LAGUNITAS CREEK
COHO SALMON
SPAWNER SURVEY REPORT
FALL & WINTER 1997-98

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California Department of Fish and Game	CDFG
California Department of Parks and Recreation	State Parks
cubic feet per second	cfs
Ecologically Significant Unit	ESU
Marin Municipal Water District	MMWD
Mean Daily Flow	MDQ
National Marine Fisheries Service	NMFS
Samuel P. Taylor State Park	S.P. Taylor
State Water Resources Control Board	SWRCB
United States Geological Survey	USGS

EXECUTIVE SUMMARY

We conducted coho salmon (*Oncorhynchus kisutch*) spawner surveys on Lagunitas Creek between 5-November-1997 and 22-January-1998. The surveys were conducted on the mainstem of Lagunitas Creek, between Tocaloma Bridge and Peters Dam, San Geronimo Creek and Devil's Gulch. Surveys on San Geronimo Creek started on 20-November-1997. Devil's Gulch surveys were conducted by the National Park Service starting on 17-November. This year, a group of volunteers also surveyed some of the tributaries to San Geronimo Creek starting on 23-November-97. Spawner surveys were terminated after 22-January-1998, when constant high flows after that date precluded further surveys and we no longer observed spawning activity. Stream flows continued to rise into February during this El Nino winter.

During the survey, a total of 239 redds and 384 live coho were observed. Of this total, 80 redds and 110 coho were observed in Lagunitas Creek, 107 redds and 195 coho were observed in San Geronimo Creek, and 52 redds and 79 coho were observed in Devil's Gulch. An additional 14 redds and 44 coho were observed by volunteers in Larsen Creek and Arroyo Road Creek (2 small tributaries to San Geronimo Creek.). We also took fin and muscle samples from 20 of 64 carcasses that we found on Lagunitas Creek and San Geronimo Creek. These samples were sent to the UC Davis Bodega Marine Laboratory for genetic analysis.

This year's spawning run was nearly as strong as last year's, when there were 254 redds and 549 live coho observed. These two runs were much stronger than the 1995/'96 run, when 86 redds and 365 coho were observed.

The first coho was observed in Lagunitas Creek on 28-October after a storm in mid-October raised the stream flows in Lagunitas Creek to 27 cubic feet per second. The majority of live coho observations and coho redd construction in the Lagunitas Creek drainage occurred in the month of December.

1.0 INTRODUCTION

1.1 Background

Lagunitas Creek originates on the north slope of Mount Tamalpais and flows in a northwesterly direction for 25 miles where it discharges into Tomales Bay (Figure 1). San Geronimo Creek, Devil's Gulch, Nicasio Creek, and Olema Creek are the major tributaries to Lagunitas Creek. Devil's Gulch, which flows through National Park and State Park land before entering Lagunitas Creek, is the smallest of these tributaries but it usually has perennial surface flows in addition to good habitat characteristics which make it an important coho producing stream. Other tributaries to Lagunitas Creek that are known to support coho include Cheda and McIsaac Creeks. Woodacre, Larsen and Arroyo Road Creeks are tributaries to San Geronimo Creek that provide coho spawning habitat. Much of the land within the Lagunitas Creek watershed is publicly owned by either the Marin Municipal Water District (MMWD), California Department of Parks and Recreation (State Parks), or the National Park Service (NPS).

MMWD is a public agency that diverts water from the Lagunitas Creek drainage in Marin County, California to provide water to residents of central and southern Marin. MMWD operates four reservoirs on the mainstem of Lagunitas Creek, including Lake Lagunitas, Bon Tempe Lake, Alpine Lake and Kent Lake. In addition, Nicasio Reservoir stores water on Nicasio Creek. MMWD diversions are permitted and regulated by the California State Water Resources Control Board (SWRCB). The MMWD reservoirs have altered flows in Lagunitas Creek by reducing peak winter storm flows and, with releases from Kent Lake, increasing summer low flows (SWRCB 1995). Natural runoff patterns in Lagunitas Creek were characterized by high, flashy winter storm flows and low summer flows, with substantial year to year variation in total runoff. In its 1995 Order WR95-17, the SWRCB required MMWD to provide releases from Kent Lake to ensure minimum stream flows at the U.S. Geological Survey (USGS) stream gauge in Samuel P. Taylor State Park for the benefit of the aquatic resources in Lagunitas Creek. The normal year flow requirements on Lagunitas Creek are outlined in Table 1. In addition to requiring minimum stream flows, the SWRCB Order also called for four upstream migration flows. An upstream migration flow is a continuous flow of at least 35 cfs for 3 days as measured at the USGS gauge in the State Park. Upstream migration flows are required on 15-November, 1-December, 1-January, and 1-February in the absence of a natural storm event in the month preceding those target dates.

The SWRCB also ordered MMWD to develop and implement a fisheries monitoring plan as well as a sediment and riparian management plan for the Lagunitas Creek watershed (SWRCB 1995). In 1996, MMWD prepared the *Aquatic Resources Monitoring Workplan for the Lagunitas Creek Drainage, Marin County, California: Final Report* (MMWD 1996). In 1997, MMWD prepared the *Lagunitas Creek Sediment and Riparian Management Plan: Final* (MMWD 1997). Both plans have been approved by the SWRCB.

Table 1. Normal water year minimum flow requirements on Lagunitas Creek at S.P. Taylor State Park.

Time Period			Flow (cfs)
1/15-November*	-	31-December	20
1-January	-	15-March	25
15-March	-	31-March	20
1-April	-	30-April	16
1-May	-	15-June	12
16-June	-	1/15-November*	8

* The minimum flow of 20 cfs in November is to begin following the first storm that produces a "trigger" flow of 25 cfs at the USGS gauge at S.P. Taylor State Park. In the absence of a storm causing a "trigger" flow, the 20 cfs requirement will become effective on 15-November of each year.

One element of MMWD's aquatic resource monitoring program is to conduct annual coho spawner surveys on the Lagunitas Creek system. MMWD sponsored coho spawner surveys on Lagunitas Creek, Devil's Gulch, and San Geronimo Creek during the 1982/'83 and 1983/'84spawning seasons and annually since the 1995/'96 season. During the years between 1984 and 1995, one day to a few day spawner surveys were conducted by the California Department of Fish and Game (CDFG), and by ENTRIX in 1992, which gave a snapshot look at the spawning season.

