# Upper Sacramento River Summary Report
## August 4th-5th, 2008

## California Department of Fish and Game
## Heritage and Wild Trout Program

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## Introduction:

The 400-mile long Sacramento River system is the largest watershed in the state of California, encompassing the McCloud, Pit, American, and Feather Rivers, and numerous smaller tributaries, in total draining nearly one-fifth of the state. From the headwaters downstream to Shasta Lake, referred to hereafter as the Upper Sacramento, this portion of the Sacramento River is a designated Wild Trout Water (with the exception of a small section near the town of Dunsmuir, which is a stocked put-and-take fishery) (Figure 1).

The California Department of Fish and Game's (DFG) Heritage and Wild Trout Program (HWTP) monitors this fishery through voluntary angler survey boxes, creel census, direct observation snorkel surveys, electrofishing surveys, and habitat analyses. The HWTP has repeated sampling over time in a number of sections to obtain trend data related to species composition, trout densities, and habitat condition to aid in the management of this popular sport fishery. In August 2008, the HWTP resurveyed four historic direct observation survey sections on the Upper Sacramento.

## Methods:

Surveys occurred between August 4$^{th}$ and 5$^{th}$, 2008 with the aid of HWTP personnel and DFG volunteers. Sections were identified prior to the start of the surveys using GPS coordinates, written directions, and past experience. Fish were counted via direct observation snorkel surveys, an effective survey technique in many streams and creeks in California and the Pacific Northwest (Hankin & Reeves, 1988). Between six and nine divers surveyed each section; the number of divers depended on stream width, habitat complexity and water clarity. Availability of the appropriate number of skilled surveyors was a limiting factor in some surveys. Divers, maintaining an evenly-spaced line perpendicular to the current, counted fish by species. All observed trout were further categorized and counted by size class. Size classes were divided into the following categories: young-of-year (YOY), small (< 6 inches), medium (6-11.9 inches), large (12-17.9 inches) and extra-large (≥ 18 inches). YOY are defined by HWTP as age 0+ fish, emerged from the gravel in the same year as the survey effort. Depending on species, date of emergence, relative growth rates, and habitat conditions, the size of YOY varies greatly, but are generally between zero and three inches in total length. If a trout was observed to be less than six inches in total length but it was difficult to determine whether it was an age 0+ or 1+ fish, by default it was classified in the small (<6 inches) size class.

Divers were instructed in both visual size class estimation and proper snorkel survey techniques (establishing a dominant side, determining the extent of their visual survey area, how and when to count (or not count) fish observed, safety considerations, etc.) prior to starting the survey. All surveys were performed in the downstream direction. For each of the sections, thalweg/section length, water and air temperature (in the shade),

average wetted width and depth, and water visibility were measured. Coordinates for the section boundaries were recorded and representative photographs were taken.

Figure 1. Map of Upper Sacramento River (blue lines represent Wild Trout designation and red line represents "put and take" hatchery-stocked area)

