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DEPARTMENT OF FISH AND GAME

2009 REPORT
TRINITY RIVER TRIBUTARIES
STEELHEAD SPAWNING SURVEY REPORT

Prepared by

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Northern Region
California Depart of Fish & Game

Anadromous Fisheries Resource Assessment Monitoring Program
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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 April of 2009. 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 April 2009, we observed a total of 110 redds in 42.397 kilometers of surveyed habitat. Overall redd density for all tributaries surveyed was 2.595 redds/kilometer. The highest redd density occurred in East Fork Hayfork Creek (6.056 redds/km), while lowest density occurred in Dutch and Grass Valley Creeks (0 redds/km). Redds were observed in ten creeks surveyed; Deadwood, South Fork Indian, East Weaver, Eltapom, East Fork Hayfork, Tule, Little Browns Creek, Rusch, Sidney Gulch, and Big Creeks. No redds were observed in Dutch, Grass Valley, and West Weaver Creeks. Fish were observed in Deadwood, South Fork Indian, Little Browns, East Weaver, East Fork Hayfork, and Big Creeks. A total of 41 fish were observed during the survey, with 21 of them occurring in East Fork Hayfork Creek and 13 of them occurring in Deadwood Creek.

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.

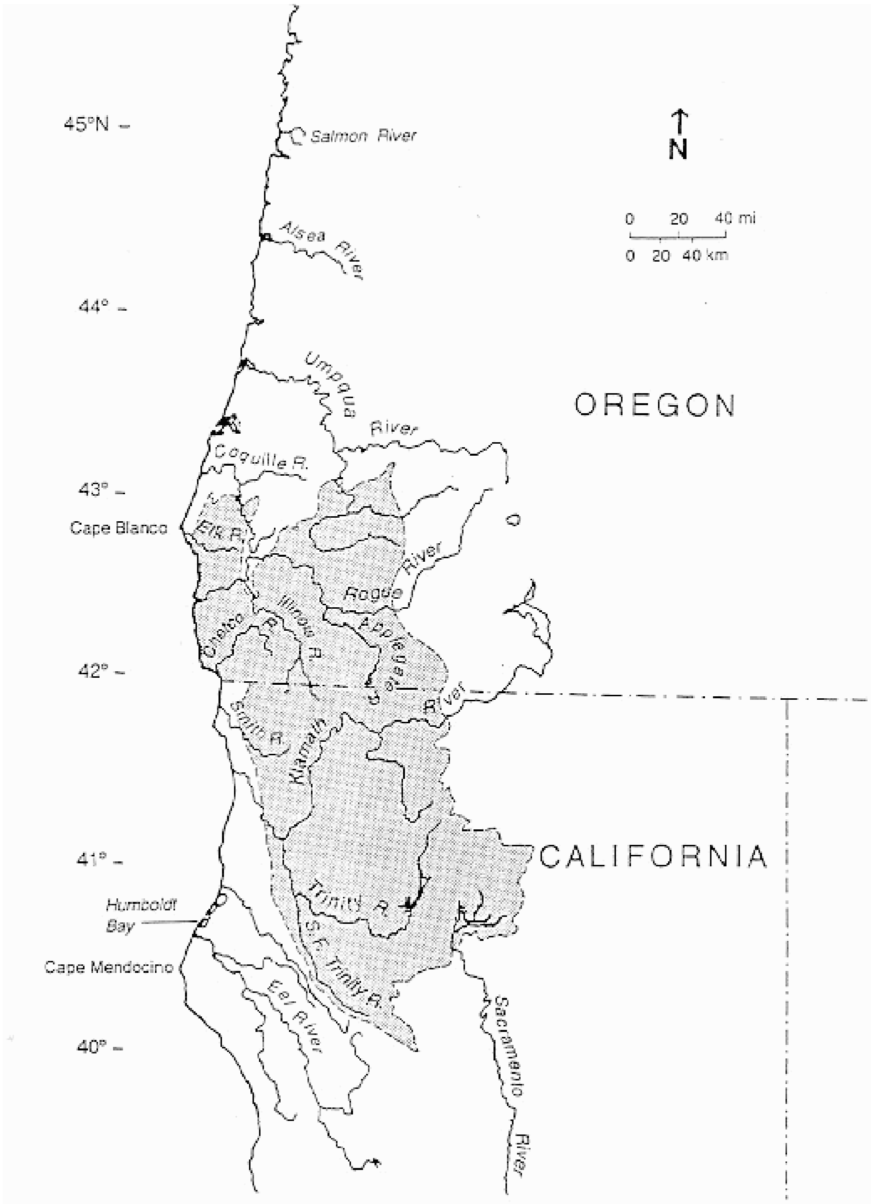

Figure 1. Map showing key geographic locations for the Klamath Mountains Geologic Province (modified from Irwin 1966 and Walker & MacLeod 1991).