The objectives of the spawner surveys are to determine the distribution and range of spawning and the relative spawner abundance within the watershed. This information will track the annual spawning run in Lagunitas Creek. It will also help satisfy one of the goals of the aquatic resource monitoring plan, which is to determine if MMWD management activities (water releases, sediment control, and riparian restoration) are improving habitat utilization and, ultimately, the abundance of coho salmon returning to the Lagunitas Creek watershed.

1.2 Coho Salmon Life History and Status

Coho salmon are anadromous fishes, spending their adult life in the ocean, migrating into freshwater streams to spawn, rearing at least partially in freshwater, and migrating to the ocean as smolts. Most coho salmon from California streams spend approximately 18 months in freshwater (including incubation) and 18 months in the ocean, returning to spawn in their natal stream in their third year, after which they die (Shapalov and Taft 1954). Unlike other salmonids in California, this three year cycle is fairly rigid and spawning years with relatively poor reproductive success can result in poor spawning runs three years later (D.W. Kelley & Associates and ENTRIX 1992). Coho can also be grouped in year classes of three year increments. For example, 1994 and 1997 young-of-the-year coho are from the same year class, with the 1997 year class being the progeny of the 1994 year class spawners. Adult coho begin to arrive near the mouth of Lagunitas Creek in late summer and fall to begin acclamation to freshwater before they migrate upstream (Bratovich and Kelley 1988). The spawning period is generally from mid-November to mid-January but adult coho have been observed as early as

mid-October and as late as early February.

Coho salmon usually spawn at the heads of riffles with gravel substrate (Moyle 1976). Females may excavate small test pits (or “diggings”) in the gravel substrate before deciding on a site to lay her eggs. Once decided, she will dig a larger pit (called a “redd”) where she deposits her eggs. Often more than one male will fertilize the eggs before the female covers the eggs with additional gravels (Moyle 1976). Following spawning, the female may guard the redd for up to two weeks before dying (Groot and Margolis 1991). Juvenile coho emerge from the gravel the following spring and usually rear in the stream for one year before migrating to the ocean (Moyle 1976). The majority of coho return as three year old fish, however, "jacks" return as sexually mature, two year old males (Groot and Margolis 1991).

Coho salmon in the Central California Coast Evolutionarily Significant Unit (which includes the Lagunitas Creek watershed) have been listed as “threatened” under the federal Endangered Species Act (61 FR 56138). Likewise, the present population in Lagunitas Creek has been significantly reduced from historical levels (Brown et al 1995). Recent surveys, however, may indicate an upward trend in the coho salmon population. Spawner surveys from the mid-1980's indicated that approximately 100 coho spawned annually in Lagunitas Creek and its tributaries (D.W. Kelley & Associates and ENTRIX 1992), while the 1995/’96 coho spawner survey indicated at least 300 coho spawned in the mainstem of Lagunitas Creek alone and the watershed total was probably around 500 (Trihey & Associates, Inc 1996). Last year, 549 adult coho were spotted in the Lagunitas Creek drainage with a total watershed estimate of around 1,000 coho (Trihey & Associates 1997).

2.0 METHODS

Stream sections were walked every week by a two person crew except during the short week of Christmas. Surveys were conducted by Gregory Andrew, Michael Cronin and Andrew Peri. Michael Meinz (SWRCB) and Ron Nerviani (MMWD) provided assistance during two surveys. Each stream section was surveyed from the downstream end to the upstream end. We divided the mainstem of Lagunitas Creek into three sections: 1) Tocaloma Bridge to Devil’s Gulch (approximately 2.5 miles) 2) Devil’s Gulch to Shafter Bridge (approximately 3.0 miles) and 3) Shafter Bridge to Peters Dam (approximately 0.5 miles). The mainstem of San Geronimo Creek was walked from its mouth to the confluence of Woodacre Creek, approximately 4 miles upstream. Two small tributaries to San Geronimo Creek, Larsen and Arroyo Road Creeks, were surveyed by volunteers. Roy’s Dam is a significant landmark 3 miles upstream of the mouth of San Geronimo Creek where fish must swim through a fish ladder to migrate upstream of the dam. Devil’s Gulch was surveyed from its mouth to a fork at 1.3 miles upstream by NPS biologists. The section of Lagunitas Creek from its mouth to Tocaloma Bridge was not surveyed because deep pools and overhanging vegetation made it difficult to observe fish and because this section has not been systematically surveyed in previous years. However, on 31-December-1997, biologists from MMWD and NPS walked the section of Lagunitas Creek from Gallaghers Ranch to Tocaloma Bridge.

During the surveys we recorded observations of redds, live adult coho, coho carcasses, diggings and any adult steelhead (*Oncorhynchus mykiss*). Live fish were recorded as male or female, their condition noted (color, wear marks, hooked jaw, etc) and their location in relation to landmarks such as tributaries or bridges was noted. All observed spawning activity was also recorded. We recorded the sex and length of recovered carcasses and collected tissue samples so that genetic analyses could be performed by Bodega Bay Marine Lab. We attempted to determine if these coho carcasses had spawned by inspecting for retained eggs or milt. Other information recorded during each survey included: survey start and stop times, air and water temperature, weather conditions, and qualitative observations of stream flow, water clarity and visibility.

We assigned a number to each redd and marked its location in the field by hanging colored tape on adjacent vegetation. Redds were marked so no redd would be double counted during subsequent surveys and so any additional redds near that site could be distinguished. Each redd was flagged with red, striped flagging and yellow flagging. We labeled each flag with the date, the number of the redd, location of the redd with respect to the channel (i.e. mid-channel, left or right bank, etc), and the number of coho, if any, observed on the redd. If it was determined that a female made a small "test" pit and not a redd, the site was recorded as a "digging" and flagged with only yellow flagging. We also marked redd locations on a copy of the USGS topographic quadrangle map for each survey date (Appendix A).

The data on live coho and redds were compiled and compared to previous years. Rainfall and stream flow data were also compiled so we could analyze the coho spawning run relative to changes in stream flow.

