COMBINED AQUATICS STUDY PLANS

CAWG-1-CHARACTERIZE STREAM AND RESERVOIR HABITATS

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CAWG 1 CHARACTERIZE STREAM AND RESERVOIR HABITATS

1.0 EXECUTIVE SUMMARY

This report summarizes information on streams and impoundments in the Project area (Map CAWG 1-1) developed from Initial Information Gathering activities that took place during 2000 and information developed in response to the Combined Aquatic Working Group (CAWG) *Technical Study Plan 1 Characterize Stream and Reservoir Habitats* during 2001.

STREAM HABITAT

In the summer and fall of 2000 and 2001, Project-affected streams and upstream areas were inventoried (mapped) for habitat on the ground. Information gathered from the habitat mapping survey provided a broad overview of habitat conditions for fish and other aquatic in the Project Area and facilitated the planning of subsequent sampling activities. The major streams included in the habitat mapping task were the South Fork San Joaquin River, the San Joaquin River (downstream of its confluence with the South Fork San Joaquin River) and Big Creek. Tributaries with Project diversions also were mapped in their bypass reaches and 1500 feet upstream of the diversions.

The principal elements included standardized mapping techniques including Rosgen Level I channel typing (Rosgen 1996) and mesohabitat typing using the approaches of Hawkins et al. (1993) and USFS R5 (McCain et al. 1990). Additional information was collected on channel substrate, pool depth, riparian vegetation and woody debris. Fish passage barriers were identified and located in the field. These data are presented here in tabular and graphical representation.

The tributaries to the South Fork San Joaquin River, San Joaquin River and Big Creek are generally characterized by their steep slope; mesohabitats are made up of a mixture of turbulent riffle and cascade habitats and scour pool habitats such as step-pools or plunge pools. Nonturbulent habitats are generally made up of step-runs. Tributary segments that had moderate slopes were typically comprised of nonturbulent habitats, such as runs, and scour pool habitats, such as lateral scour pools and mid-channel pools.

Approximately half of the South Fork San Joaquin River from its confluence with the San Joaquin River upstream to Rattlesnake Crossing lies in a deep bedrock dominated canyon. The upstream half of the river was a mix of small canyon and open channel. The habitats are composed mostly of large pool type habitats, with approximately equal amounts of turbulent (riffle and cascade) and nonturbulent (run and pocket water) habitats.

The San Joaquin River lies in a deep, steep-walled bedrock canyon from upstream of Redinger Lake to its confluence with the South Fork San Joaquin River. The habitats that were observed for this river included large deep pools with long run-type habitats. Bedrock and boulders dominated the channel substrate.

Big Creek lies in a deep, steep-walled bedrock canyon from its confluence with the San Joaquin River upstream to Powerhouse 1. The habitats that were observed for this creek included long step-pool and step-run habitats. Bedrock dominated the channel substrate.

RESERVOIR HABITAT

Reservoir habitat data was collected from 2000-2002 at Project impoundments to characterize conditions for fish and other aquatic organisms in Project reservoirs. Reservoirs were evaluated from morphometric surveys, substrate characterization, available habitat (based on area-capacity curves and reservoir morphometry) and fish passage. Large Project reservoirs included Florence Lake, Huntington Lake, Shaver Lake and Mammoth Pool Reservoir (Redinger and Thomas A. Edison lakes, which are also part of the Big Creek hydroelectric system, are undergoing traditional relicensing processes, and have already been characterized in the Big Creek 4 and Vermilion Project license applications).

The reservoir water surface elevation and storage of each impoundment is a function of available stream inflow storage, and releases for generation and other uses. This changes seasonally. Potential reservoir habitat was evaluated based on area capacity curves and surface elevation. Substrate and fish passage also were visually characterized based on underwater video and observation at low lake levels.

2.0 STUDY OBJECTIVES

This report summarizes information on Project-affected streams and impoundments in the Project area (Map CAWG 1-1) developed from Initial Information Gathering activities that took place during 2000 and information developed in response to the Combined Aquatic Working Group (CAWG) *Technical Study Plan 1 Characterize Stream and Reservoir Habitats* during 2001.

Objectives for stream habitat characterization for aquatic organisms in the CAWG Technical Study Plan include:

- Determine existing habitats in Project bypass reaches by habitat mapping.
- Determine existing channel types in Project bypass reaches (Level I field evaluation, Rosgen 1996).
- Characterize existing habitat in Project reservoirs from morphometry and area-capacity curves.

- Characterize the effect of water levels on available aquatic habitat in Project reservoirs.
- Characterize the effect of water levels on fish passage from Project reservoirs to tributaries.
- Determine sediment conditions for aquatic organisms during habitat mapping.
- Determine substrate size class.
- Evaluate spawning habitat during habitat mapping.
- Evaluate fines that may affect habitat use during habitat mapping.
- Characterize substrate composition.
- Determine other channel conditions during habitat mapping.
- Determine the presence of woody debris during habitat mapping.
- Determine riparian conditions and shade during habitat mapping.
- Characterize riparian community during habitat mapping.
- Identify passage barriers in bypass reaches during habitat mapping.
- Characterize the effect of water levels on fish passage between small tributaries and reservoirs, and/or bypass reaches.

2.1 STUDY IMPLEMENTATION

Data collection for this study was carried out during 2000 through 2002 to meet the objectives.

2.1.1 STUDY ELEMENT STATUS

In terms of addressing these objectives, this report contains information related to all of these objectives. However, certain analyses or data collections may be incomplete or supplemented in one of the other CAWG reports. The status of study elements is identified below.

Study Elements Completed	**Outstanding Study Elements**
• Habitat inventory (mapping) is complete with the exception of a short reach between Balsam Meadow Forebay and upstream of Balsam Creek diversion.	• A short reach between Balsam Meadow Forebay and upstream of Balsam Creek diversion will be mapped in 2003. A quality control check will be performed in the lower portion of the Big Creek Powerhouse 8 to Dam 5 reach during 2003. This will be done by the instream flow team as part of work for CAWG 3.
• Determining Rosgen Level I channel types was completed in conjunction with work performed in support of CAWG 2 Geomorphology.	• None.
• Characterizing habitat areas for Project reservoirs from morphometry and area capacity curves has been completed from existing SCE information; new bathymetric surveys by echosounder of the reservoirs are not yet complete.	• New bathymetric surveys by echosounder of the reservoirs are not yet complete. Work is to be completed in conjunction with CAWG 2 Geomorphology.
• Changes in the effect of water levels on total lake area, total lake volume, and available shallow water habitat areas was analyzed for Project reservoirs using existing SCE information.	• See bullet above. Results may affect analyses based on existing SCE information for changes in the effect of water levels on total lake area, total lake volume, and available shallow water habitat areas.
• The effect of Project reservoir water levels on fish passage was characterized in the field and from existing SCE information.	• None.
• Sediment conditions were characterized during habitat inventory activities. This information was supplemented by work performed under CAWG 2 Geomorphology.	• None.
• Sediment size classes identified under Methods were used to characterize sediments. This information was supplemented by work performed under CAWG 2 Geomorphology.	• None.
• Spawning gravel presence and quality was identified in the field and summarized by channel type and mesohabitat. This information was supplemented by work performed under CAWG 2 Geomorphology.	• None with information supplemented by work performed under CAWG 2 Geomorphology.

Study Elements Completed	Outstanding Study Elements
• Where fines were a dominant substrate constituent, they were identified for individual habitat units. This information was supplemented by work performed under CAWG 2 Geomorphology in characterizing accumulations of sands or fines.	• None with information supplemented by work performed under CAWG 2 Geomorphology in characterizing accumulations of sands or fines.
• Dominant substrate constituents were visually assessed in the field. This information was supplemented by work performed under CAWG 2 Geomorphology.	• None with information supplemented by work performed under CAWG 2 Geomorphology.
• A variety of additional channel characteristics were noted during habitat inventory data collection including cover types, percent cover, and canopy. This information was supplemented by work performed under CAWG 2 Geomorphology.	• None with information was supplemented by work performed under CAWG 2 Geomorphology.
• Woody debris was mapped in many Project streams, but not all. This information was supplemented by work performed under CAWG 2 Geomorphology. A GIS map accompanies the CAWG 2 report indicating the presence of woody debris.	• Woody debris was mapped on the ground in many Project streams, but not all. This information was supplemented by work performed under CAWG 2 Geomorphology. The focus of stakeholder concerns, as identified during the May 6, 2003 CAWG meeting, is how SCE manages woody debris at dams and diversions. Specifically, whether SCE removes large woody debris at diversions. This will be addressed under the CAWG 2 work scheduled for 2003.
• Riparian and shade information that relates to habitat conditions was collected during habitat inventory activities. More detailed information will be collected as Part of the CAWG 11 Riparian Study during 2003.	• None, but more detailed information will be collected as Part of the CAWG 11 Riparian Study during 2003.
• Riparian information that relates to habitat conditions such as cover and canopy were collected during habitat inventory activities. This information was supplemented by work performed under CAWG 2 Geomorphology and incorporated in GIS format. Information on riparian encroachment and some ground survey information on community make-up is being used in planning the 2003 riparian studies.	• None, information was supplemented by work performed under CAWG 2 Geomorphology and incorporated in GIS format in CAWG 2 report. 2003 riparian studies will provide more detailed information.

Study Elements Completed	Outstanding Study Elements
• Passage barriers are identified and summarized in this report.	• None.
• Access to tributaries from Project Reservoirs was characterized in the field. Project diversions were characterized as to whether provide barriers to fish migration. Additional detail on barriers associated with Project facilities will be evaluated during 2003 in the CAWG 13 Fish Passage Study.	• None. Information on barriers associated with Project facilities will be evaluated and summarized during 2003 in the CAWG 13 Fish Passage Study.

Information was gathered on the ground to the extent feasible. This information provides a broad overview of habitat characteristics relevant to fish and other aquatic life in the Project area and was used to facilitate the planning of subsequent sampling activities. In particular, information on channel type was used to provide a stratification of sampling sites, and mesohabitat data provided information useful to the selection of representative sampling locations.

Information on sediment, channel classifications, and riparian conditions will be developed in much more detail in other studies. Those results are or will be summarized in other reports.

2.2 STUDY METHODOLOGY

2.2.1 STREAM HABITAT METHODS

The major elements of this effort included:

- Rosgen channel typing – Level I was applied to Project streams. Channel types were evaluated using criteria developed by Rosgen (1996).
- Mesohabitat typing (Hawkins et al. 1993 and McCain et al. 1990) was performed. Mesohabitat is the stream channel structure aquatic organisms might use for shelter, feeding, spawning, rearing or other activity.
- Dominant substrates, including the presence of fines and spawning substrate, pool depth, riparian vegetation, and woody debris was characterized and recorded. Potential passage barriers were identified and located in the field.
- Riparian vegetation communities along bypass reaches were characterized primarily as components of habitat for aquatic organisms. The information will be supplemented by a combination of aerial photography and partial ground-truthing.
- Spatial referencing of data collections was performed using GPS (where feasible) and hip chain distances between measured coordinates on each stream reach.

The data from the stream habitat mapping were analyzed and recorded. This report presents a summary of the results.

2.2.2 STREAMS ADDRESSED

The streams in the Big Creek ALP Project area are grouped by major stream drainage (Table CAWG 1-1). Studies of habitats reported here were conducted from 2000 through 2002, with the date(s) reaches were evaluated shown in Table CAWG 1-1. The upper-most stream segment is the South Fork San Joaquin River and its tributaries. Downstream, the South Fork San Joaquin joins the next segment, the San Joaquin River and its tributaries. The Big Creek drainage is a tributary to the San Joaquin River, but due to its size and importance is discussed separately.

Project streams, tributary to the South Fork San Joaquin River, San Joaquin River and Big Creek, are mostly situated in fairly steep channels, in rugged terrain. The western half of the Basin generally consists of gentle to steep hills and valleys deeply incised by the San Joaquin River and its tributaries (e.g. Big Creek, Stevenson Creek, and Willow Creek). In the eastern half of the Basin above 6,000 feet MSL, glaciers carved U-shaped valleys in the upper reaches of Big Creek and Bear Creek. These contrast with the more deeply incised reaches of the San Joaquin River at lower elevations. Medium to coarse grained sands and large boulders make up much of the substrate in the drainages in these mainly granitic watersheds, while fine-grained silts and clays are often lacking in streams.

2.2.3 STREAM HABITAT AND CHANNEL TYPING

Project streams were evaluated using the Rosgen Level I (Rosgen 1996) stream classification system with supplemental data collection. Level I classification can be based on maps and aerial photography, but some field observations are generally used. The shape, slope and pattern of streams can be evaluated using aerial photographs and existing inventories of geology, landform evolution, valley morphology, depositional history and associated river slopes. Rosgen Level I classifications were made based on a combination of topographic information and field verification. In general, the Rosgen Level I classifications were based upon the information provided in the CAWG 2 "SCE Big Creek ALP Level I Geomorphic Classification Information August 2002" CD-ROM. Information missing from the "SCE Big Creek ALP Level I Geomorphic Classification Information August 2002" was supplemented, when the geomorphology ground-truthing was completed. More detailed classifications were made during activities conducted in support of the CAWG 2 Geomorphology Study Plan, but these exceeded the level of detail needed to conduct this work.

Habitat inventories were made for all Project area streams during the summer and fall of 2000 and 2001. These were supplemented for inaccessible areas by typing based on aerial photography and visual observations.

A habitat inventory was used to characterize the aquatic habitat types (mesohabitats) of Project area streams. Mesohabitats represent the commonly identified local conditions, which aquatic organisms use for shelter, feeding, spawning, rearing or other activities. These include such types as pools, runs, and riffles at a general level of characterization. The inventory helps describe places available for aquatic organisms to live and proportions of mesohabitats, which may influence the composition of aquatic communities present. Aquatic habitat types were identified using the most commonly accepted classification approaches for the Sierra Nevada. The composition and distribution of instream habitats were determined by on-the-ground surveys. Trained field biologists walked the entire length of the stream segments and identified habitat types based on two classification levels.

The first level assigns channel habitat to the following four broad categories: turbulent, non-turbulent, scour pool and dammed pool habitat (Table CAWG 1-2) (Hawkins et al., 1993). Riffle and run habitats fall into the turbulent and non-turbulent categories described by Hawkins et al. Pool habitats are described by their position and cause of their formation; they are either dammed pool habitats or scour pool habitats. This level of assessment provides a general view of the habitat based on geomorphic and hydraulic characteristics.

The second level of classification reflects a higher level of resolution and is based on the USFS Region 5 habitat types (Table CAWG 1-3) (McCain et al., 1990). USFS Region 5 methodology outlines procedures to inventory fish habitat (McCain et al., 1990). Riffle, run, and pool habitats describe the three major categories found in stream channels (Table CAWG 1-3). Each category is further subdivided to reflect the diverse habitat types found in natural channels. Riffle habitat is classified as either being high gradient or low gradient. Pool habitat is classified by the location of the pool in the stream channel (whether it is in the main channel, secondary channel, backwater, or lateral) and the occurrence and cause of the scour that forms the pool (obstruction, blockage, constriction, or merging flows). Run habitat is typically low gradient and is classified by the velocity and depth of the habitat. In general, a mesohabitat must be at least one-channel width in length to be identified as an individual habitat unit.

Some stretches of stream reaches within the Big Creek Basin are inaccessible and posed surveying safety concerns. Mapping of these stream segments was completed from aerial photographs and orthorectified digital imagery (where available) and relatively low-level overflights. This was carried out by experienced field biologists familiar with the Big Creek area, after verifying identifications of mesohabitats identified from this method against areas identified on the ground in reaches containing similar features. Lengths were based on information derived from GIS from orthorectified imagery. The study stream reaches and the lengths of those reaches that were completed from aerial photographs overflights were: the South Fork San Joaquin River (SFSJR) downstream of Hoffman Creek to the San Joaquin River/SFSJR confluence (6.4 river miles); a portion of Rock Creek below the Rock Creek diversion (1000 feet); a steep Rosgen Aa+ channel type section of Big Creek between Dam 1 and Powerhouse 1 (6,610 feet) containing many water falls; and

Stevenson Creek near the confluence with the SJR (3,326 feet), a steep section consisting primarily of a waterfall. These lengths are summarized in Appendix E Table E-1. Mesohabitat summaries of these reaches are footnoted to indicate this source of information. In general, the identification of mesohabitats obtained from this method was at a lower level of resolution than from ground-based identifications. The level of classification presented reflects this.

Describing the mesohabitats of the Project area waters with the Hawkins and USFS Region 5 habitat classification methodologies provided both a general and a detailed assessment of available aquatic habitats. This assessment, when combined with the collection of associated information on habitat characteristics such as pool depth, dominant substrate, cover, and spawning gravels (described below), described the presence and condition of aquatic habitats in the Project area waters, and served as a framework for analyzing habitat, and selection of sampling locations to understand potential Project effects on aquatic life.

Habitat lengths and widths were measured to the nearest foot using a hip-chain for length and a stadia rod or tape for widths. Where aerial photographs or aerial typing was used habitat lengths were determined from digital orthorectified imaging. The mean and maximum depth of each habitat type was measured to the nearest 0.1 feet with a stadia rod for depth of less than 20 feet. For depths in excess of 20 feet, a hand held depth finder was used.

Streambed substrates provide microhabitat conditions required for aquatic organisms and provides information about local influences on stream habitat quality. During the habitat mapping surveys, the two most abundant class sizes of surficial substrate were visually estimated to the nearest ten percent. Substrate data were visually classified following the categories described by Rosgen (1996):

- fines (silt/clay), <0.062 mm
- sands, 0.062 - <2 mm
- gravels, 2 – <64 mm
- cobbles, 64 – <256 mm
- boulders, 256 – <4,096 mm
- bedrock, ≥4,096 mm

Substrate smaller than gravel was compared to a sand gage, so that sands could be distinguished from fines. Gravel-sized and larger substrates were determined based on diameter. Substrate was compared to common items for easy evaluation. Stream bank vegetation was measured as the percentage of stream bank covered by vegetation in the following groups: zero, 1-25, 26-50, 51-75, and 76-100 percent.

Spawning gravel is measured as the estimated amount (square feet) of spawning-sized gravel (0.64-7.6 mm diameter, adapted from Bjornn and Reiser (1991)) occurring in each habitat. In addition, habitat areas with spawning gravel are assigned a “Spawning Quality” score of “Poor, Fair, Good, or Excellent.” The score was based primarily on substrate composition, since much of the mapping was conducted during the summer and fall months when streamflow was lowest. The quality of spawning gravel was characterized based on the angularity of the gravels and embeddedness. Gravels of higher suitability for use by spawning trout are highly rounded. Gravel that is more angular is considered of lower quality for spawning. Generally, a “Good” or “Excellent” score was assigned to rounded spawning gravels with little sand and fines present and low embeddedness. Spawning gravels with high embeddedness and high proportion of sand received a “Fair” or “Poor” score, regardless of angularity. Table CAWG 1-4 presents the scoring criteria for spawning gravel.

Riparian vegetation was described by the dominant vegetation covering the stream banks. Vegetative groups included no vegetation, grasses, shrubs, deciduous trees, coniferous trees, and mixed trees. Stream bank vegetation was characterized by the percentage category of stream bank covered by vegetation. The categories recorded were zero, 1-25, 25-50, 50-75, and 75-100 percent. Canopy was measured to the nearest 10 percent using a spherical densiometer. Canopy cover was recorded as hardwood or softwood.

Cover (instream shelter) provides refuge habitat for fish from predators and high water velocities. Cover elements, including undercut banks, woody debris, root wad, terrestrial vegetation, aquatic vegetation, surface turbulence, boulder/cobble, and bedrock, were evaluated for their percent contribution to the total available cover for the habitat unit to the nearest quartile.

Large woody debris (LWD) was counted by stream habitat unit. The total number of pieces of wood in or intersecting the active stream channel with a diameter of six inches or greater was recorded. Wood was counted if approximately 33 percent or greater of the total length of the wood was situated within the stream channel. In the case of debris jams or other accumulations of wood, all pieces of wood meeting the criteria were counted. Woody debris counts were added to the data collection after data for some reaches had been collected without these counts. In those cases, the text indicates that no wood counts were made. Stakeholders indicated that the primary concern with LWD was related to SCE’s handling of LWD at diversions, and whether this handling results in a change in LWD transport and abundance. This is discussed in Appendix C.

Fish passage barriers were visually assessed and characterized by experienced fish biologists. These included culverts, road crossings, debris jams, cascades, bedrock sheets, shallow riffles, and dewatered areas, among others. Photographs were taken and spatial coordinates collected using GPS for each of the barriers identified during the ground surveys.

Crews also identified the location of prominent features, such as tributaries, gaging stations, diversions, recreational facilities and other facilities with GPS coordinates.

The data collected from the habitat mapping surveys and channel typing were stored in an electronic format and used to produce a tabular summary of existing habitats by stream reach. The database output will provide detailed information on the aquatic habitat in Project streams. The analyzed data will also prioritize areas for protection, mitigation, enhancement, or further evaluation.

2.2.4 STREAM DATA ANALYSIS

Data were entered into an electronic database. Standard reports were designed to provide tabular and graphic summaries of habitat types, channel types, dominant substrates, woody debris counts, vegetation conditions, and pool depths by stream. Habitat data for surveyed stream reaches were summarized by Rosgen Level I channel types and by the presence of a diversion (i.e. above diversion [AD] versus below diversion [BD]). Pie charts were generated summarizing mesohabitat data. Data were analyzed to characterize average pool depths, counts of large woody debris, cover, canopy, and substrate.

POOL DEPTH

Average pool depths were categorized in one-foot bins and the number of pools in each bin category was tabulated. The date when these data were collected is footnoted on each tabulation.

WOOD COUNT

Counts of large woody debris (greater than six inches in diameter) for each habitat unit were categorized in bins of five (e.g. zero to five pieces of large woody debris, five to 10, 10 to 15, etc.). The number of habitat units in each of these bin categories was tabulated (also see Appendix C).

COVER SUMMARY

Aquatic cover type was recorded as a quartile percentage in each habitat unit. This report presents the data as a percentage weighted by surface area.

CANOPY SUMMARY

The percentage of stream area shaded by canopy cover was categorized in bins grouped in ten percent increments. The number of habitat units in each category was tabulated. Canopy cover is also described as either softwood or hardwood.

DOMINANT SUBSTRATES

Substrate is described by the average percentage of dominant substrate type in each reach.

RESERVOIR HABITAT

Reservoir habitat data were collected to characterize conditions for fish and other aquatic organisms in Project reservoirs. Reservoir habitat data were collected in the summer and fall of 2002. Project reservoirs included in the study were: Florence Lake, Bear Diversion Forebay, Mono Diversion Forebay, Mammoth Pool, Dam 6 Forebay, Huntington Lake, Dam 4 Forebay, Dam 5 Forebay, Balsam Meadow Forebay, and Shaver Lake. Non-ALP reservoirs within the Big Creek Hydroelectric System were reported in license applications for Big Creek No. 4, Vermilion Valley, and Portal. The main elements of reservoir habitat collection are identified below.

- Reservoir morphometry, and shoreline development were analyzed using SCE plans and drawings.
- Reservoir substrate was characterized at low lake elevations by observation. If necessary, substrates in deeper areas were characterized using an underwater camera (Atlantis Underwater Black and White Camera), or by sampling. Reservoir surficial substrate was evaluated by visually estimated percentage by category using the same size categories as used in stream habitat mapping. The percentages of near shore substrate types were recorded, along with the presence or absence of aquatic vegetation, and the types of cover available for fish.
- Available habitats in Project reservoirs were evaluated based on the following information:
    - SCE's stage-capacity tables, which are more detailed versions of those published by USGS (2002);
    - Reservoir water storage data obtained from USGS published records for the period 1980-2001;
    - Reservoir morphometry from SCE Project drawings; and
    - Arithmetic calculation of surface area by depth interval based on stage-capacity tables for each reservoir.
- Spawning access for fish into reservoir tributaries were evaluated by observation, reservoir morphometry, and area-capacity curves.
- Limnological conditions including the physical properties of the reservoir waters were evaluated in conjunction with the Water Temperature (CAWG 5).

Available habitat in Project reservoirs was evaluated based on area-capacity curves and reservoir morphometry. The reservoir morphometry was determined from SCE plans and drawings of the reservoir. Available area and volume were calculated for each reservoir for three-foot elevation intervals. Where necessary, values were interpolated between points. In addition using this information, potential habitat areas for the following depth intervals were calculated:

- 3 feet
- 6 feet
- 9 feet
- 12 feet

These intervals represent areas for potential habitat for shallow water or near-shore species.

Elevation and storage data for the forebays (Balsam Meadow Forebay, Bear Diversion Forebay, Mono Diversion Forebay, Dam 4 Forebay, Dam 5 Forebay, and Dam 6 Forebay) were obtained from SCE, they are not reported by United States Geological Survey (USGS). Forebay elevations fluctuate frequently and information was summarized on a daily basis for information available during the past three years.

Larger Project reservoirs include Shaver Lake, Huntington Lake, Mammoth Pool Reservoir, and Florence Lake. Elevation and storage data for these reservoirs were obtained from USGS (2001, 2002) and CDEC (2001). Reservoir storage and seasonal changes in storage are affected by the amount of runoff and therefore, water year type. Water year types for the San Joaquin Valley are classified (CDWR 2002) as critical, dry, below normal, above normal, and wet based on runoff. Using USGS records for the period 1980 to 2001, one water year was selected to represent each of the water year types that occurred during that period, respectively. For that period (1980 to 2001), no below normal water year type occurred. The last below normal water year for the San Joaquin Valley occurred in 1971. USGS data from the 1971 water year is included in the report so that all water year types are represented. Daily area and volume for the reservoirs was plotted for each of the representative water years. Average seasonal elevation, volume (storage), and surface area for the reservoirs also were presented by representative water years. The specific water years selected to represent each of the water year types for this analysis were: 1992 for critical, 1985 for dry, 1971 for below normal, 2000 for above normal, and 1997 for wet. These were selected on the basis of years with reasonably typical Project operations and relatively recent data, the below normal water year was selected as the most recent occurrence of that water year type.

Several standard indices are used to characterize lake morphometry and habitat characteristics (Busch and Sly 1992). These were used to analyze morphometry for Project reservoirs. Surface dimensions for each reservoir included maximum length, average breadth, surface area, length of shoreline and shoreline development index. Shoreline development index is the ratio of the length of the lake shoreline to the circumference of a circle with an area equal to that of the lake. This index provides a means of describing the amount shoreline relative to a circle-a shoreline development index of 1.0.

$D_L = L \div 2\sqrt{(\pi A)}$ ($A = \pi r^2$, therefore the denominator is $2\sqrt{(\pi^2 r^2)} = 2\pi r = \pi D$ = circumference)

Subsurface dimensions such as maximum depth, mean depth, and volume were calculated from area-capacity curves for the reservoir.

Each reservoir was characterized by the shoreline steepness, near shore substrate, the presence of aquatic vegetation, and the presence of potential habitat structure. Shoreline steepness was measured from SCE drawings and reservoir morphometry. Near shore substrate, the presence of aquatic vegetation, and the presence of potential habitat structure were measured from reservoir surveys.

The effects of water levels on passage from Project reservoirs to tributary streams were assessed based on data collected during field reconnaissance, operational data, and reservoir morphometry (primarily to be discussed in the report resulting from the CAWG 14 Fish Passage Study Plan). Tributaries used, or with the potential to be used, by stream spawning fish were identified in each reservoir. The reservoir elevation(s) that provide access to the stream were determined from field surveys and reservoir morphometry during low reservoir elevations. In addition, each tributary stream was visited to determine the reservoir elevation at which passage into the stream is likely limited. As the reservoir water levels dropped, fish passage from the reservoirs into the tributaries was visually evaluated. Field biologists evaluated potential fish passage barriers such as limited stream flow, passage obstacles, and height barriers that occurred without adequately deep pools. Reservoir morphometry, or specifically, the shape and the gradient of the slope around the reservoir, along with fluctuations in the reservoir elevation also were taken into account.

Limnological conditions including physical properties and water quality also define the habitat of reservoirs (Busch and Sly 1992). Thermal stratification of lakes affects the quality of habitat for fish. The presence of stratification can facilitate the coexistence of both warm and cold water fish species by thermal partitioning of the lake environment. Temperature stratification also affects productivity and dissolved oxygen concentration. Temperature profiles of the Project reservoirs were collected in conjunction with the Water Temperature (CAWG 5) as were profiles of other parameters including specific conductance. Transparency of waters also affects productivity and habitat. Transparency also was measured in conjunction with these programs. Transparency was measured using a Secchi disc, which is a standard limnological instrument and provides an index of the passage of light through water. The information in this report derives specifically from the data collected for the CAWG 5 study.

2.3 STUDY RESULTS AND ANALYSES

Habitat evaluation data are presented by major stream drainages and segments within the each drainage (Maps CAWG 1-2 through CAWG 1-9). The upper-most drainage is the South Fork San Joaquin River and its tributaries. Downstream, the South Fork San Joaquin joins the next drainage, the San Joaquin River. The San Joaquin River downstream of the South Fork includes the Mammoth Pool and Stevenson Reaches and their tributaries. The Big Creek and Stevenson Creek drainages also are tributaries to the San Joaquin River, but are discussed as separate portions of the drainage.

2.3.1 SOUTH FORK SAN JOAQUIN RIVER DRAINAGE

The South Fork San Joaquin River (SFSJR) study segment starts with the Project bypass reach downstream of Florence Dam and extends approximately 29 miles downstream to the confluence with the San Joaquin River (Maps CAWG 1-2 through CAWG 1-4). Several reaches within the mainstem were evaluated, as well as tributaries that drain into the South Fork San Joaquin River. Downstream of the Hoffman Creek confluence, ground surveys were not completed because of access and safety concerns, a visual assessment of mesohabitats was made for that reach (See Section 2.2.3 Stream Habitat and Channel Typing in Study Methodology).

The segments of the mainstream of the South Fork San Joaquin River (SFSJR) that were evaluated and their tributaries, from upstream to downstream, include:

- SFSJR from Florence Lake to the confluence with Bear Creek (with a reach length of 37,881 feet), including the following tributaries: Tombstone, South Slide, North Slide, Hooper, Crater, Bear creeks;

- SFSJR from Bear Creek to Mono Crossing (with a reach length of 24,702 feet) and tributaries Chinquapin, Camp 62, Bolsillo, Camp 61 Creek, and Adit No. 2 Creek (Camp 61 Creek and Adit No. 2 Creek are described in the Portal Application for New License (SCE 2002);

- SFSJR from Mono Creek Crossing to downstream of Rattlesnake Creek crossing (with a reach length of 33,573 feet) and two Project-affected tributaries Mono and Warm creeks (Warm Creek was described in Vermilion Application for New License [SCE, 2001]).

- SFSJR from downstream of Rattlesnake Creek to upstream of Hoffman Creek (with a reach length of 22,189 feet)

- SFSJR from upstream of Hoffman Creek to the San Joaquin/South Fork San Joaquin rivers confluence (with a reach length of 35,059 feet)

The three upstream reaches of the South Fork San Joaquin River downstream of Florence Lake are primarily composed of Rosgen Level I B-type channels, with inclusions of C and G-type channels. The reach between Rattlesnake and Hoffman creeks was classified as a G-type channel, while the remainder of the river to the confluence was classified as G-type channel with B inclusions.

Surveyed tributaries to the South Fork San Joaquin River, from upstream to downstream, include: Tombstone, South Slide, North Slide, Hooper, Crater, Bear, Chinquapin, Camp 62, Bolsillo, Camp 61, and Mono creeks. Adit No. 2 Creek is a tributary of Camp 61 Creek. In general, these tributaries are steep, granitic streams and many of them are classified as Rosgen Aa+-type channels, although lower gradient channel types are represented as well. Several have a diversion structure across the creek located in a location where there is a natural change in channel slope. Habitat was evaluated above and below these diversion structures.

Detailed descriptions of these reaches are presented below.

2.3.2 SOUTH FORK SAN JOAQUIN RIVER MAINSTREAM

2.3.2.1 SFSJR - Florence Lake to Bear Creek

INTRODUCTION

The South Fork San Joaquin River between Florence Lake and Bear Creek is of low to moderate gradient and runs through a valley underlain by granite. This segment is composed primarily of Rosgen B channel, with a lessor portion of C channel and a small inclusion of G channel. It had a mixture of complex habitat types. It contained many pools that could provide habitat for fish and a complex mix of cover types. It was one of the few segments of stream channel that contained finer sediments, including sands and gravels. Little spawning gravel was observed, except in the “C“ channel areas. Although this segment did not contain barriers to fish migration, a waterfall located downstream in the South Fork San Joaquin River between Mono and Rattlesnake creeks forms a complete barrier to upstream fish migration at all flows.

This segment was evaluated from Florence Lake to Bear Creek for a length of 37,881 feet on the ground (Map CAWG 1-2). The South Fork San Joaquin River has an elevation of 7,218 feet above MSL at Florence Lake, and drops to an elevation of 6,675 feet above MSL at the confluence with Bear Creek.

ROSGEN LEVEL I CLASSIFICATION

This segment consists of three Rosgen Level I channel types (Table CAWG 1-5). The majority of the reach is classified as a B-type channel (69.8 percent), a substantial portion is a C-type channel (27.4 percent), and there is a minor inclusion of G-type channel (2.8 percent).

MESOHABITAT

The Rosgen C channel was composed primarily of Hawkins fast water habitat types nonturbulent (50.2 percent) and turbulent (1.1 percent), with a large component of the scour pool slow water habitat type (44.5 percent) (Figure CAWG 1-1). Dammed pool was a very small component (4.1 percent). This reach was predominantly composed of USFS-R5 flatwater habitat types including run (34.4 percent), glide (11.8 percent), step water (3.5 percent), and minor pocket water (Figure CAWG 1-2 for reach location and Rosgen Level I type channels and Map CAWG 1-10 for mesohabitats by Rosgen Level I type channel). There were substantial components of pool habitats consisting primarily of lateral scour pool (21.3 percent) and mid channel pool (21.1 percent). This reach also had small components of low gradient riffle and other habitats.

The Rosgen B channel was mostly composed of Hawkins non-turbulent habitat type (49.5 percent), turbulent habitats (25.9 percent) and slow water habitat type scour pool (24.0 percent). Dammed pool (0.6 percent) was a minor component. This reach was composed predominantly of USFS-R5 run habitats including step run (16.8 percent), pocket water (16.6 percent), and runs (16.2 percent). The principal turbulent habitats consisted of high gradient riffles (19.2 percent), low gradient riffles (3.5 percent), and cascades (3.1 percent). Pool habitats primarily consisted of lateral scour pool (12.4 percent) and mid channel pool (6.0 percent).

The Rosgen G channel was composed primarily of Hawkins fast water habitat type nonturbulent (50.3 percent) and slow water habitat type scour pool (38.2 percent). There was a smaller component of turbulent habitat (11.5 percent). Half of this reach was composed of USFS-R5 step run (50.3 percent), and rest was step pool (38.2 percent) and cascade (11.5 percent).

POOL DEPTH

Many of the average pool depths in the Rosgen C channel were in the one to two foot depth range, but over half had average depths of between two to five feet (Figure CAWG 1-3). Most of the average pool depths in the Rosgen B channel were in the two to three foot and one to two foot depth ranges, but some were deeper, and one had an average depth of greater than 10 feet. The one pool in the Rosgen G channel had an average depth in the two to three foot range.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in this segment of the South Fork San Joaquin River.

COVER SUMMARY

A variety of cover types were found in this segment. Average weighted cover in the Rosgen C channel was primarily woody debris (22 percent) and boulder/cobble (16 percent), with smaller amounts of aquatic and terrestrial vegetation, bedrock, and surface turbulence (Table CAWG 1-6). Average weighted cover in the Rosgen B channel was primarily boulder/cobble (48 percent) and surface turbulence (17 percent), with smaller amounts of bedrock, woody debris and terrestrial vegetation. Average weighted cover in the Rosgen G channel was surface turbulence (16 percent), bedrock (14 percent), terrestrial vegetation (13 percent), and boulder/cobble.

CANOPY SUMMARY

Canopy cover was generally zero to 60 percent and composed mostly of softwood (Table CAWG 1-7).

FISH BARRIERS

No barriers to fish migration were identified.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen C channel were primarily sands (averaging 30 percent of the mesohabitats) and gravel (averaging 29 percent of the mesohabitats) (Table CAWG 1-8). Additional dominant substrates included cobble, fines, bedrock, and boulders. The dominant substrates in the Rosgen B channels were boulders (averaging 53 percent) and cobble (averaging 21 percent). Additional dominant substrates included bedrock and sands. The dominant average substrate in the Rosgen G channel was mostly bedrock (averaging 83 percent) with additional substrates dominated by boulders and gravel.

SPAWNING GRAVEL

This reach of the South Fork San Joaquin River had a little spawning gravel in the B or G channel types. Most gravel was located in the C channel type, located in glide and run habitat, with smaller amounts in lateral scour pool and pocket water (Table CAWG 1-9). Most gravel found was characterized as fair or poor in quality.

SIDE CHANNELS

Side channels were observed in 16 out of 152 habitat units, for a total length of 3,554 feet of side channel. Side channel units were composed of a variety of habitat types, including high and low gradient riffles, runs, step runs, cascade, and pools.

2.3.2.2 SFSJR - Bear Creek to Mono Crossing

INTRODUCTION

This segment of the SFSJR is of low gradient, predominantly composed of Rosgen B channels and with smaller sections of Rosgen C and G channels. It had a mixture of complex habitat types. It contained deep pools that could provide habitat for fish. It was one of the few segments of stream channel that contained a relatively high frequency of habitat units with dominant finer sediments, including sand. Little spawning gravel was observed. Although this segment did not contain barriers to fish migration, a waterfall located downstream in the South Fork San Joaquin River between Mono Crossing and Rattlesnake creeks forms a complete barrier to fish migration at all flows.

This segment of the South Fork San Joaquin River was evaluated from Bear Creek to Mono Crossing for a length of 24,702 feet (Maps CAWG 1-2 and CAWG 1-3). The South Fork San Joaquin River has an elevation of 6,675 feet above MSL at the confluence with Bear Creek, and drops to an elevation of approximately 6,400 feet above MSL at Mono Crossing.

ROSGEN LEVEL I CLASSIFICATION

This segment consists of three Rosgen Level I channel types. Over half of this reach (58.9 percent) is classified as a B-type channel (Table CAWG 1-10). The remainder is classified as C-type (20.4 percent) and G-type (20.7 percent) channel.

MESOHABITAT

The Rosgen B channel was composed of Hawkins slow water habitat type scour pool (48.1 percent) and fast water habitat types turbulent (26.6 percent) and nonturbulent (25.3 percent) (Figure CAWG 1-4). The predominant USFS-R5 habitat types included lateral scour pool (39.8 percent), low gradient (16.6 percent) and high gradient (8.2 percent) riffles, and flatwater habitat types run (14.3 percent) and pocket water (10.3 percent) (Figure CAWG 1-5 and Maps CAWG 1-10 and CAWG 1-11). This reach also had small components of step pool and other pool habitat and step run. There were only small components of cascade and bedrock sheet.

The Rosgen C channel was composed of Hawkins habitat types scour pool (44.2 percent), turbulent (37.3 percent) and nonturbulent (18.6 percent). This reach was composed of USFS-R5 pool habitat types lateral scour (25 percent) and main channel (10.5 percent) pools, high gradient (20 percent) and low gradient (17.2 percent) riffles, and flatwater habitat types run (12.6 percent) and pocket water (six percent). There were also small components of step pool and corner pool.

The Rosgen G channel was composed of Hawkins habitat types scour pool (51.1 percent), turbulent (26.2 percent) and nonturbulent (22.8 percent). The predominant USFS-R5 habitat type was lateral scour pool (51.1 percent). There was also low gradient riffle (26.2 percent), flatwater habitat including run (13.3 percent) and step run (6 percent), and a small component of pocket water.

POOL DEPTH

Most of the average pool depths in the Rosgen B channels were in the one to two and two to three foot depth range intervals, but several others were deeper (Figure

CAWG 1-6). In the Rosgen C channel over half of the pools had average depths of less than three feet in depth. Almost half of the pools in this channel type were deeper, mostly in the three to four foot depth range. Most of the average pool depths in the Rosgen G channel were in the one to two or two to three foot depth ranges, but two were deeper.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in this segment of the South Fork San Joaquin River.

COVER SUMMARY

Average weighted cover in the Rosgen B channels was primarily boulder/cobble (35 percent) and bedrock (28 percent) and some surface turbulence (10 percent), with small amounts of undercut banks (Table CAWG 1-11). Average weighted cover in the Rosgen C channel was primarily boulder/cobble (51 percent), with some surface turbulence (13 percent), bedrock (11 percent), and small amounts of woody debris, terrestrial vegetation, and undercut bank. Average weighted cover in the Rosgen G channel was primarily boulder/cobble (35 percent) and bedrock (22 percent), with some surface turbulence, undercut banks and terrestrial vegetation.

CANOPY SUMMARY

Generally, there was no canopy in the South Fork San Joaquin River between Bear and Mono creeks. A small percentage of this reach had less than 10 percent canopy composed of softwood (Table CAWG 1-12).

FISH BARRIERS

No barriers to fish migration were identified.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen B channels were primarily boulder (averaging 35 percent) cobble (averaging 22 percent) and bedrock (averaging 20 percent) (Table CAWG 1-13). Additional dominant substrates included sands. The dominant substrates in the Rosgen C channels were primarily cobble (averaging 39 percent) and boulders (averaging 36 percent). Additional substrates included sands, fines and gravel. The dominant substrates in the Rosgen G channel were primarily boulders (averaging 44 percent) and cobble (averaging 20 percent). Additional substrates included sands and bedrock.

SPAWNING GRAVEL

This reach of the South Fork San Joaquin River had relatively little spawning gravel, mostly located in pool (lateral scour pool and step pool), and run habitat. A small portion was located in low and high gradient riffles, as well as in pocket water (Table CAWG 1-14). Most of the gravel was of fair to poor quality.

SIDE CHANNELS

A side channel was observed in one out of 152 habitat units, for a total length of 88 feet of side channel. The side channel unit was a low gradient riffle.

2.3.2.3 SFSJR - Mono Crossing to Downstream of Rattlesnake Crossing

INTRODUCTION

This segment of the South Fork San Joaquin River was of a low gradient, over half of which was Rosgen B channel, with a smaller percentage of Rosgen G channel. This segment was composed predominantly of pool and riffle habitat, but had a mixture of complex habitat types. It contained deep pools that could provide habitat for fish. It was one of the few segments in which habitat units were frequently dominated by finer sediments, including sand. Spawning gravel was relatively abundant in the B channel type. A waterfall that forms a complete barrier to upstream fish migration at all flows was observed in this reach that may fragment the upstream and downstream portions of this part of the SFSJR.

This segment of the South Fork San Joaquin River was evaluated from Mono Crossing to downstream of the confluence with Rattlesnake Creek for a length of 33,573 feet (Maps CAWG 1-3 and CAWG 1-4). The South Fork San Joaquin River has an elevation of about 6,400 feet above MSL at Mono Crossing, then drops to an elevation of 5,945 feet above MSL below Rattlesnake Creek.

ROSGEN LEVEL I CLASSIFICATION

Over half of the reach (65.4 percent) is classified as a B-type channel, with the remainder (34.6 percent) as G-type channel in the upper portion of the segment (Table CAWG 1-15).

MESOHABITAT

The Rosgen B channel was composed of Hawkins slow water habitat type scour pool (50.4 percent) and fast water habitat types turbulent (31.9 percent) and nonturbulent (17.6 percent) (Figure CAWG 1-7). The predominant USFS-R5 habitat types included pool habitat types lateral scour pool (26 percent) and step pool (21.9 percent), low gradient (20.3 percent) and high gradient (11.3 percent) riffles, and pocket water (11 percent) (Figure CAWG 1-8 and Maps CAWG 1-11 and CAWG 1-12). There were small components of additional flatwater habitats (run and step run) and corner pool, and only a very small component of cascade.

The Rosgen G channel was composed primarily of Hawkins slow water habitat type scour pool (62.3 percent) with smaller components of fast water habitat types turbulent (26.3 percent) and nonturbulent (11.3 percent). The predominant USFS-R5 habitat types included pool habitat types step pool (34.6 percent) and lateral scour pool (26.2 percent), high gradient riffle (23.7 percent), and pocket water (9 percent). There were small components of run and additional pool habitats, and only a small component of cascade.

POOL DEPTH

The most frequent average pool depths were in the two to three-foot range, with most of the rest in the one to two and three to four foot ranges (Figure CAWG 1-9). A few pools were deeper, up to a six to seven foot average depth range in the Rosgen B channel and an eight to nine foot average depth range in the Rosgen G channel.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in this segment of the South Fork San Joaquin River.

COVER SUMMARY

Average weighted cover in the Rosgen B channel was bedrock (24 percent), boulder/cobble (23 percent) and surface turbulence (11 percent), with a small amount of terrestrial vegetation (Table CAWG 1-16). Average weighted cover in the Rosgen G channel was bedrock (29 percent) and boulder/cobble (11 percent), with a smaller amount of surface turbulence.

CANOPY SUMMARY

Almost none of this reach had any canopy cover. Several units had a small amount of canopy composed of softwood, and one unit had a small amount composed of hardwood (Table CAWG 1-17).

FISH BARRIERS

Two barriers to upstream fish migration were identified in the Rosgen G channel (Table CAWG 1-18). Both are waterfalls located in cascade habitats. One waterfall is located 10,953 feet upstream of Rattlesnake Creek and forms a complete barrier to migration at low flows. The other waterfall is located 5,423 feet upstream of Rattlesnake Creek and forms only a partial barrier at low flows. The heights of these two waterfalls are five feet and four feet in height, respectively.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen B channel were primarily boulder (averaging 44 percent) and bedrock (averaging 20 percent) (Table CAWG 1-19). Additional dominant substrates included sands and cobble. The dominant substrates in the Rosgen G channel were primarily bedrock (averaging 41 percent), boulders (averaging 24 percent) and sands (averaging 22 percent), with a small amount of cobble.

<u>SPAWNING GRAVEL</u>

This segment of the South Fork San Joaquin River had a greater amount of spawning gravel than reaches upstream (Table CAWG 1-20). Most of the spawning gravels were located in B channel type in step pool and lateral scour pool habitat, as well as a fair amount in riffles, pocket water and step runs. Gravel quality varied from excellent to poor.

<u>SIDE CHANNELS</u>

Side channels were observed in seven out of 159 habitat units, for a total length of 1,142 feet. The side channel units included one step run, one run, two high gradient riffles, two lateral scour pools, and one low gradient riffle.

2.3.2.4 SFSJR - Downstream of Rattlesnake Crossing to Upstream of Hoffman Creek

<u>INTRODUCTION</u>

This segment of the South Fork San Joaquin River was of low gradient consisting of Rosgen G type channel. It had a mixture of pool, riffle and flatwater habitats. It contained deep pools that could provide habitat for fish and had large woody debris, which provided cover. A smaller amount of spawning gravel was observed than in the reach upstream. One of the three waterfalls that form barriers to upstream fish migration was evaluated as a complete barrier at all flows.

This segment was evaluated from downstream of the confluence with Rattlesnake Creek to upstream of the confluence with Hoffman Creek for a length of 22,189 feet (Map CAWG 1-4). The South Fork San Joaquin River has an elevation of 5,937 feet above MSL downstream of Rattlesnake Creek, then drops to an elevation of 5,150 feet above MSL upstream of Hoffman Creek.

<u>ROSGEN LEVEL I CLASSIFICATION</u>

This segment is classified as a Rosgen Level I G-type channel (Table CAWG 1-21).

<u>MESOHABITAT</u>

Mesohabitats in this Rosgen G channel were composed of Hawkins slow water habitat type scour pool (47.8 percent) and fast water habitat types turbulent (29.4 percent) and nonturbulent (22.5 percent) (Figure CAWG 1-10). Dammed pool habitat was a very small component of the total. The predominant USFS-R5 habitat types included pool habitats composed of step pool (30.5 percent), lateral scour pool (14.3 percent), and mid-channel pool (2.3 percent). The other major types were high gradient riffle (22.9 percent); and flatwater habitats composed of pocket water (14 percent) and step run (7.1 percent) (Figure CAWG 1-11 and Map CAWG 1-12). There were small components of additional habitats, as well.

POOL DEPTH

Many pools were deep, with the most frequent average pool depth in the three to four foot depth range and some deeper (Figure CAWG 1-12). Less than half of the pools were shallower than three feet and slightly more than half were deeper.

WOOD COUNT

Most of the habitat units in this segment of the South Fork San Joaquin did not have large woody debris (> six inches) (Table CAWG 1-22). However, 15 habitat units had one to five pieces of large woody debris and two had more at the time of this survey.

COVER SUMMARY

Average weighted cover in this reach was primarily bedrock (27 percent), boulder/cobble (23 percent), with some surface turbulence (11 percent) (Table CAWG 1-23).

CANOPY SUMMARY

Over half of this reach had no canopy cover (Table CAWG 1-24). Most of the rest of the reach units had small amounts of canopy composed primarily of softwood, and a few units had up to 40 percent canopy cover composed of softwood or hardwood.

FISH BARRIERS

Three barriers to upstream fish migration were identified (Table CAWG 1-25). All three are waterfalls. The first two waterfalls are located 4,332 and 3,140 feet upstream of Hoffman Creek in cascade and step pool habitats respectively, and form complete barriers to upstream migration only at low flows. These two waterfalls are 12 feet and eight feet in height, respectively. The third waterfall is located 2,839 feet upstream of Hoffman Creek in a cascade and was evaluated as forming a complete barrier to migration at all flows. This barrier had a height of 36 ft.

DOMINANT SUBSTRATES

The dominant substrates were primarily boulder (averaging 41 percent) and bedrock (averaging 29 percent) (Table CAWG 1-26). Additional dominant substrates included sands (averaging 14 percent), fines and cobble.

SPAWNING GRAVEL

This reach of the South Fork San Joaquin River had less spawning gravel than in the B channel type in the reach upstream, most of it located in step pool or pocket water habitat (Table CAWG 1-27). A small portion was located in lateral scour pool, low gradient riffles and step run. Gravels were generally of fair to poor quality.

SIDE CHANNELS

No side channels were observed in this segment of the South Fork San Joaquin River.

2.3.2.5 SFSJR - Upstream of Hoffman Creek to San Joaquin River/South Fork Confluence

INTRODUCTION

This segment of the South Fork San Joaquin River was evaluated from upstream of the confluence with Hoffman Creek to the confluence with the San Joaquin River for a length of 37,586 feet (Map CAWG 1-4). The South Fork San Joaquin River has an elevation of 5,150 feet above MSL upstream of Hoffman Creek, then drops to an elevation of 3,721 feet above MSL at the confluence with the San Joaquin River.

This reach consisted primarily of Rosgen Level I G channel with a small length of B channel. The G channel area included nearly equal amounts of turbulent, nonturbulent, and dammed pool habitat types. Dammed pool habitats were the most common on the reach. In the B channel area, large mid-channel pools and dammed pools were the predominant habitat type comprising 79 percent of the habitat combined. Substrates in this reach were dominated by boulders and bedrock, with cobbles found in more localized areas.

ROSGEN LEVEL I CLASSIFICATION

The dominant Rosgen Level I channel type for this reach is classified as G-type channel (86.2 percent); two short segments of B -type channel occur upstream of the confluence with the San Joaquin River (13.7 percent) (Table CAWG 1-28).

MESOHABITAT

This segment of the South Fork San Joaquin River was not habitat mapped on the ground due to access and safety concerns. Mapping from aerial photography, video, and overflight indicated that pools and flatwater habitats were dominant features of this segment. This method does not provide for the level of detail that can be obtained on the ground. However, major mesohabitat types could be resolved. Figure CAWG 1-13 indicated that the Rosgen G-type channel, was dominated by pool habitats (45 percent); pool habitats were comprised of dammed pool (29 percent) and scour pool (16 percent). Fast water turbulent (27 percent) and nonturbulent (28 percent) habitats accounted for the remainder of the observed habitat. Among the USFS R5 habitat types, dammed pool habitat (28 percent) was the most abundant habitat observed; other pool habitats included mid-channel pool (14 percent), corner pool (two percent) and plunge pool (one percent). Turbulent habitats included cascade (16 percent) and riffle (11 percent). Nonturbulent habitats included pocket water (17 percent) and run (11 percent) (Figure CAWG 1-14 and Map CAWG 1-12).

In the Rosgen B channel, Hawkins slow water habitats scour and dammed pool, accounted for the majority of the observed reach (79 percent, combined). Turbulent and nonturbulent habitat types were also observed for the reach (16 and five percent, respectively) (Figure CAWG 1-13). The scour and dammed pools consisted of USFS R5 mid-channel pool (40 percent) and dammed pool (39 percent), respectively. Other fast water turbulent habitats included riffle cascade (12 percent) and riffle (four percent). Nonturbulent habitats consisted of runs (five percent) (Figure CAWG 1-14 and Map CAWG 1-12).

SUBSTRATE

Major substrate types were characterized as part of the CAWG 2 Geomorphology Study. From the confluence with the San Joaquin River to a distance of 1.5 River Miles upstream, the substrate was dominated by boulders overlaying bedrock. From River Mile 1.5 upstream to River Mile 1.9 cobble was the dominant bed element. From River Mile 1.9 to upstream of the confluence with Hoffman Creek at River Mile 5.4 boulders were the dominant bed elements over bedrock.

2.3.3 SFSJR PROJECT-AFFECTED TRIBUTARIES

2.3.3.1 Tombstone Creek

INTRODUCTION

Tombstone Creek is a tributary on the eastern side of the South Fork San Joaquin River downstream of Florence Lake. It is a very steep, granitic stream until it flattens out through its lower reach in Jackass Meadow. Tombstone Creek Diversion, located across Tombstone Creek approximately one mile northeast of Florence Lake, is a masonry diversion, five feet high. The crest, at elevation 7,673 feet above MSL, is 26.4 feet long. This diversion is not currently in operation. Formerly, diverted water was conveyed through a combination of 14-inch-diameter steel pipe and natural channel 3,300 feet long to Florence Lake. Flow through the conduit is controlled by a manually operated 24-inch-diameter head gate located on the upstream face of the diversion.

Tombstone Creek was evaluated for a length of 1,535 feet above the diversion and a total length of 6,464 feet below the diversion (Map CAWG 1-2). Approximately 3,685 feet of the stream channel crosses Jackass Meadow before flowing into the SFSJR. Upstream of Jackass Meadow the channel climbs steeply. Tombstone Creek has an elevation of 8,372 feet above MSL at the upstream end, drops to an elevation of 7,923 feet above MSL at the Tombstone Creek Diversion, then drops to an elevation of 7,234 at Jackass Meadow. The confluence of Tombstone Creek with the South Fork San Joaquin River is at an elevation of 7,185 feet above MSL.

Tombstone Creek contains two Rosgen Level I channel types. The upstream portion of Tombstone Creek, both above and below the diversion, consists of Rosgen Aa+ channel type. This reach is a very steep, shaded, bedrock/boulder portion of the stream. The downstream portion of the stream below the diversion, and lower Aa+ channel reach, is a reach of Rosgen C/E channel, which flows through Jackass Meadow. Much of the Aa+ channel areas are composed of cascade or bedrock sheet that may reduce the habitat value for fish. However, a fair amount of step run habitat and smaller components of more complex habitat types were observed, as well as a variety of dominant substrates, cover types and small woody debris.

The lower gradient C/E channel differed considerably from the Aa+ channel and was composed predominantly of run and pool habitat. Deep pools were observed below the diversion. Some spawning gravels were observed, much of them in run, step run and low gradient riffle habitat. There was no barrier to upstream fish migration other than the diversion, itself. The portion of Tombstone Creek that flows through Jackass Meadow contains habitat that is relatively rare in this portion of the watershed, with a low gradient stream channel and substantial amounts of fine sediments.

ROSGEN LEVEL I CLASSIFICATION

Tombstone Creek consists of two Rosgen Level I channel types. The entire reach above the diversion is classified as an Aa+-type channel (Table CAWG 1-29). The reach directly below the diversion is classified as an Aa+-type channel (39.5 percent of the stream below the diversion), with the lower reach classified as C/E-type channel (60.5 percent of the stream below the diversion) as it flows through Jackass Meadow (Table CAWG 1-30).

MESOHABITAT

The Rosgen Aa+ channel above the diversion was composed of Hawkins fast water habitat types turbulent (70 percent) and nonturbulent (22.7 percent) (Figure CAWG 1-15). Scour pool (7.4 percent) was a smaller component. This reach was predominantly composed of USFS-R5 habitat type cascade (51 percent), as well as step run (19.7 percent) (Figure CAWG 1-16 and Map CAWG 1-10), bedrock sheet (9.6 percent), and high gradient riffle (9.3 percent). Additional components included step pool, run, and mid channel pool.

The Rosgen Aa+ channel below the diversion was predominantly composed of Hawkins fast water habitat types turbulent (45.1 percent) and nonturbulent (39.6 percent), and a smaller component of scour pool (15.2 percent). This reach was composed of a variety of USFS-R5 habitat types including step run (37.6 percent), cascade (24.6 percent), step pool (14.0 percent), bedrock sheet (12.4 percent) and high gradient riffle (8.1 percent). There were very small components of run and plunge pool.

The Rosgen C/E channel below the diversion was predominantly composed of Hawkins fast water habitat type nonturbulent (71.8 percent), with a fair amount of scour pool (26.6 percent). Turbulent habitat was only a very small component of the total. This reach was predominantly composed of USFS-R5 habitat type run (60.7 percent), as well as mid channel pool (23.2 percent) and step run (11.2 percent).

Additional small components included step pool and corner pool, as well as low gradient riffle.

POOL DEPTH

The Rosgen Aa+ channels above and below the diversion had few pools (only two above the diversion) and the average pool depths were shallow. A greater number of pools were observed in the Rosgen C/E-type channel crossing Jackass Meadow. Many of these pools were in the one to two foot average depth range, but a fair number were in the zero to one and two to three foot depth ranges and one pool was deeper (Figure CAWG 1-17).

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Tombstone Creek.

COVER SUMMARY

A variety of cover types were present in Tombstone Creek. Average weighted cover in the Rosgen Aa+ channel above the diversion was composed primarily of woody debris (34 percent) and boulder/cobble (24 percent), with small amounts of surface turbulence (Table CAWG 1-31).

Average weighted cover in the Rosgen Aa+ channel below the diversion was composed primarily of woody debris (25 percent) and boulder/cobble (17 percent), with smaller amounts of terrestrial vegetation (seven percent), surface turbulence (six percent), undercut banks, root wad, aquatic vegetation and bedrock (Table CAWG 1-32).

Average weighted cover in the Rosgen C/E channel was predominantly woody debris (22 percent), terrestrial vegetation (13 percent) and aquatic vegetation (12 percent), as well as root wad (seven percent) and undercut banks (three percent).

CANOPY SUMMARY

Canopy cover above the diversion was 40 to 70 percent (Table CAWG 1-33) and composed mostly of hardwood. Canopy cover below the diversion was mostly in the one to 10 percent and 60 to 80 percent ranges, but many units had more or less than this (Table CAWG 1-34). Canopy cover was mostly composed of hardwood.

FISH BARRIERS

No barriers to fish migration were identified in Tombstone Creek, other than the diversion itself.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were primarily sands (averaging 28 percent) and boulders (averaging 24 percent) (Table CAWG 1-35). Additional dominant substrates included bedrock (16 percent) and gravel (averaging 13 percent). The dominant substrates in the Rosgen Aa+ channel below the diversion were bedrock (averaging 28 percent), sands (averaging 17 percent), boulders (averaging 15 percent) and cobble (averaging 13 percent) (Table CAWG 1-36). Additional dominant substrates included gravel and fines.

The dominant average substrate in the Rosgen C/E channel below the diversion were fines (averaging 56 percent) and sands (averaging 32 percent), with a small amount of gravel.

SPAWNING GRAVEL

The reach above the Tombstone Creek diversion had a small amount of spawning gravel, most of it located in step run habitat, with small amounts in high gradient riffle and run (Table CAWG 1-37). Gravel in this reach was of fair to poor quality. The Aa+ channel reach below the diversion, which was a longer reach, had more spawning gravel, most of fair to poor quality (Table CAWG 1-38). In the C/E channel reach, a greater amount of gravel was present than in the Aa+ channel. Gravels were of fair to poor quality.

SIDE CHANNELS

No side channels were observed on Tombstone Creek.

2.3.3.2 South Slide Creek

INTRODUCTION

South Slide Creek is a very steep, granitic stream on the eastern side of the South Fork San Joaquin River downstream of Florence Lake (Map CAWG 1-2). The confluence with the South Fork San Joaquin is located just south of North Slide Creek. South Slide Creek Diversion, located at a point where there is a natural change in channel slope, diverts water to Florence Lake.

South Slide Creek Diversion, located across South Slide Creek, is a five-foot high masonry diversion. The crest, at elevation 7,501.5 feet above MSL, is 22 feet long. Diverted water is conveyed through eight-inch-diameter steel pipes between the diversion to a wye branch, and thence, through 12-inch-diameter steel pipe, 1,028 feet to a point where it discharges into Hooper Creek conduit. Manually operated 14-inch-head gates located on the upstream face of the diversion control flow through the conduits. The diversion is currently out of operation.

South Slide Creek was evaluated for a length of 1,531 feet above the diversion and a length of 1,824 feet below the diversion. The most upstream location surveyed in

South Slide Creek has an elevation of 8,176 feet above MSL. The stream drops to an elevation of 7,590 feet above MSL at the diversion, then drops to an elevation of 7,160 feet above MSL at the confluence with the South Fork San Joaquin River.

South Slide Creek consists of Rosgen Level I Aa+ channel type. Below the diversion the stream is a very steep, bedrock/boulder stream. Much of it is cascade or bedrock sheet that may limit the habitat value of this stream. However, smaller components of more complex habitat types were observed as well as some small woody debris that could provide cover. No pools were observed. Small amounts of spawning gravel were observed and there were no barriers to upstream fish migration other than the diversion.

ROSGEN LEVEL I CLASSIFICATION

South Slide Creek is classified as a Rosgen Level I Aa+-type channel (Table CAWG 1-39).

MESOHABITAT

The reach above the diversion was inaccessible and was not characterized further. The reach below the diversion was composed of Hawkins fast water habitat types turbulent (58.1 percent) and nonturbulent (38 percent) (Figure CAWG 1-18), with the remainder not classified (3.8 percent). This reach was predominantly composed of USFS-R5 habitat types step run (37 percent) (Figure CAWG 1-19 and Map CAWG 1-10), cascade (33.8 percent), and bedrock sheet (17.1 percent), with a smaller component of high gradient riffle (7.2 percent). Additional components included road-crossing and run. No pool habitat was identified.

POOL DEPTH

No pools were found in South Slide Creek.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in South Slide Creek.

COVER SUMMARY

Average weighted cover in the reach below the diversion was composed primarily of boulder/cobble (14 percent) and woody debris (12 percent) (Table CAWG 1-40), with smaller amounts of surface turbulence, terrestrial vegetation and aquatic vegetation.

CANOPY SUMMARY

Canopy cover in the reach below the diversion was evenly distributed in categories between zero to 80 percent and composed of hardwood (Table CAWG 1-41).

FISH BARRIERS

No barriers to upstream fish migration were identified in South Slide Creek, other than the diversion.

DOMINANT SUBSTRATES

The dominant substrates were primarily boulders (averaging 24 percent), cobble (averaging 22 percent), with some sands (averaging 14 percent) and bedrock (averaging 11 percent) (Table CAWG 1-42). Additional dominant substrates included very small components of fines and gravel.

SPAWNING GRAVEL

The Rosgen Aa+ channel in South Slide Creek had a small amount of spawning gravel, most of it located in cascades (50 square feet) (Table CAWG 1-43) and a small amount in step runs (10 square feet). Most of the gravel was of poor quality.

SIDE CHANNELS

A side channel was observed in one out of 16 habitat units, for a total length of 83 feet of side channel in 1,824 feet of stream length evaluated. The side channel unit was a high gradient riffle.

2.3.3.3 North Slide Creek

INTRODUCTION

North Slide Creek is a tributary on the eastern side of the South Fork San Joaquin River downstream of Florence Lake. The confluence with the South Fork San Joaquin is located just north of South Slide Creek (Map CAWG 1-2). It is a very steep, granitic stream with a pond at its upstream end. The North Slide Creek Diversion, located at a point where there is a natural change in channel slope, diverts water to Florence Lake.

North Slide Creek Diversion, located across North Slide Creek approximately two miles north of Florence Lake, is a masonry diversion, five feet high. The crest, at elevation 7,501.5 feet above MSL, is 19 feet long. Diverted water is conveyed through eight-inch-diameter steel pipes between the diversion to a wye branch, and thence, through 12-inch-diameter steel pipe 1,028 feet to a point where it discharges into Hooper Creek conduit. Manually operated 14-inch-head gates located on the upstream face of the diversion control flow through the conduits. This diversion is currently out of operation.

North Slide Creek was evaluated for a length of 1,531 feet above the North Slide Creek Diversion and a length of 1,951 feet below the diversion. North Slide Creek has an elevation of 8,294 feet above MSL at the upstream end, drops to an elevation of 7,590 above MSL at the North Slide Creek Diversion, then drops to an elevation of 7,154 feet above MSL at the confluence with the South Fork San Joaquin River.

North Slide Creek below the diversion is a very steep, bedrock/boulder stream with a Rosgen Aa+ channel. It is predominantly cascade or bedrock sheet habitat that may limit the habitat value of this stream. Only small components of more complex habitat types were observed. Large woody debris was observed, but no pools or spawning gravel. A small portion was dry. Several barriers to upstream fish migration, including one near the confluence with the river, are likely to fragment fish habitat in this creek.

ROSGEN LEVEL I CLASSIFICATION

North Slide Creek is classified as a Rosgen Level I Aa+-type channel. It has a very steep channel slope, particularly in the reach above the diversion (Table CAWG 1-44).

MESOHABITAT

The reach above the diversion was inaccessible and was not characterized further. The reach below the diversion was composed predominantly of Hawkins fast water habitat type turbulent (85 percent) with the remainder nonturbulent (6.9 percent) (Figure CAWG 1-20) or not classified (8.1 percent). The reach was predominantly composed of the USFS-R5 habitat type cascade (71.9 percent). Additional components included high gradient riffle (13.1 percent) and step run (6.9 percent) (Figure CAWG 1-21 and Map CAWG 1-10), and some of the creek was dry (5.5 percent). No pool habitat was identified.

POOL DEPTH

No pools were found in North Slide Creek.

WOOD COUNT

Well over half of the habitat units had large woody debris (> six inches) at the time of this survey (Table CAWG 1-45). Four habitat units had one to five pieces of large woody debris and two units had five to 10 pieces.

COVER SUMMARY

Average weighted cover was composed of terrestrial vegetation (16 percent), boulder/cobble (16 percent), surface turbulence (13 percent) (Table CAWG 1-46) and woody debris (11 percent).

CANOPY SUMMARY

Most of the reach below the diversion had some canopy cover, primarily in the 60 to 70 percent or 80 to 90 percent ranges, although some units had less or none (Table CAWG 1-47). Canopy cover was composed mostly of hardwood.

FISH BARRIERS

Four barriers to upstream fish migration were identified in the reach below the diversion (Table CAWG 1-48). One is a dry stream channel beginning at 1,209 feet upstream of the confluence with the South Fork San Joaquin River that forms a complete barrier to migration only at low flows. Two are waterfalls located at 1,067 feet and 17 feet upstream of the confluence in cascades. They form complete barriers to upstream migration at all flows. The heights of these two waterfalls are 20 feet and 15 feet in height, respectively. Between these two waterfalls is a road crossing located 326 feet upstream of the confluence that is a complete barrier to migration at all flows. The diversion, when in operation, likely serves as a complete barrier to upstream migration.

DOMINANT SUBSTRATES

The dominant substrates were boulders (averaging 34 percent), with some sands (averaging 17 percent) and cobble (averaging 13 percent) (Table CAWG 1-49). Additional dominant substrates included fines and gravel.

SPAWNING GRAVEL

No spawning gravels were observed in North Slide Creek.

SIDE CHANNELS

No side channels were observed in North Slide Creek.

2.3.3.4 Hooper Creek

INTRODUCTION

Hooper Creek is a tributary on the eastern side of the South Fork San Joaquin River between Florence Lake and Bear Creek. It is a steep, granite bedrock stream with several tributaries of its own. Hooper Creek Diversion is located at a point where there is a natural change in channel slope.

Hooper Creek Diversion, located across Hooper Creek approximately three miles north of Florence Lake, is a 30 foot high concrete diversion. The crest, at elevation 7,507 feet above MSL, is 158 feet long. The spillway, which is an overpour type located on the left side of the diversion, is 75 feet long with a crest elevation at 7,505 feet above MSL. Diverted water is conveyed through a 34-inch diameter, 13,097 foot-long, steel pipe to Florence Lake. Flow through the conduit is controlled by a manually operated 48-inch head gate located on the upstream face of the diversion.

Hooper Creek was evaluated for a length of 1,025 feet above the Hooper Creek Diversion and a length of 4,167 feet below the diversion to the confluence with the South Fork San Joaquin River (Map CAWG 1-2). Hooper Creek has an elevation of 7,745 feet above MSL at the upstream end then drops to an elevation of 7,014 feet above MSL at the confluence with the South Fork San Joaquin River.

Hooper Creek is a very steep, bedrock stream with a Rosgen Aa+ channel. Most habitats are cascade or bedrock sheet that may limit the habitat value of this stream. Pools were shallow. Habitats upstream of the diversion were dominated by bedrock sheet, which has little habitat value. Downstream of the diversion, cascades were more abundant than bedrock sheet. Spawning gravel was observed, but only small amounts in riffles and pools. Except for the diversion and one barrier above the diversion, all barriers to upstream fish migration were complete barriers only at low flows.

ROSGEN LEVEL I CLASSIFICATION

Hooper Creek is classified as a Rosgen Level I Aa+-type channel (Tables CAWG 1-50 and 1-51).

MESOHABITAT

The reach above the diversion was primarily composed of Hawkins fast water habitat type turbulent (97.9 percent) (Figure CAWG 1-22). Slow water habitat type scour pool (2.1 percent) was a very small component. This reach was predominantly composed of USFS-R5 habitat type bedrock sheet (80.8 percent), with small components of high gradient riffle (7 percent) and cascade (6.5 percent) (Figure CAWG 1-23 and Map CAWG 1-10). There also were small components of low gradient riffle and lateral scour pool.

The reach below the diversion also was predominantly composed of Hawkins fast water habitat type (turbulent 90.1 percent), with the remainder composed of slow water habitat types including scour pool (6.6 percent) and dammed pool (1.6 percent). This reach was predominantly composed of USFS-R5 habitat type cascade (66.5 percent). There were smaller amounts of high gradient riffle (15.1 percent) and bedrock sheet (7.5 percent) and only small components of pool (lateral scour pool, dammed pool and mid channel pool), run, and low gradient riffle.

POOL DEPTH

The reach above the diversion had many pools, but only two pools were observed below the diversion. Average pool depths were shallow, predominantly in the one to two foot depth range (Figure CAWG 1-24).

WOOD COUNT

Large woody debris (> six inches) was not observed in Hooper Creek above the diversion at the time of this survey (Table CAWG 1-52). In the reach below the diversion, two habitat units had one to five pieces of large woody debris and one unit had 10 to 15 pieces (Table CAWG 1-53).

COVER SUMMARY

Average weighted cover in the reach above the diversion was composed primarily of surface turbulence (43 percent), with smaller amounts of boulder/cobble (14 percent), woody debris and terrestrial vegetation (Table CAWG 1-54). Average weighted cover in the reach below the diversion was composed primarily of surface turbulence (32 percent) and boulder/cobble (25 percent), with small amounts of terrestrial vegetation and woody debris (Table CAWG 1-55).

CANOPY SUMMARY

All of the reach above the diversion had some canopy cover, primarily in the one to 20 percent or 40 to 70 percent ranges (Table CAWG 1-56). Canopy cover was composed mostly of hardwood. Most of the reach below the diversion had canopy cover in various categories (Table CAWG 1-57). Canopy cover was generally composed of hardwood in the higher categories, and softwood in the lower categories.

FISH BARRIERS

One barrier to upstream fish migration was identified in the reach above Hooper Creek Diversion (Table CAWG 1-58). It was a waterfall located 1,025 feet above the diversion in a lateral scour pool. It has a height of 25 feet and is a complete barrier to upstream fish migration at all flows. The diversion also forms a complete barrier to upstream fish migration.

Five barriers to upstream fish migrations were identified in the reach below the diversion (Table CAWG 1-59). All five barriers were located in cascade habitats and are complete barriers to migration only at low flows. One was a waterfall located 3,201 feet upstream of the confluence with the South Fork San Joaquin River with a height of five feet. The next barrier was a section of stream with insufficient depth located 2,517 feet upstream of the confluence. The third barrier was a waterfall five feet high located 2,084 feet upstream of the confluence. The fourth and fifth barriers were sections of stream with insufficient depth located 781 feet upstream of the confluence and at the confluence respectively.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were cobble (averaging 33 percent) and bedrock (averaging 26 percent) (Table CAWG 1-60). Additional dominant substrates included boulders, sands, and gravel. The largest dominant substrates in the reach below the diversion were boulders (averaging 51 percent) and cobble (averaging 22 percent) (Table CAWG 1-61). Additional dominant substrates included sands, bedrock, and gravel.

SPAWNING GRAVEL

In the reach above the diversion, low gradient riffles had 15 square feet of spawning gravel and lateral scour pools had three square feet (Table CAWG 1-62). These gravels were fair to good in quality. A greater amount of spawning gravel was observed in the reach below the diversion, which was about four times longer (Table CAWG 1-63). Most of it was located in cascades (85 square feet) and dammed pools (55 square feet), with small amounts in high gradient riffles, lateral scour pools, runs, and low gradient riffles. Gravels below the diversion were fair to good in quality.

SIDE CHANNELS

No side channels were observed in Hooper Creek.

2.3.3.5 Crater Creek

INTRODUCTION

Crater Creek is located on the south side of the South Fork San Joaquin River between Florence Lake and Bear Creek. It is a steep, granitic channel until it flattens out near the confluence with the South Fork San Joaquin River through Hell Hole Meadow. Crater Creek Diversion is located at a point where there is a natural change in channel slope.

Crater Creek Diversion, located across Crater Creek approximately one mile west of Florence Lake, is a concrete diversion, three feet high. The crest, at elevation 8,764.6 feet above MSL, is 21 feet long. Diverted water is conveyed through a combination of ditch and natural channel, 7,260 feet long, to Florence Lake.

Crater Creek was evaluated for a length of 1,515 feet above the diversion and a total length of 18,161 feet below the diversion (Map CAWG 1-2). Crater Creek has an elevation of 8,930 feet above MSL at the upstream end, drops to an elevation of 8,762 feet above MSL at the Crater Creek Diversion, then drops to an elevation of 6,865 at the upstream end of Reach 2 BD. The confluence of Crater Creek with the South Fork San Joaquin River is at an elevation of 6,814 feet above MSL.

Crater Creek is a steep, bedrock stream with primarily Rosgen Aa+ channel, above and below the diversion, and a short segment of Rosgen C/E channel below the diversion and near the confluence with the South Fork San Joaquin River. Much of it is cascade and step run. The large percentage of cascade habitat above the diversion may limit the habitat value for fish in this reach. However, in the reach below the diversion, several of the more complex habitat types were observed, and the Rosgen C/E channel had a substantial amount of pool habitat. Pools were shallow. A fair amount of large woody debris, large amounts of spawning gravel, and substrates dominated by fines, sands or gravels were observed. The barriers to upstream fish migration in the lower portion of the creek, which contain the more valuable fish habitat, are barriers only at low flows.

ROSGEN LEVEL I CLASSIFICATION

Crater Creek consists of two Rosgen Level I channel types. The reach above the diversion is classified as an Aa+-type channel. The reach below the diversion is classified as an Aa+-type channel (85.1 percent) until it flattens out into a wider C/E-type channel (14.9 percent) (Tables CAWG 1-64 and 1-65) near the confluence of the South Fork San Joaquin River.

MESOHABITAT

The channel above the diversion was composed of predominantly of Hawkins fast water habitat types turbulent (76.7 percent) and nonturbulent (22.7 percent) (Figure CAWG 1-25). Scour pool (1.6 percent) was a small component. This reach was predominantly composed of USFS-R5 habitat type cascade (76.7 percent), as well as step run (21.7 percent). Lateral scour pool was only a small component (1.6 percent).

The Rosgen Aa+-type channel below the diversion was predominantly composed of Hawkins fast water habitat type turbulent (55.1 percent), as well as components of scour pool (27 percent) and nonturbulent (17.4 percent). Dammed pool was a very small component. This reach was composed of USFS-R5 habitat types cascade (29.8 percent), step pool (21.6 percent), step run (15.4 percent) (Figure CAWG 1-26 and Map CAWG 1-10), high gradient riffle (12.8 percent), and bedrock sheet (12.6 percent). Additional smaller components included pool habitats (lateral scour pool, plunge pool, corner pool, dammed pool), run and glide.

The Rosgen C/E-type channel below the diversion was composed of Hawkins fast water habitat type nonturbulent (55 percent) and a large amount of scour pool (44.3 percent). Turbulent habitat (0.7 percent) was only a small component. This reach was predominantly composed of USFS-R5 habitat type run (55 percent), and pool habitats composed of lateral scour pool (37.8 percent) and mid channel pool (6.4 percent). Low gradient riffle was a very small component.

POOL DEPTH

Pools in Crater Creek were shallow. The Rosgen Aa+-type channel reach above the diversion had one shallow pool. The Rosgen Aa+-type channel reach below the diversion had many shallow pools, with most of the average pool depths in the zero to one foot and one to two foot depth ranges. The Rosgen C/E-type channel had many pools, all with an average depth of less than two feet (Figure CAWG 1-27).

WOOD COUNT

A fair amount of large woody debris (> six inches) (Table CAWG 1-66) was observed on Crater Creek at the time of this survey. In the Rosgen Aa+ channel above the diversion, two of the four habitat units had one to five pieces of large wood debris and one unit had 15 to 20 pieces. In the Rosgen Aa+ channel below the diversion, many habitat units had one to five pieces of large woody debris, and a few had more (Table CAWG 1-67).

In the Rosgen C/E channel below the diversion, over half of the habitat units had large woody debris, generally one to five pieces, but several had more, up to the 30 to 35 piece category (Table CAWG 1-68).

COVER SUMMARY

Average weighted cover in the Rosgen Aa+ channel above the diversion was composed primarily of boulder/cobble (56 percent) and surface turbulence (31 percent) (Table CAWG 1-69), with smaller amounts of undercut banks and woody debris (six percent each). Average weighted cover in the Rosgen Aa+ channel below the diversion was composed primarily of boulder/cobble (29 percent) and surface turbulence (21 percent), with smaller amounts of terrestrial vegetation (13 percent), woody debris, aquatic vegetation and undercut banks (Table CAWG 1-70).

Average weighted cover in the Rosgen C/E channel was composed primarily of woody debris (22 percent) and terrestrial vegetation (18 percent), with small amounts of boulder/cobble, aquatic vegetation, undercut banks and surface turbulence.

CANOPY SUMMARY

Most of Crater Creek above the diversion had no canopy cover, with one of the four habitat units in the one to 10 percent range (Table CAWG 1-71). Canopy cover was composed of softwood. Canopy cover below the diversion, including the Rosgen Aa+ and C/E channels, was mostly in the zero to 30 percent ranges, but some units had up to 80 percent (Table CAWG 1-72). Canopy cover was predominantly composed of hardwood.

FISH BARRIERS

Seven barriers to upstream fish migration were identified (Table CAWG 1-73) in the Rosgen Aa+-type channel below the diversion. One is a waterfall 20 feet high located 12,824 feet upstream of the confluence with the South Fork San Joaquin River (in the 18,161 feet long reach below the diversion) in a cascade. It is a complete barrier to migration at all flows. The second is a section of cascade with insufficient depth located 9,490 feet upstream of the confluence. It is a complete barrier to upstream migration only at low flows. The next two are waterfalls located 8,022 feet and 7,607 feet upstream of the confluence in bedrock sheet and cascade habitats and 25 feet and 10 feet in height, respectively. They are both complete barriers to upstream migration at all flows. The remainder of the barriers in the downstream reaches were complete barriers to migration only at low flows. The fifth and sixth barriers are sections of stream with insufficient depth located 6,624 and 3,340 feet upstream of the confluence in plunge pool and lateral scour pool habitat respectively. The final barrier is a waterfall 12 feet high located 2,809 feet upstream of the confluence in a lateral scour pool.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were boulders (averaging 63 percent) and cobble (averaging 20 percent) (Table CAWG 1-74). The dominant substrates in the Rosgen Aa+-type channel below the diversion were boulders (averaging 41 percent) and sands (averaging 18 percent), with smaller amounts of cobble, bedrock and gravel (Table CAWG 1-75).

The dominant substrate in the Rosgen C/E-type channel were sands (averaging 56 percent) and gravels (averaging 16 percent), with small amounts of boulders, fines and cobble.

SPAWNING GRAVEL

In the reach above the diversion, 50 square feet of good quality spawning gravel was located entirely in step runs (Table CAWG 1-76). Large amounts of spawning gravel were observed over many habitat types in the reaches below the diversion, which were much longer (Table CAWG 1-77). In the Rosgen Aa+ channel reach gravels of good quality were common and fair quality less so. In the C/E channel good to excellent gravels were prevalent. Spawning gravel was located primarily in step runs, with fair amounts in runs, lateral scour pools, and step pools. Smaller amounts were located in cascades, high gradient riffles, plunge pools and dammed pools, bedrock sheets, glides, and a very small amount in a low gradient riffle.

SIDE CHANNELS

Side channels were observed below the diversion in two out of 153 habitat units, for a total length of 259 feet of side channel in 18,161 feet of stream length evaluated. The side channel units were cascade and bedrock sheet.

2.3.3.6 Crater Creek Diversion Channel

INTRODUCTION

The Crater Creek Diversion Channel connects Crater Creek Diversion to Florence Lake. It is a steep channel flowing over granitic bedrock.

The Crater Creek Diversion Channel was evaluated for a length of 9,486 feet between the Crater Creek Diversion and Florence Lake. The Crater Creek Diversion Channel has an elevation of 8,762 feet above MSL at the Crater Creek Diversion, then drops to an elevation of 7,343 feet above MSL at the confluence with Florence Lake (Map CAWG 1-2).

The Crater Creek Diversion Channel is a steep, bedrock stream with a Rosgen Aa+ channel. Much of the habitat is cascade or bedrock sheet that may limit the habitat value of this stream. However, small components of the more complex habitat types were observed. Pools were very shallow and no large woody debris was observed. Partial canopy cover was present in many habitat units. Spawning gravels of poor to fair quality were distributed over many habitat types, and barriers to fish migration were present that may not block migration at all flows.

ROSGEN LEVEL I CLASSIFICATION

The Crater Creek Diversion Channel is classified as a Rosgen Level I Aa+-type channel (Table CAWG 1-78).

MESOHABITAT

This channel was composed of predominantly of Hawkins fast water habitat types turbulent (57.7 percent) and nonturbulent (32.3 percent) (Figure CAWG 1-28). Slow water habitat type scour pool (8.9 percent) was a smaller component and dammed pool was a very small component. This reach was predominantly composed of USFS-R5 habitat type bedrock sheet (32.5 percent), cascade (22.9 percent), and step run (27.9 percent) (Figure CAWG 1-29 and Map CAWG 1-10). Pool habitat was primarily step pool, with smaller components of mid channel pool, lateral scour pool, backwater pool and plunge pool. Three were also small components of high and low gradient riffles, run, and road crossing.

POOL DEPTH

There were many shallow pools, with most average pool depths in the zero to one foot depth range (Figure CAWG 1-30).

WOOD COUNT

Large woody debris (> six inches) was not observed in the Crater Creek Diversion Channel at the time of this survey.

COVER SUMMARY

Average weighted cover in this reach was primarily boulder/cobble (26 percent), and woody debris (18 percent) (Table CAWG 1-79), with smaller amounts of terrestrial vegetation, surface turbulence, bedrock, root wad and undercut banks.

CANOPY SUMMARY

Much of the Crater Creek Diversion Channel had some canopy cover (Table CAWG 1-80), primarily in the range categories between one to 60 percent, with some units having up to 80 percent. Canopy cover was a mixture of hardwood and softwood.

FISH BARRIERS

Two barriers to fish migration were identified (Table CAWG 1-81). One is a waterfall located 1,245 feet upstream of Florence Lake in a cascade with a height of 4.2 feet and is a partial barrier to upstream migration at all flows. The other is a road crossing located 445 feet upstream of Florence Lake and is a partial barrier to migration only at low flows.

DOMINANT SUBSTRATES

The dominant substrates were bedrock (averaging 22 percent), cobble (averaging 20 percent), and boulders (averaging 16 percent) (Table CAWG 1-82), with a small amounts of sands, and gravel.

SPAWNING GRAVEL

Spawning gravels were observed over several habitat types (Table CAWG 1-83). Spawning gravel was located primarily in step runs, step pools, and low gradient riffles, with smaller amounts in runs, pools, cascades and high gradient riffles. Poor to fair quality gravels were observed.

SIDE CHANNELS

Side channels were observed in three out of 84 habitat units, for a total length of 386 feet of side channel in the 9,486 feet of stream length evaluated. Two side channel units were step runs and one was bedrock sheet.

2.3.3.7 Bear Creek

INTRODUCTION

Bear Creek is part of a large watershed located on the northeast side of the South Fork San Joaquin River between Florence Lake and Lake Thomas A. Edison. It has a moderate to steep channel that runs through granite bedrock. Bear Creek Diversion, located at a point where there is a natural change in channel slope, forms an impoundment on Bear Creek and diverts water to the Ward Tunnel.

Bear Creek Diversion, located across Bear Creek approximately two miles south of Lake Thomas A. Edison, is a constant-radius, concrete arch diversion, that is 55 feet high. The crest, at elevation 7,356 feet above MSL, is 293 feet-long. The ungated, overpour spillway has an effective length of 232 feet and a crest at elevation 7,350 feet above MSL. Diverted water is conveyed through a seven-by seven-foot cross section, 7,596-foot-long, tunnel through granite into the Mono-Bear Siphon. Flow through the conduit is controlled by a manually operated 7.5-foot-wide by 15-foot-high radial gate, located in the outlet works on the right abutment of the diversion.

Bear Creek was evaluated for a length of 1,556 feet above the Bear Creek Diversion, and a total length of 8,349 feet below the diversion. Bear Creek has an elevation of 7,431 feet at the upstream end and drops to an elevation of 7350 feet at the Bear Creek Diversion. The confluence of Bear Creek with the South Fork San Joaquin River is at an elevation of 6,715 feet above MSL (Map CAWG 1-3).

Bear Creek is a bedrock/boulder stream with Rosgen Level I A and B channels. The channel upstream of the diversion differs from that downstream. The reach upstream of the diversion is of B channel type, while the channel downstream is primarily A channel type. The reach above the diversion has a large amount of riffle, run and pool habitats. Pools above the diversion were shallow, but pools below the diversion were a little deeper. A fair amount of large woody debris was observed. A fair amount of spawning gravel was located in pool and riffle habitat. The only waterfall that formed a complete barrier to upstream fish migration at all flows was located approximately 4,000 feet upstream of the confluence, which blocks fish migration to over half of the creek. The diversion also blocks upstream fish migration.

ROSGEN LEVEL I CLASSIFICATION

Bear Creek consists of two reaches based on Rosgen Level I channel types divided by the diversion. The reach above the diversion is classified as a B-type channel. The reach below the diversion is classified as an A-type channel (Tables CAWG 1-84 and 1-85).

MESOHABITAT

The B channel reach above the diversion was composed of predominantly of Hawkins fast water habitat types turbulent (50 percent) and nonturbulent (37 percent) (Figure CAWG 1-31), with a smaller component of scour pool (13 percent). This reach was composed of USFS-R5 habitat types high and low gradient riffles (26.5 and 23.5 percent respectively), step run (23 percent) (Figure CAWG 1-32 and Map CAWG 1-11), as well as run (13.9 percent) and lateral scour pool (13 percent).

The A channel reach below the diversion was predominantly composed of Hawkins slow water habitat type scour pool (64.1 percent), with smaller components of fast water habitat types turbulent (32.7 percent) and nonturbulent (3.2 percent). This reach was predominantly composed of USFS-R5 habitat types step pool (57.2 percent), and high gradient riffle (30.3 percent). Additional components included lateral scour pool, step run, cascade, bedrock sheet, plunge pool and run.

POOL DEPTH

The reach above the diversion had only two pools and the average pool depths were in the one to two foot depth ranges. The reach below the diversion had many pools and they were generally a little deeper, mostly in the one to two foot and two to three foot depth ranges (Figure CAWG 1-33).

WOOD COUNT

In the reach above the Bear Creek diversion, over half of the habitat units had large woody debris (> six inches) (Table CAWG 1-86) at the time of this survey, in categories ranging from one to fifteen pieces. In the reach below the diversion, most units did not have large woody debris, but six habitat units had one to five pieces of large woody debris, and one had five to 10 pieces (Table CAWG 1-87, also see Appendix C).

COVER SUMMARY

Average weighted cover in the Rosgen B channel above the diversion was composed primarily of boulder/cobble (29 percent) and surface turbulence (27 percent), with smaller amounts of woody debris and terrestrial vegetation (Table CAWG 1-88). Average weighted cover in the reach below the diversion was composed primarily of boulder/cobble (50 percent) and surface turbulence (34 percent), with small amounts of terrestrial vegetation and aquatic vegetation (Table CAWG 1-89).

CANOPY SUMMARY

There was no canopy cover in the reach above Bear Creek diversion. Canopy cover below the diversion was mostly in the zero to 10 percent ranges, but some units had up to 40 percent (Table CAWG 1-90). Canopy cover was predominantly composed of softwood, but hardwood was also well represented.

FISH BARRIERS

Four barriers to upstream fish migration were identified (Table CAWG 1-91) in the reach below the Bear Creek Diversion, in addition to the diversion itself. They were all waterfalls located in step pool habitat. The first waterfall, six feet in height, was located 4,000 feet upstream of the confluence with the South Fork San Joaquin River (in an 8,349-foot long reach) and formed only a partial barrier to migration at low flows. The second waterfall, 12 feet in height, was located five feet downstream of the first waterfall and formed a complete barrier to migration at all flows. The third and fourth waterfalls were located 2,727 and 1,457 feet upstream of the confluence respectively and formed complete barriers to migration at low flows. These waterfalls were six feet and 15 feet in height, respectively and occurred in step-pool habitats. At higher flows, water levels in the step-pools and edgewater habitat may be sufficient to provide some passage.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen B channel above the diversion were boulders and bedrock (averaging 23 percent each), sands (averaging 20 percent), and cobble (averaging 15 percent) (Table CAWG 1-92). The dominant substrate in the Rosgen A channel below the diversion was boulders (averaging 69 percent), with smaller amounts of cobble (averaging 17 percent) and bedrock (Table CAWG 1-93).

SPAWNING GRAVEL

A small amount of spawning gravel was observed in the reach above the diversion in low gradient riffle and run habitat (Table CAWG 1-94). These gravels were of fair quality. A fair amount of spawning gravel was observed in the reach below the diversion, mostly located in step pools, lateral scour pools, and high gradient riffles (Table CAWG 1-95). A small amount also was located in step runs. In the reach below the diversion, gravels were generally of fair to good quality.

SIDE CHANNELS

No side channels were observed in Bear Creek

2.3.3.8 Chinquapin Creek

INTRODUCTION

Chinquapin Creek is a tributary of Camp 62 Creek on the south side of the South Fork San Joaquin River. It is a steep, granitic stream. Chinquapin Creek Diversion is located at a point where there is a natural change in channel slope and diverts water to Ward Tunnel.

Chinquapin Creek Diversion, located across Chinquapin Creek approximately three miles east of Portal Forebay, is a newly constructed diversion. The previous structure was destroyed in the 1997 flood and was rebuilt to a design adapted from the Bolsillo Creek Diversion. The new diversion dam is above Ward Tunnel. An intake shaft was drilled directly into the top of the Ward Tunnel and is located behind the new diversion dam / structure. This facilitated the removal of the existing flow-line. The diversion dam / structure diverts stream flows into this vertical shaft intake. The diversion dam / structure also directs minimum release flow to Station 181 directly below the diversion dam. The shelter and well consist of a 36 inch diameter steel pipe stilling well with an attached metal structure housing the Sutron Recorder / float / shaft encoder system. The stilling well / structure are attached to the diversion dam / metal walkway structure on top of the diversion dam.

The vertical intake shaft does not have a means of regulating flow. A minimum release pipe with regulating butterfly valve originating at the diversion dam above the station regulates flow. The butterfly valve assists in regulating minimum release flows during high flow periods. The spillway is a broad-crested weir located on top of the dam. Diverted flow and spill from Chinquapin Creek are recorded.

Chinquapin Creek was evaluated for a length of 472 feet above the Chinquapin Creek Diversion and a length of 5,370 feet below the diversion to the confluence with Camp 62 Creek (Map CAWG 1-9). Chinquapin Creek has an elevation of 7,761 feet above MSL at the uppermost surveyed point, drops to an elevation of 7,641 feet at the diversion, then drops to an elevation of 6,976 above MSL at the confluence with Camp 62 Creek.

Chinquapin Creek is a steep, bedrock/boulder stream composed of Rosgen Level I Aa+ channel type. Most of the stream consists of step pool, step run or cascade. In the reach below the diversion, only small amounts of other complex habitat types were observed. Pools were shallow. Small amounts of large woody debris and a fair amount of spawning gravels were observed. Only one of the barriers identified, in addition to the diversion, was a complete barrier to upstream fish migration at all flows, but it was located only 785 feet upstream of the confluence with the river and is likely to isolate most of Chinquapin Creek fish habitat from the rest of the watershed.

ROSGEN LEVEL I CLASSIFICATION

Chinquapin Creek is classified as a Rosgen Level I Aa+-type channel both above and below the diversion. Chinquapin Creek has a steep channel slope, particularly above the Chinquapin Creek Diversion (Tables CAWG 1-96 and 1-97).

MESOHABITAT

The reach above the diversion was composed of entirely of Hawkins slow water habitat type scour pool. This reach was composed entirely of USFS-R5 habitat type step pool.

The reach below the diversion was composed of Hawkins slow water habitat type scour pool (40.3 percent), and fast water habitat types nonturbulent (37.5 percent) and turbulent (20.8 percent) (Figure CAWG 1-34). Dammed pool was a very small component. This reach was predominantly composed of USFS-R5 habitat types step run (34.3 percent) (Figure CAWG 1-35 and Map CAWG 1-10), step pool (32.3 percent) and cascade (13.4 percent). Additional components included high gradient riffle, several additional pool types including plunge pool, mid channel pool, lateral scour pool, and dammed pool, as well as a small component of run. There were also small sections of bedrock sheet, low gradient riffle, and road-crossing.

POOL DEPTH

The reach above the diversion had one pool with an average pool depth in the one to two foot range. The reach below the diversion had many shallow pools and almost all of the average pool depths were in the zero to one and one to two foot depth ranges (Figure CAWG 1-36).

WOOD COUNT

In the reach above the Chinquapin Creek Diversion, one habitat unit had large woody debris (> six inches) at the time of this survey, in the one to five pieces category (Table CAWG 1-98). In the reach below the diversion, most units had large woody debris in the one to five pieces category, and one unit had 16 to 20 pieces (Table CAWG 1-99).

COVER SUMMARY

Average weighted cover in the reach above the diversion was composed of surface turbulence and boulder/cobble (50 percent each) (Table CAWG 1-100). Average weighted cover in the reach below the diversion was composed primarily of boulder/cobble (33 percent) and surface turbulence (22 percent), with smaller amounts of terrestrial vegetation and woody debris (Table CAWG 1-101).

CANOPY SUMMARY

There was no canopy cover in the reach above Chinquapin Creek diversion. Canopy cover below the diversion was mostly in the zero to 20 percent ranges, but a third of the habitat units had more, up to 60 percent (Table CAWG 1-102). Canopy cover was composed of softwood and hardwood.

FISH BARRIERS

One barrier to upstream fish migration was identified above the diversion (Table CAWG 1-103). It was a waterfall with a height of 15 feet, located 472 feet upstream of the diversion in a step pool and formed a complete barrier to migration at all flows. The diversion also was a barrier to upstream fish migration.

Four barriers to fish migration were identified in the 5,371-foot long reach below the diversion (Table CAWG 1-104). One was a weir located 2,273 feet upstream of the confluence with Camp 62 Creek in a step pool and formed a complete barrier to migration only at low flows. The second barrier was located 785 feet upstream of the confluence at a plunge pool of four feet in height and was a complete barrier to migration at all flows. The third and fourth were waterfalls located 563 feet and 318 feet upstream of the confluence in step pool and step run habitats respectively. They formed a complete barrier to migration only at low flows and were six feet and eight feet in height, respectively. When the barrier was mapped during the base (low) flow period, it was noted that it was a total barrier at that time, but at higher flows the step-pools and edgewater habitat present may be sufficient to provide some passage.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were boulders (averaging 80 percent) and cobble (averaging 10 percent) (Table CAWG 1-105). The dominant substrates in the reach below the diversion were boulders (averaging 35 percent) and cobble (averaging 26 percent), with smaller amounts of sands, bedrock, and gravel (Table CAWG 1-106).

SPAWNING GRAVEL

There was no spawning gravel in the step pools above the diversion. A fair amount of spawning gravel was observed in the reach below the diversion, mostly located in step runs and step pools, with smaller amounts in runs, high gradient riffles, and pools (Table CAWG 1-107). Gravel quality in the reach below the diversion was generally good with some of fair quality.

SIDE CHANNELS

Side channels were observed below the diversion in three out of 58 habitat units, for a total length of 400 feet of side channel in 5,371 feet of stream length evaluated. The side channel units included two step runs and a mid channel pool.

2.3.3.9 Camp 62 Creek

INTRODUCTION

Camp 62 Creek is a steep, granitic stream on the south side of the South Fork San Joaquin River, located between Bear and Mono creeks. Camp 62 Diversion is located at a point in the stream where there is a natural break in the channel slope.

Camp 62 Diversion, located across Camp 62 Creek approximately two miles east of Portal Forebay, was damaged during the January 1997 flood and was modified before being put back in service using a new shaft to Ward Tunnel. The diversion dam / structure now diverts stream flows into a slanted shaft intake that enters directly into the Ward Tunnel. It also directs minimum release flow to Station 180 directly below the diversion dam. A Sutron 8210 multi-logger / float tape / shaft encoder system is incorporated in the last section of the weir box and is connected to the Sutron unit. The shelter and well is a buffalo metal works 4 x 4 USGS type gauging station. The dam is a concrete structure. Low flow is conveyed through a minimum release pipe and high flow over the weir and dam. Diverted water and spill are recorded.

Camp 62 Creek was evaluated for a length of 1,515 feet above the Camp 62 Creek Diversion and a length of 7,699 feet below the diversion. The most upstream location surveyed in Camp 62 Creek has an elevation of 7,729 feet above MSL. The stream drops to an elevation of 7,371 feet above MSL at the Camp 62 Creek Diversion, then drops to an elevation of 6,523 above MSL at the confluence with the South Fork San Joaquin River (Map CAWG 1-2).

Camp 62 Creek is a steep, bedrock/boulder stream with Rosgen Aa+ channel above and below the diversion. There were fair amounts of complex habitat types as well as a substantial amount of large woody debris and a variety of cover types. There was a fair amount of canopy cover. Pools were shallow. Spawning gravel was observed in several habitat types. Two complete barriers to upstream fish migration at all flows were located in the in the lower portion of the creek, and one was only 413 upstream of the confluence. These were in addition to the diversion itself. This is likely to isolate fish habitat in almost all of Camp 62 Creek from access to upstream migrants from the South Fork San Joaquin River.

Rosgen Level I Classification

Camp 62 Creek above the Camp 62 Creek Diversion is classified as a Rosgen Level I Aa+-type channel and is very steep. Camp 62 Creek below the diversion also is classified as an Aa+-type channel (Tables CAWG 1-108 and 1-109).

Mesohabitat

The reach above the diversion was composed of Hawkins fast water habitat type turbulent (66.2 percent) and slow water habitat type scour pool (27 percent) (Figure CAWG 1-37). Nonturbulent habitat was a smaller component (6.8 percent). This reach was predominantly composed of USFS-R5 habitat type cascade (52 percent), as well as step pool (27 percent) and high gradient riffle (14.2 percent) (Figure CAWG 1-38 and Map CAWG 1-10). Step run was a smaller component.

The reach below the diversion was composed of Hawkins slow water habitat type scour pool (51.8 percent), and fast water habitat types turbulent (38.2 percent) and nonturbulent (8.5 percent). Dammed pool was a very small component (0.2 percent). This reach was composed of USFS-R5 habitat types step pool (33.2 percent), high gradient riffle (16.7 percent) cascade (10.9 percent) and low gradient riffle (9.4 percent). Additional pool habitats included plunge pool, lateral scour pool, and small components of corner pool, channel confluence pool, and backwater pool. Additional flatwater habitat types included step run and run. There were also small components of bedrock sheet, dry, and road-crossing.

Pool Depth

The surveyed reach above the diversion had four pools and the average pool depths were in the one to two foot depth range. The reach below the diversion had many shallow pools. The average pool depths were primarily in the zero to one foot depth ranges, with many in the one to two foot range (Figure CAWG 1-39).

Wood Count

Large woody debris (> six inches) (Table CAWG 1-110) was observed in five of the nine habitat units in the reach above the Camp 62 diversion at the time of this survey. Two of these units had a fair number of pieces, one in the five to 10 range and one in the 15 to 20 range. Large woody debris was observed in about half of the habitat units below the diversion, mostly in the zero to five pieces per habitat unit range (Table CAWG 1-111).

Cover Summary

Average weighted cover in the reach above the diversion was composed primarily of boulder/cobble (37 percent) and surface turbulence (31 percent), as well as terrestrial vegetation (14 percent) and woody debris (13 percent) (Table CAWG 1-112). Average weighted cover in the reach below the diversion was composed primarily of boulder/cobble (33 percent) and surface turbulence (27 percent), with smaller amounts of terrestrial vegetation, woody debris, and undercut bank (Table CAWG 1-113).

Canopy Summary

All habitat units above Camp 62 diversion had some canopy cover, two in the one to 10 percent range and the rest between 20 to 70 percent (Table CAWG 1-114). Canopy cover was composed primarily of hardwood. About twenty percent of the habitat units below the diversion had no canopy cover but the rest had between one to 80 percent (Table CAWG 1-115). Canopy cover below the diversion was composed primarily of hardwood.

Fish Barriers

No barriers to upstream fish migration were identified above the diversion. The diversion acts as a barrier to upstream migration. Five barriers were identified in the reach below the diversion (Table CAWG 1-116). Two were waterfalls of seven feet and six feet located 5,379 feet and 3,185 upstream of the confluence with the South Fork San Joaquin River in plunge pool and cascade habitats, respectively. They were complete barriers to migration only at low flows. The third barrier was a dry section of stream channel beginning 2,710 feet upstream of the confluence. The fourth and fifth were waterfalls of 12 feet and 45 feet in height located 2,415 and 413 feet upstream of the confluence with the river in plunge pool and cascade habitat, respectively. They both formed complete barriers to upstream migration at all flows.

Dominant Substrates

The dominant substrates in the reach above the diversion were boulders (averaging 52 percent) and cobble (averaging 30 percent), with small amounts of sands (Table CAWG 1-117). The dominant substrates in the reach below the diversion were boulders (averaging 35 percent) and cobble (averaging 28 percent), with smaller amounts of sands, gravel, and bedrock (Table CAWG 1-118).

Spawning Gravel

Spawning gravel was observed in the reach above the diversion, mostly located in cascades and step pools, with a small amount in step run (Table CAWG 1-119). These gravels were of fair to good quality. A relatively large amount of spawning gravel was observed in the reach below the diversion, located in step pools, low gradient riffles, plunge pools, lateral scour pools, step runs, runs, and high gradient riffles (Table CAWG 1-120). Small amounts were also located in channel confluence pools and backwater pools. Gravels in the reach below the diversion were dominated by those of good to excellent quality.

SIDE CHANNELS

Side channels were observed below the diversion in one out of 101 habitat units, for a total length of 89 feet of side channel in 7,699 feet of stream length evaluated. The side channel unit was a cascade.

2.3.3.10 Bolsillo Creek

INTRODUCTION

Bolsillo Creek is a steep, granitic stream on the southern side of the South Fork San Joaquin River located between Bear and Mono creeks. Bolsillo Creek Diversion is located near a natural break in the stream channel slope.

Bolsillo Creek Diversion, located across Bolsillo Creek approximately 1-1/2 miles east of Portal Forebay, is a concrete-lined, rock and earth diversion, six feet high. The crest, at elevation 7,538 feet above MSL, is 54 feet long. The spillway, which is an overpour type located on the right side of the diversion, is eight feet long with a crest elevation at 7,535 feet above MSL. Water impounded behind the diversion enters an uncontrolled 388-foot-deep bore hole in the bottom of the reservoir that intersects the top of Ward Tunnel. The top of the hole is 66 inches in diameter, then tapers down to a 12-inch-diameter steel pipe and then a 10-inch-diameter bore through granite. The whole inlet is protected by trash grids and has a level crest higher than the minimum instream release.

Bolsillo Creek was evaluated for a length of 1,506 feet above the Bolsillo Creek Diversion and for a length of 9,204 feet below the diversion (Map CAWG 1-2). The most upstream location surveyed in Bolsillo Creek has an elevation of 8,051 feet above MSL. The stream drops to an elevation of 7,623 feet above MSL at the Bolsillo Creek Diversion, then drops to an elevation of 6,521 feet above MSL at the confluence with the South Fork San Joaquin River.

Bolsillo Creek is a steep, bedrock/boulder stream with a Rosgen Aa+ channel above the diversion and approximately equal components of Aa+ and B channels below the diversion. It has mostly step pool, step run, and cascade habitats. There was a variety of cover types, and pools were shallow. There was a fair amount of canopy coverage and spawning gravel. Four of the nine barriers to upstream fish migration in the lower portion of the creek were complete barriers at all flows, and one was only 130 feet upstream of the confluence of the river, which is likely to isolate fish habitat from the rest of the watershed. The diversion also acts as a barrier to upstream fish migration.

ROSGEN LEVEL I CLASSIFICATION

Bolsillo Creek consists of two Rosgen Level I channel types. The reach above the diversion has a very steep channel slope and is classified as an Aa+-type channel (Table CAWG 1-121). The reach below the diversion is comprised of Aa+-type channel (57.3 percent) near the confluence with the South Fork San Joaquin River and B-type channel (42.7 percent) near the diversion (Table CAWG 1-122)

MESOHABITAT

The reach above the diversion was composed of Hawkins slow water habitat type scour pool (47.9 percent) and fast water habitat types nonturbulent (28.3 percent) and turbulent (23.8 percent) (Figure CAWG 1-40). This reach was predominantly composed of USFS-R5 habitat types step pool (45.4 percent), step run (28.3 percent) and cascade (22.6 percent) (Figure CAWG 1-41 and Map CAWG 1-10). Lateral scour pool and high gradient riffle were small components of total habitat.

The Rosgen Aa+ channel below the diversion was composed of Hawkins fast water habitat types turbulent (38.7 percent) and nonturbulent (32 percent), and slow water habitat type scour pool (24.5 percent). Dammed pool was a very small component. It was composed of USFS-R5 habitat types step run (29.9 percent), step pool (24.5 percent), cascade (21.6 percent) and bedrock sheet (16.5 percent). A small portion was dry (3.9 percent). There were small components of run, dammed pool, and low gradient riffle.

The Rosgen B channel below the diversion was composed predominantly of Hawkins habitat type scour pool (60.2 percent), with smaller components of nonturbulent (18.5 percent) and turbulent (17.8 percent). Dammed pool was a very small component. It was predominantly composed of USFS-R5 habitat type step pool (59.9 percent), with substantial components of step run (18.5 percent) and cascade (14.2 percent). A small component was dry (2.1 percent). There were small components of bedrock sheet and additional pool habitats.

POOL DEPTH

The pools in Bolsillo Creek were very shallow, with all of the average pool depths in the zero to one foot depth range. (Figure CAWG 1-42)

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Bolsillo Creek.

COVER SUMMARY

There were a variety of cover types in Bolsillo Creek. Average weighted cover in the reach above the diversion was composed of boulder/cobble (19 percent) undercut banks, woody debris, and terrestrial vegetation (11 percent each), as well as aquatic vegetation, surface turbulence and a small component of bedrock (Table CAWG 1-

123). Average weighted cover in the Rosgen Aa+ channel below the diversion was composed of terrestrial vegetation (19 percent) and woody debris (14 percent), with smaller amounts of bedrock, boulder/cobble, surface turbulence and undercut banks (Table CAWG 1-124). The Rosgen B channel below the diversion was composed of a similar range of cover types, including woody debris (23 percent), terrestrial vegetation (14 percent), boulder/cobble, undercut banks, surface turbulence and bedrock.

CANOPY SUMMARY

Canopy cover in the reaches above and below the diversion was fairly evenly distributed in the ranges between zero to 80 percent. Canopy cover in the smaller percentage ranges was composed of softwood, and in the larger percentage ranges of hardwood (Table CAWG 1-125 and 1-126).

FISH BARRIERS

One barrier to fish migration was identified in the Rosgen B reach above the Bolsillo Creek diversion (Table CAWG 1-127). It was a waterfall of 16 feet in height located 1,116 feet upstream of the diversion at a step pool and formed a complete barrier to migration only at low flows. The diversion also acts as a barrier to upstream migration of fish.

Nine barriers to fish migration were identified in the reach below the diversion. Five were located in the Rosgen Aa+ channel and four in the B channel (Table CAWG 1-128). One was a section of stream with insufficient depth located 8,920 feet upstream of the confluence with the South Fork San Joaquin River in a step pool. It formed a complete barrier to migration only at low flows. The second barrier was located in a cascade of 10 feet in height 7,154 feet upstream of the confluence. It also formed a complete barrier to migration at low flows. The next four were waterfalls located 6,413, 5,576, 5,173 and 4,642 feet upstream of the confluence at dammed pool, cascade, step pool and cascade habitats respectively. Of these, the first and third waterfalls of 12 feet and eight feet in height, respectively, formed complete barriers to migration at low flows (the 12 foot barrier is potentially a barrier at high flows as well), but the second and fourth waterfalls of 20 feet and 17 feet in height, respectively formed complete barriers to migration at all flows. The seventh barrier was located 1,252 feet upstream of the confluence in bedrock sheet and formed a complete barrier to migration in all flows. The last two barriers were waterfalls of seven feet and 90 feet in height, respectively located in a cascade located 130 feet upstream of the confluence. One of these two waterfalls formed a complete barrier to migration only at low flows, but the other was a complete barrier to migration at all flows.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were boulders (averaging 28 percent), cobble (averaging 25 percent) and sands (averaging 22 percent), with smaller amounts of bedrock and gravel (Table CAWG 1-129). The dominant substrates in the Rosgen Aa+ channel below the diversion were primarily bedrock (averaging 36 percent) and sands (averaging 35 percent), with smaller amounts of boulders, cobble, gravel and fines (Table CAWG 1-130). The dominant average substrates in the Rosgen B channel were primarily sands (averaging 41 percent) and bedrock (averaging 28 percent), with smaller amounts of boulders and cobble.

SPAWNING GRAVEL

A small amount of spawning gravel was observed in the reach above the diversion, located in step pools and step runs (Table CAWG 1-131). These gravels were of good quality.

A fair amount of spawning gravel was also observed in the reach below the diversion, these gravels were found primarily in the Aa+ channel reach, primarily located in step pools and step runs (Table CAWG 1-132). Small amounts were also located in runs and cascades. These gravels were primarily of fair to good quality.

SIDE CHANNELS

No side channels were observed in Bolsillo Creek.

2.3.3.11 Mono Creek below Mono Diversion

INTRODUCTION

Mono Creek is located on the northwest side of the South Fork San Joaquin River. Lake Thomas A. Edison was created by the construction of Vermilion Dam across Mono Creek. The watershed flows through granite bedrock and glacial moraine. Although some of the downstream reaches evaluated are moderately steep, much of the stream is relatively flat and wider than other South Fork San Joaquin River tributaries that were evaluated. A low-gradient reach flows through Mono Meadow.

Mono Creek Diversion, located across Mono Creek approximately one mile southwest of Lake Thomas A. Edison, is a constant-radius, concrete arch diversion, 64 feet high. The crest, at elevation 7,360 feet above MSL, is 156 feet-long. The ungated, overpour spillway has an effective length of 106 feet and a crest at elevation 7,350 feet above MSL. Diverted water from Mono Creek is conveyed through a 92-inch-diameter, 4,538 foot-long, steel pipe, an eight-foot to 9.5-foot cross section, 3,933-foot-long, bore through granite, and a 102-inch, 13,806-foot-long, steel pipe into Ward Tunnel Adit No. 1. Flow through the conduit is controlled by a manually operated six by nine foot slide gate, located in the outlet works on the left abutment of the diversion.

Mono Creek was evaluated from the Mono Creek Diversion to the confluence of the South Fork San Joaquin River for a length 32,477 feet. Mono Creek has an elevation of 7,333 feet above MSL at the diversion, and drops to an elevation of 6,313 feet above MSL at the confluence with the South Fork San Joaquin River (Map CAWG 1-3).

Mono Creek below the Mono Diversion is a mostly steep, boulder/bedrock stream with Rosgen B channels. It was primarily composed of pool, step run, and cascade habitats. However, there were components of complex habitat types such as pocket water and riffles. A low gradient reach flows through Mono Meadow. There was a fair amount of canopy cover in some of the habitat units. Many pools were deeper than those found in other tributaries of the South Fork San Joaquin River. Large amounts of spawning gravels were observed. Two waterfalls were evaluated as barriers to upstream fish migration but were not complete barriers at all flows. Mono Diversion is a barrier to upstream fish migration at all flows.

ROSGEN LEVEL I CLASSIFICATION

Mono Creek below Mono Diversion is classified as a Rosgen Level I B-type channel (Table CAWG 1-133).

MESOHABITAT

Mono Creek below Mono Diversion was composed of Hawkins fast water habitat types nonturbulent (45.5 percent) and turbulent (20.9 percent) and slow water habitat type scour pool 32.3 percent (Figure CAWG 1-43). There was a very small component of dammed pool. This reach was composed of USFS-R5 habitat type step run (30.7 percent) and a substantial component of pool habitat including step pool (14.0 percent), lateral scour pool (12.1 percent), mid channel pool (6 percent), and other pool types (Figure CAWG 1-44 and Map CAWG 1-11). There were additional flatwater habitats including run and pocket water (seven percent each) and glide. There were components of high gradient (6.9 percent) and low gradient riffles, and cascade (9.6 percent).

POOL DEPTH

Average pool depths were predominantly in the one to two and two to three foot depth ranges, but some were deeper, up to the five to six foot depth range (Figure CAWG 1-45).

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Mono Creek below the diversion. (see Appendix C)

COVER SUMMARY

A variety of cover types were observed. Average weighted cover was composed primarily of boulder/cobble (30 percent), bedrock (16 percent), surface turbulence (14 percent), and terrestrial vegetation (12 percent), with small amounts of woody debris, aquatic vegetation and undercut banks (Table CAWG 1-134).

CANOPY SUMMARY

Canopy cover was fairly evenly distributed in the ranges between zero to 70 percent. Canopy cover was composed primarily of softwood in the lower percentage ranges and hardwood in the larger percentage ranges (Table CAWG 1-135).

FISH BARRIERS

Two barriers to upstream fish migration were identified in addition to the Mono Diversion (Table CAWG 1-136). Both were waterfalls, but neither was a complete barrier to migration at all flows. One waterfall of eight feet in height was located 25,647 feet upstream of the confluence with the South Fork San Joaquin River in a cascade and was a partial barrier to migration at all flows. The other waterfall of 11 feet in height was located 10,754 feet upstream of the confluence in a lateral scour pool and was a complete barrier to upstream migration only at low flows.

DOMINANT SUBSTRATES

The dominant substrates were primarily boulders (averaging 37 percent), bedrock and sands (averaging 17 percent), with smaller amounts of cobble, gravel and fines (Table CAWG 1-137).

SPAWNING GRAVEL

Mono Creek below the diversion had a large amount of spawning gravel, most of it located in pool (lateral scour pool and step pool) and flatwater (step run and run) habitats (Table CAWG 1-138). There was also a fair amount in other pool habitats (mid channel pool, dammed pool, pocket water) and in glides. Smaller amounts of spawning gravels were located in high and low gradient riffle, secondary channel pool, and cascade habitats. Gravel quality varied from poor to excellent, and primarily consisted of fair to good gravels.

SIDE CHANNELS

Side channels were observed in nine out of 258 habitat units, for a total length of 817 feet of side channel. Side channel units included two step pools, five runs, one lateral scour pool, and one low gradient riffle.

2.3.4 SAN JOAQUIN RIVER DRAINAGE

The San Joaquin River study segment starts with the confluence of the South Fork San Joaquin River and the San Joaquin River and extends downstream. For purposes of this study, the furthest downstream location considered is the location of Big Creek Powerhouse 3 upstream of where the river enters Redinger Lake. Two principal reaches of the mainstem were evaluated, as well as Project-affected tributaries that drain into the San Joaquin River. The Big Creek drainage, which is tributary to the San Joaquin River, is discussed in a separate section. The segments of the mainstem of the San Joaquin River (SJR) that were evaluated and their tributaries, from upstream to downstream, include:

- SJR from the confluence with the SFSJR to Mammoth Pool Reservoir;
- SJR from Mammoth Pool Dam to Mammoth Pool Powerhouse (Mammoth Reach) The segments of the mainstem of the South Fork San Joaquin River (SFSJR) that were evaluated and their tributaries, from upstream to downstream, include:
- including the following tributaries: Rock Creek, Ross Creek; and
- SJR from Dam 6 to Big Creek Powerhouse 3 (Stevenson Reach), including Stevenson Creek.

The reaches of the San Joaquin River are primarily Rosgen Level I B and G channel types. The upstream reaches include B and G channel types, with the Stevenson Reach primarily G type channel.

Detailed descriptions of these reaches are presented in this section.

2.3.4.1 SFSJR Confluence to Mammoth Pool

INTRODUCTION

This segment of the San Joaquin River is the northern-most portion of the San Joaquin River evaluated. Downstream, the low gradient river channel runs through granite bedrock and widens near its confluence with the South Fork San Joaquin River.

This segment of the San Joaquin River was evaluated from the confluence with the South Fork San Joaquin River to Mammoth Pool for a length of 21,490 feet (Map CAWG 1-4). The San Joaquin River has an elevation of 3,721 feet above MSL at the confluence with the South Fork San Joaquin River, then drops to an elevation of 3,365 feet above MSL at Mammoth Pool.

This reach consists of Rosgen Level I B and G channel types, with G predominant. The B channel was dominated by nonturbulent habitat, run, and pools. The G channel was dominated by slow water habitat including mid channel pools and nonturbulent habitat including pocket water.

Sand deposition was noted in the B channel and bedrock and boulders were dominant substrates in the G channel.

ROSGEN LEVEL I CLASSIFICATION

This segment is classified as a Rosgen Level I G and B channel type. The G channel comprises 79 percent of the reach length; 21 percent is B-type channel. It has a moderately low gradient channel slope. The B channel type was located immediately downstream of the confluence at RM 38.4 downstream to RM 37.6. The G channel type covered the reach from RM 37.6 downstream to RM 35.6 at the headwater of Mammoth Pool Reservoir. (Table CAWG 1-139)

MESOHABITAT

This segment of the San Joaquin River was not habitat mapped on the ground due to access and safety issues. Mapping from aerial photography, video, and overflight indicated that pools and flatwater habitats were dominant features of this segment. This method does not provide for the level of detail that can be obtained on the ground however major mesohabitat types could be resolved.

The Rosgen B channel was predominantly composed of Hawkins fast water habitat types nonturbulent (59 percent) and turbulent (18 percent), with the remainder composed of slow water habitat type scour pool (23 percent) (Figure CAWG 1-46). It was predominantly composed of USFS-R5 pool habitat types, including run (58 percent), mid channel pool (21 percent), corner pool (three percent) and (Figure CAWG 1-47 and Map CAWG 1-12). This reach also had components of high gradient riffle (10 percent), and cascade (eight percent) habitats.

The Rosgen G channel was predominantly composed of Hawkins slow water habitat type scour pool (57 percent) and dammed pool (nine percent), with the remainder composed of nonturbulent and turbulent habitat types. It was predominantly composed of USFS-R5 pool habitats including midchannel pool (58 percent)) and other pool habitats. There also was flatwater habitat consisting of pocket water (27 percent). There were very small components of riffle and cascade.

SUBSTRATE

Major substrate types were characterized as part of the CAWG 2 Geomorphology Study. In the B channel type, present from the confluence with the South Fork San Joaquin River at RM 38.4 downstream to RM 37.6 the dominant substrate was classified to be sand. From RM 37.6 to RM 35.6, in the G channel type, the dominant substrates were characterized as bedrock and boulders.

2.3.4.2 San Joaquin River Mammoth Reach - Mammoth Pool to Mammoth Pool Powerhouse

INTRODUCTION

The Mammoth Reach of the San Joaquin River extends from Mammoth Pool Dam (RM 26.0) to the Mammoth Pool Powerhouse (RM 18.3). The river runs through a deep, granitic canyon.

This segment of the San Joaquin River was evaluated from the Mammoth Pool Dam to the Mammoth Pool Powerhouse for a ground length of 45,272 feet (Maps CAWG 1-5 and CAWG 1-6). The San Joaquin River has an elevation of 3,052 feet above

MSL at the Mammoth Pool Dam, then drops to an elevation of 2,222 feet above MSL at the Mammoth Pool Powerhouse.

The Mammoth reach of the San Joaquin River is a moderately low gradient, boulder/bedrock stream with areas of finer materials. The stream channel consists of Rosgen Level I B and G channels, with B channel type predominant in the lower portion of the reach. There was a mixture of habitat types, dominated by pools, many of which were moderately to very deep. Complex habitats, such as pocket water and riffles also were observed. A few large deposits of spawning gravel were observed, mostly in step pools but also in runs, pools and riffles. The overall abundance of spawning gravel for the reach was small. The only waterfall that was a complete barrier to upstream fish migration at all flows was located near the upstream end of the surveyed reach near the Mammoth Pool Dam, which is a complete barrier to upstream migration.

ROSGEN LEVEL I CLASSIFICATION

This segment consists of two Rosgen Level I channel types (Table CAWG 1-140). Over half of this reach (54.3 percent) is classified as a B-type channel, and most of the B-type channel is located in the lower half of the reach. The remainder is classified as G-type channel (45.7 percent).

MESOHABITAT

The Rosgen B channel was predominantly composed of Hawkins slow water habitat type scour pool (67.9 percent), with the remainder composed of fast water habitat types nonturbulent (18 percent) and turbulent (14 percent) (Figure CAWG 1-48). It was predominantly composed of USFS-R5 pool habitat types, including step pool (30 percent), lateral scour pool (22.7 percent) and mid channel pool (14.5 percent) (Figure CAWG 1-49 and Maps CAWG 1-13 and CAWG 1-14). This reach also had components of high gradient riffle (11.1 percent), and of flatwater habitats including pocket water (9.2 percent), run and step run. It had small components of low gradient riffle, cascade and additional pool habitats.

The Rosgen G channel also was predominantly composed of Hawkins slow water habitat type scour pool (77.4 percent), with the remainder composed of turbulent and nonturbulent habitat types. It was predominantly composed of USFS-R5 pool habitats including lateral scour pool (37.8 percent), step pool (30.3 percent) and other pool habitats. There were also components of high gradient riffle (13.6 percent) and flatwater habitats including run, pocket water, and step run. There were very small components of low gradient riffle and cascade.

POOL DEPTH

Almost half of the average pool depths in the Rosgen B channel were in the two to three foot depth range, but many were deeper, some over 10 feet deep. Many pools in the Rosgen G channel reaches had average pool depths in the one to two foot range, but many more were deeper, including greater than 10 feet deep. (Figure CAWG 1-50)

WOOD COUNT

Large woody debris (> six inches) counts were not performed in the Mammoth Reach of the San Joaquin River.

COVER SUMMARY

Average weighted cover in the Rosgen B channel was primarily boulder/cobble (26 percent) and bedrock (16 percent), with a smaller amount surface turbulence (Table CAWG 1-141). Average weighted cover in Rosgen G channel was about the same, primarily boulder/cobble (25 percent) and bedrock (17 percent) with a smaller amount of surface turbulence.

CANOPY SUMMARY

Canopy cover was generally low. The majority of the units had no canopy cover, several units had up to 20 percent, and only two units had between 50 and 70 percent (Table CAWG 1-142). Canopy cover was generally composed of hardwood, but softwood was also represented.

FISH BARRIERS

One barrier to fish migration was identified in the Rosgen B channel and three in G channel (Table CAWG 1-143). All four barriers are waterfalls. One is located 45,012 feet upstream of the Mammoth Pool Powerhouse (near the Mammoth Pool Dam) in a cascade of 30 feet and forms a complete barrier to migration at all flows. Three barriers are located 43,404, 25,544, and 1,468 feet upstream of the powerhouse in cascade and step pool habitats. They are all complete barriers to migration only at low flows. Their heights are 10 feet, 15 feet, and eight feet, respectively. Mammoth Pool Dam provides a complete barrier to upstream fish migration from this reach.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen B channel were primarily boulders (averaging 45 percent), with smaller amounts of sands and cobble (averaging 16 percent each), and bedrock (averaging 10 percent) (Table CAWG 1-144). There was also a small amount of gravel. The dominant substrates in the Rosgen G channel were boulders (averaging 41 percent), bedrock (averaging 15 percent), sands and gravel (averaging 13 percent each).

SPAWNING GRAVEL

The B channel type areas of this segment of the San Joaquin River had little gravel present. In the G channel type, there was a limited amount of spawning gravel, but more than present in the B channel. The gravels in the G channel type were widely distributed, most of it located in step pool habitat (Table CAWG 1-145). Spawning gravel was also found in run, pool, and high gradient riffle habitats. Gravel quality varied from fair to excellent.

SIDE CHANNELS

No side channels were observed in this segment of the San Joaquin River.

2.3.4.3 SJR Stevenson Reach

INTRODUCTION

The Stevenson Reach of the San Joaquin River between Dam 6 at about RM 17.0 and Big Creek Powerhouse 3 near Redinger Lake, at about RM 11.3, includes the confluence with Stevenson Creek. Big Creek enters the San Joaquin River upstream of Dam 6 at RM 17.25. Big Creek is discussed as a separate drainage.

This segment of the San Joaquin River was evaluated from Dam 6 to Powerhouse 3 for a ground length of 26,011 feet. The Stevenson Reach has an elevation of 2,222 feet above MSL at Dam 6, then drops to an elevation of 1,432 feet above MSL at Powerhouse 3. (Map CAWG 1-9)

The Stevenson Reach of the San Joaquin River is a moderate gradient, boulder/bedrock stream with a Rosgen Level I G channel type. It has primarily pool and complex pocket water habitats, as well as very small components of riffles. Most pools were moderately to very deep. Canopy cover was low and no large woody debris was observed. Small amounts of relatively widely distributed spawning gravels were observed. One waterfall was identified as a barrier to upstream fish migration at low flows. Dam 6 is a complete barrier to upstream fish migration from this reach.

ROSGEN LEVEL I CLASSIFICATION

This segment is classified as a Rosgen Level I G-type channel. (Table CAWG 1-146)

MESOHABITAT

This segment of the San Joaquin River was predominantly composed of Hawkins slow water habitat type scour pool (69.9 percent), with a smaller component of fast water habitat type nonturbulent (26.2 percent) (Figure CAWG 1-51). Turbulent and dammed pool habitats were small components. This reach was predominantly composed of USFS-R5 pool habitat types, including step pool (41.1 percent), lateral scour pool (15.7 percent) and mid channel pool (13.1 percent) (Figure CAWG 1-52 and Map CAWG 1-17). There was a substantial component of pocket water (25.8 percent). This reach also had a small component of high gradient riffle and very small components of step run, low gradient riffle, and dammed pool.

Pool Depth

Many of the average pool depths in this Rosgen G channel were in the three to four foot depth range, and the same number were shallower (Figure CAWG 1-53). Three pools were deeper, up to the six to seven foot depth range.

Wood Count

Large woody debris (> six inches), in the one to five pieces category, (Table CAWG 1-147) was observed in three units in the Stevenson Reach of the San Joaquin River at the time of this survey. Wood counts were only performed for 14,091 feet of this 26,011 long reach (the segment between 2,820 to 16,911 feet from the downstream end of the reach).

Cover Summary

Average weighted cover was primarily boulder/cobble (34 percent) and bedrock (33 percent), with a small amount surface turbulence (Table CAWG 1-148).

Canopy Summary

Canopy cover was low. Most of the habitat units had up to 10 percent, and some had none. Canopy cover was composed of hardwood (Table CAWG 1-149).

Fish Barriers

One barrier to fish migration was identified (Table CAWG 1-150) in addition to Dam 6 on the mainstem of the reach. It is a waterfall of five feet in height located 3,441 feet upstream of Powerhouse 3 in pocket water habitat. It forms a complete barrier to migration only at low flows.

Dominant Substrates

The dominant substrates in the Stevenson Reach of the San Joaquin River were primarily boulders (averaging 35 percent), bedrock and sands (averaging 20 percent each) (Table CAWG 1-151). Additional dominant substrates included cobble and gravel.

Spawning Gravel

This reach of the San Joaquin River contained a modest amount of spawning gravel, which was widely distributed. Most of the gravel was located in step pool, pocket water and lateral scour pool habitat (Table CAWG 1-152). Spawning gravel was also found in step run habitat. Gravel quality was fair to good.

Side Channels

No side channels were observed in this segment of the San Joaquin River.

2.3.5 TRIBUTARIES

2.3.5.1 Rock Creek

INTRODUCTION

Rock Creek is steep, granitic stream on the northwest side of the San Joaquin River located downstream of Mammoth Pool Reservoir with a confluence at San Joaquin River RM 22.55. Rock Creek Diversion is located at a point in the stream where there is a natural break in the channel slope about 0.4 miles upstream of the San Joaquin River confluence.

Rock Creek Diversion, located across Rock Creek approximately 3-1/2 miles south of Mammoth Pool Dam, is a concrete diversion approximately nine feet high. The crest length is approximately 93 feet and the spill elevation is 3,336 feet above MSL. Diverted water is conveyed through 434 feet of steel pipe with a 30 to 20-inch-diameter to a 20-inch-diameter vertical bore hole into Mammoth Pool Power Tunnel.

Rock Creek was evaluated for a length of 1,151 feet above the Rock Creek Diversion and for a length of 2,702 feet below the diversion. Rock Creek has an elevation of 3,561 feet above MSL at the upstream end, drops to an elevation of 3,352 feet MSL at the Rock Creek Diversion, then drops steeply to an elevation of 2,670 feet above MSL at the confluence with the San Joaquin River (Map CAWG 1-6).

Rock Creek is a steep, bedrock/boulder stream with Rosgen Level I Aa+ channel. It has mostly step pool, cascade and bedrock sheet habitats, with small components of other pool habitats. There were several pools that were moderately to very deep. No spawning gravel was observed. Three waterfalls form a complete barrier to fish migration at all flows, and two of them are located only several hundred feet upstream of the confluence with the San Joaquin River. The diversion also serves as a barrier to fish migration.

ROSGEN LEVEL I CLASSIFICATION

Rock Creek is classified as a Rosgen Level I Aa+ channel type (Tables CAWG 1-153 and 1-154).

MESOHABITAT

The reach above the diversion was composed of equal segments of Hawkins slow water habitat type scour pool (45.7 percent) and fast water habitat type turbulent (45.6 percent). Dammed pool (8.7 percent) was a smaller component (Figure CAWG 1-54). This reach was predominantly composed of USFS-R5 pool habitat types, including step pool (36.3 percent), mid channel pool (9.4 percent) and dammed pool (8.7 percent) as well as cascade (36.9 percent) and bedrock sheet (8.7 percent) (Figure CAWG 1-55 and Map CAWG 1-14).

A large segment (37.1 percent) of the reach below the diversion was not classified because of difficult access and safety concerns. This consisted of 1000 feet of steep terrain including cascades and waterfalls (as identified from visual inspection and aerial imagery). The portion of the reach that was classified on the ground was predominantly composed of Hawkins fast water habitat type turbulent (39.8 percent) and slow water habitat type scour pool (17.4 percent). This reach was predominantly composed of USFS-R5 habitat types bedrock sheet (30.1 percent), with a small component of cascade. However, there was a substantial amount of pool habitat including step pool, plunge pool, pocket water and dammed pool.

POOL DEPTH

Most of the average pool depths in the reach above the diversion were in the two to three foot depth range, and one was deeper (four to five foot depth range) (Figure CAWG 1-56). Over half (five pools) of the pools in the reach below the diversion had average pool depths in the three to four foot range or deeper, but the rest had average pool depths of less than two feet deep.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Rock Creek.

COVER SUMMARY

Average weighted cover in the reach above the diversion was primarily boulder/cobble (42 percent) and bedrock (21 percent), with a smaller amount of undercut banks (Table CAWG 1-155). Average weighted cover in the reach below the diversion was primarily bedrock (31 percent), with a smaller amount of boulder/cobble (10 percent) (Table CAWG 1-156).

CANOPY SUMMARY

Canopy cover in the reach above the diversion was distributed through most of the percentage ranges, and all units had some canopy cover (Table CAWG 1-157). Canopy cover was composed of hardwood. Canopy cover in the reach below the diversion was generally low (Table CAWG 1-158). Almost all units had less than 20 percent, and the majority of the units had no canopy cover. Canopy cover was mostly composed of hardwood

FISH BARRIERS

One barrier to fish migration was identified above Rock Creek Diversion (Table CAWG 1-159). It is a waterfall of 30 feet in height located 1,151 feet upstream of the diversion in bedrock sheet habitat and forms a complete barrier to upstream fish migration at all flows. The diversion also acts a barrier to upstream fish migration at all flows.

Two barriers to fish migration were identified below the diversion (Table CAWG 1-160). They are waterfalls located 610 and 344 feet upstream of the confluence with the San Joaquin River in step pool habitat. These waterfalls were of 14 feet and 20 feet in height, respectively. Both are complete barriers to migration at all flows.

DOMINANT SUBSTRATES

The dominant substrate in the reach above the diversion was primarily boulders (averaging 42 percent), with a smaller amount of bedrock (averaging 27 percent) (Table CAWG 1-161). Additional dominant substrates included sands, fines and gravel. The dominant substrate in the reach below the diversion was primarily bedrock (averaging 75 percent) (Table CAWG 1-162). Additional dominant substrates included boulders, sands, gravel and cobble.

SPAWNING GRAVEL

No spawning gravel was observed in Rock Creek.

SIDE CHANNELS

No side channels were observed in Rock Creek.

2.3.5.2 Ross Creek

INTRODUCTION

Ross Creek is a tributary on the northwest side of the San Joaquin River located downstream of Mammoth Pool Reservoir and Rock Creek at about San Joaquin River RM 18.7. It is a very steep stream that flows through granitic bedrock. Ross Creek Diversion is located at a point in the stream where there is a natural break in the channel slope, approximately 0.85 miles upstream of the confluence with the San Joaquin River.

Ross Creek Diversion, located across Ross Creek approximately seven miles south of Mammoth Pool Dam, is a concrete diversion approximately seven feet high. The crest length is approximately 53 feet and the spill elevation is 3,359 feet above MSL. Diverted water is conveyed through 607 feet of steel pipe with a 12 to 10 inch diameter to a 10-inch vertical bore hole into the Mammoth Pool Power Tunnel.

Ross Creek was evaluated for a length of 931 feet above the Ross Creek Diversion and a length of 2,796 feet below the diversion to the confluence with the San Joaquin River. Ross Creek has an elevation of 3,763 feet above MSL at the upstream end, drops to an elevation of 3,373 feet above MSL at the Ross Creek Diversion, then drops to an elevation of 2,289 feet above MSL at the confluence with the San Joaquin River (Map CAWG 1-6).

Ross Creek is a very steep, bedrock/boulder stream with a Rosgen Level I Aa+ channel. It was dry in about a third of the downstream reach during the time of the survey, and dry above the diversion at the time of the first survey. Habitat types were mostly step pool above and below the diversion, with substantial components of cascade and bedrock sheet. The reach above the diversion also had a small amount of trench chute and riffle. Pools were shallow. No spawning gravel was observed. There was some canopy cover composed of hardwood downstream of the diversion. Several waterfalls throughout the stream form complete barriers to upstream fish migration at all flows.

ROSGEN LEVEL I CLASSIFICATION

Ross Creek is classified as a Rosgen Level I Aa+-type channel (Table CAWG 1-163 and 1-164).

MESOHABITAT

The reach above the Ross Creek Diversion was dry at the time it was surveyed in 2001, but was wetted when it was resurveyed in 2002. It was predominantly composed of Hawkins slow water habitat type scour pool (63.9 percent) with the remainder composed of Hawkins fast water habitat type turbulent (Figure CAWG 1-57). This reach was predominantly composed of USFS-R5 pool habitat types, including step pool (50.7 percent), mid channel pool (11.2 percent) and a small component of plunge pool. There also were components of cascade (18.1 percent), bedrock sheet and trench chute, as well as small components of high and low gradient riffle (Figure CAWG 1-58 and Map CAWG 1-14).

The reach below the diversion was predominantly composed of Hawkins habitat type scour pool (45.2 percent) and a smaller component of habitat type turbulent (21.5 percent). A large segment (33.3 percent) was dry at the time the stream was surveyed. The wetted portion of this reach was predominantly composed of USFS-R5 habitat type step pool (41.3 percent), with smaller components of cascade (11.8 percent) and bedrock sheet (9.7 percent). There also was a small component of lateral scour pool.

POOL DEPTH

Pools in the reach above Ross Creek Diversion were shallow, with almost all average pool depths at one foot or less deep (Figure CAWG 1-59). Pools in the reach below the diversion were shallow, with all of the average depths less than two feet.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Ross Creek.

COVER SUMMARY

Average weighted cover in the reach above the diversion was primarily boulder/cobble (13 percent) and surface turbulence (12 percent), with smaller amounts of terrestrial vegetation and bedrock (Table CAWG 1-165).

Average weighted cover in the reach below the diversion was primarily boulder/cobble (12 percent) and bedrock (nine percent), with smaller amounts of surface turbulence, terrestrial vegetation, undercut banks and aquatic vegetation (Table CAWG 1-166).

CANOPY SUMMARY

There was no canopy cover in the reach above the diversion. Canopy cover in the reach below the diversion was generally between zero to 60 percent, with one unit in the 70 to 80 percent range (Table CAWG 1-167). Canopy cover was composed of hardwood.

FISH BARRIERS

One barrier to fish migration was identified above Ross Creek Diversion (Table CAWG 1-168). It is a waterfall of 60 feet in height located approximately 931 feet upstream of the diversion. It forms a complete barrier to upstream fish migration at all flows. It was dry at the time of the survey. The diversion also is a barrier to upstream fish migration.

Five barriers to migration were identified in the 2,796-foot long reach below the diversion (Table CAWG 1-169). They are all waterfalls and form complete barriers to migration at all flows. The waterfalls are located 1,866, 809, 693, 477 and 75 feet upstream of the confluence with the San Joaquin River and are located in bedrock sheet, cascade and step pool habitats. These waterfalls were of 15 feet, 150 feet, 20 feet, 20 feet, and 35 feet in height, respectively.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were primarily bedrock (averaging 63 percent), with a smaller amount of boulder (averaging 18 percent), cobble, sands and gravel (Table CAWG 1-170). The dominant substrate in the reach below the diversion was primarily bedrock (averaging 64 percent). Additional dominant substrates included boulders and sands.

SPAWNING GRAVEL

No spawning gravel was observed in Ross Creek.

SIDE CHANNELS

No side channels were observed in Ross Creek.

2.3.5.3 Stevenson Creek

INTRODUCTION

The Stevenson Creek study reaches include Stevenson Creek downstream of Shaver Lake to the confluence with the San Joaquin River and North Fork Stevenson Creek upstream of Shaver Lake. Prior to the construction of Shaver Lake and its predecessor sawmill pond, North Fork Stevenson Creek was a direct tributary to Stevenson Creek. Currently it discharges to Shaver Lake. North Fork Stevenson Creek is discussed following Stevenson Creek.

The studied reach of Stevenson Creek flows downstream from Shaver Lake. It has a granitic stream channel with a moderate to very steep channel gradient. A portion of the stream was not habitat mapped on the ground because long sections of very steep waterfalls made it inaccessible and unsafe. This area was assessed visually (Map CAWG 1-8).

Stevenson Creek was evaluated from Shaver Lake Dam at Stevenson Creek RM 4.3 to the confluence with the San Joaquin River at RM 0.0 for a ground length of 22,382 feet. Stevenson Creek has an elevation of 5,252 feet above MSL at Shaver Lake Dam and drops to an elevation of 1,638 feet above MSL at the confluence with the San Joaquin River.

Over half of Stevenson Creek is composed of Rosgen Level I Aa+ channel type, with the rest composed of A and B channels and a small section of G channel. The dominant habitat types in the Rosgen Aa+ channel were cascade and pools, with small components of other habitat types. The Rosgen A and B channels were dominated by step pool, cascade, and other pool types, but smaller components of a variety of other habitat types were also evaluated. The G channel was also dominated by step pool and cascade habitat, with small components of other habitats. Large woody debris was observed in many of the habitat units. Most pools were shallow, but others were moderately to very deep. Small amounts of spawning gravel were observed in pools. Many waterfalls throughout the creek are complete barriers to upstream fish migration at all flows. Stevenson Creek Falls provides a complete barrier to upstream migration relatively close to its confluence with the San Joaquin River. Shaver Lake Dam provides a complete barrier at the upstream end of the reach. These waterfalls are likely to fragment a substantial portion of Stevenson Creek.

ROSGEN LEVEL I CLASSIFICATION

Stevenson Creek is composed of four Rosgen Level I channel types. Over half of this stream was classified as an Aa+ channel (51.2 percent). There were inclusions of B-type (29.9 percent) and G-type (3.2 percent) channels in the upstream reaches and an inclusion of A-type channel (15.8 percent) in the downstream reach (Table CAWG 1-172).

MESOHABITAT

The Rosgen Aa+ channels were predominantly composed of Hawkins fast water habitat type turbulent (50.8 percent) and slow water habitat type scour pool (38.6 percent). Nonturbulent (10.1 percent) and dammed pool were small components (Figure CAWG 1-60). The predominant USFS-R5 habitat type was cascade (44.1 percent) (Figure CAWG 1-61 and Map CAWG 1-16). A substantial component of pool habitat included step pool (21.9 percent), plunge pool, mid channel pool, lateral scour pool, corner pool and dammed pool. There were smaller components of high gradient riffle, flatwater habitats including step run, trench chute and pocket water, and a small component of bedrock sheet. Due to safety concerns and access issues a portion of this channel type near the San Joaquin River confluence (3326 feet of cascades and waterfalls) was mapped from aerial imagery and visual inspection.

The Rosgen A channel was predominantly composed of Hawkins slow water habitat type scour pool (62.4 percent), with smaller components of fast water habitat types nonturbulent (30.6 percent), and turbulent (7.0 percent). The predominant USFS-R5 habitat type was step pool (39.4 percent). There were substantial components of cascade (15.4 percent), of additional pool habitats including mid channel pool (13.6 percent), plunge pool, and lateral scour pool, and of high gradient riffle (13.2 percent). There were only small components of flatwater habitat including step run, trench chute, run and pocket water, and a small component of bedrock sheet.

The Rosgen B channels were predominantly composed of Hawkins slow water habitat type scour pool (67.1 percent). Most of the remainder of the Rosgen B channel was composed of fast water habitat types turbulent (24.5 percent) and nonturbulent. The predominant USFS-R5 habitat type was step pool (45.9 percent) with a substantial component of additional pool habitat including mid channel pool (13.2 percent), lateral scour pool, plunge pool, and dammed pool. There was also cascade (12.3 percent) and a small component of bedrock sheet. There were only small components of high gradient (4.5 percent) and low gradient riffles, as well as small components of flatwater habitats including step run, trench chute, run and pocket water. Concrete box culvert was a small component.

The Rosgen G channel was predominantly composed of Hawkins slow water habitat type scour pool (65.3 percent), with a substantial component of turbulent (31.2 percent). The predominant USFS-R5 habitat types were step pool (46.2 percent) and cascade (27.3 percent). There were additional pool habitats including mid channel pool (13.1 percent) and plunge pool. There were only small components of high gradient riffle and trench chute.

POOL DEPTH

Average pool depths were mostly in the one to two foot depth range (Figure CAWG 1-62). However, all Rosgen channel types contained deeper pools, up to the five to six foot depth range.

WOOD COUNT

Large woody debris (> six inches) was observed in many of the habitat units in Stevenson Creek. Many of the habitat units in the Aa+ channel (24 units out of 94) contained large woody debris (Table CAWG 1-173). Most of these had zero to five pieces, but several had more. The A and B channels also had a fair number of units in the zero to five piece category (Tables CAWG 1-174 and 1-175), and some, especially in the B channel, had more. The G channel had one unit that contained a small amount of large woody debris (Table CAWG 1-176).

COVER SUMMARY

There were a variety of cover types in Stevenson Creek. Average weighted cover in the Rosgen Aa+ channels was composed of boulder/cobble (12 percent) with smaller amounts of bedrock, surface turbulence, terrestrial vegetation, woody debris and undercut banks (Table CAWG 1-177). Cover in the Rosgen A channel was composed primarily of boulder/cobble (10 percent), bedrock (eight percent) and surface turbulence (six percent), as well as woody debris, terrestrial vegetation, and undercut banks. Cover in the B channel was composed of boulder/cobble (11 percent) with smaller amounts of bedrock, surface turbulence, terrestrial vegetation, woody debris and undercut banks. Cover in the G channel was composed of bedrock (eight percent), undercut banks (six percent), boulder/cobble (five percent), surface turbulence and terrestrial vegetation.

CANOPY SUMMARY

The majority of habitat units had canopy cover that was primarily distributed between the zero to 40 percent ranges (Table CAWG 1-178). Canopy cover was composed of hardwood and softwood.

FISH BARRIERS

Thirteen barriers to upstream fish migration were identified in Stevenson Creek (Table CAWG 1-179). All except one form complete barriers to migration at all flows. Four barriers are located in Rosgen Aa+ channels, one in A channel, seven in B channels and one in a G channel. Shaver Lake Dam also is a complete barrier to upstream fish migration.

The largest complete barrier to upstream fish migration was the series of waterfalls in the first 0.5 miles upstream of the confluence with the San Joaquin River located in the Aa+ channel type. This included the waterfall several hundreds of feet in height known as Stevenson Creek Falls. Other waterfalls located 19,150 and 18,850 and 15,433 feet upstream of the confluence with the San Joaquin River of 100 feet, 15 feet, and 30 feet in height form complete barriers to upstream fish migration at all flows. These are located in cascade, plunge pool and high gradient riffle habitats respectively. A weir of 2.5 feet in height located 15,327 feet upstream of the confluence in a step pool also forms a complete barrier to migration at all flows. The only barrier that is not a complete barrier to migration is a waterfall located 14,252 feet upstream of the confluence in a cascade, it is three feet in height and forms a complete barrier only at low flows. Waterfalls located 14,067, 13,268, 12,684, 12,488, 11,537, 9,987, and 5,128 feet upstream of the confluence are located in primarily in cascade habitats. These waterfalls were six feet, 10 feet, 15 feet, nine feet, 13 feet, 18 feet, and 16 feet in height, respectively.

DOMINANT SUBSTRATES

The dominant substrates were primarily bedrock and boulders, with fair amounts of sand and some cobble (Table CAWG 1-180). The dominant substrates in the Rosgen Aa+ channels were primarily bedrock (averaging 52 percent) and boulders (averaging 26 percent), with smaller amounts of sands and cobble. The dominant substrate in the Rosgen A channel was primarily bedrock (averaging 45 percent) and boulders (averaging 22 percent), with a fair amount of sands and a small amount of cobble. The dominant average substrate in the Rosgen B channel was primarily bedrock (averaging 45 percent) and boulders (averaging 25 percent), with smaller amounts of sands and cobble and a very small amount of fines. The dominant average substrate in the G channel was bedrock (averaging 66 percent) with smaller amounts of boulders and sands (averaging 14 and 13 percent, respectively).

SPAWNING GRAVEL

Small amounts of spawning gravel were observed, primarily located in step pool habitat, with very small amounts found in additional pool habitats (Table CAWG 1-181). Gravels were generally of fair quality.

SIDE CHANNELS

Side channels were observed in 10 out of 245 habitat units, for a total length of 670 feet of side channel. The side channel habitat units were composed of pools (two step pools, a corner pool and a mid channel pool), two cascades, one high gradient riffle, two step runs and a run.

2.3.5.4 North Fork Stevenson Creek

INTRODUCTION

North Fork Stevenson Creek is a moderate to steep gradient stream that flows to Shaver Lake from the northwest. Natural streamflow is enhanced by releases made at Tunnel 7. Prior to the operation of the Balsam Meadow Project, water was transferred from Huntington Lake to Shaver Lake through this channel. Currently water from Huntington Lake enters Shaver Lake through Eastwood Powerhouse.

North Fork Stevenson Creek was evaluated for an approximate length of 16,081 feet upstream of the confluence with Shaver Lake. At approximately 14,098 feet upstream of the confluence, Tunnel 7 releases water into North Fork Stevenson Creek. The most upstream location surveyed is at an elevation of 7,082 feet above

MSL. The stream drops to an elevation of 5,434 feet above MSL at Shaver Lake (Map CAWG 1-8).

North Fork Stevenson Creek is a moderate to steep gradient, bedrock/boulder stream with Rosgen Aa+, A, B, C and G channels. The reach above the outlet is upstream of where flow released from Huntington Lake may have affected the channel. This reach was primarily cascade and bedrock sheet, which may limit the habitat value of this reach. However, smaller components of pool habitats were evaluated. Much of the reach downstream of the outlet was step pool and cascade or step run, but small components of riffles and other pools were also observed. Canopy cover downstream of the outlet was low. Pools upstream of the outlet were shallow, but many pools downstream of the outlet were up to three feet deep. Small amounts of fair to good quality spawning gravels were observed distributed downstream of the outlet, with little gravel of poor quality, upstream. Many waterfalls throughout the creek were complete barriers to upstream fish migration at all flows, and this is likely to fragment fish habitat in this reach. A large waterfall near the confluence with Shaver Lake limits access to fish from the lake.

ROSGEN LEVEL I CLASSIFICATION

North Fork Stevenson Creek consists of five Rosgen Level I channel types (Table CAWG 1-182). The reach upstream of the outlet is classified as an Aa+-type channel. Half of the reach downstream of the tunnel outlet is Aa+ channel (50.4 percent), with smaller components of B channel (20.2 percent) and C channel (17.1 percent) in the downstream reaches. There also are small components of G-type (8.1 percent) and A-type channels (4.3 percent) near the lake (Table CAWG 1-183).

MESOHABITAT

The Rosgen Aa+ reach above the Tunnel 7 outlet was predominantly composed of Hawkins fast water habitat type turbulent (68.1 percent) with the remainder composed of slow water habitat type scour pool (31.9 percent) (Figure CAWG 1-63). The predominant USFS-R5 habitat types were bedrock sheet (38.6 percent), cascade (29.4 percent) and step pool (19.6 percent) (Figure CAWG 1-64 and Map CAWG 1-16). There also was a substantial component of additional pool habitat composed of plunge pool and mid channel pool.

The Rosgen Aa+ channels below the Tunnel 7 outlet were predominantly composed of Hawkins fast water habitat type turbulent (68.3 percent) and slow water habitat type scour pool (21.1 percent). Nonturbulent and dammed pool were small components. The predominant USFS-R5 habitat types were cascade (37.9 percent), bedrock sheet (17.4 percent), step pool (16.5 percent) and high gradient riffle (11.8 percent). There were small components of additional pool habitats (mid channel pool, plunge pool and backwater pool) and flatwater habitats (trench chute, step run, pocket water and run), as well as a small component of low gradient riffle.

The small component of Rosgen A channel below the Tunnel 7 outlet was predominantly composed of Hawkins fast water habitat type turbulent (70.3 percent), with smaller components of nonturbulent (20.0 percent) and scour pool (9.7 percent). The predominant USFS-R5 habitat type was cascade (70.3 percent) with the remainder composed of step run (20 percent) and mid channel pool (9.7 percent).

The Rosgen B channel below the Tunnel 7 outlet was predominantly composed of Hawkins slow water habitat type scour pool (86.1 percent) with smaller components of and fast water habitat types turbulent and nonturbulent. The predominant USFS-R5 habitat type was step pool (86.1 percent). The remainder was high gradient riffle (9.6 percent) and step run.

