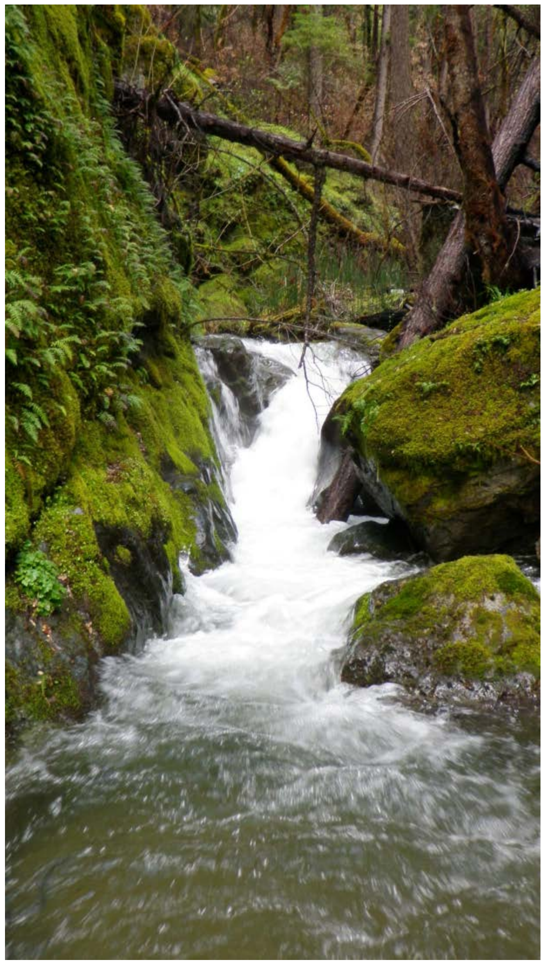
State of California
The Resources Agency
DEPARTMENT OF FISH AND WILDLIFE

2010 REPORT
TRINITY RIVER TRIBUTARIES
STEELHEAD SPAWNING SURVEY REPORT



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ABSTRACT

This report documents the results of spawning surveys conducted by the California Department of Fish and Game on selected Trinity River tributaries from March through May of 2010. This is a continuation of spawning surveys on selected tributaries and serves to create an index of spawning steelhead abundance by enumerating redds. Between March and May 2010, we observed a total of 141 redds in 65.08 kilometers of surveyed habitat. Overall redd density for all tributaries surveyed was 2.17 redds/kilometer. The highest redd density occurred in Grass Valley Creek (4.48 redds/km), while lowest density occurred in Rusch Creek (0.51 redds/km). Redds were observed in ten creeks surveyed; Dutch, Maxwell, South Fork Indian, Weaver, East Weaver, East Fork Hayfork, Sidney Gulch, Grass Valley, Rusch, and Big Creeks. No redds were observed in Potato, Bear, Packers, and West Weaver Creeks. A total of 6 fish were observed in Dutch, Weaver, East Weaver, and East Fork Hayfork Creeks.

INTRODUCTION

The current state of knowledge regarding steelhead (*Oncorhynchus mykiss*) spawning in the Trinity basin is limited. Steelhead found within the Trinity basin have been classified by the National Marine Fisheries Service as the Klamath Mountains Province (KMP) Steelhead based on geologic boundaries. These boundaries extend from the Cape Blanco area in southern Oregon to the Klamath River Basin in northern California (Figure 1) (Busby et al. 1994). This includes the Klamath, Trinity, Rogue, Elk, and Smith River Basins. In 2001, the KMP Steelhead were determined not warranted for listing by the Endangered Species Act (ESA) due to the fact they are not a separate evolutionarily significant unit (ESU) of the steelhead species. An ESU is a “reproductively isolated population” which “represents an important component in the evolutionary legacy of the species” (Waples 1991). The determination for this ESU was made by combining the winter, fall, summer, and nonanadromous populations within the KMP boundaries. The summer populations were labeled depressed, but the winter populations were labeled healthy and the ESA listing was deferred.

