

LAGUNITAS CREEK COHO SALMON SPAWNER SURVEY REPORT 2000-2001

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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	MCOSD
Marin Municipal Water District	MMWD
National Marine Fisheries Service	NMFS
National Park Service	NPS
Samuel P. Taylor State Park	S.P. Taylor
State Water Resources Control Board	SWRCB
United States Geological Survey	USGS

EXECUTIVE SUMMARY

The Marin Municipal Water District (MMWD) conducted coho salmon (*Oncorhynchus kisutch*) spawner surveys on Lagunitas Creek between 30-October-2000 and 2-February-2001. Surveys were conducted weekly on Lagunitas Creek between Tocaloma Bridge and Peters Dam. We also conducted surveys on San Geronimo Creek starting on 7-December-2000 and on Devil's Gulch starting on 11-January-2001. These surveys were coordinated with staff from the National Park Service (NPS) Coho and Steelhead Restoration Program, who conducted spawner surveys on Olema Creek. This year we conducted one survey on Lagunitas Creek between Nicasio Creek and Tocaloma. Leslie Ferguson (graduate student at UC Davis) and Robert Schneider also conducted a survey on this stretch of creek. Staff of the Salmon Protection and Watershed Network (SPAWN) and volunteers from Trout Unlimited conducted surveys on six tributaries of San Geronimo Creek.

We observed the first coho in Lagunitas Creek on 30-October. The majority of coho observations and redd construction in the Lagunitas Creek drainage occurred in the month of January. During the surveys, we observed a total of 204 redds and 320 live coho. We observed 119 of these redds and 181 of the coho in Lagunitas Creek, 56 redds and 76 coho in San Geronimo Creek, and 11 redds and 24 coho in Devil's Gulch. The remaining 18 redds and 39 coho were observed in tributaries to San Geronimo Creek. We also took fin and muscle samples from 15 of 33 carcasses found in Lagunitas Creek, San Geronimo Creek and Devil's Gulch. Three of these carcasses were likely chinook salmon, but this has yet to be confirmed. Samples will be sent to the National Marine Fisheries Service (NMFS) office in Santa Cruz for genetic analysis. We terminated spawner surveys after 2-February-2001 when the coho spawning run appeared to have ended and steelhead observations began to outnumber coho observations.

This year's spawning run was roughly the same size as last year's run but not as strong as the runs of 1996/'97 and 1997/'98. Last year we observed 203 redds and 568 coho. In 1996/'97 and 1997/'98 we observed 254 and 253 redds, respectively. Most of the fish that spawned this year were descendants of fish that spawned in 1997/'98.

Under the minimum stream flow requirements mandated by the California State Water Resources Control Board (SWRCB) order WR95-17, MMWD ensured upstream migration flows of 35 cubic feet per second (cfs) for three-day periods. Releases from Kent Lake were conducted for these upstream migration flows starting on 28-November, 1-December and 1-January. This year's upstream migration flows were more than sufficient to allow fish passage but did not appear to be effective at encouraging coho to swim upstream.

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 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. 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 (MCOSSD).

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 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. 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 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 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	- 1/27-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. In 1999 and 2000, 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 and 1983/’84 spawning 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 fish being the progeny of spawners in the 1994 year class. Adult 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 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). In the last six spawning seasons we have observed an average of fewer than 400 spawning coho and 200 redds.

2.0 METHODS AND SURVEY AREA

Stream sections were walked every week by a two person crew. Surveys were conducted by Eric Ettlinger, Gregory Andrew, Aviva Rossi and Christian Hellwig. John Fuche, Paul Mackie Wendy Ralson and Ramdom Turner also provided assistance. Each stream section was surveyed from the downstream end to the upstream end. 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. San Geronimo Creek was walked from its mouth to the confluence of Woodacre Creek, approximately 4.5 miles upstream. Staff of the Salmon Protection and Watershed Network (SPAWN) surveyed six small tributaries to San Geronimo Creek, namely Arroyo Road Creek (including Barranca and El Cerrito Creeks), Larsen Creek, Deer Camp Creek, Creamery Gulch, Bates Canyon, and Woodacre Creek. Roy’s Dam 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 four small, artificial waterfalls to migrate upstream of the dam. We surveyed Devil’s Gulch from its mouth to a bedrock cascade almost two miles upstream. The section of Lagunitas Creek from Nicasio Creek to Tocaloma Bridge was surveyed twice, once by MMWD staff and once by Leslie Ferguson and Robert Schneider of UC Davis. The section of Lagunitas Creek from its mouth to Nicasio Creek was not surveyed because little spawning habitat exists in this section.

During the surveys we recorded observations of redds, live adult coho, coho carcasses, diggings and adult steelhead. Live fish were recorded as male or female or jack, 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 NMFS. We attempted to determine if these coho 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 map of the creek for each survey date (Appendix A). We recorded the length and width of all redds. When fish were observed on a redd we approximated the redd dimensions. We attempted to identify when redds appeared to have been built on or overlapping older redds. High levels of such “superimposition” can reduce salmon breeding success.

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 numbers of coho 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 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 between six and nine days apart. In addition, an attempt was made to identify the number of double-counted fish after the survey season had ended.

3.0 RESULTS

3.1 Live Coho Salmon, Redds, and Carcasses

We observed a total of 204 redds and 320 live coho during the spawner surveys in Lagunitas Creek, San Geronimo Creek (including tributaries), and Devil’s Gulch (Table 2). A total of 203 redds and 568 live fish were recorded last year (MMWD 2000b). There was a 44% decrease in live coho observed from last year while the number of redds hardly changed (Figure 2). We located 20 fewer redds in Lagunitas Creek, 13 additional redds in San Geronimo Creek and eight more redds in Devil’s Gulch. The relative proportions of redds in each creek are shown in Figure 3. The 1997/’98 spawning survey (three years ago and representing the same year class) recorded 253 redds and 428 live coho (MMWD 2000a).

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 47 redds in the lower section, 53 redds in the middle section, and 11 redds in the upper section (Table 2). In addition, we observed eight redds and zero coho between Nicasio Creek and Tocaloma, a section of creek that has only been surveyed occasionally before this year. We observed 50 live coho in the lower section, 104 live coho in the middle section, and 27 live coho in the upper section. These observations do not include 15 coho observations that were most likely double counts (Table 2). No coho were observed between Nicasio Creek and Tocaloma.

The section of San Geronimo Creek from its mouth to Roy's Dam had 40 redds and 56 live coho. The section above Roy's Dam to Woodacre Creek had 16 redds and 20 live coho (Table 2). Surveys in Devil's Gulch recorded 11 redds and 24 coho. Coho spawned in three of the six surveyed tributaries to San Geronimo Creek. Arroyo Road Creek had six redds and 16 live coho, Larsen Creek had three redds and six live coho, and Woodacre Creek had nine redds, 17 live coho and two coho carcasses. Surveys in Olema Creek recorded 142 redds and 191 live coho (Table 3).

Redds in the Lagunitas Creek drainage averaged 14.5 feet long and 6.7 feet wide, with an elliptical area of 76.3 square feet. Redds in the lower section of Lagunitas Creek were smaller, on average, than redds elsewhere, with an average elliptical area of 51.5 square feet. Upstream of Devil's Gulch, redds averaged 84.3 square feet in area. In San Geronimo Creek, redds were the largest on average, with an elliptical area of 95.0 square feet. Devil's Gulch redds had an area of 87.3 square feet on average.

We identified 26 coho redds that were superimposed by subsequent redds (13% of all redds). Three of these redds were superimposed by steelhead redds. Twenty-three superimpositions occurred in Lagunitas Creek (19% of Lagunitas Creek redds) and three were in San Geronimo Creek (4% of San Geronimo Creek redds). No superimpositions were observed in Devil's Gulch. These rates of superimposition are very similar to the rates observed last year, the first year these data were collected.

We located a total of 33 salmonid carcasses in the Lagunitas Creek system with 18 carcasses in Lagunitas Creek, 13 carcasses in San Geronimo Creek, and two carcasses in Devil's Gulch. Genetic tissue samples were collected from eight coho carcasses in Lagunitas Creek, two carcasses in San Geronimo Creek and two carcasses in Devil's Gulch. In addition, one chinook salmon carcass was found in Lagunitas Creek on 1-November-2000. It measured 32 inches long, was green overall in color, and had black gums and spots on both caudal fin lobes, all typical characteristics of chinook salmon. Two additional carcasses sampled in Lagunitas Creek were only partial carcasses and were most likely chinook salmon. This will have to be confirmed through DNA analysis. Of the 12 coho carcasses sampled, two were females, four were adult males, two were "jack" males (two years old) and no sex was recorded for four carcasses.

We observed as many as five live chinook salmon in Lagunitas Creek between 30-October and 30-November, although we were never able to definitively identify them. These fish had heavily spotted backs and were greenish in color, but did not appear to be significantly larger than most male coho salmon. The chinook carcass found this year was only the third credible observation of this species in Lagunitas Creek since 1995.

3.2 Stream Flows, Water Releases and Correlated Spawning Activity

Stream flows at the Samuel P. Taylor gage were fairly constant at between eight and nine cfs from 1-July-2000 to 25-October-2000. We observed the first two redds on 19-October, but later decided that these redds were too small to be coho redds. The first observation of coho on a redd was by Al Piscotta on 26-October. An early season storm dropped over four inches of rain and raised creek flows to 24.1 cfs on 29-October (Figure 4). Following this storm, we conducted our first spawner surveys in Lagunitas Creek and observed 24 redds and 14 coho (Figures 5 and 6). These redds were most likely built following the storm, but could have been built earlier. Eight additional redds were observed over the ensuing three weeks. Two small storms in November dropped less than an inch of rain each and did not increase flows substantially. On 28-November MMWD began the first three-day upstream migration flow by releasing 35 cfs from Peters Dam. MMWD is required to start the second upstream migration flow on 1-December, so the 35 cfs release was maintained for six consecutive days. On the second day of this release nearly an inch of rain fell, increasing the flow to 40.5 cfs. This upstream migration flow was the first of the season above 25 cfs and triggered the SWRCB requirement to maintain a flow of 20 cfs through 31-December (hence this flow is also called a “trigger” flow). Following the six-day upstream migration flow we observed 20 redds and 57 live coho, an increase in spawning activity that may have been due to rain, the upstream migration flow, or a combination of the two.

Other than a small storm that briefly raised stream flows to 28 cfs, almost no rain fell in December and flows remained at roughly 23 cfs throughout the month. Very few coho or redds were observed through most of December, although a large mixed school of coho and steelhead was observed in a deep pool below the Highway 1 bridge, near the mouth of Lagunitas Creek, possibly waiting for a storm before swimming upstream (Brannon Ketcham, pers comm). We also observed from four to 15 coho holding in a deep pool we call Bike Bridge Pool between 4- and 27-December. By the end of December we had observed only three redds in San Geronimo Creek and low flows in Devil’s Gulch prevented fish passage. The last upstream migration flow increased stream flows to 37 cfs between 3- and 5-January-2001. Surveys conducted during the last two days of this upstream migration flow revealed only one new redd. The flows also failed to persuade the large school of coho at the mouth of Lagunitas Creek to move upstream. These fish finally left their pool following early January rains and spawning activity increased dramatically in mid-January. Between 8- and 12-January nearly four inches of rain fell, increasing stream flows to 76 cfs and interrupting surveys until the following week. When the surveys resumed we observed 76 coho and 109 redds. The largest storm of the coho spawning season dropped 4.6 inches of rain during the week of 22-January, raised stream flows to 150 cfs, and again made surveying difficult. The final ten redds were observed during the last days of January and the first days of February. The storms in January produced stream flows that exceeded the minimum SWRCB upstream migration flow requirement of 35 cfs for three days, so the upstream migration flow scheduled to begin on 1-February was not required. By 2-February steelhead were as abundant as coho and the spawner survey was terminated.

4.0 DISCUSSION

We characterize this year's run as moderately strong; the 204 redds observed was close to the average of the past six years and the 320 live coho observed was somewhat below average. The 2000/2001 coho spawner year class has been the second strongest of the three year classes since 1993, based on juvenile and spawner surveys. The spawning run of 1997/'98 (which was the parent generation for most of the coho this year) was one of the strongest runs in the last six years. However, the 1998 juvenile survey (which sampled the current coho generation) recorded the lowest numbers of juvenile coho in eight years of such sampling, most likely due to redd scour and coho egg destruction resulting from El Niño storms during the winter of 1997/'98 (MMWD 2001). Based on the trends in both juvenile population estimates and redd counts it appears that this year class has declined since the 1997/'98 spawning run.

The 119 redds built in Lagunitas Creek this year were the second highest documented in this creek and continues the generally upward trend in Lagunitas Creek redds. Fifty-nine percent of the redds built this year were built in Lagunitas Creek (Figure 3). The 74 redds built in San Geronimo Creek were roughly the average over the last six years, while the 11 redds in Devil's Gulch were more than last year but far below average. For the second year in a row, late rains hampered access to San Geronimo Creek and Devil's Gulch until late in the spawning season. Unlike last year, however, coho largely delayed spawning until the January storms instead of spawning in Lagunitas Creek throughout the season, as they did in 1999/2000. This delayed spawning seems to have resulted in more redds built in the tributaries than last year.

The majority of the spawning activity this year occurred in the second half of January, the latest spawning observed to date (Figure 7). The late coho spawning overlapped with early steelhead spawning, producing uncertainty about the origins of some redds when we did not observe fish on or near the redd (we observed coho on 42% of all redds). During the last 12 spawner surveys we observed 20 steelhead, or roughly 14% of all salmonids observed during these surveys. Since steelhead generally remain in fresh water for only a brief period before returning to the ocean, and since steelhead are more cryptically colored than coho, we probably observed only a portion of the steelhead spawning in late January and early February. It is possible, therefore, that of the 104 redds identified as coho redds during this period, some were actually built by steelhead. In the field we identified 11 redds as steelhead redds, based on the presence of steelhead or the smaller size of the redds (which we have observed to be a general characteristic). We have conservatively assumed that 14%, or 16 of the 104 redds, were steelhead redds. To account for this we subtracted four redds from the San Geronimo Creek coho redd total and one redd from the Devil's Gulch total (Table 2). We identified these redds as coho redds while in the field, but noted them as possible steelhead redds. Some misidentification of redds most likely occurred in these creeks because we observed nine steelhead in San Geronimo Creek and only identified one steelhead redd, and in Devil's Gulch we observed one steelhead and no steelhead redds.

The 320 live coho observed this year was down sharply from the 568 coho observed last year. Much of this decrease may be due to having fewer survey personnel. Last year we generally had four staff

conducting surveys at one time, while this year we generally had two. There is a direct correlation between the number of survey personnel and the number of live coho observed. We also likely overestimated the number of live coho by counting the same fish on redds over multiple surveys. We attempted to compensate for this by identifying redds where coho had been observed over multiple surveys and counting only the first observation of each fish on the redds. This only occurred with 17 fish, bringing the total observations down from 337 to 320 coho. It is nearly certain that we still counted some fish more than once, so this number should be regarded as a very rough approximation of the number of coho present in the Lagunitas Creek drainage. Redd totals are a more accurate means of tracking trends in the coho spawning runs.

Superimposition of redds varied from slight overlap to complete reconstruction of the redd. High levels of intraspecific superimposition can indicate a shortage of adequate spawning habitat. Superimposition can kill eggs through physical shock, exposure, displacement into less favorable incubation conditions, or predation (Groot and Margolis, 1991). The level of redd superimposition we observed (13%) does not include superimposition by steelhead after the coho spawner survey ended. The number of such superimpositions is unknown but could be significant given that we observed three steelhead redds superimposing coho redds out of 11 steelhead redds observed. Superimposition of coho redds by other coho does not yet appear to be a significant problem, however.

The back-to-back upstream migration flows in late November and early December coincided with rain, so the flows themselves may not be responsible for the subsequent modest increases in coho and redd observations. The upstream migration flow in early January, however, occurred after ten days without rain and after a very dry December. We surveyed the lower section of Lagunitas Creek during the second day of increased flows and then surveyed the upper section on the last day of the upstream migration flow. We observed only seven coho and one redd during these surveys. A large storm arrived before we could survey again the following week. The large mixed school of coho and steelhead remained near the mouth of Lagunitas Creek through the upstream migration flow but had left following the storm the following week. It appears that the third upstream migration flow was a reliable test of these flows but was not effective at encouraging fish to swim upstream. In late October 2000, the first coho migrated upstream using stream flows of less than 10 cfs, evidence that upstream migration flows do not seem to be required for fish passage. Six of 12 upstream migration flows conducted since 1995 occurred without coincident rain. Only one of these flows, the upstream migration flow in January 1999, produced a significant increase in spawning activity.

This year's coho spawning run will hopefully produce an abundance of juvenile coho. The peak winter stream flow this winter was 508 cfs, probably not enough to scour redds in Lagunitas Creek. Flows exceeding 1,700 cfs last winter may have been responsible for the low juvenile coho catch in 2000. The moderate winter stream flow is cause for cautious optimism that juvenile survivorship will be high this year. If our 2001 juvenile survey confirms this, we may look forward to a strong coho run in 2003/2004.

