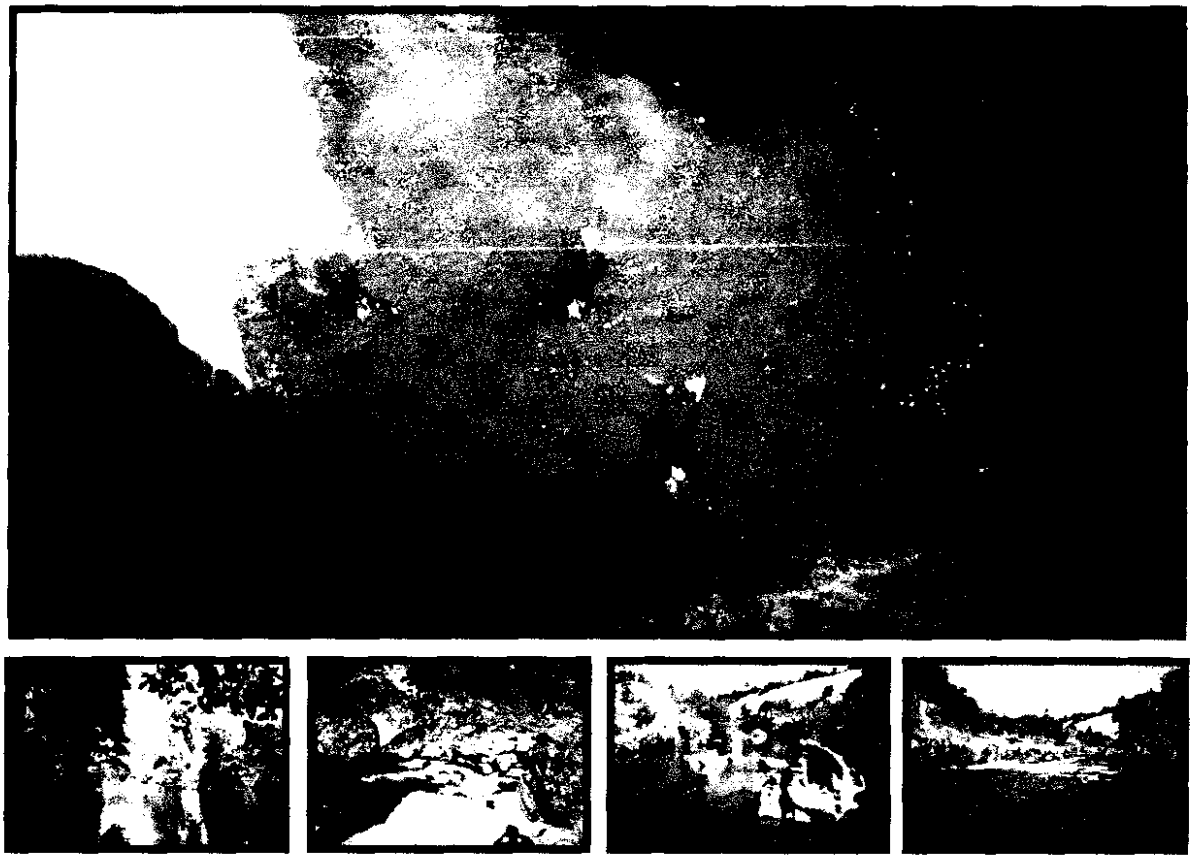
Upper Russian River
Steelhead Distribution Study



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UPPER RUSSIAN RIVER
STEELHEAD DISTRIBUTION STUDY

INTRODUCTION

The purpose of the Upper Russian River Steelhead Distribution Study is to evaluate the distribution of steelhead (*Oncorhynchus mykiss*) during summer conditions and assess habitat along the Russian River. Rearing habitat for steelhead may be limited in the river during summer when flows are lowest and water temperatures are highest. This study was a component of the Fisheries Enhancement Program (FEP) implemented by the Sonoma County Water Agency. The goal of the FEP is to improve native fish resources of the Russian River basin.

The distribution of rearing steelhead in the Russian River during the summer is affected by habitat conditions. Water quality is an important factor in the growth and survival of steelhead. Steelhead require streams with cold, clear water. Flow rates influence habitat features such as water temperature, flow velocities, and water depth. Russian River summer flows are supplemented by dam releases at Coyote Dam (Lake Mendocino) located on the East Fork of the Russian River near Ukiah and Warm Springs Dam (Lake Sonoma) located on Dry Creek west of Healdsburg.

In summer and fall 2001 a flow-related habitat study was conducted in collaboration with several entities, including U.S. Army Corps of Engineers, National Marine Fisheries Service, California Department of Fish and Game, North Coast Regional Water Quality Control Board, Sonoma County Water Agency, and Entrix. The study evaluated habitat value for steelhead along the Russian River and Dry Creek at a range of water release rates from Coyote and Warm Springs dams. Observations made during the flow study indicated that potential spawning and summer rearing habitat for steelhead was present in the upper main stem of the Russian River. The Steelhead Distribution Study was developed to further determine the extent of potential rearing habitat. The objectives of the study were to

- determine the summer distribution of steelhead and rearing habitat,
- compare the relative abundances of steelhead and habitats, and
- develop a photograph library of habitats along the Russian River.

The study area extended 106 km along the Russian River from Ukiah to Healdsburg. Dive surveys were conducted to count fish at randomly selected river segments. Also, habitat characteristics were recorded and photographs taken at all survey sites.

METHODS

Sampling Design

The survey design for the Steelhead Distribution Study was based on underwater visual observations of fish during dive (snorkel) surveys within selected segments of the Russian River. The study was conducted on the upper Russian River from the confluence of the East and West forks of the Russian River near Ukiah to the confluence with Dry Creek near Healdsburg. The river was divided into 4 reaches based on gradient and surrounding topography, including Ukiah,

Canyon, Alexander Valley, and Healdsburg reaches. Between 5 and 12 sample segments of approximately 0.5 km in length were randomly selected within each reach. A total of 37 segments were sampled, which equals approximately 17.5% of the upper Russian River. Dive surveys were conducted in the summer from July 31 through September 19, 2002, typically a time of year when flows are at low levels and temperatures are relatively high.

The purpose of this study is to determine the relative abundance and distribution of steelhead, and is not intended to generate population estimates. Dive count surveys are most useful in determining the relative abundances of fish but are limited in determining the true fish population. Numerous factors, such as water clarity, water depth, water velocity, water temperature, fish size, fish behavior, and sampling methods will affect the ratio of the fish observed to the true population. Comparisons of fish counts between sites are appropriate only when the factors that cause variation are similar. Comparisons of fish counts were restricted to segments within reaches and combined segment data among reaches.

Habitat Assessment

River sample segments were classified into 4 habitat types: deep pool, flatwater, riffle, and cascade. These habitat categories were modified from California Department of Fish and Game habitat types (Flosi et al. 1998). Habitat descriptions are as follows:

> *Deep Pools*: Deep pools are characterized by areas of still or slow moving water with a highly pronounced scour channel or pocket. Deep pools were greater than two meters in depth.
>
> *Flatwater*: Flatwater is characterized by consistent water depths and even or gradually changing velocities of low to moderate speeds. Also, some shallow pools or lateral trenches were included in flatwater. Surface character ranged from smooth to choppy with few standing waves. Unlike riffles, flatwater generally lacked whitewater and extensive waves.
>
> *Riffles*: Riffles were habitats of increased gradient with considerable surface turbulence, much of which could be whitewater. Surface turbulence was typically maintained by irregular substrate, such as boulders or angular bedrock, or and abrupt change in gradient. Riffles were relatively shallow with an even depth profile.
>
> *Cascade:* Cascades are steep gradient, narrow streams with step-pools connected by small waterfalls and fast-moving shoots. Water turbulence is mostly whitewater. Because of the high-energy flows, the substrate is predominantly boulders and bedrock.

Habitat characteristics of each survey segment were recorded in the field. Segments were marked with flagging and delineated on aerial photographs. Habitat percent cover was visually approximated in the field with the aid of aerial photographs. Prominent habitat features (e.g., large woody debris, scour pools, undercut banks, overhanging vegetation) were noted and used to qualitatively describe habitats within segments. Bottom water temperatures were taken at each segment during the afternoon when daily temperatures are generally highest. Water temperatures

were compared with permanent temperature stations located within reaches using weekly average and weekly maximum temperatures. Weekly average temperature is the 7-day average of the average daily temperature and weekly maximum is the 7-day average of the daily maximum temperatures. Also, each habitat unit was photographed and coordinates recorded using a global positioning system (GPS). A Photograph Library of river habitats and observed fish is included in the Appendix.

Visual Underwater Fish Counts

Crews of three biologists were used to conduct visual underwater dive surveys. Survey sites were accessed by walking along stream banks or by kayak. Kayaks were typically moored downstream of the sample segment. Each diver was equipped with a mask, snorkel, swim fins, and wetsuit (see Appendix for photographs of divers). Also, each diver was equipped with an arm cuff and pencil to tally fish.

The upper and lower boundaries and dive lanes of a segment were determined before divers entered the water. The segment was partitioned into parallel dive lanes running along the stream length. Partitioning reduced the possibility of duplicating or missing fish observations between divers and improved confidence in each diver's count. Typically, 2 divers would survey along the banks and 1 diver would survey the mid-stream lane. Segments having non-parallel streambanks were accommodated by constricting or expanding lane widths. In broad sections of the river were the mid-stream lane was disproportionately wide the diver would survey in an "S" pattern.

To conduct visual underwater surveys divers entered the water at the downstream boundary, moved to a lane, and proceeded upstream. Divers counted fish observed to pass downstream within their lanes and maintained visual contact with adjacent diver(s) to minimize multiple counting of the same fish. The ability to see underwater was monitored during dive counts by estimating water visibility at each dive site. Typically, minimum visibility was at least 1-2 m and often >3 m.

All fish observed during surveys were identified to species when feasible. The Appendix includes photographs of fish. Several minnow species have similar diagnostic features and can be difficult to identify when young. California roach (*Hesperoleucus symmetricus*), pikeminnow (Sacramento squawfish, *Ptychocheilus grandis*), carp (*Cyprinus carpio*), and hardhead (*Mylopharodon conocephalus*) are common fish in the minnow family (Cyprinidae) and were identified to family when species identity was not possible. Each diver recorded the number of observed fish and size class during the survey. At the end of a survey fish data from all divers were recorded on a data form for each segment.