The Rosgen C channel below the Tunnel 7 outlet was composed of Hawkins habitat types nonturbulent (43.9 percent), scour pool (41.2 percent) and turbulent (14.9 percent). The USFS-R5 habitat types included substantial components of flatwater habitat types including step run (36.2 percent) and run, pool habitat including main channel (17 percent), lateral scour (16.2 percent) and step pools, as well as high gradient (10 percent) and low gradient riffles. There was only a small component of cascade.

The Rosgen G channel below the Tunnel 7 outlet was composed predominantly of Hawkins slow water habitat type scour pool (57.5 percent), with smaller components of fast water habitat types nonturbulent (37.2 percent) and turbulent. The predominant USFS-R5 habitat type was step pool (57.5 percent), with a substantial component of step run (37.2 percent) and a small component of high gradient riffle.

Pool Depth

All pools in the reach above the Tunnel 7 outlet were shallow, with average pool depths in the zero to one foot depth range. Average pool depths in the reaches below the tunnel outlet were deeper, but all had average depths of three feet or less (Figure CAWG 1-65). The Rosgen Aa+ channel had average pool depths primarily in the one to two and two to three foot depth ranges. The one pool in the A channel was in the one to two foot depth range, and the pools in the B channel were in the two to three foot depth range. The C channel pools were predominantly in the one to two foot range with a few deeper, and the two pools in the G channel were in the two to three foot range.

Wood Count

Large woody debris (> six inches) counts were not performed in North Fork Stevenson Creek.

COVER SUMMARY

Average weighted cover in the reach above the Tunnel 7 outlet was composed of primarily of boulder/cobble (19 percent) with smaller amounts of woody debris, terrestrial vegetation, surface turbulence and bedrock (Table CAWG 1-184).

Average weighted cover in the Rosgen Aa+ channel below the Tunnel 7 outlet was composed primarily of boulder/cobble (21 percent) and bedrock (14 percent), with a smaller amount of surface turbulence (Table CAWG 1-185). Cover in the A channel was predominantly bedrock (17 percent), with smaller components of surface turbulence and boulder/cobble. Cover in the B channel was composed of bedrock (17 percent), boulder/cobble (16 percent) and surface turbulence (11 percent), with a small amount of woody debris. Cover in the C channel was predominantly boulder/cobble (26 percent) with smaller amounts of bedrock, surface turbulence, terrestrial vegetation, woody debris and undercut banks. Cover in the G channel was predominantly boulder/cobble (14 percent) and bedrock (11 percent), with smaller amounts of surface turbulence, woody debris and undercut banks.

CANOPY SUMMARY

Canopy cover above the Tunnel 7 outlet was fairly evenly distributed between the zero to 100 percent ranges and was composed of softwood (Table CAWG 1-186). Canopy cover below the outlet was low (Table CAWG 1-187). Over half of the habitat units had no canopy cover and most of the rest had 20 percent or less. Canopy cover was composed of hardwood and softwood.

FISH BARRIERS

One barrier to upstream fish migration was identified above the Tunnel 7 outlet (Total Number of Barriers). It is a waterfall of 15 feet in height located 1,232 feet upstream of the outlet in a cascade and forms a complete barrier to migration at all flows (Table CAWG 1-188).

Seventeen barriers to fish migration were identified below the Tunnel 7 outlet; 12 in the Rosgen Aa+ channel, two in the small component of A channel, and three in the B channel. All are waterfalls and all except one are complete barriers to migration at all flows. The first waterfall, 20 feet in height, is located 14,236 feet upstream of Shaver Lake in a cascade. The second waterfall, 10 feet in height, is located 14,104 feet upstream of the lake in a high gradient riffle and is the one that is only a partial barrier at all flows. The next twelve waterfalls are located 14,000, 13,729, 13,343, 11,775, 11,432, 10,769, 10,259, 9,054, 7,845, 7,145, 3,183, and 1,992 feet upstream of the lake in cascade, step pool, bedrock sheet, and high gradient riffle habitats. These waterfalls are of five feet, 22 feet, 13 feet, 20 feet, 20 feet, 35 feet, 20 feet, 40 feet, 18 feet, 23 feet, 30 feet, and 15 feet in height, respectively. The next waterfall is located 1,130 feet upstream of the lake in a cascade, and the final two waterfalls are located 903 and 457 feet upstream of the lake in cascades, 15 feet, 25 feet, and 30 feet in height, respectively (Table CAWG 1-189).

DOMINANT SUBSTRATES

The dominant substrates in the reach above the outlet were bedrock (averaging 32 percent) and boulders (averaging 24 percent) with smaller amounts of cobble, fines and sands and a very small amount of gravel (Table CAWG 1-190).

The dominant substrates in the reaches below the outlet were predominantly boulders and bedrock, with the addition of some sands in the Rosgen B, C and G channels (Table CAWG 1-191). The dominant substrates in the Rosgen Aa+ channels were bedrock (averaging 55 percent) and boulders (averaging 28 percent), with smaller amounts of cobble, sands and gravel. The dominant substrate in the A channel was predominantly bedrock (averaging 83 percent), with smaller amounts of boulders and sands. The dominant substrates in the B channel were primarily boulders (averaging 36 percent) and bedrock (averaging 26 percent), with smaller amounts of sands and cobble. The dominant substrates in the C channel were boulders (averaging 24 percent), cobble (averaging 23 percent) and sands (averaging 20 percent), with smaller amounts of bedrock and gravel. The dominant substrates in the G channel were bedrock (averaging 40 percent), sands (averaging 20 percent) and boulders (averaging 15 percent), with a smaller amount of cobble.

SPAWNING GRAVEL

A very small amount of spawning gravel was observed in the reaches above the Tunnel 7 outlet, located in plunge pool and mid channel pool habitats. It was of poor to fair quality (Table CAWG 1-192). A larger, but modest amount of gravel was found downstream of the outlet. Gravels in this reach were more widely distributed than above the outlet and of fair to good quality.

SIDE CHANNELS

Side channels were observed below the outlet in three out of 102 habitat units, for a total length of 239 feet of side channel. The side channels were composed of step pool, backwater pool and run habitats.

2.3.6 BIG CREEK DRAINAGE

The Big Creek segment starts at Dam 1 at Huntington Lake (Big Creek RM 9.9) and extends to Big Creek Powerhouse 8 at the confluence of Big Creek and the San Joaquin River Big Creek RM 0.0). Several reaches within Big Creek were evaluated, as well as several Project-affected tributaries that drain into Big Creek or into Huntington Lake upstream. One portion of one Big Creek reach was not habitat mapped on the ground because steep waterfalls resulted in access and safety issues. This reach was mapped visually.

The segments of Big Creek that were evaluated and their tributaries, from upstream to downstream, include:

- Big Creek from Dam 1 to Big Creek Powerhouse (PH) 1 (19,325 feet). Tributaries to this reach or upstream include Rancheria Creek, Portal Powerhouse Tailrace, and Pitman Creek.

- Big Creek from Dam 4 to Big Creek PH 2 (23,114 feet) and south-side tributaries Balsam, Ely and Adit No. 8 creeks

- Big Creek from Dam 5 to Big Creek PH 8 (8,170 feet)

The upstream segments of Big Creek Between Dam 1 and Powerhouse 1 are primarily composed of Rosgen Aa+-type channels, with smaller inclusions of A, B and G-type channels. Downstream reaches are predominantly composed of A-type channels, with smaller percentages of Aa+ and B-type channels. Waterfalls throughout these reaches formed complete barriers to fish migration.

Surveyed tributaries to Big Creek, from upstream to downstream, include Rancheria Creek (this was included in the Portal Project license application, it is included here to facilitate interpretation of information regarding the Portal tailrace, which was not part of that project), the Portal Tailrace (the lower portion of Rancheria Creek, a tributary to Big Creek), and Pitman, Balsam, and Ely creeks. Many of these tributaries have very steep channels and are classified as Rosgen Aa+-type channels, but other channel types were also evaluated in some reaches. Pitman, Balsam and Ely creeks each have a diversion structure located across the creek in a location where there is a natural change in channel slope. Habitat was evaluated above and below these diversion structures.

Detailed descriptions of these reaches are presented in this section.

2.3.6.1 Big Creek: Powerhouse 1 to Dam 1

INTRODUCTION

This segment of Big Creek was evaluated from Dam 1 (Big Creek RM 9.9) on the southwestern shore of Huntington Lake downstream to Big Creek Powerhouse 1 (19,325 ft, approximately RM 3.5). Big Creek has an elevation of 6,950 feet above MSL at the release point below Dam 1, and drops to an elevation of 4,836 feet above MSL at the confluence with the Big Creek Powerhouse 1 tailrace (Map CAWG 1-7).

A steep section (6,513 ft of Aa+ channel type) of this reach was not mapped on the ground due to difficulty in scaling the natural barriers (e.g. cascades, waterfalls) and safety concerns. This section was therefore mapped by surveying aerial photographs for mesohabitat types. Certain parameters were not collected for that part of the data collection; these include: Pool Depth, Wood Count, Cover, Canopy and Spawning Gravel.

This segment of Big Creek is a sandy, bedrock/boulder stream composed mostly of Rosgen Level I Aa+ channel type; with B, A, and G-type channels also present. It has a mixture of habitat types, including some that are fairly complex. A substantial number of habitat units had at least small amounts of large woody debris at the time of the survey. In the lower gradient channel types, there was considerable encroachment of riparian vegetation in the stream channel. In the ground mapped habitats, pools were mostly shallow, and small amounts of spawning gravel were observed in pools. Many waterfalls located within the approximately 7,438 feet of Aa+ channel upstream of Big Creek Powerhouse 1 form complete barriers to upstream fish migration at all flows.

ROSGEN LEVEL I CLASSIFICATION

This segment consists of four Rosgen Level I channel types. The majority of the reach is Aa+-type (45.8 percent) with approximately equal amounts of B-type and A type (26.7 and 21.2 percent, respectively). There is a small inclusion of G-type (6.3 percent) channel below the lake (Table CAWG 1-193).

MESOHABITAT

The Rosgen A channel was composed of Hawkins slow water habitat type scour pool (48.1 percent) and fast water habitat types nonturbulent (30.2 percent) and turbulent (21.4 percent) (Figure CAWG 1-66). Dammed pool was a very small component. The predominant USFS-R5 habitat types were step pool (32.7 percent) and run (16.4 percent), with substantial components of high gradient riffle (12.1 percent) and cascade (9.3 percent) (Figure CAWG 1-67 and Map CAWG 1-15). Additional pool habitats included mid-channel pool, plunge pool, lateral scour pool and backwater pool. Additional flatwater habitats included step run, pocket water and glide.

The Rosgen B channel was predominantly composed of Hawkins fast water habitat type nonturbulent (56.4 percent), as well as a substantial portion of slow water habitat type scour pool (35.3 percent). The remainder was classified as turbulent. The predominant USFS-R5 habitat types were run (31.3 percent) and step pool (26 percent), with substantial components of pocket water (15.1 percent) and step run (10 percent). Additional small components included pools (mid-channel pool, lateral scour pool, corner pool and plunge pool), cascade and high gradient riffle.

The Rosgen Aa+ channel was composed mostly of Hawkins fast water habitat types turbulent and nonturbulent (42 and 16 percent, respectively). Hawkins slow water habitat types were composed of scour pool and dammed pool (24 and five percent, respectively). The predominant USFS-R5 habitat type was cascade habitats (including waterfalls) (38 percent); other turbulent habitats include trench chute (three percent), bedrock sheet (two percent) and high gradient riffle (less than one percent). Pool habitats, including step pool (15 percent) midchannel pool (seven percent), plunge pool (six percent) and dammed pool (one percent), were the second most abundant habitat types. Run habitats, including pocket water (10 percent), step-run (three percent), and run (two percent) were the second most abundant habitat types.

One percent of the reach was dry, where the stream traveled approximately 73 feet under a boulder field. Twelve percent of the reach was unresolved due to heavy vegetation/image distortion.

The Rosgen G channel was composed predominantly of Hawkins fast water habitat types nonturbulent (61.4 percent) and turbulent (31.4 percent), with only a small component of scour pool (7.2 percent). The predominant USFS-R5 habitat type was step run (59.7 percent), with a substantial component of cascade (22.7 percent). There was a smaller component of high gradient riffle, as well as pool habitats (plunge pool and main channel pool) and run.

POOL DEPTH

Most of the average pool depths were in the one to two foot depth range. Only two pools measured in the Rosgen Aa+ channel were deeper, in the two to three-foot and three to four-foot depth range (Figure CAWG 1-68).

WOOD COUNT

A substantial number of habitat units in this segment of Big Creek had at least small amounts of large woody debris (> six inches) at the time of this survey (Tables CAWG 1-194 and 1-195). Many of the habitat units in the A and B channels had zero to five pieces of large woody debris and a few had five to 10 pieces. The Aa+ channel also had several units (five of 32 units) with zero to five pieces. Over half of habitat units in the small inclusion of G channel had large woody debris.

COVER SUMMARY

There was a variety of cover types. Average weighted cover in the Rosgen A channel was bedrock (12 percent) and smaller components of boulder/cobble, terrestrial vegetation, surface turbulence and woody debris (Table CAWG 1-196). Average weighted cover in the B channel was terrestrial vegetation (13 percent), with smaller amounts of bedrock, boulder/cobble, undercut banks, woody debris, surface turbulence and root wad. Average weighted cover in the Aa+ channel was bedrock (13 percent), boulder/cobble (13 percent), surface turbulence (seven percent), and terrestrial vegetation (five percent), with smaller amounts of woody debris. The Cover Summary does not include the 6,513 feet of Rosgen Aa+ aerial mapped channel. Average weighted cover in the G channel was terrestrial vegetation (nine percent), boulder/cobble (nine percent), surface turbulence, woody debris and bedrock.

CANOPY SUMMARY

Most of the units had some canopy cover, and a large number had a large percentage of canopy cover, up to 90 percent (Table CAWG 1-197). In the smaller percentage ranges, canopy cover was composed of softwood, but in the larger percentage ranges it was composed of hardwood. The Canopy Summary does not include the 6,513 feet of aerial Mapped channel.

FISH BARRIERS

Twelve barriers to fish migration were identified in this segment of Big Creek, all were located in the Rosgen Aa+ channel (Table CAWG 1-198). Five barriers were mapped from the ground, and seven were observed from the aerial photographs. All of the barriers were waterfalls that form complete barriers to migration at all flows. Barriers that were mapped from the ground occurred at 242, 563, 925, 7,573 and 7,589 feet upstream of Big Creek Powerhouse 1. These had heights of eight feet, 17 feet, 10 feet, 15 feet, and 20 feet, respectively. Barriers that were visible from the aerial photographs occurred at 1,712, 2,616, 2,792, 3,094, 3,189, 3,239 and 3,889 feet upstream of Big Creek Powerhouse 1. Dam 1 at Huntington Lake is a complete barrier to upstream fish migration.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen A channel were primarily sands (averaging 40 percent), boulders (averaging 30 percent) and bedrock (averaging 16 percent), with smaller amounts of gravel and fines (Table CAWG 1-199). The dominant substrates in the B channel were primarily sands (averaging 43 percent), boulders (averaging 20 percent) and bedrock (averaging 19 percent), with smaller amounts of gravel, fines and cobble. The dominant substrates in the ground mapped Aa+ channel sections were bedrock (averaging 43 percent) and smaller components of sands (averaging 18 percent) and boulders (averaging 18 percent), with a small amount of cobble. The aerial mapped section of the Aa+ section (6,513 feet) was composed mostly of bedrock with lesser amounts of boulder. The dominant substrates in the G channel were boulders (averaging 31 percent) and sands (averaging 28 percent), with smaller components of bedrock (averaging 13 percent), cobble (11 percent) and gravel.

SPAWNING GRAVEL

Small amounts of spawning gravel were found in pools (step pool, plunge pool, mid channel pool and lateral scour pool) and flatwater habitats (glide, run, and pocket water) (Table CAWG 1-200). Gravels were of fair to good quality.

SIDE CHANNELS

No side channels were observed in this segment of Big Creek.

2.3.6.2 Big Creek: Powerhouse 2 to Dam 4

INTRODUCTION

This segment of Big Creek begins at Dam 4 (Big Creek RM 6.2) located downstream of Pitman Creek, and extends to Big Creek Powerhouse 2 (RM 1.9). Big Creek

Powerhouse 2 is located downstream of Adit No. 8 Creek near the confluence of Ordinance Creek with Big Creek.

Water for Big Creek Powerhouse 2 is diverted from Dam 4 and includes the discharge of Big Creek Powerhouse 1, Big Creek and Pitman Creek. Dam 4 serves as the forebay for Big Creek Powerhouse 2.

Dam 4 is a 75-foot high constant-radius concrete arch dam with a crest length of 287 feet at elevation 4,805 MSL. The crest without flashboards is at an elevation 4,805 MSL. The reservoir net storage capacity with the flashboards in place at elevation 4,810 feet MSL is 60-acre feet.

The segment of Big Creek was evaluated from Dam 4 to Big Creek Powerhouse 2 for a ground length of 23,144 feet (Map CAWG 1-7). Big Creek has an elevation of 4,811 feet above MSL below Dam 4, and drops to an elevation of 2,972 feet above MSL at Big Creek Powerhouse 2.

Big Creek from Dam 4 to Powerhouse 2 is a moderately steep, bedrock/boulder stream comprised primarily of Rosgen A channel, with a small inclusion of B channel. It primarily includes step pool and cascade habitats. However, substantial amounts of pool, riffle and flatwater habitats also were present. A substantial number of habitat units had at least small amounts of large woody debris at the time of the survey. There were many pools and many of them were moderately to very deep. A fair amount of spawning gravel was observed in pools. Five waterfalls located in the upstream half of this segment of Big Creek form complete barriers to upstream fish migration at all flows. Dam 4 was a complete barrier to upstream fish migration at the upstream end of the reach.

ROSGEN LEVEL I CLASSIFICATION

This segment consists of two Rosgen Level I channel types. The majority of the reach (95.3 percent) is A-type channel, and there is a small inclusion of B-type channel (4.7 percent) in the upstream portion of the segment (Table CAWG 1-201).

MESOHABITAT

The Rosgen A channel was predominantly composed of Hawkins slow water habitat type scour pool (61.1 percent) and fast water habitat type turbulent (28.4 percent) (Figure CAWG 1-69). This reach also had components of nonturbulent and dammed pool. The predominant USFS-R5 habitat types were step pool (42.4 percent) and cascade (19.6 percent), but there were a variety of other habitat types (Figure CAWG 1-70 and Map CAWG 1-15). A substantial amount of additional pool habitat included primarily mid channel pool, plunge pool, and lateral scour pool. Additional habitat components included high gradient riffle (7.1 percent) and small sections of flatwater habitats (pocket water, trench chute, step run, run and glide), as well as bedrock sheet.

The Rosgen B channel was predominantly composed of Hawkins slow water habitat type scour pool (50.2 percent) and fast water habitat type turbulent (45.5 percent), with only a small component of nonturbulent. Half of the USFS-R5 habitat types were pools including step pool (34.8 percent), plunge pool (10.6 percent), and mid channel pool (4.9 percent). There were substantial components of high gradient riffle (15.4 percent), and of cascade habitats including bedrock sheet (20.7 percent) and cascade. There was a small component of trench chute.

Pool Depth

This segment of Big Creek had many pools, the majority of which had an average pool depth in the one to two-foot range (Figure CAWG 1-71). However, the Rosgen A channel had many pools that were deeper, and a few pools had an average pool depth up to the eight to nine-foot depth range. The Rosgen B channel had only one deep pool with an average depth in the three to four foot depth range.

Wood Count

Large woody debris (> six inches) was observed in many habitat units at the time of this survey (Tables CAWG 1-202 and 1-203). In the A channel, 33 of 186 habitat units had zero to five pieces and 10 units had more. Two of the habitat units in the small segment of B channel had small amounts of large woody debris as well.

Cover Summary

Average weighted cover in the Rosgen A channel was primarily composed of boulder/cobble (14 percent) and bedrock (12 percent) (Table CAWG 1-204). There were also smaller amounts of surface turbulence and undercut bank. Average weighted cover in the Rosgen B channel was also primarily composed of bedrock (13 percent) and boulder/cobble (10 percent), with a small amount of surface turbulence.

Canopy Summary

Generally, canopy cover was low (Table CAWG 1-205). In most habitat units it ranged from zero to 20 percent. Canopy cover was composed of hardwood and softwood.

Fish Barriers

Five barriers to upstream fish migration were identified in this segment of Big Creek, all of them located in Rosgen A channel (Table CAWG 1-206). All are waterfalls that form complete barriers to migration at all flows. Two waterfalls are located 16,398 and 15,285 feet upstream of Big Creek Powerhouse 2 in cascades with heights of eight feet and four feet, respectively. The third and fourth waterfalls are located 14,828 and 14,600 feet upstream of Big Creek Powerhouse 2 in mid channel pool and step pool habitats with heights of nine feet and 60 feet, respectively. The fifth waterfall is located 11,851 feet upstream of the powerhouse in a cascade and has a height of 10 feet. Dam 4 also acts as a complete barrier to upstream fish migration.

DOMINANT SUBSTRATES

The dominant substrates in the Rosgen A channel were bedrock (averaging 40 percent) and boulders (averaging 31 percent) (Table CAWG 1-207). Additional dominant substrates included sands, cobble, fines and gravel. The dominant substrate in the Rosgen B channel was bedrock (averaging 69 percent), with a smaller component of boulders (averaging 23 percent). There were small components of gravel and cobble.

SPAWNING GRAVEL

A small amount of amount of spawning gravel was observed, mostly located in step pools and plunge pools (Table CAWG 1-208). Small amounts were observed in pool and high gradient riffle habitats. These were generally of fair to good quality.

SIDE CHANNELS

Side channels were observed in seven out of 294 habitat units, for a total length of 169 feet of side channel. The side channel units included two cascades, one trench chute, one run, and three pools including plunge pool, mid channel pool and step pool.

2.3.6.3 Big Creek: Powerhouse 8 to Dam 5

This segment of Big Creek begins at Dam 5 located downstream of Adit No. 8 Creek at Big Creek RM 1.7, and extends to Powerhouse 8 near RM 0.0. Powerhouse 8 is located at the confluence of Big Creek with the San Joaquin River.

Dam 5 is built across Big Creek just downstream of Powerhouses 2/2A. It is a constant-radius concrete arch dam, 60 feet high. The crest, at elevation 2,950 feet above MSL, is 224 feet long. It impounds the discharge from both powerhouses to form a regulating reservoir and forebay for Powerhouse 8 downstream. The dam creates a reservoir with a net capacity of 49 acre feet (53 acre feet with dam flashboards installed) and a surface area of 3.3 acres when the water surface is at elevation 2,943 feet MSL.

This segment of Big Creek was evaluated from Powerhouse 8 to Dam 5 for a length of 8,170 feet (Maps CAWG 1-7 and CAWG 1-8). Big Creek has an elevation of 2,947 feet above MSL at the release point below Dam 5, and drops to an elevation of 2,284 feet above MSL at Powerhouse 8

Big Creek from Big Creek Powerhouse 8 to Dam 5 is a moderately steep, bedrock/boulder stream composed primarily of Rosgen A channel, with a smaller component of Aa+ channel at its downstream end. It has mostly step pool and other pool habitats. Only small amounts of riffle and flatwater habitats occurred. Although most of the pools were shallow, there were many pools that were moderately to very deep. Many of the habitat units had small amounts of large woody debris at the time of the survey. Canopy cover was low. Small amounts of spawning gravel were observed in pools. Two waterfalls near Big Creek Powerhouse 8 form complete barriers to upstream fish migration at all flows. Dam 5 also provides a complete barrier to upstream fish migration.

ROSGEN LEVEL I CLASSIFICATION

This segment consists of two Rosgen Level I channel types. The majority of the reach is classified as an A-type channel (70.9 percent) (Table CAWG 1-209). The remainder, immediately upstream of the confluence with the San Joaquin River, is classified as an Aa+-type channel (29.1 percent).

MESOHABITAT

The dominant USFS-R5 habitat type was step pool (46.3 percent) with a substantial component of additional pool habitat including mid channel pool (10.6 percent), lateral scour pool (11.9 percent) and plunge pool. Additional habitat components included cascade (11.3 percent), high and low gradient riffle, bedrock sheet, run, step run and trench chute.

The Rosgen A channel was predominantly composed of Hawkins slow water habitat type scour pool (77.8 percent) with a smaller component of fast water habitat type turbulent (19.4 percent) (Figure CAWG 1-72). This reach also had a small component of nonturbulent habitat. The dominant USFS-R5 habitat types were pools including step pool (41.5 percent), lateral scour pool (16.4 percent), mid channel pool (10.5 percent) and plunge pool (9.3 percent) (Figure CAWG 1-73 and Map CAWG 1-15). Additional habitat components included high gradient (7.7 percent) and low gradient riffles, as well as small components of flatwater habitat (run, step run, and trench chute) and cascade and bedrock sheet.

The Rosgen Aa+ channel was predominantly composed of Hawkins slow water habitat type scour pool (72.4 percent), with a smaller component of fast water habitat type turbulent (23.4 percent). Nonturbulent was a small component. The dominant USFS-R5 habitat types were pools including step pool (57.9 percent), mid channel pool (10.9 percent) and small components of plunge pool, and lateral scour pool. There was a substantial component of cascade (19 percent). There were only small components of high gradient riffle, run, step run, trench chute, and bedrock sheet.

POOL DEPTH

This segment of Big Creek had many pools, the majority of which were shallow with an average pool depth in the one to two foot range or less (Figure CAWG 1-74). In the Rosgen A channel, many pools were deeper, and a few had an average pool depth up to the six to seven foot depth range. The Rosgen Aa+ channel had three deeper pools, ranging to the six to seven foot average pool depth range.

WOOD COUNT

Large woody debris (> six inches) (Tables CAWG 1-210 and 1-211) was observed in many habitat units at the time of this survey. In the A channel, 12 of the 70 habitat units had up to five pieces, and one had more. In the Aa+ channel, three of the 28 habitat units had up to five pieces.

COVER SUMMARY

Average weighted cover was primarily composed of boulder/cobble and bedrock, with smaller amounts of surface turbulence (Table CAWG 1-212). The Rosgen Aa+ channel also had a small amount of terrestrial vegetation.

CANOPY SUMMARY

Generally, canopy cover was low (Table CAWG 1-213). Over half of the habitat units had no canopy cover, and most of the remainder had canopy cover in the zero to 20 percent ranges. Canopy cover was composed predominantly of hardwood.

FISH BARRIERS

Two barriers to upstream fish migration were identified in this segment of Big Creek, located in Rosgen Aa+ channel (Table CAWG 1-214). Both are waterfalls that form complete barriers to migration at all flows. They are located 476 and six feet upstream of Big Creek Powerhouse 8 and both barriers are located in cascades. The heights of the waterfalls were 25 feet and 18 feet, respectively. Dam 5 also acts as a complete barrier to upstream fish migration.

DOMINANT SUBSTRATES

The dominant substrates in this segment of Big Creek were predominantly bedrock and boulders, with small amounts of cobble and sands (Table CAWG 1-215). The Rosgen Aa+ channel also had small components of gravel and fines.

SPAWNING GRAVEL

Small amounts of spawning gravel were observed, mostly located in step pools, with smaller amounts in additional pool habitats (lateral scour pool, mid channel pool and plunge pool). Gravel quality ranged from poor to excellent, with most deposits classified as fair (Table CAWG 1-216).

SIDE CHANNELS

Side channels were observed in four out of 117 habitat units, for a total length of 120 feet of side channel. The side channel units included two high gradient riffles and two lateral scour pools.

2.3.7 BIG CREEK TRIBUTARIES

2.3.7.1 Upper Segment of Rancheria Creek

INTRODUCTION

Rancheria Creek is a low to moderate gradient tributary of Big Creek located upstream of Huntington Lake. There are two segments of Rancheria Creek. One segment begins with the confluence of Rancheria Creek with the Portal Powerhouse tailrace and extends upstream. This is the upper segment. The other segment is the Portal Powerhouse tailrace from Huntington Lake upstream to the powerhouse. Both segments have been subject to alteration. The upper segment of Rancheria Creek was evaluated for a total length of 3,522 feet. This includes a length of 1,510 feet above the energy dissipater and a total length of 2,012 feet below the energy dissipater to the Portal Powerhouse tailrace (Map CAWG 1-7). The most upstream location surveyed in the upper segment of Rancheria Creek has an elevation of 7,099 feet above MSL. The stream drops to an elevation of 7,018 feet above MSL at the energy dissipater, and then drops to an elevation of 6,952 feet above MSL at the point at which it has its confluence with the powerhouse tailrace.

The upper segment of Rancheria Creek is a low to moderate gradient stream composed of Rosgen B and A channels. The Rosgen B channel above and below the energy dissipater were a mixture of riffle, run and pool habitats, and the B channel below the energy dissipater also had a component of cascade. In the Rosgen A channel immediately above the powerhouse tailrace, run, step run and cascade habitats were the principal habitat types. There were a variety of cover types in Rancheria Creek. Pools were shallow. Only small amounts of spawning gravel were observed above and below the diversion in low gradient riffles and pools, and no barriers to upstream fish migration were identified.

ROSGEN LEVEL I CLASSIFICATION

Rancheria Creek consists of two Rosgen Level I channel types. The channel above the energy dissipater is classified as a B-type channel (Table CAWG 1-217). Approximately half of the surveyed segment below the energy dissipater is classified as B-type channel (49.9 percent). The remainder, located between the B channel and the confluence with the powerhouse tailrace, is classified as A-type channel (50.1 percent) (Table CAWG 1-218).

MESOHABITAT

The Rosgen B channel above the energy dissipater was predominantly composed of Hawkins fast water habitat types nonturbulent (48.5 percent) and turbulent (33.4 percent) (Figure CAWG 1-75). Slow water habitat type scour pool and dammed pool were smaller components. The predominant USFS-R5 habitat types were run (34.2 percent) and high gradient riffle (22.5 percent) (Figure CAWG 1-76 and Map CAWG 1-15). There was a substantial component of pool habitat composed of mid channel pool, plunge pool, lateral scour pool and dammed pool, as well as components of other habitat types including step run and low gradient riffle. There were also small components glide and cascade.

The Rosgen B channel below the energy dissipater was predominantly composed of Hawkins fast water habitat types turbulent (41.6 percent) and nonturbulent (30.3 percent), with the remainder classified as scour pool (28.1 percent). The predominant USFS-R5 habitat types were low gradient riffle (30.3 percent), step run (21.2 percent), and pool habitat composed of mid channel pool (18 percent) and lateral scour pool (10.1 percent). Smaller components included high gradient riffle (11.3 percent) and run (9.1 percent).

The Rosgen A channel was located between the B channel and the confluence with the powerhouse tailrace. This reach was composed primarily of Hawkins non-turbulent habitat (75.3 percent) with 24.7 percent turbulent habitat. The dominant USFS-R5 habitat was run (59.1 percent), with the remainder cascade, step run, and low gradient riffle. No pools were found in this reach.

POOL DEPTH

The majority of pools are located upstream of the energy dissipater, and most of these pools have an average depth of less than two feet (Figure CAWG 1-77). The pools in the Rosgen B channel below the energy dissipater also were shallow, generally with an average pool depth in the one to two foot range or less. There were no pools in the Rosgen A channel.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Rancheria Creek.

COVER SUMMARY

Average weighted cover for fish above the energy dissipater was primarily terrestrial vegetation (23 percent) and boulder/cobble (12 percent), with smaller amounts of surface turbulence, woody debris and undercut banks (Table CAWG 1-219). Average weighted cover in the Rosgen B channel below the energy dissipater was primarily terrestrial vegetation (28 percent) and surface turbulence (19 percent), with smaller amounts of boulder/cobble, undercut banks and woody debris (Table CAWG 1-220). Average weighted cover in the Rosgen A channel just upstream of the Portal Power tailrace was primarily boulder/cobble (38 percent), with smaller amounts of surface turbulence (19 percent) and terrestrial vegetation (14 percent).

CANOPY SUMMARY

In the reach above the energy dissipater, canopy cover was low, with most units in the zero to 10 percent range (Table CAWG 1-221). In the reaches below the energy dissipater, canopy cover ranged from zero to 100 percent (Table CAWG 1-222). Canopy cover was composed of predominantly of softwood in both reaches.

FISH BARRIERS

No barriers to fish migration were identified in Rancheria Creek.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the energy dissipater were primarily cobble (averaging 41 percent) and sand (averaging 31 percent), with a smaller amount of boulders (Table CAWG 1-223). The dominant substrates in the Rosgen B channel below the energy dissipater were primarily sands (averaging 42 percent) and cobble (averaging 23 percent), with smaller amounts of boulders and gravel (Table CAWG 1-224). In the Rosgen A channel dominant substrates were cobble (averaging 28 percent), sands (averaging 26 percent) and boulders (averaging 24 percent).

SPAWNING GRAVEL

Above the energy dissipater, a very small amount of spawning gravel was observed in low gradient riffle habitat (Table CAWG 1-225). A small amount was also observed in the Rosgen B channel below the energy dissipater in low gradient riffle and mid channel pool habitat (Table CAWG 1-226). No spawning gravel was found in the Rosgen A channel reach. Gravel quality ranged from poor to fair.

SIDE CHANNELS

No side channels were observed on Rancheria Creek.

2.3.7.2 Lower Segment of Rancheria Creek Portal Powerhouse Tailrace Reach

INTRODUCTION

The lower segment of Rancheria Creek consists of the Portal Powerhouse Tailrace reach. This is the short length of stream (432 feet) between Portal Powerhouse downstream to the confluence with Huntington Lake. This reach was altered to accommodate discharge from Ward Tunnel to Huntington Lake. Currently that discharge comes by way of Portal Powerhouse or a Howell-Bunger (HB) valve at the end of Ward Tunnel. The Portal Tailrace reach is at 6,952 feet above MSL at the Portal Powerhouse, and drops to an elevation of 6,949 feet above MSL at the confluence with Rancheria Creek. (Map CAWG 1-7)

The Portal Power Tailrace reach is a low to moderate gradient stream with a Rosgen C channel. It is composed mostly of run habitat and a smaller component of cascade. Cover is composed primarily of boulder/cobble. There were no pools, no canopy cover and no spawning gravel. No barriers to fish migration were identified.

ROSGEN LEVEL I CLASSIFICATION

The Portal Powerhouse Tailrace reach is heavily modified, but is provisionally classified as a Rosgen Level I C-type channel. This reach has a fairly low gradient channel slope. (Table CAWG 1-227)

MESOHABITAT

This reach was composed entirely of Hawkins fast water habitat types nonturbulent (70.4 percent) and nonturbulent (29.6 percent) (Figure CAWG 1-78). The predominant USFS-R5 habitat type was run (70.4 percent) with the remainder cascade (29.6 percent) (Figure CAWG 1-79 and Map CAWG 1-15). There were no pools observed in the Portal Powerhouse Tailrace reach at the flow evaluated.

POOL DEPTH

No pools were found in the Portal Power Tailrace reach.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in the Portal Powerhouse Tailrace reach.

COVER SUMMARY

Average weighted cover was boulder/cobble (56 percent) and surface turbulence (19 percent) (Table CAWG 1-228).

CANOPY SUMMARY

There was no canopy cover in the Portal Power Tailrace reach.

FISH BARRIERS

No barriers to upstream fish migration were identified.

DOMINANT SUBSTRATES

The dominant substrates were boulders (averaging 60 percent) and cobble (averaging 10 percent) (Table CAWG 1-229).

SPAWNING GRAVEL

No spawning gravel was observed during habitat mapping. However, discharge from Ward Tunnel and backwater from Huntington Lake prevented an adequate assessment of spawning gravels. Observations made during low water level and flow indicated that some gravels were present.

SIDE CHANNELS

No side channels were observed in the Portal Power Tailrace reach.

2.3.7.3 Pitman Creek

INTRODUCTION

Pitman Creek is part of the first large watershed draining to Big Creek downstream of Huntington Lake. Pitman Creek has its confluence with Big Creek near Big Creek RM 6.3. It is a moderate gradient stream above the Pitman Creek diversion, and a very steep gradient, granitic stream below the diversion. The diversion is located at a point in the stream where there is a natural break in the channel slope (Map CAWG 1-7).

Pitman Creek Diversion, located across Pitman Creek approximately 1-1/2 miles east of Big Creek, is a concrete diversion, 10 feet high. The crest, at elevation 6,998 feet above MSL, is 68 feet long. Diverted water is conveyed through a 185-foot-deep bore hole abutting the left side of the dam face, which intersects Tunnel No. 7. The top of the hole, protected by trash grids, has a 17-by-31 foot cross section that tapers down to a six foot-square bore through granite. Flow into the bore hole is controlled by three four-by-11 foot, slide gates at its upstream end. In 2001, the gates were replaced as part of an improvement agreement. In 2002, motor drives with remote operation capability were added to the gates and the existing trash rack at the intake was realigned and rebuilt. Additionally, a new 12-inch release pipe and intake grid was installed through the dam and extended downstream to a location approximately 25 feet downstream of the dam. An acoustic flow meter measures the instream flow release and transmits flow data to the project operator via datalogger/FM radio.

Pitman Creek was evaluated for a length of 1,506 feet above the Pitman Creek Diversion, and for a length of 6,222 feet below the Pitman Creek Diversion. The most upstream location surveyed in Pitman Creek has an elevation of 7,113 feet above MSL. The stream drops to an elevation of 7,034 feet above MSL at the Pitman Creek Diversion, then drops steeply to an elevation of 4,843 feet above MSL at its confluence with Big Creek.

Pitman Creek is a bedrock/boulder stream with moderate gradient stream channel above the diversion and a very steep channel below the diversion. The Rosgen Level I B channel above the diversion consisted of mostly step pool and flatwater habitats including run and glide, but had small components of complex habitats such as pocket water and riffle. The Rosgen Aa+ and B channels below the diversion was almost completely step pool, cascade and bedrock sheet, with only small components other pool habitats and pocket water. Pools above the diversion were shallow, but below the diversion there were many pools that were moderately to very deep. The only spawning gravels observed were small amounts above the diversion. Four barriers to upstream fish migration at all flows are likely to fragment habitat in the reach downstream of the diversion, and one of these was located at the confluence with Big Creek. Pitman Diversion also forms a complete barrier to upstream fish migration.

ROSGEN LEVEL I CLASSIFICATION

Pitman Creek consists of two Rosgen Level I channel types. The reach above the Pitman Creek Diversion is classified as a B-type channel (Table CAWG 1-230). The majority of the reach below the diversion is Aa+ channel (87.8 percent), with a smaller component of as B-type channel (12.2 percent) near the diversion (Table CAWG 1-231).

MESOHABITAT

The Rosgen B channel above the diversion was composed of Hawkins slow water habitat type scour pool (48.5 percent) and fast water habitat types nonturbulent (36.4 percent) and turbulent (15.1 percent) (Figure CAWG 1-80). The predominant USFS-R5 habitat type was step pool (40.6 percent) (Figure CAWG 1-81 and Map CAWG 1-15). There were also substantial components of flatwater habitats including glide (16.3 percent), pocket water (11.7 percent) and run (8.4 percent). There were small components of additional pool habitat, including mid channel pool and lateral scour pool. Additional habitat types included bedrock sheet, cascade, and high gradient riffle.

The Rosgen Aa+ channel below the diversion was predominantly composed of Hawkins slow water habitat type scour pool (44.8 percent) and fast water habitat type turbulent (44.7 percent). Nonturbulent and dammed pool were small components. The predominant USFS-R5 habitat types were step pool (39.8 percent) and cascade (40.1 percent). There were also smaller components of additional pool habitat including plunge pool and dammed pool, and flatwater habitat including pocket water, trench chute, run and glide. There was only a small component of bedrock sheet.

The Rosgen B channel below the diversion was predominantly composed of Hawkins habitat types scour pool (54.1 percent) and turbulent (36.2 percent), with a smaller component of dammed pool. The predominant USFS-R5 habitat types were step pool (41.4 percent) and bedrock sheet (36.2 percent), and the remainder were pool habitats including dammed pool, plunge pool and mid channel pool.

POOL DEPTH

The pools within the Rosgen B channel above the Pitman Creek diversion were shallow, with average pool depths in the zero to one or one to two foot depth range (Figure CAWG 1-82). Pools in the Rosgen Aa+ channel below the diversion were deeper. Many of the average pool depths were in the two to three foot or three to four foot depth range, and several were much deeper, up the greater than 10-foot depth range. Pools in the Rosgen B channel below the diversion were shallow, generally with an average depth of less than two feet.

Wood Count

Large woody debris (> six inches) counts were not performed in Pitman Creek

Cover Summary

Average weighted cover in the Rosgen B channel above the diversion was primarily bedrock (19 percent) and boulder/cobble (17 percent), with small amounts of undercut banks, terrestrial vegetation and surface turbulence (Table CAWG 1-232). Cover in the reaches below the diversion was similar. Average weighted cover in the Rosgen Aa+ channel below the diversion was primarily bedrock (22 percent) and boulder/cobble (19 percent), with small amounts of surface turbulence and undercut banks (Table CAWG 1-233). In the Rosgen B channel below the diversion it was primarily bedrock (28 percent) with smaller components of boulder/cobble and undercut banks.

Canopy Summary

There was canopy cover in all of the habitat units above the diversion, with canopy cover fairly evenly distributed between zero to 70 percent ranges. Canopy cover was composed of softwood. Canopy cover in the reach below the diversion was primarily in the zero or zero to 10 percent ranges, but some units had more. Canopy cover was composed mostly of softwood (Tables CAWG 1-234 and 1-235).

Fish Barriers

No barriers to fish migration were identified in the reach above the diversion. Four barriers to upstream fish migration were identified in the Rosgen Aa+ channel below the diversion. All four formed complete barriers to migration at all flows. Three waterfalls were located 2,111, 1,365, and 917 feet upstream of the confluence with Big Creek in cascade, plunge pool and bedrock sheet habitats respectively. The heights of these barriers were six feet, 28 feet, and 20 feet, respectively. The other barrier was located at the dammed pool at the confluence with Big Creek. It had a height of nine feet. Pitman Diversion also was a barrier to upstream fish migration (Table CAWG 1-236).

Dominant Substrates

The dominant substrates in the reach above the diversion were primarily cobble (averaging 32 percent), bedrock (averaging 31 percent), and boulders (averaging 15 percent), with smaller amounts of gravel and sands (Table CAWG 1-237). The dominant substrate in the Rosgen Aa+ channel below the diversion was mostly bedrock (averaging 79 percent) with smaller amounts of boulders, cobble, and fines (Table CAWG 1-238). In the Rosgen B channel below the diversion it was also predominantly bedrock (averaging 79 percent), with small amounts of fines, sands, boulders and cobble.

SPAWNING GRAVEL

Small amounts of spawning gravel were observed in the reach above the diversion, located in run and lateral scour pool habitats (Table CAWG 1-239). Gravels were generally of good quality. No spawning gravel was observed in the reach below the diversion.

SIDE CHANNELS

Side channels were observed below the diversion in two out of 63 habitat units. The side channel units included a step pool and a plunge pool.

2.3.7.4 Balsam Creek

INTRODUCTION

Balsam Creek is a small, steep, granitic stream on the southern side of Big Creek with a confluence with Big Creek at Big Creek RM 4.9, downstream of Dam 4 and Pitman Creek. Balsam Creek Diversion is located at a point in the stream where there is a natural break in the channel slope (Map CAWG 1-7).

Balsam Creek Diversion, located across Balsam Creek approximately two miles southwest of Big Creek, is a nine foot high, concrete diversion with a crest length of 72 feet. Diverted water is conveyed through approximately 400 feet of 12-inch diameter steel pipe to Tunnel No. 2 where it enters through Adit No. 3. Flow through the conduits controlled by a gate valve located upstream of the diversion structure.

Balsam Creek was evaluated for a length of 1,637 feet above the Balsam Creek Diversion and a length of 3,802 feet below the diversion. Balsam Creek has an elevation of 5,198 feet above MSL at the upstream end, drops to an elevation of 4,865 feet at the Balsam Creek Diversion, then drops to an elevation of 4,140 feet MSL at the confluence with Big Creek.

Balsam Creek is a steep, bedrock stream with a Rosgen Level I Aa+ channel. It has pool, riffle, cascade and flatwater habitats. Pools were shallow, but the reaches above and below the diversion each had one deep pool. Small amounts of spawning gravel were observed above and below the diversion in low gradient riffles, runs and pools. Balsam Creek had many waterfalls throughout that formed complete barriers to upstream fish migration at all flows. Balsam Diversion also was a complete barrier to upstream migration.

ROSGEN LEVEL I CLASSIFICATION

Balsam Creek is classified as a Rosgen Level I Aa+-type channel both above and below the diversion (Tables CAWG 1-240 and 1-241).

MESOHABITAT

The reach above the diversion was composed of Hawkins slow water habitat type scour pool (44.9 percent) and fast water habitat types turbulent (28.3 percent) and nonturbulent (24.1 percent) (Figure CAWG 1-83). Dammed pool was a very small component. The predominant USFS-R5 habitat types were step pool (31.6 percent) and high gradient riffle (15 percent) (Figure CAWG 1-84 and Map CAWG 1-15). There was also a substantial component of flatwater habitat including run, step run and trench chute, as well as additional pool habitat including plunge pool, dammed pool, mid channel pool and lateral scour pool. There were small components of bedrock sheet and cascade.

The reach below the diversion was composed of Hawkins fast water habitat types turbulent (44.2 percent) and nonturbulent (12.9 percent), and slow water habitat type scour pool (39.4 percent). Dammed pool was a very small component. The predominant USFS-R5 habitat types were step pool (32.8 percent), bedrock sheet (21.5 percent) and high gradient riffle (11.9 percent). There were also components of cascade, flatwater habitat including step run, run, and trench chute, and additional pool habitat including plunge pool, dammed pool, lateral scour pool and mid channel pool. Road crossing was a very small component.

POOL DEPTH

The pools in Balsam Creek were shallow, with average pool depths mostly in the zero to one foot depth range. However, the reaches above and below the diversion each had one pool that was deep, in the three to four and four to five foot depth ranges (Figure CAWG 1-85).

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Balsam Creek.

COVER SUMMARY

Average weighted cover in the reach above the diversion was primarily boulder/cobble (21 percent) and surface turbulence (11 percent), with smaller amounts of bedrock, undercut banks, and woody debris (Table CAWG 1-242). Average weighed cover in the reach below the diversion was also primarily boulder/cobble (15 percent) and surface turbulence (10 percent), with smaller amounts of bedrock, undercut banks and root wad (Table CAWG 1-243).

CANOPY SUMMARY

Canopy cover in all of the habitat units above the Balsam Creek diversion was high, with canopy cover in the 40 to 90 percent ranges (Table CAWG 1-244). Canopy cover was composed of softwood. Canopy cover in the reach below the diversion was also high, primarily in the 40 to 80 percent ranges (Table CAWG 1-245). Canopy cover was composed mostly of softwood.

FISH BARRIERS

Balsam Creek has many waterfalls that act as barriers to fish migration. Three waterfalls were identified as barriers to migration in the reach above the diversion, all located in plunge pools. Two waterfalls located 1,404 and 1,285 feet upstream of the diversion are complete barriers to migration at all flows. The heights of these barriers were 18 feet, and 30 feet, respectively. One is located 483 feet upstream of the diversion and is five feet in height. It is a complete barrier to migration only at low flows. The diversion also serves as a complete barrier to upstream migration (Table CAWG 1-246).

Ten barriers to fish migration were identified in the reach below the diversion (Table CAWG 1-247). They are also waterfalls. The first eight waterfalls are complete barriers to migration at all flows. They are located 4,256, 3,526, 2090, 2037, 1,506, 1,397, 1,145, and 454 feet upstream of the confluence with Big Creek in bedrock sheet, step pool and plunge pool habitats. The heights of these barriers were 30 feet, nine feet, 12 feet, 15 feet, 21 feet, 13 feet, 35 feet, 69 feet, 60 feet, and nine feet, respectively. The ninth waterfall is located 312 feet upstream of the confluence in a plunge pool and is only a partial barrier at low flows. It has a height of three feet. The final waterfall is located 105 feet upstream of the confluence in a step pool and is a complete barrier to migration at all flows. It has a height of 27 feet.

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were primarily sands (averaging 25 percent), and bedrock (averaging 20 percent), with smaller amounts of boulders, cobble, gravel and fines (Table CAWG 1-248). The dominant substrates in the reach below the diversion were also primarily bedrock (averaging 32 percent) and sands (averaging 28 percent), with smaller amounts of boulders, cobble, and gravel (Table CAWG 1-249).

SPAWNING GRAVEL

Very small amounts of spawning gravel were observed in the reach above the diversion, located in high gradient riffle and run habitats (Table CAWG 1-250). Small amounts of spawning gravels were observed in the reach below the diversion, located in high gradient riffle, step pool and step run habitats (Table CAWG 1-251). Gravel quality was varied, but largely fair.

SIDE CHANNELS

A side channel was observed below the diversion in one out of 62 habitat units, for a total length of 37 feet of side channel. The side channel unit was a bedrock sheet.

2.3.7.5 Ely Creek

INTRODUCTION

Ely Creek is a small tributary on the southern side of Big Creek located between Dam 4 and Dam 5. It has its confluence with Big Creek at Big Creek RM 3.3. It is a very steep, granitic stream that flows downstream of Ely Meadow. Ely Creek Diversion is located at a point in the stream where there is a natural break in the channel slope (Map CAWG 1-7).

Ely Creek Diversion, located across Ely Creek approximately three miles southwest of Big Creek, is a seven-foot high, concrete diversion with a crest length of 44 feet. Diverted water is conveyed through approximately 300 feet of 12-inch diameter steel pipe to Tunnel No. 2 where it enters through Adit No. 6. Flow through the conduit is controlled by a gate valve located upstream of the diversion structure.

Ely Creek was evaluated for a length of 1,350 feet above the diversion and a length of 5,961 feet below the diversion. Ely Creek has an elevation of 5,361 feet above MSL at the upstream end, drops to an elevation of 4,856 feet above MSL at the Ely Creek Diversion, then drops to an elevation of 3,454 feet above MSL at the confluence with Big Creek.

Ely Creek is a very steep, bedrock/boulder stream with a Rosgen Level I Aa+ channel. The reach above the diversion was primarily cascade and bedrock sheet, which may limit the habitat value of this reach. However, smaller components of plunge pool and flatwater habitats also were observed. Much of the reach downstream of the diversion was dry, but the wetted reaches were composed primarily of step run, step pool and high gradient riffle. Pools were shallow. Small amounts of spawning gravel were observed only below the diversion in flatwater habitats and pools. Two complete barriers to upstream fish migration at all flows were identified in the 5,961-foot long reach below the diversion. The Ely Creek Diversion also provides a complete barrier to upstream migration.

ROSGEN LEVEL I CLASSIFICATION

Ely Creek contains Rosgen Level I Aa+ channel type above and below the diversion. (Table CAWG 1-252 and 1-253)

MESOHABITAT

The reach above the diversion was predominantly composed of Hawkins fast water habitat types turbulent (71.0 percent) and nonturbulent (10.7 percent), with some slow water habitat type scour pool (17.5 percent) (Figure CAWG 1-86). Dammed pool was a very small component. This reach was predominantly composed of USFS-R5 habitat types bedrock sheet (36.4 percent) and cascade (34.7 percent) (Figure CAWG 1-87 and Map CAWG 1-15). There were also substantial components of plunge pool (17.0 percent) and flatwater habitat composed of step run and run. Dammed pool and lateral scour pool were very small components.

The reach below the Ely Creek diversion was mostly dry at the time the creek was surveyed (65.3 percent) and therefore was not evaluated with the Hawkins classification system. The wetted portion of the channel was composed of Hawkins fast water habitat types nonturbulent (14.1 percent) and turbulent (10.4 percent), and slow water habitat type scour pool (9.2 percent). Dammed pool was a very small component. This reach was composed of USFS-R5 habitat types dry (45.7 percent), with a portion not classified (18.6 percent). The wetted reaches were predominantly composed of step run (11.2 percent), high gradient riffle (7.6 percent), and step pool (7.7 percent). There were small components of cascade, flatwater habitat comprised of run and trench chute, and a very small component of pool habitat comprised of dammed pool, plunge pool, and mid channel pool. Road crossing and concrete box were also recorded.

POOL DEPTH

The pools in Ely Creek were shallow. Almost all of the pools had average pool depths in the zero to one and one to two foot depth ranges (Figure CAWG 1-88). Only three pools were evaluated above the diversion, but more pools were evaluated in the downstream reach, which covered a much longer length of stream.

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Ely Creek.

COVER SUMMARY

Average weighted cover in the reach above the diversion was composed of primarily of boulder/cobble (18 percent), with small components of woody debris, bedrock, and terrestrial vegetation (Table CAWG 1-254). Average weighted cover in the reach below the diversion was similar, predominantly composed of boulder/cobble (24 percent), with small components of undercut banks, woody debris, and terrestrial vegetation (Table CAWG 1-255).

CANOPY SUMMARY

There was no canopy cover in about a third of the habitat units above the diversion. The remainder of the units had canopy cover primarily in ranges between 40 to 60 percent (Table CAWG 1-256). Canopy cover in the reach below the diversion was greater, primarily in the ranges between 50 and 80 percent (Table CAWG 1-257). Canopy cover was composed predominantly of softwood in both reaches.

FISH BARRIERS

Two barriers to upstream fish migration were identified below the Ely Creek diversion. Both form a complete barrier to migration at all flows. One is located 2,789 feet upstream of the confluence with Big Creek in a high gradient riffle and has a height of 24 feet. The other is a waterfall located 1,870 feet upstream of the confluence in a trench chute and has a height of six feet. The Ely Creek Diversion also acts as a complete barrier to upstream migration (Table CAWG 1-258).

DOMINANT SUBSTRATES

The dominant substrates in the reach above the diversion were primarily bedrock (averaging 44 percent) and sands (averaging 21 percent), with smaller amounts of boulders, cobble, fines and gravel (Table CAWG 1-259). The dominant substrates in the reach below the diversion were primarily cobble (averaging 31 percent) and boulders (averaging 28 percent), with smaller amounts of bedrock, sands, gravel, and fines (Table CAWG 1-260).

SPAWNING GRAVEL

No spawning gravel was observed in the reach above the diversion. Small amounts of spawning gravel were observed in the reach below the diversion, located in step run, run, and step pool habitats (Table CAWG 1-261). Gravels were of fair to good quality.

SIDE CHANNELS

No side channels were observed in Ely Creek.

2.3.7.6 Adit No. 8 Creek

INTRODUCTION

Adit No. 8 Creek is a small, very steep, granitic stream on the southern side of Big Creek located upstream of Dam 5. Adit No. 8 Creek has a confluence with Big Creek near Big Creek RM 2.6. Adit No. 8 Creek Diversion is located at a point in the stream where there is a natural break in the channel slope (Map CAWG 1-7).

The Adit No. 8 Diversion, located on Adit No. 8 Creek about 3-1/2 miles southwest of Big Creek, is a concrete diversion approximately 30 feet high with a crest length of approximately 44 feet. When used, water was diverted through a vertical bore hole that intersects Tunnel No. 2 at Adit No. 8.

The Adit No. 8 Diversion was built to divert Tunnel 5 water (from Shaver Lake) into Tunnel 2 (to Powerhouse 2). A bulkhead was poured in Tunnel 5 with a pipe leading downhill to a valve and an energy dissipation structure just above the Adit No. 8 diversion. The bulkhead, piping, valve, and energy dissipation structure are known as the Shoofly.

This was used during the construction of Shaver Lake Dam and Powerhouse 2A to keep water off the dam under construction and increase generation at Powerhouse 2 while Powerhouse 2A was being constructed. When Powerhouse 2A came on line, it was more efficient to run the water through this powerhouse than to use the Shoofly and Adit No. 8 Diversion. Although not currently in use, it gives SCE the flexibility to divert water from one water system into another if required.

Adit No. 8 Creek was evaluated upstream from the confluence with Big Creek for a length 4,247 feet. Adit No. 8 Creek has an upstream elevation of 4,320 feet above MSL, drops to an elevation of 3,569 feet at the diversion, then drops to an elevation of 3,242 feet above MSL at the confluence with Big Creek.

Adit No. 8 Creek is a very steep, boulder-dominated stream with a Rosgen Aa+ channel. Much of the creek was dry and a substantial component was cascade, which may limit the habitat value. However, the wetted reaches contained some components of more complex habitat like riffles as well as some pool habitat. Pools were shallow. Canopy cover was high. A fair amount of spawning gravel was observed, primarily in flatwater and high gradient riffles, with small amounts in pools and low gradient riffles. Nine waterfalls, most of which form complete barriers to upstream fish migration at all flows, are located throughout the upper 60 percent of the creek. Adit No. 8 Diversion also provides a complete barrier to upstream fish migration.

ROSGEN LEVEL I CLASSIFICATION

Adit No. 8 Creek is classified as a Rosgen Level I Aa+-type channel (Table CAWG 1-262). The channel slope is substantially steeper below the diversion than above it.

MESOHABITAT

Most of the channel was dry (42 percent) at the time it was surveyed. The wetted portion of this Rosgen Aa+-type channel was predominantly composed of Hawkins fast water habitat types turbulent (27 percent) and nonturbulent (17.7 percent), with scour pool (13.3 percent) a smaller component (Figure CAWG 1-89). This reach was predominantly composed of USFS-R5 habitat type dry (42.0 percent) (Figure CAWG 1-90 and Map CAWG 1-15). The wetted portions were composed of cascade (20.7 percent), step run (13.3 percent), step pool (10.1 percent), and high gradient riffle (six percent). There were small components of flatwater habitat composed of run and glide, of pool habitat composed of plunge pool and mid channel pool, and a very small component of low gradient riffle. The large amount of dry and cascade mesohabitat types limits the amount of habitat available to fish in Adit No. 8 Creek.

POOL DEPTH

All pools in Adit No. 8 Creek were shallow, with average pool depths of less than one foot. (Figure CAWG 1-91)

WOOD COUNT

Large woody debris (> six inches) counts were not performed in Adit No. 8 Creek.

COVER SUMMARY

Average weighted cover was composed of primarily of undercut banks (17 percent), surface turbulence (15 percent), and boulder/cobble (11 percent) (Table CAWG 1-263). There were also small amounts of woody debris and terrestrial vegetation.

CANOPY SUMMARY

Canopy cover was generally high. Most of the habitat units had canopy cover in the 50 to 80 percent ranges (Table CAWG 1-264). Canopy cover was composed of softwood.

FISH BARRIERS

Nine barriers to upstream fish migration were identified in Adit No. 8 Creek (Table CAWG 1-265). All nine barriers are waterfalls and most form complete barriers at all flows. Two waterfalls located 3,313 and 2,380 feet upstream of the confluence with Big Creek are complete barriers to upstream migration only at low flows. They are located in cascade and run habitats and are 15 feet and three feet in height, respectively. The remaining seven waterfalls are located 3,801, 3,240, 2,072, 2,045, 1,889, 1,867, and 1,798 feet upstream of the confluence in high gradient riffle, run, step pool, step run, plunge pool, and cascade habitats. They are 20 feet, 15 feet, seven feet, eight feet, 5.5 feet, six feet, and 13 feet, respectively. They form a complete barrier at all flows. Adit No. 8 Diversion also provides a barrier to upstream migration. Dry areas of the creek also act as barriers to both upstream and downstream fish migration.

DOMINANT SUBSTRATES

The dominant substrates were sands, boulders (averaging 24 percent each), gravel (averaging 21 percent) and cobble (averaging 14 percent), with a small amount of bedrock (Table CAWG 1-266).

SPAWNING GRAVEL

A fair amount of spawning gravel was observed, primarily located in step run, run, and high gradient riffle habitats (Table CAWG 1-267). Small amounts of spawning gravels were also located in additional pool habitats and low gradient riffles. Gravel quality was primarily fair to good.

SIDE CHANNELS

No side channels were observed in Adit No. 8 Creek.

2.3.8 RESERVOIR HABITAT

This section presents summaries of reservoir and forebay habitat characteristics collected in support of the ALP studies. Results are provided for reservoirs and forebays other than those discussed in recent FERC license applications including Redinger Lake, Portal Forebay, and Lake Thomas A. Edison. Information about those waterbodies may be found in the appropriate license applications.

2.3.8.1 Florence Lake

GENERAL DESCRIPTION

The current Florence Lake Reservoir (Map CAWG 1-2), with a drainage area of 171 square miles, was created by the construction of the Florence Lake Dam across the South Fork of the San Joaquin River impounding a reach of the SFSJR and inundating a smaller alpine lake that predated the dam. Inflow to the lake is obtained from natural flows into the South Fork of the San Joaquin River and Boulder Creek above the lake and from Crater Creek, Tombstone Creek (not in current operation), North Slide Creek (not in current operation), South Slide Creek (not in current operation), and Hooper Creek diversions. Project releases from the reservoir are normally controlled to supply water to Huntington Lake. An eight-inch diameter cast iron pipe, for minimum water release, passes through the base of Arch 53 at elevation 7,200 feet above MSL, which is near the bottom of the lake. Minimum instream flow releases are made to the SFSJR downstream of Florence Dam by means of a release outlet at the base of the dam and spills may occur over the dam spillway, which is controlled by hydraulic gates with a crest length of 100 ft at an elevation of 7,315.5 ft above MSL.

Water level in the reservoir varies considerably throughout the year with the reservoir normally operated to store runoff for use downstream and to avoid water storage in winter with the associated potential for freeze-thaw damage to the dam that might result. The Florence Lake dam outlet works, located 2,000 feet from the left abutment on the western shore of Florence Lake, form the entrance to Ward Tunnel. The intake to Ward Tunnel has an invert at elevation 7,220 feet above MSL, which is 20 feet higher than the minimum release flow pipe to the South Fork San Joaquin River.

RESERVOIR HABITAT

VOLUME AND AREA

The corresponding volume and surface area for water surface (lake) elevations in Florence Lake are shown in Table CAWG 1-268. Over the past 21 years (1980-2001) using data available from USGS, the average maximum yearly storage volume in Florence Lake was 60,096 acre-feet (af). For the same period, the average minimum yearly storage volume was 1,008 af. These correspond to approximately 7,323.0 ft and 7,230.8 ft above MSL, respectively.

For representative water year types for the period 1980-2001, Figure CAWG 1-92 shows daily volumes and corresponding surface areas at Florence Lake. During this period, four of the five types of water years occurred. A below normal water year did not occur during this period. Data from the last below normal water year (1971) is included in the figure. In the spring, usually around May, the reservoir begins to fill. By July, the reservoir is usually at its maximum volume and surface area. The volume and surface area of the reservoir slowly drop from July to the beginning of September, and quickly fall from September to November. By December, the reservoir is usually at its minimum volume and surface area. In wet water years, the reservoir fills more quickly and can reach maximum storage earlier. In critical years (very dry conditions), the maximum reservoir storage is generally lower than that which occurs for wetter years.

All five of the water years are presented in Figure CAWG 1-92, and Table CAWG 1-269 presents the average volume and corresponding water surface elevation and surface area for winter and summer for each water year type.

Habitat Areas

Habitat area for near shore and shallow habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of lake elevations. Table CAWG 1-270 presents this information based on available lake storage curves and morphometry. The relatively small amount of shallow habitat available at most higher reservoir elevations is indicative of the steep sides of the reservoir within this elevation range.

For the average maximum storage for the period 1980-2001, 60,096 af, at the corresponding water surface elevation of around 7,323 feet above MSL, Florence Lake has 13.7 acres of habitat in three feet or less of water; 28.3 acres of habitat in six feet or less; 46.3 acres of habitat in nine feet or less; and 64.3 acres in 12 feet or less. For the average maximum storage for the period 1980-2001, 1,008 af, at the corresponding water surface elevation of around 7,230.8 feet above MSL, Florence Lake has 32 acres of habitat in three feet or less of water; 64 acres of habitat in six feet or less; 107 acres of habitat in nine feet or less; and 127 acres in 12 feet or less.

Shoreline Development

Florence Lake has a maximum length of 2.83 miles, and an average breadth of 0.61 miles. The maximum surface area of Florence Lake is 1.5 square miles, and the shoreline length is 8.31 miles. The shoreline development index is, therefore, equal to 1.9.

Thermal Structure

As stated in CAWG 5, the reservoir stratifies annually during the summer months and mixes in the fall. Figures CAWG 1-93 and 1-94 present the reservoir temperature profiles for 2000 and 2001. In 2000, a thermocline was present between six to seven meters in July, but minimal to no thermal stratification occurred in other months at the inflow profile location. Near the dam, a thermocline was present at 10 to 13 meters in July, and at 16 to 17 meters in August 2000. In 2001, a thermocline did not develop at the inflow end. At the dam, however, a thermocline was present between five to six meters in May, seven to 11 meters in June, eight to nine meters in July, and 13 to 14 meters in August. By September 2001, the thermocline was from 16 to 19 meters, and the lake was vertically mixing by October. At the deepest region of the lake (Dam Site), the epilimnion ranged in thickness from five to 16 meters, and the hypolimnion ranged in thickness from two to 21 meters, when stratified (Table CAWG 1-271). The average temperature of the epilimnion (Dam Site) ranged from a low of 10.7^{o}C in May 2001, to a high of 19.4^{o}C in August 2001. The average temperature of the hypolimnion at the Dam Site ranged from a low of 6.6^{o}C in May 2001, to a high of 15.2^{o}C in August 2001 (Table CAWG 1-271). The average Dissolved Oxygen (DO) of the reservoir ranged from 6.6 to 8.2 mg/L in 2000, and from 7.1 to 9.9 mg/L in 2001. The average Specific Conductance (SpC) of the reservoir ranged from 9.0 μS/cm to 12.0 μS/cm in 2000, and from 9.0 μS/cm to 15.0 μS/cm in 2001, and the Secchi Disk Transparency (Visibility) of the reservoir ranged from 2.7 m to 9.0 m in 2000, and from 6.0 m to 11.8 m in 2001, as determined by secchi depth (Table CAWG 1-271).

SUBSTRATE

The area around Florence Lake is dominated by bedrock and boulders. Sand and gravel deposition from the granite dominated mountains surrounding Florence Lake is found along the perimeter of the reservoir, especially towards the upstream end. Finer materials are located along the bottom of the reservoir thalweg. Finer materials also are found in the areas of tributary confluences, and in the vicinity of the dam and spillway. Specific regions of the reservoir are discussed below.

Crater Creek Diversion Inflow area: The near shore surficial substrate near the Crater Creek Diversion inflow is composed of sand (30 percent), with gravel (20 percent), fines (10 percent) cobbles (20 percent) and boulders (20 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble elements.

Western Shore area: The shoreline surficial substrate along the western side of the reservoir near mid-lake was mostly composed of sand (50 percent), with gravel (20 percent), fines (five percent) cobbles (10 percent) and boulders (15 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble.

SFSJR Inflow area: The surficial substrate near the inflow end of the reservoir was mostly composed of sand (60 percent), with gravel (20 percent), fines (five percent) cobbles (five percent) and boulders (10 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble and large woody debris.

Southeastern Shore area: The near shore surficial substrate in the southeastern end of Florence Lake was mostly composed of sand (60 percent), with gravel (15 percent), fines (five percent) cobbles (10 percent) and boulders (10 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble.

Northeastern Shore area: The shoreline surficial substrate along the northeastern end of Florence Lake near the dam was mostly composed of sand (60 percent), with gravel (15 percent), fines (five percent) cobbles (five percent) and bedrock (15 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble.

In summary, the shoreline surficial substrate of the reservoir was mostly composed of sand. There was an ample amount of gravel mixed with the sand, with scattered patches of fines, boulders, cobbles, and bedrock. Large areas of bedrock predominate in many areas upslope of the lake. Large woody debris and boulder/cobbles provided fish cover. Aquatic vegetation was absent in all areas observed.

TRIBUTARY SPAWNING ACCESS

There are no major migration barriers between Florence Lake and the South Fork San Joaquin River (SFSJR) at all lake elevations. There is, however, a partial migration barrier in the SFSJR immediately upstream of Florence Lake. Fish have been observed crowding in a large plunge pool underneath a wooden footbridge, just upstream of Florence Lake. The pool is approximately 20 feet deep and the plunge into the pool is approximately 10 feet high. The crowding occurs due to the difficulty of passage above the barrier. Fish might potentially be able to get over the waterfall that drops into the plunge pool, but it seems to require significant effort based on observation. Boulder Creek is a tributary to the South Fork San Joaquin River immediately upstream of Florence Lake. Fish have access into Boulder Creek from Florence Lake via a small section of the South Fork San Joaquin River. There was a large debris dam approximately 250 feet upstream of the confluence of the SFSJR and Boulder Creek. The debris dam is approximately nine feet high, 20 feet long, and covers the width of the stream. Fish have been observed upstream and downstream of the debris dam, but fish have not been observed passing through the debris dam during these studies. The debris dam is potentially a complete fish migration barrier.

Crater Creek is diverted into Florence Lake via the Crater Creek Diversion Channel. There are no major migration barriers for fish into the Crater Creek Diversion Channel when the reservoir is at maximum capacity. The diversion is only operated during the principal run-off period. As the elevation of the reservoir begins to lower, water is no longer diverted into Florence Lake from Crater Creek. Therefore, fish migration access into Crater Creek Diversion Channel is not possible when the reservoir is drawn down, due to insufficient water in the stream channel. Also, there are two partial migration barriers upstream of the reservoir. One is a partial barrier (road crossing) at low flows at 445 ft upstream of the reservoir, and the other is a partial barrier (cascade) at all flows at 1245 ft upstream of the reservoir (see discussion of stream habitat).

The other diversions that potentially supply water into Florence Lake are Tombstone Creek, North Slide Creek, South Slide Creek, and Hooper Creek diversions (Hooper Creek has the only currently operational diversion of the four). The natural watercourse for the streams reach confluence with the SFSJR downstream of Florence Lake. The diverted flow into Florence Lake arrives via flow line, which fish cannot access.

2.3.8.2 Bear Diversion Forebay

GENERAL DESCRIPTION

Bear Diversion Forebay is located on Bear Creek (Map CAWG 1-3). Impounded water from Bear Diversion Forebay flows into the Mono-Bear Siphon, which eventually flows into Ward Tunnel. The forebay lies at, approximately, an elevation of 7,350.0 feet above MSL. The forebay has a capacity of 103 acre-feet of water.

Bear Creek Diversion, located across Bear Creek approximately two miles south of Lake Thomas A. Edison, is a constant-radius, concrete arch diversion, 55 feet high. The crest, at elevation 7,356 feet above MSL, is 293 foot-long. The ungated, overpour spillway has an effective length of 232 feet and a crest at elevation 7,350 feet above MSL. Diverted water is conveyed through a seven-by seven-foot cross section, 7,596-foot-long, bore through granite into the Mono-Bear Siphon. Flow through the conduit is controlled by a manually operated 7.5-foot-wide by 15-foot-high radial gate, located in the outlet works on the right abutment of the diversion.

FOREBAY HABITAT

VOLUME AND AREA

The volume and surface area to corresponding forebay water surface elevations in Bear Diversion Forebay are shown in Table CAWG 1-272. At a forebay elevation of around 7,362 feet above MSL, Bear Diversion Forebay has a volume of 360 acre-feet and a surface area of 16.9 acres. As the forebay is drawn down to 7,350 and 7,335 feet above MSL the corresponding reservoir volumes drop to 180 and 44 acre-feet, respectively, and the corresponding surface areas drop to 13.3 and 4.8 acres, respectively. When the forebay reaches an elevation of 7,311 feet, the reservoir volume has dropped to 0.4 acre-feet and the reservoir surface area is 0.1 acres.

HABITAT AREAS

Available area for near shore and shallow water habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of forebay elevations. Table CAWG 1-273 presents this information based on available forebay storage curves and morphometry. The greatest amount of shallow water habitat was available in the middle range of forebay elevations.

At the highest forebay elevation of 7,365 feet above MSL, Bear Diversion Forebay has 0.9 acres of habitat in three feet or less of water; 1.8 acres of habitat in six feet or less; 2.5 acres of habitat in nine feet or less; and 3.5 acres in 12 feet or less. At the forebay elevation of 7,323 feet above MSL, Bear Diversion Forebay has 0.5 acres of habitat in three feet or less of water; 0.8 acres of habitat in six feet or less; 1.1 acres of habitat in nine feet or less; and 1.3 acres in 12 feet or less.

SHORELINE DEVELOPMENT

Bear Diversion Forebay has a maximum length of 0.21 miles, and an average breadth of 0.05 miles. The maximum surface area of Bear Diversion Forebay is 0.026 square miles, and the shoreline length is 0.50 miles. The shoreline development index is, therefore, equal to 1.14.

THERMAL STRUCTURE

Bear Diversion Forebay is a small forebay, which is well-mixed. Due to the small size and nature of the forebay thermal stratification is not likely to occur in the forebay. The temperature of the forebay was monitored with a water temperature monitor, which was suspended below the surface waters of the forebay.

The average monthly temperature of the Bear Diversion Forebay in 2000 ranged from a high of 14.2^{o}C in August to a low of 6.8^{o}C in October, and in 2001 from a high of 18.2^{o}C in August to a low of 12.7^{o}C in October (Table CAWG 1-274).

SUBSTRATE

Much of the area around Bear Diversion Forebay is dominated by bedrock, and boulders. Finer materials are located along the bottom thalweg, and along the perimeter of the reservoir. Finer materials are also found at the confluence of Bear Creek inflow with the forebay. Specific regions of the reservoir are discussed below.

Western Shore area: The surficial substrate on the western shore near the dam was mostly composed of sand (50 percent), followed by gravels (30 percent) and fines (20 percent). Aquatic vegetation and cover for fish were not present in the area observed.

Bear Creek Inflow area: The near shore surficial substrate along the inflow end of the forebay was predominantly composed of sands (75 percent), followed by gravels (20 percent), and fines (five percent). Aquatic vegetation and cover for fish were not present in the area observed.

Eastern Cove area: Along the east cove of the forebay, the shoreline surficial substrate was also mostly composed of sands (70 percent), followed by gravels (20 percent), and fines (10 percent). Small rooted aquatic vegetation was present in approximately 25 percent of the area observed.

The surficial substrate on the bottom of the forebay was mostly composed of silt/sand. Gravel was also observed on the floor of the forebay.

TRIBUTARY SPAWNING ACCESS

Upstream migration for fish into Bear Creek from Bear Creek Diversion Forebay would be difficult at any reservoir elevation. There is a large, steep bedrock sheet in Bear Creek immediately upstream of the forebay. It would be extremely difficult for fish to migrate upstream of the forebay, into Bear Creek due to the steep and long bedrock sheet.

2.3.8.3 Mono Diversion Forebay

GENERAL DESCRIPTION

Mono Diversion Forebay is located on Mono Creek (Map CAWG 1-3). Water released from Lake Thomas A. Edison (Vermilion Valley Hydroelectric Project) flows through Mono Creek upstream of the forebay to the forebay for diversion through the Mono-Bear Siphon to Ward Tunnel. The forebay lies at, approximately, an elevation of 7,350 feet above MSL. The forebay has a surface area of 9.7 acres, and a capacity of 46 acre-feet of water. During peak releases from Lake Edison, retention of water in the forebay may last from one to a few hours.

FOREBAY HABITAT

VOLUME AND AREA

The volume and surface area corresponding to forebay water surface elevations in Mono Diversion Forebay are shown in Table CAWG 1-275. At a lake elevation of 7,361 feet above MSL, Mono Diversion Forebay has a volume of 147 acre-feet, and a surface area of 9.5 acres. As the forebay draws down to 7,343 feet above MSL, the forebay has a volume of 25 acre-feet and a surface area of 3.0 acres. At an elevation of 7,322 feet above MSL, the reservoir volume has dropped to 0.4 acre-feet and the reservoir surface area has dropped to 0.04 acres. Water surface elevations are not recorded at the Mono Forebay and therefore, changes in available area and volume over time are not presented.

HABITAT AREAS

Available area in Mono Diversion Forebay for near shore and shallow water habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of forebay elevations. Table CAWG 1-276 presents this information based on available forebay storage curves and morphometry. As previously seen in Bear Diversion Forebay, the greatest amount of shallow water habitat was available in the middle range of forebay elevations.

In Mono Diversion Forebay, the highest elevation with surface area data available was 7,361 feet above MSL. At 7,361 feet above MSL, Mono Diversion Forebay has 0.6 acres of habitat in three feet or less of water; 1.3 acres of habitat in six feet or less; 2.2 acres of habitat in nine feet or less; and 3.3 acres in 12 feet or less. At a low forebay elevation of 7,331 feet above MSL, Mono Diversion Forebay has 0.16

acres of habitat in three feet or less of water; 0.28 acres of habitat in six feet or less; 0.34 acres of habitat in nine feet or less; and 0.38 acres in 12 feet or less.

SHORELINE DEVELOPMENT

Mono Diversion Forebay has a maximum length of 0.15 miles, and an average breadth of 0.04 miles. The maximum surface area of Mono Diversion Forebay is 0.015 square miles, and the shoreline length is 0.49 miles. The shoreline development index is, therefore, equal to 1.13.

THERMAL STRUCTURE

Mono Diversion Forebay is a small forebay, which has a short retention time when flows are released from Lake Edison and consequently, a well-mixed thermal structure. Due to the small size and nature of the forebay thermal stratification is not likely to occur in the forebay. The temperature of the forebay was monitored with a water temperature monitor, which was suspended below the surface waters of the forebay.

The average monthly temperature of the Mono Diversion Forebay in 2000 ranged from a high of 13.6°C in June to a low of 10.7°C in October and August, and in 2001 from a high of 15.9°C in September to a low of 10.8°C in July (Table CAWG 1-274).

SUBSTRATE

Much of the area around Mono Diversion Forebay is dominated by boulder, gravel, and sand. Finer materials are located along the bottom thalweg, and along the perimeter of the reservoir. Finer materials are also found at the confluence of Mono Creek with the forebay. Specific regions of the reservoir are discussed below.

Northern Shore area: The surficial substrate along the northern shore near the dam was mostly composed of sand (60 percent), followed by gravels (30 percent) and fines (10 percent). Aquatic vegetation and cover for fish were not present in the area observed.

Southern Shore area: The near shore surficial substrate along the southern shore near the dam was predominantly composed of sands (75 percent), followed by gravels (15 percent), and fines (10 percent). Small rooted aquatic vegetation was present in approximately 35 percent of the area observed. Cover for fish was not available in the area observed.

Mono Creek Inflow area: Near the inflow end of the forebay, the shoreline surficial substrate was also mostly composed of sands (80 percent), followed by gravels (15 percent), and fines (five percent). Aquatic vegetation and cover for fish were not present in the area observed.

The substrate on the bottom of the forebay was mostly composed of silt/sand. Gravel was also observed on the floor of the forebay, particularly in the vicinity of the Mono Creek thalweg.

TRIBUTARY SPAWNING ACCESS

There are no migration barriers for fish between Mono Diversion Forebay and Mono Creek. Upstream migration, therefore, from Mono Diversion Forebay to Mono Creek should not be impeded.

2.3.8.4 Mammoth Pool Reservoir

GENERAL DESCRIPTION

Mammoth Pool Reservoir is formed by an earth-fill dam built across the San Joaquin River about eight miles upstream from its junction with Big Creek, at 3,030 ft above MSL elevation (Map CAWG 1-5). The reservoir, with a length of over eight miles when filled to the spillway crest, covers 1,290 acres of land. It impounds the waters of the San Joaquin River, and intercepts flow from tributaries including Jackass Creek, Mill Creek, Kaiser Creek, Chiquito Creek, and Daulton Creek.

The dam embankment has a chimney drain, plus a drainage blanket under a course granular downstream shell. A drainpipe extends from the drainage blanket through the rockfill zone to the toe. The upstream and downstream shells consist of compacted non-plastic coarse silty sands with occasional gravel. The core consists of fine to medium, slightly plastic, silty sands with some fine gravel. Both slopes of the embankment are protected by riprap. The downstream toe zone is dumped quarried rockfill.

The spillway is a separate overflow channel cut through a rock ridge approximately 1,500 feet west of the west abutment of the dam. It is an ungated, chute-type spillway having a modified ogee control section with an effective crest length of 403 feet at elevation 3,361 feet above MSL. It is designed to discharge 170,000 cfs with reservoir level at elevation 3355.7 feet above MSL or approximately five feet below the dam crest. There is a fishwater generator which is powered by minimum instream flow releases made at that location, which is in a diversion tunnel which was used in dam construction.

A water conduit, consisting of the Mammoth Pool Power Tunnel and a penstock, connects Mammoth Pool Reservoir to Mammoth Pool Powerhouse. Intake to the tunnel is controlled by a fixed-wheel gate powered by an electrically operated hoist. The rock trap and surge chamber are located in the tunnel section approximately 490 feet and 800 feet respectively, above the outlet portal.

RESERVOIR HABITAT

VOLUME AND AREA

The reservoir volumes and surface areas corresponding to water surface elevations in Mammoth Pool Reservoir are shown in Table CAWG 1-277. Over the past 21 years (1980-2001) for which data are available from USGS, the average maximum yearly storage volume in Mammoth Pool Reservoir was 114,922 acre-feet (af). For the same period, the average minimum yearly storage volume was 12,764 af. These correspond to approximately 3325.3 ft and 3175.7 ft above MSL, respectively.

For representative water year types for the period 1980-2001, Figure CAWG 1-95 shows daily volumes and corresponding surface areas at Mammoth Pool. During this period, four of the five types of water years occurred. A below normal water year did not occur during this period. Data from the last below normal water year (1971) is included in the figure. In the spring, usually around mid-April, the reservoir begins to fill. By June, the reservoir is usually at its maximum volume and surface area. The volume and surface area of the reservoir usually drop to the annual minimum level by the beginning of November. The reservoir elevation rises and falls a few times in the winter, and the cycle begins again in April. In wet water years, the reservoir fills more quickly and can reach maximum storage earlier. Under these conditions, higher levels of storage tend to have a longer duration. In drier water years, the maximum reservoir storage occurs later in the season and is generally lower than that which occurs for wetter years.

All five of the water years are presented in Figure CAWG 1-95, and Table CAWG 1-278 presents the average reservoir storage and corresponding elevation and surface area for winter and summer operations periods. This table clearly shows the differences in seasonal storage, as well as the differences between those seasons among water year types.

HABITAT AREAS

Habitat areas for near shore and shallow habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of lake elevations. Table CAWG 1-279 presents this information based on available lake storage curves and morphometry. The long, narrow shape of the reservoir yields a moderate amount of shallow water habitat at most lake elevations. At high lake elevations the total area of shallow water habitat (three feet or less) is relatively small.

At the 21-year average (1980-2001) of yearly maximum reservoir storage, 114,922 af, water surface elevation is approximately 3,325.3 feet above MSL. At this water surface elevation Mammoth Pool has 13.8 acres of habitat in three feet or less of water; 32.1 acres of habitat in six feet or less; 48.7 acres of habitat in nine feet or less; and 62.1 acres in 12 feet or less. The 21-year average (1980-2001) of yearly minimum reservoir storage, 12,764, has a corresponding water surface elevation of

3,175.7 feet above MSL, Mammoth Pool has 9.3 acres of habitat in three feet or less of water; 20.7 acres of habitat in six feet or less; 31 acres of habitat in nine feet or less; and 40 acres in 12 feet or less.

SHORELINE DEVELOPMENT

Mammoth Pool has a maximum length of 8.11 miles, and an average breadth of 0.23 miles. The maximum surface area of Mammoth Pool is 2.01 square miles, and the shoreline length is 21.10 miles. The shoreline development index is, therefore, equal to 4.2.

THERMAL STRUCTURE

As stated in the CAWG 5 Temperature Report, Mammoth Pool Reservoir stratifies annually during the summer months and mixes in the fall. Figures CAWG 1-96 and 1-97 present the temperature profiles for 2000 and 2001. In 2000, a thermocline was present between seven to eight meters in July at the inflow profile location, but minimal to no thermal stratification occurred in other months at the other profile locations. In 2001, a thermocline was present between four to seven meters in June, and seven to eight meters in July at the dam profile location. At the middle profile location in 2001, a thermocline was present between seven and nine meters in early June, between six and seven meters later in June, and between eight and nine meters in July. At the inflow profile site in 2001, a thermocline was present between six and ten meters in early June, between three and seven meters later in June, between seven and ten meters in July, and between two and four meters in August. The temperature differential at the inflow profile site is likely due to the cool, dense inflow waters from the SJR settling under the warmer Mammoth Pool Reservoir waters. At the deepest region of the lake (dam site), the epilimnion ranged in thickness from four to seven meters, and the hypolimnion ranged in thickness from 36 to 43 meters (Table CAWG 1-280). The average temperature of the epilimnion (dam site) ranged from a low of 21.7^{o}C in June 2001, to a high of 22.6^{o}C in July 2001. The average temperature of the hypolimnion (dam site) ranged from a low of 15.0^{o}C in June 2001, to a high of 17.4^{o}C in July 2001 (Table CAWG 1-280). The average Dissolved Oxygen (DO) of the reservoir ranged from 6.6 to 7.3 mg/L in 2000, and from 6.4 to 9.3 mg/L in 2001. The average Specific Conductance (SpC) of the reservoir was 68.0 μS/cm in October 2000, and ranged from 19.0 μS/cm to 62.0 μS/cm in 2001, and the Secchi Transparency of the reservoir was 3.0 m in October 2000, and ranged from 5.5 m to 8.6 m in 2001 (Table CAWG 1-280).

SUBSTRATE

Much of the area around Mammoth Pool Reservoir is dominated by bedrock and boulders. Large bedrock dominated areas are particularly prevalent in the upper reaches of the reservoir. Finer materials are located along the bottom of the reservoir thalweg. Finer materials also are found in the areas of tributary confluences and in the vicinity of the dam and spillway. These are discussed below.

Chiquito Creek area: The shoreline surficial substrate of the Chiquito Creek Cove was mostly composed of sand (60 percent), with gravel (20 percent each), fines (five percent) cobbles (five percent) and boulders (10 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble.

Jackass Creek area: The near shore surficial substrate in the cove around Jackass Creek was mostly composed of sand (70 percent), with gravel (15 percent), fines (10 percent), and boulders (five percent) comprising the remaining substrate. Aquatic vegetation was not present in the area observed. Available fish cover was provided by boulder/cobble.

Mill Creek area: The surficial substrate near Mill Creek was mostly composed of sand (75 percent), gravel (15 percent), and fines and boulders (five percent each) comprising the remaining substrate. Aquatic vegetation was not present in the area observed. Available fish cover was provided by boulder/cobble.

Kaiser Creek area: The shoreline surficial substrate near Kaiser Creek was mostly composed of sand (70 percent), with gravels, fines, and boulders (10 percent each) comprising the remaining substrate. Aquatic vegetation was not present in the area observed. Available fish cover was provided by boulder/cobble.

Mammoth Pool Reservoir Dam area: The near shore surficial substrate near the Mammoth Pool Reservoir Dam was mostly composed of sand (75 percent), with gravel (10 percent), fines (10 percent), and boulders (five percent) comprising the remaining substrate. Aquatic vegetation was not present in the area observed. Available fish cover was provided by boulder/cobble.

In summary, the shoreline surficial substrate of the reservoir was mostly composed of sand. There was an ample amount of gravel mixed with the sand, with scattered patches of fines, boulders and cobbles. Aquatic vegetation was absent in all areas observed. Boulder/cobbles provided fish cover.

TRIBUTARY SPAWNING ACCESS

There are no major migration barriers between Mammoth Pool Reservoir and the San Joaquin River upstream, nor Mammoth Pool Reservoir and Jackass Creek. There are, however, major migration barriers between Mammoth Pool and Mill Creek, and Mammoth Pool and Kaiser Creek, when the reservoir is below maximum capacity. When the reservoir is full, there is access for fish to migrate into Mill and Kaiser Creeks, but fish cannot readily access these creeks at lower reservoir elevations. Both Mill and Kaiser Creeks have steep bedrock sheets that drop into Mammoth Pool when the reservoir is drawn below maximum capacity. These steep bedrock sheets are impassable for fish in the reservoir. There are major migration barriers between Mammoth Pool Reservoir and Chiquito Creek, and between Mammoth Pool Reservoir and Daulton Creek, at all reservoir elevations. Fish will not be able to access these creeks from the reservoir regardless of reservoir elevation.

There are steep bedrock sheet falls, and large boulders at the confluence of both Chiquito Creek and Daulton Creek. These barriers are present even when the reservoir is at maximum capacity.

2.3.8.5 Dam 6 Forebay

GENERAL DESCRIPTION

Dam No. 6 Forebay receives the discharge from both the Mammoth Pool Powerhouse (MPPH) and Big Creek Powerhouse No. 8 (PH 8) (Map CAWG 1-6). The reservoir serves as the forebay for Big Creek Powerhouse No. 3 several miles downstream. The forebay also receives flow from both the San Joaquin River and Big Creek. The crest of Dam No. 6, at elevation 2,250 feet above MSL, is 495 feet long. The dam forms a small reservoir with a surface area of 23 acres containing 993 acre-feet of water.

FOREBAY HABITAT

VOLUME AND AREA

The forebay volume and surface area corresponding to water surface elevations in Dam 6 Forebay are shown in Table CAWG 1-281. At a normal annual maximum lake elevation of around 2,229 feet above MSL, Dam 6 Forebay has a volume of 964 acre-feet, and a surface area of 28.7 acres. The elevation of the forebay rarely varies significantly over the year, but occasionally the forebay drops to elevations as low as 2,214 feet above MSL. The forebay volume at 2,214 feet above MSL is 587 acre-feet, and the forebay surface area is 21.7 acres.

Figure CAWG 1-98 shows daily volumes and surface areas at Dam 6 Forebay from the fall of 1999 through the fall of 2002. The forebay elevation rises and falls a few times over the year, but remains near 2,229 feet above MSL for most of the year.

The Dam 6 Forebay winter and summer average forebay water surface elevation, volume, and surface area by water year are presented in Table CAWG 1-282.

SHORELINE DEVELOPMENT

Dam 6 Forebay has a maximum length of 1.12 miles, and an average breadth of 0.03 miles. The maximum surface area of Dam 6 Forebay is 0.034 square miles, and the shoreline length is 2.39 miles. The shoreline development index is, therefore, equal to 3.66.

THERMAL STRUCTURE

As stated in CAWG 5, the forebay stratified during the summer months and mixed in the fall. Figure CAWG 1-99 presents the temperature profiles for 2001. Stratification had set in during August in 2001 and persisted to September. The depth of the thermocline was between four and five meters in August and between four and five meters in September, as well. The epilimnion was four meters thick in August and September 2001, and the hypolimnion ranged in thickness from 13 to 21 meters (Table CAWG 1-283). The average temperature of the epilimnion ranged from a low of 17.3^{o}C in August 2001, to a high of 19.5^{o}C in September 2001. The average temperature of the hypolimnion ranged from a low of 14.6^{o}C in August 2001, to a high of 17.2^{o}C in September 2001 (Table CAWG 1-283). The average Dissolved Oxygen (DO) of the reservoir ranged from 7.4 to 10.9 mg/L in 2001. The average Specific Conductance (SpC) of the reservoir ranged from 18.0 μS/cm to 40.0 μS/cm in 2001, and the Transparency (Visibility) of the reservoir was 4.0 m in October 2001, as determined by secchi depth (Table CAWG 1-283).

SUBSTRATE

Much of the area around Dam 6 Forebay is dominated by bedrock, and boulders. Finer materials are located along the bottom thalweg. Boulders and cobbles dominate the region at the mouth of the forebay, at the confluence of the San Joaquin River with the forebay. Specific regions of the reservoir are discussed below.

Eastern Shore area: The surficial substrate along the eastern shore upstream of the forebay was mostly composed of silt/sand (80 percent) followed by bedrock (20 percent). Aquatic vegetation and available cover were not present in the area observed.

Western Shore area: Likewise, the surficial substrate along the western shore upstream of Dam 6 Forebay was mostly composed of silt/sand (80 percent) followed by bedrock (20 percent). Aquatic vegetation and available cover were not present in the area observed.

Mammoth Pool Powerhouse area (east bank): Closer to the Mammoth Pool Powerhouse (MPPH), the near shore surficial substrate along the east bank of the Dam 6 Forebay was mostly composed of boulder (70 percent), followed by cobble, gravel, and sand (each representing 10 percent). Aquatic vegetation was not present in the area observed. Available fish cover was provided by boulder/cobble.

Mammoth Pool Powerhouse area (west bank): The near shore surficial substrate along the west bank of the reservoir near the MPPH was mostly composed of boulder (50 percent), cobble (25 percent), gravel (15 percent), and sand (10 percent). Aquatic vegetation was not present in the area observed. Available fish cover was provided by boulder/cobble.

The substrate on the bottom of the forebay was predominantly composed of silt/sand followed by bedrock and to a lesser extent boulder and cobble.

TRIBUTARY SPAWNING ACCESS

There are no migration barriers for fish between Dam 6 Forebay and the San Joaquin River or Big Creek. Upstream migration, therefore, between Dam 6 Forebay and the San Joaquin River should not be difficult for fish.

2.3.8.6 Huntington Lake

GENERAL DESCRIPTION

Huntington Lake Reservoir, with a drainage area of 81 square miles, was the first reservoir built as part of the "Initial Development" at Big Creek in 1911-13 (Map CAWG 1-7). Originally created by the construction of three dams, Dam Nos. 1, 2, and 3, Huntington Lake was enlarged in 1917-18 by the raising of those dams, and by the construction of an additional dam, No. 3A. The spillway of the lake is at 6,950 feet above MSL. Water from this lake can either be sent to Big Creek Powerhouse No. 1 or to Shaver Lake via Balsam Forebay and Eastwood Power Station. It impounds the waters of upper Big Creek, Rancheria Creek, Coon Creek, Line Creek, and Home Camp Creek, as well as the water diverted through Ward Tunnel.

RESERVOIR HABITAT

VOLUME AND AREA

The volume and surface area to corresponding water surface elevations in Huntington Lake are shown in Table CAWG 1-284. Over the past 21 years (1980-2001) for which data are available from USGS, the average maximum yearly storage volume in Huntington Lake was 88,619 af, with a corresponding water surface elevation of elevation 6949.6 ft above msl, and a surface area of 1425 acres. As the lake draws down to 6,940, 6,930, 6,920, and 6,910 feet above MSL the corresponding reservoir volumes drop to 75,344, 62,555, and 50,812, and 40,216 af, respectively, and the corresponding surface areas drop from 1325, 1223, 1112, and 994 acres, respectively. When the lake reaches the average minimum yearly storage volume (winter conditions) of 32,404 af, the water surface elevation has dropped to approximately 6,901.8 ft above msl, and the reservoir surface area is approximately 886 acres.

For representative water year types for the period 1980-2001 and the below water year type of 1971, Figure CAWG 1-100 shows daily volumes and corresponding surface areas at Huntington Lake. In the spring, usually around mid-April, the reservoir begins to fill. By June, the reservoir is usually at its maximum volume and surface area. The volume and surface area of the reservoir remain relatively consistent from June through September, and quickly fall from about mid-September through December and sometimes beyond. By January, the reservoir is usually at its average minimum volume and surface area. In some drier years, higher reservoir storage is maintained over the winter than in some wetter years.

All five of the water years are presented in Figure CAWG 1-100, and Table CAWG 1-285 presents the average reservoir storage and corresponding elevation, and surface area for winter and summer operations periods. This table clearly shows the differences in seasonal storage, as well as the differences between those seasons among water year types.

HABITAT AREAS

Habitat area for near shore and shallow habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of lake elevations. Table CAWG 1-286 presents this information based on available lake storage curves and morphometry. There is a relatively large amount of shallow habitat available at most reservoir elevations with relatively little change with elevation.

At a water surface elevation of 6,949.6 ft above MSL (corresponding to the about 21-year average maximum yearly storage), Huntington Lake has 31.5 acres of habitat in three feet or less of water; 62.5 acres of habitat in six feet or less; 93.5 acres of habitat in nine feet or less; and 124.5 acres in 12 feet or less. When the lake reaches a water surface elevation of approximately of 6,902 ft above MSL, Huntington Lake has 41.7 acres of habitat in three feet or less of water; 83.3 acres of habitat in six feet or less; 126.3 acres of habitat in nine feet or less; and 170.3 acres in 12 feet or less.

SHORELINE DEVELOPMENT

Huntington Lake has a maximum length of 4.51 miles, and an average breadth of 0.38 miles. The maximum surface area of Huntington Lake is 2.24 square miles, and the shoreline length is 12.79 miles. The shoreline development index is, therefore, equal to 2.4.

THERMAL STRUCTURE

As stated in the CAWG 5 report, the reservoir stratifies annually during the summer months and mixes in the fall. Figure CAWG 1-101 and 1-102 present the temperature profiles for 2000 and 2001. In 2000, a thermocline was present between 16 and 21 meters in August at the dam profile site; between 26 and 28 meters at the middle lake profile site; and between 11 and 13 meters at the East End profile site. The thermal layers had mixed by October 2000. In 2001, at the dam profile site, a thermocline was present between four and five meters in May, between seven and nine meters in June, between eight and ten meters in July, between eight and ten meters in August, and the site was mixed by September. At the middle lake profile site in 2001, a thermocline was present between three and four meters in May, between two and three meters in June, between seven and nine meters in July, between seven and eight meters in August, and the site was mixed by September. Stratification was not observed at the shallow inflow (east end) site in 2001. At the deepest region of the lake (dam site), the epilimnion ranged in thickness from four to

16 meters, and the hypolimnion ranged in thickness from 10 to 35 meters (Table CAWG 1-287). The average temperature of the epilimnion (dam site) ranged from a low of 11.3°C in May 2001, to a high of 19.2°C in August 2001. The average temperature of the hypolimnion (dam site) ranged from a low of 6.5°C in May 2001, to a high of 13.1°C in August 2001 (Table CAWG 1-287). The average Dissolved Oxygen (DO) of the reservoir ranged from 7.6 to 11.0 mg/L in 2000, and from 6.4 to 9.4 mg/L in 2001. The average Specific Conductance (SpC) of the reservoir was 12.0 μS/cm in October 2000, and ranged from 12.0 μS/cm to 19.0 μS/cm in 2001. The Secchi disk Transparency of the reservoir was 7.7 m in October 2000, and ranged from 5.1 m to 7.0 m in 2001 (Table CAWG 1-287).

SUBSTRATE

The area around Huntington Lake is dominated by sand, gravel, and boulders. There are also large forested areas around Huntington Lake dominated by coniferous trees. Finer materials are located along the thalweg of the reservoir, in areas near tributary confluences, and near the dams. Specific regions of the reservoir are discussed below.

Rancheria Creek area: The shoreline surficial substrate in the region near the Rancheria Creek confluence with Huntington Lake was mostly composed of sand (50 percent), with gravel (30 percent each), fines (10 percent) cobbles (five percent) and boulders (five percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble and some large woody debris.

Big Creek area: The near shore surficial substrate of the Big Creek cove was mostly composed of sand (40 percent), with gravel (30 percent each), fines (10 percent) cobbles (10 percent) and boulders (10 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble and some large woody debris.

Dam No. 3 area: Along the middle of the lake, between Big Creek Cove and Dam No. 3, the shoreline surficial substrate was mostly composed of sand (35 percent) and gravel (35 percent each), with lesser amounts of fines (10 percent) cobbles (10 percent) and boulders (10 percent). Aquatic vegetation was not present, and available cover was provided by boulder/cobble and some large woody debris.

Western Shore area: Along the western end of the reservoir the surficial substrate was mostly composed of sand (45 percent) and gravel (25 percent each), with equal amounts of fines, cobbles, and boulders (10 percent each). Aquatic vegetation was not present, and available cover was provided by boulder/cobble and some large woody debris.

Northern Shore area: The near shore surficial substrate along the northern shore of the reservoir was mostly composed of sand (45 percent) and gravel (25 percent each), with equal amounts of fines, cobbles, and boulders (10 percent each).

Aquatic vegetation was not present, and available cover was provided by boulder/cobble and some large woody debris.

In summary, the shoreline surficial substrate of the reservoir was mostly composed of sand. There was an ample amount of gravel mixed with the sand, with scattered patches of fines, boulders and cobbles. Large woody debris and boulder/cobbles provided fish cover. Aquatic vegetation was absent in all areas observed. Along the thalweg of the lake, near the channel of Big Creek prior to impoundment, alluvial materials are present, as well as the remains of trees not removed prior to reservoir construction.

TRIBUTARY SPAWNING ACCESS

There are no major migration barriers between Huntington Lake and Rancheria Creek, Big Creek, Line Creek, Coon Creek, and Home Camp Creek at all lake elevations. Therefore, fish can access all major tributaries of Huntington Lake, from the reservoir, regardless of lake elevation. However, when the reservoir is drawn down, stream flows from Big Creek, Line Creek, Coon Creek, and Home Camp Creek are potentially insufficient for upstream fish migration.

2.3.8.7 Dam 4 Forebay

GENERAL DESCRIPTION

Dam 4 Forebay is located immediately downstream of Big Creek Powerhouse No. 1, and is formed by Dam No. 4, which serves as an afterbay for Big Creek Powerhouse No. 1 and receives the inflow of Big Creek and Pitman Creek (Map CAWG 1-7). Dam No. 4 is a 75-foot high constant-radius concrete arch dam with a crest length of 287 feet at elevation 4,805 feet above MSL. Water from Dam 4 Forebay flows into Big Creek below Dam No. 4 and into an intake for Big Creek Powerhouse No. 2. The reservoir net storage capacity with the flashboards in place at 4,810 feet MSL is 60 acre-feet and a surface area of 3.3 acres. During typical operations of Big Creek Powerhouse No. 1, the volume of water in the forebay is replaced many times in a single day.

RESERVOIR HABITAT

VOLUME AND AREA

The volume and surface area to corresponding forebay water surface elevations in Dam 4 Forebay are shown in Table CAWG 1-288. At a normal annual maximum forebay elevation of around 4,808 feet above MSL, Dam 4 Forebay has a volume of 49.3 acre-feet, and a surface area of 3.2 acres. The elevation of the forebay rarely varies significantly over the year, but occasionally the forebay drops to elevations as low as 4,799 feet above MSL. The forebay volume at a water surface elevation of 4,799 feet above MSL is 23.4 acre-feet, and the forebay surface area is 2.5 acres.

Figure CAWG 1-103 shows daily volumes and surface areas at Dam 4 Forebay from January 2000 through October 2002. The forebay elevation rises and falls a few times over the year, but remains near 4,808 feet above MSL for most of the year.

The Dam 4 Forebay winter and summer average lake elevation, volume, and surface area by water year are presented in Table CAWG 1-289.

SHORELINE DEVELOPMENT

Dam 4 Forebay has a maximum length of 0.16 miles, and an average breadth of 0.03 miles. The maximum surface area of Dam 4 Forebay is 0.005 square miles, and the shoreline length is 0.41 miles. The shoreline development index is, therefore, equal to 1.64.

THERMAL STRUCTURE

Dam 4 Forebay is a small waterbody, with a well-mixed thermal structure. Due to the small size and nature of the forebay, and the large volumes of water that pass through it during the summer months, thermal stratification is not likely to occur. The temperature of the forebay was monitored with a water temperature monitor, which was suspended below the surface waters of the forebay.

The average monthly temperature of the Dam 4 Forebay in 2000 ranged from a high of 14.0^{o}C in September to a low of 11.6^{o}C in July, and in 2001 from a high of 14.6^{o}C in October to a low of 10.4^{o}C in June (Table CAWG 1-274).

SUBSTRATE

Much of the area around Dam 4 Forebay is dominated by bedrock, boulders, and sand. Fine materials are located along the bottom thalweg, and at the Big Creek and Pitman Creek confluences with the forebay. Specific regions of the reservoir are discussed below.

Powerhouse 2 Intake area: The near shore surficial substrate of Dam 4 Forebay near the Powerhouse 2 intake was primarily composed of bedrock (90 percent), with some cobbles (10 percent). Aquatic vegetation and available fish cover were not present in the area observed.

Opposite Shore of Powerhouse 1 Tailrace area: The near shore surficial substrate across the forebay from the Powerhouse 1 tailrace was composed of cobble (60 percent), and boulders (40 percent). Aquatic vegetation was not present, and available fish cover was provided by cobble/boulder in the area observed.

Big Creek and Pitman Creek Confluence area: The shoreline surficial substrate near the inflows from Big Creek and Pitman Creek was mostly composed of sands (70 percent), followed by bedrock (20 percent) and boulders (10 percent). Aquatic vegetation was not present, and available fish cover was provided by boulder/cobble, bedrock, and terrestrial vegetation.

The substrate on the bottom of the forebay was mostly composed of silt/sand with smaller components of boulder, cobble, and bedrock. There was also some submerged wood along the forebay floor.

TRIBUTARY SPAWNING ACCESS

Upstream fish migration into Pitman and Big Creeks from Dam 4 Forebay is not impeded, even during periods of reservoir drawdown. There are no major barriers between the forebay, and the two creeks.

2.3.8.8 Dam 5 Forebay

GENERAL DESCRIPTION

Dam 5 Forebay is a small reservoir that impounds the discharge from both Powerhouse Nos. 2 and 2A, as well as the stream flow from Big Creek (Map CAWG 1-7). Dam No. 5 is a constant-radius concrete arch dam, 60 feet high, built across Big Creek just below Powerhouse Nos. 2/2A. Water from Dam 5 Forebay flows into Big Creek below Dam No. 5, and into an intake for Powerhouse No. 8. The forebay lies at an elevation of 2,943 feet MSL, and has a surface of 3.3 acres, and capacity of 49 acre-feet. The forebay is small and large volumes of water that may pass through it during power generation. This results in the water in the forebay being replaced many times each day when generation is taking place.

RESERVOIR HABITAT

VOLUME AND AREA

The volume and surface area corresponding to forebay water surface elevations in Dam 5 Forebay are shown in Table CAWG 1-290. At a normal annual maximum forebay elevation of around 2,942 feet above MSL, Dam 5 Forebay has a volume of 43.4 acre-feet, and a surface area of 3.2 acres. The elevation of the forebay rarely varies significantly over the year, but occasionally the forebay water surface elevation drops to elevations as low as 2,938 feet above MSL. The forebay volume at 2,938 feet above MSL is 31.5 acre-feet, and the surface area is 2.7 acres.

Figure CAWG 1-104 shows daily volumes and surface areas at Dam 5 Forebay from January 2000 through October 2002. The forebay surface elevation rises and falls a few times over the year, but remains near 2,942 feet above MSL for most of the year.

The Dam 5 Forebay winter and summer average forebay elevation, volume, and surface area by water year are presented in Table CAWG 1-291.

SHORELINE DEVELOPMENT

Dam 5 Forebay has a maximum length of 0.20 miles, and an average breadth of 0.02 miles. The maximum surface area of Dam 5 Forebay is 0.005 square miles, and the shoreline length is 0.44 miles. The shoreline development index is, therefore, equal to 1.76.

THERMAL STRUCTURE

Dam 5 Forebay is a small forebay, with a well-mixed thermal structure. Due to the small size and volume of water that moves through the forebay during generation, thermal stratification is not likely to occur in the forebay. The temperature of the forebay was monitored with a water temperature monitor, which was suspended below the surface waters of the forebay.

The average monthly temperature of the Dam 5 Forebay in 2000 ranged from a high of 15.8^{o}C in October to a low of 11.4^{o}C in June, and in 2001 from a high of 15.9^{o}C in September and October to a low of 7.0^{o}C in May (Table CAWG 1-274).

SUBSTRATE

Much of the area around Dam 5 Forebay is dominated by bedrock, and boulders. Fine materials are located along the bottom thalweg, and at the confluence of Big Creek with the forebay. Specific regions of the reservoir are discussed below.

Powerhouse 8 Intake area: The surficial substrate of Dam 5 Forebay near the intake to Powerhouse No. 8 was mostly composed of bedrock (80 percent) followed by fines (20 percent). Small rooted vegetation was present in approximately five percent of the area observed. Available fish cover was provided by root wad, terrestrial vegetation, and woody debris in the area observed.

Eastern Shore area: Along the east bank of the forebay, between the powerhouses and the dam, the near shore surficial substrate was mostly composed of bedrock (60 percent), boulder (30 percent), and fines (10 percent). Small rooted vegetation was present in approximately five percent of the area observed. Available fish cover was provided by terrestrial vegetation, undercut bank, and woody debris.

Western Shore area: The shoreline surficial substrate along the west bank of the forebay, near the powerhouses, was composed entirely of bedrock. Aquatic vegetation and available cover were not present in the area observed.

The substrate on the bottom of the forebay was mostly composed of silt/sand with smaller components of boulder, cobble, and bedrock.

TRIBUTARY SPAWNING ACCESS

Big Creek is the only stream that flows into Dam 5 Forebay. There are no barriers to upstream migration for fish between the reservoir and Big Creek.

2.3.8.9 Balsam Meadow Forebay

GENERAL DESCRIPTION

Balsam Meadow Forebay is located on Balsam Creek (Map CAWG 1-8). The forebay is the regulating reservoir that controls the water flow into the John S. Eastwood underground power station. The forebay is filled by water carried down the Huntington-Pitman-Shaver Conduit from Huntington Lake and Pitman Diversion, or from water pumped back from Shaver Lake via Eastwood Power Station. The forebay lies at 6,670 feet MSL and has a surface area of 60 acres and a capacity of 1,547 acre-feet of water.

RESERVOIR HABITAT

VOLUME AND AREA

The volume and surface area corresponding to lake water surface elevations in Balsam Meadow Forebay are shown in Table CAWG 1-292. At a normal annual maximum lake elevation of around 6,662 feet above MSL, Balsam Meadow Forebay has a volume of 1,247 acre-feet, and a surface area of 51 acres. As the forebay water surface elevation draws down to 6,650, and 6,645 feet above MSL the corresponding forebay volumes drop to 705, and 515 acre-feet, respectively, and the corresponding surface areas drop from 38, and 32 acres, respectively. When the forebay reaches a normal annual minimum lake elevation of 6,639 feet, the reservoir volume has dropped to 326 acre-feet, and the reservoir surface area is 32 acres.

Figure CAWG 1-105 shows daily volumes and surface areas at Balsam Meadow Forebay from the fall of 1999 through the fall of 2002. The water surface elevation of the forebay, and therefore, the volume and surface area, vary on a daily basis. Generally, though, the forebay water surface elevation in the summer is higher than in the winter.

The Balsam Meadow Forebay winter and summer average water surface elevation, volume, and surface area by water year are presented in Table CAWG 1-293.

HABITAT AREAS

Habitat areas for near shore and shallow habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of lake elevations. Table CAWG 1-294 presents this information based on available forebay storage curves and morphometry. The amount and variability of shallow habitat available at most water surface elevations is indicative of the small size and relatively steep shoreline of much of the reservoir.

At a normal annual maximum lake elevation of around 6,662 feet above MSL, Balsam Meadow Forebay has one acre of habitat in three feet or less of water; one acre of habitat in six feet or less; 13 acres of habitat in nine feet or less; and 13 acres in 12 feet or less. When the lake reaches a normal annual minimum lake elevation of

6,639 feet above MSL, Balsam Meadow Forebay has one acre of habitat in three feet or less of water; 17 acres of habitat in six feet or less; 32 acres of habitat in nine feet or less; and 32 acres in 12 feet or less.

SHORELINE DEVELOPMENT

Balsam Meadow Forebay has a maximum length of 0.37 miles, and an average breadth of 0.18 miles. The maximum surface area of Balsam Meadow Forebay is 0.094 square miles, and the shoreline length is 1.44 miles. The shoreline development index is, therefore, equal to 1.3.

THERMAL STRUCTURE

As stated in CAWG 5, the reservoir was minimally stratified during two of the summer months. Due to the small size and nature of the forebay and the movement of water through the forebay from Huntington Lake and back and forth to Shaver Lake, thermal stratification is not often likely to occur or persist in the forebay. Figure CAWG 1-106 presents the temperature profiles for 2001. Stratification set in at the Balsam Meadow Profile site in May and July of 2001. The depth of the thermocline was observed within the first meter of water in May and between one and two meters in July (Table CAWG 1-295). The average temperature of the epilimnion ranged from a low of 8.3^{o}C in May 2001, to a high of 20.8^{o}C in July 2001. The average temperature of the hypolimnion ranged from a low of 6.4^{o}C in May 2001, to a high of 19.0^{o}C in July 2001 (Table CAWG 1-295). The average Dissolved Oxygen (DO) of the reservoir ranged from 7.2 to 10.2 mg/L in 2001. The average Specific Conductance (SpC) of the reservoir ranged from 15.0 μS/cm to 18.0 μS/cm, and the Secchi disc transparency of the reservoir ranged from 4.2 m to 6.6 m in 2001 (Table CAWG 1-295).

SUBSTRATE

The area around Balsam Meadow Forebay is dominated by sand, fines, and boulders. Finer materials are located all across the bottom of the reservoir, and near the dam. Specific regions of the reservoir are discussed below.

East Cove area: The surficial substrate along the east cove of Balsam Meadow Forebay was mostly composed of bedrock (40 percent), with equal amounts of boulders, sands, and fines (20 percent each). Aquatic vegetation was not present, and available cover was provided by boulder/cobble and bedrock.

Eastwood Powerhouse Intake area: The surficial substrate along the north side of the forebay near the Eastwood Powerhouse intake was predominantly composed of sands (60 percent), followed by cobbles (30 percent), and gravels (10 percent). Small rooted vegetation was present in approximately 25 percent of the area observed. Available fish cover was provided by terrestrial vegetation and boulder/cobble.

North Cove area: Along the north cove of the forebay, the near shore surficial substrate was mostly composed of sands (60 percent), followed by gravels (25 percent), cobbles (10 percent), and fines (five percent). Small rooted vegetation was present in approximately 25 percent of the area observed. Fish cover was provided by terrestrial vegetation and boulder/cobble.

South Cove area: The shoreline surficial substrate along the south cove of Balsam Meadow Forebay was mostly composed of sands (90 percent), followed by boulders and cobbles (five percent each). Small rooted aquatic vegetation was present in approximately 25 percent of the area observed. Available fish cover was provided by woody debris, terrestrial vegetation, and boulder/cobble.

The substrate on the bottom of the forebay was mostly composed of silt/sand with smaller components of boulder, cobble, and bedrock.

TRIBUTARY SPAWNING ACCESS

No stream flows into Balsam Meadow Forebay. Therefore, upstream migration from the reservoir into a stream is not possible.

2.3.8.10 Shaver Lake

GENERAL DESCRIPTION

Shaver Lake Reservoir is the largest on the Big Creek system (Map CAWG 1-8). Shaver Lake was created in 1927 by the construction of the Shaver Lake Dam across Stevenson Creek, a tributary of the San Joaquin River. It replaced a mill pond that was there previously. The drainage area into Shaver Lake is only 29 square miles, so the majority of the water impounded in the reservoir is diverted through the Huntington-Pitman-Shaver Conduit from Huntington Lake through Balsam Forebay and the Eastwood Powerhouse. Swanson Meadow Creek, Stevenson Creek, Azalea Creek, North Fork Stevenson Creek, as well as a number of unnamed ephemeral creeks flow into Shaver Lake. Stevenson Creek and North Fork Stevenson Creek contribute the majority of the stream flow input to the reservoir.

Shaver Lake Dam is a concrete gravity dam, 185 feet high. The spillway, an overpour type, consists of a notch, 0.9 feet deep by 250 feet long, in the dam's three feet high parapet wall. The spillway is located in the center of the dam at elevation 5,370 feet above MSL. The spillway rated discharge capacity at elevation 5,371 feet above MSL is 745 cubic feet per second.

The reservoir is deepest near the dam. There are shallow reef-like areas, which become islands at lowered lake elevations, scattered around the reservoir, but mostly near the center of the lake. Artificial shallow water habitat was constructed by SCE near the lake margin to provide additional habitat for bass.

RESERVOIR HABITAT

VOLUME AND AREA

The reservoir volumes and surface area to corresponding water surface elevations in Shaver Lake are shown in Table CAWG 1-296. Over the past 21 years (1980-2001) for which data are available from USGS, the average maximum yearly storage volume in Shaver Lake has been 113,884 acre-feet, with a corresponding water surface elevation 5359.8 ft above msl and a surface area of about 2,030 acres. As the lake draws down to 5,350 feet above MSL, the corresponding reservoir volume drops to 94,568 af, and the corresponding surface area drops to 1,888 acre. For the 1980-2001 period, the average minimum yearly storage volume was 48,875 af, with a corresponding water surface elevation of about 5,321.5 feet.

For representative water year types for the period 1980-2001, Figure CAWG 1-107 shows daily volumes and corresponding surface areas at Shaver Lake. During this period, four of the five types of water years occurred. A below normal water year did not occur during this period. Data from the last below normal water year (1971) is included in the figure. The lowest water surface elevations, and therefore, the lowest volumes and surface areas are usually in the spring. The reservoir is usually at its maximum volume and surface area at some point in the summer, usually around July. In wetter water year types, storage is generally higher and higher storage levels are maintained over longer periods than during drier years.

All five of the water years are presented in Figure CAWG 1-107, and Table CAWG 1-297 presents the average reservoir storage and corresponding elevation and surface area for winter and summer operations periods. This table clearly shows the differences in seasonal storage, as well as the differences between those seasons among water year types.

HABITAT AREAS

Habitat area for near shore and shallow habitats were calculated for depths of three feet or less, six feet or less, nine feet or less, and 12 feet or less for a wide range of lake elevations. Table CAWG 1-298 presents this information based on available lake storage curves and morphometry. The relatively large amount of shallow habitat available at most reservoir elevations is indicative of the shallow depth and large size of the reservoir.

At the average maximum storage of 113,884 acre-feet (1980-2001), with a corresponding water surface elevation 5359.8 ft above msl, Shaver Lake has approximately 41.6 acres of habitat in three feet or less of water; 90.5 acres of habitat in six feet or less; 126.7 acres of habitat in nine feet or less; and 193.9 acres in 12 feet or less. The 21-year average (1980-2001) of yearly minimum reservoir storage is 48,875 af, with a corresponding water surface elevation of about 5,321.5 feet ft above MSL, Shaver Lake has 60.2 acres of habitat in three feet or less of water;

117.2 acres of habitat in six feet or less; 170.5 acres of habitat in nine feet or less; and 226.8 acres in 12 feet or less.

Shoreline Development

Shaver Lake has a maximum length of 3.19 miles, and an average breadth of 1.06 miles. The maximum surface area of Shaver Lake is 3.41 square miles, and the shoreline length is 17.49 miles. The shoreline development index is, therefore, equal to 2.7.

Thermal Structure

As stated in CAWG 5, the reservoir stratifies annually during the summer months and mixes in the fall. Figures CAWG 1-108 and 1-109 present the temperature profiles for 2000 and 2001. A thermocline was not observed at the dam site in 2000, but a thermocline was present at the east end profile site in August 2000 between four and six meters. In 2001, at the dam site, a thermocline was present between one and four meters in May, between four and six meters in June, between six and seven meters in July, and the site was mixed by August. At the east end profile site, in 2001, a thermocline was present between three and nine meters in May, between three and four meters in June, between four and 11 meters in July, and between four and five meters in August. At the deepest region of the lake (dam site), the epilimnion ranged in thickness from one to six meters, and the hypolimnion ranged in thickness from 33 to 38 meters (Table CAWG 1-299). The average temperature of the epilimnion (dam site) ranged from a low of 16.1^{o}C in May 2001, to a high of 21.1^{o}C in July 2001. The average temperature of the hypolimnion (dam site) ranged from a low of 7.6^{o}C in May 2001, to a high of 13.6^{o}C in July 2001 (Table CAWG 1-299). The average Dissolved Oxygen (DO) of the reservoir ranged from 7.1 to 7.5 mg/L in 2000, and from 5.6 to 9.2 mg/L in 2001. The average Specific Conductance (SpC) of the reservoir was 15.0 μS/cm in October 2000, and 17.0 for all months in 2001, and the Secchi disk transparency of the reservoir was 4.2 m in October 2000, and ranged from 3.8 m to 7.1 m in 2001 (Table CAWG 1-299).

Substrate

The area around Shaver Lake is dominated by bedrock, boulders, and sand. There are also large forested areas around Shaver Lake dominated by coniferous trees. Finer materials are located along the thalweg of the reservoir, in areas near tributary confluences, and near the dam. Specific regions of the reservoir are discussed below.

Sierra Marina area: The shoreline surficial substrate near the Sierra Marina boat launching facility was mostly composed of sand (30 percent), with gravel (20 percent), fines (10 percent) cobbles (20 percent) and boulders (10 percent) and bedrock (10 percent) comprising the remaining substrate. Small rooted vegetation was present in approximately 25 percent of the area observed, and available cover was provided by boulder/cobble.

North Fork Stevenson Creek area: The near shore surficial substrate in the North Fork Stevenson Creek cove was mostly composed of sand (25 percent), with gravel (20 percent), fines (five percent) cobbles (20 percent) and boulders (15 percent) and bedrock (15 percent) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble, and submerged large woody debris.

Stevenson Creek area: The surficial substrate in the Stevenson Creek cove was mostly composed of sand (55 percent), gravel (15 percent), with fines, cobbles, and boulders (10 percent each) comprising the remaining substrate. Aquatic vegetation was not present, and available cover was provided by boulder/cobble, and submerged large woody debris.

Dorabelle Campground area: The near shore surficial substrate in the cove near Dorabelle campground was mostly composed of sand (35 percent), with gravel (20 percent), fines (15 percent) cobbles (10 percent) and boulders (10 percent) comprising the remaining substrate. Small rooted vegetation was present in approximately 35 percent of the area observed, and available cover was provided by boulder/cobble, and submerged large woody debris.

Camp Edison area: The shoreline surficial substrate near the Shaver Marina in Camp Edison was mostly composed of sand (50 percent), with gravel (15 percent), fines (15 percent) cobbles (10 percent) and boulders (10 percent) and comprising the remaining substrate. Small rooted vegetation was present in approximately 15 percent of the area observed, and available cover was provided by boulder/cobble.

In summary, the shoreline surficial substrate of the reservoir was mostly composed of sand. There was an ample amount of gravel mixed with the sand, with scattered patches of fines, boulders, cobbles, and bedrock. Large woody debris and boulder/cobbles provided fish cover. Aquatic vegetation was present in some of the areas observed.

TRIBUTARY SPAWNING ACCESS

There are no major migration barriers between Shaver Lake and Stevenson Creek upstream of the lake. However, a major migration barrier exists between Shaver Lake and North Fork Stevenson Creek, when the reservoir is below maximum capacity. When the reservoir is full, there is access for fish to migrate into North Fork Stevenson Creek, but fish will not be able to access the creek at lower reservoir elevations. There is also a complete barrier to fish migration in North Fork Stevenson Creek only 306 ft upstream of the reservoir high water mark. All other streams that flow into Shaver Lake do not have sufficient water flow for fish to access the streams from Shaver Lake. Therefore, access from the reservoir for fish into all other creeks that contribute water into Shaver Lake is not possible.

3.0 LITERATURE CITED

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TABLES

Table CAWG 1-1 Status of Study Stream Habitat Mapping

SOUTH FORK SAN JOAQUIN RIVER SUB BASIN	INVENTORY STATUS	DATE OF STUDY
Tombstone Creek		
• Tombstone Creek Above Diversion	C	7/11/2000
• Tombstone Creek Below Diversion	C	7/10/2000
South Slide Creek	C	7/12/2000
North Slide Creek	C	7/12/2000
Hooper Creek		
• Hooper Creek Above Diversion	C	7/11/2000
• Hooper Creek Below Diversion	C	7/10/2000
Crater Creek		
• Crater Creek Above Diversion	C	7/20/2000
• Crater Creek Below Diversion	C	7/18/2000
Crater Creek Diversion Channel	C	7/18/2000
Bear Creek		
• Bear Creek Above Diversion	C	7/27/2000
• Bear Creek Below Diversion	C	7/26/2000
Chinquapin Creek[2]	C	7/25/2000
Camp 62 Creek[2]	C	8/1/2000
Bolsillo Creek		
• Bolsillo Creek Above Diversion	C	8/16/2000
• Bolsillo Creek Below Diversion	C	8/15/2000
Camp 61 Creek*	C	2000
Mono Creek (Div. Forebay to San Joaquin River)	C	8/11/2000
Adit No. 2 Seepage (below Portal Forebay)*	C	2000
SOUTH FORK SAN JOAQUIN RIVER		
• Florence Lake to Bear Creek	C	8/8/2000
• Bear Creek to Mono Crossing	C	8/8/2000
• Mono Crossing to Rattlesnake	C	8/30/2000
• Rattlesnake to Hoffman	C	9/13/2000
• Hoffman to San Joaquin River Confluence	C[1]	2000
SAN JOAQUIN RIVER SUB BASIN		
Rock Creek		
• Rock Creek Above Diversion	C	8/4/2000
• Rock Creek Below Diversion	C[1]	8/4/2000
Ross Creek		
• Ross Creek Above Diversion	C	6/8/2002
• Ross Creek Below Diversion	C	8/25/2000
San Joaquin River (SFSJR confluence to Mammoth Pool)	-[1]	2002
San Joaquin River Mammoth Reach (Mammoth Pool Dam to PH)	C	9/19/2000
San Joaquin River - Stevenson Reach (Dam 6 to PH 3)	C	7/26/2000

Table CAWG 1-1 Status of Study Stream Habitat Mapping (cont)

BIG CREEK REACH	INVENTORY STATUS	DATE OF STUDY
Rancheria Creek[2]	C	7/25/2000
Tributary to Big Creek (Adit No. 8)	C	7/27/2000
Big Creek (Dam 1 to PH 1)	C[1]	11/9/2000
Big Creek (Dam 4 to PH 2)	C	9/5/2001
Big Creek (Dam 5 to PH 8)	C	8/8/2001
Pitman Creek[2]	C	8/3/2000
Balsam Creek (Dam to Low. Div. Forebay)	C	7/31/2000
Balsam Creek (Lower Div. Forebay to Big Creek)	C	7/31/2000
Balsam Creek (Balsam Forebay Dam to Lower Div. Forebay)		2003[3]
Ely Creek Above Diversion	C	7/27/2000
Ely Creek Below Diversion	C	7/28/2000
STEVENSON CREEK REACH		
North Fork Stevenson Creek Above Outlet	C	10/26/2000
North Fork Stevenson Creek Below Outlet	C	10/25/2000
Stevenson Creek (Shaver Lake to San Joaquin River)	C	7/16/2001[1]

C – Complete

* - Streams and reservoirs included in the Big Creek 4, Vermilion, and Portal License Applications are not included in this document.

1 Reach not fully accessible, supplemented using aerial photography in 2002.

2. Both Above and Below Diversions were habitat mapped on the same day.

3. Scheduled to be completed 2003.

Table CAWG 1-2 Hawkins Level I Habitat Designations

Fast Water (Riffle/Run		Slow Water (Pool	
Turbulent (T)	**Non-Turbulent (NT)**	**Scour Pool (SP)**	**Dammed Pool (DP)**
Riffle Habitat – High Turbulence – Caused by geomorphic differences (i.e. gradient, bed roughness, and/or step development).	Run Habitat – Low or Non-Turbulent – Caused by geomorphic differences (i.e. gradient, bed roughness, and/or step development.	Pool Habitat – Formed by Scour – Pool created by erosion of stream bank, boulder, bedrock, etc.	Pool Habitat – Formed by Dam – Pool created by water blockage due to debris, landslide, beaver dam, large boulders, etc.

Source: Hawkins, 1993

Table CAWG 1-3 USFS Region 5 Habitat (McCain et al., 1990) Types and Definitions

Habitat Types	Abbreviation	Definition
RIFFLE		
Low Gradient Riffle	LGR	Shallow reaches with turbulent water. Gradient is <4 percent, with a substrate that is usually dominated with cobble.
High Gradient Riffle	HGR	Steep reaches with a gradient >4 Percent, with swift, very turbulent water. The substrate is usually dominated with boulders. The amount of exposed substrate is high.
Cascade	CAS	Steepest of the riffle habitats. Alternating between small waterfalls and shallow pools. Substrate is usually bedrock and boulders.
FLATWATER		
Pocket Water	POW	A section of a swiftly flowing stream with large boulders or other obstructions, which creates eddies or scour holes (pockets).
Glide	GLD	A wide, shallow pool with a gentle flow, and little to no surface turbulence. The substrate usually consists of cobble, gravel, and/or sand.
Run	RUN	Swiftly flowing reaches with very little surface turbulence, and no flow obstructions (a flooded riffle). Substrate usually consists of gravel, cobble, and boulders.
Step Run	SRN	A sequence of runs separated by short riffles. The substrate is usually dominated by cobble and boulder.
Trench/Chute	TRC	A channel cross-section that is typically U-shaped with a bedrock or coarse bottom and bedrock walls. Uniform and swift current flow. May be pool-like.
Edgewater	EGW	A quiet, shallow area found at the edge of streams, often associated with riffles. Water velocity is low. Substrate often consists of cobbles and/or boulders.
Bedrock Sheet *	BRS	A stream segment that flows over a steep sheet of bedrock. The water is fast flowing.

Table CAWG 1-3 USFS Region 5 Habitat (McCain et al., 1990) Types and Definitions (cont)

Habitat Types	Abbreviation	Definition
POOL		
Mid-Channel Pool	MCP	Large pools formed by mid-channel scour. The scour encompasses >60 Percent of the wetted channel. Water velocity is slow, and the substrate is variable.
Lateral Scour Pool	LSP	A partial channel obstruction formed by flow scouring boulders. The scour is confined to <60 Percent of the wetted channel.
Corner Pool	CRP	Lateral scour pools formed at the corner of a channel. Often found in lowland valley bottoms where stream banks lack hard obstructions.
Secondary Channel Pool	SCP	Pools that are outside of the average wetted channel. Mainly associated with gravel bars. These pools will dry up in the summer, and drier months.
Dammed Pool	DPL	Water blocked from complete or nearly complete flow. Often caused by debris jams, rock landslides, or beaver dams. Usually sand or gravel substrate.
Backwater Pool	BWP	Found along channel margins, and usually caused by eddies around obstructions such as boulders, rootwads, or woody debris. Usually shallow with low velocities.
Step Pool *	SPO	A sequence of pools separated by short riffles. The substrate is variable.
Plunge Pool	PLP	Found where a stream passes over an obstruction and drops steeply into the streambed below, scouring out a depression. Variable substrate.
Channel Confluence Pool	CCP	Large pools formed at the confluence of two or more channels. Usually CCP's have a greater velocity and more turbulence than the other pools.
ADDITIONAL UNIT DESIGNATIONS		
Dry *	DRY	No flowing water.
Road Crossing **	RDC	A place where a road crosses the stream.
Concrete Box Culvert **	CBC	A stream segment that flows through a concrete box culvert.

* Denotes additional habitat unit types used in this study.
** Denotes artificial instream structure types.

Table CAWG 1-4 Description of Spawning Gravel Quality

SPAWNING QUALITY	DESCRIPTION OF SUBSTRATE
Excellent	Round-shaped spawning gravels loose in substrate.
Good	Round-shaped spawning gravels slightly embedded in substrate or moderately jagged-shaped spawning gravels loose in substrate.
Fair	Round-shaped spawning gravels embedded in substrate or moderately jagged-shaped spawning gravels slightly embedded in substrate.
Poor	Round or jagged-shaped gravels deeply embedded in substrate.