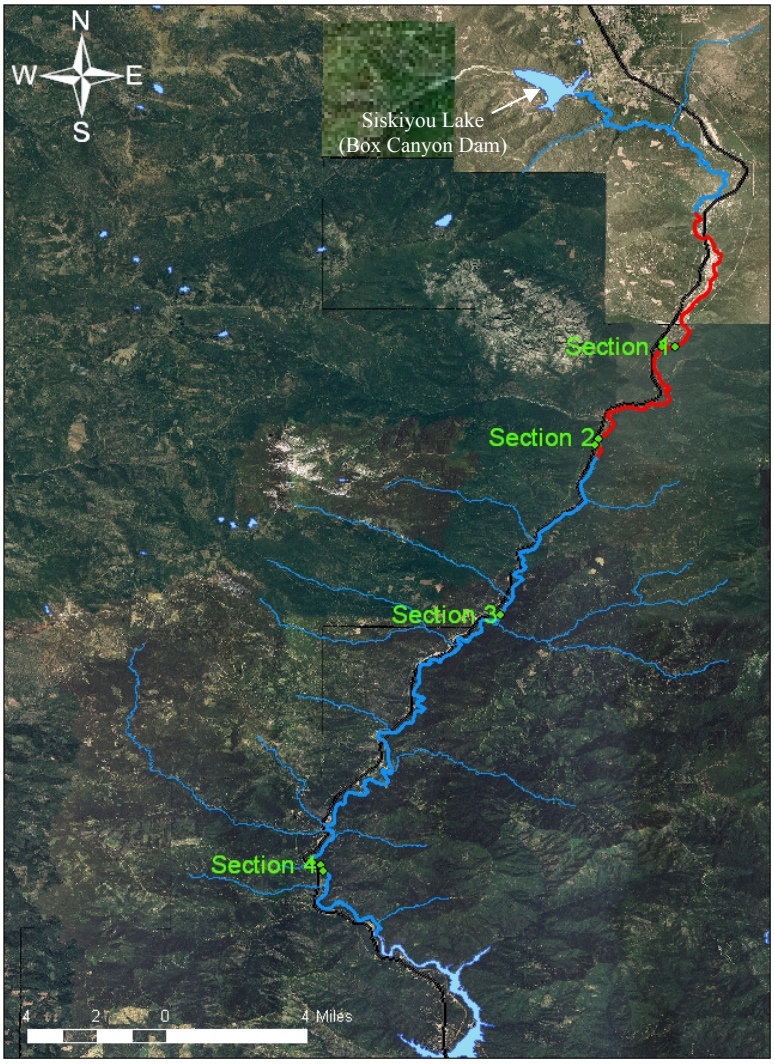
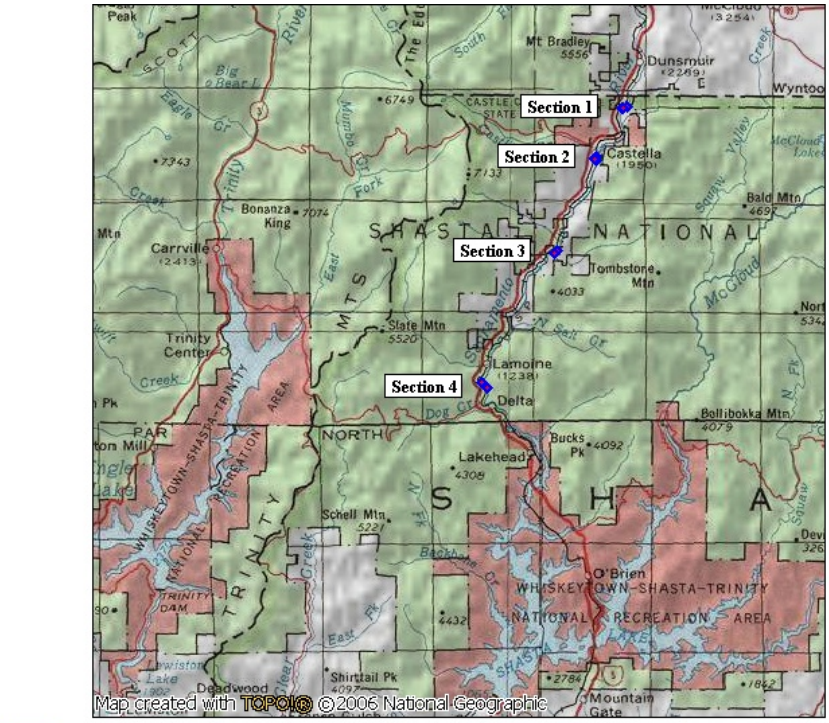


