Hat Creek 2010 summary report

July 22, 23, and 29, 2010

State of California

Natural Resources Agency

Department of Fish and Game

Heritage and Wild Trout Program

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Introduction:

Hat Creek, tributary to the Pit River at Lake Britton (Shasta County; Figure 1), was one of the first waters in California to receive designation as a Wild Trout Water by the California Fish and Game Commission (CFGC). This designation includes approximately 3.5 miles of stream habitat from Lake Britton upstream to Hat #2 Powerhouse (Figure 2) that is managed by the California Department of Fish and Game (DFG) Heritage and Wild Trout Program (HWTP). Wild Trout Waters are those that support self-sustaining trout populations, are aesthetically pleasing and environmentally productive, provide adequate catch rates in terms of numbers or size of trout, and are open to public angling. Wild Trout Waters may not be stocked with catchable-sized hatchery trout (Bloom and Weaver 2008). Hat Creek contains wild populations of rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and numerous non-game species. The HWTP monitors the fishery by conducting population, habitat, and angler assessments. Since 2007, the HWTP has conducted annual direct observation snorkel surveys along 1.7 miles of Hat Creek (Section 1), within the Wild Trout-designated section, from the Powerhouse # 2 riffle (just downstream of the dam) to the Highway 299 Bridge (Weaver and Mehalick, 2007-2009).

In 2009, the HWTP recommended that future monitoring efforts encompass the entire length of the Wild Trout-designated reach to obtain species composition, size class structure, and density estimates for the entire area managed by the HWTP (Weaver and Mehalick 2009). In an effort to evaluate detection rates using direct observation, the HWTP also recommended conducting an electrofishing effort in concert with direct observation in Section 1. Results from these two different survey methods could then be compared to assess the limitations and advantages of the two different sampling methods.

Turbidity and aquatic vegetation may negatively affect direct observation detection of fishes in Hat Creek. Detection and identification to species of small fishes has been difficult in the past, and detection of larger-sized brown trout may be limited due to habitat preferences. Based on these recommendations, in 2010 the HWTP:

- Conducted direct observation snorkel surveys of the entire Wild Trout-designated reach, including Section 1 (historic) and Section 2 (newly established in 2010; Figures 3 and 4).

- Conducted boat electrofish surveys to compare species composition and salmonid size class structure to that observed during the snorkel surveys and to identify non-game fishes.

- Continued monitoring and maintenance of the four Angler Survey Boxes (ASB) on Hat Creek to better understand catch rates, catch sizes, angler preferences, and angler satisfaction.

Figure 1. Vicinity map of Hat Creek 2010 survey location.

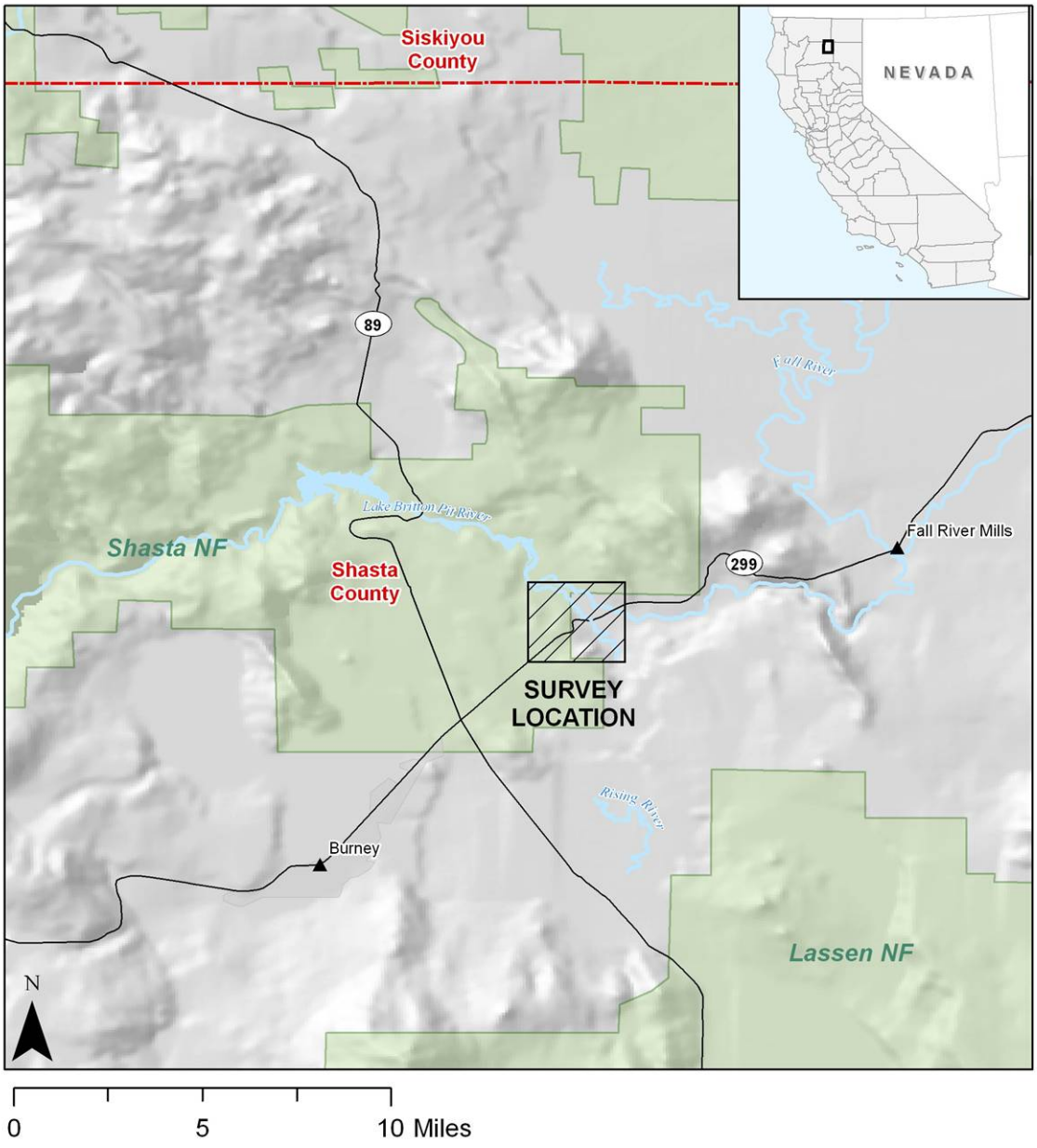
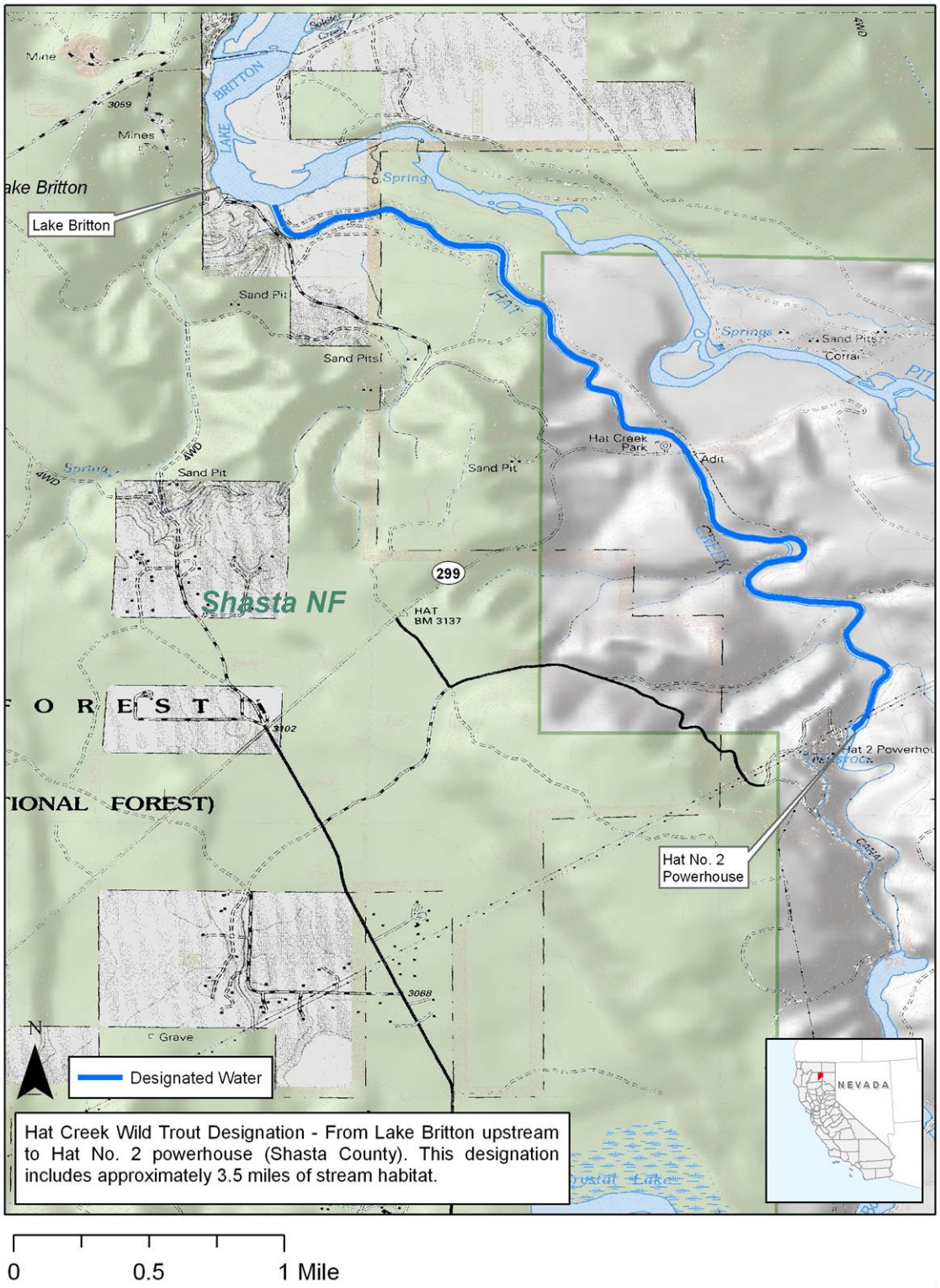