Divers calibrated 3 fish size classes (i.e., <100 mm, 101-300 mm, and >300 mm) by viewing fish silhouettes prior to surveying a segment. Age analysis of steelhead scale annuli (i.e., scale growth rings) captured in the Russian River watershed indicated a direct correlation between fish size and age (Cook and Manning 2002). In general, steelhead size indicated that fish <100 mm in length correspond to young-of-the-year fish, fish 101-300 mm in length are >1 year old (i.e., 1+), and fish greater than 300 mm in length are >2 years old (i.e., 2+).

RESULTS AND DISCUSSION

Steelhead Distribution and Habitat

Steelhead were observed in all 4 study reaches; however, their distribution and numbers varied substantially (Figure 1). A total of 1,436 steelhead were observed in the 37 sample segments. Each segment was approximately 0.5 km in stream length. Steelhead were found in the upper portion of the Ukiah reach, throughout most the Canyon reach, and infrequently in the Alexander Valley and Healdsburg reaches. The fish composition of the study reaches included 12 native and non-native fish species. Steelhead composed <1% to 5% of the counted fish (Figure 2). The largest numbers of steelhead were observed in the Canyon reach at 265 steelhead/km followed by the Ukiah reach at 37 steelhead/km (Figure 3). The Alexander Valley and Healdsburg reaches had relatively few steelhead observations at <1 and 7 steelhead/km, respectively. Fish numbers were determined by visually counting fish during dive surveys and are not population estimates.

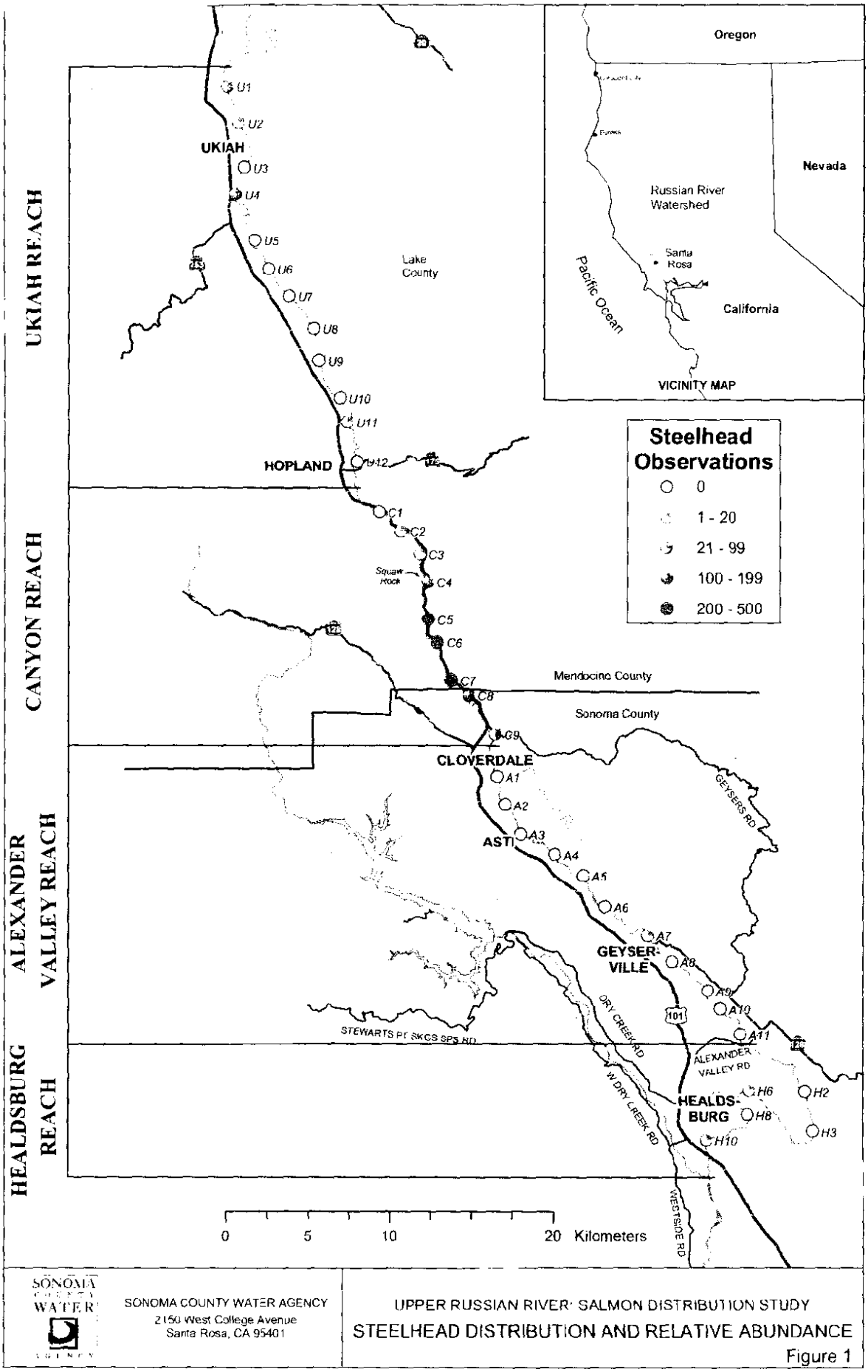
Most of the habitats within reaches were composed of flatwater with relatively low frequencies of cascade, riffle, and deep pool habitats (Figure 2). Also, the Appendix includes photographs that characterize the habitat with each reach. Dive observations indicated that steelhead were almost exclusively found in riffle and cascade habitats, and flatwater and deep pool habitats were seldom utilized. Riffle and cascade habitats occur in moderate to high gradient stream sections and were most frequently found in the Canyon reach with an average slope of 0.0026% (Figure 4). In comparison, the Ukiah, Alexander Valley, and Healdsburg reaches had average gradients approximately half of the Canyon reach and ranged from a slope of 0.0012% to 0.0014%.

Water Temperature

Water temperature can affect the growth rate and survival of steelhead. Exposure to short duration of high temperatures can cause mortality and long-term exposure to elevated temperatures can retard growth. Dive surveys were conducted in late summer when annual temperatures and potential stress on steelhead were highest. Sullivan et al. (2000) reviewed several studies mainly from Oregon and Washington on the affects of temperature on salmonids, including steelhead. In general, suitable temperatures for young steelhead in freshwater habitats range from 12°C to 20.5°C. Temperatures from 20.5°C to 23.5°C may result in behavioral changes (e.g., reduced activity and feeding) and restrict growth. Prolonged exposure to temperatures from 23.5°C to 26.5°C can cause mortality and temperatures above 26.5°C result in rapid death. However, the Russian River is located in the southern range of the species where regional temperatures are relatively high and the temperature tolerance of steelhead may be higher than northern populations. For example, juvenile steelhead in the Eel River, located north of the Russian River, have been observed feeding in surface waters with temperatures up to 24.0°C (Nielsen et al. 1994).

Maximum water temperatures of study reaches generally increased with distance downstream and had similar patterns in temperature fluctuations. Figure 5 shows the weekly maximum temperatures for the 4 reaches. Temperature trends among reaches showed a convergence over the duration of the study with in broader range of temperatures in mid-summer than observed in late summer.

Temperature data collected during dive surveys were comparable to permanent temperature stations located in the study reaches. In general, water temperatures at survey segments were



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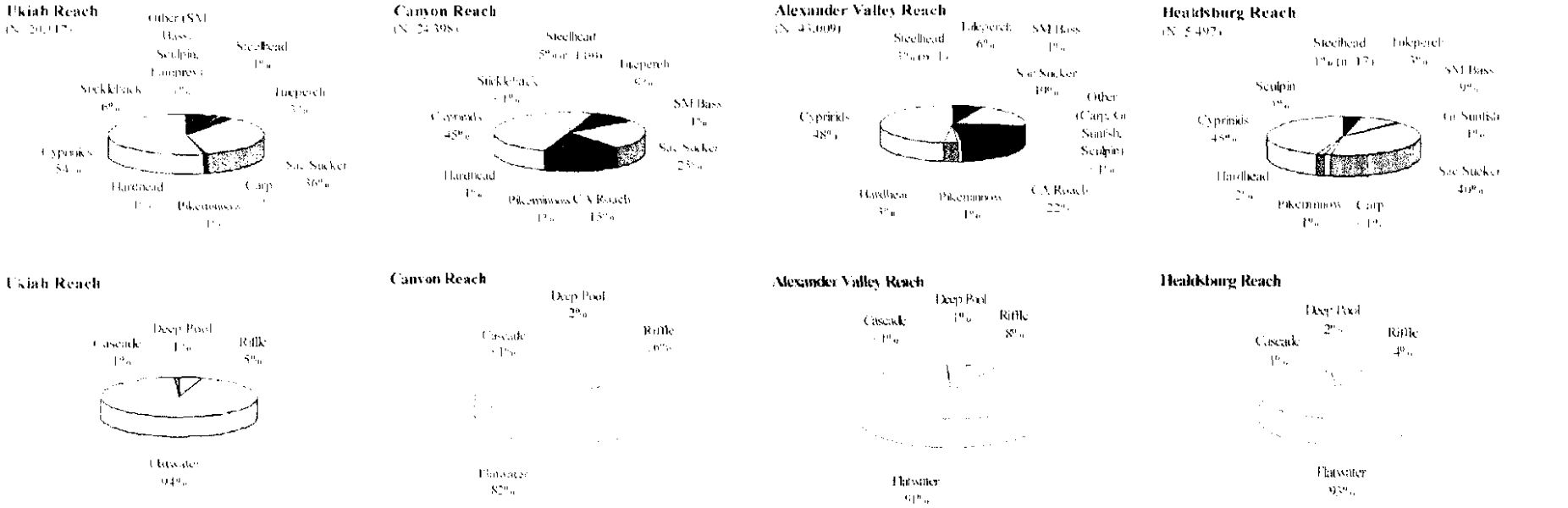
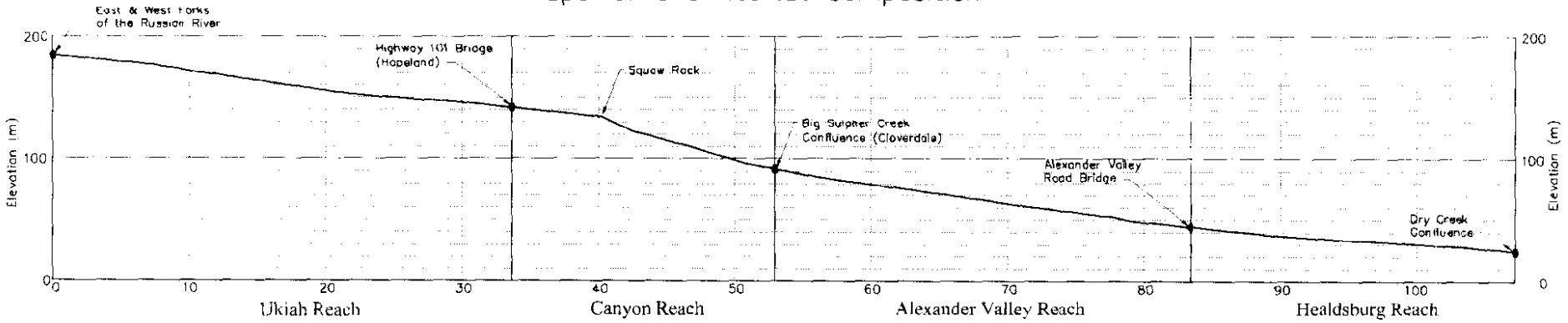
UPPER RUSSIAN RIVER SALMON DISTRIBUTION STUDY