We had no way of positively determining if we were recounting the same fish during subsequent surveys or missing fish during the intervals between surveys. We attempted to survey upstream stream sections before downstream sections to reduce the possibility of recounting the same fish that might be moving upstream. For example, we surveyed San Geronimo Creek first , Devil's Gulch to Peters Dam next, and then Tocaloma Bridge to Devil's Gulch. Most surveys on each section were conducted at least 7 days and usually more than 11 days apart.

3.0 RESULTS

3.1 Live Coho Salmon, Redds, and Carcasses

Adult coho were first observed in Lagunitas Creek this year on 28-October-1997. A single coho was observed by Gregory Andrew on this date during a survey for California freshwater shrimp. The live coho was observed moving upstream through a riffle in the section of creek between Tocaloma Bridge and Devil's Gulch. That same day, he encountered a coho carcass in the same section.

We observed a total of 239 redds and 384 live coho during the spawner surveys in Lagunitas Creek, San Geronimo Creek (excluding Larsen and Arroyo Road Creeks), and Devil's Gulch (Table 2). This

is less than the 254 redds and 549 live coho seen last year (Trihey & Associates 1997) but more than the 86 redds and 365 live coho seen in 1995/'96 (Trihey & Associates 1996). In comparing the last three spawning seasons, we do not include the data from Larsen and Arroyo Road Creeks because they were not surveyed before this year. That data will be summarized separately.

Totaling the observations made in Lagunitas Creek, San Geronimo Creek, and Devil's Gulch with the observations made in Larsen and Arroyo Road Creeks, there were 253 redds and 428 live coho observed during this year's spawner survey effort.

The lower, middle and upper sections of Lagunitas Creek are Tocaloma Bridge to Devil's Gulch, Devil's Gulch to Shafter Bridge, and Shafter Bridge to Peters Dam, respectively (Figure 1). We observed 24 redds in the lower section, 41 redds in the middle section, and 15 redds in the upper section (Table 2). We also observed 25 live coho in the lower section, 47 live coho in the middle section, and 38 live coho in the upper section (Table 2). As during the 1996/'97 spawning season, we counted redds and observed coho spawning in the discharge channel at the Kent Lake release structure, below Peters Dam. The discharge channel is only about 200 feet long and carries water from the release structure to the plunge pool at the base of Peters Dam.

We observed a total of 107 redds and 195 live coho in San Geronimo Creek, with 74 redds and 134 live coho in the section of San Geronimo Creek from its mouth to Roy's Dam and 33 redds and 61 live coho above Roy's Dam (Table 2). Surveys by the NPS in Devil's Gulch recorded 52 redds and 79 live coho. The volunteers who surveyed Larsen and Arroyo Road Creeks, tributaries to San Geronimo Creek, observed a total of 14 redds and 44 live coho. As in the previous spawning season, coho were also reported to be spawning in Woodacre Creek, but numbers were not recorded.

We located a total of 77 coho carcasses from the Lagunitas Creek system (Table 2), with 27 coho carcasses in Lagunitas Creek, 37 carcasses in San Geronimo Creek, 9 carcasses in Devil's Gulch, and 4 carcasses in Larsen and Arroyo Road Creeks. Tissue samples for genetic analysis were taken from 16 coho carcasses in Lagunitas Creek, 10 coho carcasses in San Geronimo Creek, and 9 coho carcasses in Devil's Gulch. Tissue samples were not taken from the other carcasses observed either because they had already been sampled (Bob Chamberlain of Trout Unlimited conducted surveys for carcasses), their bodies were too degraded, or they could not be retrieved from deep pools.

On 8-January-1998, a male chum salmon (*Oncorhynchus keta*) carcass was recovered from Lagunitas Creek, approximately 300 meters below Peters Dam. The salmon had probably not been dead for more than two days because the purple blotches on its side were still bright and it was still emitting milt. The chum salmon had large teeth around the upper and lower jaw and its caudal peduncle was more narrow than a coho. The observation of this chum salmon is rare and there is no recent history of chum salmon adults being observed in the Lagunitas Creek drainage. During the 1996/'97 spawning season, a chinook salmon (*Oncorhynchus tshawytscha*) carcass was observed in San Geronimo Creek (Trihey & Associates 1997) which is also a rare occurrence. Both the chum and chinook were undoubtedly stray individuals.