Figure 2. Map of 2008 survey locations



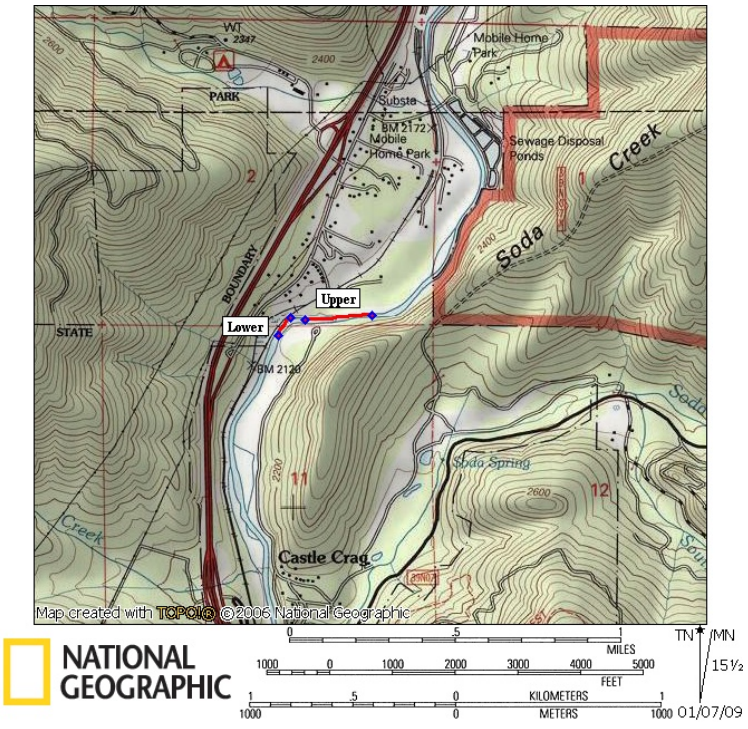
## Results:

### Section 1 (Upper and Lower):

Sections 1 and 1-lower are located south of Dunsmuir and are outside of the designated Wild Trout area (Figures 1 and 3). Both were surveyed on August 4th when air temperature was 19º Celsius (C) and water temperature was 12º C (measured at 9:30 a.m.). The weather was clear and sunny. Section 1 is a historic section and Section 1-lower was added in 2007; the two sections were separated by a high-gradient riffle and were determined to be two separate habitat units starting in 2007. During the survey effort, divers observed numerous trout with "sore-like" injuries on their mouths and heads.

Section 1 was dominated by shallow flatwater, with good water visibility (six feet). Section length was 1096 feet, the average wetted width was 99.7 feet, and the average water depth was 1.2 feet. Nine divers observed 337 coastal rainbow trout (*Oncorhynchus mykiss irideus*) and 14 sculpin (*Cottus* spp.) (Table 1). The majority of coastal rainbow trout observed were in the small size class (66 %).

Figure 3. Map of Section 1

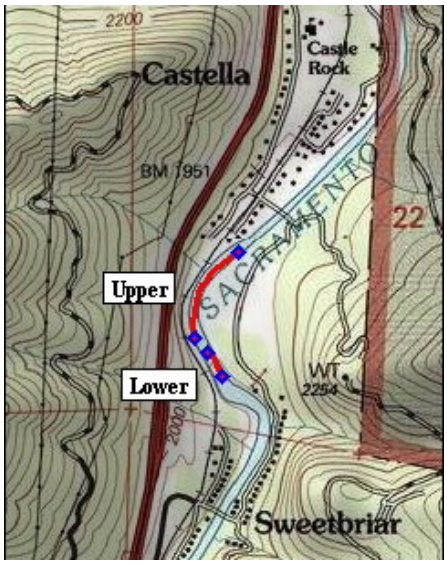



Section 1-lower was also dominated by flatwater habitat; however, it consisted of a short deep run with much narrower stream widths. Section length was 395 feet, with an average wetted width of 69.0 feet, and average water depth of 2.2 feet. Water visibility was greater than eight feet. Six divers observed 552 coastal rainbow trout in Section 1-lower, with the majority of trout falling into the small size class (75 %) (Table 1). There were also a good number of medium and large fish holding in this lower section. No other species were observed.

**Section 2 (Upper and Lower):**

Section 2 is also located within the put-and-take stocked area near the town of Dunsmuir, outside of the designated Wild Trout area (Figures 1 and 4). Historically, this section has been divided into an upper and lower section and fish are tallied separately for each of these units. These were surveyed on the afternoon of August 4th, when the air temperature was 28º C and water temperature was 18º C (at 2:00 p.m.). The weather was clear, sunny and hot and water visibility was greater than six feet for both the upper and lower sections.