STEELHEAD DISTRIBUTION AND RELATIVE ABUNDANCE

Figure 1



Species and Habitat Composition



LONGITUDINAL PROFILE (km)

SONOMA WATER

UPPER RUSSIAN RIVER, SALMONID DISTRIBUTION STUDY
SPECIES COMPOSITION AND HABITAT CHARACTERISTICS

FIGURE 2

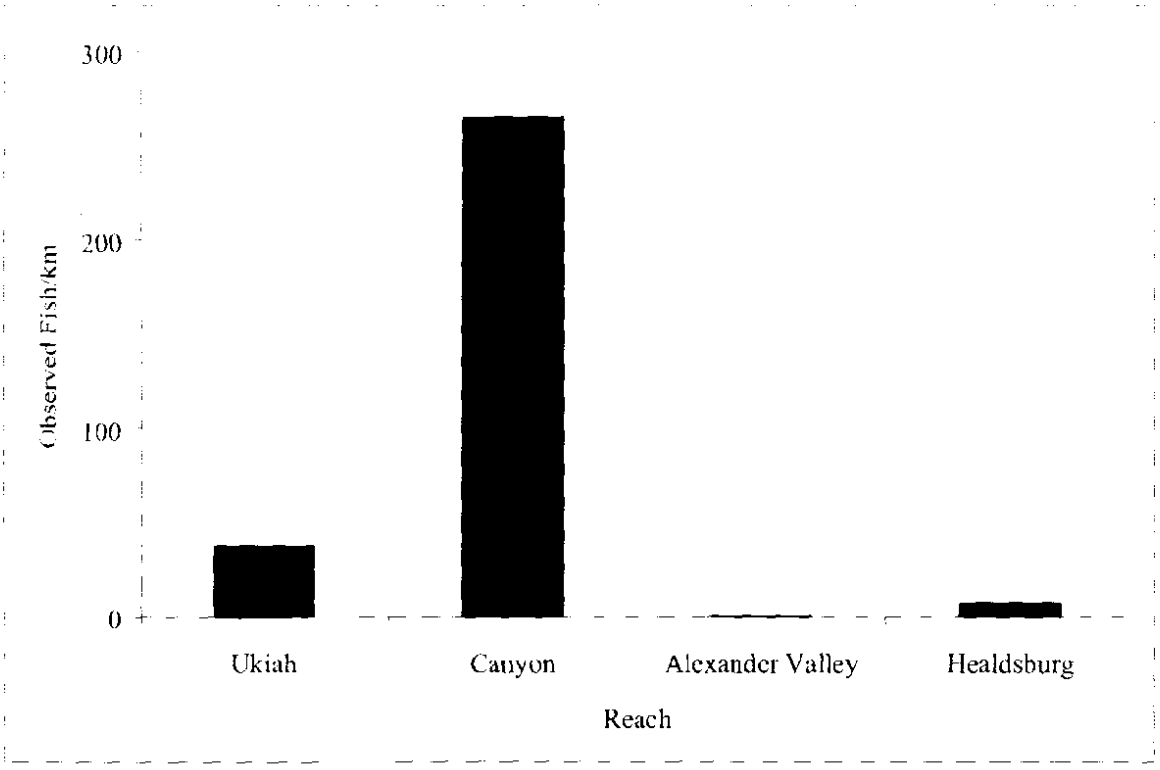


Figure 3: Steelhead observations by reach. Fish counts are based on visual dive surveys and are not population estimates.

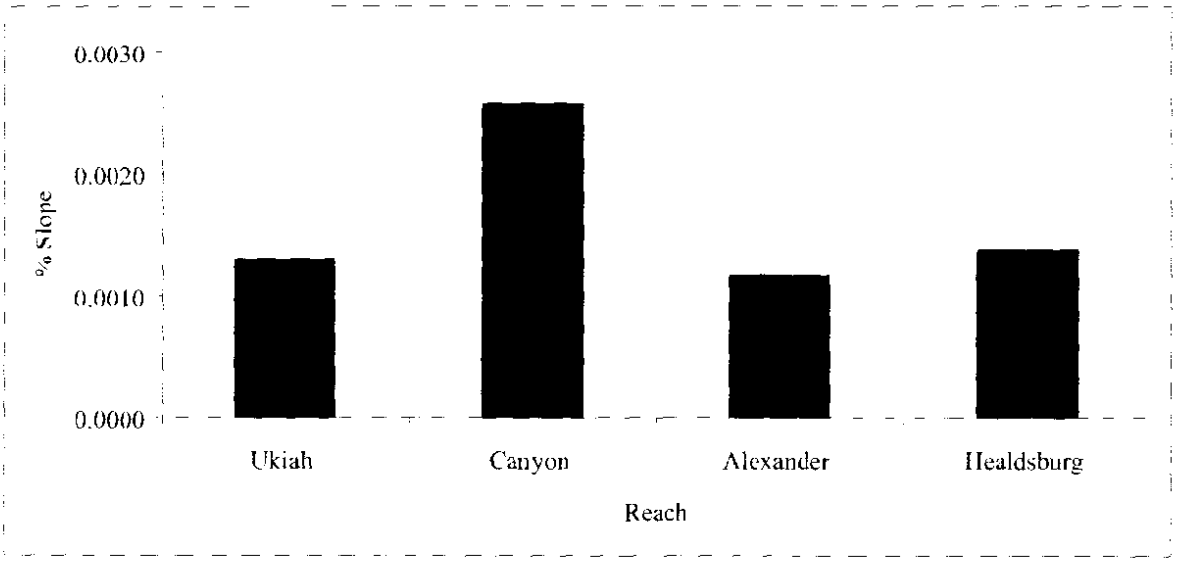


Figure 4: Average gradient by reach.

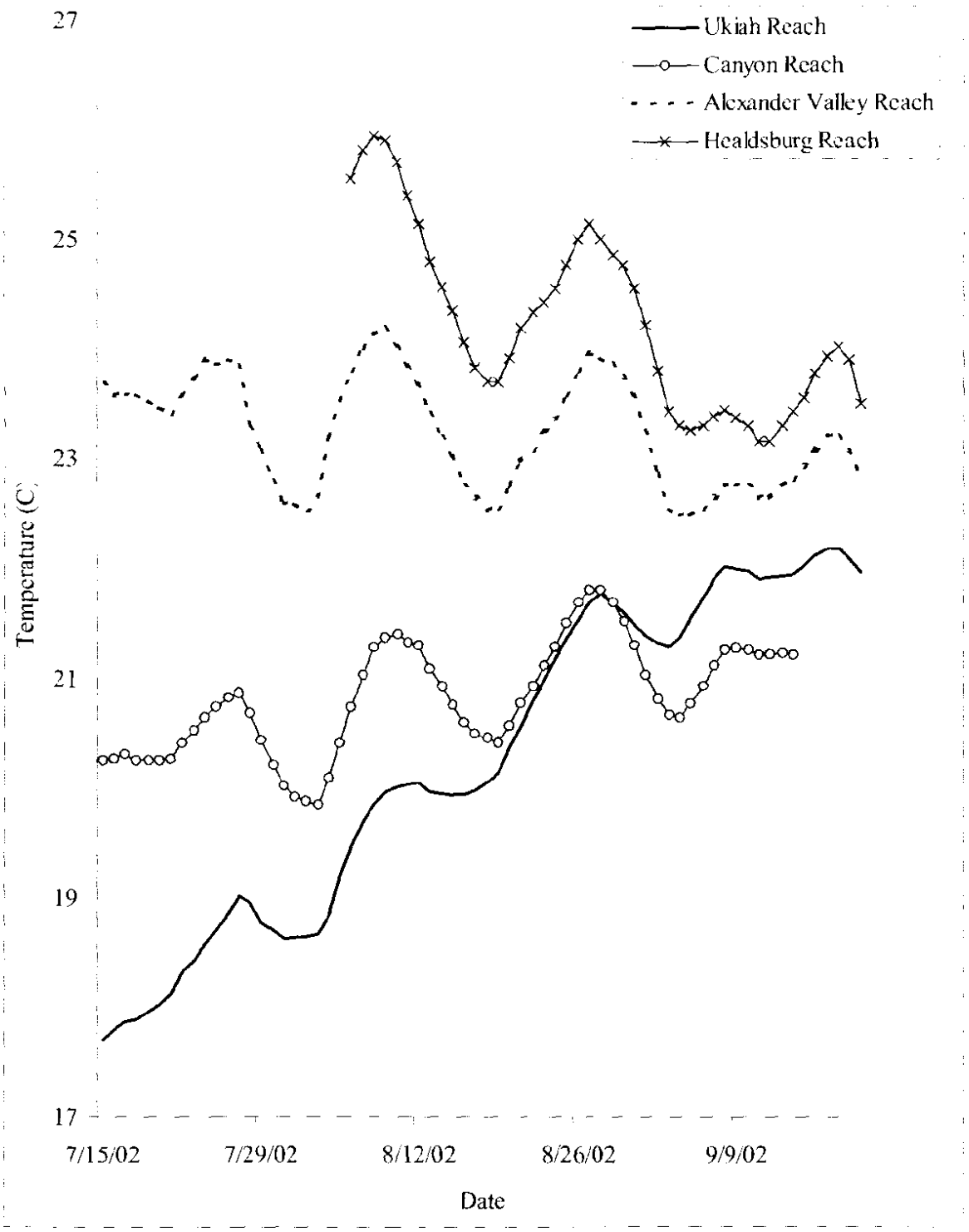


Figure 5: Weekly maximum water temperatures by reach. Temperature data collected at permanent stations.

within the range of weekly average and weekly maximum temperatures at permanent stations located in the 4 reaches (Figures 6, 7, 8, and 9). The similarity of segment and station water temperatures indicate that dive surveys were conducted under conditions characteristic of a reach.