5.0 REFERENCES

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COHO SPAWNER SURVEY DATA

2000/2001 SURVEY RESULTS

Compiled by: Marin Municipal Water District

Updated: 2/6/01

SURVEY DATE	LAGUNITAS CREEK												TOTAL		
	Nicasio Creek - Tocaloma			Tocaloma-Devils Gulch			Devils Gulch-Shafter Bridge			Shafter Bridge-Peters Dam			Live Coho	Carcasses	Redds
	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds			
19-Oct-00*	-	-	-	-	-	-	0	1*	2*	-	-	-	0	0	0
26-Oct-00^	-	-	-	-	-	-	2	0	1	-	-	-	2	0	1
30-Oct-00	-	-	-	4	0	1	-	-	-	-	-	-	4	0	1
31-Oct-00^^	0	0	1	-	-	-	-	-	-	-	-	-	0	0	1
1-Nov-00	-	-	-	-	-	-	10	1	9	0	0	1	10	1	10
2-Nov-00	-	-	-	0	0	11	-	-	1^	-	-	-	0	0	12
8-Nov-00	-	-	-	-	-	-	1	4	1	0	0	0	1	4	1
9-Nov-00	-	-	-	0	0	1	-	-	-	-	-	-	0	0	1
14-Nov-00	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
16-Nov-00	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
21-Nov-00	-	-	-	-	-	-	0	0	5	0	0	0	0	0	5
22-Nov-00	-	-	-	0	0	1	-	-	-	-	-	-	0	0	1
28-Nov-00	0	0	1	-	-	-	-	-	-	-	-	-	0	0	1
30-Nov-00	-	-	-	-	-	-	3	1	2	1	0	0	4	1	2
1-Dec-00	-	-	-	16	0	5	-	-	-	7	0	2	23	0	7
4-Dec-00	-	-	-	-	-	-	1	0	2	4	0	2	5	0	4
5-Dec-00	-	-	-	2	0	1	19	1	6	4	0	0	25	1	7
11-Dec-00	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
12-Dec-00	-	-	-	-	-	-	18	0	2	-	-	-	18	0	2
14-Dec-00	-	-	-	-	-	-	1	1	0	5	1	1	6	2	1
20-Dec-00	-	-	-	-	-	-	12	0	2	0	1	0	12	1	2
21-Dec-00	-	-	-	5	0	4	-	-	-	-	-	-	5	0	4
27-Dec-00	-	-	-	-	-	-	10	0	1	0	0	0	10	0	1
28-Dec-00	-	-	-	0	0	1	-	-	-	-	-	-	0	0	1
4-Jan-01	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
5-Jan-01	-	-	-	-	-	-	7	0	1	0	0	0	7	0	1
10-Jan-01	-	-	-	16	0	8	-	-	-	-	-	-	16	0	8
11-Jan-01	-	-	-	-	-	-	6	0	0	6	0	2	12	0	2
17-Jan-01	-	-	-	-	-	-	-	-	-	4	0	3	4	0	3
18-Jan-01	0	0	6^^	5	2	14	11	2	15	-	-	-	16	4	35
30-Jan-01	-	-	-	-	-	-	13	3	5	0	0	0	13	3	5
31-Jan-01	-	-	-	3	1	0	-	-	-	-	-	-	3	1	0
SUB-TOTAL	0	0	8	51	3	47	114	13	53	31	2	11	196	18	119
Corrected**	0			50			104			27					
TOTAL													181	18	119

Notes:

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

* These redds and carcass were probably not coho and have not been included in the total.

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

^ Observed by Al Piscotta

^^ Observed by Leslie Ferguson, Robert Schneider and/or Reuven Walder

Table 2. Coho Spawner Survey Results, Spawning Season 2000-2001

COHO SPAWNER SURVEY DATA

2000/2001 SURVEY RESULTS

Compiled by: Marin Municipal Water District

Updated: 2/6/01

SURVEY DATE	SAN			GERONIMO CREEK			DEVIL'S GULCH			TOTAL		
	Mouth-Roys Dam			Above Roys Dam			Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds
	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds						
7-Dec-00	0	0	2	-	-	-	-	-	-	0	0	2
15-Dec-00	4	0	1	-	-	-	-	-	-	4	0	1
3-Jan-01	0	0	0	-	-	-	-	-	-	0	0	0
11-Jan-01	-	-	-	-	-	-	7	0	1	7	0	1
16-Jan-01	23	1	31	-	-	-	-	-	-	23	1	31
17-Jan-01	4	0	6	11	0	11	5	0	10	20	0	27
24-Jan-01	-	-	-	-	-	-	14	0	0	14	0	0
25-Jan-01	21	0	0	-	-	-	-	-	-	21	0	0
29-Jan-01^	-	-	-	2	0	2	-	-	-	2	0	2
1-Feb-01	4	5	1	7	7	6	-	-	-	11	12	7
2-Feb-01	-	-	-	-	-	-	0	2	1	0	2	1
SUB-TOTAL	56	6	41	20	7	19	26	2	12	102	15	72
Corrected*	56		40	20		16	24		11			

ARROYO ROAD CREEK SURVEYS^	16	0	6
LARSEN CREEK SURVEYS^	6	0	3
WOODACRE CREEK SURVEYS^	17	2	9
TOTAL	139	17	85

Notes:

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

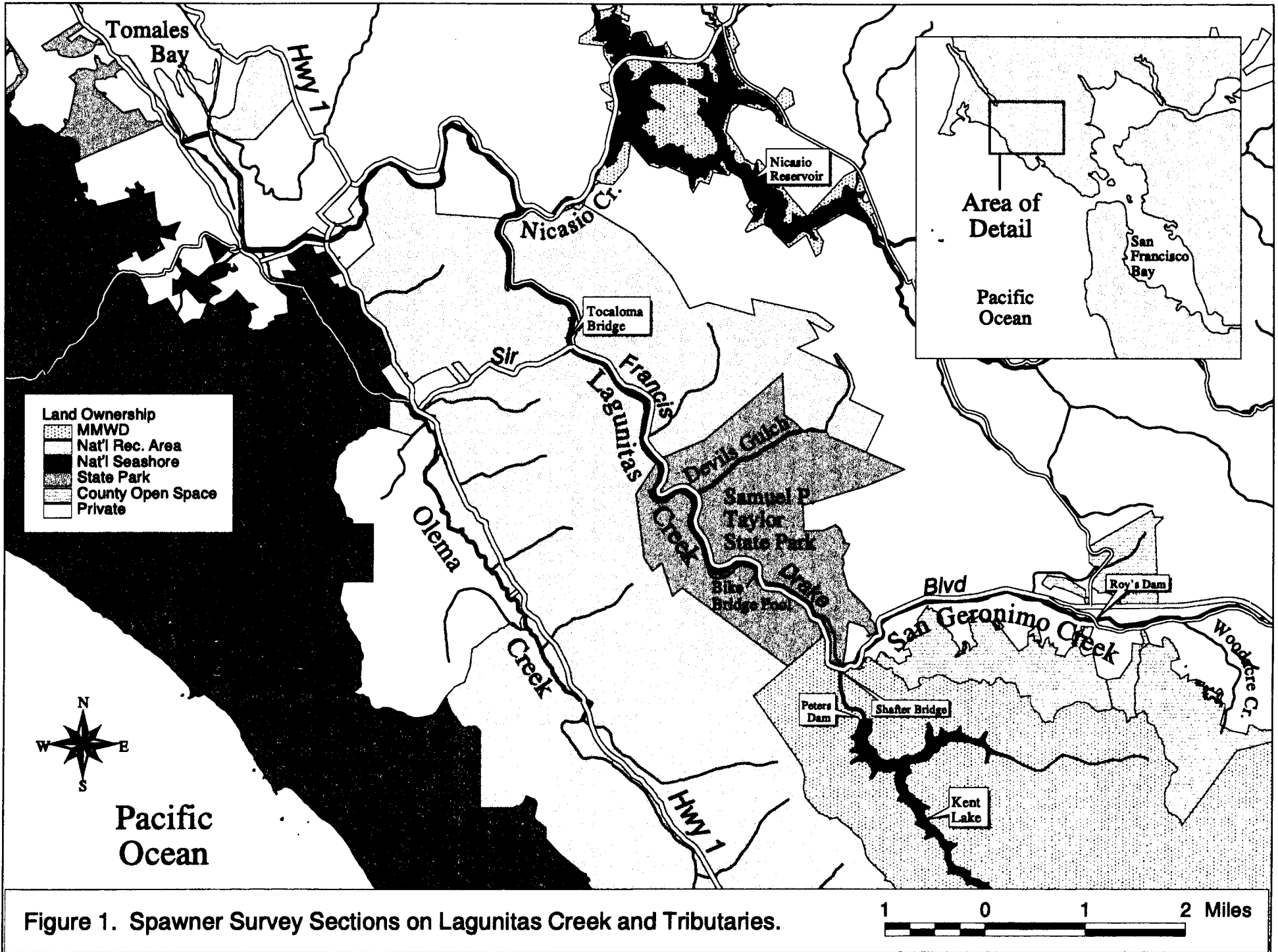
* Corrected coho and redd observations compensate for coho that presumably were double-counted and redds that were most likely built by steelhead.

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

Table 2. Coho Spawner Survey Results, Spawning Season 2000-2001

	Lagunitas Creek	San Geronimo Creek	Devil's Gulch	Total	Olema Creek (for comparison)
1995-'96	70	6	10	86	n/a
1996-'97	98	115	41	254	n/a
1997-'98	80	121	52	253	126
1998-'99	92	60	32	184	42
1999-'00	139	61	3	203	27
2000-'01	119	74	11	204	142

Table 3. Coho Redds in the Lagunitas Creek Drainage, 1995/'96-2000/'01.



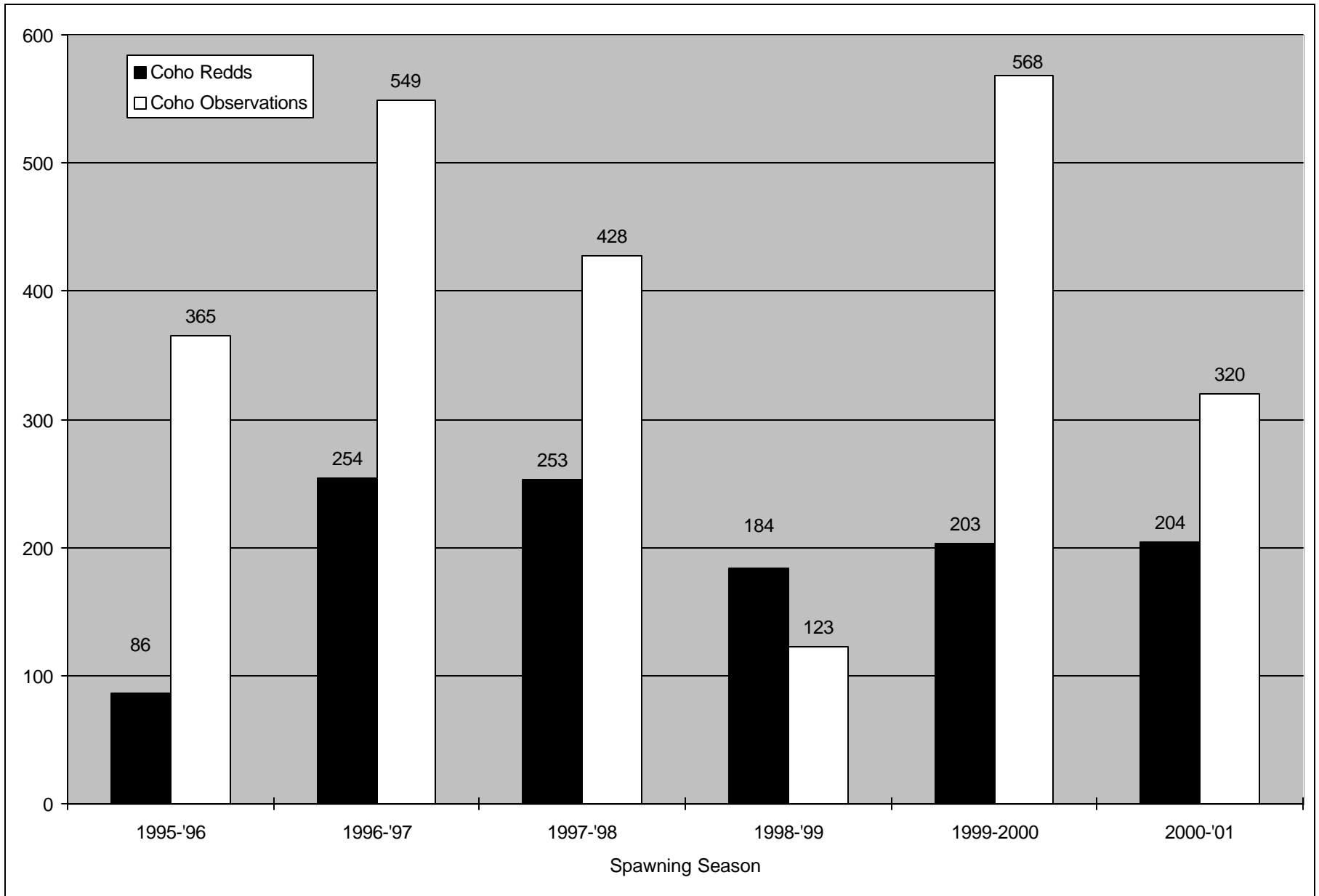
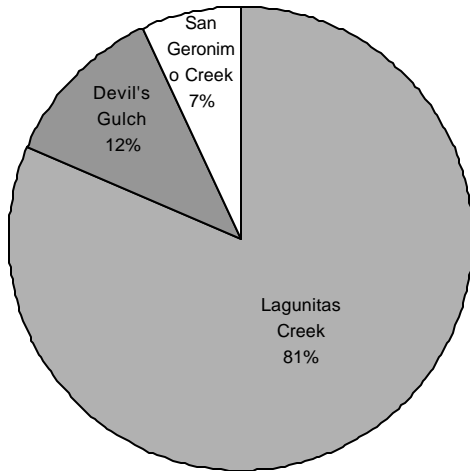
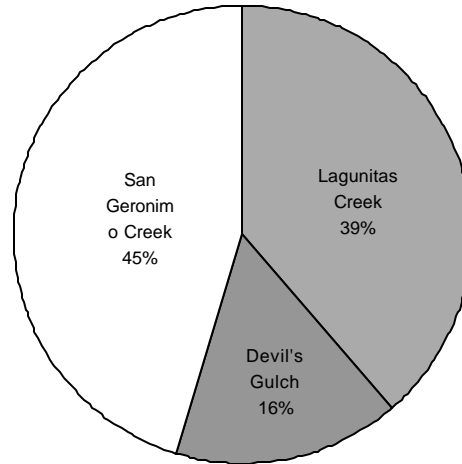


Figure 2. Coho Redds and Observations, Spawning Seasons 1995/96-2000/01.

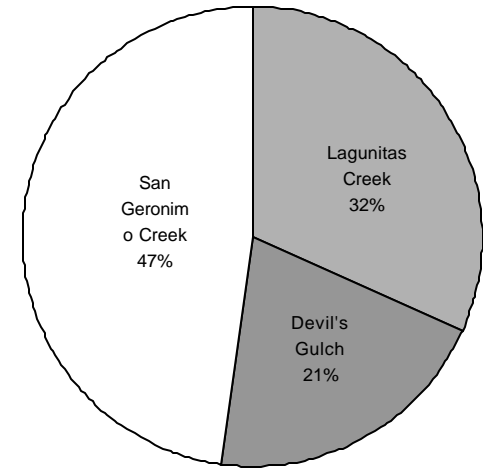
1995-1996



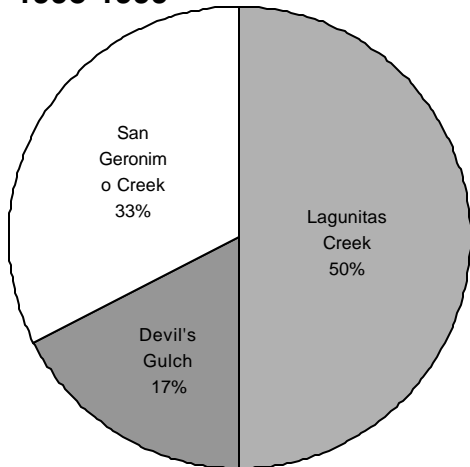
1996-1997



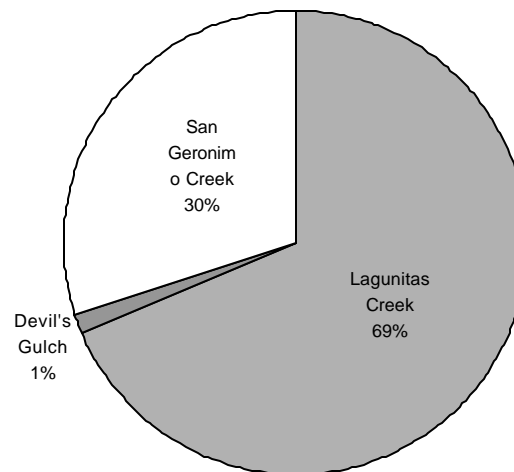
1997-1998



1998-1999



1999-2000



2000-2001

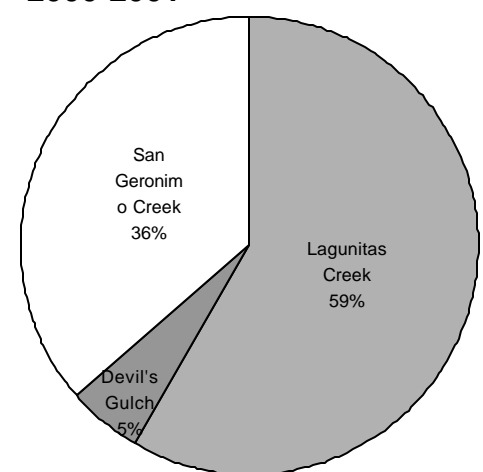


Figure 3. Coho Redd Locations in the Lagunitas Creek Watershed, Spawning Seasons 1995/'96-2000/'01