Figure 2. Map of Hat Creek Wild Trout-designated reach.



Methods:

Direct Observation

Direct observation surveys were conducted using snorkeling methods, an effective survey technique in many streams and creeks in northern California and the Pacific Northwest (Hankin and Reeves, 1988). Section 1 (historic) was surveyed via direct observation on July 22, 2010; the survey extended from the riffle below Hat Creek Powerhouse #2 to the Highway 299 Bridge (Figures 3 and 4). Section 2 (established in 2010) was surveyed via direct observation on July 29, 2010 and was selected in order to expand the sampling frame and obtain population estimates for the remaining portion of the Wild Trout-designated reach. Section 2 extended from Hat Creek Park downstream to the buoy line associated with the barrier upstream of Lake Britton (Figures 3 and 4). The number of divers was determined based on stream width, water visibility, habitat complexity, and the availability of personnel trained in direct observation survey techniques. Thirteen divers participated in the Section 1 survey and 16 divers surveyed Section 2 (not including the two additional back-up divers). Divers, maintaining an evenly-spaced line perpendicular to the current, surveyed in a downstream direction and 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). The YOY category is defined by the HWTP as age 0+ fish, emerged from the gravel in the same year as the survey. Depending on species, date of emergence, relative growth rates, and habitat conditions, the size of YOY varies greatly, but is generally between zero and three inches in total length. If a trout was observed to be less than six inches but 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. Two personnel on paddle craft followed behind the divers to assist them in maintaining their dive lanes, acted as a safety backup and lookout for the dive team and recorded data for the divers at intervals throughout the section. Two additional divers followed behind the survey effort to more thoroughly examine areas with decreased visibility (i.e. undercut banks and woody debris complexes). Basic habitat attributes were measured including water temperature (ºC), water visibility (ft), average wetted width (ft), and average water depth (ft). Coordinates were recorded for both the upstream and downstream boundaries of the survey using Global Positioning System hand-held units (North American Datum 1983) and representative photographs of each section were taken. Section length was determined based on previous survey efforts and GIS analysis.

Electrofishing

A boat electrofishing effort was conducted on Hat Creek Section 1 on July 23, 2010 to compare species composition and salmonid size class structure to that observed during the direct observation survey. The survey was conducted with a Smith Root SR-16 electrofishing boat in a downstream direction with two netters. The electrofishing effort was not initiated to establish population or abundance estimates but, rather, to target a variety of micro-habitat types in an effort to capture the broadest ranges of species composition and size classes. This effort was conducted in areas of Section 1 in which water depths were conducive to boat electrofishing. Physical measurements of the stream and environmental conditions were taken, including air and water temperature (ºC) and conductivity (both specific and ambient in microsiemens). These factors were used to determine appropriate electroshocker settings. Over the course of the survey, fish were handled carefully to minimize injury and stress. All fish were identified to species (or genus if species-level identification was not possible) and were weighed (g) and measured (total length in mm). Fish were then recovered in live cars secured in the stream (with fresh flowing water) and released back into the section. Representative photographs were taken.