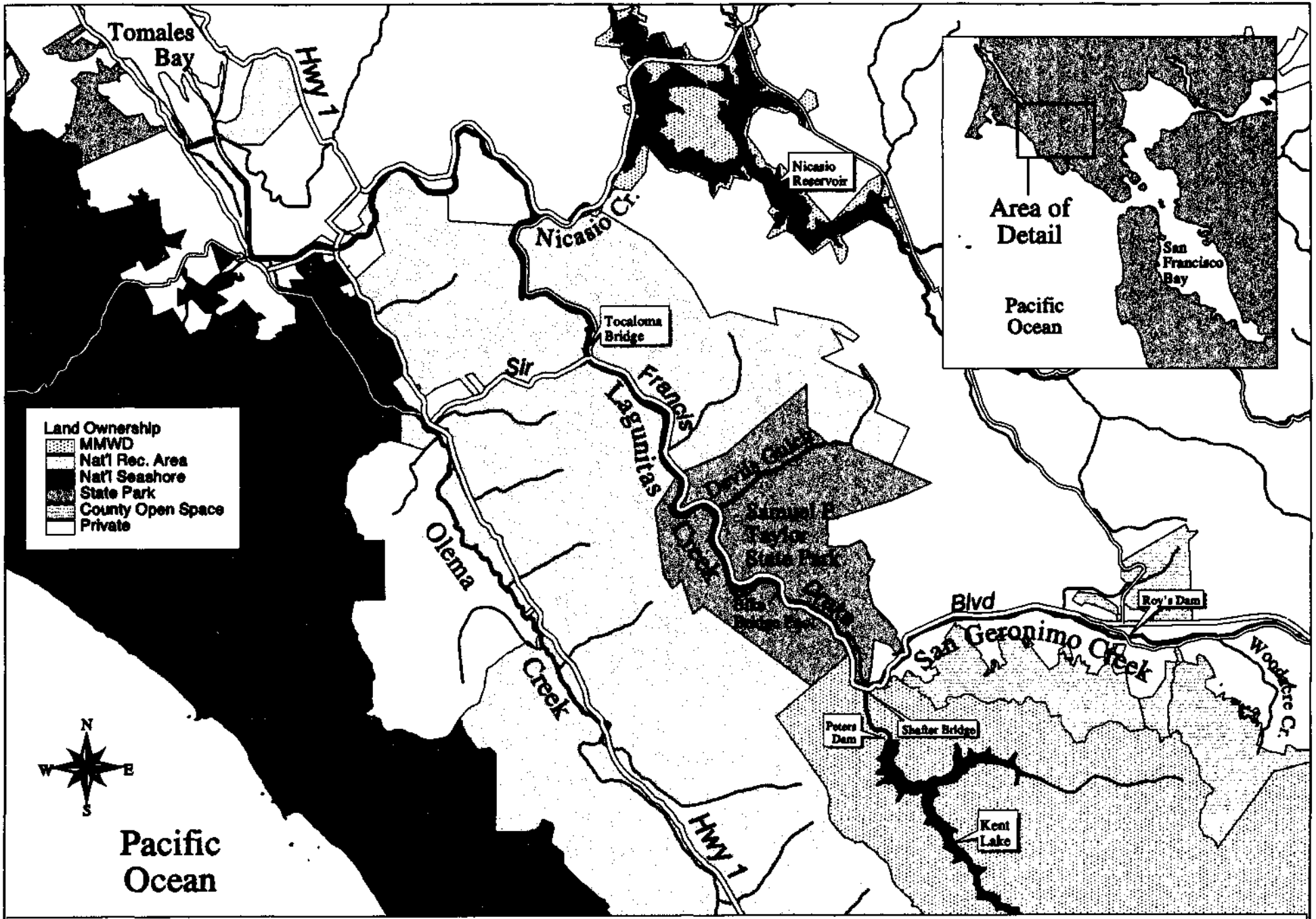

Figure 1. Spawner Survey Sections on Lagunitas Creek and Tributaries.

COHO SPAWNER SURVEY DATA **1997/98 SURVEY RESULTS**

Compiled by: Marin Municipal Water District

Updated: 21-Mar-00

SURVEY	LAGUNITAS CREEK									SAN GERONIMO CREEK						TOTAL		
	Tocaloma-Devils Gulch			Devils Gulch-Shafter			Shafter-Peters			Mouth-Roys Dam			Above Roys Dam					
DATE	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	**Live Coho**	**Carcasses**	**Redds**
28-Oct-97*	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0
31-Oct-97*	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1
5-Nov-97	1	0	4	0	0	0	0	0	0	-	-	-	-	-	-	1	0	4
6-Nov-97*	-	-	-	1	0	0	-	-	-	-	-	-	-	-	-	1	0	0
10-Nov-97*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov-97*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov-97	1	0	0	18	0	6	2	0	0	-	-	-	-	-	-	21	0	6
19-Nov-97*	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
20-Nov-97	-	-	-	-	-	-	-	-	-	17	0	8	4	0	2	21	0	10
26-Nov-97	-	-	-	-	-	-	11	0	1	-	-	-	-	-	-	11	0	1
1-Dec-97*	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	3	0	1
2-Dec-97	-	-	-	-	-	-	0	0	2	20	2	20	5	0	1	25	2	23
3-Dec-97	-	-	-	9	2	12	5	0	2	-	-	-	-	-	-	14	2	14
4-Dec-97	0	0	4	-	-	-	-	-	-	-	-	-	2	0	2	2	0	6
12-Dec-97	-	-	-	-	-	-	-	-	-	41	4	10	15	2	11	56	6	21
16-Dec-97	-	-	-	15	4	17	8	2	8	-	-	-	-	-	-	23	6	25
17-Dec-97	20	6	11	-	-	-	-	-	-	-	-	-	-	-	-	20	6	11
19-Dec-97	-	-	-	-	-	-	-	-	-	20	5	9	21	2	12	41	7	21
30-Dec-97	-	-	-	-	-	-	-	-	-	11	8	11	10	7	2	21	15	13
31-Dec-97	-	-	-	4	3	6	0	0	0	-	-	-	-	-	-	4	3	6
2-Jan-98*	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
6-Jan-98	1	5	4	-	-	-	-	-	-	-	-	-	-	-	-	1	5	4
8-Jan-98	-	-	-	0	3	0	5	1	0	23	5	16	4	2	3	32	11	19
16-Jan-98	-	-	-	0	0	0	4	0	1	-	-	-	-	-	-	4	0	1
22-Jan-98	-	-	-	-	-	-	-	-	-	2	0	0	0	0	0	2	0	0
SUB-TOTAL	**25**	**12**	**24**	**47**	**12**	**41**	**38**	**3**	**15**	**134**	**24**	**74**	**61**	**13**	**33**	**305**	**64**	**187**
	DEVIL'S GULCH SURVEYS															79	9	52
SUB-TOTAL																**384**	**73**	**239**
	LARSEN CREEK SURVEYS															17	1	4
	ARROYO ROAD CREEK SURVEYS															27	3	10
TOTAL																**428**	**77**	**253**

Notes:
(-) Indicates that the spawner survey did not cover the area on that date.
* The entire reach was not surveyed on this date.
Larsen Creek and Arroyo Road Creek were not surveyd in 1995/96 or 1996/97.

Table 2. Results of the Coho Spawner Survey in the Lagunitas Creek Watershed, 1997-1998.

3.2 Stream Flows, Water Releases and Correlated Spawning Activity

Stream flow at the Samuel P. Taylor (USGS) gauge remained at approximately 8 to 9 cfs until 12-November-97 (Figure 2). A storm starting on 9-November-97 brought nearly 5 inches of rain to the region over the next week. Keeping with the required stream flows mandated by the SWRCB, MMWD increased water releases from 8 to 30 cfs to create an upstream migration flow between 14-November and 17-November-1997. The rainfall and water releases increased stream flow at the USGS gauge to 68 cfs on 15-November-97, which was the first flow in November greater than 25 cfs and triggered the SWRCB requirement to maintain a flow of 20 and 25 cfs thereafter (hence this flow is called a "trigger" flow; see Table 1). Increased releases were not necessary to achieve the 1-December-97, 1-January-98, or 1-February-98 upstream migration flows since rainstorms during or prior to those periods provided sufficient runoff for the upstream migration flows. Moderate rainstorms occured through November and into early December. By early January, winter storms were consistent and flows well above 25 cfs were maintained at the USGS gauge by a combination of runoff in the watershed and Kent Lake releases. The El Nino storms of 1998 had begun by mid-January and Kent Lake began to spill over Peters Dam on 16-January-98. A peak flow of 5,200 cfs was recorded at the S.P. Taylor USGS gauge on 3-February-98.

