of the original PHABSIM programs (Milhous et al. 1989). While it produces the same results as PHABSIM, RHABSIM substantially adds to the utility of these programs by providing a much improved user interface, facilitating data entry and error checking, and providing enhanced graphical displays which facilitate model calibration and interpretation.

1.3.2.2 Determination of Given Flow

Determination of the best flow estimate (the given flow) is an important component of PHABSIM model calibration. For each measured flow in this study, a site-specific discharge was usually determined from measurements collected at the transects with the best hydraulic characteristics for measuring flow, although the raw flow measurements at all transects were reviewed. Because the habitat transects were selected to represent typical habitat in the stream and not for measuring flow, sometimes it was not possible to obtain a good discharge measurement at the transects. Where this occurred, the calibration flow was measured at a transect selected specifically for measuring flow. This transect was located in or near the site, in an area with a smooth bottom profile, laminar flow, and no hydraulic control (typically runs). In rare cases where the transect with the "best hydraulic characteristics for measuring flow" differed systematically from the remainder of the transects, then the given flow was selected to represent the flow at the bulk of the transects.

1.3.2.3 Selection of Bed Profile and Starting Water Surface Elevations

Prior to model calibration, the bed profile must be determined. This was accomplished through a review of all available information. Bed elevation information was provided by the combination of survey data and the depth of each in-water cell subtracted from the WSL for that flow[6]. Generally, there was good agreement among the bed profiles derived from the different measurements, but occasionally these values differed at some of the verticals. This generally occurred where there was a difference in WSL across the width of the transect. When this happened, the change in WSL was usually not consistent between flow levels. As the model can accept only one bed profile for a transect, this could result in some error at alternate flow levels (see next paragraph).

PHABSIM can accommodate only one stage measurement for each discharge. However, PHABSIM studies commonly include habitat types (e.g., riffles, pocket waters) that have complex bed topography (e.g., split channel, braiding). This is particularly true in the Big Creek system, where most of the streams are relatively steep and confined, with abundant large substrate. Transects installed in these habitat types may be influenced by multiple hydraulic controls. Consequently, more than one WSL along the length of a transect is common. In such situations, WSL was leveled across the transect to model the hydraulics and provide accurate simulation of velocity and depth for all verticals in a transect. The initial WSLs selected were based either on the average of the measured WSLs across each transect where these were relatively flat, or based on the WSL in the thalweg or where the majority of the flow was passing through the channel, where WSLs varied substantially across the channel. In some cases, where substantial modifications of WSL had to be made across a portion of the channel, the bed profile was also modified by the same amount to preserve the measured depths and discharge.

The initial bed profile and WSLs described above were used in conjunction with the measured velocities to estimate the flow at each transect. This flow was compared with the given flow to determine if there was a good match between these values. Where these values differed significantly, the selected WSL or, more rarely, the selected bed profile, was altered to better match the given flow.

1.3.2.4 Calibration of the Stage-Discharge Relationship

The next step in hydrological modeling within PHABSIM is the development of a stage-discharge relationship based upon the WSLs and calibration flows. The stage-discharge relationship is used in conjunction with bed elevations to predict the depths along a transect over a range of stream flows. During model calibration, WSLs and

[6] Two sets of depths, associated with the high and low–calibration flows, were recorded; thus the bed profile depends on the choice of either: one of these sets, a concurrence of one of these sets with the rod readings, or an average of the data available. As the models were being calibrated to the high-flow velocity set, the depths associated with this measurement were usually used in setting the bed profile. However, if there was better correspondence between the bed elevations determined from the low-flow depths and the rod readings then the bed elevation from this velocity set was used.

velocities were simulated for the three calibration flows and for flows of 0.4 times the low flow calibration measurement and 2.5 times the high flow calibration measurement. The latter two values were used to evaluate how the model performs when extrapolated beyond the range of calibration flows. The 0.4 and 2.5 multipliers are those suggested by the IFG for this purpose (Milhous et al. 1989).

In this study, the preferred method used in developing the stage-discharge relationship was the IFG4-a regression technique (SCE 2001). This model regresses the logarithm of discharge against the logarithm of the WSL minus the STZ. This approach generally works well within a reasonable range of extrapolation and is relatively easy to calibrate.

At least three stage-discharge measurements are needed (termed high, mid and low) to utilize the IFG4-a model. The model is calibrated to minimize the difference between the measured and predicted stages at the calibration flows. This difference is expressed as the mean error of the relationship. Guidance from the IFG (Milhous et al. 1989), indicates that mean error of less than five percent is considered an excellent stage-discharge relationship, while a mean error of less than 10 percent is considered a good relationship. If the mean error is greater than 10 percent, the use of other methods is recommended, such as ManSQ or WSP. Although data were collected to allow the use of these different methods, the IFG-4a stage-discharge relationship performed well for all transects and the ManSQ and Step Backwater modeling techniques were not employed.

To improve the fit of the stage-discharge relationship, the WSL values for a transect were sometimes adjusted slightly (usually less than 0.03 ft). Where this adjustment was necessary, the WSL selected was within the range of measured WSLs for that transect.

1.3.2.5 Velocity Calibration

The final step of hydraulic modeling involves velocity calibration for each cell along each transect. In simulating velocities, the model uses the velocity measurement and simulated depth at each cell to calculate a cell-specific roughness factor, "*n*," using Mannings equation. This roughness factor is analogous to a Mannings *n* value, but in PHABSIM it functions more as a velocity distribution (conveyance) factor (Hardy 2000) and the values of *n* may differ markedly from those provided in hydraulic roughness tables. This *n* is then used in conjunction with the predicted depth at each cell at each simulation flow to calculate the velocity for that cell. The model then calculates the transect-specific flow based on these simulated velocities and divides this into the specified simulation flow to obtain a velocity adjustment factor (VAF) for that flow level. The initial velocities for each cell are then multiplied by the VAF to obtain final velocities for that simulation flow. These final velocities will result in a calculated flow that matches the specified simulation flow.

The goal of the velocity calibration is to replicate the measured velocities within a reasonable range and to provide a realistic representation of how velocities would change at alternate flow levels. Velocity calibration was performed based on the high-flow velocity measurements, as the model tends to predict velocities better when extrapolating to lower flows than when extrapolating to higher flows. The philosophy employed during velocity calibration was to make adjustments only where absolutely needed to improve simulations.

This type of adjustment was generally associated with a cell that had a calculated *n* value that was too low, and tended to capture more flow than it should at higher simulation flows, or for cells at the stream margin, where the simulated velocities could be misrepresented (either too high or too low) due to edge effects. Field notes and photographs of the individual transects were used to guide the velocity calibration process. Predicted velocities were examined for each of the simulation flows to determine if they were realistic given the configuration of the channel and the location of features that might influence velocity patterns, such as large objects, eddies, and vegetation. Calibration was conducted to preserve the influence of these features. The reasonableness of the velocity in a particular cell is specific to the transect and was judged based on the habitat type, velocities in surrounding cells, conditions upstream and downstream of the transect, and professional opinion.

It was sometimes necessary to improve velocity simulations at different flow levels at the expense of increasing the error between the simulated and measured velocity at the calibration flow. Where velocities at the measured flows were increased, the difference was generally less than 0.2 ft/s. In cases where velocities were decreased to remove a velocity spike, this difference was generally larger. Generally, an attempt was made to keep these velocities within 20 percent of the measured value at the calibration flow, but sometimes a larger reduction was necessary. In most instances where this larger adjustment was necessary, the measured velocities exceeded three ft/s at the calibration flow and would not provide suitable habitat. The adjustment, therefore, would have an insignificant effect on the total amount of predicted habitat available.

1.3.2.6 Re-calibration of BiCEP Models

Based on the recommendations in the BiCEP model review (Appendix B) and with the agreement of the CAWG, the BiCEP models were reconfigured from three-flow models to single-flow models. In reconfiguring these models, the stage-discharge relationship from the original model was retained, but the velocity simulation portion of the model was recalibrated based on the high-flow velocity set collected at flows of 173 and 178 cfs. This followed the same velocity calibration approach described above for new transects, but was based entirely on the values entered in the BiCEP models and professional judgement, as field data sheets and transect photos were not available.

1.3.3 Model Calibration Standards

Several standards were used to evaluate the utility of the models developed during the Big Creek PHABSIM studies. These standards have been developed based on review of the pertinent literature, discussions with experts in hydraulic modeling, and practices developed through many years of experience. Because of the variability of stream conditions to which the PHABSIM models are applied, the IFG no longer recommends specific standards to which models must be calibrated (T. Waddle, USGS May 2004).

Historically, however, this group has provided some standards and “rules of thumb” that continue to be applicable. Among the factors considered in evaluating the utility of a model are:

- the hydraulic conditions at the specific location of the transect and its immediate vicinity,
- the concurrence between the flow at the transect and the best estimate of flow for a site,
- the ability of the stage-discharge relationship to accurately predict the measured stage at the calibration flows,
- the reasonableness of the velocity distribution over the range of flows simulated, and
- the range and shape of VAF vs. flow relationship.

The hydraulic conditions at the specific transect location include considerations such as the shape of the bed profile, the complexity of the area, shifting of velocities between one area and another as flow changes, etc. Where there are substantial changes in the bed profile over the range of flows simulated, the stage-discharge relationship may change, which may affect the reliability of this relationship at different flow levels. Channel complexity includes both the shape of the profile and the conditions upstream and downstream of a transect that may cause flow to shift from one area to another.

The concurrence between the measured flow at a transect and the given flow can also affect the reliability of model simulations. Different habitat types have different characteristics, and flows measured at different transects within a site may vary substantially from one transect to the next. If the measured flow at a transect varies from the given flow, the model adjusts for this using a VAF to increase or decrease velocities across the transect so that the simulated flow equals the calibration flow. This results in the simulated velocities differing somewhat from those measured. Trihey (1980) states that transects with a flow measurement error of less than 30 percent are suitable for routine applications of PHABSIM, while errors greater than this will dilute the quality of the analysis (Table CAWG 3-7).

The ability of the stage-discharge relationship to accurately predict WSLs affects the determination of depth at each cell (as this is calculated by subtracting the bed elevation from the simulated WSL) and the flow calculation (as flow is the product of depth, width and velocity). Even small changes in WSL can have a large effect on the calculated flow for some transects. This in turn affects the velocity simulation, as the model uses VAFs to adjust the velocity to make the calculated flow equal the desired simulation flow. The strength of the stage-discharge relationship is evaluated both by the absolute difference in the simulated vs. the measured WSLs and by the mean error of the stage-discharge relationship. Ideally, the simulated stage should match the measured stage at the calibration flows as closely as possible (Hardy 2000). Milhous et al. (1989)

indicates that a mean error of less than five percent is considered excellent and a mean error of five to 10 percent is considered good.

The shape of the VAF vs. flow relationship should generally increase with flow in a log-linear pattern (Milhous et al. 1989). This is because PHABSIM treats "*n*," the channel roughness coefficient, as a constant, when in fact it generally decreases with increasing depth. Thus when the model predicts velocities for simulation flows less than calibration flow, the roughness will be too low, resulting in velocities that are too high. The model corrects this by reducing the velocities using a VAF that is less than one. Conversely, when the model is predicting velocities for simulation flows higher than the calibration flow, the *n* value is too high, resulting in velocities that are too low, which the model increases with the VAF. There are exceptions to this pattern, such as areas where there are changes in channel roughness along the margins, caused by bars, large materials, or dense riparian vegetation.

The magnitude of the VAFs is one of the factors that has been used to set boundaries to the range of flows over which the model can be extrapolated (Hardy 2000). There are different opinions about the utility of VAF values for single-flow models. Various practitioners have suggested different standards. Bovee (pers. comm.) has indicated that VAFs between 0.2 and 5 provide good reliability, Milhous (pers. comm.) has suggested that values between 0.1 and 10 are acceptable, and Hardy (2000) states that "there is no rational basis for judging the validity of or efficacy of hydraulic simulations based on some perception of the magnitude of the range in computed VAF values." Based on this diversity of opinion, we have elected to use Milhous' criteria as the most central of these opinions.

During the velocity calibration process, the magnitude of the predicted velocities are evaluated to determine if they appear to be reasonable. The "reasonableness" of the velocity in a particular cell is specific to the transect and is judged based on the habitat type, velocities in surrounding cells, review of field notes and transect photos, experience, and professional opinion.

These calibration standards were used to evaluate the reliability of model simulations. The model limitations noted in the results section are based on consideration of these standards. Models that meet the calibration standards provide accurate estimates of the habitat variables being modeled and provide for reliable simulation of habitat quantity and quality.

1.3.4 Habitat Modeling

Habitat modeling was conducted using the HABSIM module of the RHABSIM program. In the habitat modeling phase, the simulated depths and velocities from the hydraulic modeling phase were evaluated for their suitability to target species and lifestage using the Big Creek ALP HSC (Section 3.3).

The following options were used when running the habitat simulations. Velocity and depth were used for all species and lifestages. Substrate was used only for spawning rainbow and brown trout where all gravels 0.1 to 3.0 inches in diameter were considered suitable (see Section 3.3). Cover was not used as it was ubiquitous in the Study streams and would not affect WUA. Cells were centered around the measurement verticals to preserve the integrity of the field measurements and decisions made during model calibration.

RHABSIM determines the suitability of the calculated depth, velocity, and substrate/cover at each cell, for each simulated flow. These suitabilities are multiplied to obtain a composite suitability for a cell. This composite suitability is then multiplied by the area of the cell to obtain WUA for that cell. The usable area of all cells is summed to obtain total WUA for a given transect and flow.

The transects were weighted based upon the proportional representation of the mesohabitat type and channel type within the stream reach, and the number of transects that were being used to represent that mesohabitat and channel type. These transect weightings are provided in Table CAWG 3-4. These weights were normalized to 100 percent, excluding channel types that were not modeled because they represented less than five percent of the total reach length and habitat types that were not represented either because they do not provide habitat for fish (cascades, bedrock sheet, etc.) or because they represented less than five percent of the habitat in that channel type.

For spawning, only transects in habitat types that could potentially be used for spawning were included in the model. Thus transects placed through the center and top of pools were excluded from the spawning models, while pool tailouts were included. All included transects within a reach were weighted equally to generate the spawning WUA function.

Spawning WUA was calculated using both the actual substrate (those observed in the field) and ideal substrate (all cells considered to have suitable substrate for spawning). The second approach considers only the effects of velocity and depth on spawning habitat. This approach was undertaken at the suggestion of Mike Henry of Federal Energy Regulatory Commission (FERC) as one approach to deal with the patchy nature of suitable spawning gravels in the study streams (M. Henry pers. comm.). The patchy nature of gravels makes it difficult to design a sampling strategy that reflects the true availability of spawning gravel in the study streams or the potential for enhancement given substrate improvement.

1.3.4.1 Habitat Modeling in the SJR - Mammoth Pool Reach

The Mammoth Pool reach was modeled using the BiCEP transects, in combination with new transects placed to supplement those models. Many of the BiCEP transects did not extend far enough up the bank to allow simulation to 500 cfs as requested by the CAWG without overtopping the headpins. When the headpins are overtopped, the model creates a vertical wall at the location of the headpin, allowing the WSLs to increase, but the stream cannot spread beyond the headpin. To evaluate the sensitivity of the model to this, the model were run following three different approaches. The first was to let the model run as it normally does, the second was to eliminate the WUA values for each transect at the flows at which the headpins are overtopped, and the third was to extrapolate the bed upward, using the last two points at the end of the transect. This analysis was performed for adult rainbow trout and Sacramento sucker.

This sensitivity analysis indicated that the first and third methods results in nearly identical results (Figures CAWG 3-1 and 3-2). This occurs, because the banks are nearly vertical at ends of most of the transects where the headpins were overtopped. The extrapolation of the last two points upward, results in a very similar effect to what the model does in that the stream does not spread outward. The approach of eliminating transects from the WUA analysis as the headpins were overtopped resulted less than a 10 percent difference in the WUA values at flows of 300 cfs or more. This difference is insignificant and would not likely affect the selection of appropriate minimum flow levels.

1.4 HABITAT SUITABILITY CRITERIA

1.4.1 INTRODUCTION

HSC represent the microhabitat (velocity, depth, substrate, cover) preferences of the target species and lifestages in the PHABSIM model. HSC are mathematical or graphical descriptions of how suitable a particular value of a microhabitat is for a particular organism. Suitability is set to range from zero for microhabitat that is completely unsuitable (e.g., cells that are out of water) to 1.0 for microhabitat values that are optimal (or at least used most frequently when there is a choice) for that organism. These criteria are used within PHABSIM to interpret the values of the hydraulic parameters predicted by the hydraulic simulation programs for the simulated flows. The result of this process is the WUA index of habitat.

The species of interest in the streams where PHABSIM studies were conducted were rainbow and brown trout, hardhead, Sacramento pikeminnow, and Sacramento sucker. The lifestages of interest were adult, juvenile and fry rearing for all species and spawning for the two species of trout.

The distribution of these species varies throughout the project area (SCE 2004c). Both rainbow and brown trout occur in most of the study streams. Rainbow trout have not been observed in Bear Creek and are not abundant in Mono Creek. Brown trout have not been observed in Stevenson Creek. The three non-trout species occur in the San Joaquin River. Sacramento sucker occur throughout the San Joaquin below Mammoth Pool Dam and hardhead and Sacramento pikeminnow occur in the Stevenson Reach of the San Joaquin River.

1.4.2 APPROACH

The CAWG 3 Study Plan (SCE 2001) identified the need to determine which existing HSC were appropriate for use on the Big Creek ALP project steams.

Appropriate existing suitability criteria will be tested for transferability within the basin. Potential suitability criteria will be reviewed with the CAWG prior to use. Verified criteria will be used to represent target species and lifestages.

The general approach for selecting appropriate HSC was described as follows:

HSC Selection and Verification

- *Appropriate habitat suitability criteria for testing will be selected in conjunction with the CAWG.*
- *It is anticipated that criteria will be needed for lifestages of rainbow trout, brown trout, hardhead, Sacramento pikeminnow, and Sacramento sucker.*
- *If appropriate macroinvertebrate criteria are available, these can be used with the approval of the CAWG.*
- *If appropriate amphibian criteria are available, these will be used with the approval of CAWG.*
- *In the absence of other criteria, fry criteria will be used.*
- *We propose the use of the Altered Flows Criteria for rainbow and brown trout and the use of the Pit River criteria for hardhead, Sacramento pikeminnow, and Sacramento sucker.*
- *A single set of existing criteria will be used, and up to four life stages, where available and appropriate (fry, juvenile, adult and spawning), will be evaluated during the habitat-modeling phase.*
- *Habitat criteria will be tested for their ability to accurately represent habitat use by fish in the Big Creek system prior to use in modeling.*

Habitat criteria suitability testing will include the following steps:

- *Existing criteria will be verified through evaluation of habitat utilization in streams within the Project boundaries.*
- *Evaluation will be conducted using the Groshens and Orth (1994) testing approach.*
- *Testing will require approximately 50-60 observations of fish habitat use for each species and life stage, and about 200 observations of habitat availability.*
- *Project specific criteria will be developed only if existing criteria cannot be verified.*
- *Observations of fish habitat utilization will follow standard snorkeling techniques.*

- *Habitat availability will be determined from 10 equally spaced verticals along two transects placed randomly within each habitat unit sampled.*

- *Upon the completion of testing, the results will be presented to the CAWG, along with recommendations for use of criteria or development of site-specific criteria. The decision as to which criteria will be used will be made in concurrence with the CAWG.*

An overview of this HSC development process is provided below. Appendix D provides a detailed description of this process, including the criteria tested, data collection procedures and results, transferability testing, and development of the final criteria to be used.

The transferability testing approach used in this study was originally developed by Groshens and Orth (1994), following the work of Thomas and Bovee (1993). This statistical analysis is designed to determine if there is a significant difference in microhabitat suitability, as predicted by HSC, and actual observed utilization by one of the target species. This hypothesis-based approach examines differences in "proportional" use of specific microhabitat values relative to a curvilinear suitability functions. The study design utilizes a two-level test based on a one-tailed 2 x 2 chi-square approach. The first level of testing is designed to determine whether the criteria set adequately predicts the use of suitable versus unsuitable habitat. The stated null hypothesis for this test is 'fish do not use suitable habitat (as described by HSC) more than unsuitable habitat". The second level of the procedure is a separate test of a second null hypothesis: that fish do not use optimal habitat more than marginal habitat. For a criteria set to pass the transferability test, the null hypotheses of both tests must be rejected.

The testing procedure requires site-specific observations of habitat use by the target species and lifestages and of the habitat available for them to use. The procedure classifies each observation of use or availability as suitable or unsuitable, and optimal or marginal. Observations are placed into these various categories based upon user defined suitability thresholds.

In this study, separate tests for depth and velocity were performed (univariate tests). In these tests, the suitability threshold between suitable and unsuitable habitat was defined as 0.1, while the suitability threshold between optimal and marginal was defined as 0.5. These threshold levels were defined *a priori* based on the previous work of Lifton et al., 1998, Lifton and Lumsden (1994), Shuler and Nehring (1994), and Newcomb et al. (1995). Testing was also conducted for both habitat parameters considered jointly (joint test). This test considers that fish may not select depth and velocity independently. For this test, the suitability thresholds were the square of those for the univariate tests. Criteria were tested as sets. For a criteria set to pass, it must either pass for both depth and velocity, or it must pass for the joint test.

1.4.2.1 Criteria Selection and Transferability Testing

In discussions with the CAWG, several sets of existing HSC were thought to be potentially appropriate for the Big Creek system. For trout, these criteria included the Altered Flows Preference (AFP), the Upper American River Project (UARP), and the Stanislaus River (Stan) criteria. For non-trout species, these included the Pit River, Deer Creek, North Fork Feather River (NFFR), West Sierra, Yosemite, UARP and Stanislaus criteria. The specific species and lifestages described by each criteria set are summarized in Tables CAWG 3-8 and 3-9.

For trout, each of the criteria sets were derived from observations collected in streams draining the western Sierra Nevada mountains in California, as these streams provide the most similar conditions to those in Big Creek. All of the non-trout species are endemic to California and the criteria shown are all of the criteria available for these species. A complete description of each criteria set is provided in Appendix D.

1.4.2.2 Field Data Collection

The magnitude, frequency, duration, and timing in streamflow patterns and associated temperature regimes are known to influence the behavior of fish species (e.g., migration patterns, spawning, etc.) (Junk et al. 1989, Poff et al. 1997) and can also influence growth, size at age, and food supply (Bjornn and Reiser 1991). To allow for these type of differences, sampling was conducted in four stream strata based on basin and stream size. The basins were divided at Mammoth Pool, and streams upstream of Mammoth Pool were considered upper basin streams, and all streams downstream of Mammoth Pool were considered lower basin streams. Size stratification was for large streams, which were the San Joaquin River and the SF San Joaquin River, and small streams, which were Big, Stevenson, NF Stevenson, Bear, and Mono creeks.

Field data collection for HSC verification was undertaken during the summers of 2002 and 2003. These observations were combined with data collected in 1999 in the Horseshoe Bend reach of the San Joaquin River and during the late 1990s in Big Creek, and NF Stevenson Creek. Observations were not made of trout in the earlier Horseshoe Bend studies, as this investigation focused on non-trout species. A sufficient number of observations of rainbow trout were collected during the earlier studies to allow verification, and criteria were verified for use on these streams at that time (ENTRIX 1996, Lifton et al. 1998).

An equal area strategy was used in selecting sampling sites for the HSC transferability study data collection. In an equal area approach, approximately the same amount of area is sampled in each important mesohabitat type. The objective of this approach is to reduce bias resulting from sampling the conditions present in the predominant habitat type more than conditions present in less common habitat types. This approach employed a randomized sampling scheme based on the most limited habitat type in each stream reach.

The way in which fish use habitat in the study streams was observed using standard snorkeling techniques. The availability of habitat to these fish was sampled at ten equally spaced locations across the stream at two randomly placed transects within each mesohabitat unit sampled for fish. A complete description of the methods employed is provided in Appendix D. This appendix describes the number of habitat utilization observations within each stream strata for each species and lifestage, as well as the number of habitat availability observations. The distribution of depths and velocities used and available is also provided.

1.4.2.3 Transferability Testing

Each of the HSC sets identified by the CAWG were tested for transferability to the study streams by stream strata using the observations of fish utilization and habitat availability (Groshens and Orth 1994). Testing was performed where more than 30 observations of habitat utilization were available. Testing was considered most reliable when more than 50 observations were made. In all cases, the number of available habitat observations greatly exceeded the recommended 200 observations. The results of this testing are presented in Appendix D.

1.4.2.4 Selection of Final Criteria Sets for Use on The Big Creek ALP

The results of transferability testing and overlays of the various criteria sets on frequency histograms of habitat use and availability were presented to the CAWG beginning in October 2003 (Appendix A). Extensive discussions of the merits of the transferability tests and of the various criteria sets were conducted over the next several months. These discussions culminated in the development of the Big Creek ALP criteria. These criteria are based on the consensus of the CAWG. The criteria are based on the criteria sets reviewed for each species, the site-specific use and availability observations, and the combined professional judgement of the CAWG representatives. The USFWS did not agree with the use of the Big Creek ALP criteria for adult rainbow and brown trout, but did express concurrence with the remaining criteria. These criteria are presented in Figures CAWG 3-3 through 3-7 and Tables CAWG 3-10 through 3-14. These criteria are used to interpret the results of hydraulic modeling as described in Section 3.2.4.

The CAWG reviewed and discussed criteria for macroinvertebrates during the February 2004 CAWG meeting. At that time, the CAWG elected not to model macroinvertebrate habitat, as they did not feel it would add to the analysis of project effects or be used in the flow negotiation process.

The use of winter criteria was also considered and discarded after discussion in February and April 2004. The CAWG felt that winter rearing criteria were unnecessary as flow considerations during the winter would likely be governed by flow needs for spawning and incubation of fish and meeting the needs of other processes such as geomorphology and riparian recruitment would affect selection of winter flows.

APPENDIX D

HABITAT SUITABILITY CRITERIA DEVELOPMENT

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1.0 INTRODUCTION

This document discusses the selection of Habitat Suitability Criteria (HSC) for use in the PHABSIM study. HSC represent the microhabitat (velocity, depth, substrate, cover) preferences of the target species and lifestages in the PHABSIM model. These criteria are used within PHABSIM (or in this case, RHABSIM) to interpret the values of the hydraulic parameters predicted by the hydraulic simulation programs and produce an index of habitat (weighted usable area) for each simulated flow.

The objective of this study element was to provide information needed to select appropriate HSC for use in the evaluation of flow-related habitat in Project Area Streams (CAWG 3 Report). The objective of this habitat suitability study was described in the CAWG 3 Study Plan (pg. 2-38):

> *Appropriate existing suitability criteria will be tested for transferability within the basin. Potential suitability criteria will be reviewed with the CAWG prior to use. Verified criteria will be used to represent target species and lifestages. Site-specific criteria will only be developed if existing criteria cannot be verified. The results of verification testing will be presented to the CAWG for review prior to modeling.*

1.1 HABITAT SUITABILITY CRITERIA OVERVIEW

HSC represent the microhabitat (velocity, depth, substrate, cover) preferences of the target species and lifestages in the PHABSIM model. HSC are mathematical or graphical descriptions of how suitable a particular value of a microhabitat is for a particular organism. Suitability is set to range from zero for microhabitat that is completely unsuitable (e.g., cells that are out of water) to 1.0 for microhabitat values that are optimal (or at least used most frequently when there is a choice) for that organism. These criteria are used within PHABSIM to interpret the values of the hydraulic parameters predicted by the hydraulic simulation programs for the simulated flows. The result of this process is the WUA index of habitat.

HSC can take a variety of forms including univariate, multivariate, binary, trinary, or continuous (Voos 1981, Bovee 1986). Most commonly, HSC are continuous, univariate functions of suitability against specific incremental values of microhabitat (depth, velocity, substrate, and cover). HSC are typically designed to represent habitat suitability for fish species but may also be developed for aquatic macroinvertebrates and amphibians. Often, HSC specific to the major lifestages of a target species (e.g., fry, juvenile, and adult) are used to accommodate differences in behavior and physiological capabilities (Bovee 1977).

HSC have been be categorized on the basis of the amount and type of site-specific information that went into their development (Bovee 1982). **Category I** curves may be based on literature reviews, data not expressly gathered for the purpose of curve development, and/or expert opinion regarding how the target organisms utilize various microhabitat parameters. This type of curve generally does not involve the collection of empirical data specifically for use in the development of microhabitat suitability criteria. **Category II** criteria are based on observed fish utilization of different microhabitat values. The data used in these curves are gathered specifically for the purpose of criteria development. The observations collected are limited to the range of conditions present and are not weighted for availability. These curves are most appropriate when applied to a range of conditions similar to those at which the observations were made, and their transferability between streams may be limited. **Category III** criteria are based on the same type of observational data used to develop Category II criteria. Category III criteria differ from Category II criteria in that utilization data is weighted or adjusted to incorporate information on the habitat conditions available for utilization. The weighting process is designed to reflect the fact that fish may utilize certain habitat conditions because preferred or desired conditions are scarce or unavailable. A common difficulty with Category III criteria is that the correction often overshoots the mark, particularly in the tails of the curves, and the suitability in areas with limited availability can be overestimated based on observations of a very small number of individuals using these values.

1.1.1 Habitat Suitability Criteria Selection

A number of strategies may be employed in the selection of HSC for the study of flow-related habitat. The spectrum of options include creation of criteria based solely on professional judgement, utilization of existing non-site specific criteria, verification and transfer of existing criteria, and development of site specific criteria. Many factors influence the selection of a criteria set including financial resources, time allocated for completion of the study, difficulty of obtaining recommended numbers of observations, anticipated level of controversy, and potential consequences for aquatic resources. Utilization of criteria based solely on professional judgement requires the smallest investment in terms of resources but may: 1) be subject to disputes by opposing experts; 2) complicate efforts to reach consensus with stakeholders; and 3) be subject to the risk of ultimately choosing inadequate flows for resource protection. On the other end of the spectrum, development of site specific criteria may increase certainty regarding the validity of the HSC, but requires a commitment of substantial resources. Further, in some circumstances efforts to develop site specific criteria may be complicated by very small population sizes, making it extremely difficult to obtain a sufficient number of observations to produce defensible curves. Criteria development may also be complicated by stream conditions that make it impractical, impossible or unsafe to collect the necessary habitat utilization observations.

The primary objective in the selection of HSC is to find or develop criteria that best describe the actual habitat preference of the target species in the stream being studied. WUA may vary greatly depending on which HSC were used in the PHABSIM modeling. The use of inaccurate curves can result in predicted release flows that can range from those that are inadequate to protect aquatic resources, to those well in excess of what is needed to meet resource management goals. Neither inadequate resource protection nor unnecessary costs and loss of generating capacity are acceptable outcomes for any of our stakeholders involved in making difficult flow balancing decisions.

Early in the collaborative process stakeholders agreed that transferability tests provided a reasonable, defensible, and cost-effective means of selecting HSC (SCE 2001). Transferability testing is a process in which microhabitat suitability indices are compared to actual observations of fish behavior to determine if fish select habitat in the manner that would be predicted based upon the HSC and the availability of habitat in the target stream. This is accomplished by using a limited number of field measurements to statistically determine if observed fish behavior differs from that predicted by a given HSC in a given stream. Transferability tests are described in greater detail in Section 2.1 of this document. Relative to other approaches, transferability testing offers several advantages including:

- Transferability testing is an objective process rather than subjective one. This approach adds statistical rigor and validity to the selection process while avoiding disagreements based on differences in professional judgement.
- The transferability process uses site specific observations to determine if a criteria set is appropriate for use, thus ensuring that the HSC are appropriate for the study streams (Thomas and Bovee 1993).
- Considerably fewer resources are required for transferability testing versus site specific criteria development. Transferability testing generally requires approximately 50-60 observations of fish habitat use whereas development of site specific criteria requires a minimum of 150 to 300 observations (Thomas and Bovee 1993).

1.2 Species of Interest

The target species for this study were initially identified in CAWG 3 study plan. The species selected were rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and hardhead (*Mylopharodon conocephalus*). These species were selected by the CAWG during the development of the study plan and are the principle species found in the project streams. Rainbow and brown trout are widely distributed throughout the project area, although rainbow trout have not been observed in Bear Creek and are relatively rare in Mono Creek. Brown trout have not been observed in Stevenson Creek and are present in low numbers in the San Joaquin River. Hardhead and pikeminnow are found in the San Joaquin River downstream of Dam 6. Dam 6 is located just downstream of the confluence of Big Creek. Suckers are found in throughout the San Joaquin River downstream of Mammoth Pool Dam. CAWG 3 identified that criteria were to be tested for adult, juvenile, and fry lifestages of all species, where feasible. Spawning criteria were not evaluated in this study because of logistical difficulties (e.g., seasonal road closures, high streamflows, etc.) associated with collecting the needed habitat utilization observations.

2.0 METHODS

2.1 GENERAL APPROACH

As part of the collaborative licensing process, the CAWG developed and implemented guidelines for the HSC selection and verification process (CAWG 3 Study Plan pgs. 2-41 and 2-42). This process defined the approach taken in developing the final habitat suitability criteria to be used. Habitat suitability criteria testing included the following steps:

- Appropriate habitat suitability criteria for testing were selected in conjunction with the CAWG.
- Criteria were selected in coordination with the CAWG to be considered for use in this project. These criteria were for adult, juvenile, fry, and spawning rainbow and brown trout, and adult and juvenile hardhead, Sacramento pikeminnow, and Sacramento sucker.
- Observations were made of fish habitat utilization following standard snorkeling techniques.
- Habitat availability was determined from 10 equally spaced verticals along two transects placed randomly within each habitat unit sampled.
- These HSC were tested for their ability to accurately represent habitat use by fish in the Big Creek system prior to use in modeling using the Groshens and Orth (1994) testing approach.
- Upon the completion of testing, the results were presented to the CAWG. The decision as to which criteria were to be used was made in concurrence with the CAWG.
- A single set of criteria were used in the habitat modeling phase for each species and lifestage to develop habitat vs. flow relationships.

2.2 ANALYTICAL APPROACH

The transferability testing approach used in this study was originally developed by Groshens and Orth (1994), following the work of Thomas and Bovee (1993). This statistical analysis is designed to determine if there is a significant difference in microhabitat suitability, as predicted by HSC, and actual observed utilization by one of the target species. The individual components of this analysis include existing HSC that assign suitability for a given microhabitat variable, field observations that characterize the range of conditions utilized by fish species, and field measurements that characterize the range of conditions available to the fish. Transferability testing was performed using pFish (ENTRIX, Inc. proprietary software), a computer program developed specifically for this purpose.

The hypothesis-based approach used in this study examines differences in "proportional" use of specific microhabitat values relative to the curvilinear suitability functions. The study design utilizes a two-level test based on a one-tailed 2 x 2 chi-square approach. The first level of testing is designed to determine whether the criteria set adequately predicts the use of suitable versus unsuitable habitat. The stated null hypothesis for this test is "fish do not use suitable habitat (as described by HSC) more than unsuitable habitat". If the null hypothesis is rejected (statistically significant result), the alternate hypothesis is accepted: "that fish use suitable habitat (as described by the suitability criteria) more than unsuitable habitat." The test layout for this level of hypothesis testing is shown in Table CAWG 3 Appendix D-1. The second level of the procedure is a separate test of a second null hypothesis. The null hypothesis of the second test is "fish do not use optimal habitat more than marginal habitat." Rejection of this null hypothesis leads to the conclusion that, "fish do use optimum habitat more than marginal habitats" (Table CAWG 3 Appendix D-2). For a criteria set to pass the transferability test, the null hypotheses of both tests must be rejected. For all tests, a standard level for statistical significance of $\alpha = 0.05$ was chosen.

In application, the test classified each observation of fish use and habitat availability as optimal or marginal and suitable or unsuitable. These categories were defined by user-specified suitability thresholds. "Suitable habitat" was defined as the sum of optimal and marginal habitat (Table CAWG 3 Appendix D-3). Unsuitable habitat was not included in the Optimal vs. Marginal test. The number of observations in each category were then counted and entered into the contingency tables above.

The threshold values to represent optimum, marginal, suitable and unsuitable habitat in testing were selected *a priori* based on the previous work of Lifton et al., 1998, Lifton and Lumsden (1994), Shuler and Nehring (1994), and Newcomb et al. (1995). The suitability levels for velocity and depth, as tested individually, are presented in Table CAWG 3 Appendix D-3. Tests were also conducted for "joint" criteria, that is, depth and velocity together. This test allows for an interaction between the selection of depth and velocities used by fish (that is, their selection may not be independent and fish may use one velocity in some depths and another value at a different depth). The joint suitability threshold values are the product of the individual depth and velocity thresholds.

In the evaluation of HSC for their applicability in Project Area streams, either both the depth and velocity criteria must pass, or the joint criteria must pass in order to be considered transferable. For example, if both hypotheses were rejected for depth but only one hypothesis was rejected for velocity, the HSC was not acceptable for use in Project Area streams. If both hypotheses were rejected in the joint threshold test, the HSC was considered acceptable for use in Project Area streams.

2.3 BASIN STRATIFICATION

HSC transferability was tested for streams in four separate stream categories (strata) in the Project Area. These stream categories were defined based on basin and stream size. The basins were divided at Mammoth Pool. All streams upstream of Mammoth Pool were considered upper basin streams, and all streams downstream of Mammoth Pool were considered lower basin streams. Streams were also stratified by size, small and large. Large streams, included the San Joaquin River and the SF San Joaquin River, and small streams, included Big, Stevenson, NF Stevenson, Bear, and Mono creeks. Table CAWG 3 Appendix D-4 identifies the individual streams that were included in the stream strata. These basins were classified, primarily based on observed differences in temperature, hydrologic regimes and species composition. The magnitude, frequency, duration, and timing in streamflow patterns and associated temperature regimes have been found to influence the behavior of fish species (e.g., migration patterns, spawning, etc.) (Junk et al. 1989, Poff et al. 1997) and can also influence growth, size at age, and food supply (Bjornn and Reiser 1991, Vondracek et al. 1992). The selection of stream strata was intended to incorporate potential differences in habitat utilization by target species (and lifestages) as a result of differing physical, chemical, and biological processes present in each of the basins.

In addition, species composition may also affect habitat use (Moyle and Baltz 1985). Observed species assemblages differed from basin to basin. Sacramento pikeminnow, hardhead, and Sacramento sucker, commonly identified as native transition zone species (Moyle 2002) are found primarily in the LBLS. Rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) are the most widely distributed fish species in the Project Area. Rainbow trout and brown trout are known to occur in all four basin groups although they were considerably less abundant in the LBLS than in other basins.

2.4 FISH AGE DETERMINATION

To conduct the transferability tests, each fish observed during field surveys was assigned to a lifestage (adult, juvenile, fry, juvenile-fry) corresponding to those provided by the criteria sets to be tested. Lifestage classifications were determined using size-at-age data previously developed for the *CAWG 7 Characterize Fish Populations* Report (SCE 2003). During the Fish Population study, length frequency distributions and the scale readings from the fish population surveys were used to develop fish-length-at-age relationships. Age class breaks for each target species, lifestage, stream, and basin group are presented in Table CAWG 3 Appendix D-5.

2.5 FIELD METHODS

The field methods employed in this study were designed to: 1) adequately represent the various habitat types and species assemblages found throughout the project area; 2) characterize physical habitat utilized by fish species in the project area; and 3) characterize physical habitat available to these fish species.

2.5.1 Site Selection

To avoid biasing the study results by disproportionately sampling different mesohabitat types, an equal-area strategy was used in selecting sampling sites for the HSC transferability study data collection. In an equal area approach, approximately the same amount of area is sampled in each important mesohabitat type. The objective of this approach is to reduce bias resulting from sampling in the predominant habitat type more than in less common habitat types. For example, while most of the length of a reach may be pool habitat with slow velocities and deep water, the equal area approach ensures that the habitat conditions in riffles and runs (if these are important components of the habitat in that reach) are represented to the same extent. Criteria based on the equal area sampling approach will better reflect the combined use of all habitat types and any selection for particular values of velocity and depth.

The type, sequence and size of the mesohabitat units in each study reach were inventoried as part of the CAWG 1 study (SCE 2003). This information was used as the basis for selecting study sites for HSC transferability data collection. Important mesohabitat types for sampling were identified as riffle, run, shallow pools and deep pools (pools were divided, based on a maximum depth threshold of three feet). Because not all habitat types are equally abundant in each stream reach, the units of the least frequent habitat type were identified and randomly ordered. Those units of this habitat type that could not be reasonably accessed (more than 1.5 miles from the nearest access point) were eliminated from consideration. The remaining habitat units were sampled in order, until the desired amount of habitat had been sampled to satisfy the equal area approach. The more common habitat types were selected from those near the randomly-selected rarer units.

Towards the end of the sampling season in 2003, it was necessary to deviate from the equal-area sampling strategy in LBLS. At this time, it was becoming apparent that there would not be sufficient observations of adult hardhead made to allow the transferability testing to be conducted. In consultation with the CAWG, it was decided to increase sampling of very large, deep pools in these streams, to see if these fish were selectively using this type of habitat and whether a sufficient number of observations could be collected.

2.5.2 Utilization

To determine habitat utilization by the target species, each habitat unit selected was sampled using standard snorkeling techniques (Bovee 1986) to identify the locations of fish within the unit. Divers, wearing dive masks and snorkels, entered the water downstream of the unit to be sampled and moved upstream slowly and carefully in order avoid disturbing any fish present. If a habitat unit was disturbed while verifying its location or identifying unit boundaries, the habitat unit was allowed to “rest” for a period of one hour prior to survey to ensure that fish returned to their natural behavior. Habitat utilization data was collected only if environmental conditions (e.g., ambient light, turbidity) were conducive to accurately identifying fish locations. For each fish observation, divers identified the species, recorded the number of fish observed, described behavior, estimated length, and noted the position of the fish in the water column. Uniquely numbered markers were placed on the channel bottom directly below the location of the observed fish once this information had been recorded. If a fish was disturbed by a diver prior to completing the observation, the observation was not recorded. For each unit surveyed, divers also recorded time of day, visibility, shade, and the time required to complete the survey.

The number of divers used to sample a unit varied depending on the characteristics of the unit. If the channel geometry of the habitat unit was especially complex (e.g., large surface area, large bed elements, or channel braiding) a team of two to three divers were used. In smaller, narrower units, without much visual isolation, a single diver conducted the sampling. Wherever multiple divers were employed, the divers stayed within visual contact to ensure that observed fish were not counted more than once. Due to the size of a number of pools encountered in the LBLS it was impossible for divers to get the necessary foothold to move upstream through the unit without disturbing the fish. Consequently it was necessary to survey the unit from upstream to downstream. The survey team consisted of four divers, two using SCUBA equipment, to facilitate surveys of the very deep water in the center of the channel.

Upon completion of the habitat unit surveys, dive markers were revisited and physical habitat characteristics at those locations were assessed. Field measurements included water column depth, mean column velocity, and focal velocity (the velocity at the actual location of the fish in the water column). Focal velocities were measured because fish frequently occupy positions in the water column where the velocity differs from the mean column velocity. Mean column velocities were measured using standard U.S. Geological Survey (USGS) protocols (Nolan and Shields, 2002; Carter and Davidian, 1968; Buchanan and Somers, 1969; Kennedy 1981). A single velocity measurement was collected at 6/10ths of the total depth if the water was less than 2.5 feet deep. Where the water was more than 2.5 feet deep, measurements were collected at 2/10ths and 8/10ths of the total depth, and the mean column velocity was recorded as the average of these two measurements.

In addition to depth and velocity measurements, cover type, percent cover, and substrate composition were visually estimated for each position occupied by a fish (see Attachment A for example of utilization data sheet).

2.5.3 AVAILABILITY

Habitat availability measurements were collected to characterize the range of habitat conditions available to the target species. These measurements were collected in each habitat unit where fish utilization surveys were conducted. Habitat availability was assessed by measuring microhabitat variables at numerous points along two transects placed at random distances along the length of the habitat unit. The habitat availability measurements were collected irrespective of fish presence or absence.

Fiberglass tapes were strung across the channel at the appropriate locations and a minimum of ten measurements were collected at regularly spaced intervals along each transect. For each sample location, depth, mean column velocity, and focal velocity were measured. Focal velocities were measured at six inches (15 cm) above the bed. Cover type, percent cover, and substrate composition were visually estimated at each sample location (see Attachment A for example of availability data sheet).

2.6 OVERVIEW OF CRITERIA TESTED

2.6.1 ALTERED FLOWS PREFERENCE

Two sets of criteria were developed as part of the *Response of Fish Populations to Altered Flows* study (Studley et al. 1995). This project was an 11-year research project designed to evaluate whether the IFIM, could be used to predict the response of trout populations to changes in stream flow. This project was overseen by a technical advisory committee consisting of nationally recognized experts in the application of the IFIM. This study consisted of a before and after phase. In the before phase, relationships between trout population size and flow levels were determined using the PHABSIM component of the IFIM. Other factors potentially affecting trout populations were also evaluated. These results were then used to predict the response of the populations to specific changes in streamflow. In the after phase, stream flows were modified and the population response was monitored over a three-year period. The study found that PHABSIM could be used to predict changes in fish populations resulting from altered flow regimes when other factors affecting their populations were considered and when habitat overlap between species and lifestages was taken into account.

The Altered Flows Preference (AFP) criteria (Wise et al. 1997) are Category III criteria and the Altered Flows Utilization (AFU) criteria are Category II. Curves were developed for rainbow trout (adult, juvenile, and fry) and brown trout (adult, juvenile, and fry) (Table CAWG 3 Appendix D-6). These criteria were developed as regional criteria for the southern, west slope Sierra Nevada streams. Field measurements for the development of these criteria were collected in Willow, Big, and North Fork Stevenson creeks as well as in the North and South Forks of the Middle Fork of the Tule River in the southern Sierra Nevada mountains. Study site elevations ranged between 2,810 and 7,080 feet. Stream discharge during the study ranged between 2 and 38 cfs. An equal area habitat type sampling strategy was employed during data collection (see Section 2.5.1 for a description of this strategy).

2.6.2 UPPER AMERICAN RIVER

The Upper American River Project (UARP) criteria (TRPA 2000, TRPA 2003), are modified Category II criteria. Curves were developed for adult and juvenile rainbow and brown trout, and adult hardhead (Table CAWG 3 Appendix D-6). Field measurements were collected in the American River and its tributaries in the central Sierra Nevada mountains at elevations ranging between 6,000 and 7,000 feet. Discharges during the study ranged between 10 and 154 cfs. An equal area habitat type sampling strategy was employed during data collection. Criteria were developed for three stream sizes, with the differences related to the size of adult trout in streams of the different sizes.

Observations were collected in large and small streams. The medium stream criteria were intermediate to these criteria and derived based on the professional judgement of the working group. The development of these criteria included extensive consultation with the U.S. Forest Service (USFS), the California State Water Resources Control Board (SWRCB), and the California Department of Fish and Game (CDFG).

2.6.3 STANISLAUS RIVER

The Stanislaus River criteria (TRPA 2002), are modified Category I and II criteria. These curves were developed for the combination of adult, juvenile and fry rainbow and brown trout, hereafter termed as “generic trout” or “total trout” (TT), and adult hardhead (Table CAWG 3 Appendix D-6). Field measurements were collected in the central Sierra Nevada mountains at elevations ranging between 1,800 and 5,600 feet. Sampled streams included the North and Middle Fork of the Stanislaus River and stream discharges during the study ranged between 26 and 333 cfs. An equal area habitat type sampling strategy was employed during data collection. Parties involved in the development of these criteria included the USFS, SWRCB, CDFG, and the USFWS.

The generic trout concept was adapted from *the Response of Fish Populations to Altered Flows* Project, described above, which found that there was a substantial amount of overlap between the habitat use of rainbow and brown trout, and that when the two species were evaluated separately, the expected population response was overpredicted because the same habitat was being counted twice.

Two sets of curves were developed and applied for adult trout and hardhead in this study, because the various parties could not come to complete agreement. These are designated Stan-1 and Stan-Alt in the remainder of this document. The Stan-Alt criteria reflect a higher suitability for higher velocities for adult trout and hardhead. Additionally, CDFG was uncomfortable with the generic trout criteria and as a result brown trout criteria from the SF American River were applied as well.

2.6.4 PIT RIVER

The Pit River criteria developed by Baltz and Vondracek (1985) are Category III criteria (preference) and were developed for adult and juvenile/fry (all smaller fish taken as a single group) hardhead and Sacramento pikeminnow, and adult, juvenile, and fry Sacramento sucker (Table CAWG 3 Appendix D-6). Field measurements were collected in the Pit River in northern California at an elevations ranging between 1,445 and 2,650 feet. Stream discharge during the study ranged between 50 and 150 cfs. An equal area habitat type sampling strategy was employed for this study.

2.6.5 DEER CREEK

The Deer Creek criteria, developed by Moyle and Baltz (1985), are Category II (utilization) criteria and were developed for hardhead and Sacramento pikeminnow adults, juveniles, and the two lifestages combined (adult/juvenile) (Table CAWG 3 Appendix D-6). Field measurements were collected in Deer Creek at elevations ranging between 30 and 3,500 feet. Stream discharge during the study ranged between 100 and 200 cfs. A reach and pool sampling strategy was employed for this study. In this sampling strategy a representative reach of stream was sampled based on the proportion of mesohabitat (riffle, run, pool) types present, thus dominant mesohabitat types were sampled to a greater extent. In addition, pools were sampled specifically. This approach may tend to bias the results to reflect the observed utilization of microhabitat types in the dominant mesohabitat type. It should be noted that the criteria were developed based on a relatively small number of observations.

Fry criteria were not developed as part of this effort. In the transferability tests conducted for hardhead, the combined juvenile/fry observations were tested against both juvenile and adult/juvenile curves. The same is true for Sacramento pikeminnow.

2.6.6 West Sierra

The West Sierra criteria, developed by Knight (1985), are Category I and II criteria and were derived from both literature describing the target species and upon field observations. Curves were developed for both adult and juvenile/fry hardhead and Sacramento pikeminnow (Table CAWG 3 Appendix D-6). Field measurements were collected in Clear, Cottonwood, Beegum, Butte, Bear, Putah, and Jackson Creeks as well as the Yuba River. Study site elevations ranged between 200 and 1,460 feet. Stream discharge during the study was not reported. A reach based sampling strategy was employed for data collection.

2.6.7 North Fork Feather River

The North Fork Feather River criteria (TRPA 2001), are Category II and III criteria. Curves were developed for adult and juvenile hardhead, Sacramento pikeminnow, and Sacramento sucker (Table CAWG 3 Appendix D-6). Field measurements were collected in the North Fork Feather River (Poe and Cresta reaches), and Rock, Belden, and Seneca creeks. Study site elevations ranged between 925 and 2,010 feet. Stream discharge ranged between 40 and 130 cfs.

2.6.8 Yosemite

The Yosemite criteria (Baltz and Moyle 1984), are Category II (utilization) criteria. These curves were developed for adult and juvenile Sacramento sucker (Table CAWG 3 Appendix D-6). Field measurements were collected in Eleanor, Upper Cherry, and Lower Cherry creeks. Study site elevations were approximately 3,800 feet. The stream discharges at the time of data collection were unavailable. A reach based sampling strategy was employed for data collection.

2.7 Transferability Testing

All field data was entered into a database and a 100 percent quality control check was performed. This database was then queried to produce appropriate data for the various tests to be conducted for input into the pFish program. For each stream strata, species and lifestage where a sufficient number of observations had been obtained, a transferability test was performed using the threshold values previously described.

Based on previous studies, (Thomas and Bovee 1993, Groshens and Orth 1994) 50 to 60 fish observations and 200 availability observations are required to provide a reliable test. Sensitivity testing by Lifton et al. (1998) using Monte Carlo simulations, indicated that reliable results could be obtained with as few as 30 fish observations if more availability observations were collected. Based on these results, reliable testing could be conducted if more than 30 observations were collected, but results are not reliable where there were fewer observations. Generally speaking, testing is more reliable with more observations.

3.0 RESULTS

3.1 OVERVIEW OF SAMPLING EFFORT

Field measurements were collected in the summer and fall of 1999, 2002, and 2003. Observed streamflows during the study ranged between 1 and 35 cfs depending on the stream, time of year, and location relative to diversion dams and tributaries (Table CAWG 3 Appendix D-7). Over 167 habitat units were sampled comprising nearly 14,000 linear feet of streams. The total surface area for these habitat units exceeded 600,000 square feet (Table CAWG 3 Appendix D-8). More than 2,400 fish were observed in the course of this study, of which 685 were rainbow trout, 570 were brown trout, 479 were hardhead, 360 were Sacramento pikeminnow, and 339 were Sacramento sucker (Table CAWG 3 Appendix D-9). Approximately eight weeks of effort was expended by six person crews.

3.2 HABITAT AVAILABILITY

Over 5,000 habitat availability measurements were collected, of which 1,623 were collected in LBLS, 1,383 measurements in Large Basin Small Streams (LBSS), 744 measurements in Upper Basin Large Streams (UBLS), and 1,262 measurements in Upper Basin Small Streams (UBSS). Because not all species were found in every stream, habitat availability differed from species to species. Species specific habitat availability is described below. Histograms illustrating the distribution of measured depths and velocities for habitat utilization and habitat availability can be found in Attachment B.

Rainbow trout are widely distributed throughout the Project Area streams. They were not, however, observed in Bear Creek during either the snorkel surveys or the fish population studies. Therefore, availability measurements collected in Bear Creek were not included in the rainbow trout transferability tests. For LBSS, transferability testing had previously been performed for all lifestages of rainbow trout (Lifton et al. 1998). In these studies the AFP criteria were found to be transferable. Therefore observations were not made for rainbow trout in these streams during the current sampling effort and new transferability tests were not conducted. When considering rainbow trout habitat use and availability for the combined stream strata, habitat availability observations from lower basin small streams were omitted from the availability plots. The median of all observed mean column velocities from the remaining stream strata was 0.28 ft/s and the central 50 percent of available mean column velocities ranged between 0.05 and 0.75 ft/s. The maximum observed mean column velocity for Project Area streams was 7.09 ft/s. The median of all observed depths was 1.0 feet and the central 50 percent of available depths ranged between 0.5 and 1.7 feet. The maximum depth availability measurement was 21.6 feet, although during utilization sampling depths of up to 31 feet were observed.

Brown trout are also widely distributed throughout Project Area streams. They were not, however, observed in Stevenson Creek during either the snorkel surveys or the fish population studies. Therefore, availability measurements collected in Stevenson Creek were not included in the brown trout transferability tests. The median of all observed mean column velocities was 0.27 ft/s and the central 50 percent of available mean column velocities ranged between 0.05 and 0.73 ft/s. The maximum observed mean column velocity for Project Area streams was 7.09 ft/s. The median of all observed depths was 0.9 feet and the central 50 percent of available depths ranged between 0.5 and 1.7 feet The maximum depth availability measurement was 21.6 feet.

Hardhead and Sacramento pikeminnow distributions were restricted to reaches of the mainstem San Joaquin River downstream of Dam 6. Since hardhead and Sacramento pikeminnow were not observed utilizing habitat in the Mammoth Pool reach of LBLS, a subset of LBLS availability measurements, excluding this area, was used in HSC transferability testing. The median of all observed mean column velocities available to hardhead and Sacramento pikeminnow in this subset of the LBLS was 0.27 ft/s and the central 50 percent of available mean column velocities ranged between 0.04 and 0.75 ft/s. The maximum observed mean column velocity was 5.25 ft/s. The median of all observed depths in this reach was 1.8 feet and the central 50 percent of available depths ranged between 0.7 and 3.4 feet. The maximum depth availability measurement was 21.6 feet.

Sacramento sucker occur throughout the LBLS. The median of all observed mean column velocities was 0.31 ft/s and the central 50 percent of available mean column velocities ranged between 0.05 and 0.83 ft/s. The maximum observed mean column velocity was 6.26 ft/s. The median of all observed depths in this reach was 1.55 feet and the central 50 percent of available depths ranged between 0.7 and 2.85 feet. The maximum depth availability measurement was 21.6 feet.

3.3 HABITAT UTILIZATION

The frequency of depth and velocity utilization for each species and lifestage are presented by stream strata in Attachment B (this is the packet provided to the CAWG on January 14, 2004). The descriptions below encompass habitat utilization in all stream strata together. Histograms for the combined stream strata are provided in this report in Attachment C (This packet was distributed to the CAWG in February 2004).

3.3.1 RAINBOW TROUT HABITAT UTILIZATION

In the course of this study 327 adult, 54 juvenile, and 60 fry rainbow trout were observed in the study streams. These totals do not include observations originally collected in LBSS as part of the Lifton (1998) study. Rainbow trout were observed to occupy positions where depths were less than 6.0 feet and velocities were less than 4.39 ft/s (Table CAWG 3 Appendix D-10). They were not observed to use depths less than 0.4 ft. Adult rainbow trout occupied positions in the streams that were generally deeper than positions occupied by juveniles or fry. The median velocity for positions occupied by adult rainbow trout was slightly higher than for those occupied by juveniles or fry. The central 50 percent of adults[1] were also observed to occupy a wider range of velocities (0.17 to 0.96 ft/s) than did the corresponding segment of juveniles (0.17 to 0.68 ft/s) or fry (0.13 to 0.68 ft/s).

3.3.2 Brown Trout Habitat Utilization

For brown trout, 346 adults, 79 juveniles, and 145 fry were observed in the study streams. Brown trout occupied positions were depths were generally less than 6.0 feet and velocities were less than 2.05 ft/s (Table CAWG 3 Appendix D-10). Although brown trout for all three lifestages occupied a relatively wide range of depths, larger fish tended to use deeper water than smaller fish, as evidenced by the higher median and central tendency (Central 50% of Observations) values of the different lifestages. The lower range of mean column velocities used was relatively similar for all three lifestages (based on the central 50 percent of observations), but it is interesting to note that adult brown trout tended to use somewhat lower velocities than juveniles or fry. The depths used by brown and rainbow trout were generally similar, as were the velocities used by fry and juveniles of the two species. Adult brown trout tended to use somewhat slower velocities than did adult rainbow trout.

3.3.3 Hardhead Habitat Utilization

Observations were made on 50 adult, 58 juvenile, and 370 fry hardhead in LBLS (the only stream stratum in which they occur). Hardhead were observed to occupy positions with depths of up to 21 feet and velocities less than 1.7 ft/s. Median depths occupied by hardhead were much greater than those occupied by either rainbow trout or brown trout. Similarly, velocities occupied by hardhead were less than those occupied by trout. Adult and juvenile hardhead occupied much deeper positions than did fry (Table CAWG 3 Appendix D-10). The central tendency for measured velocities at the positions occupied by juveniles and fry were similar. Adult hardhead used a little faster water than the younger lifestages, as indicated by the higher upper boundary of the central 50% column.

3.3.4 Sacramento Pikeminnow Habitat Utilization

Sacramento pikeminnow were also observed only in LBLS. In the course of this study 23 adult, 67 juvenile, and 270 fry Sacramento pikeminnow were observed. They occupied positions where depths were less than 8.2 feet and velocities were less than 1.1 ft/s (Table CAWG 3 Appendix D-10). The median depth of the occupied positions for each lifestage indicates that adult Sacramento pikeminnow utilize deeper water (2.5 feet) than juveniles (1.6 feet) or fry (1.4 feet). The value of the lower boundary of the central tendency of observed depth use also increases with age. Stream velocity at the

[1] In Table CAWG 3 Appendix D-10 the column "Central 50% of Observations" gives the range of velocity or depth values where half of the observations surrounding the median were made. One quarter of the fish observed used values lower than the range and one quarter used values higher than the range.

occupied positions was quite low for all lifestages. There did seem to be a trend toward slightly faster velocities with increasing age.

3.3.5 Sacramento Sucker Habitat Utilization

In the course of this study 75 adult, 96 juvenile, and 168 fry Sacramento suckers were observed in LBLS (the only stream stratum in which they occur). Sacramento suckers occupied positions where depths were less than 6.8 feet and velocities were less than 2.82 feet. Adults tended to use substantially deeper water than juveniles or fry based on the median and central 50 percent of habitat used. Larger Sacramento suckers tended to use higher velocities than smaller fish. This differential habitat use among the lifestages was more pronounced than for the other species studied. Adults and juveniles were observed to occupy positions with higher velocities than either hardhead or Sacramento pikeminnow and similar to that of the trout. Depth utilization was very similar to that observed for Sacramento pikeminnow for the fry and juveniles.

3.4 Transferability Testing Results

3.4.1 Adult Rainbow Trout

Lower Basin Large Streams

For all of the HSC tested, excluding AFU criteria, the null hypothesis was rejected in the joint suitability threshold tests (Table CAWG 3 Appendix D-11). This result suggests that these criteria are acceptable for use in LBLS. The Upper American River (UARP) criteria that were developed for medium sized streams are also considered acceptable for use in Project Area streams on the basis that both the depth and velocity suitability indices simultaneously passed the threshold test.

Lower Basin Small Streams

As mentioned previously, for LBSS, transferability testing had previously been performed for all lifestages of rainbow trout (Lifton et al. 1998). In these studies the AFP criteria were found to be transferable. Therefore observations were not made for rainbow trout in these streams and new transferability tests were not conducted.

Upper Basin Large Streams

For all of the HSC tested, excluding AF Utilization, the null hypotheses were rejected in the joint suitability threshold tests. This result suggests that these criteria are acceptable for use in UBLS. The Stan-1 (TT) and Stan-Alt (TT) generic trout criteria were also acceptable for use in Project Area streams on the basis that both the depth and velocity suitability indices simultaneously passed the threshold test.

Upper Basin Small Streams

Thirty-eight adult rainbow trout were observed in UBSS. For AFP, AFU, UARP Medium, Stan-1, and Stan-Alt criteria, the null hypotheses were rejected in the joint suitability threshold tests (Table CAWG 3 Appendix D-11). This result suggests that these criteria are acceptable for use in UBSS. None of the tested criteria satisfied the condition of simultaneously passing threshold tests for both depth and velocity. Due to the low number of adult rainbow trout observed in UBSS, these results may be less reliable compared to tests performed with a larger number of observations.

3.4.2 Juvenile Rainbow Trout

Insufficient numbers of juvenile rainbow trout were observed in any stream stratum to adequately test the transferability of this group. Only 23 juvenile rainbow trout were observed in LBLS, 21 in UBLS, and ten in UBSS (Table CAWG 3 Appendix D-11). As mentioned previously, for LBSS, transferability testing had previously been performed for all lifestages of rainbow trout (Lifton et al. 1998). In these studies the AFP criteria were found to be transferable.

3.4.3 Rainbow Trout Fry

Insufficient numbers of rainbow trout fry were observed in any stream stratum to adequately test the transferability of this group. Only 29 rainbow trout fry were observed in LBLS, 28 in UBLS, and three in UBSS (Table CAWG 3 Appendix D-11). As mentioned previously, for LBSS, transferability testing had previously been performed for all lifestages of rainbow trout (Lifton et al. 1998). In these studies the AFP criteria were found to be transferable. Therefore observations were not made for rainbow trout in these streams and new transferability tests were not conducted.

3.4.4 Adult brown trout

Large Basin Large Streams

Only 25 adult brown trout were observed in LBLS (Table CAWG 3 Appendix D-11). Therefore, insufficient numbers were observed to adequately test the transferability of HSC and testing was not performed.

Lower Basin Small Streams

Eighty four adult brown trout were observed in LBSS. For all of the HSC tested, the null hypotheses were rejected in the joint suitability threshold tests. This result suggests that these criteria are acceptable for use in LBSS. None of the tested criteria satisfied the condition of simultaneously passing threshold tests for both depth and velocity.

Upper Basin Large Streams

The null hypotheses were rejected in the joint suitability threshold tests for AFP, Stan-1 (TT), and Stan-Alt (TT) criteria. These results suggest that these criteria are acceptable for use in UBLS. The Stan-1 (TT) and Stan-Alt (TT) criteria are also considered acceptable for use in Project Area streams on the basis that both the depth and velocity suitability indices simultaneously passed the threshold test.

Upper Basin Small Streams

One hundred and fifty adult brown trout were observed in upper basin small streams. For all of the HSC tested, the null hypotheses were rejected in the joint suitability threshold tests. These results suggest that these criteria are acceptable for use in UBSS. The UARP Medium, UARP Small, Stan-1 (brown trout juvenile criteria), Stan-1 (TT), Stan-Alt (TT) criteria are also considered acceptable for use in Project Area streams on the basis that both the depth and velocity suitability indices simultaneously passed the threshold test.

3.4.5 Juvenile Brown Trout

Too few observations of juvenile brown trout were collected in any of the four stream strata to allow reliable transferability testing. Only 18 juvenile brown trout were observed in LBLS, 25 in LBSS, 15 in UBLS, and 21 in UBSS (Table CAWG 3 Appendix D-11).

3.4.6 Brown Trout Fry

The only stream strata where a sufficient number of brown trout fry observations were made to allow testing was LBSS, with 101 observations. For this basin, the null hypotheses were rejected in the joint threshold suitability test for the AFP criteria. This result suggests that these criteria are acceptable for use in LBSS. None of the tested criteria satisfied the condition of simultaneously passing threshold tests for both depth and velocity. In the other basins, only one brown trout fry was observed in LBLS, eighteen in UBLS, and 25 in UBSS (Table CAWG 3 Appendix D-11).

3.4.7 Adult Hardhead

For West Sierra, Stan-1, and Stan-Alt criteria, the null hypotheses were rejected in the joint suitability threshold tests (Table CAWG 3 Appendix D-11). These results suggest that these criteria are acceptable for use in LBLS. The West Sierra criteria are also considered acceptable for use in LBLS on the basis that both the depth and velocity suitability indices simultaneously passed the threshold test.

3.4.8 Hardhead Juvenile / Fry

For the Stan-1 criteria, the null hypotheses were rejected in the joint suitability threshold tests (Table CAWG 3 Appendix D-11). These results suggest that these criteria are acceptable for use in LBLS. The Stan-1 criteria did not satisfy the condition of simultaneously passing threshold tests for both depth and velocity. As discussed previously, the Deer Creek HSC contain one set of curves for adult-juvenile hardhead and another set of curves for juvenile hardhead. No curves were developed explicitly for fry. The juvenile-fry observations were tested against each of these curves. For the Deer Creek combined adult-juvenile criteria, the null hypotheses were rejected in joint suitability threshold tests. These results suggest that the criteria are acceptable for use in LBLS. The null hypotheses were not rejected for the Deer Creek juvenile criteria and therefore they were not acceptable for use in LBLS. Based on the results of the transferability tests, none of the remaining HSC were acceptable for use in LBLS.

3.4.9 Adult Sacramento Pikeminnow

Only 23 adult Sacramento pikeminnow were observed in LBLS (Table CAWG 3 Appendix D-11). Because this number is insufficient to adequately test the transferability of HSC for this species/lifestage, no tests were performed.

3.4.10 Sacramento Pikeminnow Juvenile / Fry

Based on 337 observations in LBLS, the null hypotheses were rejected for the joint suitability threshold tests for both the Pit River and West Sierra criteria. These results suggest that these criteria are acceptable for use in LBLS. The joint transferability tests indicate that the Deer Creek and NF Feather-Preference criteria are not acceptable for use in LBLS. None of the tested criteria satisfied the condition of simultaneously passing threshold tests for both depth and velocity.

3.4.11 Adult Sacramento Sucker

Seventy-five observations of adult Sacramento sucker were made in LBLS. Testing resulted in the rejection of the null hypotheses for the joint suitability threshold tests for both the Pit River and NF Feather-Preference criteria (Table CAWG 3 Appendix D-11). These results suggest that these criteria are acceptable for use in LBLS. The joint transferability tests indicate that the Yosemite criteria are not acceptable for use in LBLS. None of the tested criteria satisfied the condition of simultaneously passing threshold tests for both depth and velocity.

3.4.12 Juvenile Sacramento Sucker

Ninety-six observations of juvenile Sacramento sucker were made in LBLS. At least one null hypothesis was accepted in all of the joint transferability tests and for the tests of depth and velocity, for each HSC tested. This indicates that none of the criteria are acceptable for use in LBLS.

3.4.13 Sacramento Sucker Fry

One hundred sixty-eight Sacramento sucker fry observations were made in the LBLS. None of the tested criteria passed either for the joint criteria or simultaneously passed for both depth and velocity. Therefore, none of the criteria would be considered to adequately predict habitat use by this species/lifestage in LBLS, and would not be considered transferable.

3.5 CAWG HSC Discussions

The first results of the transferability testing were presented to the CAWG on August 19, 2003 following a review of the transferability testing protocol. At this time, a sufficient number of observations had been made for several species/lifestage groups in one or more stream strata. Sampling was continuing for other species and lifestages at this time. A brief update of this information was provided in September 2003 and final results were presented to the CAWG in October 2003. Between October 2003 and May 2004, HSC were a major topic of discussion by the CAWG. During this time information regarding the origin and data used in developing the candidate criteria was reviewed. This included discussions about the streams where the data were collected, relevant physical parameters (time of year, flows, elevation, stream size), species present, number of observations, and sampling methods.

As part of this process, the CAWG expressed some concern about the results of the transferability testing. These concerns stemmed from review of the criteria that had passed and those that had not and comparison of these criteria with the observed patterns of utilization and availability in the project streams. For some species/lifestage groups, two or more criteria with very different shapes passed, while in other cases no criteria passed, although the curves fit the observed pattern of utilization well. Through discussion, it was decided that the transferability test would be used as guidance, but the selection of the final criteria would be based more on the way the criteria fit the observed patterns of use and availability and modified through discussion and consensus of the group.

During HSC sub-group meetings conducted on January 28 and 29, 2004 tentative criteria were developed for all species and lifestages. These criteria were based on a review of the site specific utilization and habitat availability data, consideration of the transferability test results, and extensive discussions among the participants regarding the life history strategies of the various species and lifestages. At this meeting the CAWG decided that the different stream strata should be combined, as the differences in fish size and behavior did not indicate that habitat use would be significantly different among the strata. This was accomplished, and the preliminary criteria were discussed based on these pooled data sets. The preliminary criteria generally followed portions of one or more of the candidate criteria, but were sometimes modified to fit the observational data, or to bridge gaps between data sets or remove inconsistencies in the source criteria (e.g., dips in the functions that seemed to have no basis in fish behavior. The preliminary criteria were distributed to all parties the week following the meeting for further review and discussion at subsequent meetings.

The next substantive discussions regarding the HSC took place at the March 2004 CAWG meeting. At this meeting, the CAWG reviewed additional analyses that had been requested. These consisted of alternate graphical depictions of the data and use-to-availability ratios. Following this review, additional discussion regarding the criteria ensued. These discussions focused on velocity use and preference, primarily for adult trout. At issue was whether any of the existing criteria sets adequately reflected trout preference at higher velocities. In the opinion of one CAWG member, none of the HSC data had been collected at flows high enough to reflect their relative preference for velocities exceeding 1.5 ft/s.

At this meeting, the CAWG agreed that the preliminary criteria developed during the January 28th and 29th meeting were appropriate for use in the Big Creek ALP instream flow studies. These were the criteria for all lifestages of Sacramento sucker and Sacramento pikeminnow and the fry and spawning lifestages of rainbow and brown trout. The CAWG was also in agreement with regard to the depth criteria for adult and juvenile rainbow and brown trout. All members, except the USFWS, felt that the tentative criteria for adult and juvenile rainbow and brown trout velocities were acceptable for use, however no decision was reached about the suitability of velocities approaching 0.0 ft/s for adult rainbow and brown trout. Several members wanted to receive input from Dr. Peter Moyle of the University of California at Davis, before finalizing the hardhead criteria. At the time of this writing, this input is still pending. During this meeting, Mark Gard of the USFWS offered to reanalyze the data collected for rainbow trout in the UARP studies using the technique of Rubin et al. (1991) to see if the resulting criteria would provide an alternative acceptable to the CAWG.

In April 2004, the group again revisited the criteria to try to reach agreement regarding the velocity criteria for adult and juvenile rainbow and brown trout. At issue was the appropriate suitability value for velocities approaching 0.0 ft/s for adult trout. After some discussion, agreement was reached, setting the suitability for 0.0 ft/s velocity equal to 0.65 for adult rainbow trout and 0.7 for adult brown trout. All participants, except the USFWS, expressed that this agreement was acceptable and appropriate for use in modeling habitat in the Big Creek system. The group decided that if the USFWS developed new criteria from the UARP data, as previously discussed, the group would consider that data when it was presented.

At the May 2004 CAWG meeting, the USFWS presented criteria derived from a reanalysis of the UARP data. The USFWS indicated that it felt these criteria were more appropriate than the criteria agreed to in April for use in the Big Creek ALP because, in the USFWS' opinion, they better reflected the preference of trout for higher velocities. There was substantial discussion about these criteria and the method used in developing them. At the conclusion of the discussion, only the USFWS felt that these criteria provided a better representation of how adult trout use velocity than the criteria agreed to by the CAWG. The CAWG decided to proceed with the tentative criteria (now known as the Big Creek ALP criteria (BCALP). The USFWS indicated that it would use its independently derived criteria in its own evaluation.

The adult trout criteria from the previous meeting were then discussed. The USFS requested that a sensitivity analysis be performed to assess how much difference a different suitability value at zero ft/s would make in the WUA functions for adult rainbow trout.

The Sensitivity Analysis was subsequently completed and discussed by the CAWG during a conference call on July 7, 2004. The presentation of the Sensitivity Analysis is included in this report as Attachment D. At the conclusion of the presentation, all members of the CAWG, except for representatives of the USFWS, were still in agreement that the BCALP HSC were acceptable and appropriate for use in modeling habitat in the Big Creek system.

3.6 BIG CREEK ALP CRITERIA

The final criteria agreed upon by the CAWG (Big Creek ALP criteria) are presented in Attachment C. These criteria were developed based upon the discussions described in the previous section, taking into account site specific observations, other existing criteria, and the collective professional judgement of the CAWG. These criteria were used in habitat simulations for the project streams with major diversions. The application of the PHABSIM models is discussed in *CAWG 3 Instream Flow Studies – PHABSIM* (SCE 2004), to which this report is an appendix.

Contained within Attachment C are the tabulated coordinates for the BCALP criteria for each species and lifestage and plots showing the BCALP HSC overlain on histograms of observed utilization and habitat availability. Also included on these plots are the other criteria considered in developing these criteria. The pages with the tabulated coordinates include a brief verbal description of the origin of the criteria.

3.6.1 TROUT

Criteria were developed for the adult, juvenile, fry and spawning lifestages of rainbow and brown trout. The BCALP HSC for rainbow and brown trout indicate that larger fish have a higher preference for deeper and faster water than do smaller fish. This pattern has been well documented in the literature and is observed in the various HSC considered as part of this study. The criteria indicate a higher preference for low velocities by adult brown trout than adult rainbow trout. The optimal depths for rainbow trout and brown trout are generally similar, although the criteria indicate that slightly shallower depths (1.7 vs. 1.9 ft) are considered optimal by adult brown trout. The velocity and depth criteria for juvenile and fry rainbow and brown trout are similar. This is consistent with the high degree of overlap in their habitat use observed in this and other studies (Studley et al., 1995, Wise et al. 1997).

3.6.1.1 Rainbow Trout

Optimal depths for adult rainbow trout range from 1.9 to 3.5 feet and depths greater than 10 ft have moderate suitability, acknowledging that depths in this range may be used, if other factors are favorable. Optimal velocities for adult rainbow trout occur from 0.35 to 1.1 ft/s, and decline to a suitability of 0.26 from 1.8 to 2.95 ft/s. Velocities of 0 ft/s have a suitability of 0.6. Velocities greater than 3.05 ft/s are considered unsuitable, for adult rainbow trout.

For juveniles, optimal depths range from 0.9 to 2.1 ft and depths greater than 3.9 ft have low suitability, as do depths less than 0.5 ft. Optimal velocities for juvenile rainbow trout range from 0.15 to 0. 5 ft/s and decline to the 0.5 suitability level at 0.95 ft/s. Velocities of 2.95 ft/s or greater, are unsuitable for juvenile rainbow trout

Optimal depths for fry of both trout species range from 0.4 to 1.6 ft, with depths of greater than 3 ft having low suitability. Velocities less than 0.5 ft/s are considered optimal for fry of both trout species, and velocities of 3 ft/s or greater are unsuitable.

Spawning criteria for the two species are the same for depth and substrate. Depths of 0.5 to 1.5 ft are considered optimal and depths of more than 1.77 ft have a moderate suitability. Depths less than 0.1 ft are considered unsuitable for spawning for both species. Substrates between 0.1 and 3 inches in diameter are considered suitable for spawning by both species. The velocity criteria for the two species differ in that rainbow trout are thought to prefer higher velocities (0.65 to 1.625 ft/s) than brown trout (0.5 to 1.25 ft/s). Velocities of up to 3 ft/s retain some suitability for rainbow trout spawning, while velocities of 2.25 ft/s or greater are considered unsuitable for brown trout spawning.

3.6.1.2 Brown Trout

Depths less than 0.9 have very low suitability for adult brown trout. Depths of 1.9 t0 3.5 have the highest suitability. Suitability then declines with depth to 10 feet. Depths of 10 ft or more have a suitability of 0.5. For velocity, optimal suitability occurs from 0.3 to 0.75 ft/s and declines to 0.16 at 2.25 ft/s. Velocities of 2.5 ft/s or higher are considered unsuitable for adult brown trout.

The depth criteria for juvenile brown trout have a suitability of zero until depths exceed 0.35 ft. Optimal depth suitability occurs from 0.9 to 1.9 ft and then declines with flow, reach a suitability of 0.48 at 3.2 ft and 0.14 ft at depths of 4 ft and greater. The velocity criteria for juvenile brown trout follows the same pattern as that for juvenile rainbow trout, with a similar peak, but declines more quickly as velocities exceed 0.5 ft/s. Velocities exceeding 2.85 ft/s are unsuitable for juvenile brown trout. .

Criteria for fry and spawning brown trout are described with those for rainbow trout, above.

3.6.2 NATIVE CYPRINIDS AND CATOSTOMIDS

For hardhead, Sacramento sucker, and Sacramento pikeminnow, criteria were developed for the adult and juvenile lifestages. Criteria were not developed for fry or spawning lifestages. With regard to fry, many of the criteria sets considered combined juveniles and fry into a single criteria set, and that may be appropriate here as well. No spawning criteria are available from the literature for any of these species and observations were not made for this lifestage as part of this study.

These fish generally prefer deeper water and slower velocities than rainbow and brown trout. As with trout, the criteria indicate that larger fish find faster and deeper water more suitable than smaller fish.

3.6.2.1 Hardhead

For adult hardhead, the most suitable depths range from 4.2 to 7.33 ft. Depths less than 1.3 ft have little or no suitability, while depths greater than 14 ft retain moderate suitability. Optimal velocities are less than 0.9 ft/s and suitability declines to zero at 2.5 ft/s.

Juvenile hardhead depth suitability is zero at less than 0.5 ft, optimal from 1 to 7 ft and then declines to 0.15 at 12 ft and zero at 18 ft. Juvenile hardhead prefer low velocities, and suitability decreases with increasing velocity to a value of 0.25 at 1.75 ft/s and zero at 2.6 ft/s.

3.6.2.2 Sacramento sucker

The depth criteria for adult sucker show the highest suitability from 2.25 to 7 ft and a suitability of at least 0.75 at all greater depths. Depths less than 0.6 ft have low suitabilities (less than 0.25). The velocities having the highest suitability for adult sucker are 0.75 to 0.92 ft/s. These velocities are similar to those for trout. Suitability declines with flow from 0.92 to 2.08 where there is a brief plateau with a suitability of about 0.45 extending to a velocity of 0.92 ft/s. Suitability then begins to decline again, reaching zero at 4.5 ft/s.

For juvenile sucker, the most suitable depths occur from 0.66 t0 2.0 ft. The suitability of depth declines to 0.25 at 4.7 ft and zero at 8 ft. Suitabilities of 1.o occur at velocities of 0.25 ft/s or less. Suitability declines with increasing velocity, with a suitability of 0.23 occurring at 1.25 ft/s and zero at 3.75 ft/s.

3.6.2.3 Sacramento Pikeminnow

Shallower depths are more suitable for adult pikeminnow than for the other two non-trout species. The highest suitability occurs from 1.5 to 3.28 ft. Suitability is low (less than 0.25) at depths less than 0.85 ft or more than 5.91 ft. The highest suitability for velocity occurs at less than 0.82 ft/s and decreases rapidly with increasing velocities, reaching 0.37 at 1.15 ft/s and zero at 2 ft/s.

The most suitable depths for juvenile pikeminnow is from 1 to 2 ft. Depths less than 0.3 or more than 4.4 ft have low suitability (less than 0.25). The velocity suitability for juvenile pikeminnow is highest from 0 to 0.19 ft/s and then decreases with increasing velocity reaching 0.2 at 1.14 ft/s and zero at 1.48 ft/s.

4.0
SUMMARY

This report has documented the data collection efforts, transferability testing and subsequent development of the HSC that were used in the Big Creek ALP PHABSIM studies. Criteria were developed for the adult, juvenile, fry and spawning lifestages of rainbow and brown trout, and the adult and juvenile lifestages of hardhead, Sacramento sucker, and Sacramento pikeminnow. These are the principal fish species found within the Project by-pass reaches where PHABSIM studies were to be conducted (SCE 2001).

The final criteria were based on the consensus of the CAWG, after consideration of site specific observations, other existing criteria, transferability testing results and extensive discussion. In the combined professional judgement of the CAWG, these criteria represent the habitat preferences of the target species and lifestages. The USFWS did not concur with the velocity criteria for adult and juvenile rainbow and brown trout. They felt that the criteria do not accurately reflect the actual suitability of very low velocities, and of higher velocities than those at which sampling occurred.

5.0
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ATTACHMENT A

EXAMPLE FIELD DATA SHEETS

Fish Utilization Data Sheet

Stream: Mono Creek - d/s of diversion Plot Order: 185 Hab. Type: SRN Hab. Length (ft): 109 Length Sampled(ft): 109

Stream Width at % of reach length 0% 17.5 25% 19.7 50% 21.4 75% 26.6 100% 24.7 Ave Width __ Date: 08 21 03 (MM DD YY)

Flow (cfs): __ Water Temp: 12 Air Temp: 21 % Cloud Cover: 95 % Canopy: 00 % Shade: 10 Visibility: 8.0 Page 1 of 1

Divers: KHB JLN Data Recorder: LRM Measurements: GEM Snorkel Start Time: 1330 Snorkel End Time: 1430

	Marker No.	Species	No. of Fish	Fish Behav.	Length (in)	Dist. off Bottom (in)	Loc. in Unit	Total Depth (ft)	Mean Col. Velocity (ft/s)	2/10ths Velocity (ft/s)	8/10ths Velocity (ft/s)	Focal Velocity (ft/s)	SUBSTRATE: Dominant Type	Dominant %	Subdom. Type	Subdom. %	Gravel %	COVER Type	COVER %	Dist. to Cover	Dist. to Shear	Diver
01	2	11	1	2	6.0	04	4	1.7	1.21	—	—	0.31	7	80	5	20	0	7	40	1	1	KHB
02	6	14	1	5	5.0	03	3	1.4	1.16	—	—	0.78	6	70	5	30	10	4	10	1	1	
03	7	11	1	2	6.0	05	2	1.6	0.68	—	—	0.42	6	60	1	20	20	3	5	1	1	
04	8	14	1	2	6.0	04	2	1.9	0.51	—	—	0.06	6	80	1	20	0	3	50	1	1	
05	9	11	1	2	4.0	02	2	1.4	0.16	—	—	0.33	6	90	1	10	0	7	15	1	1	
06	10	14	1	8	6.0	01	2	2.3	.14	—	—	0.43	6	80	1	10	10	3	10	1	1	
07	34	14	1	5	6.0	06	4	1.2	0.12	—	—	0.12	4	50	2	50	50	7	25	1	1	JLN
08	32	14	1	2	2.5	03	3	0.35	0.20	—	—	0.30	6	50	1	50	0	5	20	1	1	
09	3	14	1	2	3.0	02	3	1.0	0.53	—	—	0.52	6	60	4	40	0	7	10	1	1	
10	28	14	1	1	3.0	01	3	1.1	.23	—	—	0.11	6	50	3	50	0	4	20	1	1	
11	22	14	1	5	3.0	05	3	0.8	0.29	—	—	0.29	6	50	1	50	0	5	20	1	1	
12	21	14	1	5	3.5	03	2	1.4	0.07	—	—	0.11	4	60	3	30	0	7	10	1	1	
13	12	14	1	1	6.0	01	1	1.1	0.03	—	—	0.26	6	70	2	30	30	3	40	1	1	
14																						
15																						
16																						
17																						
18																						
19																						
20																						

NOTES:

Line out errors - do not erase or overwrite
All information must be completed
Crew Leader or designee to check form before leaving site

Species Codes: 11- Rainbow Trout, 14-Brown Trout, 21-Hitch, 22-Roach, 31-pikeminnow, 32-Hardhead, 33-Sacto. Sucker, 51-Green Sunfish, 53-Lgmouth Bass, 59-Prickly Sculpin, 98-Hatchery Rainbow trout, others-specify
Fish Behavior: 1-resting (on bottom or under rock), 2-holding (in current but not feeding), 3-defending, 4-surface feeding, 5-drift feeding, 6-bottom feeding, 7-general agonistic; 8 Hiding
ENTRIX Substrate Codes: 1-fines(<4mm), 2-sm gravel(4-25mm), 3-lg gravel(26-75mm), 4-cobble(76-225mm), 5-rubble(225-300mm), 6-sm boulder(300-600mm), 7-lg boulder (>600mm), 8-bedrock
Cover Type: 1-No Cover, 2-Object<150mm, 3-Object 150-300, 4-Object >300, 5- Overhanging Veg., 6-Root wad or undercut bank, 7-Surface Turbulence Coding Dom,SDom,Pct Cov in quartiles
Distance: 1 = < 1m, 2 = 1-2m, 3 = >2m

Checked by: KCG

Date: 08 21 03 (MM DD YY)

Habitat Availability Data Sheet

00046

Date: 08 21 03

Page 1 of 1

Stream: Mono Creek BD

Plot Order: 185 Hab. Type: SRN Unit Length: 17.4

Current Meter ID: Marsh McBirney #1 Random # 53 Distance U.S. 056

Need 10 in water measurements per transect

	Distance (ft)	Total Depth (ft)	Mean Column Velocity (ft/s)	2/10 Velocity (ft/s)	8/10 Velocity (ft/s)	Focal Velocity 15 cm from Bottom (ft/s)	SUBSTRATE Dominant Type	Dominant %	Subdominant Type	Subdominant %	Gravel %	COVER Type	COVER %	Dist. to: Shear	Dist. to: Cover
01	16.5	00.6	0.08	—	—	0.04	5	70	1	10	10	5	05	3	1
02	14.5	00.5	0.55	—	—	0.45	5	90	—	—	10	5	05	3	1
03	13.5	0~~1~~.55	0.61	—	—	0.08	5	100	—	—	—	5	20	3	1
04	12.0	01.6	0.63	—	—	0.26	5	90	—	—	05	4	60	3	1
05	10.5	01.4	0.54	—	—	0.27	5	80	6	20	00	3	10	3	1
06	09.0	01.3	0.65	—	—	0.60	5	90	—	—	10	2	05	3	1
07	07.5	01.7	0.01	—	—	0.05	6	90	1	05	05	2	05	3	1
08	06.0	01.1	0.09	—	—	0.19	6	100	—	—	—	4	15	3	1
09	04.5	00.6	0.44	—	—	0.48	6	80	1	05	05	5	05	3	1
10	03.0	00.8	0.01	—	—	.07	6	50	1	50	00	1	100	3	2
11															
12															
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17															
18															
19															
20															

Line out errors - do not erase or overwrite
All information must be completed
Crew Leader or designee to check form before leaving site

Crew Initials: Recorder. GEM Meas. 1 GEM Meas. 2

NOTES: RWE = 0.6 ft LWE = 18.0 ft. Recorder = Gina Morimoto
Meas. 1 = Graciela Moore

PHOTOS:

Species Codes: 11- Rainbow Trout, 14-Brown Trout, 21-Hitch, 22-Roach, 31-Squawfish, 32-Hardhead, 33-Sacto. Sucker, 51-Green Sunfish, 53-Lgmouth Bass, 59-Prickly Sculpin, 98-Hatchery Rainbow trout, others-specify

Checked by: KCG

Date: 08 21 03

Substrate Codes: 1-fines(<4mm), 2-sm grav.(4-25mm), 3-lg grav.(26-75mm), 4-cobble(76-225mm), 5-rubble(225-300mm), 6-sm boul.(300-600mm), 7-lg boul. (>600mm), 8-bed.

Cover Type: 1-No Cover, 2-Object<150mm, 3-Object 150-300, 4-Object >300, 5-Overhanging Veg., 6-Root wad or undercut bank, 7-Surface Turbulence Coding Dom,SDom,Pct Cov in quartiles

Distance: 1= < 1m, 2 = 1-2m, 3 = >2m

ATTACHMENT B

CRITERIA CONSIDERED FOR TRANSFERABILITY TESTING

Habitat Suitability Criteria
vs.
Observed Utilization and Habitat Availability

Prepared for:
Combined Aquatic Working Group

By: ENTRIX, Inc.

January 14, 2004

TABLE OF CONTENTS

Results of Habitat Preference Tests for Adult Rainbow Trout

	Adult Rainbow Trout			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	117		172	38
AF Pref	J/D	--	J/D	J/D
UARP Large	J/V	--	J/D	--
UARP Medium	J/D/V	--	J/D	J/D
UARP Small	--	--	--	D
STAN-1 (Generic)	J	--	J/D/V	J
STAN-ALT (Generic)	J	--	J/D/V	J

Results of Habitat Preference Tests for Juvenile Rainbow Trout

	Juvenile Rainbow Trout			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	23		21	10
AF Pref	F	--	D	--
UARP All-Juvenile	D	--	J/D	D
STAN-1 (Generic)	F	--	J/D	D

Results of Habitat Preference Tests for Fry Rainbow Trout

	Fry Rainbow Trout			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	29		28	3
AF Pref	J	--	D	--
STAN-1 (Generic)	F	--	F	F

Results of Habitat Preference Tests for Rainbow Trout Base

	Rainbow Trout Base			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	140	--	193	48
AF Pref	J/D	--	J/D	J/D

Highlighted cells pass transferability test.

Results of Habitat Preference Tests for Adult Brown Trout

	Adult Brown Trout			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	25	84	87	150
AF Pref	F	J/D	J/D	J/D
UARP Large	F	--	F	--
UARP Medium	J	J/D	F	J/D/V
UARP Small	--	J/D	--	J/D/V
STAN-1 (BT)	F	J/D	F	J/D/V
STAN-1 (Generic)	F	J/D	J/D/V	J/D/V
STAN-ALT (Generic)	F	J/D	J/D/V	J/D/V

Results of Habitat Preference Tests for Juvenile Brown Trout

	Juvenile Brown Trout			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	18	25	15	21
AF Pref	--	J/D	D	D
UARP All-Juvenile	F	F	F	F
STAN-1 (BT)	F	J/D	J/D	D
STAN-1 (Generic)	D	J/D	J/D	D

Results of Habitat Preference Tests for Fry Brown Trout

	Fry Brown Trout			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	1	101	18	25
AF Pref	--	J	D	F
STAN-1 (Generic)	F	F	F	F

Results of Habitat Preference Tests for Brown Trout Base

	Brown Trout Base			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	43	109	102	171
AF Pref	F	J/D	J/D	J/D

Highlighted cells pass transferability test.

Results of Habitat Preference Tests for Total Trout Adult

	Total Trout Adult			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	142	103	259	188
AF Pref	J	J/D/V	J/D	J/D/V
STAN-1 (Generic)	J	J/D/V	J/D	J/D/V
STAN-ALT (Generic)	J/V	J/D	J/D/V	J/D/V

Results of Habitat Preference Tests for Total Trout Juvenile

	Total Trout Juvenile			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	41	39	36	31
AF Pref	F	J/D	D	D
STAN-1 (Generic)	F	J/D	D	D

Results of Habitat Preference Tests for Total Trout Fry

	Total Trout Fry			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	30	126	46	25
AF Pref	J/D	F	F	F
STAN-1 (Generic)	J/D	F	F	F

Results of Habitat Preference Tests for Total Trout Base

	Total Trout Base			
Stream Group	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	183	142	295	219
AF Pref	J	J/D	J/D	J/D/V
STAN-1 (Generic)	J	J/D	J/D	J/D/V

Highlighted cells pass transferability test.

Results of Habitat Preference Tests for non-Trout Species - Lower Large Streams - Hardhead

	Hardhead	
	Adult	Juvenile/Fry
No. of Fish	50	429
Pit River	F	D
Deer Creek	F	F(j); J/D (a,j)
West Sierra	J/D/V	F (j)
NF Feather-Preference	J	F (j)
UARP	F	--
STAN-1	J/V	J/D (j)
STAN-ALT	J	--

Results of Habitat Preference Tests for non-Trout Species - Lower Large Streams - Pikeminnow

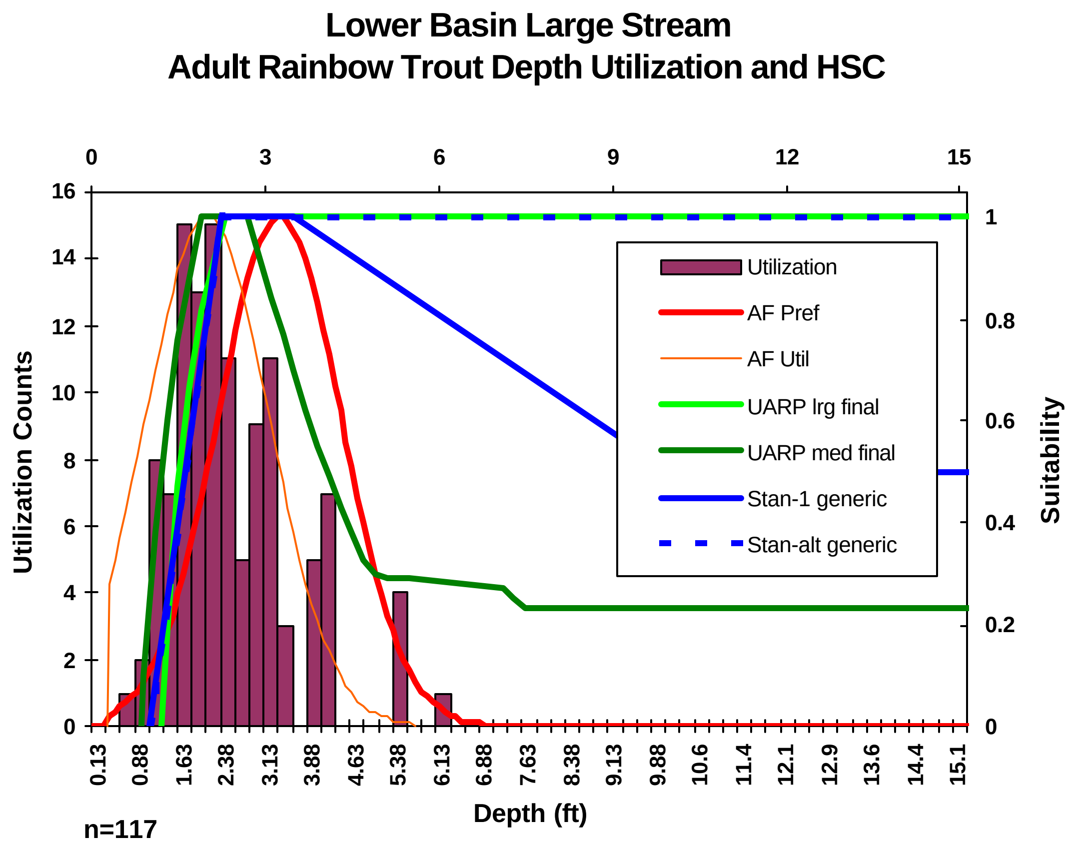
	Pikeminnow	
	Adult	Juvenile/Fry
No. of Fish	23	337
Pit River	D	J/V
Deer Creek	F (a/j)	F (a/j)
West Sierra	J	J/D (j)
NF Feather-Preference	F	F (j)

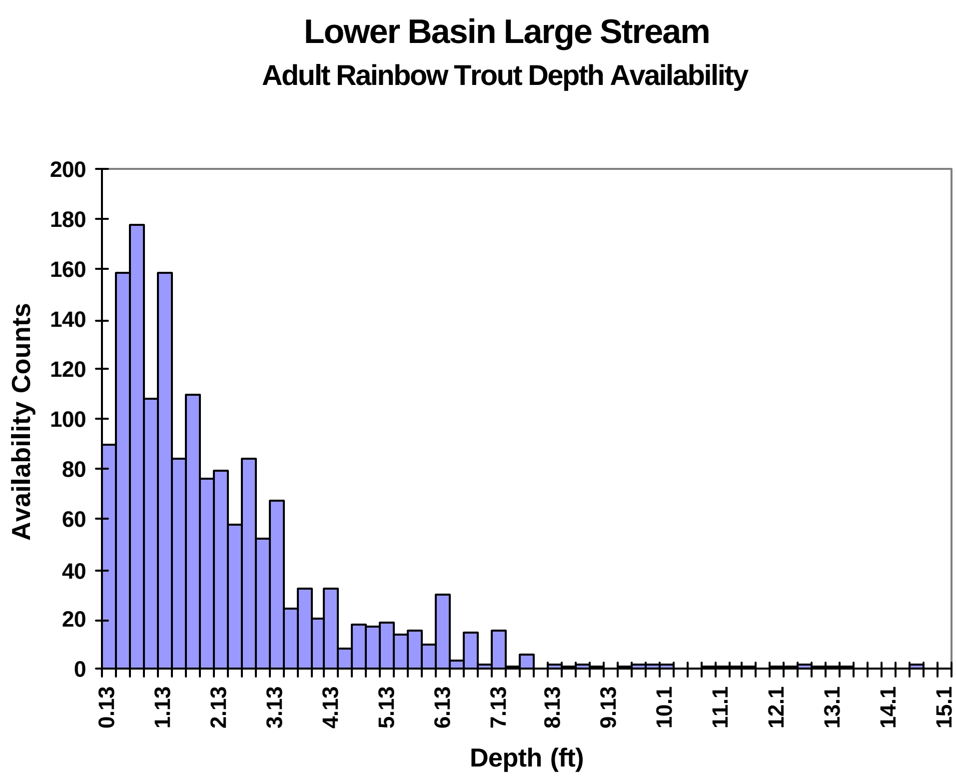
Results of Habitat Preference Tests for non-Trout Species - Lower Large Streams - Sacramento Sucker

	Sacramento Sucker		
	Adult	Juvenile	Fry
No. of Fish	75	96	168
Pit River	J/D	F	V
Deer Creek	--	--	--
NF Feather-Preference	J/D	F	--
Yosemite	F	F	--

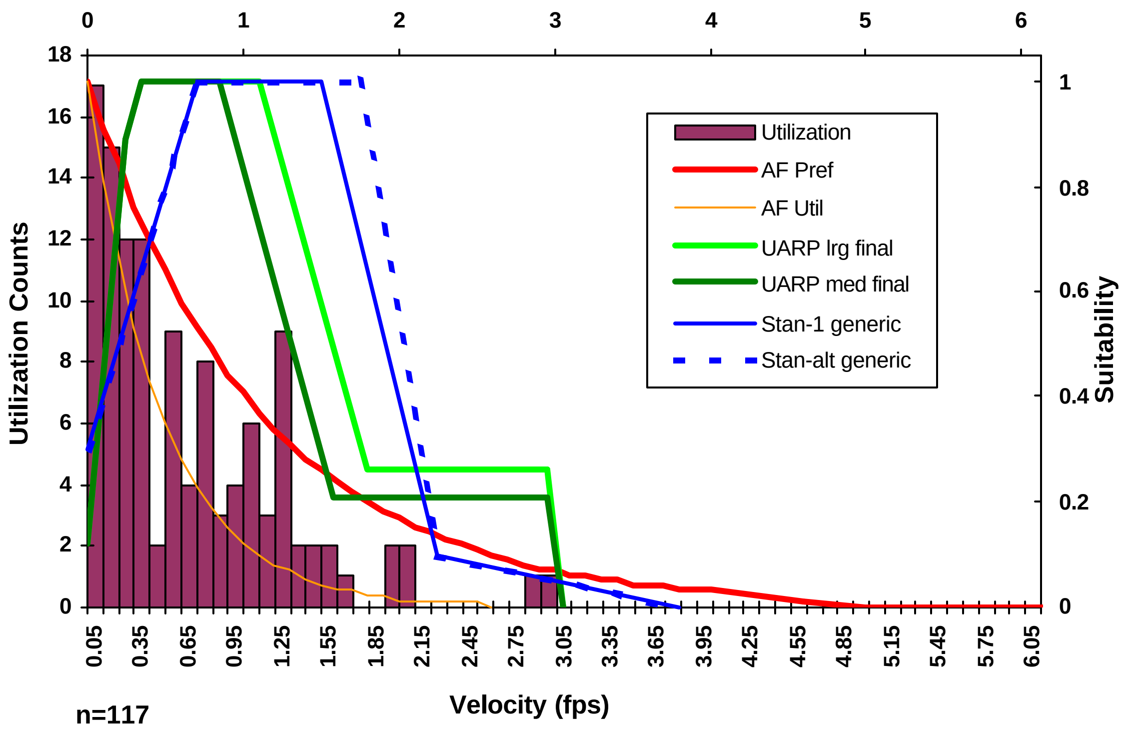
Highlighted cells pass transferability test.

Lower Basin, Large Stream

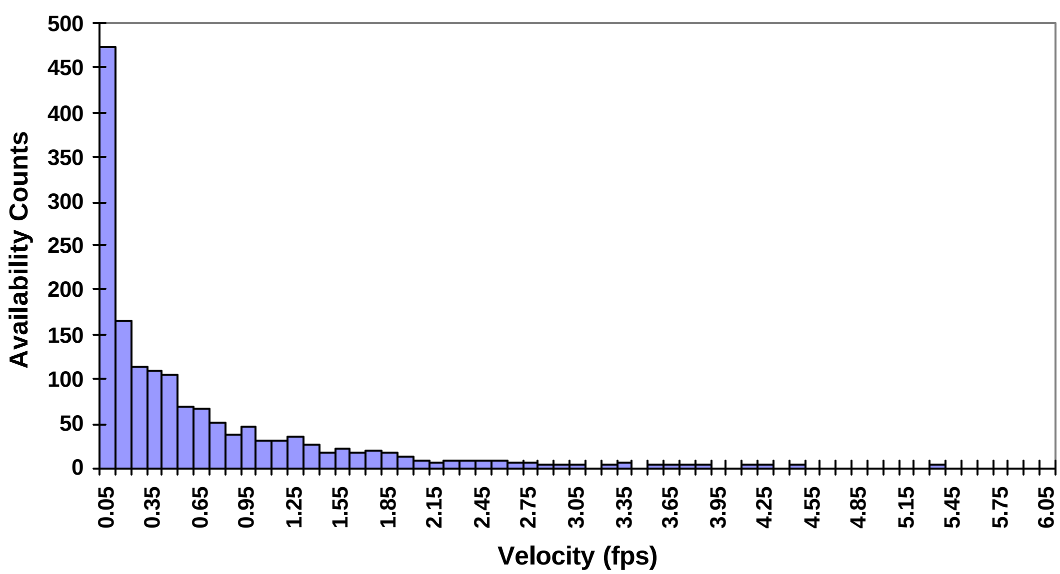

Lower Basin Large Stream
Adult Rainbow Trout Depth Utilization and HSC
0
3
6
9
12
15
16
14
12
10
8
6
4
2
0
1
0.8
0.6
0.4
0.2
0
Utilization Counts
Suitability
Utilization
AF Pref
AF Util
UARP lrg final
UARP med final
Stan-1 generic
Stan-alt generic
0.13
0.88
1.63
2.38
3.13
3.88
4.63
5.38
6.13
6.88
7.63
8.38
9.13
9.88
10.6
11.4
12.1
12.9
13.6
14.4
15.1
Depth (ft)
n=117


Lower Basin Large Stream
Adult Rainbow Trout Depth Availability
200
180
160
140
120
100
80
60
40
20
0
Availability Counts
0.13
1.13
2.13
3.13
4.13
5.13
6.13
7.13
8.13
9.13
10.1
11.1
12.1
13.1
14.1
15.1
Depth (ft)

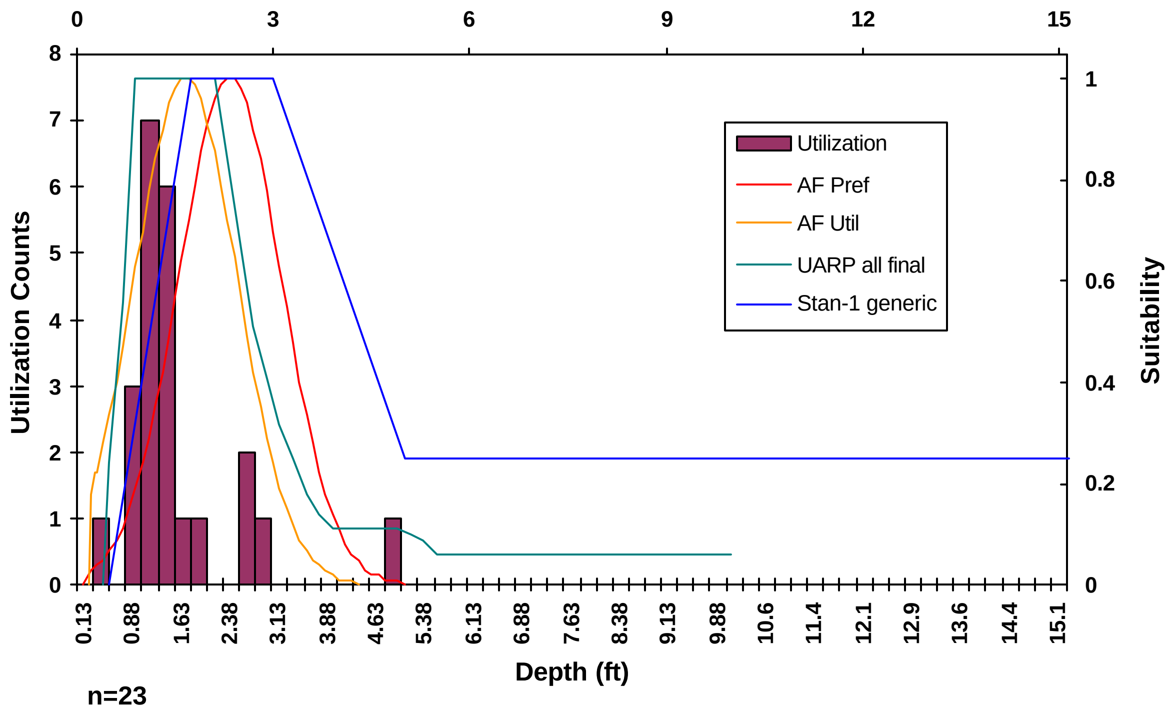
Lower Basin Large Stream
Adult Rainbow Trout Velocity Utilization and HSC



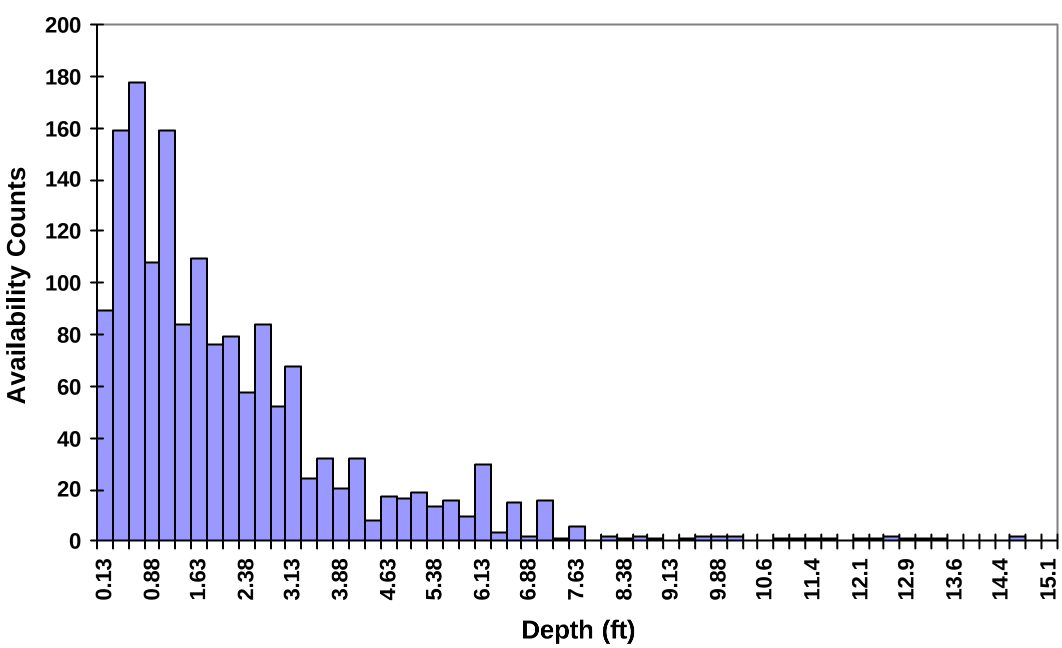
Lower Basin Large Stream
Adult Rainbow Trout Velocity Availability



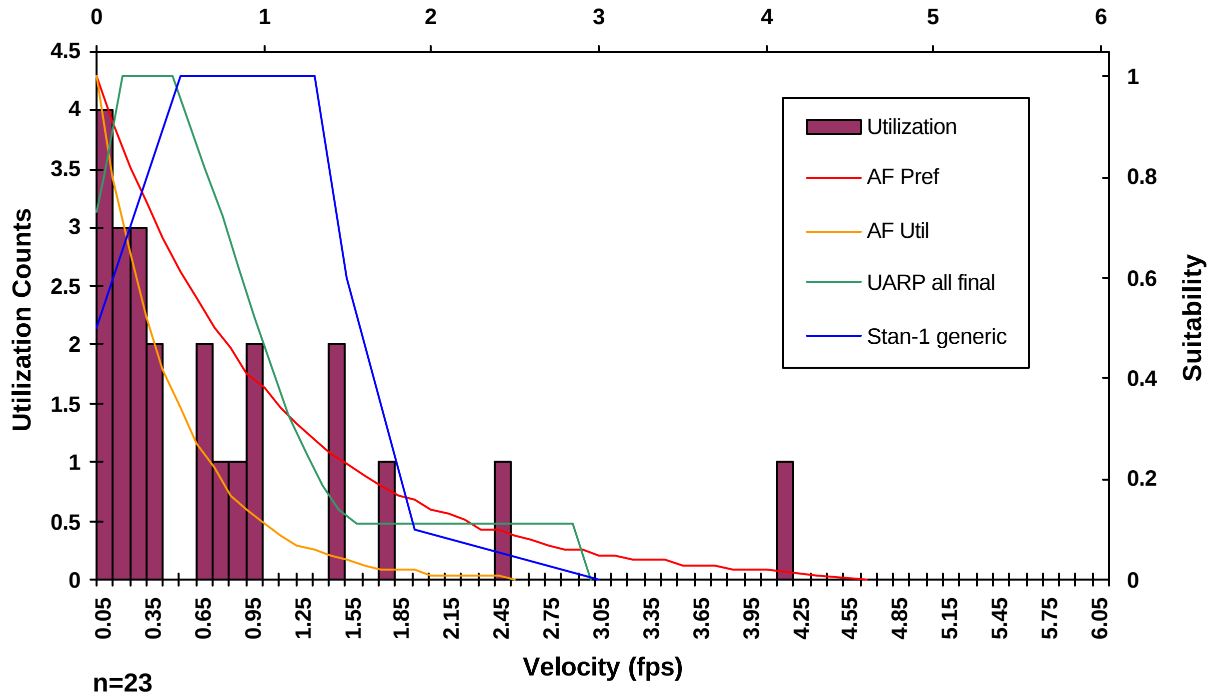
Lower Basin Large Stream
Juvenile Rainbow Trout Depth Utilization and HSC



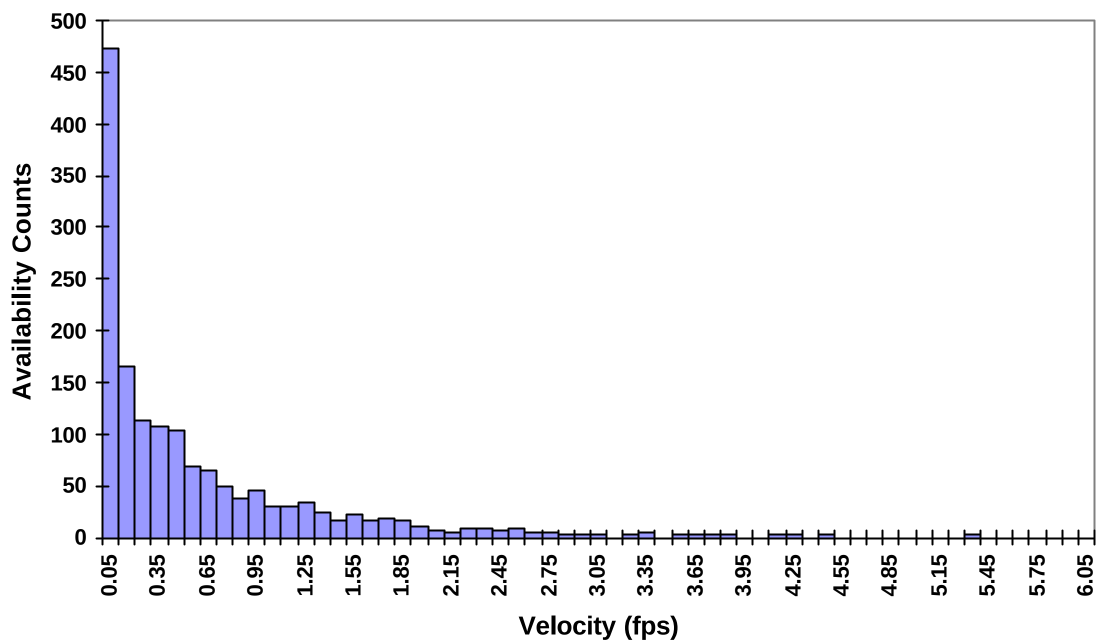
Lower Basin Large Stream
Juvenile Rainbow Trout Depth Availability



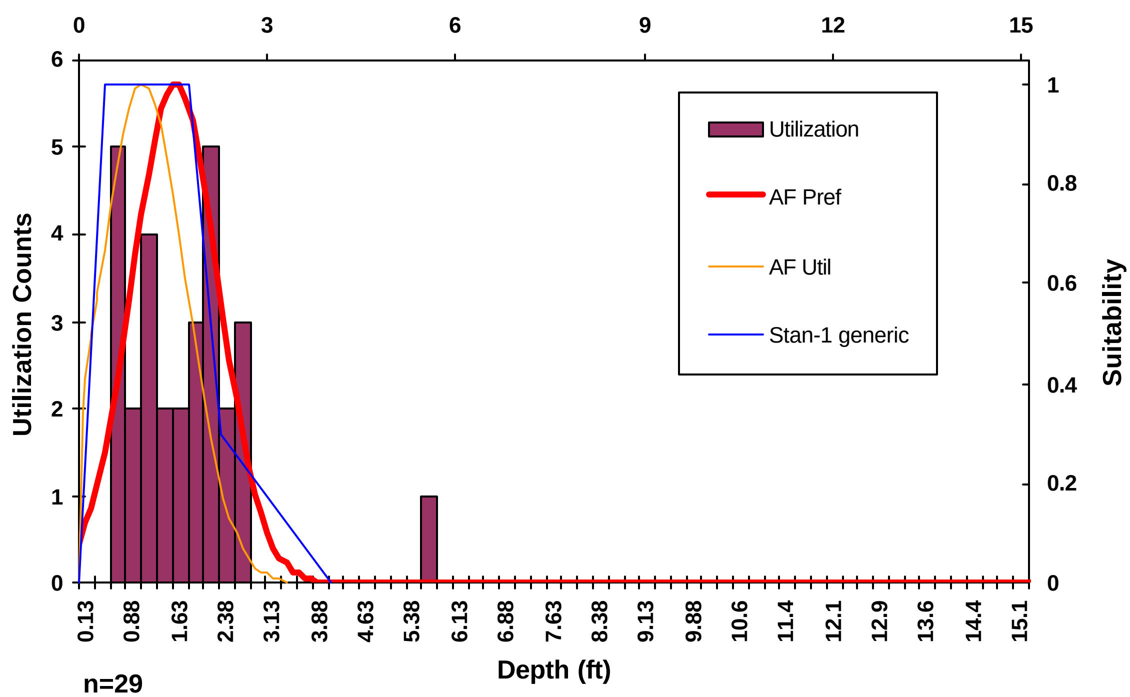
Lower Basin Large Stream
Juvenile Rainbow Trout Velocity Utilization and HSC



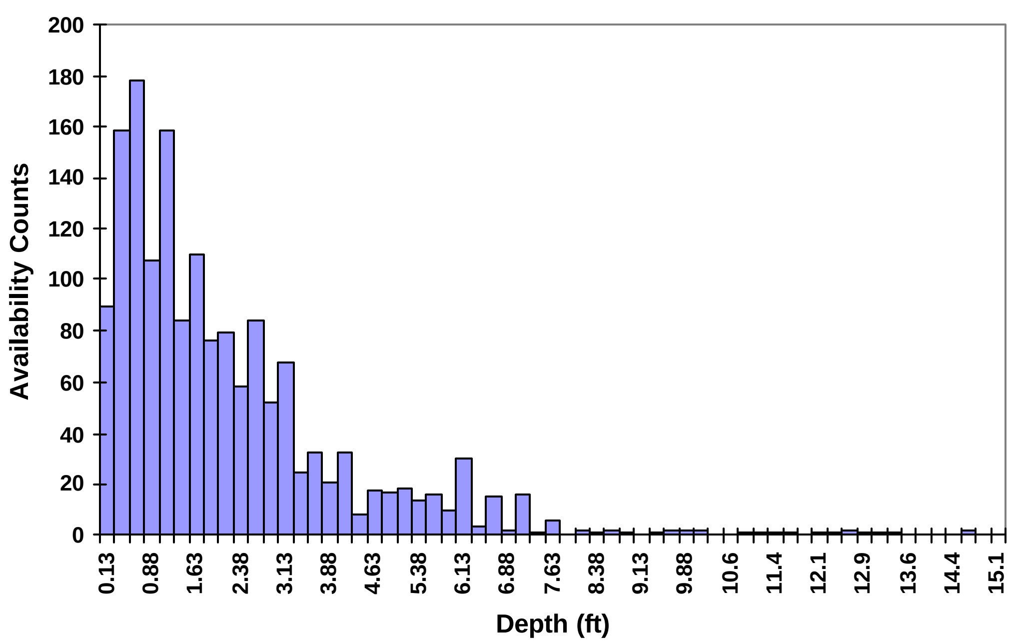
Lower Basin Large Stream
Juvenile Rainbow Trout Velocity Availability



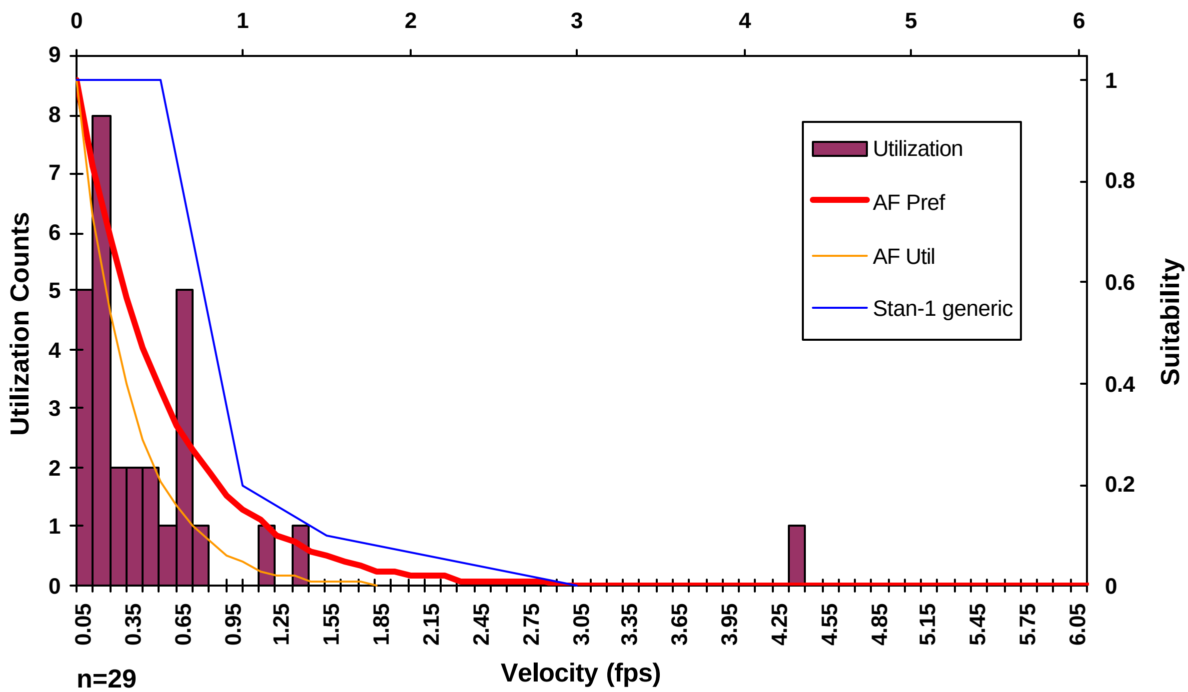
Lower Basin Large Stream
Fry Rainbow Trout Depth Utilization and HSC



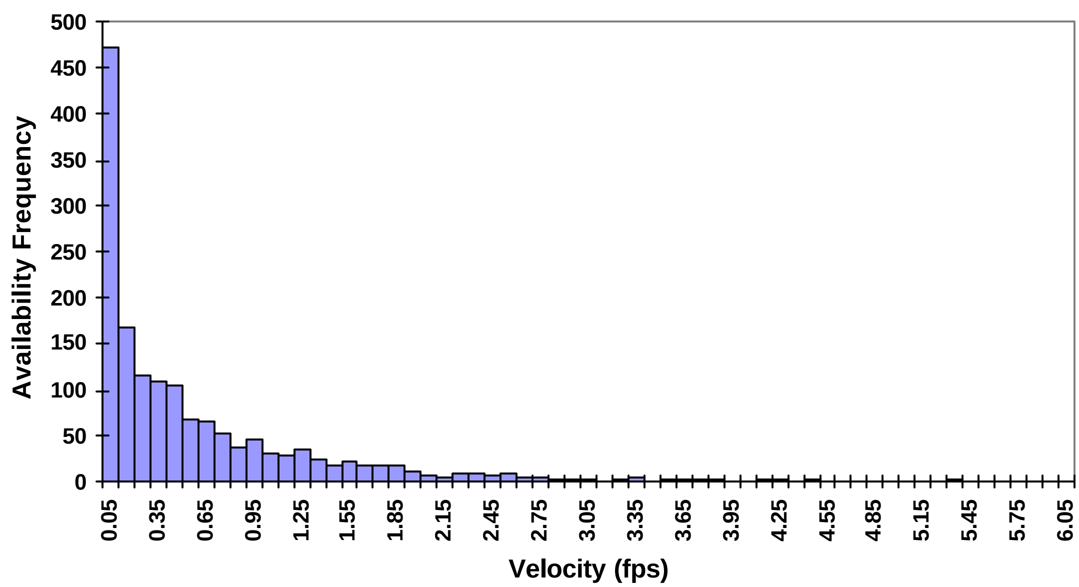
Lower Basin Large Stream
Fry Rainbow Trout Depth Availability



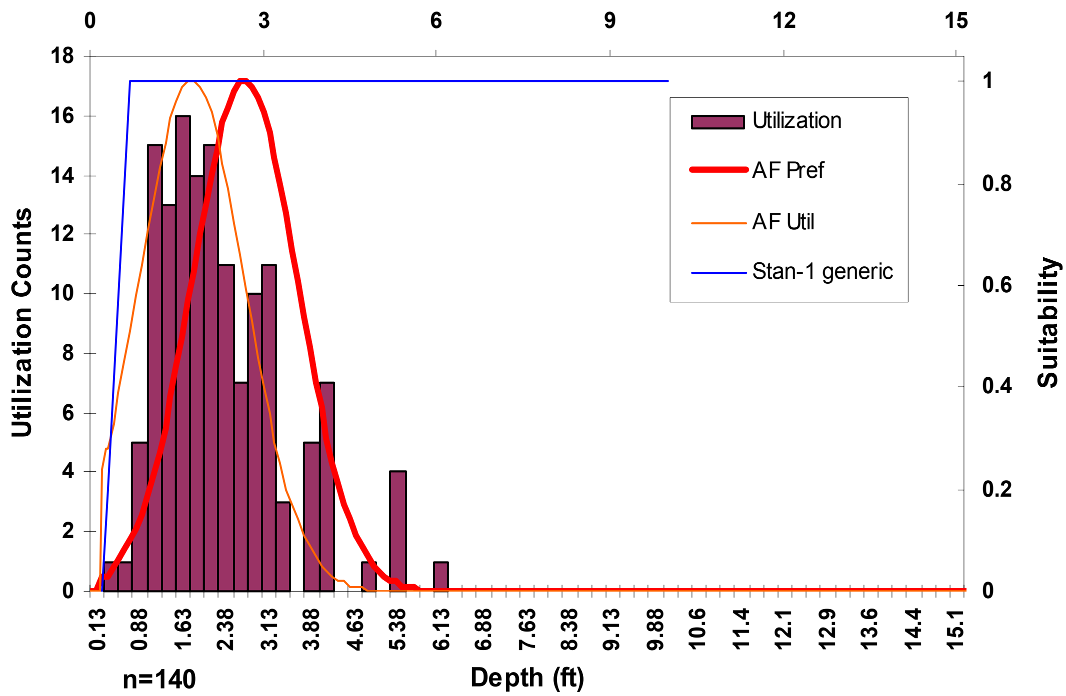
Lower Basin Large Stream
Fry Rainbow Trout Velocity Utilization and HSC



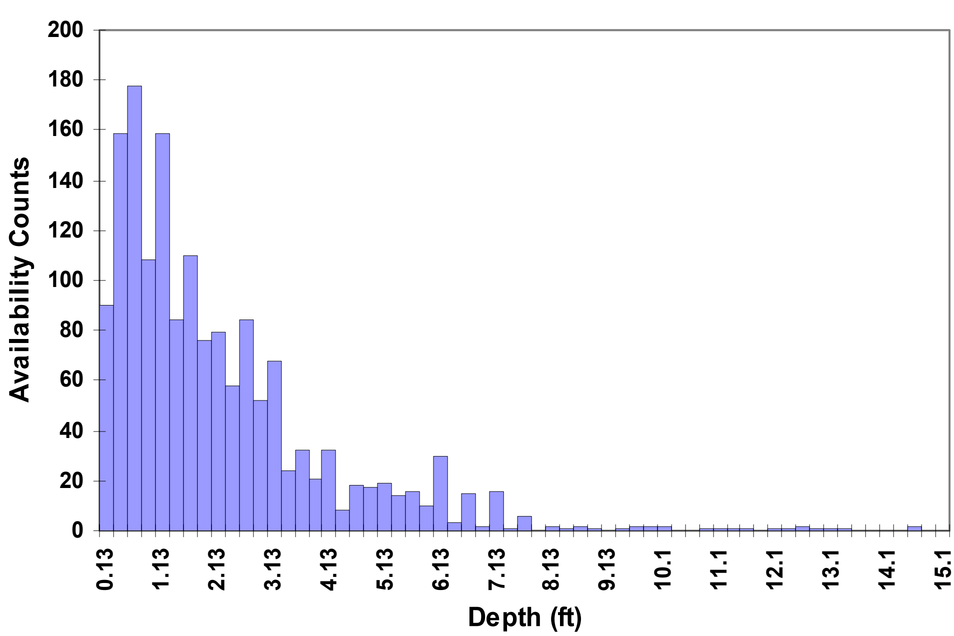
Lower Basin Large Stream
Fry Rainbow Trout Velocity Availability



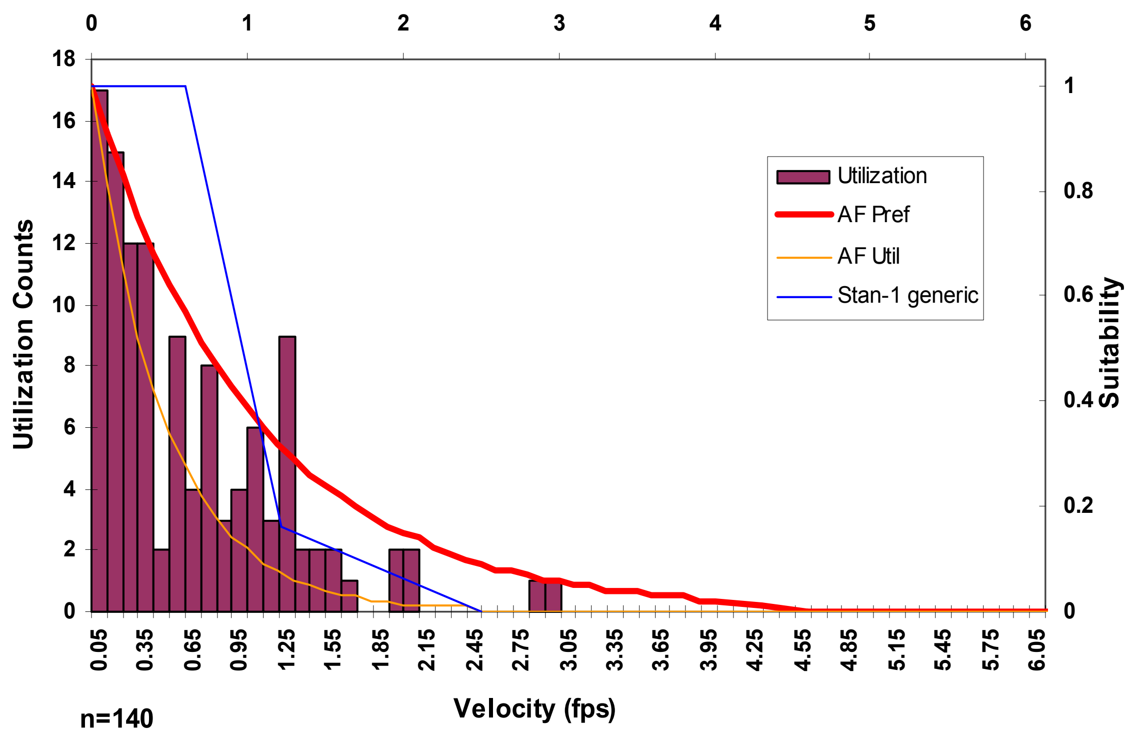
Lower Basin Large Stream
Base Rainbow Trout Depth Utilization and HSC



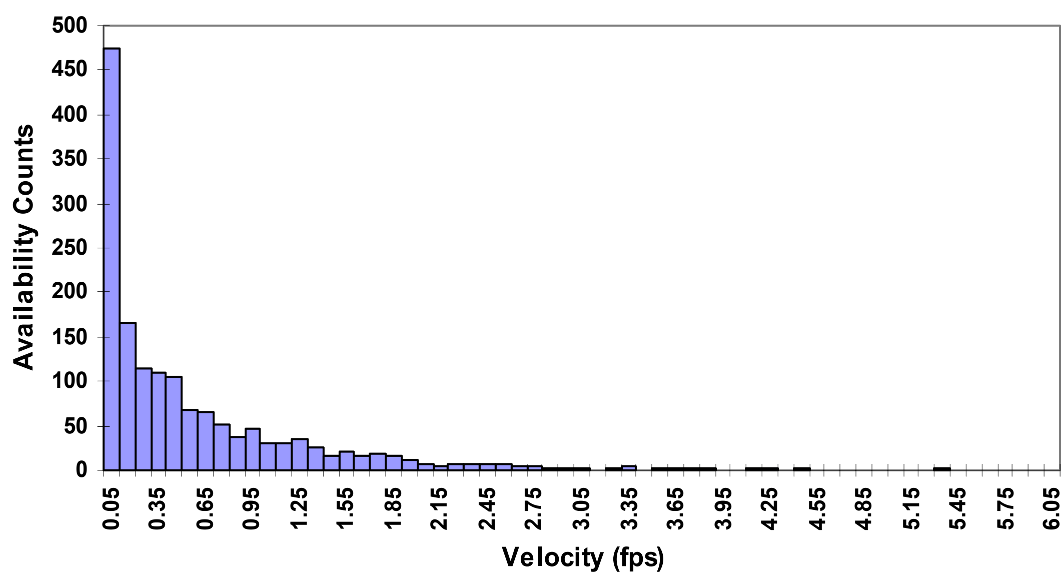
Lower Basin Large Stream
Base Rainbow Trout Depth Availability



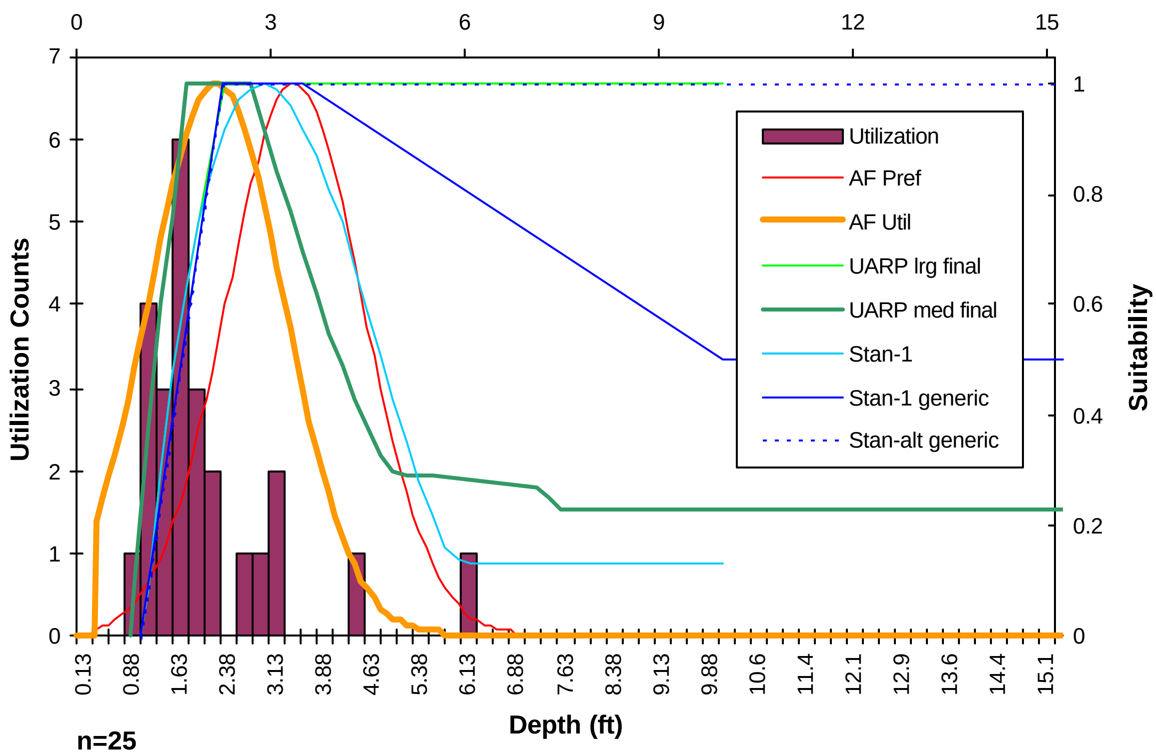
Lower Basin Large Stream
Base Rainbow Trout Velocity Utilization and HSC



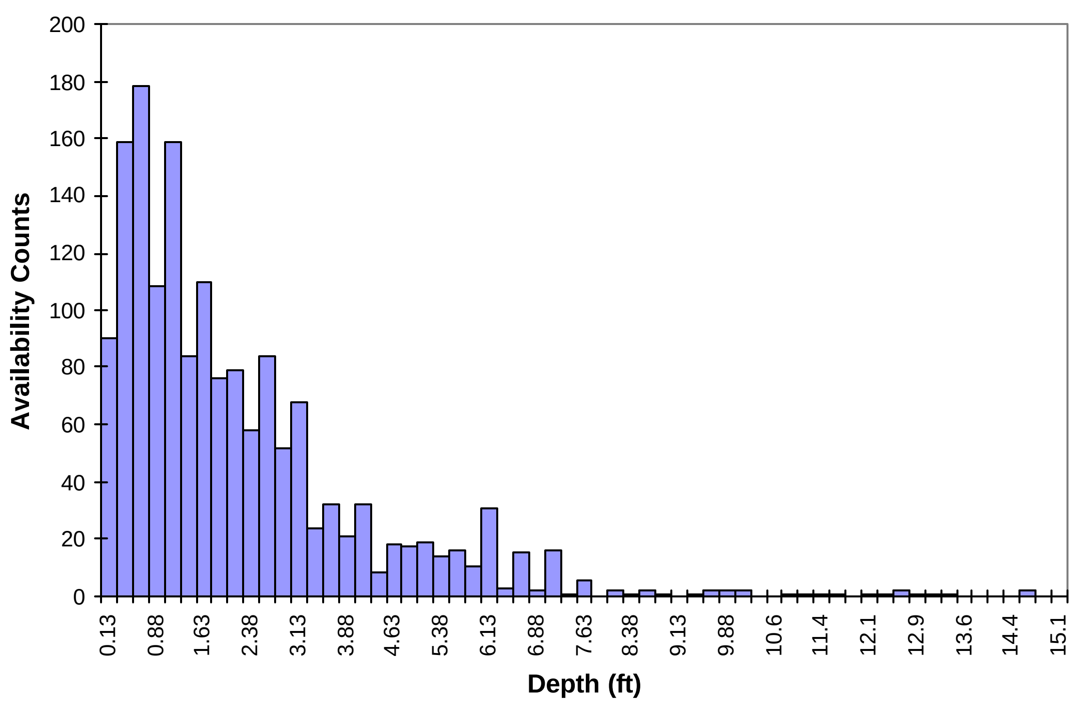
Lower Basin Large Stream
Base Rainbow Trout Velocity Availability



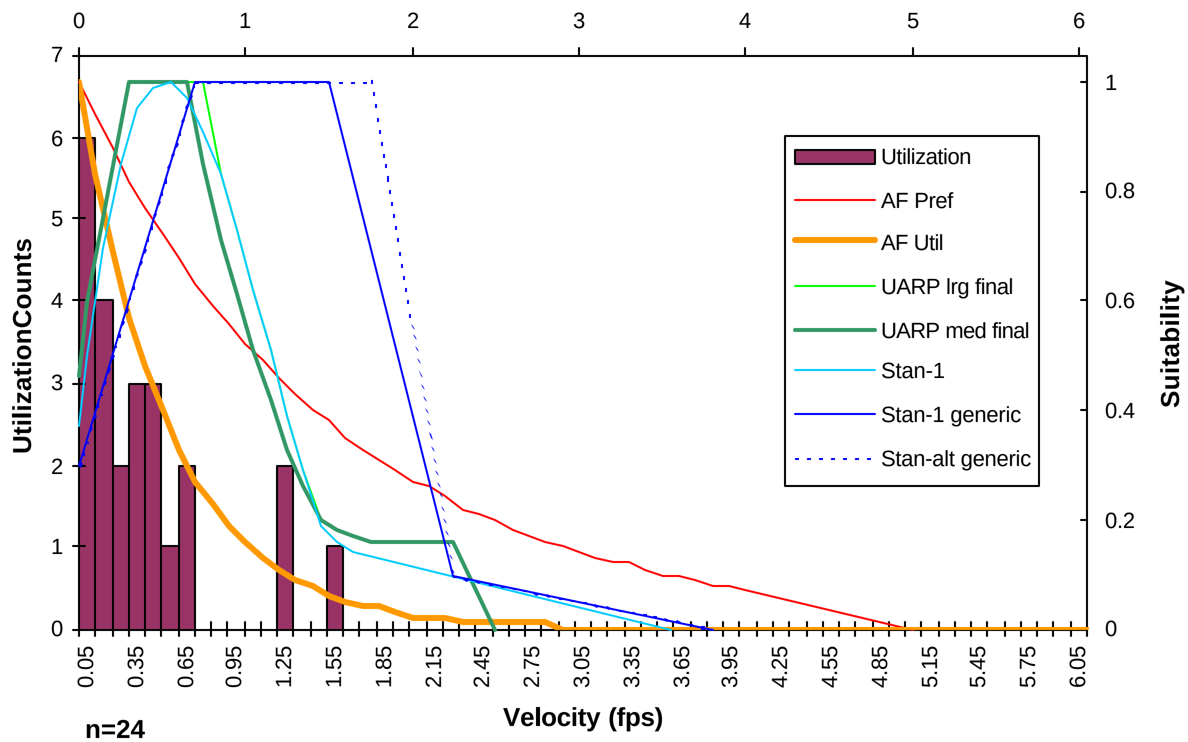
Lower Basin Large Stream
Adult Brown Trout Depth Utilization and HSC



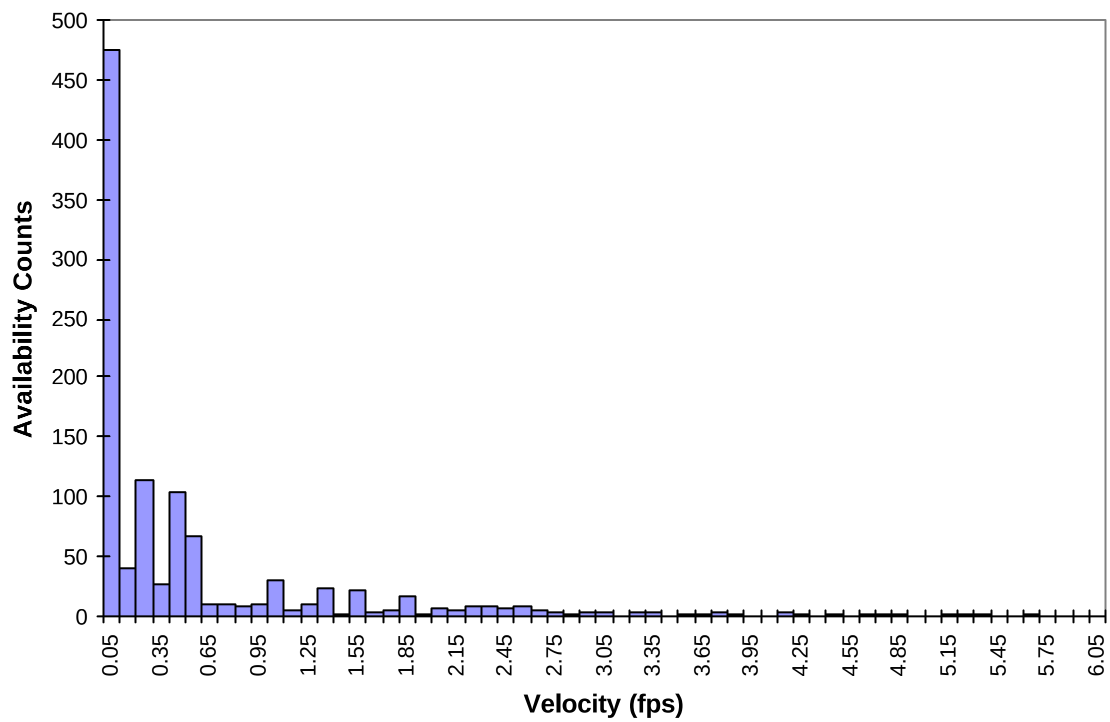
Lower Basin Large Stream
Adult Brown Trout Depth Availability

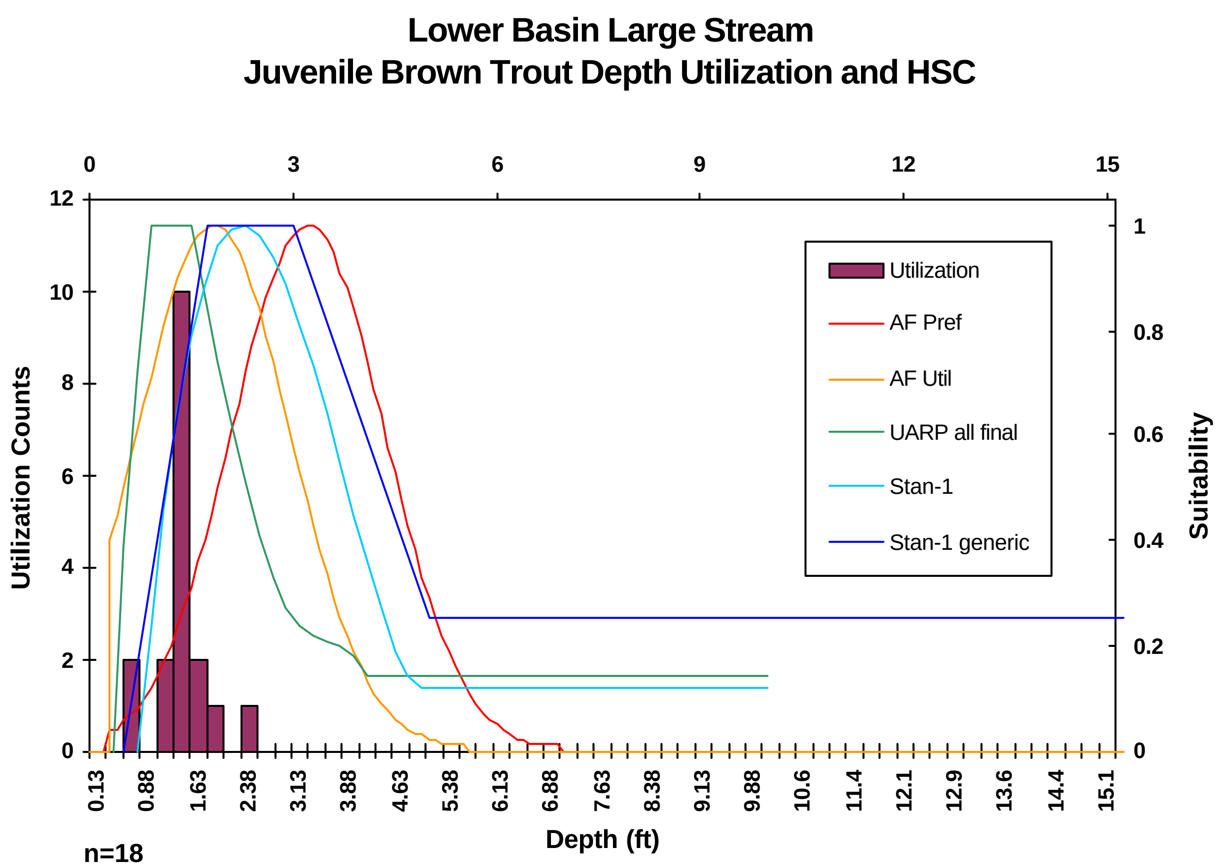


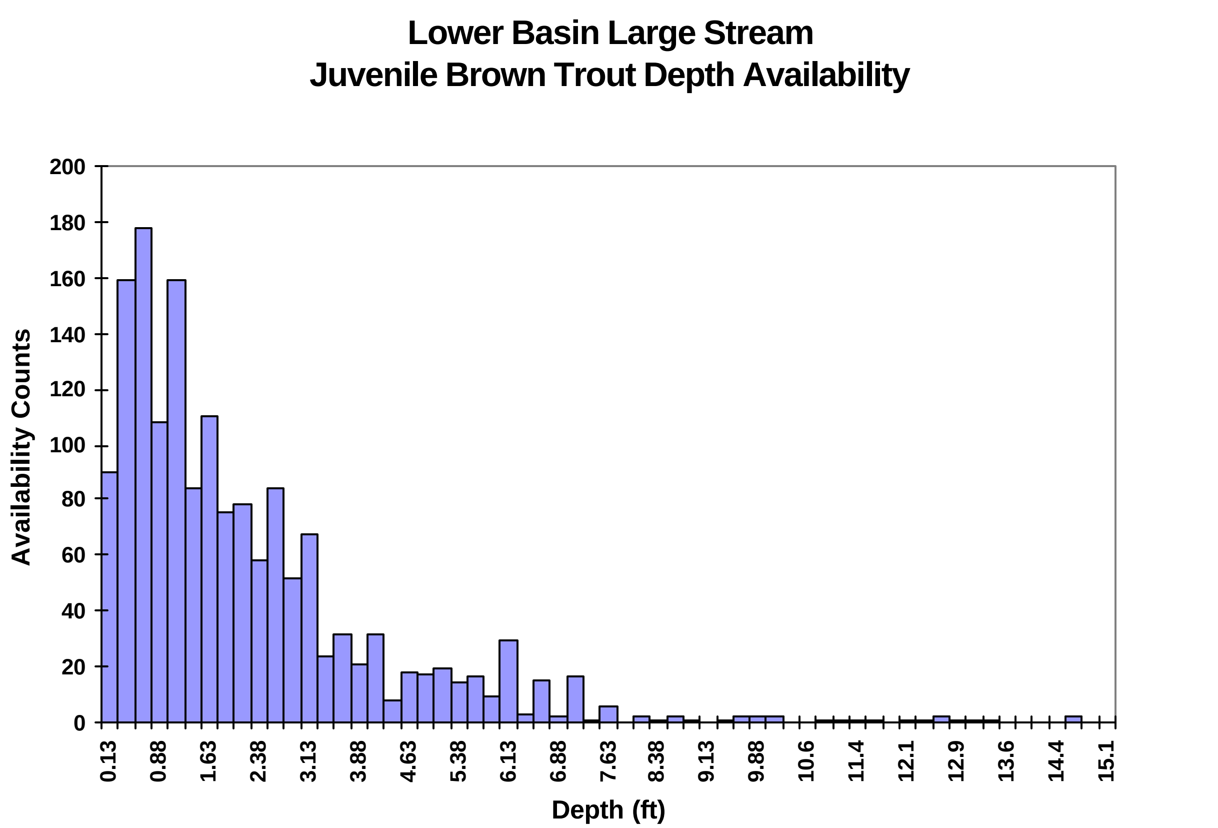
Lower Basin Large Stream
Adult Brown Trout Velocity Utilization and HSC



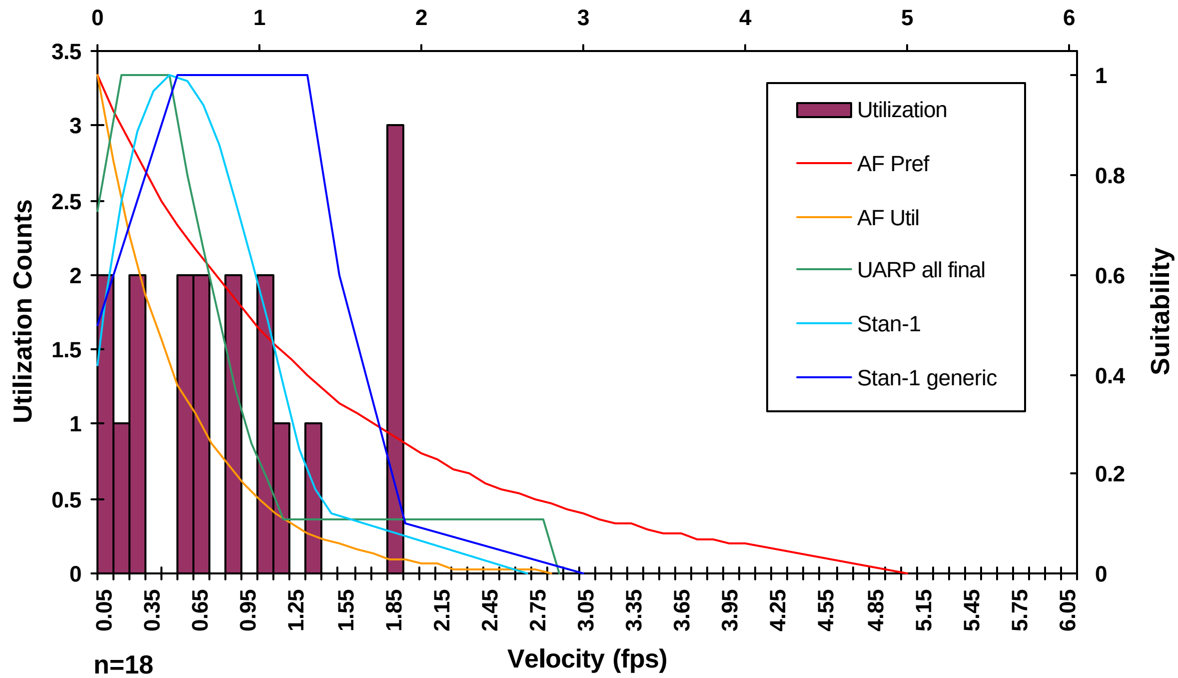
Lower Basin Large Stream
Adult Brown Trout Velocity Availability



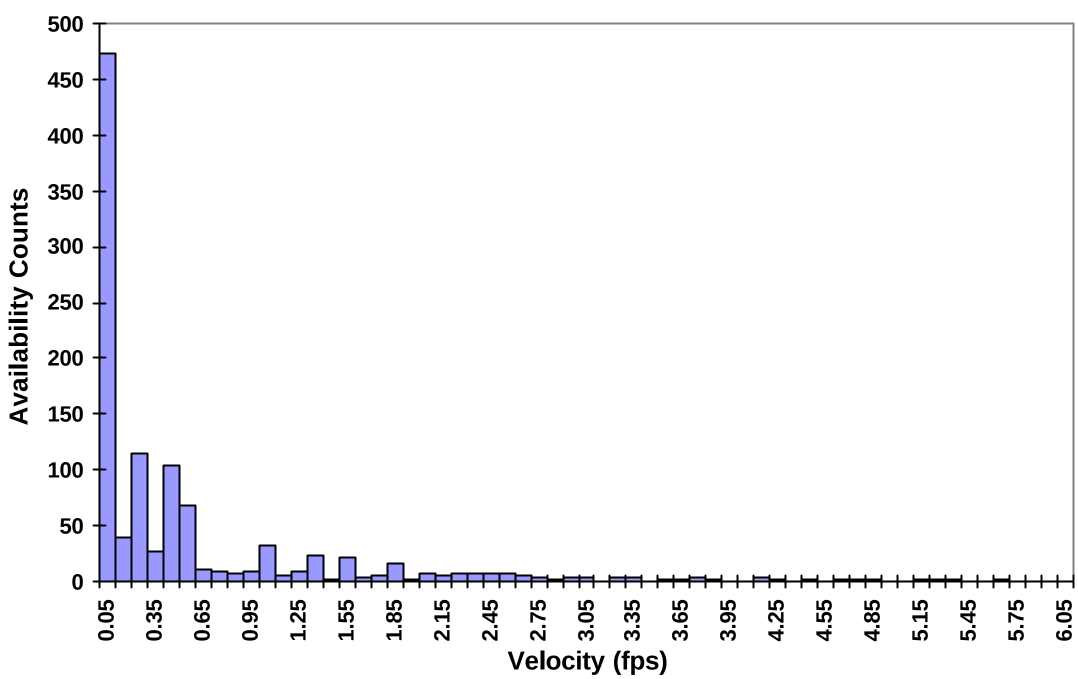

Lower Basin Large Stream
Juvenile Brown Trout Depth Utilization and HSC
Utilization
AF Pref
AF Util
UARP all final
Stan-1
Stan-1 generic
Utilization Counts
Suitability
Depth (ft)
n=18


Lower Basin Large Stream
Juvenile Brown Trout Depth Availability
Availability Counts
Depth (ft)

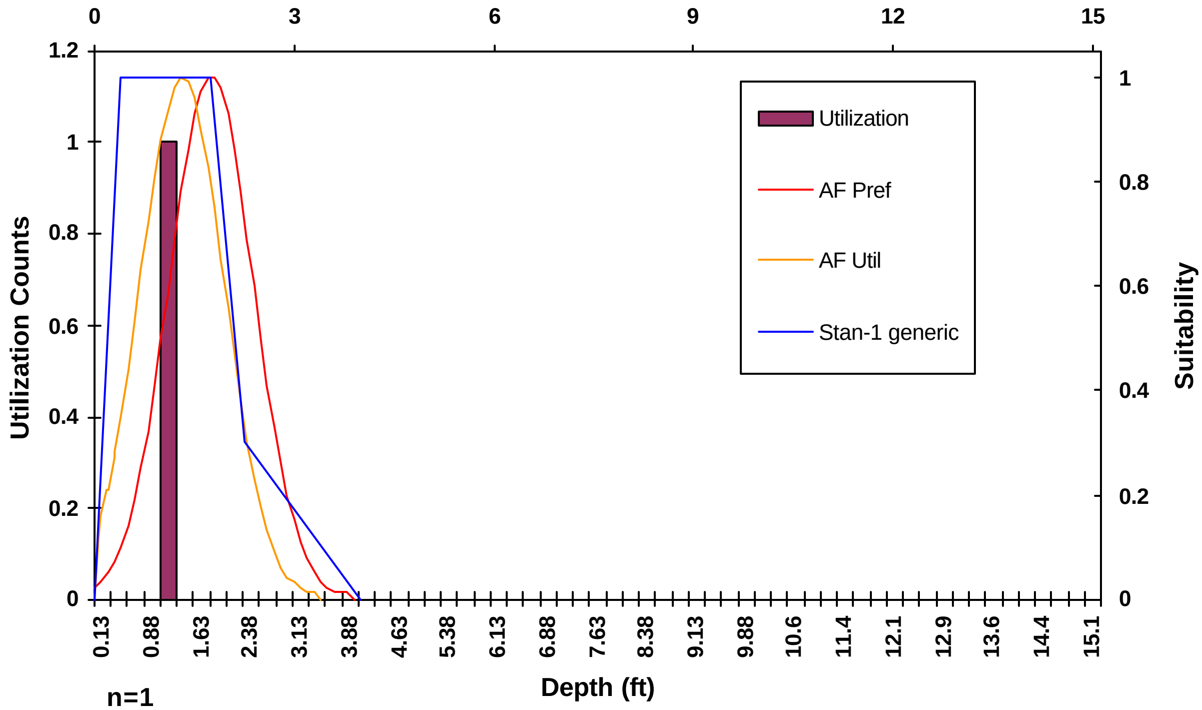
Lower Basin Large Stream
Juvenile Brown Trout Velocity Utilization and HSC



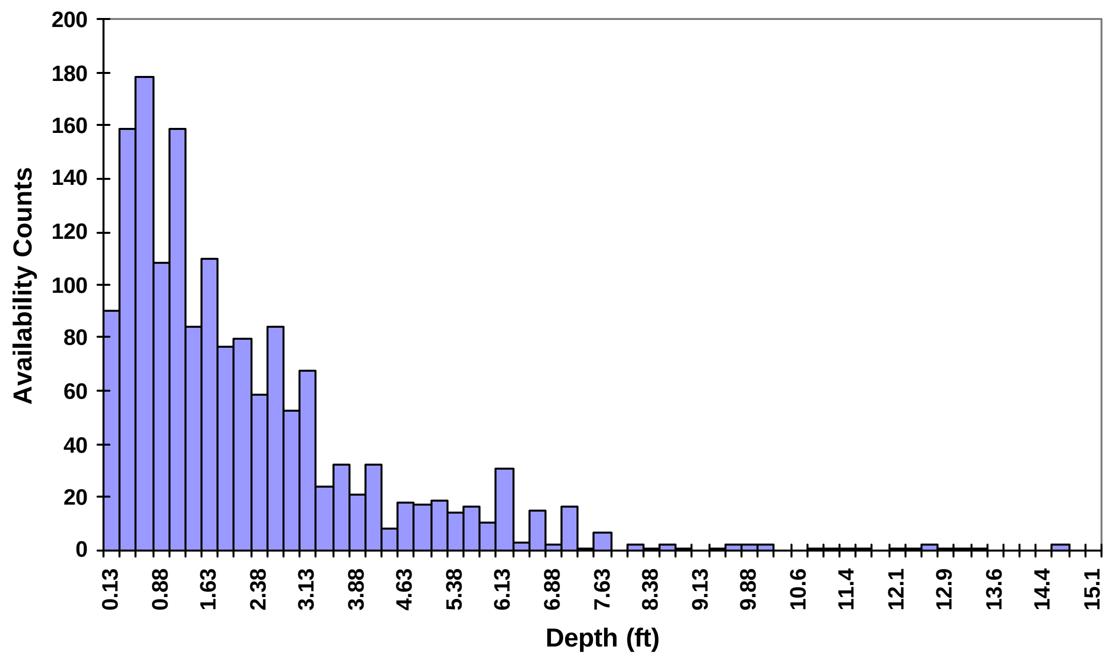
Lower Basin Large Stream
Juvenile Brown Trout Velocity Availability



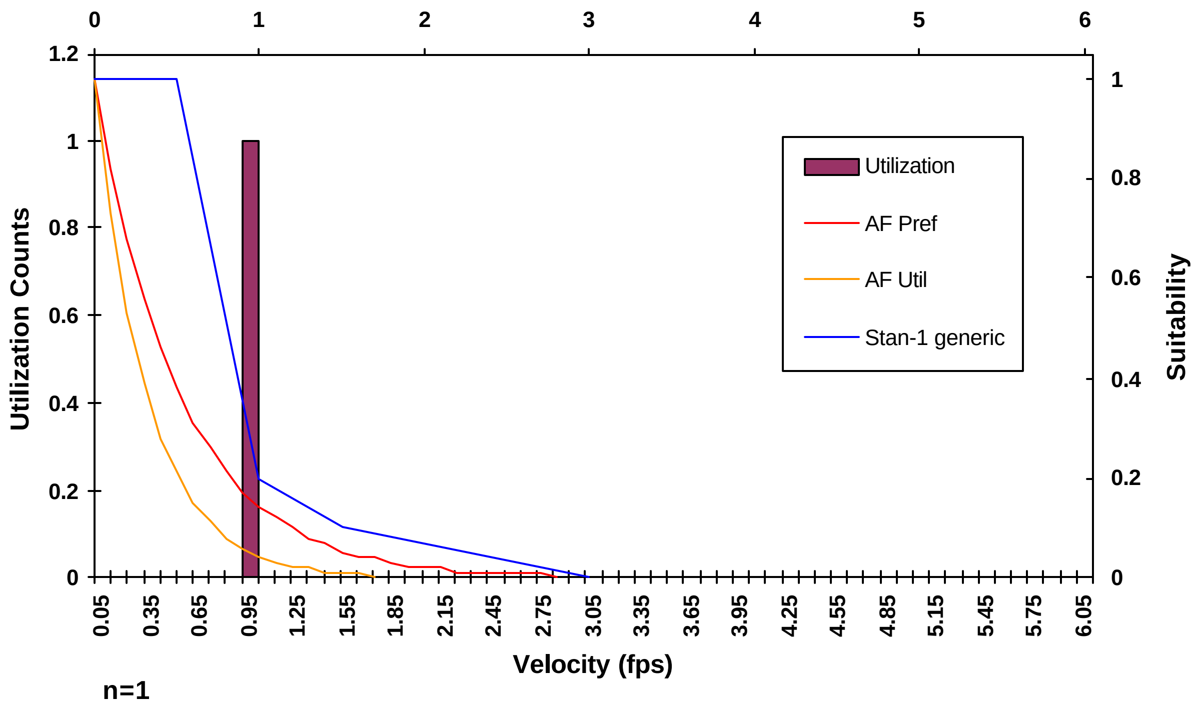
Lower Basin Large Stream
Fry Brown Trout Depth Utilization and HSC



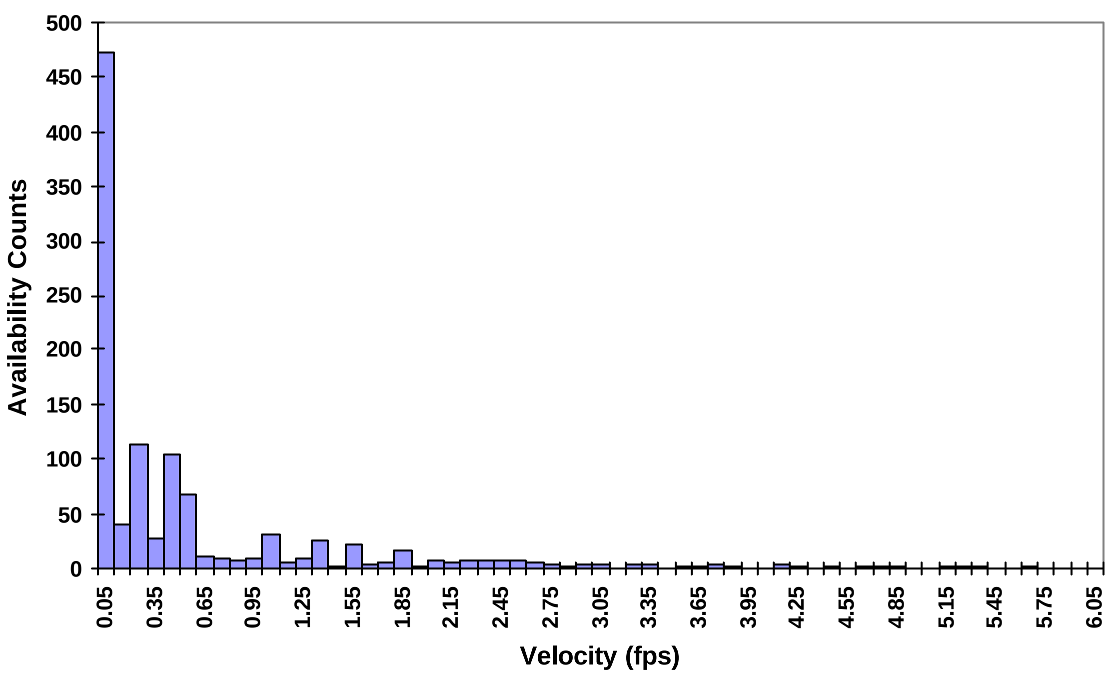
Lower Basin Large Stream
Fry Brown Trout Depth Availability



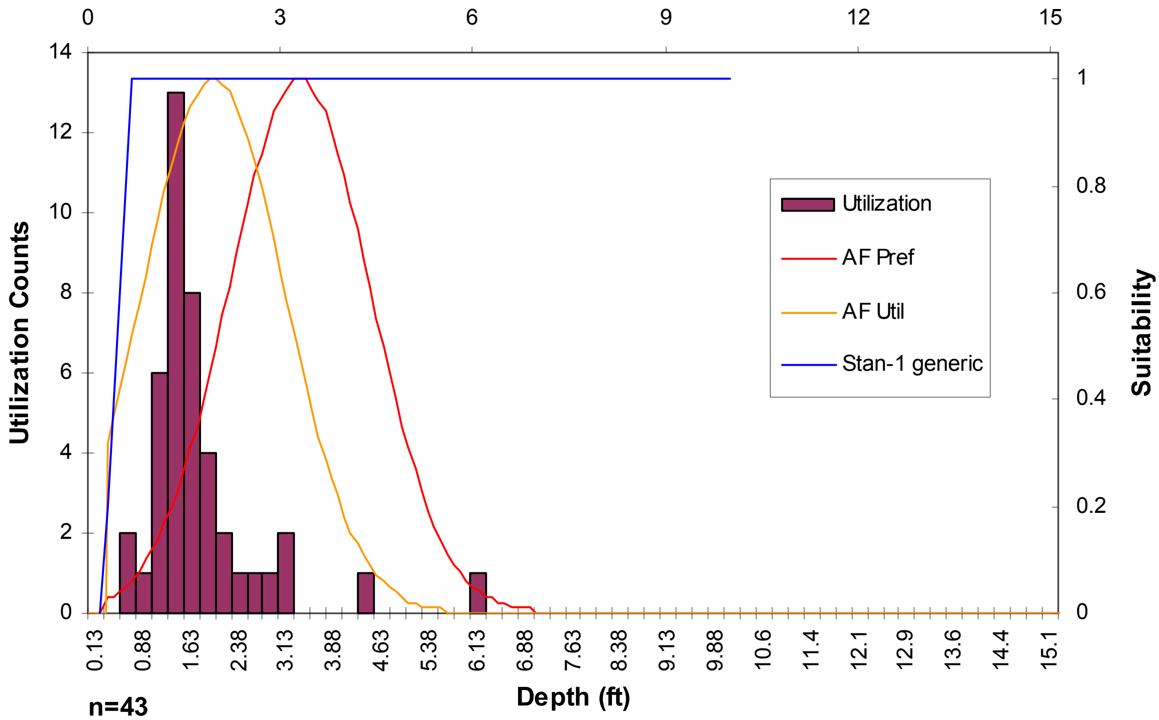
Lower Basin Large Stream
Fry Brown Trout Velocity Utilization and HSC



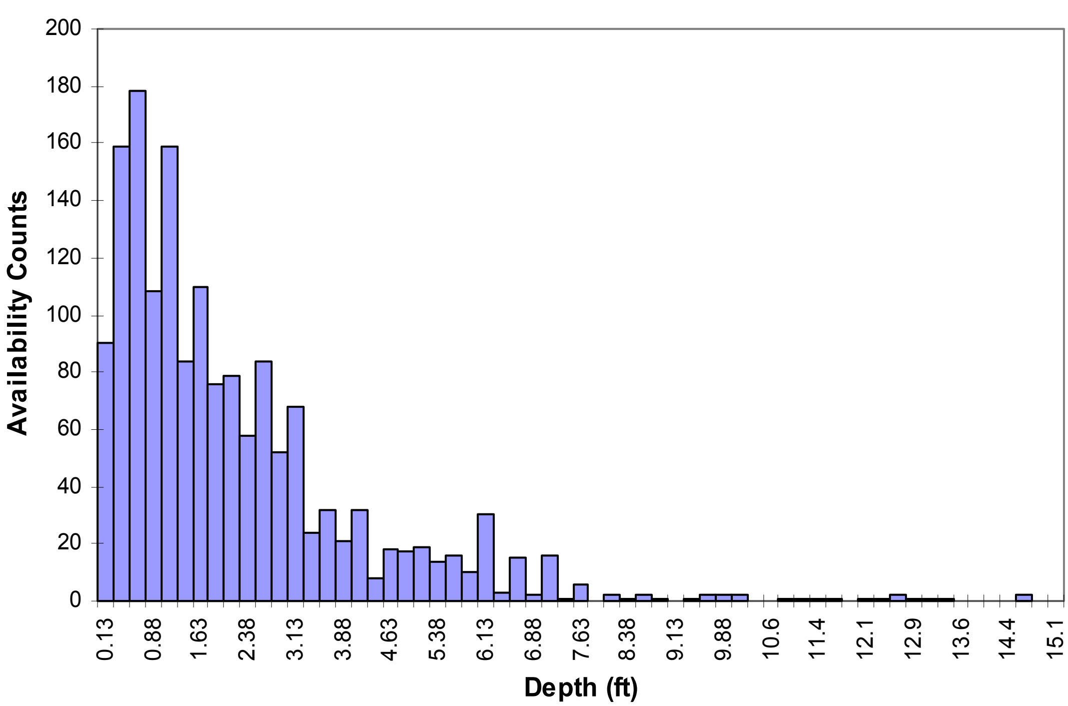
Lower Basin Large Stream
Fry Brown Trout Velocity Availability



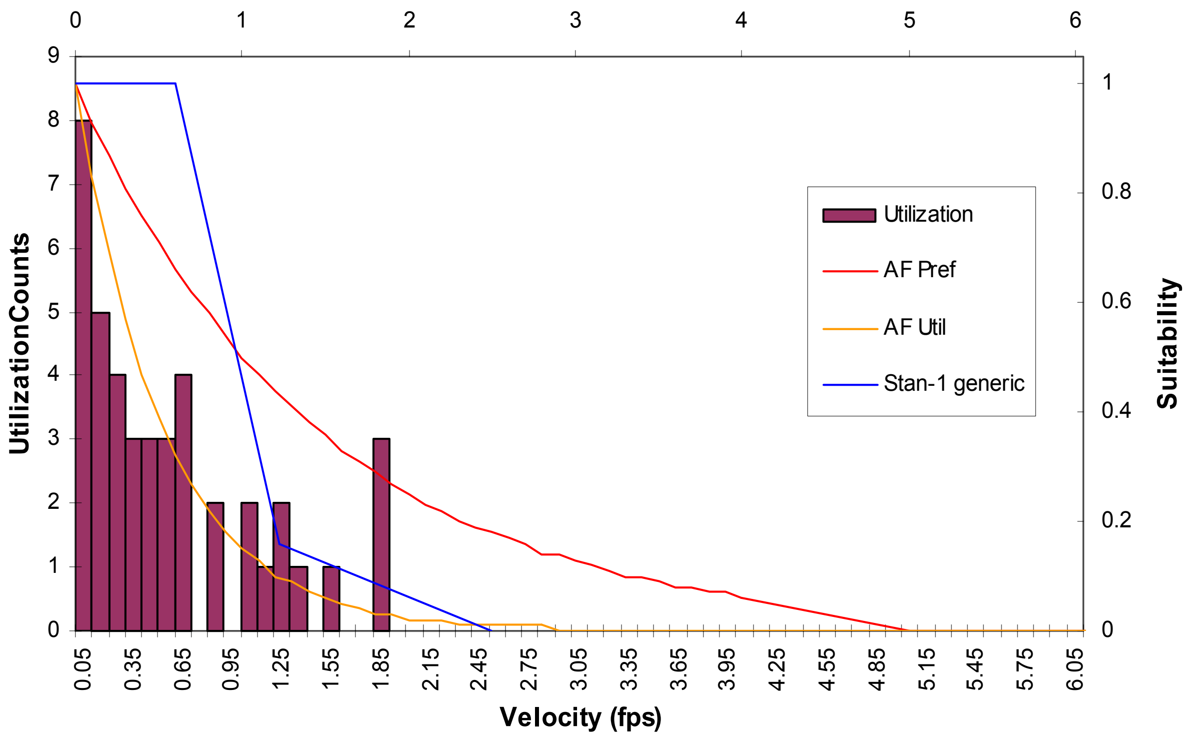
Lower Basin Large Stream
Base Brown Trout Depth Utilization and HSC



Lower Basin Large Stream
Base Brown Trout Depth Availability

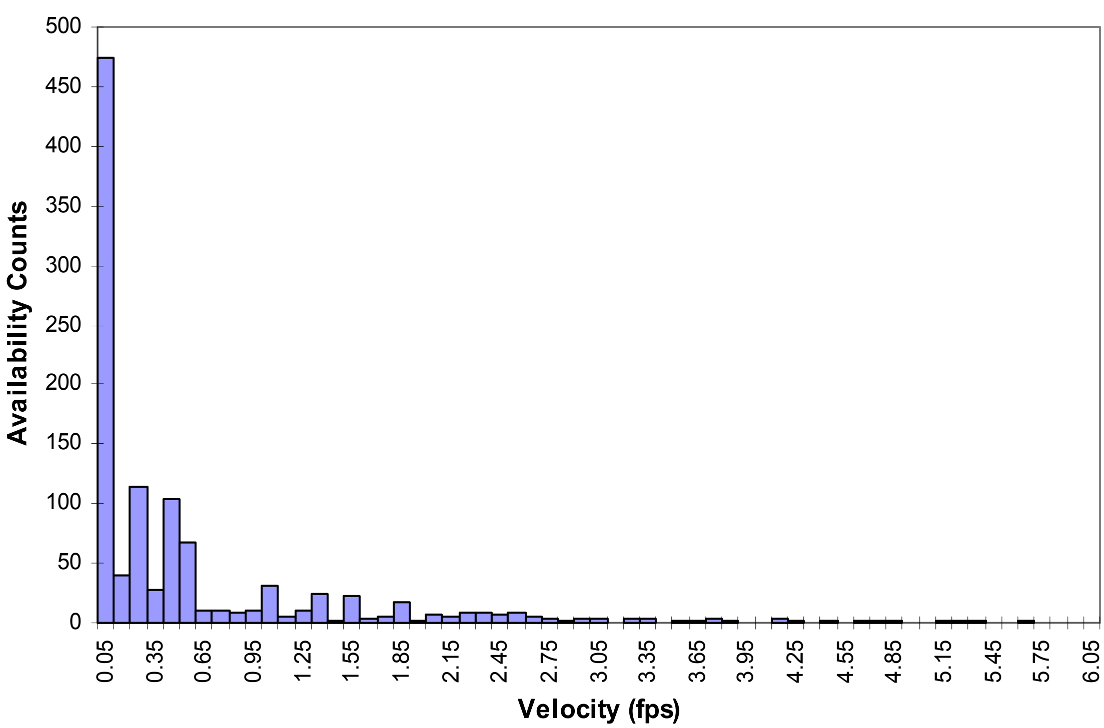


Lower Basin Large Stream
Base Brown Trout Velocity Utilization and HSC

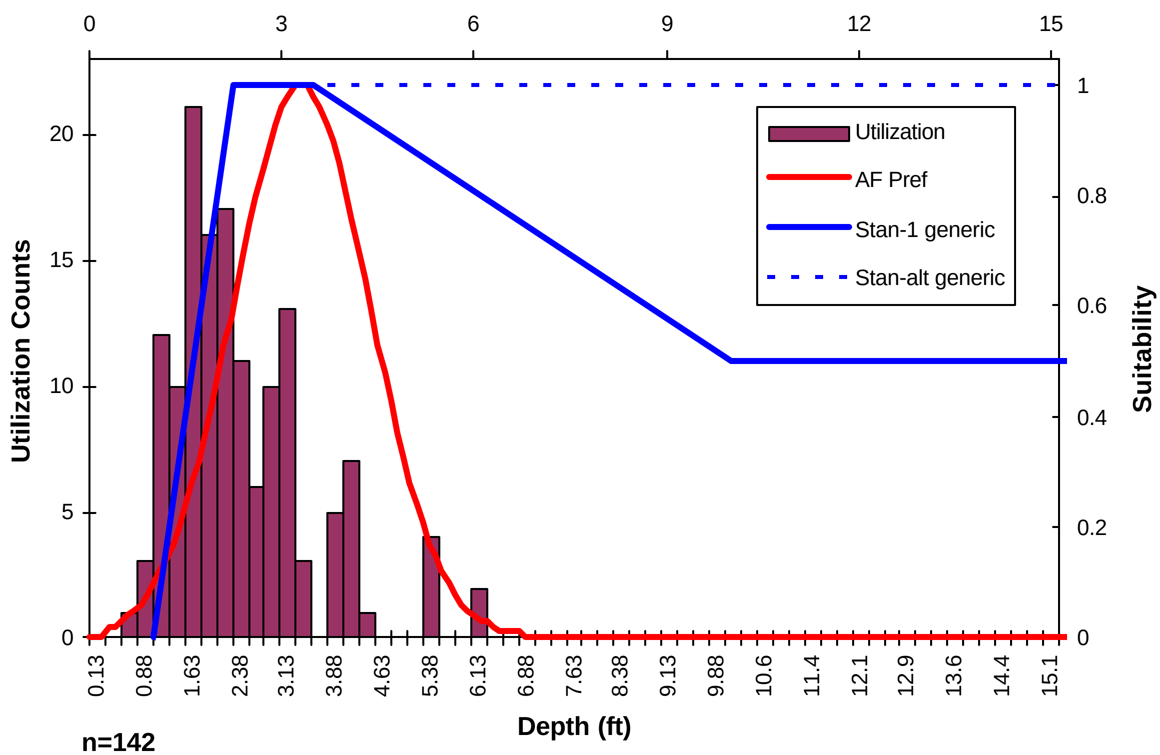


n=42

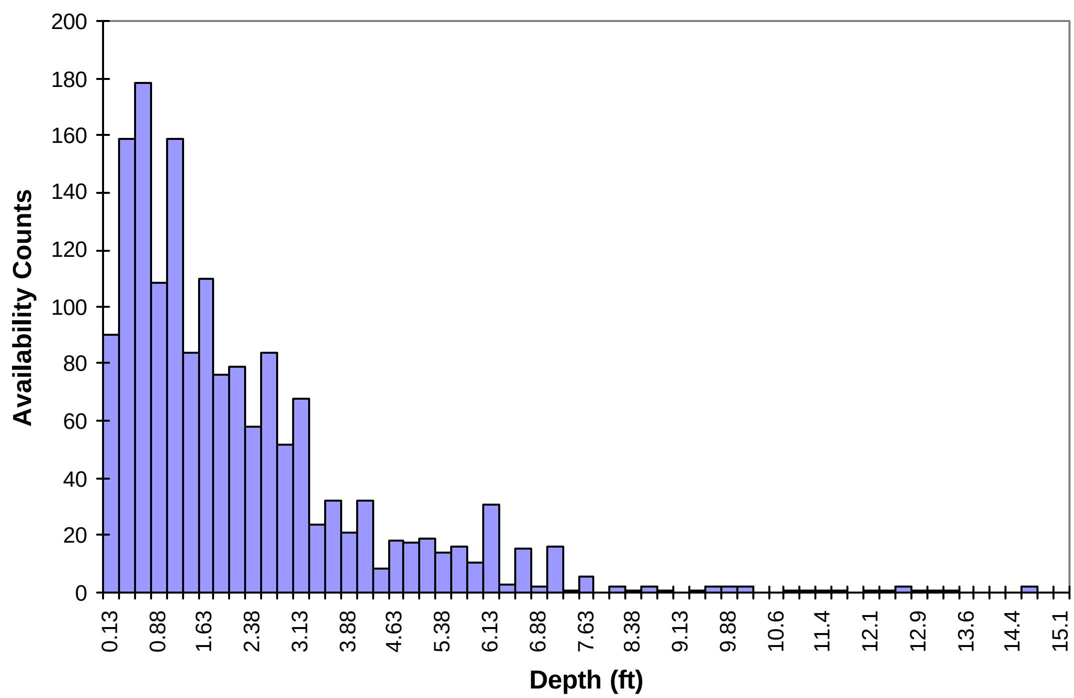
Lower Basin Large Stream
Base Brown Trout Velocity Availability



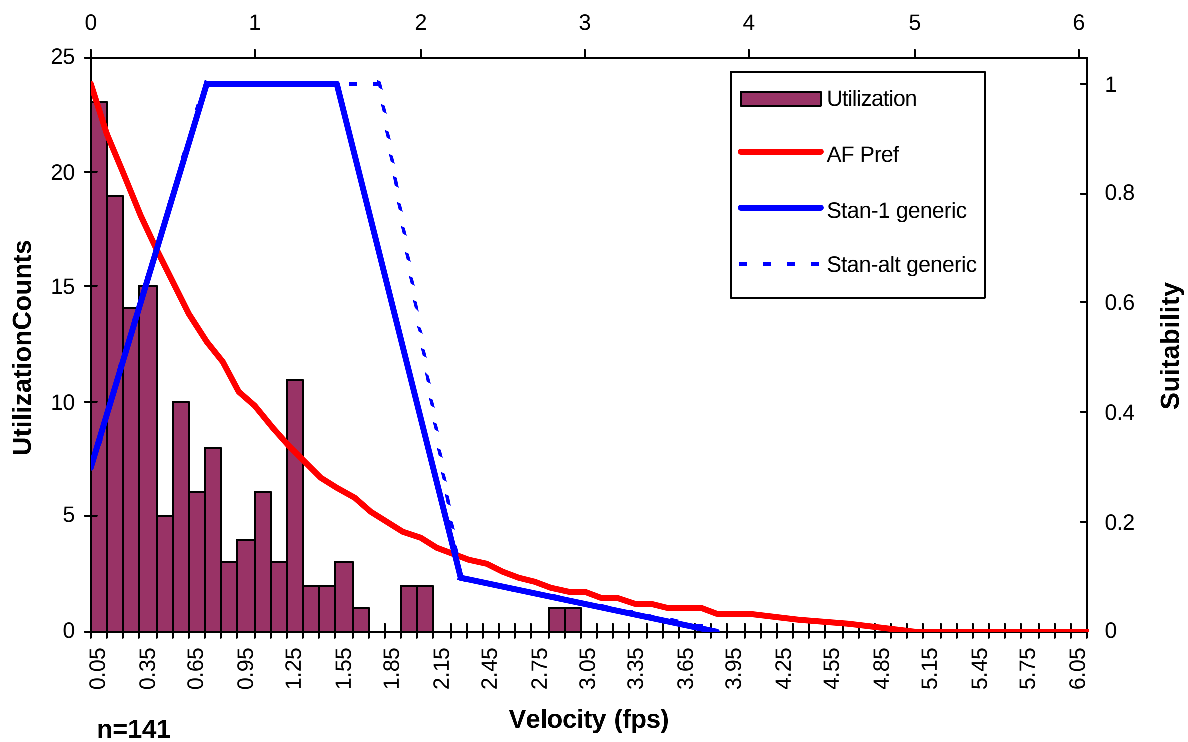
Lower Basin Large Stream
Adult Total Trout Depth Utilization and HSC



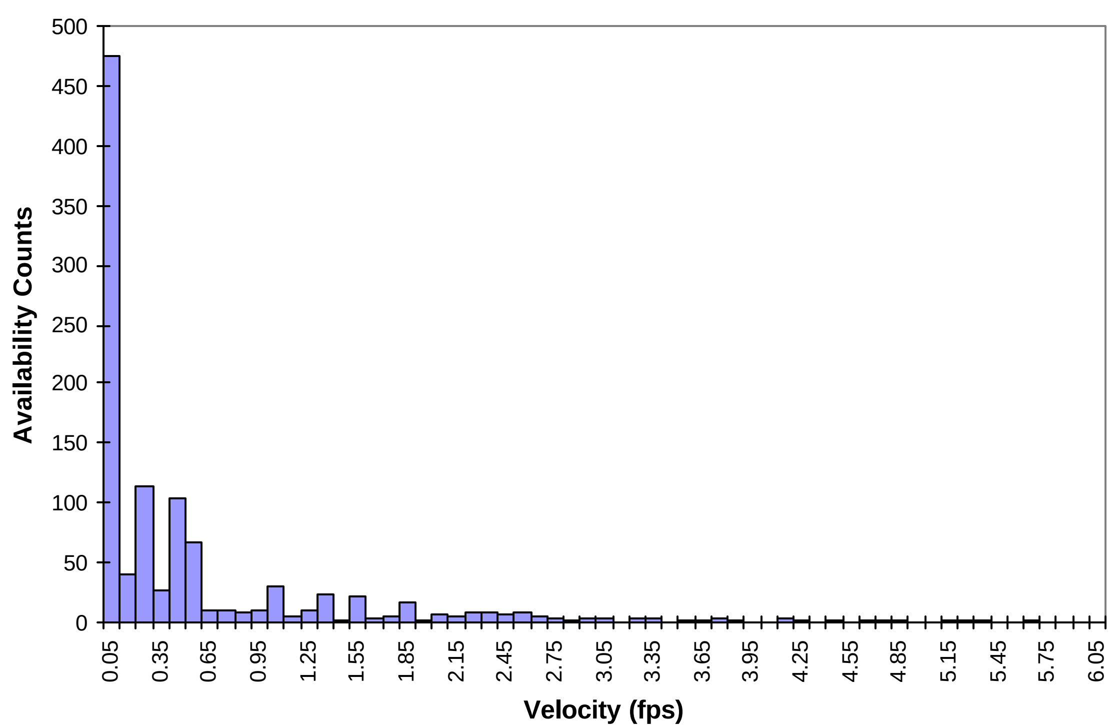
Lower Basin Large Stream
Adult Total Trout Depth Availability



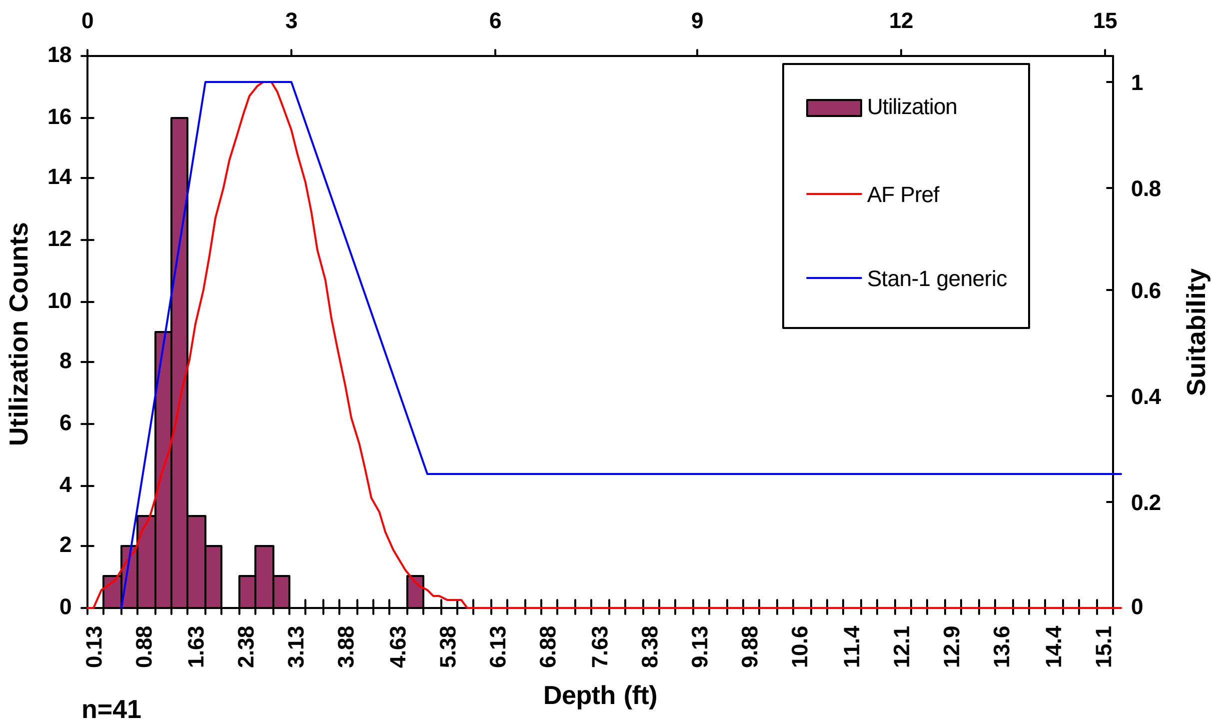
Lower Basin Large Stream
Adult Total Trout Velocity Utilization and HSC



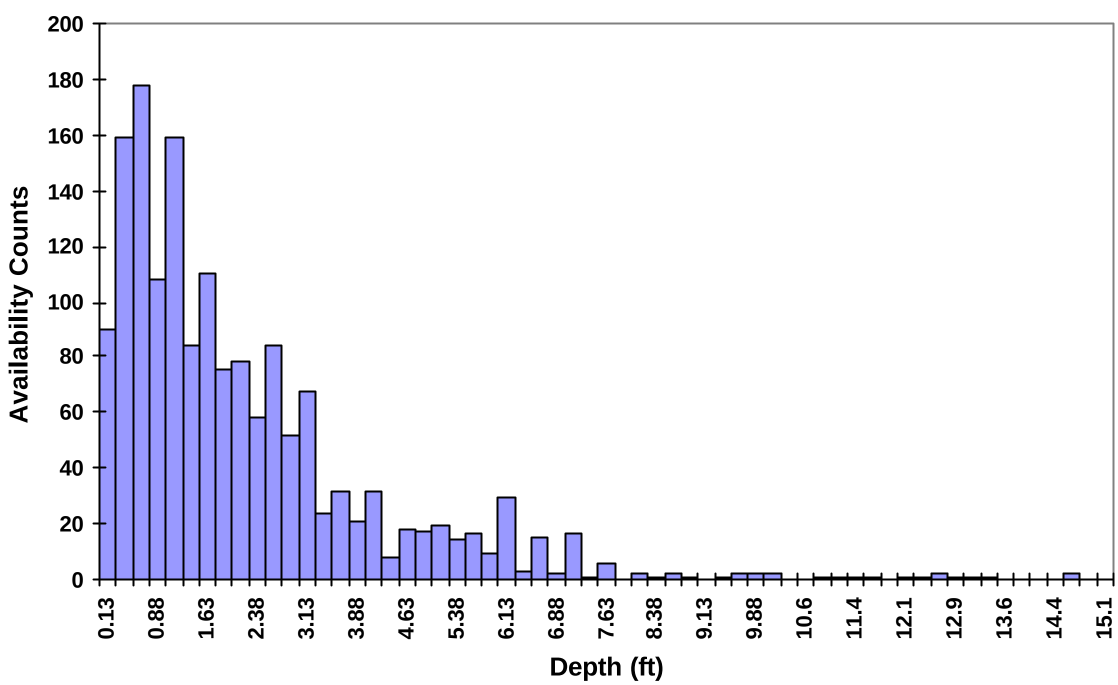
Lower Basin Large Stream
Adult Total Trout Velocity Availability



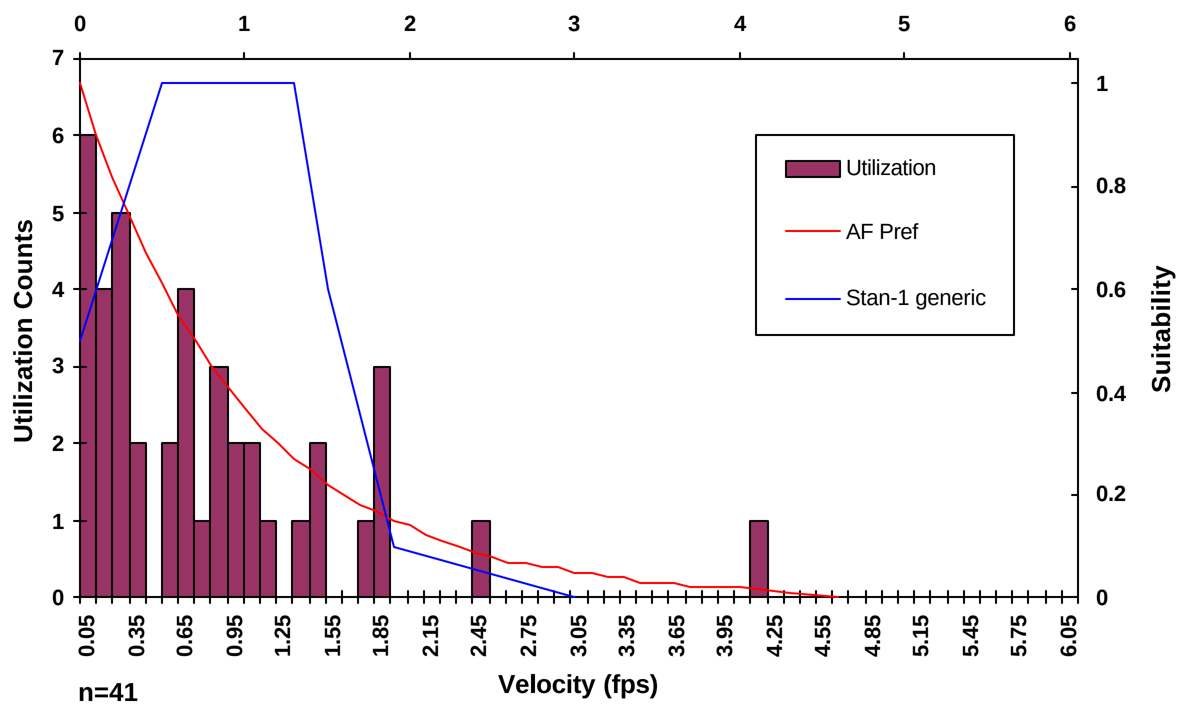
Lower Basin Large Stream
Juvenile Total Trout Depth Utilization and HSC



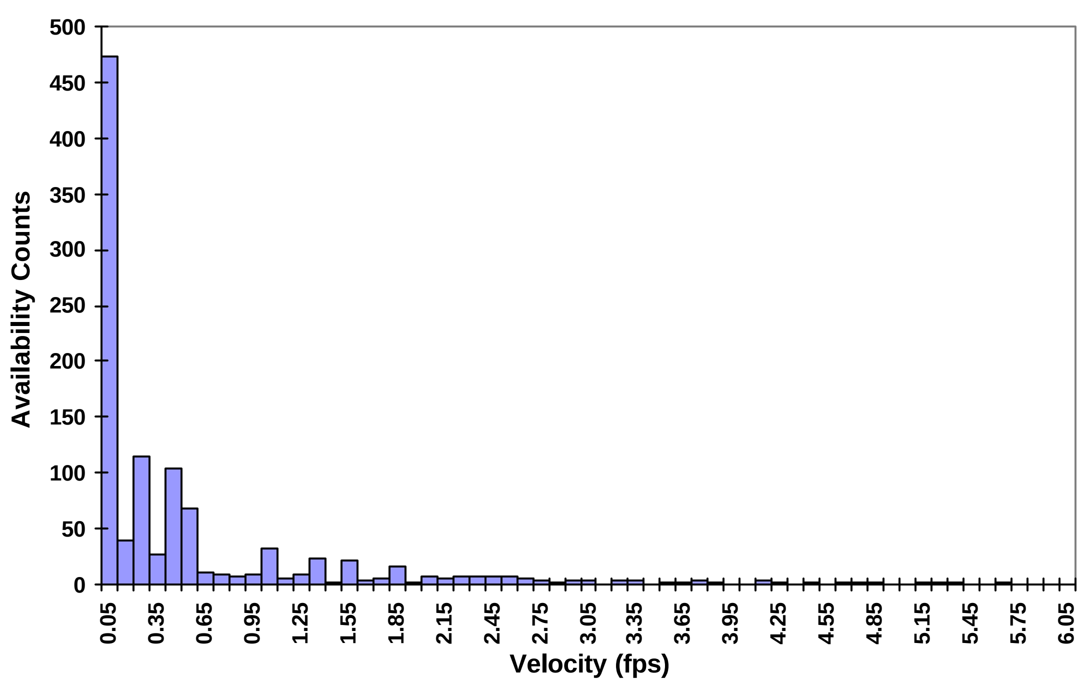
Lower Basin Large Stream
Juvenile Total Trout Depth Availability



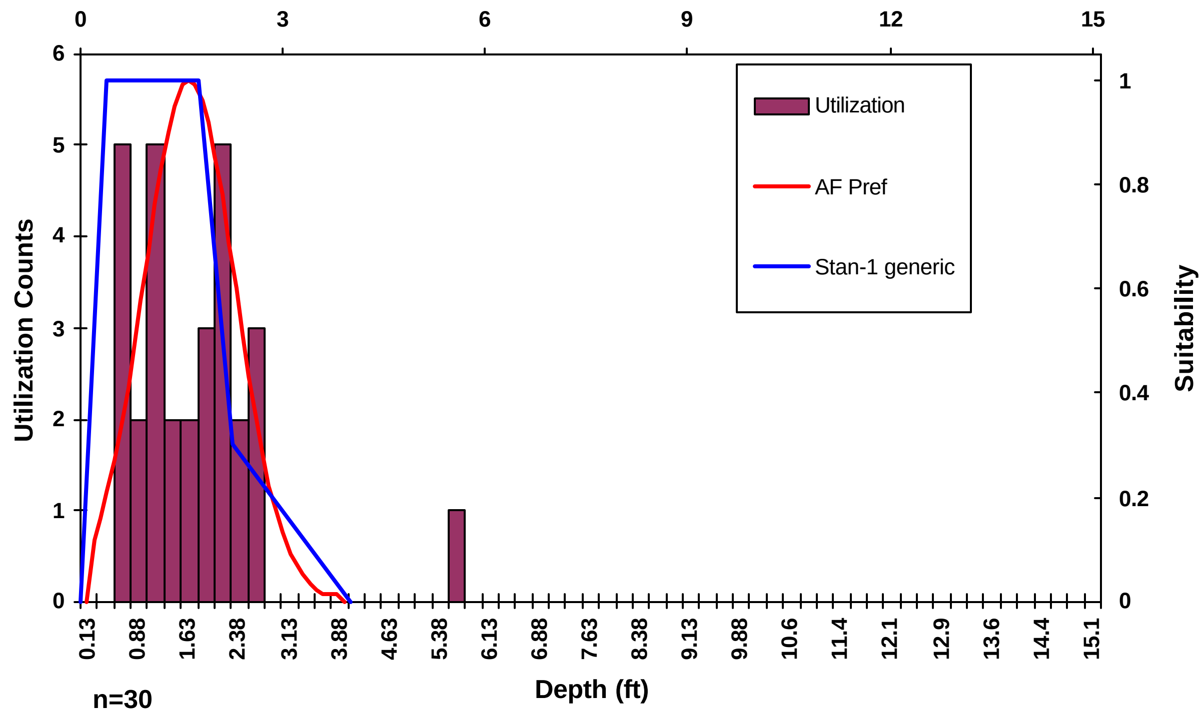
Lower Basin Large Stream
Juvenile Total Trout Velocity Utilization and HSC