Table CAWG 1-5 Percent Length by Rosgen Channel Type for SFSJR Bear Creek to Florence Lake

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	26448	69.8
C	10391	27.4
G	1042	2.8

Table CAWG 1-6 Average Weighted Cover Per Dominant Rosgen Channel Type for SFSJR Bear Creek to Florence Lake

	Rosgen Channel Type		
	B	**C**	**G**
Average Weighted Cover (Percent)			
Undercut Banks	0	0	0
Woody Debris	3	22	0
Root Wad	0	0	0
Terrestrial Vegetation	1	5	13
Aquatic Vegetation	0	7	0
Surface Turbulence	17	1	16
Boulder/Cobble	48	16	8
Bedrock	9	3	14

Table CAWG 1-7 Frequency of Canopy Percentages for SFSJR Bear Creek to Florence Lake

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake

Bin	Canopy	Hardwood	Softwood
[0] %	25	123	70
(0-10] %	37	2	35
(10-20] %	25	0	25
(20-30] %	20	0	20
(30-40] %	15	0	15
(40-50] %	16	14	2
(50-60] %	20	20	0
(60-70] %	6	5	1
(70-80] %	4	4	0
(80-90] %	0	0	0
(90-100] %	0	0	0
Summary for 'Reach' = SF San Joaquin River Bear Crk to Florence Lake (11 detail records)			
Sum	*168*	*168*	*168*

Grand Total	*168*	*168*	*168*

Table CAWG 1-8 Average Percent Dominant Substrate by Rosgen Channel Type for SFSJR Bear Creek to Florence Lake

Average Percent Dominant Substrate	Rosgen Channel Type		
	B	C	G
Fines	0	5	0
Sands	4	30	0
Gravel	0	29	3
Cobble	21	8	0
Boulders	53	1	8
Bedrock	8	1	83

Table CAWG 1-9 Spawning Gravel by USFS-R5 Habitat Types for SFSJR Bear Creek to Florence Lake

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

SF San Joaquin River **SF San Joaquin River Bear Crk to Florence Lake**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
HGR	High Gradient Riffle	50	0.53
CAS	Cascade	0	0.00
SCP	Secondary Channel Pool	0	0.00
BWP	Backwater Pool	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	0	0.00
DPL	Dammed Pool	0	0.00
GLD	Glide	5200	54.96
RUN	Run	2900	30.65
SRN	Step Run	50	0.53
MCP	Main Channel Pool	50	0.53
CCP	Channel Confluence Pool	50	0.53
LSP	Lateral Scour Pool	632	6.68
POW	Pocket Water	530	5.60
CRP	Corner Pool	0	0.00

Table CAWG 1-10 Percent Length by Rosgen Channel Type for SFSJR Mono Crossing to Bear Creek

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	14560	58.9
C	5032	20.4
G	5110	20.7

Table CAWG 1-11 Average Weighted Cover Per Dominant Rosgen Channel Type for SFSJR Mono Crossing to Bear Creek

	Rosgen Channel Type		
	B	**C**	**G**
Average Weighted Cover (Percent)			
Undercut Banks	1	1	2
Woody Debris	0	2	0
Root Wad	0	0	0
Terrestrial Vegetation	0	2	1
Aquatic Vegetation	0	0	0
Surface Turbulence	10	13	7
Boulder/Cobble	35	51	35
Bedrock	28	11	22

Table CAWG 1-12 Frequency of Canopy Percentages for SFSJR Mono Crossing to Bear Creek

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Bin	*Canopy*	*Hardwood*	*Softwood*
[0] %	131	153	131
(0-10] %	21	0	21
(10-20] %	1	0	1
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0
Summary for 'Reach' = SF San Joaquin River Mono X to Bear Crk Reach (11 detail records)			
Sum	*153*	*153*	*153*

Grand Total	*153*	*153*	*153*

Table CAWG 1-13 Average Percent Dominant Substrate by Rosgen Channel Type for SFSJR Mono Crossing to Bear Creek

Average Percent Dominant Substrate	Rosgen Channel Type		
	B	C	G
Fines	0	2	0
Sands	9	9	10
Gravel	0	1	0
Cobble	22	39	20
Boulders	35	36	44
Bedrock	20	0	9

Table CAWG 1-14 Spawning Gravel by USFS-R5 Habitat Types for SFSJR Mono Crossing to Bear Creek

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

SF San Joaquin River **SF San Joaquin River Mono X to Bear Crk Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	20	1.87
HGR	High Gradient Riffle	20	1.87
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
SPO	Step Pool	60	5.62
RUN	Run	80	7.49
SRN	Step Run	0	0.00
LSP	Lateral Scour Pool	848	79.40
POW	Pocket Water	35	3.28
CRP	Corner Pool	5	0.47

Table CAWG 1-15 Percent Length by Rosgen Channel Type for SFSJR Mono Crossing to Downstream of Rattlesnake Crossing

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	21944	65.4
G	11629	34.6

Table CAWG 1-16 Average Weighted Cover Per Dominant Rosgen Channel Type for SFSJR Mono Crossing to Downstream of Rattlesnake Crossing

	Rosgen Channel Type	
	B	**G**
Average Weighted Cover (Percent)		
Undercut Banks	0	0
Woody Debris	0	0
Root Wad	0	0
Terrestrial Vegetation	1	0
Aquatic Vegetation	0	0
Surface Turbulence	11	8
Boulder/Cobble	23	11
Bedrock	24	29

Table CAWG1-17 Frequency of Canopy Percentages for SFSJR Mono Crossing to Downstream of Rattlesnake Crossing

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to ds of Rattlesnake X

Bin	Canopy	Hardwood	Softwood
[0] %	159	165	160
(0-10] %	6	0	6
(10-20] %	1	1	0
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = SF San Joaquin River Mono X to ds of Rattlesnake X (11 detail records)

Sum	*166*	*166*	*166*

Grand Total	*166*	*166*	*166*

Table CAWG 1-18 Number of Barriers Per Dominant Rosgen Channel Type for SFSJR Mono Crossing to Downstream of Rattlesnake Crossing

	Rosgen Channel Type
	G
Number of Barriers	2

Table CAWG 1-19 Average Percent Dominant Substrate by Rosgen Channel Type for SFSJR Mono Crossing to Downstream of Rattlesnake Crossing

Average Percent Dominant Substrate	Rosgen Channel Type	
	B	G
Fines	0	0
Sands	11	22
Gravel	0	0
Cobble	8	1
Boulders	44	24
Bedrock	20	41

Table CAWG 1-20 Spawning Gravel by USFS-R5 Habitat Types for SFSJR Mono Crossing to Downstream of Rattlesnake Crossing

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

SF San Joaquin River **SF San Joaquin River Mono X to ds of Rattlesnake X**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	805	15.77
HGR	High Gradient Riffle	461	9.03
CAS	Cascade	0	0.00
SPO	Step Pool	1720	33.69
RUN	Run	50	0.98
SRN	Step Run	200	3.92
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	1215	23.80
POW	Pocket Water	650	12.73
CRP	Corner Pool	4	0.08

Table CAWG 1-21 Percent Length by Rosgen Channel Type for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

Rosgen Channel Type	Length (ft) Evaluated	Percent
G	22189	100.0

Table CAWG 1-22 Frequency of Wood Counts for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: SF San Joaquin River

Reach: SF San Joaquin River us of Hoffman Creek to ds of Rattlesnake Crossing

Rosgen 1 Channel Type = G

Bin	Wood Count
[0]	88
[1-5]	26
[6-10]	1
[11-15]	0
[16-20]	1
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-23 Average Weighted Cover Per Dominant Rosgen Channel Type for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

	Rosgen Channel Type
	G
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	11
Boulder/Cobble	23
Bedrock	27

Table CAWG 1-24 Frequency of Canopy Percentages for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River us of Hoffman Creek to ds of Rattlesnake Crossing

Bin	Canopy	Hardwood	Softwood
[0] %	64	84	96
(0-10] %	22	14	8
(10-20] %	18	13	5
(20-30] %	9	5	4
(30-40] %	3	0	3
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = SF San Joaquin River u.s. of Hoffman Creek Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*116*	*116*	*116*
Grand Total	*116*	*116*	*116*

Table CAWG 1-25 Number of Barriers Per Dominant Rosgen Channel Type for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

	Rosgen Channel Type
	G
Number of Barriers	3

Table CAWG 1-26 Average Substrate Per Dominant Rosgen Channel Type for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

	Rosgen Channel Type
	G
Average Substrate (Percent)	
Fines	1
Sands	14
Gravel	0
Cobble	1
Boulders	41
Bedrock	29

Table CAWG 1-27 Spawning Gravel by USFS-R5 Habitat Types for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

SF San Joaquin River **SF San Joaquin River us of Hoffman Creek to ds of Rattlesnake Crossing**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	20	3.08
HGR	High Gradient Riffle	5	0.77
CAS	Cascade	0	0.00
BWP	Backwater Pool	0	0.00
SPO	Step Pool	320	49.23
RUN	Run	0	0.00
SRN	Step Run	20	3.08
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	75	11.54
POW	Pocket Water	210	32.31
CRP	Corner Pool	0	0.00

Table CAWG 1-28 Percent Length by Rosgen Channel Type for SFSJR, SJR Confluence to Upstream of Hoffman Creek

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	5159	13.7
G	32427	86.2

Table CAWG 1-29 Percent Length by Rosgen Channel Type for Tombstone Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1535	100.0

Table CAWG 1-30 Percent Length by Rosgen Channel Type for Tombstone Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	2555	39.5
C/E	3909	60.5

Table CAWG 1-31 Average Weighted Cover Per Dominant Rosgen Channel Type for Tombstone Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	34
Root Wad	0
Terrestrial Vegetation	1
Aquatic Vegetation	0
Surface Turbulence	5
Boulder/Cobble	24
Bedrock	0

Table CAWG 1-32 Average Weighted Cover Per Dominant Rosgen Channel Type for Tombstone Creek BD

	Rosgen Channel Type	
	Aa+	**C/E**
Average Weighted Cover (Percent)		
Undercut Banks	2	3
Woody Debris	25	22
Root Wad	2	7
Terrestrial Vegetation	7	13
Aquatic Vegetation	1	12
Surface Turbulence	6	0
Boulder/Cobble	17	0
Bedrock	1	0

Table CAWG 1-33 Frequency of Canopy Percentages for Tombstone Creek above the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek AD Reach

Bin	*Canopy*	*Hardwood*	*Softwood*
[0] %	0	2	14
(0-10] %	0	0	0
(10-20] %	0	0	0
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	4	2	2
(50-60] %	6	6	0
(60-70] %	6	6	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Tombstone Creek AD Reach (11 detail records)

Sum	*16*	*16*	*16*

Grand Total	*16*	*16*	*16*

Table CAWG 1-34 Frequency of Canopy Percentages for Tombstone Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	7	21	63
(0-10] %	15	9	6
(10-20] %	5	4	1
(20-30] %	4	3	1
(30-40] %	7	6	1
(40-50] %	5	3	2
(50-60] %	8	5	3
(60-70] %	12	12	0
(70-80] %	12	12	0
(80-90] %	2	2	0
(90-100] %	0	0	0
Summary for 'Reach' = Tombstone Creek BD Reach (11 detail records)			
Sum	*77*	*77*	*77*

Grand Total	*77*	*77*	*77*

Table CAWG 1-35 Average Percent Dominant Substrate by Rosgen Channel Type for Tombstone Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	28
Gravel	13
Cobble	0
Boulders	24
Bedrock	16

Table CAWG 1-36 Average Percent Dominant Substrate by Rosgen Channel Type for Tombstone Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type	
	Aa+	E
Fines	2	56
Sands	17	32
Gravel	8	6
Cobble	13	0
Boulders	15	0
Bedrock	28	0

Table CAWG 1-37 Spawning Gravel by USFS-R5 Habitat Types for Tombstone Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Tombstone Creek **Tombstone Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	10	20.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
SPO	Step Pool	0	0.00
RUN	Run	5	10.00
SRN	Step Run	35	70.00
MCP	Main Channel Pool	0	0.00

Table CAWG 1-38 Spawning Gravel by USFS-R5 Habitat Types for Tombstone Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Tombstone Creek **Tombstone Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	140	16.63
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	25	2.97
RUN	Run	295	35.04
SRN	Step Run	347	41.21
MCP	Main Channel Pool	35	4.16
CRP	Corner Pool	0	0.00

Table CAWG 1-39 Percent Length by Rosgen Channel Type for South Slide Creek

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1824	100.0

Table CAWG 1-40 Average Weighted Cover Per Dominant Rosgen Channel Type for South Slide Creek

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	12
Root Wad	0
Terrestrial Vegetation	4
Aquatic Vegetation	1
Surface Turbulence	5
Boulder/Cobble	14
Bedrock	0

Table CAWG 1-41 Frequency of Canopy Percentages for South Slide Creek

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

South Slide Creek

South Slide Creek Reach

Bin	*Canopy*	*Hardwood*	*Softwood*
[0] %	2	2	17
(0-10] %	0	0	0
(10-20] %	1	1	0
(20-30] %	2	2	0
(30-40] %	3	3	0
(40-50] %	2	2	0
(50-60] %	2	2	0
(60-70] %	3	3	0
(70-80] %	2	2	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = South Slide Creek Reach (11 detail records)

Sum	*17*	*17*	*17*

Grand Total	*17*	*17*	*17*

Table CAWG 1-42 Average Substrate Per Dominant Rosgen Channel Type for South Slide Creek

	Rosgen Channel Type
	Aa+
Average Substrate (Percent)	
Fines	2
Sands	14
Gravel	2
Cobble	22
Boulders	24
Bedrock	11

Table CAWG 1-43 Spawning Gravel by USFS-R5 Habitat Types for South Slide Creek

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

South Slide Creek **South Slide Creek Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	50	83.33
BRS	Bedrock Sheet	0	0.00
RUN	Run	0	0.00
SRN	Step Run	10	16.67

Table CAWG 1-44 Percent Length by Rosgen Channel Type for North Slide Creek

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1951	100.0

Table CAWG 1-45 Frequency of Wood Counts for North Slide Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: North Slide Creek

Reach: North Slide Creek Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	3
[1-5]	6
[6-10]	2
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-46 Average Weighted Cover Per Dominant Rosgen Channel Type for North Slide Creek

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	11
Root Wad	0
Terrestrial Vegetation	16
Aquatic Vegetation	0
Surface Turbulence	13
Boulder/Cobble	16
Bedrock	0

Table CAWG 1-47 Frequency of Canopy Percentages for North Slide Creek

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

North Slide Creek

North Slide Creek Reach

Bin	Canopy	Hardwood	Softwood
[0] %	2	3	12
(0-10] %	0	0	0
(10-20] %	1	1	0
(20-30] %	1	0	1
(30-40] %	0	0	0
(40-50] %	1	1	0
(50-60] %	1	1	0
(60-70] %	4	4	0
(70-80] %	0	0	0
(80-90] %	3	3	0
(90-100] %	0	0	0

Summary for 'Reach' = North Slide Creek Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*13*	*13*	*13*
Grand Total	*13*	*13*	*13*

Table CAWG 1-48 Number of Barriers Per Dominant Rosgen Channel Type for North Slide Creek

	Rosgen Channel Type
	Aa+
Number of Barriers	4

Table CAWG 1-49 Average Percent Dominant Substrate by Rosgen Channel Type for North Slide Creek

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	7
Sands	17
Gravel	2
Cobble	13
Boulders	34
Bedrock	0

Table CAWG 1-50 Percent Length by Rosgen Channel Type for Hooper Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1025	100

Table CAWG 1-51 Percent Length by Rosgen Channel Type for Hooper Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	4167	100

Table CAWG 1-52 Frequency of Wood Counts for Hooper Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Hooper Creek

Reach: Hooper Creek AD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	4
[1-5]	3
[6-10]	0
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-53 Frequency of Wood Counts for Hooper Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Hooper Creek

Reach: Hooper Creek BD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	28
[1-5]	16
[6-10]	1
[11-15]	3
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-54 Average Weighted Cover Per Dominant Rosgen Channel Type for Hooper Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	2
Root Wad	0
Terrestrial Vegetation	2
Aquatic Vegetation	0
Surface Turbulence	43
Boulder/Cobble	14
Bedrock	0

Table CAWG 1-55 Average Weighted Cover Per Dominant Rosgen Channel Type for Hooper Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	2
Root Wad	0
Terrestrial Vegetation	3
Aquatic Vegetation	0
Surface Turbulence	32
Boulder/Cobble	25
Bedrock	0

Table CAWG 1-56 Frequency of Canopy Percentages for Hooper Creek above the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Hooper Creek

Hooper Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	0	1	6
(0-10] %	2	1	1
(10-20] %	1	1	0
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	2	2	0
(50-60] %	1	1	0
(60-70] %	1	1	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Hooper Creek AD Reach (11 detail records)

Sum	*7*	*7*	*7*

Grand Total	*7*	*7*	*7*

Table CAWG 1-57 Frequency of Canopy Percentages for Hooper Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Hooper Creek

Hooper Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	1	12	38
(0-10] %	4	0	4
(10-20] %	5	1	4
(20-30] %	8	5	3
(30-40] %	4	4	0
(40-50] %	2	2	0
(50-60] %	3	3	0
(60-70] %	11	11	0
(70-80] %	4	4	0
(80-90] %	7	7	0
(90-100] %	0	0	0

Summary for 'Reach' = Hooper Creek BD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*49*	*49*	*49*
Grand Total	*49*	*49*	*49*

Table CAWG 1-58 Number of Barriers Per Dominant Rosgen Channel Type for Hooper Creek AD

	Rosgen Channel Type
	Aa+
Number of Barriers	1

Table CAWG 1-59 Number of Barriers Per Dominant Rosgen Channel Type for Hooper Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	5

Table CAWG 1-60 Average Percent Dominant Substrate by Rosgen Channel Type for Hooper Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	10
Gravel	3
Cobble	33
Boulders	16
Bedrock	26

Table CAWG 1-61 Average Percent Dominant Substrate by Rosgen Channel Type for Hooper Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	9
Gravel	2
Cobble	22
Boulders	51
Bedrock	3

Table CAWG 1-62 Spawning Gravel by USFS-R5 Habitat Types for Hooper Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Hooper Creek **Hooper Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	15	83.33
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
LSP	Lateral Scour Pool	3	16.67

Table CAWG 1-63 Spawning Gravel by USFS-R5 Habitat Types for Hooper Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Hooper Creek **Hooper Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	5	2.73
HGR	High Gradient Riffle	15	8.20
CAS	Cascade	85	46.45
BRS	Bedrock Sheet	0	0.00
DPL	Dammed Pool	55	30.05
RUN	Run	10	5.46
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	13	7.10

Table CAWG 1-64 Percent Length by Rosgen Channel Type for Crater Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1515	100.0

Table CAWG 1-65 Percent Length by Rosgen Channel Type for Crater Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	15455	85.1
C/E	2706	14.9

Table CAWG 1-66 Frequency of Wood Counts for Crater Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Crater Creek

Reach: Crater Creek AD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	1
[1-5]	2
[6-10]	0
[11-15]	0
[16-20]	1
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-67 Frequency of Wood Counts for Crater Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Crater Creek

Reach: Crater Creek BD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	56
[1-5]	66
[6-10]	4
[11-15]	1
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-68 Frequency of Wood Counts for Crater Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Crater Creek

Reach: Crater Creek BD Reach

Rosgen 1 Channel Type = C/E

Bin	Wood Count
[0]	10
[1-5]	12
[6-10]	1
[11-15]	0
[16-20]	1
[21-25]	2
[26-30]	0
[31-35]	1
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-69 Average Weighted Cover Per Dominant Rosgen Channel Type for Crater Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	6
Woody Debris	6
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	31
Boulder/Cobble	56
Bedrock	0

Table CAWG 1-70 Average Weighted Cover Per Dominant Rosgen Channel Type for Crater Creek BD

	Rosgen Channel Type	
	Aa+	**C**
Average Weighted Cover (Percent)		
Undercut Banks	1	2
Woody Debris	6	22
Root Wad	0	0
Terrestrial Vegetation	13	18
Aquatic Vegetation	1	3
Surface Turbulence	21	2
Boulder/Cobble	29	7
Bedrock	0	0

Table CAWG 1-71 Frequency of Canopy Percentages for Crater Creek above the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	3	4	3
(0-10] %	1	0	1
(10-20] %	0	0	0
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Crater Creek AD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*4*	*4*	*4*
Grand Total	*4*	*4*	*4*

Table CAWG 1-72 Frequency of Canopy Percentages for Crater Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	19	67	107
(0-10] %	29	5	24
(10-20] %	29	15	14
(20-30] %	24	19	5
(30-40] %	13	12	1
(40-50] %	11	9	2
(50-60] %	13	12	1
(60-70] %	9	8	1
(70-80] %	8	8	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Crater Creek BD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*155*	*155*	*155*

Grand Total	*155*	*155*	*155*

Table CAWG 1-73 Number of Barriers Per Dominant Rosgen Channel Type for Crater Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	7

Table CAWG 1-74 Average Percent Dominant Substrate by Rosgen Channel Type for Crater Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	0
Gravel	0
Cobble	20
Boulders	63
Bedrock	0

Table CAWG 1-75 Average Percent Dominant Substrate by Rosgen Channel Type for Crater Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type	
	Aa+	C
Fines	0	4
Sands	18	56
Gravel	6	16
Cobble	12	4
Boulders	41	9
Bedrock	9	0

Table CAWG 1-76 Spawning Gravel by USFS-R5 Habitat Types for Crater Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Crater Creek **Crater Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
CAS	Cascade	0	0.00
SRN	Step Run	50	100.00
LSP	Lateral Scour Pool	0	0.00

Table CAWG 1-77 Spawning Gravel by USFS-R5 Habitat Types for Crater Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Crater Creek **Crater Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	2	0.07
HGR	High Gradient Riffle	50	1.63
CAS	Cascade	55	1.79
BRS	Bedrock Sheet	10	0.33
PLP	Plunge Pool	20	0.65
SPO	Step Pool	260	8.48
DPL	Dammed Pool	20	0.65
GLD	Glide	10	0.33
RUN	Run	627	20.45
SRN	Step Run	1517	49.48
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	495	16.14
CRP	Corner Pool	0	0.00

Table CAWG 1-78 Percent Length by Rosgen Channel Type for Crater Creek Diversion

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	9486	100

Table CAWG 1-79 Average Weighted Cover Per Dominant Rosgen Channel Type for Crater Creek Diversion

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	18
Root Wad	2
Terrestrial Vegetation	6
Aquatic Vegetation	0
Surface Turbulence	5
Boulder/Cobble	26
Bedrock	3

Table CAWG 1-80 Frequency of Canopy Percentages for Crater Creek

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Crater Creek Diversion

Crater Creek Diversion Reach

Bin	Canopy	Hardwood	Softwood
[0] %	16	33	70
(0-10] %	9	5	4
(10-20] %	16	12	4
(20-30] %	11	9	2
(30-40] %	11	6	5
(40-50] %	6	5	1
(50-60] %	10	9	1
(60-70] %	5	5	0
(70-80] %	3	3	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Crater Creek Diversion Reach (11 detail records)

Sum	*87*	*87*	*87*

Grand Total	*87*	*87*	*87*

Table CAWG 1-81 Number of Barriers Per Dominant Rosgen Channel Type for Crater Creek Diversion

	Rosgen Channel Type
	Aa+
Number of Barriers	2

Table CAWG 1-82 Average Substrate Per Dominant Rosgen Channel Type for Crater Creek Diversion

	Rosgen Channel Type
	Aa+
Average Substrate (Percent)	
Fines	0
Sands	8
Gravel	7
Cobble	20
Boulders	16
Bedrock	22

Table CAWG 1-83 Spawning Gravel by USFS-R5 Habitat Types for Crater Creek Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Crater Creek Diversion **Crater Creek Diversion Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	108	19.29
HGR	High Gradient Riffle	3	0.54
CAS	Cascade	10	1.79
BRS	Bedrock Sheet	0	0.00
BWP	Backwater Pool	3	0.54
PLP	Plunge Pool	0	0.00
SPO	Step Pool	130	23.21
RUN	Run	40	7.14
SRN	Step Run	250	44.64
MCP	Main Channel Pool	6	1.07
LSP	Lateral Scour Pool	10	1.79

Table CAWG 1-84 Percent Length by Rosgen Channel Type for Bear Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	1556	100.0

Table CAWG 1-85 Percent Length by Rosgen Channel Type for Bear Creek BD

Rosgen Channel Type	Length (ft) Elvaluated	Percent
A	8349	100.0

Table CAWG 1-86 Frequency of Wood Counts for Bear Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Bear Creek

Reach: Bear Creek AD Reach

Rosgen 1 Channel Type = B

Bin	Wood Count
[0]	2
[1-5]	4
[6-10]	1
[11-15]	1
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-87 Frequency of Wood Counts for Bear Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Bear Creek

Reach: Bear Creek BD Reach

Rosgen 1 Channel Type = A

Bin	Wood Count
[0]	67
[1-5]	15
[6-10]	1
[11-15]	0
[16-20]	1
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-88 Average Weighted Cover Per Dominant Rosgen Channel Type for Bear Creek AD

	Rosgen Channel Type
	B
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	9
Root Wad	0
Terrestrial Vegetation	2
Aquatic Vegetation	0
Surface Turbulence	27
Boulder/Cobble	29
Bedrock	0

Table CAWG 1-89 Average Weighted Cover Per Dominant Rosgen Channel Type for Bear Creek BD

	Rosgen Channel Type
	A
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	2
Aquatic Vegetation	1
Surface Turbulence	34
Boulder/Cobble	50
Bedrock	0

Table CAWG 1-90 Frequency of Canopy Percentages for Bear Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Bear Creek

Bear Creek BD Reach

Bin	*Canopy*	*Hardwood*	*Softwood*
[0] %	25	63	46
(0-10] %	38	10	28
(10-20] %	17	9	8
(20-30] %	3	1	2
(30-40] %	1	1	0
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Bear Creek BD Reach (11 detail records)

Sum	*84*	*84*	*84*

Grand Total	*84*	*84*	*84*

Table CAWG 1-91 Number of Barriers Per Dominant Rosgen Channel Type for Bear Creek BD

	Rosgen Channel Type
	A
Number of Barriers	4

Table CAWG 1-92 Average Percent Dominant Substrate by Rosgen Channel Type for Bear Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	B
Fines	0
Sands	20
Gravel	0
Cobble	15
Boulders	23
Bedrock	23

Table CAWG 1-93 Average Percent Dominant Substrate by Rosgen Channel Type for Bear Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	A
Fines	0
Sands	0
Gravel	0
Cobble	17
Boulders	69
Bedrock	4

Table CAWG 1-94 Spawning Gravel by USFS-R5 Habitat Types for Bear Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Bear Creek **Bear Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	20	66.67
HGR	High Gradient Riffle	0	0.00
RUN	Run	10	33.33
SRN	Step Run	0	0.00
LSP	Lateral Scour Pool	0	0.00

Table CAWG 1-95 Spawning Gravel by USFS-R5 Habitat Types for Bear Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Bear Creek **Bear Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	70	17.07
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	260	63.41
RUN	Run	0	0.00
SRN	Step Run	10	2.44
LSP	Lateral Scour Pool	70	17.07

Table CAWG 1-96 Percent Length by Rosgen Channel Type for Chinquapin Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	472	100.0

Table CAWG 1-97 Percent Length by Rosgen Channel Type for Chinquapin Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	5370	100.0

Table CAWG 1-98 Frequency of Wood Counts for Chinquapin Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Chinquapin Creek

Reach: Chinquapin Creek AD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	0
[1-5]	1
[6-10]	0
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-99 Frequency of Wood Counts for Chinquapin Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Chinquapin Creek

Reach: Chinquapin Creek BD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	35
[1-5]	24
[6-10]	0
[11-15]	0
[16-20]	1
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-100 Average Weighted Cover Per Dominant Rosgen Channel Type for Chinquapin Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	50
Boulder/Cobble	50
Bedrock	0

Table CAWG 1-101 Average Weighted Cover Per Dominant Rosgen Channel Type for Chinquapin Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	5
Root Wad	0
Terrestrial Vegetation	12
Aquatic Vegetation	0
Surface Turbulence	22
Boulder/Cobble	33
Bedrock	0

Table CAWG 1-102 Frequency of Canopy Percentages for Chinquapin Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Chinquapin Creek

Chinquapin Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	12	35	38
(0-10] %	13	1	12
(10-20] %	16	7	9
(20-30] %	8	6	2
(30-40] %	6	6	0
(40-50] %	3	3	0
(50-60] %	3	3	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Chinquapin Creek BD Reach (11 detail records)

Sum	*61*	*61*	*61*

Grand Total	*61*	*61*	*61*

Table CAWG 1-103 Number of Barriers Per Dominant Rosgen Channel Type for Chinquapin Creek AD

	Rosgen Channel Type
	Aa+
Number of Barriers	1

Table CAWG 1-104 Number of Barriers Per Dominant Rosgen Channel Type for Chinquapin Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	4

Table CAWG 1-105 Average Substrate Per Dominant Rosgen Channel Type for Chinquapin Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	0
Gravel	0
Cobble	10
Boulders	80
Bedrock	0

Table CAWG 1-106 Average Percent Dominant Substrate by Rosgen Channel Type for Chinquapin Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	9
Gravel	4
Cobble	26
Boulders	35
Bedrock	6

Table CAWG 1-107 Spawning Gravel by USFS-R5 Habitat Types for Chinquapin Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Chinquapin Creek **Chinquapin Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
HGR	High Gradient Riffle	40	6.40
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
PLP	Plunge Pool	10	1.60
SPO	Step Pool	190	30.40
DPL	Dammed Pool	0	0.00
RUN	Run	50	8.00
SRN	Step Run	310	49.60
MCP	Main Channel Pool	15	2.40
LSP	Lateral Scour Pool	10	1.60

Table CAWG 1-108 Percent Length by Rosgen Channel Type for Camp 62 Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1515	100.0

Table CAWG 1-109 Percent Length by Rosgen Channel Type for Camp 62 Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	7699	100.0

Table CAWG 1-110 Frequency of Wood Counts for Camp 62 Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Camp 62 Creek

Reach: Camp 62 Creek AD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	4
[1-5]	4
[6-10]	1
[11-15]	0
[16-20]	1
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-111 Frequency of Wood Counts for Camp 62 Creek

Wood Count Frequencies

Basin: South Fork San Joaquin River (Basin)

Stream: Camp 62 Creek

Reach: Camp 62 Creek BD Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	42
[1-5]	51
[6-10]	6
[11-15]	1
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-112 Average Weighted Cover Per Dominant Rosgen Channel Type for Camp 62 Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	13
Root Wad	0
Terrestrial Vegetation	14
Aquatic Vegetation	0
Surface Turbulence	31
Boulder/Cobble	37
Bedrock	0

Table CAWG 1-113 Average Weighted Cover Per Dominant Rosgen Channel Type for Camp 62 Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	8
Root Wad	0
Terrestrial Vegetation	10
Aquatic Vegetation	0
Surface Turbulence	27
Boulder/Cobble	33
Bedrock	0

Table CAWG 1-114 Frequency of Canopy Percentages for Camp 62 Creek above the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Camp 62 Creek

Camp 62 Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	0	2	8
(0-10] %	2	0	2
(10-20] %	0	0	0
(20-30] %	1	1	0
(30-40] %	1	1	0
(40-50] %	3	3	0
(50-60] %	1	1	0
(60-70] %	2	2	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Camp 62 Creek AD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*10*	*10*	*10*

Grand Total	*10*	*10*	*10*

Table CAWG 1-115 Frequency of Canopy Percentages for Camp 62 Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Camp 62 Creek

Camp 62 Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	22	38	86
(0-10] %	15	4	11
(10-20] %	9	8	1
(20-30] %	13	9	4
(30-40] %	13	13	0
(40-50] %	8	8	0
(50-60] %	9	9	0
(60-70] %	7	7	0
(70-80] %	6	6	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Camp 62 Creek BD Reach (11 detail records)

Sum	*102*	*102*	*102*

Grand Total	*102*	*102*	*102*

Table CAWG 1-116 Number of Barriers Per Dominant Rosgen Channel Type for Camp 62 Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	5

Table CAWG 1-117 Average Percent Dominant Substrate by Rosgen Channel Type for Camp 62 Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	3
Gravel	0
Cobble	30
Boulders	52
Bedrock	0

Table CAWG 1-118 Average Substrate Per Dominant Rosgen Channel Type for Camp 62 Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	8
Gravel	8
Cobble	28
Boulders	35
Bedrock	2

Table CAWG 1-119 Spawning Gravel by USFS-R5 Habitat Types for Camp 62 Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Camp 62 Creek **Camp 62 Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	60	66.67
SPO	Step Pool	25	27.78
SRN	Step Run	5	5.56

Table CAWG 1-120 Spawning Gravel by USFS-R5 Habitat Types for Camp 62 Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Camp 62 Creek **Camp 62 Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	445	21.94
HGR	High Gradient Riffle	70	3.45
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
BWP	Backwater Pool	10	0.49
PLP	Plunge Pool	187	9.22
SPO	Step Pool	910	44.87
RUN	Run	100	4.93
SRN	Step Run	115	5.67
CCP	Channel Confluence Pool	20	0.99
LSP	Lateral Scour Pool	171	8.43
CRP	Corner Pool	0	0.00

Table CAWG 1-121 Percent Length by Rosgen Channel Type for Bolsillo Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1506	100.0

Table CAWG 1-122 Percent Length by Rosgen Channel Type for Bolsillo Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	5271	57.3
B	3933	42.7

Table CAWG 1-123 Average Weighted Cover Per Dominant Rosgen Channel Type for Bolsillo Creek AD

	Rosgen Channel Type
	B
Average Weighted Cover (Percent)	
Undercut Banks	11
Woody Debris	11
Root Wad	0
Terrestrial Vegetation	11
Aquatic Vegetation	9
Surface Turbulence	9
Boulder/Cobble	19
Bedrock	2

Table CAWG 1-124 Average Weighted Cover Per Dominant Rosgen Channel Type for Bolsillo Creek BD

	Rosgen Channel Type	
	Aa+	**B**
Average Weighted Cover (Percent)		
Undercut Banks	3	8
Woody Debris	14	23
Root Wad	0	0
Terrestrial Vegetation	19	14
Aquatic Vegetation	0	0
Surface Turbulence	6	5
Boulder/Cobble	7	10
Bedrock	8	5

Table CAWG 1-125 Frequency of Canopy Percentages for Bolsillo Creek above the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	2	6	9
(0-10] %	2	0	2
(10-20] %	1	0	1
(20-30] %	1	0	1
(30-40] %	1	1	0
(40-50] %	2	2	0
(50-60] %	2	2	0
(60-70] %	1	1	0
(70-80] %	1	1	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Bolsillo Creek AD Reach (11 detail records)

Sum	*13*	*13*	*13*

Grand Total	*13*	*13*	*13*

Table CAWG 1-126 Frequency of Canopy Percentages for Bolsillo Creek below the Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	4	30	48
(0-10] %	6	0	6
(10-20] %	7	0	7
(20-30] %	9	1	8
(30-40] %	7	2	5
(40-50] %	4	4	0
(50-60] %	12	12	0
(60-70] %	9	9	0
(70-80] %	9	9	0
(80-90] %	7	7	0
(90-100] %	0	0	0

Summary for 'Reach' = Bolsillo Creek BD Reach (11 detail records)

Sum	*74*	*74*	*74*

Grand Total	*74*	*74*	*74*

Table CAWG 1-127 Number of Barriers Per Dominant Rosgen Channel Type for Bolsillo Creek AD

	Rosgen Channel Type
	B
Number of Barriers	1

Table CAWG 1-128 Number of Barriers Per Dominant Rosgen Channel Type for Bolsillo Creek BD

	Rosgen Channel Type	
	Aa+	**B**
Number of Barriers	5	4

Table CAWG 1-129 Average Percent Dominant Substrate by Rosgen Channel Type for Bolsillo Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	B
Fines	0
Sands	22
Gravel	2
Cobble	25
Boulders	28
Bedrock	12

Table CAWG 1-130 Average Percent Dominant Substrate by Rosgen Channel Type for Bolsillo Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type	
	Aa+	B
Fines	4	0
Sands	35	41
Gravel	2	0
Cobble	4	2
Boulders	8	14
Bedrock	36	28

Table CAWG 1-131 Spawning Gravel by USFS-R5 Habitat Types for Bolsillo Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Bolsillo Creek **Bolsillo Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
SPO	Step Pool	50	62.50
SRN	Step Run	30	37.50
LSP	Lateral Scour Pool	0	0.00

Table CAWG 1-132 Spawning Gravel by USFS-R5 Habitat Types for Bolsillo Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Bolsillo Creek **Bolsillo Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
CAS	Cascade	5	1.12
BRS	Bedrock Sheet	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	350	78.65
DPL	Dammed Pool	0	0.00
RUN	Run	10	2.25
SRN	Step Run	80	17.98
DRY	Dry	0	0.00

Table CAWG 1-133 Percent Length by Rosgen Channel Type for Mono Creek Below Mono Diversion

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	32477	100

Table CAWG 1-134 Average Weighted Cover Per Dominant Rosgen Channel Type for Mono Creek Below Mono Diversion

	Rosgen Channel Type
	B
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	4
Root Wad	0
Terrestrial Vegetation	12
Aquatic Vegetation	2
Surface Turbulence	14
Boulder/Cobble	30
Bedrock	16

Table CAWG 1-135 Frequency of Canopy Percentages for Mono Creek below Mono Diversion

Frequency Of Canopy Percentages

South Fork San Joaquin River (Basin)

Mono Creek

Mono Creek below Mono Diversion Reach

Bin	Canopy	Hardwood	Softwood
[0] %	38	202	103
(0-10] %	59	1	58
(10-20] %	38	4	34
(20-30] %	23	2	21
(30-40] %	37	0	37
(40-50] %	32	21	11
(50-60] %	26	23	3
(60-70] %	14	14	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Mono Creek below Mono Diversion Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*267*	*267*	*267*
Grand Total	*267*	*267*	*267*

Table CAWG 1-136 Number of Barriers Per Dominant Rosgen Channel Type for Mono Creek Below Mono Diversion

	Rosgen Channel Type
	B
Number of Barriers	2

Table CAWG 1-137 Average Percent Doominant Substrate by Rosgen Channel Type for Mono Creek Below Mono Diversion

Average Percent Dominant Substrate	Rosgen Channel Type
	B
Fines	1
Sands	17
Gravel	5
Cobble	8
Boulders	37
Bedrock	17

Table CAWG 1-138 Spawning Gravel by USFS-R5 Habitat Types for Mono Creek below Mono Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

South Fork San Joaquin River (Basin)

Mono Creek **Mono Creek below Mono Diversion Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	50	0.36
HGR	High Gradient Riffle	53	0.38
CAS	Cascade	53	0.38
SCP	Secondary Channel Pool	50	0.36
BWP	Backwater Pool	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	1390	9.95
DPL	Dammed Pool	400	2.86
GLD	Glide	300	2.15
RUN	Run	2315	16.56
SRN	Step Run	4178	29.89
MCP	Main Channel Pool	710	5.08
LSP	Lateral Scour Pool	4335	31.02
POW	Pocket Water	142	1.02

Table CAWG 1-139 Percent Length by Rosgen Channel Type for South Fork San Joaquin River, Mammoth Pool Reservoir to South Fork San Joaquin River Confluence

Rosgen Channel Type	Length (ft) Evaluated	Percent
G	16974	79
B	4516	21

Table CAWG 1-140 Percent Length by Rosgen Channel Type for SJR Mammoth Reach

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	24573	54.3
G	20699	45.7

Table CAWG 1-141 Average Weighted Cover Per Dominant Rosgen Channel Type for SJR Mammoth Reach

	Rosgen Channel Type	
	B	G
Average Weighted Cover (Percent)		
Undercut Banks	0	0
Woody Debris	0	1
Root Wad	0	0
Terrestrial Vegetation	0	1
Aquatic Vegetation	0	0
Surface Turbulence	8	9
Boulder/Cobble	26	25
Bedrock	16	17

Table CAWG 1-142 Frequency of Canopy Percentages for SJR Mammoth Reach

Frequency Of Canopy Percentages

Mammoth Reach (Basin)

San Joaquin River

San Joaquin River Reach

Bin	Canopy	Hardwood	Softwood
[0] %	148	151	153
(0-10] %	2	0	2
(10-20] %	4	3	1
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	0	0	0
(50-60] %	1	1	0
(60-70] %	1	1	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = San Joaquin River Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*156*	*156*	*156*

Grand Total	*156*	*156*	*156*

Table CAWG 1-143 Number of Barriers Per Dominant Rosgen Channel Type for SJR Mammoth Reach

	Rosgen Channel Type	
	B	G
Number of Barriers	1	3

Table CAWG 1-144 Average Percent Dominant Substrate by Rosgen Channel Type for SJR Mammoth Reach

Average Percent Dominant Substrate	Rosgen Channel Type	
	B	G
Fines	0	0
Sands	16	13
Gravel	1	0
Cobble	16	13
Boulders	45	41
Bedrock	10	15

Table CAWG 1-145 Spawning Gravel by USFS-R5 Habitat Types for SJR Mammoth Reach

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Mammoth Reach (Basin)

San Joaquin River **San Joaquin River Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
HGR	High Gradient Riffle	65	3.24
CAS	Cascade	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	1665	83.04
RUN	Run	105	5.24
SRN	Step Run	0	0.00
MCP	Main Channel Pool	100	4.99
LSP	Lateral Scour Pool	50	2.49
POW	Pocket Water	0	0.00
CRP	Corner Pool	20	1.00

Table CAWG 1-146 Percent Length by Rosgen Channel Type for SJR Stevenson Reach

Rosgen Channel Type	Length (ft) Evaluated	Percent
G	26011	100.0

Table CAWG 1-147 Frequency of Wood Counts for SJR Stevenson Reach

Wood Count Frequencies

Basin: Stevenson Reach (Basin)

Stream: San Joaquin River

Reach: SJR Stevenson Reach

Rosgen 1 Channel Type = G

Bin	Wood Count
[0]	72
[1-5]	3
[6-10]	0
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-148 Average Weighted Cover Per Dominant Rosgen Channel Type for SJR Stevenson Reach

	Rosgen Channel Type
	G
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	5
Boulder/Cobble	34
Bedrock	33

Table CAWG 1-149 Frequency of Canopy Percentages for SJR Stevenson Reach

Frequency Of Canopy Percentages

Stevenson Reach (Basin)

San Joaquin River

SJR Stevenson Reach

Bin	*Canopy*	*Hardwood*	*Softwood*
[0] %	10	10	39
(0-10] %	29	29	0
(10-20] %	0	0	0
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0
Summary for 'Reach' = SJR Stevenson Reach (11 detail records)			
Sum	*39*	*39*	*39*

Grand Total	*39*	*39*	*39*

Table CAWG 1-150 Number of Barriers Per Dominant Rosgen Channel Type for SJR Stevenson Reach

	Rosgen Channel Type
	G
Number of Barriers	1

Table CAWG 1-151 Average Percent Dominant Substrate by Rosgen Channel Type for SJR Stevenson Reach

Average Percent Dominant Substrate	Rosgen Channel Type
	G
Fines	0
Sands	20
Gravel	4
Cobble	8
Boulders	35
Bedrock	20

Table CAWG 1-152 Spawning Gravel by USFS-R5 Habitat Types for SJR Stevenson Reach

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Stevenson Reach (Basin)

San Joaquin River **SJR Stevenson Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
HGR	High Gradient Riffle	0	0.00
SPO	Step Pool	280	50.00
DPL	Dammed Pool	0	0.00
SRN	Step Run	5	0.89
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	130	23.21
POW	Pocket Water	145	25.89

Table CAWG 1-153 Percent Length by Rosgen Channel Type for Rock Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1151	100.0

Table CAWG 1-154 Percent Length by Rosgen Channel Type for Rock Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	2702	100.0

Table CAWG 1-155 Average Weighted Cover Per Dominant Rosgen Channel Type for Rock Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	7
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	0
Boulder/Cobble	42
Bedrock	21

Table CAWG 1-156 Average Weighted Cover Per Dominant Rosgen Channel Type for Rock Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	0
Boulder/Cobble	10
Bedrock	31

Table CAWG 1-157 Frequency of Canopy Percentages for Rock Creek above the Diversion

Frequency Of Canopy Percentages

Mammoth Reach (Basin)

Rock Creek

Rock Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	0	0	9
(0-10] %	1	1	0
(10-20] %	1	1	0
(20-30] %	0	0	0
(30-40] %	1	1	0
(40-50] %	1	1	0
(50-60] %	3	3	0
(60-70] %	1	1	0
(70-80] %	0	0	0
(80-90] %	1	1	0
(90-100] %	0	0	0

Summary for 'Reach' = Rock Creek AD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*9*	*9*	*9*
Grand Total	*9*	*9*	*9*

Table CAWG 1-158 Frequency of Canopy Percentages for Rock Creek below the Diversion

Frequency Of Canopy Percentages

Mammoth Reach (Basin)

Rock Creek

Rock Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	13	15	19
(0-10] %	3	3	0
(10-20] %	3	2	1
(20-30] %	1	1	0
(30-40] %	0	0	0
(40-50] %	0	0	0
(50-60] %	0	0	0
(60-70] %	1	0	1
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Rock Creek BD Reach (11 detail records)

Sum	*21*	*21*	*21*

Grand Total	*21*	*21*	*21*

Table CAWG 1-159 Number of Barriers Per Dominant Rosgen Channel Type for Rock Creek AD

	Rosgen Channel Type
	Aa+
Number of Barriers	1

Table CAWG 1-160 Number of Barriers Per Dominant Rosgen Channel Type for Rock Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	2

Table CAWG 1-161 Average Percent Dominant Substrate by Rosgen Channel Type for Rock Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	2
Sands	11
Gravel	2
Cobble	0
Boulders	42
Bedrock	27

Table CAWG 1-162 Average Percent Dominant Substrate by Rosgen Channel Type for Rock Creek BD

Average Percent Dominate Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	5
Gravel	2
Cobble	1
Boulders	9
Bedrock	75

Table CAWG 1-163 Percent Length by Rosgen Channel Type for Ross Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	931	100.0

Table CAWG 1-164 Percent Length by Rosgen Channel Type for Ross Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	2796	100.0

Table CAWG 1-165 Average Weighted Cover Per Dominant Rosgen Channel Type for Ross Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	3
Aquatic Vegetation	0
Surface Turbulence	12
Boulder/Cobble	13
Bedrock	3

Table CAWG 1-166 Average Weighted Cover Per Dominant Rosgen Channel Type for Ross Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	2
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	4
Aquatic Vegetation	1
Surface Turbulence	4
Boulder/Cobble	12
Bedrock	9

Table CAWG 1-167 Frequency of Canopy Percentages for Ross Creek below the Diversion

Frequency Of Canopy Percentages

Mammoth Reach (Basin)

Ross Creek

Ross Creek BD Reach

Bin	*Canopy*	*Hardwood*	*Softwood*
[0] %	3	3	14
(0-10] %	3	3	0
(10-20] %	0	0	0
(20-30] %	1	1	0
(30-40] %	1	1	0
(40-50] %	1	1	0
(50-60] %	4	4	0
(60-70] %	0	0	0
(70-80] %	1	1	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Ross Creek BD Reach (11 detail records)

Sum	*14*	*14*	*14*

Grand Total	*14*	*14*	*14*

Table CAWG 1-168 Number of Barriers Per Dominant Rosgen Channel Type for Ross Creek AD

	Rosgen Channel Type
	Aa+
Number of Barriers	1

Table CAWG 1-169 Number of Barriers Per Dominant Rosgen Channel Type for Ross Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	5

Table CAWG 1-170 Average Percvent Dominate Substrate by Rosgen Channel Type for Ross Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	4
Gravel	3
Cobble	4
Boulders	18
Bedrock	63

Table CAWG 1-171 Average Percent Dominant Substrate by Rosgen Channel Type for Ross Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	12
Gravel	0
Cobble	0
Boulders	17
Bedrock	64

Table CAWG 1-172 Percent Length by Rosgen Channel Type for Stevenson Creek

Rosgen Channel Type	Length (ft) Evaluated	Percent
A	3527	15.8
Aa+	11460	51.2
B	6687	29.9
G	708	3.2

Table CAWG 1-173 Frequency of Wood Counts for Stevenson Creek

Wood Count Frequencies

Basin: Stevenson Reach (Basin)

Stream: Stevenson Creek

Reach: Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	70
[1-5]	36
[6-10]	4
[11-15]	1
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-174 Frequency of Wood Counts for Stevenson Creek

Wood Count Frequencies

Basin: Stevenson Reach (Basin)

Stream: Stevenson Creek

Reach: Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = A

Bin	*Wood Count*
[0]	42
[1-5]	13
[6-10]	1
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-175 Frequency of Wood Counts for Stevenson Creek

Wood Count Frequencies

Basin: Stevenson Reach (Basin)

Stream: Stevenson Creek

Reach: Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = B

Bin	Wood Count
[0]	48
[1-5]	22
[6-10]	4
[11-15]	2
[16-20]	1
[21-25]	1
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-176 Frequency of Wood Counts for Stevenson Creek

Wood Count Frequencies

Basin: Stevenson Reach (Basin)

Stream: Stevenson Creek

Reach: Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = G

Bin	Wood Count
[0]	6
[1-5]	2
[6-10]	0
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-177 Average Weighted Cover Per Dominant Rosgen Channel Type for Stevenson Creek

	Rosgen Channel Type			
	Aa+	A	B	G
Average Weighted Cover (Percent)				
Undercut Banks	2	2	4	6
Woody Debris	4	3	6	0
Root Wad	0	0	0	0
Terrestrial Vegetation	4	2	7	3
Aquatic Vegetation	0	0	0	0
Surface Turbulence	5	6	5	4
Boulder/Cobble	12	10	11	5
Bedrock	6	8	8	8

Table CAWG 1-178 Frequency of Canopy Percentages for Stevenson Creek

Frequency Of Canopy Percentages

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Bin	Canopy	Hardwood	Softwood
[0] %	75	149	181
(0-10] %	50	16	34
(10-20] %	34	10	24
(20-30] %	31	15	16
(30-40] %	31	31	0
(40-50] %	13	13	0
(50-60] %	10	10	0
(60-70] %	5	5	0
(70-80] %	4	4	0
(80-90] %	2	2	0
(90-100] %	0	0	0

Summary for 'Reach' = Stevenson Creek Reach (2001) (11 detail records)

Sum	*255*	*255*	*255*

Grand Total	*255*	*255*	*255*

Table CAWG 1-179 Number of Barriers Per Dominant Rosgen Channel Type for Stevenson Creek

	Rosgen Channel Type			
	Aa+	A	B	G
Number of Barriers	**4**	1	7	1

Table CAWG 1-180 Average Percent Dominant Substrate by Rosgen Channel Type for Stevenson Creek

Average Percent Dominant Substrate	Rosgen Channel Type			
	Aa+	A	B	G
Fines	0	0	1	0
Sands	9	17	10	13
Gravel	0	0	0	0
Cobble	4	4	8	0
Boulders	26	22	25	14
Bedrock	52	45	45	66

Table CAWG 1-181 Spawning Gravel by USFS-R5 Habitat Types for Stevenson Creek

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Stevenson Reach (Basin)

Stevenson Creek **Stevenson Creek Reach (2001)**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	5	3.70
SPO	Step Pool	100	74.07
DPL	Dammed Pool	0	0.00
RUN	Run	0	0.00
SRN	Step Run	20	14.81
MCP	Main Channel Pool	5	3.70
LSP	Lateral Scour Pool	5	3.70
POW	Pocket Water	0	0.00
CRP	Corner Pool	0	0.00

Table CAWG 1-182 Percent Length by Rosgen Channel Type for North Fork Stevenson Creek Above Outlet

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1400	100.0

Table CAWG 1-183 Percent Length by Rosgen Channel Type for North Fork Stevenson Creek Below Outlet

Rosgen Channel Type	Length (ft) Evaluated	Percent
A	626	4.3
Aa+	7400	50.4
B	2959	20.2
C	2511	17.1
G	1185	8.1

Table CAWG 1-184 Average Weighted Cover Per Dominant Rosgen Channel Type for North Fork Stevenson Creek Above Outlet

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	7
Root Wad	0
Terrestrial Vegetation	5
Aquatic Vegetation	0
Surface Turbulence	4
Boulder/Cobble	19
Bedrock	2

Table CAWG 1-185 Average Weighted Cover Per Dominant Rosgen Channel Type for North Fork Stevenson Creek Below Outlet

	Rosgen Channel Type				
	Aa+	**A**	**B**	**C**	**G**
Average Weighted Cover (Percent)					
Undercut Banks	0	0	0	2	3
Woody Debris	0	0	1	5	3
Root Wad	0	0	0	0	0
Terrestrial Vegetation	0	0	0	6	0
Aquatic Vegetation	0	0	0	0	0
Surface Turbulence	8	9	11	7	6
Boulder/Cobble	21	5	16	26	14
Bedrock	14	17	17	8	11

Table CAWG 1-186 Frequency of Canopy Percentages for NF Stevenson Creek

Frequency Of Canopy Percentages

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek above outlet Reach

Bin	Canopy	Hardwood	Softwood
[0] %	1	29	1
(0-10] %	4	0	4
(10-20] %	3	0	3
(20-30] %	3	0	3
(30-40] %	5	0	5
(40-50] %	4	0	4
(50-60] %	1	0	1
(60-70] %	1	0	1
(70-80] %	3	0	3
(80-90] %	3	0	3
(90-100] %	1	0	1

Summary for 'Reach' = NF Stevenson Creek above outlet Reach (11 detail records)

Sum	*29*	*29*	*29*

Grand Total	*29*	*29*	*29*

Table CAWG 1-187 Frequency of Canopy Percentages for NF Stevenson Creek

Frequency Of Canopy Percentages

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Bin	Canopy	Hardwood	Softwood
[0] %	63	93	75
(0-10] %	19	1	18
(10-20] %	11	2	9
(20-30] %	4	2	2
(30-40] %	0	0	0
(40-50] %	3	3	0
(50-60] %	5	4	1
(60-70] %	0	0	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = NF Stevenson Creek below outlet Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*105*	*105*	*105*

Grand Total	*105*	*105*	*105*

Table CAWG 1-188 Number of Barriers Per Dominant Rosgen Channel Type for North Fork Stevenson Creek Above Outlet

	Rosgen Channel Type
	Aa+
Number of Barriers	1

Table CAWG 1-189 Number of Barriers Per Dominant Rosgen Channel Type for North Fork Stevenson Creek Below Outlet

	Rosgen Channel Type		
	Aa+	A	B
Number of Barriers	12	2	3

Table CAWG 1-190 Average Percent Dominate Substrate by Rosgen Channel Type for North Fork Stevenson Creek Above Outlet

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	13
Sands	12
Gravel	1
Cobble	15
Boulders	24
Bedrock	32

Table CAWG 1-191 Average Percent Dominant Substrate by Rosgen Channel Type for North Fork Stevenson Creek Below Outlet

Average Percent Dominant Substrate	Rosgen Channel Type				
	Aa+	A	B	C	G
Fines	0	0	0	0	0
Sands	3	3	13	20	20
Gravel	1	0	0	8	0
Cobble	9	0	9	23	5
Boulders	28	10	36	24	15
Bedrock	55	83	26	11	40

Table CAWG 1-192 Spawning Gravel by USFS-R5 Habitat Types for NF Stevenson Creek

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Stevenson Reach (Basin)

NF Stevenson Creek **NF Stevenson Creek above outlet Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
PLP	Plunge Pool	10	76.92
SPO	Step Pool	0	0.00
MCP	Main Channel Pool	3	23.08

Table CAWG 1-193 Percent Length by Rosgen Channel Type for Big Creek PH 1 to Dam 1

Rosgen Channel Type	Length (ft) Evaluated	Percent
A	3843	21.2
Aa+	8309	45.8
B	4855	26.7
G	1153	6.3

Table CAWG 1-194 Frequency of Wood Counts for Big Creek PH 1 to Dam 1

Wood Count Frequencies

Basin: Big Creek Reach (Basin)

Stream: Big Creek

Reach: Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	27
[1-5]	10
[6-10]	0
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

[* Note: This figure does not include wood counts for 6,513 feet which were aerially mapped.]

Table CAWG 1-195 Frequency of Wood Counts for Big Creek PH 1 to Dam 1

Wood Count Frequencies

Bin	Wood Count

Basin: Big Creek Reach (Basin)

Stream: Big Creek

Reach: Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = G

Bin	Wood Count
[0]	8
[1-5]	6
[6-10]	2
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

[* Note: This figure does not include wood counts for 6,513 feet which were aerially mapped.]

Table CAWG 1-196 Average Weighted Cover Per Dominant Rosgen Channel Type for Big Creek PH 1 to Dam 1

	Rosgen Channel Type			
	Aa+	**A**	**B**	**G**
Average Weighted Cover (Percent)				
Undercut Banks	0	4	4	0
Woody Debris	1	2	3	4
Root Wad	0	0	1	0
Terrestrial Vegetation	5	8	13	9
Aquatic Vegetation	0	0	0	0
Surface Turbulence	7	3	3	7
Boulder/Cobble	13	10	7	9
Bedrock	13	5	8	2

Table CAWG 1-197 Frequency of Canopy Percentages for Big Creek PH 1 to Dam 1

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Bin	Canopy	Hardwood	Softwood
[0] %	32	78	121
(0-10] %	29	1	28
(10-20] %	18	4	14
(20-30] %	15	11	4
(30-40] %	5	5	0
(40-50] %	5	5	0
(50-60] %	7	7	0
(60-70] %	6	6	0
(70-80] %	12	12	0
(80-90] %	38	38	0
(90-100] %	0	0	0
Summary for 'Reach' = Big Creek PH 1 to Dam 1 Reach (11 detail records)			
Sum	*167*	*167*	*167*

Grand Total	*167*	*167*	*167*

[* Note: This figure does not include freguency of canopy percentages for 6,513 feet which were aerially mapped.]

Table CAWG 1-198 Number of Barriers Per Dominant Rosgen Channel Type for Big Creek PH 1 to Dam 1

	Rosgen Channel Type
	Aa+
Number of Barriers	12

Table CAWG 1-199 Average Percent Dominant Substrate by Rosgen Channel Type for Big Creek PH 1 to Dam 1

	Rosgen Channel Type			
	Aa+	A	B	G
Average Substrate (Percent)				
Fines	0	2	3	0
Sands	16	40	43	28
Gravel	0	3	5	4
Cobble	4	0	2	11
Boulders	18	30	20	31
Bedrock	43	16	19	13

Table CAWG 1-200 Spawning Gravel by USFS-R5 Habitat Types for Big Creek PH 1 to Dam 1

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Big Creek **Big Creek PH 1 to Dam 1 Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
BWP	Backwater Pool	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	20	7.80
SPO	Step Pool	105	40.94
GLD	Glide	50	19.49
RUN	Run	35	13.65
SRN	Step Run	0	0.00
MCP	Main Channel Pool	26.5	10.33
LSP	Lateral Scour Pool	10	3.90
POW	Pocket Water	10	3.90
CRP	Corner Pool	0	0.00

[* Note: This figure does not include spawning gravel for 6,513 feet which were aerially mapped.]

Table CAWG 1-201 Percent Length by Rosgen Channel Type for Big Creek PH 2 to Dam 4

Rosgen Channel Type	Length (ft) Evaluated	Percent
A	22065	95.3
B	1079	4.7

Table CAWG 1-202 Frequency of Wood Counts for Big Creek PH 2 to Dam 4

Wood Count Frequencies

Basin: Big Creek Reach (Basin)

Stream: Big Creek

Reach: Big Creek PH 2 to Dam 4 Reach (2001)

Rosgen 1 Channel Type = A

Bin	Wood Count
[0]	142
[1-5]	70
[6-10]	10
[11-15]	1
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-203 Frequency of Wood Counts for Big Creek PH 2 to Dam 4

Wood Count Frequencies

Basin: Big Creek Reach (Basin)

Stream: Big Creek

Reach: Big Creek PH 2 to Dam 4 Reach (2001)

Rosgen 1 Channel Type = B

Bin	Wood Count
[0]	10
[1-5]	2
[6-10]	1
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-204 Average Weighted Cover Per Dominant Rosgen Channel Type for Big Creek PH 2 to Dam 4

	Rosgen Channel Type	
	A	B
Average Weighted Cover (Percent)		
Undercut Banks	2	0
Woody Debris	0	0
Root Wad	0	0
Terrestrial Vegetation	0	0
Aquatic Vegetation	0	0
Surface Turbulence	5	3
Boulder/Cobble	14	10
Bedrock	12	13

Table CAWG 1-205 Frequency of Canopy Percentages for Big Creek PH 2 to Dam 4

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Big Creek

Big Creek PH 2 to Dam 4 Reach (2001)

Bin	Canopy	Hardwood	Softwood
[0] %	117	166	252
(0-10] %	93	56	37
(10-20] %	50	38	12
(20-30] %	15	15	0
(30-40] %	12	12	0
(40-50] %	10	10	0
(50-60] %	2	2	0
(60-70] %	2	2	0
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Big Creek PH 2 to Dam 4 Reach (2001) (11 detail records)

Sum	*301*	*301*	*301*

Grand Total	*301*	*301*	*301*

Table CAWG 1-206 Number of Barriers Per Dominant Rosgen Channel Type for Big Creek PH 2 to Dam 4

	Rosgen Channel Type
	A
Number of Barriers	5

Table CAWG 1-207 Average Percent Dominant Substrate by Rosgen Channel Type for Big Creek PH 2 to Dam 4

Average Percent Dominant Substrate	Rosgen Channel Type	
	A	B
Fines	3	0
Sands	11	0
Gravel	1	2
Cobble	5	2
Boulders	31	23
Bedrock	40	69

Table CAWG 1-208 Spawning Gravel by USFS-R5 Habitat Types for Big Creek PH 2 to Dam 4

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Big Creek **Big Creek PH 2 to Dam 4 Reach (2001)**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	25	2.89
CAS	Cascade	7	0.81
BRS	Bedrock Sheet	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	144	16.67
SPO	Step Pool	524	60.65
DPL	Dammed Pool	30	3.47
GLD	Glide	0	0.00
RUN	Run	30	3.47
SRN	Step Run	10	1.16
MCP	Main Channel Pool	60	6.94
LSP	Lateral Scour Pool	20	2.31
POW	Pocket Water	14	1.62

Table CAWG 1-209 Percent Length by Rosgen Channel Type for Big Creek PH 8 to Dam 5

Rosgen Channel Type	Length (ft) Evaluated	Percent
A	5789	70.9
Aa+	2381	29.1

Table CAWG 1-210 Frequency of Wood Counts for Big Creek PH 8 to Dam 5

Wood Count Frequencies

Basin: Big Creek Reach (Basin)

Stream: Big Creek

Reach: Big Creek PH 8 to Dam 5 Reach (2001)

Rosgen 1 Channel Type = A

Bin	*Wood Count*
[0]	57
[1-5]	27
[6-10]	1
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-211 Frequency of Wood Counts for Big Creek PH 8 to Dam 5

Wood Count Frequencies

Basin: Big Creek Reach (Basin)

Stream: Big Creek

Reach: Big Creek PH 8 to Dam 5 Reach (2001)

Rosgen 1 Channel Type = Aa+

Bin	Wood Count
[0]	25
[1-5]	11
[6-10]	0
[11-15]	0
[16-20]	0
[21-25]	0
[26-30]	0
[31-35]	0
[36-40]	0
[41-45]	0
[46-50]	0
[>50]	0

Table CAWG 1-212 Average Weighted Cover Per Dominant Rosgen Channel Type for Big Creek PH 8 to Dam

	Rosgen Channel Type	
	Aa+	**A**
Average Weighted Cover (Percent)		
Undercut Banks	0	0
Woody Debris	0	0
Root Wad	0	0
Terrestrial Vegetation	2	0
Aquatic Vegetation	0	0
Surface Turbulence	4	7
Boulder/Cobble	10	13
Bedrock	10	12

Table CAWG 1-213 Frequency of Canopy Percentages for Big Creek PH 8 to Dam 5

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Big Creek

Big Creek PH 8 to Dam 5 Reach (2001)

Bin	Canopy	Hardwood	Softwood
[0] %	74	82	113
(0-10] %	19	13	6
(10-20] %	15	13	2
(20-30] %	4	4	0
(30-40] %	5	5	0
(40-50] %	1	1	0
(50-60] %	2	2	0
(60-70] %	0	0	0
(70-80] %	1	1	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Big Creek Dam 5 to PH 8 Reach (2001) (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*121*	*121*	*121*
Grand Total	*121*	*121*	*121*

Table CAWG 1-214 Number of Barriers Per Dominant Rosgen Channel Type for Big Creek PH 8 to Dam 5

	Rosgen Channel Type
	Aa+
Number of Barriers	2

Table CAWG 1-215 Average Percent Dominant Substrate by Rosgen Channel Type for Big Creek PH 8 to Dam 5

Average Percent Dominant Substrate	Rosgen Channel Type	
	Aa+	A
Fines	1	0
Sands	3	1
Gravel	1	0
Cobble	8	6
Boulders	30	42
Bedrock	49	40

Table CAWG 1-216 Spawning Gravel by USFS-R5 Habitat Types for Big Creek PH 8 to Dam 5

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Big Creek **Big Creek PH 8 to Dam 5 Reach (2001)**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	0	0.00
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	20	8.30
SPO	Step Pool	143	59.34
RUN	Run	0	0.00
SRN	Step Run	0	0.00
MCP	Main Channel Pool	25	10.37
LSP	Lateral Scour Pool	53	21.99

Table CAWG 1-217 Percent Length by Rosgen Channel Type for Rancheria Creek above Energy Dissipater

Rosgen Channel Type	Length (ft) Evaluted	Percent
B	1510	100.0

Table CAWG 1-218 Percent Length by Rosgen Channel Type for Rancheria Creek below Energy Dissipater

Rosgen Channel Type	Length (ft) Evaluated	Percent
A	1009	50.1
B	1003	49.9

Table CAWG 1-219 Average Weighted Cover Per Dominant Rosgen Channel Type for Rancheria Creek above Energy Dissipater

	Rosgen Channel Type
	B
Average Weighted Cover (Percent)	
Undercut Banks	1
Woody Debris	8
Root Wad	0
Terrestrial Vegetation	23
Aquatic Vegetation	0
Surface Turbulence	9
Boulder/Cobble	12
Bedrock	0

Table CAWG 1-220 Average Weighted Cover Per Dominant Rosgen Channel Type for Rancheria Creek below Energy Dissipater

	Rosgen Channel Type	
	A	**B**
Average Weighted Cover (Percent)		
Undercut Banks	0	7
Woody Debris	0	2
Root Wad	0	0
Terrestrial Vegetation	14	28
Aquatic Vegetation	0	0
Surface Turbulence	19	19
Boulder/Cobble	38	7
Bedrock	0	0

Table CAWG 1-221 Frequency of Canopy Percentages for Rancheria Creek above Energy Dissipater

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek above Energy Dissipater

Bin	Canopy	Hardwood	Softwood
[0] %	2	35	2
(0-10] %	18	0	18
(10-20] %	3	0	3
(20-30] %	6	0	6
(30-40] %	1	0	1
(40-50] %	1	0	1
(50-60] %	1	0	1
(60-70] %	0	0	0
(70-80] %	1	0	1
(80-90] %	2	0	2
(90-100] %	0	0	0
Summary for 'Reach' = Rancheria Creek above Energy Dissipater (11 detail records)			
Sum	*35*	*35*	*35*
Grand Total	*35*	*35*	*35*

Table CAWG 1-222 Frequency of Canopy Percentages for Rancheria Creek below Energy Dissipater

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek below Energy Dissipater

Bin	Canopy	Hardwood	Softwood
[0] %	0	16	0
(0-10] %	3	0	3
(10-20] %	4	0	4
(20-30] %	0	0	0
(30-40] %	2	0	2
(40-50] %	1	0	1
(50-60] %	1	0	1
(60-70] %	1	0	1
(70-80] %	2	0	2
(80-90] %	0	0	0
(90-100] %	2	0	2

Summary for 'Reach' = Rancheria Creek below Energy Dissipater (11 detail records)

Sum	*16*	*16*	*16*

Grand Total	*16*	*16*	*16*

Table CAWG 1-223 Average Percent Dominant Substrate by Rosgen Channel Type for Rancheria Creek above Energy Dissipater

Average Percent Dominant Substrate	Rosgen Channel Type
	B
Fines	0
Sands	31
Gravel	0
Cobble	41
Boulders	15
Bedrock	0

Table CAWG 1-224 Average Percent Dominant Substrate by Rosgen Channel Type for Rancheria Creek below Energy Dissipater

Average Percent Dominant Substrate	Rosgen Channel Type	
	A	B
Fines	0	0
Sands	26	42
Gravel	0	10
Cobble	28	23
Boulders	24	10
Bedrock	0	0

Table CAWG 1-225 Spawning Gravel by USFS-R5 Habitat Types for Rancheria Creek above Energy Dissipater

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Rancheria Creek **Rancheria Creek above Energy Dissipater**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	20	100.00
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
PLP	Plunge Pool	0	0.00
DPL	Dammed Pool	0	0.00
GLD	Glide	0	0.00
RUN	Run	0	0.00
SRN	Step Run	0	0.00
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	0	0.00

Table CAWG 1-226 Spawning Gravel by USFS-R5 Habitat Types for Rancheria Creek below Energy Dissipater

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Rancheria Creek — **Rancheria Creek below Energy Dissipater**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	50	50.00
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
RUN	Run	0	0.00
SRN	Step Run	0	0.00
MCP	Main Channel Pool	50	50.00
LSP	Lateral Scour Pool	0	0.00

Table CAWG 1-227 Percent Length by Rosgen Channel Type for Portal Tailrace

Rosgen Channel Type	Length (ft) Evaluated	Percent
C	432	100.0

Table CAWG 1-228 Average Weighted Cover Per Dominant Rosgen Channel Type for Portal Tailrace

	Rosgen Channel Type
	C
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	19
Boulder/Cobble	56
Bedrock	0

Table CAWG 1-229 Average Percent Dominant Substrate by Rosgen Channel Type for Portal Tailrace

Average Percent Dominant Substrate	Rosgen Channel Type
	C
Fines	0
Sands	0
Gravel	0
Cobble	10
Boulders	60
Bedrock	0

Table CAWG 1-230 Percent Length by Rosgen Channel Type for Pitman Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
B	1506	100.0

Table CAWG 1-231 Percent Length by Rosgen Channel Type for Pitman Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	5466	87.8
B	756	12.2

Table CAWG 1-232 Average Weighted Cover Per Dominant Rosgen Channel Type for Pitman Creek AD

	Rosgen Channel Type
	B
Average Weighted Cover (Percent)	
Undercut Banks	4
Woody Debris	0
Root Wad	0
Terrestrial Vegetation	1
Aquatic Vegetation	0
Surface Turbulence	1
Boulder/Cobble	17
Bedrock	19

Table CAWG 1-233 Average Weighted Cover Per Dominant Rosgen Channel Type for Pitman Creek BD

	Rosgen Channel Type	
	Aa+	**B**
Average Weighted Cover (Percent)		
Undercut Banks	1	1
Woody Debris	0	0
Root Wad	0	0
Terrestrial Vegetation	0	0
Aquatic Vegetation	0	0
Surface Turbulence	5	0
Boulder/Cobble	19	7
Bedrock	22	28

Table CAWG 1-234 Frequency of Canopy Percentages for Pitman Creek above the Diversion

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	0	17	0
(0-10] %	1	0	1
(10-20] %	4	0	4
(20-30] %	4	0	4
(30-40] %	2	0	2
(40-50] %	3	0	3
(50-60] %	1	0	1
(60-70] %	2	0	2
(70-80] %	0	0	0
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Pitman Creek AD Reach (11 detail records)

Sum	*17*	*17*	*17*

Grand Total	*17*	*17*	*17*

Table CAWG 1-235 Frequency of Canopy Percentages for Pitman Creek below the Diversion

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	23	54	34
(0-10] %	23	8	15
(10-20] %	8	2	6
(20-30] %	4	1	3
(30-40] %	0	0	0
(40-50] %	1	0	1
(50-60] %	3	0	3
(60-70] %	1	0	1
(70-80] %	1	0	1
(80-90] %	1	0	1
(90-100] %	0	0	0

Summary for 'Reach' = Pitman Creek BD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*65*	*65*	*65*

Grand Total	*65*	*65*	*65*

Table CAWG 1-236 Number of Barriers Per Dominant Rosgen Channel Type for Pitman Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	4

Table CAWG 1-237 Average Percent Dominant Substrate by Rosgen Channel Type for Pitman Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	B
Fines	0
Sands	2
Gravel	6
Cobble	32
Boulders	15
Bedrock	31

Table CAWG 1-238 Average Percent Dominant Substrate by Rosgen Channel Type for Pitman Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type	
	Aa+	B
Fines	1	6
Sands	0	5
Gravel	0	0
Cobble	3	1
Boulders	15	5
Bedrock	79	79

Table CAWG 1-239 Spawning Gravel by USFS-R5 Habitat Types for Pitman Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Pitman Creek **Pitman Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
SPO	Step Pool	0	0.00
GLD	Glide	0	0.00
RUN	Run	60	85.71
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	10	14.29
POW	Pocket Water	0	0.00

Table CAWG 1-240 Percent Length by Rosgen Channel Type for Balsam Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1505	100.0

Table CAWG 1-241 Percent Length by Rosgen Channel Type for Balsam Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	4293	100.0

Table CAWG 1-242 Average Weighted Cover Per Dominant Rosgen Channel Type for Balsam Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	3
Woody Debris	1
Root Wad	0
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	11
Boulder/Cobble	21
Bedrock	5

Table CAWG 1-243 Average Weighted Cover Per Dominant Rosgen Channel Type for Balsam Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	4
Woody Debris	0
Root Wad	1
Terrestrial Vegetation	0
Aquatic Vegetation	0
Surface Turbulence	10
Boulder/Cobble	15
Bedrock	9

Table CAWG 1-244 Frequency of Canopy Percentages for Balsam Creek above the Diversion

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Balsam Creek

Balsam Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	0	37	0
(0-10] %	0	0	0
(10-20] %	0	0	0
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	6	0	6
(50-60] %	7	0	7
(60-70] %	14	0	14
(70-80] %	8	0	8
(80-90] %	2	0	2
(90-100] %	0	0	0

Summary for 'Reach' = Balsam Creek AD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*37*	*37*	*37*
Grand Total	*37*	*37*	*37*

Table CAWG 1-245 Frequency of Canopy Percentages for Balsam Creek below the Diversion

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Balsam Creek

Balsam Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	2	60	6
(0-10] %	1	0	1
(10-20] %	1	0	1
(20-30] %	1	1	0
(30-40] %	4	2	2
(40-50] %	8	0	7
(50-60] %	15	0	15
(60-70] %	12	0	12
(70-80] %	13	0	13
(80-90] %	6	0	6
(90-100] %	0	0	0

Summary for 'Reach' = Balsam Creek BD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*63*	*63*	*63*
Grand Total	*63*	*63*	*63*

Table.CAWG 1-246 Number of Barriers Per Dominant Rosgen Channel Type for Balsam Creek AD

	Rosgen Channel Type
	Aa+
Number of Barriers	3

Table CAWG 1-247 Number of Barriers Per Dominant Rosgen Channel Type for Balsam Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	10

Table CAWG 1-248 Average Percent Dominant Substrate by Rosgen Channel Type for Balsam Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	8
Sands	25
Gravel	9
Cobble	12
Boulders	14
Bedrock	20

Table CAWG 1-249 Average Percent Dominant Substrate by Rosgen Channel Type for Balsam Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	28
Gravel	4
Cobble	10
Boulders	14
Bedrock	32

Table CAWG 1-250 Spawning Gravel by USFS-R5 Habitat Types for Balsam Creek above the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Balsam Creek **Balsam Creek AD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	28	77.78
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	0	0.00
DPL	Dammed Pool	0	0.00
RUN	Run	8	22.22
SRN	Step Run	0	0.00
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	0	0.00

Table CAWG 1-251 Spawning Gravel by USFS-R5 Habitat Types for Balsam Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Balsam Creek **Balsam Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	45	53.57
CAS	Cascade	0	0.00
BRS	Bedrock Sheet	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	34	40.48
DPL	Dammed Pool	0	0.00
RUN	Run	0	0.00
SRN	Step Run	5	5.95
MCP	Main Channel Pool	0	0.00
LSP	Lateral Scour Pool	0	0.00
RDC	Road-Crossing	0	0.00

Table CAWG 1-252 Percent Length by Rosgen Channel Type for Ely Creek AD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	1350	100.0

Table CAWG 1-253 Percent Length by Rosgen Channel Type for Ely Creek BD

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	5961	100.0

Table CAWG 1-254 Average Weighted Cover Per Dominant Rosgen Channel Type for Ely Creek AD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	0
Woody Debris	5
Root Wad	0
Terrestrial Vegetation	2
Aquatic Vegetation	0
Surface Turbulence	0
Boulder/Cobble	18
Bedrock	3

Table CAWG 1-255 Average Weighted Cover Per Dominant Rosgen Channel Type for Ely Creek BD

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	6
Woody Debris	2
Root Wad	0
Terrestrial Vegetation	1
Aquatic Vegetation	0
Surface Turbulence	0
Boulder/Cobble	24
Bedrock	0

Table CAWG 1-256 Frequency of Canopy Percentages for Ely Creek above the Diversion

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Ely Creek

Ely Creek AD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	3	8	4
(0-10] %	0	0	0
(10-20] %	1	0	1
(20-30] %	0	0	0
(30-40] %	0	0	0
(40-50] %	2	1	1
(50-60] %	2	0	2
(60-70] %	0	0	0
(70-80] %	1	0	1
(80-90] %	0	0	0
(90-100] %	0	0	0

Summary for 'Reach' = Ely Creek AD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*9*	*9*	*9*

Grand Total	*9*	*9*	*9*

Table CAWG 1-257 Frequency of Canopy Percentages for Ely Creek below the Diversion

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Ely Creek

Ely Creek BD Reach

Bin	Canopy	Hardwood	Softwood
[0] %	4	69	4
(0-10] %	0	0	0
(10-20] %	0	0	0
(20-30] %	2	0	2
(30-40] %	1	0	1
(40-50] %	9	0	9
(50-60] %	15	0	15
(60-70] %	17	0	17
(70-80] %	15	0	15
(80-90] %	6	0	6
(90-100] %	0	0	0

Summary for 'Reach' = Ely Creek BD Reach (11 detail records)

	Canopy	Hardwood	Softwood
Sum	*69*	*69*	*69*

Grand Total	*69*	*69*	*69*

Table CAWG 1-258 Number of Barriers Per Dominant Rosgen Channel Type for Ely Creek BD

	Rosgen Channel Type
	Aa+
Number of Barriers	2

Table CAWG 1-259 Average Percent Dominant Substrate by Rosgen Channel Type for Ely Creek AD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	2
Sands	21
Gravel	2
Cobble	7
Boulders	14
Bedrock	44

Table CAWG 1-260 Average Substrate Per Dominant Rosgen Channel Type for Ely Creek BD

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	1
Sands	10
Gravel	6
Cobble	31
Boulders	28
Bedrock	13

Table CAWG 1-261 Spawning Gravel by USFS-R5 Habitat Types for Ely Creek below the Diversion

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Ely Creek **Ely Creek BD Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
HGR	High Gradient Riffle	0	0.00
CAS	Cascade	0	0.00
TRC	Trench Chute	0	0.00
PLP	Plunge Pool	0	0.00
SPO	Step Pool	10	13.89
DPL	Dammed Pool	0	0.00
RUN	Run	15	20.83
SRN	Step Run	47	65.28
MCP	Main Channel Pool	0	0.00
CBC	Concrete Box Culvert	0	0.00
DRY	Dry	0	0.00

Table CAWG 1-262 Percent Length by Rosgen Channel Type for Adit No. 8 Creek

Rosgen Channel Type	Length (ft) Evaluated	Percent
Aa+	4247	100.0

Table CAWG 1-263 Average Weighted Cover Per Dominant Rosgen Channel Type for Adit No. 8 Creek

	Rosgen Channel Type
	Aa+
Average Weighted Cover (Percent)	
Undercut Banks	17
Woody Debris	5
Root Wad	0
Terrestrial Vegetation	3
Aquatic Vegetation	0
Surface Turbulence	15
Boulder/Cobble	11
Bedrock	0

Table CAWG 1-264 Frequency of Canopy Percentages for Adit No. 8 Creek

Frequency Of Canopy Percentages

Big Creek Reach (Basin)

Adit #8 Creek

Adit #8 Creek Reach

Bin	Canopy	Hardwood	Softwood
[0] %	1	62	1
(0-10] %	1	0	1
(10-20] %	0	0	0
(20-30] %	0	0	0
(30-40] %	2	0	2
(40-50] %	4	0	4
(50-60] %	14	0	14
(60-70] %	20	0	20
(70-80] %	14	0	14
(80-90] %	6	0	6
(90-100] %	0	0	0
Summary for 'Reach' = Adit #8 Creek Reach (11 detail records)			
Sum	*62*	*62*	*62*
Grand Total	*62*	*62*	*62*

Table CAWG 1-265 Number of Barriers Per Dominant Rosgen Channel Type for Adit No. 8 Creek

	Rosgen Channel Type
	Aa+
Number of Barriers	9

Table CAWG 1-266 Average Percent Dominant Substrate by Rosgen Channel Type for Adit No. 8 Creek

Average Percent Dominant Substrate	Rosgen Channel Type
	Aa+
Fines	0
Sands	24
Gravel	21
Cobble	14
Boulders	24
Bedrock	4

Table CAWG 1-267 Spawning Gravel by USFS-R5 Habitat Types for Adit No. 8 Creek

Spawning Gravel by USFS-R5 Habitat Types, Stream, and Reach

Big Creek Reach (Basin)

Adit #8 Creek **Adit #8 Creek Reach**

Type		*Spawning Gravel (sqft)*	*Percent*
LGR	Low Gradient Riffle	5	1.30
HGR	High Gradient Riffle	43	11.20
CAS	Cascade	0	0.00
PLP	Plunge Pool	6	1.56
SPO	Step Pool	10	2.60
GLD	Glide	0	0.00
RUN	Run	103	26.82
SRN	Step Run	210	54.69
MCP	Main Channel Pool	7	1.82

Table CAWG 1-268 Florence Lake Volume (Storage) and Surface Area by Reservoir Elevation.

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
7330	66826	972
7327	63925	958
7324	61065	945
7321	58243	931
7318	55464	918
7315	52725	900
7312	50042	882
7309	47414	864
7306	44841	846
7303	42321	829
7300	39851	812
7297	37431	795
7294	35060	781
7291	32732	766
7288	30450	751
7285	28213	735
7282	26023	721
7279	23879	703
7276	21784	687
7273	19743	669
7270	17755	648
7267	15829	629
7264	13970	602
7261	12183	575
7258	10508	533
7255	8950	488
7252	7528	447
7249	6228	408
7246	5038	372
7243	3959	338
7240	2976	286
7237	2212	225
7234	1578	187
7231	1042	155
7228	618	123
7225	281	80
7222	63	60

Source: SCE supplied elevation-storage relationship.This is the same as that published by USGS 2002.
Note: Surface area was calculated by depth interval.

Table CAWG 1-269 Florence Lake Mean Seasonal Elevation, Volume (Storage), and Surface Area by Water Year Type

		Winter (Low Water)			Summer (High Water)		
Water Year Type	**Representative Water Year**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**
Wet	1997	23,936	653	7,277	47,031	854	7,307
Above Normal	2000	1,106	160	7,231	47,072	857	7,308
Below Normal	1971	360	95	7,226	54,153	904	7,316
Dry	1985	1,178	167	7,232	44,191	839	7,304
Critical	1992	1,121	162	7,231	31,558	754	7,289

Note: Mean Storage, and Corresponding Surface Area rounded to nearest whole number. Surface Area and Elevation correspond to calculated average storage.
Averaging periods - Winter (December 21-March 19), Summer (June 21-September 22)
Source: USGS (2001, 2002) daily midnight storage data. Period of Record used 1980-2001.

Table CAWG 1-270 Florence Lake Depth Related Habitat Area (Acres) by Reservoir Elevation

Elevation (feet)	Area shallower than 3 ft (acres)	Area shallower than 6 ft (acres)	Area shallower than 9 ft (acres)	Area shallower than 12 ft (acres)
7330	14	27	41	54
7327	13	27	40	58
7324	14	27	45	63
7321	13	31	49	67
7318	18	36	54	72
7315	18	36	54	71
7312	18	36	53	70
7309	18	35	52	69
7306	17	34	51	65
7303	17	34	48	63
7300	17	31	46	61
7297	14	29	44	60
7294	15	30	46	60
7291	15	31	45	63
7288	16	30	48	64
7285	14	32	48	66
7282	18	34	52	73
7279	16	34	55	74
7276	18	39	58	85
7273	21	40	67	94
7270	19	46	73	115
7267	27	54	96	141
7264	27	69	114	155
7261	42	87	128	167
7258	45	86	125	161
7255	41	80	116	150
7252	39	75	109	161
7249	36	70	122	183
7246	34	86	147	185
7243	52	113	151	183
7240	61	99	131	163
7237	38	70	102	145
7234	32	64	107	127
7231	32	75	95	*
7228	43	63	*	*
7225	20	*	*	*

* Reservoir bottom is below interval range.
Source: SCE supplied elevation-storage relationship. This is the same relationship as that published by USGS 2002.
Note: Surface area was calculated by depth interval.

Table CAWG 1-271 Temperature and Water Quality Characteristics of Florence Lake, Dam Site, 2000-2001

	Characteristics of Stratified Layers				Average Water Quality		
2000	Epilimnion[1]		Hypolimnion[2]		Dissolved Oxygen [3]	Specific Conductance[4]	Visibility [5]
Month	Water Temperature (°C)[6]	Thickness (m)	Water Temperature (°C)[6]	Thickness (m)	(mg/L)	(uS/cm)	(m)
July	16.3	10	11.4	8	6.6	9.0	9.0
Aug	15.9	16	14.0	16	6.6	N/A	N/A
Sept[7]	15.7	-----	15.7	-----	7.4	N/A	N/A
Oct[7]	11.3	-----	11.3	-----	8.2	12.0	2.7
2001							
May	10.7	5	6.6	21	8.9	11.0	6.0
June	17.3	7	9.8	16	8.7	9.0	8.0
July	17.8	8	13.7	14	8.6	10.0	10.2
Aug	19.4	13	15.2	7	9.9	11.0	6.9
Sept	17.2	16	12.3	2	7.1	12.0	11.8
Oct[7]	13.3	-----	13.3	-----	7.2	15.0	7.9

[1] - Epilimnion is the warm upper layer above the thermocline
[2] - Hypolimnion is the cool lower layer below the thermocline
[3] - Average Dissolved Oxygen at the profile site
[4] - Average Specific Conductance at the profile site
[5] - Recorded Secchi disc visibility at the profile site
[6] - Average water temperature within layer (not including the thermocline)
[7] - Average temperature at profile site - Reservoir not stratified

Table CAWG 1-272 Bear Creek Diversion Forebay Volume (Storage) and Surface Area at Forebay Elevations

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
7365		17.8
7362	360	16.9
7359	314	16.1
7356	266	15.3
7353	222	14.3
7350	180	13.3
7347	144	11.6
7344	113	9.9
7341	86	8.1
7338	65	6.4
7335	44	4.8
7332	31	3.7
7329	21	2.8
7326	14	2.0
7323	8	1.3
7320	4	0.8
7317	2.8	0.5
7314	1.6	0.3
7311	0.4	0.1

Source: Surface area and volume values were obtained from SCE supplied capacity and area curves.

Table CAWG 1-273 Bear Creek Diversion Forebay Depth Related Habitat Area (Acres) by Forebay Elevation

Elevation (feet)	Area shallower than 3 ft (acres)	Area shallower than 6 ft (acres)	Area shallower than 9 ft (acres)	Area shallower than 12 ft (acres)
7365	0.9	1.8	2.5	3.5
7362	0.8	1.6	2.6	3.6
7359	0.8	1.7	2.8	4.5
7356	1.0	2.0	3.7	5.5
7353	1.0	2.8	4.5	6.3
7350	1.7	3.5	5.2	6.9
7347	1.7	3.5	5.1	6.8
7344	1.8	3.4	5.1	6.1
7341	1.7	3.3	4.4	5.3
7338	1.6	2.7	3.7	4.5
7335	1.1	2.0	2.8	3.5
7332	1.0	1.8	2.4	2.9
7329	0.8	1.4	2.0	2.2
7326	0.6	1.2	1.4	1.7
7323	0.5	0.8	1.1	1.3
7320	0.3	0.5	0.7	
7317	0.2	0.5		
7314	0.2			

Source: Surface area and volume values were obtained from SCE supplied capacity and area curves.

Table CAWG 1-274 Monthly Average, and Maximum and Minimum Daily Average Temperatures for Small Forebays[1], 2000-2001

	2000				2001		
	Bear Diversion Forebay				Bear Diversion Forebay		
Month	Average	Maximum	Minimum		Average	Maximum	Minimum
May	-	-	-		-	-	-
June	8.5	14.1	2.2		13.1	17.8	8.6
July	13.0	17.3	7.8		15.3	20.1	10.8
August	14.2	17.5	11.2		18.2	21.0	14.9
September	11.4	15.9	7.9		15.2	19.4	12.5
October	6.8	11.0	1.1		12.7	15.6	9.8
	Mono Diversion Forebay				Mono Diversion Forebay		
	Average	Maximum	Minimum		Average	Maximum	Minimum
May	-	-	-		-	-	-
June	13.6	16.2	9.6		13.6	17.6	9.8
July	11.0	15.4	9.0		10.8	15.4	9.6
August	10.7	11.8	10.0		12.5	15.8	10.7
September	11.6	14.0	10.1		15.9	18.4	13.6
October	10.7	13.1	7.9		14.1	16.3	12.1
	Dam 4 Forebay				Dam 4 Forebay		
	Average	Maximum	Minimum		Average	Maximum	Minimum
May	-	-	-		-	-	-
June	-	-	-		10.4	11.0	9.9
July	11.6	12.3	11.1		11.2	12.7	10.3
August	13.0	14.2	11.8		12.7	14.0	11.3
September	14.0	14.6	13.1		14.2	15.5	13.3
October	13.4	15.3	3.3		14.6	15.7	13.0
	Dam 5 Forebay				Dam 5 Forebay		
	Average	Maximum	Minimum		Average	Maximum	Minimum
May	-	-	-		7.0	8.9	5.8
June	11.4	11.8	11.1		9.1	12.0	7.8
July	12.2	13.2	11.2		11.4	14.0	10.3
August	13.8	14.8	12.8		13.2	15.9	11.7
September	15.4	17.9	14.0		15.9	17.6	13.8
October	15.8	17.8	14.1		15.9	18.3	13.8

[1] - Small Forebays where stratification does not occur.

Table CAWG 1-275 Mono Creek Diversion Forebay Volume (Storage) and Surface Area at Forebay Elevations.

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
7364	180	
7361	147	9.50
7358	120	8.90
7355	90	8.20
7352	69	7.30
7349	50	6.20
7346	36	4.60
7343	25	3.00
7340	14	2.00
7337	8	1.25
7334	5	0.70
7331	2.5	0.38
7328	1.6	0.22
7325	1.0	0.10
7322	0.4	0.04

Source: Surface area and volume values were obtained from SCE supplied capacity and area curves.

Table CAWG 1-276 Mono Creek Diversion Forebay Depth Related Habitat Area (Acres) by Forebay Elevation

Elevation (feet)	Area shallower than 3 ft (acres)	Area shallower than 6 ft (acres)	Area shallower than 9 ft (acres)	Area shallower than 12 ft (acres)
7364				
7361	0.60	1.30	2.20	3.30
7358	0.70	1.60	2.70	4.30
7355	0.90	2.00	3.60	5.20
7352	1.10	2.70	4.30	5.30
7349	1.60	3.20	4.20	4.95
7346	1.60	2.60	3.35	3.90
7343	1.00	1.75	2.30	2.62
7340	0.75	1.30	1.62	1.78
7337	0.55	0.87	1.03	1.15
7334	0.32	0.48	0.60	0.66
7331	0.16	0.28	0.34	0.38
7328	0.12	0.18	0.22	
7325	0.06	0.10		
7322				

Source: Surface area and volume values were obtained from SCE supplied capacity and area curves.

Table CAWG 1-277 Mammoth Pool Volume (Storage) and Surface Area by Reservoir Elevation

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)	Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
3360	155832	1287	3228	35543	568
3357	151988	1271	3228	35543	568
3354	148149	1216	3225	33857	557
3351	144436	1240	3222	32197	546
3348	140757	1206	3219	30573	531
3345	137159	1191	3216	28992	518
3342	133601	1176	3213	27450	506
3339	130096	1152	3210	25946	482
3336	126661	1131	3207	24522	456
3333	123278	1118	3204	23160	447
3330	119940	1092	3201	21833	433
3327	116697	1064	3198	20559	411
3324	113517	1053	3195	19346	396
3321	110373	1037	3192	18172	381
3318	107284	1017	3189	17051	353
3315	104252	1003	3186	16015	336
3312	101255	990	3183	15018	324
3309	98306	965	3180	14060	308
3306	95429	949	3177	13151	293
3303	92589	940	3174	12283	285
3300	89781	927	3171	11439	274
3297	87014	914	3168	10629	262
3294	84285	903	3165	9855	253
3291	81588	891	3162	9105	245
3288	78941	868	3159	8381	234
3285	76354	857	3156	7691	223
3282	73795	845	3153	7031	213
3279	71275	830	3150	6402	198
3276	68800	816	3147	5823	183
3273	66362	804	3144	5284	175
3270	63961	783	3141	4770	165
3267	61633	761	3138	4284	156
3264	59359	751	3135	3826	148
3261	57119	738	3132	3391	140
3258	54929	717	3129	2981	130
3255	52794	704	3126	2599	121
3252	50694	691	3123	2241	116
3249	48640	670	3120	1900	112
3246	46653	652	3117	1569	108
3243	44704	643	3114	1252	100
3240	42787	628	3111	956	95
3237	40916	613	3108	677	88
3234	39087	603	3105	417	84
3231	37290	592	3102	166	83

Source: SCE supplied elevation-storage relationship. This is the same as that published by USGS 2002.
Note: Surface area was calculated by depth interval.

Table CAWG 1-278 Mammoth Pool Reservoir Mean Seasonal Elevation, Volume (Storage), and Surface Area by Water Year Type

		Winter (Low Water)			Summer (High Water)		
Water Year Type	**Representative Water Year**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**
Wet	1997	83,643	888	3,291	96,347	959	3,306
Above Normal	2000	29,905	494	3,214	75,385	832	3,280
Below Normal	1971	21,298	419	3,199	83,244	884	3,291
Dry	2001	17,483	357	3,187	89,917	926	3,300
Critical	1992	20,059	399	3,195	47,326	613	3,237

Note: Mean Storage, and Corresponding Surface Area rounded to nearest whole number. Surface Area and Elevation correspond to calculated average storage.
Averaging periods - Winter (December 21-March 19), Summer (June 21-September 22)
Source: USGS (2001, 2002) daily midnight storage data. Period of Record used 1980-2001.

Table CAWG 1-279 Mammoth Pool Depth Related Habitat Area (Acres) by Reservoir Elevation

Elevation (feet)	Area shallower than 3 ft (acres)	Area shallower than 6 ft (acres)	Area shallower than 9 ft (acres)	Area shallower than 12 ft (acres)
3360	16	71	47	81
3357	55	31	65	80
3354	0	10	25	40
3351	34	49	64	88
3348	15	30	54	75
3345	15	39	60	73
3342	24	45	58	84
3339	21	34	60	88
3336	13	39	67	78
3333	26	54	65	81
3330	28	39	55	75
3327	11	27	47	61
3324	16	36	50	63
3321	20	34	47	72
3318	14	27	52	68
3315	13	38	54	63
3312	25	41	50	63
3309	16	25	38	51
3306	9	22	35	46
3303	13	26	37	49
3300	13	24	36	59
3297	11	23	46	57
3294	12	35	46	58
3291	23	34	46	61
3288	11	23	38	52
3285	12	27	41	53
3282	15	29	41	62
3279	14	26	47	69
3276	12	33	55	65
3273	21	43	53	66
3270	22	32	45	66
3267	10	23	44	57
3264	13	34	47	60
3261	21	34	47	68
3258	13	26	47	65
3255	13	34	52	61
3252	21	39	48	63
3249	18	27	42	57
3246	9	24	39	49
3243	15	30	40	51
3240	15	25	36	60
3237	10	21	45	56
3234	11	35	46	57
3231	24	35	46	61
3228	11	22	37	50
3225	11	26	39	51
3222	15	28	40	64
3219	13	25	49	75
3216	12	36	62	71
3213	24	50	59	73
3210	26	35	49	71
3207	9	23	45	60
3204	14	36	51	66
3201	22	37	52	80
3198	15	30	58	75
3195	15	43	60	72
3192	28	45	57	73
3189	17	29	45	60
3186	12	28	43	51
3183	16	31	39	50
3180	15	23	34	46
3177	8	19	31	40
3174	11	23	32	40
3171	12	21	29	40
3168	9	17	28	39
3165	8	19	30	40
3162	11	22	32	47
3159	11	21	36	51
3156	10	25	40	48

Table CAWG 1-279 Mammoth Pool Habitat Areas (acres) by Depth Interval (cont)

3153	15	30	38	48
3150	15	23	33	42
3147	8	18	27	35
3144	10	19	27	35
3141	9	17	25	35
3138	8	16	26	35
3135	8	18	27	32
3132	10	19	24	28
3129	9	14	18	22
3126	5	9	13	21
3123	4	8	16	21
3120	4	12	17	24
3117	8	13	20	24
3114	5	12	16	17

Table CAWG 1-280 Temperature and Water Quality Characteristics of Mammoth Pool Reservoir, Dam Site, 2000-2001

	Characteristics of Stratified Layers				Average Water Quality		
2000	Epilimnion[1]		Hypolimnion[2]		Dissolved Oxygen [3]	Specific Conductance[4]	Visibility [5]
Month	Water Temperature (°C)[6]	Thickness (m)	Water Temperature (°C)[6]	Thickness (m)	(mg/L)	(uS/cm)	(m)
Sept[7]	18.1	-----	18.1	-----	6.6	N/A	N/A
Oct[7]	13.3	-----	13.3	-----	7.3	68.0	3.0
2001							
early June[7]	14.4	-----	14.4	-----	9.3	19.0	5.7
June	21.7	4	15.0	43	8.0	20.0	7.8
July	22.6	7	17.4	36	7.3	31.0	5.5
Aug[7]	21.1	-----	21.1	-----	8.3	40.5	7.0
Sept[7]	20.2	-----	20.2	-----	7.4	52.0	8.6
Oct[7]	18.0	-----	18.0	-----	6.4	62.0	6.4

[1] - Epilimnion is the warm upper layer above the thermocline
[2] - Hypolimnion is the cool lower layer below the thermocline
[3] - Average Dissolved Oxygen at the profile site
[4] - Average Specific Conductance at the profile site
[5] - Recorded Secchi disc visibility at the profile site
[6] - Average water temperature within layer (not including the thermocline)
[7] - Average temperature at profile site - Reservoir not stratified

Table CAWG 1-281 Dam 6 Forebay Volume (Storage) and Surface Area at Forebay Elevations.

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
2250	1726	43.7
2247	1597	41.5
2244	1475	39.2
2241	1360	36.8
2238	1252	34.7
2235	1150	32.8
2232	1053	30.6
2229	964	28.7
2226	879	26.8
2223	800	25.4
2220	725	24.0
2217	654	23.0
2214	587	21.7
2211	524	20.1
2208	465	18.8
2205	409	17.6
2202	358	16.5
2199	309	15.5
2196	264	14.6
2193	221	13.5
2190	182	12.3
2187	146	11.5
2184	112	10.6
2181	82	9.4
2178	54	8.6
2175	29	8.0
2172	7	6.6

Source: SCE supplied elevation-storage relationships. Surface area was calculated.

Table CAWG 1-282 Average Dam 6 Winter and Summer Elevation, Volume, and Surface Area by Water Year

Season	2000			2001			2002		
	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)
Winter (Low Water)	2226.8	908.4	27.6	2228.2	942.5	28.2	2228.6	953.2	28.5
Summer (High Water)	2230.7	1014.0	29.7	2228.6	953.9	28.4	2229.1	965.3	28.7

Source: SCE supplied 2000-2002 hourly reservoir storage records and elevation-storage relationships. Surface area was calculated.

Table CAWG 1-283 Temperature and Water Quality Characteristics of Dam 6 Forebay, 2001

	Characteristics of Stratified Layers				Average Water Quality		
2001	Epilimnion[1]		Hypolimnion[2]		Dissolved Oxygen [3]	Specific Conductance[4]	Visibility [5]
Month	Water Temperature (°C)[6]	Thickness (m)	Water Temperature (°C)[6]	Thickness (m)	(mg/L)	(uS/cm)	(m)
May[7]	8.7	-----	8.7	-----	10.7	18.0	N/A
June[7]	11.7	-----	11.7	-----	10.9	18.0	N/A
July[7]	13.9	-----	13.9	-----	8.2	20.0	N/A
Aug	17.3	4	14.6	13	10.5	21.0	N/A
Sept	19.5	4	17.2	21	7.4	27.0	N/A
Oct[7]	17.1	-----	17.1	-----	8.1	40.0	4.0

[1] - Epilimnion is the warm upper layer above the thermocline
[2] - Hypolimnion is the cool lower layer below the thermocline
[3] - Average Dissolved Oxygen at the profile site
[4] - Average Specific Conductance at the profile site
[5] - Recorded Secchi disc visibility at the profile site
[6] - Average water temperature within layer (not including the thermocline)
[7] - Average temperature at profile site - Reservoir not stratified

Table CAWG 1-284 Huntington Lake Volume (Storage) and Surface Area by Reservoir Elevation

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
6960	104055	1538
6957	99474	1505
6954	94992	1473
6951	90606	1440
6948	86317	1408
6945	82124	1377
6942	78025	1346
6939	74019	1315
6936	70105	1284
6933	66284	1253
6930	62555	1223
6927	58917	1191
6924	55377	1158
6921	51936	1124
6918	48599	1089
6915	45366	1054
6912	42240	1018
6909	39222	981
6906	36317	943
6903	33528	903
6900	30861	861
6897	28319	820
6894	25903	777
6891	23616	734
6888	21459	688
6885	19440	644
6882	17553	599
6879	15801	555
6876	14178	514
6873	12676	474
6870	11293	436
6867	10020	402
6864	8847	369
6861	7769	342
6858	6768	316
6855	5846	291
6852	5000	264
6849	4233	239
6846	3540	216
6843	2915	194
6840	2354	173
6837	1854	154
6834	1410	136
6831	1018	119
6828	687	105
6825	382	90
6822	142	69

Source: SCE supplied elevation-storage relationship. This is the same as that published by USGS 2002.

Note: Surface area was calculated by depth interval.

Table CAWG 1-285 Huntington Lake Mean Seasonal Elevation, Volume (Storage), and Surface Area by Water Year Type

		Winter (Low Water)			Summer (High Water)		
Water Year Type	**Representative Water Year**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**
Wet	1997	58,188	1,171	6,926	88,131	1,422	6,949
Above Normal	2000	36,634	946	6,906	87,671	1,418	6,949
Below Normal	1971	54,713	1,145	6,923	84,608	1,395	6,947
Dry	2001	37,592	960	6,907	87,568	1,418	6,949
Critical	1992	52,452	1,128	6,921	86,094	1,407	6,948

Note: Mean Storage, and Corresponding Surface Area rounded to nearest whole number. Surface Area and Elevation correspond to calculated average storage.
Averaging periods - Winter (December 21-March 19), Summer (June 21-September 22)
Source: USGS (2001, 2002) daily midnight storage data. Period of Record used 1980-2001.

Table CAWG 1-286 Huntington Lake Depth Related Habitat Area (Acres) by Reservoir Elevation

Elevation (feet)	Area shallower than 3 ft (acres)	Area shallower than 6 ft (acres)	Area shallower than 9 ft (acres)	Area shallower than 12 ft (acres)
6960	33	65	98	130
6957	32	65	97	128
6954	33	65	96	127
6951	32	63	94	125
6948	31	62	93	124
6945	31	62	93	124
6942	31	62	93	123
6939	31	62	92	124
6936	31	61	93	126
6933	30	62	95	129
6930	32	65	99	134
6927	33	67	102	137
6924	34	69	104	140
6921	35	70	106	143
6918	35	71	108	146
6915	36	73	111	151
6912	37	75	115	157
6909	38	78	120	161
6906	40	82	123	166
6903	42	83	126	169
6900	41	84	127	173
6897	43	86	132	176
6894	43	89	133	178
6891	46	90	135	179
6888	44	89	133	174
6885	45	89	130	170
6882	44	85	125	163
6879	41	81	119	153
6876	40	78	112	145
6873	38	72	105	132
6870	34	67	94	120
6867	33	60	86	111
6864	27	53	78	105
6861	26	51	78	103
6858	25	52	77	100
6855	27	52	75	97
6852	25	48	70	91
6849	23	45	66	85
6846	22	43	62	80
6843	21	40	58	75
6840	19	37	54	68
6837	18	35	49	64
6834	17	31	46	67

Source: SCE supplied elevation-storage relationship. This is the same relationship as that published by USGS 2002.
Note: Surface area was calculated by depth interval.

Table CAWG 1-287 Temperature and Water Quality Characteristics of Huntington Lake, Dam 1 Site, 2000-2001

	Characteristics of Stratified Layers				**Average Water Quality**		
2000	Epilimnion[1]		Hypolimnion[2]		Dissolved Oxygen [3]	Specific Conductance[4]	Visibility [5]
Month	Water Temperature (°C)[6]	Thickness (m)	Water Temperature (°C)[6]	Thickness (m)	(mg/L)	(uS/cm)	(m)
Aug	15.4	16	10.9	29	11.0	N/A	N/A
Oct[7]	12.5	-----	12.5	-----	7.6	12.0	7.7
2001							
May	11.3	4	6.5	35	9.4	19.0	5.1
June	16.2	7	10.5	10	8.3	12.0	6.4
July	18.1	8	11.5	30	8.8	12.0	7.0
Aug	19.2	8	13.1	26	9.2	13.0	5.6
Sept[7]	15.1	-----	15.1	-----	6.4	14.0	5.7
Oct[7]	14.6	-----	14.6	-----	7.0	14.0	5.6

[1] - Epilimnion is the warm upper layer above the thermocline
[2] - Hypolimnion is the cool lower layer below the thermocline
[3] - Average Dissolved Oxygen at the profile site
[4] - Average Specific Conductance at the profile site
[5] - Recorded Secchi disc visibility at the profile site
[6] - Average water temperature within layer (not including the thermocline)
[7] - Average temperature at profile site - Reservoir not stratified

Table CAWG 1-288 Dam 4 Forebay Volume (Storage) and Surface Area at Forebay Elevations.

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
4814	70.7	4.0
4811	59.3	3.4
4808	49.3	3.2
4805	40.0	3.0
4802	31.3	2.7
4799	23.4	2.5
4796	16.0	2.3
4793	9.2	2.2
4790	2.8	2.1

Source: SCE supplied elevation-storage relationships. Surface area was calculated.

Table CAWG 1-289 Dam 4 Forebay Seasonal Elevation, Volume (Storage), and Surface Area by Water Year

Season	2000			2001			2002		
	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)
Winter (Low Water)	4808.9	52.4	3.3	4809.0	52.7	3.3	4809.1	53.0	3.3
Summer (High Water)	4810.4	53.5	3.3	4810.5	52.4	3.3	4809.0	52.6	3.3

Source: SCE supplied 2000-2002 hourly reservoir storage records and elevation-storage relationships. Surface area was calculated.

Table CAWG 1-290 Dam 5 Forebay Volume (Storage) and Surface Area at Forebay Elevations

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
2946	57.0	3.7
2943	46.6	3.2
2940	37.2	2.9
2937	28.8	2.7
2934	21.1	2.3
2931	14.4	2.1
2928	8.4	1.9
2925	3.1	1.6

Source: SCE supplied elevation-storage relationships. Surface area was calculated.

Table CAWG 1-291 Dam 5 Forebay Seasonal Elevation, Volume (Storage), and Surface Area by Water Year

Season	2000			2001			2002		
	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)
Winter (Low Water)	2941.2	40.9	3.1	2941.7	42.5	3.2	2941.9	43.0	3.2
Summer (High Water)	2942.0	43.3	3.2	2941.7	42.4	3.1	2941.9	43.2	3.2

Source: SCE supplied 2000-2002 hourly reservoir storage records and elevation-storage relationships. Surface area was calculated.

Table CAWG 1-292 Balsam Meadow Forebay Volume (Storage) and Surface Area at Forebay Elevations.

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
6671	1715	60
6668	1548	50
6665	1397	50
6662	1247	51
6659	1096	50
6656	945	50
6653	819	38
6650	705	38
6647	591	38
6644	483	31
6641	389	32
6638	294	31
6635	200	15
6632	155	15

Source: SCE supplied elevation-storage relationships. Surface area was calculated.

Table CAWG 1-293 Balsam Meadow Forebay Seasonal Elevation, Volume (Storage), and Surface Area by Water Year

Season	2000			2001			2002		
	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)	Average Elevation (feet)	Average Storage (acre-feet)	Average Surface Area (acres)
Winter (Low Water)	6,648	625	36	6,647	591	36	6,648	647	37
Summer (High Water)	6,654	866	42	6,655	895	43	6,651	755	38

Source: SCE supplied 2000-2002 hourly reservoir storage records and elevation-storage relationships. Surface area was calculated.

Table CAWG 1-294 Balsam Meadow Forebay Depth Related Habitat Area (Acres) by Forebay Elevation

Elevation	Area shallower than 3 ft	Area shallower than 6 ft	Area shallower than 9 ft	Area shallower than 12 ft
(feet)	(acres)	(acres)	(acres)	(acres)
6671	10	10	9	10
6668	0	0	0	0
6665	0	0	0	12
6662	1	1	13	13
6659	0	12	12	12
6656	12	12	12	19
6653	0	0	7	6
6650	0	7	6	7

Source: SCE supplied elevation-storage relationships. Surface area was calculated.

Table CAWG 1-295 Temperature and Water Quality Characteristics of Balsam Meadow Forebay, 2001

	Characteristics of Stratified Layers				**Average Water Quality**		
2001	Epilimnion[1]		Hypolimnion[2]		Dissolved Oxygen [3]	Specific Conductance[4]	Visibility [5]
Month	Water Temperature (°C)[6]	Thickness (m)	Water Temperature (°C)[6]	Thickness (m)	(mg/L)	(uS/cm)	(m)
May	8.3	1	6.4	9	10.2	17.0	5.0
June[7]	14.4	-----	14.4	-----	7.5	15.0	5.7
July	20.8	2	19.0	4	7.6	18.0	4.2
Aug[7]	19.4	-----	19.4	-----	8.2	17.0	5.1
Sept[7]	17.0	-----	17.0	-----	7.2	15.0	6.6
Oct[7]	15.3	-----	15.3	-----	7.4	15.0	N/A

[1] - Epilimnion is the warm upper layer above the thermocline
[2] - Hypolimnion is the cool lower layer below the thermocline
[3] - Average Dissolved Oxygen at the profile site
[4] - Average Specific Conductance at the profile site
[5] - Recorded Secchi disc visibility at the profile site
[6] - Average water temperature within layer (not including the thermocline)
[7] - Average temperature at profile site - Reservoir not stratified

Table CAWG 1-296 Huntington Lake Volume (Storage) and Surface Area at Reservoir Elevation

Elevation (feet)	Volume (acre-feet)	Surface Area (acres)
6960	104055	1538
6957	99474	1505
6954	94992	1473
6951	90606	1440
6948	86317	1408
6945	82124	1377
6942	78025	1346
6939	74019	1315
6936	70105	1284
6933	66284	1253
6930	62555	1223
6927	58917	1191
6924	55377	1158
6921	51936	1124
6918	48599	1089
6915	45366	1054
6912	42240	1018
6909	39222	981
6906	36317	943
6903	33528	903
6900	30861	861
6897	28319	820
6894	25903	777
6891	23616	734
6888	21459	688
6885	19440	644
6882	17553	599
6879	15801	555
6876	14178	514
6873	12676	474
6870	11293	436
6867	10020	402
6864	8847	369
6861	7769	342
6858	6768	316
6855	5846	291
6852	5000	264
6849	4233	239
6846	3540	216
6843	2915	194
6840	2354	173
6837	1854	154
6834	1410	136
6831	1018	119
6828	687	105
6825	382	90
6822	142	69

Source: SCE supplied elevation-storage relationship. This is the same as that published by USGS 2002.

Note: Surface area was calculated by depth interval.

Table CAWG 1-297 Shaver Lake Mean Seasonal Elevation, Volume (Storage), and Surface Area by Water Year Type

		Winter (Low Water)			Summer (High Water)		
Water Year Type	**Representative Water Year**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**	**Mean Storage (acre-feet)**	**Corresponding Surface Area (acres)**	**Corresponding Elevation (feet)**
Wet	1997	113,037	2,022	5,359	130,644	2,141	5,368
Above Normal	2000	92,419	1,858	5,349	128,682	2,126	5,367
Below Normal	1971	40,614	1,224	5,315	110,392	1,979	5,358
Dry	2001	45,719	1,300	5,319	68,296	1,570	5,335
Critical	1992	73,718	1,631	5,338	60,684	1,481	5,330

Note: Mean Storage, and Corresponding Surface Area rounded to nearest whole number. Surface Area and Elevation correspond to calculated average storage.

Averaging periods - Winter (December 21-March 19), Summer (June 21-September 22)

Source: USGS (2001, 2002) daily midnight storage data. Period of Record used 1980-2001.

Table CAWG 1-298 Shaver Lake Depth Related Habitat Area (Acres) by Reservoir Elevation

Elevation (feet)	Area shallower than 3 ft (acres)	Area shallower than 6 ft (acres)	Area shallower than 9 ft (acres)	Area shallower than 12 ft (acres)
5375	58	112	156	197
5372	54	98	139	180
5369	44	85	126	167
5366	41	82	123	173
5363	41	82	132	166
5360	41	91	125	192
5357	50	84	151	220
5354	34	101	170	234
5351	67	136	200	256
5348	69	133	189	249
5345	64	120	180	244
5342	56	116	180	215
5339	60	124	159	200
5336	64	99	140	216
5333	35	76	152	178
5330	41	117	143	210
5327	76	102	169	224
5324	26	93	148	201
5321	67	122	175	232
5318	55	108	165	226
5315	53	110	171	226
5312	57	118	173	240
5309	61	116	183	243
5306	55	122	182	245
5303	67	127	190	251
5300	60	123	184	237
5297	63	124	177	243
5294	61	114	180	238
5291	53	119	177	238
5288	66	124	185	245
5285	58	119	179	229
5282	61	121	171	232
5279	60	110	171	217
5276	50	111	157	208
5273	61	107	158	202
5270	46	97	141	174
5267	51	95	128	165
5264	44	77	114	139
5261	33	70	95	127
5258	37	62	94	115
5255	25	57	78	88
5252	32	53	63	80
5249	21	31	48	54
5246	10	27	33	38
5243	17	23	28	30
5240	6	11	13	15
5237	5	7	9	
5234	2	4		

Source: SCE supplied elevation-storage relationship. This is the same relationship as that published by USGS 2002.
Note: Surface area was calculated by depth interval.

Table CAWG 1-299 Temperature and Water Quality Characteristics of Shaver Lake, Dam Site, 2000-2001

	Characteristics of Stratified Layers				Average Water Quality		
2000	Epilimnion[1]		Hypolimnion[2]		Dissolved Oxygen [3]	Specific Conductance[4]	Visibility [5]
Month	Water Temperature (°C)[6]	Thickness (m)	Water Temperature (°C)[6]	Thickness (m)	(mg/L)	(uS/cm)	(m)
Aug[7]	14.9	-----	14.9	-----	7.5	N/A	N/A
Sept[7]	17.2	-----	17.2	-----	7.1	N/A	N/A
Oct[7]	15.0	-----	15.0	-----	7.1	15.0	4.2
2001							
May	16.1	1	7.6	36	9.2	17.0	5.3
June	19.7	4	11.4	38	7.8	17.0	7.1
July	21.1	6	13.6	33	7.7	17.0	6.9
Aug[7]	16.8	-----	16.8	-----	8.1	17.0	3.8
Sept[7]	18.5	-----	18.0	-----	5.6	17.0	5.3
Oct[7]	17.9	-----	17.9	-----	6.3	17.0	5.0

[1] - Epilimnion is the warm upper layer above the thermocline
[2] - Hypolimnion is the cool lower layer below the thermocline
[3] - Average Dissolved Oxygen at the profile site
[4] - Average Specific Conductance at the profile site
[5]- Recorded Secchi disc visibility at the profile site
[6] - Average water temperature within layer (not including the thermocline)
[7] - Average temperature at profile site - Reservoir not stratified

FIGURES

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake Reach

Rosgen 1 Channel Type = B

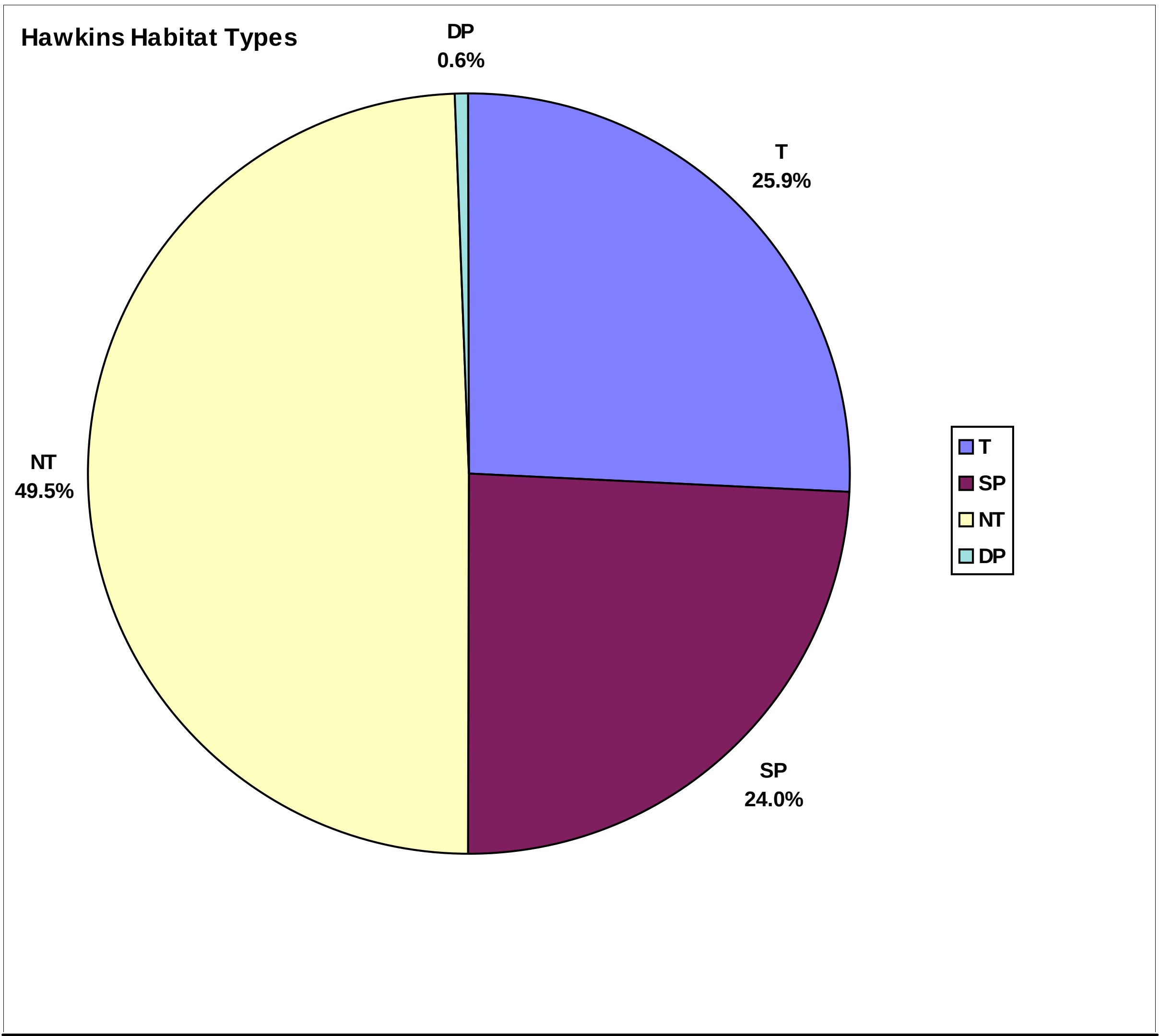


Figure CAWG 1-1. Hawkins Habitat Types for SFSJR Bear Creek to Florence Lake.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake Reach

Rosgen 1 Channel Type = C

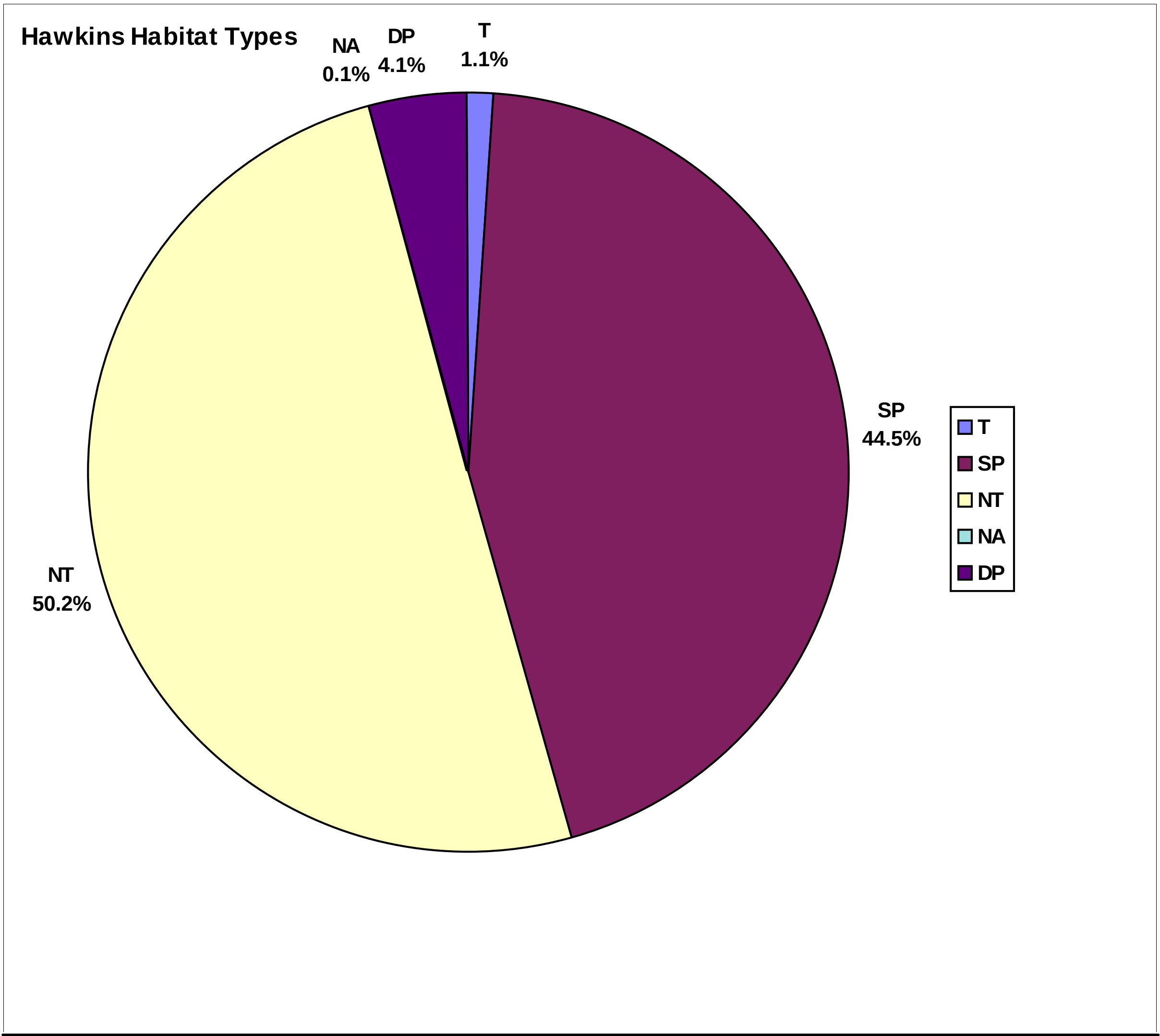


Figure CAWG 1-1. Hawkins Habitat Types for SFSJR Bear Creek to Florence Lake (cont).

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake Reach

Rosgen 1 Channel Type = G

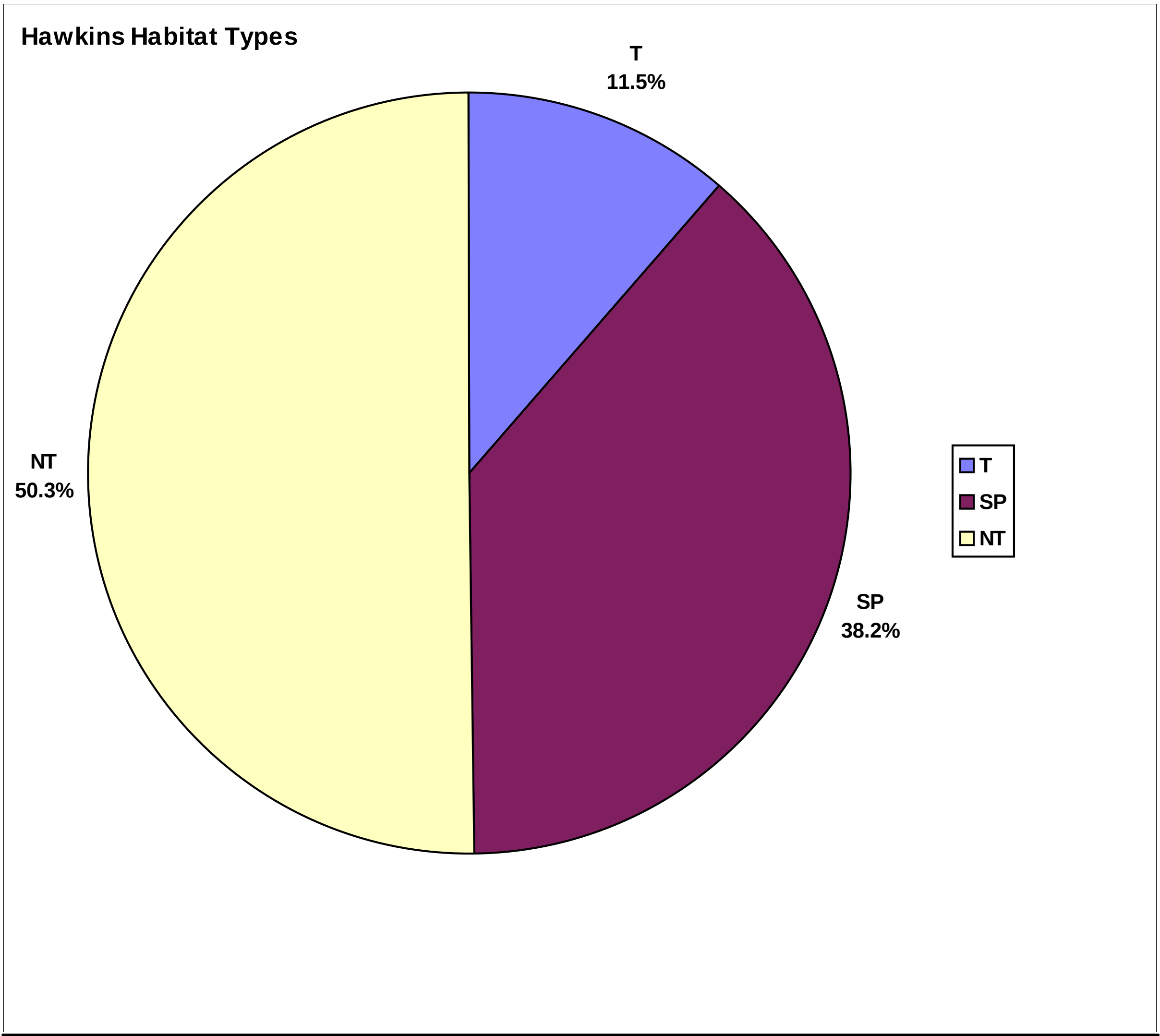


Figure CAWG 1-1. Hawkins Habitat Types for SFSJR Bear Creek to Florence Lake (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake Reach

Rosgen 1 Channel Type = B

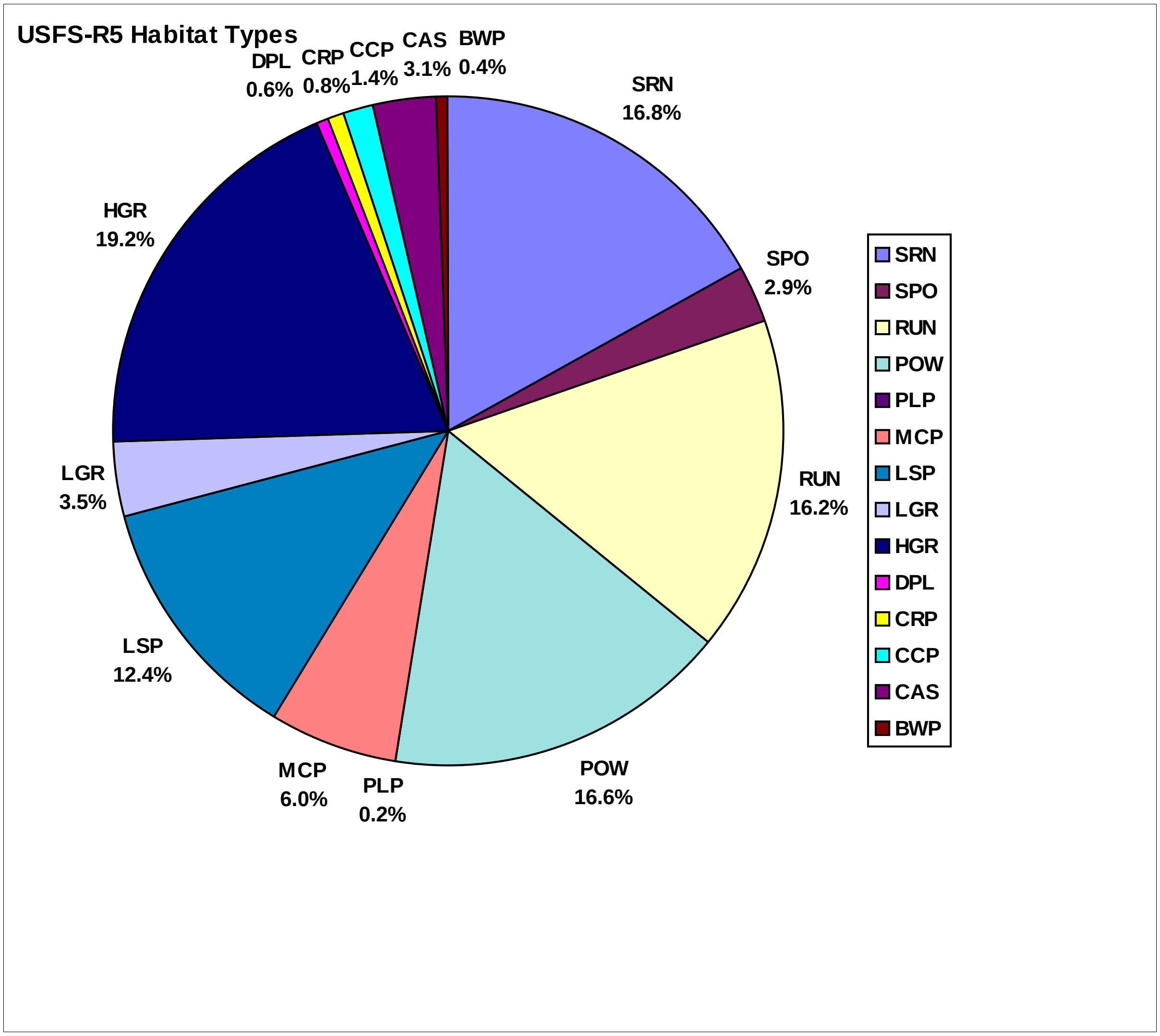


Figure CAWG 1-2. USFS-R5 Habitat Types for SFSJR Bear Creek to Florence Lake.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake Reach

Rosgen 1 Channel Type = C

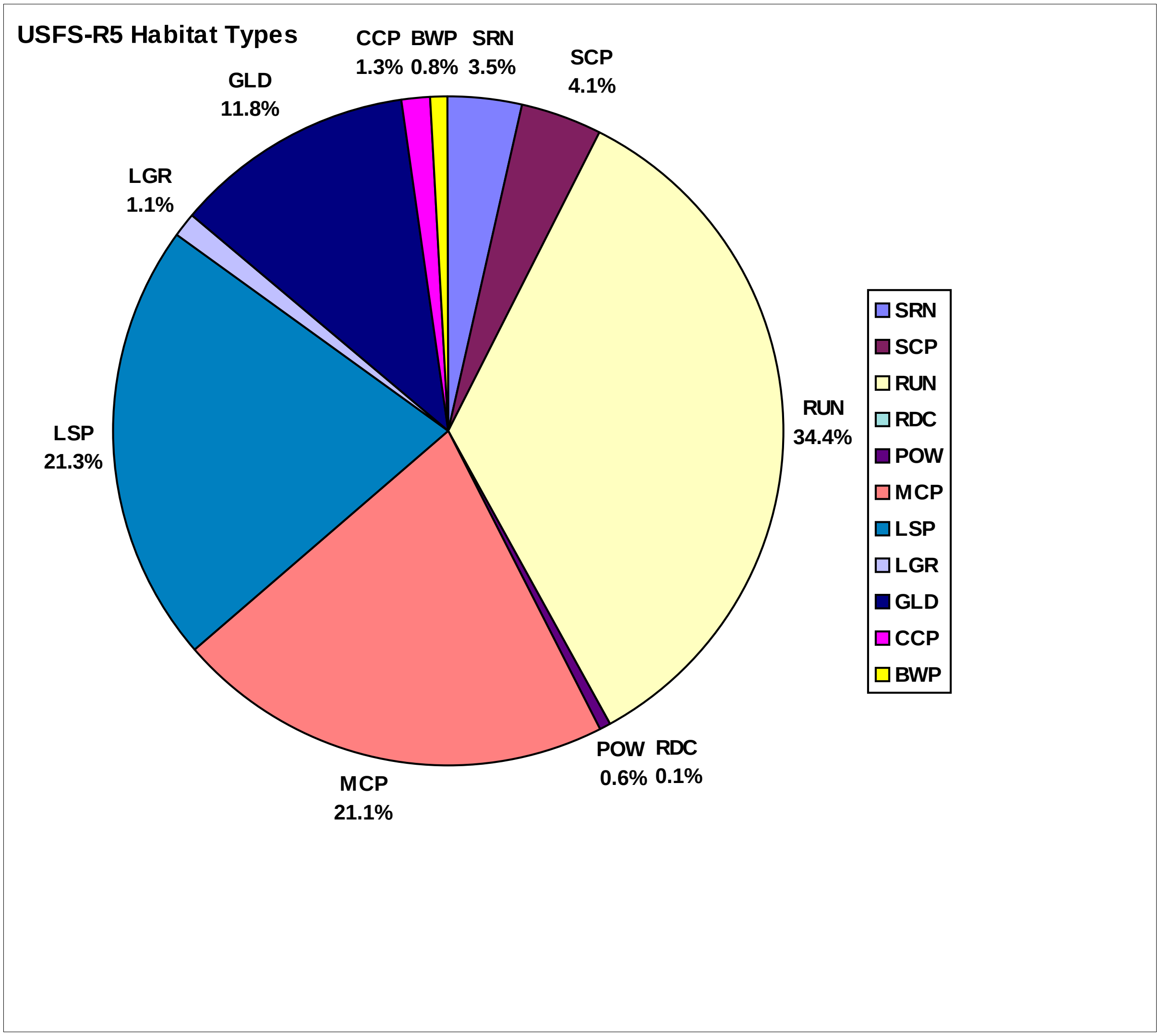


Figure CAWG 1-2. USFS-R5 Habitat Types for SFSJR Bear Creek to Florence Lake (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Bear Crk to Florence Lake Reach

Rosgen 1 Channel Type = G

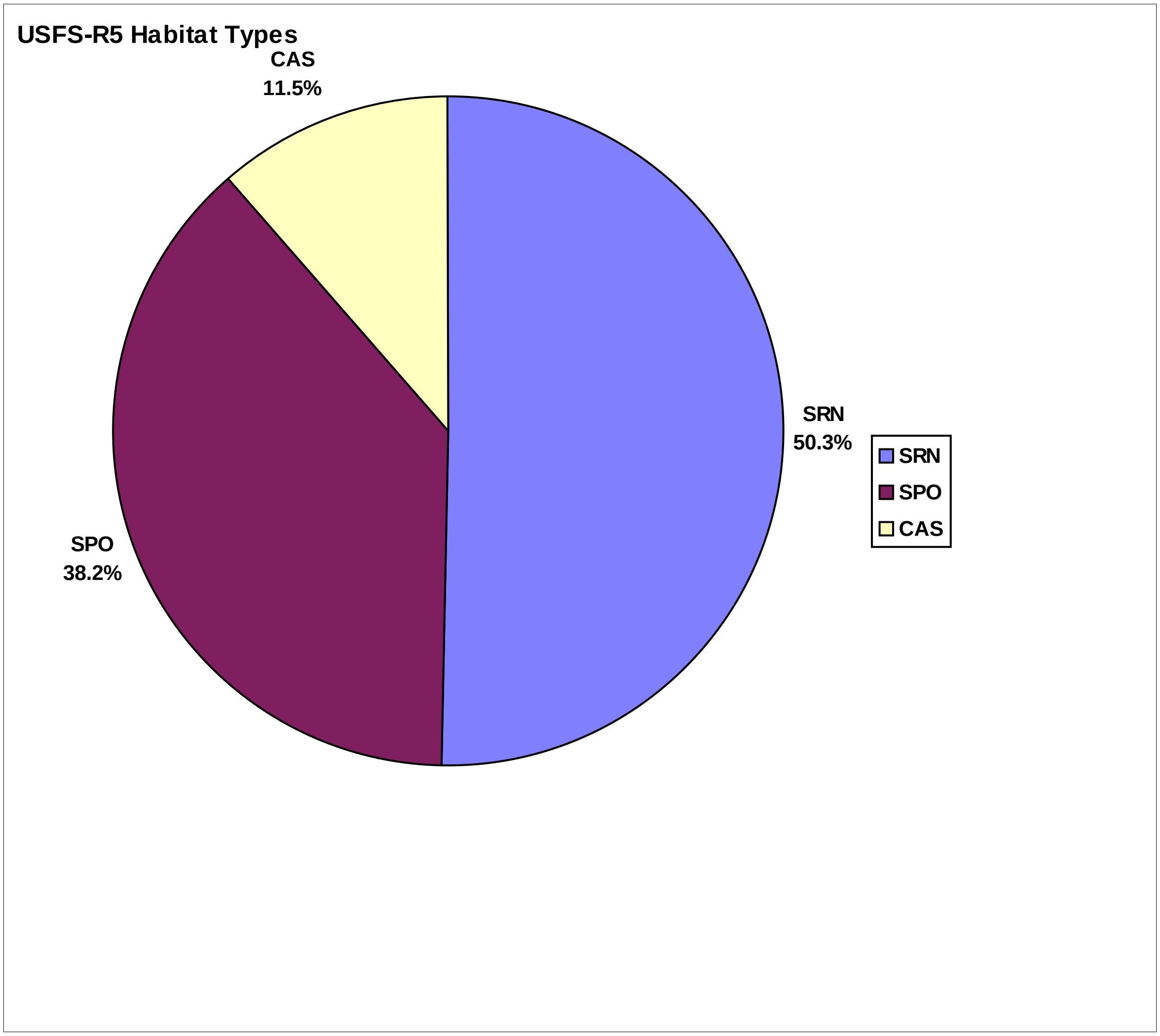


Figure CAWG 1-2. USFS-R5 Habitat Types for SFSJR Bear Creek to Florence Lake (cont).

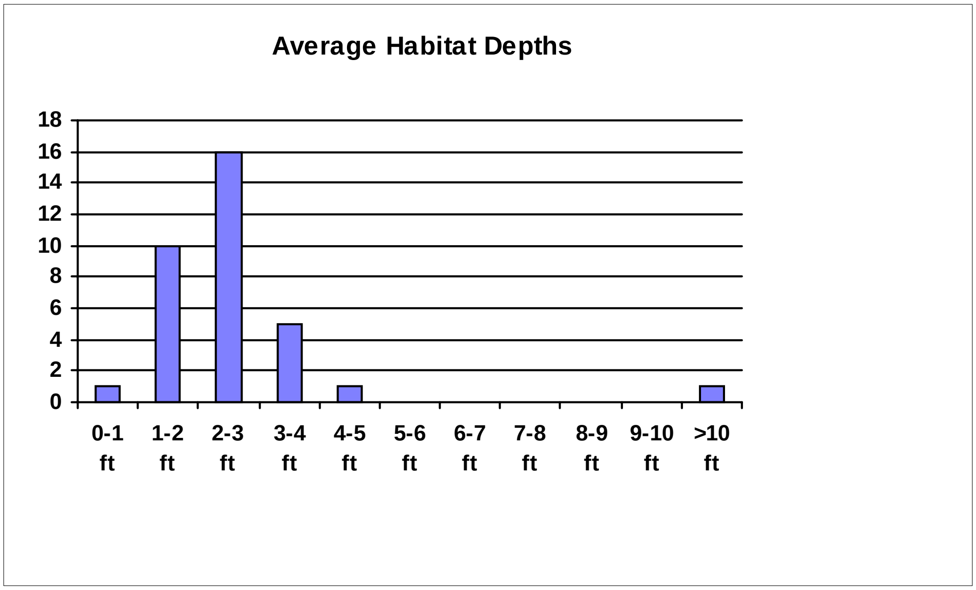
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River Bear Crk to Florence Lake Reach SFSJR4_



B Channel Type

Figure CAWG 1-3. Average Habitat Depth Histograms for SFSJR Bear Creek to Florence Lake (1 foot bin size, frequency = number of pools).

Data collected starting on 8/8/2000.

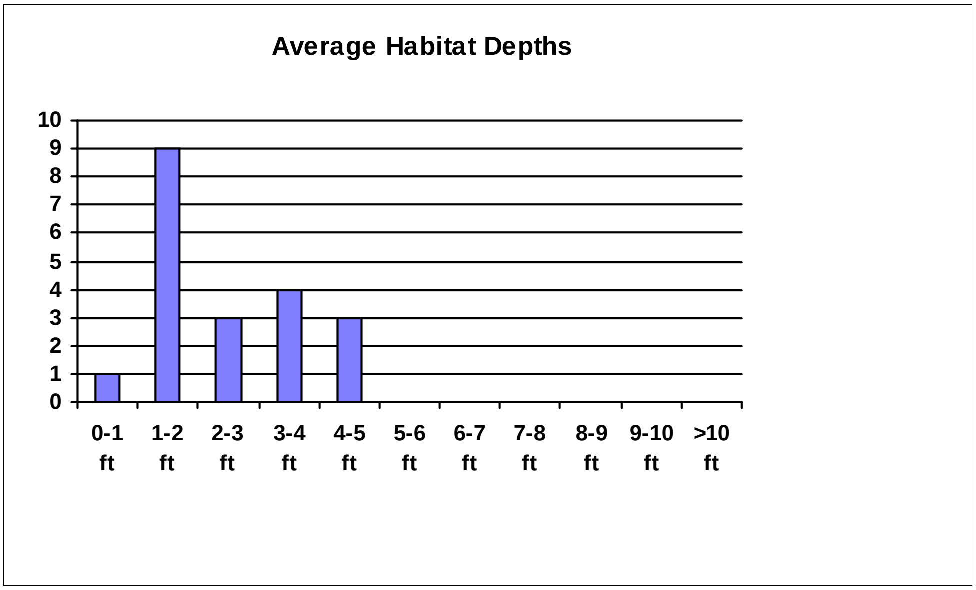
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River Bear Crk to Florence Lake Reach SFSJR4_



C Channel Type

Figure CAWG 1-3. Average Habitat Depth Histograms for SFSJR Bear Creek to Florence Lake (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/8/2000.

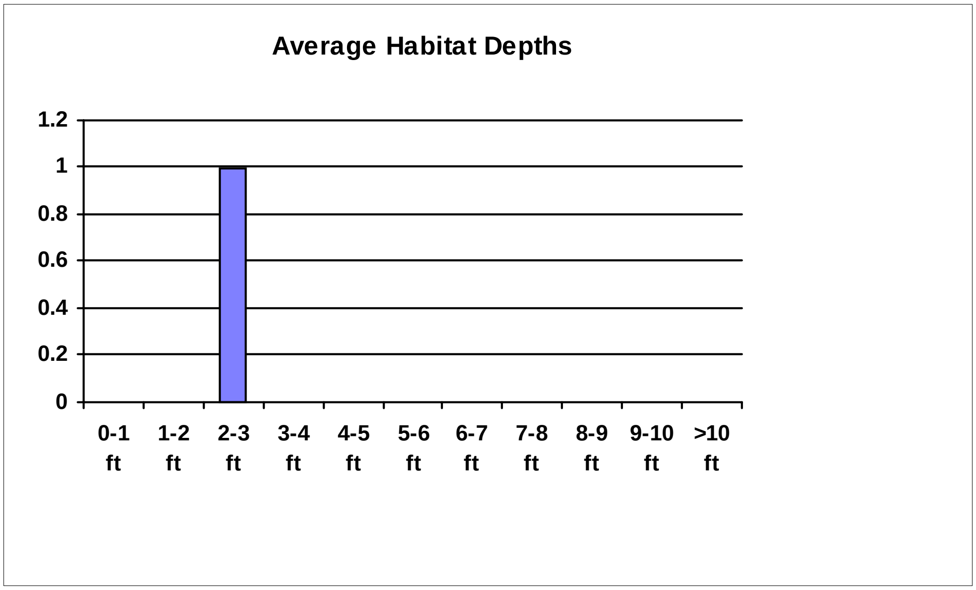
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River Bear Crk to Florence Lake Reach SFSJR4_



G Channel Type

Figure CAWG 1-3. Average Habitat Depth Histograms for SFSJR Bear Creek to Florence Lake (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/8/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Rosgen 1 Channel Type = B

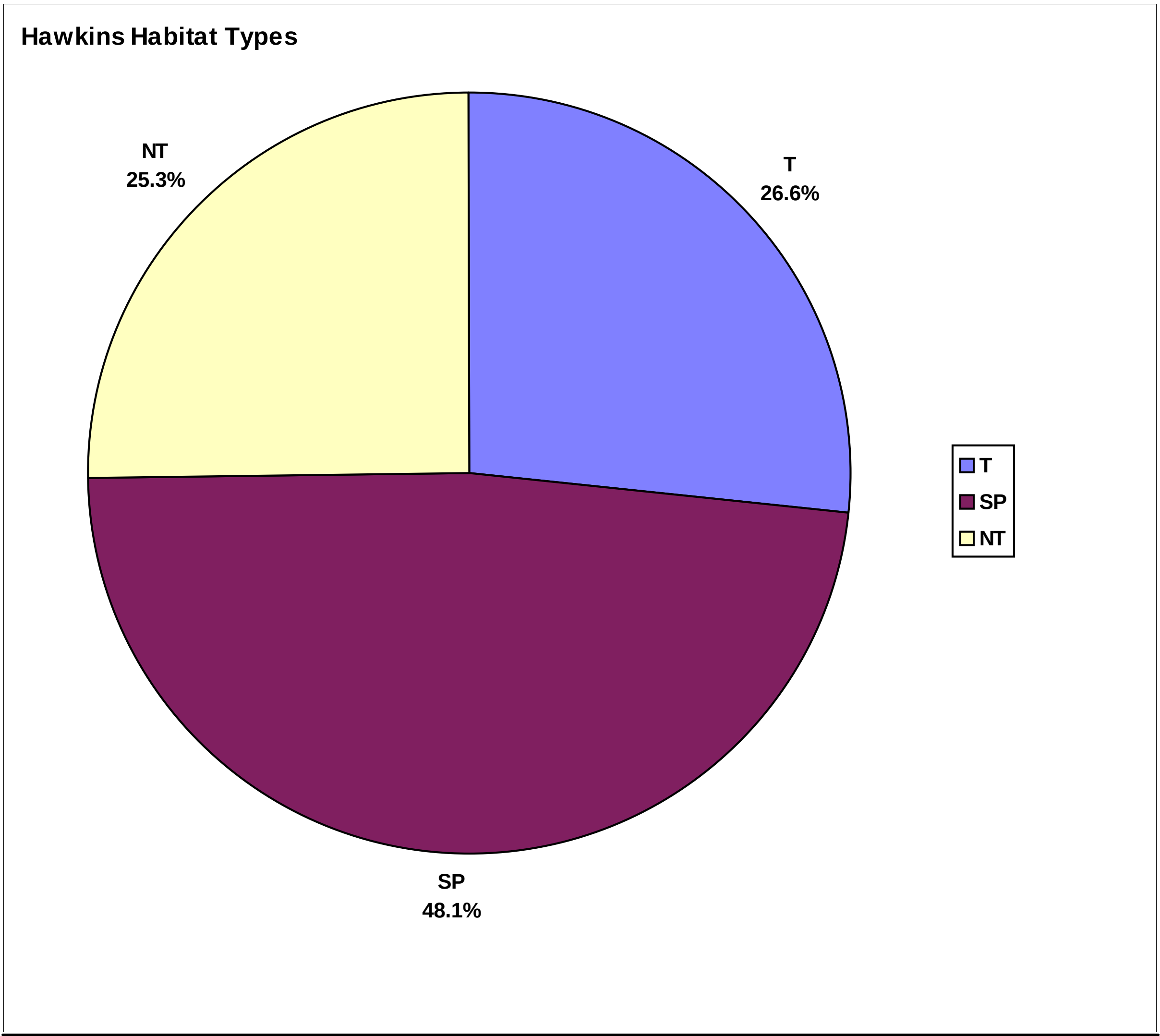


Figure CAWG 1-4. Hawkins Habitat Types for SFSJR Mono Crossing to Bear Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Rosgen 1 Channel Type = C

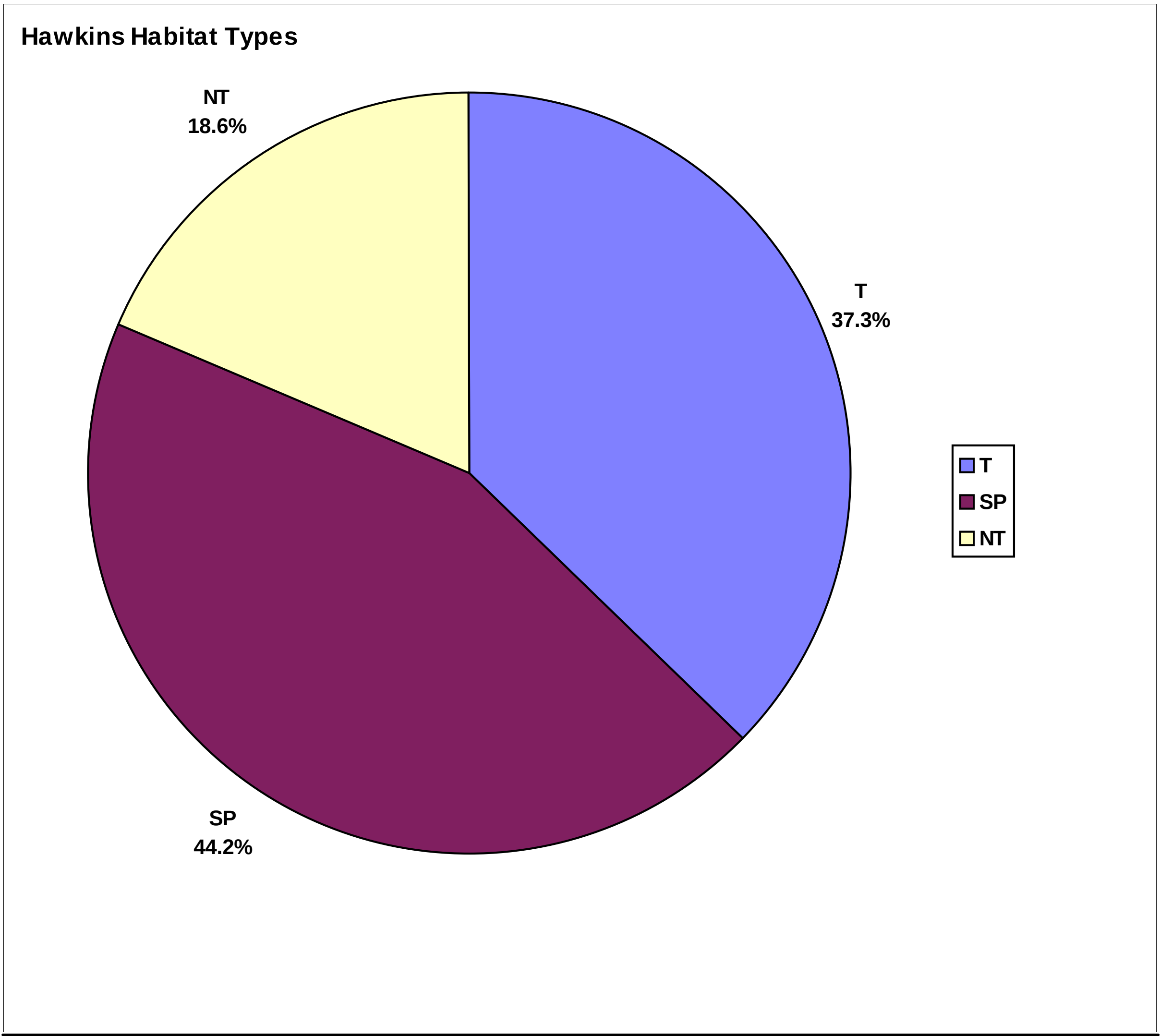


Figure CAWG 1-4. Hawkins Habitat Types for SFSJR Mono Crossing to Bear Creek (cont).

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Rosgen 1 Channel Type = G

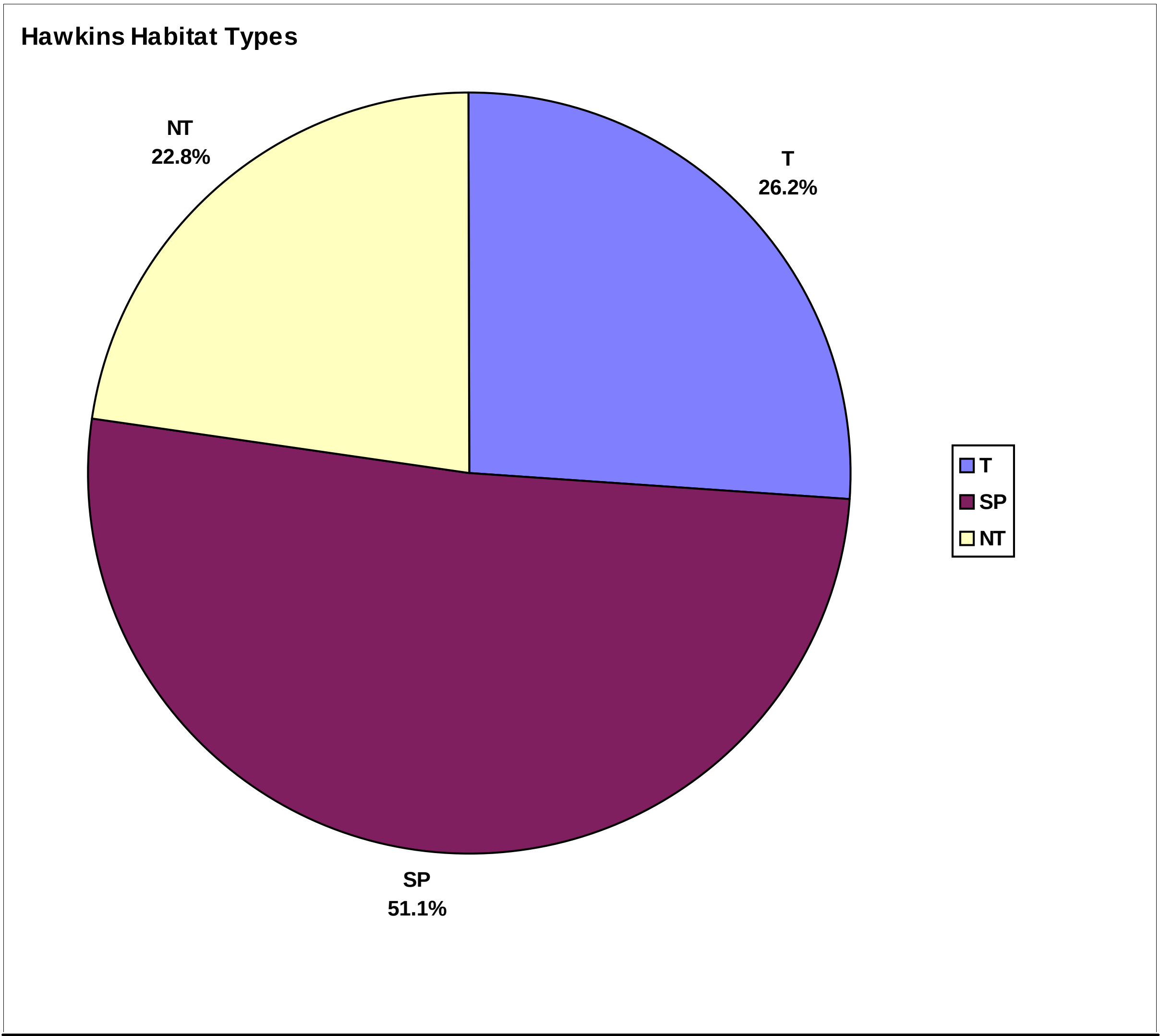


Figure CAWG 1-4. Hawkins Habitat Types for SFSJR Mono Crossing to Bear Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Rosgen 1 Channel Type = B

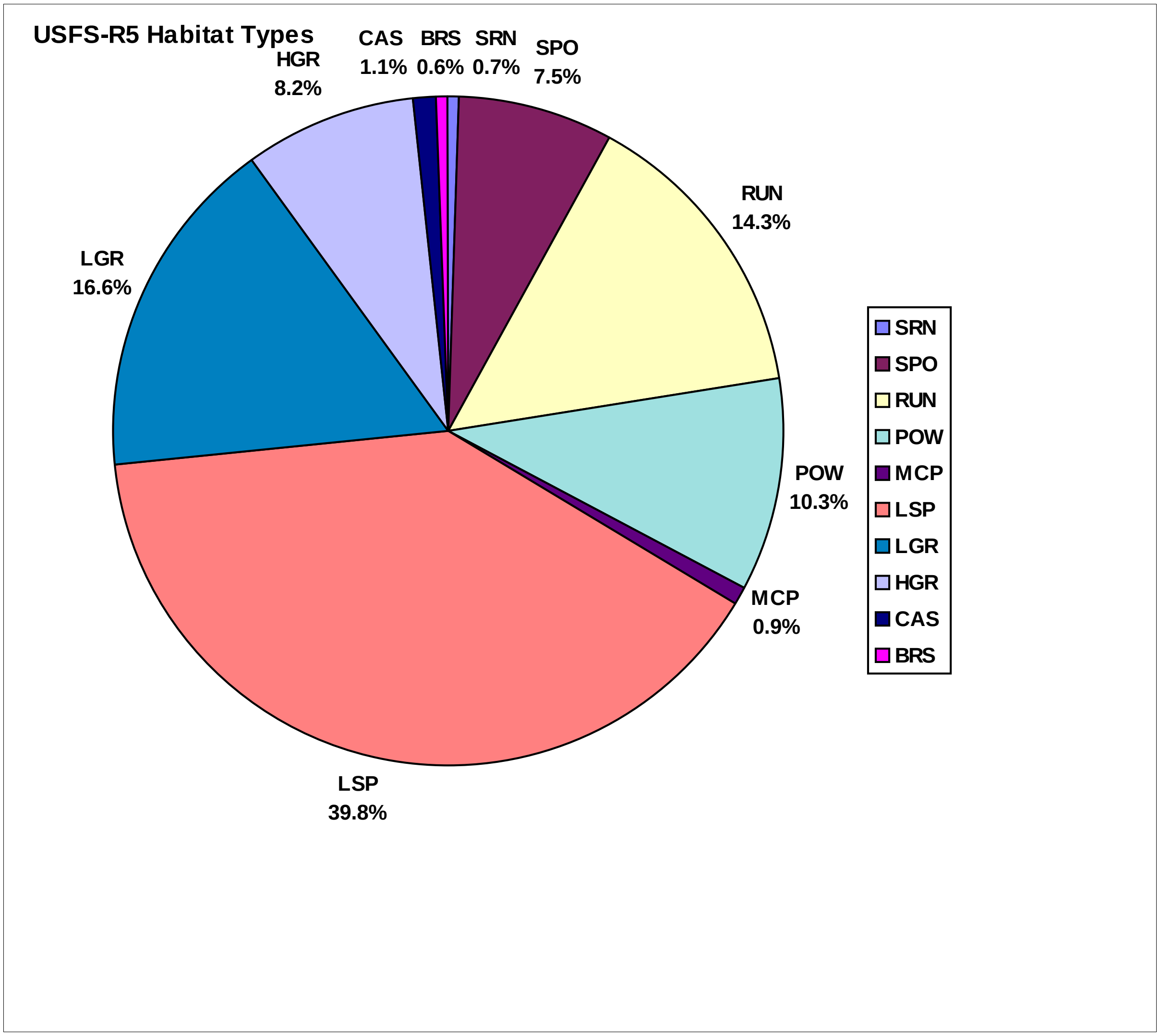


Figure CAWG 1-5. USFS-R5 Habitat Types for SFSJR Mono Crossing to Bear Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Rosgen 1 Channel Type = C

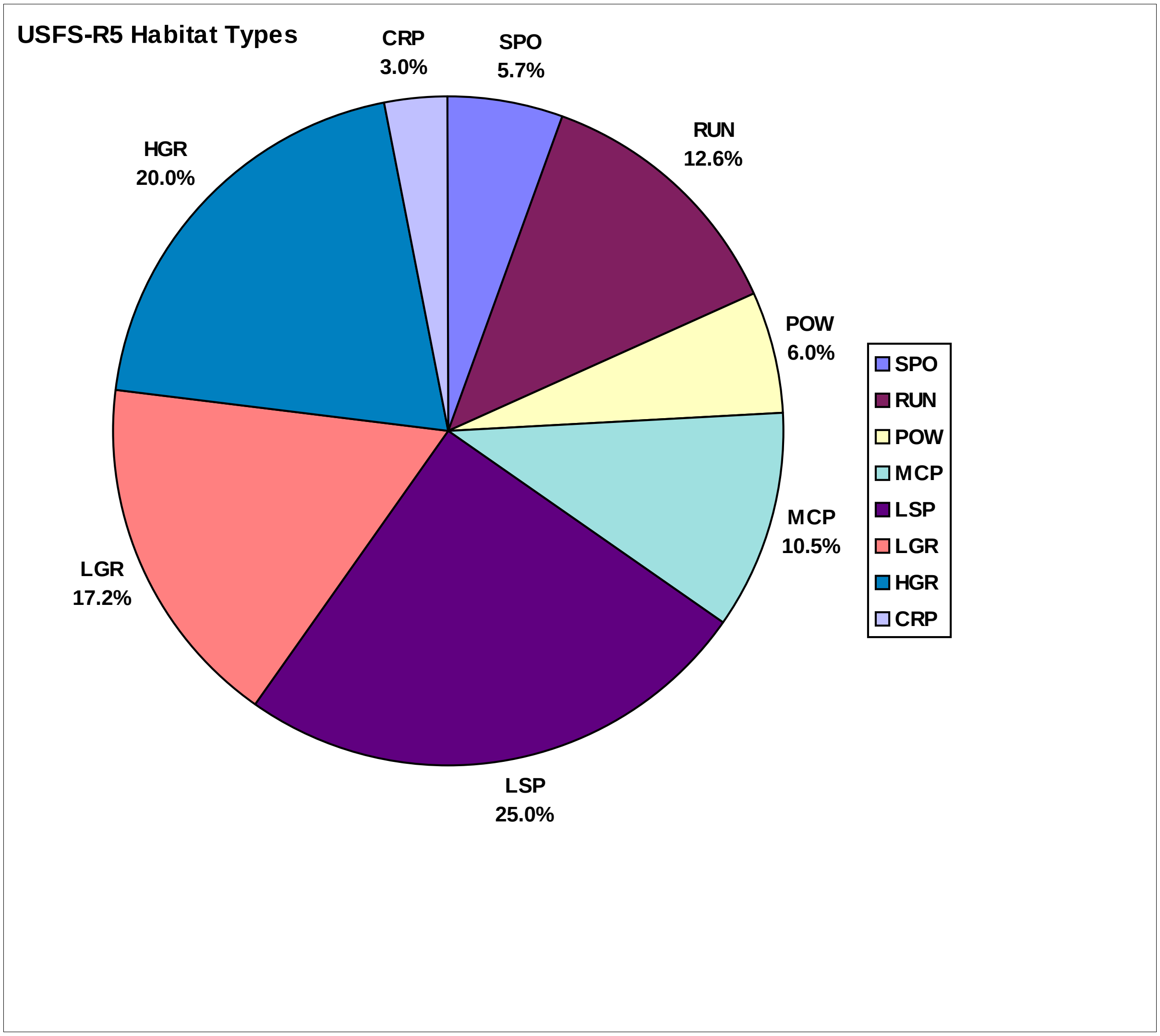


Figure CAWG 1-5. USFS-R5 Habitat Types for SFSJR Mono Crossing to Bear Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River Mono X to Bear Crk Reach

Rosgen 1 Channel Type = G

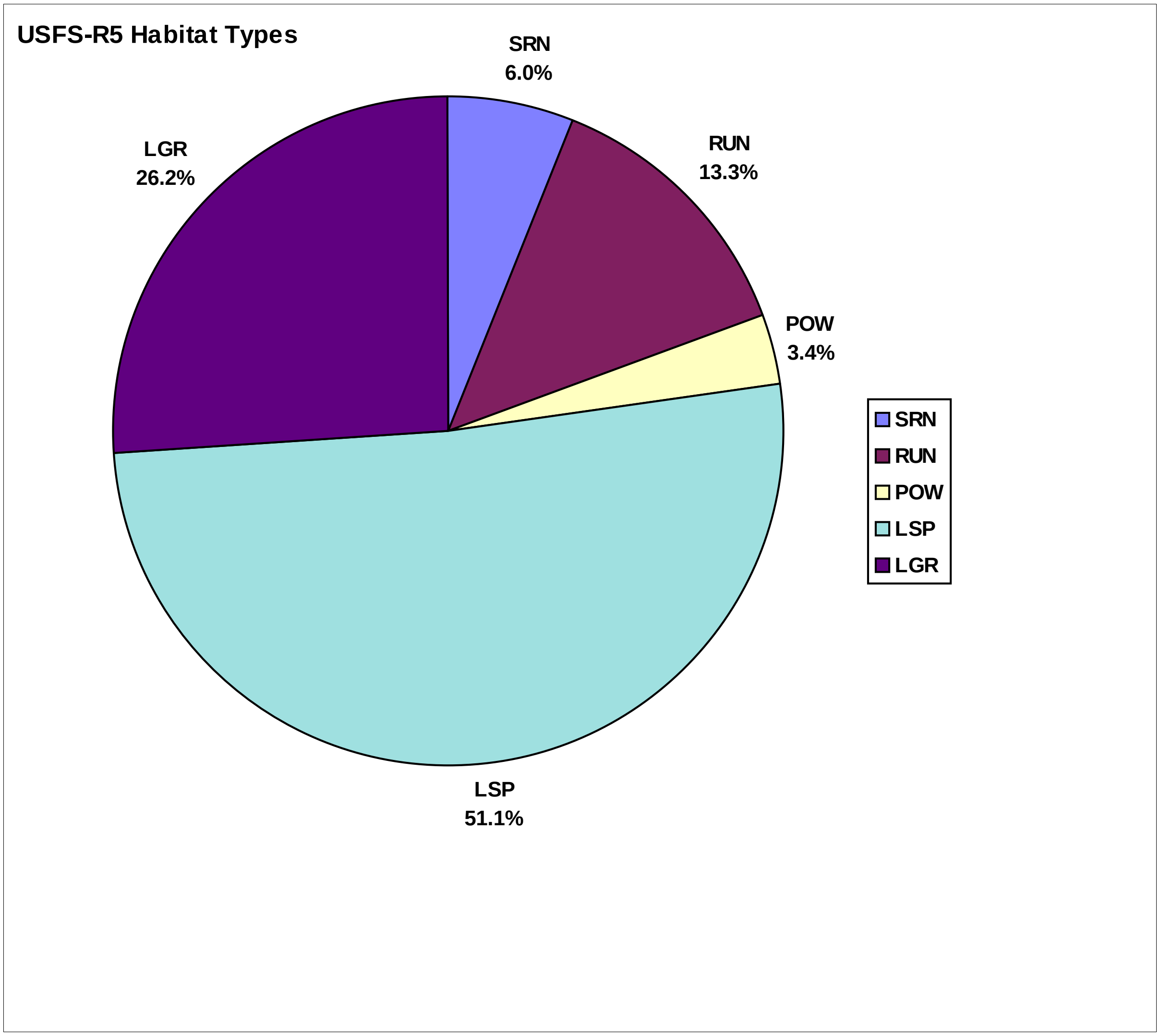


Figure CAWG 1-5. USFS-R5 Habitat Types for SFSJR Mono Crossing to Bear Creek (cont).

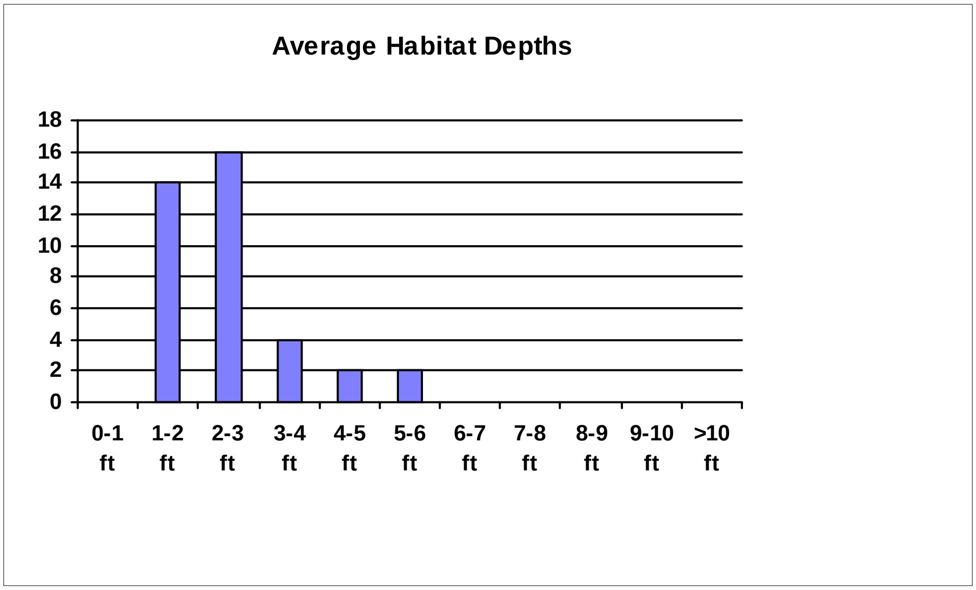
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River Mono X to Bear Crk Reach SFSJR3_



B Channel Type

Figure CAWG 1-6. Average Habitat Depth Histograms for SFSJR Mono Crossing to Bear Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 8/8/2000.

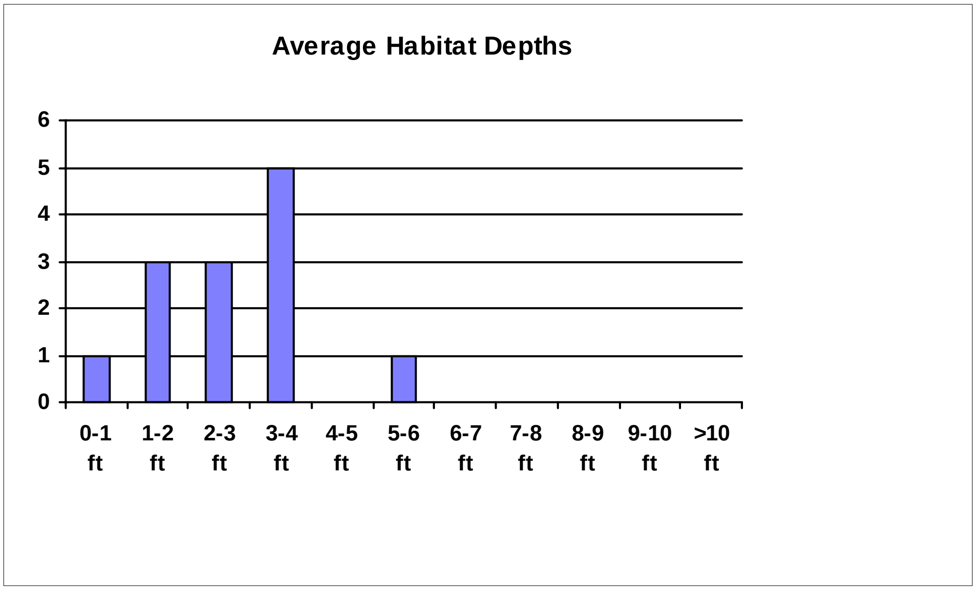
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River Mono X to Bear Crk Reach SFSJR3_



C Channel Type

Figure CAWG 1-6. Average Habitat Depth Histograms for SFSJR Mono Crossing to Bear Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/8/2000.