The distribution of steelhead was correlated with water temperatures and there was a significant difference in temperatures collected at dive survey sites among reaches (ANOVA F-Ratio = 3.13, p=0.038). Survey site maximum temperatures in the Ukiah and Canyon reaches were 22°C and 22.5°C, respectively (Figure 10). These temperatures were above the 20.5°C suitable temperature condition for young steelhead; however, steelhead observed during Russian River dive surveys appeared healthy and vigorous, and not stressed or lethargic from high water temperatures. The highest temperatures occurred in the Alexander Valley and Healdsburg reaches at 25°C and 24°C, respectively (Figure 10). Prolonged exposure of steelhead at these temperatures may result in behavioral changes or mortality.

Reach Habitat and Fish Abundance

Ukiah Reach

The Ukiah reach is located in Ukiah Valley area and is the upstream limit of the study area. The reach extends 33 km from the confluence of the East and West Forks of the Russian River to Highway 101 Bridge near Hopland and contained 12 sample segments. Land use along the river consists of vineyard and orchard outside of the riparian zone and occasional aggregate mining along the gravel bars. Also, Norgard Dam is located in the upper portion of Ukiah reach, approximately 1 km downstream from the Talmage Road Bridge. This dam is approximately 3 m high and is the only dam along the reach. Elevation in the reach ranged from 143 m to 186 m, a change of 43 m (Figure 2). See Figures 5 through 17 in the Appendix for photographs of the reach.

The habitat characteristics in the survey segments ranged from a mosaic of well-developed riparian forest along an incised channel to a moderately broad channel with exposed gravel bars and adjacent riparian forest. Flatwater was the dominant habitat throughout the reach and consisted of 94% of the sampled reach, while other habitats included 0.8% deep pool, 5% riffle, and 0.2% cascade (Figure 2). Fastwater habitat (i.e., riffle and cascade) occurred in the upper portion of the reach while the lower reach was entirely flatwater (Figure 11). Cascade habitat occurred in 2 segments, including the upstream end of the reach at U1 and at the Norgard Dam located in U4. The cascade at Norgard Dam consisted of riprap boulders and concrete slabs below the dam (see Figure 9 of the Appendix). Deep pool habitat was concentrated in the central portion of the reach and the largest pool was located below Norgard Dam. The 4 downstream segments (U9-U12) consisted entirely of flatwater habitat.

The fish composition of the Ukiah reach included several native and non-native fish common in the Russian River (Figure 2). A total of 20,117 fish were counted during dive surveys in 12 segments. Cyprinids (minnow species) and Sacramento sucker dominated the composition at 54% and 36% of the fish observed, respectively. A total of 224 steelhead were observed in the reach contributing 1% of the fish counted. Steelhead were present in 3 segments located in the upper one-third of the reach and were correlated with the distribution of riffle and cascade

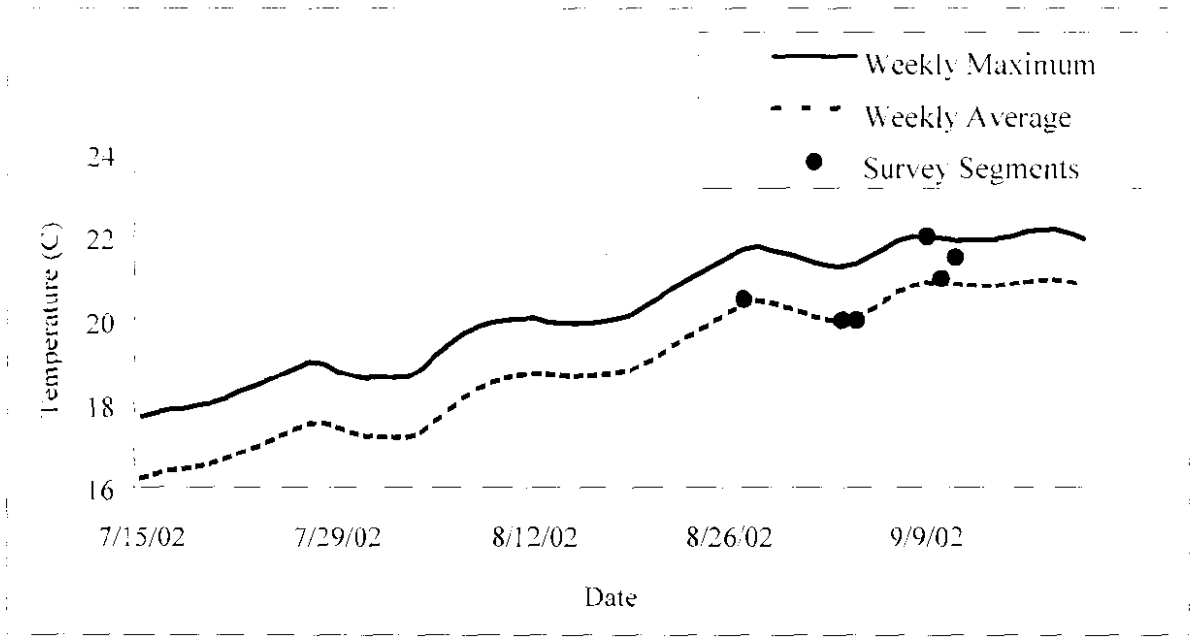


Figure 6: Water temperatures, Ukiah reach. Temperatures recorded continuously at a permanent station near Hopland and at sample segments during dive surveys.

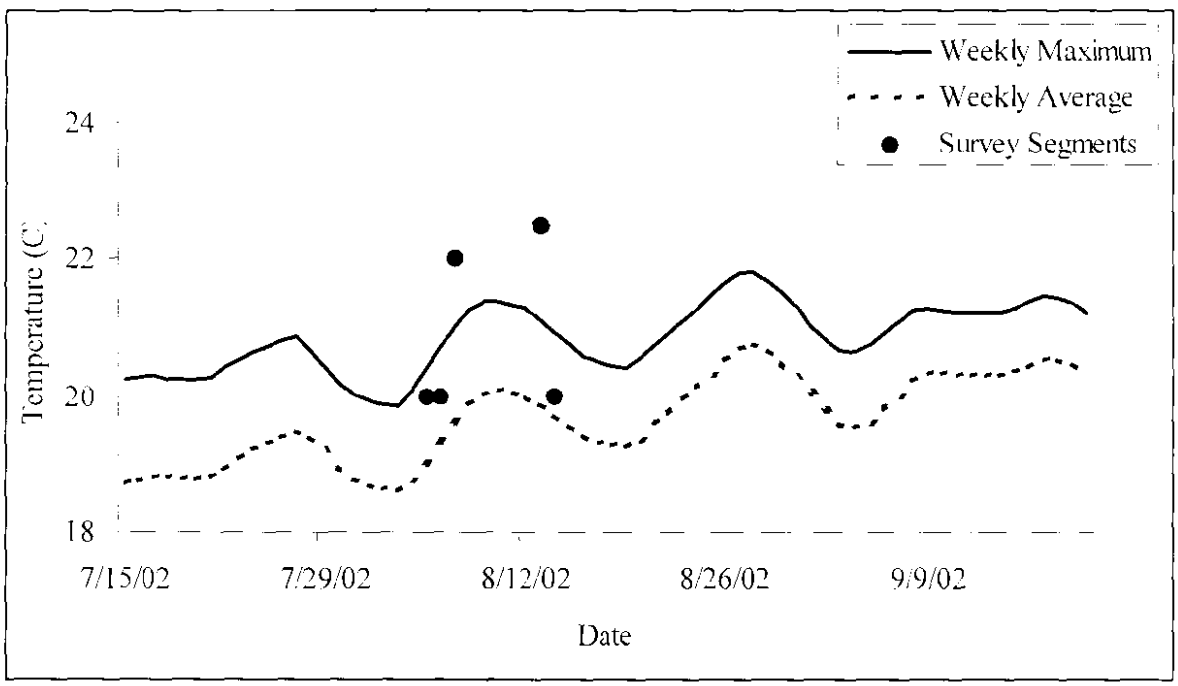


Figure 7: Water temperatures, Canyon reach. Temperatures recorded continuously at a permanent station at Comminsky Road and at sample segments during dive surveys.

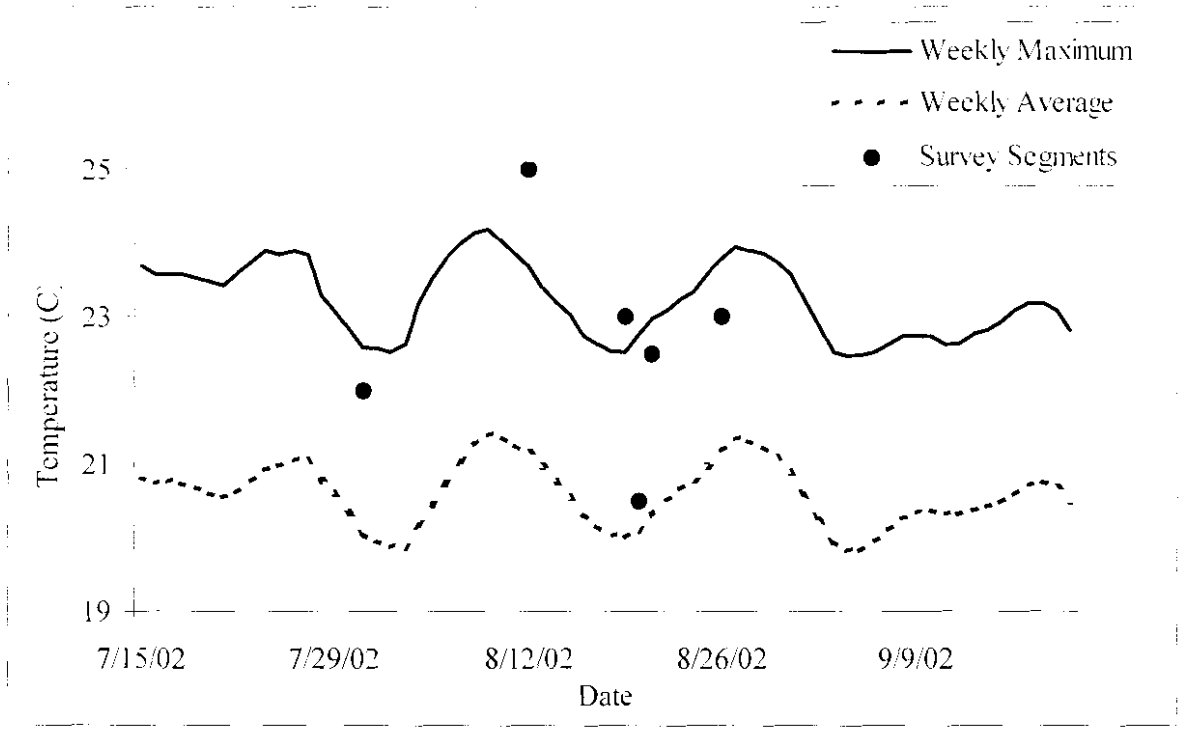


Figure 8: Water temperatures, Alexander Valley reach. Temperatures recorded continuously at a permanent station near Cloverdale Airport and at sample segments during dive surveys.

