

LAGUNITAS CREEK SALMON SPAWNER SURVEY REPORT 2003-2004

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LIST OF ACRONYMS

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 County Open Space District	MCOSED
Marin Municipal Water District	MMWD
National Marine Fisheries Service	NMFS
National Oceanographic and Atmospheric Administration	NOAA
National Park Service	NPS
Salmon Protection and Watershed Network	SPAWN
State Water Resources Control Board	SWRCB
Trout Unlimited	TU
United States Geological Survey	USGS
Upstream Migration Flow	UMF

EXECUTIVE SUMMARY

Marin Municipal Water District (MMWD) Fisheries staff conducted salmonid spawner surveys on Lagunitas Creek between 14-October-2003 and 10-March-2004. These surveys were intended to document the spawning run of coho salmon (*Oncorhynchus kisutch*), while also collecting data on steelhead trout (*O. mykiss*), Chinook or “king” salmon (*O. tshawytscha*) and chum salmon (*O. keta*). Surveys were conducted weekly on Lagunitas Creek between Tocaloma Bridge and Peters Dam, with a few exceptions. There were five additional surveys in Lagunitas Creek, downstream from Tocaloma Bridge to the mouth of Nicasio Creek. We also conducted weekly surveys on San Geronimo Creek starting on 13-November-2003 and on Devil’s Gulch starting on 8-December-2003. The staff of the Salmon Protection and Watershed Network (SPAWN) and volunteers from Trout Unlimited (TU) conducted surveys on seven tributaries of San Geronimo Creek, plus an upper reach of San Geronimo Creek. Staff from the National Park Service (NPS) surveyed Olema Creek and Cheda Creek. These organizations provided summary data that are included in this report.

We observed the first coho in San Geronimo Creek on 3-December-03. The majority of coho observations and redd construction in the Lagunitas Creek basin occurred in the month of December. During this year’s spawning run, we observed a total of 383 coho redds and 949 live coho. We observed 124 redds and 270 coho in Lagunitas Creek, 139 redds and 385 coho in San Geronimo Creek, and 48 redds and 97 coho in Devil’s Gulch. NPS staff observed six redds and one coho in Cheda Creek. The remaining 66 redds and 196 coho were observed by SPAWN and TU personnel in tributaries to San Geronimo Creek. We took fin or operculum samples from 56 of 82 coho carcasses along with two operculum samples from Chinook and three from steelhead found in Lagunitas Creek, San Geronimo Creek, and Devil’s Gulch. Samples have been sent to the NOAA Fisheries, Santa Cruz Lab for genetic analysis. This year we observed 18 Chinook and two chum salmon, compared with 33 Chinook and five chum observed last year.

This year we documented the largest number of coho redds and live coho observed in nine years of spawner surveys. Most of this year’s spawning coho were part of the year class that was last observed during the 2001 juvenile salmonid survey. That juvenile survey estimated the second largest population in the last nine years, indicating that this is a large year class.

Under the minimum stream flow requirements mandated by the California State Water Resources Control Board (SWRCB) Order WR95-17, MMWD ensured upstream migration flows (UMFs) of at least 35 cubic feet per second (cfs) for three-day periods. Releases from Kent Lake were only required twice for these UMFs, starting on 27-November and 1-December-03. Natural runoff in December and January was sufficient to provide UMFs during these months. The first coho of the season, and large numbers of them, were observed following the early December artificial UMF, which coincided with a storm.

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 has perennial surface flows in addition to good habitat characteristics, which make it an important coho spawning stream. Other tributaries to Lagunitas Creek that are known to support coho include Cheda and McIsaac Creeks. Arroyo Road, Evans, Larsen, Montezuma and Woodacre Creeks are tributaries to San Geronimo Creek that provide coho spawning habitat. Fifty-two percent of the land within the Lagunitas Creek watershed is publicly owned by either the Marin Municipal Water District, the National Park Service, California Department of Parks and Recreation (State Parks), or Marin County Open Space District (MCOSD).

MMWD is a public agency that withdraws water from the Lagunitas Creek basin in Marin County, California to provide water to residents of central and southern Marin. MMWD operates four reservoirs on Lagunitas Creek, including Lake Lagunitas, Bon Tempe Lake, Alpine Lake and Kent Lake. MMWD diversions are permitted and regulated by the California State Water Resources Control Board. 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 US Geological Survey (USGS) stream gage 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 (UMF) is a continuous flow of at least 35-cfs for three days as measured at the USGS gage 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 gage 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. Each year since 1999, the SWRCB granted a request to delay the November flow increase until 27-November or following the first “trigger” flow.

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 spawning season and annually since the 1995/’96 season. During the years between 1983 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 annual spawner surveys are to determine the distribution and range of spawning coho 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 resources monitoring plan, which is to determine if MMWD management activities (water releases, sediment control, and riparian restoration) are improving habitat conditions and, ultimately, the abundance of coho salmon returning to the Lagunitas Creek watershed. Observations of spawning steelhead and other salmonids are also noted during the surveys.

1.2 Coho Salmon Life History and Status

Coho salmon are anadromous fishes, rearing at least partially in freshwater, migrating to the ocean as smolts, spending their adult life in the ocean, and finally migrating back into freshwater streams to spawn. They can be grouped in year classes of three-year increments. 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, Moyle 2002). Therefore, spawning years with relatively poor reproductive success can result in poor spawning runs three years later (D.W. Kelley & Associates and ENTRIX 1992). For example, 2000 and 2003 young-of-the-year coho are from the same year class, with the 2003 fish being the progeny of spawners from the 2000 year class. While the majority of coho return as three-year-old fish, some males, called jacks, spend less than a year in the ocean before becoming sexually reproductive and return to their natal stream to spawn at two years of age (Groot and Margolis 1991). Spawning coho begin to arrive near the mouth of Lagunitas Creek in late summer and fall to begin acclimation to freshwater before migrating upstream (Bratovich and Kelley 1988). The spawning period is

generally from mid-November to mid-January but adult coho have been observed from late-October to early-February.

Coho salmon usually spawn at the heads of riffles with gravel substrate (Moyle 2002). 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 adult male will fertilize the eggs by releasing milt before the female covers the eggs with additional gravel (Moyle 2002). Following spawning, the female may guard the redd for up to four weeks before dying. Juvenile coho emerge from the gravel the following spring and usually rear in the stream for one year before migrating to the ocean (Moyle 2002).

The present population of coho salmon in Lagunitas Creek has been significantly reduced from historical levels (NMFS 2001, Brown et al 1995). 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) and “endangered” under the California Endangered Species Act. In the last nine spawning seasons we have observed an average of approximately 500 spawning coho and 220 redds.

2.0 METHODS AND SURVEY AREA

MMWD fishery staff walked sections of creek once per week, with a few exceptions (described below). Eric Ettlinger (Aquatic Ecologist), Gregory Andrew (Fishery Program Manager), Jake Riley (Fisheries Watershed Aide), and Greg Vogeazopoulos (Fisheries Watershed Aides) conducted the surveys. We divided 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). We generally walked sections two and three on the same day. We started surveys for Lagunitas Creek on 14-October-03, San Geronimo on 13-November-03, and Devil’s Gulch on 8-December-03. The section of Lagunitas Creek from Tocaloma Bridge to Nicasio Creek was surveyed five times by MMWD staff on 29-October-03, 12-November-03, and 26-November-03, 12-December-03, and 22-January-04. We did not survey downstream of Nicasio Creek because small substrates and high winter flows in this section provide poor spawning and incubation habitat. In Devil’s Gulch, we surveyed from the mouth to a bedrock cascade almost two miles upstream, as well as a ¼-mile-long fork near the upstream end of our survey reach. San Geronimo Creek was walked in two sections: from its mouth to Meadow Way Bridge (2.2 miles) and from Meadow Way to the confluence of Woodacre Creek (1.6 miles). Each stream section was surveyed from the downstream end to the upstream end, with the exception of the Tocaloma Bridge to Nicasio Creek section, which was surveyed in a downstream direction using float tubes for the deep sections. We did not survey Devil’s Gulch or the upstream section of San Geronimo Creek until early December due to low stream flows that were insufficient for fish passage. High flows prevented surveys during the last week of December and the last two weeks of February.