The first substantial run of fish, 21 live coho and 6 redds, were recorded during the spawner survey in Lagunitas Creek on 17-November-97 (Figure 3). The storm between 9-November and 16-November-97 also raised the level of San Geronimo Creek to a stage of 2.4 feet at a stream gauge maintained by MMWD on this creek (located at the Lagunitas Street bridge). These flows allowed for passage of salmonids over the "Inkwells," the bedrock step pools located about 100 feet upstream from the mouth of San Geronimo Creek. A spawner survey conducted in San Geronimo Creek on 20-November-97 recorded the first substantial run of 21 live coho and 10 redds.

A storm from 3-December to 8-December-97 dropped 3.28 inches of rain at Kent Lake, raised Lagunitas Creek mean daily flow to 166 cfs on 7-December-97, and was followed by the peak in coho spawning activity for the season. The level of San Geronimo Creek rose to over 3 feet at the MMWD gauge, which is equivalent to 80 cfs. A survey in San Geronimo Creek on 12-December-97 resulted in the highest number of live coho seen with 56 coho and 21 new redds (Figures 3 & 4; Table 2). Surveys in Lagunitas Creek on 16-December and 17-December-97 resulted in 43 live coho and 36 new redds. Surveys in Devil's Gulch on 11-December and 17-December-97 resulted in 44 live coho and 20 new redds. The last substantial run of coho appears to have occurred in early January when a survey of San Geronimo Creek on 8-January-98 recorded 32 live coho and 19 new redds. The last spawner survey of the season was conducted through San Geronimo Creek on 22-January-98, during which a live steelhead was observed. After that, flows in all of the creeks remained too high to conduct further surveys.

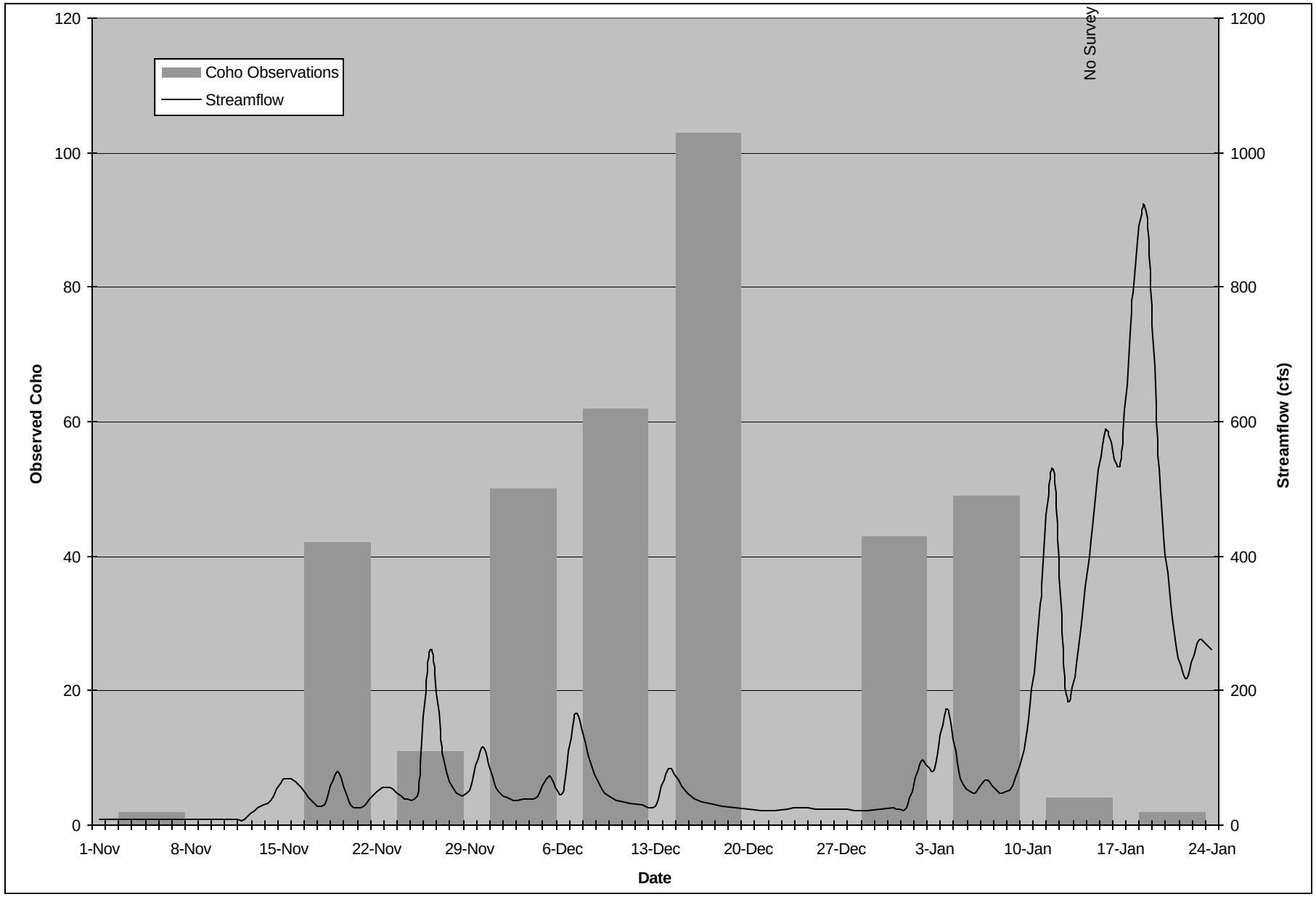

Figure 3. Live Coho Observations and Lagunitas Creek Flow, Spawning Season 1997-1998.