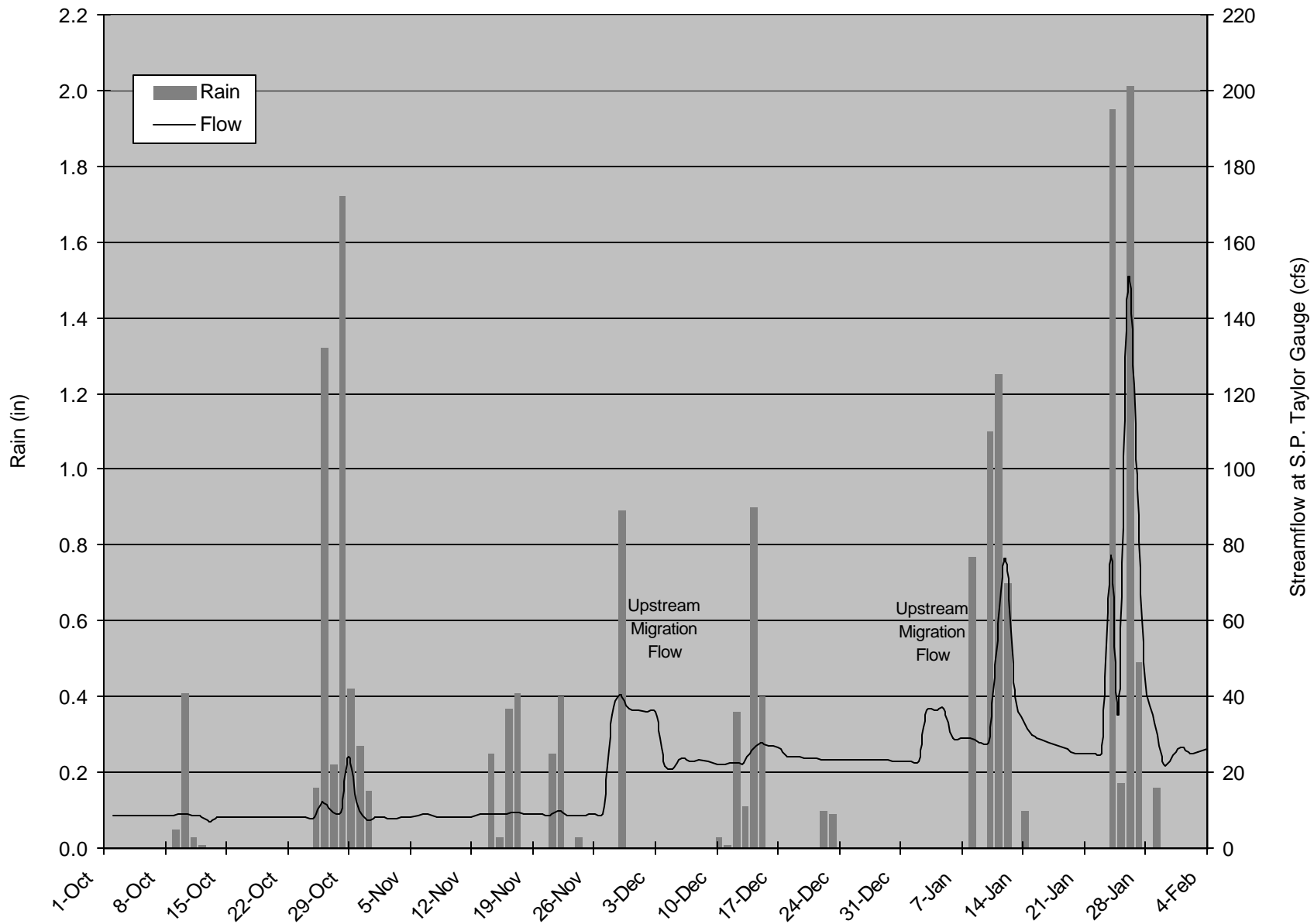


Figure 4. Rain and Stream Flows Measured at the Samuel P. Taylor Gage Station, 2000-2001.

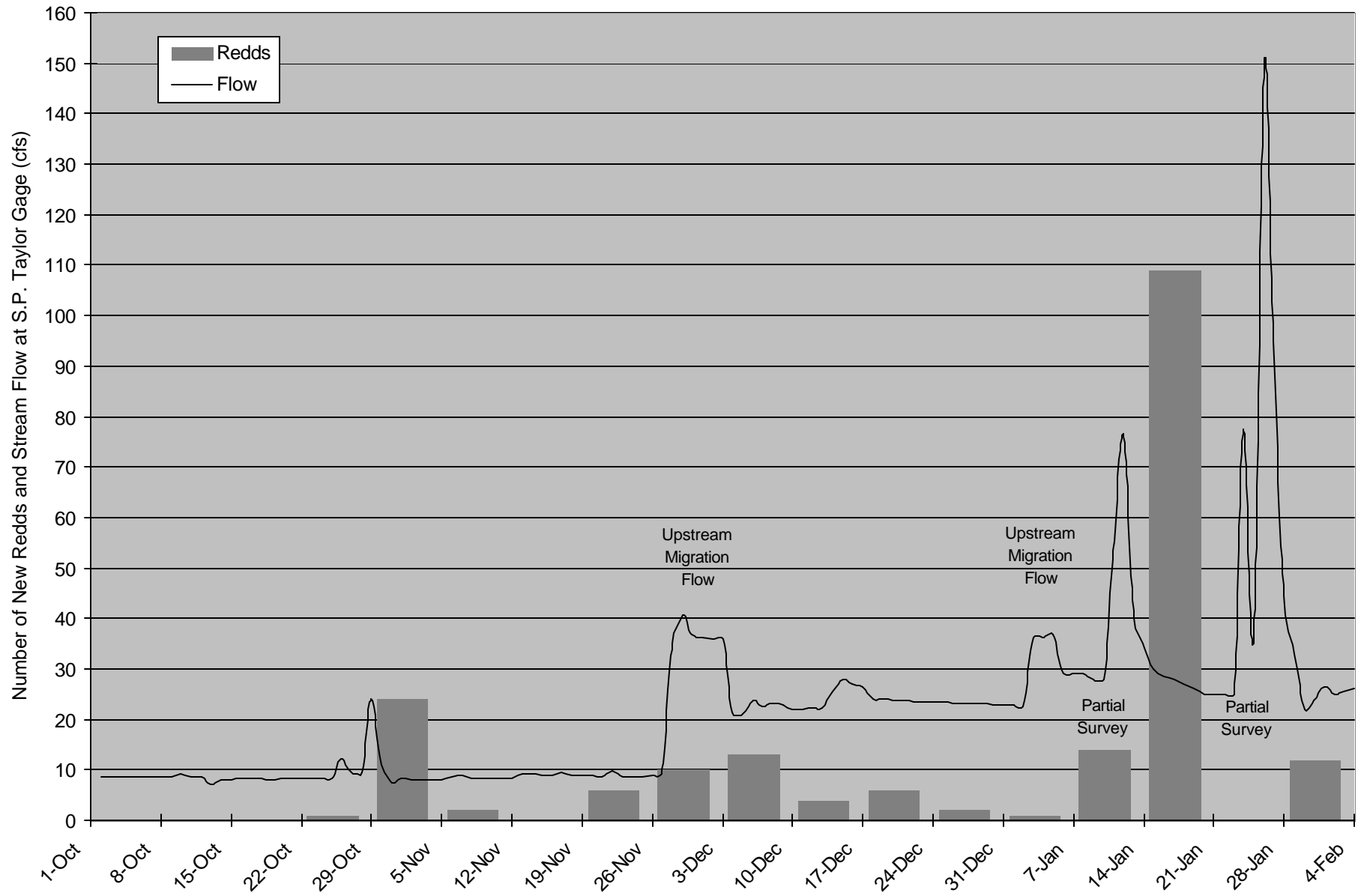


Figure 5. Coho Redds and Stream Flow, 2000-2001

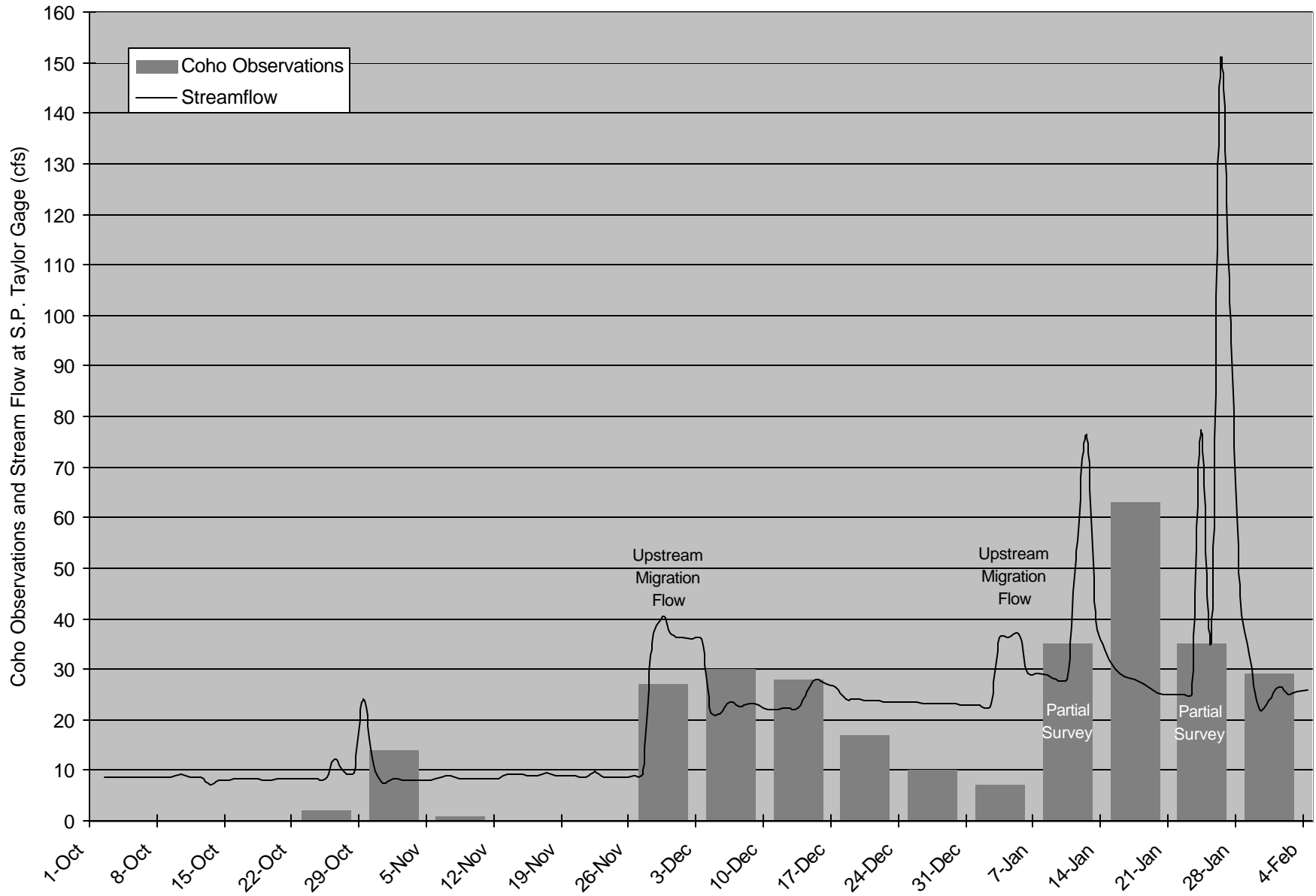


Figure 6. Live Coho Observations and Stream Flow, 2000-2001.

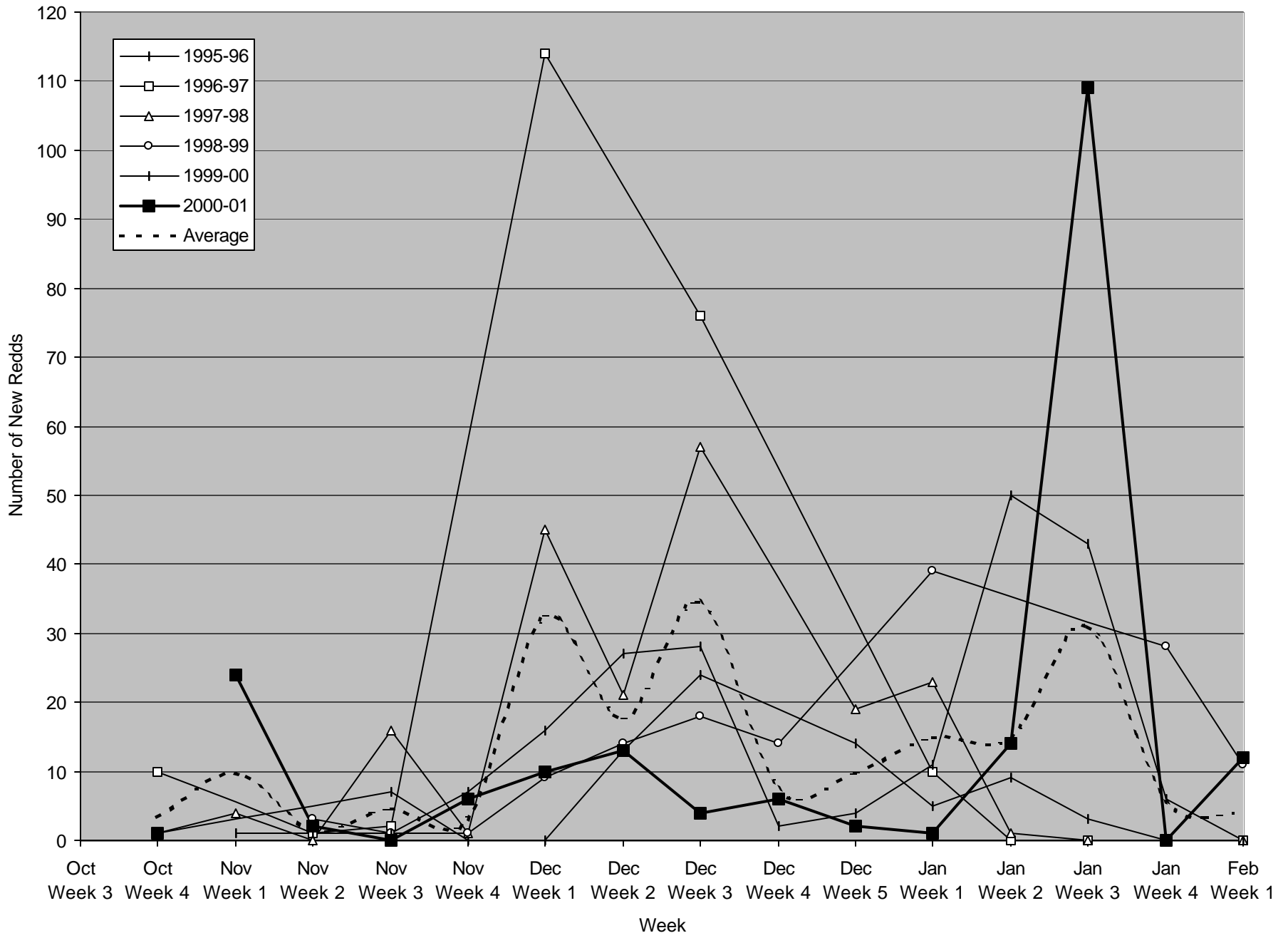


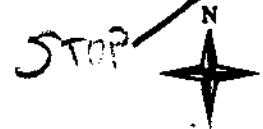
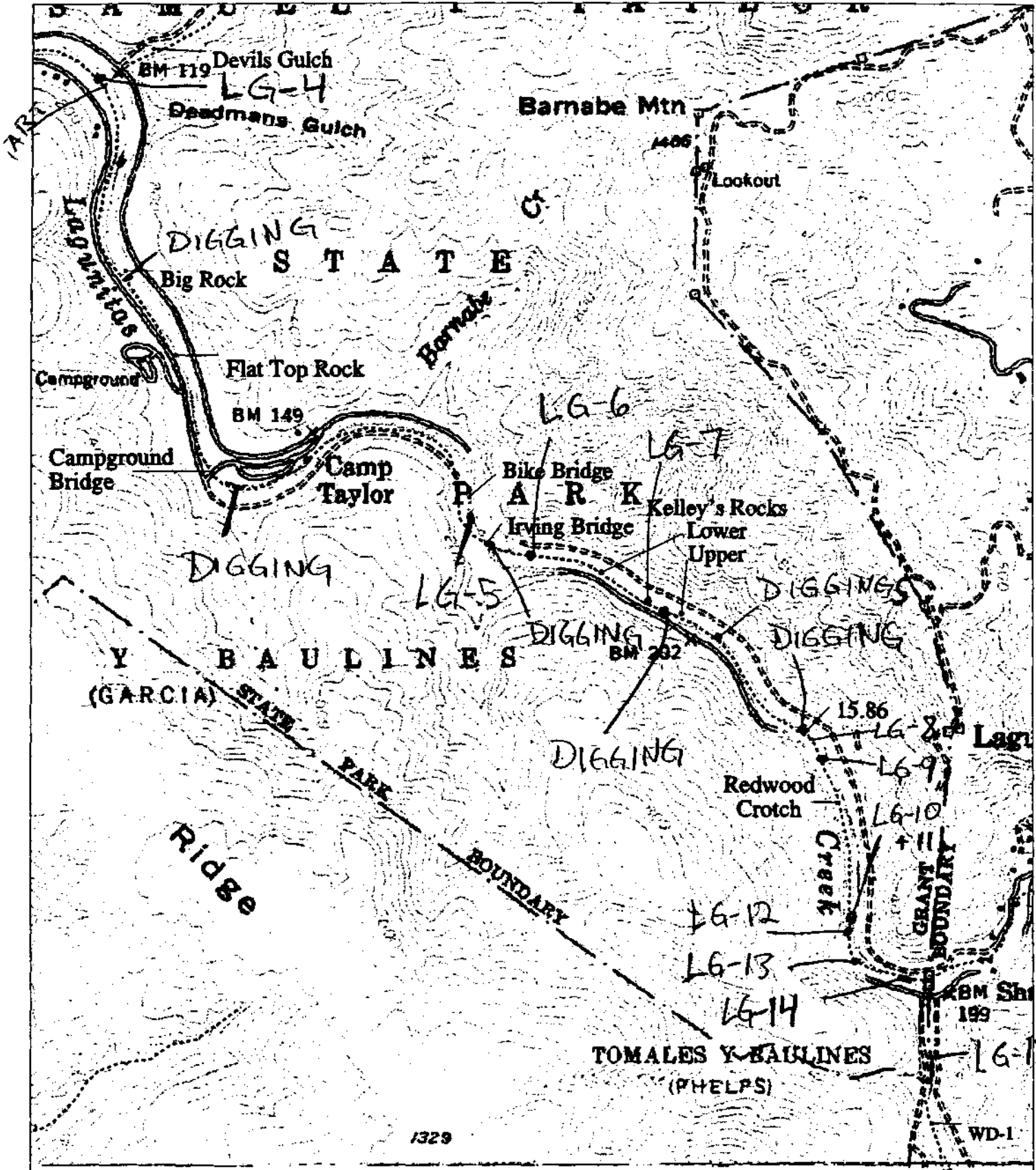
Figure 7. Timing of Coho Spawning Activity in the Lagunitas Creek Drainage, Spawning Seasons 1995-'96 - 2000-'01.