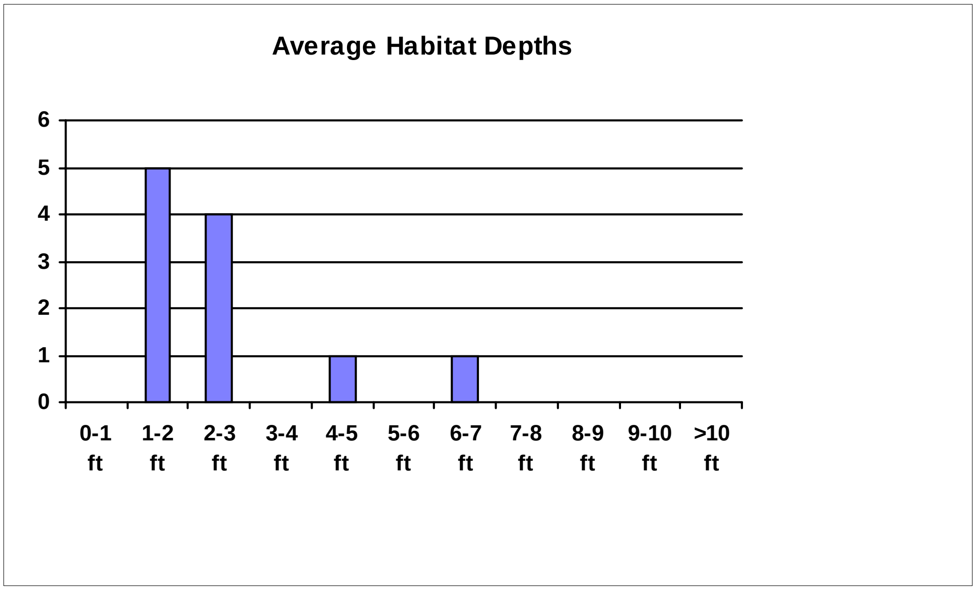
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River Mono X to Bear Crk Reach SFSJR3_



G Channel Type

Figure CAWG 1-6. Average Habitat Depth Histograms for SFSJR Mono Crossing to Bear Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/8/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River ds of Rattlesnake X to Mono X Reach

Rosgen 1 Channel Type = B

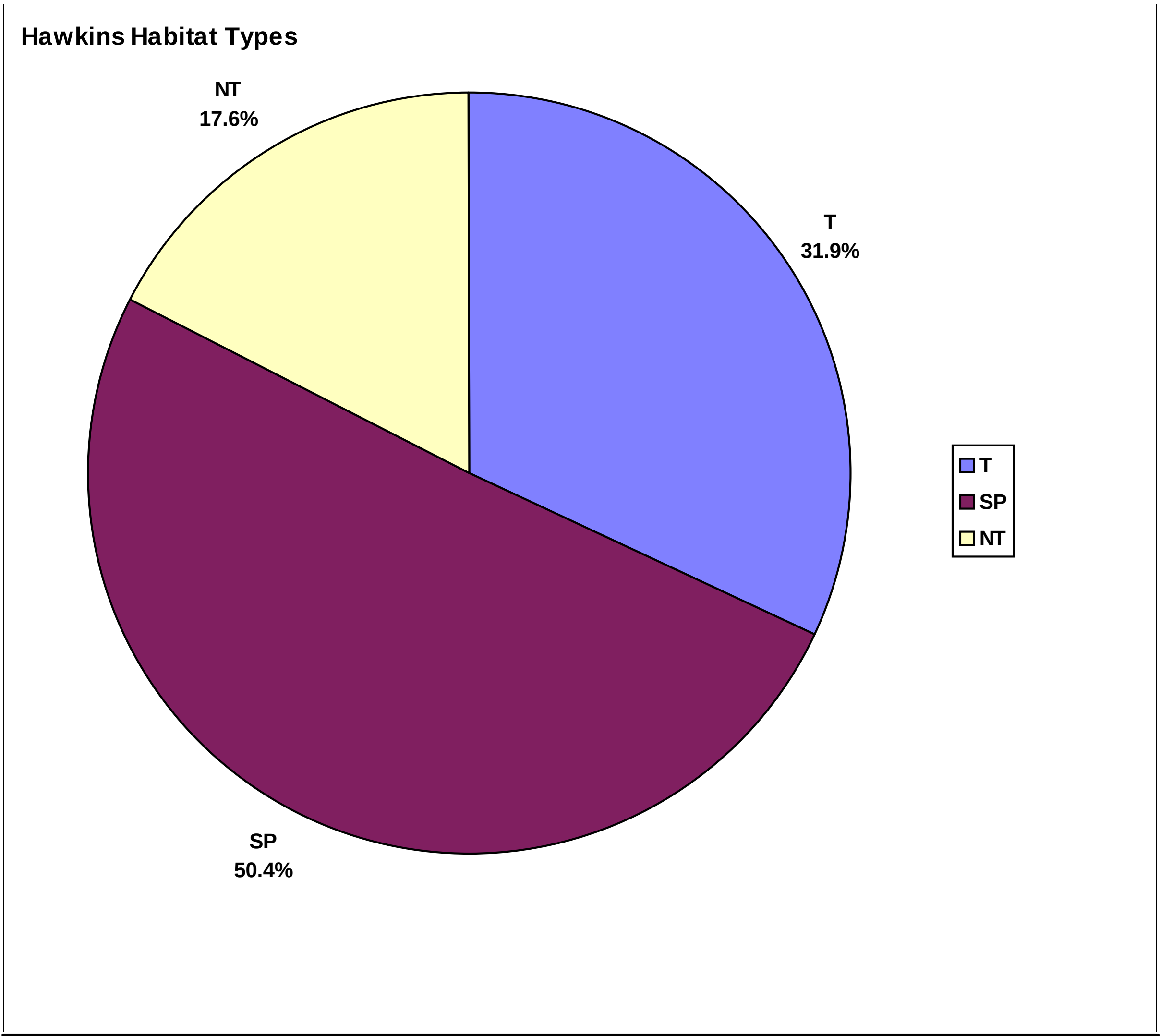


Figure CAWG 1-7. Hawkins Habitat Types for SFSJR Rattlesnake Crossing to Mono Crossing.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River ds of Rattlesnake X to Mono X Reach

Rosgen 1 Channel Type = G

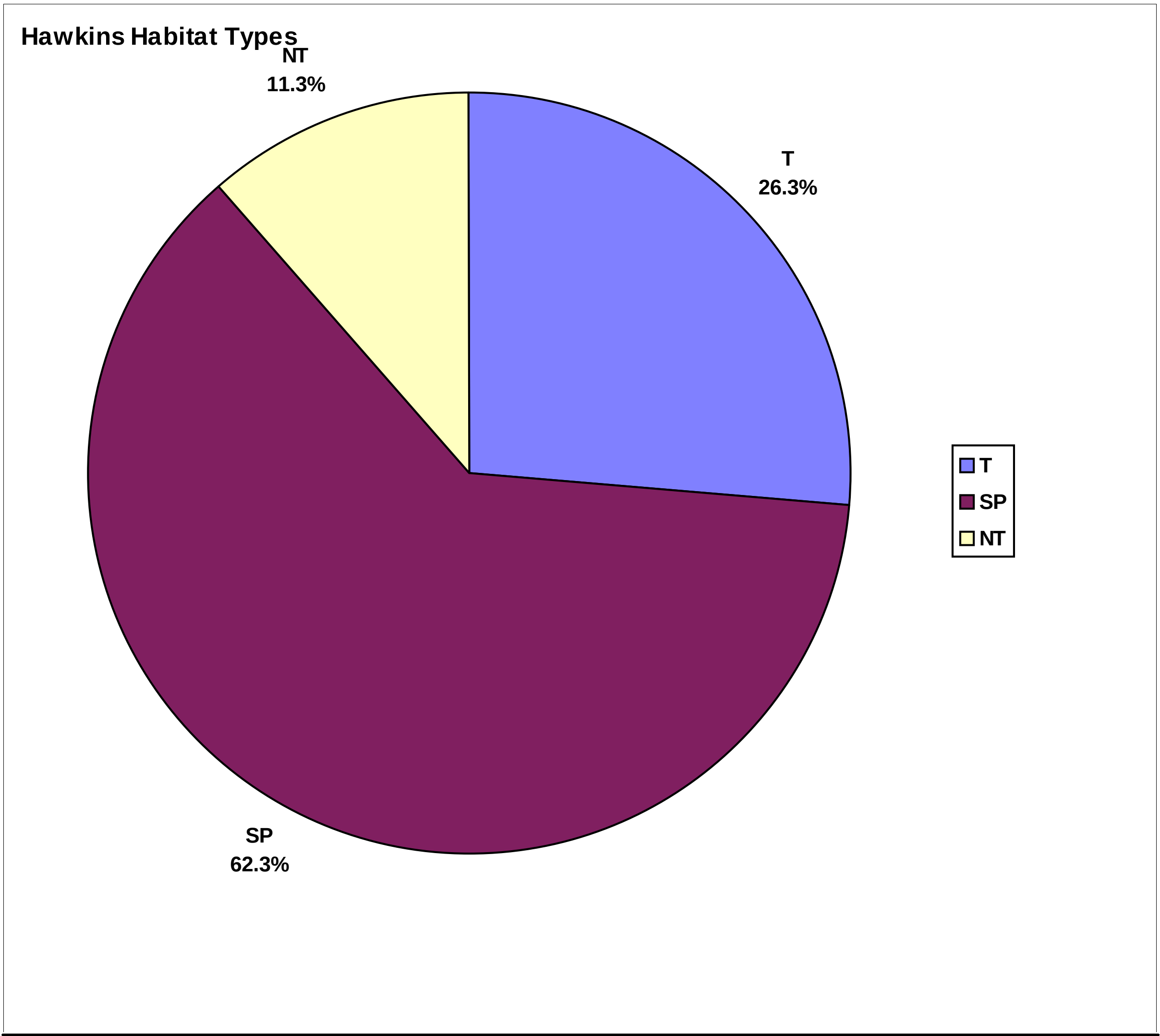


Figure CAWG 1-7. Hawkins Habitat Types for SFSJR Rattlesnake Crossing to Mono Crossing (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River ds of Rattlesnake X to Mono X Reach

Rosgen 1 Channel Type = B

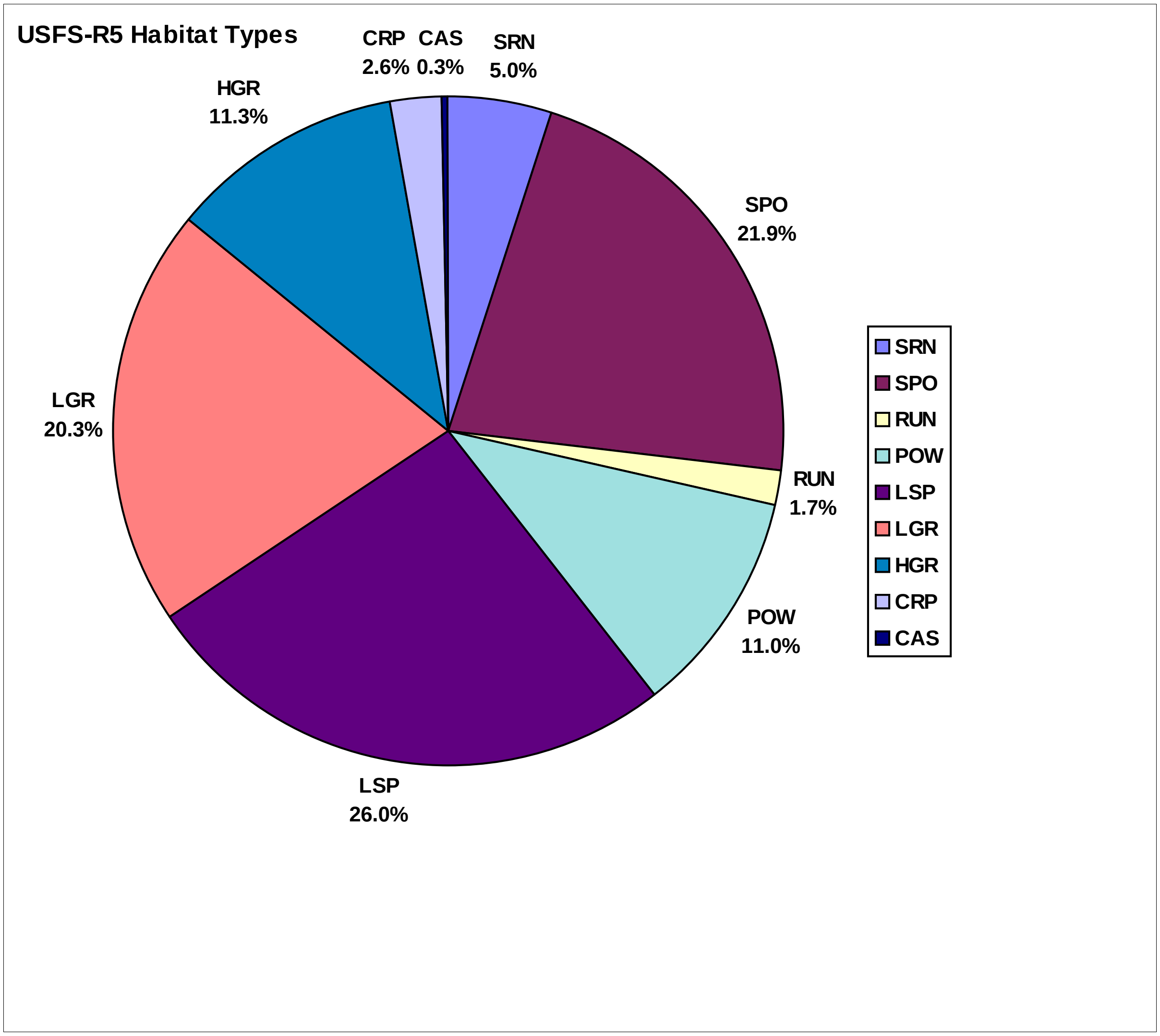


Figure CAWG 1-8. USFS-R5 Habitat Types for SFSJR Rattlesnake Crossing to Mono Crossing.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River ds of Rattlesnake X to Mono X Reach

Rosgen 1 Channel Type = G

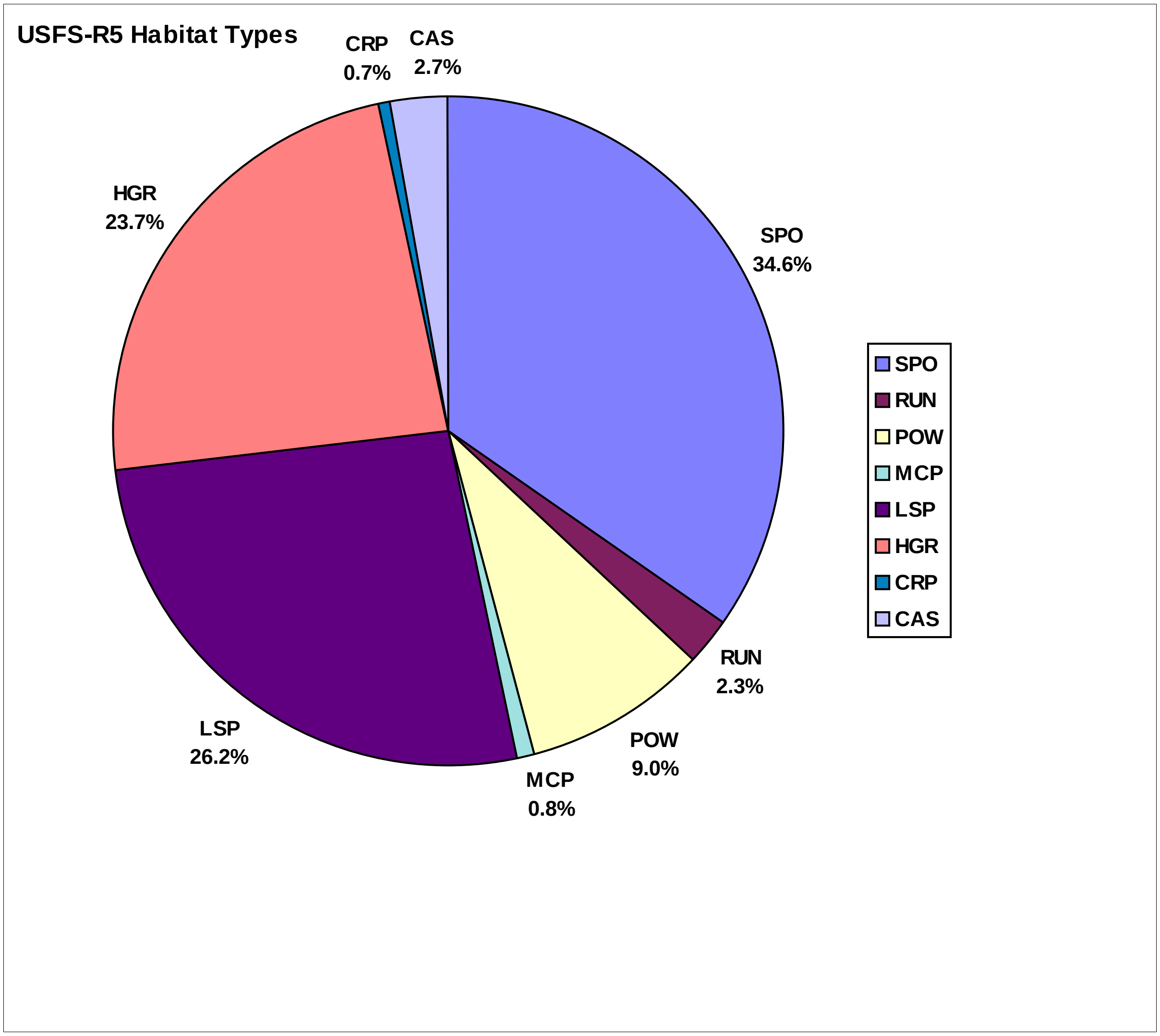


Figure CAWG 1-8. USFS-R5 Habitat Types for SFSJR Rattlesnake Crossing to Mono Crossing (cont).

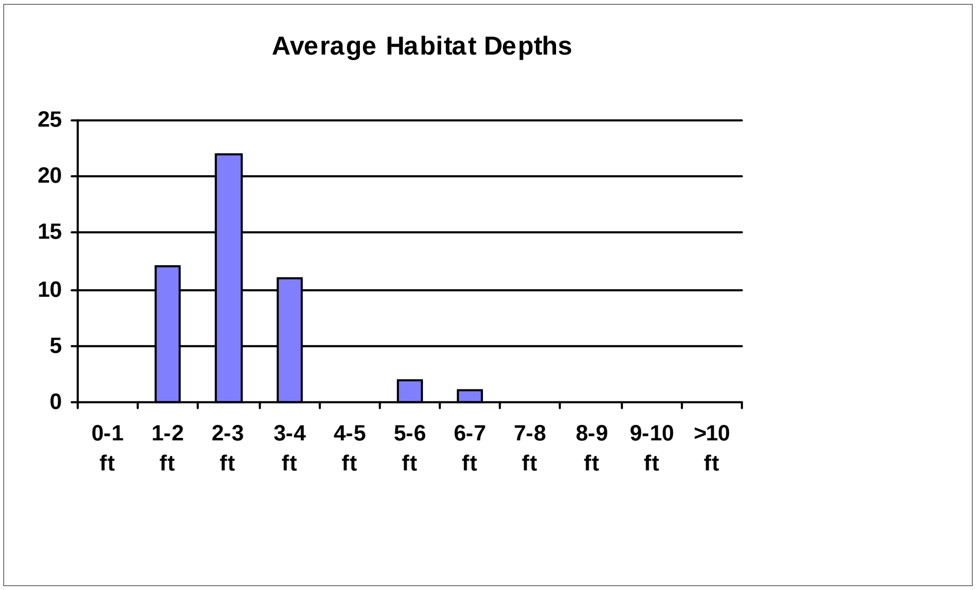
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River ds of Rattlesnake X to Mono X Reach SFSJR2_



B Channel Type

Figure CAWG 1-9. Average Habitat Depth Histograms for SFSJR Rattlesnake Crossing to Mono Crossing (1 foot bin size, frequency = number of pools).

Data collected starting on 8/30/2000.

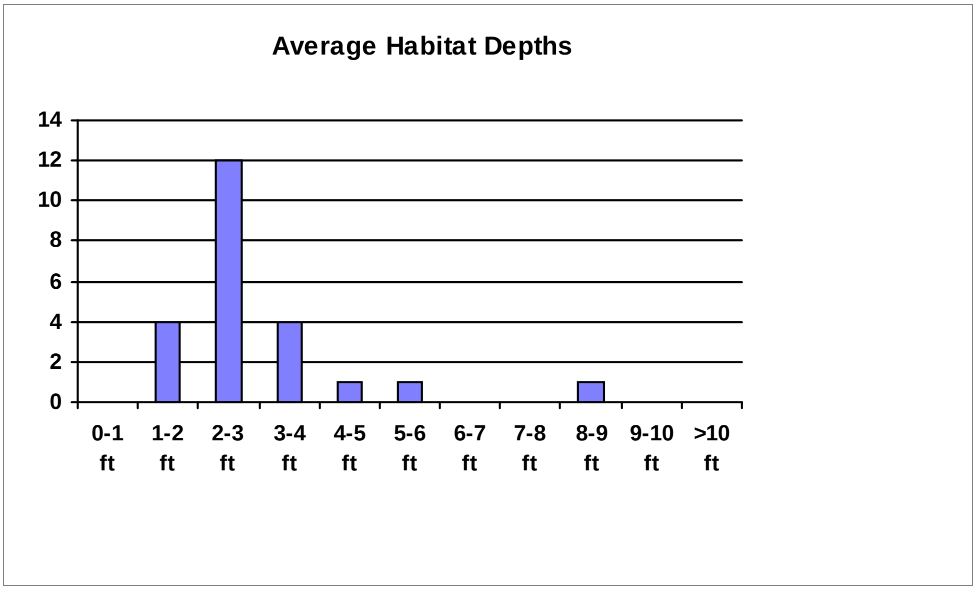
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River ds of Rattlesnake X to Mono X Reach SFSJR2_



G Channel Type

Figure CAWG 1-9. Average Habitat Depth Histograms for SFSJR Rattlesnake Crossing to Mono Crossing (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/30/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River us of Hoffman Creek to ds of Rattlesnake Crossing

Rosgen 1 Channel Type = G

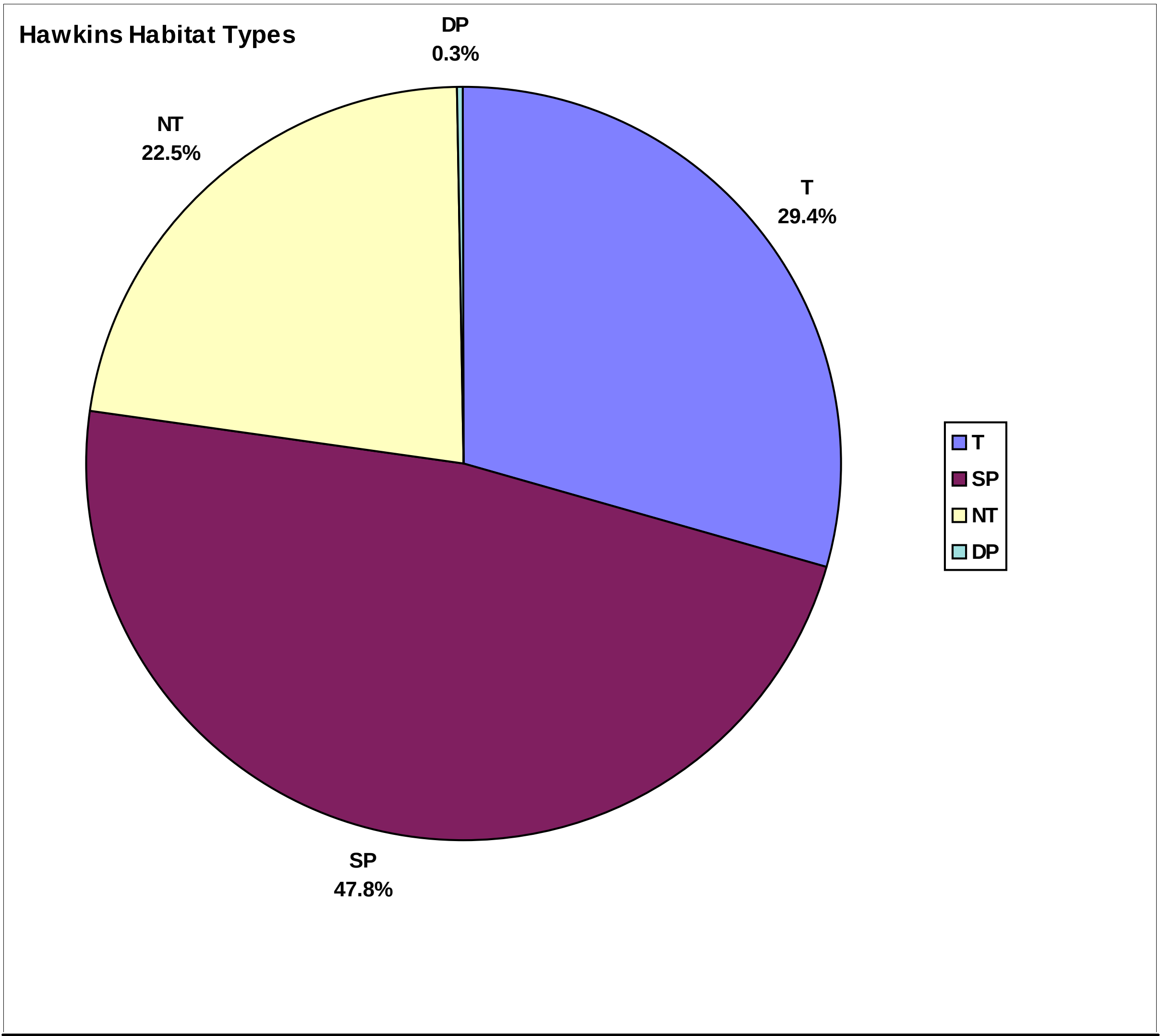


Figure CAWG 1-10. Hawkins Habitat Types for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

SF San Joaquin River

SF San Joaquin River us of Hoffman Creek to ds of Rattlesnake Crossing

Rosgen 1 Channel Type = G

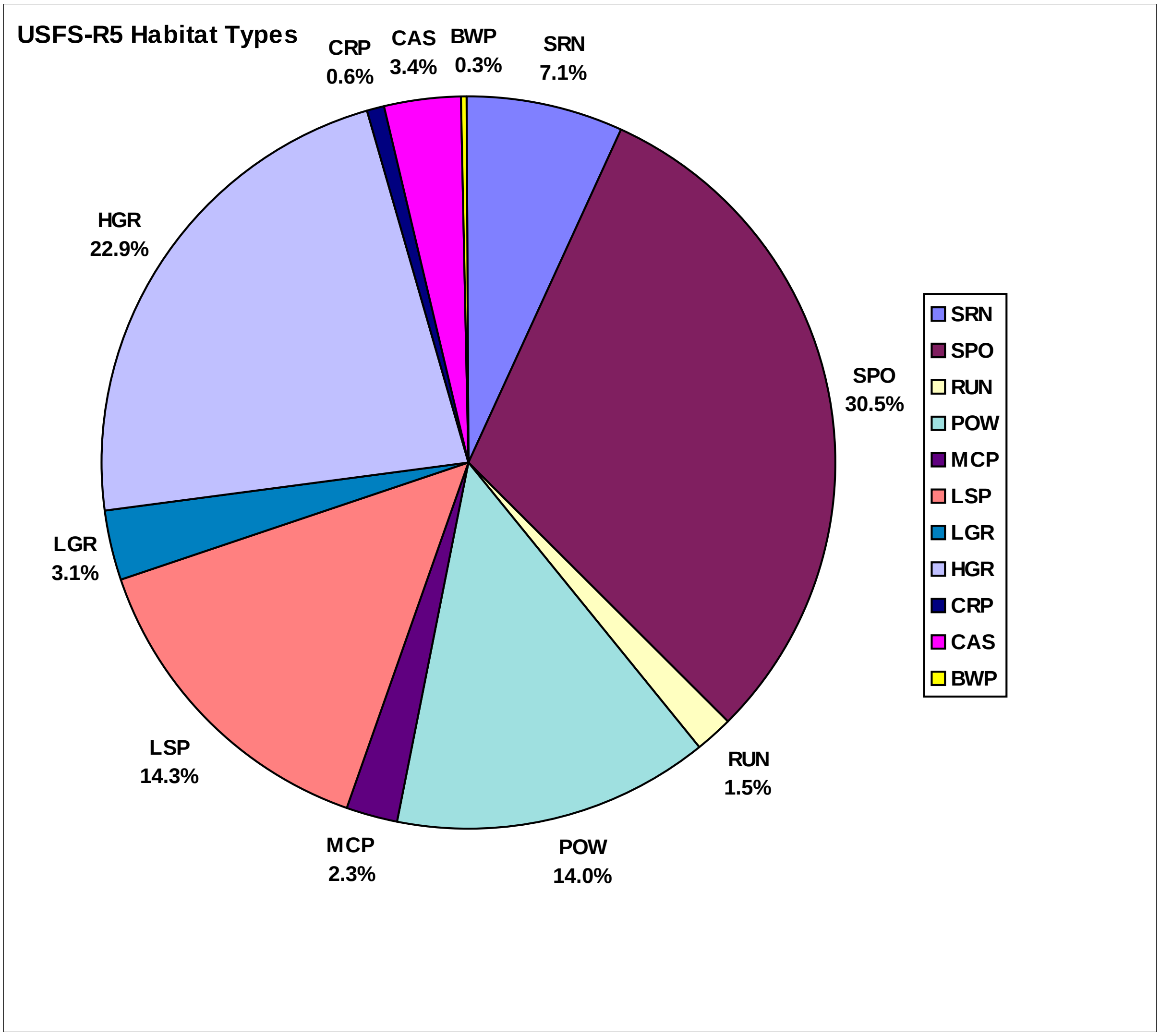


Figure CAWG 1-11. USFS-R5 Habitat Types for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing.

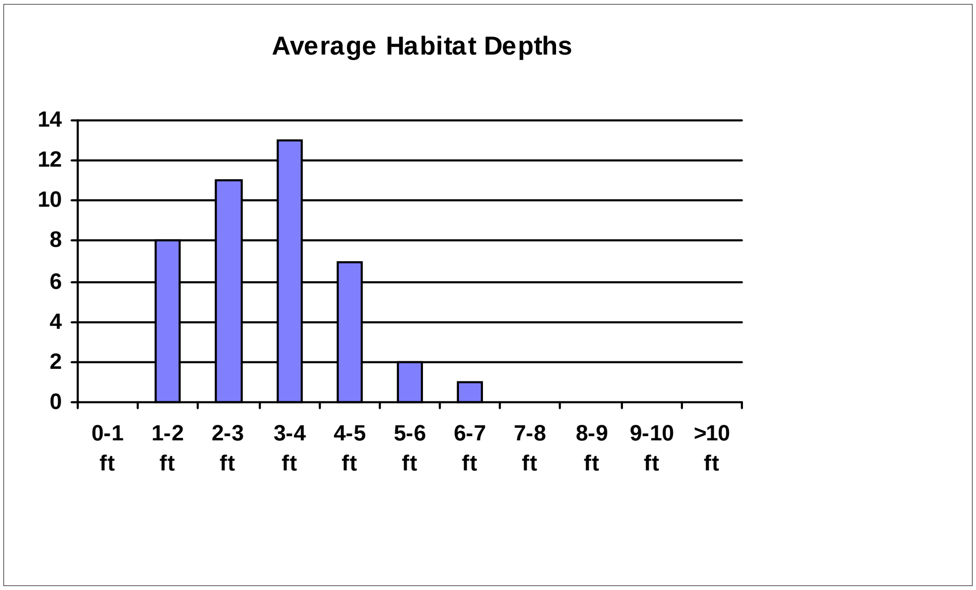
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

SF San Joaquin River SFSJR

SF San Joaquin River us of Hoffman Creek to ds of Rattlesnake Crossing



G Channel Type

Figure CAWG 1-12. Average Habitat Depth Histograms for SFSJR us of Hoffman Creek to ds of Rattlesnake Crossing (1 foot bin size, frequency = number of pools).

Data collected starting on 9/13/2000.

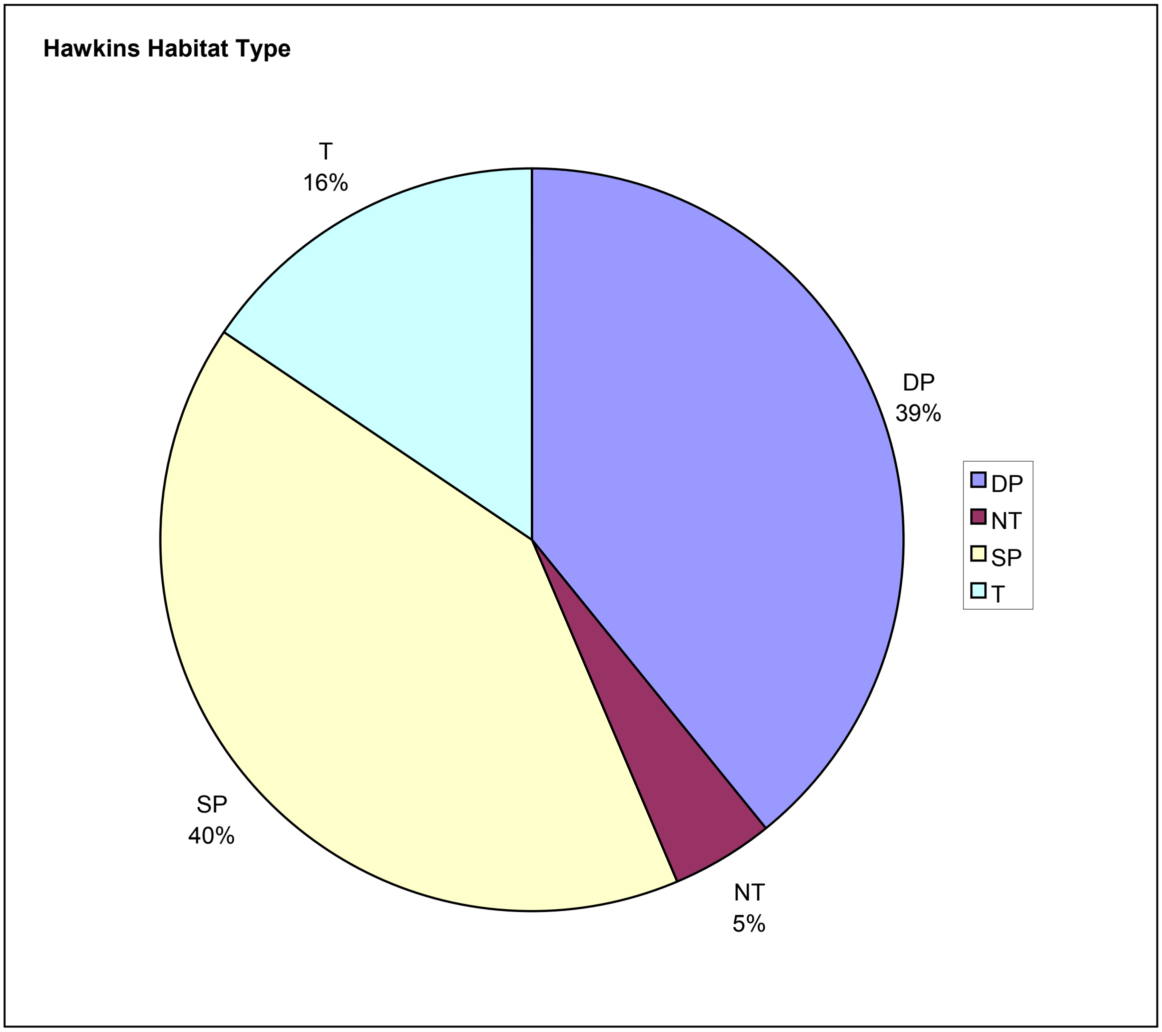
Hawkins Habitat Types by Channel Type

South Fork San Joaquin River Reach (Basin)

South Fork San Joaquin River

South Fork San Joaquin River SJR Confluence to Upstream of Hoffman Crk Reach

Rosgen 1 Channel Type = B



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Figure CAWG 1-13. Hawkins Habitat Types for SFSJR, SJR Confluence to Upstream of Hoffman Creek.

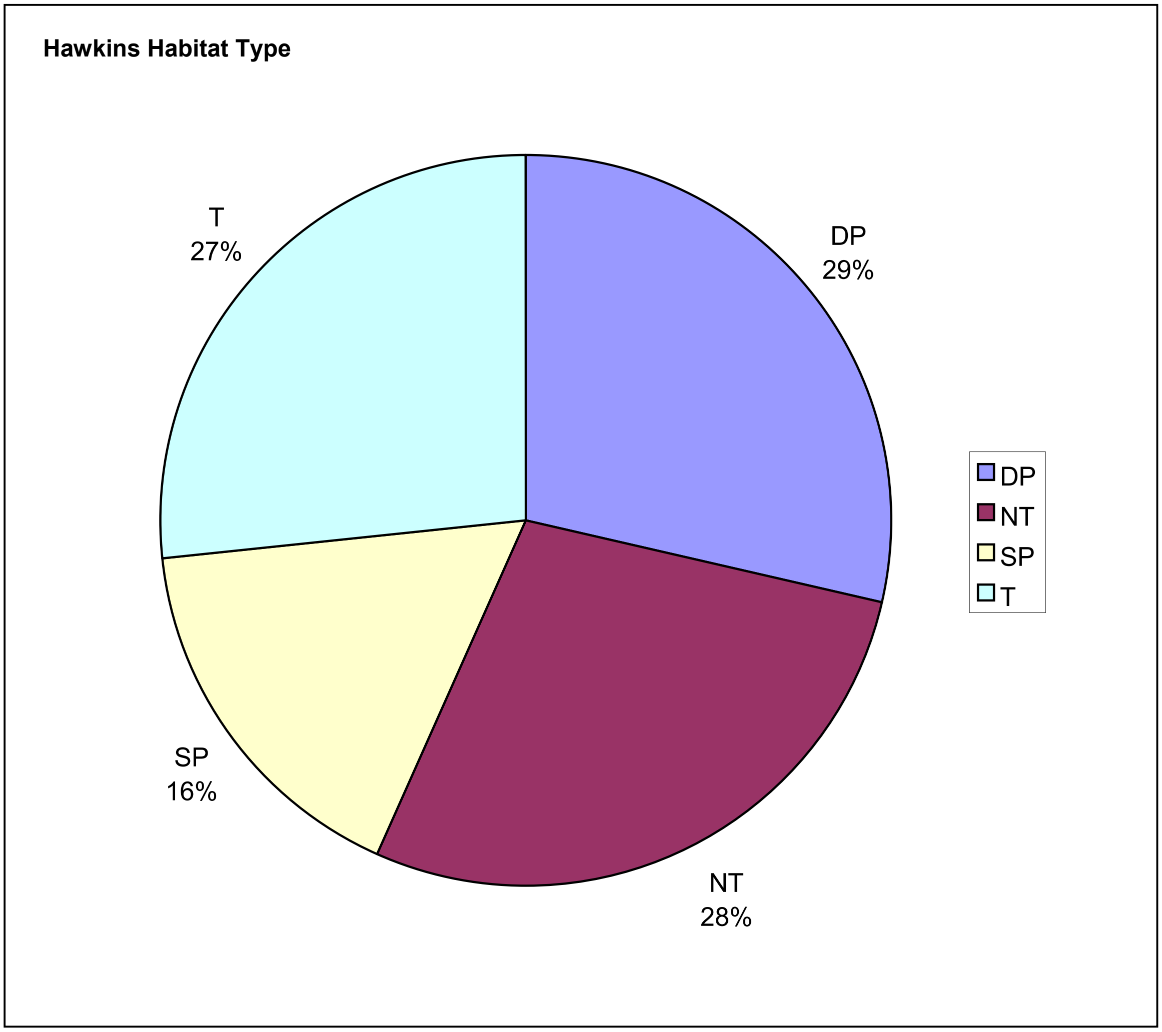
Hawkins Habitat Types by Channel Type

South Fork San Joaquin River Reach (Basin)

South Fork San Joaquin River

South Fork San Joaquin River SJR Confluence to Upstream of Hoffman Crk Reach

Rosgen 1 Channel Type = G



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Note: 6.4 river miles of mesohabitat was visually estimated from aerial photography and overflight.

Figure CAWG 1-13. Hawkins Habitat Types for SFSJR, SJR Confluence to Upstream of Hoffman Creek (cont).

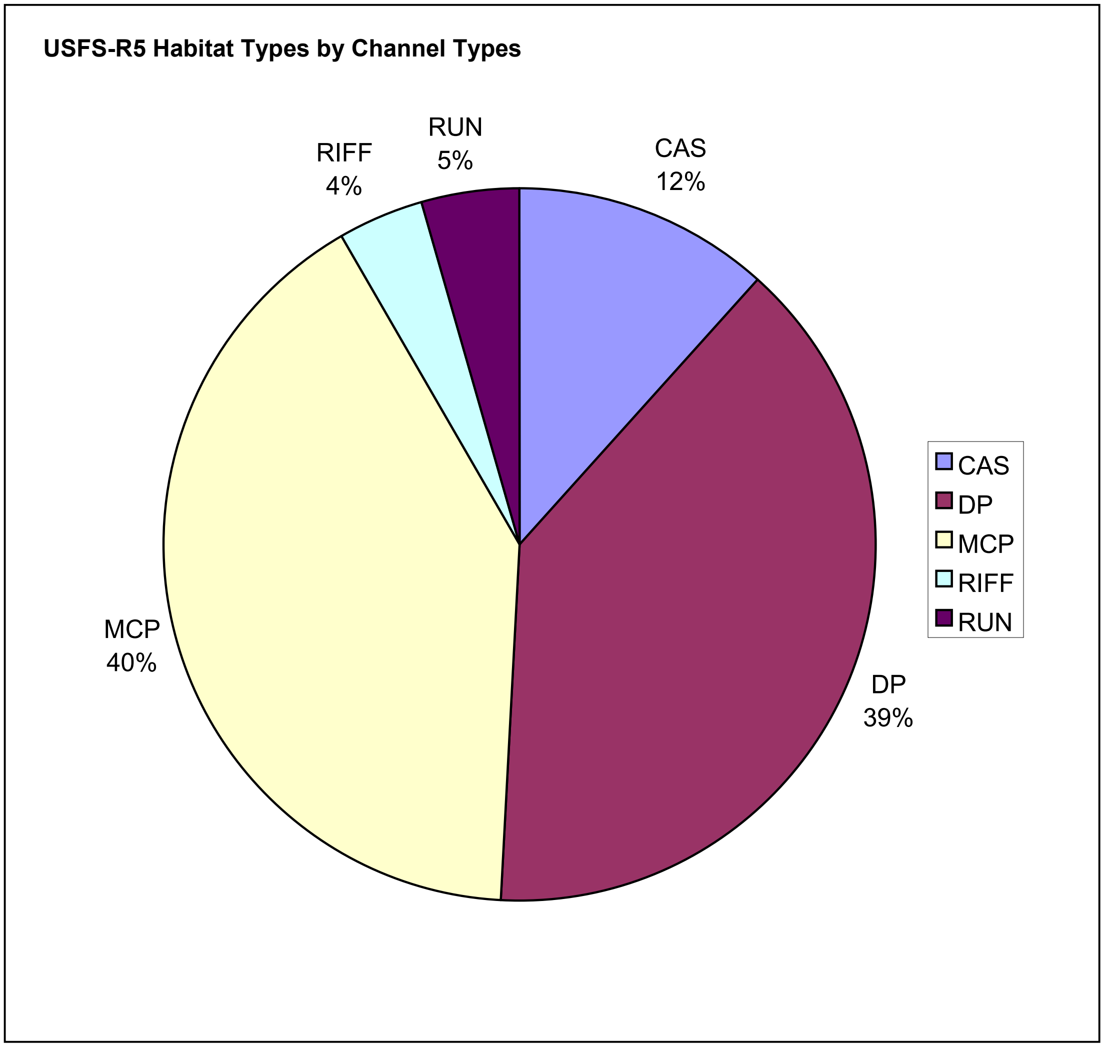
USFS R5 Habitat Types by Channel Type

South Fork San Joaquin River Reach (Basin)

South Fork San Joaquin River

South Fork San Joaquin River SJR Confluence to Upstream of Hoffman Crk Reach

Rosgen 1 Channel Type = B



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Figure CAWG 1-14. USFS-R5 Habitat Types for SFSJR, SJR Confluence to Upstream of Hoffman Creek.

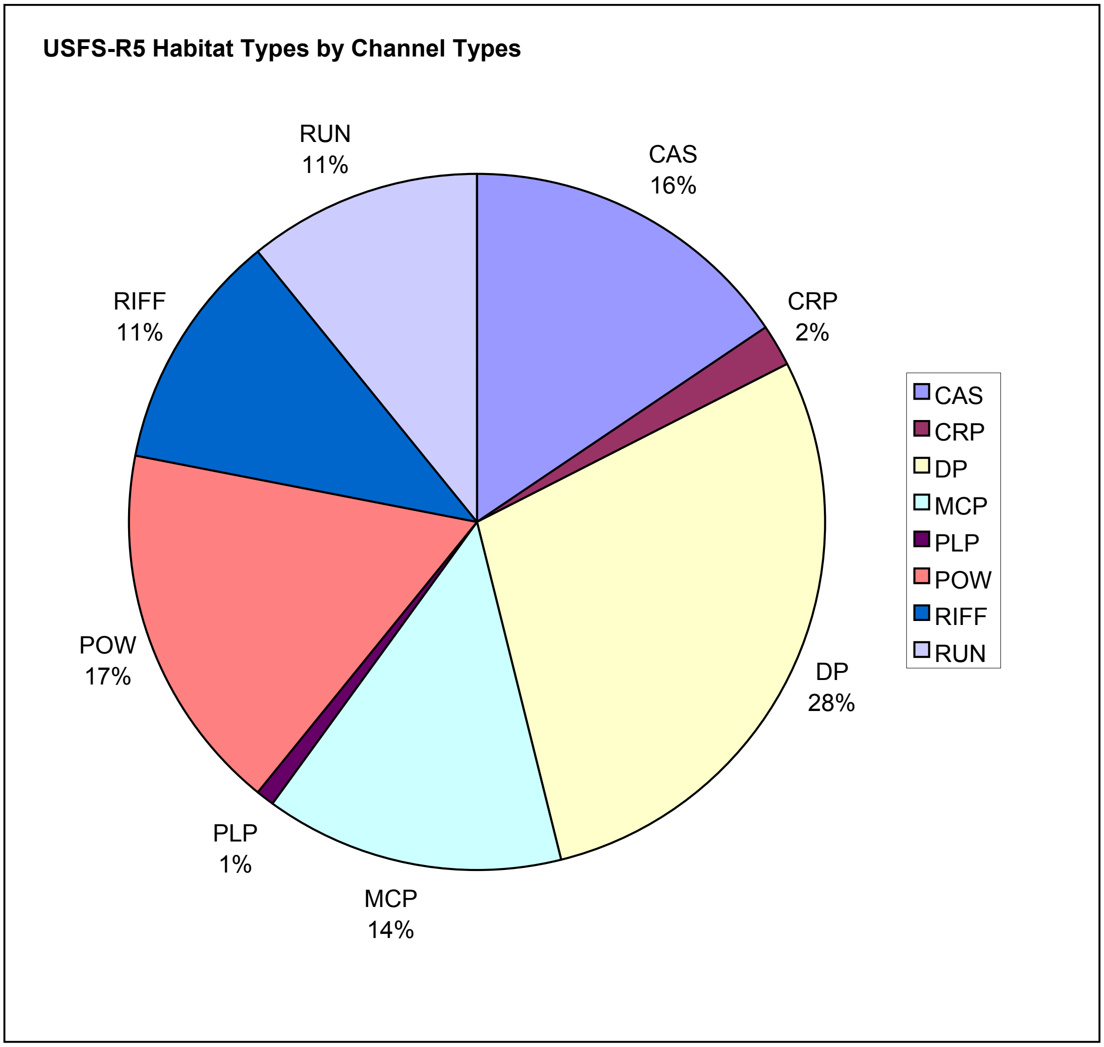
USFS R5 Habitat Types by Channel Type

South Fork San Joaquin River Reach (Basin)

South Fork San Joaquin River

South Fork San Joaquin River SJR Confluence to Upstream of Hoffman Crk Reach

Rosgen 1 Channel Type = G



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Note: 6.4 river miles of mesohabitat was visually estimated from aerial photography and overflight.

Figure CAWG 1-14. USFS-R5 Habitat Types for SFSJR, SJR Confluence to Upstream of Hoffman Creek (cont).

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek AD Reach

Rosgen 1 Channel Type = Aa+

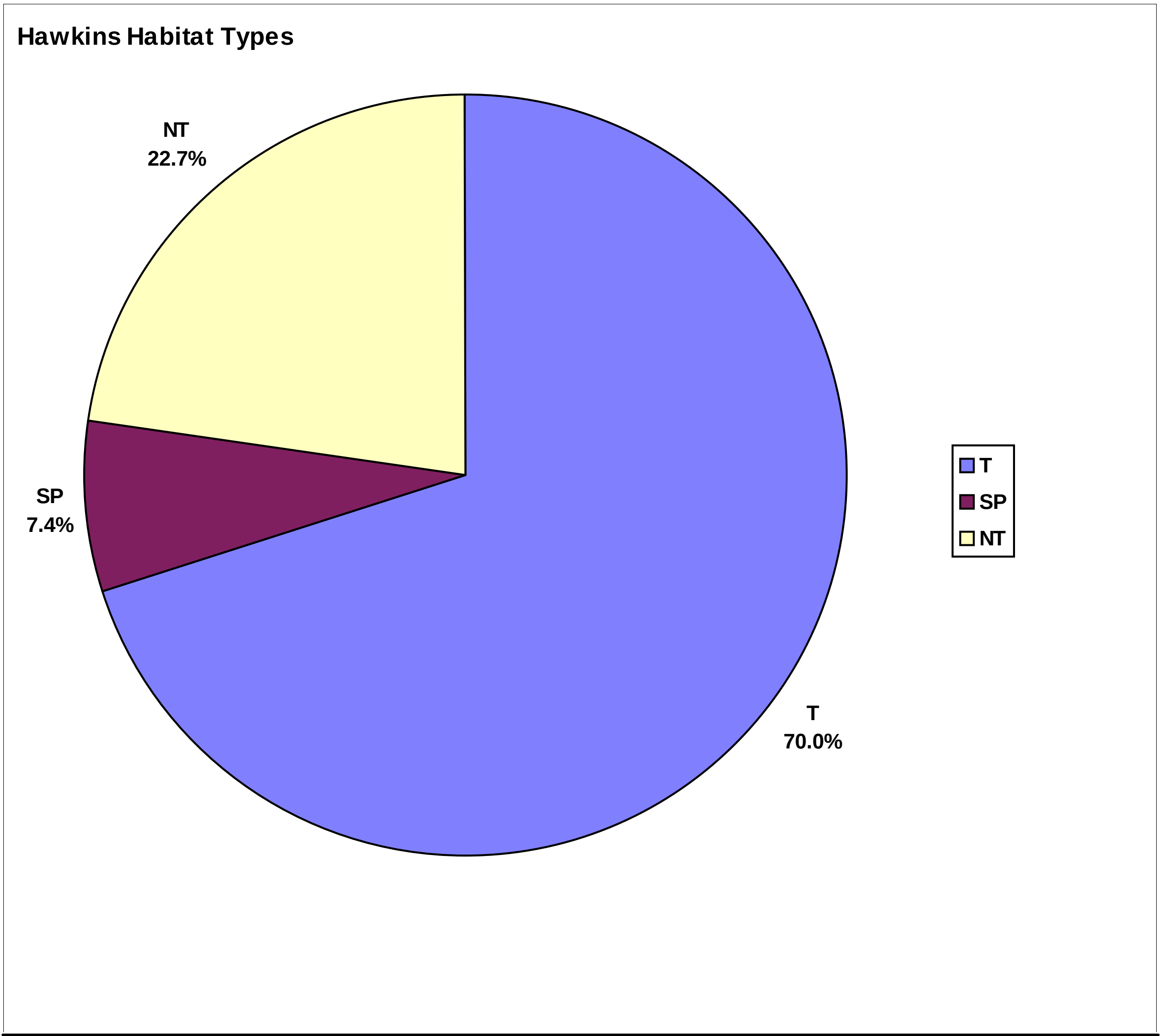


Figure CAWG 1-15. Hawkins Habitat Types for Tombstone Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek BD Reach

Rosgen 1 Channel Type = Aa+

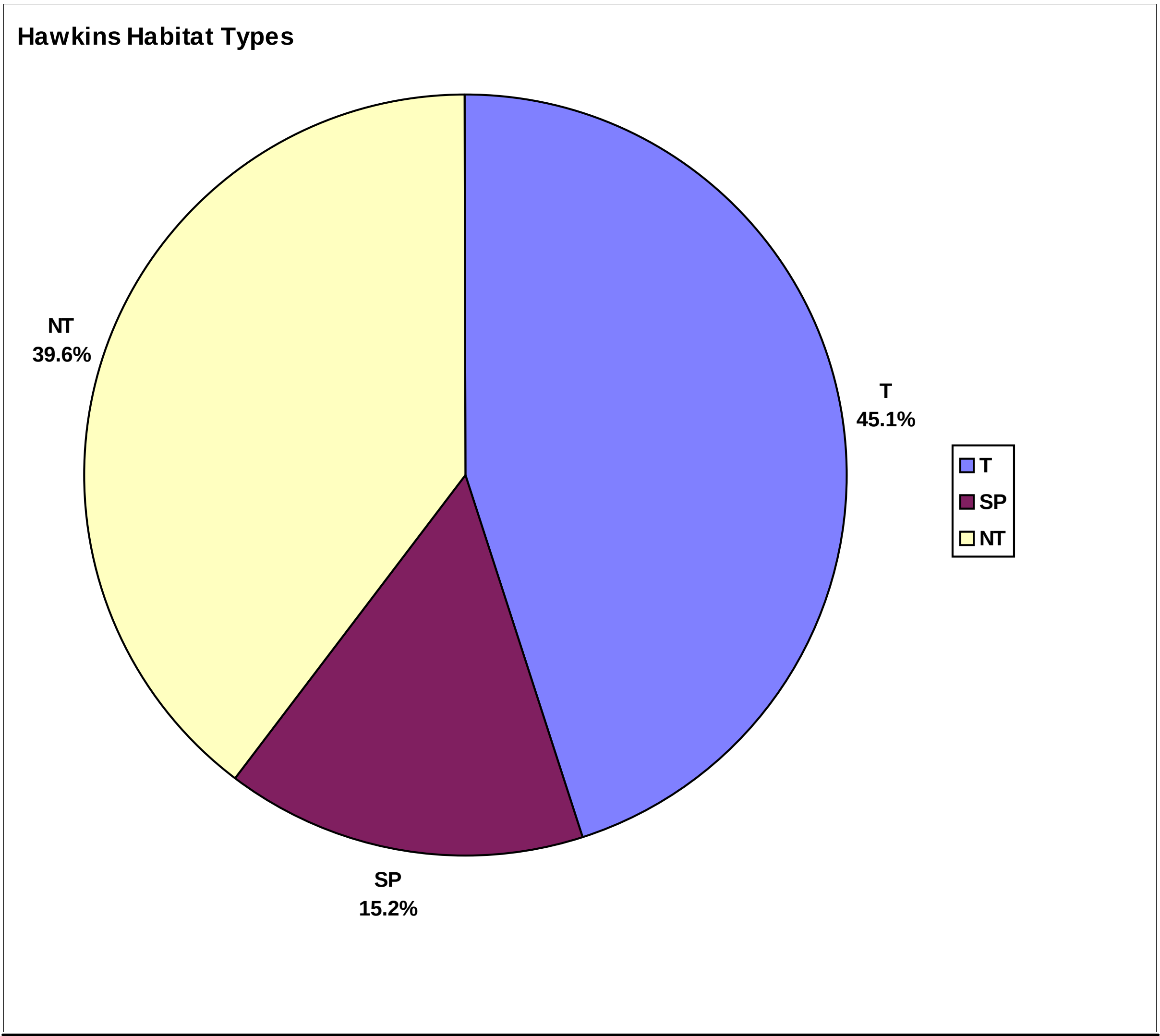


Figure CAWG 1-15. Hawkins Habitat Types for Tombstone Creek (cont).

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek BD Reach

Rosgen 1 Channel Type = C/E

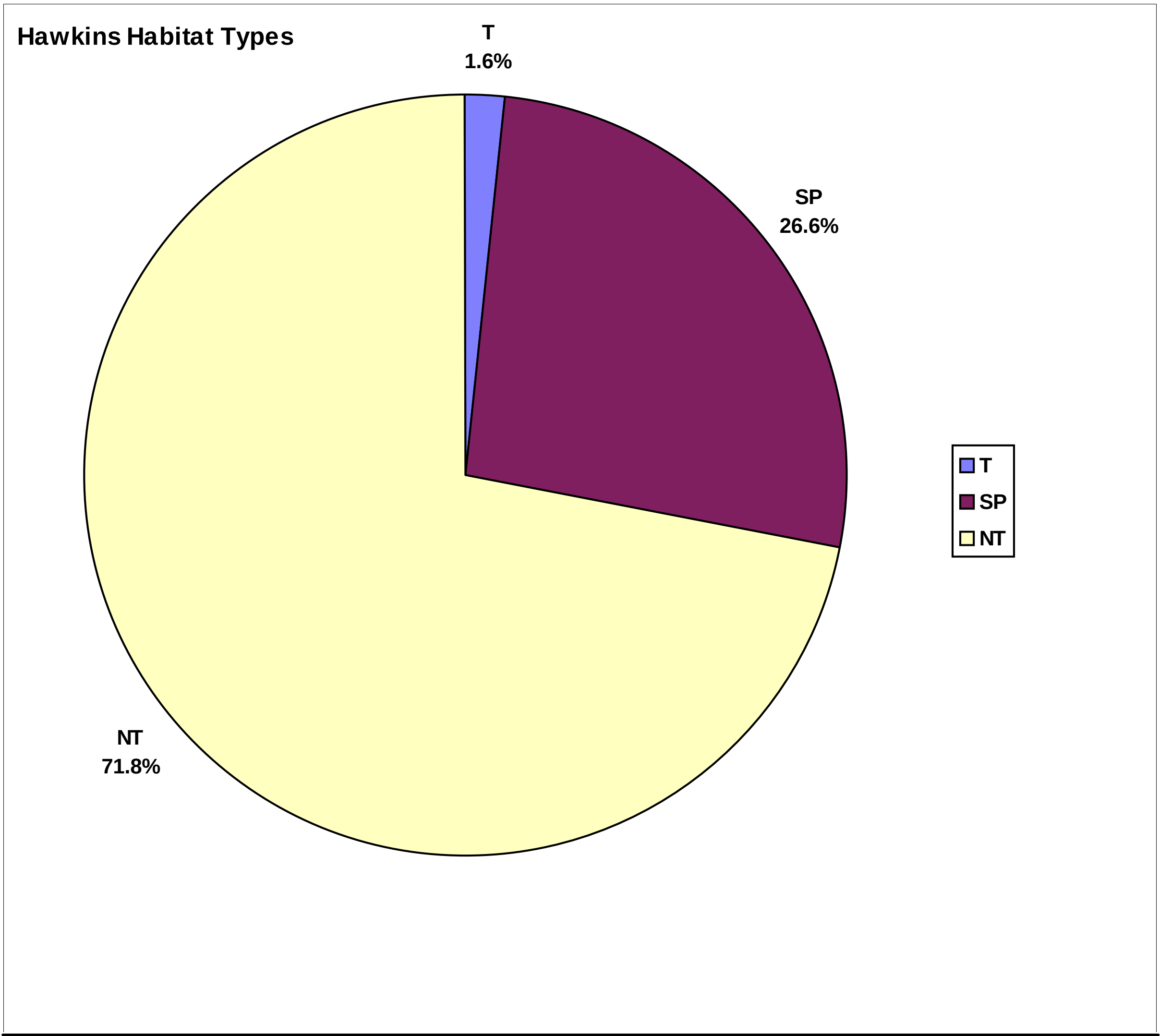


Figure CAWG 1-15. Hawkins Habitat Types for Tombstone Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek AD Reach

Rosgen 1 Channel Type = Aa+

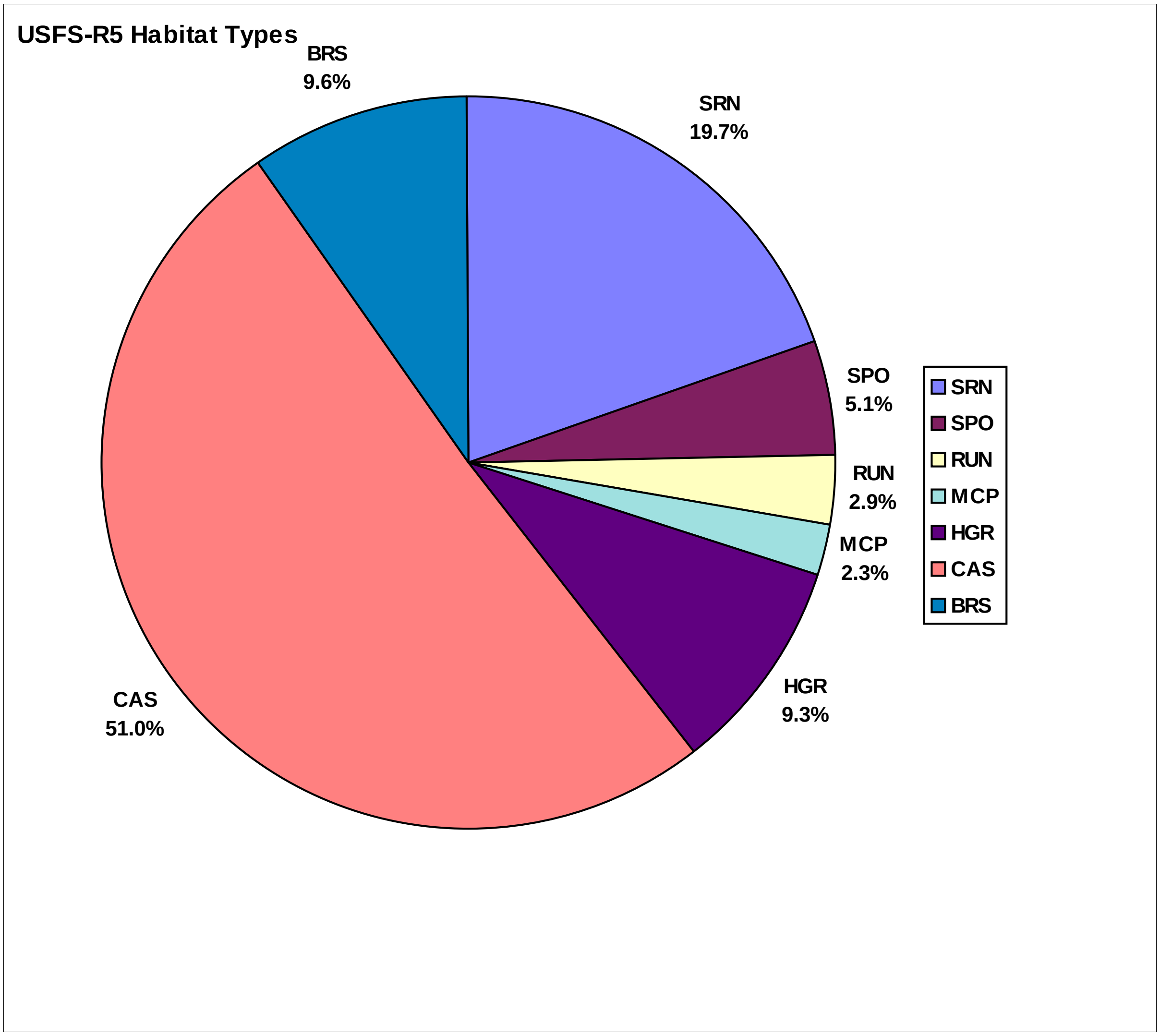


Figure CAWG 1-16. USFS-R5 Habitat Types for Tombstone Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek BD Reach

Rosgen 1 Channel Type = Aa+

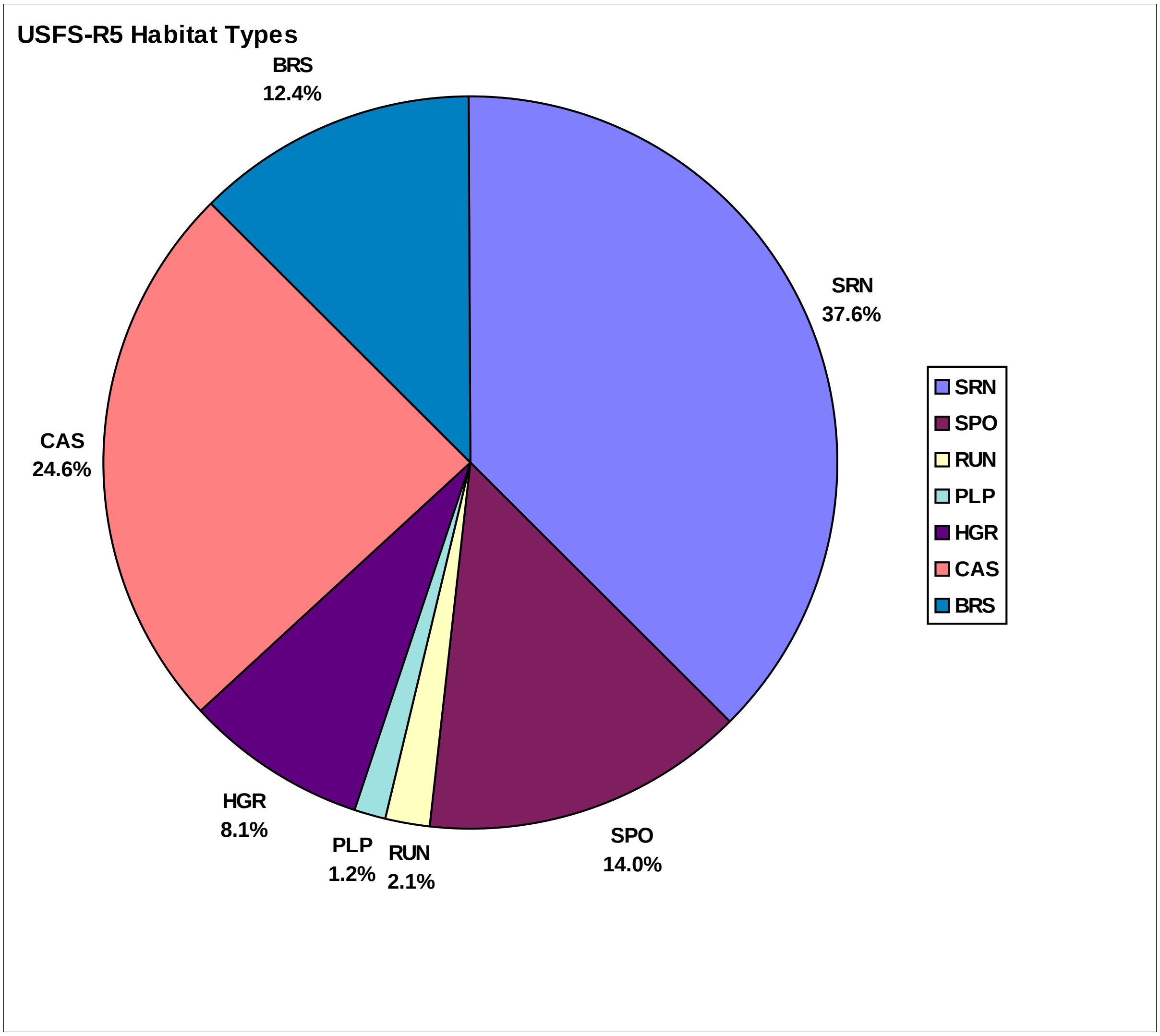


Figure CAWG 1-16. USFS-R5 Habitat Types for Tombstone Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Tombstone Creek

Tombstone Creek BD Reach

Rosgen 1 Channel Type = C/E

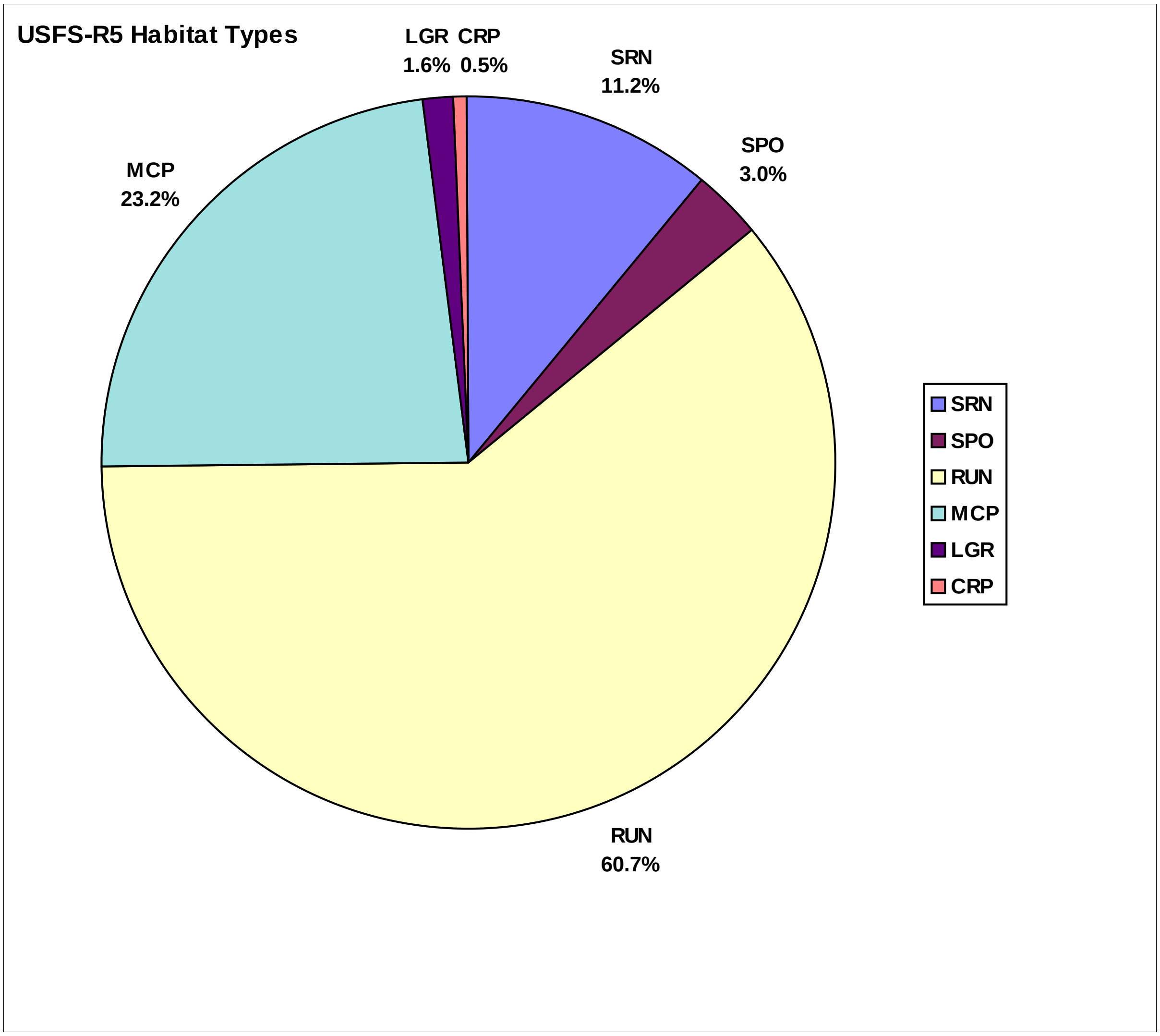


Figure CAWG 1-16. USFS-R5 Habitat Types for Tombstone Creek (cont).

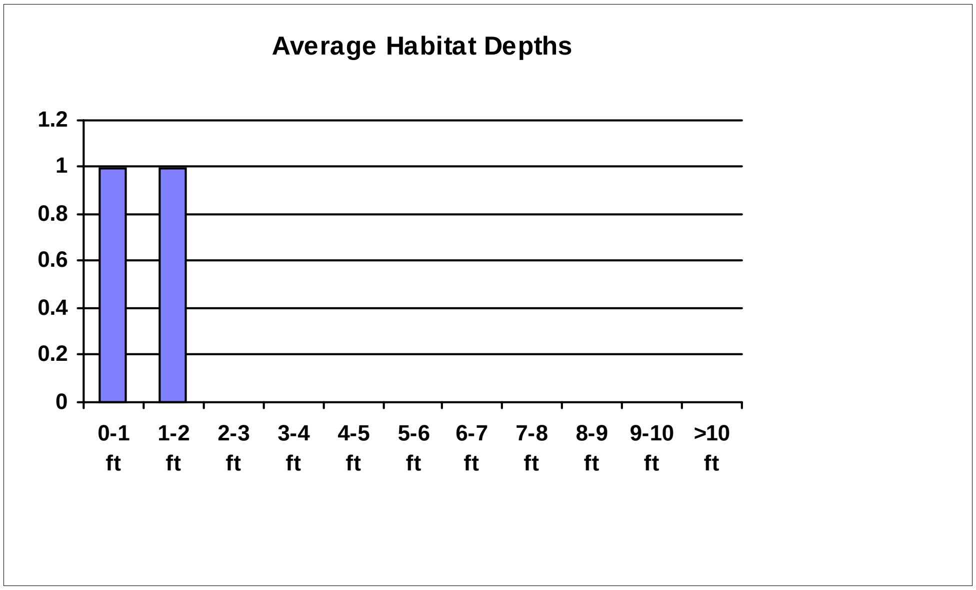
Recorded Average Habitat Depth Histograms

1 foot bin size

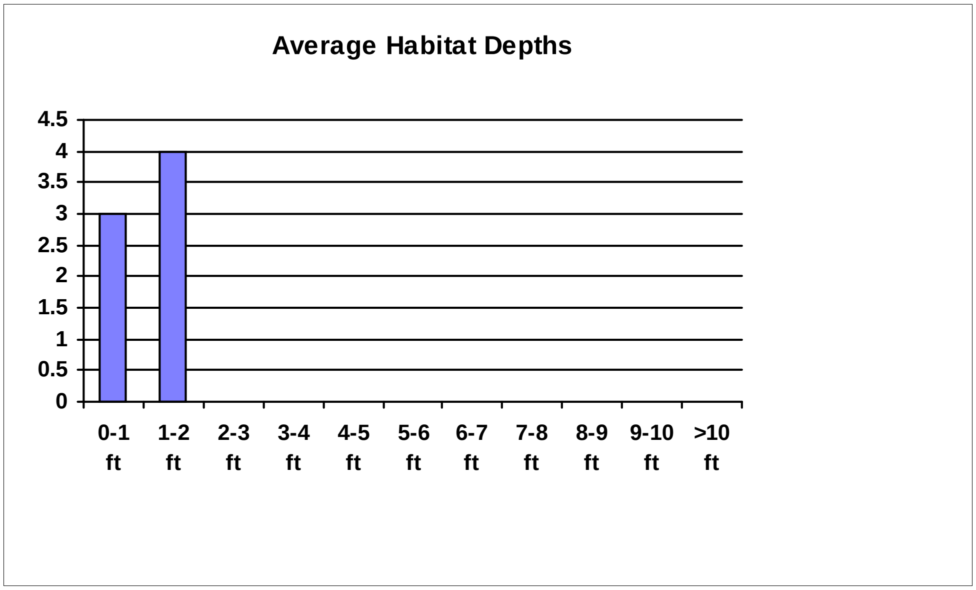
South Fork San Joaquin River (Basin) BAS_SF

Tombstone Creek ToC

Tombstone Creek AD Reach ToCAD_



Tombstone Creek BD Reach ToC_R



Aa+ Channel Type

Figure CAWG 1-17 Average Habitat Depth Histograms for Tombstone Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/11/2000 Above Diversion and 7/10/2000 Below Diversion.

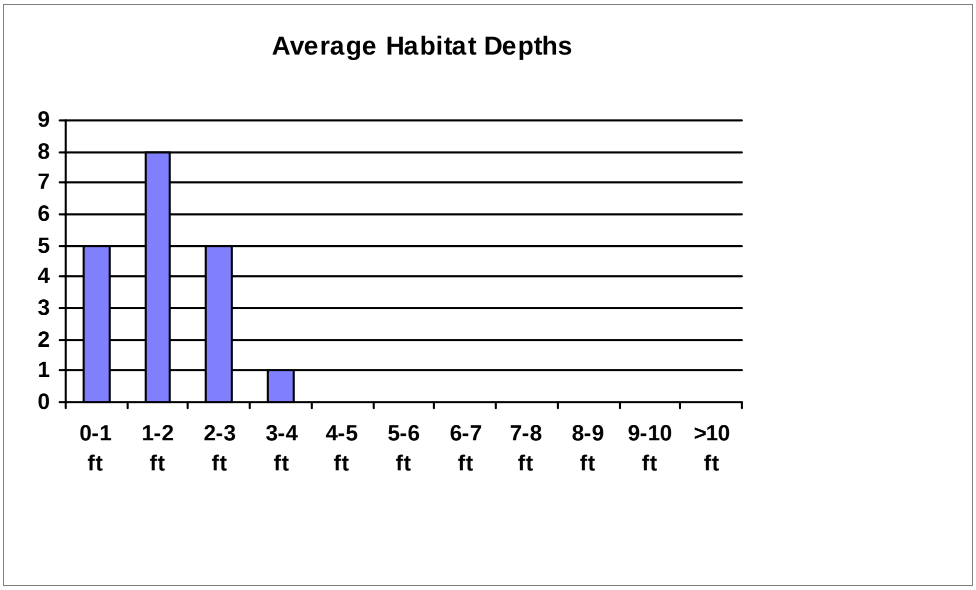
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Tombstone Creek ToC

Tombstone Creek BD Reach ToC_R



C/E Channel Type

Figure CAWG 1-17 Average Habitat Depth Histograms for Tombstone Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 7/10/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

South Slide Creek

South Slide Creek Reach

Rosgen 1 Channel Type = Aa+

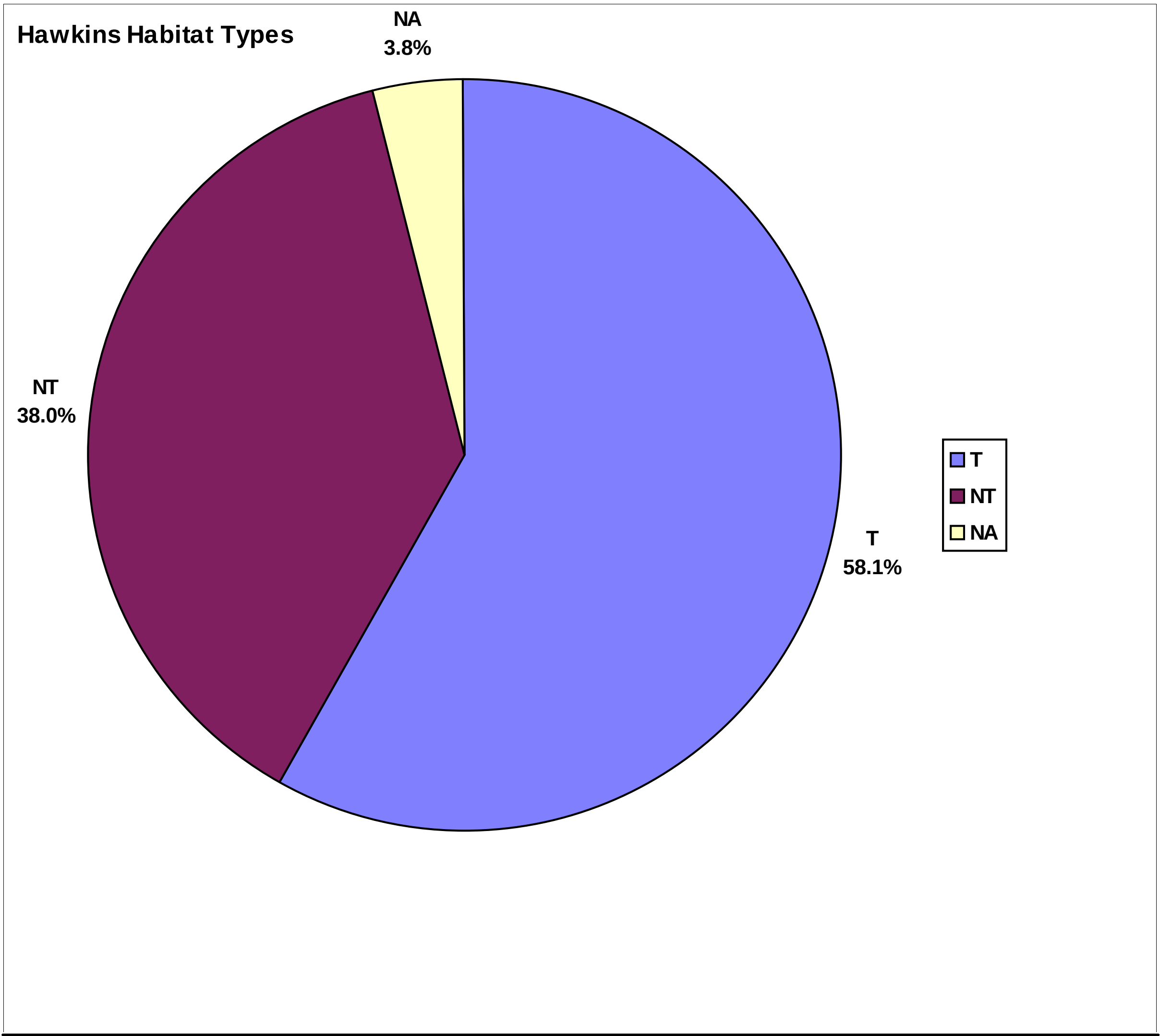


Figure CAWG 1-18. Hawkins Habitat Types for South Slide Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

South Slide Creek

South Slide Creek Reach

Rosgen 1 Channel Type = Aa+

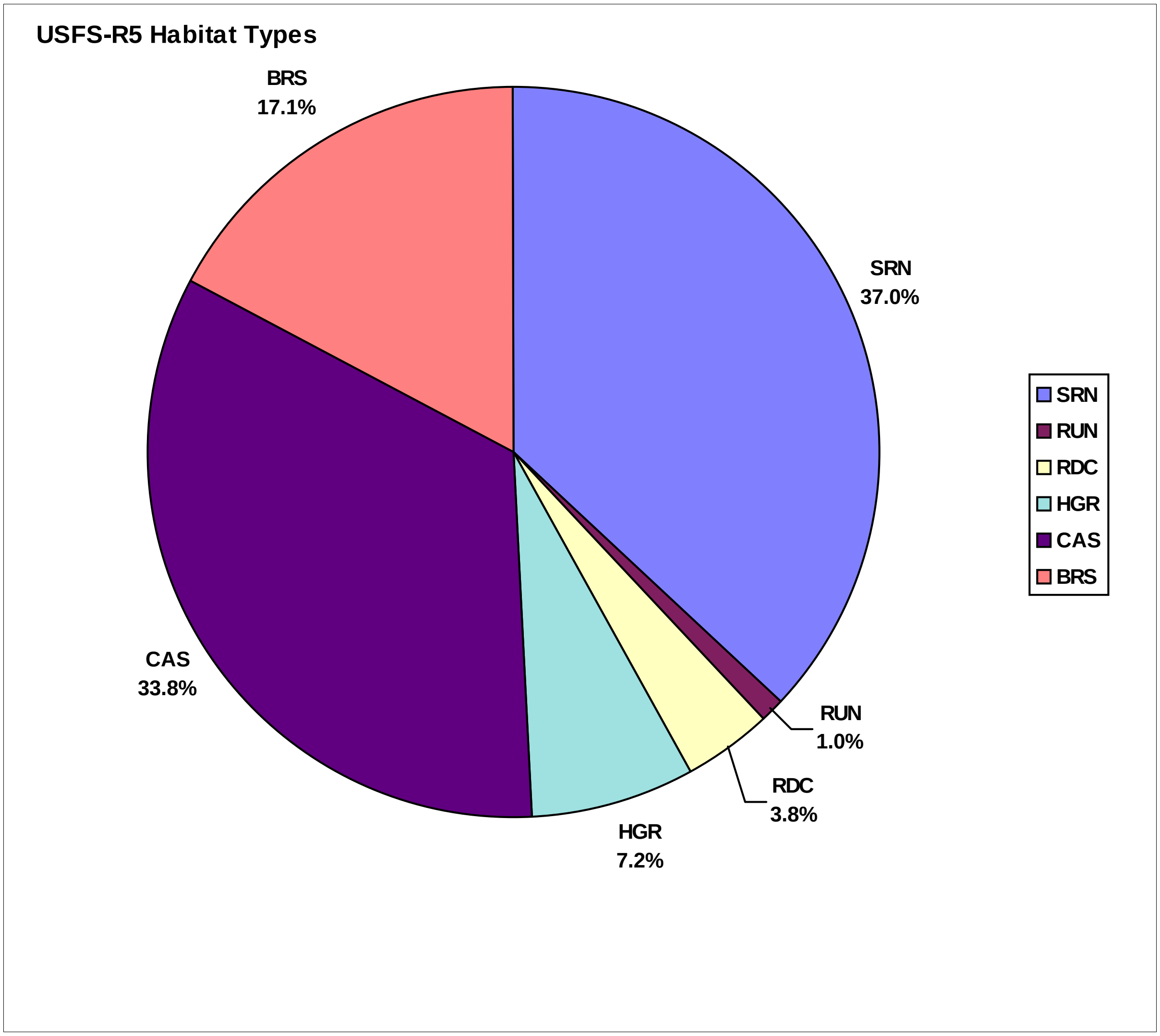


Figure CAWG 1-19. USFS-R5 Habitat Types for South Slide Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

North Slide Creek

North Slide Creek Reach

Rosgen 1 Channel Type = Aa+

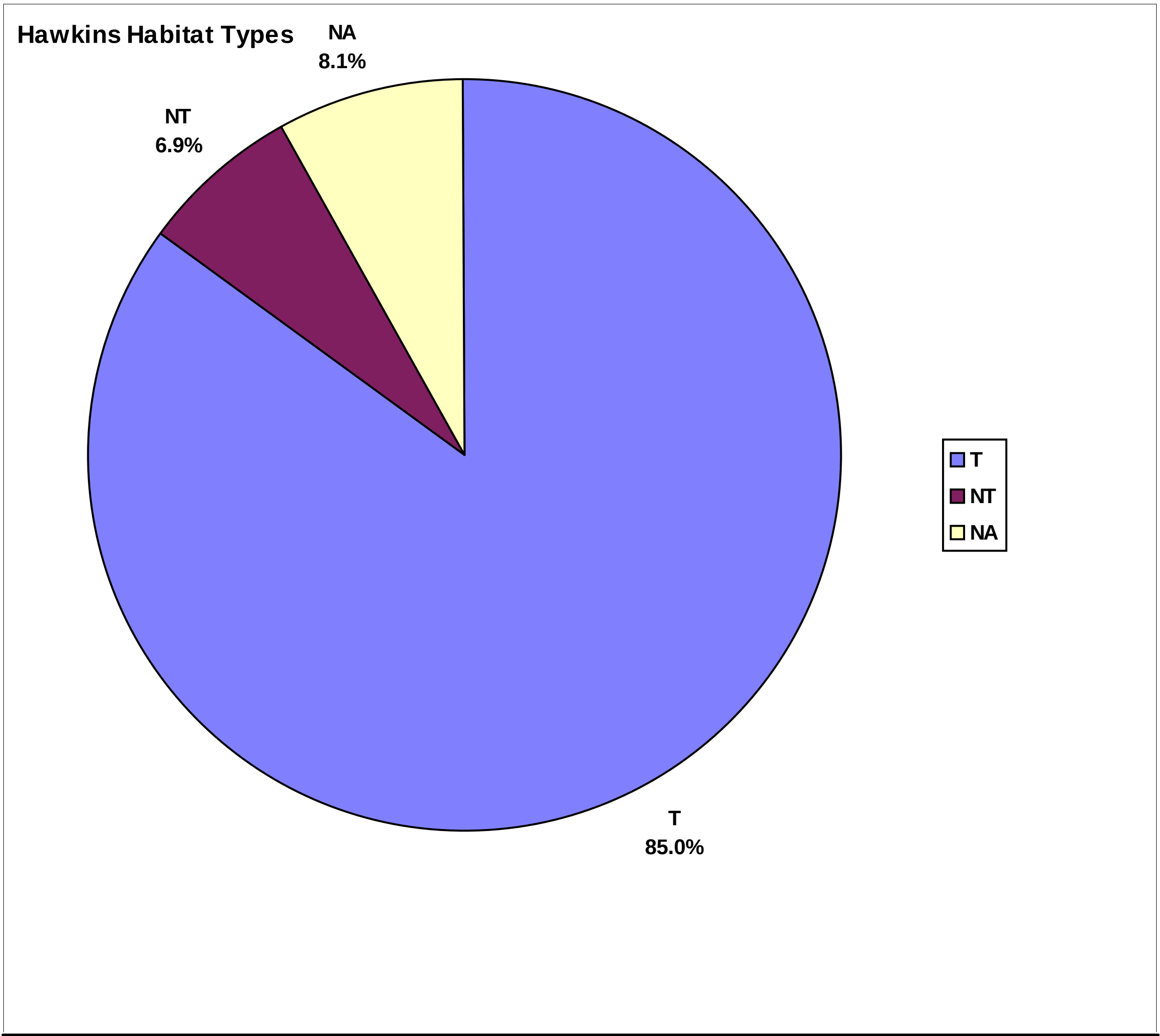


Figure CAWG 1-20. Hawkins Habitat Types for North Slide Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

North Slide Creek

North Slide Creek Reach

Rosgen 1 Channel Type = Aa+

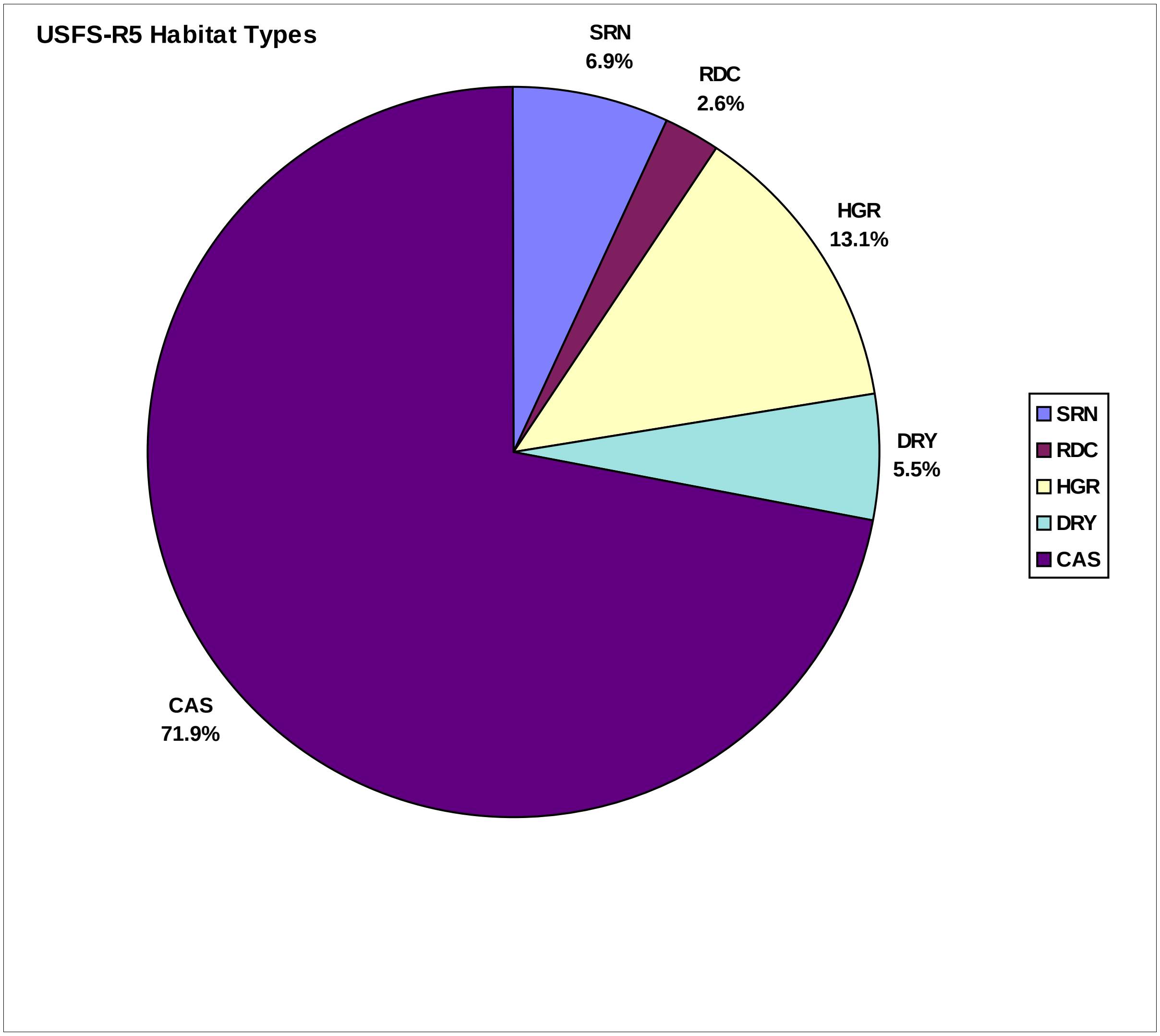


Figure CAWG 1-21. USFS-R5 Habitat Types for North Slide Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Hooper Creek

Hooper Creek AD Reach

Rosgen 1 Channel Type = Aa+

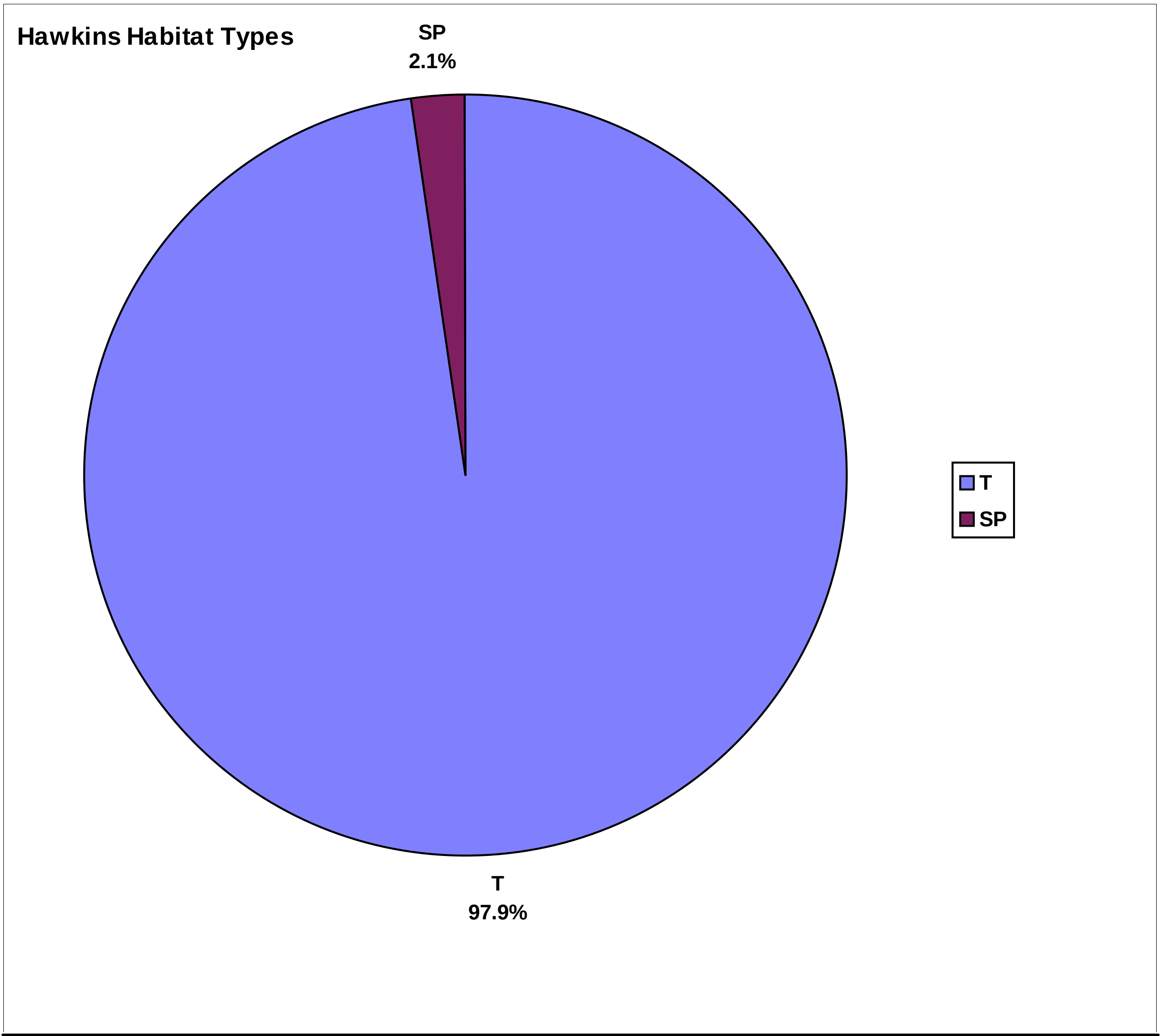


Figure CAWG 1-22. Hawkins Habitat Types for Hooper Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Hooper Creek

Hooper Creek BD Reach

Rosgen 1 Channel Type = Aa+

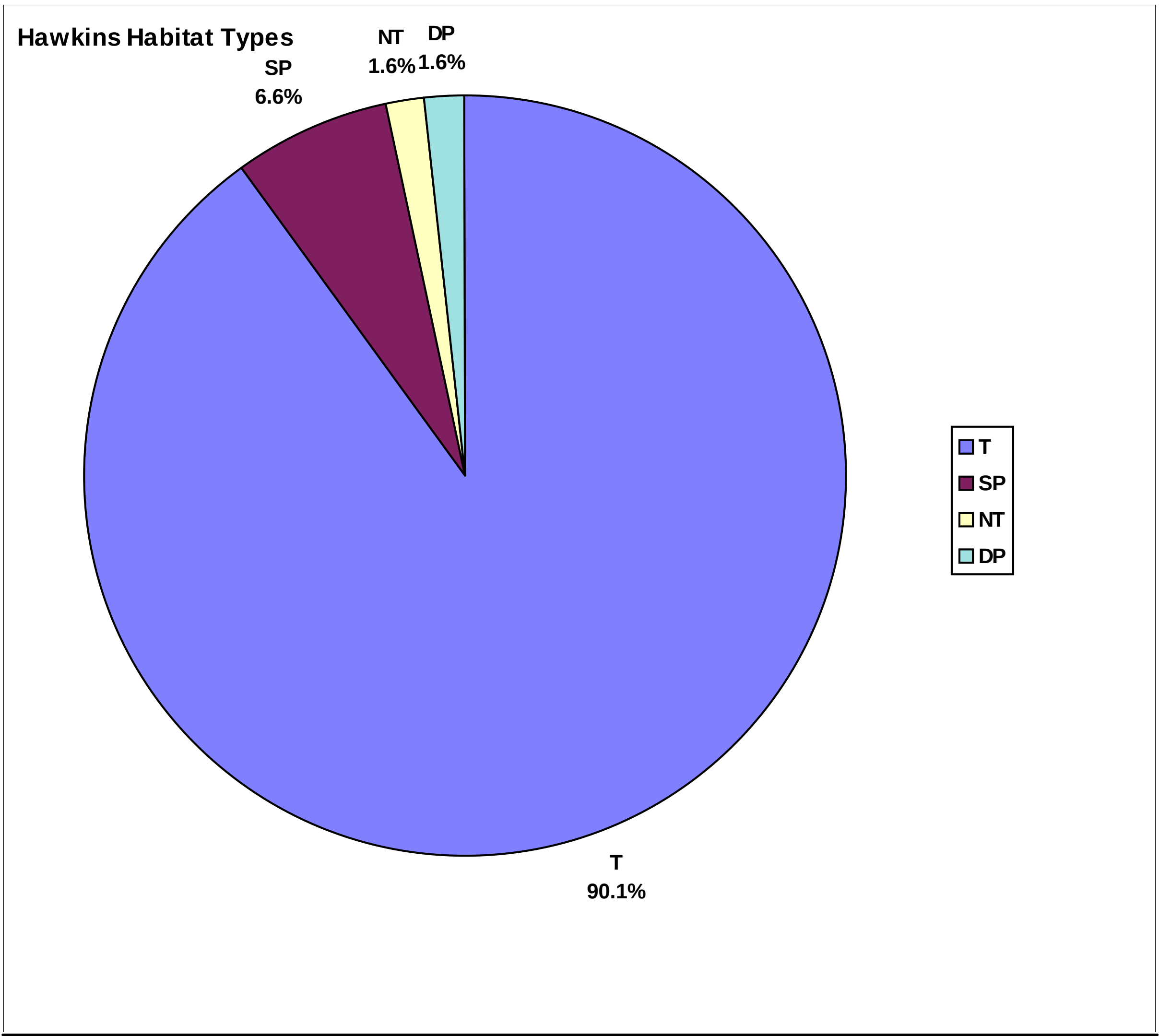


Figure CAWG 1-22. Hawkins Habitat Types for Hooper Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Hooper Creek

Hooper Creek AD Reach

Rosgen 1 Channel Type = Aa+

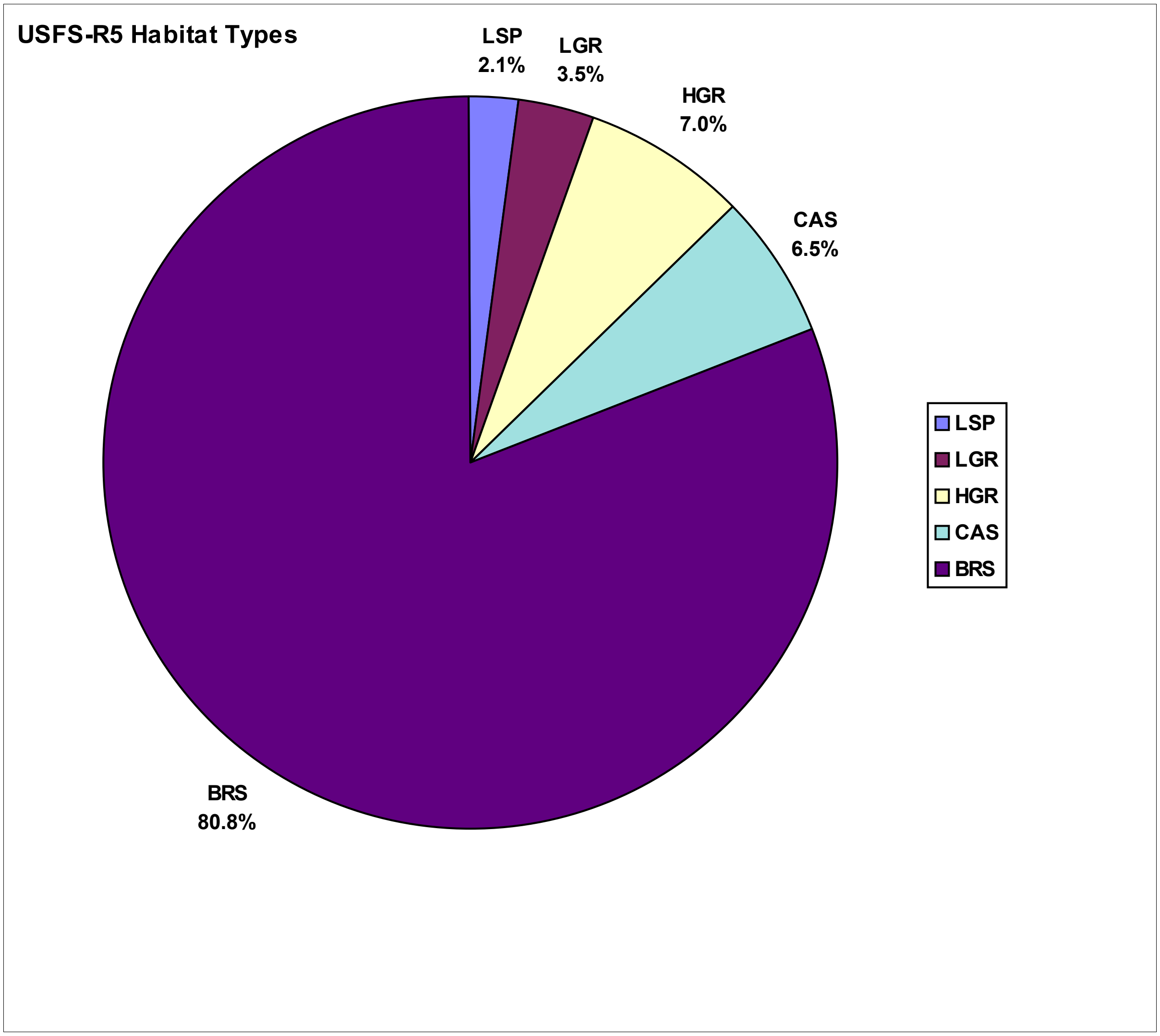


Figure CAWG 1-23. USFS-R5 Habitat Types for Hooper Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Hooper Creek

Hooper Creek BD Reach

Rosgen 1 Channel Type = Aa+

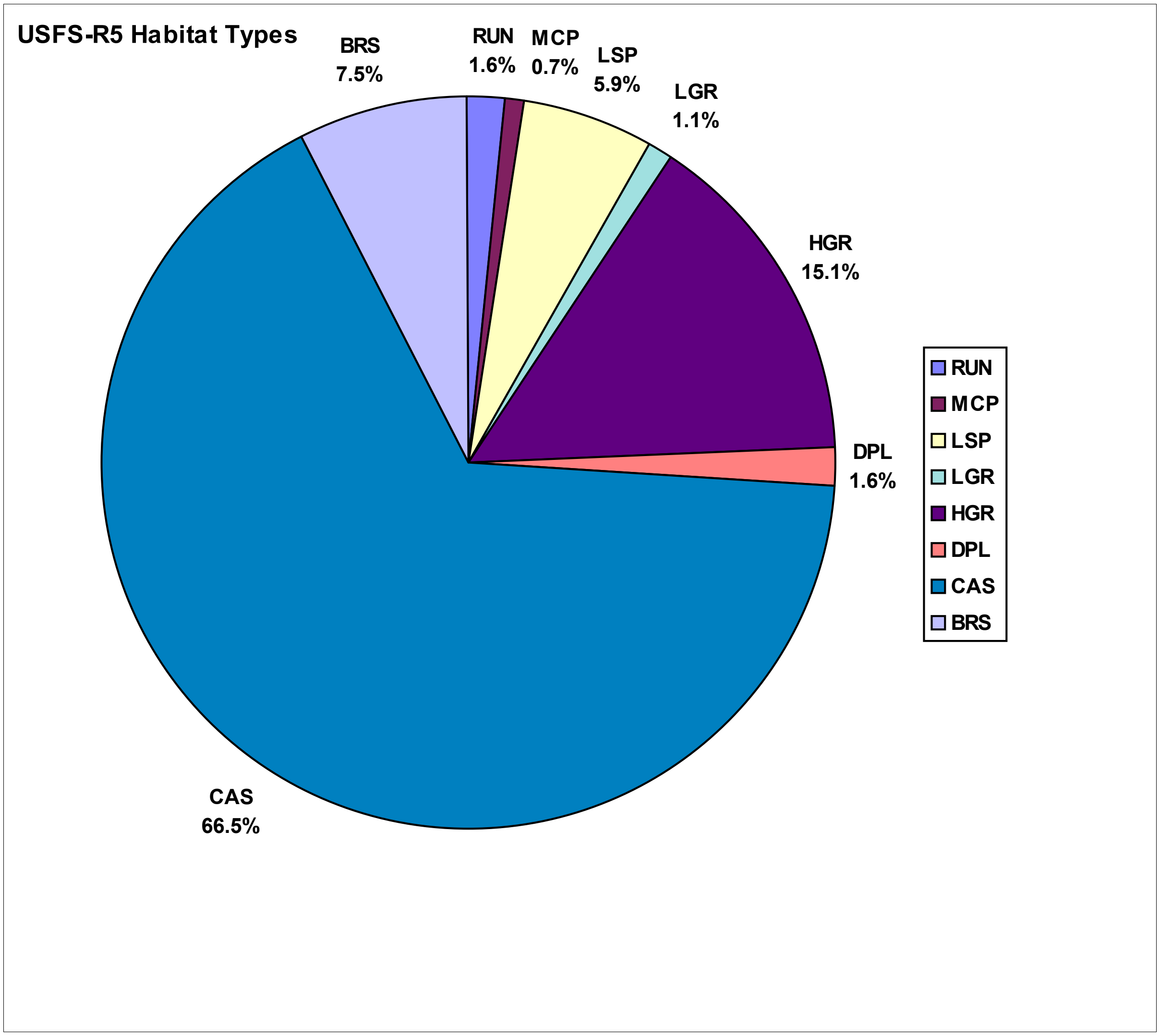


Figure CAWG 1-23. USFS-R5 Habitat Types for Hooper Creek (cont).

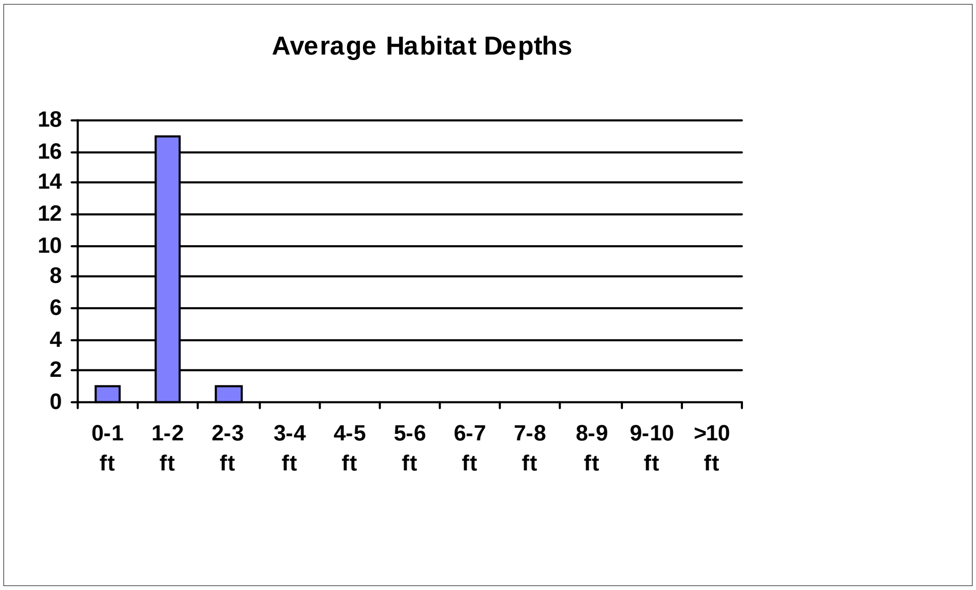
Recorded Average Habitat Depth Histograms

1 foot bin size

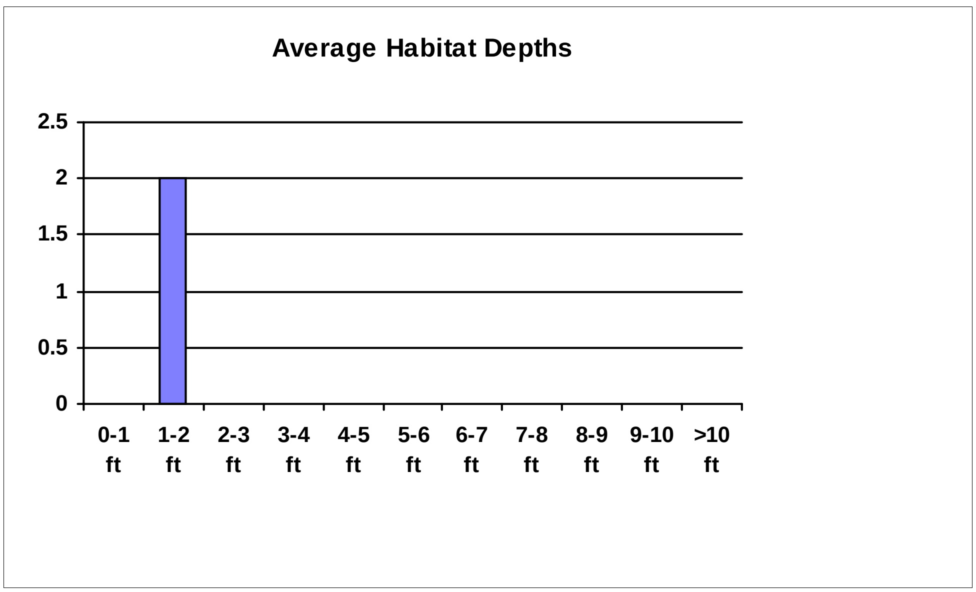
South Fork San Joaquin River (Basin) BAS_SF

Hooper Creek HoC

Hooper Creek BD Reach HoCb_R



Hooper Creek AD Reach HoCa_R



Aa+ Channel Type

Figure CAWG 1-24. Average Habitat Depth Histograms for Hooper Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/10/2000 Below Diversion and 7/11/2000 Above Diversion.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek AD Reach

Rosgen 1 Channel Type = Aa+

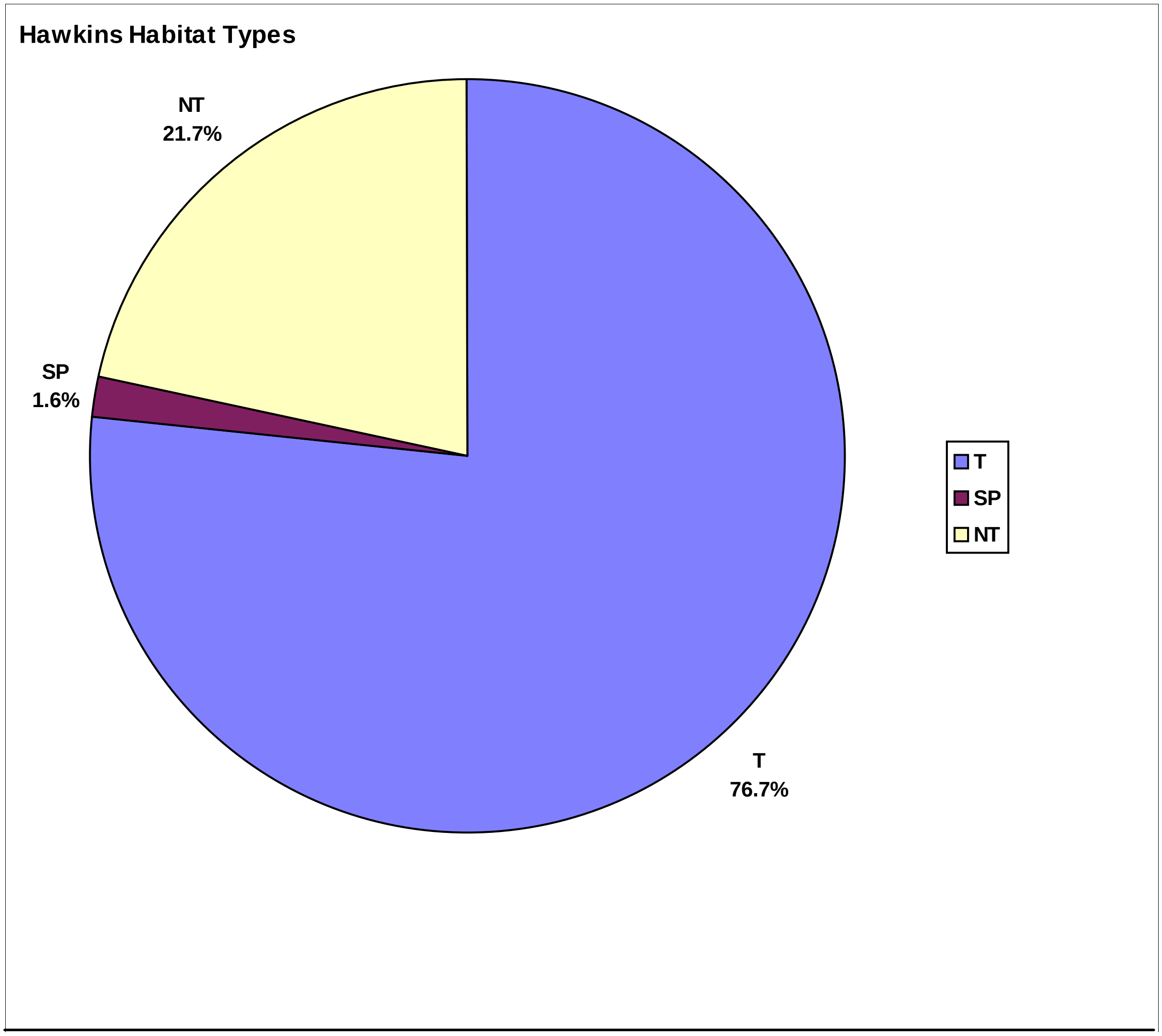


Figure CAWG 1-25. Hawkins Habitat Types for Crater Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek BD Reach

Rosgen 1 Channel Type = Aa+

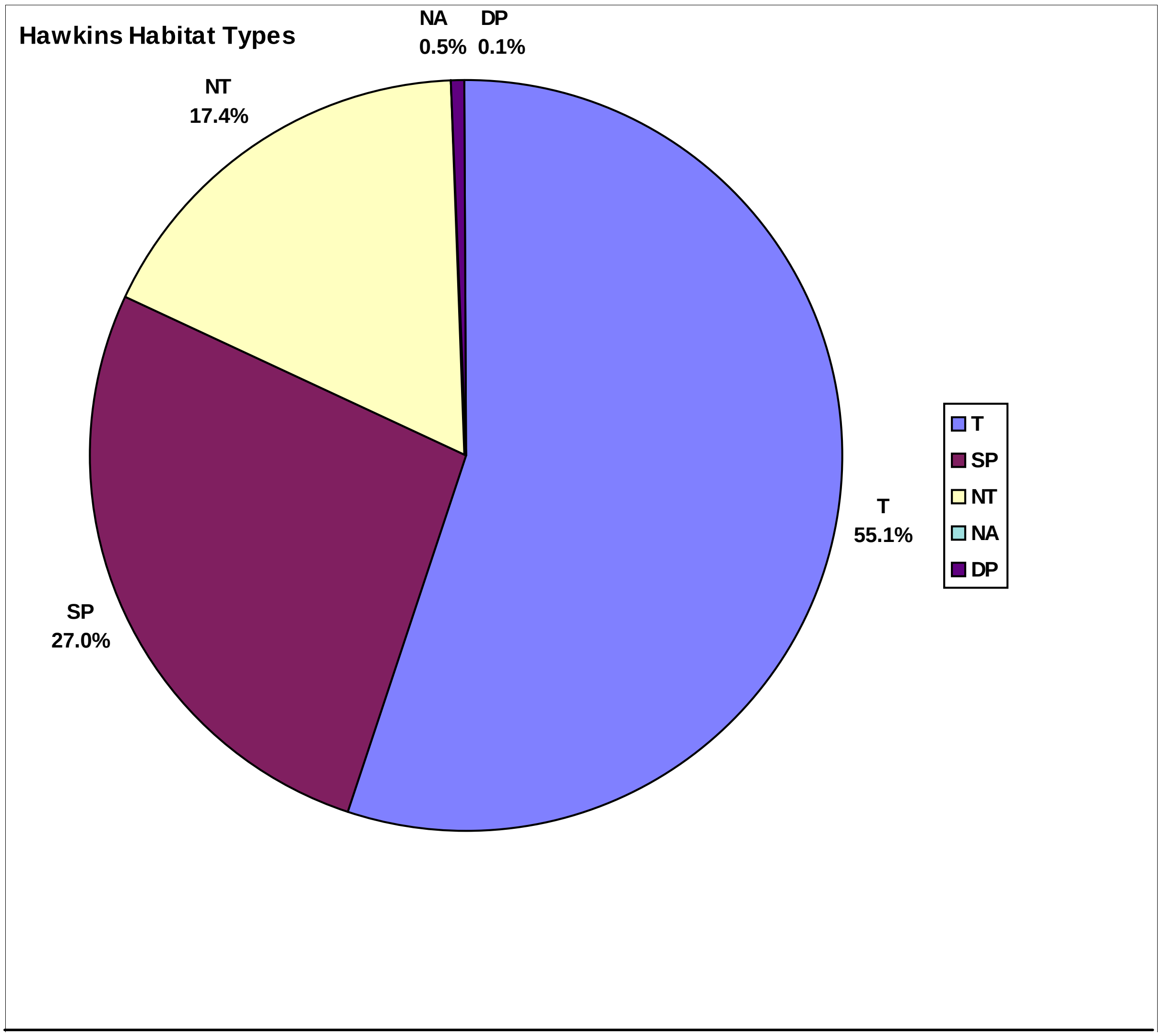


Figure CAWG 1-25. Hawkins Habitat Types for Crater Creek (cont).

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek BD Reach

Rosgen 1 Channel Type = C/E

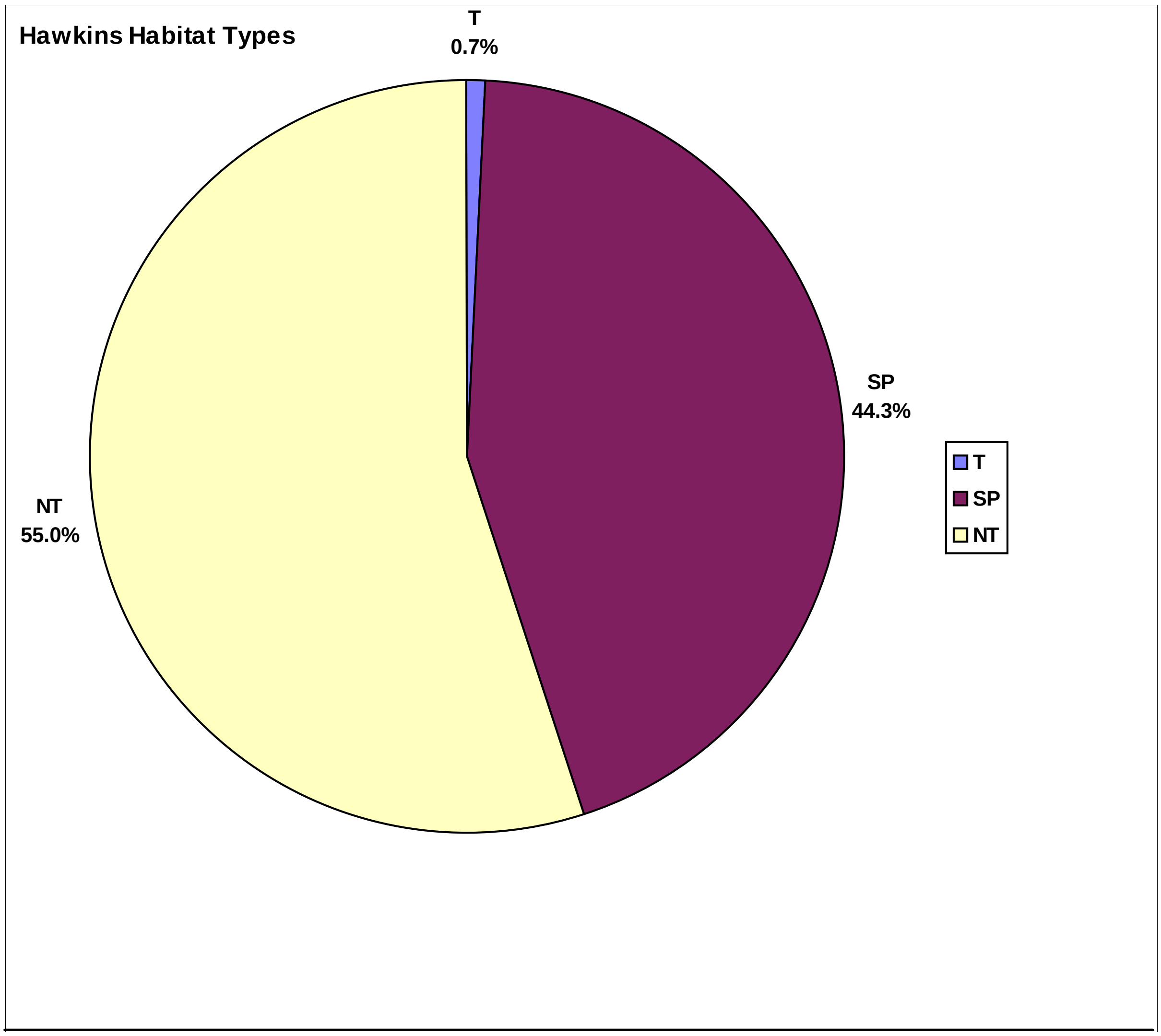


Figure CAWG 1-25. Hawkins Habitat Types for Crater Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek AD Reach

Rosgen 1 Channel Type = Aa+

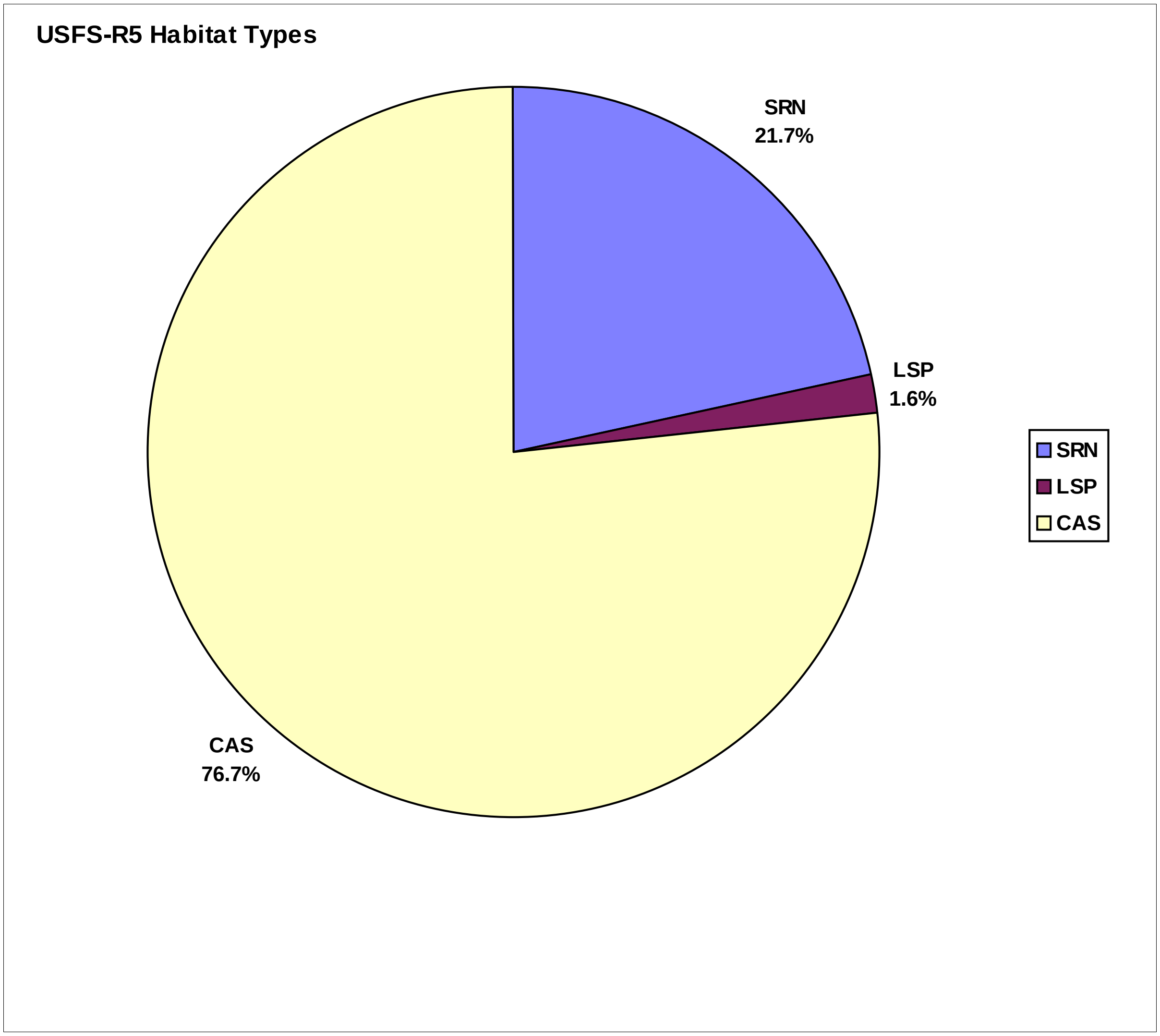


Figure CAWG 1-26. USFS-R5 Habitat Types for Crater Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek BD Reach

Rosgen 1 Channel Type = Aa+

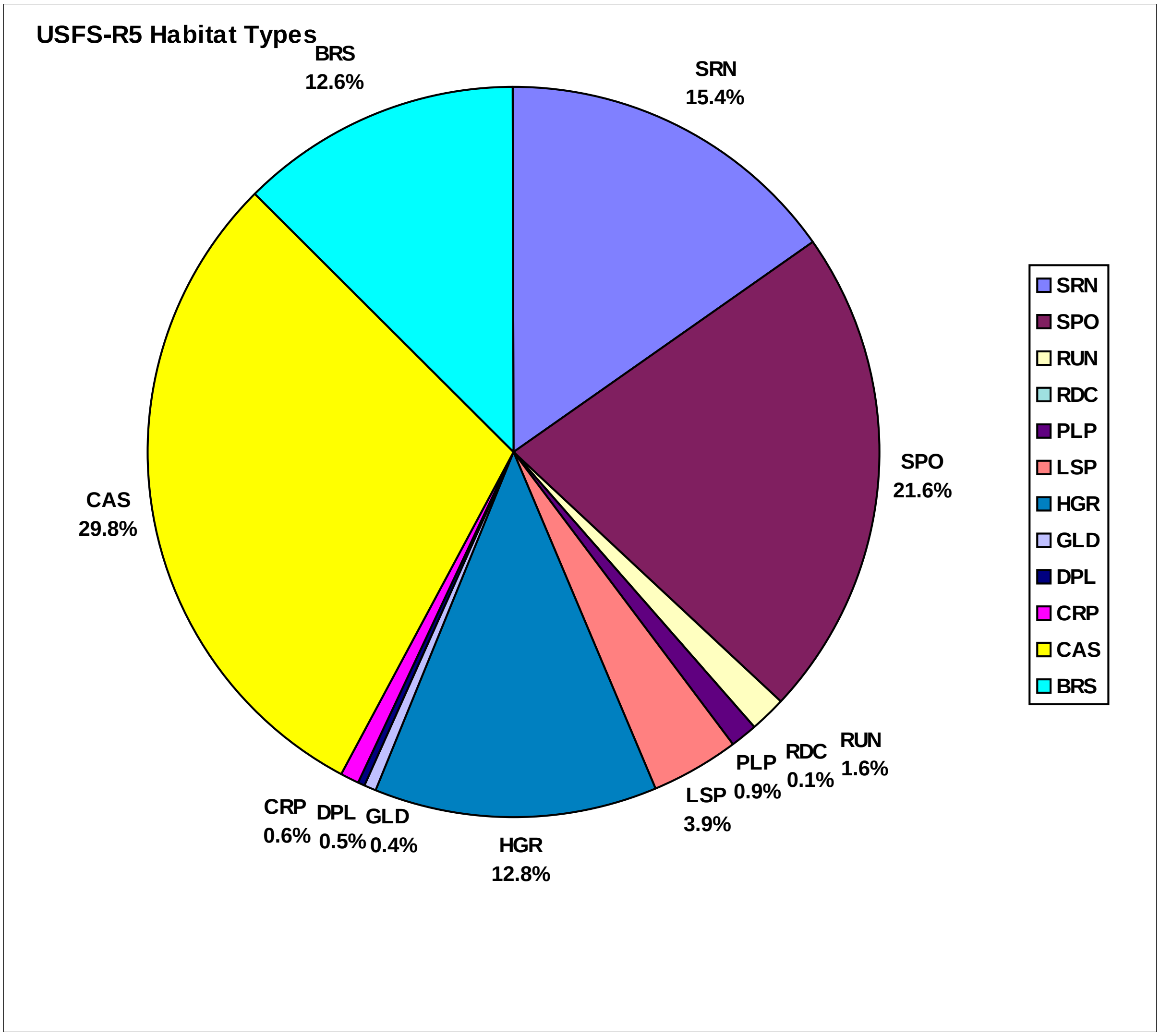


Figure CAWG 1-26. USFS-R5 Habitat Types for Crater Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek

Crater Creek BD Reach

Rosgen 1 Channel Type = C/E

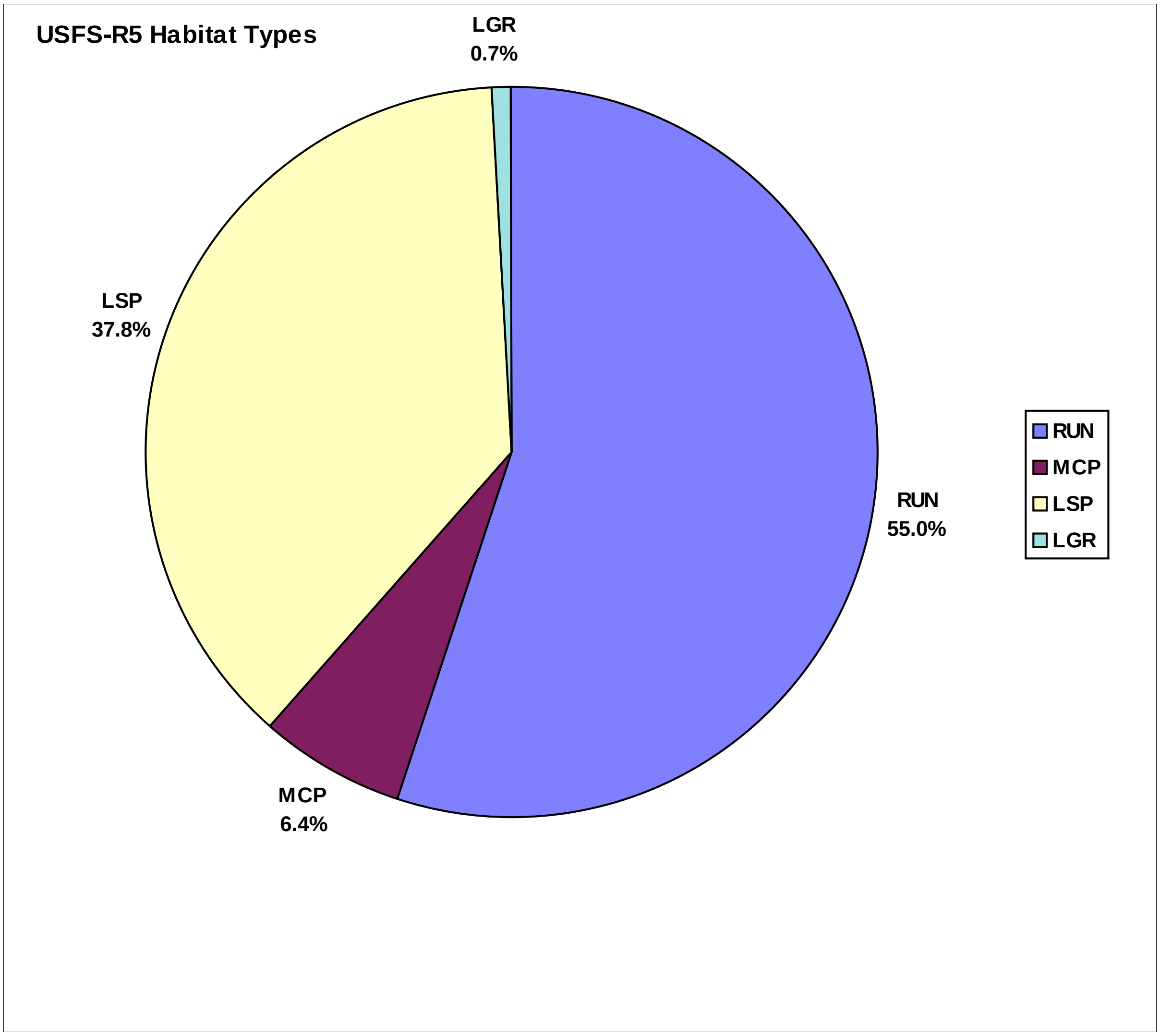


Figure CAWG 1-26. USFS-R5 Habitat Types for Crater Creek (cont).

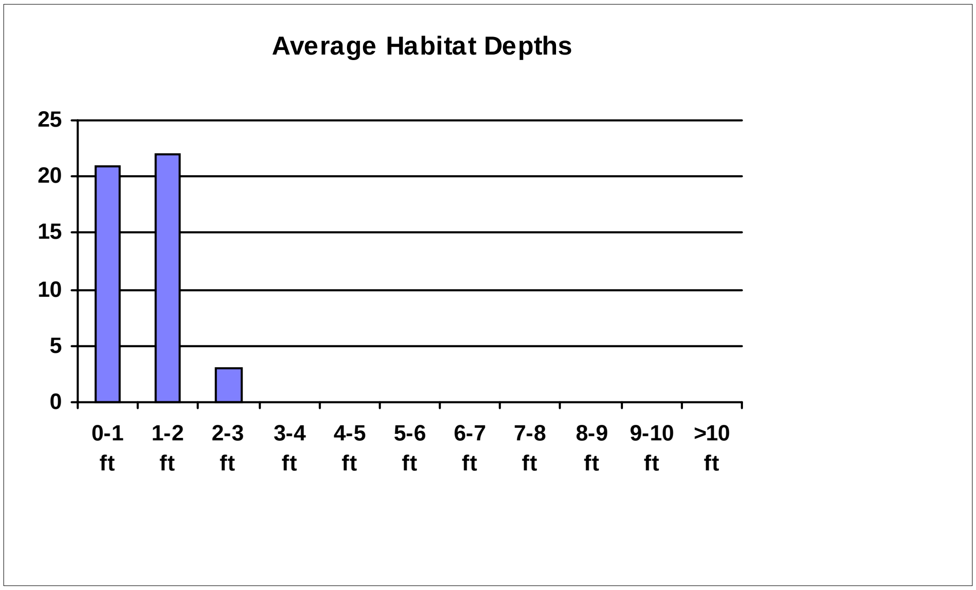
Recorded Average Habitat Depth Histograms

1 foot bin size

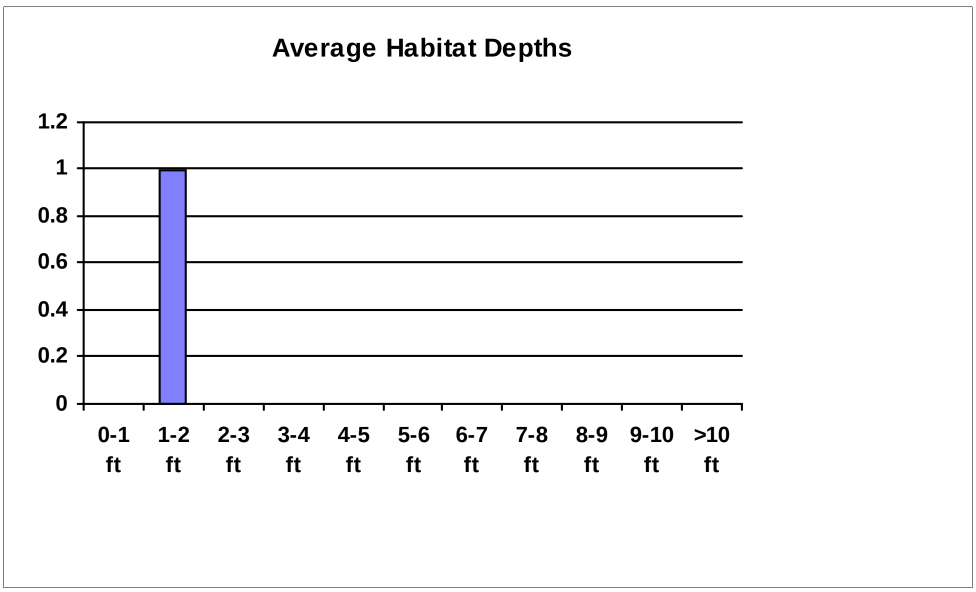
South Fork San Joaquin River (Basin) BAS_SF

Crater Creek CrC

Crater Creek BD Reach CrCb_R



Crater Creek AD Reach CrCa_R



Aa+ Channel Type

Figure CAWG 1-27. Average Habitat Depth Histograms for Crater Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/18/2000 Below Diversion and 7/20/2000 Above Diversion.

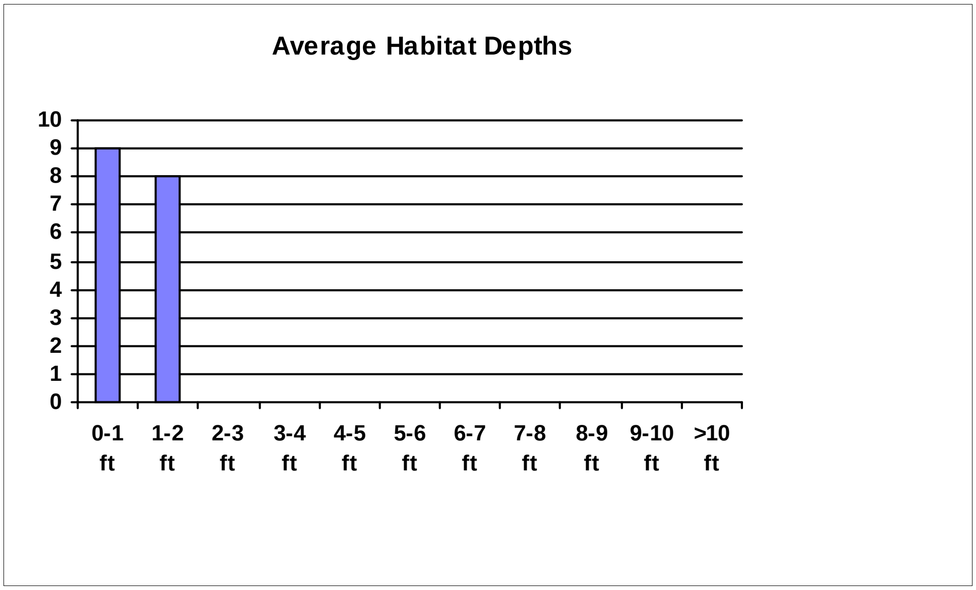
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Crater Creek CrC

Crater Creek BD Reach CrCb_R



C/E Channel Type

Figure CAWG 1-27. Average Habitat Depth Histograms for Crater Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 7/18/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek Diversion

Crater Creek Diversion Reach

Rosgen 1 Channel Type = Aa+

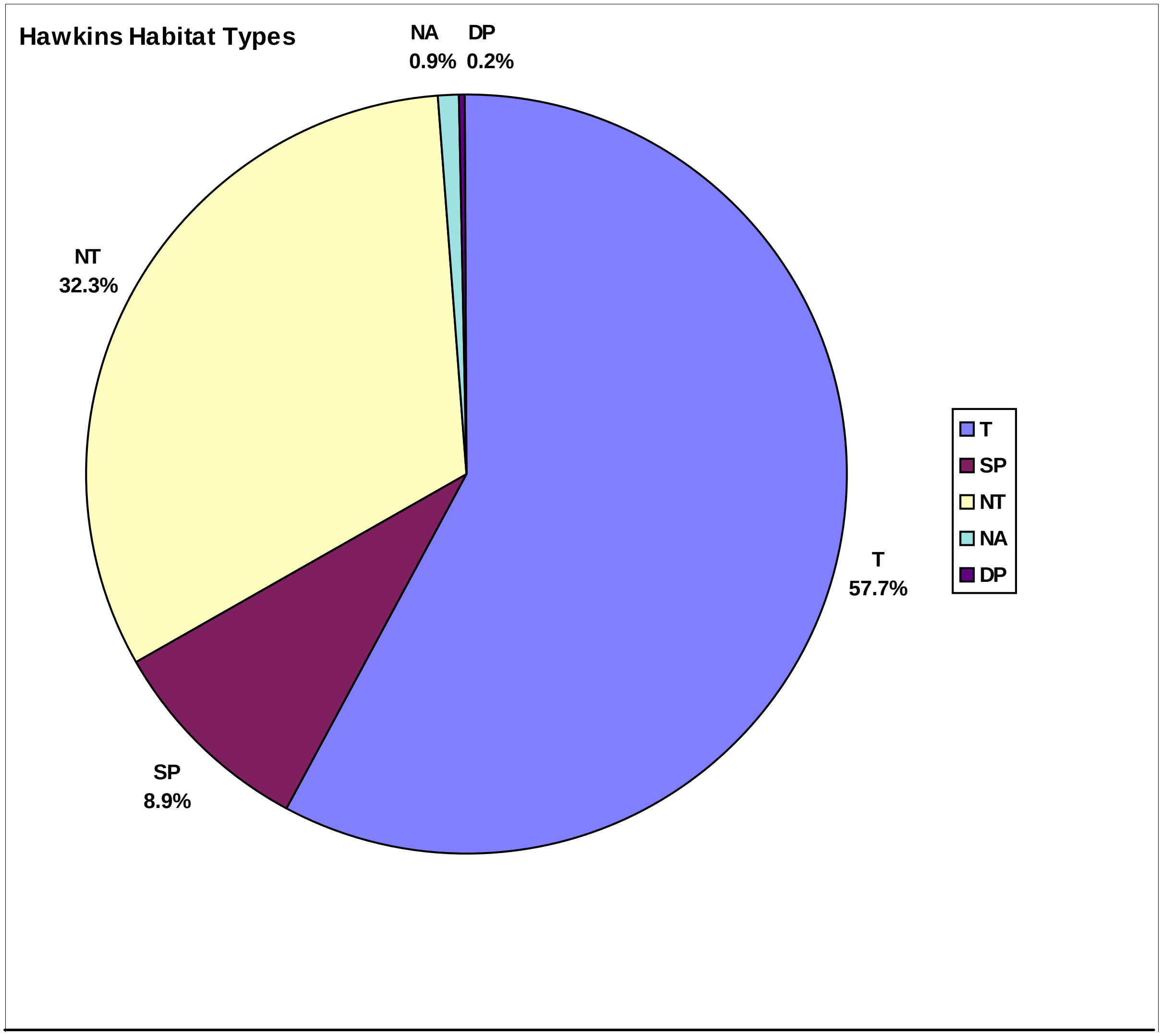


Figure CAWG 1-28. Hawkins Habitat Types for Crater Creek Diversion.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Crater Creek Diversion

Crater Creek Diversion Reach

Rosgen 1 Channel Type = Aa+

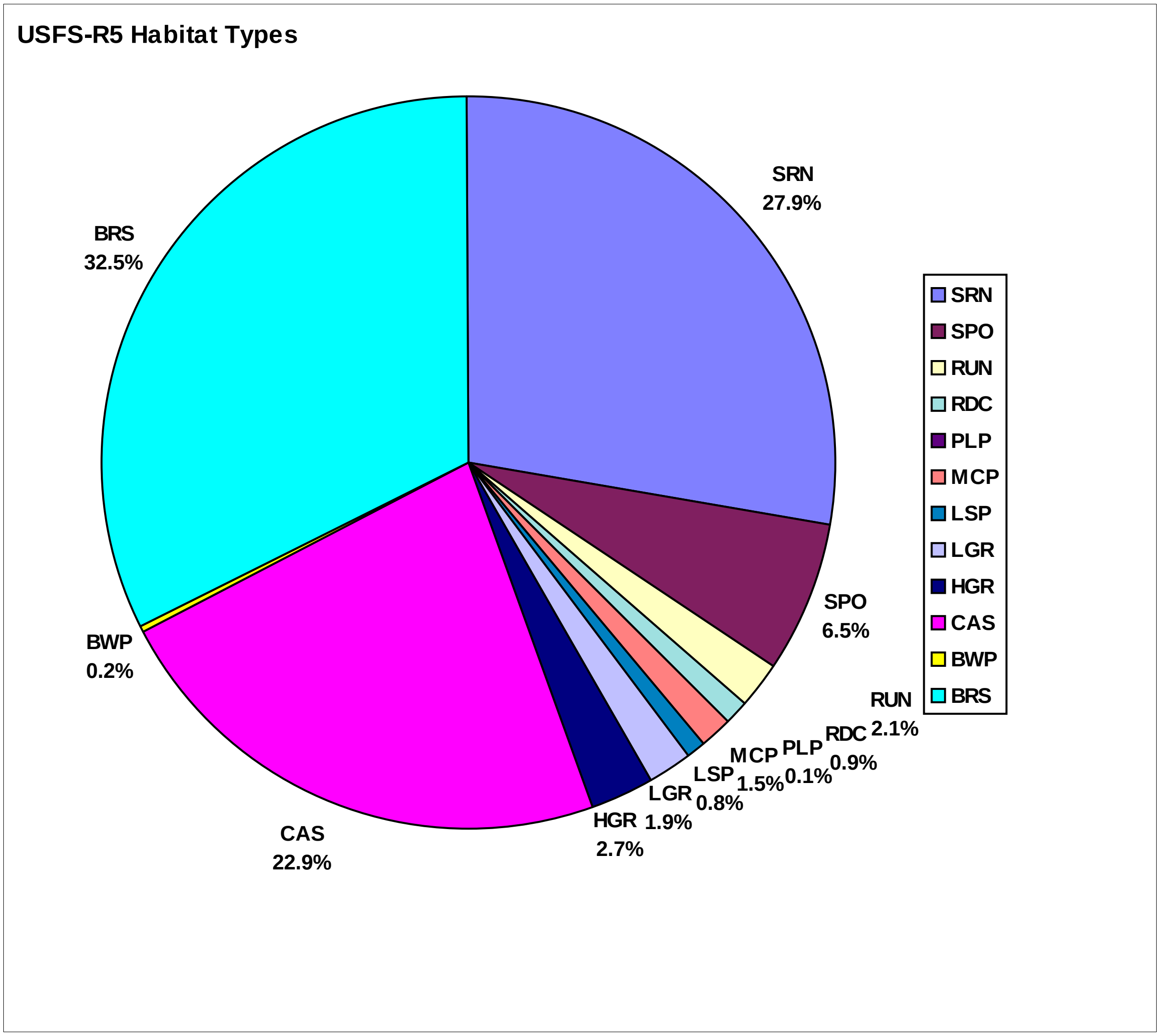


Figure CAWG 1-29. USFS-R5 Habitat Types for Crater Creek Diversion.

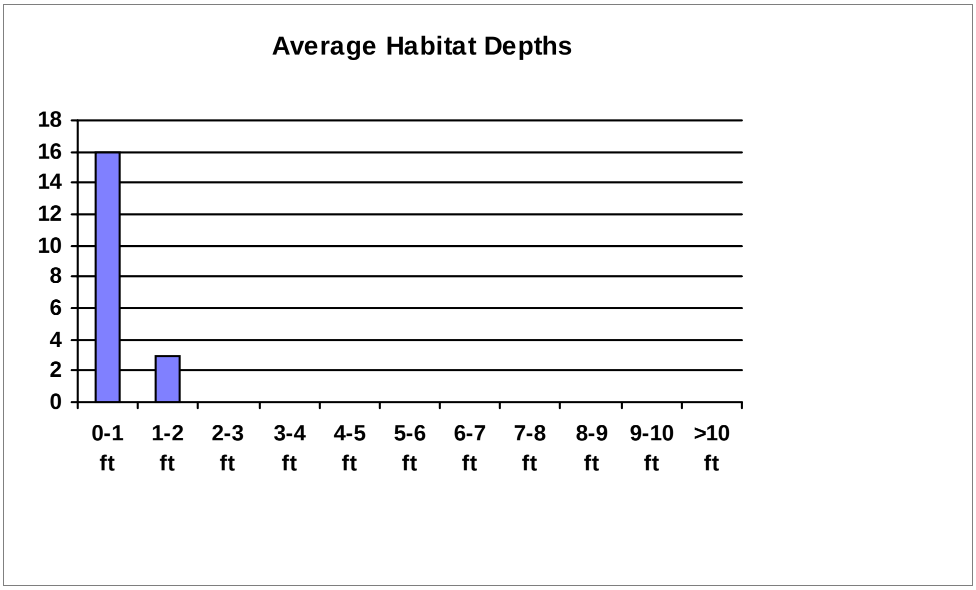
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Crater Creek Diversion CCD

Crater Creek Diversion Reach CCD_R



Aa+ Channel Type

Figure CAWG 1-30. Average Habitat Depth Histograms for Crater Creek Diversion (1 foot bin size, frequency = number of pools).