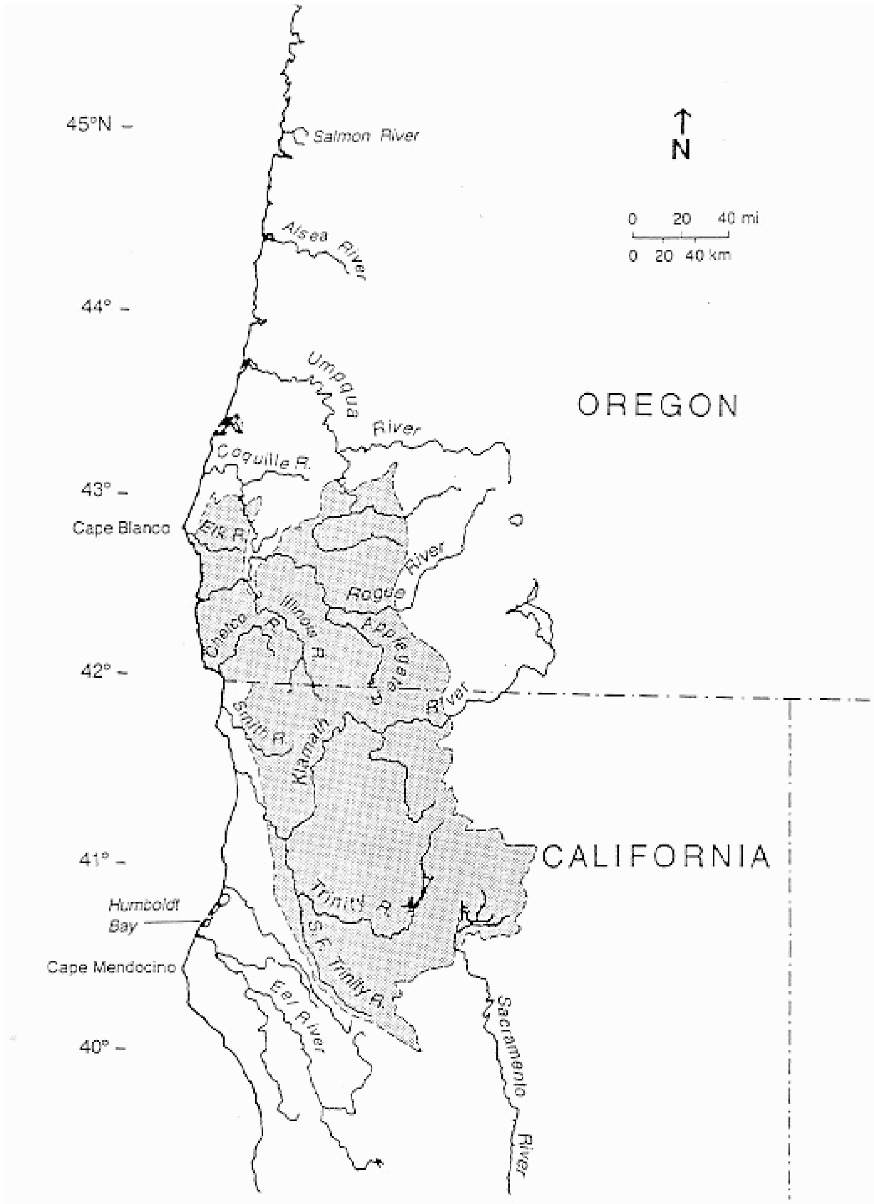

Figure 1. Map showing key geographic locations for the Klamath Mountains Geologic Province (modified from Irwin 1966 and Walker & MacLeod 1991).

Most prior spawner surveys within the Klamath Mountains Province concentrated on salmon and were therefore terminated prior to steelhead spawning. Prior surveys have been conducted on main-stem Trinity River tributaries in 1964, 1971, 1972, and 1973 to monitor the effect of Lewiston Dam on steelhead populations. Most recently, steelhead spawning surveys were conducted in South Fork Trinity River tributaries in 1990 - 1995 under the California Department Fish and Game's Trinity River Project. This is the tenth year of spawning surveys conducted by the Anadromous Fisheries Monitoring Assessment Program (formerly the Steelhead Research and Monitoring Program) on selected Trinity River tributaries which started in 2000. Traditional basin-wide estimates of steelhead abundance provide little information on the distribution of steelhead spawning. Surveys conducted to enumerate successful steelhead spawning and habitat utilization in tributaries will help to assess this critical component of life history.

Steelhead in the Trinity basin can be split into three races based upon spatial and temporal segregation: summer, fall, and winter which are all included in the same ESU (Busby et al. 1994). Summer-run fish enter freshwater in April through September and over-summer in deep pools prior to entering smaller tributary streams during the first November rains. They continue to migrate upstream through January, and spawn in January and February. (Barnhardt,1986). Fall-run fish, referred to as summer run-B in systems such as the Rogue, enter freshwater in September and October and spawn from January through April (Currier, personal communication). Winter-run steelhead enter the mouth of the Klamath and migrate upstream from November 1st through April 30th (Barnhardt, 1986). Winter-run steelhead spawning begins in early March and continues through May (Fukushima and Lesh, 1998). Historically, Moffitt and Smith (1950) observed, prior to the completion of Trinity Dam, that spawning of winter-run steelhead began in the upper Trinity drainage in the last part of February, peaking in late March and early April, with some scattered spawning continuing through early June. Previous spawning surveys of Trinity tributaries by the Department of Fish and Game from 2000-2009 showed that spawning in main-stem tributaries peaked by April 1st, approximately two to three weeks prior to peaks in the South Fork basin in April (Garrison, 2002).

Study Objectives

1. Quantify the number of steelhead redds in selected tributaries.

2. Assess spawning habitat conditions.

3. Create index for future comparison of redd numbers. Selected tributaries are included in future surveys for comparison and possible trend analysis.

4. Determine temporal and spatial spawning distribution of steelhead in Trinity River tributaries.

5. Verify and assess barriers to steelhead migration on surveyed tributaries.

6. Detect trends of redd abundance of selected tributaries in relation to numbers of steelhead returning to the Trinity River Hatchery.

Study Area

The area covered by these spawning surveys includes anadromous tributaries of the Trinity basin upstream of the New River, including the South Fork of the Trinity River (Figure 2). To develop a sampling universe, anadromous tributaries within the named basins were identified. The entire basin was then stratified into two sub-basins, the South Fork and the main-stem. Six of the following Trinity River tributaries were surveyed from their confluence to an upstream migrational barrier, and portions of the other eight tributaries were surveyed as described.

<u>Main stem Trinity River sub-basin tributaries</u>

South Fork of Indian Creek (SF Indian) was surveyed from its confluence with Indian Creek to a waterfall barrier 1.567 km upstream. Access is available via Reading Creek Rd. and by an unnamed SPI logging road. South Fork Indian Creek is a high energy bedrock channel flowing through historic mine tailings. Some spawning habitat is available in the lower reach, but gravel availability in the upper reach is sporadic. South Fork Indian has an abundance of deep pools, a thick riparian corridor, and is classified as a fourth order stream.

Dutch Creek was surveyed from its confluence with the Trinity River to a culvert barrier created by a SPI logging road 3.70 km upstream. Access is available via Dutch Creek Road. At the end of the road is a large meadow with an old decommissioned road crossing the creek. Take this road down to the confluence with the Trinity River to begin surveys. A historical mining ditch can be used for access on the uppermost reach of Dutch Creek. Spawning habitat is limiting in all areas except around the meadow near the access point. The mouth of Dutch Creek could prove problematic and may be negatively affecting fish numbers; although it is not a barrier to fish passage. Dutch Creek is surveyed in the fall by the U.S. Forest Service for salmon, and is classified as a fourth order stream.

Maxwell Creek was surveyed from its confluence with the Trinity to a 8.25 foot waterfall barrier approximately 2.5 km upstream. The creek is most easily accessed by Dutch Creek Road and a short hike up along the Trinity River over from the Dutch Creek watershed. The majority of Maxwell Creek consists of a steep V-shaped canyon with plentiful riparian vegetation, in-stream cover and moderate quantities of suitable spawning gravels, and it is classified as a third order stream.

West Weaver Creek was surveyed from its intersection with Highway 299 1.20 km upstream. The creek just upstream from the highway is steel and fast flowing, but it flattens out as you go up. The development of the town of Weaverville has rerouted the stream significantly from its historic channel, and there has been a lot of gold mining done in the area. This is one of the sources of the town of Weaverville's water supply and is classified as a third order stream.