While processing fish collected during the 2010 electrofishing effort, fish handlers noted external black spotting on nearly 100% of the trout and some suckers (*Catostomus* sp.). Trout were collected by HWTP Northern Region biologists in August and September, 2010 for the purpose of pathological analyses. Hat Creek was stratified into three sections (upstream of the Powerhouse #2 outflow, downstream of the Powerhouse #2 outflow, and downstream of Highway 299) and surveyors used Smith Root backpack electroshockers to collect a minimum of 20 salmonids in each of the three sections. A total of 70 rainbow trout and 15 brown trout were collected and processed in the field; the head of each trout was removed, placed in an individual plastic bag labeled with information pertaining to that fish, and stored on ice in a cooler until transported to a freezer at the DFG Northern Region office. In addition, a few trout were collected and maintained as whole specimens. Samples were transported frozen to the DFG Fisheries Pathology Laboratory (Rancho Cordova, CA). The whole specimens were retained at this facility and assayed for black spot disease. The head samples were sent to the Washington Animal Disease Diagnostic Laboratory (Pullman, WA) where they were assayed for whirling disease and other cranial myxosporeans.

Angler Survey

There are four ASBs located within the Wild Trout-designated section of Hat Creek (at Hat Creek Park, Highway 299, Powerhouse #2, and Carbon Bridge; Figures 3-4). An examination of voluntary angling data obtained at these four ASB locations provides further insight into this fishery from an angler perspective including catch rates, catch sizes, angler preferences, and angler satisfaction. All completed forms received from these boxes from 2003 through 2008 were

examined (Table 4 and Figures 7-9). Forms which were missing pertinent information such as the date or number of hours fished were removed from this analysis.

Figure 3. Detail map of Hat Creek 2010 survey sections and ASB locations.

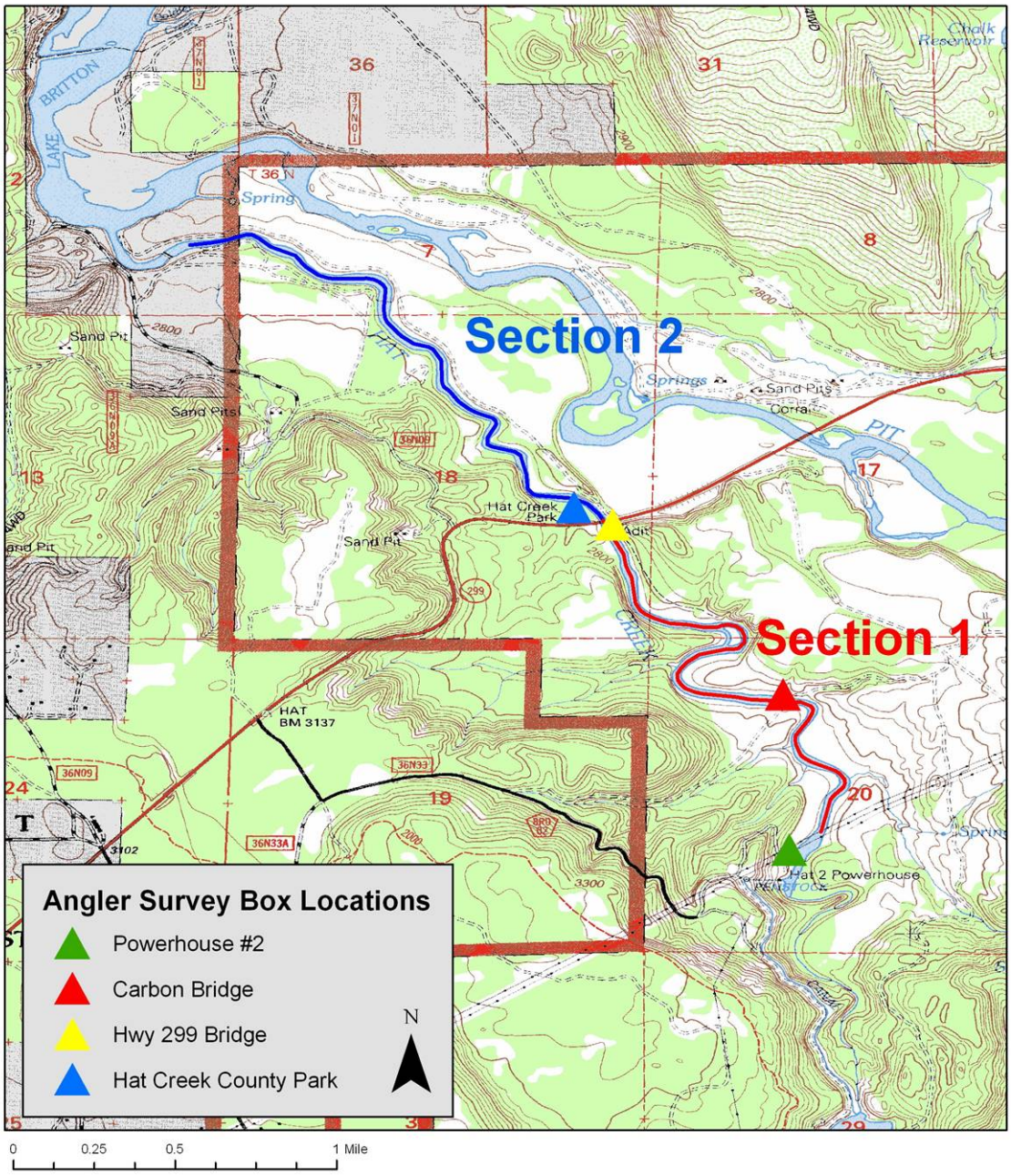
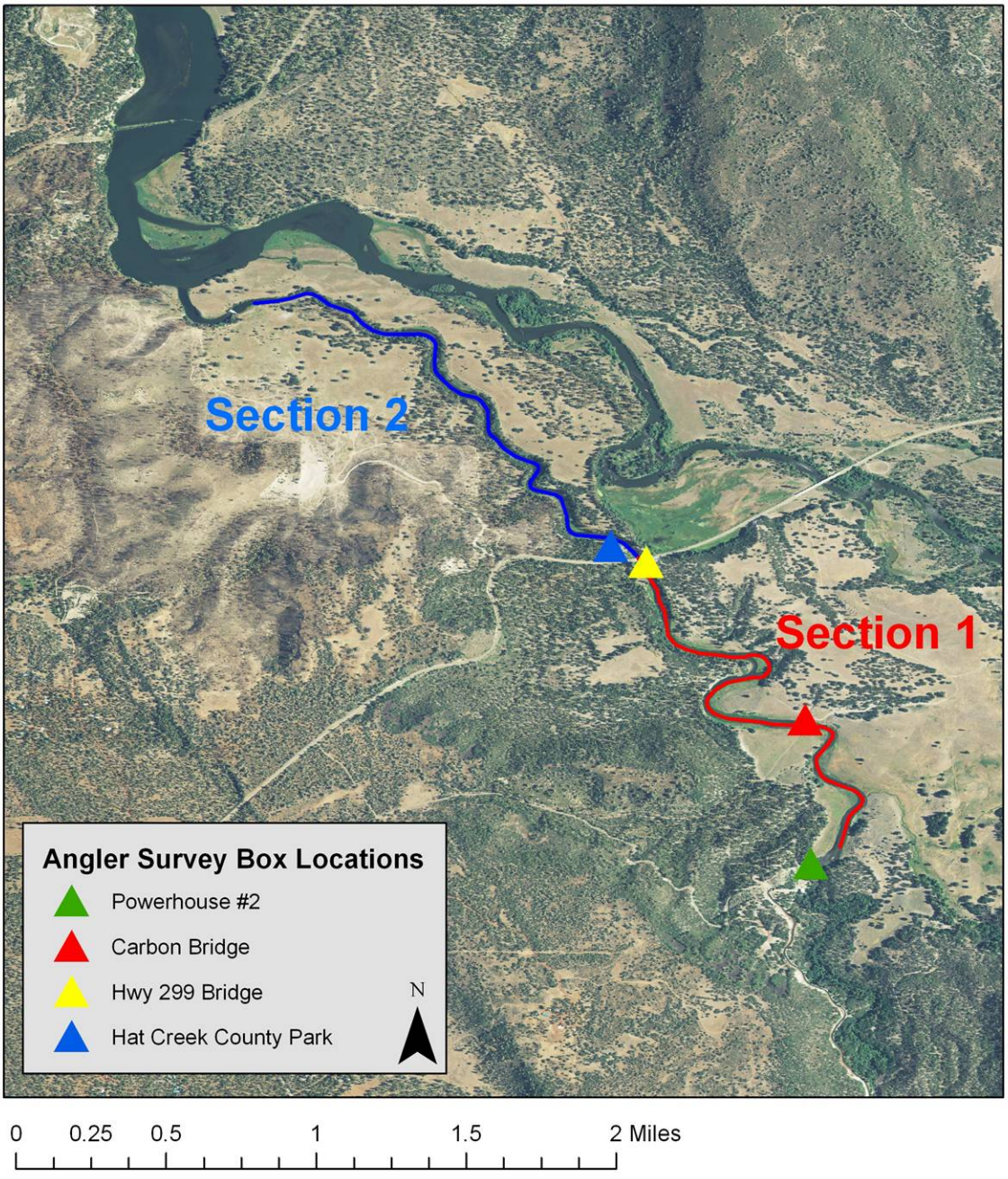