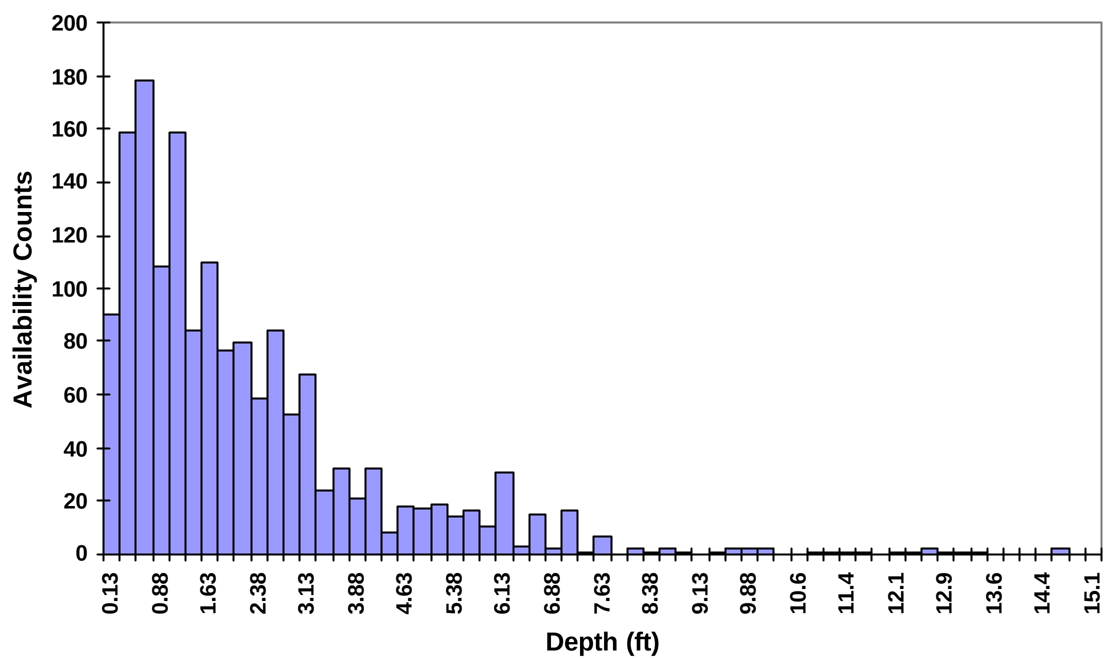
Lower Basin Large Stream
Juvenile Total Trout Velocity Availability



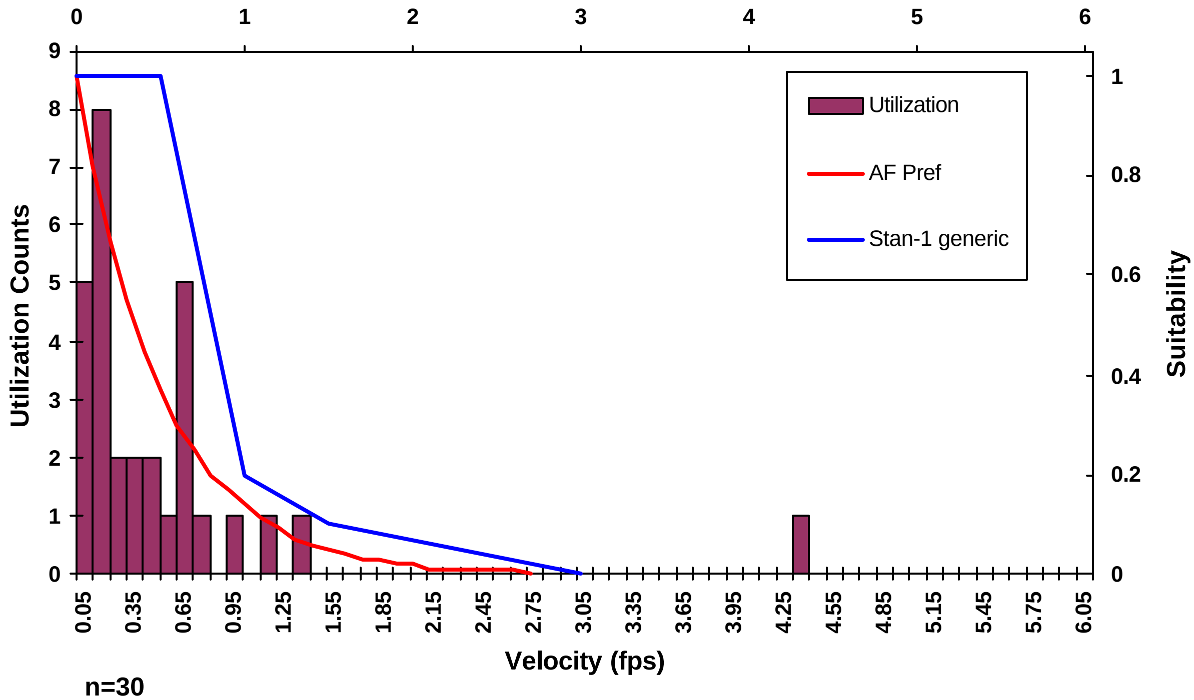
Lower Basin Large Stream
Fry Total Trout Depth Utilization and HSC



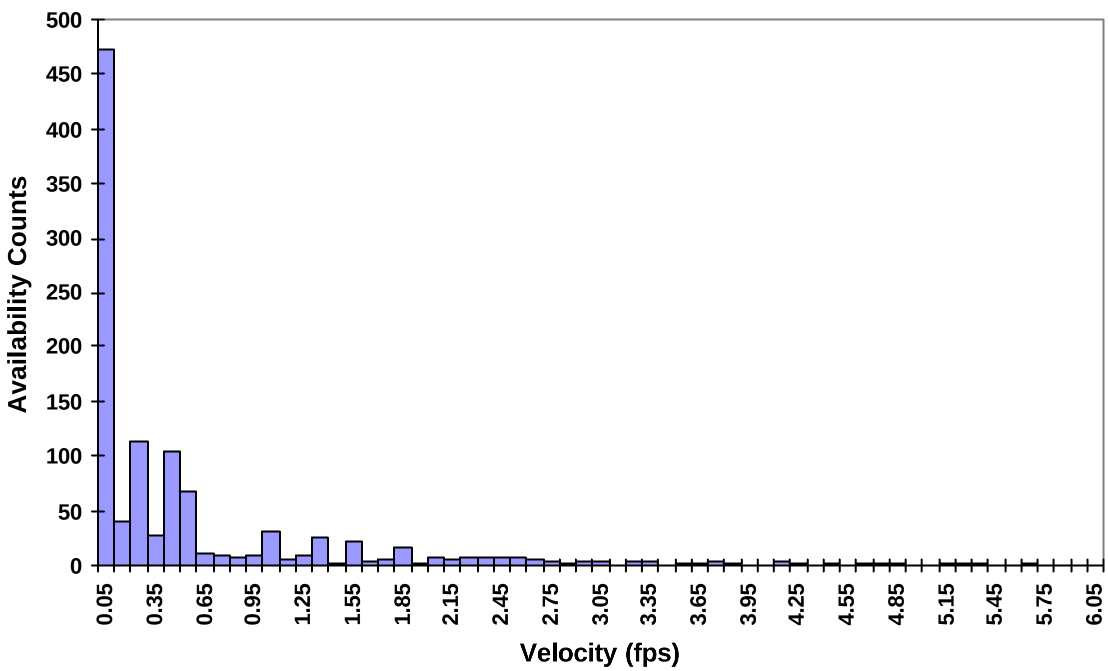
Lower Basin Large Stream
Fry Total Trout Depth Availability



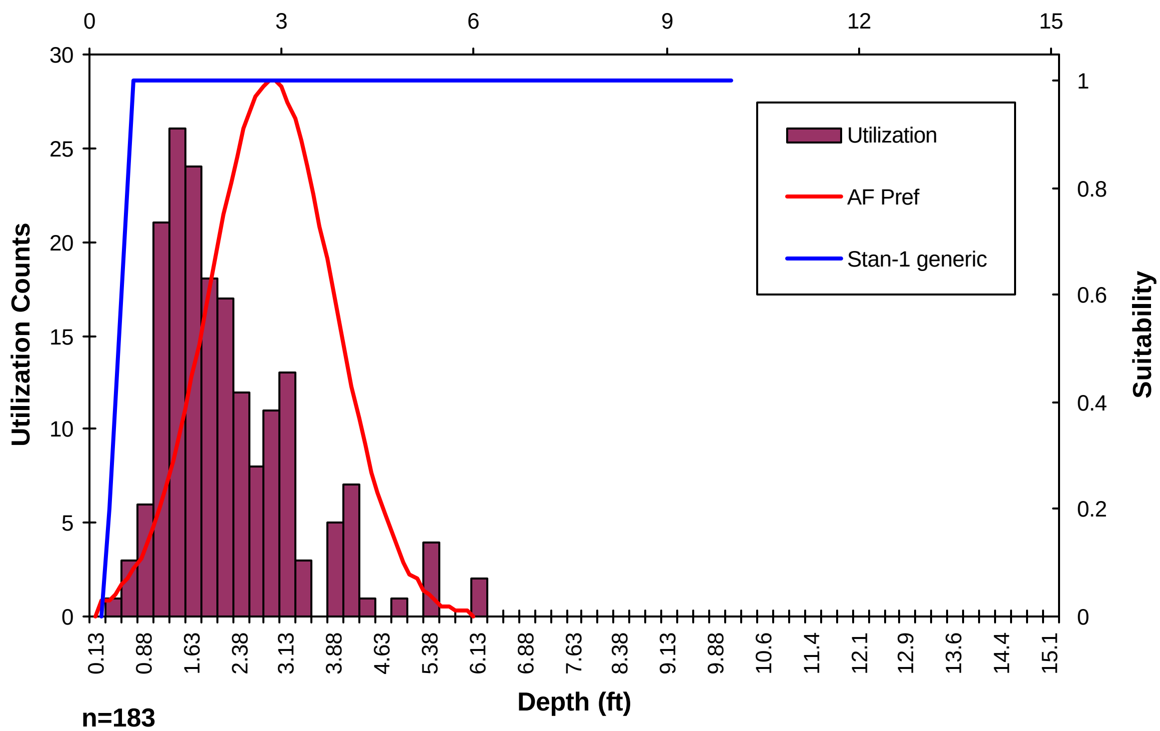
Lower Basin Large Stream
Fry Total Trout Velocity Utilization and HSC



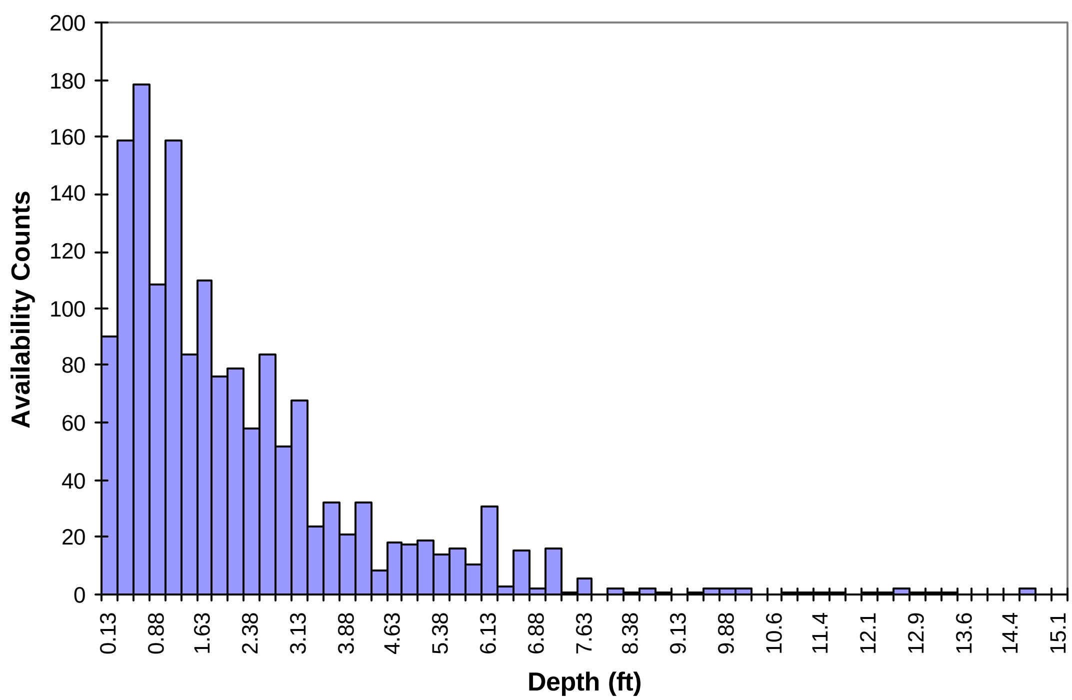
Lower Basin Large Stream
Fry Total Trout Velocity Availability



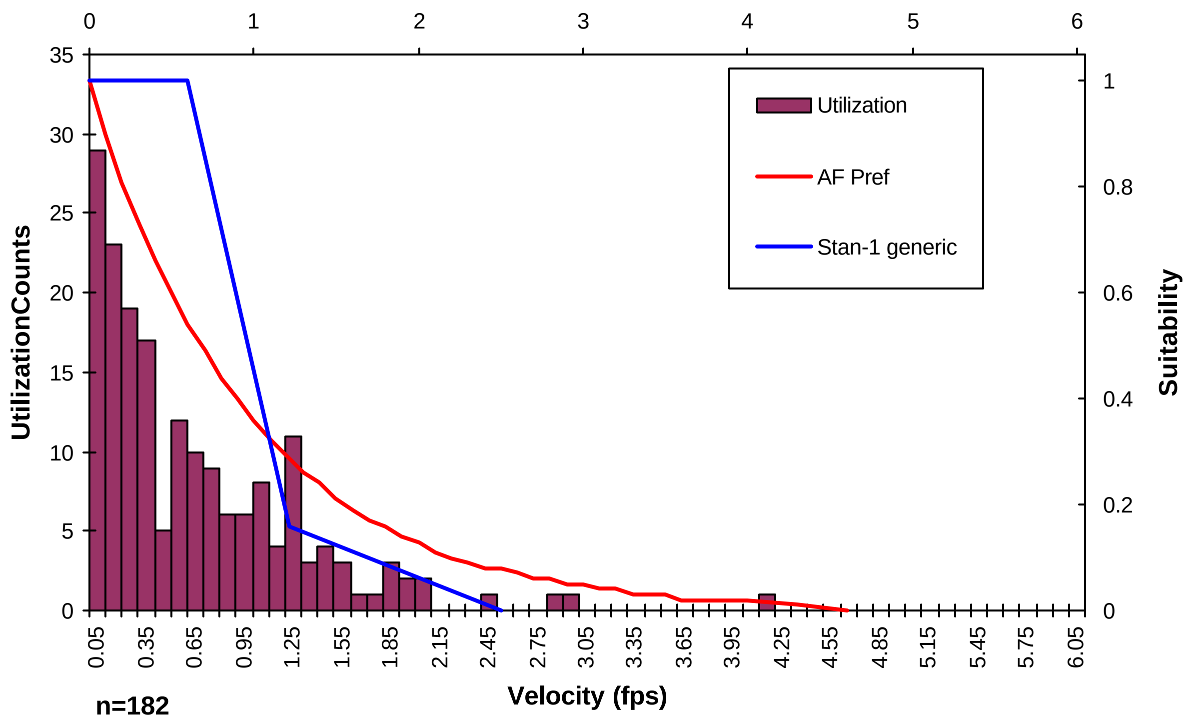
Lower Basin Large Stream
Base Total Trout Depth Utilization and HSC



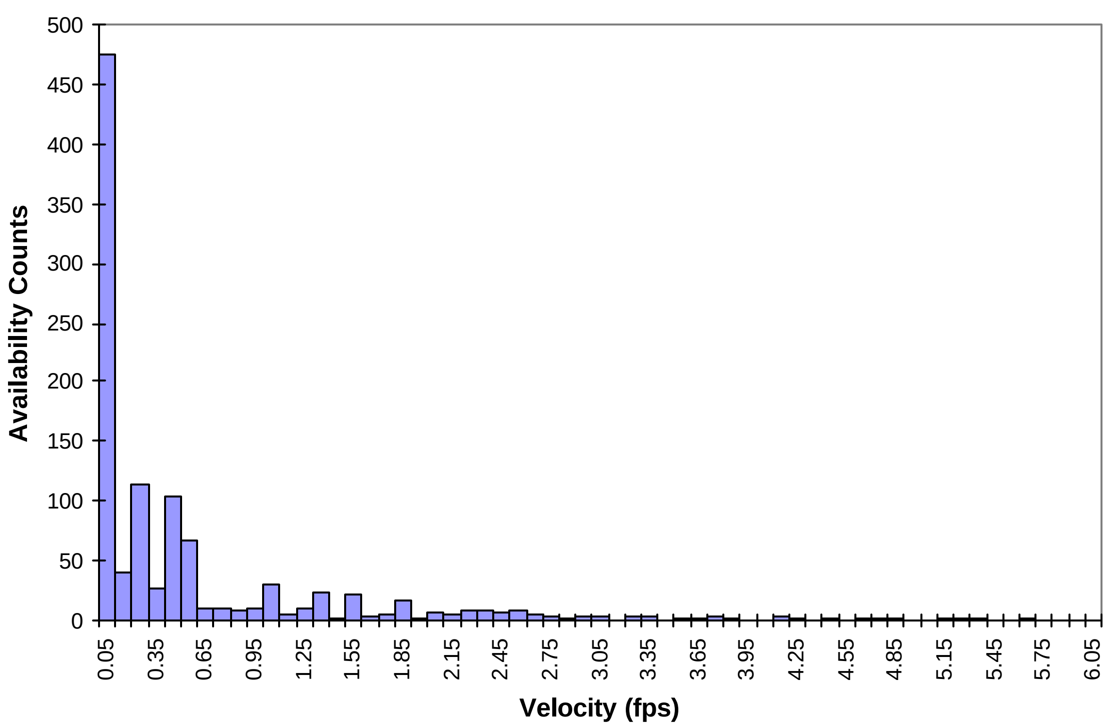
Lower Basin Large Stream
Base Total Trout Depth Availability



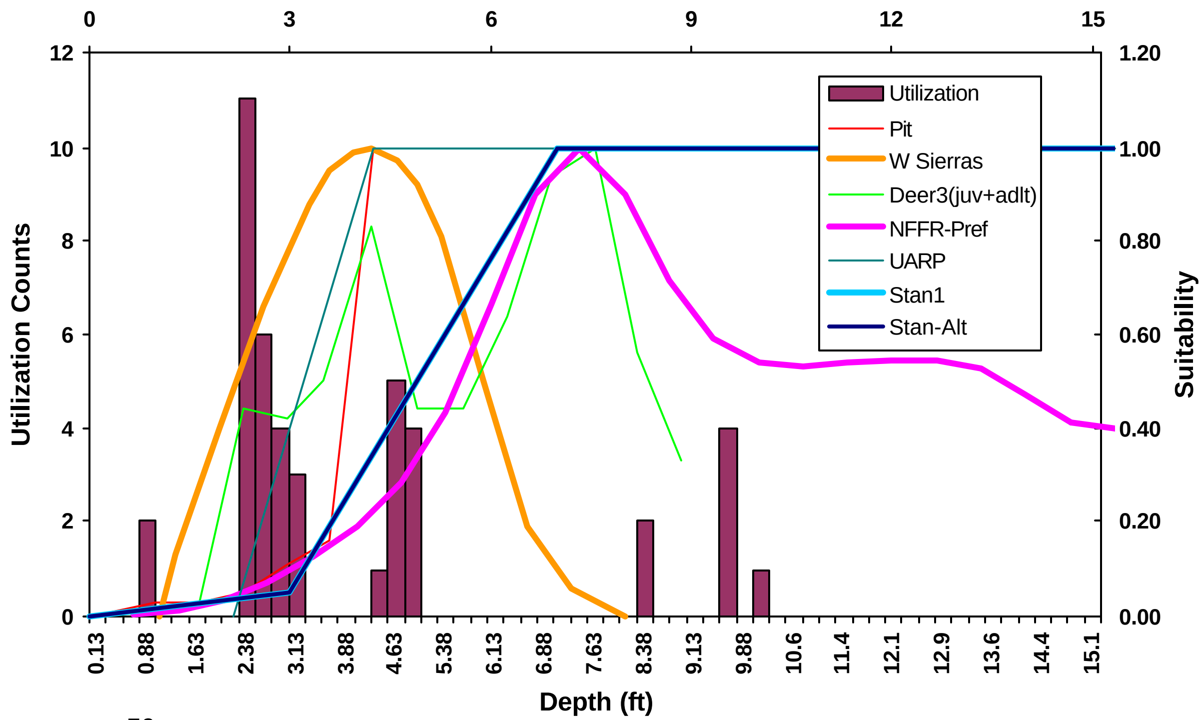
Lower Basin Large Stream
Base Total Trout Velocity Utilization and HSC



Lower Basin Large Stream
Base Total Trout Velocity Availability

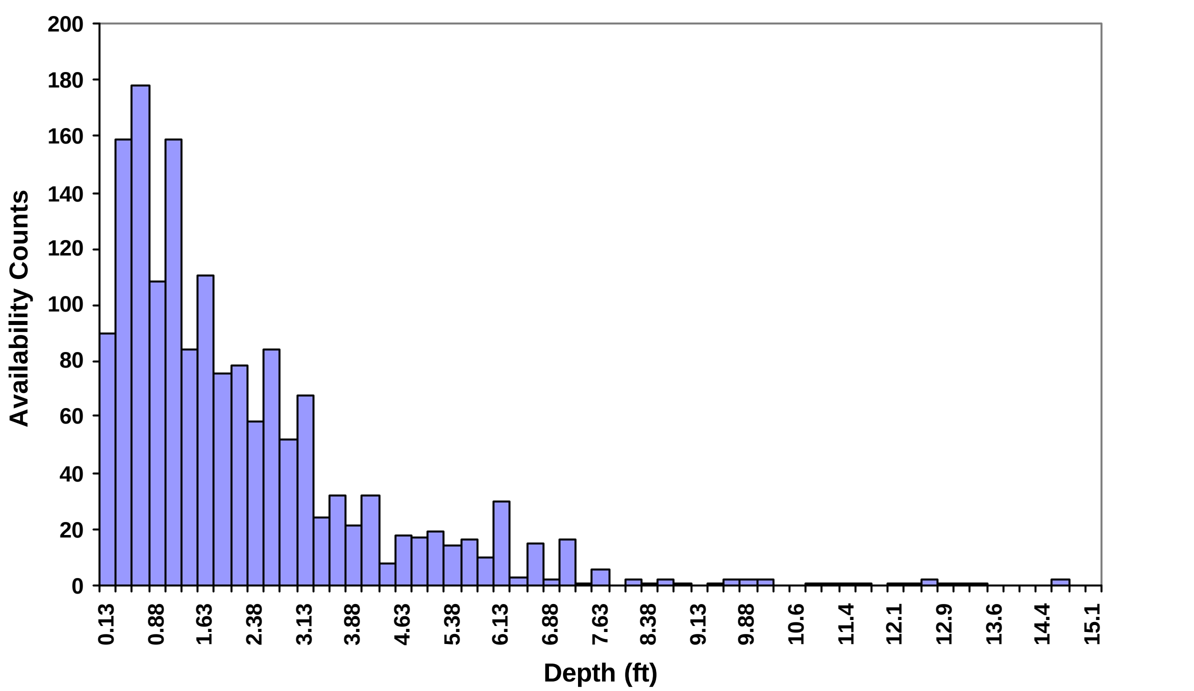


Lower Basin Large Stream
Adult Hardhead Depth Utilization and HSC

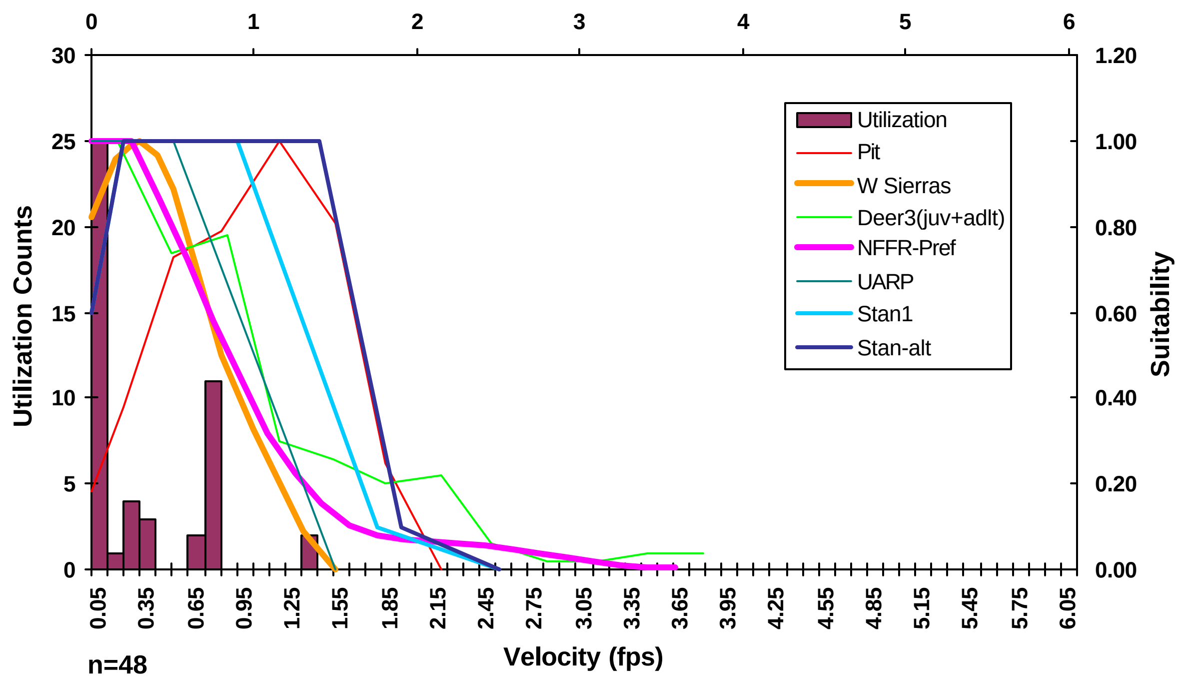


n=50

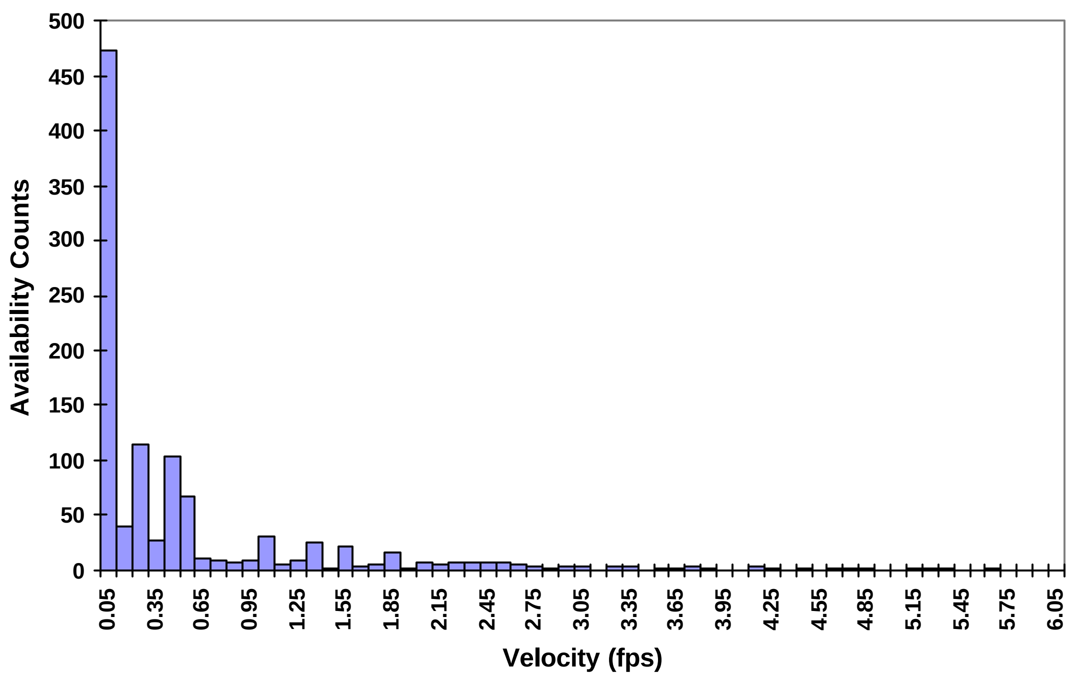
Lower Basin Large Stream
Adult Hardhead Depth Availability



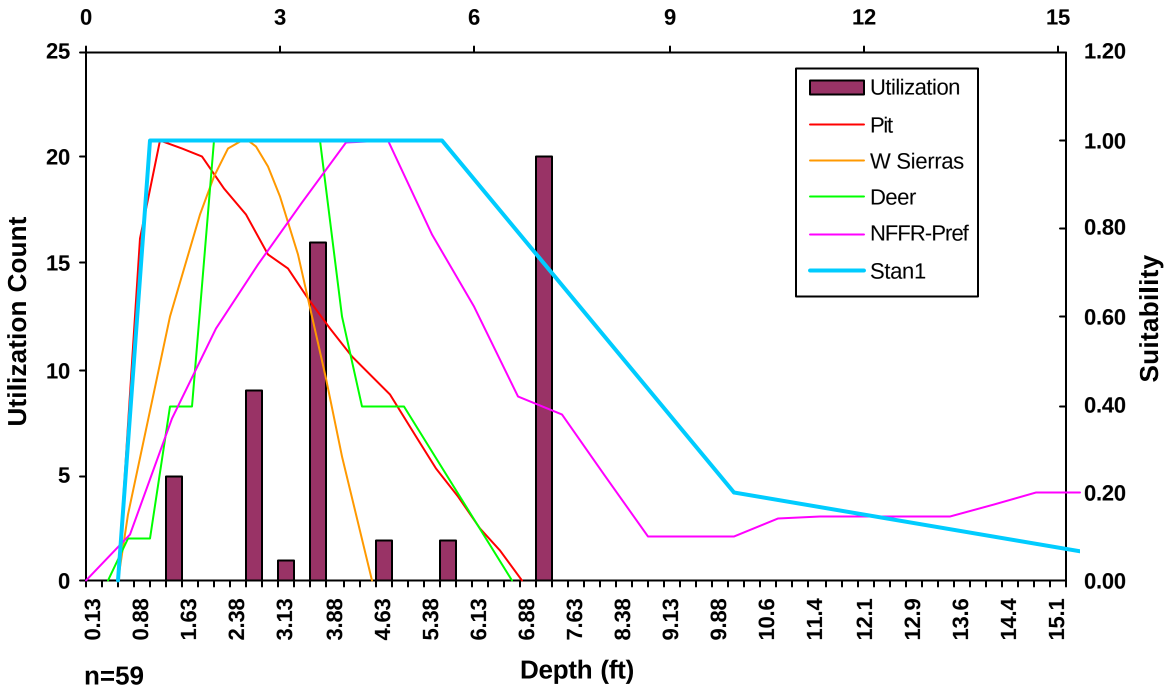
Lower Basin Large Stream
Adult Hardhead Velocity Utilization and HSC



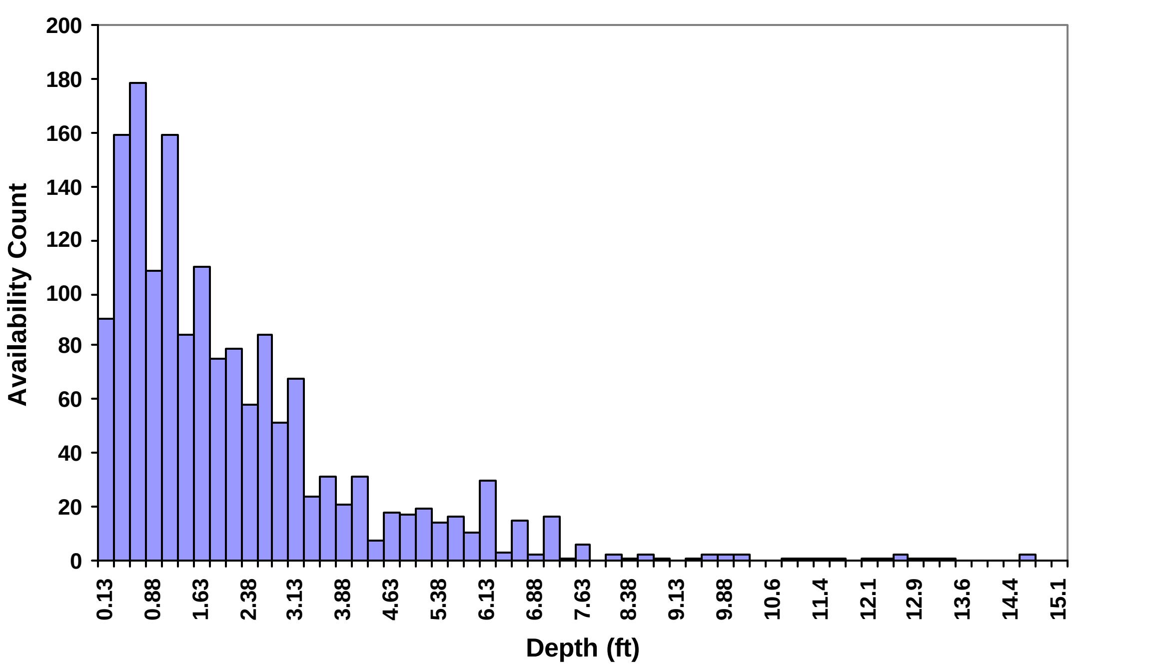
Lower Basin Large Stream
Adult Hardhead Velocity Availability



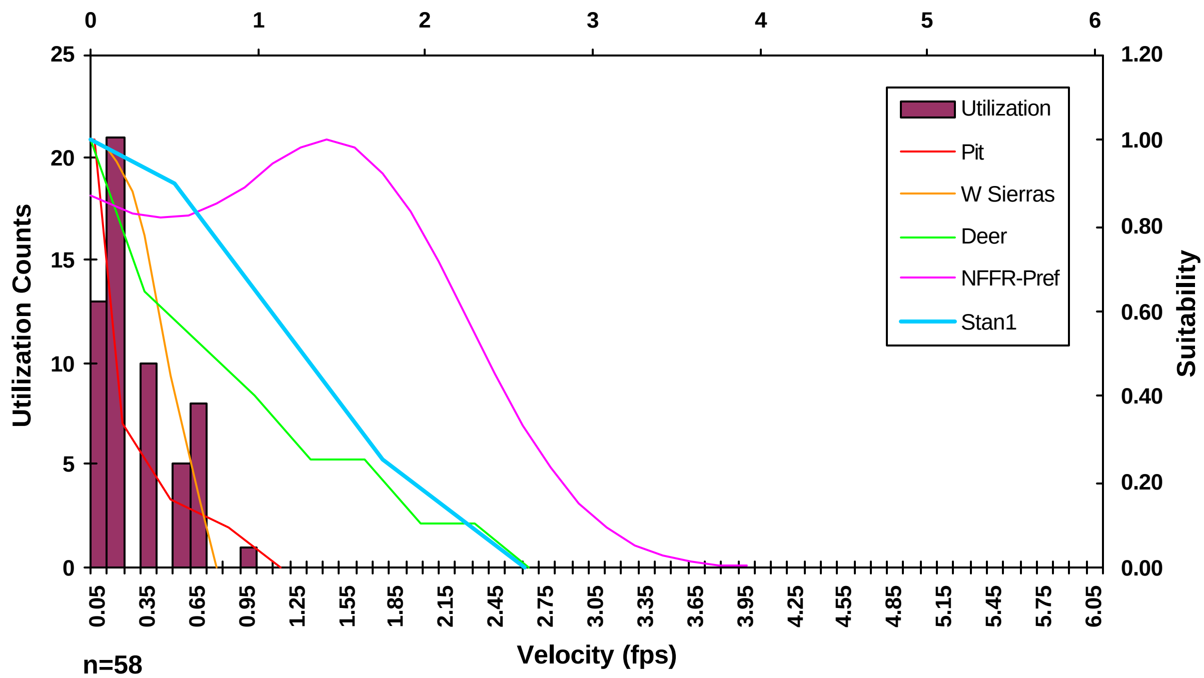
Lower Basin Large Stream
Juvenile Hardhead Depth Utilization and HSC



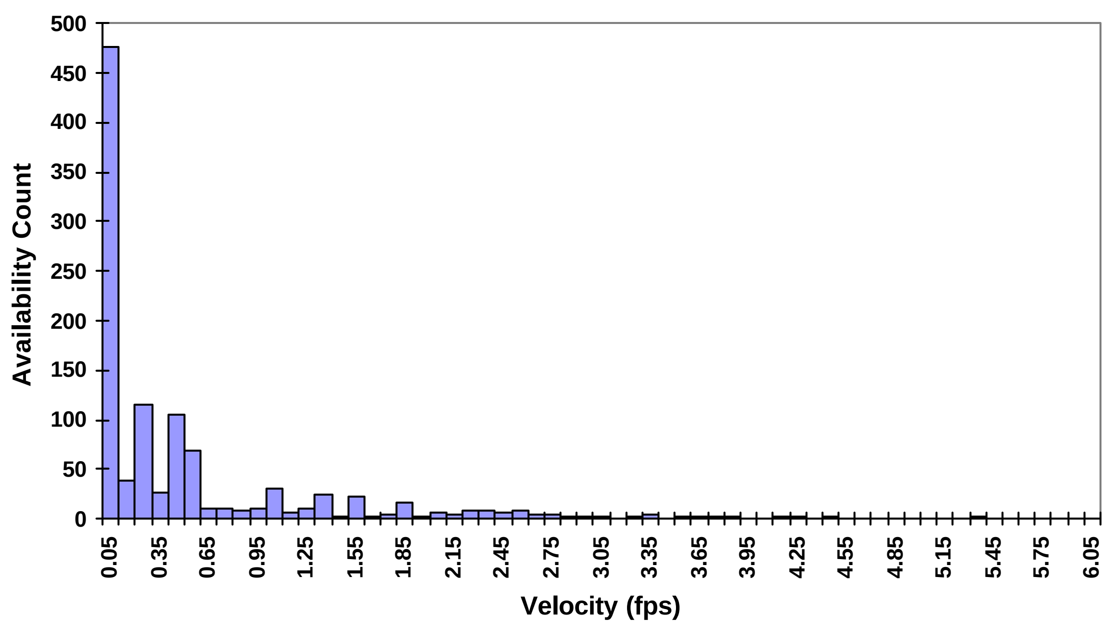
Lower Basin Large Stream
Juvenile Hardhead Depth Availability



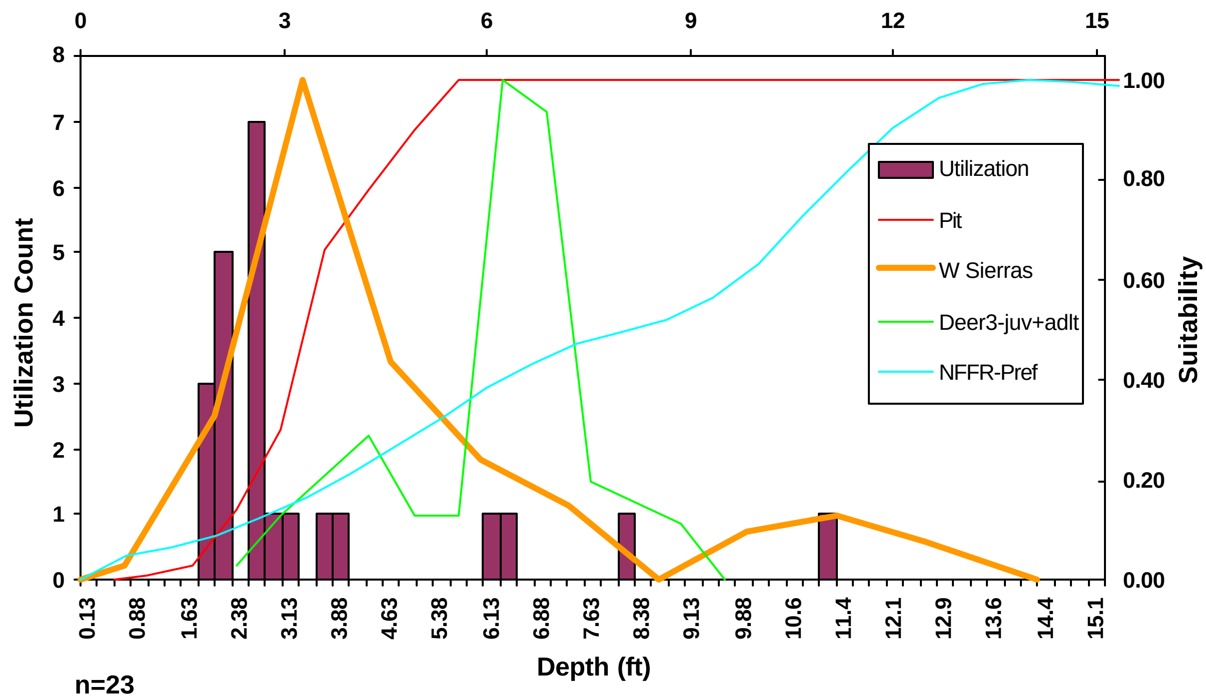
Lower Basin Large Stream
Juvenile Hardhead Velocity Utilization and HSC



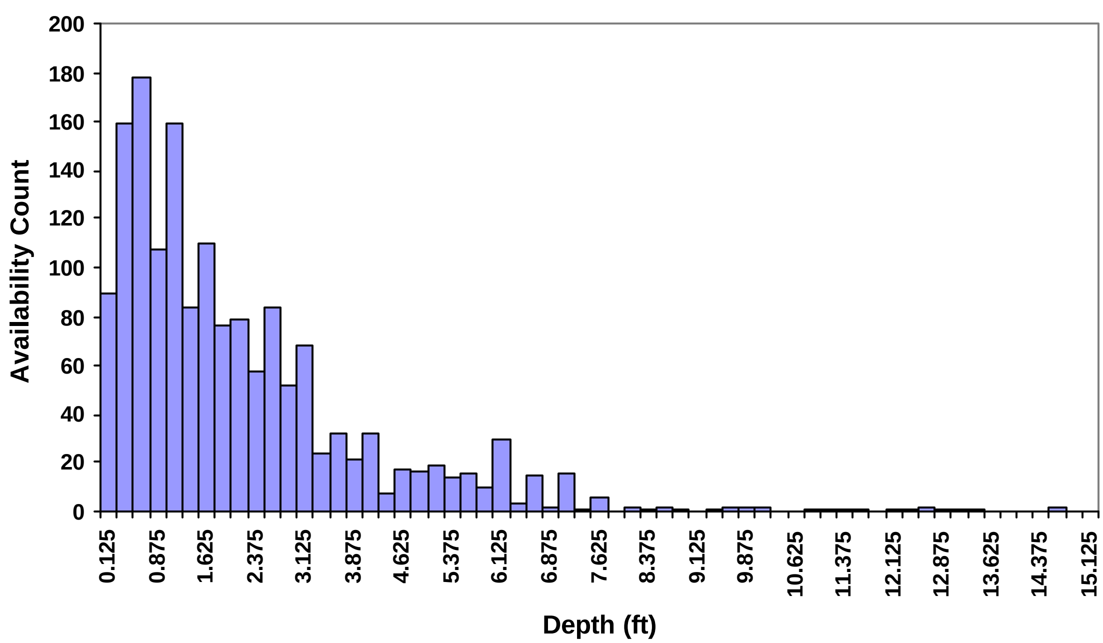
Lower Basin Large Stream
Juvenile Hardhead Velocity Availability



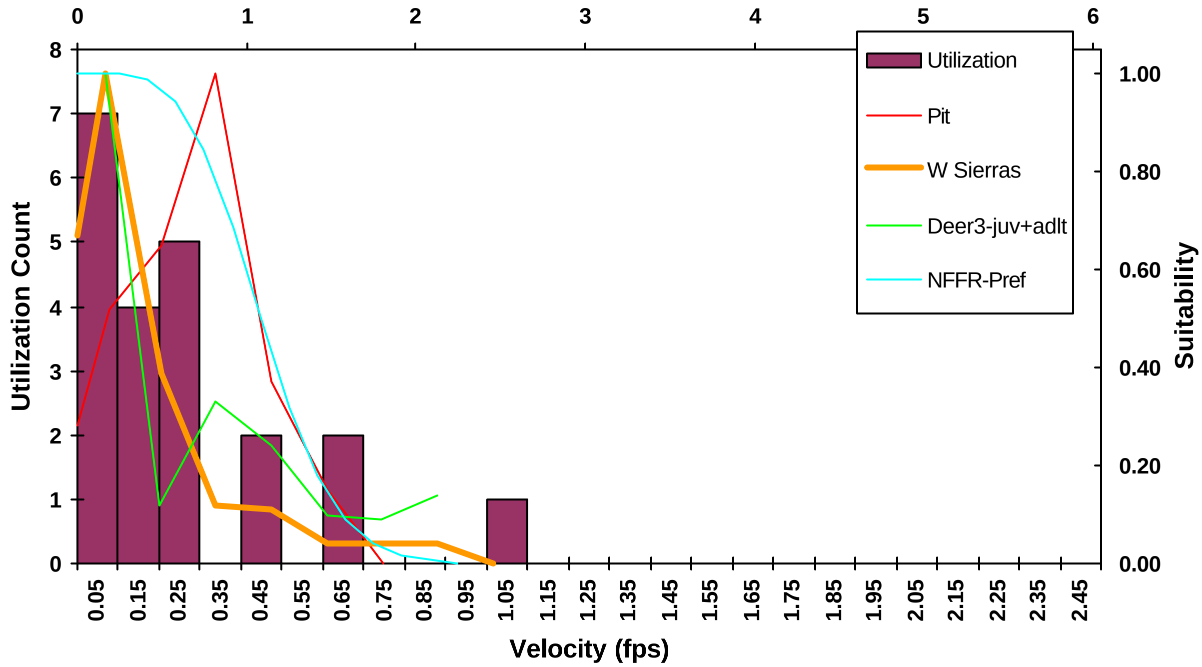
Lower Basin Large Stream
Adult Pikeminnow Depth Utilization and HSC



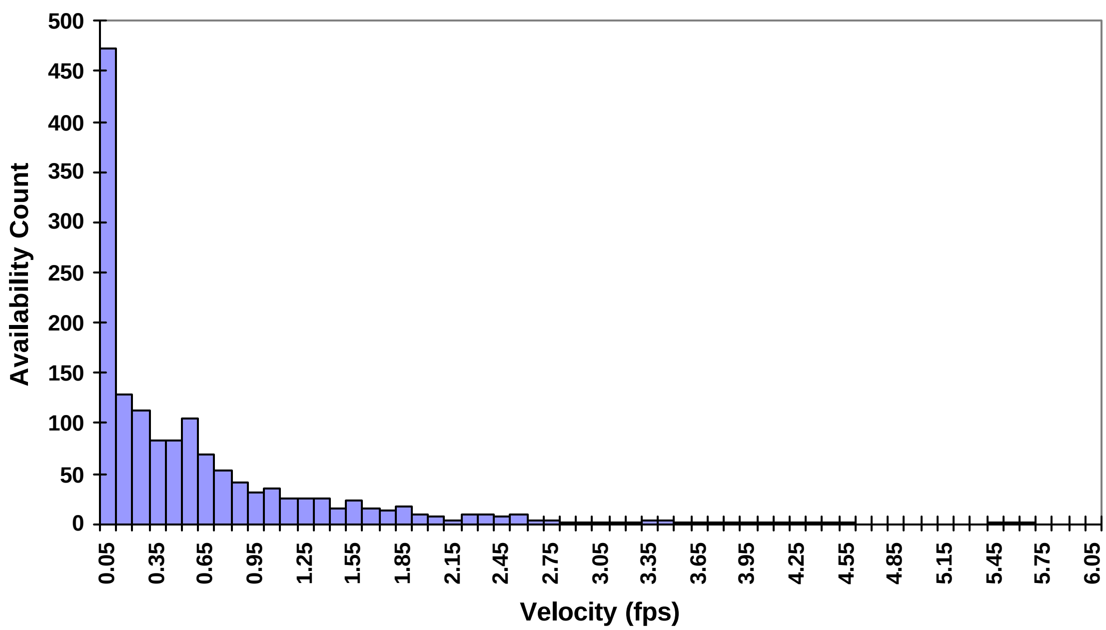
Lower Basin Large Stream
Adult Pikeminnow Depth Availability

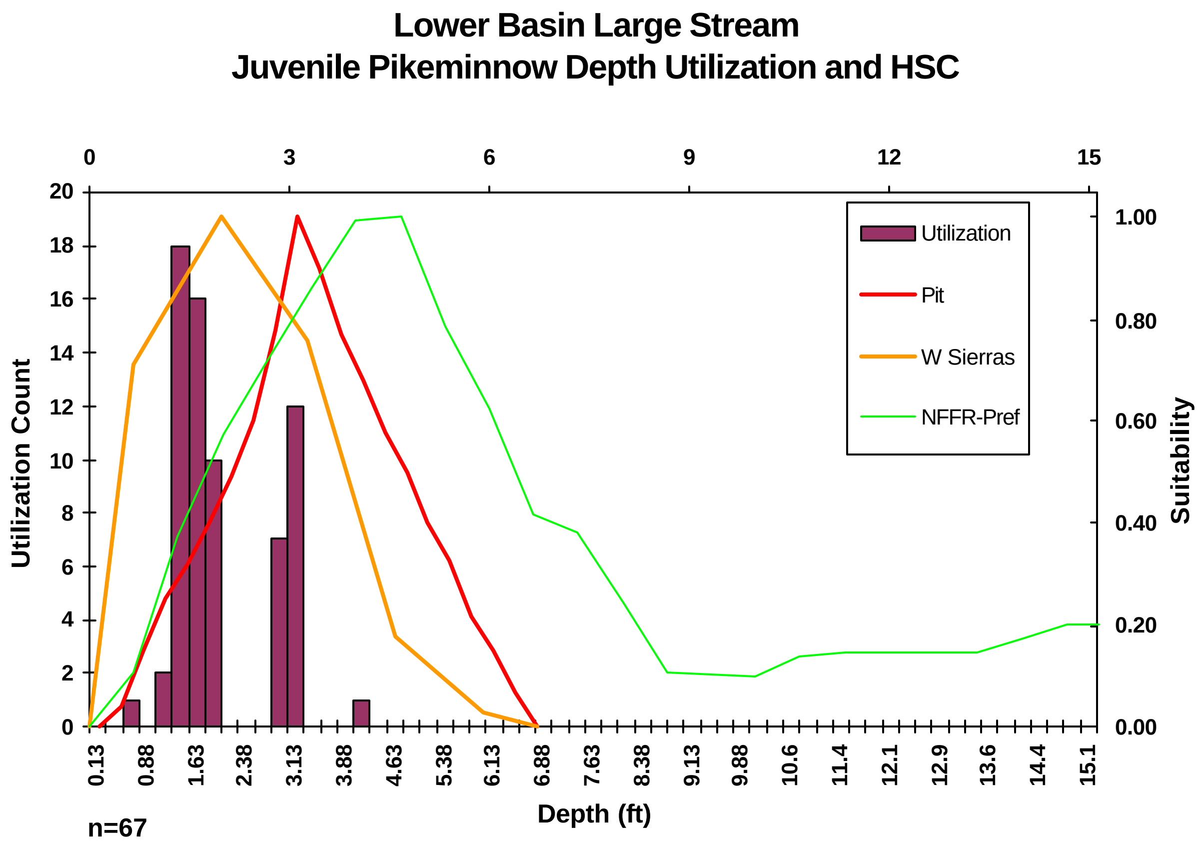


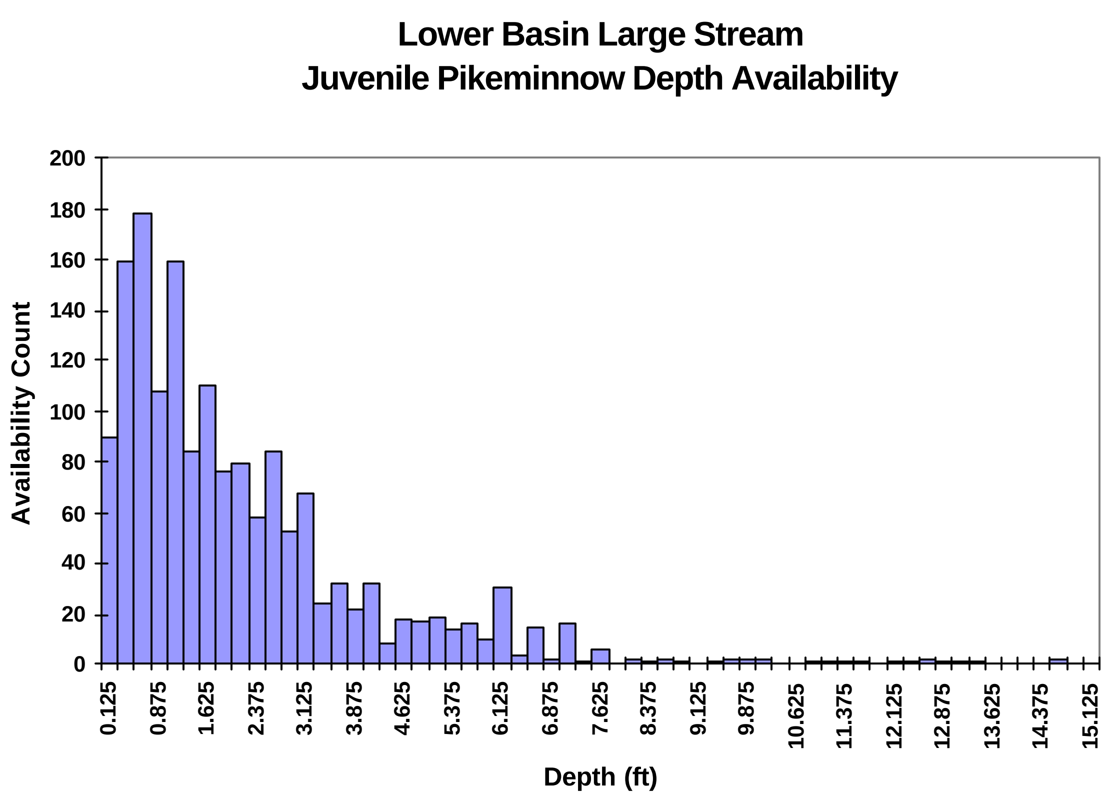
Lower Basin Large Stream
Adult Pikeminnow Velocity Utilization and HSC



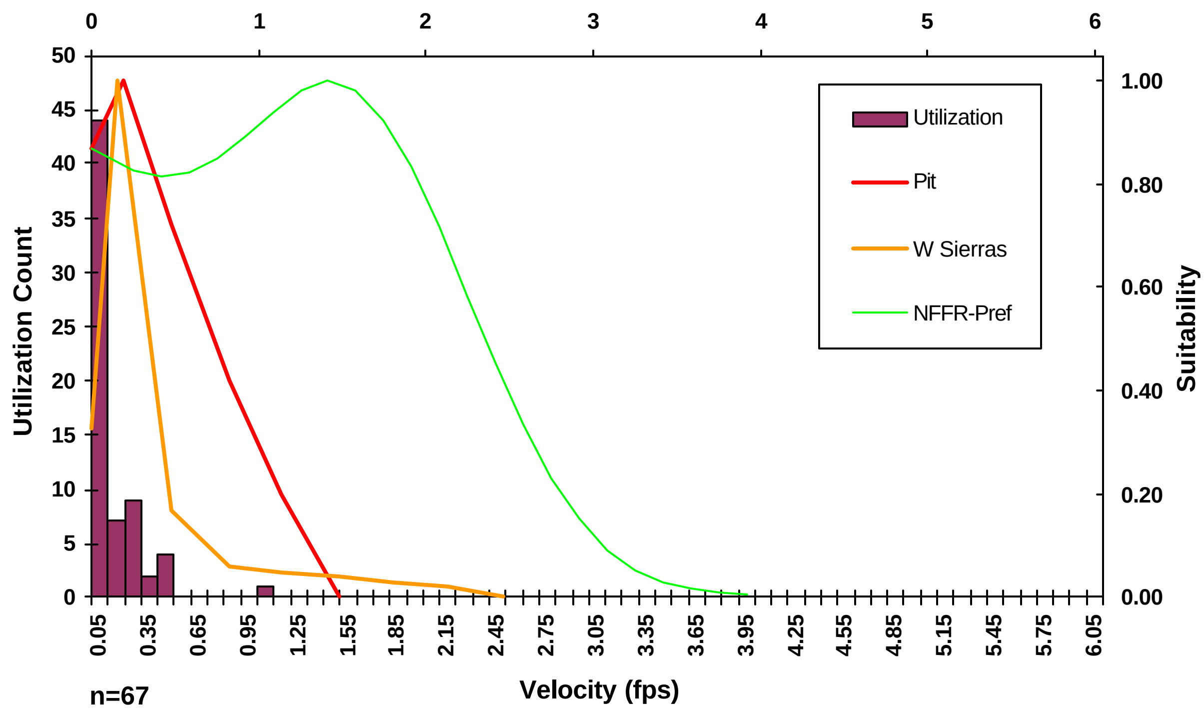
Lower Basin Large Stream
Adult Pikeminnow Velocity Availability



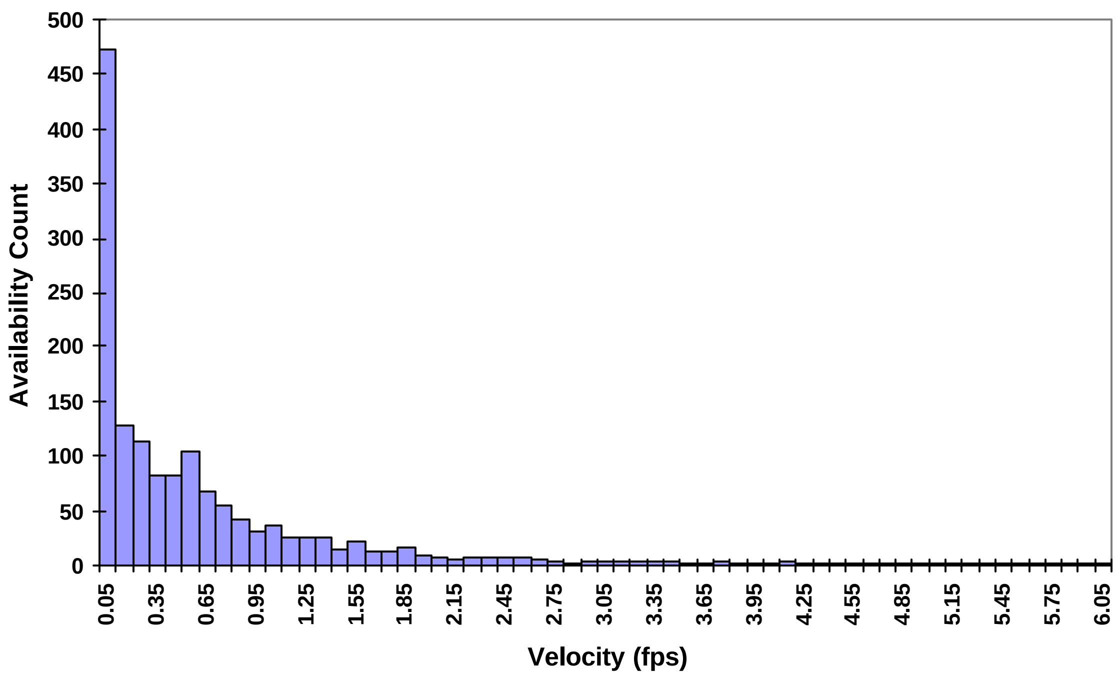

Lower Basin Large Stream
Juvenile Pikeminnow Depth Utilization and HSC
0
3
6
9
12
15
20
18
16
14
12
10
8
6
4
2
0
Utilization Count
1.00
0.80
0.60
0.40
0.20
0.00
Suitability
Utilization
Pit
W Sierras
NFFR-Pref
0.13
0.88
1.63
2.38
3.13
3.88
4.63
5.38
6.13
6.88
7.63
8.38
9.13
9.88
10.6
11.4
12.1
12.9
13.6
14.4
15.1
Depth (ft)
n=67


Lower Basin Large Stream
Juvenile Pikeminnow Depth Availability
200
180
160
140
120
100
80
60
40
20
0
Availability Count
0.125
0.875
1.625
2.375
3.125
3.875
4.625
5.375
6.125
6.875
7.625
8.375
9.125
9.875
10.625
11.375
12.125
12.875
13.625
14.375
15.125
Depth (ft)

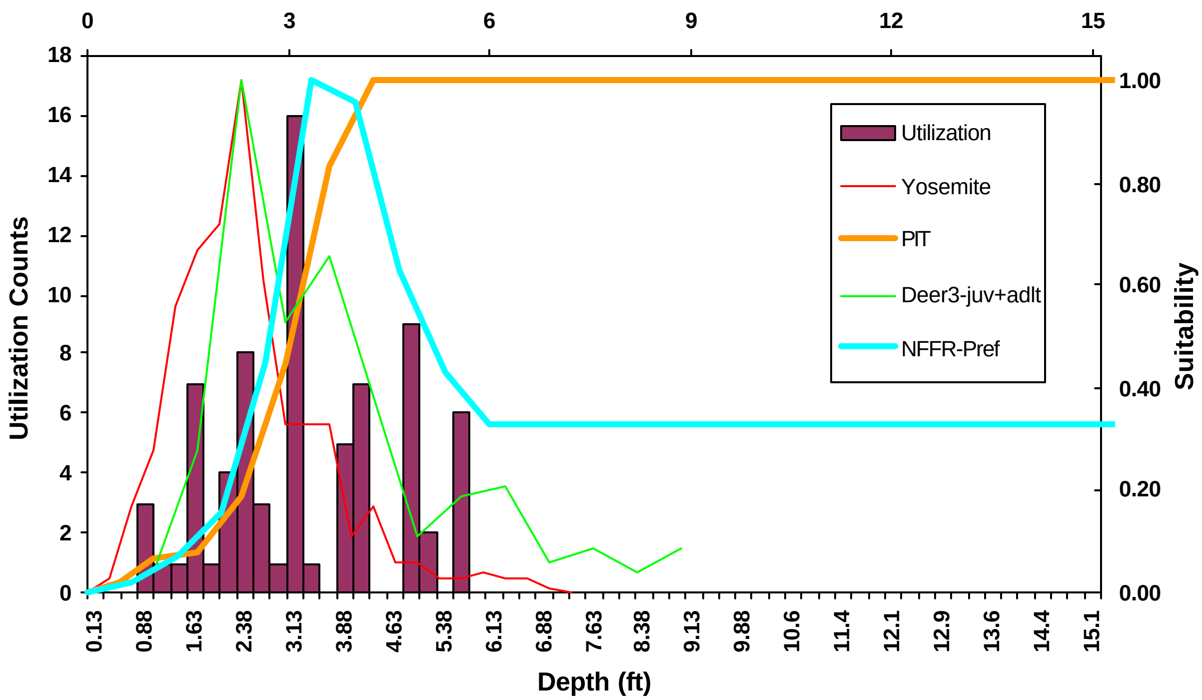
Lower Basin Large Stream
Juvenile Pikeminnow Velocity Utilization and HSC



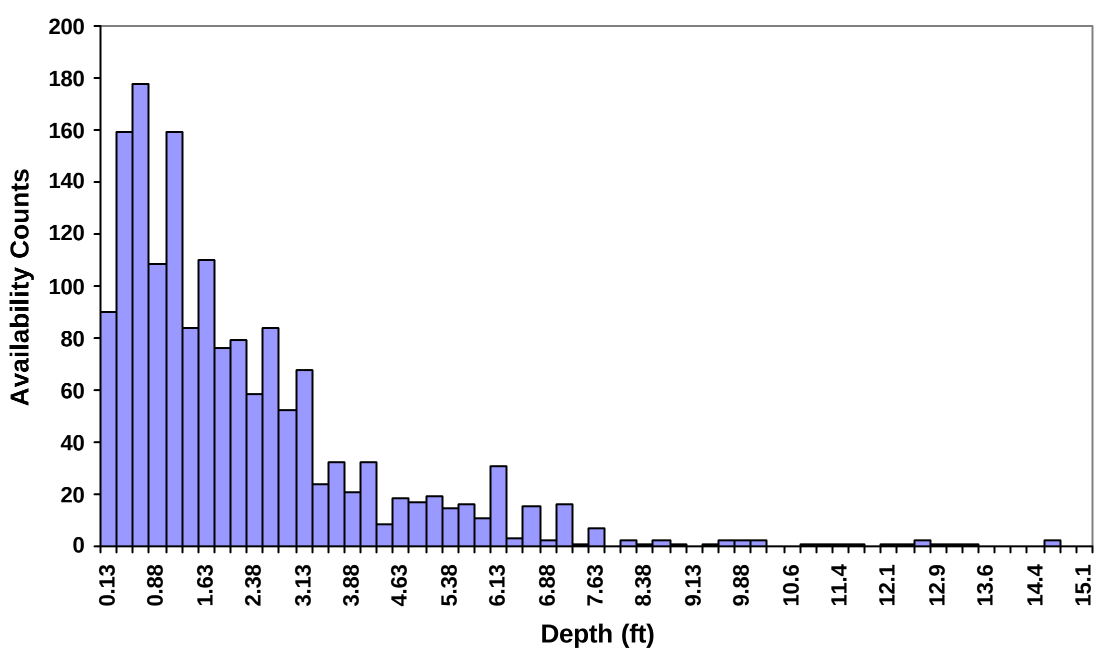
Lower Basin Large Stream
Juvenile Pikeminnow Velocity Availability



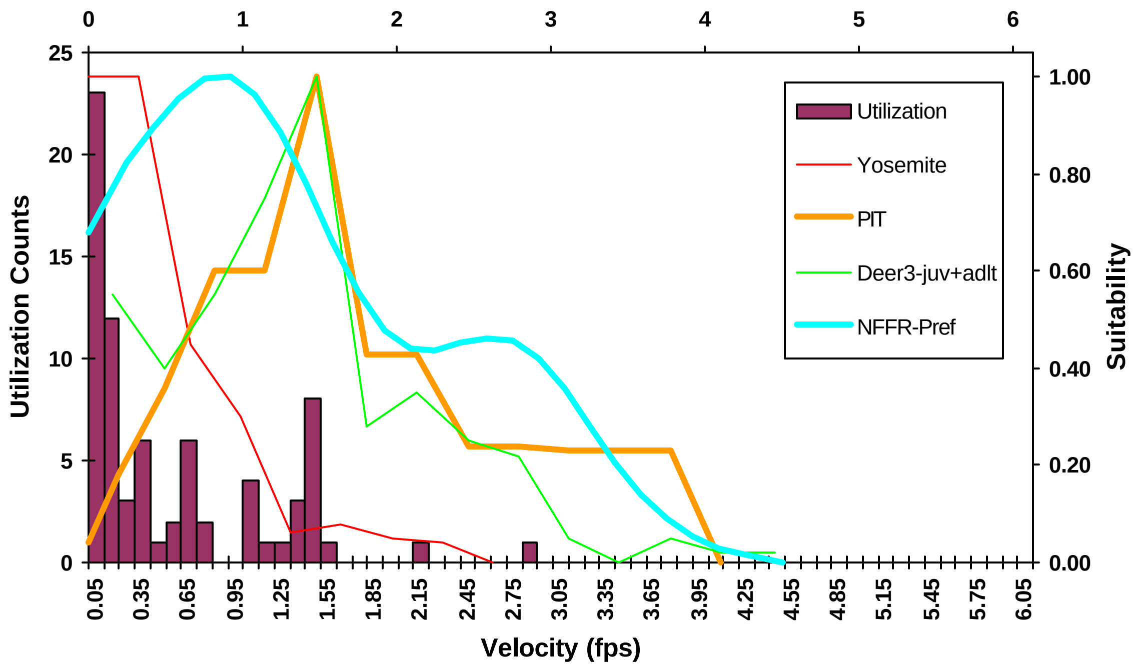
Lower Basin Large Stream
Adult Sacramento Sucker Depth Utilization and HSC



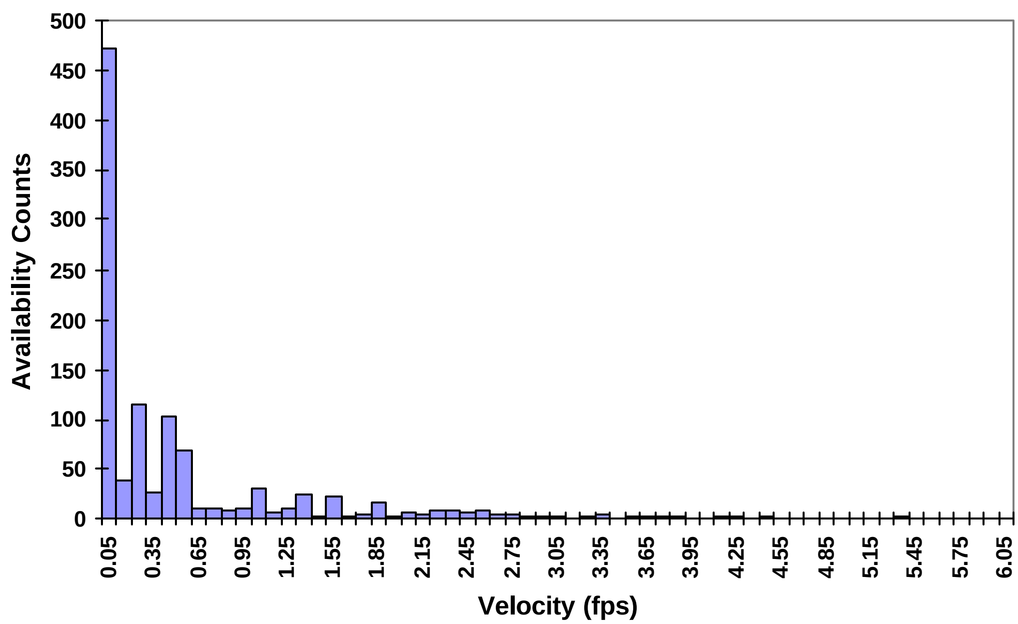
Lower Basin Large Stream
Adult Sacramento Sucker Depth Availability



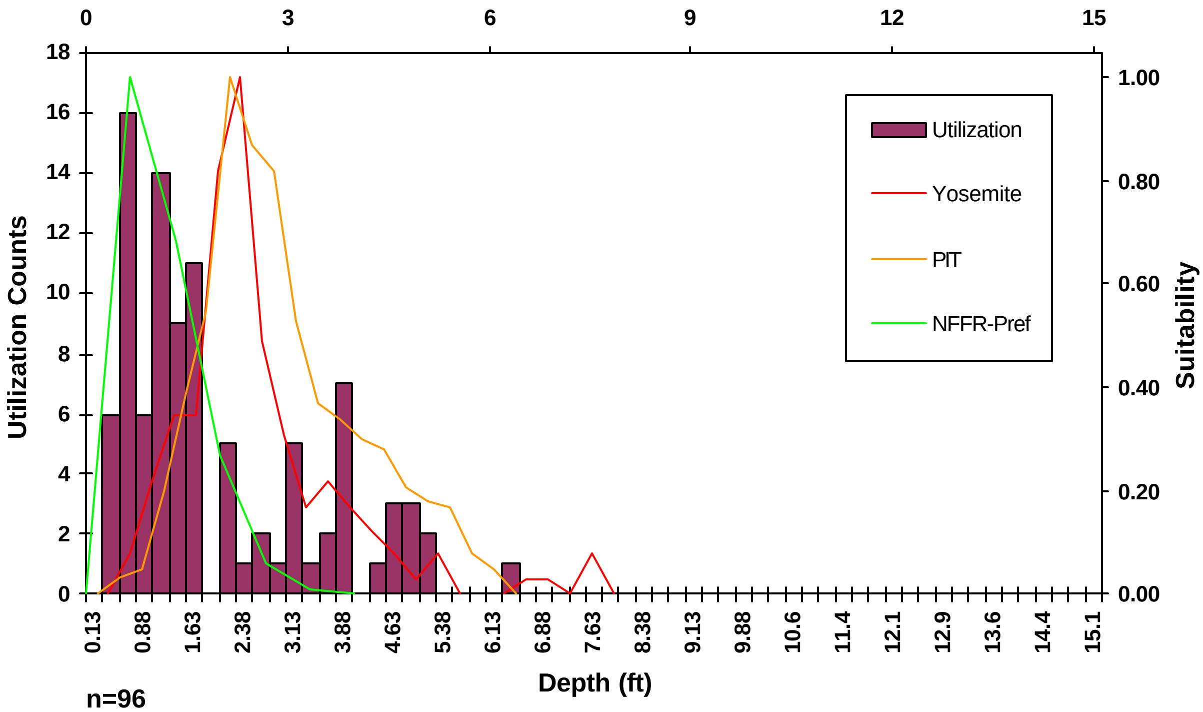
Lower Basin Large Stream
Adult Sacramento Sucker Velocity Utilization and HSC



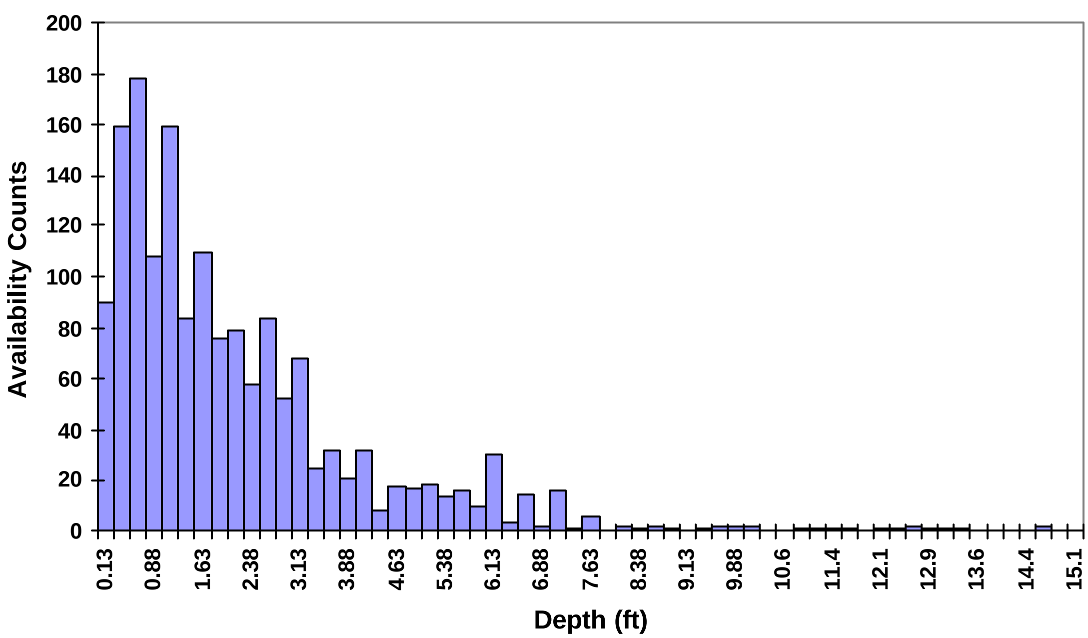
Lower Basin Large Stream
Adult Sacramento Sucker Velocity Availability



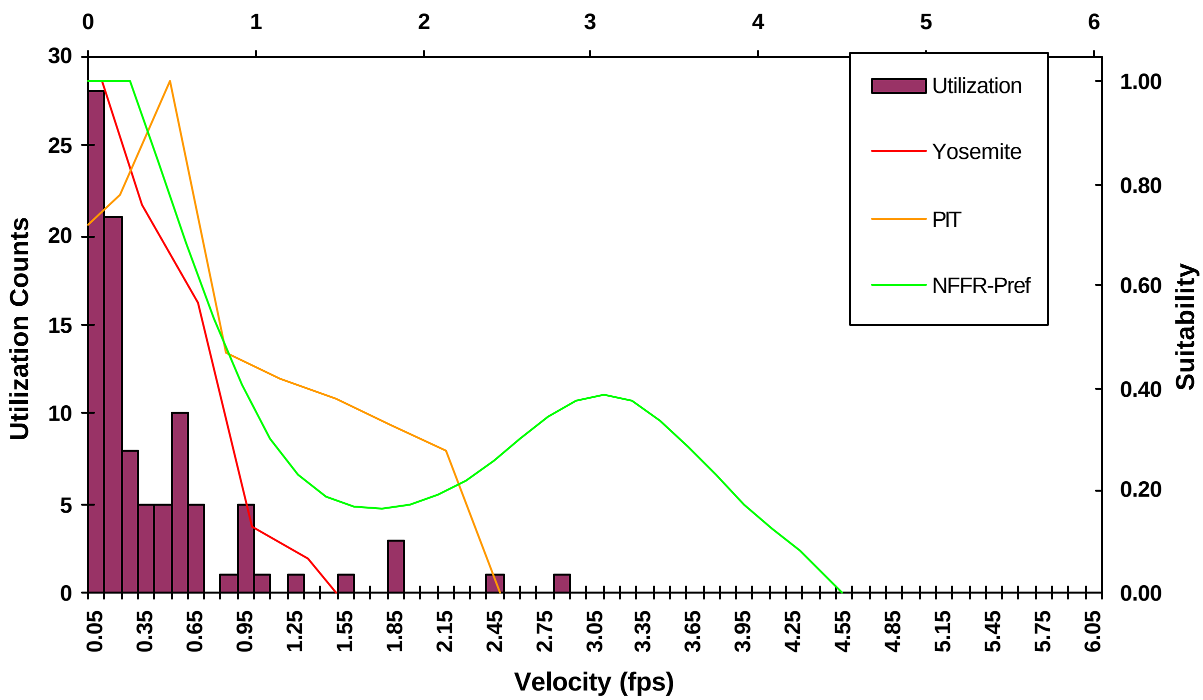
Lower Basin Large Stream
Juvenile Sacramento Sucker Depth Utilization and HSC



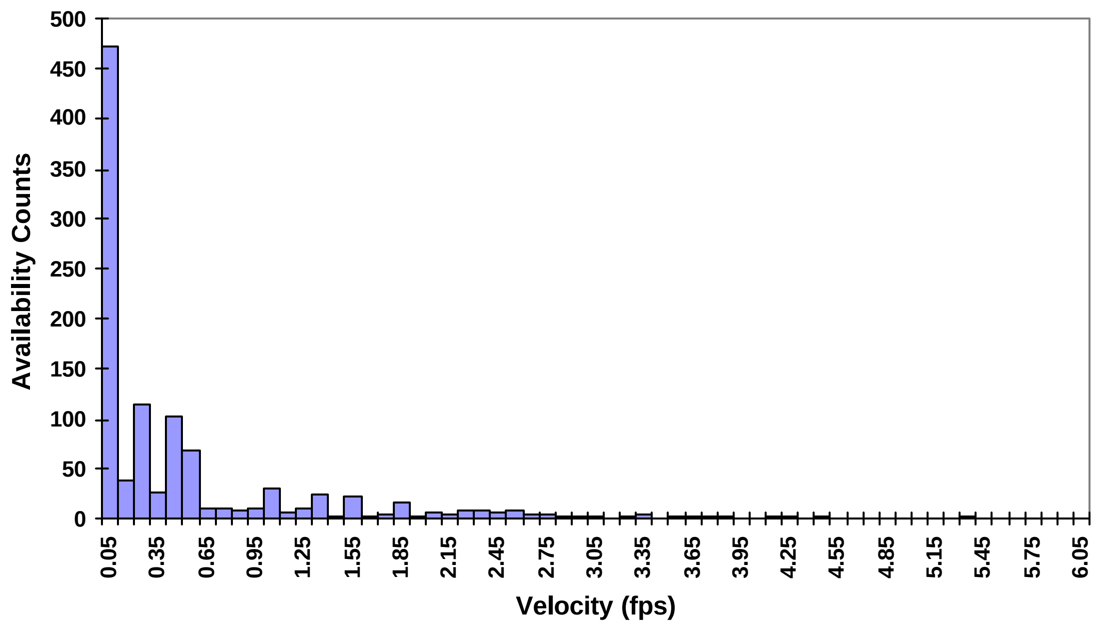
Lower Basin Large Stream
Juvenile Sacramento Sucker Depth Availability



Lower Basin Large Stream
Juvenile Sacramento Sucker Velocity Utilization and HSC

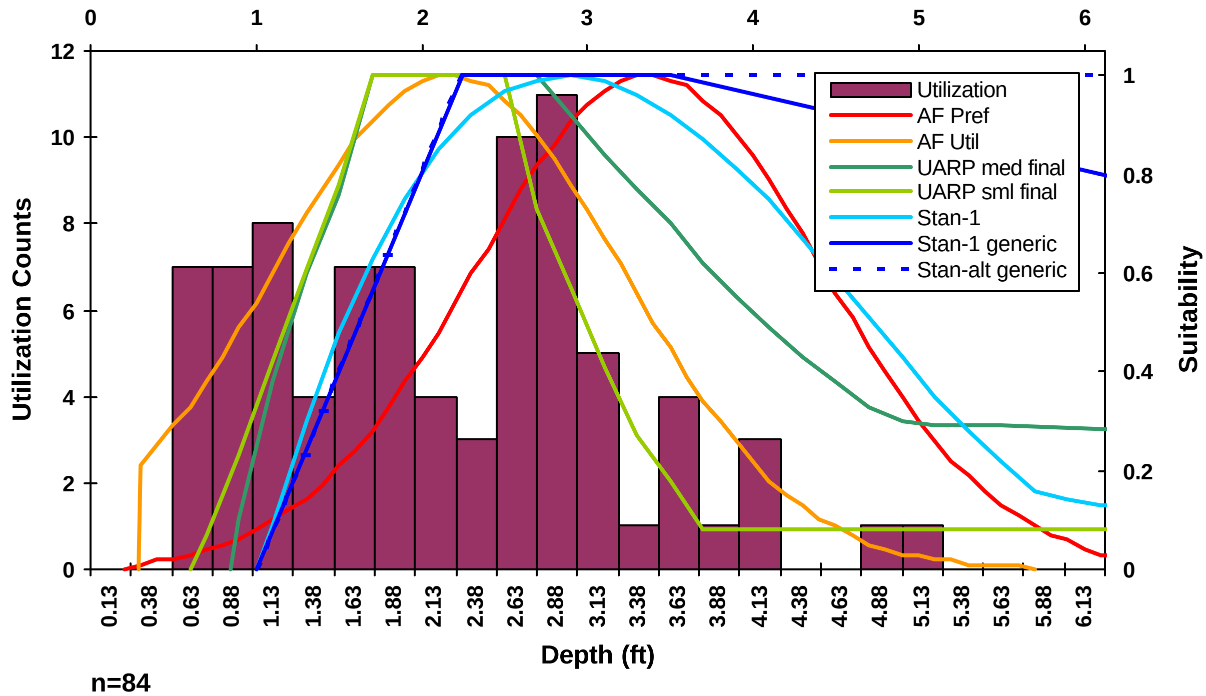


Lower Basin Large Stream
Juvenile Sacramento Sucker Velocity Availability

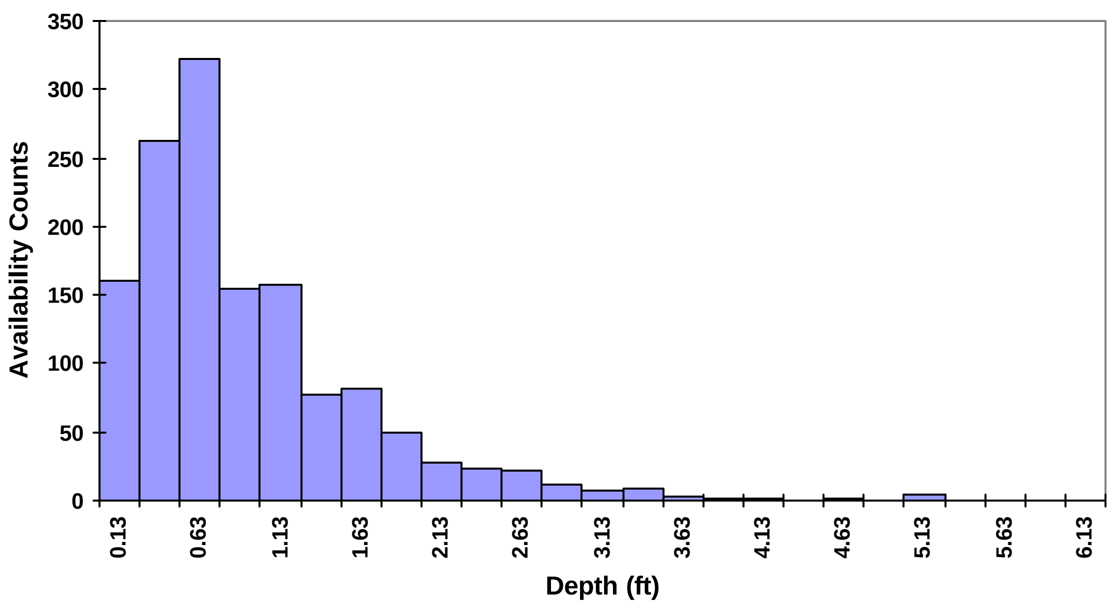


Lower Basin, Small Stream

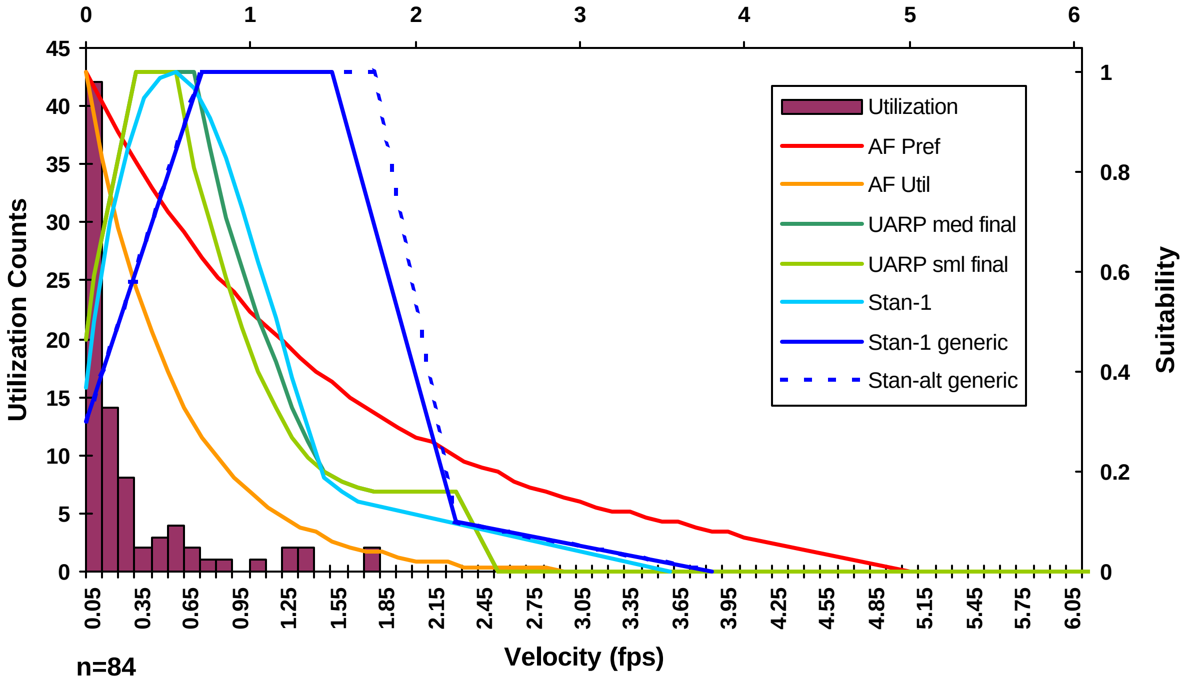
Lower Basin Small Stream
Adult Brown Trout Depth Utilization and HSC



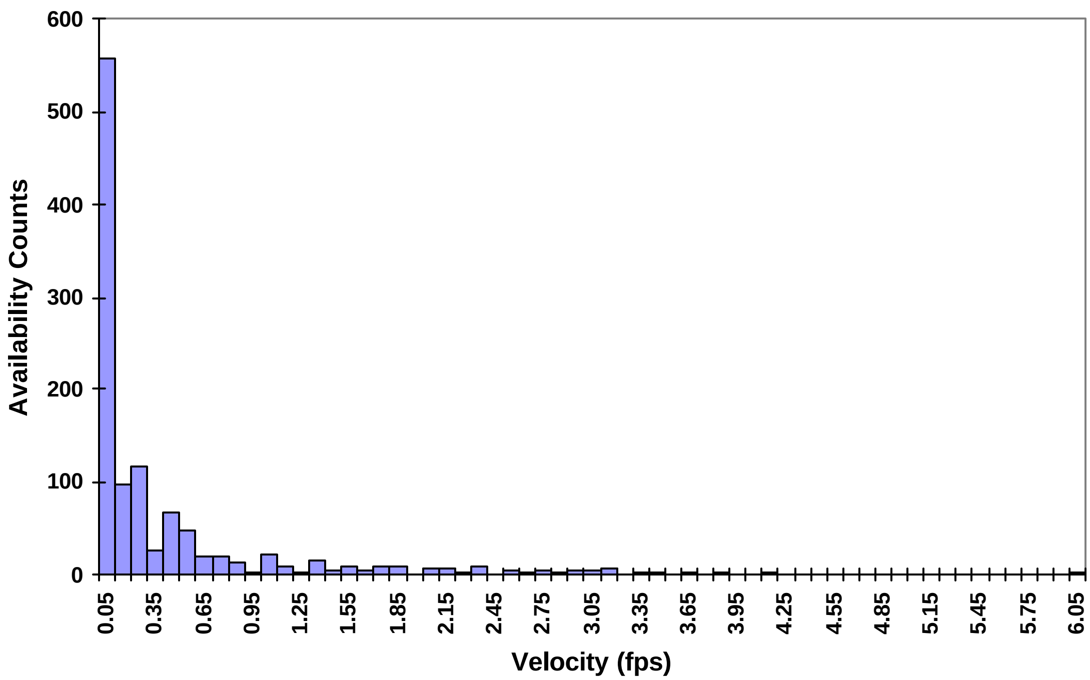
Lower Basin Small Stream
Adult Brown Trout Depth Availability

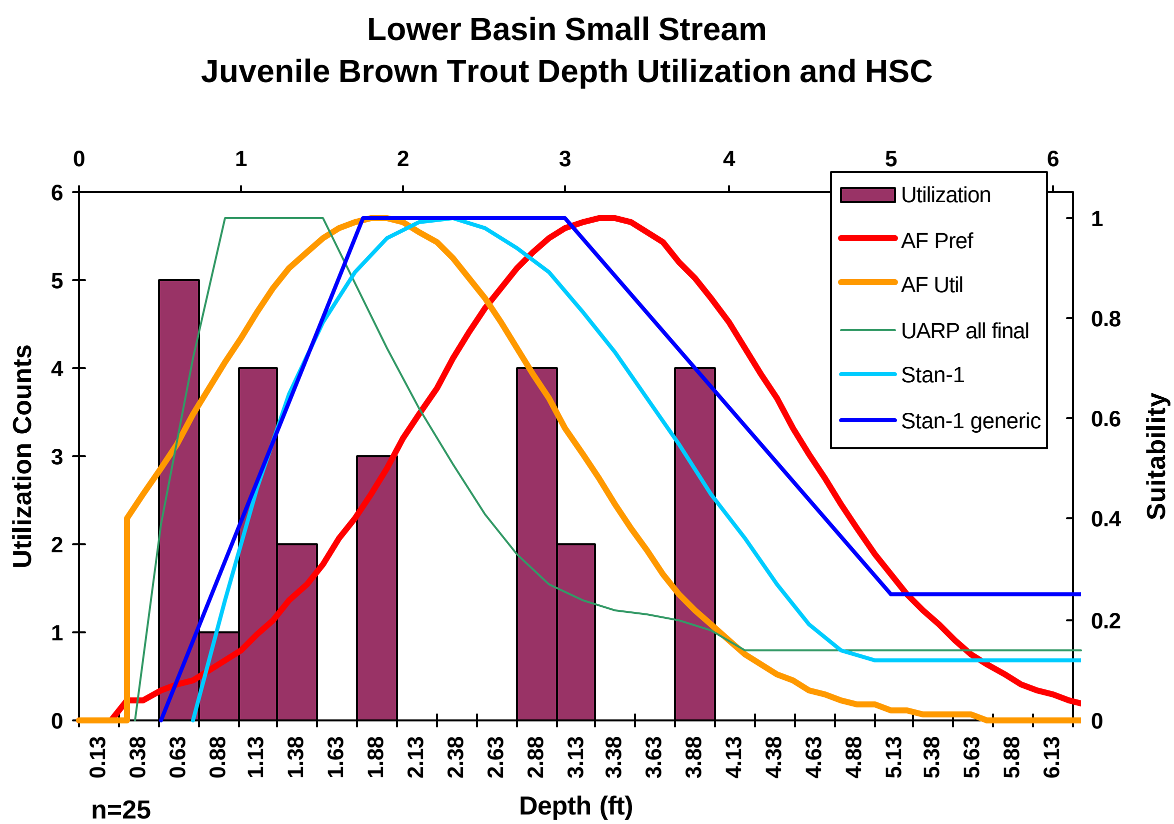


Lower Basin Small Stream
Adult Brown Trout Velocity Utilization and HSC



Lower Basin Small Stream
Adult Brown Trout Velocity Availability





Lower Basin Small Stream
Juvenile Brown Trout Depth Utilization and HSC
Utilization
AF Pref
AF Util
UARP all final
Stan-1
Stan-1 generic
Utilization Counts
Suitability
Depth (ft)
n=25
0.13
0.38
0.63
0.88
1.13
1.38
1.63
1.88
2.13
2.38
2.63
2.88
3.13
3.38
3.63
3.88
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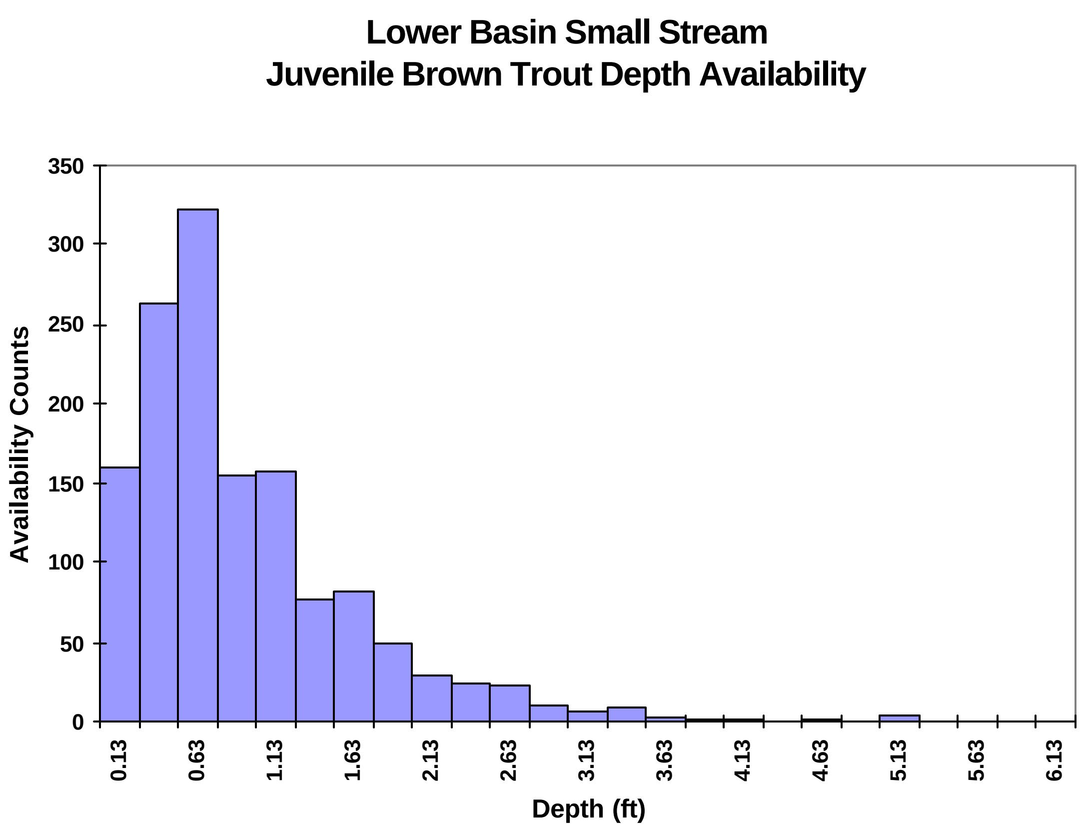
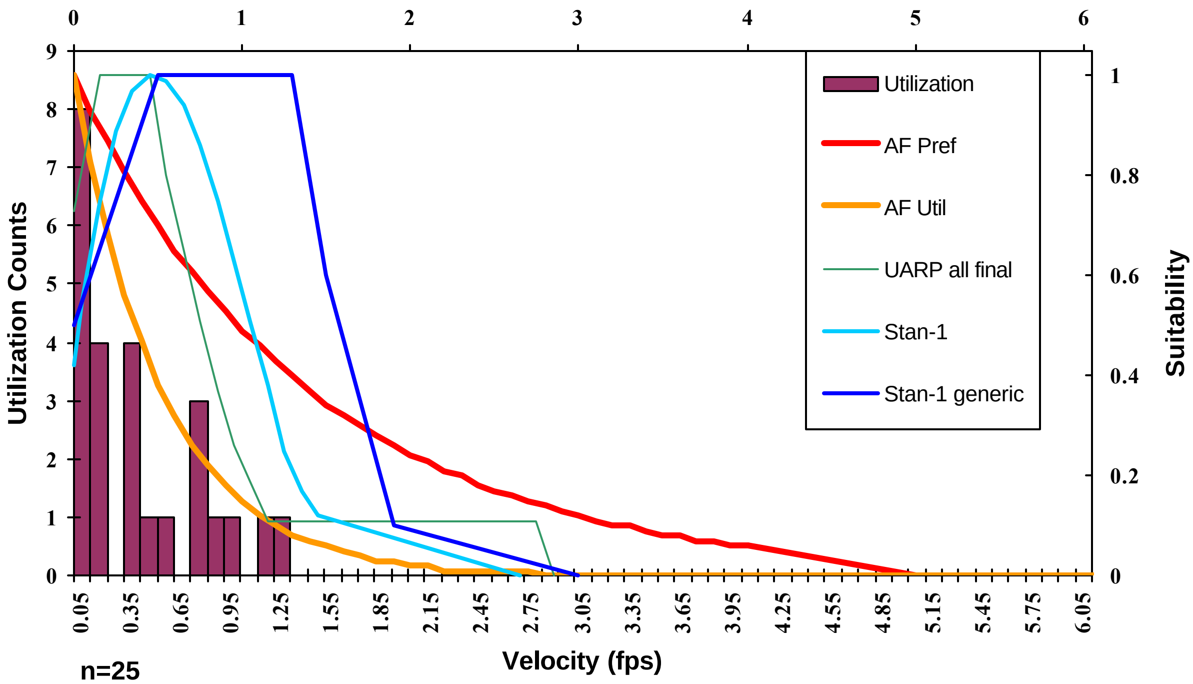
5.63
5.88
6.13

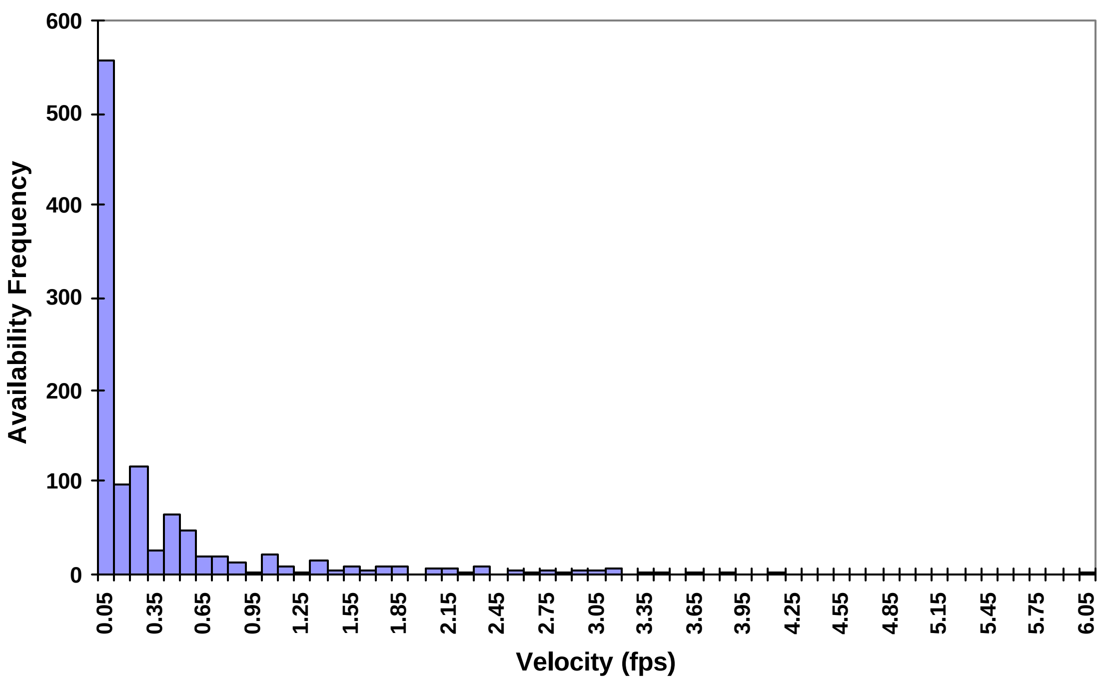


Lower Basin Small Stream
Juvenile Brown Trout Depth Availability
Availability Counts
Depth (ft)
0.13
0.63
1.13
1.63
2.13
2.63
3.13
3.63
4.13
4.63
5.13
5.63
6.13

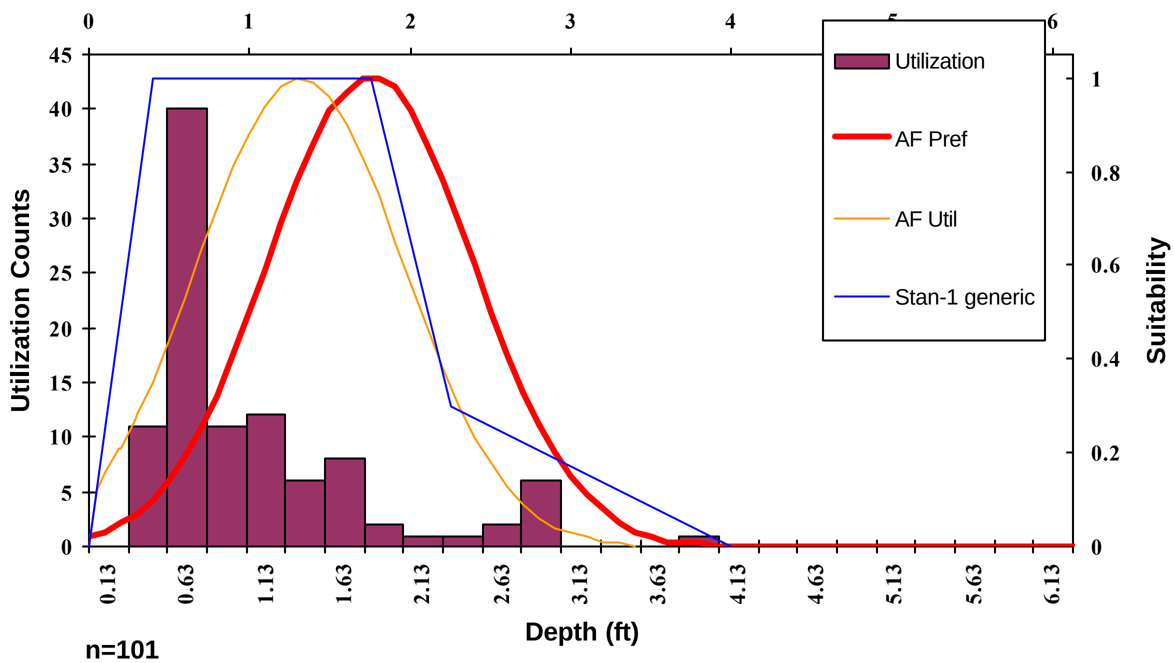
Lower Basin Small Stream
Juvenile Brown Trout Velocity Utilization and HSC



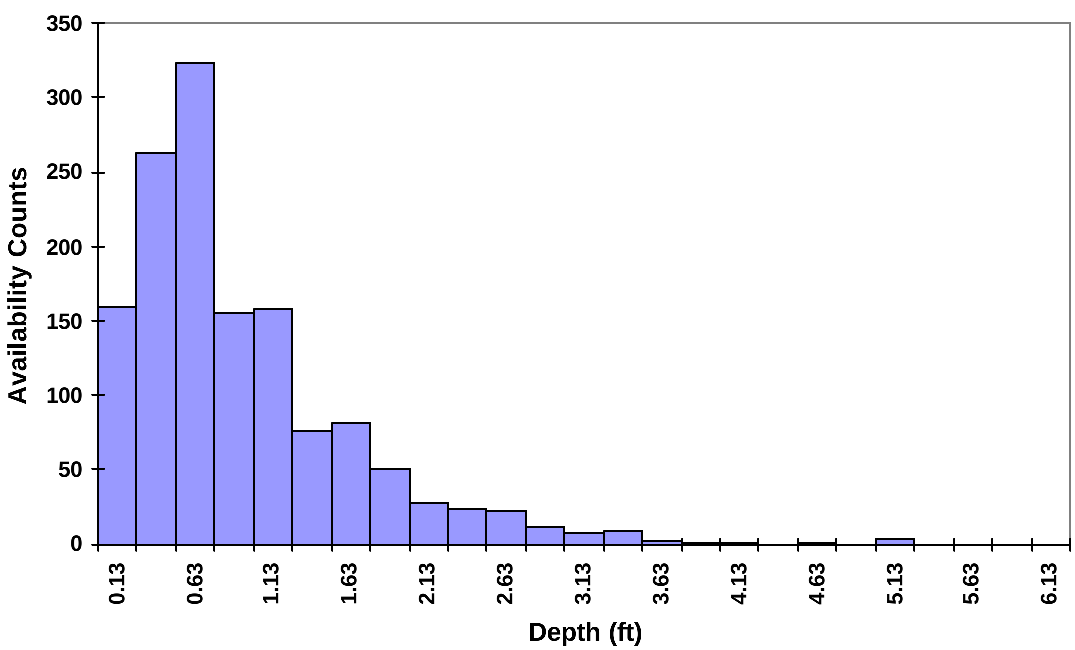
Lower Basin Small Stream
Juvenile Brown Trout Velocity Availability



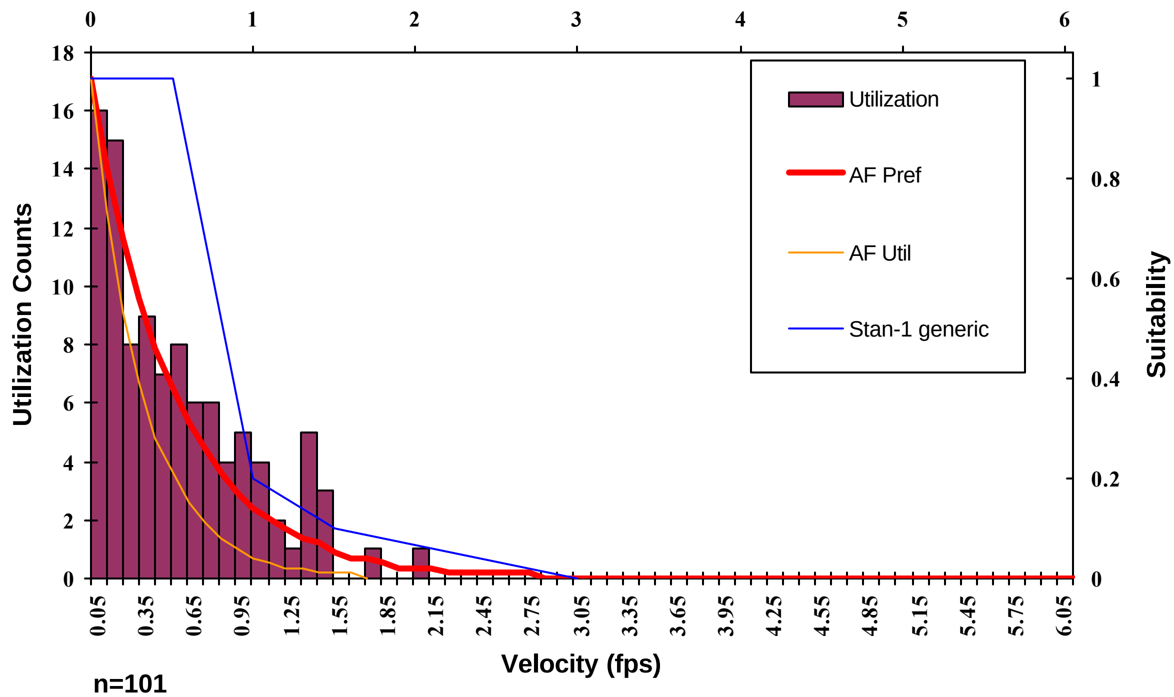
Lower Basin Small Stream
Fry Brown Trout Depth Utilization and HSC



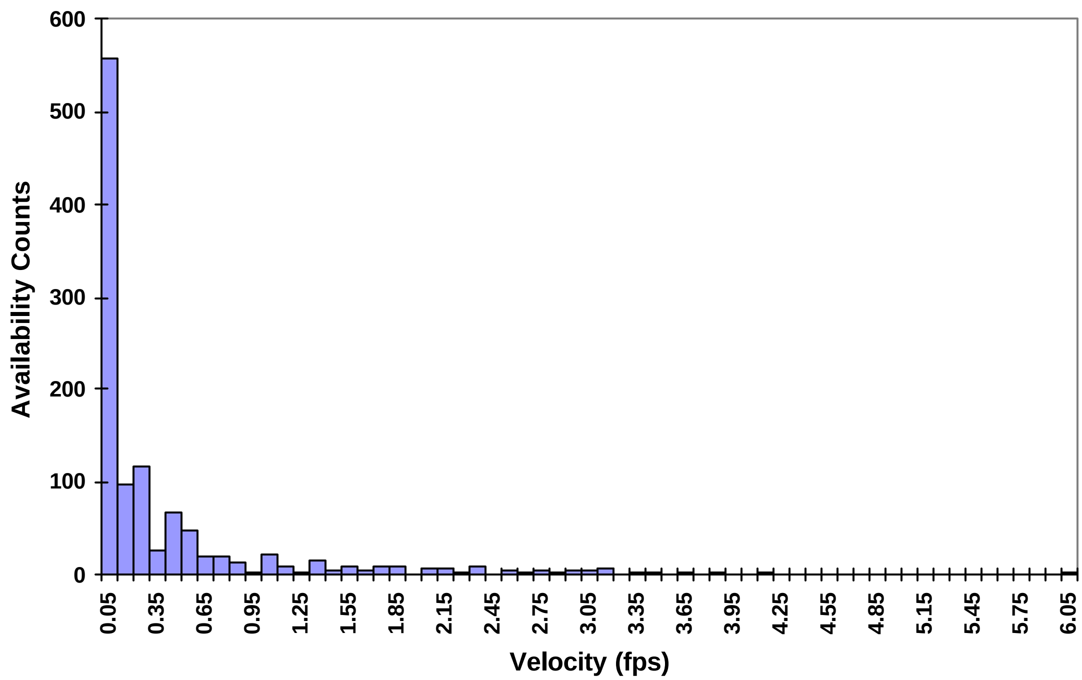
Lower Basin Small Stream
Fry Brown Trout Depth Availability



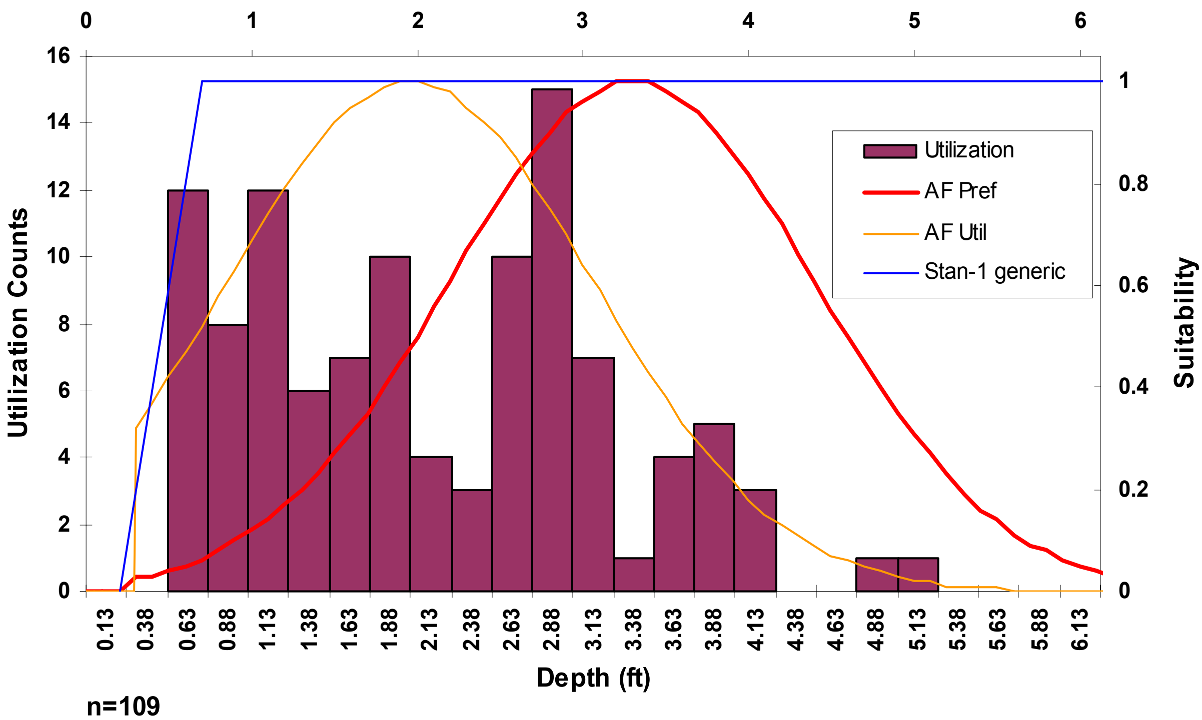
Lower Basin Small Stream
Fry Brown Trout Velocity Utilization and HSC



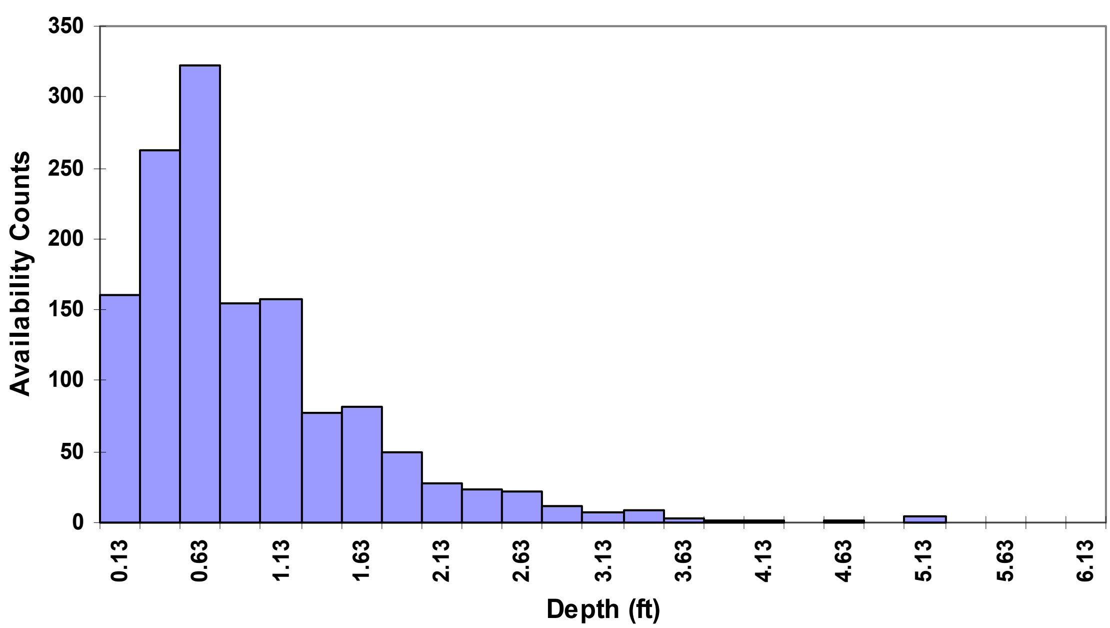
Lower Basin Small Stream
Fry Brown Trout Velocity Availability



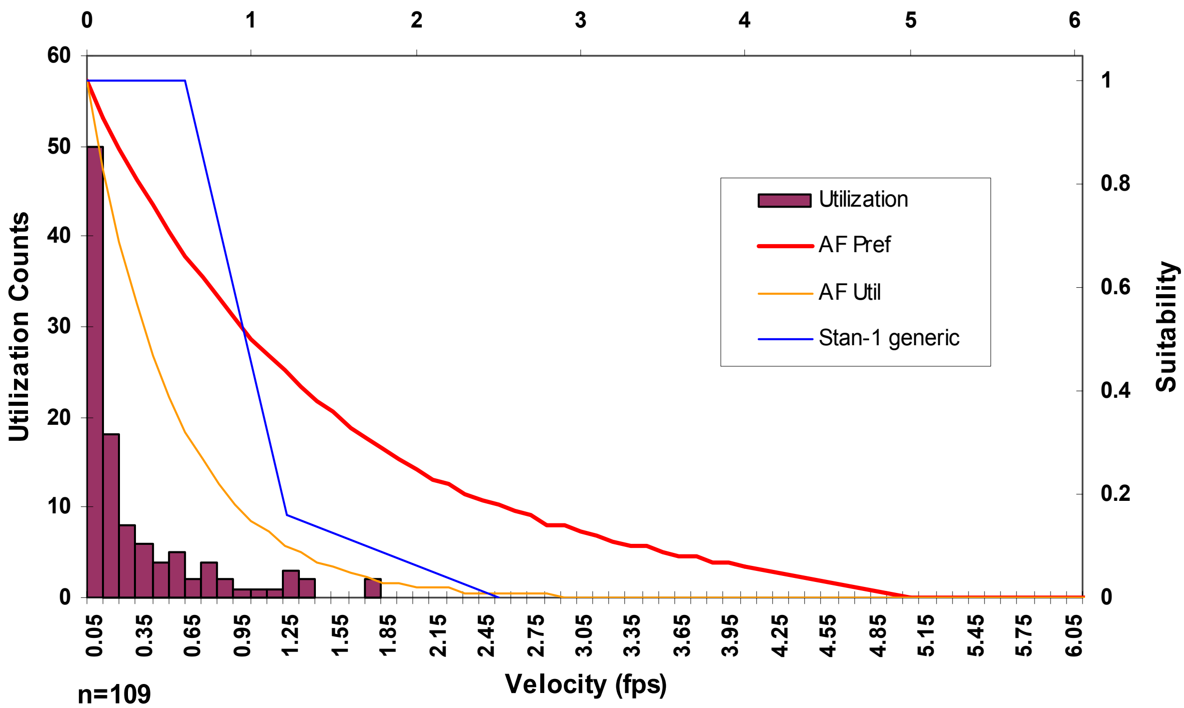
Lower Basin Small Stream
Base Brown Trout Depth Utilization and HSC



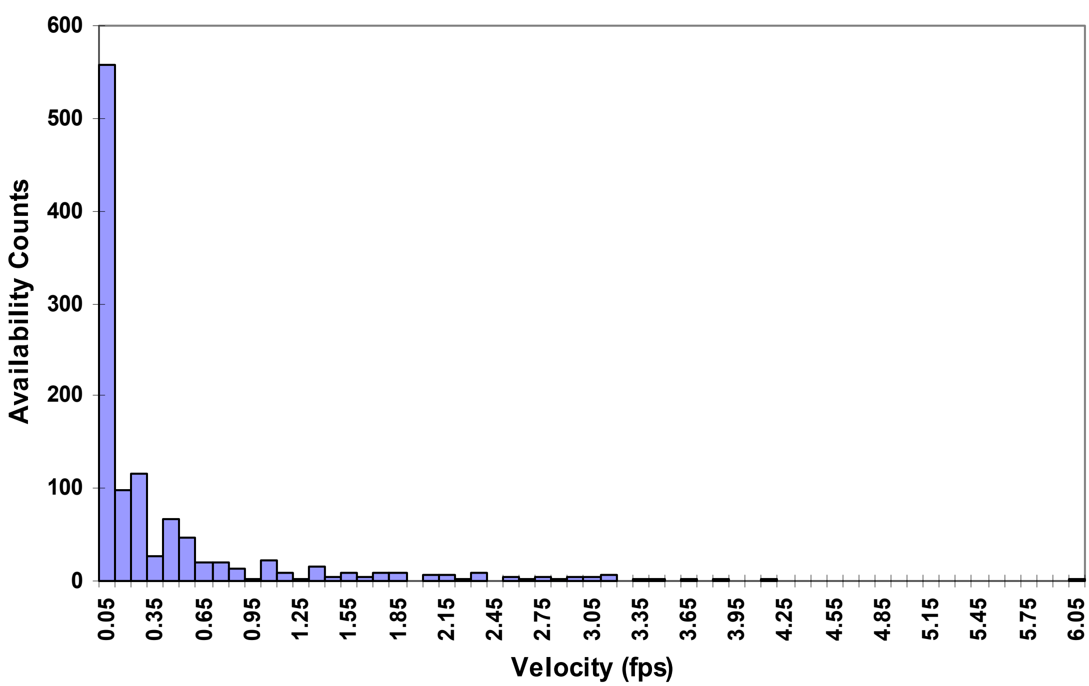
Lower Basin Small Stream
Base Brown Trout Depth Availability



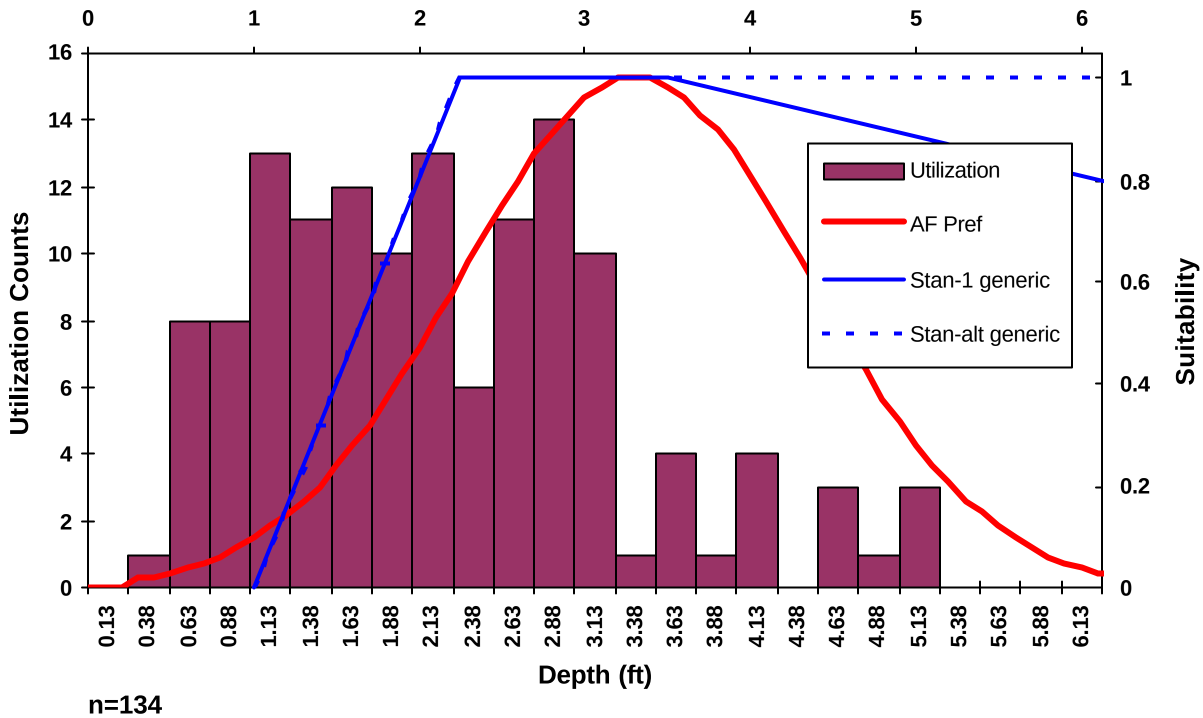
Lower Basin Small Stream
Base Brown Trout Velocity Utilization and HSC



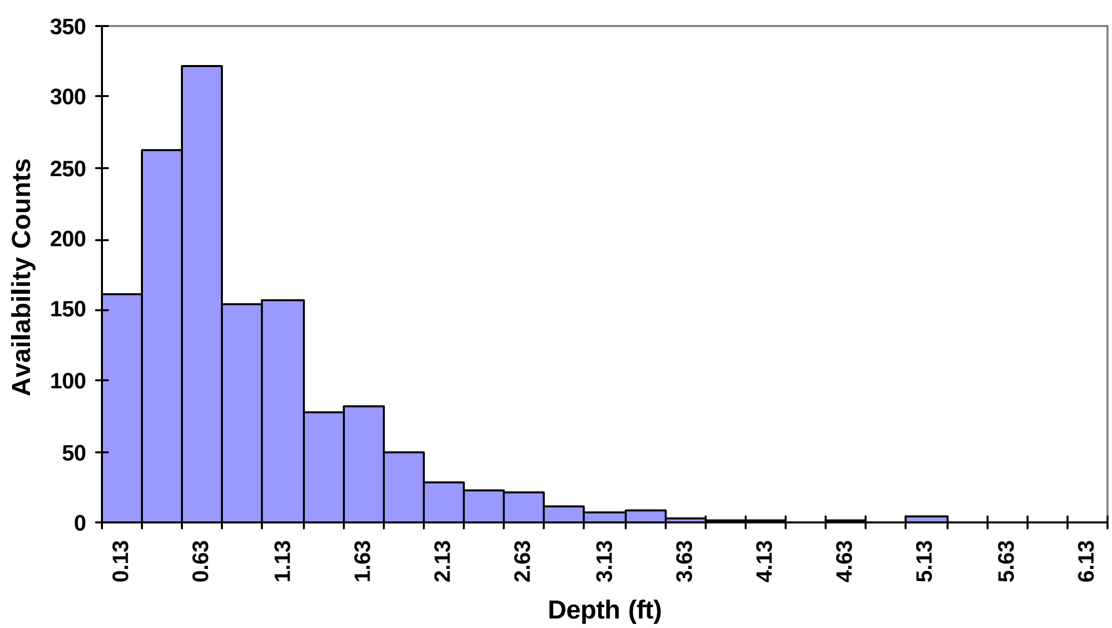
Lower Basin Small Stream
Base Brown Trout Velocity Availability



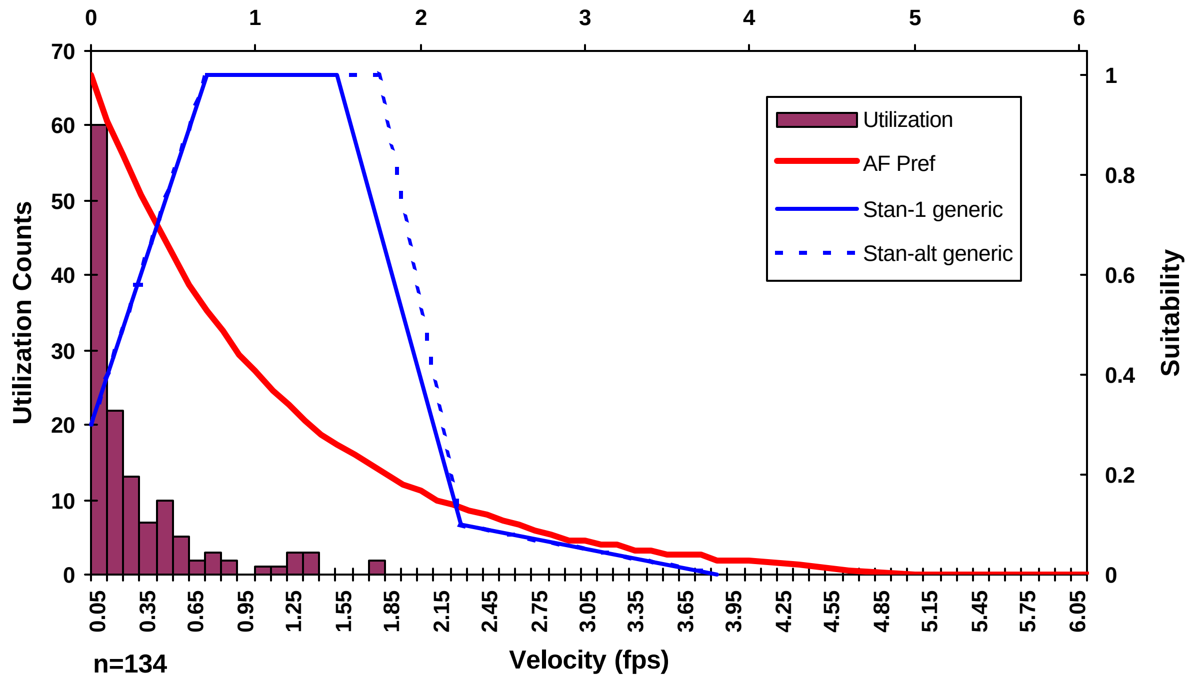
Lower Basin Small Stream
Adult Total Trout Depth Utilization and HSC



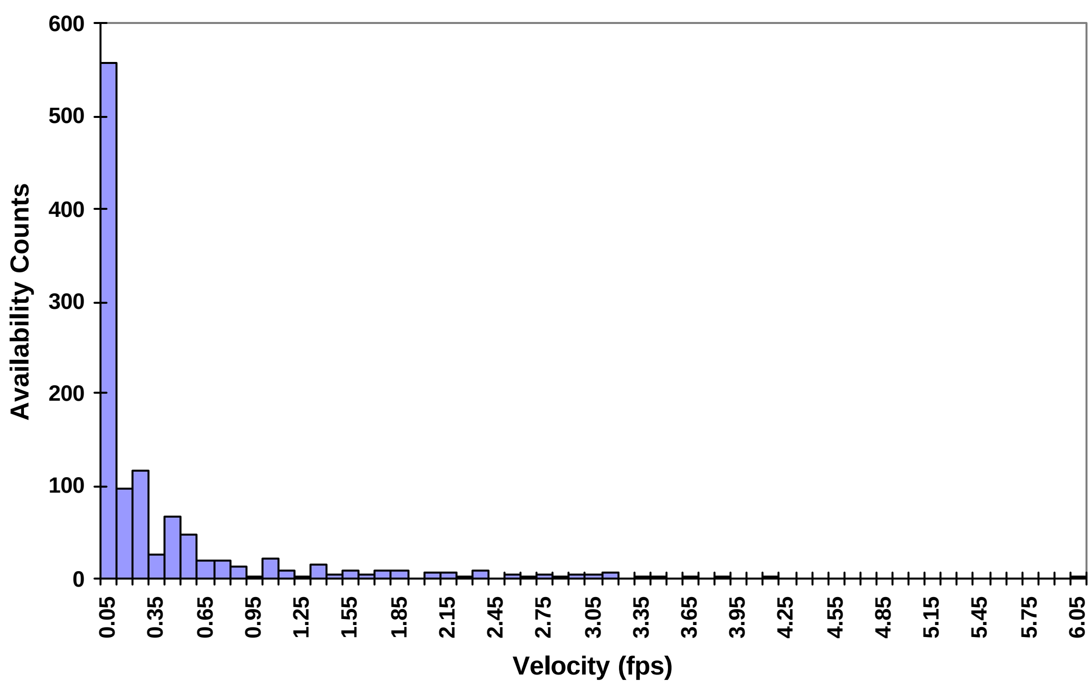
Lower Basin Small Stream
Adult Total Trout Depth Availability



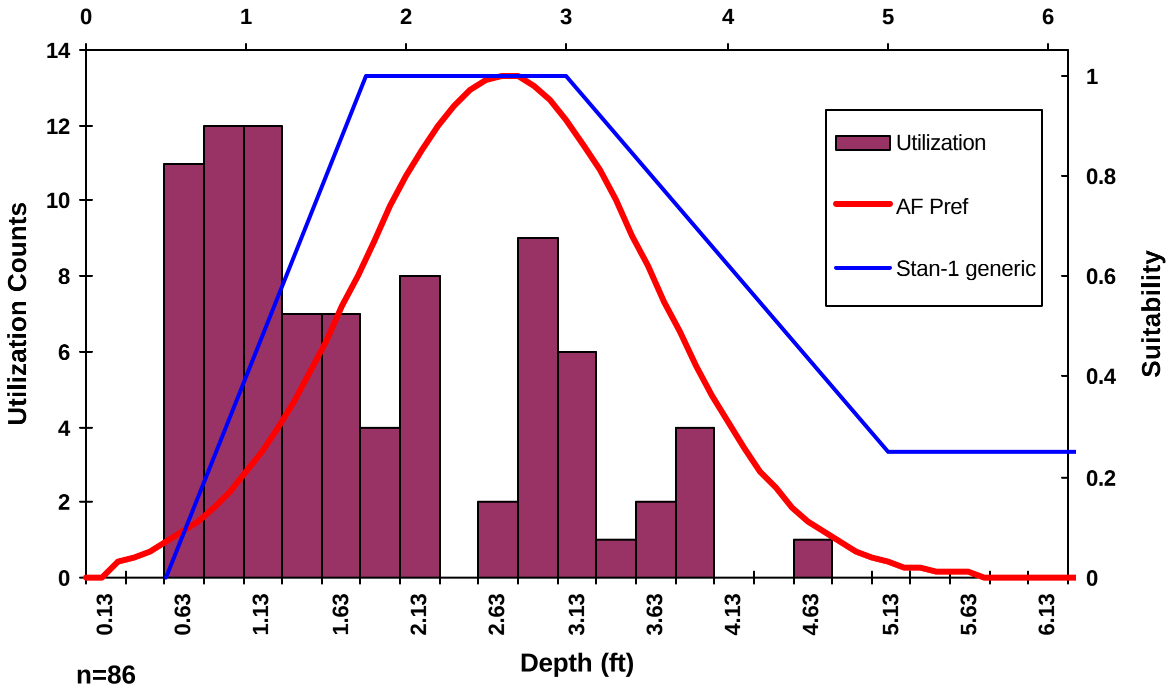
Lower Basin Small Stream
Adult Total Trout Velocity Utilization and HSC



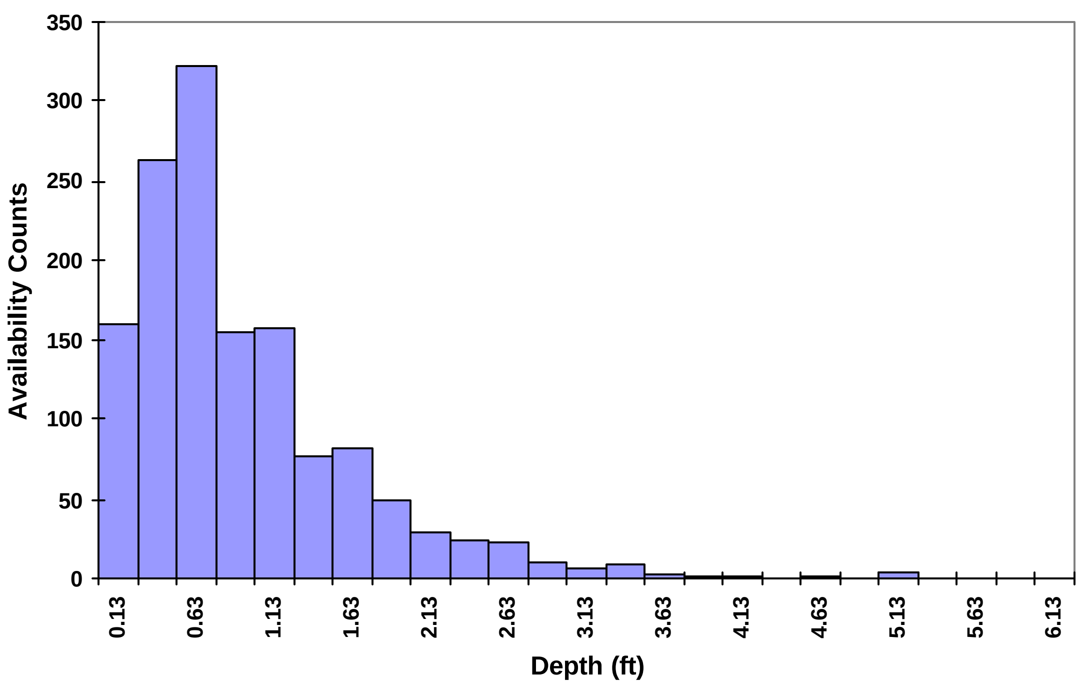
Lower Basin Small Stream
Adult Total Trout Velocity Availability



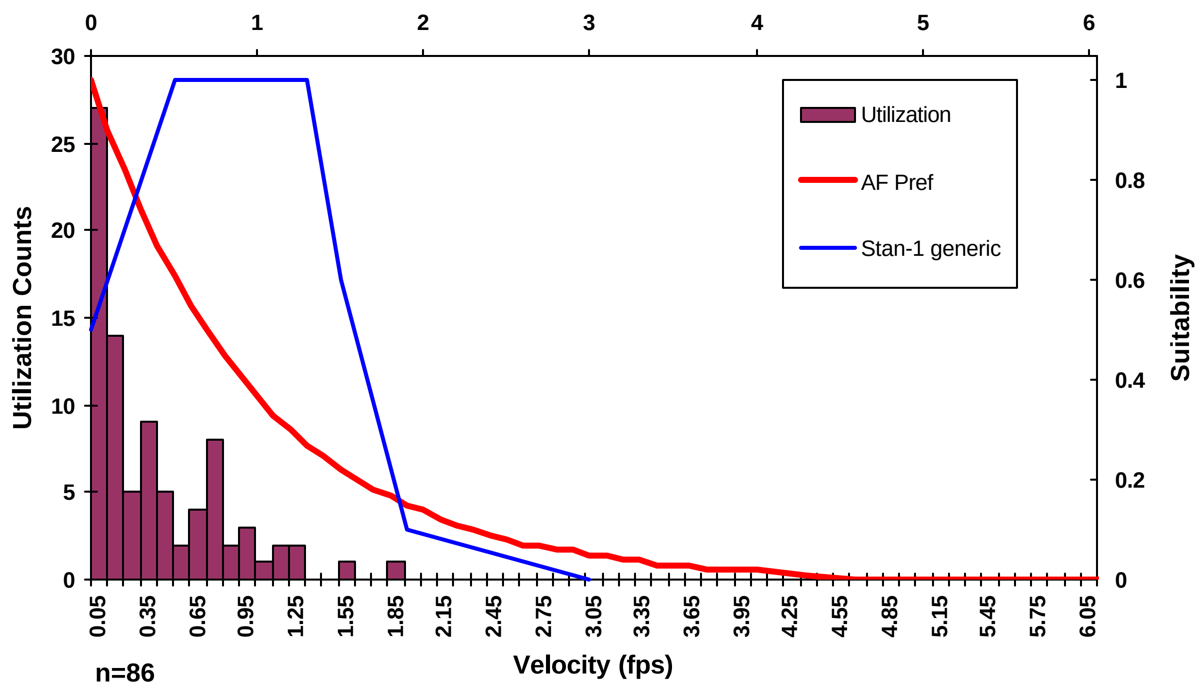
Lower Basin Small Stream
Juvenile Total Trout Depth Utilization and HSC



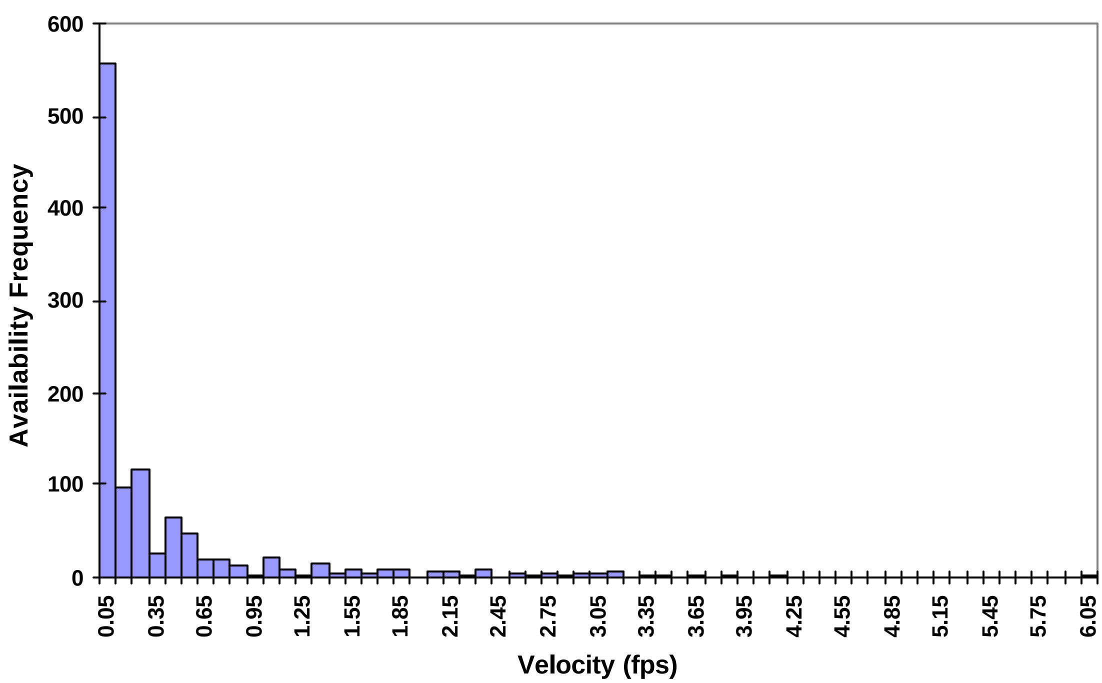
Lower Basin Small Stream
Juvenile Total Trout Depth Availability



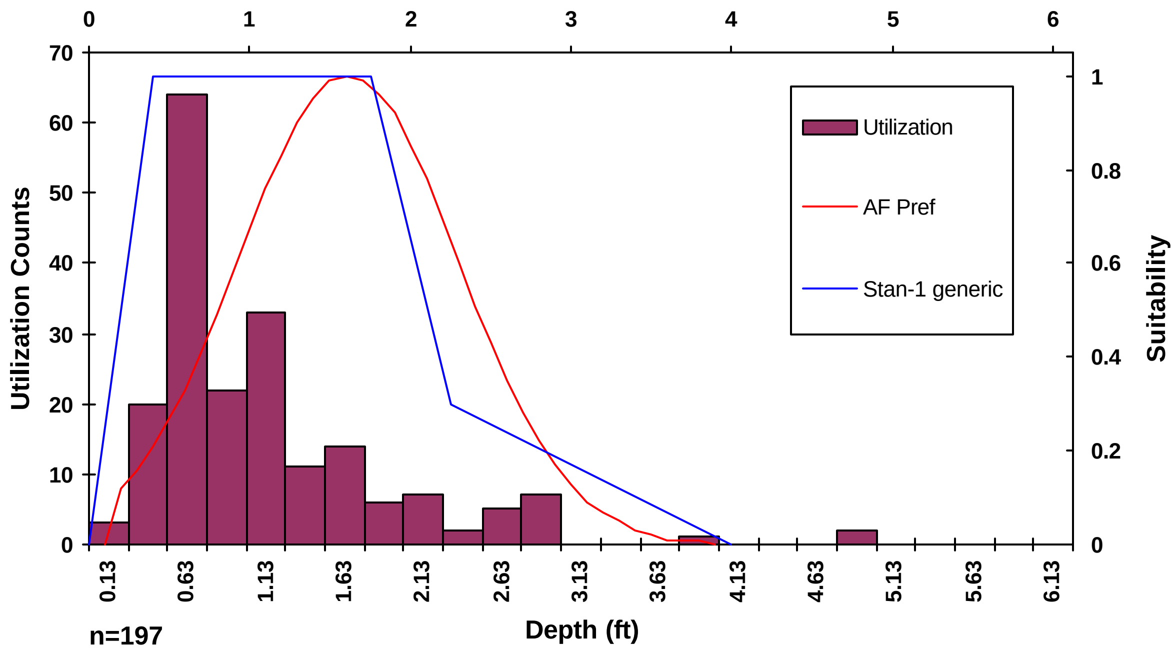
Lower Basin Small Stream
Juvenile Total Trout Velocity Utilization and HSC



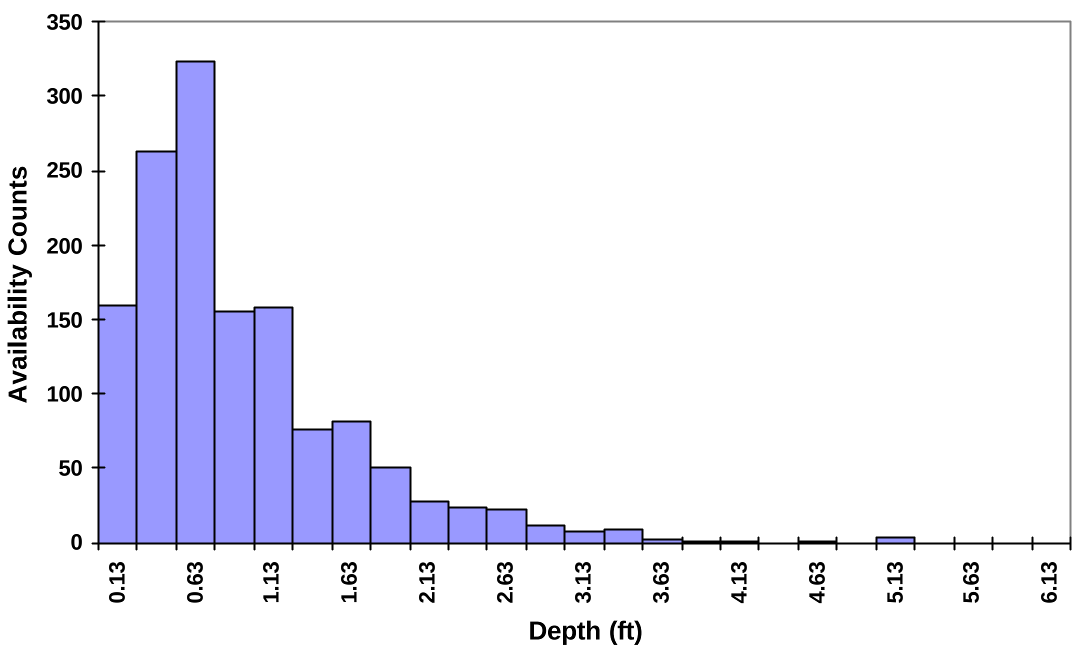
Lower Basin Small Stream
Juvenile Total Trout Velocity Availability



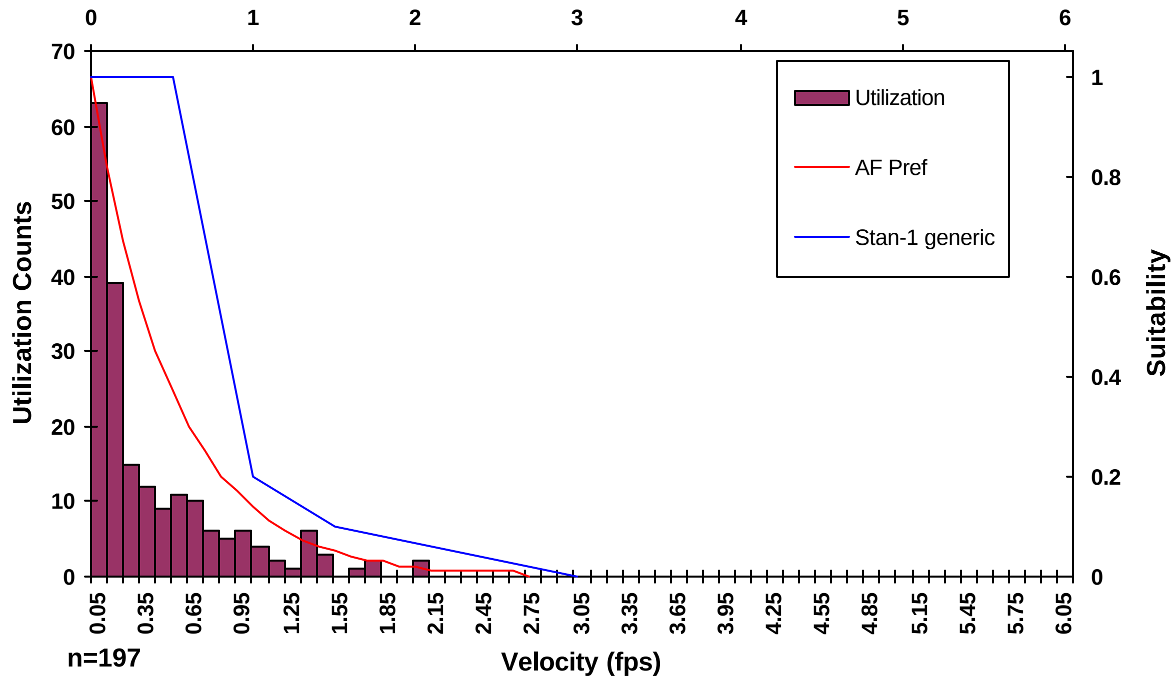
Lower Basin Small Stream
Fry Total Trout Depth Utilization and HSC



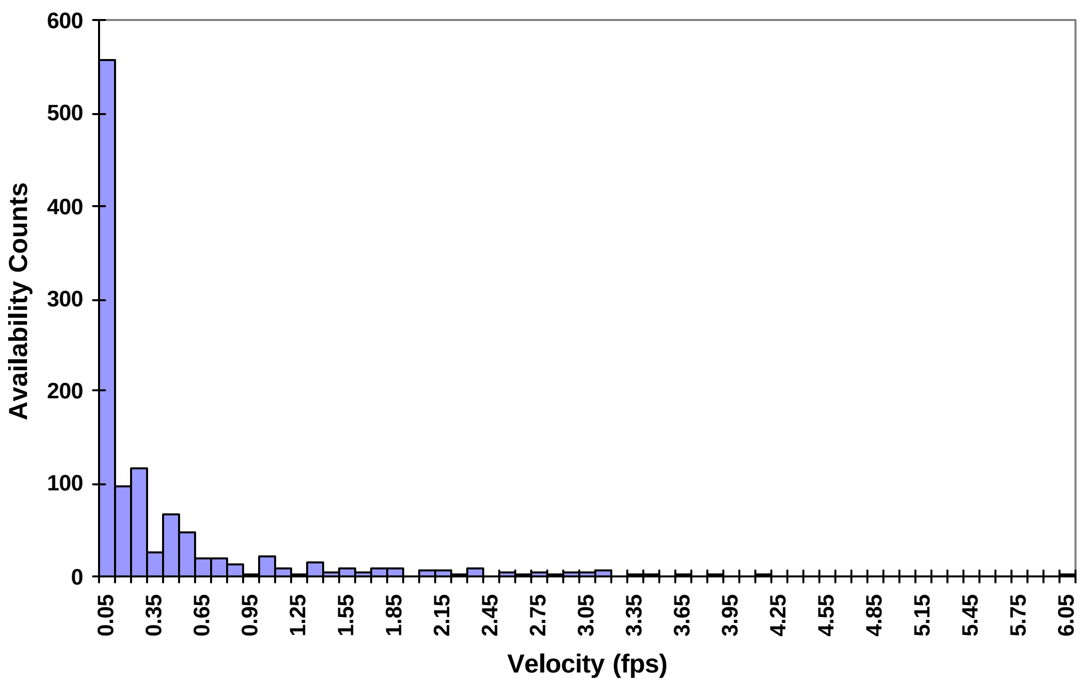
Lower Basin Small Stream
Fry Total Trout Depth Availability



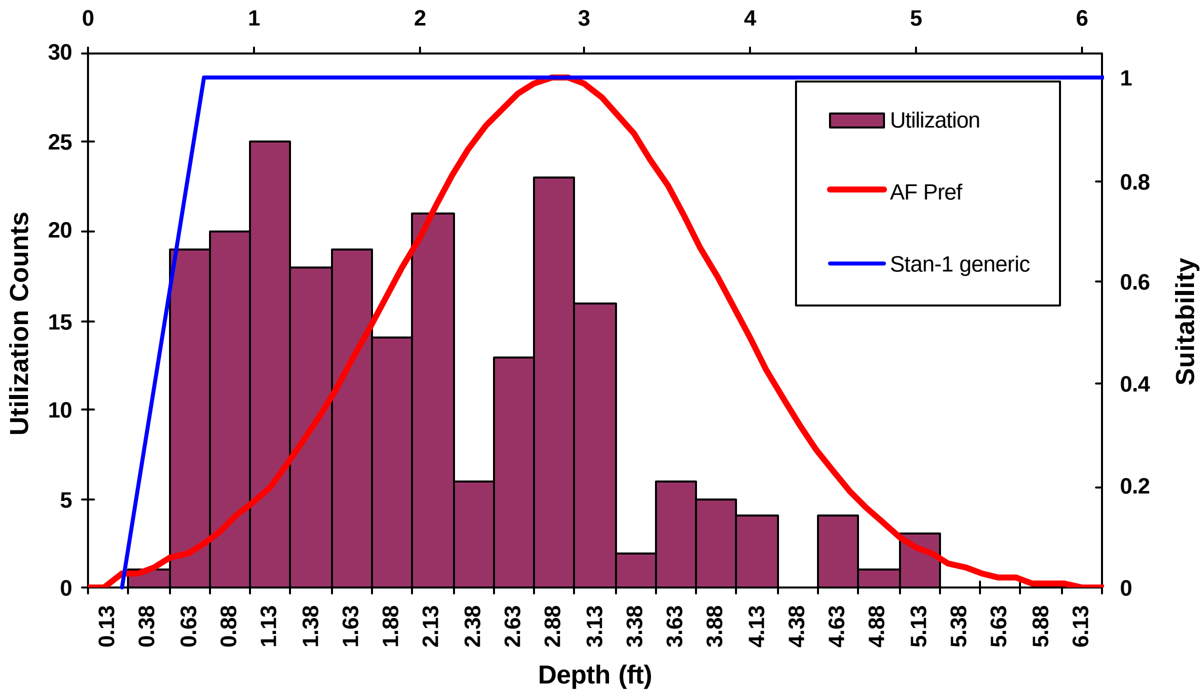
Lower Basin Small Stream
Fry Total Trout Velocity Utilization and HSC



Lower Basin Small Stream
Fry Total Trout Velocity Availability

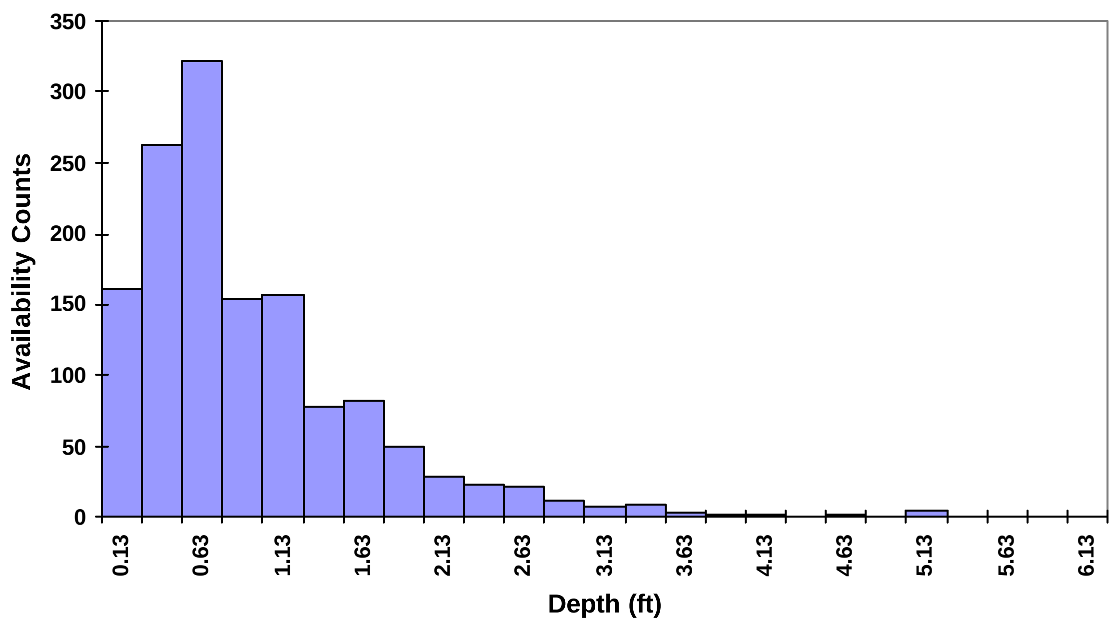


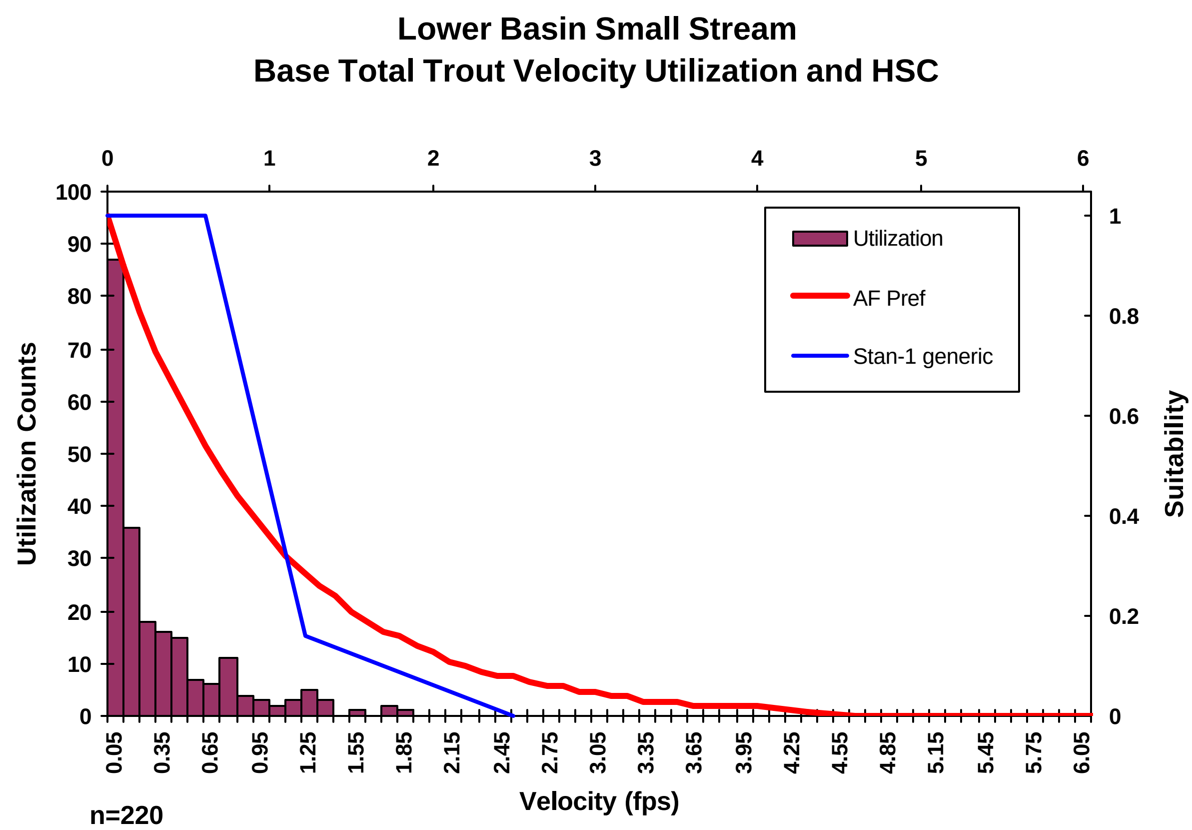
Lower Basin Small Stream
Base Total Trout Depth Utilization and HSC



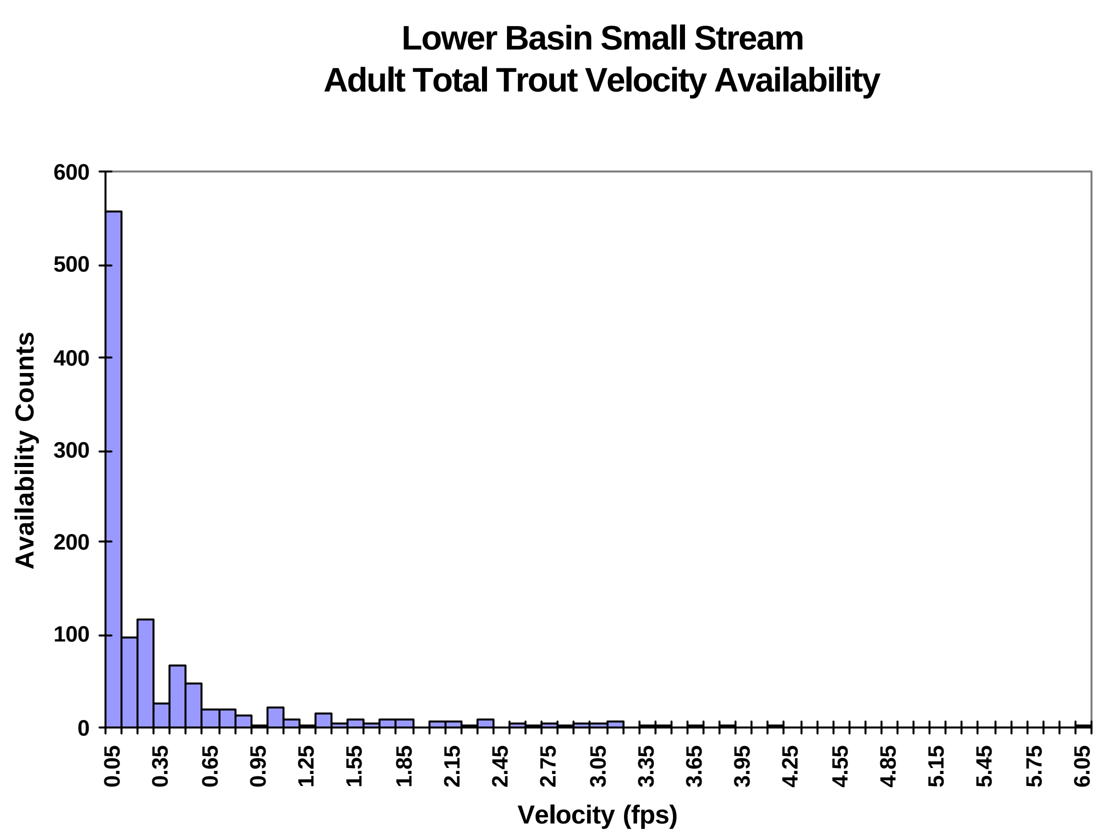
n=220

Lower Basin Small Stream
Base Total Trout Depth Availability





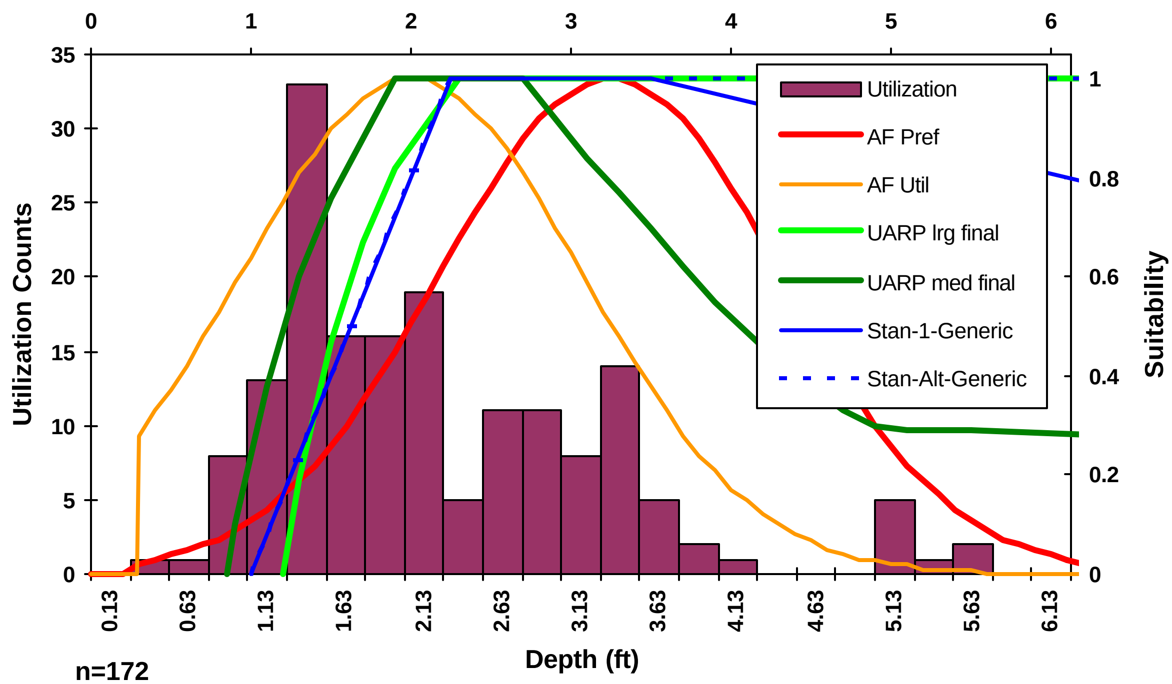
Lower Basin Small Stream
Base Total Trout Velocity Utilization and HSC
Utilization Counts
Suitability
Utilization
AF Pref
Stan-1 generic
Velocity (fps)
n=220



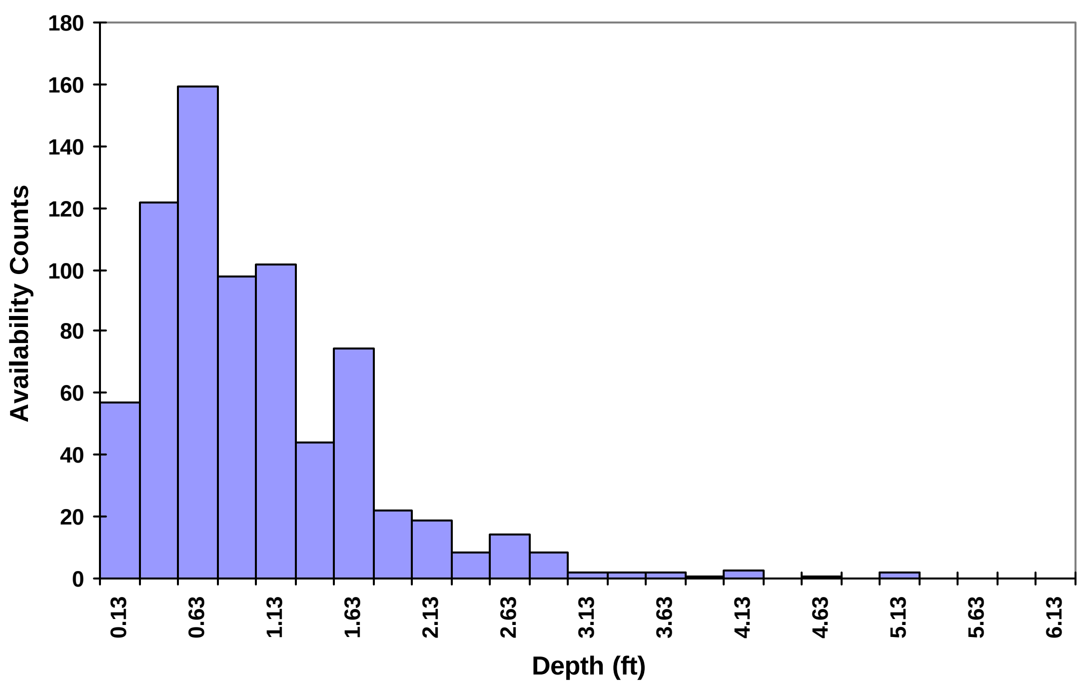
Lower Basin Small Stream
Adult Total Trout Velocity Availability
Availability Counts
Velocity (fps)

Upper Basin, Large Stream

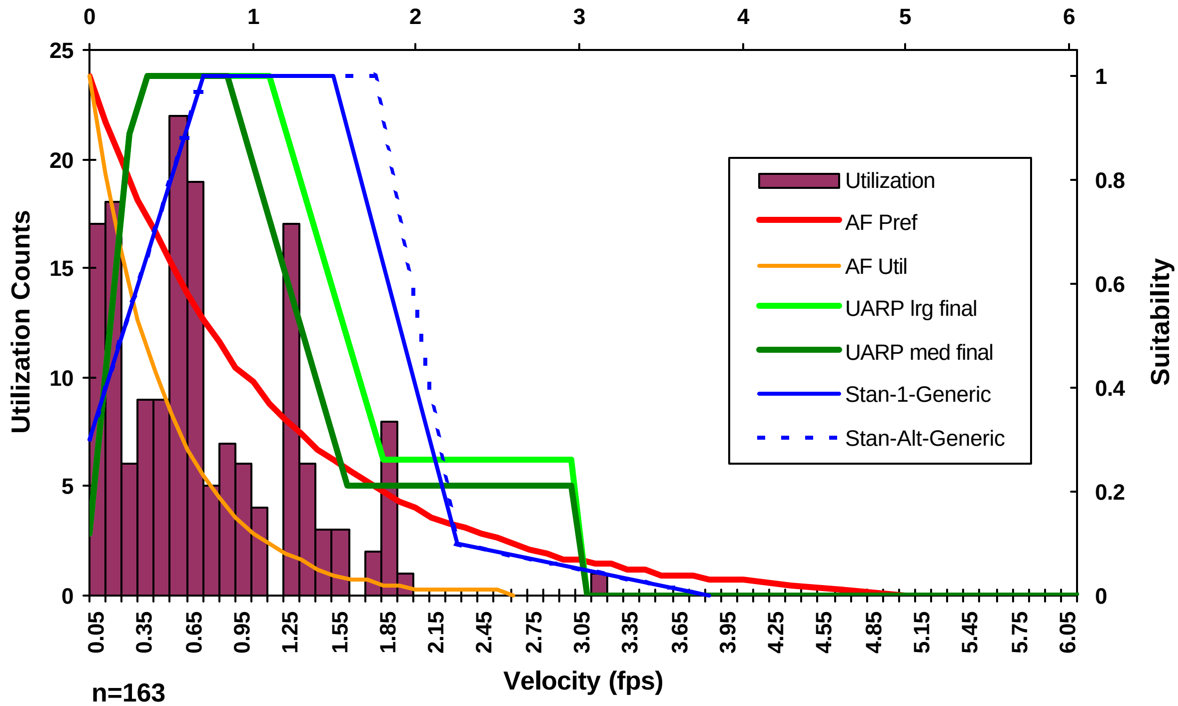
Upper Basin Large Stream
Adult Rainbow Trout Depth Utilization and HSC



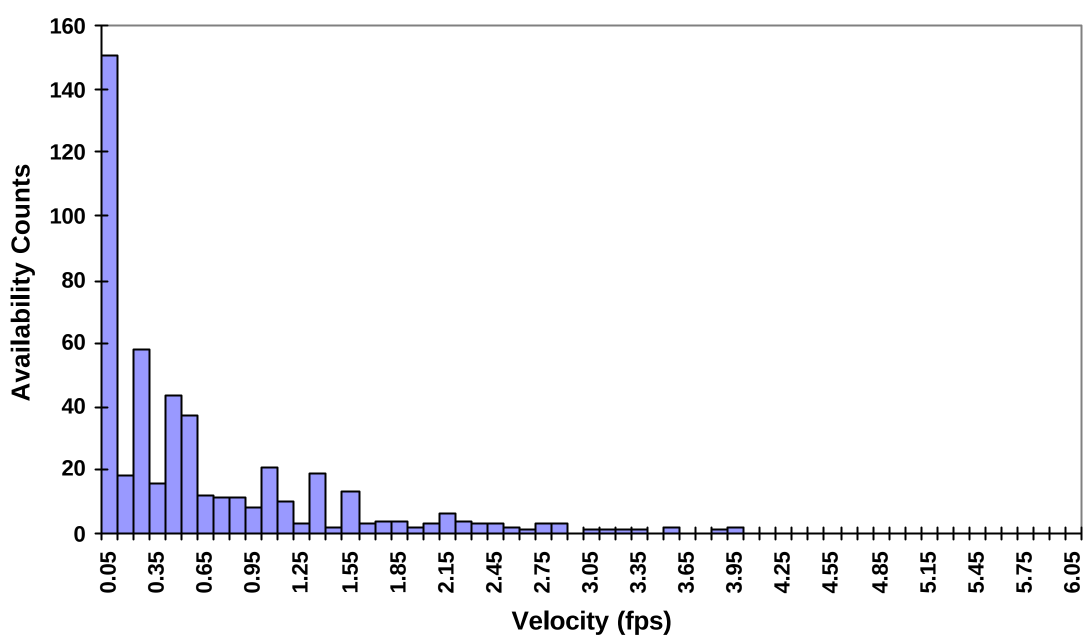
Upper Basin Large Stream
Adult Rainbow Trout Depth Availability



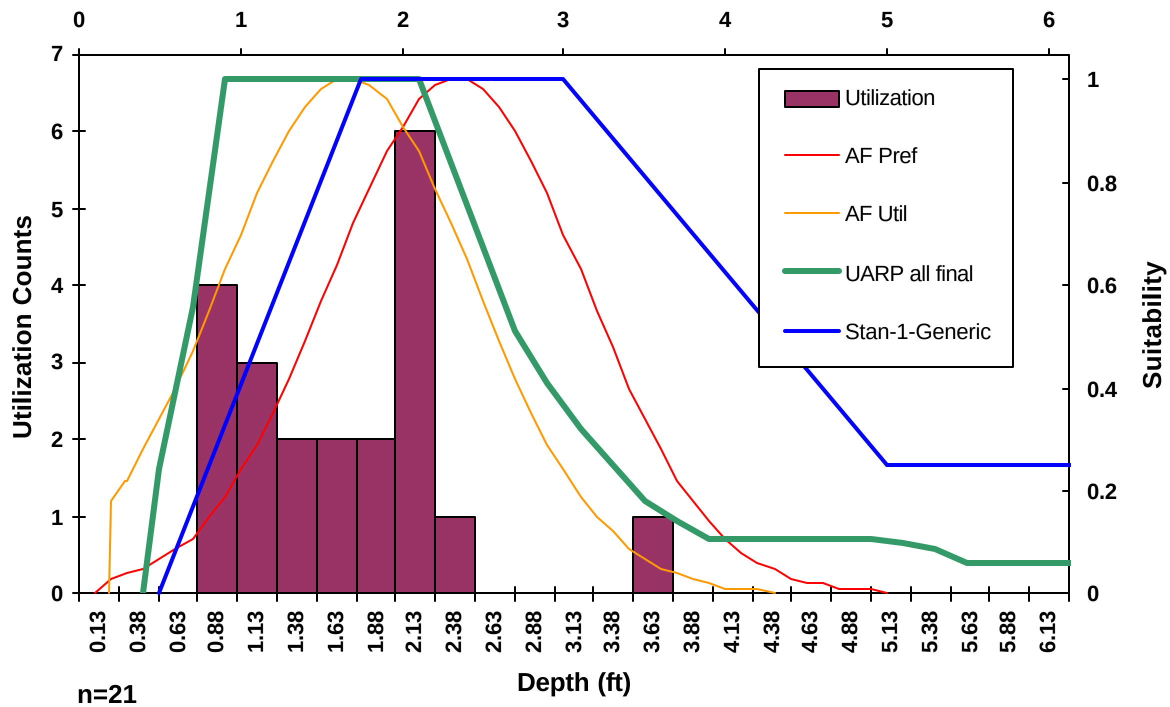
Upper Basin Large Stream
Adult Rainbow Trout Velocity Utilization and HSC



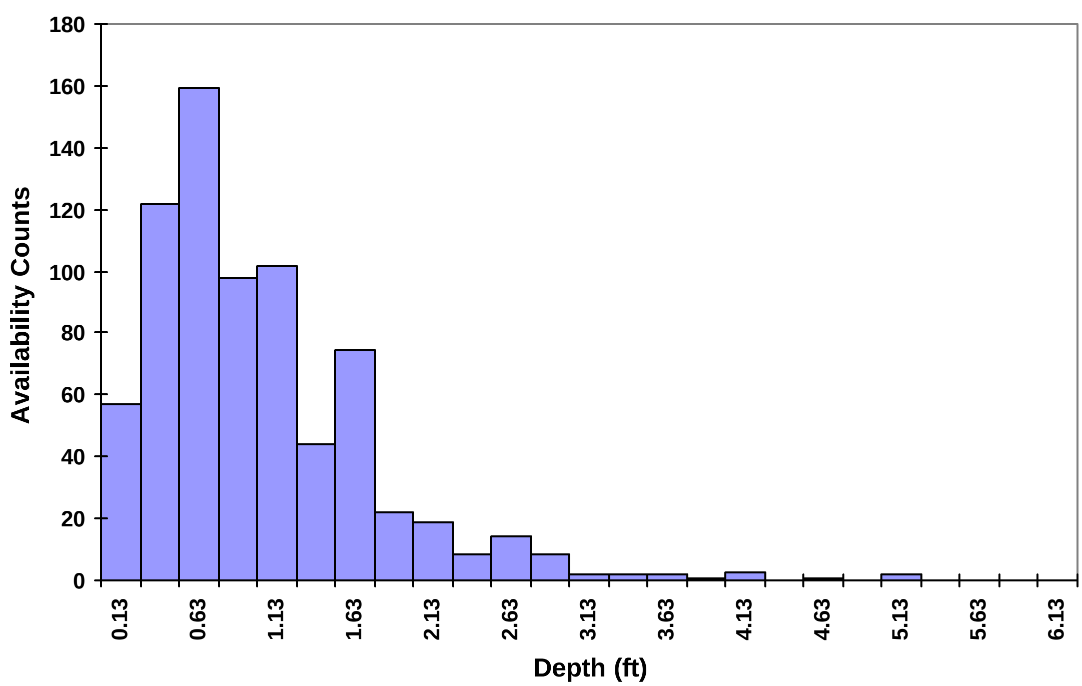
Upper Basin Large Stream
Adult Rainbow Trout Velocity Availability

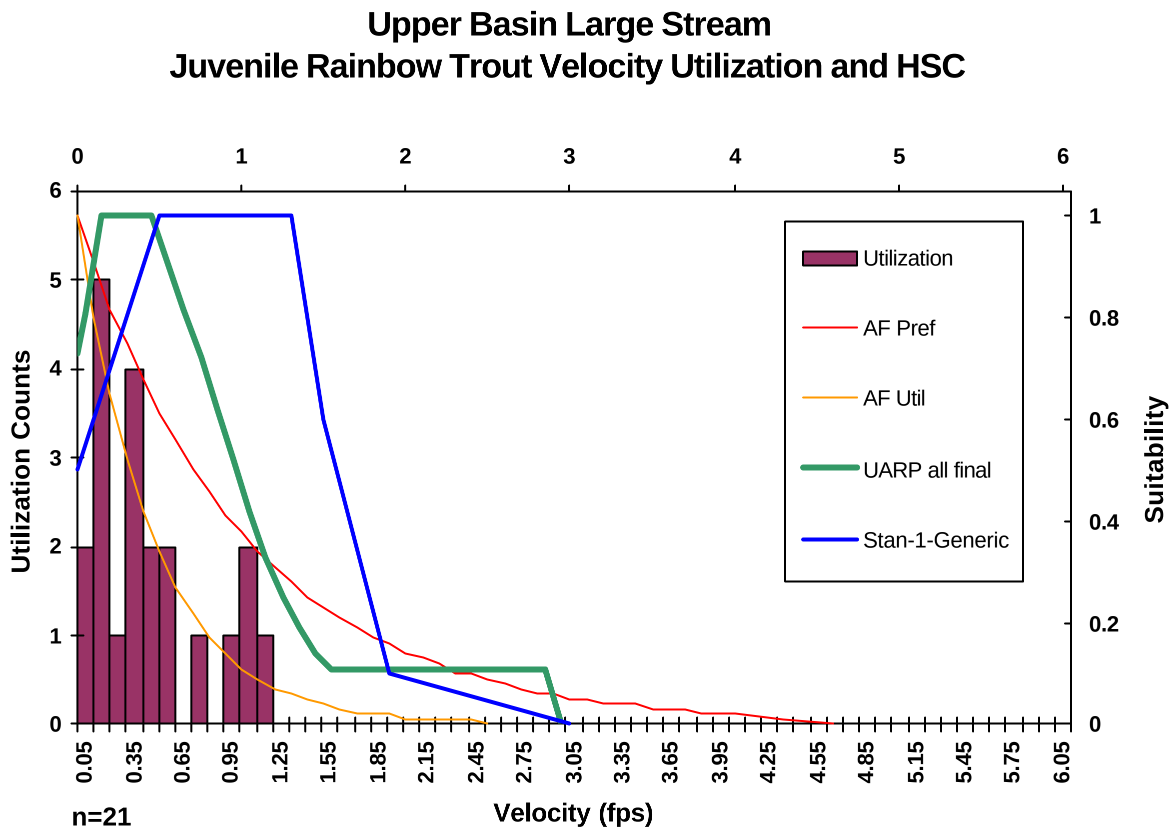


Upper Basin Large Stream
Juvenile Rainbow Trout Depth Utilization and HSC

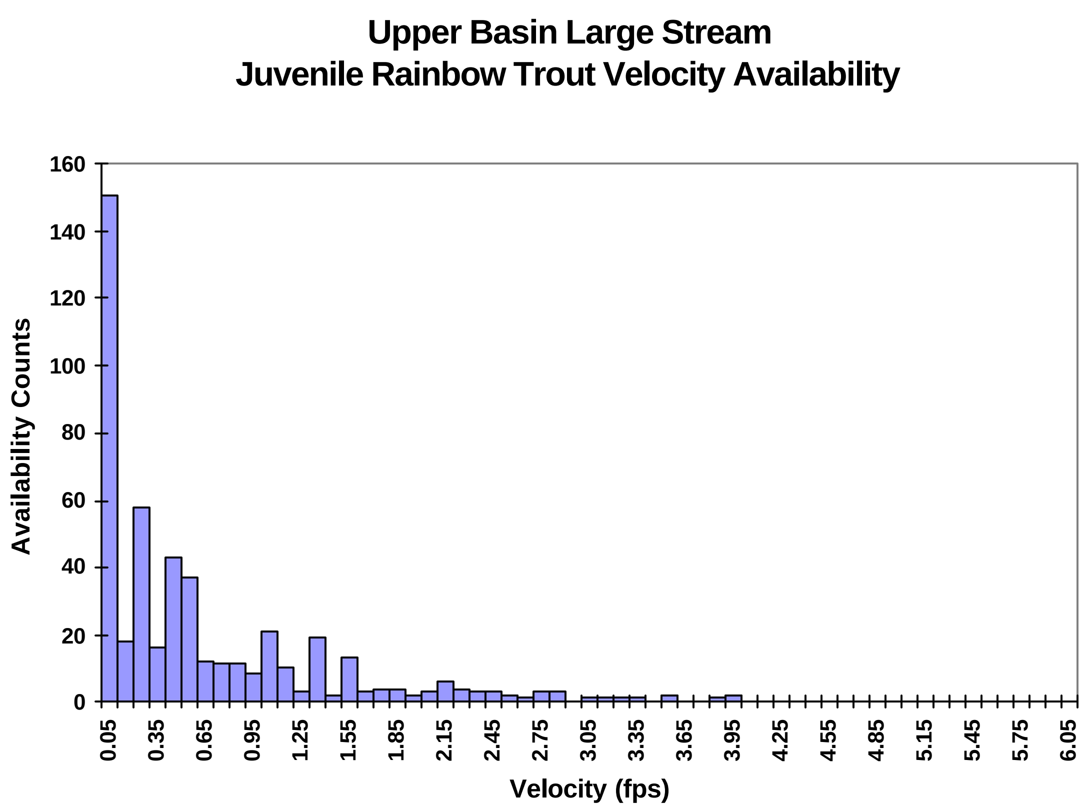


Upper Basin Large Stream
Juvenile Rainbow Trout Depth Availability



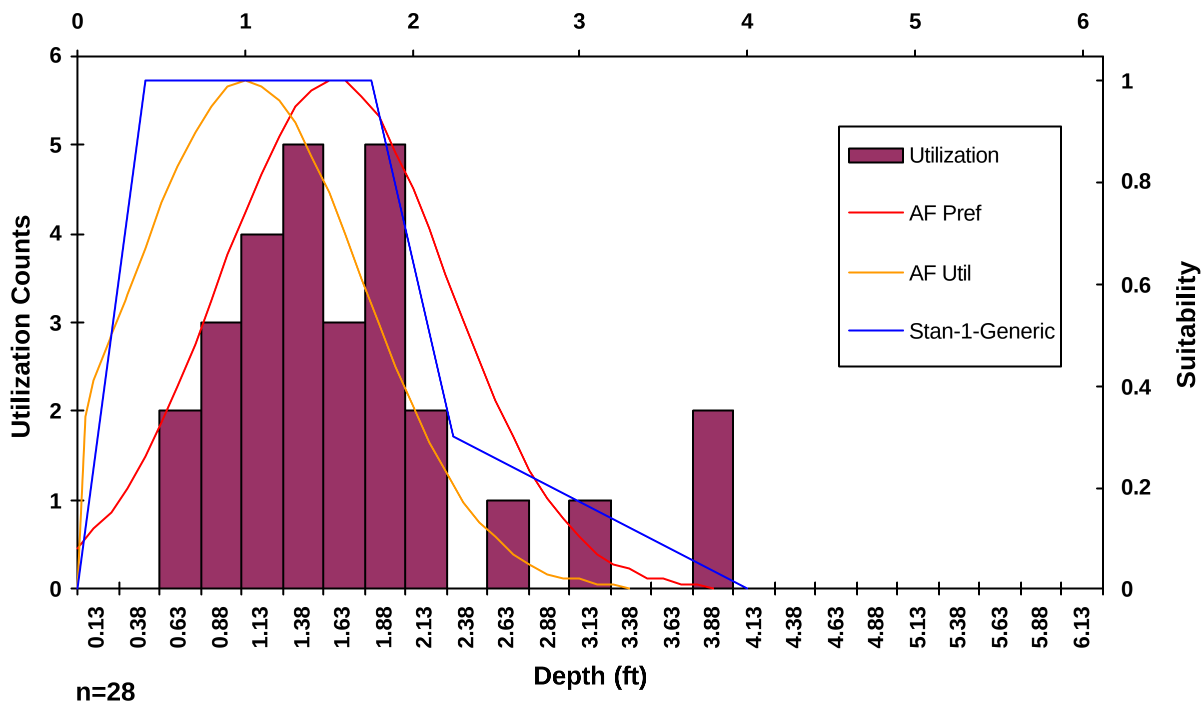


Upper Basin Large Stream
Juvenile Rainbow Trout Velocity Utilization and HSC
Utilization
AF Pref
AF Util
UARP all final
Stan-1-Generic
Utilization Counts
Suitability
Velocity (fps)
n=21

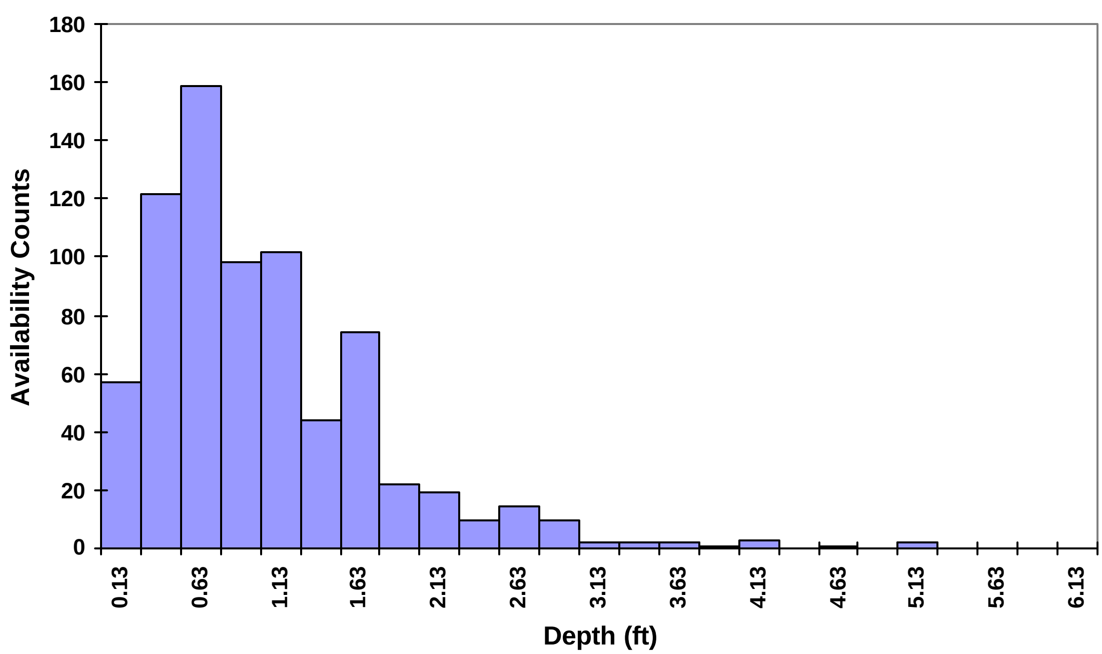


Upper Basin Large Stream
Juvenile Rainbow Trout Velocity Availability
Availability Counts
Velocity (fps)

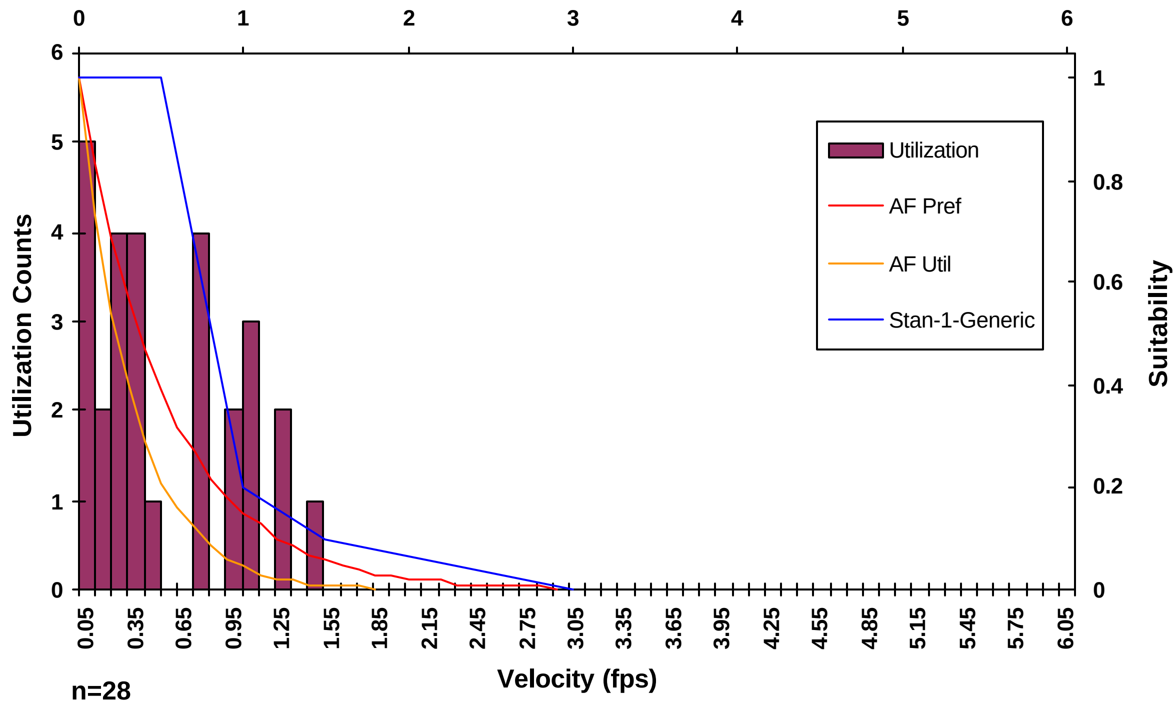
Upper Basin Large Stream
Fry Rainbow Trout Depth Utilization and HSC



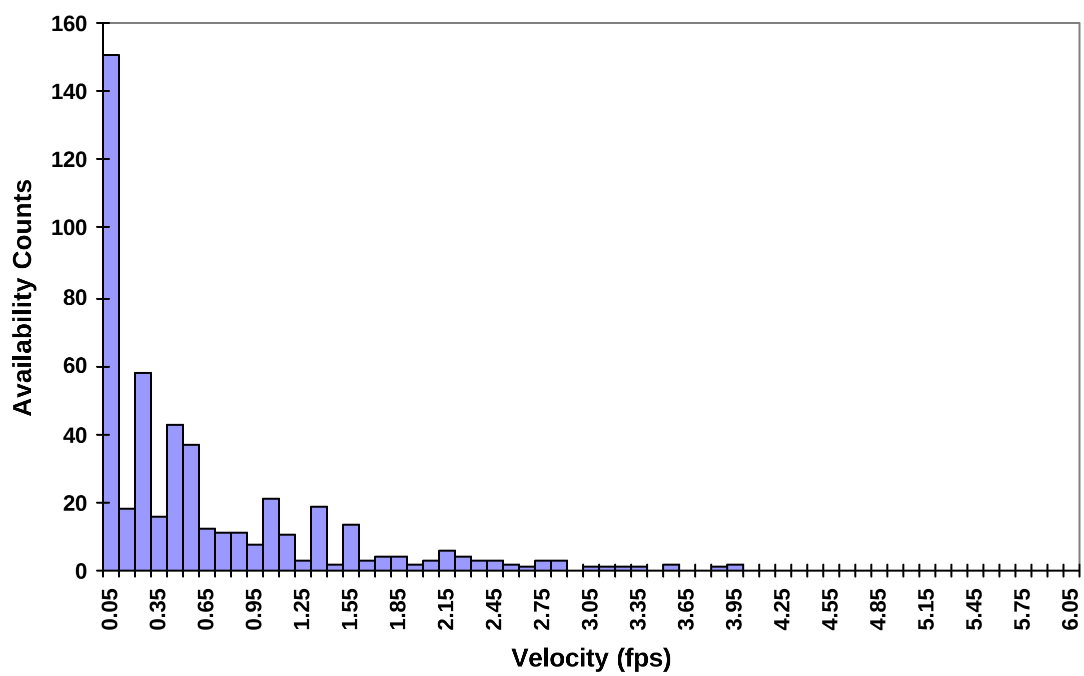
Upper Basin Large Stream
Fry Rainbow Trout Depth Availability



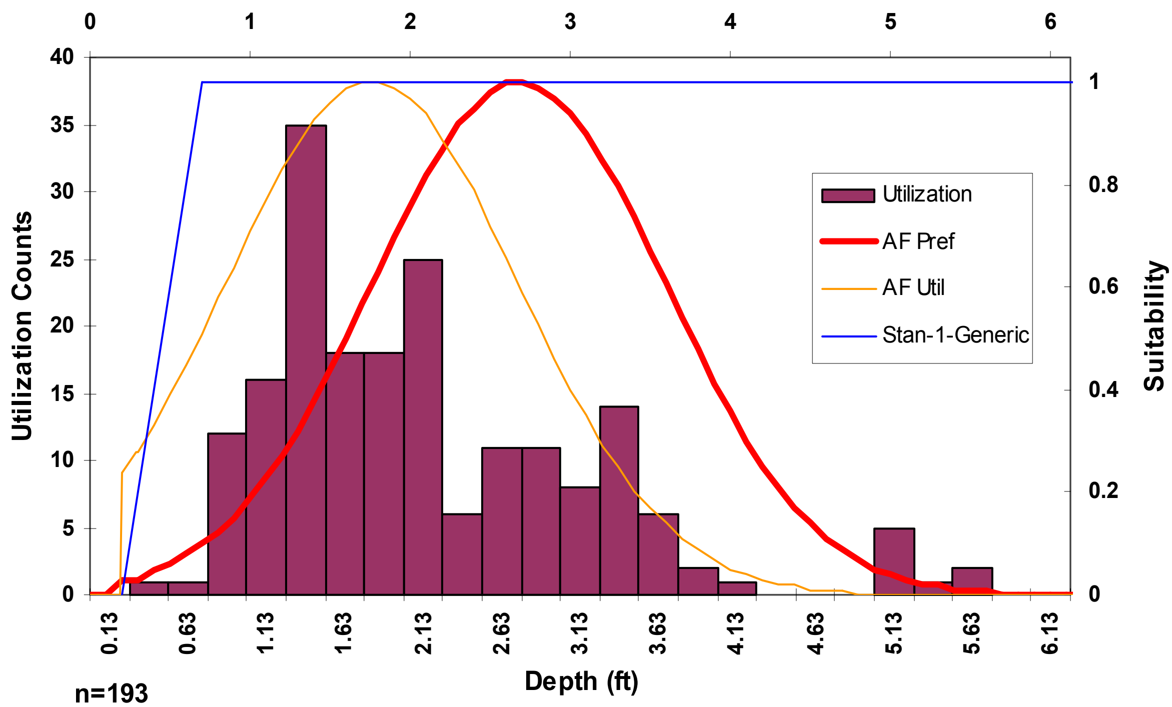
Upper Basin Large Stream
Fry Rainbow Trout Velocity Utilization and HSC



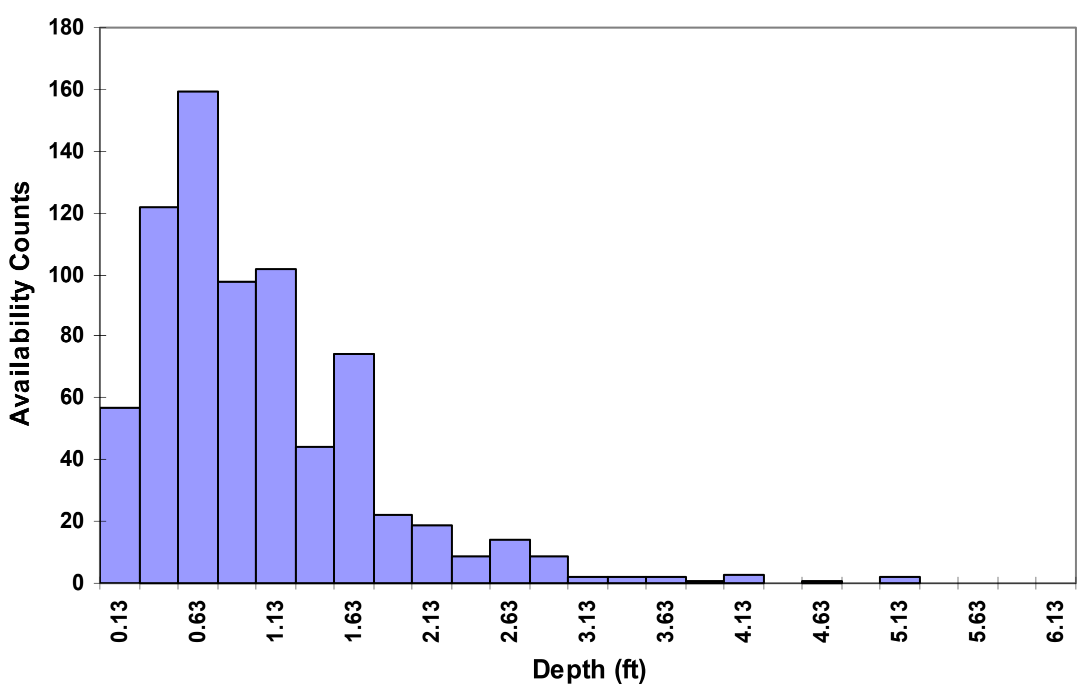
Upper Basin Large Stream
Fry Rainbow Trout Velocity Availability