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, and 1972 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 ninth 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 2000-2006 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 all anadromous tributaries of the Trinity basin upstream of the New River, including the South Fork of the Trinity River (Figure 2). A stratified random sampling design was used to select tributaries within the basin. To develop a sampling universe, all 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, each of which was sampled approximately evenly. Seven of the following Trinity River tributaries were surveyed from their confluence to an upstream migrational barrier, and portions of the other six tributaries were surveyed as described.

Main stem Trinity River sub-basin tributaries

Deadwood Creek was surveyed from its confluence with the Trinity River to a waterfall barrier 4.283 km upstream. Access is available from Deadwood Road. Deadwood is the uppermost tributary to the Trinity River below Lewiston Dam. Deadwood Creek has a steep high energy channel in the lower kilometer, which flattens out into a section of sinuous, complex spawning habitat with adequate large wood and a dense riparian corridor. One aesthetic problem is that Deadwood has become a dumping ground for trash, cars, and used appliances; these litter the banks of the creek in several areas, but have not yet led to any perceived or observable acute pollution problems. Five Counties Salmonid Conservation Program has initiated several restoration projects involving sediment control and fish passage since 2005 along Deadwood Creek.

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. SF Indian has a high energy bedrock channel with no anadromous tributaries. Some spawning habitat is available in the lower reach, but gravel availability in the upper reach is sporadic. SF Indian has an abundance of deep pools and a thick riparian corridor.

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, but it is not advisable to drive to the confluence, especially during winter flows. Access is available to the uppermost reach via an SPI logging road. In the event of heavy rains or other events which close the logging road, an historical mining ditch is 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 the mouth is not a barrier to fish passage, it passes through a narrow maze of willow trees, which dissipate much of its energy before it enters the main stem Trinity River. This lack of attraction flow could be the reason few winter fish are found up Dutch Creek.

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. There is also a lot of gold mining done in the area, especially in the spring, and this is one of the sources of the town of Weaverville's water supply.

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.

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 resulted in a lot of stream channel re-routing and rip wrapping.

Little Browns Creek was surveyed from the Highway 299 cross road China Gulch 1.447 km upstream to the Roundy Road bridge where a Five Counties project replaced a culvert barrier with a fish friendly one. The development of the town of Weaverville has also significantly altered this creeks historic channel.

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.

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

Eltapom Creek was surveyed from the South Fork Trinity River confluence to a waterfall barrier 1.26 km upstream. Access is only available by crossing the South Fork Trinity River (SFTR), off of Forest Highway 311. A raft is recommended and sometimes necessary for crossing the SFTR at higher flows, especially in March and early April. Eltapom Creek is often referred to as the gem of the South Fork Trinity River; it has excellent spawning gravel, sufficient holding pools, and a dense riparian corridor. Although very short in length, it consistently shows high redd densities and fish counts.

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. 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.

Tule Creek was surveyed from its confluence with Hayfork Creek to a long cascade barrier approximately 5.189 km. upstream. The confluence of Tule Creek is accessible by walking the fence-line from the Salt Creek confluence; the remainder of Tule Creek is accessible via FH 10. Tule Creek is one of the larger tributaries to Hayfork Creek and drains the west side of the mountains creating the Hayfork Valley. The lower reach of Tule Creek is has an abundance of deep holes with excellent spawning areas and plentiful gravel. The riparian corridor is dominated by thick willows with the occasional alder providing many holding areas for steelhead. Restoration efforts have been accomplished by the U.S. Forest Service in West Tule Creek involving log sediment traps.

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 is unfortunate because it is probably the best stream for anadromous salmonids in the Hayfork Valley.

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.