Figure 4. Aerial map of Hat Creek 2010 survey sections and ASB locations.



Results:

Direct Observation

Section 1 was approximately 1.7 miles in total length with an average wetted width of 121 feet and an average water depth of 2.8 feet. Weather conditions

were sunny and clear during the survey. Water visibility was approximately five feet in this flatwater-dominated section. Divers observed a total of 3381 rainbow trout, five brown trout, 18 sculpin (*Cottus* sp.*)*, 1345 suckers, 30 speckled dace (*Rhinichthys osculus*), and 7805 unknown fishes (Table 1). Sculpin and suckers were not identified to species. The unknown fishes were too small to identify and may have included cyprinids and/or catostomids. Also observed were western pond turtles (*Clemmys marmorata*)*,* mussels (not identified to species), crayfish (*Pacifastacus* sp.), and two dead rainbow trout. Rainbow trout size class distribution was less than 1% YOY, 87% small, 12% medium, less than 1% large, and less than 1% extra-large-sized fish. Brown trout size class distribution was 60% small and 40% medium-sized fish. Estimated abundance in Section 1 was 1989 rainbow trout per mile, three brown trout per mile, 11 sculpin per mile, 791 suckers per mile, 18 speckled dace per mile, and 4591 unknown fishes per mile.

Section 2 was approximately 1.5 miles in total length with an average wetted width of 119 feet and an average water depth of 2.2 feet. Weather conditions were sunny and clear during the survey and water visibility was approximately two feet. Fish detection may have been limited due to poor water visibility, turbidity caused by divers, and/or complex cover (large woody debris, overhanging vegetation, boulders, and bubble curtains). Water velocity varied across the wetted width in many areas and divers had difficulty maintaining a dive line in this section. Divers in both the main current and slower velocity areas often had to swim (either to increase or decrease their speed) or place their feet in the streambed to maintain the dive line, resulting in decreased water visibility directly downstream of the survey effort. The edgewater habitat in Section 2 was especially problematic due to slow water velocities, silt, shallow water, and the presence of cover (woody debris and overhanging vegetation). Habitat was dominated by flatwater with varied water velocities and substrate included cobbles, boulders, and silts (in contrast to Section 1 which had relatively laminar flow and substrate dominated by silts and sands). Divers observed a total of 1964 rainbow trout, six brown trout, 152 unknown trout, 11 sculpin, 459 suckers, and 122 unknown fishes (Table 1). The latter may have included cyprinids and/or catostomids. Size class distribution of rainbow trout was 3% YOY, 83% small, 11% medium, 3% large, and less than 1% extra-large sized fish. Size class distribution of brown trout was 67% small, 17% medium, and 17% large-sized fish. Estimated abundance in Section 2 was 1309 rainbow trout per mile, four brown trout per mile, 101 unknown trout per mile, seven sculpin per mile, 306 suckers per mile, and 81 unknown fishes per mile.

Overall abundance in the Hat Creek Wild Trout-designated reach (Sections 1 and 2 combined) was estimated at 1670 rainbow trout per mile, three brown trout per mile, 48 unknown trout per mile, nine sculpin per mile, 564 suckers per mile, nine speckled dace per mile, and 2477 unknown fishes per mile.

Table 1. Summary of Hat Creek 2010 direct observation survey results including the number of fish observed and estimated density by species. Only trout species were counted by size class.