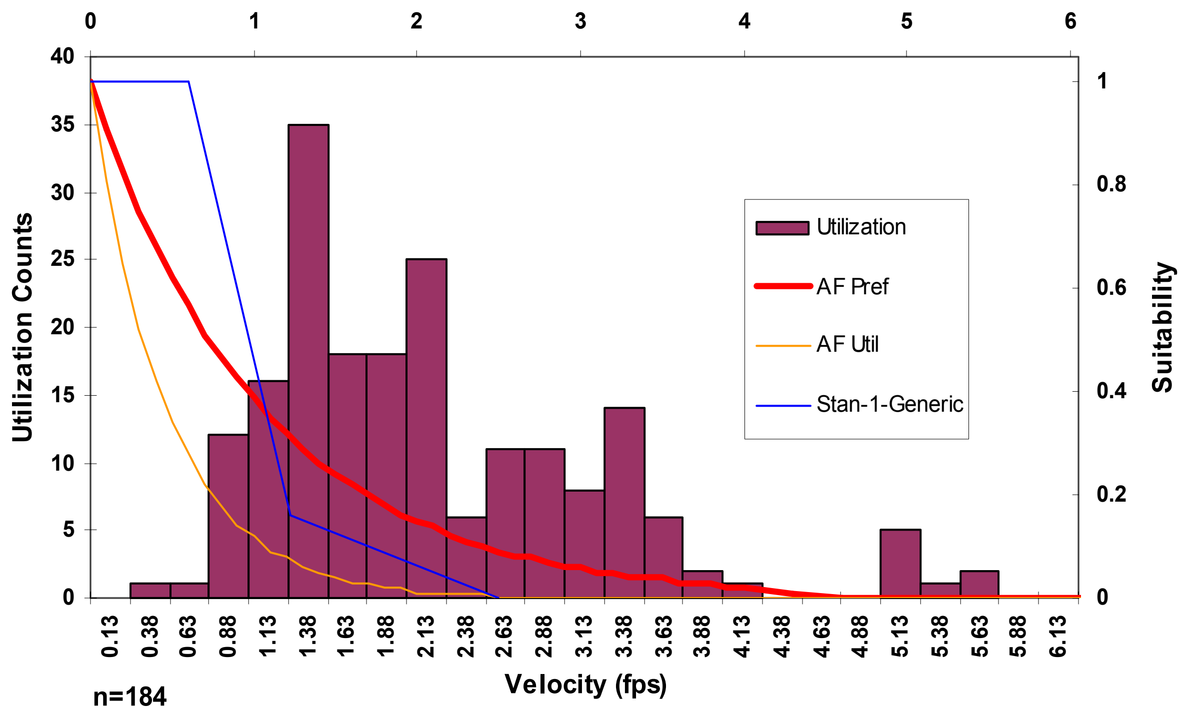
Upper Basin Large Stream
Base Rainbow Trout Depth Utilization and HSC



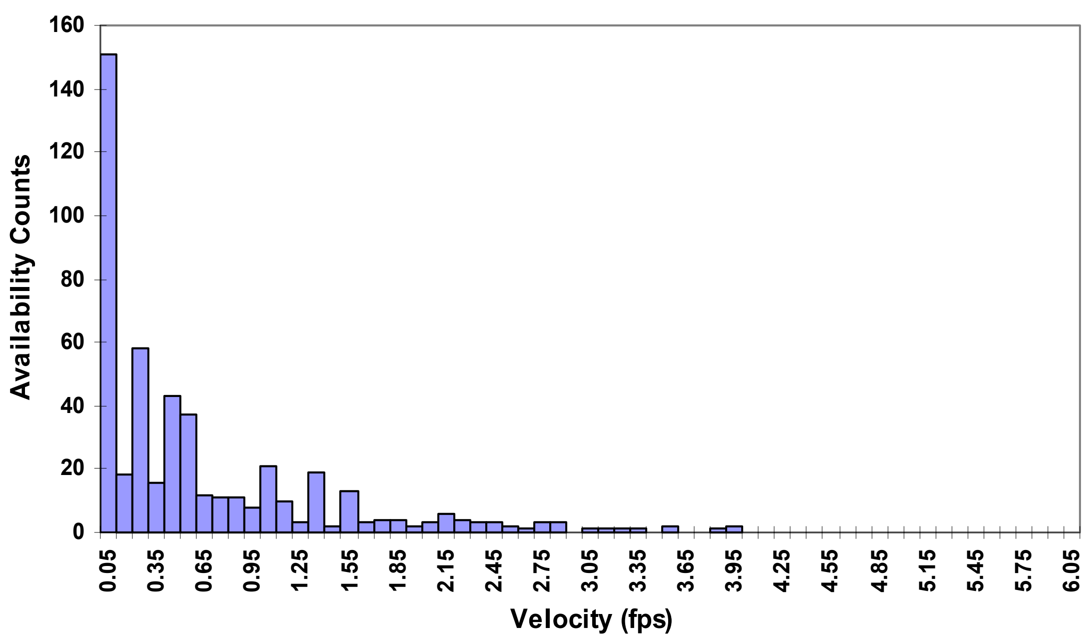
Upper Basin Large Stream
Base Rainbow Trout Depth Availability



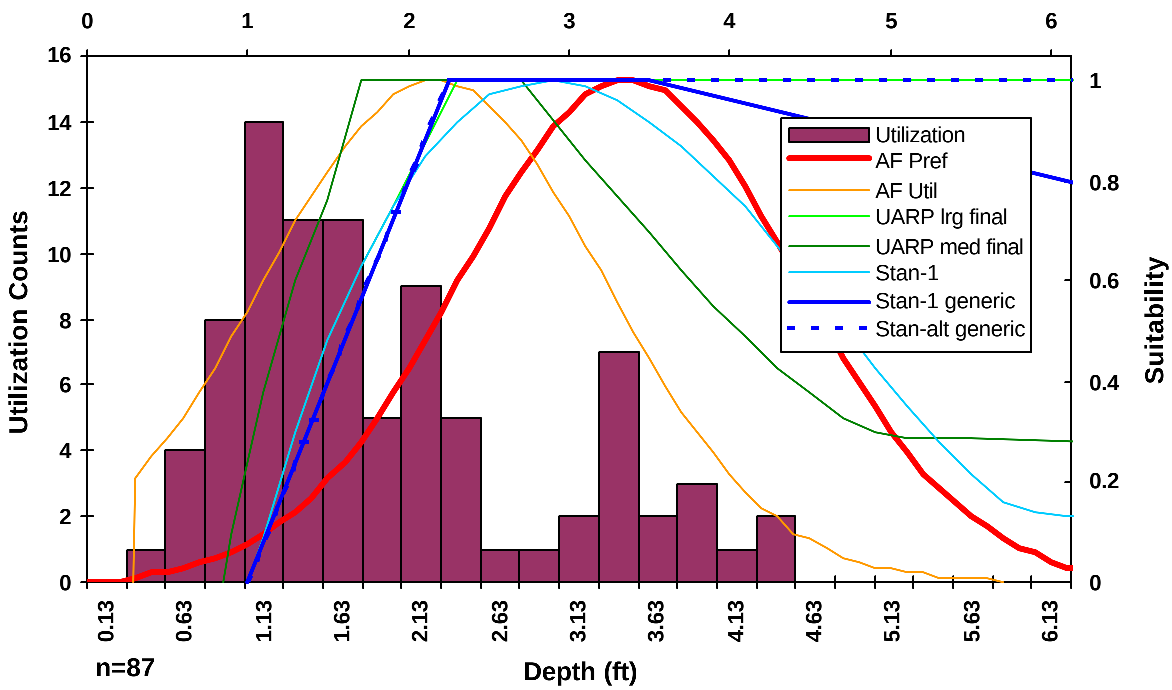
Upper Basin Large Stream
Base Rainbow Trout Velocity Utilization and HSC



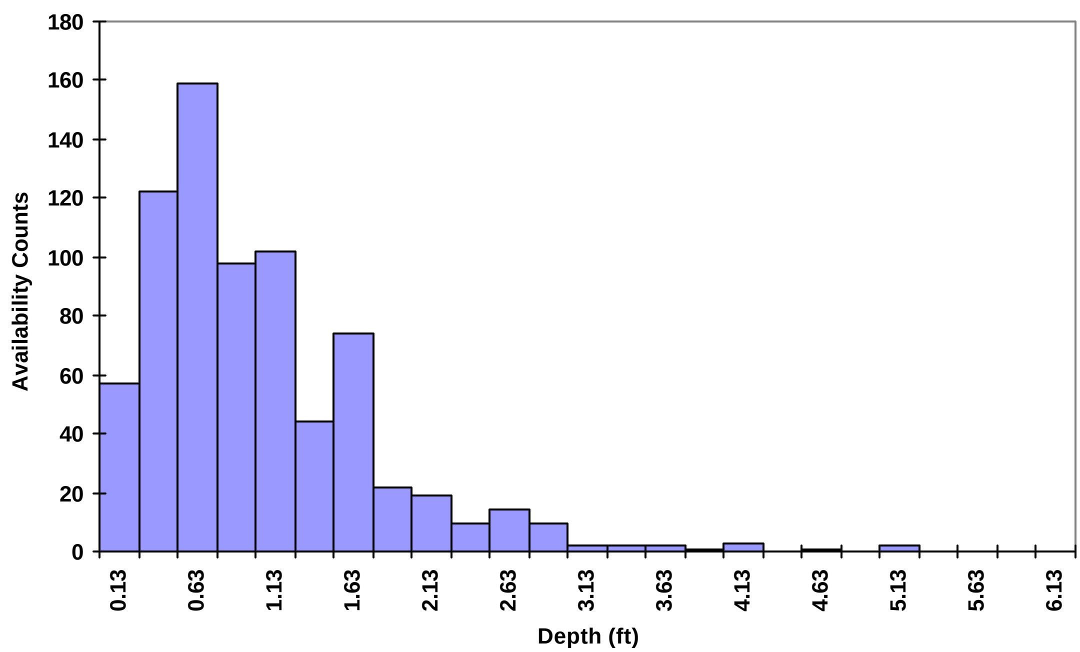
Upper Basin Large Stream
Base Rainbow Trout Velocity Availability



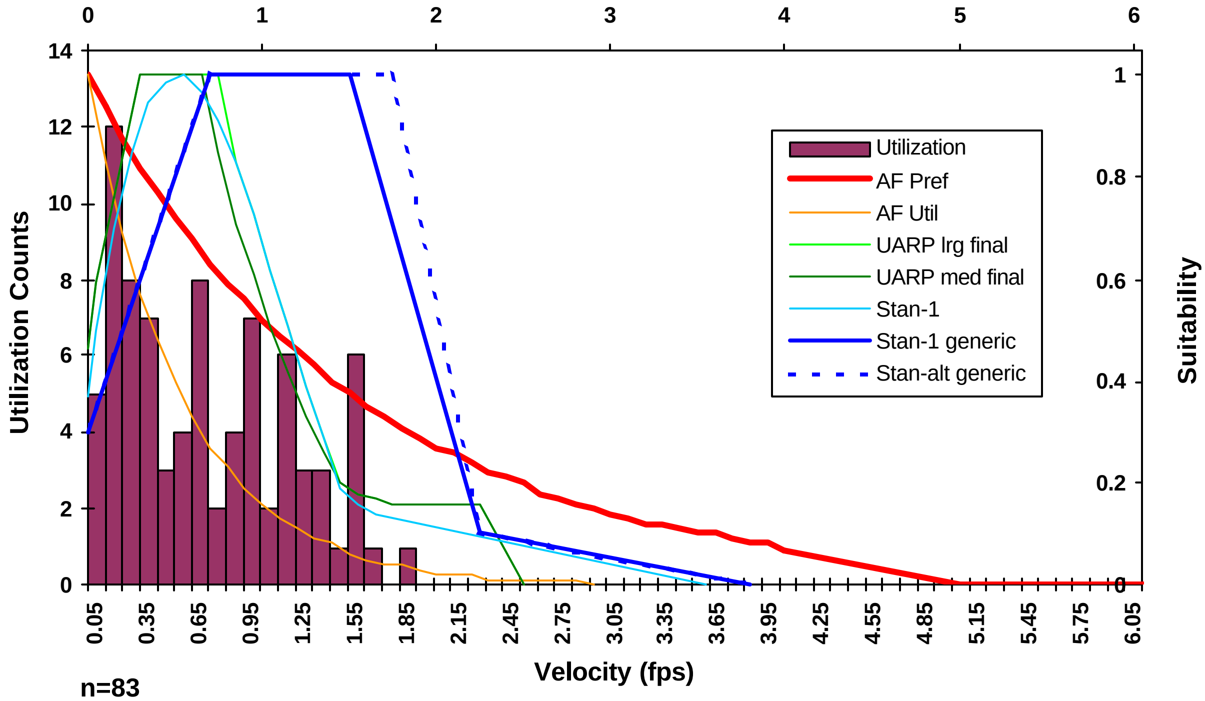
Upper Basin Large Stream
Adult Brown Trout Depth Utilization and HSC



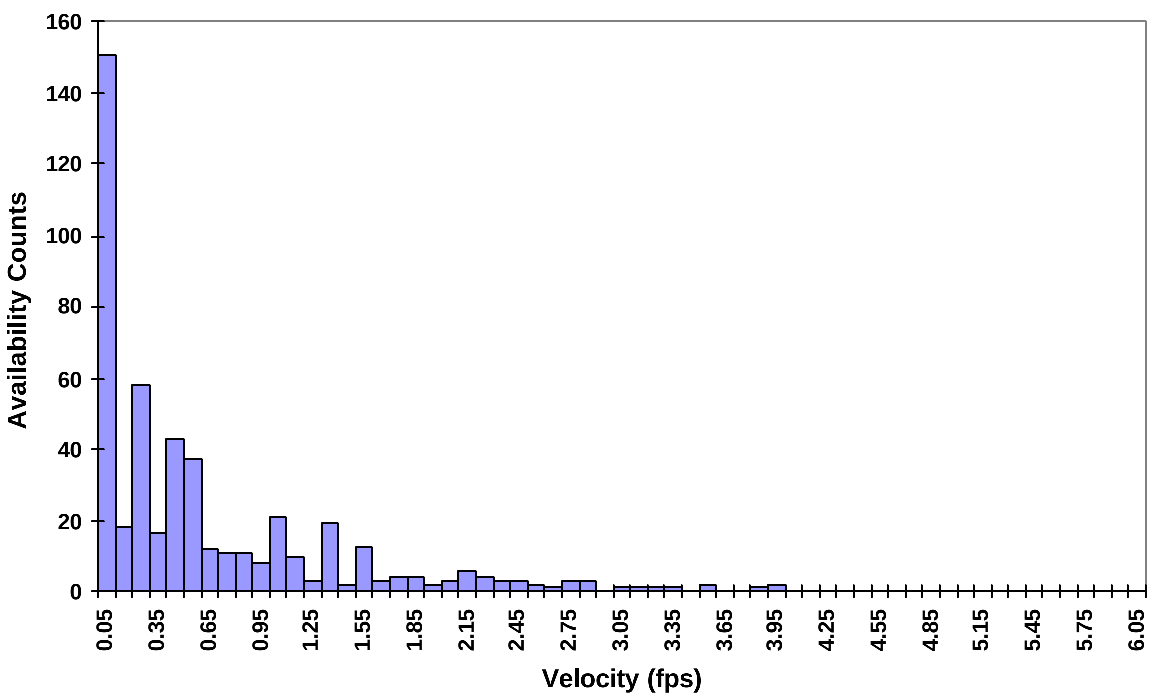
Upper Basin Large Stream
Adult Brown Trout Depth Availability

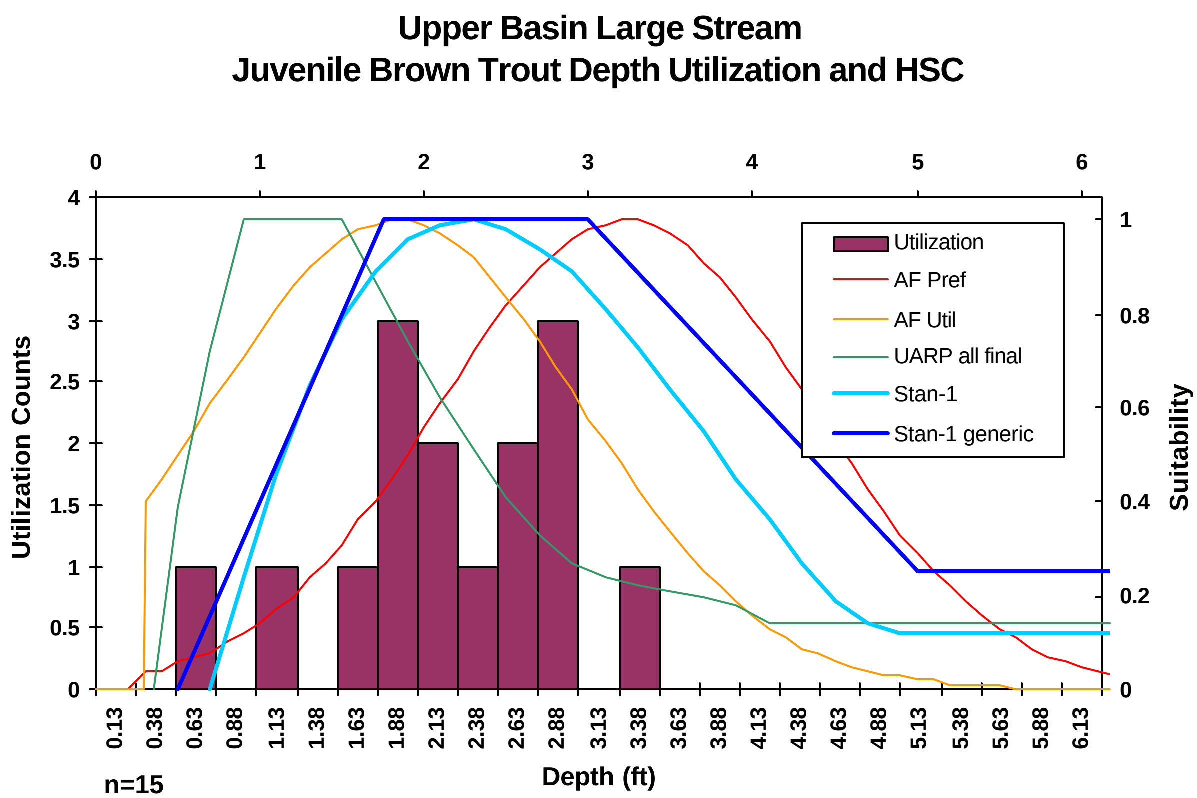


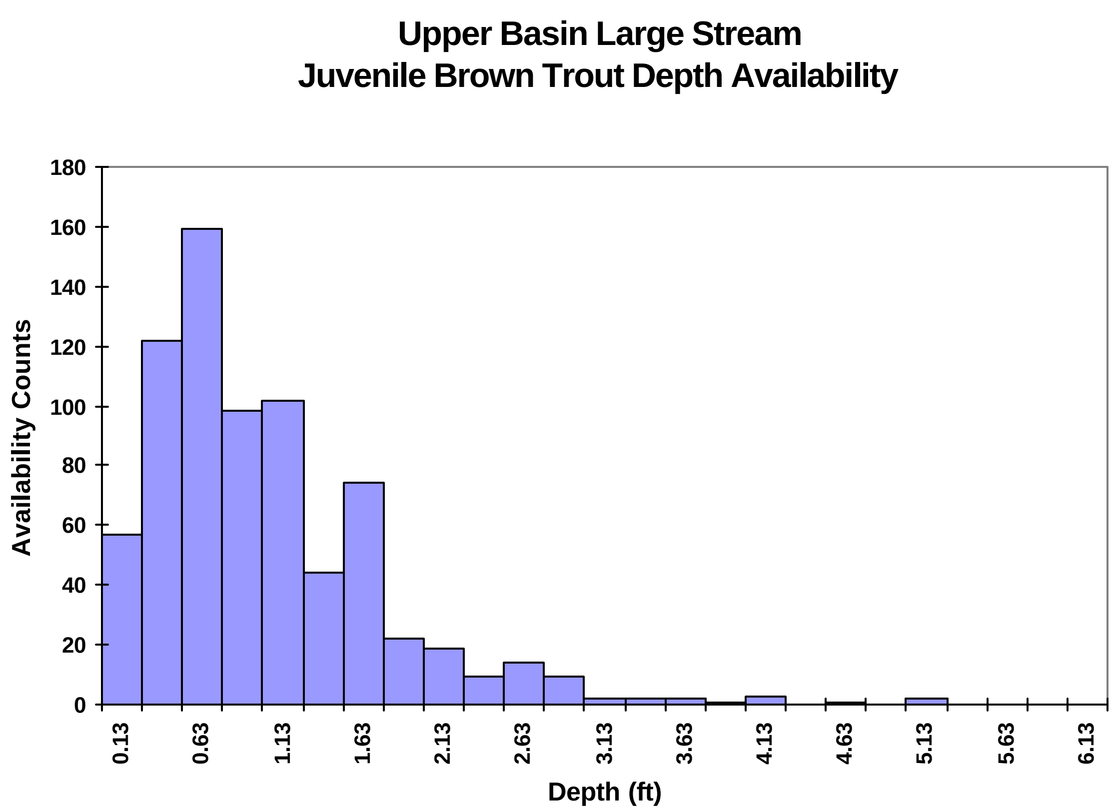
Upper Basin Large Stream
Adult Brown Trout Velocity Utilization and HSC



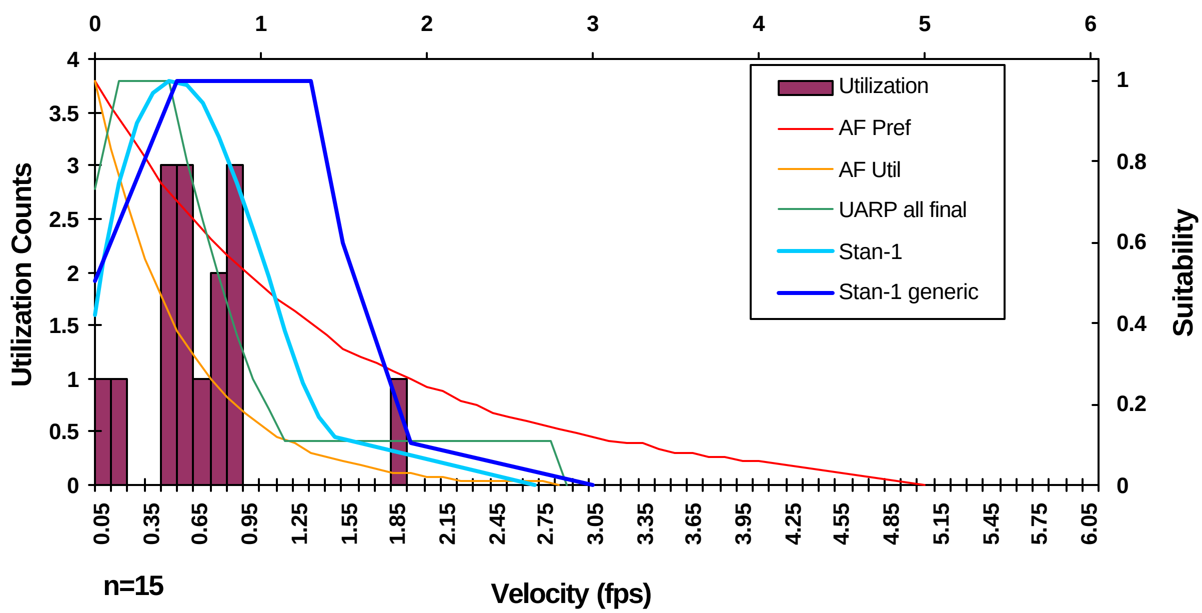
Upper Basin Large Stream
Adult Brown Trout Velocity Availability



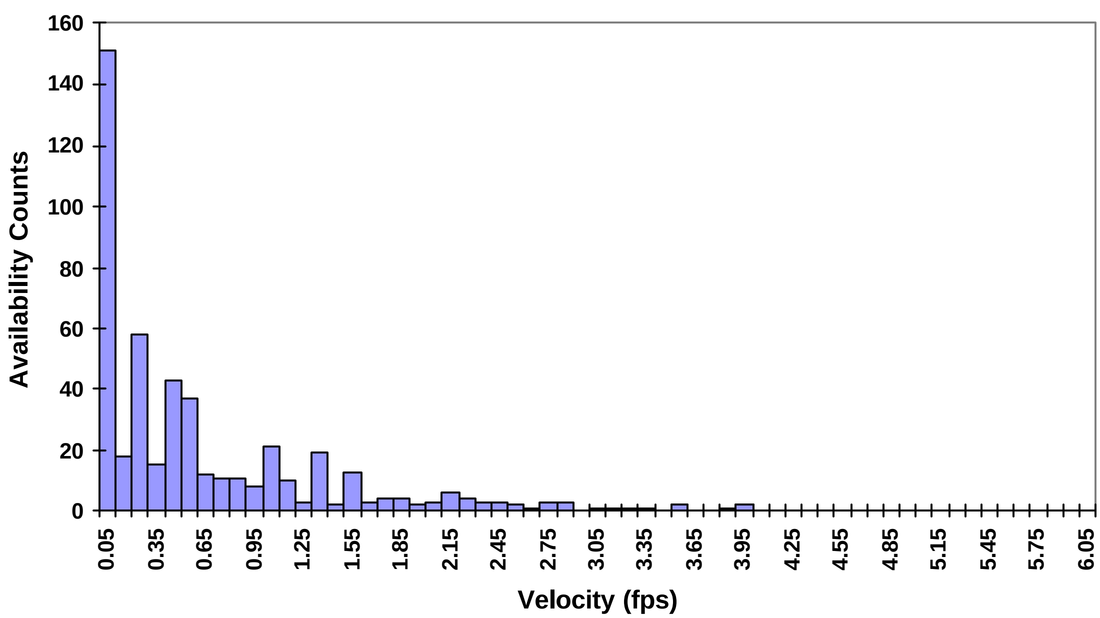

Upper Basin Large Stream
Juvenile Brown Trout Depth Utilization and HSC
Utilization Counts
Suitability
Utilization
AF Pref
AF Util
UARP all final
Stan-1
Stan-1 generic
0
1
2
3
4
5
6
0.5
1.5
2.5
3.5
0.2
0.4
0.6
0.8
0.13
0.38
0.63
0.88
1.13
1.38
1.63
1.88
2.13
2.38
2.63
2.88
3.13
3.38
3.63
3.88
4.13
4.38
4.63
4.88
5.13
5.38
5.63
5.88
6.13
n=15
Depth (ft)


Upper Basin Large Stream
Juvenile Brown Trout Depth Availability
Availability Counts
0
20
40
60
80
100
120
140
160
180
0.13
0.63
1.13
1.63
2.13
2.63
3.13
3.63
4.13
4.63
5.13
5.63
6.13
Depth (ft)

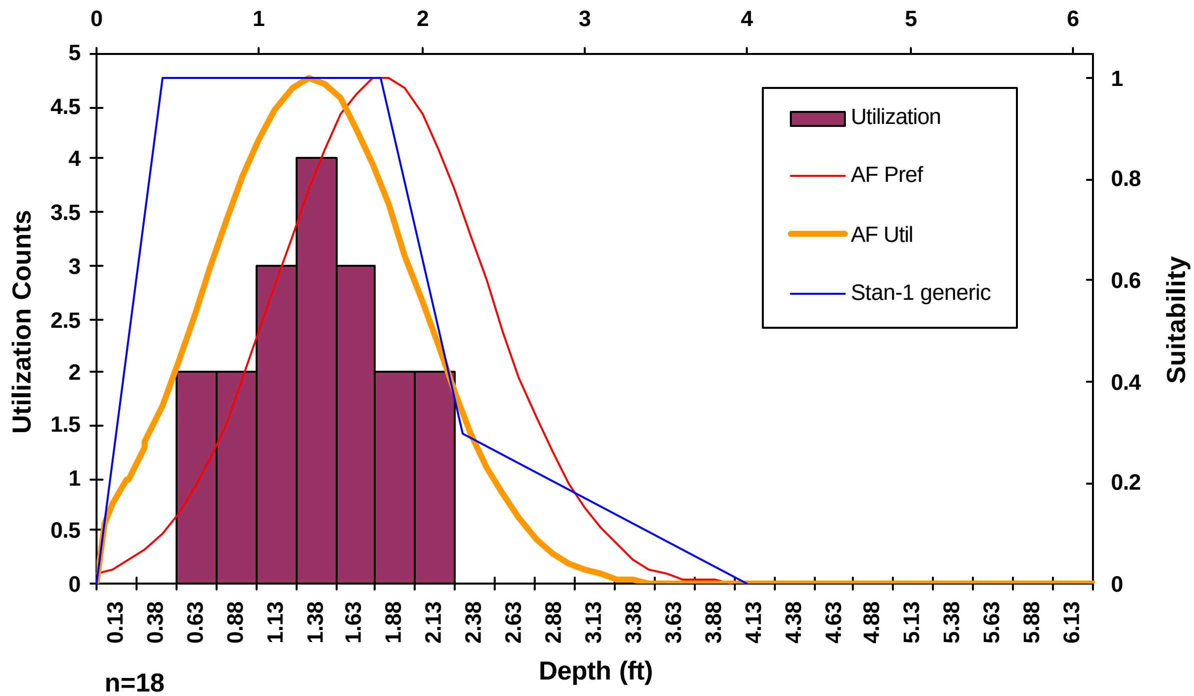
Upper Basin Large Stream
Juvenile Brown Trout Velocity Utilization and HSC



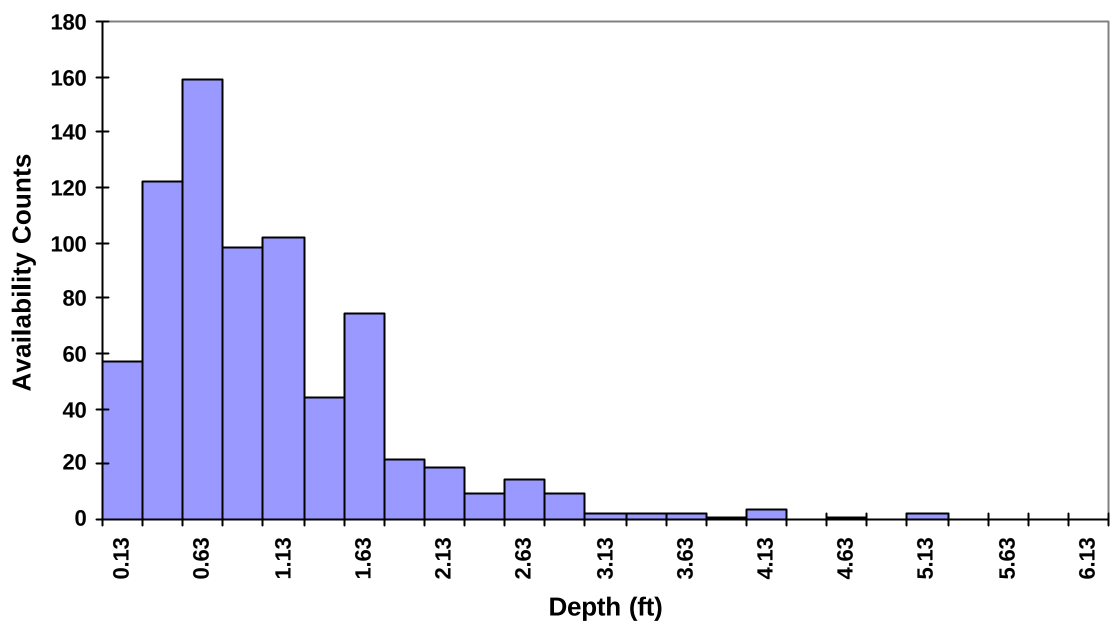
Upper Basin Large Stream
Juvenile Brown Trout Velocity Availability

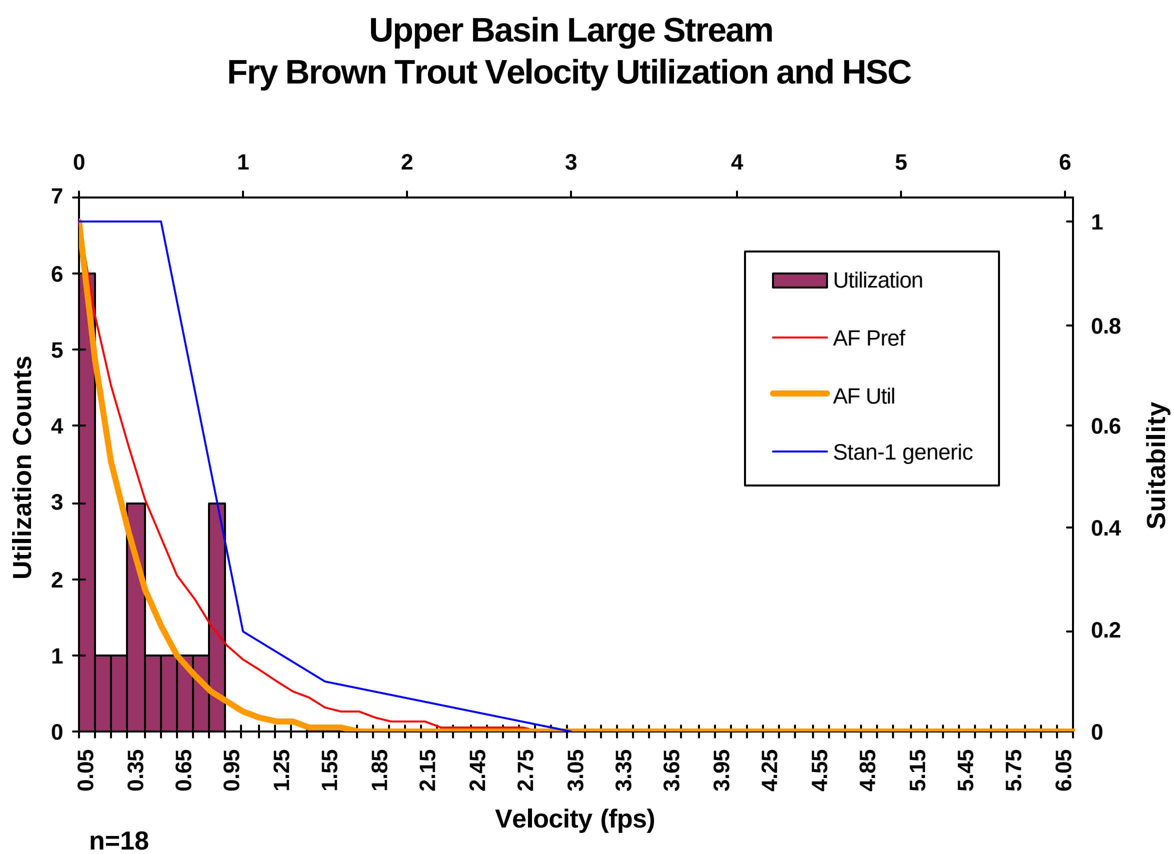


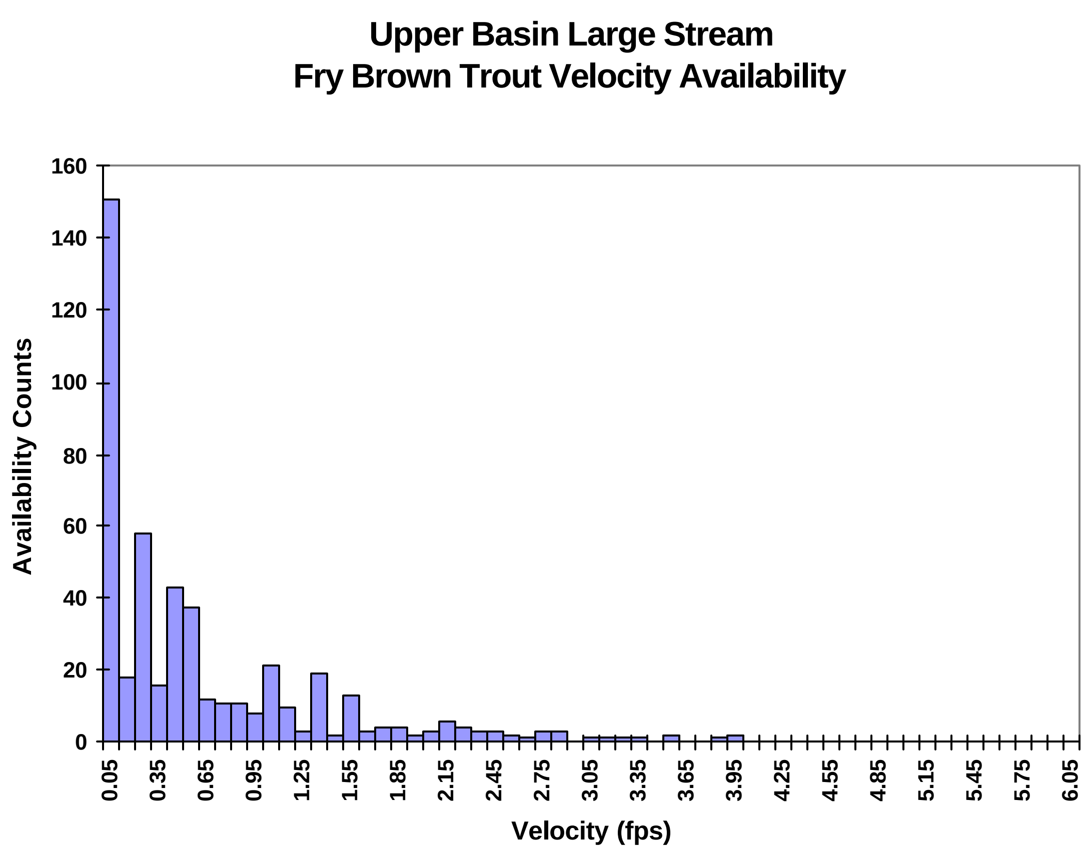
Upper Basin Large Stream
Fry Brown Trout Depth Utilization and HSC



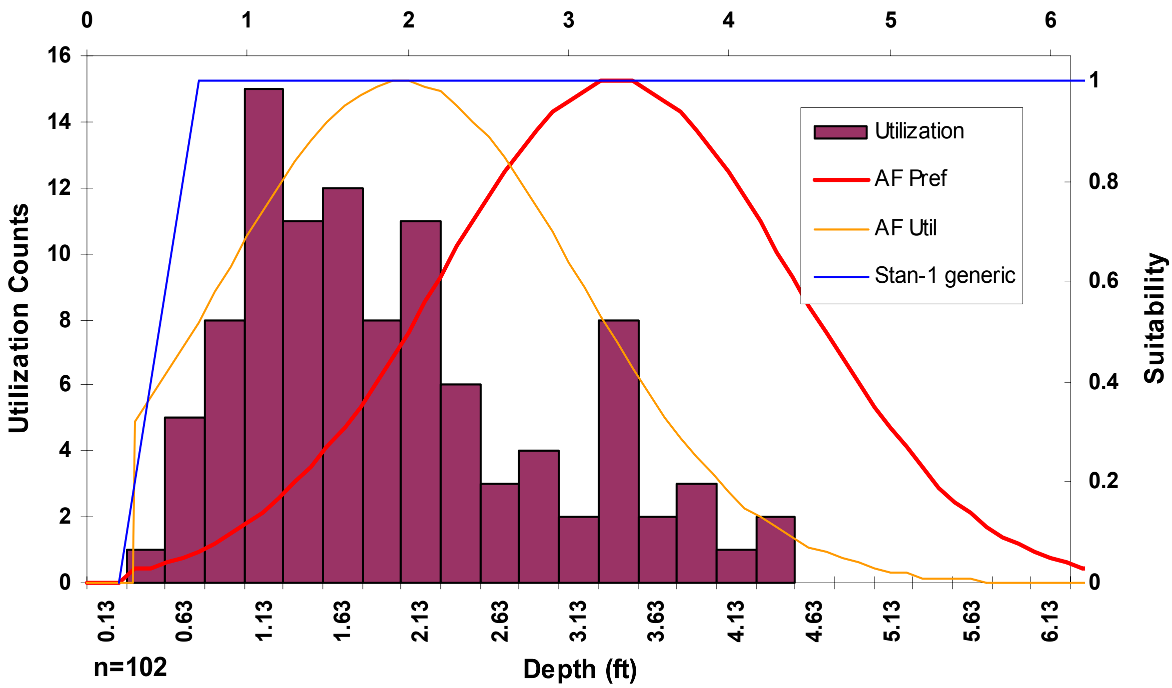
Upper Basin Large Stream
Fry Brown Trout Depth Availability



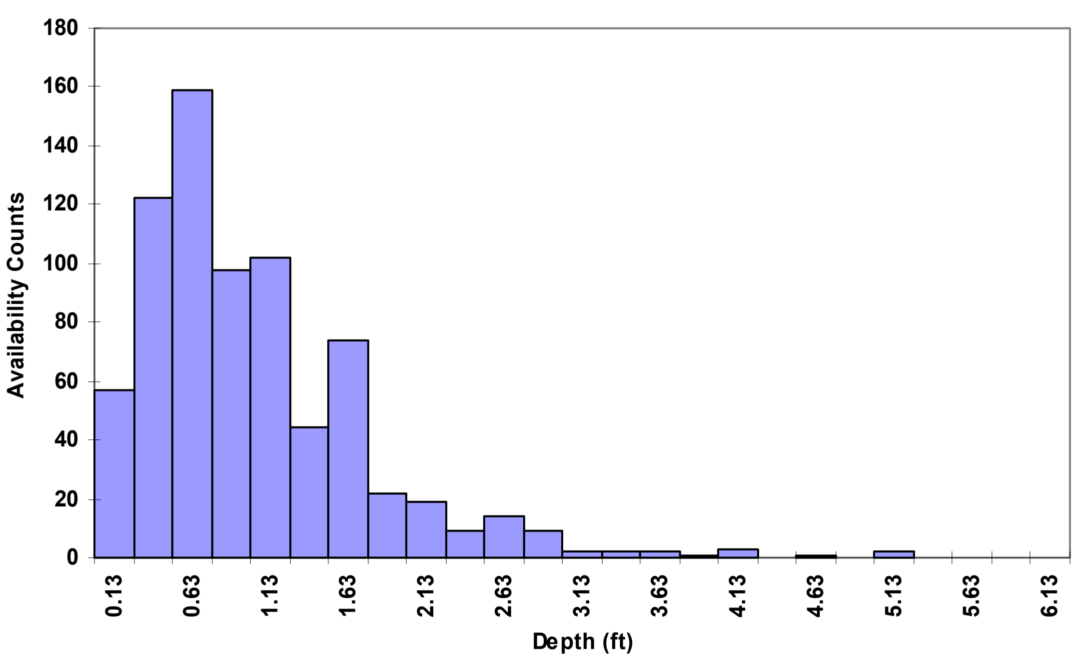

Upper Basin Large Stream
Fry Brown Trout Velocity Utilization and HSC
Utilization
AF Pref
AF Util
Stan-1 generic
Utilization Counts
Suitability
Velocity (fps)
n=18


Upper Basin Large Stream
Fry Brown Trout Velocity Availability
Availability Counts
Velocity (fps)

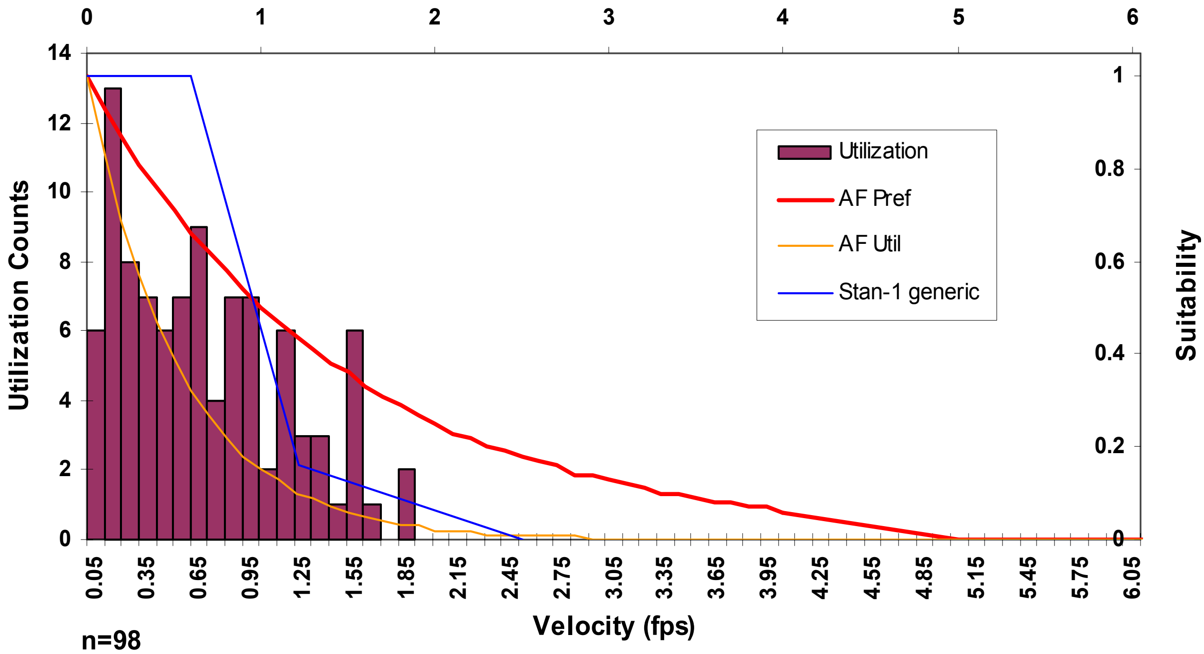
Upper Basin Large Stream
Base Brown Trout Depth Utilization and HSC



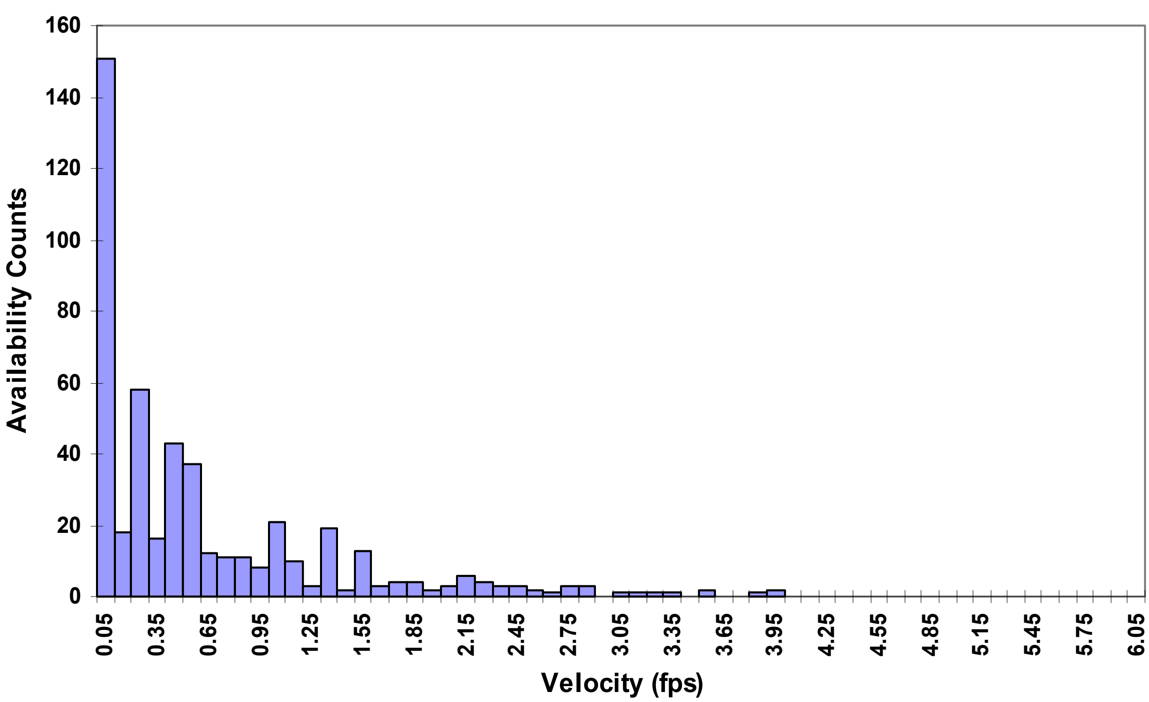
Upper Basin Large Stream
Base Brown Trout Depth Availability



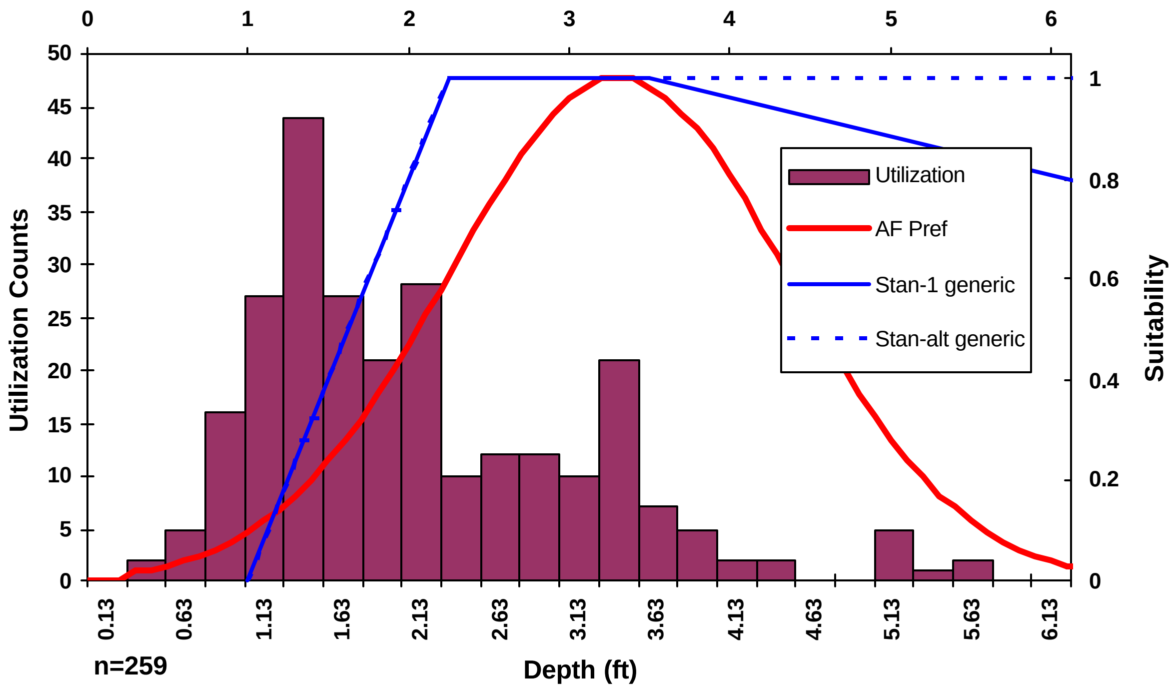
Upper Basin Large Stream
Base Brown Trout Velocity Utilization and HSC



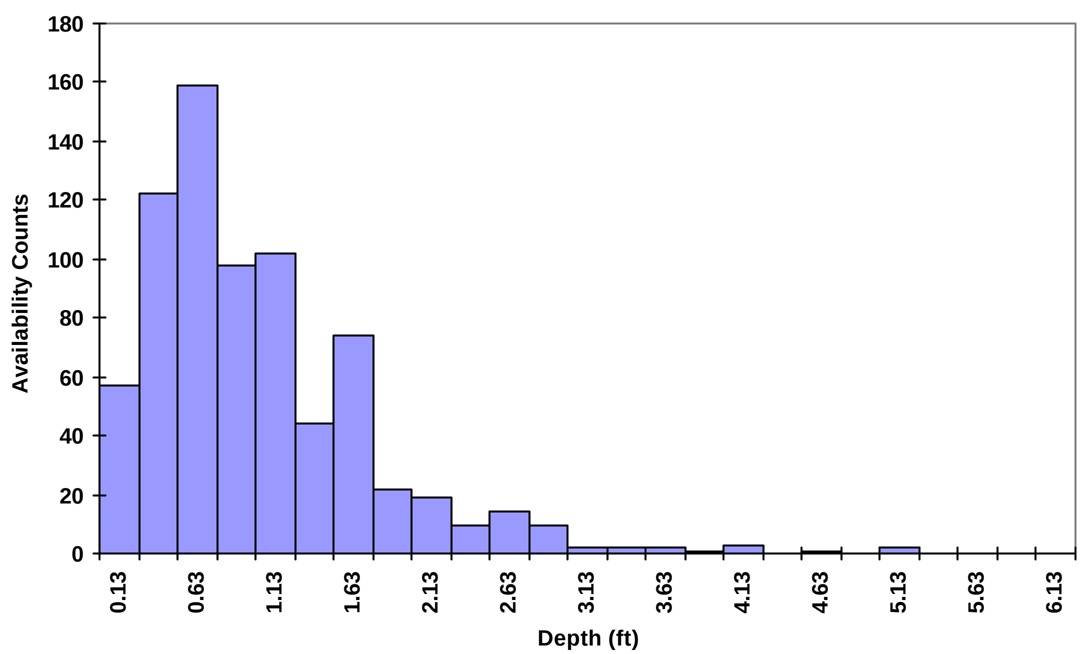
Upper Basin Large Stream
Base Brown Trout Velocity Availability



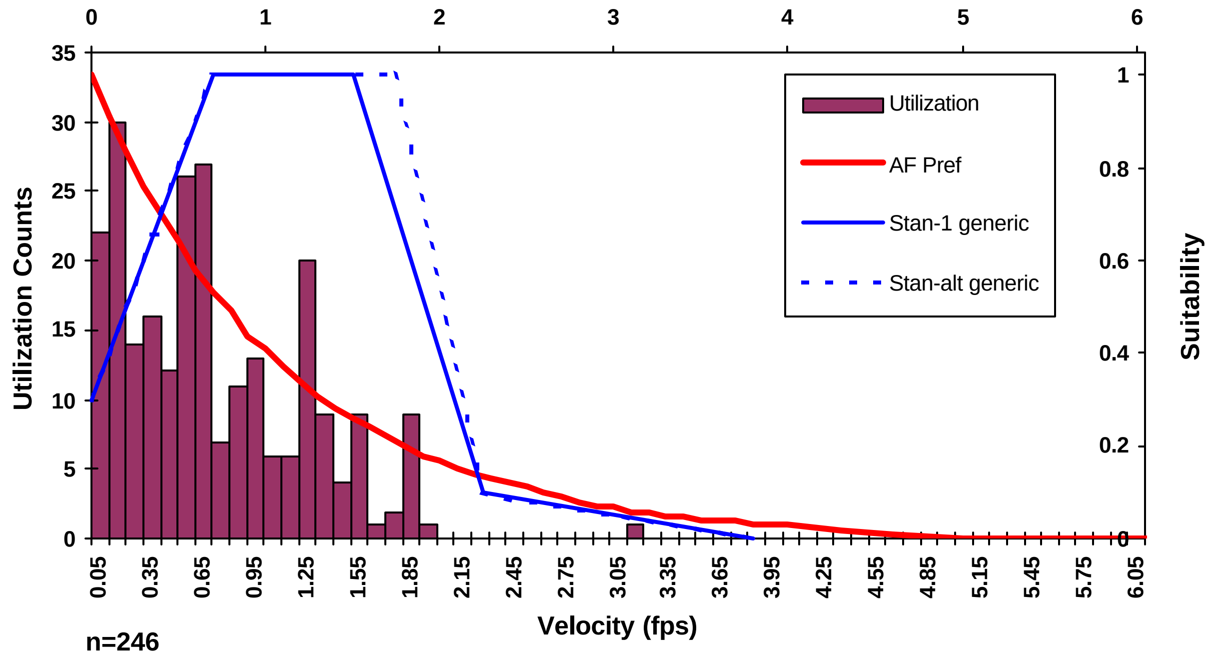
Upper Basin Large Stream
Adult Total Trout Depth Utilization and HSC



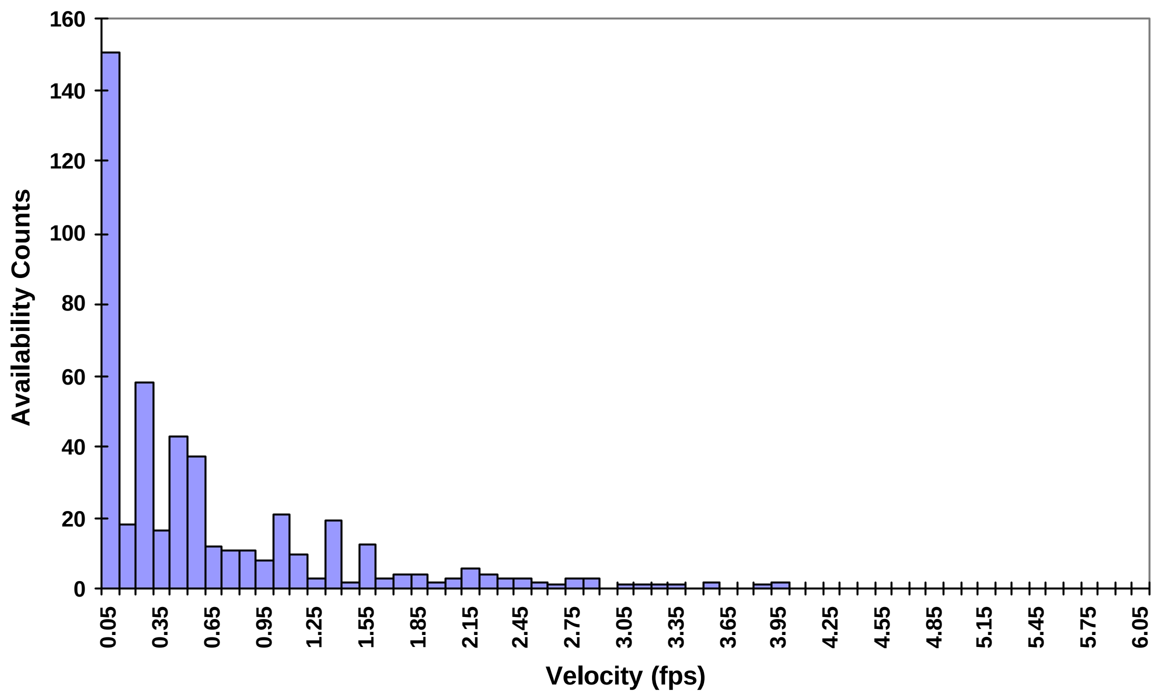
Upper Basin Large Stream
Adult Total Trout Depth Availability



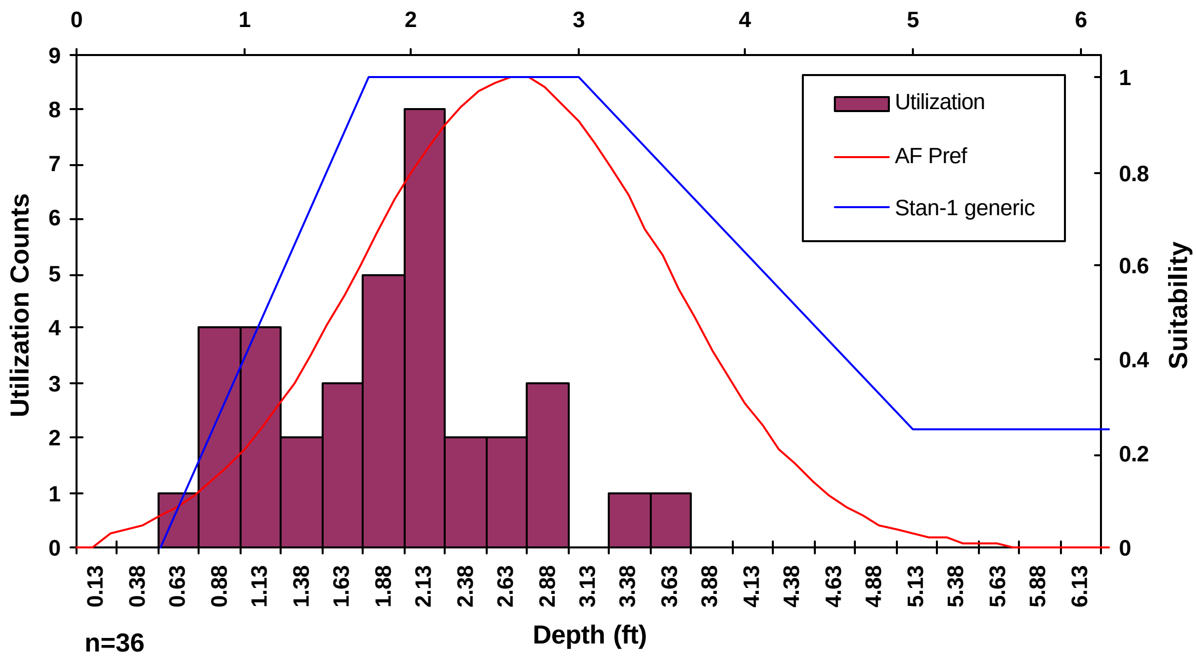
Upper Basin Large Stream
Adult Total Trout Velocity Utilization and HSC



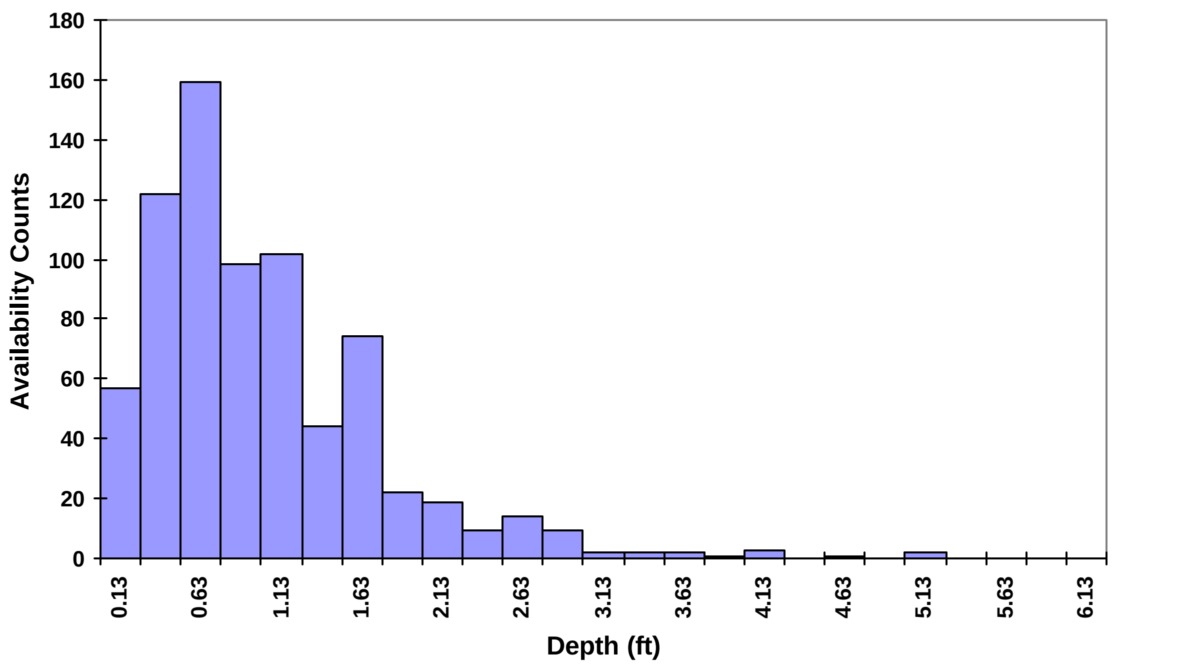
Upper Basin Large Stream
Adult Total Trout Velocity Availability



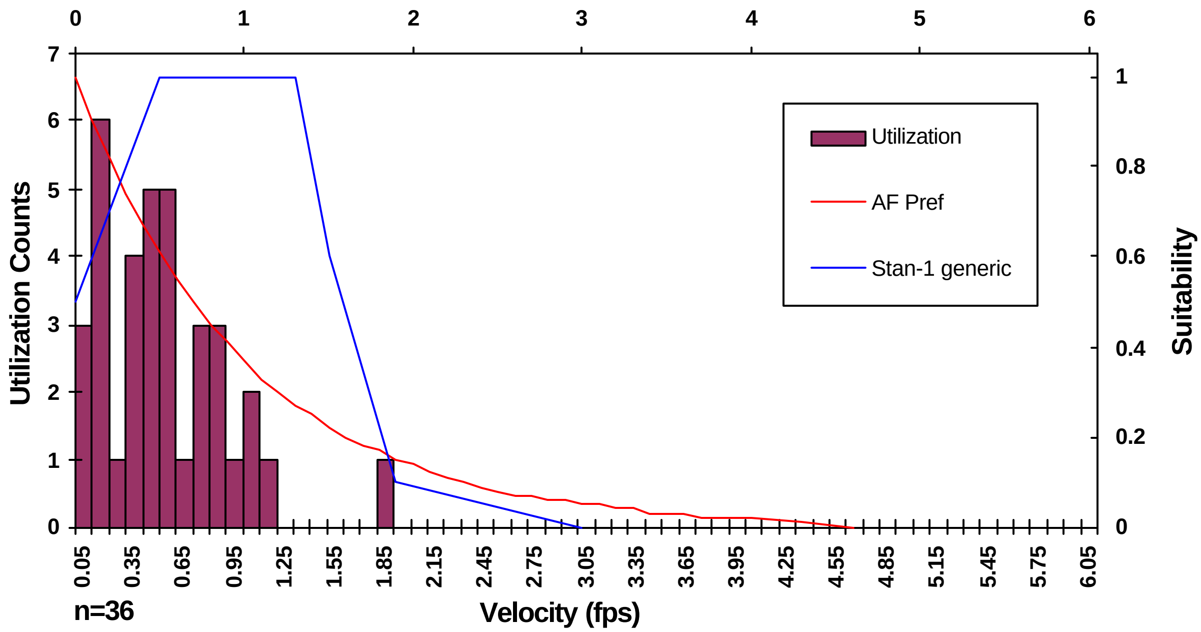
Upper Basin Large Stream
Juvenile Total Trout Depth Utilization and HSC



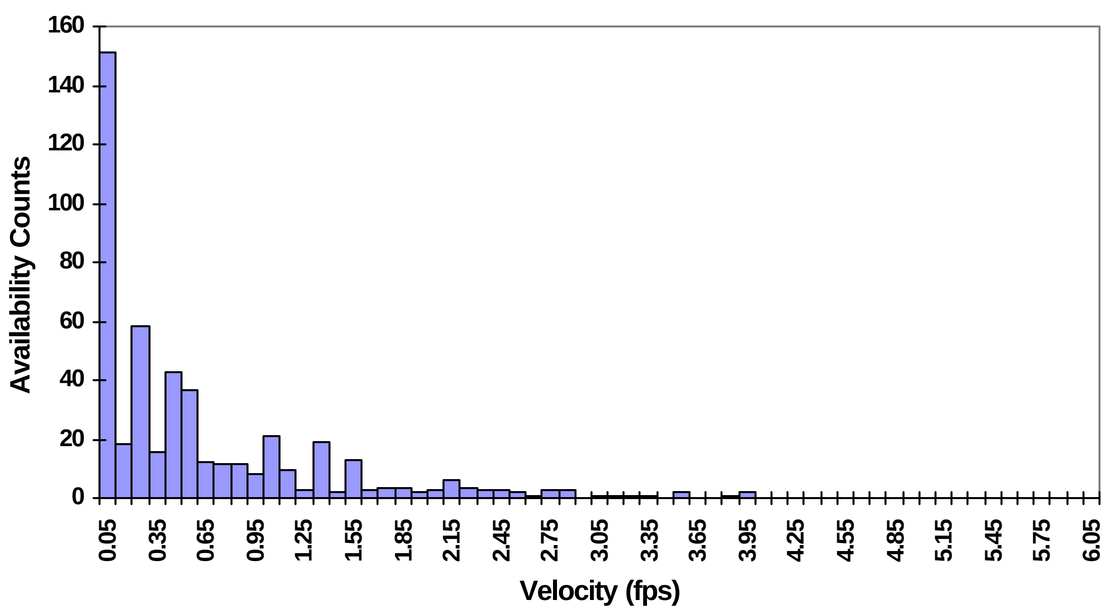
Upper Basin Large Stream
Juvenile Total Trout Depth Availability



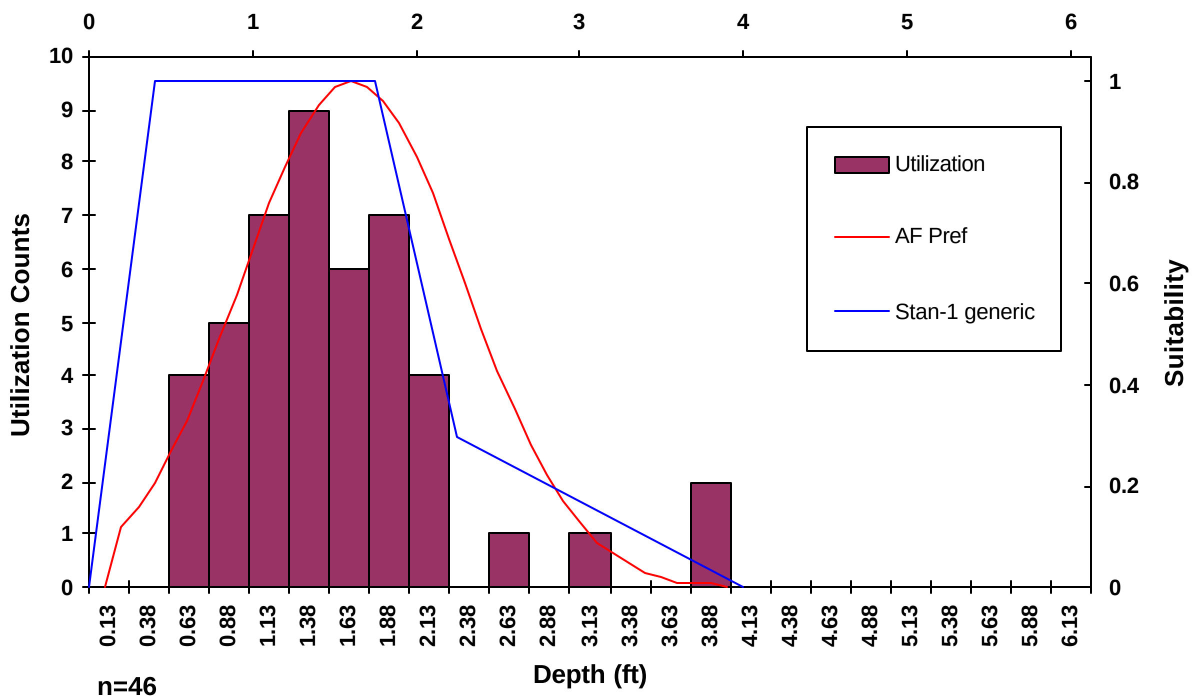
Upper Basin Large Stream
Juvenile Total Trout Velocity Utilization and HSC



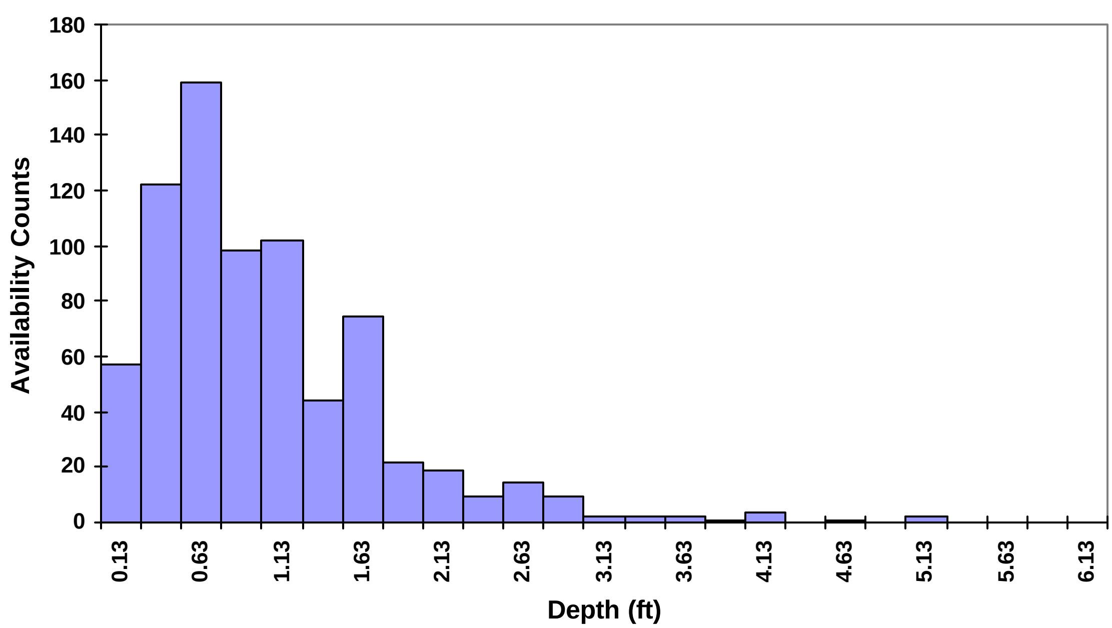
Upper Basin Large Stream
Juvenile Total Trout Velocity Availability



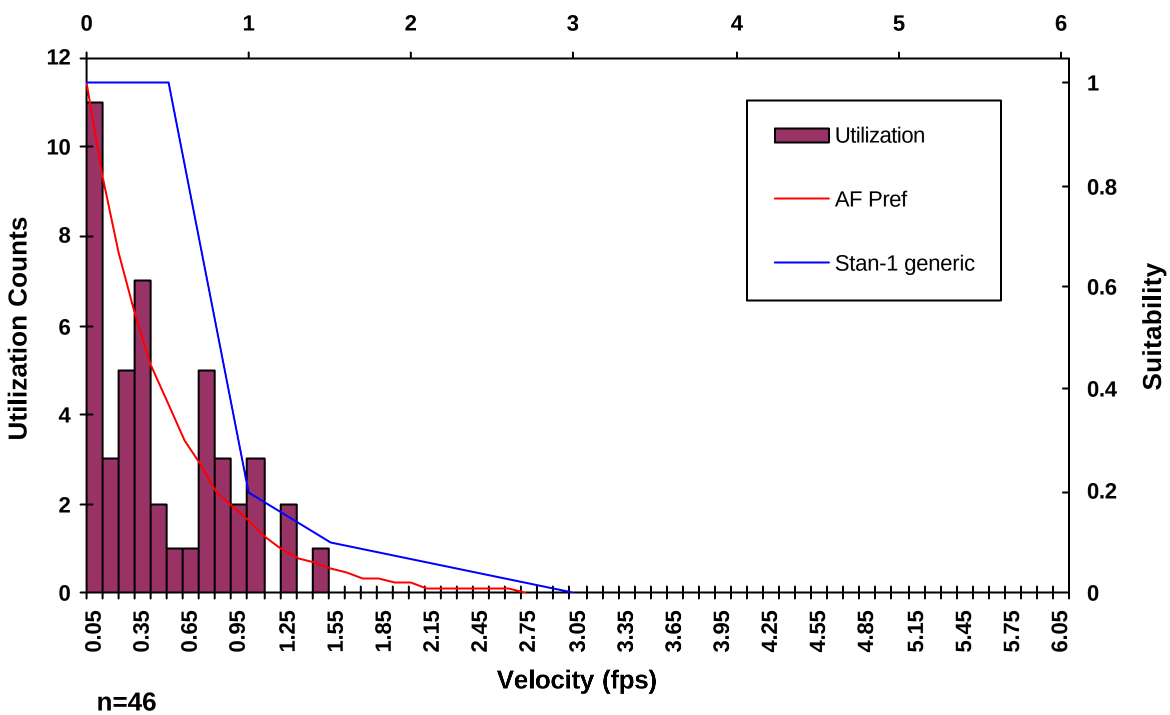
Upper Basin Large Stream
Fry Total Trout Depth Utilization and HSC



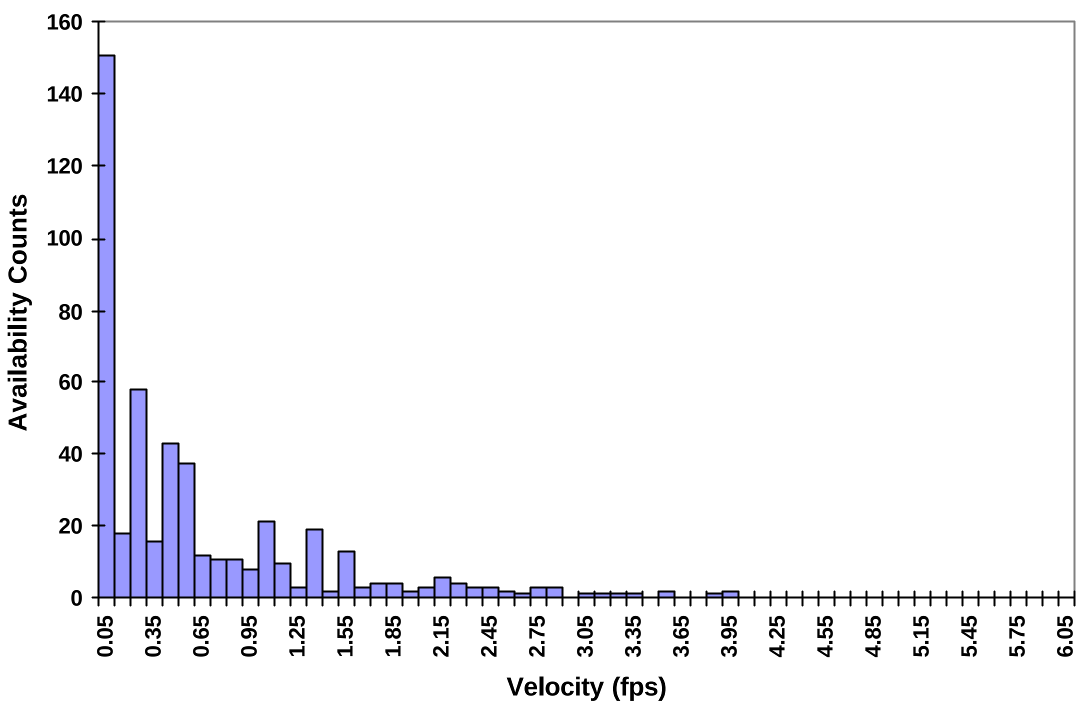
Upper Basin Large Stream
Fry Total Trout Depth Availability



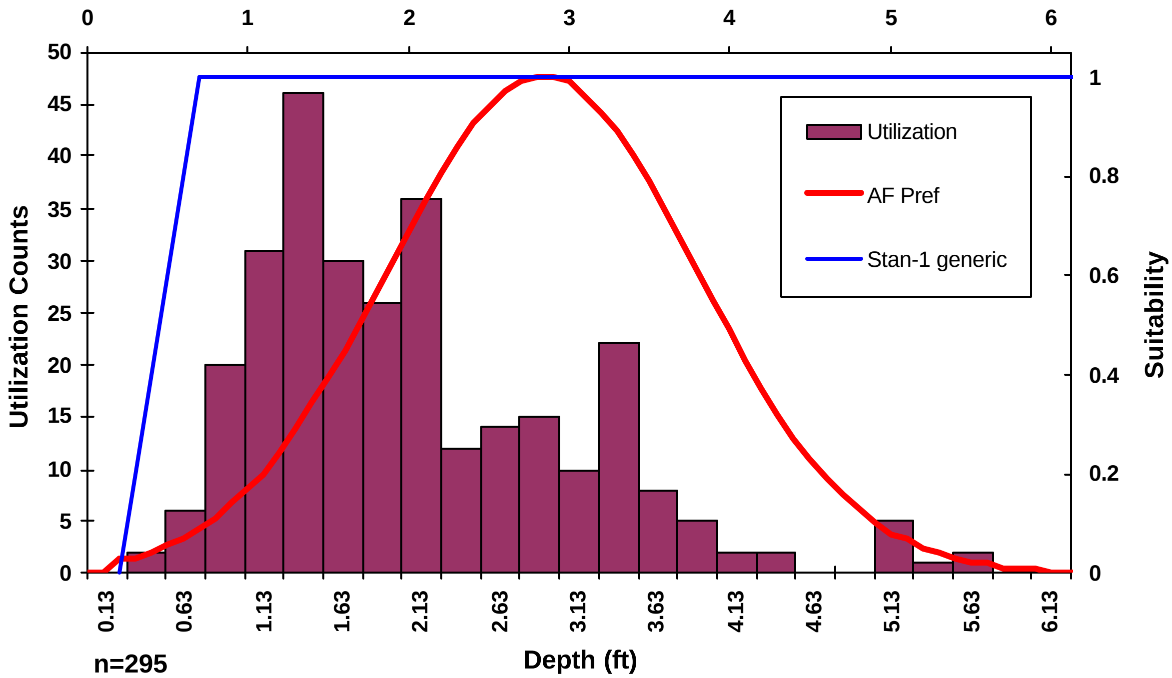
Upper Basin Large Stream
Fry Total Trout Velocity Utilization and HSC



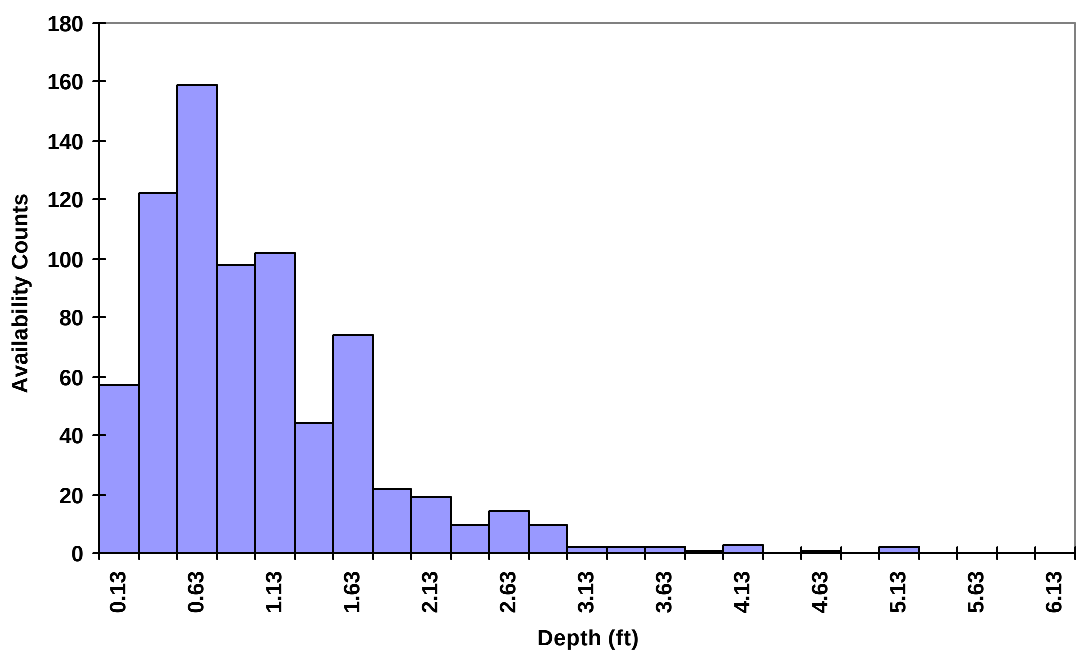
Upper Basin Large Stream
Fry Total Trout Velocity Availability



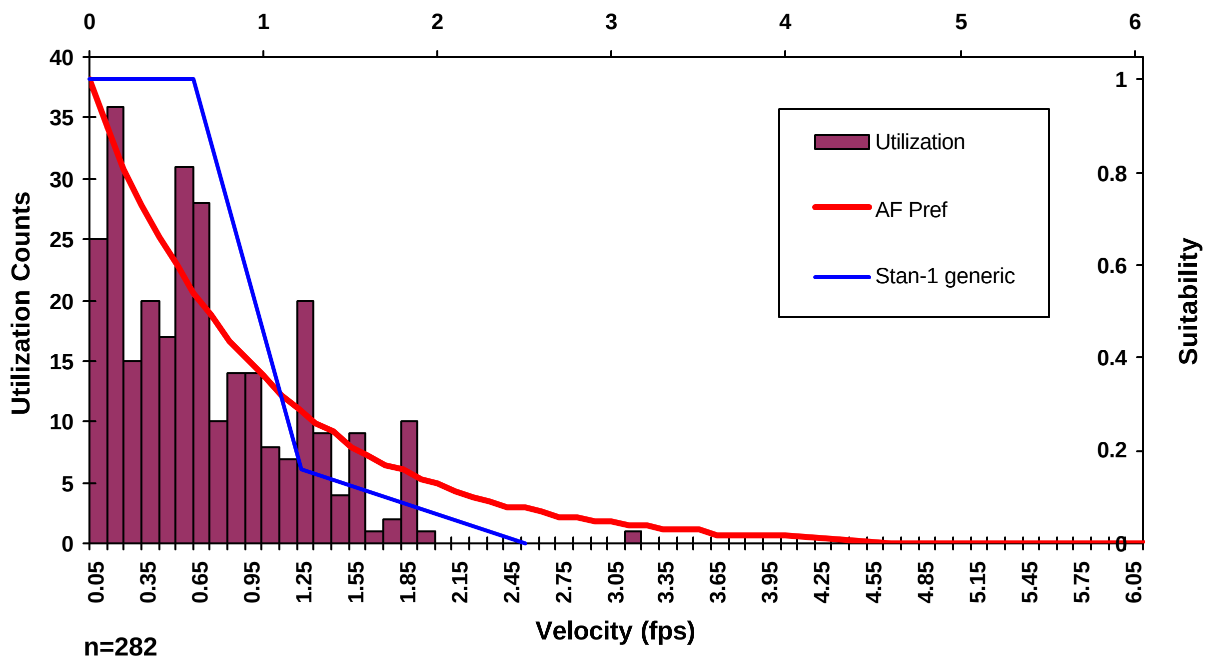
Upper Basin Large Stream
Base Total Trout Depth Utilization and HSC



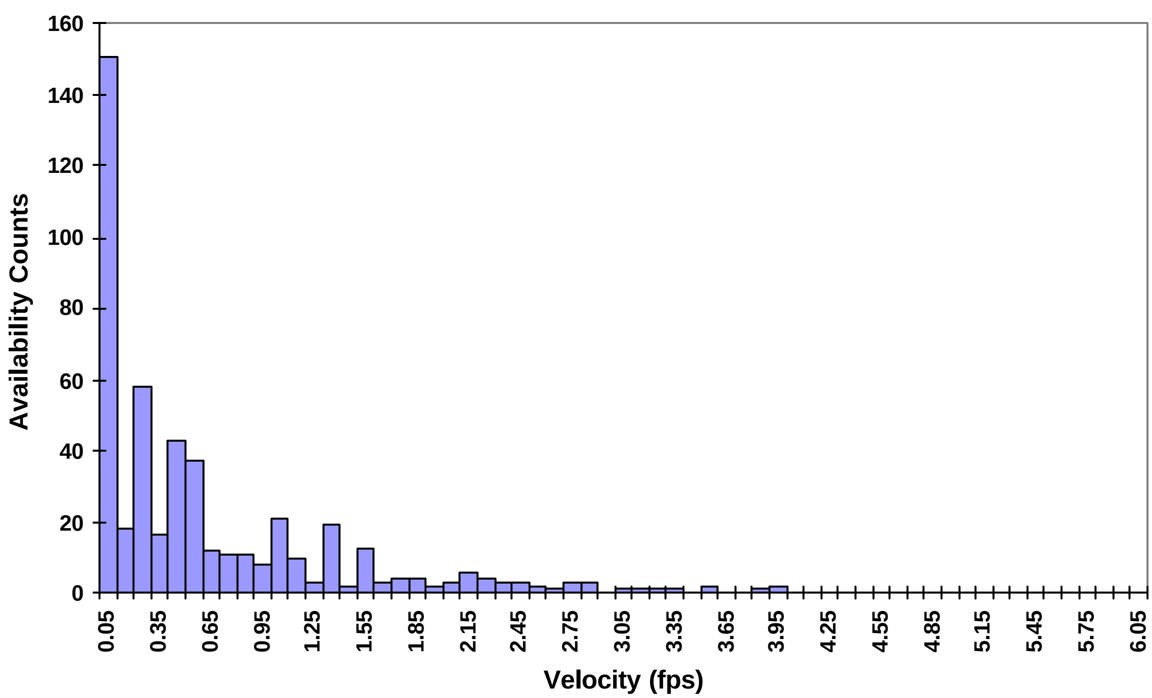
Upper Basin Large Stream
Base Total Trout Depth Availability



Upper Basin Large Stream
Base Total Trout Velocity Utilization and HSC

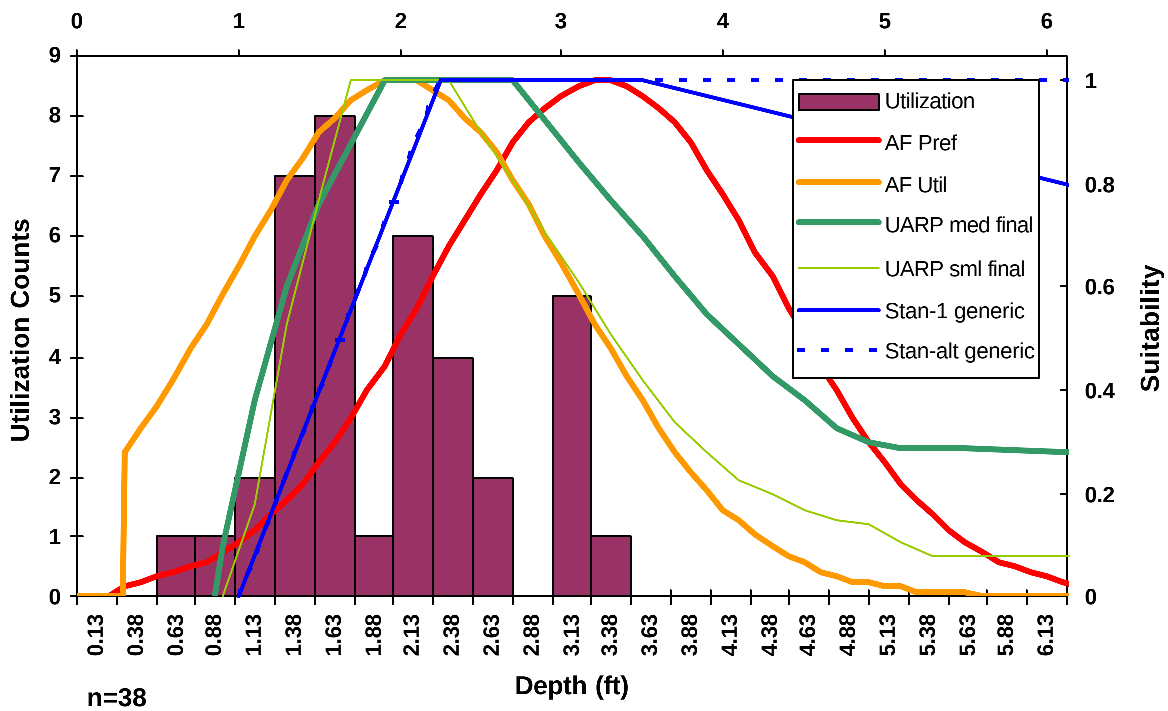


Upper Basin Large Stream
Base Total Trout Velocity Availability

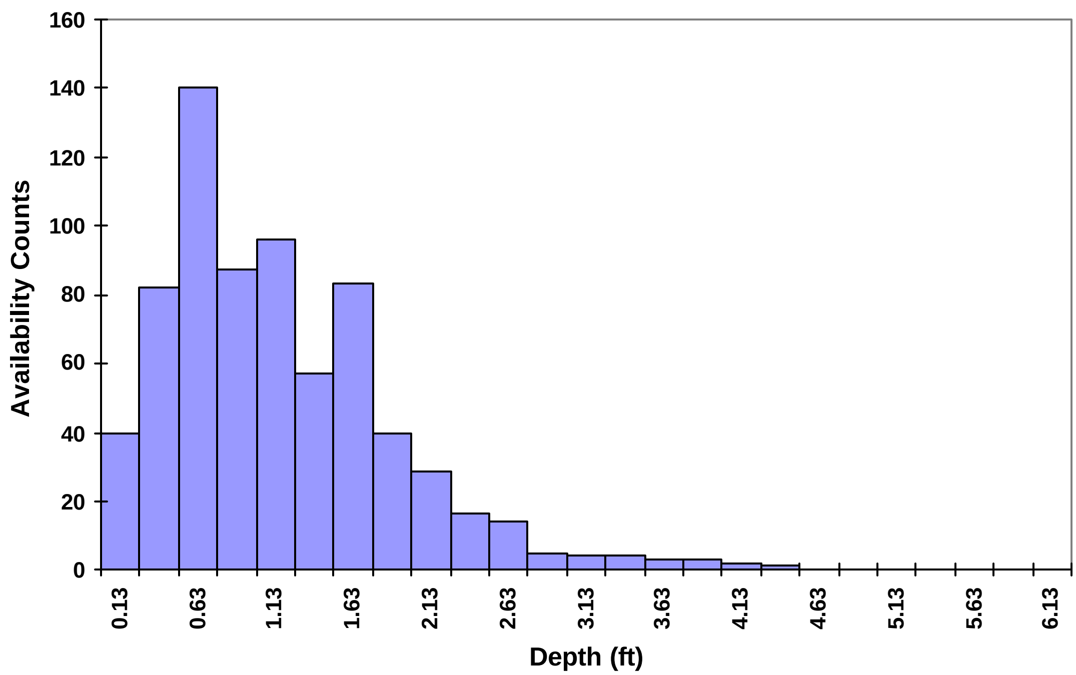


Upper Basin, Small Stream

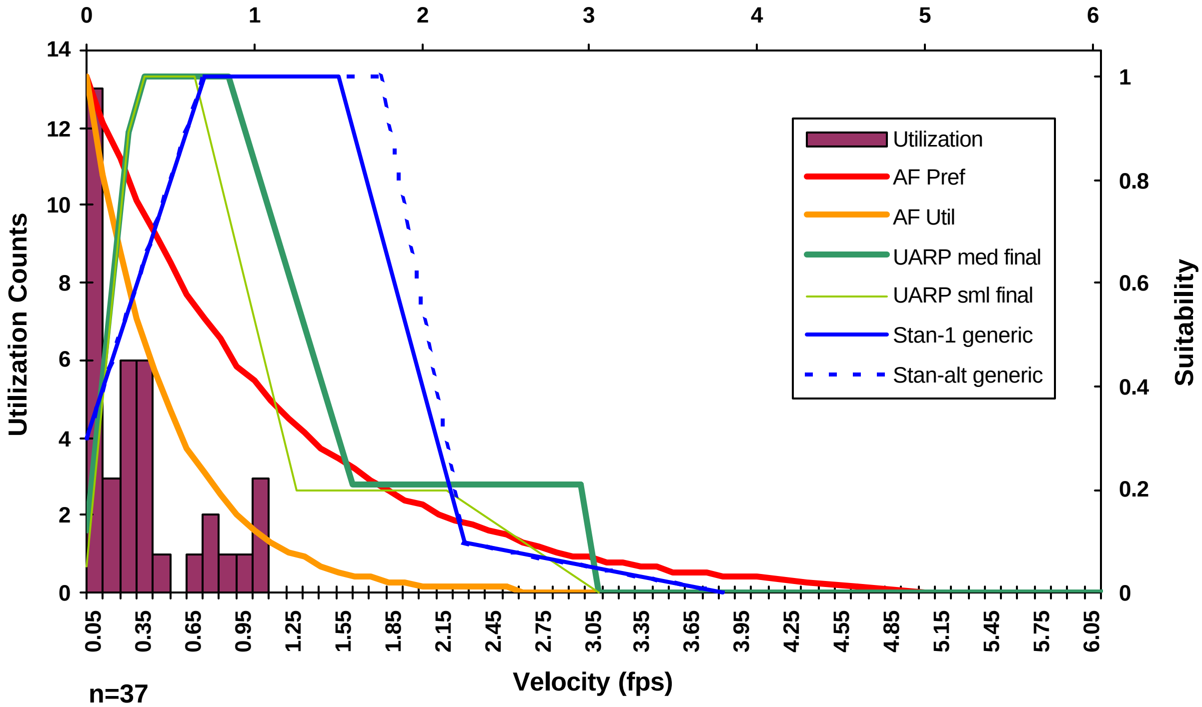
Upper Basin Small Stream
Adult Rainbow Trout Depth Utilization and HSC



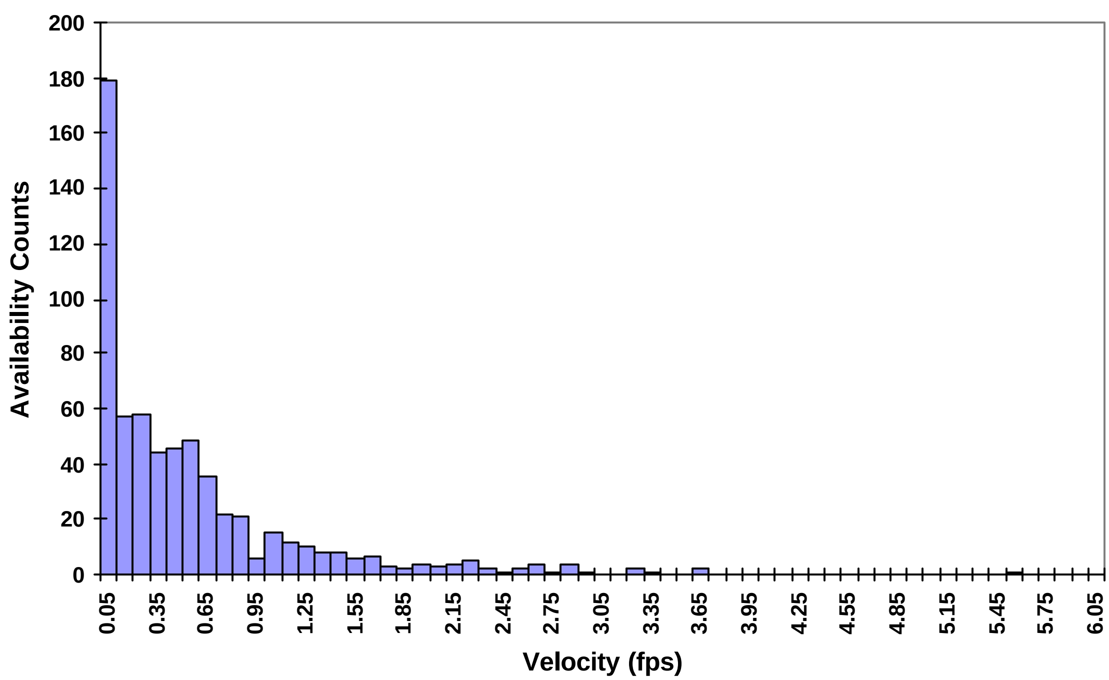
Upper Basin Small Stream
Adult Rainbow Trout Depth Availability



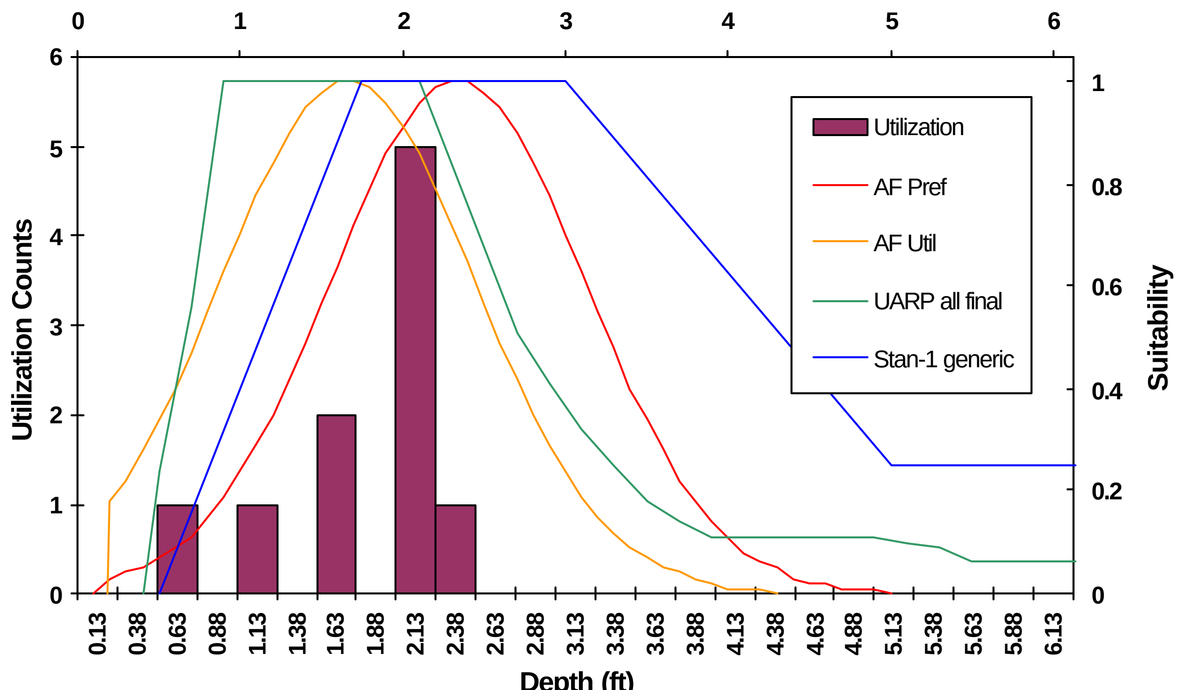
Upper Basin Small Stream
Adult Rainbow Trout Velocity Utilization and HSC



Upper Basin Small Stream
Adult Rainbow Trout Velocity Availability

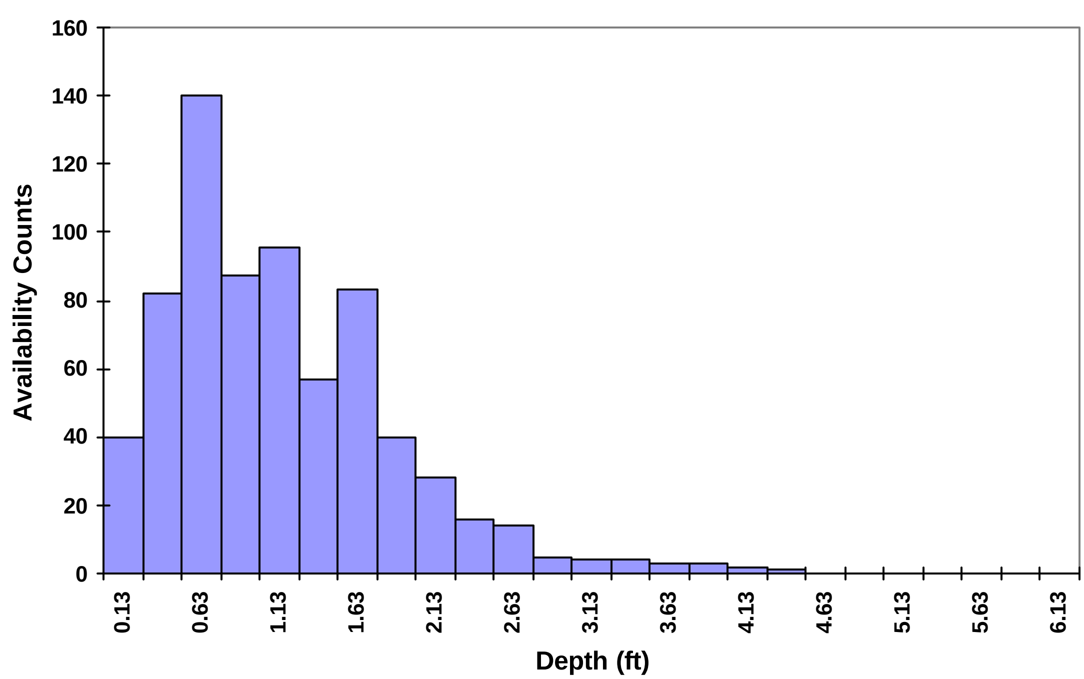


Upper Basin Small Stream
Juvenile Rainbow Trout Depth Utilization and HSC

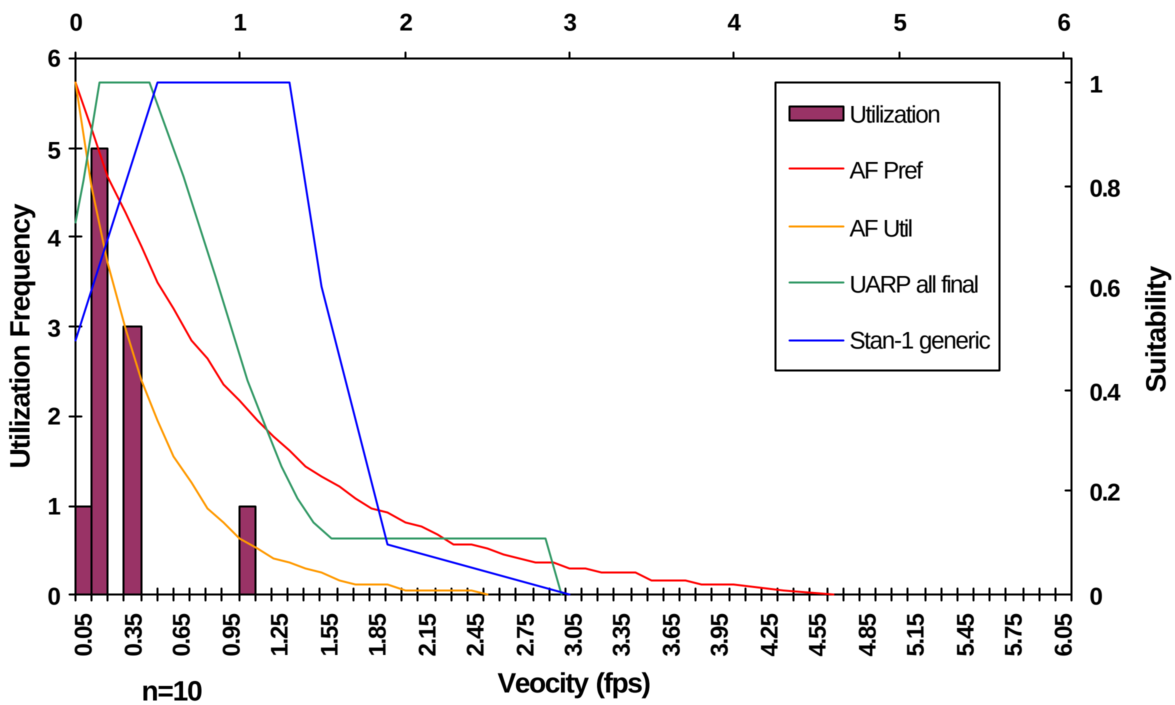


n=10

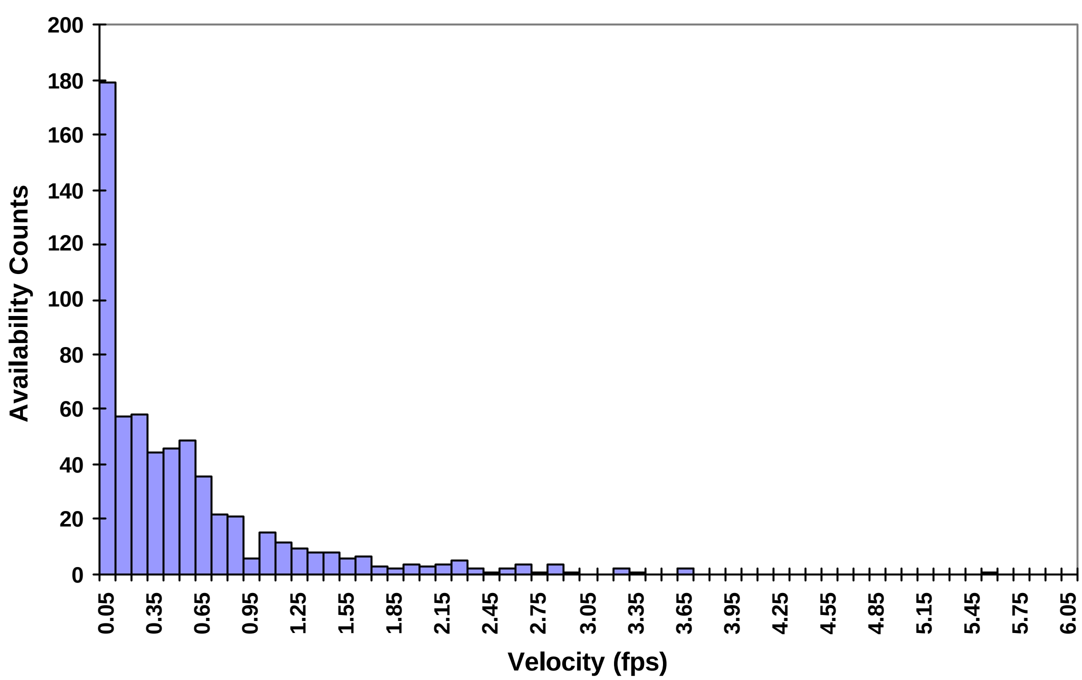
Upper Basin Small Stream
Juvenile Rainbow Trout Depth Availability

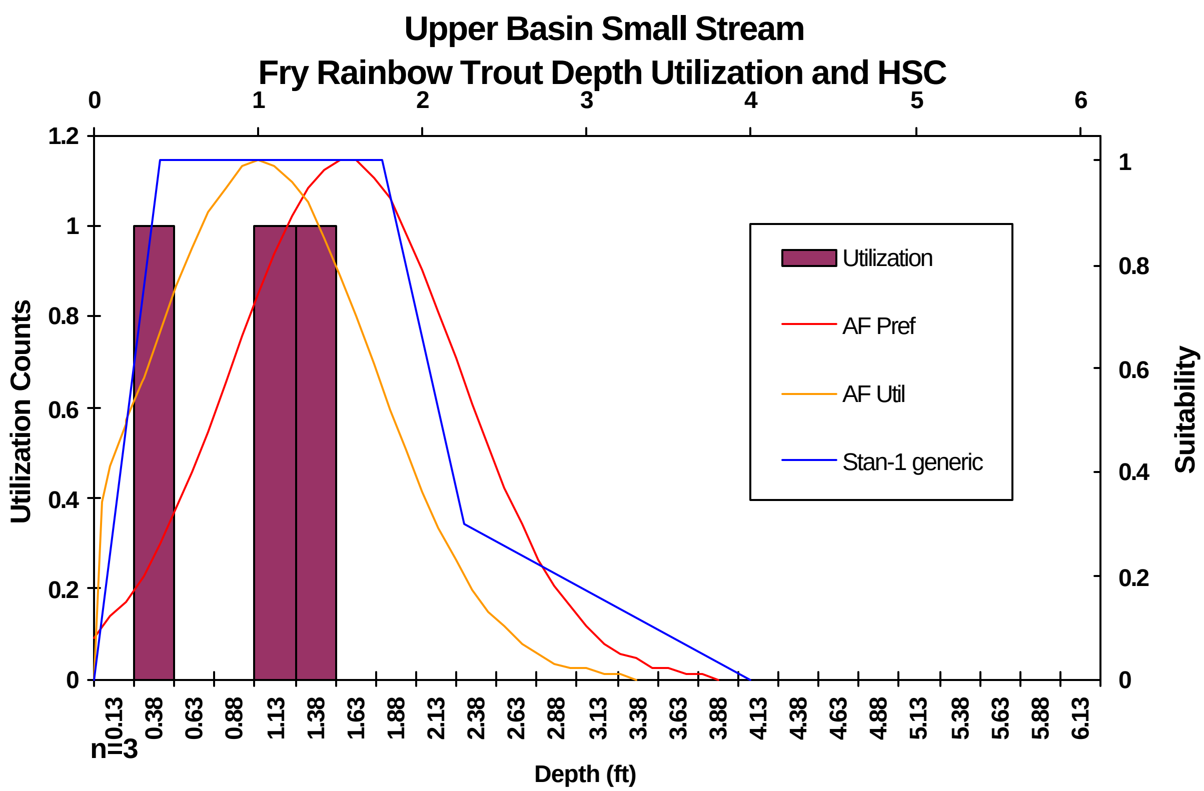


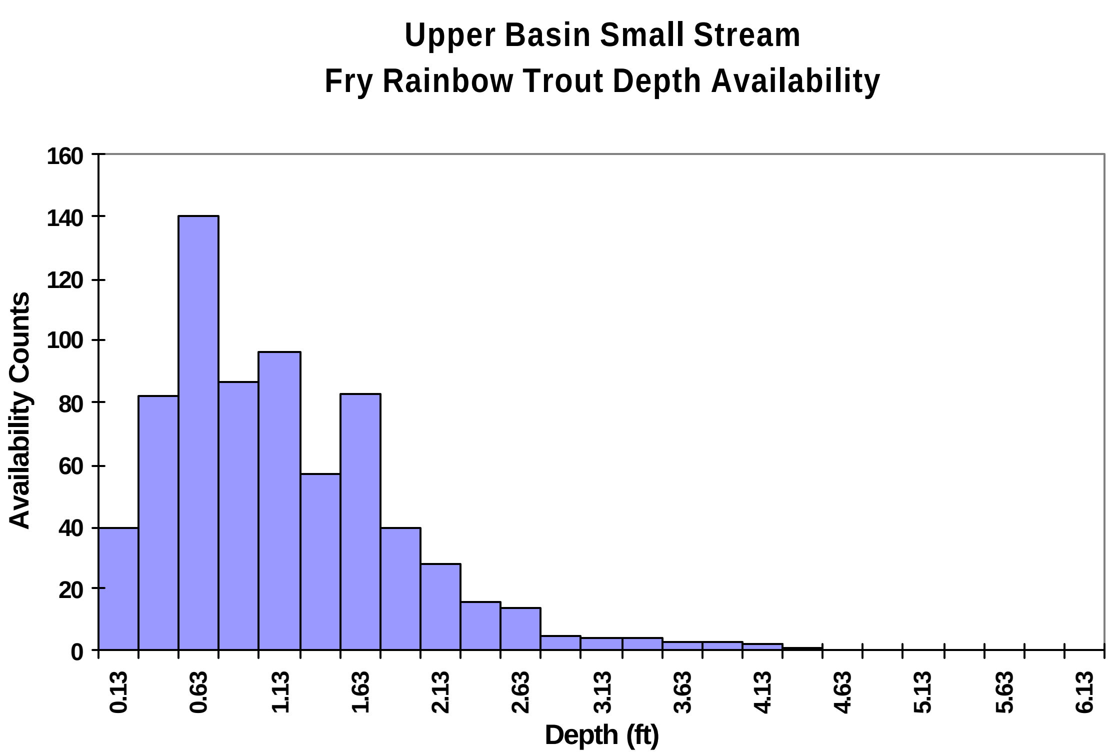
Upper Basin Small Stream
Juvenile Rainbow Trout Velocity Utilization and HSC



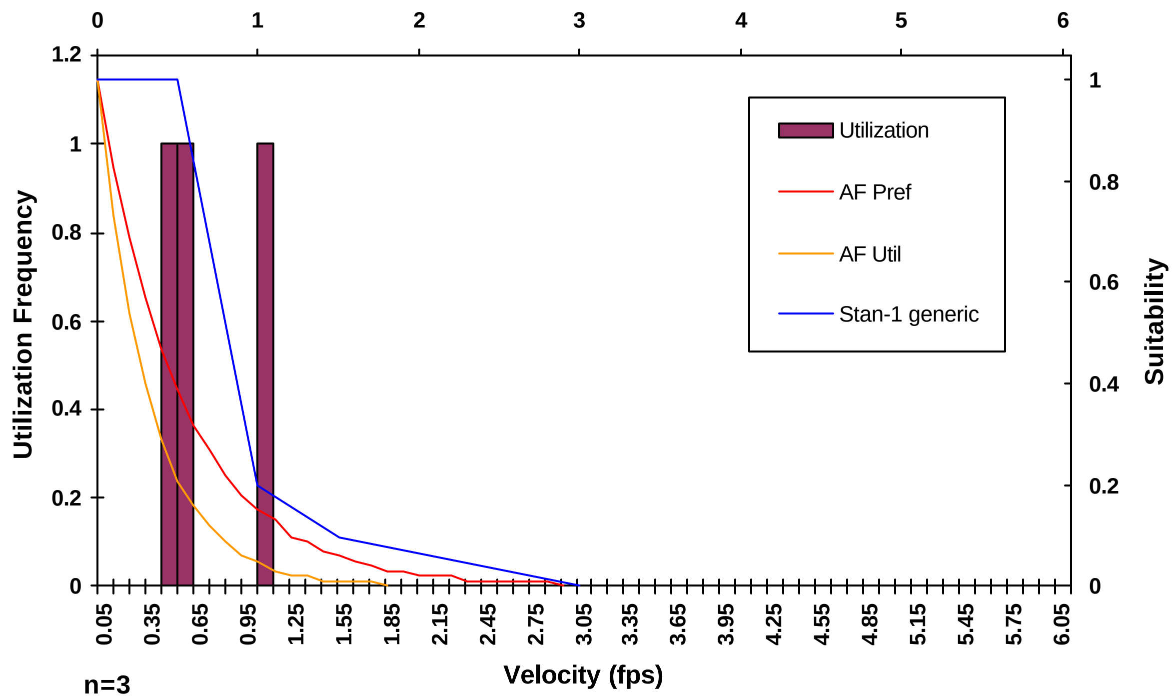
Upper Basin Small Stream
Juvenile Rainbow Trout Velocity Availability



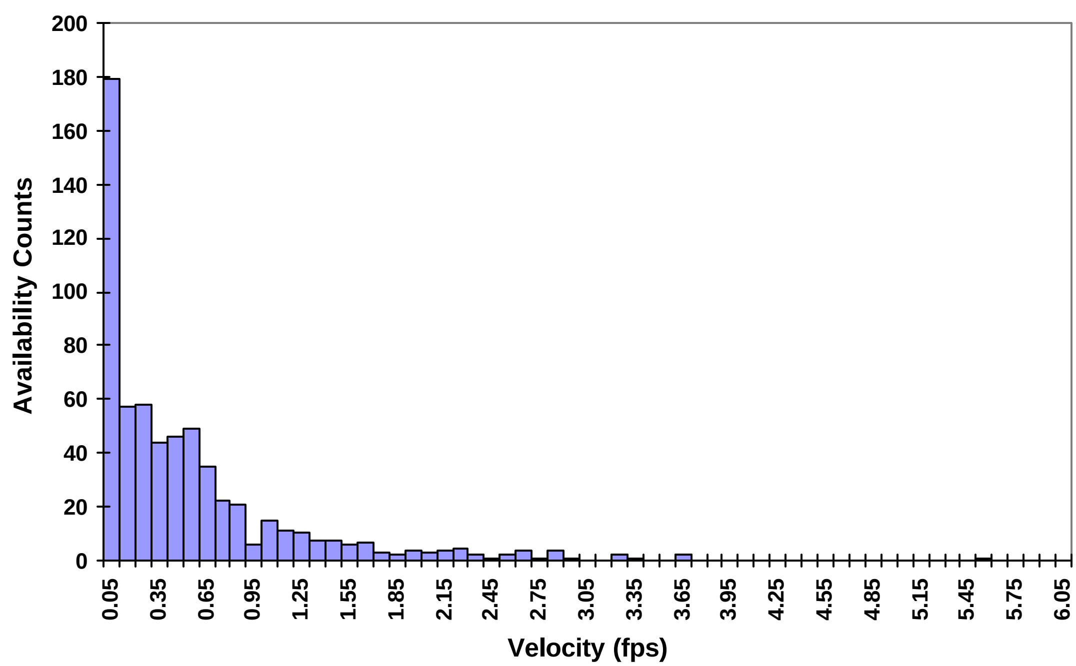

Upper Basin Small Stream
Fry Rainbow Trout Depth Utilization and HSC
Utilization Counts
Suitability
Utilization
AF Pref
AF Util
Stan-1 generic
n=3
Depth (ft)


Upper Basin Small Stream
Fry Rainbow Trout Depth Availability
Availability Counts
Depth (ft)

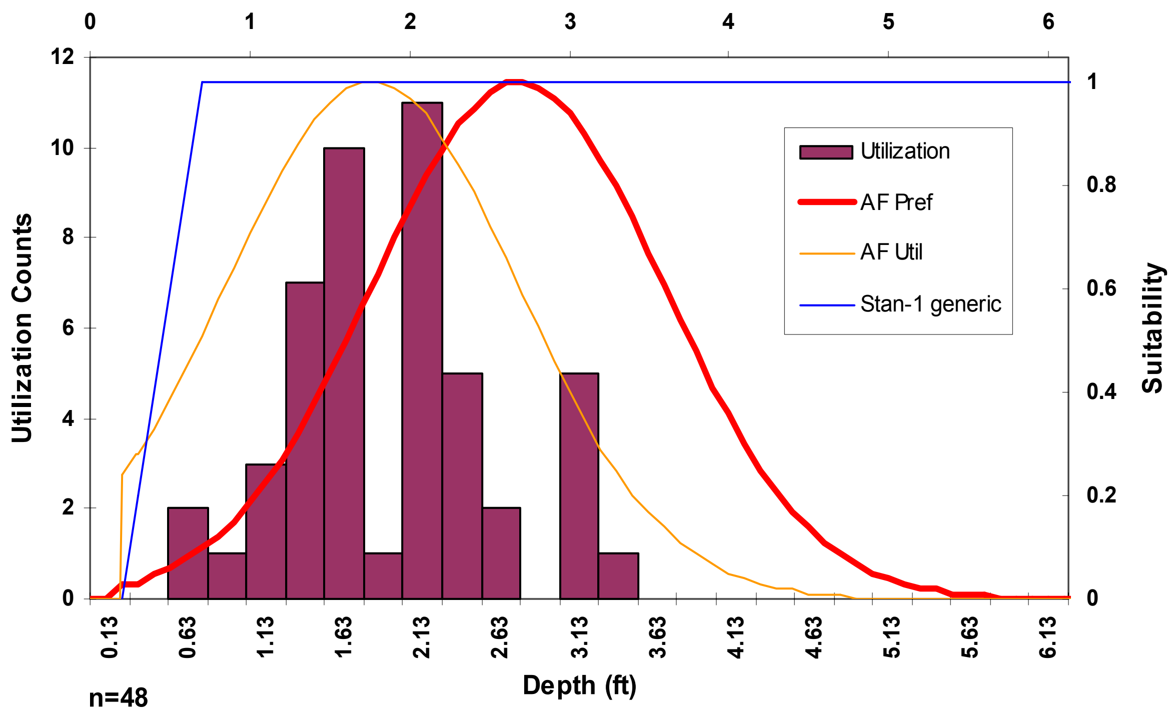
Upper Basin Small Stream
Fry Rainbow Trout Velocity Utilization and HSC



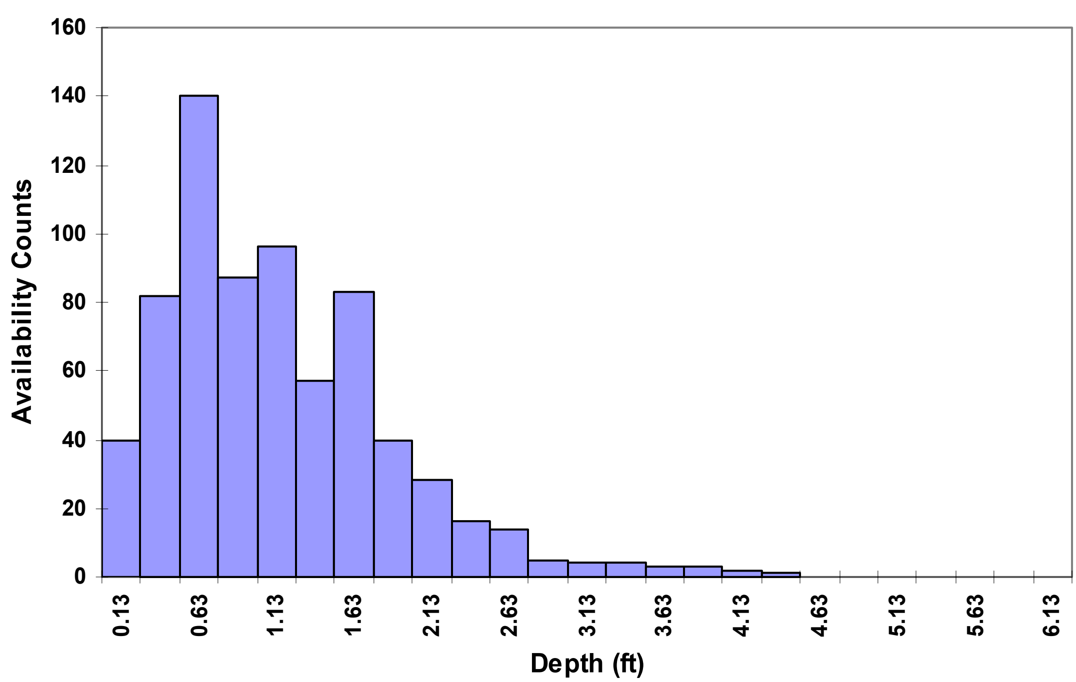
Upper Basin Small Stream
Fry Rainbow Trout Velocity Availability



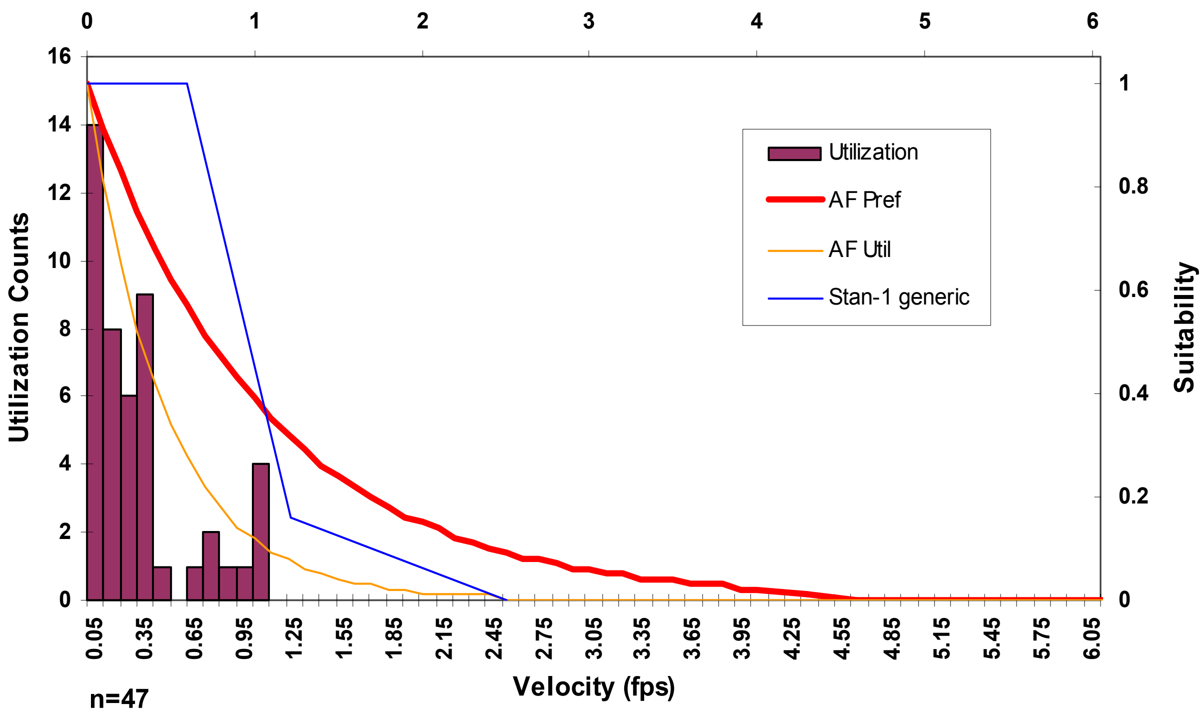
Upper Basin Small Stream
Base Rainbow Trout Depth Utilization and HSC



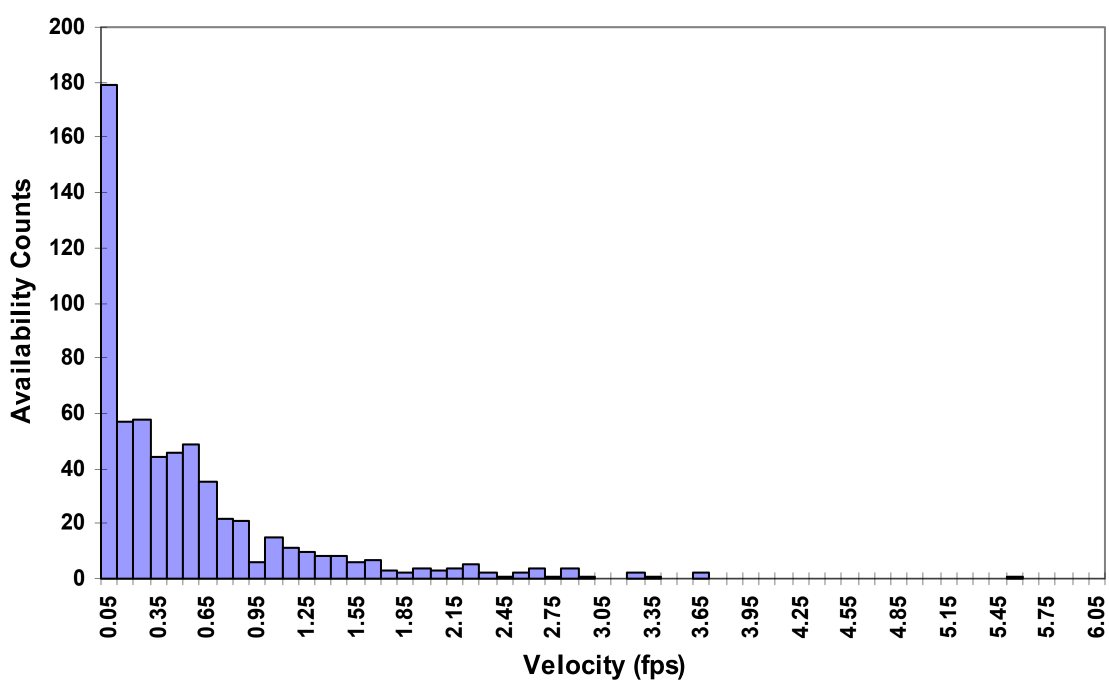
Upper Basin Small Stream
Base Rainbow Trout Depth Availability



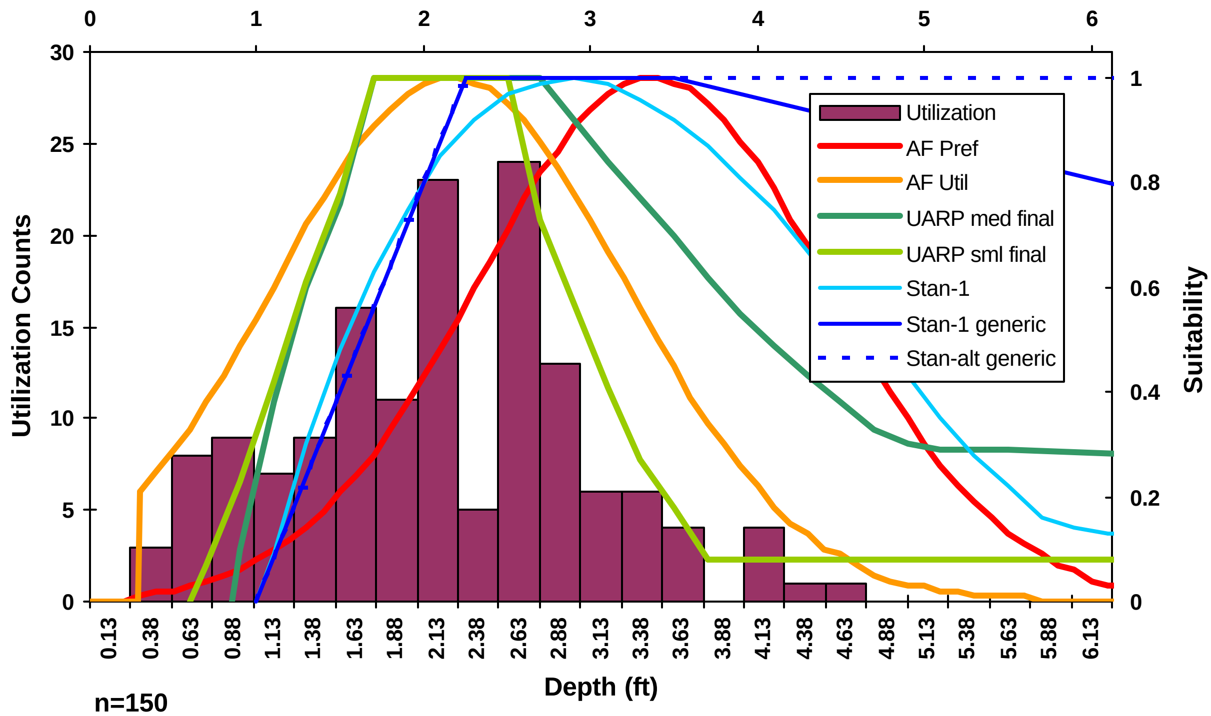
Upper Basin Small Stream
Base Rainbow Trout Velocity Utilization and HSC



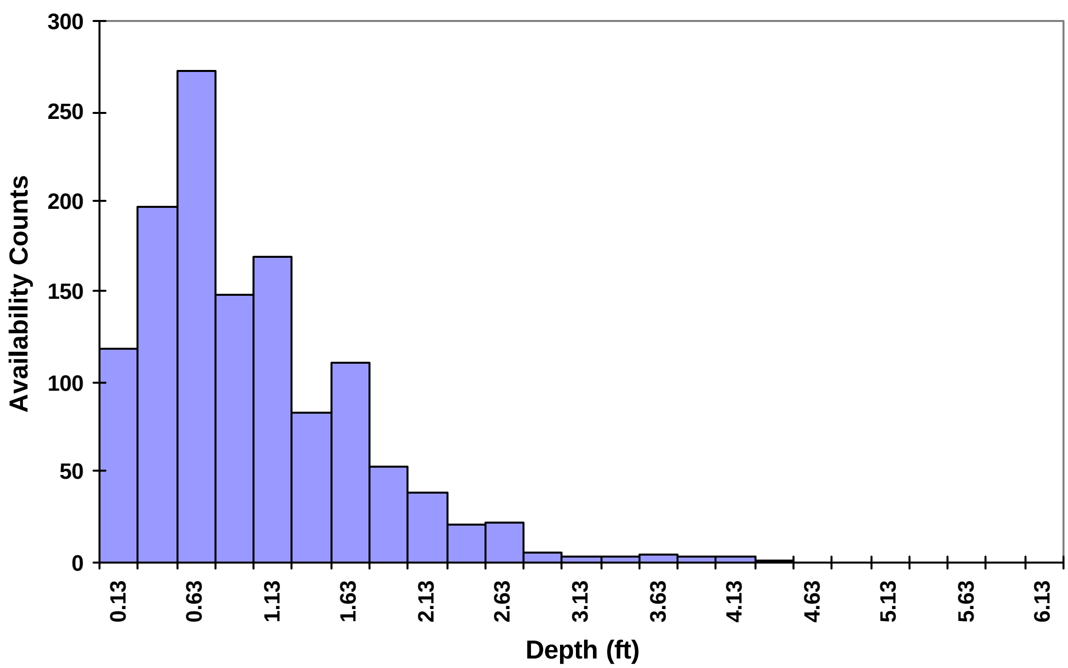
Upper Basin Small Stream
Base Rainbow Trout Velocity Availability



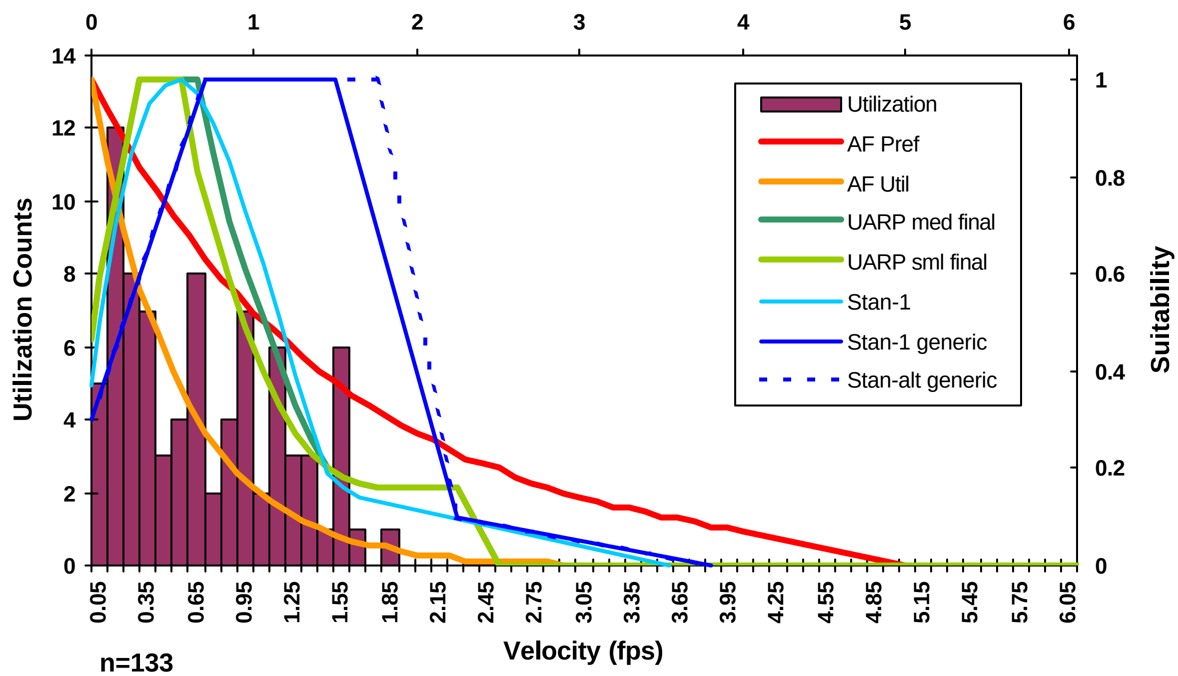
Upper Basin Small Stream
Adult Brown Trout Depth Utilization and HSC



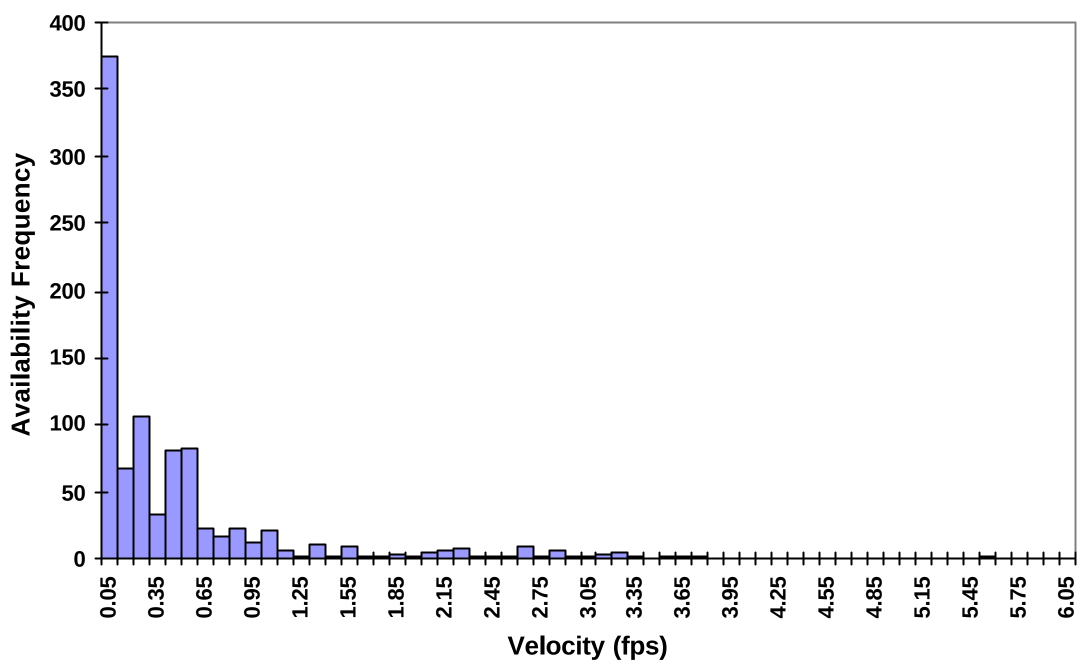
Upper Basin Small Stream
Adult Brown Trout Depth Availability



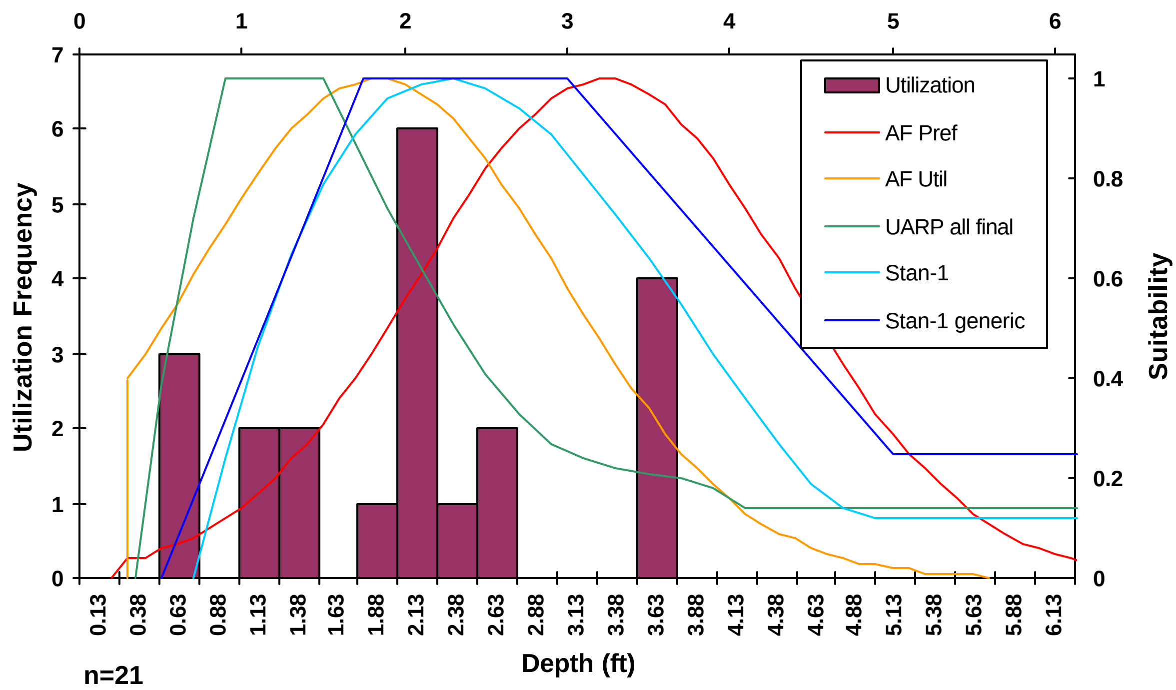
Upper Basin Small Stream
Adult Brown Trout Velocity Utilization and HSC



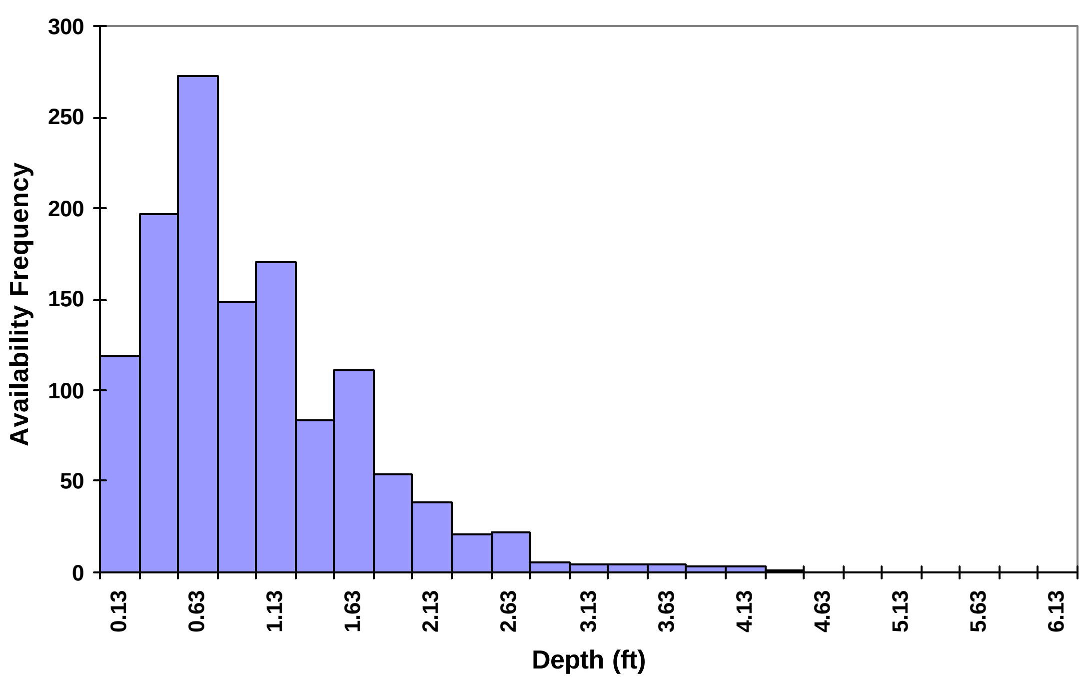
Upper Basin Small Stream
Adult Brown Trout Velocity Availability



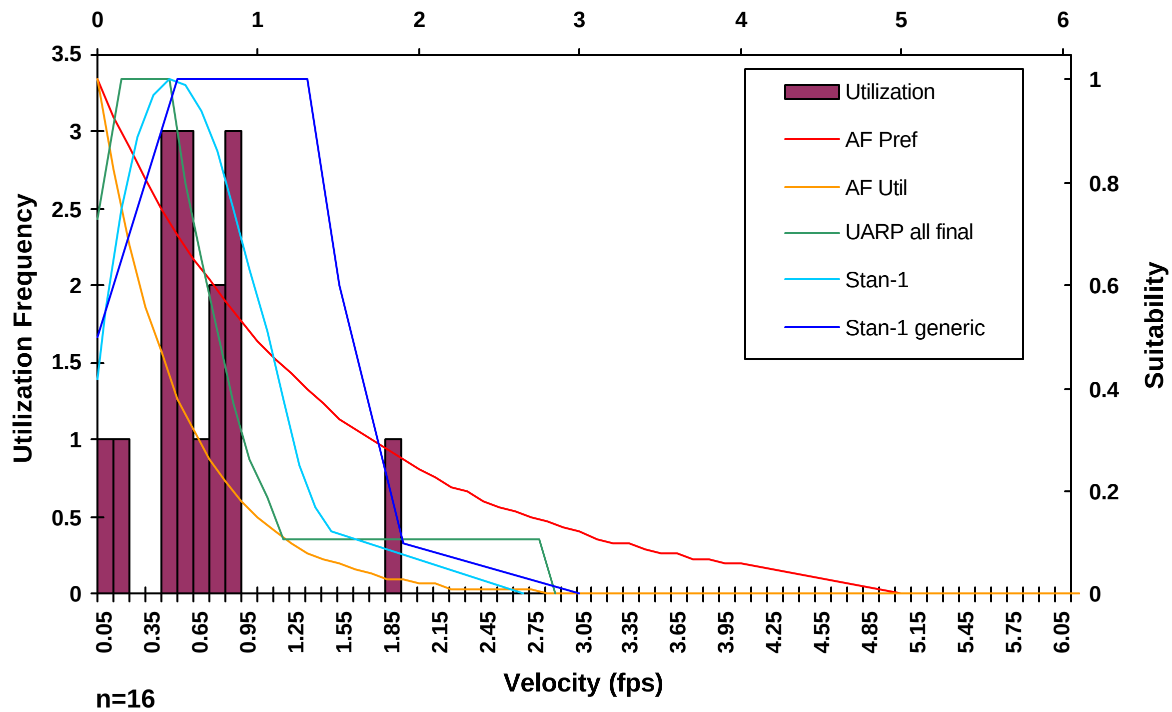
Upper Basin Small Stream
Juvenile Brown Trout Depth Utilization and HSC



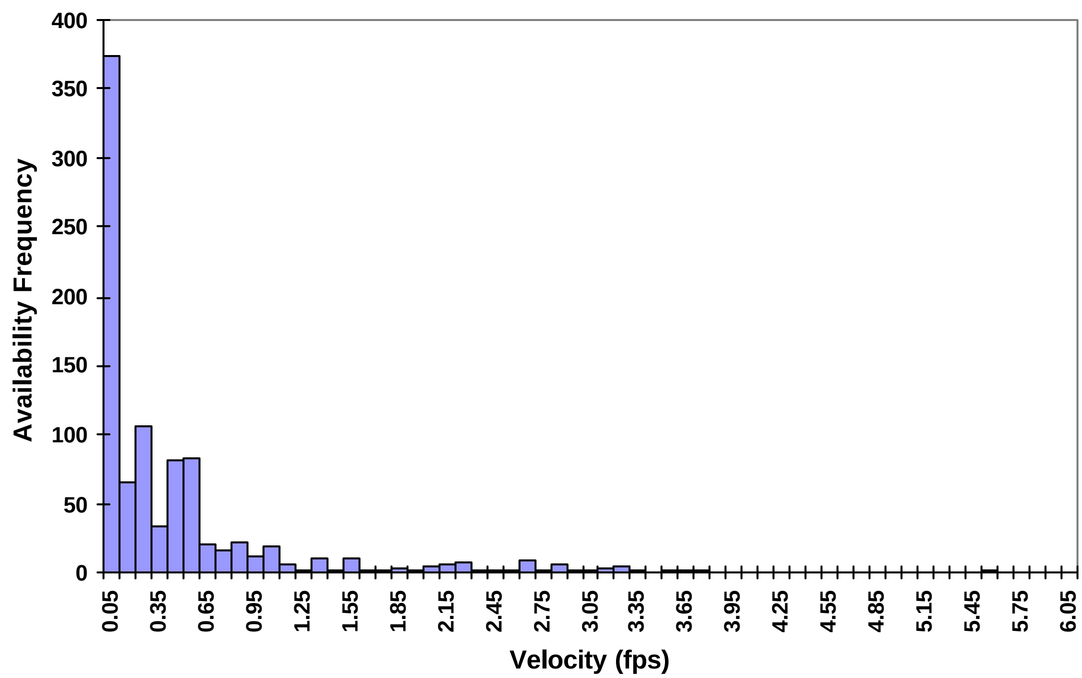
Upper Basin Small Stream
Juvenile Brown Trout Depth Availability



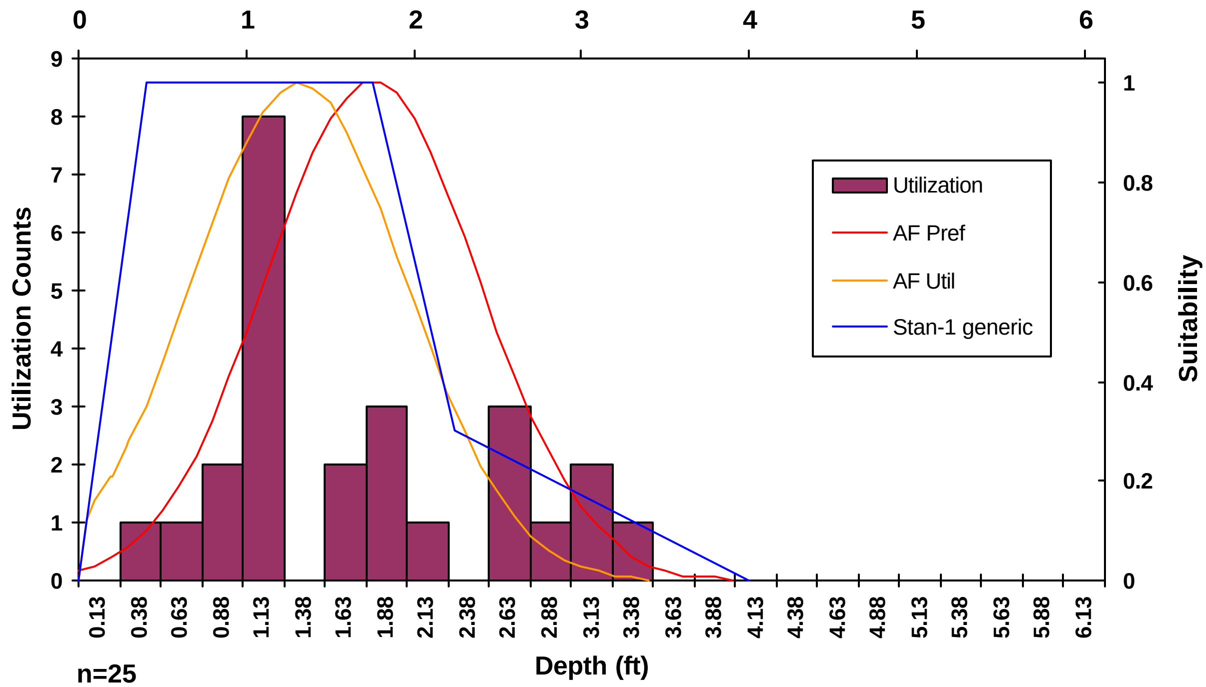
Upper Basin Small Stream
Juvenile Brown Trout Velocity Utilization and HSC



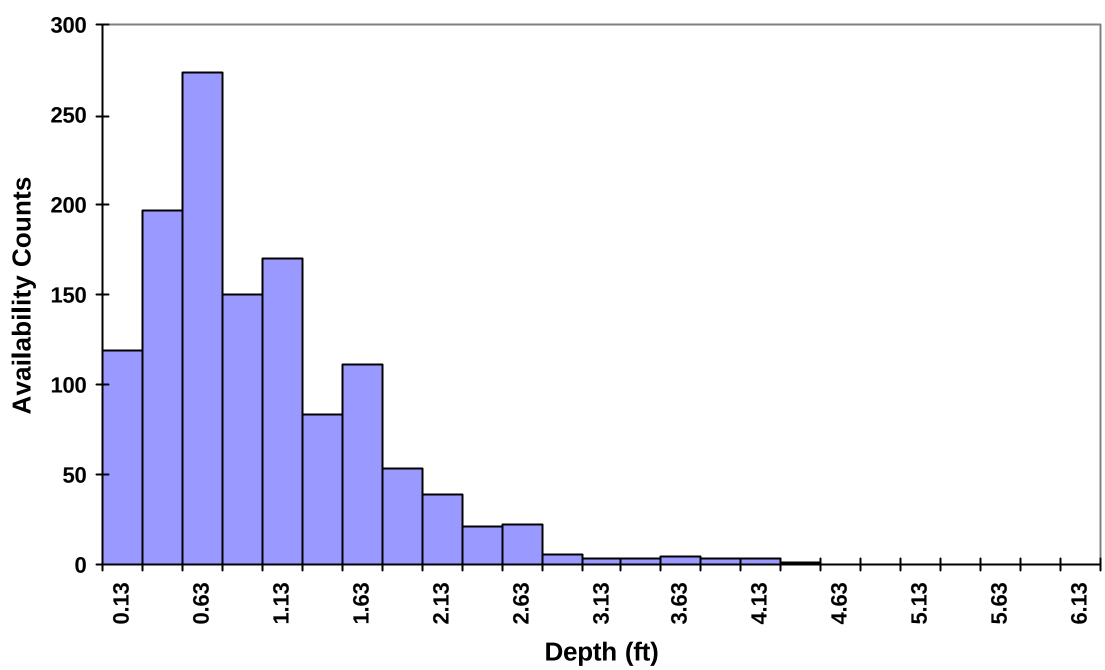
Upper Basin Small Stream
Juvenile Brown Trout Velocity Availability



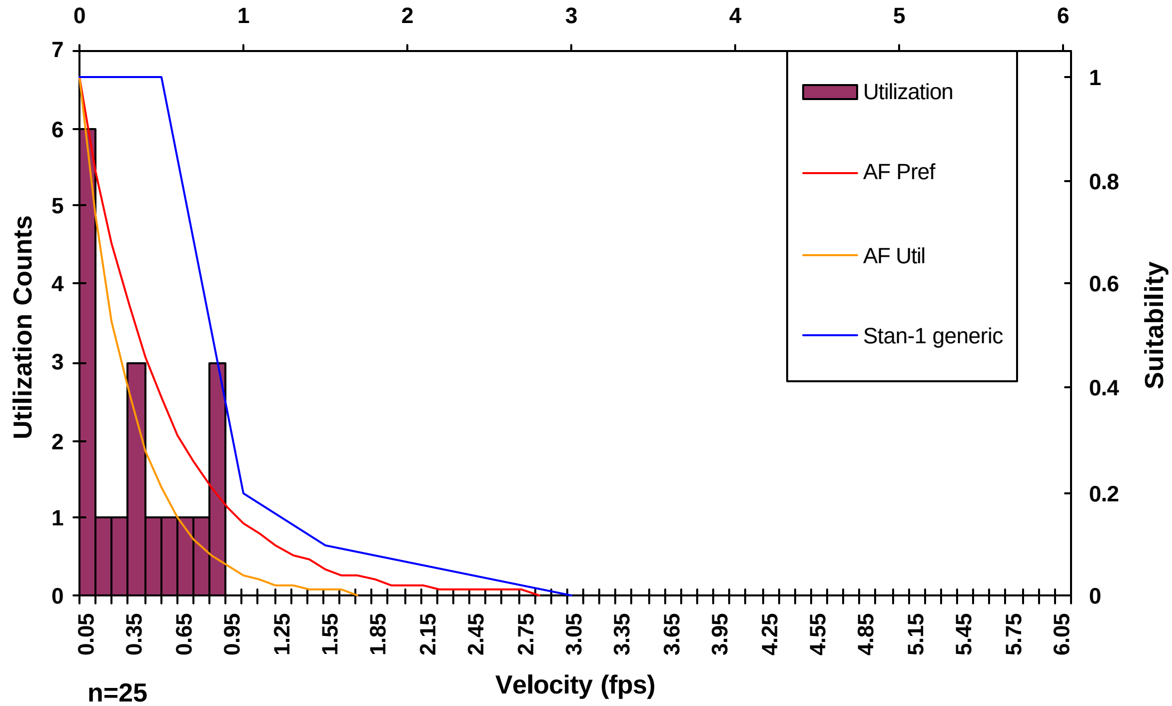
Upper Basin Small Stream
Fry Brown Trout Depth Utilization and HSC



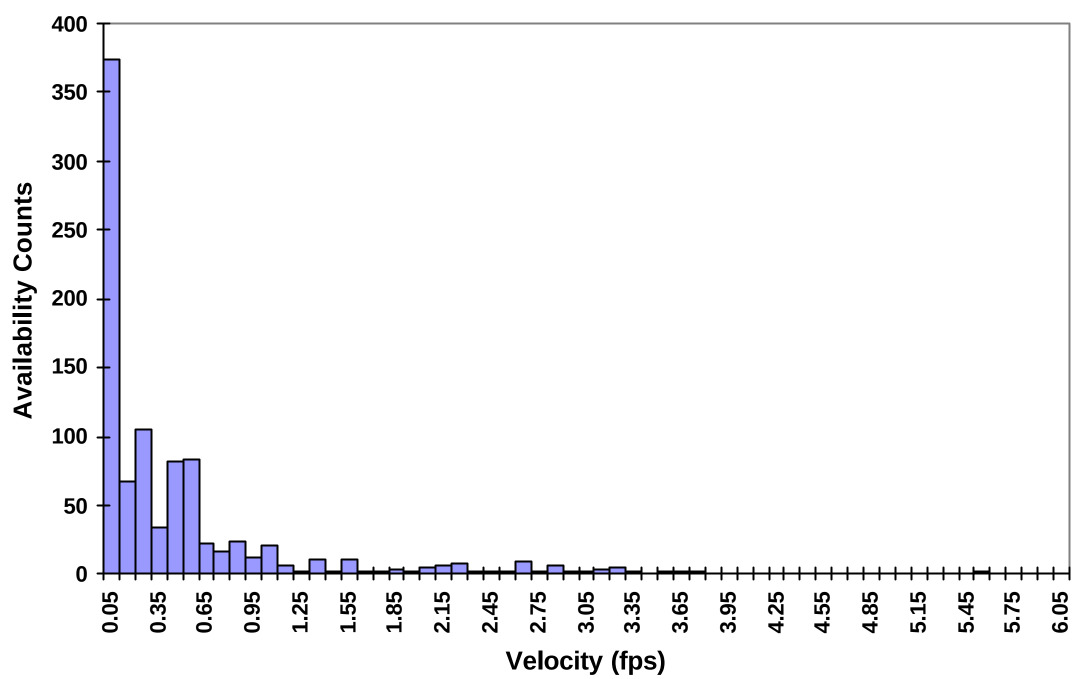
Upper Basin Small Stream
Fry Brown Trout Depth Availability



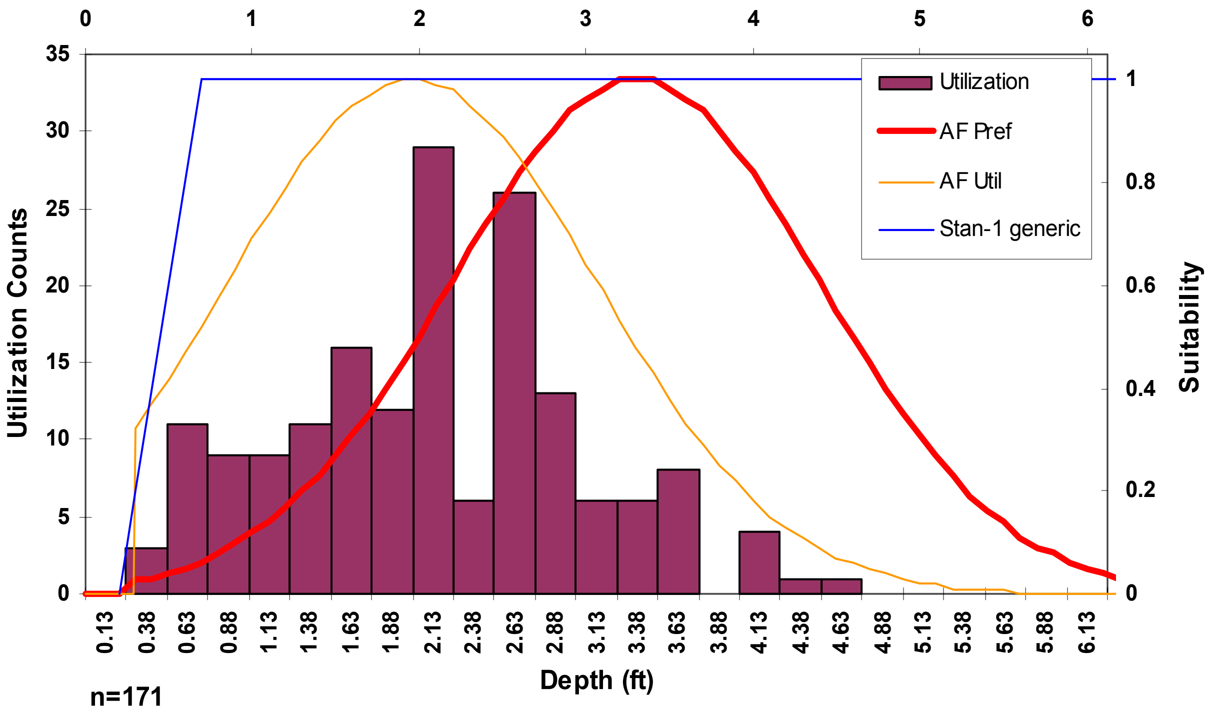
Upper Basin Small Stream
Fry Brown Trout Velocity Utilization and HSC



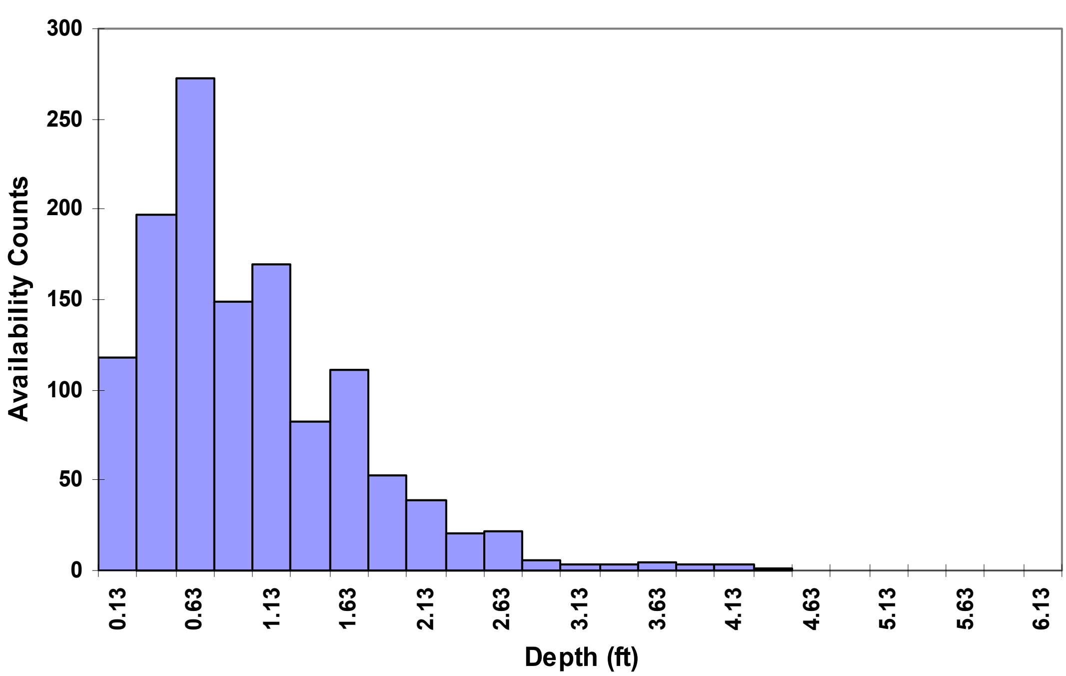
Upper Basin Small Stream
Fry Brown Trout Velocity Availability

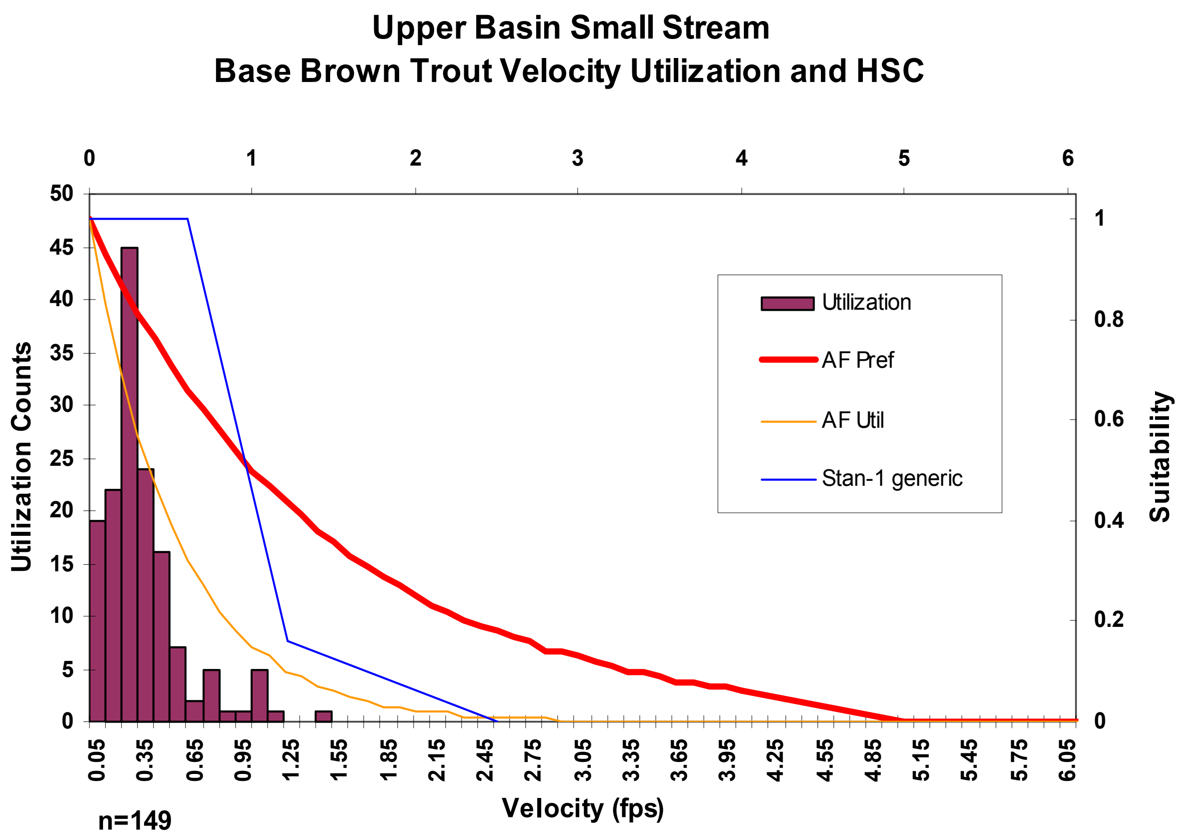


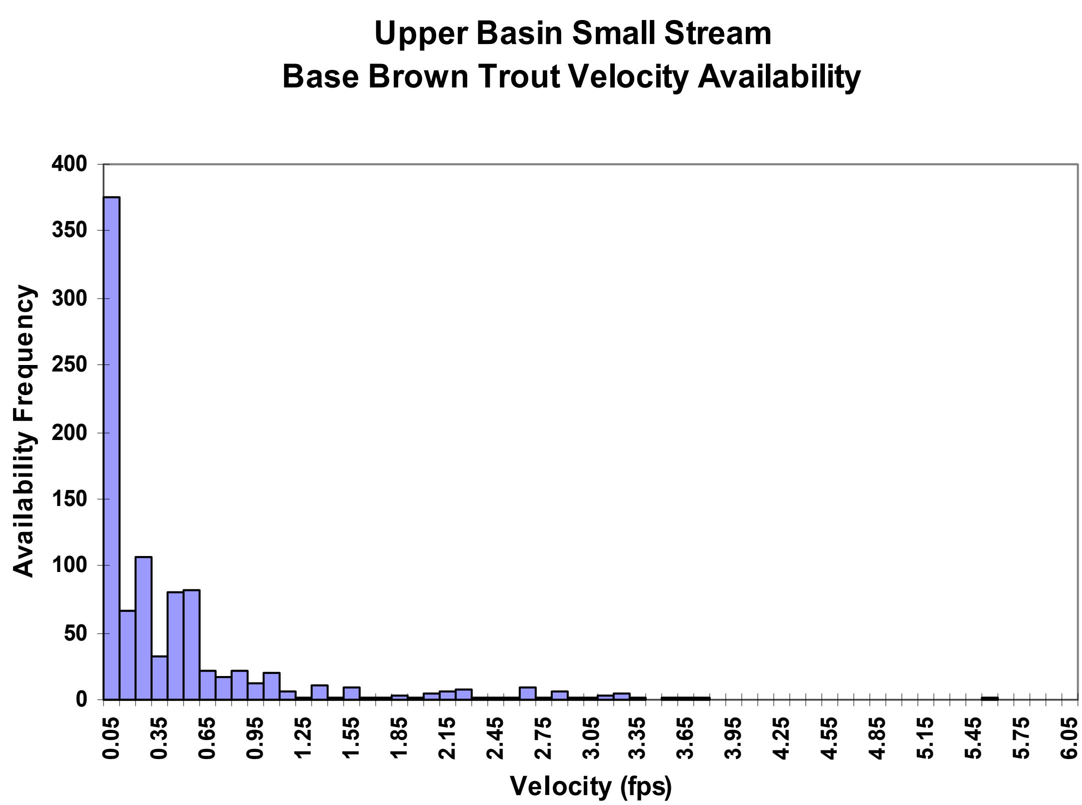
Upper Basin Small Stream
Base Brown Trout Depth Utilization and HSC



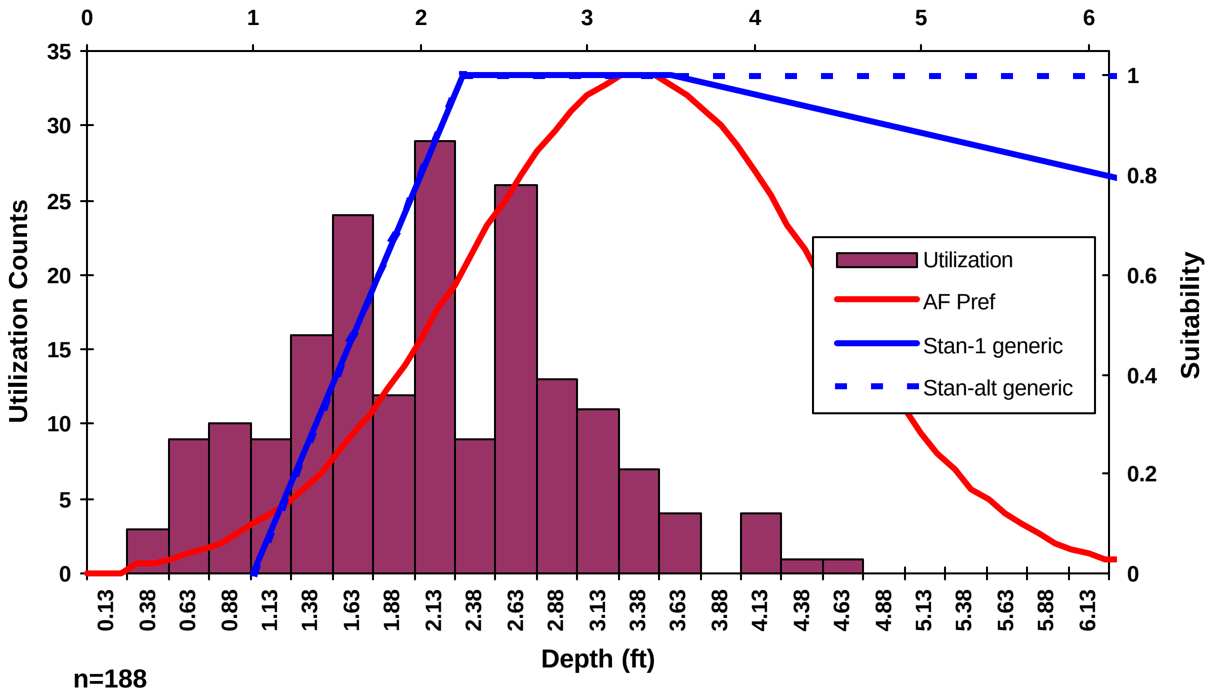
Upper Basin Small Stream
Base Brown Trout Depth Availability




Upper Basin Small Stream
Base Brown Trout Velocity Utilization and HSC
0 1 2 3 4 5 6
Utilization Counts
Suitability
Utilization
AF Pref
AF Util
Stan-1 generic
0.05 0.35 0.65 0.95 1.25 1.55 1.85 2.15 2.45 2.75 3.05 3.35 3.65 3.95 4.25 4.55 4.85 5.15 5.45 5.75 6.05
Velocity (fps)
n=149

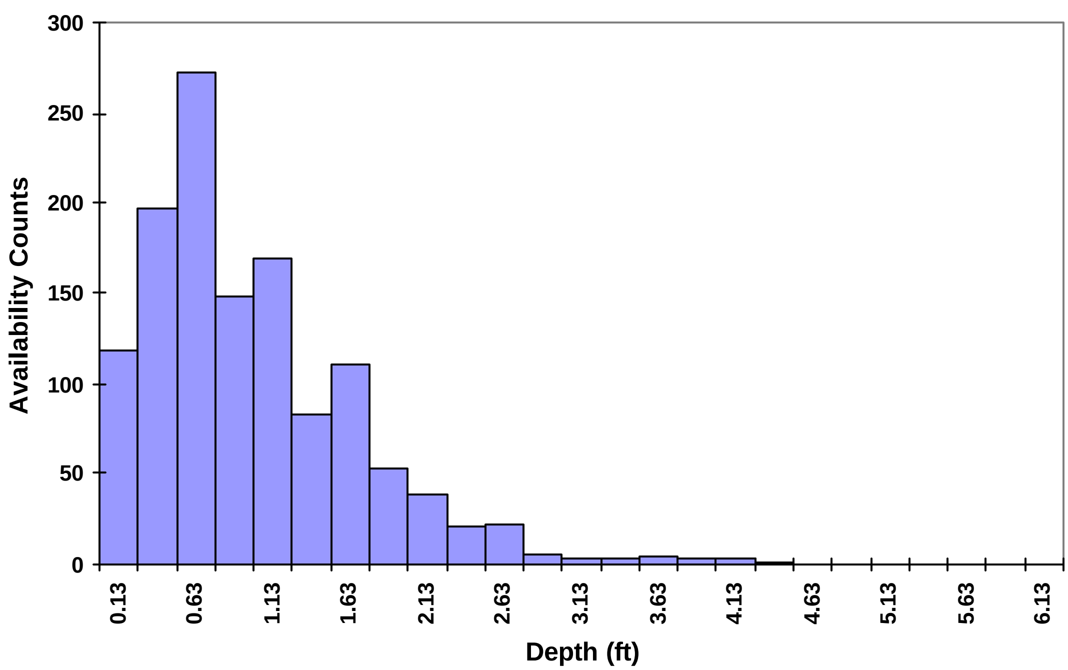

Upper Basin Small Stream
Base Brown Trout Velocity Availability
Availability Frequency
0.05 0.35 0.65 0.95 1.25 1.55 1.85 2.15 2.45 2.75 3.05 3.35 3.65 3.95 4.25 4.55 4.85 5.15 5.45 5.75 6.05
Velocity (fps)

Upper Basin Small Stream
Adult Total Trout Depth Utilization and HSC

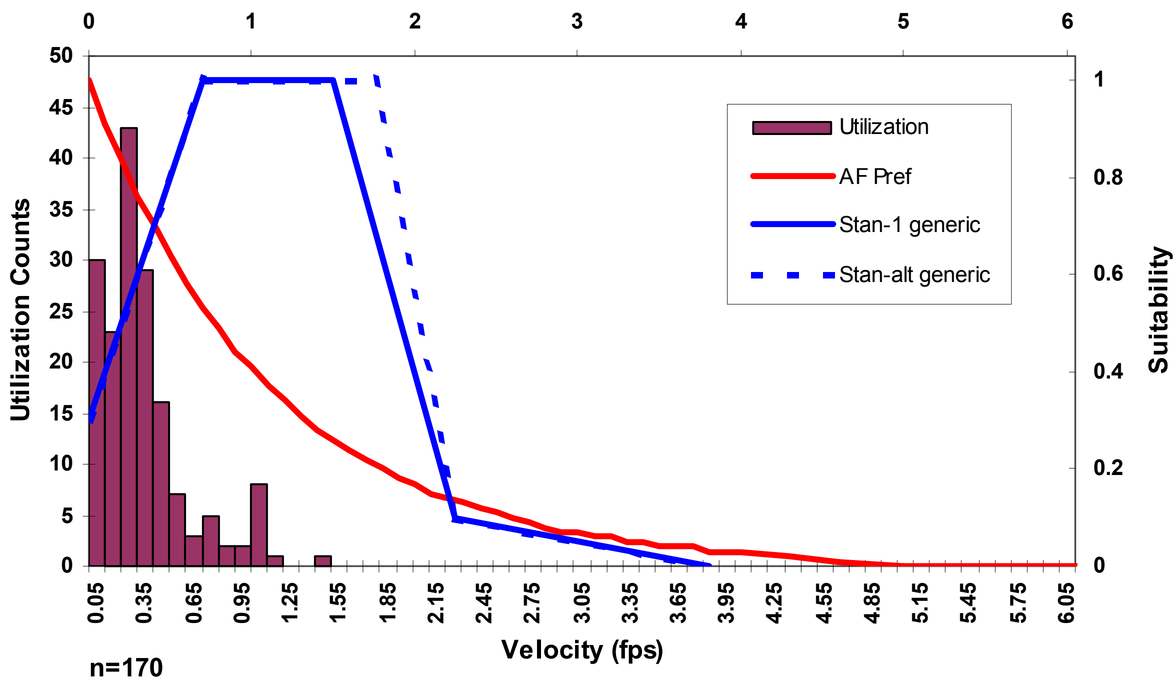


n=188

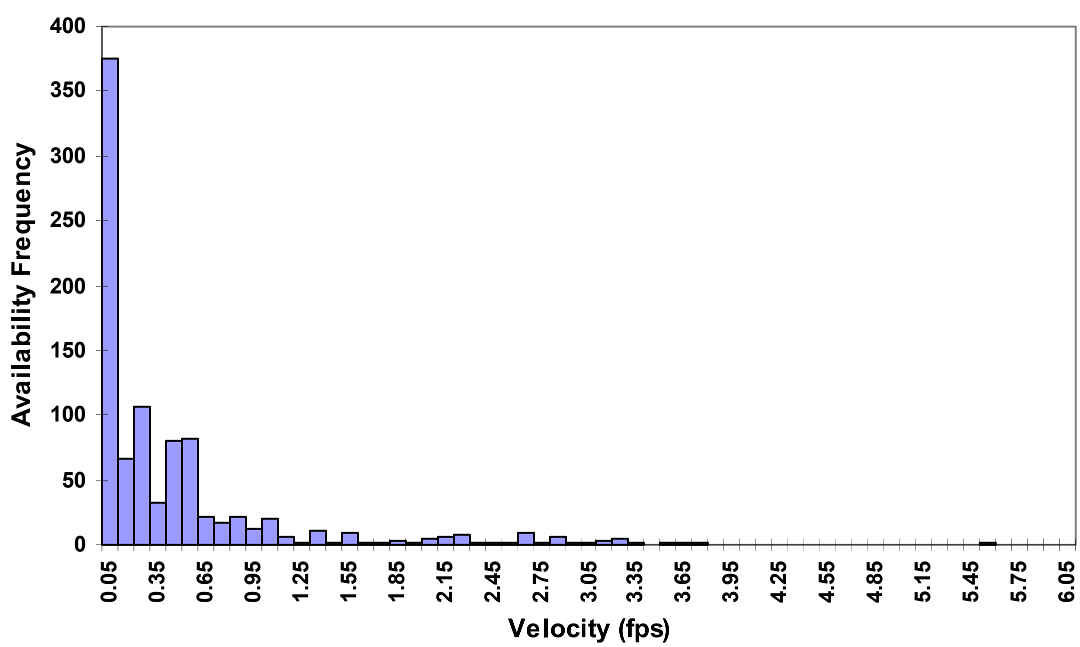
Upper Basin Small Stream
Adult Total Trout Depth Availability



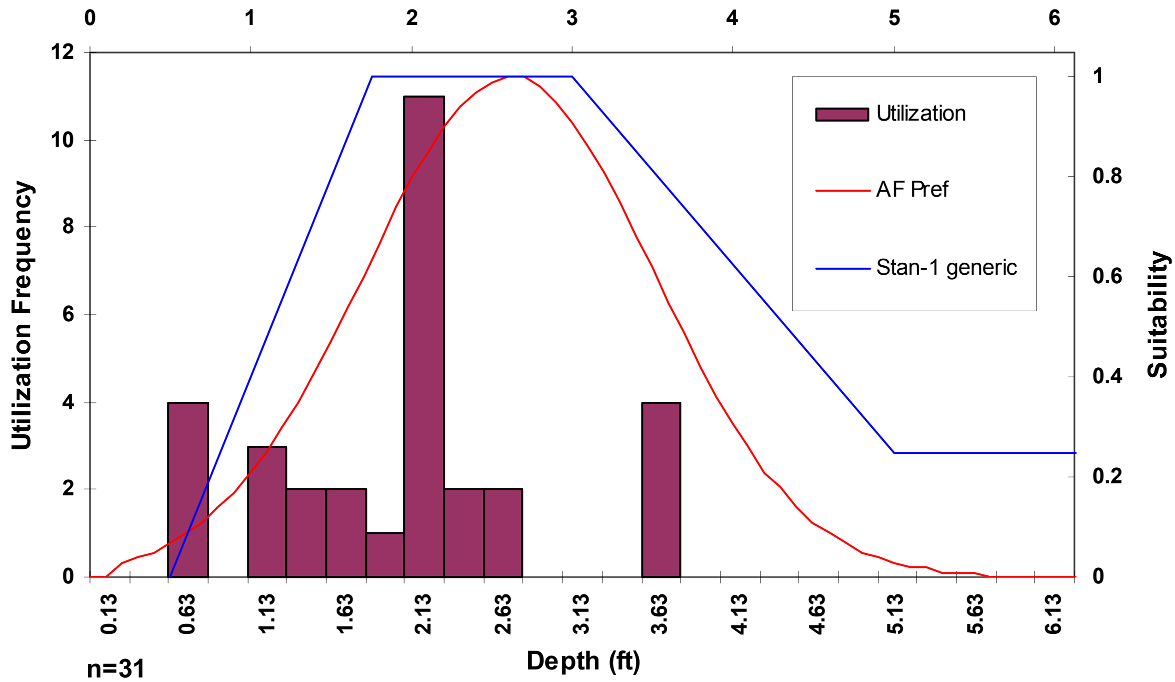
Upper Basin Small Stream
Adult Total Trout Velocity Utilization and HSC



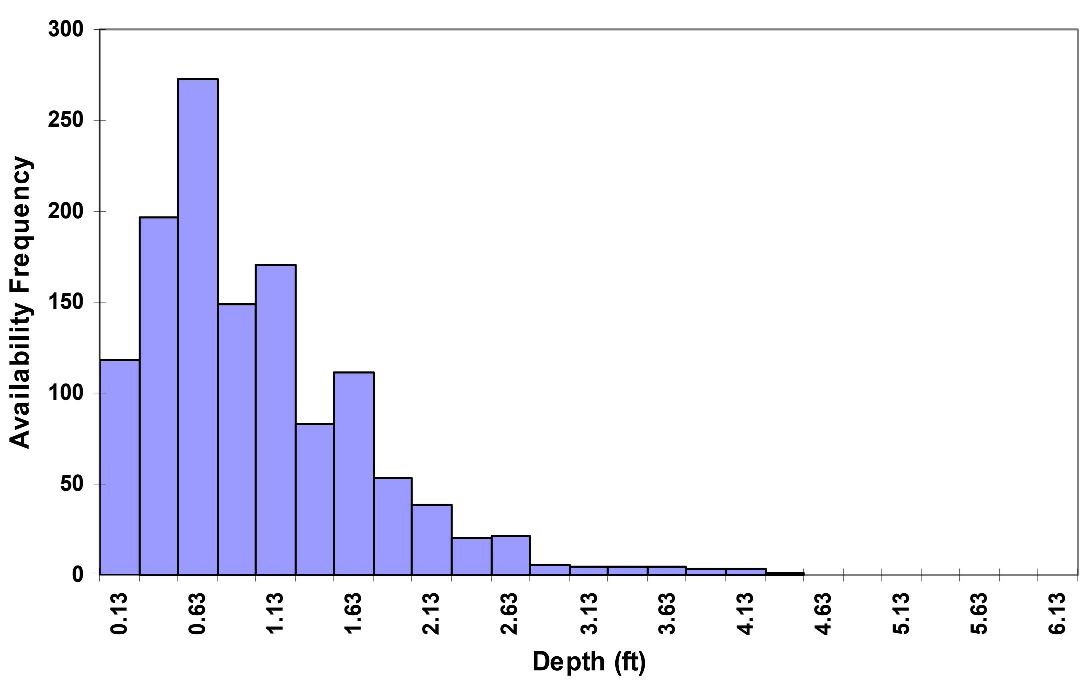
Upper Basin Small Stream
Adult Total Trout Velocity Availability



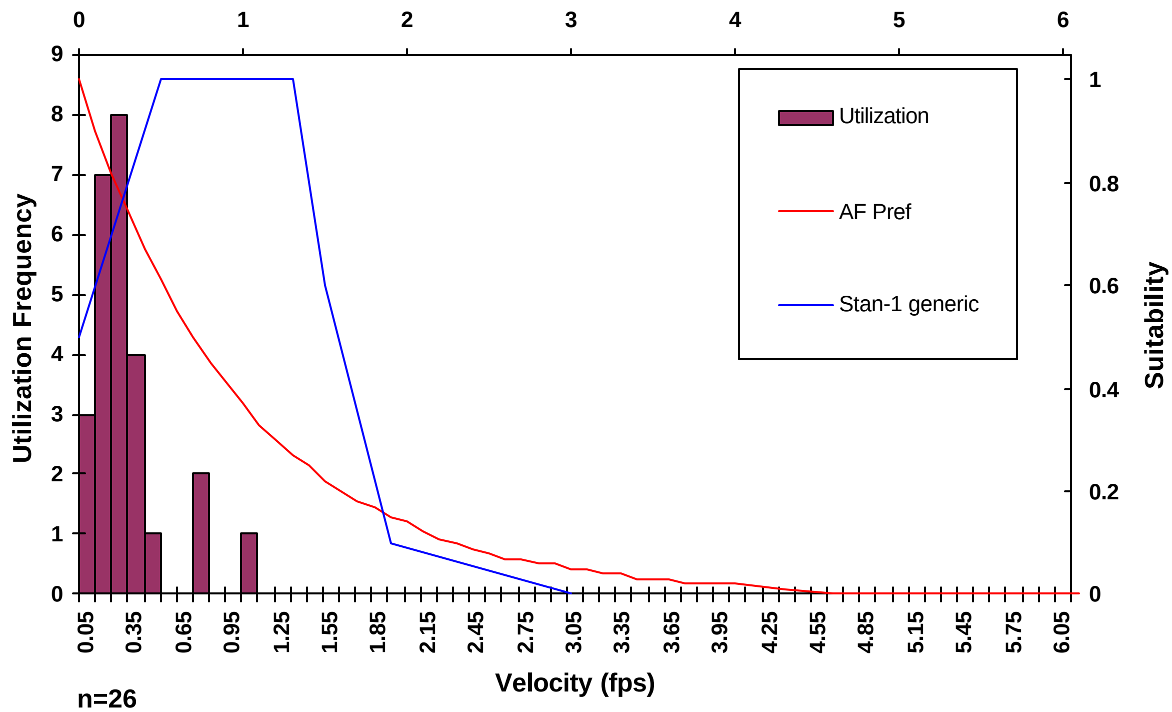
Upper Basin Small Stream
Juvenile Total Trout Depth Utilization and HSC



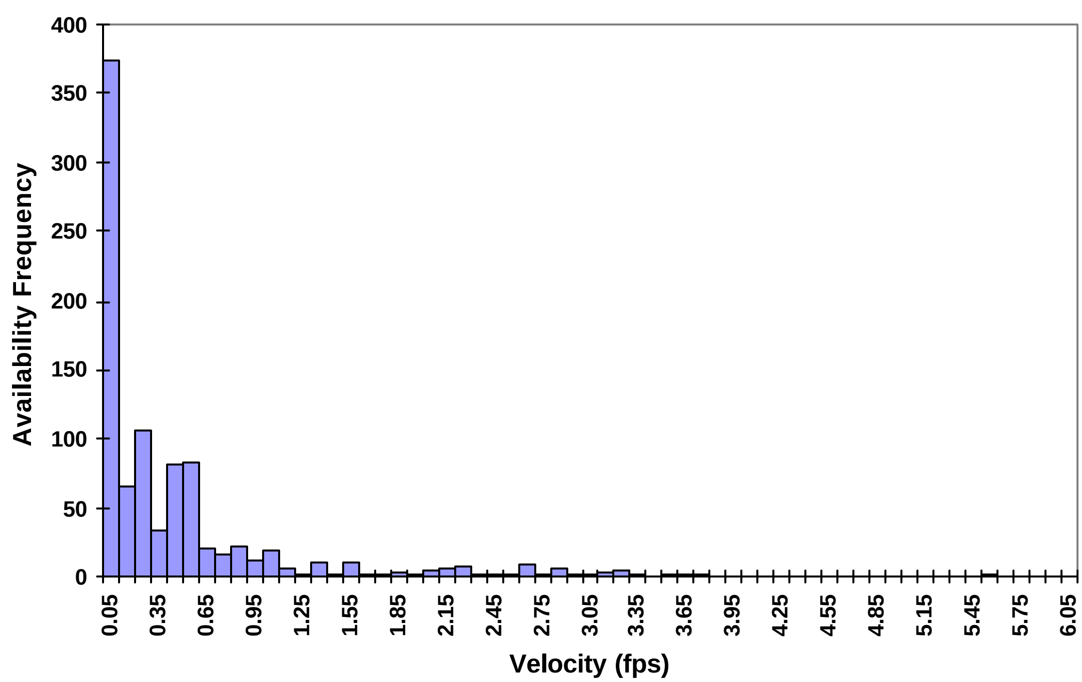
Upper Basin Small Stream
Juvenile Total Trout Depth Availability



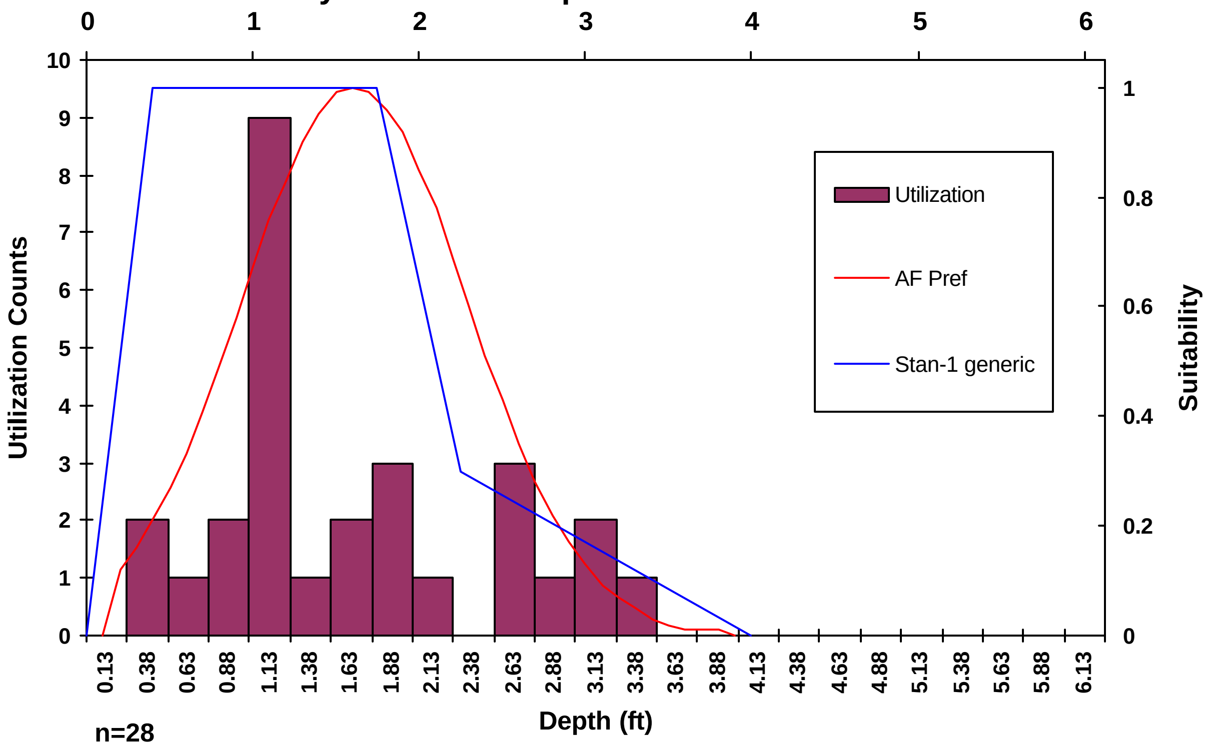
Upper Basin Small Stream
Juvenile Total Trout Velocity Utilization and HSC



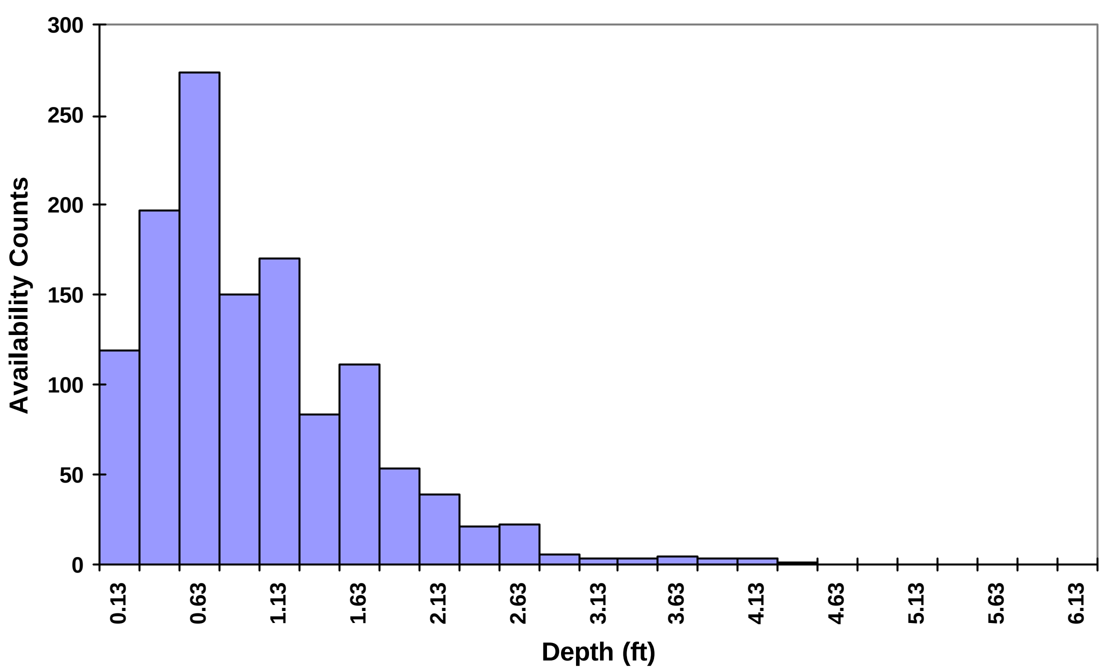
Upper Basin Small Stream
Juvenile Total Trout Velocity Availability



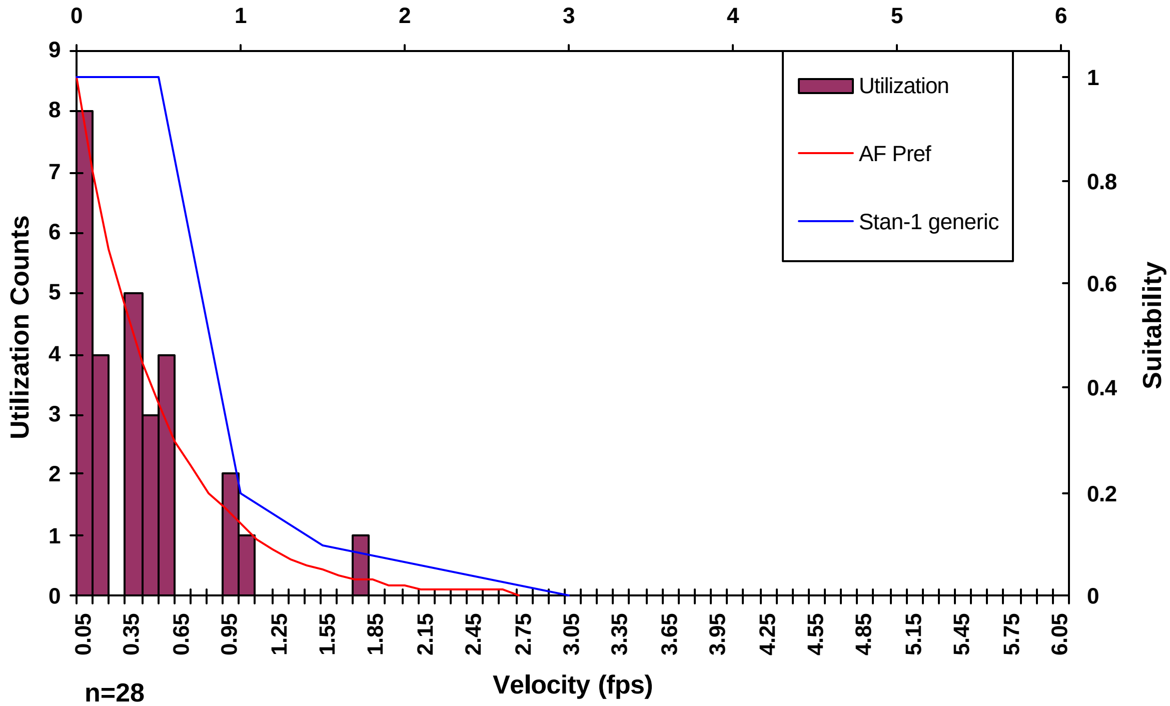
Upper Basin Small Stream
Fry Total Trout Depth Utilization and HSC



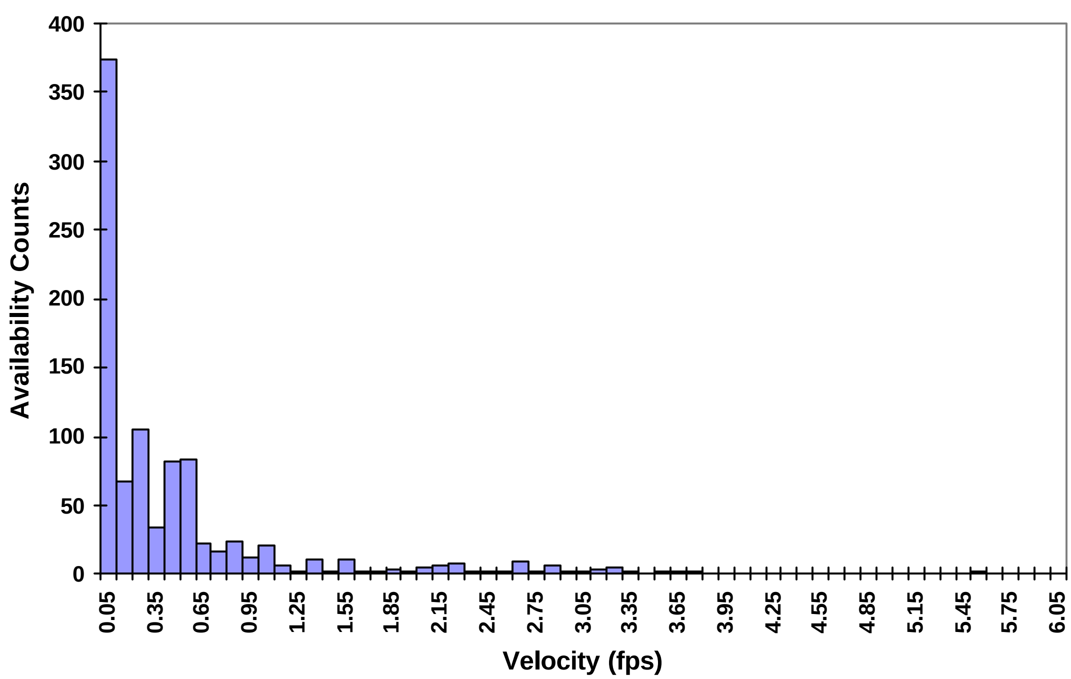
Upper Basin Small Stream
Fry Total Trout Depth Availability



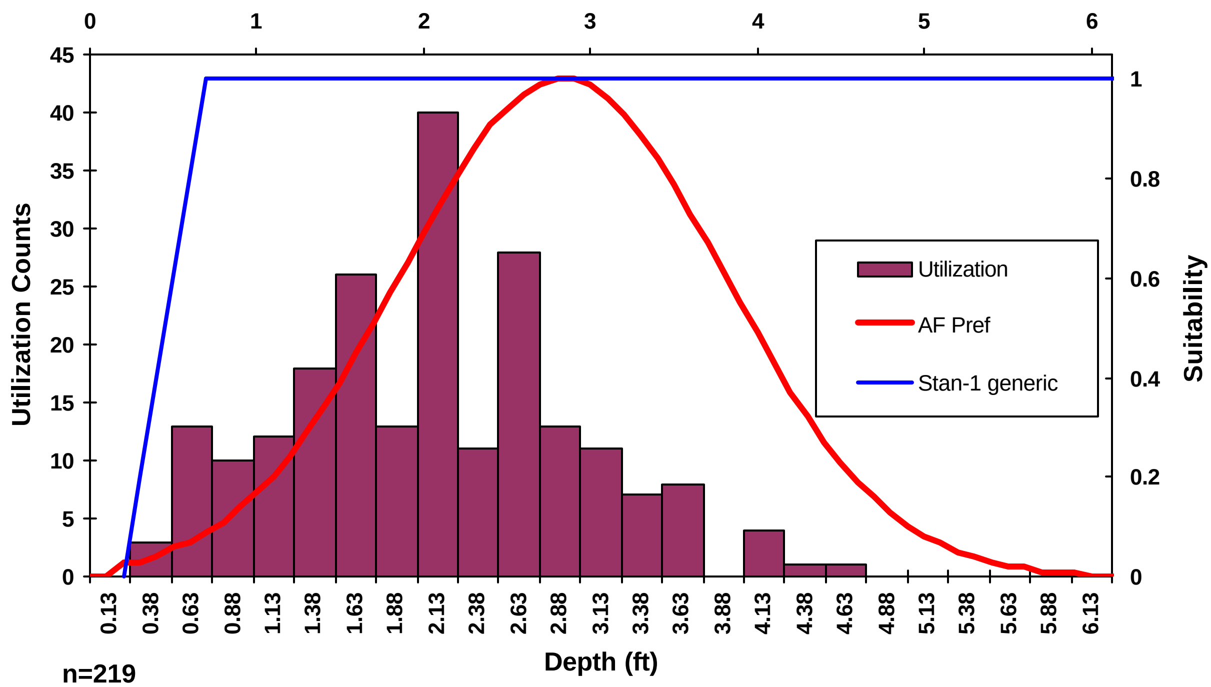
Upper Basin Small Stream
Fry Total Trout Velocity Utilization and HSC



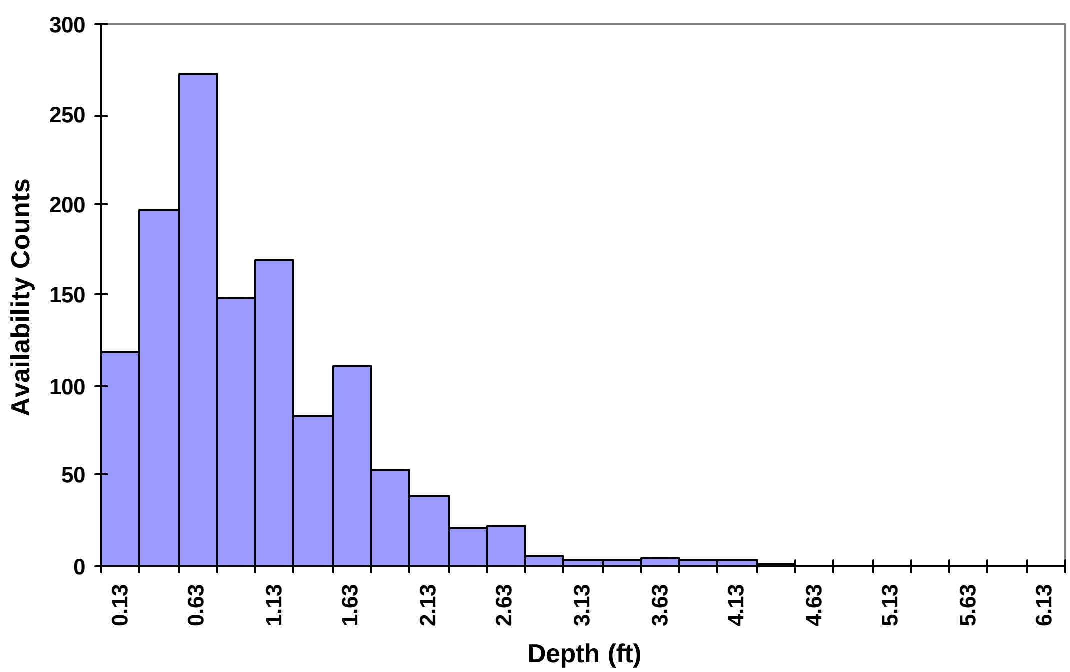
Upper Basin Small Stream
Fry Total Trout Velocity Availability

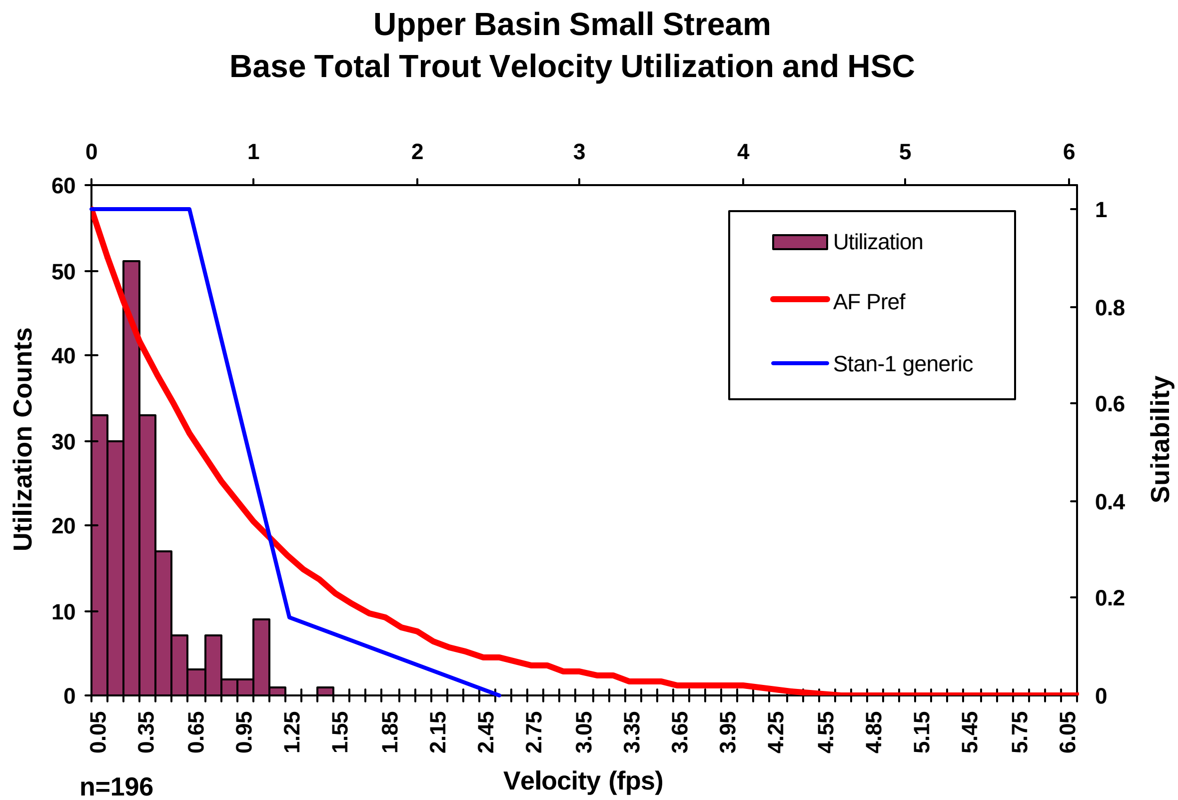


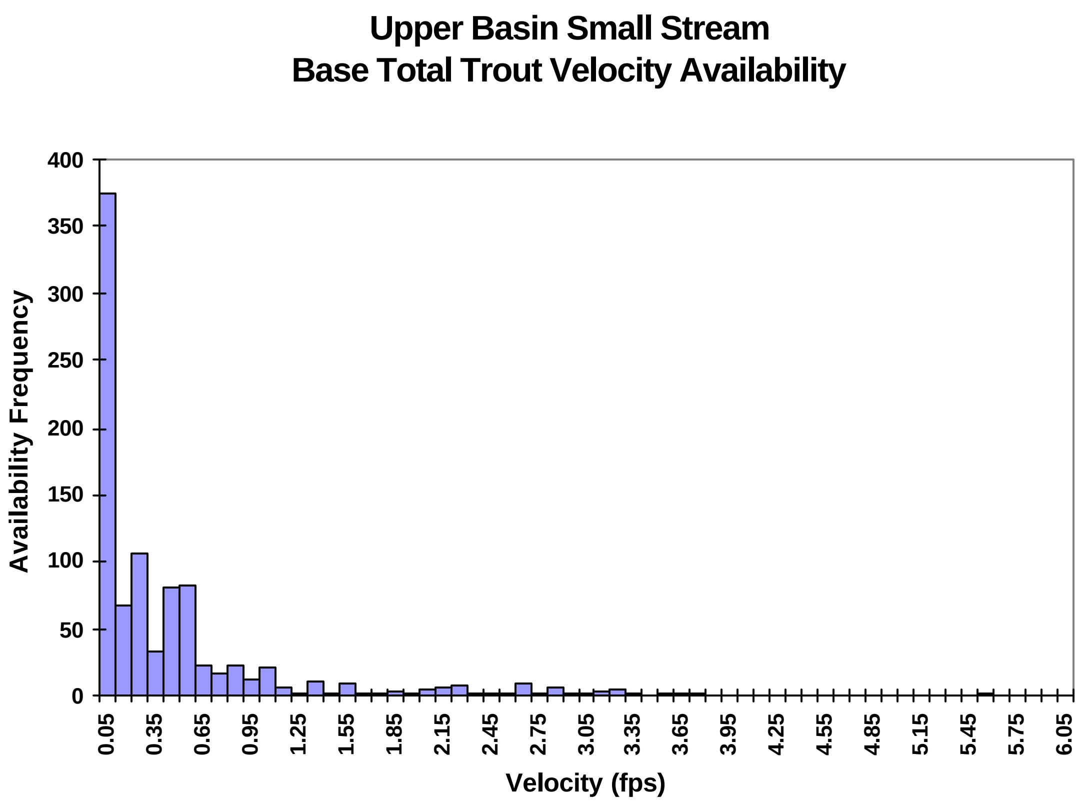
Upper Basin Small Stream
Base Total Trout Depth Utilization and HSC



Upper Basin Small Stream
Base Total Trout Depth Availability




Upper Basin Small Stream
Base Total Trout Velocity Utilization and HSC
Utilization
AF Pref
Stan-1 generic
Utilization Counts
Suitability
Velocity (fps)
n=196


Upper Basin Small Stream
Base Total Trout Velocity Availability
Availability Frequency
Velocity (fps)

ATTACHMENT C

FINAL BIG CREEK ALP HABITAT SUITABILITY CRITERIA

Big Creek ALP

Final Habitat Suitability Criteria

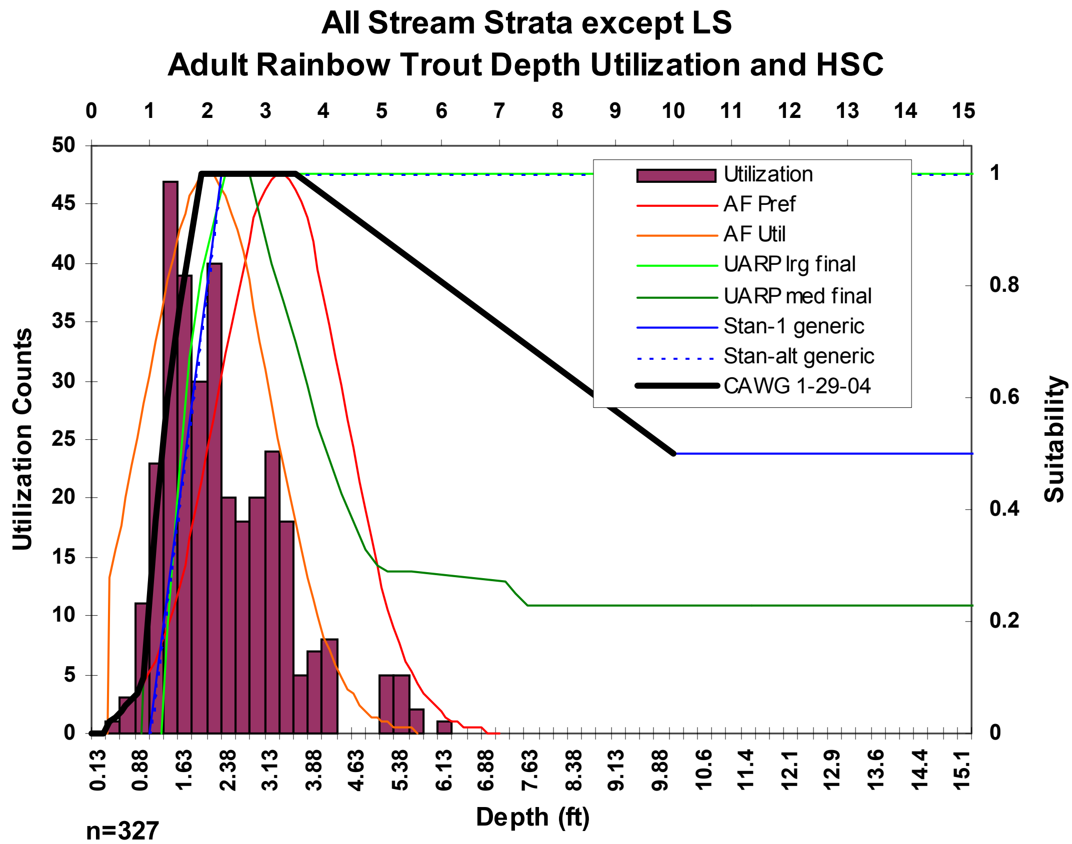
Approved by CAWG

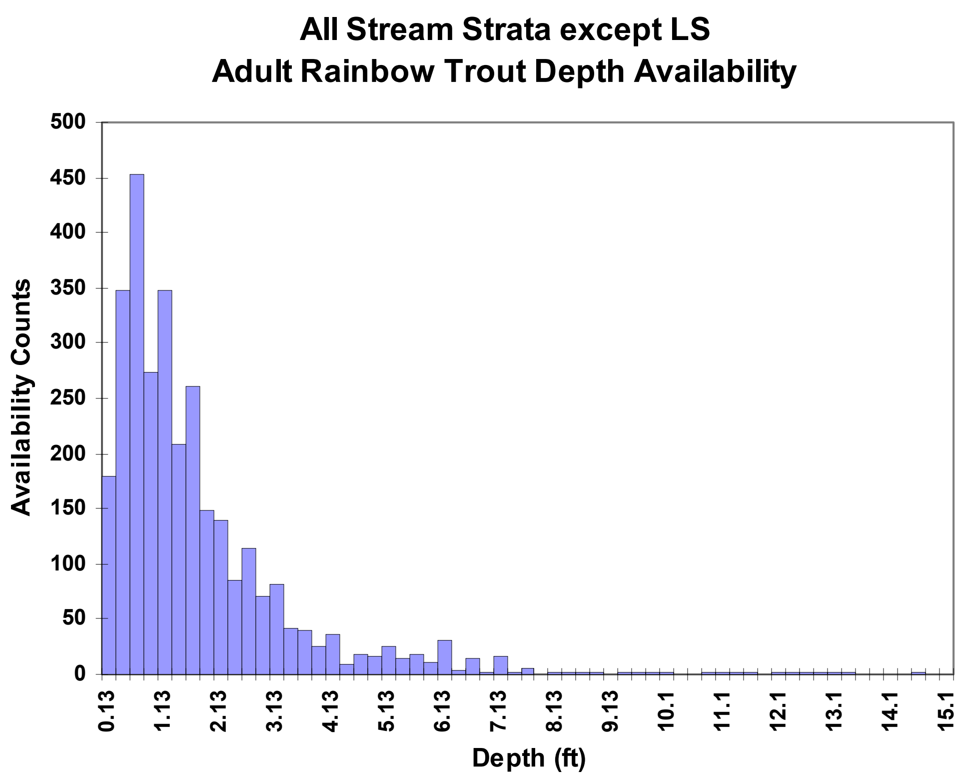
4/14/04

Curve Set ID: CAWG Criteria 4/14/04			
Species Name: RAINBOW TROUT			
Life Stage: ADULT			
Velocity	**Suitability**	**Depth**	**Suitability**
0.00	0.60	0.00	0.00
0.35	1.00	0.10	0.00
1.10	1.00	0.20	0.00
1.80	0.26	0.30	0.02
2.95	0.26	0.40	0.03
3.05	0.00	0.50	0.04
100.00	0.00	0.60	0.05
		0.70	0.06
		0.80	0.07
		0.90	0.10
		1.10	0.38
		1.30	0.60
		1.50	0.76
		1.90	1.00
		3.50	1.00
		10.00	0.50
		100.00	0.50

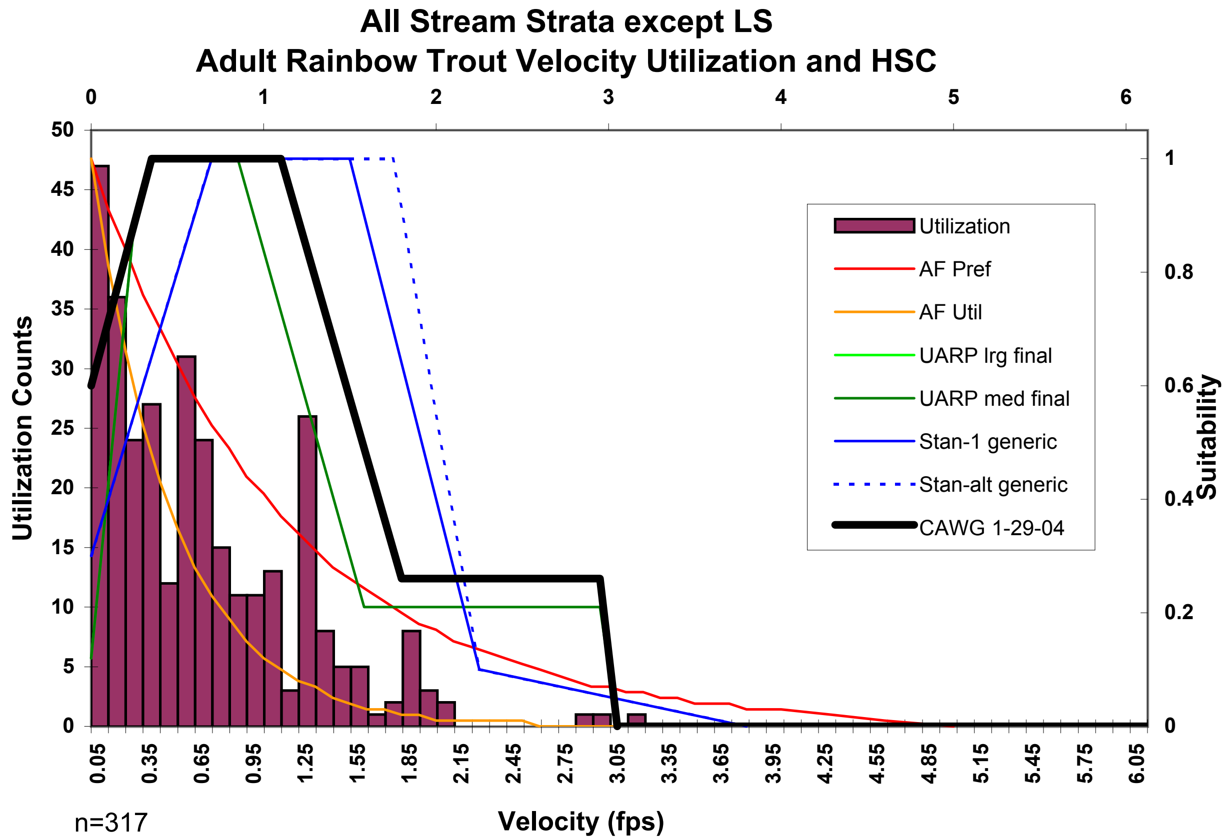
- **Velocity Criteria** - start at 0 fps with suitability = 0.6, use UARP-large final criteria curve for rest of curve.