Figure 4. Map of Section 2




Section 2-upper was dominated by flatwater habitat which included a large area of shallow edgewater. This edgewater provided habitat for a large number of YOY. Because this habitat was too shallow to snorkel, one diver was dedicated to walking the edgewater and counting juveniles from above the water's surface. Nine divers observed 1105 coastal rainbow trout, two sculpin, and 100 Sacramento pikeminnow (*Ptychocheilus grandis*). The average wetted width was 70.3 feet, the average water depth was 1.5 feet, and the section length was 1066 feet.

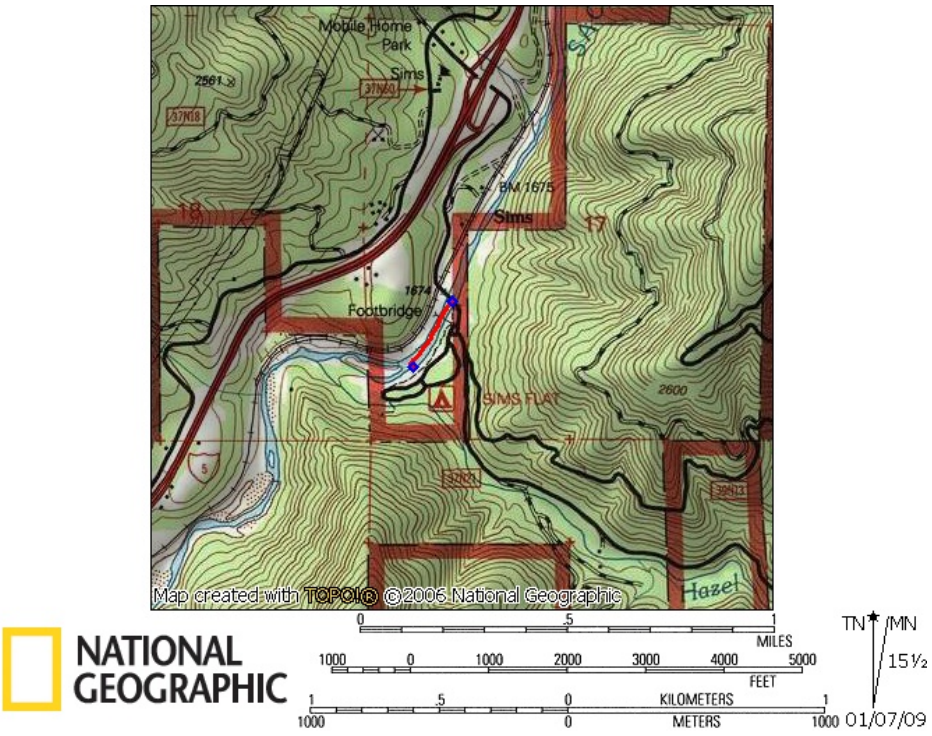
In Section 2-lower, six divers observed 575 coastal rainbow trout and one sculpin. This section was dominated by flatwater habitat and was 333 feet in length. The average wetted width was 67.0 feet and the average water depth was 2.1 feet. Water clarity was greater than six feet. Both sections had notable aggregations of tadpoles in shallow, warm backwater areas including those of Pacific tree frog (*Hyla regilla*) and Western toad (*Bufo boreas*).

**Section 3**

On August 5th, the HWTP surveyed Section 3, which is within the Wild Trout-designated area (Figures 1 and 5). The weather was warm and sunny, with a water temperature of 14º C and an air temperature of 19º C at 10:00 a.m. Section 3 is adjacent to the Sims Flat Campground (administered by the United States Forest Service), providing good

public access and trails down to and along the river. This flatwater (flooded riffle) dominated section was wide (average wetted width of 109.6 feet) and seven divers participated in the survey. The average water depth in Section 3 was 1.9 feet, section length was 969 feet, and water clarity was approximately ten feet. Based on water clarity and stream width, seven divers were not enough to provide adequate coverage of the entire section. Divers counted 348 coastal rainbow trout and 25 Sacramento suckers (*Catostomus occidentalis*) (Table 1); the majority of the trout were observed along the banks where there was cover (undercut banks, deeper water, and overhanging vegetation).