Salmon Protection and Watershed Network (SPAWN) staff and trained volunteers surveyed nine small tributaries to San Geronimo Creek. These streams were Arroyo Road Creek (including Barranca and Upper Arroyo tributaries), Candellero Creek, Creamery Creek, Deer Camp Canyon,

Evans (formerly Bates) Canyon, Larsen Creek, Montezuma Creek, Sylvestris Creek, and Woodacre Creek. In addition, SPAWN staff and volunteers surveyed the headwater section of San Geronimo Creek upstream of Woodacre Creek and three small tributaries to Lagunitas Creek: Barnabe Creek, Deadman's Gulch and Irving Creek. National Park Service staff surveyed Cheda Creek, a tributary of Lagunitas Creek, as well as Olema Creek.

We ended spawner surveys on 10-March-2004. During all surveys we recorded observations of redds, live adult salmonids, salmonid carcasses, and diggings. Live fish were recorded as male, female, or jack. Their behavior, condition, (color, wear marks, hooked jaw, etc.) and their location in relation to landmarks such as tributaries or bridges were noted. All observed spawning activity was also recorded. We recorded the sex and length of recovered carcasses and collected tissue samples for subsequent genetic analyses by NOAA Fisheries. We attempted to determine if these salmonids 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 water visibility.

Redds were classified as having been constructed by coho, Chinook, chum, steelhead, or unknown. When fish were not present, redds were classified based on their area, depth, substrate, location and/or time of year. All unoccupied redds observed in October and November (prior to any coho observations) were classified as Chinook redds. Unoccupied redds built in February and March (after the last live coho were observed) were classified as steelhead redds. During December and January (when coho were being observed), large redds with wide pits were classified as coho redds. Smaller redds with deep pits were generally classified as steelhead redds after the first live steelhead were observed. Chum redds were identified based on fish presence only. Unoccupied redds observed at a time when multiple salmonid species were in the creek, and that did not display obvious distinguishing characteristics, were classified as "unknown."

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 blue, striped flagging. We labeled each flag with the date, the redd number and the position of the redd with respect to the channel (i.e. mid-channel, left or right bank, etc). 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 yellow flagging. We also marked redd and digging locations on a map of the creek for each survey date (Appendix A). We measured the maximum length and width of all redds, unless fish were present. To avoid disturbing fish, we hung yellow flagging, in addition to the blue striped flagging, next to occupied redds as a reminder to measure the redd at a later date. We attempted to identify when redds appeared to have been built on or overlapping older redds. High levels of such "superimposition" can indicate a shortage of adequate spawning habitat. Superimposition can kill eggs deposited in the first redd through physical shock, exposure, displacement into less favorable incubation conditions, or predation (Burgner 1991).

From 3-November to 21-December MMWD operated a time-lapse video camera a short distance downstream of Tocaloma. The camera recorded salmonids swimming through a long, shallow riffle during daylight hours. Camera batteries and videotape were replaced every two or three days. Salmonids videotaped swimming upstream through the camera's field of view were noted,

along with the exact time and observations of other wildlife. The velocity of salmonids moving through the riffle made identifying fish species and sex impossible. The camera was removed on 23-December-03, shortly before the arrival of a large storm that threatened to raise stream flows and damage the video equipment.

We had no way of positively determining if we were recounting the same fish during subsequent surveys or missing spawning activity during the intervals between surveys. We generally surveyed upstream stream sections before downstream sections to reduce the possibility of recounting the same fish as they moved upstream. For example, we surveyed San Geronimo Creek first, Lagunitas Creek from Devil's Gulch to Peters Dam next, and then Tocaloma Bridge to Devil's Gulch. Most surveys on each section were conducted between five and nine days apart. In addition, an attempt was made to identify the number of double-counted fish after the survey season had ended. Observations of fish on redds over multiple surveys were subtracted from the total, as were schools of fish observed holding in the same pool over multiple surveys. Even with these efforts, we acknowledge that some fish may have been counted multiple times.

3.0 RESULTS

3.1 Live Coho Salmon, Redds, and Carcasses

A total of 383 coho redds and 949 live coho were observed during the spawner surveys in Lagunitas Creek, San Geronimo Creek, Devil's Gulch, and the smaller tributaries to Lagunitas and San Geronimo Creeks. A total of 158 redds and 572 live fish were recorded last year (Table 2). This is a 142% increase in redds and a 66% increase in live fish observations from last year. The relative proportions of redds in each creek are shown in Figure 2. The 2000/'01 spawning survey (three years ago and representing the same year class) recorded 204 redds and 320 live coho (MMWD 2001).

We observed 124 coho redds and 270 live coho in Lagunitas Creek this year (Table 3). We observed 139 coho redds and 385 live coho in the main stem of San Geronimo Creek. In Devil's Gulch we observed 48 coho redds and 97 live coho. SPAWN staff and TU volunteers observed 66 coho redds and 194 live coho in the tributaries to San Geronimo Creek (Table 3). NPS staff observed six coho redds and one live coho in Cheda Creek, the third year of spawning activity documented in this creek in the last seven years. NPS surveys in Olema Creek and its tributaries recorded 109 coho redds and a peak count of 138 live coho and carcasses (Table 2). Olema Creek observations are not included in the survey totals for the Lagunitas Creek basin presented in this report.

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 41 redds in the lower section, 51 redds in the middle section, and 28 redds in the upper section (Table 3). We observed 69 live coho in the lower section, 149 live coho in the middle section, and 52 live coho in the upper section. These numbers do not include 52 coho observations that were most likely double counts (Table 3). During the five surveys between Nicasio

Creek and Tocaloma we observed no coho, no carcasses, and four coho redds. Overall we observed 53 more redds in Lagunitas Creek than last year.

Roy's Pools is a significant landmark three miles upstream of the mouth of San Geronimo Creek where fish must swim through a fish ladder or jump over three artificial step pools to migrate upstream of the structure. We documented coho above and below this structure to investigate whether fish passage was a problem. The section of San Geronimo Creek from its mouth to Roy's Pools had 93 redds and 262 live coho. The section above Roy's Pools to Woodacre Creek had 46 redds and 123 live coho (Table 3). Seven coho redds, 22 live coho and no carcasses were observed in San Geronimo Creek upstream of Woodacre Creek. The two tributaries upstream of Roy's Pools, Evans Creek and Woodacre Creek, had a total of 25 redds, 83 live coho and no carcasses. The tributaries downstream of Roy's Pools had a total of 34 redds, 91 coho and no carcasses.

The sex and age structure of the coho run consisted of 333 adult males (41% of MMWD observations where sex and age were determined), 337 females (41%), and 145 jacks (18%). In addition, the sex of 63 live coho was not recorded or could not be determined.

We identified a total of 19 redds that were superimposed, including 13 coho redds that were completely superimposed by a subsequent redd and six that were partly superimposed. Out of 311 redds identified by MMWD staff, 6% of redds were affected by superimposition. Four of the superimpositions occurred in Lagunitas Creek, 13 in San Geronimo Creek and two in Devil's Gulch. Eight of the superimposing redds were built by coho, the rest were built by steelhead.

We observed 23 coho carcasses in Lagunitas Creek, 47 coho carcasses in San Geronimo Creek, and 12 coho carcasses in Devil's Gulch. The 82 coho carcasses observed this year is more than double the 39 documented in 2002/'03. We took tissue samples from 56 of the carcasses and these have been sent to NOAA Fisheries, Santa Cruz Lab for genetic analysis.

3.2 Other Salmonid Observations

This year we continued to observe Chinook, chum and steelhead. While the number of live Chinook observed was lower than last year, the number of Chinook redds increased. We observed 19 live Chinook, 36 Chinook redds and two Chinook carcasses in the Lagunitas Creek basin. Prior to the 2001/'02 spawning season, MMWD staff had definitively observed only three Chinook in Lagunitas Creek. This year, one Chinook redd, one live Chinook, and one carcass (the same fish) were observed in San Geronimo Creek, while the rest of the Chinook activity was in Lagunitas Creek. The first three Chinook redds were observed during our first spawner survey on 14-October, which was the earliest start date for this survey. The first live Chinook was observed on one of these redds on 15-October. Chinook redd observations peaked two weeks later with 20 new redds (Table 4). Live Chinook observations were scattered from late October to early December, with one live Chinook observed in January.