Data collected starting on 7/18/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bear Creek

Bear Creek AD Reach

Rosgen 1 Channel Type = B

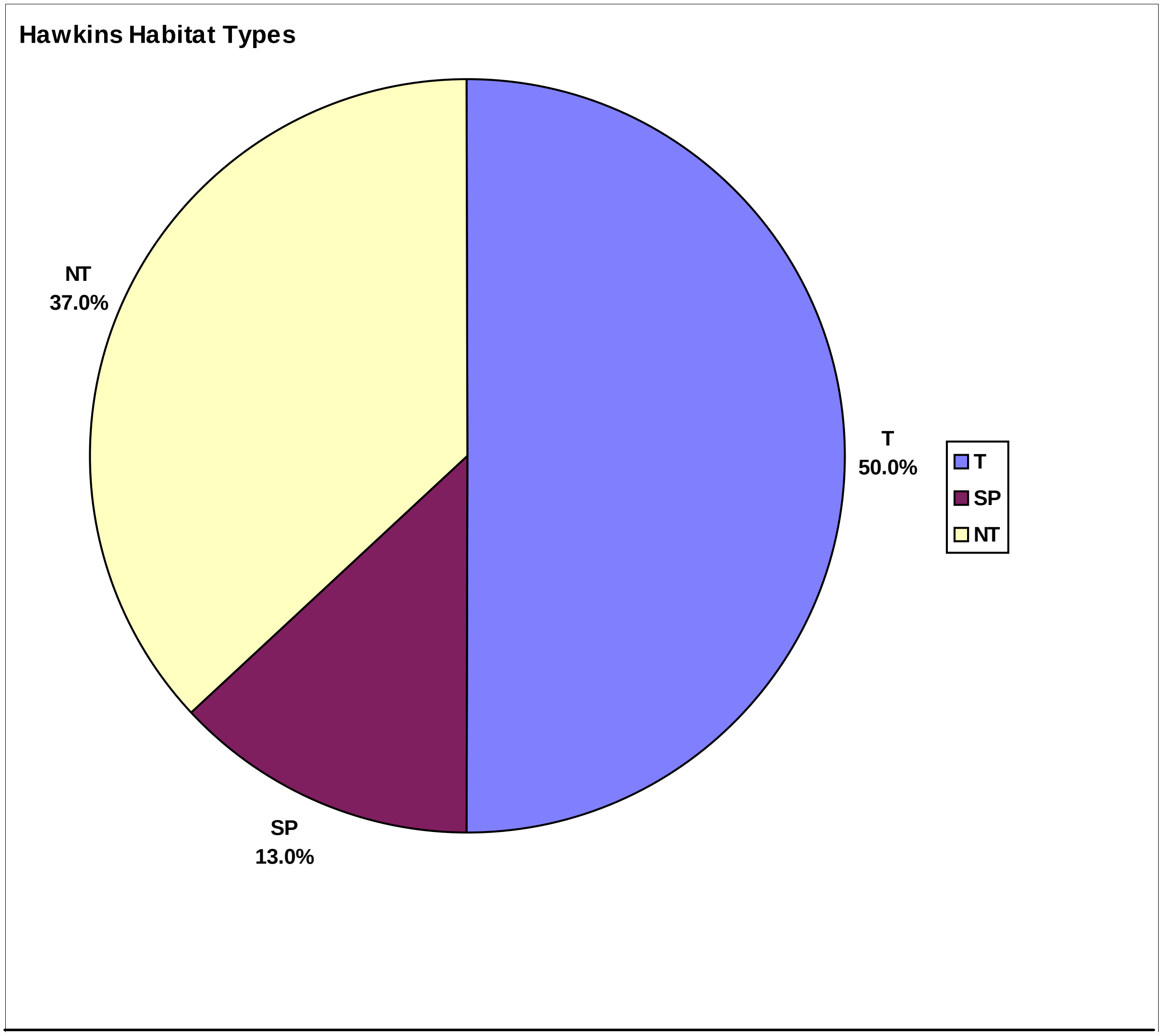


Figure CAWG 1-31. Hawkins Habitat Types for Bear Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bear Creek

Bear Creek BD Reach

Rosgen 1 Channel Type = A

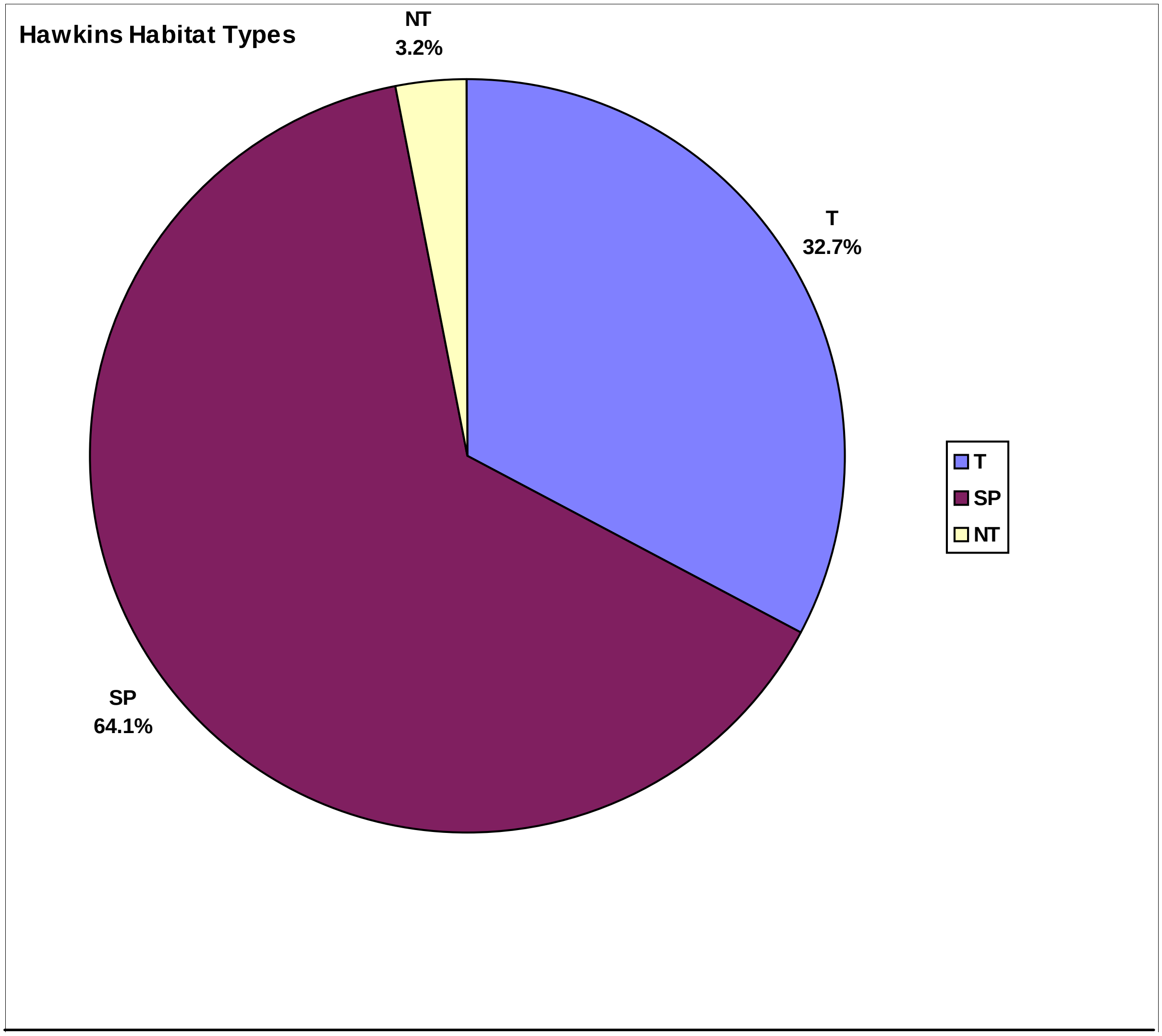


Figure CAWG 1-31. Hawkins Habitat Types for Bear Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bear Creek

Bear Creek AD Reach

Rosgen 1 Channel Type = B

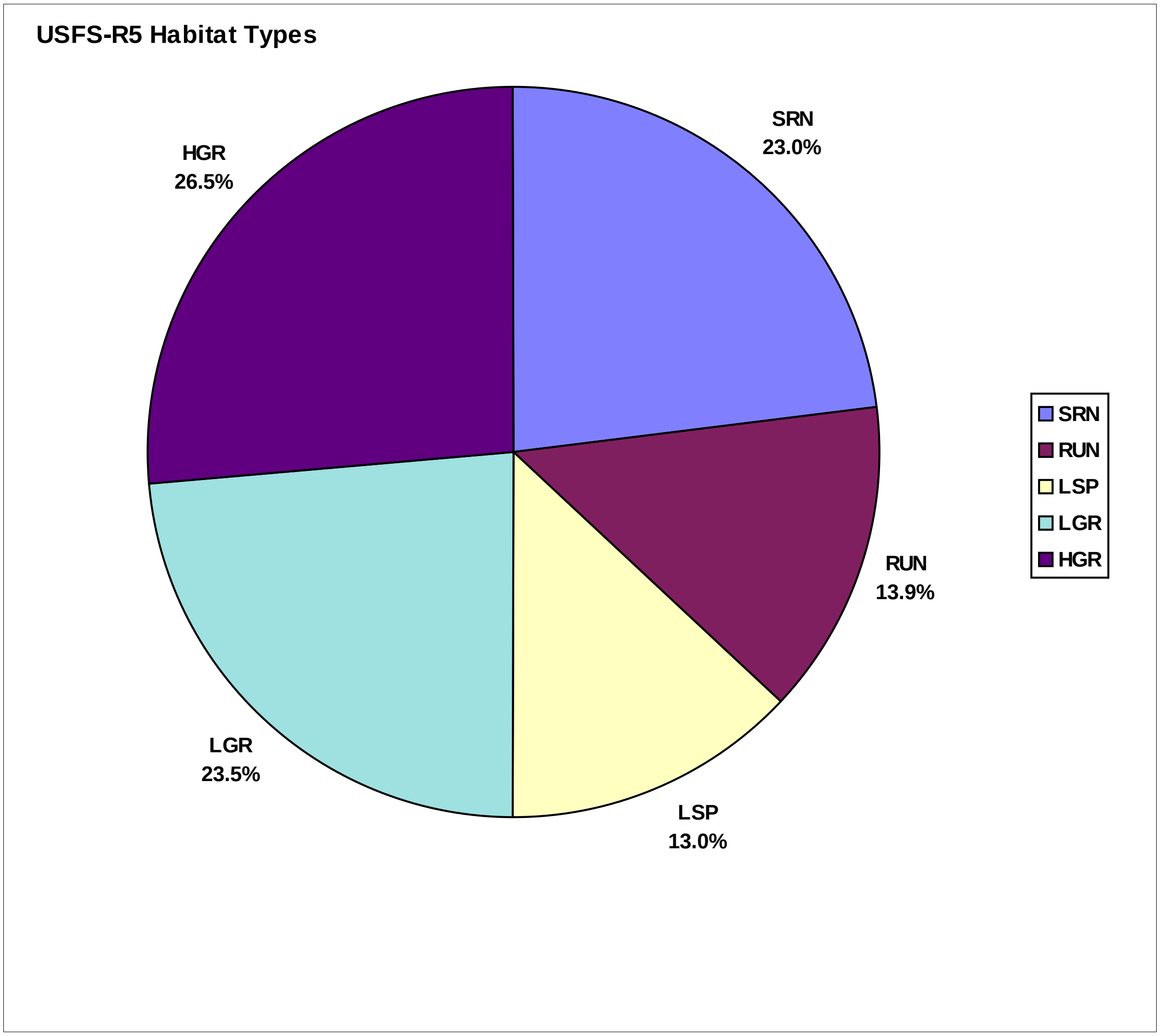


Figure CAWG 1-32. USFS-R5 Habitat Types for Bear Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bear Creek

Bear Creek BD Reach

Rosgen 1 Channel Type = A

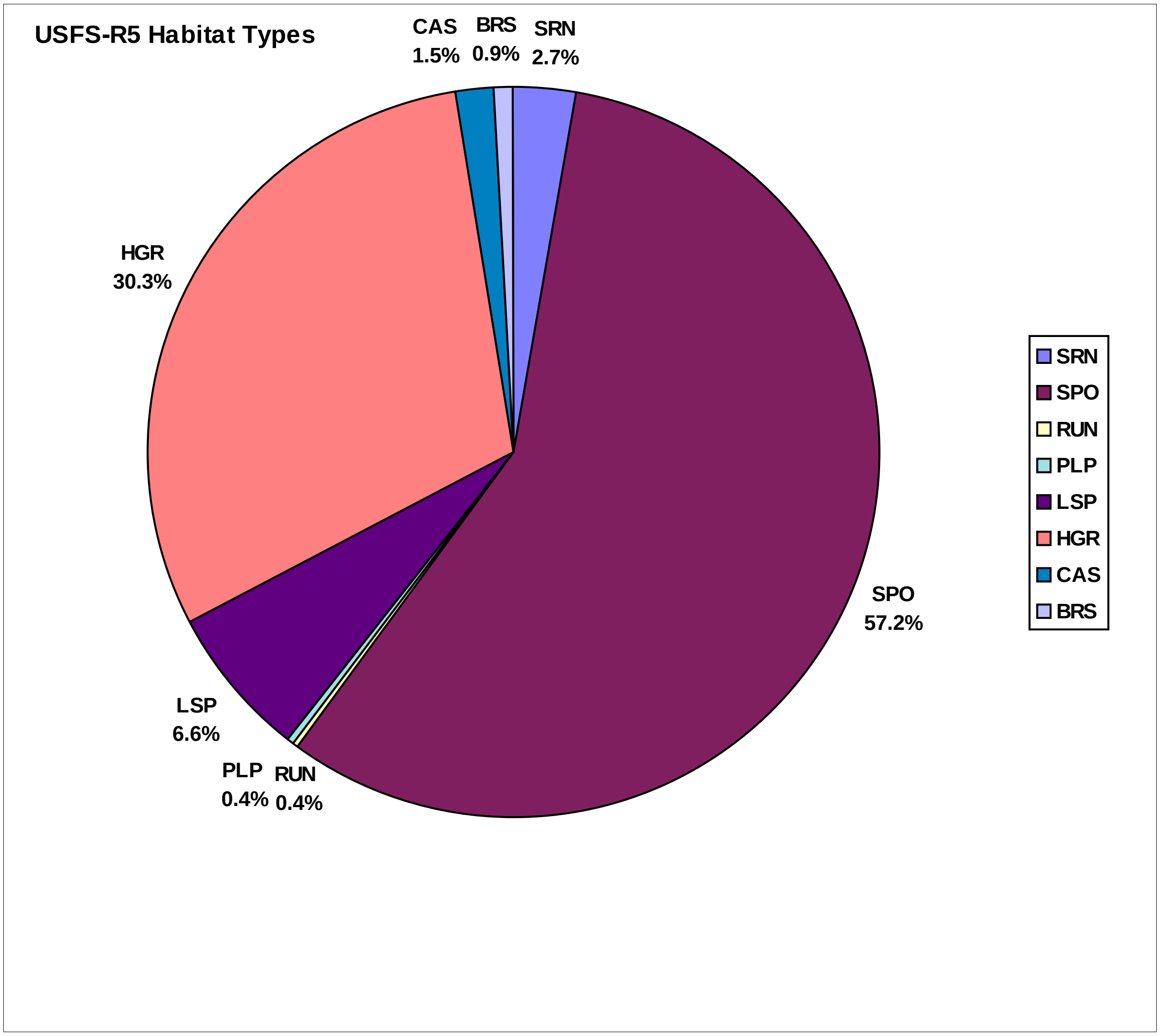


Figure CAWG 1-32. USFS-R5 Habitat Types for Bear Creek (cont).

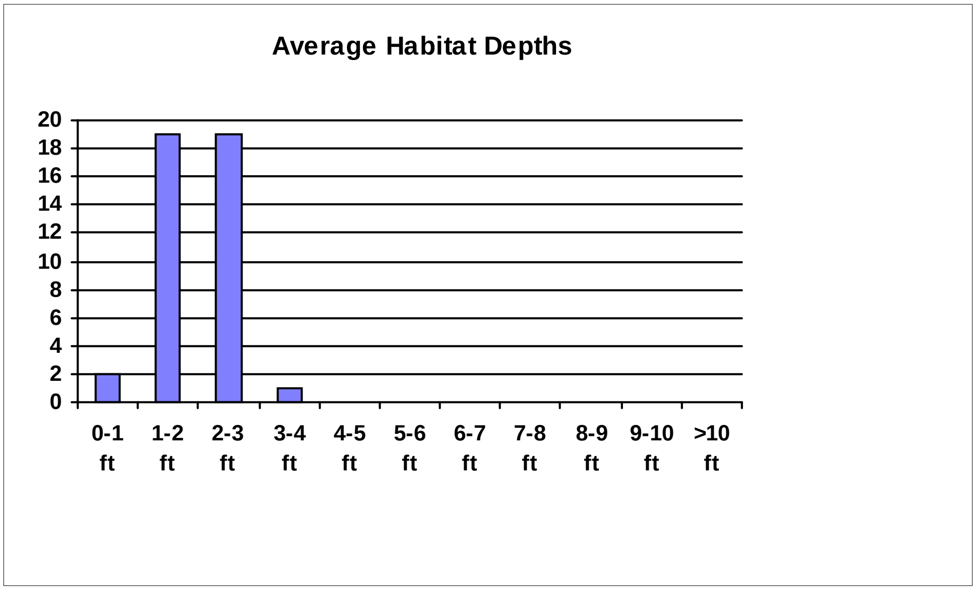
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Bear Creek BeC

Bear Creek BD Reach BeC_R



A Channel Type

Figure CAWG 1-33. Average Habitat Depth Histograms for Bear Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/26/2000.

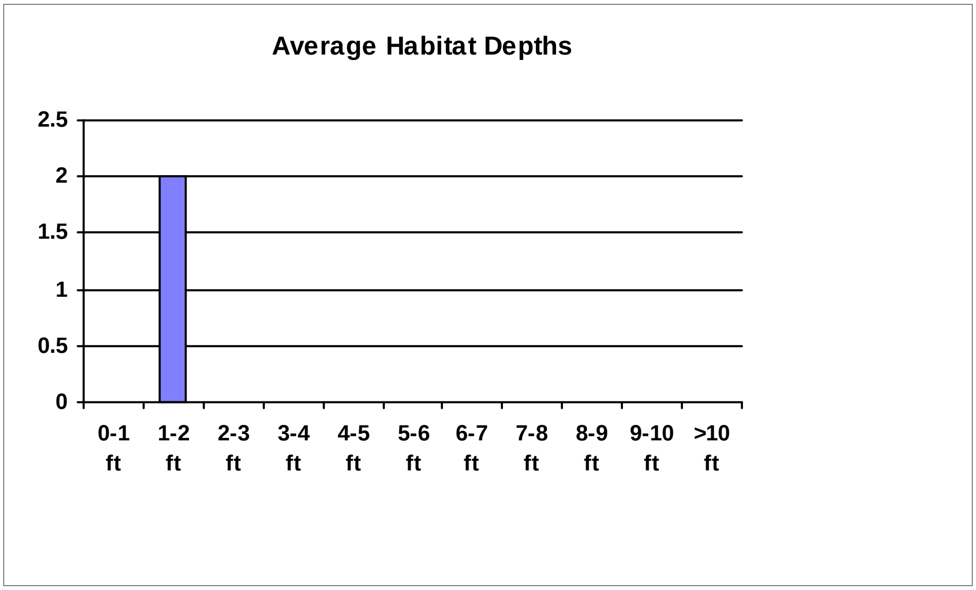
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Bear Creek BeC

Bear Creek AD Reach BeCa_R



B Channel Type

Figure CAWG 1-33. Average Habitat Depth Histograms for Bear Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 7/27/2000.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Chinquapin Creek

Chinquapin Creek BD Reach

Rosgen 1 Channel Type = Aa+

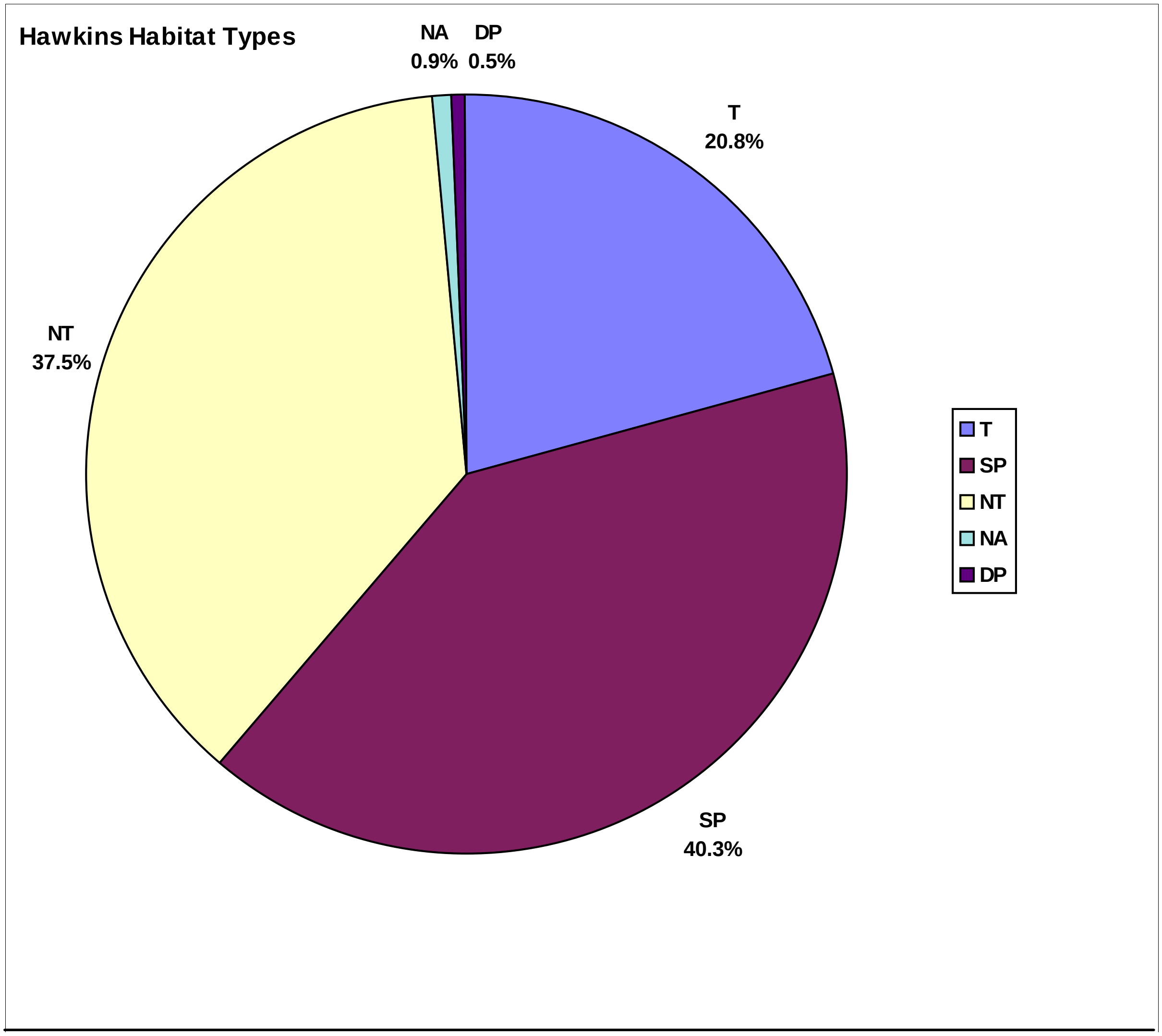


Figure CAWG 1-34. Hawkins Habitat Types for Chinquapin Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Chinquapin Creek

Chinquapin Creek BD Reach

Rosgen 1 Channel Type = Aa+

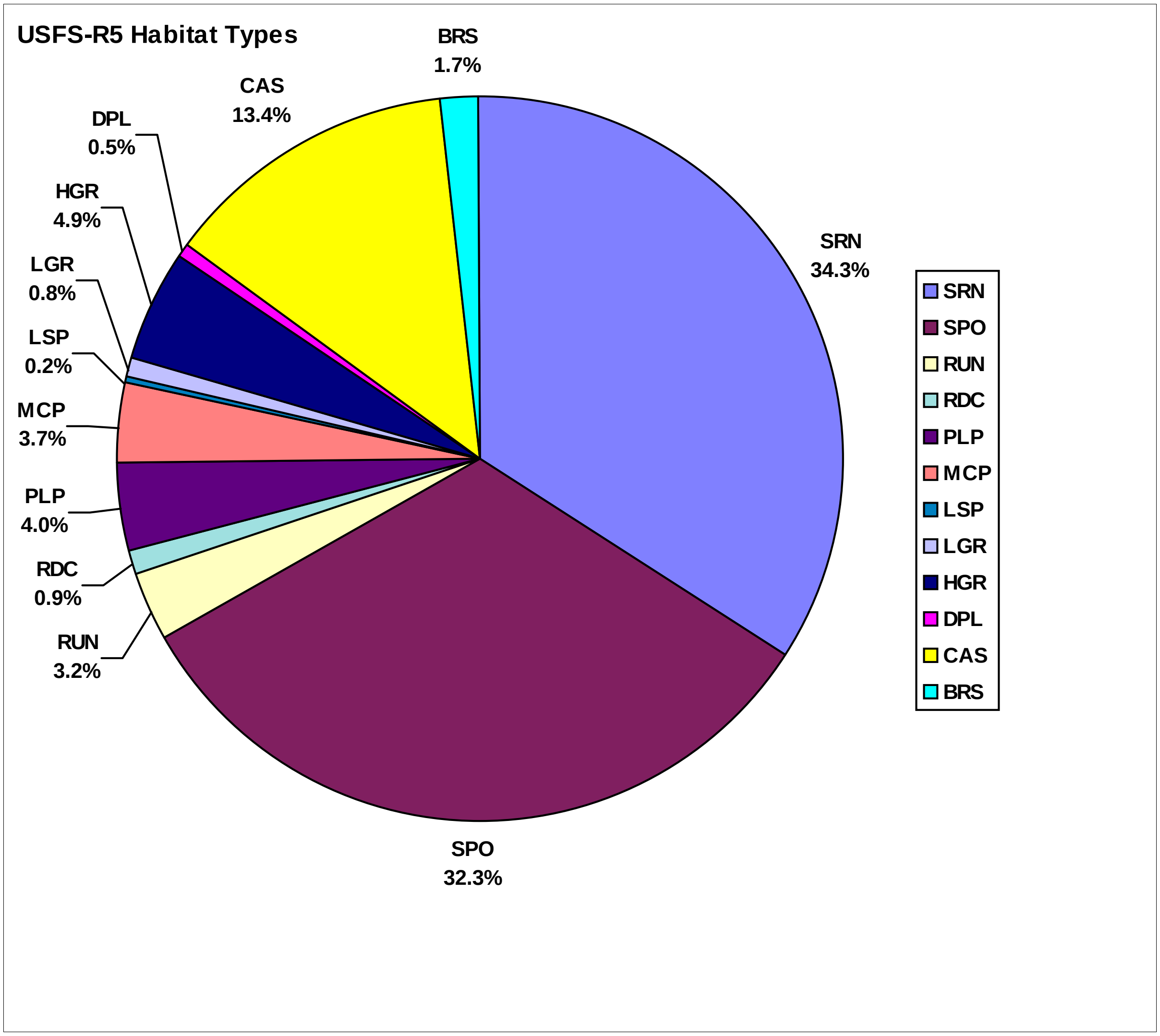


Figure CAWG 1-35. USFS-R5 Habitat Types for Chinquapin Creek.

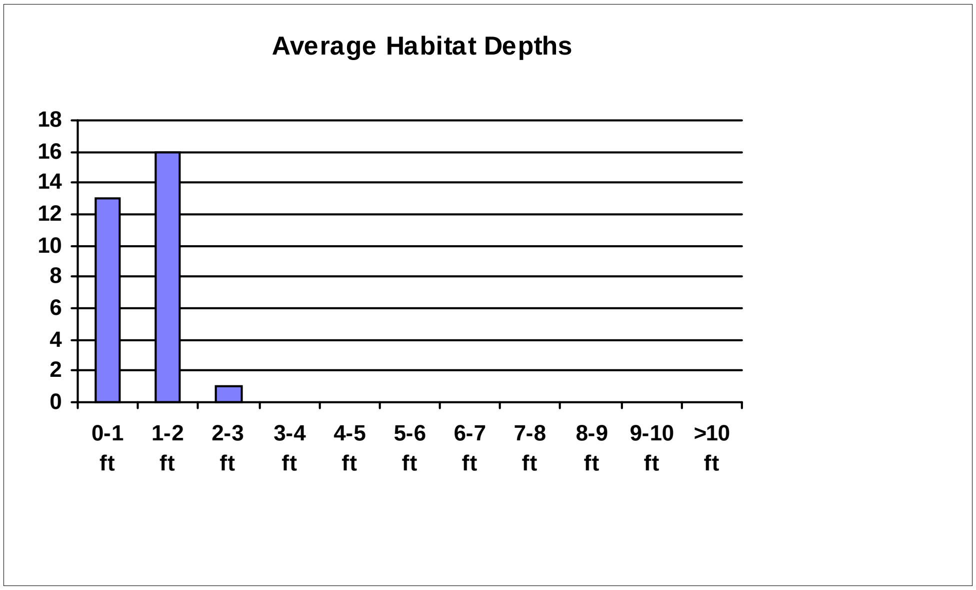
Recorded Average Habitat Depth Histograms

1 foot bin size

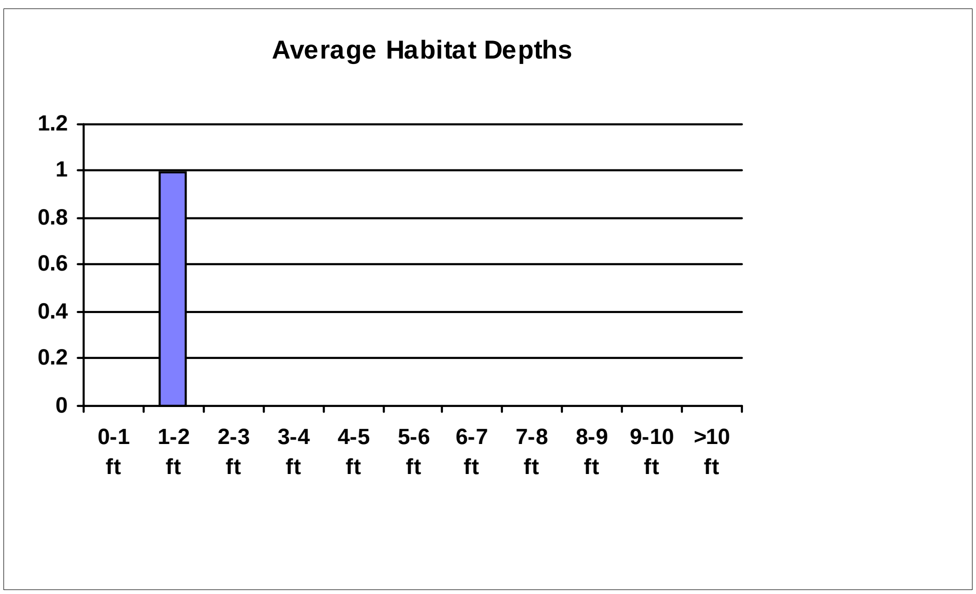
South Fork San Joaquin River (Basin) BAS_SF

Chinquapin Creek ChC

Chinquapin Creek BD Reach ChCb_R



Chinquapin Creek AD Reach ChCa_R



Aa+ Channel Type

Figure CAWG 1-36. Average Habitat Depth Histograms for Chinquapin Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/25/2000 for both Below and Above Diversion sites.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Camp 62 Creek

Camp 62 Creek AD Reach

Rosgen 1 Channel Type = Aa+

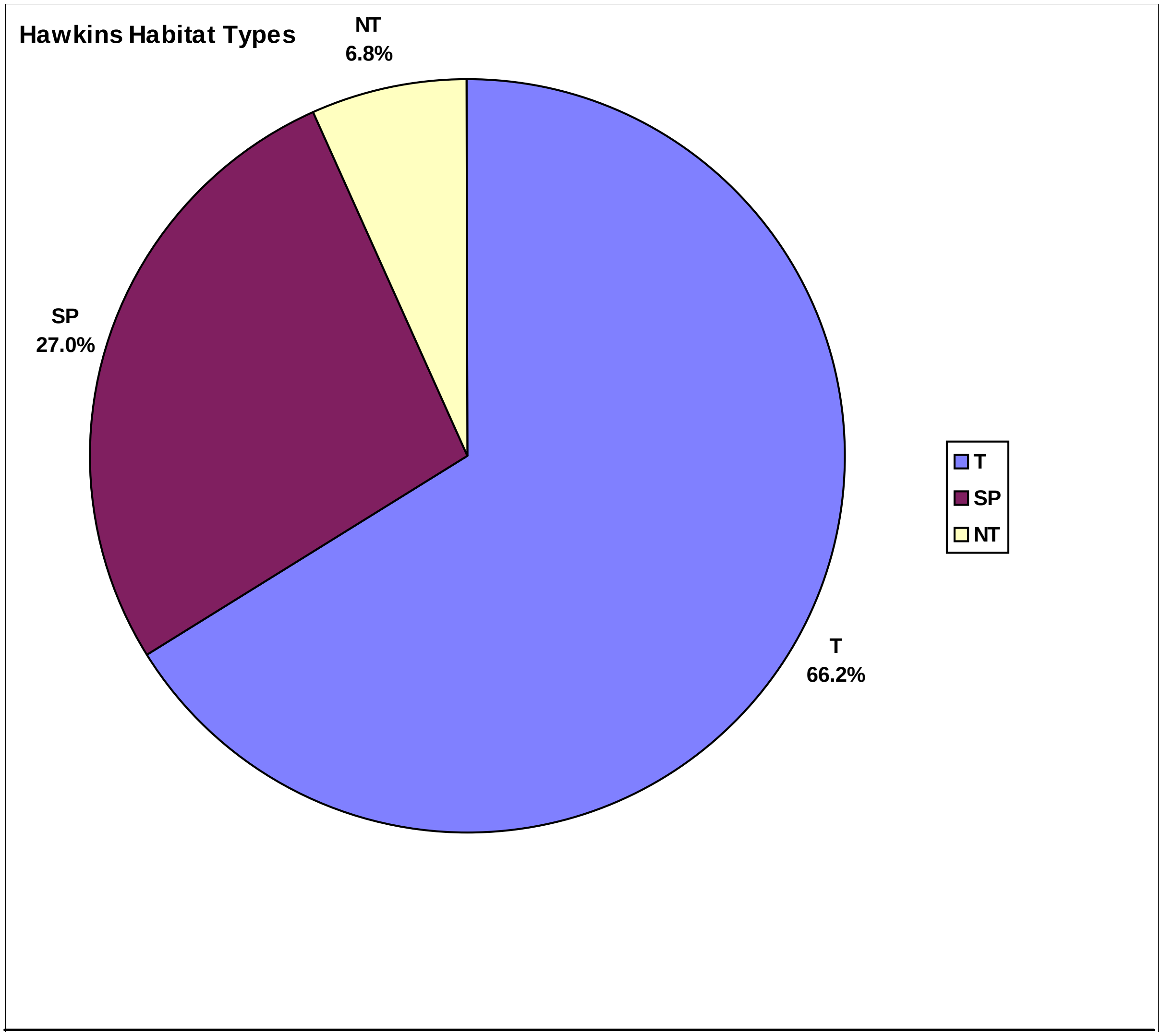


Figure CAWG 1-37. Hawkins Habitat Types for Camp 62 Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Camp 62 Creek

Camp 62 Creek BD Reach

Rosgen 1 Channel Type = Aa+

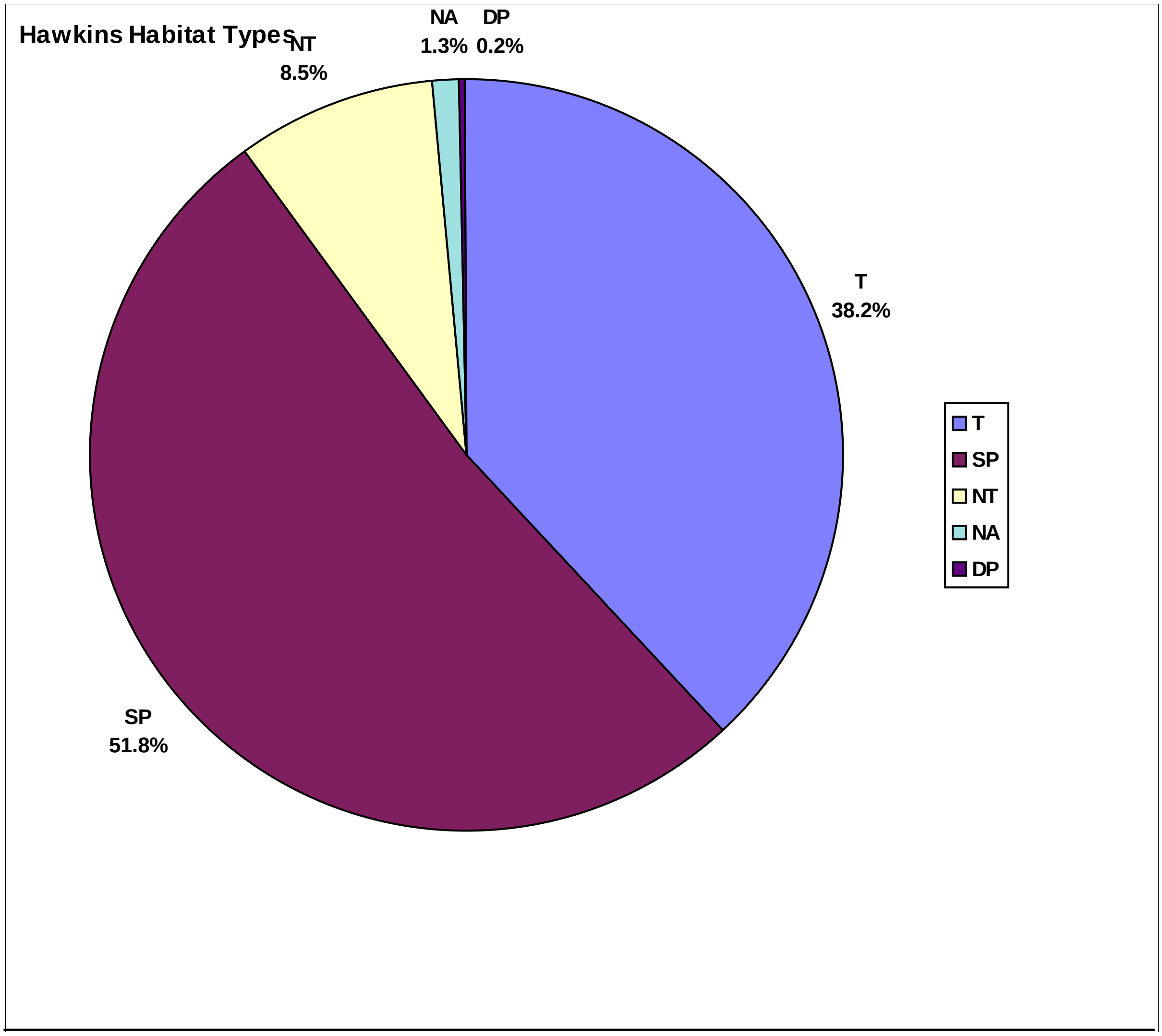


Figure CAWG 1-37. Hawkins Habitat Types for Camp 62 Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Camp 62 Creek

Camp 62 Creek AD Reach

Rosgen 1 Channel Type = Aa+

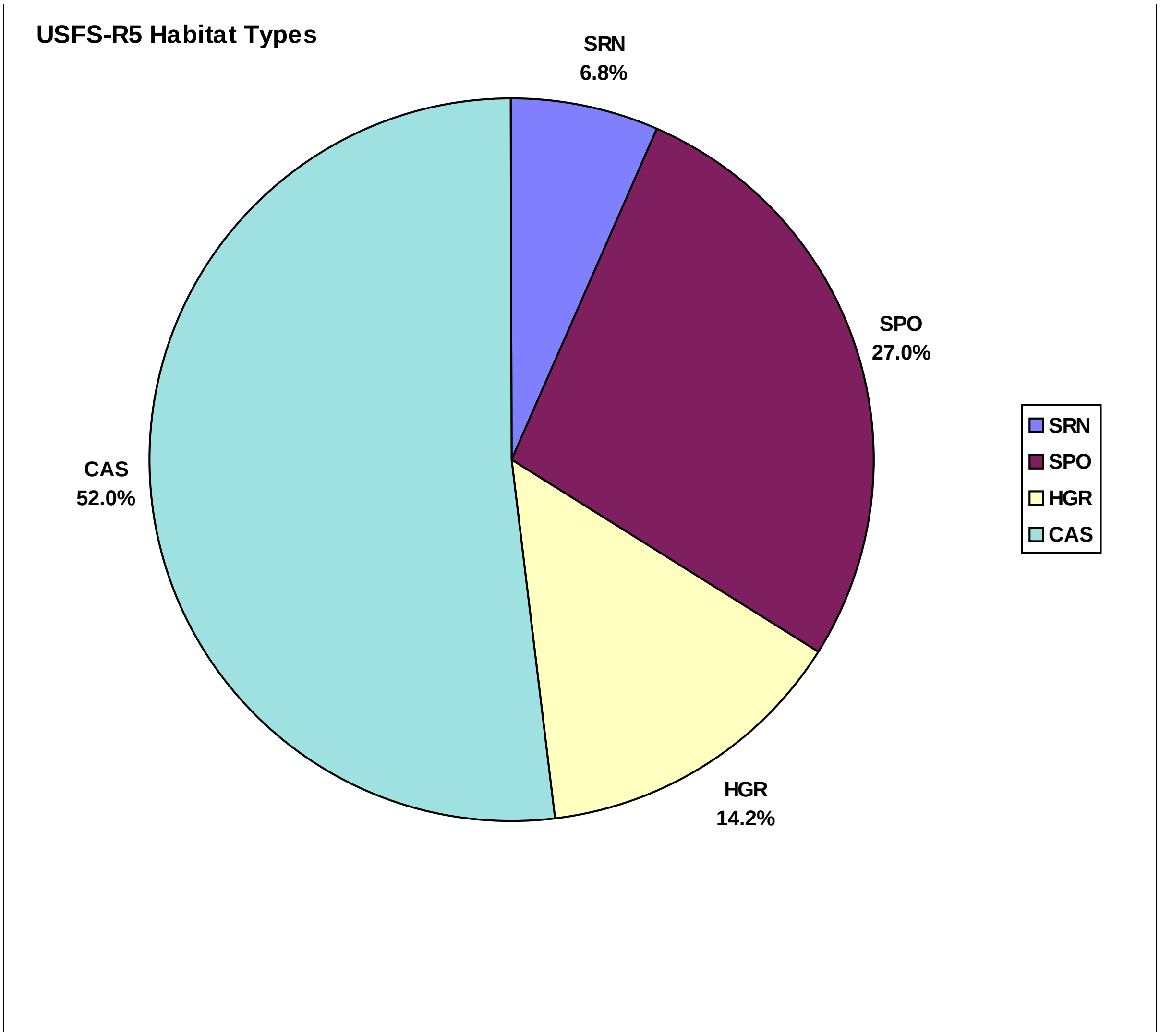


Figure CAWG 1-38. USFS-R5 Habitat Types for Camp 62 Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Camp 62 Creek

Camp 62 Creek BD Reach

Rosgen 1 Channel Type = Aa+

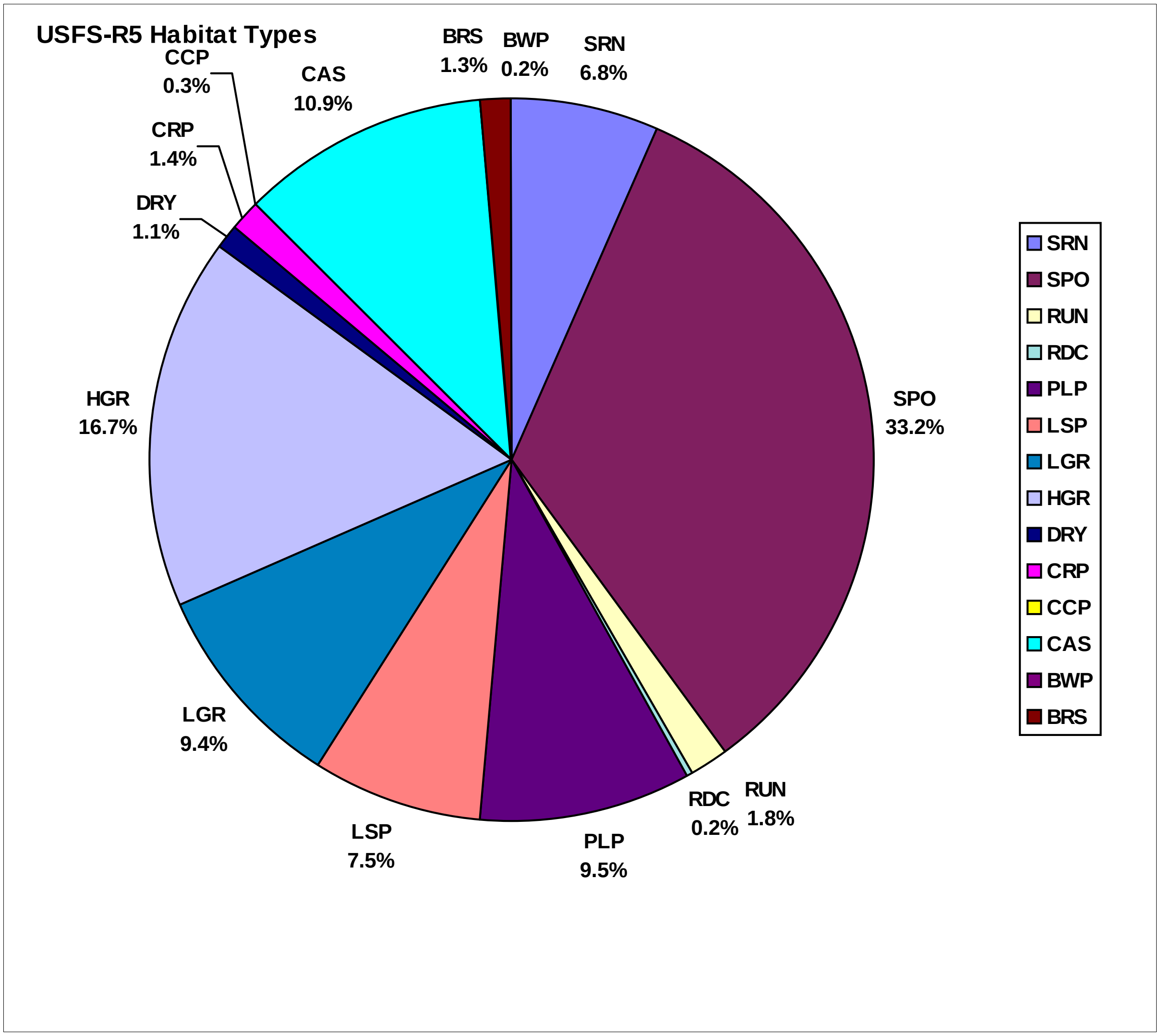


Figure CAWG 1-38. USFS-R5 Habitat Types for Camp 62 Creek (cont).

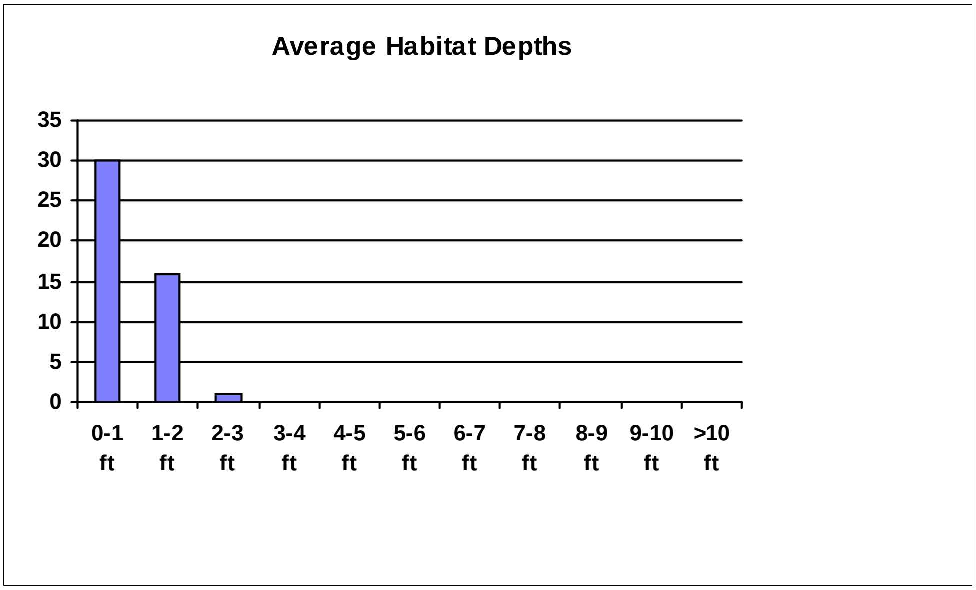
Recorded Average Habitat Depth Histograms

1 foot bin size

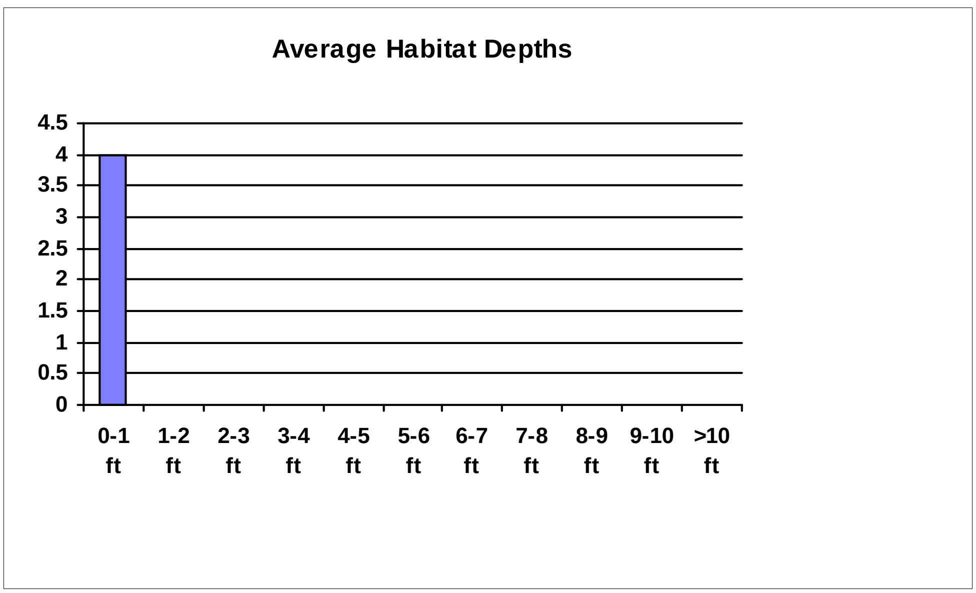
South Fork San Joaquin River (Basin) BAS_SF

Camp 62 Creek C62C

Camp 62 Creek BD Reach C62Cb_R



Camp 62 Creek AD Reach C62C_R



Aa+ Channel Type

Figure CAWG 1-39. Average Habitat Depth Histograms for Camp 62 Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 8/1/2000 for both Below and Above Diversion sites.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek AD Reach

Rosgen 1 Channel Type = B

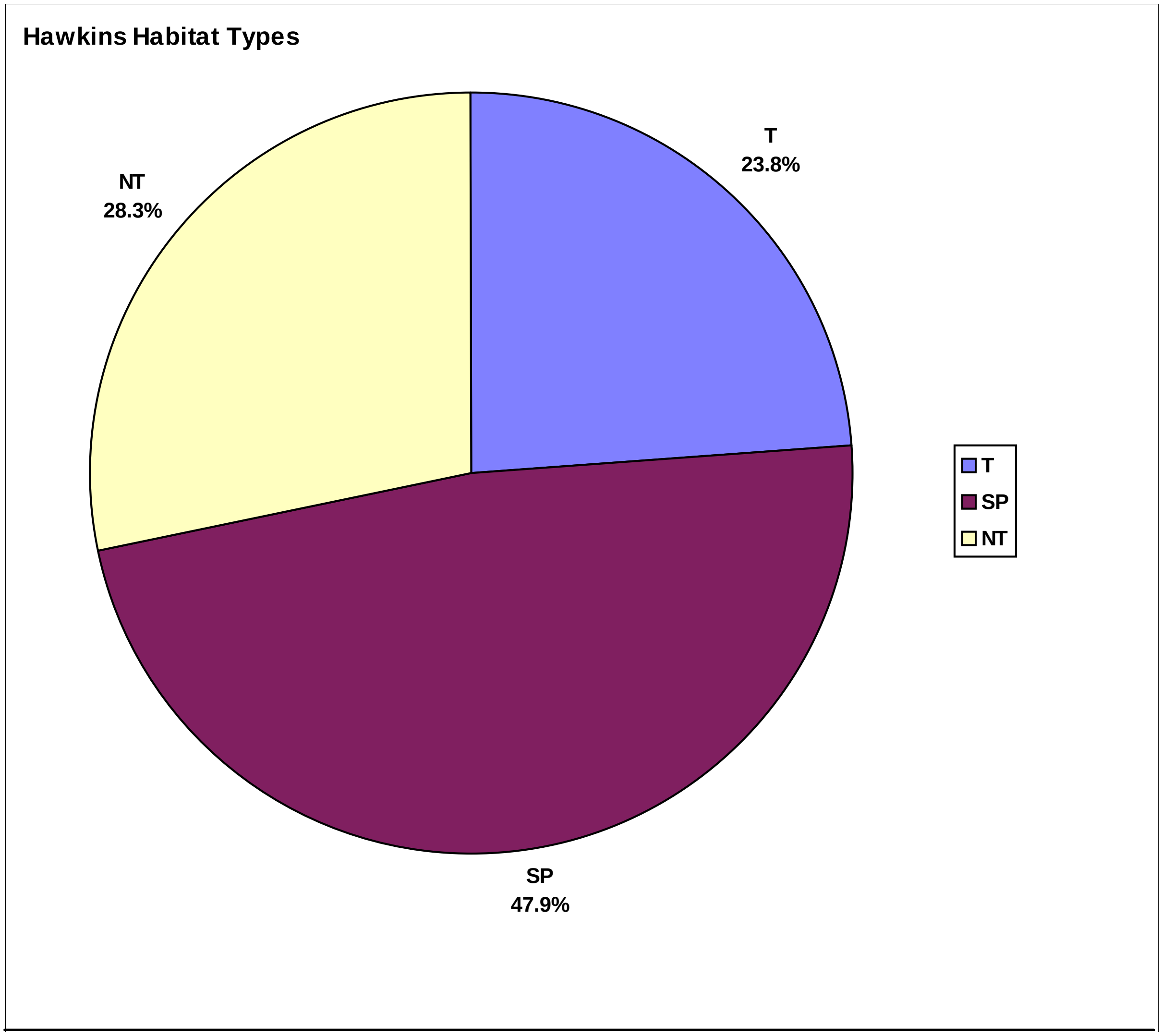


Figure CAWG 1-40. Hawkins Habitat Types for Bolsillo Creek.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek BD Reach

Rosgen 1 Channel Type = Aa+

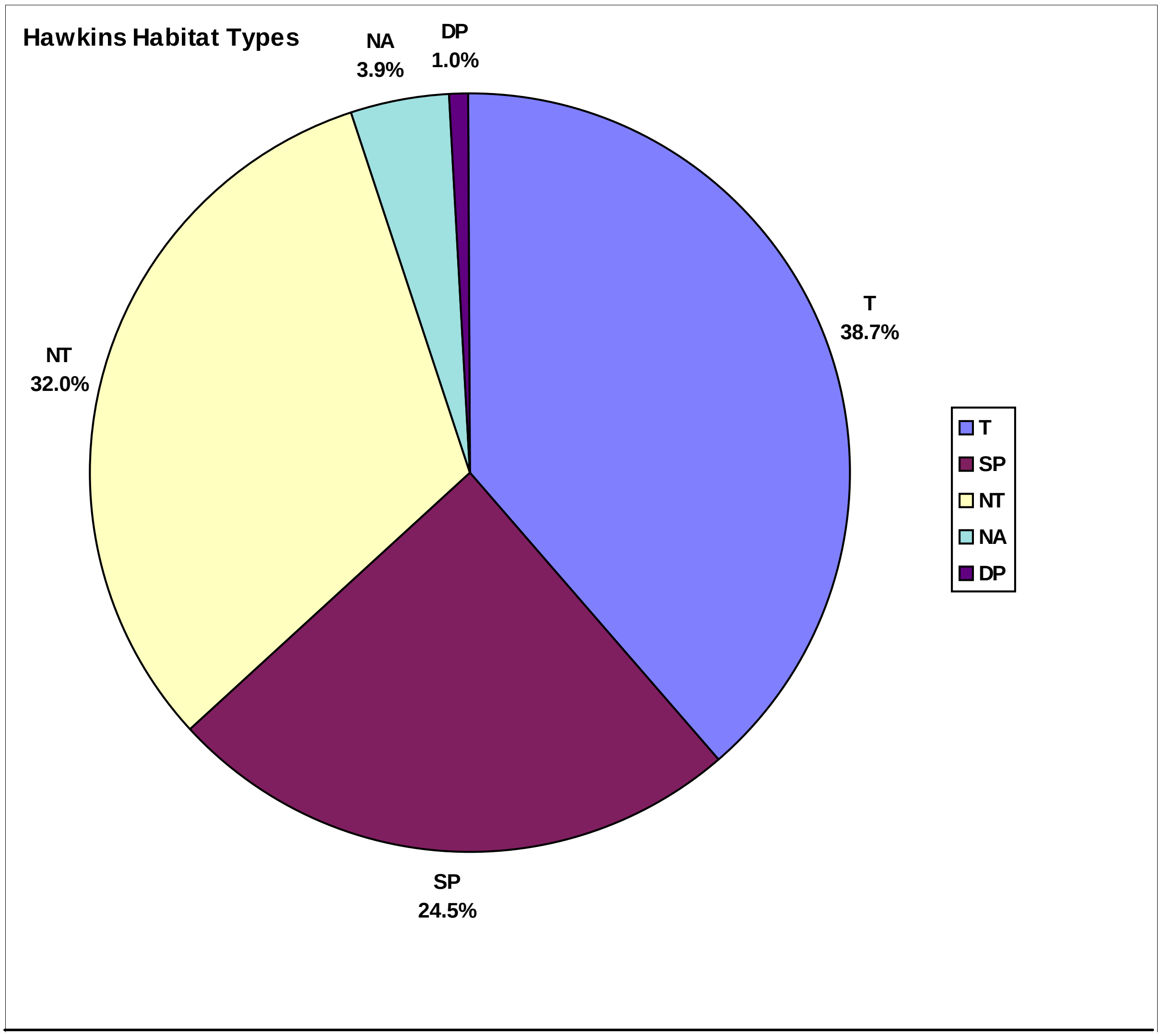


Figure CAWG 1-40. Hawkins Habitat Types for Bolsillo Creek (cont).

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek BD Reach

Rosgen 1 Channel Type = B

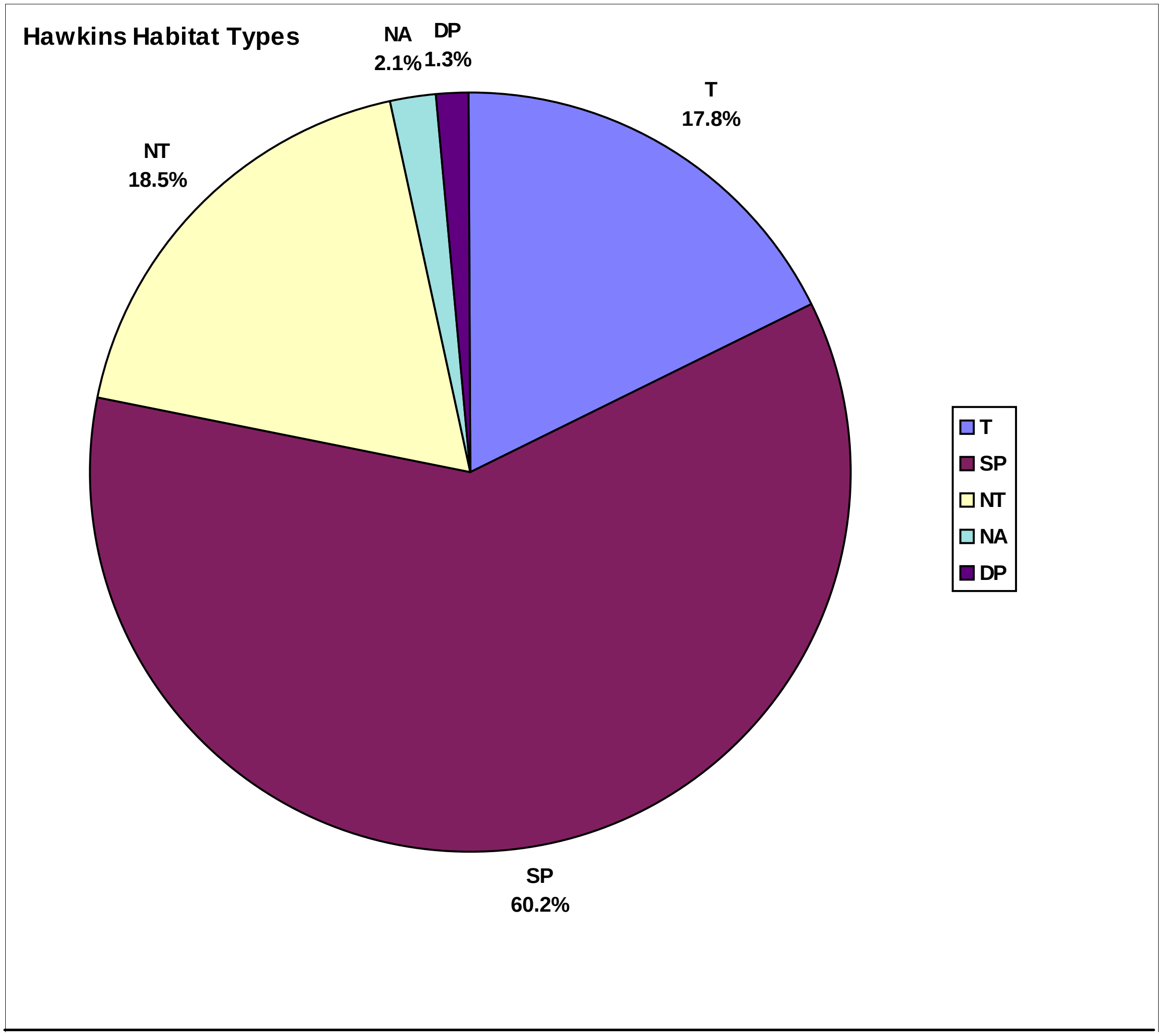


Figure CAWG 1-40. Hawkins Habitat Types for Bolsillo Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek AD Reach

Rosgen 1 Channel Type = B

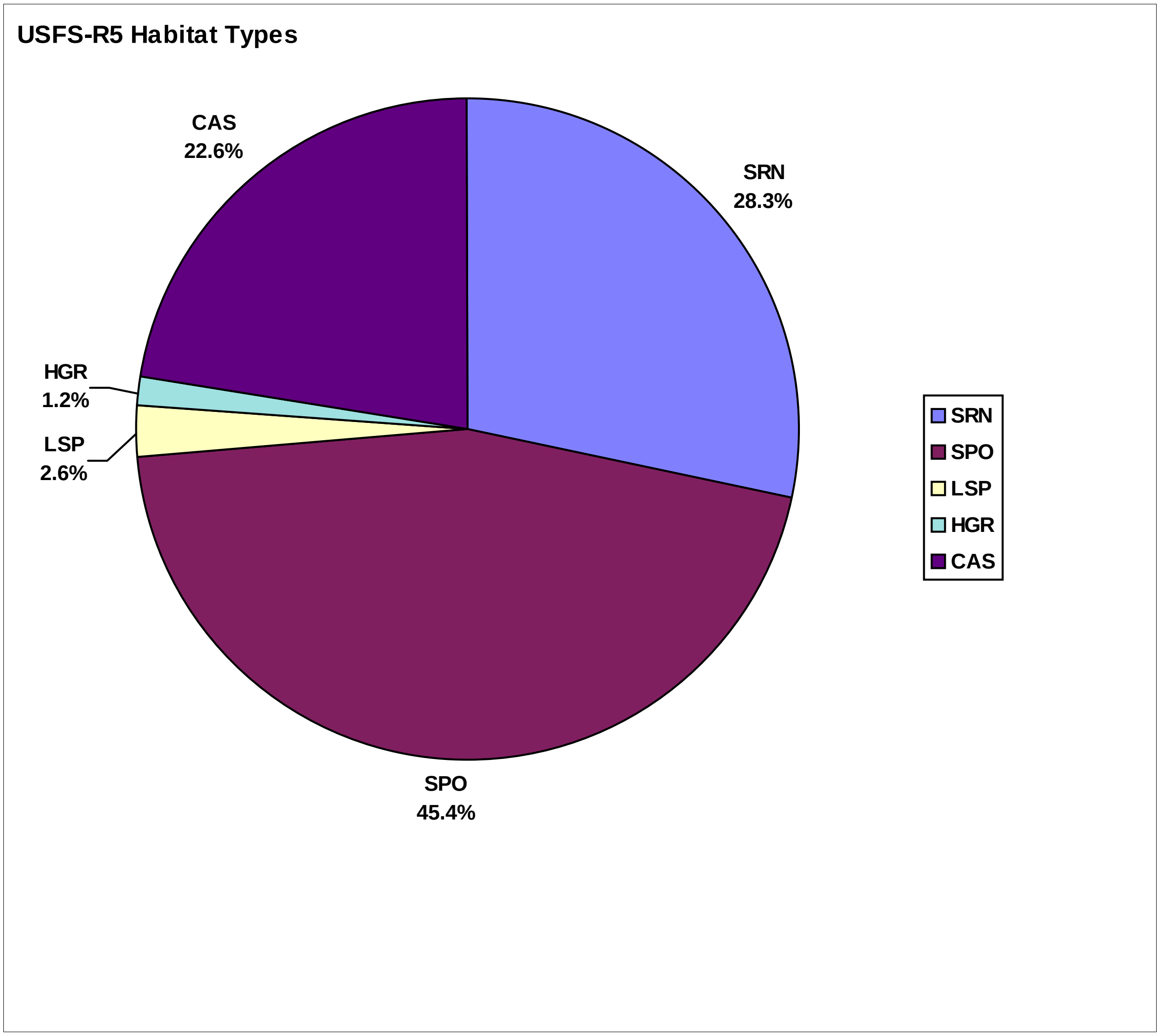


Figure CAWG 1-41. USFS-R5 Habitat Types for Bolsillo Creek.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek BD Reach

Rosgen 1 Channel Type = Aa+

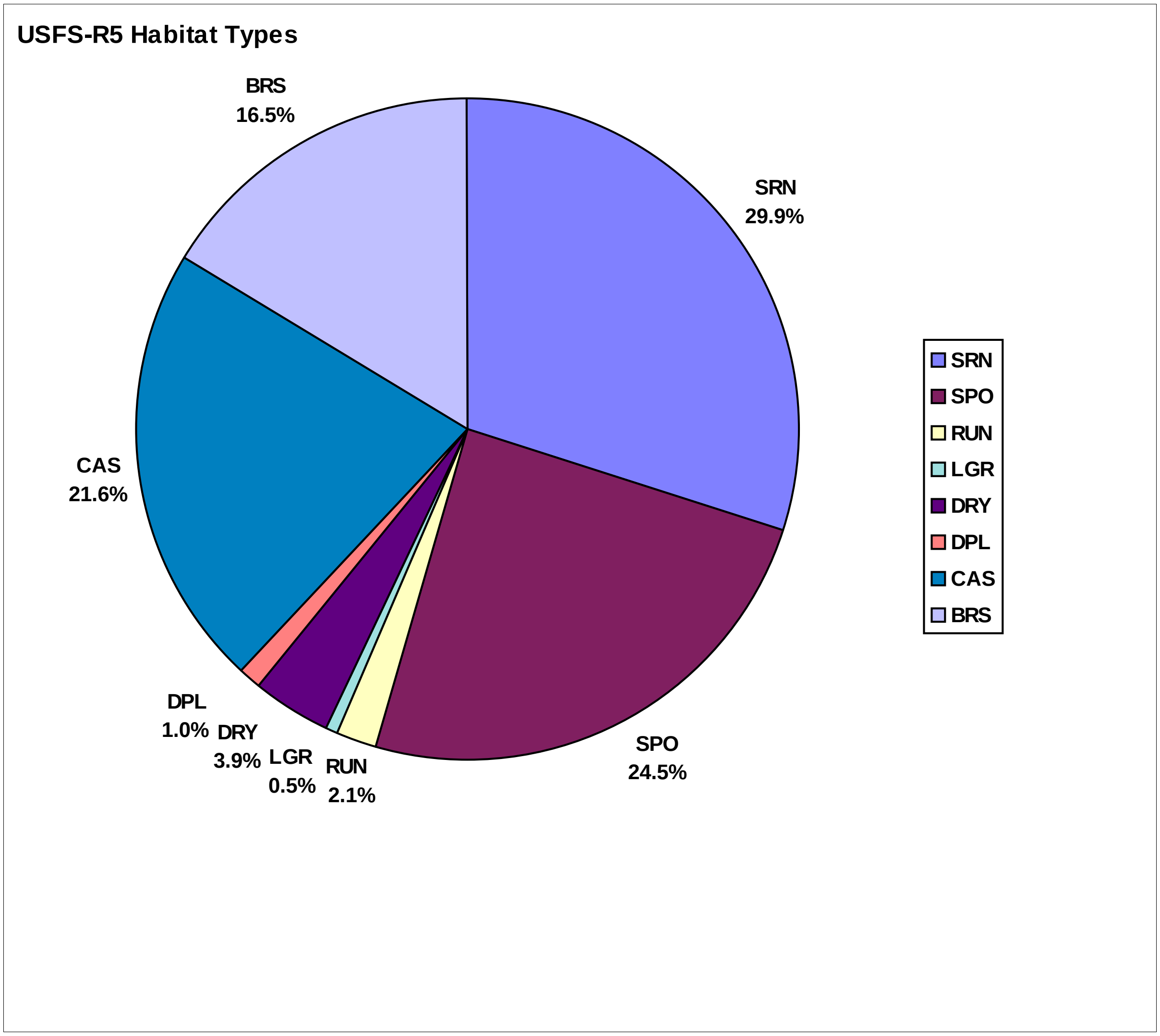


Figure CAWG 1-41. USFS-R5 Habitat Types for Bolsillo Creek (cont).

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Bolsillo Creek

Bolsillo Creek BD Reach

Rosgen 1 Channel Type = B

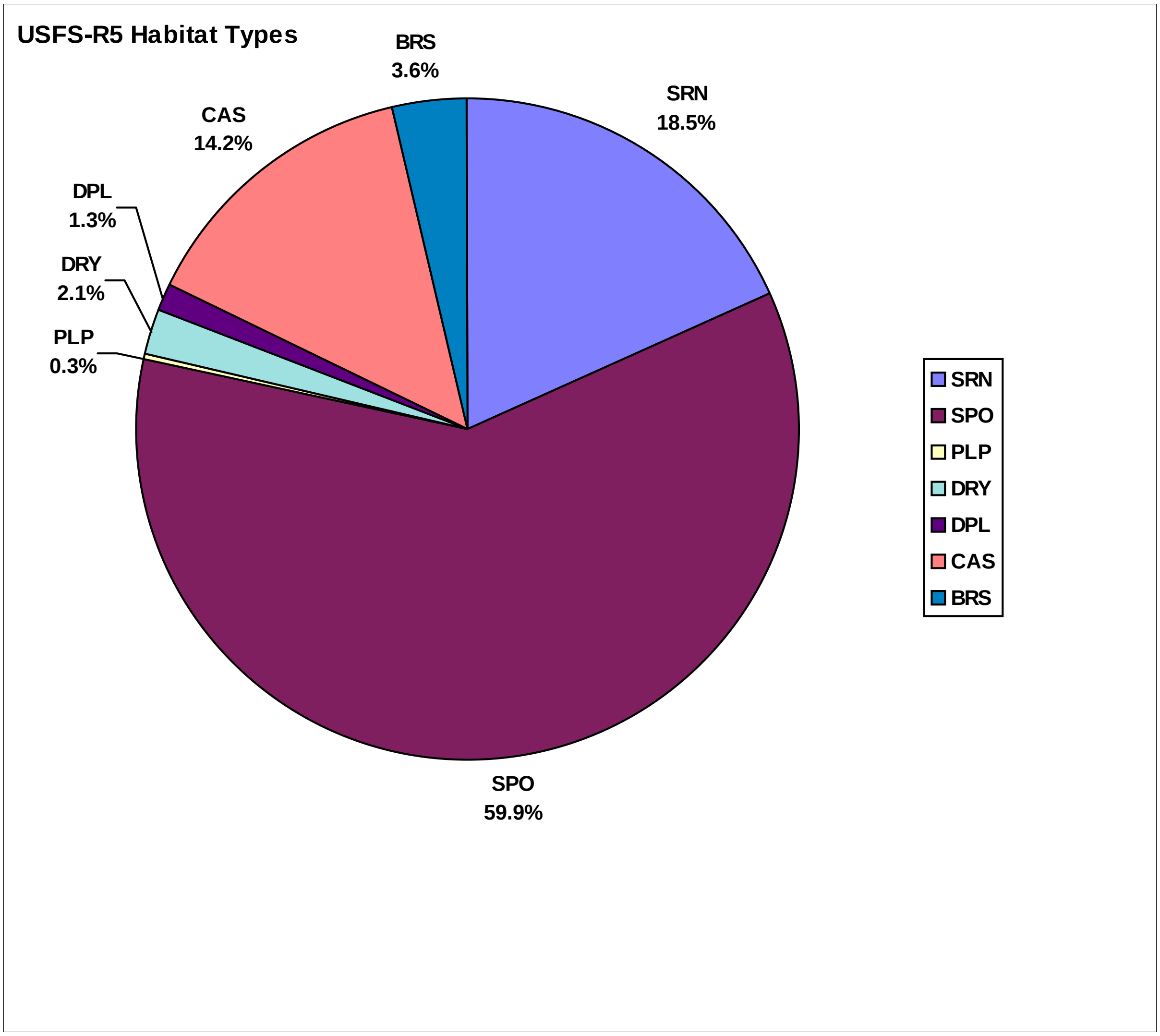


Figure CAWG 1-41. USFS-R5 Habitat Types for Bolsillo Creek (cont).

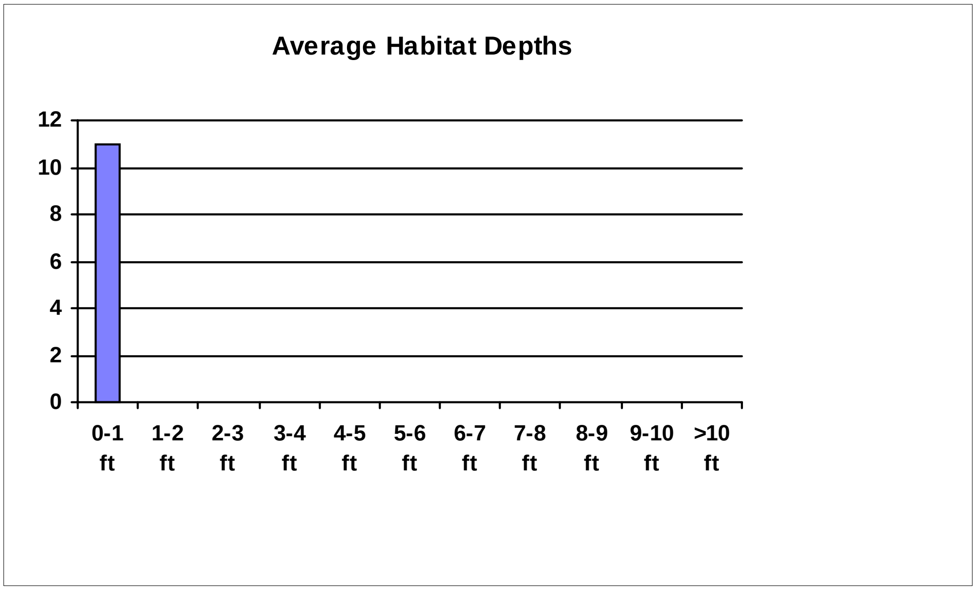
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Bolsillo Creek BoC

Bolsillo Creek BD Reach BoCb_R



Aa+ Channel Type

Figure CAWG 1-42. Average Habitat Depth Histograms for Bolsillo Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 8/15/2000.

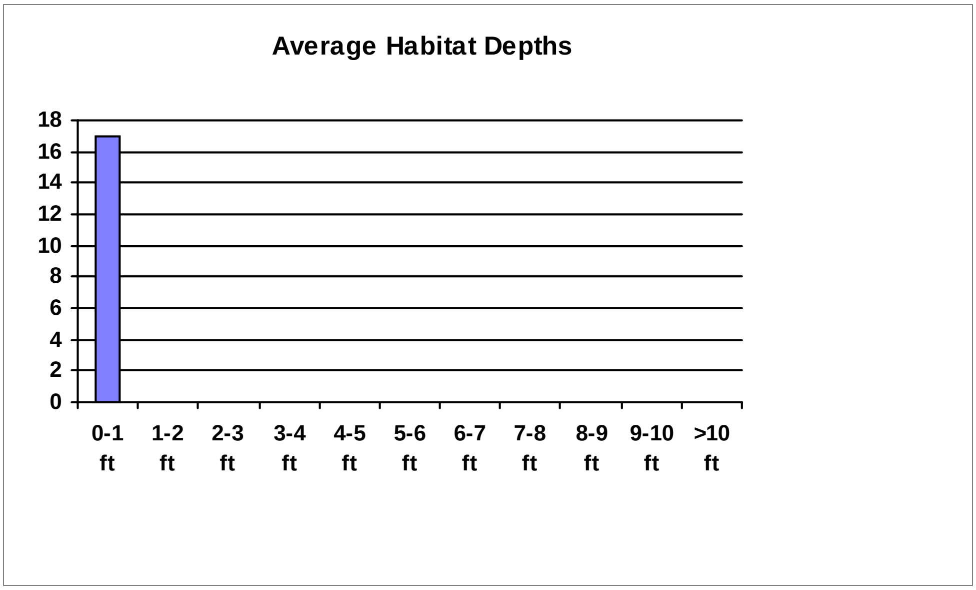
Recorded Average Habitat Depth Histograms

1 foot bin size

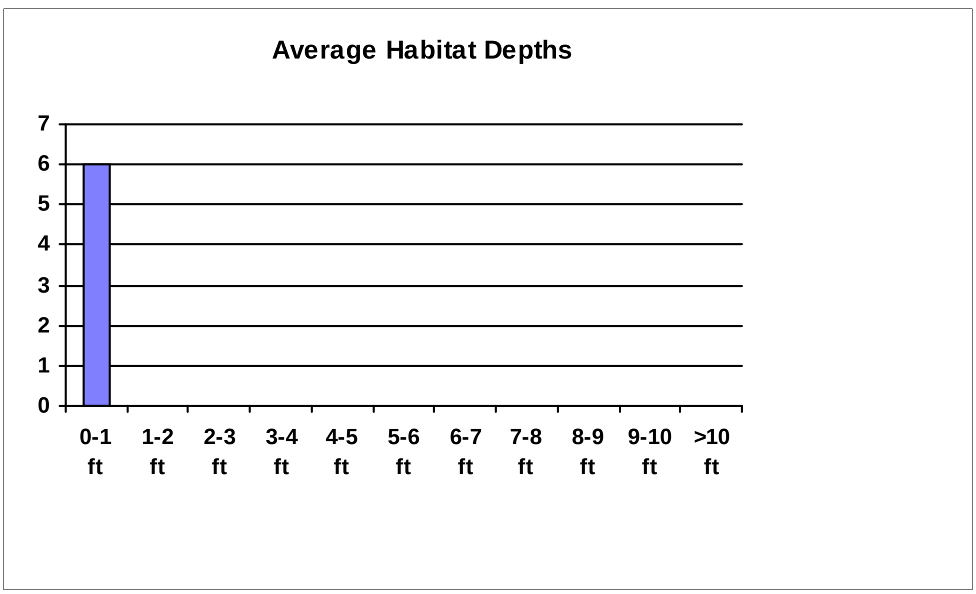
South Fork San Joaquin River (Basin) BAS_SF

Bolsillo Creek BoC

Bolsillo Creek BD Reach BoCb_R



Bolsillo Creek AD Reach BoC_R



B Channel Type

Figure CAWG 1-42. Average Habitat Depth Histograms for Bolsillo Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/15/2000 Below Diversion and 8/16/2000 Above Diversion.

Hawkins Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Mono Creek

Mono Creek below Mono Diversion Reach

Rosgen 1 Channel Type = B

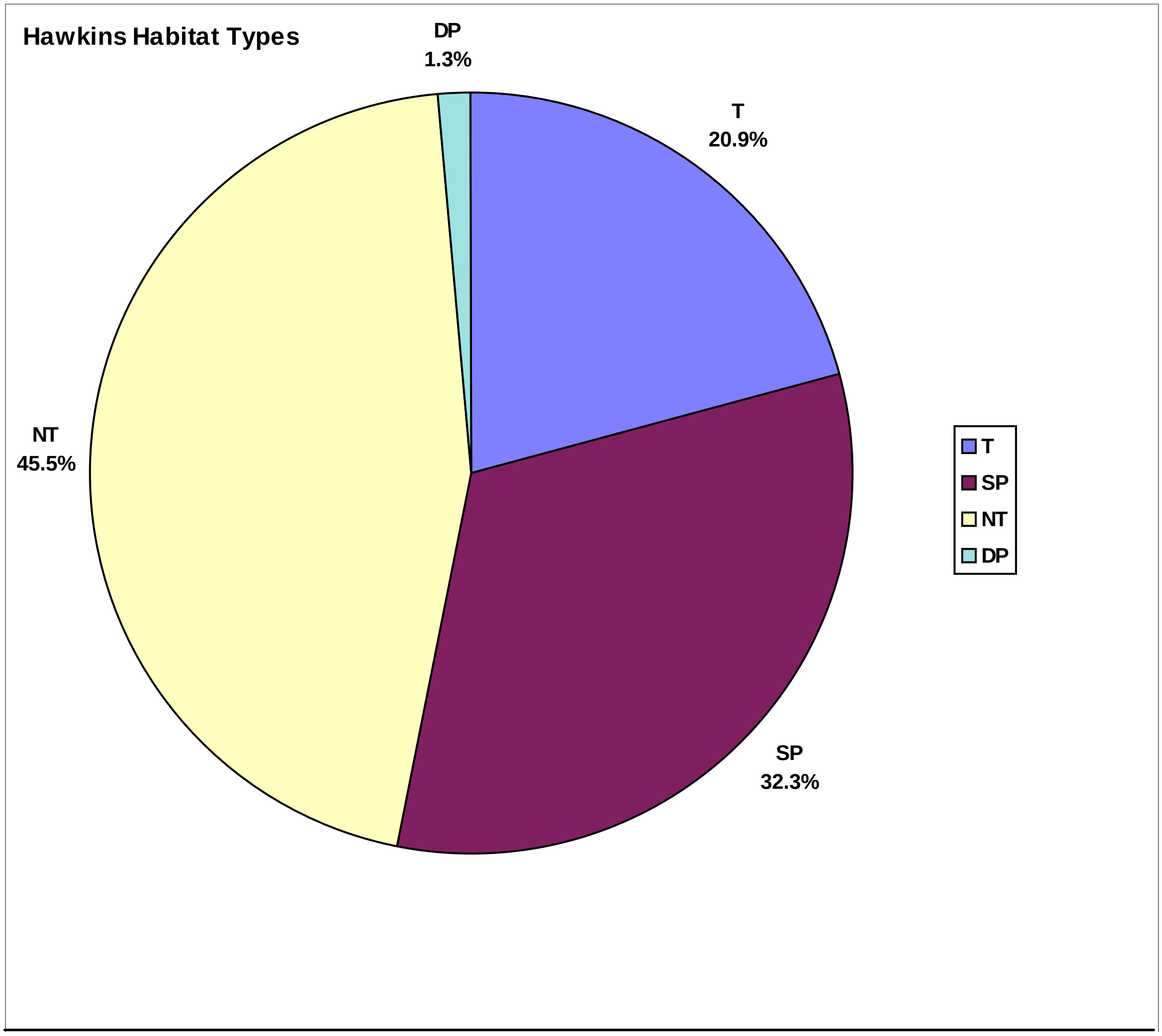


Figure CAWG 1-43. Hawkins Habitat Types for Mono Creek below Mono Diversion.

USFS-R5 Habitat Types by Channel Type

South Fork San Joaquin River (Basin)

Mono Creek

Mono Creek below Mono Diversion Reach

Rosgen 1 Channel Type = B

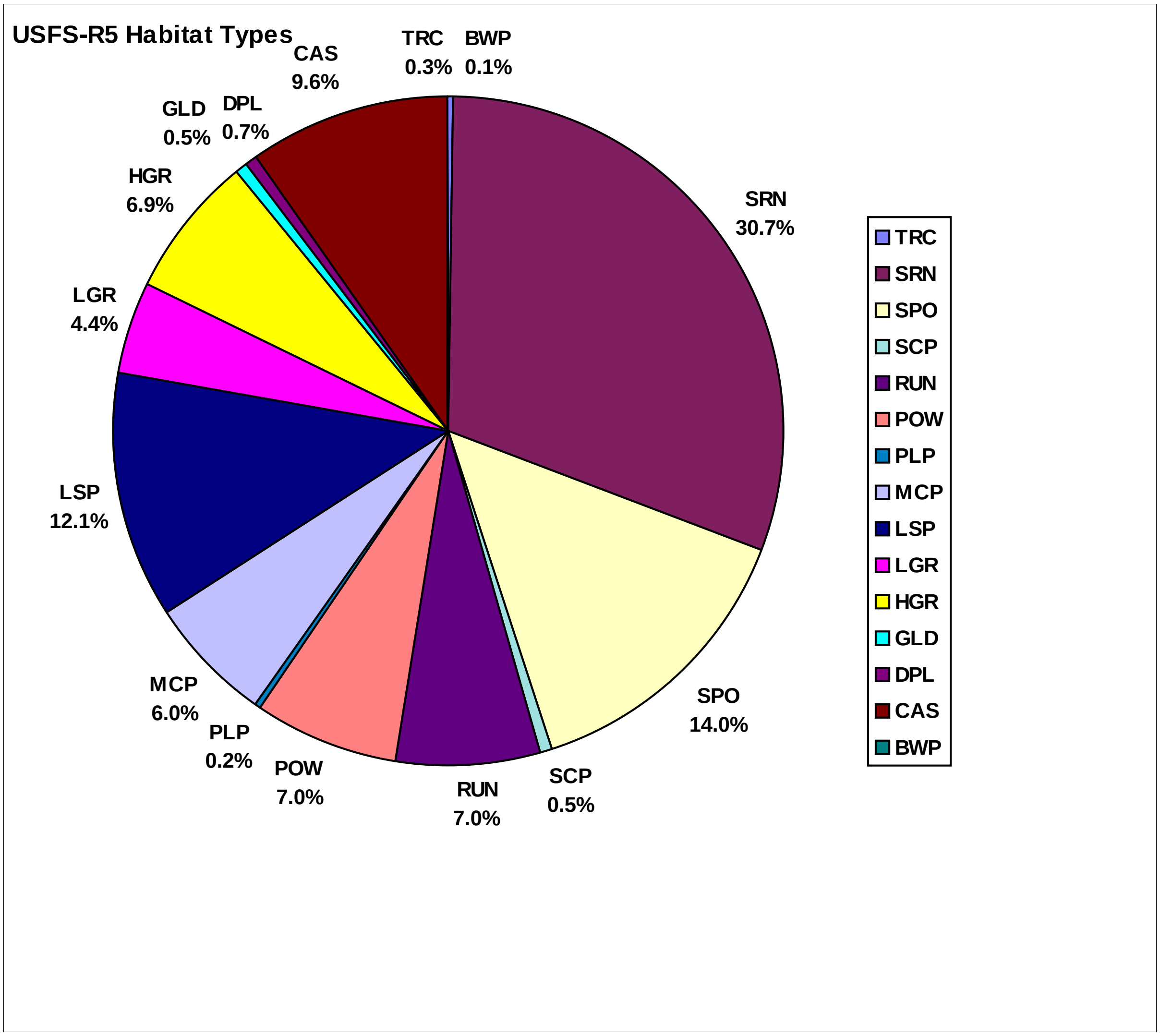


Figure CAWG 1-44. USFS-R5 Habitat Types for Mono Creek below Mono Diversion.

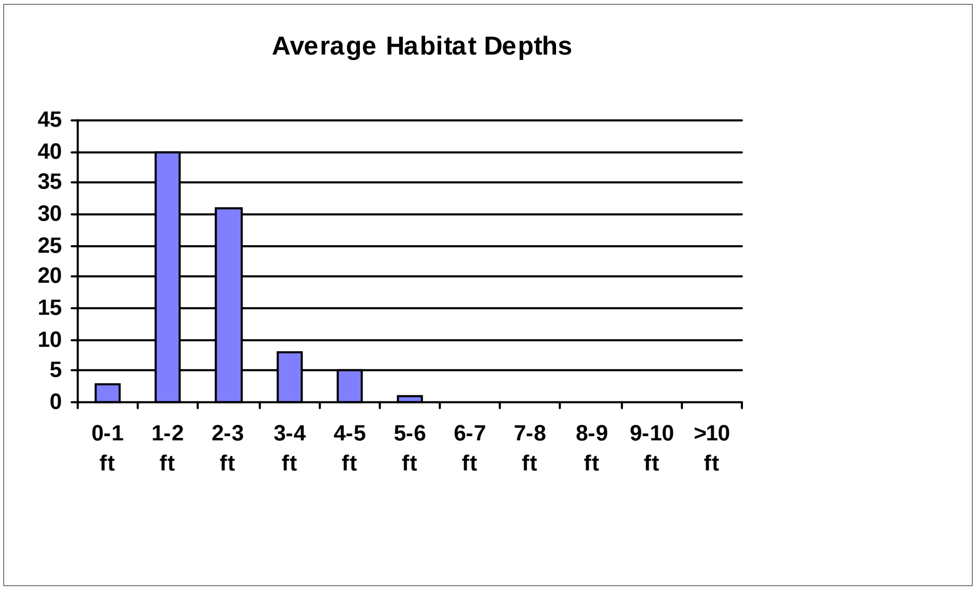
Recorded Average Habitat Depth Histograms

1 foot bin size

South Fork San Joaquin River (Basin) BAS_SF

Mono Creek MoC

Mono Creek below Mono Diversion Reach MoC_R



B Channel Type

Figure CAWG 1-45. Average Habitat Depth Histograms for Mono Creek below Mono Diversion (1 foot bin size, frequency = number of pools).

Data collected starting on 8/11/2000.

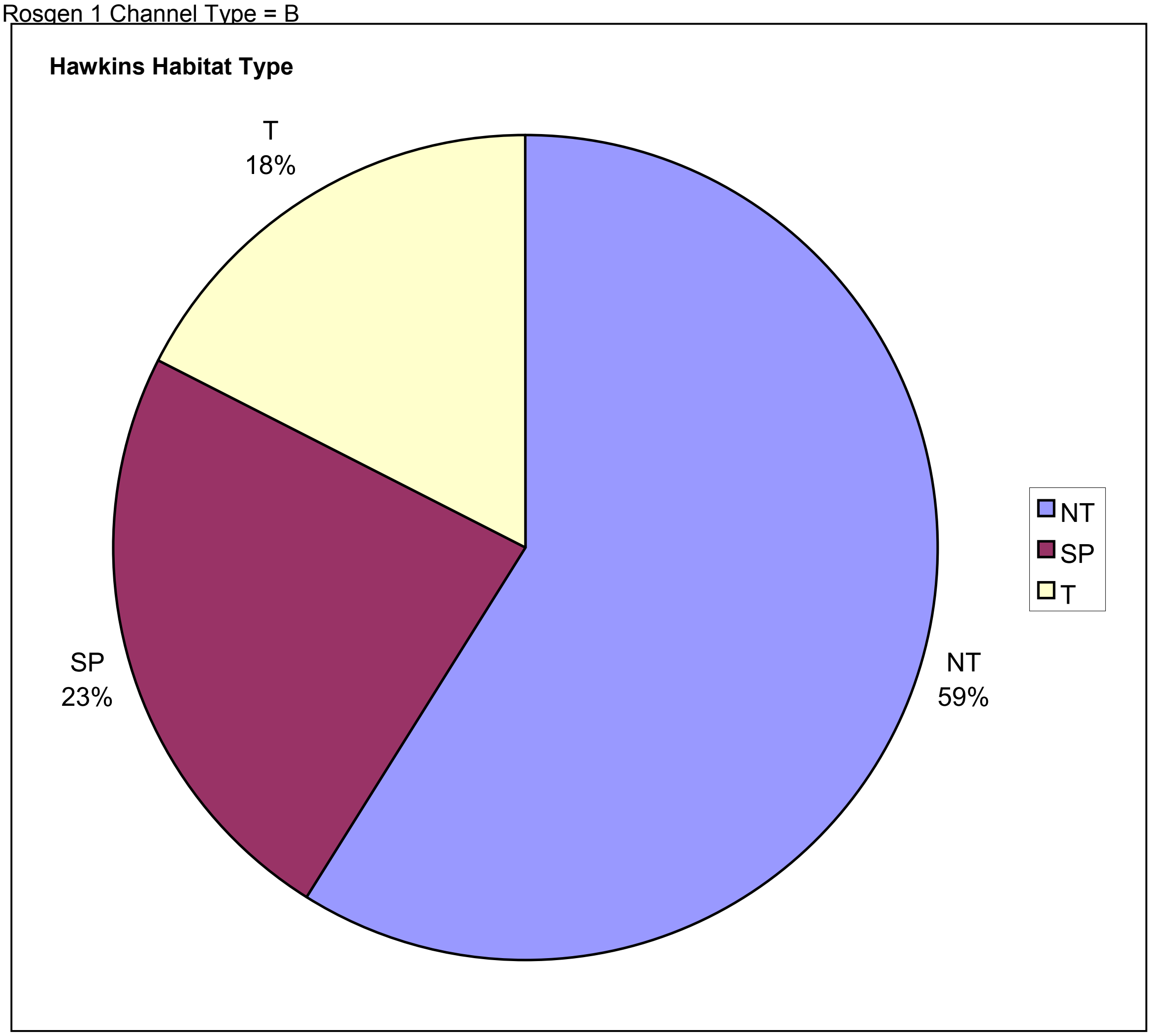
Hawkins Habitat Types by Channel Type

San Joaquin River Reach (Basin)

San Joaquin River

San Joaquin River Mammoth Pool Reservoir to SFSJR Confluence Reach

Rosgen 1 Channel Type = B



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Figure CAWG 1-46. Hawkins Habitat Types for San Joaquin River Mammoth Pool Reservoir to South Fork San Joaquin River Confluence.

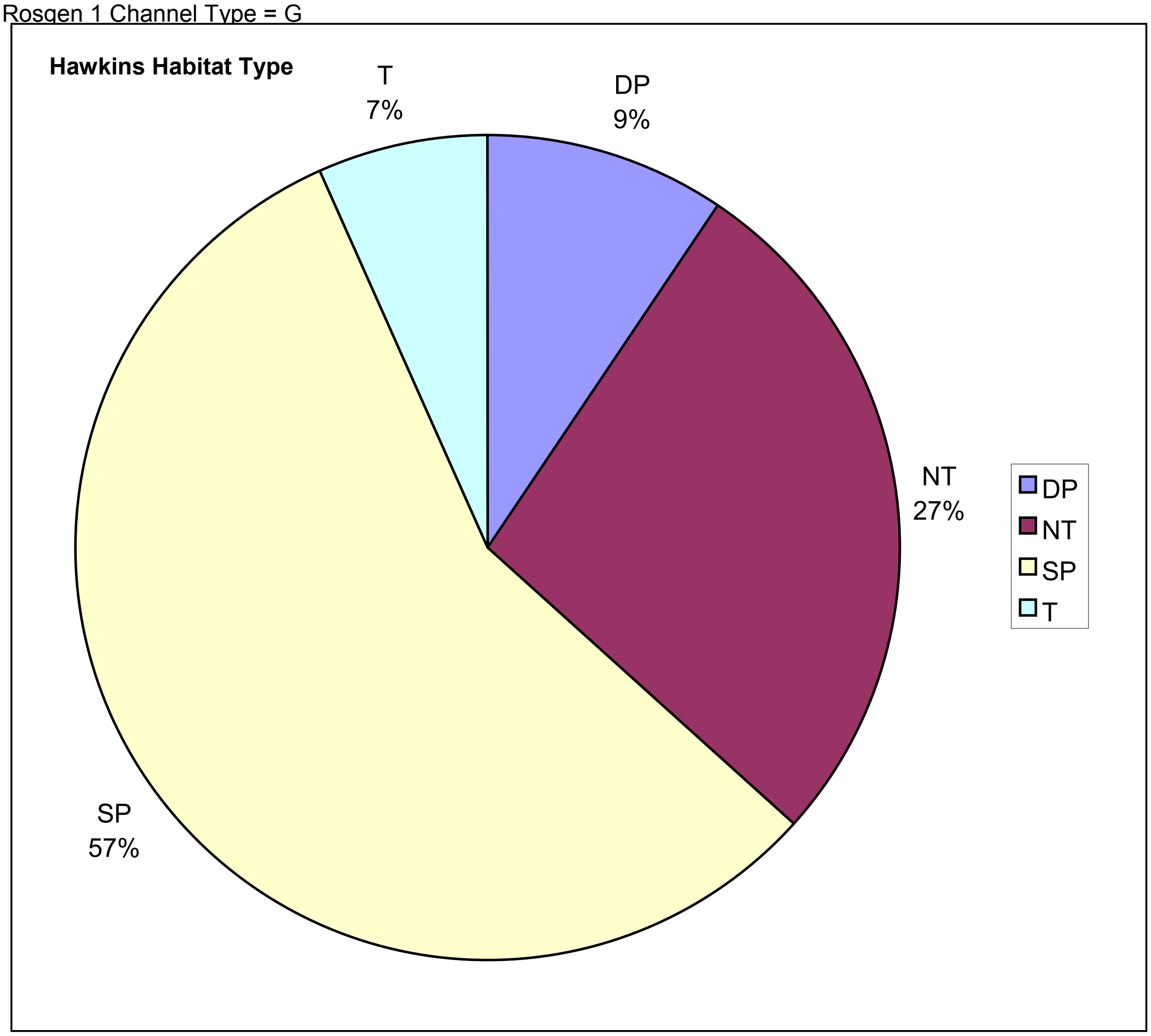
Hawkins Habitat Types by Channel Type

San Joaquin River Reach (Basin)

San Joaquin River

San Joaquin River Mammoth Pool Reservoir to SFSJR Confluence Reach

Rosgen 1 Channel Type = G



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Figure CAWG 1-46. Hawkins Habitat Types for San Joaquin River Mammoth Pool Reservoir to South Fork San Joaquin River Confluence (cont).

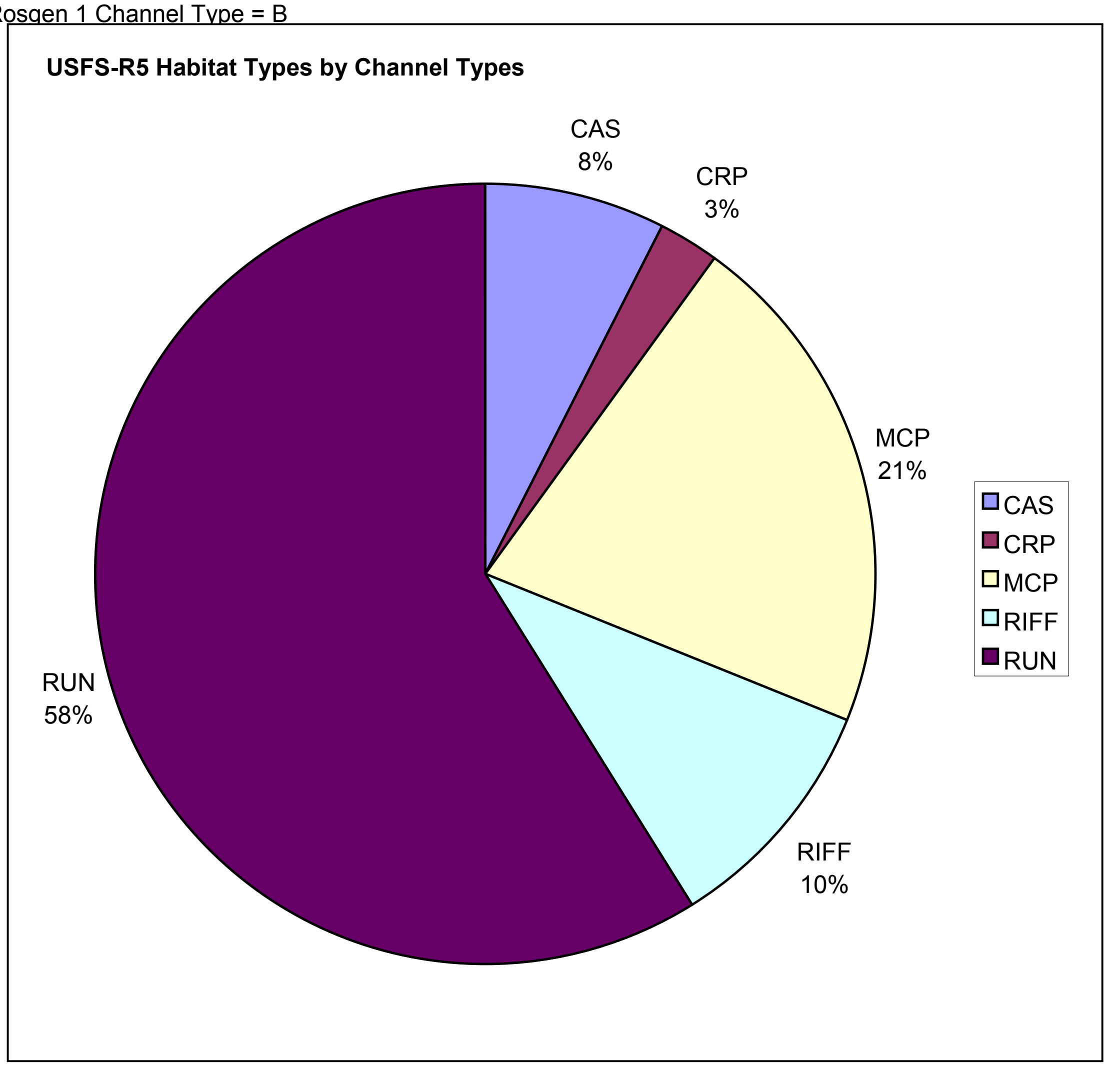
USFS R5 Habitat Types by Channel Type

San Joaquin River Reach (Basin)

San Joaquin River

San Joaquin River Mammoth Pool Reservoir to SFSJR Confluence Reach

Rosgen 1 Channel Type = B



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Figure CAWG 1-47. UFSF-R5 Habitat Types for San Joaquin River Mammoth Pool Reservoir to South Fork San Joaquin River Confluence.

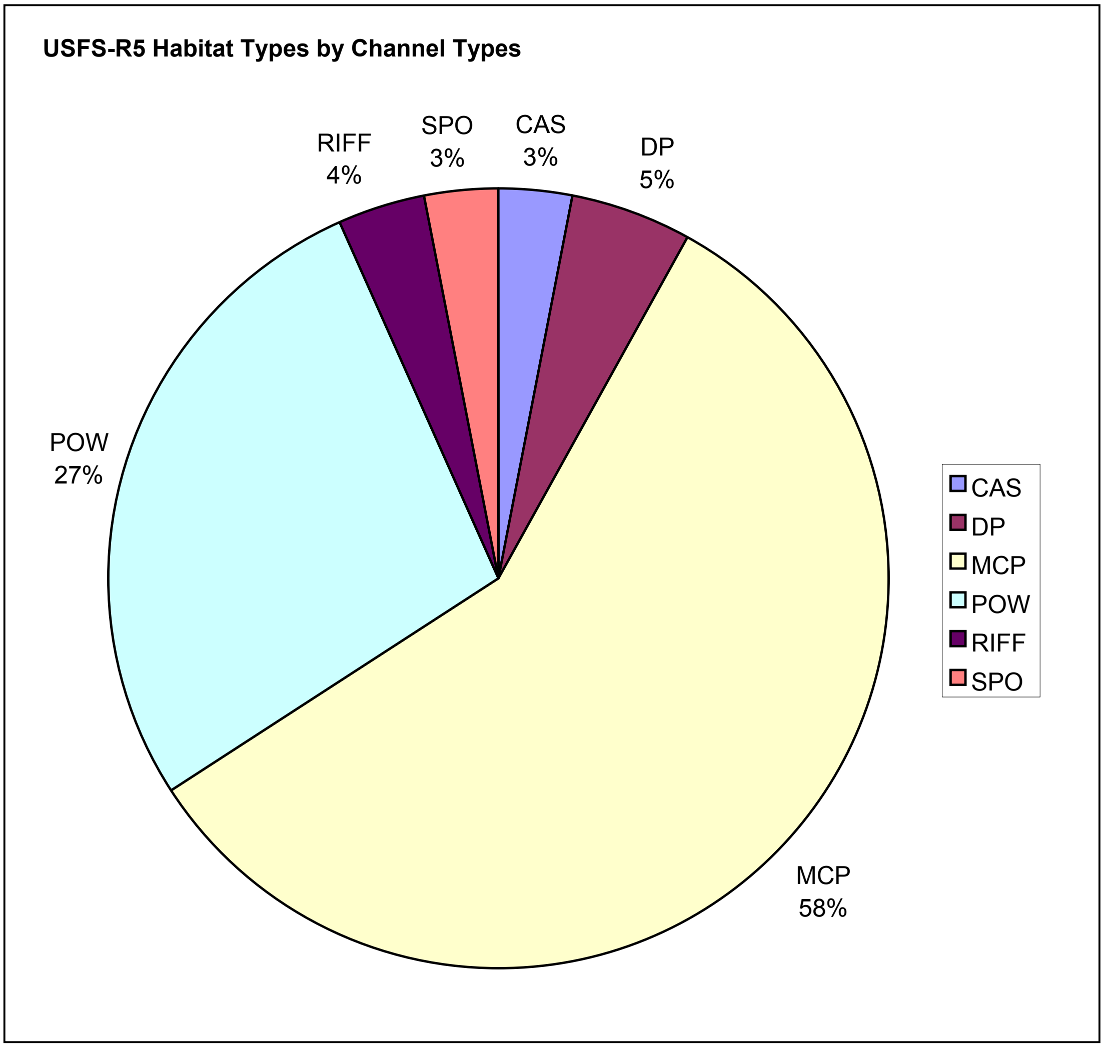
USFS R5 Habitat Types by Channel Type

San Joaquin River Reach (Basin)

San Joaquin River

San Joaquin River Mammoth Pool Reservoir to SFSJR Confluence Reach

Rosgen 1 Channel Type = G



Habitat Units were obtained from aerial photographs, less resolution shown for classification than for ground-based mapping

Figure CAWG 1-47. UFSF-R5 Habitat Types for San Joaquin River Mammoth Pool Reservoir to South Fork San Joaquin River Confluence (cont).

Hawkins Habitat Types by Channel Type

Mammoth Reach (Basin)

San Joaquin River

San Joaquin River Reach

Rosgen 1 Channel Type = B

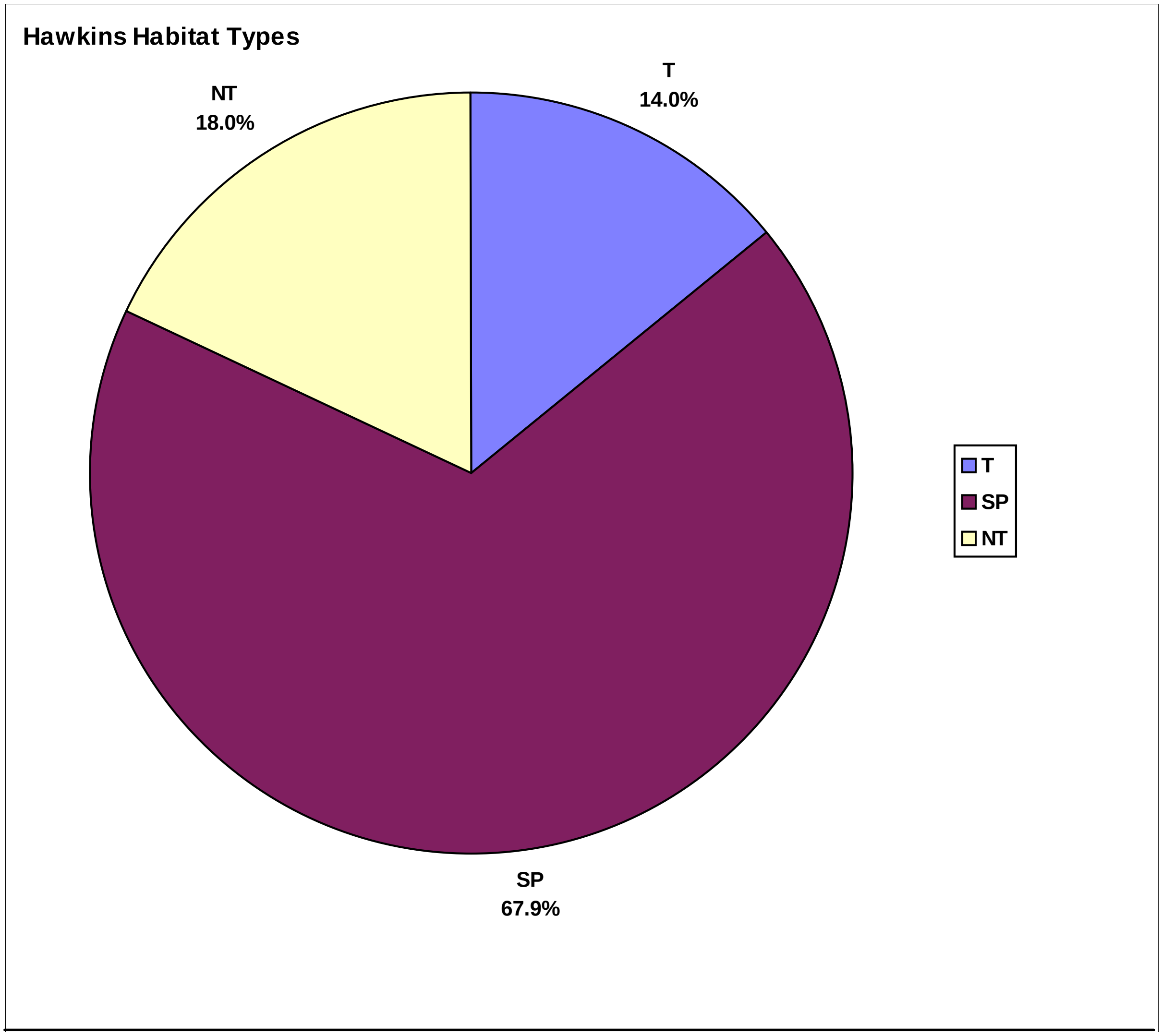


Figure CAWG 1-48. Hawkins Habitat Types for San Joaquin River Mammoth Reach.

Hawkins Habitat Types by Channel Type

Mammoth Reach (Basin)

San Joaquin River

San Joaquin River Reach

Rosgen 1 Channel Type = G

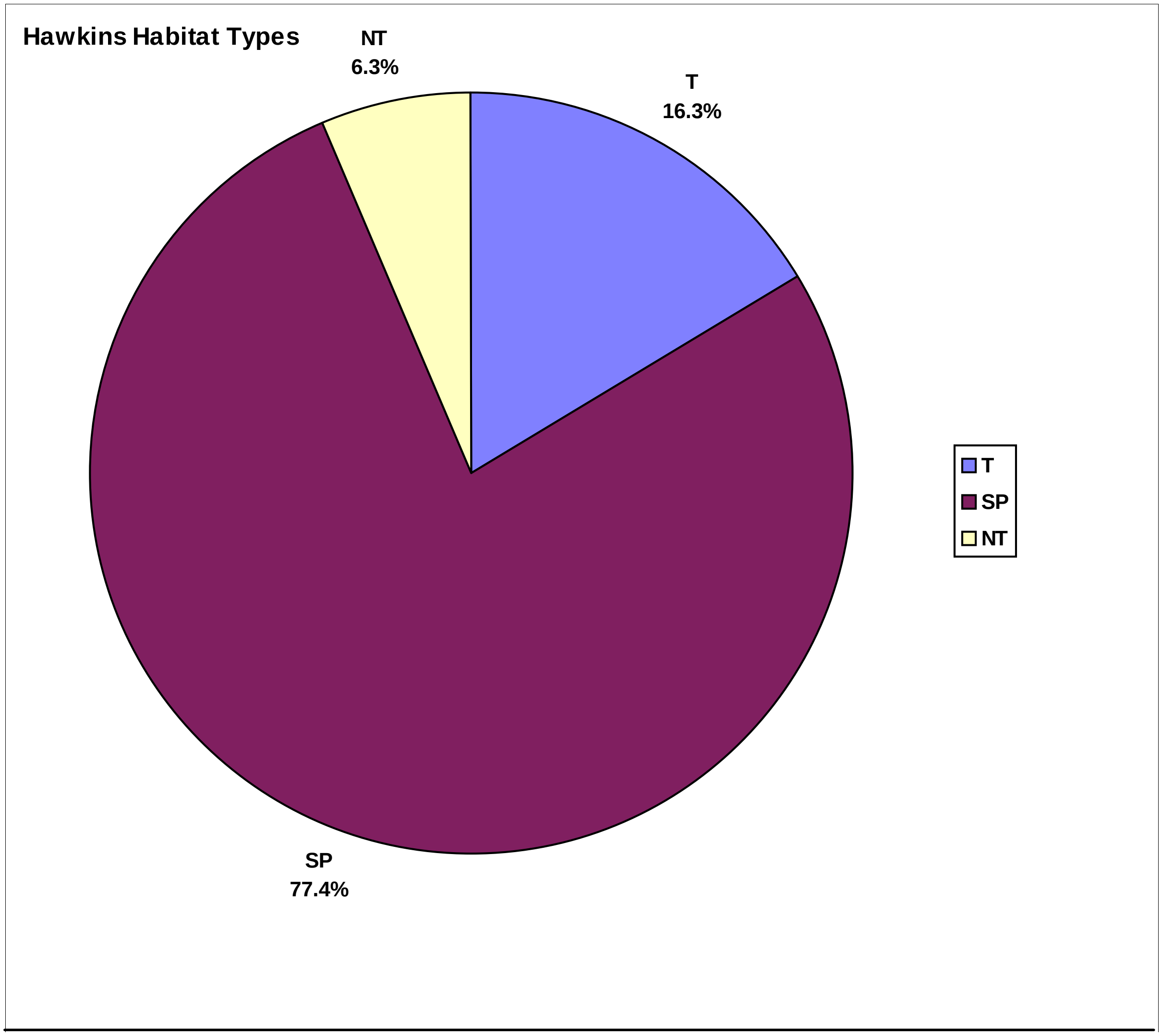


Figure CAWG 1-48. Hawkins Habitat Types for San Joaquin River Mammoth Reach (cont).

USFS-R5 Habitat Types by Channel Type

Mammoth Reach (Basin)

San Joaquin River

San Joaquin River Reach

Rosgen 1 Channel Type = B

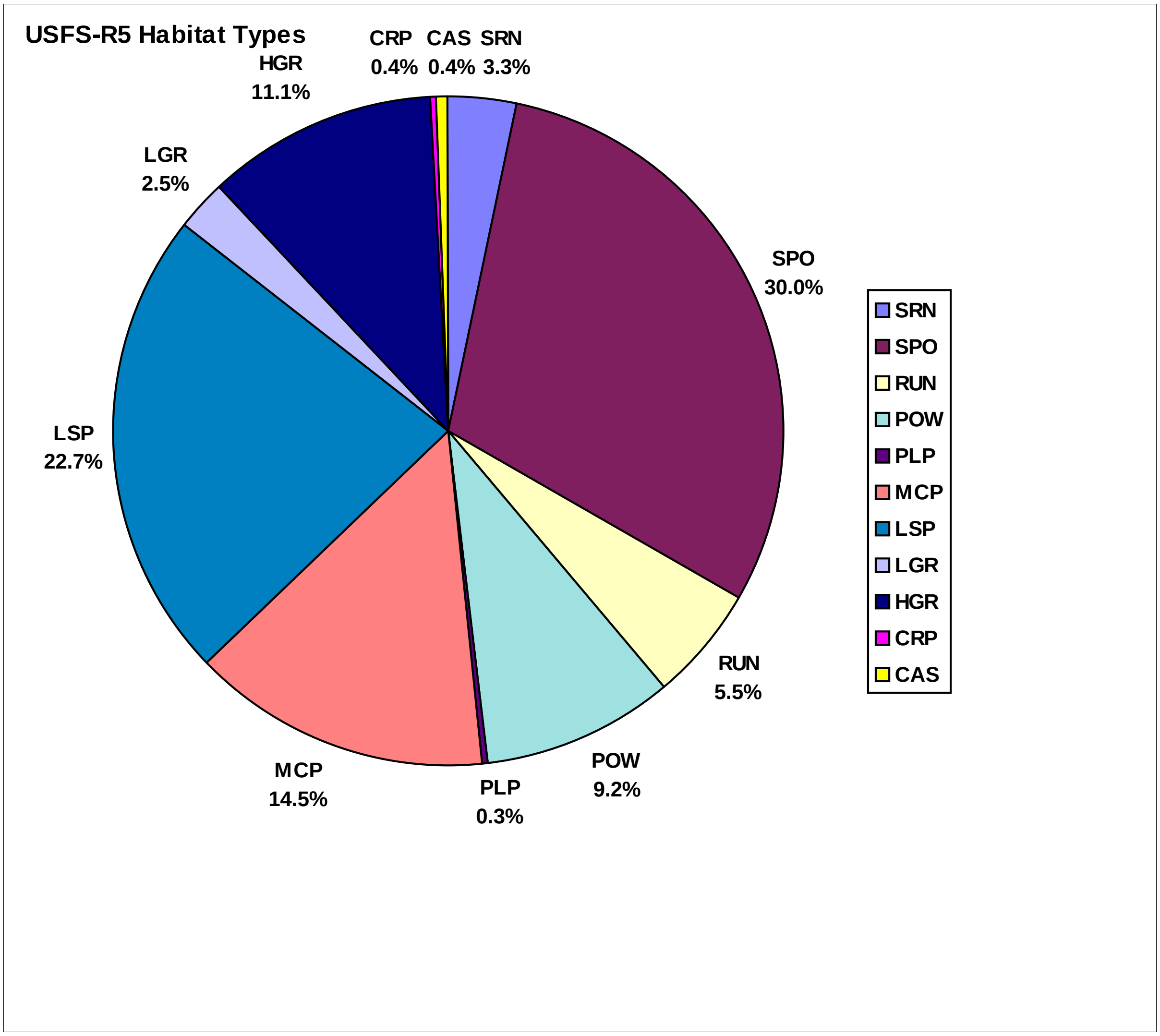


Figure CAWG 1-49. USFS-R5 Habitat Types for San Joaquin River Mammoth Reach.

USFS-R5 Habitat Types by Channel Type

Mammoth Reach (Basin)

San Joaquin River

San Joaquin River Reach

Rosgen 1 Channel Type = G

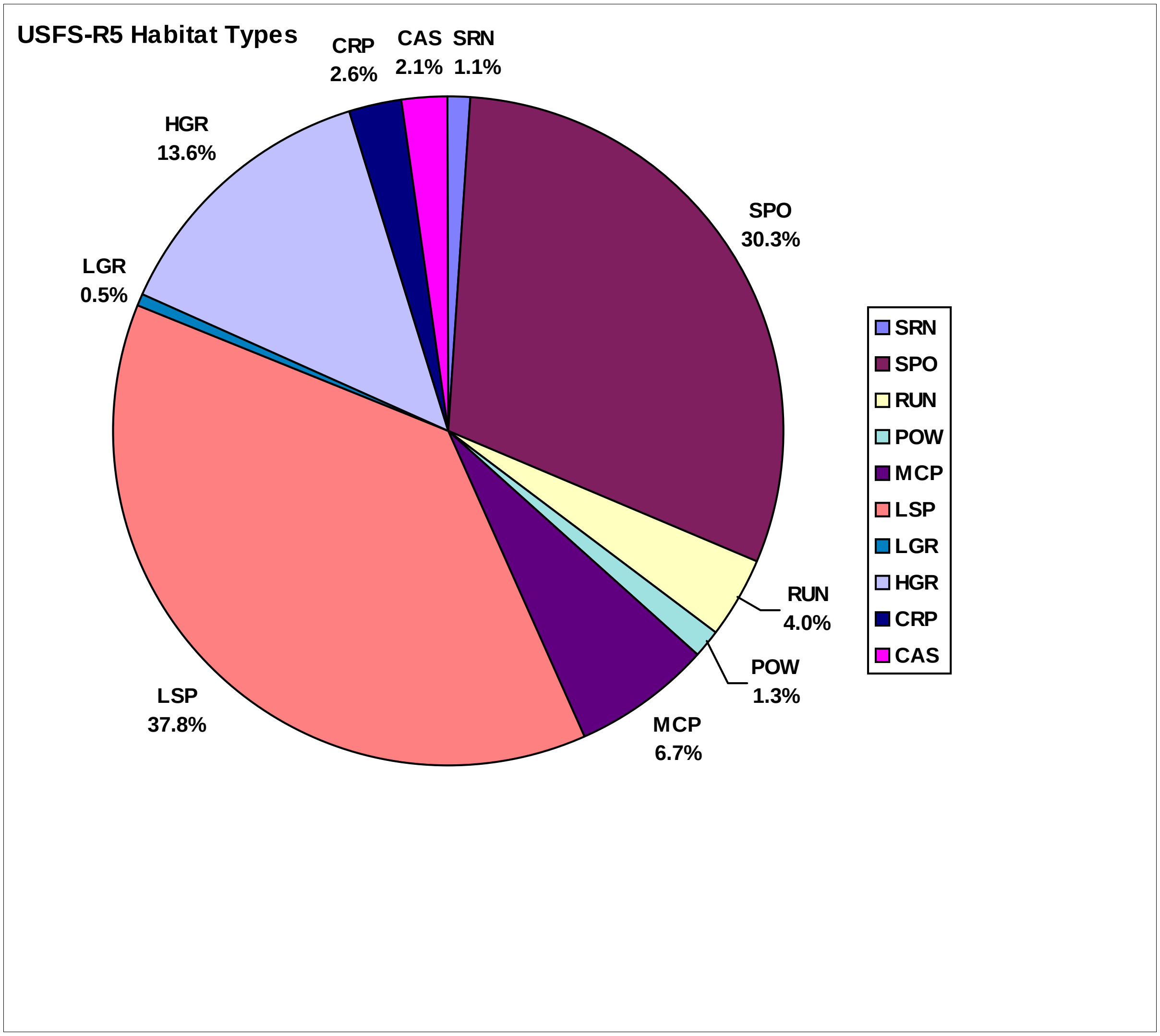


Figure CAWG 1-49. USFS-R5 Habitat Types for San Joaquin River Mammoth Reach (cont).

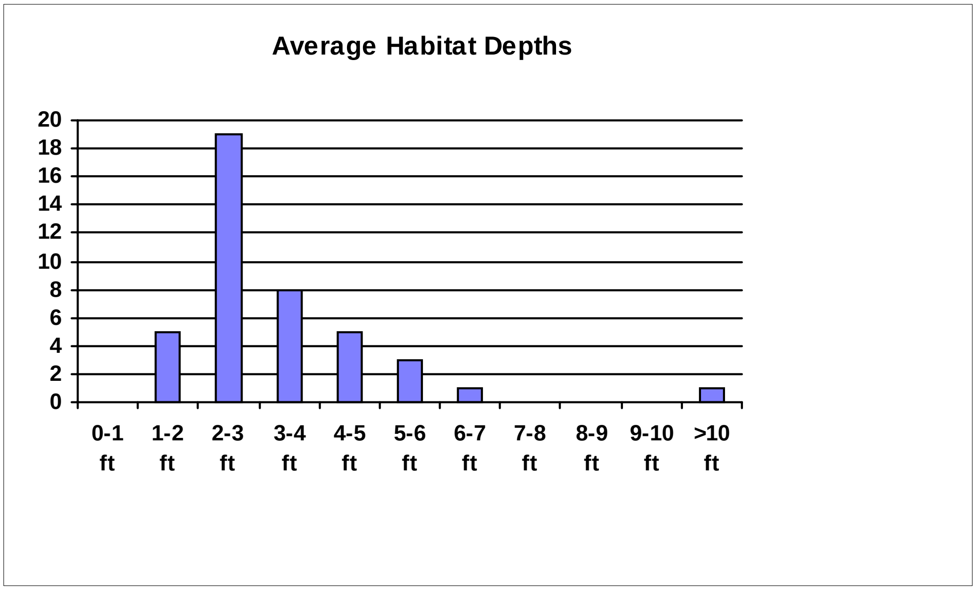
Recorded Average Habitat Depth Histograms

1 foot bin size

Mammoth Reach (Basin) BAS_M

San Joaquin River SJR_M

San Joaquin River Reach SJR_M_



B Channel Type

Figure CAWG 1-50. Average Habitat Depth Histograms for San Joaquin River Mammoth Reach (1 foot bin size, frequency = number of pools).

Data collected starting on 9/19/2000.

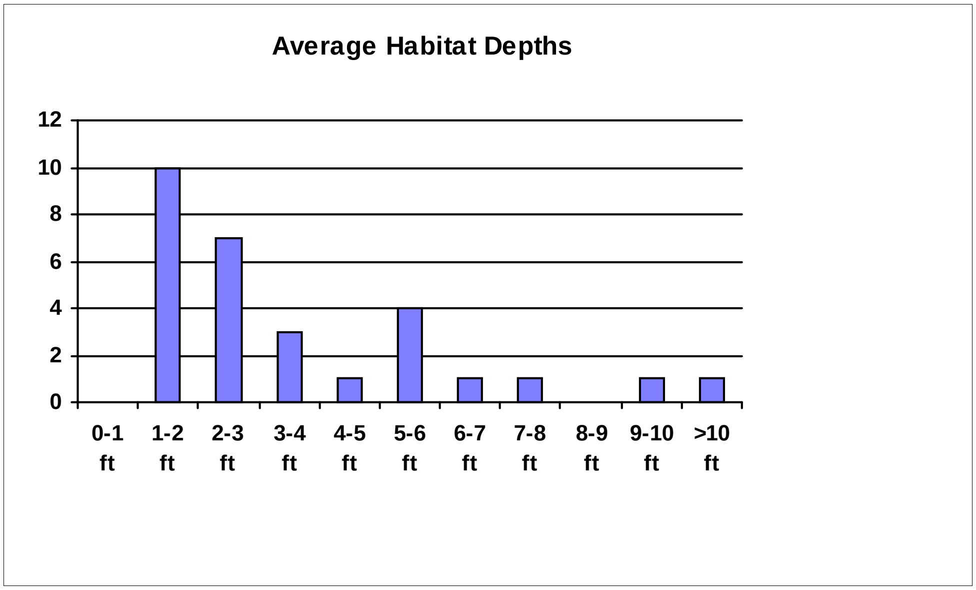
Recorded Average Habitat Depth Histograms

1 foot bin size

Mammoth Reach (Basin) BAS_M

San Joaquin River SJR_M

San Joaquin River Reach SJR_M_



G Channel Type

Figure CAWG 1-50. Average Habitat Depth Histograms for San Joaquin River Mammoth Reach (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 9/19/2000.

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

San Joaquin River

SJR Stevenson Reach

Rosgen 1 Channel Type = G

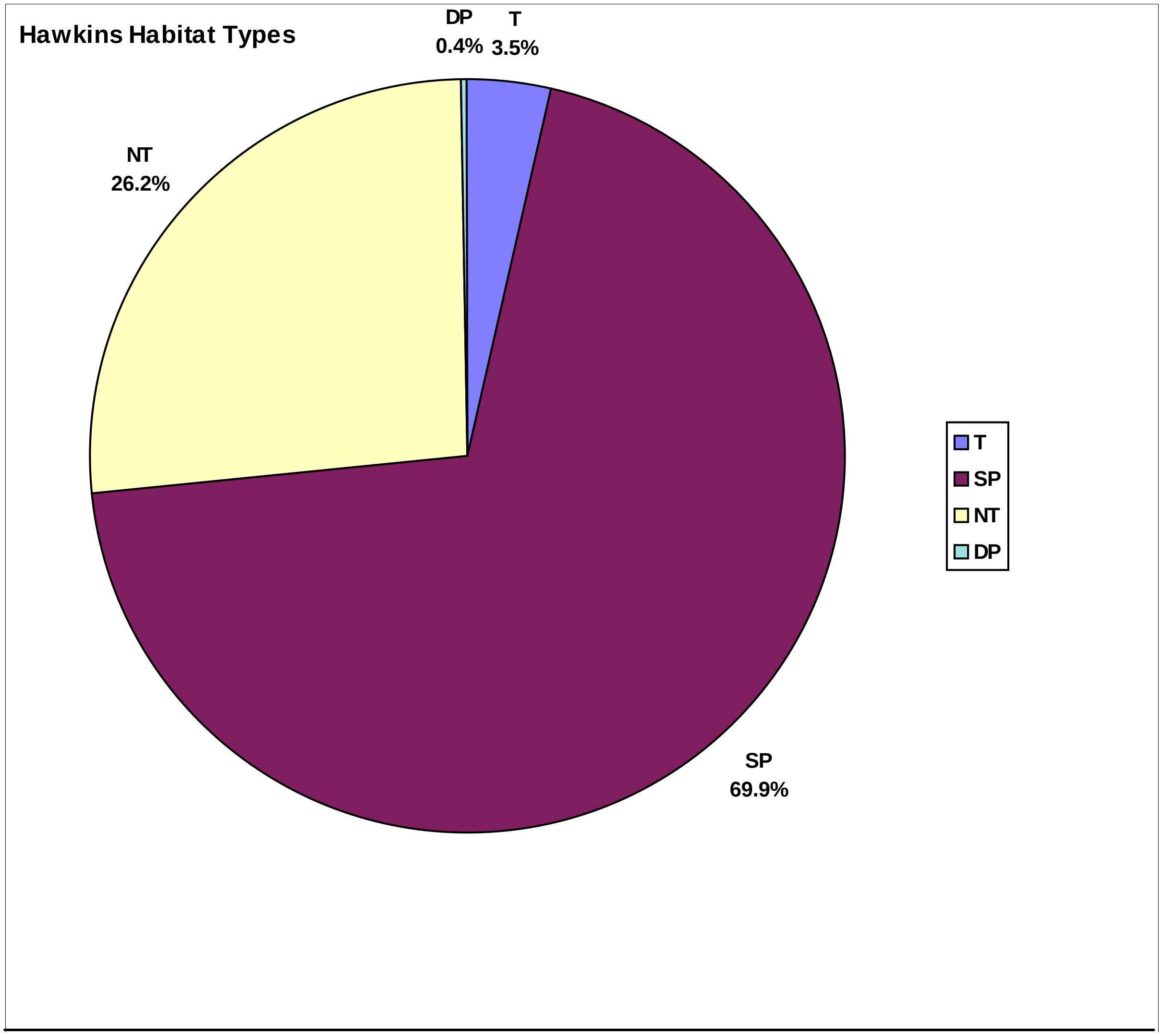


Figure CAWG 1-51. Hawkins Habitat Types for San Joaquin River Stevenson Reach.

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

San Joaquin River

SJR Stevenson Reach

Rosgen 1 Channel Type = G

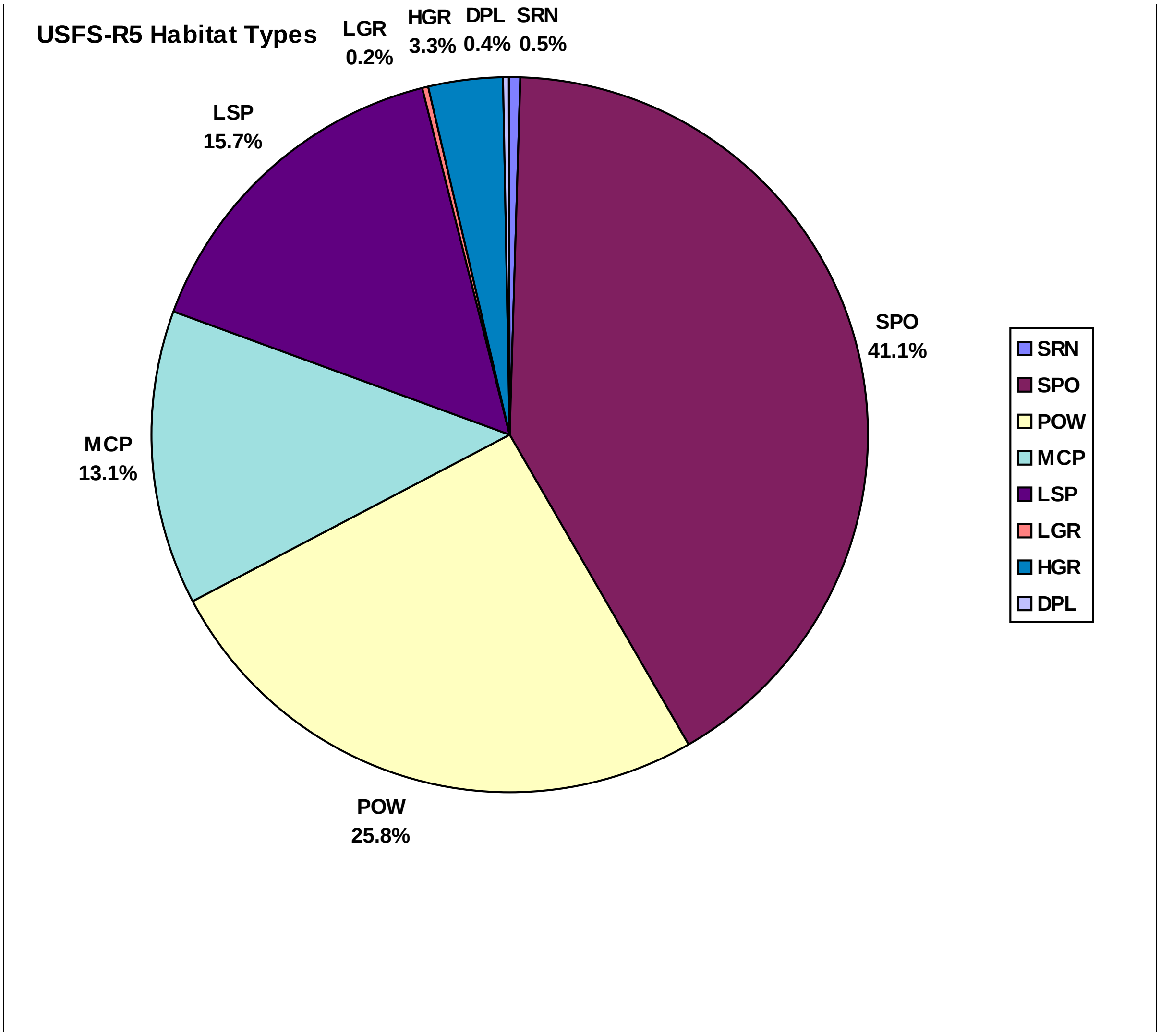


Figure CAWG 1-52. USFS-R5 Habitat Types for San Joaquin River Stevenson Reach.

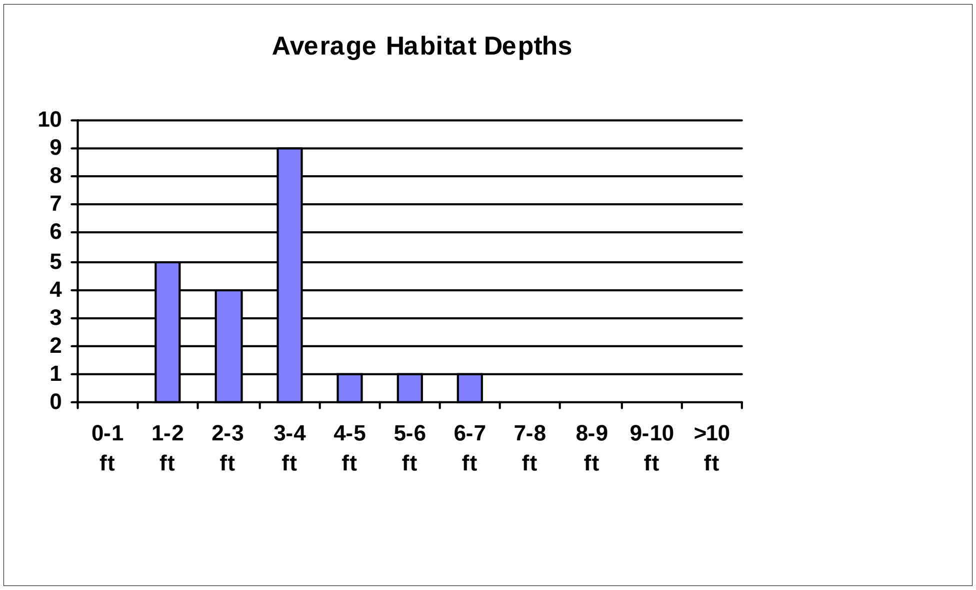
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

San Joaquin River SJR_S

SJR Stevenson Reach SJRS_R



G Channel Type

Figure CAWG 1-53. Average Habitat Depth Histograms for San Joaquin River Stevenson Reach (1 foot bin size, frequency = number of pools).

Data collected starting on 7/26/2000.

Hawkins Habitat Types by Channel Type

Mammoth Reach (Basin)

Rock Creek

Rock Creek AD Reach

Rosgen 1 Channel Type = Aa+

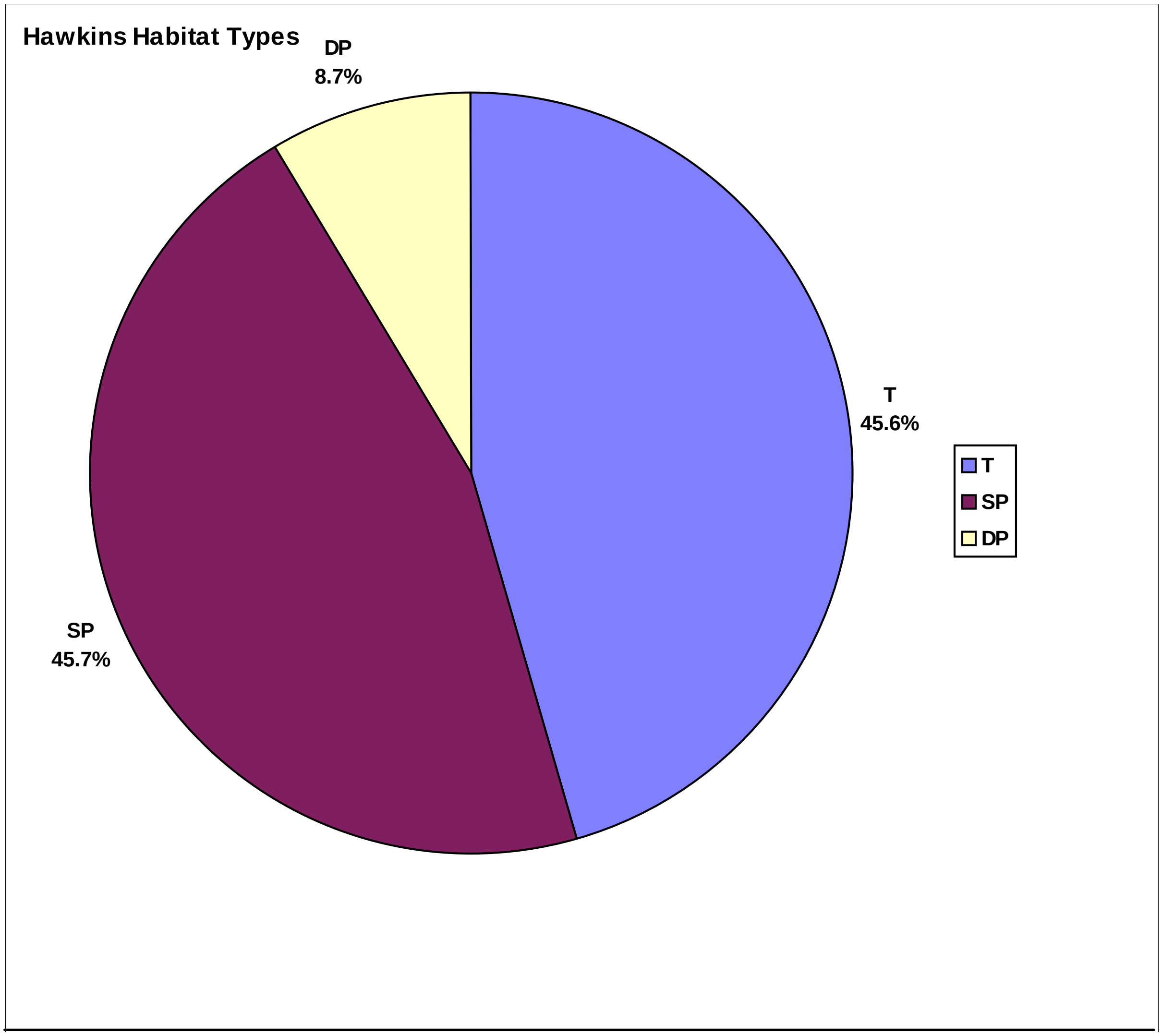


Figure CAWG 1-54. Hawkins Habitat Types for Rock Creek.

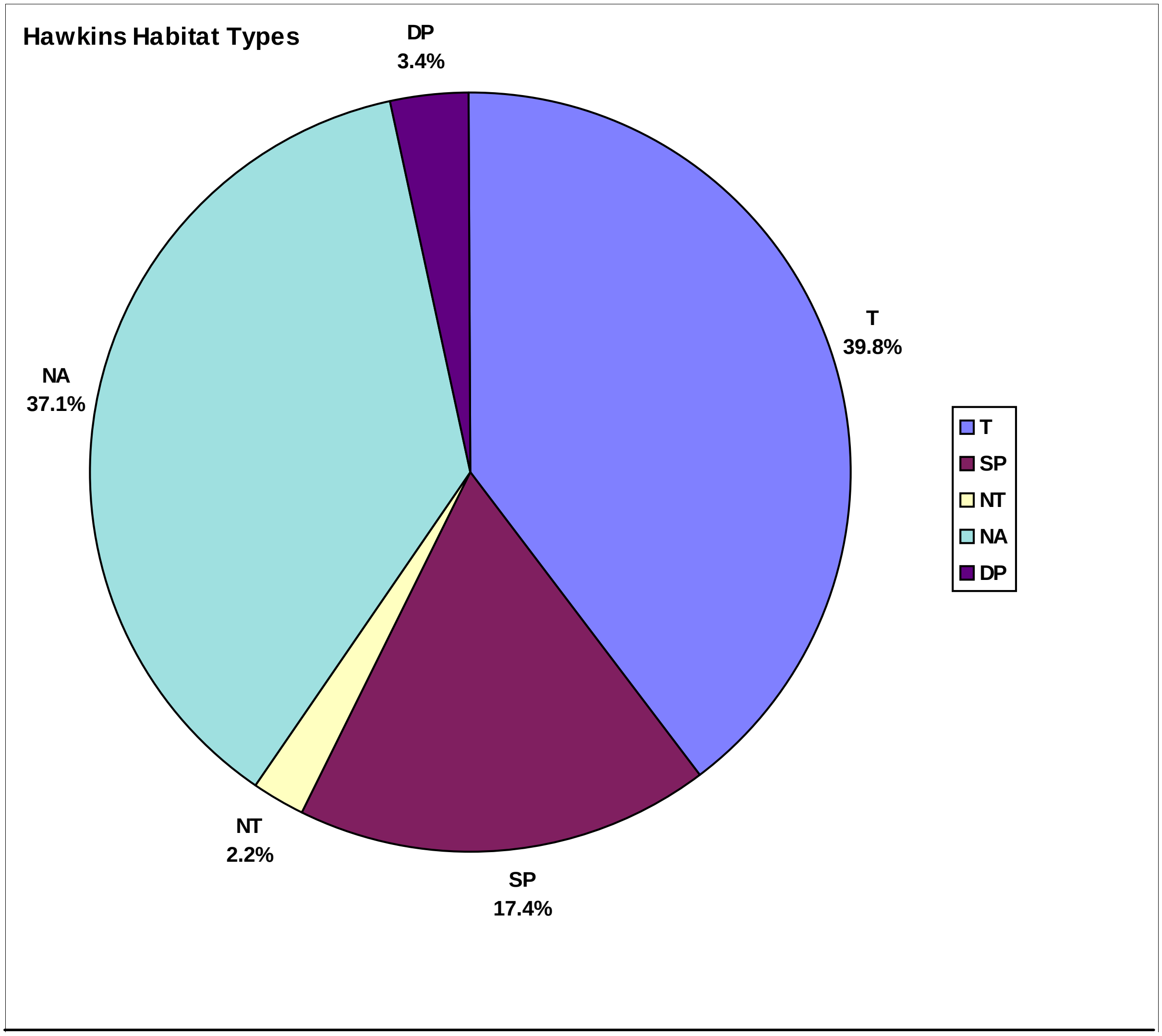
Hawkins Habitat Types by Channel Type

Mammoth Reach (Basin)

Rock Creek

Rock Creek BD Reach

Rosgen 1 Channel Type = Aa+



Note: 1,000 feet of mesohabitat was visually estimated from aerial photography and overflight.

Figure CAWG 1-54. Hawkins Habitat Types for Rock Creek (cont).

USFS-R5 Habitat Types by Channel Type

Mammoth Reach (Basin)

Rock Creek

Rock Creek AD Reach

Rosgen 1 Channel Type = Aa+

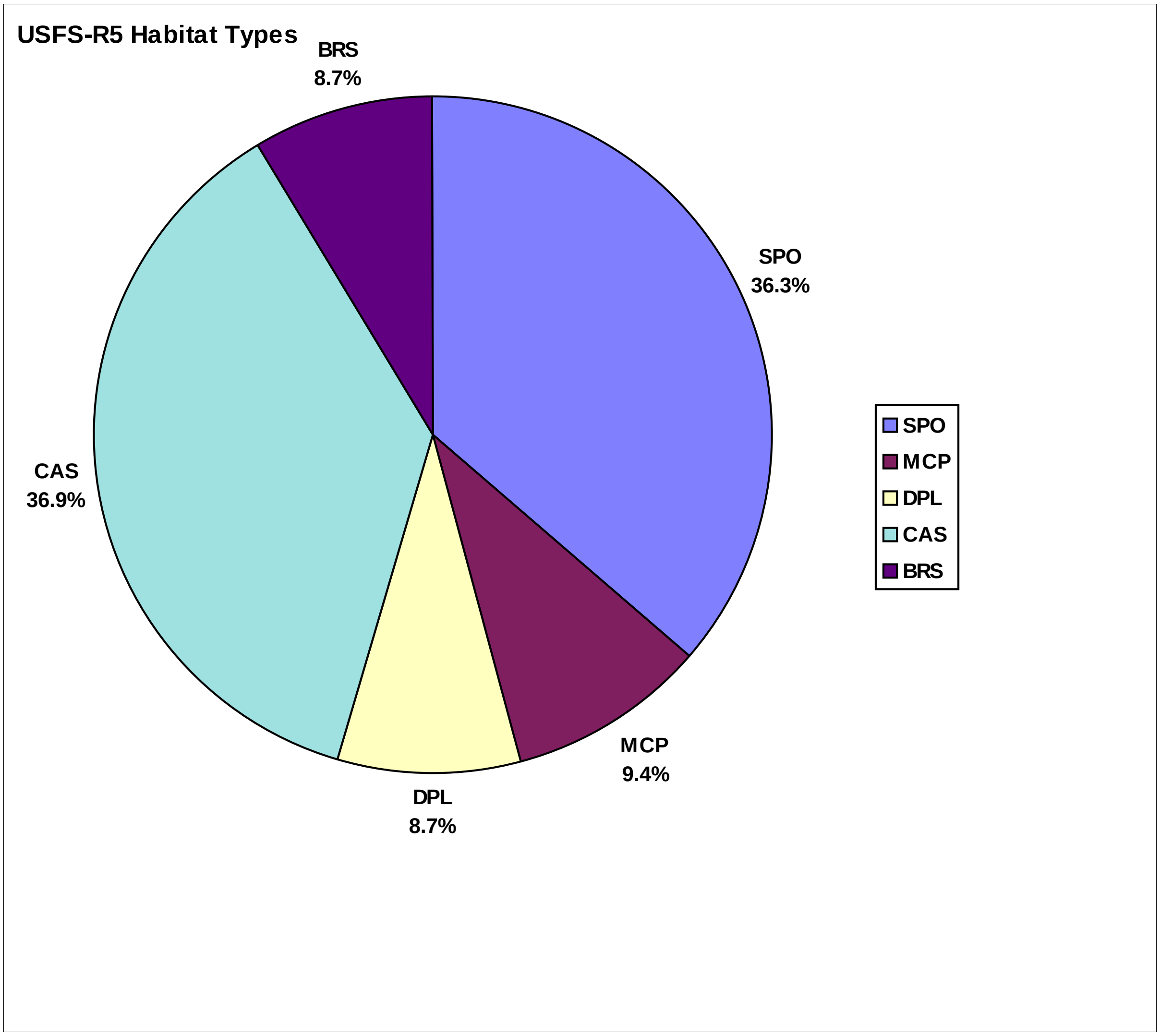


Figure CAWG 1-55. USFS-R5 Habitat Types for Rock Creek.

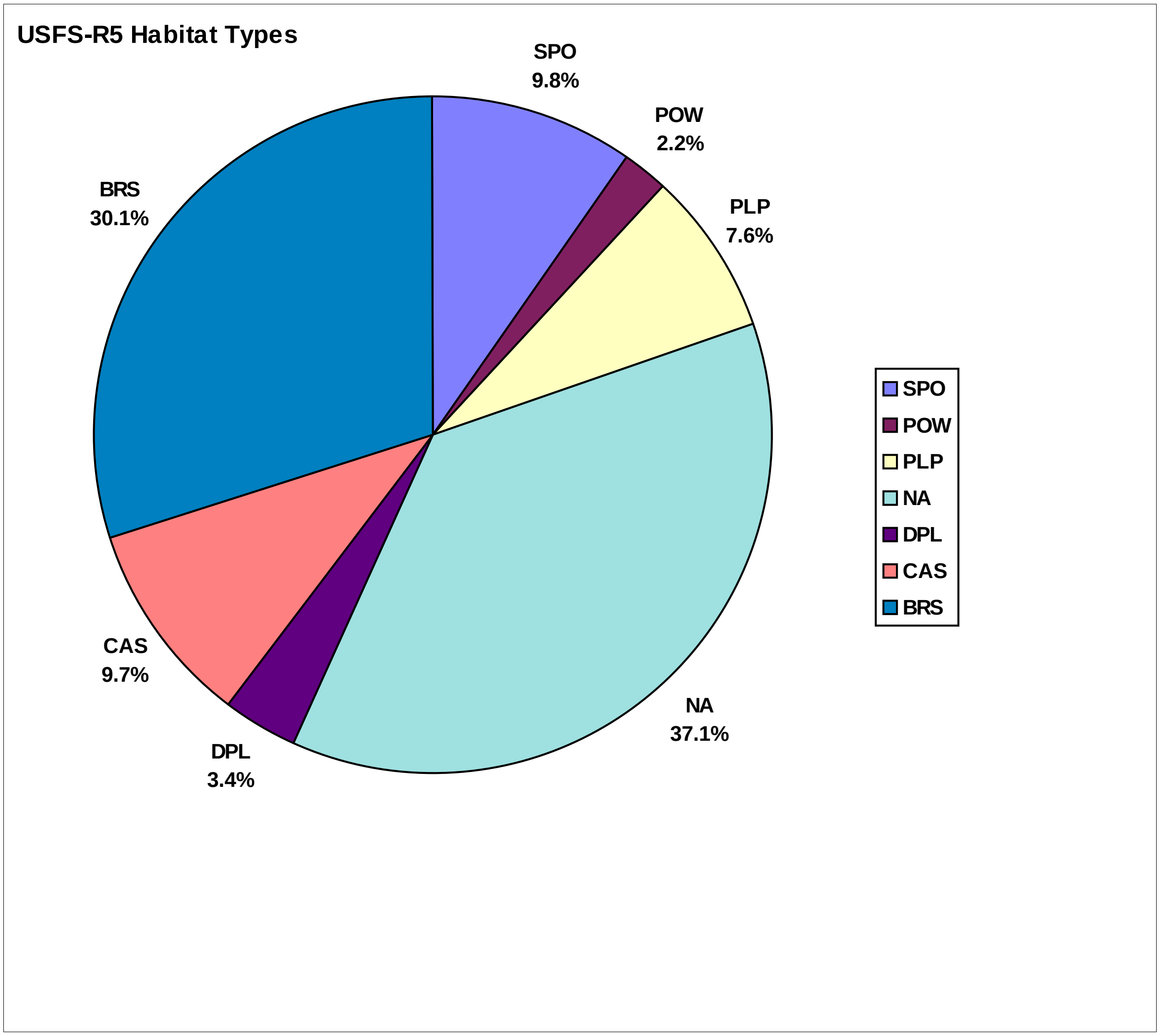
USFS-R5 Habitat Types by Channel Type

Mammoth Reach (Basin)

Rock Creek

Rock Creek BD Reach

Rosgen 1 Channel Type = Aa+



Note: 1,000 feet of mesohabitat was visually estimated from aerial photography and overflight.