Hat Creek Section 1

Species	YOY	Small	Medium	Large	Extra-large	Total	Estimated density (fish/mile)
		< 6"	6"- 11.9"	12-17.9"	≥18"		
rainbow trout	20	2932	399	27	3	3381	1989
brown trout	0	3	2	0	0	5	3
sculpin						18	11
suckers						1345	791
speckled dace						30	18
unknown fishes						7805	4591

Hat Creek Section 2

Species	YOY	Small	Medium	Large	Extra-large	Total	Estimated density (fish/mile)
		< 6"	6"- 11.9"	12-17.9"	≥18"		
rainbow trout	53	1630	216	54	11	1964	1309
brown trout	0	4	1	1	0	6	4
unknown trout	3	123	22	3	1	152	101
sculpin						11	7
suckers						459	306
unknown fishes						122	81

Hat Creek Sections 1 and 2 combined

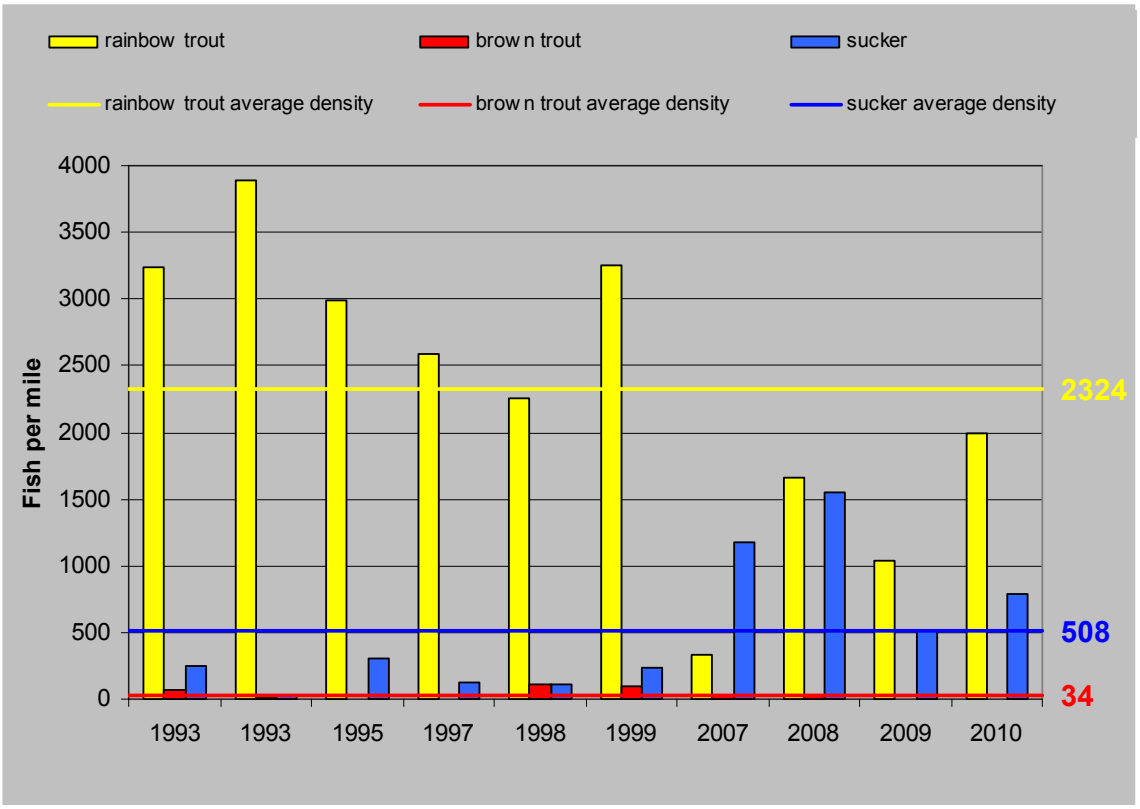
Species	YOY	Small	Medium	Large	Extra-large	Total	Estimated density (fish/mile)
		< 6"	6"- 11.9"	12-17.9"	≥18"		
rainbow trout	73	4562	615	81	14	5345	1670
brown trout	0	7	3	1	0	11	3
sculpin						29	9
suckers						1804	564
speckled dace						30	9
unknown fishes						7927	2477
unknown trout	3	123	22	3	1	152	48

The HWTP has a long-standing dataset on Hat Creek Section 1; a comparison of current year results with past data can be used to study trends in the population (Table 2). Data prior to 2007 include counts for rainbow trout, brown trout, and suckers. A density estimate was generated for each of these species for the years 1993 through 2010 based on the total number of fish observed in Section 1 (Figure 5). These estimates were then averaged across all years. This allows for a comparison between the most recent estimated density of a species and the long-term average density based on historic data. Rainbow trout densities in Hat Creek Section 1 have ranged from 336 fish per mile (2007) to 3890 fish per mile (1993) with an average of 2324 fish per mile. The estimated density of rainbow trout in Section 1 in 2010 (1989 fish per mile) is lower than the long-term aggregate average. Brown trout densities observed in Section 1 have ranged from zero fish per mile (2009) to 112 fish per mile (1998) with an average of 34 fish per mile. The brown trout density observed in 2010 (3 fish per mile) was slightly lower than the long-term average. Density estimates for suckers have ranged from 25 fish per mile (1993) to 1545 fish per mile (2008) with an average of 508 fish per mile. The sucker density observed in 2010 (791 fish per mile) is slightly higher than the long-term average. From 2007 through 2010, surveys were conducted annually on Hat Creek Section 1 and divers observed other non-game fishes in relatively low densities including Sacramento pikeminnow, sculpin, and unidentified fishes. The first observation of speckled dace by the HWTP in the Hat Creek Wild Trout-designated section occurred in 2010.

Table 2. Hat Creek Section 1 direct observation data from 1993-2010.

Survey Date	# of Divers	rainbow trout		brown trout		Sacramento sucker	
		# observed	density (fish/mile)	# observed	density (fish/mile)	# observed	density (fish/mile)
8/19/1993	8	5499	3235	117	69	422	248
8/26/1993	14	6613	3890	18	11	43	25
8/3/1995	11	5080	2988	3	2	512	301
8/7/1997	9	4394	2585	5	3	217	128
7/28/1998	13	3846	2262	191	112	198	116
8/3/1999	14	5523	3249	161	95	402	236
7/16/2007	9	572	336	38	22	1999	1176
7/28/2008	14	2831	1665	46	27	2626	1545
7/21/2009	9	1762	1036	0	0	873	514
7/22/2010	13	3381	1989	5	3	1345	791
Average	**-**	**-**	**2324**	**-**	**34**	**-**	**508**

Figure 5. Graph of Hat Creek Section 1 direct observation data from 1993-2010.



Electrofishing

The boat electrofishing effort in Section 1 resulted in the capture of 185 rainbow trout, 29 brown trout, 85 suckers, 26 sculpin, and one lamprey (*Lampetra* sp.; Table 3). The HWTP targeted areas where boat electroshocking was feasible and did not attempt to collect all fish within Section 1; therefore, abundance estimates were not generated from the electrofishing effort. Captured rainbow trout ranged in size from 62 mm (2.4 in) to 425 mm (16.7 in) total length with an average of 153 mm (6.0 in). Captured brown trout ranged in size from 79 mm (3.1 in) to 590 mm (23.2 in) total length with an average of 203 mm (8.0 in). Captured suckers ranged in size from 65 mm (2.6 in) to 574 mm (22.6 in) total length with an average of 363 mm (14.3 in). Captured sculpin ranged in size from 69 mm (2.7 in) to 132 mm (5.2 in) with an average of 91 mm (3.6 in). The one captured lamprey was 105 mm in total length. To compare size class distribution between the two survey types, trout captured during the electrofishing effort were categorized by size class (small to extra-large). YOY were not differentiated from small-sized fish for this effort. Rainbow trout size class distribution was 63% small, 28% medium, and 9% large-sized fish. Brown trout size class distribution was 62% small, 17% medium, 3% large, and 17% extra-large sized fish (Figures 10 -11).