Even more unusual than Chinook, chum salmon were observed in Lagunitas Creek for the third straight year. Only two live chum were observed, along with one chum redd and one carcass. All chum observations occurred in November in Lagunitas Creek.

We observed the first live steelhead on 5-January-04 in Devil's Gulch. We observed a total of 57 live steelhead and 71 steelhead redds through 10-March-04, compared to 20 live steelhead and 15 steelhead redds in 2002/'03. Steelhead observations peaked during the second week of February and the second week of March.

Due to the significant overlap in run timing of the different salmonid species and our inability to definitively distinguish all fish and redds, we characterized some fish and redds as "unknown." The number of "unknown redd" observations reached a peak during the first week in December when the Chinook, chum and coho spawning runs were overlapping. Nine redds in January were called "unknown" due to the seasonal overlap of coho and steelhead runs. In total, we were unable to identify three salmonids and 14 redds, which is far less than last year's unknown totals (35 salmonids and 27 redds).

This year we observed many redds that did not have fish on them and therefore could not be confirmed as being built by a certain salmonid species. However, based on shape, size, location and the date of observation, some of these redds were confidently attributed to being built by coho, Chinook or steelhead. The other unoccupied redds were called unknown. Of the 311 coho redds identified by MMWD staff, 237 (76%) were occupied by coho. Another 41 redds (13%) were built between 14-December and 27-December, when over 400 coho were observed, but no other species. All Chinook redds were observed at least four weeks before the first coho observation, or were occupied by Chinook. Of the 71 steelhead redds observed, 67 (94%) were built at least a week after the last adult coho observation, or were occupied by steelhead.

We observed two Chinook carcasses, one chum carcass and three steelhead carcasses in the Lagunitas Creek system. Tissue samples were collected from all Chinook and steelhead carcasses, but the single chum carcass was too decomposed for sampling. One of the Chinook carcasses measured 34.5 inches in fork length, and was the largest salmonid yet recorded by MMWD staff.

3.3 Stream Flows, Water Releases and Correlated Spawning Activity

Stream flows at the Samuel P. Taylor gage were fairly constant between eight and nine cubic feet per second (cfs) from 1-July through 7-November-03. A small storm dropped 1.1 inches of rain starting on 5-November and increased stream flows to a mean daily flow of 14 cfs (Figure 3). We photographed the first two salmonids swimming past our video camera during this storm, most likely Chinook based on the time of year (Figure 4). We had already observed 32 Chinook redds prior to this first storm. One of these early redds was located a short distance downstream of San Geronimo Creek, indicating that at least one fish had reached that location using summer base flows. Three Chinook and one chum were observed following this storm.

No significant rain fell through the rest of November and no fish were videotaped again until 28-November, after MMWD began the first three-day upstream migration flow by releasing enough water to maintain 35 cfs at the Samuel P. Taylor gage. MMWD is required to start the second UMF on 1-December, so the artificial release was maintained for six consecutive days. Rain increased the mean daily flow to 48 cfs on 1-December. We videotaped six salmonids during the first three days of the UMF when flows were below 40 cfs, and then 56 more salmonids when flows increased due to the combined effects of rain and artificial releases. Surveys immediately after the UMF documented 152 live coho and 42 coho redds, as well as five live Chinook and two Chinook redds (Figures 5 and 6).

The second significant storm of the season dropped 2.2 inches of rain between 5-December and 7-December and raised the mean daily flow to 41 cfs. 122 salmonids were videotaped swimming past our video camera on 7-December, which was the largest number of salmonids recorded by video in a single day since video monitoring started in 2001. Two more storms dropped over three inches of rain by 14-December, increasing mean daily flows to 71 cfs on 11-December. The peak of the coho spawning run occurred during the second week of December, when we observed 92 coho redds and 195 live coho. The timing of the peak in spawning was consistent with previous years (Figure 7).

Two more storms dropped over five inches of rain between 20-December and 26-December, increasing the mean daily flow to 492 cfs. The largest storm of the season began on 29-December and dropped 8.7 inches of rain over six days. This storm brought the total rainfall for December to nearly 19 inches. Instantaneous stream flows peaked at 2,730 cfs on 29-December, which was the highest peak flow in Lagunitas Creek since February 1998. The video monitoring equipment was removed just prior to this storm to avoid damage. We were unable to conduct surveys until the following week, when we observed 93 live coho, 49 coho redds, and the first steelhead of the season. A UMF scheduled to start on 1-January was not required due to December's high flows. Rain and flows decreased in January, and spawning activity declined until the last two coho (both jacks) were observed on 29-January-04. The last coho redd was observed on 20-January. A UMF scheduled to start in February was not required due to adequate flows in January.

The first steelhead was observed on 5-January, and low numbers of steelhead were observed through January (Table 4). Steelhead numbers increased dramatically during the second week of February, when 18 live steelhead and 24 steelhead redds were observed. No significant rainfall or increase in stream flows preceded the increased spawning activity. Kent Lake started to spill on 16-February during a storm that dropped nearly five inches of rain. Lagunitas Creek flows peaked again at 1,060 cfs on 18-February. No surveys were conducted until flows receded in early March. Despite little rain during the first two weeks of March, we observed 18 live steelhead and 28 steelhead redds. The final spawner survey was conducted on 10-March-04.

4.0 DISCUSSION

This year's remarkable coho run was the largest coho run since annual surveys began in 1995/'96 (Table 2). We observed 97 more redds and 211 more coho than were observed during the previous record run of 2001/'02. This year's run also represents a large improvement in this year

class. The number of redds this year was 88% higher than during the run of 2000/'01.

The live coho count of 949 is likely an overestimate caused by counting fish multiple times. Because of this double counting of fish, live fish observations are less reliable than redd counts at estimating the size of the coho run. Although we attempted to wait at least five days between spawner surveys, many coho were likely counted as they held in pools or migrated upstream over multiple weeks. In addition, the 194 coho observed in the San Geronimo Creek tributaries by SPAWN staff may have been counted previously as they swam through Lagunitas Creek and then San Geronimo Creek. To compensate for this, at least partially, we subtracted from the total count multiple observations of individual coho holding on redds and schools of coho in specific pools over consecutive weeks (Table 3). National Park Service staff avoid the issue of double-counting fish by estimating the size of the run as the one-day peak in live fish and carcasses. This eliminates the possibility of double-counts, but also underestimates the size of the run.

The Chinook run appears to have been larger this year compared with last year, despite fewer live Chinook observations. We observed 36 Chinook redds and 18 live Chinook compared with 20 redds and 33 live Chinook last year. The lower number of live Chinook observed this year may be due to skipping a week of surveys during what was likely the peak Chinook spawning period. Nearly half the Chinook redds were observed during one survey in late October following a week without surveys, and it seems likely that many Chinook would have been observed during the intervening week. Substantial runs of Chinook have been observed each year since 2000/2001, and at least a few Chinook were observed prior to then, so it seems very likely that the Chinook population in Lagunitas Creek is self-sustaining. Chinook salmon were planted in Lagunitas Creek as early as 1898 (Schofield 1898). As in previous years, the Chinook observed this year did not appear to be strays from the nearest Chinook hatchery, the Warm Springs Hatchery on the Russian River, where all released salmon receive adipose fin clips. None of the observed Chinook had clipped adipose fins.

Only one chum salmon redd was observed this year, and that redd was occupied by a female chum and a male Chinook (Todd Steiner, pers. comm.). It is unknown if a male chum fertilized the eggs or whether this redd produced viable offspring. A carcass of a male chum salmon was observed three days following the chum redd observation, over three miles downstream of the redd. Schofield (1898) and Rutter (1901) observed chum in Lagunitas Creek at the turn of the last century. Bob Gallagher, a local resident, also recalled seeing numerous chum salmon during the 1960s (personal communication). It is unclear whether the chum salmon that are occasionally observed in the Lagunitas Creek basin are returning to their natal stream or are strays from streams farther north.