APPENDIX A

Field maps with redd locations on Lagunitas Creek, San Geronimo Creek and Devil's Gulch.

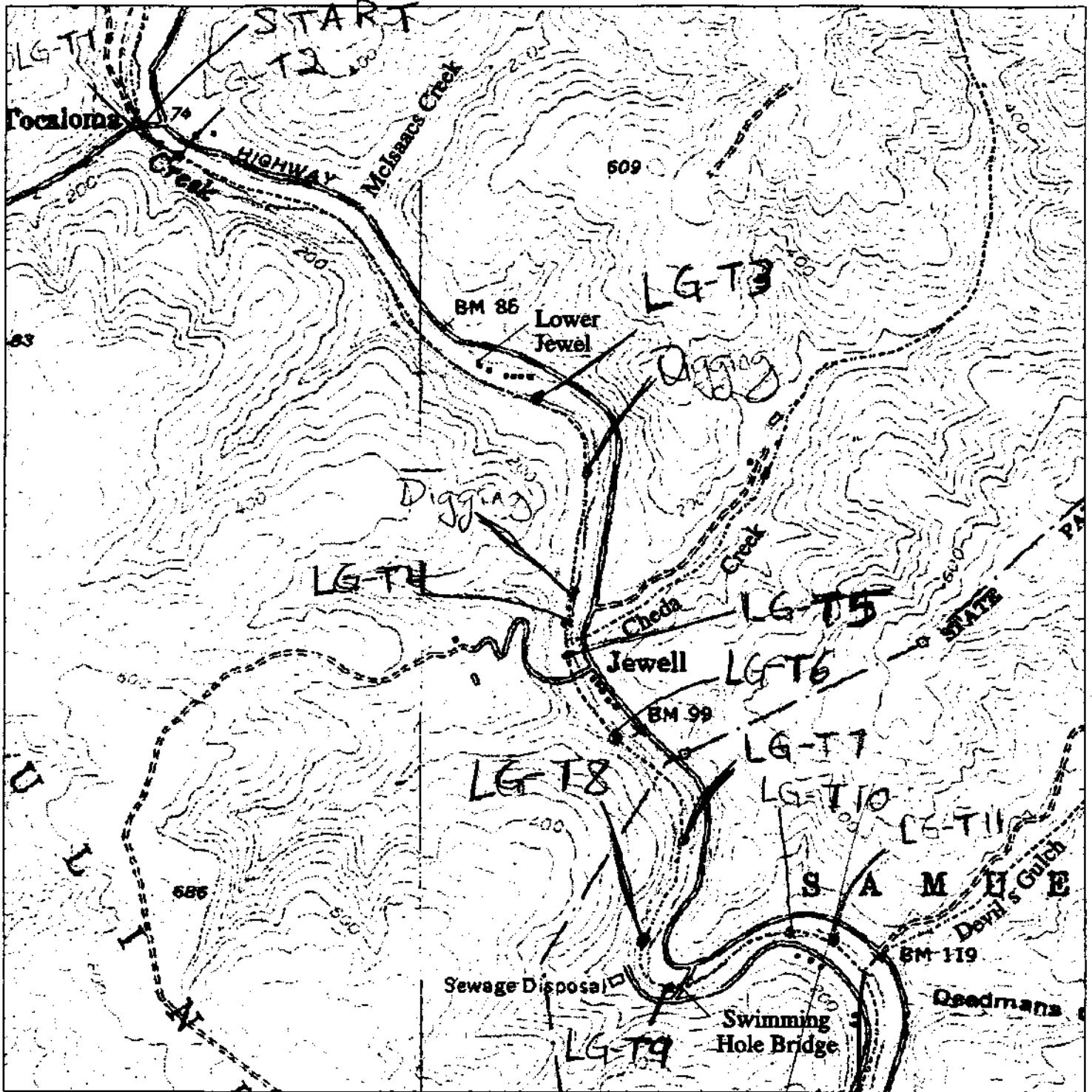
Coho Spawner Survey
Devil's Gulch to Peter's Dam

Date: 1-NOV-00



Coho Spawner Survey Tocaloma to Devil's Gulch

Date: 2-NOV-0



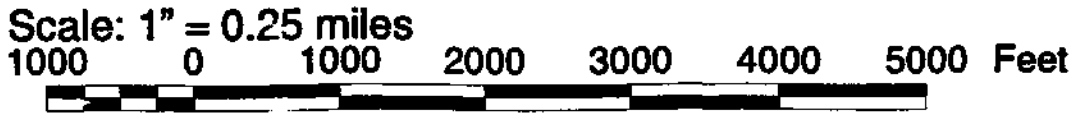
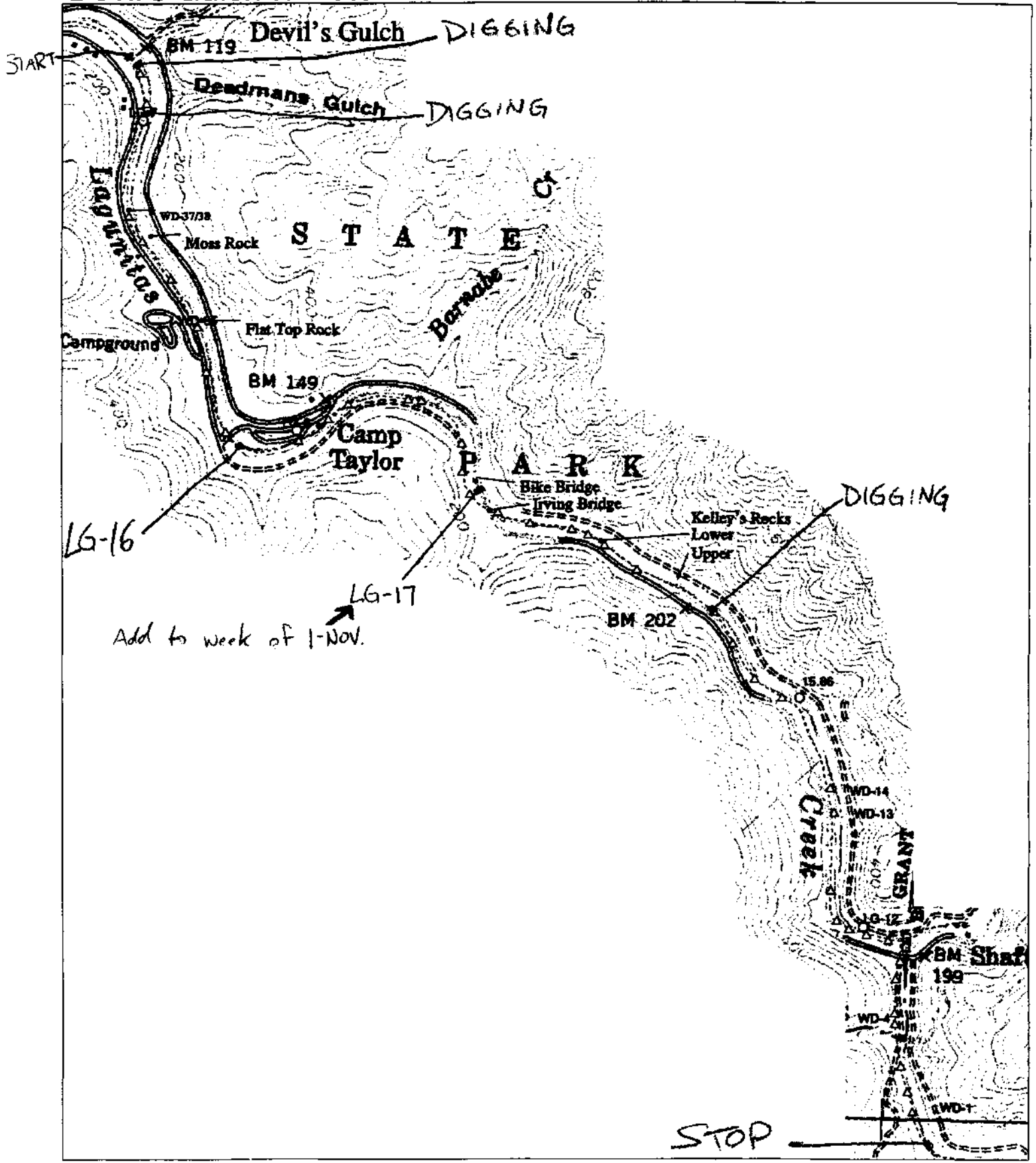
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STOP

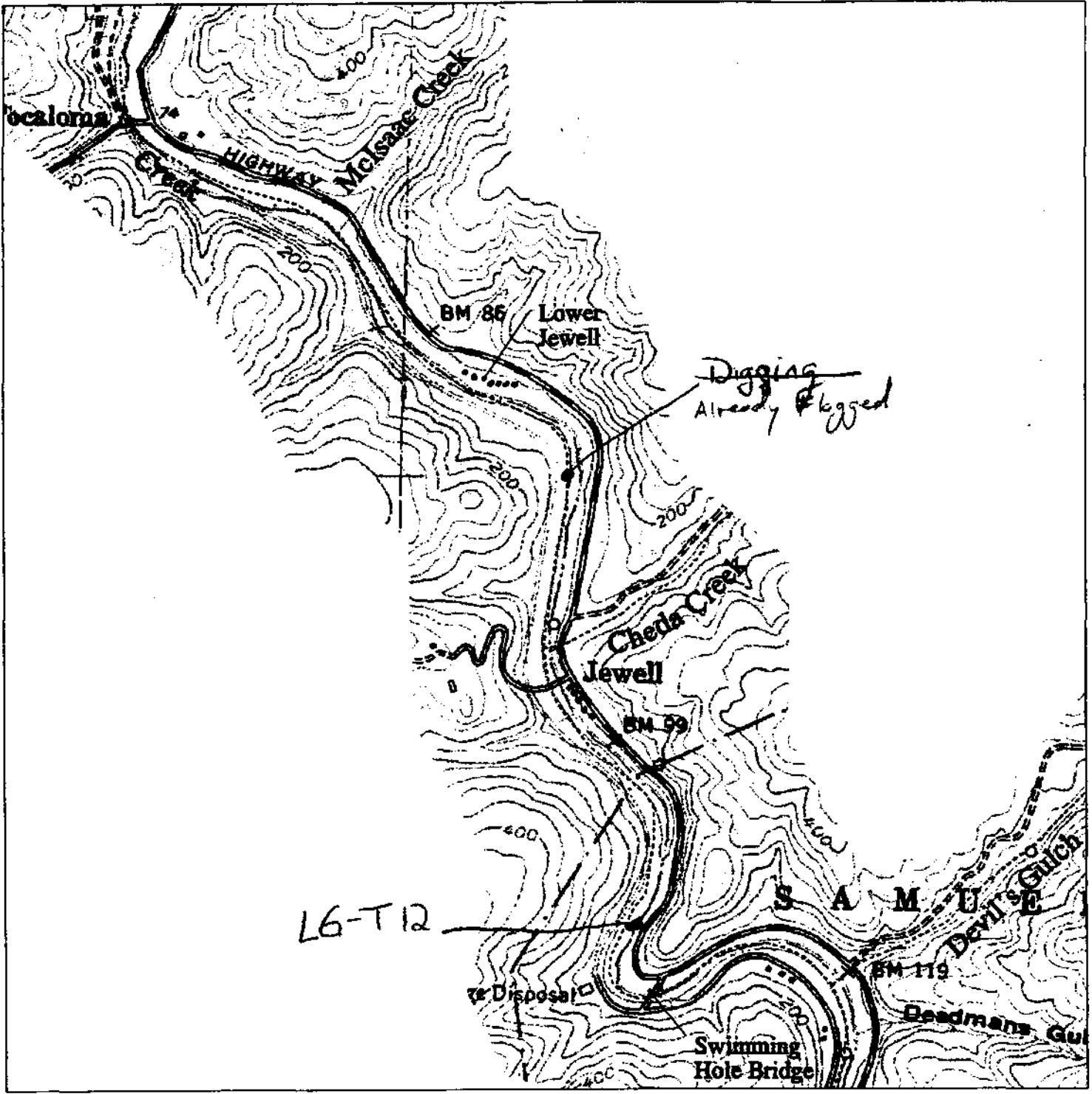
Coho-Spawner Survey Devil's Gulch to Peter's Dam

Date: 8-NOV-00



Coho Spawner Survey
Tocaloma to Devil's Gulch

Date: 9-NOV-00



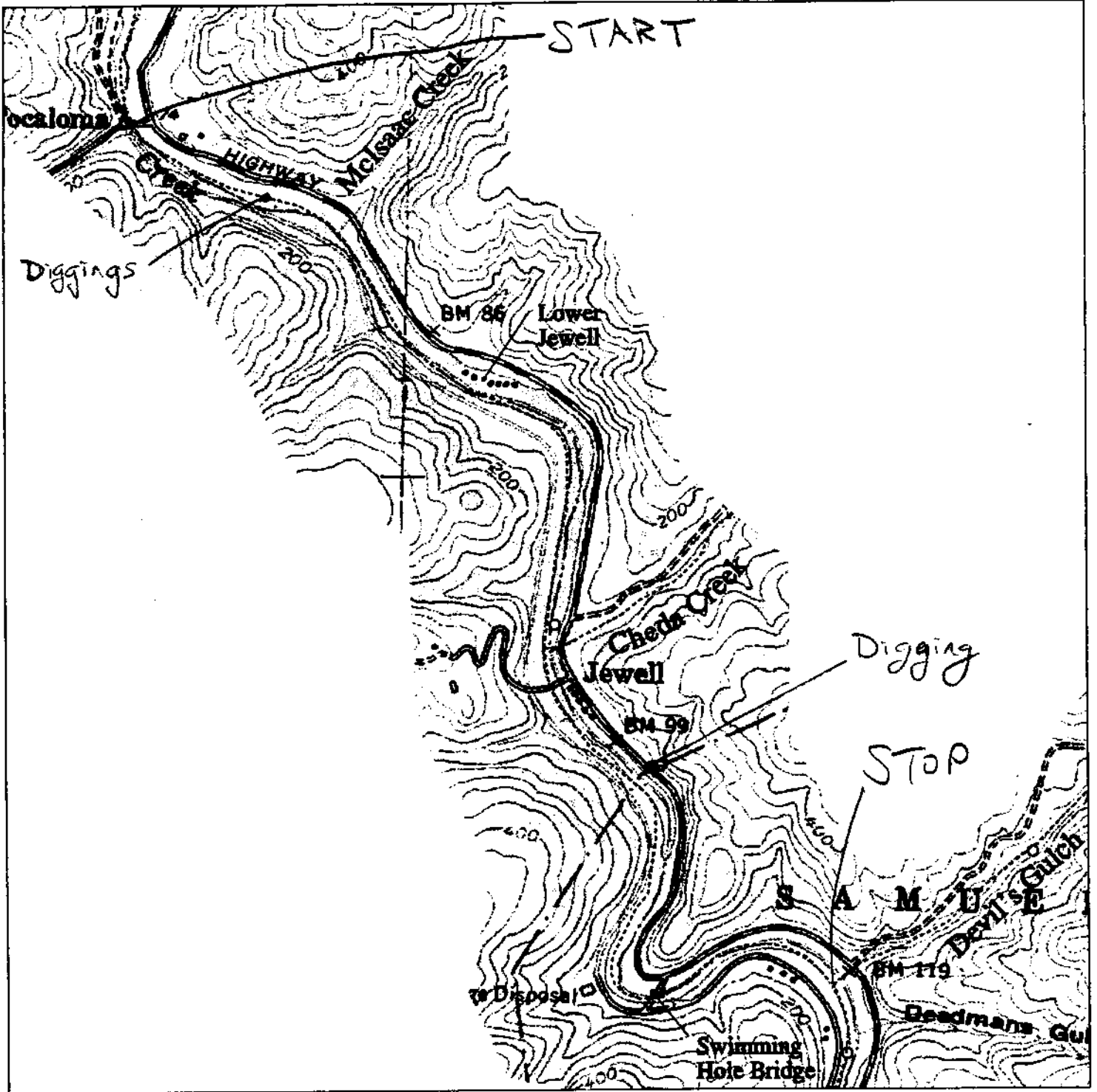
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Coho Spawner Survey
Tocaloma to Devil's Gulch