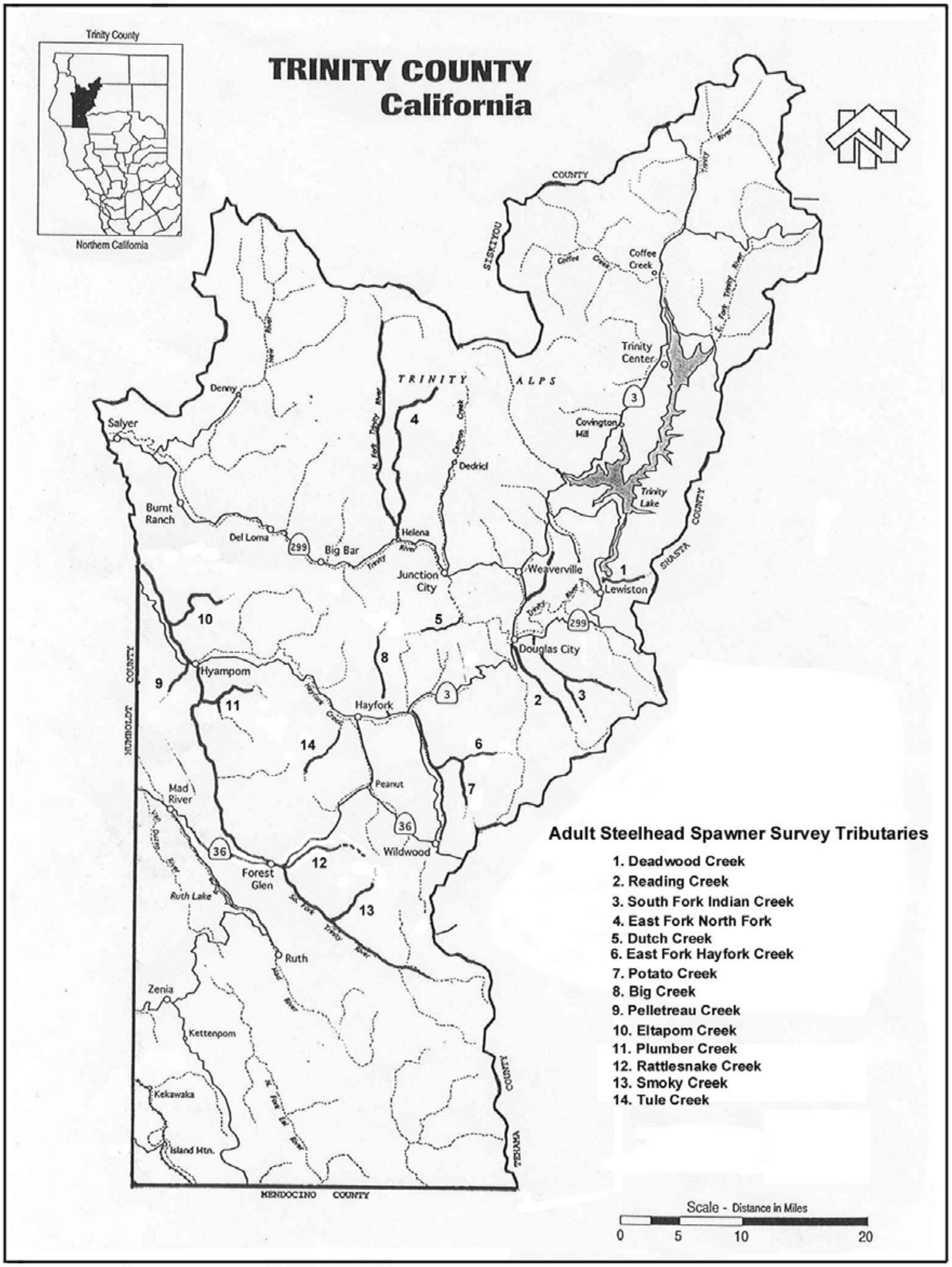

Figure 2. Map of Trinity basin with selected spawner survey tributaries.

METHODS

Sampling Frame/Tributary Selection

The sampling frame was developed by scouring U.S. Forest Service habitat typing files located in the Hayfork and Weaverville Forest Service Fisheries offices. Tributaries located in the Six Rivers National Forest were confirmed with the local Forest Service zone fisheries biologist (L. Morgan, personal communication). Most habitat typing data from the Forest Service is 15-30 years old; some barriers are classified as semi-permanent, i.e. log-jams, short cascade fields. We are currently verifying and expanding our sampling universe when time allows.

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. Sierra Pacific Industries (SPI) is the largest private landowner in Trinity County and has been most cooperative in allowing permission on all SPI lands.