East Weaver Creek was surveyed from the confluence with West Weaver creek 2.250 km upstream to the bridge at Brown's Mountain Road. This creek is the other main source of the town of Weaverville's water supply and has received a lot of mining activity and rerouting with the development of the town. East Weaver Creek is classified as a fourth order stream.

Sidney Gulch was surveyed from the bottom of Lee Fong Park downtown 1.51 km to a barrier bridge on Garden Gulch Steet bordering the United States Forest Service compound. The development of the town of Weaverville re-routed and canalized the majority of this stream. This stream is regularly used by spawning coho salmon and is classified as a third order stream.

Grass Valley Creek starts in the Mount Bally area and has a reservoir near the top of it. The reservoir was constructed in 1997 to trap decomposed granite from flowing downstream. Near it's confluence with the Trinity River the Hamilton Ponds were constructed to trap more sediment from entering the river. Historically, Grass Valley Creek was a huge decomposed granite source for the Trinity River limiting spawning in sections of the river. Immediately downstream from the upper reservoir, Trinity County Resource Conservation District has been adding spawning gravel to the creek and coho have been observed spawning on it. We surveyed the uppermost 1.34 km below the reservoir to see if steelhead are utilizing the injection gravel. Grass Valley Creek is classified as a fifth order stream.

<u>South Fork Trinity River sub-basin tributaries</u>

East Fork of Hayfork Creek (EF Hayfork) was surveyed from its confluence with Hayfork Creek to Byron Gulch approximately 6.77 km upstream. There is no permanent barrier on EF Hayfork. EF Hayfork has been heavily impacted by historic mining, evidenced by large piles of mine tailings that stand above the channel. In the lower section some log structures were constructed in the 1980's to attempt to slow the river's current, these are now functional strainers. Even through much of the boulder/cobble framework needed to retain gravel has been removed, plentiful spawning gravel and suitable habitat flourishes. Major anadromous tributaries to EF Hayfork include Potato Creek and North Fork East Fork Hayfork Creek. This creek is classified as a fourth order stream.

Potato Creek was surveyed from its confluence East Fork Hayfork Creek to a temporary barrier 1.0 km upstream. Access is available via FH 343 and is the access point for reach one of the East Fork of Hayfork Creek survey reach. The creek in the survey section flows through historic mine dredger tailings. Potato Creek is classified as a third order stream.

Big Creek was surveyed from the water diversion dam approximately 7.989 km to where Packers Creek empties into Big Creek. This section is entirely on Forest Service land. The lower private sections of Big Creek offer excellent spawning conditions and water flow for steelhead. The department has not been able to survey it since the 1990's. This year the Hayfork Watershed Center was able to survey the lower sections for steelhead. Big Creek is classified as a fourth order stream.

Packers Creek is a tributary to Big Creek and is surveyed from its confluence with Big Creek one mile upstream. It had a dysfunctional fish ladder to the culvert under Big Creek Road which was replaced in 2008 with a functional half pipe culvert allowing fish to pass upstream. Packers Creek is classified as a third order stream.

Rusch Creek was surveyed from its confluence with Hayfork Creek approximately 3.892 km upstream. From Hayfork, California, the confluence is accessed by taking Tule Creek road to Forest Route 3N08, then right on 2N02 to 32N11 road. Walk down to the confluence from the road and survey up to the shuttle vehicle. The U.S. Forest Service has initiated restoration activities including gabion baskets, floating log covers, and structures for preventative bank erosion along the creek. Rusch Creek is classified as a fourth order stream.

Bear Creek is a tributary to Hayfork Creek and was surveyed for a half a mile up to tis barrier from its confluence with Hayfork Creek. From Hayfork, California, its confluence is accessed from a small road past Nine Mile Bridge on the Hyampom Road. Bear Creek is classified as a third order stream.