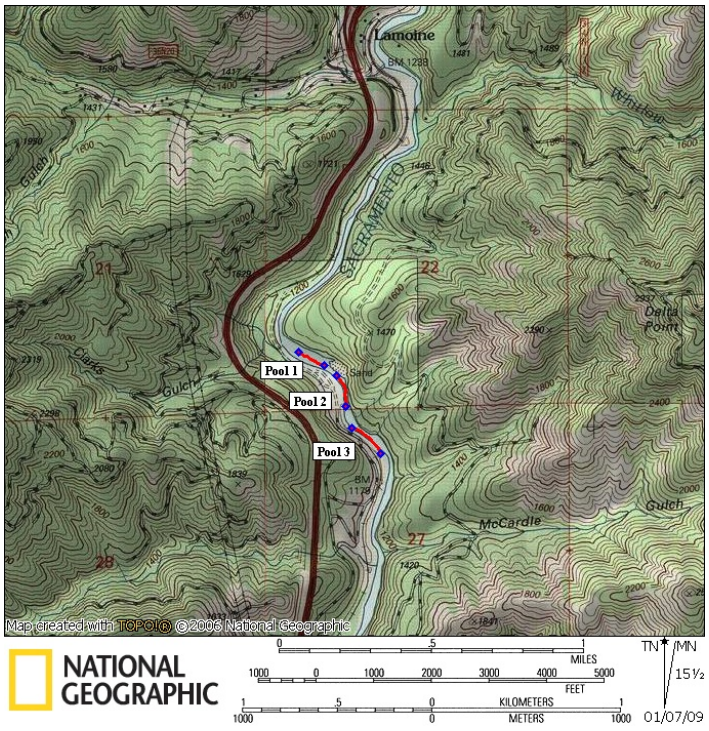
Figure 5. Map of Section 3



**Section 4 (Pool 1, Pool 2, and Pool 3):**

Section 4 was surveyed on August 5th and consisted of a series of three pools separated by runs and riffles (Figure 6). Section 4 is located within the designated Wild Trout area of the Upper Sacramento (Figure 1). Following historic sampling protocols, only the pools were sampled and fish were tallied separately for each pool. Pools were labeled Pool 1 (farthest upstream), Pool 2 (in the middle of the section), and Pool 3 (farthest downstream). Weather conditions at the time of the survey were clear and sunny. Water clarity was greater than eight feet; however, due to the depth of the large pools, divers could not see clearly all the way to the bottom of the streambed. In addition, at the head of each pool, water visibility was further decreased due to a bubble curtain. Eight divers participated in the survey effort; see Table 1 for a summary of total fish counts and habitat results for each unit surveyed. Algae were growing at each of the pool tailouts and divers counted thousands of juvenile non-salmonids in these algae mats. Some divers classified these fish as non-salmonids, while others further divided them into basic fish types (minnows, suckers, etc.) The majority of these fish were less than 30 mm in length and, therefore, difficult to identify. In addition to large numbers of coastal rainbow trout, including many large and extra-large fish holding at the heads of the pools, there were Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento suckers, spotted bass (*Micropterus punctulatus*), and crayfish (unknown species).

Figure 6. Map of Section 4




As mentioned, only fish observed in the three pool habitats were counted. However, divers snorkeled the riffle sections that separated the pools to assess whether or not they were missing important habitat types and observed hundreds of coastal rainbow trout, including many in the small size class (however, based on the existing survey protocols, these fish were not included in the counts for the section). It is estimated that there were many more small coastal rainbow trout in the short riffles than in the pool habitats (which were

dominated by medium, large and extra-large rainbow trout).

Table 1. Summary of 2008 Upper Sacramento River direct observation survey results