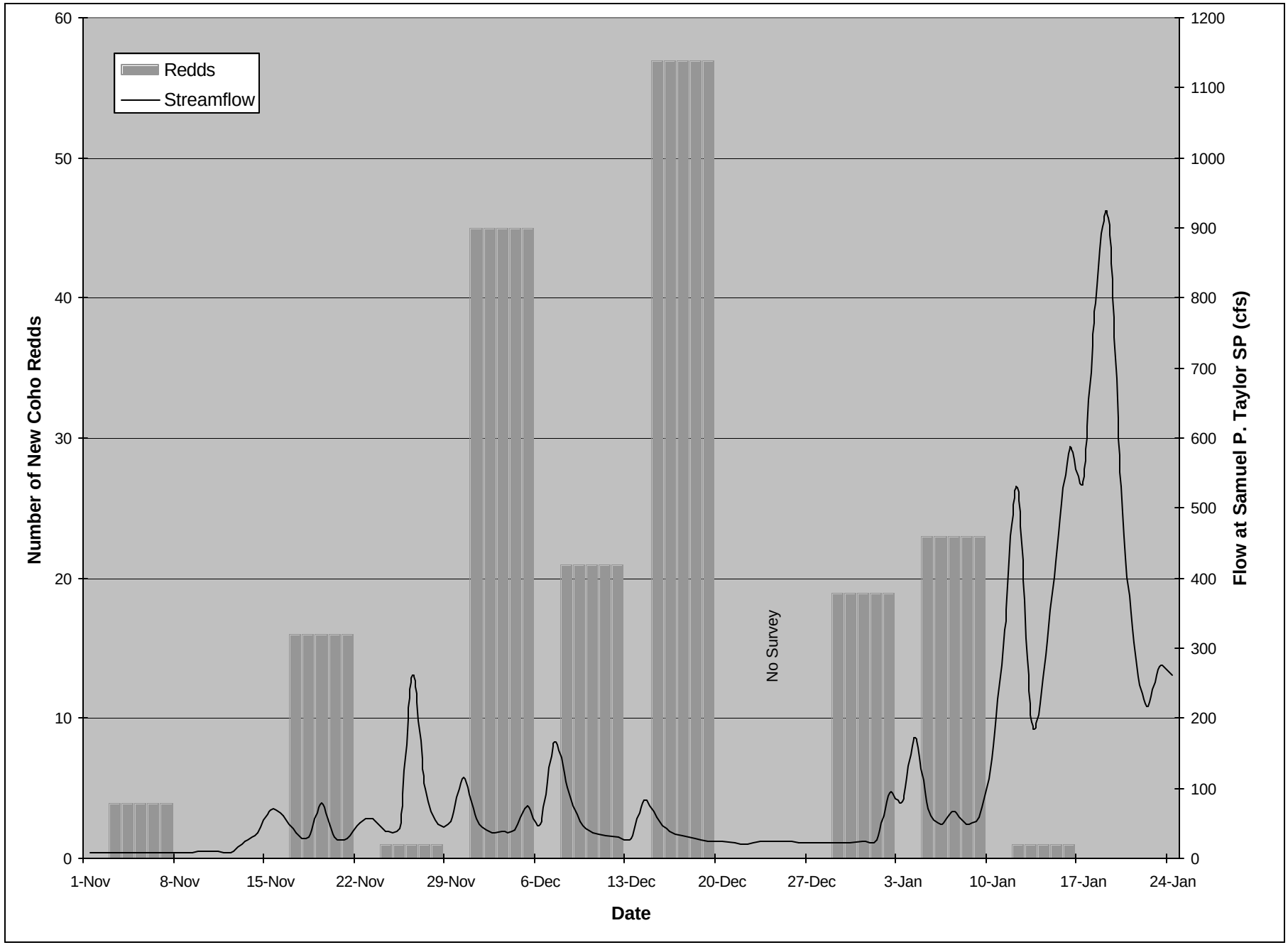

Figure 4. Coho Redd Observations and Lagunitas Creek Streamflow, Spawning Season 1997-1998.

4.0 DISCUSSION

The 1997/'98 coho spawning season in the Lagunitas Creek watershed was one of the strongest runs of recent years, nearly equaling the 1996/'97 spawning season in terms of the number of redds, but with fewer coho observed (Figure 5). This year's run was unexpectedly strong for this year class (which also includes the 1994/'95 run). Spawner surveys were not conducted prior to 1995, but juvenile coho surveys in 1994 and 1995 indicate that the 1994'/95 run was much weaker than the 1993/'94 run (Trihey & Associates 1994; Trihey & Associates 1995). This decline was not observed this year, possibly indicating that survivorship of this year class has improved since 1994.

Another possible explanation for the appearance of an equally strong run this year, compared to last year, is increased sampling effort. The likelihood of overlooking redds decreases as more surveys are conducted, particularly when high stream flows occur between surveys that could scour or bury redds. We conducted 17 surveys during 10 weeks this year, compared with 13 surveys during 8 weeks last year. More importantly, we only missed one week (Christmas week) during the height of the spawning run, compared with 3 missed weeks last year. Redds may have been missed during the 1996/'97 surveys, particularly after a two week gap in surveys during late December after which extremely high stream flows may have scoured or buried redds or made finding redds difficult. It is unknown, however, how many more redds might have been observed in 1996/'97 if the sampling effort had been equal to 1997/'98.

The distribution of redds among creeks was similar to last year's but quite different from the distribution in 1995/'96 (Figure 6). This year we observed 31% of redds in Lagunitas Creek, 49% in San Geronimo Creek and 20% in Devil's Gulch. The percentage of redds in Lagunitas Creek is far below the 81% of redds seen in 1995/'96. Lagunitas Creek has also shown a decrease in the number of live coho observed over the last three spawning seasons (Figure 7). We observed 110 live coho in Lagunitas Creek this year, down 39% from the 180 seen last year and down 60% from the 279 seen in the 1995/'96 season. The decrease in the number of coho spawning in Lagunitas Creek since 1995/'96 may be the result of the pattern of rain and stream flows. During the 1995/'96 season, only two storm events occurred from October through January, probably hindering access to San Geronimo Creek and Devil's Gulch during much of the spawning season. In contrast, during the last two years frequent storm events occurred during the spawning season, particularly in December, allowing access to the tributaries of Lagunitas Creek. Given that nearly half of the observed redds occurred in San Geronimo Creek during the past two years, this creek may be the preferred spawning stream for coho in the Lagunitas Creek drainage when stream flows are adequate to allow access.