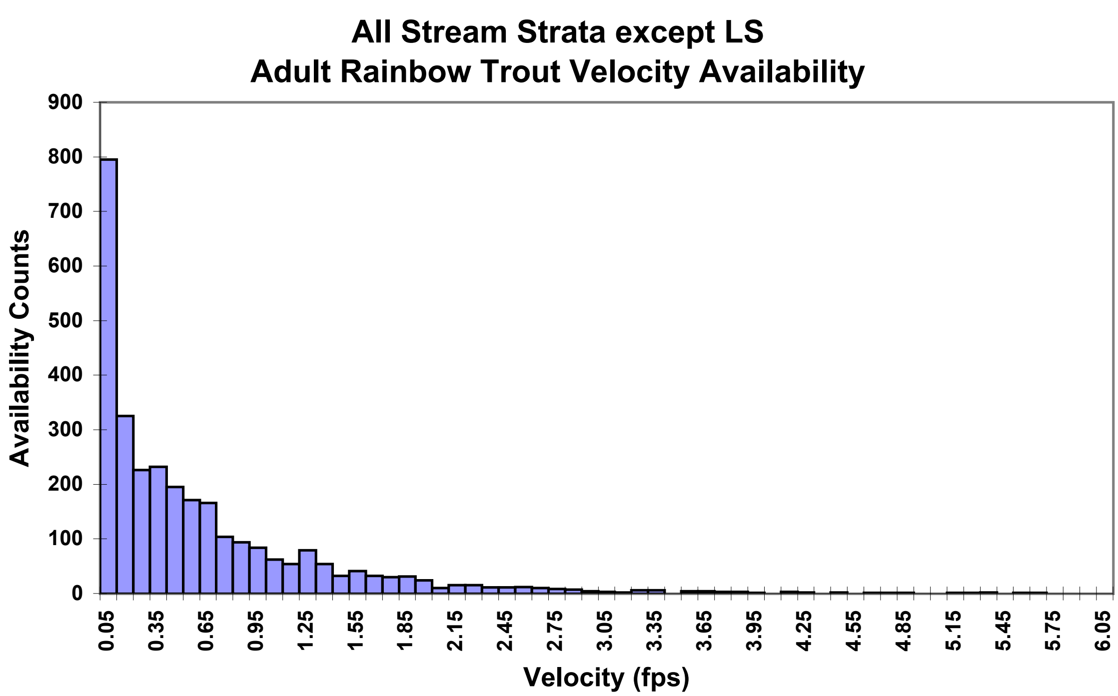
- **Depth Criteria** - use AF Pref (AFP) criteria curve to intersection with UARP-med final criteria curve, take UARP-med to peak, broaden the peak to Stan-1 generic criteria curve and take the descending limb to the end.





Proposed CAWG Criteria may overlay some of the original criteria sets

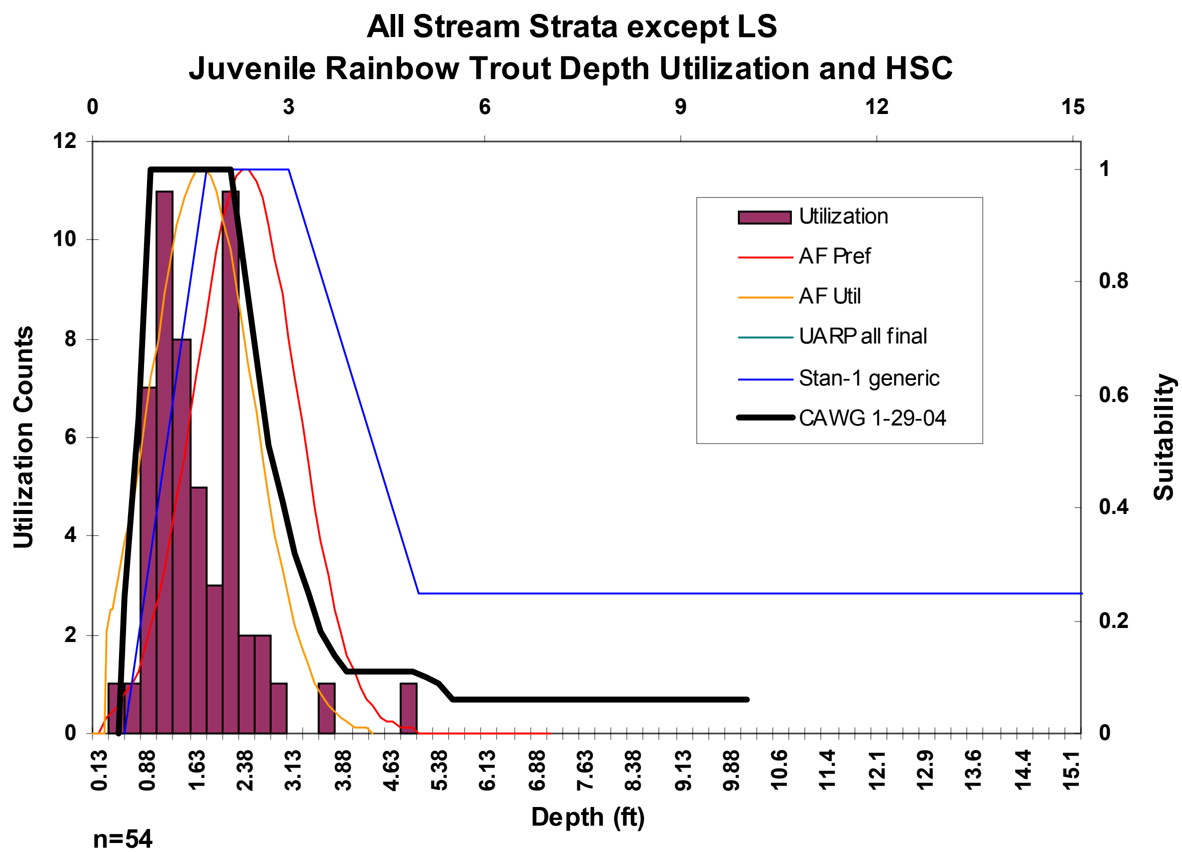

All Stream Strata except LS
Adult Rainbow Trout Velocity Utilization and HSC
Utilization Counts
Suitability
Utilization
AF Pref
AF Util
UARP lrg final
UARP med final
Stan-1 generic
Stan-alt generic
CAWG 1-29-04
n=317
Velocity (fps)

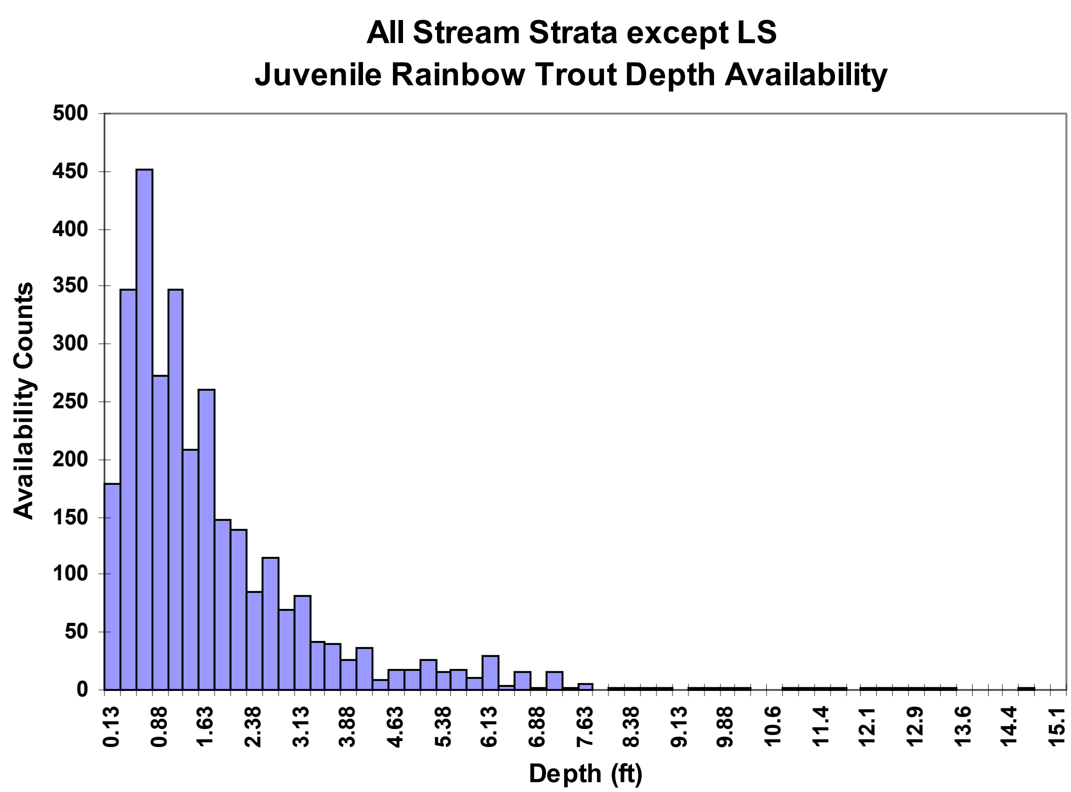

All Stream Strata except LS
Adult Rainbow Trout Velocity Availability
Availability Counts
Velocity (fps)

Curve Set ID: CAWG Criteria 1/29/04
Species Name: RAINBOW TROUT
Life Stage: JUVENILE

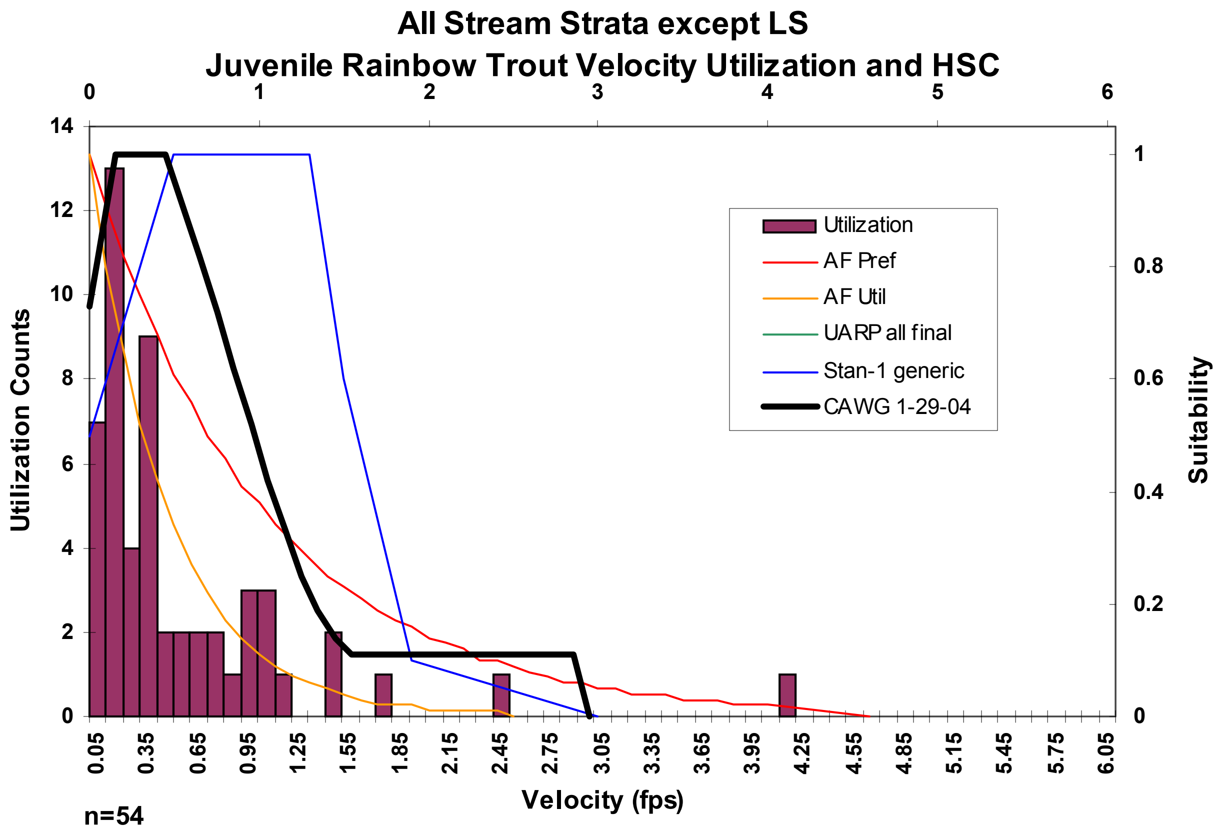
Velocity	Suitability	Depth	Suitability
0.00	0.73	0.40	0.00
0.05	0.81	0.50	0.24
0.15	1.00	0.70	0.56
0.25	1.00	0.90	1.00
0.35	1.00	1.10	1.00
0.50	1.00	1.30	1.00
0.65	0.82	1.50	1.00
0.75	0.72	1.70	1.00
0.85	0.62	1.90	1.00
0.95	0.52	2.10	1.00
1.05	0.42	2.70	0.51
1.15	0.33	2.90	0.41
1.25	0.25	3.10	0.32
1.35	0.19	3.30	0.25
1.45	0.14	3.50	0.18
1.55	0.11	3.70	0.14
2.25	0.11	3.90	0.11
2.85	0.11	4.90	0.11
2.95	0.00	5.10	0.10
100.00	0.00	5.30	0.09
		5.50	0.06
		10.00	0.06
		100.00	0.06

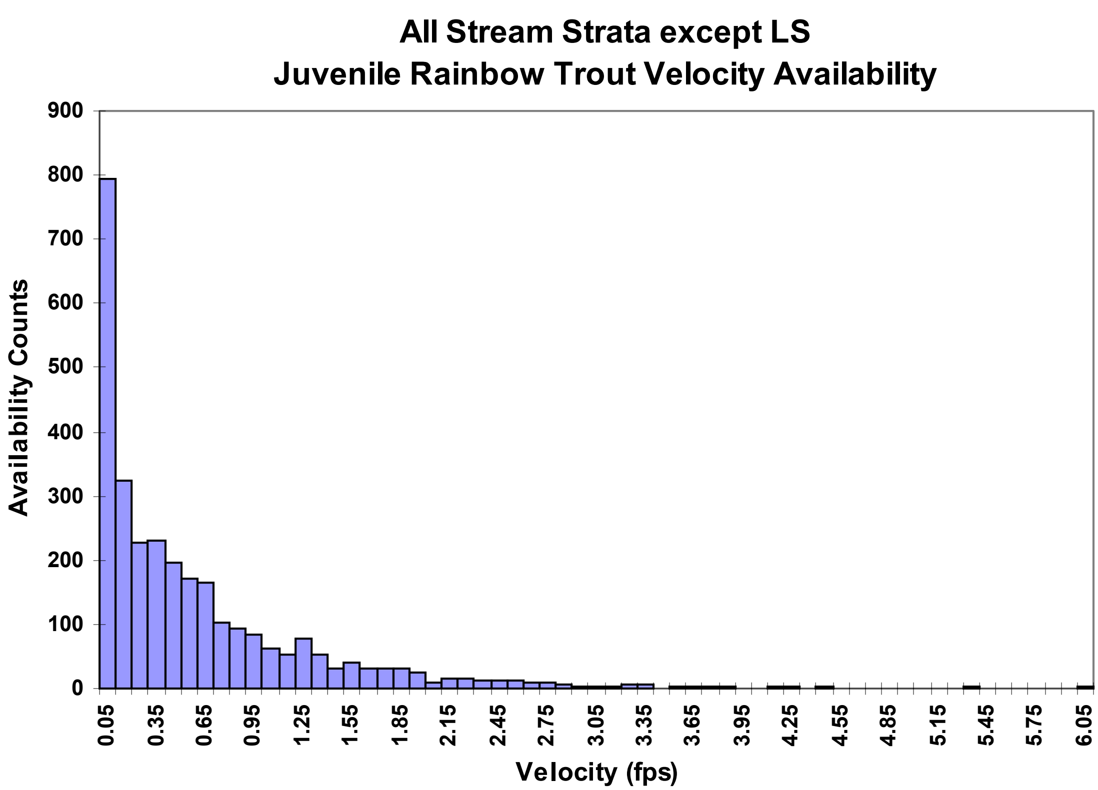
- **Velocity Criteria** - use UARP all final criteria curve without alteration
- **Depth Criteria** - use UARP all final criteria curve without alteration





Proposed CAWG Criteria may overlay some of the original criteria sets



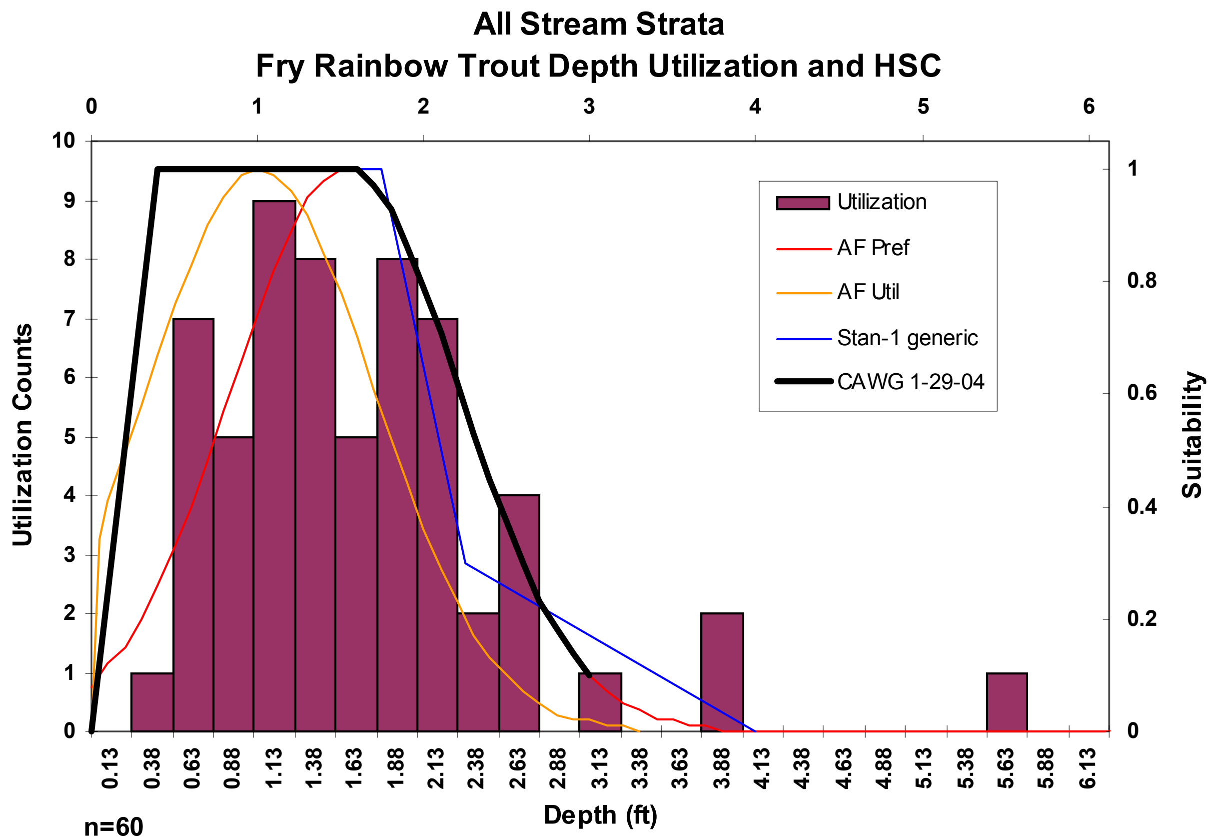


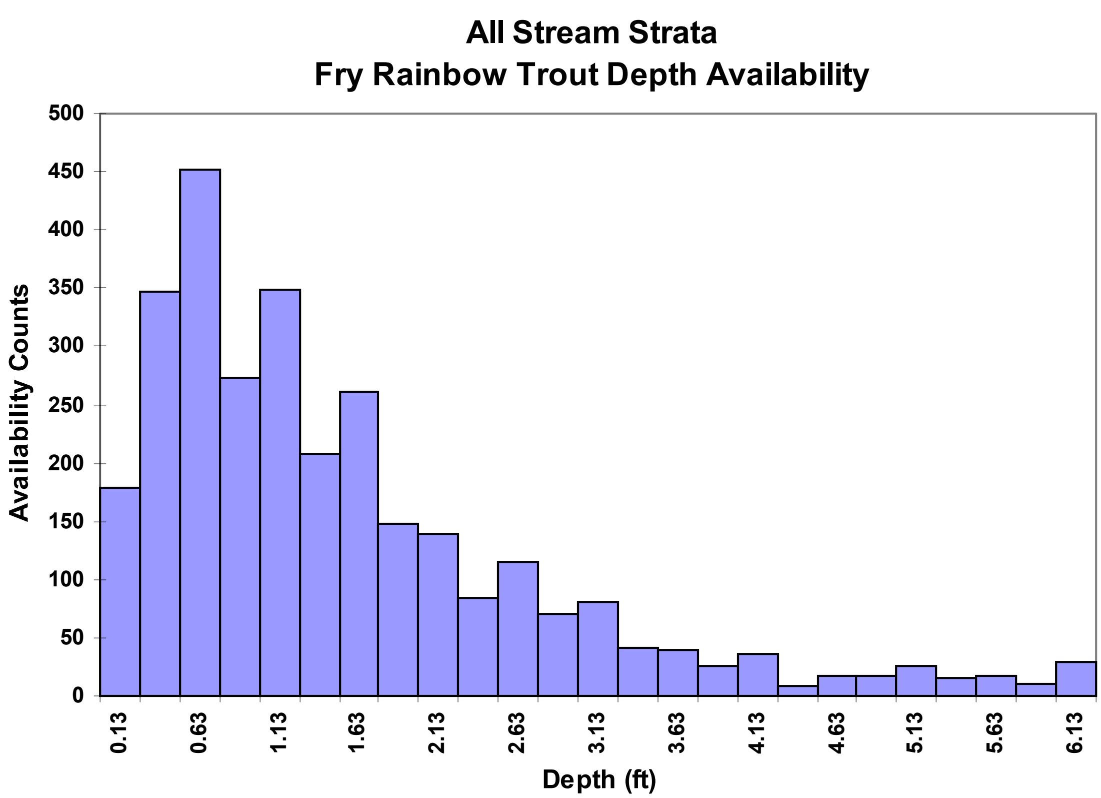
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: RAINBOW TROUT
Life Stage: FRY

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.50	1.00	0.40	1.00
1.00	0.20	1.50	1.00
1.50	0.10	1.60	1.00
3.00	0.00	1.70	0.97
100.00	0.00	1.80	0.93
		1.90	0.86
		2.00	0.79
		2.10	0.71
		2.20	0.62
		2.30	0.53
		2.40	0.45
		2.50	0.37
		2.60	0.30
		2.70	0.23
		2.80	0.18
		2.90	0.14
		3.00	0.10
		100.00	0.10

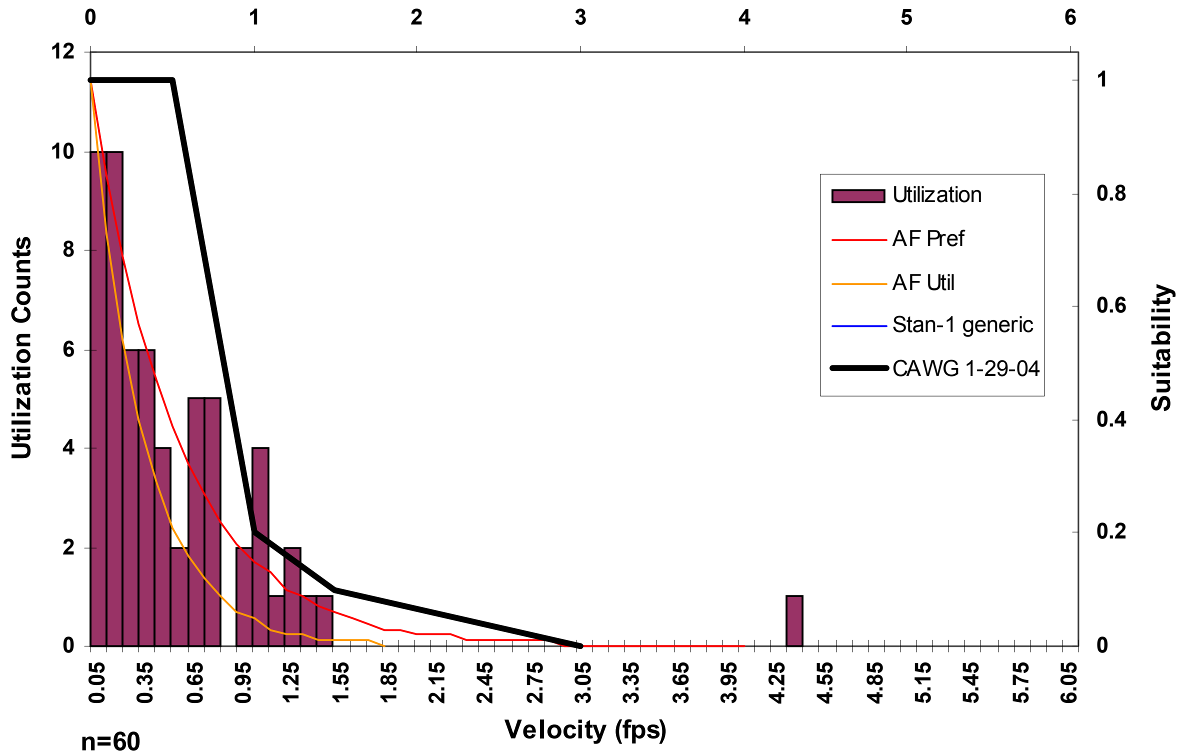
- **Velocity Criteria** - use Stan-1 generic criteria curve without alteration
- **Depth Criteria** - follow Stan-1 generic to peak, broaden peak to AF Pref (AFP) criteria curve, follow AFP down to 3.0 feet, make a straight line at suitability = 0.1



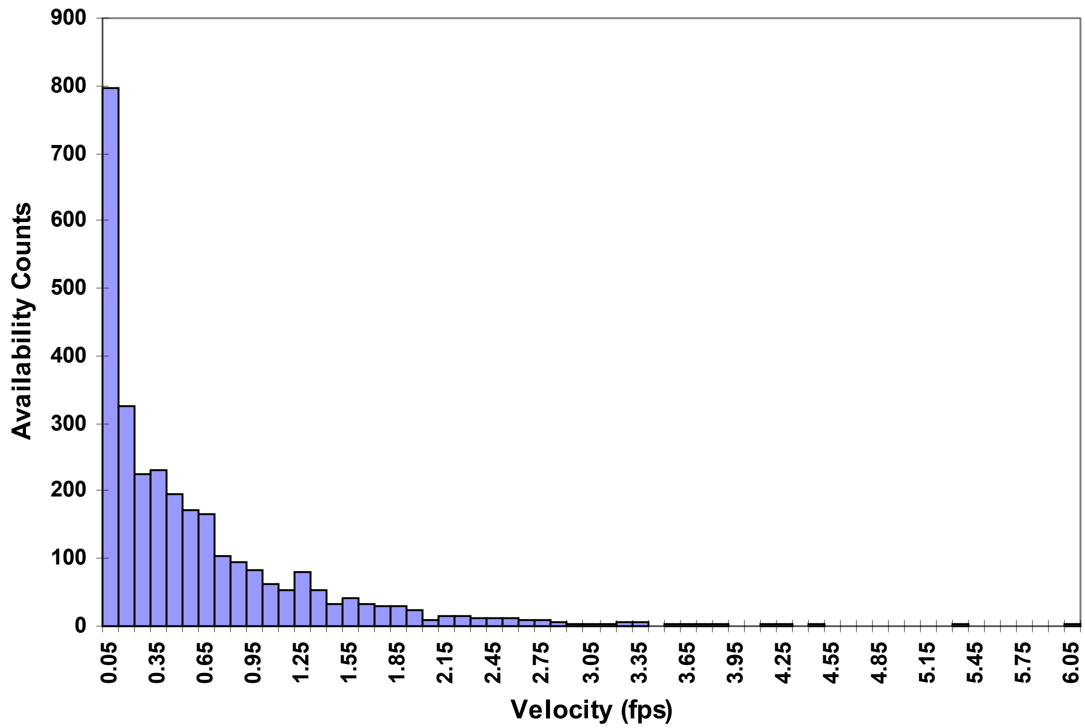


Proposed CAWG Criteria may overlay some of the original criteria sets

All Stream Strata
Fry Rainbow Trout Velocity Utilization and HSC



All Stream Strata
Fry Rainbow Trout Velocity Availability

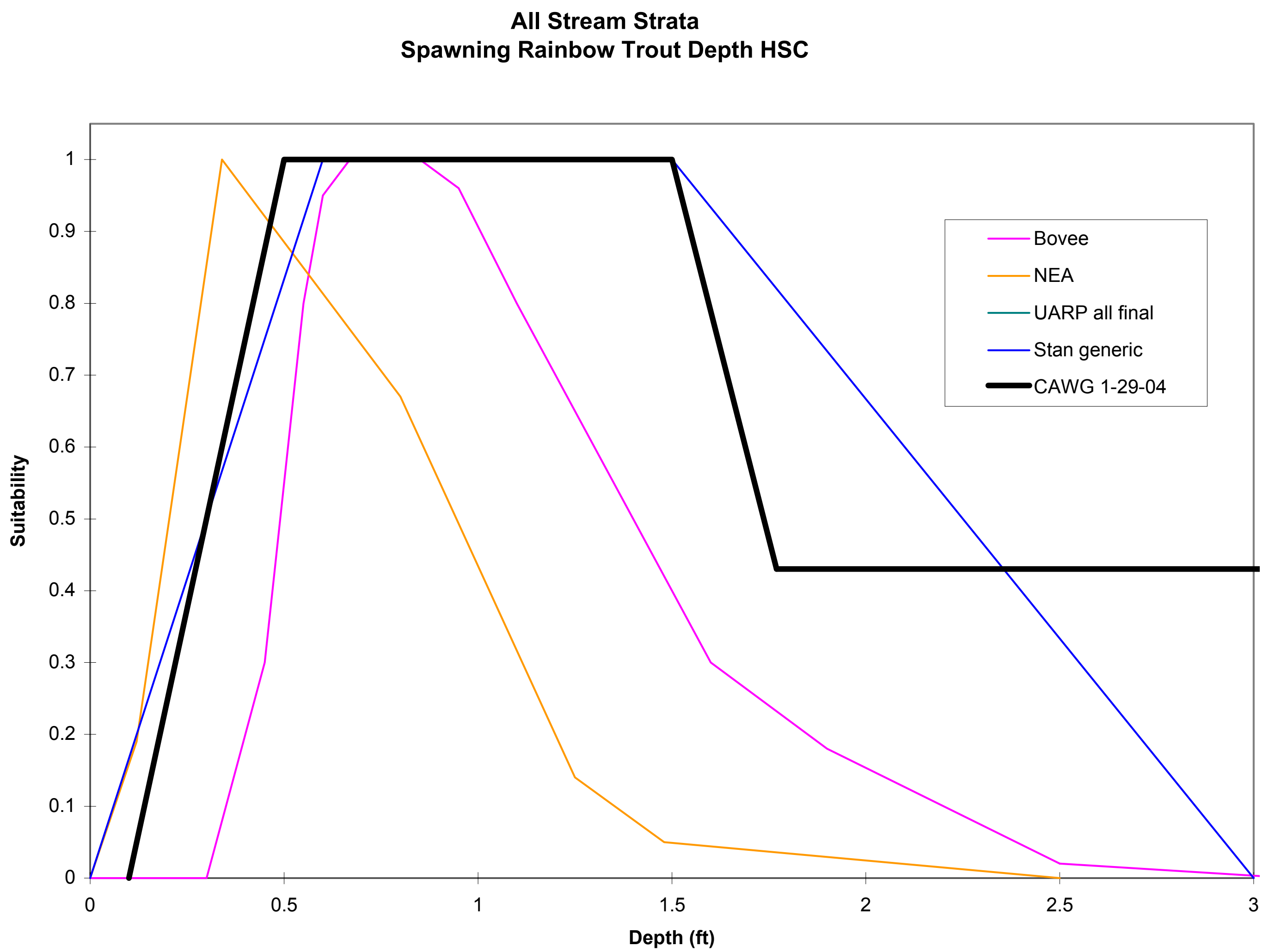


Proposed CAWG Criteria may overlay some of the original criteria sets

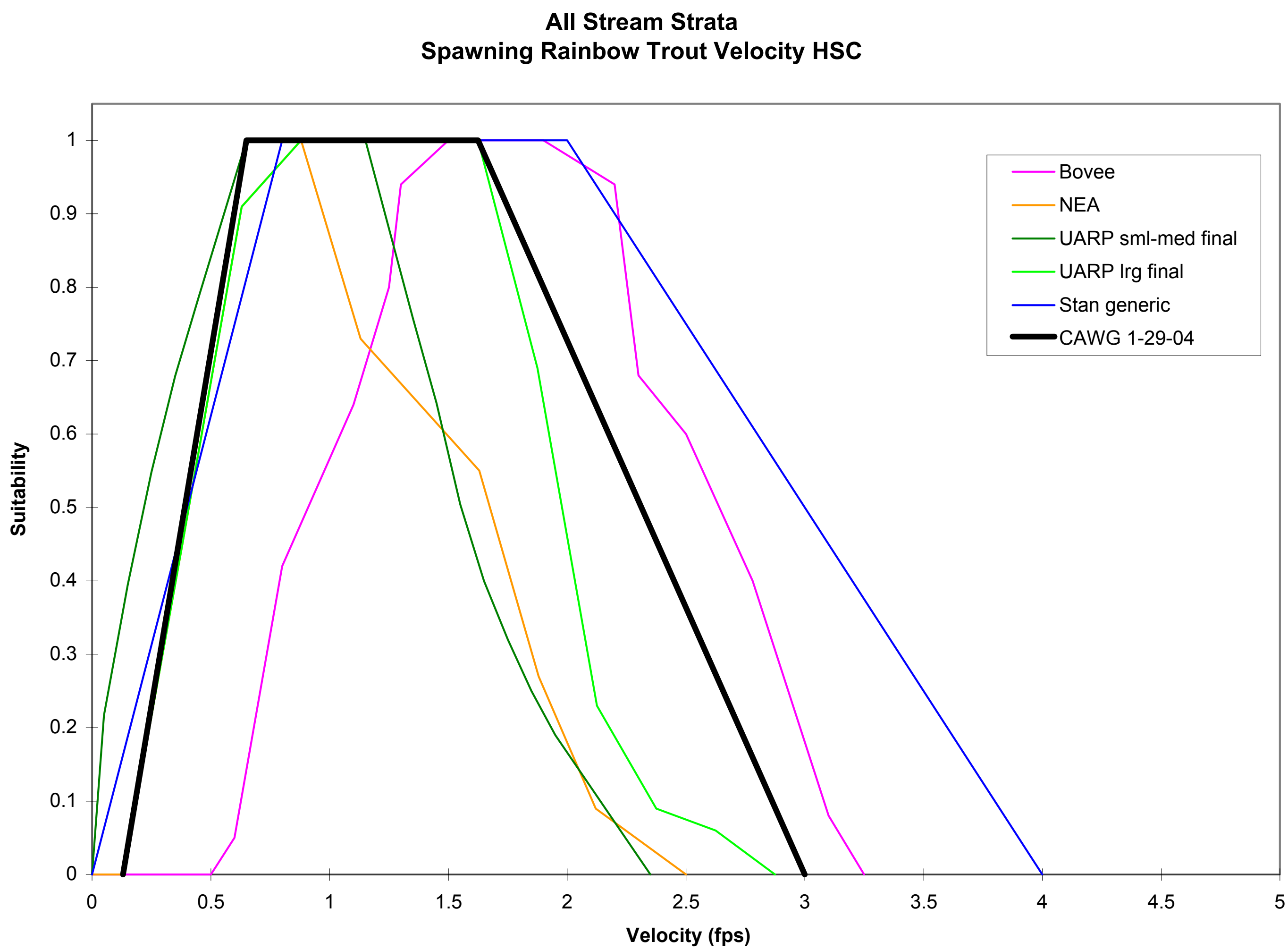
Curve Set ID: CAWG Criteria 1/29/04
Species Name: RAINBOW TROUT
Life Stage: SPAWNING

Velocity	Suitability	Depth	Suitability
0.13	0.00	0.10	0.00
0.65	1.00	0.50	1.00
1.15	1.00	1.50	1.00
1.625	1.00	1.77	0.43
3.00	0.00	5.00	0.43
100.00	0.00	100.00	0.43

- **Velocity Criteria** - start with UARP-large final, make a straight line to UARP-sm/med final peak, broaden peak to end of UARP-large final, drop straight to 0 suitability at 3.0 fps.
- **Depth Criteria** - use UARP all final criteria curve without alteration.



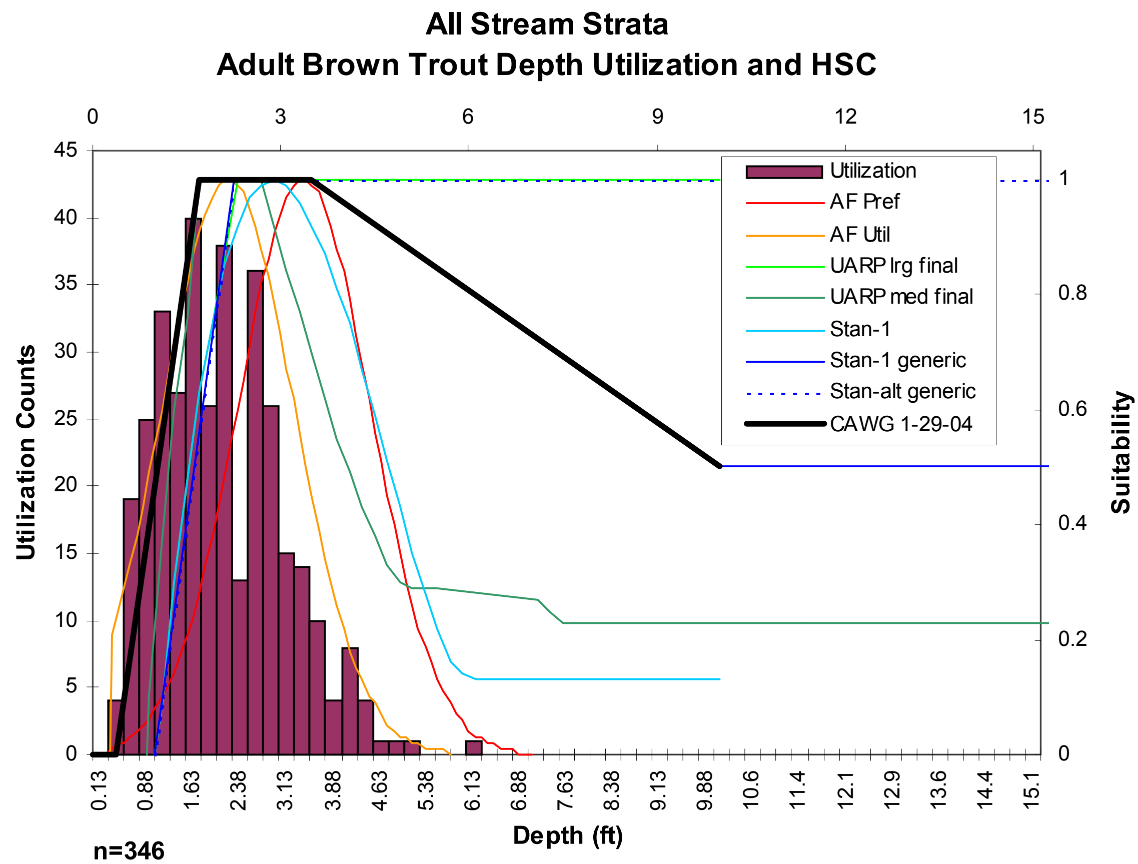
Proposed CAWG Criteria may overlay some of the original criteria sets

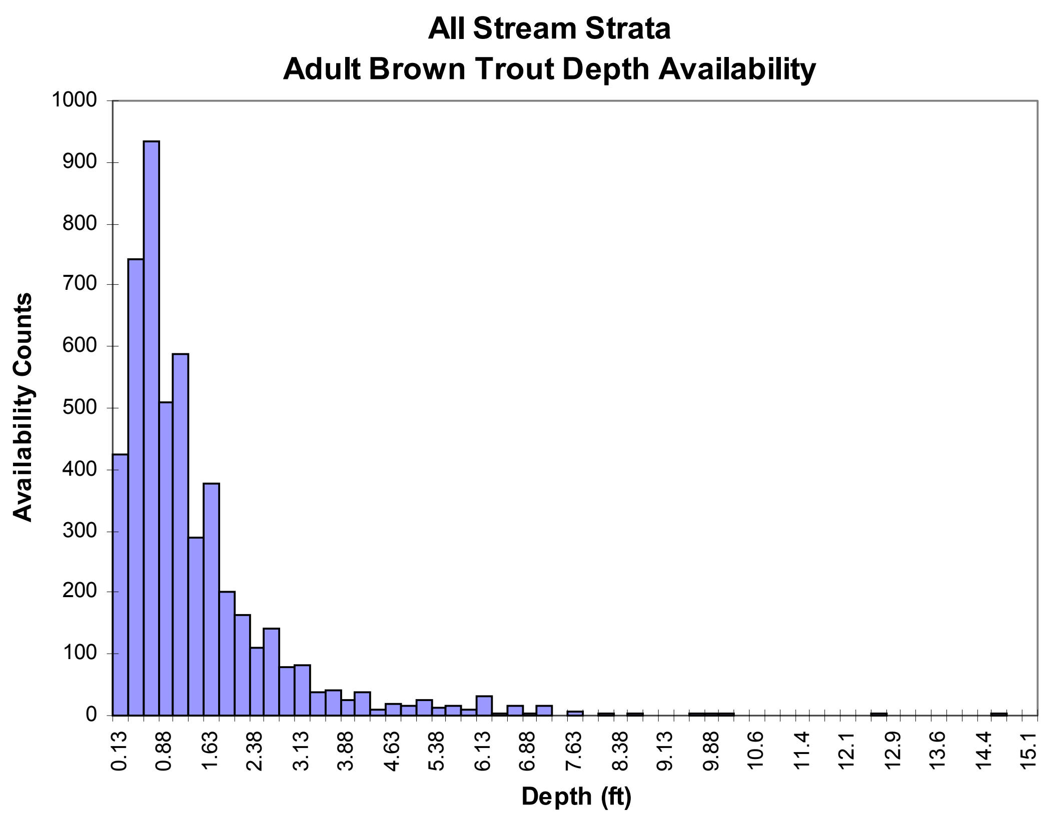


Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 4/14/04			
Species Name: BROWN TROUT			
Life Stage: ADULT			
Velocity	**Suitability**	**Depth**	**Suitability**
0.00	0.70	0.00	0.00
0.30	1.00	0.38	0.00
0.75	1.00	1.70	1.00
0.85	0.83	3.50	1.00
0.95	0.73	10.00	0.50
1.05	0.62	100.00	0.50
1.15	0.51		
1.25	0.39		
1.35	0.29		
1.45	0.20		
1.55	0.18		
2.25	0.16		
2.50	0.00		
100.00	0.00		

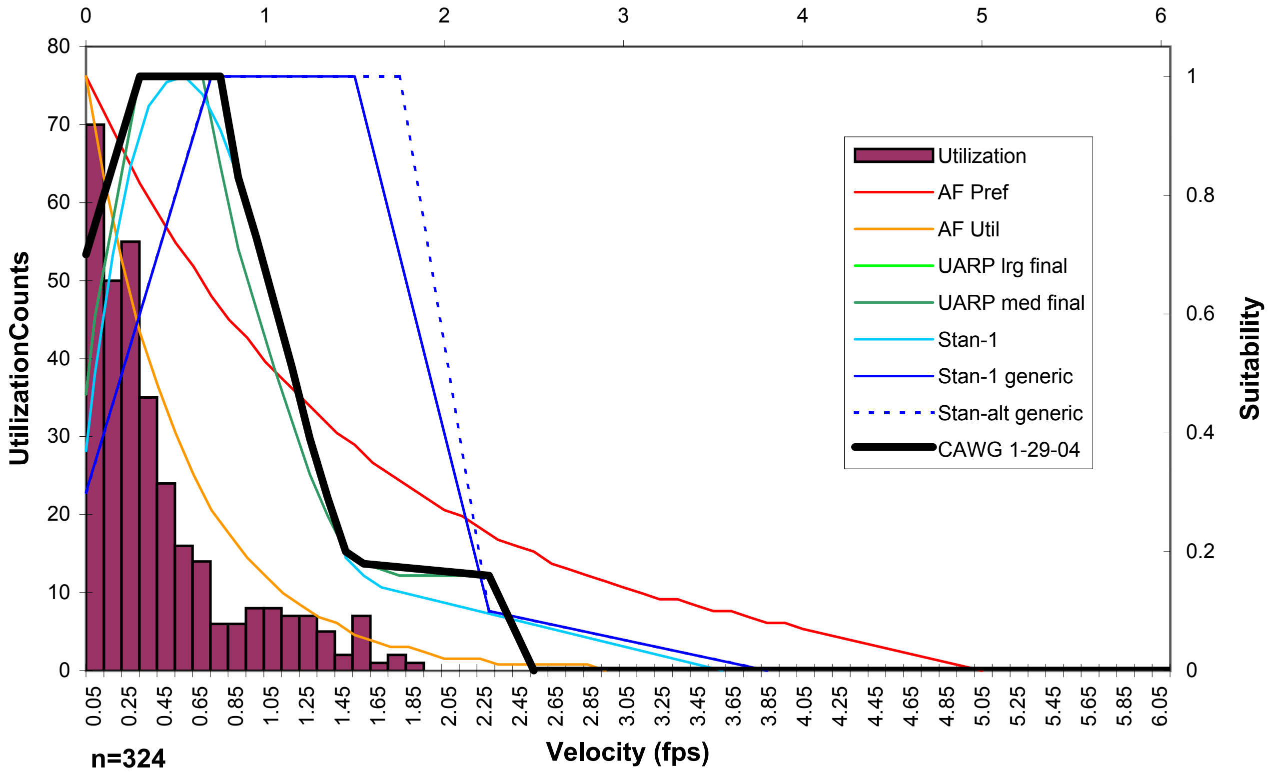
- **Velocity Criteria** - start with 0.0, 0.7 and then follow UARP-large final criteria curve
- **Depth Criteria** - start with depth of 0.375 feet, suitability=0, to peak of UARP-med final criteria curve peak, broaden peak over to Stan-1 generic criteria curve, follow Stan-1 down.



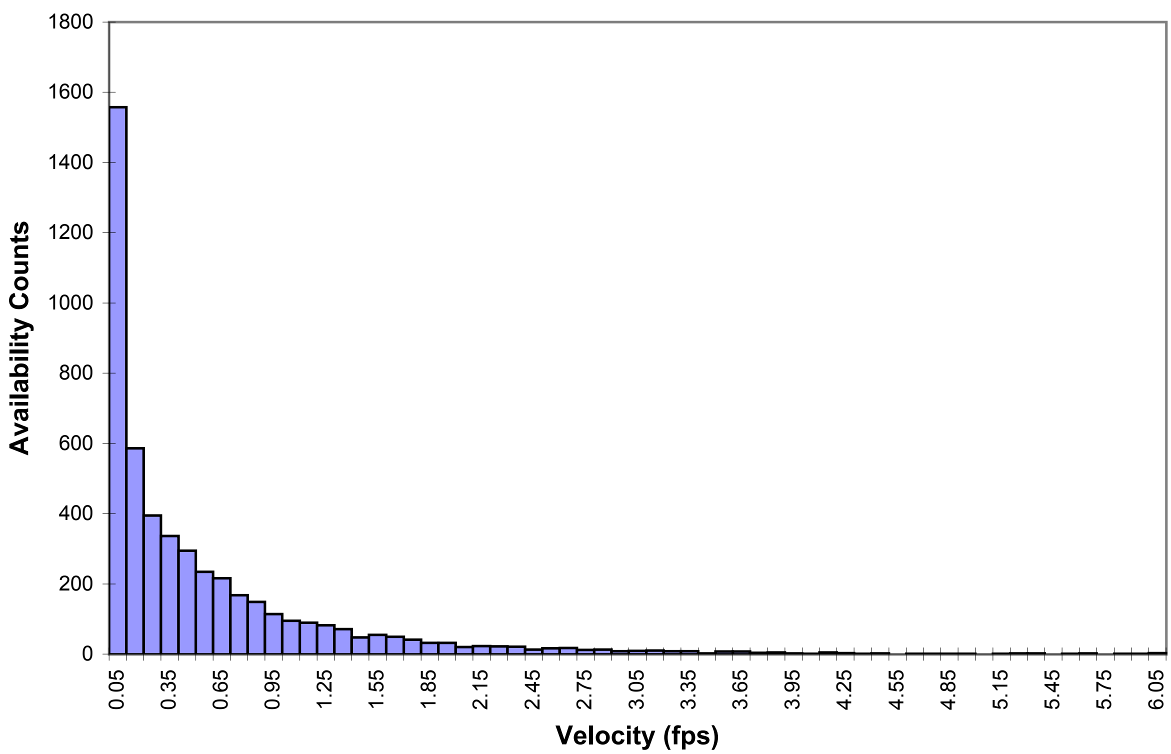


Proposed CAWG Criteria may overlay some of the original criteria sets

All Stream Strata
Adult Brown Trout Velocity Utilization and HSC



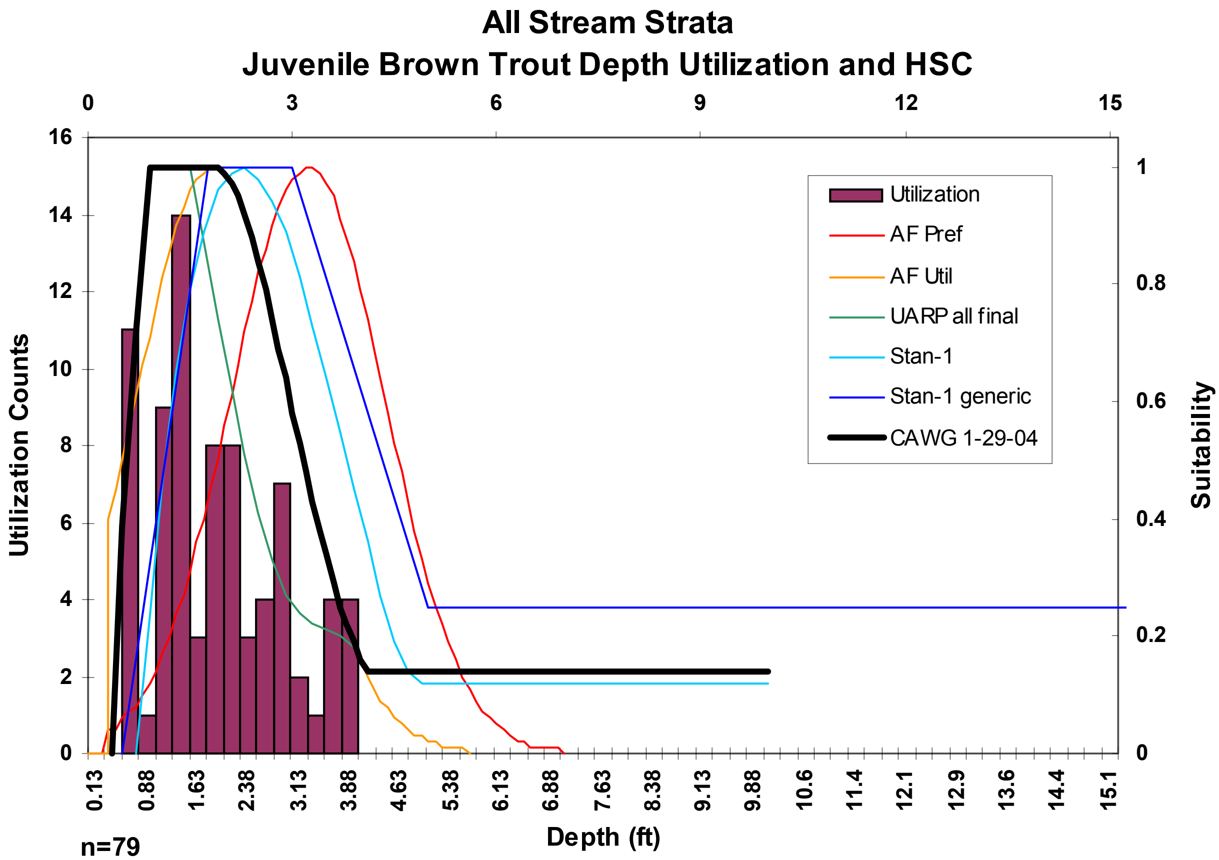
All Stream Strata
Adult Brown Trout Velocity Availability

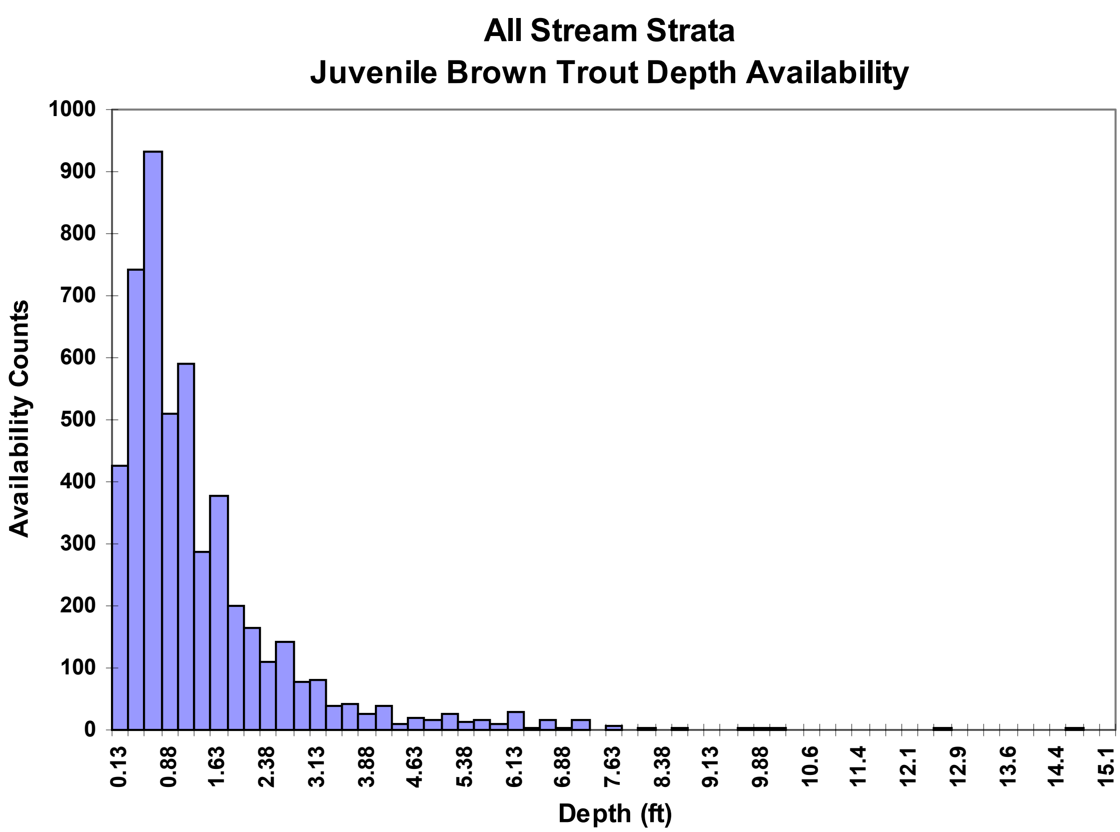


Curve Set ID: CAWG Criteria 1/29/04
Species Name: BROWN TROUT
Life Stage: JUVENILE

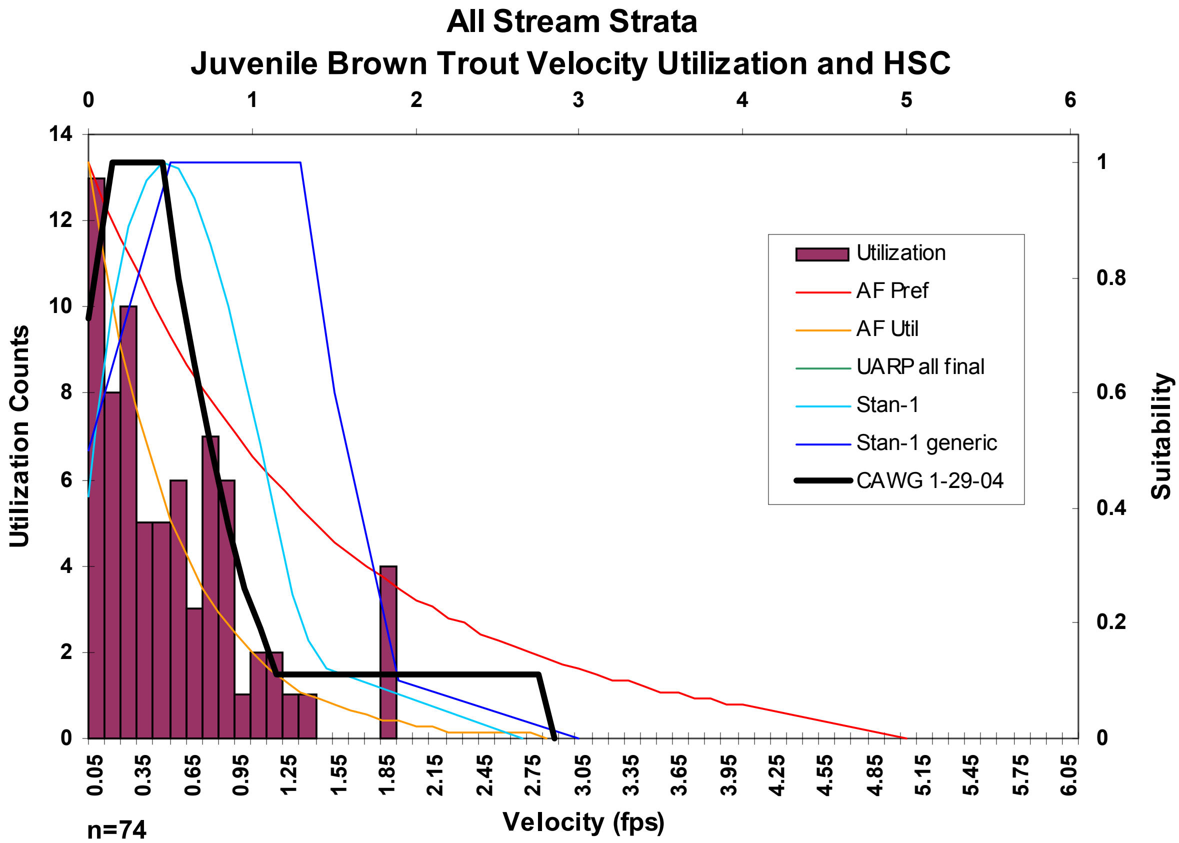
Velocity	Suitability	Depth	Suitability
0.00	0.73	0.35	0.00
0.15	1.00	0.50	0.39
0.50	1.00	0.70	0.72
0.55	0.80	0.90	1.00
0.65	0.65	1.90	1.00
0.75	0.51	2.00	0.99
0.85	0.37	2.10	0.97
0.95	0.26	2.20	0.95
1.05	0.19	2.30	0.92
1.15	0.11	2.40	0.88
2.75	0.11	2.50	0.84
2.85	0.00	2.60	0.79
100.00	0.00	2.70	0.74
		2.80	0.69
		2.90	0.64
		3.00	0.58
		3.10	0.53
		3.20	0.48
		3.30	0.43
		3.40	0.38
		3.50	0.34
		3.60	0.29
		3.70	0.25
		3.80	0.22
		3.90	0.19
		4.00	0.16
		4.10	0.14
		8.00	0.14
		10.00	0.14
		100.00	0.14

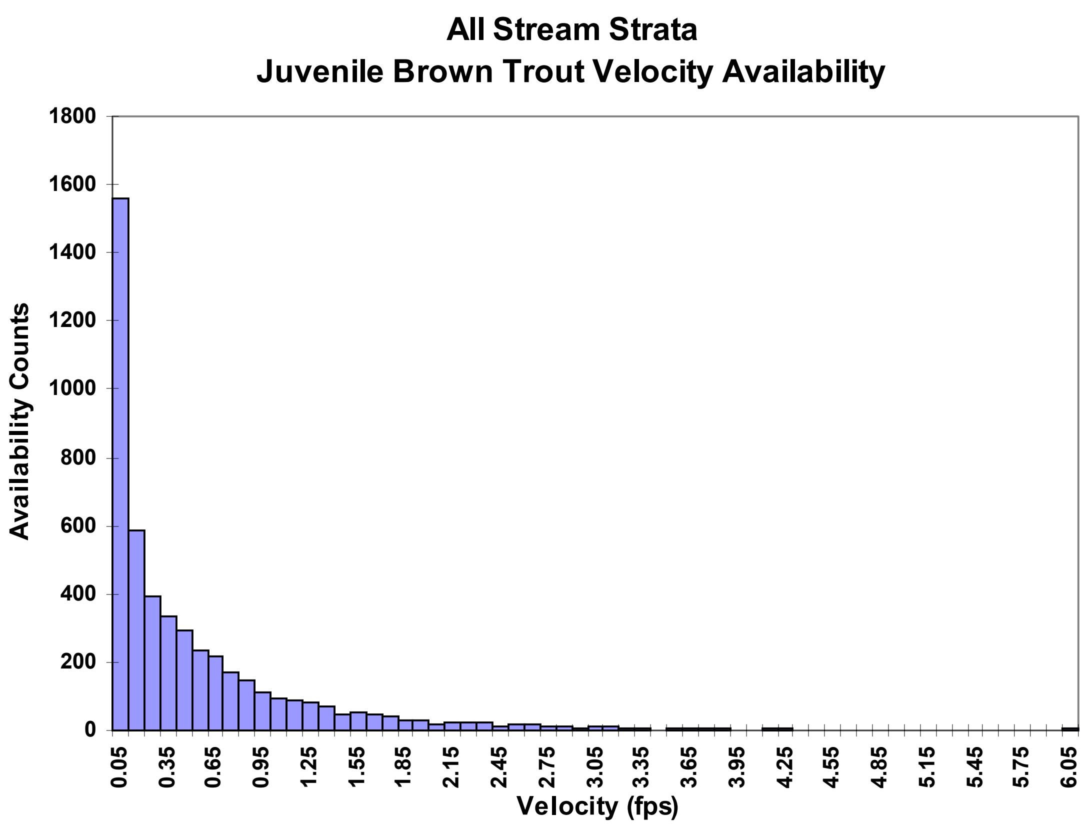
- **Velocity Criteria** - use UARP-all final criteria curve without alteration.
- **Depth Criteria** - take UARP-all final criteria curve up to peak, broaden peak to AFP Utilization (AF Util) criteria curve, take descending limb of AFP down to intersection with UARP, flatline at suitability = 0.14.





Proposed CAWG Criteria may overlay some of the original criteria sets



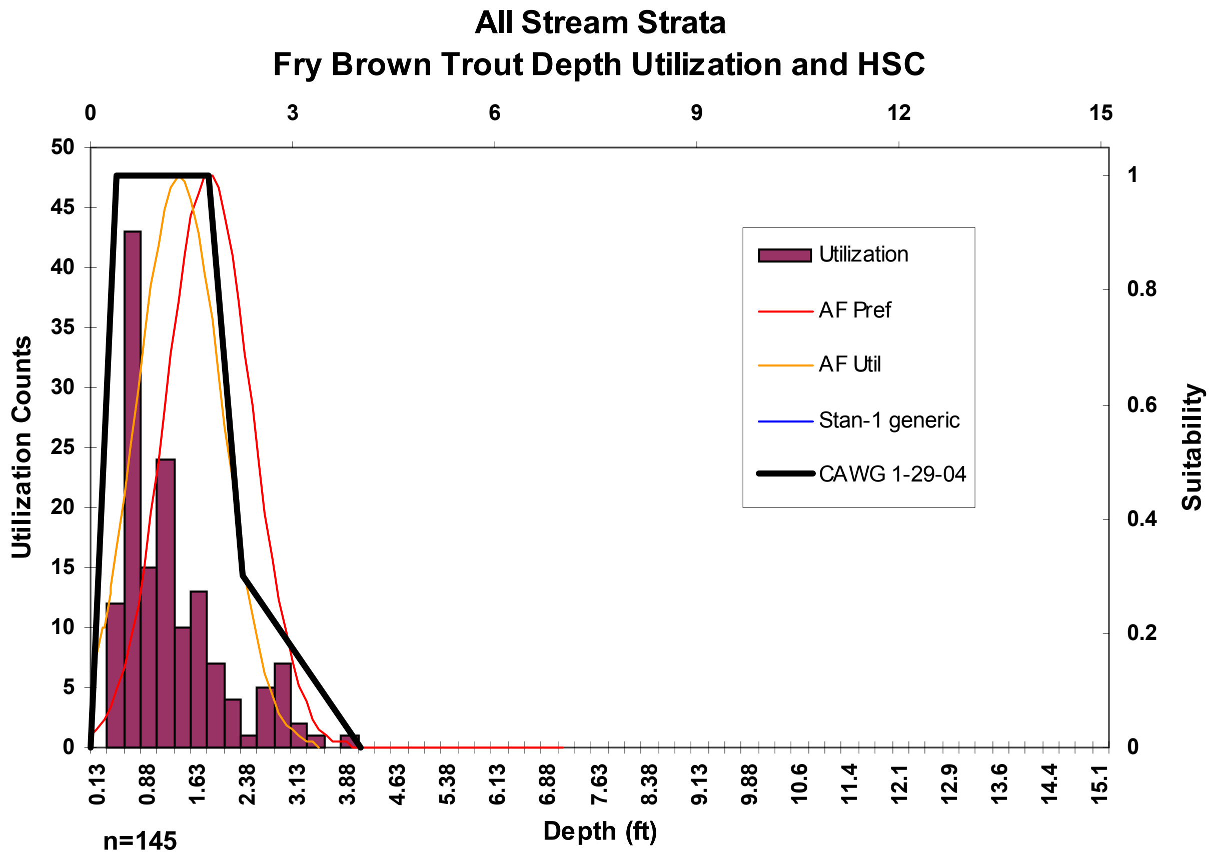


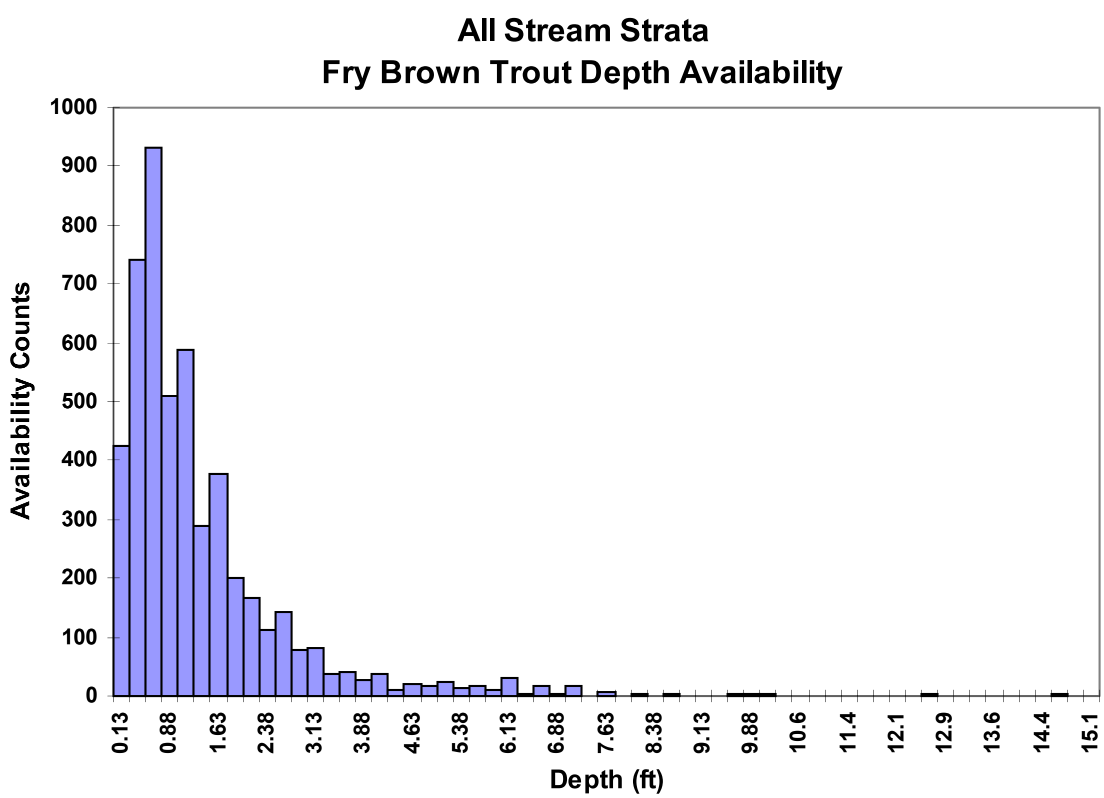
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: BROWN TROUT
Life Stage: FRY

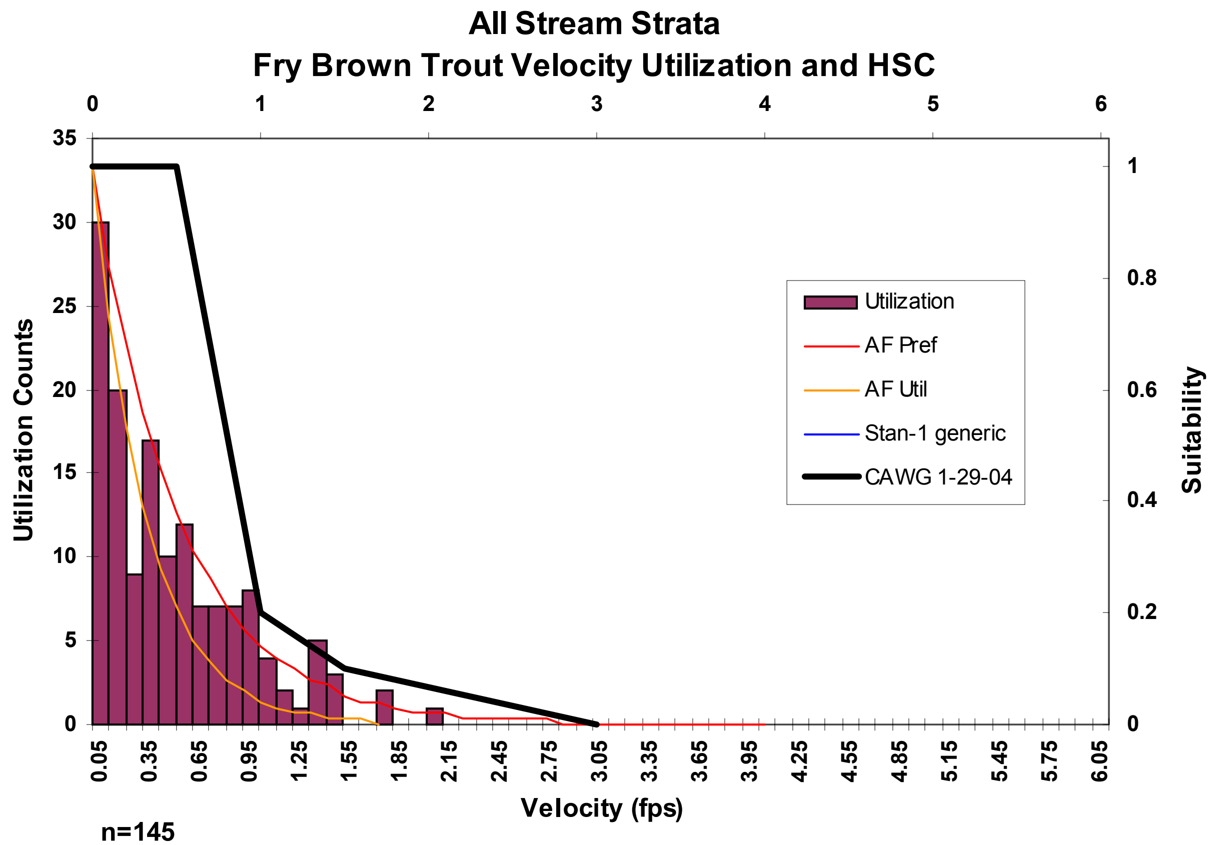
Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.50	1.00	0.40	1.00
1.00	0.20	1.75	1.00
1.50	0.10	2.25	0.30
3.00	0.00	4.00	0.00
100.00	0.00	100.00	0.00

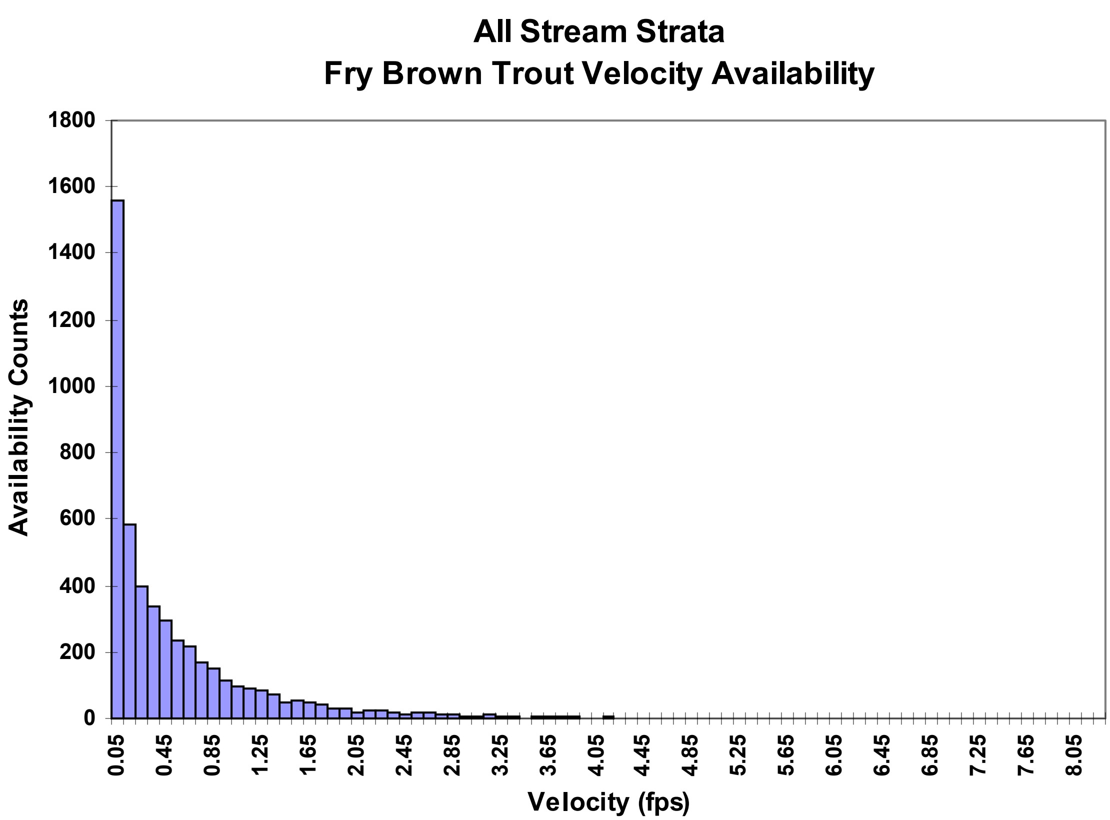
- **Velocity Criteria** - use Stan-1 generic criteria curve without alteration
- **Depth Criteria** - use Stan-1 generic criteria curve without alteration





Proposed CAWG Criteria may overlay some of the original criteria sets



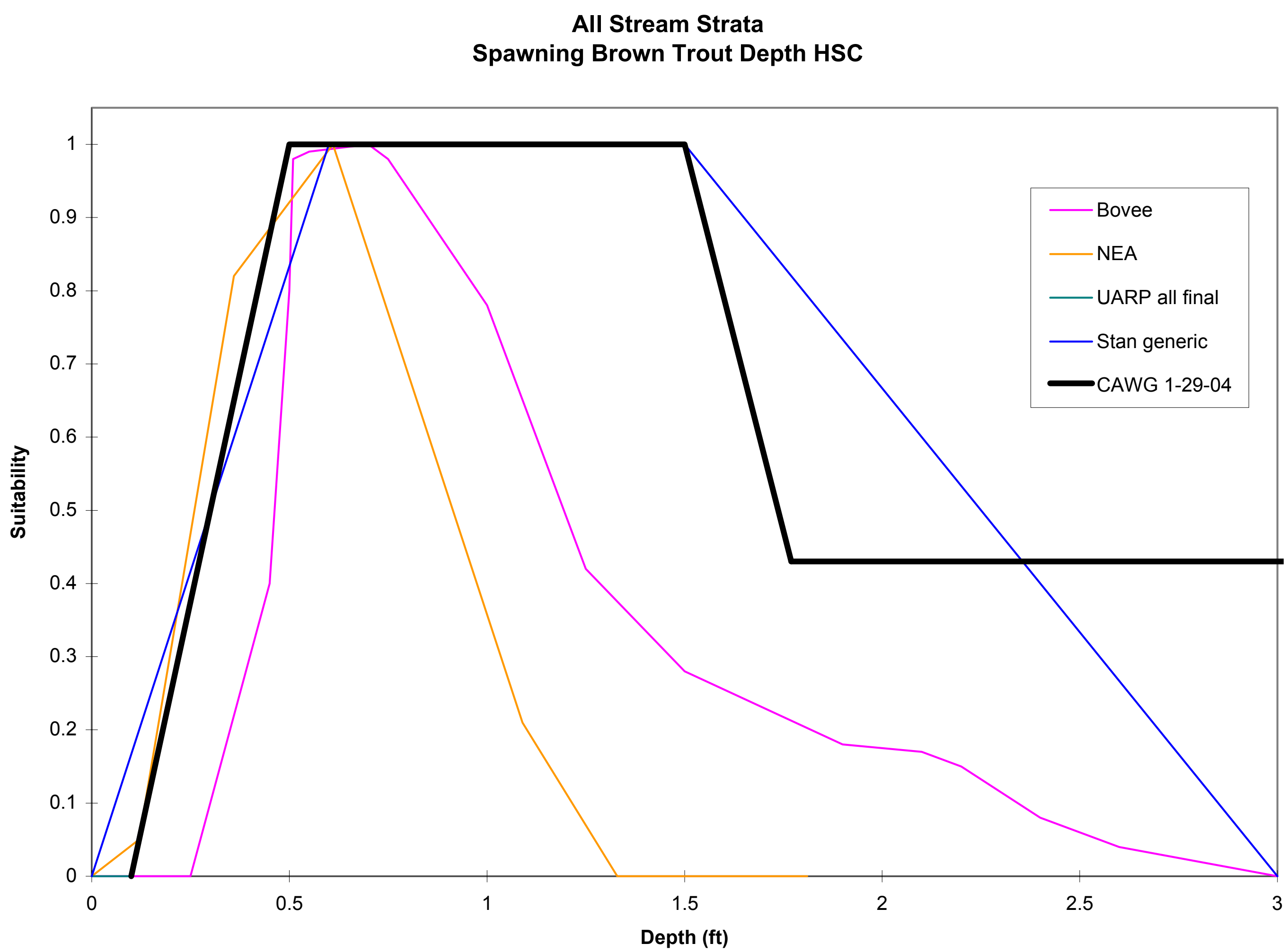


Proposed CAWG Criteria may overlay some of the original criteria sets

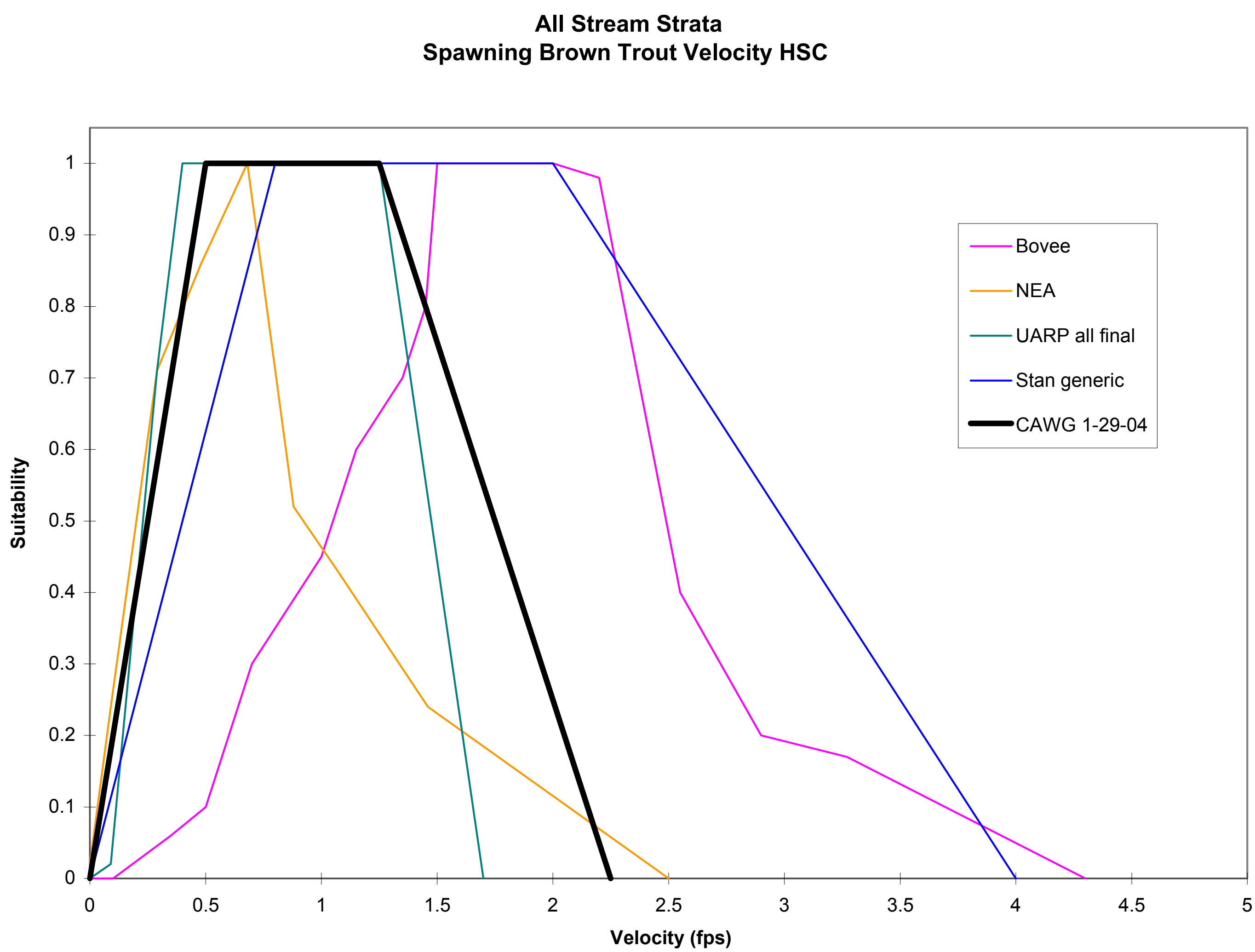
Curve Set ID: CAWG Criteria 1/29/04
Species Name: BROWN TROUT
Life Stage: SPAWNING

Velocity	Suitability	Depth	Suitability
0.00	0.00	0.10	0.00
0.50	1.00	0.50	1.00
1.25	1.00	1.50	1.00
2.25	0.00	1.77	0.43
100.00	0.00	5.00	0.43
		100.00	0.43

- **Velocity Criteria** - use criteria set established by CAWG.
- **Depth Criteria** - use UARP all final criteria curve without alteration (same as rainbow trout spawning criteria).



Proposed CAWG Criteria may overlay some of the original criteria sets



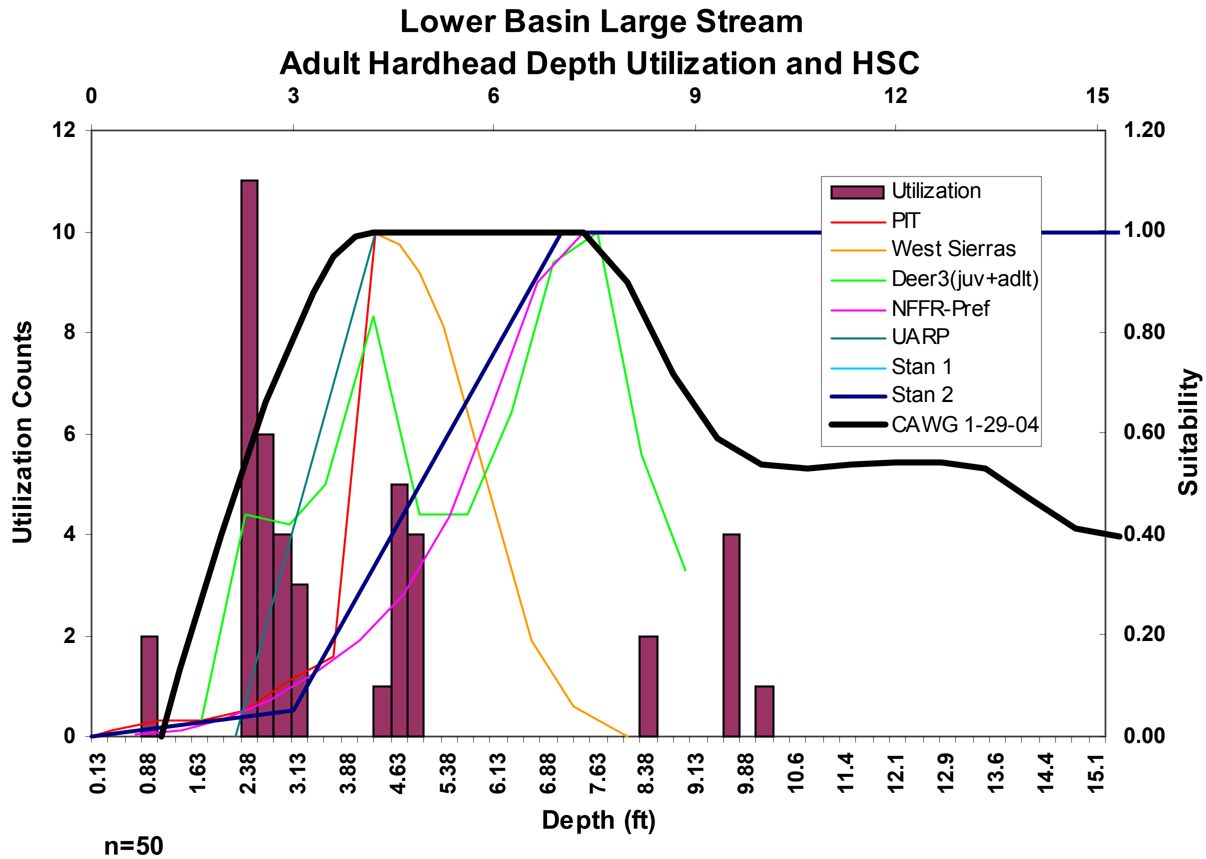
Proposed CAWG Criteria may overlay some of the original criteria sets

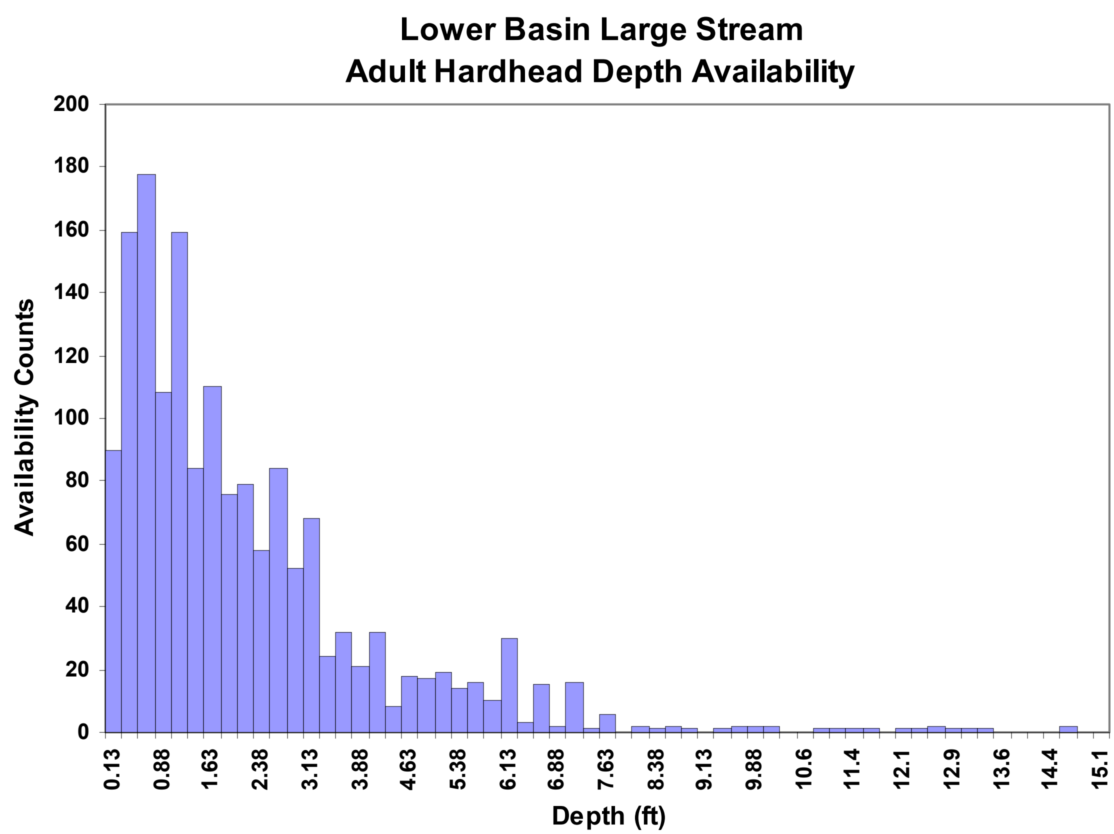
Curve Set ID: CAWG Criteria 1/29/04
Species Name: HARDHEAD
Life Stage: ADULT

Velocity	Suitability
0.00	1.00
0.90	1.00
1.75	0.08
2.50	0.00
100.00	0.00

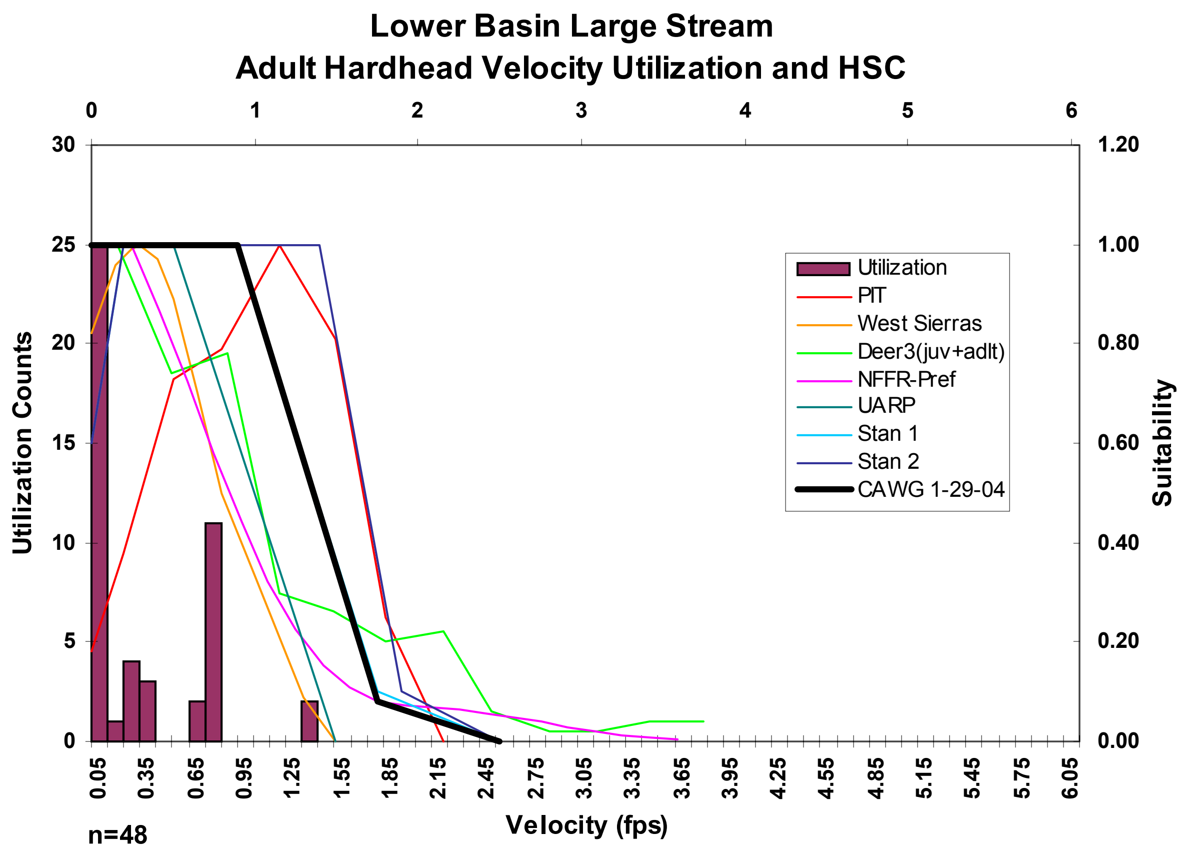
Depth	Suitability
1.05	0.00
1.30	0.13
1.95	0.40
2.60	0.66
3.30	0.88
3.60	0.95
3.95	0.99
4.20	1.00
7.33	1.00
8.00	0.90
8.67	0.72
9.33	0.59
10.00	0.54
10.67	0.53
11.33	0.54
12.00	0.54
12.67	0.54
13.33	0.53
14.00	0.47
14.67	0.41
15.33	0.40
16.00	0.39
18.00	0.39
100.00	0.39

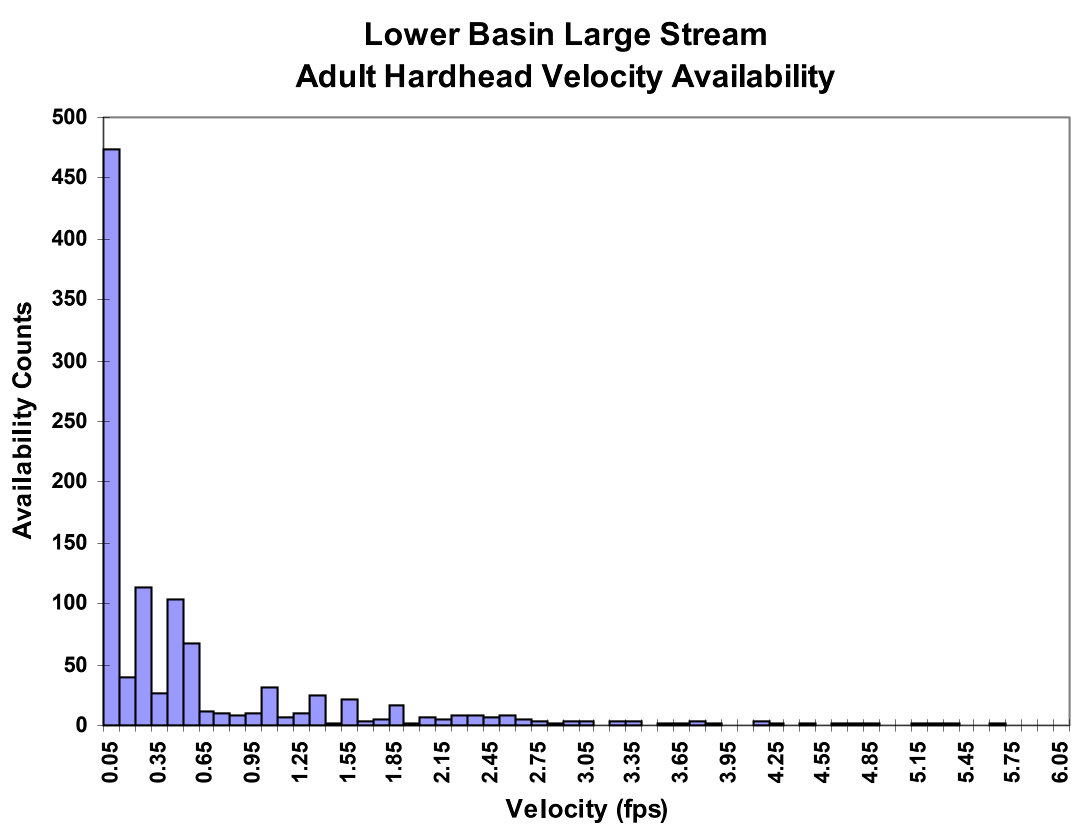
- **Velocity Criteria** - start with 0,1 (velocity of 0 fps = suitability of 1.0), follow Stan-1 generic criteria to end.
- **Depth Criteria** - take ascending limb of West Sierras, broaden to peak of NFFR-Pref, take descending limb of NFFR-Pref to end.





Proposed CAWG Criteria may overlay some of the original criteria sets



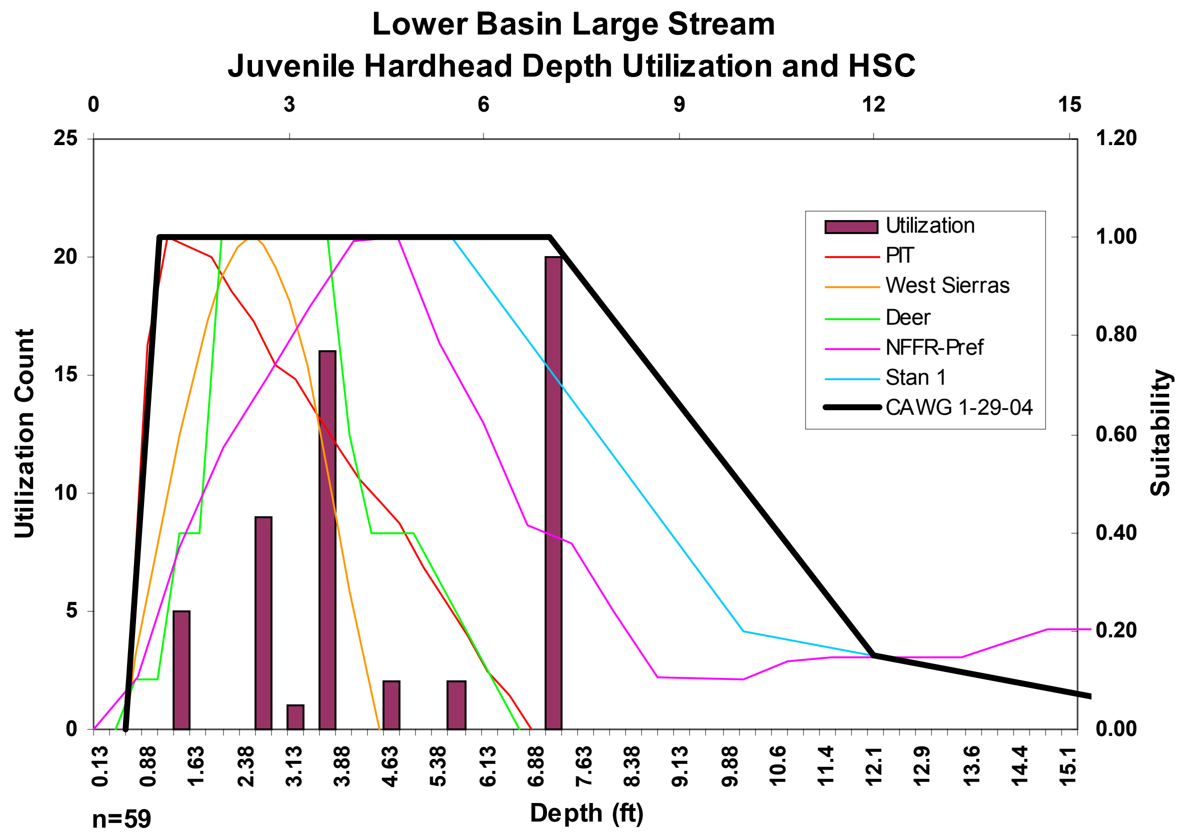


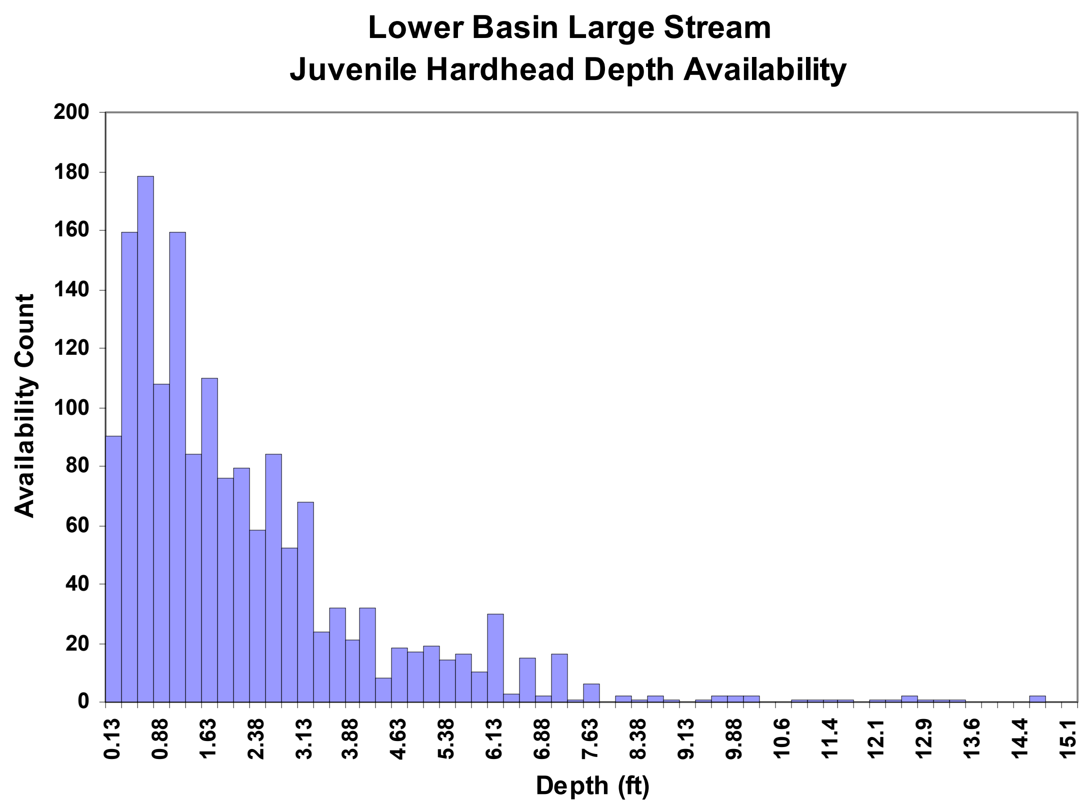
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: HARDHEAD
Life Stage: JUVENILE

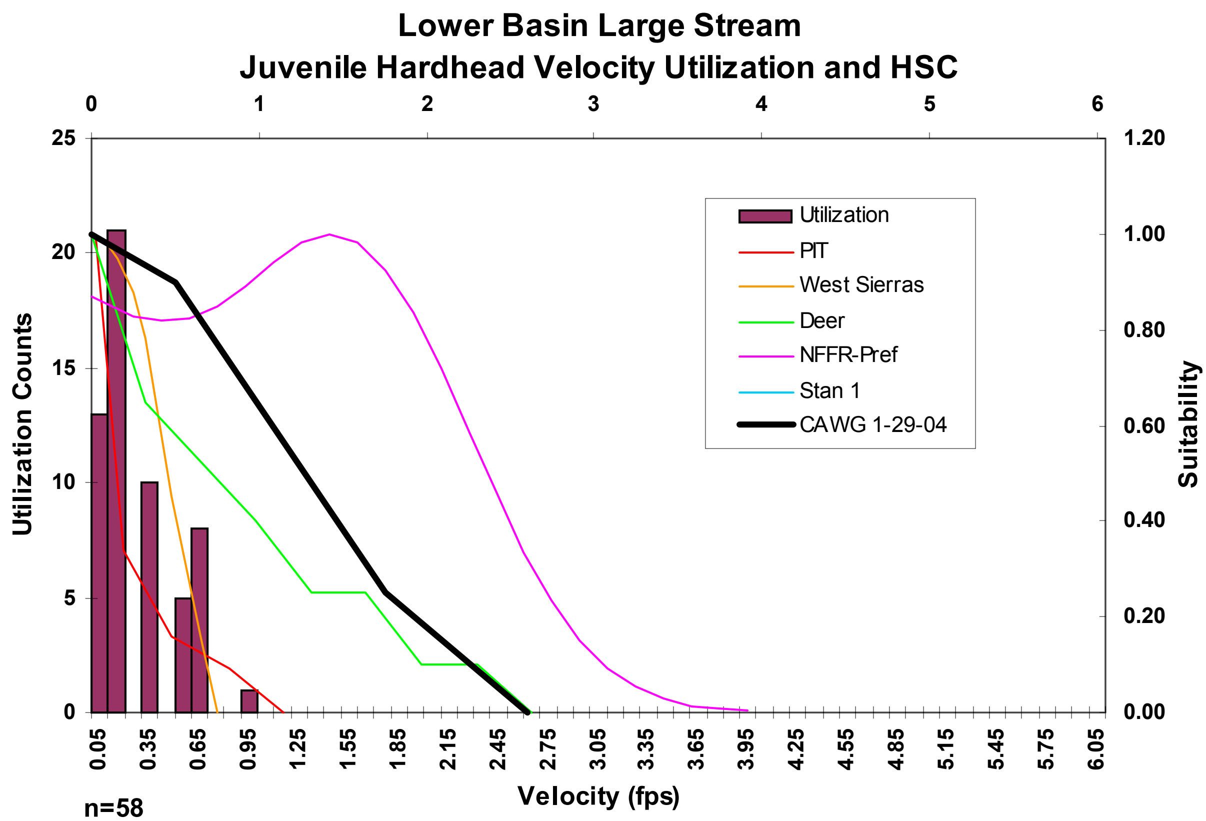
Velocity	Suitability	Depth	Suitability
0.00	1.00	0.50	0.00
0.50	0.90	1.00	1.00
1.75	0.25	7.00	1.00
2.60	0.00	12.00	0.15
100.00	0.00	18.00	0.00
		100.00	0.00

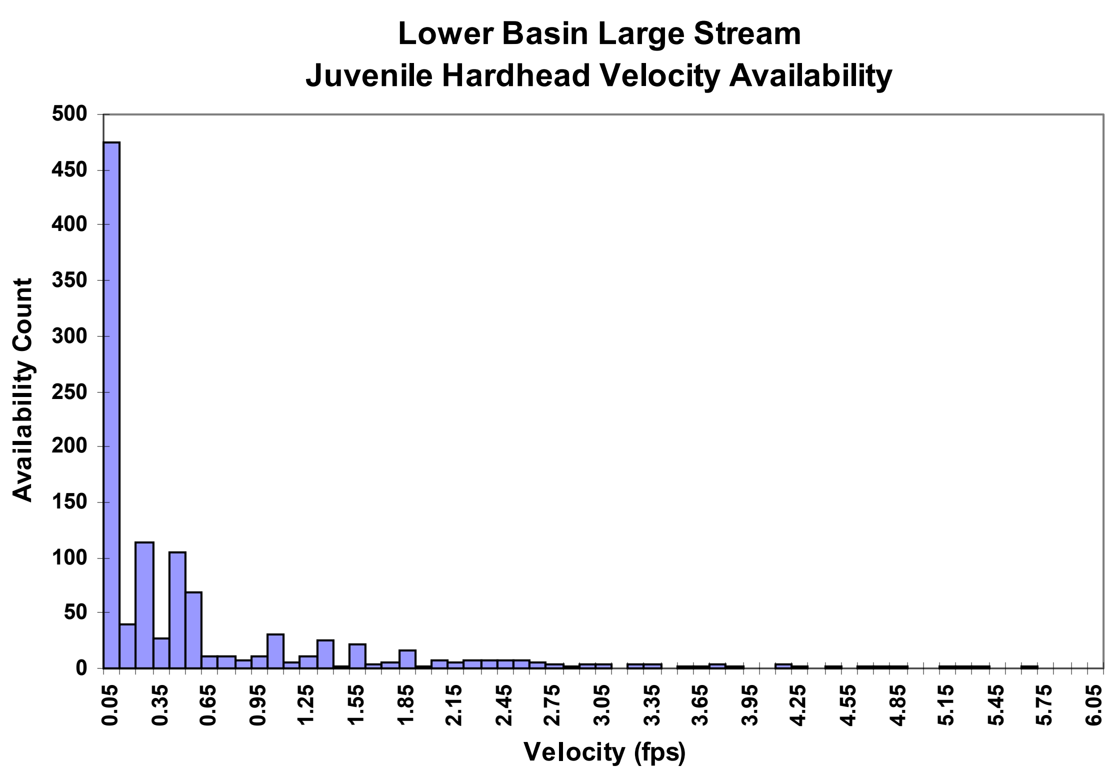
- **Velocity Criteria** - use Stan-1 generic criteria curve with no alteration.
- **Depth Criteria** - start with Stan-1, extend peak to depth = 7.0 feet, drop to inflection while paralleling Stan-1, follow Stan-1 to suitability = 0





Proposed CAWG Criteria may overlay some of the original criteria sets



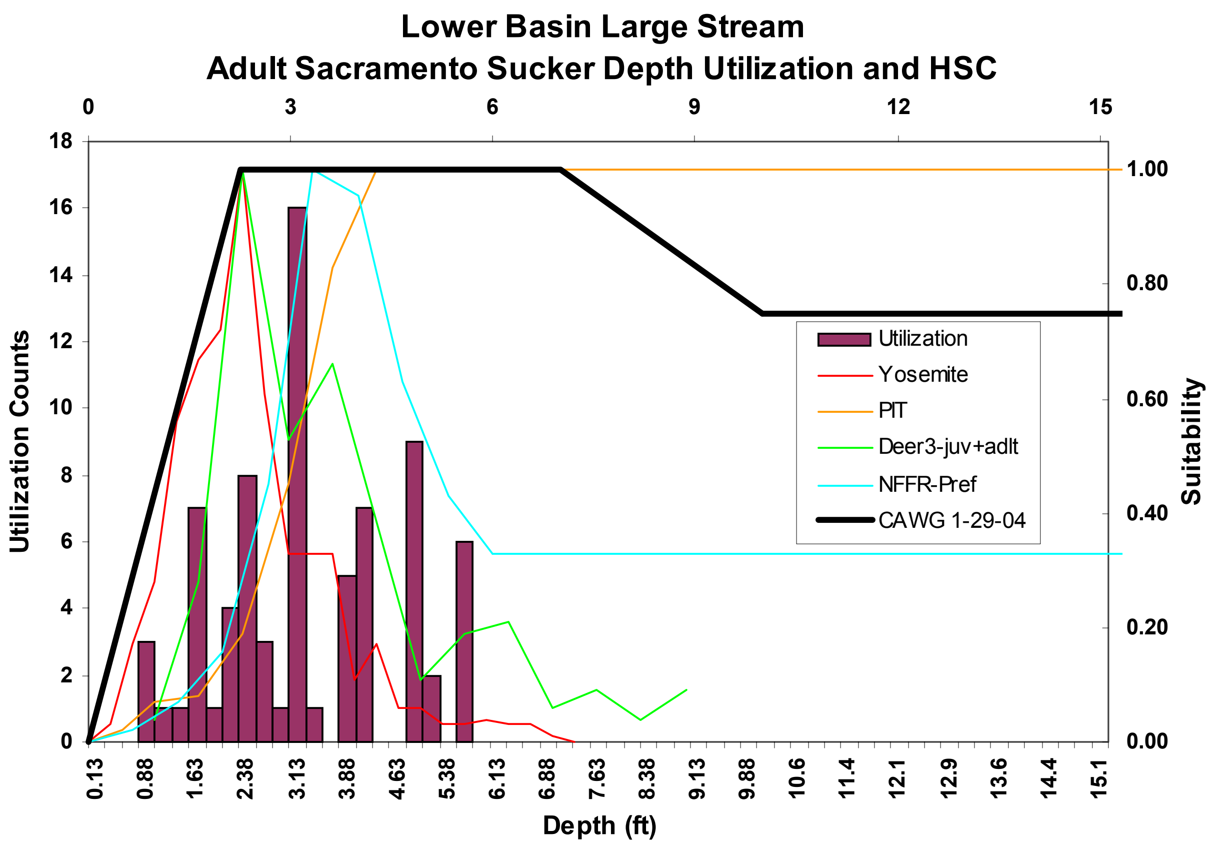


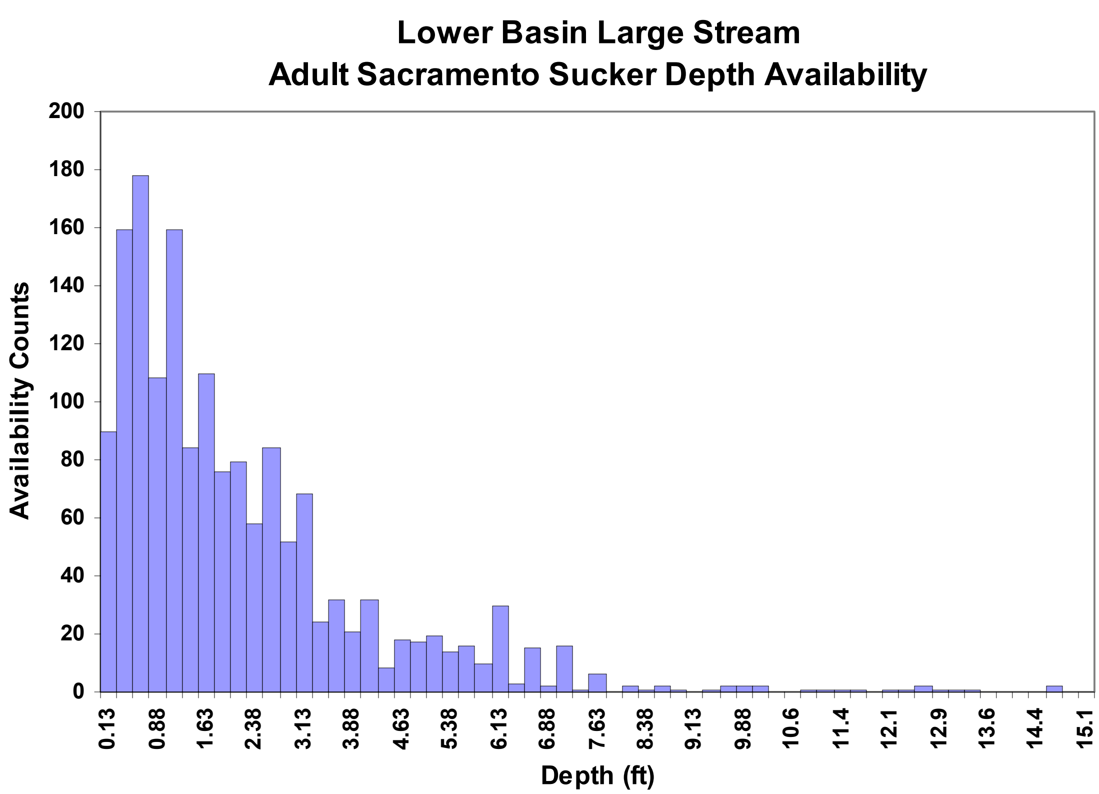
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: SACRAMENTO SUCKER
Life Stage: ADULT

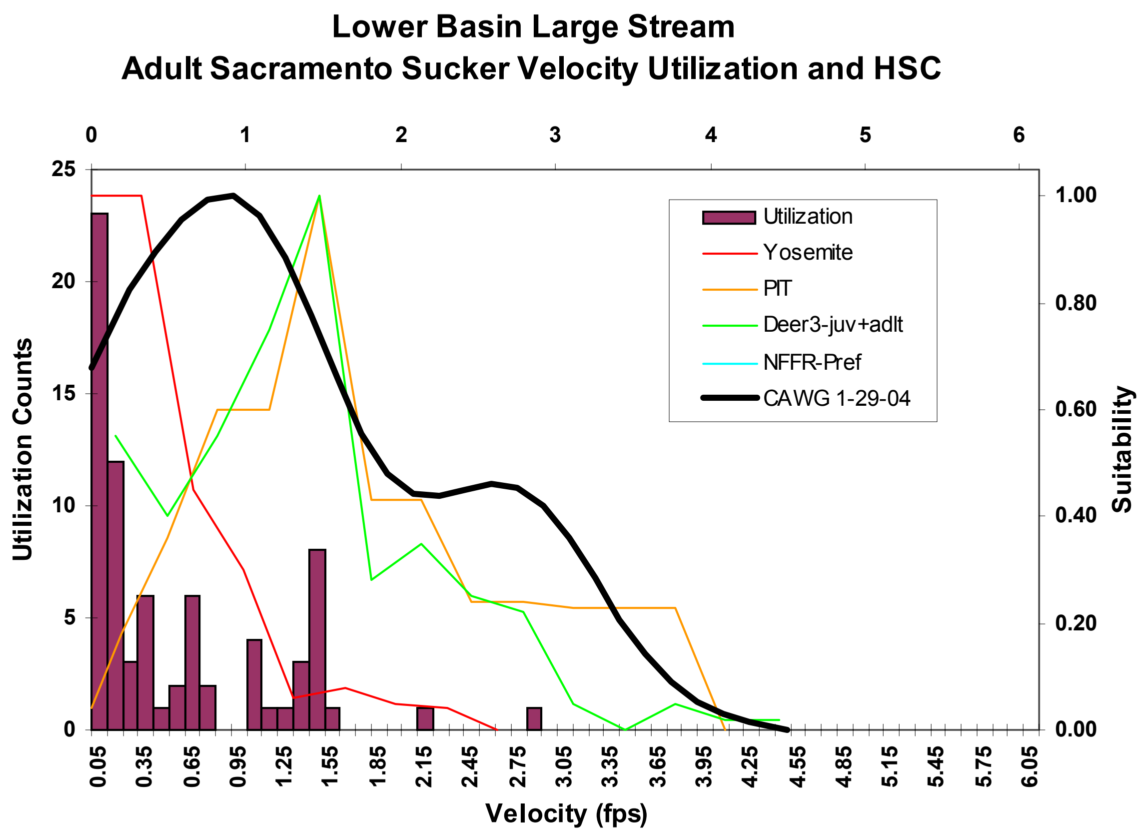
Velocity	Suitability	Depth	Suitability
0.00	0.68	0.00	0.00
0.25	0.82	2.25	1.00
0.42	0.90	7.00	1.00
0.58	0.96	10.00	0.75
0.75	1.00	16.00	0.75
0.92	1.00	100.00	0.75
1.08	0.96		
1.25	0.89		
1.42	0.78		
1.58	0.66		
1.75	0.55		
1.92	0.48		
2.08	0.44		
2.25	0.44		
2.42	0.45		
2.58	0.46		
2.75	0.46		
2.92	0.42		
3.08	0.36		
3.25	0.28		
3.42	0.21		
3.58	0.14		
3.75	0.09		
3.92	0.05		
4.08	0.03		
4.25	0.02		
4.50	0.00		
100.00	0.00		

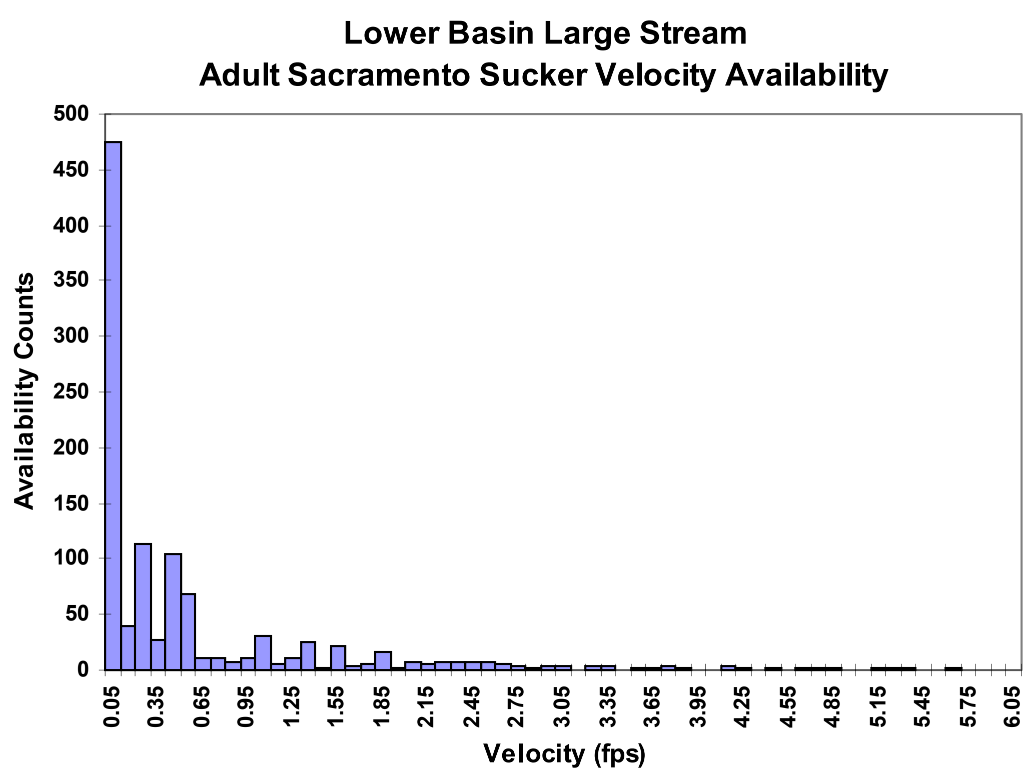
- **Velocity Criteria** - use NFFR-Pref criteria curve with no alteration
- **Depth Criteria** - use Stan-1 generic criteria curve with no alteration





Proposed CAWG Criteria may overlay some of the original criteria sets



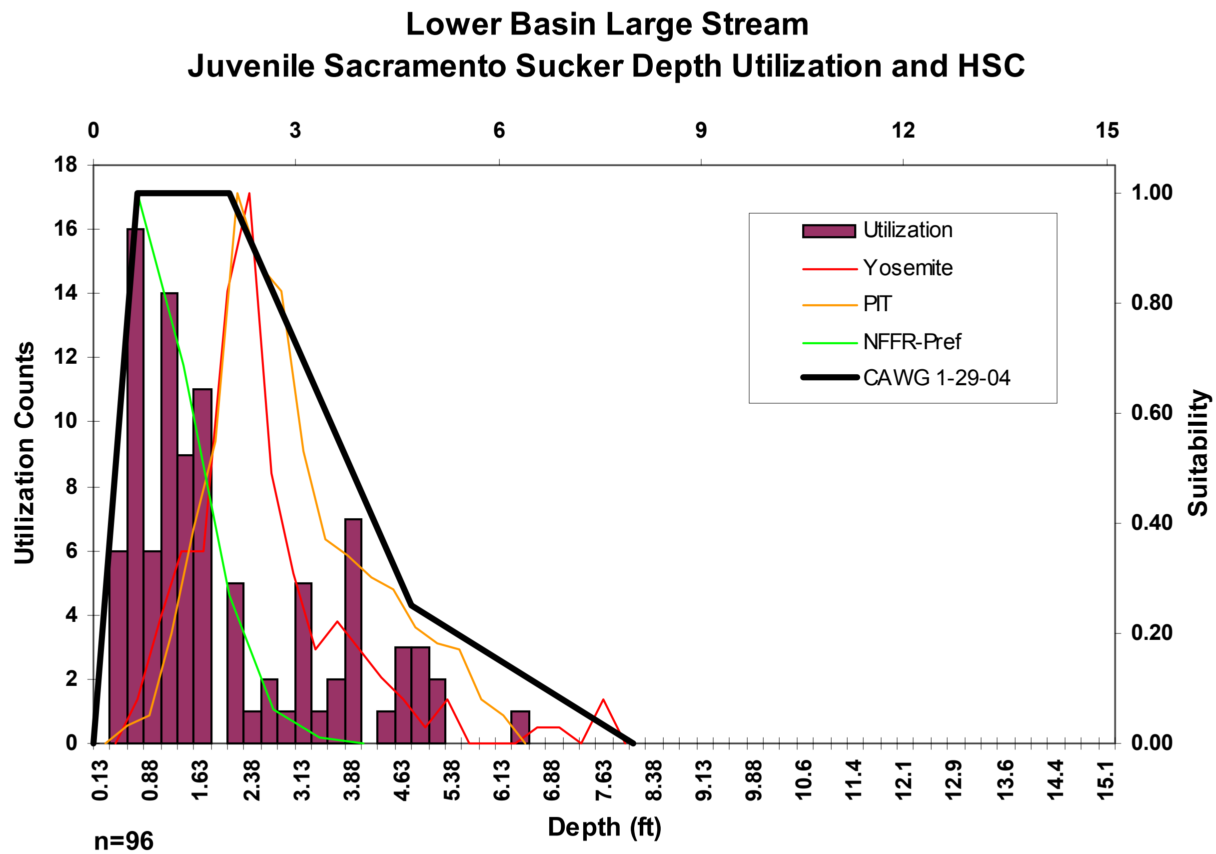


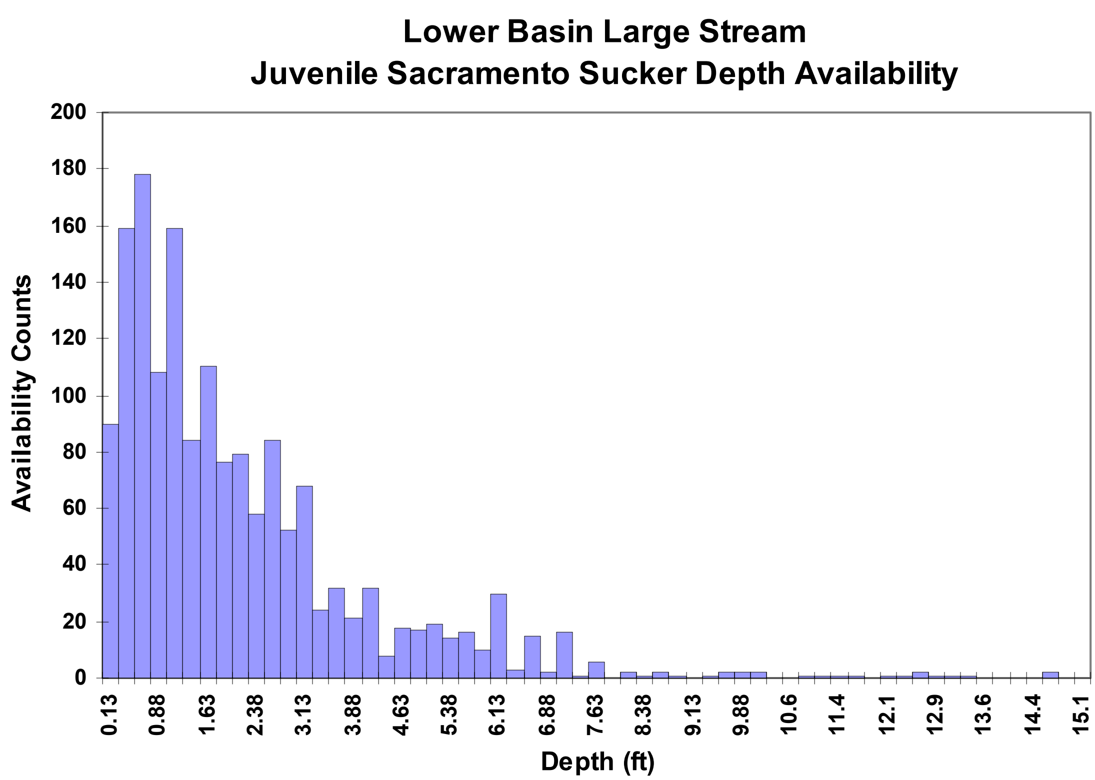
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: SACRAMENTO SUCKER
Life Stage: JUVENILE

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.25	1.00	0.66	1.00
0.42	0.85	2.00	1.00
0.58	0.69	4.70	0.25
0.75	0.54	8.00	0.00
0.92	0.41	100.00	0.00
1.08	0.30		
1.25	0.23		
1.42	0.19		
1.58	0.17		
3.75	0.00		
100.00	0.00		

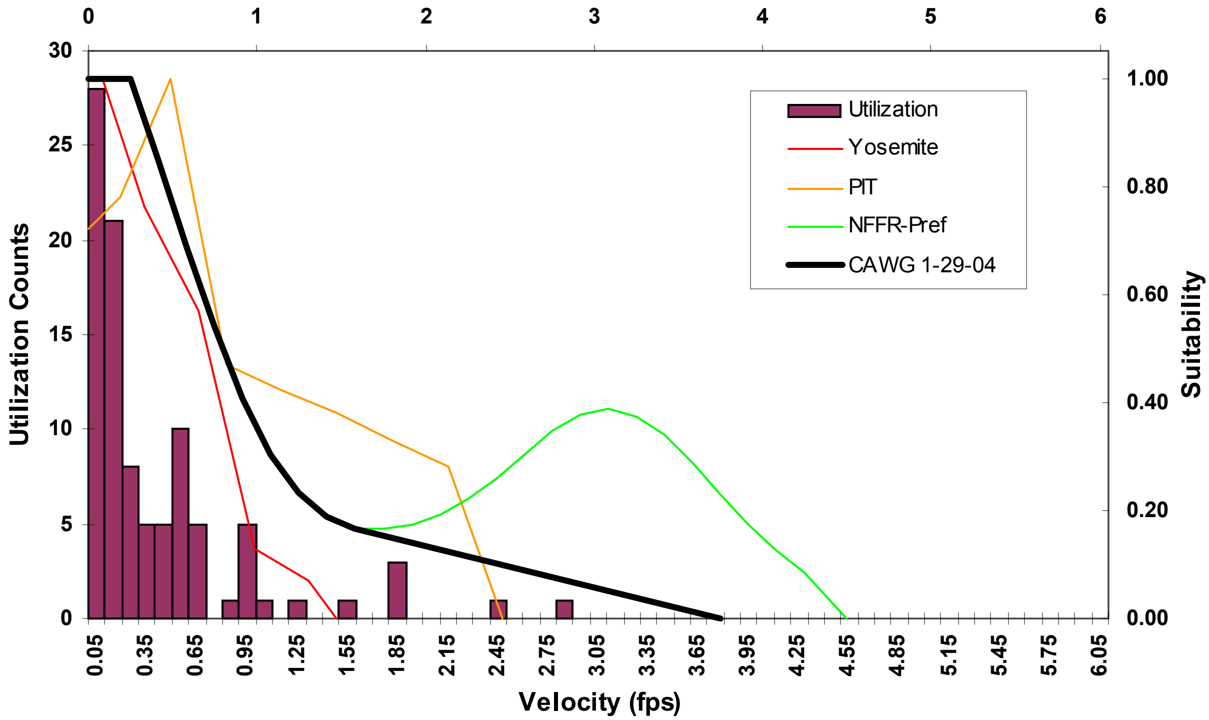
- **Velocity Criteria** - use NFFR-Pref criteria curve to bottom of first dip, straight line to depth = 3.75 feet and suitability = 0.
- **Depth Criteria** - use NFFR-Pref criteria curve up to peak, broaden peak to depth = 2.0 feet, then depth = 4.7 feet and suitability = 0.25, then depth = 8.0 feet and suitability = 0.



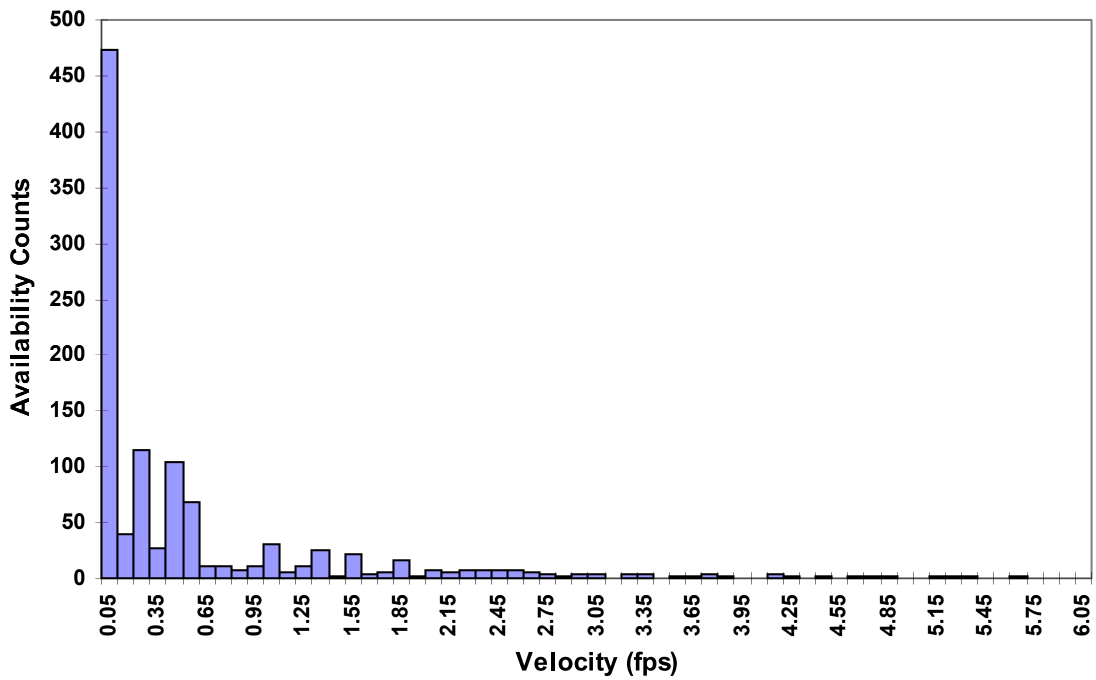


Proposed CAWG Criteria may overlay some of the original criteria sets

Lower Basin Large Stream
Juvenile Sacramento Sucker Velocity Utilization and HSC



Lower Basin Large Stream
Juvenile Sacramento Sucker Velocity Availability

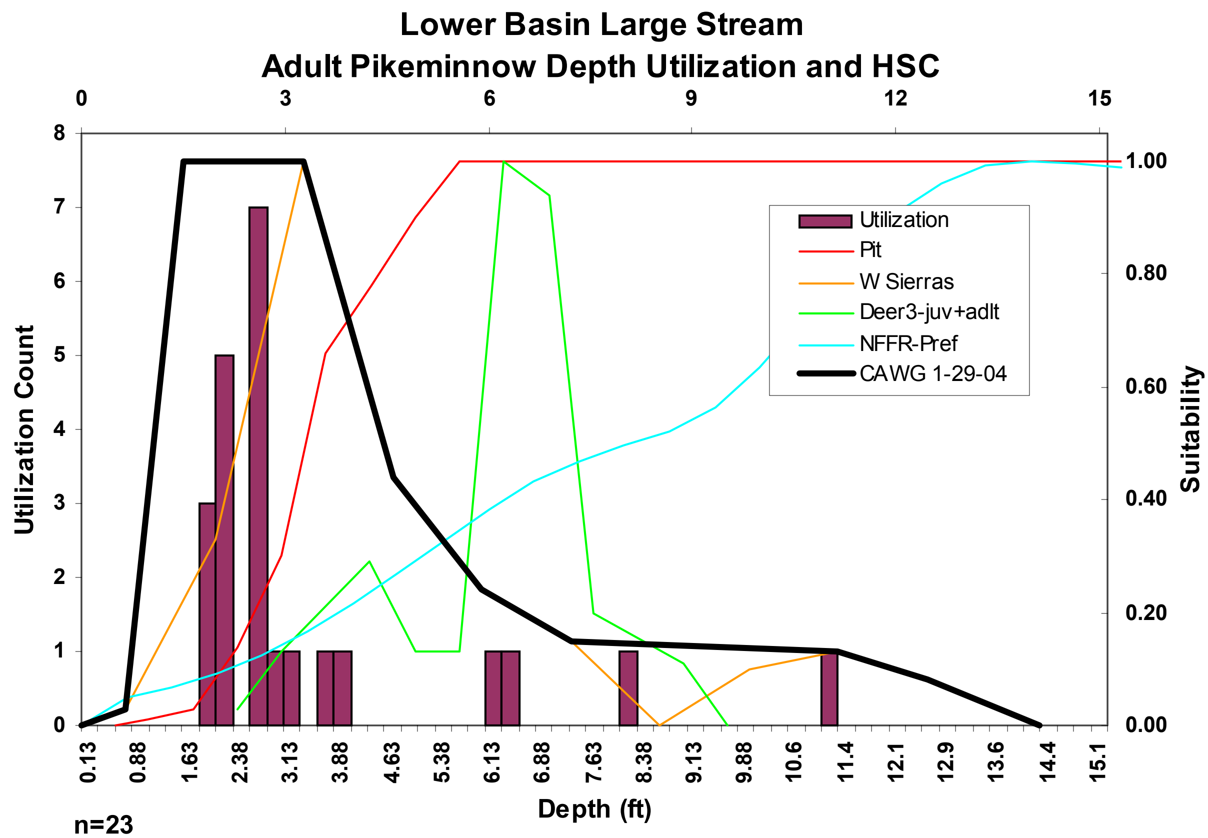


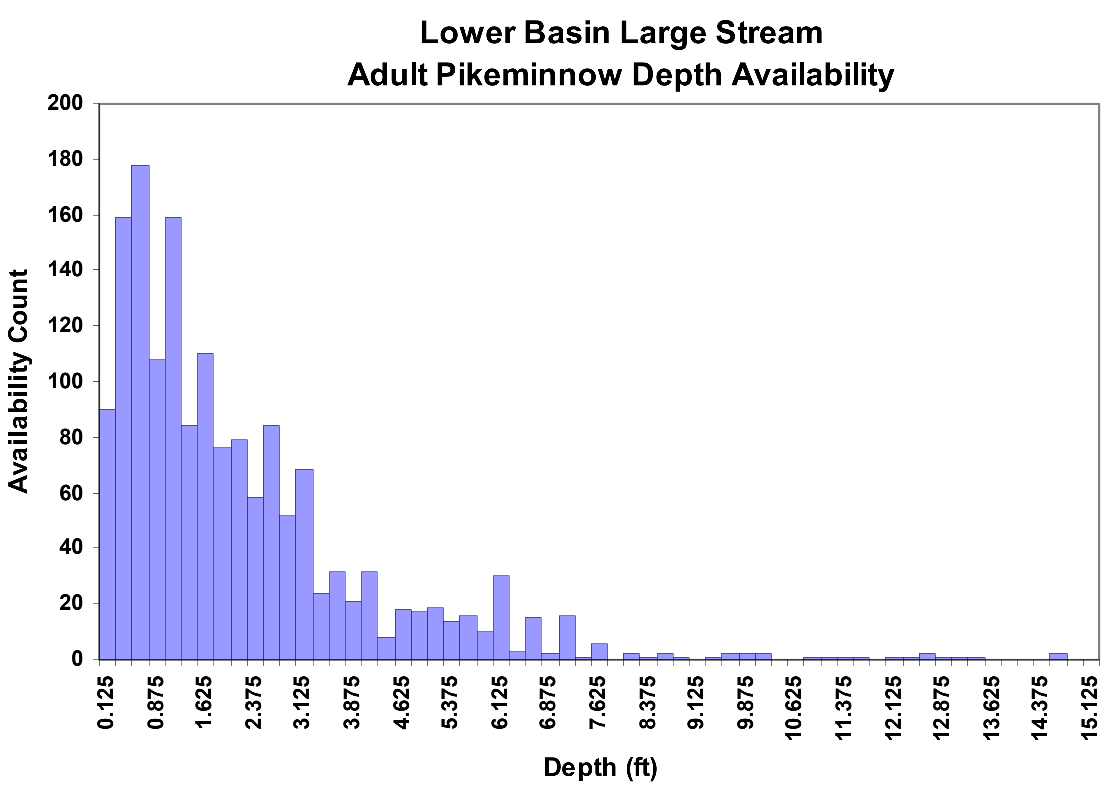
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: PIKEMINNOW
Life Stage: ADULT

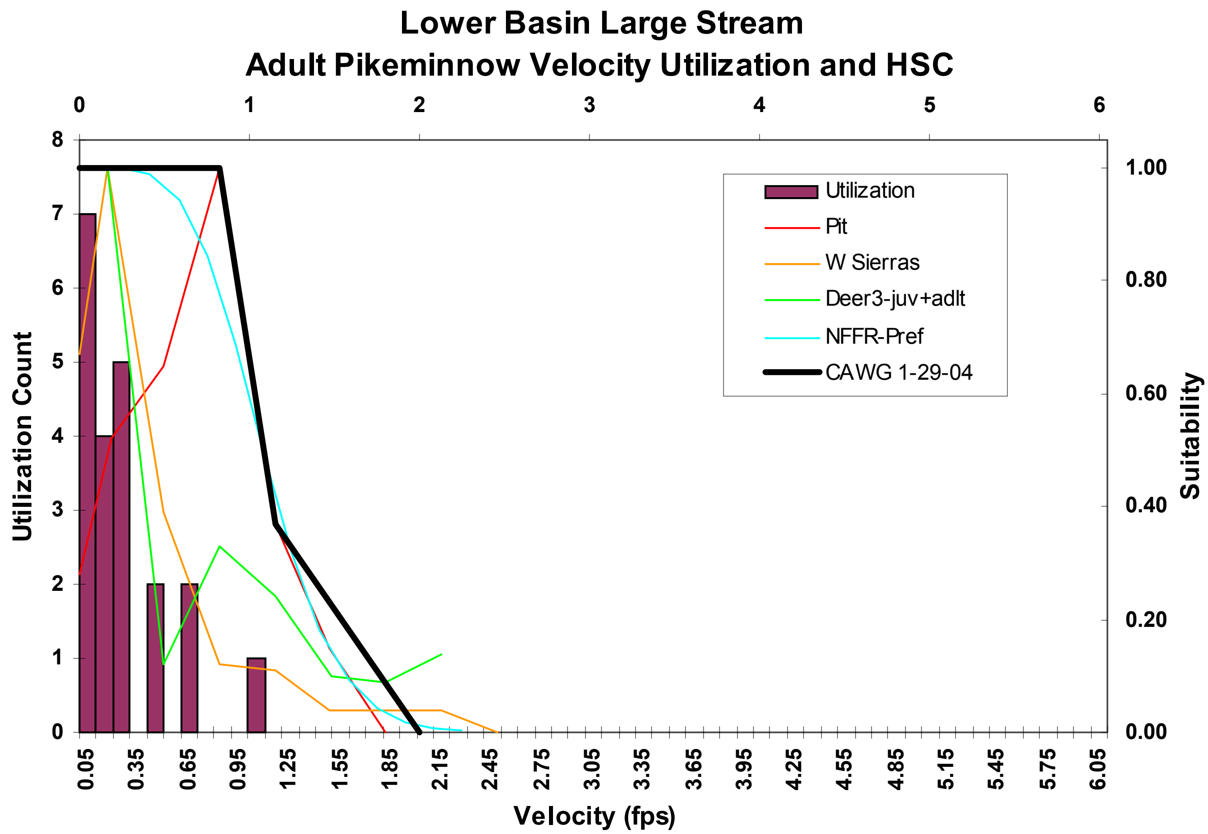
Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.82	1.00	0.66	0.03
1.15	0.37	1.50	1.00
2.00	0.00	3.28	1.00
100.00	0.00	4.59	0.44
		5.91	0.24
		7.22	0.15
		11.15	0.13
		12.47	0.08
		14.11	0.00
		100.00	0.00

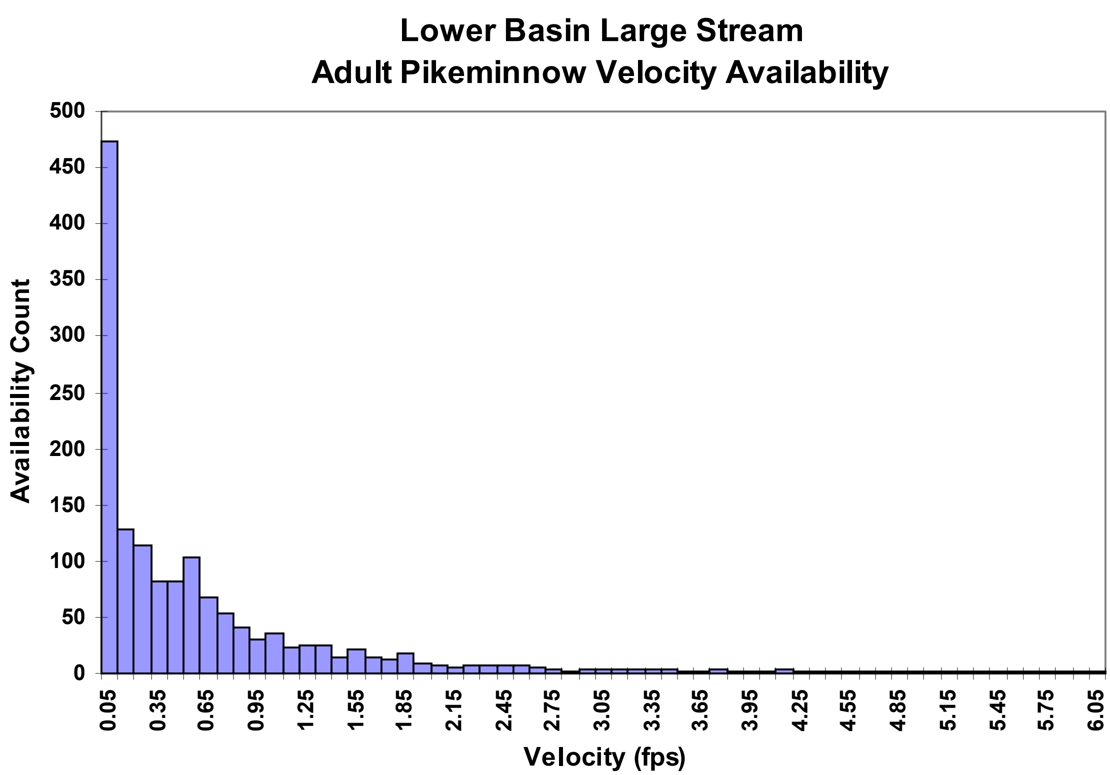
- **Velocity Criteria** - start with 0,1 (velocity = 0 fps and suitability = 1.0), broaden to peak of Pit criteria, follow Pit to inflection, straight line to velocity = 2.0 fps and suitability = 0.
- **Depth Criteria** - follow West Sierras criteria, but broaden peak to left (depth = 1.5 feet), follow descending limb of West Sierras, flat across valley, continue down descending limb of West Sierras to suitability = 0.





Proposed CAWG Criteria may overlay some of the original criteria sets



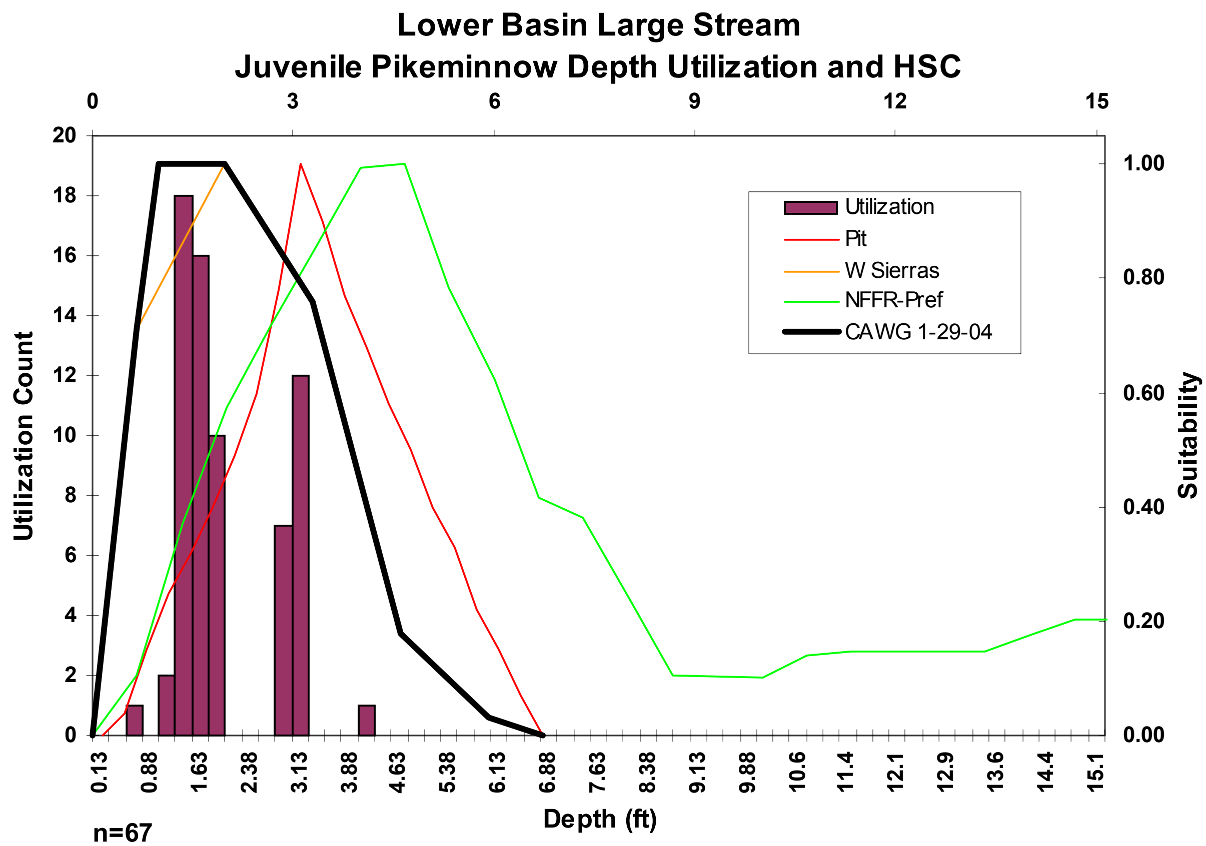


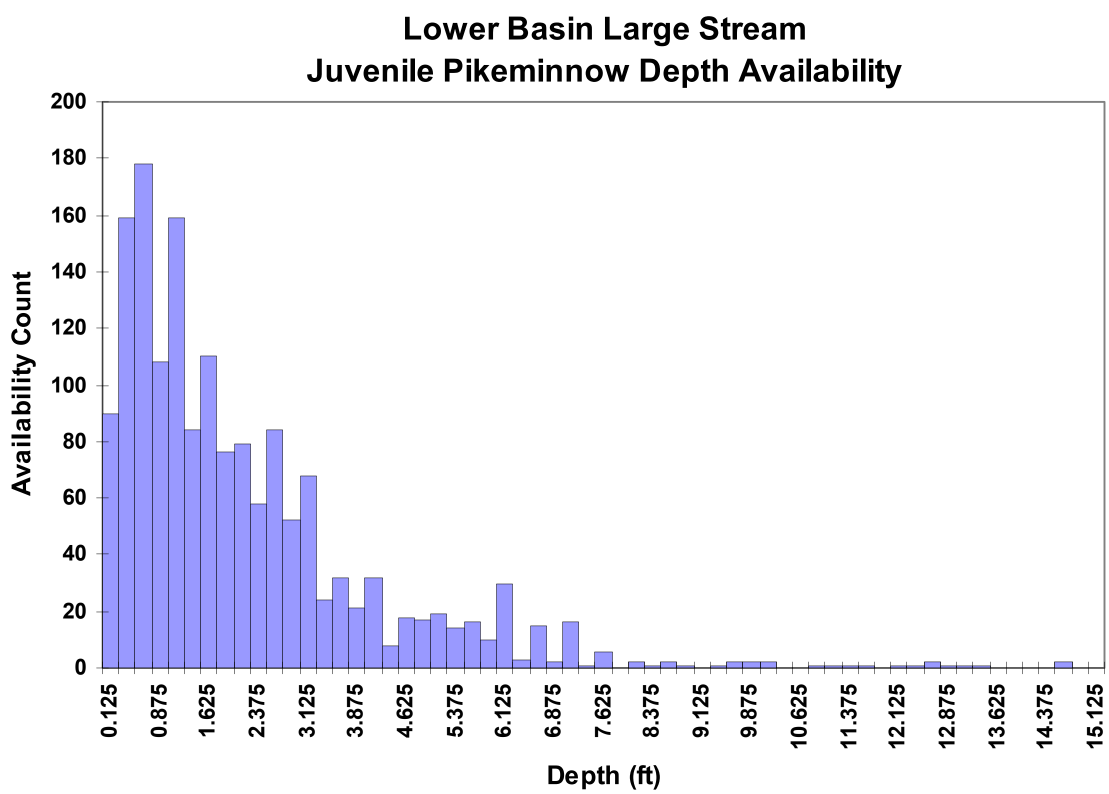
Proposed CAWG Criteria may overlay some of the original criteria sets

Curve Set ID: CAWG Criteria 1/29/04
Species Name: PIKEMINNOW
Life Stage: JUVENILE

Velocity	Suitability	Depth	Suitability
0.00	1.00	0.00	0.00
0.19	1.00	0.66	0.71
0.48	0.72	1.00	1.00
0.82	0.42	1.97	1.00
1.14	0.20	3.28	0.76
1.48	0.00	4.59	0.18
100.00	0.00	5.91	0.03
		6.73	0.00
		100.00	0.00

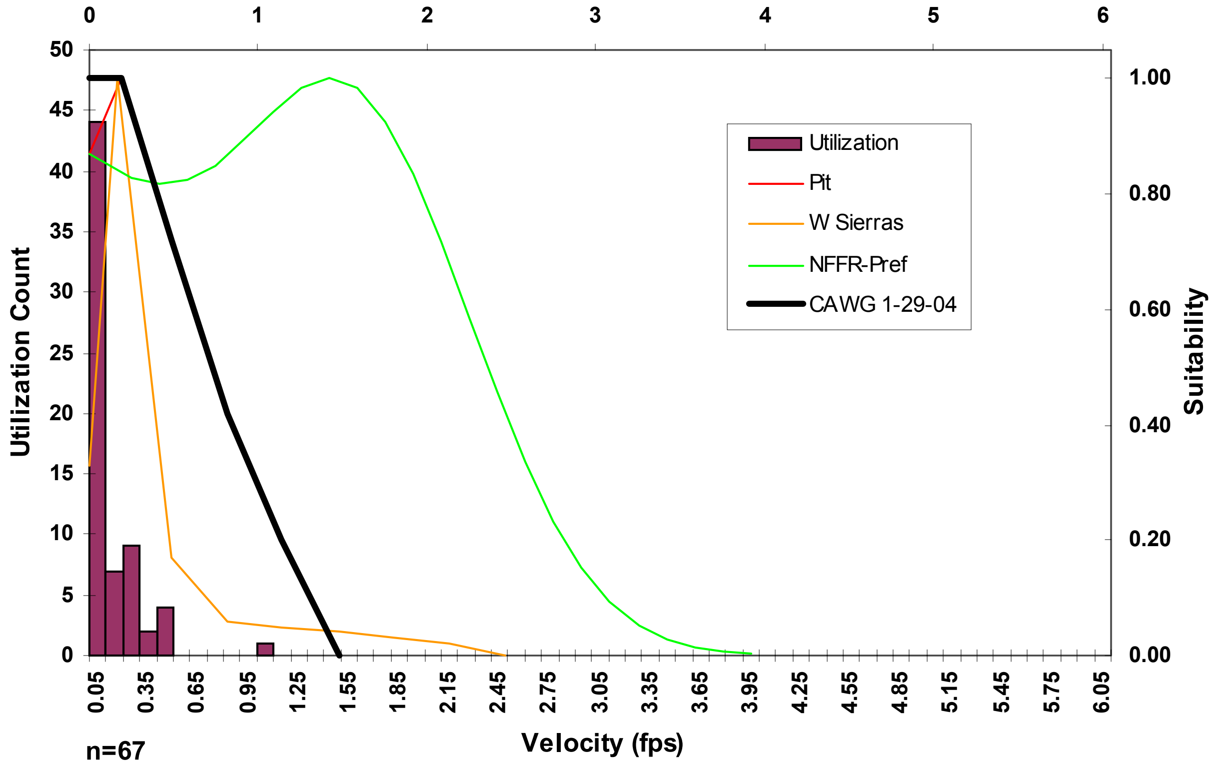
- **Velocity Criteria** - start with 0,1 (velocity = 0 fps and suitability = 1.0), then follow PIT criteria curve to end.
- **Depth Criteria** - take ascending limb of West Sierras straight up to depth = 1.0 foot and suitability = 1.0, broaden peak to depth = 1.97 feet, follow West Sierras to end.



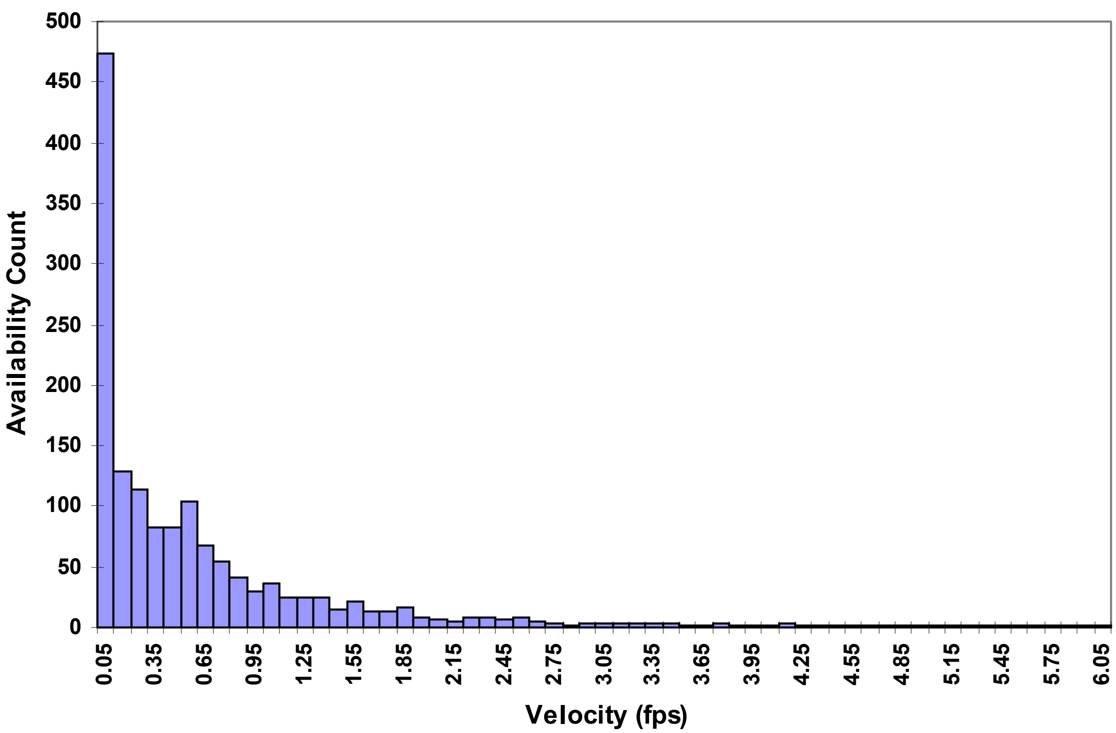


Proposed CAWG Criteria may overlay some of the original criteria sets

Lower Basin Large Stream
Juvenile Pikeminnow Velocity Utilization and HSC



Lower Basin Large Stream
Juvenile Pikeminnow Velocity Availability



Proposed CAWG Criteria may overlay some of the original criteria sets

ATTACHMENT D

SENSITIVITY ANALYSIS

Adult Rainbow and Brown Trout WUA Sensitivity Analysis

Prepared for:

the Combined Aquatics Working Group

By:

ENTRIX, Inc

June 30, 2004

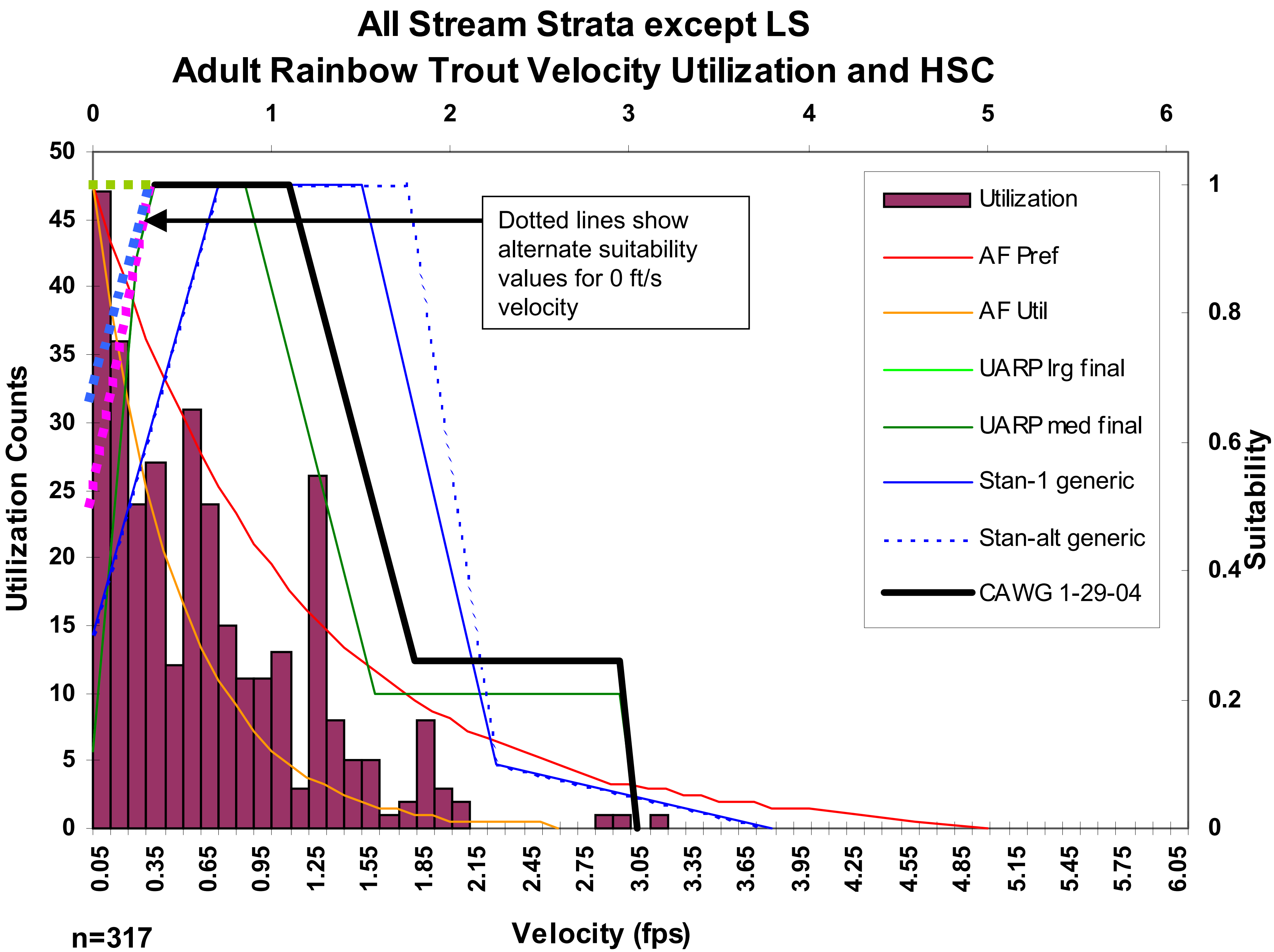
Background

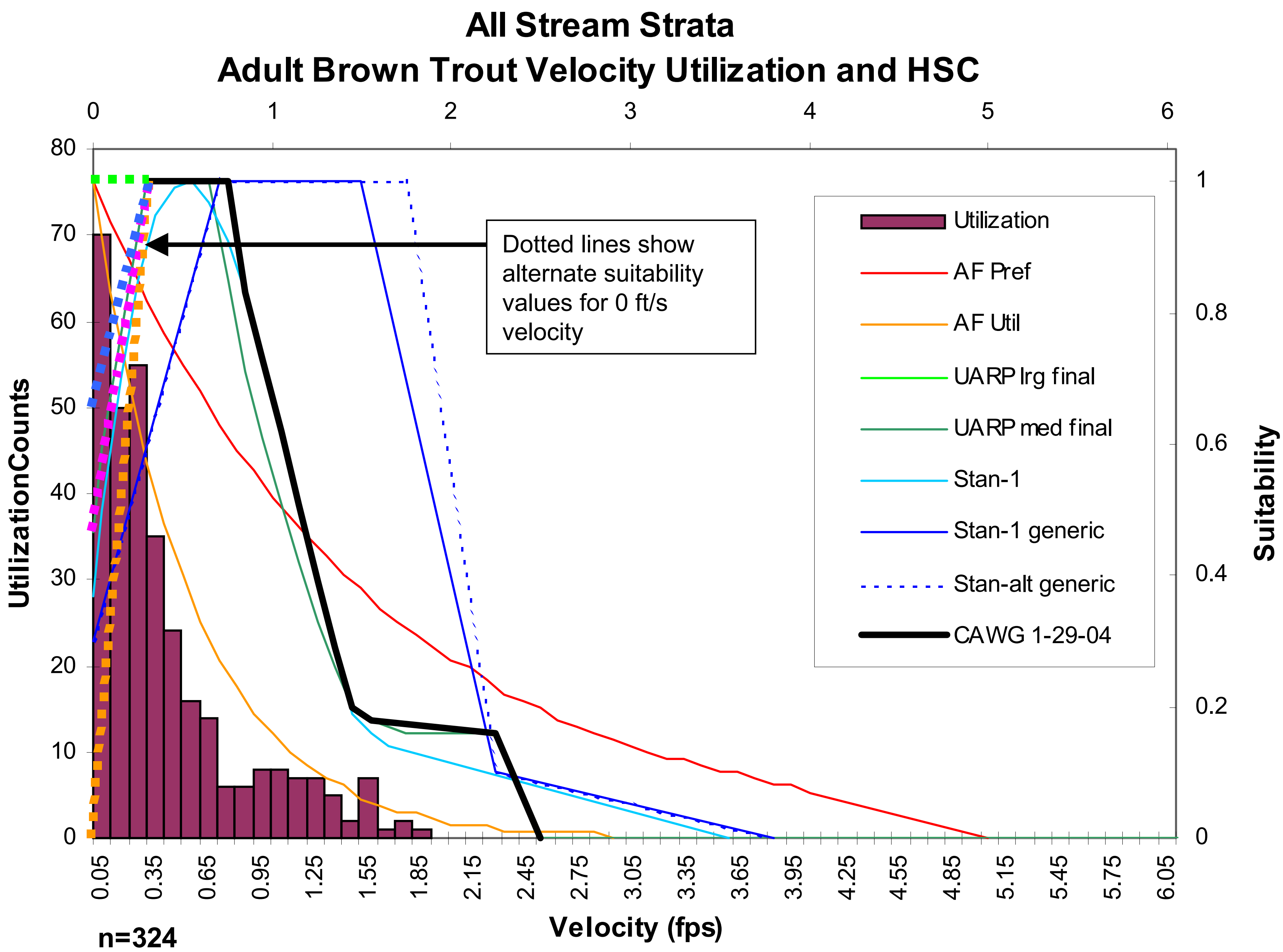
- The different HSC proposed for adult trout suggested different values of suitability for velocities near 0 ft/s
- Observations in the Big Creek system indicate that velocities near 0 ft/s are used extensively by adult trout
- The CAWG has requested that an analysis of the sensitivity of the suitabilities of 0 ft/s on the shape of the WUA function

Approach

- Used the Big Creek ALP adult rainbow and brown trout criteria varying only the suitability of velocity at 0 ft/s
- Applied these criteria to five different stream systems with different habitat characteristics and different summer base flows.
- Plotted WUA with flow to show differences in the response to these changes in suitability

HSC Plots


All Stream Strata except LS
Adult Rainbow Trout Velocity Utilization and HSC
Utilization Counts
Suitability
Velocity (fps)
n=317
Dotted lines show alternate suitability values for 0 ft/s velocity
Utilization
AF Pref
AF Util
UARP lrg final
UARP med final
Stan-1 generic
Stan-alt generic
CAWG 1-29-04
0
1
2
3
4
5
6
50
45
40
35
30
25
20
15
10
5
0
1
0.8
0.6
0.4
0.2
0
0.05
0.35
0.65
0.95
1.25
1.55
1.85
2.15
2.45
2.75
3.05
3.35
3.65
3.95
4.25
4.55
4.85
5.15
5.45
5.75
6.05



All Stream Strata
Adult Brown Trout Velocity Utilization and HSC
0
1
2
3
4
5
6
80
70
60
50
40
30
20
10
0
UtilizationCounts
1
0.8
0.6
0.4
0.2
0
Suitability
Dotted lines show alternate suitability values for 0 ft/s velocity
Utilization
AF Pref
AF Util
UARP lrg final
UARP med final
Stan-1
Stan-1 generic
Stan-alt generic
CAWG 1-29-04
0.05
0.35
0.65
0.95
1.25
1.55
1.85
2.15
2.45
2.75
3.05
3.35
3.65
3.95
4.25
4.55
4.85
5.15
5.45
5.75
6.05
Velocity (fps)
n=324

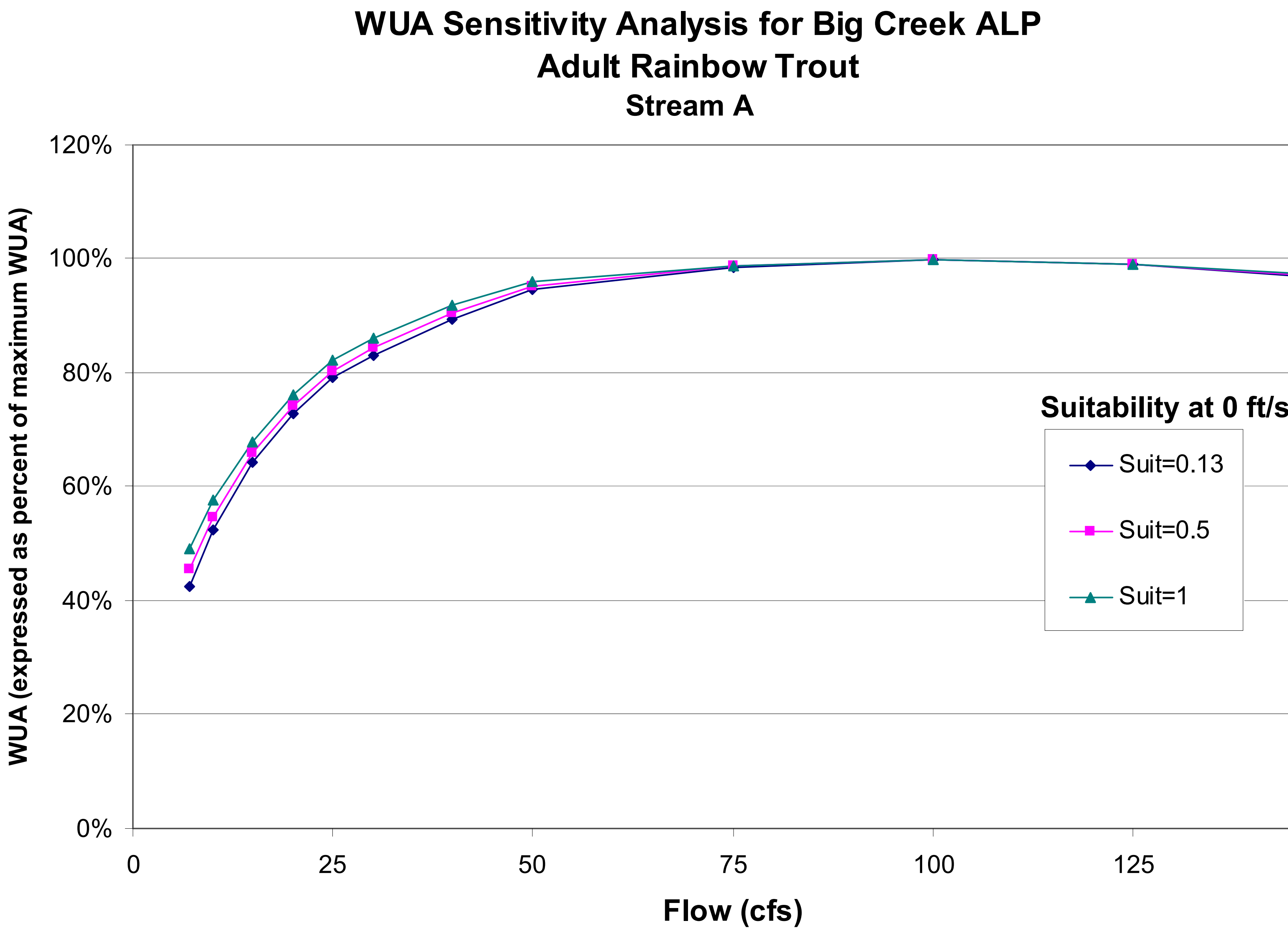
Stream Characteristics

- Five non-ALP streams labeled A through E. Characterized as follows:
  - **A**-Mid-sized stream in California with cobble/boulder substrate, steep gradient, summer base flows of 20 to 30 cfs
  - **B**-Moderate-sized river in California, steep gradient, substrate of cobble and large boulders, summer base flows of 150 to 200 cfs
  - **C**-Large river in Oregon with a moderate to steep gradient, bedrock controls and summer base flows of 300 to 400 cfs.