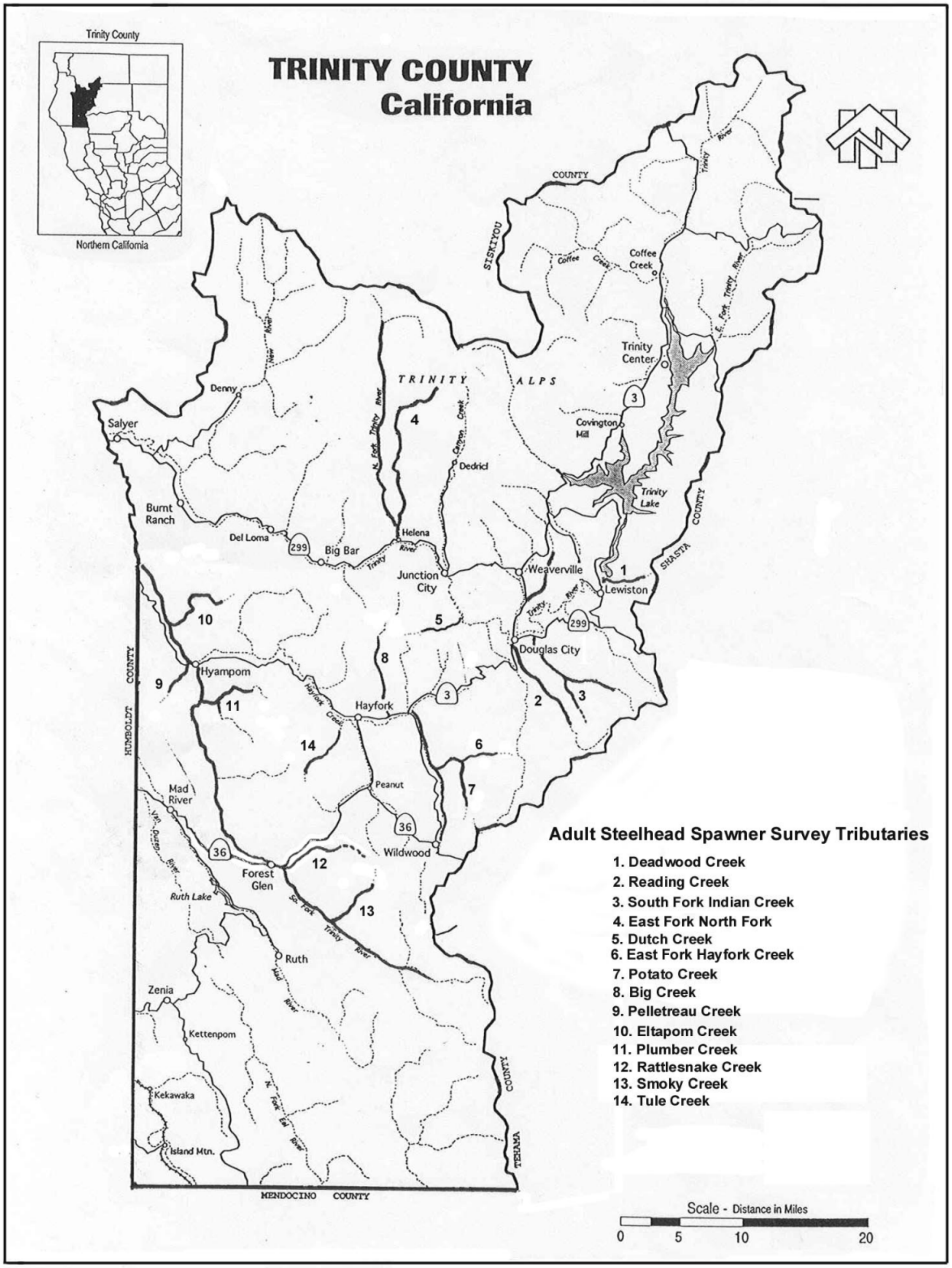

Figure 2. Map of Trinity basin with selected spawner survey tributaries.

METHODS

Tributary Selection

The same panel of selected tributaries is surveyed every year, and other tributaries are either randomly selected or selected if restoration work is going to be performed on it. Restoration efforts by Five Counties Salmonid Conservation Program have been made in Soldier, Little Browns, and Deadwood Creeks, and Trinity County Resource Conservation District has added spawning gravel to Grass Valley Creek below Buckhorn Reservoir. The Forest Service has also performed restoration activities on West Tule and Rusch Creeks.

Tributaries are surveyed on foot by surveyors walking in the tributary creeks from the confluence of the creek with another water body upstream to the anadromous barrier or the end of the survey section. Surveyors wear polarized glasses and visually survey the stream for steelhead redds. Encountered redds are measured and all data from Table 3 is collected and written on data sheets.

Private Property Permission

Permission to survey across private property is obtained from all landowners prior to any surveys being conducted. Specific parcels to be surveyed across are identified using Trinity County Assessor maps. All landowners are notified by mail and asked to return a postcard allowing the Department permission to survey the named tributary across their property with the condition that crews stay below the high-water mark. Additional permission is ascertained in cases where access to the tributary across a landowners property is necessary. Letters verifying permission are sent out annually in late January or early February.

Redd Identification

Crews are trained in proper redd identification prior to the beginning of the season. Ultimately, an experienced crew leader is present to make all “tough calls” in terms of redd identification. Inexperienced technicians often overlook redds or have trouble distinguishing steelhead redds from scour hydraulics or lamprey and resident trout redds. The following criteria (Table 2) is used to insure proper identification of steelhead redds; not all criteria must necessarily be satisfied in order for a redd to be called a redd.

Table 1. Redd identification criteria.

Criteria	Explanation
Location	Most redds are located in pool tail-outs or riffles; Briggs (1953) found that most redds occupied the transitional area between pools and riffles.
Size	Hunter (1973) found the area of average steelhead redds to be 4.4 $meter^2$, although, redds are often smaller when spawning habitat is limited or constrained by channel morphology.
Structure	Redd should consist of a pit and mound (tail-spill), with the mound downstream of the pit. Steelhead redds can be easily differentiated from lamprey redds, as lamprey redds lack a mound or tail-spill.
Substrate size	Steelhead prefer to spawn in gravel 0.6-10.2 cm in diameter. (Smith, 1973).
Gravel sorted	The substrate of freshly constructed redds is usually well sorted, with larger gravel positioned anterior compared to smaller gravel.
% fines	Redds should not be overly embedded with fine substrate, as the mechanics of redd construction should wash away fine sediment.
Water velocity	There must be adequate velocity to insure oxygenation of eggs. Bovee (1978) found optimum velocity for steelhead spawning at 2 feet/sec.
Pit/tailspill mechanics	Redds should be properly spatially positioned, so that the pit is upstream of the tail-spill and gravel excavated from pit could form tail-spill.
Lack of algae or detritus	New constructed redds should be free of algal formation (i.e. periphyton) and detritus. Detritus often accumulates in the pit of older redds.
Presence of fish on redd	Presence of an actively spawning pair of fish indicates probable construction of a successful redd. Test digging can often be confused for successful completion of a redd.

Table 3 contains the data recorded on all redds encountered during the course of the survey. GPS coordinates were taken using a Garmin eTrex GPS unit utilizing the NAD

85 datum. All redd measurements were taken using a water-proof tape measure. During measurements, extreme caution was taken to avoid disturbing redds. Redds currently under construction (fish on redd) were not measured at the time of survey to avoid disturbing spawning activity. These redds were measured on the subsequent pass. All encountered redds are flagged with date, redd number, position, and recorders initials, to prevent double counting, and to allow future evaluation.

Table 2. Data recorded on each redd.

Data Field	Description
Redd I.D.#	3 digit code with the first digit being the reach no. and the second two being the consecutive redd no. for that reach e.g. R101=reach 1, redd no.1
GPS coordinates	Lat/Long waypoint of redd location
Pit length	Pit length measured parallel to the flow
Pit width	Pit width measured perpendicular to the flow
Depth 1	Depth from substrate to bottom of the pit
Depth 2	Depth from water surface to bottom of the pit
Pit substrate	Dominant substrate in the pit
Tail spill length	Tail spill length measured parallel to the flow
Tail spill width 1	Tail spill width perpendicular to the flow at 1/3 of the distance down from the upstream end
Tail spill substrate	Dominant substrate in the tail spill
Habitat type	Habitat type where redd is located
Redd type	Condition of redd: 1=well defined recently completed 2=well defined but not new 3=not well defined 4=older and difficult to identify, may be questionable
Comments	Redd location description and information on redd condition

Field Crew

This year's surveys were performed out of the Weaverville Department of Fish and Game Field Office with additional help provided by the Hayfork Watershed Center and Yurok Tribal Fisheries for surveying Big and Bear Creeks. California Department of Fish and Game personnel include: Andrew Hill (Marine/Fisheries Biologist) Justin Papich (Fish and Wildlife Scientific Aid), and Cadella Thomas (Seasonal Aid). Hayfork Watershed Center personnel included Josh Smith and Yurok Tribal Fisheries personnel included Kyle Dejuilio, a previous DFG employee on the project.