Determining the total number of spawners entering the Lagunitas Creek system is a challenging task. While some fish were counted twice, many more were likely not observed at all. The 428 live coho observed is most likely less than the total number of spawners in the system. A reasonable method of estimating the number of spawners is to assume that there should be two fish for each redd. We often saw more than two fish

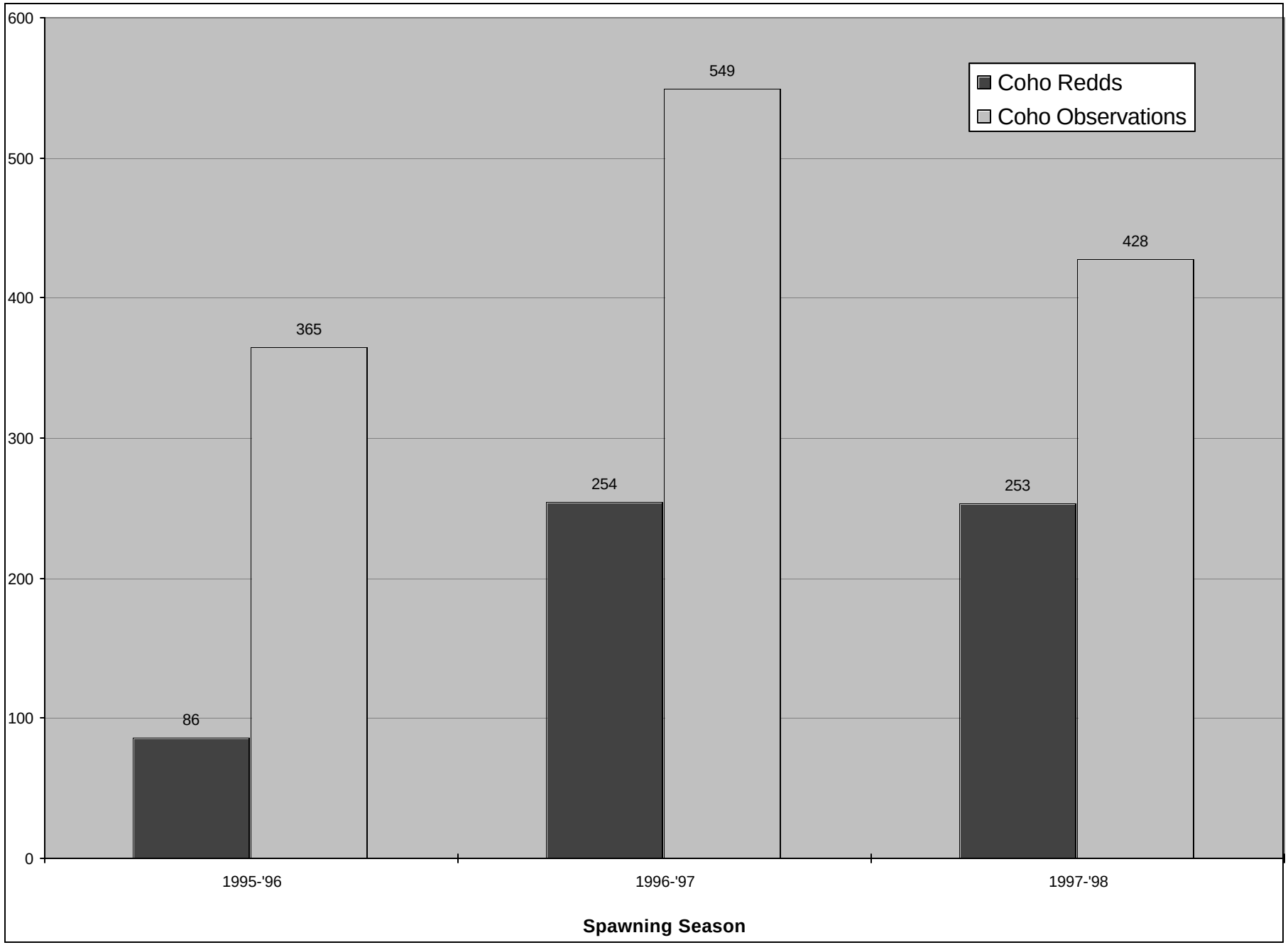

Figure 5. Coho Redds and Live Coho Observations in the Lagunitas Creek Watershed, Spawning Seasons 1995/'96-1997/'98.