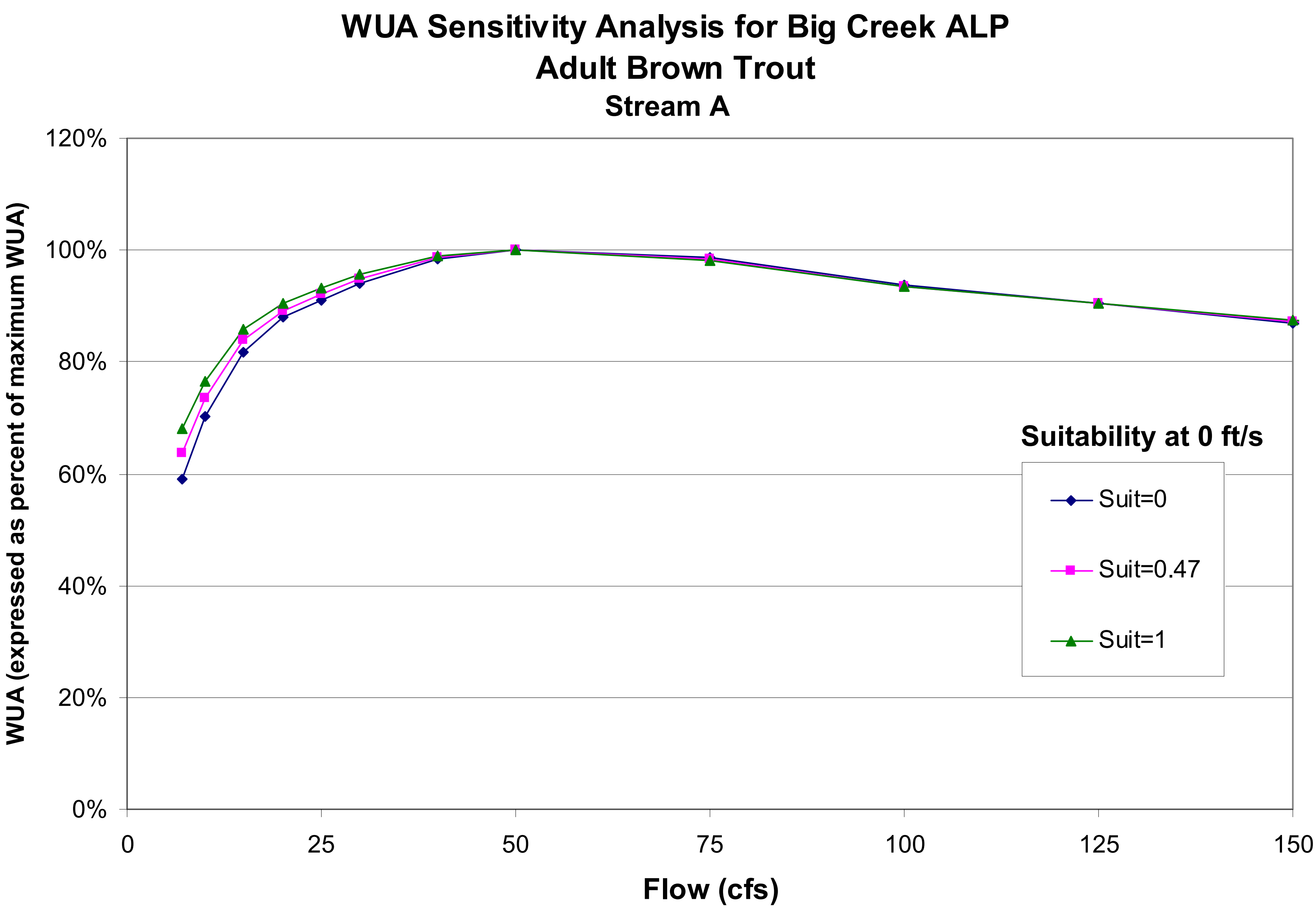
Stream Characteristics

- **D**-small-sized stream in California with cobble/sand substrate with abundant boulders, moderate to steep gradient, summer base flows of 3 to 5 cfs
- **E**-Moderate-sized stream in Oregon, moderate gradient, substrate of sand and gravel, summer base flows of 50 to 80 cfs

Results



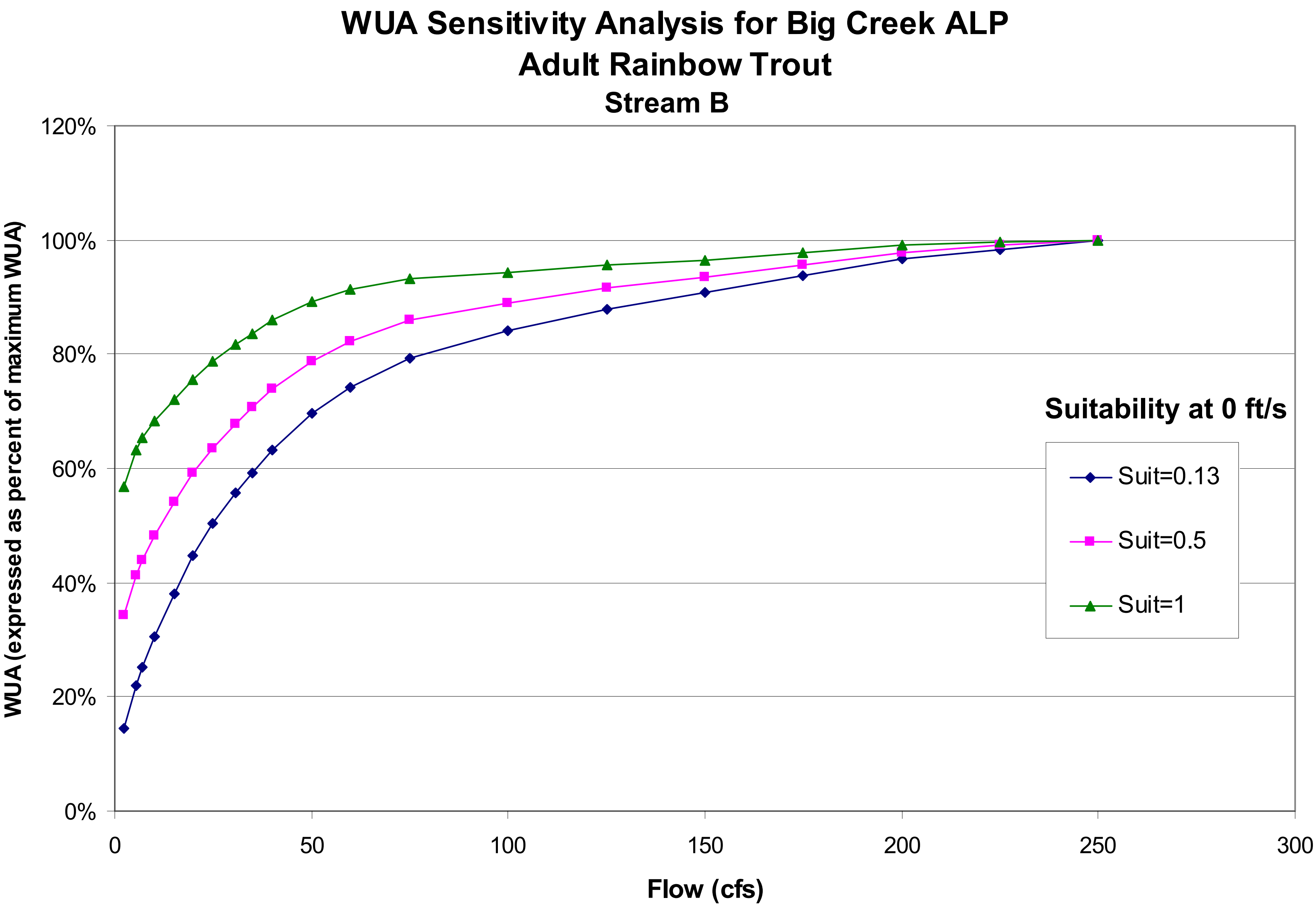
WUA Sensitivity Analysis for Big Creek ALP
Adult Rainbow Trout
Stream A
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
25
50
75
100
125
150
Flow (cfs)
Suitability at 0 ft/s
Suit=0.13
Suit=0.5
Suit=1



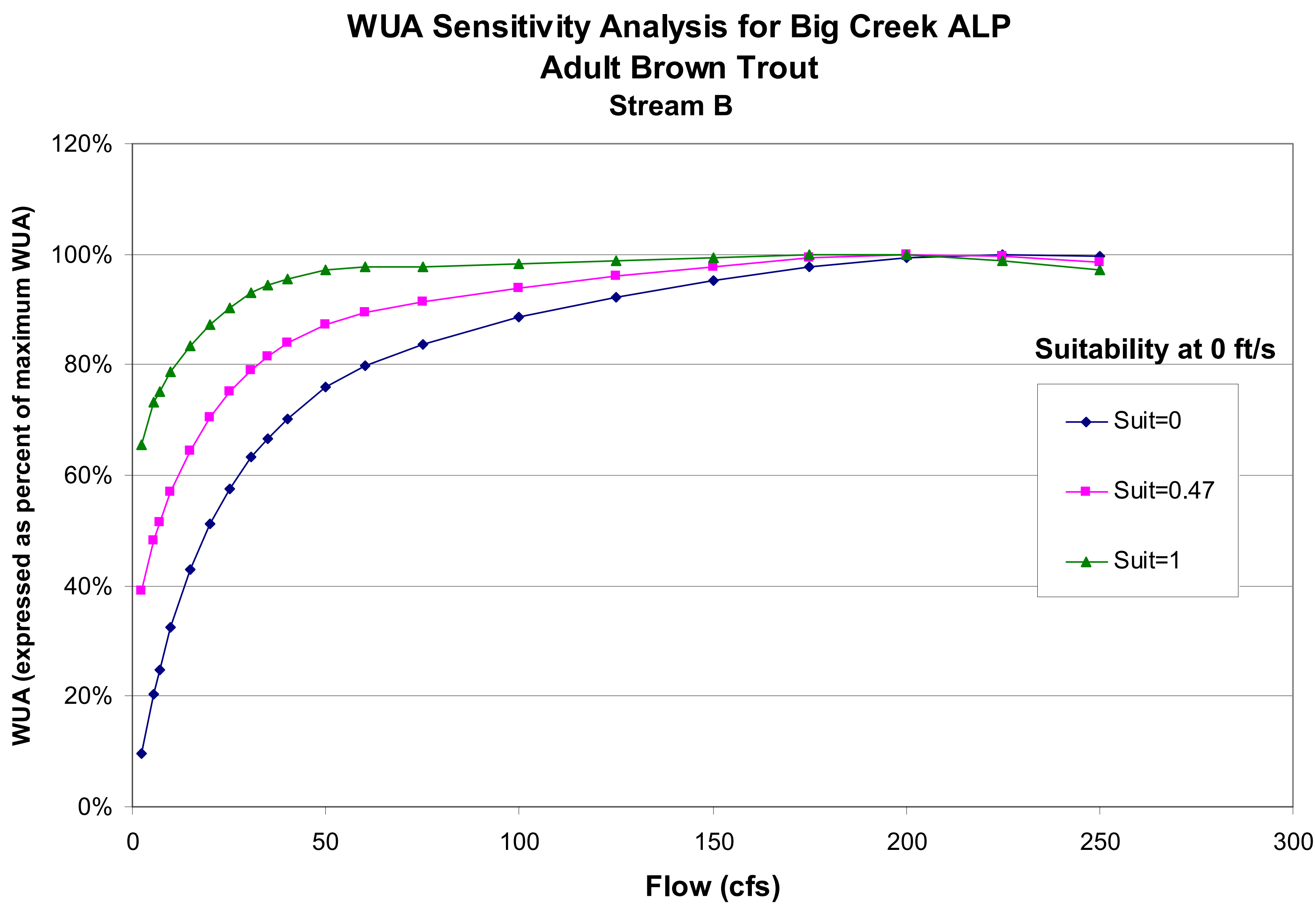
WUA Sensitivity Analysis for Big Creek ALP
Adult Brown Trout
Stream A
120%
100%
80%
60%
40%
20%
0%
WUA (expressed as percent of maximum WUA)
0
25
50
75
100
125
150
Flow (cfs)
Suitability at 0 ft/s
Suit=0
Suit=0.47
Suit=1

Effects on Stream A WUA Predictions

- Changing the suitability value of 0 ft/s velocity on this stream resulted in relatively little change in the shape or magnitude of the WUA-flow function
- Changing the suitability of 0 ft/s velocity on this stream likely would not affect consideration of minimum flow

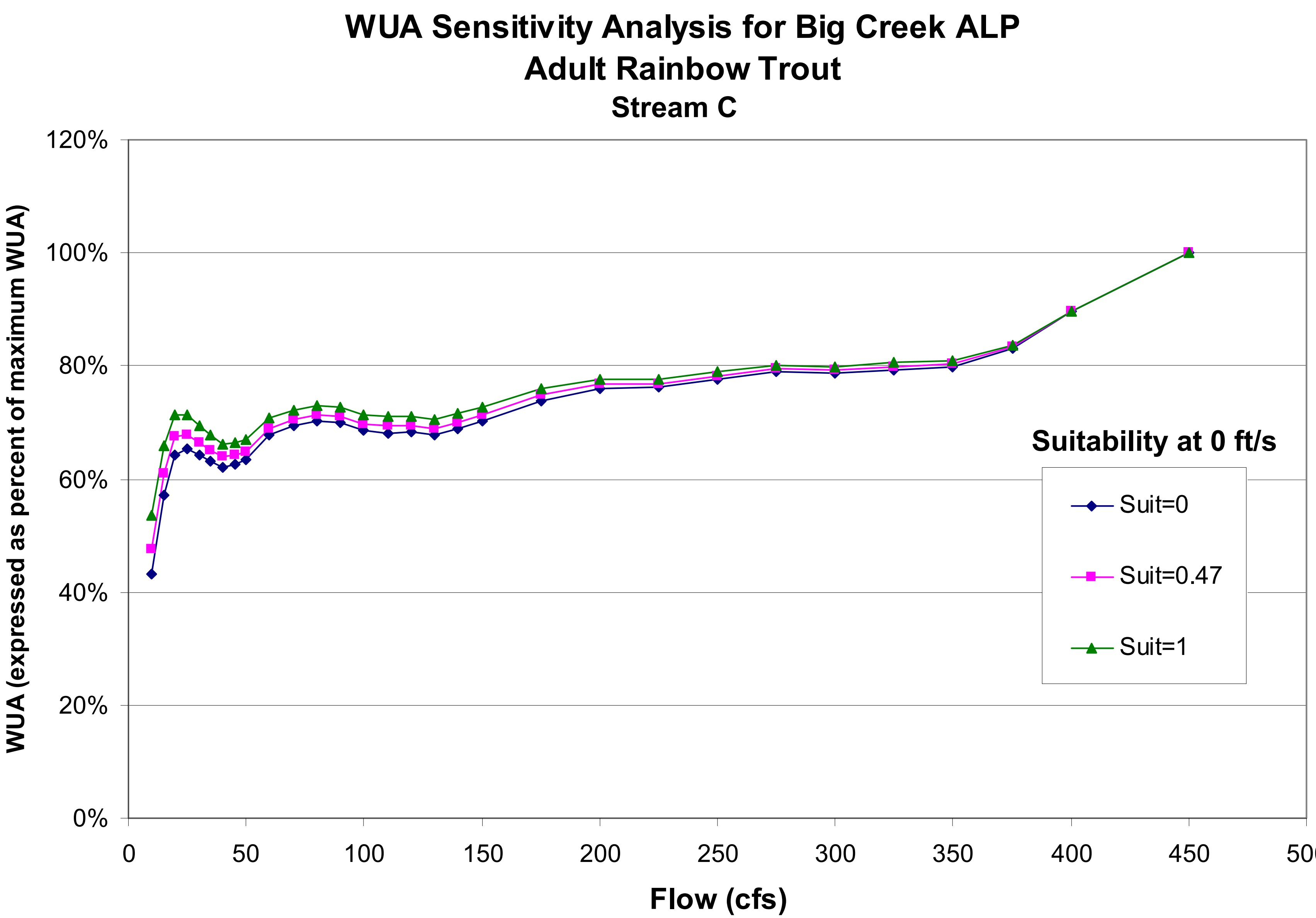


WUA Sensitivity Analysis for Big Creek ALP
Adult Rainbow Trout
Stream B
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
50
100
150
200
250
300
Flow (cfs)
Suitability at 0 ft/s
Suit=0.13
Suit=0.5
Suit=1

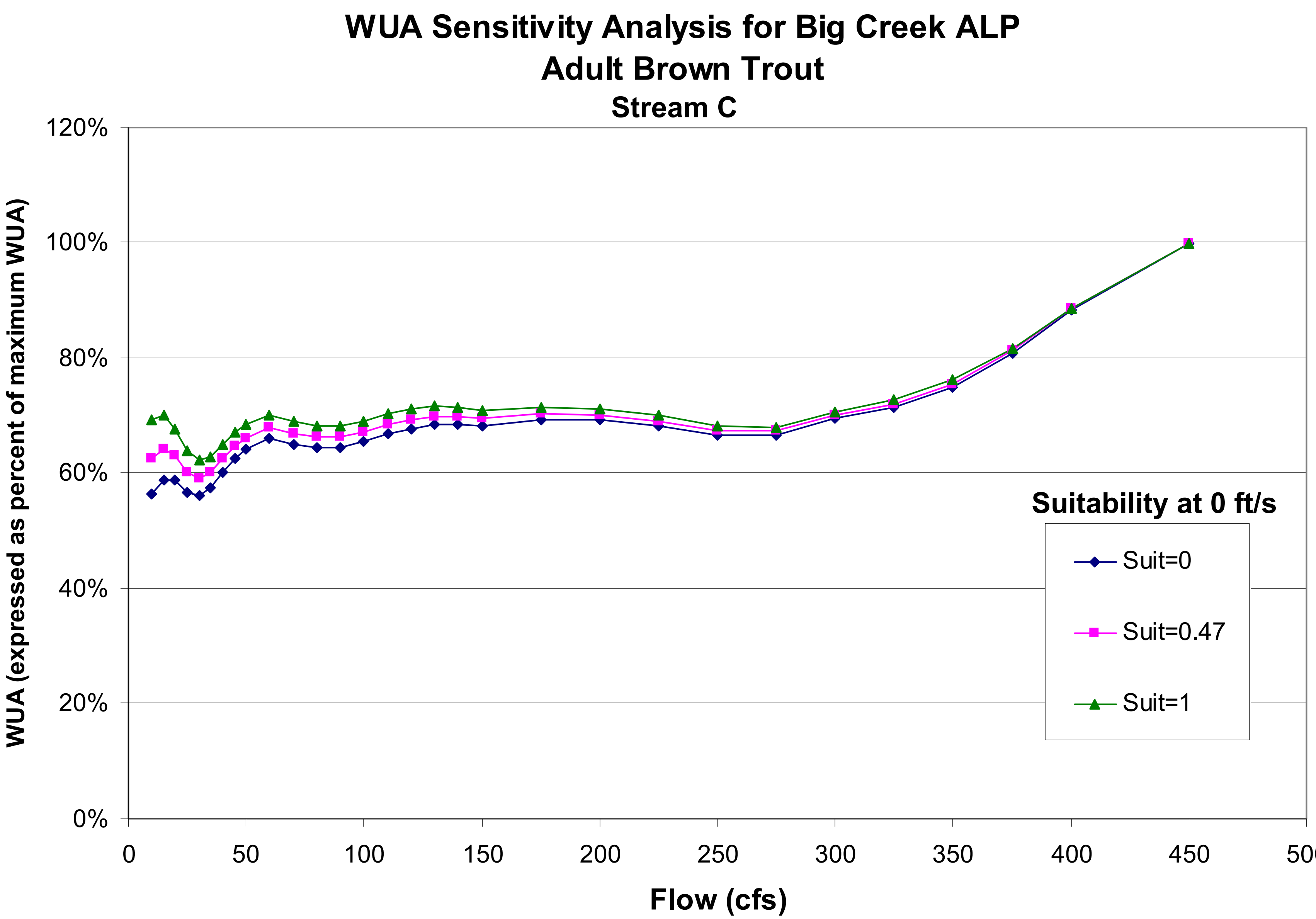

WUA Sensitivity Analysis for Big Creek ALP
Adult Brown Trout
Stream B
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
50
100
150
200
250
300
Flow (cfs)
Suitability at 0 ft/s
Suit=0
Suit=0.47
Suit=1

Effects on Stream B WUA Predictions

- WUA was increased at lower flows when the suitability of 0 ft/s velocity was higher
- The general shape of the WUA with flow function did not change as much. The most rapid increase in WUA with flow occurred in the same flow range for all three 0 ft/s suitabilities.

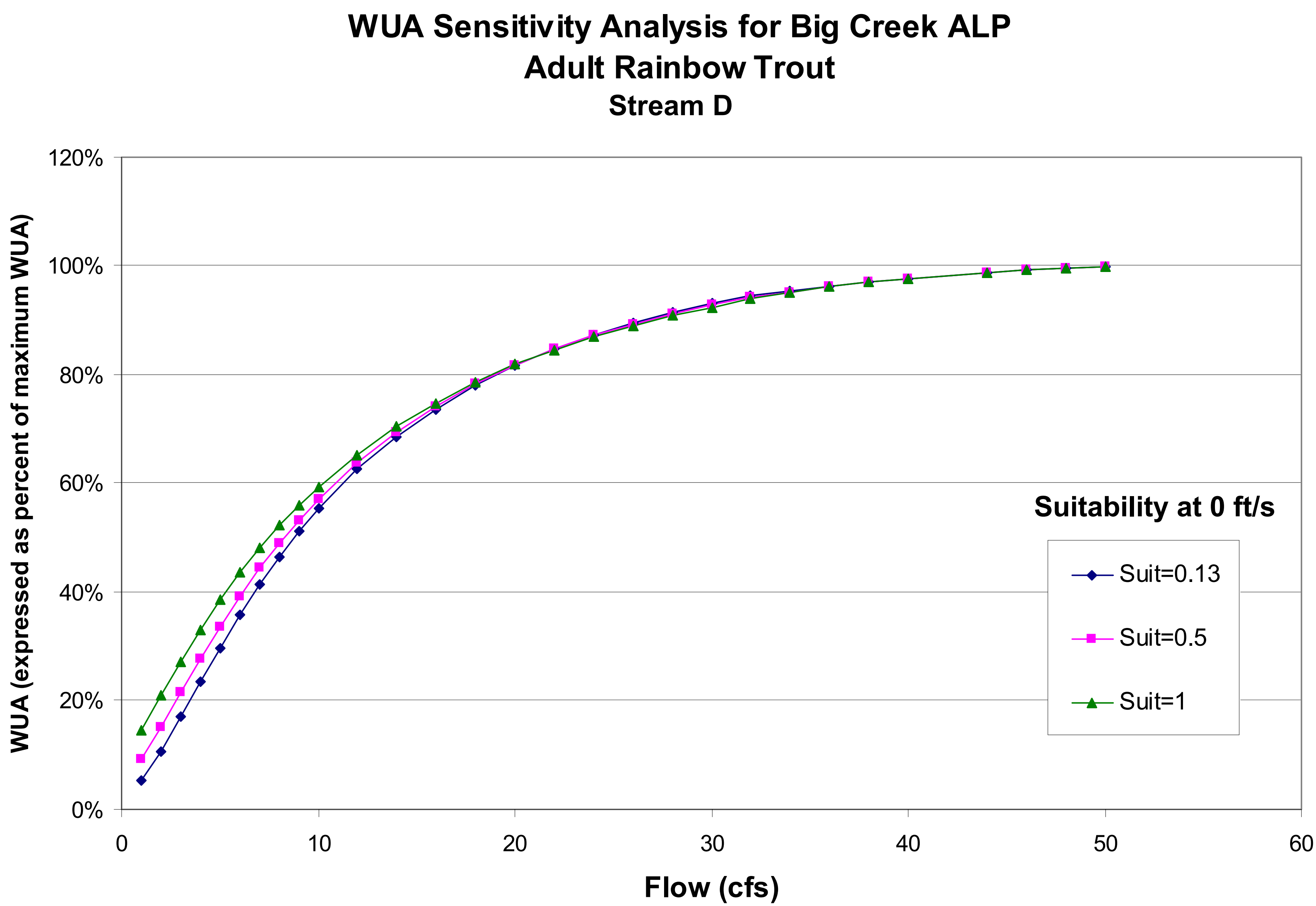


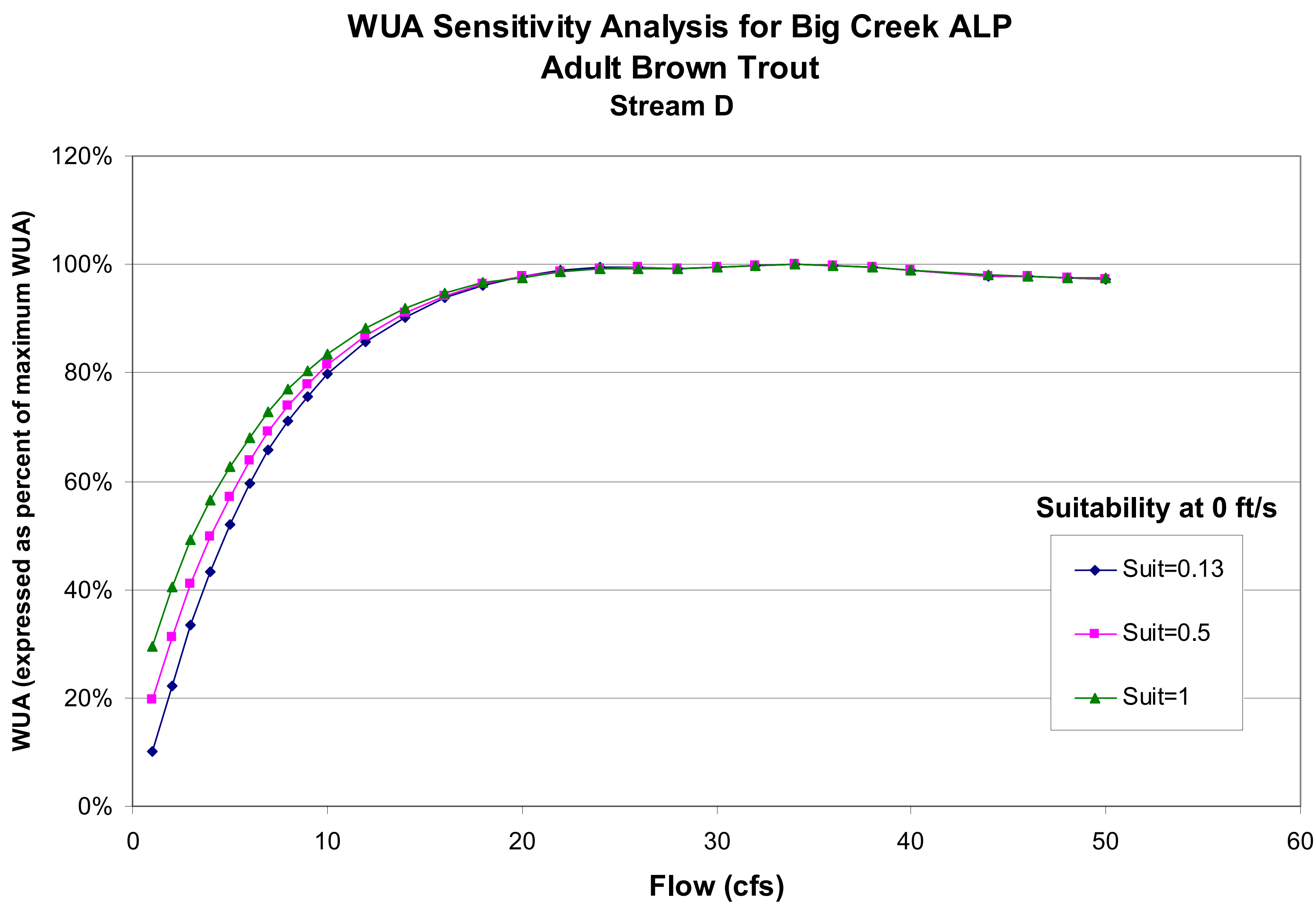
WUA Sensitivity Analysis for Big Creek ALP
Adult Rainbow Trout
Stream C
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
50
100
150
200
250
300
350
400
450
500
Flow (cfs)
Suitability at 0 ft/s
Suit=0
Suit=0.47
Suit=1


WUA Sensitivity Analysis for Big Creek ALP
Adult Brown Trout
Stream C
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
50
100
150
200
250
300
350
400
450
500
Flow (cfs)
Suitability at 0 ft/s
Suit=0
Suit=0.47
Suit=1

Effects on Stream C

- Changing the suitability value of 0 ft/s on this stream resulted in a slight increase in WUA at lower flows
- There was little change to the WUA with flow function as a result of differences in 0 ft/s suitabilities

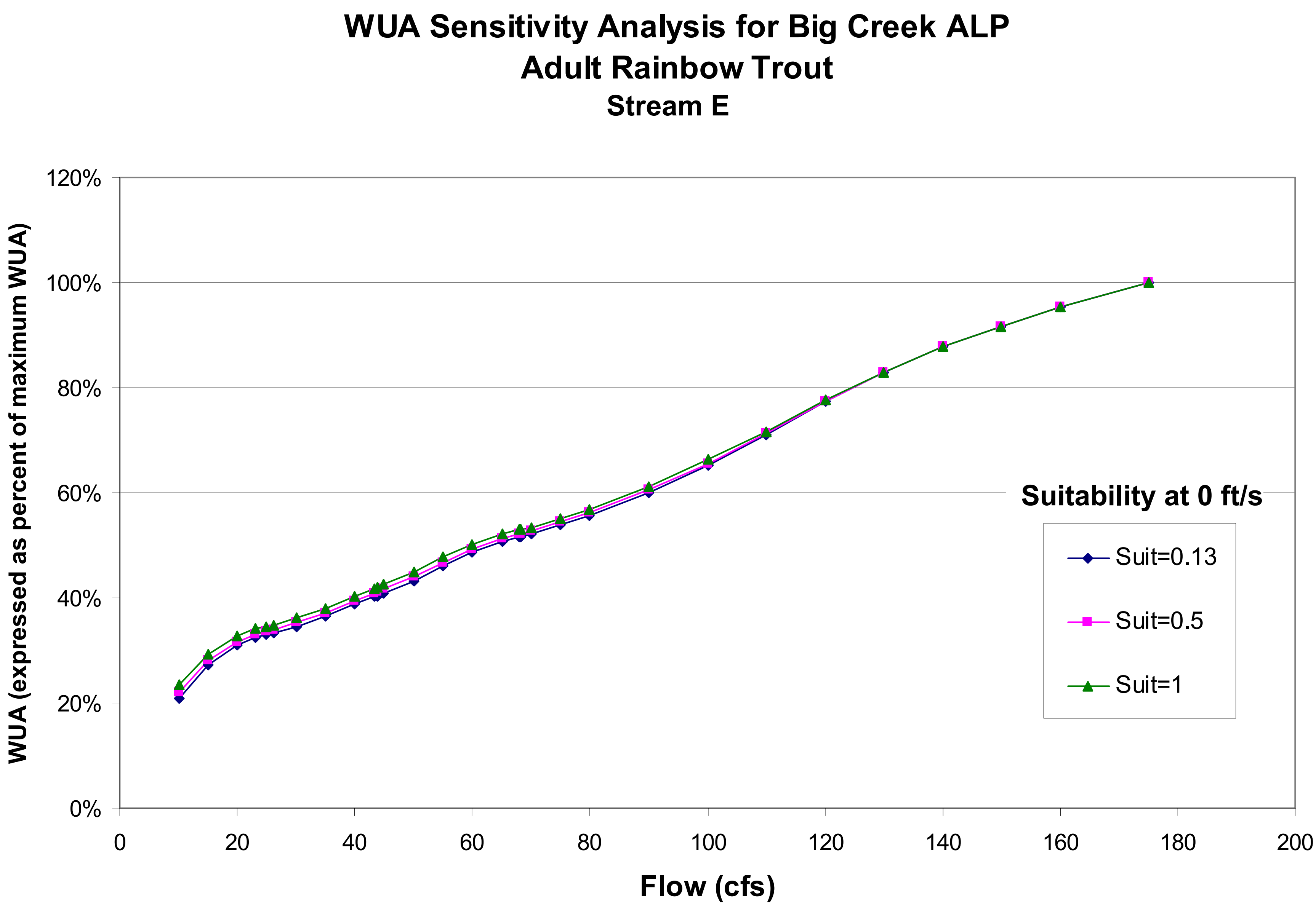

WUA Sensitivity Analysis for Big Creek ALP
Adult Rainbow Trout
Stream D
WUA (expressed as percent of maximum WUA)
0%
20%
40%
60%
80%
100%
120%
0
10
20
30
40
50
60
Flow (cfs)
Suitability at 0 ft/s
Suit=0.13
Suit=0.5
Suit=1

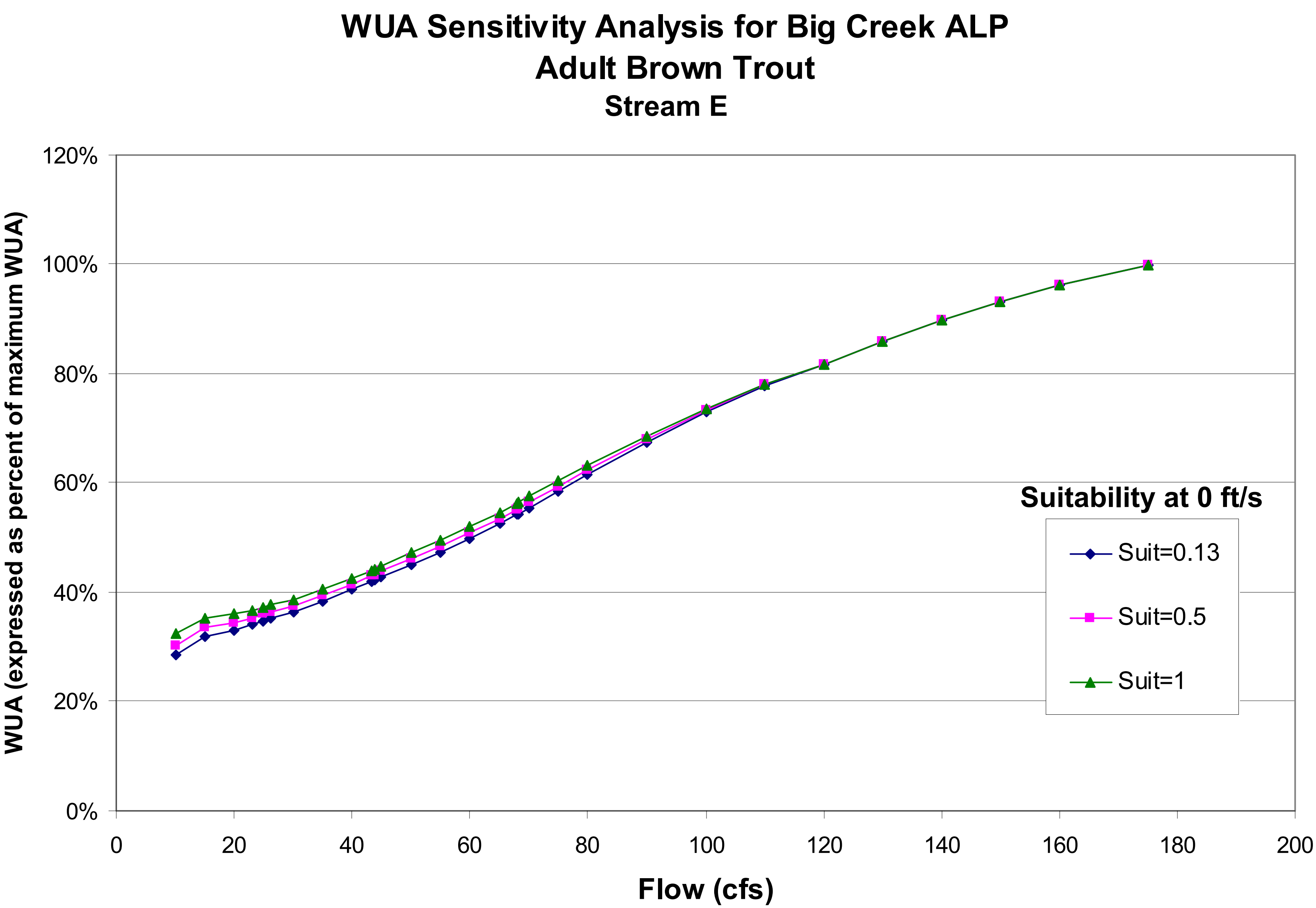


WUA Sensitivity Analysis for Big Creek ALP
Adult Brown Trout
Stream D
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
10
20
30
40
50
60
Flow (cfs)
Suitability at 0 ft/s
Suit=0.13
Suit=0.5
Suit=1

Effects on Stream D

- Changing the suitability value of 0 ft/s on this stream resulted in a slight increase in WUA at lower flows
- There was little change to the WUA with flow function as a result of differences in 0 ft/s suitabilities


WUA Sensitivity Analysis for Big Creek ALP
Adult Rainbow Trout
Stream E
WUA (expressed as percent of maximum WUA)
0%
20%
40%
60%
80%
100%
120%
Flow (cfs)
0
20
40
60
80
100
120
140
160
180
200
Suitability at 0 ft/s
Suit=0.13
Suit=0.5
Suit=1



WUA Sensitivity Analysis for Big Creek ALP
Adult Brown Trout
Stream E
WUA (expressed as percent of maximum WUA)
120%
100%
80%
60%
40%
20%
0%
0
20
40
60
80
100
120
140
160
180
200
Flow (cfs)
Suitability at 0 ft/s
Suit=0.13
Suit=0.5
Suit=1

Effects on Stream E

- Changing the suitability value of 0 ft/s on this stream resulted in a very slight increase in WUA at lower flows
- There was little change to the WUA with flow function as a result of differences in 0 ft/s suitabilities

Summary

- In 4 of the 5 streams considered, changing the suitability of 0 ft/s velocity had little or no effect on WUA for any flow and almost no effect on the shape of the curve.
- In Stream B (middle flow range) changing the suitability of 0 ft/s velocity changed WUA values at most flows. The shape of the curve was less affected and the range of flows that resulted in the largest changes in WUA with flow did not change.

Conclusions

- This analysis indicates that the effects of 0 ft/s velocity suitability are small in most streams considered. This effect is likely to be highly stream specific
- Results do not appear to be related to stream size as indicated by summer base flows
- The shape of the WUA with flow relationship appears to be less sensitive to the 0 ft/s suitability value than specific WUA values.

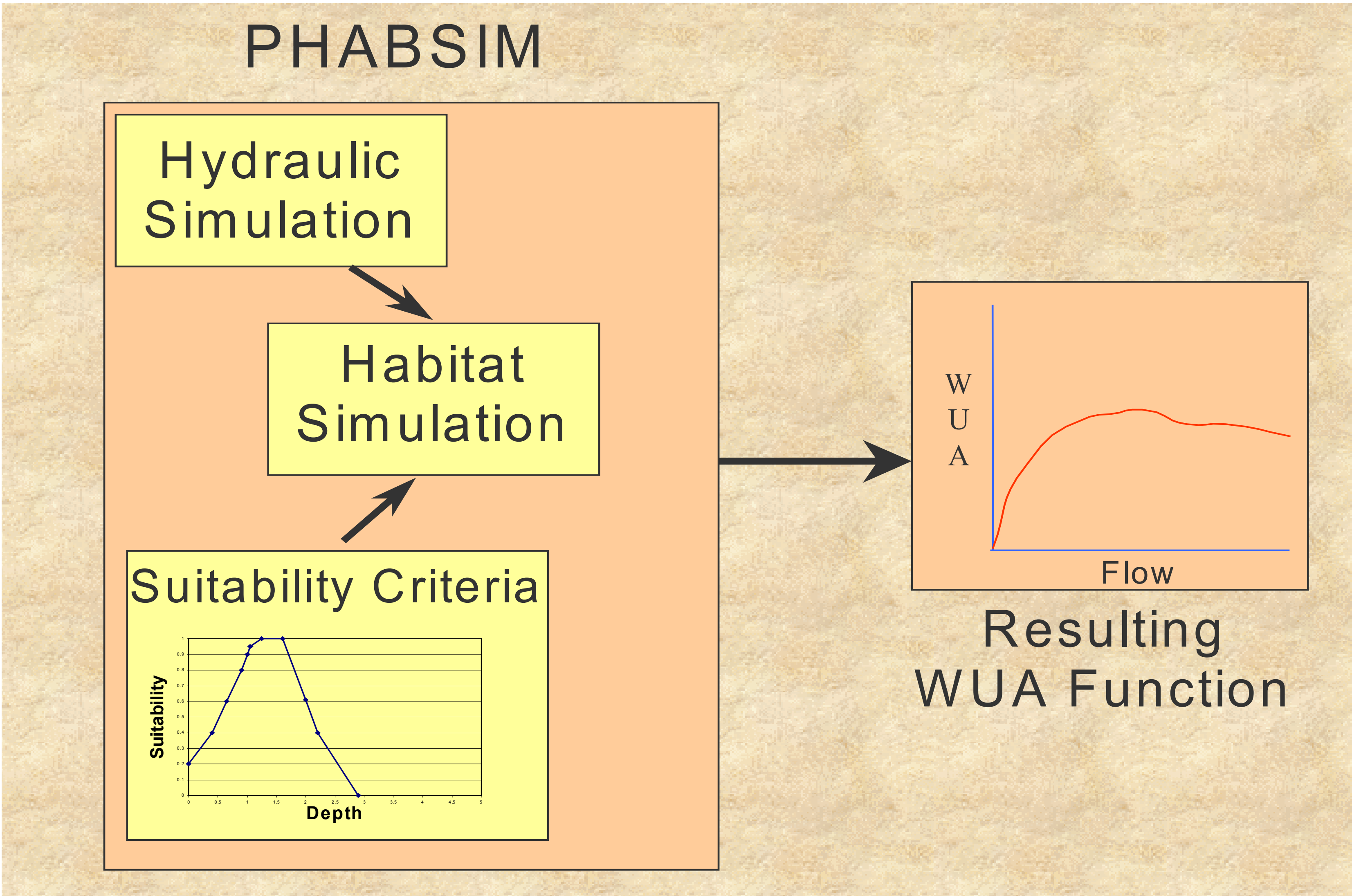


Figure CAWG 3 Appendix D-1. PHABSIM Overview.

Table CAWG 3 Appendix D-1. Level 1 Hypothesis - Suitable Versus Unsuitable Habitat.

Suitable vs. Unsuitable	Occupied	Unoccupied
Suitable	A	C
Unsuitable	B	D

Table CAWG 3 Appendix D-2. Level 2 Hypothesis - Optimal Versus Marginal Habitat.

Optimal vs. Marginal	Occupied	Unoccupied
Optimal	A	C
Marginal	B	D

Table CAWG 3 Appendix D-3. Suitability Threshold Levels for Transferability Tests.

	Single Microhabitat Variable	Joint Microhabitat Variable
Unsuitable	SI =< 0.1	SI =< 0.01
Suitable	SI > 0.1	SI > 0.01
Marginal	0.1 < SI < 0.5	0.01 < SI < 0.25
Optimal	SI >= 0.5	SI >= 0.25

SI = Suitability Index

Table CAWG 3 Appendix D-4. Sampling Locations and Stream Category.

Stream	Description
San Joaquin River – Horseshoe Bend	Lower basin, large stream (LBLS)
San Joaquin River – Stevenson Reach	Lower basin, large stream
San Joaquin River – Mammoth Reach	Lower basin, large stream
Big Creek	Lower basin, small stream (LBSS)
Stevenson Creek	Lower basin, small stream
North Fork Stevenson Creek	Lower basin, small stream
South Fork San Joaquin River	Upper basin, large stream (UBLS)
Mono Creek	Upper basin, small stream (UBSS)
Bear Creek	Upper basin, small stream

Table CAWG 3 Appendix D-5. Fish-Length-at-Age Classifications for Project Area Streams.

Species	Basin Strata	Stream	Adult (mm)	Juvenile (mm)	YOY (mm)
Rainbow Trout	Lower Basin Large Streams	San Joaquin River	>125	80-124	<79
	Lower Basin Small Streams	NF Stevenson Creek	>120	80-119	<79
		Big Creek	>111	76-110	<75
	Upper Basin Large Streams	SF San Joaquin River	>110	76-109	<75
	Upper Basin Small Streams	Mono Creek	>110	76-109	<75
Brown trout	Lower Basin Large Streams	San Joaquin River	>120	70-119	<69
	Lower Basin Small Streams	Big Creek	>111	76-110	<75
		NF Stevenson Creek	>125	85-124	<84
	Upper Basin Large Streams	SF San Joaquin River	>120	76-119	<75
	Upper Basin Small Streams	Bear Creek	>120	90-119	<89
		Mono Creek	>120	90-119	<89
Hardhead	Lower Basin Large Streams	San Joaquin River	>130	80-129	<79
Sacramento Pikeminnow	Lower Basin Large Streams	San Joaquin River	>120	70-119	<69
Sacramento Sucker	Lower Basin Large Streams	San Joaquin River	>180	70-179	<69

Table CAWG 3 Appendix D-6. Summary of Habitat Suitability Criteria Considered for Use in the Big Creek ALP Study Streams.

Criteria	Criteria Type	Waterbody	Sample Strategy	Elevation (ft)	Category	Flows (cfs)	Species	Life-stage[1]	Number of Observations
Pit River	Preference	Pit River	Equal Area	1445-2650	III	50-150	Hardhead	A J/F	72 90
							Pikeminnow	A J/F	97 88
							Sacramento Sucker	A J F	254 352 130
Deer Creek	Utilization	Deer Creek	Reach and Pool	30-3500	II	100-200	Hardhead	A A/J J	57 81
							Pikeminnow	A A/J J	92
							Sacramento Sucker	All	172 (pool only)
West Sierra	Literature and Utilization	Clear, Cottonwood, Beegum, Butte, Bear, Putah, and Jackson Creeks and Yuba River	Reach	200-1460	I and II	NA	Hardhead	A J/F	434 537
							Pikeminnow	A J/F	195 717
NF Feather	Preference and Utilization	North Fork Feather River, Poe, Cresta, Rock, Belden and Seneca Creeks	Reach	925-2010	II and III	40-130	Hardhead	A J	140 140
							Pikeminnow	A J	70 140
							Sacramento Sucker	A J	76 88
Yosemite	Utilization	Eleanor, Upper Cherry and Lower Cherry Creeks	Reach	3800	II	NA	Sacramento Sucker	A J	399 116
Altered Flows	Preference and Utilization	Willow, Big and NF Stevenson Creeks, and NF and SF Middle Fork Tule River	Equal Area	2810-7080	II and III	2-38	Rainbow Trout	A J F	211 383 594
							Brown Trout	A J F	130 143 211

Table CAWG 3 Appendix D-6. Summary of Habitat Suitability Criteria Considered for Use in the Big Creek ALP Study Streams (continued).

Criteria	Criteria Type	Waterbody	Sample Strategy	Elevation (ft)	Category	Flows (cfs)	Species	Life-stage[1]	Number of Observations
Upper American River	Modified Preference and Utilization	American River and tributaries – large and small	Equal Area	6000-7000	II (adjusted)	small: 10-32 large: 154	Rainbow Trout	A J	145 169
							Brown Trout	A J	63 113
							Hardhead	A	56
Stanislaus River	Modified Utilization	NF and MF Stanislaus River	Equal Area	1800-5600	I and II (adjusted)	26-333	Rainbow Trout	A J	110 162
							Brown Trout	A J	82 99
							Hardhead	NA	None[2]

[1] A = adult, J = juvenile, F = fry, JF = juvenile and fry, All = adult, juvenile and fry.

[2] None – adjusted envelope of existing criteria.

Table CAWG 3 Appendix D-7. Big Creek ALP Stream Flows During 2003 HSC Verification Sampling.

Stream	Reach_ID	Daily Average cfs
SF San Joaquin River	Florence to Mono Crossing	20.3 – 23
Bear Creek	Below Diversion	2.5
Mono Creek	Below Diversion	9.8
San Joaquin River	Mammoth Reach	30 – 32
San Joaquin River	Stevenson Reach	8.5 *est.*
San Joaquin River	Horseshoe Bend	12 – 34.5
Big Creek	Upstream of PH 1	4.4 – 5.5
Big Creek	Below Dam 4	1 – 2 *est.*
Big Creek	Below Dam 5	2.6
NF Stevenson Creek	Below Diversion	3.9 – 4.4

est. Indicates an estimated flow level. No gaging data is available for this reach.

Table CAWG 3 Appendix D-8. Surface Area (ft^2) Sampled by Stream Group and Habitat Type.

Basin Group	Riffle	Flatwater	Shallow Pool	Deep Pool	Grand Total
Lower Basin Large Streams	67361	101761	117645	106579	393346
Lower Basin Small Streams	25703	19585	18789	20506	84583
Upper Basin Large Streams	24780	34996	*	23088	82864
Upper Basin Small Streams	18004	16866	6785	13814	55469
Grand Total	135848	173208	143219	163987	616262

* Habitat type not sample because it comprised less than five percent of total reach length.

Table CAWG 3 Appendix D-9. Number of Fish Observations by Basin and Lifestage.

Basin Strata	Rainbow Trout			Brown Trout			Hardhead			Sacramento Pikeminnow			Sacramento Sucker		
	Adult	Juvenile	YOY	Adult	Juvenile	YOY	Adult	Juvenile	YOY	Adult	Juvenile	YOY	Adult	Juvenile	YOY
Lower Basin Large Streams	117	23	29	25	18	1	50	59	370	23	67	270	75	96	168
Lower Basin Small Streams*	61	76	107	84	25	101	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upper Basin Large Streams	172	21	28	87	15	18	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upper Basin Small Streams	38	10	3	150	21	25	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	388	130	167	346	79	145	50	59	370	23	67	270	75	96	168

* Rainbow trout observation originally presented in Lifton 1998.

Table CAWG 3 Appendix D-10. Observed Habitat Use During HSC Studies.

Species	Lifestage	No. of Observations	Depth			Velocity		
			Range	Median	Central 50% of Observations	Range	Median	Central 50% of Observations
Rainbow Trout	Adult	327	0.4 - 6	1.9	1.4 - 2.8	0 - 3.16	0.53	0.17 - 0.96
	Juvenile	54	0.4 - 4.8	1.6	1.1 - 2.1	0 - 4.13	0.31	0.17 - 0.68
	Fry	60	0.4 - 5.5	1.3	0.8 - 1.9	0 - 4.39	0.38	0.13 - 0.68
Brown Trout	Adult	346	0.3 - 6	1.85	1.25 - 2.6	0 - 1.82	0.25	0.11 - 0.53
	Juvenile	79	0.5 - 3.8	1.53	1.1 - 2.4	0 - 1.88	0.44	0.13 - 0.76
	Fry	145	0.25 - 3.9	1	0.6 - 1.6	0 - 2.05	0.35	0.13 - 0.77
Hardhead	Adult	50	0.9 - 21	3	2.4 - 7.15	0 - 1.31	0.1	0.01 - 0.74
	Juvenile	58	1.3 - 19.5	3.6	3.5 - 7	0 - 0.99	0.1	0.1 - 0.32
	Fry	370	1 - 6.2	2.7	2.1 - 3.5	0 - 1.61	0.21	0.05 - 0.31
Sacramento Pikeminnow	Adult	23	1.8 - 8.2	2.5	2.2 - 2.8	0 - 1.07	0.14	0.03 - 0.27
	Juvenile	67	0.5 - 4	1.6	1.4 - 2.9	0 - 1.05	0.06	0 - 0.17
	Fry	270	0.2 - 6.8	1.4	1 - 2.2	0 - 0.85	0	0 - 0.05
Sacramento Sucker	Adult	75	0.9 - 5.55	3.1	2.3 - 4.2	0 - 2.81	0.27	0.07 - 1.01
	Juvenile	96	0.4 - 6.3	1.4	0.8 - 3	0 - 2.82	0.19	0.08 - 0.53
	Fry	168	0.3 - 6.8	1.5	0.7 - 3.3	0 - 2.05	0.04	0 - 0.28

Table CAWG 3 Appendix D-11. Results of Transferability Testing.

Stream Group	Adult Rainbow Trout			
	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	117		172	38
AF-Preference	J/D	--	J/D	J/D
AF-Utilization	D	--	D/V	J
UARP Large	J/V	--	J/D	--
UARP Medium	J/D/V	--	J/D	J/D
UARP Small	--	--	--	D
Stan-1 (TT)	J	--	J/D/V	J
Stan-Alt (TT)	J	--	J/D/V	J

Stream Group	Juvenile Rainbow Trout			
	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	23		21	10
AF-Preference	**	--	**	**
AF-Utilization	**	--	**	**
UARP All-Juvenile	**	--	**	**
Stan-1 (TT)	**	--	**	**

Stream Group	Fry Rainbow Trout			
	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	29		28	3
AF-Preference	**	--	**	**
AF-Utilization	**	--	**	**
Stan-1 (TT)	**	--	**	**

-- No test performed
* Insufficient number of observations

Note: Letters in boxes indicate that an individual suitability index passed threshold tests. Shading indicates that HSC acceptable for use in Project Area streams.
J = joint suitability test, D = depth suitability test, V = velocity suitability test, F = Fail.

Table CAWG 3 Appendix D-11. Results of Transferability Testing (continued).

Stream Group	Adult Brown Trout			
	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	25	84	87	150
AF-Preference	**	J/D	J/D	J/D
AF-Utilization	**	J/D	D	J/D
UARP Large	**	--	F	--
UARP Medium	**	J/D	F	J/D/V
UARP Small	--	J/D	--	J/D/V
Stan-1	**	J/D	F	J/D/V
Stan-1 (TT)	**	J/D	J/D/V	J/D/V
Stan-Alt (TT)	**	J/D	J/D/V	J/D/V

Stream Group	Juvenile Brown Trout			
	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	18	25	15	21
AF-Preference	**	**	**	**
AF-Utilization	**	**	**	**
UARP All-Juvenile	**	**	**	**
Stan-1	**	**	**	**
Stan-1 (TT)	**	**	**	**

Stream Group	Fry Brown Trout			
	Low Lg	Low Sm	Up Lg	Up Sm
No. of Fish	1	101	18	25
AF-Preference	**	J	**	**
AF-Utilization	**	D	**	**
Stan-1 (TT)	**	F	**	**

-- No test performed
* Insufficient number of observations

Note: Letters in boxes indicate that an individual suitability index passed threshold tests. Shading indicates that HSC acceptable for use in Project Area streams.
J = joint suitability test, D = depth suitability test, V = velocity suitability test, F = Fail.

Table CAWG 3 Appendix D-11. Results of Transferability Testing (continued).

	Species	Pikeminnow	
	Lifestage	**Adult**	**Juvenile/Fry**
No. of Fish		23	337
Pit River		**	J/V
Deer Creek		**	F (a/j)
West Sierra		**	J/D
NF Feather-Preference		**	F

	Species	Hardhead	
	Lifestage	**Adult**	**Juvenile/Fry**
No. of Fish		50	429
Pit River		F	D
Deer Creek		F	F(j); J/D (a/j)
West Sierra		J/D/V	F (j)
NF Feather-Preference		J	F (j)
UARP		F	--
Stan-1		J/V	J/D (j)
Stan-Alt		J	--

	Species	Sacramento Sucker		
	Lifestage	**Adult**	**Juvenile**	**Fry**
No. of Fish		75	96	168
Pit River		J/D	F	V
NF Feather-Preference		J/D	F	--
Yosemite		F	F	--

-- No test performed
* Insufficient number of observations
(a/j) Tested juvenile / fry observations against adult / juvenile criteria
(j) Tested juvenile/fry observations against juvenile criteria

Note: Letters in boxes indicate that an individual suitability index passed threshold tests. Shading indicates that HSC acceptable for use in Project Area streams.
J = joint suitability test, D = depth suitability test, V = velocity suitability test, F = Fail.

Big Creek Collaborative Relicensing
Combined Aquatics Working Group – HSC Subgroup Conference Call
July 7, 2004
3:00PM – 3:30PM
Draft Meeting Notes
TO BE REPLACED WITH FINAL NOTES WHEN AVAILABLE

Attendees

Bill Pistor	Kearns & West
Andrew Wyckoff	Kearns & West
Geoff Rabone	SCE
Julie Tupper	USFS-RHAT
Phil Strand	USFS
Dudley Reiser	R2 Consultants
Paul DeVries	R2 Consultants
Wayne Lifton	ENTRIX
Larry Wise	ENTRIX
Julie Means	CDFG
Roger Robb	FWUA

Introduction

Bill Pistor (Kearns & West) initiated the meeting and all attendees and phone participants introduced themselves and the organizations they represent.

Sensitivity Analysis Slide Discussion

Larry Wise (Entrix) recapped for the group why the WUA sensitivity analysis slides distributed to the CAWG on June 30, 2004 were developed. He explained that he applied the CAWG-approved HSC curve sets with three different suitability values for velocities of 0 ft/s. This was done for adults of both rainbow and brown trout. These were then run on five different streams with summer base flows ranging between 3 and 400 cfs. Phil Strand (USFS) was pleased to see that Larry included both low and intermediate flow streams in the revised set of slides. He felt that these had not been adequately represented in the original set of sensitivity analysis slides distributed to the CAWG on June 14, 2004.

There was then a brief discussion about stream "E" and why it seemed to have a different shape than the other four. Larry suggested this was due to the stream's low gradient, lack of cover and gravelly/sandy substrate. He stated that stream "E" was the least similar to the Big Creek System streams being evaluated.

Larry concluded by saying that the WUA values determined from different suitability values for 0 ft/s were quite similar for most streams and would not have a substantial effect on the minimum flow selected. Based on this, Larry asked if any of the CAWG members felt that the suitability value of 0 ft/s needed to be revised from the value approved by the CAWG (except USFWS) in April. Bill then asked the rest of the group how they felt about the final CAWG HSC in light of the sensitivity analysis. Phil stated that he was much more comfortable as a result of the sensitivity analysis being performed and that he was ready to move forward. Julie Means (CDFG) concurred that her questions had been answered as well. Dudley Reiser (R2 Consultants) verified that the group had never indicated a "1" suitability at 0 ft/s for either rainbow or brown trout.

Larry reaffirmed that 0.6 (for rainbow trout) and 0.7 (for brown trout) were the suitability values at 0 cfs previously agreed upon by the CAWG. All meeting participants agreed with this.

Wayne Lifton (Entrix) indicated that the revised slide set would be incorporated as an appendix in the CAWG-3 PHABSIM report. The meeting adjourned.

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December 21, 2004

Jim Canaday
California State Water Resources Control Board
1001 I Street
Sacramento, CA 95812
(916) 341-5308
(Hand Delivered)

Re: Distribution of 2003 Draft Technical Study Report Package
Southern California Edison's Big Creek Alternative Licensing Project

Dear Mr. Canaday:

Please find enclosed the 2003 Draft Technical Study Report Package (DTSRP) for the Big Creek Hydroelectric Projects (FERC Project Nos. 67, 120, 2085, and 2175). The 2003 DTSRP presents the results of study elements completed in 2003 as part of the Big Creek Alternative Licensing Process (ALP).

The attached Package contains Southern California Edison's (SCE's) Cover Letter and Introduction which clearly explains the review process.

Sincerely,

Eileen F. Dessaso (Project Coordinator)

Enclosure: 2003 DTSRP

cc G. Rabone (SCE); E. Bianchi (ENTRIX)

APPENDIX E

MODEL CALIBRATION SUMMARY TABLES

APPENDIX E

Description of information provided on the Model Calibration Summary tables.

The model calibration summary tables are intended to provide the reader with the basic information needed to assess the quality of the PHABSIM models used in the Big Creek ALP. The following describes the information contained in the columns of this table.

Title – Indicates the stream, reach and channel type for which information is being provided.

Transect – The transect identifier. These are unique to each stream reach, although they may be repeated between reaches.

[1] **Habitat Type –** The mesohabitat type represented by the transect. These are based on the habitat types described in CAWG 1.

HGR –High gradient riffle > 4%
LGR– Low gradient riffle < 4%
RIF – Riffle, gradient unknown (BiCEP transect)
RUN – Run
POW – Pocket water
SP – Shallow pool – less than 3 ft maximum depth
DP – Deep pool – more than 3 ft maximum depth

Link - Transects with the same number share a common benchmark datum.

Bed Profile

[2] **Bed Adjustment –** Indicates stations where manual bed adjustments were necessary because of varied water surface elevations across a transect.

[3] **Formula Chosen:** - Formula used to determine bed profile

Calculated vs. Given Flow

Flow Level – Calibration flow level

Field Measurement – Best estimate of flow from review of field measurements

Model Calculation – Flow at transect, based on transect specific measurements

Percent Difference – Percentage difference between given and calculated flow

Water Surface Elevation

Measured – Value measured in field

Model Prediction – Value predicted by the stage discharge relationship

Model Parameters

[4] **STZ –** Stage of Zero Flow, the elevation at which water pools behind a control, when flow is set to zero

Mean Error – Mean Error of the stage discharge relationship

[5] ***Velocity Adjustment Factors* –** Ratio of calculated flow and simulation flow

[6] **Calib. Flow –**The velocity calibration factor at the calibration flow (generally the high calibration flow)

Min – The lowest VAF observed in the simulation range

Max – The highest VAF observed in the simulation range

CAWG 3 Appendix E Table E-1. Model Calibration Summary for South Fork San Joaquin River, Bear Creek to Florence Lake, C-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
157-1	LGR (SP)	1	-	High WSL	High	114.2	108.39	5%	94.50	94.50	92.30	1.27	0.97	0.57	1.23
					Mid	41.4	-	-	93.91	93.92					
					Low	20.7	22.43	8%	93.62	93.62					
157-2	LGR (SP)	1	-	High WSL	High	114.2	110.72	3%	94.56	94.56	92.36	0.46	0.99	0.82	1.09
					Mid	41.4	-	-	93.96	93.96					
					Low	20.7	20.27	2%	93.64	93.64					
158-1	DP	1	-	High WSL	High	114.2	107.89	6%	94.68	94.68	92.68	0.94	1.00	0.71	1.18
					Mid	41.4	-	-	94.10	94.09					
					Low	20.7	19.95	4%	93.79	93.79					
158-2	DP	2	-	High WSL	High	114.2	106.64	7%	96.29	96.30	94.23	1.03	1.04	0.11	2.13
					Mid	41.4	-	-	95.68	95.67					
					Low	20.7	-	-	95.36	95.36					
158-3	DP	3	-	High WSL	High	114.2	107.40	6%	96.23	96.23	94.16	1.16	1.05	0.17	1.77
					Mid	41.4	-	-	95.60	95.60					
					Low	20.7	16.71	19%	95.30	95.29					
162-1	RUN	4	-	High WSL	High	114.2	112.45	2%	96.25	96.26	94.52	1.46	1.00	0.28	1.31
					Mid	41.4	-	-	95.59	95.58					
					Low	20.7	19.99	3%	95.27	95.28					
162-2	RUN	5	-	High WSL	High	114.2	106.94	6%	98.65	98.66	96.91	1.73	1.04	0.47	1.23
					Mid	41.4	-	-	97.99	97.98					
					Low	20.7	16.83	19%	97.67	97.67					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-2. Model Calibration Summary for South Fork San Joaquin River, Bear Creek to Florence Lake, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
102-1	RUN	1	-	High WSL	High	114.2	105.92	7%	96.33	96.33	93.03	0.17	1.08	0.44	1.45
					Mid	49.8	-	-	95.62	95.62					
					Low	20.7	18.96	8%	95.03	95.03					
102-2	RUN	1	-	High WSL	High	114.2	114.21	0%	97.93	97.94	95.22	1.42	0.99	0.26	1.60
					Mid	49.8	-	-	97.47	97.46					
					Low	20.7	25.22	22%	97.04	97.04					
103-1	HGR	2	-	Low WSL	High	114.2	116.73	2%	95.46	95.45	92.50	2.89	1.03	0.74	1.37
					Mid	49.8	-	-	94.91	94.93					
					Low	20.7	12.83	38%	94.50	94.49					
104-1	DP	2	-	Low WSL	High	114.2	103.74	9%	97.64	97.63	94.53	1.15	1.11	0.30	1.76
					Mid	49.8	-	-	97.06	97.07					
					Low	20.7	24.12	17%	96.59	96.59					
104-2	DP	2	-	High WSL	High	114.2	112.22	2%	97.68	97.67	94.53	0.92	1.03	0.17	1.88
					Mid	49.8	-	-	97.11	97.12					
					Low	20.7	23.99	16%	96.64	96.64					
104-3	DP	2	-	High WSL	High	114.2	109.73	4%	97.88	97.87	94.53	1.38	1.04	0.28	1.63
					Mid	49.8	-	-	97.22	97.23					
					Low	20.7	20.57	1%	96.69	96.68					
105-1	HGR	2	-	High WSL	High	114.2	125.49	10%	99.89	99.91	97.27	2.90	0.92	0.47	1.32
					Mid	49.8	-	-	99.40	99.38					
					Low	20.7	23.29	13%	98.92	98.93					
109-1	POW	3	-	Average WSL	High	114.2	114.61	0%	92.25	92.25	90.56	0.18	1.00	0.56	1.14
					Mid	49.8	-		91.73	91.73					
					Low	20.7	20.95	1%	91.35	91.35					
109-2	POW	4	-	Low WSL	High	114.2	115.72	1%	98.32	98.32	96.30	0.50	0.99	0.25	1.45
					Mid	49.8	-	-	97.88	97.88					
					Low	20.7	26.62	29%	97.51	97.51					
110-1	RUN	5	-	High WSL	High	114.2	114.25	0%	98.84	98.85	96.86	1.16	0.98	0.24	1.52
					Mid	49.8	-	-	98.36	98.35					
					Low	20.7	21.3	3%	97.95	97.95					
110-2	RUN	5	-	High WSL	High	114.2	121.21	6%	98.92	98.92	96.86	0.61	0.96	0.19	1.56
					Mid	49.8	-	-	98.47	98.47					
					Low	20.7	19.81	4%	98.09	98.09					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-3. Model Calibration Summary for South Fork San Joaquin River, Mono Crossing to Bear Creek, C-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
242-1	DP	1	-	High WSL	High	109.21	108.78	0%	98.08	98.08	95.66	0.34	0.97	0.51	1.26
					Mid	53.58	-	-	97.59	97.59					
					Low	24.87	22.92	8%	97.18	97.18					
242-2	DP	1	-	High WSL	High	109.21	110.80	1%	98.12	98.12	95.66	0.25	1.00	0.13	2.04
					Mid	53.58	-	-	97.62	97.62					
					Low	24.87	22.80	8%	97.20	97.20					
242-3	DP	1	-	High WSL	High	109.21	112.58	3%	98.12	98.13	95.66	1.17	1.02	0.18	1.89
					Mid	53.58	-	-	97.64	97.63					
					Low	24.87	30.72	24%	97.20	97.20					
244-1	HGR	1	-	Low WSL	High	109.21	112.13	3%	99.90	99.90	98.30	0.53	1.03	0.69	1.33
					Mid	53.58	-	-	99.64	99.64					
					Low	24.87	29.53	19%	99.40	99.40					
244-2	LGR	2	-	High WSL	High	109.21	103.81	5%	97.64	97.64	96.07	0.80	1.05	0.74	1.36
					Mid	53.58	-	-	97.37	97.37					
					Low	24.87	29.03	17%	97.12	97.12					
244-3	LGR	2	-	High WSL	High	109.21	115.68	6%	98.47	98.47	96.87	0.09	0.98	0.50	1.38
					Mid	53.58	-	-	98.24	98.24					
					Low	24.87	23.46	6%	98.03	98.03					
245-1	RUN	2	-	Low WSL	High	109.21	107.00	2%	99.52	99.51	97.62	1.41	1.01	0.57	1.36
					Mid	53.58	-	-	99.19	99.20					
					Low	24.87	27.03	9%	98.92	98.92					
245-2	RUN	3	-	Low WSL	High	109.21	103.39	5%	98.54	98.53	96.34	1.49	1.06	0.47	1.48
					Mid	53.58	-	-	98.19	98.20					
					Low	24.87	25.16	1%	97.90	97.90					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-4. Model Calibration Summary for South Fork San Joaquin River, Mono Crossing to Bear Creek, G-Channel Transects.

Transect	Habitat Type [1]	Link	Bed Profile: Bed Adjust. [2]	Bed Profile: Formula Chosen [3]	Flow Level	Calculated vs. Given Flow (cfs): Field Measurement	Model Calculation	Percent Difference	Water Surface Elevation (ft): Measured	Model Prediction	Model Parameters: SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
201-1	RUN	1	-	High WSL	High	113.11	116.81	3%	97.02	97.03	95.02	3.15	0.95	0.61	1.24
					Mid	51.63	-	-	96.66	96.64					
					Low	24.70	25.21	2%	96.33	96.34					
202-1	DP	1	-	High WSL	High	113.11	111.03	2%	98.07	98.07	95.68	0.76	1.02	0.37	1.49
					Mid	51.63	-	-	97.55	97.56					
					Low	24.70	23.64	4%	97.18	97.18					
202-2	DP	1	-	High WSL	High	113.11	109.15	4%	98.08	98.08	95.68	0.05	1.01	0.21	1.68
					Mid	51.63	-	-	97.55	97.55					
					Low	24.70	19.93	19%	97.16	97.16					
202-3	DP	1	-	Low WSL	High	113.11	119.84	6%	98.04	98.05	95.68	0.85	0.96	0.15	1.78
					Mid	51.63	-	-	97.54	97.53					
					Low	24.70	26.94	9%	97.15	97.15					
203-1	RUN	2	-	High WSL	High	113.11	116.48	3%	94.59	94.63	91.84	4.63	0.94	0.76	1.22
					Mid	51.63	-	-	94.04	93.99					
					Low	24.70	27.30	11%	93.51	93.53					
203-2	RUN	2	-	High WSL	High	113.11	115.71	2%	94.71	94.74	91.84	4.26	0.95	0.55	1.14
					Mid	51.63	-	-	94.14	94.09					
					Low	24.70	28.02	13%	93.60	93.62					
205-1	LGR	3	-	High WSL	High	113.11	108.83	4%	96.36	96.38	93.96	2.54	1.04	0.69	1.19
					Mid	51.63	-	-	95.84	95.82					
					Low	24.70	29.09	18%	95.40	95.41					
205-2	LGR	3	-	High WSL	High	113.11	114.19	1%	97.11	97.13	95.10	2.99	0.94	0.83	1.00
					Mid	51.63	-	-	96.58	96.55					
					Low	24.70	27.01	9%	96.15	96.16					
206-1	SP	4	-	High WSL	High	113.11	114.12	1%	96.09	96.10	93.79	1.94	1.01	0.46	1.45
					Mid	51.63	-	-	95.67	95.66					
					Low	24.70	29.40	19%	95.31	95.32					
206-2	SP	4	-	Low WSL	High	113.11	113.10	0%	96.10	96.11	93.79	1.92	1.01	0.31	1.47
					Mid	51.63	-	-	95.68	95.67					
					Low	24.70	28.77	16%	95.32	95.33					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-5. Model Calibration Summary for South Fork San Joaquin River, Mono Crossing to Bear Creek, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
														VAF[5]	
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	Min	Max
191-1	RUN	4	-	High WSL	High	113.11	117.95	4%	95.13	95.13	93.55	0.47	0.96	0.30	1.31
					Mid	51.63	-	-	94.75	94.75					
					Low	24.71	27.21	10%	94.47	94.47					
190-2	LGR	3	-	High WSL	High	113.11	112.29	1%	92.05	92.05	90.81	0.70	1.00	0.53	1.42
					Mid	51.63	-	-	91.81	91.81					
					Low	24.71	29.45	19%	91.62	91.62					
190-1	LGR	3	-	High WSL	High	113.11	115.59	2%	91.18	91.18	90.28	0.65	1.00	0.60	1.37
					Mid	51.63	-	-	91.02	91.02					
					Low	24.71	26.60	8%	90.90	90.90					
184-2	POW	2	-	High WSL	High	113.11	97.24	14%	96.26	96.26	94.16	0.00	1.16	0.62	1.41
					Mid	51.63	-	-	95.80	95.80					
					Low	24.71	30.63	24%	95.46	95.46					
184-1	POW	2	-	Low WSL	High	113.11	92.84	18%	95.98	95.99	93.65	2.17	1.10	0.47	1.47
					Mid	51.63	-	-	95.49	95.47					
					Low	24.71	23.35	5%	95.08	95.09					
168-3	DP	1	-	High WSL	High	113.11	121.50	7%	96.64	96.64	94.21	1.01	0.92	0.16	1.69
					Mid	51.63	-	-	96.23	96.22					
					Low	24.71	23.80	4%	95.89	95.89					
168-2	DP	1	-	High WSL	High	113.11	104.37	8%	96.63	96.63	94.21	0.47	1.06	0.19	1.89
					Mid	51.63	-	-	96.22	96.22					
					Low	24.71	21.54	13%	95.89	95.89					
168-1	DP	1	-	High WSL	High	113.11	109.08	4%	96.61	96.61	94.21	0.87	1.04	0.38	1.54
					Mid	51.63	-	-	96.21	96.20					
					Low	24.17	24.05	3%	95.88	95.88					
167-1	RUN	1	-	High WSL	High	113.11	109.57	3%	96.41	96.42	94.21	2.86	1.02	0.58	1.38
					Mid	51.63	-	-	96.01	95.99					
					Low	24.17	27.21	10%	95.65	95.66					

Footnotes are located with example table at the front of Appendix E.

CAWG 3 Appendix E Table E-6. Model Calibration Summary for Bear Creek, below Diversion Reach, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]		Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
T1	DP	1	-	Low WSL	Low	2.8	3.03	8%	92.96	92.96	92.01	3.16	0.99	0.64	1.17
					Mid	29	-	-	93.93	93.90					
					High	50	49.19	2%	94.20	94.23					
T2	DP	1	-	High WSL	Low	2.8	1.71	39%	92.96	92.96	92.01	3.02	0.96	0.13	1.32
					Mid	29	-	-	93.95	93.92					
					High	50	51.68	3%	94.23	94.26					
T3	DP	1	Sta 14-22	As entered	Low	2.8	3.26	16%	92.96	92.96	92.01	3.02	0.93	0.09	1.39
					Mid	29	-	-	93.95	93.92					
					High	50	54.46	9%	94.23	94.26					
T4	HGR	2	-	Rod	Low	2.8	3.77	35%	95.31	95.31	94.40	0.08	1.09	0.51	1.46
					Mid	29	-	-	96.01	96.01					
					High	50	54.58	9%	96.24	96.24					
T5	HGR	2	-	Average all	Low	2.8	3.22	15%	95.42	95.42	94.46	0.56	1.00	0.65	1.10
					Mid	29	-	-	96.25	96.25					
					High	50	51.51	3%	96.52	96.52					
T6	HGR	3	Sta 0-18	As entered	Low	2.8	3.62	29%	97.55	97.55	96.45	1.18	1.10	0.39	1.22
					Mid	29		-	98.62	98.63					
					High	50	47.46	5%	99.02	99.01					
T7	SP	4	-	Low WSL	Low	2.8	2.35	16%	96.72	96.72	95.73	0.06	1.03	0.19	1.35
					Mid	29	-	-	97.67	97.67					
					High	50	48.49	3%	98.00	98.00					
T8	SP	4	-	Low WSL	Low	2.8	2.29	18%	96.76	96.76	95.73	0.24	1.14	0.15	1.72
					Mid	29	-	-	97.72	97.72					
					High	50	45.07	10%	98.06	98.05					
T9	SP	4	-	Low WSL	Low	2.8	2.97	6%	96.76	96.76	95.73	0.46	1.05	0.19	1.49
					Mid	29	-	-	97.73	97.73					
					High	50	50.15	0%	98.06	98.06					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-7a. Model Calibration Summary for Mono Creek, below Diversion Reach, Upper Site, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
198-1	RUN	1	-	Low WSL	High	71.9	73.23	2%	98.84	98.86	96.19	3.72	0.96	0.43	1.38
					Mid	19.6	-	-	98.14	98.12					
					Low	8.8	10.84	23%	97.75	97.76					
200-1	POW	2	sta. 3, 26	Rod	High	71.9	70.08	3%	95.71	95.71	92.48	0.48	1.05	0.53	1.42
					Mid	19.6	-	-	94.82	94.82					
					Low	8.8	13.52	54%	94.39	94.39					
219-1	SP	3	-	High WSL	High	71.9	58.85	18%	97.56	97.56	93.74	0.57	1.23	0.26	1.87
					Mid	19.6	-	-	96.65	96.65					
					Low	8.8	9.13	4%	96.19	96.19					
219-2	SP	3	-	High WSL	High	71.9	69.54	3%	97.56	97.57	93.74	2.20	1.05	0.52	1.44
					Mid	19.6	-	-	96.68	96.66					
					Low	8.8	10.08	15%	96.20	96.21					
221-1	DP	4	-	Low WSL	High	71.9	62.93	12%	95.05	95.05	91.32	0.36	1.14	0.56	1.43
					Mid	19.6	-	-	93.94	93.94					
					Low	8.8	8.80	0%	93.42	93.42					
221-2	DP	4	-	Low WSL	High	71.9	76.48	6%	95.06	95.06	91.32	0.47	1.00	0.37	1.30
					Mid	19.6	-	-	93.96	93.97					
					Low	8.8	6.70	24%	93.46	93.46					
221-3	DP	4	-	Low WSL	High	71.9	83.89	17%	95.11	95.13	91.32	2.36	0.84	0.20	1.28
					Mid	19.6	-	-	94.02	93.99					
					Low	8.8	12.11	38%	93.46	93.47					
222-1	HGR	5	-	High WSL	High	71.9	81.23	13%	93.99	93.99	91.07	0.57	0.89	0.48	1.20
					Mid	19.6	-	-	93.09	93.09					
					Low	8.8	10.95	24%	92.67	92.67					
222-2	HGR	5	25.5 - 28.5 used lowQ bed elev.	High WSL	High	71.9	73.92	3%	94.81	94.80	91.97	0.28	1.02	0.38	1.24
					Mid	19.6	-	-	94.01	94.01					
					Low	8.8	9.02	2%	93.64	93.64					
223-1	POW	5	21,34,35,43, 44 used lowQ bed elev.	High WSL	High	71.9	72.98	2%	96.27	96.28	92.18	1.99	0.97	0.33	1.28
					Mid	19.6	-	-	95.25	95.23					
					Low	8.8	9.06	3%	94.71	94.72					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-7b. Model Calibration Summary for Mono Creek, below Diversion Reach, Meadow Site, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
174-1	DP	1	-	Low WSL	High	70	72.66	4%	97.94	97.94	95.77	0.70	0.96	0.85	1.64
					Mid	22.6	-	-	97.05	97.06					
					Low	13	12.06	7%	96.77	96.77					
174-2	DP	1	-	High WSL	High	70	72.12	3%	97.99	97.98	95.77	1.98	0.95	0.13	1.69
					Mid	22.6	-	-	97.09	97.10					
					Low	13	10.61	18%	96.82	96.81					
174-3	DP	1	-	High WSL	High	70	73.00	4%	98.03	98.03	95.77	0.65	0.96	0.15	1.59
					Mid	22.6	-	-	97.12	97.13					
					Low	13	10.18	22%	96.83	96.83					
174-4	DP	1	-	Low WSL	High	70	-	-	98.04	98.04	95.77	0.78	1.42	0.52	1.85
					Mid	22.6	23.90	-	97.12	97.13					
					Low	13	10.56	19%	96.83	96.83					
176-1	LGR	2	-	High WSL	High	70	69.72	0%	93.93	93.92	91.98	1.65	1.02	0.91	4.02
					Mid	22.6	-	-	93.03	93.04					
					Low	13	13.79	6%	92.78	92.77					
177-1	RUN	3	-	High WSL	High	70	68.06	3%	94.95	94.94	92.36	1.18	1.03	0.54	1.29
					Mid	22.6	-	-	94.08	94.09					
					Low	13	9.49	27%	93.79	93.78					
178-1	SP	3	-	Low WSL	High	70	73.28	5%	94.95	94.95	93.10	1.02	0.92	0.33	1.09
					Mid	22.6	-	-	94.15	94.16					
					Low	13	10.09	22%	93.91	93.91					
178-2	SP	3	-	Rod/High	High	70	66.92	4%	95.04	95.03	93.10	1.46	1.00	0.20	1.45
					Mid	22.6	-	-	94.16	94.17					
					Low	13	13.24	2%	93.91	93.90					
178-3	SP	4	-	Low WSL	High	70	74.95	7%	96.49	96.49	94.59	0.14	0.93	0.25	1.27
					Mid	22.6	-	-	95.66	95.66					
					Low	13	10.83	17%	95.40	95.40					
179	LGR	4	-	High WSL	High	70	70.36	1%	96.54	96.53	94.59	2.96	1.01	1.01	1.27
					Mid	22.6	-	-	95.65	95.68					
					Low	13	13.06	0%	95.42	95.41					
180	RUN	4	-	High WSL	High	70	65.91	6%	96.63	96.63	94.59	1.14	1.06	0.53	1.30
					Mid	22.6	-	-	95.77	95.78					
					Low	13	11.31	13%	95.51	95.51					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-8. Model Calibration Summary for San Joaquin, Mammoth Shakeflat, G-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
136-1	POW	1	-	High WSL	Low	25	24.84	1%	94.99	94.99	93.23	1.08	0.97	0.23	1.34
					Mid	91.05	-	-	95.85	95.86					
					High	200	207.23	4%	96.61	96.60					
136-2	POW	1	-	High WSL	Low	25	27.67	11%	95.03	95.03	93.23	0.94	0.95	0.21	1.35
					Mid	91.05	-	-	95.89	95.9					
					High	200	210.73	5%	96.64	96.63					
144-1	DP	3	-	High WSL	Low	19	19.81	4%	93.96	93.97	92.31	3.98	0.97	0.17	1.46
					Mid	85	-	-	94.99	94.94					
					High	194	191.75	1%	95.66	95.70					
143-1 RC	HGR	2	-	High WSL	Low	19.89	19.21	3%	91.48	91.49	89.08	2.62	1.05	0.35	1.33
					Mid	71.02	-	-	92.36	92.33					
					High	154.52	158.65	3%	92.96	92.98					
143-1 LC	HGR	2	-	High WSL	Low	5.11	4.66	9%	90.23	90.23	89.43	3.74	0.87	0.17	1.29
					Mid	19.81	-	-	90.56	90.58					
					High	45.48	53.66	4%	90.88	90.87					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-9a. Model Calibration Summary for the San Joaquin River, Mammoth Reach, G-Channel BiCEP Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
11	DP	1	-	As entered	Low	23.17	26.27	13%	93.67	93.67	92.37	0.27	1.00	0.06	2.31
					Mid	63.45	65.29	3%	94.22	94.22					
					High	173.48	173.07	0%	94.99	94.99					
12	DP	1	-	As entered	Low	23.17	23.10	0%	93.67	93.67	92.37	0.27	1.02	0.08	2.15
					Mid	63.45	63.64	0%	94.22	94.22					
					High	173.48	170.65	2%	94.99	94.99					
13	DP	1	-	As entered	Low	23.17	23.12	0%	93.67	93.67	92.37	0.27	1.01	0.08	2.18
					Mid	63.45	62.92	1%	94.22	94.22					
					High	173.48	171.07	1%	94.99	94.99					
14	DP	1	-	As entered	Low	23.17	25.59	10%	93.68	93.67	92.37	1.85	0.83	0.12	1.40
					Mid	63.45	67.28	6%	94.20	94.21					
					High	173.48	209.83	21%	95.00	94.99					
15	DP	1	-	As entered	Low	23.17	19.94	14%	93.68	93.67	92.37	1.85	0.93	0.15	1.54
					Mid	63.45	77.63	22%	94.20	94.22					
					High	173.48	184.26	6%	95.00	94.99					
17	DP	2	-	As entered	Low	23.17	32.80	42%	95.14	95.14	94.10	0.15	0.85	0.17	1.11
					Mid	63.45	69.06	9%	95.58	95.58					
					High	173.48	204.91	18%	96.20	96.20					
18	DP	2	-	As entered	Low	23.17	22.57	3%	95.14	95.14	94.10	0.15	1.01	0.08	2.10
					Mid	63.45	62.72	1%	95.58	95.58					
					High	173.48	170.95	1%	96.20	96.20					
19	DP	2	-	As entered	Low	23.17	22.39	3%	95.14	95.14	94.10	0.15	1.03	0.08	2.14
					Mid	63.45	61.52	3%	95.58	95.58					
					High	173.48	168.29	3%	96.20	96.20					
20	DP	2	-	As entered	Low	23.17	18.88	19%	95.14	95.14	94.10	1.01	0.94	0.12	1.66
					Mid	63.45	64.22	1%	95.59	95.58					
					High	173.48	183.70	6%	96.20	96.21					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-9b. Model Calibration Summary for the San Joaquin River, Mammoth Reach, G-Channel BiCEP Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
														VAF[5]	
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	Min	Max
21	**POW**	3	-	As entered	Low	23.17	24.94	8%	95.20	95.20	93.54	0.61	0.95	0.36	1.40
					Mid	63.45	79.10	25%	95.73	95.74					
					High	173.48	191.05	10%	96.45	96.45					
22	**POW**	4	-	As entered	Low	23.17	20.77	10%	96.42	96.43	94.76	2.57	1.00	0.37	1.29
					Mid	63.45	63.47	0%	97.14	97.11					
					High	173.48	170.97	1%	98.04	98.06					
23	**RUN**	5	-	As entered	Low	23.17	23.17	0%	95.85	95.86	94.60	3.28	0.98	0.40	1.19
					Mid	63.45	63.45	0%	96.60	96.56					
					High	173.48	173.48	0%	97.60	97.63					
24	**RF**	6	-	As entered	Low	23.17	22.45	3%	96.29	96.27	95.40	6.62	0.97	0.96	1.27
					Mid	63.45	70.54	11%	96.72	96.78					
					High	173.48	184.96	7%	97.65	97.61					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-10. Model Calibration Summary for San Joaquin, Mammoth Powerhouse, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
1-1	POW	1	-	High WSL	Low	80.6	88.27	10%	96.03	96.03	93.13	0.26	1.06	0.53	1.39
					Mid	152.47	-	-	96.49	96.49					
					High	261.78	248.35	5%	96.95	96.95					
3-1	LGR	2	-	High WSL	Low	80.6	77.87	3%	97.60	97.60	95.65	1.07	1.00	0.92	1.18
					Mid	152.47	-	-	97.96	97.97					
					High	261.78	261.62	0%	98.35	98.34					
6-1	DP	3	-	High WSL	Low	80.6	74.53	8%	96.72	96.72	94.78	0.99	0.95	0.25	1.58
					Mid	152.47	-	-	97.21	97.20					
					High	261.78	274.43	5%	97.68	97.69					
6-2	DP	3	-	High WSL	Low	80.6	79.55	1%	96.74	96.74	94.78	0.94	0.94	0.18	1.80
					Mid	152.47	-	-	97.22	97.21					
					High	261.78	278.60	6%	97.68	97.69					
9-1	HGR	4	-	High WSL	Low	80.6	78.26	3%	93.49	93.49	91.93	0.30	1.04	0.91	1.57
					Mid	152.47	-	-	94.02	94.02					
					High	261.78	250.57	4%	94.60	94.60					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-11. Model Calibration Summary for the San Joaquin River, Mammoth Reach, B-Channel BiCEP Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
1	HGR	1	-	As entered	Low	28.17	6.16	78%	96.73	96.73	96.06	1.68	1.42	0.79	1.42
					Mid	68.45	24.66	64%	97.09	97.08					
					High	178.48	117.99	34%	97.64	97.65					
2	POW	1	-	As entered	Low	28.17	34.64	23%	97.31	97.31	96.06	0.04	1.17	0.43	1.57
					Mid	68.45	77.28	13%	97.74	97.74					
					High	178.48	149.10	16%	98.37	98.37					
3	RUN	1	-	As entered	Low	28.17	24.12	14%	97.38	97.37	96.06	1.78	1.00	0.35	1.41
					Mid	68.45	58.37	15%	97.82	97.84					
					High	178.48	165.98	7%	98.53	98.52					
4	DP	1	-	As entered	Low	28.17	23.76	16%	97.38	97.38	96.06	0.56	1.09	0.18	1.77
					Mid	68.45	53.10	22%	97.84	97.85					
					High	178.48	151.17	15%	98.54	98.54					
5	DP	1	-	As entered	Low	28.17	32.14	14%	97.38	97.38	96.06	0.64	0.98	0.17	1.53
					Mid	68.45	72.12	5%	97.86	97.85					
					High	178.48	193.31	8%	98.55	98.55					
6	RUN	2	-	As entered	Low	28.17	30.50	8%	97.91	97.92	96.78	2.25	1.04	0.23	1.45
					Mid	68.45	63.97	7%	98.43	98.41					
					High	178.48	170.34	5%	99.16	99.18					
7	DP	2	-	As entered	Low	28.17	30.63	9%	97.93	97.94	96.78	2.78	1.03	0.08	2.10
					Mid	68.45	51.15	25%	98.47	98.44					
					High	178.48	172.89	3%	99.21	99.23					
8	DP	2	-	As entered	Low	28.17	24.42	13%	97.94	97.95	96.78	2.31	1.00	0.10	1.79
					Mid	68.45	57.28	16%	98.47	98.45					
					High	178.48	177.03	1%	99.21	99.23					
9	DP	3	-	As entered	Low	28.17	23.97	15%	101.34	101.35	100.68	7.03	0.97	0.24	1.22
					Mid	68.45	62.05	9%	101.75	101.70					
					High	178.48	171.15	4%	102.23	102.27					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-12. Model Calibration Summary for the San Joaquin River, Stevenson Reach at Staircase, G-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
96-4	SP	1	-	High WSL	Low	5.99	6.71	12%	91.46	91.45	90.20	3.47	1.00	0.27	1.00
					Mid	51.30	-	-	93.10	93.17					
					Mid	89.37	-	-	93.97	93.91					
					Mid	136.52	-	-	94.66	94.60					
					High	242.00	235.43	3%	95.68	95.73					
96-5	SP	1	-	High WSL	Low	5.99	8.36	40%	91.47	91.45	90.20	3.41	1.00	0.21	1.00
					Mid	51.30	-	-	93.07	93.17					
					Mid	89.37	-	-	93.91	93.91					
					Mid	136.52	-	-	94.64	94.59					
					High	242.00	242.97	0%	95.78	95.73					
96-6	SP	1	-	High WSL	Low	5.99	6.69	12%	91.48	91.47	90.20	2.89	1.03	0.50	1.29
					Mid	51.30	-	-	93.22	93.20					
					Mid	89.37	-	-	93.88	93.95					
					Mid	136.52	-	-	94.59	94.64					
					High	242.00	237.55	2%	95.88	95.78					
96-1	HGR	2	-	High WSL	Low	5.99	3.87	35%	97.71	97.71	96.62	0.69	1.12	1.11	1.49
					Mid	51.30	-	-	98.79	98.79					
					Mid	89.37	77.85	13%	99.22	99.21					
					Mid	116.72	-	-	99.45	99.44					
					High	242.00	-	-	100.17	100.19					
96-2	HGR	2	-	High WSL	Low	5.99	5.83	3%	97.72	97.73	96.66	3.80	1.01	0.23	2.11
					Mid	51.30	-	-	98.83	98.83					
					Mid	89.37	95.17	6%	99.32	99.26					
					Mid	116.72	-	-	99.53	99.50					
					High	242.00	-	-	100.19	100.28					
96-3	HGR	2	-	High WSL	Low	5.99	8.91	49%	97.74	97.74	96.33	2.57	1.08	0.18	2.14
					Mid	51.30	-	-	98.84	98.85					
					Mid	89.37	80.74	10%	99.32	99.29					
					Mid	116.72	-	-	99.55	99.53					
					High	242.00	-	-	100.25	100.30					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-13a. Model Calibration Summary for Big Creek, Powerhouse 2 to Dam 4, A-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
18-1	POW	1	-	Low WSL	Low	3.70	3.53	5%	94.49	94.49	93.33	1.50	0.92	0.28	1.27
					Mid	14.11	-	-	94.99	94.98					
					High	39.30	41.93	7%	95.48	95.49					
18-2	POW	1	-	High WSL	Low	3.70	3.38	9%	94.54	94.55	93.33	2.84	1.09	0.49	1.34
					Mid	14.11	-	-	95.12	95.10					
					High	39.30	36.31	8%	95.67	95.69					
19-1	HGR	1	-	High WSL	Low	3.70	4.44	20%	95.00	95.00	93.97	1.04	1.02	0.44	1.25
					Mid	14.11	-	-	95.48	95.47					
					High	39.30	38.36	2%	95.97	95.98					
19-2	HGR	1	-	Low WSL	Low	3.70	3.52	5%	95.58	95.58	94.88	3.09	0.96	0.48	1.35
					Mid	14.11	-	-	95.92	95.91					
					High	39.30	41.74	6%	96.24	96.25					
24-1	DP	2	-	Low WSL	Low	3.70	1.99	46%	97.67	97.67	97.07	1.73	1.21	1.06	4.27
					Mid	14.11	-	-	98.12	98.13					
					High	39.30	32.92	16%	98.73	98.72					
24-2	DP	2	-	Low WSL	Low	3.70	2.79	25%	97.67	97.67	97.07	1.73	0.93	0.12	1.38
					Mid	14.11	-	-	98.12	98.13					
					High	39.30	41.37	5%	98.73	98.72					
24-3	DP	2	-	High WSL	Low	3.70	2.75	26%	97.67	97.67	97.07	0.21	0.98	0.13	1.37
					Mid	14.11	-	-	98.14	98.14					
					High	39.30	40.27	2%	98.73	98.74					
24-4	RUN	2	-	Low WSL	Low	3.70	4.00	8%	97.70	97.70	97.07	0.93	0.96	0.19	1.23
					Mid	14.11	-	-	98.23	98.22					
					High	39.30	40.66	3%	98.89	98.90					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-13b. Model Calibration Summary for Big Creek, Powerhouse 2 to Dam 4, A-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
31-1	SP	3	-	High WSL	Low	3.70	3.42	8%	98.38	98.37	97.46	6.66	0.95	0.56	1.31
					Mid	14.11	-	-	98.69	98.72					
					High	39.30	43.22	10%	99.10	99.08					
31-2	SP	3	-	High WSL	Low	3.70	4.06	10%	98.45	98.45	97.46	2.41	1.04	0.15	1.50
					Mid	14.11	-	-	98.83	98.84					
					High	39.30	37.28	5%	99.26	99.25					
31-3	SP	3	-	Low WSL	Low	3.70	5.11	38%	98.45	98.45	97.46	1.67	0.96	0.10	1.72
					Mid	14.11	-	-	98.84	98.85					
					High	39.30	39.40	0%	99.27	99.26					
261-1	DP	4	-	High WSL	Low	0.73	0.78	7%	97.98	97.99	97.42	9.09	0.93	0.25	1.14
					Mid	9.33	-	-	98.80	98.74					
					High	39.3	39.60	1%	99.47	99.53					
261-2	DP	4	-	High WSL	Low	0.73	1.24	70%	97.98	97.99	97.42	9.16	0.95	0.03	1.45
					Mid	9.33	-	-	98.81	98.74					
					High	39.3	39.30	0%	99.49	99.56					
273-1	HGR	5	-	High WSL	Low	0.73	0.89	22%	97.78	97.78	96.85	0.11	0.95	0.23	1.40
					Mid	9.33	-	-	98.51	98.51					
					High	39.3	41.79	6%	99.15	99.15					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-14. Model Calibration Summary for Big Creek, Powerhouse 2 to Dam 4, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
														VAF[5]	
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	Min	Max
258-1	HGR	1	-	Low WSL	Low	0.73	0.88	21%	94.75	94.75	94.22	0.75	0.90	0.12	1.19
					Mid	9.33	-	-	95.38	95.38					
					High	39.30	43.25	10%	96.01	96.01					
258-2	HGR	2	-	High WSL	Low	0.73	0.66	10%	96.04	96.04	95.34	2.93	0.96	0.32	1.21
					Mid	9.33	-	-	96.68	96.67					
					High	39.30	41.18	5%	97.23	97.24					
259-1	DP	3	-	Low WSL	Low	0.73	0.49	33%	95.94	95.95	95.12	4.56	0.96	0.04	1.28
					Mid	9.33	-	-	96.81	96.78					
					High	39.30	39.59	1%	97.55	97.58					
259-2	DP	3	-	High WSL	Low	0.73	0.84	15%	95.94	95.95	95.12	7.37	0.83	0.02	1.51
					Mid	9.33	-	-	96.85	96.80					
					High	39.30	46.41	18%	97.57	97.62					
259-3	DP	3	-	Average all	Low	0.73	0.78	7%	95.94	95.95	95.12	7.37	0.81	0.06	1.20
					Mid	9.33	-	-	96.85	96.80					
					High	39.30	43.3	10%	97.57	97.62					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-15a. Model Calibration Summary for Big Creek, Powerhouse 8 to Dam 5, A-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
100-1	HGR	1	-	High WSEL	Low	3.78	3.84	2%	94.75	94.75	94.27	0.66	0.99	0.93	1.09
					Mid	20.3	-	-	95.19	95.19					
					High	46.81	49.00	5%	95.53	95.53					
101-1	DP	1	-	High WSEL	Low	3.78	3.40	10%	94.96	94.96	94.27	3.74	1.18	0.17	1.80
					Mid	20.3	-	-	95.36	95.38					
					High	46.81	40.41	14%	95.69	95.68					
101-2	DP	1	-	High WSEL	Low	3.78	-	-	94.96	94.95	94.27	4.97	Depth Calibration		
					Mid	20.3	-	-	95.37	95.40					
					High	46.81	-	-	95.73	95.71					
107-1	DP	2	-	Low WSEL	Low	3.78	2.83	25%	98.28	98.28	97.28	2.86	1.18	0.12	1.93
					Mid	20.3	-		98.86	98.88					
					High	46.81	40.15	14%	99.32	99.30					
107-2	DP	2	-	High WSEL	Low	3.78	4.68	24%	98.28	98.28	97.28	2.86	0.99	0.13	1.44
					Mid	20.3	-	-	98.86	98.88					
					High	46.81	48.54	4%	99.32	99.30					
108-1	SP	3	-	High WSEL	Low	3.78	3.59	5%	92.09	92.09	91.38	0.02	1.04	0.19	1.25
					Mid	20.3	-	-	92.75	92.75					
					High	46.81	44.50	5%	93.28	93.28					
108-2	SP	3	-	High WSEL	Low	3.78	3.54	6%	92.10	92.10	91.38	0.01	1.00	0.40	1.09
					Mid	20.3	-	-	92.76	92.76					
					High	46.81	49.94	7%	93.30	93.30					
108-3	SP	3	-	Low WSEL	Low	3.78	3.84	2%	92.10	92.10	91.38	0.03	0.90	0.12	1.24
					Mid	20.3	-	-	92.77	92.77					
					High	46.81	53.58	14%	93.30	93.30					
109-1	HGR	4	STAs 23 to 47	As Entered	Low	3.78	4.13	9%	94.74	94.74	94.41	2.48	0.78	0.12	0.93
					Mid	20.3	-	-	95.22	95.21					
					High	46.81	59.67	27%	95.62	95.64					
109-2	HGR	4	-	High WSEL	Low	3.78	4.22	12%	95.20	95.20	95.03	0.13	0.99	0.14	0.99
					Mid	20.3	-	-	95.69	95.68					
					High	46.81	47.28	1%	96.33	96.33					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-15b. Model Calibration Summary for Big Creek, Powerhouse 8 to Dam 5, A-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
114-1	RIF	5	STAs-16 to 11&22 to 43	As Entered	Low	3.78	3.81	1%	95.43	95.43	94.62	0.03	1.03	0.42	1.36
					Mid	20.3	-	-	95.89	95.89					
					High	46.81	46.81	0%	96.20	96.20					
119-1	RUN	6	STA -4	Low WSEL	Low	3.78	3.78	0%	95.82	95.82	94.80	2.64	0.93	0.14	1.59
					Mid	20.3	-	-	96.25	96.24					
					High	46.81	50.25	7%	96.50	96.51					
119-2	RUN	6	-	High WSEL	Low	3.78	3.72	2%	95.86	95.86	94.83	0.59	1.01	0.37	1.32
					Mid	20.3	-	-	96.38	96.38					
					High	46.81	46.27	1%	96.74	96.73					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-16. Model Calibration Summary for Big Creek, Powerhouse 8 to Dam 5, Aa-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
														VAF[5]	
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	Min	Max
8-1	SP	1	-	High WSL	Low	3.19	3.00	6%	95.70	95.70	94.87	0.09	0.96	0.14	1.40
					Mid	17.78	-	-	96.23	96.23					
					High	51.06	53.22	4%	96.71	96.71					
8-2	SP	1	Sta 30 and 32	As Entered	Low	3.19	3.03	5%	95.70	95.70	94.87	0.09	0.99	0.12	1.54
					Mid	17.78	-	-	96.23	96.23					
					High	51.06	51.35	1%	96.71	96.71					
8-3	SP	1	Sta -1 and 44	As Entered	Low	3.19	4.65	46%	95.70	95.70	94.87	0.09	0.91	0.09	1.46
					Mid	17.78	-	-	96.23	96.23					
					High	51.06	59.04	16%	96.71	96.71					
8-4	SP	1	-	High WSL	Low	3.19	1.90	40%	96.88	96.88	92.26	0.22	0.98	0.09	1.37
					Mid	17.78	-	-	97.47	97.47					
					High	51.06	47.24	7%	98.09	98.09					
21-1	DP	2	-	High WSL	Low	3.19	3.19	0%	93.09	93.10	91.91	5.02	0.98	0.05	1.91
					Mid	17.78	-	-	93.96	93.91					
					High	51.06	51.07	0%	94.63	94.67					
21-2	DP	2	-	High WSL	Low	3.19	3.95	24%	93.09	93.10	91.91	5.02	Depth Calibration		
					Mid	17.78	-	-	93.96	93.92					
					High	51.06	-	-	94.63	94.67					
21-3	DP	2	-	High WSL	Low	3.19	4.24	33%	93.09	93.10	91.91	5.02	Depth Calibration		
					Mid	17.78	-	-	93.96	93.91					
					High	51.06	-	-	94.63	94.67					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-17. Model Calibration Summary for Stevenson Creek, Aa-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
190-1	SP	1	-	Low WSL	Low	3.5	3.15	10%	96.07	96.07	95.36	0.24	1.03	0.69	1.26
					Mid	19.0	-	-	96.64	96.64					
					High	44.0	42.47	3%	97.08	97.08					
190-2	SP	1	-	High WSL	Low	3.5	3.72	6%	96.07	96.07	95.36	0.24	0.96	0.09	1.57
					Mid	19.0	-	-	96.65	96.65					
					High	44.0	46.09	5%	97.09	97.09					
190-3	SP	1	-	Low WSL	Low	3.5	4.20	20%	96.07	96.07	95.36	0.24	0.85	0.19	1.20
					Mid	19.0	-	-	96.65	96.65					
					High	44.0	53.20	21%	97.09	97.09					
198-1	DP	2	-	High WSL	Low	3.5	3.08	12%	97.49	97.49	96.40	0.83	1.03	0.44	1.39
					Mid	16.5	-	-	98.19	98.20					
					High	39.0	37.99	3%	98.78	98.77					
198-2	DP	2	-	High WSL	Low	3.5	3.78	8%	97.49	97.49	96.40	0.83	0.95	0.14	1.58
					Mid	16.5	-	-	98.19	98.20					
					High	39.0	44.54	14%	98.78	98.77					
198-3	DP	2	-	Low WSL	Low	3.5	5.02	43%	97.49	97.49	96.40	0.83	0.99	0.22	1.55
					Mid	16.5	-	-	98.19	98.20					
					High	39.0	44.50	14%	98.78	98.77					
199-1	RUN	3	-	Low WSL	Low	3.5	3.99	14%	98.89	98.89	97.80	0.34	0.99	0.37	1.33
					Mid	16.5	-	-	99.45	99.45					
					High	39.0	42.99	10%	99.87	99.87					
199-2	RUN	3	-	High WSL	Low	3.5	2.82	19%	100.59	100.59	99.39	1.21	0.99	0.50	1.19
					Mid	16.5	-	-	101.18	101.17					
					High	39.0	38.87	0%	101.60	101.61					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-18. Model Calibration Summary for Stevenson Creek, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
130-1	SP	1	-	High WSL	Low	4	3.20	20%	97.03	97.03	96.33	0.24	1.01	0.33	1.35
					Mid	19	-	-	97.51	97.51					
					High	45	45.44	1%	97.91	97.91					
130-2	SP	1	-	High WSL	Low	4	3.24	19%	97.09	97.08	96.33	4.22	1.07	0.11	1.80
					Mid	19	-	-	97.57	97.60					
					High	45	42.34	6%	98.04	98.02					
130-3	SP	1	-	High WSL	Low	4	3.95	1%	97.09	97.09	96.33	2.14	1.04	0.16	1.57
					Mid	19	-	-	97.59	97.60					
					High	45	46.11	2%	98.04	98.03					
131-1	LGR	1	-	High WSL	Low	4	3.77	6%	97.10	97.10	96.57	2.03	0.95	0.95	2.87
					Mid	19	-	-	97.61	97.62					
					High	45	47.73	6%	98.13	98.12					
132-1	RUN	2	-	Low WSL	Low	4	3.52	12%	94.38	94.38	93.53	0.22	0.98	0.68	1.20
					Mid	19	-	-	95.14	95.14					
					High	45	45.82	2%	95.83	95.83					
132-1	DP	2	-	High WSL	Low	4	6.39	60%	94.40	94.40	93.53	0.82	1.04	0.13	1.61
					Mid	19	-	-	95.18	95.19					
					High	45	42.57	5%	95.91	95.90					
132-2	DP	2	-	High WSL	Low	4	2.95	26%	94.42	94.42	93.53	0.98	0.97	0.10	1.54
					Mid	19	-	-	95.20	95.21					
					High	45	46.42	3%	95.93	95.92					
133-1	HGR	2	Sta. 13.25 & 13.75	Low WSL	Low	4	3.22	20%	94.84	94.84	94.34	0.38	1.15	1.13	2.94
					Mid	19	-	-	95.49	95.49					
					High	45	38.18	15%	96.15	96.15					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-19. Model Calibration Summary for Stevenson Creek, A-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
														VAF[5]	
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	Min	Max
39-1	SP	1	Sta 39.0, 40.0	As Entered	Low	4	3.30	18%	96.74	96.74	95.54	0.70	0.93	0.36	0.93
					Mid	19	-	-	97.52	97.51					
					High	50	50.12	0%	98.22	98.23					
39-2	SP	1	-	Low WSL	Low	4	2.81	30%	96.76	96.76	95.54	0.86	1.09	0.41	1.25
					Mid	19	-	-	97.59	97.58					
					High	50	44.53	11%	98.34	98.35					
40-1	HGR	1	-	Low WSL	Low	4	4.11	3%	97.60	97.60	96.85	0.66	1.00	0.96	1.38
					Mid	19	-	-	98.21	98.20					
					High	50	49.96	0%	98.80	98.80					
42-1	POW	2	-	Low WSL	Low	4	3.29	18%	96.97	96.97	95.63	0.18	1.05	0.15	1.74
					Mid	19	-	-	97.64	97.64					
					High	50	50.33	1%	98.22	98.22					
42-2	POW	2	-	Low WSL	Low	4	4.30	8%	97.23	97.23	96.34	0.97	1.00	0.63	1.02
					Mid	19	-	-	98.03	98.02					
					High	50	50.78	2%	98.82	98.83					
43-1	DP	2	-	Low WSL	Low	4	3.84	4%	97.31	97.31	96.34	2.14	0.97	0.10	1.44
					Mid	19	-	-	98.17	98.15					
					High	50	51.16	2%	98.97	98.99					
43-2	DP	2	-	Rod WSL	Low	4	3.75	6%	97.32	97.32	96.34	1.80	0.87	0.07	1.61
					Mid	19	-	-	98.18	98.16					
					High	50	58.49	17%	98.99	99.01					

Footnotes are located at the front of Appendix E.

Table CAWG 3 Appendix E-20. Model Calibration Summary for North Fork Stevenson Creek, below Outlet Reach, Aa-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
82-1	RUN	1	-	Low WSL	Low	4.64	4.21	9%	95.62	95.61	94.52	3.51	1.02	0.64	0.94
					Mid	11.18	-	-	95.96	95.99					
					High	24.27	24.27	0%	96.44	96.42					
83-1	DP	1	-	High WSL	Low	4.64	3.18	31%	96.49	96.49	95.49	0.09	1.04	0.58	1.29
					Mid	11.18	-	-	96.79	96.79					
					High	24.27	22.64	7%	97.13	97.13					
83-2	DP	1	-	Low WSL	Low	4.64	6.03	30%	96.54	96.54	95.49	0.44	0.96	0.15	1.69
					Mid	11.18	-	-	96.90	96.90					
					High	24.27	24.66	2%	97.33	97.33					
83-3	DP	1	-	Low WSL	Low	4.64	4.30	7%	96.56	96.56	95.49	0.57	0.98	0.95	1.19
					Mid	11.18	-	-	96.94	96.94					
					High	24.27	24.26	0%	97.37	97.37					
85-1	HGR	2	-	High WSL	Low	4.64	4.27	8%	94.18	94.18	92.62	0.83	0.98	0.64	1.21
					Mid	11.18	-	-	94.50	94.50					
					High	24.27	24.67	2%	94.82	94.82					
85-2	HGR	2	-	Low WSL	Low	4.64	3.62	22%	97.40	97.40	95.94	1.61	0.98	0.41	1.30
					Mid	11.18	-	-	97.73	97.72					
					High	24.27	24.80	2%	98.05	98.06					
85-3	HGR	2	STA 0-46	As Entered	Low	4.64	5.16	11%	97.46	97.46	95.56	0.76	1.04	0.31	1.35
					Mid	11.18	-	-	97.84	97.84					
					High	24.27	18.76	23%	98.22	98.22					
90-1	SP	3	-	Low WSL	Low	4.64	5.15	11%	94.87	94.87	93.13	0.05	1.02	0.28	1.46
					Mid	11.18	-	-	95.35	95.35					
					High	24.27	23.07	5%	95.88	95.88					
90-2	SP	3	-	High WSL	Low	4.64	4.86	5%	94.87	94.87	93.13	0.05	1.05	0.33	1.49
					Mid	11.18	-	-	95.35	95.35					
					High	24.27	20.30	16%	95.88	95.88					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-21. Model Calibration Summary for North Fork Stevenson Creek, below Outlet Reach, B-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
39-1	**DP**	1	-	Low WSL	Low	4.7	3.54	25%	97.08	97.08	96.45	0.43	1.03	0.15	1.84
					Mid	14.17	-	-	97.25	97.25					
					High	30.82	29.50	4%	97.40	97.40					
39-2	**DP**	1	-	Leave as entered	Low	4.7	2.74	42%	97.10	97.10	96.45	0.09	1.02	0.09	2.20
					Mid	14.17	-	-	97.27	97.27					
					High	30.82	29.47	4%	97.42	97.42					
39-3	**DP**	1	-	Low WSL	Low	4.7	5.09	8%	97.11	97.11	96.45	0.07	1.05	0.12	2.06
					Mid	14.17	-	-	97.28	97.28					
					High	30.82	30.82	0%	97.42	97.42					
40-1	**HGR**	2	-	High WSL	Low	4.7	4.80	2%	97.81	97.81	97.16	0.92	1.03	0.79	1.24
					Mid	14.17	-	-	98.07	98.07					
					High	30.82	30.11	2%	98.32	98.31					
40-2	**HGR**	2	-	High WSL	Low	4.7	4.64	1%	98.26	98.26	97.44	0.77	1.00	0.53	1.39
					Mid	14.17	-	-	98.51	98.51					
					High	30.82	30.82	0%	98.74	98.74					
40-3	**HGR**	2		High WSL	Low	4.7	4.58	3%	98.48	98.48	97.37	0.51	1.03	0.32	1.42
					Mid	14.17	-	-	98.76	98.76					
					High	30.82	29.80	3%	99.00	98.99					

Footnotes are located at the front of Appendix E.

CAWG 3 Appendix E Table E-22. Model Calibration Summary for North Fork Stevenson Creek, below Outlet Reach, C-Channel Transects.

			Bed Profile		Calculated vs. Given Flow (cfs)				Water Surface Elevation (ft)		Model Parameters				
Transect	Habitat Type [1]	Link	Bed Adjust. [2]	Formula Chosen [3]	Flow Level	Field Measurement	Model Calculation	Percent Difference	Measured	Model Prediction	SZF [4]	Mean Error	Calib. Flow [6]	VAF[5] Min	VAF[5] Max
29-1	LGR	1	-	Hi WSL	Low	4.82	5.18	7%	96.67	96.67	96.01	0.20	1.02	0.84	1.17
					Mid	13.36	-	-	97.03	97.03					
					High	30.68	30.10	2%	97.47	97.47					
29-2	LGR	1	-30 to 28	Leave as entered	Low	4.82	3.85	20%	98.33	98.33	97.82	0.04	0.98	0.62	1.15
					Mid	13.36	-	-	98.52	98.52					
					High	30.68	30.89	1%	98.72	98.72					
30-1	DP	2	-	Hi WSL	Low	4.82	3.49	28%	95.33	95.33	94.73	0.37	0.96	0.11	1.86
					Mid	13.36	-	-	95.54	95.54					
					High	30.68	31.67	3%	95.76	95.76					
30-2	DP	2	-	Low WSL	Low	4.82	4.58	5%	95.34	95.34	94.73	0.30	0.83	0.08	1.74
					Mid	13.36	-	-	95.55	95.55					
					High	30.68	36.85	20%	95.77	95.77					
32-1	SP	3	-	Hi WSL	Low	4.82	4.81	0%	96.95	96.95	96.33	0.02	1.00	0.19	1.57
					Mid	13.36	-	-	97.23	97.23					
					High	30.68	30.55	0%	97.55	97.55					
32-2	SP	3	-	Hi WSL	Low	4.82	4.25	12%	96.96	96.96	96.33	0.50	1.03	0.18	1.65
					Mid	13.36	-	-	97.25	97.25					
					High	30.68	29.71	3%	97.58	97.58					
33-1	RUN	3	-	Low WSL	Low	4.82	5.49	14%	96.99	96.99	96.33	1.41	1.05	0.43	1.29
					Mid	13.36	-	-	97.30	97.29					
					High	30.68	29.94	2%	97.63	97.64					
33-2	RUN	4	-	Low WSL	Low	4.82	4.66	3%	96.54	96.54	95.87	0.23	0.98	0.43	1.34
					Mid	13.36	-	-	96.81	96.81					
					High	30.68	31.37	2%	97.11	97.11					
35-1	RUN	5	-	Hi WSL	Low	4.82	4.84	0%	96.41	96.41	95.39	0.11	0.96	0.20	1.62
					Mid	13.36	-	-	96.66	96.66					
					High	30.68	31.61	3%	96.91	96.91					

Footnotes are located at the front of Appendix E.

APPENDIX F

CROSS SECTION PROFILE PLOTS

APPENDIX F

Description of the Cross Section Plots

The cross section plots provided in this appendix show the bed profile, and the water surface elevation and velocity profiles for each transect. The bed profile is shown using a black line, while the water surface elevations and velocity profiles are shown in green. Water surface elevations are the straight, horizontal and the velocity profiles are jagged lines.

The water surface elevations and velocity profiles are provided for the three calibration flows and flows 0.4 times the low calibration flow and 2.5 times the high calibration flow. The flows represented in each plot are shown in the legend. An example is provided on the following page. In these plots Distance and Elevation are measured in feet, Velocity in feet per second, and flows in cubic feet per second.

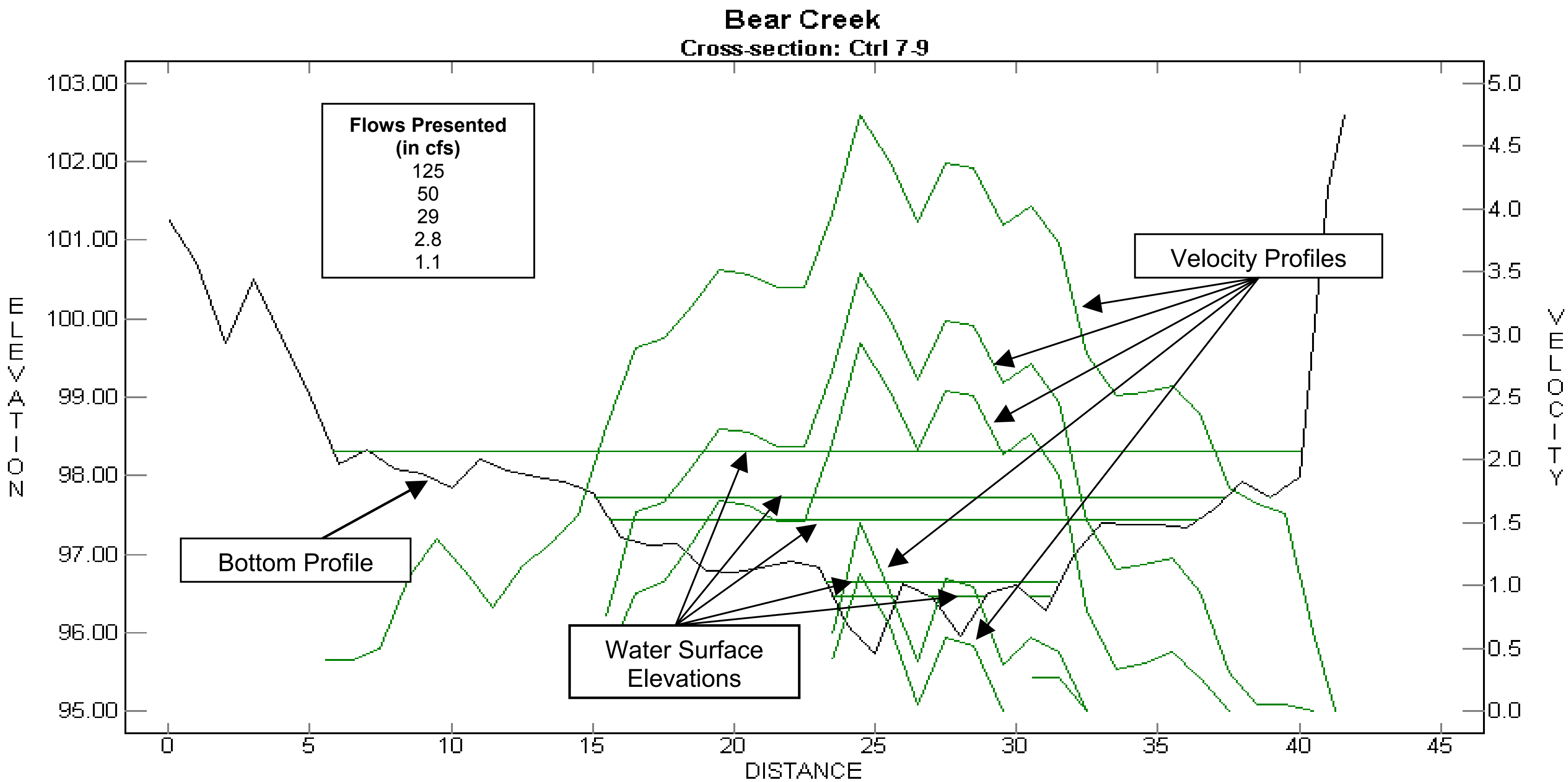
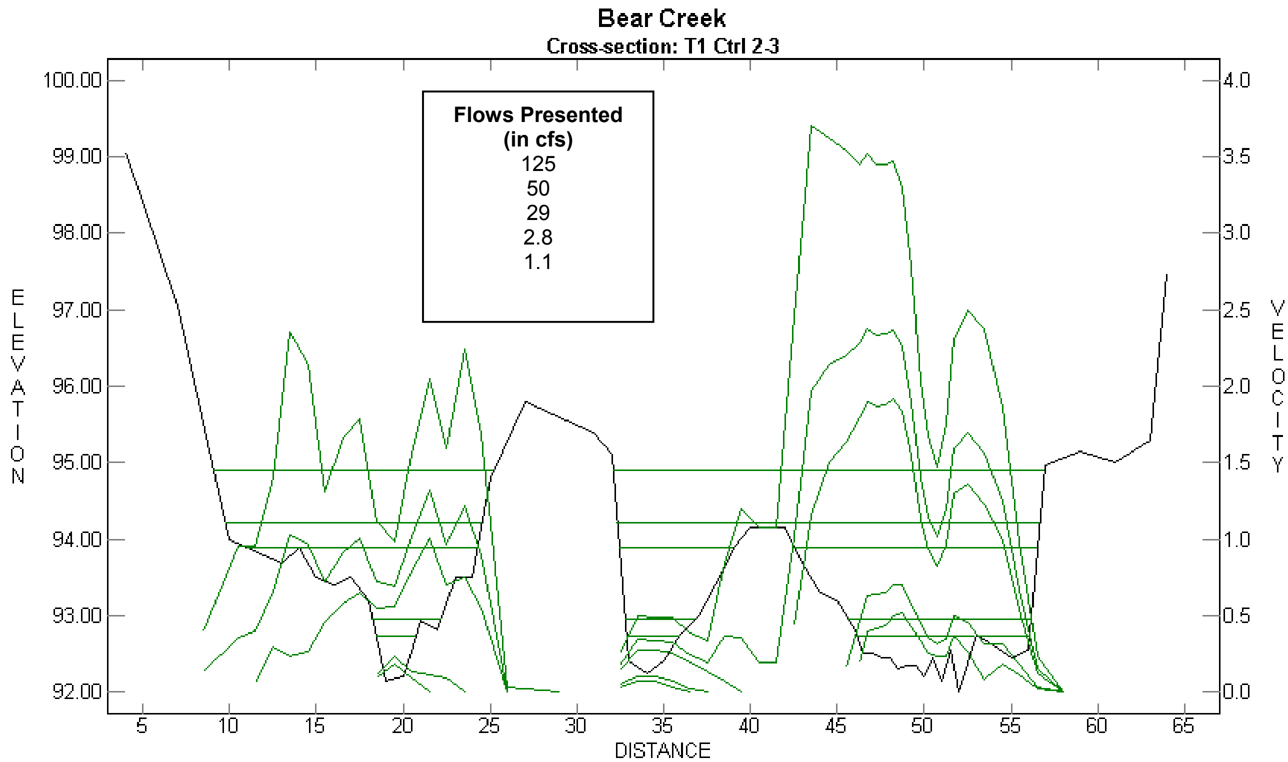
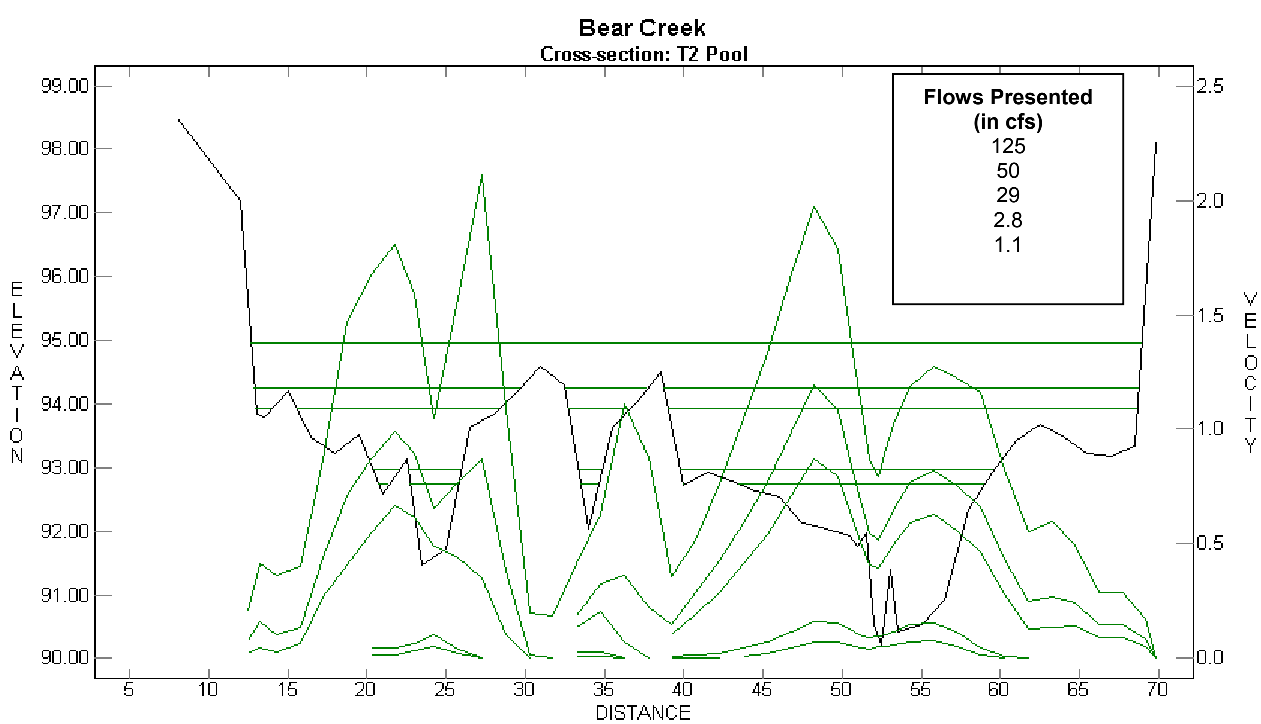
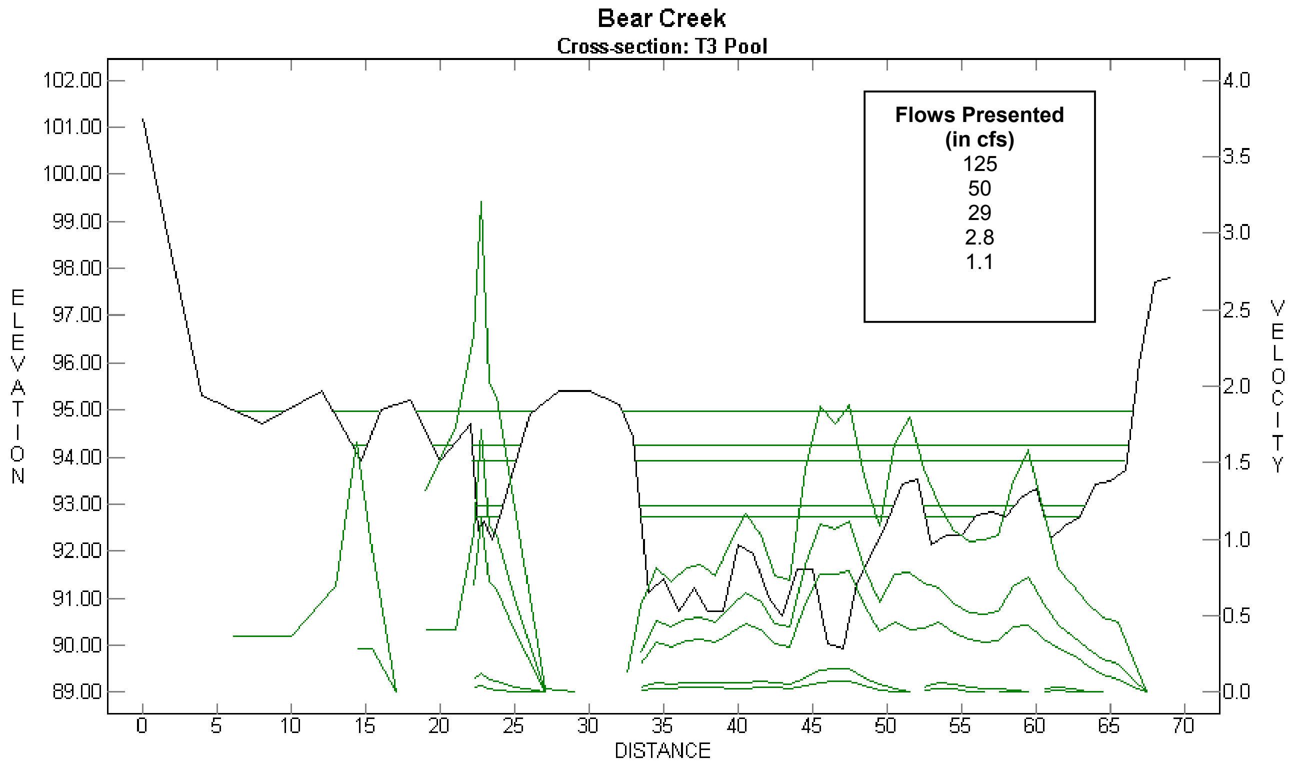
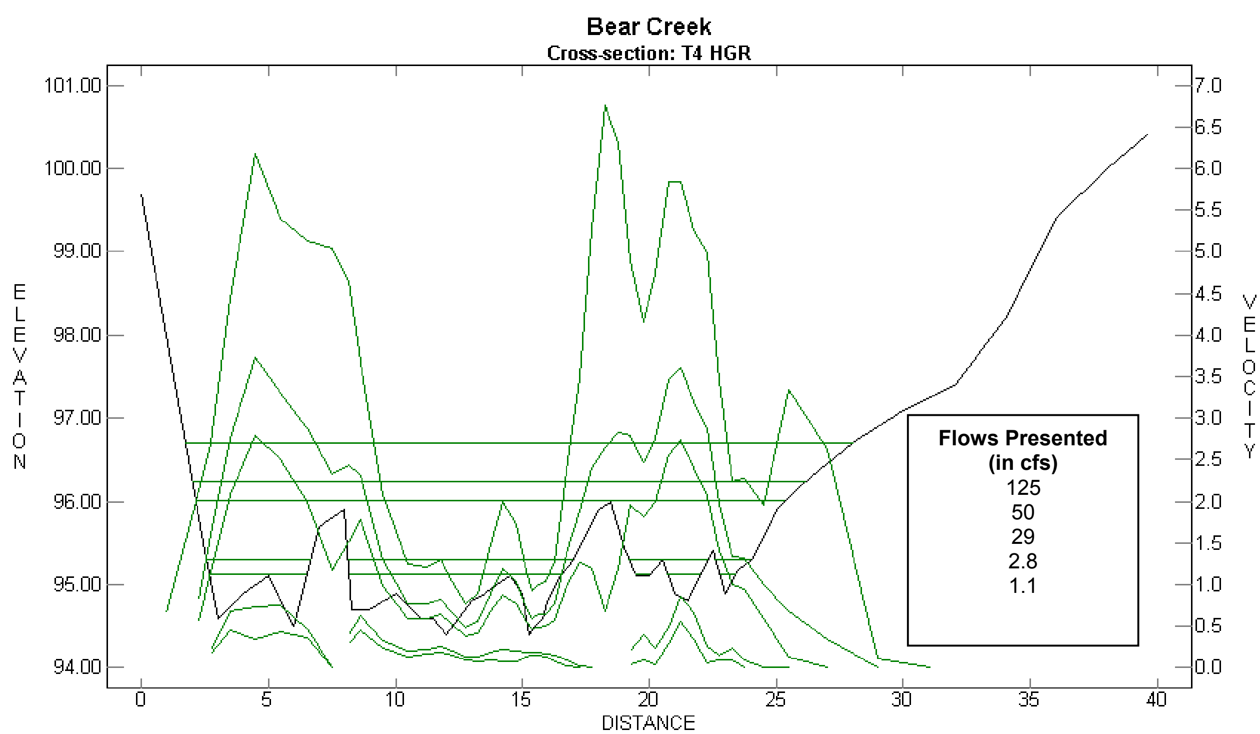


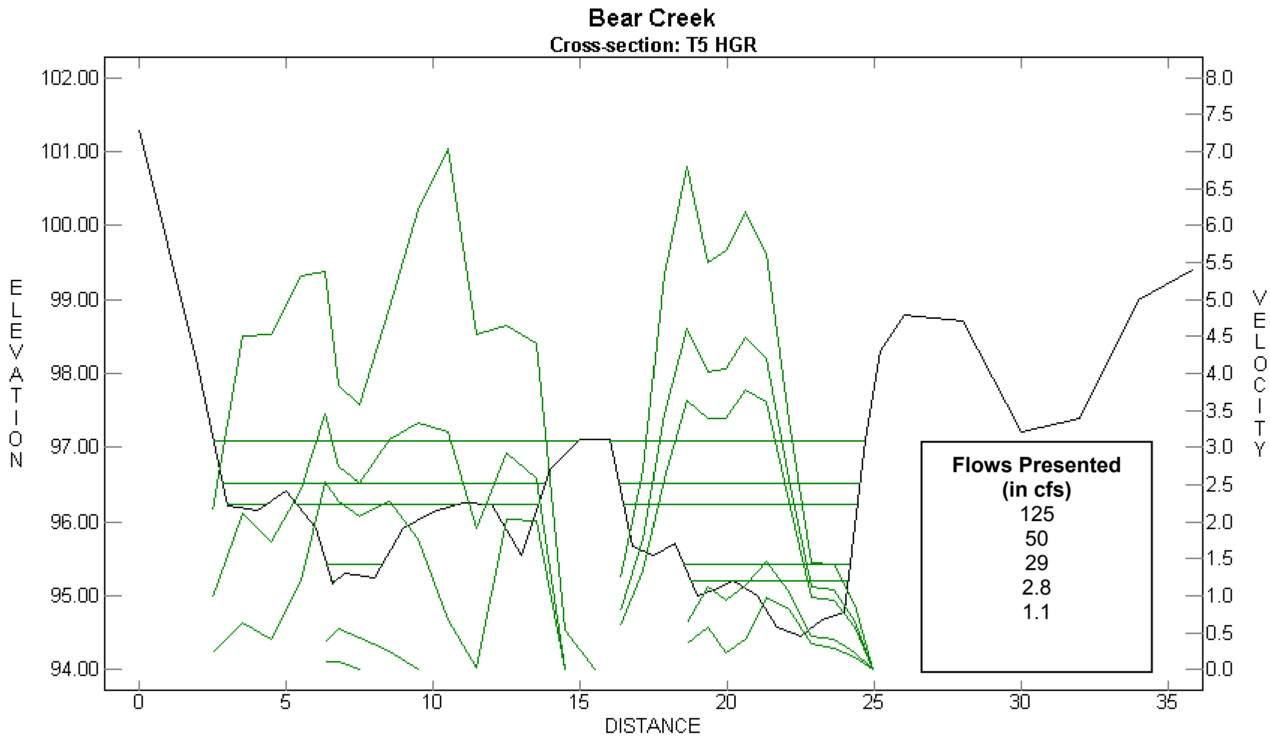
Figure XX. An example of a typical Cross-section. This shows the bottom profile at this location with the water surfaces and corresponding velocity profiles overlaid. The "Flows Presented" text box lists the flow in cubic feet per second for each water surface elevation.

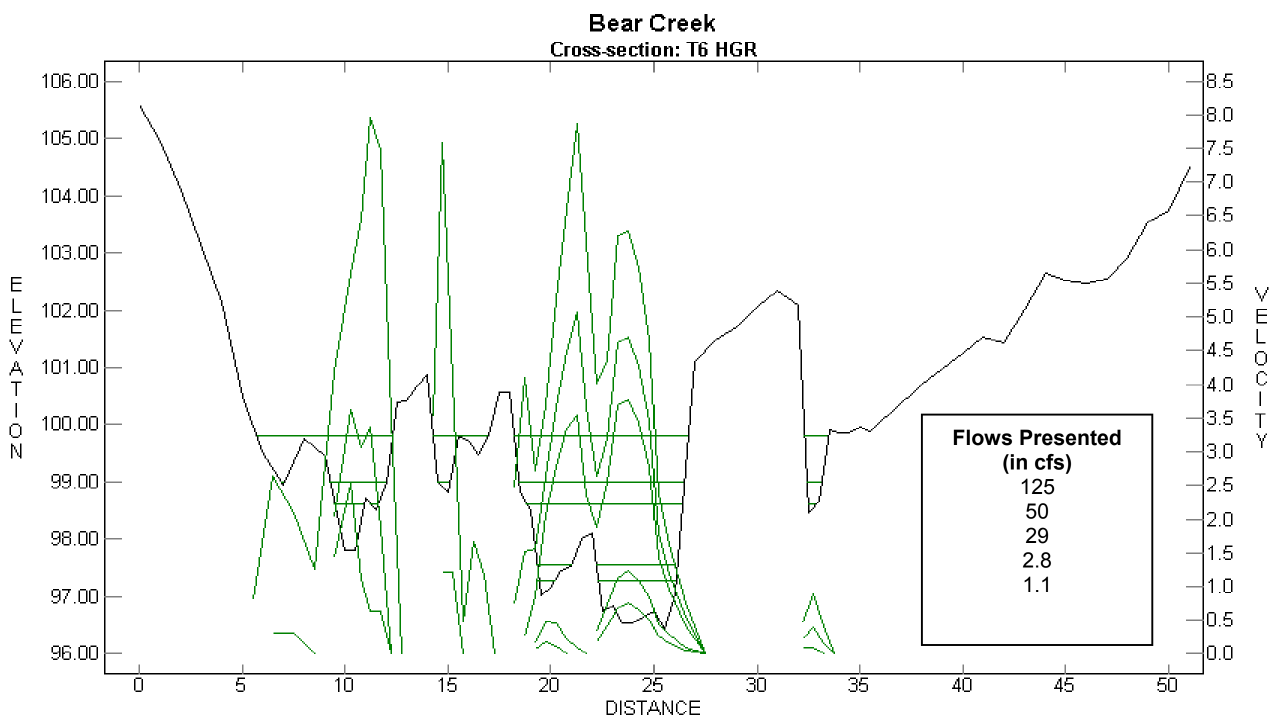

Bear Creek
Cross-section: T1 Ctrl 2-3
Flows Presented
(in cfs)
125
50
29
2.8
1.1
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5
10
15
20
25
30
35
40
45
50
55
60
65

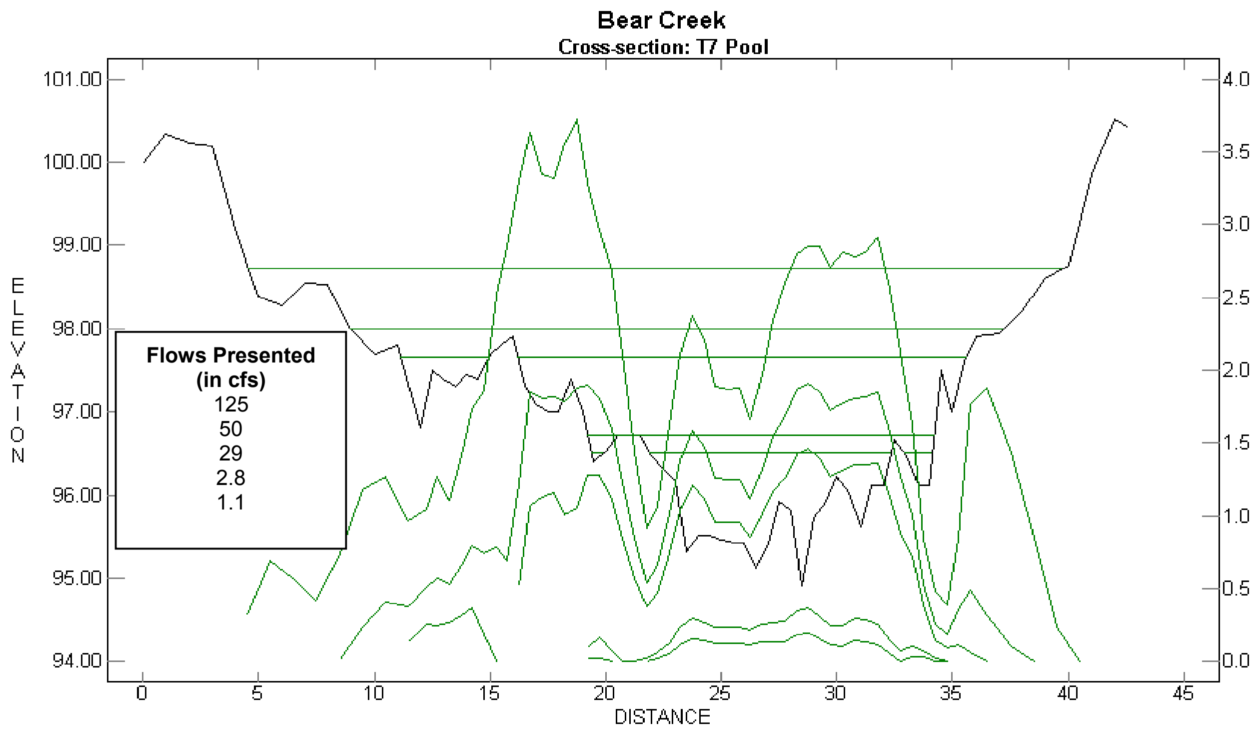

Bear Creek
Cross-section: T2 Pool
Flows Presented
(in cfs)
125
50
29
2.8
1.1
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
2.5
2.0
1.5
1.0
0.5
0.0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

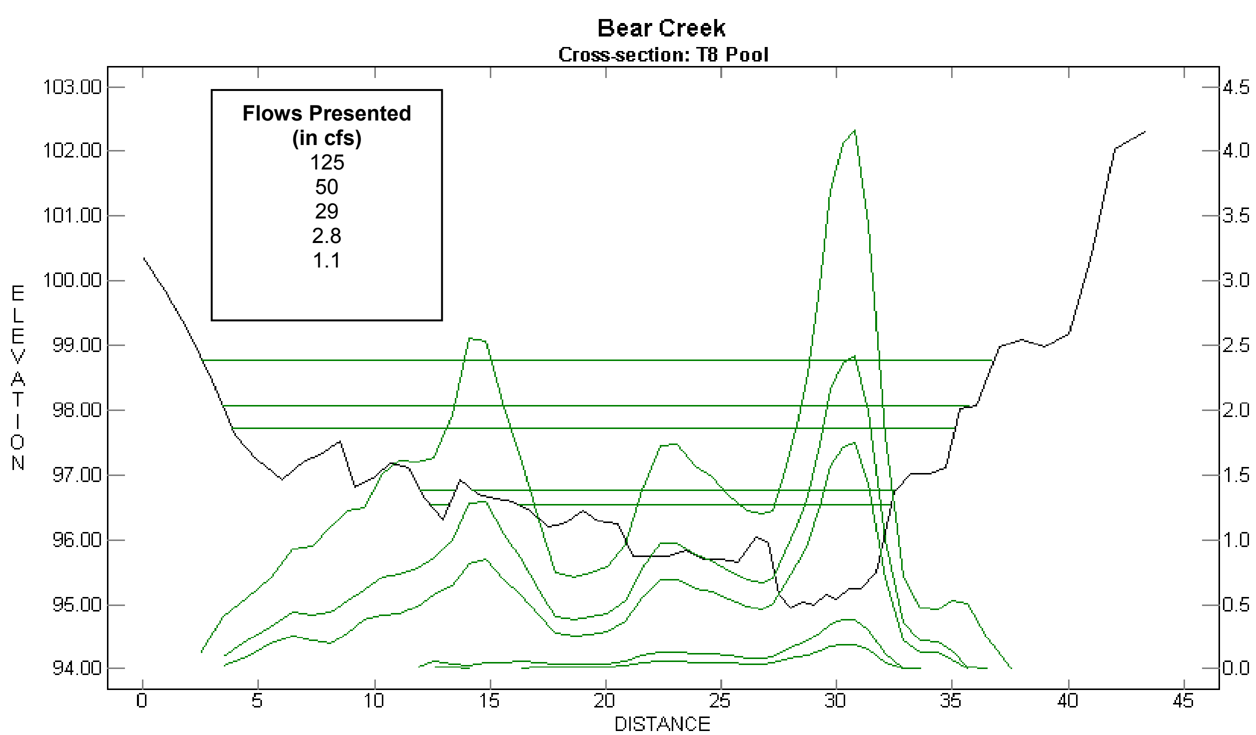

Bear Creek
Cross-section: T3 Pool
Flows Presented
(in cfs)
125
50
29
2.8
1.1
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

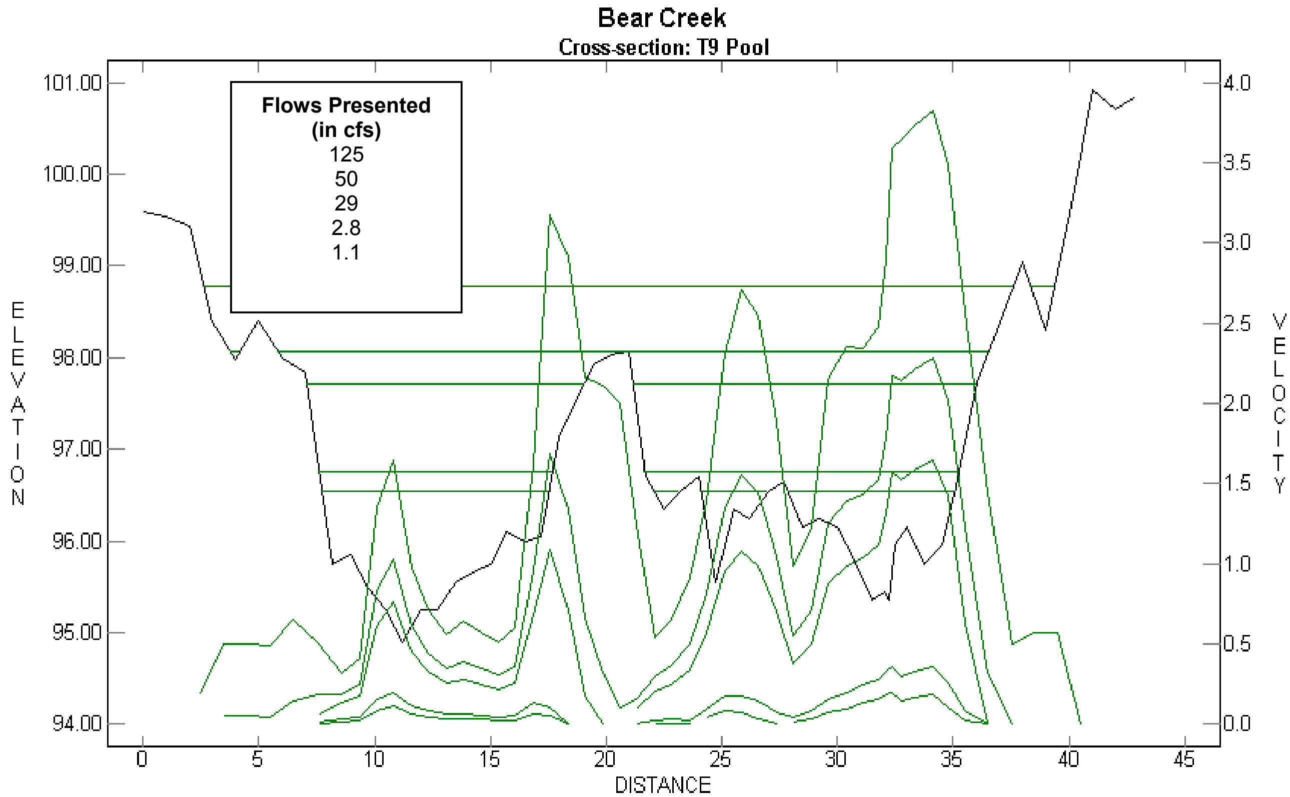

Bear Creek
Cross-section: T4 HGR
Flows Presented
(in cfs)
125
50
29
2.8
1.1
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40

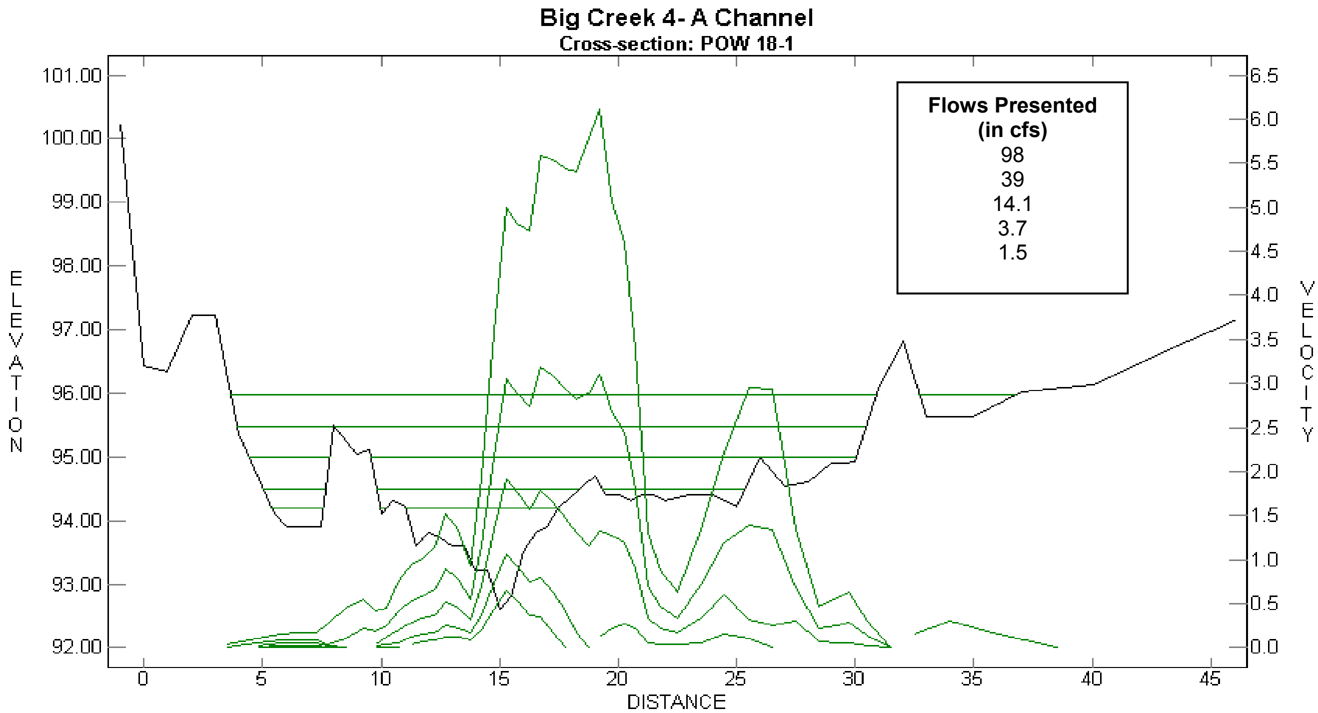

Bear Creek
Cross-section: T5 HGR
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
Flows Presented
(in cfs)
125
50
29
2.8
1.1

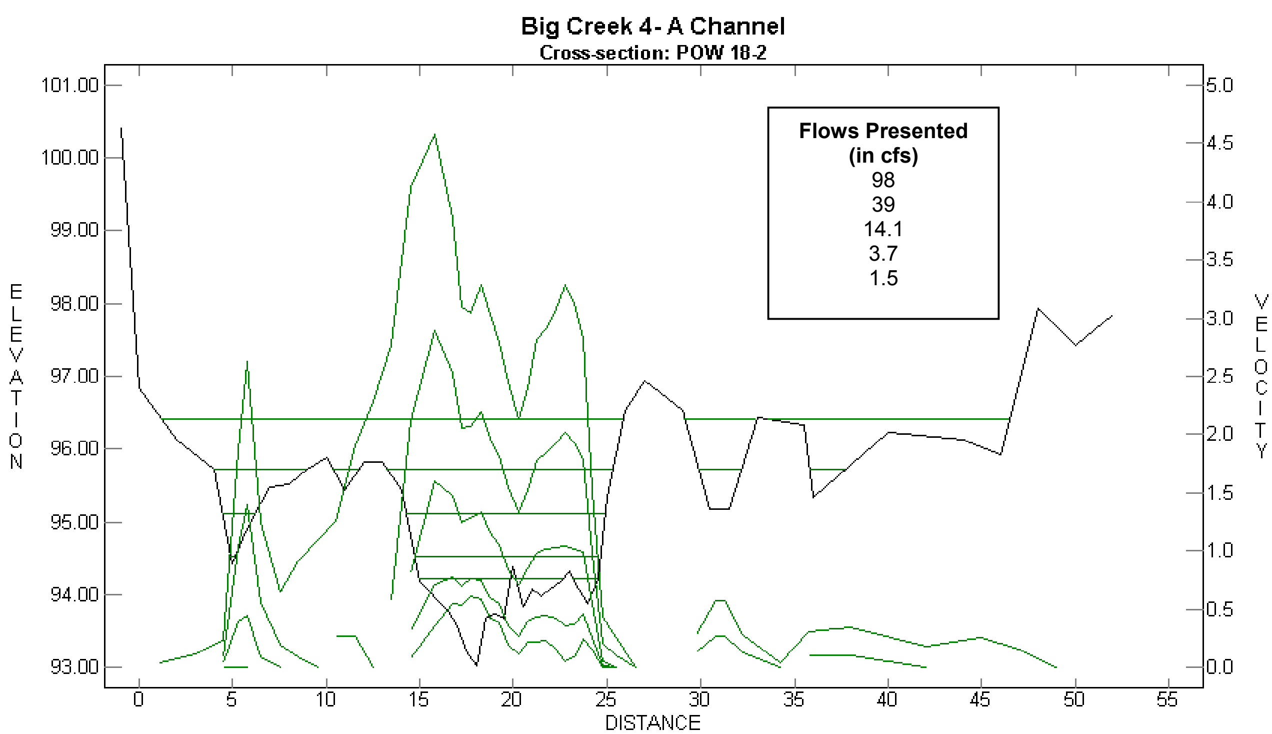

Bear Creek
Cross-section: T6 HGR
ELEVATION
VELOCITY
DISTANCE
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
Flows Presented
(in cfs)
125
50
29
2.8
1.1

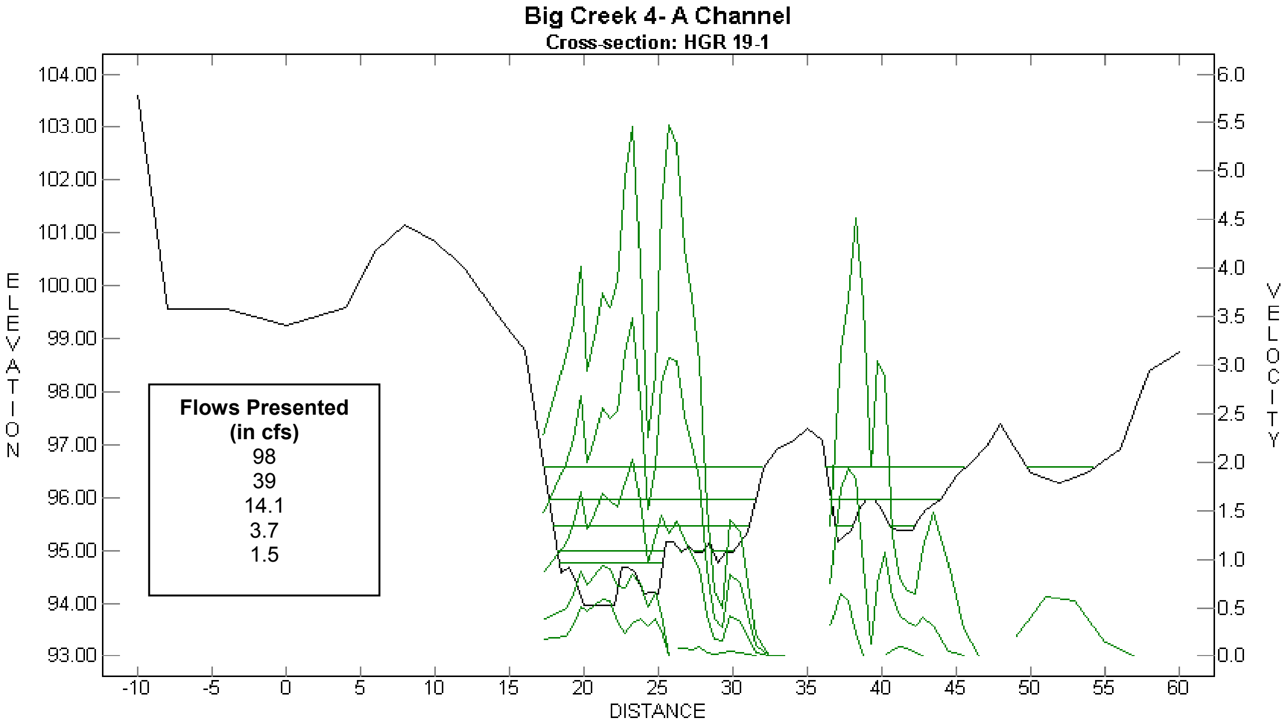

Bear Creek
Cross-section: T7 Pool
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
125
50
29
2.8
1.1
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45

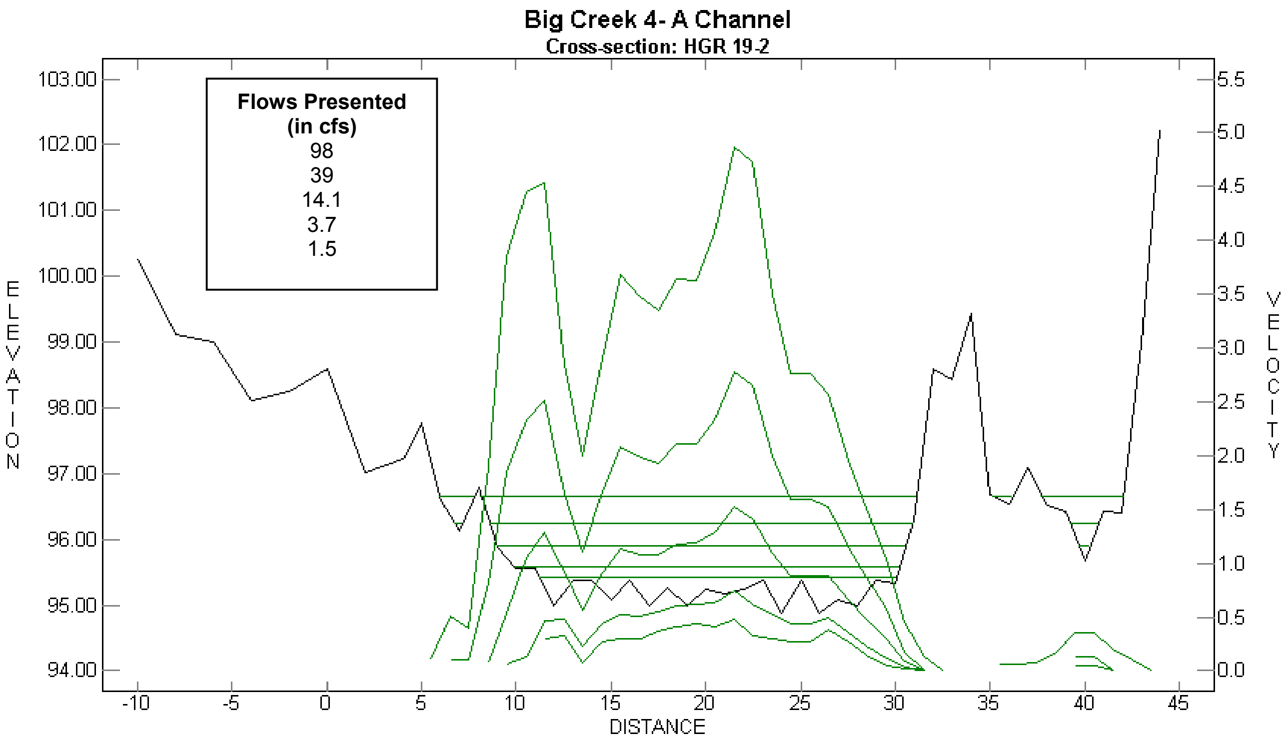

Bear Creek
Cross-section: T8 Pool
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
125
50
29
2.8
1.1
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45

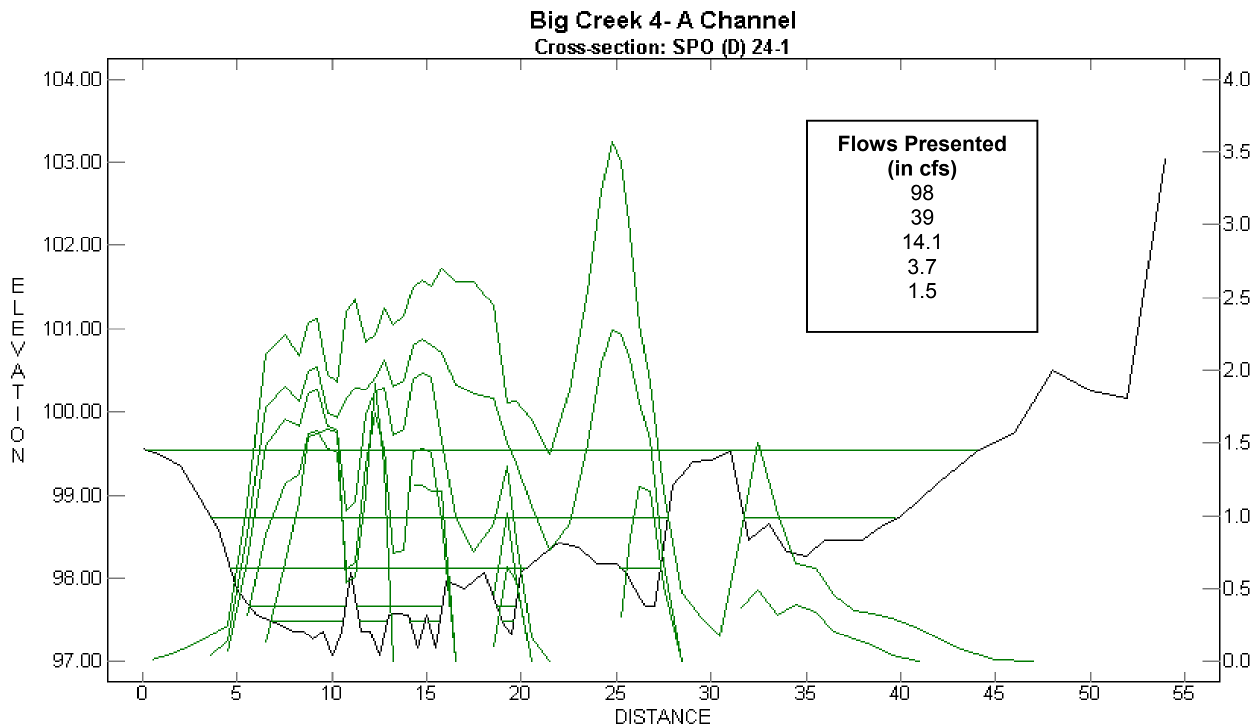

Bear Creek
Cross-section: T9 Pool
Flows Presented
(in cfs)
125
50
29
2.8
1.1
ELEVATION
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
VELOCITY
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
DISTANCE

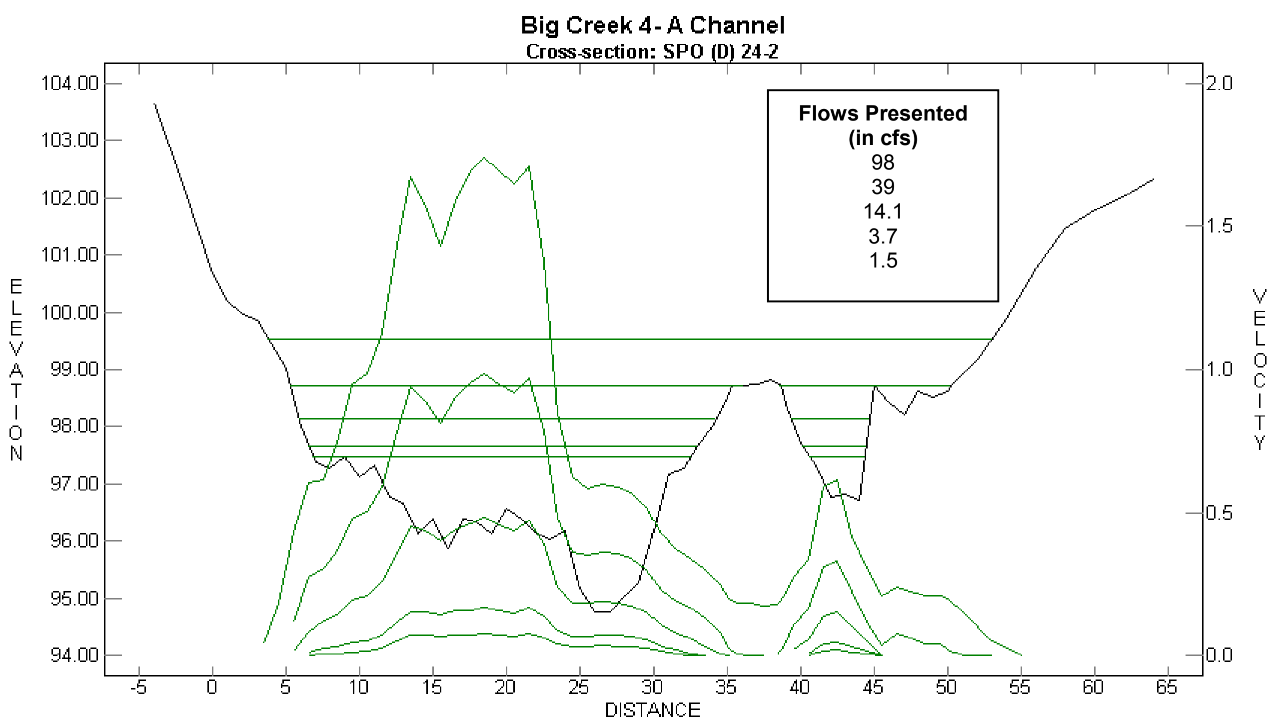

Big Creek 4- A Channel
Cross-section: POW 18-1
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45

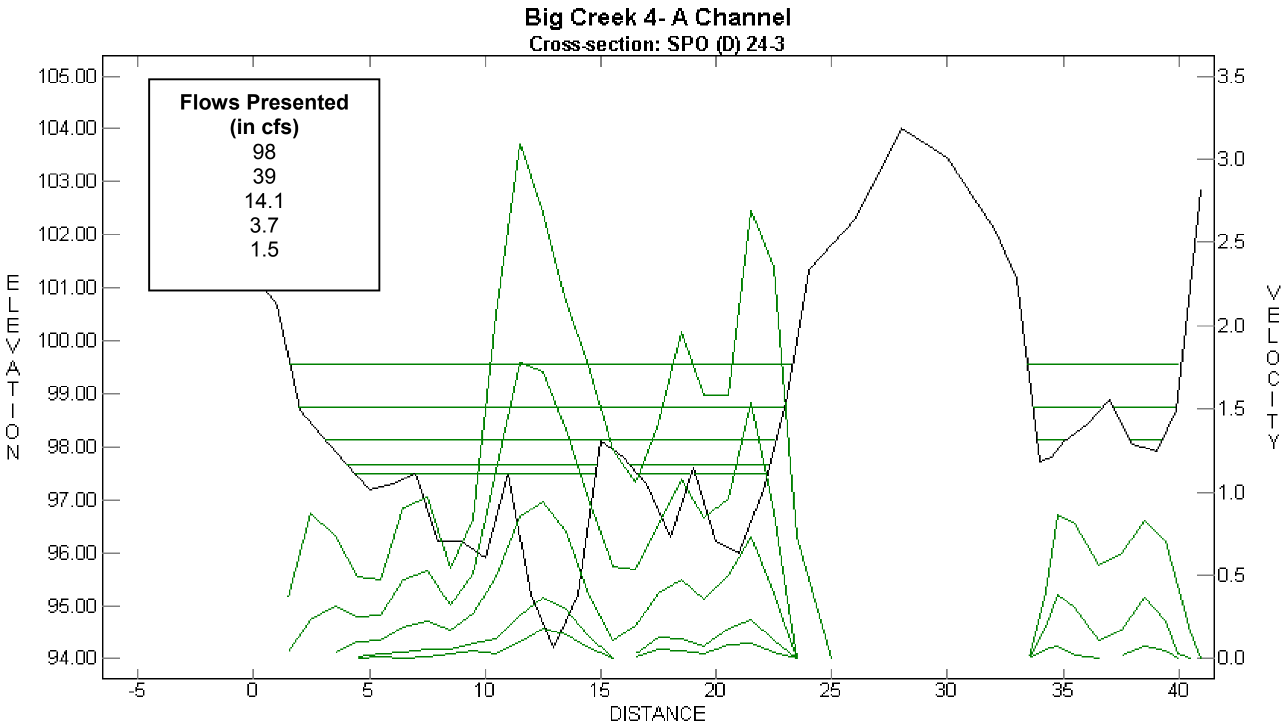

Big Creek 4- A Channel
Cross-section: POW 18-2
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55

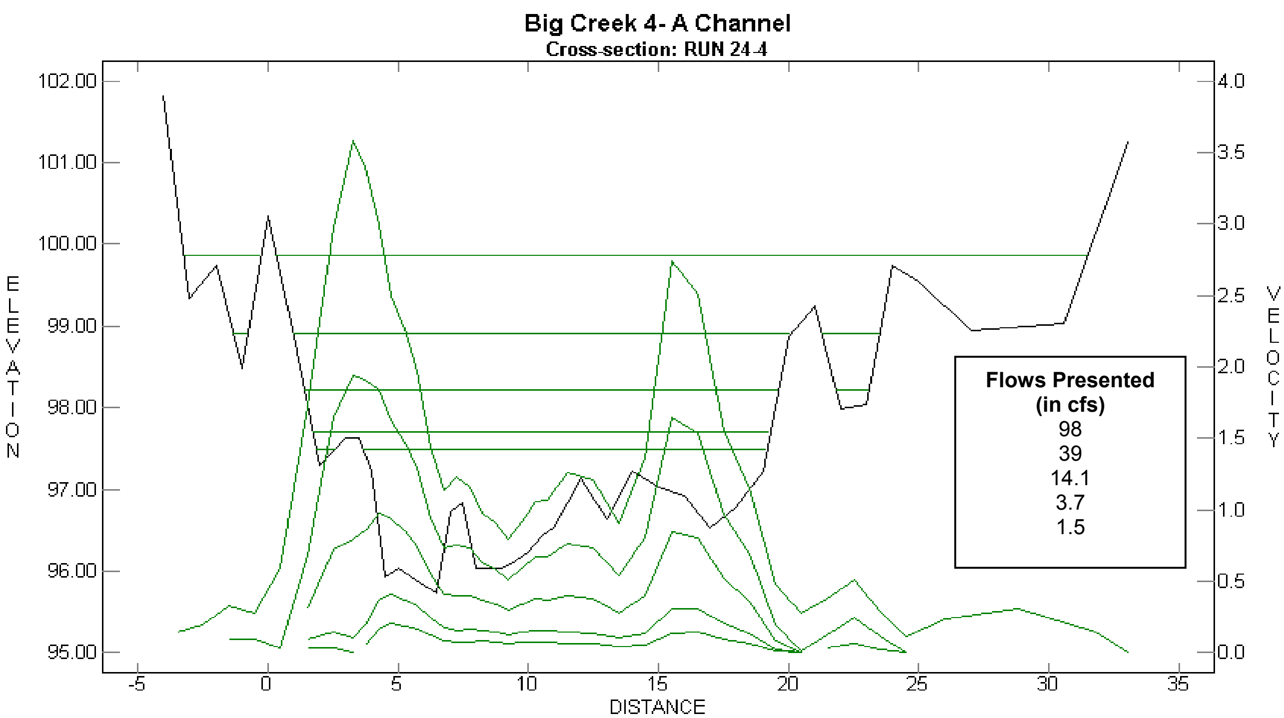

Big Creek 4- A Channel
Cross-section: HGR 19-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5

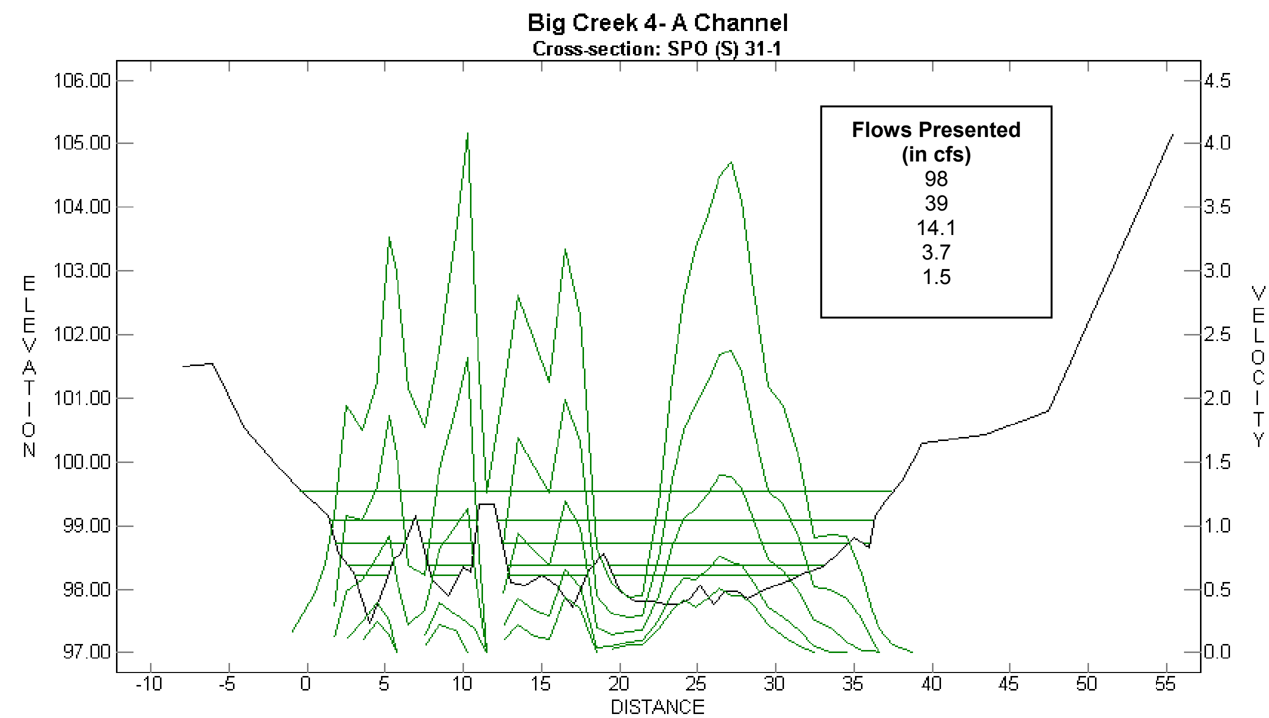

Big Creek 4- A Channel
Cross-section: HGR 19-2
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5

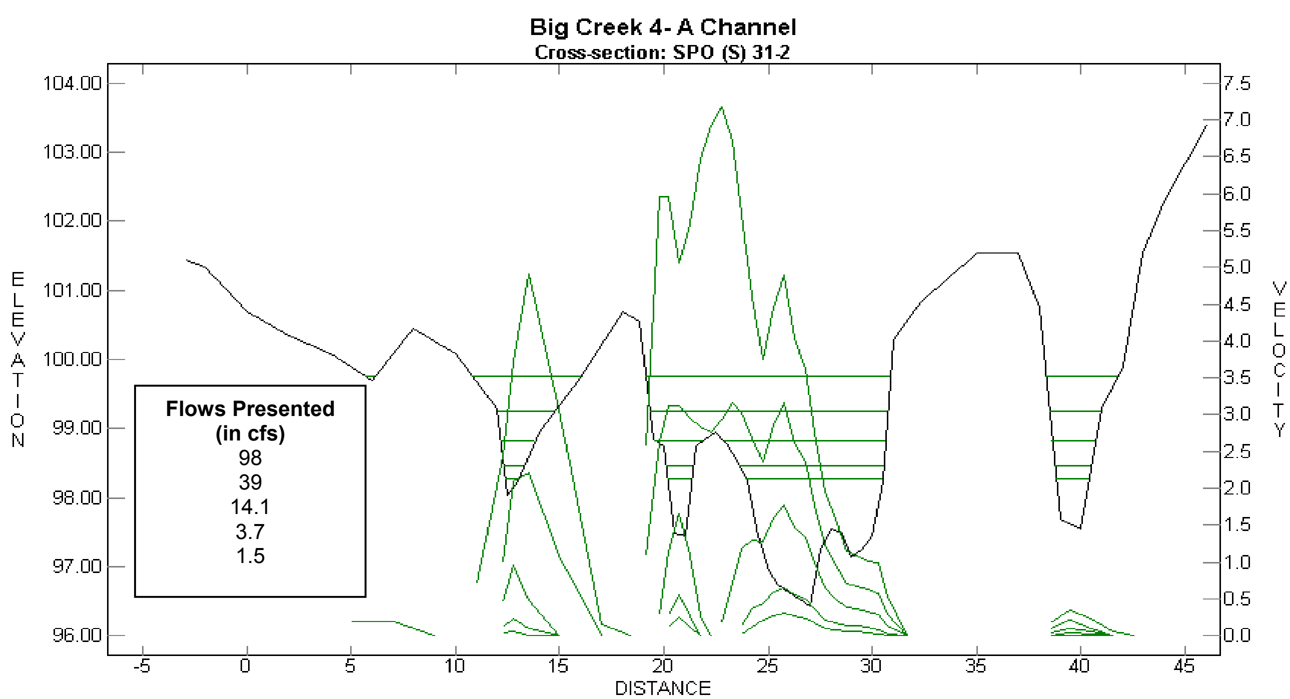

Big Creek 4- A Channel
Cross-section: SPO (D) 24-1
Flows Presented (in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0 5 10 15 20 25 30 35 40 45 50 55

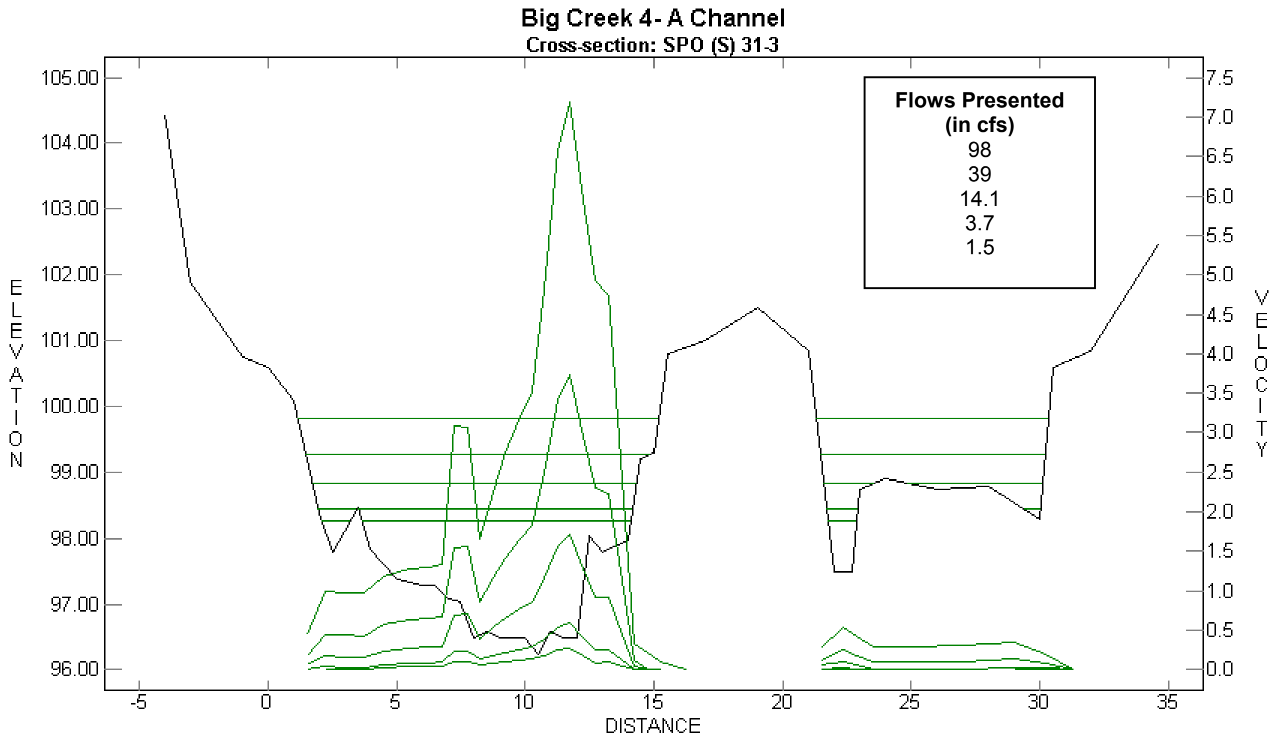

Big Creek 4- A Channel
Cross-section: SPO (D) 24-2
Flows Presented (in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
2.0
1.5
1.0
0.5
0.0
-5 0 5 10 15 20 25 30 35 40 45 50 55 60 65

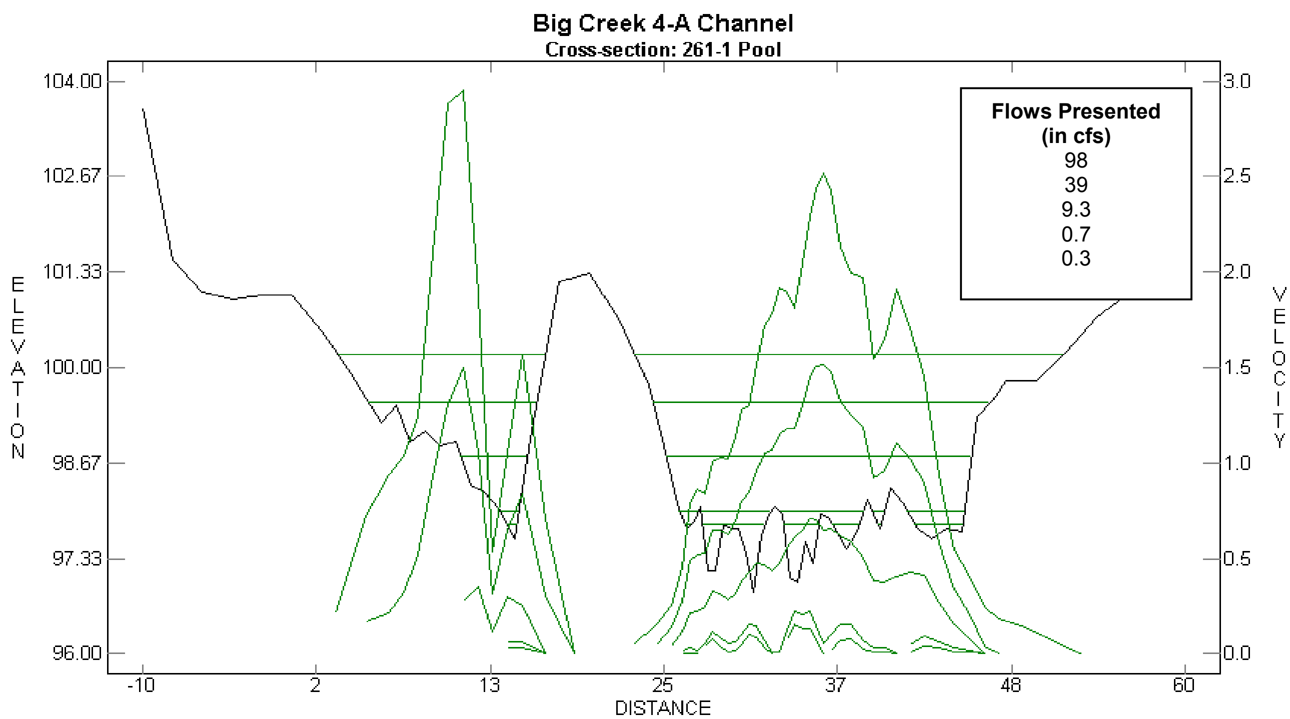

Big Creek 4- A Channel
Cross-section: SPO (D) 24-3
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40

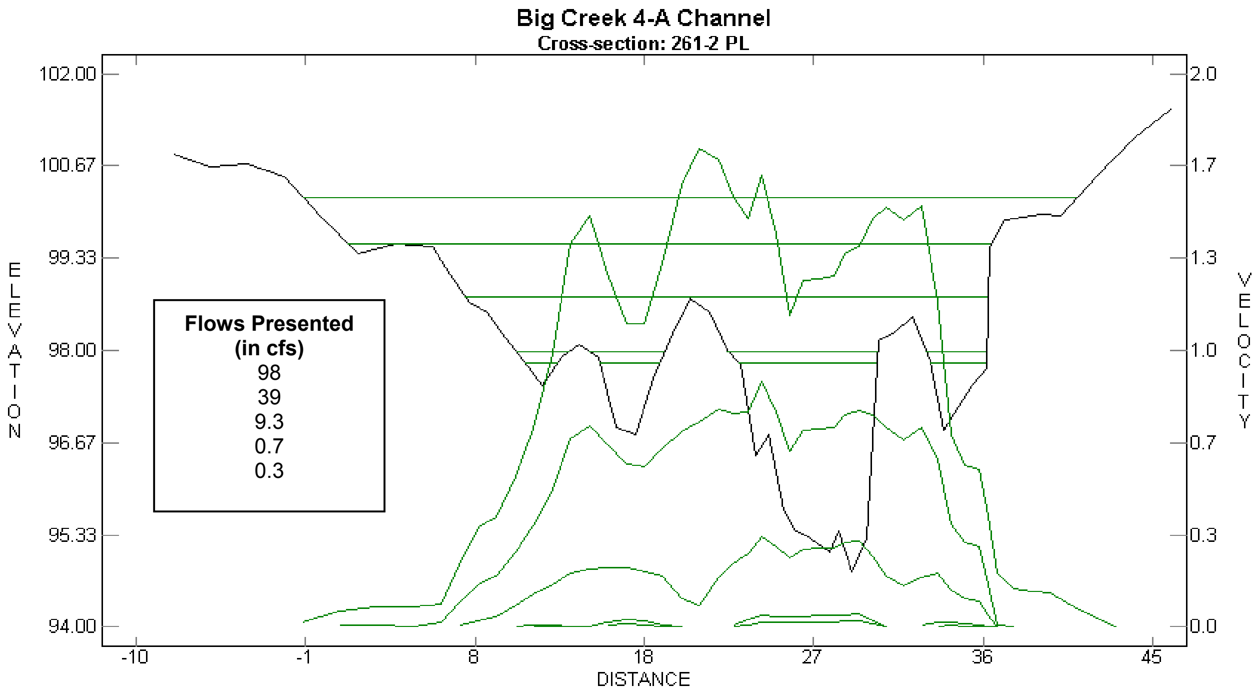

Big Creek 4- A Channel
Cross-section: RUN 24-4
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35

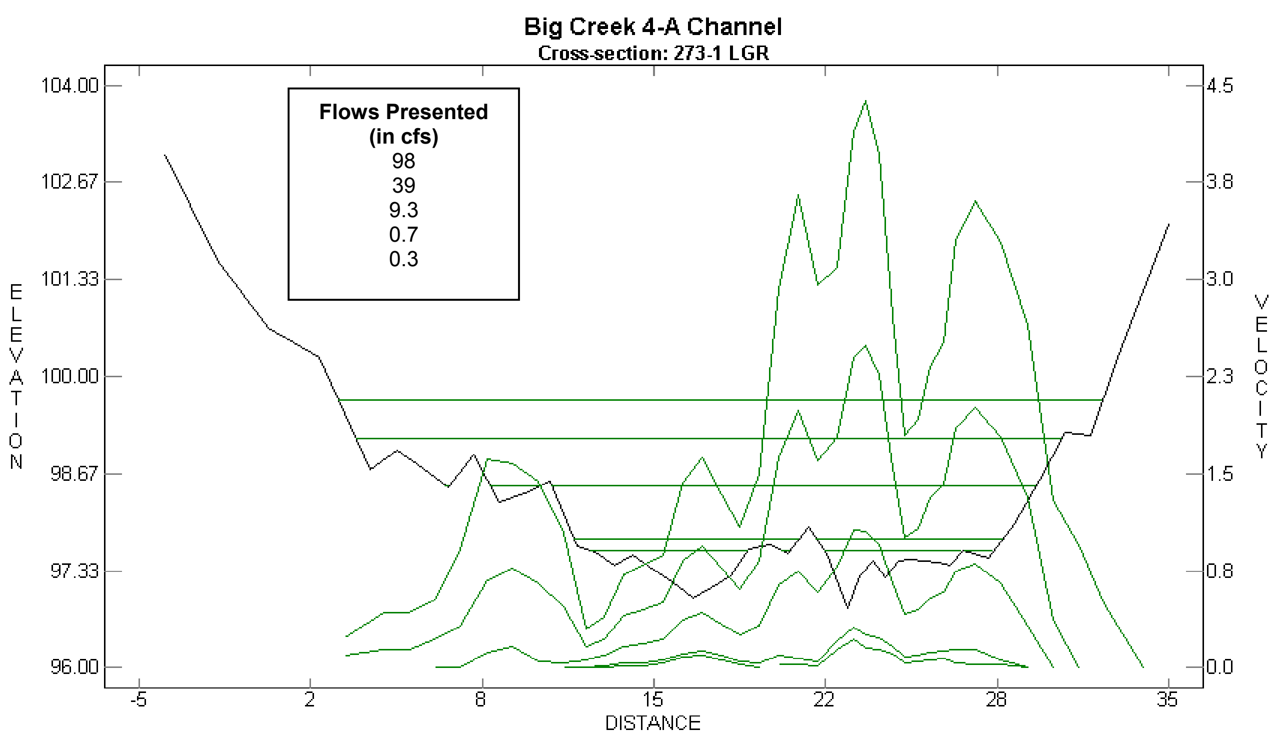

Big Creek 4- A Channel
Cross-section: SPO (S) 31-1
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55

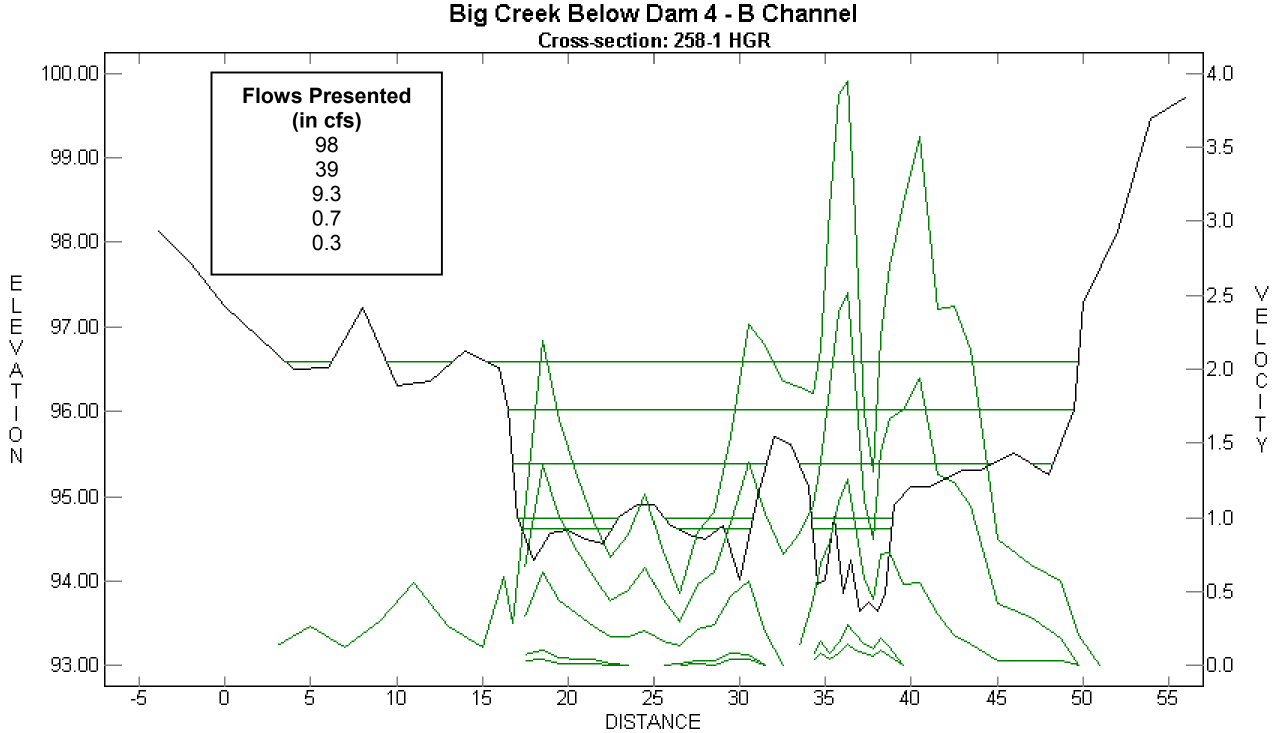

Big Creek 4- A Channel
Cross-section: SPO (S) 31-2
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45

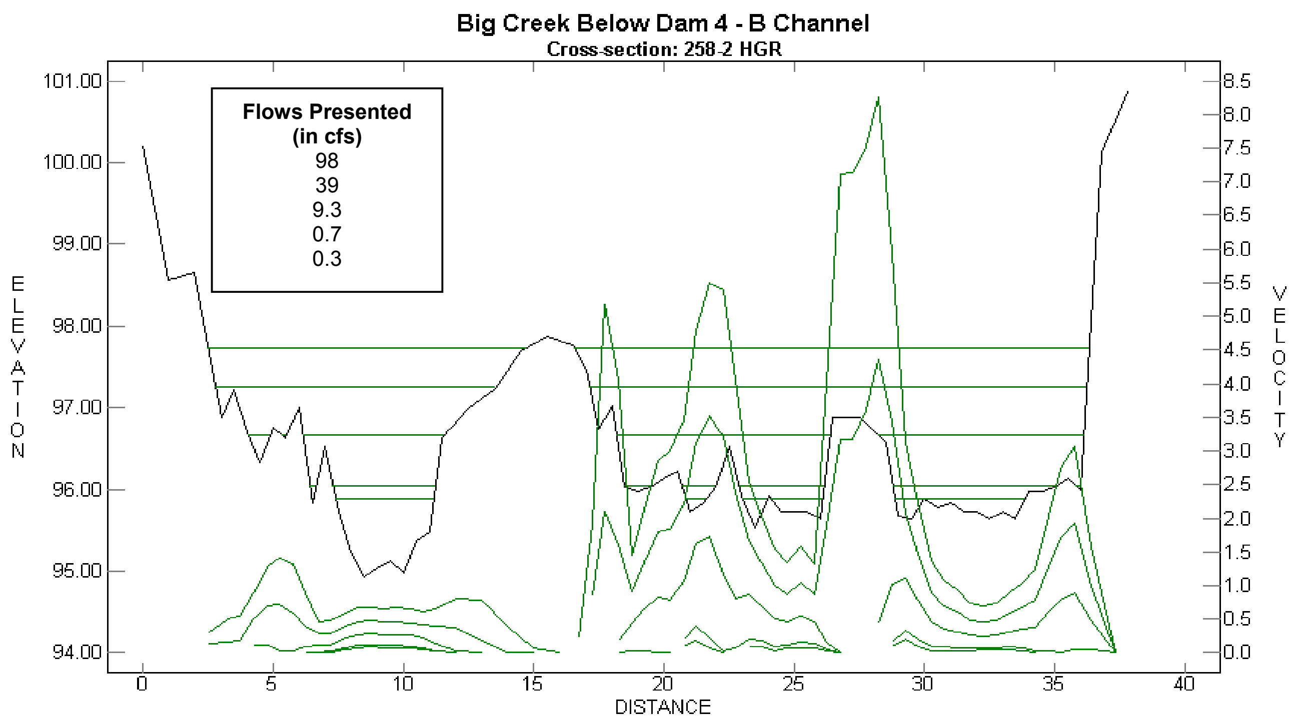

Big Creek 4- A Channel
Cross-section: SPO (S) 31-3
Flows Presented
(in cfs)
98
39
14.1
3.7
1.5
ELEVATION
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
VELOCITY
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
DISTANCE
-5
0
5
10
15
20
25
30
35

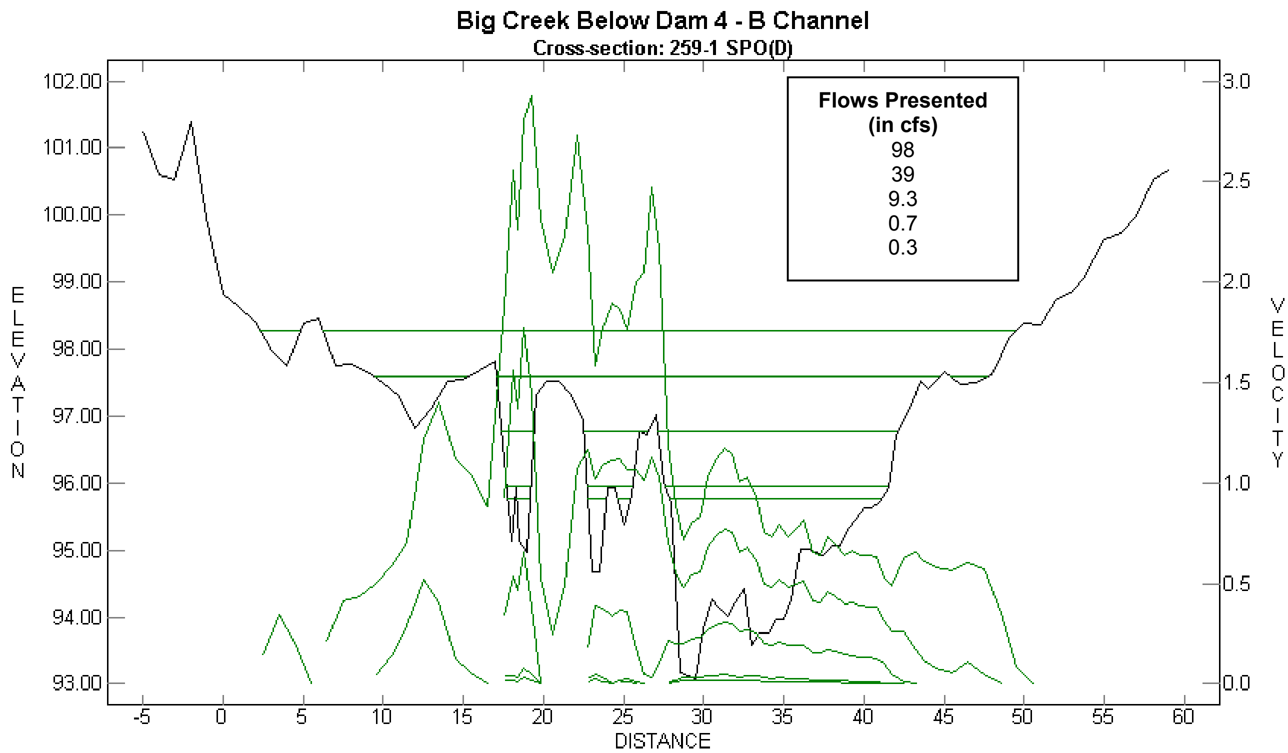

Big Creek 4-A Channel
Cross-section: 261-1 Pool
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
ELEVATION
104.00
102.67
101.33
100.00
98.67
97.33
96.00
VELOCITY
3.0
2.5
2.0
1.5
1.0
0.5
0.0
DISTANCE
-10
2
13
25
37
48
60

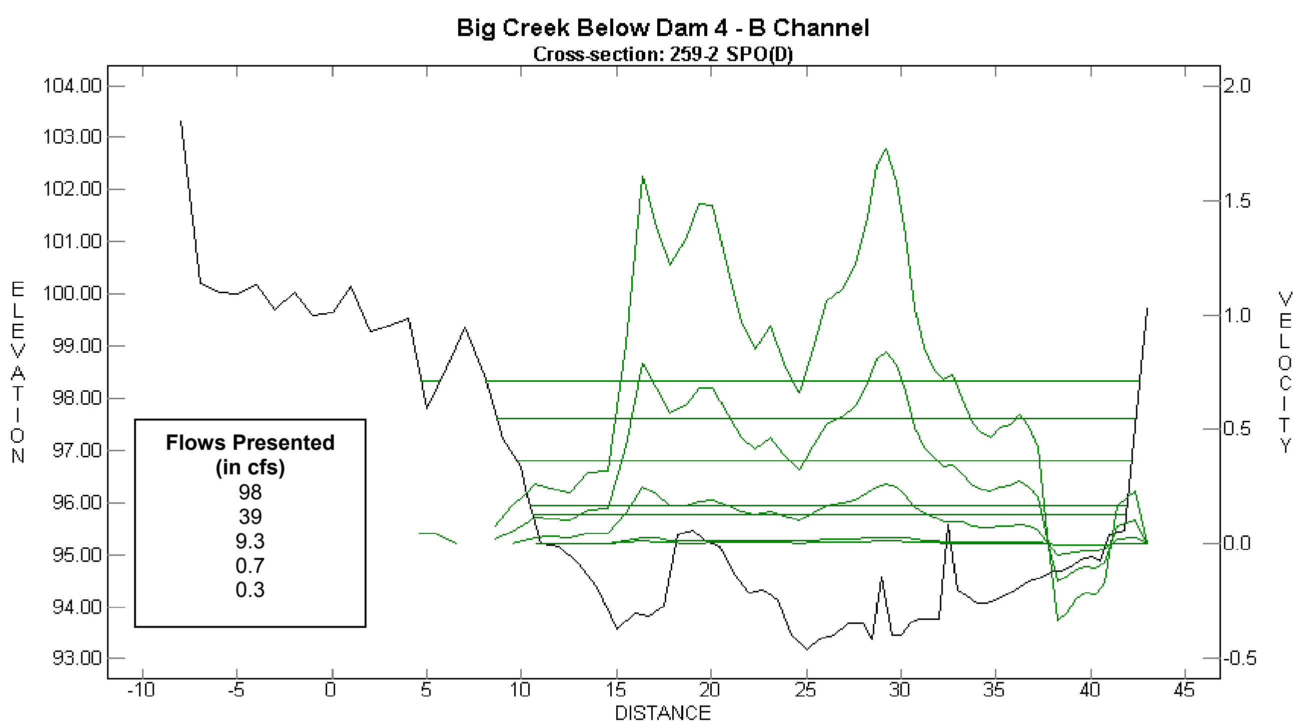

Big Creek 4-A Channel
Cross-section: 261-2 PL
ELEVATION
102.00
100.67
99.33
98.00
96.67
95.33
94.00
VELOCITY
2.0
1.7
1.3
1.0
0.7
0.3
0.0
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
-10
-1
8
18
27
36
45
DISTANCE