Date: 14-NOV-00



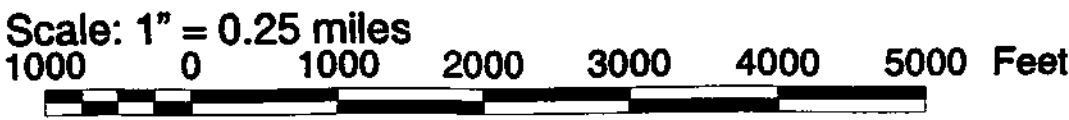
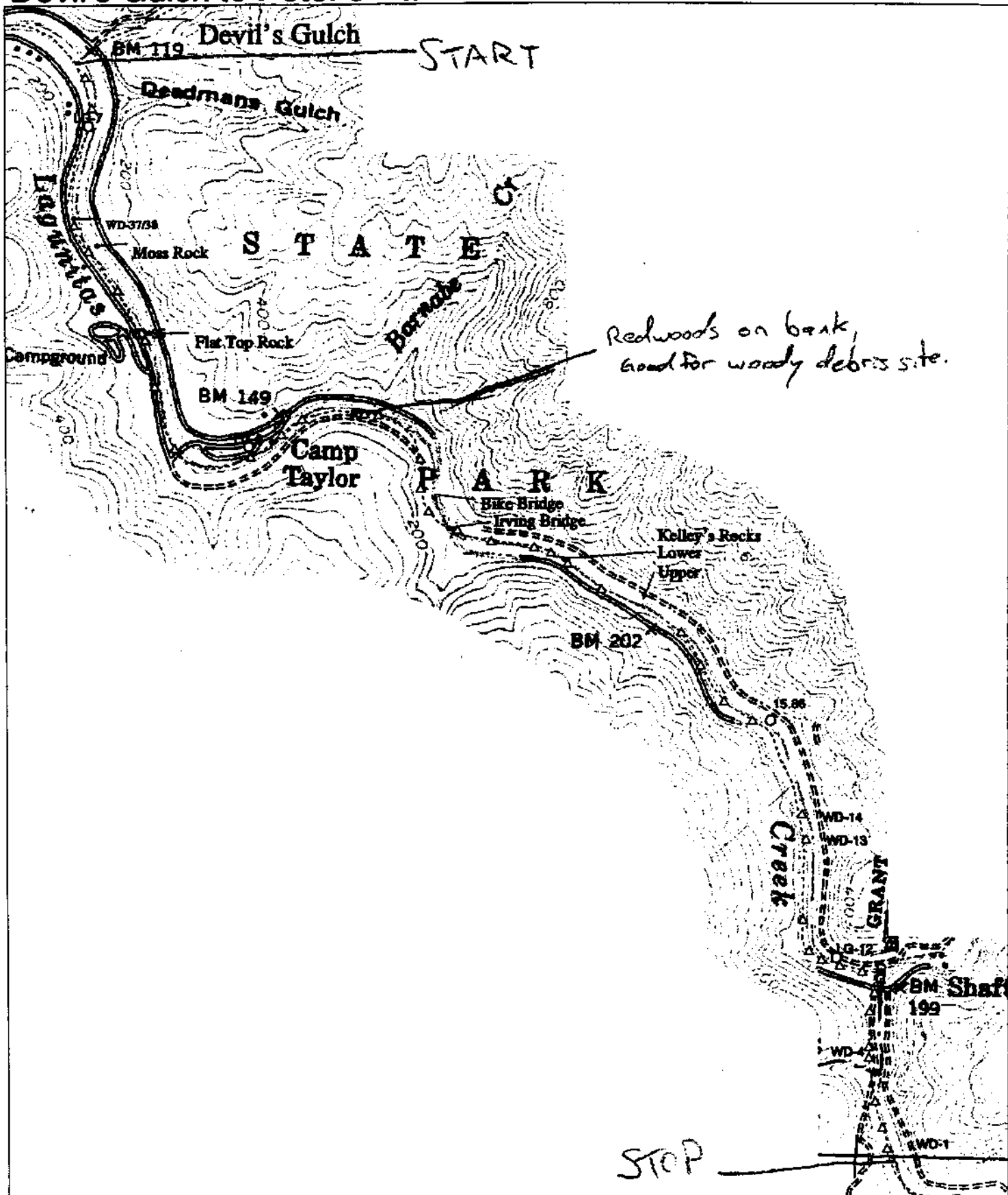
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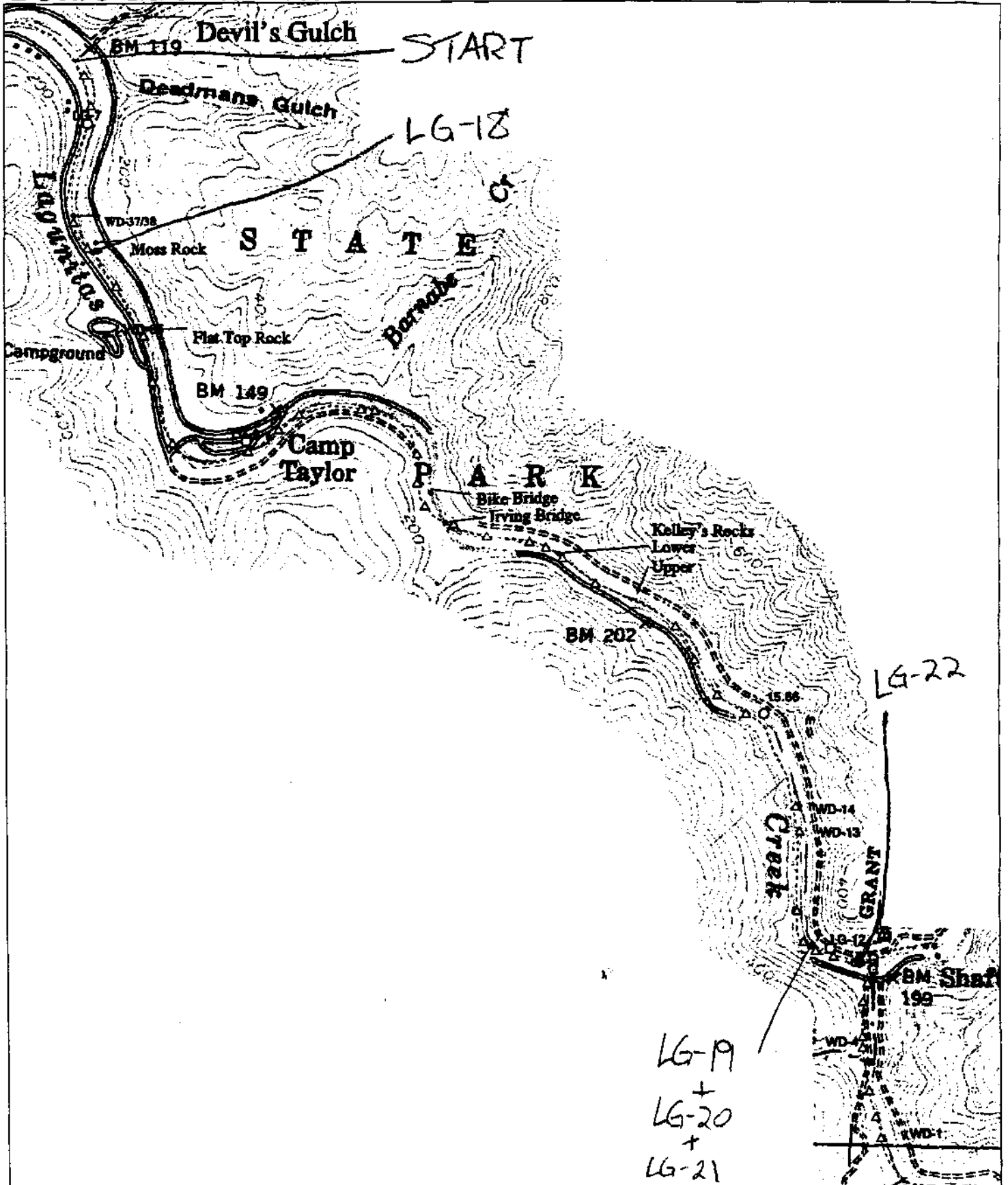
Goho Spawner Survey Devil's Gulch to Peter's Dam

Date: 16-NOV-00

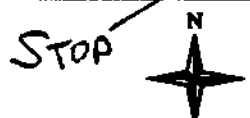


Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 21-Nov-00

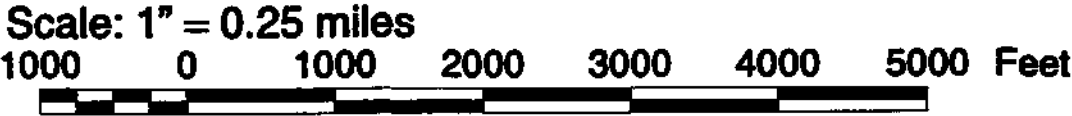
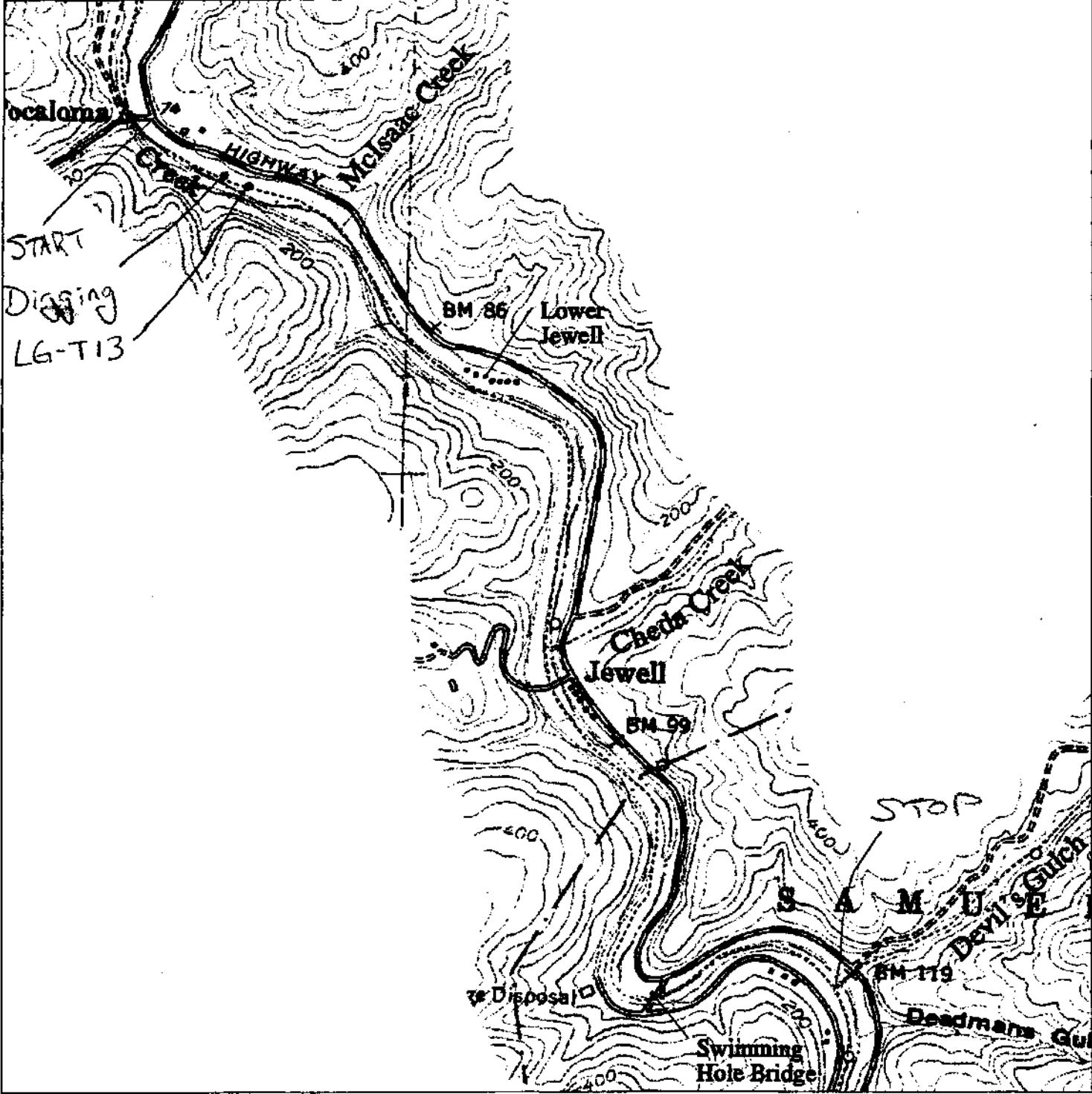


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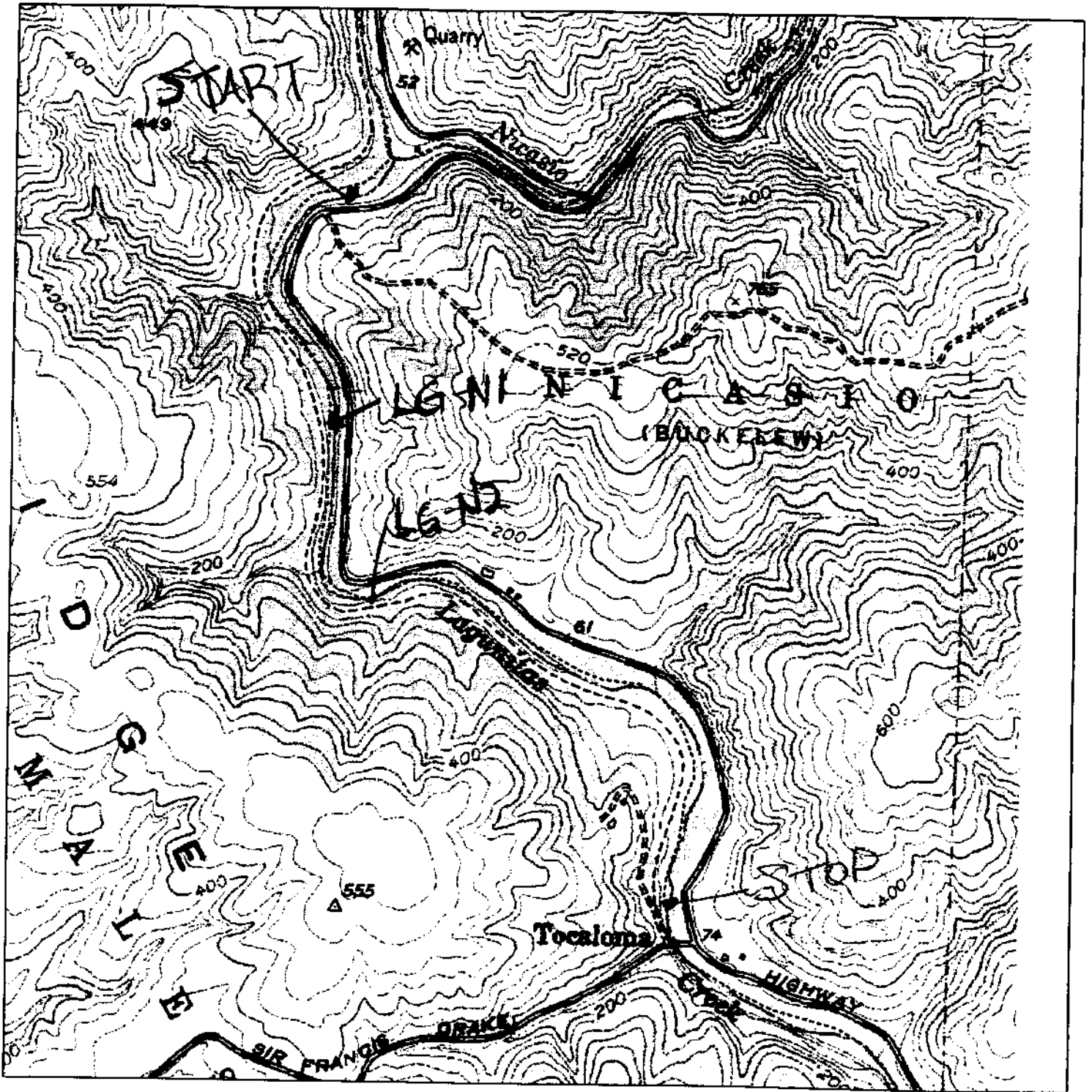
**Coho Spawner Survey
Tocaloma to Devil's Gulch**

Date: 22 - NOV - 00



**Coho Spawner Survey
Nicasio Creek to Tocaloma**

Date: 28-NOV-00



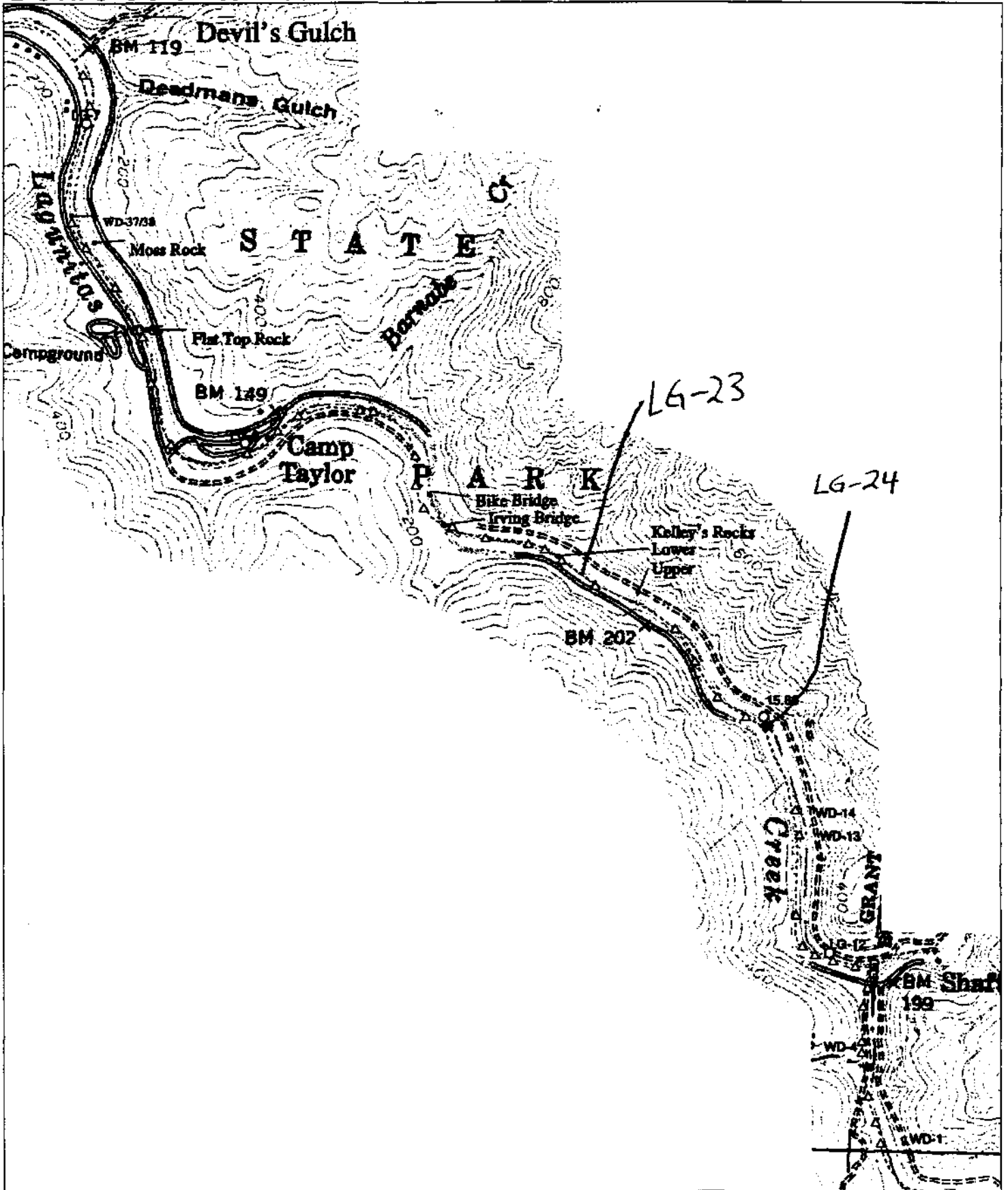
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Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 30-NOV-00