We are confident that our identification of redds was highly accurate this year. Of 311 coho redds identified by MMWD staff, 33 (11%) were unoccupied and built at a time when multiple species were spawning. Of these redds, eight were in Devil's Gulch or San Geronimo Creek in early December when only coho were in those creeks. Only 25 coho redds (8% of redds documented by MMWD staff) were identified based on size and substrate. Three of these redds were built in early December, but were closer in size to the mean coho redd than the mean Chinook redd, so were likely coho. Eight additional redds were built in January, but were closer in size to the mean coho redd than to the mean steelhead redd, so were also likely coho redds. 14 redds (5%)

classified as coho were small enough to have a significant probability of being either Chinook or steelhead redds. Smaller redds such as these were generally classified as coho redds based on qualitative factors such as irregular margins (“sloppy appearance”) and shallow pits (depth was not measured). Without these telltale signs these redds would have been classified as “unknown.”

Of 71 redds identified as steelhead redds, only nine were unoccupied redds observed in January, while coho were still present. Six of these redds were closer in size to the mean steelhead redd than to the mean coho redd, so were likely steelhead redds. Two redds were large enough to have possibly been coho redds, and a third redd wasn’t measured, so it’s identification can’t be verified. In summary, there is little evidence that many, if any, steelhead redds were misidentified.

The 19 coho redds either totally or partially superimposed by later redds was a small fraction (6%) of the redds identified by MMWD staff. This is an increase over last year’s superimposition level (2%), but is not surprising given the large increase in redds. The highest level of superimposition occurred in San Geronimo Creek, where 11% of redds (13) were superimposed to some degree. Generally these superimpositions did not appear to disturb the egg pocket in the redd, so reproductive success was unlikely to have been impacted. We did not find evidence to suggest that superimposition of coho redds is a major problem or that spawning habitat was limited for this year’s coho run.

Since 1995, more than half of the upstream migration flows have coincided with rain, so increases in coho observations could not be attributed to the migration flows alone. This year was typical, with rain increasing flows halfway through the six-day, late-November/early-December UMF. Based on our video monitoring, only a handful of salmonids responded to the beginning of the UMF, but many fish migrated upstream when rain increased flows during the last three days of the UMF. We hypothesize that stream flows associated with rainfall events, and potentially other cues such as barometric pressure, are more influential stimuli for coho migration than increased releases from Kent Lake. Only two UMFs to date, the January 1999 UMF and the November 2002 UMF, occurred without coincident rain and also produced significant increases in spawning activity.

Hopefully, this year’s phenomenal coho spawning run will produce an abundance of juvenile coho. The 124 redds built in Lagunitas Creek (33% of all redds), however, were subjected to multiple instantaneous flows in excess of 1,100 cfs, and many of these redds were no longer apparent following these flows. By contrast, 120 redds were built in Devil’s Gulch, Cheda Creek and the small tributaries to San Geronimo Creek. These sheltered redds, along with many redds in San Geronimo Creek, will hopefully contribute to high survival of coho eggs and fry, and lead to a continued improvement in this year class.

Looking forward to next year’s coho run, we are optimistic that the run will be even larger than this year’s. The juvenile coho population in 2002 was the largest we have documented, and was estimated to be 40% larger than the juvenile population of 2001. Those coho will be three years old and returning to spawn in 2004/’05.

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Years	Lagunitas Creek	San Geronimo Creek	Devil's Gulch	Other Tributaries	Total	Olema Creek (for comparison)
1982/'83	65	47	27	No Data	139	No Data
1995/'96	70	6	10	No Data	86	No Data
1996/'97	98	115	41	No Data	254	No Data
1997/'98	80	107	52	14	253	126
1998/'99	92	46	32	14	184	42
1999/'00	139	58	3	3	203	27
2000/'01	119	56	11	18	204	142
2001/'02	79	102	59	46	286	90
2002/'03	71	39	24	24	158	17
2003/'04	124	139	48	72	383	109

Notes: Other tributaries include Arroyo Road Creek, Larsen Creek, Montezuma Creek, Evans Canyon, Woodacre Creek, San Geronimo Creek above Woodacre Creek, and Cheda Creek.
Lagunitas Creek is surveyed from Tocaloma to Peters Dam.
San Geronimo Creek is surveyed from its mouth to its confluence with Woodacre Creek.
Devil's Gulch is surveyed from its mouth to an impassable cascade roughly two miles upstream.

Table 2. Coho Redds in the Lagunitas Creek Drainage, 1982/'83 and 1995/'96-2003/'04.

SURVEY DATE	COHO SALMON IN LAGUNITAS CREEK												COHO SALMON IN SAN GERONIMO CREEK						COHO SALMON IN DEVIL'S GULCH			TOTAL		
	Nicasio Creek - Tocaloma			Tocaloma-Devils Gulch			Devils Gulch-Shafter Bridge			Shafter Bridge-Peters Dam			Mouth-Roys Pools			Above Roys Pools			IN DEVIL'S GULCH			TOTAL		
	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds
14-Oct-03	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
28-Oct-03	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
29-Oct-03	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
5-Nov-03	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
10-Nov-03	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
12-Nov-03	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
13-Nov-03	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
17-Nov-03	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
18-Nov-03	-	-	-	-	-	-	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
24-Nov-03	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
26-Nov-03	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
3-Dec-03	-	-	-	-	-	-	-	-	-	-	-	-	48	0	14	-	-	-	-	-	-	48	0	14
4-Dec-03	-	-	-	33	0	6	56	0	12	13	0	8	-	-	-	2	0	2	-	-	-	104	0	28
8-Dec-03	-	-	-	-	-	-	-	-	-	10	0	0	66	1	23	9	1	4	0	0	0	85	2	27
9-Dec-03	-	-	-	13	0	9	51	1	12	-	-	-	-	-	-	-	-	-	-	-	64	1	21	
12-Dec-03	0	0	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	0	10	31	0	14
15-Dec-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	1	10	24	1	10
16-Dec-03	-	-	-	-	-	-	-	-	-	-	-	-	72	2	28	34	1	16	-	-	-	106	3	44
18-Dec-03	-	-	-	10	1	17	44	5	13	-	-	-	-	-	-	-	-	-	-	-	54	6	30	
19-Dec-03	-	-	-	-	-	-	-	-	-	11	0	8	-	-	-	-	-	-	-	-	11	0	8	
22-Dec-03*	-	-	-	-	-	-	-	-	-	-	-	-	84	7	21	49	2	10	9	0	3	142	9	34
23-Dec-03*	-	-	-	12	0	6	8	2	4	-	-	-	-	-	-	-	-	-	0	0	0	20	2	10
26-Dec-03*	-	-	-	-	-	-	20	3	2	18	0	8	-	-	-	-	-	-	-	-	38	3	10	
5-Jan-04*	-	-	-	-	-	-	-	-	-	-	-	-	11	2	4	28	1	9	35	5	16	74	8	29
6-Jan-04*	-	-	-	4	0	3	7	4	6	2	0	4	-	-	-	-	-	-	6	2	7	19	6	20
12-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	7	6	2	21	9	5	9	3	2	37	18	9
13-Jan-04	-	-	-	1	0	0	5	5	2	0	0	0	-	-	-	-	-	-	-	-	6	5	2	
20-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	10	7	1	1	0	0	-	-	11	7	1	
21-Jan-04	-	-	-	1	1	0	1	1	0	0	0	0	-	-	-	-	-	-	0	1	0	2	3	0
22-Jan-04	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
26-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	0	3	0	0	5	0	-	-	0	8	0	
28-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
29-Jan-04	-	-	-	0	0	0	1	0	0	1	0	0	-	-	-	-	-	-	-	-	2	0	0	
5-Feb-04	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
6-Feb-04	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0	0	0
11-Feb-04	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
12-Feb-04	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	0	0	0
COHO SUB-TOTAL	0	0	4	74	2	41	193	21	51	55	0	28	298	28	93	144	19	46	114	12	48	878	82	311
Corrected**	0			69			149			52			262			123			97			752		

Notes:

(-) Indicates that the spawner survey did not cover the area on that date.

* Partial survey or incidental observation

** Corrected coho observations compensate for coho that were presumably double-counted.

^ These surveys were conducted by Salmon Protection and Watershed Network (SPAWN) staff.

Only streams where coho or redds were observed are listed.

^^ These surveys were conducted by National Park Service staff.