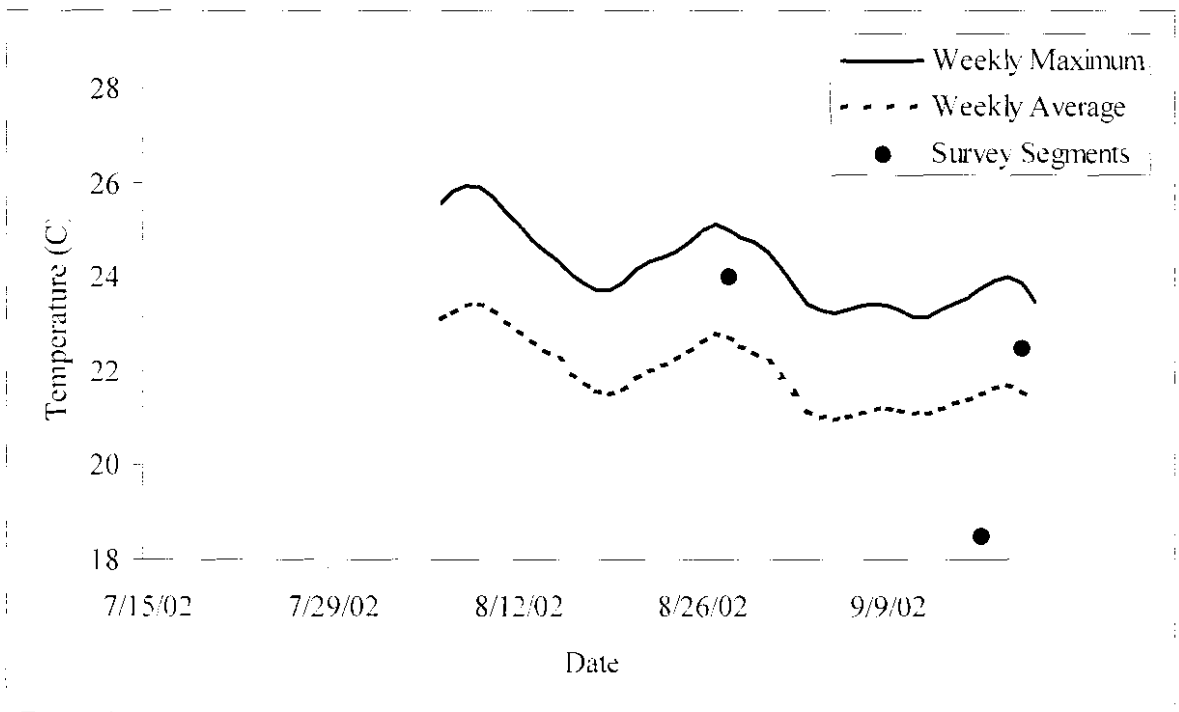


Figure 9: Water temperatures, Healdsburg reach. Temperatures recorded continuously at a permanent station at Digger Bend near Healdsburg and at sample segments during dive surveys.

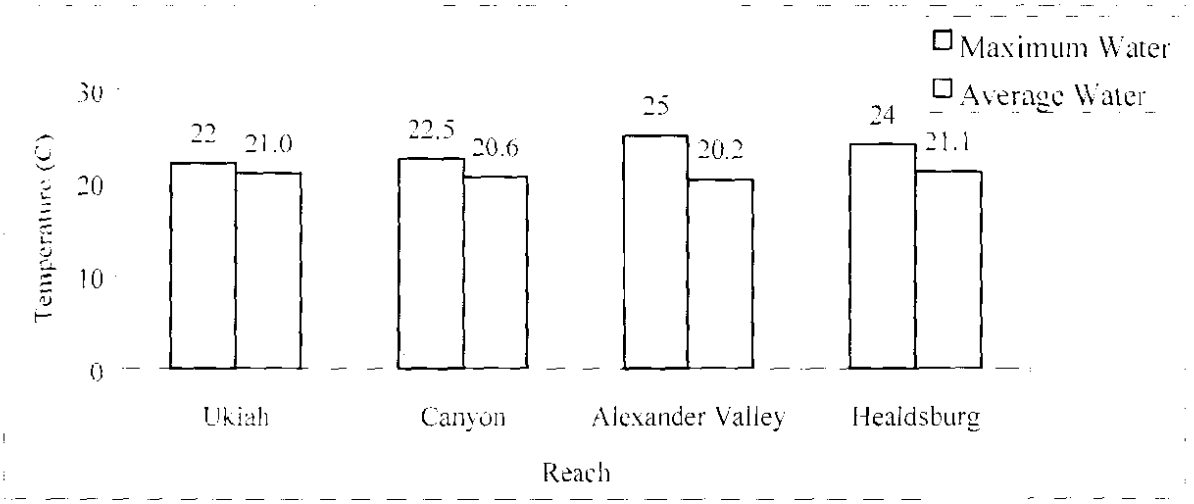


Figure 10: Maximum and average water temperatures at sample sites by reach. Temperature data collected during daytime dive surveys. Water temperatures differed significantly among reaches (ANOVA F-Ratio = 3.13, p=0.038).

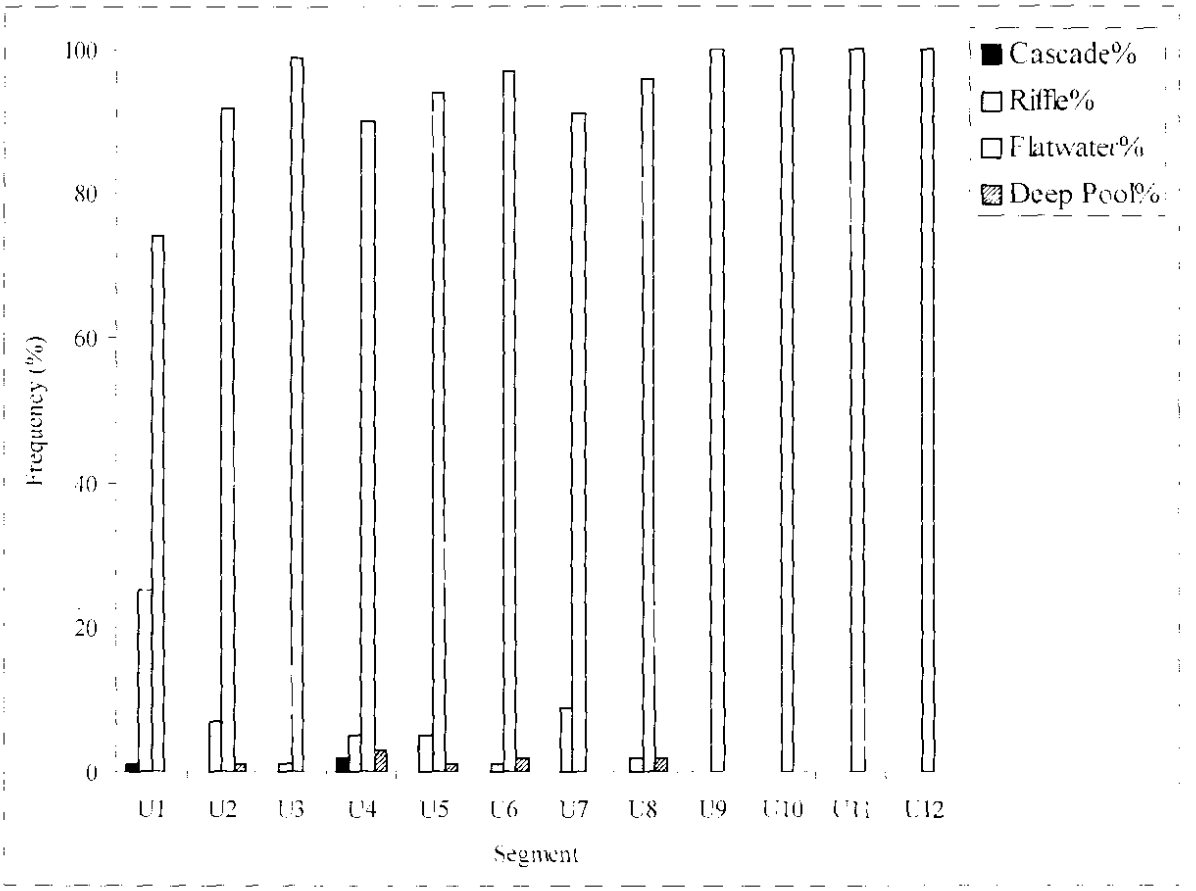


Figure 11: Habitat types, Ukiah reach. Habitat percent based of visual estimates.

habitats (Figures 11 and 12). Segment U1, where 55 steelhead were observed, contained cascade habitat and the highest percentage of riffle habitat in the reach. Segment U2 contained the third highest percentage of riffle and 7 steelhead were counted. Segment U4 had the largest count of steelhead at 161, contained riffle habitat, and the highest percentage of cascade habitat located at Norgard Dam. As shown in Figure 12, 3 steelhead age groups were present in the reach and most steelhead were 1+ fish (64%) followed by young-of-the-year (35%) and 2+ fish (1%). The disproportionately high frequency of 1+ fish suggests a relatively large population of resident steelhead.