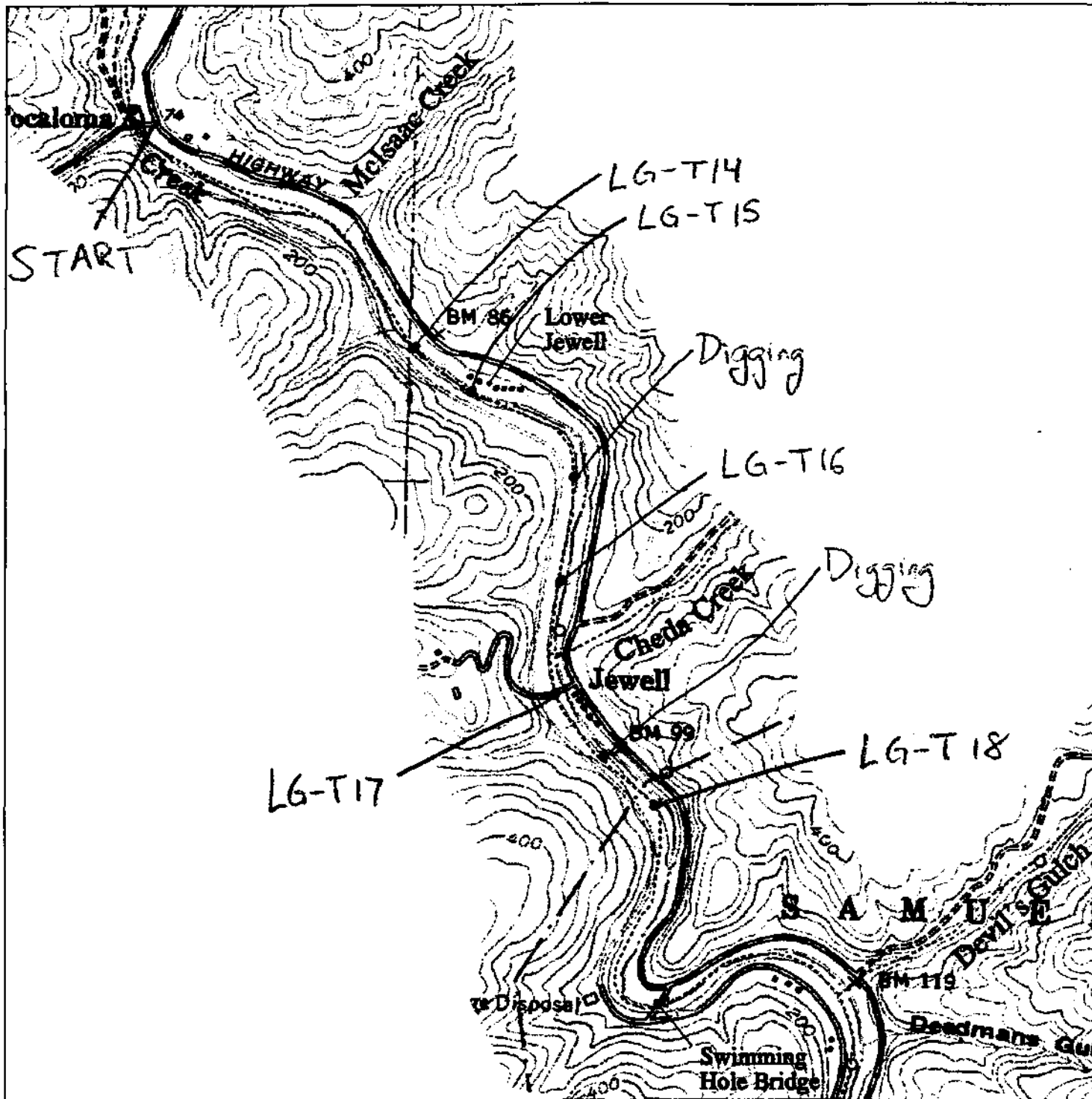
Scale: 1" = 0.25 miles

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Coho Spawner Survey Tocaloma to Devil's Gulch

Date: 1-DEC-00



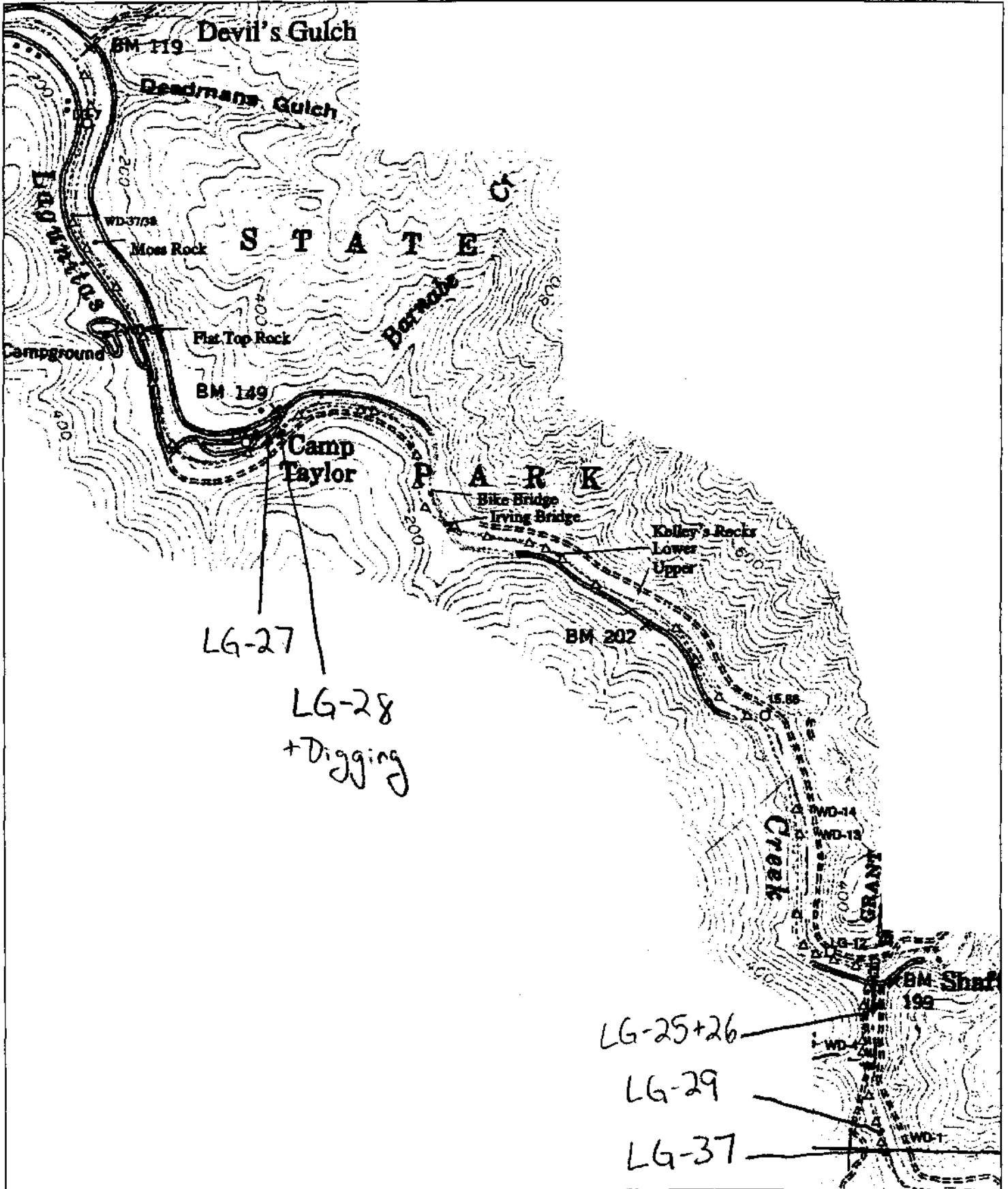
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Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 4-DEC-00

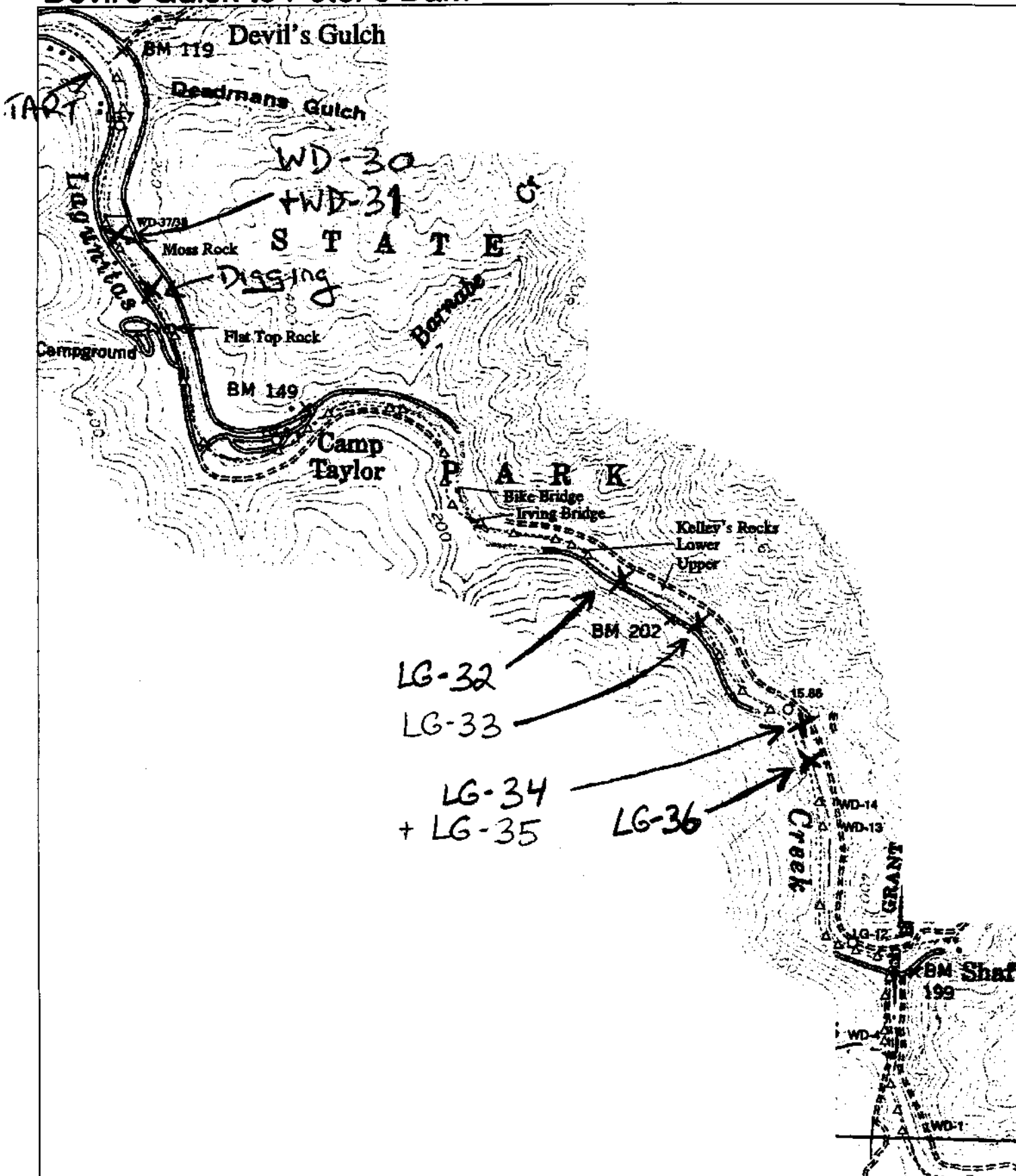


Scale: 1" = 0.25 miles
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Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 5-DEC-01



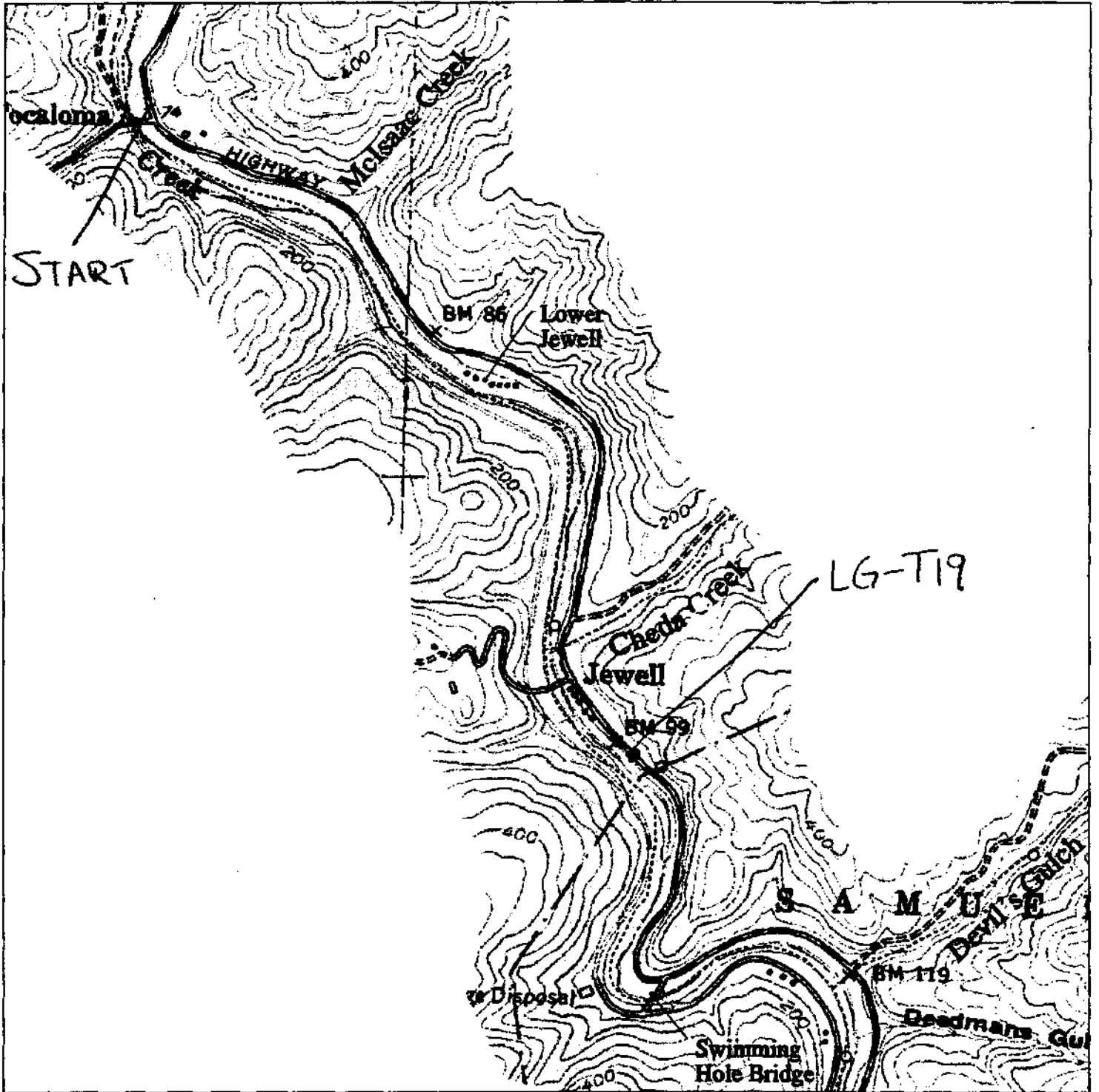
Scale: 1" = 0.25 miles

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Coho Spawner Survey
Tocaloma to Devil's Gulch