RESULTS

This 2010 season, a total of 141 redds were observed in ten tributary creeks during surveys encompassing 65.08 kilometers of habitat. Summary redd and fish observation data by tributary is provided in Table 3, and summaries of previous year's surveys are provided in Table 6, Table 7, and Appendix 2. Evidence of steelhead spawning was observed in ten of fourteen creeks surveyed. Six steelhead were observed during this season's surveys. No steelhead carcasses were encountered during this year's survey.

Table 3. Trinity River winter-run steelhead spawning survey summary results, March-May 2010.

Tributary	Mileage (km)	Redds	Redds/km	Adult Steelhead
Maxwell Creek	2.50	1	0.40	0
South Fork Indian Creek	1.57	3	1.91	0
Dutch Creek	3.7	16	4.32	1-U
Weaver Creek	3.88	12	3.09	1-W, 1-U
East Weaver Creek	2.25	8	3.56	1-W
West Weaver Creek	1.2	0	0	0
Sidney Gulch	1.51	1	0.66	0
Grass Valley Creek	1.34	6	4.48	0
East Fork Hayfork Creek	6.77	24	3.55	2-U
Rusch Creek	3.89	2	0.51	0
Potato Creek	1.00	0	0	0
Big Creek	33.97	68	2.00	0
Bear Creek	0.5	0	0	0
Packers Creek	1.00	0	0	0
Total	65.08	141	2.17	6

Redd location was characterized by habitat type for all redds observed. Steelhead this season preferred to spawn in glides (n=45, 31.91%) closely followed in preference by runs (n=41, 29.08%), pool tails (n=39, 27.66%), and riffles (n=16, 11.35%). No redds were located in other types of habitat. The average depth of water over the pit for all redds observed was 15.45 inches (39.24 cm). The average depth of excavation (material removed from pit to create tail-spill) was 4.73 inches (12.01 cm).

Table 4. Redd area measurements by tributary.

Tributary	N=	Mean pit area $(ft)^2$	Mean tailspill area $(ft)^2$	Mean total redd area $(ft)^2$	Mean pit depth in substrate (inches)	Mean pit depth in water (inches)	Dominant redd location
Maxwell	1	1.56	5.11	6.67	4.0	15.0	Run
South Fork Indian	3	3.40	4.68	8.07	4.33	11.0	Pool Tail
Dutch	16	3.66	6.41	10.07	5.13	14.5	Run
Weaver	12	3.17	6.02	9.19	3.85	16.1	Run/Glide
East Weaver	8	2.55	5.42	7.96	5.00	13.5	Run/Glide
Sidney Gulch	1	1.56	1.15	2.71	4.00	12.0	Riffle
Grass Valley	6	5.47	6.12	11.59	4.75	23.0	Run
East Fork Hayfork	24	4.19	6.97	11.16	4.48	15.24	Glide
Rusch	2	5.15	8.78	13.93	3.5	11.5	Run
Big	68	7.14	8.64	15.78	4.95	15.79	Pool Tail
Total	141	5.37	7.43	12.81	4.73	15.45	Glide

All redds were measured utilizing methods put forth by Gallagher (2002). Table 4 provides summary area measurements for all redds observed by tributary. Overall, the average total area of all redds observed during the survey was 12.81 ft^2. The smallest redd observed during the survey occurred in Sidney Gulch and measured 2.71 ft^2. The largest redd was observed in East Fork Hayfork Creek and measured 23.67 ft^2.

Water temperature was recorded at the beginning and end of each survey. Temperatures during peak spawning activity this year were between 5.5°C to 11.5°C (Table 5). During the course of the survey, 101 redds were classified as redd type 1, 22 as redd type 2, 13 as redd type 3, and 5 as redd type 4. Daily recorded temperatures for each tributary surveyed are listed in Appendix 3. Cold weather fronts throughout the steelhead spawning season kept water temperatures lower than usual in the spawning tributaries.

Table 5. Cumulative steelhead redds observed by date, redd type, and temperature (celcius)

Tributary	Drainage basin	Date	Number of redds	Redd type /a	Average survey temperature
SF Indian	Main stem Trinity River	3/26/2010	3	3-T1	5.5
Maxwell	Main stem Trinity River	4/7/2010	1	1-T3	7
Sidney Gulch	Main stem Trinity River	4/20/2010	1	1-T1	11.5
Dutch	Main stem Trinity River	3/22/2010	8	5-T1, 2-T2, 1-T3	7.5
Dutch	Main stem Trinity River	4/5/2010	6	4-T1, 1-T2, 1-T3	7.5
Dutch	Main stem Trinity River	4/7/2010	2	2-T1	8
Weaver	Main stem Trinity River	3/29/2010	8	6-T1, 1-T2, 1-T3	9
Weaver	Main stem Trinity River	4/23/2010	4	4-T1	9
East Weaver	Main stem Trinity River	3/16/2010	3	3-T1	7.5
East Weaver	Main stem Trinity River	3/30/2010	5	4-T1, 1-T2	6
Grass Valley Creek	Main stem Trinity River	4/21/2010	6	6-T1	8
EFHayfork	Hayfork Creek	3/24/2010	4	3-T1, 1-T3	6.5
EFHayfork	Hayfork Creek	3/25/2010	13	9-T1, 4-T3	6.0
EFHayfork	Hayfork Creek	4/19/2010	1	1-T2	9.5
EFHayfork	Hayfork Creek	4/22/2010	1	1-T1	7.5
EFHayfork	Hayfork Creek	5/4/2010	4	3-T1, 1-T3	7
EFHayfork	Hayfork Creek	5/5/2010	1	1-T1	7.5
Big	Hayfork Creek	4/6/2010	34	20-T1, 7-T2, 4-T3, 3-T4	7.5
Big	Hayfork Creek	4/8/2010	9	9-T1	5.5
Big	Hayfork Creek	4/17/2010	23	13-T1, 9-T2, 1-T4	5.5
Big	Hayfork Creek	5/12/2010	2	2-T1	7.5
Rusch	Hayfork Creek	4/26/2010	2	2-T1	8.5

a/ Redd types are designated as # of redds-T(redd type)

DISCUSSION

Redd surveys serve as a good, but partially incomplete means of monitoring steelhead spawning escapement. These surveys are most appropriate when other means of estimating adult escapement or spawning success are not appropriate or impossible to conduct. In the Trinity basin, problems do occur which limit the ability to estimate the abundance of winter-run steelhead. High flows and the extended length of adult steelhead migration make weir estimates partial at best. Several weirs were constructed to estimate winter-run steelhead run-size by the Department in 1986-1996 at Sandy Bar and at Forest Glen on the South Fork of the Trinity River (CDFG, 1990-95). Efforts were finally terminated after multiple blow-outs due to high flows.