Canyon Reach

The Canyon reach is located between Highway 101 Bridge near Hopland and the confluence with Big Sulphur Creek near Cloverdale. The reach included 9 sample segments along 21 km of river. Land use in the area is primarily rangeland and transportation routes. Highway 101 and Northwestern Pacific Railroad tracks parallel the river on either side. The Russian River in this reach flows through a steep canyon with the highest gradient of the 4 study reaches. Elevation in the reach ranges from 90 m to 143 m; however most of the gradient change in the river occurs in the lower two-thirds of the reach below Squaw Rock from segments C4 to C9 (Figure 2). Figures 18 through 26 in the Appendix show photographs of the reach.

The habitats in the Canyon reach varied from deep pool to cascade habitats, and included the highest proportion of fastwater habitat of any reach (Figure 13). The 3 upper segments (C1-C3) of the reach were composed almost entirely of flatwater habitat with well-developed riparian vegetation and were similar in character to the lower portion of the Ukiah reach. The lower 6 segments (C4-C9) were characterized by steep canyon topography, fastwater habitats with a substrate dominated by boulder and bedrock, and patchy riparian vegetation. The fastwater habitat in the reach included 16% riffle and 0.2% cascade. Segments C4, C6, and C9 had the highest occurrence of riffle habitat at 27%, 28%, and 50%, respectively. Cascade habitat occurred at C4 located at Squaw Rock and consisted of 2% of the segment. Deep pool habitat occurred from C3 through C9 and ranged from 1% to 8% of the segment. These pools were generally formed by boulders or bedrock structures.

A total of 24,398 fish were counted in the 9 segments of the Canyon reach for an average of 2,711 fish/segment. Cyprinids (i.e., California roach, pikeminnow, and hardhead) were the most abundant fish at 60% of the fish count followed by Sacramento sucker (25%) and Russian River tuleperch (9%). Steelhead observations included 1,194 fish and consisted of 5% of the total fish count. The age classes of steelhead, based on size categories, were 69% young-of-the-year and 31% 1+ age fish (Figure 14).

Steelhead were distributed throughout the reach except for the upstream segment (C1); however, most steelhead were observed in fastwater habitats located in the lower two-thirds of the reach where the gradient is relatively high. Steelhead numbers were zero or very low in segments C1 through C3 where the habitat was primarily flatwater (Figures 13 and 14). In contrast, steelhead observations were relatively high in segments C4 through C9 where fastwater habitats were abundant. The largest steelhead counts were in segment C5 at 435 fish followed by C6 and C7 at 254 and 210 fish, respectively.

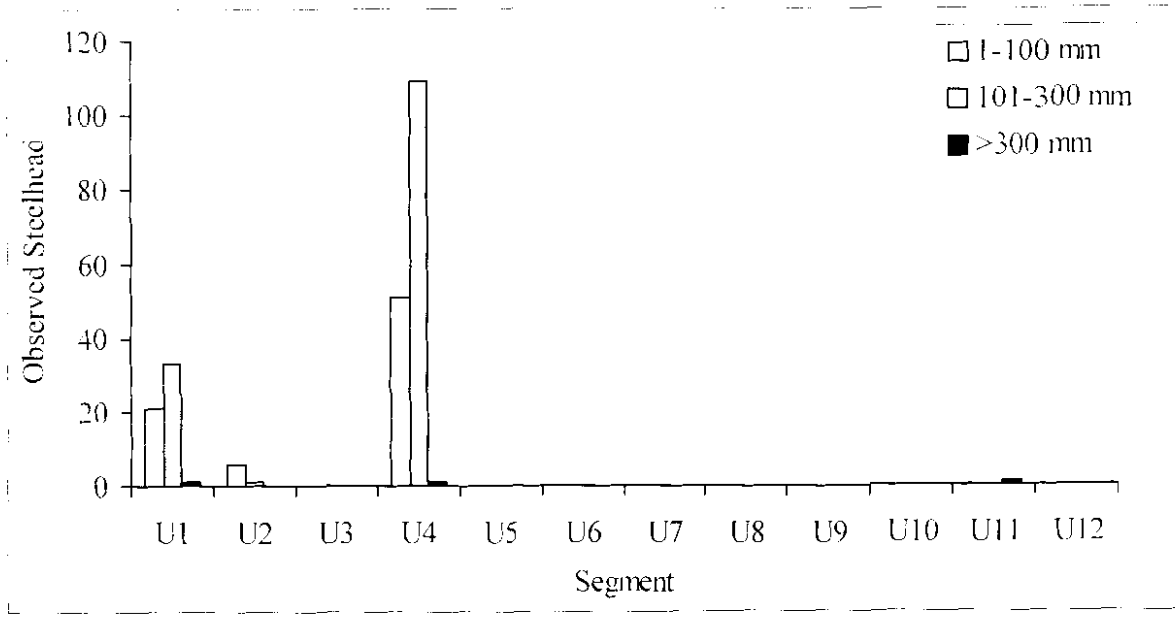


Figure 12: Steelhead abundance and size distribution, Ukiah reach. Fish counts and size categories are based on visual dive surveys and are not population estimates.

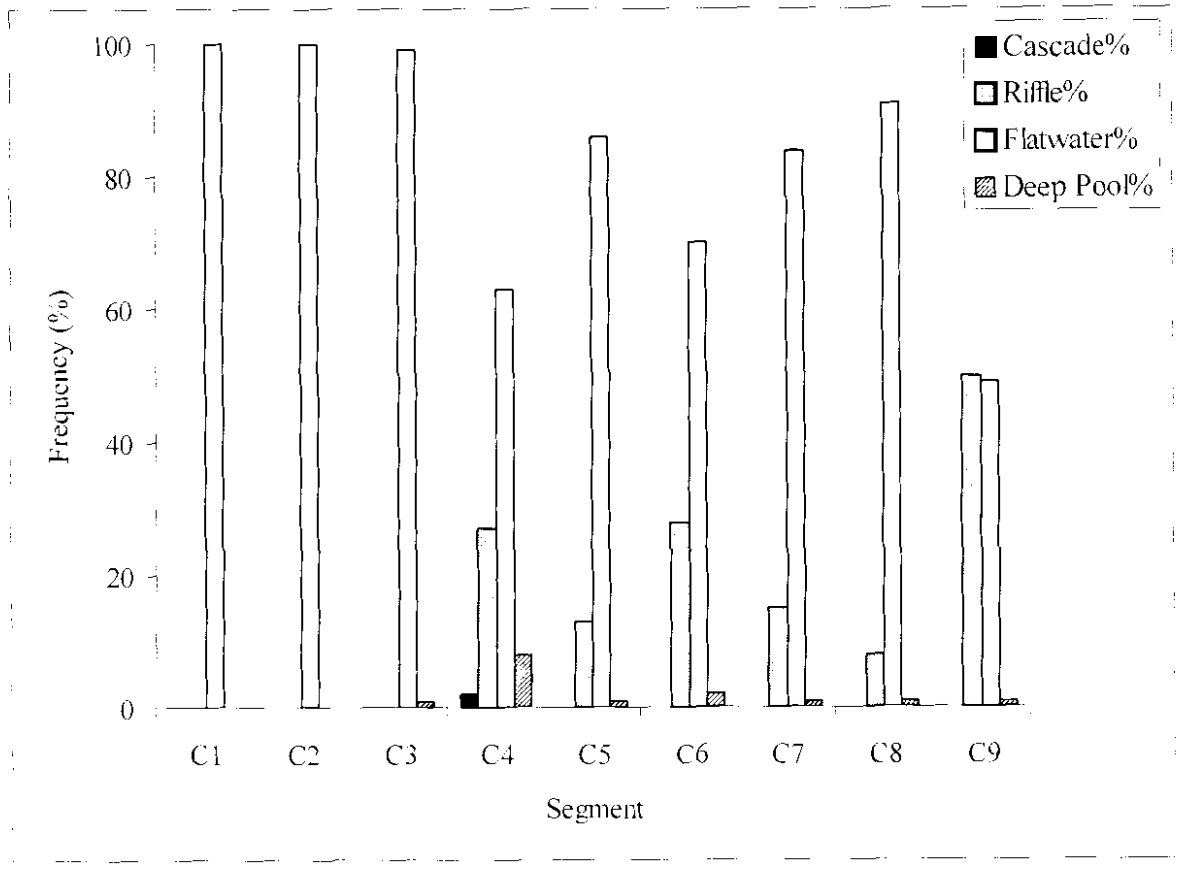


Figure 13: Habitat types, Canyon reach. Habitat percent based of visual estimates.

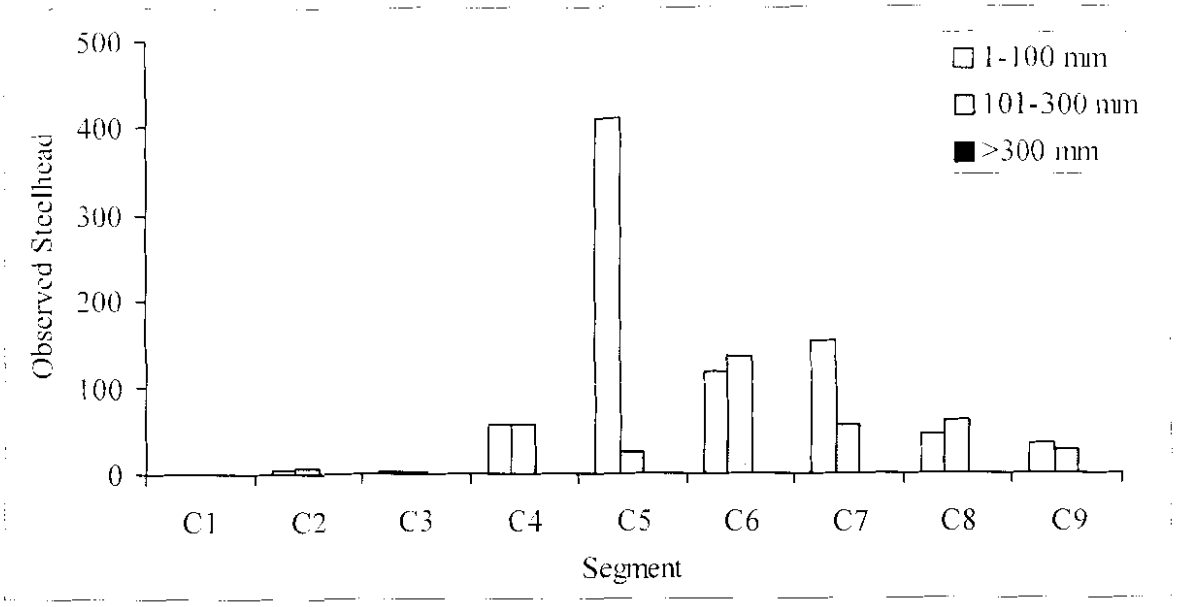


Figure 14: Steelhead abundance and size distribution, Canyon reach. Fish counts and size categories are based on visual dive surveys and are not population estimates.