Date: 5-DEC-00



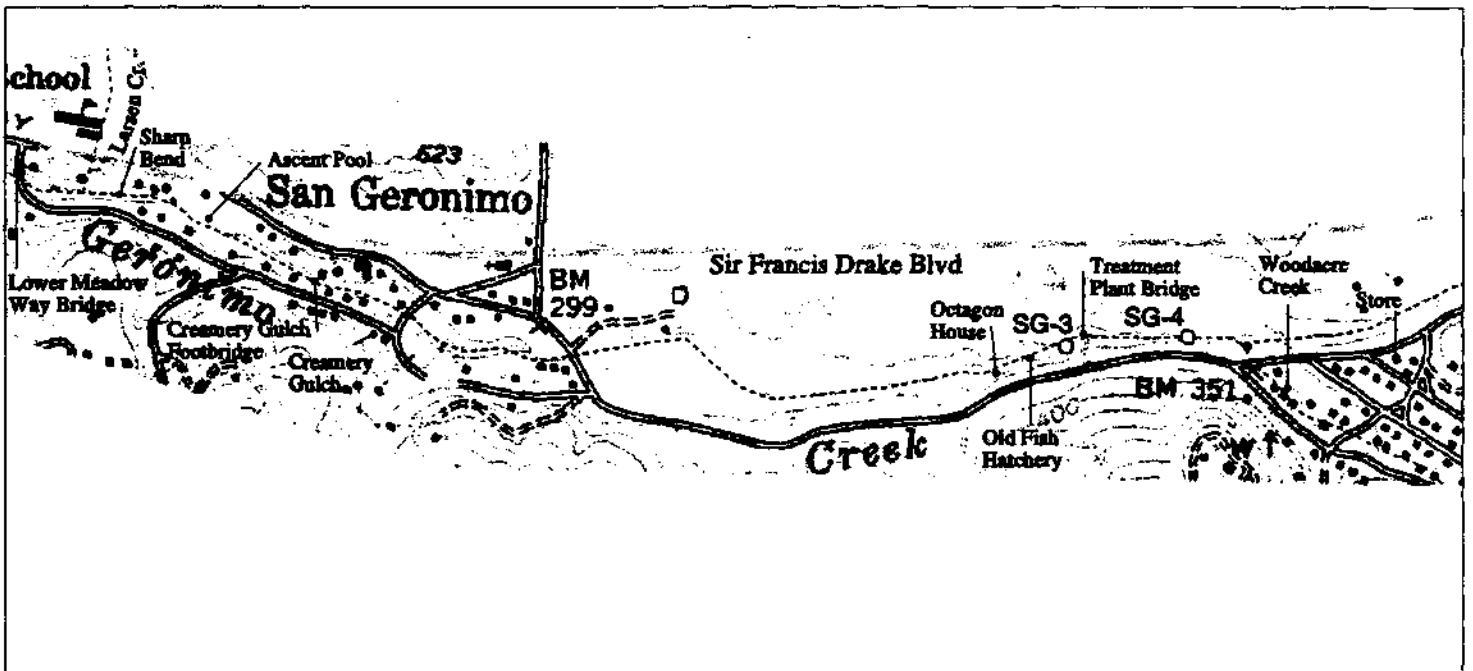
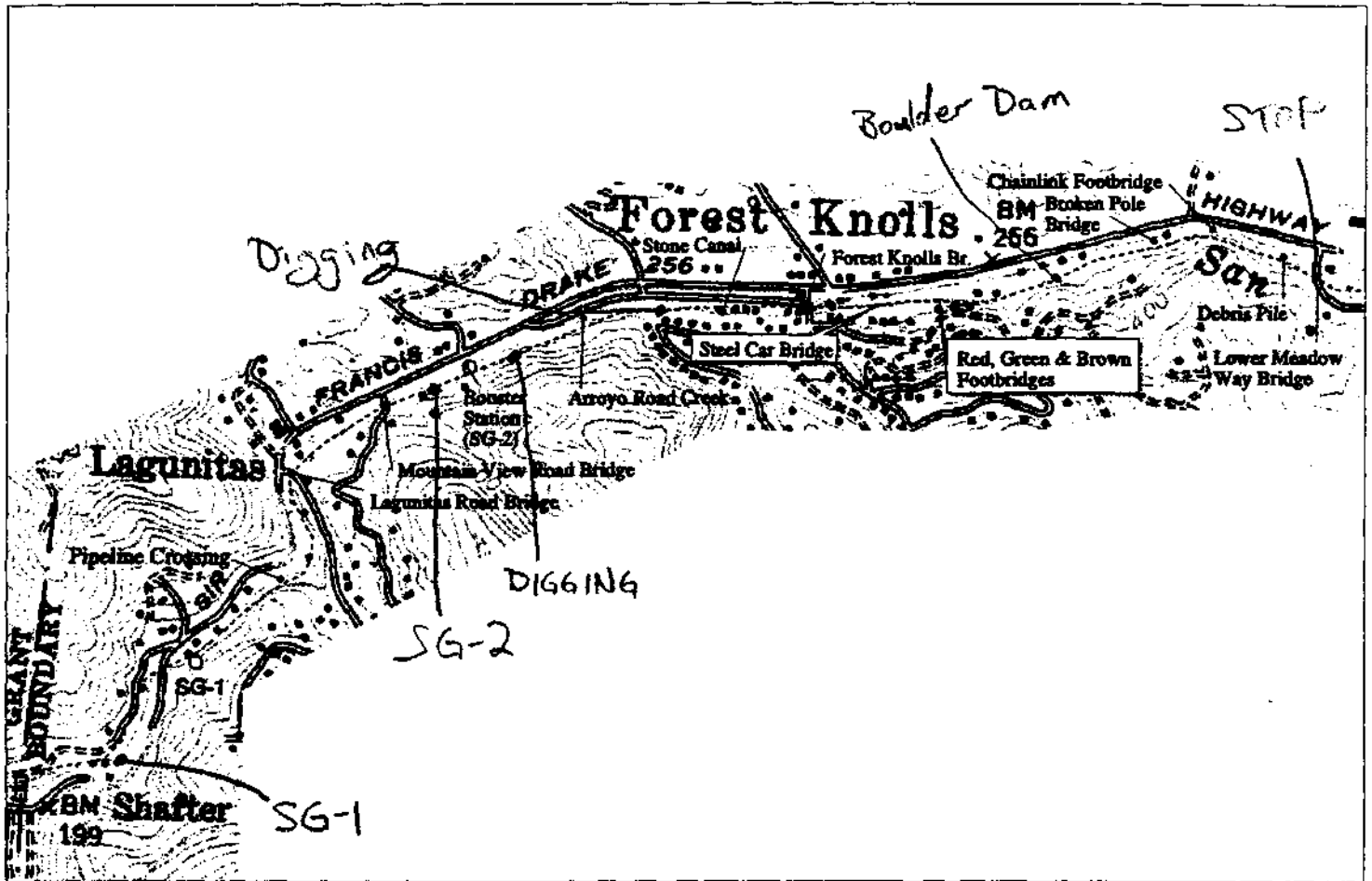
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Coho Spawner Survey San Geronimo Creek

Date: 7-DEC-00



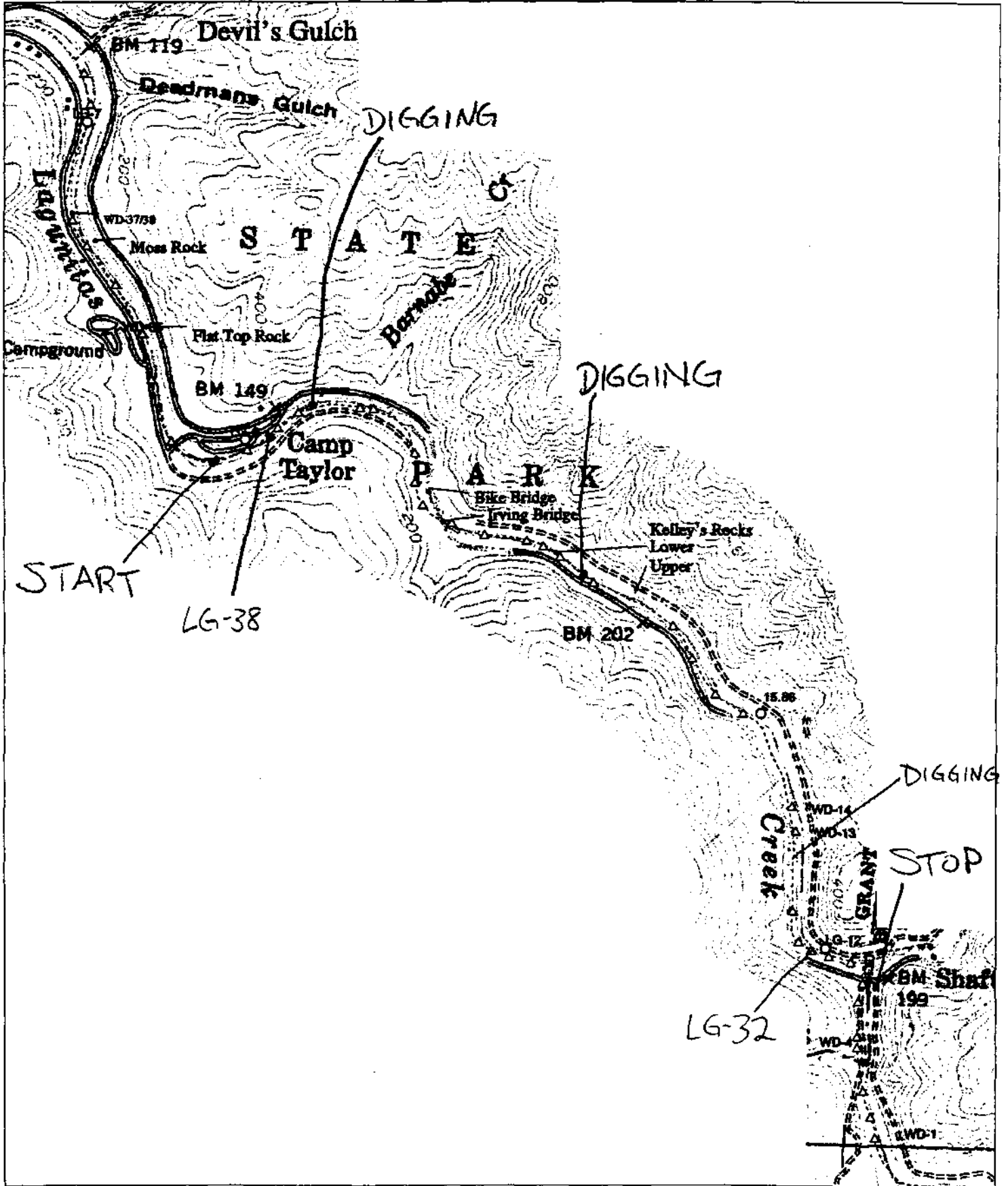
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Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 12-DEC-00



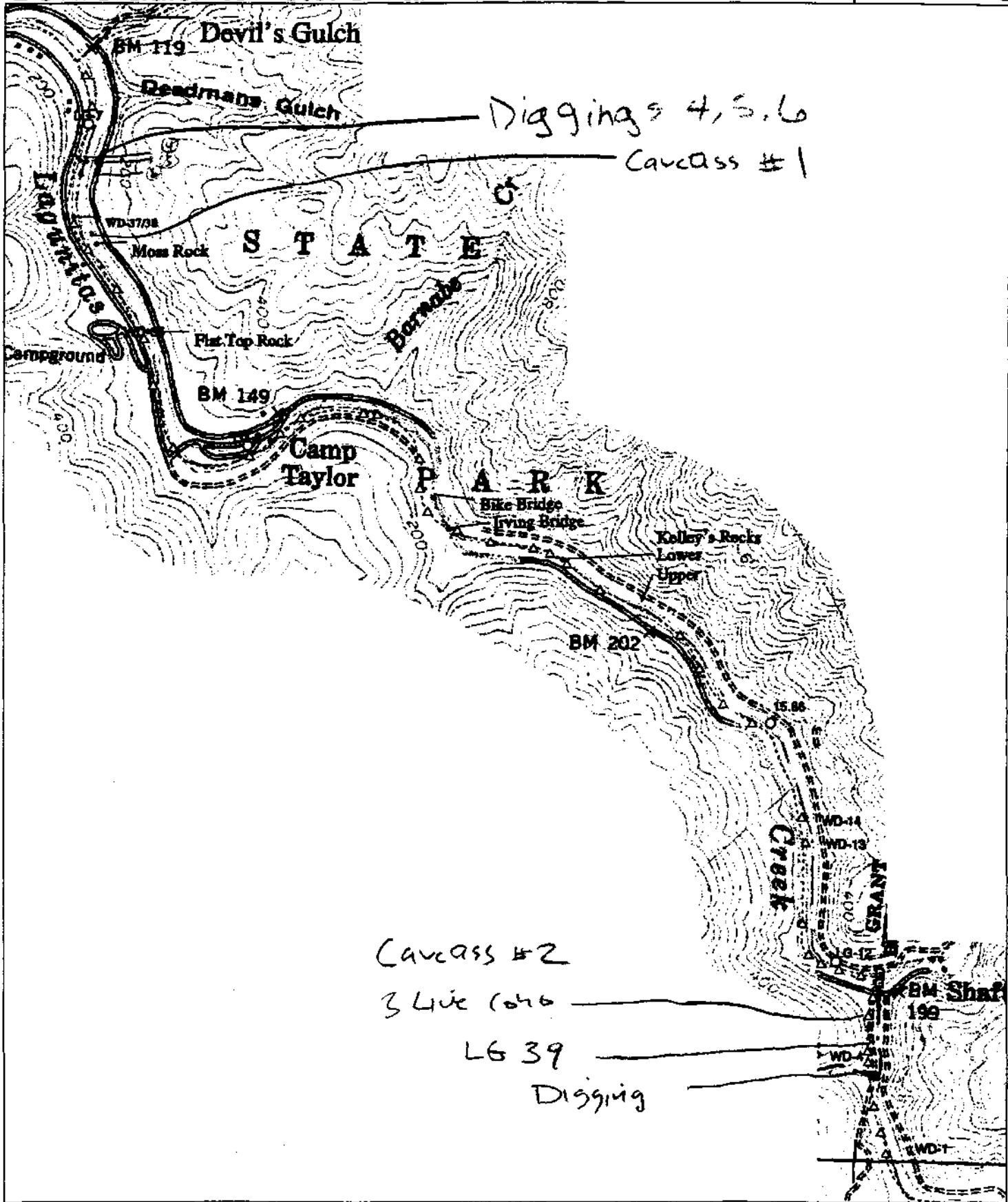
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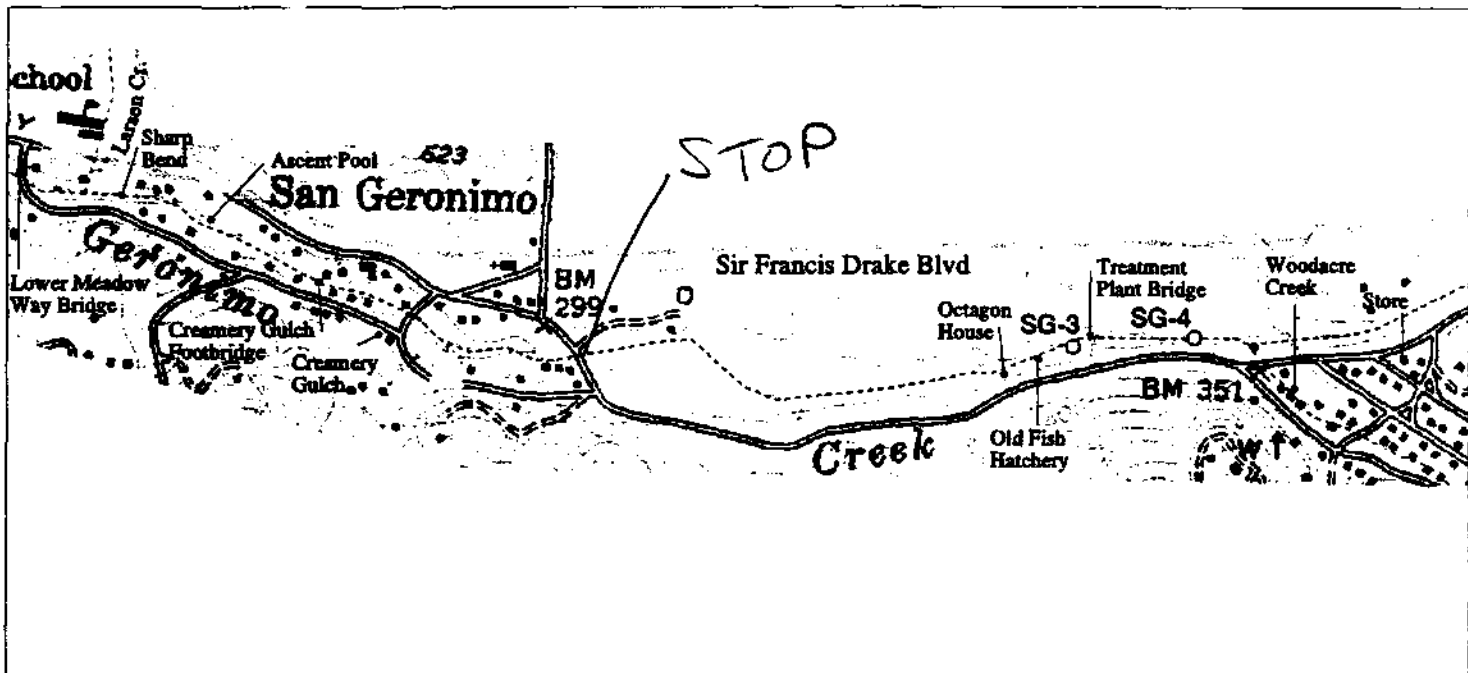
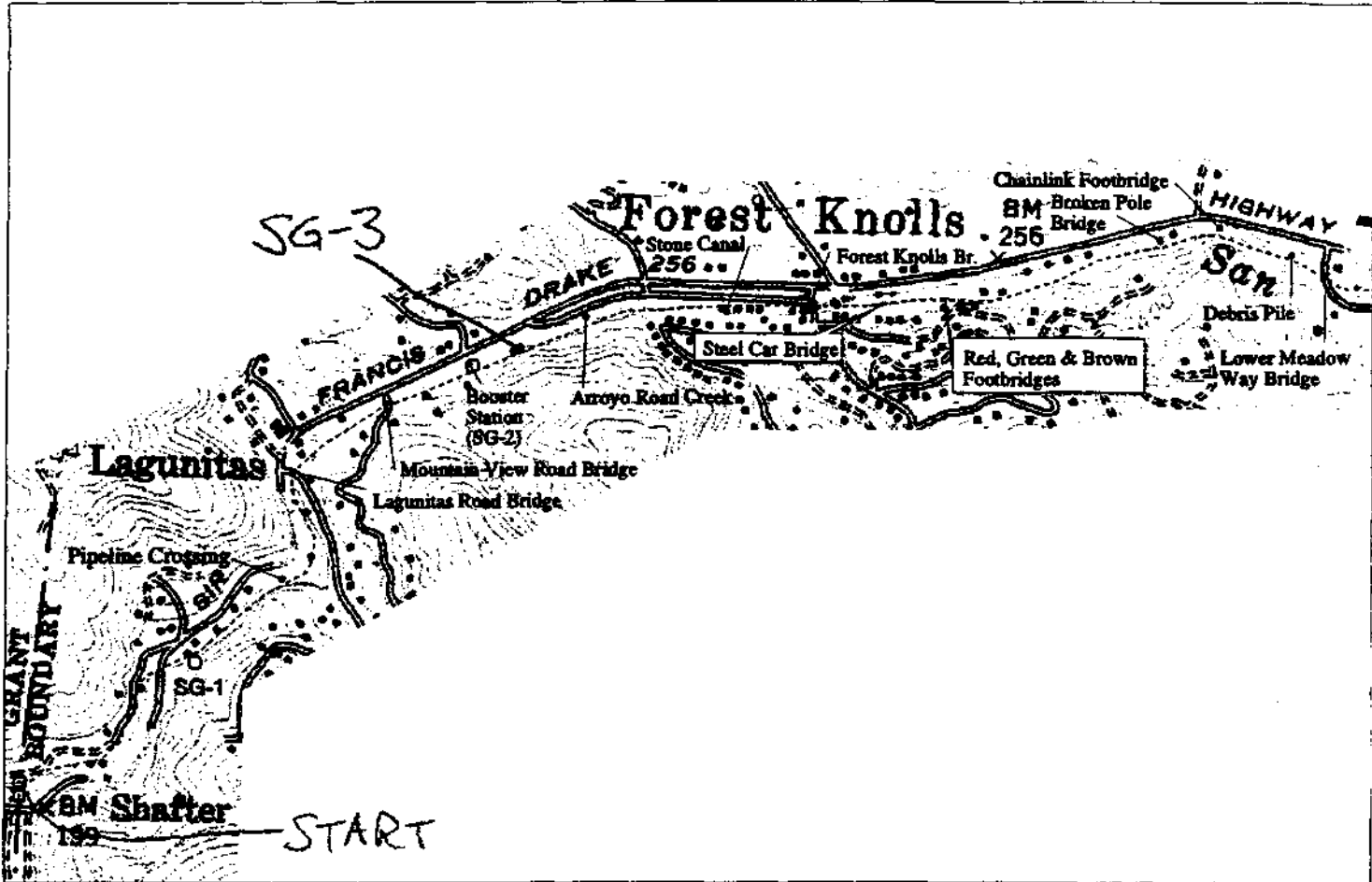
Coho Spawner Survey
Devil's Gulch to Peter's Dam