Table 3. Summary of 2010 Hat Creek Section 1 boat electrofish data.

Hat Creek Section 1						
Section	Species	Number of fish captured				Total
		Small	Medium	Large	X-Large	
		<6"	6"-11.9"	12"-17.9"	≥18"	
1	rainbow trout	116	52	17	0	185
1	brown trout	18	5	1	5	29
1	Sacramento sucker					85
1	sculpin					26
1	lamprey					1

Pathological Assays

The Washington Animal Disease Diagnostic Laboratory assayed 56 trout samples for whirling disease; all tested negative (not all samples were tested). Trout specimens assayed at the DFG Fisheries Pathology Laboratory tested positive for black spot disease, a parasitic disease that infects the muscle of the fish (Figure 6). Black-spot disease is caused by numerous species of *Neascus* and its life-cycle includes three hosts (snails, fish, and fish-eating birds). Black-spot disease may cause fish mortality in heavily infected populations (United States Fish and Wildlife Service 2009).

Figure 6. Photographs of rainbow trout captured in Hat Creek in 2010 with black body spotting (black spot disease).

Angler Survey

Data from the four Hat Creek ASB were examined for the years 2003-2010. In 2010, a total of 155 forms were completed with an average catch rate of 1.37 fish per hour (Table 4). The average catch rate appears relatively consistent over time, with anglers reporting approximately one fish per hour for each year from 2003-2010. In 2010, anglers reported catching 569 rainbow trout and 100 brown trout (Figure 7). ASB data show that rainbow trout were the dominant trout species caught in Hat Creek each year since 2003. In 2010, size class distribution of captured rainbow trout was 22% small, 53% medium, 16% large, and 9% extra-large sized fish (Figure 8). The brown trout reported caught consisted of 3% small, 17% medium, 27% large, and 53% extra-large sized fish (Figure 9). Size class distribution of captured rainbow trout appears relatively consistent over time; however, the percentage of extra-large sized brown trout reported caught in 2010 was much higher than in previous years.

Table 4. Summary of Hat Creek ASB data (Hat Creek Park, Highway 199, Carbon Bridge, and Powerhouse #2) from 2003-2010.

Year	# Forms	Total hours fished	Total fish reported caught	Catch per hour
2003	127	402.5	521	1.29
2004	73	221.8	203	0.92
2005	156	485.8	362	0.75
2006	131	404	320	0.79
2007	154	489.5	433	0.88
2008	125	400.5	352	0.88
2009	141	432.5	428	0.99
2010	155	487	669	1.37

Figure 7. Hat Creek ASB data showing the number of fish reported caught by species from 2003-2010.

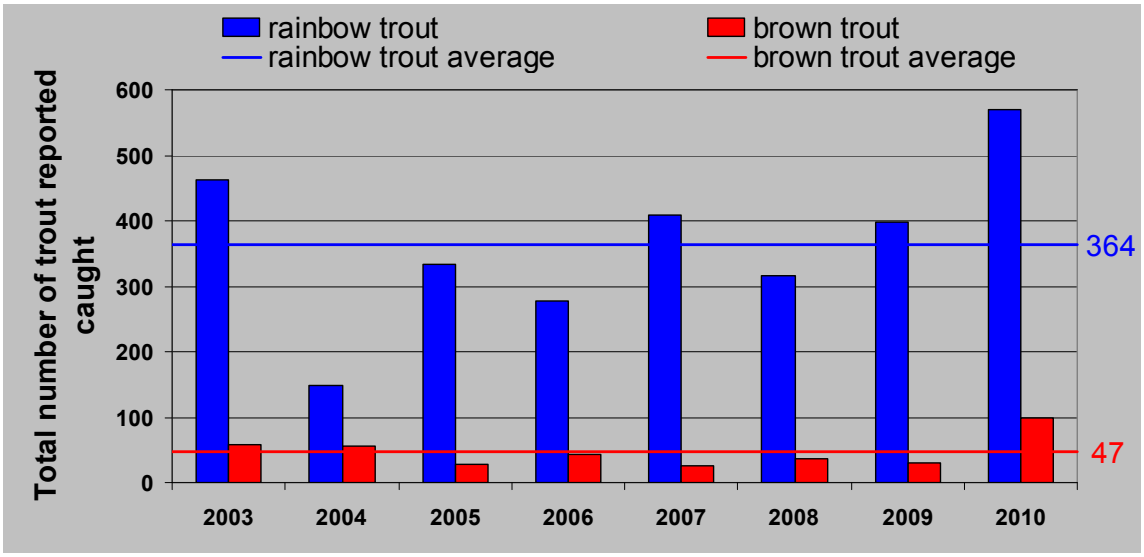


Figure 8. Graph of Hat Creek ASB data showing the number of rainbow trout reported caught by size class from 2003-2010.