ARROYO ROAD CREEK^	64	0	30
EVANS CANYON^	3	0	1
LARSEN CREEK^	27	0	3
MONTEZUMA CREEK^	0	0	1
NORTH FORK SAN GERONIMO CREEK^	22	0	7
WOODACRE CREEK^	80	0	24
CHEDA CREEK^^	1	0	6

COHO TOTAL	949	82	383
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Table 3. Observations of Coho Salmon in the Lagunitas Creek Basin, Spawning Season 2003/04

SURVEY DATE	CHINOOK SALMON IN LAGUNITAS CREEK												CHINOOK SALMON IN SAN GERONIMO CREEK						TOTAL		
	Nicasio Creek - Tocaloma			Tocaloma-Devils Gulch			Devils Gulch-Shafter Bridge			Shafter Bridge-Peters Dam			Mouth-Roys Dam			Above Roys Dam			Chinook	Carcasses	Redds
	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds			
14-Oct-03	-	-	-	0	0	3	0	0	0	0	0	0	-	-	-	-	-	-	0	0	3
15-Oct-03*	-	-	-	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0
28-Oct-03	-	-	-	2	0	15	2	0	0	0	0	0	-	-	-	-	-	-	4	0	15
29-Oct-03	1	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	5
5-Nov-03	-	-	-	0	0	3	0	0	6	0	0	0	-	-	-	-	-	-	0	0	9
10-Nov-03	-	-	-	0	0	0	3	0	1	0	0	0	-	-	-	-	-	-	3	0	1
4-Dec-03	-	-	-	1	0	0	1	0	1	3	0	1	-	-	-	-	-	-	5	0	2
9-Dec-03	-	-	-	0	0	0	5	0	0	-	-	-	-	-	-	-	-	-	5	0	0
12-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	1	0	1	1	0	1
20-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	0	0	0	1	0
CHINOOK TOTAL	1	1	5	4	0	21	11	0	8	3	0	1	0	1	0	1	0	1	20	2	36
Corrected**	1			4			10			3			0			1			19		

SURVEY DATE	CHUM SALMON IN LAGUNITAS CREEK												TOTAL		
	Nicasio Creek - Tocaloma			Tocaloma-Devils Gulch			Devils Gulch-Shafter Bridge			Shafter Bridge-Peters Dam			Live Chum	Carcasses	Redds
	Live Chum	Carcasses	Redds	Live Chum	Carcasses	Redds	Live Chum	Carcasses	Redds	Live Chum	Carcasses	Redds			
9-Nov-03*	-	-	-	-	-	-	1	0	1	-	-	-	1	0	1
12-Nov-03	0	1	0	-	-	-	-	-	-	-	-	-	0	1	0
26-Nov-03	1	0	0	-	-	-	-	-	-	-	-	-	1	0	0
CHUM TOTAL	1	1	0	0	0	0	1	0	1	0	0	0	2	1	1
Corrected**	1			0			1			0			2		

SURVEY DATE	STEELHEAD TROUT IN LAGUNITAS CREEK									STEELHEAD TROUT IN SAN GERONIMO CREEK						STEELHEAD TROUT IN DEVIL'S GULCH			TOTAL		
	Tocaloma-Devils Gulch			Devils Gulch-Shafter Bridge			Shafter Bridge-Peters Dam			Mouth-Roys Dam			Above Roys Dam			Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds
	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds						
5-Jan-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	1	0	1
12-Jan-04	-	-	-	-	-	-	-	-	-	3	0	2	0	0	0	0	0	0	3	0	2
20-Jan-04	-	-	-	-	-	-	-	-	-	0	0	3	0	0	0	-	-	-	0	0	3
21-Jan-04	1	0	0	0	0	1	0	0	0	-	-	-	-	-	-	0	0	0	1	0	1
26-Jan-04	-	-	-	-	-	-	-	-	-	0	0	0	0	1	0	-	-	-	0	1	0
29-Jan-04	6	0	3	0	0	2	1	0	1	-	-	-	-	-	-	-	-	-	7	0	6
5-Feb-04	-	-	-	-	-	-	-	-	-	1	0	0	4	0	0	0	0	1	5	0	1
6-Feb-04	4	0	4	0	0	1	0	0	0	-	-	-	-	-	-	-	-	4	0	5	
11-Feb-04	-	-	-	-	-	-	-	-	-	3	0	4	8	0	8	1	0	0	12	0	12
12-Feb-04	6	1	5	0	0	6	0	0	1	-	-	-	-	-	-	-	-	6	1	12	
4-Mar-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	5	1	0	5
8-Mar-04	-	-	-	-	-	-	-	-	-	4	1	6	1	0	8	-	-	-	5	1	14
10-Mar-04	3	0	3	9	0	5	0	0	1	-	-	-	-	-	-	-	-	-	12	0	9
STEELHEAD TOTAL	20	1	15	9	0	15	1	0	3	11	1	15	13	1	16	3	0	7	57	3	71
Corrected**	20			9			1			11			13			3			57		

Notes: Only surveys where chinook, chum, or steelhead were observed are shown.
 (-) Indicates that the spawner survey did not cover the area on that date.
 * Partial survey or incidental observation.
 ** Corrected salmonid observations compensate for fish that were presumably double-counted.

Table 4. Observations of Chinook Salmon, Chum Salmon, and Steelhead Trout, Spawning Season 2003/04