The availability of spawning habitat could possibly inhibit spawning and resulting production of steelhead, especially in smaller order tributaries. In these tributaries gravel availability is often scarce. The amount of suitable stream substrate for spawning varies with the size (order) of the stream and species of salmonid using it, as Boehne and House (1983) learned from their study of two coastal and two Cascade Range watersheds in Oregon. First and second order streams were rarely used by anadromous salmonids; the larger anadromous steelhead, Coho, and Chinook salmon spawned in a few third-order streams, but most were found in fourth- and fifth-order streams. As stream order increased, gradient decreased but stream length, width, and depth increased. The amount of spawning gravel per kilometer of stream was greatest in fourth order coastal watersheds and fifth order Cascade Range watersheds. Precursory examinations of gravel in surveyed tributaries have found that in the Trinity basin gravel retention could be impeded by the following factors: effects of historic mining and the 1964 flood. Retention of gravel is often problematic, even in fourth- and fifth-order streams due to incision of the channel as a result of historic mining. This incision causes loss of channel sinuosity, and increases channel energy, especially during high flow events. Without the complexity associated with a sinuous channel, little large wood or boulder/cobble framework is available to sort and retain gravels. Further complicating the problem is the long lasting effects of the 1964 flood; this 100-year flood aggraded spawning beds up to eight feet deep with unsuitable substrate. Most tributaries continue to down-cut through this aggregation, but many have yet to reach channel equilibrium years later.

No apparent trend is evident when examining redd survey data collected during previous field seasons. Some tributary creeks appear to annually fluctuate more than others, and some appear to show a trend of declining numbers of redds since the 1990’s (Appendix 2). 2002 redd surveys document the highest numbers of redds since the Anadromous Fisheries Research and Management Program begin in 2000. The best data possible trend data is from East Fork of Hayfork Creek. East Fork of Hayfork creek steelhead redd counts fluctuate the most from 64 redds in 2002 to 0 redds in year 2000 with no upward or downward trend.

Studies conducted in Washington and Idaho have both approximated average steelhead redd area at 47 ft^2 (Hunter 1973, Reiser and White 1981). Gallagher and Gallagher in 2005 found steelhead redds in several anadromous streams in Mendocino County to average 19.2 ft^2 with a standard deviation of 1.5 ft^2. Redds in the Trinity basin appear be smaller than those constructed by steelhead elsewhere which may be an indication that wild steelhead in the upper Trinity River basin may be smaller than those closer to the ocean. Different substrate compositions in the Trinity Basin compared to coastal watersheds may also account for this difference in redd size. This year the average redd area measured during these surveys was 12.81 ft^2. Previous years redd area averages are as follows: 8.63 ft^2in 2009, 8.35 ft^2 in 2008, 11.05ft^2 in 2007, 12.85ft^2 in 2006, 23.63ft^2 in 2005, and 13.78ft^2 in 2004. These are all smaller than those in Washington and Idaho and may be a result of smaller fish sizes, but the data is not available to make that statement.

Patrick Higgins (personal communication, 2000) hypothesizes that South Fork Trinity River steelhead begin spawning when water temperatures approach 8°C. Hunter (1973) states the range of preferred temperatures for steelhead spawning at 3.9-9.4°C. The results of this year's survey support Hunter's statement where 99.3% (140/141) of all redds observed had been completed prior to water temperatures reaching 10°C (Table 5). Of the 141 redds discovered this year, one redd (0.7%) was discovered when water temperatures averaged 11.5°C. This redd was discovered in Sidney Gulch on a hot afternoon in this small third order stream, and it was likely constructed prior to the high temperature. All the other 140 (99.3%) redds were discovered when beginning and end water temperatures were less than 10°C supporting of Hunter's statement.

Steelhead run size is highly variable from year to year. For comparison, work by D.A. La Faunce in 1964 and D.W. Rogers in 1971 and 1972 set up base-line numbers for natural production of steelhead in the Trinity basin (Tables 6&7). Those surveys show that adult steelhead estimates were markedly higher in 1964 than in any of the following years. However, these numbers could also be biased due to the construction of the Trinity Dam and displacement of the returning steelhead from their historic spawning grounds. The dam may have forced the steelhead to exploit new tributaries and produce higher than average redd counts that year. Survey results by D.W. Rogers are more similar to results obtained by these surveys. This may indicate that after the completion of dam work on the Trinity River, the steelhead populations have now reached their carrying capacities in the Trinity River basin at reduced population sizes than before dam construction.

Table 6. Summary results of work by D.A. LaFaunce (1964). A steelhead spawning survey of the upper Trinity River system.

Tributary	Mileage (km)	Redds	Redds/km
Maxwell Creek	0.32	6	18.75
South Fork Indian Creek	0.32	4	12.50
Dutch Creek	2.25	6	2.67
Weaver Creek	9.66	134	13.87
East Weaver Creek	7.56	89	11.77
West Weaver Creek	2.41	2	0.83

Table 7. Results of steelhead spawning surveys conducted by D.W. Rogers (1971 and 1972) and E.E. Miller 1973.