Figure CAWG 1-55. USFS-R5 Habitat Types for Rock Creek (cont).

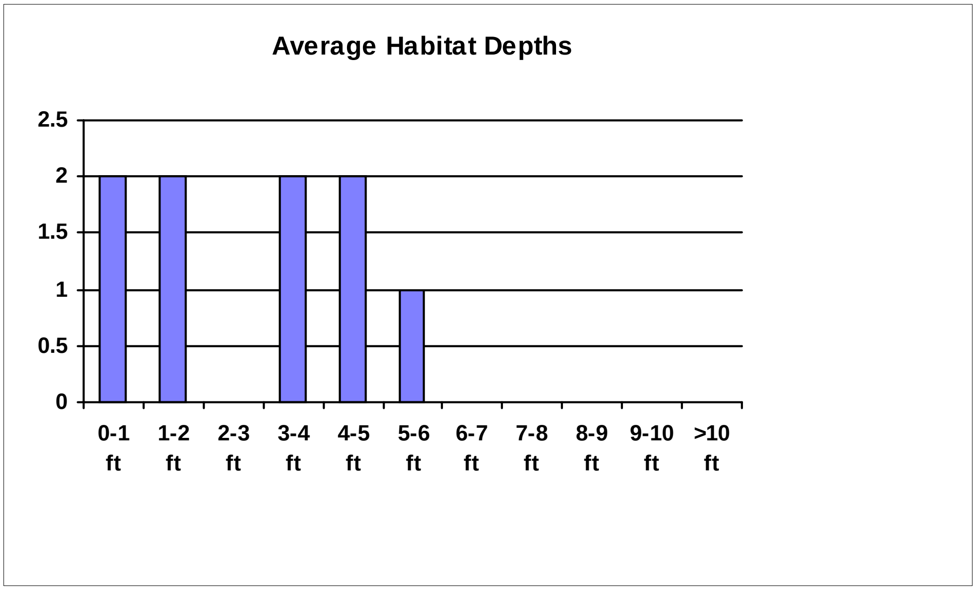
Recorded Average Habitat Depth Histograms

1 foot bin size

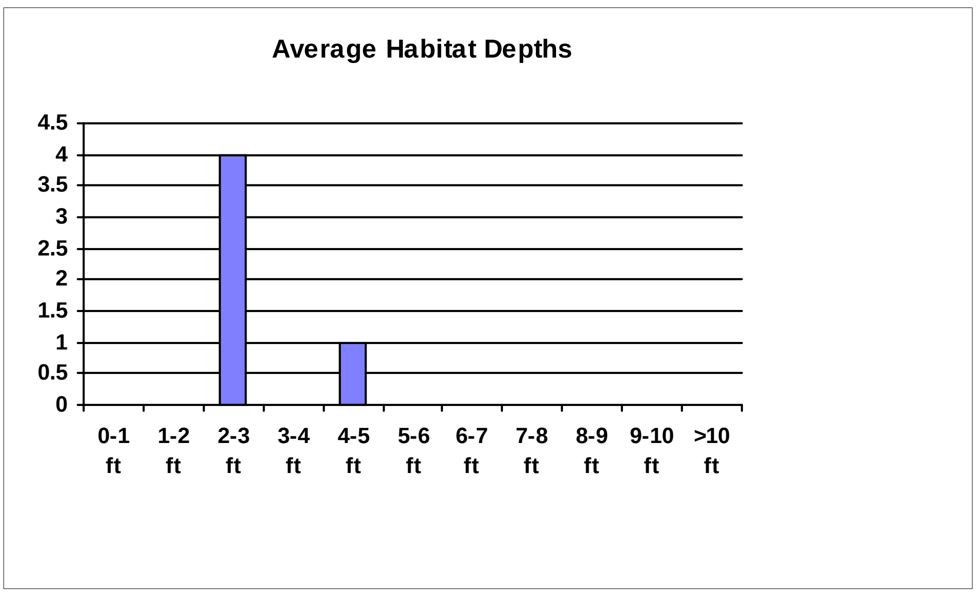
Mammoth Reach (Basin) BAS_M

Rock Creek RkC

Rock Creek BD Reach RkC_R



Rock Creek AD Reach RkCa_R



Aa+ Channel Type

Figure CAWG 1-56. Average Habitat Depth Histograms for Rock Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 8/4/2000.

Hawkins Habitat Types by Channel Type

Mammoth Reach (Basin)

Ross Creek

Ross Creek AD Reach

Rosgen 1 Channel Type = Aa+

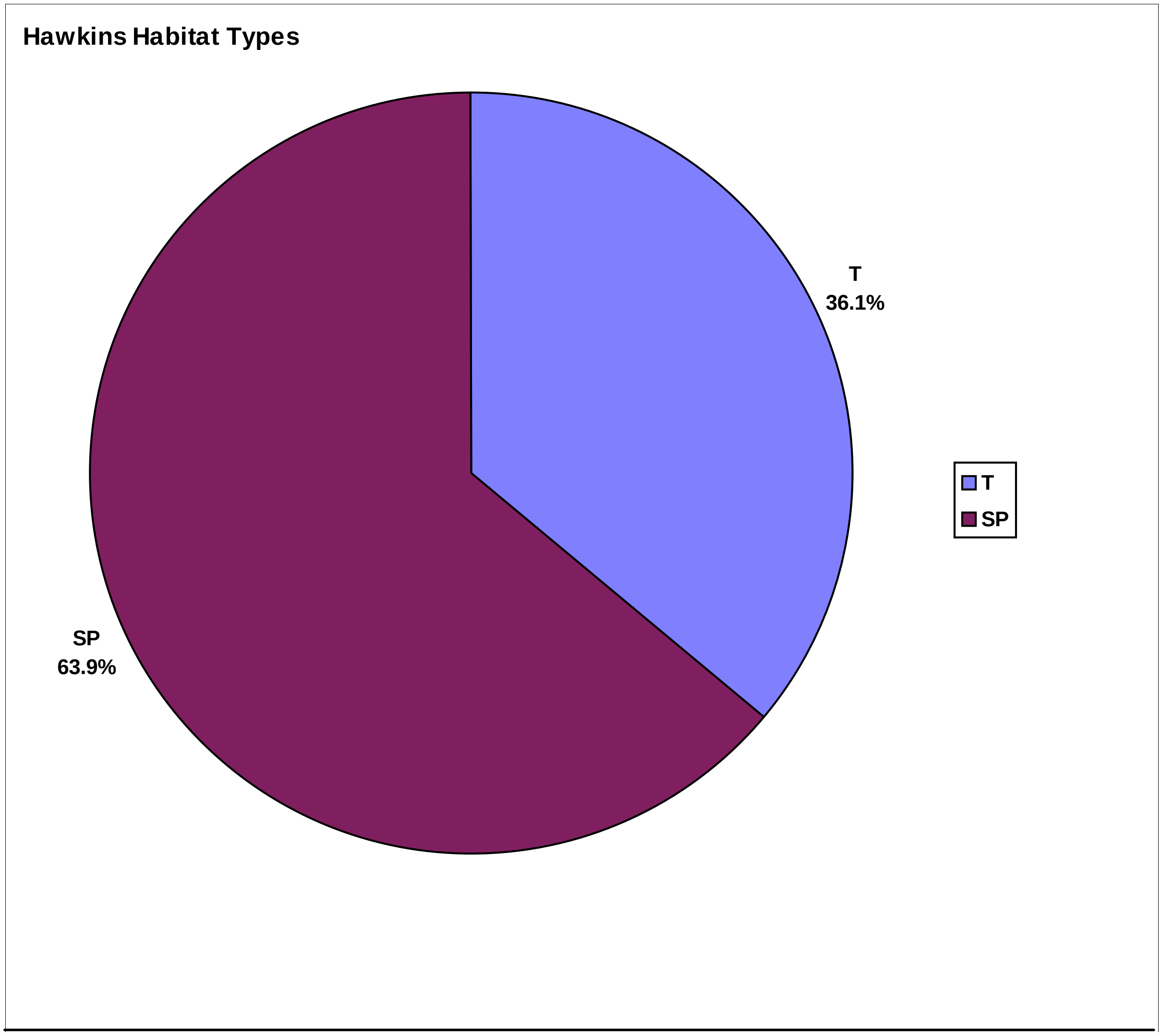


Figure CAWG 1-57. Hawkins Habitat Types for Ross Creek.

Hawkins Habitat Types by Channel Type

Mammoth Reach (Basin)

Ross Creek

Ross Creek BD Reach

Rosgen 1 Channel Type = Aa+

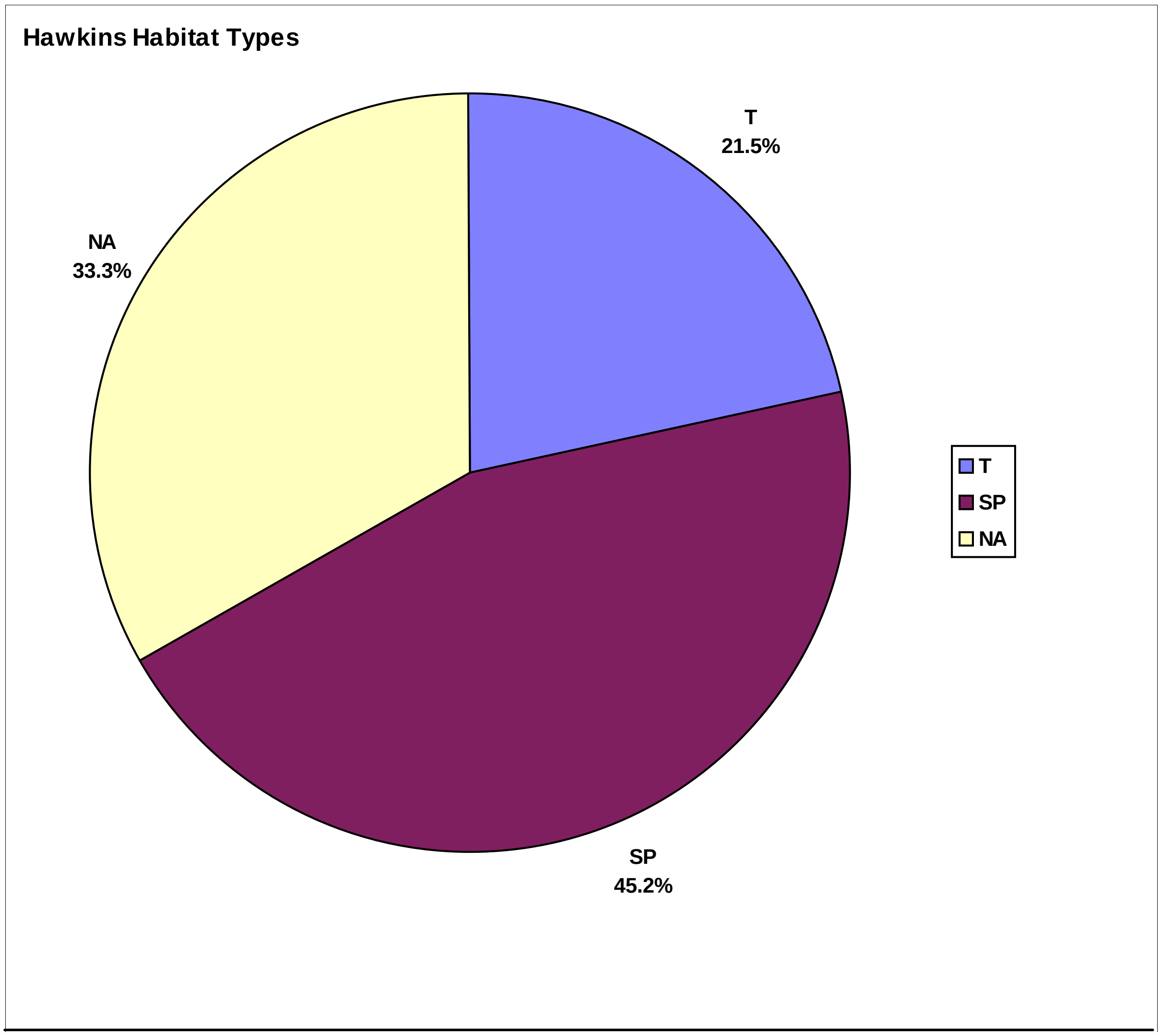


Figure CAWG 1-57. Hawkins Habitat Types for Ross Creek (cont).

USFS-R5 Habitat Types by Channel Type

Mammoth Reach (Basin)

Ross Creek

Ross Creek AD Reach

Rosgen 1 Channel Type = Aa+

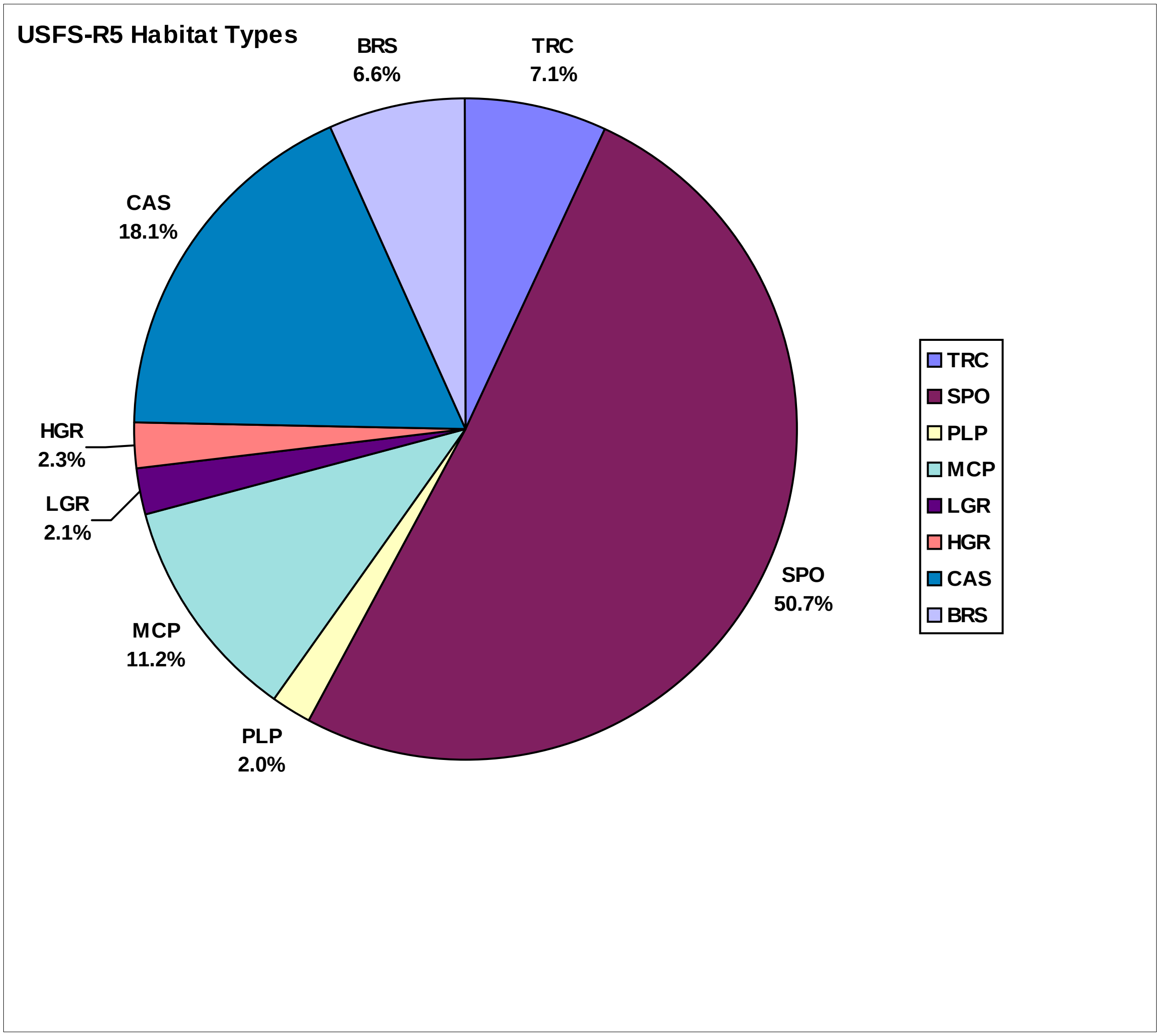


Figure CAWG 1-58. USFS-R5 Habitat Types for Ross Creek.

USFS-R5 Habitat Types by Channel Type

Mammoth Reach (Basin)

Ross Creek

Ross Creek BD Reach

Rosgen 1 Channel Type = Aa+

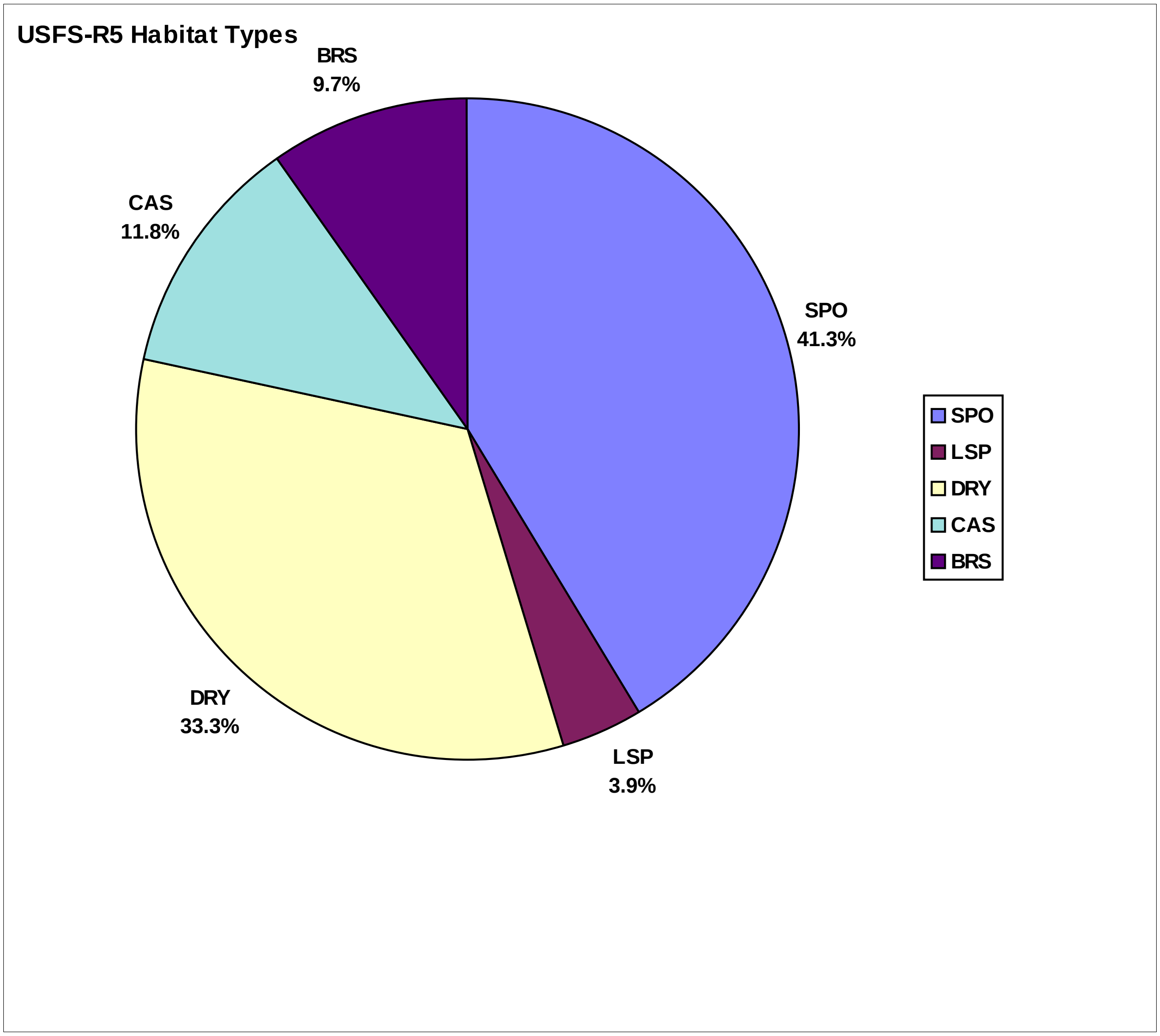


Figure CAWG 1-58. USFS-R5 Habitat Types for Ross Creek (cont).

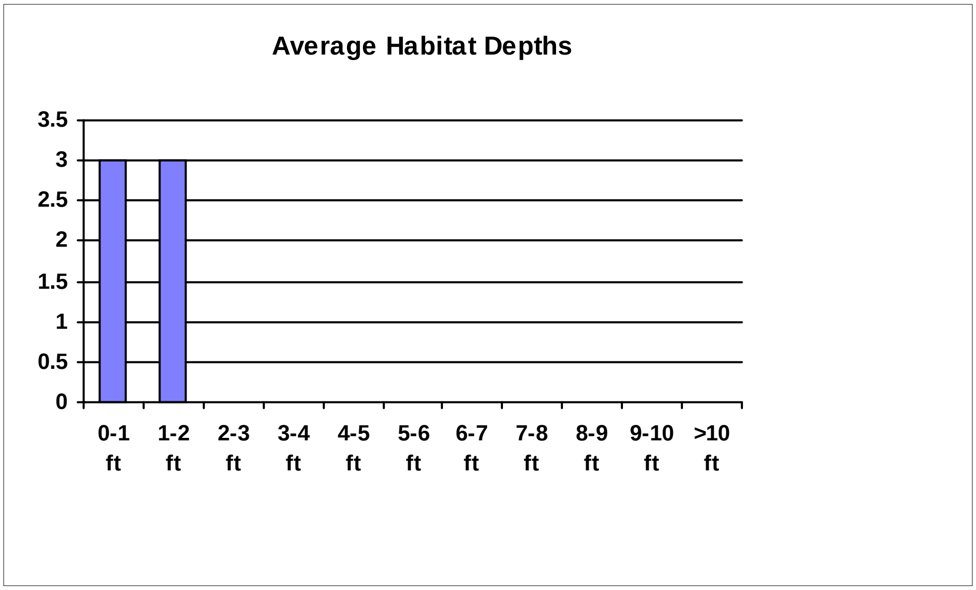
Recorded Average Habitat Depth Histograms

1 foot bin size

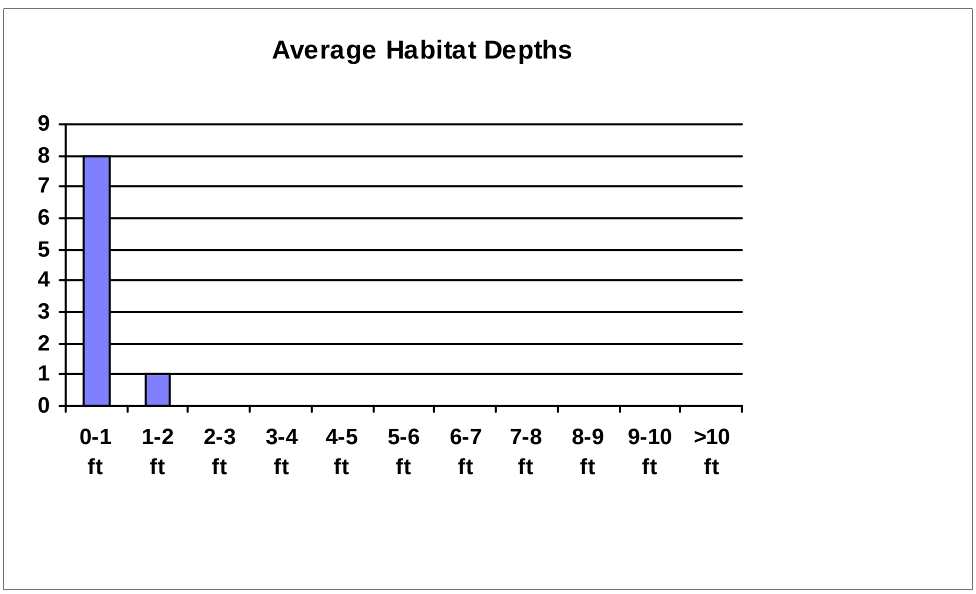
Mammoth Reach (Basin) BAS_M

Ross Creek RsC

Ross Creek BD Reach RsC_R



Ross Creek AD Reach RsCa_R



Aa+ Channel Type

Figure CAWG 1-59. Average Habitat Depth Histograms for Ross Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 8/25/2000 Below Diversion and 6/8/2002 Above Diversion.

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = A

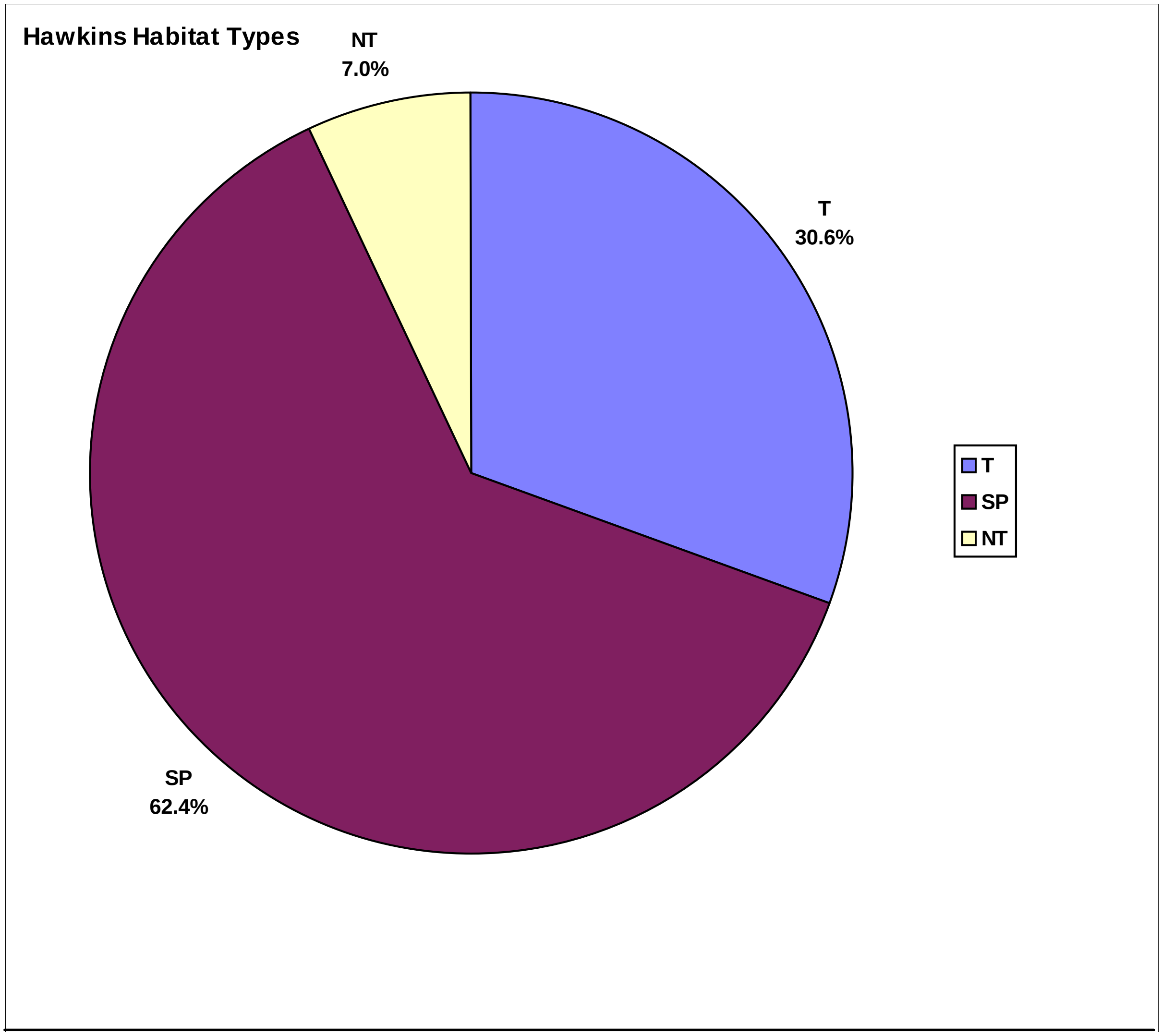


Figure CAWG 1-60. Hawkins Habitat Types for Stevenson Creek.

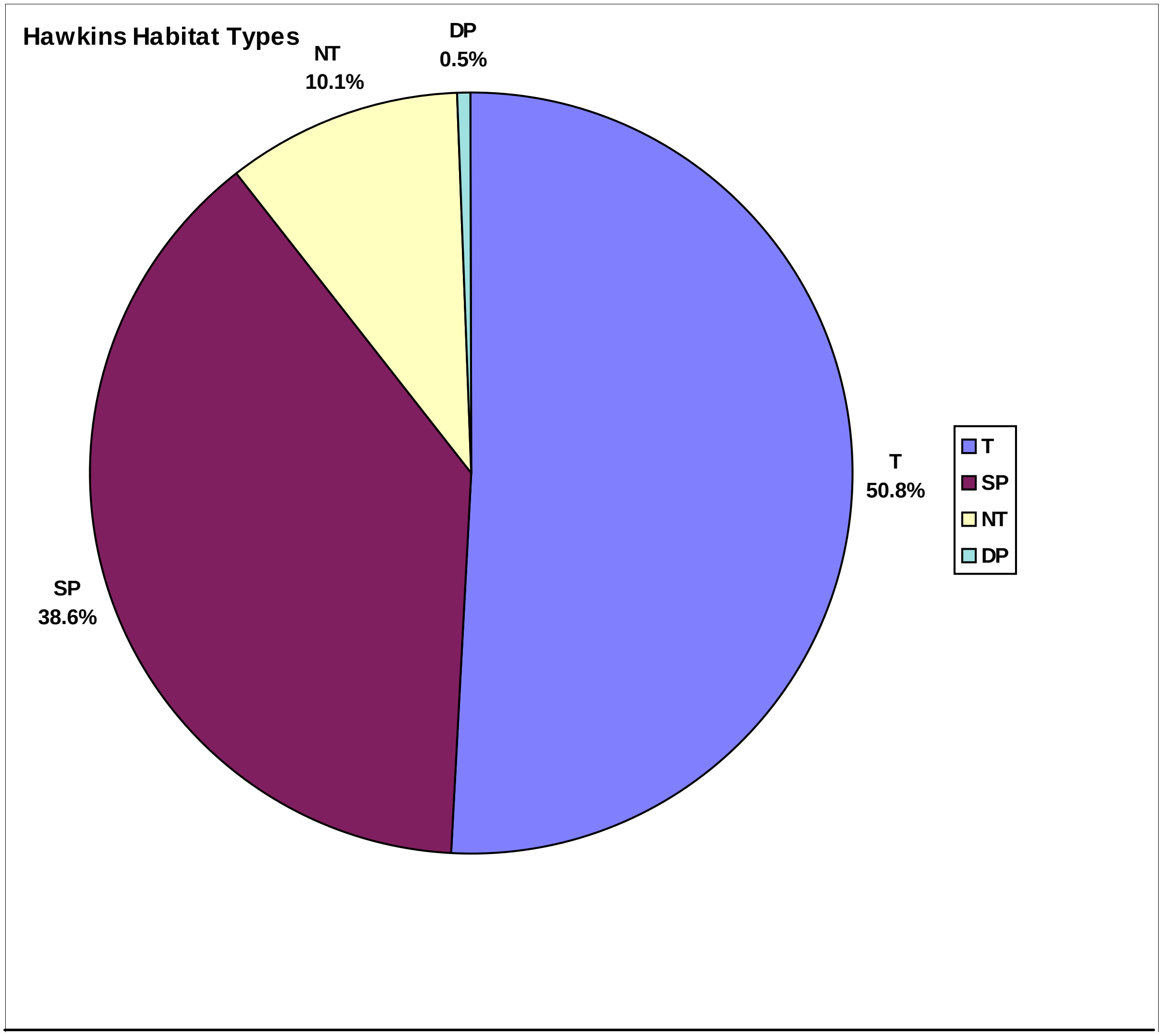
Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = Aa+



Note: 3,326 feet of mesohabitat upstream of the confluence with the San Joaquin River was visually estimated from aerial photography and overflight.

Figure CAWG 1-60. Hawkins Habitat Types for Stevenson Creek (cont).

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = B

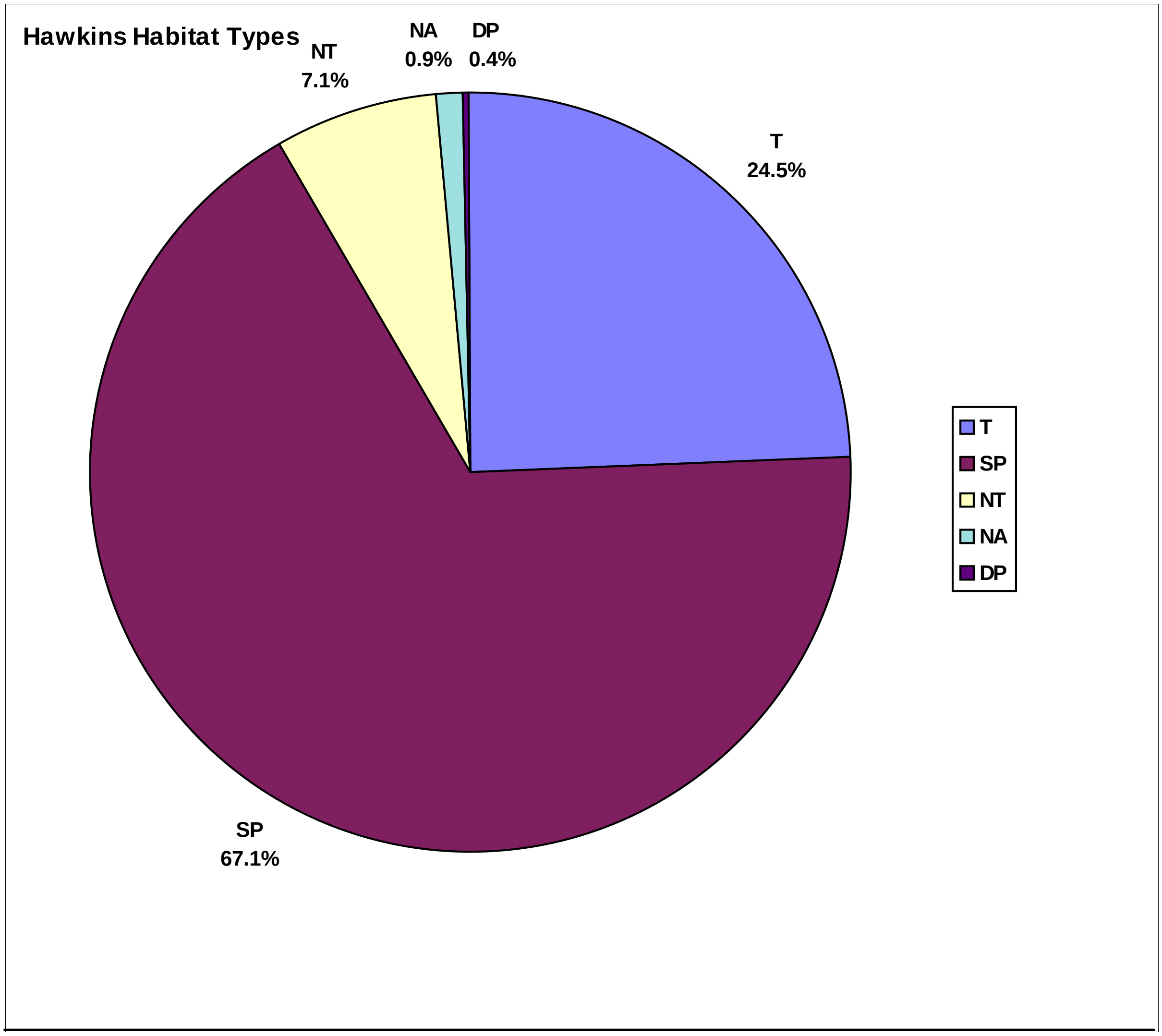


Figure CAWG 1-60. Hawkins Habitat Types for Stevenson Creek (cont).

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = G

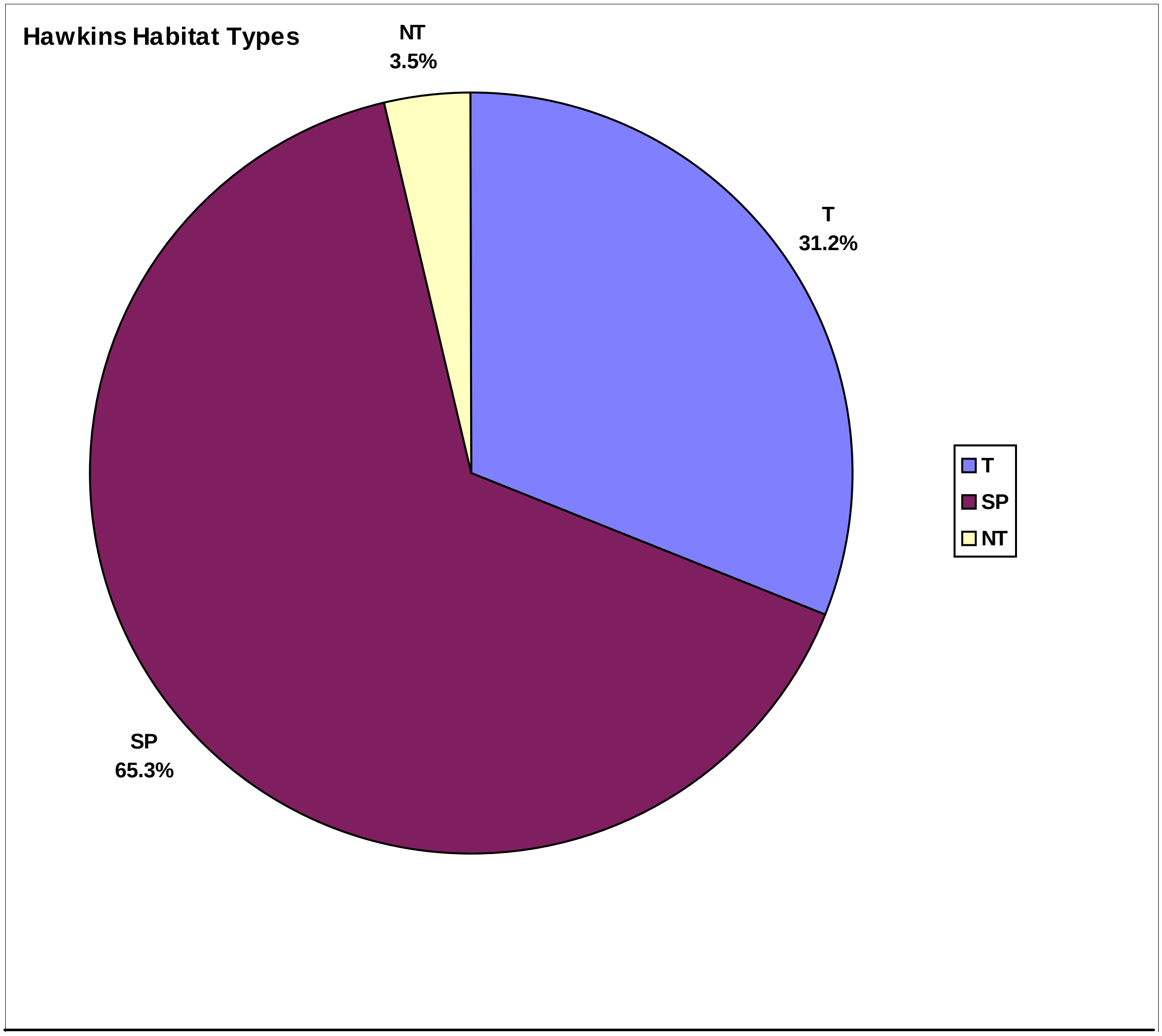


Figure CAWG 1-60. Hawkins Habitat Types for Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = A

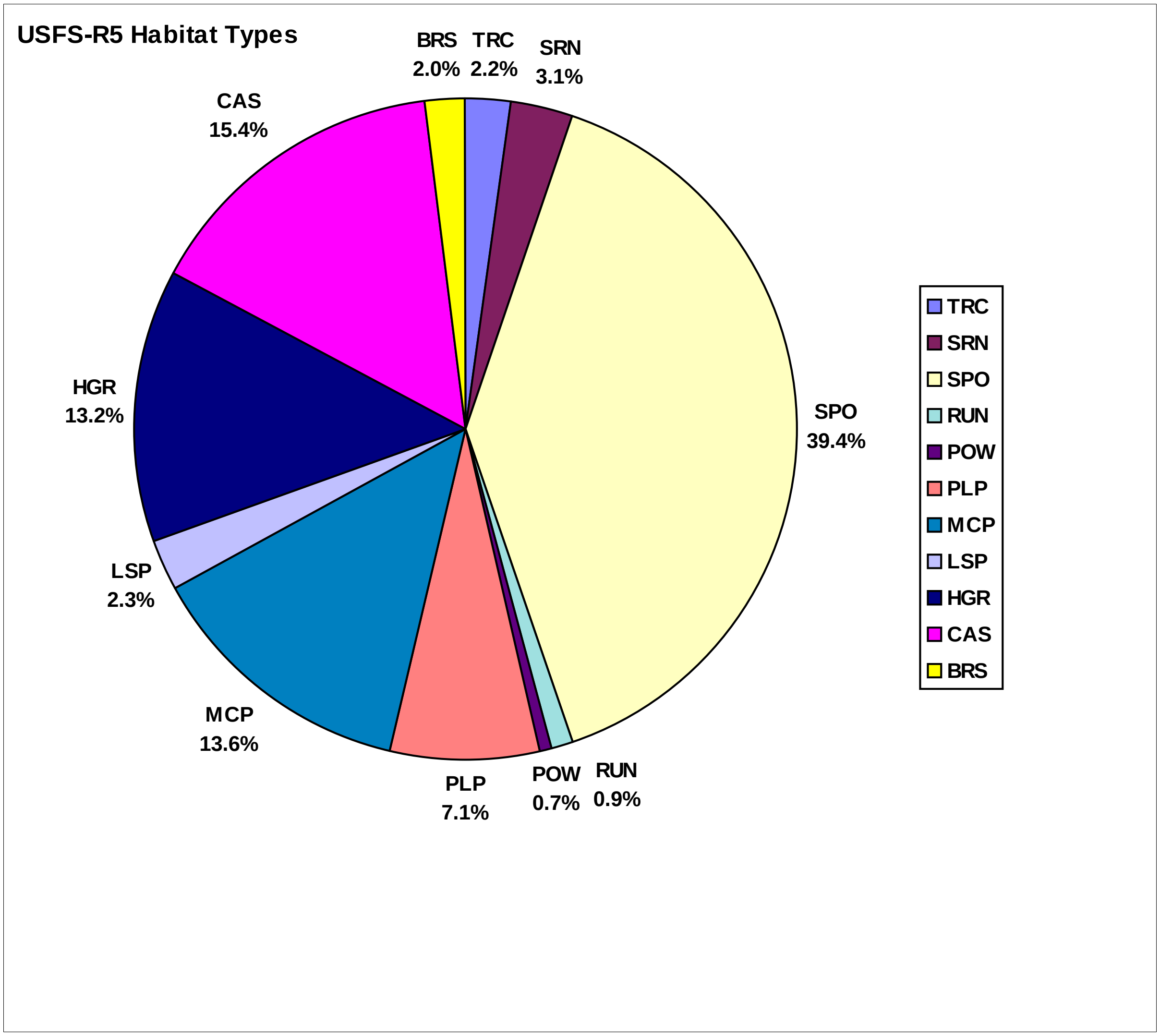


Figure CAWG 1-61. USFS-R5 Habitat Types for Stevenson Creek.

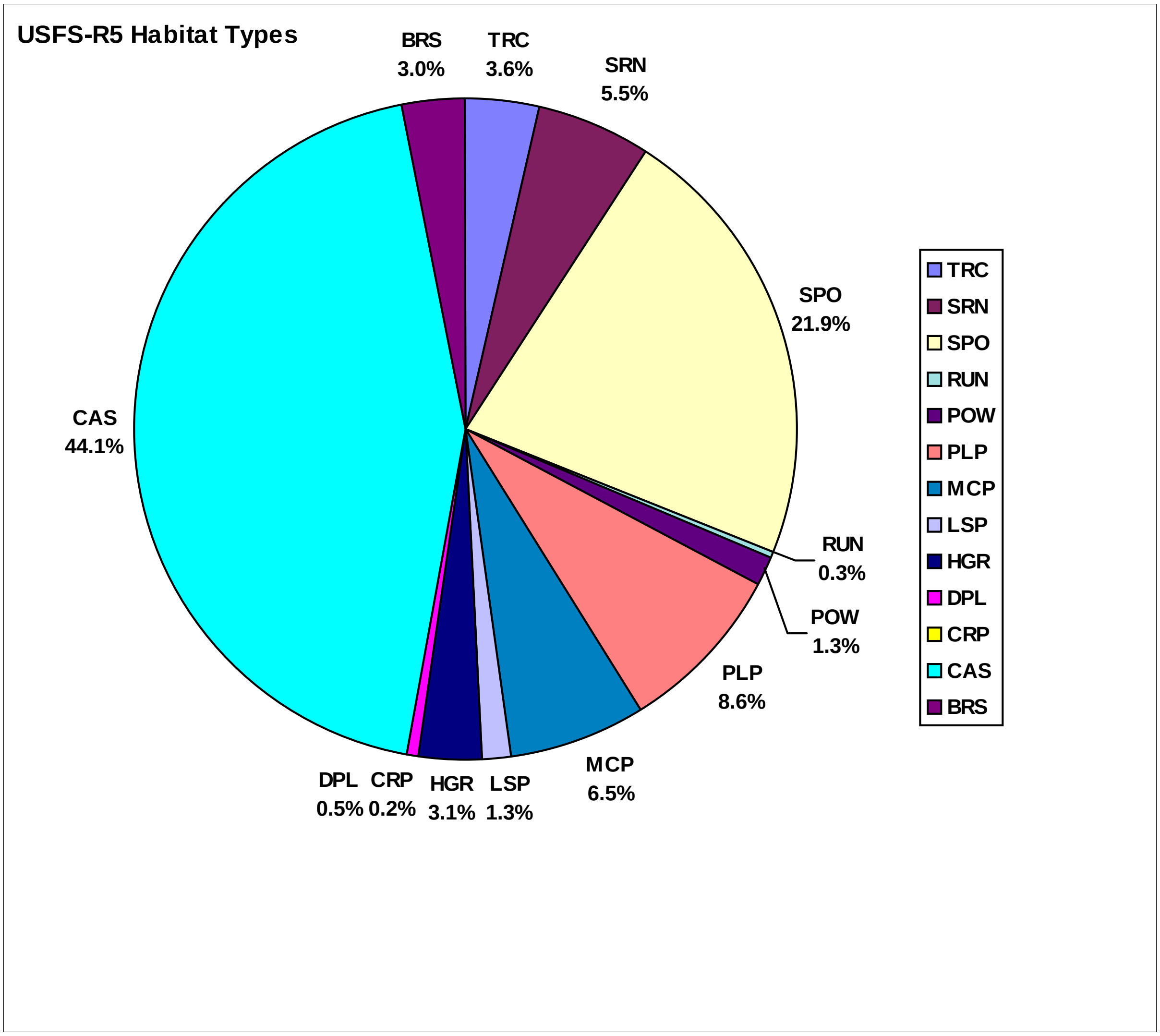
USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = Aa+



Note: 3,326 feet of mesohabitat upstream of the confluence with the San Joaquin River was visually estimated from aerial photography and overflight.

Figure CAWG 1-61. USFS-R5 Habitat Types for Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = B

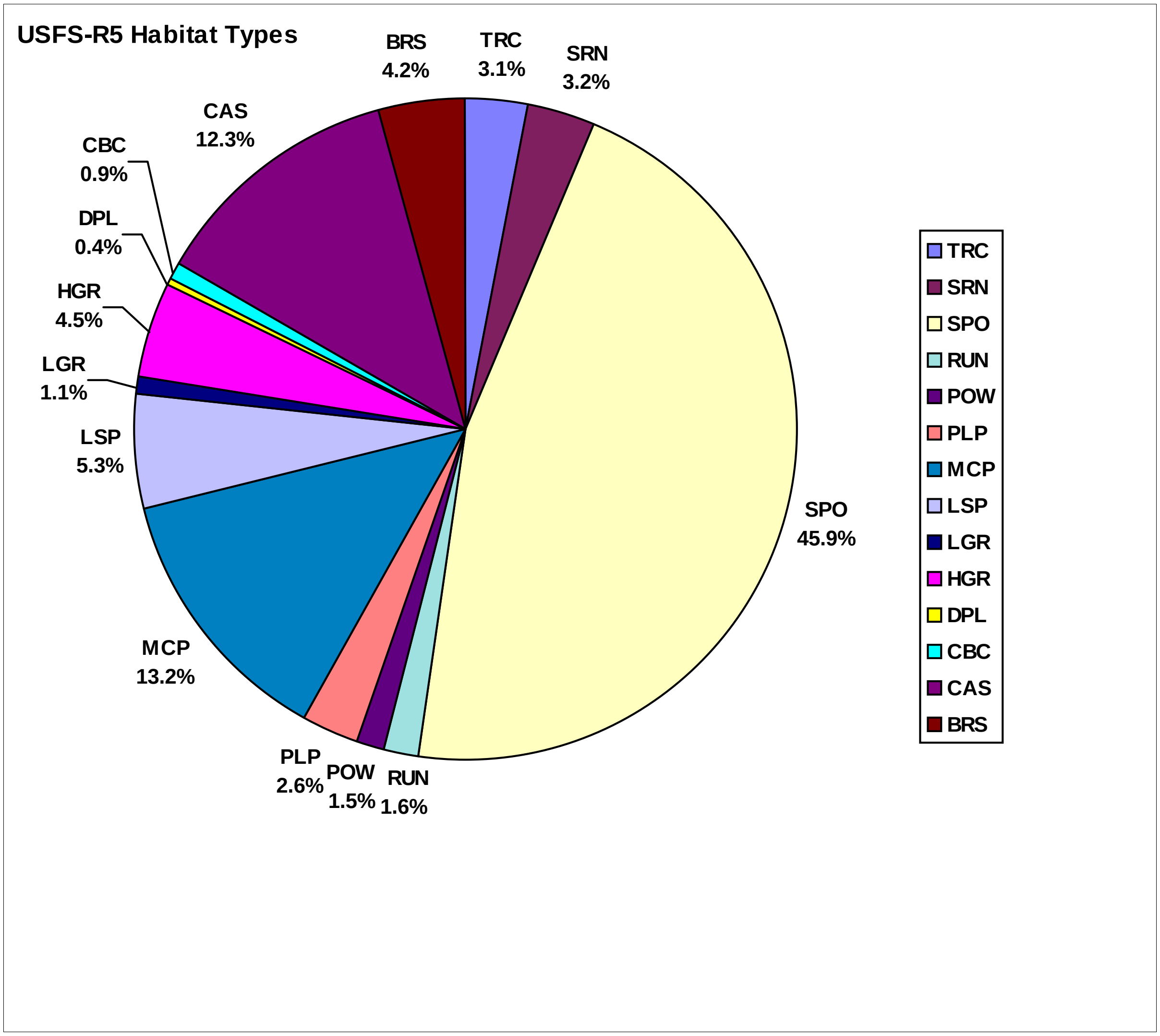


Figure CAWG 1-61. USFS-R5 Habitat Types for Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

Stevenson Creek

Stevenson Creek Reach (2001)

Rosgen 1 Channel Type = G

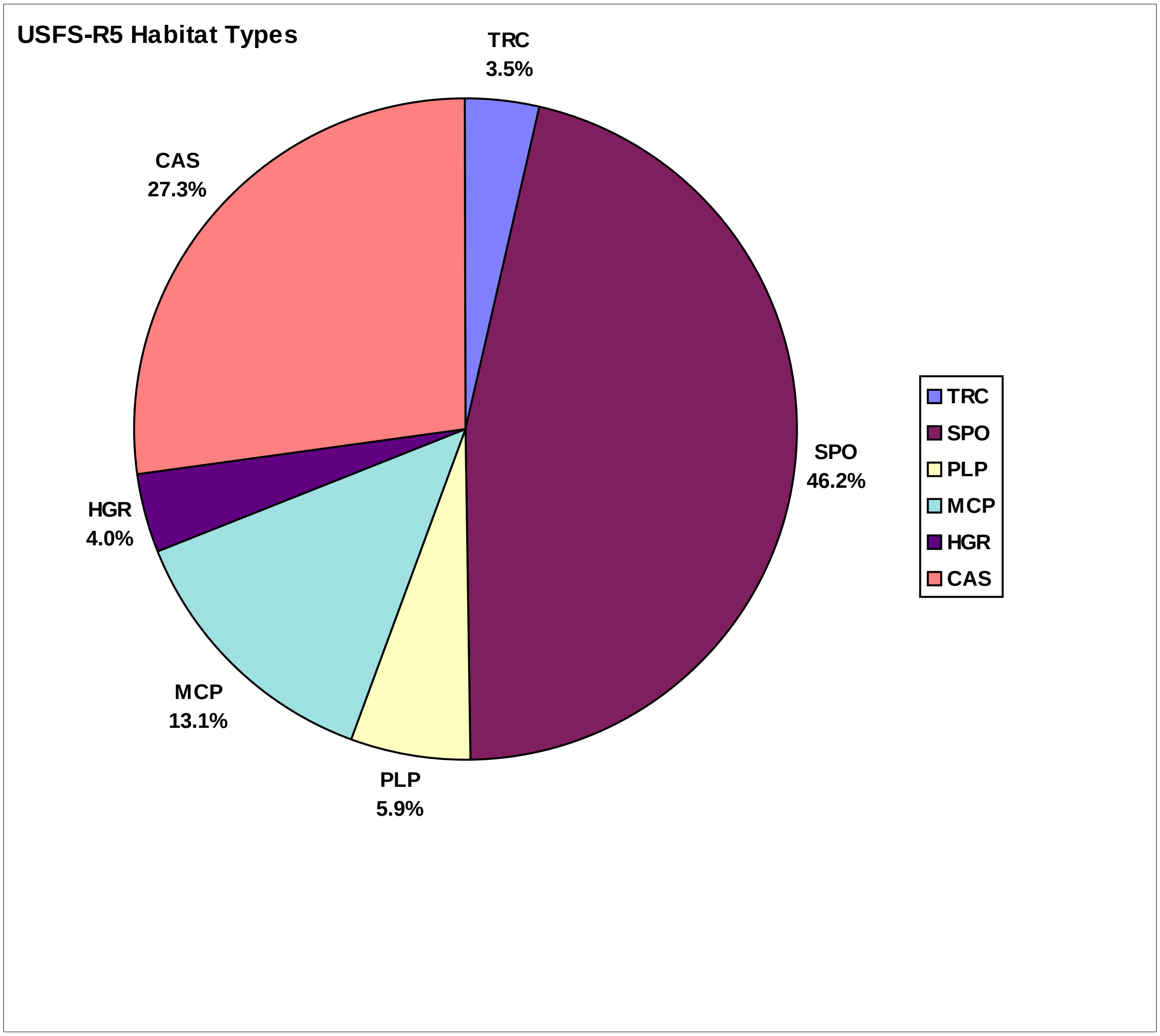


Figure CAWG 1-61. USFS-R5 Habitat Types for Stevenson Creek (cont).

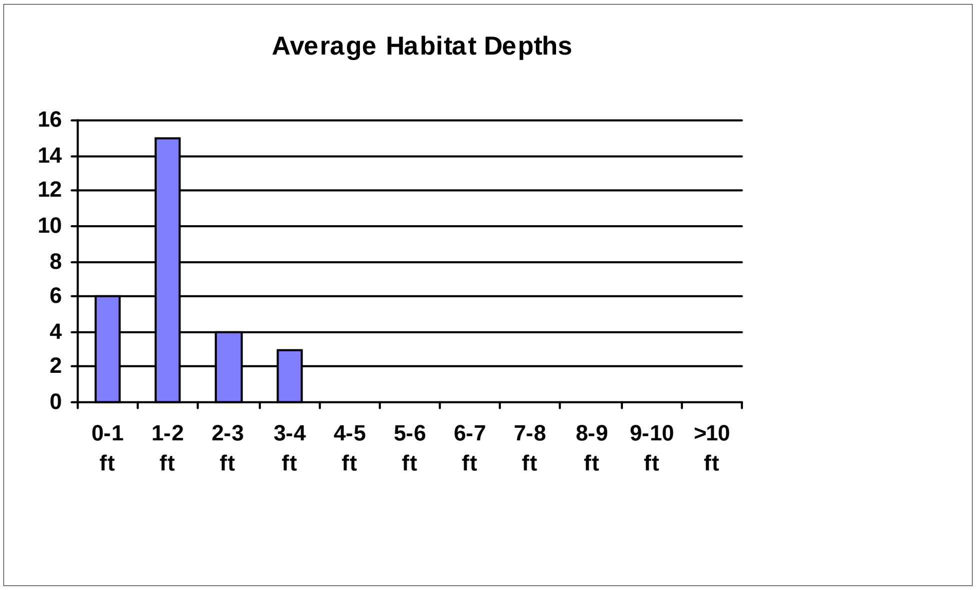
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

Stevenson Creek StC

Stevenson Creek Reach (2001) StC01_R



A Channel Type

Figure CAWG 1-62. Average Habitat Depth Histograms for Stevenson Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/16/2001.

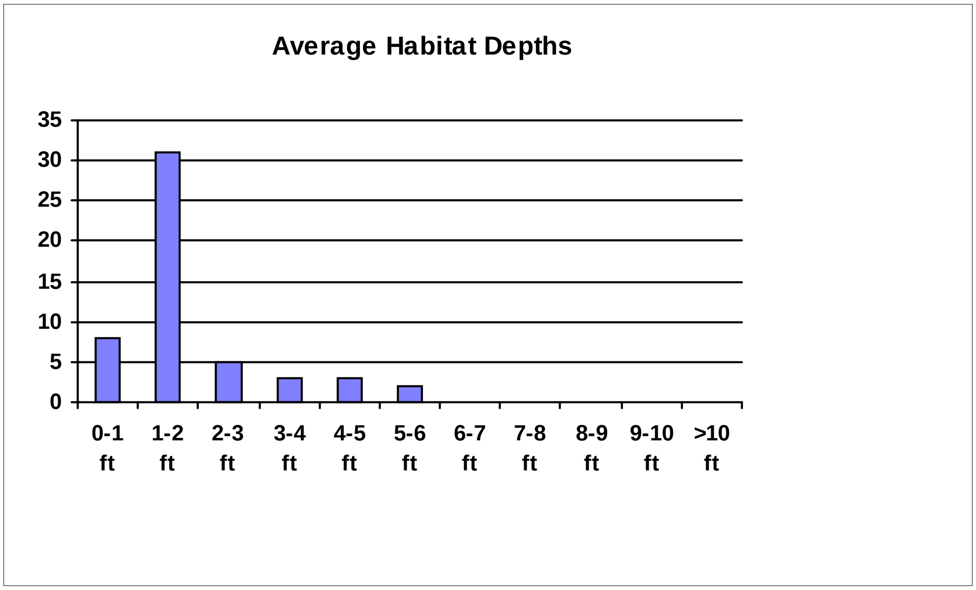
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

Stevenson Creek StC

Stevenson Creek Reach (2001) StC01_R



Aa+ Channel Type

Figure CAWG 1-62. Average Habitat Depth Histograms for Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 7/16/2001.

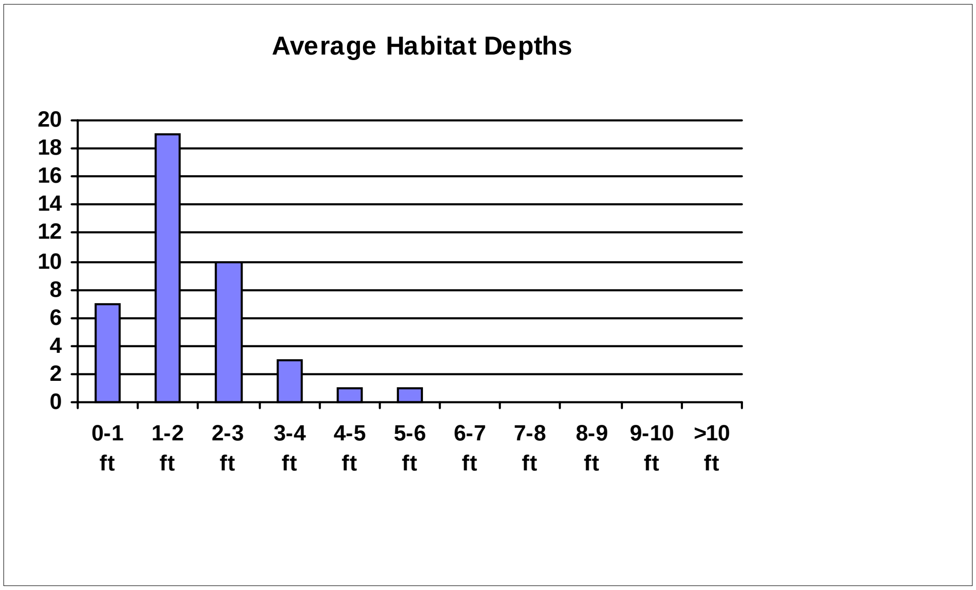
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

Stevenson Creek StC

Stevenson Creek Reach (2001) StC01_R



B Channel Type

Figure CAWG 1-62. Average Habitat Depth Histograms for Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 7/16/2001.

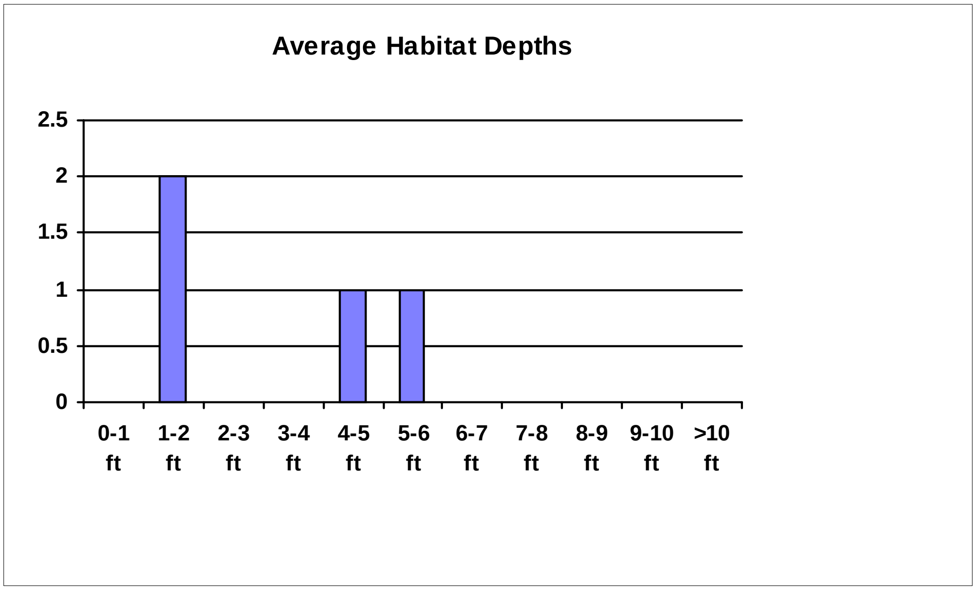
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

Stevenson Creek StC

Stevenson Creek Reach (2001) StC01_R



G Channel Type

Figure CAWG 1-62. Average Habitat Depth Histograms for Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 7/16/2001.

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek above outlet Reach

Rosgen 1 Channel Type = Aa+

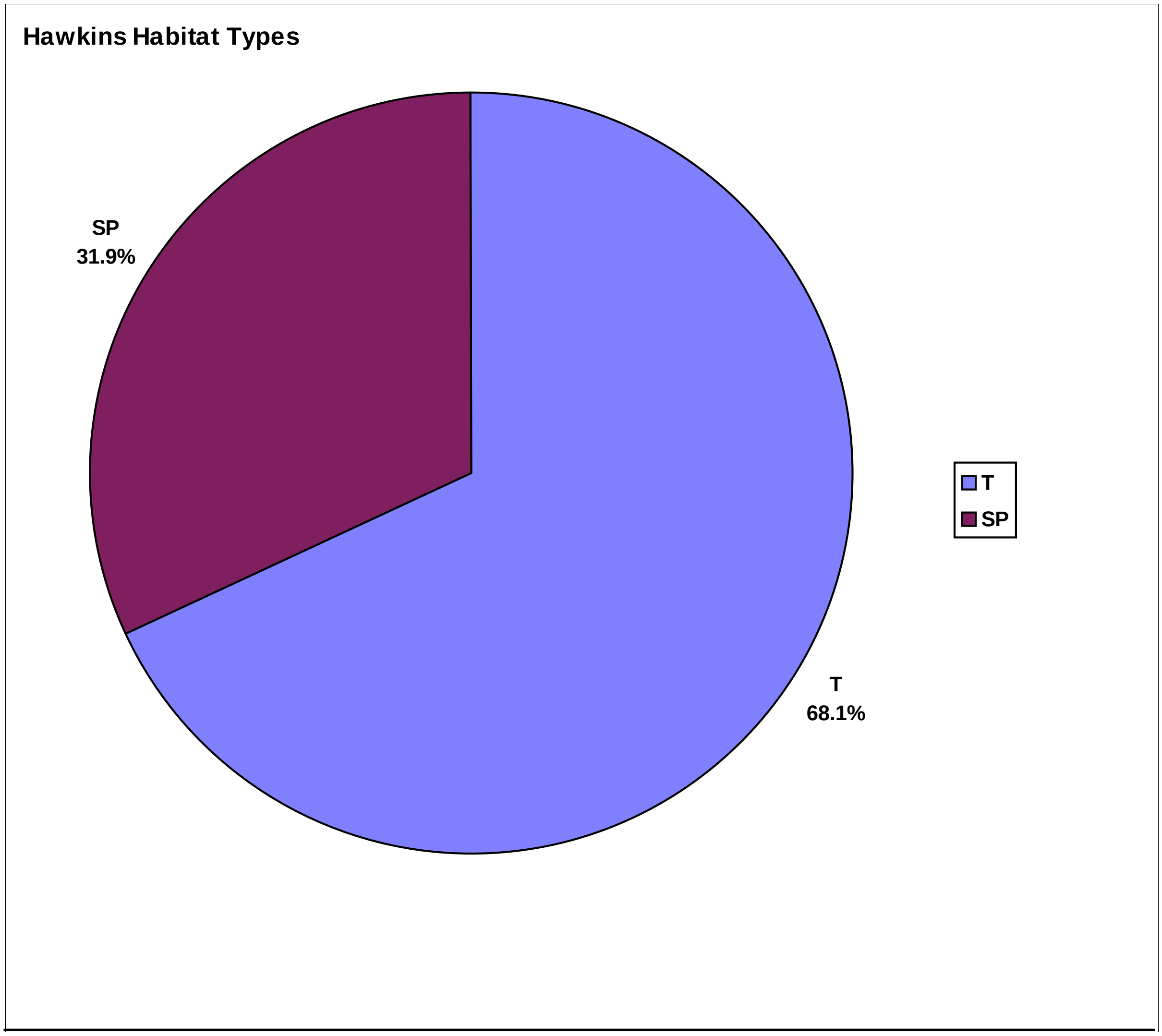


Figure CAWG 1-63. Hawkins Habitat Types for NF Stevenson Creek.

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = A

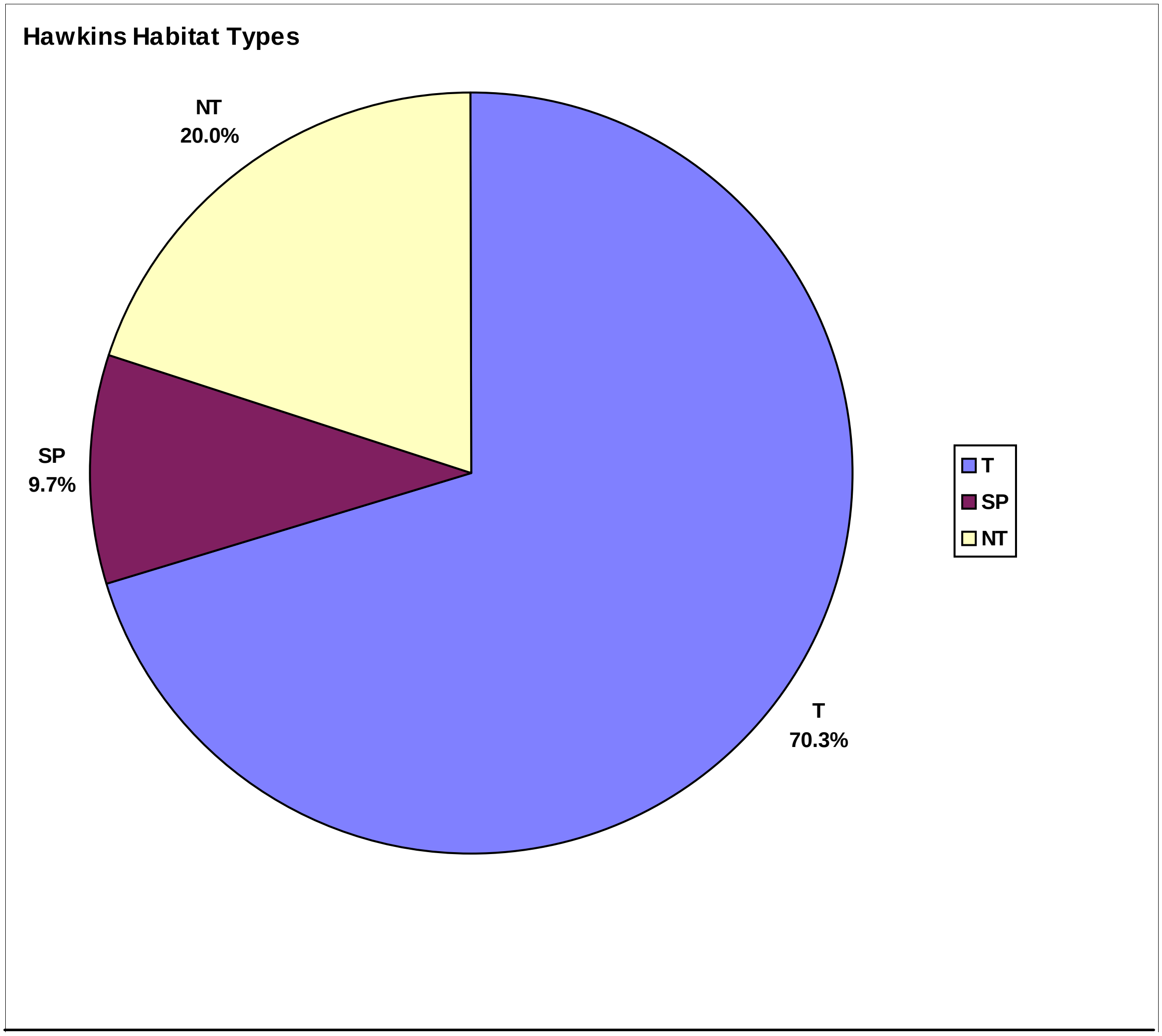


Figure CAWG 1-63. Hawkins Habitat Types for NF Stevenson Creek (cont).

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = Aa+

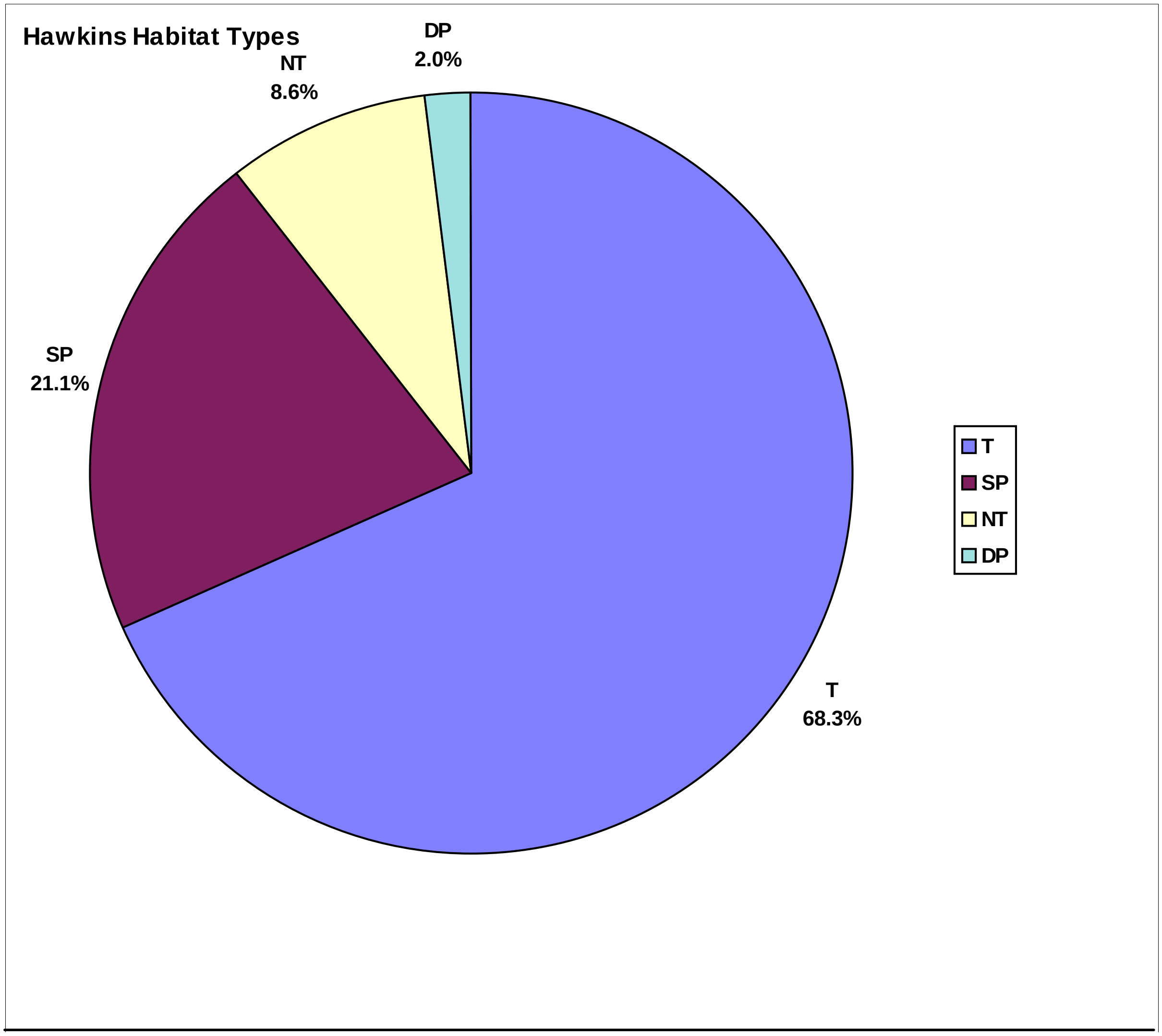


Figure CAWG 1-63. Hawkins Habitat Types for NF Stevenson Creek (cont).

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = B

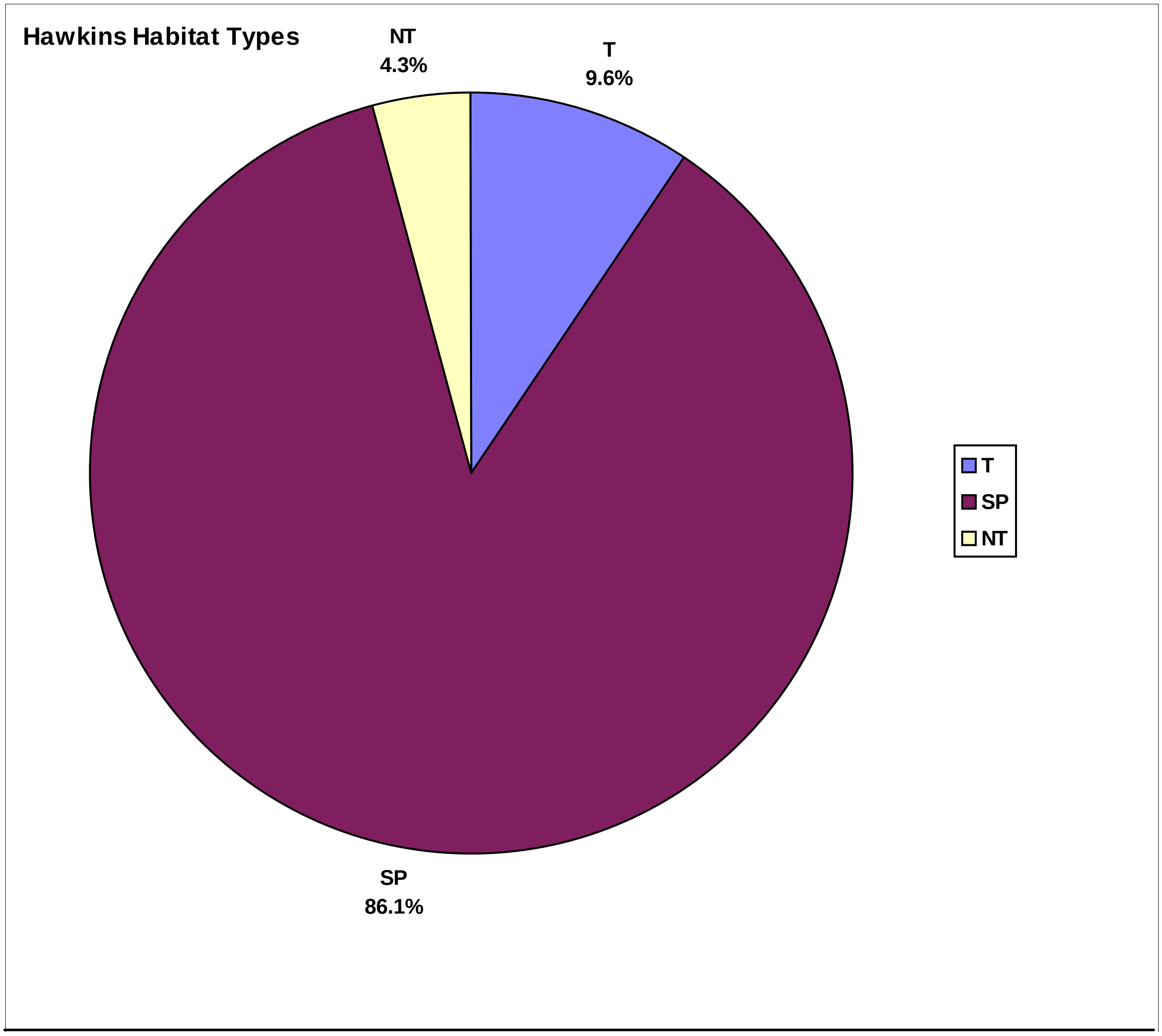


Figure CAWG 1-63. Hawkins Habitat Types for NF Stevenson Creek (cont).

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = C

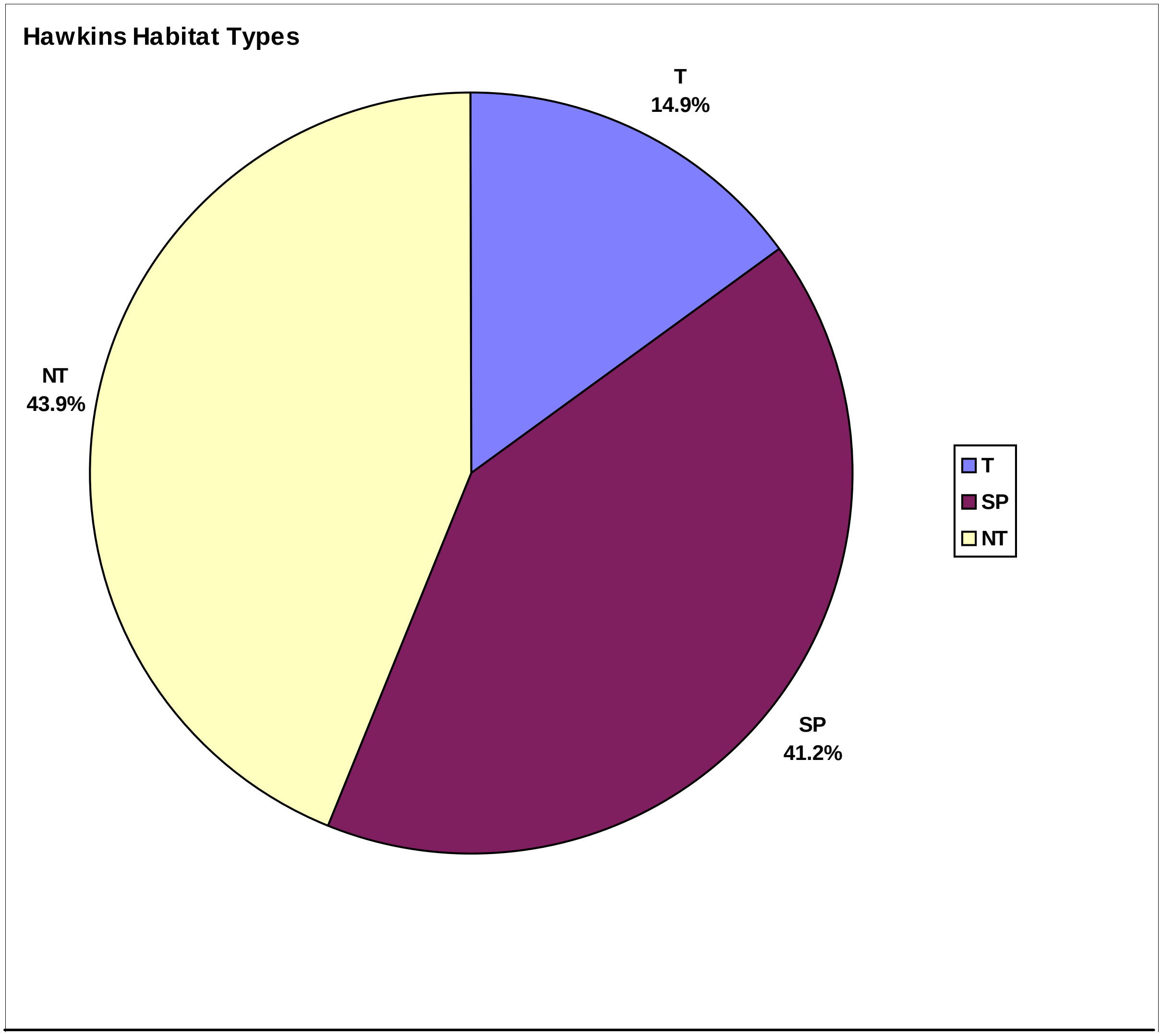


Figure CAWG 1-63. Hawkins Habitat Types for NF Stevenson Creek (cont).

Hawkins Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = G

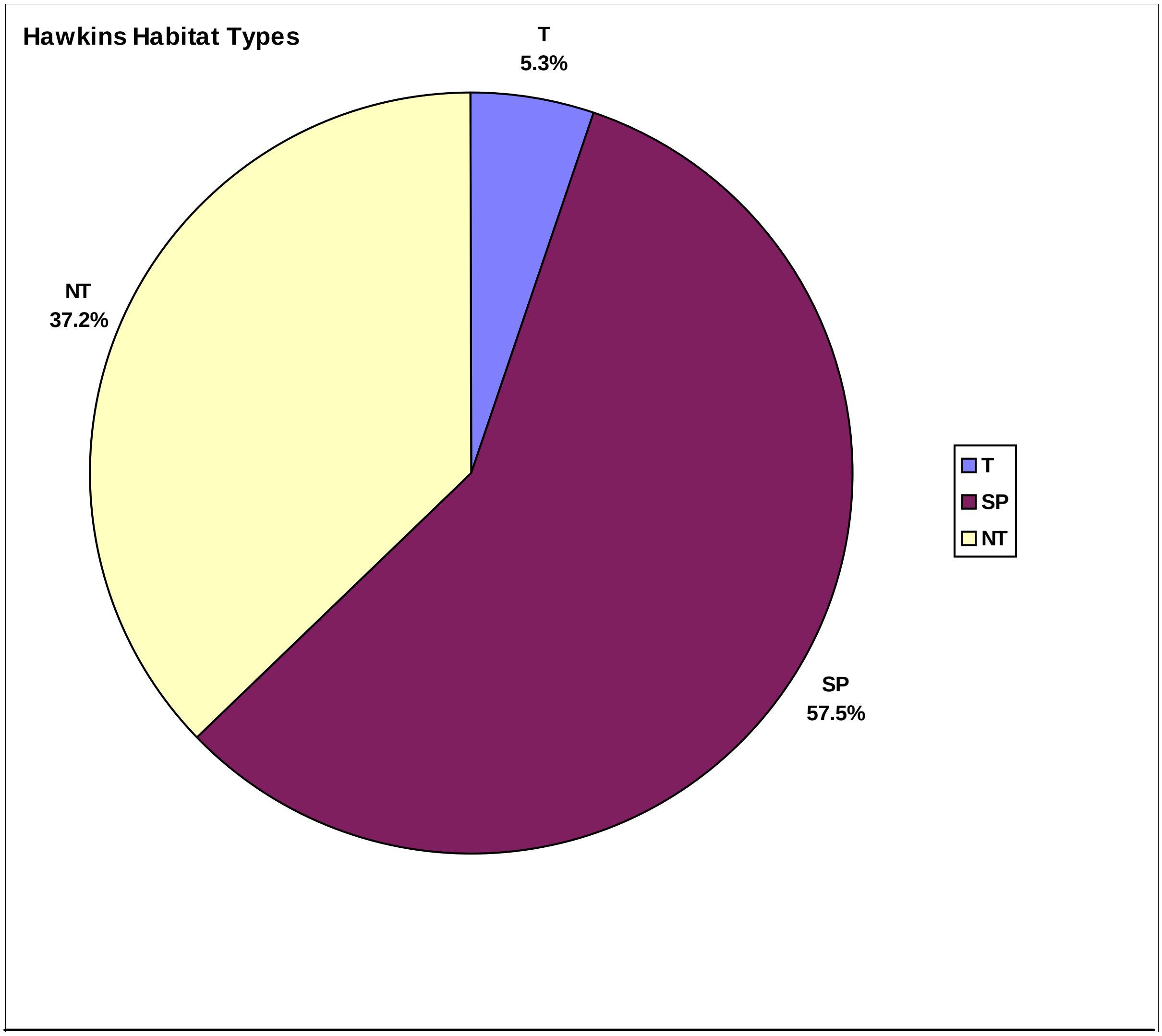


Figure CAWG 1-63. Hawkins Habitat Types for NF Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek above outlet Reach

Rosgen 1 Channel Type = Aa+

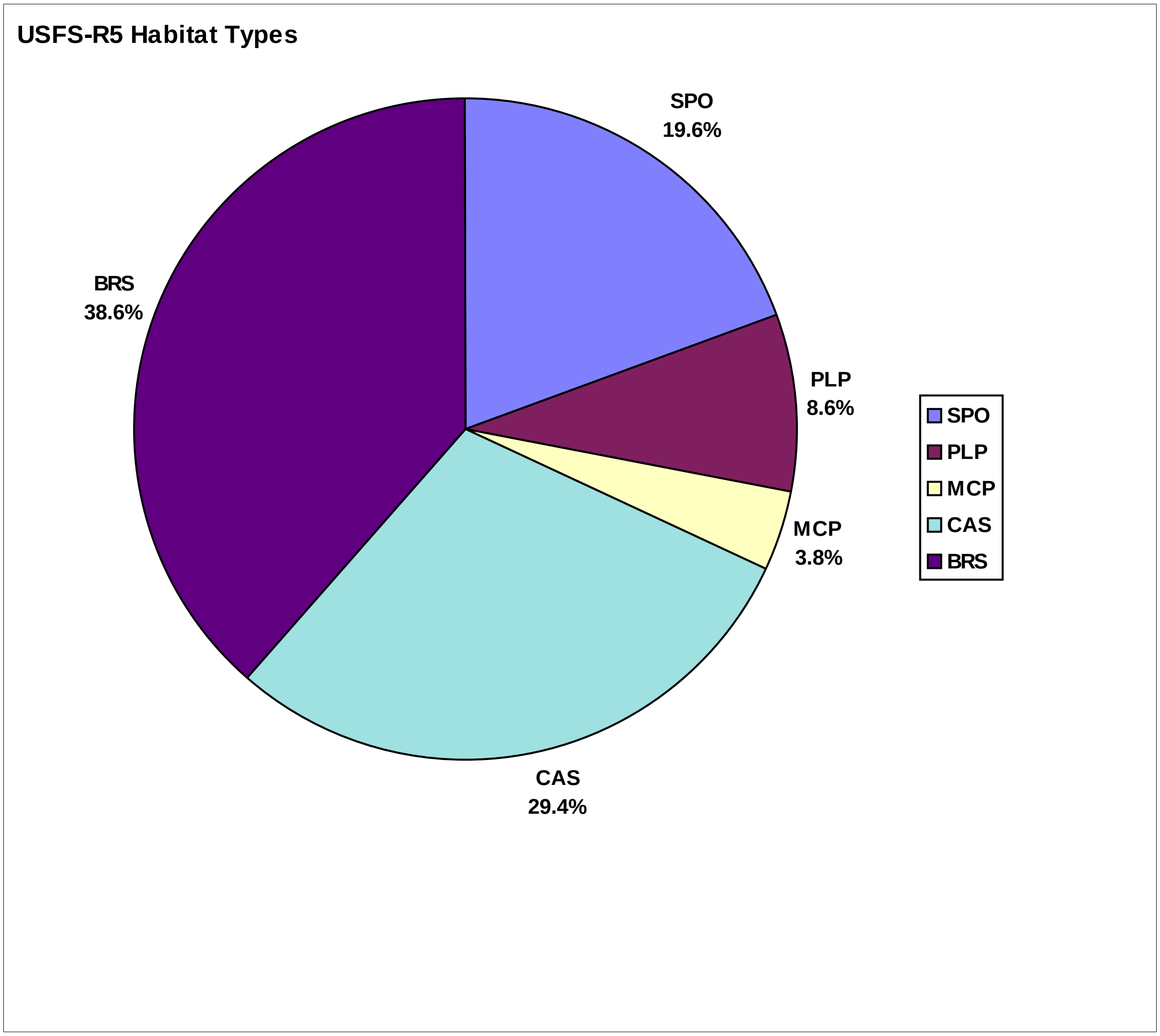


Figure CAWG 1-64. USFS-R5 Habitat Types for NF Stevenson Creek.

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = A

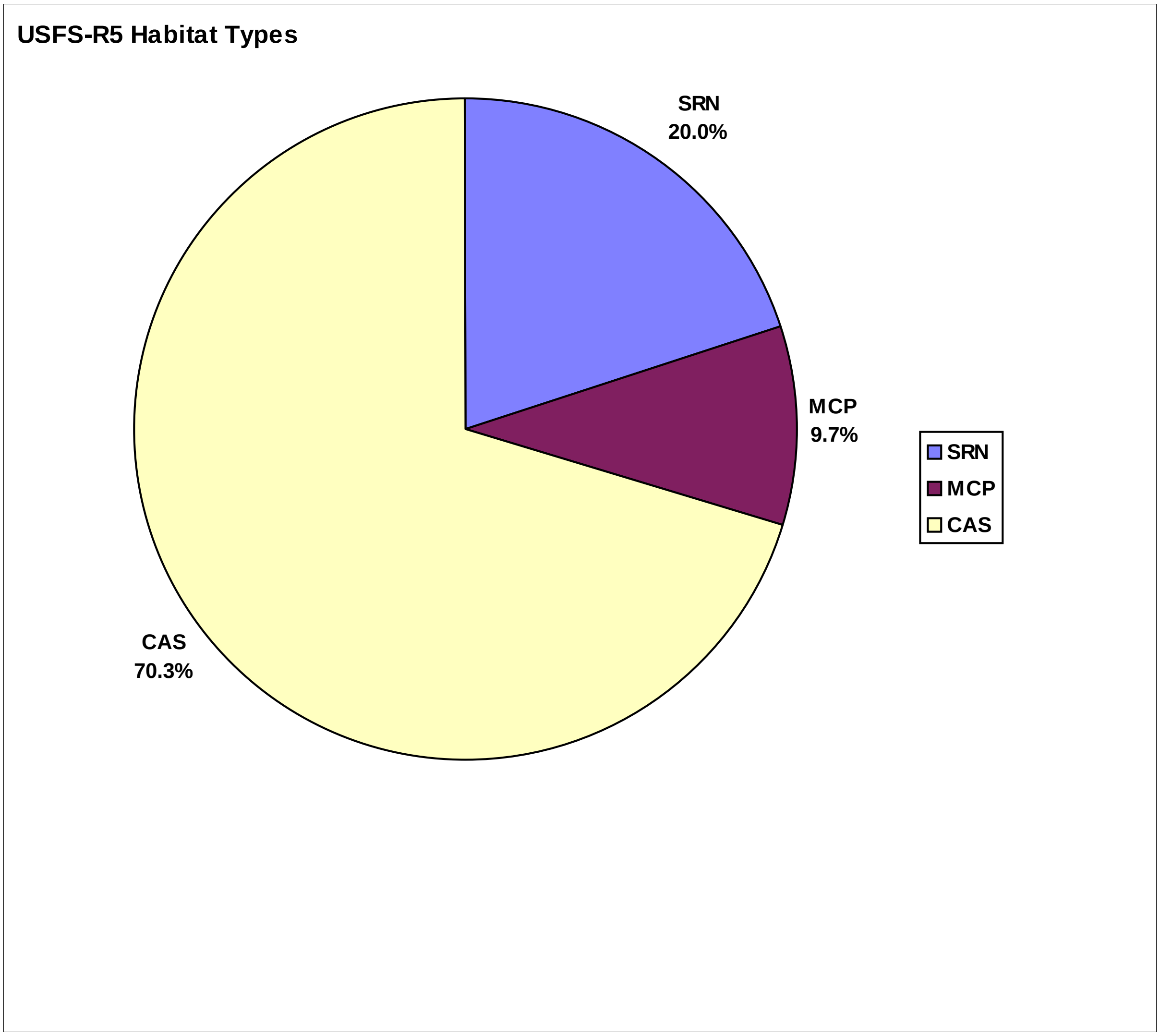


Figure CAWG 1-64. USFS-R5 Habitat Types for NF Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = Aa+

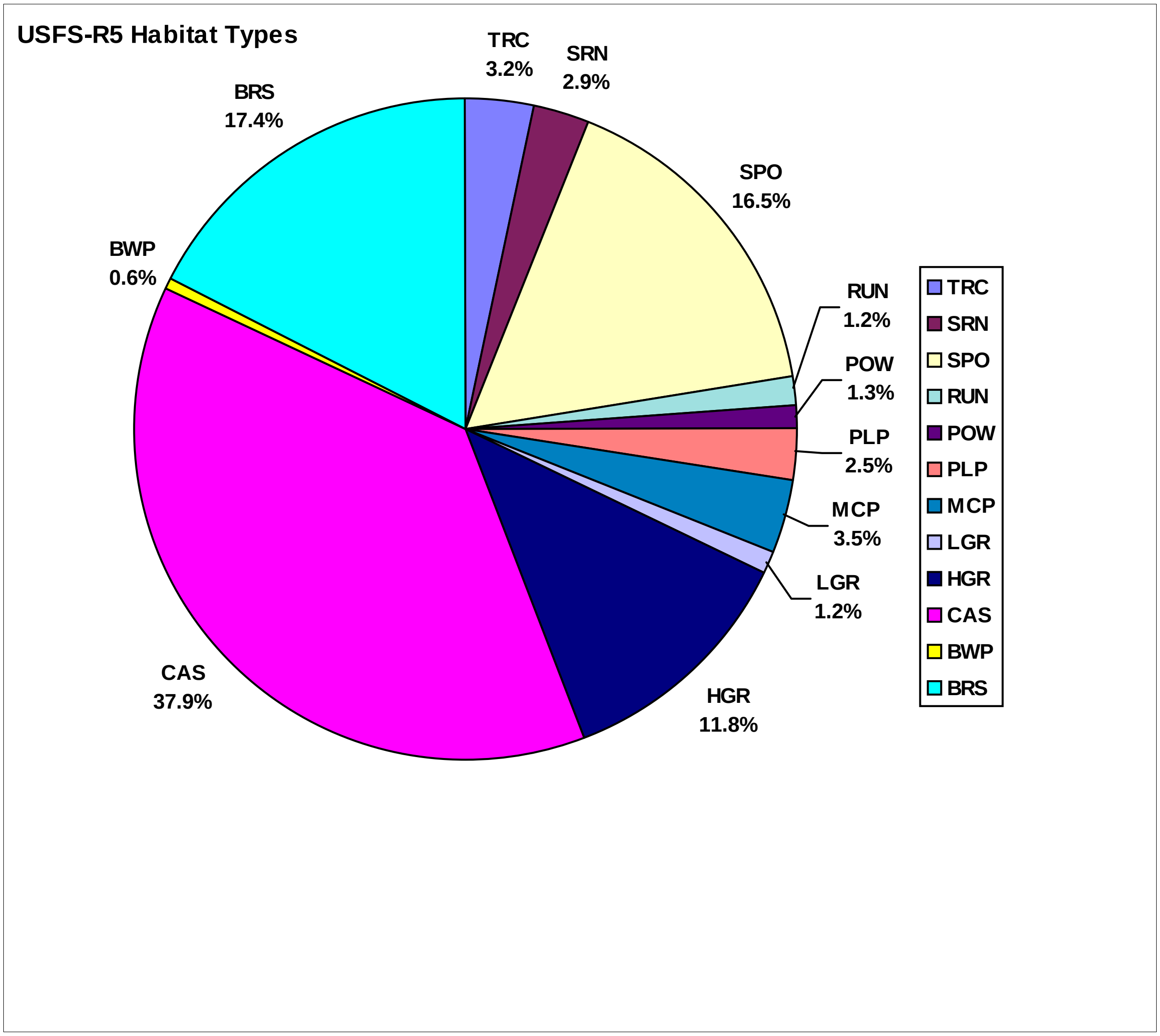


Figure CAWG 1-64. USFS-R5 Habitat Types for NF Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = B

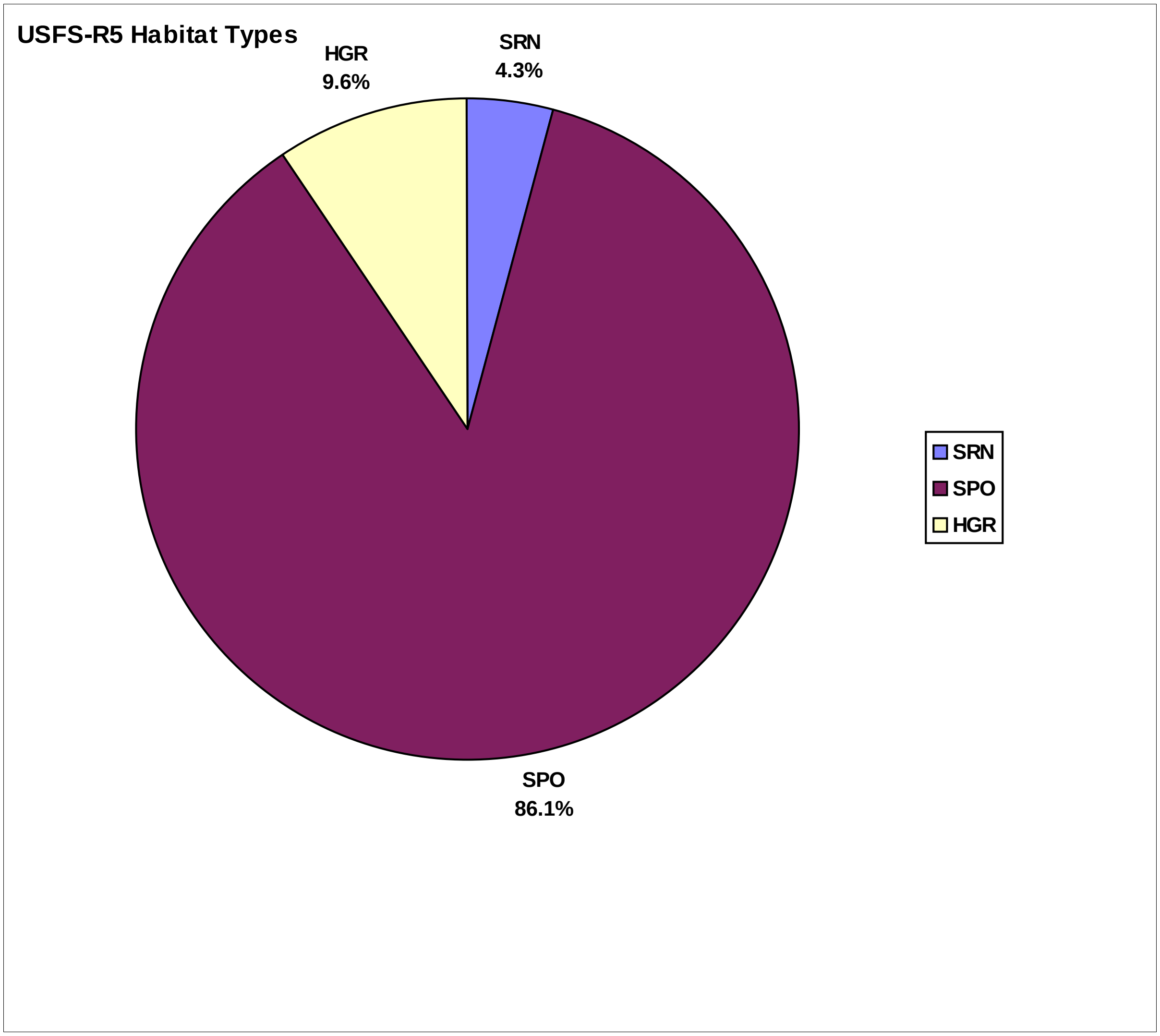


Figure CAWG 1-64. USFS-R5 Habitat Types for NF Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = C

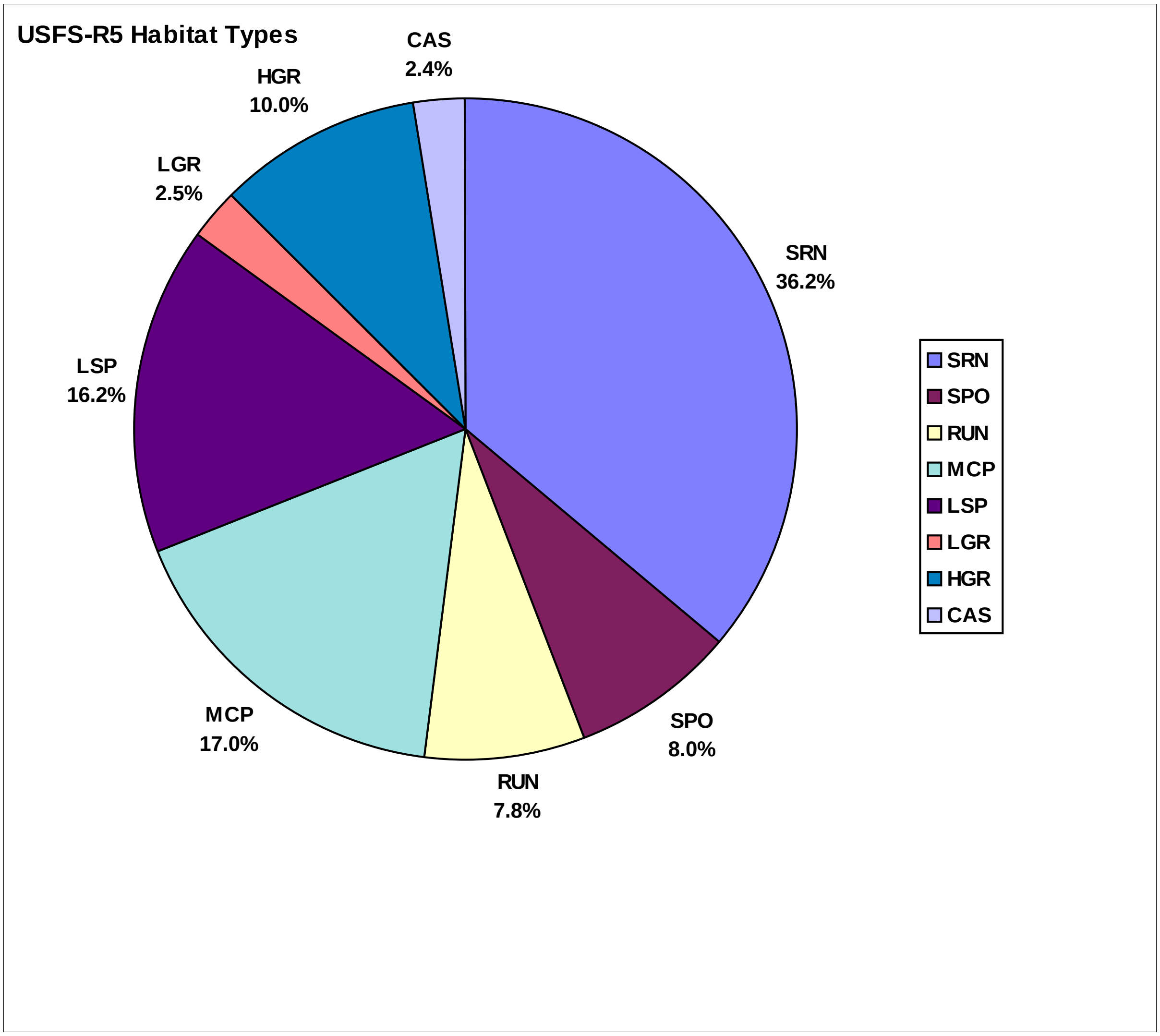


Figure CAWG 1-64. USFS-R5 Habitat Types for NF Stevenson Creek (cont).

USFS-R5 Habitat Types by Channel Type

Stevenson Reach (Basin)

NF Stevenson Creek

NF Stevenson Creek below outlet Reach

Rosgen 1 Channel Type = G

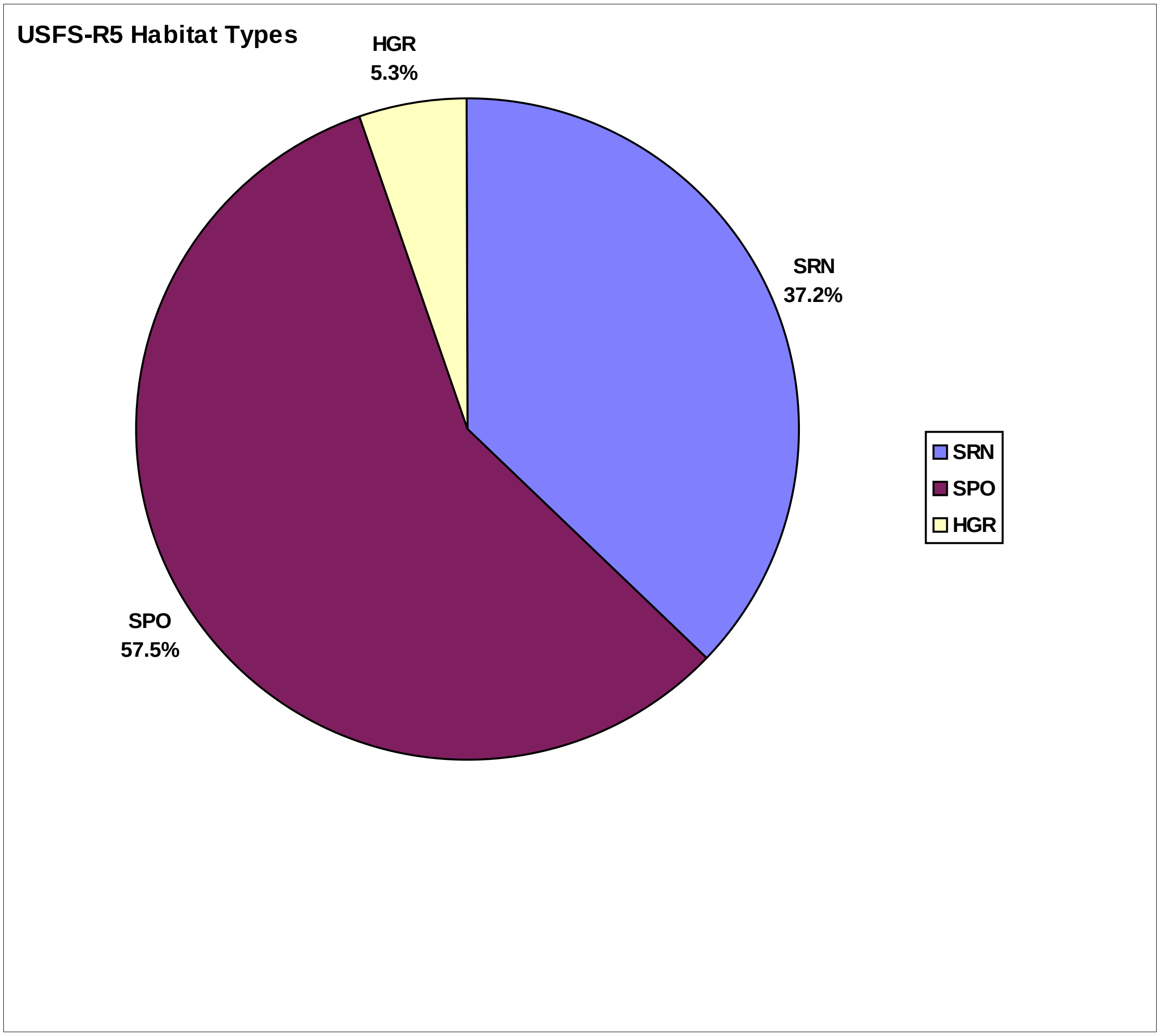


Figure CAWG 1-64. USFS-R5 Habitat Types for NF Stevenson Creek (cont).

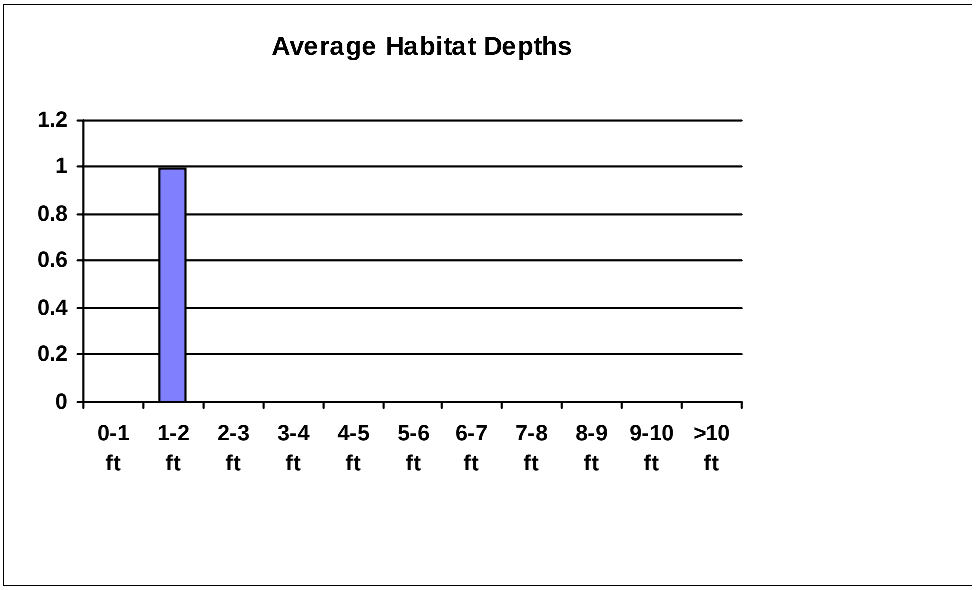
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

NF Stevenson Creek NFSC

NF Stevenson Creek below outlet Reach NFSC_R



A Channel Type

Figure CAWG 1-65. Average Habitat Depth Histograms for NF Stevenson Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 10/25/2000 Below Outlet.

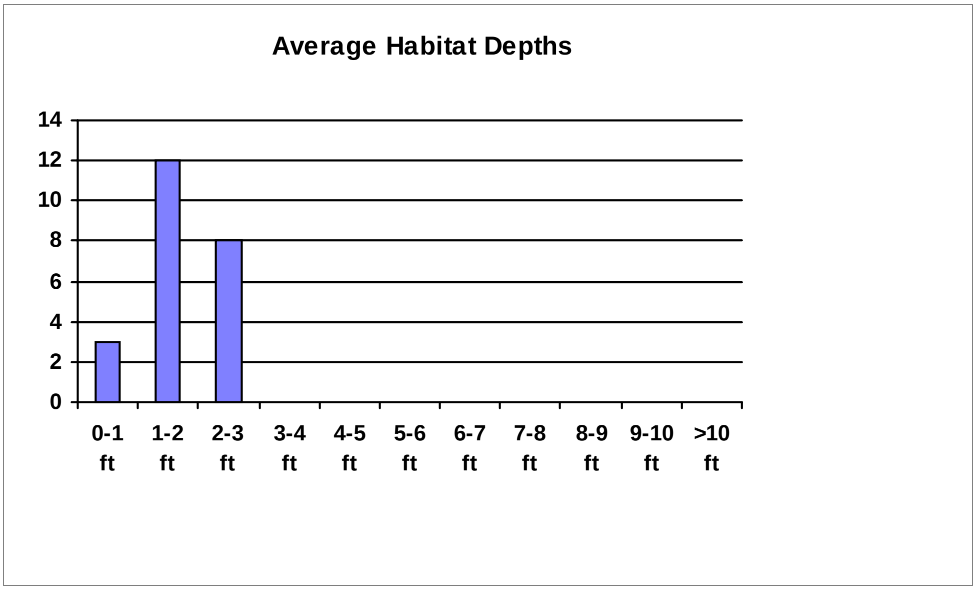
Recorded Average Habitat Depth Histograms

1 foot bin size

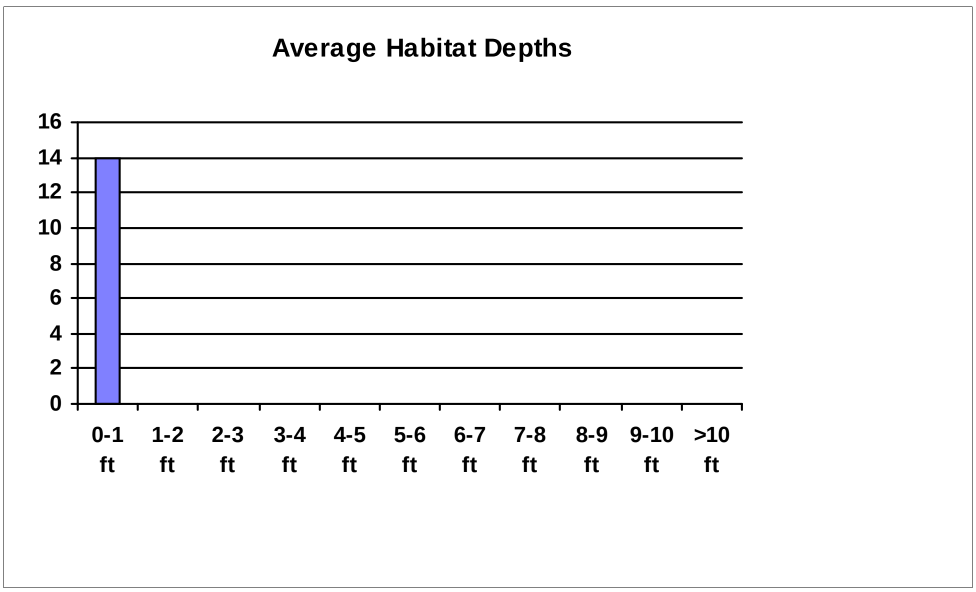
Stevenson Reach (Basin) BAS_S

NF Stevenson Creek NFSC

NF Stevenson Creek below outlet Reach NFSC_R



NF Stevenson Creek above outlet Reach NFSCa_



Aa+ Channel Type

Figure CAWG 1-65. Average Habitat Depth Histograms for NF Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 10/25/2000 Below Outlet and 10/26/2000 Above Outlet.

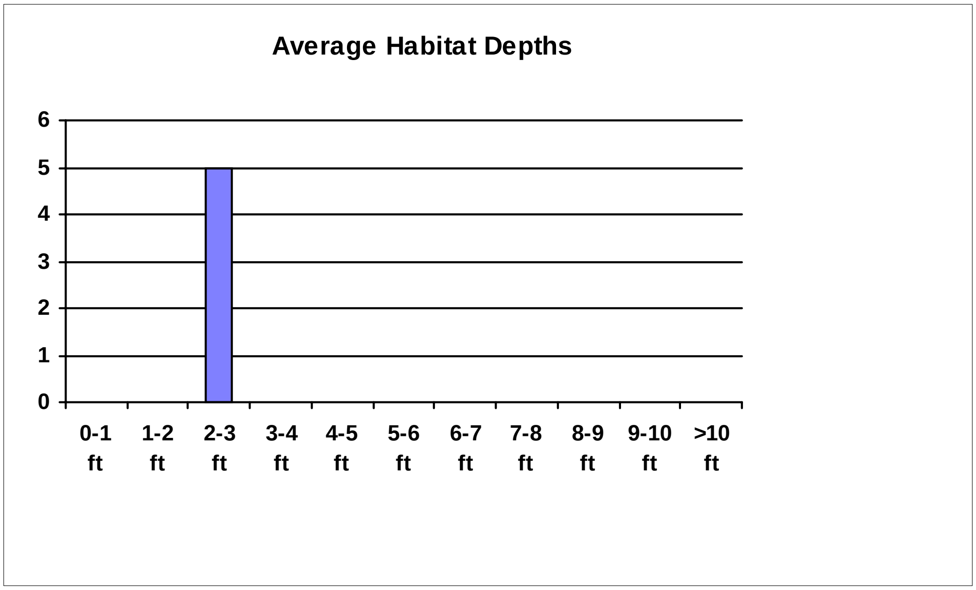
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

NF Stevenson Creek NFSC

NF Stevenson Creek below outlet Reach NFSC_R



B Channel Type

Figure CAWG 1-65. Average Habitat Depth Histograms for NF Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 10/25/2000 Below Outlet.

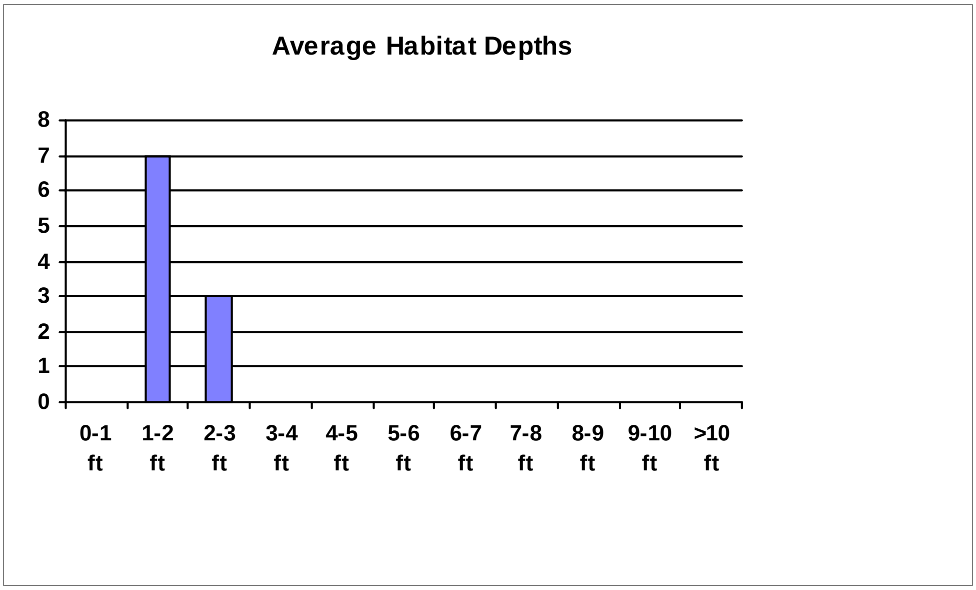
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

NF Stevenson Creek NFSC

NF Stevenson Creek below outlet Reach NFSC_R



C Channel Type

Figure CAWG 1-65. Average Habitat Depth Histograms for NF Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 10/25/2000 Below Outlet.

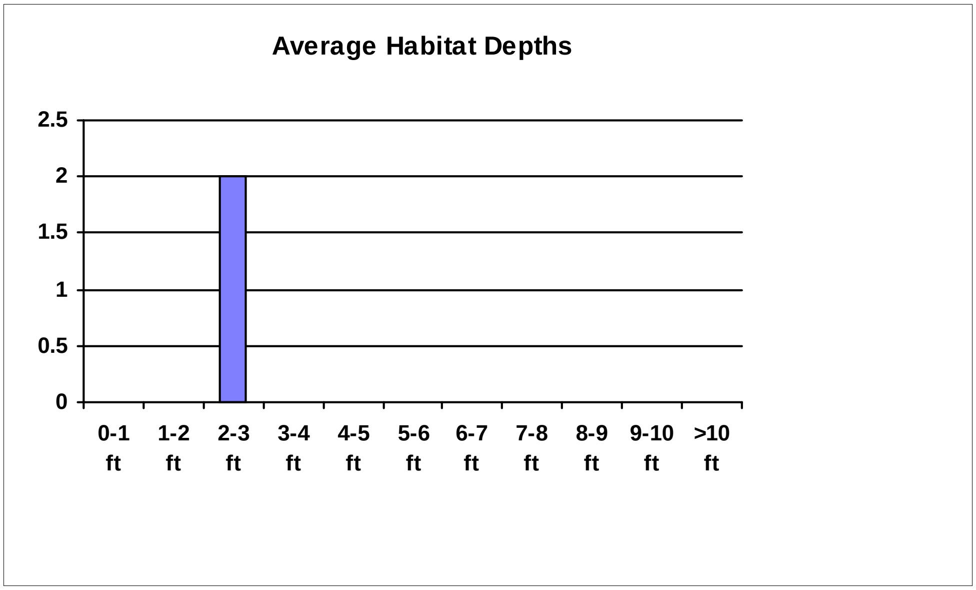
Recorded Average Habitat Depth Histograms

1 foot bin size

Stevenson Reach (Basin) BAS_S

NF Stevenson Creek NFSC

NF Stevenson Creek below outlet Reach NFSC_R



G Channel Type

Figure CAWG 1-65. Average Habitat Depth Histograms for NF Stevenson Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 10/25/2000 Below Outlet.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam1 Reach

Rosgen 1 Channel Type = A

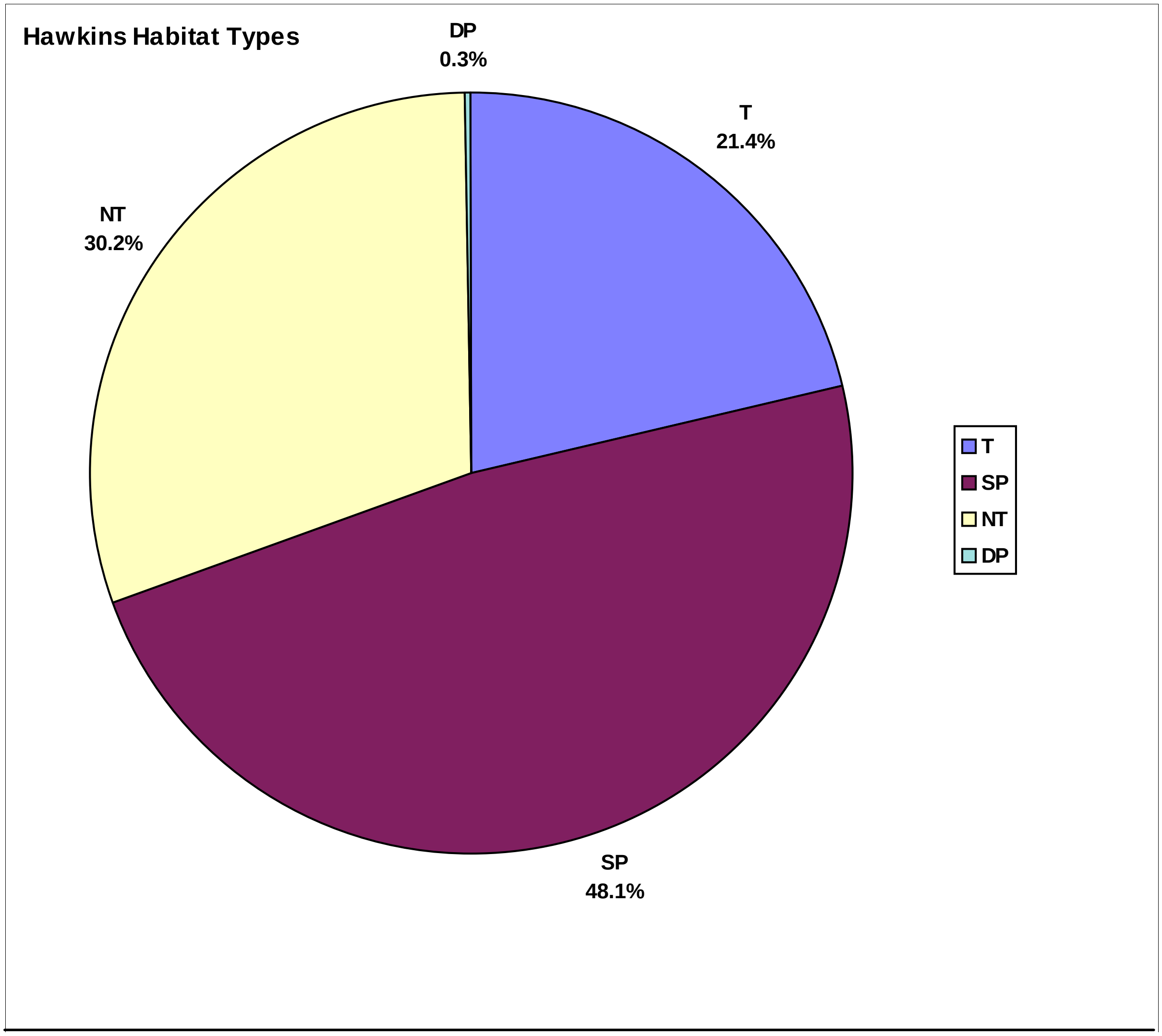


Figure CAWG 1-66. Hawkins Habitat Types for Big Creek PH 1 to Dam 1.

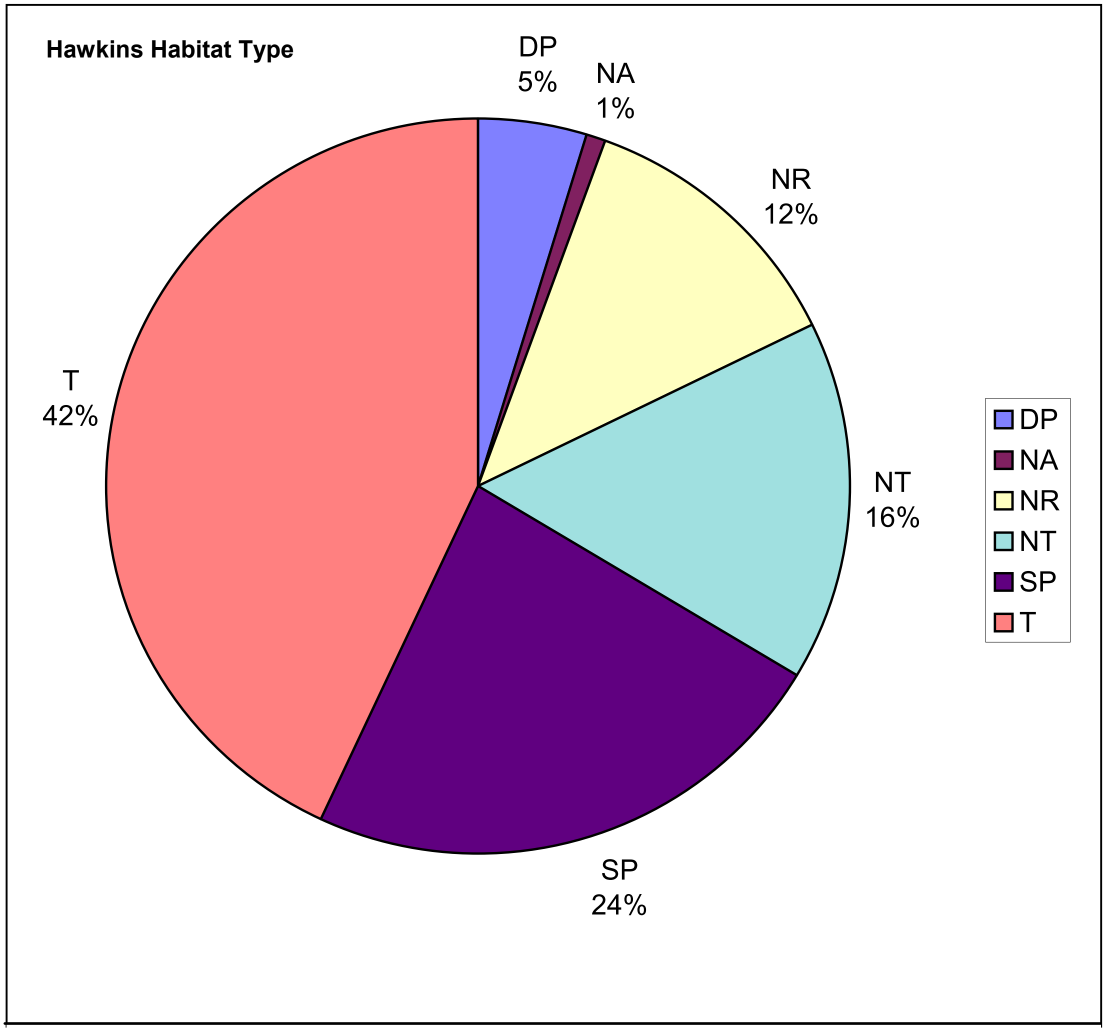
Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = Aa+



NR = Not Resolved (from aerial mapping)

Note: 6,610 feet of mesohabitat was visually estimated from aerial photography and overflight.

Figure CAWG 1-66. Hawkins Habitat Types for Big Creek PH 1 to Dam 1 (cont).

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = B

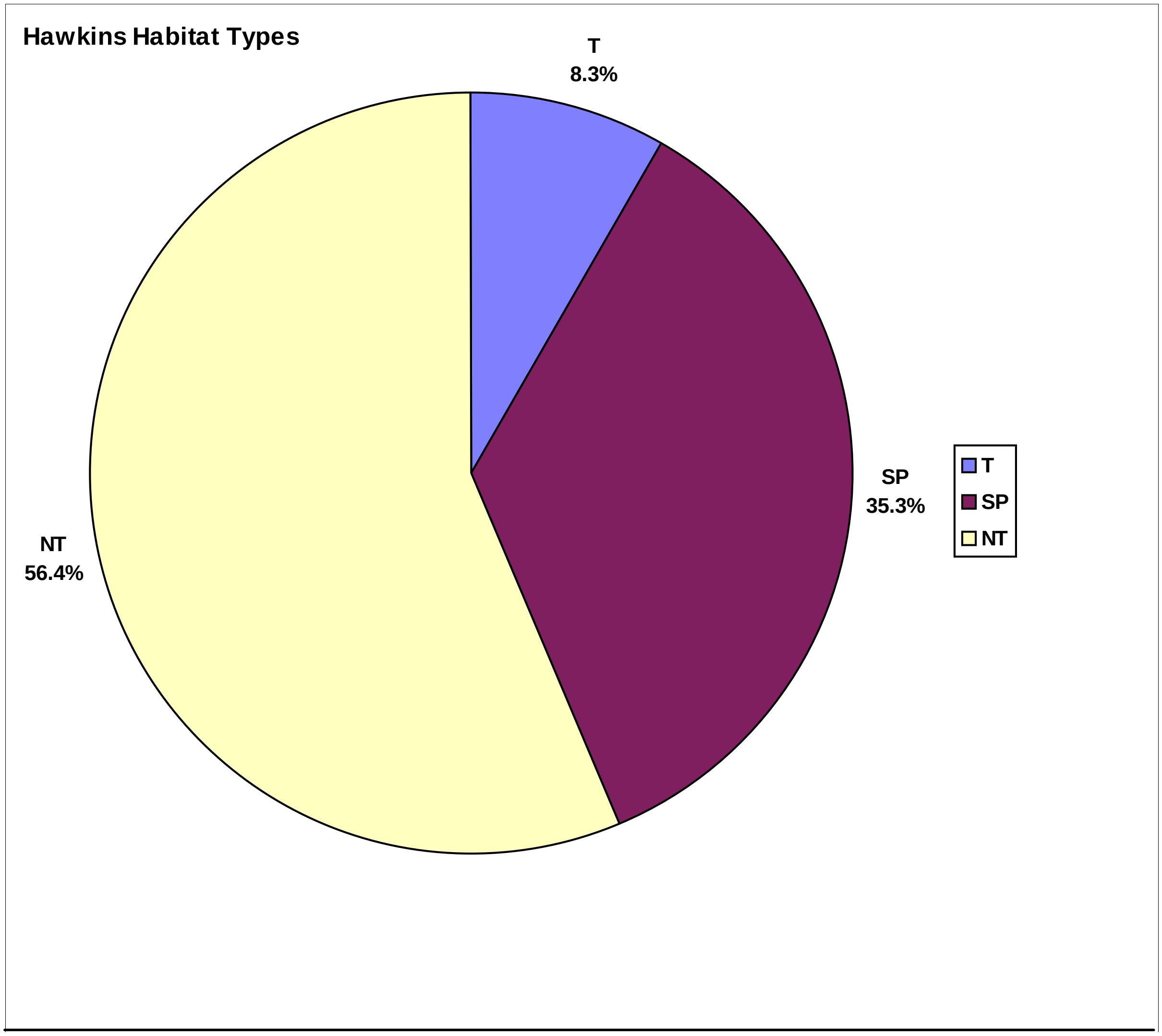


Figure CAWG 1-66. Hawkins Habitat Types for Big Creek PH 1 to Dam 1 (cont).

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = G

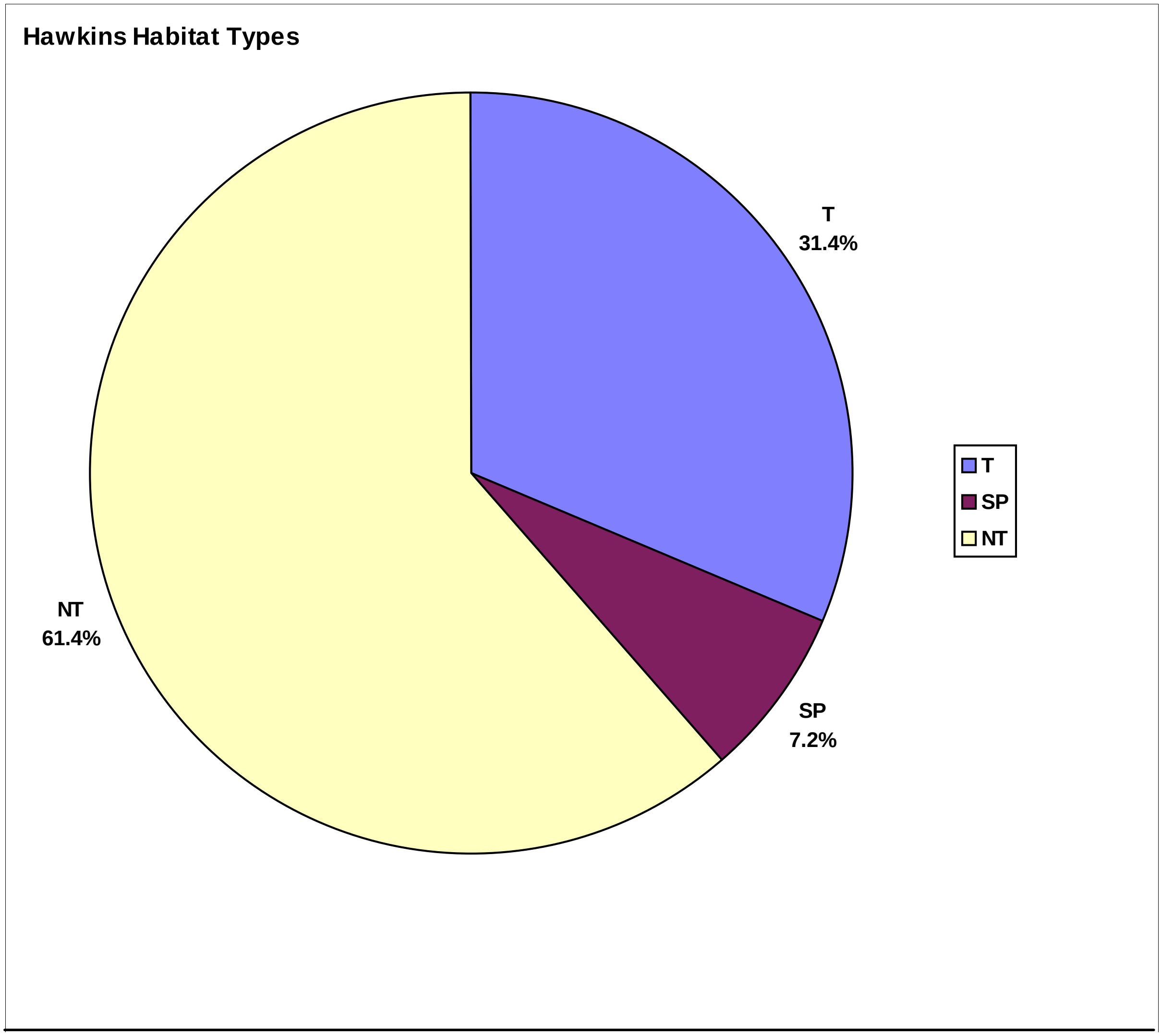


Figure CAWG 1-66. Hawkins Habitat Types for Big Creek PH 1 to Dam 1 (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = A

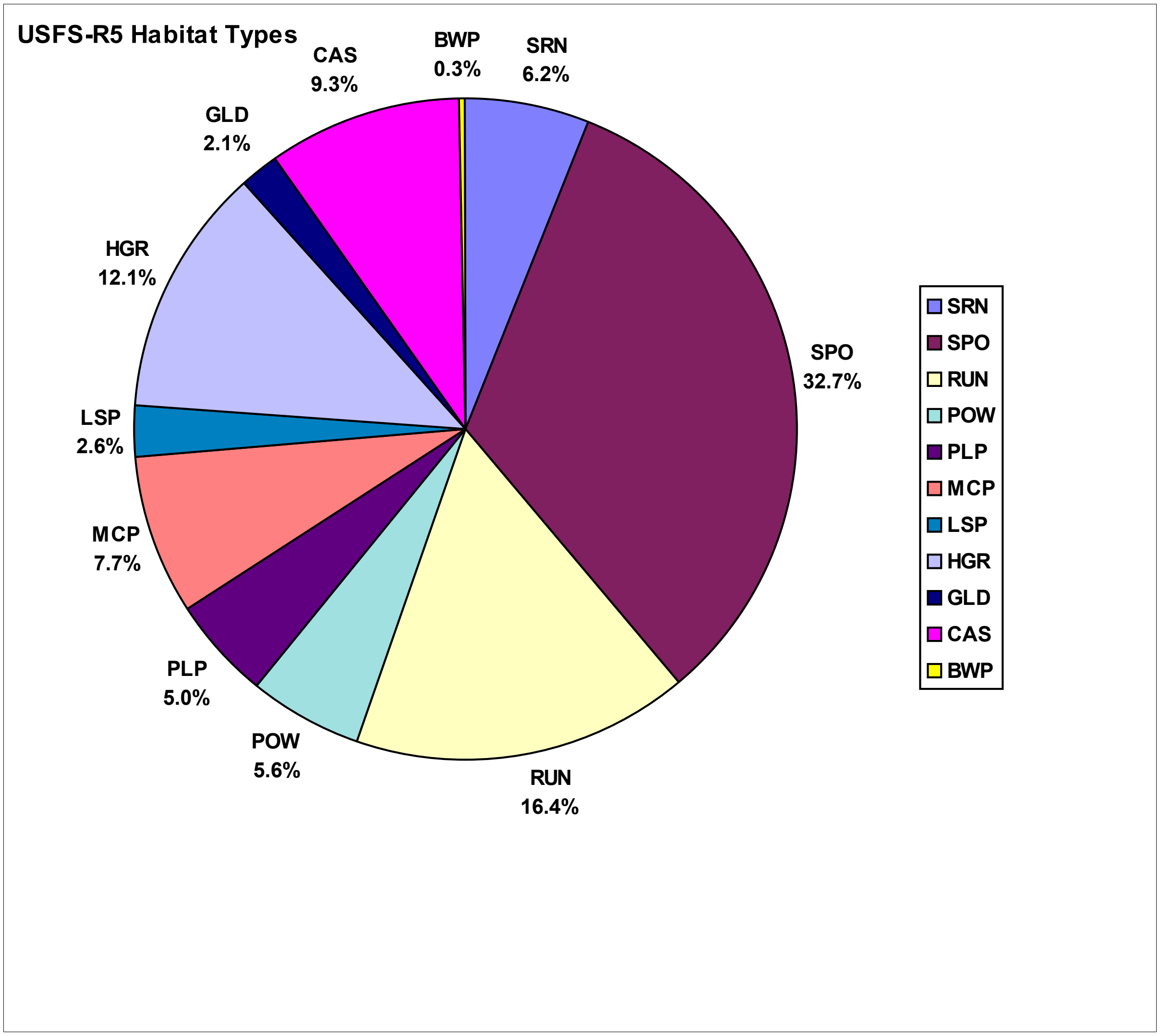


Figure CAWG 1-67. USFS-R5 Habitat Types for Big Creek PH 1 to Dam 1.

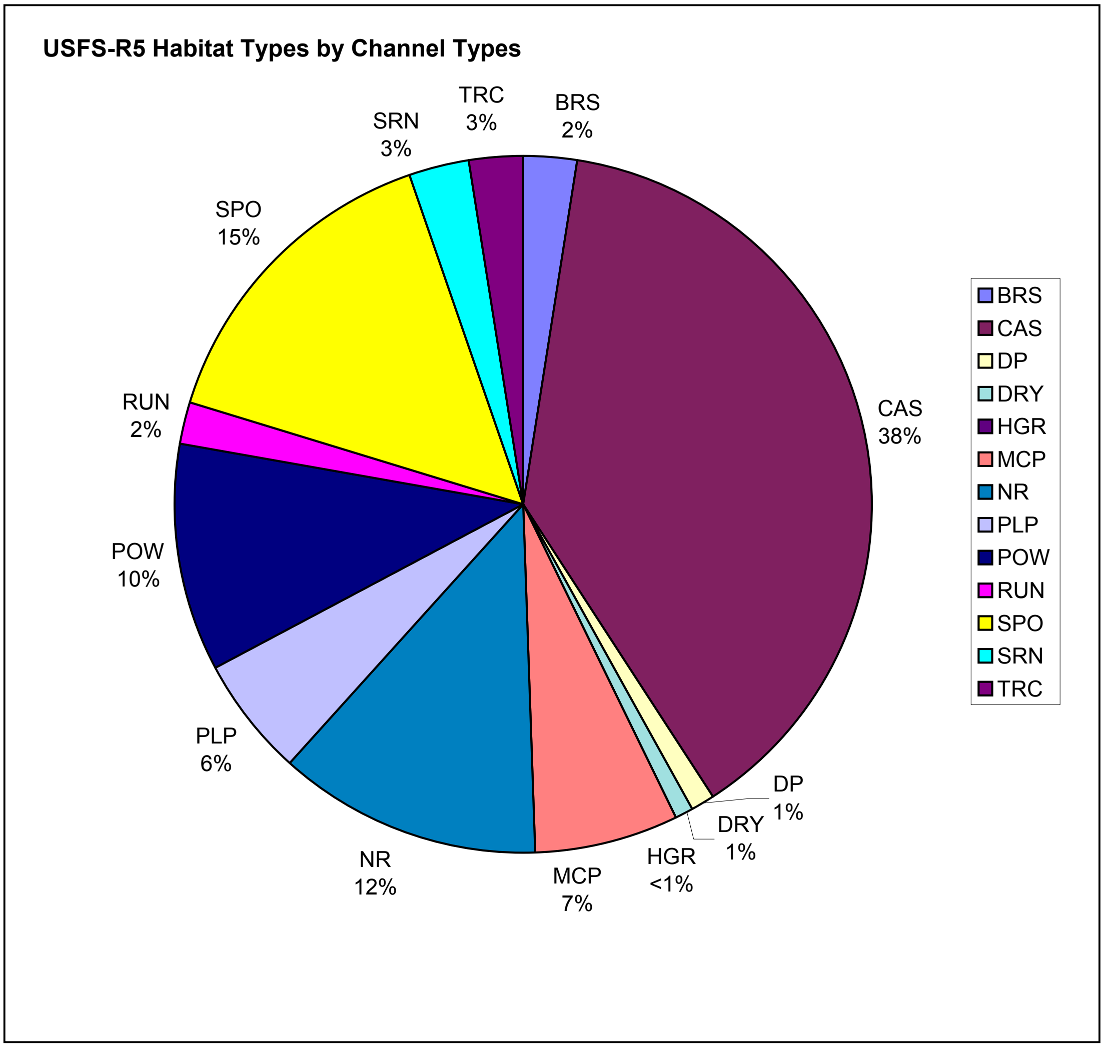
USFS R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = Aa+



NR = Not Resolved (from aerial mapping)

Note: 6,610 feet of mesohabitat was visually estimated from aerial photography and overflight.

Figure CAWG 1-67. USFS-R5 Habitat Types for Big Creek PH 1 to Dam 1 (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = B

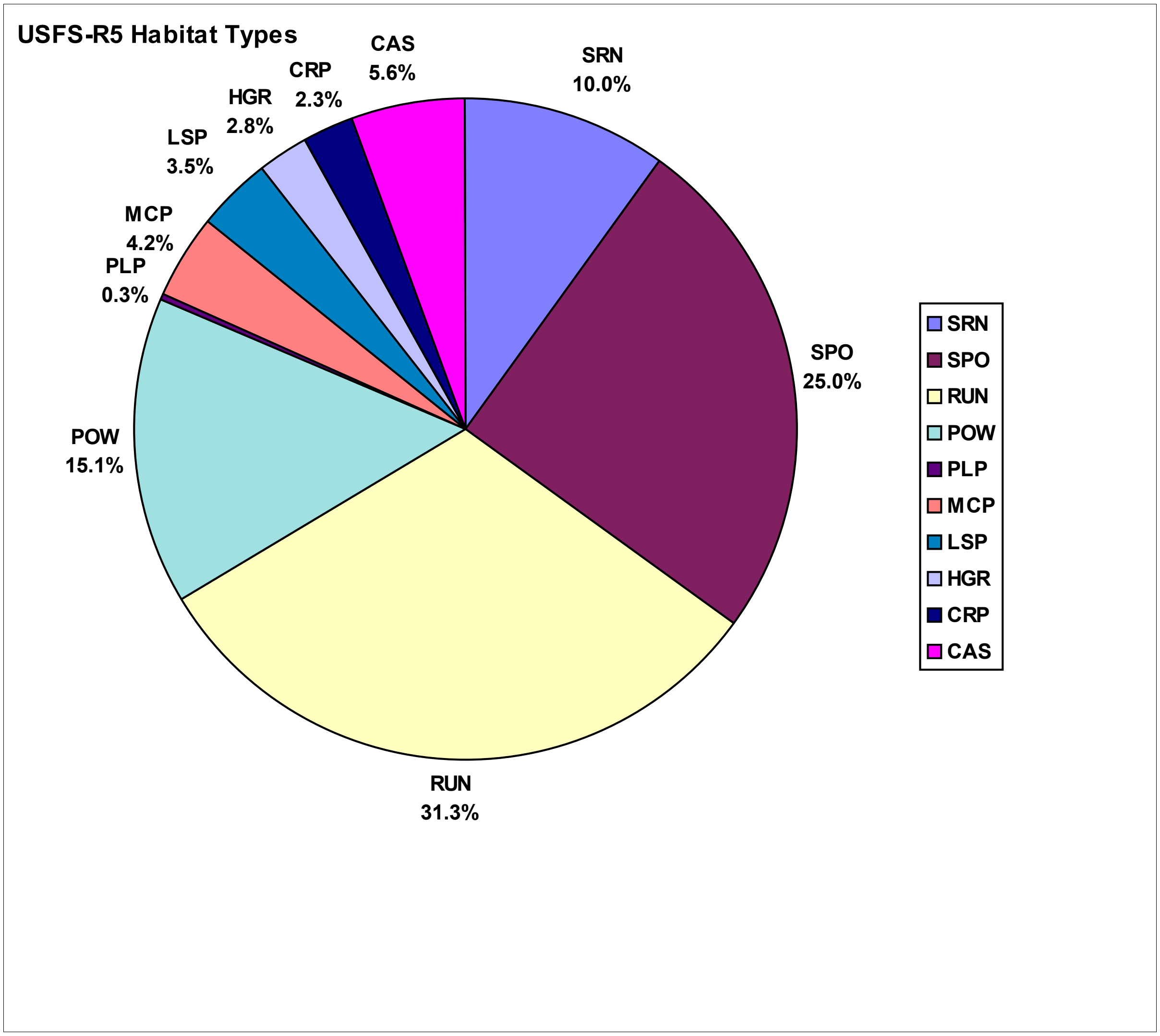


Figure CAWG 1-67. USFS-R5 Habitat Types for Big Creek PH 1 to Dam 1 (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 1 to Dam 1 Reach

Rosgen 1 Channel Type = G

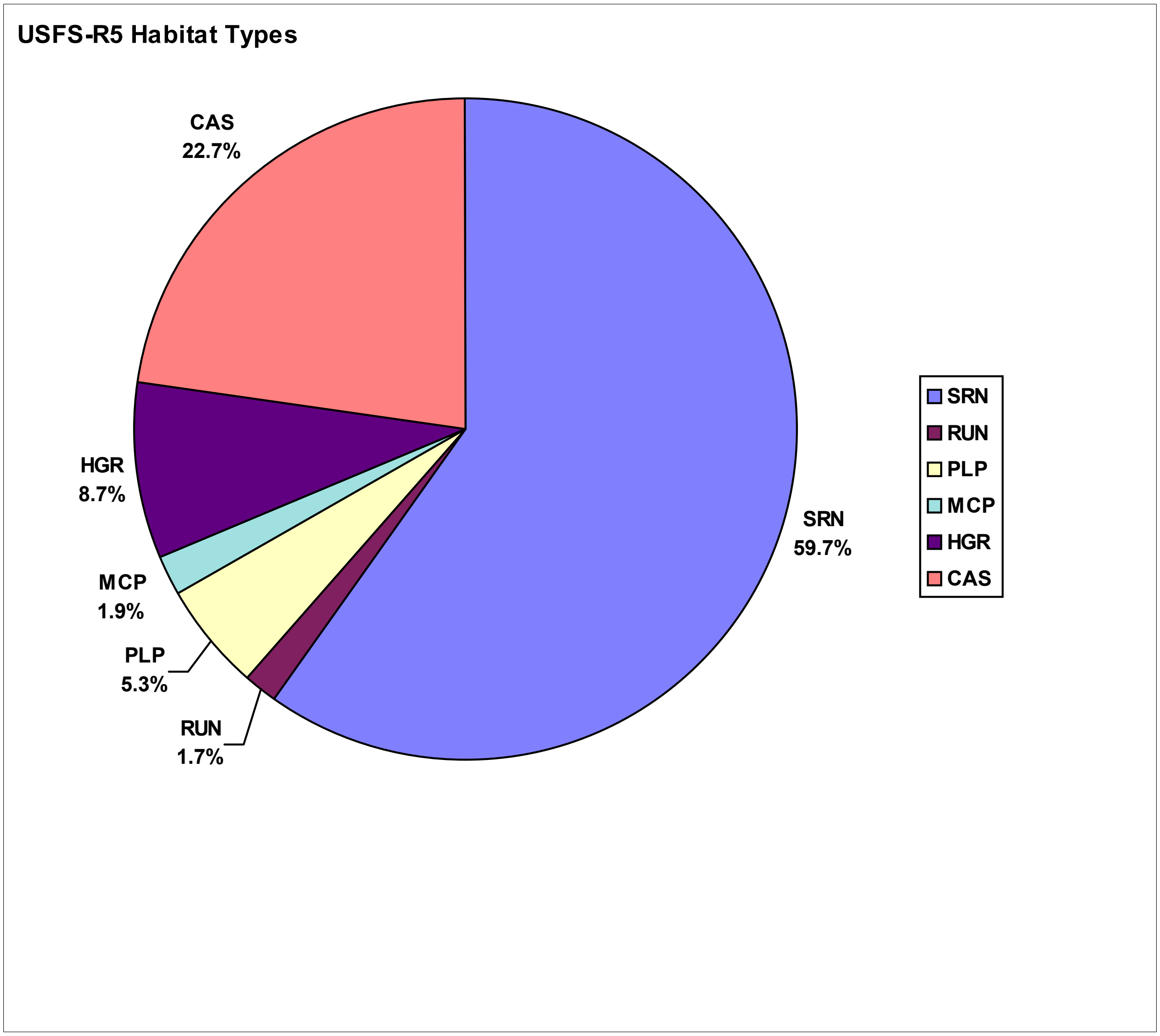


Figure CAWG 1-67. USFS-R5 Habitat Types for Big Creek PH 1 to Dam 1 (cont).