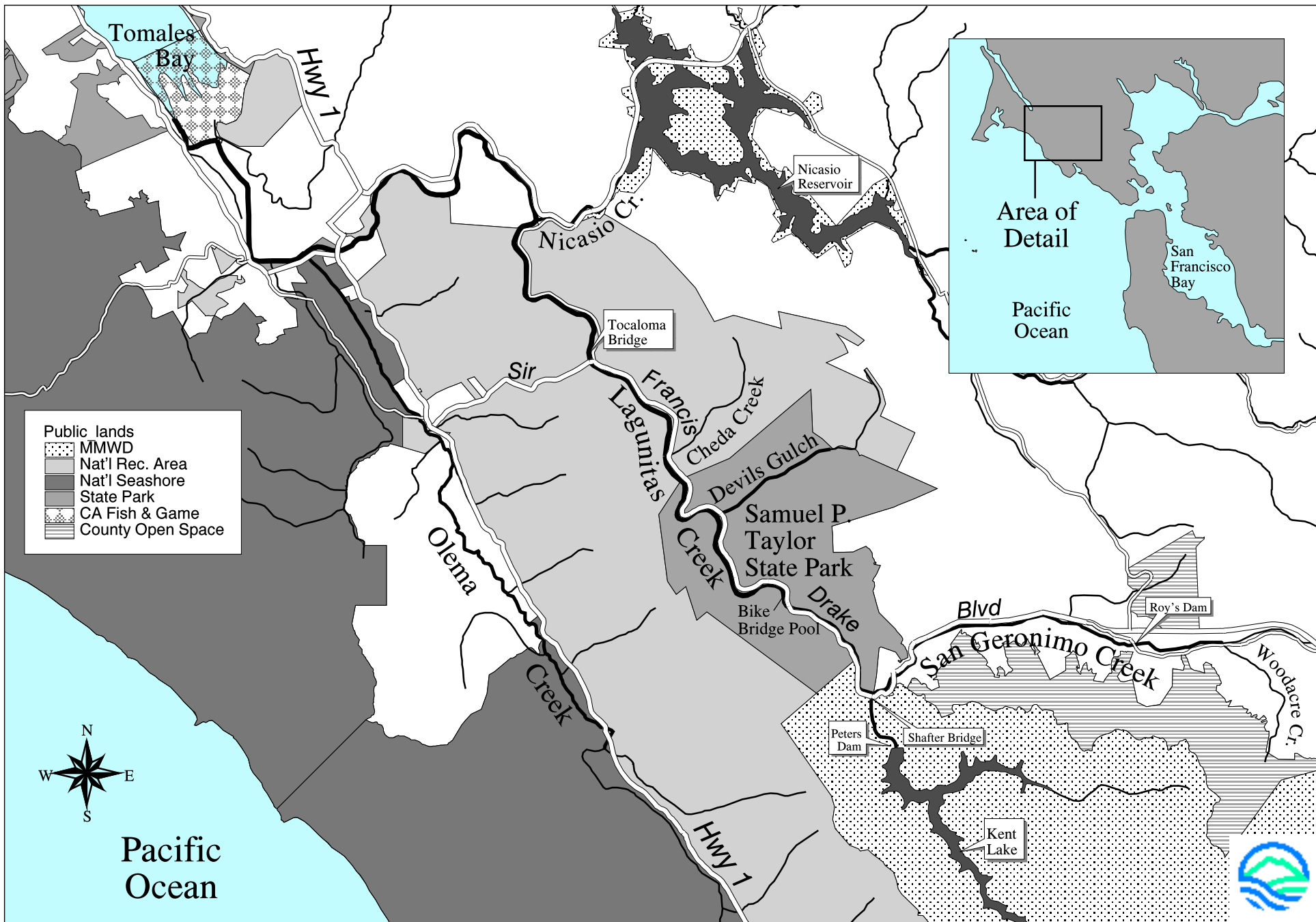
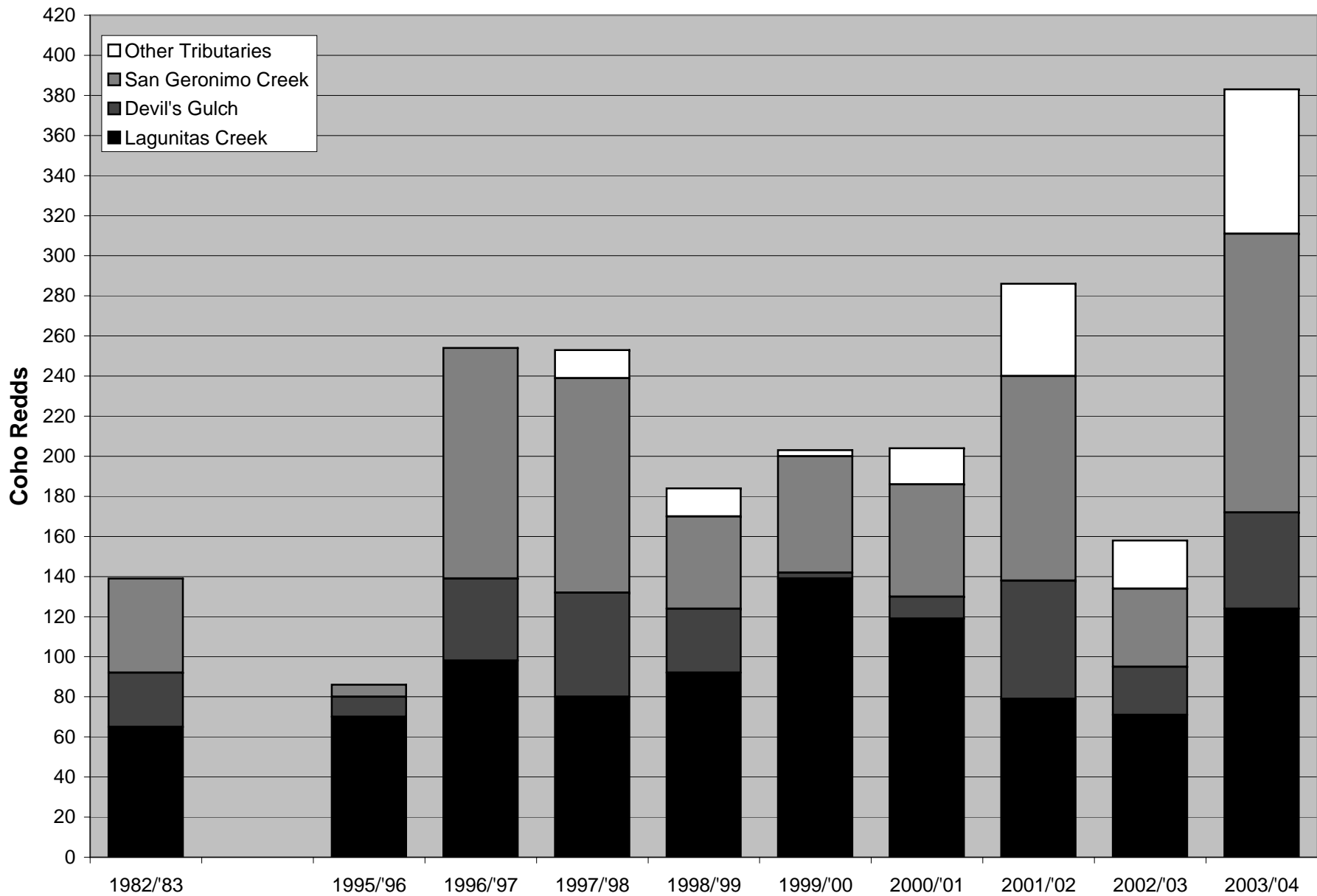


Figure 1. Spawner Survey Sections on Lagunitas Creek and Tributaries.





Note: Tributaries to San Geronimo Creek were not surveyed prior to 1997/98.

Figure 2. Coho Redds by Creek and Spawning Season

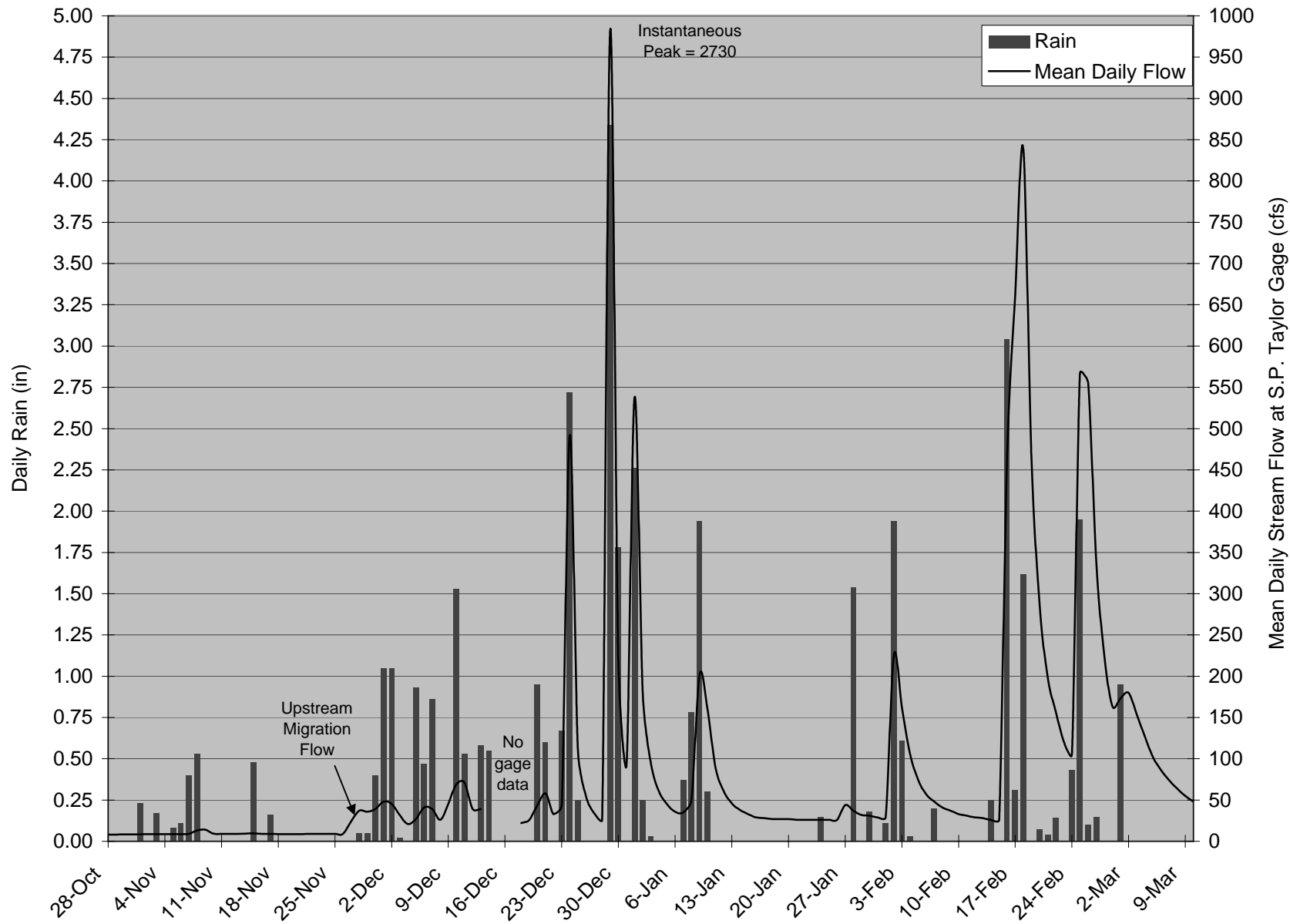


Figure 3. Rain and Lagunitas Creek Stream Flow, Spawning Season 2003/04.