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. In-experienced 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 27 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 intials, 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

RESULTS

This 2009 season, a total of 110 redds were observed in nine tributary creeks during surveys encompassing 42.397 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 nine creeks surveyed. Forty one steelhead were observed during this season’s surveys. Two steelhead carcasses were encountered during this year’s survey, one adipse fin clipped hatchery steelhead in Deadwood Creek and a wild steelhead in East Fork of Hayfork Creek.

Table 3. Trinity River winter-run steelhead spawning survey summary results, March-April 2009.

Tributary	Mileage (km)	Redds	Redds/km	Adult Steelhead
Deadwood	4.283	13	3.035	13
South Fork Indian	1.567	6	3.829	1
Dutch	3.70	0	0	0
Little Browns Creek	1.447	2	1.382	1
East Weaver	2.250	2	0.889	3
West Weaver	1.2	0	0	0
Sidney Gulch	1.51	2	1.325	0
Grass Valley Creek	1.34	0	0	0
East Fork Hayfork	6.77	41	6.056	21
Rusch	3.892	6	1.541	0
Tule	5.189	11	2.120	0
Big	7.989	23	2.879	2
Eltapom	1.26	4	3.174	0
Total	42.397	110	2.595	41

Redd location was characterized by habitat type for all redds observed. Steelhead this season preferred to spawn in glides (n=57, 51.81%) closely followed in preference by runs (n=45, 40.90%), and pools (n=8, 7.27%). No redds were located in other types of habitat, most likely due to the need for suitable flow. The average depth of water over the pit for all redds observed was 12.441 inches (31.60 cm). The average depth of excavation (material removed from pit to create tail-spill) was 4.360 inches (11.074 cm).

All redds were measured utilizing methods put forth by Gallagher (2002). Table 4 (below) provides summary area measurements for all redds observed by tributary. Overall, the average total area of all redds observed during the survey was 8.626 ft^2. The smallest redd observed during the survey occurred in Deadwood Creek and measured 2.097 ft^2. The largest redd was observed in East Fork Hayfork Creek and measured 35.090 ft^2.

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
Deadwood	13	4.526	4.635	9.161	3.769	12.539	Run
South Fork Indian	6	3.183	3.832	7.015	3.833	11.833	Run
Little Browns	2	1.486	2.076	3.562	3.500	8.500	Run
East Weaver	2	3.528	3.115	6.642	5.000	14.500	Run
Sidney Gulch	2	3.660	5.049	8.708	4.000	20.000	Run
East Fork Hayfork	41	4.355	5.316	9.671	4.310	12.715	Run/Glide
Rusch	6	3.080	4.125	7.205	4.333	9.000	Run
Eltapom	4	2.401	3.806	6.207	5.000	11.250	Run/Glide
Tule	11	3.312	5.455	8.767	4.909	12.909	Glide
Big	23	3.366	4.797	8.162	4.609	12.435	Glide
Total	110	3.785	4.841	8.626	4.360	12.441	Glide

Water temperature was recorded at the beginning and end of each survey. Temperatures during peak spawning activity this year were between 3.5°C to 15.0°C (Table 5). During the course of the survey, 83 redds were classified as redd type 1, 25 as redd type 2, 2 as redd type 3, and 0 as redd type 4. Daily recorded temperatures for each tributary surveyed are listed in Appendix 3. A cold weather front during the middle of the steelhead spawning season dropped water temperatures in the spawning tributaries. Temperatures ranged from 3°C on a cold morning start temperature to 15°C on an afternoon end temperature (Appendix 3).