| Section # | Section Length (ft) | Number of Divers | Average Width (ft) | Average Depth (ft) | Water Visibility (ft) | Species | YOY | Small < 5.9" | Med 6" - 11.9" | Lg 12" - 17.9" | XL > 18" | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1096 | 9 | 99.7 | 1.2 | 6 | coastal rainbow trout | 33 | 224 | 72 | 7 | 1 | 337 |
| | | | | | | sculpin | 14 | | | | | 14 |
| 1 Lower | 395 | 6 | 69 | 2.2 | 8 | Coastal rainbow trout | 37 | 415 | 87 | 12 | 1 | 552 |
| 2 Upper | 1066 | 9 | 70.3 | 1.5 | 10 | coastal rainbow trout | 182 | 636 | 265 | 21 | 1 | 1105 |
| | | | | | | sculpin | 2 | | | | | 2 |
| | | | | | | Sacramento pikeminnow | 100 | | | | | 100 |
| 2 Lower | 333 | 6 | 67 | 2.1 | 6 | coastal rainbow trout | 37 | 407 | 109 | 21 | 1 | 575 |
| | | | | | | sculpin | 1 | | | | | 1 |
| 3 | 969 | 7 | 109.6 | 1.9 | 10 | coastal rainbow trout | 18 | 148 | 155 | 24 | 3 | 348 |
| | | | | | | Sacramento sucker | 25 | | | | | 25 |
| 4-Pool 1 | 633 | 8 | 82 | 3.5 | 8 | coastal rainbow trout | 2 | 90 | 91 | 71 | 2 | 256 |
| | | | | | | unknown non-salmonid | 440 | | | | | 440 |
| | | | | | | Sacramento pikeminnow | 3 | | | | | 3 |
| | | | | | | spotted bass | 6 | | | | | 6 |
| 4-Pool 2 | 631 | 8 | 117.8 | 4.1 | 8 | coastal rainbow trout | 0 | 30 | 32 | 52 | 14 | 128 |
| | | | | | | unknown non-salmonid | >1000 | | | | | >1000 |
| | | | | | | unknown minnow | 1734 | | | | | 1734 |
| | | | | | | unknown bass | 1 | | | | | 1 |
| | | | | | | Sacramento sucker | 91 | | | | | 91 |
| 4-Pool 3 | 712 | 8 | 85.2 | 2.7 | 6 | coastal rainbow trout | 0 | 23 | 56 | 61 | 6 | 146 |
| | | | | | | unknown non-salmonid | 250 | | | | | 250 |
| | | | | | | Sacramento pikeminnow | 32 | | | | | 32 |
| | | | | | | unknown minnow | 2500 | | | | | 2500 |
| | | | | | | Sacramento sucker | 267 | | | | | 267 |
| | | | | | | spotted bass | 18 | | | | | 18 |

Table 2. Coastal rainbow trout density estimates based on fish observed during 2007 and 2008 direct observation surveys

| 2008 | | | |
|---|---|---|---|
| **Section #** | **Section Length (ft)** | **Total # coastal rainbow trout observed** | **Trout per mile** |
| 1 | 1096 | 337 | 1624 |
| 1 Lower | 395 | 552 | 7379 |
| 2 Upper | 1066 | 1105 | 5473 |
| 2 Lower | 333 | 575 | 9117 |
| 3 | 969 | 348 | 1896 |
| 4-Pool 1 | 633 | 256 | 2135 |
| 4-Pool 2 | 631 | 128 | 1071 |
| 4-Pool 3 | 712 | 146 | 1083 |
| Total | 5835 | 3447 | 3119 |

| 2007 | | | |
|---|---|---|---|
| **Section #** | **Section Length (ft)** | **Total # coastal rainbow trout observed** | **Trout per mile** |
| 1 | 1096 | 583 | 2809 |
| 1 Lower | 179 | 447 | 13185 |
| 2 Upper | 648.5 | 2655 | 21617 |
| 2 Lower | 215 | 692 | 16994 |
| 3 | 969 | 1103 | 6010 |
| 4-Pool 1 | 593 | 2352 | 20942 |
| 4-Pool 2 | 590 | 146 | 1307 |
| 4-Pool 3 | 714.4 | 195 | 1441 |
| 5 | 106 | 61 | 3038 |
| 6 | 236.7 | 82 | 1829 |
| Total | 5347.6 | 8316 | 8211 |

## Discussion:

In certain sections (see Table 2), total section length differed from year to year. Although our goal is to keep section length consistent from year to year, it was sometimes difficult to locate the end of the section, even when we performed reconnaissance to locate upstream and downstream boundaries before initiating the survey. A comparison of total trout counted in these sections may be misleading; comparing trout densities is more accurate because it accounts for differences in section length. Estimated coastal rainbow trout density in the Upper Sacramento River decreased from 2007 to 2008, both overall and between sections. Based on average water depths and wetted widths, flow levels were similar in 2007 and 2008. Water visibility varied between years and either increased or decreased, depending on the section. In 2008, more divers participated in the surveys overall, which is likely to have increased fish detection during the surveys. Diver experience and/or natural fluctuations in the population may have played a role in lower 2008 fish counts; however, this water should be closely monitored to better understand the population dynamics of this system and whether the perceived decline in trout numbers is due to natural population cycles, habitat limitations or sampling variation and/or error.