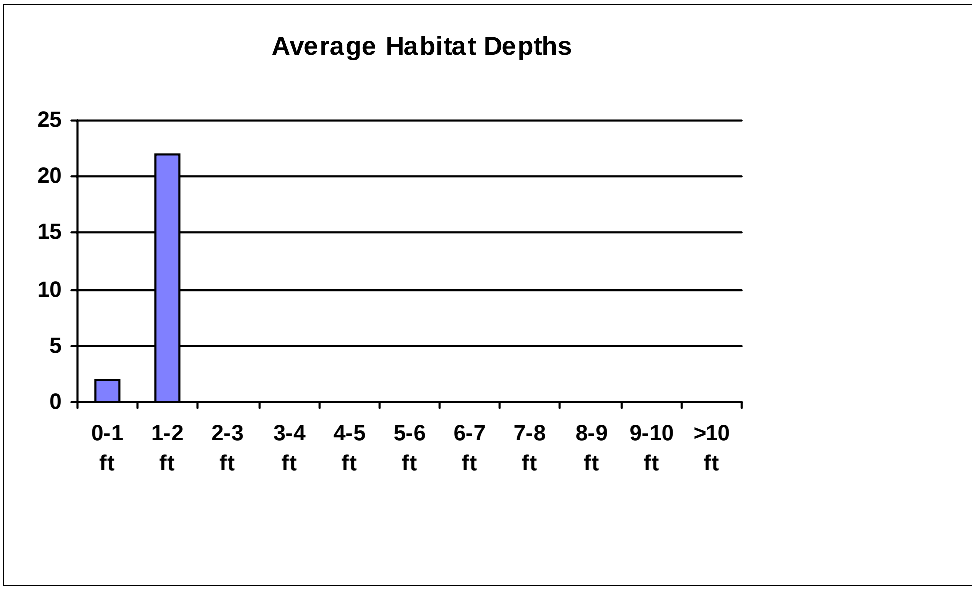
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 1 to Dam 1 Reach



A Channel Type

Figure CAWG 1-68. Average Habitat Depth Histograms for Big Creek PH 1 to Dam 1 (1 foot bin size, frequency = number of pools).

Data collected starting on 11/9/2000.

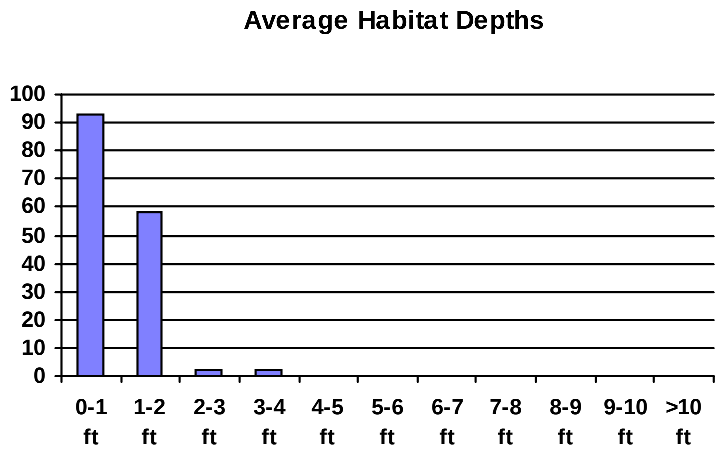
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 1 to Dam 1 Reach



[* Note: This figure does not include pool depths for 6,513 feet which were aerially mapped.]

Aa+ Channel Type

Figure CAWG 1-68. Average Habitat Depth Histograms for Big Creek PH 1 to Dam 1 (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 11/9/2000.

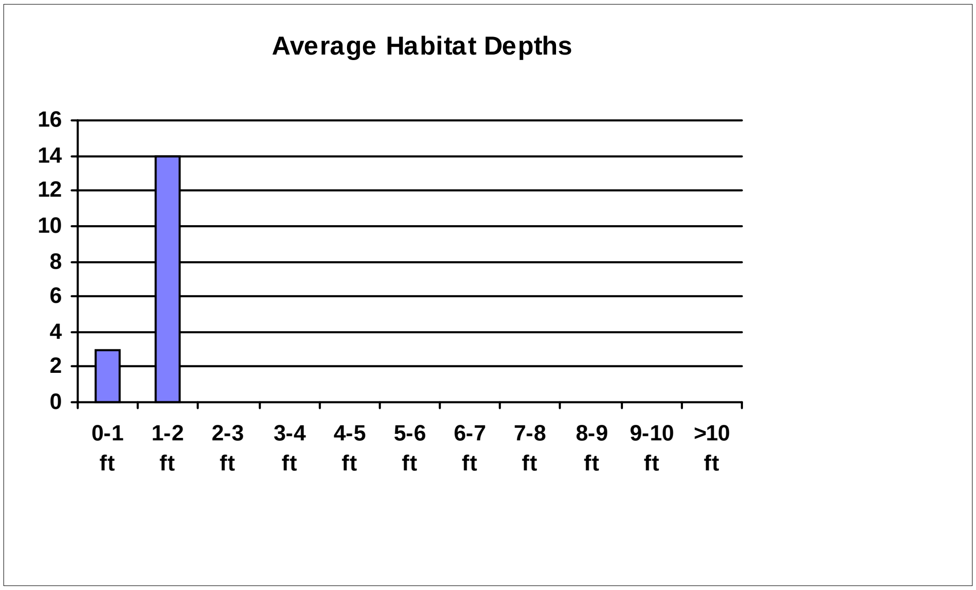
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 1 to Dam 1 Reach



B Channel Type

Figure CAWG 1-68. Average Habitat Depth Histograms for Big Creek PH 1 to Dam 1 (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 11/9/2000.

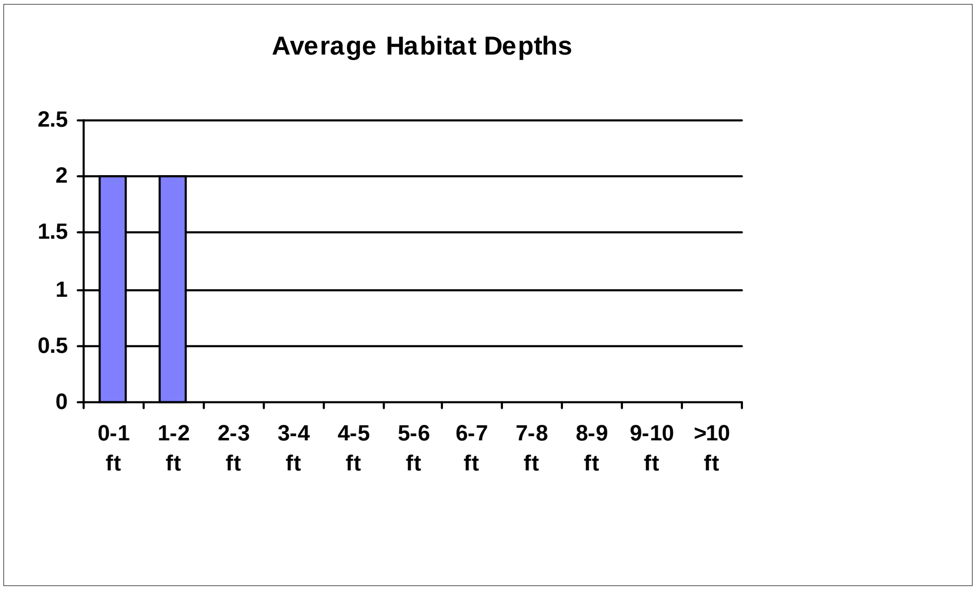
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 1 to Dam 1 Reach



G Channel Type

Figure CAWG 1-68. Average Habitat Depth Histograms for Big Creek PH 1 to Dam 1 (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 11/9/2000.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 2 to Dam 4 Reach (2001)

Rosgen 1 Channel Type = A

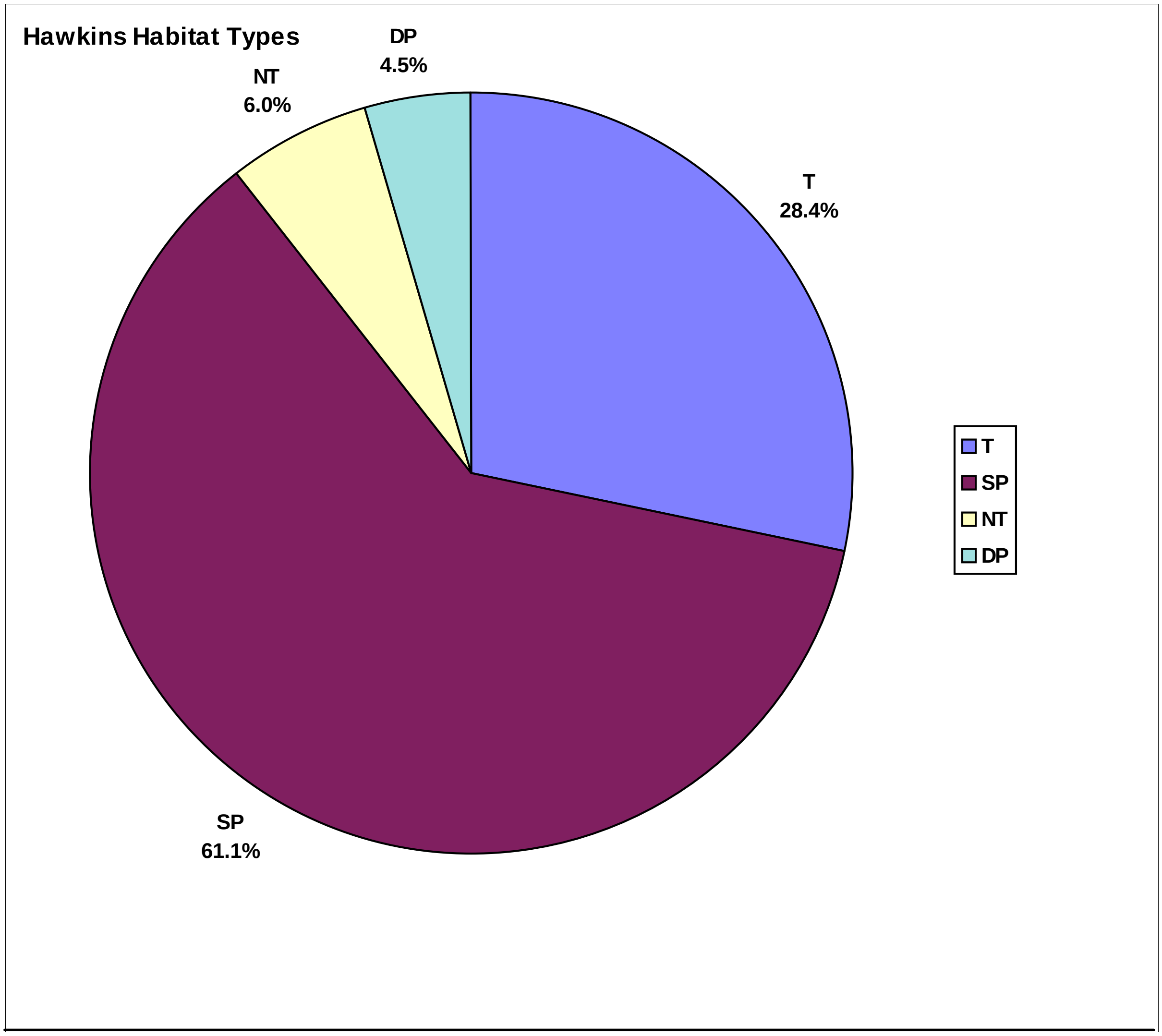


Figure CAWG 1-69. Hawkins Habitat Types for Big Creek PH 2 to Dam 4.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 2 to Dam 4 Reach (2001)

Rosgen 1 Channel Type = B

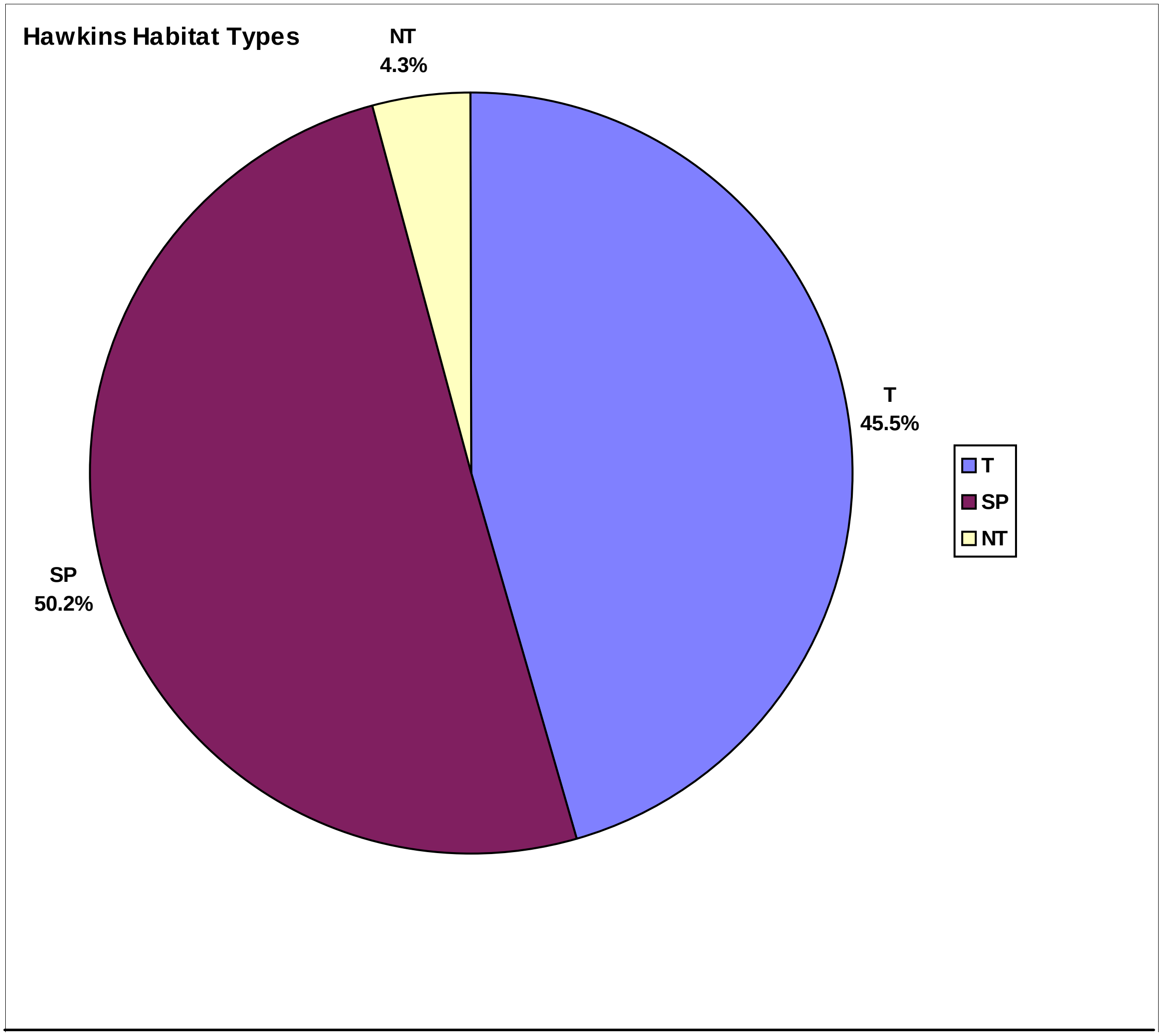


Figure CAWG 1-69. Hawkins Habitat Types for Big Creek PH 2 to Dam 4 (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 2 to Dam 4 Reach (2001)

Rosgen 1 Channel Type = A

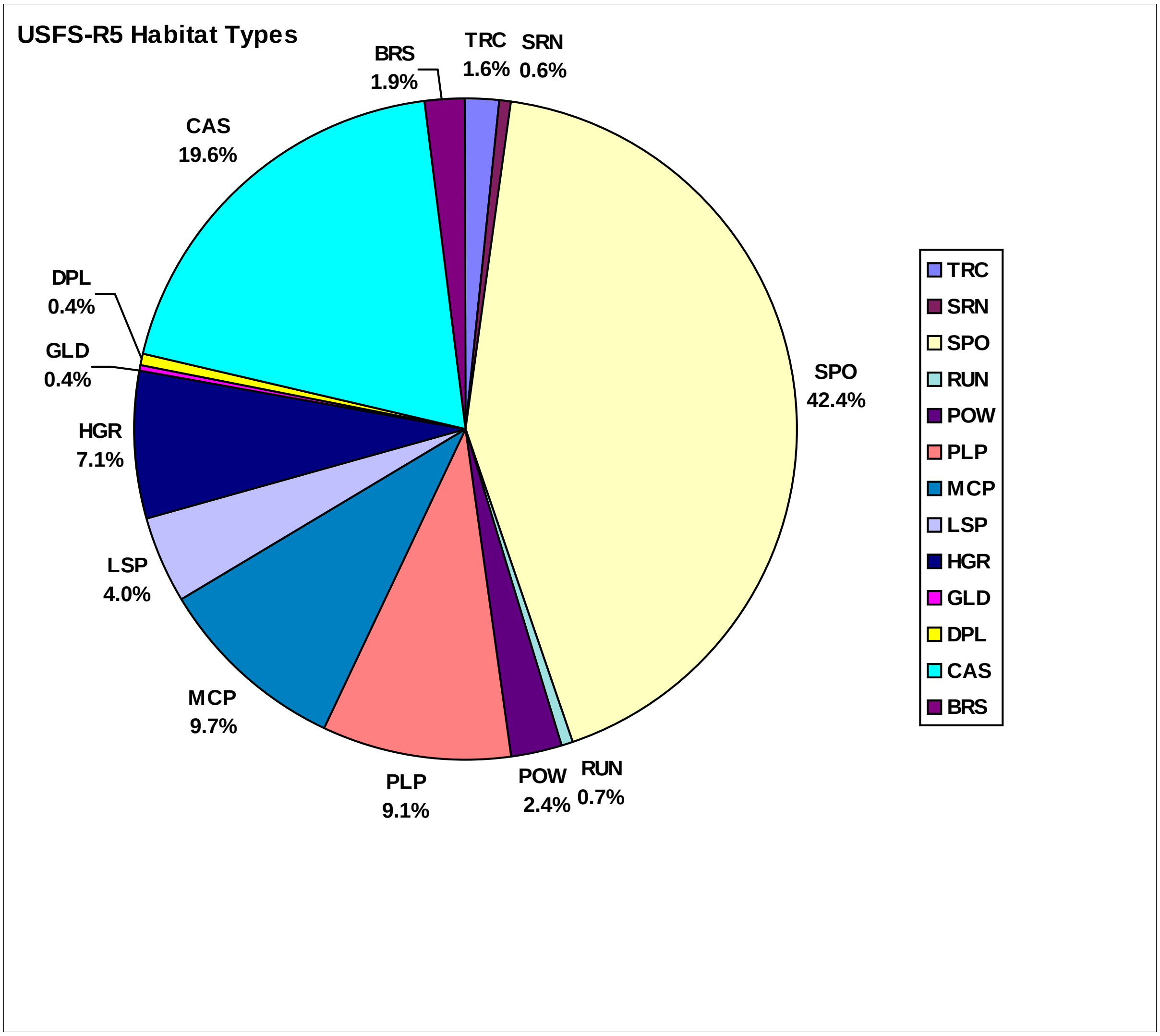


Figure CAWG 1-70. USFS-R5 Habitat Types for Big Creek PH 2 to Dam 4.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 2 to Dam 4 Reach (2001)

Rosgen 1 Channel Type = B

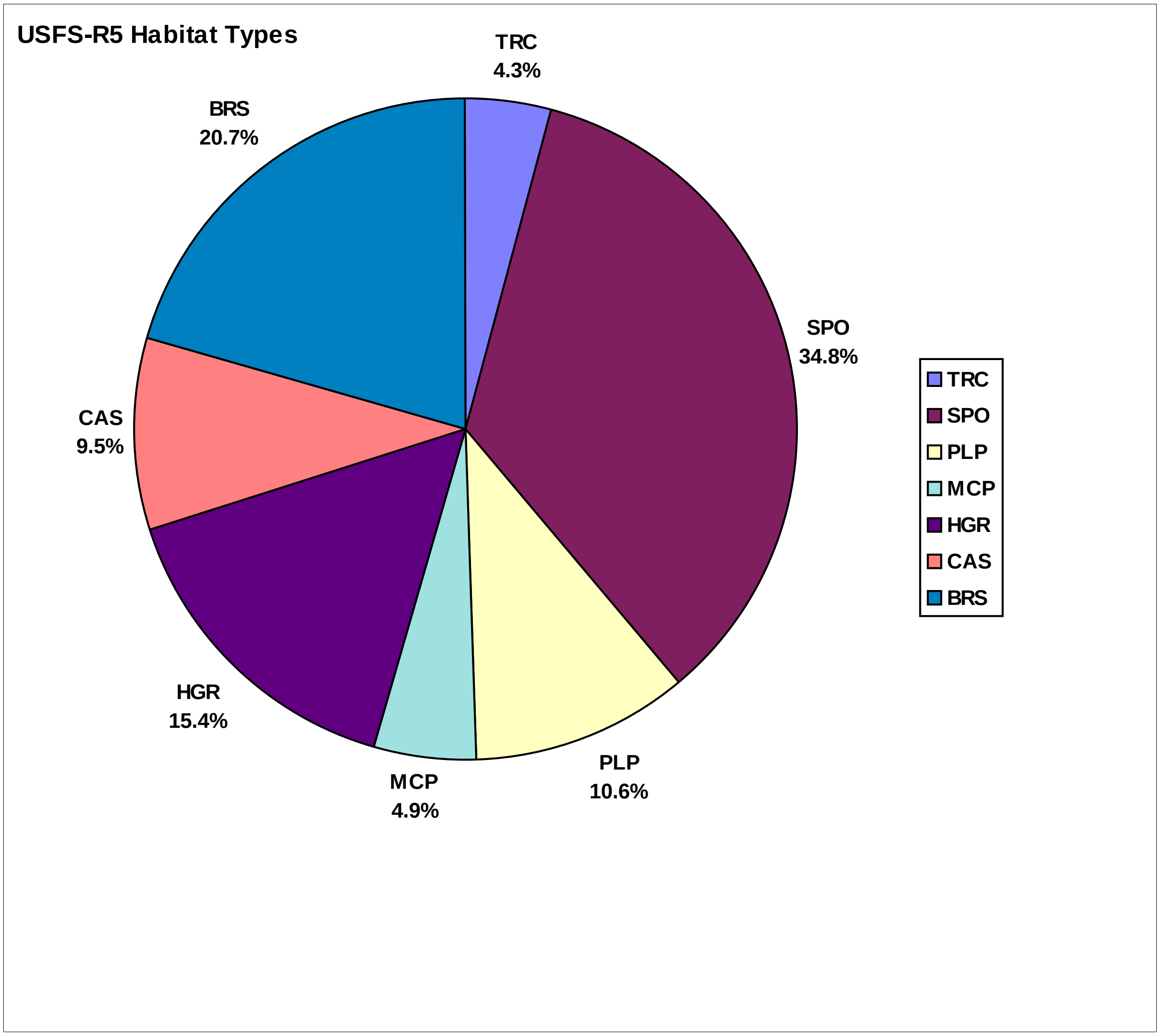


Figure CAWG 1-70. USFS-R5 Habitat Types for Big Creek PH 2 to Dam 4 (cont).

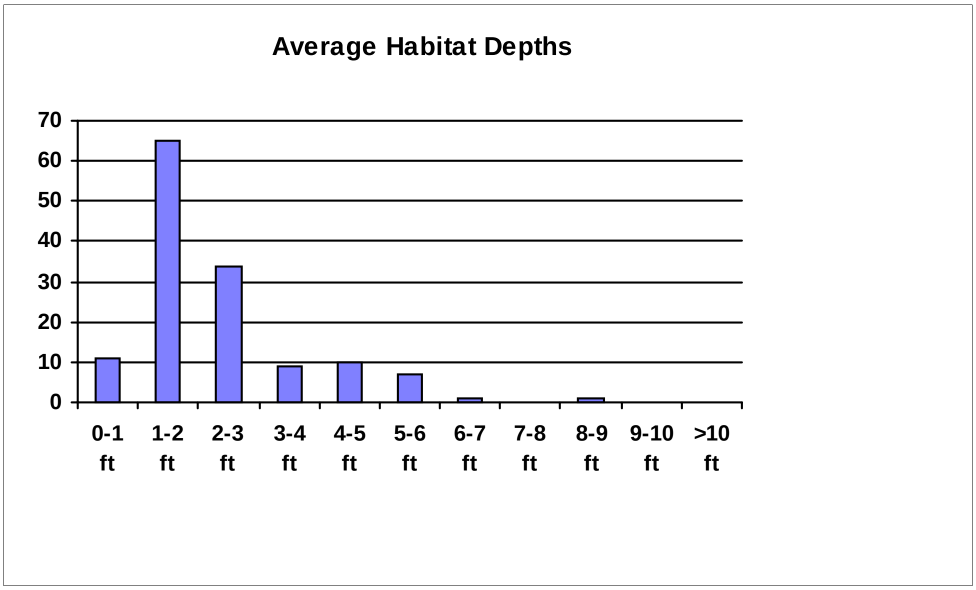
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 2 to Dam 4 Reach (2001) BCD401_



A Channel Type

Figure CAWG 1-71. Average Habitat Depth Histograms for Big Creek PH 2 to Dam 4 (1 foot bin size, frequency = number of pools).

Data collected starting on 9/5/2001.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 8 to Dam 5 Reach (2001)

Rosgen 1 Channel Type = A

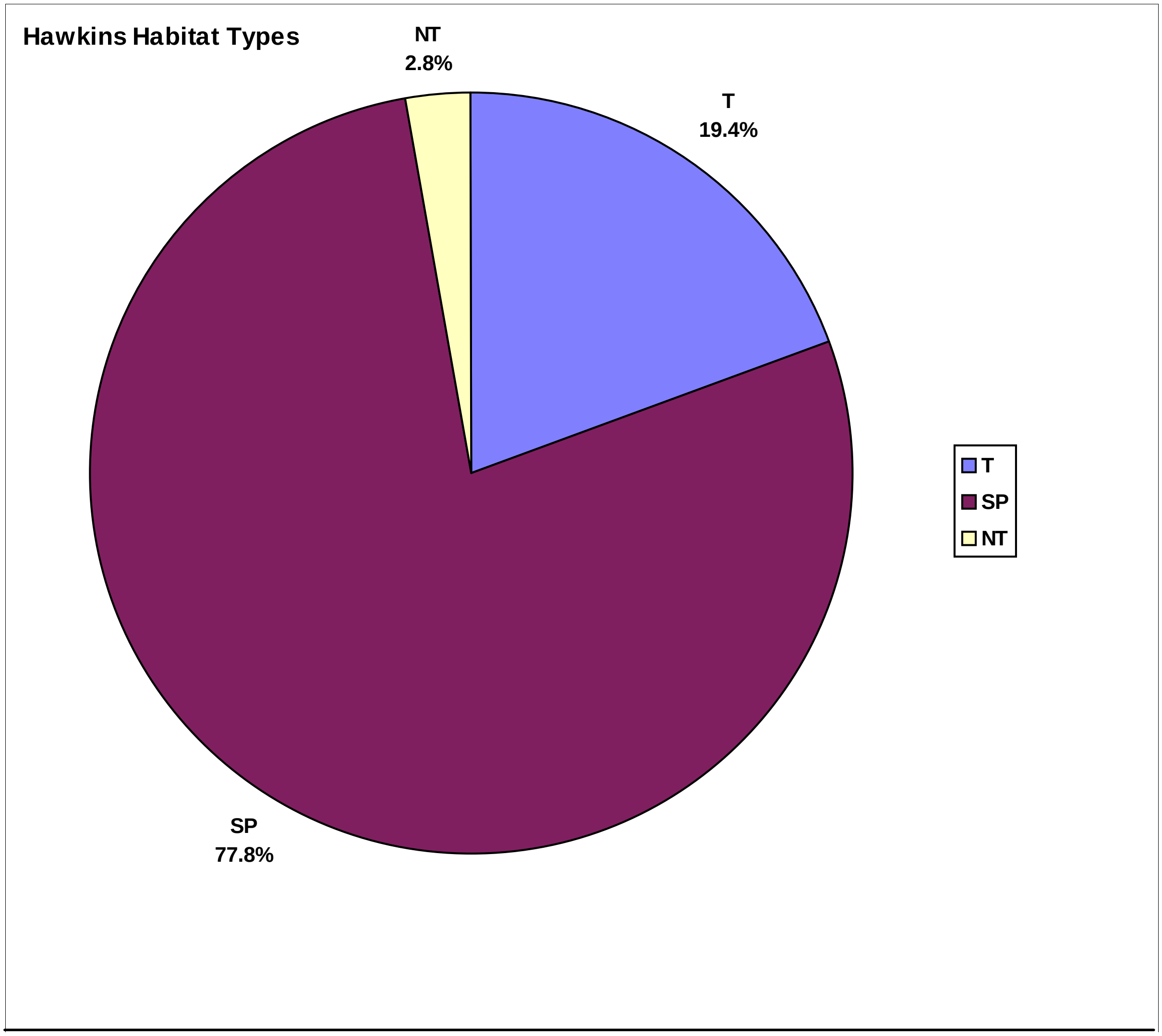


Figure CAWG 1-72. Hawkins Habitat Types for Big Creek PH 8 to Dam 5.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 8 to Dam 5 Reach (2001)

Rosgen 1 Channel Type = Aa+

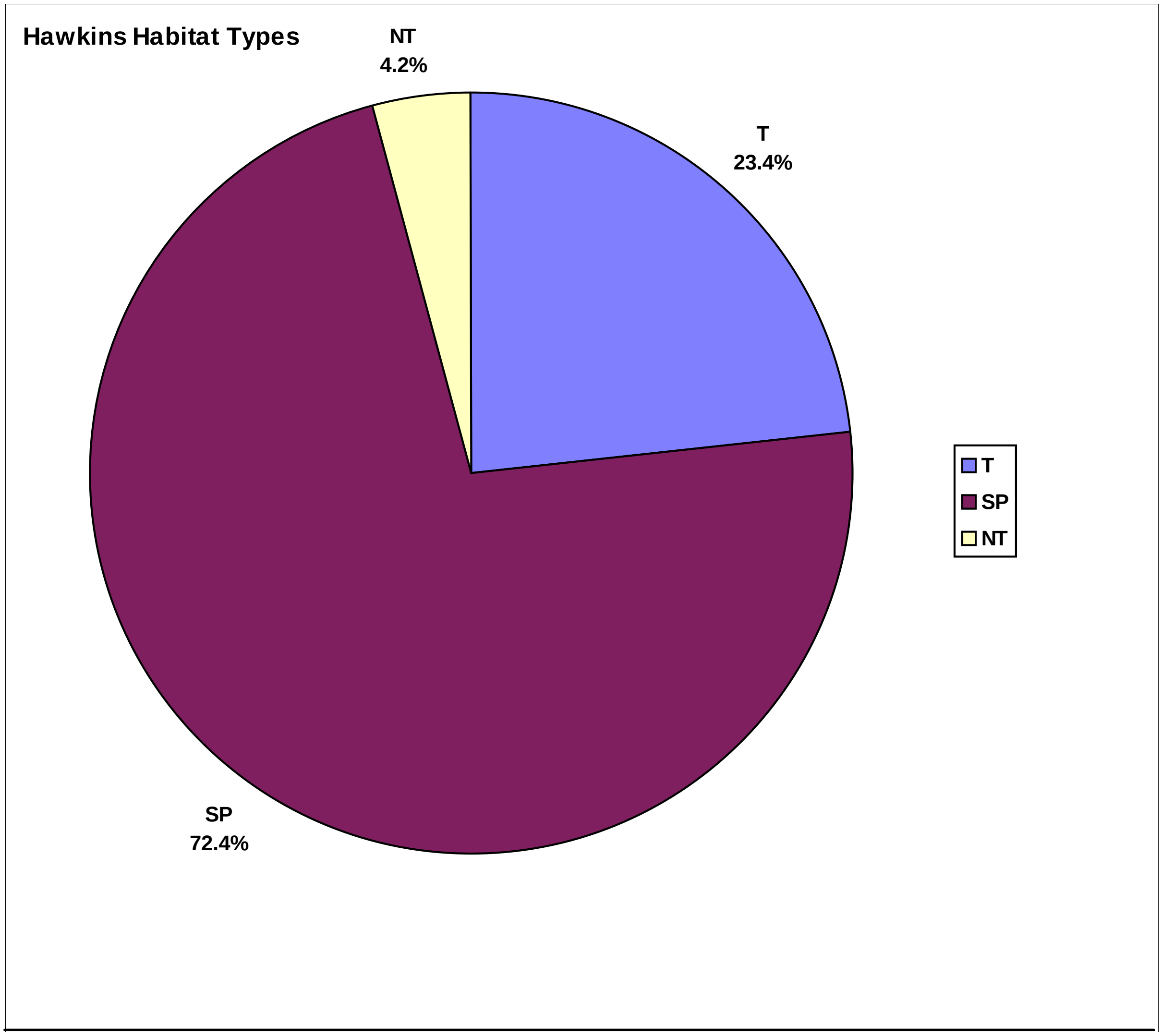


Figure CAWG 1-72. Hawkins Habitat Types for Big Creek PH 8 to Dam 5 (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 8 to Dam 5 Reach (2001)

Rosgen 1 Channel Type = A

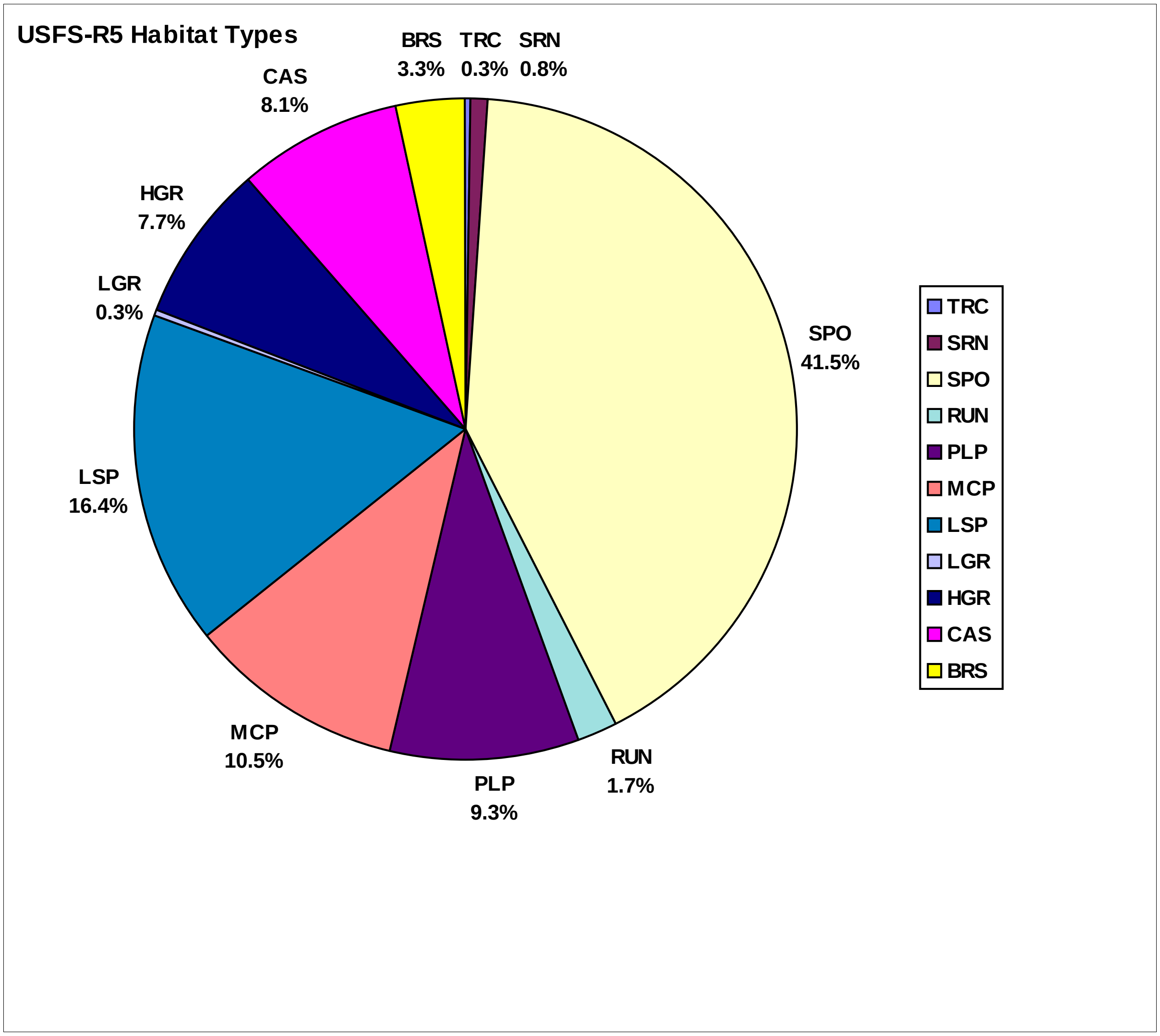


Figure CAWG 1-73. USFS-R5 Habitat Types for Big Creek PH 8 to Dam 5.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Big Creek

Big Creek PH 8 to Dam 5 Reach (2001)

Rosgen 1 Channel Type = Aa+

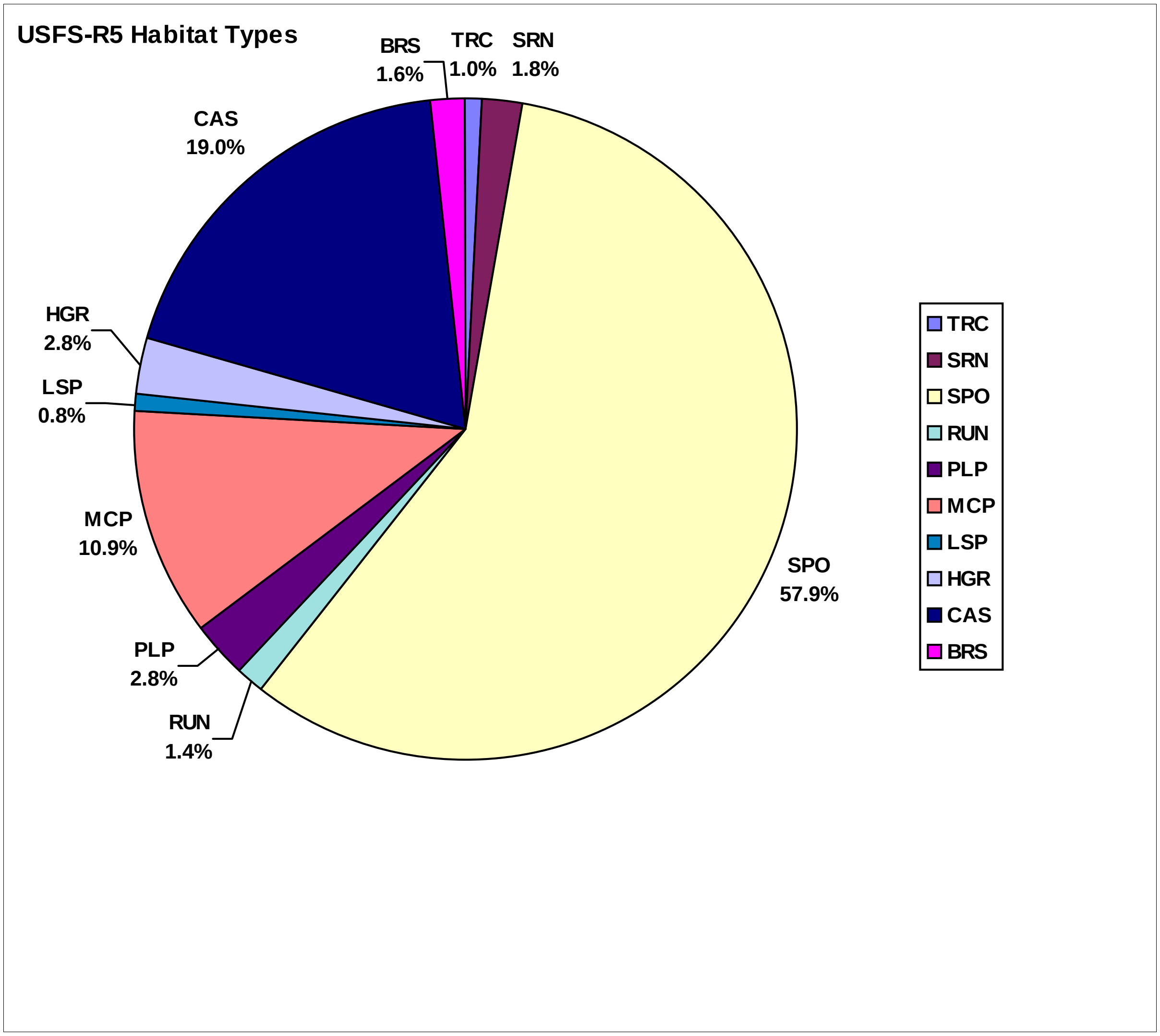


Figure CAWG 1-73. USFS-R5 Habitat Types for Big Creek PH 8 to Dam 5 (cont).

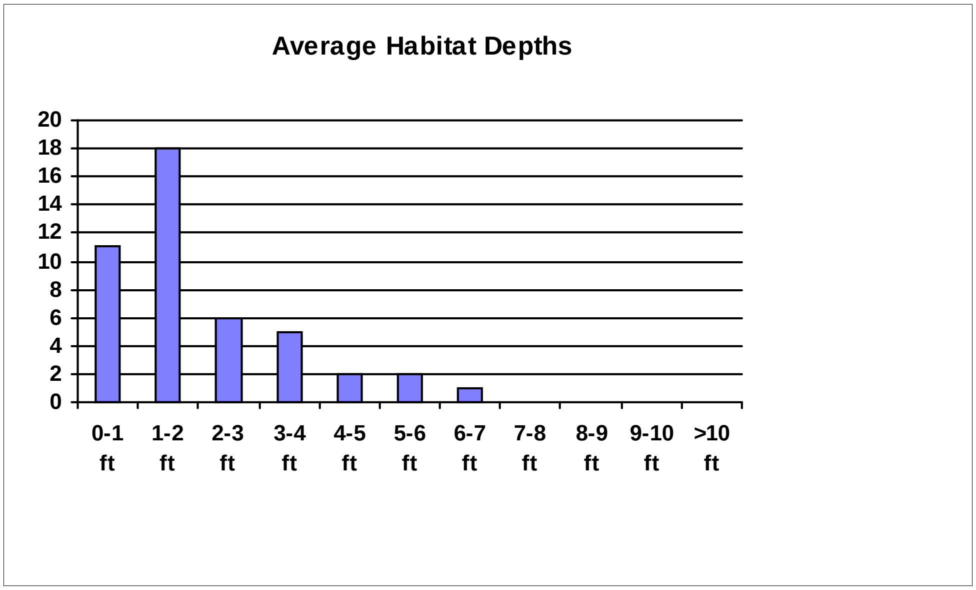
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 8 to Dam 5 Reach (2001) BCD501_



A Channel Type

Figure CAWG 1-74. Average Habitat Depth Histograms for Big Creek PH 8 to Dam 5 (1 foot bin size, frequency = number of pools).

Data collected starting on 8/8/2001.

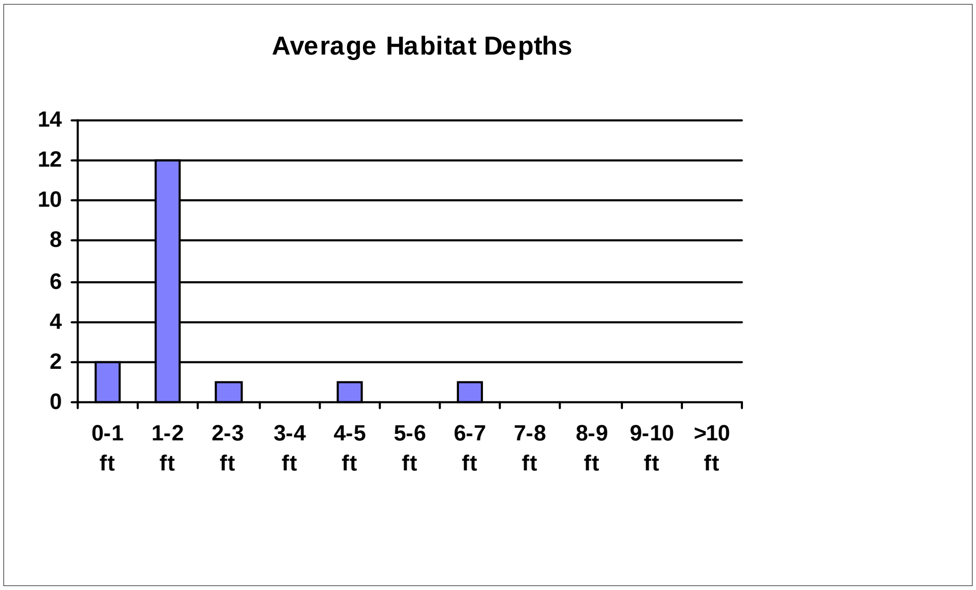
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Big Creek BC

Big Creek PH 8 to Dam 5 Reach (2001) BCD501_



Aa+ Channel Type

Figure CAWG 1-74. Average Habitat Depth Histograms for Big Creek PH 8 to Dam 5 (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/8/2001.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek above Energy Dissipater

Rosgen 1 Channel Type = B

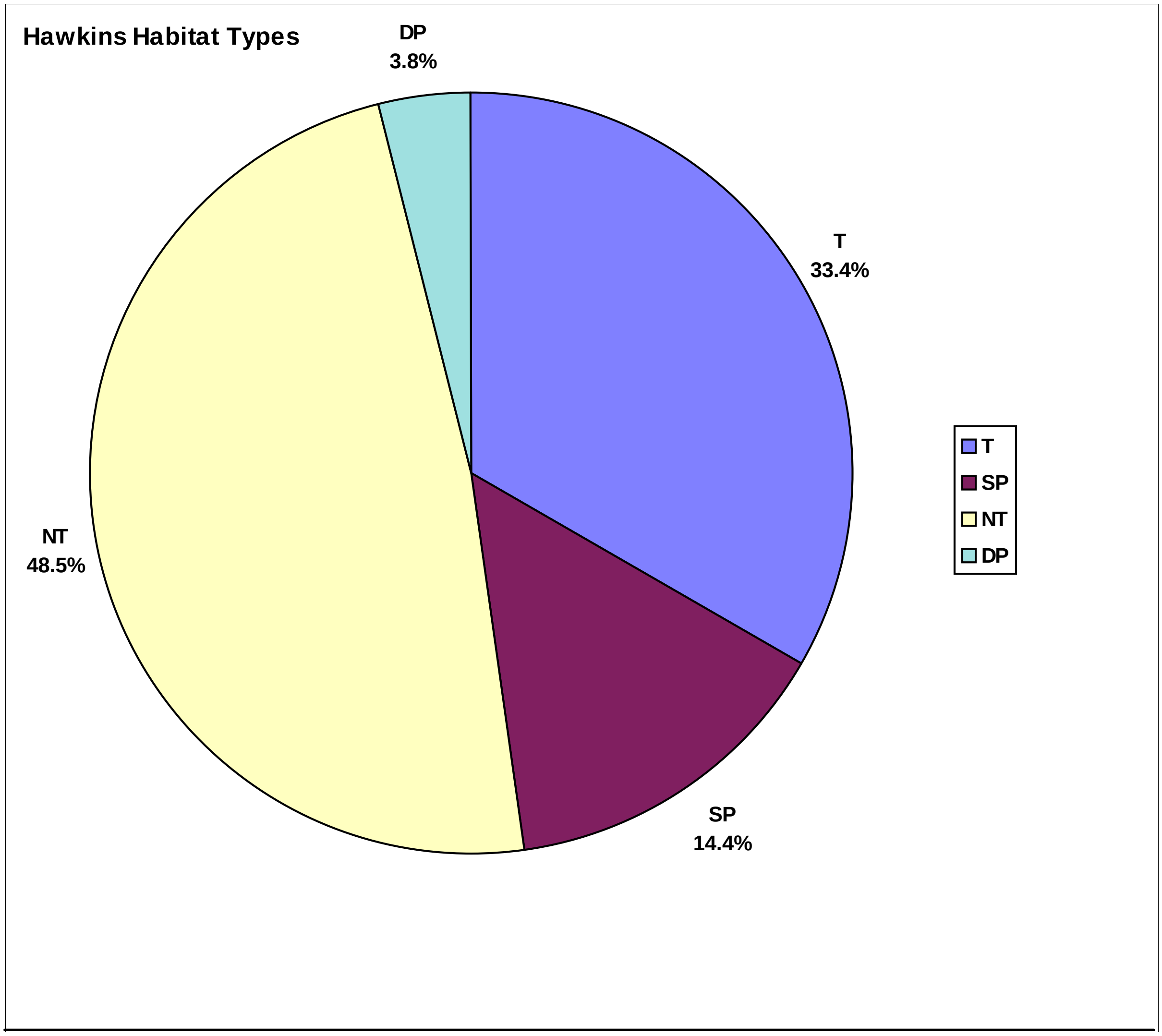


Figure CAWG 1-75. Hawkins Habitat Types for Rancheria Creek.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek below Energy Dissipater

Rosgen 1 Channel Type = A

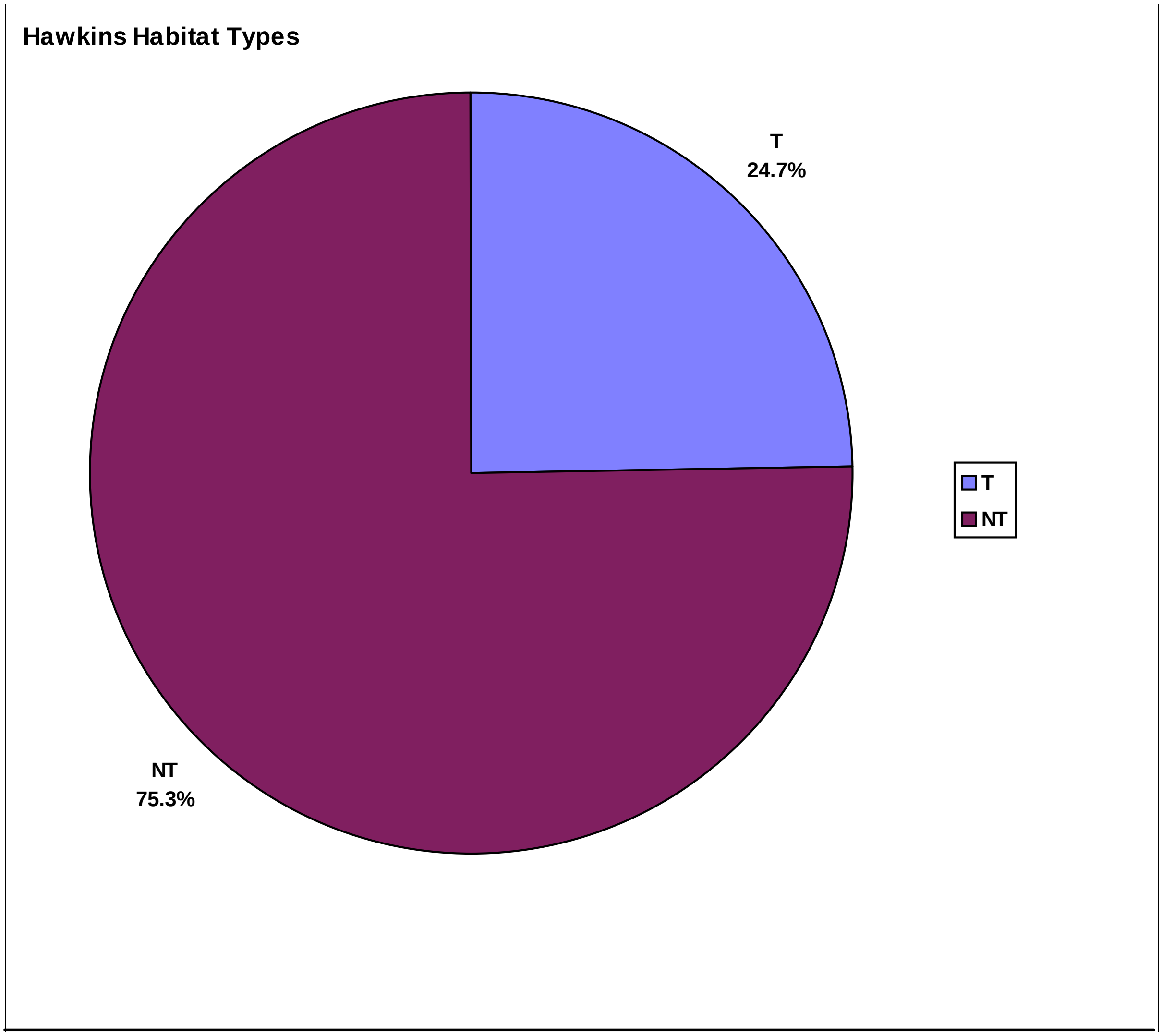


Figure CAWG 1-75. Hawkins Habitat Types for Rancheria Creek (cont).

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek below Energy Dissipater

Rosgen 1 Channel Type = B

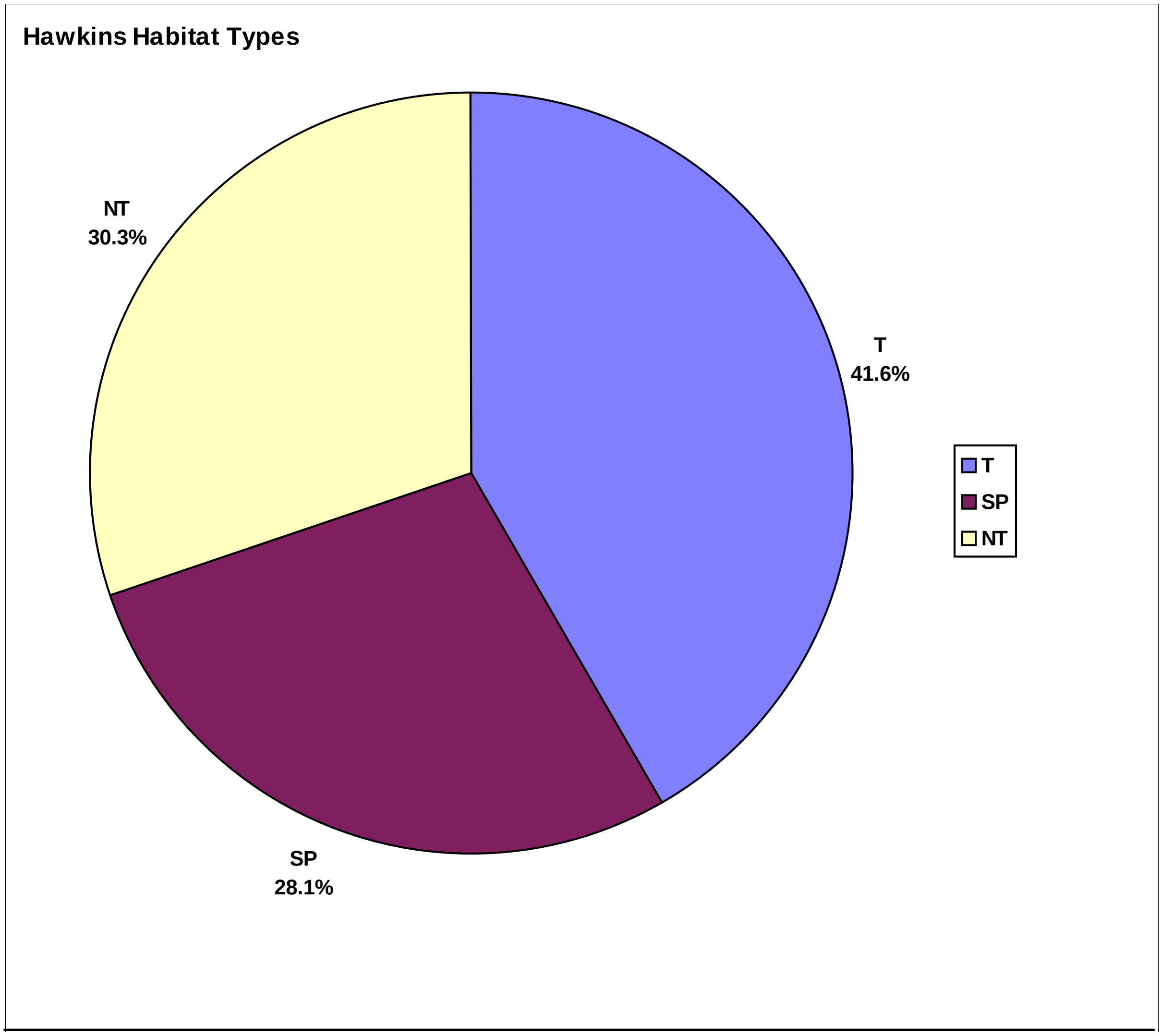


Figure CAWG 1-75. Hawkins Habitat Types for Rancheria Creek (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek above Energy Dissipater

Rosgen 1 Channel Type = B

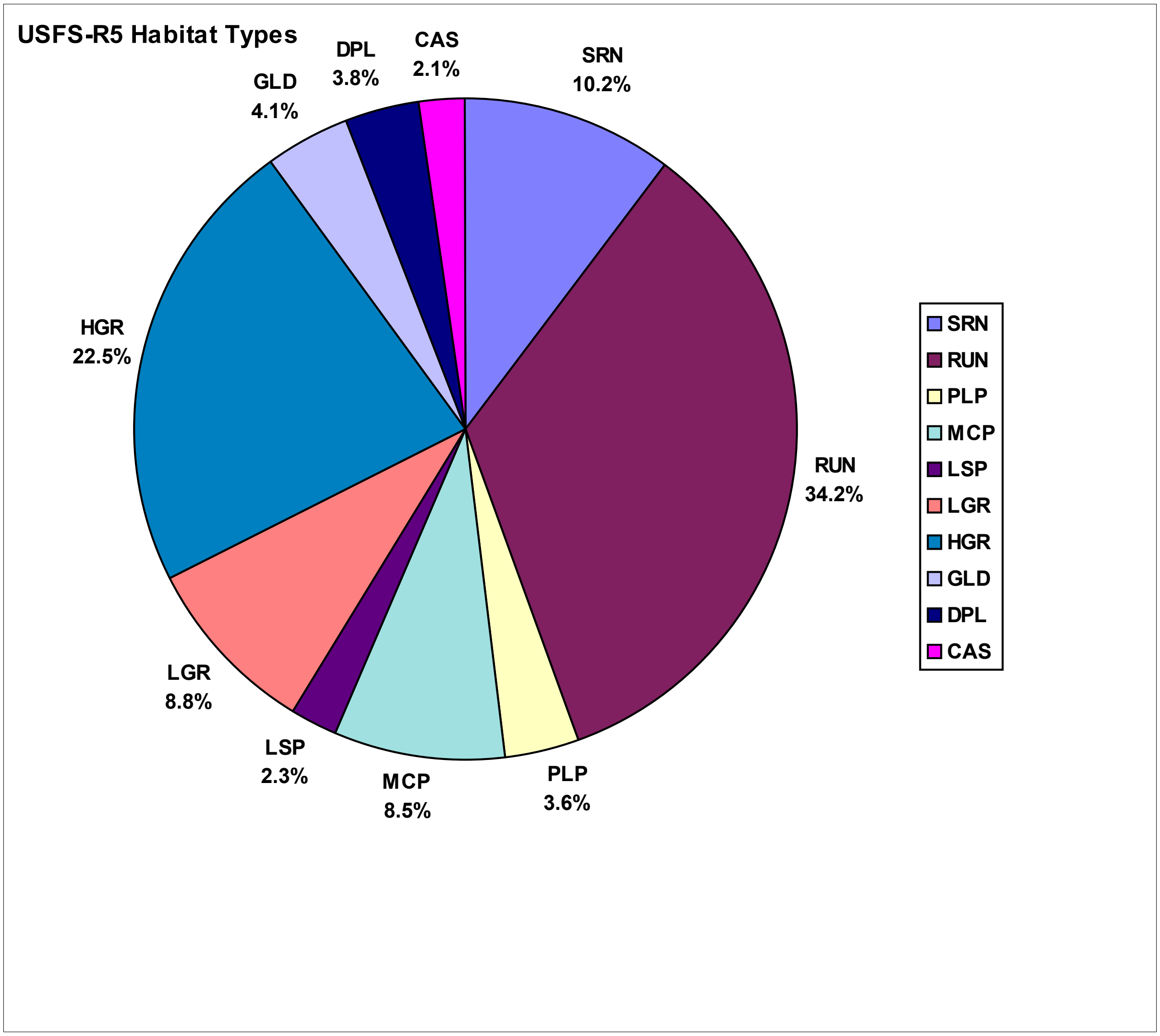


Figure CAWG 1-76. USFS-R5 Habitat Types for Rancheria Creek.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek below Energy Dissipater

Rosgen 1 Channel Type = A

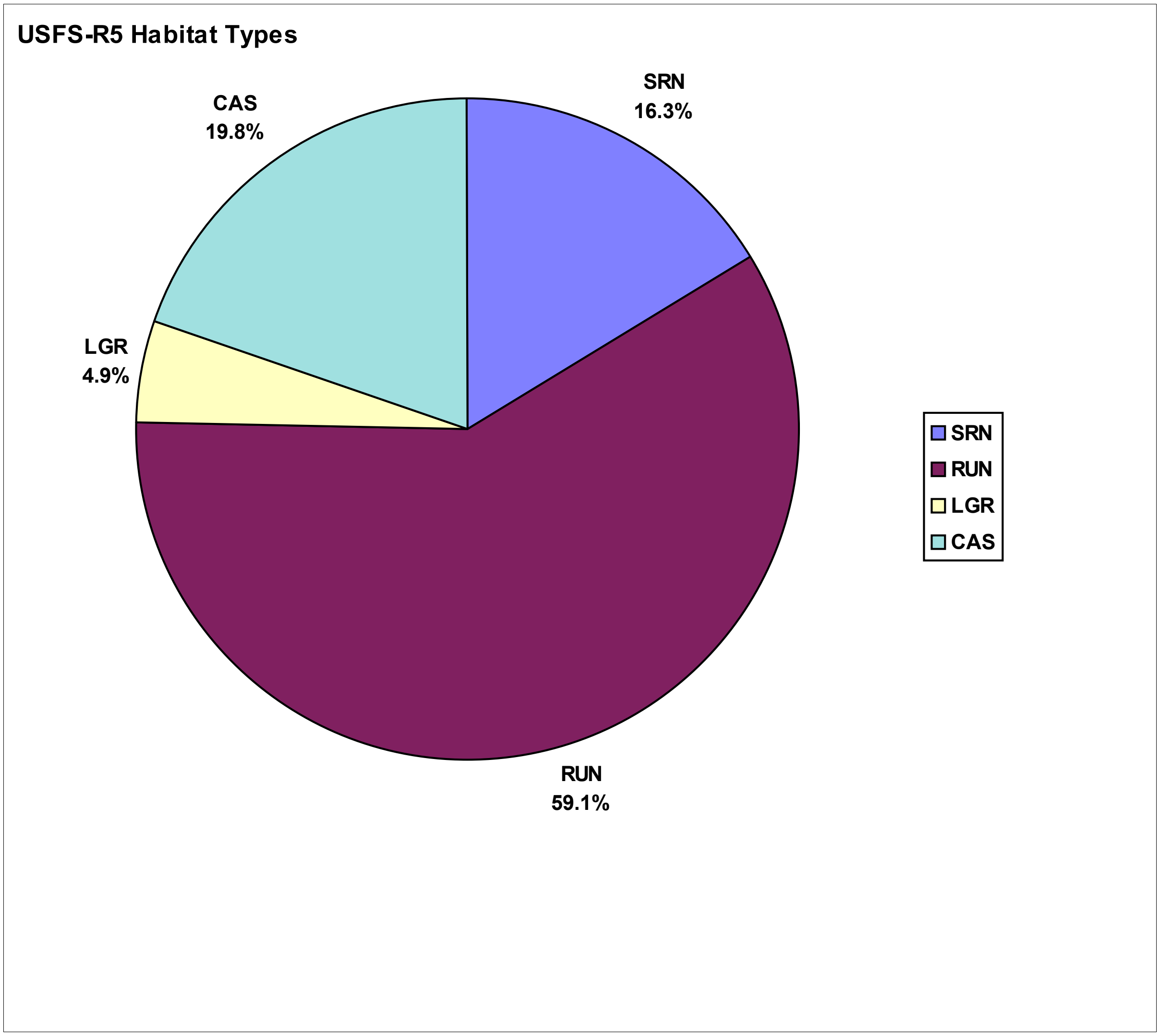


Figure CAWG 1-76. USFS-R5 Habitat Types for Rancheria Creek (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Rancheria Creek

Rancheria Creek below Energy Dissipater

Rosgen 1 Channel Type = B

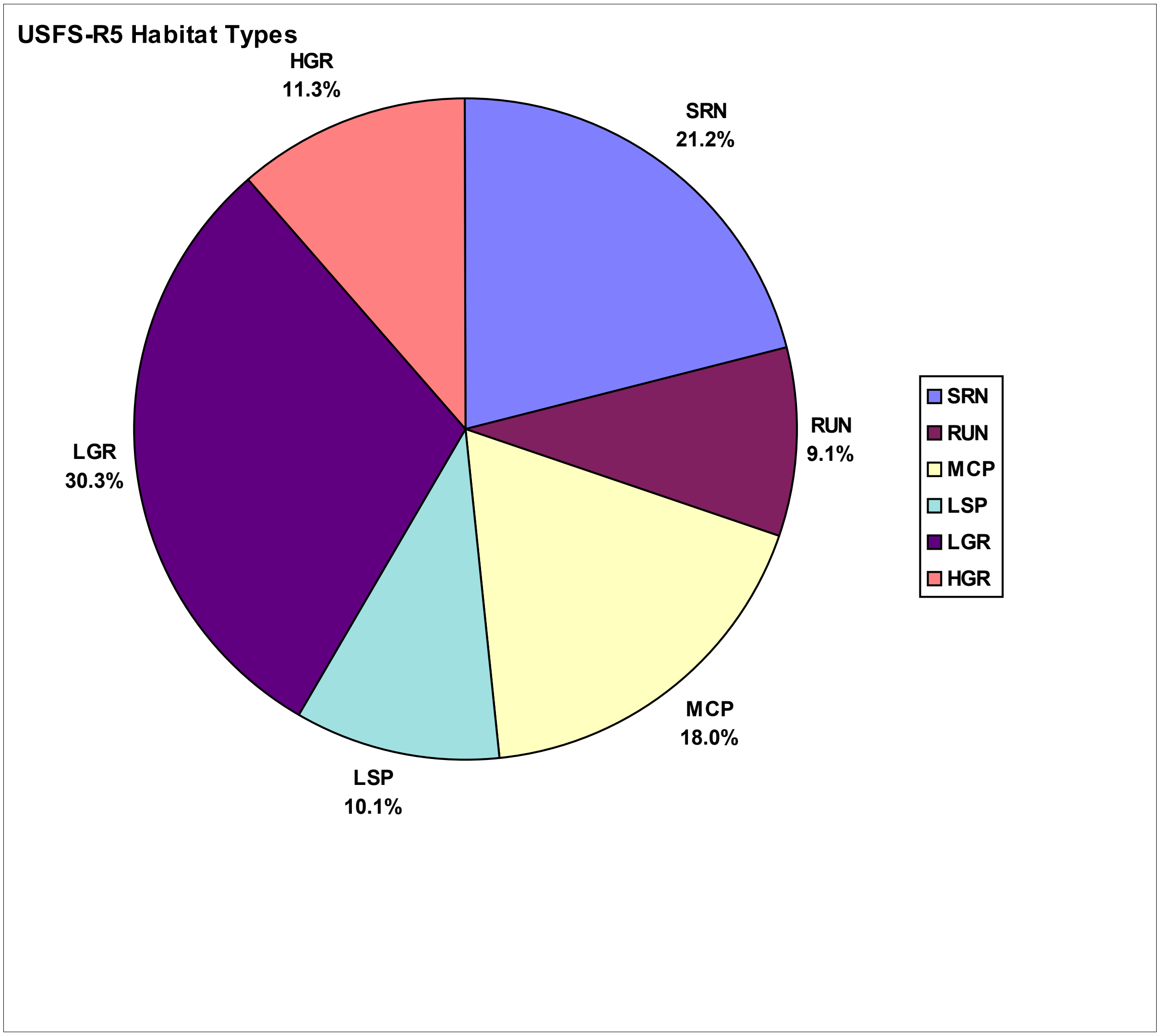


Figure CAWG 1-76. USFS-R5 Habitat Types for Rancheria Creek (cont).

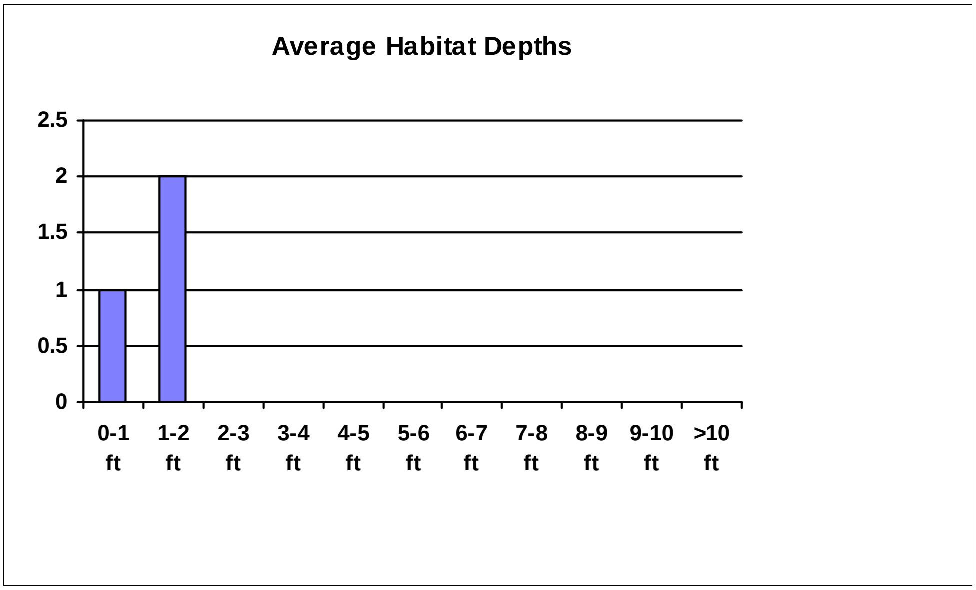
Recorded Average Habitat Depth Histograms

1 foot bin size

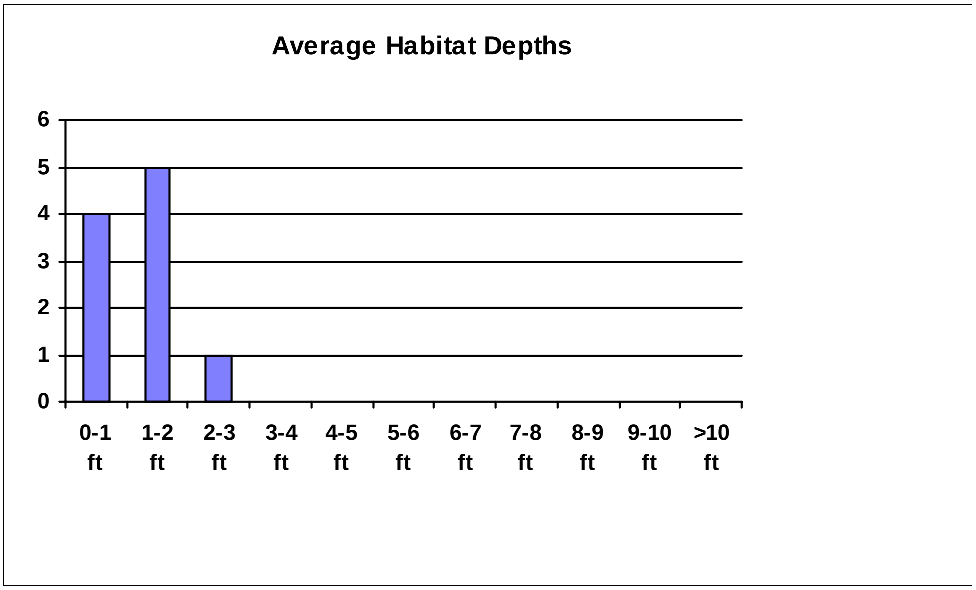
Big Creek Reach (Basin) BAS_BC

Rancheria Creek RaC

Rancheria Creek below Energy Dissipater



Rancheria Creek above Energy Dissipater



B Channel Type

Figure CAWG 1-77. Average Habitat Depth Histograms for Rancheria Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/25/2000.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Portal Tailrace

Portal Tailrace Reach

Rosgen 1 Channel Type = C

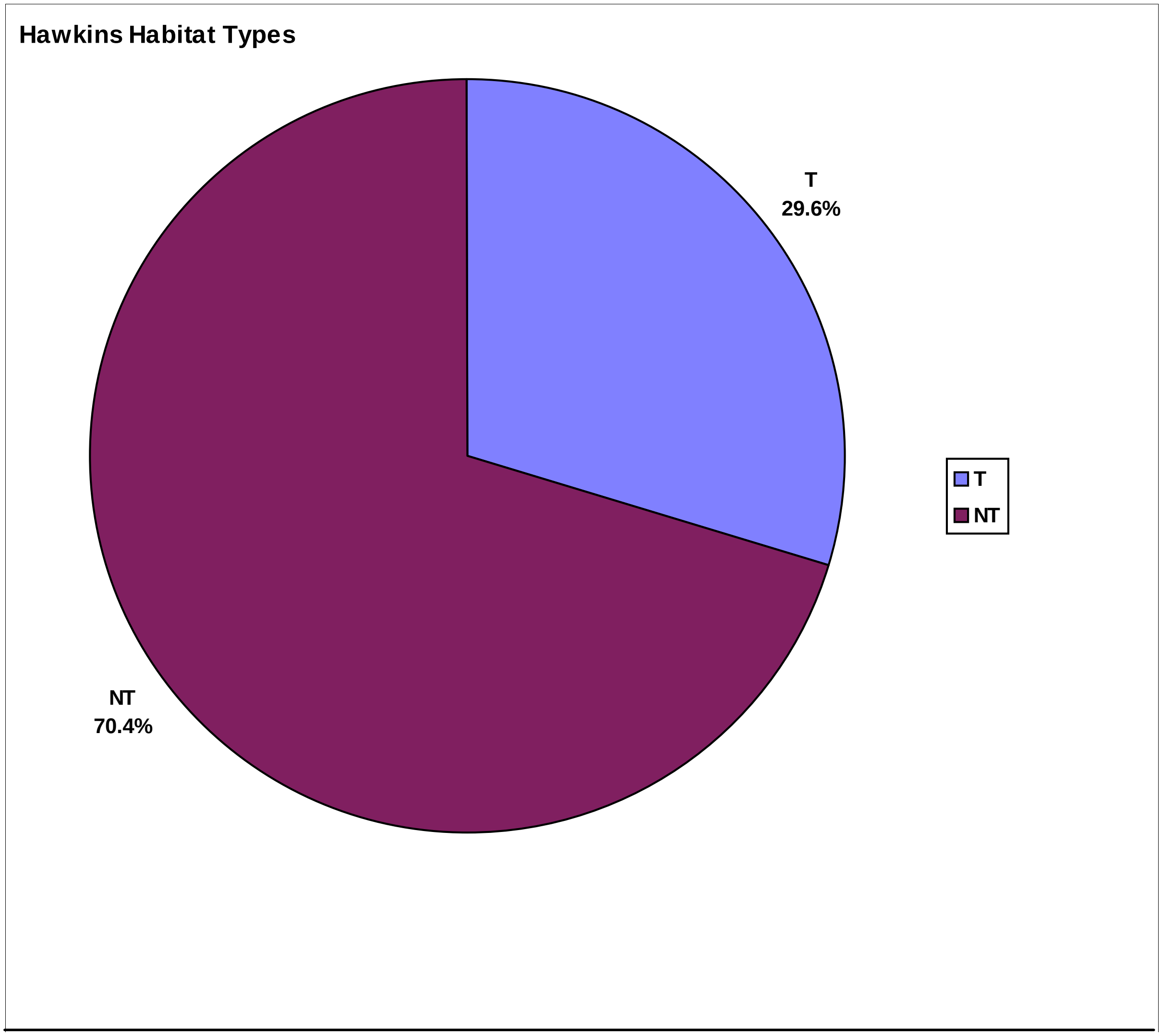


Figure CAWG 1-78. Hawkins Habitat Types for Portal Tailrace Reach.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Portal Tailrace

Portal Tailrace Reach

Rosgen 1 Channel Type = C

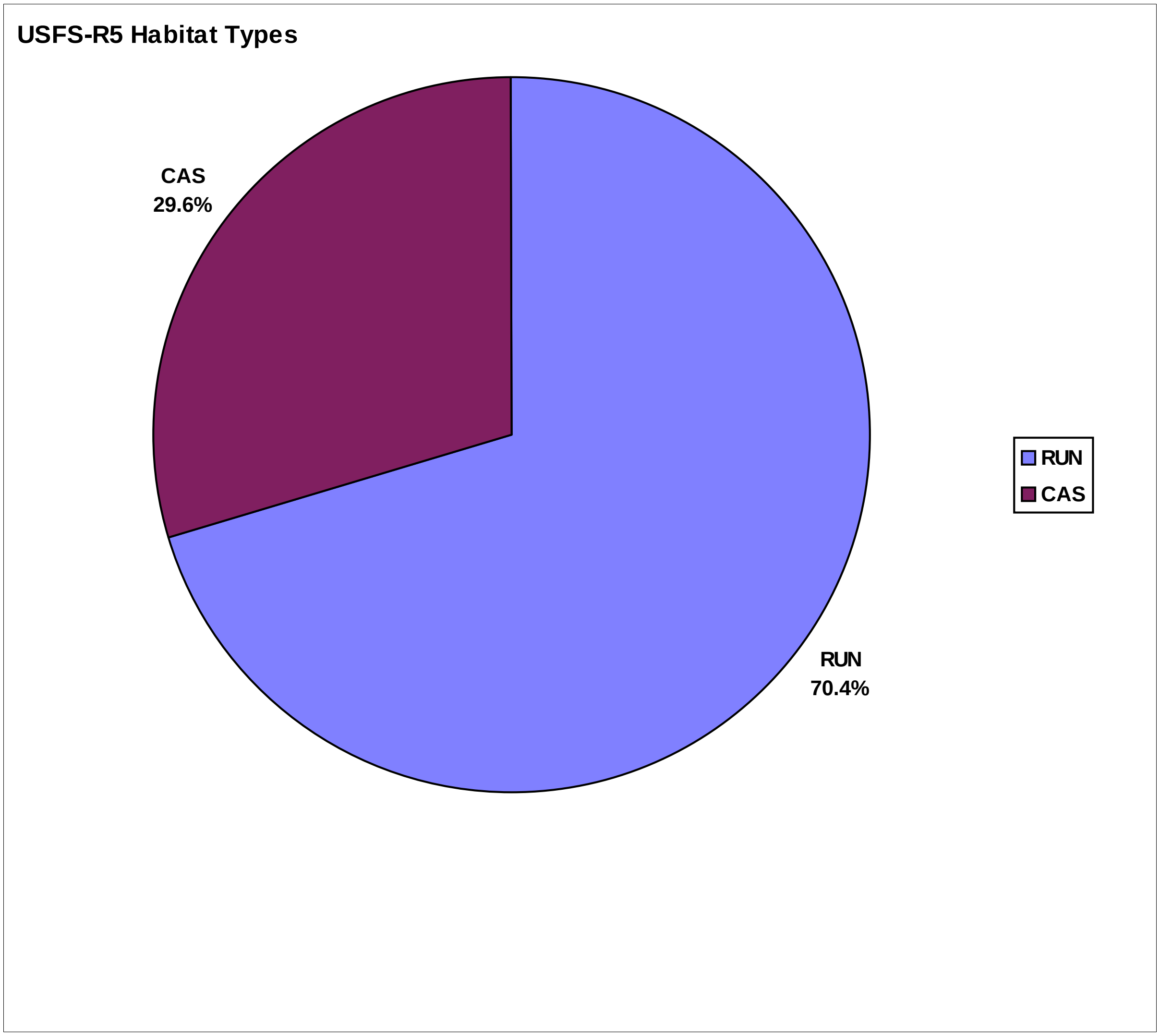


Figure CAWG 1-79. USFS-R5 Habitat Types for Portal Tailrace Reach.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek AD Reach

Rosgen 1 Channel Type = B

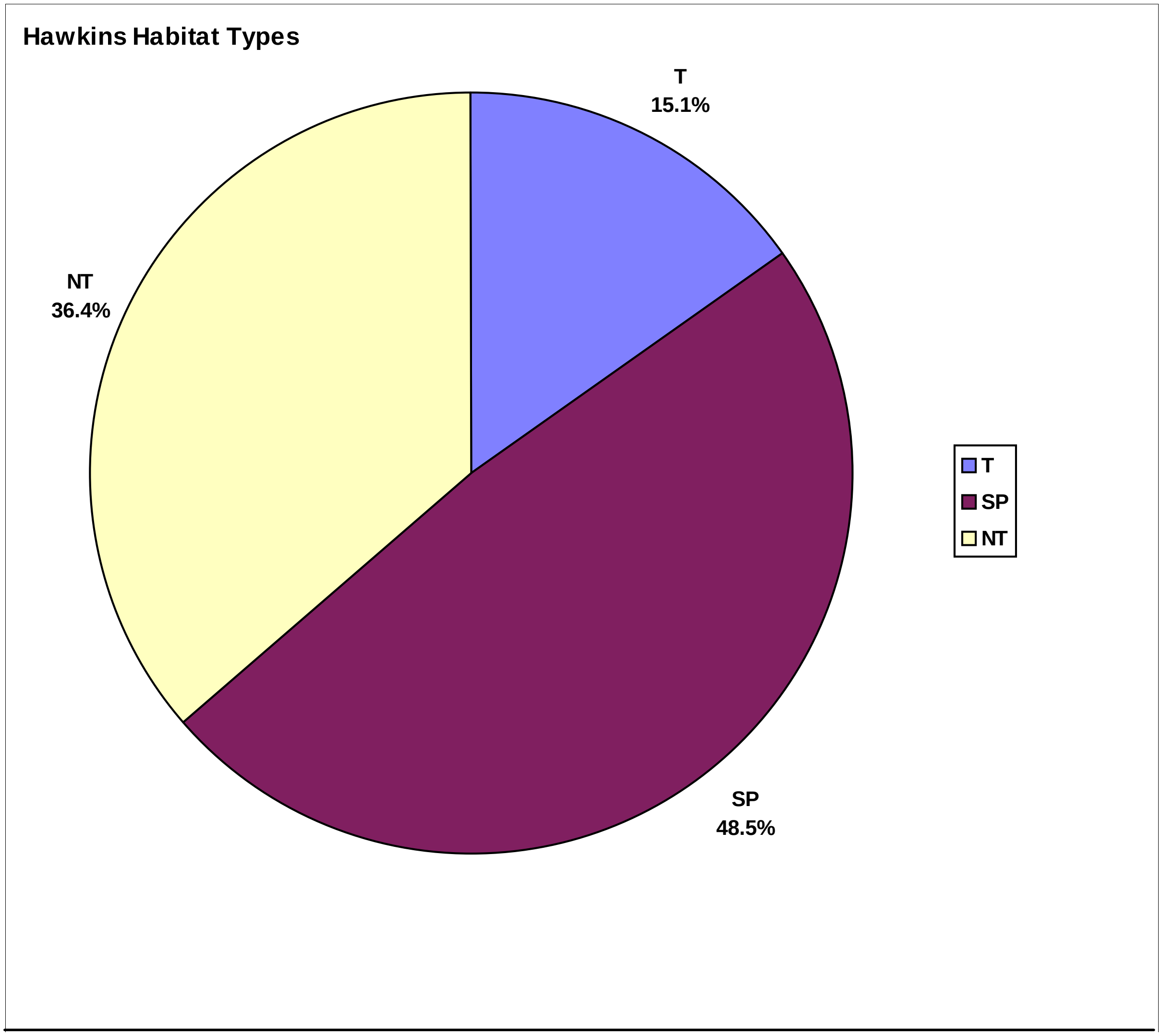


Figure CAWG 1-80. Hawkins Habitat Types for Pitman Creek.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek BD Reach

Rosgen 1 Channel Type = Aa+

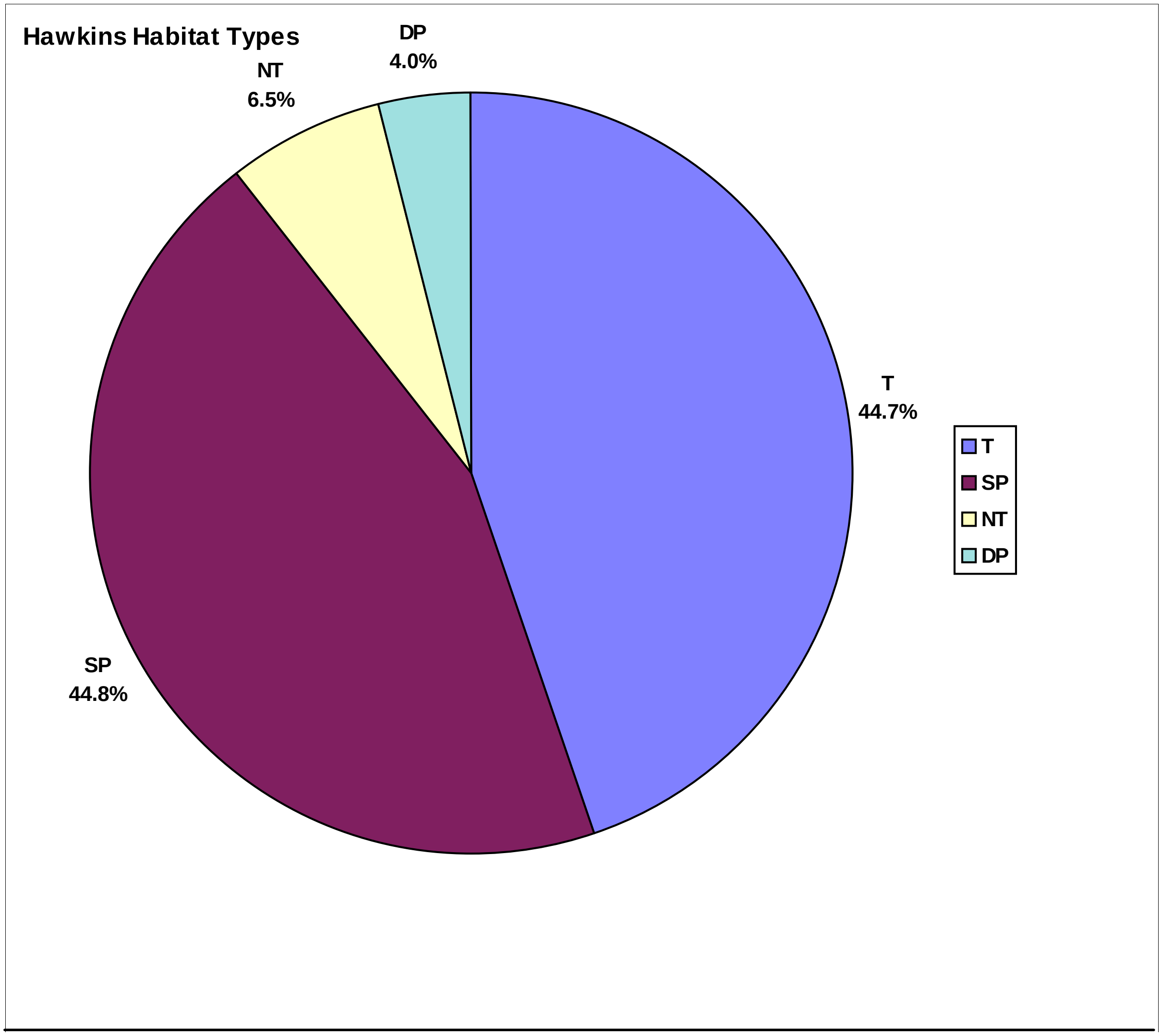


Figure CAWG 1-80. Hawkins Habitat Types for Pitman Creek (cont).

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek BD Reach

Rosgen 1 Channel Type = B

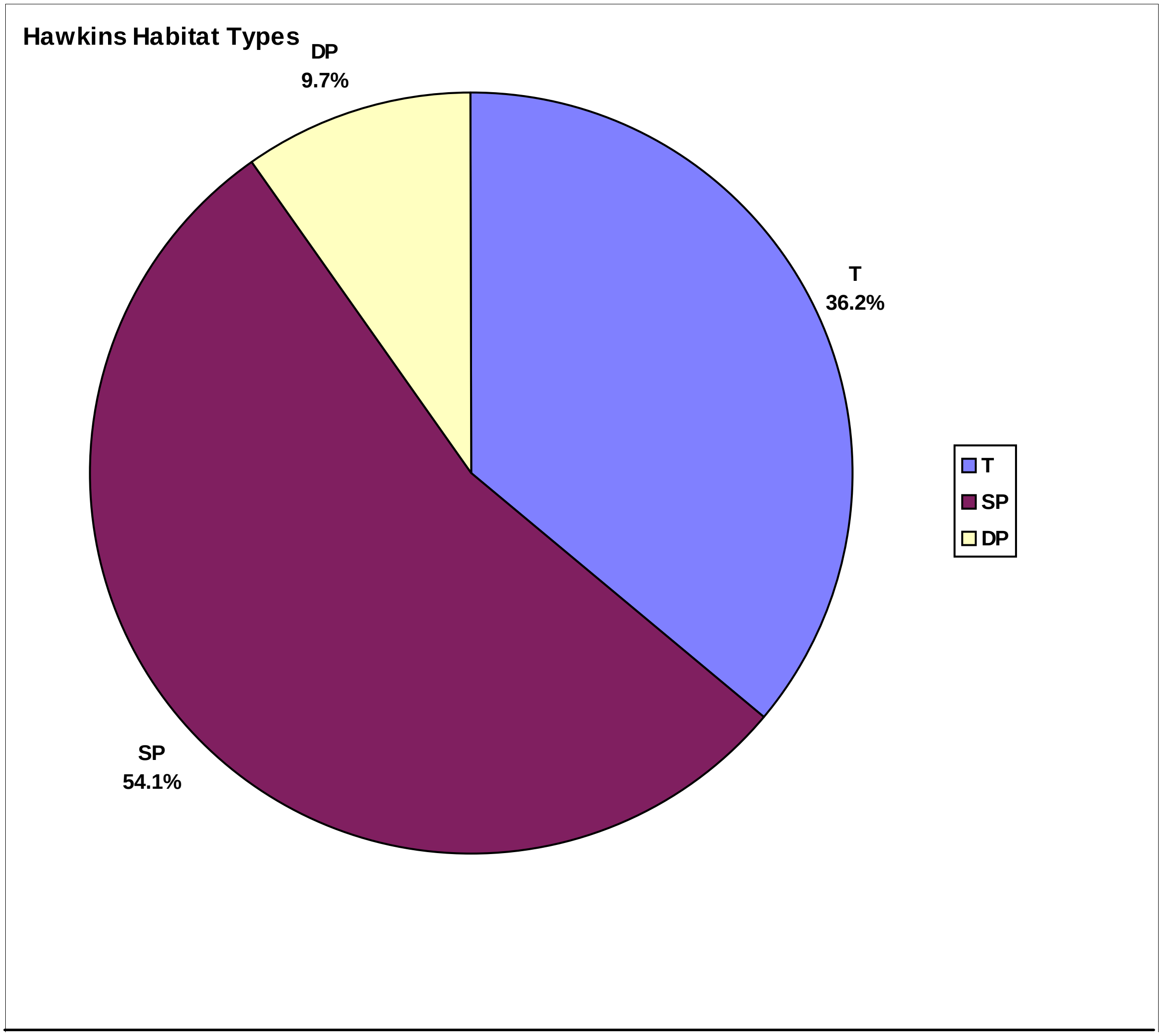


Figure CAWG 1-80. Hawkins Habitat Types for Pitman Creek (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek AD Reach

Rosgen 1 Channel Type = B

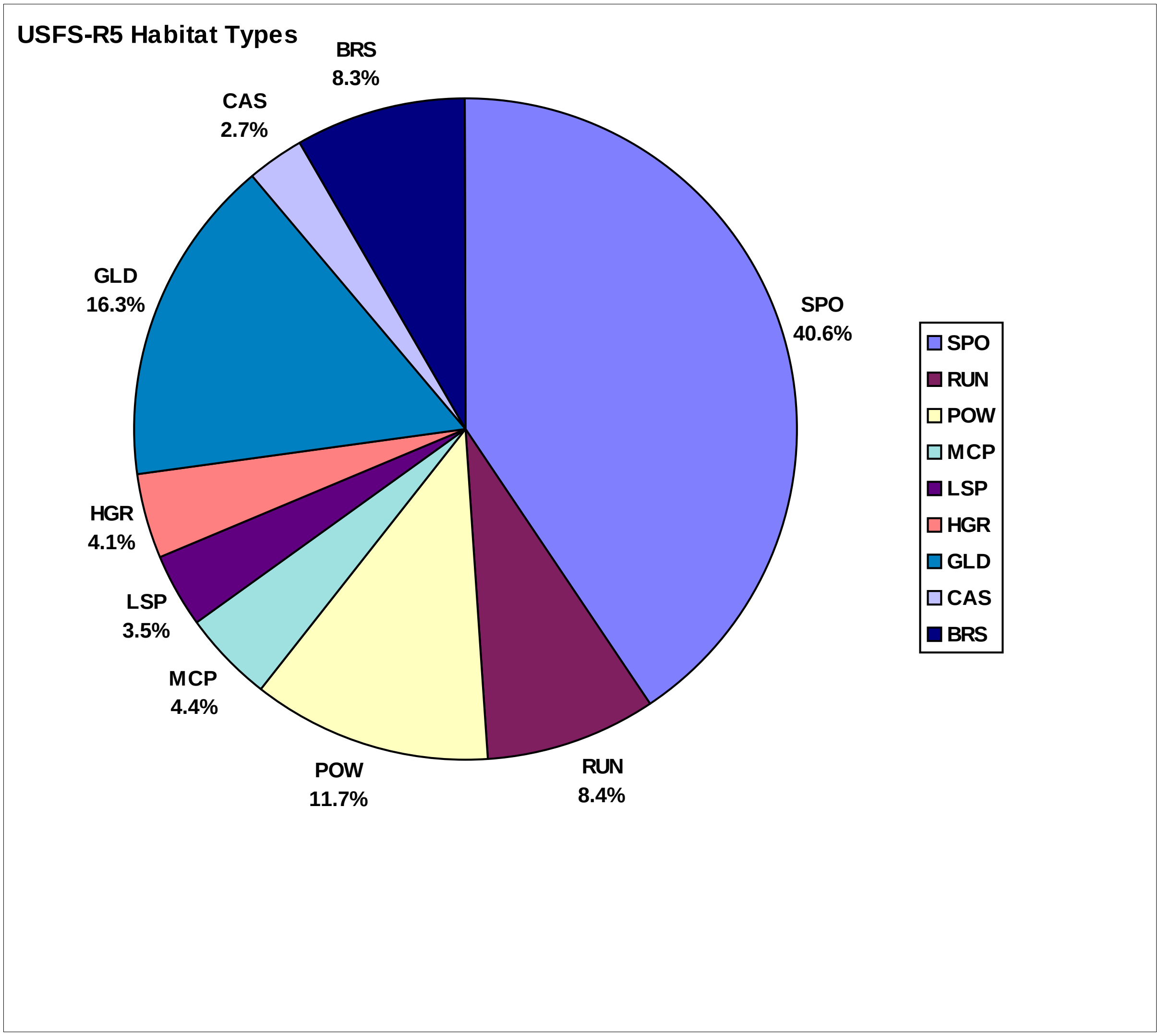


Figure CAWG 1-81. USFS-R5 Habitat Types for Pitman Creek.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek BD Reach

Rosgen 1 Channel Type = Aa+

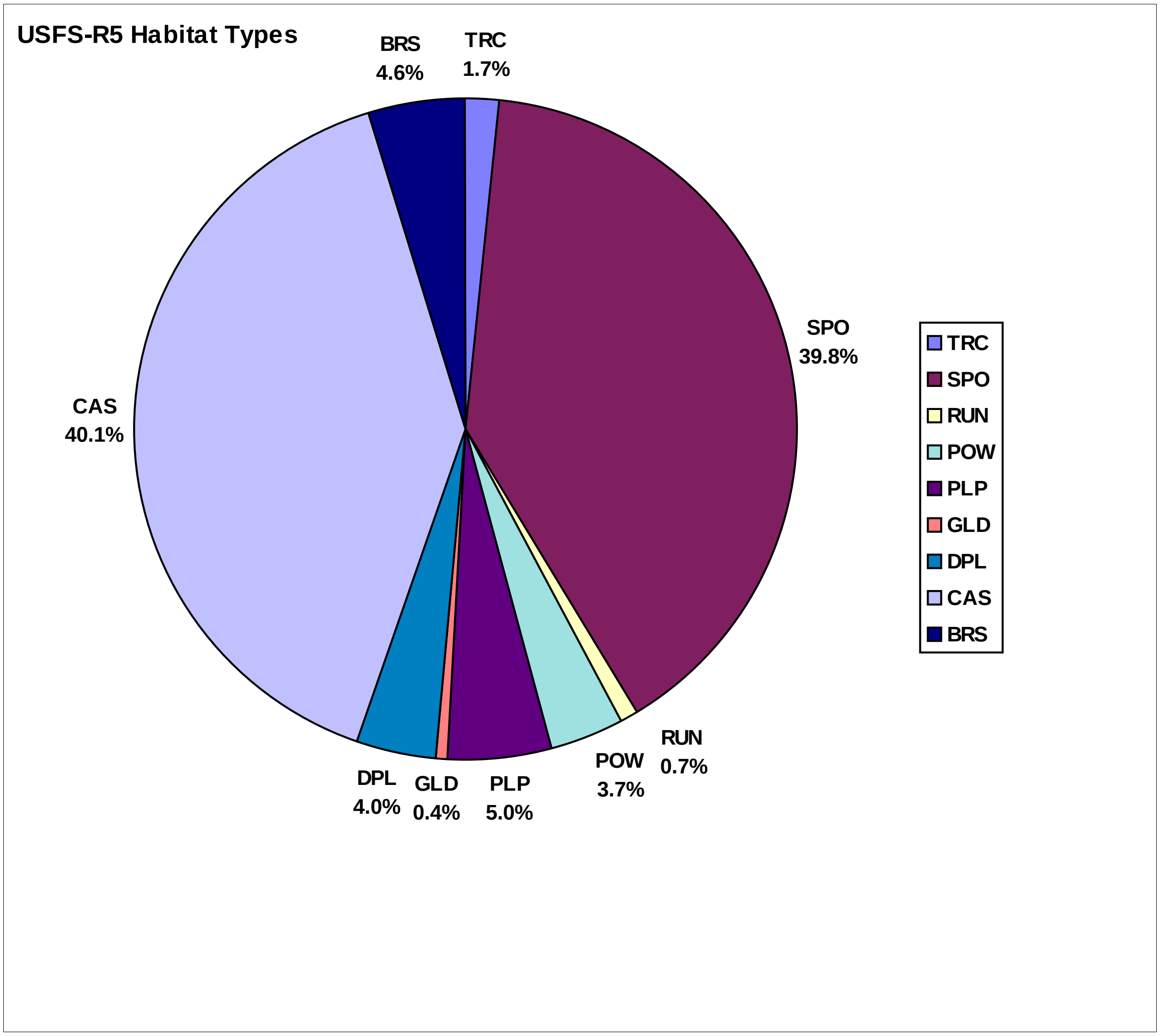


Figure CAWG 1-81. USFS-R5 Habitat Types for Pitman Creek (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Pitman Creek

Pitman Creek BD Reach

Rosgen 1 Channel Type = B

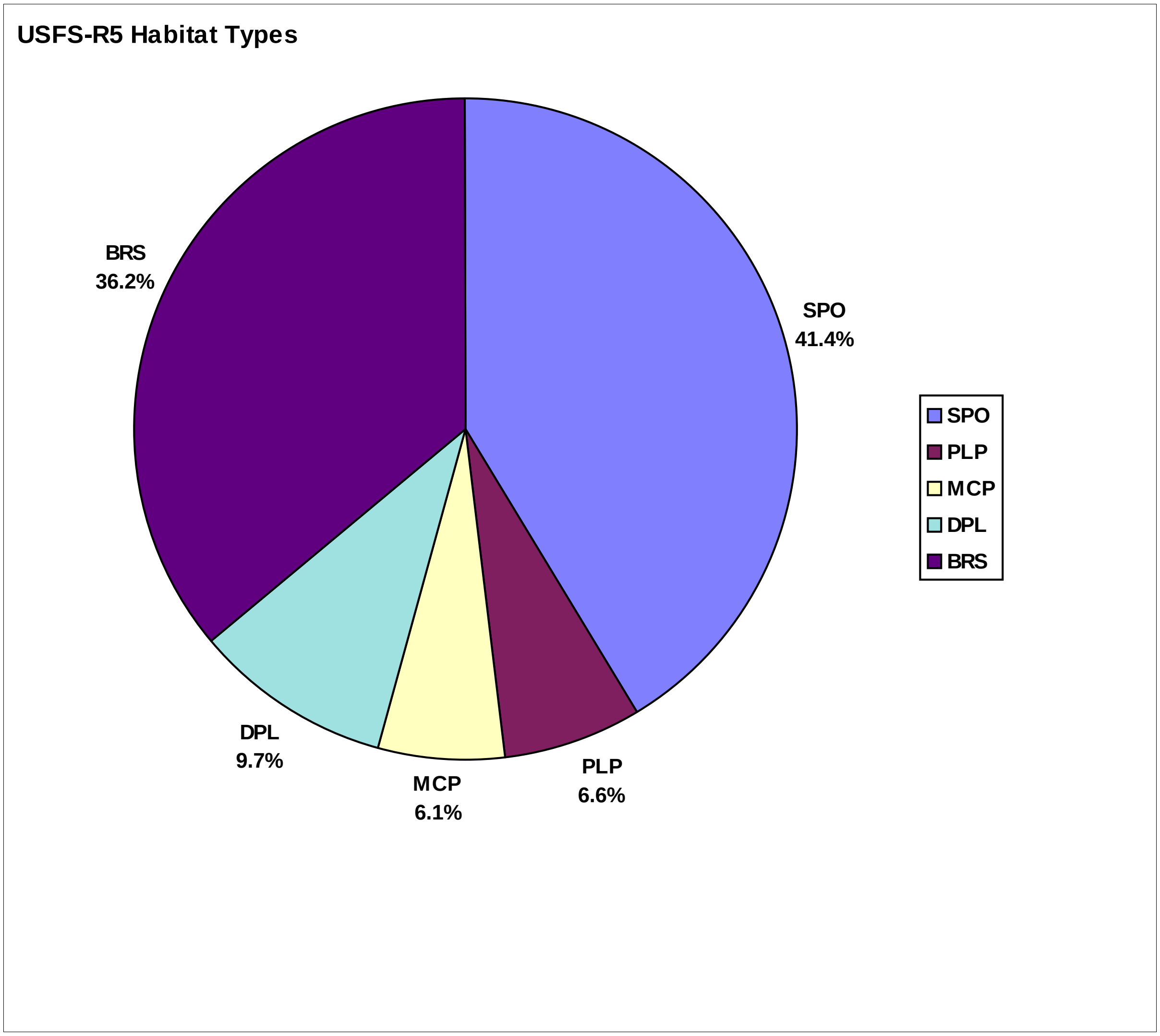


Figure CAWG 1-81. USFS-R5 Habitat Types for Pitman Creek (cont).

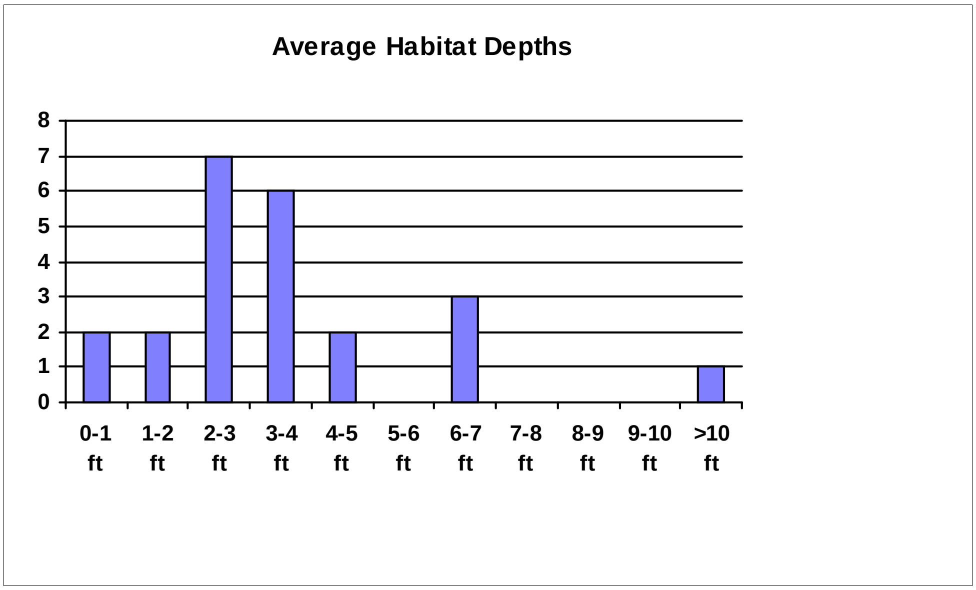
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Pitman Creek PiC

Pitman Creek BD Reach PiC_R



Aa+ Channel Type

Figure CAWG 1-82. Average Habitat Depth Histograms for Pitman Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 8/3/2000.

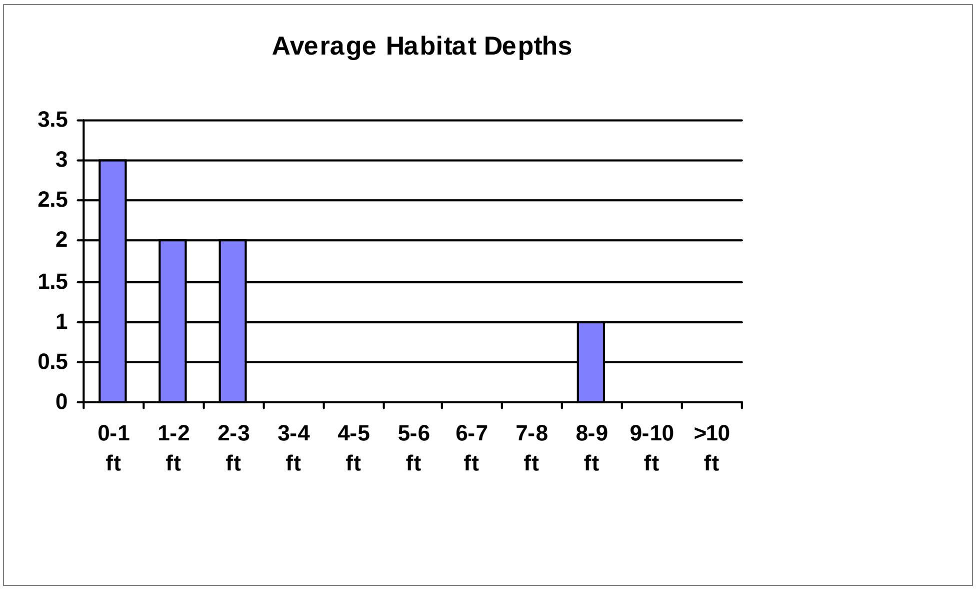
Recorded Average Habitat Depth Histograms

1 foot bin size

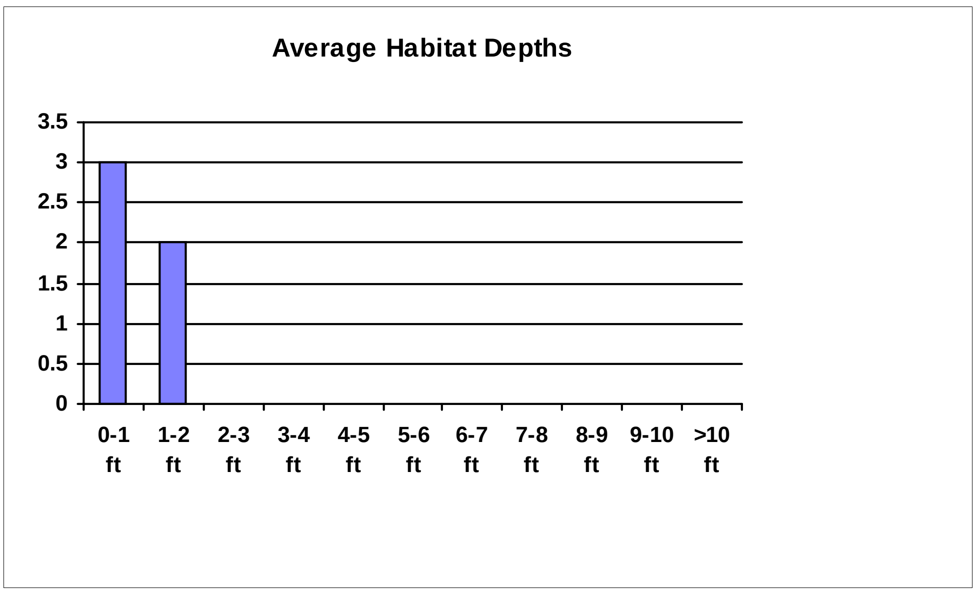
Big Creek Reach (Basin) BAS_BC

Pitman Creek PiC

Pitman Creek BD Reach PiC_R



Pitman Creek AD Reach PiCa_R



B Channel Type

Figure CAWG 1-82. Average Habitat Depth Histograms for Pitman Creek (1 foot bin size, frequency = number of pools) (cont).

Data collected starting on 8/3/2000.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Balsam Creek

Balsam Creek AD Reach

Rosgen 1 Channel Type = Aa+

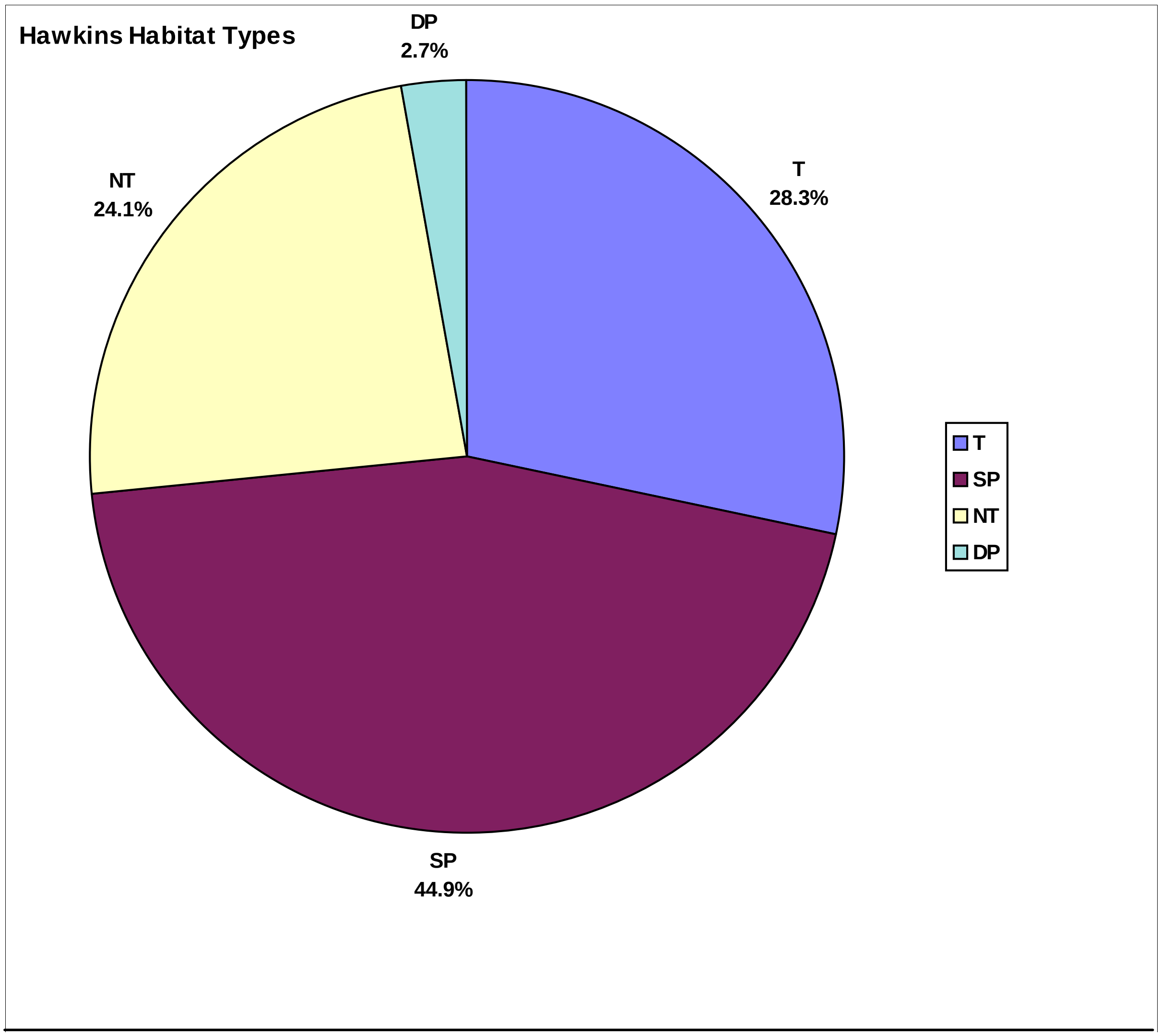


Figure CAWG 1-83. Hawkins Habitat Types for Balsam Creek.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Balsam Creek

Balsam Creek BD Reach

Rosgen 1 Channel Type = Aa+

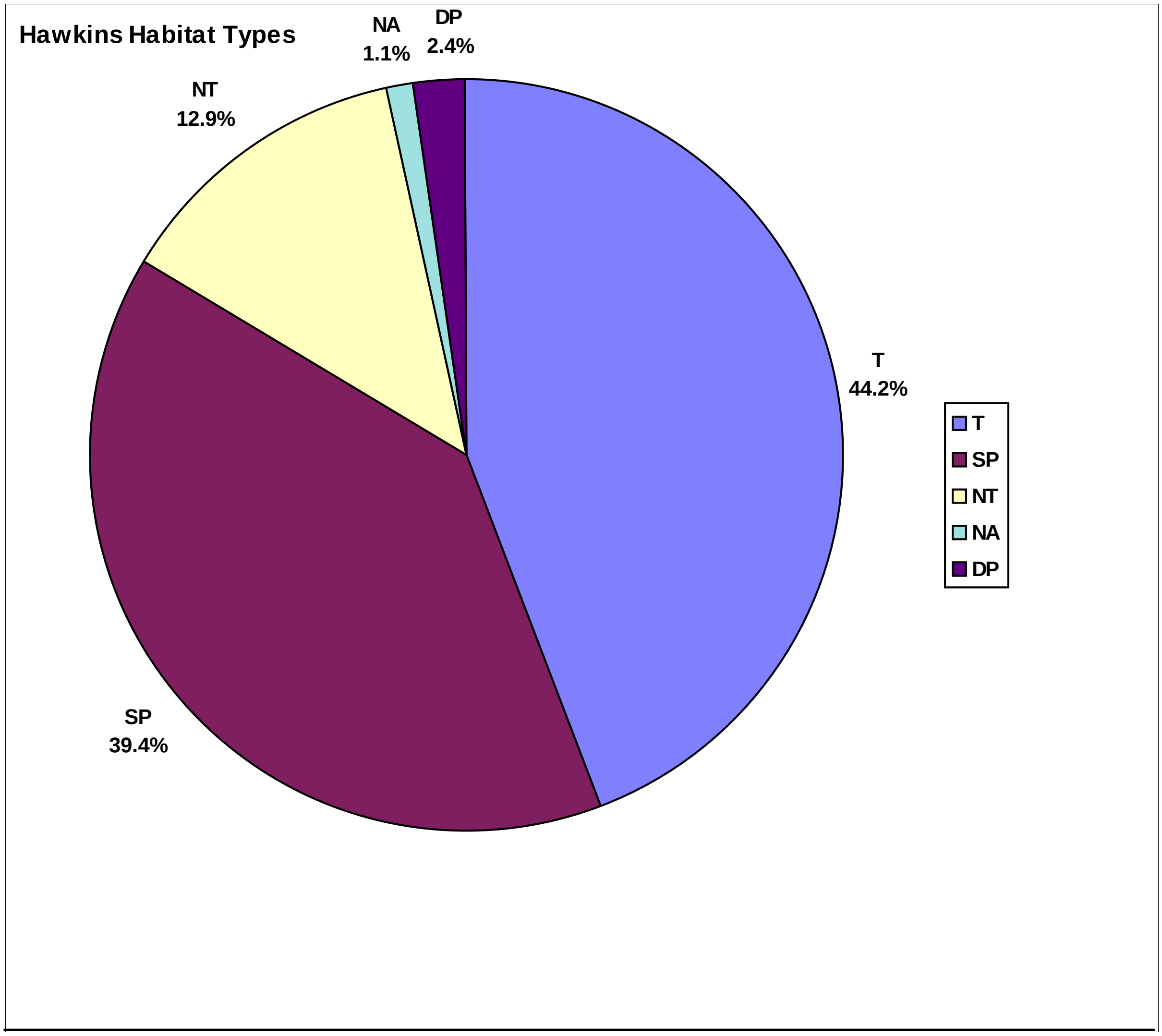


Figure CAWG 1-83. Hawkins Habitat Types for Balsam Creek (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Balsam Creek

Balsam Creek AD Reach

Rosgen 1 Channel Type = Aa+

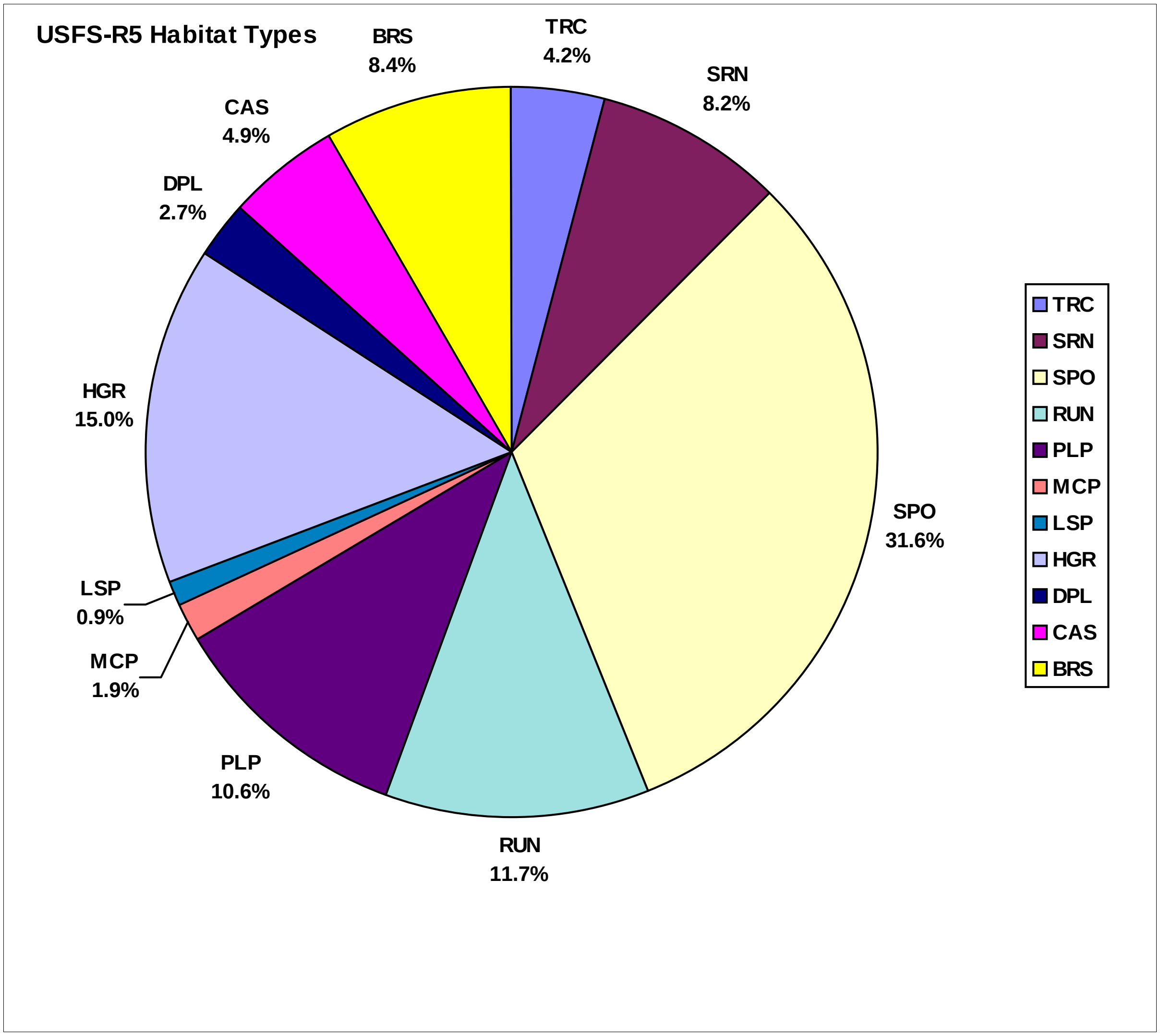


Figure CAWG 1-84. USFS-R5 Habitat Types for Balsam Creek.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Balsam Creek

Balsam Creek BD Reach

Rosgen 1 Channel Type = Aa+

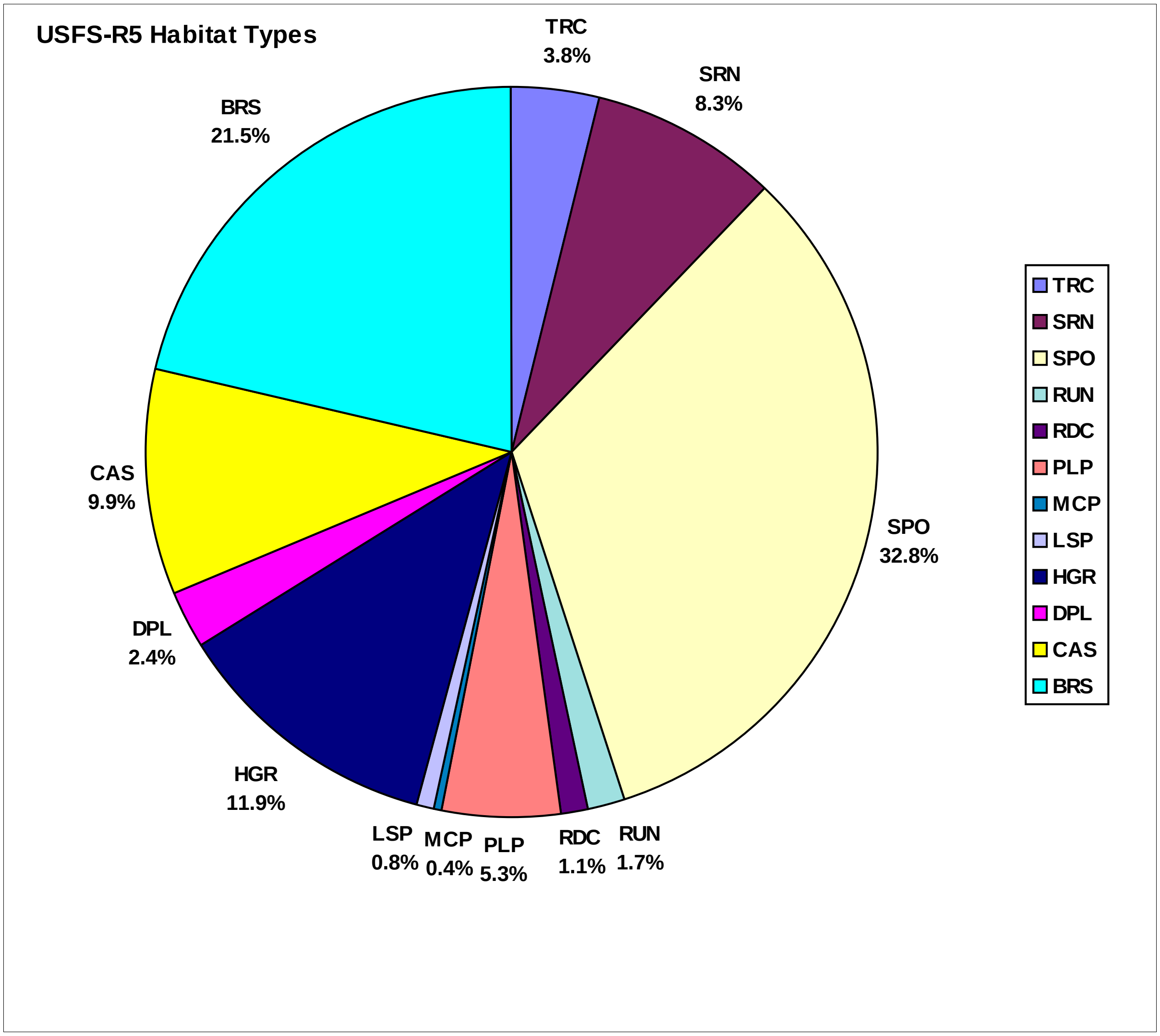


Figure CAWG 1-84. USFS-R5 Habitat Types for Balsam Creek (cont).

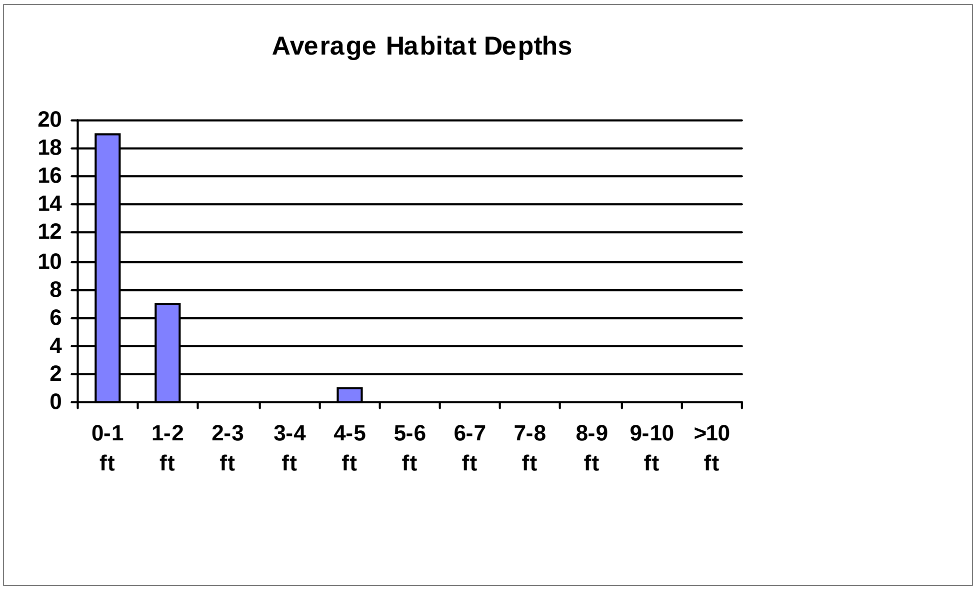
Recorded Average Habitat Depth Histograms

1 foot bin size

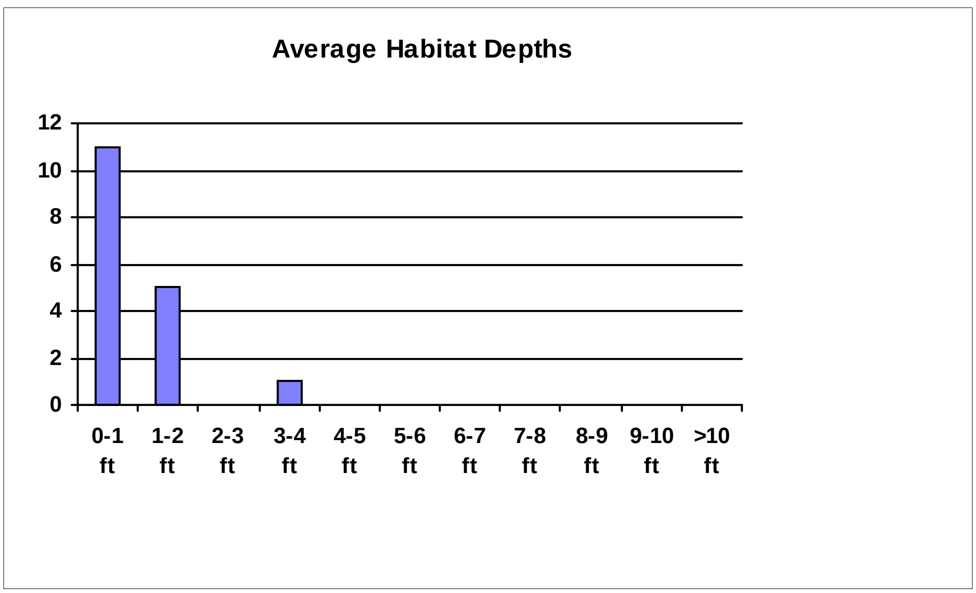
Big Creek Reach (Basin) BAS_BC

Balsam Creek BaC

Balsam Creek BD Reach BaC_R



Balsam Creek AD Reach BaCa_R



Aa+ Channel Type

Figure CAWG 1-85. Average Habitat Depth Histograms for Balsam Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/31/2000.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Ely Creek

Ely Creek AD Reach

Rosgen 1 Channel Type = Aa+

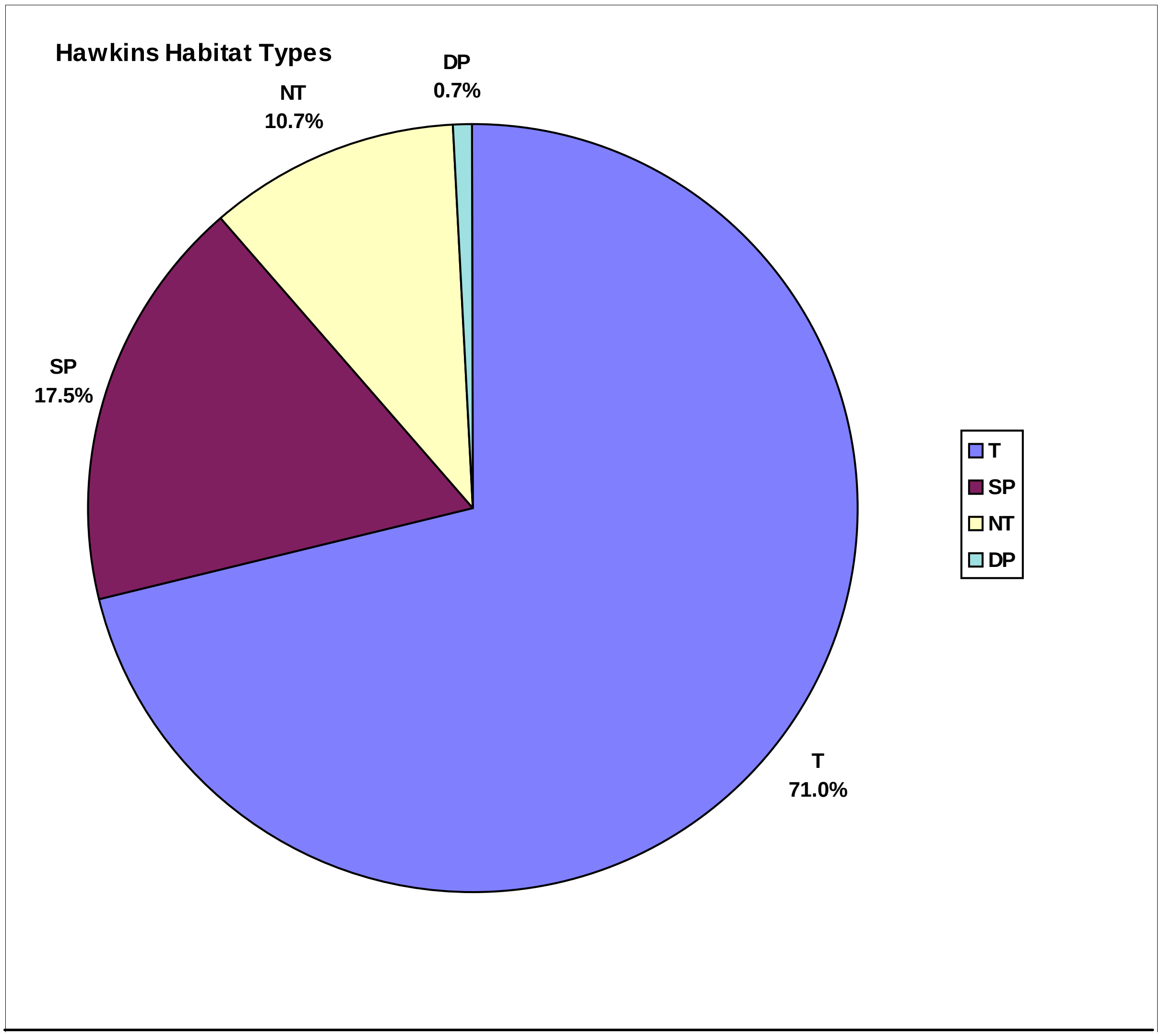


Figure CAWG 1-86. Hawkins Habitat Types for Ely Creek.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Ely Creek

Ely Creek BD Reach

Rosgen 1 Channel Type = Aa+

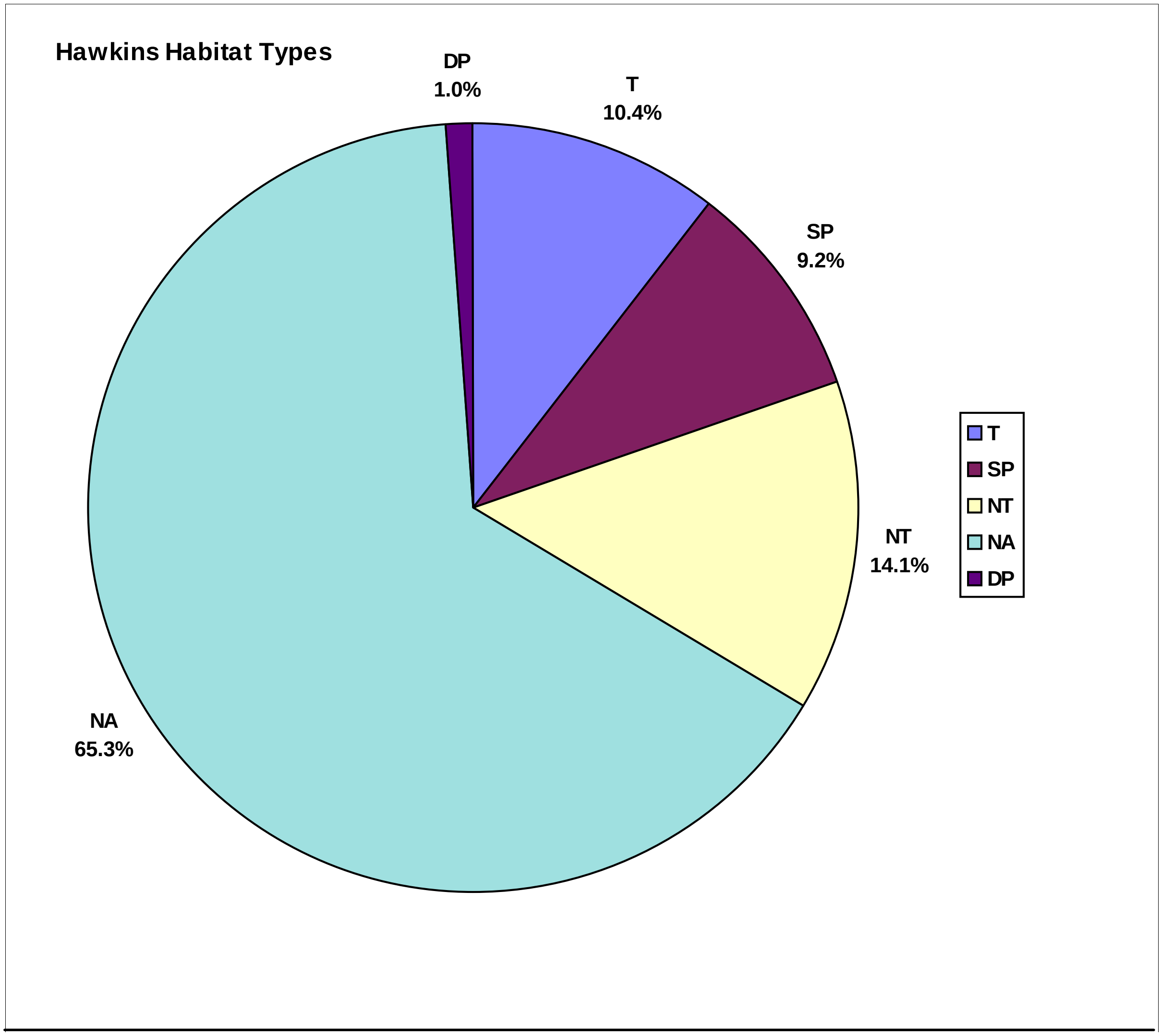


Figure CAWG 1-86. Hawkins Habitat Types for Ely Creek (cont).

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Ely Creek

Ely Creek AD Reach

Rosgen 1 Channel Type = Aa+

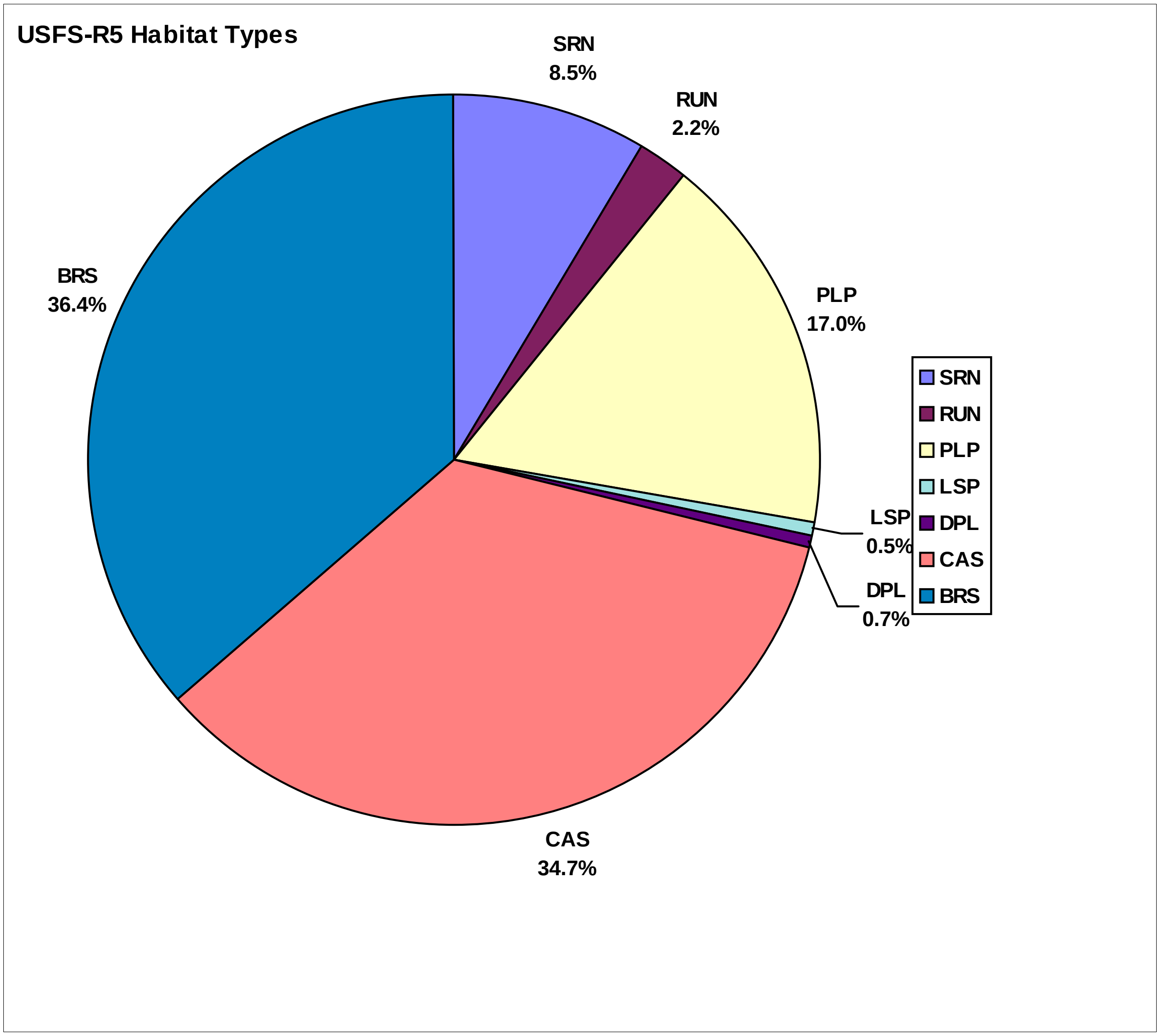


Figure CAWG 1-87. USFS-R5 Habitat Types for Ely Creek.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Ely Creek

Ely Creek BD Reach

Rosgen 1 Channel Type = Aa+

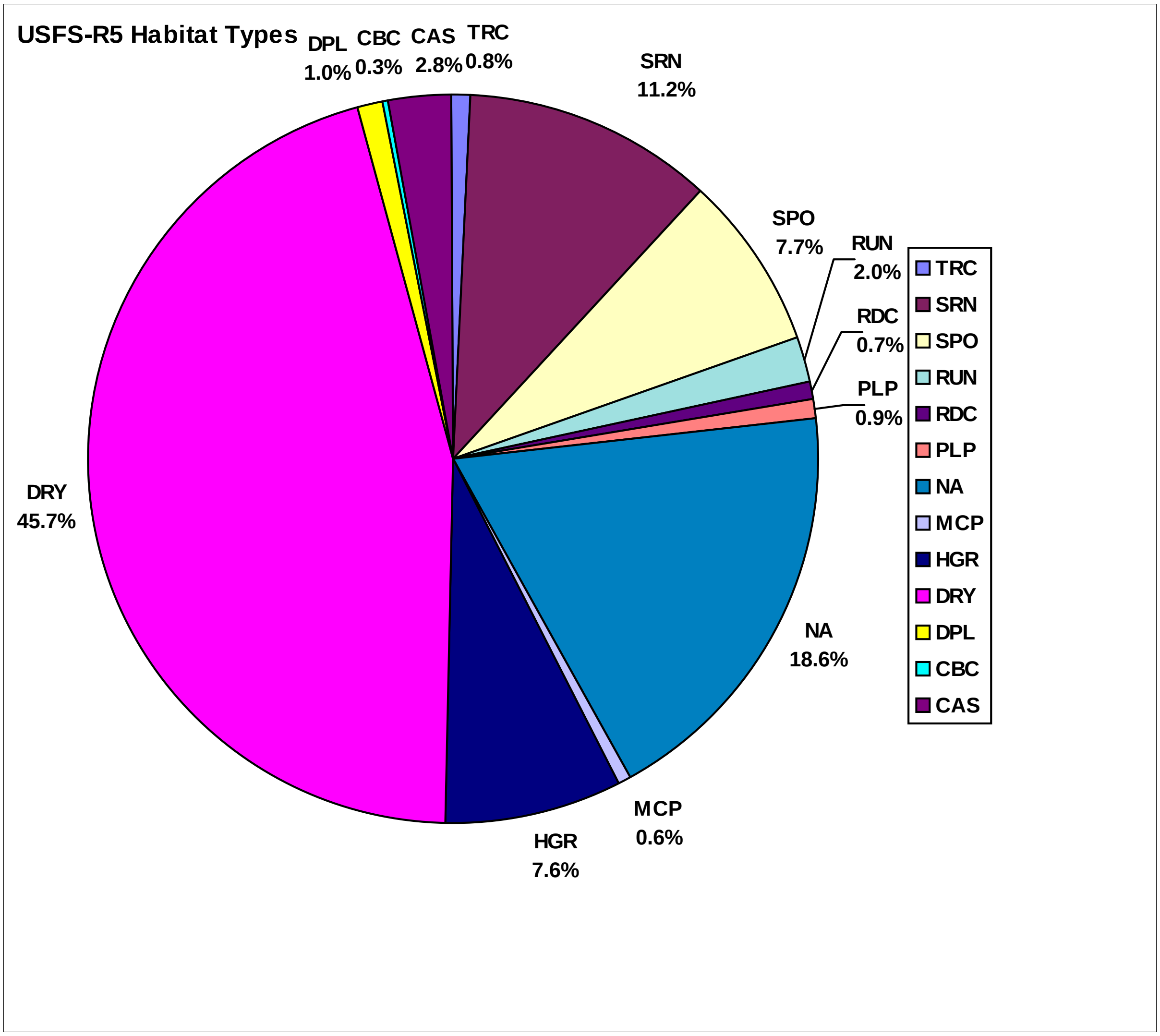


Figure CAWG 1-87. USFS-R5 Habitat Types for Ely Creek (cont).

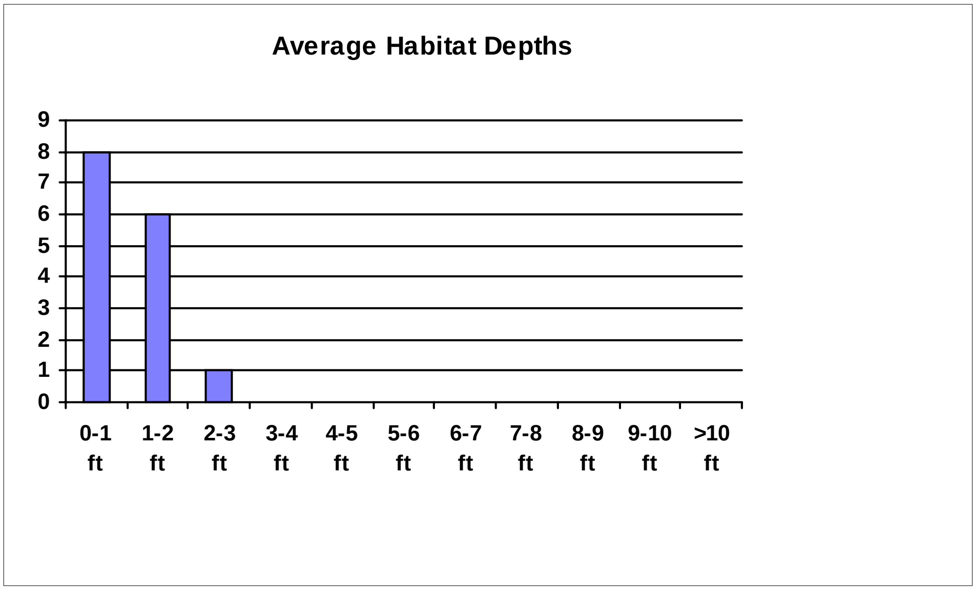
Recorded Average Habitat Depth Histograms

1 foot bin size

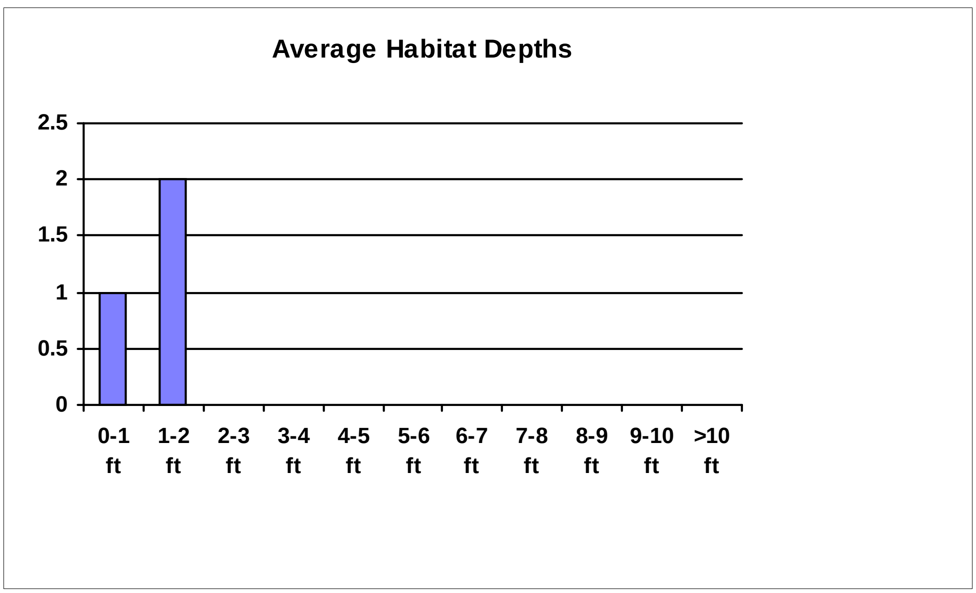
Big Creek Reach (Basin) BAS_BC

Ely Creek ElC

Ely Creek BD Reach ElC_R



Ely Creek AD Reach ElCa_R



Aa+ Channel Type

Figure CAWG 1-88. Average Habitat Depth Histograms for Ely Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/28/2000 Below Diversion and 7/27/2000 Above Diversion.