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
Deadwood	Mainstem Trinity River	5-Mar	2	2-T1	6
Deadwood	Mainstem Trinity River	9-Mar	6	2-T1, 4-T2	3.5
Deadwood	Mainstem Trinity River	23-Mar	3	2-T1, 1-T2	4.5
Deadwood	Mainstem Trinity River	24-Mar	1	1-T1	4.5
Deadwood	Mainstem Trinity River	7-Apr	1	1-T1	7.5
South Fork Indian	Mainstem Trinity River	16-Mar	3	1-T1, 1-T2, 1-T3	6.5
South Fork Indian	Mainstem Trinity River	27-Mar	2	1-T1, 1-T2	6.5
South Fork Indian	Mainstem Trinity River	15-Apr	1	1-T1	3.5
Little Browns Creek	Mainstem Trinity River	19-Mar	2	2-T2	6.5
East Weaver	Mainstem Trinity River	21-Apr	2	2-T2	9
Sidney Gulch	Mainstem Trinity River	27-Mar	2	2-T1	15
East Fork Hayfork	South Fork Trinty River	17-Mar	6	3-T1, 2-T2, 1-T3	7
East Fork Hayfork	South Fork Trinty River	18-Mar	8	4-T1, 4-T2	7
East Fork Hayfork	South Fork Trinty River	30-Mar	9	8-T1, 1-T2	5
East Fork Hayfork	South Fork Trinty River	1-Apr	3	2-T1, 1-T2	7
East Fork Hayfork	South Fork Trinty River	13-Apr	7	6-T1, 1-T2	8
East Fork Hayfork	South Fork Trinty River	14-Apr	8	7-T1, 1-T2	4.5
Rusch	South Fork Trinty River	10-Apr	4	1-T1, 3-T2	6.5
Rusch	South Fork Trinty River	22-Apr	2	2-T1	10.5
Eltapom	South Fork Trinty River	29-Apr	4	4-T1	7
Tule	South Fork Trinty River	8-Apr	7	7-T1	7.5
Tule	South Fork Trinty River	24-Apr	4	4-T1	8
Big	South Fork Trinty River	16-Apr	12	12-T1	6
Big	South Fork Trinty River	17-Apr	3	2-T1, 1-T2	6
Big	South Fork Trinty River	27-Apr	5	5-T1	7.5
Big	South Fork Trinty River	28-Apr	3	3-T1	6

a/ Redd types are designeated 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 than other years. The best data possible trend data is from the two creeks which were surveyed every one of these years; East Fork of Hayfork Creek, and Eltapom Creeks. 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. Eltapom has fluctuated from 2 in 2005 and 2006 to 25 in 1994.

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 8.63 ft^2. Previous years redd area averages are as follows: 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 years' survey support Hunter's statement where most all spawning in the Trinity basin had been completed prior to water temperatures reaching 10°C (Table 5). Of the 110 redds discovered this year, four (3.6%) of redds were discovered when water temperatures were greater than 10°C. Two of these redds were discovered in Sidney Gulch when it was surveyed on a very hot afternoon. No adult fish were observed during the survey and the higher creek temperatures at the time of survey could be due to the streams exposure to the sun and low flow. In addition to the low flow, redds were likely construction prior to the high temperature and were able to stay in excellent condition because of the low flow. The other two redds were discovered in Rusch creek when beginning and ending temperatures averaged 10.5°C. No fish were discovered during the survey and the beginning water temperature was 9°C and ending was 12°C. This indicates that this spawning activity had probably occurred prior to the higher temperatures and that the survey was conducted at the very end of the spawning in Rusch Creek. All the other 106 (96.4%) redds were discovered when beginning and end water temperatures were less than 10°C in support 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 7&8). 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 Surveyed	Distance surveyed (km)	Redds observed	Redds/km
Deadwood Creek	1.66	27	16.26
S.F. Indian Creek	0.37	4	10.81
Dutch Creek	2.53	72	28.46
Little Browns Creek	2.09	8	3.83
East Weaver	7.56	89	11.77

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

Tributary Surveyed	Distance surveyed (km) 1971	Redds observed 1971	Redds/ km 1971	Distance surveyed (km) 1972	Redds observed 1972	Redds/ km 1972
Deadwood Creek	3.70	0	0	3.70	0	0
S.F. Indian Creek	1.85	3	1.62	0.81	0	0
Dutch Creek	1.61	0	0	no survey	no survey	no survey
Little Browns Creek	4.83	3	0.62	no survey	no survey	no survey
East Weaver	7.56	0	0	3.22	3	0.93
West Weaver	2.41	0	0	3.22	0	0
Big Creek	12.55	35	2.79	12.55	78	6.22

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 occurring. Possible problems include adequate survey frequency; redd discrimination by species, tributary sample selection, access, weather, and private property permission. 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 Smoky Creek, in South Fork Trinity basin, and 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 years 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. Six of the thirteen tributaries selected for the 2009 survey are located entirely on public land. Two of the thirteen tributaries are located on Southern Pacific Industries land. SPI has been very cooperative in allowing the department to survey on their land. Access to the remaining two 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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Personal Communications

Loren Everest, Spring 2008. US Forest Service, Trinity River Management Unit.
Monty Currier, December 2004. California Department of Fish and Game.