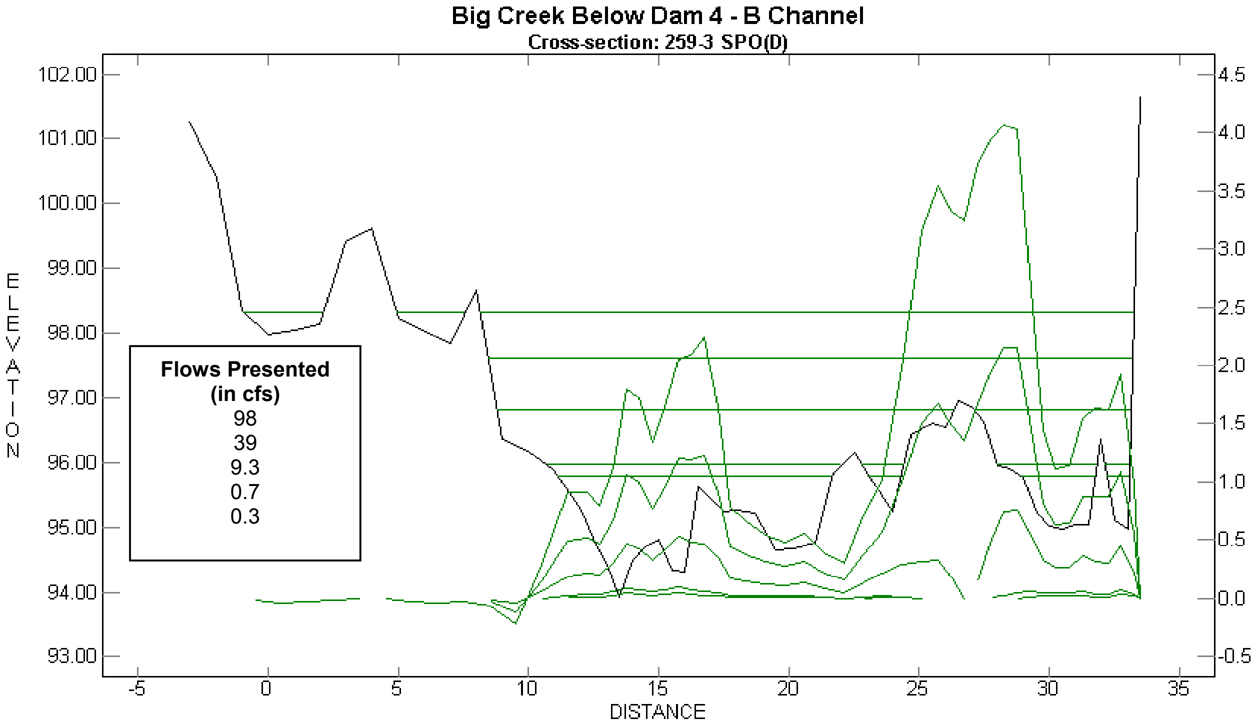

Big Creek 4-A Channel
Cross-section: 273-1 LGR
ELEVATION
104.00
102.67
101.33
100.00
98.67
97.33
96.00
VELOCITY
4.5
3.8
3.0
2.3
1.5
0.8
0.0
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
-5
2
8
15
22
28
35
DISTANCE

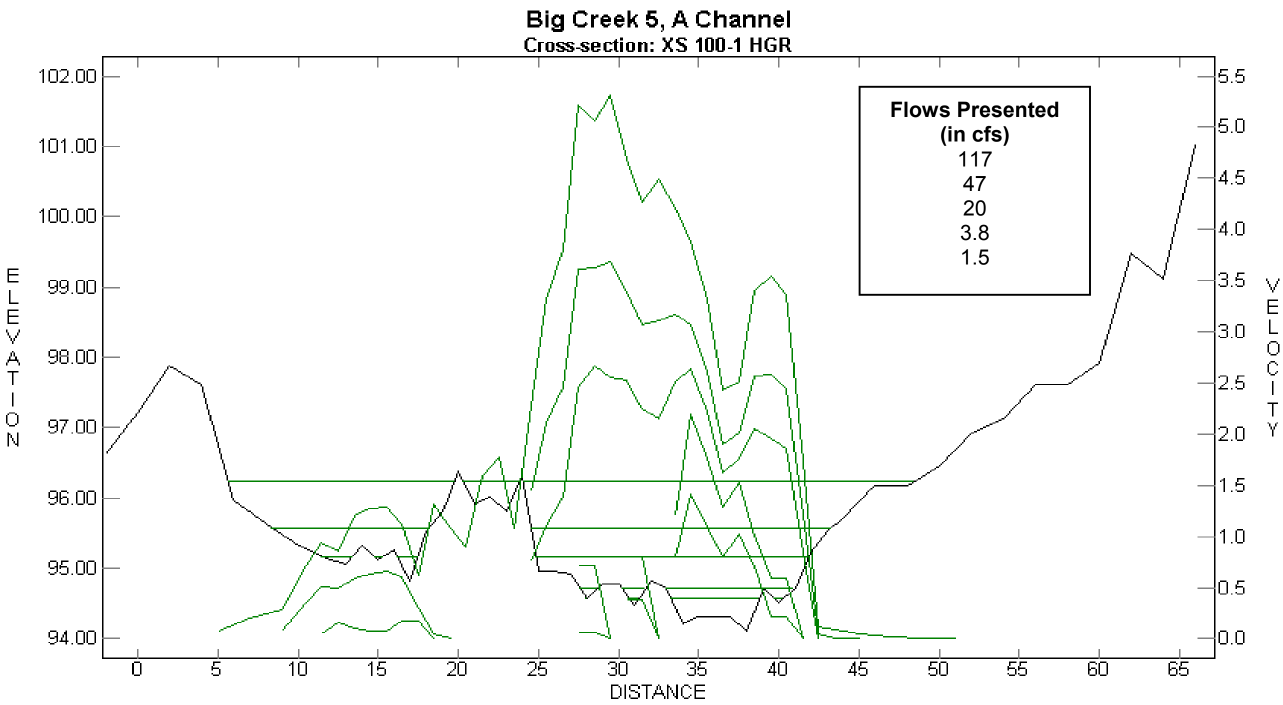

Big Creek Below Dam 4 - B Channel
Cross-section: 258-1 HGR
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55

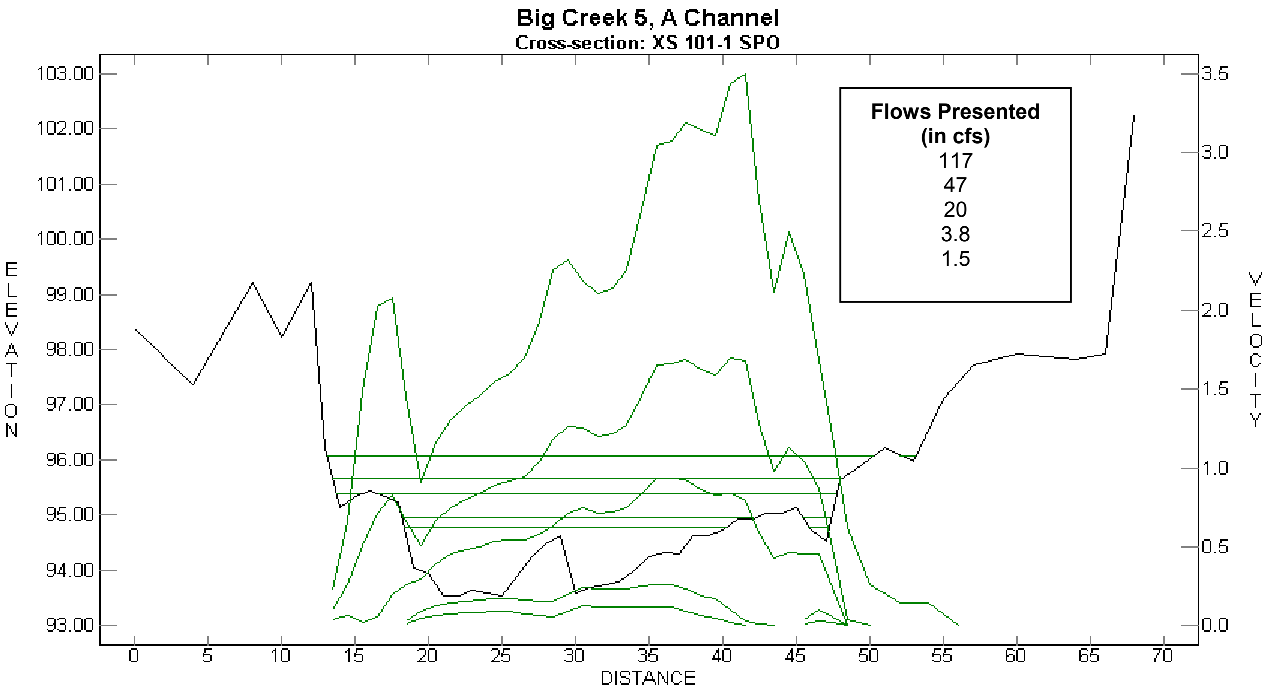

Big Creek Below Dam 4 - B Channel
Cross-section: 258-2 HGR
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40

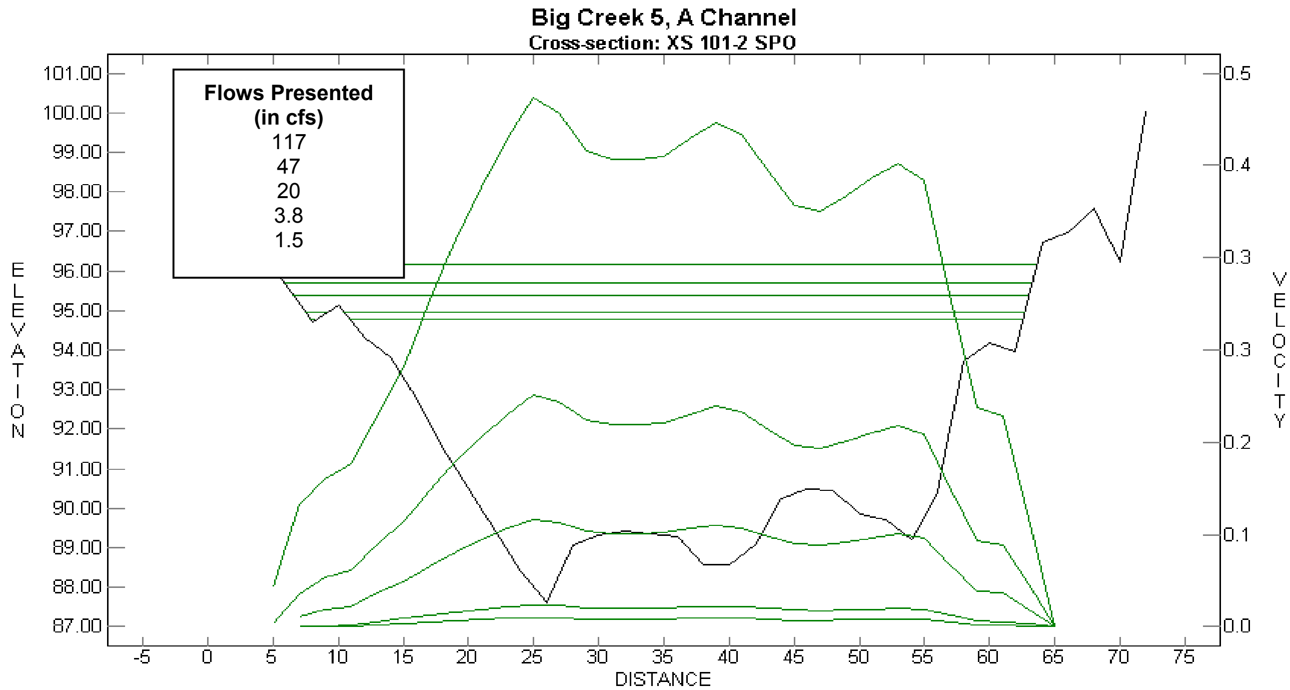

Big Creek Below Dam 4 - B Channel
Cross-section: 259-1 SPO(D)
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55
60

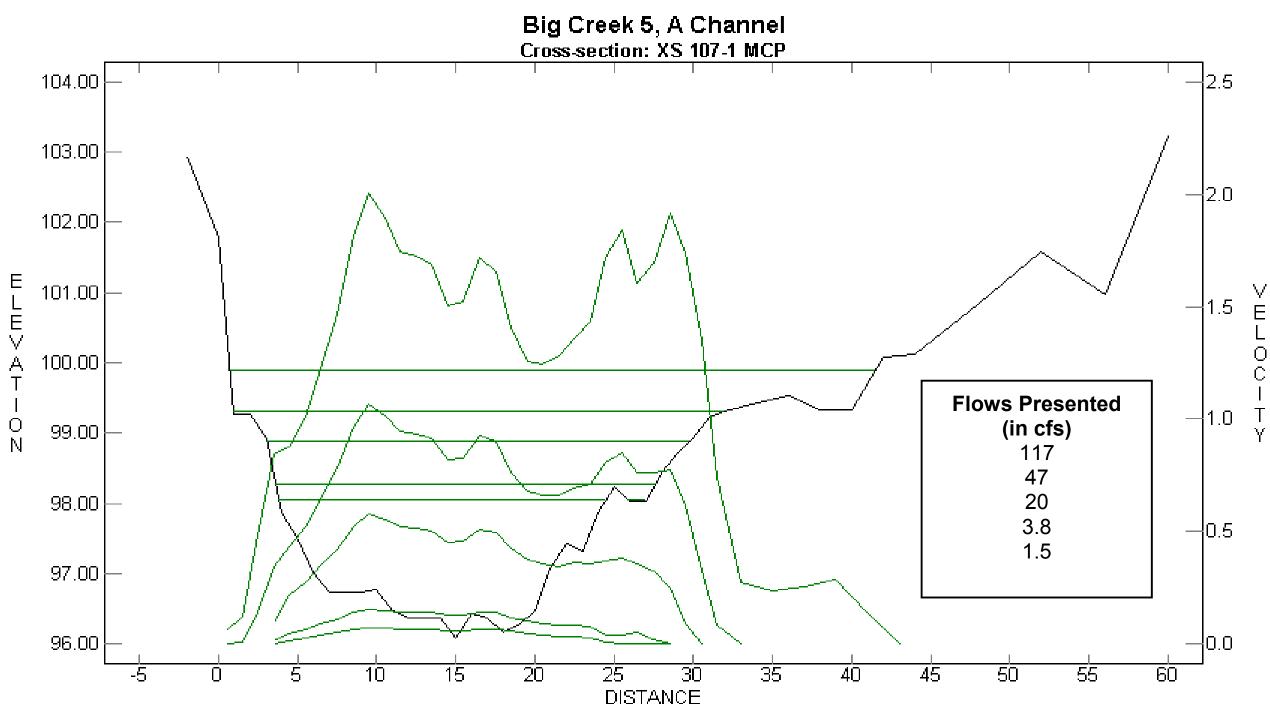

Big Creek Below Dam 4 - B Channel
Cross-section: 259-2 SPO(D)
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
2.0
1.5
1.0
0.5
0.0
-0.5
-10
-5
0
5
10
15
20
25
30
35
40
45

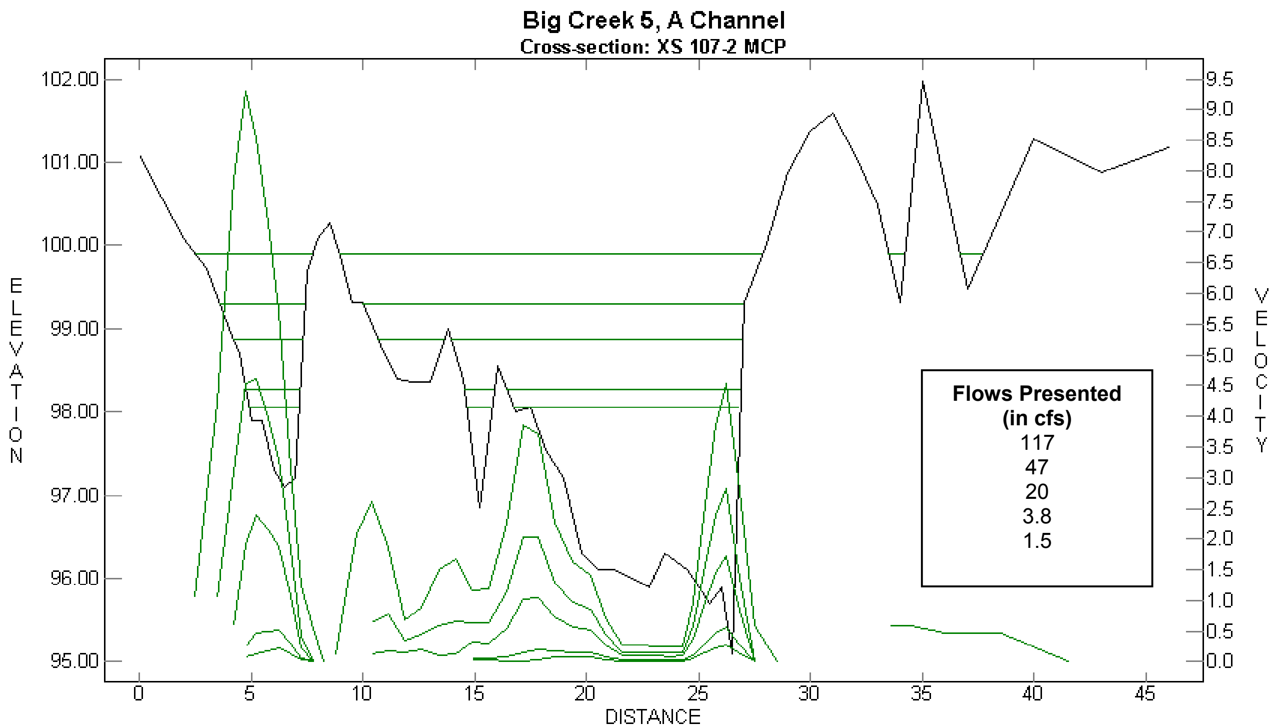

Big Creek Below Dam 4 - B Channel
Cross-section: 259-3 SPO(D)
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-5
0
5
10
15
20
25
30
35
Flows Presented
(in cfs)
98
39
9.3
0.7
0.3

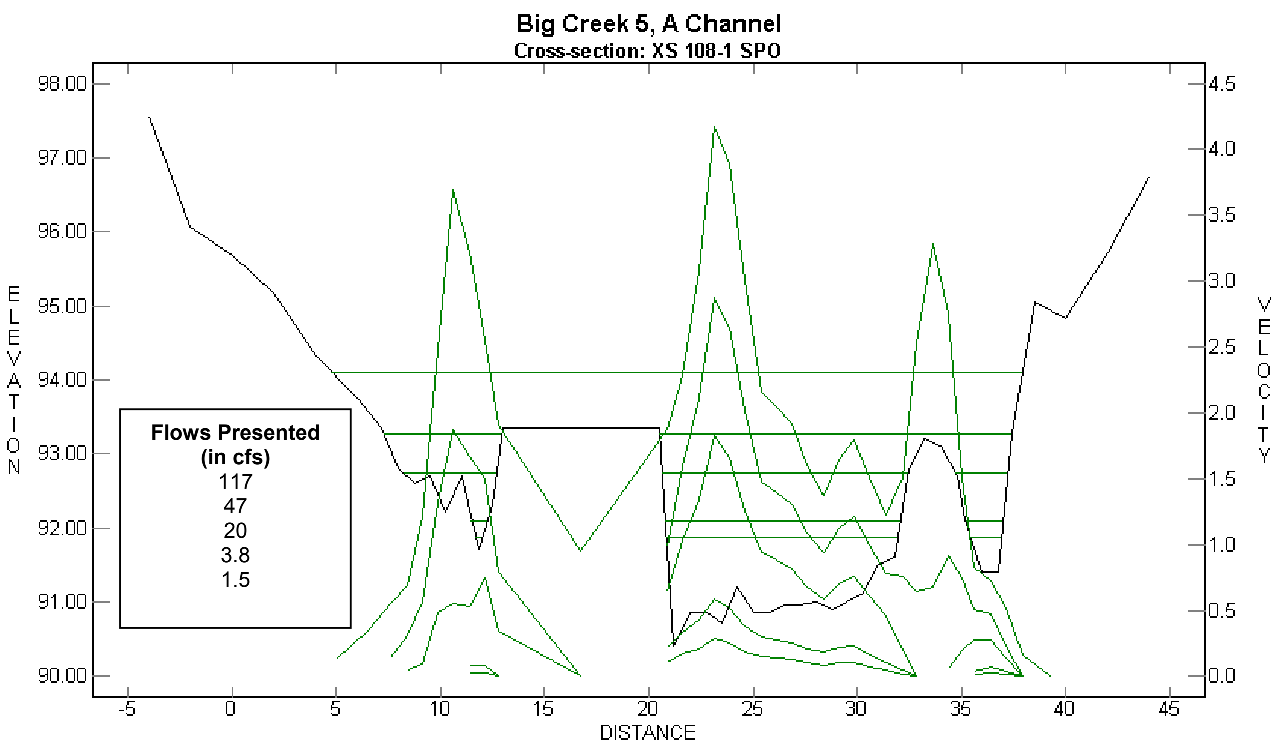

Big Creek 5, A Channel
Cross-section: XS 100-1 HGR
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65

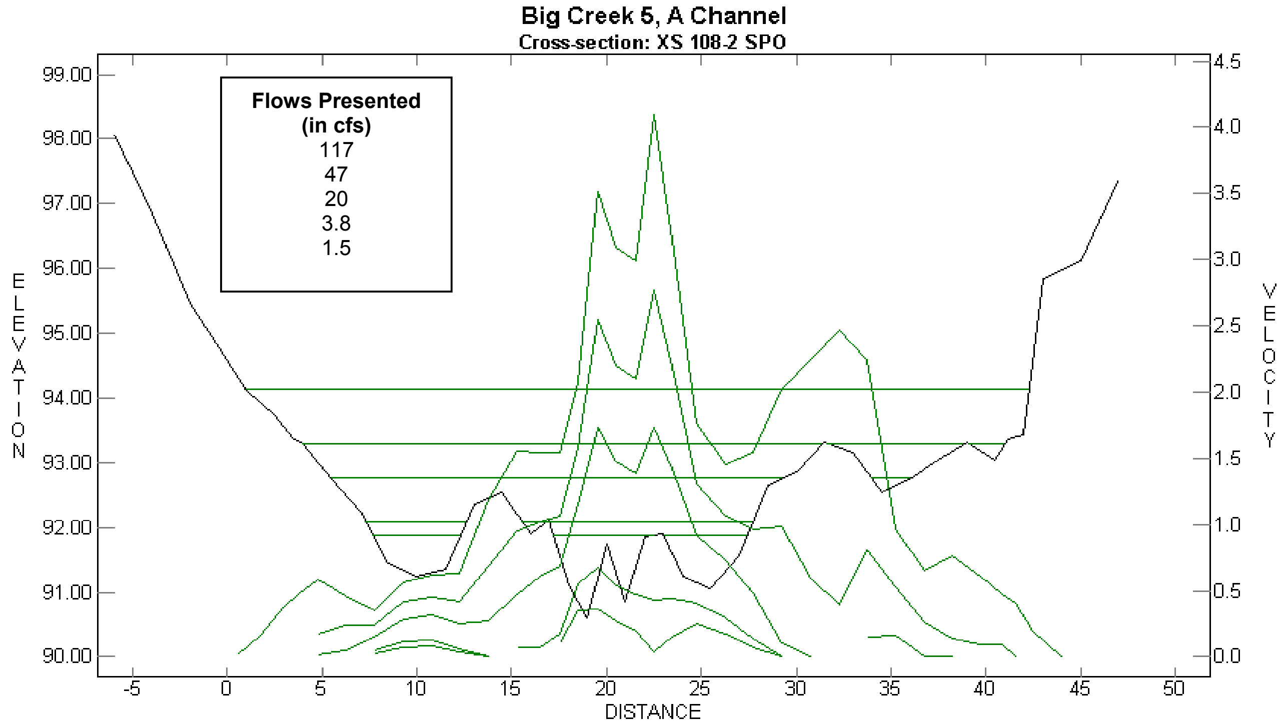

Big Creek 5, A Channel
Cross-section: XS 101-1 SPO
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

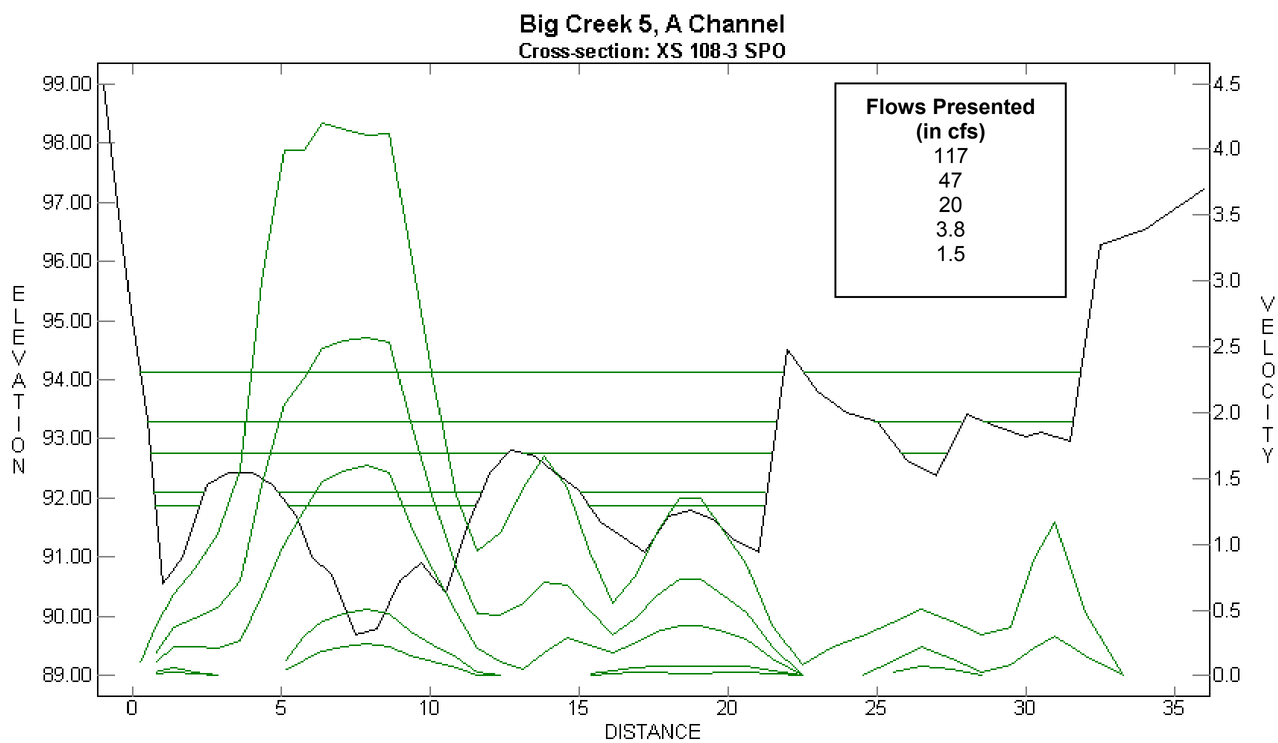

Big Creek 5, A Channel
Cross-section: XS 101-2 SPO
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE

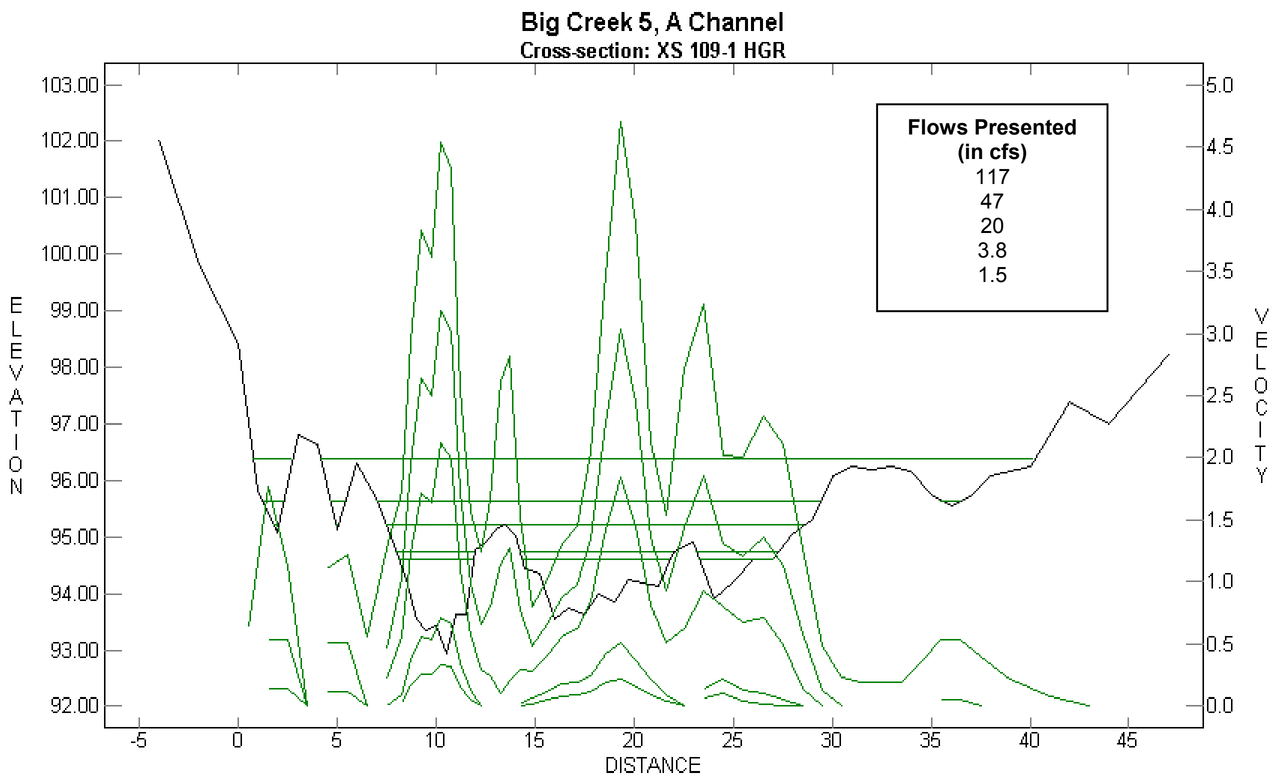

Big Creek 5, A Channel
Cross-section: XS 107-1 MCP
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE

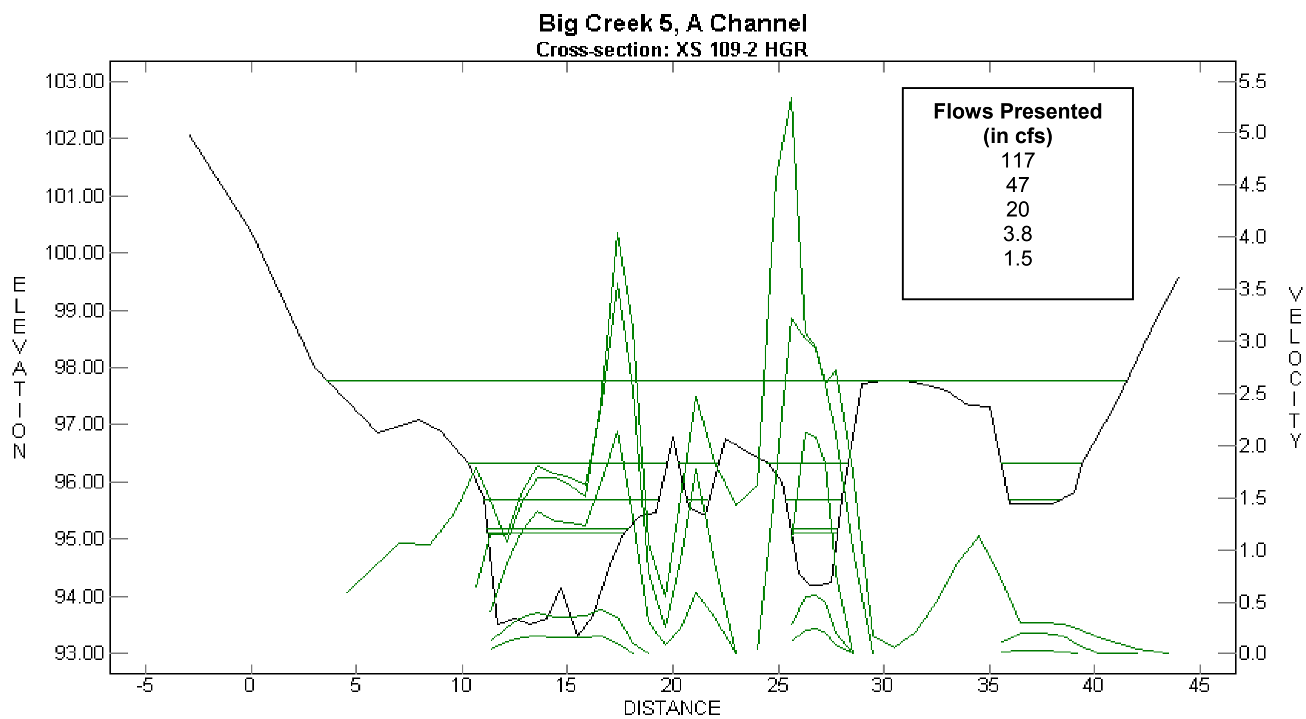

Big Creek 5, A Channel
Cross-section: XS 107-2 MCP
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
117
47
20
3.8
1.5

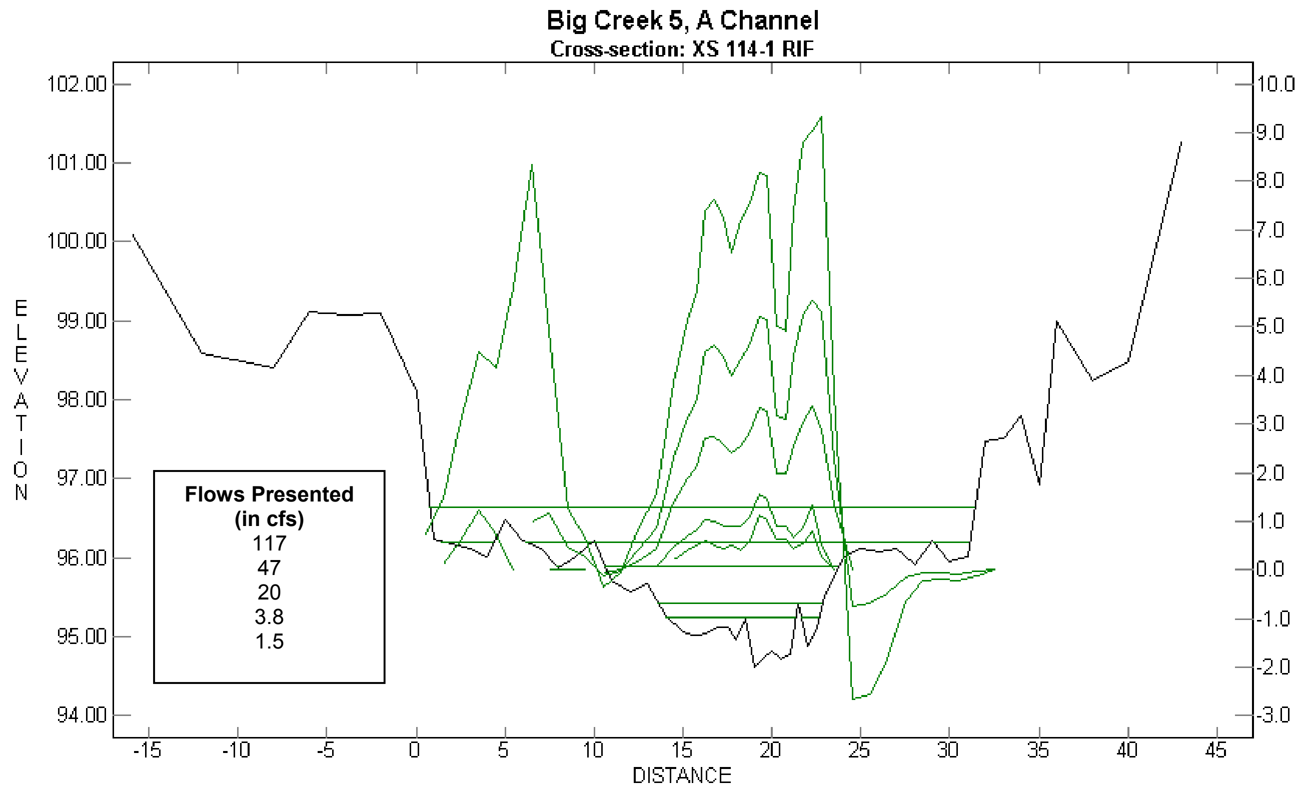

Big Creek 5, A Channel
Cross-section: XS 108-1 SPO
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
117
47
20
3.8
1.5


Big Creek 5, A Channel
Cross-section: XS 108-2 SPO
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50

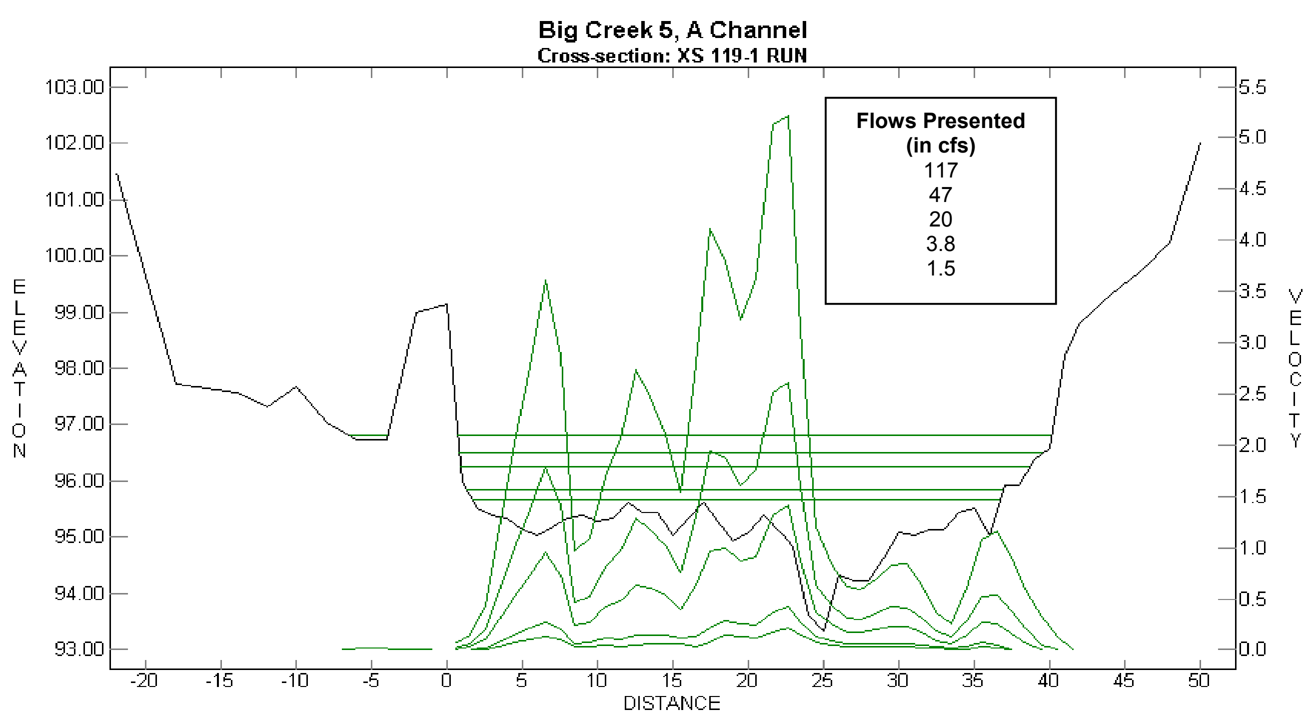

Big Creek 5, A Channel
Cross-section: XS 108-3 SPO
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35


Big Creek 5, A Channel
Cross-section: XS 109-1 HGR
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE

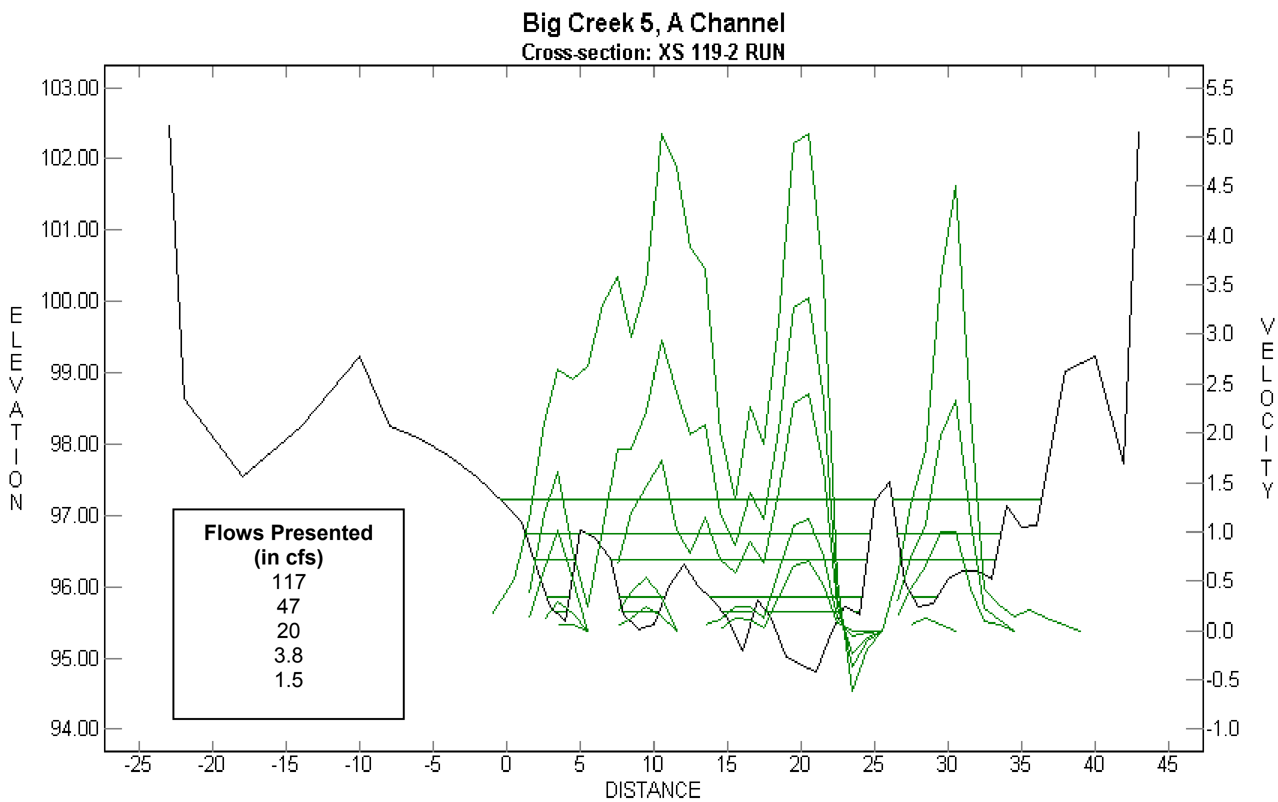

Big Creek 5, A Channel
Cross-section: XS 109-2 HGR
Flows Presented
(in cfs)
117
47
20
3.8
1.5
ELEVATION
VELOCITY
DISTANCE



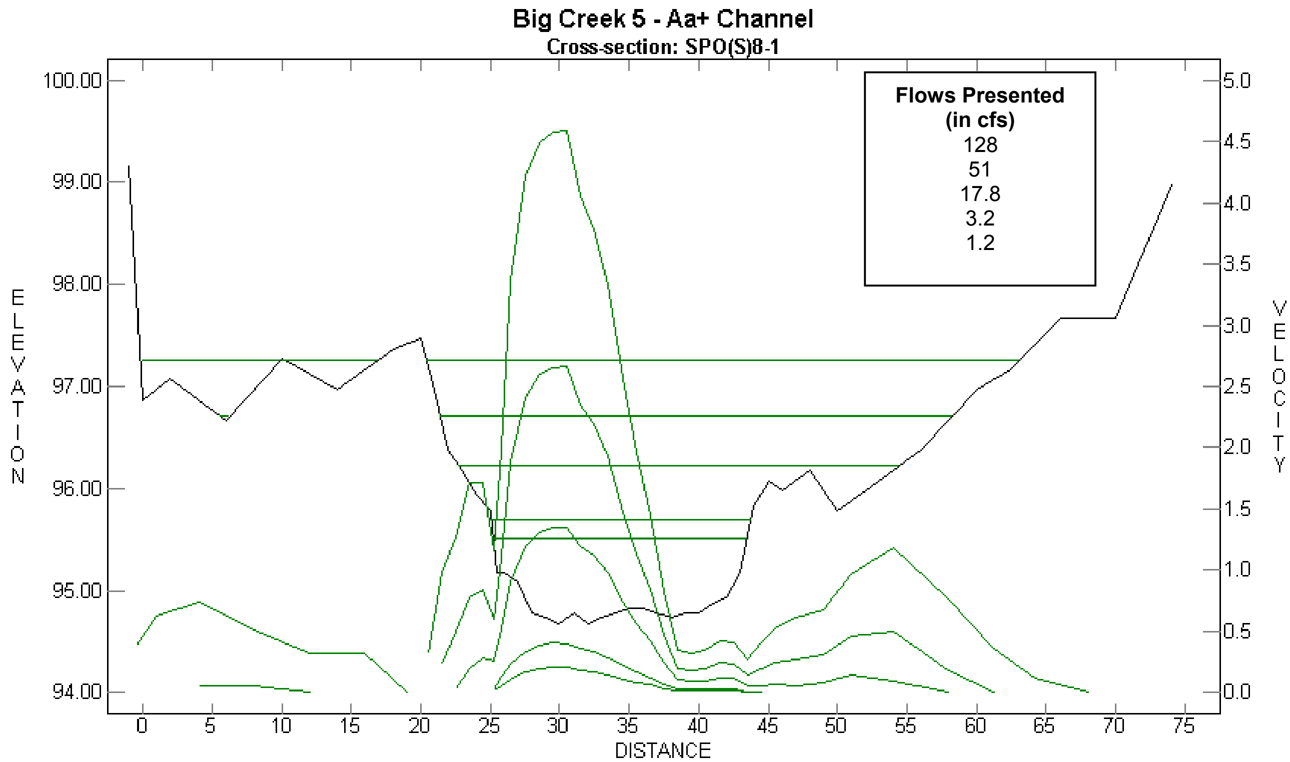
Big Creek 5, A Channel
Cross-section: XS 114-1 RIF
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
117
47
20
3.8
1.5

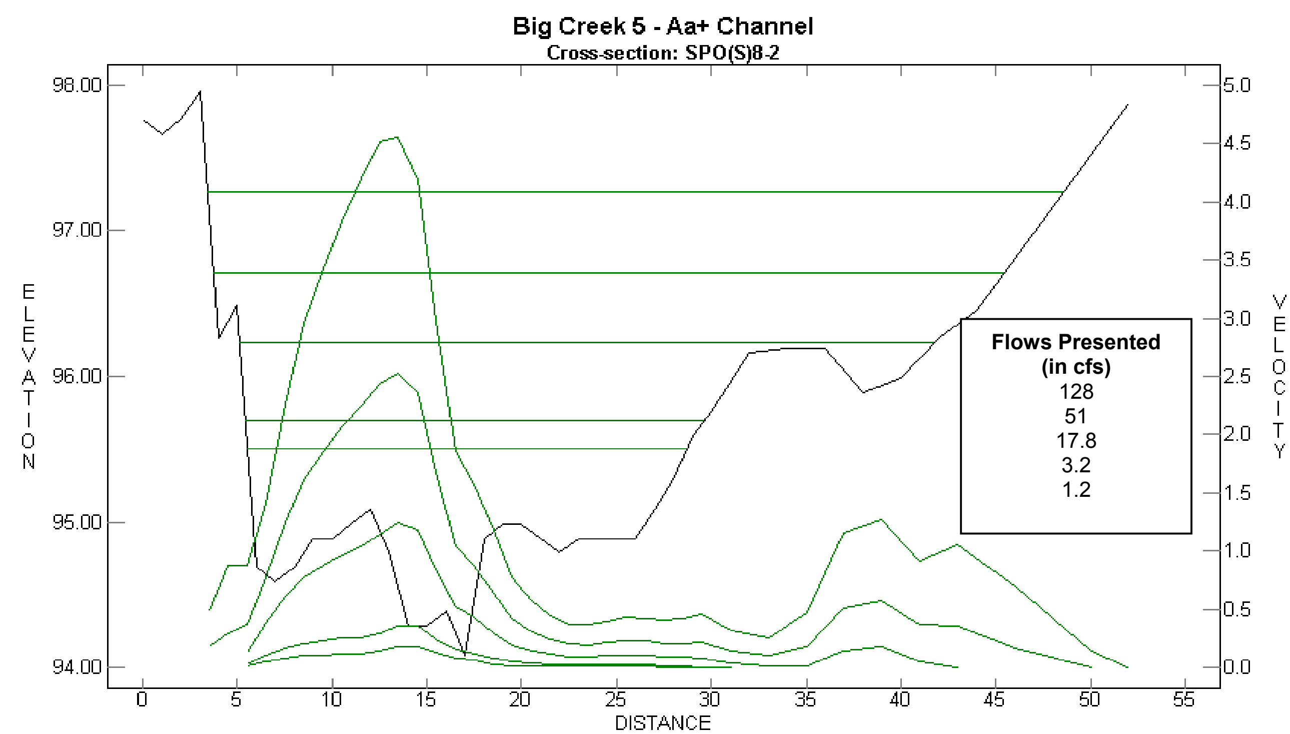


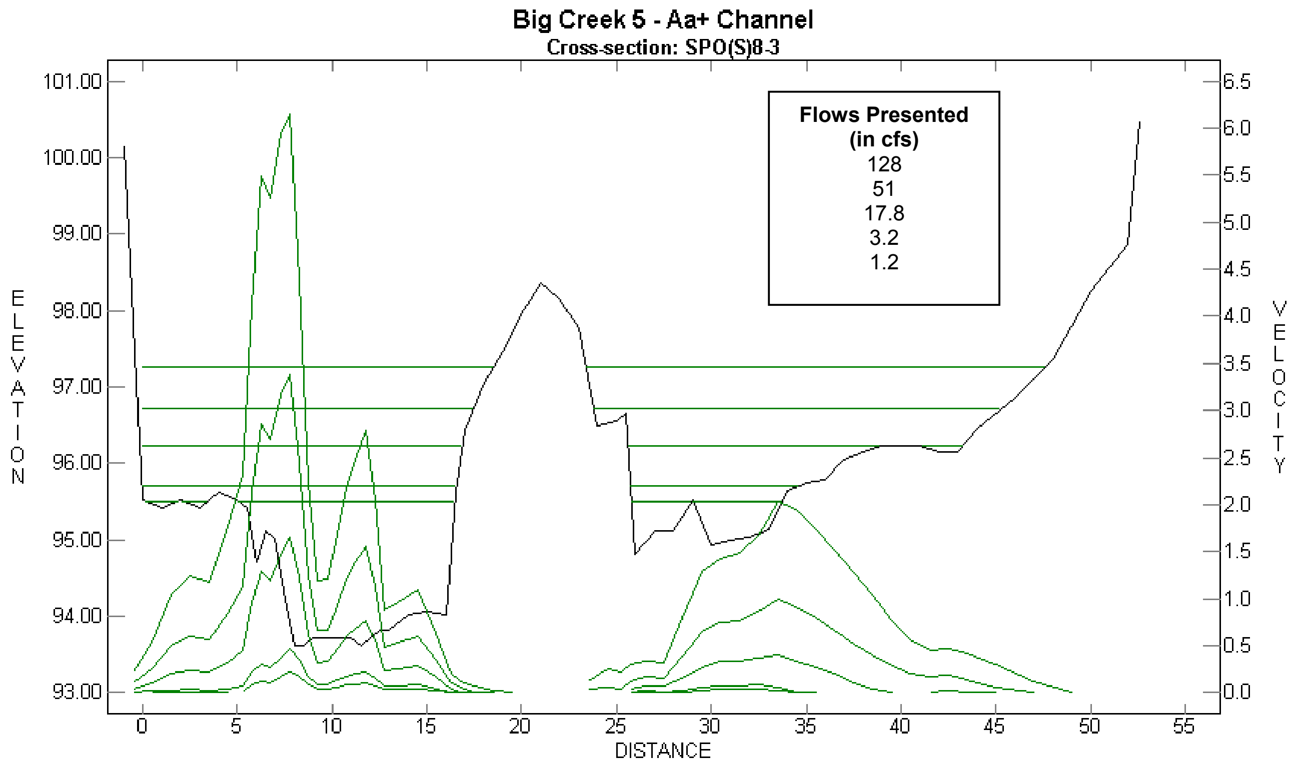
Big Creek 5, A Channel
Cross-section: XS 119-1 RUN
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
117
47
20
3.8
1.5

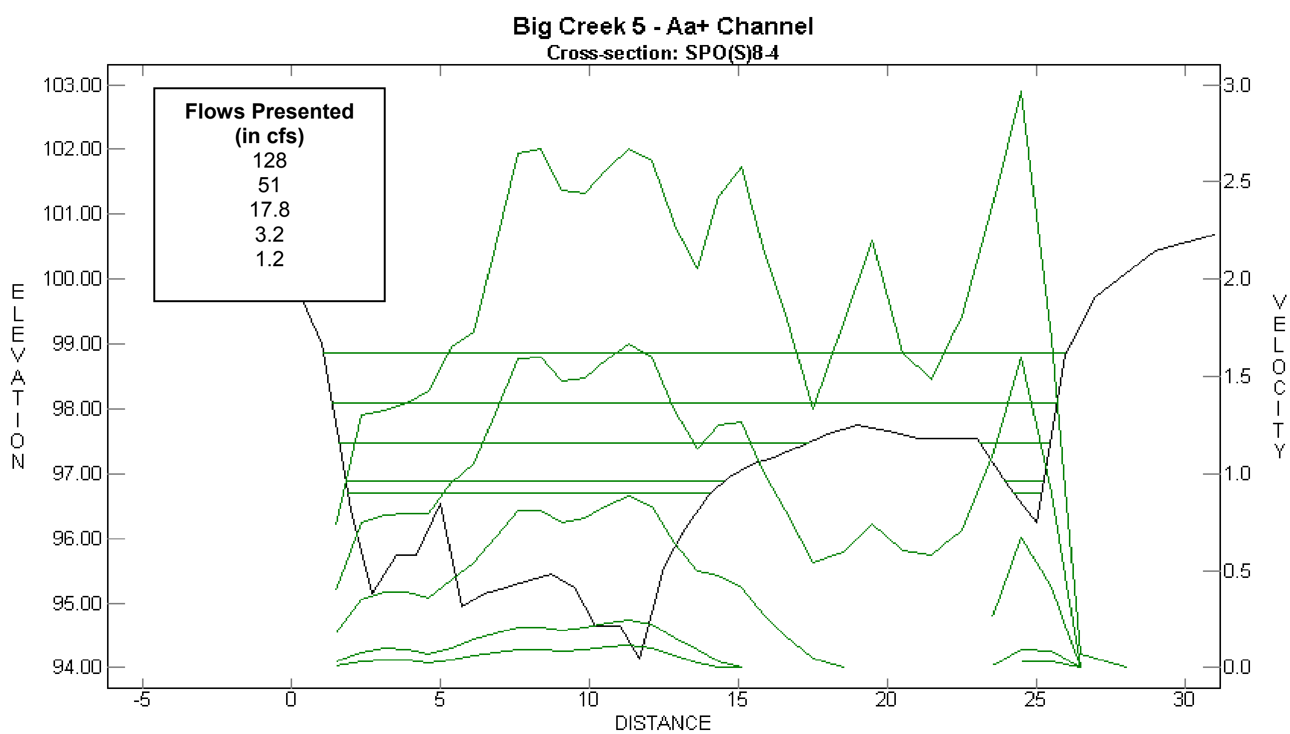


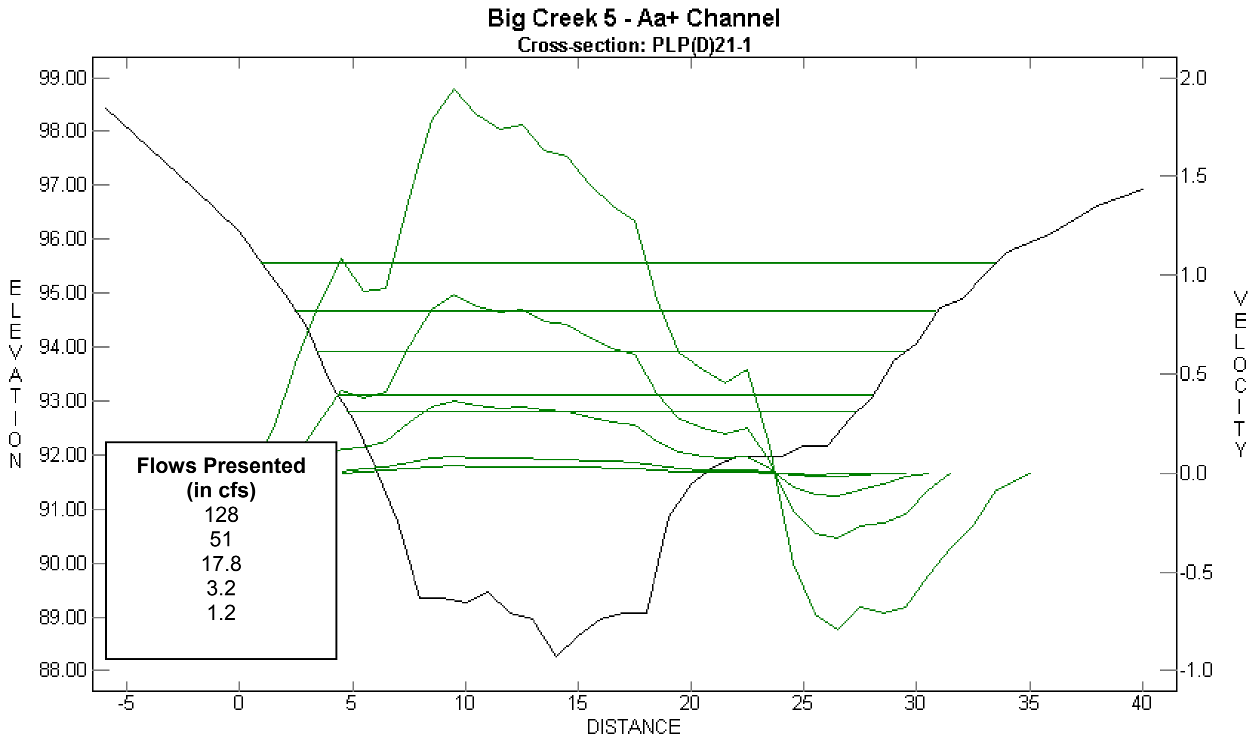
Big Creek 5, A Channel
Cross-section: XS 119-2 RUN
ELEVATION
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
VELOCITY
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45
DISTANCE
Flows Presented
(in cfs)
117
47
20
3.8
1.5

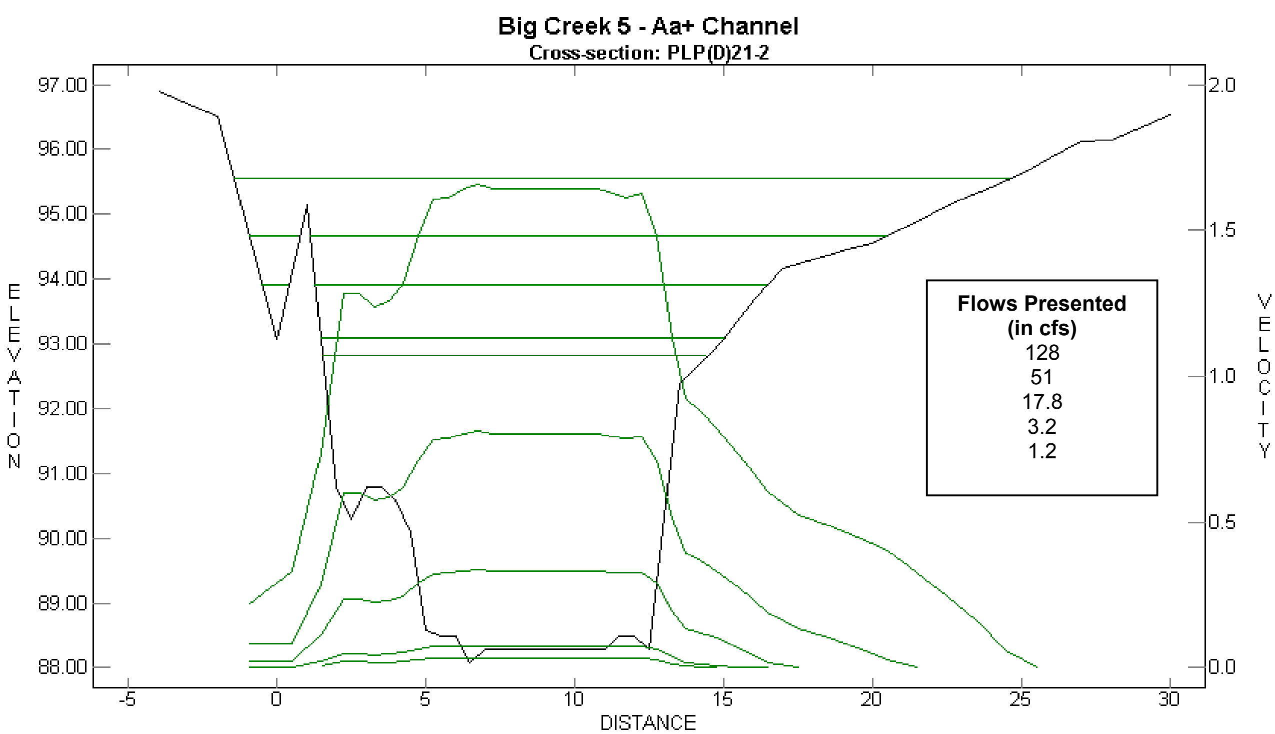

Big Creek 5 - Aa+ Channel
Cross-section: SPO(S)8-1
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

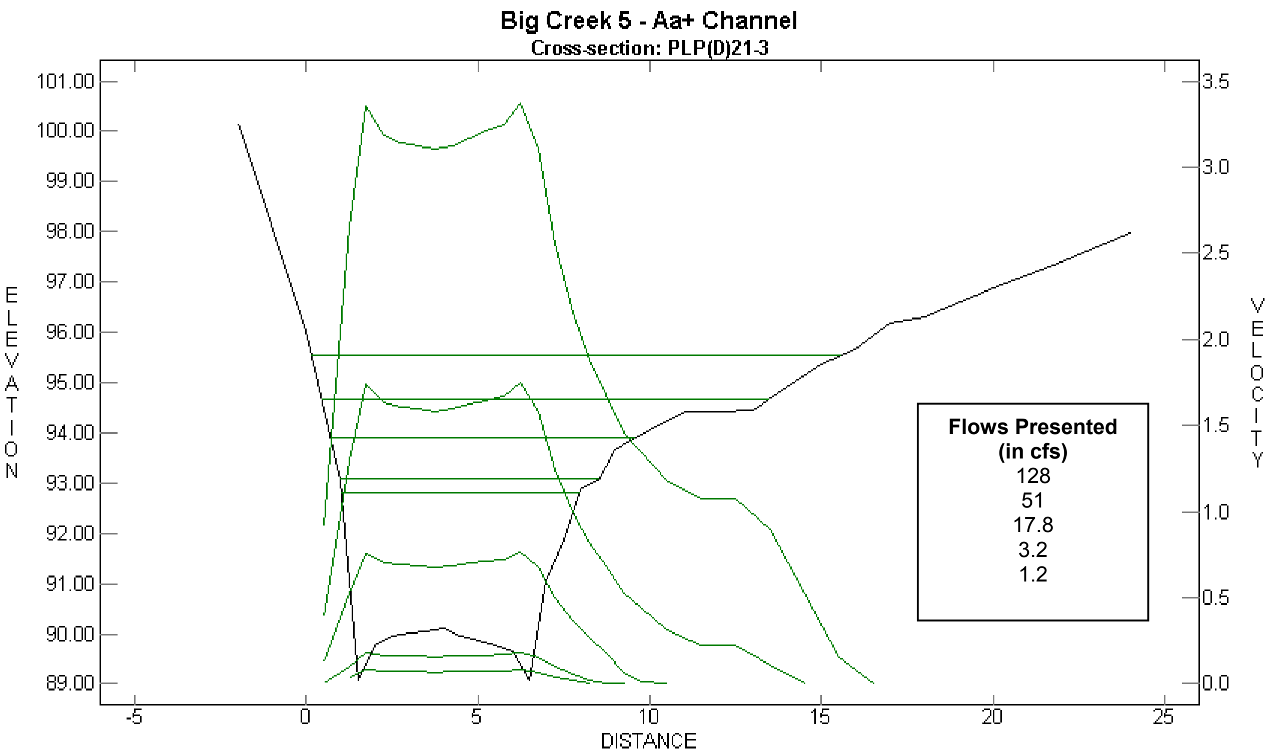

Big Creek 5 - Aa+ Channel
Cross-section: SPO(S)8-2
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2
ELEVATION
VELOCITY
DISTANCE
98.00
97.00
96.00
95.00
94.00
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55

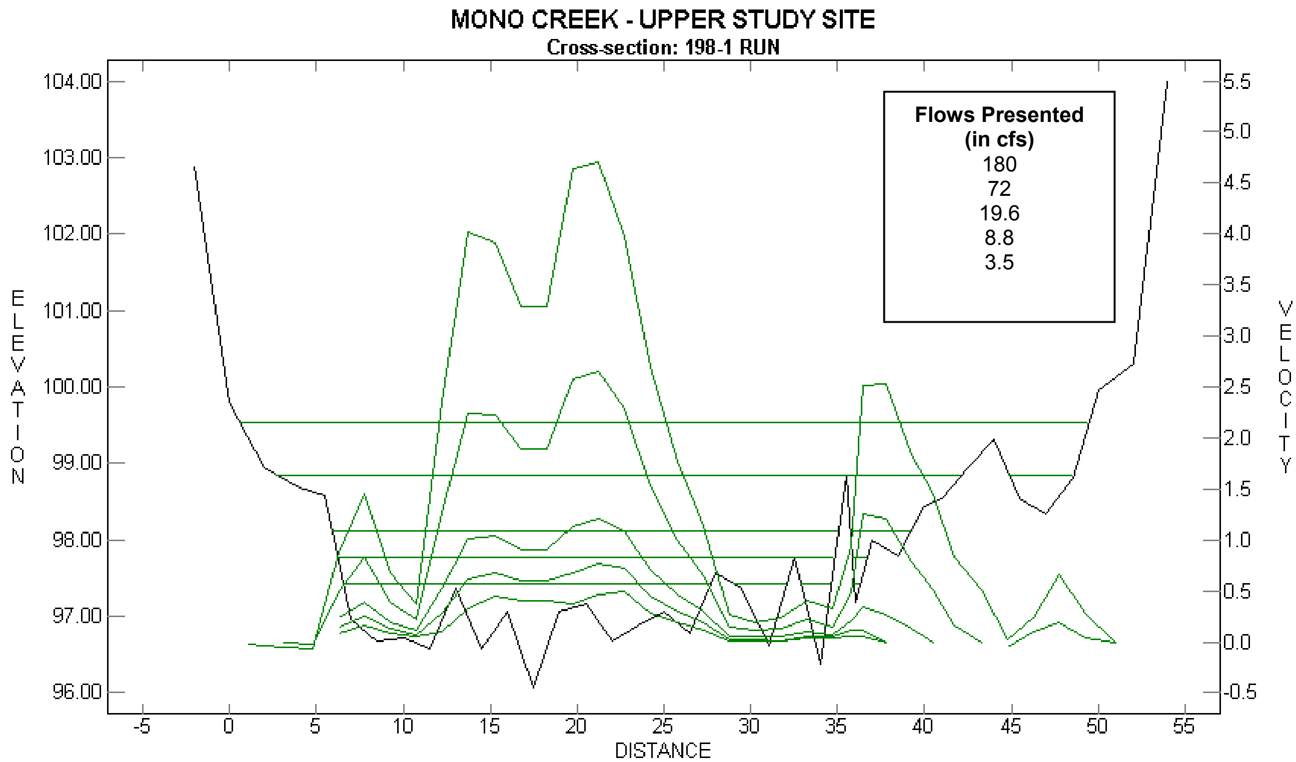

Big Creek 5 - Aa+ Channel
Cross-section: SPO(S)8-3
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55

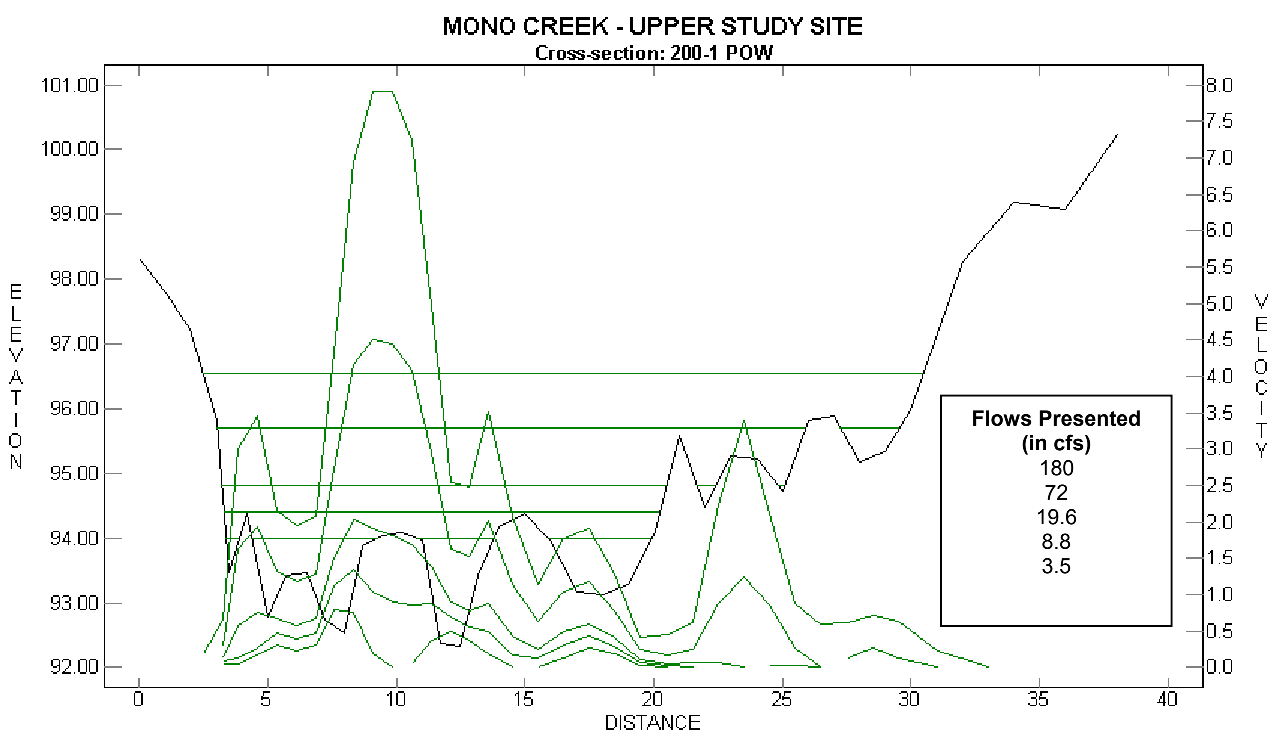

Big Creek 5 - Aa+ Channel
Cross-section: SPO(S)8-4
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30


Big Creek 5 - Aa+ Channel
Cross-section: PLP(D)21-1
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-5
0
5
10
15
20
25
30
35
40
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2

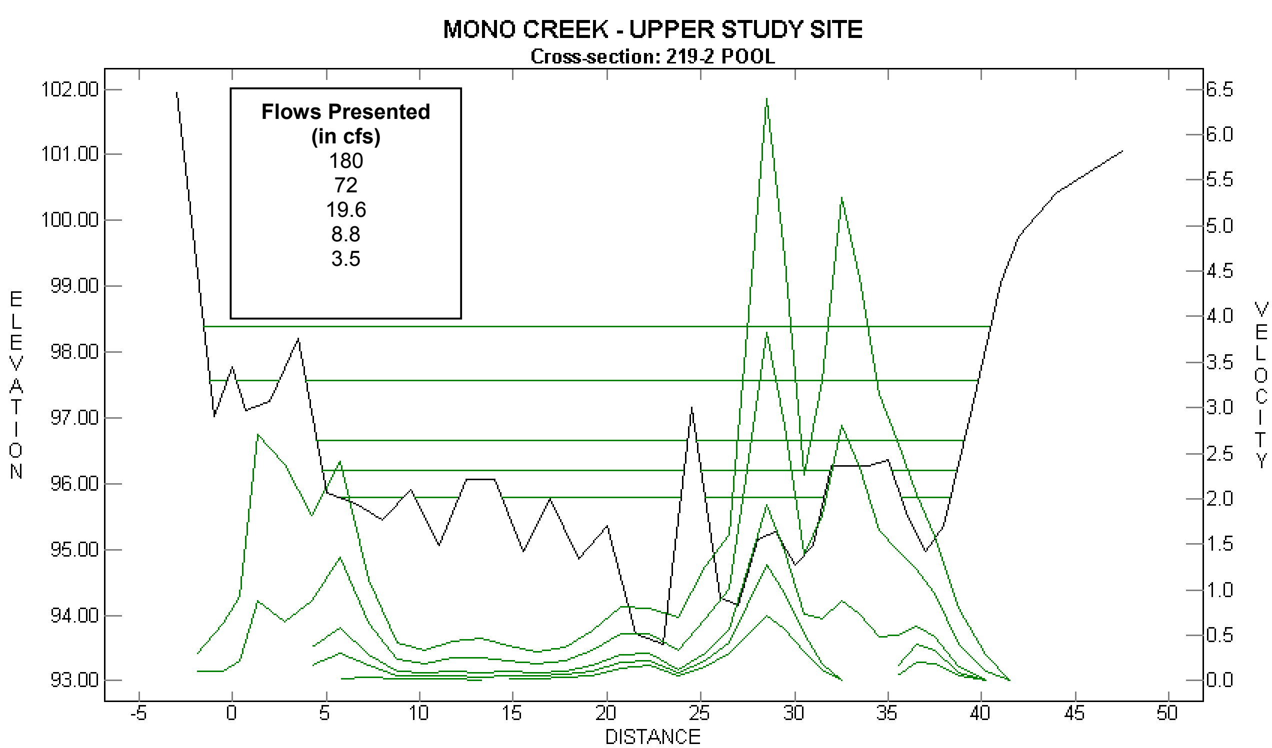

Big Creek 5 - Aa+ Channel
Cross-section: PLP(D)21-2
ELEVATION
VELOCITY
DISTANCE
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2

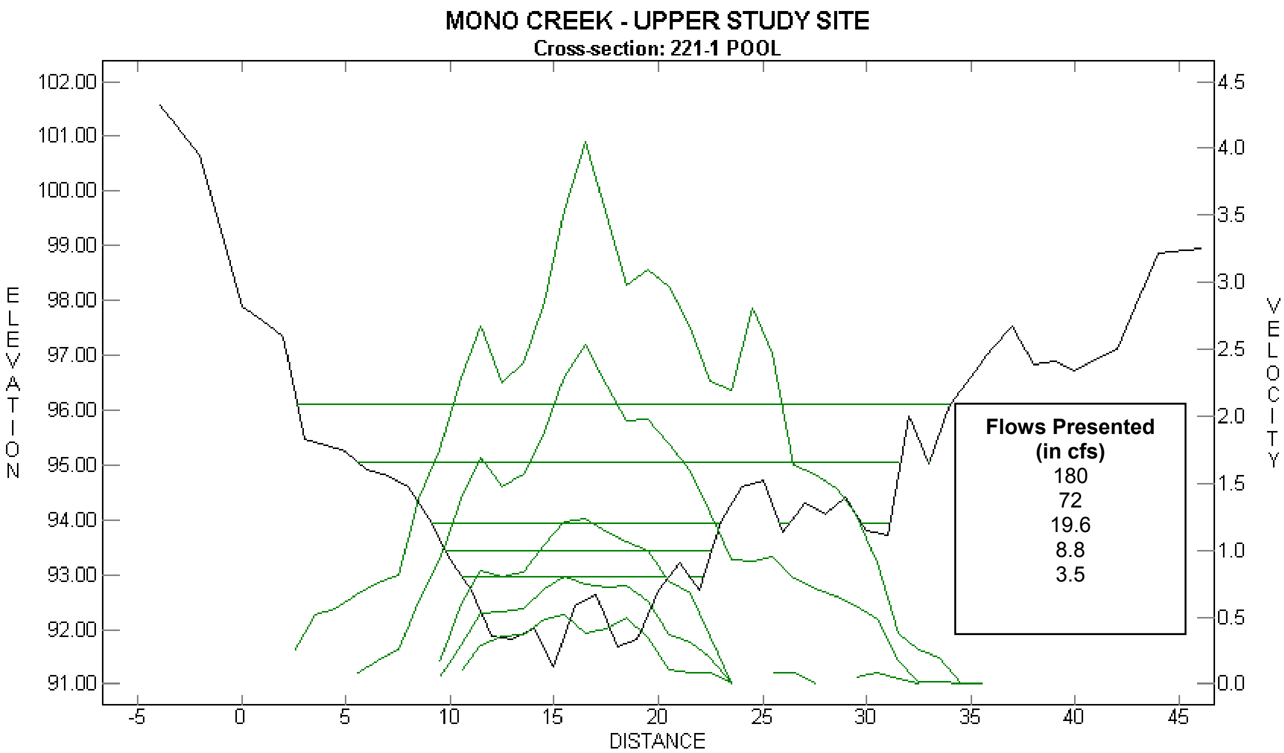

Big Creek 5 - Aa+ Channel
Cross-section: PLP(D)21-3
ELEVATION
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
VELOCITY
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
DISTANCE
Flows Presented
(in cfs)
128
51
17.8
3.2
1.2

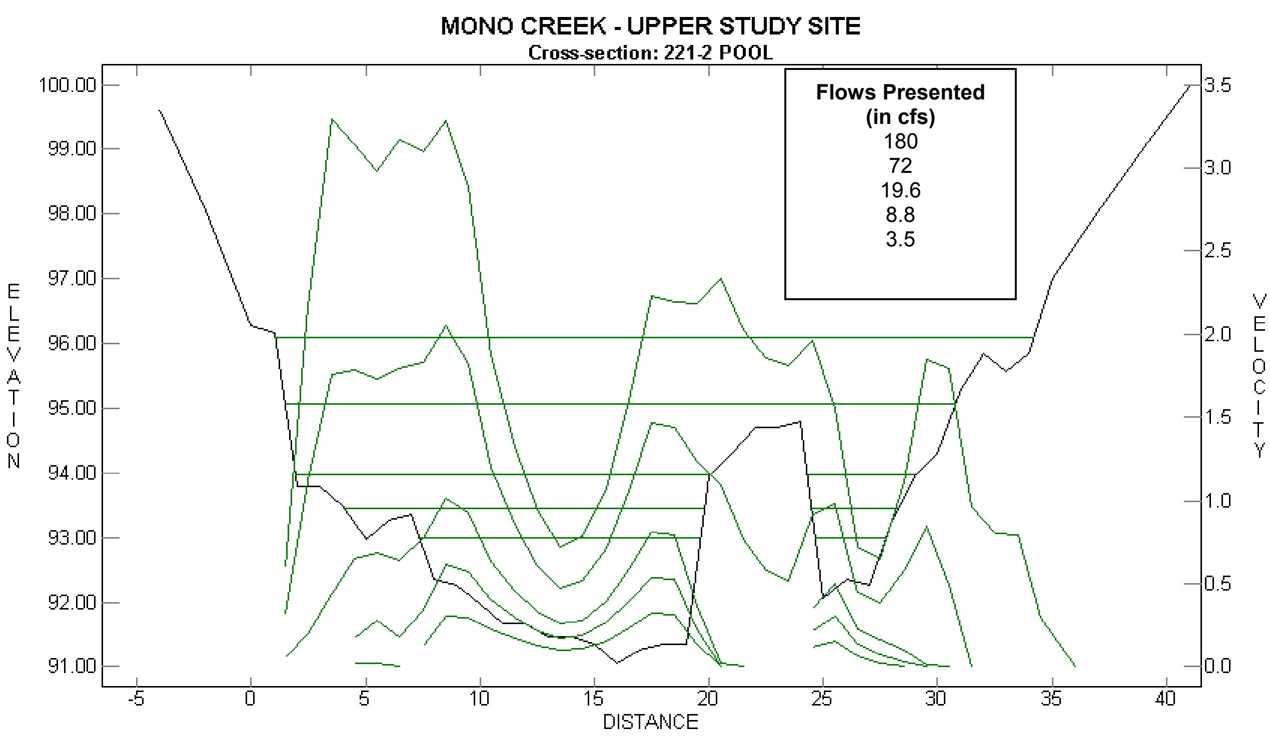

MONO CREEK - UPPER STUDY SITE
Cross-section: 198-1 RUN
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-5
0
5
10
15
20
25
30
35
40
45
50
55


MONO CREEK - UPPER STUDY SITE
Cross-section: 200-1 POW
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40

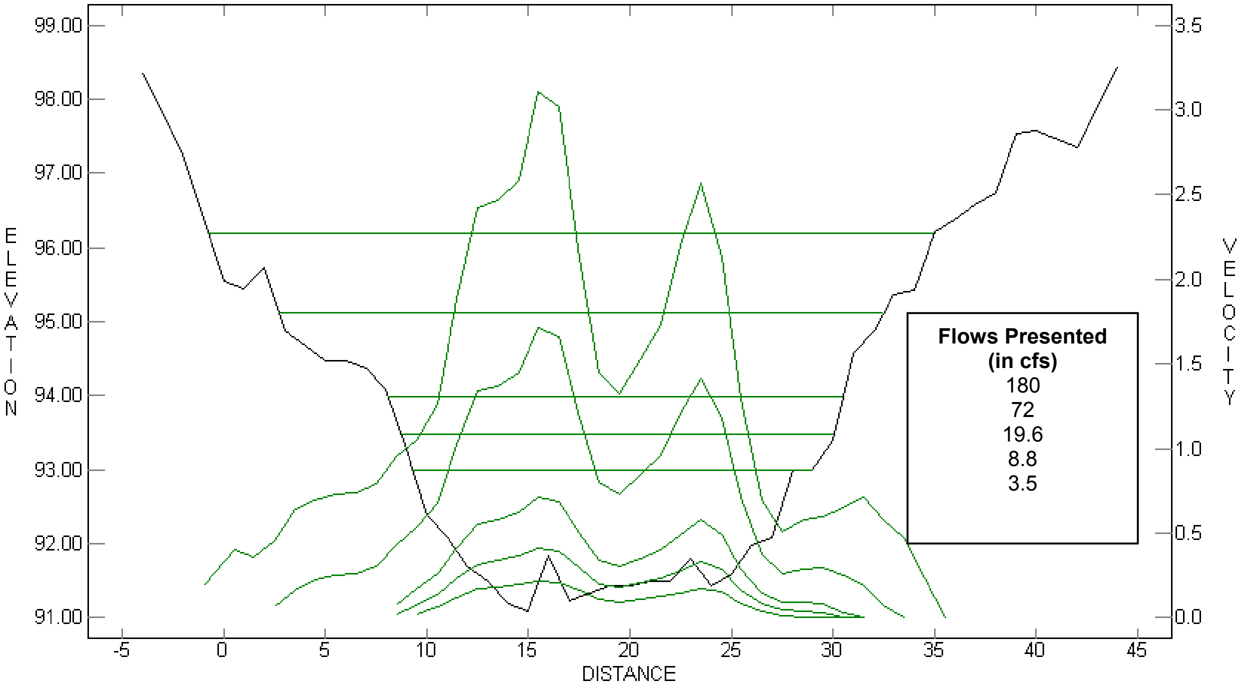

MONO CREEK - UPPER STUDY SITE
Cross-section: 219-1 POOL
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5
ELEVATION
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
VELOCITY
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
DISTANCE


MONO CREEK - UPPER STUDY SITE
Cross-section: 219-2 POOL
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5
ELEVATION
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
VELOCITY
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
DISTANCE

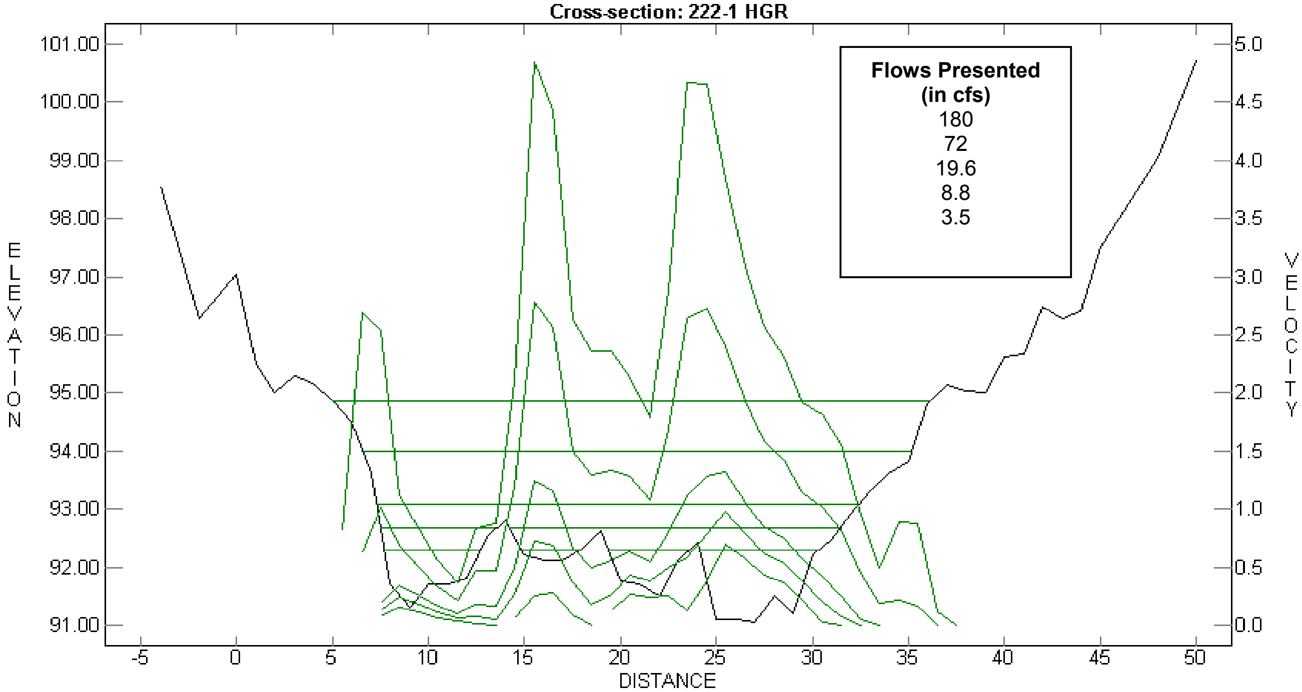

MONO CREEK - UPPER STUDY SITE
Cross-section: 221-1 POOL
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5

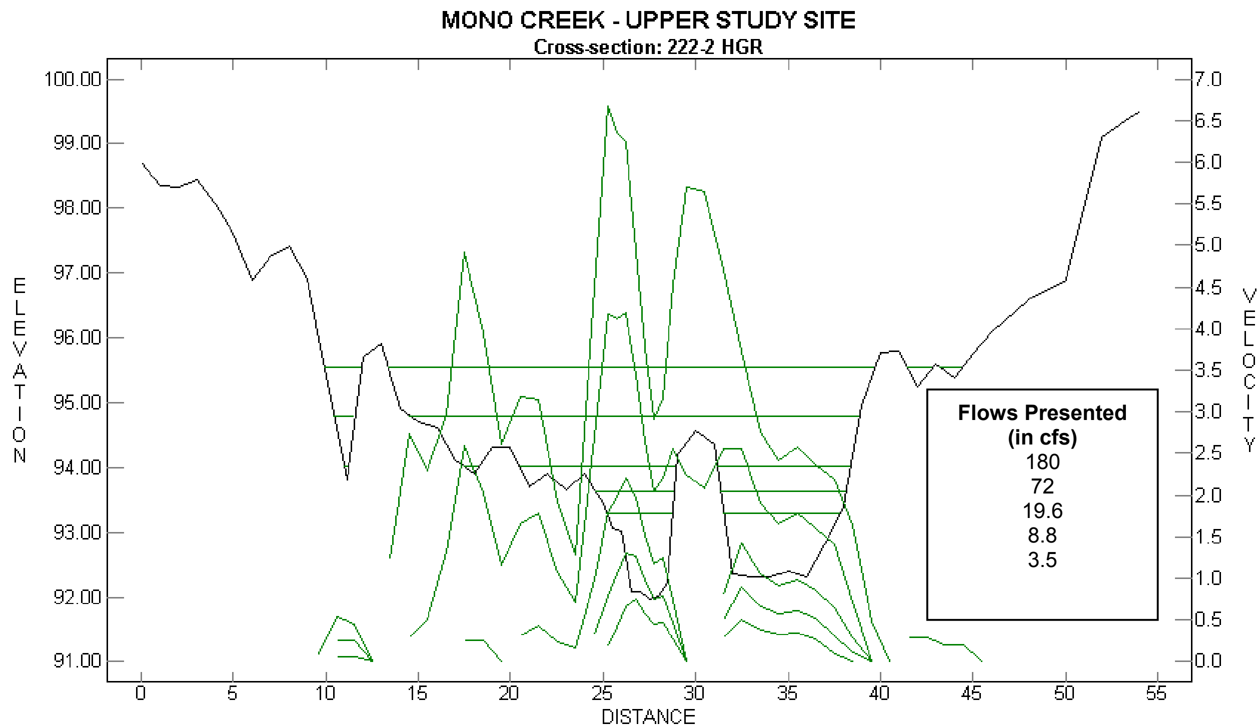

MONO CREEK - UPPER STUDY SITE
Cross-section: 221-2 POOL
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5

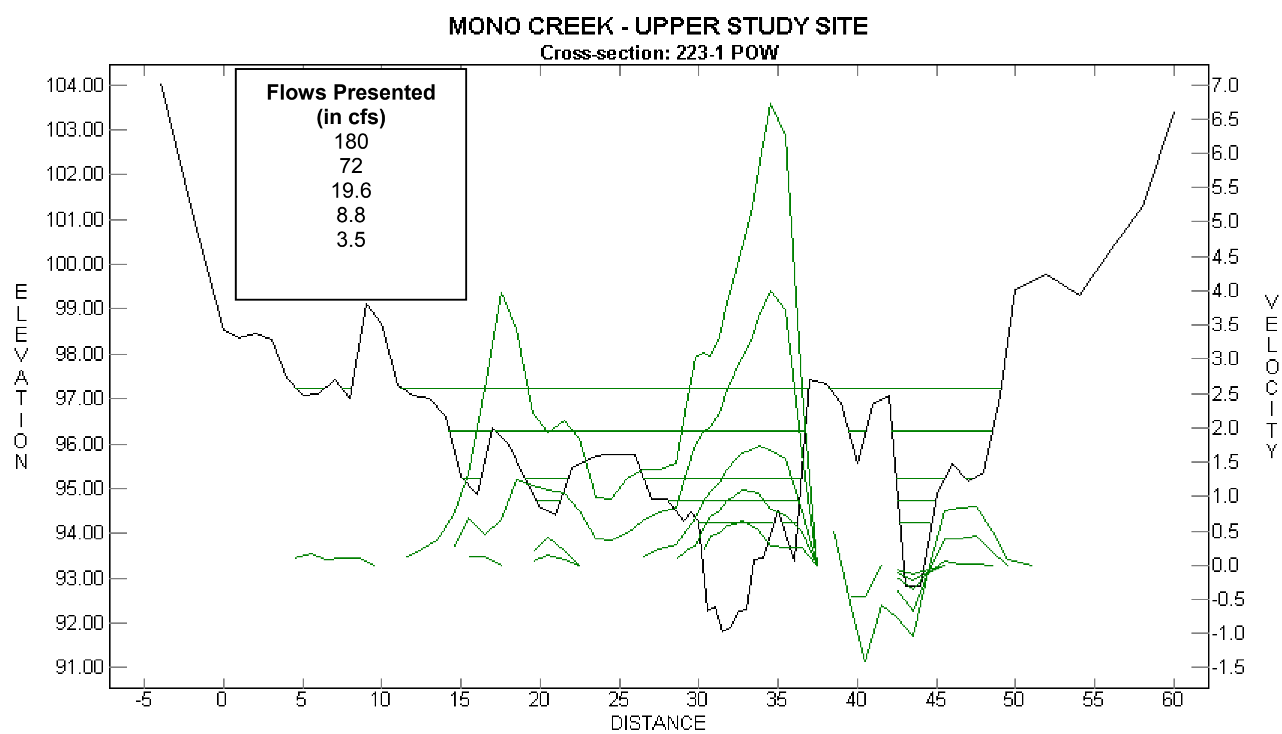
MONO CREEK - UPPER STUDY SITE
Cross-section: 221-3 POOL

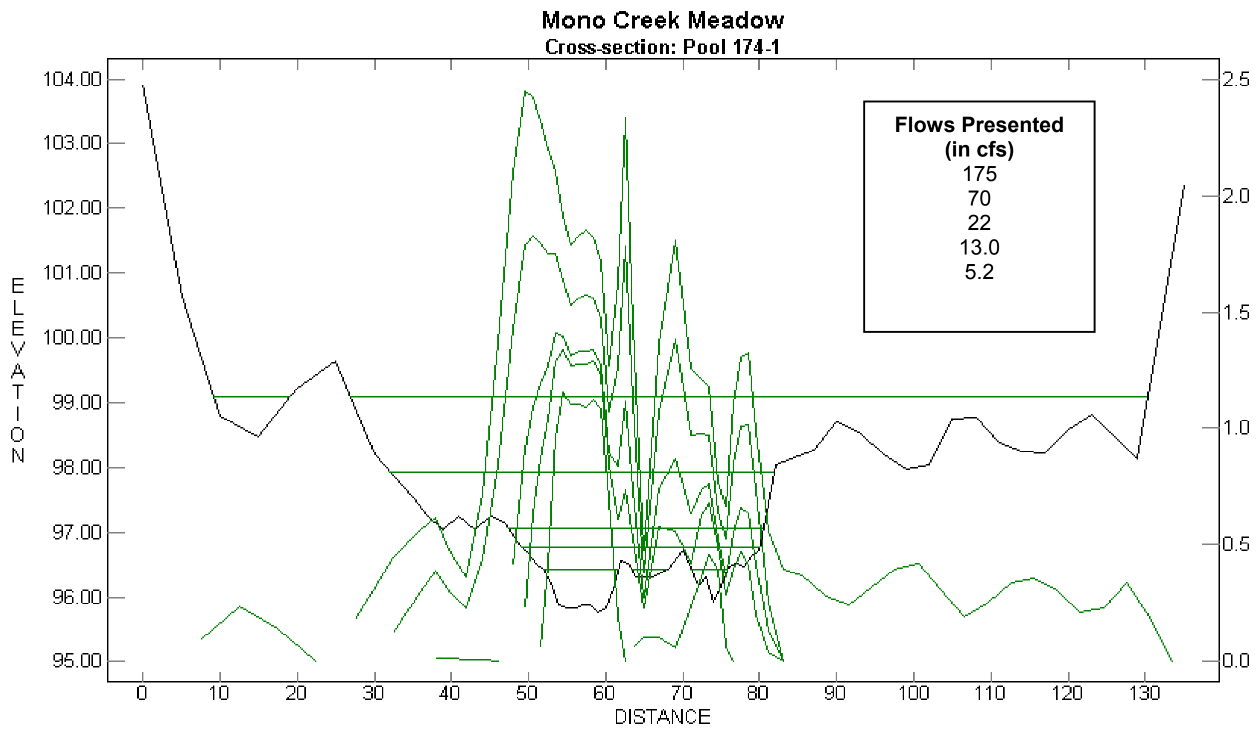


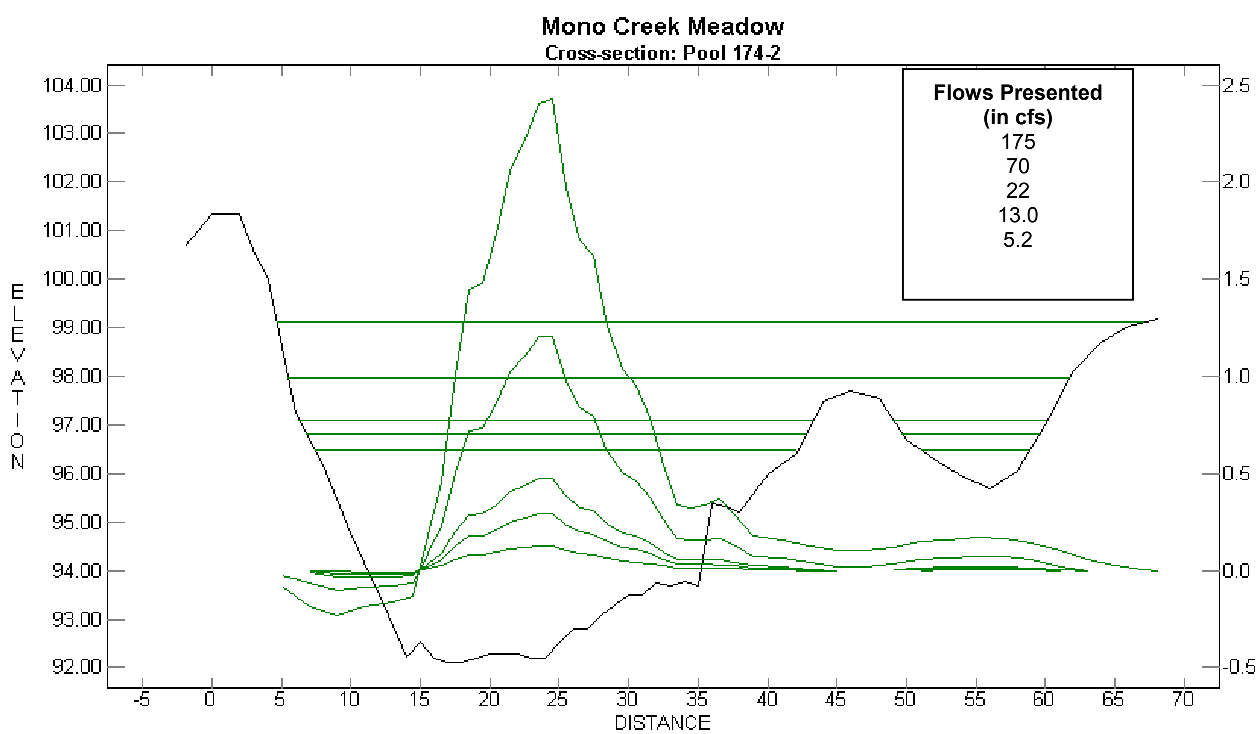
MONO CREEK - UPPER STUDY SITE
Cross-section: 222-1 HGR

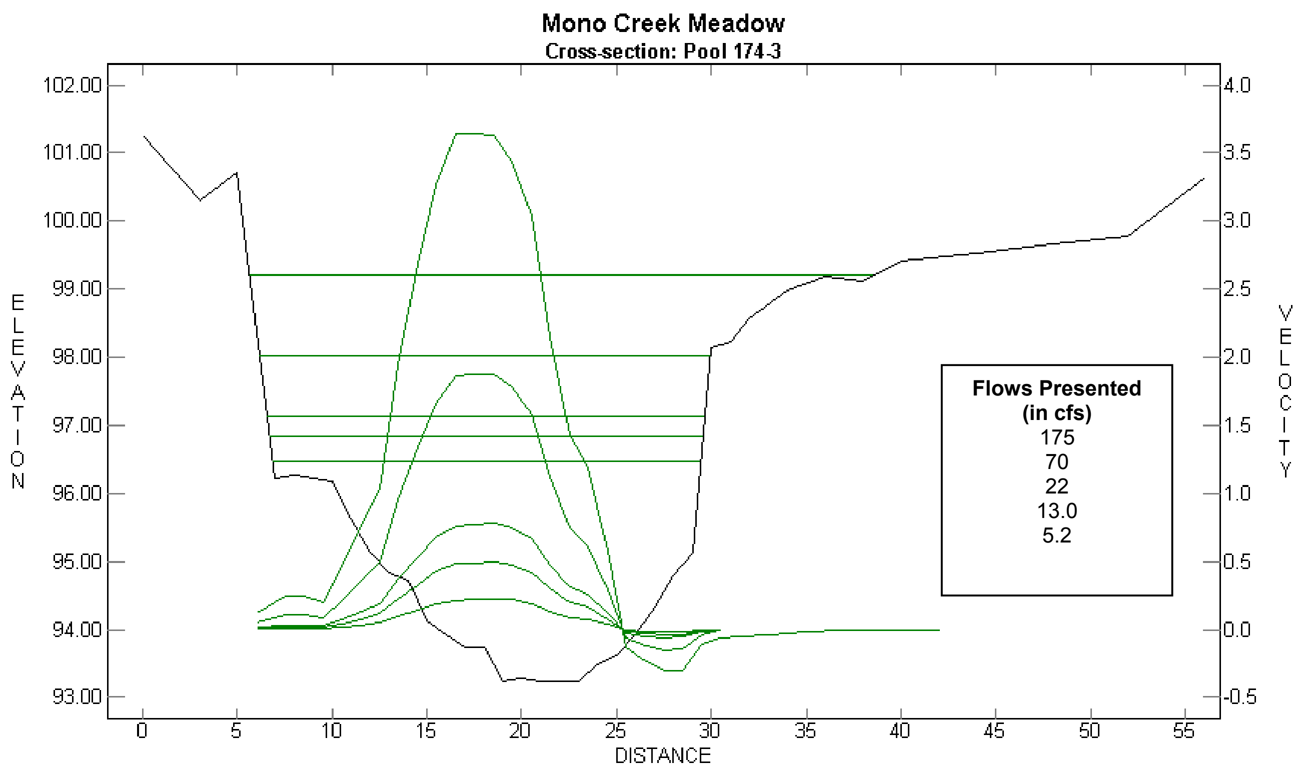



MONO CREEK - UPPER STUDY SITE
Cross-section: 222-2 HGR
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5

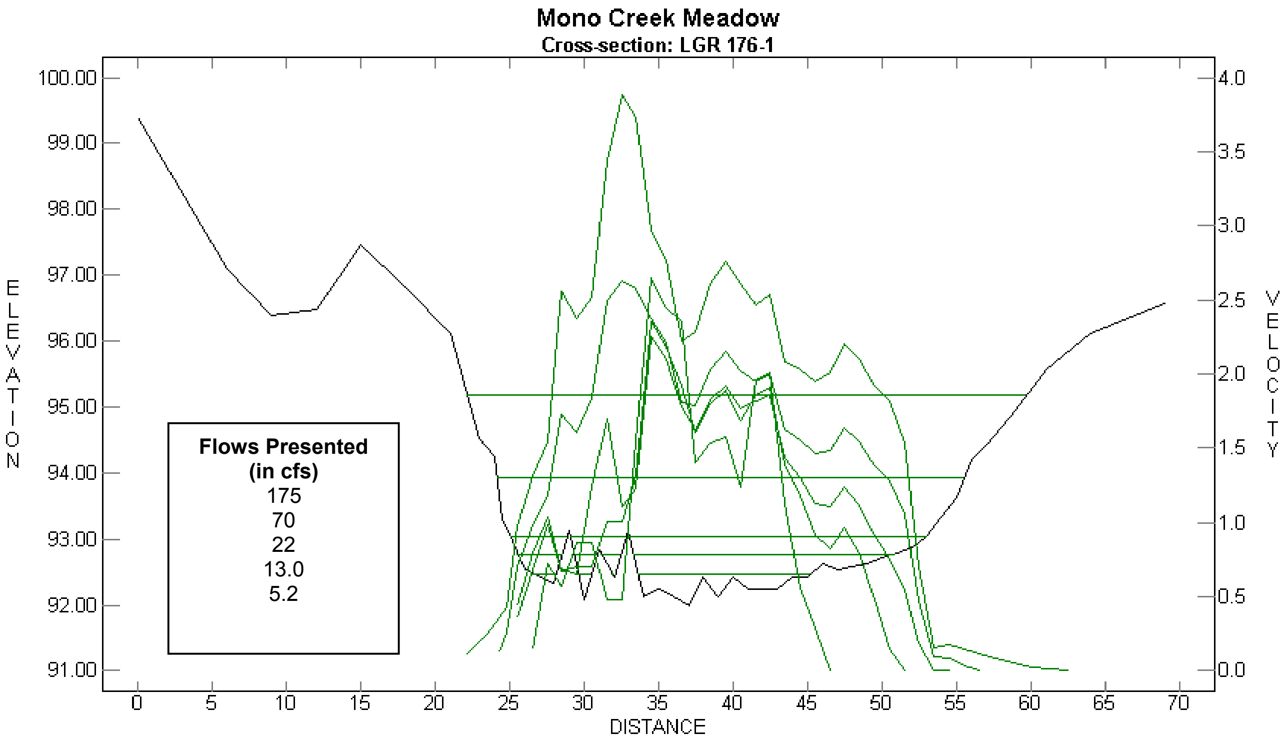

MONO CREEK - UPPER STUDY SITE
Cross-section: 223-1 POW
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
180
72
19.6
8.8
3.5

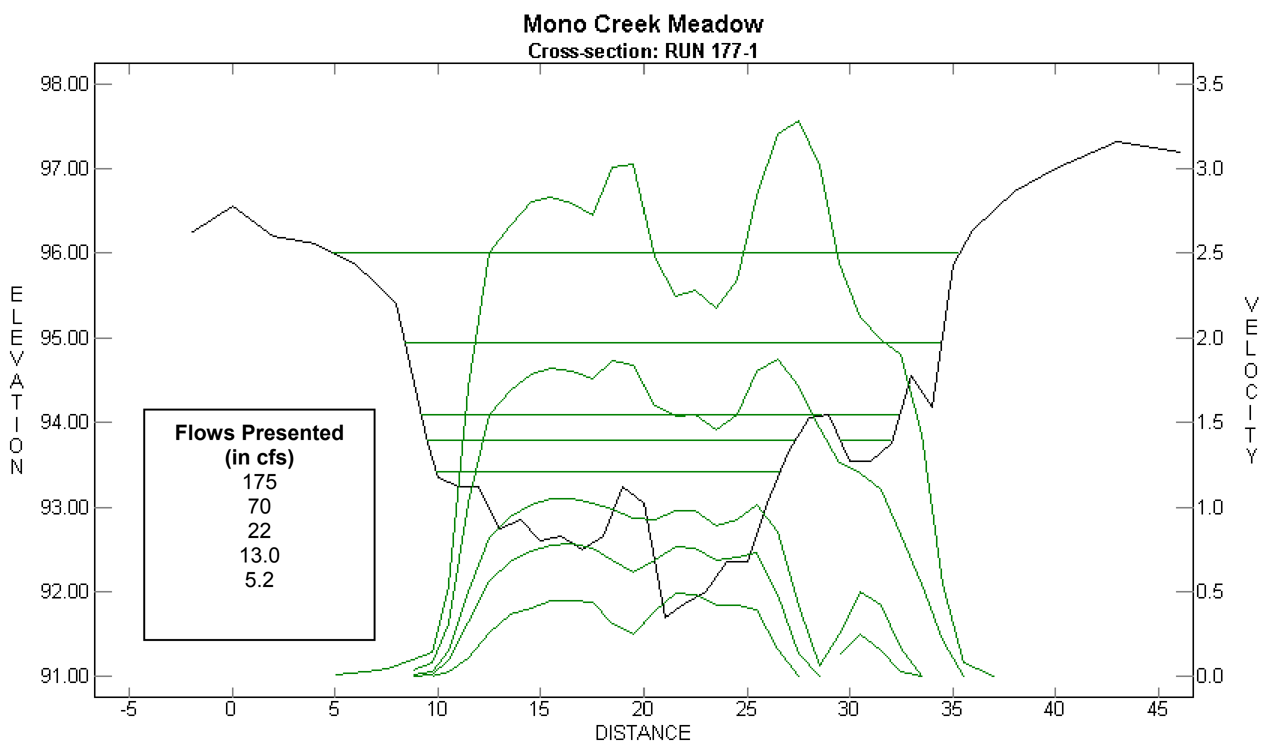

Mono Creek Meadow
Cross-section: Pool 174-1
Flows Presented
(in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130

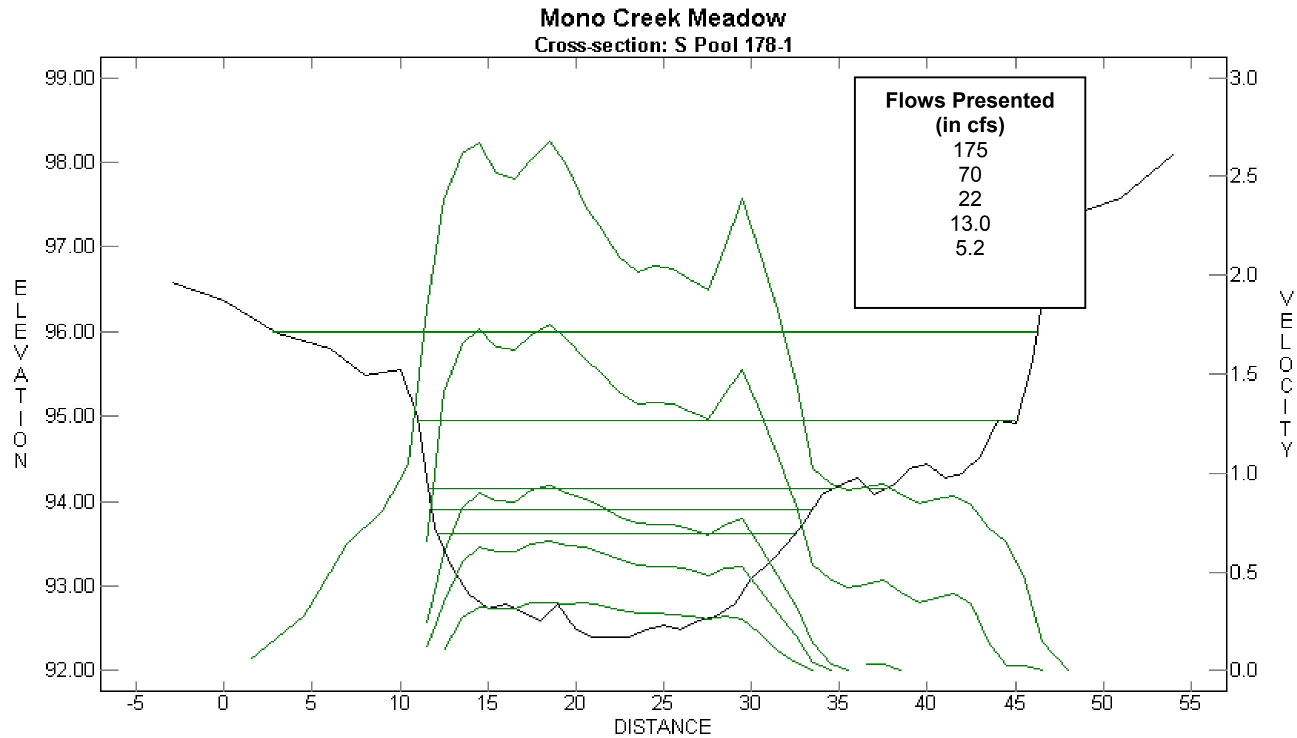

Mono Creek Meadow
Cross-section: Pool 174-2
Flows Presented
(in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

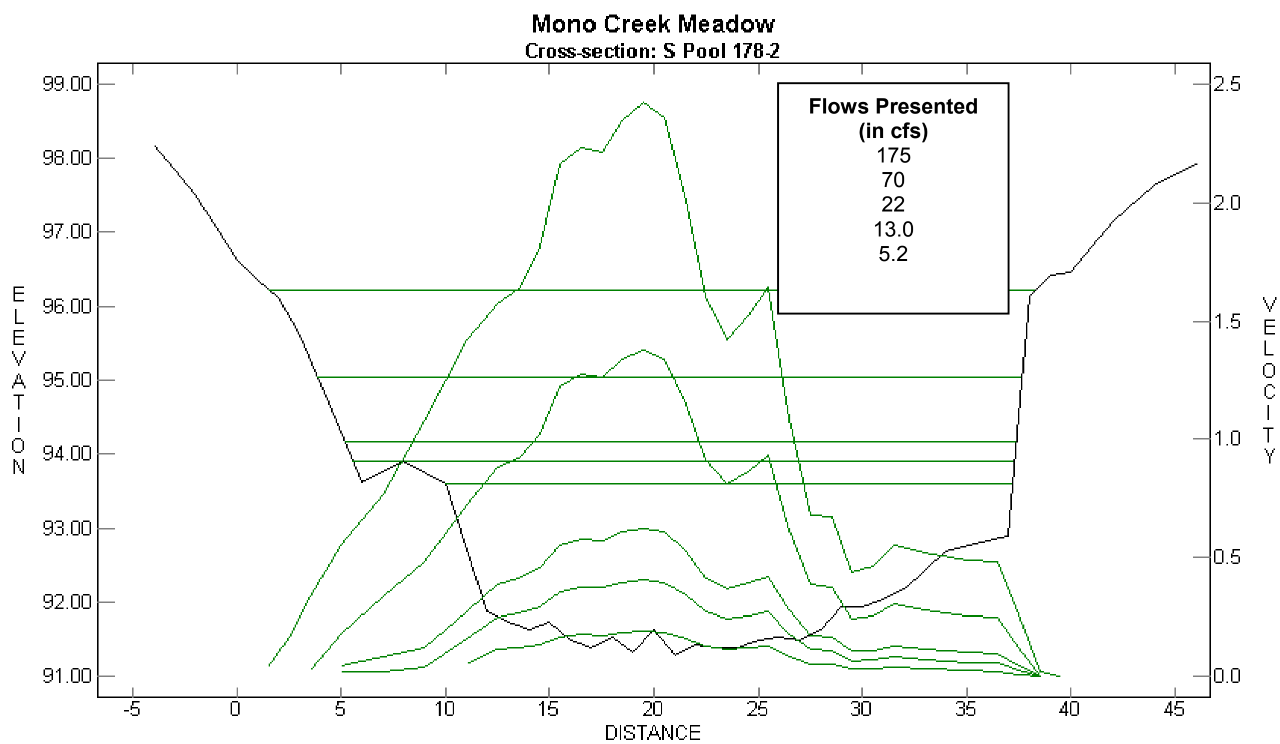

Mono Creek Meadow
Cross-section: Pool 174-3
ELEVATION
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
VELOCITY
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0
5
10
15
20
25
30
35
40
45
50
55
DISTANCE
Flows Presented
(in cfs)
175
70
22
13.0
5.2

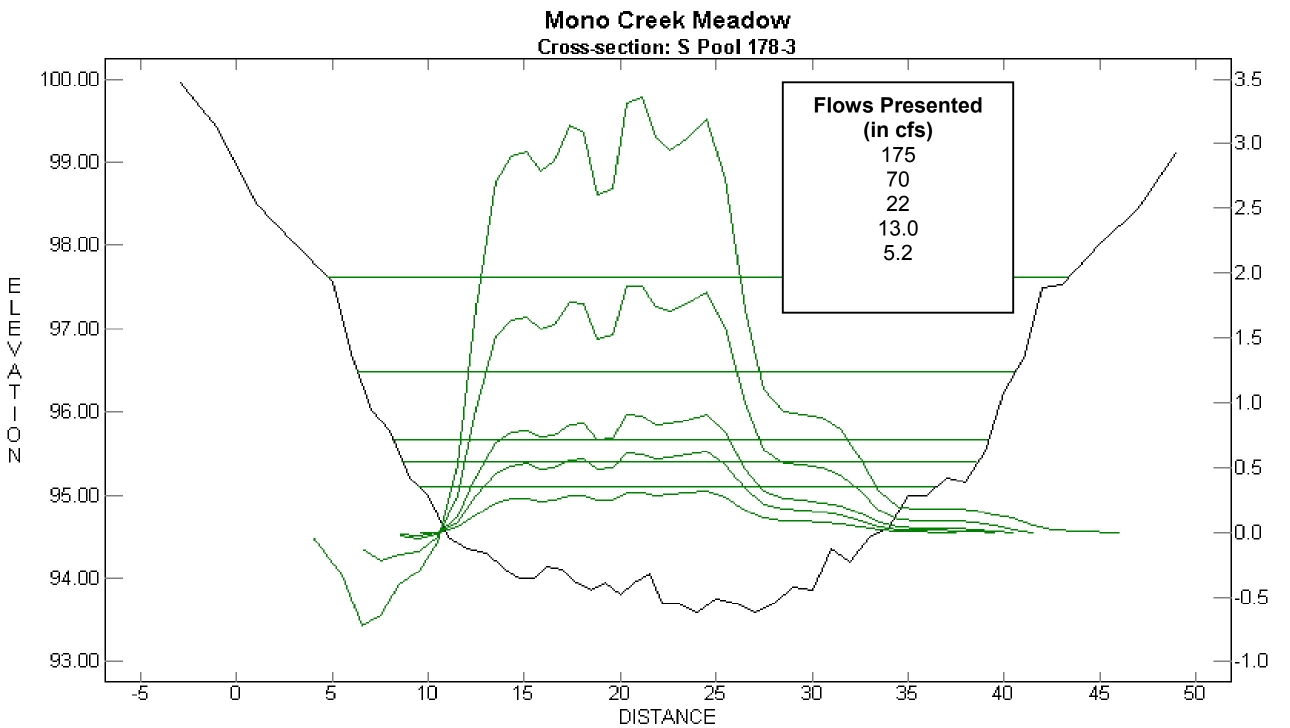

Mono Creek Meadow
Cross-section: Pool 174-4
ELEVATION
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
VELOCITY
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5
10
15
20
25
30
35
40
45
50
55
DISTANCE
Flows Presented
(in cfs)
175
70
22
13.0
5.2

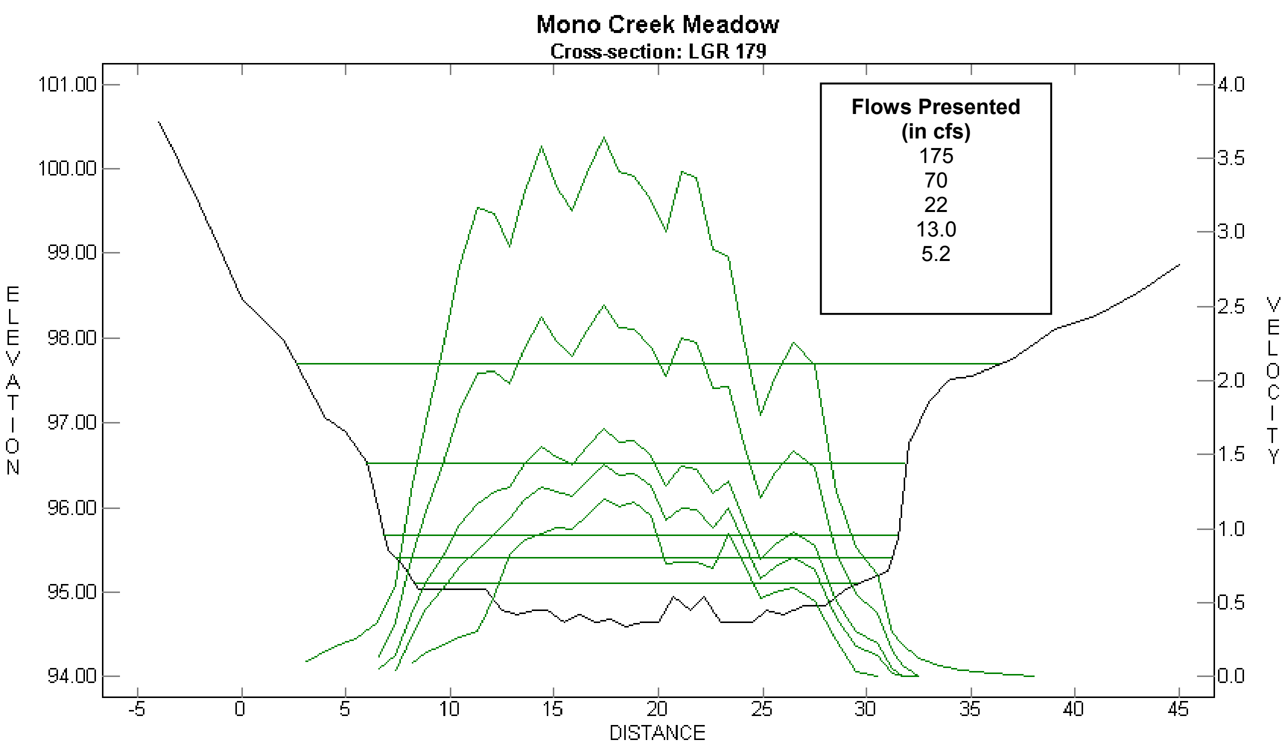

Mono Creek Meadow
Cross-section: LGR 176-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
175
70
22
13.0
5.2

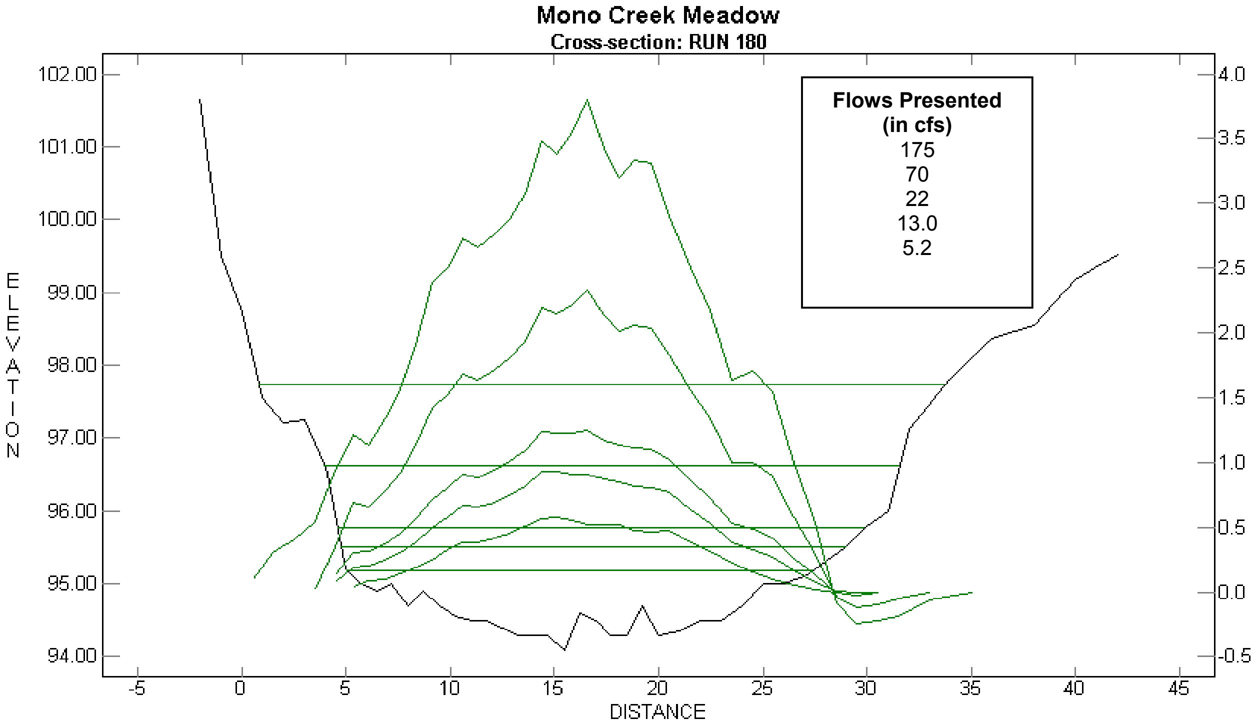

Mono Creek Meadow
Cross-section: RUN 177-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
175
70
22
13.0
5.2

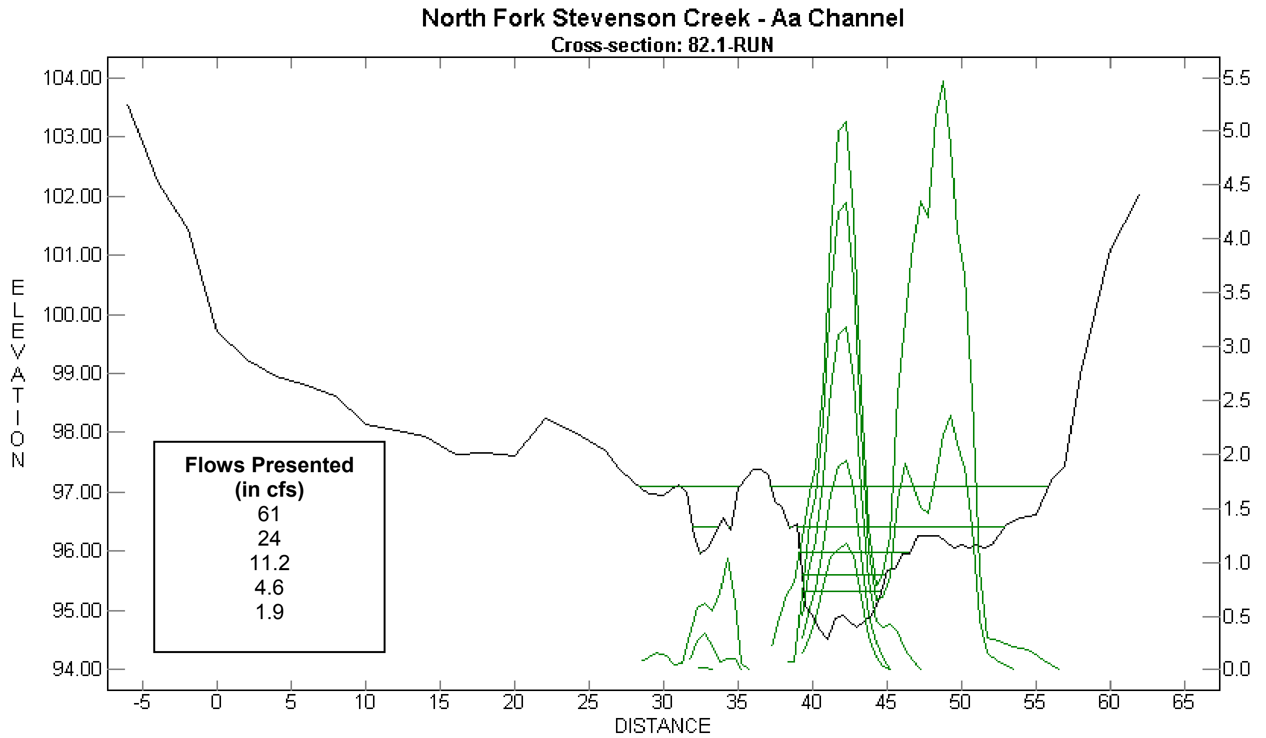

Mono Creek Meadow
Cross-section: S Pool 178-1
Flows Presented
(in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55

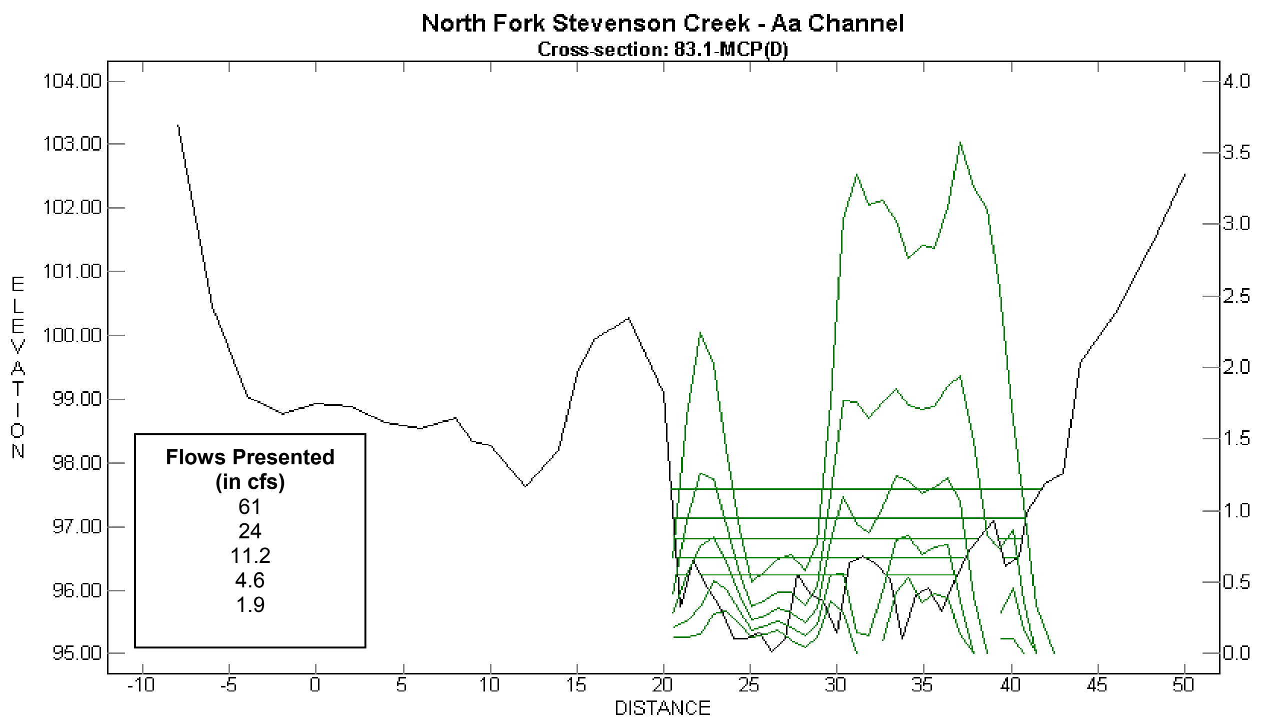

Mono Creek Meadow
Cross-section: S Pool 178-2
Flows Presented
(in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45

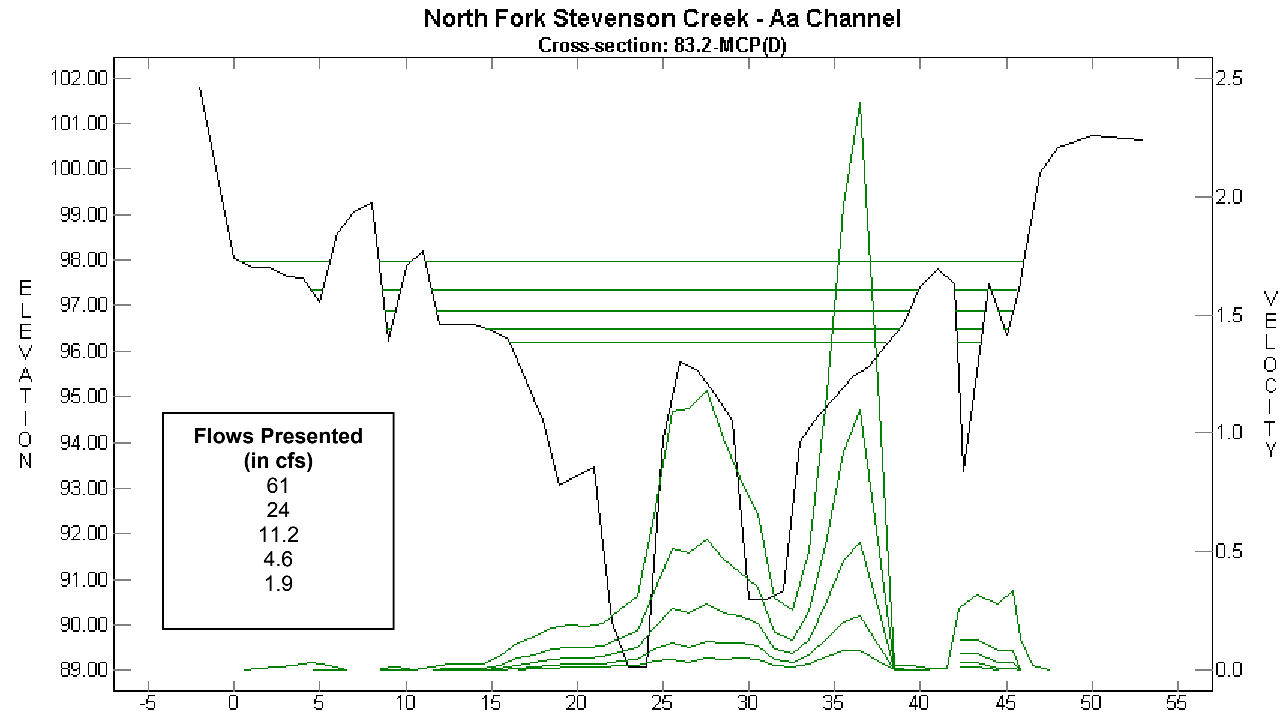

Mono Creek Meadow
Cross-section: S Pool 178-3
Flows Presented (in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-5
0
5
10
15
20
25
30
35
40
45
50

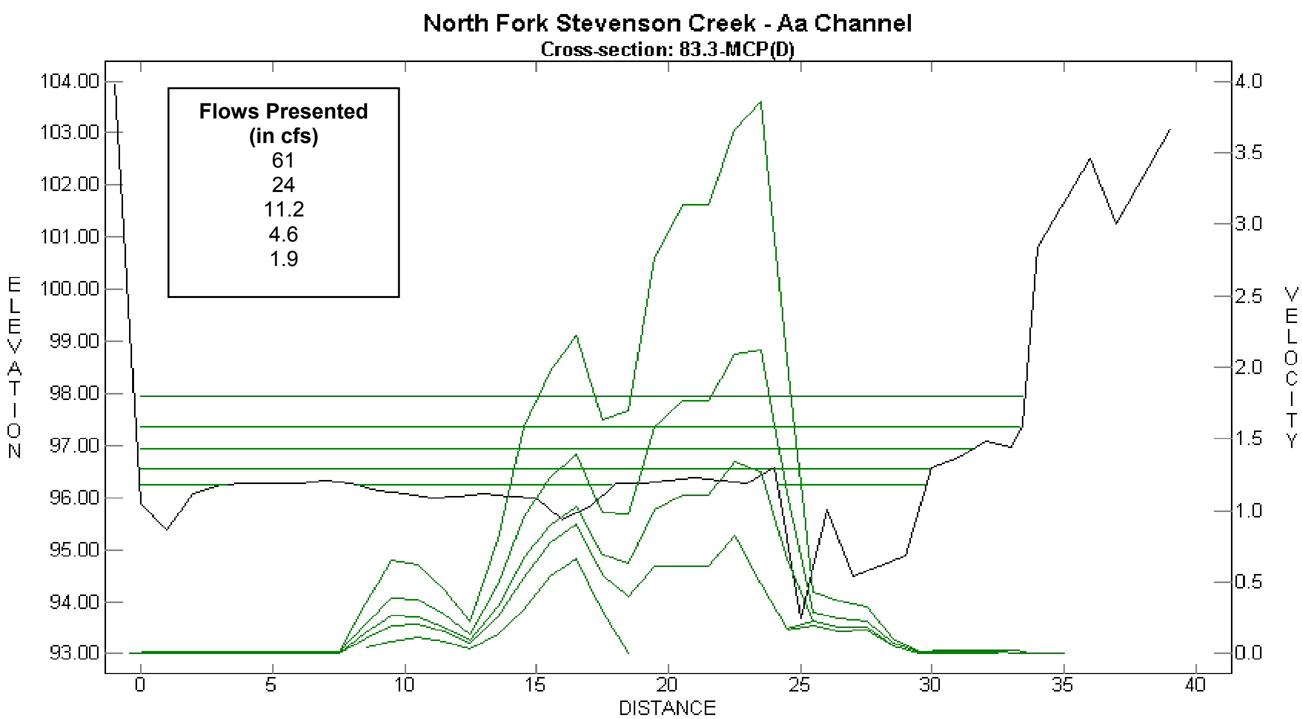

Mono Creek Meadow
Cross-section: LGR 179
Flows Presented (in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45

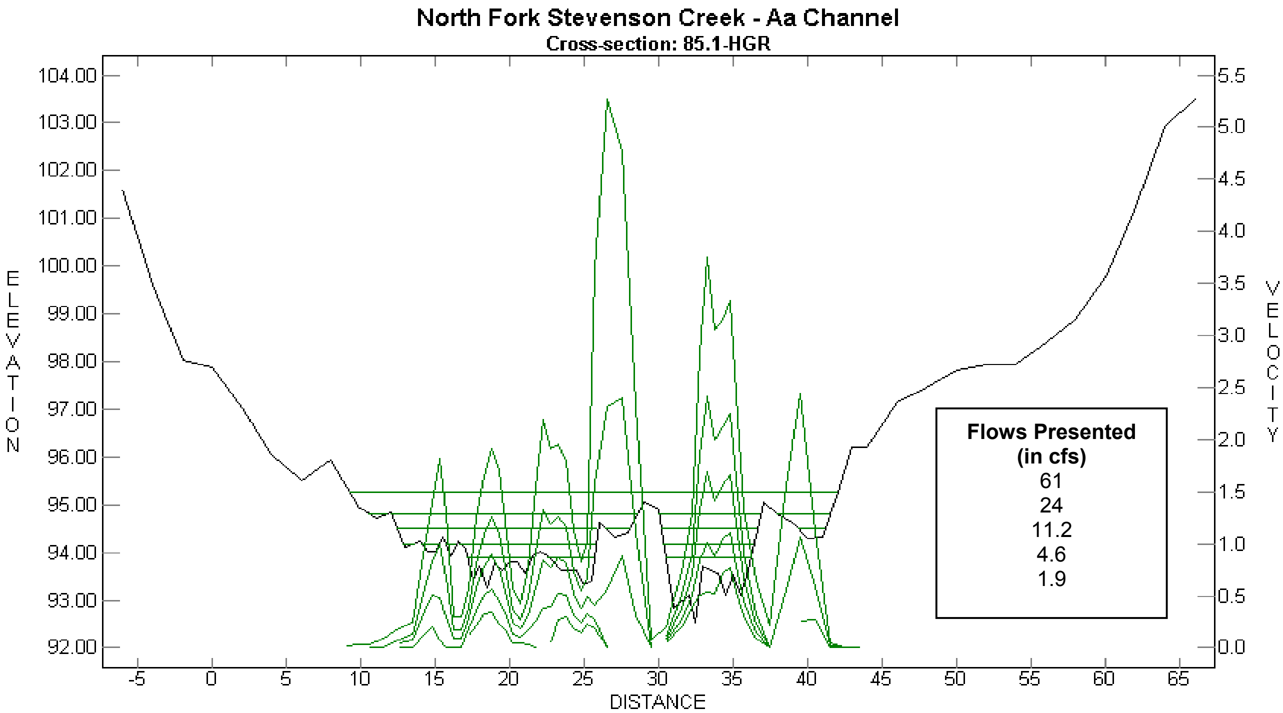

Mono Creek Meadow
Cross-section: RUN 180
Flows Presented (in cfs)
175
70
22
13.0
5.2
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-5
0
5
10
15
20
25
30
35
40
45

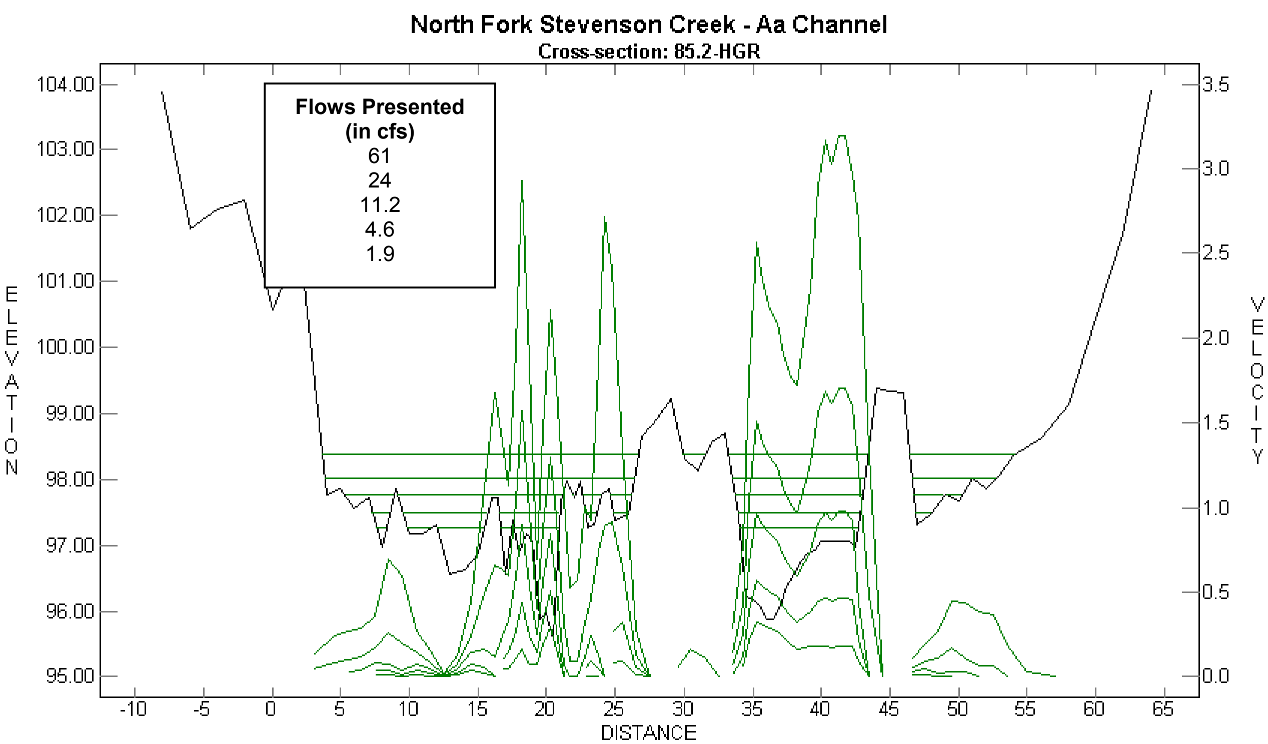

North Fork Stevenson Creek - Aa Channel
Cross-section: 82.1-RUN
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9

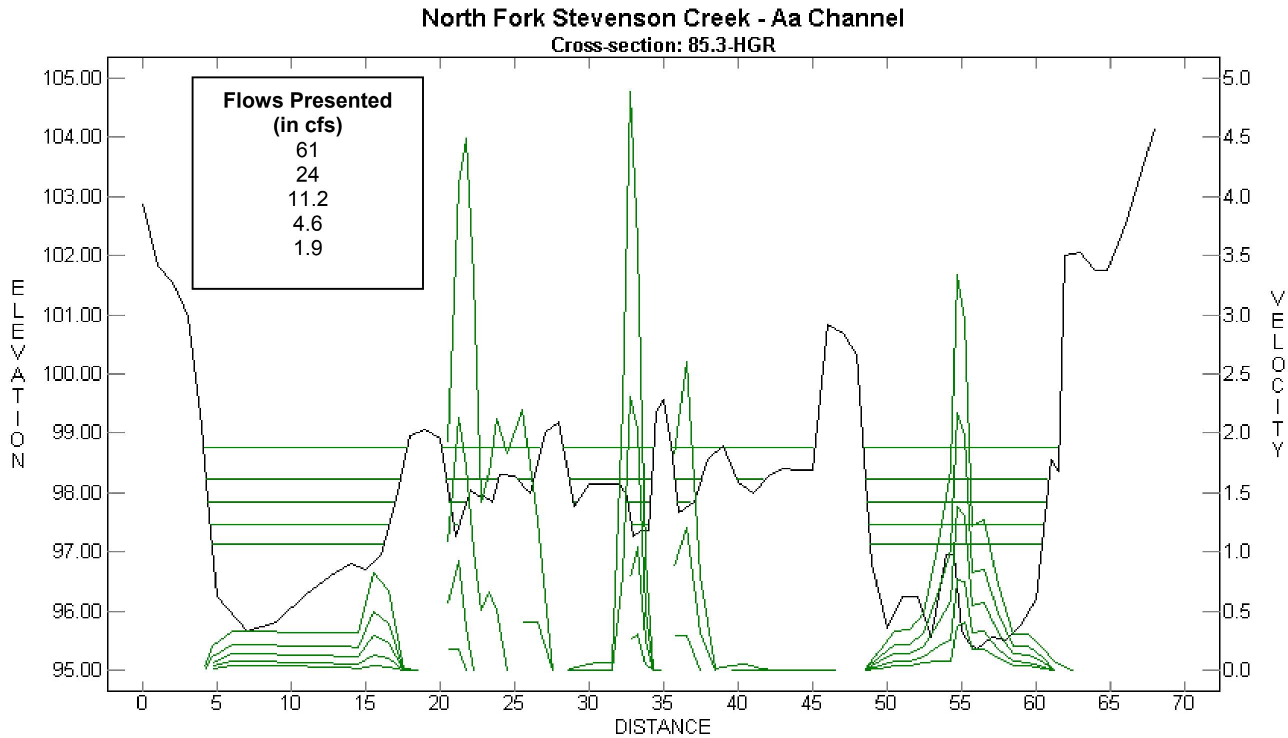

North Fork Stevenson Creek - Aa Channel
Cross-section: 83.1-MCP(D)
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9

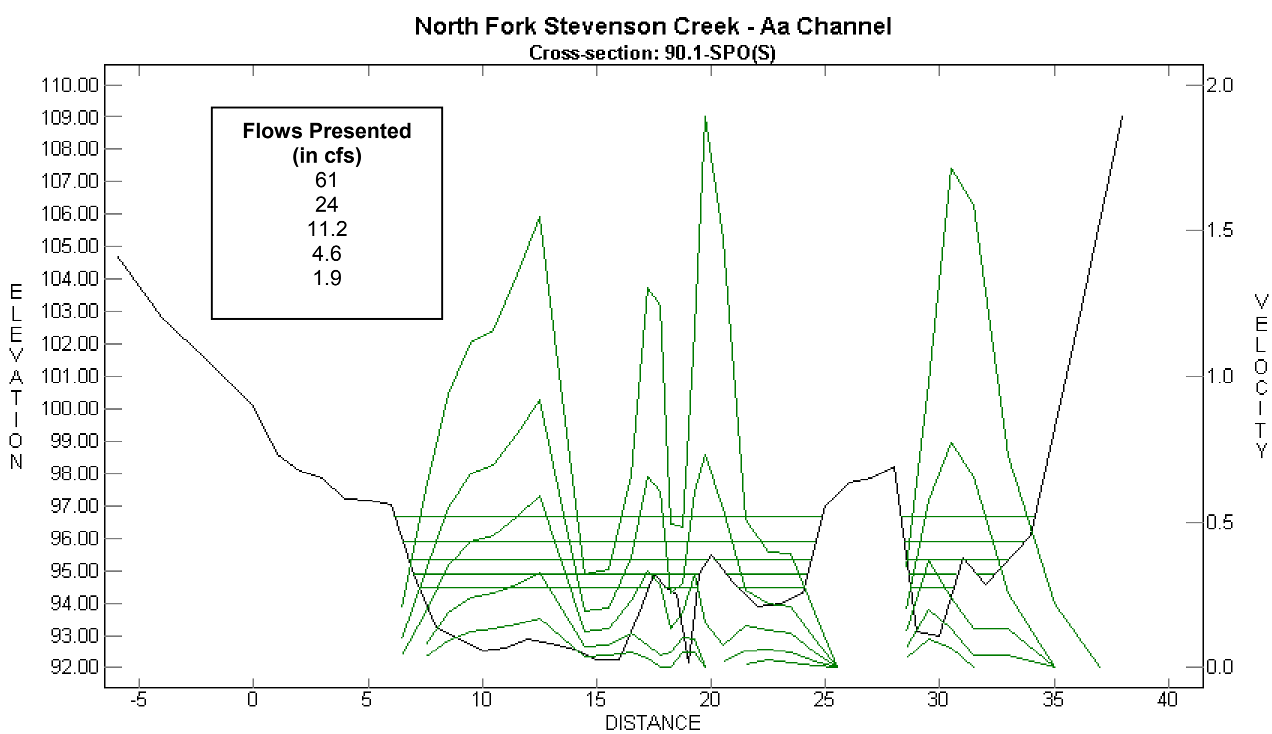

North Fork Stevenson Creek - Aa Channel
Cross-section: 83.2-MCP(D)
ELEVATION
VELOCITY
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55

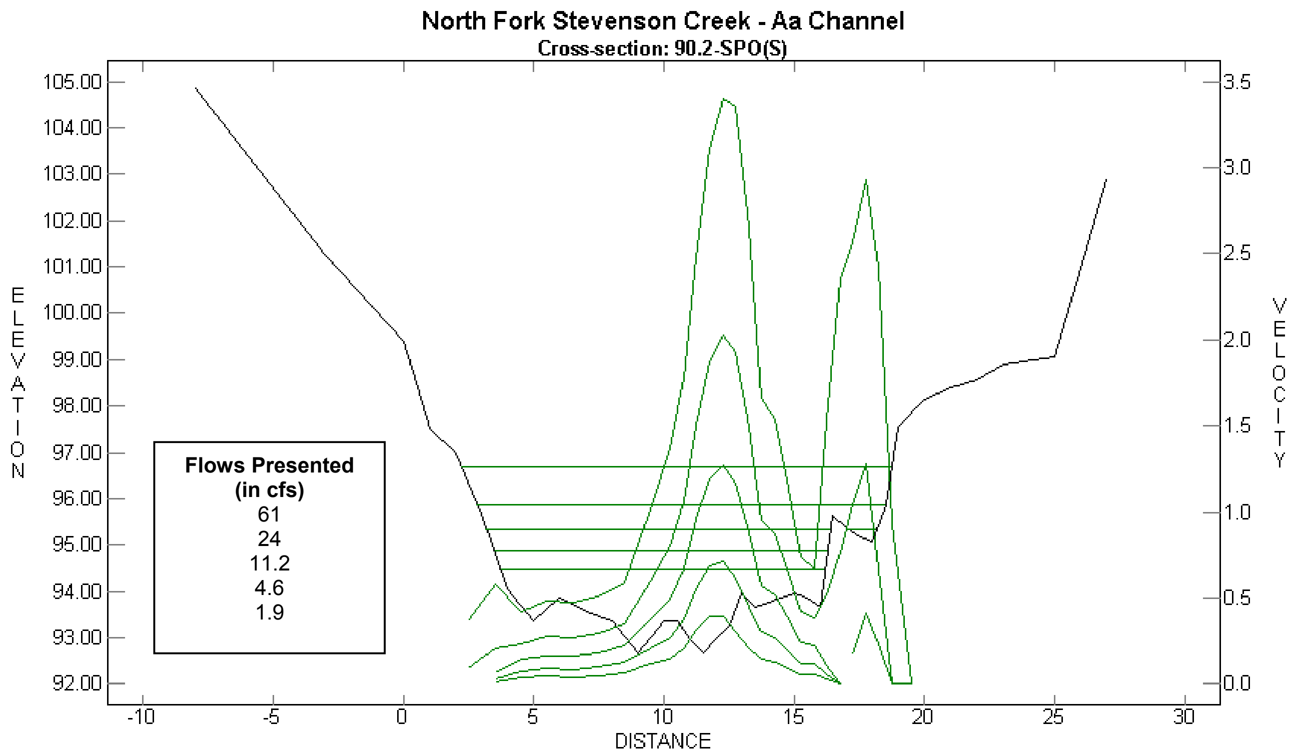

North Fork Stevenson Creek - Aa Channel
Cross-section: 83.3-MCP(D)
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40

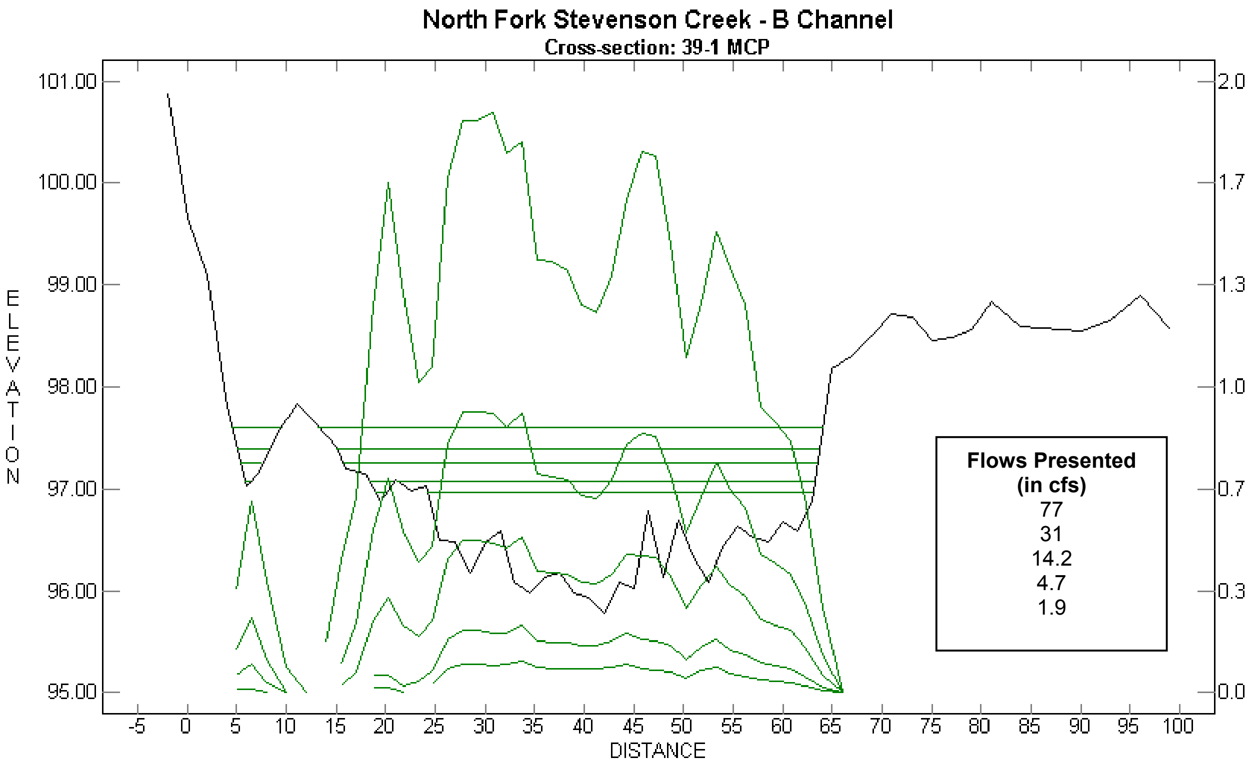

North Fork Stevenson Creek - Aa Channel
Cross-section: 85.1-HGR
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9

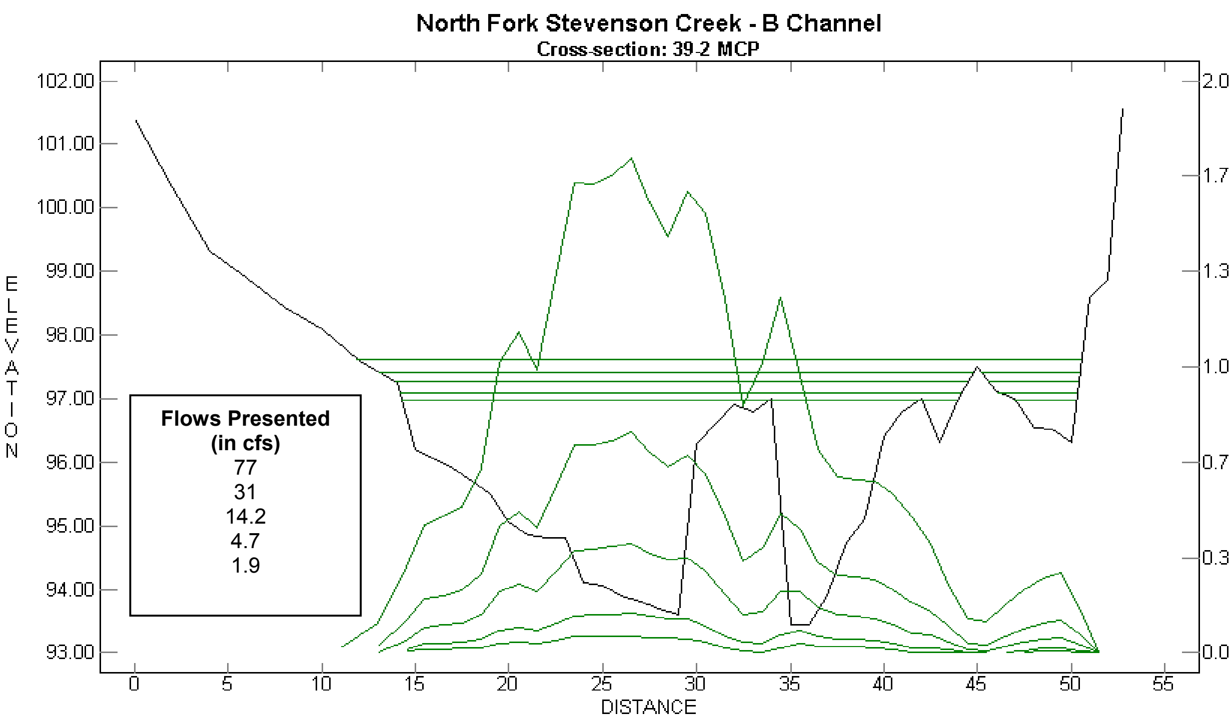

North Fork Stevenson Creek - Aa Channel
Cross-section: 85.2-HGR
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9

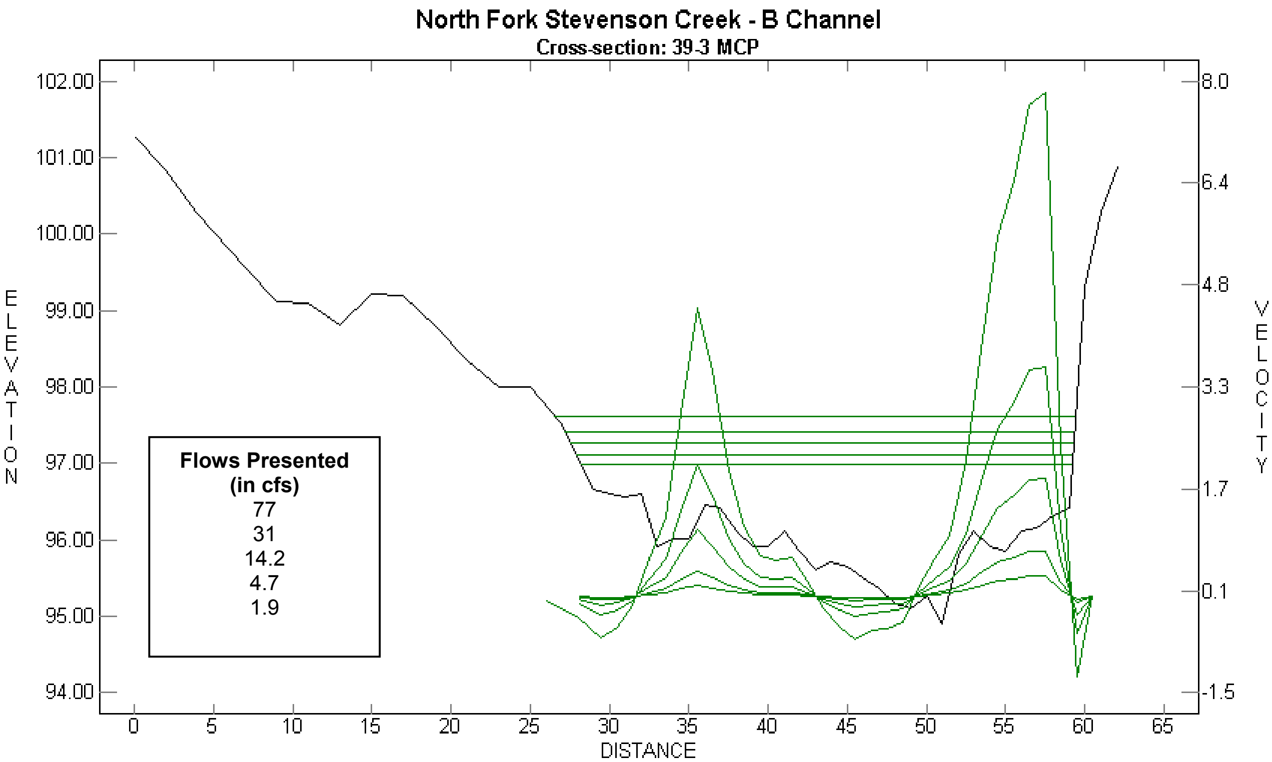

North Fork Stevenson Creek - Aa Channel
Cross-section: 85.3-HGR
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9
ELEVATION
VELOCITY
DISTANCE
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

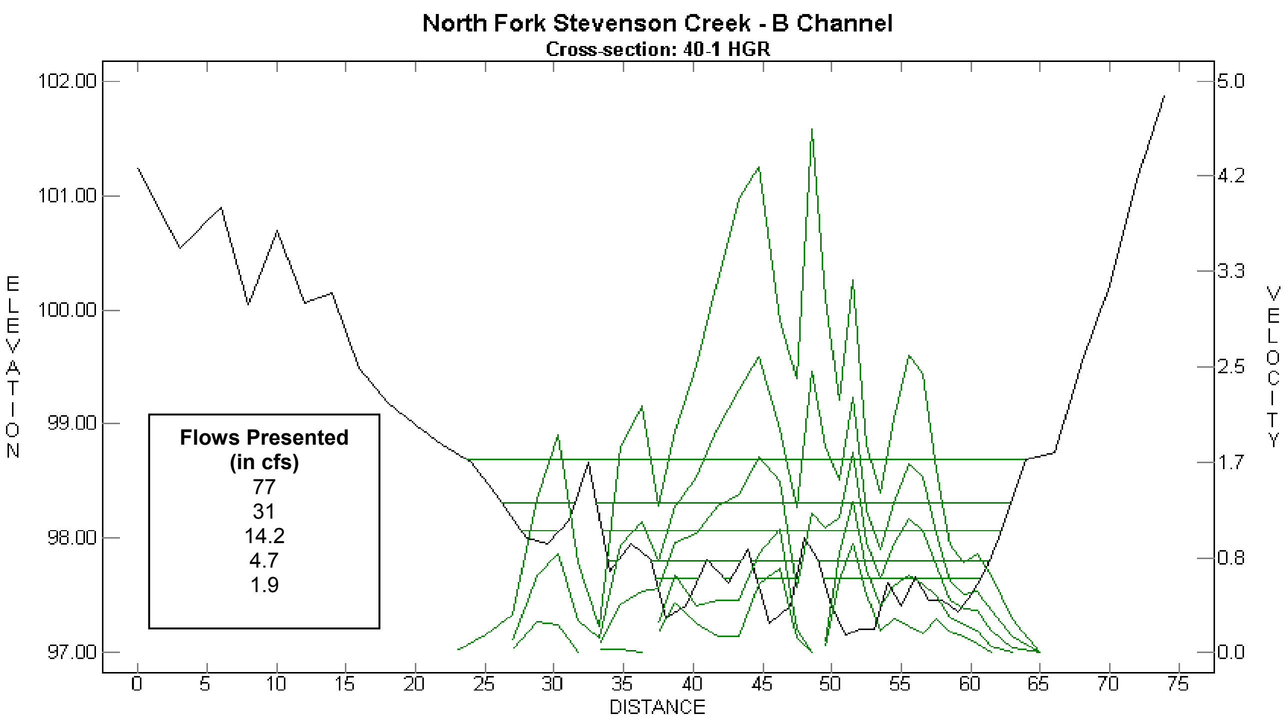

North Fork Stevenson Creek - Aa Channel
Cross-section: 90.1-SPO(S)
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9
ELEVATION
VELOCITY
DISTANCE
110.00
109.00
108.00
107.00
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40

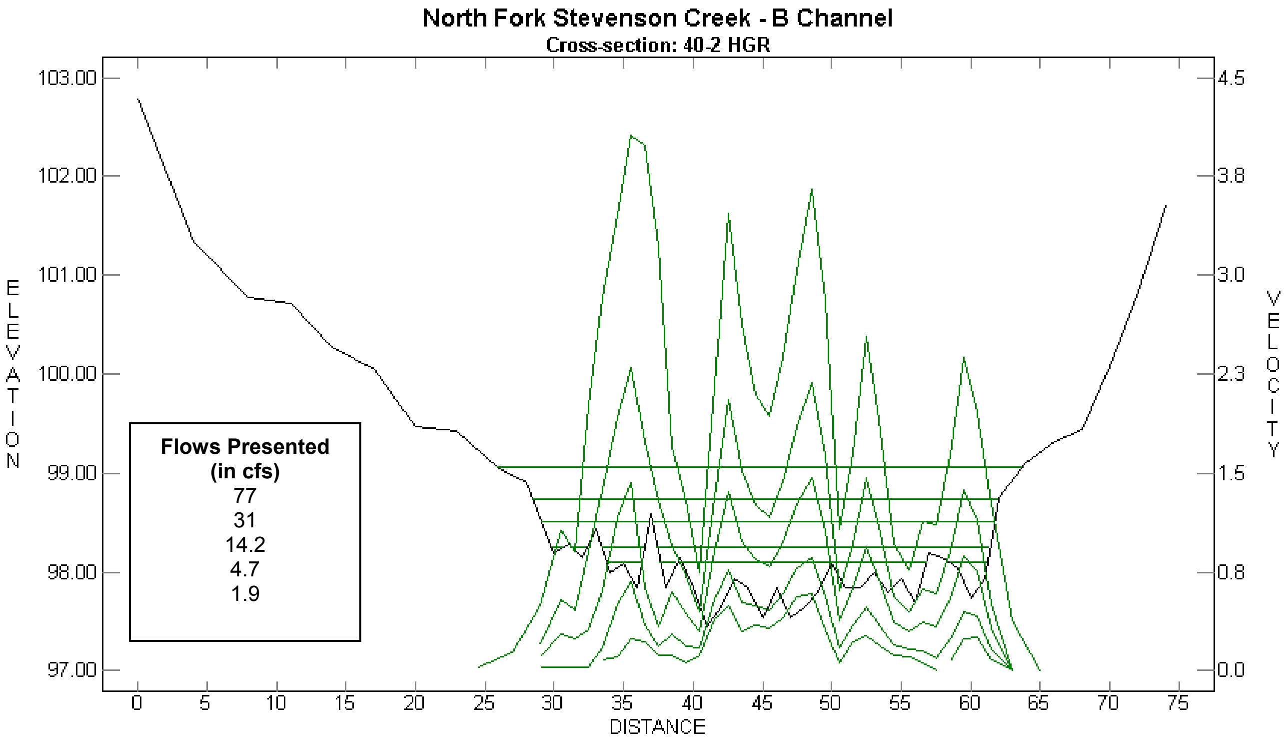

North Fork Stevenson Creek - Aa Channel
Cross-section: 90.2-SPO(S)
ELEVATION
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
VELOCITY
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-10
-5
0
5
10
15
20
25
30
DISTANCE
Flows Presented
(in cfs)
61
24
11.2
4.6
1.9

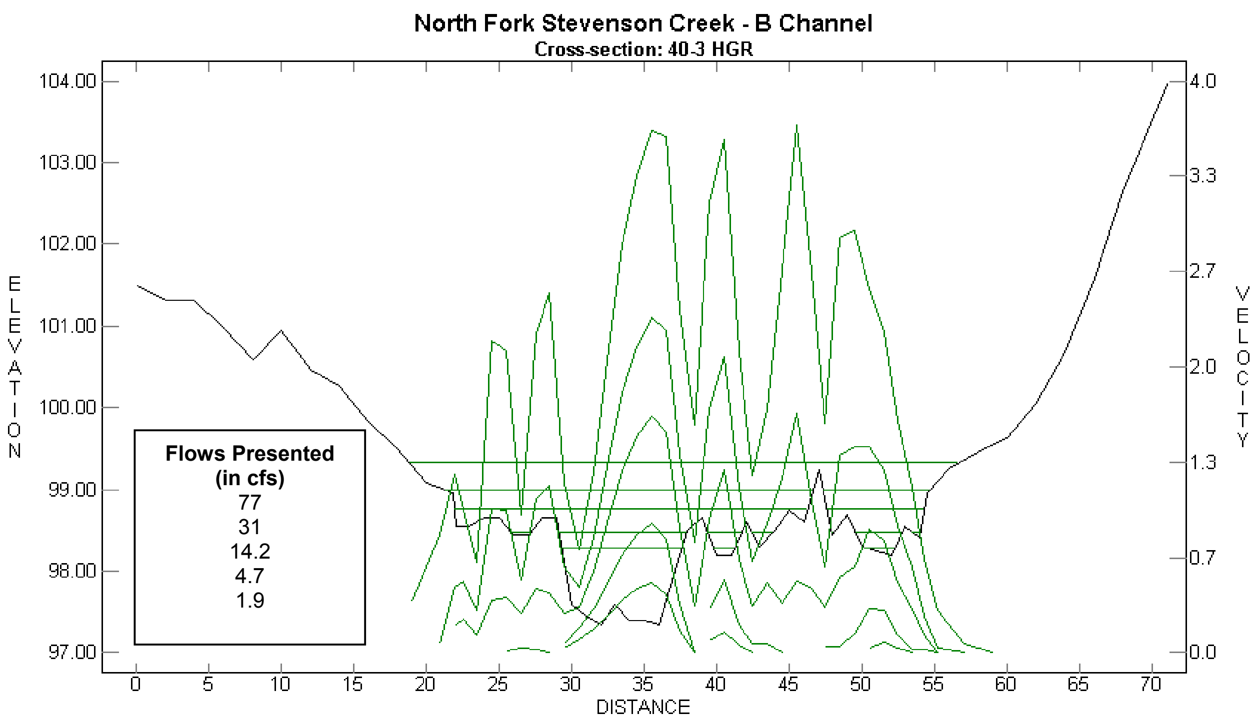

North Fork Stevenson Creek - B Channel
Cross-section: 39-1 MCP
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
2.0
1.7
1.3
1.0
0.7
0.3
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Flows Presented
(in cfs)
77
31
14.2
4.7
1.9

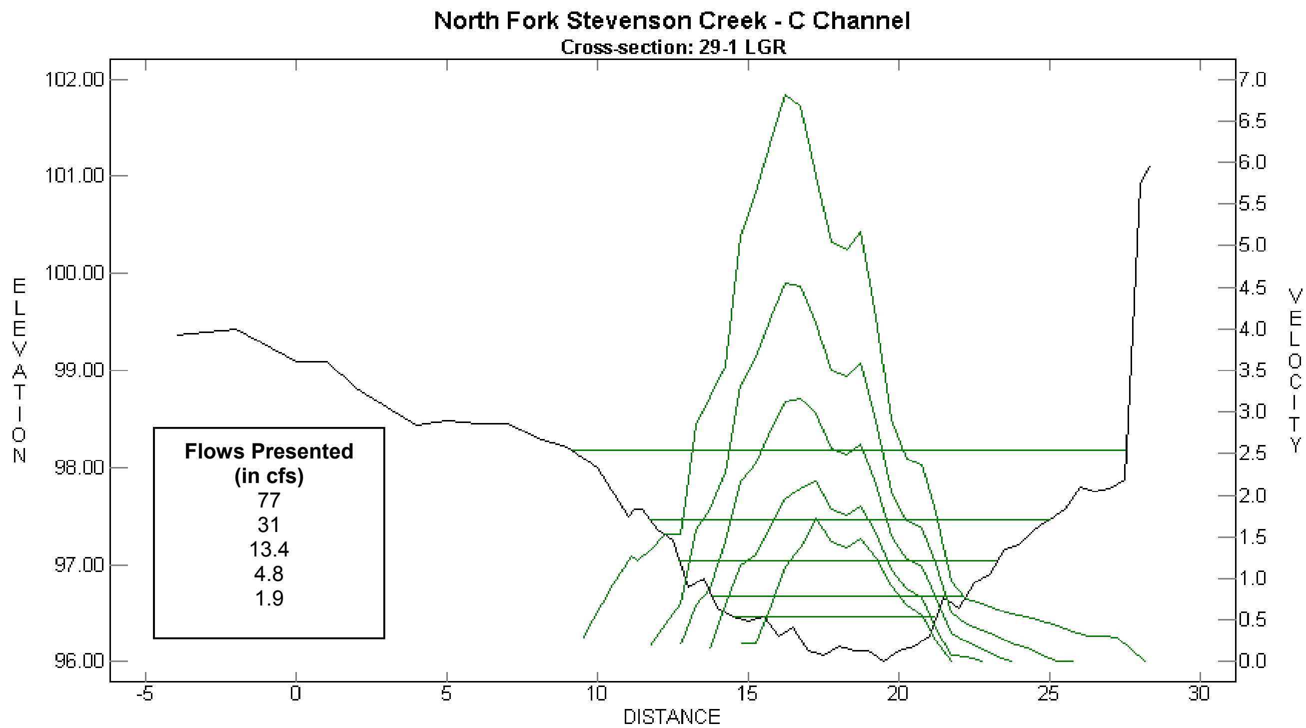

North Fork Stevenson Creek - B Channel
Cross-section: 39-2 MCP
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
2.0
1.7
1.3
1.0
0.7
0.3
0.0
0
5
10
15
20
25
30
35
40
45
50
55
Flows Presented
(in cfs)
77
31
14.2
4.7
1.9

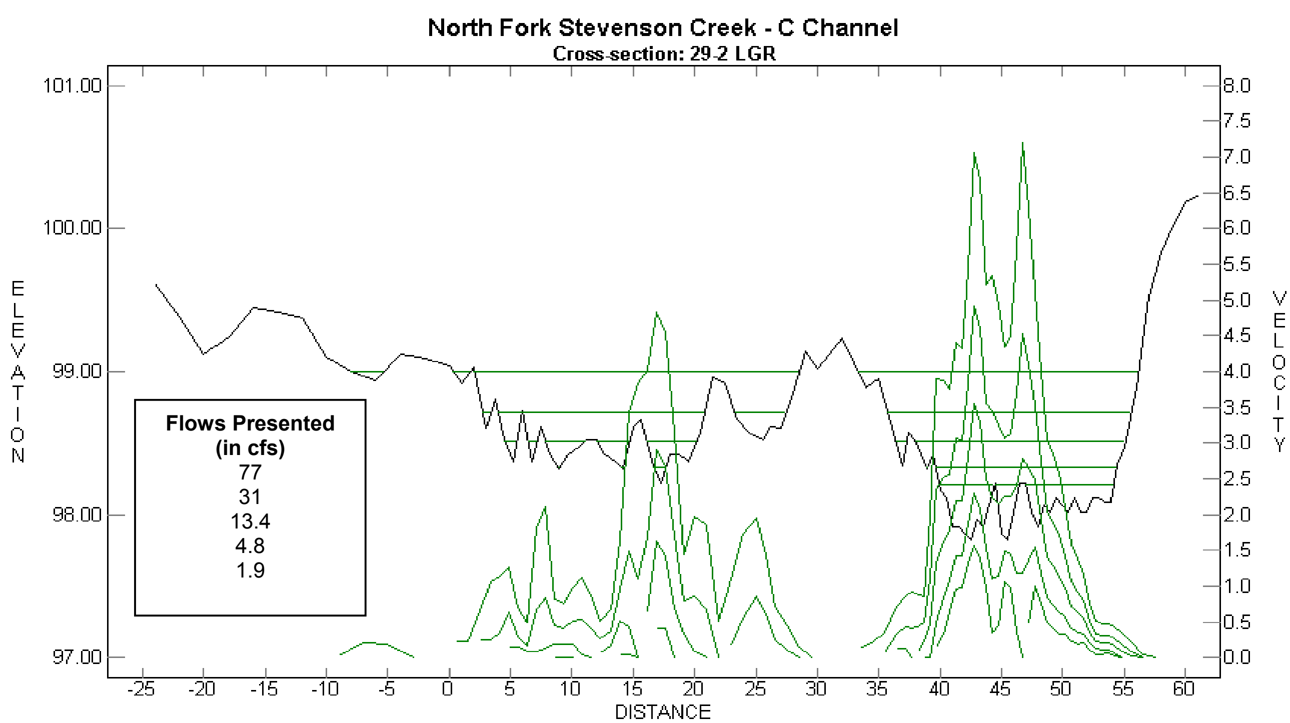

North Fork Stevenson Creek - B Channel
Cross-section: 39-3 MCP
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
8.0
6.4
4.8
3.3
1.7
0.1
-1.5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Flows Presented
(in cfs)
77
31
14.2
4.7
1.9

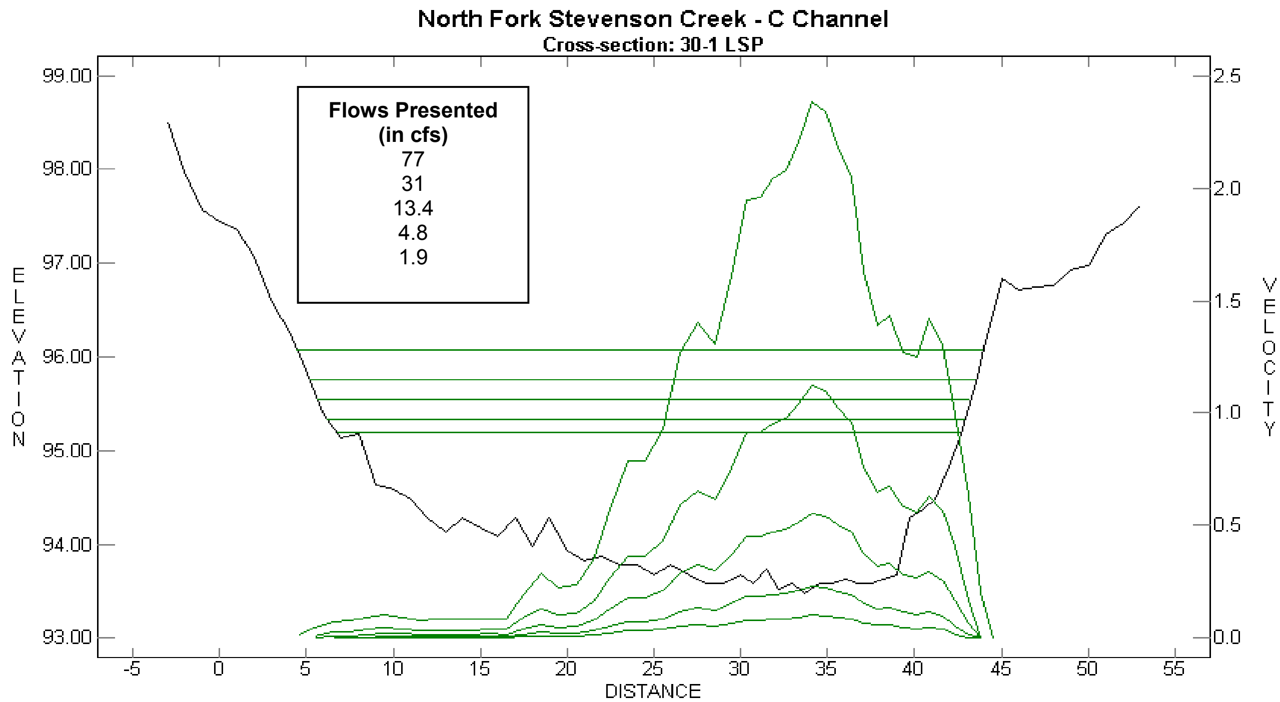

North Fork Stevenson Creek - B Channel
Cross-section: 40-1 HGR
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
5.0
4.2
3.3
2.5
1.7
0.8
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Flows Presented
(in cfs)
77
31
14.2
4.7
1.9

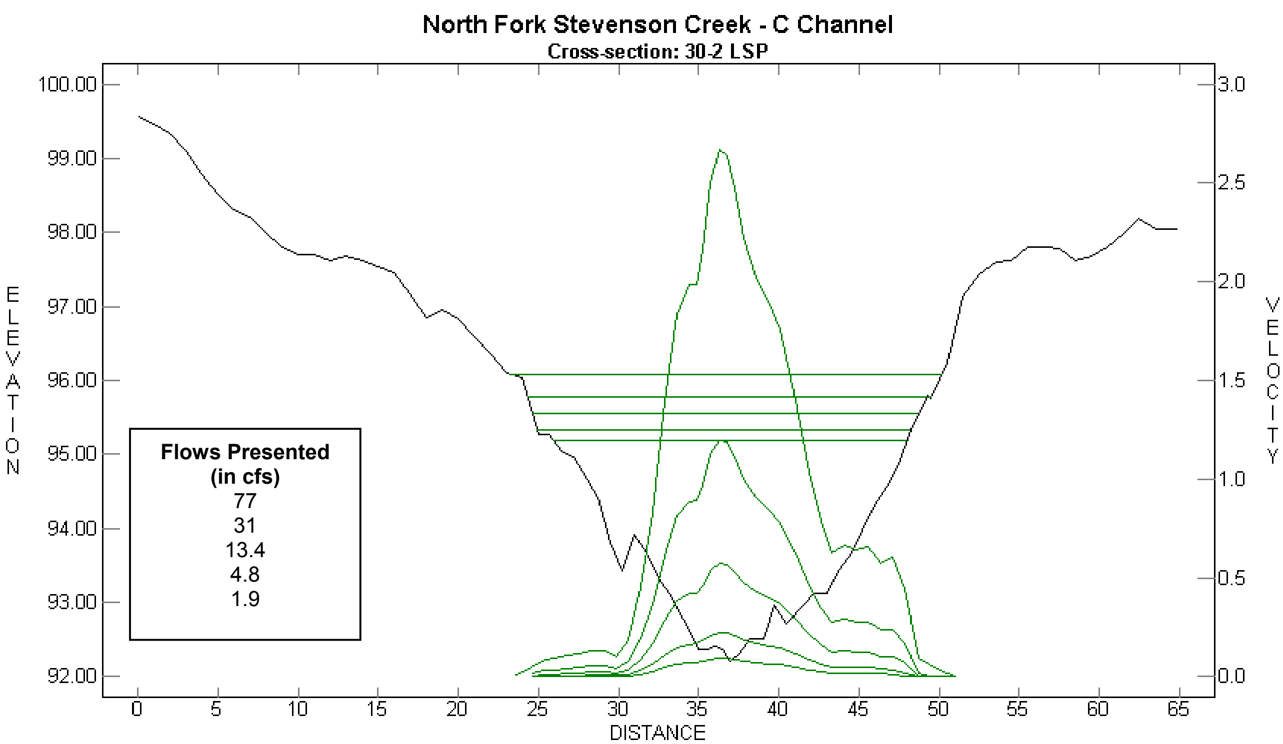

North Fork Stevenson Creek - B Channel
Cross-section: 40-2 HGR
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
4.5
3.8
3.0
2.3
1.5
0.8
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Flows Presented
(in cfs)
77
31
14.2
4.7
1.9

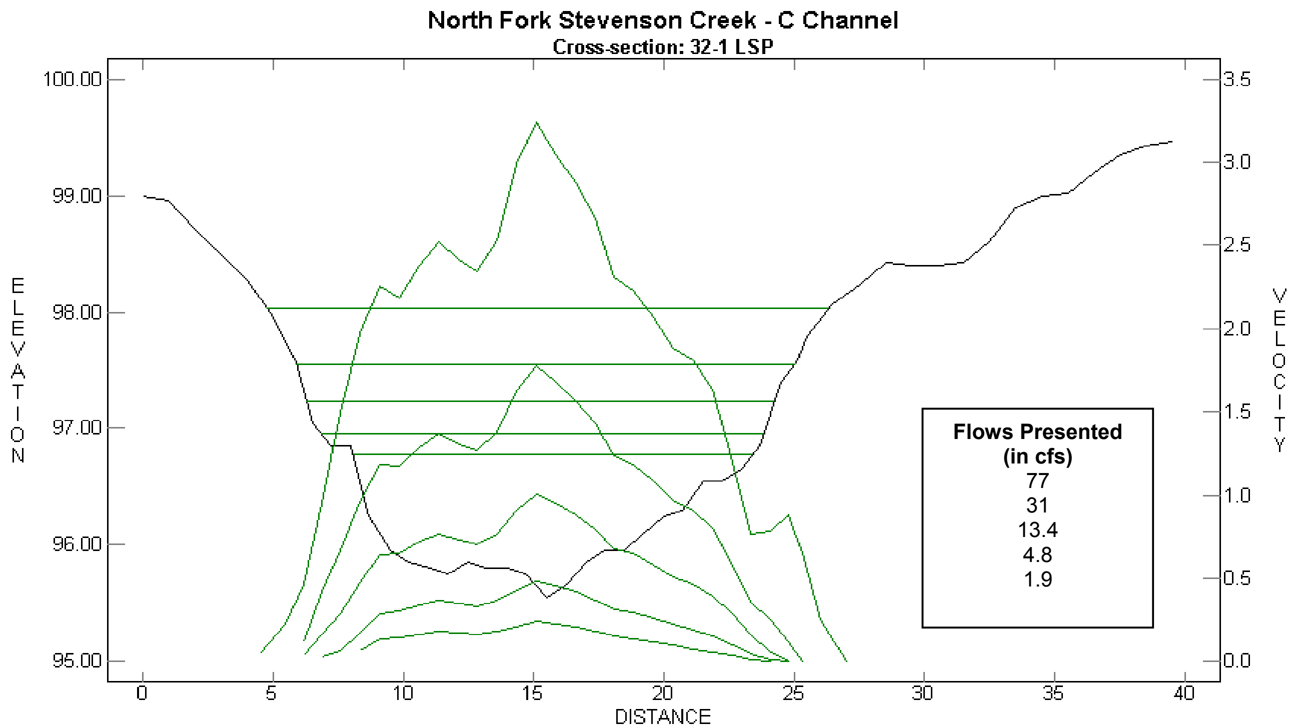

North Fork Stevenson Creek - B Channel
Cross-section: 40-3 HGR
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
4.0
3.3
2.7
2.0
1.3
0.7
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Flows Presented
(in cfs)
77
31
14.2
4.7
1.9


North Fork Stevenson Creek - C Channel
Cross-section: 29-1 LGR
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
Flows Presented
(in cfs)
77
31
13.4
4.8
1.9

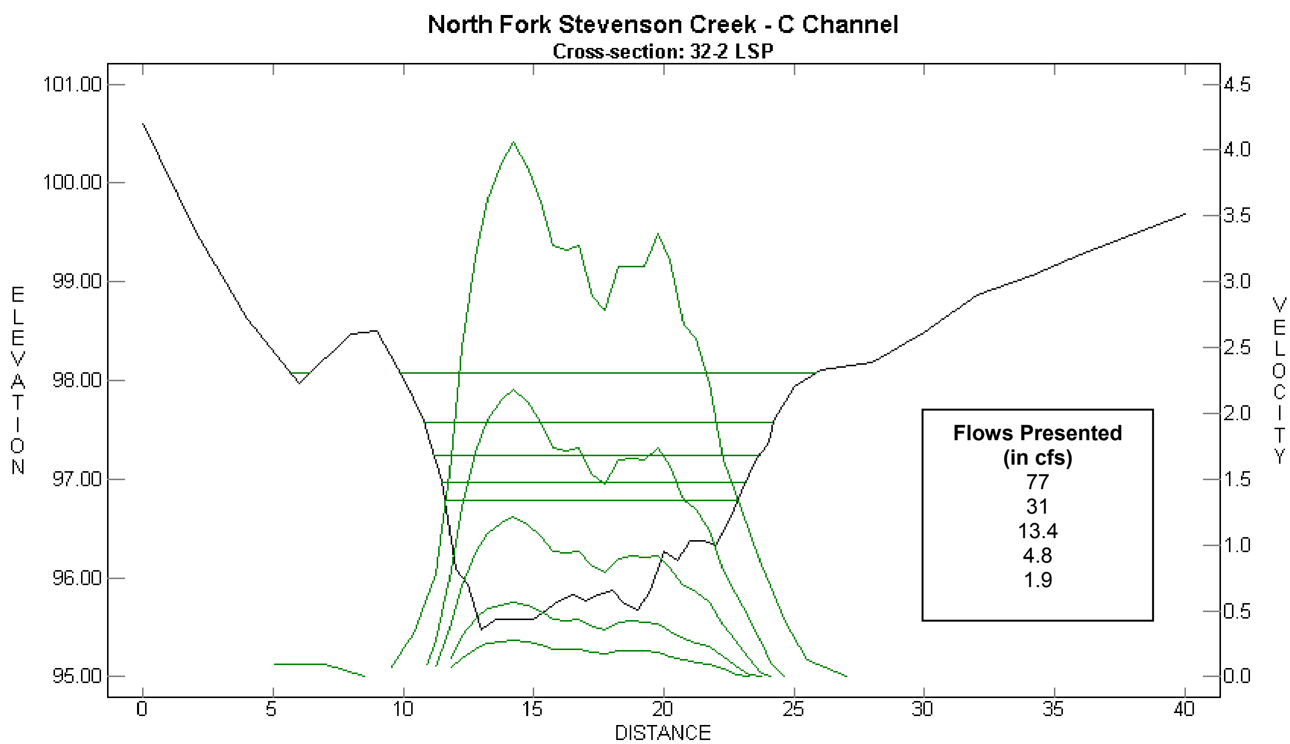

North Fork Stevenson Creek - C Channel
Cross-section: 29-2 LGR
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
Flows Presented
(in cfs)
77
31
13.4
4.8
1.9


North Fork Stevenson Creek - C Channel
Cross-section: 30-1 LSP
Flows Presented
(in cfs)
77
31
13.4
4.8
1.9
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
2.5
2.0
1.5
1.0
0.5
0.0
-5
0
5
10
15
20
25
30
35
40
45
50
55

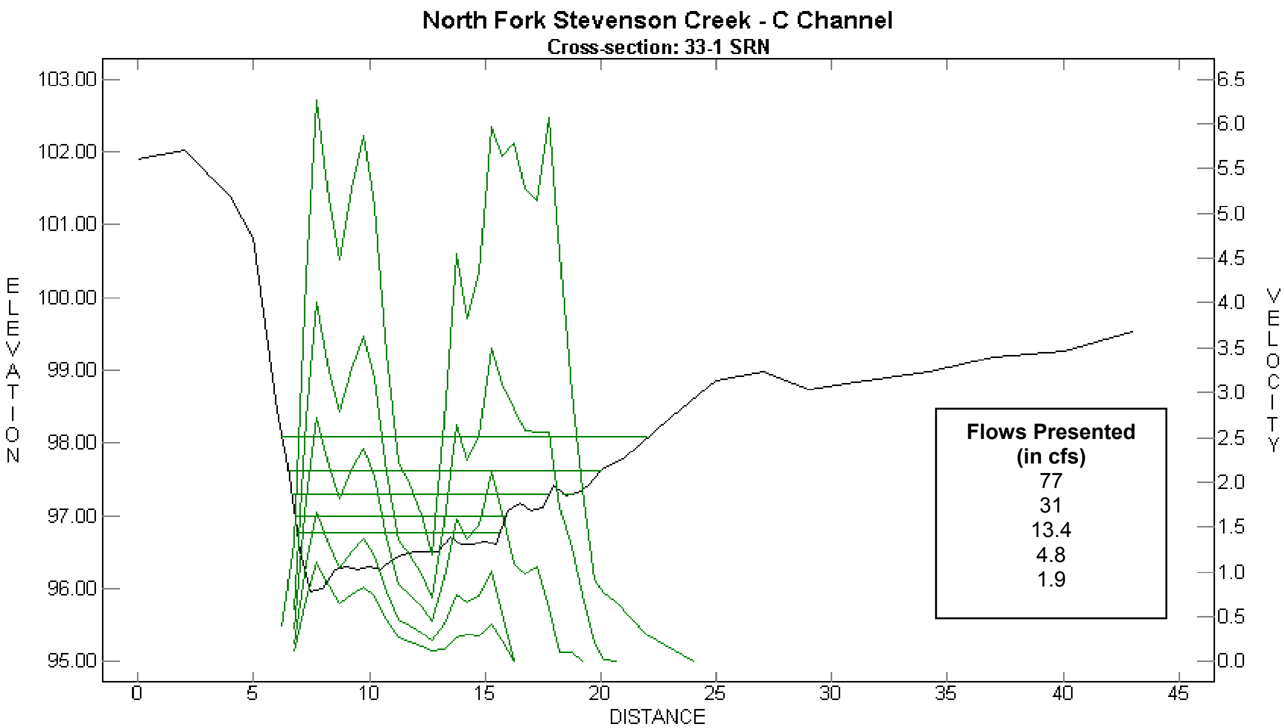

North Fork Stevenson Creek - C Channel
Cross-section: 30-2 LSP
Flows Presented
(in cfs)
77
31
13.4
4.8
1.9
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65

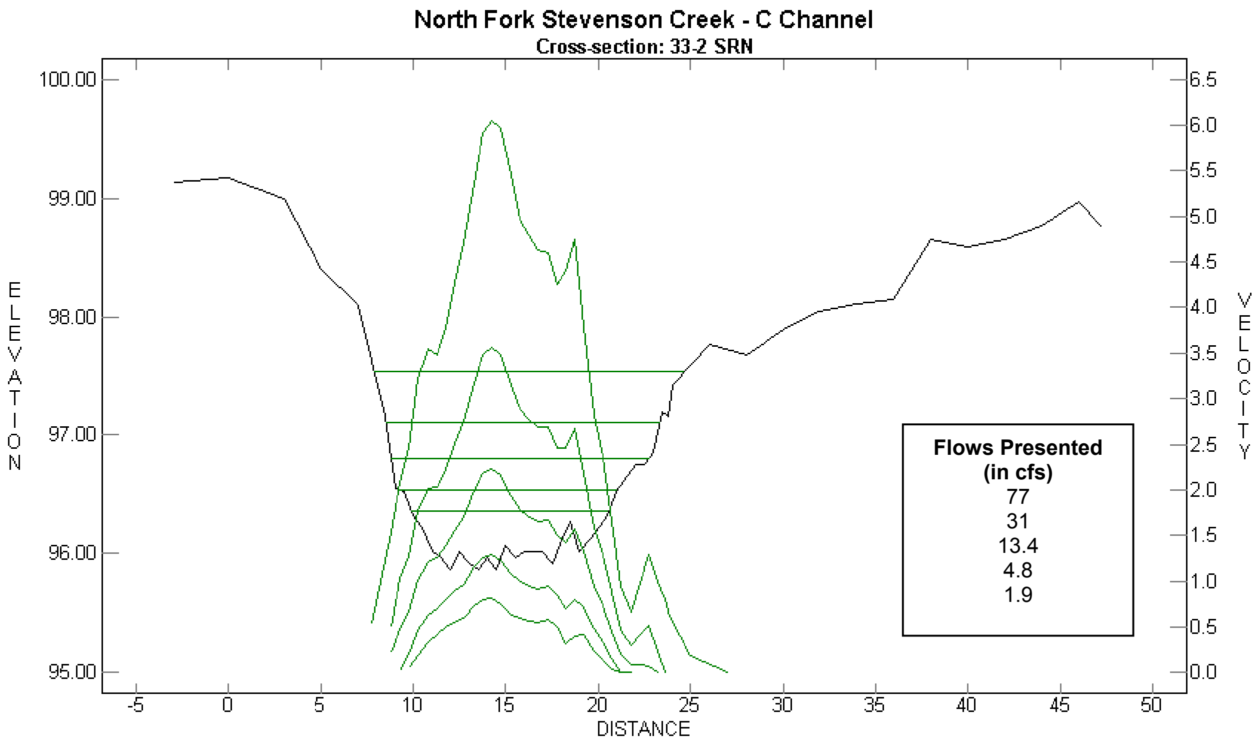


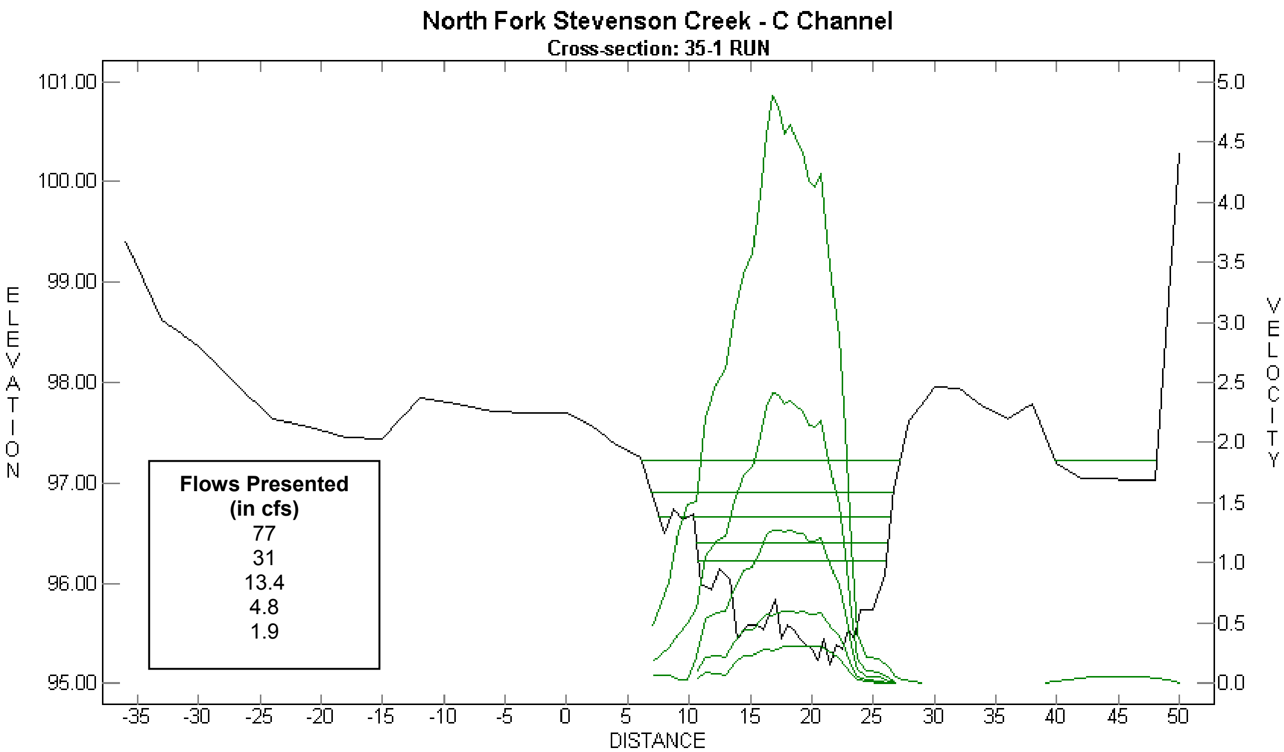
North Fork Stevenson Creek - C Channel
Cross-section: 32-1 LSP
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Flows Presented (in cfs)
77
31
13.4
4.8
1.9