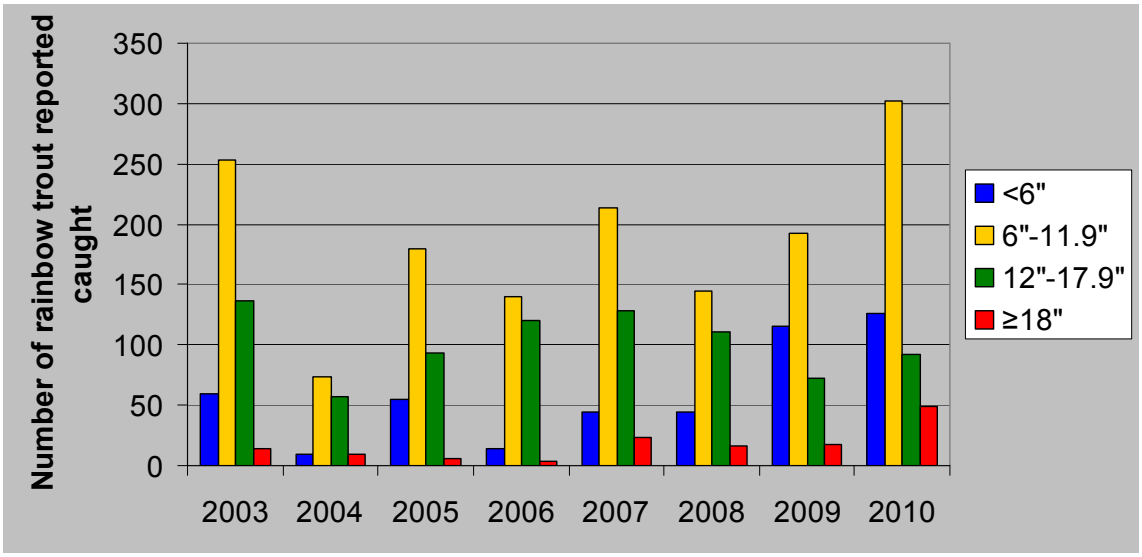
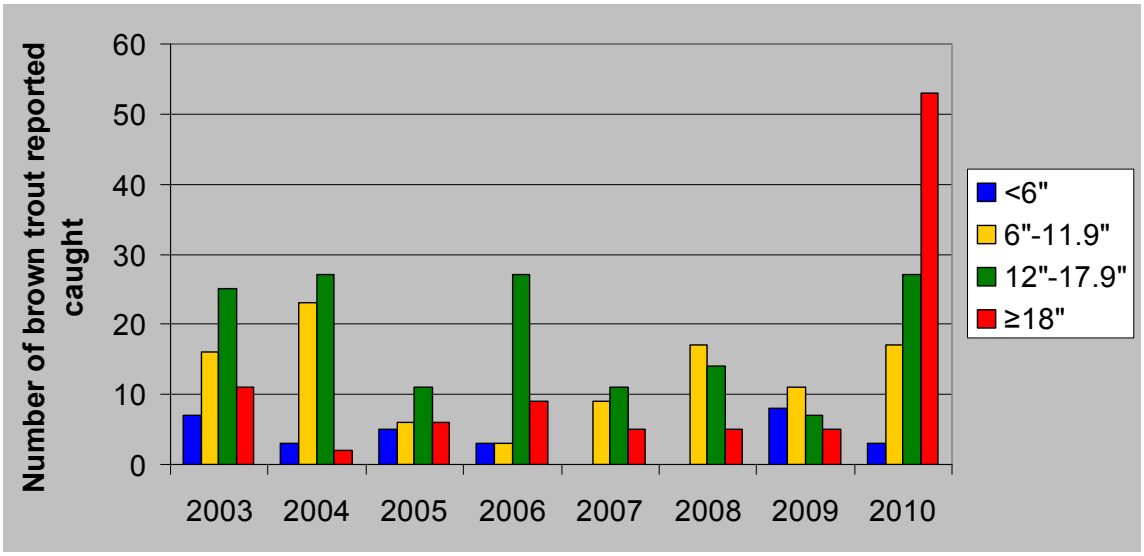


Figure 9. Graph of Hat Creek ASB data showing the number of brown trout reported caught by size class from 2003-2010.



Discussion:

A comparison of 2010 Hat Creek direct observation data between Sections 1 and 2 show similar trout density and size class distribution, with the exception of a higher percentage of larger-sized brown trout observed in Section 2. Section 2 was difficult to snorkel and fish detection (and, therefore, estimated density) may have been low. However, the higher percentage of larger-sized brown trout detected may be a function of surveyors taking more time to thoroughly inspect edgewater habitats and areas with log jams and woody debris and/or due to the effect of differing micro-habitats on flight response. The HWTP recommends refining survey techniques in this section to address changes in water velocity, both across the stream channel and throughout the section, and to develop techniques to improve fish detection in the slow edgewater habitats. In the faster water habitat, disturbance of fish by divers appeared low with trout maintaining micro-habitat site fidelity as divers approached within a few feet. The feasibility of separating the slower edgewater and faster mid-channel habitats should be examined; an upstream survey of the edgewater may limit diver-induced turbidity and increase fish detectability in areas with complex cover.

The HWTP also compared trout size class structure between the three survey types (direct observation, boat electrofishing, and analysis of ASB data) utilized in 2010. The electrofishing survey captured a higher percentage of larger-sized rainbow and brown trout than detected during direct observation (Figures 10 and 11), which was an expected result that needed validation. Zero brown trout greater than 12 inches in length were observed during the snorkel surveys, whereas 20% of brown trout captured during the electrofishing survey were

larger than 12 inches (large to extra-large sized fish). The proportion of rainbow trout to brown trout captured during the electrofishing effort was six to one, while the proportion was 676 to one observed during the snorkel survey. It is likely that brown trout detectability may be poor during direct observation (and, conversely, rainbow trout detectability may be high) due to differential habitat preferences, species-specific flight response, misidentification, and/or other factors. Sculpin captured during the electrofishing effort included bigeye marble sculpin (C. *klamathensis macrops*), although identification to species was difficult and each individual sculpin was not identified to species. Numerous juvenile fishes were observed in the stream margins during both survey efforts (these accounted for the majority of unknown fishes observed in Section 1 during direct observation); these fishes were not captured during electrofishing. This may be due to direct observation and electrofishing survey bias against smaller fishes and/or the mesh size of nets and perforation size of live cars were too large to hold fish in this size range. Surveyors hand-netted some of these fishes but they were too small to identify to species. One lamprey was captured during electrofishing, although zero were observed during direct observation.

The ASB data showed the highest percentage of larger-sized trout compared to either direct observation or electrofishing results. This may be due to angler bias. Anglers may inflate their catch sizes and/or exclusively target larger trout by technique and habitat. However, it is interesting to note that the proportion of extra-large rainbow trout reported caught (~10%) is considerably lower than that of brown trout (~50%), which may be reflective of accurate reporting. If anglers purposefully inflated their reporting of fish sizes, it would be reasonable to expect that they would do so for both rainbow and brown trout, but not necessarily one over the other. It is also worth noting that the relatively high proportion of extra-large brown trout captured during electrofishing is consistent with the high proportion of extra-large brown trout reported from ASB forms, another indication that anglers may be reporting their information accurately (Figure 11). An outlier analysis of the ASB form data may be useful in identifying potential inaccuracies in the data set, but was not performed for the purposes of this report.

Figure 10. Graph of 2010 Hat Creek data showing the percentage of rainbow trout captured or observed by size class via direct observation, electrofishing, and angler survey reports.