As mentioned earlier, Sections 1 and 2 fall outside of the Wild Trout-designated area, whereas Sections 3 and 4 are within the Wild Trout designation. A comparison of trout densities between these two areas shows a higher density of trout near the stocked (non-Wild Trout) portion of the river. There are approximately 4694 trout per mile in the

vicinity of Sections 1 and 2, as compared to 1574 trout per mile in the vicinity of Sections 3 and 4 (Wild Trout Water). It is possible that the higher density estimates in the stocked portion of the river is due to artificial supplementation; however, it is important to acknowledge and understand the effects of stocking on wild trout population dynamics. In Section 1, divers noted apparent mouth injuries on some of the trout. This may be due to angling, a natural phenomenon in the system, or hatchery influence. An electrofishing effort might be useful to quantify the proportion of hatchery versus wild fish in the Upper Sacramento River and the extent of hatchery fish movement and distribution, both in the Wild Trout and non-Wild Trout portions of the system.

All size classes of trout were well represented, including some beautiful trophy-sized coastal rainbow trout (greater than 18 inches). Based on voluntary angler survey forms, anglers have periodically reported catching brown trout (*Salmo trutta*) on the Upper Sacramento River. However, zero brown trout were observed in any of the 2007 or 2008 surveys. It is possible that any (or all) of the following may account for the lack of detection of brown trout by HWTP divers in this system: brown trout were hidden in cover or deep habitat and divers did not see them; brown trout may have been misidentified by HWTP divers as coastal rainbow trout; anglers inadvertently misidentified their catch and mistakenly reported brown trout; anglers knowingly misreported catching brown trout; or brown trout may not present in any of the sections HWTP divers have sampled.

Shasta Dam, built in the 1940s, had a tremendous impact on the fishery of the Upper Sacramento; it effectively closed this section of the river to anadromous fishes, including steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha).* It also altered the hydrology and morphology of the river downstream of the dam, decreasing its sinuosity and providing more constant water flows and temperatures throughout the year. The dam was initially constructed for flood control, although it is now a fixture of California's Central Valley landscape that provides water, power, and recreational opportunities to an ever-growing population. As more water is diverted and stored within Shasta Lake, it becomes all the more important to monitor the Upper Sacramento trout fishery's health.

The Fishery Management Plan for the Upper Sacramento River (Box Canyon Dam to Lake Shasta) (2000) recommends obtaining indices of trout abundance every second or third year through a combination of snorkel surveys in established index reaches, return of volunteer angler survey forms, and electrofishing surveys. The HWTP recommends expanding future surveys to include tributaries and other survey methodology such as electrofishing. Currently, out of the four established index reaches, only two are within the designated Wild Trout portion of the river. If the goals of future surveys include an assessment of the wild trout fishery, then new sections should be selected in the Wild Trout-designated area, specifically, in some of the tributaries and farther upstream in the headwaters. Given that divers cannot easily identify hatchery from wild fish based on visual observation, the value of maintaining sections in the non-Wild Trout portion of the river is questionable. The management plan includes a delineation of the stream into distinct habitat types and categorizes the river as 25% pool, 40% riffles (which includes

pocketwater), and 35% runs. Future survey sections should be chosen with a stratified random sampling methodology based on this habitat typing for the main-stem Upper Sacramento River and should include sampling of some of its tributaries. None of the established survey sections are in the dominant (riffle) habitat type. As noted in the results, the informal findings from the 2008 surveys in the vicinity of the Section 4 pools indicate that important fish population data may be overlooked by subjectively choosing to sample and tally fish counts only in the non-connected pool habitats.

## References: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