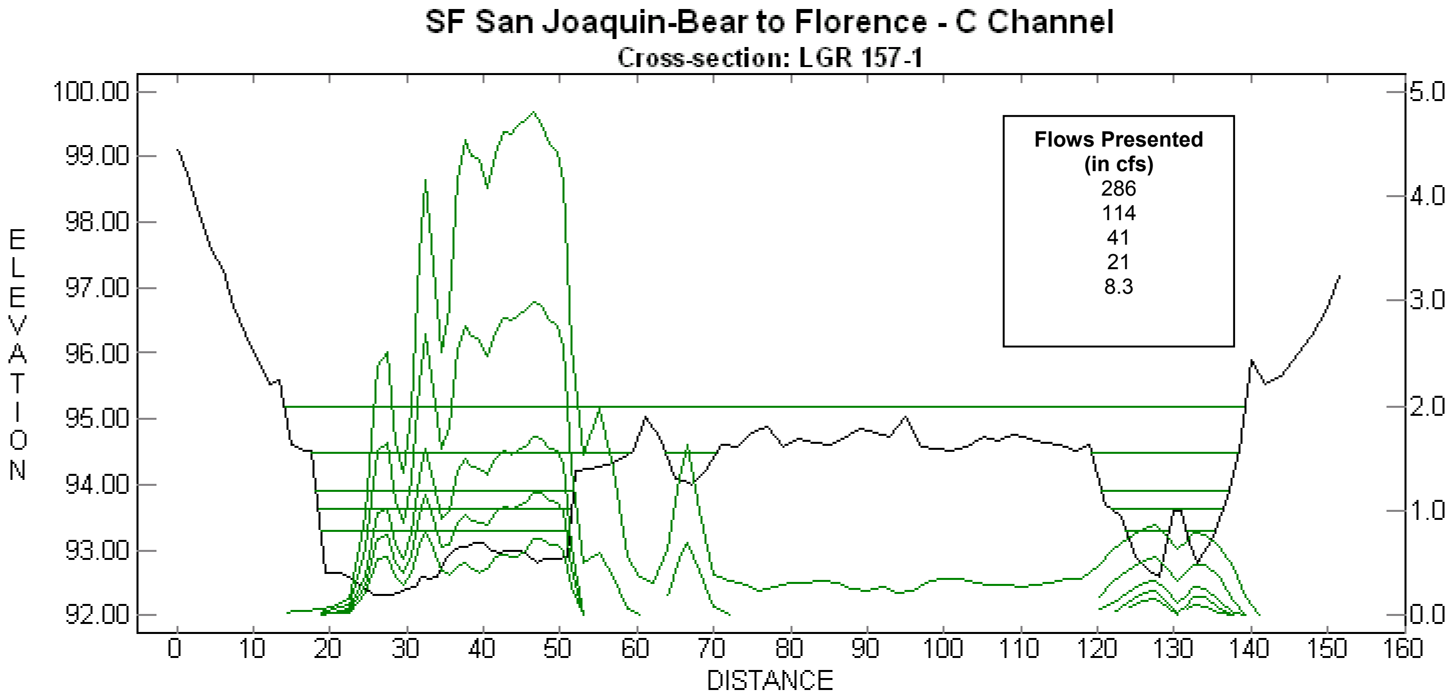


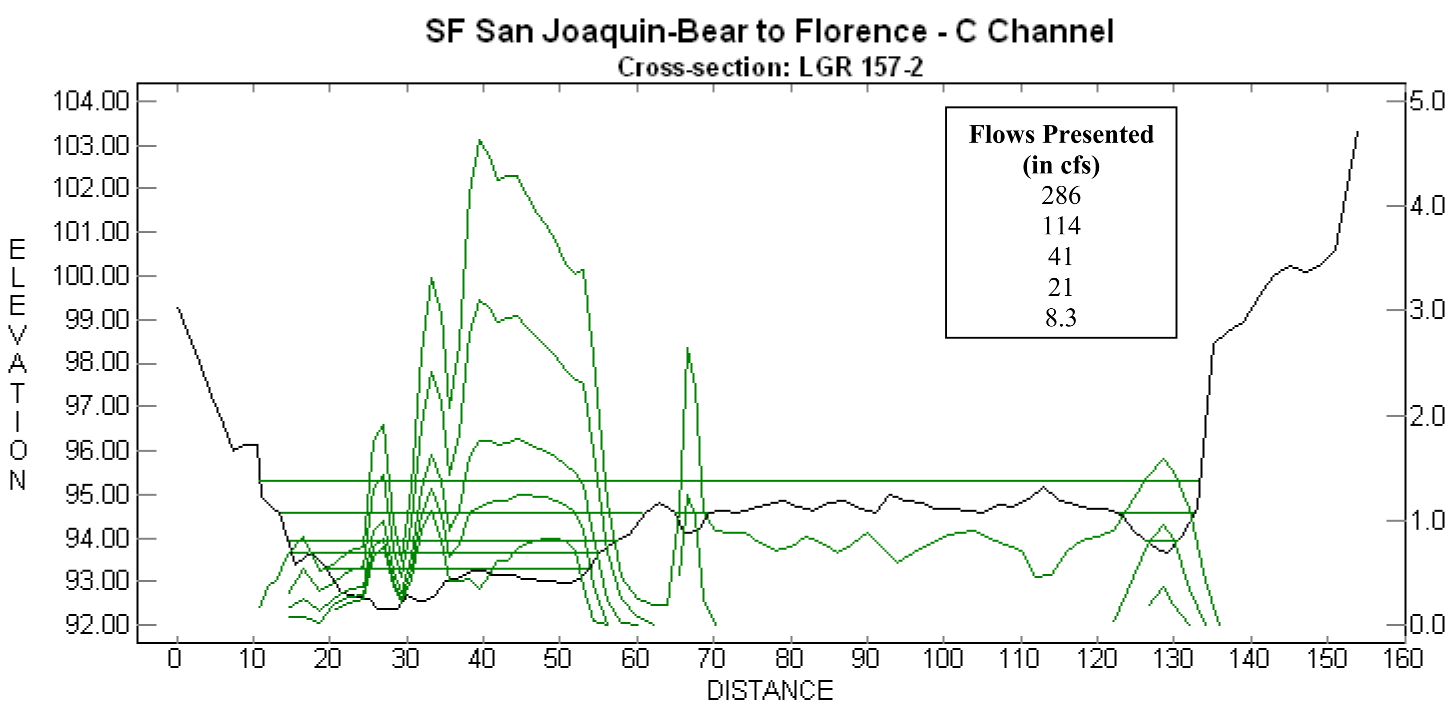
North Fork Stevenson Creek - C Channel
Cross-section: 32-2 LSP
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Flows Presented (in cfs)
77
31
13.4
4.8
1.9

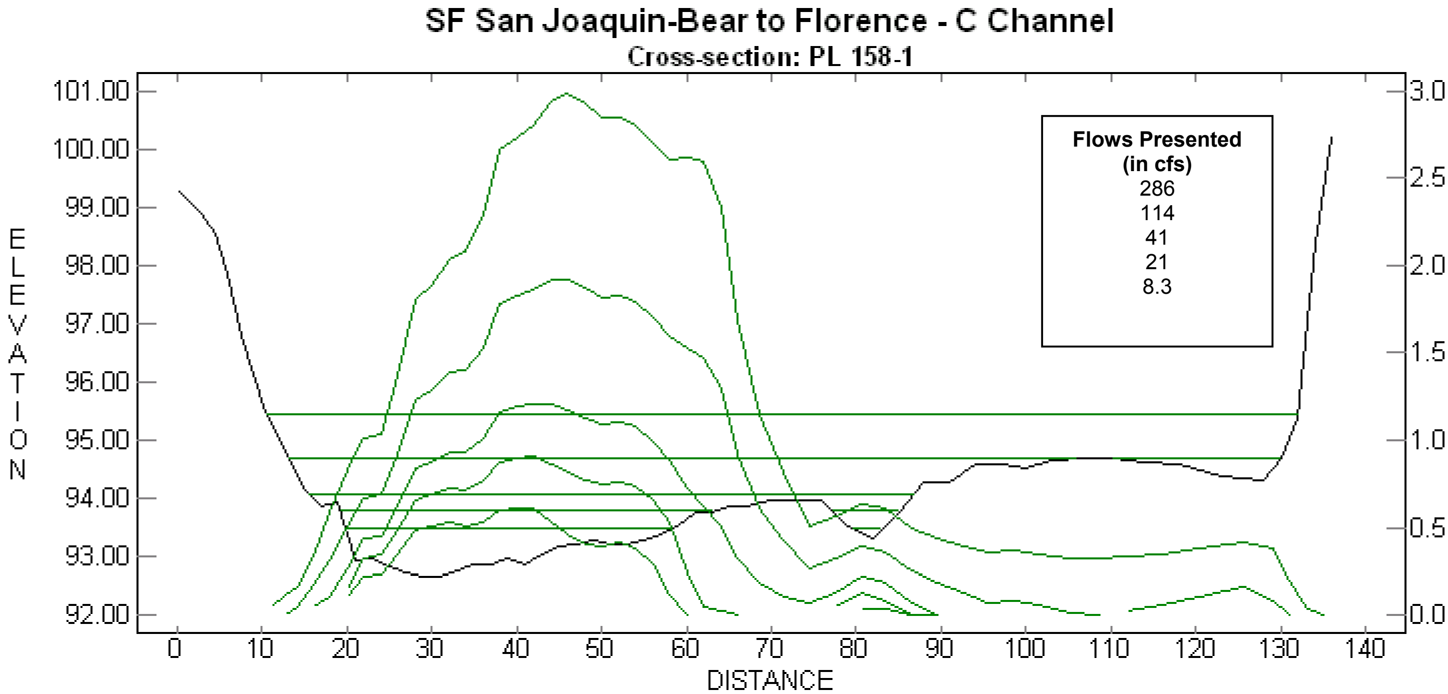

North Fork Stevenson Creek - C Channel
Cross-section: 33-1 SRN
ELEVATION
VELOCITY
DISTANCE
Flows Presented (in cfs)
77
31
13.4
4.8
1.9

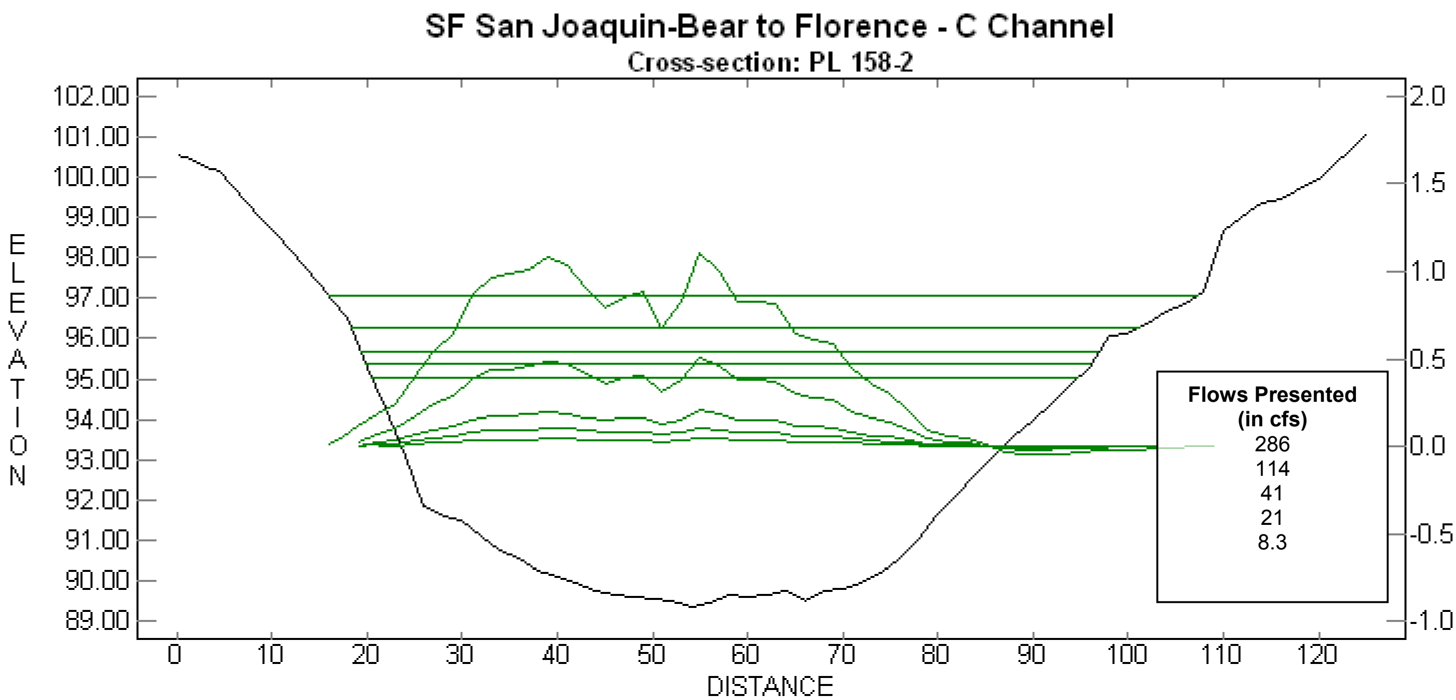

North Fork Stevenson Creek - C Channel
Cross-section: 33-2 SRN
ELEVATION
VELOCITY
DISTANCE
Flows Presented (in cfs)
77
31
13.4
4.8
1.9

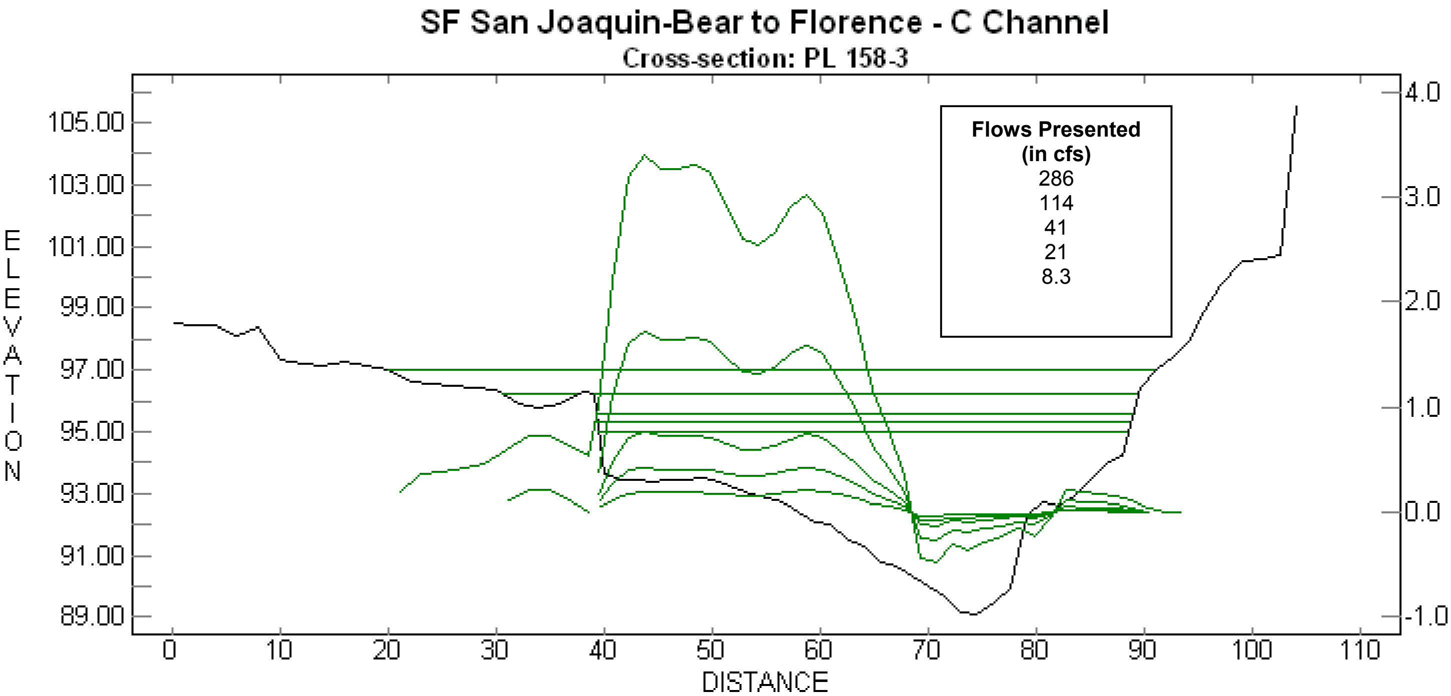

North Fork Stevenson Creek - C Channel
Cross-section: 35-1 RUN
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
45
50
Flows Presented
(in cfs)
77
31
13.4
4.8
1.9

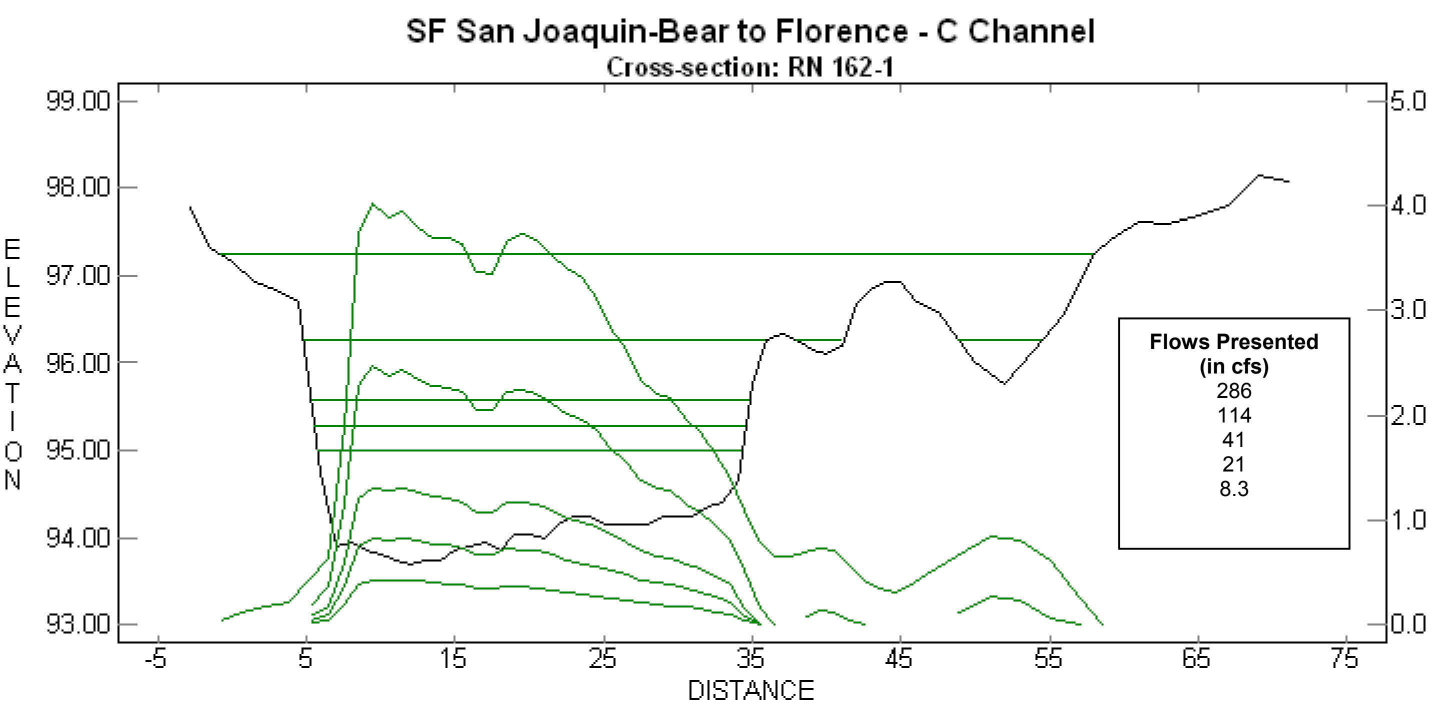

SF San Joaquin-Bear to Florence - C Channel
Cross-section: LGR 157-1
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
5.0
4.0
3.0
2.0
1.0
0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Flows Presented
(in cfs)
286
114
41
21
8.3

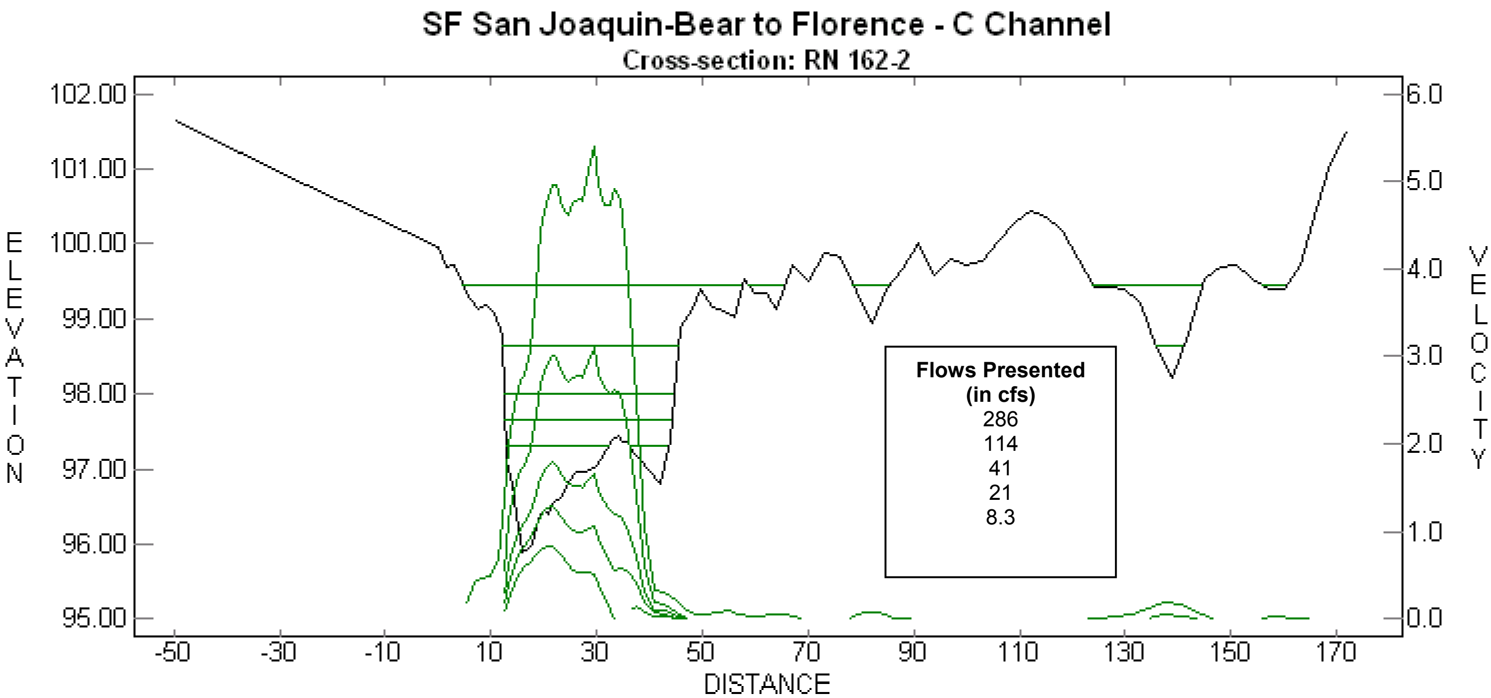

SF San Joaquin-Bear to Florence - C Channel
Cross-section: LGR 157-2
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
5.0
4.0
3.0
2.0
1.0
0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Flows Presented
(in cfs)
286
114
41
21
8.3

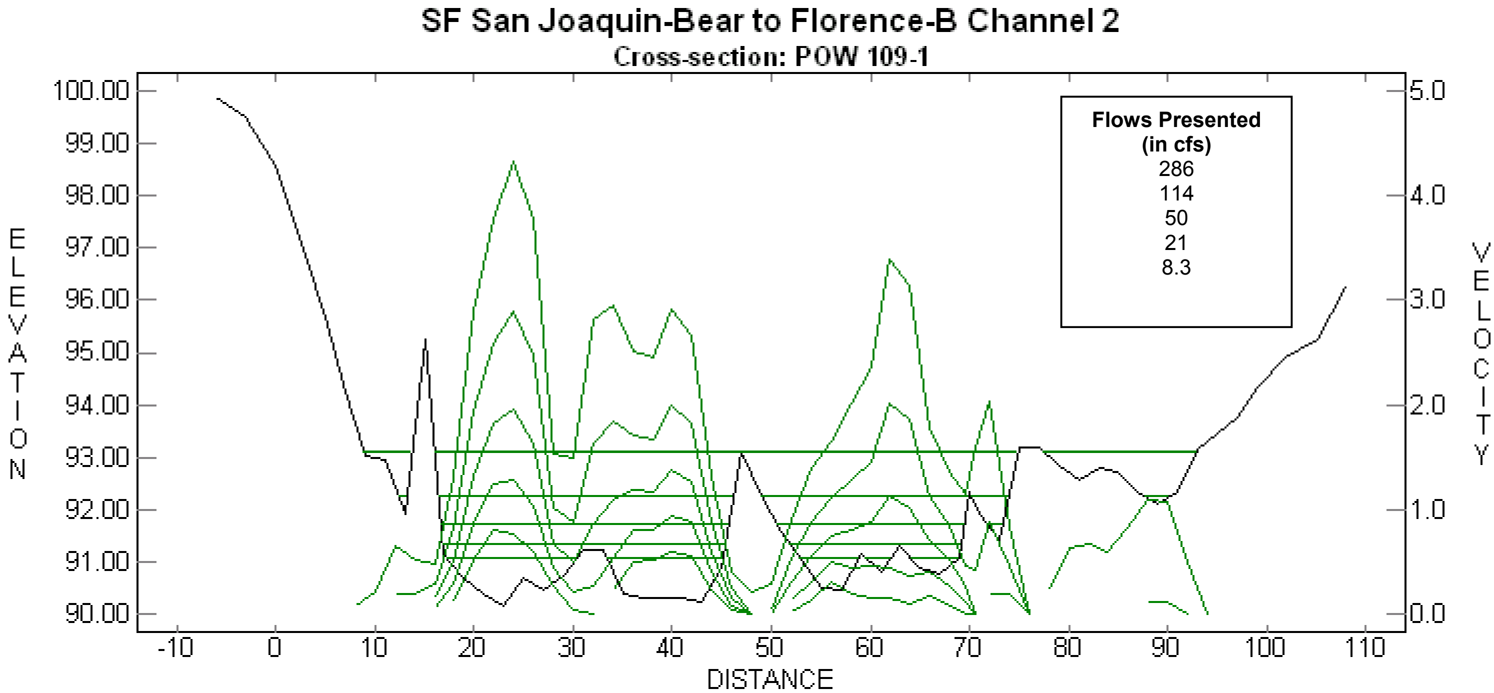

SF San Joaquin-Bear to Florence - C Channel
Cross-section: PL 158-1
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Flows Presented
(in cfs)
286
114
41
21
8.3


SF San Joaquin-Bear to Florence - C Channel
Cross-section: PL 158-2
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
10
20
30
40
50
60
70
80
90
100
110
120
Flows Presented
(in cfs)
286
114
41
21
8.3

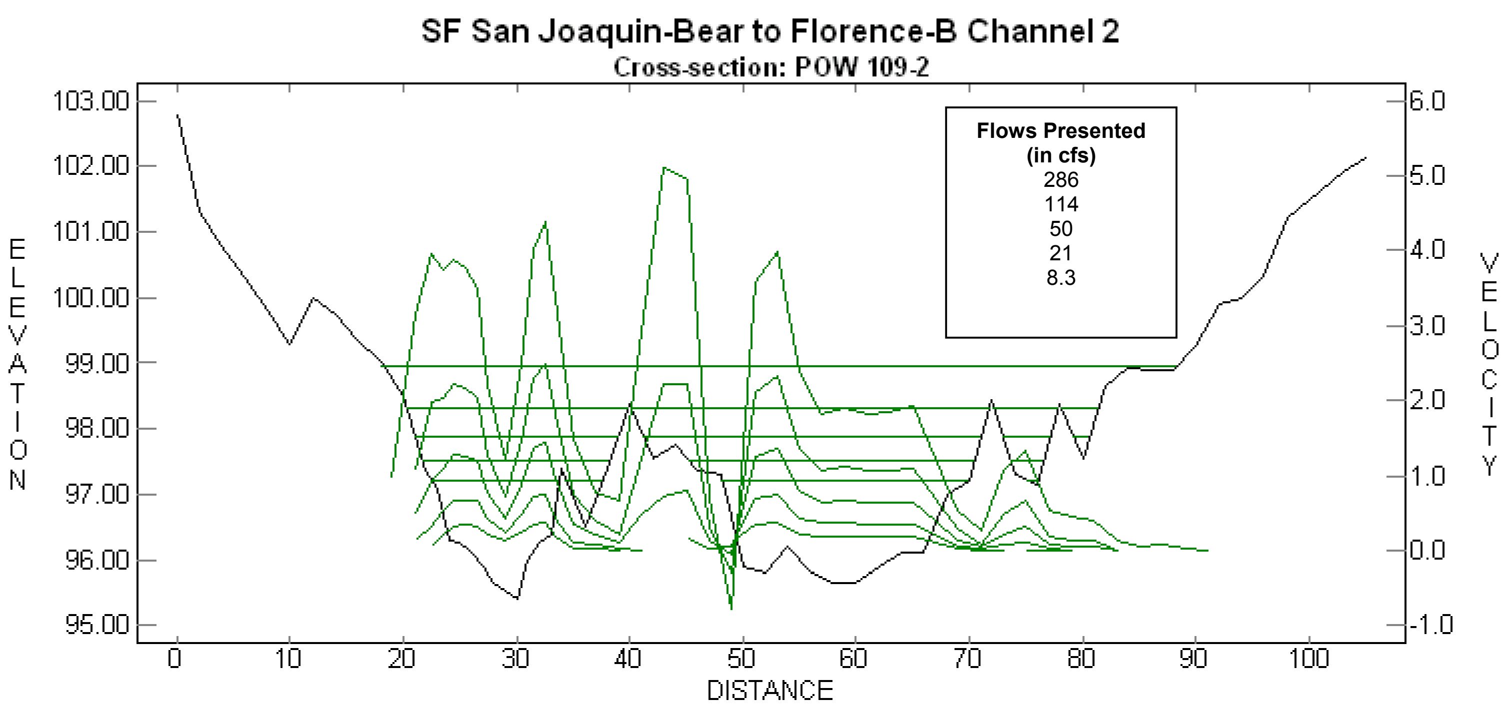

SF San Joaquin-Bear to Florence - C Channel
Cross-section: PL 158-3
ELEVATION
105.00
103.00
101.00
99.00
97.00
95.00
93.00
91.00
89.00
VELOCITY
4.0
3.0
2.0
1.0
0.0
-1.0
DISTANCE
0
10
20
30
40
50
60
70
80
90
100
110
Flows Presented
(in cfs)
286
114
41
21
8.3


SF San Joaquin-Bear to Florence - C Channel
Cross-section: RN 162-1
ELEVATION
99.00
98.00
97.00
96.00
95.00
94.00
93.00
VELOCITY
5.0
4.0
3.0
2.0
1.0
0.0
DISTANCE
-5
5
15
25
35
45
55
65
75
Flows Presented
(in cfs)
286
114
41
21
8.3

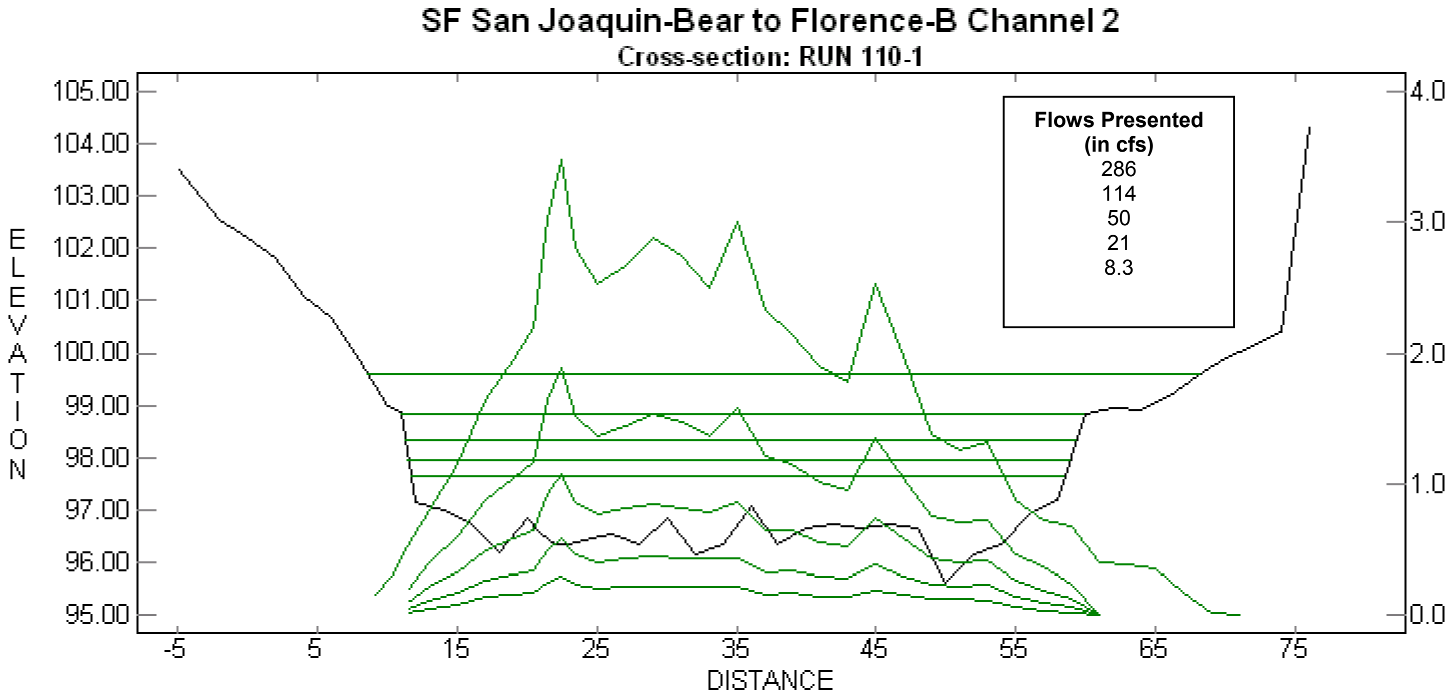

SF San Joaquin-Bear to Florence - C Channel
Cross-section: RN 162-2
ELEVATION
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
VELOCITY
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-50
-30
-10
10
30
50
70
90
110
130
150
170
DISTANCE
Flows Presented
(in cfs)
286
114
41
21
8.3

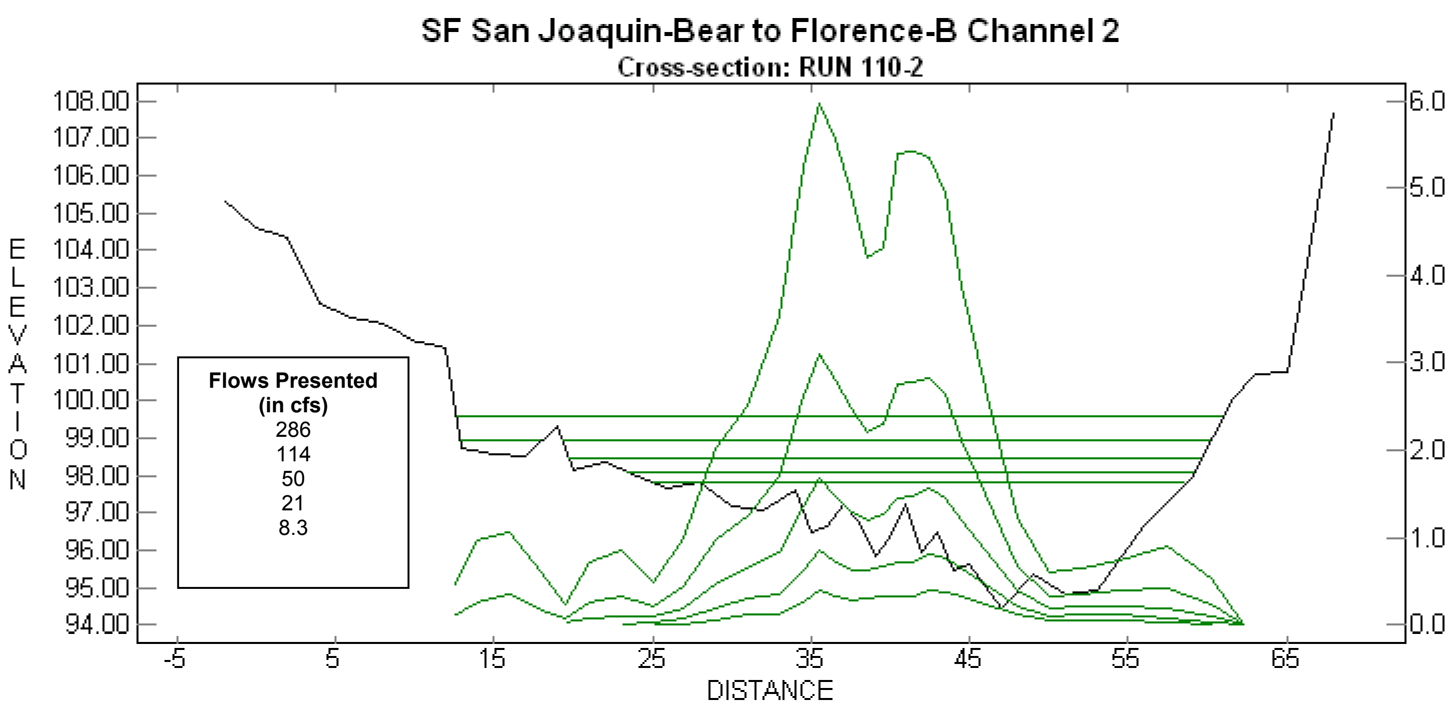


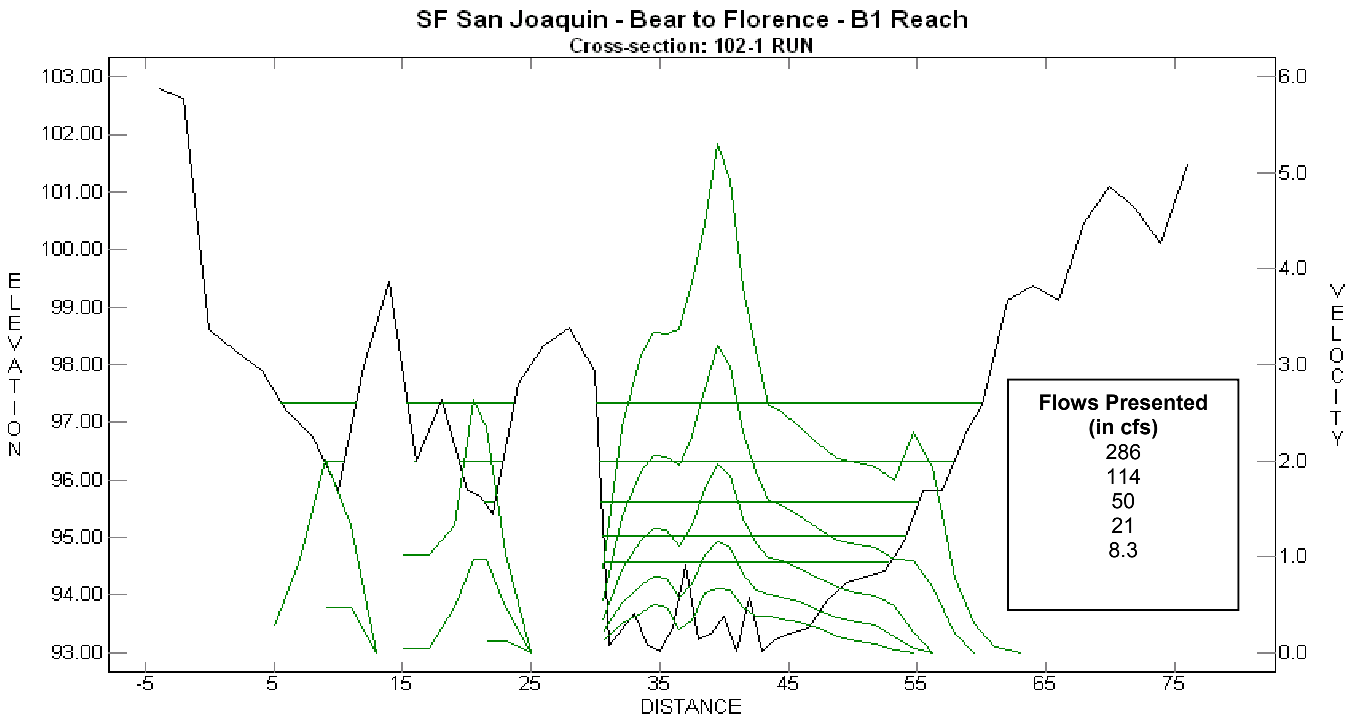
SF San Joaquin-Bear to Florence-B Channel 2
Cross-section: POW 109-1
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
5.0
4.0
3.0
2.0
1.0
0.0
-10
0
10
20
30
40
50
60
70
80
90
100
110

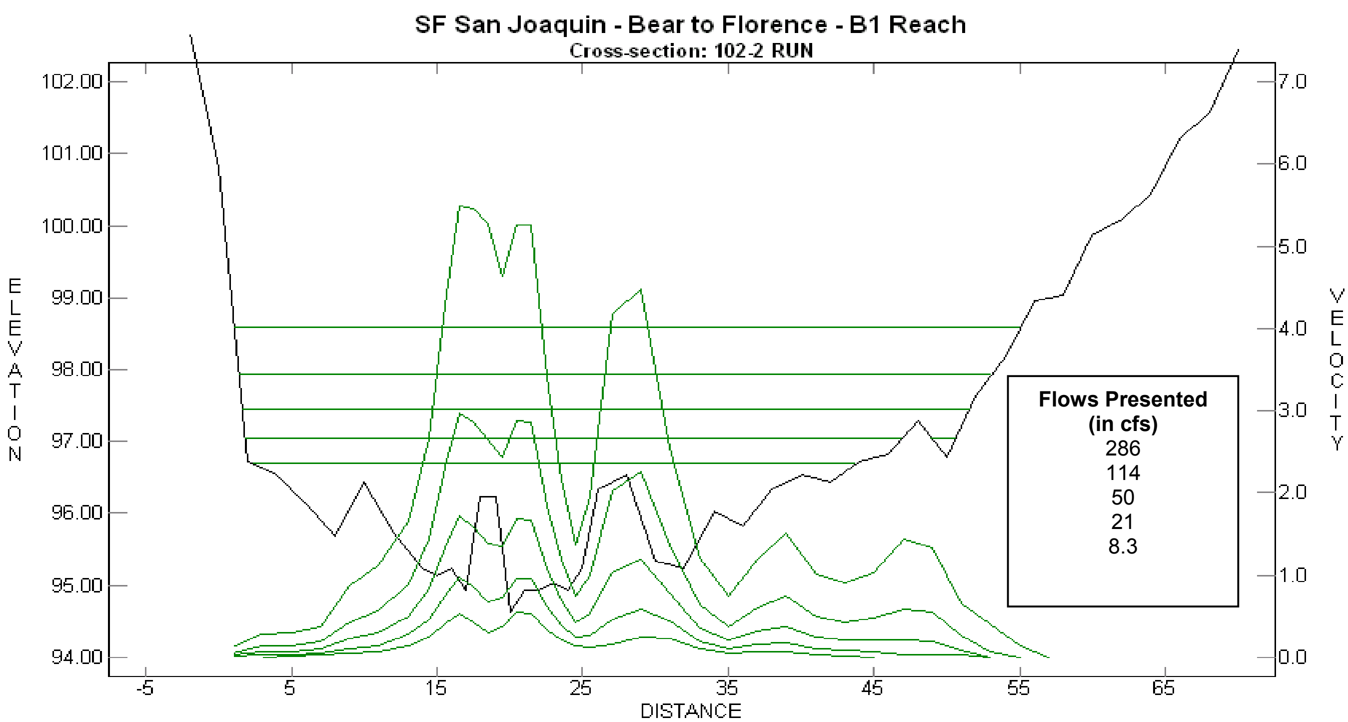


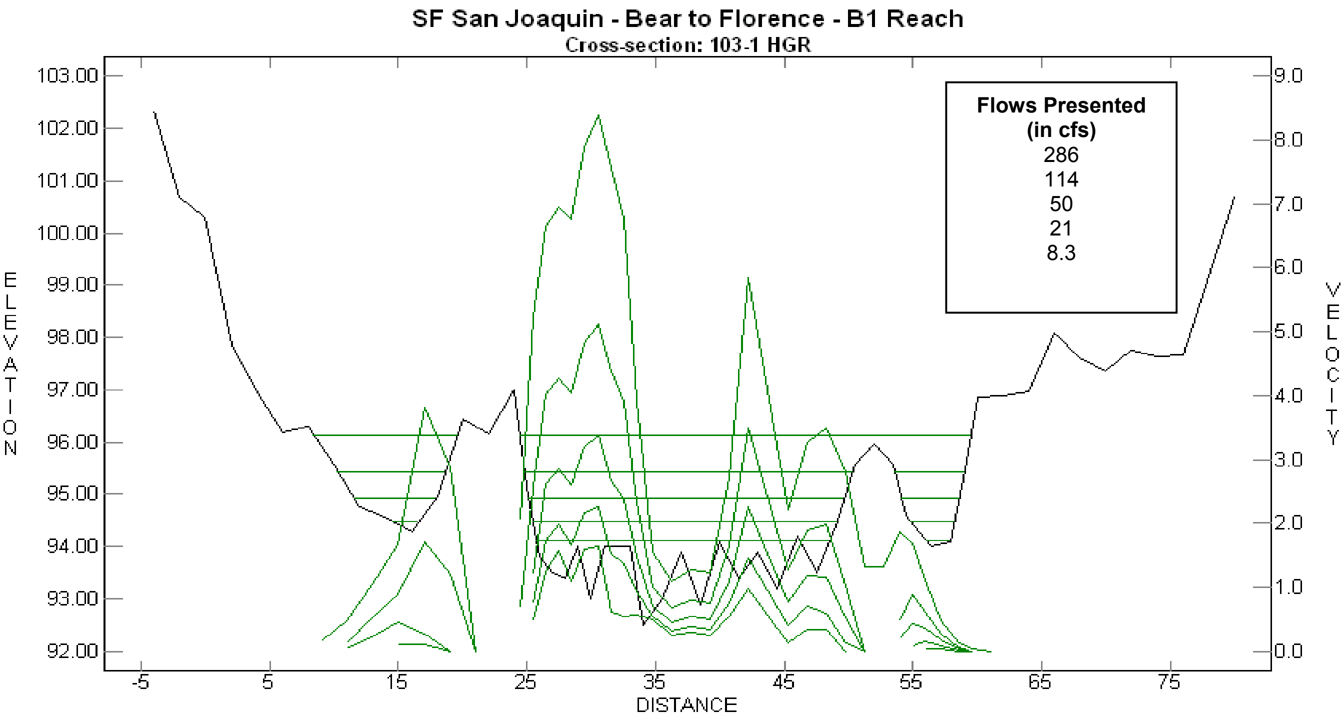
SF San Joaquin-Bear to Florence-B Channel 2
Cross-section: POW 109-2
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0
10
20
30
40
50
60
70
80
90
100

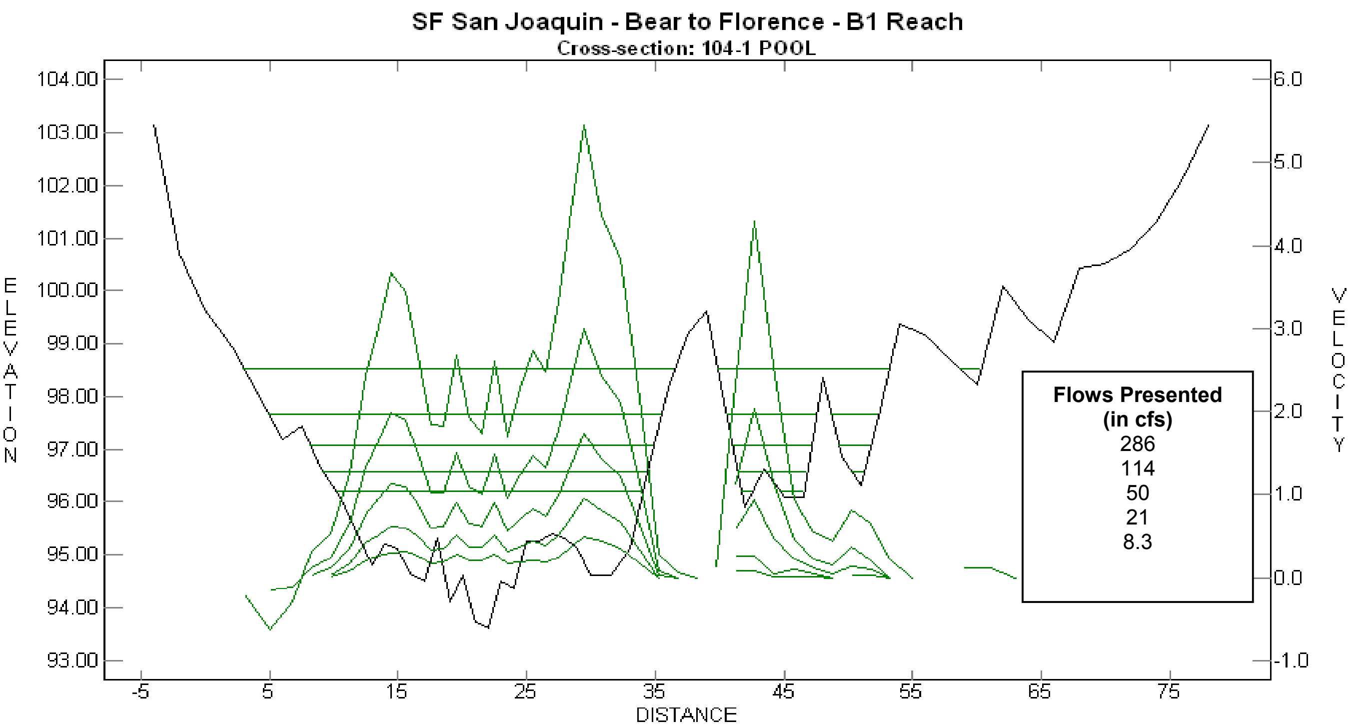

SF San Joaquin-Bear to Florence-B Channel 2
Cross-section: RUN 110-1
Flows Presented (in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
4.0
3.0
2.0
1.0
0.0
-5
5
15
25
35
45
55
65
75


SF San Joaquin-Bear to Florence-B Channel 2
Cross-section: RUN 110-2
Flows Presented (in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
108.00
107.00
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-5
5
15
25
35
45
55
65


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 102-1 RUN
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
286
114
50
21
8.3


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 102-2 RUN
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
286
114
50
21
8.3


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 103-1 HGR
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-5
5
15
25
35
45
55
65
75


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 104-1 POOL
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-5
5
15
25
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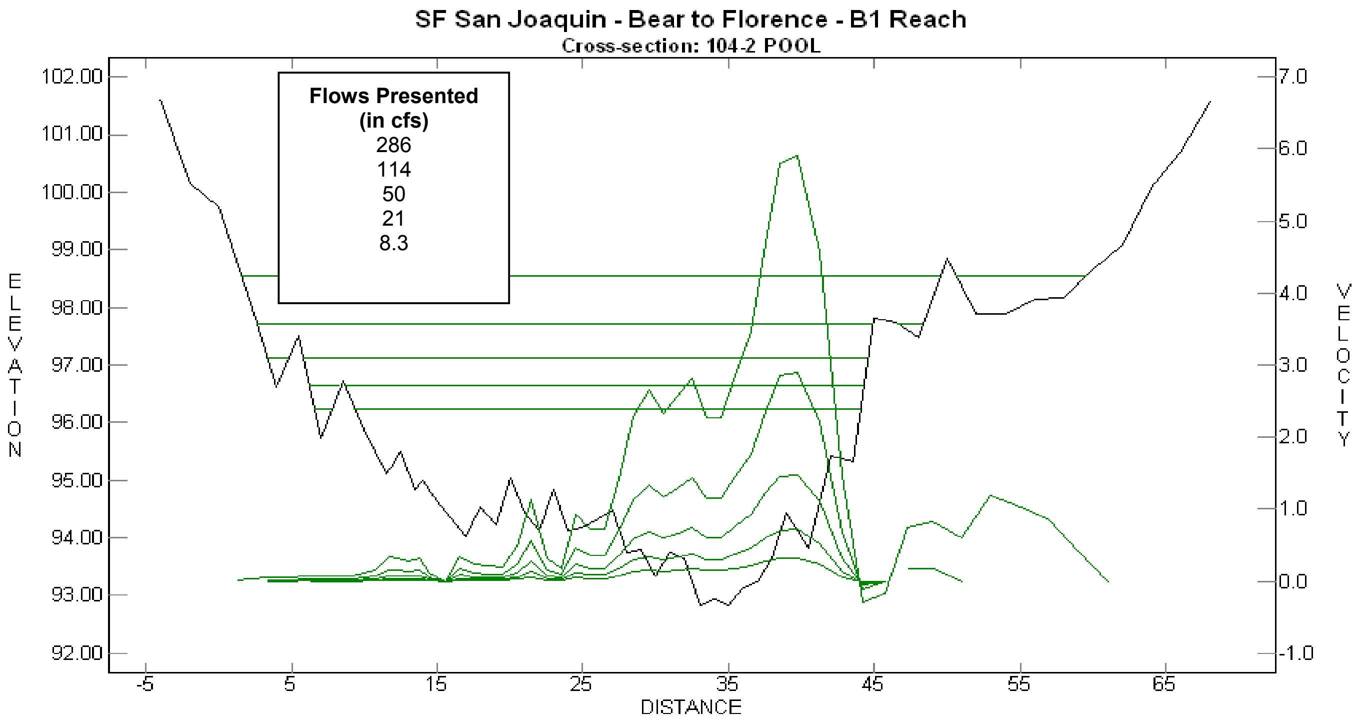
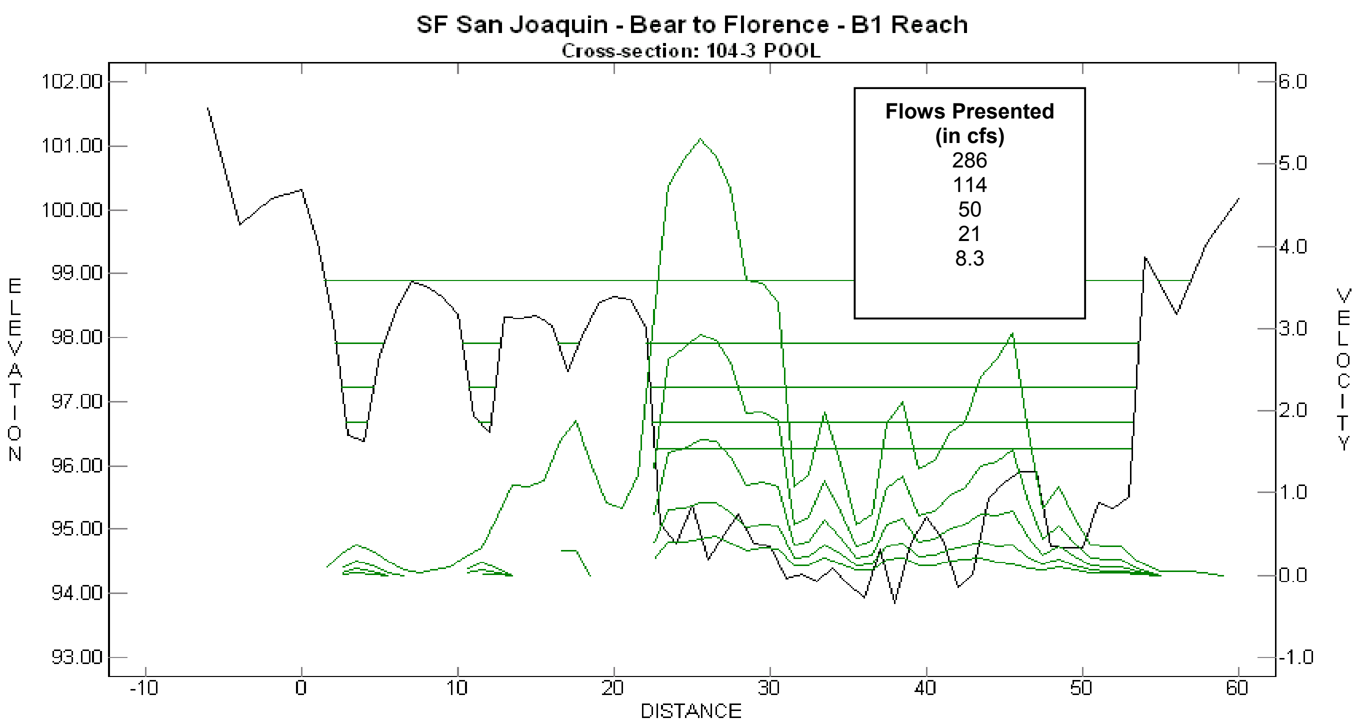
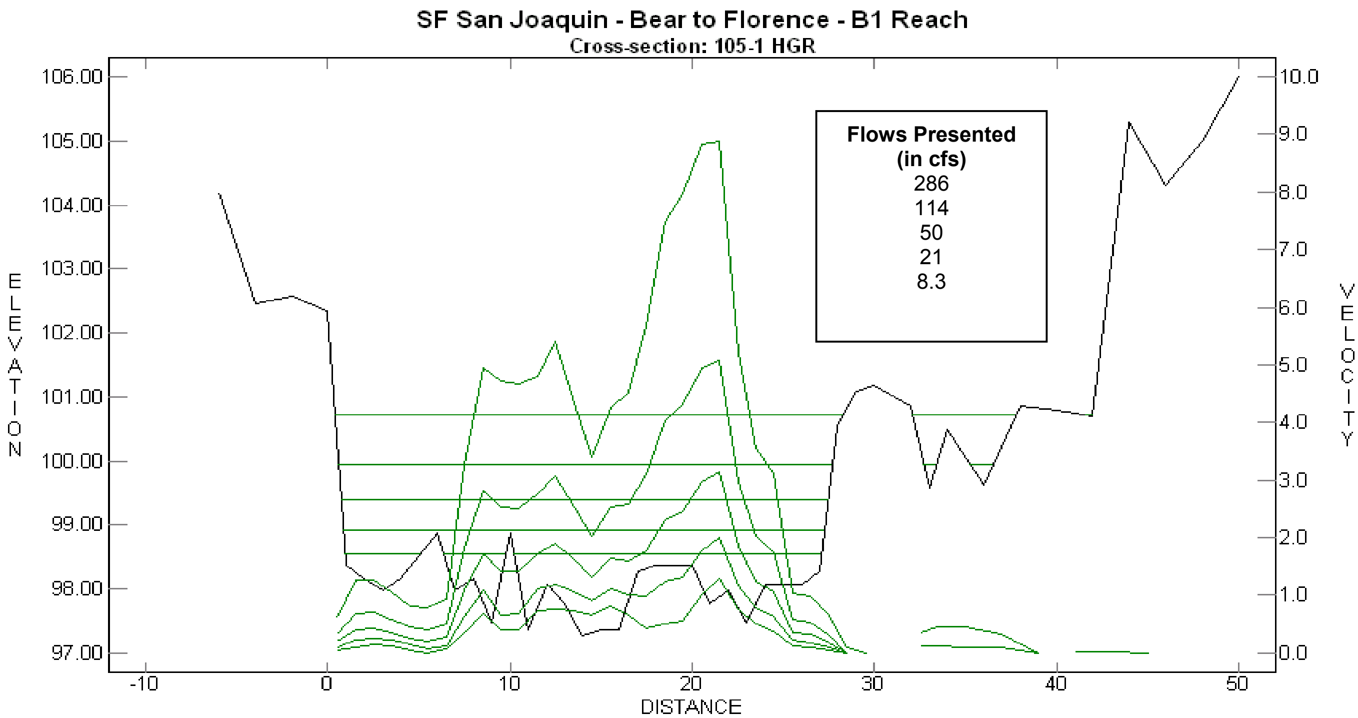
45
55
65
75


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 104-2 POOL
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-5
5
15
25
35
45
55
65


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 104-3 POOL
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-10
0
10
20
30
40
50
60


SF San Joaquin - Bear to Florence - B1 Reach
Cross-section: 105-1 HGR
Flows Presented
(in cfs)
286
114
50
21
8.3
ELEVATION
VELOCITY
DISTANCE
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
10.0
9.0
8.0
7.0
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4.0
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2.0
1.0
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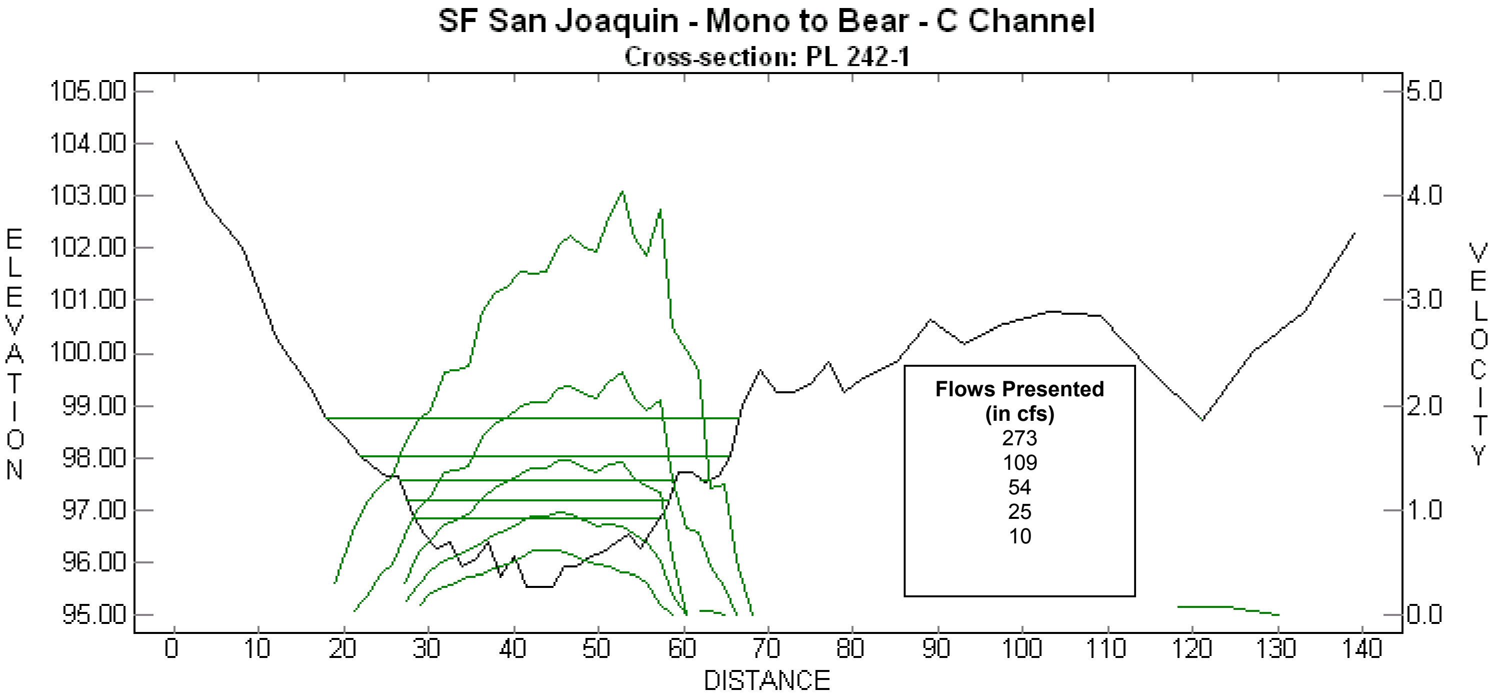
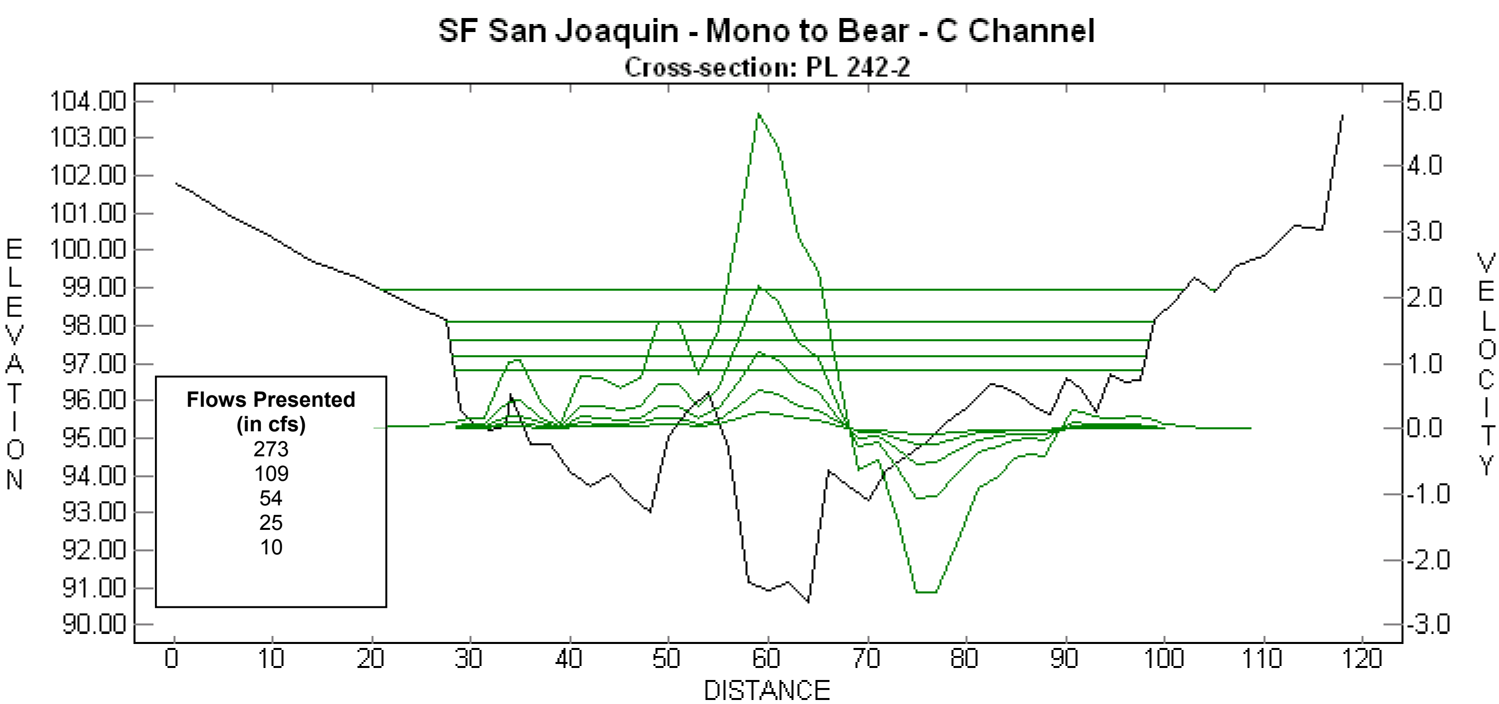
-10
0
10
20
30
40
50


SF San Joaquin - Mono to Bear - C Channel
Cross-section: PL 242-1
ELEVATION
VELOCITY
DISTANCE
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Flows Presented
(in cfs)
273
109
54
25
10


SF San Joaquin - Mono to Bear - C Channel
Cross-section: PL 242-2
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
0
10
20
30
40
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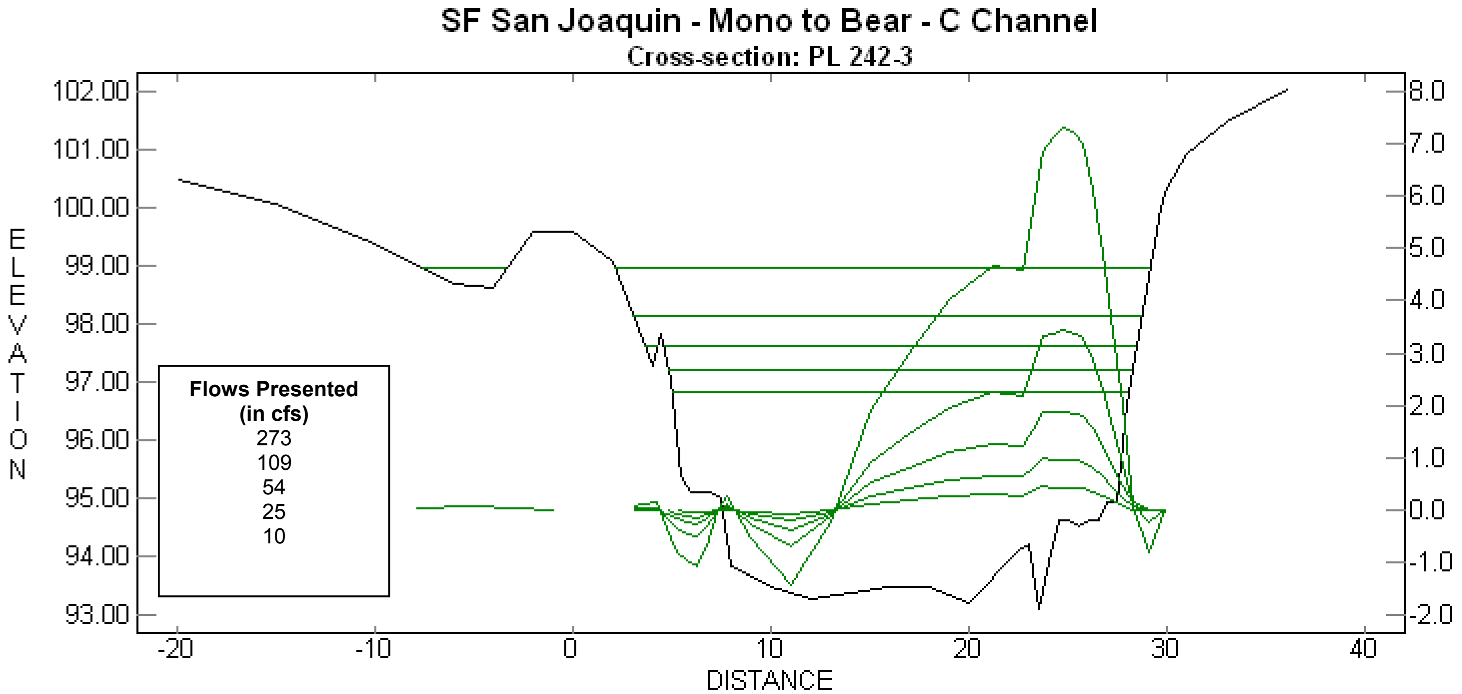
60
70
80
90
100
110
120
Flows Presented
(in cfs)
273
109
54
25
10


SF San Joaquin - Mono to Bear - C Channel
Cross-section: PL 242-3
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
273
109
54
25
10
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
8.0
7.0
6.0
5.0
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1.0
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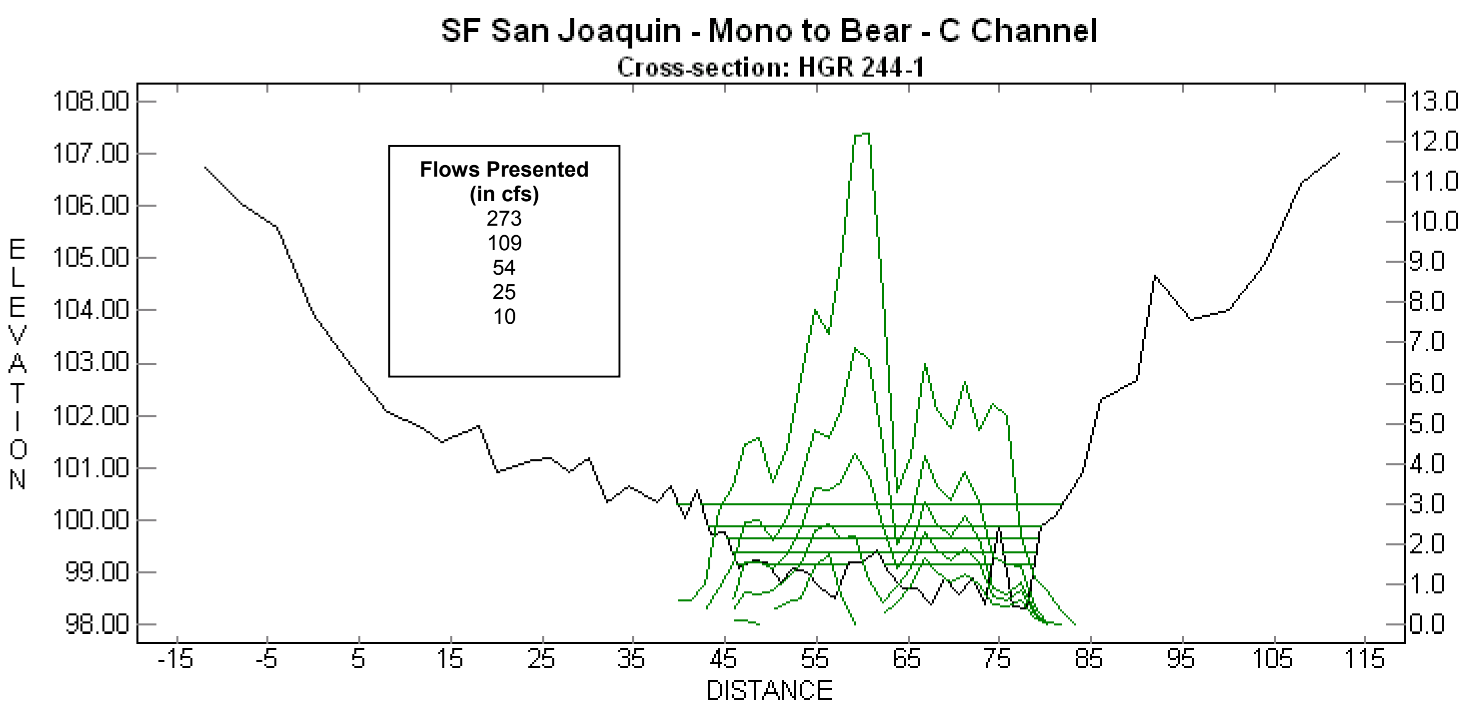
-1.0
-2.0
-20
-10
0
10
20
30
40


SF San Joaquin - Mono to Bear - C Channel
Cross-section: HGR 244-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
273
109
54
25
10
108.00
107.00
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
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-15
-5
5
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25
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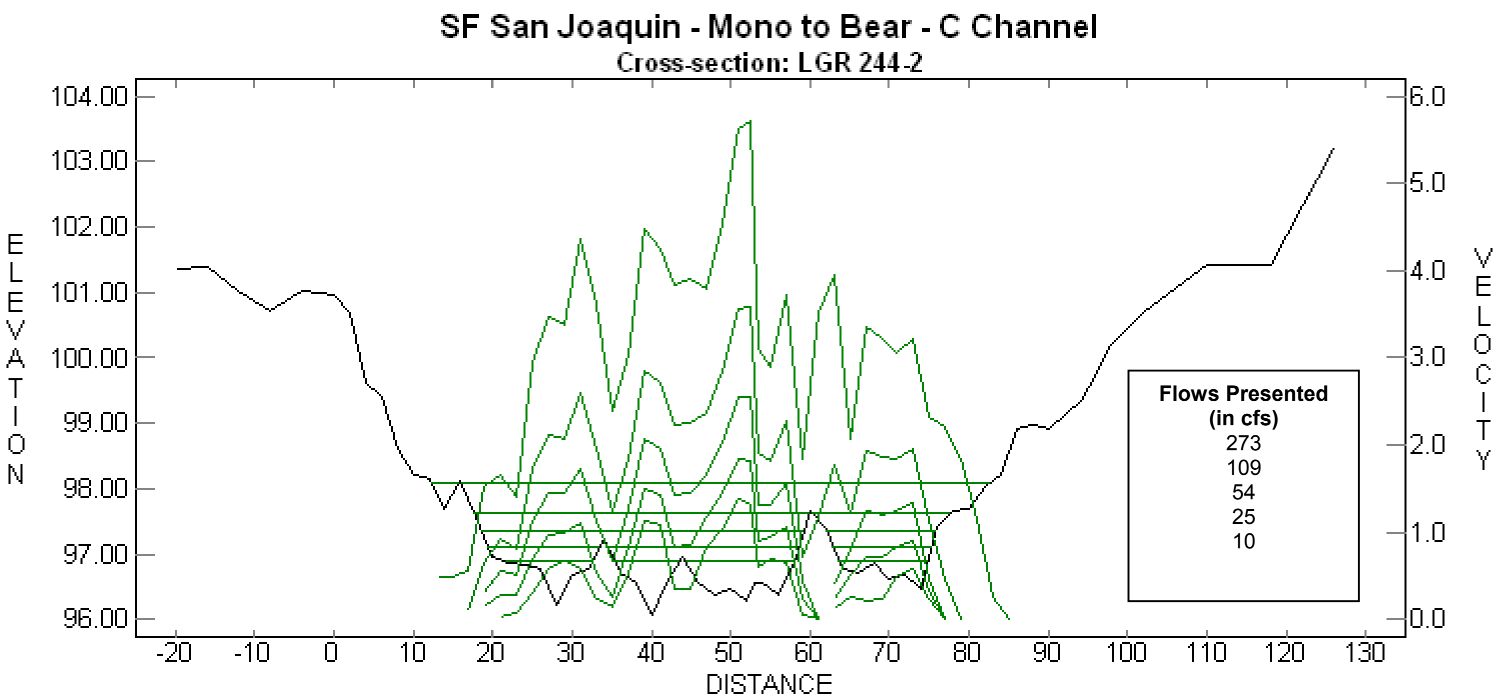
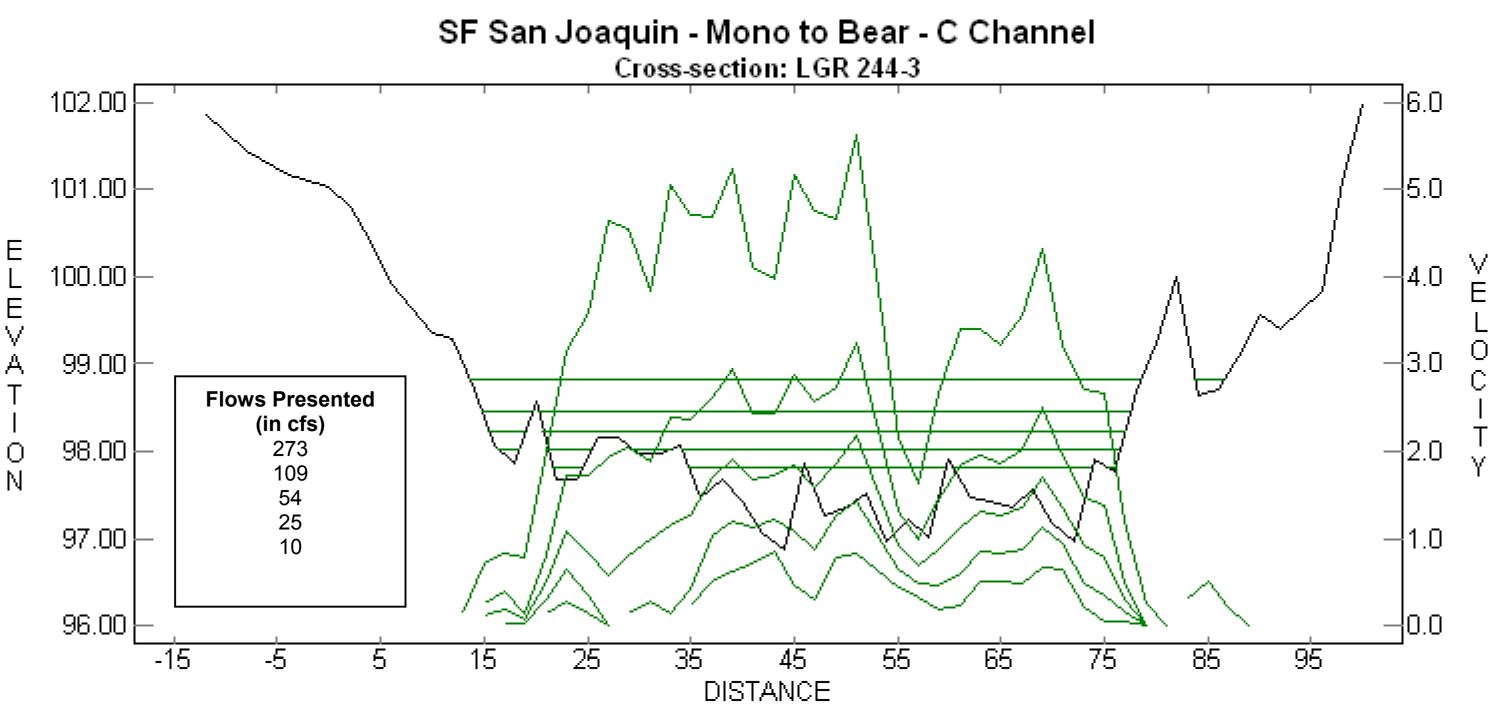
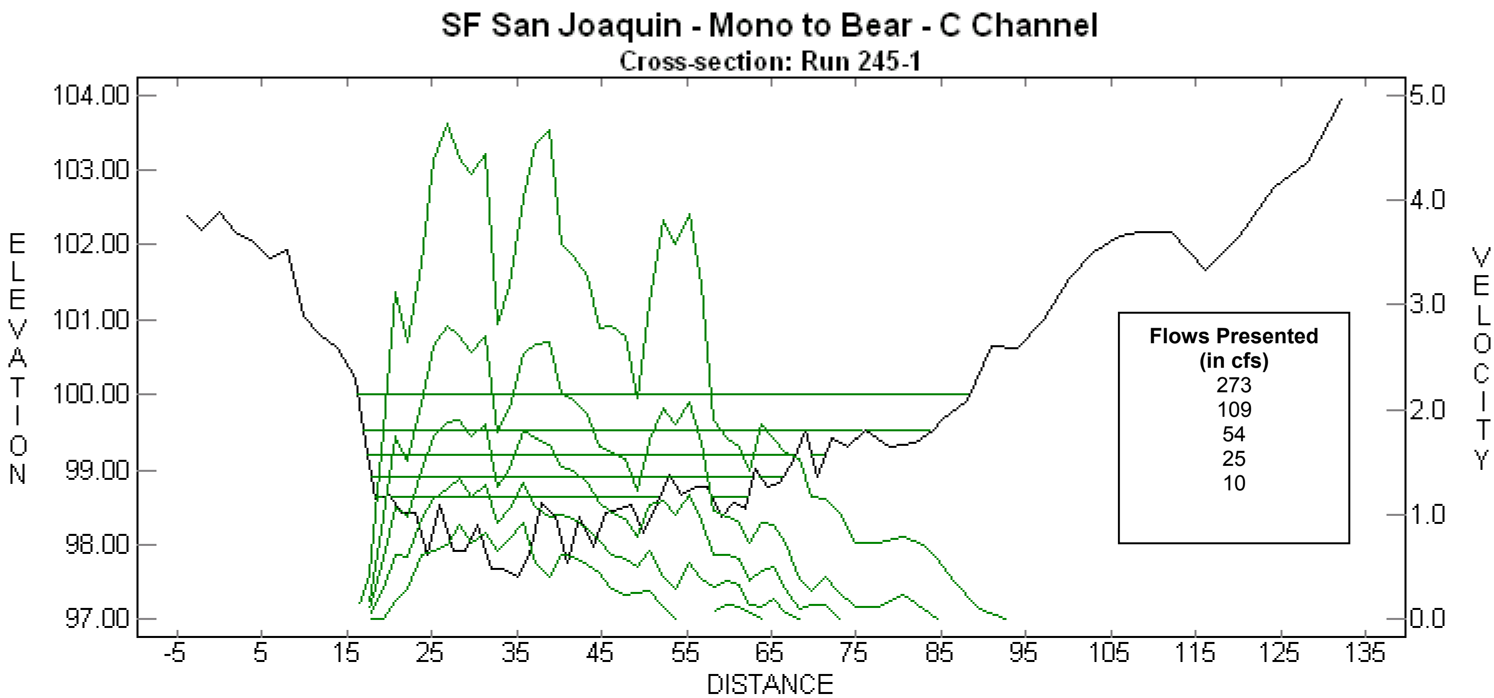
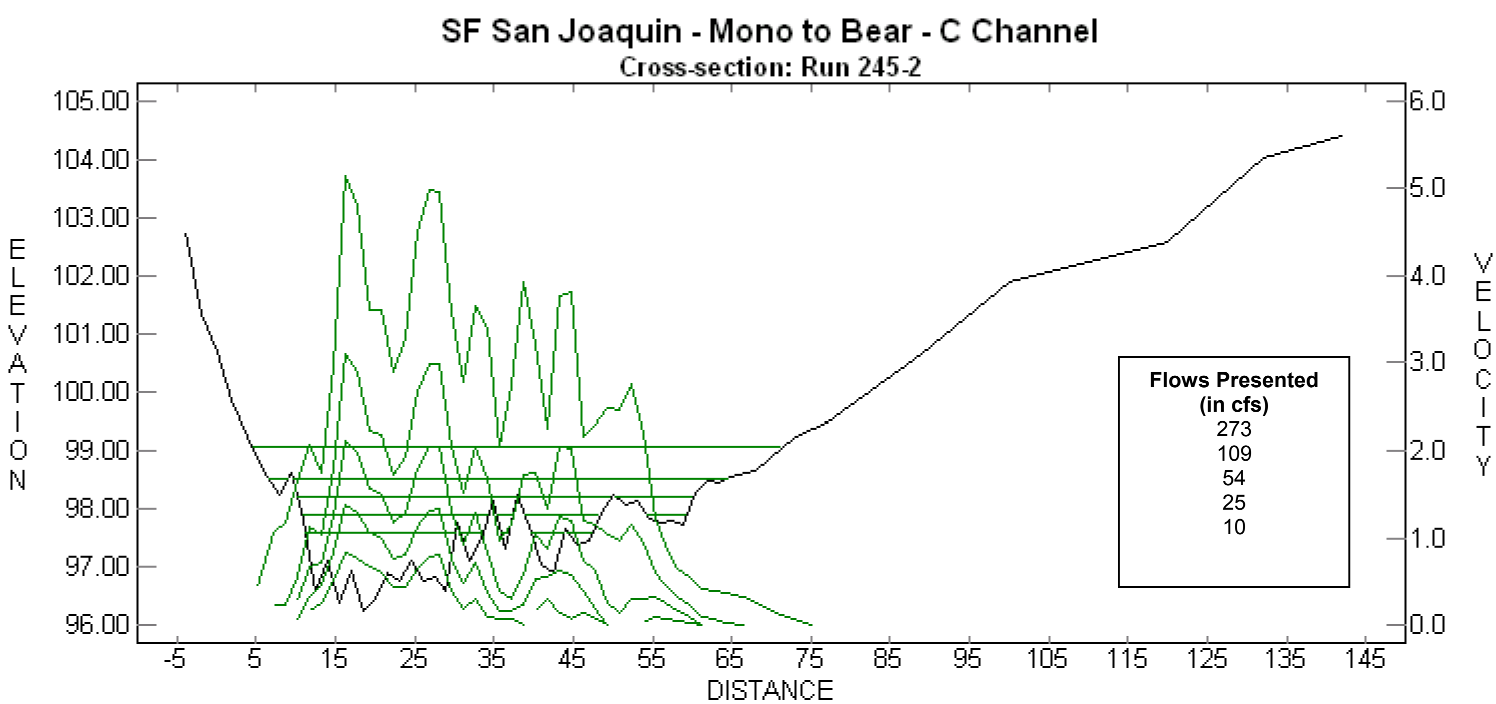
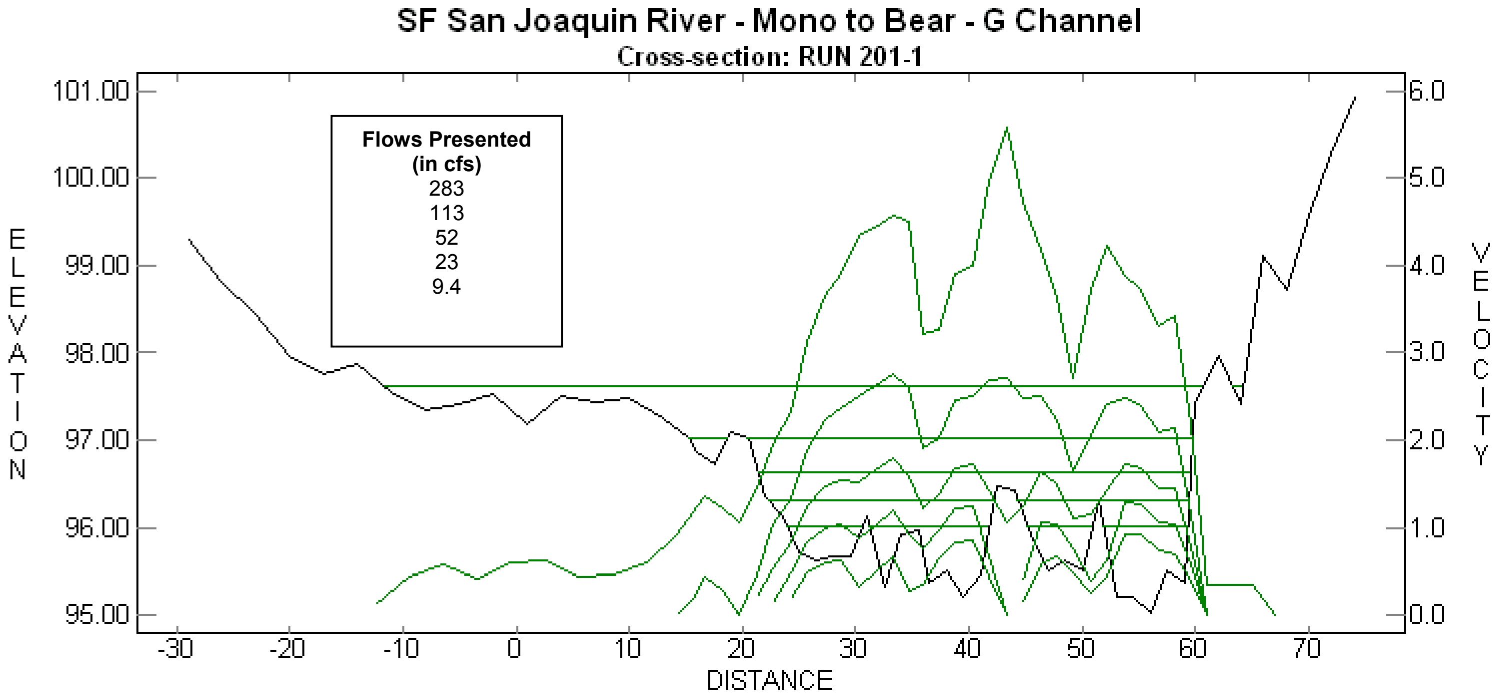
45
55
65
75
85
95
105
115

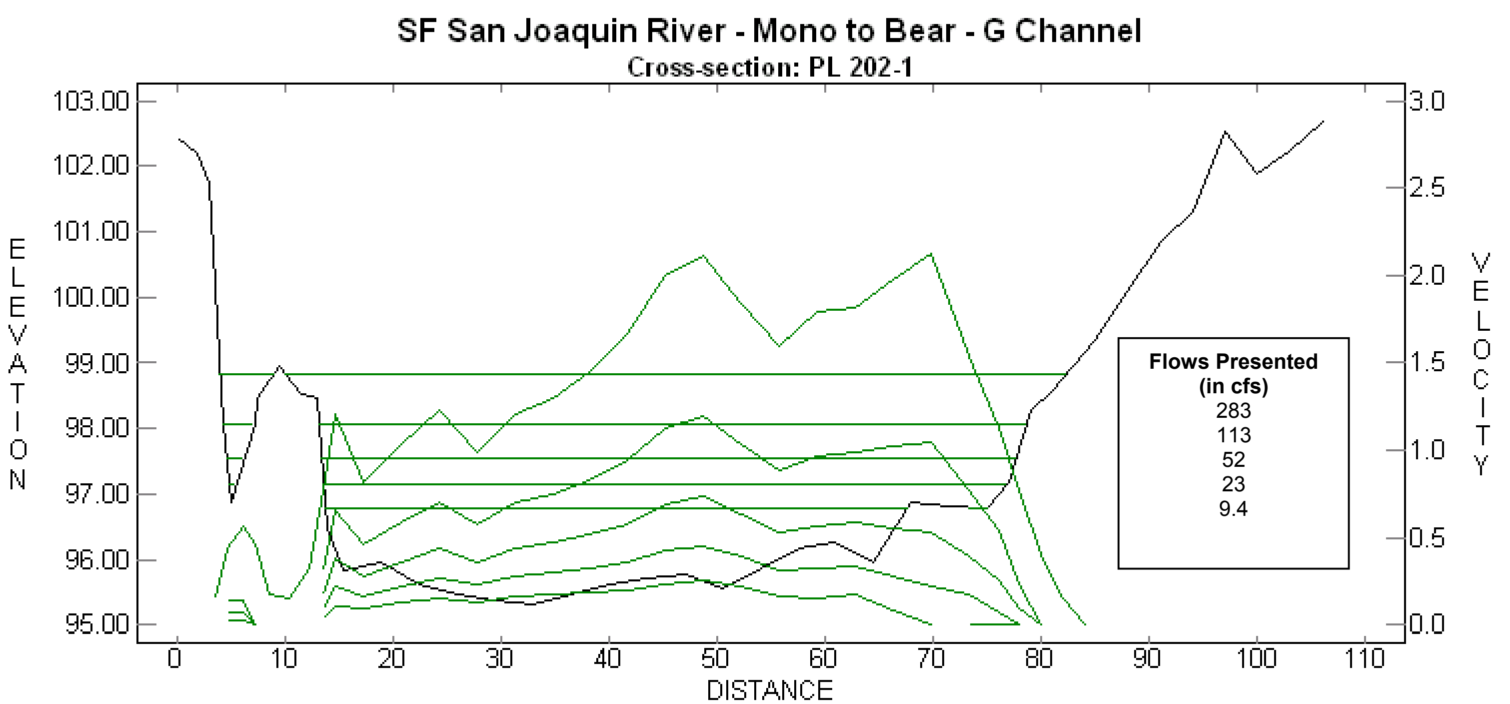

SF San Joaquin - Mono to Bear - C Channel
Cross-section: LGR 244-2
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
273
109
54
25
10

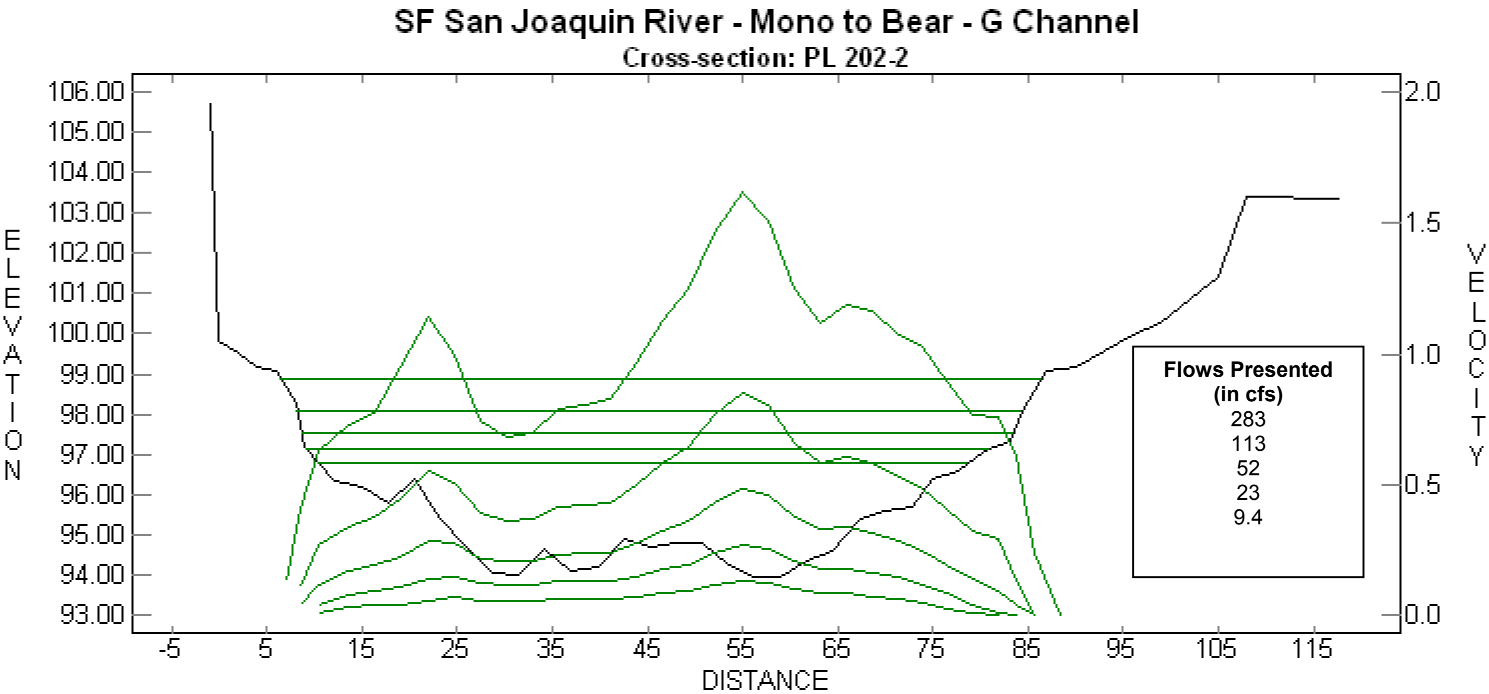

SF San Joaquin - Mono to Bear - C Channel
Cross-section: LGR 244-3
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
273
109
54
25
10

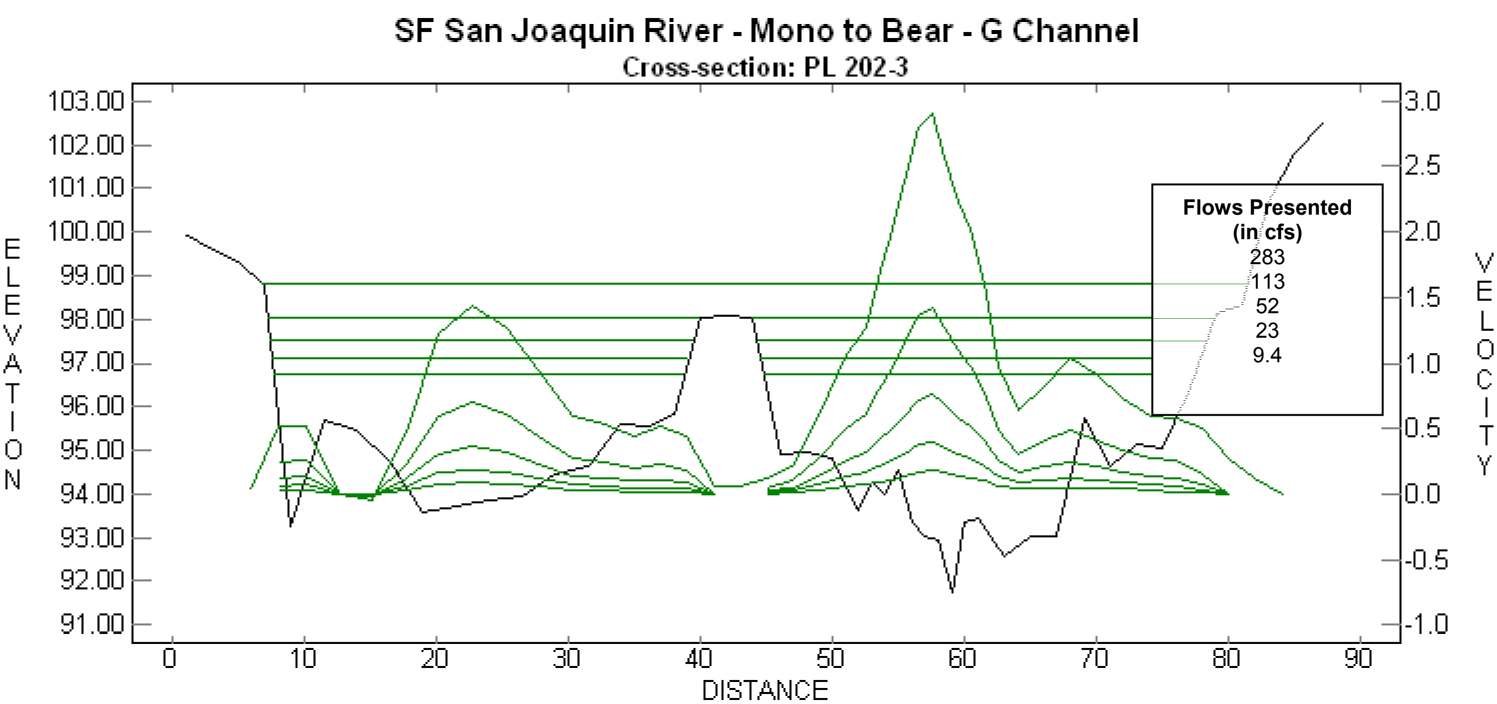

SF San Joaquin - Mono to Bear - C Channel
Cross-section: Run 245-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented (in cfs)
273
109
54
25
10

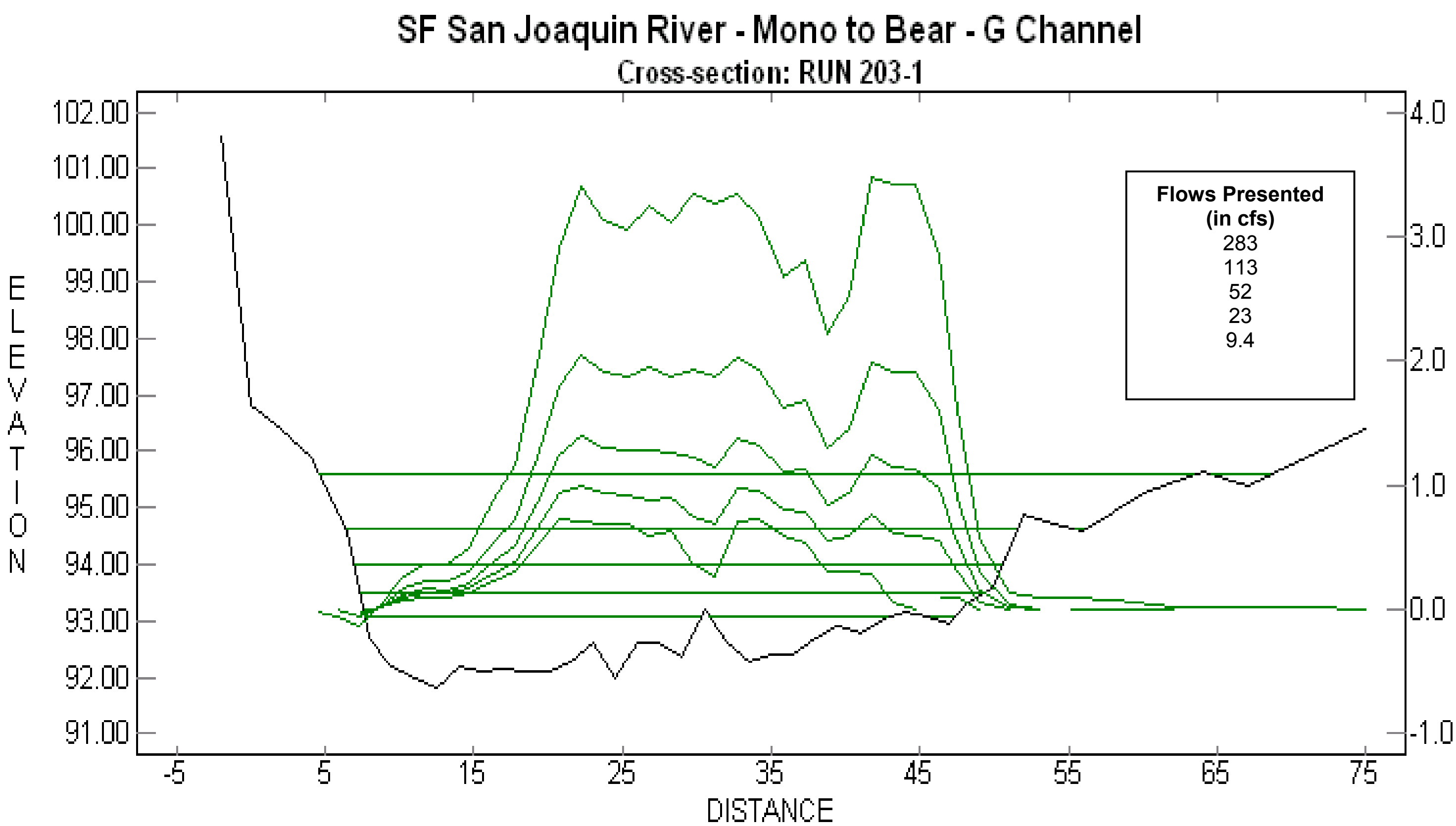

SF San Joaquin - Mono to Bear - C Channel
Cross-section: Run 245-2
ELEVATION
VELOCITY
DISTANCE
Flows Presented (in cfs)
273
109
54
25
10


SF San Joaquin River - Mono to Bear - G Channel
Cross-section: RUN 201-1
Flows Presented
(in cfs)
283
113
52
23
9.4
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-30
-20
-10
0
10
20
30
40
50
60
70


SF San Joaquin River - Mono to Bear - G Channel
Cross-section: PL 202-1
Flows Presented
(in cfs)
283
113
52
23
9.4
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110


SF San Joaquin River - Mono to Bear - G Channel
Cross-section: PL 202-2
ELEVATION
VELOCITY
DISTANCE
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
2.0
1.5
1.0
0.5
0.0
-5
5
15
25
35
45
55
65
75
85
95
105
115
Flows Presented
(in cfs)
283
113
52
23
9.4


SF San Joaquin River - Mono to Bear - G Channel
Cross-section: PL 202-3
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
10
20
30
40
50
60
70
80
90
Flows Presented
(in cfs)
283
113
52
23
9.4


SF San Joaquin River - Mono to Bear - G Channel
Cross-section: RUN 203-1
Flows Presented
(in cfs)
283
113
52
23
9.4
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
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1.0
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-5
5
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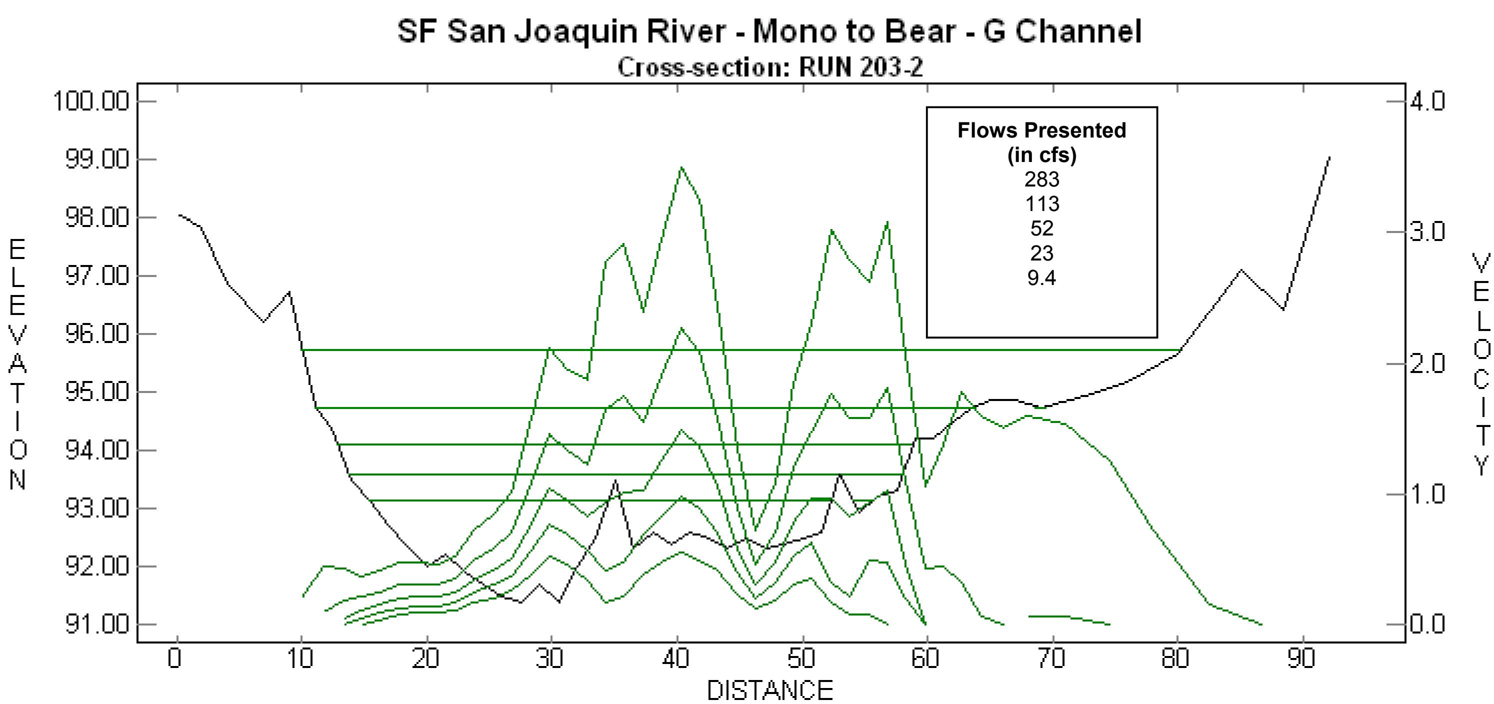
75


SF San Joaquin River - Mono to Bear - G Channel
Cross-section: RUN 203-2
Flows Presented
(in cfs)
283
113
52
23
9.4
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
4.0
3.0
2.0
1.0
0.0
0
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20
30
40
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60
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80
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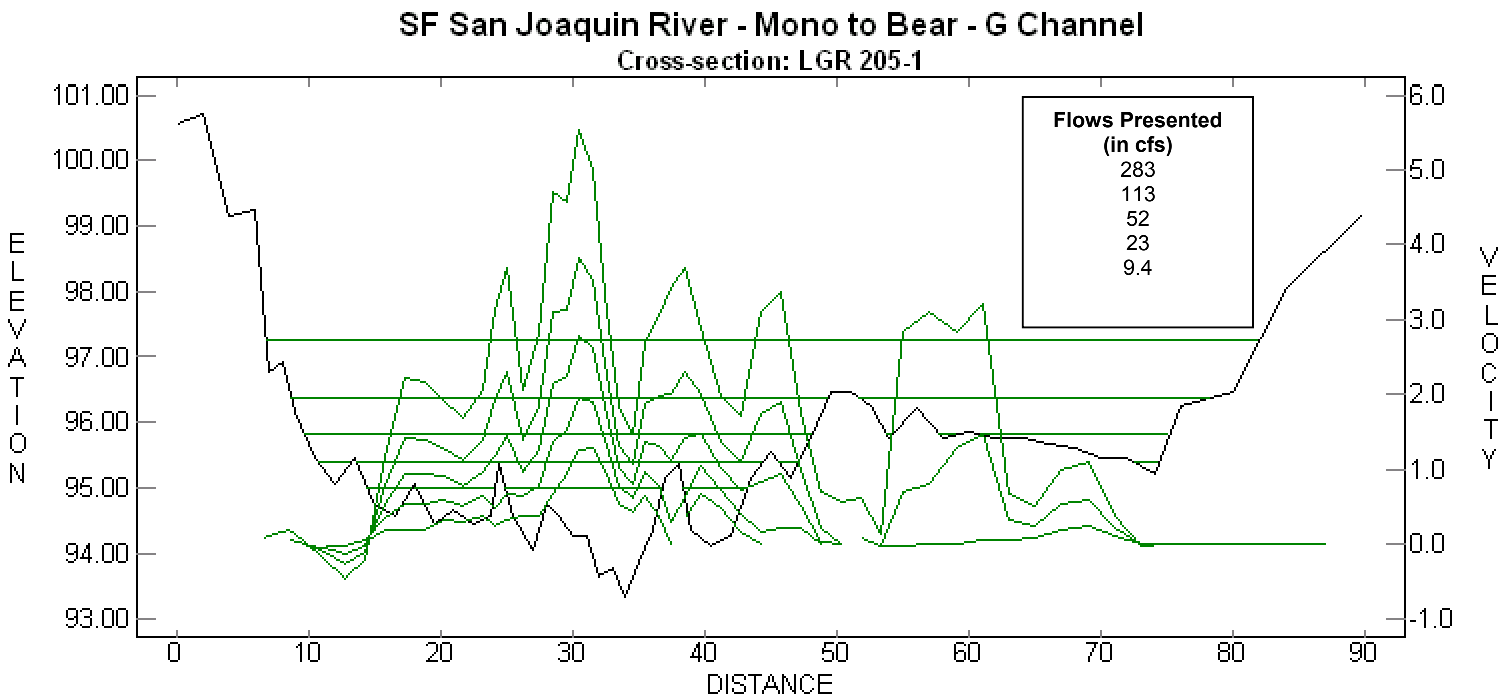
SF San Joaquin River - Mono to Bear - G Channel
Cross-section: LGR 205-1
Flows Presented
(in cfs)
283
113
52
23
9.4
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
6.0
5.0
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20
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60
70
80
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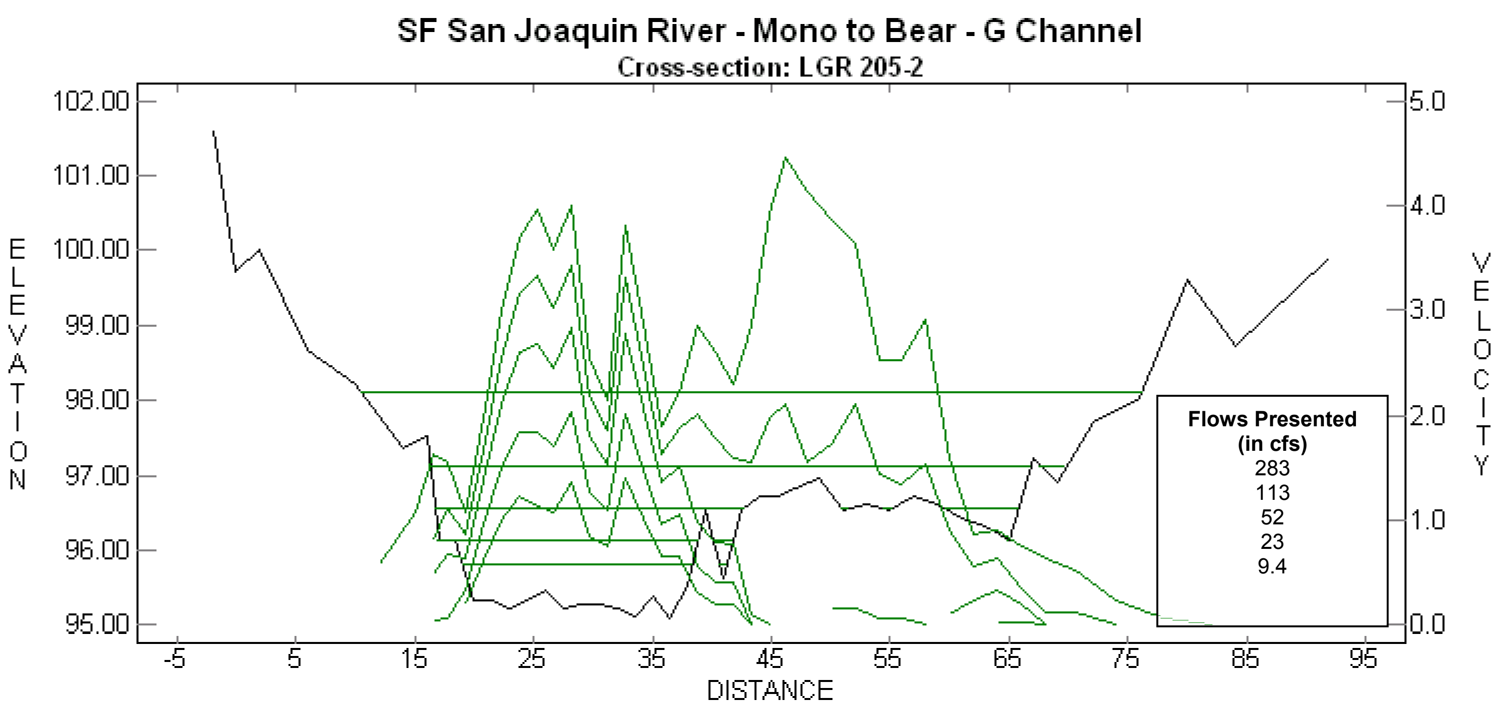
SF San Joaquin River - Mono to Bear - G Channel
Cross-section: LGR 205-2
Flows Presented
(in cfs)
283
113
52
23
9.4
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
5.0
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1.0
0.0
-5
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25
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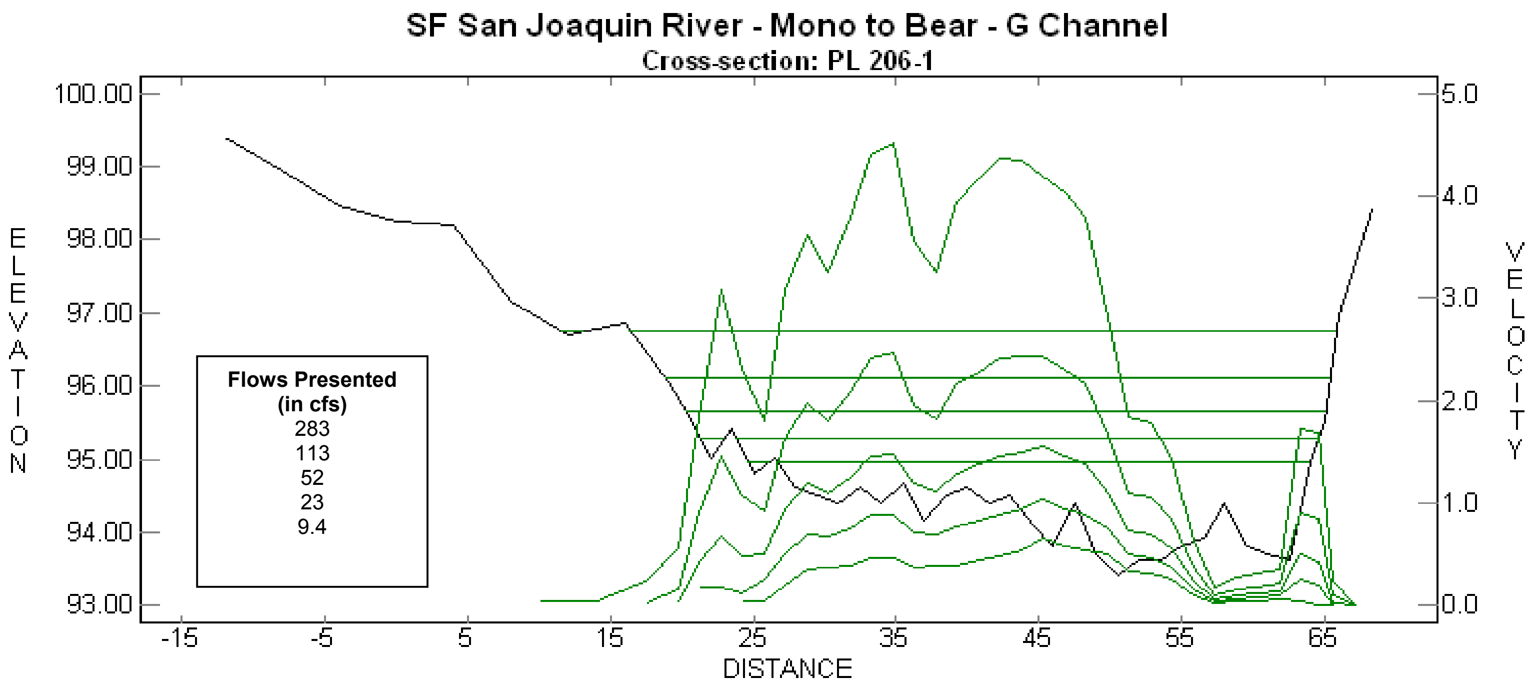
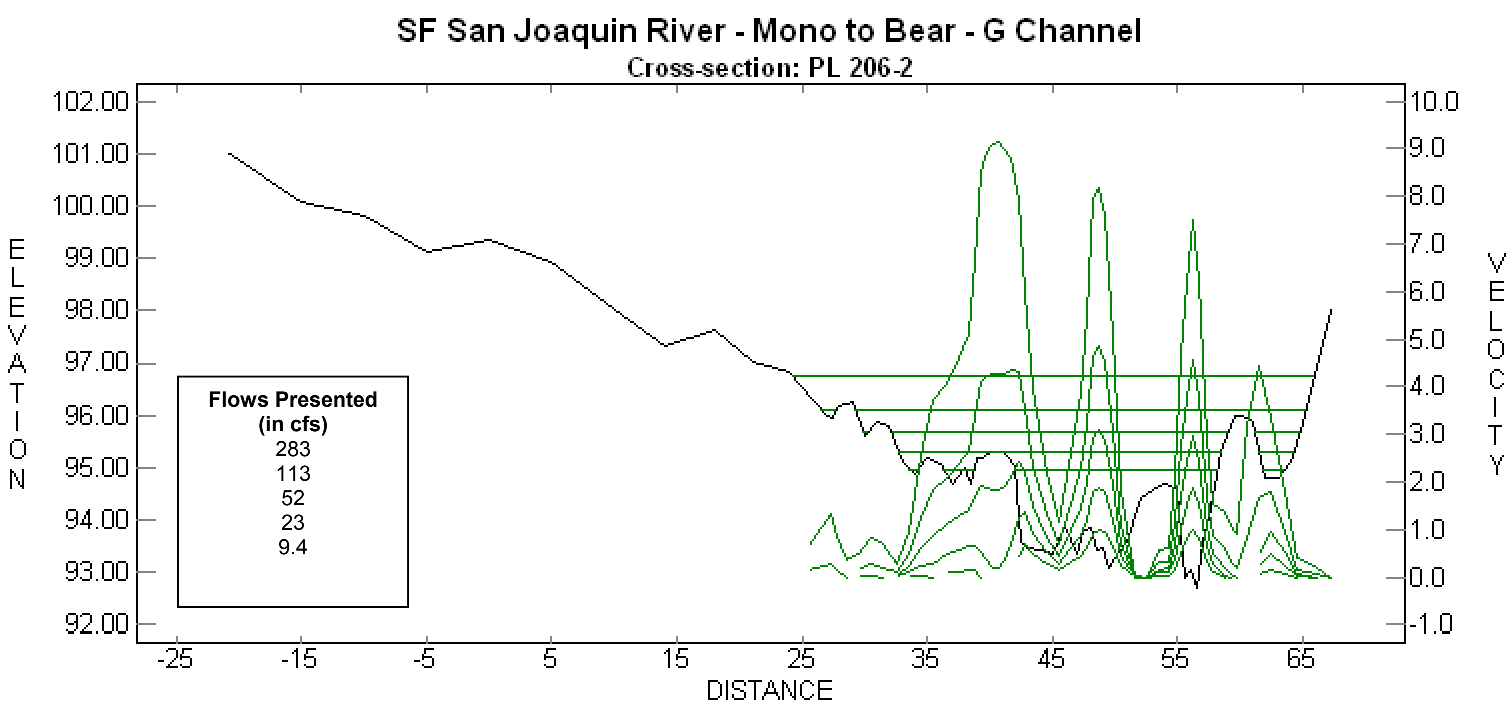
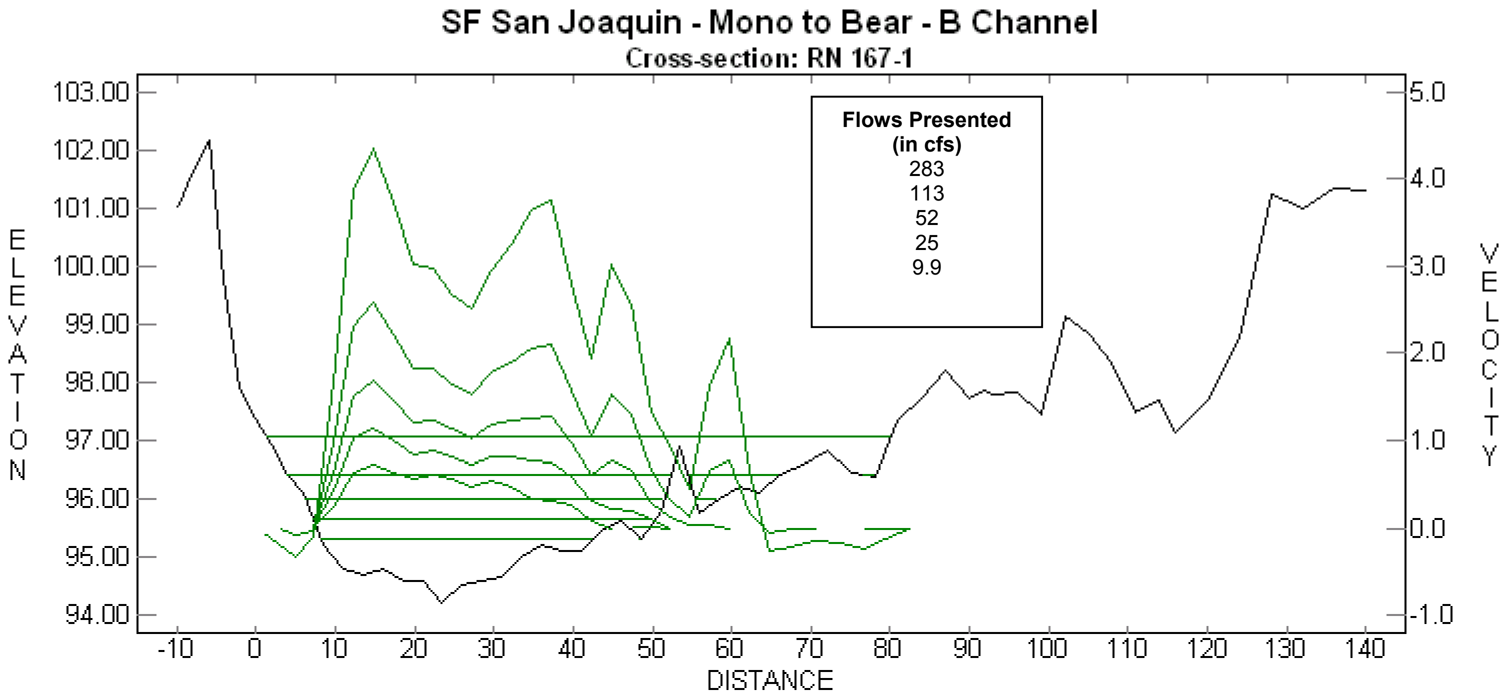
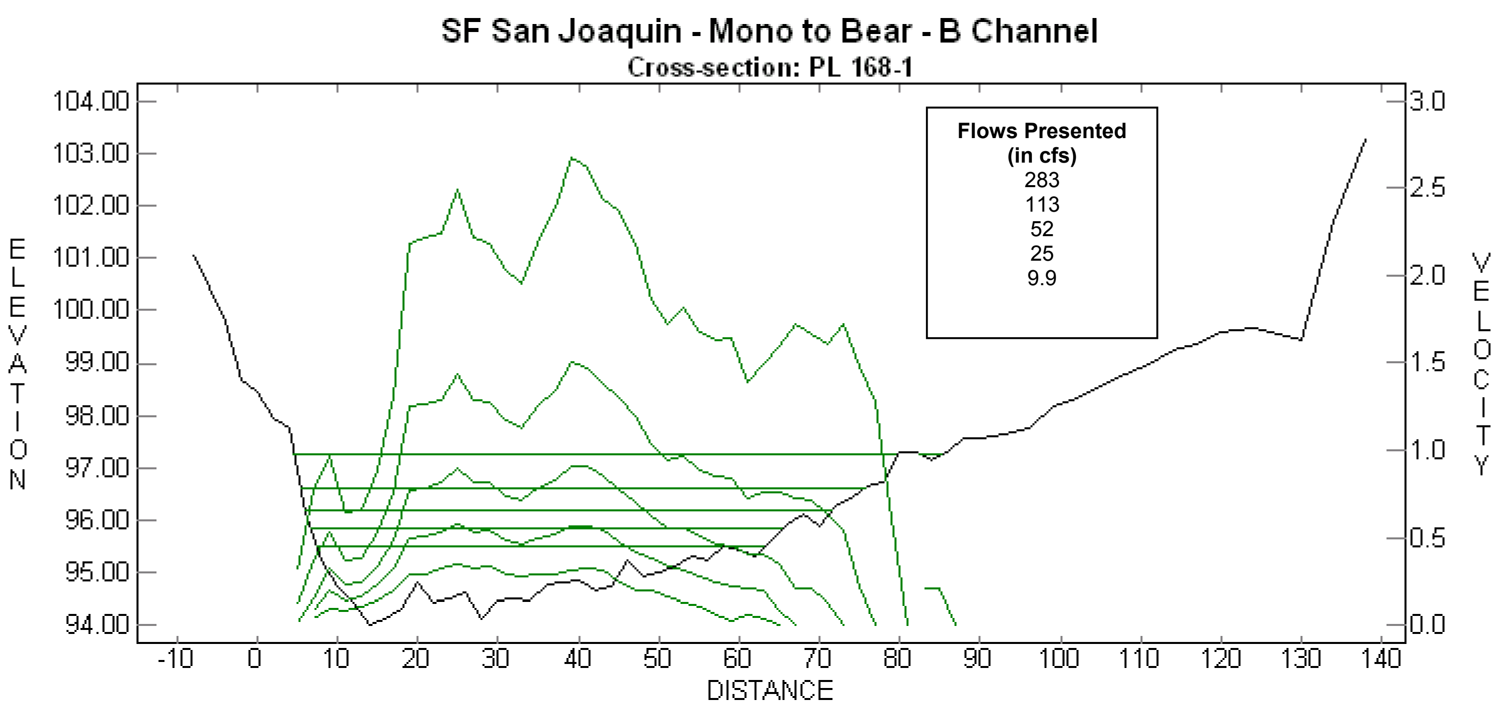
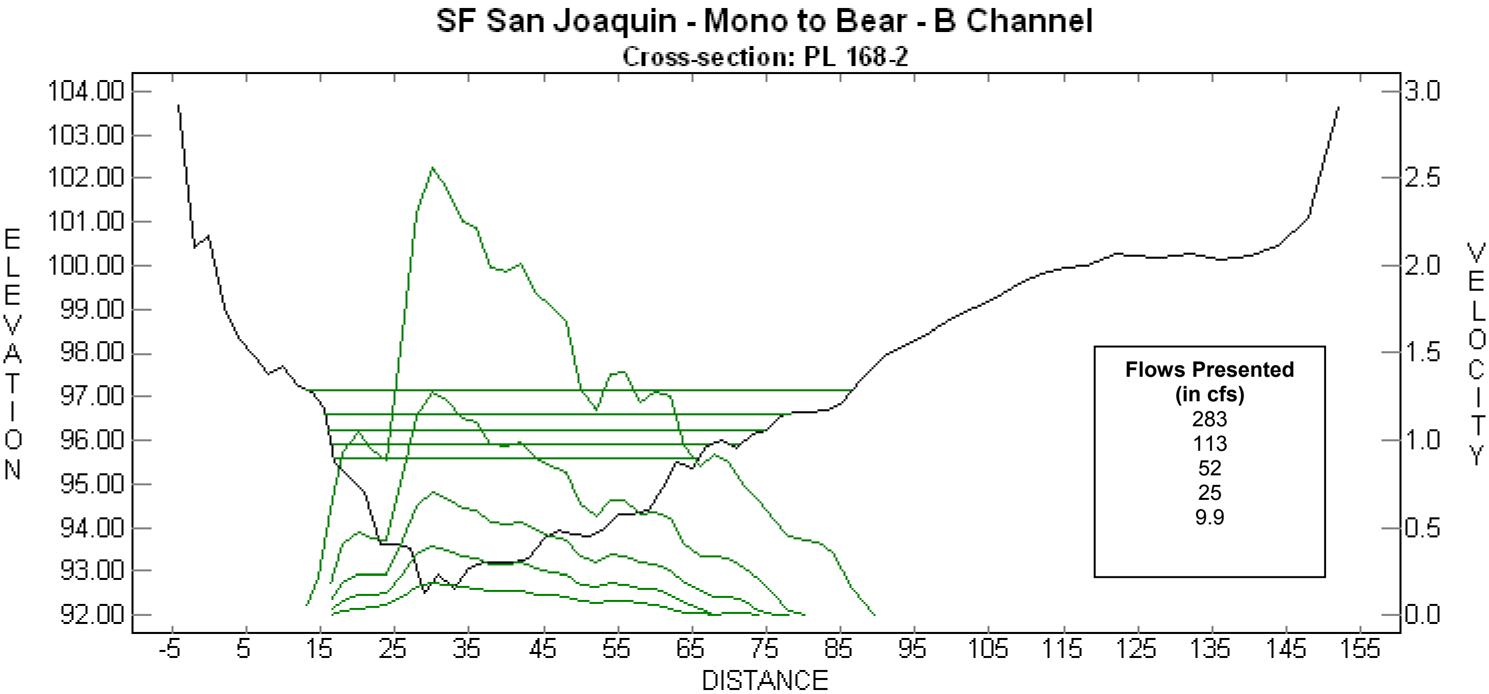
45
55
65
75
85
95

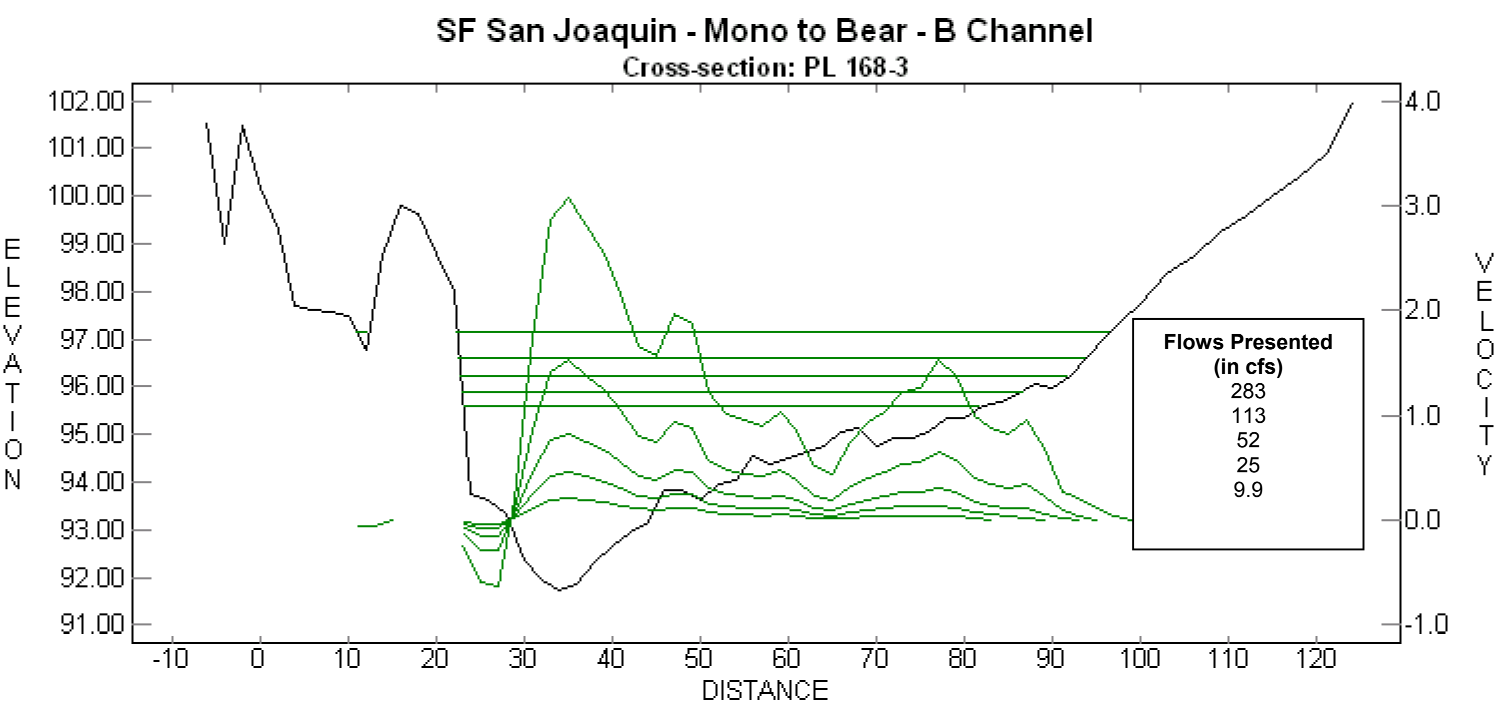

SF San Joaquin River - Mono to Bear - G Channel
Cross-section: PL 206-1
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
5.0
4.0
3.0
2.0
1.0
0.0
-15
-5
5
15
25
35
45
55
65
Flows Presented
(in cfs)
283
113
52
23
9.4

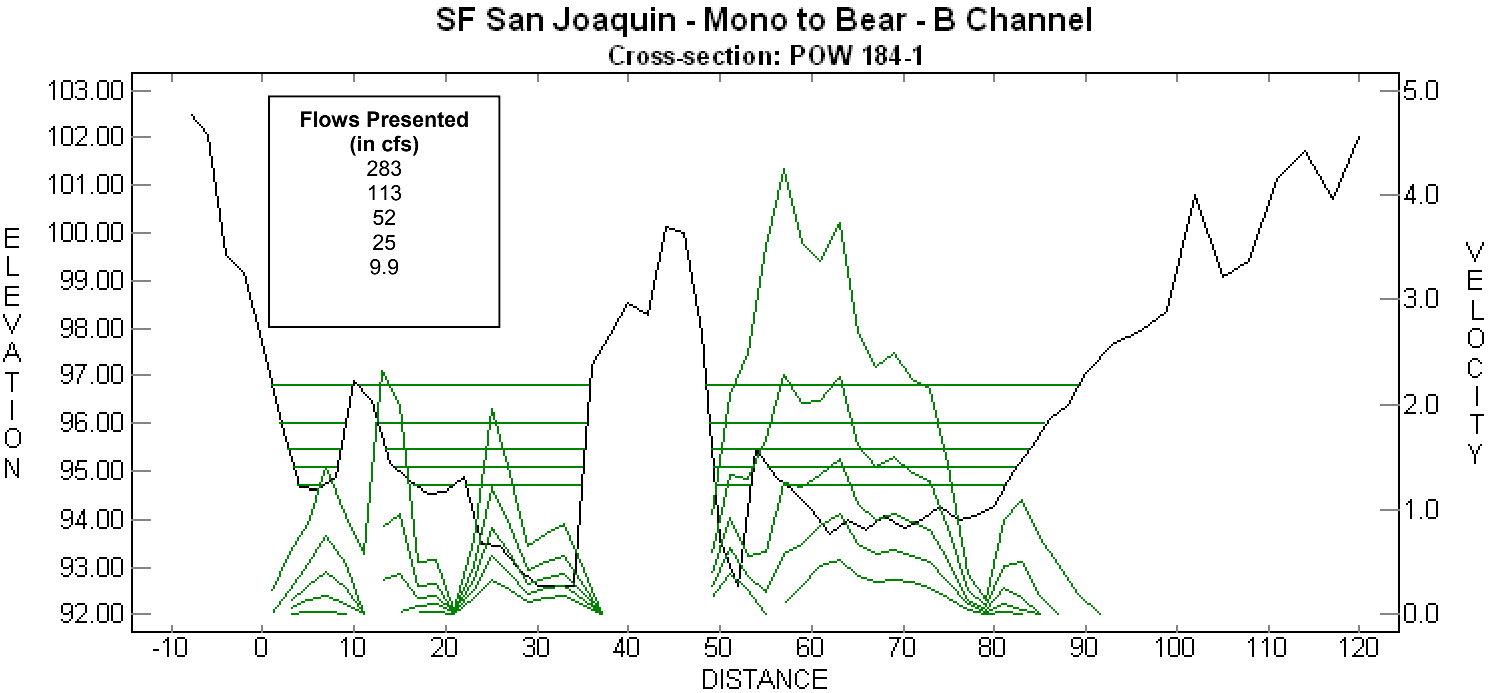

SF San Joaquin River - Mono to Bear - G Channel
Cross-section: PL 206-2
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-25
-15
-5
5
15
25
35
45
55
65
Flows Presented
(in cfs)
283
113
52
23
9.4

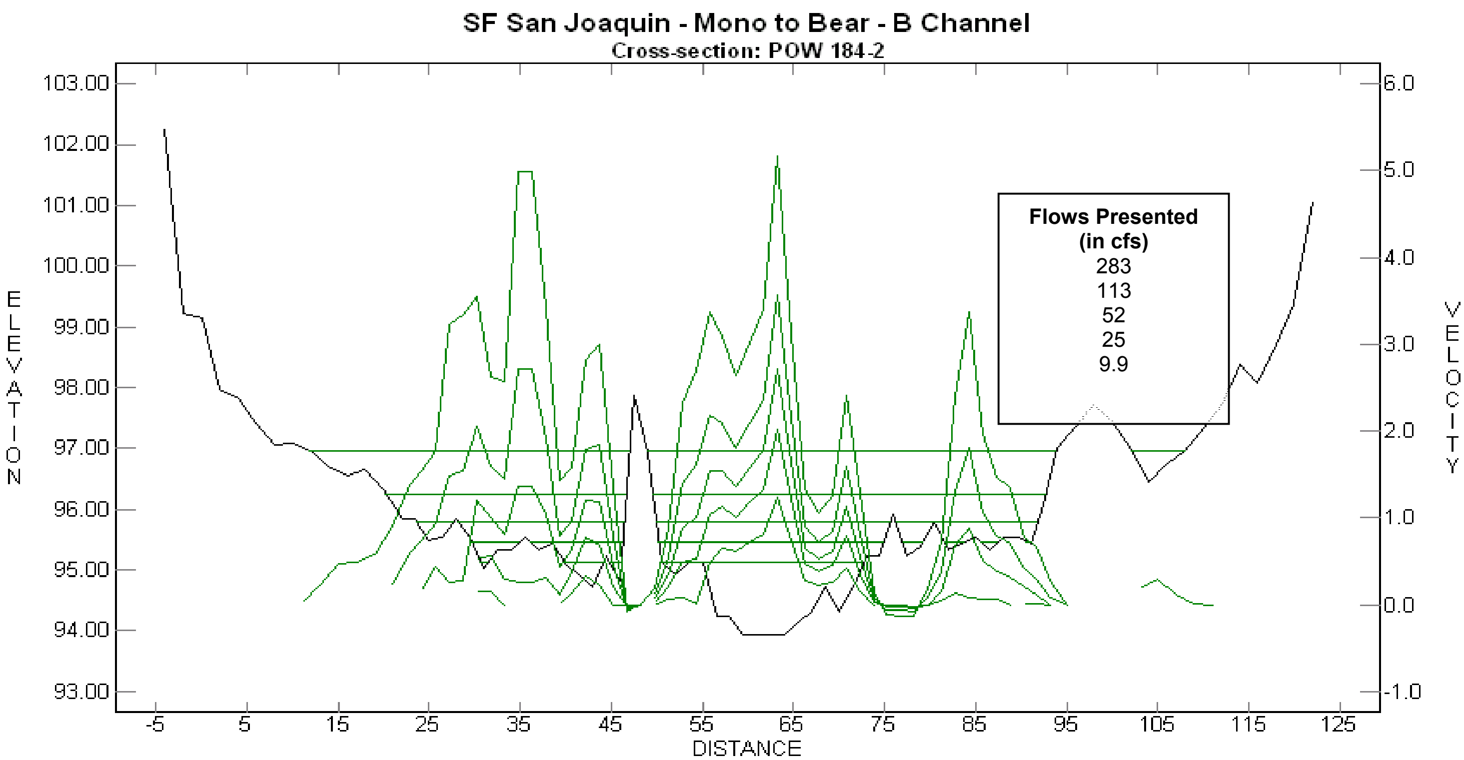

SF San Joaquin - Mono to Bear - B Channel
Cross-section: RN 167-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
283
113
52
25
9.9

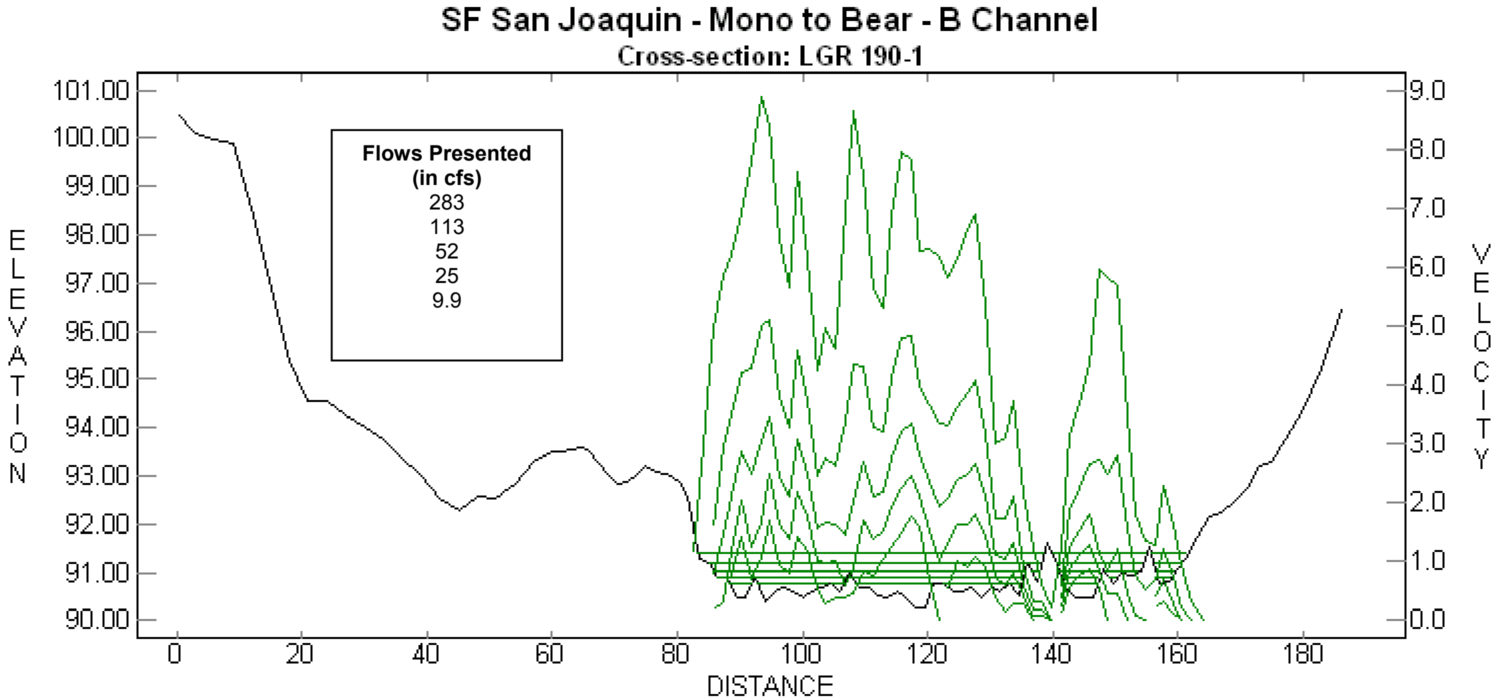

SF San Joaquin - Mono to Bear - B Channel
Cross-section: PL 168-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
283
113
52
25
9.9

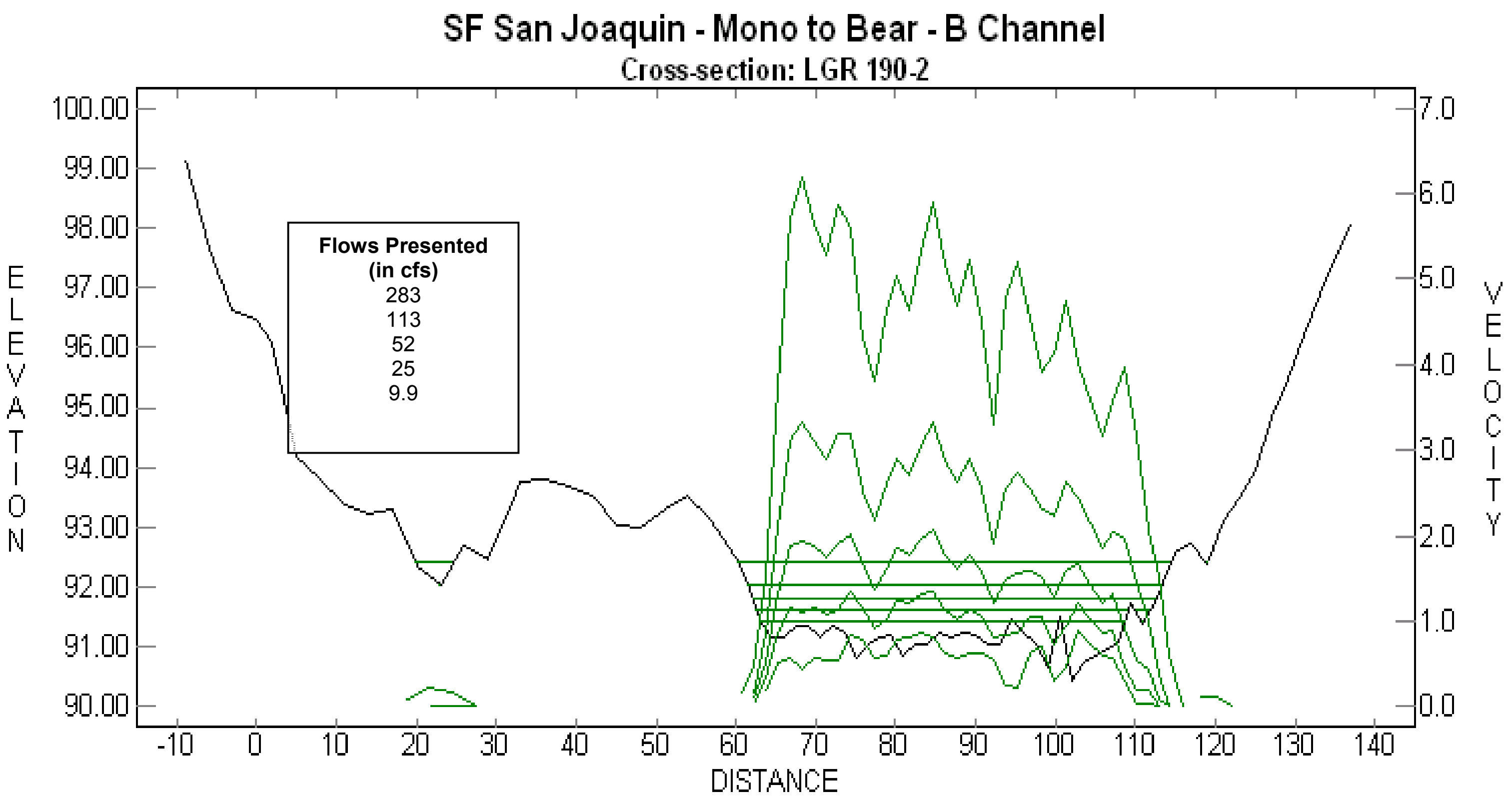

SF San Joaquin - Mono to Bear - B Channel
Cross-section: PL 168-2
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
ELEVATION
3.0
2.5
2.0
1.5
1.0
0.5
0.0
VELOCITY
-5
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
DISTANCE
Flows Presented
(in cfs)
283
113
52
25
9.9

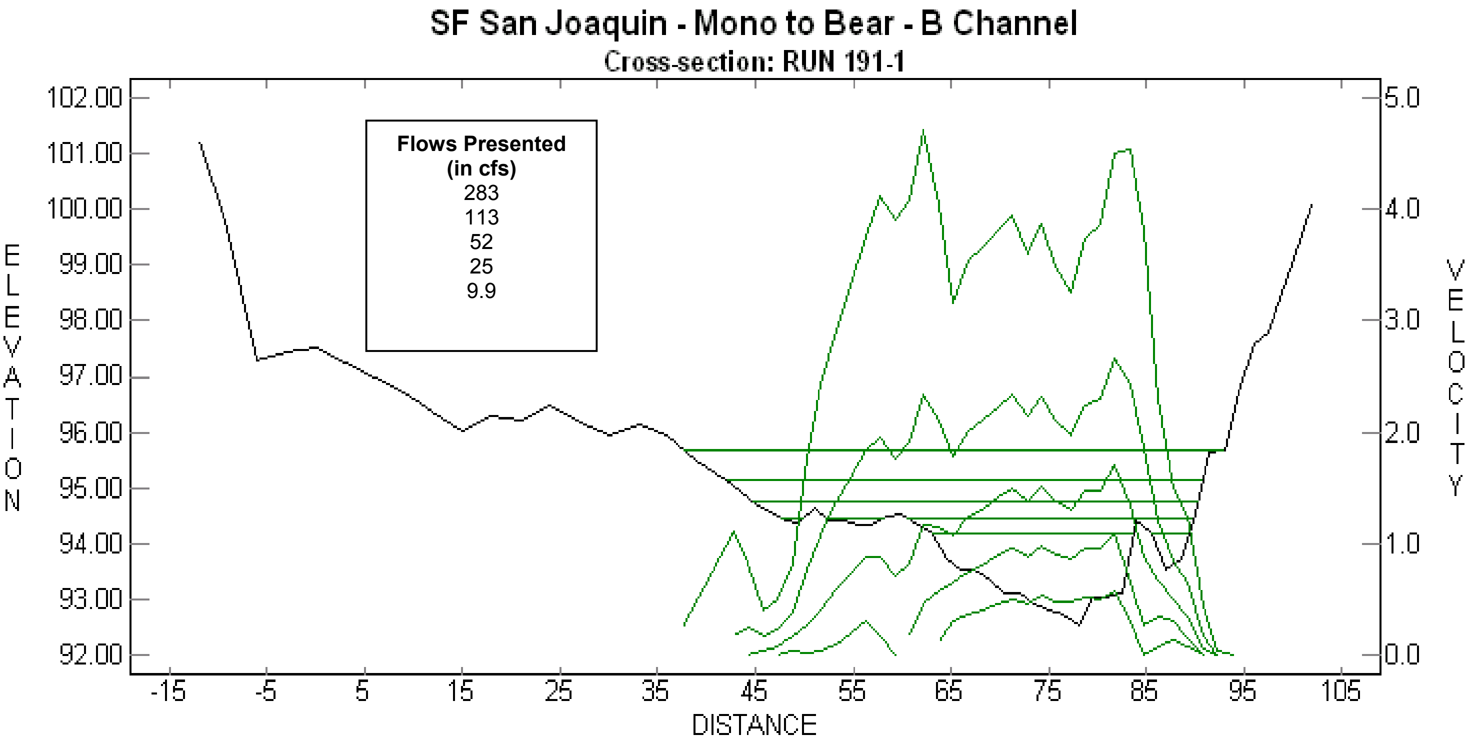

SF San Joaquin - Mono to Bear - B Channel
Cross-section: PL 168-3
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
ELEVATION
4.0
3.0
2.0
1.0
0.0
-1.0
VELOCITY
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
DISTANCE
Flows Presented
(in cfs)
283
113
52
25
9.9

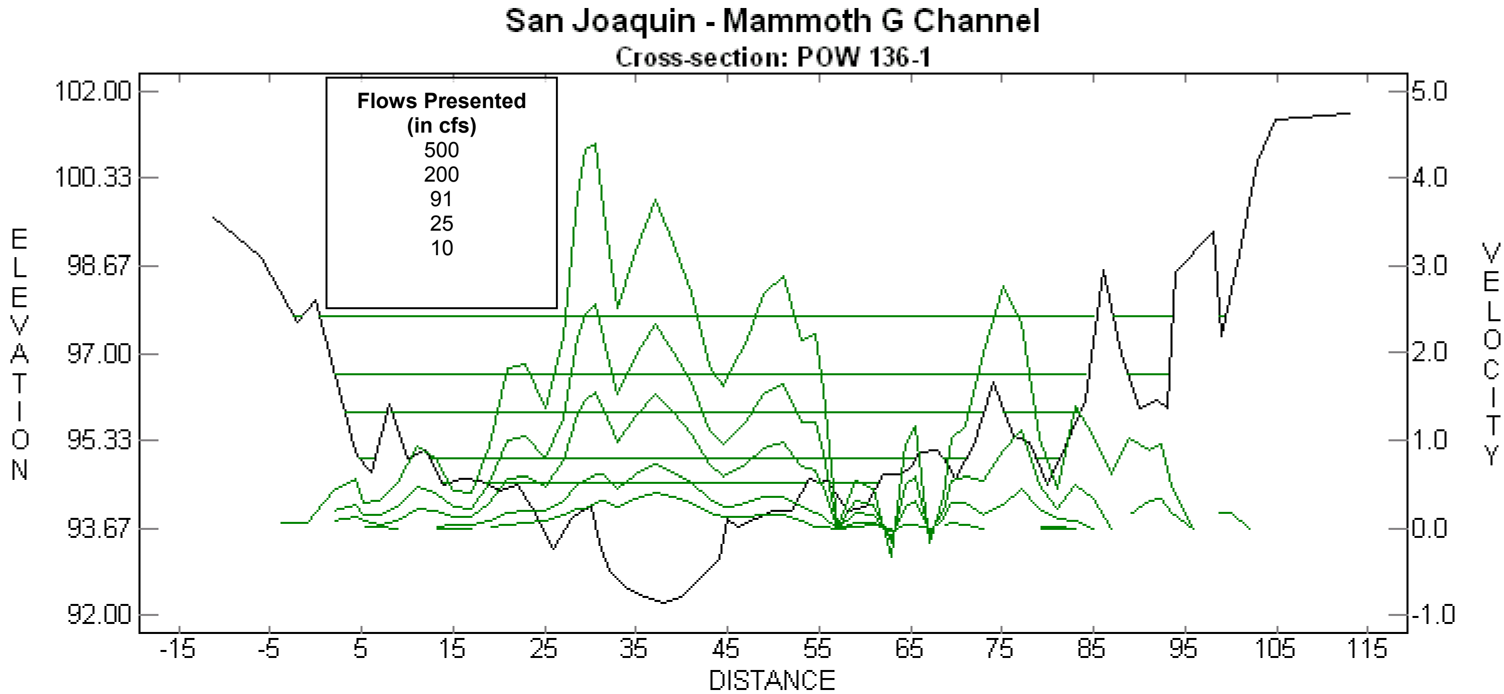

SF San Joaquin - Mono to Bear - B Channel
Cross-section: POW 184-1
Flows Presented (in cfs)
283
113
52
25
9.9
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
5.0
4.0
3.0
2.0
1.0
0.0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120

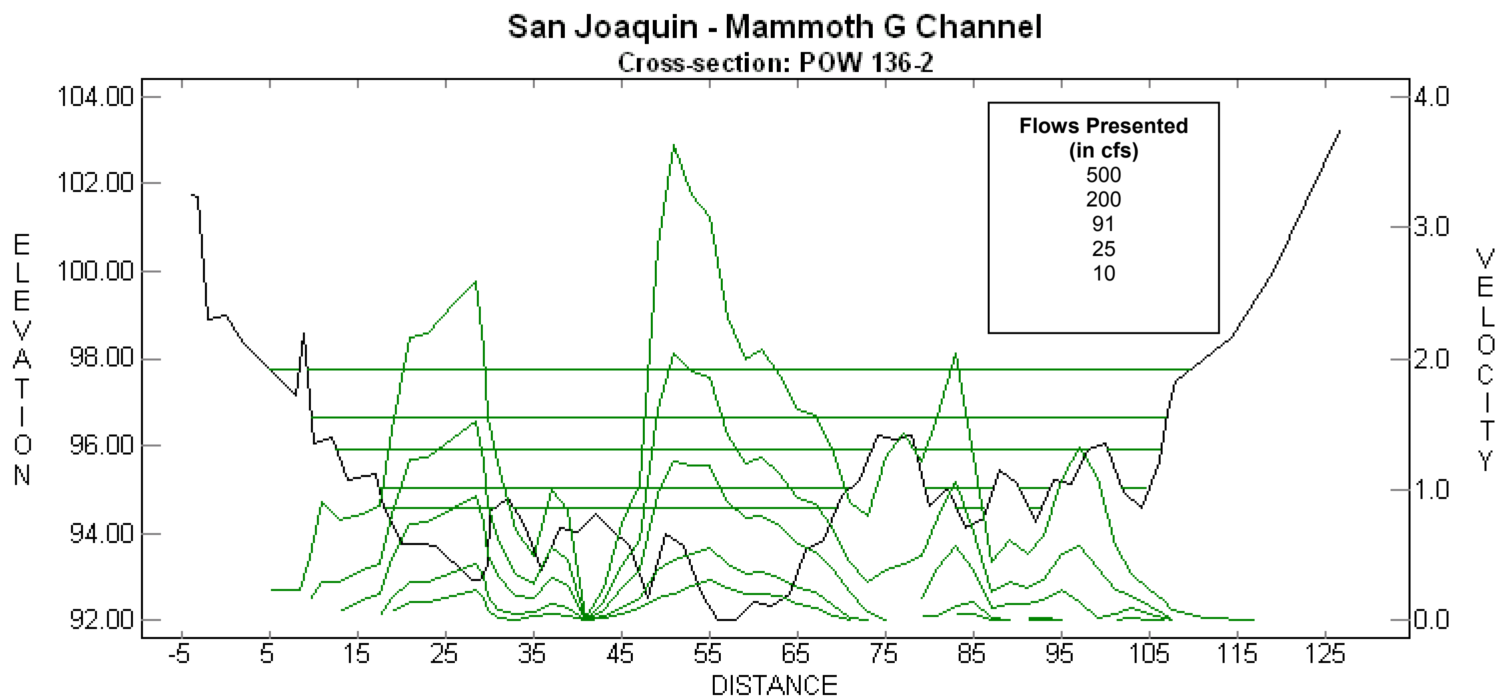

SF San Joaquin - Mono to Bear - B Channel
Cross-section: POW 184-2
Flows Presented (in cfs)
283
113
52
25
9.9
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-5
5
15
25
35
45
55
65
75
85
95
105
115
125

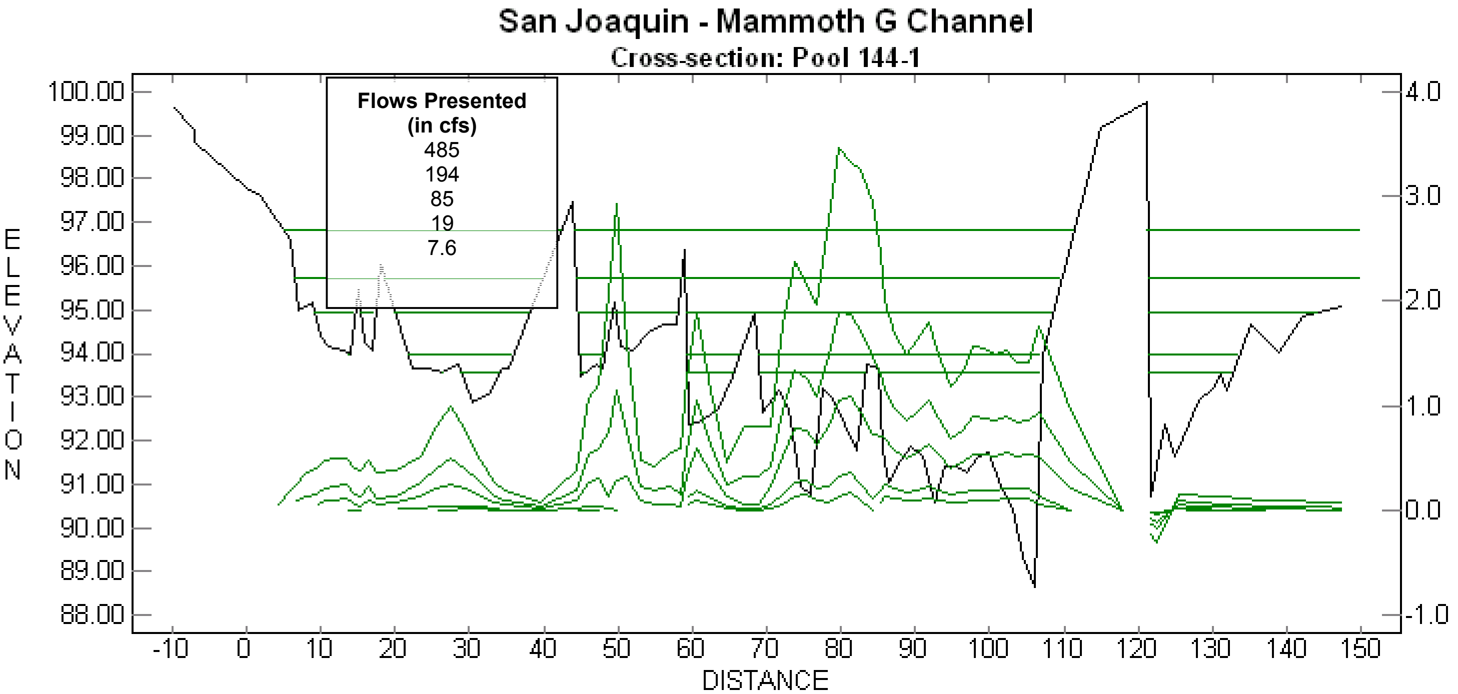

SF San Joaquin - Mono to Bear - B Channel
Cross-section: LGR 190-1
Flows Presented
(in cfs)
283
113
52
25
9.9
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
120
140
160
180

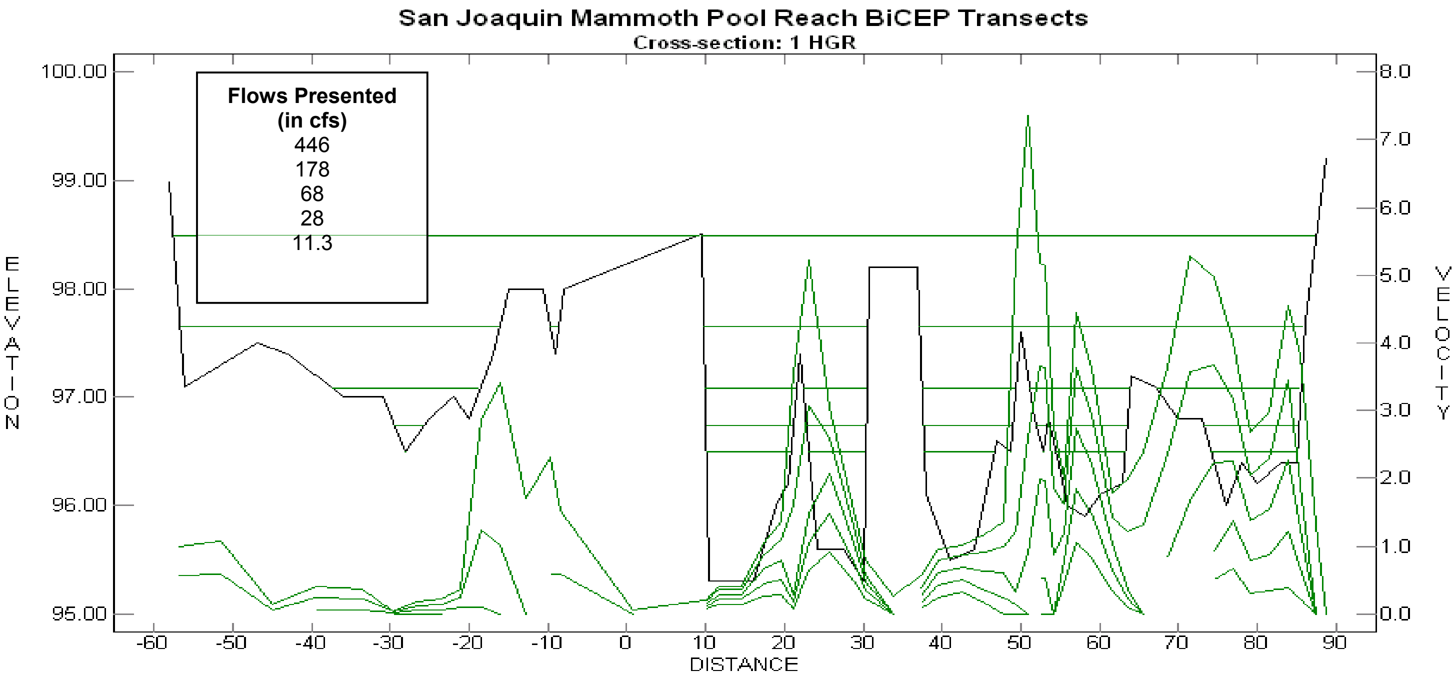

SF San Joaquin - Mono to Bear - B Channel
Cross-section: LGR 190-2
Flows Presented
(in cfs)
283
113
52
25
9.9
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140

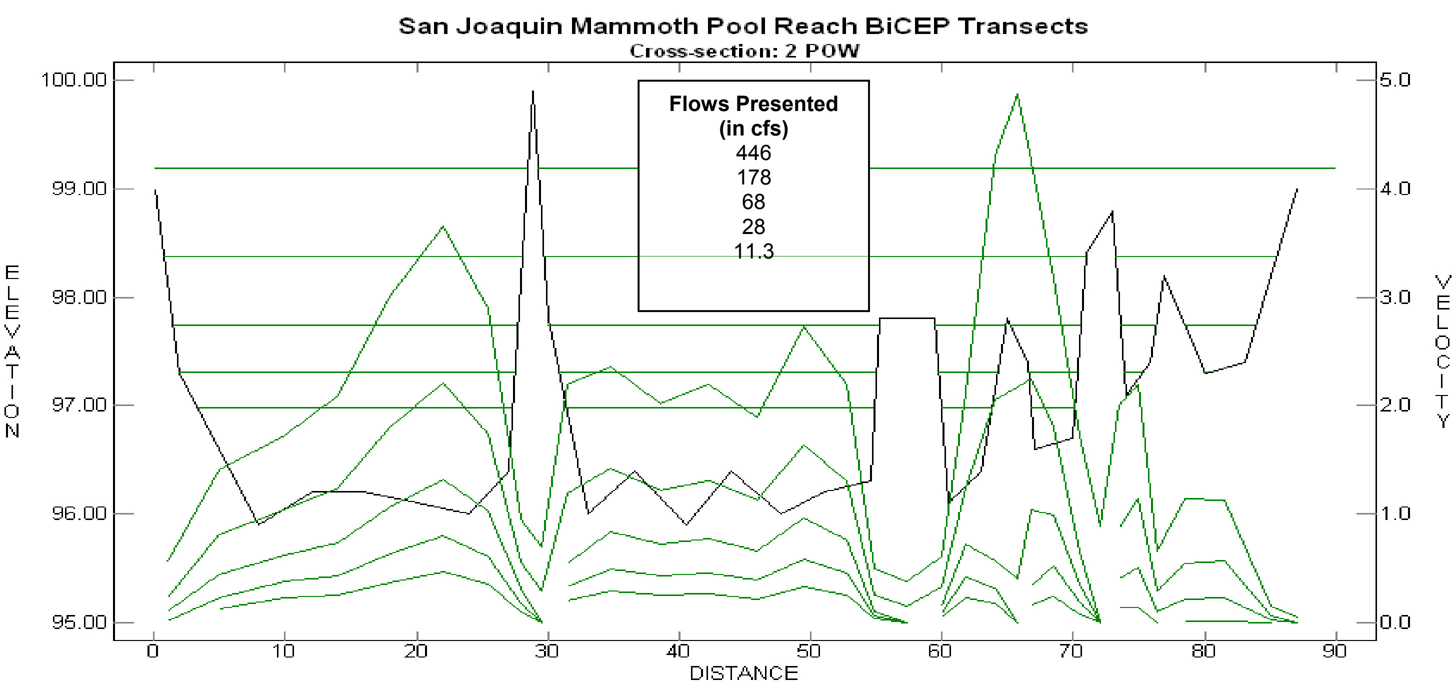

SF San Joaquin - Mono to Bear - B Channel
Cross-section: RUN 191-1
Flows Presented
(in cfs)
283
113
52
25
9.9
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
5.0
4.0
3.0
2.0
1.0
0.0
-15
-5
5
15
25
35
45
55
65
75
85
95
105

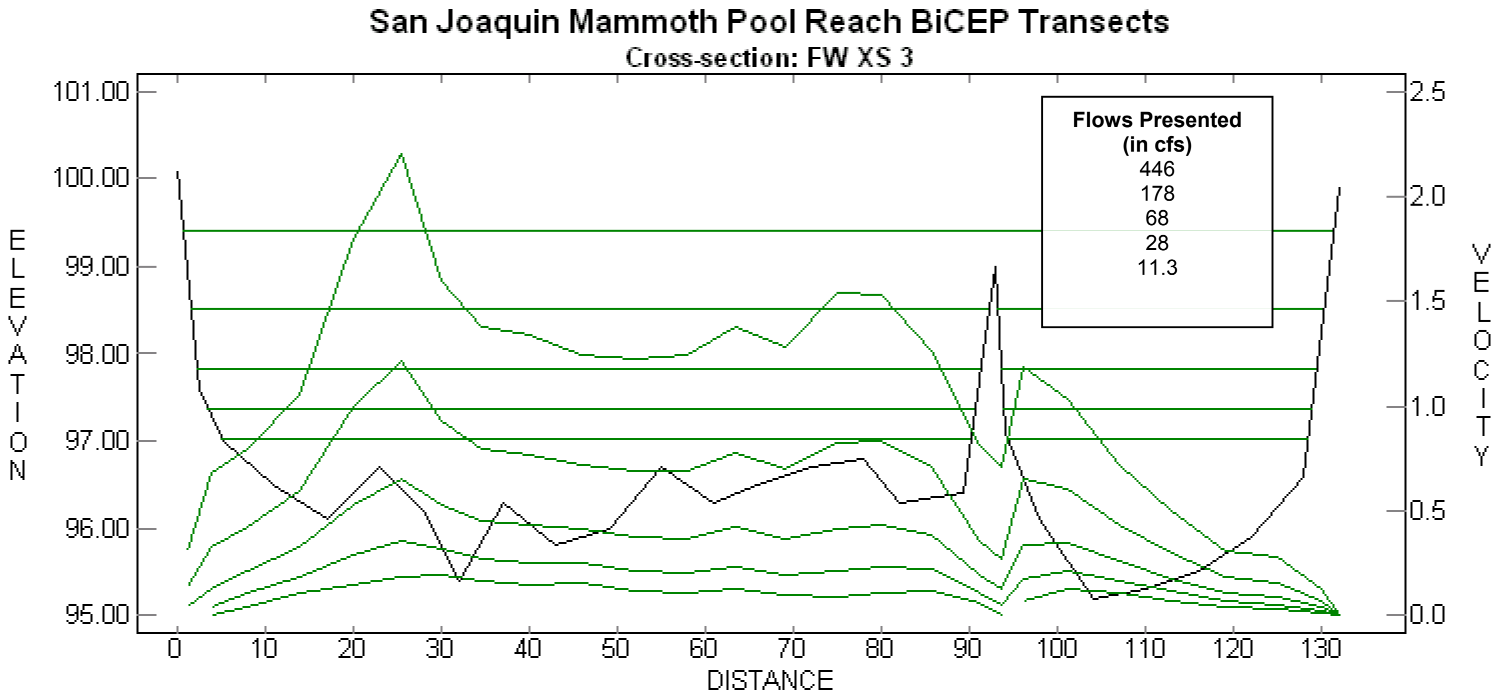

San Joaquin - Mammoth G Channel
Cross-section: POW 136-1
Flows Presented
(in cfs)
500
200
91
25
10
ELEVATION
102.00
100.33
98.67
97.00
95.33
93.67
92.00
VELOCITY
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
DISTANCE
-15
-5
5
15
25
35
45
55
65
75
85
95
105
115

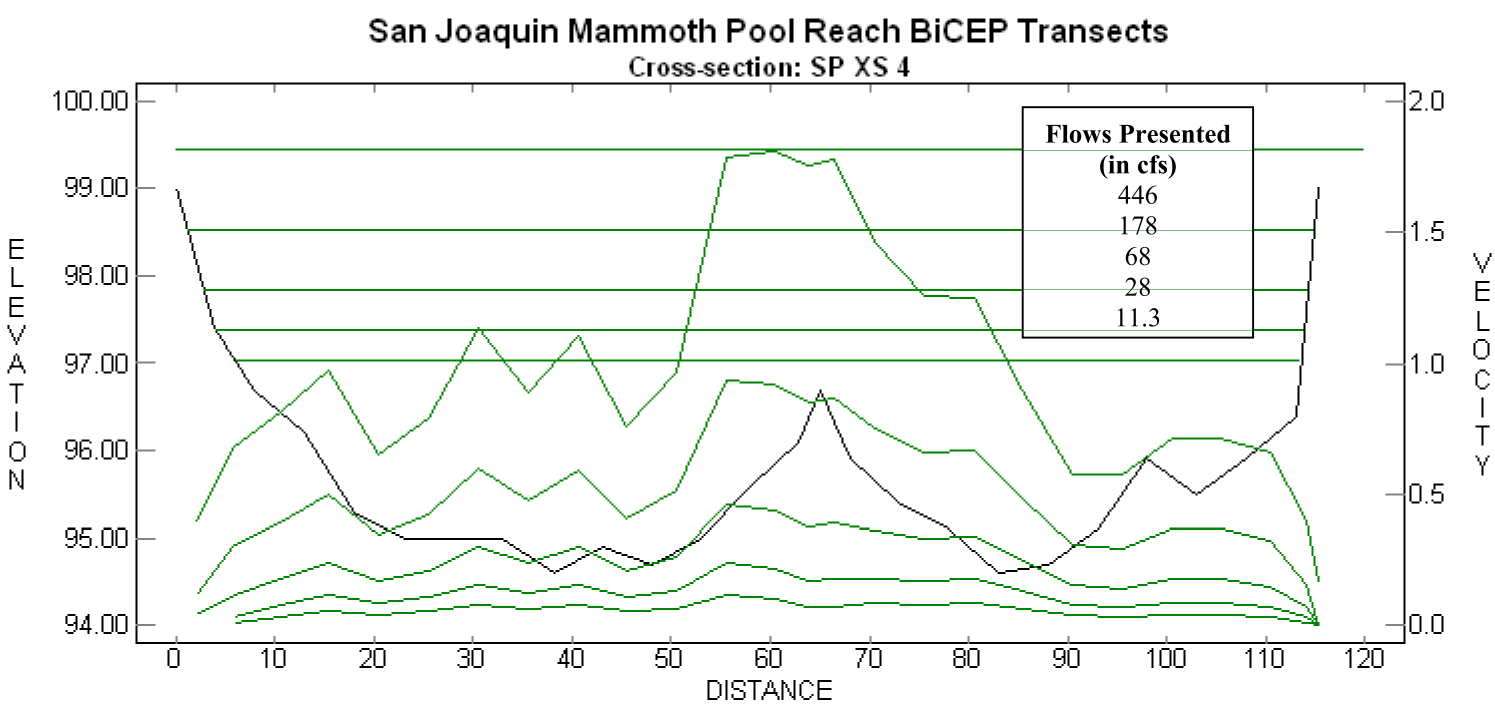

San Joaquin - Mammoth G Channel
Cross-section: POW 136-2
Flows Presented
(in cfs)
500
200
91
25
10
ELEVATION
104.00
102.00
100.00
98.00
96.00
94.00
92.00
VELOCITY
4.0
3.0
2.0
1.0
0.0
DISTANCE
-5
5
15
25
35
45
55
65
75
85
95
105
115
125

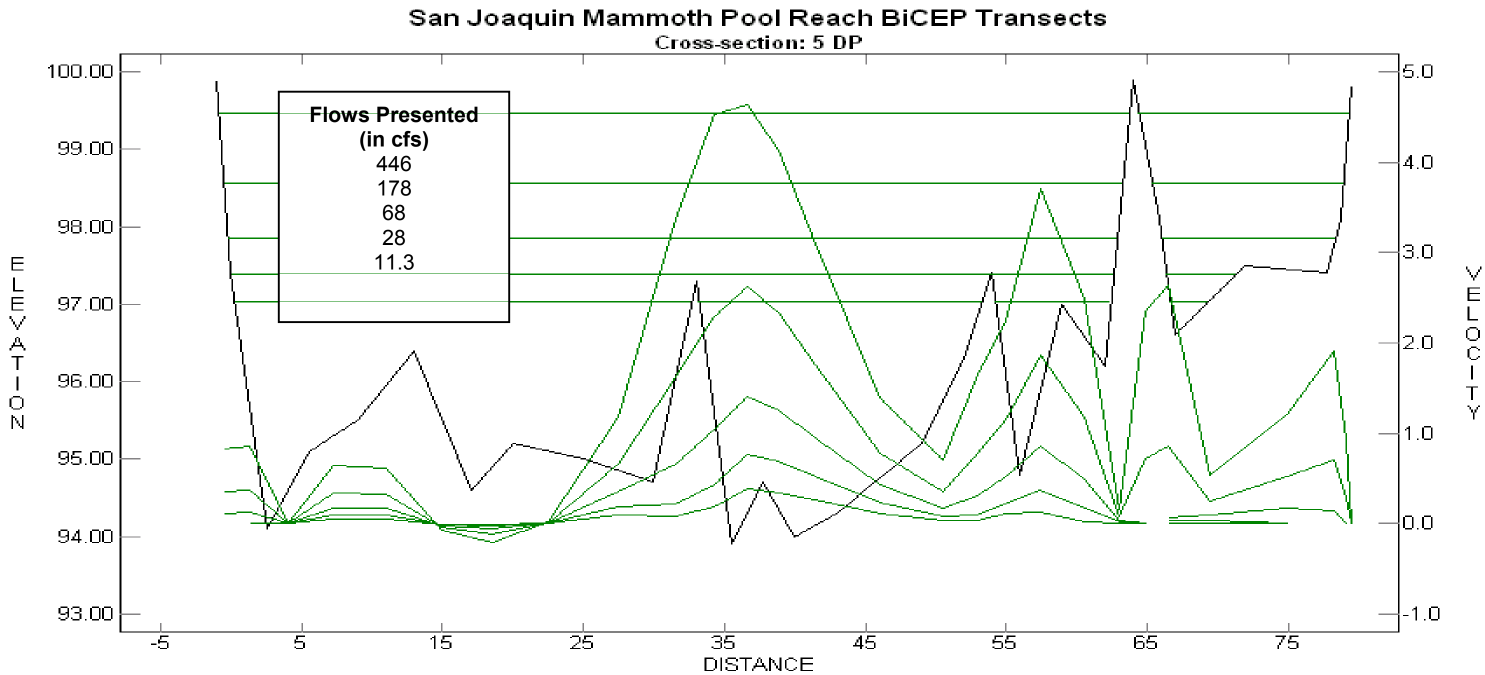

San Joaquin - Mammoth G Channel
Cross-section: Pool 144-1
Flows Presented
(in cfs)
485
194
85
19
7.6
ELEVATION
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
VELOCITY
4.0
3.0
2.0
1.0
0.0
-1.0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
DISTANCE

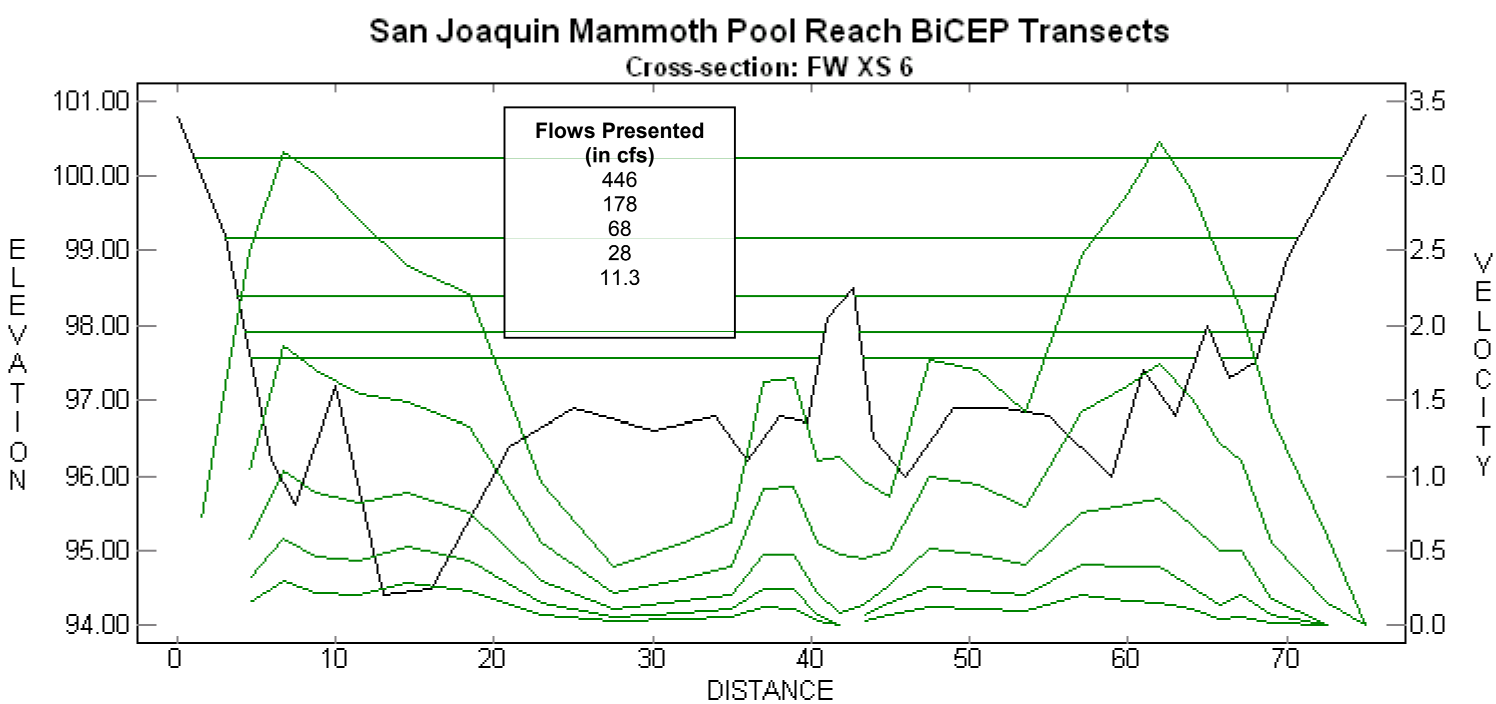

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: 1 HGR
Flows Presented
(in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90

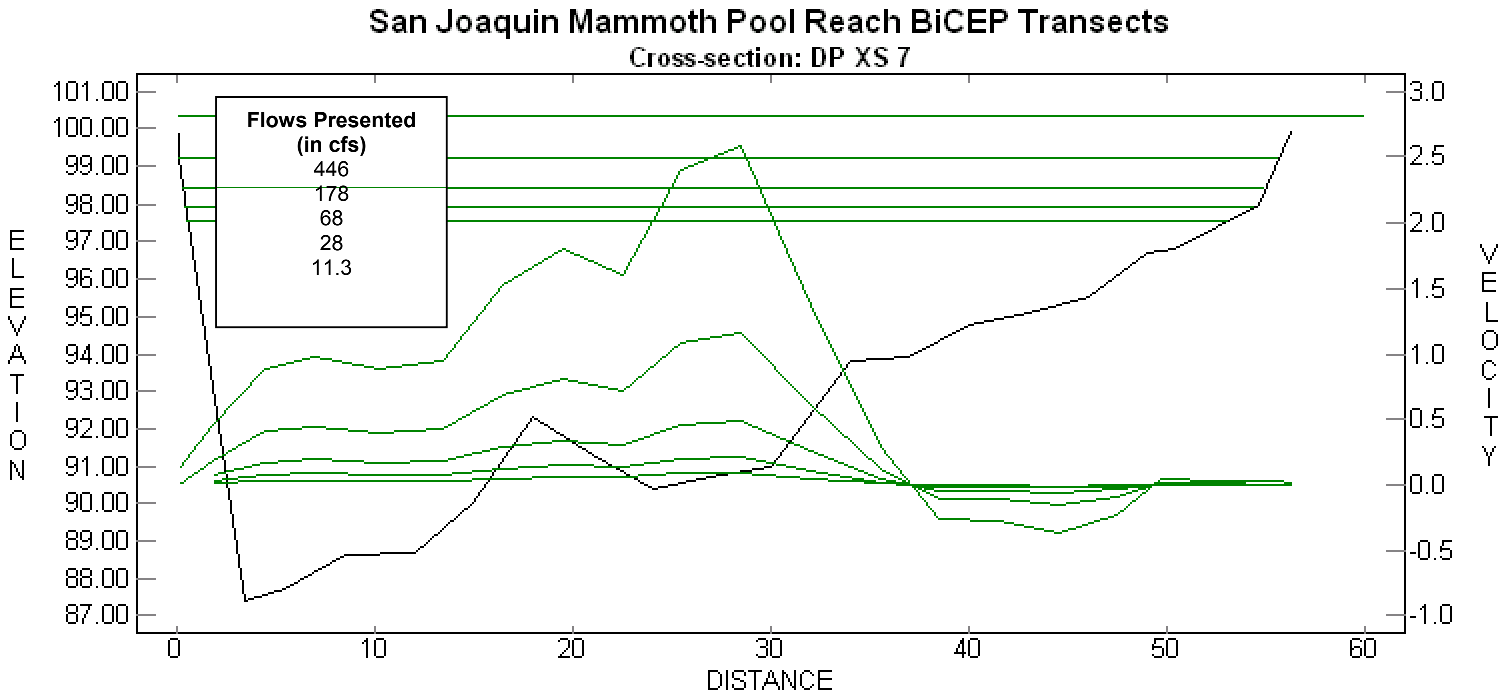

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: 2 POW
Flows Presented
(in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
60
70
80
90

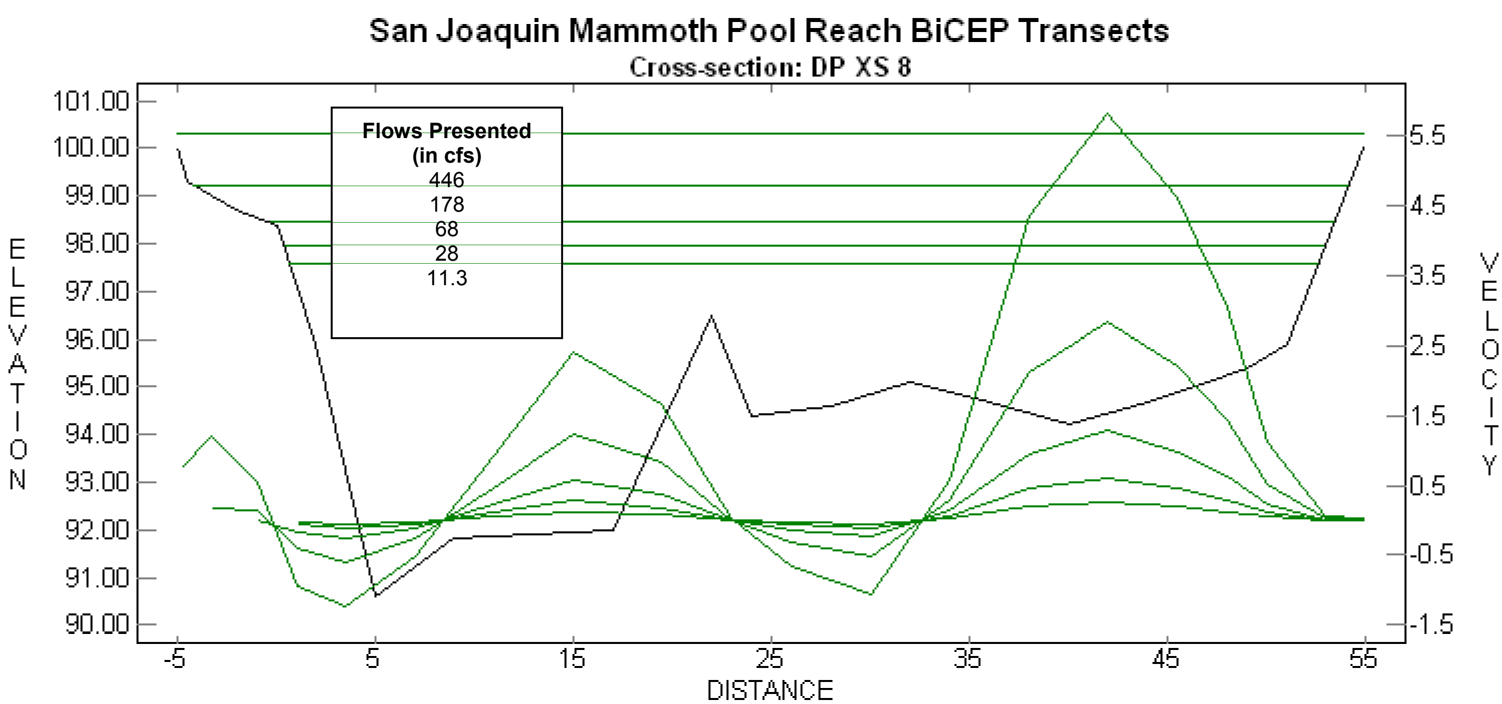

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: FW XS 3
Flows Presented
(in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
2.5
2.0
1.5
1.0
0.5
0.0

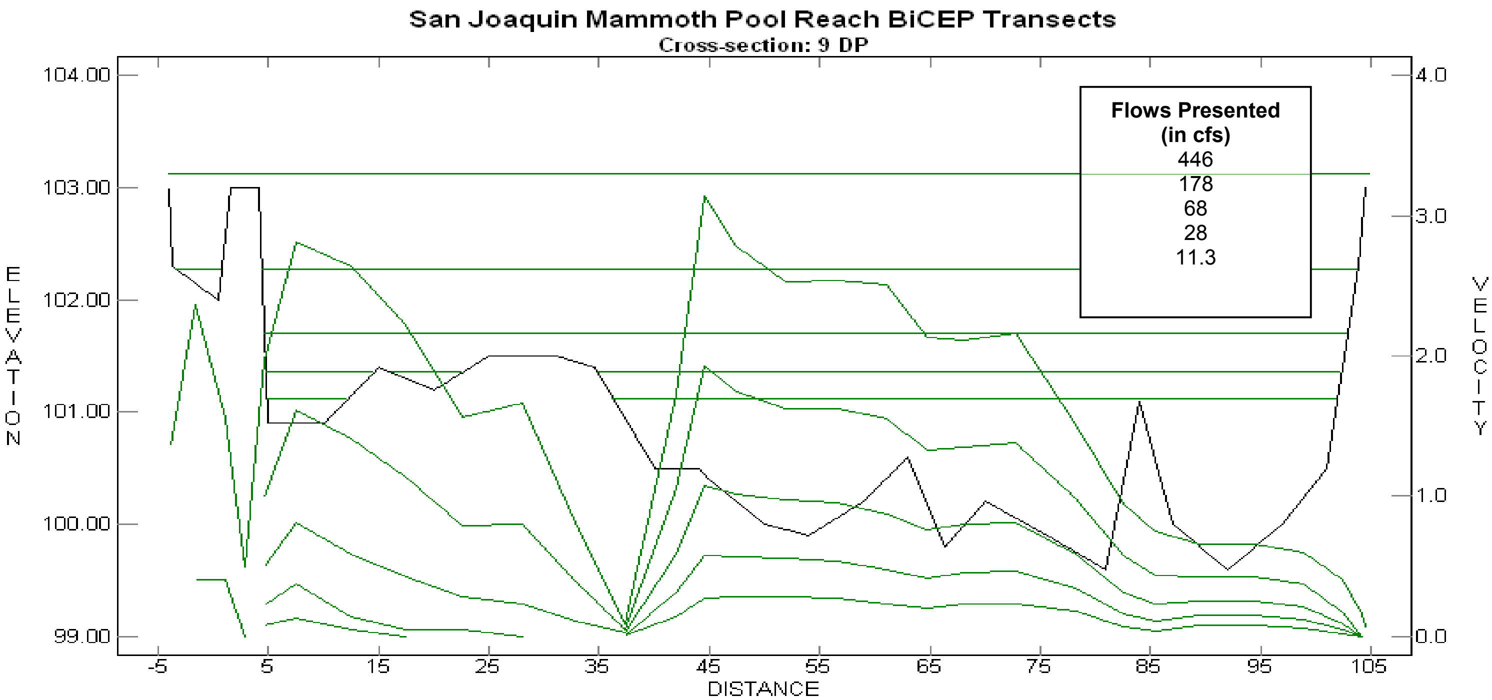

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: SP XS 4
Flows Presented
(in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
0
10
20
30
40
50
60
70
80
90
100
110
120
2.0
1.5
1.0
0.5
0.0

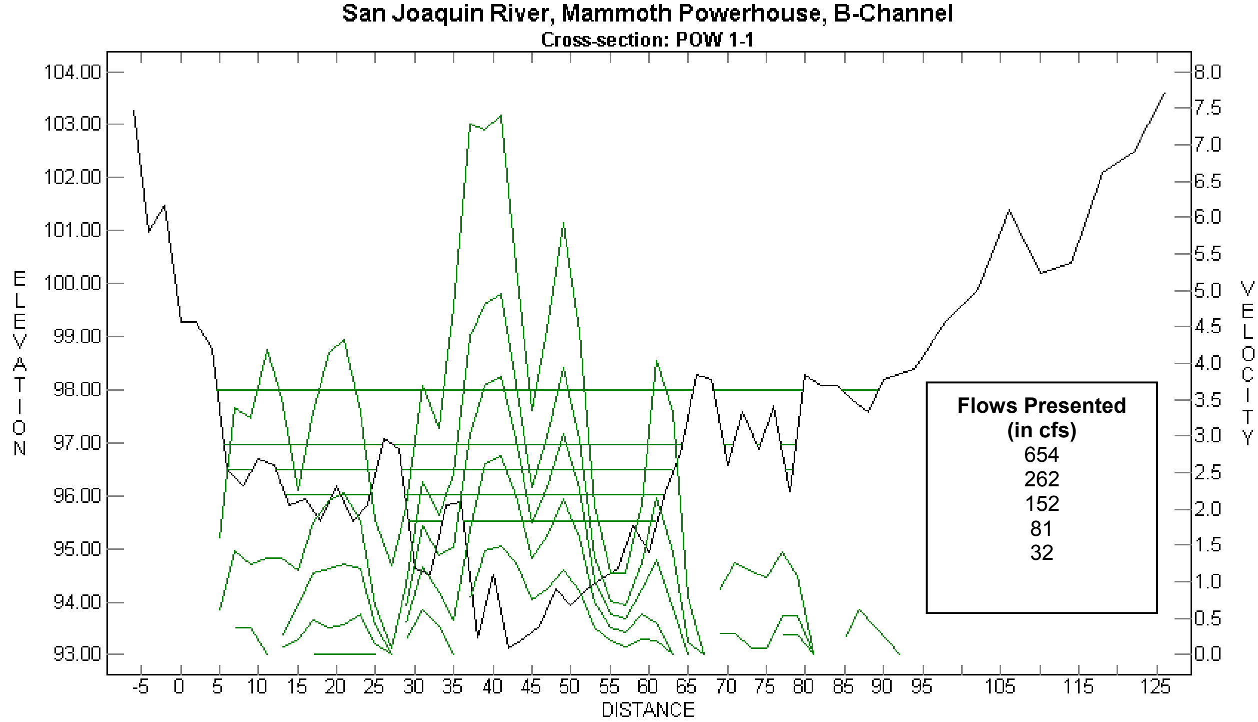

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: 5 DP
Flows Presented
(in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-5
5
15
25
35
45
55
65
75