Appendix 1. Reach location and total distance.

Tributary	Start Latitude/Longitude	End Latitude/ Longitude	Reach distance (km)
Deadwood	N 40 43.083 W 122 48.169	N 40 42.833 W 122 45.907	4.28
South Fork Indian	N 40 35.869 W 122 49.868	N 40 35.346 W 122 49.278	1.57
Little Browns Creek	N 40 45.691 W 122 53.225	N 40 46.664 W 122 53.643	1.45
Sidney Gulch	N 40 43.489 W 122 56.431	N 40 44.023 W 122 56.545	1.51
Dutch	N 40 39.869 W 123 00.994	N 40 39.488 W 123 02.828	3.70
West Weaver	N 40 44.588 W 122 58.116	N 40 45.050 W 122 58.399	1.20
East Weaver	N 40 43.268 W 122 56.415	N 40 44.171 W 122 55.623	2.25
Grass Valley Creek	N 40 62.833 W 122 76.847	N 40 62.525 W 122 76.122	1.34
Eltapom	N 40 39.710 W 123 29.642	N 40 39.595 W 123 29.030	1.26
East Fork Hayfork	N 40 29.322 W 123 04.132	N 40 30.542 W 122 59.695	6.77
Rusch	N 40 35.339 W 123 15.877	N 40 39.256 W 123 17.730	3.89
Tule	N 40 33.081 W 123 12.849	N 40 31.483 W 123 14.120	5.19
Big	N 40 36.104 W123 09.750	N 40 39.203 W 123 09.422	7.99

Appendix 2: Redd counts from previous 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
Deadwood	27	0	0	-	-	-	-	-	-	0	2	17	14	22	6	0	16	45
South Fork Indian	4	3	0	-	-	-	-	-	-	0	2	7	2	4	0	0	9	3
Dutch	72	0	-	-	-	-	-	-	-	0	0	2	0	2	3	-	-	6
West Weaver	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Little Browns	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sidney Gulch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Grass Valley Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Rusch	-	-	-	13	-	-	1	1	1	-	-	11	-	-	-	0	5	-
East Fork Hayfork	-	-	-	32	20	5	3	16	2	0	10	64	16	37	13	18	60	33
Eltapom	-	-	-	18	8	13	18	25	3	11	5	11	5	17	2	2	12	16
Tule	-	-	-	35	1	11	6	13	2	16	4	19	5	19	8	-	-	14
Big	-	35	78	36	18	53	7	46	16	-	-	21	-	-	-	-	-	6

Appendix 3. Survey beginning and ending water temperatures.

Tributary Name	Date	Reach	Start Water Temp (C°)	End Water Temp (C°)
Deadwood	3/5/2009	2	5	7
Deadwood	3/9/2009	1	3	4
Deadwood	3/23/2009	1	4	5
Deadwood	3/24/2009	2	4	5
Deadwood	4/7/2009	1&2	7	8
Dutch	3/12/2009	1	4	5
Dutch	3/13/2009	2	4	6
Dutch	3/25/2009	1	6	7
Dutch	3/26/2009	2	6	7
South Fork Indian	3/16/2009	1	6	7
South Fork Indian	3/27/2009	1	6	7
South Fork Indian	4/15/2009	1	3	4
Little Browns	3/19/2009	1	6	7
East Weaver	4/2/2009	1	7	7
East Weaver	4/21/2009	1	9	9
West Weaver	4/2/2008	1	8	7
West Weaver	4/21/2009	2	12	12
Sidney Gulch	3/27/2009	1	15	15
Sidney Gulch	4/15/2009	1	13	13
Grass Valley	4/2/2009	1	8	9
East Fork Hayfork	3/17/2009	1	6	8
East Fork Hayfork	3/18/2009	2	6	8
East Fork Hayfork	3/30/2009	1	4	6
East Fork Hayfork	4/1/2009	2	6	8
East Fork Hayfork	4/13/2009	1	7	9
East Fork Hayfork	4/14/2009	2	4	5
Rusch	4/12/2009	1	6	7
Rusch	4/22/2009	1	9	12
Tule	4/8/2009	1	7	8
Tule	4/9/2009	2	7	7
Tule	4/24/2009	1&2	8	8
Big	4/16/2009	1	5	7
Big	4/17/2009	2	5	7
Big	4/27/2009	1	7	8
Big	4/28/2009	2	6	6
Eltapom	4/29/2009	1	7	7

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