The largest count of steelhead did not correlate with the highest frequency of fastwater habitat, as expected. Segment C9 contained the highest proportion of riffle habitat at 50% and had 59 observed steelhead, while C5 through C7 had steelhead counts several times this amount and less than half of the fastwater habitat. One explanation for the distribution of young steelhead within riffles is the presence of refugia from excessive water velocities. Large substrate particles in high gradient areas provide important shelter for fish from high velocities. The substrate in C9 riffles was primarily loose cobble while C4 through C7 riffle substrate was dominated by boulder and bedrock.

Alexander Valley Reach

The Alexander Valley reach is located in Alexander Valley and extends from the confluence of Big Sulphur Creek near Cloverdale to the Alexander Valley Road Bridge. The length of the reach was approximately 26 km and included 11 sample segments. Land use along the reach consists of agricultural land (vineyard) outside of the riparian zone and occasional aggregate mining along the gravel bars. Elevation ranges from 59 m to 90 m and has the lowest gradient of all the study reaches (Figure 2). See Appendix Figures 27 through 37 for photographs of the reach.

The Alexander Valley reach consists of a slow-moving meandering river in a broad channel with exposed gravel bars and dense riparian vegetation along the outer banks. Flatwater was the dominant habitat and consisted of 91% of the reach, while other habitats included 0.8% deep pool, 8% riffle, and 0.2% cascade (Figures 2). Segments A1-A6 and A9-A11 contained almost entirely flatwater habitat (Figure 15). Segments A7 and A8 had relatively high proportions of riffle habitat at 60% and 15%, respectively. Riffle habitats were characterized by fast flows in a

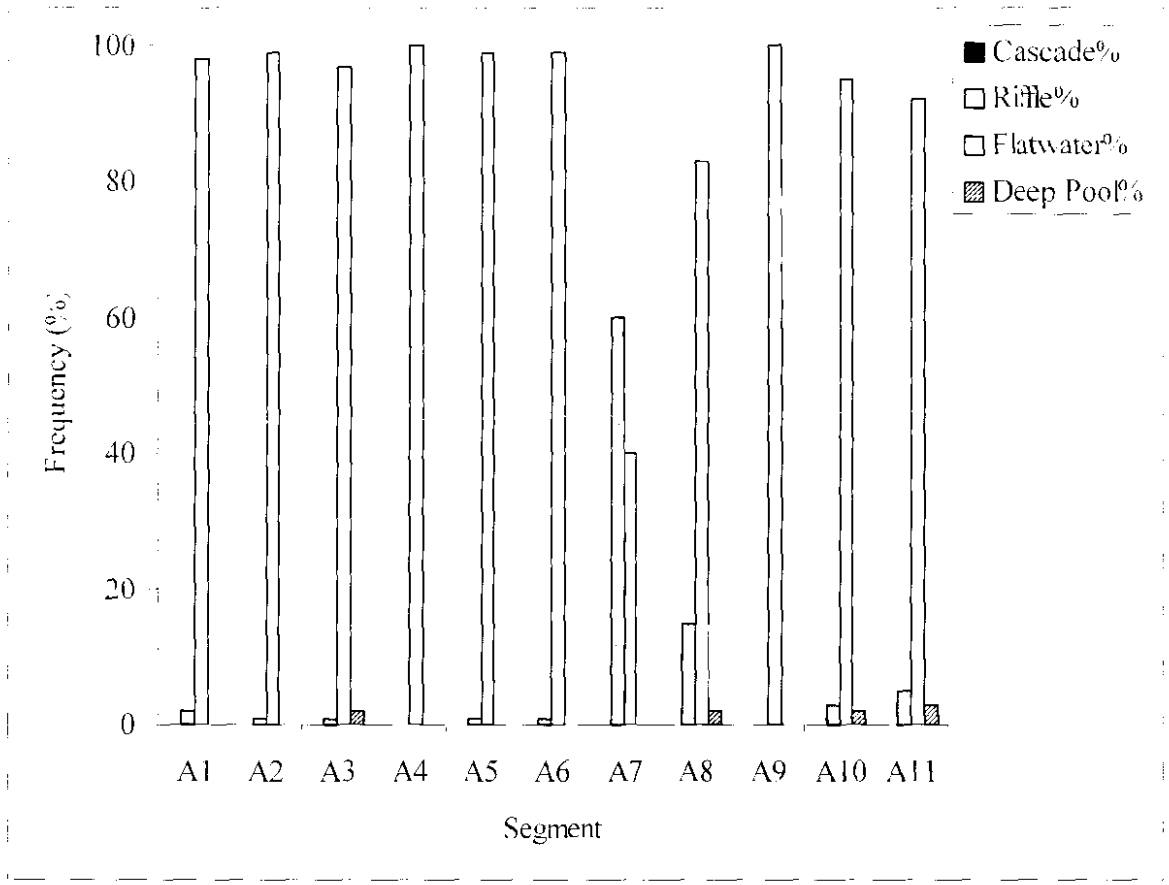


Figure 15: Habitat types. Alexander Valley reach. Habitat percentages based of visual estimates.

broad and shallow channel with unconsolidated large gravel to cobble substrate. Deep pools occurred in 4 segments distributed throughout the reach.

The fish composition of the Alexander Valley reach contained several native and non-native fish common in the Russian River (Figure 2). A total of 43,009 fish were counted during dive surveys for an average of 7,820 fish/km. Cyprinids (minnow species) were the most abundant species in the reach and composed 74% of the fish count. Other common species included Sacramento sucker (19%) and Russian River tuleperch (6%). One steelhead was observed in the entire reach in segment A7 (Figure 16), which had the highest occurrence of riffle habitat at 60%. Riffles in this segment were broader, shallower, and contained smaller substrate size than riffles in other reaches that contained relatively high numbers of steelhead.

Healdsburg Reach

The Healdsburg reach is the downstream end of the study area and extends 26 km from Alexander Valley Road bridge to the confluence with Dry Creek south of Healdsburg. A total of 5 segments were sampled in this reach. The lowland topography in the area includes Alexander Valley and Dry Creek Valley at the upper and lower ends of the reach. The central portion of the reach makes several large bends around Fitch Mountain and surrounding hills. The river gradient is low and similar to Ukiah and Alexander Valley reaches (Figures 2 and 4). The elevation ranges from 24 m to 59 m. In the upper and lower portions of the reach surrounding land use is

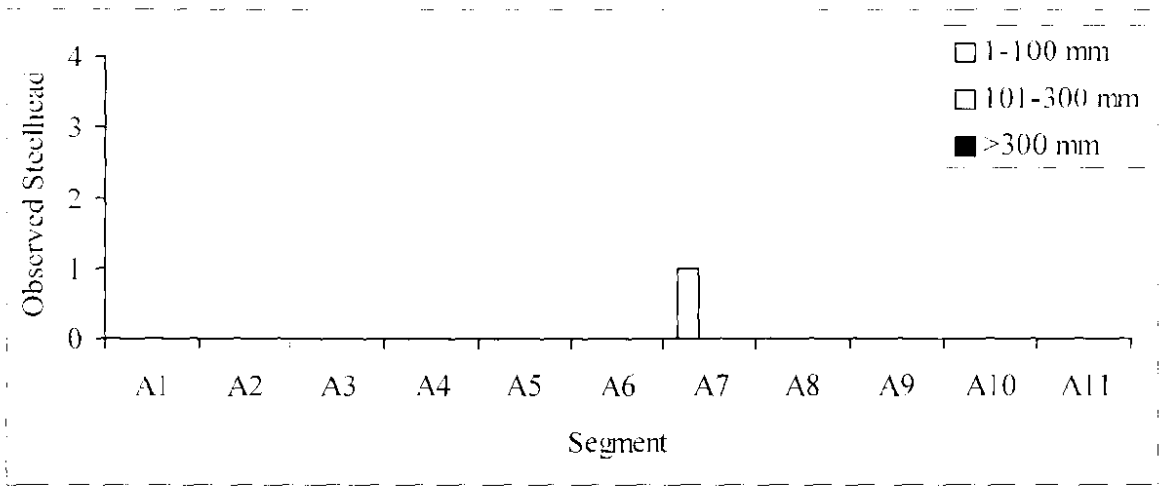


Figure 16: Steelhead abundance and size distribution, Alexander Valley reach. Fish counts and size categories are based on visual dive surveys and are not population estimates.

vineyard and aggregate mining. The hilly central portion of the reach is undeveloped land and rural residences along the banks of the river. Also, Healdsburg Dam is located in the lower portion of the reach. The dam is approximately 5 m high and impounds water above the dam for approximately 2 km upstream. Photographs of the reach are shown in Figures 38 through 47 of the Appendix.

River habitat in the Healdsburg reach is similar to Alexander Valley reach and consists of a slow-moving meandering river in a broad channel with exposed gravel bars and dense riparian vegetation along the outer banks. Habitat in the reach consisted of 93% flatwater, 2% deep pool, 4% riffle, and 1% cascade (Figure 2). Flatwater was the dominant habitat in the reach, while low frequencies of riffle and deep pool habitats occurred throughout the reach (Figure 17). Cascade habitat was present at a single site in segment H10. This cascade is an artificial feature created by large boulder riprap at Healdsburg Dam.

The fish assemblage in the Healdsburg reach was similar to the flatwater-dominated reach of Alexander Valley (Figure 2). A total of 5,497 fish were counted during dive surveys at an average of 2,199 fish/km. Cyprinids were the most abundant fish species in the reach and composed 48% of the fish count followed by Sacramento sucker (40%) and smallmouth bass (9%). Steelhead consisted of 0.3% of the fish count and a total of 17 steelhead were observed (Figure 18). Steelhead were observed in riffle and cascade habitats in 2 segments. One steelhead was observed in H6, which had 3% riffle habitat. Sixteen steelhead were counted in 2 fastwater habitats in H10, including the artificial cascade at Healdsburg Dam and a narrow riffle created by the Syar summer bridge crossing located approximately 400 m below Healdsburg Dam.