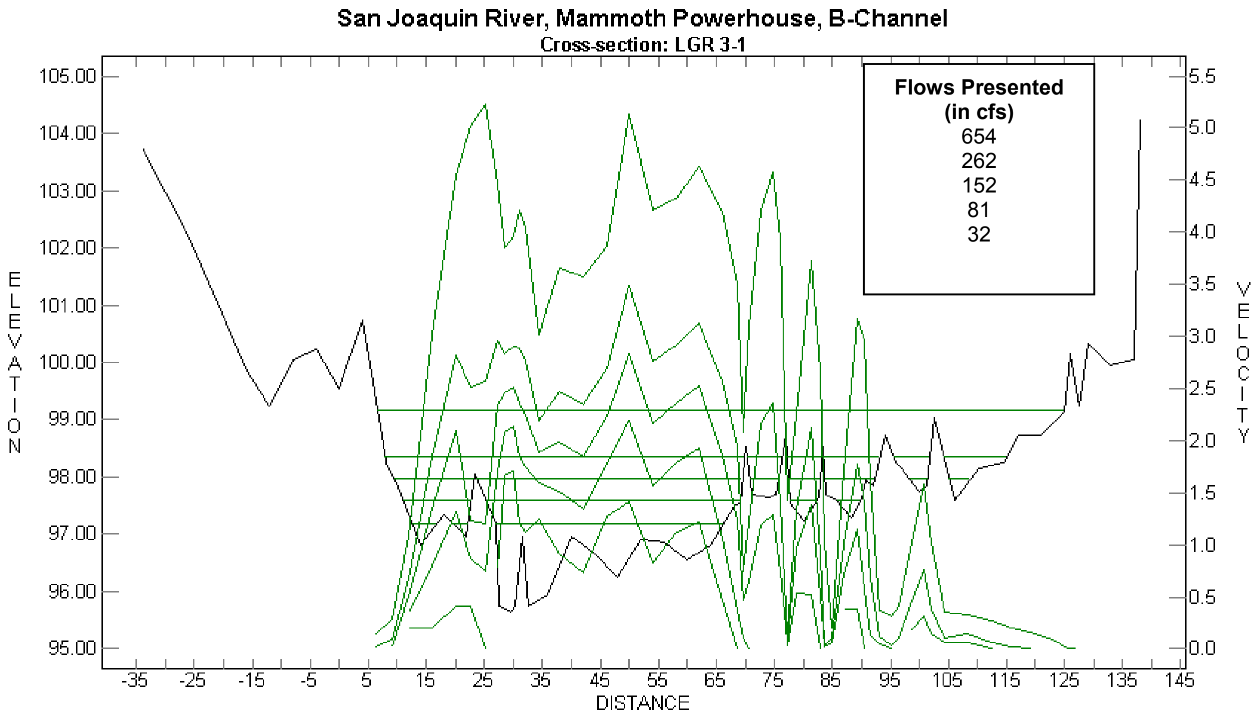

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: FW XS 6
Flows Presented
(in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70

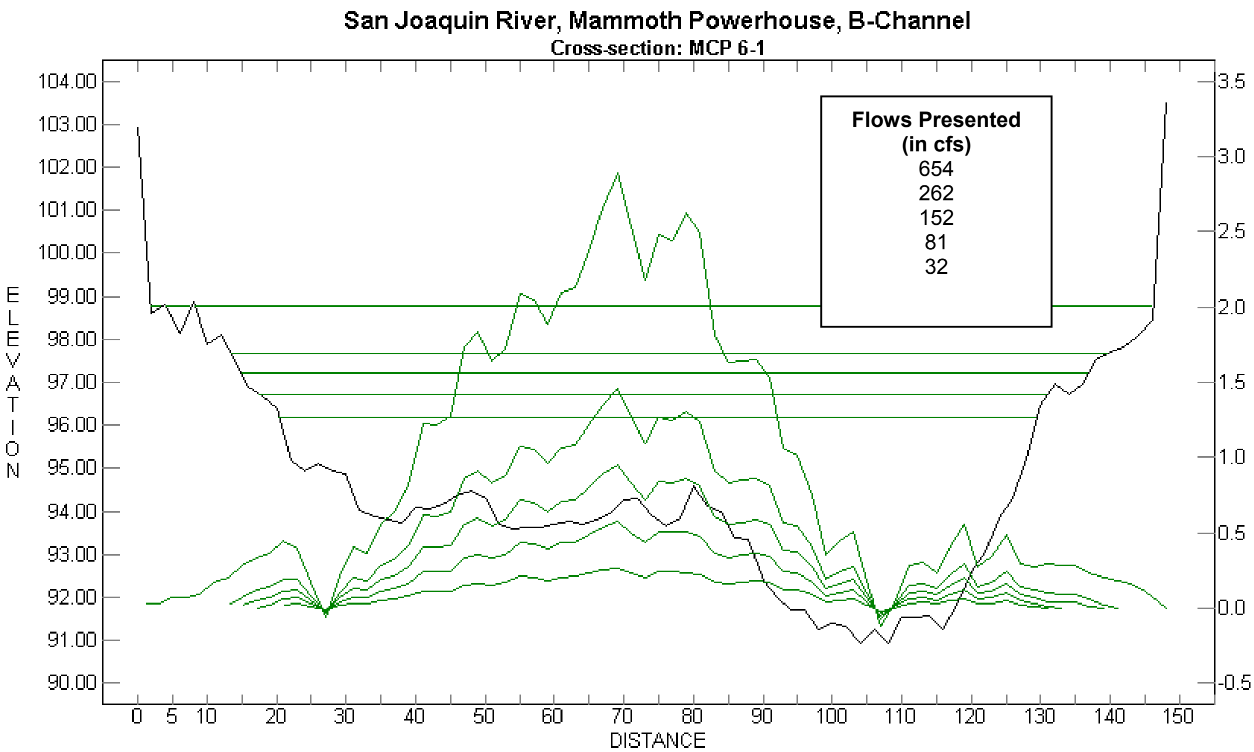

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 7
Flows Presented (in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
87.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
10
20
30
40
50
60

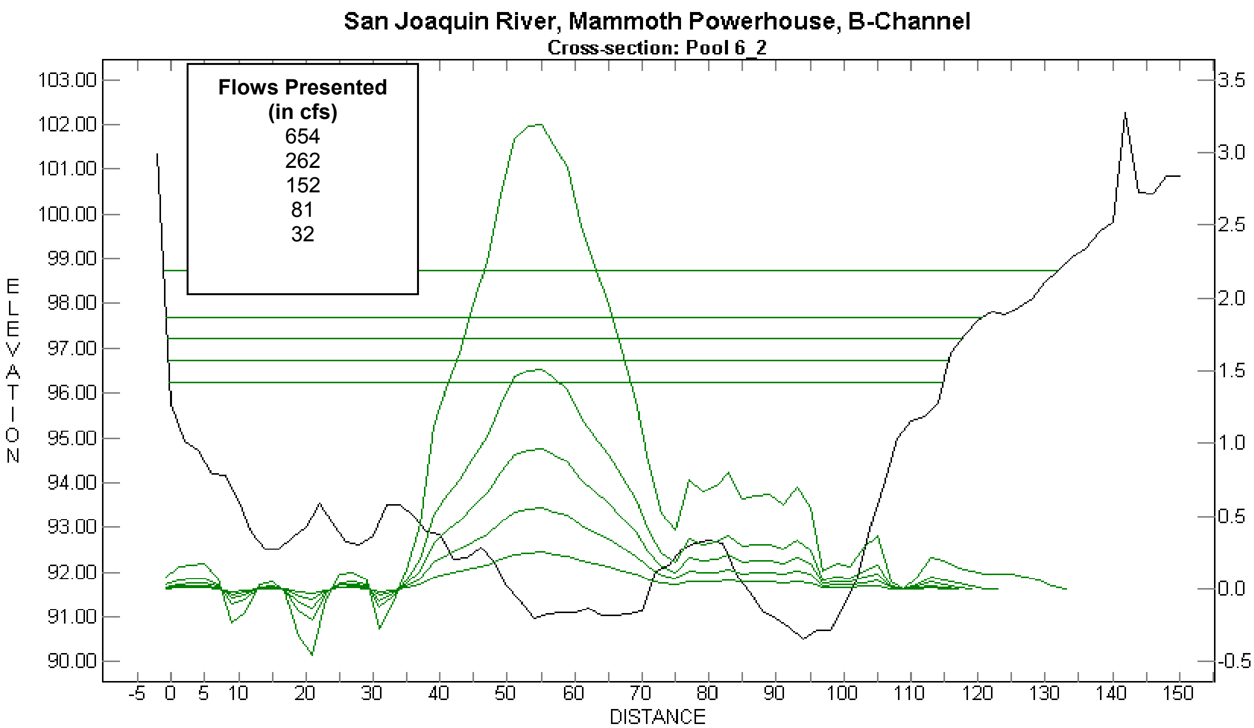

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 8
Flows Presented (in cfs)
446
178
68
28
11.3
ELEVATION
VELOCITY
DISTANCE
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
-5
5
15
25
35
45
55

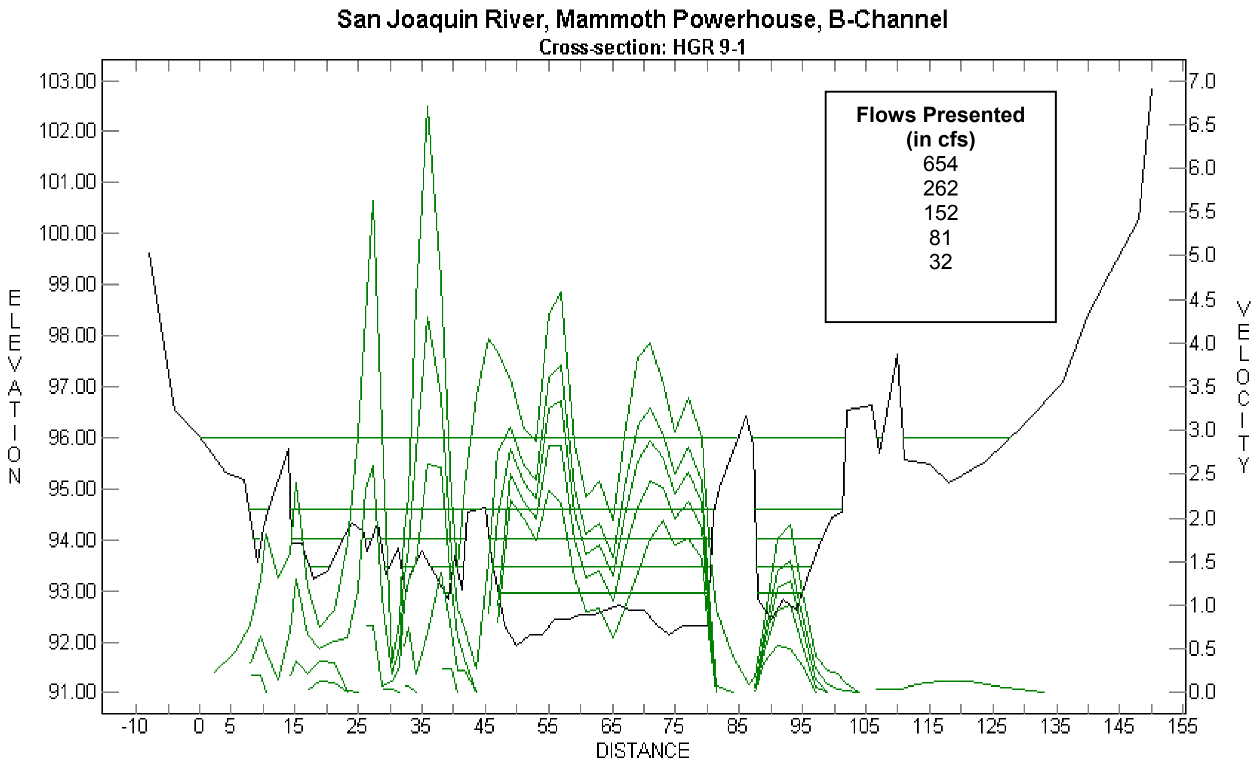

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: 9 DP
ELEVATION
104.00
103.00
102.00
101.00
100.00
99.00
VELOCITY
4.0
3.0
2.0
1.0
0.0
DISTANCE
-5
5
15
25
35
45
55
65
75
85
95
105
Flows Presented
(in cfs)
446
178
68
28
11.3

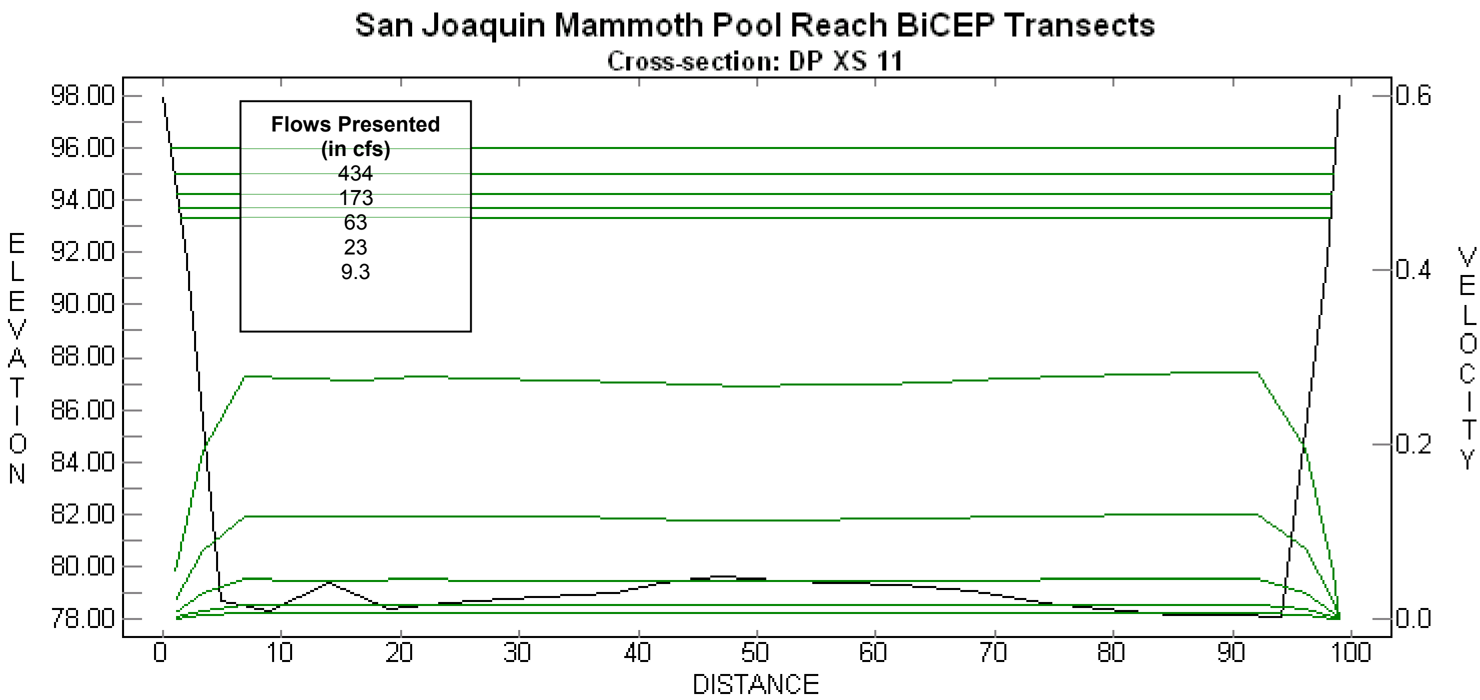

San Joaquin River, Mammoth Powerhouse, B-Channel
Cross-section: POW 1-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
654
262
152
81
32

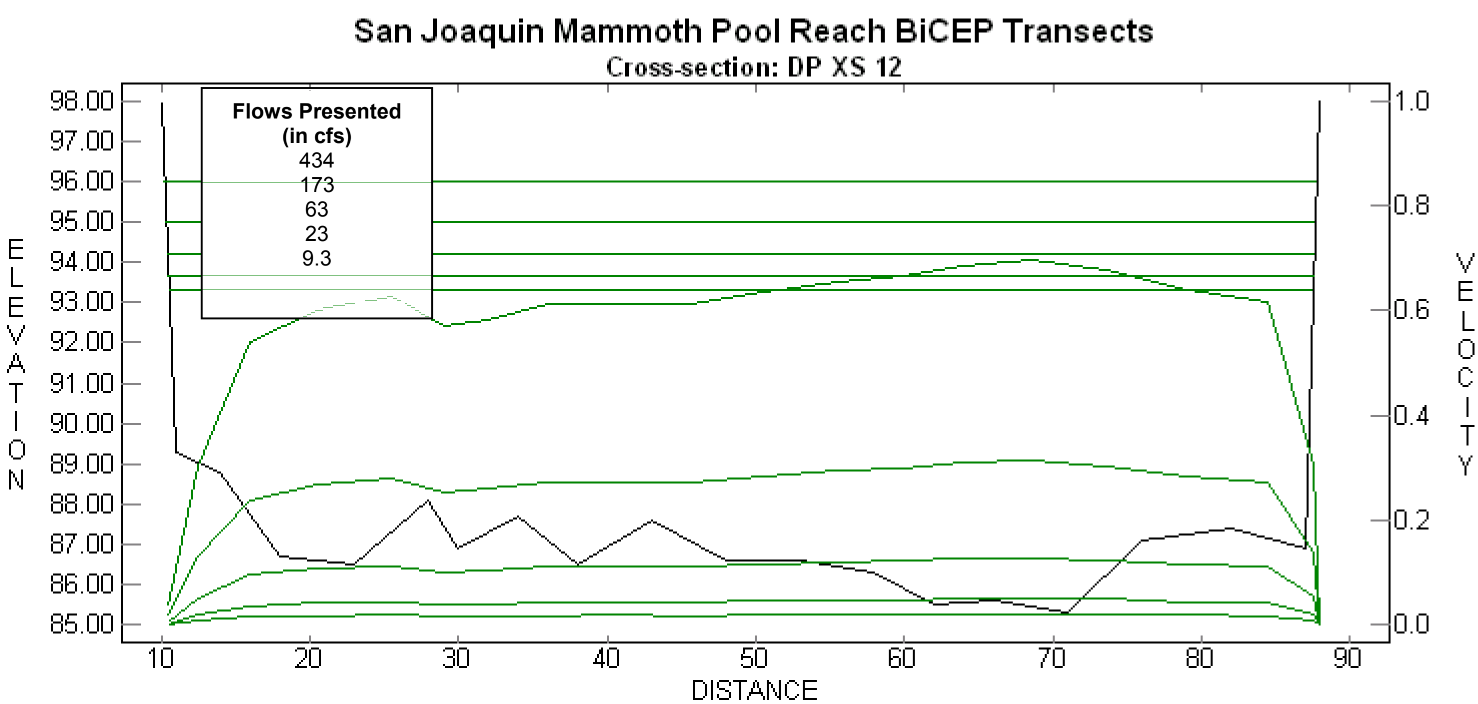

San Joaquin River, Mammoth Powerhouse, B-Channel
Cross-section: LGR 3-1
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
654
262
152
81
32

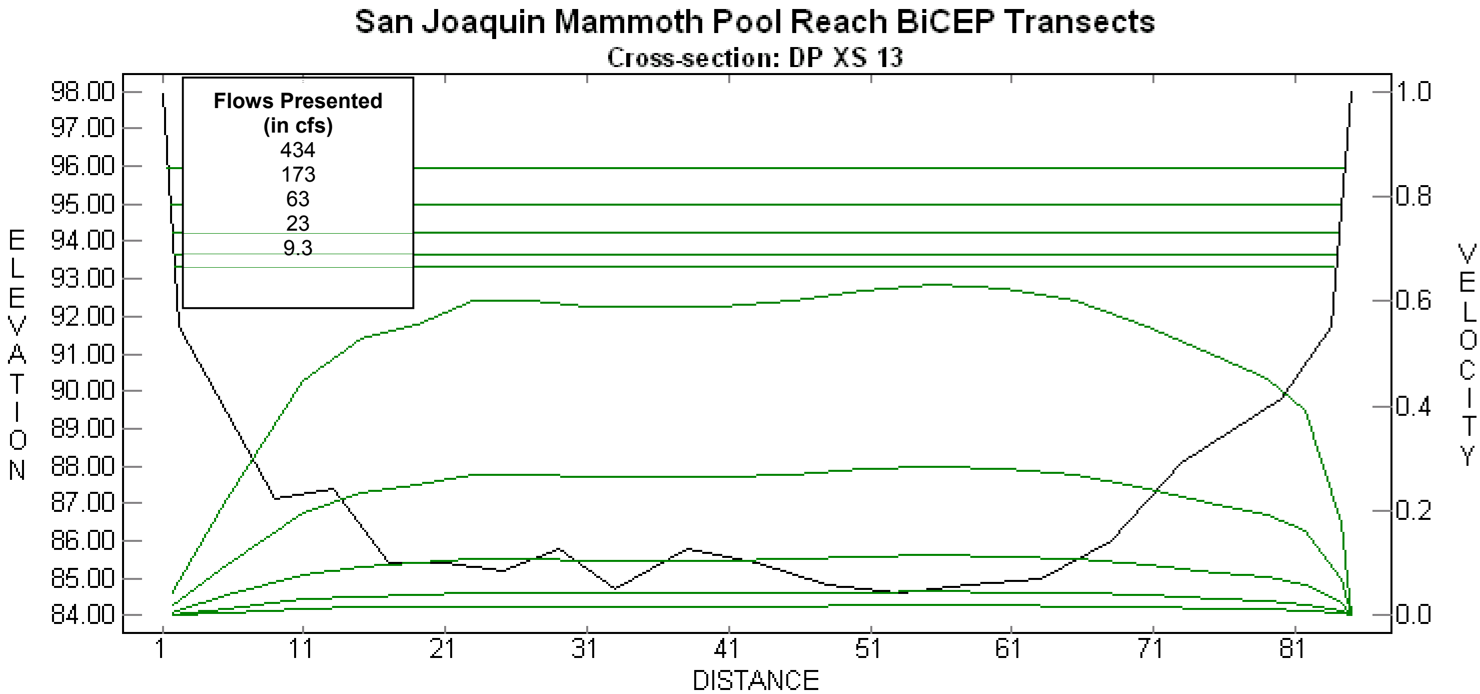

San Joaquin River, Mammoth Powerhouse, B-Channel
Cross-section: MCP 6-1
Flows Presented
(in cfs)
654
262
152
81
32
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0
5
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

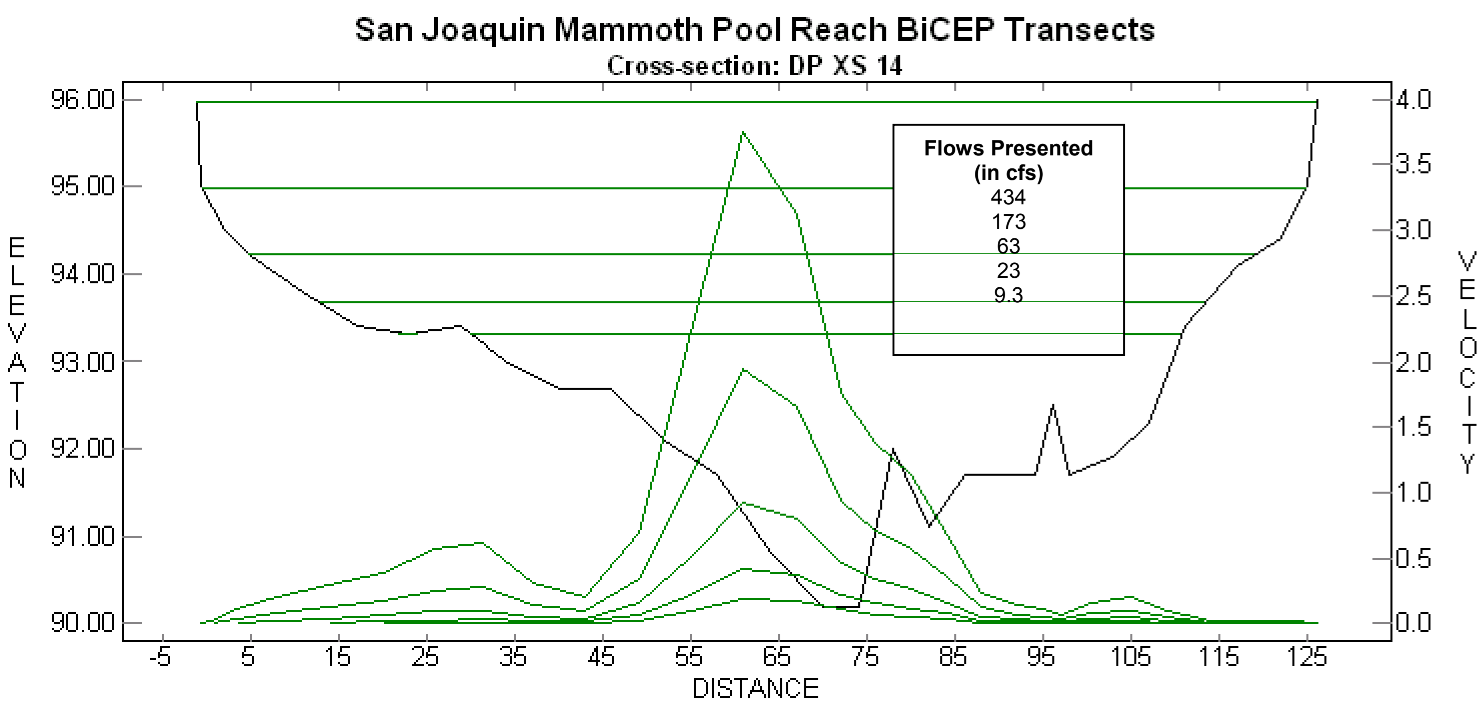

San Joaquin River, Mammoth Powerhouse, B-Channel
Cross-section: Pool 6_2
Flows Presented
(in cfs)
654
262
152
81
32
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-5
0
5
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

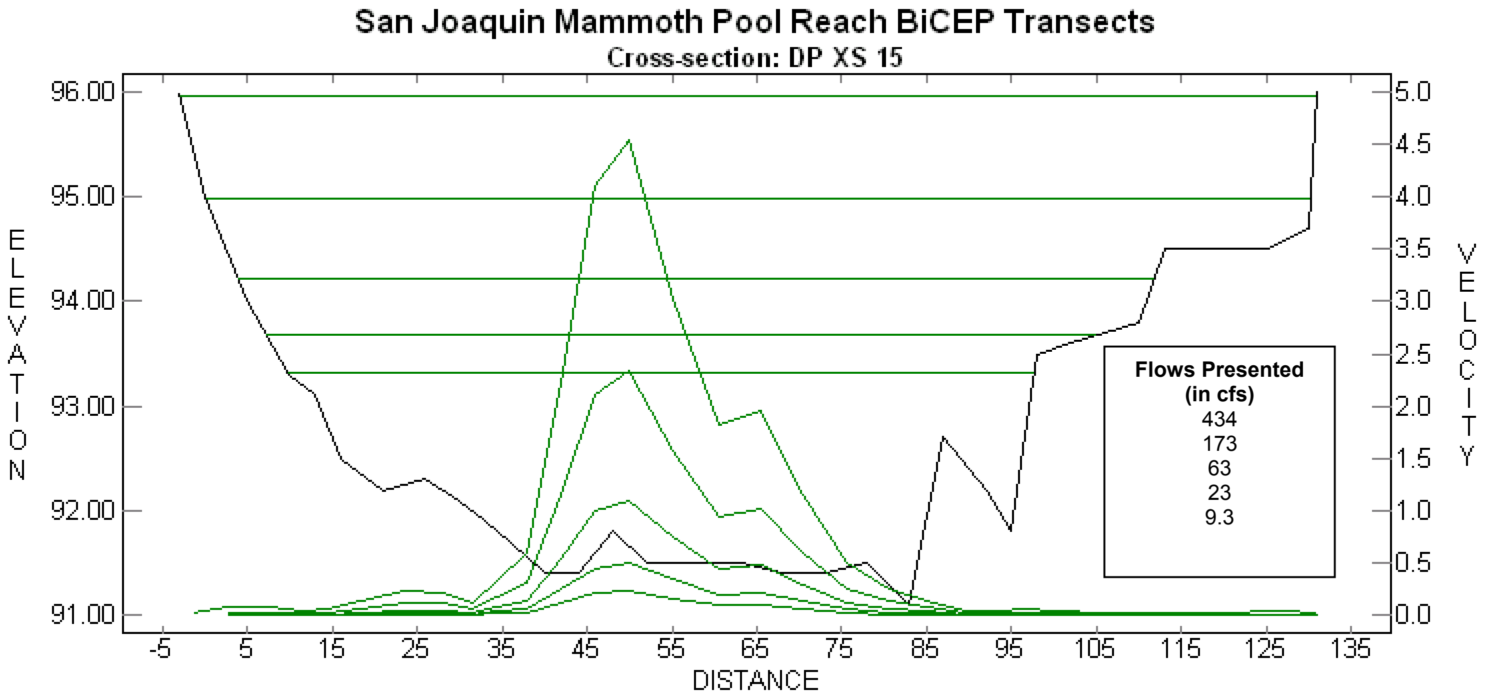

San Joaquin River, Mammoth Powerhouse, B-Channel
Cross-section: HGR 9-1
Flows Presented
(in cfs)
654
262
152
81
32
ELEVATION
VELOCITY
DISTANCE
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-10
0
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155

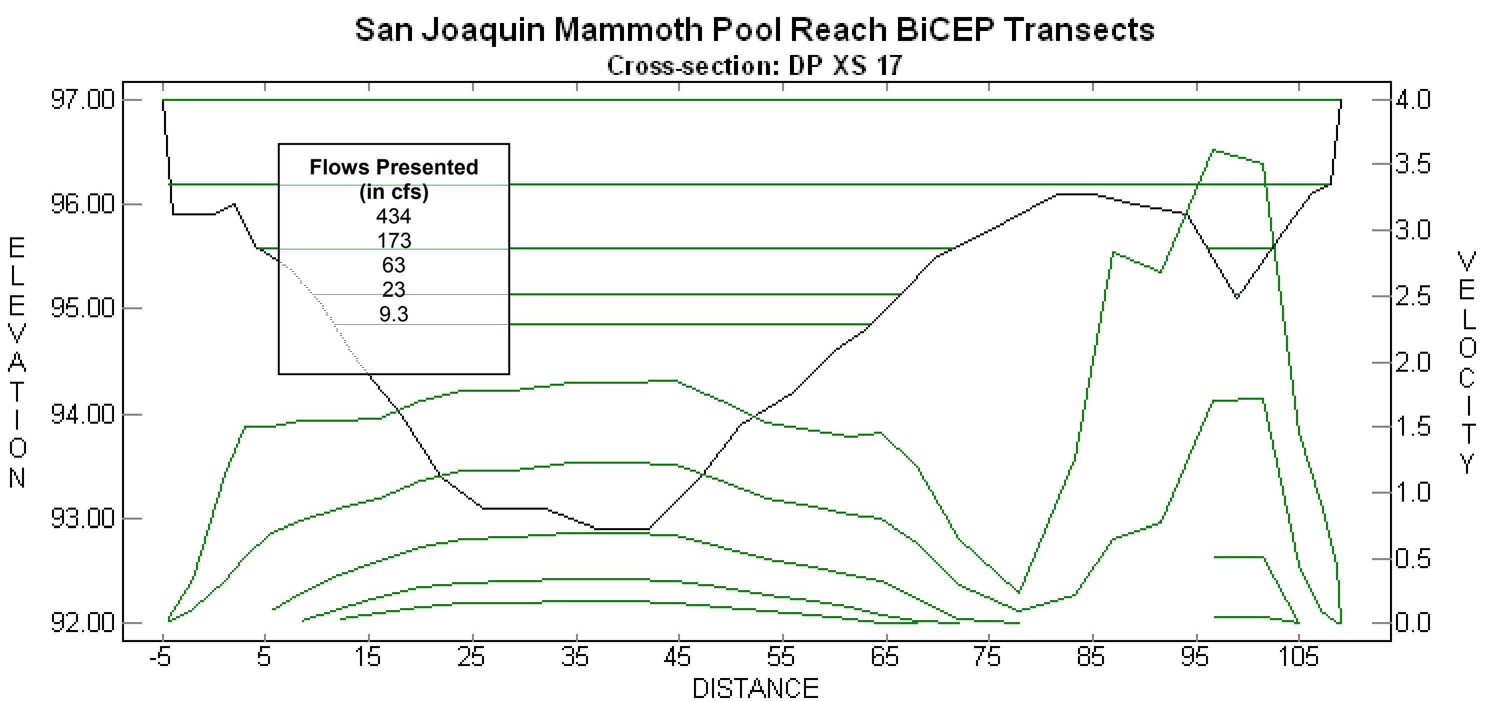

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 11
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
98.00
96.00
94.00
92.00
90.00
88.00
86.00
84.00
82.00
80.00
78.00
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
70
80
90
100

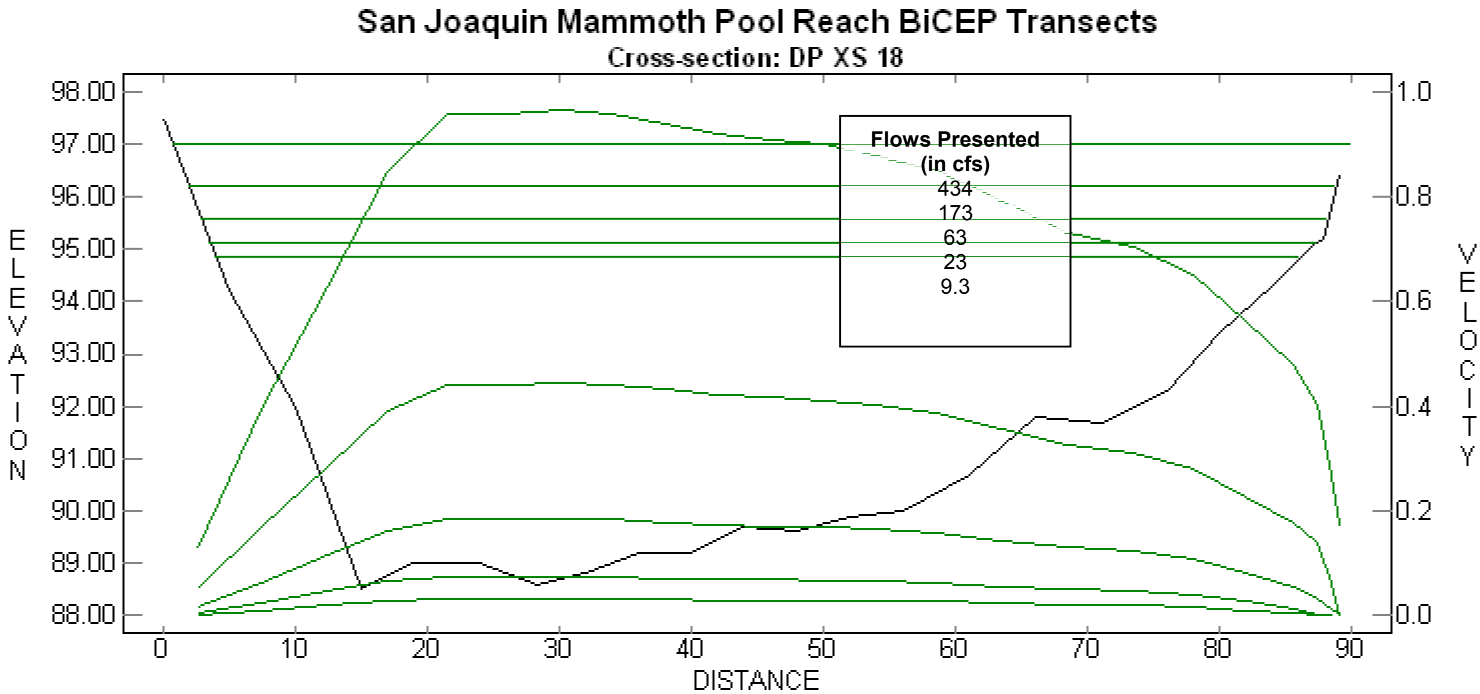

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 12
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
87.00
86.00
85.00
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
80
90

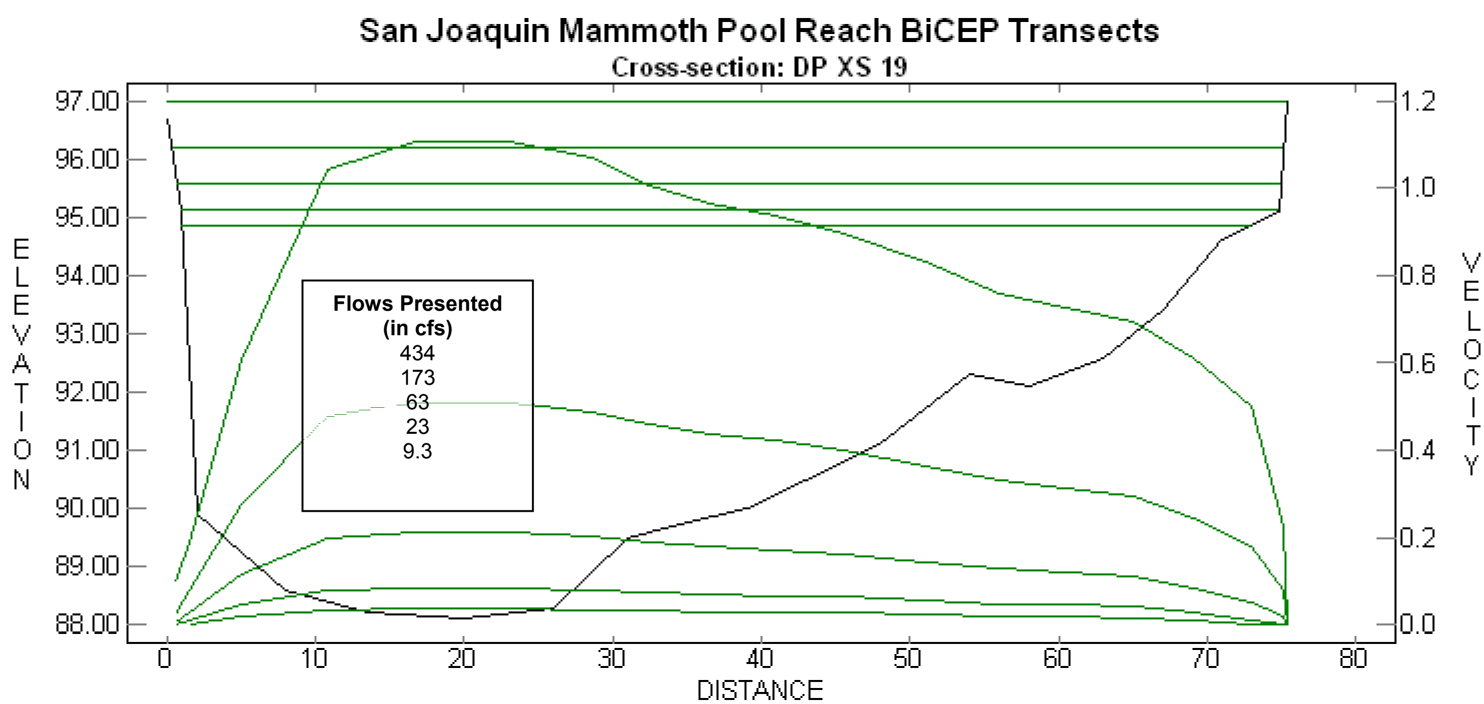

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 13
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
87.00
86.00
85.00
84.00
1.0
0.8
0.6
0.4
0.2
0.0
1
11
21
31
41
51
61
71
81

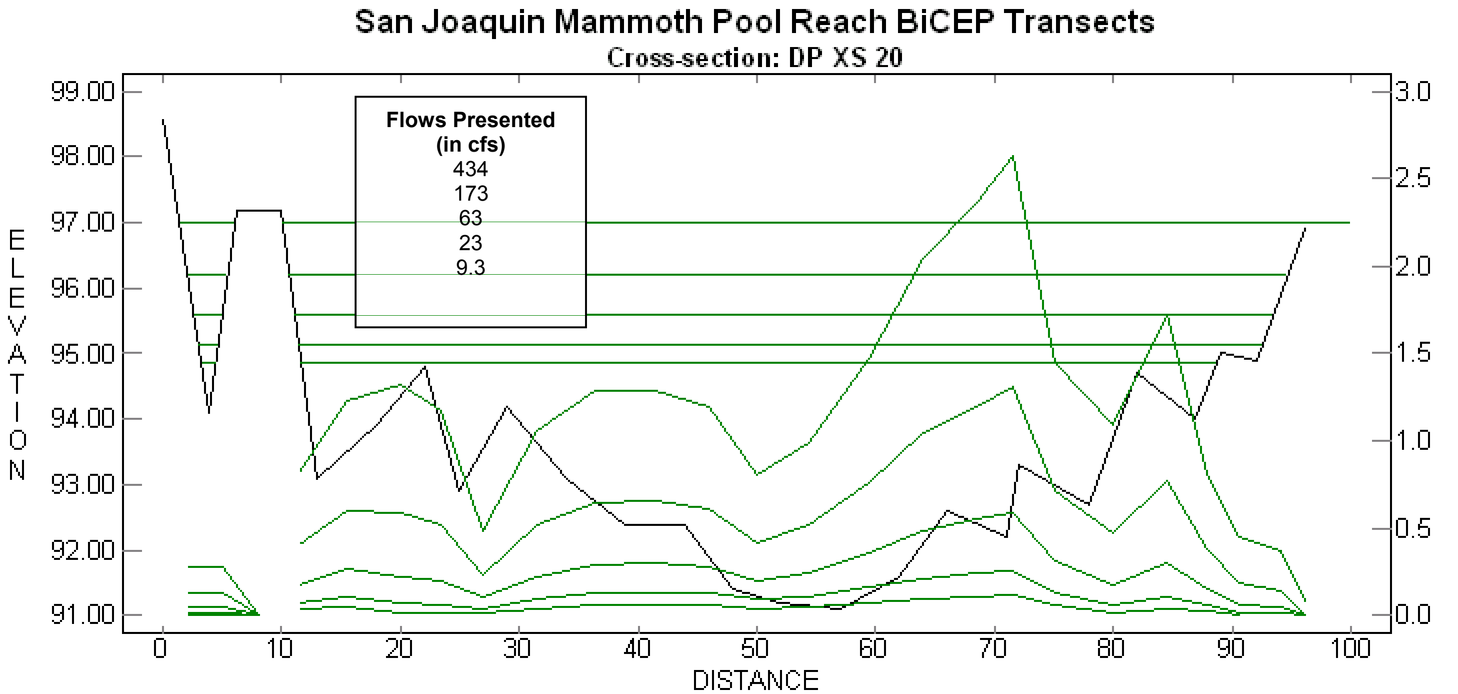

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 14
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
96.00
95.00
94.00
93.00
92.00
91.00
90.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
5
15
25
35
45
55
65
75
85
95
105
115
125

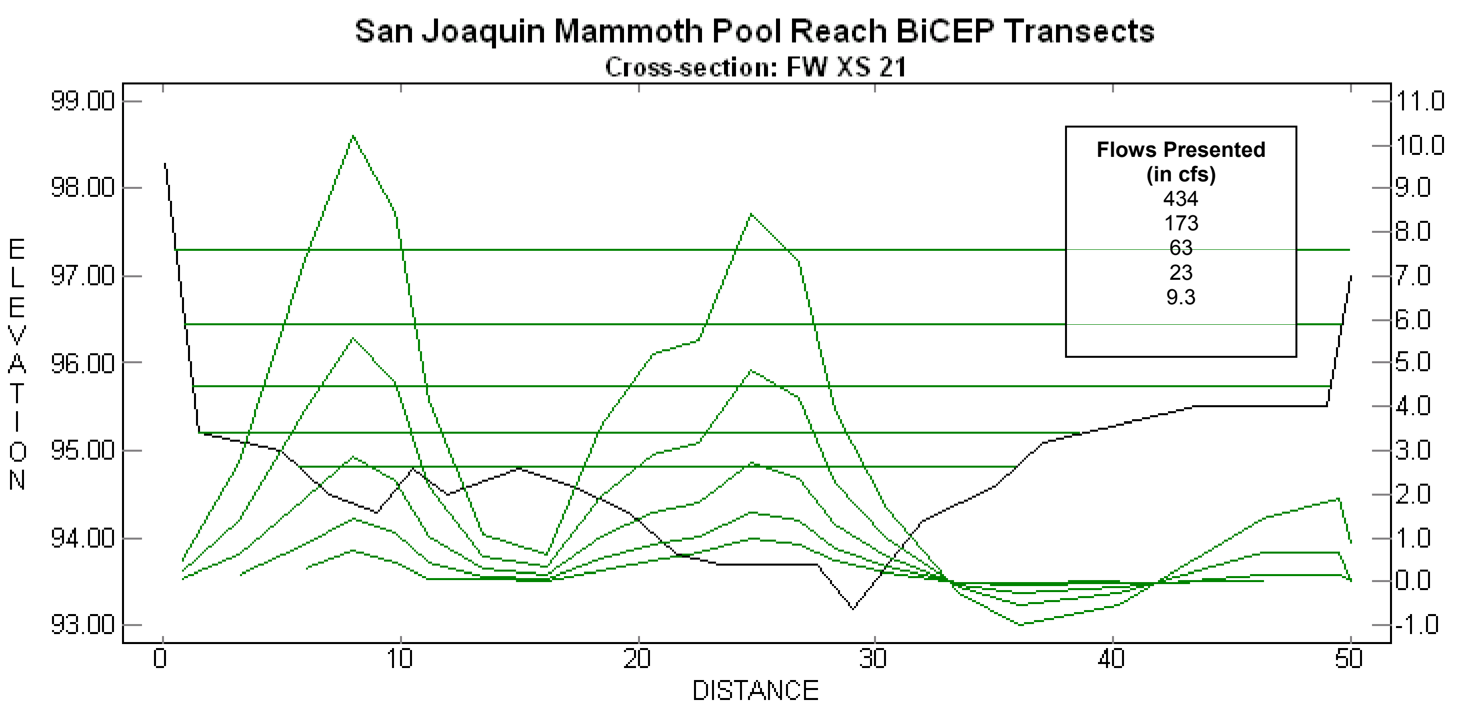

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 15
ELEVATION
VELOCITY
DISTANCE
96.00
95.00
94.00
93.00
92.00
91.00
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
5
15
25
35
45
55
65
75
85
95
105
115
125
135
Flows Presented
(in cfs)
434
173
63
23
9.3

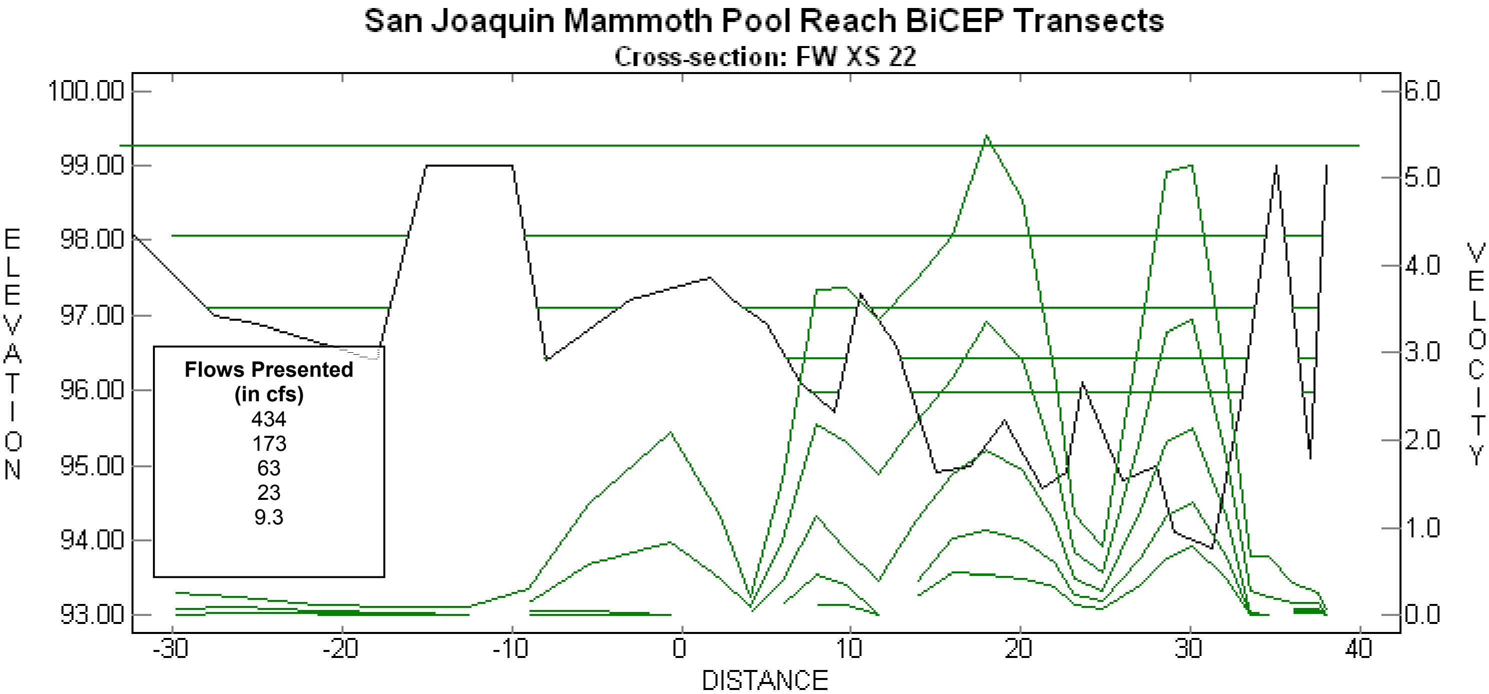

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 17
ELEVATION
VELOCITY
DISTANCE
97.00
96.00
95.00
94.00
93.00
92.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-5
5
15
25
35
45
55
65
75
85
95
105
Flows Presented
(in cfs)
434
173
63
23
9.3

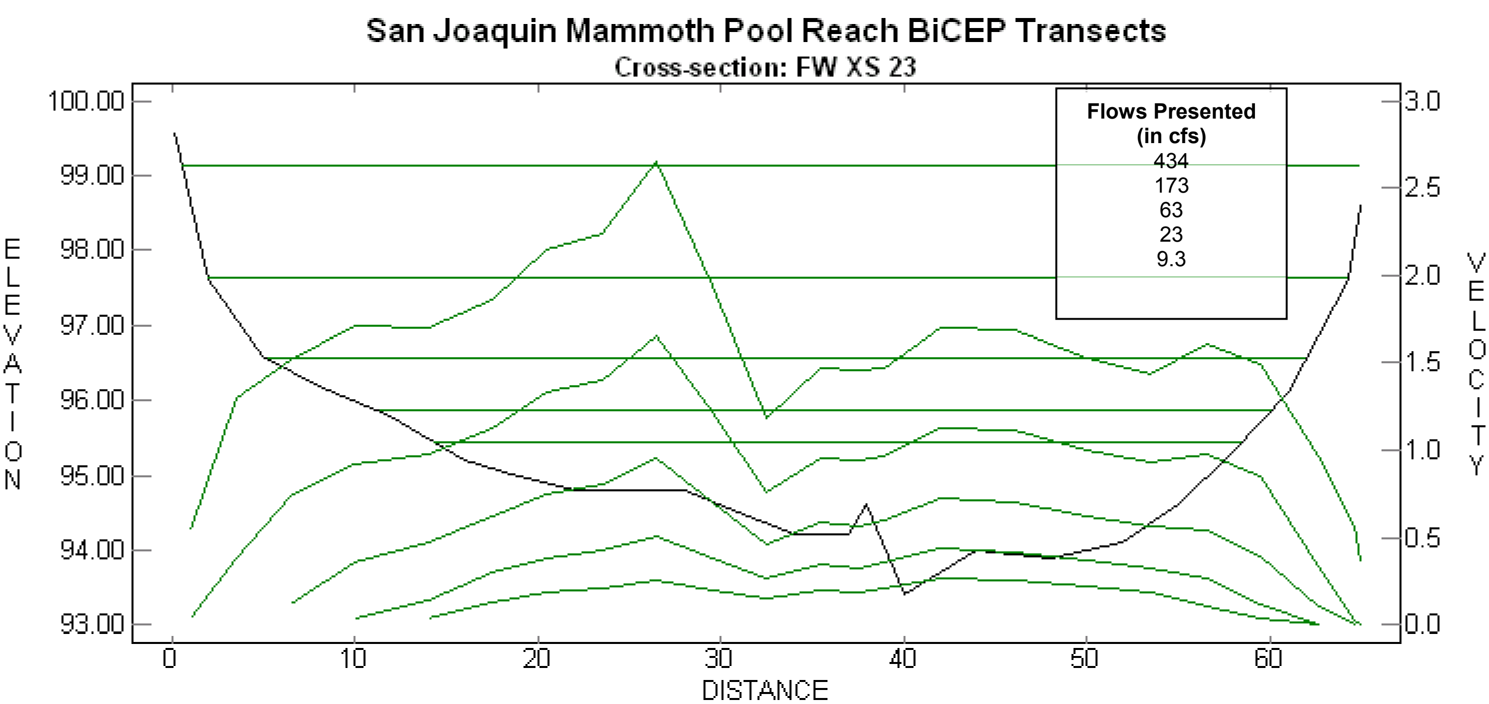

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 18
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
70
80
90

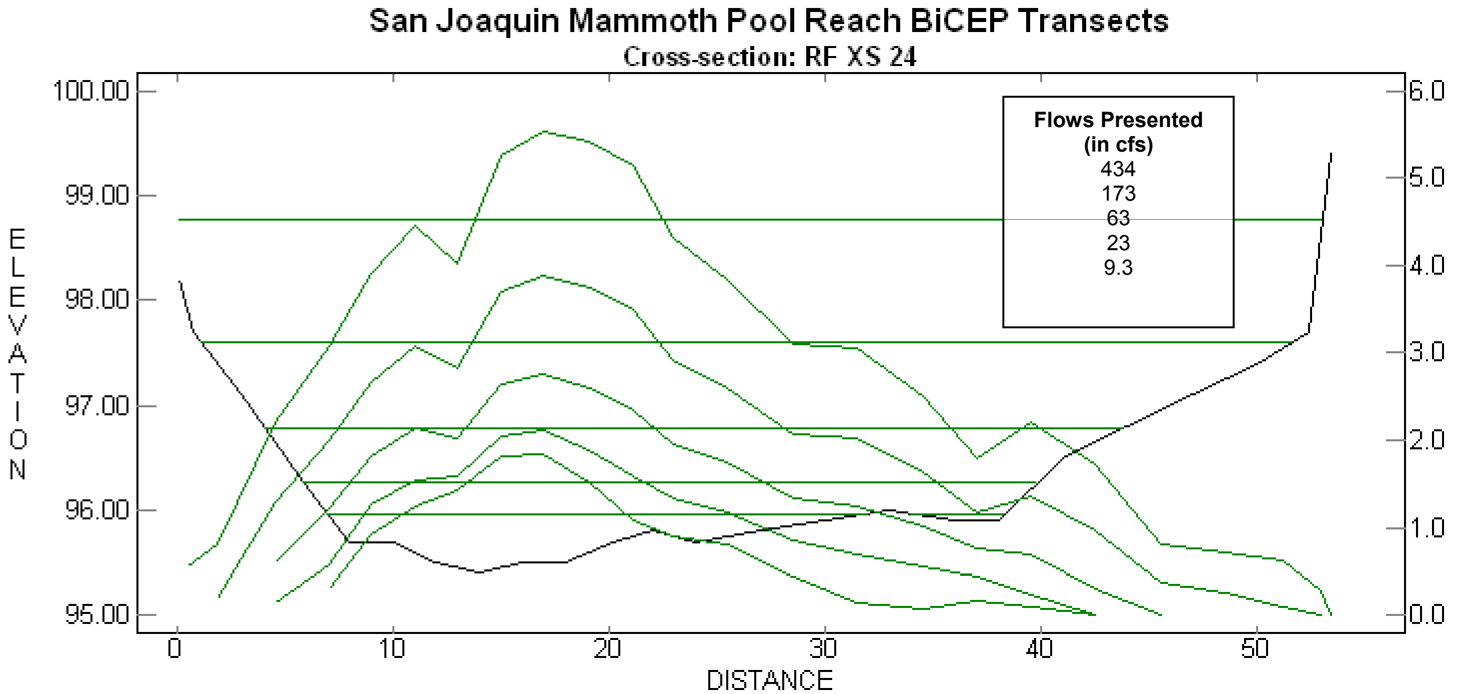

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 19
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
70
80

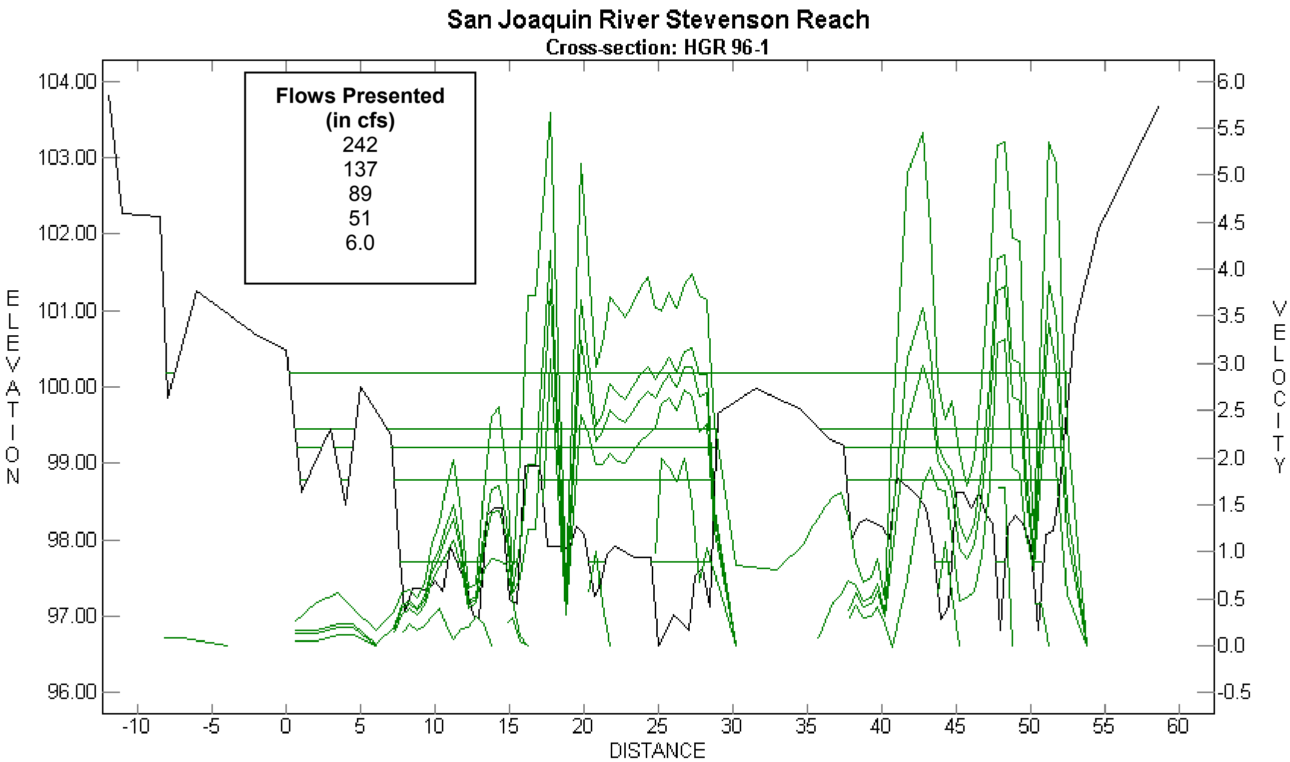

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: DP XS 20
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100

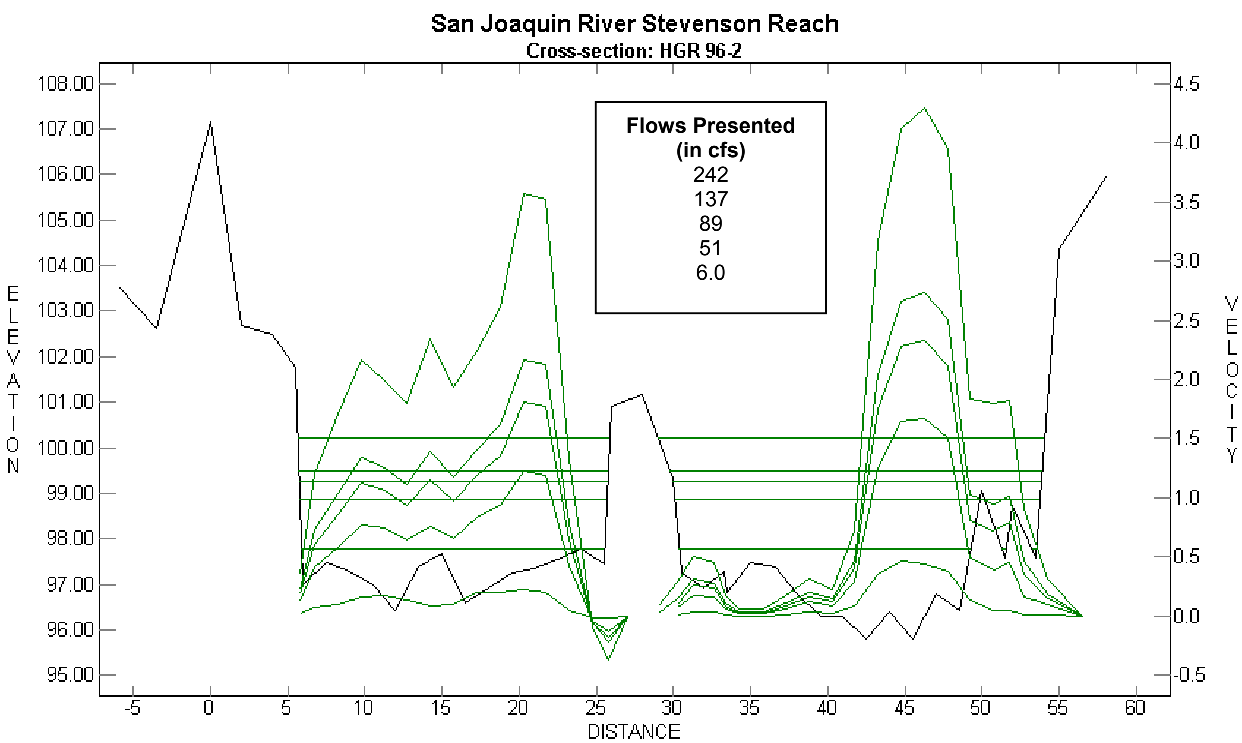

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: FW XS 21
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
99.00
98.00
97.00
96.00
95.00
94.00
93.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0
10
20
30
40
50

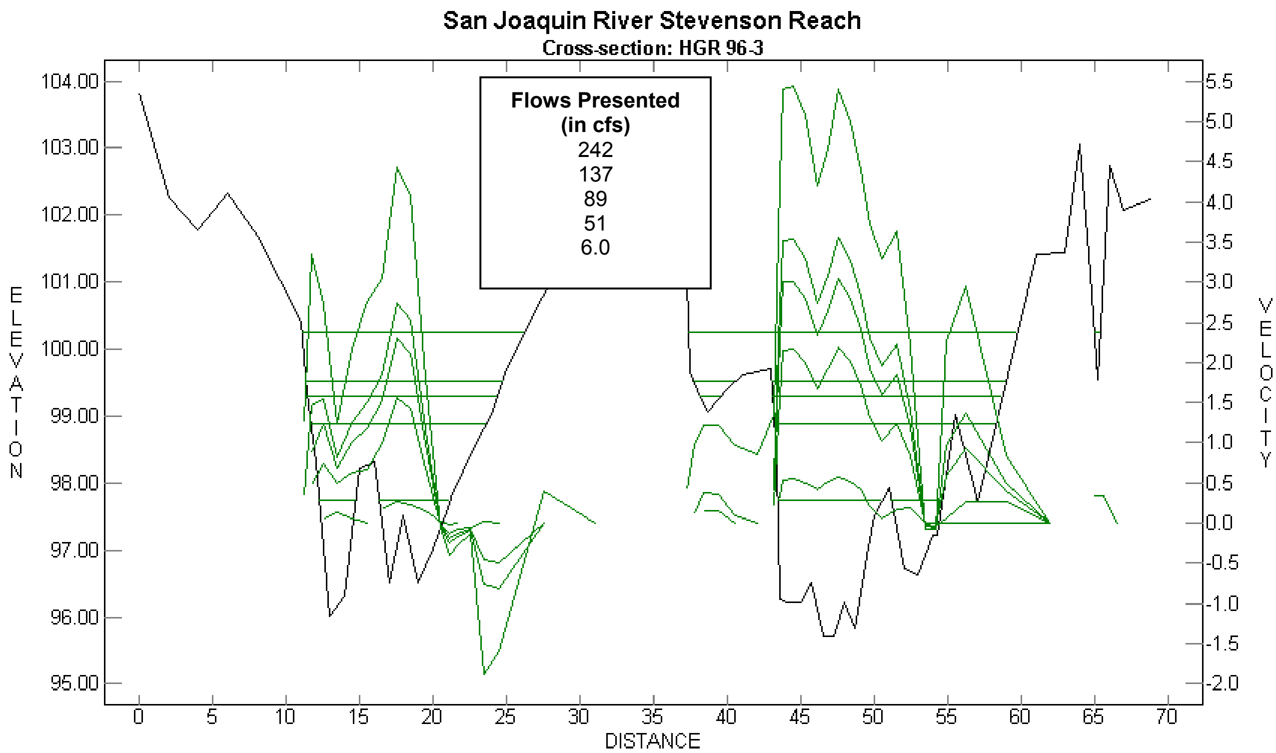

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: FW XS 22
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
434
173
63
23
9.3
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-30
-20
-10
0
10
20
30
40

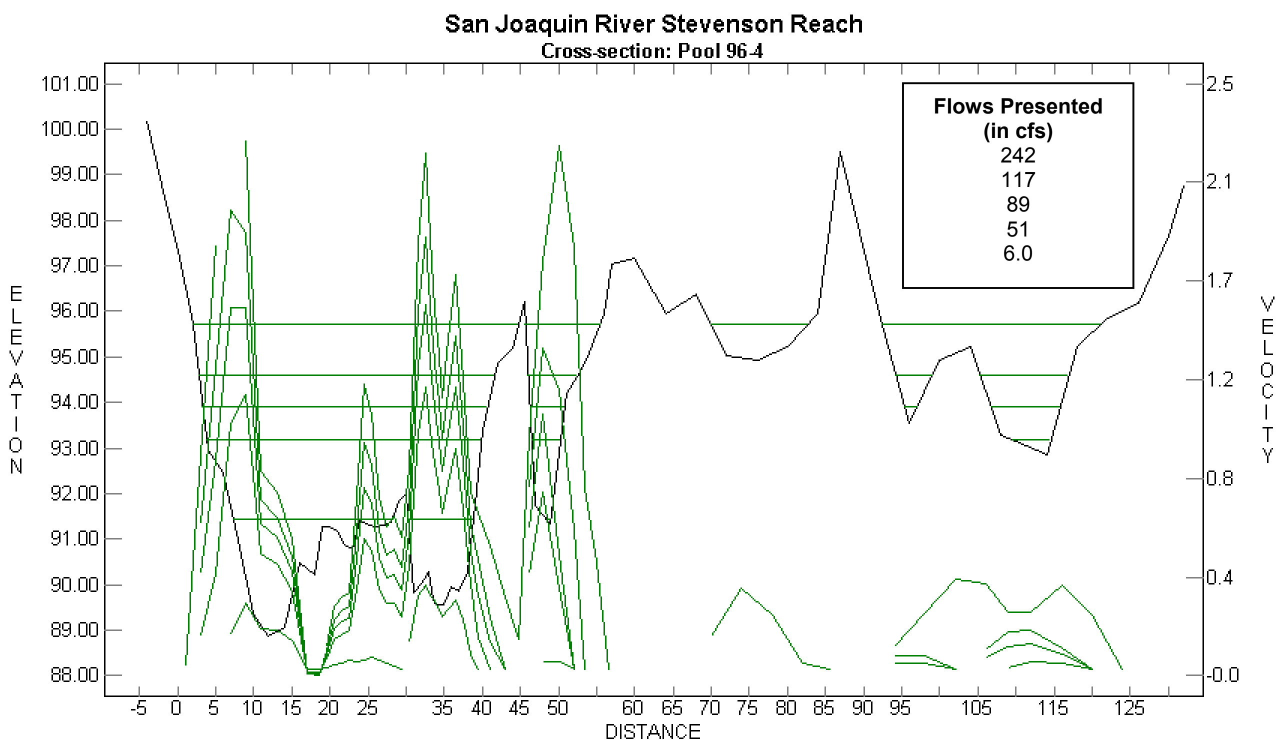

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: FW XS 23
ELEVATION
VELOCITY
DISTANCE
Flows Presented
(in cfs)
434
173
63
23
9.3
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60

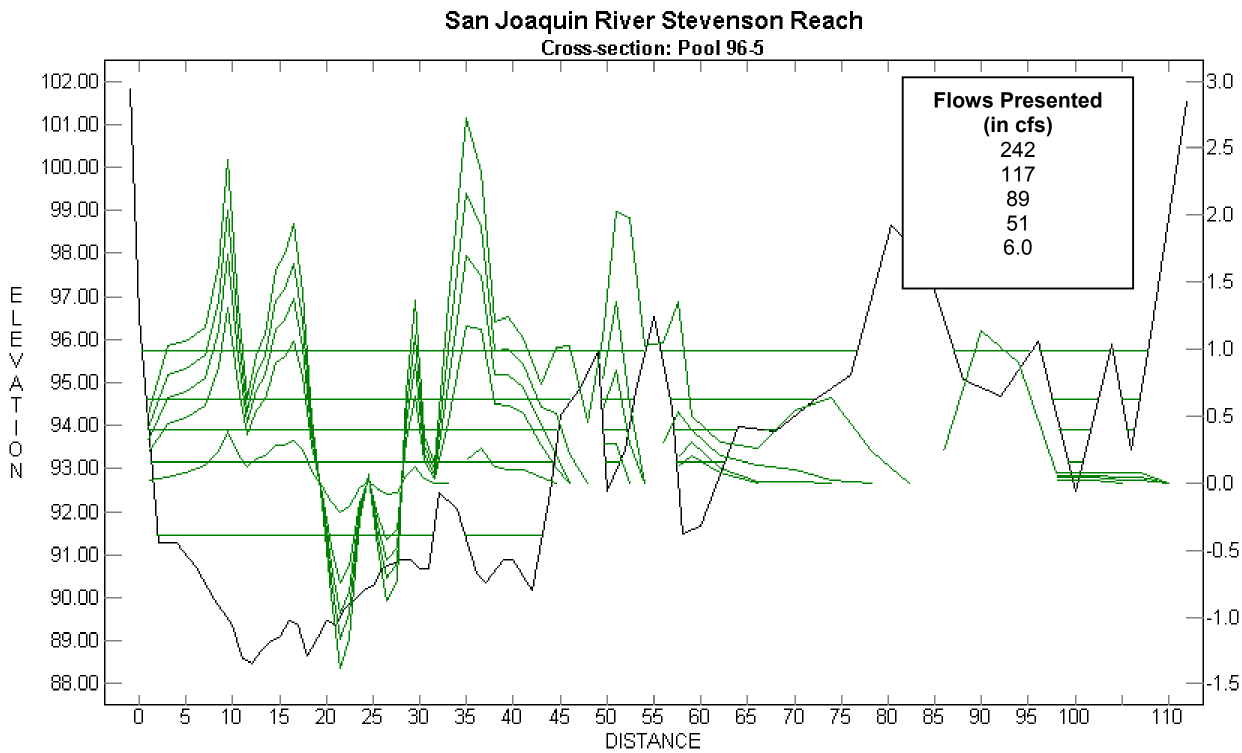

San Joaquin Mammoth Pool Reach BiCEP Transects
Cross-section: RF XS 24
Flows Presented
(in cfs)
434
173
63
23
9.3
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50

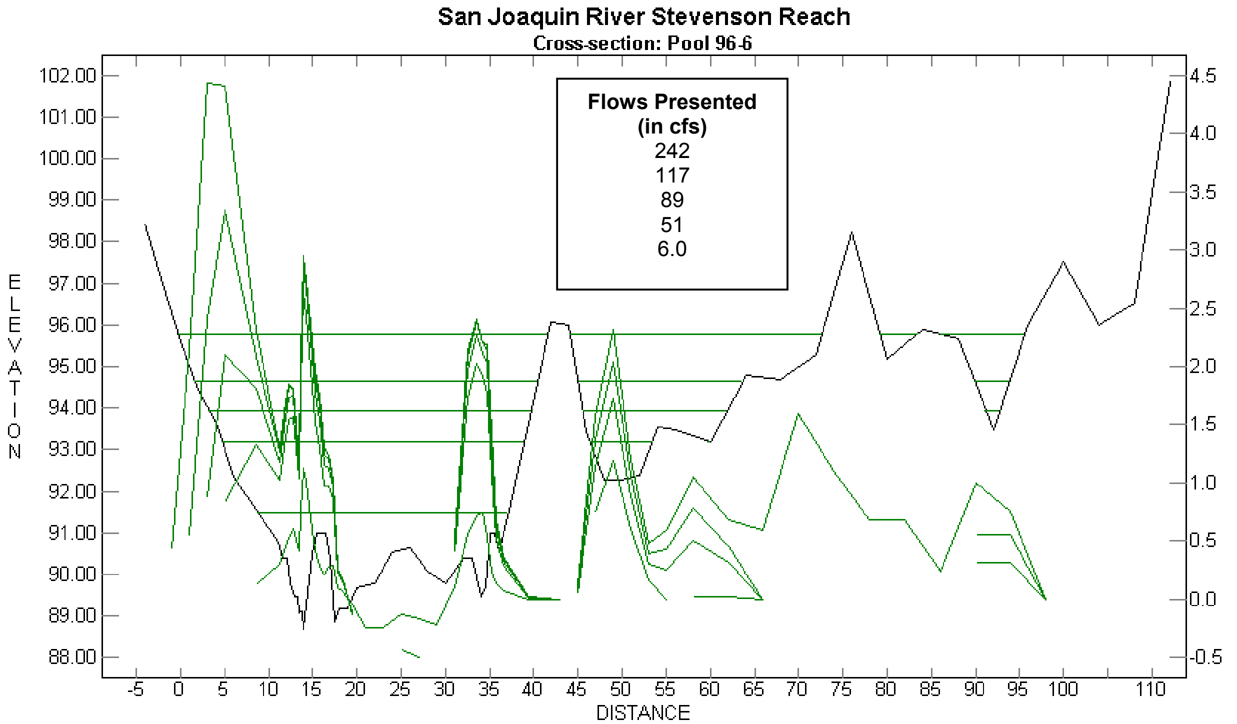

San Joaquin River Stevenson Reach
Cross-section: HGR 96-1
Flows Presented
(in cfs)
242
137
89
51
6.0
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60


San Joaquin River Stevenson Reach
Cross-section: HGR 96-2
Flows Presented
(in cfs)
242
137
89
51
6.0
ELEVATION
VELOCITY
DISTANCE
108.00
107.00
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-5
0
5
10
15
20
25
30
35
40
45
50
55
60


San Joaquin River Stevenson Reach
Cross-section: HGR 96-3
Flows Presented
(in cfs)
242
137
89
51
6.0
ELEVATION
VELOCITY
DISTANCE

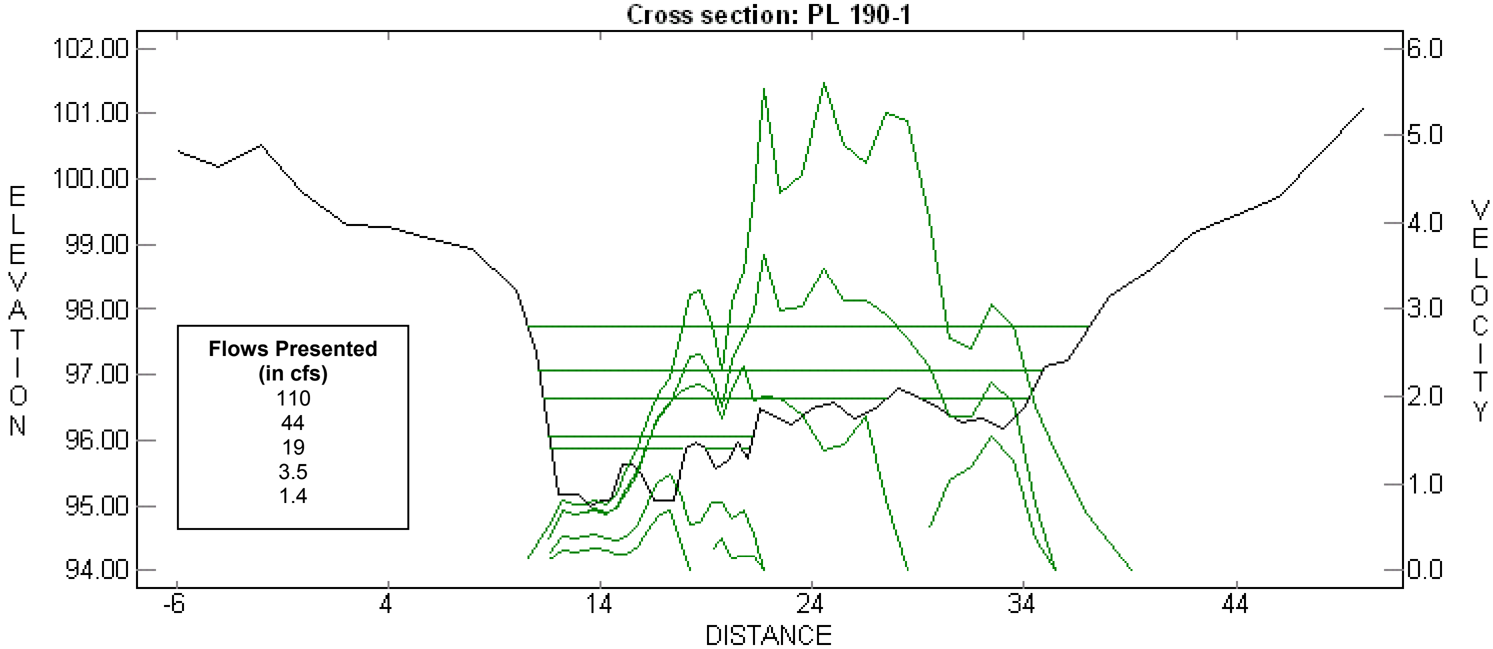

San Joaquin River Stevenson Reach
Cross-section: Pool 96-4
Flows Presented
(in cfs)
242
117
89
51
6.0
ELEVATION
VELOCITY
DISTANCE


San Joaquin River Stevenson Reach
Cross-section: Pool 96-5
Flows Presented
(in cfs)
242
117
89
51
6.0
ELEVATION
VELOCITY
DISTANCE


San Joaquin River Stevenson Reach
Cross-section: Pool 96-6
Flows Presented
(in cfs)
242
117
89
51
6.0
ELEVATION
VELOCITY
DISTANCE

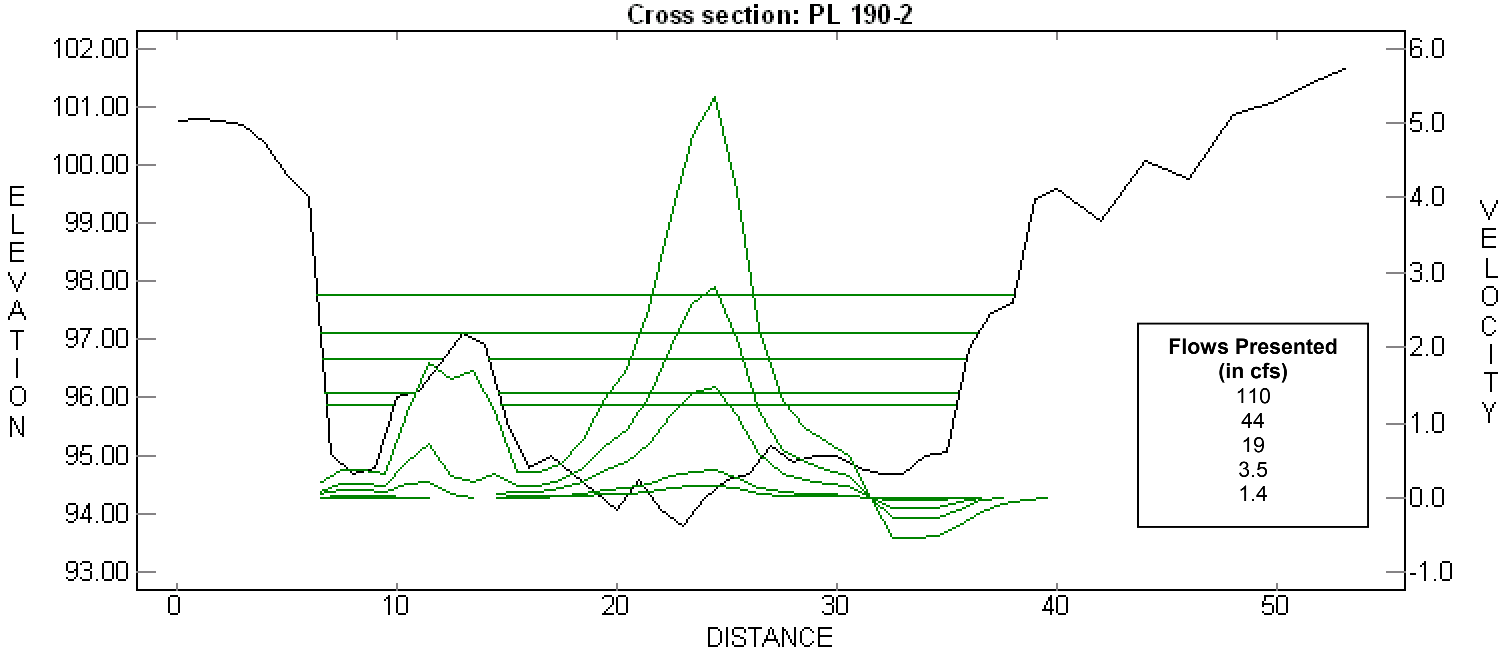
Stevenson Creek Aa+ Channel

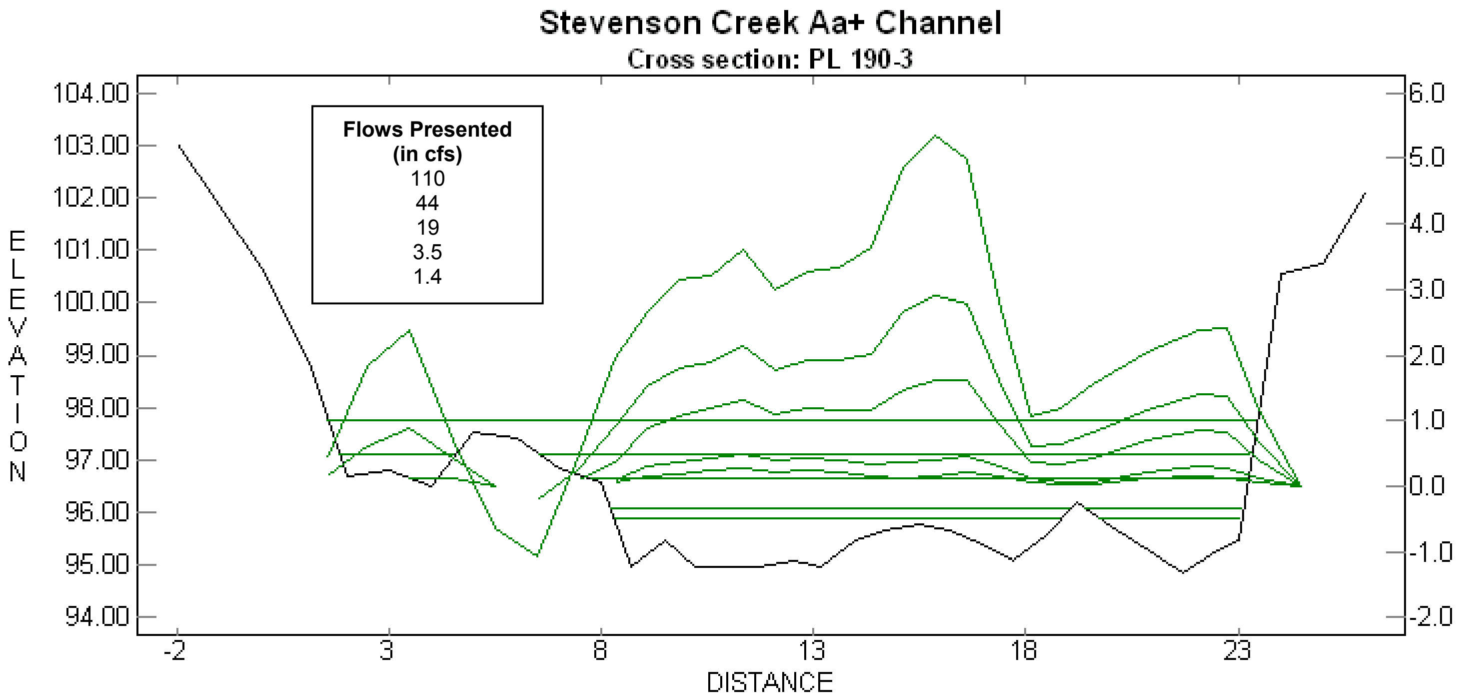
Cross section: PL 190-1

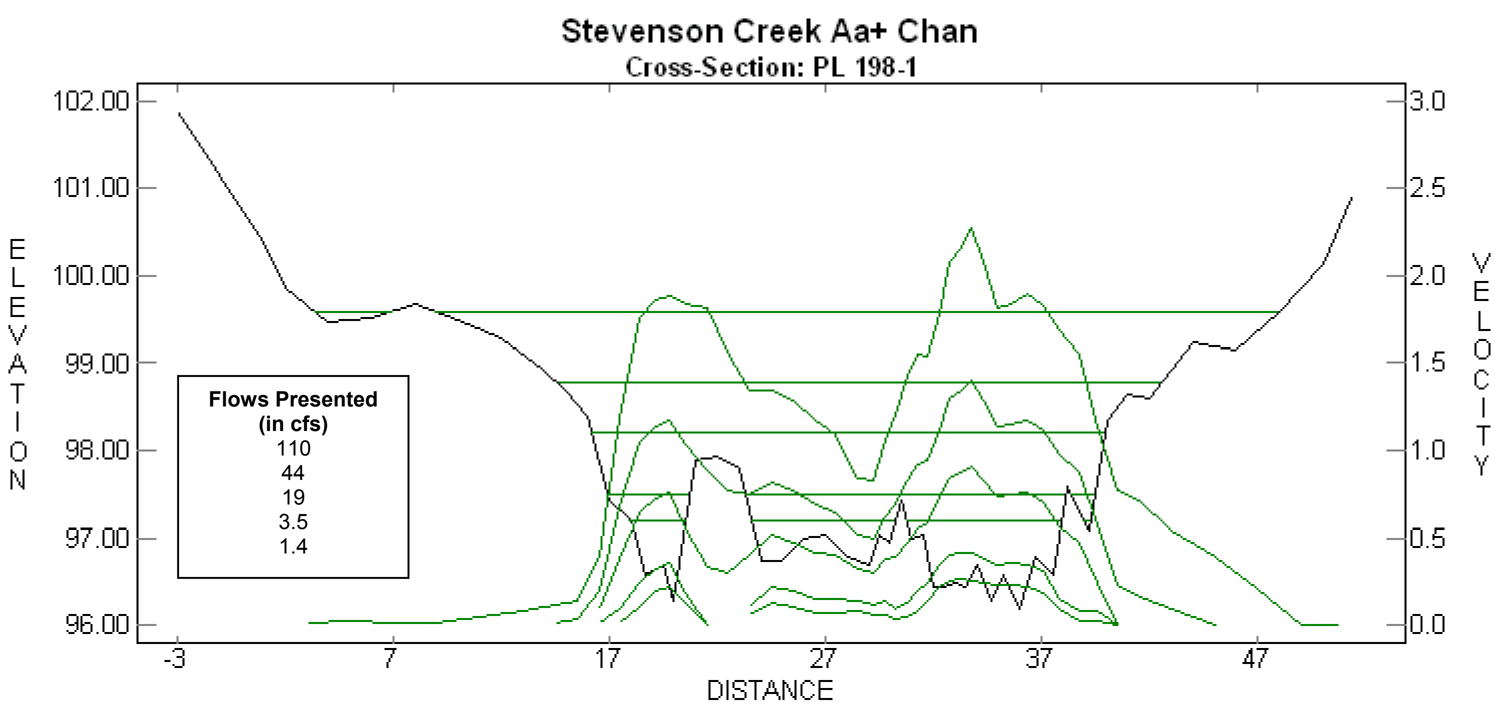


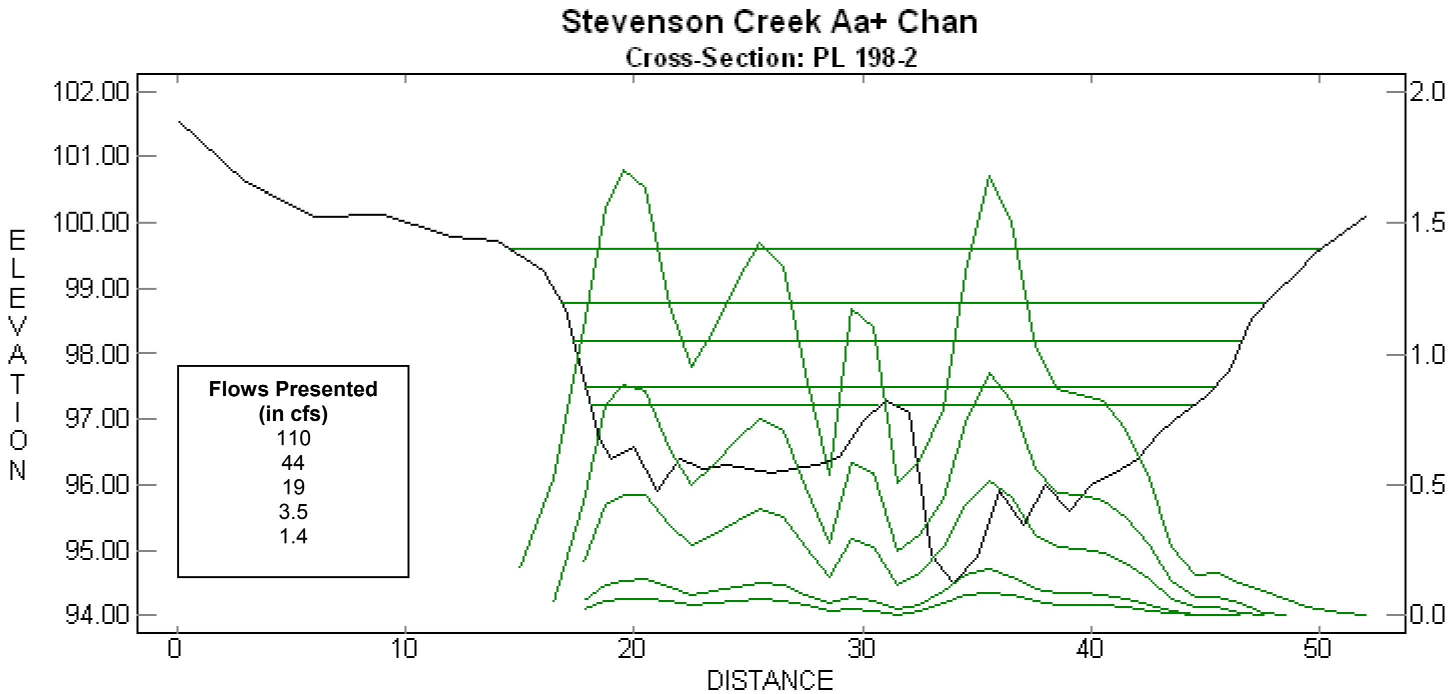
Stevenson Creek Aa+ Channel

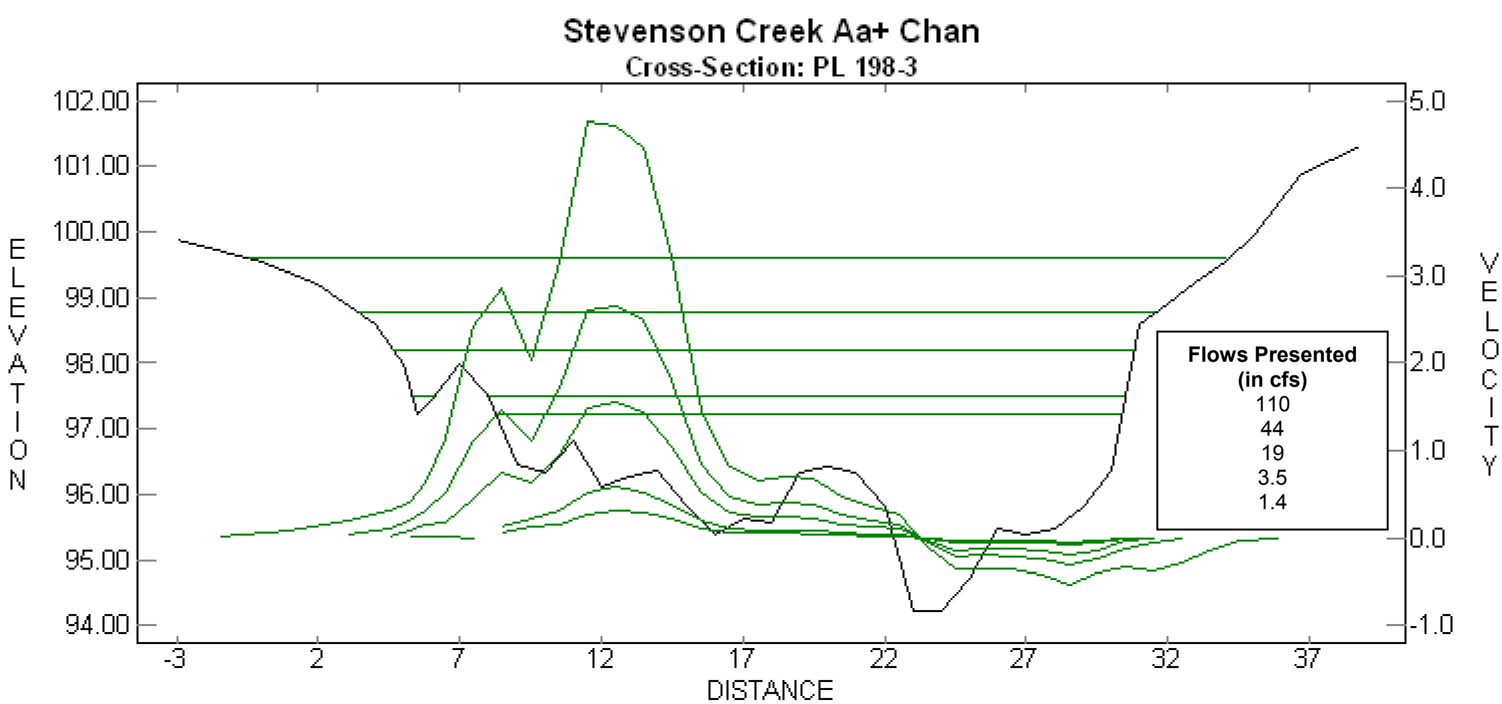
Cross section: PL 190-2

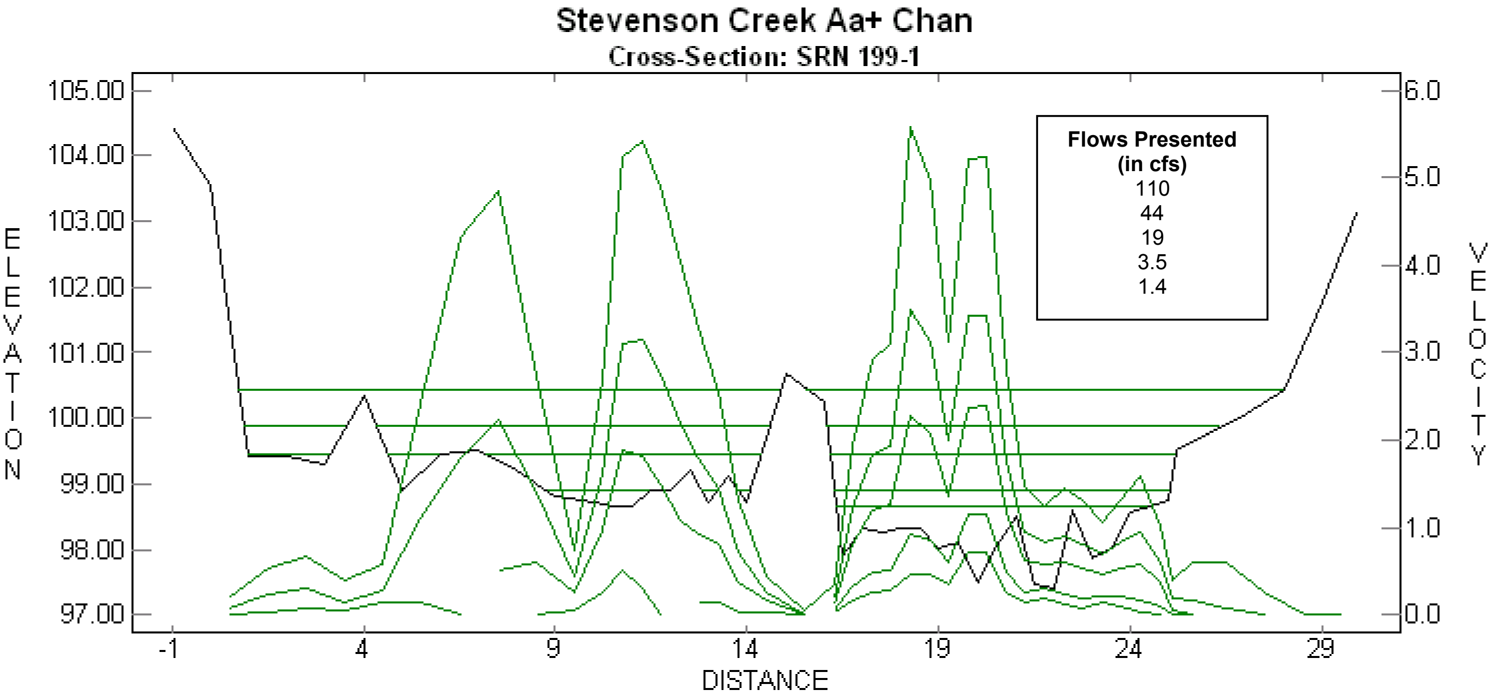


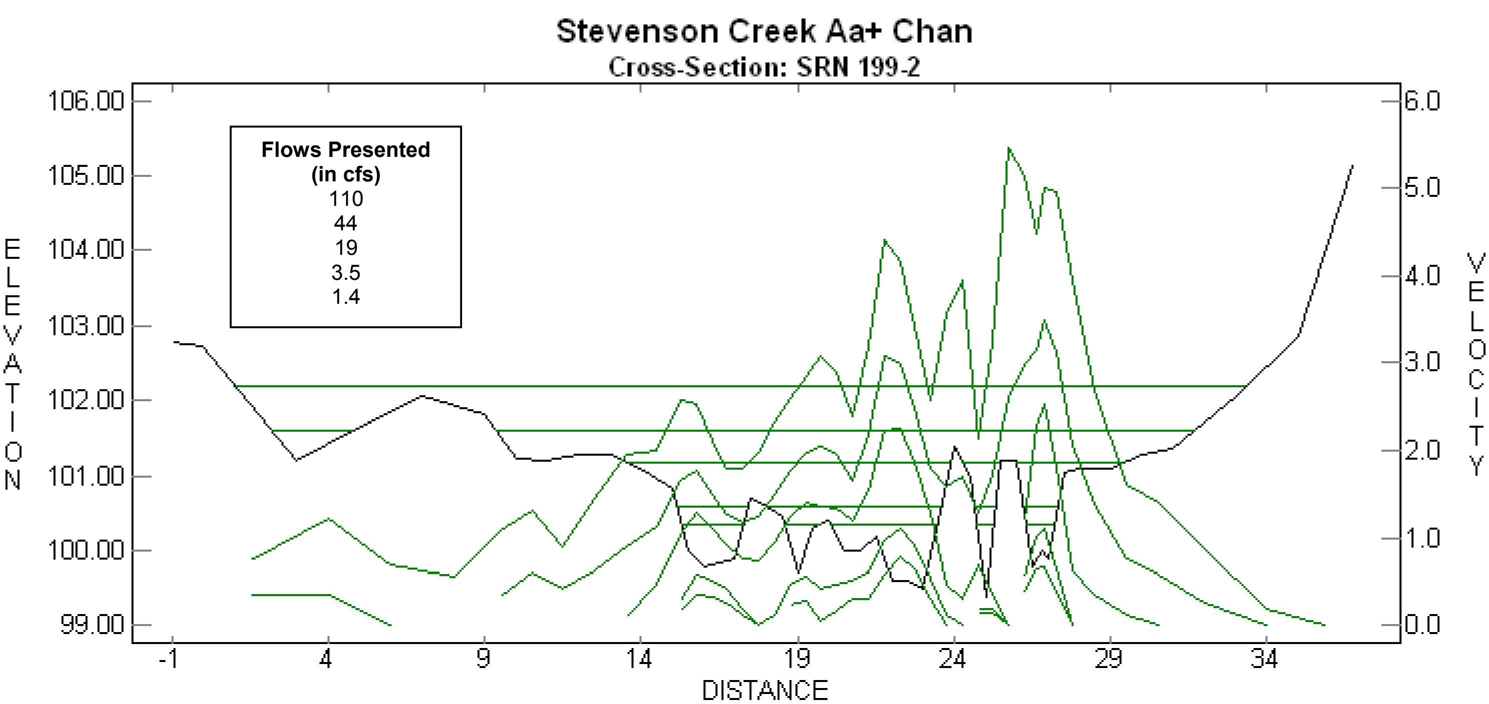

Stevenson Creek Aa+ Channel
Cross section: PL 190-3
Flows Presented
(in cfs)
110
44
19
3.5
1.4
ELEVATION
VELOCITY
DISTANCE
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-2
3
8
13
18
23

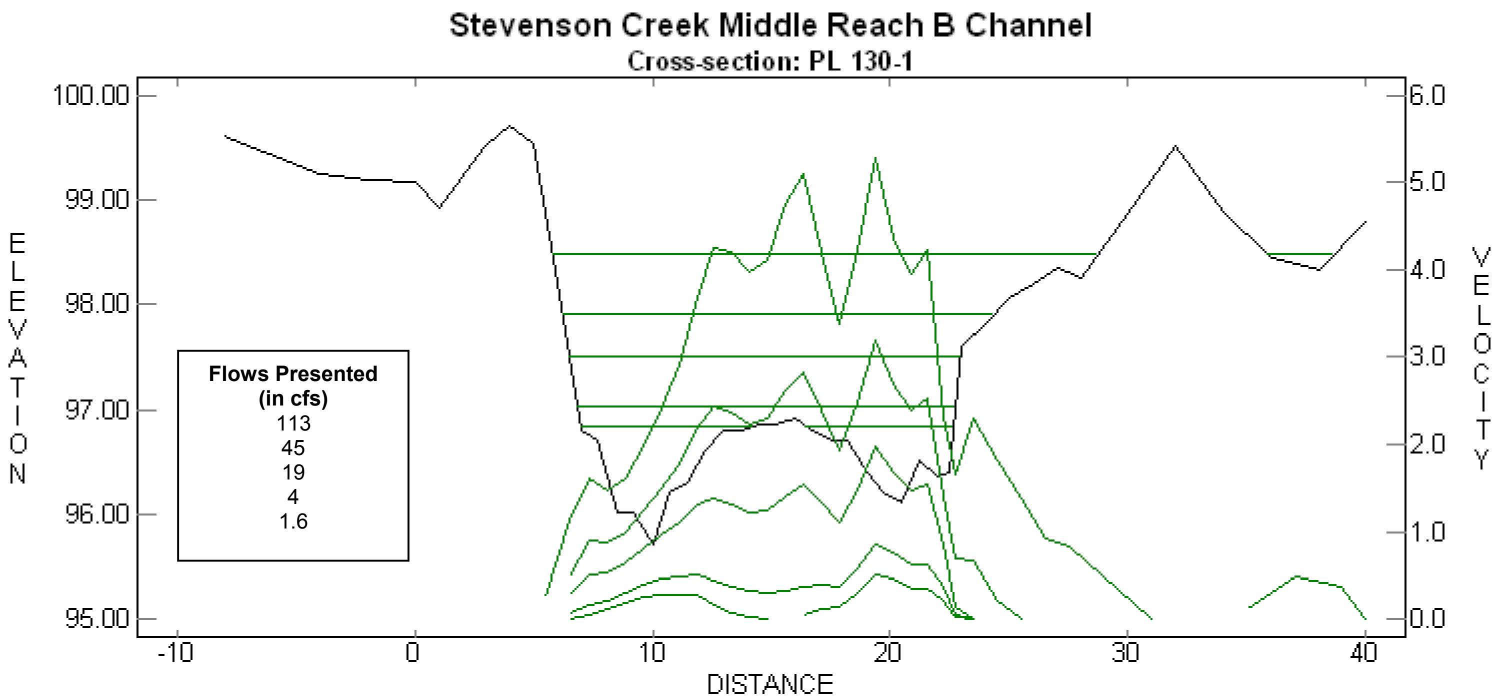

Stevenson Creek Aa+ Chan
Cross-Section: PL 198-1
Flows Presented
(in cfs)
110
44
19
3.5
1.4
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-3
7
17
27
37
47

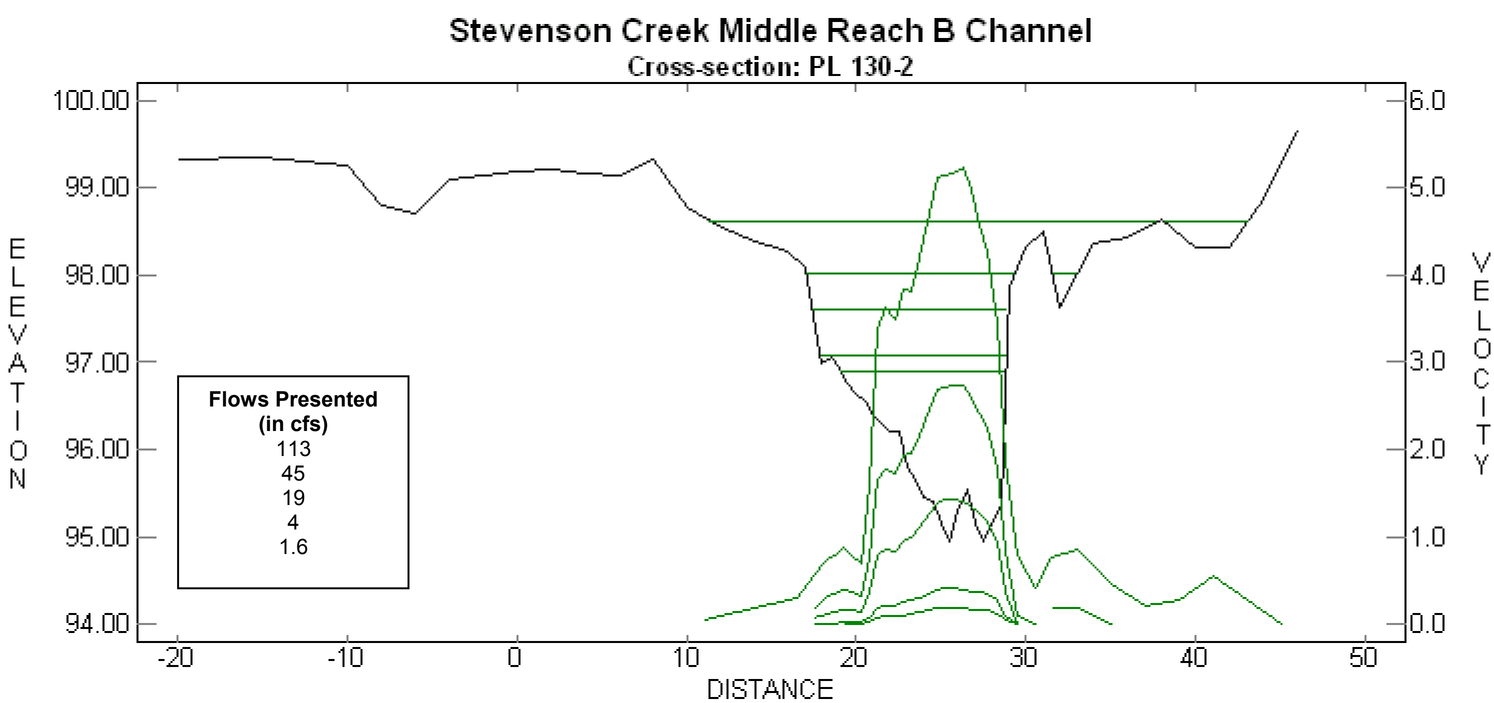

Stevenson Creek Aa+ Chan
Cross-Section: PL 198-2
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
ELEVATION
2.0
1.5
1.0
0.5
0.0
VELOCITY
0
10
20
30
40
50
DISTANCE
Flows Presented
(in cfs)
110
44
19
3.5
1.4

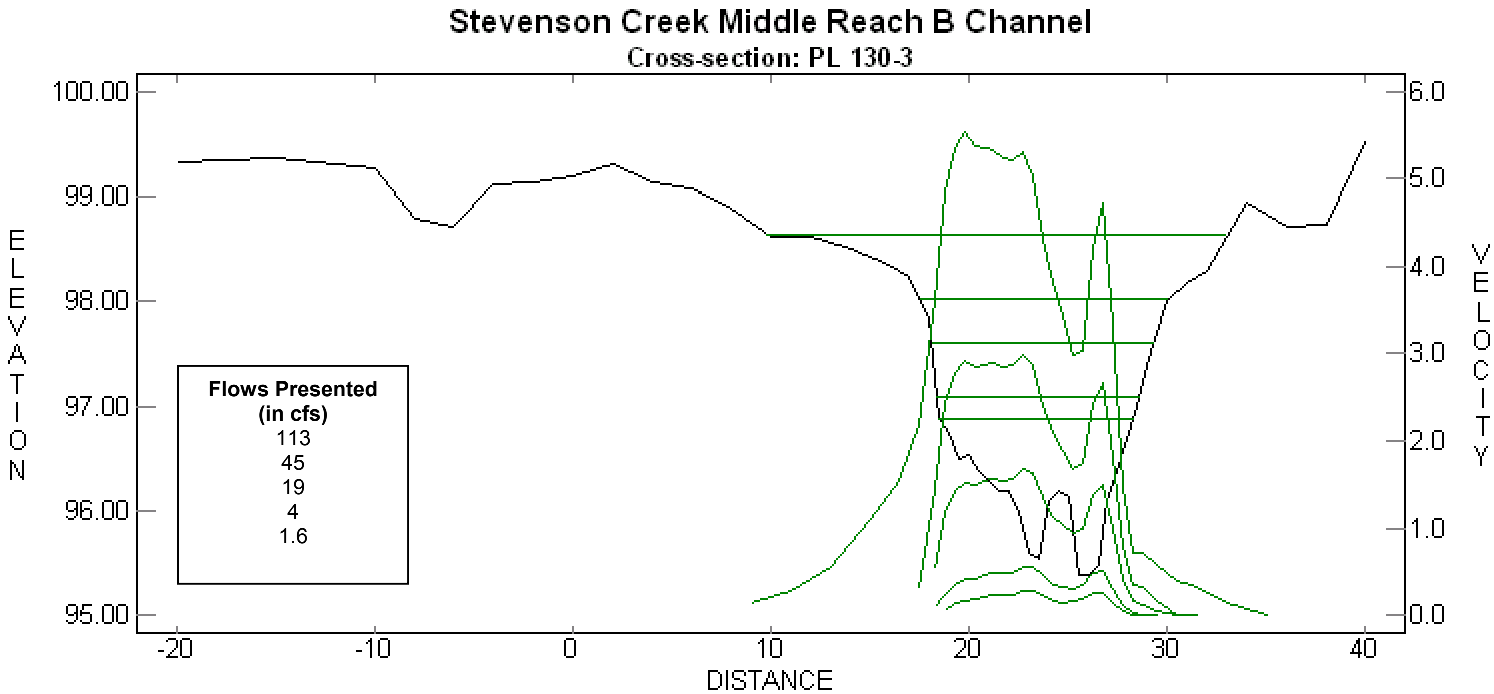

Stevenson Creek Aa+ Chan
Cross-Section: PL 198-3
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
ELEVATION
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
VELOCITY
-3
2
7
12
17
22
27
32
37
DISTANCE
Flows Presented
(in cfs)
110
44
19
3.5
1.4

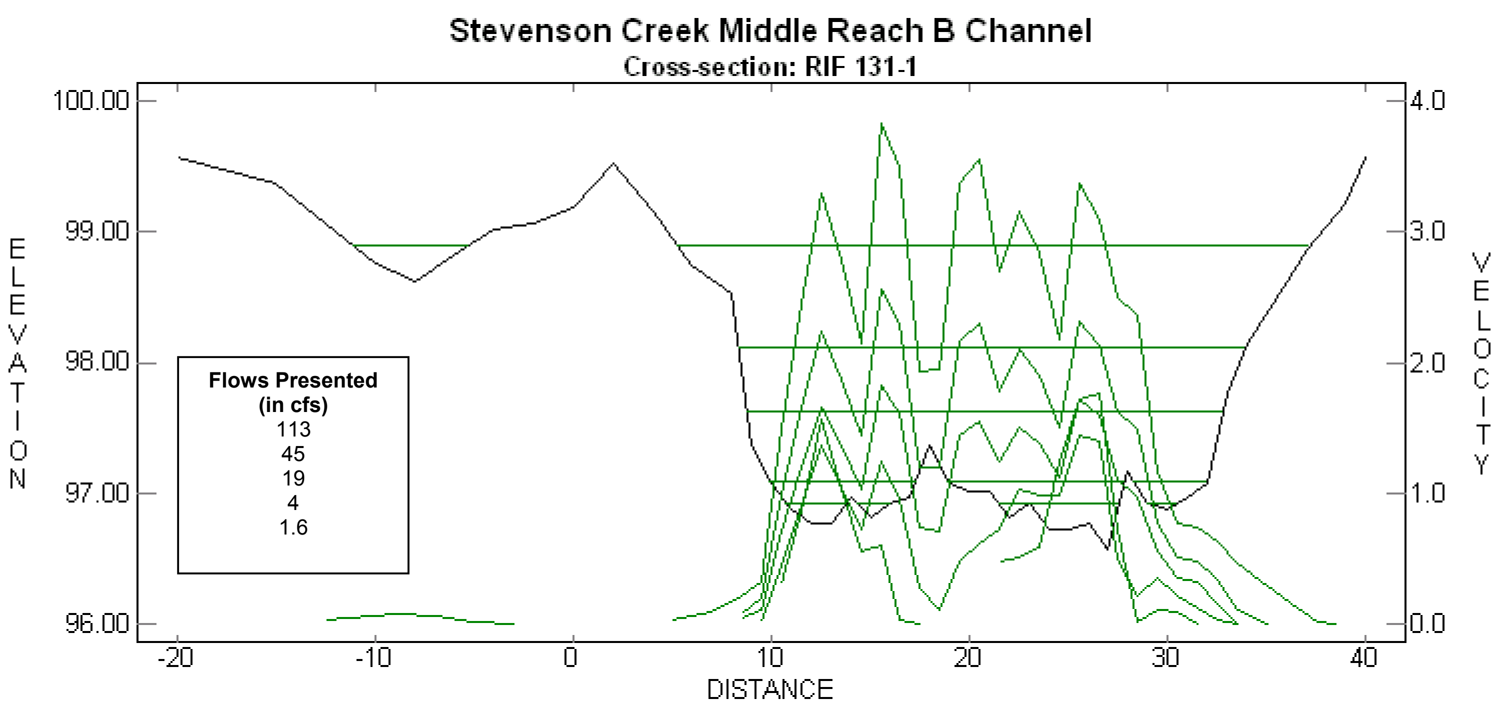

Stevenson Creek Aa+ Chan
Cross-Section: SRN 199-1
Flows Presented
(in cfs)
110
44
19
3.5
1.4
ELEVATION
VELOCITY
DISTANCE
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1
4
9
14
19
24
29

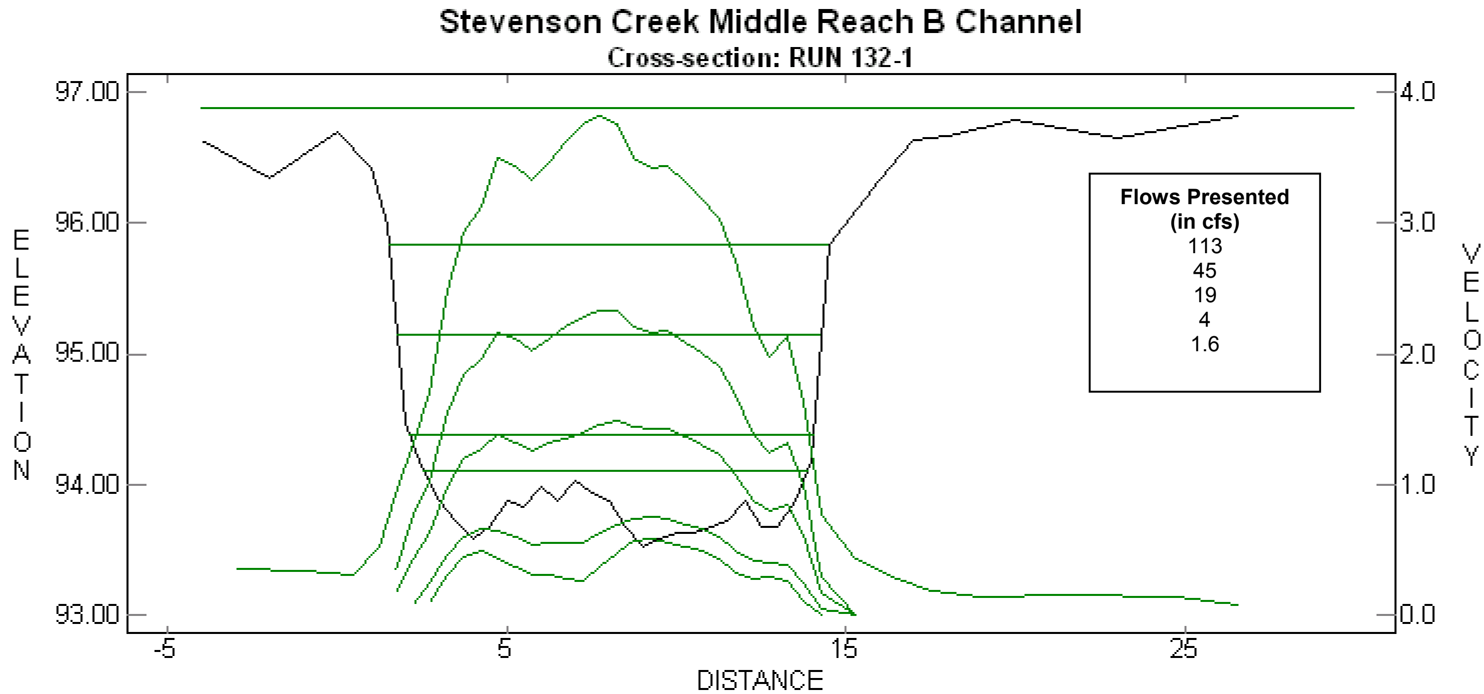

Stevenson Creek Aa+ Chan
Cross-Section: SRN 199-2
Flows Presented
(in cfs)
110
44
19
3.5
1.4
ELEVATION
VELOCITY
DISTANCE
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1
4
9
14
19
24
29
34

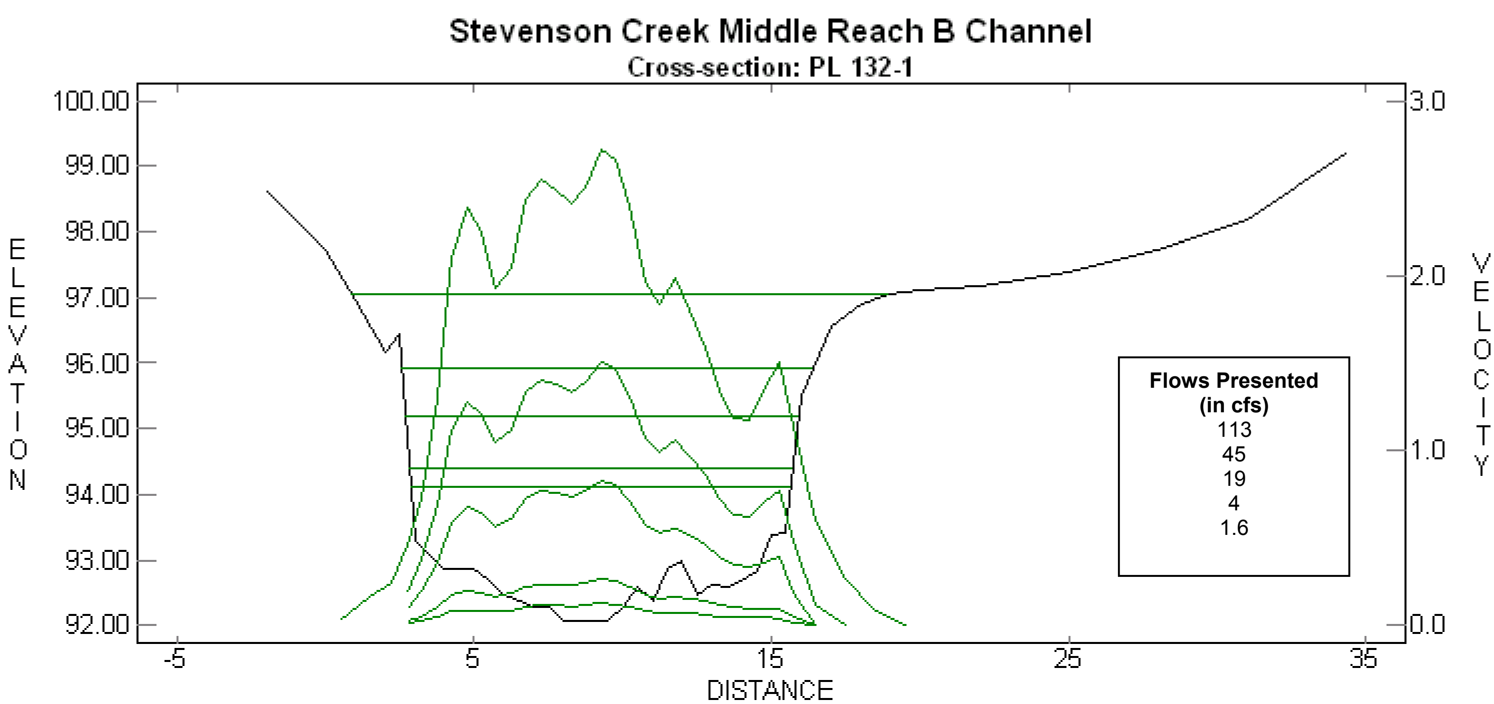

Stevenson Creek Middle Reach B Channel
Cross-section: PL 130-1
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-10
0
10
20
30
40
Flows Presented
(in cfs)
113
45
19
4
1.6

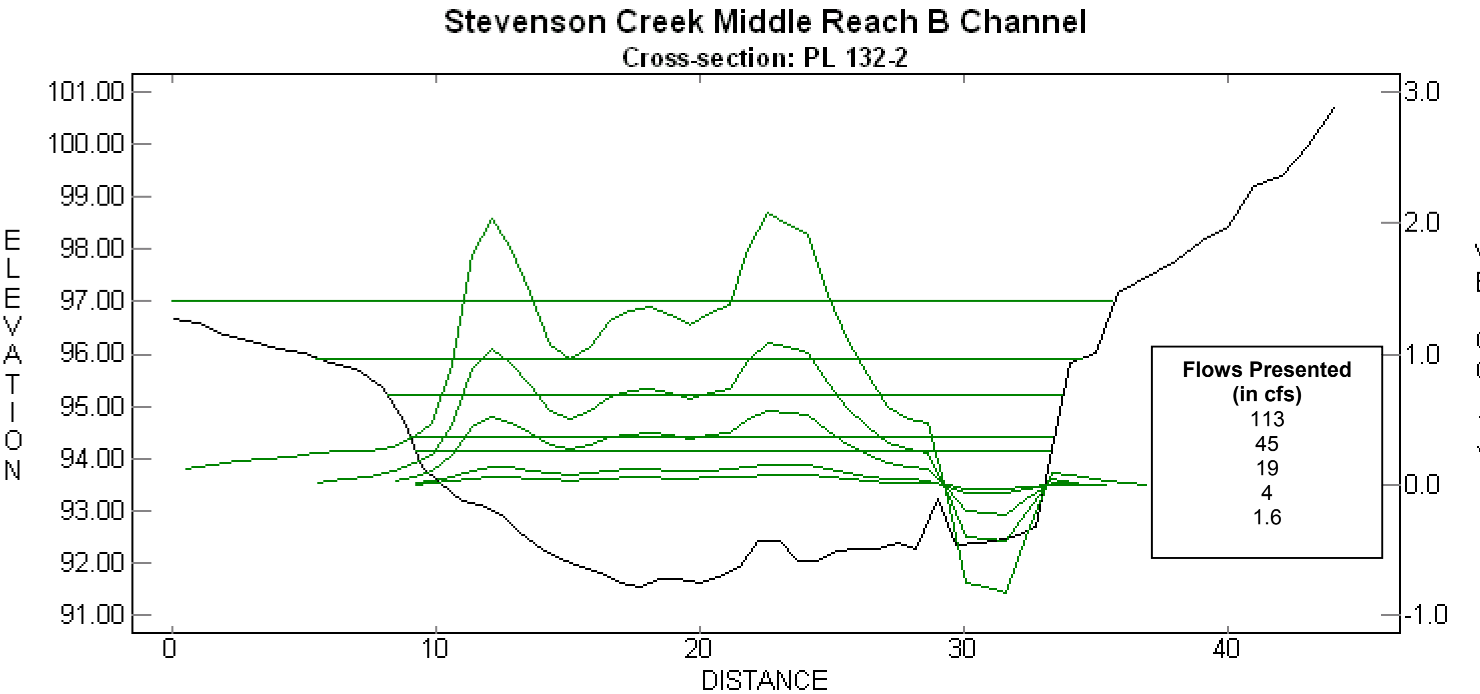

Stevenson Creek Middle Reach B Channel
Cross-section: PL 130-2
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-20
-10
0
10
20
30
40
50
Flows Presented
(in cfs)
113
45
19
4
1.6

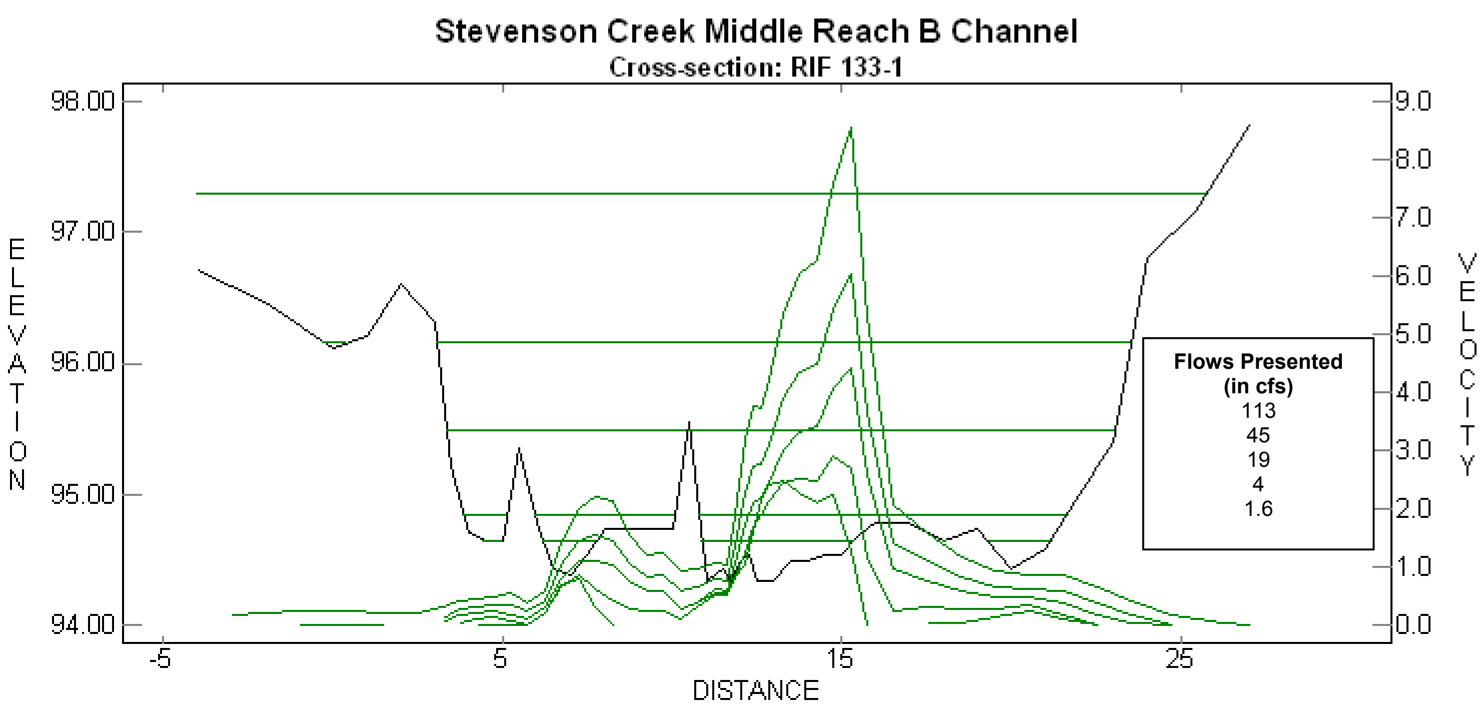

Stevenson Creek Middle Reach B Channel
Cross-section: PL 130-3
100.00
99.00
98.00
97.00
96.00
95.00
ELEVATION
6.0
5.0
4.0
3.0
2.0
1.0
0.0
VELOCITY
-20
-10
0
10
20
30
40
DISTANCE
Flows Presented
(in cfs)
113
45
19
4
1.6

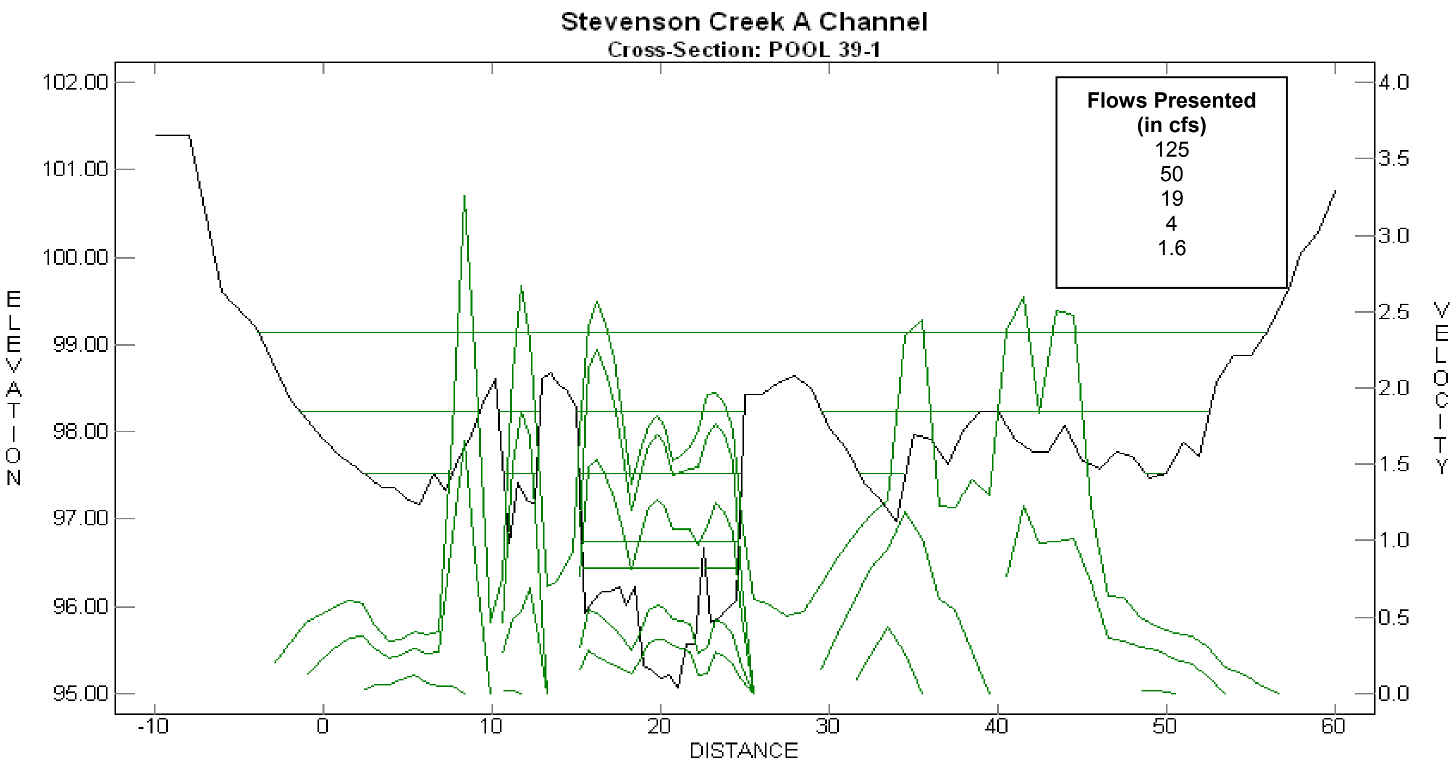

Stevenson Creek Middle Reach B Channel
Cross-section: RIF 131-1
100.00
99.00
98.00
97.00
96.00
ELEVATION
4.0
3.0
2.0
1.0
0.0
VELOCITY
-20
-10
0
10
20
30
40
DISTANCE
Flows Presented
(in cfs)
113
45
19
4
1.6

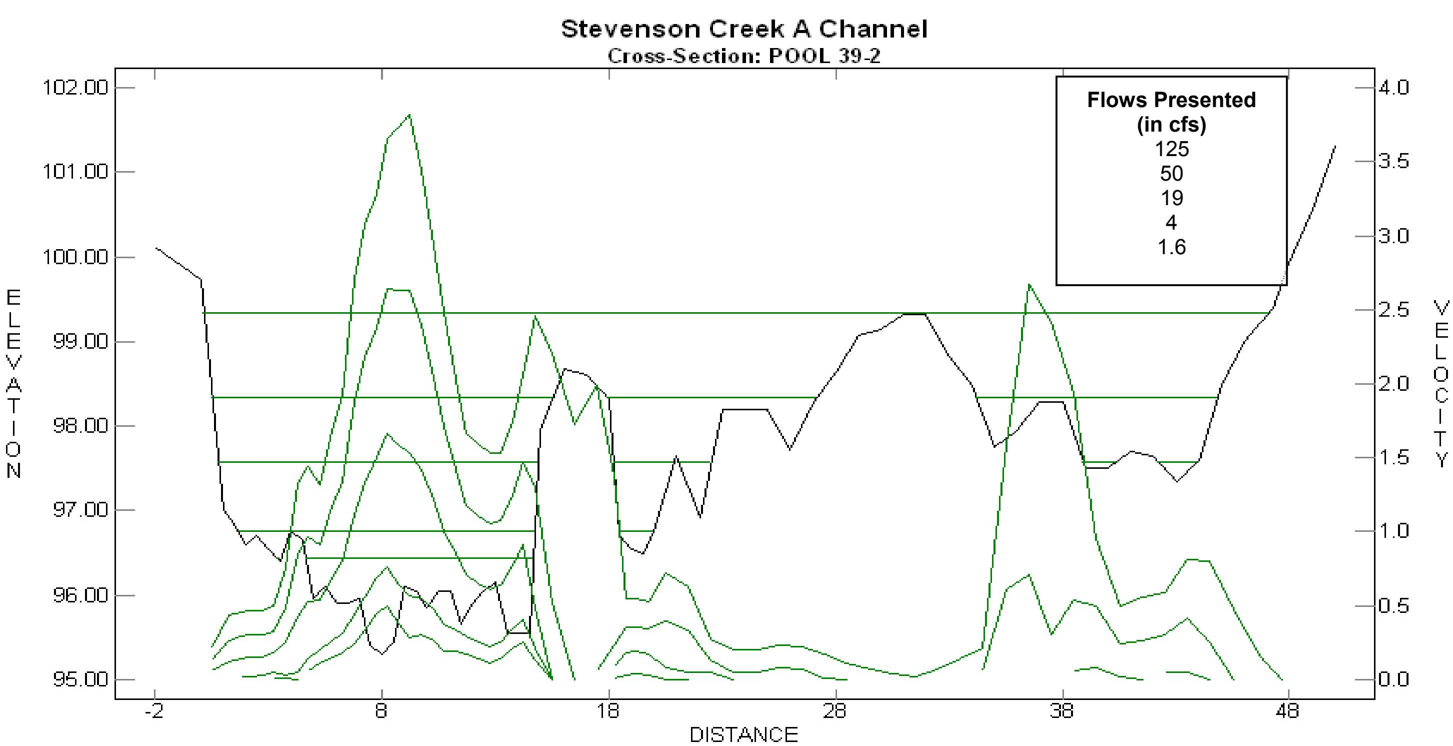

Stevenson Creek Middle Reach B Channel
Cross-section: RUN 132-1
ELEVATION
VELOCITY
DISTANCE
97.00
96.00
95.00
94.00
93.00
4.0
3.0
2.0
1.0
0.0
-5
5
15
25
Flows Presented
(in cfs)
113
45
19
4
1.6

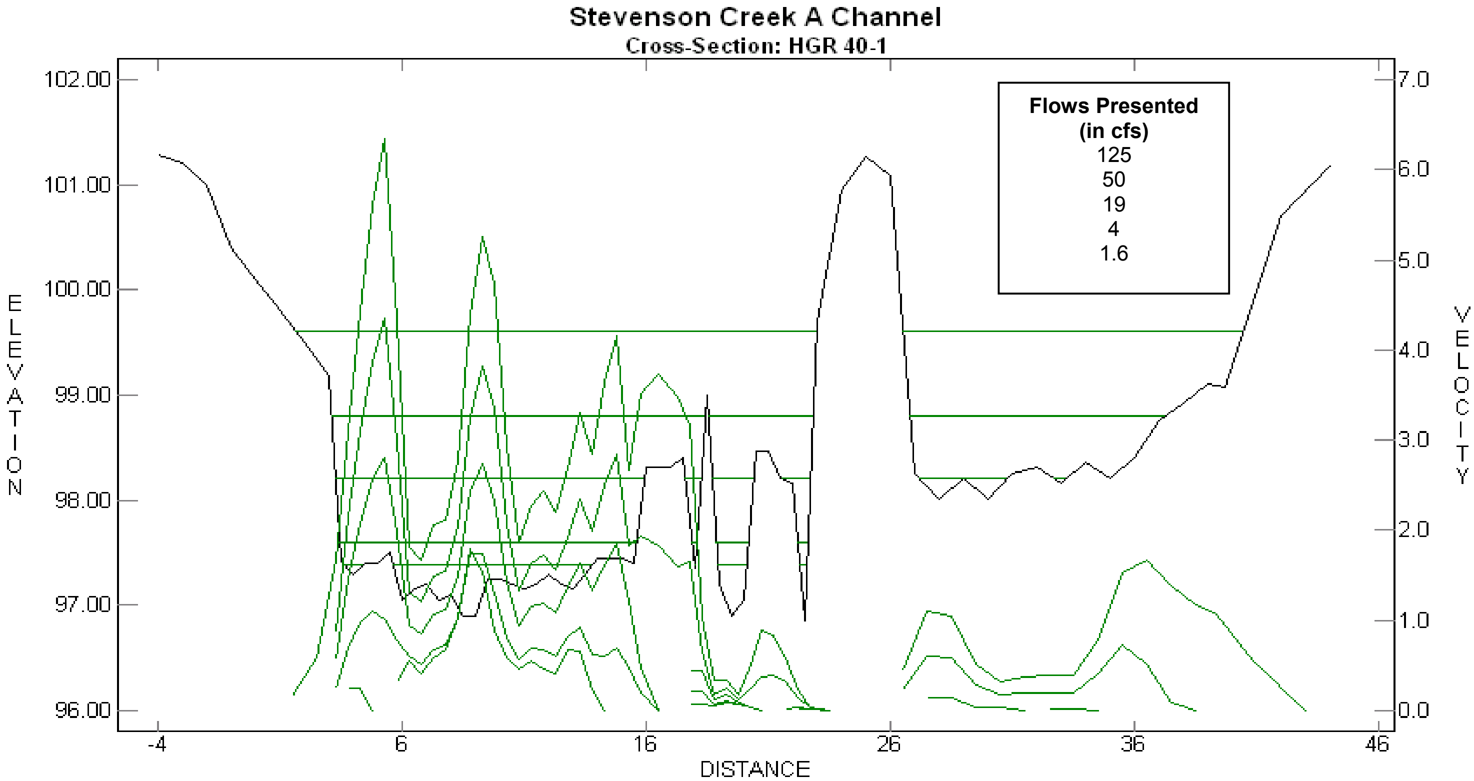

Stevenson Creek Middle Reach B Channel
Cross-section: PL 132-1
ELEVATION
VELOCITY
DISTANCE
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
3.0
2.0
1.0
0.0
-5
5
15
25
35
Flows Presented
(in cfs)
113
45
19
4
1.6

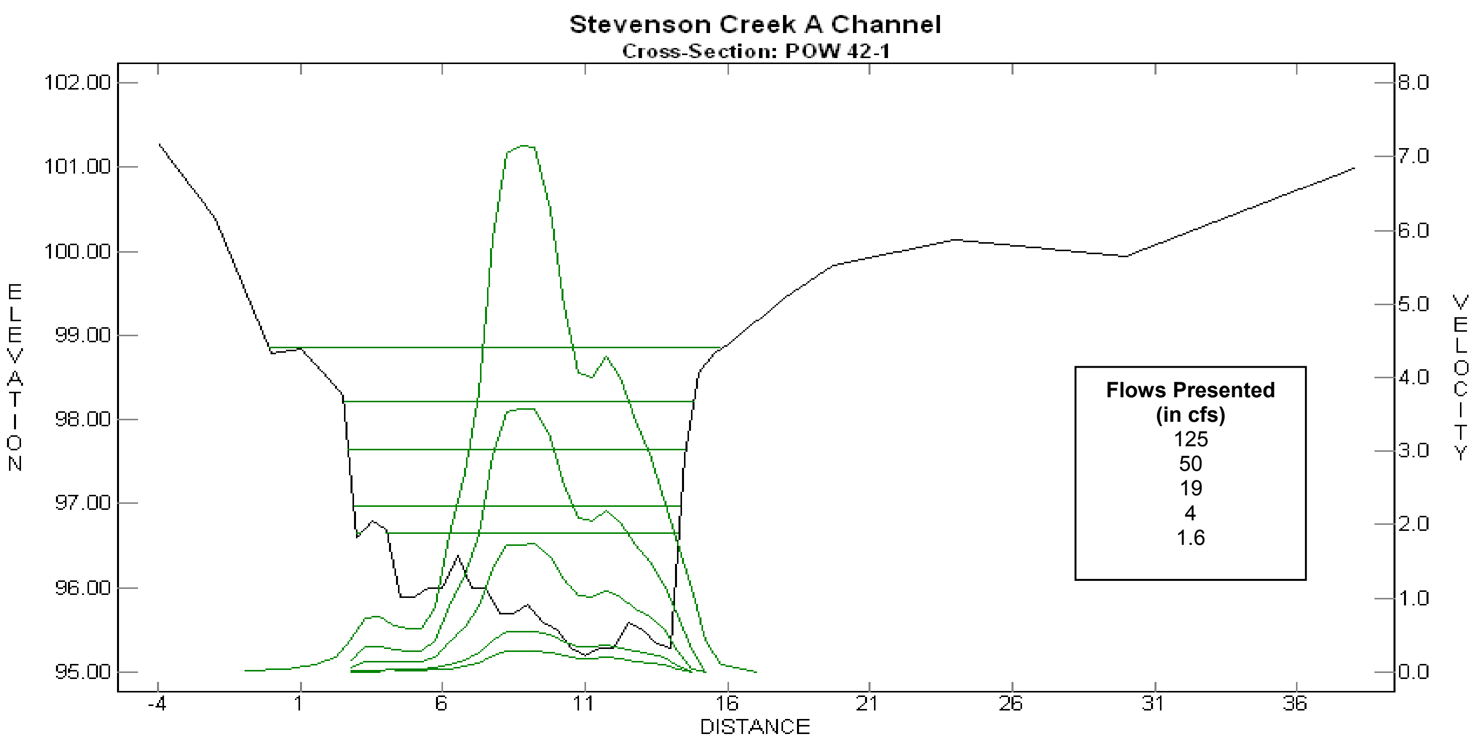

Stevenson Creek Middle Reach B Channel
Cross-section: PL 132-2
ELEVATION
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
VELOCITY
3.0
2.0
1.0
0.0
-1.0
DISTANCE
0
10
20
30
40
Flows Presented
(in cfs)
113
45
19
4
1.6

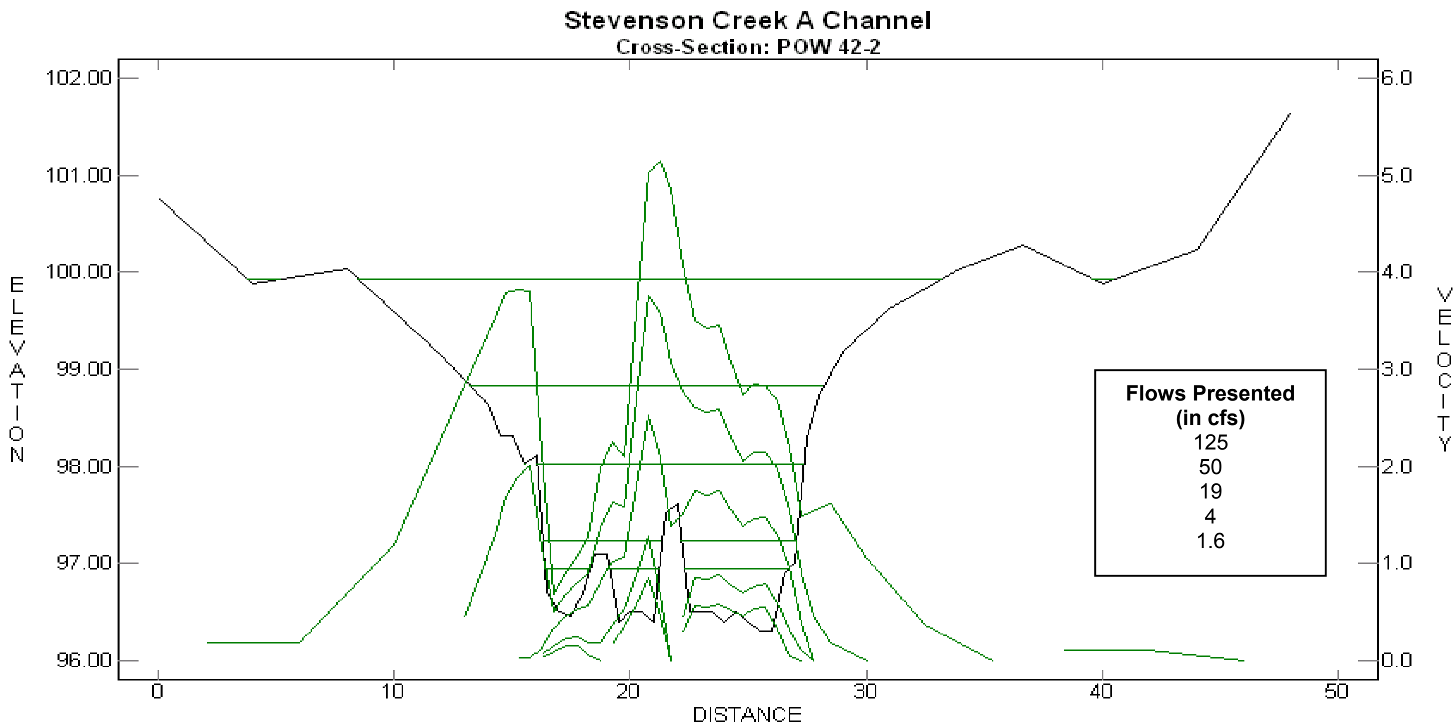

Stevenson Creek Middle Reach B Channel
Cross-section: RIF 133-1
ELEVATION
98.00
97.00
96.00
95.00
94.00
VELOCITY
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
DISTANCE
-5
5
15
25
Flows Presented
(in cfs)
113
45
19
4
1.6

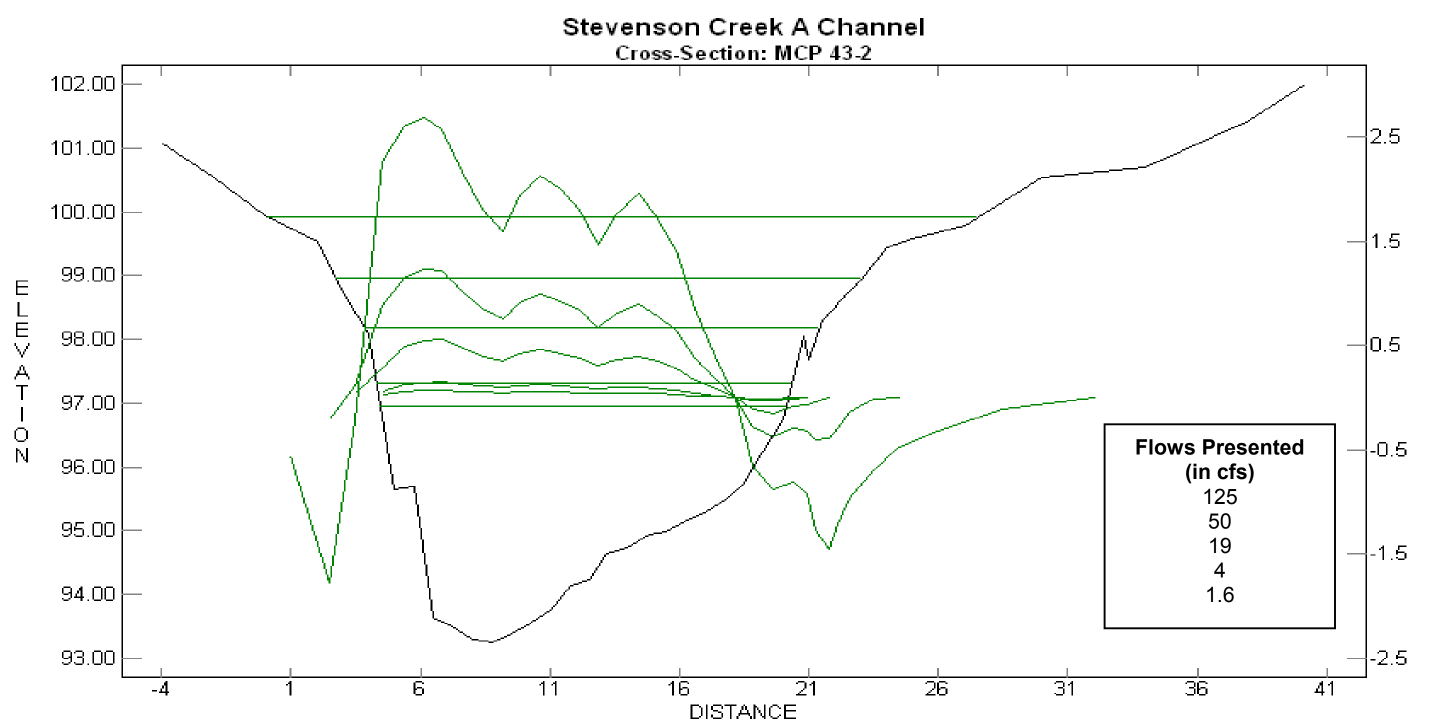

Stevenson Creek A Channel
Cross-Section: POOL 39-1
Flows Presented
(in cfs)
125
50
19
4
1.6
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-10
0
10
20
30
40
50
60

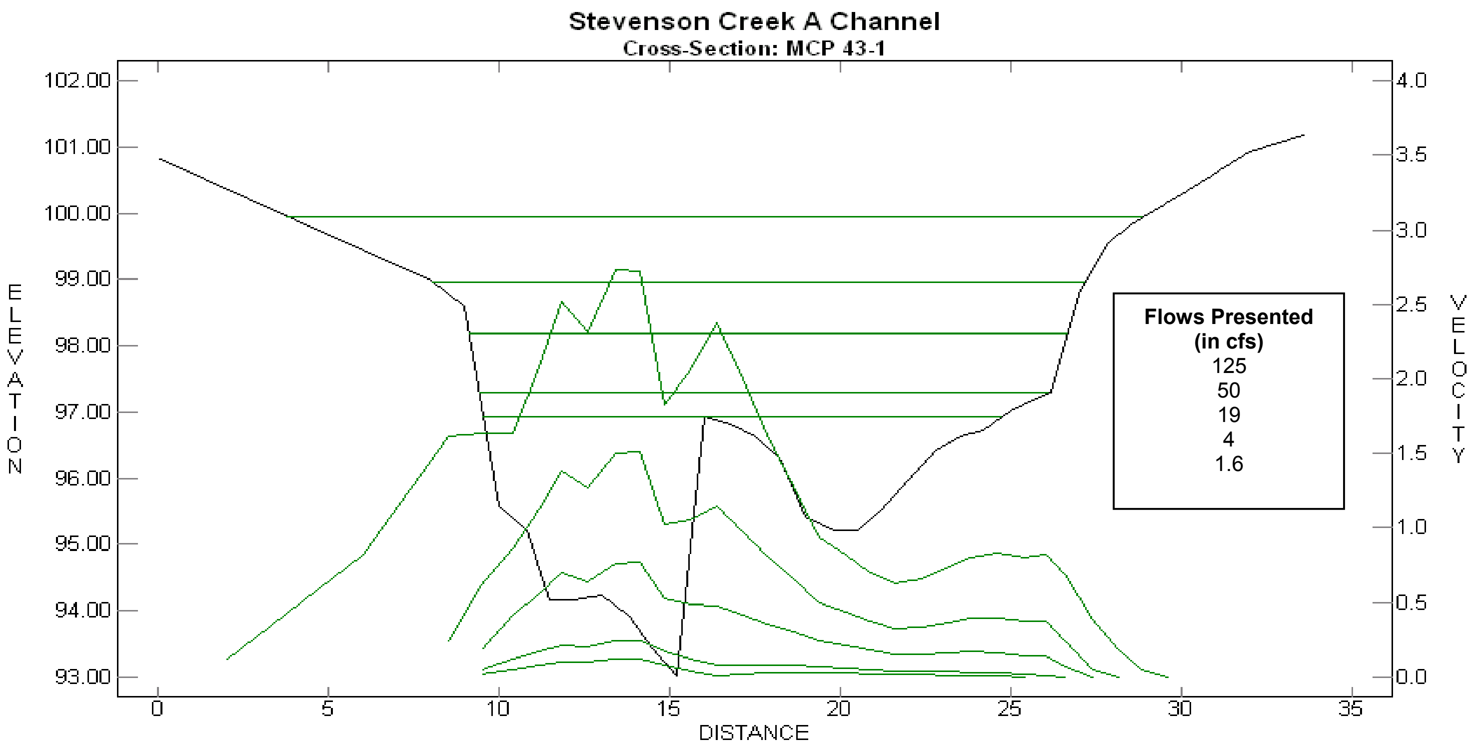

Stevenson Creek A Channel
Cross-Section: POOL 39-2
Flows Presented
(in cfs)
125
50
19
4
1.6
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-2
8
18
28
38
48


Stevenson Creek A Channel
Cross-Section: HGR 40-1
Flows Presented
(in cfs)
125
50
19
4
1.6
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-4
6
16
26
36
46


Stevenson Creek A Channel
Cross-Section: POW 42-1
Flows Presented
(in cfs)
125
50
19
4
1.6
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-4
1
6
11
16
21
26
31
36


Stevenson Creek A Channel
Cross-Section: POW 42-2
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
Flows Presented
(in cfs)
125
50
19
4
1.6


Stevenson Creek A Channel
Cross-Section: MCP 43-2
ELEVATION
VELOCITY
DISTANCE
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
2.5
1.5
0.5
-0.5
-1.5
-2.5
-4
1
6
11
16
21
26
31
36
41
Flows Presented
(in cfs)
125
50
19
4
1.6


Stevenson Creek A Channel
Cross-Section: MCP 43-1
ELEVATION
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
VELOCITY
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
DISTANCE
Flows Presented
(in cfs)
125
50
19
4
1.6

APPENDIX G

WUA TABLES

CAWG 3 Appendix G Table G-1. WUA for Rainbow Trout in South Fork San Joaquin River - Bear to Florence Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	11,567	18,735	25,747	2,013	11,988
12.0	12,614	19,276	25,665	2,398	13,836
14.0	13,568	19,597	25,433	2,722	15,377
16.0	14,446	19,768	25,087	2,980	16,653
18.0	15,239	19,863	24,716	3,175	17,699
20.0	15,954	19,884	24,329	3,311	18,499
25.0	17,422	19,850	23,251	3,540	19,866
30.0	18,590	19,450	22,120	3,653	20,762
35.0	19,521	18,930	21,124	3,708	21,393
40.0	20,137	18,453	20,247	3,691	21,712
45.0	20,536	18,007	19,398	3,627	21,874
50.0	20,841	17,533	18,694	3,529	21,927
55.0	21,060	17,108	18,019	3,405	21,916
60.0	21,247	16,710	17,442	3,255	21,784
65.0	21,383	16,382	16,972	3,093	21,615
70.0	21,495	16,101	16,595	2,929	21,424
75.0	21,581	15,817	16,315	2,756	21,183
80.0	21,616	15,573	16,093	2,585	20,929
85.0	21,666	15,334	15,908	2,414	20,676
90.0	21,669	15,121	15,744	2,248	20,411
95.0	21,635	14,925	15,606	2,077	20,159
100.0	21,589	14,726	15,525	1,913	19,917
125.0	21,035	13,715	15,822	1,256	18,877
150.0	20,437	13,133	16,459	898	18,341
175.0	20,243	12,898	16,971	740	18,862
200.0	19,982	13,025	17,333	676	20,032
225.0	19,907	13,357	17,773	634	21,593
250.0	19,850	13,710	18,438	599	23,078
275.0	19,883	14,135	19,213	557	24,099
300.0	20,020	14,682	19,916	522	24,668

CAWG 3 Appendix G Table G-2. WUA for Brown Trout in South Fork San Joaquin River - Bear to Florence Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	15,164	19,586	25,109	2,380	16,846
12.0	16,203	19,865	24,995	2,719	18,577
14.0	17,083	19,901	24,744	3,005	19,921
16.0	17,782	19,787	24,365	3,229	20,951
18.0	18,371	19,653	23,949	3,401	21,780
20.0	18,851	19,539	23,520	3,516	22,416
25.0	19,602	19,174	22,391	3,625	23,290
30.0	20,035	18,514	21,232	3,575	23,524
35.0	20,260	17,852	20,207	3,444	23,530
40.0	20,376	17,330	19,339	3,277	23,369
45.0	20,365	16,846	18,487	3,091	23,109
50.0	20,252	16,419	17,768	2,872	22,797
55.0	20,115	16,051	17,094	2,624	22,436
60.0	19,943	15,732	16,529	2,365	21,930
65.0	19,792	15,470	16,062	2,115	21,377
70.0	19,661	15,228	15,698	1,886	20,868
75.0	19,491	15,000	15,422	1,678	20,422
80.0	19,288	14,798	15,191	1,504	20,050
85.0	19,083	14,627	15,005	1,357	19,698
90.0	18,886	14,481	14,842	1,232	19,355
95.0	18,715	14,314	14,710	1,120	19,038
100.0	18,540	14,140	14,632	1,027	18,781
125.0	17,891	13,408	14,907	708	18,250
150.0	17,538	12,980	15,504	510	18,470
175.0	17,401	12,986	16,024	430	19,522
200.0	17,333	13,228	16,404	400	21,015
225.0	17,361	13,457	16,913	397	22,648
250.0	17,396	13,677	17,621	403	24,235
275.0	17,525	14,108	18,432	404	25,505
300.0	17,732	14,558	19,181	407	26,378

CAWG 3 Appendix G Table G-3. WUA for Rainbow Trout in South Fork San Joaquin River - Mono to Bear Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	10,948	18,278	28,434	108	15,129
12.0	11,860	19,183	28,513	122	17,206
14.0	12,720	19,828	28,503	134	18,953
16.0	13,544	20,359	28,400	143	20,475
18.0	14,340	20,727	28,241	150	21,760
20.0	15,090	21,029	28,032	157	22,900
25.0	16,771	21,554	27,299	167	25,303
30.0	18,221	21,704	26,506	172	27,022
35.0	19,426	21,624	25,770	176	28,339
40.0	20,430	21,426	25,182	179	29,205
45.0	21,252	21,255	24,593	179	29,702
50.0	21,925	21,041	23,966	179	29,927
55.0	22,542	20,774	23,389	180	29,955
60.0	23,085	20,491	22,832	184	29,851
65.0	23,556	20,214	22,299	192	29,648
70.0	23,994	19,967	21,788	201	29,362
75.0	24,369	19,721	21,302	213	29,048
80.0	24,658	19,486	20,823	224	28,640
85.0	24,874	19,235	20,363	233	28,153
90.0	25,061	18,996	19,910	241	27,651
95.0	25,217	18,752	19,466	246	27,144
100.0	25,344	18,497	19,039	249	26,647
125.0	25,528	17,169	17,358	233	24,233
150.0	25,048	15,984	16,283	215	22,149
175.0	24,463	14,800	15,437	211	20,809
200.0	23,906	13,666	14,677	213	19,812
225.0	23,417	12,835	14,005	212	19,180
250.0	22,949	12,247	13,405	208	18,765
275.0	22,461	11,675	13,062	201	18,466
300.0	22,071	11,212	12,873	198	18,265

CAWG 3 Appendix G Table G-4. WUA for Brown Trout in South Fork San Joaquin River - Mono to Bear Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	14,608	19,904	27,809	137	19,073
12.0	15,612	20,576	27,865	148	20,822
14.0	16,504	21,040	27,815	157	22,264
16.0	17,287	21,388	27,690	164	23,517
18.0	17,987	21,630	27,516	171	24,580
20.0	18,623	21,817	27,299	176	25,500
25.0	19,932	21,946	26,521	180	27,268
30.0	20,956	21,906	25,662	179	28,263
35.0	21,756	21,705	24,890	179	28,748
40.0	22,416	21,441	24,280	180	28,797
45.0	22,878	21,173	23,675	179	28,594
50.0	23,198	20,801	23,038	178	28,140
55.0	23,423	20,480	22,436	182	27,560
60.0	23,559	20,187	21,853	186	26,827
65.0	23,651	19,941	21,283	194	26,053
70.0	23,713	19,681	20,759	203	25,318
75.0	23,730	19,427	20,279	211	24,630
80.0	23,699	19,144	19,814	218	23,892
85.0	23,593	18,881	19,367	223	23,157
90.0	23,462	18,629	18,923	227	22,486
95.0	23,309	18,330	18,482	228	21,871
100.0	23,140	18,052	18,060	227	21,318
125.0	22,260	16,628	16,426	206	19,170
150.0	21,317	15,318	15,431	200	17,818
175.0	20,502	14,002	14,635	204	17,206
200.0	19,764	12,825	13,942	211	16,758
225.0	19,034	12,160	13,349	214	16,443
250.0	18,328	11,553	12,831	211	16,181
275.0	17,541	11,015	12,539	203	15,974
300.0	16,774	10,617	12,377	195	15,782

CAWG 3 Appendix G Table G-5. WUA for Rainbow Trout in South Fork San Joaquin River - Rattlesnake to Mono Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	13,698	22,178	31,805	131	14,039
12.0	14,787	23,123	31,809	148	16,011
14.0	15,812	23,805	31,779	162	17,661
16.0	16,780	24,404	31,684	173	19,111
18.0	17,705	24,845	31,544	181	20,356
20.0	18,588	25,214	31,372	189	21,474
25.0	20,581	25,831	30,717	201	23,882
30.0	22,295	26,100	29,950	208	25,635
35.0	23,738	26,102	29,204	214	26,933
40.0	24,968	25,907	28,626	218	27,762
45.0	26,014	25,733	28,026	217	28,230
50.0	26,922	25,475	27,329	214	28,464
55.0	27,745	25,121	26,696	215	28,536
60.0	28,481	24,754	26,042	220	28,464
65.0	29,142	24,380	25,403	232	28,347
70.0	29,761	24,004	24,787	247	28,201
75.0	30,305	23,623	24,172	266	28,038
80.0	30,723	23,278	23,545	284	27,750
85.0	31,041	22,924	22,937	299	27,355
90.0	31,313	22,596	22,344	311	26,968
95.0	31,554	22,263	21,764	320	26,596
100.0	31,757	21,906	21,205	326	26,230
125.0	32,070	19,969	19,065	312	24,086
150.0	31,609	18,330	17,674	293	22,303
175.0	30,962	16,791	16,617	289	21,046
200.0	30,337	15,330	15,714	293	20,177
225.0	29,659	14,316	14,871	290	19,741
250.0	29,029	13,587	14,105	282	19,491
275.0	28,359	12,874	13,618	271	19,322
300.0	27,744	12,313	13,306	262	19,270

CAWG 3 Appendix G Table G-6. WUA for Brown Trout in South Fork San Joaquin River - Rattlesnake to Mono Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	17,936	24,223	30,880	158	18,599
12.0	19,114	25,047	30,868	169	20,228
14.0	20,166	25,641	30,801	179	21,576
16.0	21,120	26,125	30,703	187	22,802
18.0	21,988	26,521	30,586	194	23,847
20.0	22,779	26,833	30,447	199	24,773
25.0	24,447	27,184	29,791	203	26,592
30.0	25,797	27,310	28,948	202	27,664
35.0	26,922	27,147	28,146	205	28,182
40.0	27,871	26,823	27,495	209	28,319
45.0	28,578	26,470	26,822	209	28,241
50.0	29,115	25,928	26,058	210	27,906
55.0	29,521	25,474	25,360	215	27,485
60.0	29,795	25,008	24,663	223	26,873
65.0	29,991	24,604	23,974	236	26,232
70.0	30,125	24,183	23,350	251	25,631
75.0	30,198	23,783	22,762	265	25,087
80.0	30,210	23,357	22,173	278	24,469
85.0	30,120	22,983	21,607	288	23,835
90.0	29,985	22,611	21,044	295	23,233
95.0	29,810	22,163	20,479	299	22,687
100.0	29,617	21,719	19,935	300	22,199
125.0	28,579	19,549	17,892	276	20,149
150.0	27,389	17,632	16,618	270	18,975
175.0	26,235	15,948	15,617	276	18,406
200.0	25,107	14,395	14,804	285	17,919
225.0	23,966	13,551	14,065	285	17,651
250.0	22,938	12,775	13,410	278	17,459
275.0	21,859	12,084	12,993	262	17,295
300.0	20,732	11,540	12,712	247	17,239

CAWG 3 Appendix G Table G-7. WUA for Rainbow Trout in South Fork San Joaquin River - Hoffman to Rattlesnake Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	15,777	24,727	32,005	163	14,381
12.0	16,973	25,768	31,675	180	16,020
14.0	18,110	26,532	31,466	194	17,284
16.0	19,176	27,178	31,270	203	18,337
18.0	20,209	27,635	31,093	211	19,339
20.0	21,253	27,905	30,925	219	20,268
25.0	23,743	28,276	30,452	232	22,256
30.0	25,943	28,407	29,881	241	23,667
35.0	27,801	28,367	29,133	247	24,615
40.0	29,352	28,081	28,364	253	25,109
45.0	30,636	27,778	27,505	248	25,273
50.0	31,788	27,337	26,651	240	25,244
55.0	32,734	26,775	25,966	234	25,095
60.0	33,546	26,197	25,324	233	24,878
65.0	34,199	25,665	24,683	245	24,716
70.0	34,787	25,134	24,036	270	24,679
75.0	35,361	24,565	23,361	303	24,625
80.0	35,824	24,080	22,671	340	24,492
85.0	36,167	23,626	22,039	374	24,252
90.0	36,477	23,239	21,405	403	24,023
95.0	36,756	22,875	20,838	424	23,838
100.0	37,007	22,528	20,253	441	23,634
125.0	37,874	20,530	18,368	424	21,860
150.0	38,030	18,675	17,800	386	20,355
175.0	37,843	17,257	17,343	393	19,847
200.0	37,478	16,045	16,668	422	19,721
225.0	36,740	15,325	15,994	433	20,006
250.0	36,202	14,873	15,652	426	20,283
275.0	35,630	14,414	15,525	406	20,482
300.0	35,030	14,137	15,395	384	20,577

CAWG 3 Appendix G Table G-8. WUA for Brown Trout in South Fork San Joaquin River - Hoffman to Rattlesnake Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	20,526	26,971	30,791	187	19,083
12.0	21,935	27,886	30,457	197	20,443
14.0	23,186	28,512	30,218	207	21,489
16.0	24,324	28,964	30,079	213	22,397
18.0	25,348	29,251	30,026	219	23,220
20.0	26,263	29,430	29,983	223	23,947
25.0	28,195	29,777	29,628	224	25,448
30.0	29,754	29,850	28,988	223	26,288
35.0	31,011	29,672	28,143	228	26,516
40.0	32,037	29,238	27,182	231	26,390
45.0	32,864	28,762	26,079	228	25,990
50.0	33,548	28,092	24,963	225	25,470
55.0	34,071	27,469	24,088	227	24,921
60.0	34,439	26,817	23,357	236	24,262
65.0	34,780	26,275	22,621	260	23,666
70.0	35,039	25,785	21,922	290	23,214
75.0	35,237	25,310	21,285	320	22,781
80.0	35,415	24,836	20,643	348	22,272
85.0	35,501	24,450	20,074	374	21,723
90.0	35,523	24,046	19,515	394	21,214
95.0	35,479	23,600	18,986	405	20,784
100.0	35,393	23,174	18,452	409	20,335
125.0	34,687	20,906	16,844	366	18,335
150.0	33,596	18,919	16,483	368	17,689
175.0	32,454	17,524	16,102	404	18,062
200.0	31,476	16,213	15,568	442	18,351
225.0	30,449	15,456	14,985	459	18,741
250.0	29,537	14,870	14,790	451	18,855
275.0	28,649	14,219	14,720	417	18,823
300.0	27,587	13,811	14,566	384	18,805

CAWG 3 Appendix G Table G-9. WUA for Brown Trout in Bear Creek.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
1.0	3,334	5,818	11,639	10	2,891
1.5	3,880	6,836	12,691	11	3,945
2.0	4,364	7,718	13,471	12	4,824
2.5	4,820	8,478	14,021	12	5,552
3.0	5,231	9,082	14,456	13	6,174
3.5	5,616	9,614	14,820	13	6,727
4.0	5,981	10,072	15,110	13	7,230
4.5	6,318	10,464	15,340	13	7,653
5.0	6,636	10,847	15,546	14	8,041
6.0	7,233	11,535	15,783	14	8,642
7.0	7,793	12,109	15,947	15	9,010
8.0	8,305	12,633	16,086	15	9,339
9.0	8,768	13,008	16,168	16	9,612
10.0	9,179	13,256	16,228	16	9,783
12.5	10,032	13,530	16,403	17	10,017
15.0	10,754	13,740	16,652	19	10,287
17.5	11,368	13,792	16,719	19	10,407
20.0	11,843	13,766	16,721	19	10,539
25.0	12,660	13,703	16,505	18	10,570
30.0	13,297	13,765	16,055	15	10,336
35.0	13,786	13,686	15,562	15	10,134
40.0	14,121	13,291	15,020	16	9,798
45.0	14,342	12,872	14,445	17	9,544
50.0	14,444	12,490	13,952	17	9,309
60.0	14,494	11,714	12,898	18	8,927
70.0	14,373	10,970	11,993	18	8,510
80.0	14,120	10,415	11,154	18	8,145
90.0	13,862	10,054	10,365	18	7,879
100.0	13,580	9,630	9,664	18	7,571
125.0	12,892	8,867	8,571	19	6,985

CAWG 3 Appendix G Table G-10. WUA for Rainbow Trout in Mono Creek.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
5.0	4,568	9,027	14,150	1,256	6,003
5.5	4,798	9,381	14,326	1,334	6,542
6.0	5,031	9,668	14,463	1,411	7,066
6.5	5,269	9,903	14,565	1,489	7,566
7.0	5,516	10,079	14,639	1,565	8,032
7.5	5,763	10,213	14,707	1,638	8,461
8.0	6,008	10,337	14,751	1,710	8,869
8.5	6,244	10,460	14,770	1,781	9,259
9.0	6,472	10,568	14,772	1,845	9,626
9.5	6,696	10,657	14,746	1,908	9,973
10.0	6,916	10,723	14,714	1,965	10,304
11.0	7,323	10,861	14,594	2,074	10,907
12.0	7,710	10,959	14,434	2,174	11,438
13.0	8,078	11,035	14,252	2,269	11,909
14.0	8,430	11,093	14,057	2,356	12,321
15.0	8,766	11,135	13,873	2,435	12,697
20.0	10,112	11,206	13,094	2,711	13,980
25.0	11,121	11,183	12,602	2,794	14,512
30.0	11,913	10,972	12,349	2,827	14,847
35.0	12,516	10,719	12,186	2,785	14,996
40.0	12,901	10,505	12,093	2,660	14,987
50.0	13,302	10,255	12,001	2,401	15,018
60.0	13,578	10,187	11,801	2,205	14,865
70.0	13,762	10,273	11,376	1,968	14,437
80.0	13,941	10,250	10,969	1,742	13,789
90.0	14,164	10,164	10,679	1,567	13,191
100.0	14,329	10,022	10,559	1,436	12,806
125.0	14,356	9,489	10,885	1,182	12,233
150.0	14,417	9,376	11,438	1,061	11,826
175.0	14,416	9,872	11,661	957	11,906

CAWG 3 Appendix G Table G-11. WUA for Brown Trout in Mono Creek.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
5.0	6,482	9,709	14,000	1,652	8,325
5.5	6,772	9,925	14,171	1,729	8,840
6.0	7,041	10,064	14,297	1,801	9,312
6.5	7,299	10,149	14,379	1,873	9,765
7.0	7,540	10,204	14,439	1,944	10,187
7.5	7,770	10,265	14,493	2,012	10,579
8.0	7,993	10,322	14,521	2,077	10,947
8.5	8,202	10,373	14,524	2,138	11,290
9.0	8,398	10,411	14,507	2,192	11,613
9.5	8,582	10,443	14,463	2,245	11,906
10.0	8,755	10,464	14,417	2,289	12,163
11.0	9,083	10,479	14,271	2,370	12,635
12.0	9,377	10,493	14,092	2,440	13,056
13.0	9,626	10,502	13,890	2,508	13,409
14.0	9,843	10,491	13,680	2,570	13,709
15.0	10,033	10,470	13,487	2,626	13,984
20.0	10,760	10,330	12,694	2,799	14,840
25.0	11,126	10,181	12,233	2,813	15,065
30.0	11,286	9,994	11,997	2,761	15,021
35.0	11,384	9,869	11,853	2,635	14,876
40.0	11,449	9,755	11,745	2,435	14,672
50.0	11,596	9,710	11,608	2,079	14,371
60.0	11,757	9,736	11,355	1,812	14,066
70.0	11,923	9,832	10,859	1,529	13,483
80.0	11,994	9,835	10,408	1,273	12,721
90.0	11,983	9,809	10,073	1,099	12,066
100.0	11,968	9,701	9,904	967	11,628
125.0	11,874	9,463	10,276	709	11,162
150.0	12,009	9,646	10,925	597	11,277
175.0	12,324	10,291	11,165	537	11,940

CAWG 3 Appendix G Table G-12. WUA for Rainbow Trout in San Joaquin River - Mammoth Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	28,779	30,461	39,280	126	2,672
11.0	29,362	31,205	39,305	136	3,008
12.0	29,929	31,589	39,330	145	3,363
14.0	31,018	32,214	39,339	161	4,062
16.0	32,031	32,731	39,265	178	4,773
18.0	32,991	33,088	39,145	192	5,503
20.0	33,872	33,358	38,994	205	6,211
25.0	35,868	33,644	38,561	225	7,905
30.0	37,582	33,766	37,933	240	9,447
35.0	39,128	33,772	37,196	257	10,845
40.0	40,527	33,564	36,562	273	12,222
45.0	41,819	33,248	35,948	288	13,418
50.0	43,013	32,858	35,354	300	14,428
60.0	44,998	32,015	34,223	326	16,181
70.0	46,618	31,274	33,153	338	17,857
80.0	47,967	30,599	32,136	345	19,340
90.0	49,056	29,962	31,247	349	20,730
100.0	49,923	29,343	30,549	350	21,869
125.0	51,471	27,970	28,977	372	24,133
150.0	52,541	26,599	27,575	387	26,084
175.0	53,213	25,447	26,155	394	27,330
200.0	53,654	24,441	24,790	400	28,153
225.0	53,915	23,539	23,504	410	28,657
250.0	53,874	22,658	22,471	425	29,145
275.0	53,495	21,837	21,540	443	29,473
300.0	53,200	21,034	20,760	461	29,566
350.0	52,322	19,581	19,375	505	29,817
400.0	51,234	18,361	18,322	549	29,791
450.0	50,438	17,209	17,509	571	29,312
500.0	49,566	16,308	16,753	586	28,938

CAWG 3 Appendix G Table G-13. WUA for Brown Trout in San Joaquin River - Mammoth Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
10.0	35,618	33,868	35,966	176	8,190
11.0	36,217	34,319	35,908	187	8,747
12.0	36,781	34,696	35,850	194	9,275
14.0	37,814	35,378	35,686	209	10,306
16.0	38,748	35,939	35,444	221	11,312
18.0	39,607	36,371	35,159	233	12,284
20.0	40,419	36,724	34,872	244	13,207
25.0	42,205	37,202	34,324	268	15,207
30.0	43,746	37,333	33,725	291	16,909
35.0	45,107	37,350	33,093	317	18,486
40.0	46,291	37,119	32,538	342	20,009
45.0	47,250	36,720	32,065	365	21,316
50.0	48,024	36,313	31,612	387	22,419
60.0	49,257	35,431	30,667	426	24,218
70.0	50,111	34,705	29,708	438	25,770
80.0	50,704	33,940	28,730	447	27,172
90.0	51,106	33,179	27,781	460	28,403
100.0	51,434	32,534	26,970	468	29,503
125.0	51,940	30,764	25,298	481	31,085
150.0	51,932	29,241	23,822	498	32,305
175.0	51,626	28,032	22,405	517	33,270
200.0	51,077	26,980	21,142	528	33,746
225.0	50,310	25,971	19,838	543	33,859
250.0	49,625	25,086	18,833	567	33,872
275.0	48,931	24,285	17,932	590	33,848
300.0	48,184	23,486	17,217	605	33,546
350.0	46,864	22,109	15,913	633	32,906
400.0	45,555	20,826	15,024	659	32,243
450.0	44,458	19,726	14,267	665	31,459
500.0	43,334	18,810	13,613	676	30,686

CAWG 3 Appendix G Table G-14. WUA for Sacramento Suckers in San Joaquin River - Mammoth Reach.

	WUA Rearing (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile
10.0	34,807	39,934
11.0	35,326	37,663
12.0	35,822	37,815
14.0	36,759	38,020
16.0	37,634	38,161
18.0	38,459	38,225
20.0	39,240	38,241
25.0	40,978	38,156
30.0	42,489	37,898
35.0	43,834	42,866
40.0	45,067	42,506
45.0	46,184	42,129
50.0	47,206	41,706
60.0	49,030	40,809
70.0	50,594	39,969
80.0	51,935	39,144
90.0	53,102	38,401
100.0	54,150	40,176
125.0	56,332	38,517
150.0	55,550	36,965
175.0	56,788	35,574
200.0	52,400	34,284
225.0	53,036	32,970
250.0	53,437	31,740
275.0	53,624	30,623
300.0	53,689	29,598
350.0	53,566	27,781
400.0	58,493	26,321
450.0	58,090	25,125
500.0	57,673	24,111

CAWG 3 Appendix G Table G-15. WUA for Rainbow Trout in San Joaquin River - Stevenson Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
3.0	24,094	21,338	31,095	57	2,214
3.5	24,519	21,652	31,367	58	2,573
4.0	24,921	21,949	31,607	59	2,932
4.5	25,296	22,247	31,835	61	3,301
5.0	25,654	22,524	32,045	63	3,656
6.0	26,323	23,068	32,281	67	4,348
7.0	26,952	23,521	32,427	72	4,955
8.0	27,559	23,907	32,502	78	5,510
9.0	28,155	24,210	32,561	84	5,950
10.0	28,730	24,460	32,652	89	6,384
12.5	30,050	25,144	32,822	107	7,468
15.0	31,247	25,809	32,875	131	8,615
20.0	33,241	26,721	33,105	173	10,352
30.0	36,535	27,657	33,444	239	12,484
40.0	39,054	28,317	32,535	276	13,935
50.0	41,233	28,408	31,561	267	14,424
60.0	43,114	28,476	30,848	289	14,397
70.0	44,768	28,527	30,151	311	13,924
80.0	46,300	28,302	29,552	322	13,638
90.0	47,666	28,051	29,029	321	13,179
100.0	48,795	27,853	28,521	311	12,956
125.0	50,849	27,251	27,003	290	13,263
150.0	52,448	26,255	25,749	296	13,056
175.0	53,444	25,389	24,666	296	12,801
200.0	54,191	24,543	23,648	283	13,359
225.0	54,760	23,728	22,587	291	15,218
250.0	54,925	22,990	21,526	292	16,623
275.0	54,677	22,237	20,372	301	17,934
300.0	54,648	21,249	19,289	300	19,163
350.0	54,348	19,327	17,322	274	20,496

CAWG 3 Appendix G Table G-16. WUA for Brown Trout in San Joaquin River - Stevenson Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
3.0	29,665	24,530	28,108	53	4,491
3.5	30,151	24,928	28,423	54	4,942
4.0	30,603	25,290	28,664	56	5,385
4.5	31,033	25,668	28,921	59	5,848
5.0	31,441	26,019	29,186	63	6,275
6.0	32,213	26,627	29,515	72	7,045
7.0	32,943	27,162	29,749	85	7,681
8.0	33,630	27,605	29,916	101	8,305
9.0	34,274	27,990	30,055	117	8,835
10.0	34,860	28,360	30,228	134	9,341
12.5	36,116	29,207	30,444	169	10,357
15.0	37,198	29,855	30,381	198	11,392
20.0	38,980	30,608	30,316	252	13,006
30.0	41,805	31,634	29,915	318	14,725
40.0	44,152	32,557	28,530	351	15,073
50.0	45,976	32,740	27,501	319	14,765
60.0	47,503	32,662	26,838	329	14,234
70.0	48,707	32,584	26,305	345	13,852
80.0	49,707	32,403	25,743	349	13,680
90.0	50,525	32,282	25,248	344	13,459
100.0	51,225	31,958	24,718	333	13,382
125.0	52,528	31,081	23,301	335	13,784
150.0	53,294	30,006	21,955	342	13,398
175.0	53,468	28,931	20,879	330	13,193
200.0	53,270	27,939	19,995	307	14,329
225.0	53,037	26,906	18,716	316	16,658
250.0	52,806	26,028	17,552	318	18,119
275.0	52,443	25,093	16,398	312	19,040
300.0	51,902	24,027	15,427	307	20,081
350.0	50,608	22,085	13,897	280	20,606

CAWG 3 Appendix G Table G-17. WUA for Hardhead in San Joaquin River - Stevenson Reach.

	WUA Rearing (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile
3.0	28,989	47,659
3.5	29,348	48,050
4.0	29,674	48,412
4.5	29,973	48,744
5.0	30,249	49,065
6.0	30,760	49,672
7.0	31,238	50,247
8.0	31,664	50,833
9.0	32,058	51,387
10.0	32,429	51,900
12.5	33,273	52,934
15.0	34,050	53,705
20.0	35,393	55,319
30.0	37,506	57,069
40.0	39,287	58,227
50.0	40,793	59,422
60.0	41,991	60,150
70.0	43,029	60,678
80.0	43,891	61,201
90.0	44,642	61,366
100.0	45,344	61,318
125.0	46,704	61,322
150.0	47,739	60,988
175.0	48,521	60,467
200.0	49,137	59,849
225.0	49,500	59,064
250.0	49,777	58,274
275.0	49,969	57,468
300.0	50,115	56,581
350.0	50,271	54,549

CAWG 3 Appendix G Table G-18. WUA for Sacramento Pikeminnow in San Joaquin River - Stevenson Reach.

	WUA Rearing (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile
3.0	32,442	35,109
3.5	32,924	35,402
4.0	33,366	35,668
4.5	33,769	35,920
5.0	34,140	36,147
6.0	34,723	36,537
7.0	35,197	36,885
8.0	35,595	37,174
9.0	35,949	37,417
10.0	36,293	37,651
12.5	37,044	38,154
15.0	37,655	38,492
20.0	38,713	38,991
30.0	40,150	39,188
40.0	41,165	38,966
50.0	41,874	38,540
60.0	42,409	37,968
70.0	42,668	37,433
80.0	42,827	36,894
90.0	42,922	36,256
100.0	42,971	35,648
125.0	42,818	34,255
150.0	42,638	32,854
175.0	42,101	31,672
200.0	41,107	30,563
225.0	40,266	29,400
250.0	39,578	28,281
275.0	38,995	27,191
300.0	38,529	26,074
350.0	37,162	24,053

CAWG 3 Appendix G Table G-19. WUA for Sacramento Sucker in San Joaquin River - Stevenson Reach.

Discharge (cfs)	WUA Rearing (sq. ft/1,000ft)	
	Adult	Juvenile
3.0	29,672	38,157
3.5	30,081	38,472
4.0	30,464	38,729
4.5	30,818	38,971
5.0	31,148	39,199
6.0	31,762	39,605
7.0	32,325	39,965
8.0	32,856	40,300
9.0	33,360	40,569
10.0	33,843	40,807
12.5	34,975	41,355
15.0	36,012	41,746
20.0	37,836	42,298
30.0	40,845	42,644
40.0	43,242	42,662
50.0	45,184	42,362
60.0	46,887	41,684
70.0	48,403	41,018
80.0	49,762	40,394
90.0	50,898	39,810
100.0	51,916	39,185
125.0	53,947	37,687
150.0	55,618	36,151
175.0	57,006	34,847
200.0	58,227	33,758
225.0	59,268	32,598
250.0	60,135	31,411
275.0	60,780	30,262
300.0	61,267	29,091
350.0	61,718	27,012

CAWG 3 Appendix G Table G-20. WUA for Rainbow Trout in Upper Big Creek - PH2 to Dam 4 Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
1.0	2,697	5,480	11,281	7	1,102
1.5	3,090	6,088	12,425	15	1,860
2.0	3,438	6,659	13,276	24	2,646
2.5	3,758	7,234	13,861	35	3,415
3.0	4,055	7,781	14,314	45	4,150
3.5	4,327	8,248	14,665	55	4,811
4.0	4,587	8,656	14,938	65	5,428
4.5	4,833	9,057	15,145	75	6,017
5.0	5,075	9,463	15,266	84	6,597
6.0	5,537	10,159	15,439	101	7,652
7.0	5,970	10,735	15,535	116	8,537
8.0	6,397	11,249	15,564	129	9,315
9.0	6,810	11,661	15,564	140	10,015
10.0	7,207	11,944	15,540	149	10,605
12.0	7,940	12,359	15,428	162	11,586
14.0	8,576	12,686	15,248	171	12,361
16.0	9,161	12,881	15,007	176	12,915
18.0	9,720	12,910	14,790	179	13,305
20.0	10,228	12,866	14,634	181	13,597
25.0	11,301	12,594	14,309	186	14,110
30.0	12,124	12,280	13,997	182	14,251
35.0	12,798	11,967	13,782	176	14,200
40.0	13,347	11,667	13,715	169	14,048
45.0	13,779	11,455	13,722	162	13,893
50.0	14,093	11,358	13,684	156	13,737
60.0	14,478	11,257	13,471	144	13,483
70.0	14,675	11,363	13,251	135	13,448
80.0	14,708	11,490	13,106	128	13,488
90.0	14,722	11,467	13,113	124	13,551
100.0	14,738	11,408	13,191	123	13,601

CAWG 3 Appendix G Table G-21. WUA for Brown Trout in Upper Big Creek - PH2 to Dam 4 Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
1.0	3,778	6,092	11,110	26	2,523
1.5	4,253	6,837	12,271	44	3,667
2.0	4,685	7,532	13,126	60	4,710
2.5	5,104	8,186	13,710	76	5,641
3.0	5,492	8,760	14,161	90	6,482
3.5	5,859	9,235	14,520	103	7,211
4.0	6,206	9,685	14,797	115	7,874
4.5	6,545	10,107	15,013	126	8,489
5.0	6,868	10,469	15,140	137	9,051
6.0	7,447	11,063	15,326	154	10,035
7.0	7,980	11,534	15,426	167	10,832
8.0	8,452	11,936	15,456	179	11,503
9.0	8,855	12,236	15,439	188	12,079
10.0	9,207	12,394	15,384	194	12,518
12.0	9,824	12,602	15,197	200	13,137
14.0	10,339	12,691	14,927	201	13,550
16.0	10,768	12,695	14,596	201	13,794
18.0	11,123	12,587	14,309	199	13,922
20.0	11,434	12,460	14,093	197	13,971
25.0	12,062	12,118	13,711	191	13,846
30.0	12,469	11,700	13,455	180	13,603
35.0	12,761	11,297	13,313	167	13,268
40.0	12,933	11,009	13,310	156	12,910
45.0	12,957	10,825	13,319	144	12,616
50.0	12,936	10,740	13,269	136	12,479
60.0	12,843	10,717	13,037	120	12,493
70.0	12,671	10,906	12,734	108	12,748
80.0	12,578	10,998	12,514	96	12,831
90.0	12,577	11,013	12,530	92	12,857
100.0	12,613	11,078	12,617	92	12,951

CAWG 3 Appendix G Table G-22. WUA for Rainbow Trout in Lower Big Creek - PH 8 to Dam 5 Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
1.0	6,667	7,410	12,351	126	702
1.5	7,078	8,056	12,673	176	1,158
2.0	7,454	8,555	12,950	228	1,645
2.5	7,786	8,960	13,191	276	2,141
3.0	8,093	9,313	13,378	320	2,632
3.5	8,379	9,612	13,524	362	3,130
4.0	8,652	9,852	13,646	403	3,619
4.5	8,909	10,037	13,736	446	4,103
5.0	9,156	10,185	13,785	487	4,555
6.0	9,630	10,415	13,861	546	5,356
7.0	10,052	10,612	13,922	606	6,089
8.0	10,435	10,771	13,981	661	6,718
9.0	10,790	10,889	14,017	713	7,267
10.0	11,124	10,973	14,016	761	7,763
12.0	11,700	11,042	13,940	843	8,620
14.0	12,157	11,028	13,821	900	9,252
16.0	12,544	11,020	13,666	938	9,743
18.0	12,896	11,011	13,479	934	10,076
20.0	13,200	10,990	13,250	914	10,334
25.0	13,854	10,783	12,725	867	10,906
30.0	14,384	10,519	12,292	817	11,441
35.0	14,778	10,209	11,800	795	11,964
40.0	15,104	9,920	11,331	783	12,409
45.0	15,343	9,710	10,905	766	12,693
50.0	15,506	9,505	10,543	754	12,919
60.0	15,836	9,016	10,259	727	13,238
70.0	16,027	8,662	10,216	701	13,600
80.0	16,089	8,334	10,158	681	13,905
90.0	16,010	8,171	10,008	651	14,161
100.0	15,851	8,038	9,781	627	14,249

CAWG 3 Appendix G Table G-23. WUA for Brown Trout in Lower Big Creek - PH 8 to Dam 5 Reach.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
1.0	8,663	8,344	11,621	217	2,118
1.5	9,163	8,995	11,873	292	2,915
2.0	9,576	9,491	12,098	344	3,632
2.5	9,932	9,910	12,282	385	4,306
3.0	10,262	10,270	12,425	421	4,942
3.5	10,567	10,547	12,540	455	5,528
4.0	10,851	10,767	12,632	489	6,049
4.5	11,123	10,929	12,690	524	6,539
5.0	11,381	11,046	12,719	552	6,972
6.0	11,834	11,237	12,783	594	7,710
7.0	12,218	11,417	12,846	637	8,350
8.0	12,542	11,575	12,903	677	8,884
9.0	12,831	11,682	12,905	714	9,344
10.0	13,085	11,741	12,882	745	9,734
12.0	13,519	11,720	12,809	772	10,266
14.0	13,897	11,673	12,713	764	10,595
16.0	14,222	11,652	12,581	746	10,828
18.0	14,453	11,598	12,413	722	11,009
20.0	14,651	11,461	12,182	703	11,190
25.0	14,953	11,091	11,669	670	11,714
30.0	15,179	10,714	11,279	663	12,100
35.0	15,246	10,246	10,831	669	12,383
40.0	15,205	9,856	10,383	665	12,516
45.0	15,154	9,579	9,971	651	12,560
50.0	15,077	9,308	9,611	633	12,594
60.0	14,731	8,822	9,340	593	12,743
70.0	14,414	8,512	9,316	560	13,028
80.0	14,036	8,351	9,269	525	13,200
90.0	13,661	8,334	9,145	486	13,209
100.0	13,432	8,238	8,958	451	13,194

CAWG 3 Appendix G Table G-24. WUA for Rainbow Trout in Stevenson Creek.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
2.0	4,874	9,361	13,466	15	2,575
2.5	5,325	9,886	13,618	23	3,228
3.0	5,745	10,327	13,677	31	3,832
3.5	6,132	10,719	13,673	40	4,413
4.0	6,498	11,026	13,619	48	4,950
4.5	6,843	11,255	13,541	56	5,447
5.0	7,169	11,417	13,444	66	5,902
5.5	7,479	11,538	13,320	75	6,309
6.0	7,781	11,619	13,190	85	6,675
7.0	8,349	11,719	12,890	103	7,331
8.0	8,862	11,739	12,562	121	7,873
9.0	9,334	11,697	12,230	135	8,307
10.0	9,776	11,611	11,924	148	8,647
12.0	10,545	11,364	11,406	162	9,169
14.0	11,153	11,095	10,953	166	9,547
16.0	11,615	10,817	10,524	167	9,831
18.0	11,972	10,549	10,141	168	10,017
20.0	12,260	10,292	9,774	168	10,117
25.0	12,835	9,621	9,031	165	10,117
30.0	13,288	8,946	8,550	161	9,959
35.0	13,587	8,347	8,242	158	9,892
40.0	13,773	7,885	7,949	156	9,900
45.0	13,851	7,469	7,735	151	9,878
50.0	13,809	7,167	7,576	141	9,819
60.0	13,515	6,856	7,420	99	9,613
70.0	13,257	6,684	7,452	77	9,553
80.0	12,971	6,577	7,650	64	9,539
90.0	12,736	6,517	7,965	58	9,679
100.0	12,558	6,513	8,484	55	9,890
125.0	12,508	6,931	9,539	48	10,711

CAWG 3 Appendix G Table G-25. WUA for Rainbow Trout in North Fork Stevenson Creek.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
3.0	4,683	9,618	16,048	128	3,710
3.5	4,975	10,013	16,296	141	4,254
4.0	5,251	10,338	16,472	152	4,776
4.5	5,511	10,612	16,587	162	5,261
5.0	5,757	10,861	16,678	170	5,712
5.5	5,990	11,095	16,740	178	6,144
6.0	6,215	11,302	16,771	185	6,537
6.5	6,429	11,484	16,773	190	6,904
7.0	6,634	11,651	16,746	194	7,247
7.5	6,828	11,800	16,711	196	7,561
8.0	7,018	11,925	16,674	198	7,850
8.5	7,204	12,034	16,640	200	8,125
9.0	7,386	12,130	16,600	201	8,384
10.0	7,715	12,298	16,532	202	8,861
11.0	8,005	12,447	16,460	201	9,322
12.0	8,282	12,566	16,420	201	9,752
13.0	8,537	12,645	16,352	200	10,156
14.0	8,767	12,713	16,286	199	10,538
15.0	8,981	12,759	16,248	198	10,871
17.5	9,476	12,795	16,061	192	11,617
20.0	9,914	12,732	15,834	187	12,243
25.0	10,624	12,520	15,302	178	13,104
30.0	11,160	12,259	14,805	167	13,479
35.0	11,563	11,967	14,428	156	13,628
40.0	11,855	11,678	14,093	145	13,642
45.0	12,070	11,449	13,764	136	13,606
50.0	12,175	11,251	13,462	127	13,538
60.0	12,266	10,882	12,992	112	13,273
70.0	12,173	10,589	12,645	96	13,024
80.0	12,076	10,302	12,370	85	12,811

CAWG 3 Appendix G Table G-26. WUA for Brown Trout in North Fork Stevenson Creek.

	WUA Rearing (sq. ft/1,000ft)			WUA Spawning (sq. ft/1,000ft)	
Discharge (cfs)	Adult	Juvenile	Fry	Actual Substrate	100% Suitable Substrate
3.0	6,657	10,478	15,828	139	5,697
3.5	6,989	10,861	16,039	150	6,302
4.0	7,298	11,155	16,186	159	6,846
4.5	7,588	11,401	16,283	165	7,318
5.0	7,857	11,643	16,364	169	7,746
5.5	8,117	11,851	16,417	173	8,142
6.0	8,358	12,032	16,438	175	8,507
6.5	8,578	12,179	16,436	177	8,832
7.0	8,778	12,306	16,400	177	9,130
7.5	8,968	12,425	16,358	177	9,412
8.0	9,146	12,531	16,315	177	9,674
8.5	9,313	12,610	16,276	177	9,914
9.0	9,467	12,678	16,228	176	10,125
10.0	9,749	12,803	16,145	173	10,509
11.0	9,995	12,892	16,062	171	10,855
12.0	10,216	12,970	16,015	169	11,188
13.0	10,415	13,003	15,942	167	11,485
14.0	10,593	13,027	15,865	166	11,765
15.0	10,756	13,053	15,814	165	12,011
17.5	11,094	12,984	15,602	159	12,478
20.0	11,373	12,848	15,351	152	12,801
25.0	11,762	12,422	14,782	140	13,115
30.0	11,993	12,013	14,257	128	13,172
35.0	12,059	11,681	13,863	117	13,171
40.0	12,056	11,419	13,556	107	13,041
45.0	11,982	11,192	13,258	99	12,867
50.0	11,889	11,021	12,973	94	12,706
60.0	11,668	10,670	12,513	84	12,353
70.0	11,482	10,418	12,105	75	11,951
80.0	11,405	10,158	11,802	67	11,626

APPENDIX H

CALIBRATION MODELS

APPENDIX H

CALIBRATION MODELS

Electronic Format Only

[This data is available in electronic format only and may be viewed using RHABSIM[1] v 2.1 or higher.]

Appendix H provides the calibration decks for the RHABSIM v 2.1 (PHABSIM) models. These models were used in calibrating each transect. The models should not be used for modeling habitat, as the transects are not weighted appropriately to represent habitat in the various reaches, and do not contain the full set of simulation flows used in the production runs.

[1]RHABSIM (Riverine HABitat SIMuation) is a fully integrated program for river hydraulics and aquatic habitat modeling using the Instream Flow Incremental Methodology (IFIM). Running in Microsoft Windows and DOS, it is an extensive conversion of the PHABSIM hydraulic and habitat simulation system developed by the U. S. Fish and Wildlife Service.

APPENDIX I

CALIBRATION OUTPUT FILES

APPENDIX I

CALIBRATION OUTPUT FILES

Electronic Format Only

[This data is available in electronic format only and may be opened using any Text Editor[2]]

Appendix I provides output that is useful in assessing the calibration of the individual transects.

[2]Microsoft Text Editor (EditPlus, UltraEdit, TextPad, etc).

APPENDIX J

PRODUCTION MODELS

APPENDIX J

PRODUCTION MODELS

Electronic Format Only

[This data is available in electronic format only and may be viewed using RHABSIM v 2.1 or higher. The *.txt files may be opened using any text editor]

Appendix J provides the production models used in the Big Creek ALP. These models are appropriately weighted and contain the full set of simulation flows presented in the report. The "JOB.txt" files in each directory are the job files which show the flows, transect weighting, and criteria and options used for each model run. The "WUA.txt" files contain the output for each model run. Separate runs were made for rearing and spawning lifestages.