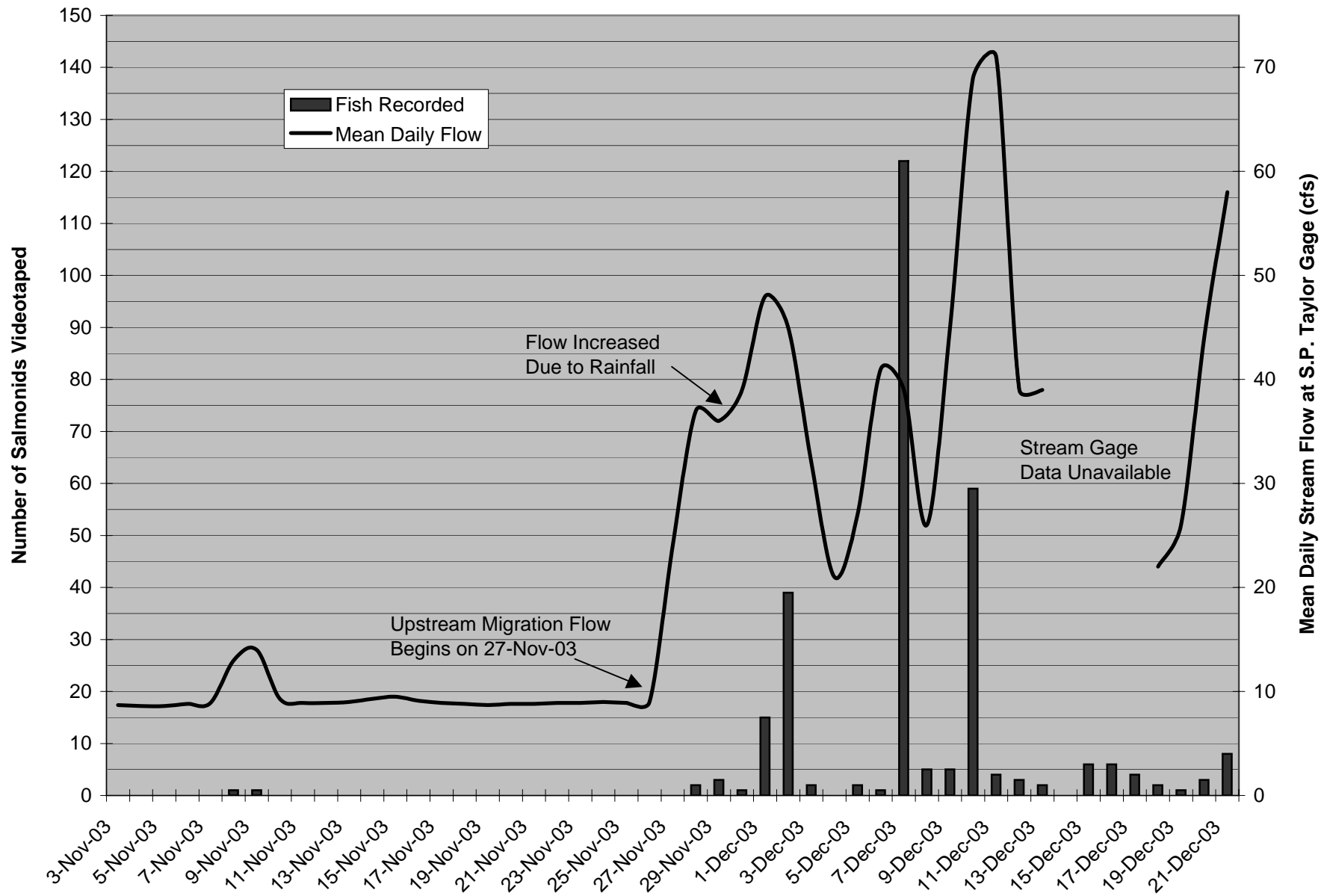


Figure 4. Video Fish Counts and Stream Flow, Spawning Season 2003/04

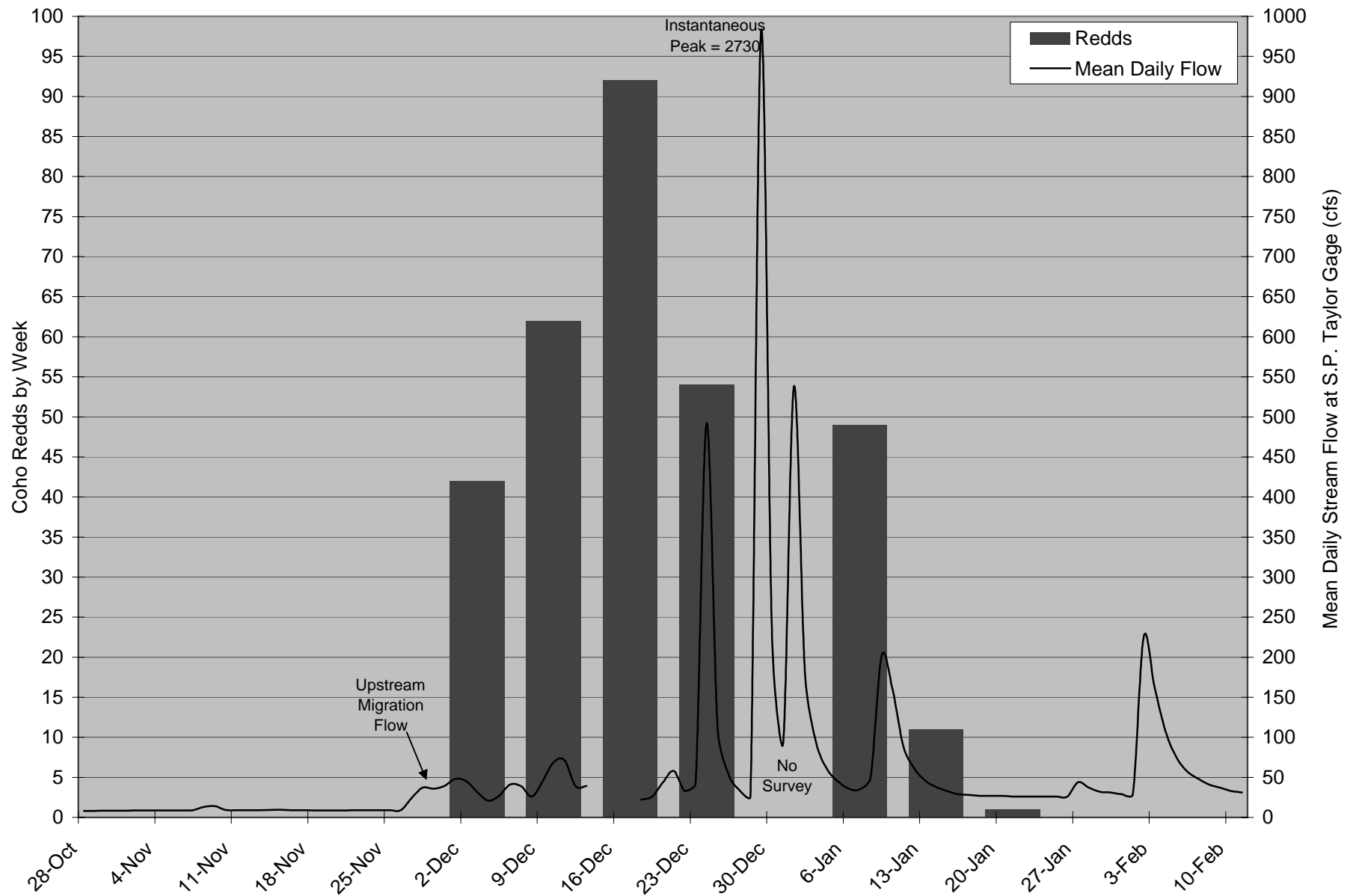


Figure 5. Coho Redd Observations, Spawning Season 2003/04.