Hawkins Habitat Types by Channel Type

Big Creek Reach (Basin)

Adit #8 Creek

Adit #8 Creek Reach

Rosgen 1 Channel Type = Aa+

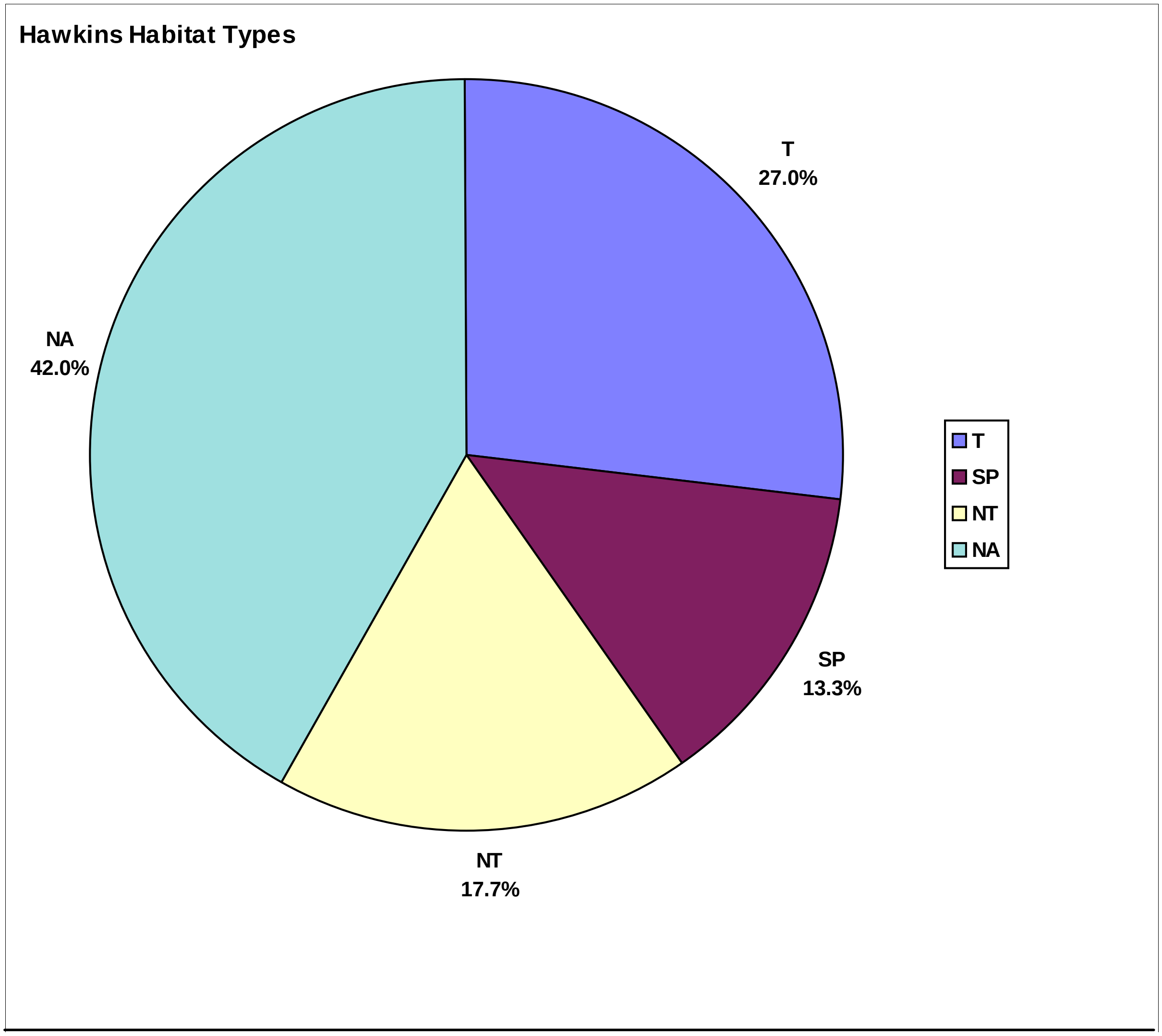


Figure CAWG 1-89. Hawkins Habitat Types for Adit No. 8 Creek.

USFS-R5 Habitat Types by Channel Type

Big Creek Reach (Basin)

Adit #8 Creek

Adit #8 Creek Reach

Rosgen 1 Channel Type = Aa+

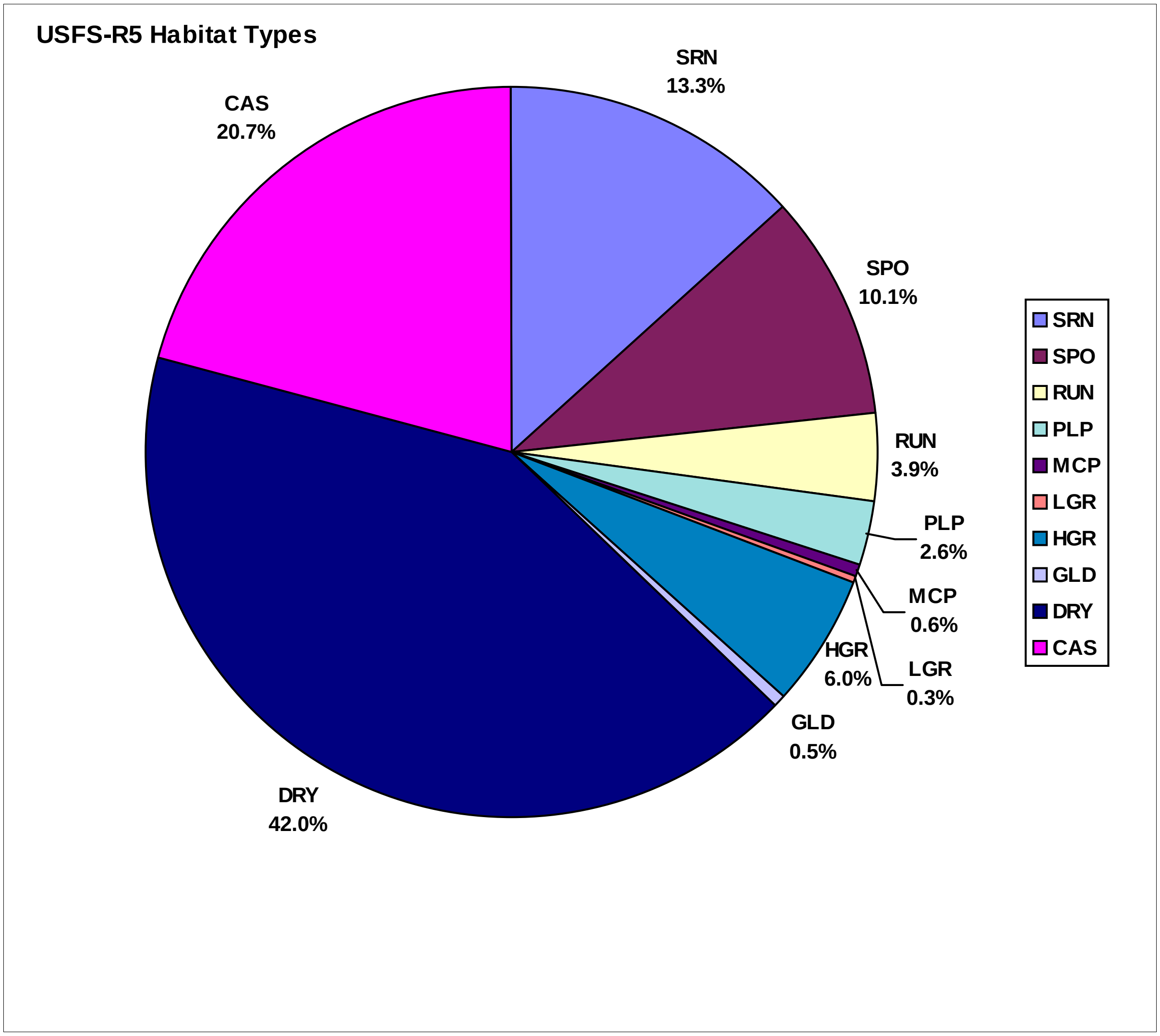


Figure CAWG 1-90. USFS-R5 Habitat Types for Adit No. 8 Creek.

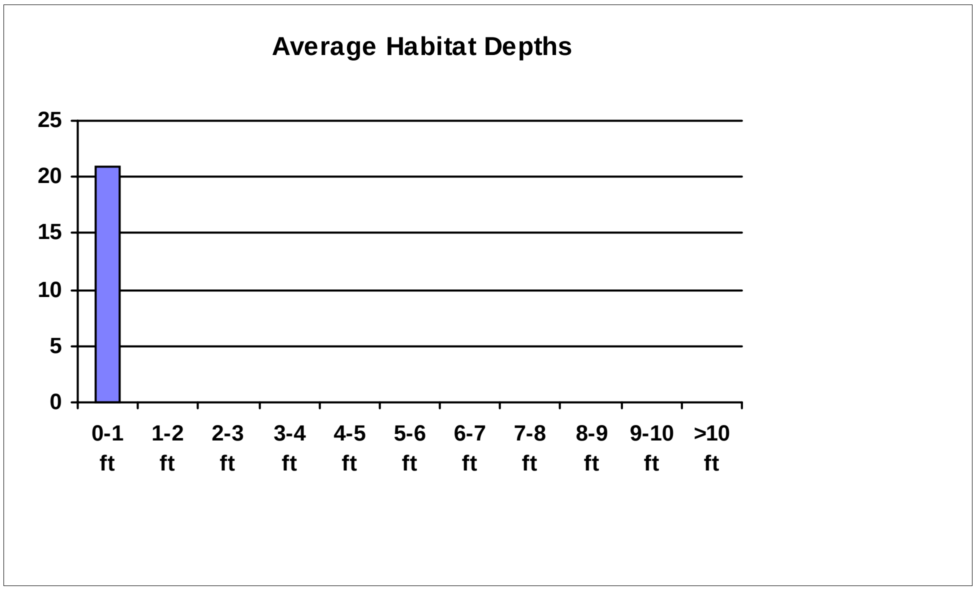
Recorded Average Habitat Depth Histograms

1 foot bin size

Big Creek Reach (Basin) BAS_BC

Adit #8 Creek A8C

Adit #8 Creek Reach A8C_R



Aa+ Channel Type

Figure CAWG 1-91. Average Habitat Depth Histograms for Adit No.8 Creek (1 foot bin size, frequency = number of pools).

Data collected starting on 7/27/2000.

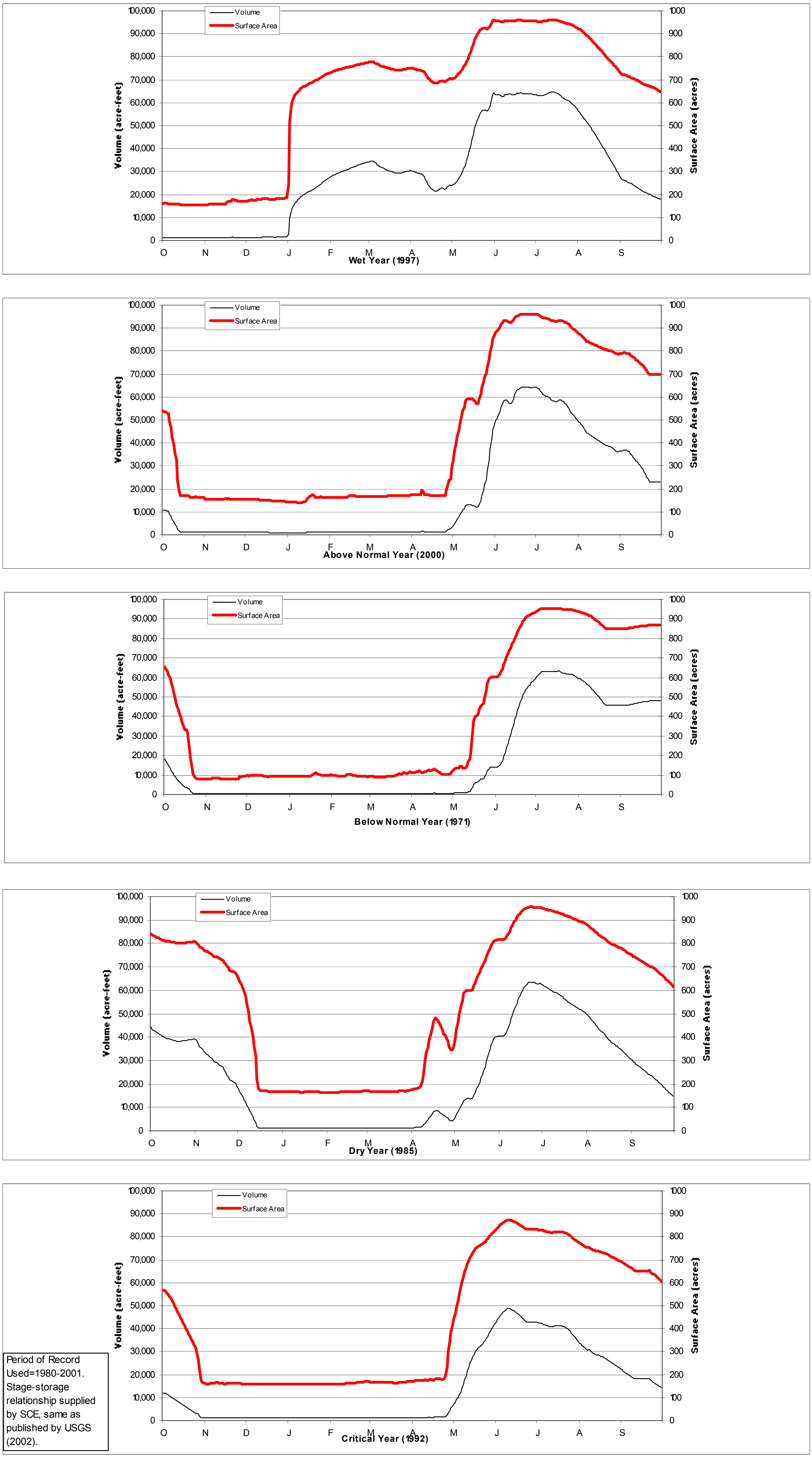
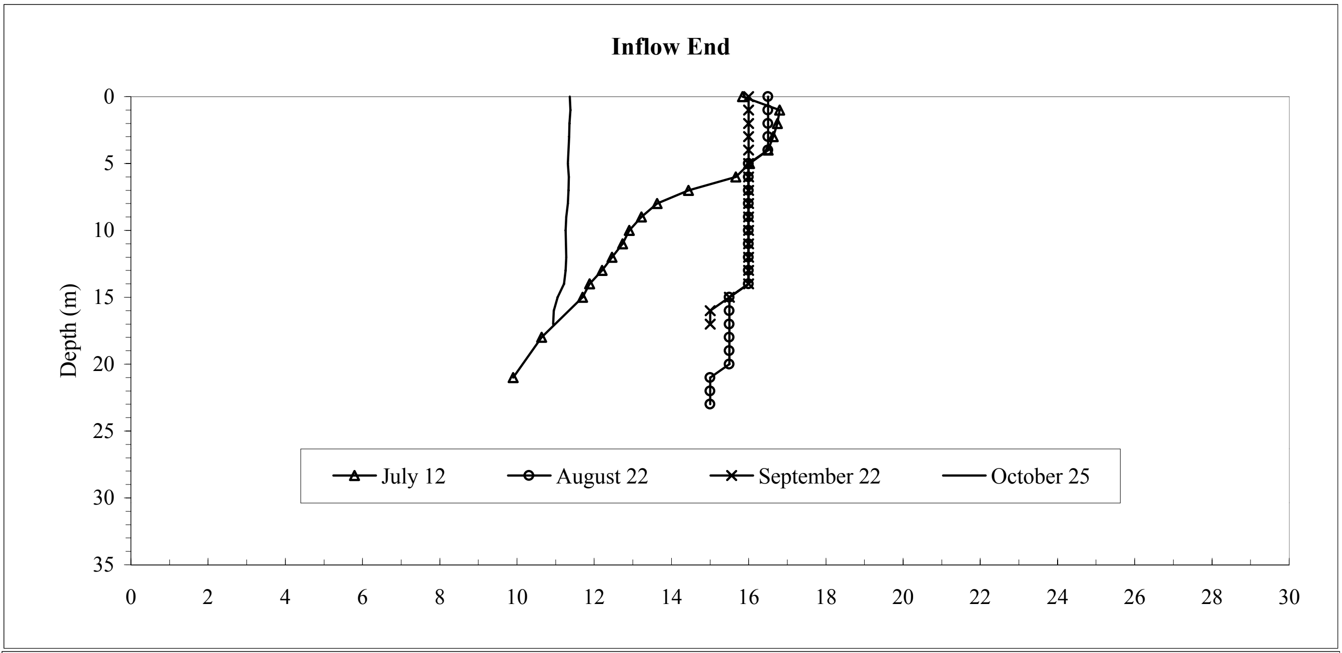
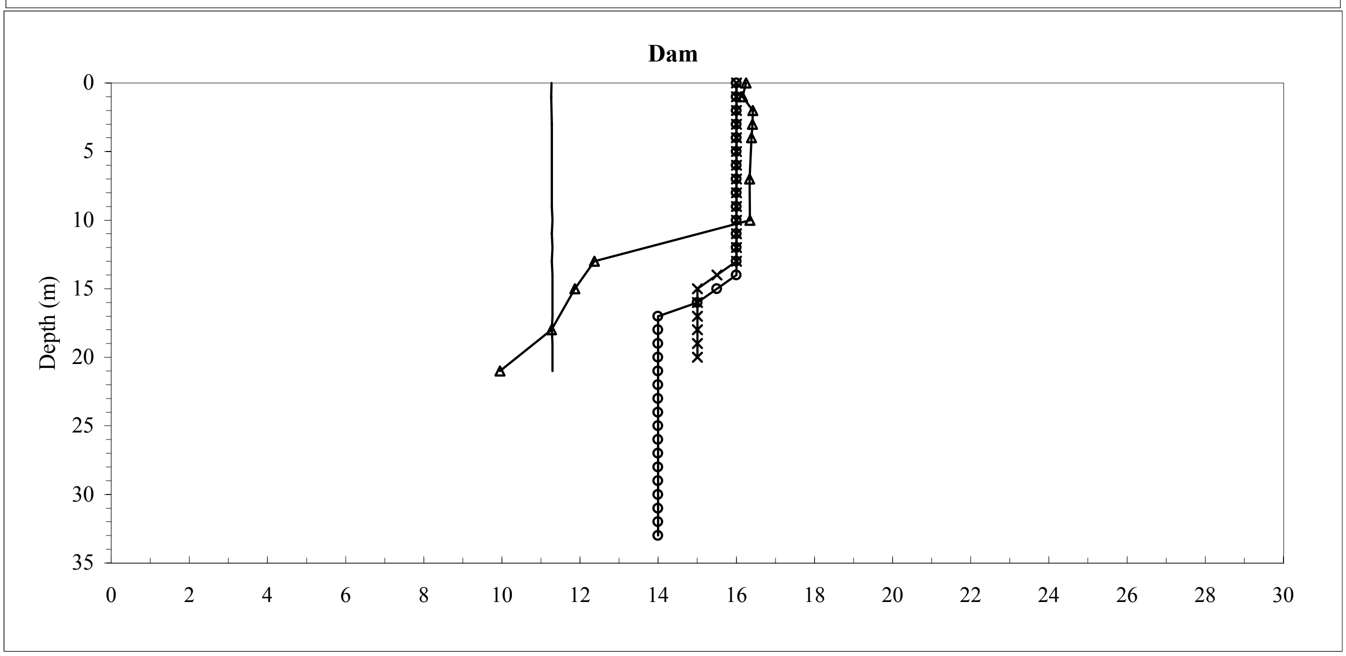


Figure CAWG 1-92. Florence Lake Daily Volume (Storage) and Surface Area for Representative Water Year Types. [Source: USGS (2001, 2002) daily midnight storage data.]





Temperature (°C)

Figure CAWG 1-93. Florence Lake Water Temperature Profiles, 2000.

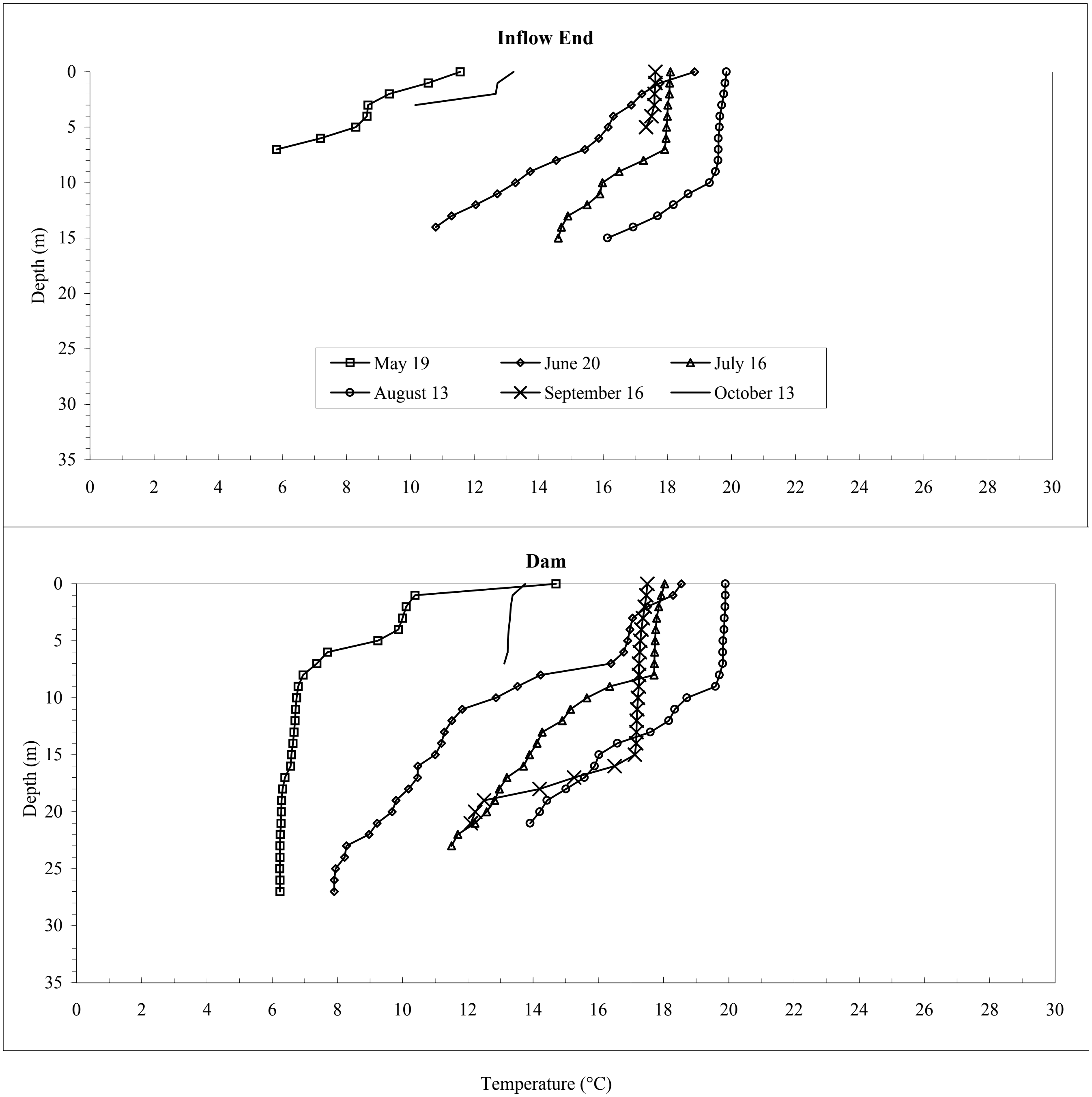


Figure CAWG 1-94. Florence Lake Water Temperature Profiles, 2001.

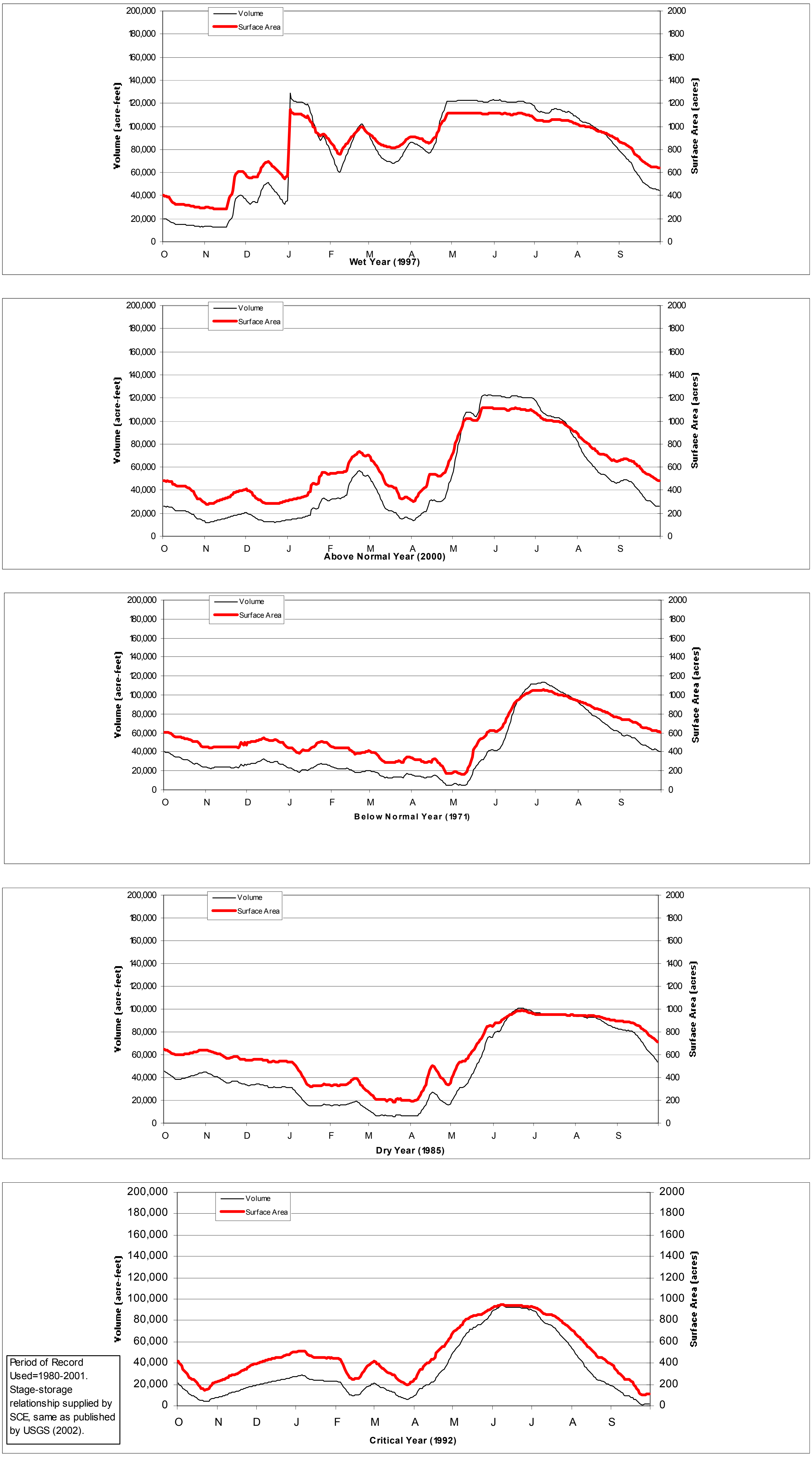


Figure CAWG 1-95. Mammoth Pool Daily Volume (Storage) and Surface Area for Representative Water Year Types. [Source: USGS (2001, 2002) daily midnight storage data.]

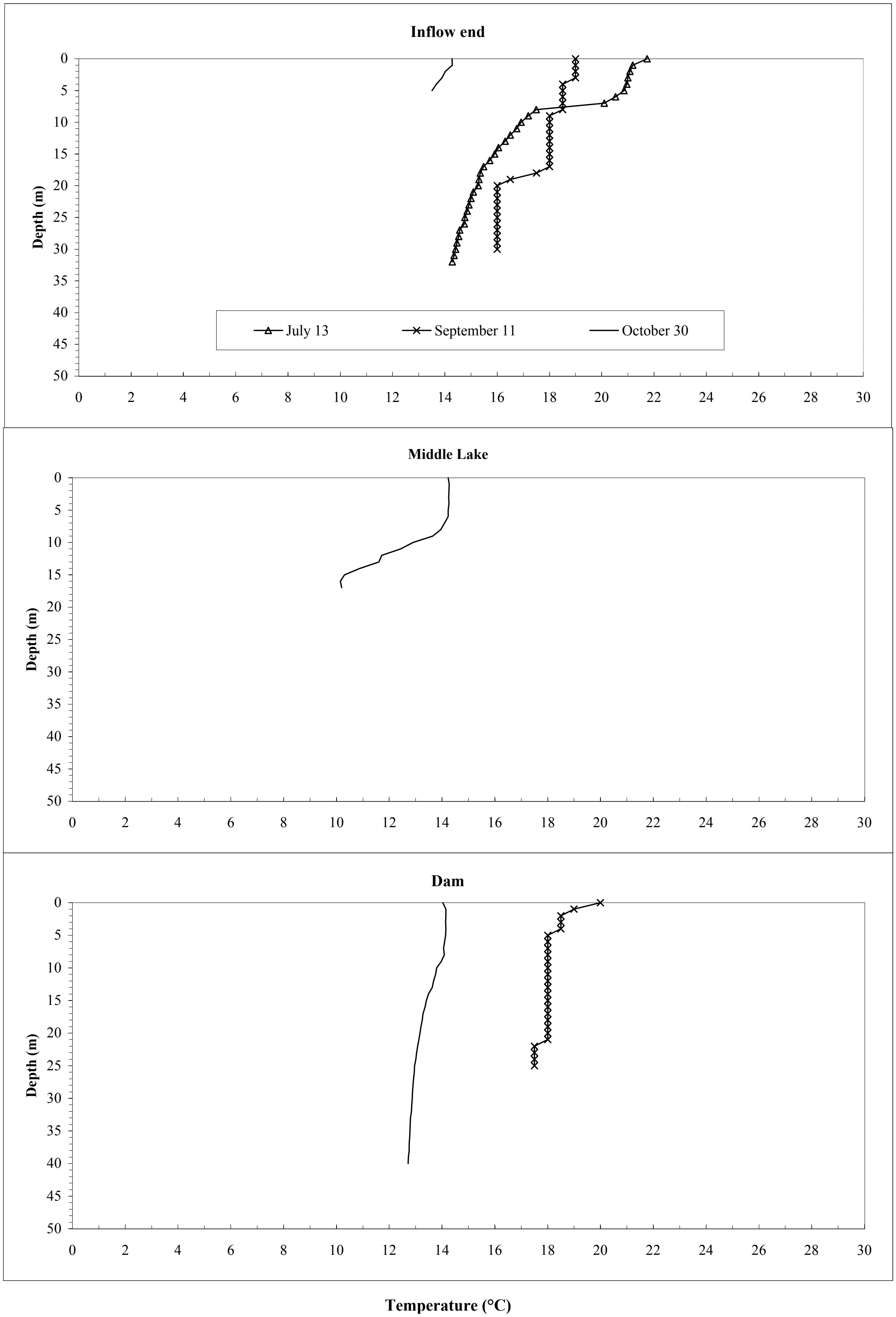


Figure CAWG 1-96. Mammoth Pool Reservoir Water Temperature Profiles, 2000.

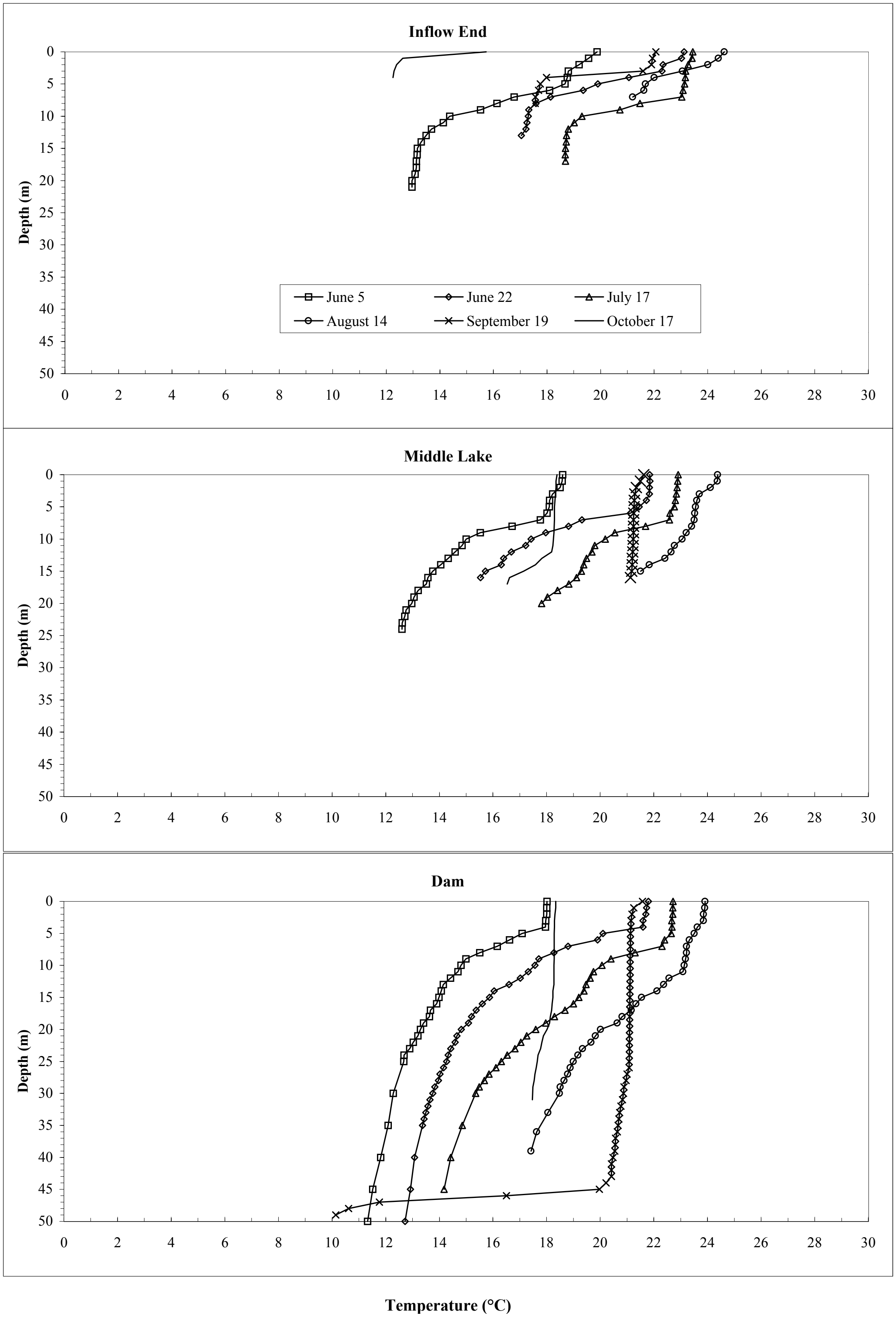
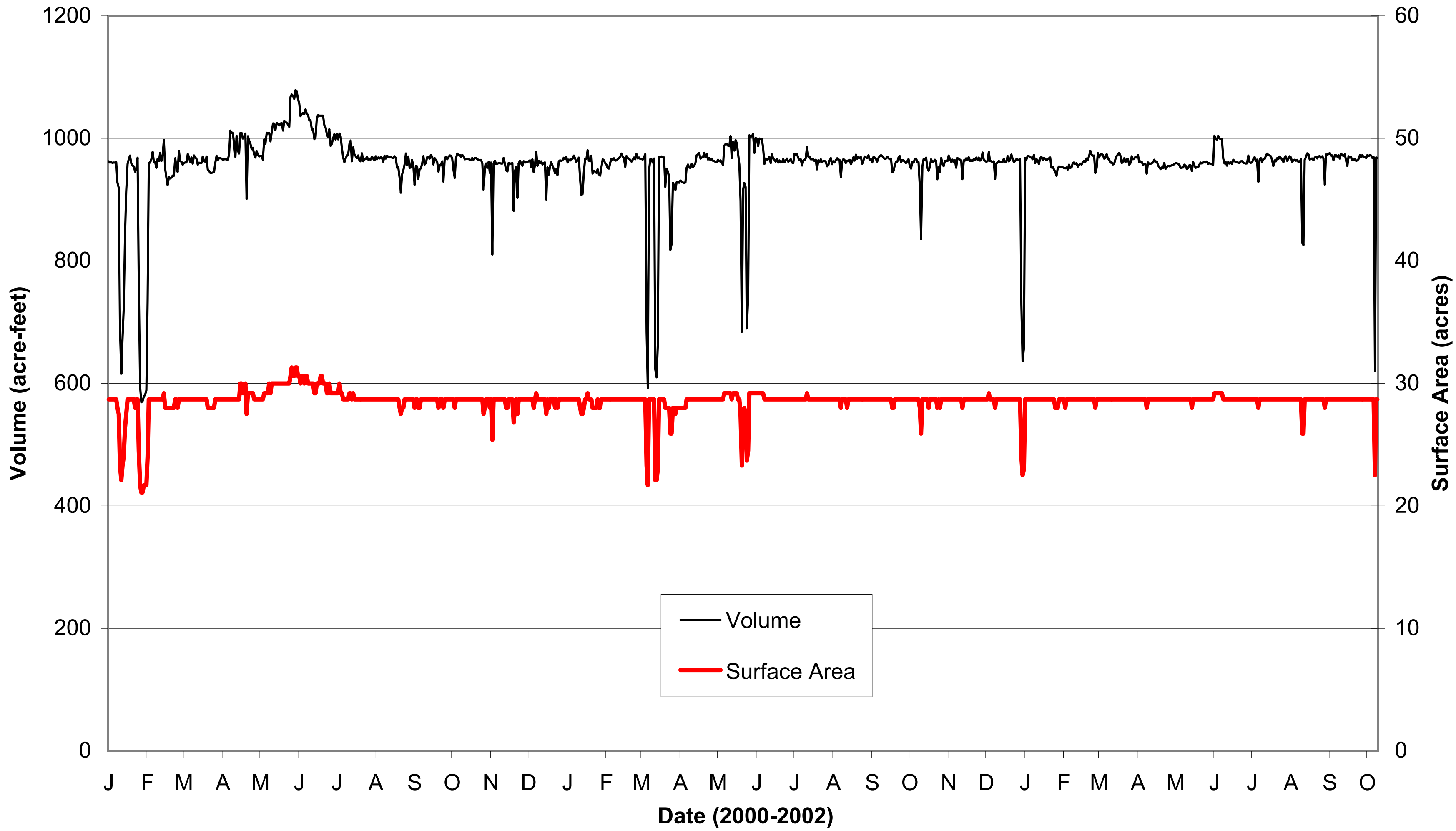


Figure CAWG 1-97. Mammoth Pool Reservoir Water Temperature Profiles, 2001.



Source: Daily means of hourly reservoir storage records and elevation-storage relationships for 2000-2002 supplied by SCE. Surface area was calculated.

Figure CAWG 1-98 Dam 6 Forebay Daily Volume (Storage) and Surface Area, 2000-2002.

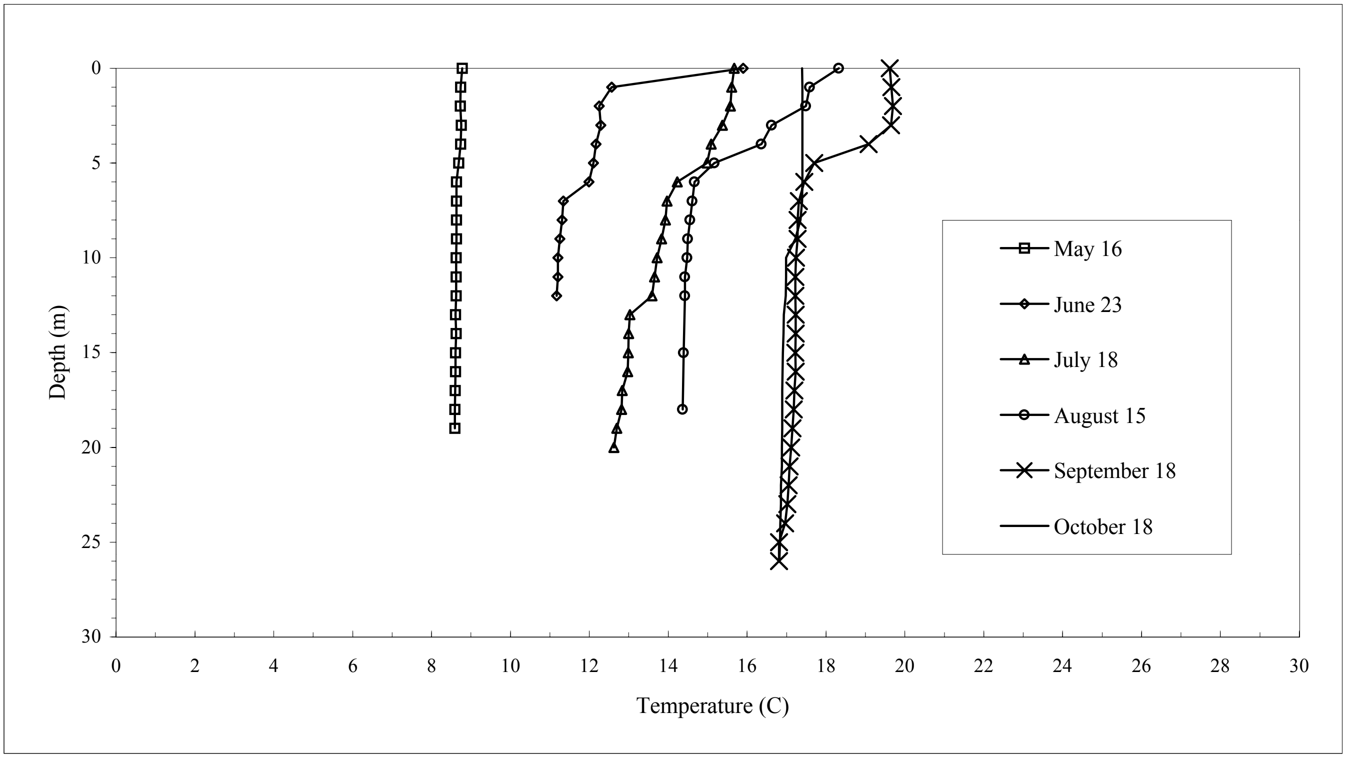


Figure CAWG 1-99. Dam 6 Forebay Water Temperature Profiles, 2001.

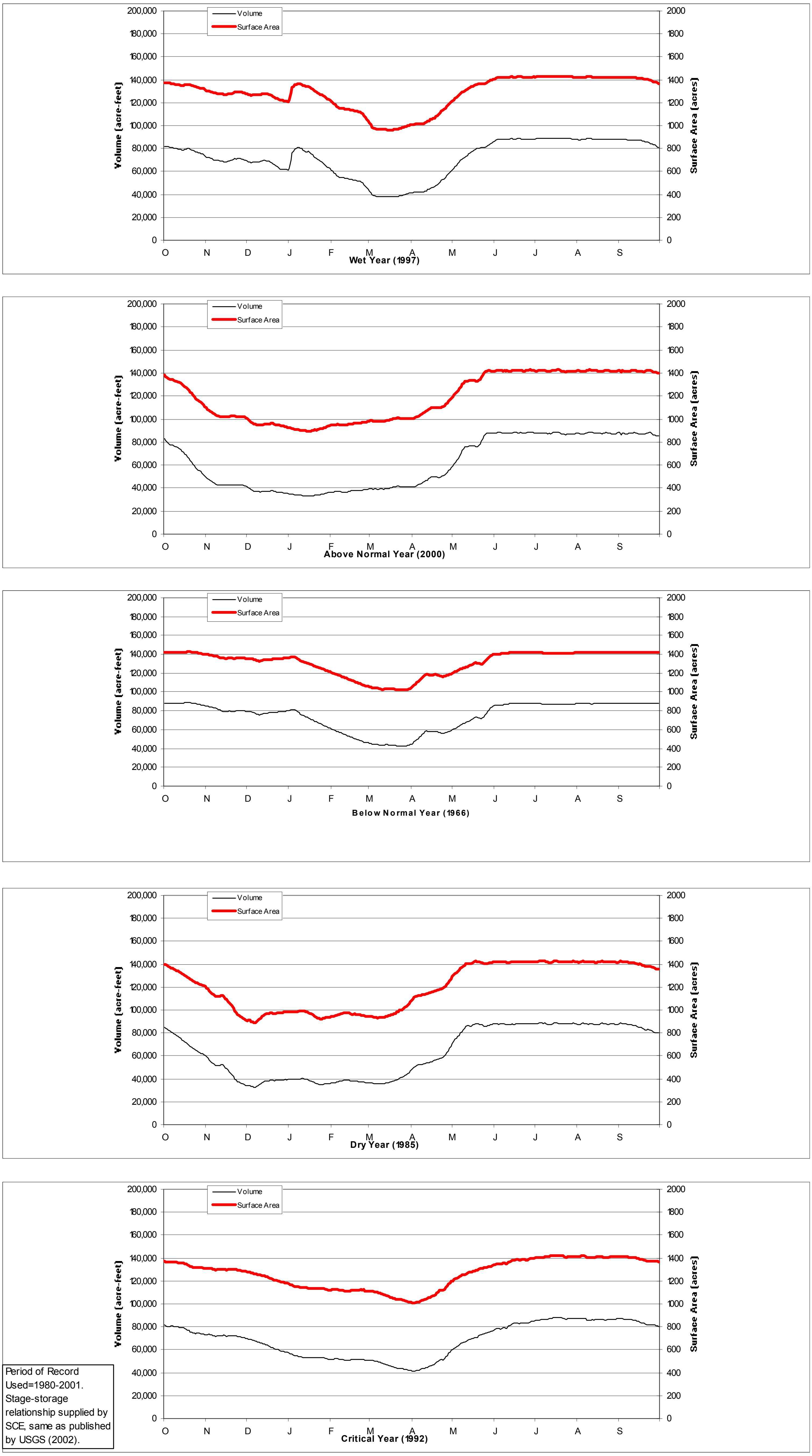


Figure CAWG 1-100. Huntington Lake Daily Volume (Storage) and Surface Area for Representative Water Year Types. [Source: USGS (2001, 2002) daily midnight storage data.]

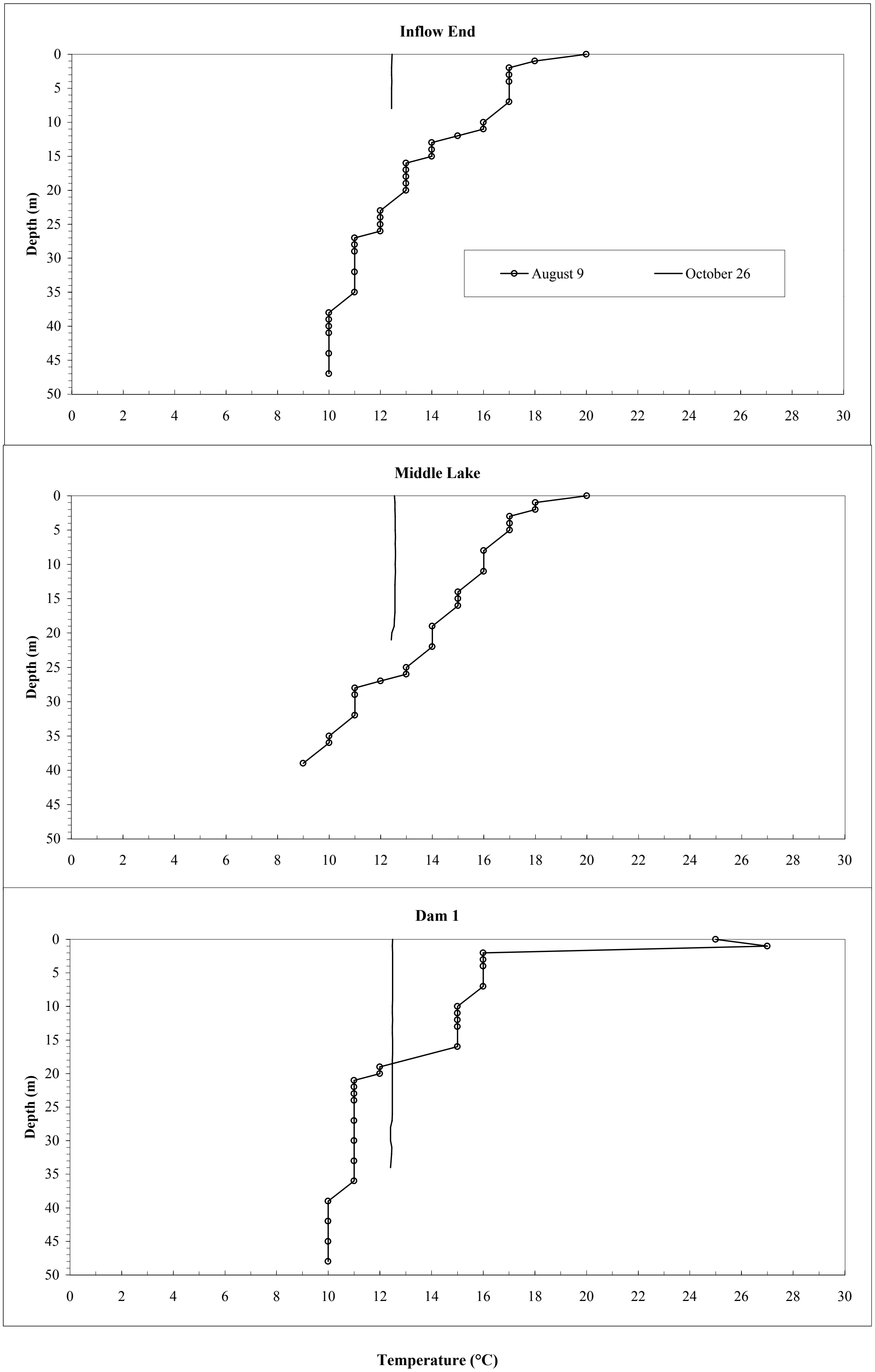


Figure CAWG 1-101. Huntington Lake Water Temperature Profiles, 2000.

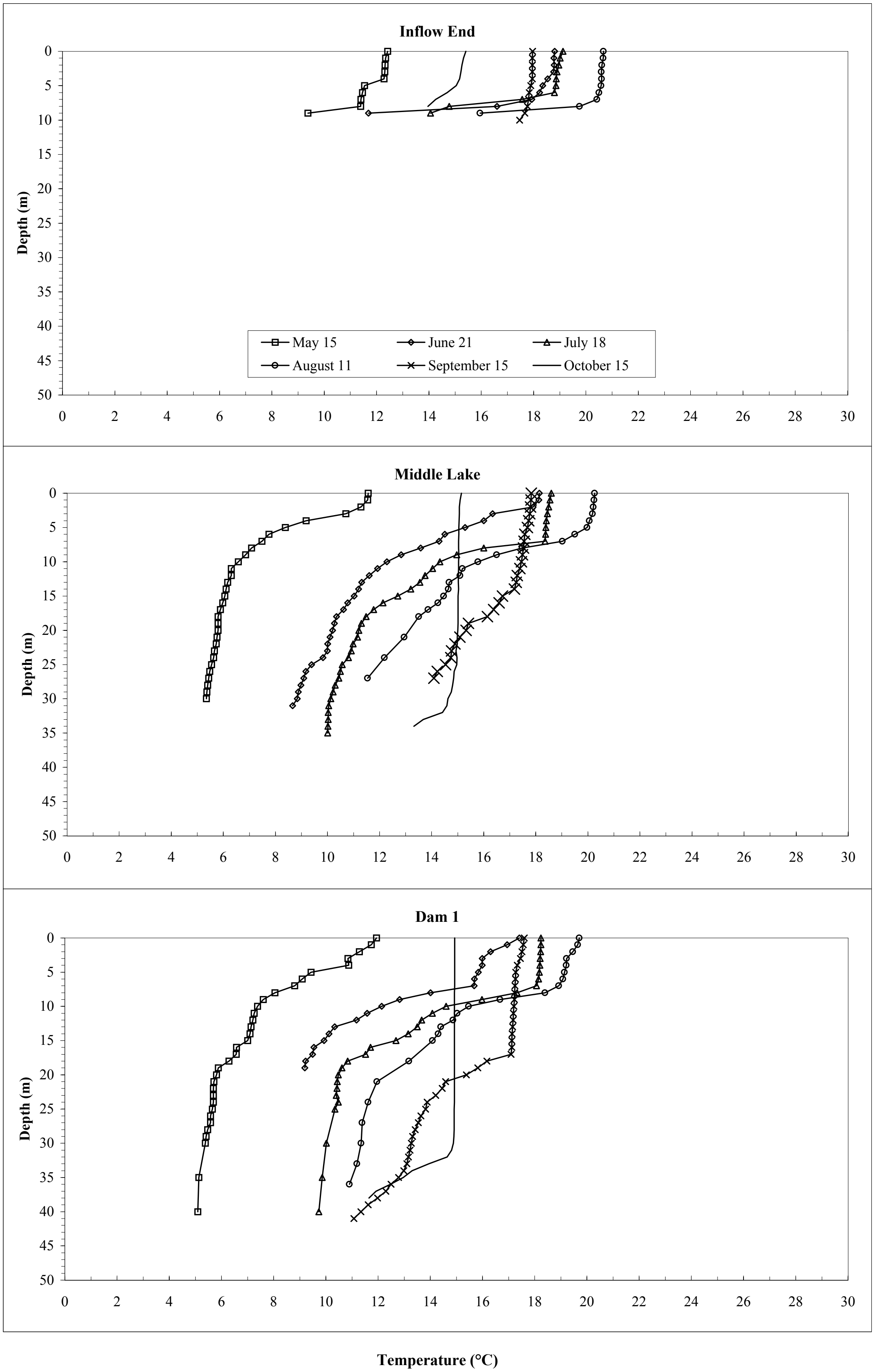
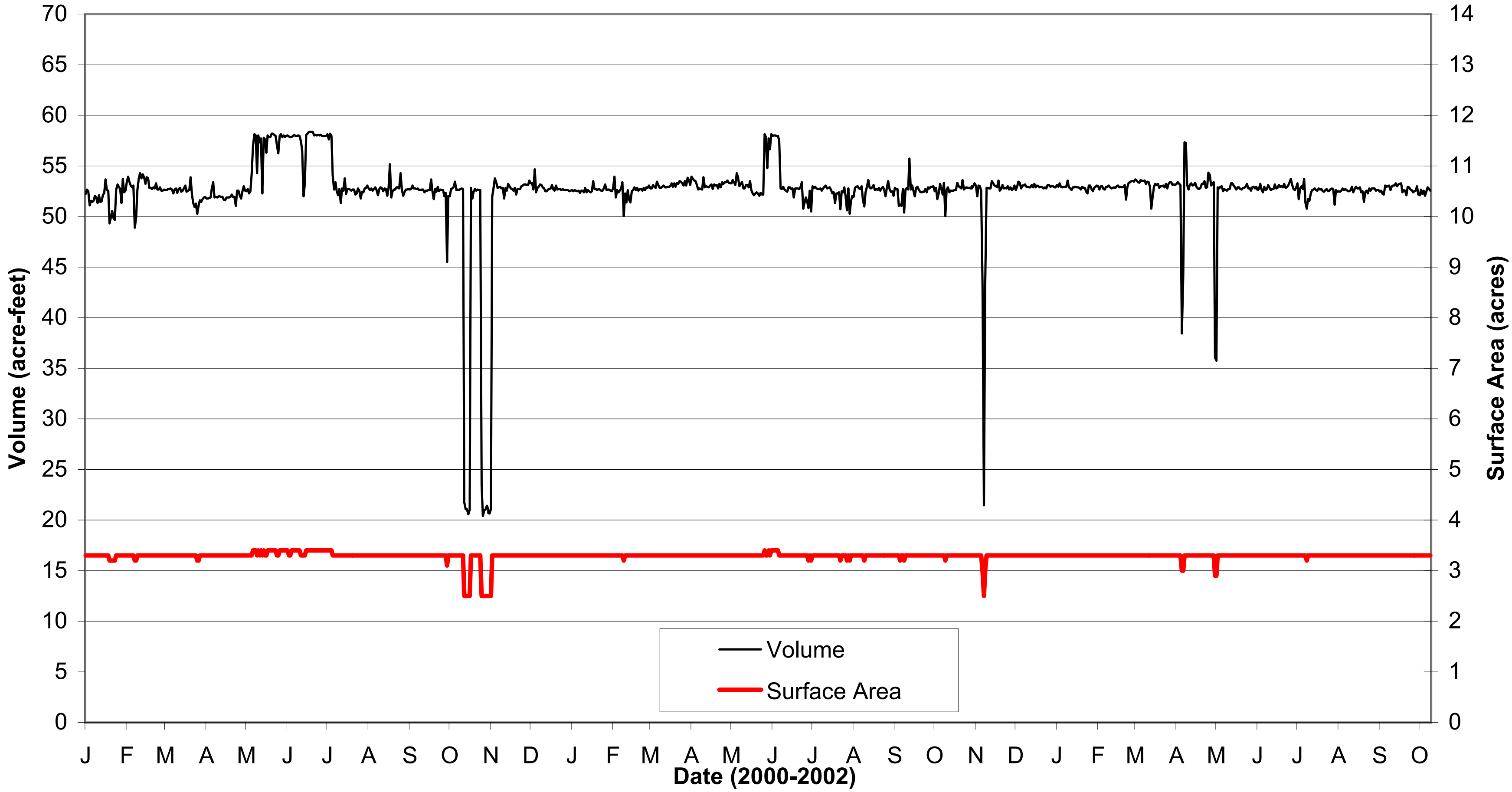
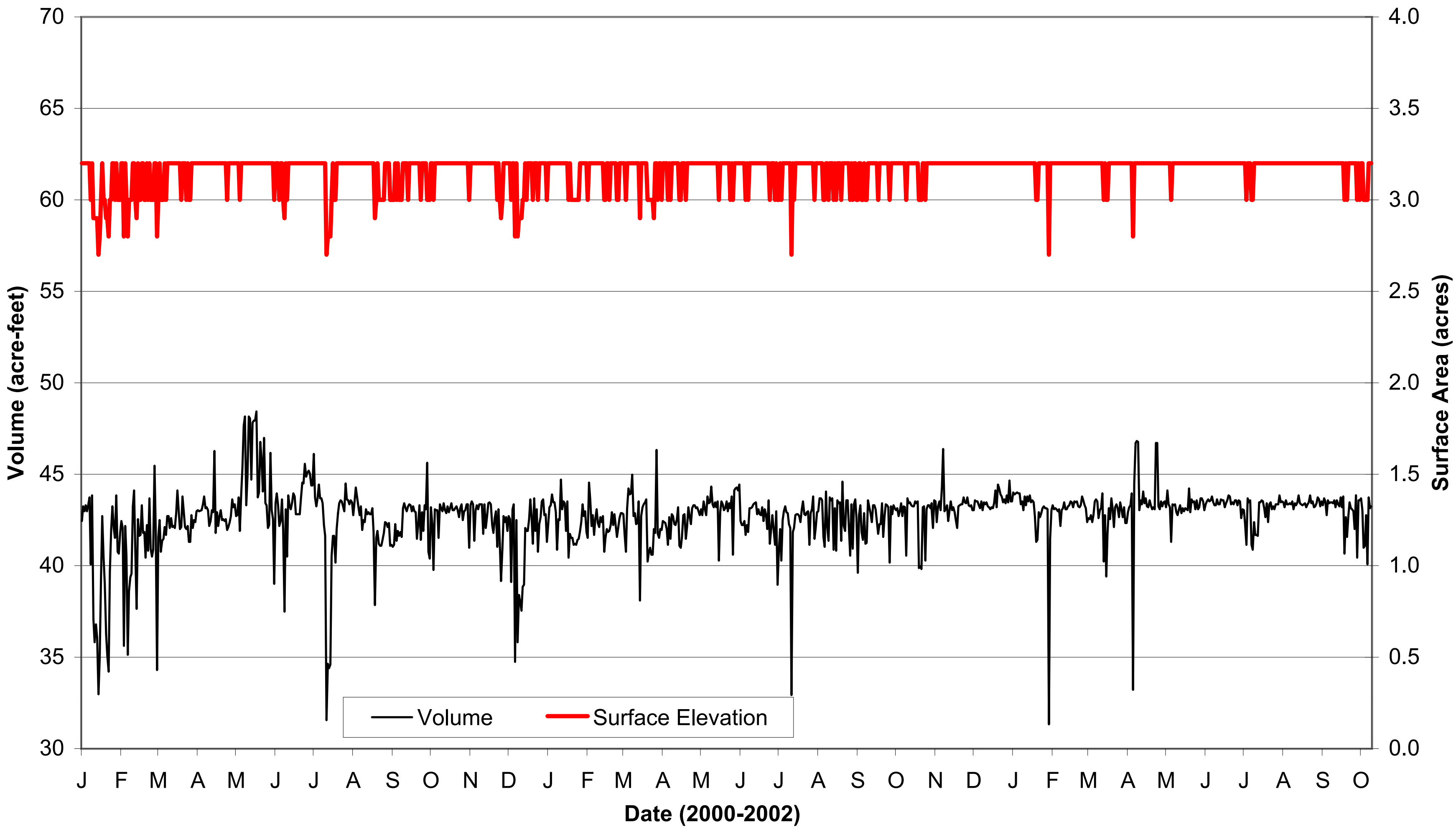


Figure CAWG 1-102. Huntington Lake Water Temperature Profiles, 2001.



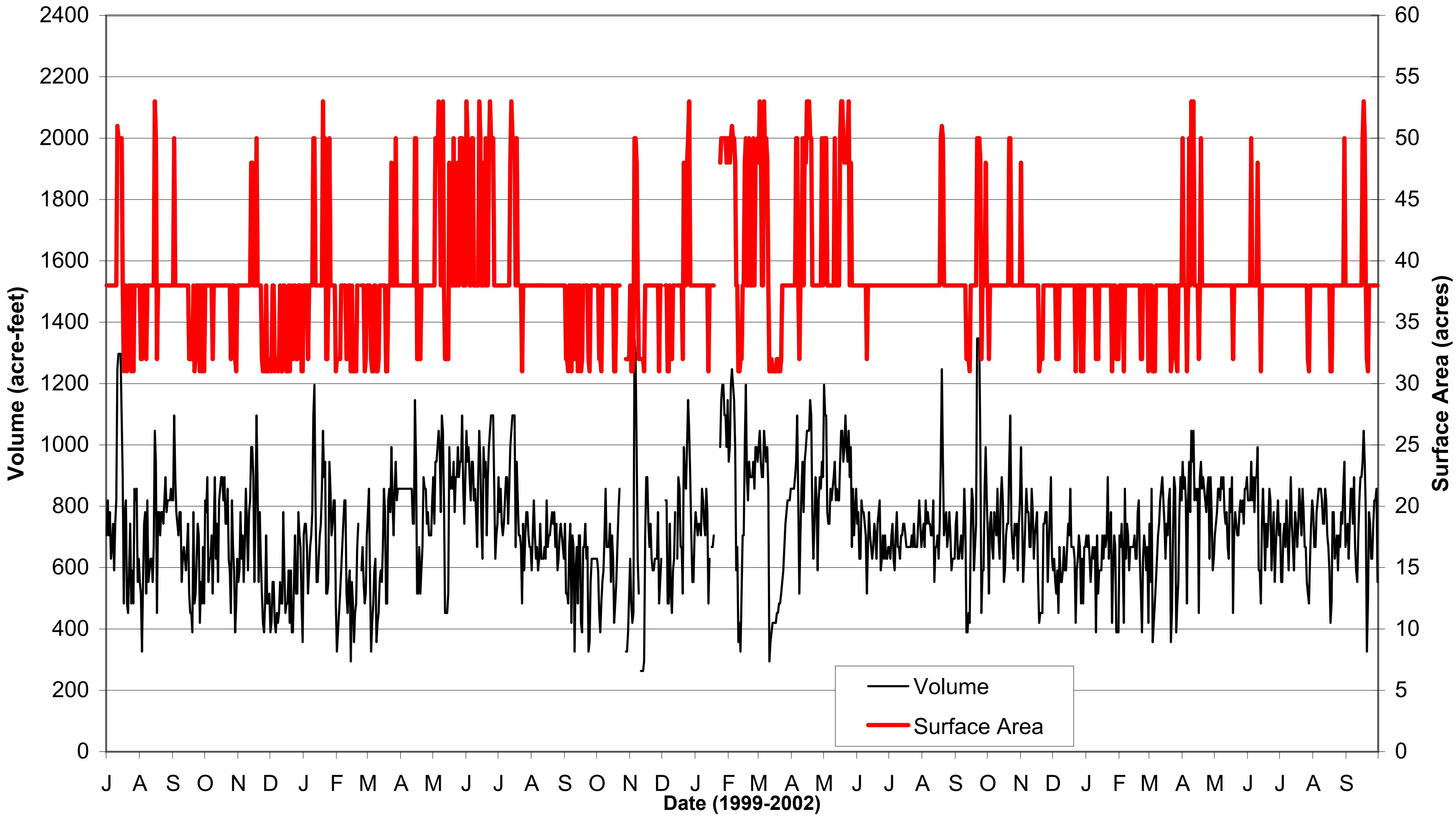
Source: Daily means of hourly reservoir storage records and elevation-storage relationships for 2000-2002 supplied by SCE. Surface area was calculated.

Figure CAWG 1-103 Dam 4 Forebay Daily Volume (Storage) and Surface Area, 2000-2002.



Source: Daily means of hourly reservoir storage records and elevation-storage relationships for 2000-2002 supplied by SCE. Surface area was calculated.

Figure CAWG 1-104 Dam 5 Forebay Daily Volume (Storage) and Surface Area, 2000-2002.



Source: Daily means of hourly reservoir storage records and elevation-storage relationships for 1999-2002 supplied by SCE. Surface area was calculated.

Figure CAWG 1-105 Balsam Meadow Forebay Daily Volume (Storage) and Surface Area, 1999-2002.

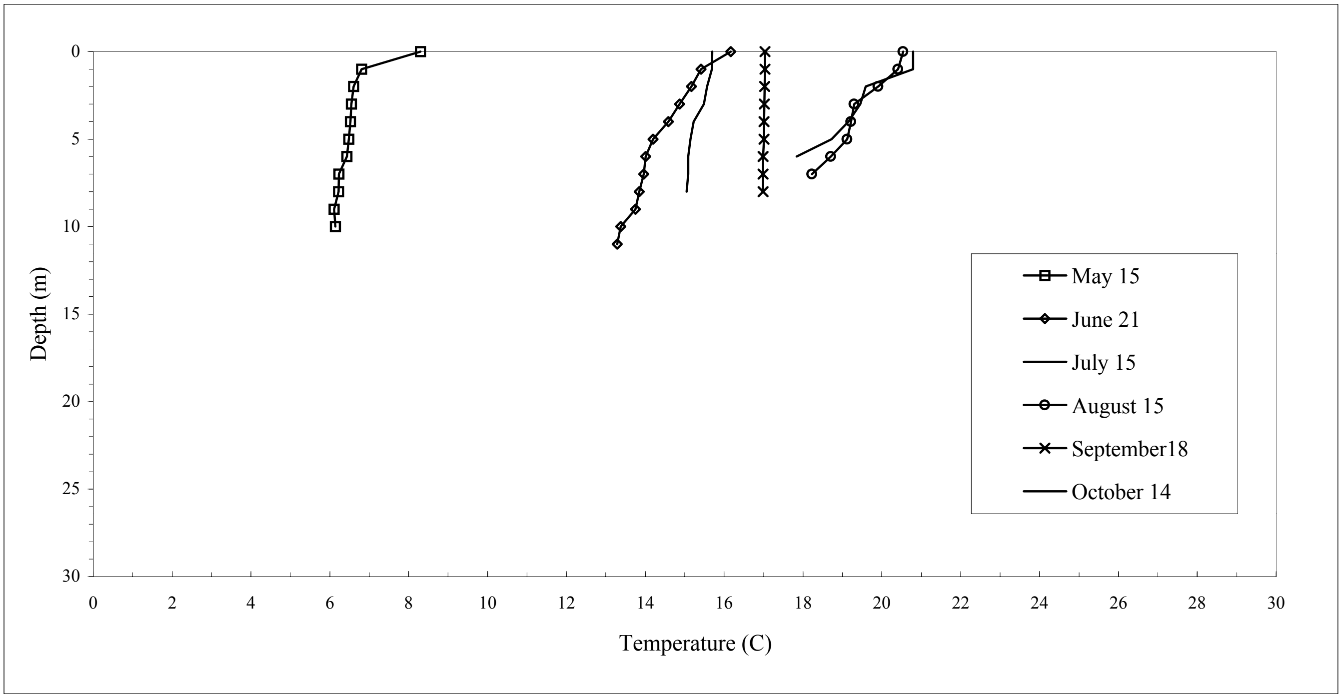


Figure CAWG 1-106. Balsam Meadow Forebay Water Temperature Profiles, 2001.

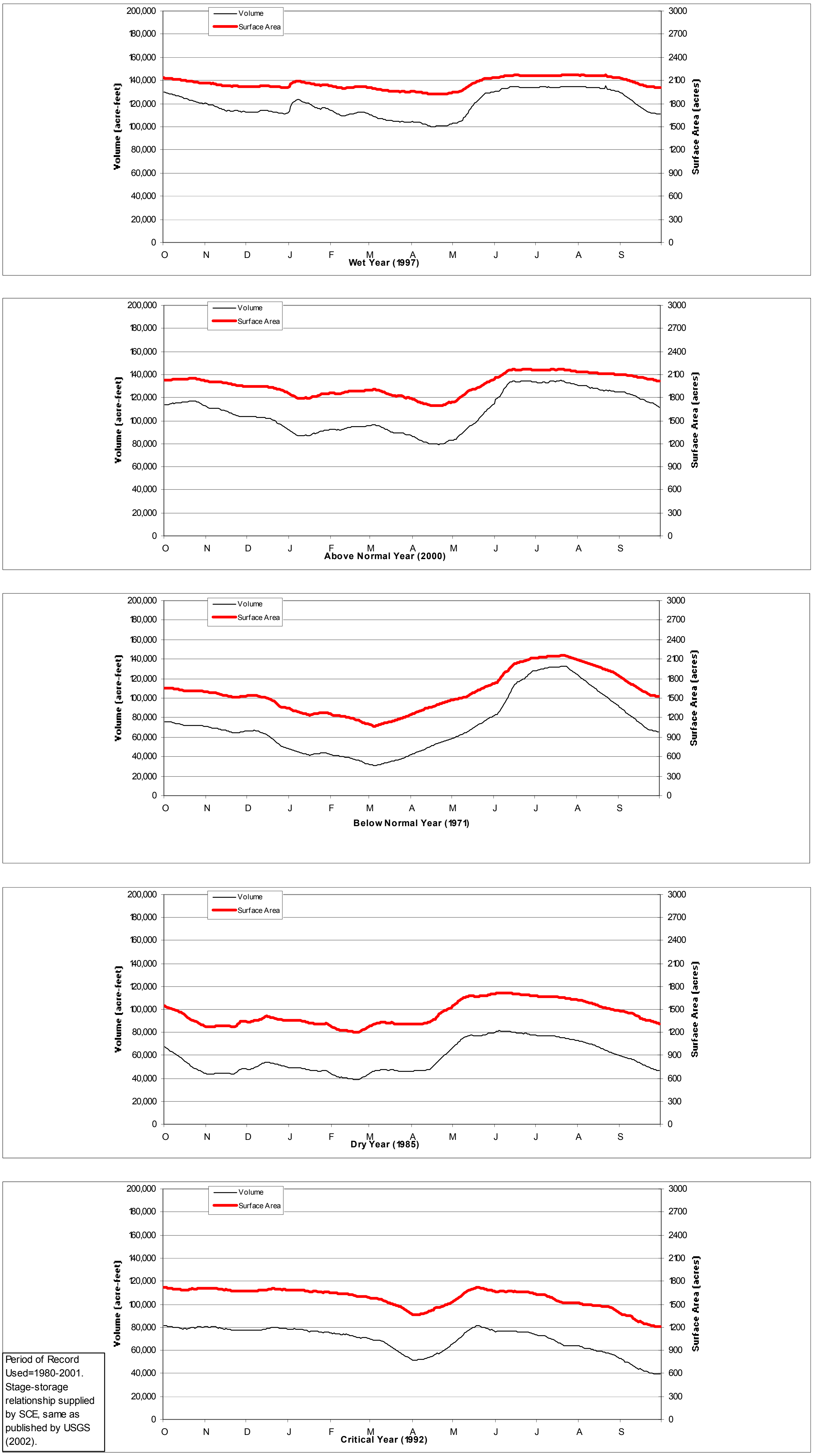


Figure CAWG 1-107. Shaver Lake Daily Volume (Storage) and Surface Area for Representative Water Year Types. [Source: USGS (2001, 2002) daily midnight storage data.]

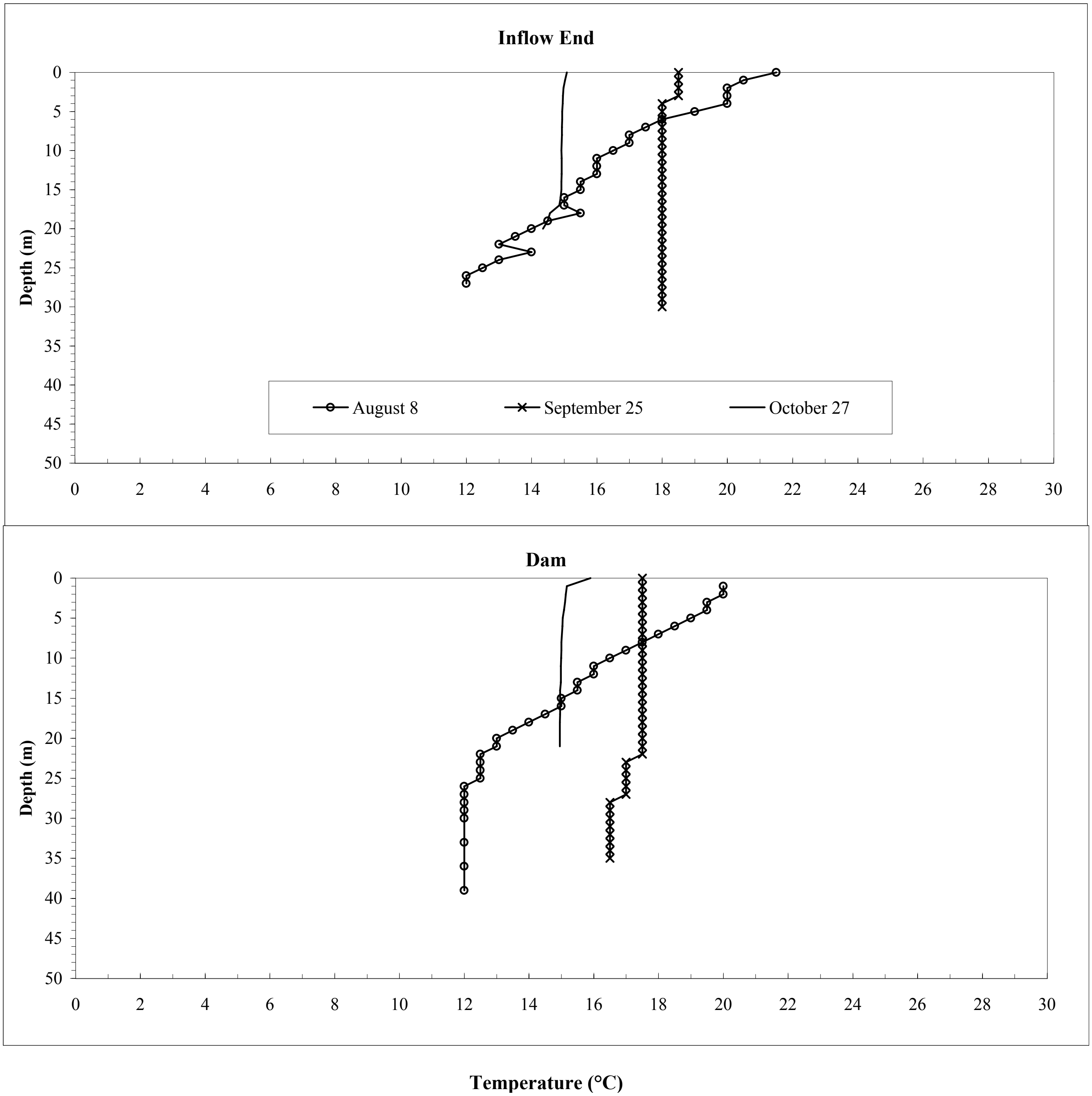


Figure CAWG 1-108. Shaver Lake Water Temperature Profiles, 2000.

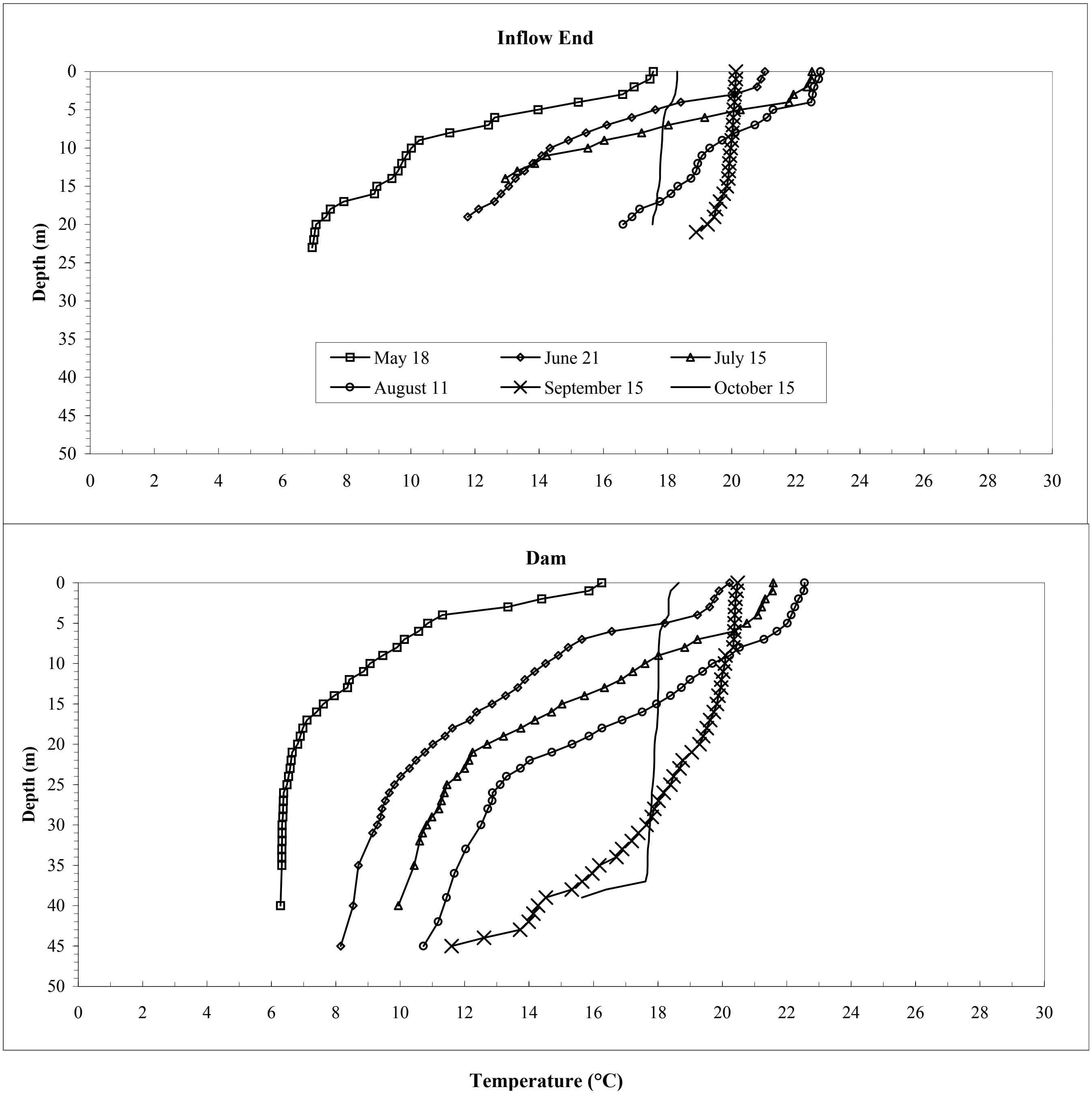


Figure CAWG 1-109. Shaver Lake Water Temperature Profiles, 2001.

MAPS

Placeholder for Maps

<u>Non-Internet Public Information</u>

These Maps have been removed in accordance with the Commission regulations at 18 CFR Section 388.112.

These Maps are 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

Hawkins et al. (1993) Level I and Level II Habitat Classifications

CAWG 1 Appendix A

Hawkins et al. (1993) Level I and Level II Habitat Classifications.

Fast Water (Riffle/Run)		Slow Water (Pool)	
TURBULENT	**NON-TURBULENT**	**SCOUR POOL**	**DAMMED POOL**
Riffle Habitat – High Turbulence – Caused by geomorphological differences (i.e. gradient, bed roughness, and/or step development)	**Run Habitat –** Non-Turbulent – Caused by geomorphological differences (i.e. gradient, bed roughness, and/or step development)	**Pool Habitat –** Formed by Scour – Pool created by erosion of stream bank, boulder, bedrock, etc.	**Pool Habitat –** Formed by Dam – Pool created by water blockage due to debris, landslide, beaver dam, large boulders, etc.

APPENDIX B

Habitat Types and Codes Adapted from McCain et al. (1990)

CAWG 1 Appendix B

Habitat Types and Codes Adapted from McCain et al. (1990).

Riffle	
Low Gradient Riffle	LGR
High Gradient Riffle	HGR
Cascade	
Cascade	CAS
Bedrock Sheet	BRS
Flatwater	
Pocket Water	POW
Glide	GLD
Run	RUN
Step Run	SRN
Trench Chute	TRC
Edgewater	EDW
Pool	
Mid channel pool	MCP
Lateral Scour Pool	LSP
Corner Pool	CRP
Secondary Channel Pool	SCP
Dammed Pool	DPL
Backwater Pool	BWP
Step Pool	SPO
Plunge Pool	PLP
Channel Confluence Pool	CCP
Additional Unit Designations	
Dry	DRY
Road-Crossing	RDC
Culvert under Road-Crossing	RDC
Concrete Box Culvert	CBC

APPENDIX C

Large Woody Debris

Large Woody Debris (LWD) data were collected in many, but not all study streams. Table CAWG 1 Appendix C-1 lists each stream in which LWD data were collected and the year in which the evaluation took place. Available aerial photography was evaluated to determine if it could be used to supplement ground-level surveys, it proved to be unsatisfactory for that use.

Stakeholders identified their concern with LWD information during the May 6, 2003 CAWG meeting. During that meeting, the primary concern was identified as possible interruption of LWD transport and potential resulting differences in LWD abundance above and below SCE diversions. The evaluation of SCE practices with regard to LWD has been included in the work to be performed under CAWG 2 Geomorphology. The evaluation will be reported as part of the results of 2003 Geomorphology study results.

Table CAWG 1 Appendix C-1. Status of Woody Debris Data Collection in Streams in the Big Creek ALP.

BIG CREEK ALP STREAMS	LARGE WOOD DEBRIS INVENTORY	YEAR STREAM HABITAT STUDIED
South Fork San Joaquin River Reach		
Florence Lake to Bear Creek	-	2000
Bear Creek to Mono Crossing	-	2000
Mono Crossing to Downstream of Rattlesnake	-	2000
Downstream of Rattlesnake to Upstream of Hoffman Creek	Y	2000
Upstream of Hoffman Creek to San Joaquin River/South Fork Confluence		2002
Tombstone Creek	-	2000
South Slide Creek	-	2000
North Slide Creek	Y	2000
Hooper Creek	Y	2000
Crater Creek	Y	2000
Bear Creek	Y	2000
Chinquapin Creek	Y	2000
Camp 62 Creek	Y	2000
Bolsillo Creek	-	2000
Mono Creek (Div. Forebay to San Joaquin River)	-	2000
San Joaquin River Reach		
San Joaquin River (SFSJR confluence to Mammoth Pool)	-	2002
San Joaquin River-Mammoth Reach (Mammoth Pool Dam to PH)	-	2000
San Joaquin River - Stevenson Reach (Dam 6 to PH 3)	Y	2000
Rock Creek	-	2000
Ross Creek	-	2000
Stevenson Creek Reach		
Stevenson Creek (Shaver Lake to San Joaquin River)	Y	2001
NF Stevenson Creek	-	2000
Big Creek Reach		
Big Creek (Powerhouse 1 to Dam 1)	Y	2000/2001
Big Creek (Powerhouse 2 to Dam 4)	Y	2000/2001
Big Creek (Powerhouse 8 to Dam 5)	Y	2000/2001
Rancheria Creek	-	2000
Pitman Creek	-	2000
Balsam Creek (Dam to Low. Div. Forebay)	*	2003*
Balsam Creek (Lower Div. Forebay to Big Creek)	-	2000
Ely Creek	-	2000
Adit No. 8 Creek	-	2000

* Scheduled to be studied in 2003.

APPENDIX D

Consultation Documentation

Agenda

Big Creek Combined Aquatics Working Group

Meeting at ENTRIX Sacramento Office
2601 Fair Oaks Boulevard, Suite 200 (Second floor)
Sacramento, CA 95864
(Tel) (916) 923-1097
(FAX) (916) 923-6251

November 29, 2000, 1000 – 1630 hrs".

Teleconference Call-in number: 1-800-569-0883
Tell Operator: SCE Aquatic Working Group Call
Moderator: Wayne Lifton

- Review Notes of November 9, 2000 AWG meeting
- Review revised Management Goals and Objectives for Aquatics
- Review simplified Project effects matrix
- Review revised Target Resources List
- Review outlined Study Plan Objectives
- Bulleted study plan outlines
- Draft USFWS letter

Big Creek Collaborative

Combined Aquatic Resources Working Group

November 29, 2000

Final Meeting Notes Version December 7, 2000

Time:	10 AM to 2:30 PM	**Moderator:**	Wayne Lifton
Location:	ENTRIX Sacramento Office	**Coordinator**:	
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:
Participants in the Sacramento ENTRIX Office
Wayne Lifton
Ed Bianchi
Bill Pistor
Martin Ostendorf
Dan Tormey
Roger Robb
Jen Carville
Sharon Storher
Julie Means
Russ Kanz

Telephone Participants
Mike Henry, FERC Portland (only participated early on)
Geoff Rabone, San Dimas
Chuck Bonham, Berkeley
Phil Strand, USFS Prather Office
Rick Hopson, USFS Prather Office
Holly Eddinger, USFS Prather Office
Larry Lockwood, SAMS

General Discussion prior to meeting

Edison received a letter from National Marine Fisheries Service (NMFS) stating that they will participate in the relicensing based on potential Impacts to anadromous fish below Millerton Lake. A copy of this letter will be posted on the SCE Hydro web-site.

New Working Group Name

Everyone agreed to rename the group “Combined Aquatics Workgroup”.

Handouts distributed to the group prior to the start of the meeting:
- Meeting Agenda
- USFWS Wayne White participation letter
- Draft Aquatic Potential Impacts, Study Objectives and Summary Nexus matrix

- Target resources table
- Draft 11_11_00 Meeting Notes
- Aquatic Resource Interest/management Goals and Objectives Matrix

It was suggested the any handout materials (flip charts and presentation materials) be placed on the web prior to the meeting so that people participating by phone can view them on the web during the meeting. Currently, this information is provided to everyone by email and fax prior to the meeting. If additional materials are developed during the meeting then we can quickly copy them and fax them to everyone, as needed.

These materials were emailed to everyone prior to the meeting. Hard copies of these materials were available for everyone attending the meeting.

Facilitation

Bill Pistor will facilitate the meeting, His role as facilitator is to:

- Maintain a focused meeting on the agenda
- To facilitate order, if needed
- To assure a more formal record of decision
- Make sure that everyone has received meeting materials
- Encourage preparation for each meeting,

Review Agenda

The meeting agenda was quickly reviewed and everyone was asked if they had anything they would like to add to the agenda. No comments were provided regarding the agenda.

The agenda items were:
- Review notes from last meeting
- Management Goals and objectives
- Aquatic potential Objectives summary
- Target resources List
- Draft USFWS Letter
- Other Business

Review November 9, 2000 Meeting Notes

The following are comments regarding the November 9, 2000 meeting notes.
- The date is incorrect and should changed to 11/9/00
- Comments were made regarding last bullet on page one of the notes which refers to "mimicking of flows" it was suggested that the bullet be changed to read, "*Mimicking is based on the timing, rate of change, and magnitude of peak and low flows, and seasonality and frequency of flushing flows, not necessarily identical to the natural hydrograph but a reflection of that natural curve*". It was agreed that basing this statement only on timing is too narrowly focused. The discussion then focused on the natural hydrograph and the following comments were made:
    - We should also be looking at base flows and peak flows
    - The original thought on mimicking was to use the shape of the natural hydrographs as a guide to providing peak and minimum flows quantified by other studies such as channel maintenance or IFIM.
    - We need to look at the natural hydrograph and the impaired hydrograph so that we have a basis for comparison

- The text in the Resource goals and objectives matrix more clearly defines what we need to say and should be used to replace this last bullet. This text states, "*Manage flow magnitude, timing, duration, and rate of change to more closely approximate the natural hydrograph*". This text will replace the bullet in question.

Review Revised Resource Goals and Objectives Matrix

The Resource Goals and Objectives Matrix has been revised to reflect the goals and objectives of the combined group. The matrix now includes water quality, riparian, and amphibians and reptiles resource management goals and objectives. Everyone in the combined group was to have provided comments on this combined matrix by Nov. 17. This review is for the working group to verify that their comments have been incorporated.

The following are comments were received on the matrix:

- Volcanic and seismic hazards are still in the Combined Aquatics Group (CAWG). What happened to Air Quality? Air quality issues will be addressed in the Land Management Group.
- Riparian issues are addressed in the CAWG. However, there must be coordination with other groups that also evaluate riparian habitat. For instance in the terrestrial group, we will need to coordinate with the terrestrial group which will address wildlife species using the riparian habitat.
- Special status amphibians and reptiles need to include effects of water quality on all lifestages.

  Action item: Provide single text edits on water quality effects on lifestage of amphibians and reptiles and forward to Wayne for inclusion into the matrix.

- We need to add the word draft next to the date in the footer of the table.
- We need to add a title to the matrix, which clearly identifies the matrix to avoid confusion associated with multiple matrices.

Review Draft Aquatic Potential Impacts, Study Objectives and Summary Nexus

This table was prepared based on earlier discussions for simplified nexus matrix. This matrix presents information on potential project impacts, potential study objectives and where a potential project nexus may occur in association with Project facilities or otherwise affected by Project operations and maintenance. This table also includes some information from earlier discussions on impact mechanisms for potential Project nexus. This matrix is a precursor step to developing bulleted study plan outlines.

This is the first look at this matrix for the group, so the comments provided today are initial thoughts. Everyone will review the matrix and provide single text edits by Dec. 6th, and these comments will be integrated into the matrix, which will then be reviewed at the next meeting.

The following are comments provided on the matrix.

- We also must determine the existing habitats in the tributaries to reservoirs and diversions not just the in the bypass reaches.
- We must identify the Project issues in order to develop PM&E alternatives and to identify where studies should be performed.

- Suggested text edit (in italics), Habitat in reservoirs is a function of the *elevation*, shape, depth, and *water temperatures* of the reservoir and changes water levels that may occur during operations.
- On page 2, Item No. 5. Why only evaluate water temperatures during the warmer months? Most impacts occur during the warm months and during the winter there is little control over flow releases that may affect temperature. Suggested text edit, change warmer months to "May through October".
- On page 1, Item No. 1. We need to discuss cover for fish in the section. Under *Determine other channel conditions during habitat mapping,* we need to note undercutting of stream banks.
- Need to evaluate and characterize streambed substrate, such as the type of substrate that would be needed for macroinvetebrates.
- Need to determine substrate compositions (general composition). This should be included in Section No. 1, "Evaluate habitat for aquatic organisms.
- Are channel types a Rosgen designation? (Yes) Is there a reason why we are not doing a Level 2 classification? Interest in having streams classified at Rosgen (1996) level two.
- Brief discussion that Rosgen Level 2 classification is most pertinent to channel maintenance and sediment evaluations, but less useful in overall habitat characterizations.
- Include Rosgen Level 2 classification in first bullet in Item No. 2.
- Need to look at the unimpaired substrate upstream from the diversion. Add another column to the matrix for the stream segment upstream of diversions. Everyone agrees to add a column on the *upstream of diversi*ons.
- Item No. 2 fourth bullet down, we need to add, "rate of change".
- Item No. 4 Water Quality, we need to add coliform bacteria to the list of water quality parameters.
- It was suggested that dissolved gasses be added to Item No. 4 water quality. However, it was asked if dissolved gases are necessary. Are the SCE dams tall enough to impact dissolved gases in spilled water, for those dams that spill? Need to look into this.
- The warmer months in Item No. 5 may not work for the amphibians such as yellow-legged frogs. At some locations we may want to monitor temperature all year to understand when frogs breed. Selected streams below 5000 feet may be monitored for water temperatures and impacts to amphibian spawning (i.e. Willow Creek Jose Creek, Lower Stevenson Creek). It was mentioned that not all of these are Project-affected.
- Need to compare temperatures to basin plan standards.
- Add the determination of bankfull flow to Item No. 2 in the matrix.
- Differentiation of small bypass reaches to larger reaches. In smaller reaches we will evaluate channel maintenance flows, in large reaches we propose to do IFIM studies to determine minimum flow.
- Many of the small diversions have no storage, so any large flows in the tributaries are not captured by the diversion.
- We should study the effects of the Project, we must be aware that we do not do studies for data acquisition alone. Studies should be performed to determine Project effects.
- In most water years, the small streams with diversions are perennial. In some dry years some of the streams may be intermittent. Many of the streams have instream flow requirements that exceed the natural flow in the summer times. Generally worded to be the minimum instream flow or natural flow, whatever is less.
- Riparian and vegetation is covered in Item Nos. 1, 2 and 11, specifically where will these resources be covered. Item No 1 refers to a general characterization of riparian habitat (broad based during habitat mapping). Item No. 2 applies to channel maintenance flows in riparian habitat and how these flows effect habitat. Item No. 11 refers to completing a true characterization of riparian community based on more riparian-directed mapping. These are three separate components of information that would be used in a riparian study.

- Characterization is not what is wanted as a result. A study objective should be aimed at determining and knowing the effect of the Project on the resources interests. Characterize does not include a determination of the Project effect.
- "Characterize and assess", is a better way of describing.
- The outcome of every study element is to determine what the Project effect is. It was suggested that we add a footnote to all studies, to this effect. **Action Item**: Wayne will craft a universal footnote to determine impacts from characterization.
- We need to make sure that the mollusks are included. They are included in the target species matrix.
- Water use: Consumptive water use in the Shaver lake community needs to be included, we can not lose this (Russ)
- We need to address the downstream effects on water use due to operational changes.
- Item No. 13, bullet no. 2, we need to make a more specific comment. Should be the reservoir and the dependence of communities on these reservoirs. We need to revisit the goals and objectives matrix and be consistent make them consistent with the version. **Action item**: Dan will redraft a more specific objective.
- It was suggested that we need to include direct, indirect, and cumulative effects. However, we are to early in the process to try to identify all of the cumulative effects. In some regard the water use evaluation is a cumulative effects analysis.

Place holder for future discussion by the working group regarding item No. 3, second bullet. We need to discuss the potential application of the Wetted Perimeter Method. We haven't come to this conclusion as a group as yet. Some feel that we should include PHABSIM in the method statement. However, others indicate that we will likely use IFIM not PHABSIM. This will be an involved discussion that the group must undertake to develop a consensus on the methods that will be used.

When can we have this future discussion? Next CAWG meeting is December 13th, from 8 to 12. At this meeting we will be providing bulleted study plans, so if people can think about their methods, then we would be prepared to develop the detailed methodologies for the study plans.

Sharon and Russ asked that we provide all the handouts before the next meeting since they will not be able to attend.

Review Revised Target Resources Matrix

Everyone was asked to review matrix and provide comments by Dec 6th. Please make sure that the list is complete. We will use this list in developing the study plans. This list reflects everyone input on target species.

We will put "X's" in the matrix boxes after we complete the bulleted outlines study plans.

Under other resources, will we list other resource targets (those abiotic resources other than biological issues)? We don't want things to fall through the cracks.

The original intent of this table was for biological resources. However, if people want to include abiotic issues, they can be added to other.

It was suggested that we title this matrix as "Target Biological Resources " and remove other from the table

We may need to add another table at a later date for abiotic resources.

Bulleted Study Plan Outlines

Discussion on the process of developing bulleted study plan outlines. How will we progress to the next step for the development of bulleted study plan outline? This discussion will be based on the procedures/process that should be implemented to develop the bulleted outlines.

- By Dec 6th people will provide their comments on the study objective and summary Nexus matrix.
- This input to the nexus matrix will be used to develop bulleted study plan outlines.
- Draft bulleted study plan outlines will be sent to everyone by Friday the 8th for everyone's review prior to the meeting on the 13th.

Review USFWS letter

This discussion was directed at the preparation of a letter from the collaborative to the USFWS requesting their participation in the Big Creek ALP.

Geoff Rabone and Wayne Lifton met with Gary Taylor at the USFWS and the following is a summary of that meeting:

- Participation in the ALP Process.
- USFWS lack of personnel to participate. New staff will be hired at the beginning of the year, one of which can be assigned to the Big Creek ALP.
- The collaborative is concerned by the lack of USFWS participation in the development of study plans especially in the ESA consultation.
- Discussed these issues and stated that we could write a letter to the USFWS expressing our concerns.
- This letter should be sent to Wayne White.
- A letter has been drafted for review by the collaborative. This letter is asking that the USFWS provide representation from both their branches (hydro and ESA).

The following are comments regarding the review of this letter:

- Comment on the description of the seven Big Creek projects. The intent of this comment is to demonstrate the size and importance of the project.
- Suggested addition to the end of the first paragraph. "A significant factor in SCE's decision to adopt the relicensing model was the strong policy endorsement on the part of resource agencies, including the USFWS of a watershed approach toward environmental analysis"
- Forth paragraph, 2nd sentence additional text (in Italics), "there is concern that *our study plan schedule may not be achievable, and t*hat these efforts may *therefore…"*
- Discussion of how to have the collaborative sign it. Have the collaborative vote on it, and then include a list of the collaborative members. Everyone agreed to this procedure.
- Third paragraph 2nd sentence additional text (in italics), "This *absence…".*
- Second paragraph 2nd sentence additional text (in italics), "This *ALP…".*

The changes will be incorporated into the letter and the revised letter will be email to all plenary participants requesting review and comment. If no comments are received, then it will be mailed on Monday, December 4th.

Other issues

Heads up issue. Due to reorganization of the USFWS and involvement by NMFS, the USFWS and the USFS service may require that candidate species be evaluated since the project extends onto the Central Valley floor. Hence we may pick up some additional species for evaluation (i. e. Delta smelt, long fin smelt. Giant garter snakes, etc). The USFS or the USFWS, may request a that a biological assessment be prepared for the studies that are being proposed for all T&E species that may be effected by the implementation of studies.

Action Items

Dec. 4 Final comments to Wayne on the Aquatic Goals and Objectives Matrix

Dec. 6 Comments due on the draft and summary nexus, and the target resources list

Provide single text edits on water quality effects on lifestage of amphibians and reptiles and forward to Wayne for inclusion into the matrix.

Dec. 8 ENTRIX will incorporate comment and return to everyone. Also will include bullet study plan outlines.

Dec. 13 Come prepared to the meeting to discuss wetted perimeter methodologies

No date specified

- Wayne, send out material on the wetted perimeter method to everyone prior to our next meeting so that they are prepared to discuss it during the meeting.

- Wayne will craft a universal footnote to determine impacts from characterization. (I.e. The outcome of every study element is to determine what the project effect is.)

- Dan redrafts a more specific objective for Item No. 13, bullet No. 2. We need a more specific comment regarding the reservoirs and the dependence of communities on these reservoirs. Revisit the goals and objectives matrix and be consistent with it.

Agenda
Big Creek Combined Aquatic Working Group

Meeting at USFS Office
Clovis, CA
February 14, 2001, 1000 – 1800 hrs".

Teleconference Call-in number: 1-800-569-0883
Tell Operator: SCE Aquatic Working Group Call
Moderator: Wayne Lifton

- Review Notes of January 10, 2001 CAWG meeting
- Review **comments** on draft study plans (we will focus on these plans)
    - CAWG-1 Habitat Characterization
    - CAWG-5 Water Temperature
    - CAWG-4 Water Quality
    - CAWG-13 Water Use
    - CAWG-10 Macroinvertebrates
- NMFS Resource Interests, Goals, and Objectives
- Future Scheduling
- Other Business/Wrap Up/Review Action Items

Big Creek Collaborative
Combined Aquatic Resources Working Group

February 14, 2001

Meeting Notes

Time:	10:00 AM to 6:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Clovis Office	**Coordinator**:	
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Wayne Lifton	ENTRIX, Inc.
Ed Bianchi	ENTRIX, Inc.
Bill Pistor	Kearns & West
Martin Ostendorf	ENTRIX, Inc (Recorder)
Roger Robb	Friant Water Users Authority
Sharon Stohrer	SWRCB
Phil Strand	USFS SNF
Lonnie Schardt	Huntington Lake Association
Holly Eddinger	USFS SNF
Geoff Rabone	SCE
DanTormey	ENTRIX, Inc. (Water Quality, sediment, wetted perimeter portion)
Julie Means	CDFG
Chuck Bonham	Trout Unlimited
Steve Rowan	SCE
Russ Kanz	SWRCB
Dale Mitchell	CDFG
Larry Lockwood	SAMS

Telephone Participants

Jen Carville	Friends of the River
Steve Edmondson	NMFS (707) 575-6080
Rick Hopson	USFS

Handouts distributed to the group during the meeting:

- Meeting Agenda
- Draft January 10, 2001 Meeting Notes
- Draft Detailed Study Plans, CAWG Nos. 1, 4, 5, 10 and 13.

Opening Discussion, General Comments/Issues

- Comment period for Detailed Draft Study Plans has been extended to March 8th.
- An interim meeting will be scheduled before the next regularly scheduled March meeting.
- A Plenary Meeting will be scheduled in March and will be followed by working group meetings.

- The National Marine Fisheries Service (NMFS) has provided management goals and objectives for the ALP. Their input has not been incorporated into the current versions of the draft detailed study plans, however, they will be incorporated into subsequent version of the study plans and will be reviewed by the plenary.
- Written comments on the current study plans were received from Rick Hopson last week and from Holly Eddinger yesterday. Rick's comments have been incorporated into study plan handouts distributed at today's meeting.
- There was general discussion regarding the study plan review process. The study plans will be reviewed and approved by the working groups and sent to the plenary for approval. Upon approval by the Plenary group the study plans will be made available for review by the Tier 2 and 3 groups. Comments provided by the Tier 2 and 3 groups will be reviewed and addressed by the working group. Final study plan will then be sent to the plenary group for approval.
- There was a general discussion regarding the time frame to complete the study plan review. There was a general consensus that not all of the study plans will be completed in the expected time frame. A lot has been asked of everyone in a relatively short time frame. Everyone agreed that the working groups may only establish interim agreements for portions of select study plans. More data may be required to determine additional study plan needs and subsequently finalize study plans.
- Summary discussion on the protocols to be followed in order to track changes to the study plan documents.
  - Written comments provided by stakeholders/participants will be presented as per the communication protocols.
  - Written changes and comments received from stakeholders/participants will be indicated by underline for new text, and strike out for deleted text and attributed to the individual.
  - Everyone must make sure that their comments are accurately represented in the record (meeting minutes and single text edits)
  - Comments and changes agreed to by the working group during the meeting will be indicated by underline for new text, and strike out for deleted text and attributed to the working group meeting.

Review Agenda

This meeting focused primarily on the review of Draft Detailed Study Plans CAWG 1, 4, 5, 10 and 13.

A request was made that the agenda include a review of SCE's meeting with the U. S. Fish and Wildlife Service (USFWS) on February. This was added to the agenda.

Added to the agenda was a discussion on a planning matrix provided by representatives of the SWRCB. (This matrix was obtained from USFWS and was a helpful tool in the planning process).

Review January 10, 2001 Meeting Notes

Only a few comments were provided regarding the January 10, 2001 meeting notes, as follows:

- Much of the second page of the notes presents questions regarding the NFMS involvement in the process. Will thee be addressed during this meeting since Steve Edmondson is not present. Steve will calling into the meeting later and we will discuss these questions when he calls in.
- On page 6 of the notes in the wetted perimeter discussion it is indicated that the wetted perimeter method was successfully applied in the Sequoia and Inyo National Forests. It was

requested that information or reports of work completed in the Inyo National Forest be provided, (i. e. case study).

- Page 8 (Action Item). Assumptions will be added to the study plans. How will this be done? Assumptions will be identified and added by the working group during the individual study plan review.

Many of the group participants had not had an opportunity to review the meeting notes. Therefore, everyone was asked to thoroughly review the minutes and provide comments. ***Action item**:* Comments on the January 10, 2001 meeting minutes must be provided to Wayne Lifton by 2/21/01

Draft Detailed Study Plan Review

The following is a review of individual detailed study plans. Note: a handout containing copies of the Draft Detailed Study Plan was distributed to the working group participants (these contained comments provided by Rick Hopson.)

A general comment that was made that the study plans should be shortened and simplified. The superfluous information should be left out, (keep the important stuff and leave out the not so important stuff. Based on this comment the working group discussed the format of the study plans. The comments were provided on study plan format and content.

- The study plans need to be prepared for the common reader.
- We can reference to accepted practices instead of spelling it out.
- How is this different from the general approach? We will break down the general approach to identify the main points and identify the methodologies that will be applied.
- We need to allow as much time for editing as we did for preparation.
- Make the study plans succinct, clear and reference material (not rewrite-it in detail).
- Summary of discussion
    - Craft to a general audience
    - Reference general methodologies
    - Need for explanation why we are doing the studies
- Are we keeping a copy of all the documents that we are referencing in the study plans. We are currently developing a list of all the references in all the study plans and in the Initial Information Package.
- What is the level of detail we need? We are creating a record that needs this level of detail. Will this document be part of the FERC Application as a record of these proceedings?
- The final version of the study plans will be part of the application and public record for the project.
- If these are part of the public record then we will need the level of detail so that we don't have to recreate the proceedings. We need a complete record. Maybe the very detailed information can be in an appendix, and we can work off of complete succinct summaries to ease the review process. However, we can not afford to conduct the studies and have someone challenge the results without the detailed methodologies to back up the studies. Reference the detailed methodologies and include the detailed methodology write-ups in an appendix.

<u>CAWG –1 Characterize Stream and Reservoir Habitats</u>

When we get to meso-habitat mapping will it be Rosgen Level 3? No, it will be Rosgen level 1 based on Hawkins methodology.

Is there a separate study on large woody debris? It is included the sediment study.

What size (diameter) is considered large wood? Anything greater 6-inch is considered large woody debris.

The USFS brought to the meeting two copies of the protocols used by the USFS to classify woody debris. **Action Item:** Everyone to get copy of the protocol.

Do we need to study large woody debris? Yes, it is an important component.

Do we need a separate study for large wood or will it be part of an existing study? Study Plan CAWG 2 (Sediment Transport and Channel Maintenance) will study the effect of woody debris, and study plan CAWG –1 (Habitat Mapping) will characterize woody debris.

Woody debris is also a habitat issue not just a channel maintenance issue.
It is easier to address wood as a separate study plan.
It was suggested that a separate folder (study) within an existing study be developed for woody debris.
Page 4 of CAWG-1 discusses cover, and this where you may address woody debris.

Maybe we need to make subtext section in CAWG-1 which more clearly identifies the subsections. More clearly organize the study.

Several people agreed that we need to more clearly explain what we are doing, better organize the study, and make sure we are addressing the stakeholder management goals and objectives.

Need to add the habitat component of woody debris in the CAWG 2 study. Other participants suggested that it should be in CAWG 1 which covers a broader area, since CAWG-2 is focused on specific areas.

Action Item: Every one agreed to Bin List this discussion, ENTRIX will more clearly explain what is being done with the woody debris study, more clearly organize the study plan, and send it out to everyone for review.

Comment was made that all measurement should be in meters. All units should be consistent. The data was collected in feet using equipment calibrated in feet.

It was suggested that we show data in the format that the data was collected then show it parenthetically in meters.

Is Study Objective #8 the same as #5? Can we just incorporate this into #5 and eliminate #8.

What type of aerial photography have we conducted or will conduct? The USFS has some aerial photos for a period over more than 20 years and longer for some areas.

The SWRCB will want new IR photos (for the record), by the same contractor that did it on the Pit River. (Resolution is a pixel to a foot). The SWRCB provided a handout on the aerial photography. This aerial photography will provide very useful information.

Would this aerial photography be in lieu of ground based reconnaissance.

It would be used as a screening tool, to focus the ground truthing.

It was recommended and agreed to by the group that we have the SWRCB bring in the technology to look at it and review.

Action Item: Establish a subgroup to review this technology and coordinate with the other working group. Review the technology, how will it streamline the process, what are the trade-offs. Identify specific contractor for this aerial photography.

It was suggested that we also determine if the USFS will be doing any fly overs of the area in the near future.

CAWG-1, Page 3.

Overall comment. Much of the work described in the study plan has already been done. However, the CAWG needs to approve the work. This study plan is written in the context of work that is proposed and then at the end plan it states that the work has already been done. This should be stated up front. This work and the results need to come back to the CAWG for approval.

CAWG 1 is the father of all CAWG study plans and is the basis for most of the subsequent CAWG studies, hence this is very important.

Habitat mapping should also reference temperature profiling in addition to geomorphic structure and sediments.

CAWG-1, Page 4.

A memorandum is cited as a reference in the 2nd full paragraph, **(Action Item)** this needs to be changed to a primary reference.

The third paragraph contains a reference to visually classified. Is this actually measured or is it physically measured? (If not physically measured, then this is not an actual Rosgen characterization.) This is intended to be a general characterization. Study plan CAWG 2 will quantify reference reaches with physically measured sediments.

CAWG-1, Page 5.

First line, canopy cover measured to 10%. It was recommended that we should go to 5% using a spherical densiometer. The USFS handed out solar pathfinder document (SCI). Much more data will be collected in much more detail.

The 2nd sentence should be changed as follows: “the amount of woody debris or the lack there of…” (Add, the lack thereof).

Spawning habitat how is it characterized in relation to sediment accumulation? We will characterize sediment accumulation and retention and what is being entrapped in the upstream systems. We will do a visual assessment of sediment and source rock. In addition, Rosgen Level 2 site assessment described in the CAWG-2 plan and will be referenced in this plan.

CAWG-1, Page 6.

First paragraph, “will be determined in the field” is this based on professional judgement, and “the likely elevation” is speculative. Are we just guessing to determine these?

This is written in a positive light, do we want to open up all stream to fish migration up streams. This is a broader study, we need a comprehensive look at the management protocol to address the species present and appropriate management practices. Not only analyze fish access but to collect data to address all resources.

CAWG-1,Page 7

The study area references Table CAWG-1-1. This table includes sites from the Portal Project and the Vermilion project, are were dealing with these sites in the ALP? These sites were put back in at the request of a stakeholder. (We will address SWRCB comment from Portal and Vermilion relicensing separately in those processes).

Are there differences in the ALP studies and the Portal and Vermilion Studies? There may be some minor differences.

In study area, where and what problem areas are there? The confluence of the North and Middle Forks San Joaquin River with the South Fork San Joaquin River have difficult access issues. We will ID specific stream reaches with these problems.

For fly over mapping in the wilderness areas are there any issues with flying in. We can land in the winter, but not in the summer.

CAWG-1, Page 8.

Holly – Table CAWG 1-1 add the year work was done for each of the entries.

CAWG-1, Page 10.

The last sentence indicates that much of this work has already been done, this should be stated early on.

Is this where we would insert assumptions, at the end of the study? We should insert assumptions where they apply.

On visual identification we assume that there will be discrepancies in the ID of cobbles and boulders and even habitat types. We need to indicate that we calibrate the data sets, and provide definitions indicating that we calibrate field teams so that everyone IDs things the same. We can add detailed descriptions and calibration data sheets in the Appendices

It was suggested that we may need more current reservoir bathemetry. We haven't identified if and when it would be done. What is the current bathemetry information? Current bathemetry is from when the reservoirs were built.

Detailed bathemetry studies may be beyond our scope. A GPS acoustic study will provide sufficient detail for water temperature for fish. Meso-habitat or micro habitat along shore lines is more of a habitat mapping issue

Would like to know when the most recent bathemetry survey were conducted. The edges of the reservoirs are the areas of issue. We will need to know the bathemetry changes due to changes in reservoir elevation levels.

Wayne – the amphibian survey study plan will likely have the level of detail that you want for the reservoir /lake margins and associated habitat issues.

Action item; Determine what bathemetry data is available.

CAWG-5   Water Temperature

Page 1. No comment

CAWG-5, Page 2.

It was suggested that we renumber the pages such as CAWG 5-1.

General Approach #6. Change so it reads as follows: "Collect sufficient temperature data to evaluate the potential for using stored water in reservoirs to modify water temperatures downstream in various water year types".

Should we add an objective to evaluate ambient air temperature effects on water temperature? This type of data is incorporated in the water temperature model.

What about solar radiation data? We are collecting solar radiation data, this data will be accounted in the model. Table CAWG 5-4 on page 11 list location where solar radiation data is being collected?

General Approach No. 8, second sentence,   should say conduct a reasonable controllable factor study (**Action Item**: SWRCB will look up language and provide appropriate language.)

CAWG-5, Page 3

The last sentence of the first paragraph indicates that we will collect sufficient data for the model whether or not modeling is needed. Reword this sentence. When rewording this be sure to include a reference to all water year types.

Action Item, We need to discuss water year types, and identify how many different water year types we need.

Define "Longer stream segment' in second sentence of General Approach to Data Collection. What is our criteria in determining a longer stream segment? Our criteria is based on the model protocols, we will cite the model protocols.

Will we need redundant temperature recorders? The CDFG has had theft problems. We will identify locations where redundant recorders are needed.

CAWG-5, Page 4

First sentence, 2^{nd} paragraph we discuss 2001 data but don't include the 2000 data, we need to include the 2000 data.

Water temperature in reservoirs should extend into November for the lower elevation reservoirs (Mammoth and Redinger).

Are there maps showing temperature recorder locations? The USFS and SWRCB requested hard copies of the maps on the wall today. **Action Item** Send a shape file of the 2000 and 2001 temperature locations to USFS and CDFG, give hard copies to the SWRCB.

CAWG-5, Page 4 and 5.

Data collected hourly data on page 4 and monthly on page 5. Hourly data is collected with a electronic data logger, and month data in-situ measurement collected by hand.

CAWG-5, Page 5.

Have we agreed on a model? First issue, do we need to model, We are proposing to use SINTEMP from the USFWS. The SWRCB is a proponent of "Heat Source" developed by the Oregon Dept. of Game and Fish. (Russ to send URL for this web-site and model).

Add Heat Source model to the references section.

Action Item: We will take a look at "Heat Source" to determine it applicability and consideration for the project.

We need the meta data for the water years to be able to model the different water year types. Is there a need to establish a subgroup to determine which model to use? Who decides if a model is needed and which model to use?

We need to evaluate each model and determine the data needs for the different models, we need the flexibility to collect the correct data.

Dale we need to make sure that the model used can be run for a range of flow releases.

Action item: We need to identify and evaluate the different models available.

CAWG-5, Page 6.

Only one year of data collection proposed for one year. Is one year of data sufficient to calibrate the model? Will more data be needed such as for a dry year and wet year? A temperature year is best. Is there an incremental benefit to collecting additional data??

We don't need to collect data from the same temperature year. We only need to determine if data needs to be collected in 2001. If additional data needs to be collected then we would add to the study plan. Add language stating that additional data will be collected if needed.

Table CAWG 5-1 Temperature recorder location, the SWRCB reserves comments on the temperature locations in the table until a map is reviewed.

CAWG- 5, Page 12.

Forth paragraph first sentence, the SWRBC does not have a criteria, **Action Item:** Russ will provide different language.

Rick – comment on 2nd to last paragraph. Why normal conditions? Should we also look at hotter years? We can also look at warmer conditions.

CAWG-5, Page 13.

First paragraph 2nd sentence, Place period after natural warming, then delete the remainder of the paragraph. The back of this paragraph text is mitigation and is not part of the study plan. Should be deleted. Everyone agreed to remove this language.

Third paragraph. CAWG will determine which model will be used. Insert text, "or other appropriate models", after SNTEMP.

CAWG-5, Page 14.

Third paragraph, again there are other paragraphs. Insert text “or other appropriate models” at the end of the forth sentence.

Last paragraph, we don’t want to limit ourselves to only fish water release intakes.

The outlet valve modification should not be limited to cold water application should also be for volume.

CAWG-4 Chemical Water Quality

CAWG-4, Page 1.

No comments

Add a management objective: “Understand project impacts on water quality”. We need to find out if there are any overflows that can provide sediment to the river.

CAWG-4, Page 2.

General Approach No. 4, 3rd sentence, “If impact is project related….”. This is decision making and should not be included in a study plan.

Global change, Inland Surface Water Plan (ISWP) to CA Toxics Rule. The ISWP was rescinded in 1994, we should be referring to the CA Toxics Rule from March of Last year promulgated by the EPA) and should also look at the National Toxics rule.

CAWG-4, Page 3.

First paragraph last two sentences, Basin plan is to bold a statement. Delete last sentence.

Comment on the Anti-degradation requirement include statement here on anti-degration requirement.

We need to add reference to sluicing, including field work monitoring of these events to assure that we do not violate standards to determine if there is an impact.

CAWG-4, Page 4.

We need to take GPS readings at the sample sites. Add a sentence to this effect in the paragraph beginning “The field investigation…”.

CAWG-4, Page 5.

Fecal coliform samples five per month in the reservoirs. We should also collect the five sample per month in streams at locations where there is increased contact recreation. Collect one sample in all streams, then collect five samples at streams with heavy contact use.

SCE does not have control over streams in these wilderness areas. Where is the project nexus? There maybe a cumulative impact effect if downstream waters become impaired due to reduce in-stream flow from SCE diversions.

CAWG-4, Page 6.

A hazardous material spills assessment will need to be completed.

CAWG-4, Page 7.

Table CAWG-4, add silver to the table.

All metals should be done as dissolved not as total, with the exception of molybdenum and boron that are measured as totals.

Mercury, (is a concern), there are new protocols to measure in mercury in sediments during a storm event. There is also a fish tissue test protocol for mercury.

CAWG-8, Page 8.

Remove section on Determination of Mitigation measures. This is a decision making item and should not be in the study plan.

CAWG-4, Page 9.

Table CWAG 4.2. A map is needed showing the location of these sample sites. Action Item Develop a map depicting the sample locations. Send the shape files to USFS and CDFG, and a hard copy to the SWRCB. We also need ground truthing knowledge from USFS people with Knowledge of these locations. We will include Portal and Vermilion sample sites in the table.

CAWG-4, Page 11.

Schedule – may not get low flow conditions in the summer

Summary of USFWS Meeting on Monday February 12th

SCE met with Ms. Jesse Wild at the USFWS. She is the designated representative from the Endangered Species Act (ESA) group. Jesse she does not have relicensing experience. Her experience is focused primarily in desert issues. Jesse will try to attend the March meetings

Maria Borja attended the beginning of the meeting, and Gary Taylor was only there for a minute. Jesse and Maria were give a description of the project and Alternative Licensing Process (ALP) process, (before Maria had to leave).

Gary Taylor is trying to hire two more people to his department. However, there is a hiring freeze due to the administration change. For know will Jesse will be the USFWS representative. She will pressure Gary to help. However, his participation will be by addressing only specific issues needing his help.

The USFWS are interested in ESA and forest species. Did they give any indication if they would require consultation for the studies? No they did not. They encourage strongly that we include forest sensitive species in a Biological Opinion. They strongly recommend it.

We can consolidate specific issues and conference call Gary at during the last 15 minutes of each meeting. We should establish a group of people to develop a list of questions for Gary which need to be answered now in the process so we know where we are going. (**Action Item**: Geoff, Wayne and Dale to craft a list of questions).

We need to identify what kind of overlay there is with Steelhead

NFMS has mandatory conditioning in the process. NMFS spoke with Jim Fargo at the FERC and Jim assured him that NMFS has mandatory conditioning authority.

Action Item: Steve Edmondson (NMFS) will try and get in contact Gary Taylor's group at the USFWS.

Meeting Closure

Scheduling

The next CAWG meeting will be on February 26th (Monday) from 9 AM to 5 PM at the ENTRIX Office in Sacramento.

Action Item – Wayne will send out a revised version of these plans reflecting comments from today.

Roger Robb requested that we also review CAWG 6 on the 26th

Rick Hopson requested that we review the sediment transport on the 26th

Agenda
Big Creek Combined Aquatic Working Group

Meeting at Courtyard by Marriott in Modesto
1720 Sisk Road, Modesto, CA
April 19, 2001, 0900-1700 hrs".

Teleconference Call-in number: 1-800-569-0883
Tell Operator: SCE Aquatic Working Group Call
Moderator: Wayne Lifton

- Review comments on revised draft study plans (we will focus on these plans)
  - Plans not completed from April 18
  - CAWG-7 Fish Populations
  - CAWG-10 Macroinvertebrates
  - CAWG-3 Instream Flow
  - CAWG-1 Habitat
- Lunch Break at Noon

Comments on the following plans will be reviewed during the afternoon following the lunch break.

  - CAWG-17 Passage
  - CAWG-15 Anadromous Fish
  - Aerial photography discussion, if material is available on time

- Future Scheduling
- Other Business/Wrap Up/Review Action Items

Big Creek Collaborative
Combined Aquatic Resources Working Group

April 19, 2001

Draft Meeting Notes

Time:	9:00 AM to 5:00 PM	**Moderator:**	Wayne Lifton
Location:	Courtyard by Marriot Modesto, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Wayne Lifton	ENTRIX, Inc.
Bill Pistor	Kearns & West
Martin Ostendorf	ENTRIX, Inc (Recorder)
Geoff Rabone	SCE
Steve Rowan	SCE
Sharon Stohrer	SWRCB
Julie Means	CDFG
Ed Bianchi	ENTRIX
Larry Lockwood	SAMs
Kevin Moody	USBR
Steve Rowan	USFS-SNF

Telephone Participants

Holly Eddinger	USFS-SNF
Phil Strand	USFS-SNF

Handouts distributed to the group during the meeting (distributed 4/18/01):

- Meeting Agenda
- Draft Meeting Minutes March 18, 2001
- Commented Detailed Study Plans, April 18 and 19, 2001

Draft Detailed Study Plan Review

The following is a review of individual detailed study plans. Note: a handout containing copies of the Draft Detailed Study Plan was distributed to the working group participants, during yesterday's meeting.

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

<u>Page 7-1</u>

Stakeholder Management Goal #2 should read, “Manage both cold water and warm water fisheries, including transitional zones and harvest vs. non-harvest species, where appropriate”.

<u>Page 7-7</u>

First partial paragraph question on sub-sample. Each sub-sample will consist of approximately 20 fish randomly drawn.

The units for data will be collected in both metric and English.

Will all fish be sampled for tissue?

Will we save fish for future studies? No we are not planning on killing any fish. We will only collect tissue samples for CDFG. We will do growth and scale analysis on the fish.

Second full paragraph first sentence, change “all non-hatchery” to “representative non-hatchery”.

<u>Page 7-8</u>

Whitewater Flow Assessment, first paragraph. The first sentence should be changed to read, “Fish sampling will be conducted on the fry of native trout, cyprinids and catostomids to assess the (negative or positive) effects of high flow releases that may be used to provide whitewater recreation”.

How do you evaluate the negative or positive effects? We will look for stranded fish and impacts to the fry population.

Whitewater Flow Assessment, second paragraph. The second sentence should read, “Three sites with substantial nursery habitat will be selected for sampling in a reach that will be subject to whitewater study flow releases”.

Whitewater flow assessment section – should we add a section on the consultation with other agencies. Is this referenced in the whitewater study and the amphibian study?

<u>Page 7-10</u>

Analysis section third paragraph, second sentence replace “specific project operations are having and effect on growth” with “differences can be observed”.

<u>Page 7-14</u>

References, update Reynolds reference.

CAWG-7 was approved by the group.

<u>CAWG-5 Water Temperature</u>

<u>Page 5-8</u>

Study Area third sentence, Insert the word proposed before the word “locations”.

Add the following sentence as the forth sentence, “The final locations to be determined by the CAWG”.

Analysis section third paragraph first sentence should read as follows, “ First we categorize the bypass reaches according to the results of water temperature monitoring into: 1) those reaches where upstream-to-downstream temperature increases appear to not be in compliance with the temperature objective of the basin plan; and 2) those reaches where upstream-to-downstream temperature increases appear to not be in compliance with water quality and temperature objective in the basin plan.

Page 5-9

Table CAWG 5-1, Adit 2, add parenthetical “(At Portal Forebay).

There is another major tributary – Willow Creek. This tributary has already been done in another study for the Big Creek No. 4 Project. We already have a calibrated model for this reach.

Add a footnote to the SJR at Horseshoe Bend reach as follows, “ Horseshoe Bend Reach from Dam 7 to Powerhouse 4 has been modeled using SNTMP and the model is available”.

Page 5-14

First full paragraph, first sentence should read, “For those reaches where temperature is observed to be above the temperature objective in the Basin Plan further analysis will take place”.

Fourth full paragraph, first sentence should read. “The third phase of this analysis involves stream temperature modeling to investigate the potential causes of warm temperature in the bypass reaches, as determined by the CAWG”. Delete the rest of the paragraph after the first sentence.

Page 5-16

Third partial paragraph, the first sentence should read, “In order to analyze the potential for water temperature control by Project reservoirs for downstream releases, the CAWG……”.

Page 5-17

First partial paragraph, add Forward Looking Infra-red (FLIR) to the list of reservoir temperature models.

Page 5-18

Coordination Needs, change from text format to a list of bullets.

Coordination Needs, add CAWG-10 Macroinvertebrates and CAWG-7 Fish Populations

General discussion on the study plan

The SWRCB reserves the right to see a map with all the temperature stations before approving the monitoring locations. The CAWG needs to meet to discuss the locations.

Update Table 5.1 Monitoring locations update.

Action Item – Complete the temperature monitoring location map.

Has last seasons (year 2000) data been complied? This data is still being processed.

Action Item – Temperature location map

Action Item – We will all be meeting on the Vermilion Project on May 8th. Lets take a hour on the 8th while we are together to review the temperature and water quality stations. Set time after the Vermilion meeting, everyone agreed that 4 PM work.

We need to have flexibility in the plan for adding stations based on data from last year.

Do we need to add another temperature monitoring location in Camp 61 Creek to determine the additional contribution of water from Adit #2 just below the confluence. Add this to the tributaries section in the table of water station locations.

CAWG-5 was approved by the group, with changes.

CAWG-10 Macroinvertebrates

A comment was made that Dr. Burke at Fresno State has done work in the Sierra National Forest. He may have some information of interest.

Are we evaluating the effects of high water spring run off or the whitewater boating study "Controlled flow releases"?

Page 10-2

Detailed Methodology second sentence, insert "ethnographic surveys" after SCE studies.

Field Data Collection, Site Selection first sentence, insert the word "help" before the word access.

Field Data Collection, Site Selection, second sentence should read, " To accomplish this objective, comparative macroinvertebrate sampling will be conducted.

Field Data Collection, Site Selection second paragraph, delete the first sentence.

Field Data Collection, Site Selection third paragraph, delete the first sentence.

Field Data Collection, Site Selection delete fourth, fifth, and sixth paragraphs.

Page 10-3

Macroinvertebrate Sample Collection, the second and third sentences should read as follows, "Either non-point source or spot sampling protocol will be used. A D-frame or other net, as approved by the CAWG, with a 0.5 mm net will be used.

Mollusk Sample Collection, first sentence replace macroinvertebrate with fish, and add "as agreed to by the CAWG'" at the end of the sentence.

How many sites will have mollusk sampling? We proposed to do one site at each macroinvertebrate sampling location. It was suggested that the site be determined by the CAWG and literature review (look for ethnography of historical occurrence).

Page 10-4

Whitewater Studies section, the first sentence should begin as follows, " Additional macroinvertebrate sampling may take place …..".

Page 10-5

Reservoirs section, add ", as feasible." to the end of the second sentence.

Laboratory procedure section first paragraph, delete the word "generally" from the first sentence.

Laboratory procedure section first paragraph add ", if possible." to the end of the sentence.

Laboratory procedure section, first paragraph forth sentence, after the word "identified" add the following text, "to the appropriate level of identification in the CSBP taxonomic effort".

Page 10-6

First full paragraph, replace the word macroinvertebrate with "fish".

Page 10-7

Coordination Needs. Change to bullet format, and add CAWG-4 Water Chemistry, and CAWG-11 Riparian.

CAWG 10 was approved with comments

CAWG-3   Instream Flow

Page 3-1

Move Stakeholder Management Goal #7 to Stakeholder Management Objective #7.

Page 3-2

First partial paragraph, third sentence change fish populations to "aquatic populations".

Page 3-5

The SWRCB wants a presentation of the transect selection methodology.

Page 3-7

HSC Selection and Verification

Add as third bullet, " If appropriate macroinvertebrate criteria are available, these will be used with the approval of the CAWG".

Would like to use other existing curves if possible. Concern was expressed about using curves from different regions of the country, we need to be cautious about the interpretation of the data and results when using these generic curves.

Add as the forth bullet, "If appropriate amphibian criteria are available, these will be used with the approval of the CAWG. In the absence of other criteria, fry criteria will be used".

Page 3-8

Third bullet change “Transect locations will” to “Transect locations may”.

Adit #2 Seepage add parenthetical (below Portal Forebay).

Page 3-12

Coordination Needs, change to bullet format, add CAWG-10 Macroinvertebrate and CAWG-8 Amphibians and Reptiles.

Do we need the Appendix. It is not part of the plan but should be included. It is subject to change. We need to check the plan for consistency and make sure the appropriate changes are made in the Appendix to assure the consistency.

CAWG-3 was approved with changes.

CAWG-1 Characterize Stream and Reservoir Habitats

The change made to this plan in the stream portion of this study reflects the data collected to date, and the reservoir section contains comments on sediments and bathemetry.

The USFS requested copies of the raw data from the studies already completed.

We need to make sure the Riparian study plan includes a GIS component.

Page 1-3

Add as last bullet of the general approach, “The CAWG will review the information collected to identify the need for any supplemental data collection”.

Page 1-9

Table CAWG 1-1, add Cold Creek and Warm Creek above Lake Edison as completed, and a partial on Boggy Meadow.

Page 1-12

Coordination Needs, change to a bullet format.

Page 1-14

Table A-1, Add culvert Additional Unit Designation.

CAWG 1 was approved with changes.

CAWG-9 Entrainment

General comments, this is one of those key studies that if you don’t have buy off on. It can be very contentious, you may have to go back and redo the studies, which may cost millions of dollars.

Page 9-1

Stakeholder Management Objective #2 should read, "Manage both cold water and warm water fisheries, including transitional zones and harvest vs. non-harvest species, where appropriate".

Page 9-6

Will Portal Forebay be included in the study area. Entrainment from the forebay will be captured at the powerhouse.

Page 9-8

Coordination Needs, change to bullet format.

We have buy in on this plan from everyone except USFWS. The USFWS has hired a new person that will start on Big Creek immediately. We need buy in from the other personnel in the USFWS also. Is NMFS involved? NMFS is involved in the anadromous fish study.

What is the sampling frequency that you we will be checking nets at the small diversion. We will sample a representative subset of small diversions, set up (see page 9-5) for about three days and nets will be checked on a 12 to 24 hour basis.

CAWG-9 was approved with changes.

CAWG-17 Fish Passage

Page 17-1

Stakeholder Management Objective #1 should read, "Manage both cold water and warm water fisheries, including transitional zones and harvest vs. non-harvest species, where appropriate".

Project Nexus, first sentence should read "In channel structures or conditions may impede the migration of aquatic life".

Page 17-2

Bullet #4, first sentence should read, " Information resulting from CAWG Study Plans 1 and 7 (Stream and reservoir Habitat Characterization and Fish Populations, respectively) will be used to evaluate if population or communities effects are observed under the current level of passage".

Add general approach #2, "If mussel pops are encountered the effect of fish passage will be evaluated on those populations as well"

Page 17-4

Strike out Adit #2 Seepage. Add footnote to table, "The Adit 8 diversion is not included because it is not an ephermal stream".

Page 17-5

Third full paragraph, the first and second sentences should read, "Data collected during the fish population and habitat mapping surveys (CAWG-7 and 1, respectively) will be considered relative to upstream and downstream potential fish passage barriers. Comparisons of populations and available aquatic habitat could determine if fish passage barriers are likely affecting the viability of fish populations".

Page 17-6

Coordination Need, change to bullet format, and include CAWG-10 Macroinvertebrates.

CAWG-17 was approved with changes.

CAWG-4 Chemical Water Quality

Rick Hopson (USFS-SNF) provided written comments prior to today's meeting.

> Page 4-3, Existing Water Quality Standards 2nd paragraph, last sentence. The lower numeric objective should state: "The most stringent objective….because the lowest standard is not always the most desirable".
>
> Page4-4, 1st partial paragraph. The new statement "reservoir and small impoundment sampling described in the next section will serve as upstream samples water quality samples". I disagree, we should collect the upstream water quality samples separate for the impoundment sample.
>
> Page 4-4, 1st complete paragraph, 2nd sentence beginning with, "For moderate diversion dams….." Same comment as above.
>
> Page 4-6, 1st paragraph under "Characterization of Sediment & Contaminant Sources". The addition, 3rd sentence, "SCE's hazardous material spill record…." If so, please state as such. The sentence has been changed to indicate the hazardous materials spill record.
>
> Page 4-8, under study area, add to the end, "Site specific water quality sampling locations will be identified and approved by the CAWG".
>
> Page 4-9, Table CAWG 4-2. Why do camp 61 Creek and Adit 8 Creek have 0 samples? Because they are not part of the ALP? If so, consider removing from the Table or adding all other water quality monitoring site within study plans for the non-ALP projects.

Comments received and edits made during the meeting.

Page 4-1

Stake Holder Management Objective # 7. Should read, " Understand potential Project impacts of Project maintenance and operations on chemical water quality".

Study Objective #1, DO should be spelled out, "Dissolved Oxygen"

Page 4-4

First partial paragraph, strikeout, delete the following sentences, "~~These samples will be collected immediately upstream and down stream of those structures. Reservoir and small impoundment sampling described in the next section will serve as upstream water quality samples.~~"

Second full paragraph, first sentence insert the word " , impoundment's" following bypassed reaches.

Second full paragraph, delete all text after the first sentence through the sentence beginning with, "Within the reach, …".and replace the deleted text with the following text.

"Samples will be taken as follows:

- for small diversions samples will be collected upstream of the diversion;
- for moderate diversions samples will be collected in the diversion pool and up stream of it's influence;
- for reservoirs samples will be collected in the reservoir and the small streams above the influence of the reservoir

Second full paragraph, last sentence, change "samples" to additional samples".

Third full paragraph, second paragraph, add pH to the list of in-situ measurements.

Third full paragraph, insert the following sentence following the second sentence. "A water depth will be measured at the stations".

Third full paragraph, second to last sentence, reference to watercraft should be changed to motorize watercraft.

<u>Page 4-5</u>

First full paragraph, second sentence change "polls" to "pools"

First full paragraph, fifth sentence should read, "Mammoth Pool has a drop of approximately 330 feet.

First full paragraph, last sentence delete parenthetical "(federal water quality standard)".

<u>Page 4-6</u>

First full paragraph should read as follows: "For all reservoir site samples fecal coliform sampling will be conducted as described in the basin plan and shall be collected at near shore areas. The fall sampling shall be conducted in the 30-day period including Labor Day."

Second full paragraph, there is reference stating that water quality parameters will be measured at 5-meter intervals. This should be changed to 3-meter intervals.

Second full paragraph, insert the following text as the last sentence, " Sampling of fish tissue for mercury and silver will be conducted in Mammoth Pool using non-hatchery harvest species after consultation with OEHA.

Last partial paragraph, insert "sluicing activities," after "storage areas".

<u>Page 4-7</u>

First paragraph second sentence SCE's spill record should be "SCE's hazardous materials spill record".

First paragraph, delete last sentence which begins with "Monitoring of the Bear Creek….".

Study Area section, add the following sentence to the end of the paragraph, "Site specific water quality sampling locations and numbers will be identified and approved by the CAWG".

Analysis section, first sentence delete the word “reservoir”, and add “,where appropriate” to the end of the sentence.

Project Effects on Water Quality section, the first sentence should now read as follows:

> The data collected in the previous tasks will be used to:
> 1) assess sediment and water quality in the project area;
> 2) identify project operations and maintenance activities that may effect water quality; and
> 3) identify how project operations influence the bioaccumulation of mercury and silver.

Project Effects on Water Quality section, delete the two following sentences that begin with “The analysis will identify….” and “The specific Project effect will be determined”.

Comment was made that sediment analysis for mercury and silver should be done before the Bear Creek sluicing event is performed.

<u>Page 4-8 Table 4-1</u>

Include dissolved metals analysis for all metals except for molybdenum

Add pH analysis.

<u>Page 4-9 Table 4-2</u>

Large Dams – Add Mono Creek below Vemilion

Moderately-sized Diversions - Add Balsam Forebay, and Portal Forebay

Small Diversions – Add Warm Creek, Upper Mono Creek, Cold Creek, and Adit 2.

Flow Augmented Streams – Add Boggy Meadow.

Footnote streams that are associated with project that are following the Traditional Licensing Process

Footnote – Stream or creeks that are ephemeral.

Change column heading from “Number of Sample Locations” to “Proposed Sample Locations”

Action Item: There will be a meeting in May 8 at the ENTRIX Sacramento Office at 4 PM to discuss water quality sampling sites and temperature monitoring locations. Before this meeting SCE will post a map of the sample and monitoring locations on the SCE Hydro web page.

CAWG 4 was approved with changes

<u>CAWG-15 Anadromous Fish.</u>

Change title to Salmonids

Page 15-2

The ending of the first partial paragraph should read, The operation of Friant Dam at Millerton Lake affects the availability and quality of water to the San Joaquin River. Federal agencies and their partners are currently studying the feasibility of restoring fall run Chinook, spring run Chinook, and steelhead.

Page 15-4

Coordination Needs change to a bullet format.

General discussion

CDFG is circulating this study plan through their department and compiling comment. They are not ready to approve the study plan

This plan was not approved by the CAWG and is pending additional comments.

Bin Item/Action Item: 1) Get additional comment from CDFG and NMFS. 2) CAWG Approval

General Comment of Process

Approved study plans fall in to the approved category with those plans from the other group. The approved plans will go to the plenary and public for review. However, we need to get everyone's input on approving the Stakeholder Management Goals and Objectives to go into the study package.

There will be a 30 day comment period after the plans are be sent out.. And a public meeting will be held half way through the 30 study plan comment period. We need to issue a 15 day public notice for the public meeting this will dictate when the meeting will be held because this notice will be sent when the plans are sent out.

Bin List Items

CAWG-2

- Obtain comments from everyone.
- ENTRIX will re-write plan with geomorphologist review.
- Set up teleconference call for subgroup review, (Ed, Russ, Julie T., Sharon, Julie M., Kevin, Dan and Wayne)
- Obtain final CAWG approval

CAWG 15

- Obtain review comments from NMFS and CDFG and edit plan accordingly.
- Email back to group for review.
- Obtain final CAWG approval.

Water temperature monitoring locations and water quality sampling location need to be determined by the CAWG. A map will be provided which depicts the locations. The group will reconvene on May 8th in Sacramento to review monitoring and sampling location.

Action Items

New Stakeholder Management Goals and Objectives from USFS must be incorporated into the study plans.

Bear Creek Sluicing Effort should not be part of the study plans and coordinated with the agencies under a separate effort.

Provide raw water temperature monitoring data from 2000 studies to the USFS once it has been reviewed.

Ward tunnel bedrock fractures, groundwater and riparian area relationship. (Subgroup to review Jerry De Graff, Dan, Janelle, Julie M., Rick, and Julie T.)

Review Land Management Volcanic and Seismic Study, and provide comments to Brenda Peters if any.

Temperature Monitoring Stations/Water Quality Sampling Location Map to be completed and sent to the group for review.

Provide reference document mollusk sampling to Kevin.

Big Creek Collaborative
Combined Aquatic Working Group

January 9, 2002

Draft Meeting Notes

Time:	10:00 – 1:00 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn Fresno, CA	**Coordinator**:	Wayne Lifton
Teleconference No.:	1-800-556-04976	**Recorder**:	Martin Ostendorf
Teleconference Name:	Combined Aquatic Working Group		

Attended By:	Ed Bianchi	ENTRIX
	Jim Canaday	SWRCB
	Jen Carville	Friends of the River
	Carson Cox	SWRCB
	Jim Fargo	FERC
	Bryan Harland	Kearns and West
	Rick Hopson	USFS-SNF
	Wayne Lifton	ENTRIX
	Larry Lockwood	HLA
	Julie Means	CDFG
	Janelle Nolan-Summers	ENTRIX
	Martin Ostendorf	ENTRIX
	Geoff Rabone	SCE
	Steve Rowan	SCE
	Lonnie Schardt	HLA
	Phil Strand	USFS-SNF
	Wayne Thompson	Fresno Flyfishers
Phone Participants:	Julie Tupper	USFS-RHAT
	Brit Fecko	SWRCB
	Chuck Bonham	Trout Unlimited

<u>Introductions and Review Agenda</u>

The following Handouts were provided to the group:

- January 9, 2002 Meeting Agenda
- Draft Meeting Notes, September 25, 2001
- 2002 Study Plan Implementation Preliminary Schedule-Amphibians and Reptiles, and Riparian Study Plans
- Three publications (papers) on food transport

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

The key agenda topics are:

Review and approve meeting notes
Review 2001 field work activities
Schedule 2002 and 2003 activities

No comments on the agenda.

Review September 25, 2001 Draft Meeting Minutes

Will review at the end of the meeting.

Review of 2001 Field Activities

The presentation slides are included in Handout A. The following minutes summarize these presentation slides and the discussion that occurred.

Habitat Mapping

Habitat mapping has been completed most of the system with exceptions of certain sections of the SJR/SFSJR, (area near the confluence of the Middle Fork). We will try to catch these areas using aerial photographs and some ground truthing. We also have completed most of the bypass reaches and upstream of the small diversions. These areas were mapped with hip chains (CAWG-1).

A question was asked that if have 95% of everything mapped, can we statistically interpret the remaining areas to be mapped based on the existing mapping? We will look at the aerial photography and some ground truthing to determine if we can do this. If the channels are similar we may be able to do this, but we will need to bring it back to the CAWG for approval.

Temperature Monitoring

The temperature monitoring was completed in 2001.

Was there any data loss? We had some data loss but we had redundant probes at many locations and we had field crews people visiting the probes often. Any probes that were discovered missing were quickly replaced and a redundant probe was installed. The data collected in 2001 is a follow up to the temperature data that was collected in 2000.

There are some locations where we are collecting winter water temperatures. There are also some locations where water temperature probes are recording winter/spring water temperatures in support of the amphibians study.

Instream flow

We selected transects at upper basin locations. We selected transects in Bear Creek for IFIM PHABSIM studies. Transects for wetted perimeter studies were also selected in the tributaries in the upper basin (locations east of Kaiser Pass).

Amphibians and Reptiles
Did the habitat mapping for amphibian and reptiles include helicopter reconnaissance and groundtruthing? Yes.

Was the stream gradient determined by Rosgen level 1 or level 2? There is a real difference between level 1 and level 2. Valley slope was used for gradient in Rosgen Level 1, but gradient measurements were collected for most individual mesohabitat units in the field.

Water temperature probes also have been installed at select locations to record over-winter water temperatures for foothill yellow-legged frogs. Sites were selected in coordination with USFS and CDFG.

An example (poster) of the false-color infrared aerial photography was posted on the wall for review by the group. The vegetation communities were mapped on the aerial photograph. Differences can be clearly seen between habitat types. Plant species that hold more water tend to show up red on the color infrared photographs (ie. meadows, riparian). The interpretation was good and very clear.

We will be able to identify the elevation ranges of the Project and the type of vegetation communities that are present.

Will the aerial photography and habitat mapping be available on the web site? Due to storage limitations, it is not feasible to put all of this information the web. We are currently trying to determine a feasible way to disseminate this information. A copy could be placed in a central location such as Big Creek or Sacramento. Or onto CDs however, it would require as many as 40 CDs. It is a very large amount of data. Maybe we need to determine exactly which people will really need access to it.

We are looking at completing all of the lower elevation mapping by February, we need to select transects for focused surveys in March. In 2002 we will collect much more detailed information at the riparian sampling and reference sites. This will include proper functioning condition (PFC) and much more, as detailed in the study plan.

Riparian

We mapped riparian areas from the aerial photography. The mapping was verified by aerial reconnaissance (i.e. helicopter survey) ground-truthing.

2002 Field Activities

The presentation summarized the activities that will be preformed in 2002. The following summarizes the bullets provided in the presentation slides.

Amphibians and Reptiles

- Select amphibian and reptile survey sampling sites
- Select appropriate survey protocols
- Conduct surveys Western Pond Turtle, Foothill Yellow-legged Frog, Mountain Yellow-legged Frog, and Yosemite Toad studies
- Complete California red-legged frog site assessment

The USFS is getting direction on the relictual salamander. Will this species be in or out? The SNF is trying to get clearer direction from the regional office in writing.

Riparian 2002

- Select sampling sites
- Conduct PFC
- Collect quantitative data.

The group was provided with a handout that identifies a preliminary implementation schedule for the Amphibian and Reptiles, and Riparian studies (Handout B). Some amphibian and reptile surveys are time sensitive, the preliminary schedule shows time periods when we need to do the specific surveys, by species.

Has a subgroup been established for the selection of amphibian and reptile focused survey sites, and for the selection of riparian study sites?

Amphibian and Reptile subgroup: Phil Strand, Holly Eddinger, Julie Means, Geoff Rabone, Carson Cox, and USFWS Participant.

Riparian subgroup: Rick Hopson, Carson Cox, Geoff Rabone, Steve Rowan, and USFWS participant.

Action Item No. 1: Develop and email out schedule for subgroup meetings and the next CAWG meeting in February.

What is the status of USFWS participation? They have been participating in the process. We are currently in the consultation process for IFIM, whitewater, and cultural studies. We want them to participate in the subgroup meetings for site selection. Our goal is to have them at all the working group and subgroup meetings.

Maria B. is no longer the lead contact on ESA. We are not sure who will be taking Maria's place. However, we will continue to maintain contact with the USFWS through Jesse Wild.

Habitat

- Map the areas with restricted/difficult access
- Map the habitat at the Project reservoirs

Instream Flow

- Review existing PHABSIM models
- Conduct studies to collected data from transect sites selected last fall
- Select additional transect sites for study

Previous models have been run at locations in the basin. Can we use those transect locations? We will use them where possible. However, we may need to redo some of the previous if they do not meet the criteria identified in CAWG-3. Before we would use transects from previous studies; we will make recommendations to the CAWG. The CAWG would then decide if these transects can be used.

We will have to look at the previous models and evaluate if they can be used again. We will need to look at the data, determine if we can find the former transect location, and we will need to determine if we have the PHABSIM deck and if they are complete. This process is described in the CAWG-3 study plan.

Based on the current water year type we will likely not be able to do transect selection until August or September. **Action Item No. 2**: We will send out a proposed schedule in the next couple of weeks and finalize the schedule at the February meeting.

Geomorphology

- Review existing information
- Conduct qualitative reconnaissance
- Select sites for qualitative evaluations
- We will develop a geomorphology subcommittee for transect selection

Temperature CAWG-5

- Review existing models
- Review scientific literature on temperature criteria
- Select bypass reaches for modeling
- Ground-truth stream structure data for use in the model
- Model the selected bypass reaches.

The temperature models will have to fit in with the beneficial use criteria established by the SWRCB for cold water fish. There are some new technical reports out from the EPA Region 10. The SWRCB has copies of this report, which we may copy for reference.

Chemical Water Quality

- Review existing information
- Collect the data, sample collection and analysis

Hydrology

Evaluate existing data
Estimation of unimpaired flow
Application of IHA to analyze flows

When will the estimation of unimpaired flows happen? We will provide products for the CAWG's review throughout the year. The methods that we will use will be presented to the group prior to the performing the analysis and developing products.

Fisheries

- Survey the bypass reaches and reservoirs (Electroshocking and snorkeling surveys)

Will we do night snorkeling? Studies at Mono Lake streams have discovered larger fish at night. A paper on this study will be coming out this spring. **Action Item No. 3**: Get a copy of the Mono Lake stream night snorkeling survey.

What was the outcome of the electroshocking consultation with USFWS? We submitted a letter to the USFWS describing the protocols, which they approved. We can proceed as described in accordance with these protocols:
(1) If we are we in area of amphibian concern we are to survey the site before sampling;
(2) If listed or candidate amphibians are present, we should try to move the site;
(3) If we do not see amphibians we can proceed, however, we must disinfect the equipment to eliminate fungal spores;
(4) If we collect an amphibian then we are to hold it and release it after the fieldwork.

Entrainment

- Evaluate intake designs
- Monitor tailraces
- Conduct hydroacoustic fish abundance surveys near intakes

Macroinvertebrates

- CA Bioassessment protocol studies in August and September
- Conduct mollusk surveys in conjunction with fish surveys
- Crayfish in conjunction with fish surveys in Mammoth Pool and Shaver Lake

Anadramous fish

- Review available information
- ID initiatives in the watershed

Water Use

- Review existing information
- Evaluate water rights and conditions

2003 Activities

Geomorphology

- Conduct qualitative surveys

Instream Flow

- Collect and analyze data at transects selected in 2002
- Prepare models to evaluate alternative flows
- Evaluate stranding

Entrainment

- Evaluate entrainment at representative small diversions

Anadramous fish

- Evaluate proposed operation changes
- Evaluate PM&Es

Water USe

- Evaluate PM&E's

Fish Passage

- Evaluate potential barriers to fish passage

Activities Schedule Summary

We will provide schedule for review and development.

Discussion

How will the cumulative Impacts analysis be completed. These will be coordinated in the Land Group. However, the individual working group will analyze their effects. The land group will coordinate with the other groups

During the transect selection filed trip last fall a recommendation was made that wetted perimeter not be used in some locations without riffles, instead we could evaluate the water velocity in pools to move food. Three publication handouts on this subject were provided to the group. The CAWG can review this issue after everyone has had time to look at the information.

One of the issues in the forefront, is the effect of recreation flows on aquatic communities including macroinvertebrates. The SWRCB is negotiating with a group for funding to do a study this summer on this issue for macroinvertebrates. Some time in the late summer is when it would occur. The SWRCB will be looking for candidate sites to do this study. We may want to consider the Big Creek area. We should think about this collectively as a group. We need to evaluate the effect of manufactured flows for recreation on macroinvertebrates. This is an opportunity that maybe used in this project.

In the recreation group we are preparing a letter to send to the USFWS regarding the single flow studies during the runoff period. A second letter will be sent to the USFWS on the controlled flow study. The USFWS was very adamant against out of season controlled flow release based on their interpretation of the Sierra Framework. The USFS and the SWRCB will consult with the USFWS, as needed.

Review Minutes from the September 25, 2001 Meeting

Clarification on the FYLF in Crane Valley. This sighting has not been confirmed.

Was some of the aerial photography flown after September 11th? Yes some of it was, we would have to look at the individual tiles to get the flight dates. **Action Item No. 4**: Compile this metadata (date and time) on these aerial tiles and develop a table on this data.

Review action Items from the last meeting.

Has the USFS found out about releasing the most recent version of the SCI protocol? The USFS will look into it.

We are currently compiling a table of all the action items and identifying the responsible party and status.

A recommendation was made that at the beginning of each meeting we review the action items from the previous meeting.

Are the meeting minutes from the meeting between USFWS and SCE available? They are being reviewed by the USFWS and will be sent to the group once approved.

Is Tombstone Creek in the project area? SCE will have to check to see if the USFS has responded to SCE on this issue.

Also will Slide Creek be kept as part of the Project? SCE is doing an economic analysis to determine it can be put back into service. We have to see what happens in relicensing.

Meeting notes approved

Review Action Items

Action Item No. 1: Develop and email out schedule for subgroup meetings and the next CAWG meeting in February.

Action Item No. 2: Send out a proposed schedule for fall 2002 IFIM transect selection sometime in the next couple of weeks and finalize the schedule at the February meeting.

Action Item No. 3: Get a copy of the Mono Lake night snorkeling survey.

Action Item No. 4: Compile metadata (date and time) for the aerial photography tiles and develop a table on this data.

Adjourn meeting.

Handout A

Slide Presentation CAWG January 9, 2002 Meeting

Handout B

2002 Study Plan Implementation Preliminary Schedule for Amphibians and Reptiles, and Riparian Study Plans

Handout C

Publications on food transport

1. Invertebrate Drift and Longitudinal Transport Processes in Streams
2. Food Transport, American Fisheries Society
3. Energetic Factors Influencing Foraging Tactics of Juvenile, Steelhead Trout

APPENDIX E

Reach Mesohabitat Typing Completed from Aerial Photography

Table CAWG 1 Appendix E-1. Big Creek ALP Reaches Supplemented with Aerial Photography and Visual Habitat Mapping.

Basin	Stream	Location on Reach	Rosgen Level I Channel Type	Length of Reach
South Fork San Joaquin River Reach	South Fork San Joaquin River	Downstream of Hoffman Creek to the SJR/SFSJR Confluence	Primarily G	6.4 river miles
Mammoth Reach	Rock Creek	Waterfalls and Cascades Downstream of the Diversion	Aa+	1,000 feet
Big Creek Reach	Big Creek	Waterfalls and Cascades Between Dam 1 and Powerhouse 1	Aa+	6,610 feet
Stevenson Reach	Stevenson Creek	Waterfalls and Cascades Immediately upstream of the San Joaquin River	Aa+	3,326 feet