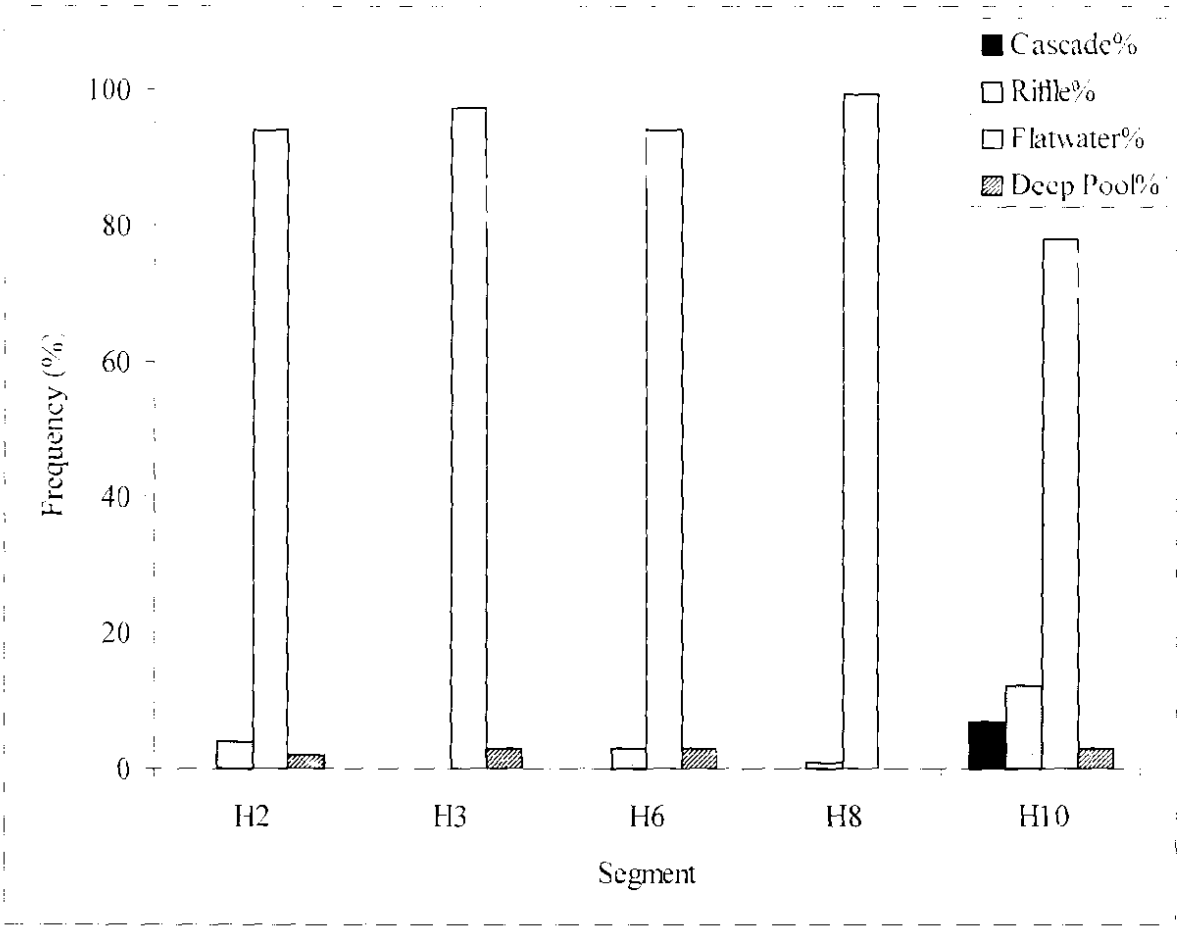


Figure 17: Habitat types, Healdsburg reach. Habitat percentage based of visual estimates.

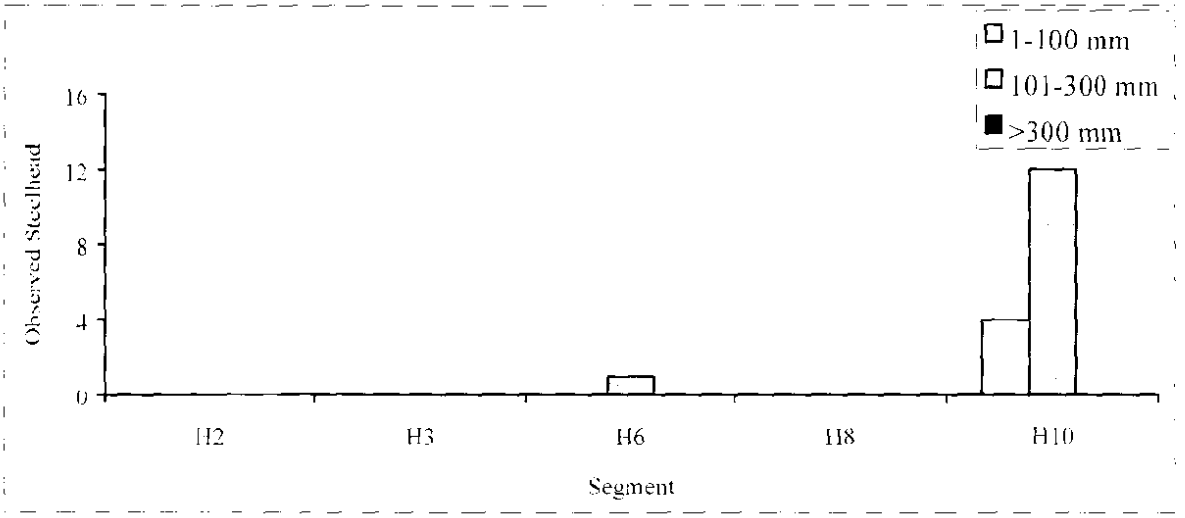
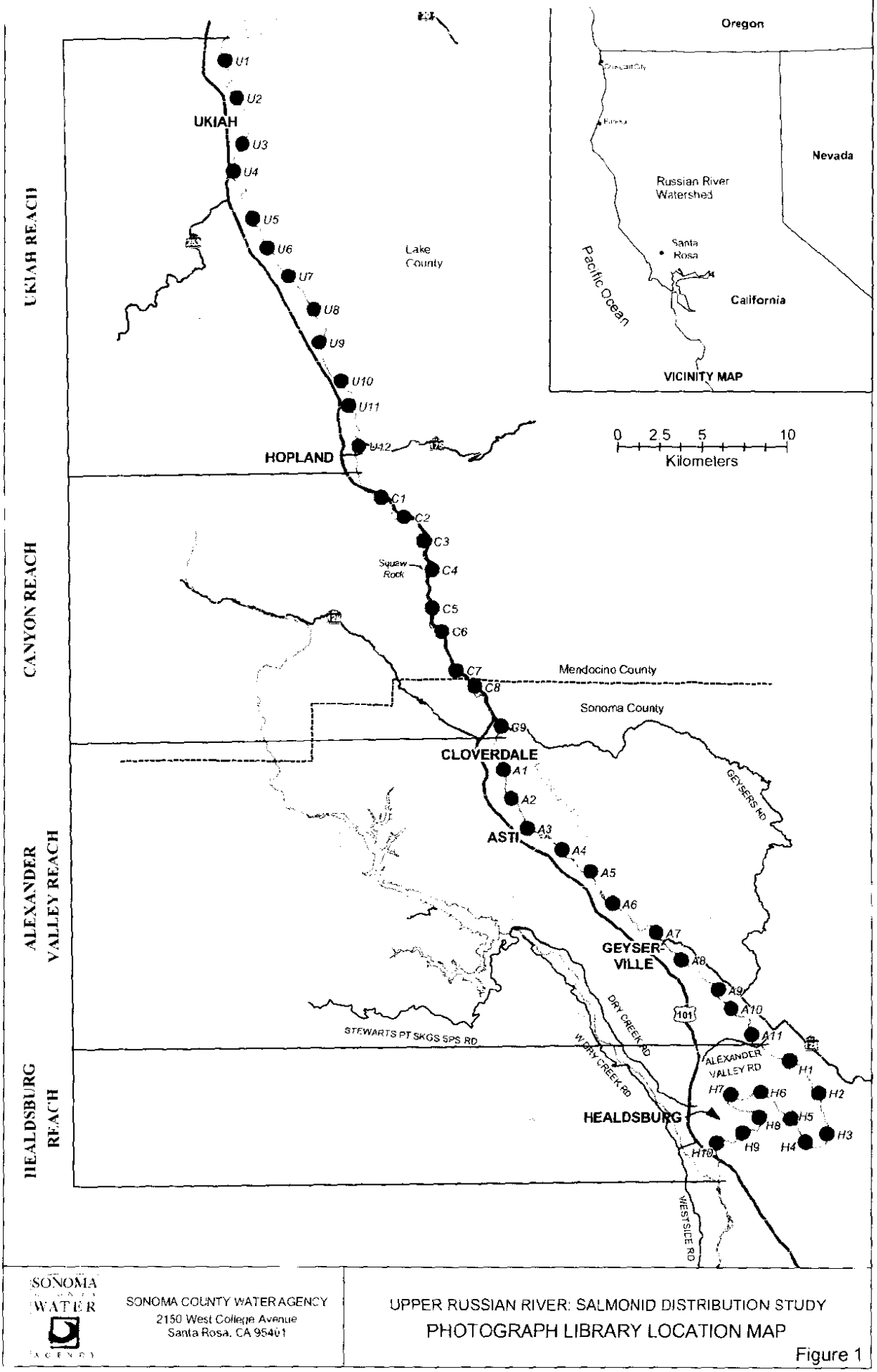


Figure 18: Steelhead abundance and size distribution, Healdsburg reach. Fish counts and size categories are based on visual dive surveys and are not population estimates.



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UPPER RUSSIAN RIVER: SALMONID DISTRIBUTION STUDY

PHOTOGRAPH LIBRARY LOCATION MAP

Figure 1

Healdsburg Reach

PHOTOGRAPH LIBRARY

INTRODUCTION

The Photograph Library documents and characterizes aquatic and riparian habitats along 106 km of the upper Russian River between Ukiah and Healdsburg. Photographs were taken within surveyed segments to characterize the habitat along the Russian River. In addition, photographs of survey techniques and fish observed during dive surveys were included in the library. The below figures are listed by subject and reach.

FIGURES

APPENDIX

PHOTOGRAPH LIBRARY

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