	1971			1972			1973		
Tributary	Mileage (km)	Redds	Redds/km	Mileage (km)	Redds	Redds/km	Mileage (km)	Redds	Redds/km
Maxwell Creek	1.45	1	0.69	ns	ns	ns	ns	ns	ns
South Fork Indian Creek	1.61	3	1.86	0.8	0	0	ns	ns	ns
Dutch Creek	1.61	0	0	ns	ns	ns	2.6	0	0
Weaver Creek	9.66	5	0.52	9.66	10	1.035	9.7	16	1.6
East Weaver Creek	7.56	0	0	3.22	3	0.932	3.2	0	0
West Weaver Creek	2.41	0	0	3.22	0	0	1.6	0	0
Big Creek	12.55	35	2.79	12.55	78	6.215	10.5	10	1

Results of this spawning survey have important fisheries management implications; fisheries managers use escapement data to analyze the ability of a stock to sustain recreational fisheries. Proposals have recently been submitted to the Fish and Game Commission to increase the bag limit on the Trinity and to allow the take of wild steelhead. The Department must make management recommendations based upon the best available science documenting the status of the steelhead in the basin. The results of this project are currently the only data available examining population status and trends of winter-run steelhead in the Trinity Basin. The Department used this justification to recommend not allowing the take of wild steelhead on the Trinity River. Should spawning surveys show a prolonged increase in escapement throughout the basin, additional fisheries and decreased angling restrictions (increased opportunities) could be considered.

Problems are commonplace and often complicate and prevent redd surveys from being performed. Possible problems include adequate survey frequency; redd discrimination by species, tributary sample selection, access, weather, and private property permission. This 2010 field season was majorly complicated by the large numbers of spring storms which created high flows and turbidity often preventing surveys from being accomplished. Some of these problems create bias within the data, while others prevent the proper coverage of a selected tributary.

One primary problem that affects sample design, as well as proper and even coverage, is access. Most of the Trinity basin is composed of rugged mountainous terrain with little road coverage. Existing roads are often poorly maintained logging roads, which rarely lead to the confluence of a selected tributary. Some tributaries lie within wilderness areas, where no roads exist, and hiking in to survey is the only possibility. Access problems are further compounded by extreme winter conditions such as snow storms and high river flows. Some tributaries, such as Rusch Creek, in the Hayfork basin, are inaccessible by road until late April due to heavy snow-pack. High flows in the South Fork Trinity River can also limit access across the river to tributaries such as Eltapom Creek.

High flows often have a negative effect on survey periodicity and quality. These high flows often prevent surveys by limiting travel through the stream corridor and impeding visibility through the whitewater. Rain further impedes a surveyor’s ability to detect redds by breaking the smooth surface of the water, making underwater terrain features nearly invisible. High flow events during the spring survey can also scour redds making them indiscernible by the time surveyors can get to them.

Discrimination of redds created by different fish species is a problem which often complicates redd surveys in systems where several species of fish co-exist and spawn during similar time frames. Several fish species temporally co-exist in the Trinity basin, a few of which have similar spawning time frames; coho salmon (*Oncorhynchus kisutch*) enter the watershed in November and December and spawn in January and February.

Similarly, Pacific Lamprey (*Lampetra tridentata*) migrate into the system in the fall and winter, and spawn during the spring months. Small trout exhibiting a resident life-history also co-exist in the system and spawn during the spring. Several measures are taken by crews to ensure proper classification of steelhead redds. All fish excavations with no substantial tail-spill or developed pit are not considered redds. Resident trout tend to utilize smaller substrate in areas with less apparent velocity. Lamprey redds are distinguished by a small circular pit and no tail-spill, but could be identified as steelhead redds by inexperience surveyors as witnessed by D.W. Rogers in 1971. In the Trinity basin, coho redds are infrequently confused with steelhead redds due to their earlier spawning (January/February vs. March-May). Based on work by Gallagher and Gallagher in 2005, coho redds were found to average 64.9 ft^2 with a standard deviation of 3.62m ft^2, and Chinook redds averaged 72.3 ft^2 with a standard deviation of 9.4 ft^2. During the course of this year's survey, no redds of those sizes were discovered in Trinity River tributaries.

Surveys utilizing multiple technicians inherently suffer from problems with inter-observer variation, both with observer efficiency and the subjective nature of identifying redds. This can be minimized by pairing experienced with inexperienced technicians, sufficient training, and frequent quality control trials. This is currently not recognized to be a problem, as all crews contain at least one experienced member.

Prior to the beginning of the first season in 2000, permission from private property owners was obtained on all tributaries to be surveyed. Tributaries with excessive refusal of landowners have been dropped from the sampling frame. For long term management, streams entirely located on public property are chosen over those with multiple private ownerships. Eleven of the fourteen tributaries selected for the 2010 survey are located entirely on public land. Access to the remaining three tributaries was obtained by sending letters to the owners asking for permission to survey on their land.

RECOMMENDATIONS

The limits of the anadromy in the Trinity basin need to be verified in order to properly delineate the sampling universe and quantify habitat available to steelhead. Previously, an effort to identify barriers to anadromy was completed by Trinity Fisheries Consulting, but focused solely on road induced barriers (Trinity Fisheries Consulting, 1988). Most other barrier information relies on antiquated US Forest Service habitat typing files, produced in the late 1960s and 1970s.

Coho salmon spawner surveys should be initiated to complement existing steelhead surveys. Few surveys quantifying Coho salmon spawning are currently conducted in the

Trinity basin, with the only effort being made the US Forest Service when funding for fisheries technicians allows (L. Everest, personal communication).

More intensive habitat evaluation needs to be included in the survey design. A quick, one pass field extensive evaluation should be made of quantity and quality of available spawning substrate in selected tributaries. Evaluation of spawning habitat was conducted previously by Fish and Game from 1994-1997 on South Fork Trinity tributaries (Borok and Jong, 1997). This effort should be expanded to include the entire sampling universe using a protocol similar to that put forward by Schuett-Hames and Pleus (1996).

Patrick Garrison has recommended that some examination be attempted to look at the relationship between channel incision, removal of boulder framework, historical mining, and availability of spawning habitat (Garrison, 2004). Historical mining in the late 1800s and early 1900s has resulted in the removal of bed-load framework necessary for the retention of suitable spawning gravel. Removal of this framework has further resulted in channel incision, loss of channel sinuosity, and loss of habitat complexity. Evidence of these effects is made apparent by the large piles of mine tailings covering the banks of over half of all Trinity tributaries; some of the piles are over 50 feet high and several hundred feet wide.