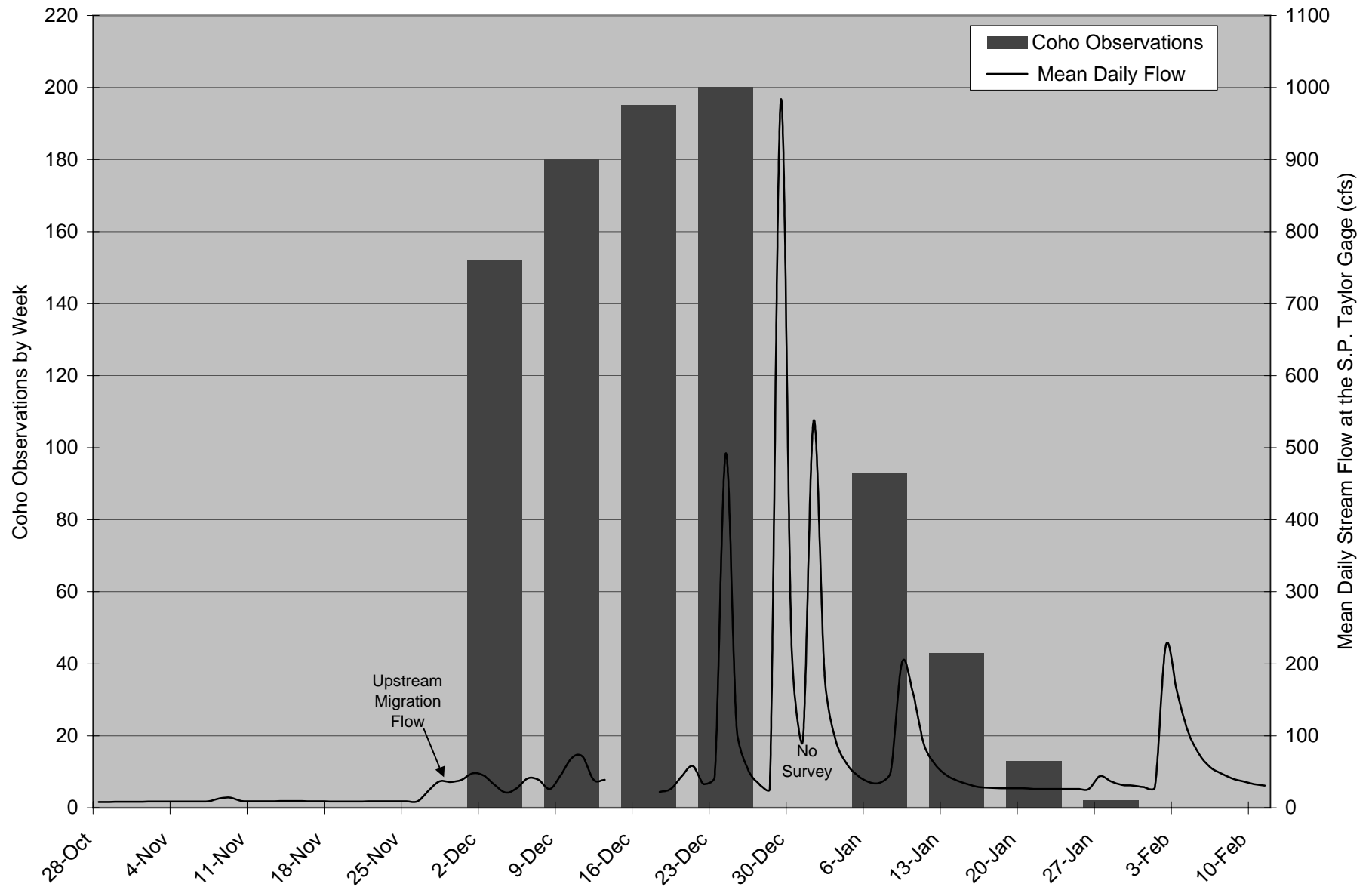


Figure 6. Live Coho Observations, Spawning Season 2003/'04.

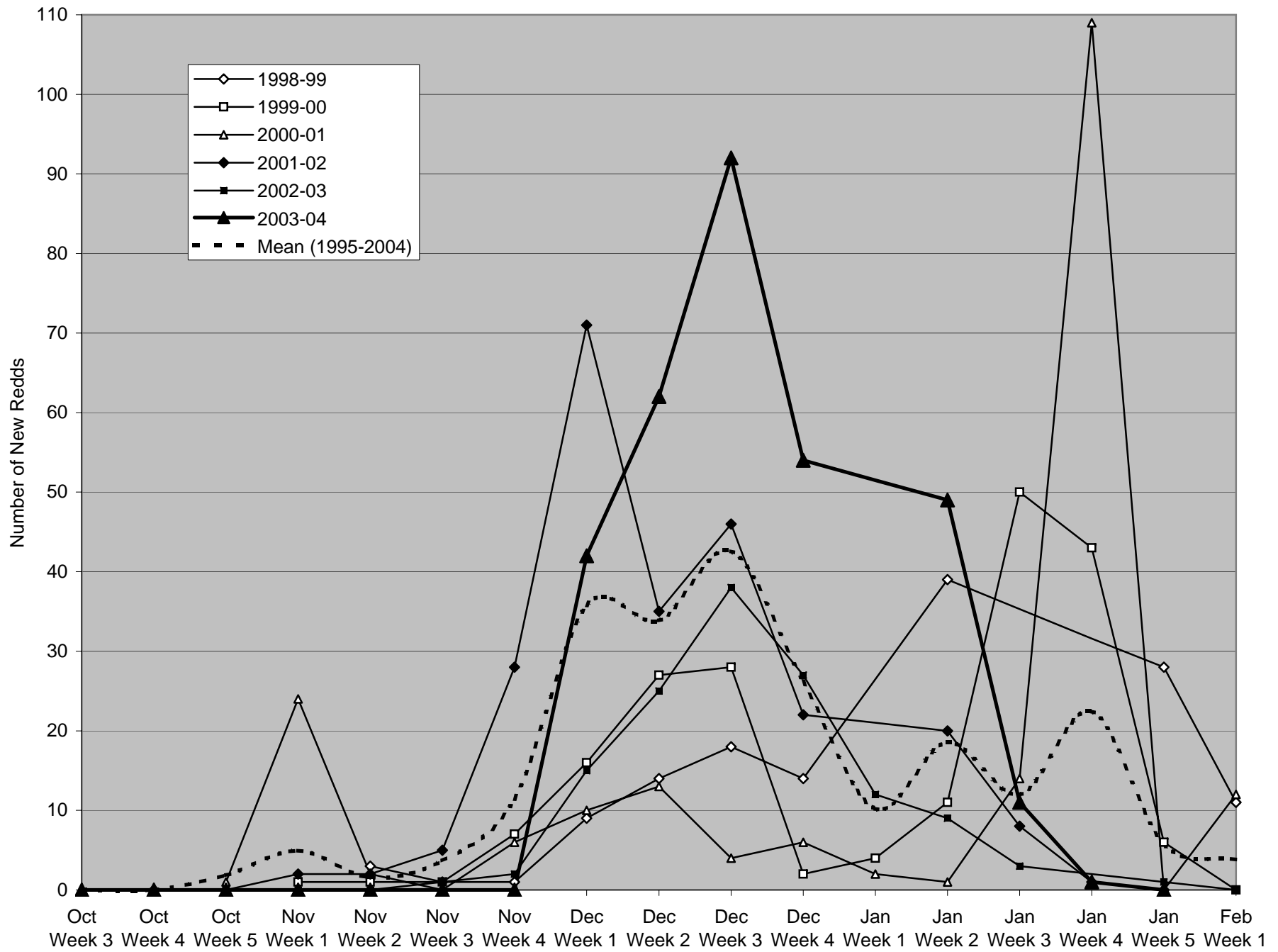


Figure 7. Timing of Coho Spawning Activity in the Lagunitas Creek Basin, Spawning Seasons 1998/99 - 2003/04.