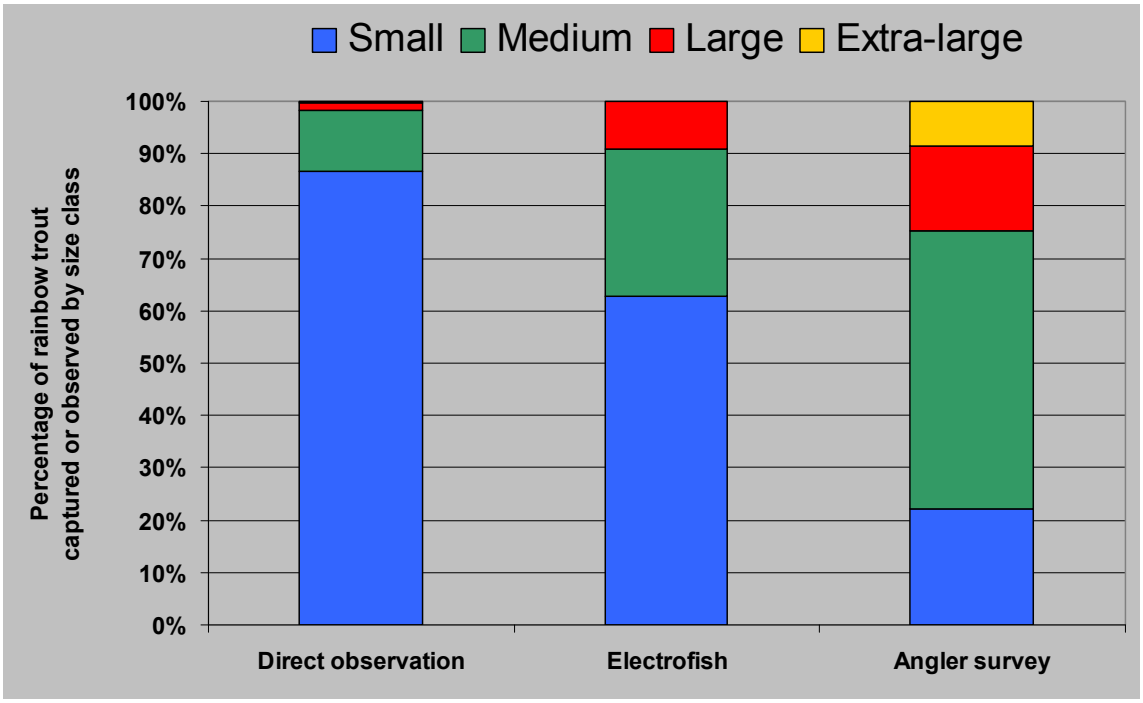
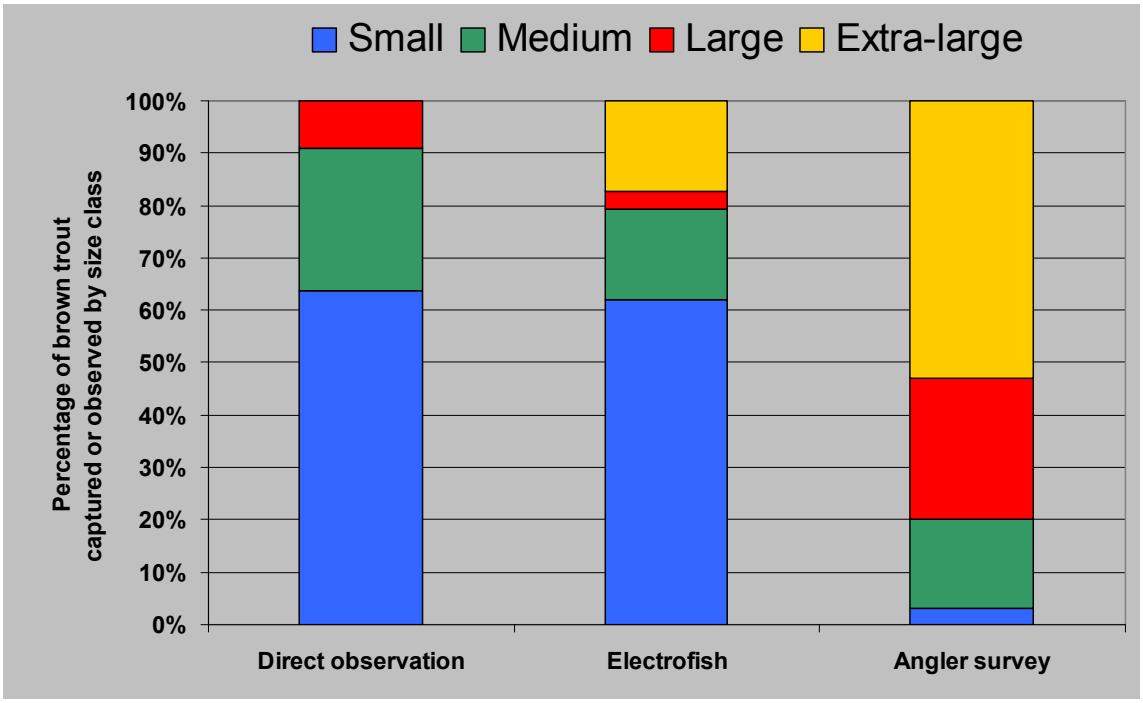


Figure 11. Graph of 2010 Hat Creek data showing the percentage of brown trout captured or observed by size class via direct observation, electrofishing, and angler survey reports.



Conclusion:

Hat Creek receives considerable fishing pressure, both within and outside of the Wild Trout-designated area. There is easy road access to the river and, during the course of the survey, a few anglers were observed on the water. Long-term monitoring shows a decline in trout numbers and a rise in sucker detection in recent years (2007-2010 compared to 1993-1998; Figure 5). Given that there is a seven year gap in the direct observation data set (2000-2006) and a noticeable shift in fish assemblage from 1999 to 2007, this fishery should continue to be closely monitored.

The HWTP is currently evaluating the need to update the Hat Creek Fishery Management Plan (FMP); this document provides management goals and strategies and will detail future monitoring efforts. Due to the importance of this fishery to the angling public, its designation as a Wild Trout Water, notable habitat changes (especially increased sedimentation between Hat Powerhouse #2 and the Highway 299 bridge), changes in species composition, and the apparent recent decline in trout numbers, the HWTP recommends continued population-level surveys on a semi-annual basis and annual angling (ASB) data analyses. Population-level monitoring should continue to include direct observation and/or electrofishing. Future direct observation surveys should continue to encompass the entire length of Hat Creek, from Powerhouse #2 riffle downstream to the mouth of Lake Britton in order to better assess the overall fishery and obtain more accurate fish counts and density estimates. Direct observation survey strategy and technique in the lower portion of the river (Section 2) should be further developed to increase fish detectability in the shallow edgewater and to maintain a better dive line.

Consideration should also be given to using mark recapture electrofishing surveys as a calibration tool for direct observation and to better understand fish abundance and size class structure. Black spot disease and its potential effects on the population should be monitored. The HWTP recommends continued annual monitoring of the four established ASBs. A creel census may also provide additional information on angler use, catch sizes and rates, and angler preferences and could be used for comparison to voluntary ASB data and past angler studies.

HWTP Northern Region biologists are currently seeking funding and evaluating feasibility of habitat restoration projects.

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