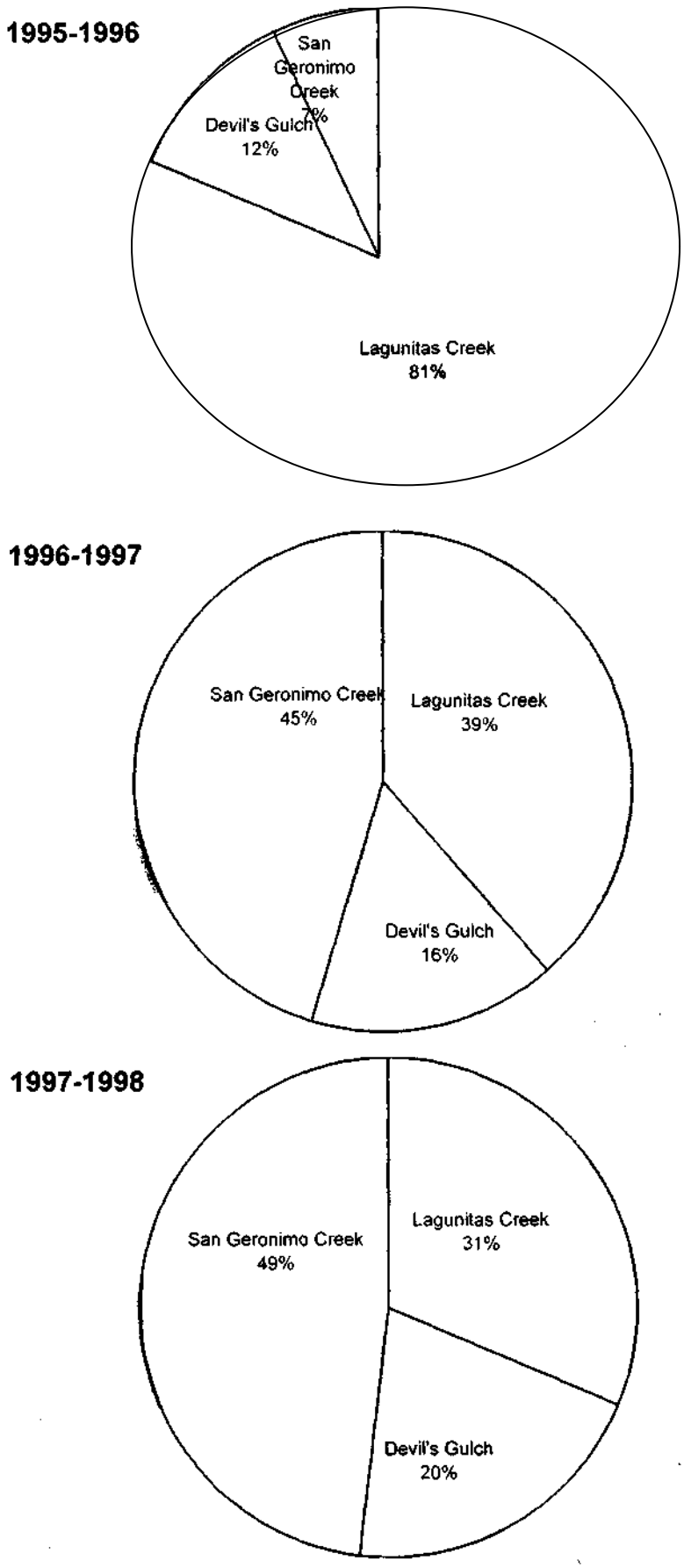

Figure 6. Coho Redd Locations in the Lagunitas Creek Watershed, Spawning Seasons 1995/'96-1997/'98.

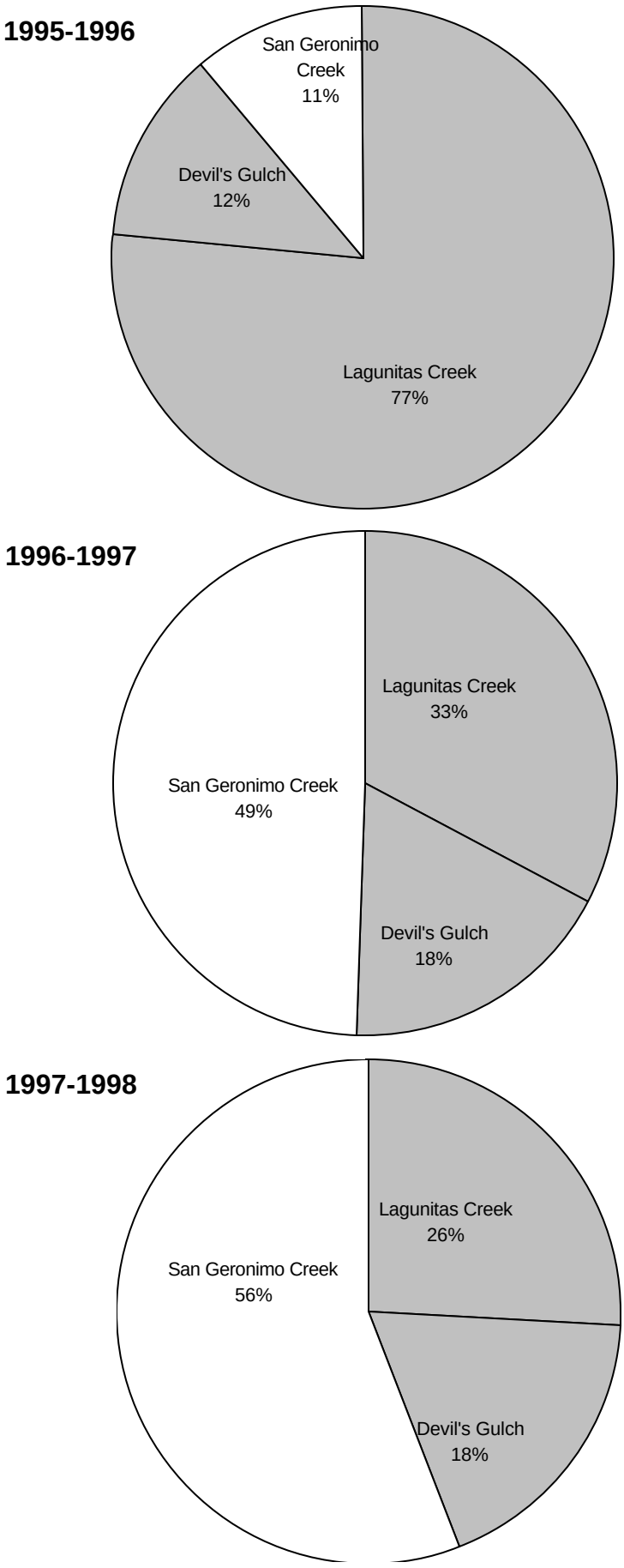

Figure 7. Coho Observations by Creek, Spawning Seasons 1995-1997

holding over a single redd (typically one female and one or more males), so this assumption would underestimate the number of spawners. Given the problems involved with estimating the total number of spawners, documenting the observed trends in spawner numbers may be more useful. The most cautious summary of the number of spawners this year is, based on observed fish and redds, that it was lower than last year but higher than in 1995/'96.

The success of the 1997/'98 coho spawning run will hopefully produce an abundance of juvenile coho. However, a major threat to the survival of the developing juveniles is the scouring and burial of redds during high stream flows. On February 3, 1998, the stream flow at the Samuel P. Taylor State Park gauge peaked at 5,200 cubic feet per second. This is an unusually high stream flow for Lagunitas Creek and may have been sufficient to scour redds in the creek. Survivorship of juvenile coho through the winter, spring and summer will be assessed during the 1998 juvenile salmonid survey. If survivorship during this period is high, chances are good that a large coho spawning run may return to Lagunitas Creek in 2000.

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APPENDIX A

USGS 7.5 minute quadrangle topographic maps with redd locations on Lagunitas and San Geronimo Creeks.