A more intensive effort should be undertaken to understand the relationship between the number of adult steelhead and the corresponding number of redds. The Oregon Department of Fish and Wildlife has five years of data in the Alsea and Nestucca basins that shows a strong relationship between redd counts and fish numbers (R^2=0.97, $p<0.001$). Using this regression as a calibration between adults and redds, they further suggest that redd counts are a good indicator of population size over a range of run-sizes form 35 – 2,131 fish (Susac and Jacobs, 2003).

A reliable funding source needs to be identified to insure that everything is fully operation by March 1st, and that funding for technicians proceeds unfettered through the completion of the season. This should insure a more even sampling effort that spans the entire season.

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Appendix 1. Reach location and total distance.

Tributary	Start Latitude/Longitude	End Latitude/ Longitude	Reach distance (km)
Maxwell	N 40 39.588	N 40 39.343	2.5
	W 123 00.301	W 123 00.390	
Dutch	N 40 39.869	N 40 39.488	3.70
	W 123 00.994	W 123 02.828	
South Fork Indian	N 40 35.869	N 40 35.346	1.57
	W 122 49.868	W 122 49.278	
Weaver Creek	N 40 42.111	N 40 43.159	3.88
	W 122 55.320	W 122 56.254	
East Weaver	N 40 43.268	N 40 44.171	2.25
	W 122 56.415	W 122 55.623	
West Weaver	N 40 44.588	N 40 45.050	1.20
	W 122 58.116	W 122 58.399	
East Weaver	N 40 43.268	N 40 44.171	2.25
	W 122 56.415	W 122 55.623	
Sidney Gulch	N 40 43.489	N 40 44.023	1.51
	W 122 56.431	W 122 56.545	
Grass Valley Creek	N 40 62.833	N 40 62.525	1.34
	W 122 76.847	W 122 76.122	
East Fork Hayfork	N 40 29.322	N 40 30.542	6.77
	W 123 04.132	W 122 59.695	
Rusch	N 40 35.339	N 40 39.256	3.89
	W 123 15.877	W 123 17.730	
Potato	N 40 30.112	N 40 30.050	1
	W 123 02.316	W 123 02.191	
Big	N 40 33.363	N 40 39.203	33.97
	W 123 08.3273	W 123 09.422	
Bear	N 40 36.158	N 40 36.246	0.5
	W 123 17.037	W 123 16.522	
Packers	N 40 39.129	N 40 39.204	1
	W 123 09.447	W 123 09.289	

Appendix 2: Redd counts from previous years of California Department of Fish and Game winter steelhead spawning surveys.

Tributary	1964	1971	1972	1990	1991	1992	1993	1994	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maxwell	6	1	-	-	-	-	-	-	-	-	-	-	-	-	2	1	3	1	-
South Fork Indian	4	3	0	-	-	-	-	-	-	0	2	7	2	4	0	0	9	3	6
Dutch	72	0	-	-	-	-	-	-	-	0	0	2	0	2	3	-	-	6	0
West Weaver	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0
East Weaver	89	0	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Sidney Gulch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	2
Grass Valley Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
Weaver	41	5	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Fork Hayfork	-	-	-	32	20	5	3	16	2	0	10	64	16	37	13	18	60	33	41
Rusch	-	-	-	13	-	-	1	1	1	-	-	11	-	-	-	0	5	-	6
Big	-	35	78	36	18	53	7	46	16	-	-	21	-	-	-	-	-	6	23

Appendix 3. Survey beginning and ending water temperatures.

Tributary Name	Date	Reach	Start Water Temp (Co)	End Water Temp (Co)
Sidney Gulch	3/15/2010	1	7	9
Sidney Gulch	4/20/2010	1	11	12
Weaver	3/29/2010	1	9	9
Weaver	4/23/2010	1	8	10
Weaver	5/10/2010	1	8	8
West Weaver	3/16/2010	1	6	6
West Weaver	3/29/2010	1	8	8
West Weaver	4/20/2010	1	7	8
East Weaver	3/16/2010	1	7	8
East Weaver	3/30/2010	1	5	7
Dutch	3/22/2010	1&2	7	8
Dutch	4/5/2010	1	7	8
Dutch	4/7/2010	2	8	8
Maxwell	3/23/2010	1	7	7
Maxwell	4/7/2010	1	7	7
EF Hayfork	3/24/2010	1	5	8
EF Hayfork	3/25/2010	2	6	6
EF Hayfork	4/19/2010	1	9	10
EF Hayfork	4/22/2010	2	7	8
EF Hayfork	5/4/2010	1	7	7
EF Hayfork	5/5/2010	2	8	7
SF Indian	3/26/2010	1	5	6
SF Indian	4/13/2010	1	7	8
SF Indian	5/6/2010	1	7	8
Big	4/8/2010	1	7.5	7.5
Big	4/8/2010	2	5	6
Big	4/17/2010	2	5	6
Big	5/11/2010	2	6	7
Big	5/12/2010	2	7	8
Bear	4/12/2010	1	8	8
Potato	4/22/2010	1	8	8
Grass Valley Creek	4/21/2010	1	8	8
Rusch	4/26/2010	1	8	9
Rusch	5/13/2010	1	9	9
Packer's	5/12/2010	1	10	8

Appendix 4. Total wild and hatchery steelhead returns to the Trinity River Hatchery.

	Steelhead Returns at the hatchery						
Year	**Steelhead**	**Year**	**Steelhead**	**Year**	**Steelhead**	**Year**	**Steelhead**
1960	2,071	**1977**	285	**1990**	930	**2003**	10,224
1961	3,526	**1978**	683	**1991**	446	**2004**	5,725
1962	3,243	**1979**	382	**1992**	455	**2005**	8,143
1963	1,687	**1980**	2,005	**1993**	885	**2006**	11,547
1964	894	**1981**	1,004	**1994**	411	**2007**	11,397
1965	6,941	**1982**	713	**1995**	705	**2008**	2,495
1966	992	**1983**	599	**1996**	4,012	**2009**	4,251
1967	135	**1984**	142	**1997**	429	**2010**	2,037
1968	232	**1985**	461	**1998**	441		
1969	554	**1986**	3,780	**1999**	1,571		
1970	241	**1987**	3,007	**2000**	768		
1971	67	**1988**	817	**2001**	2,333		
1972	242	**1989**	4,765	**2002**	6,038		