Date: 14-DEC-00



Coho Spawner Survey San Geronimo Creek

Date: 15-DEC-00



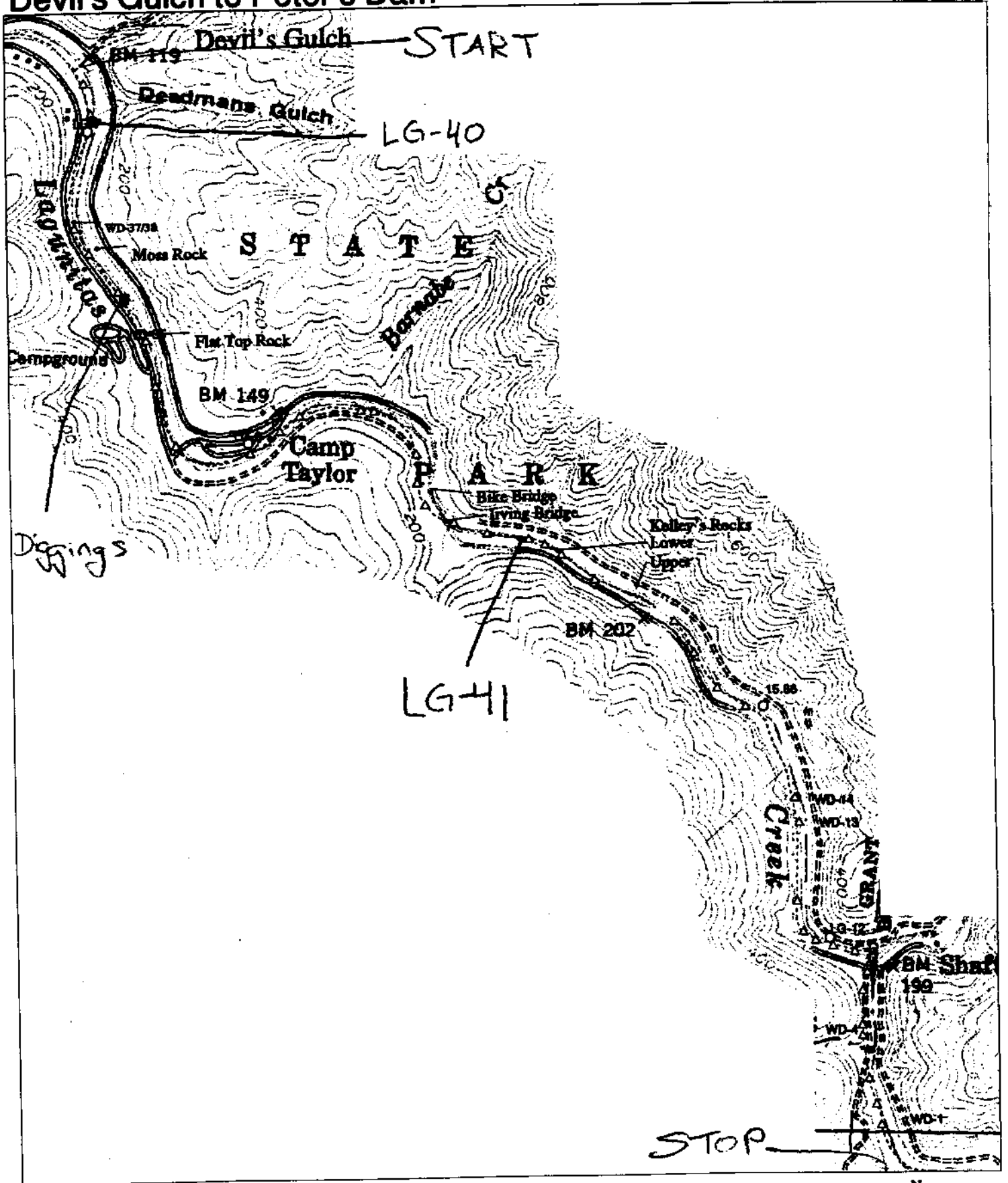
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Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 20-DEC-00



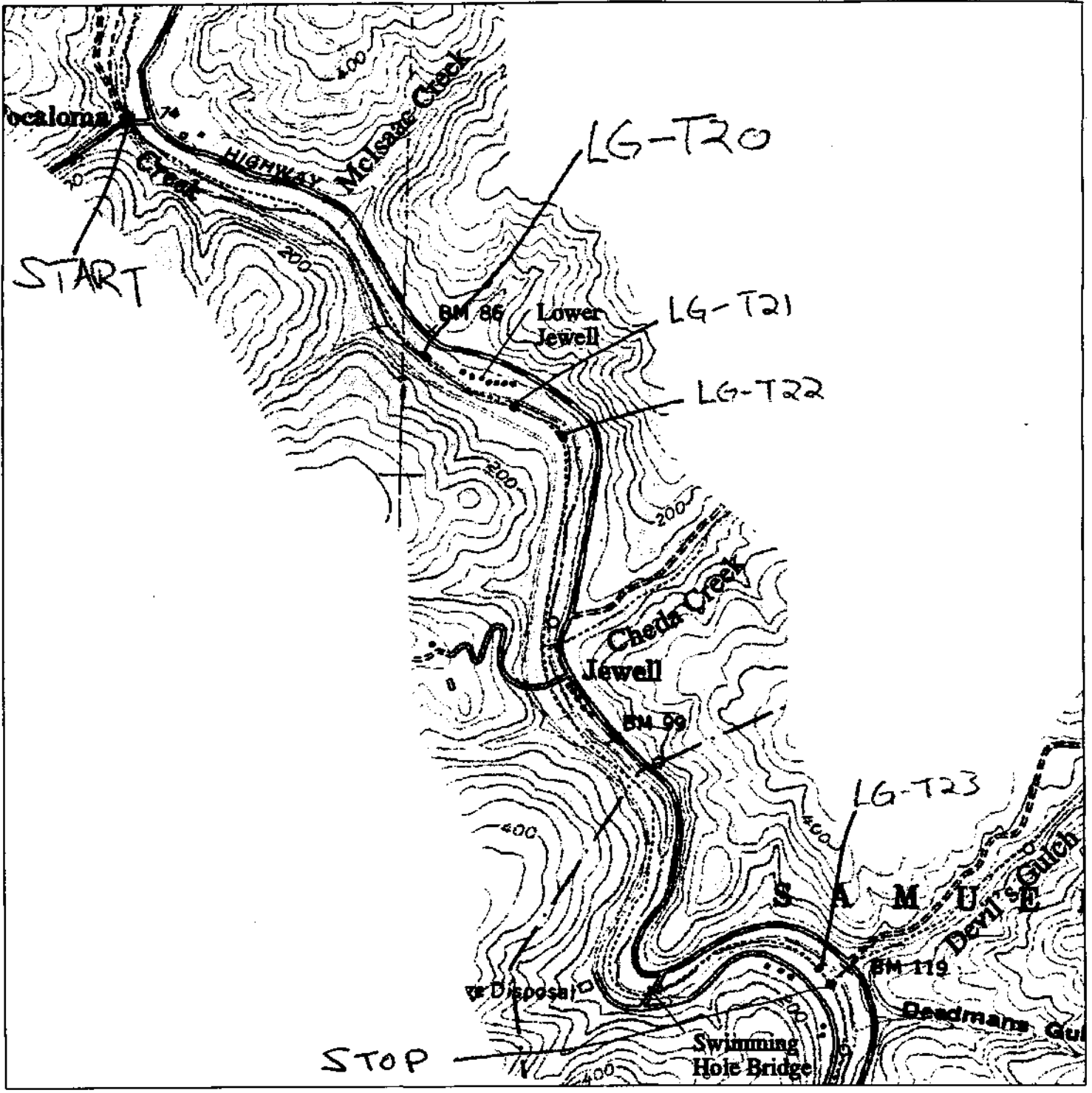
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Coho Spawner Survey
Tocaloma to Devil's Gulch

Date: 21-DEC-00



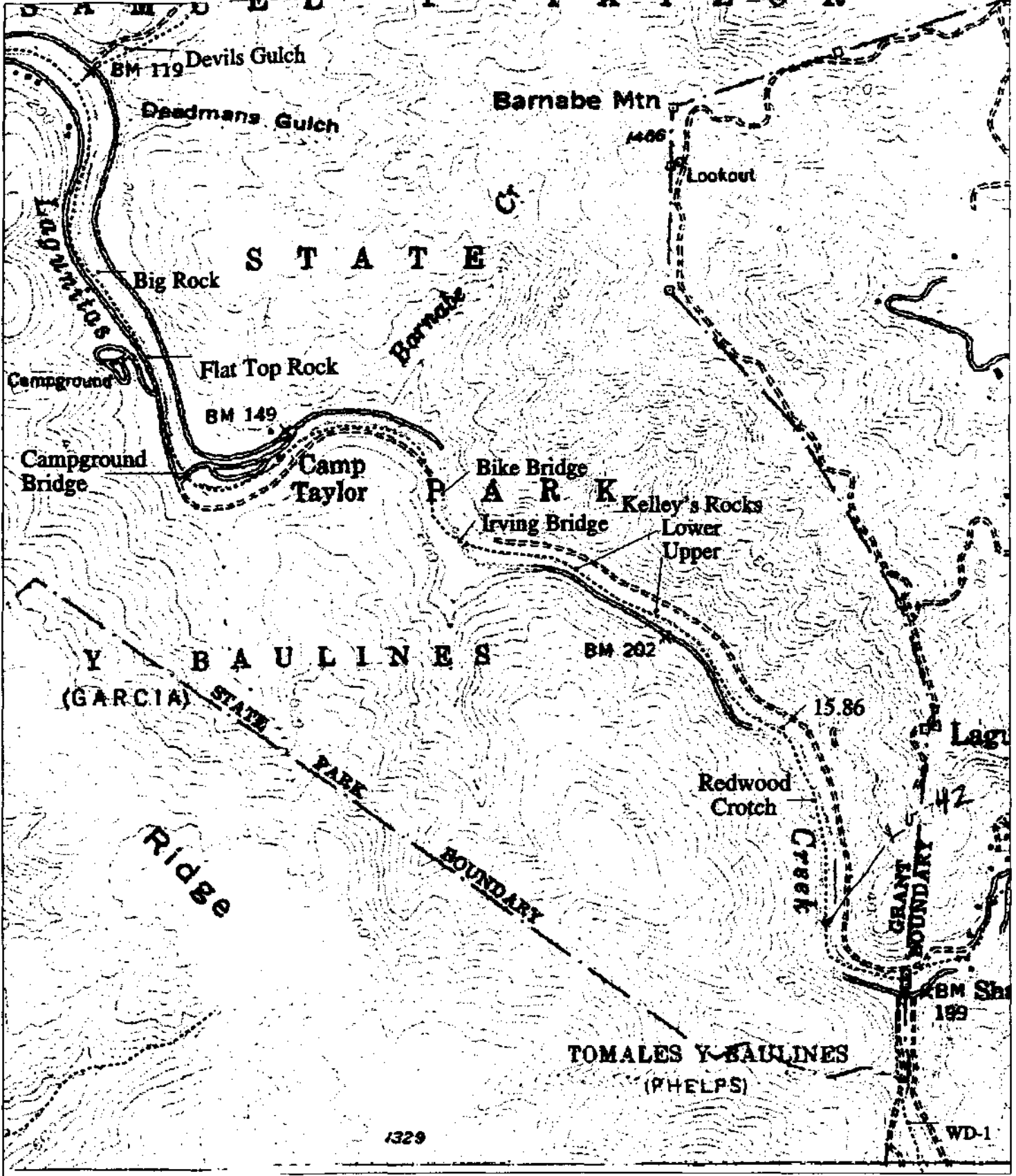
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Coho Spawner Survey Devil's Gulch to Peter's Dam

A. Ross
C. Andrew

Date: 27-DEC-00

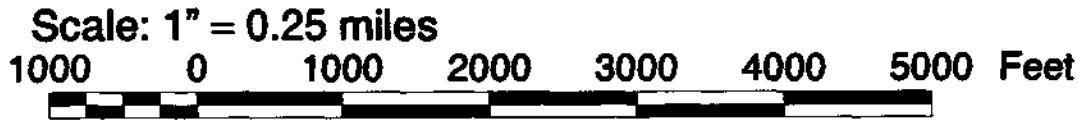
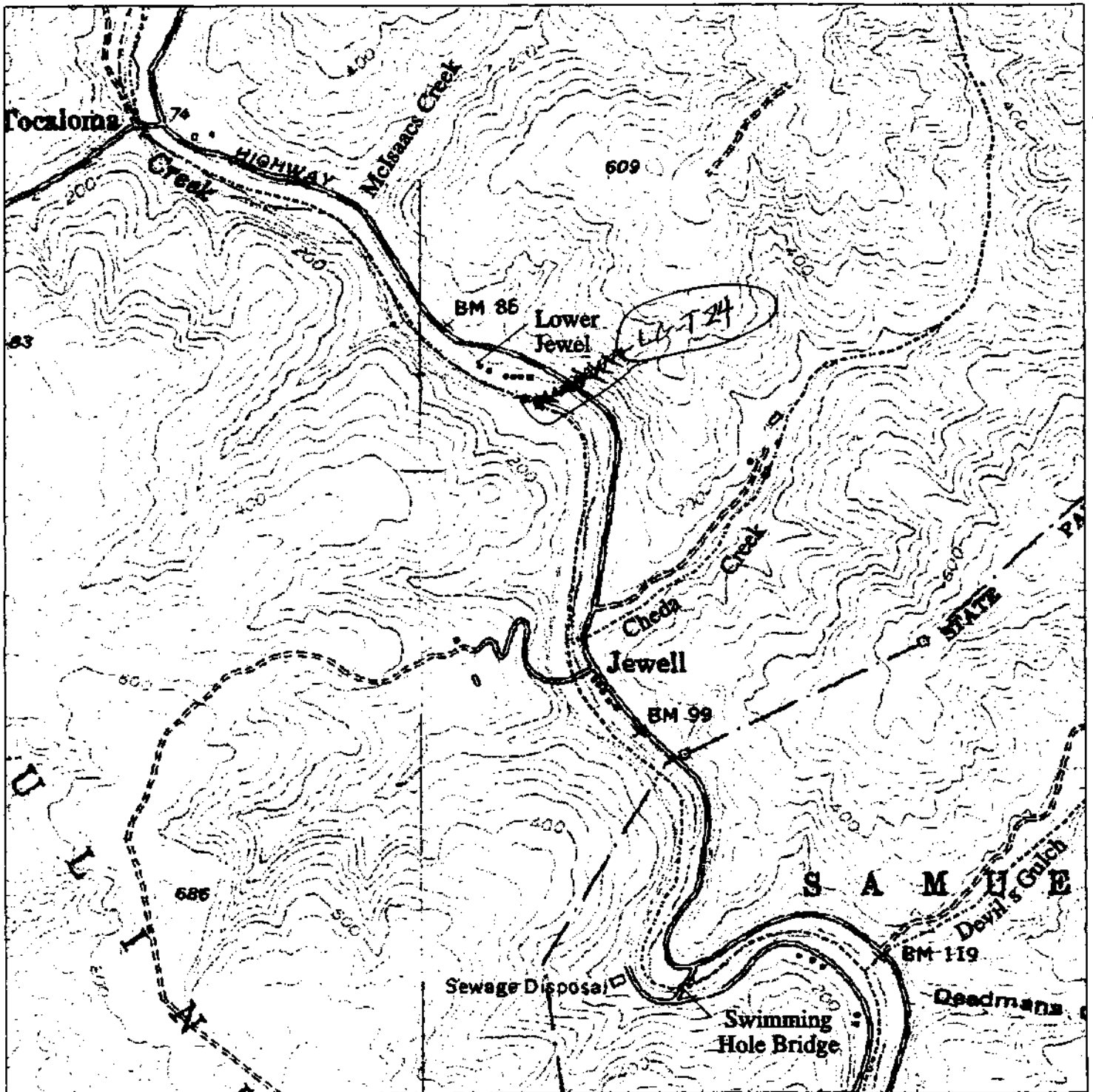


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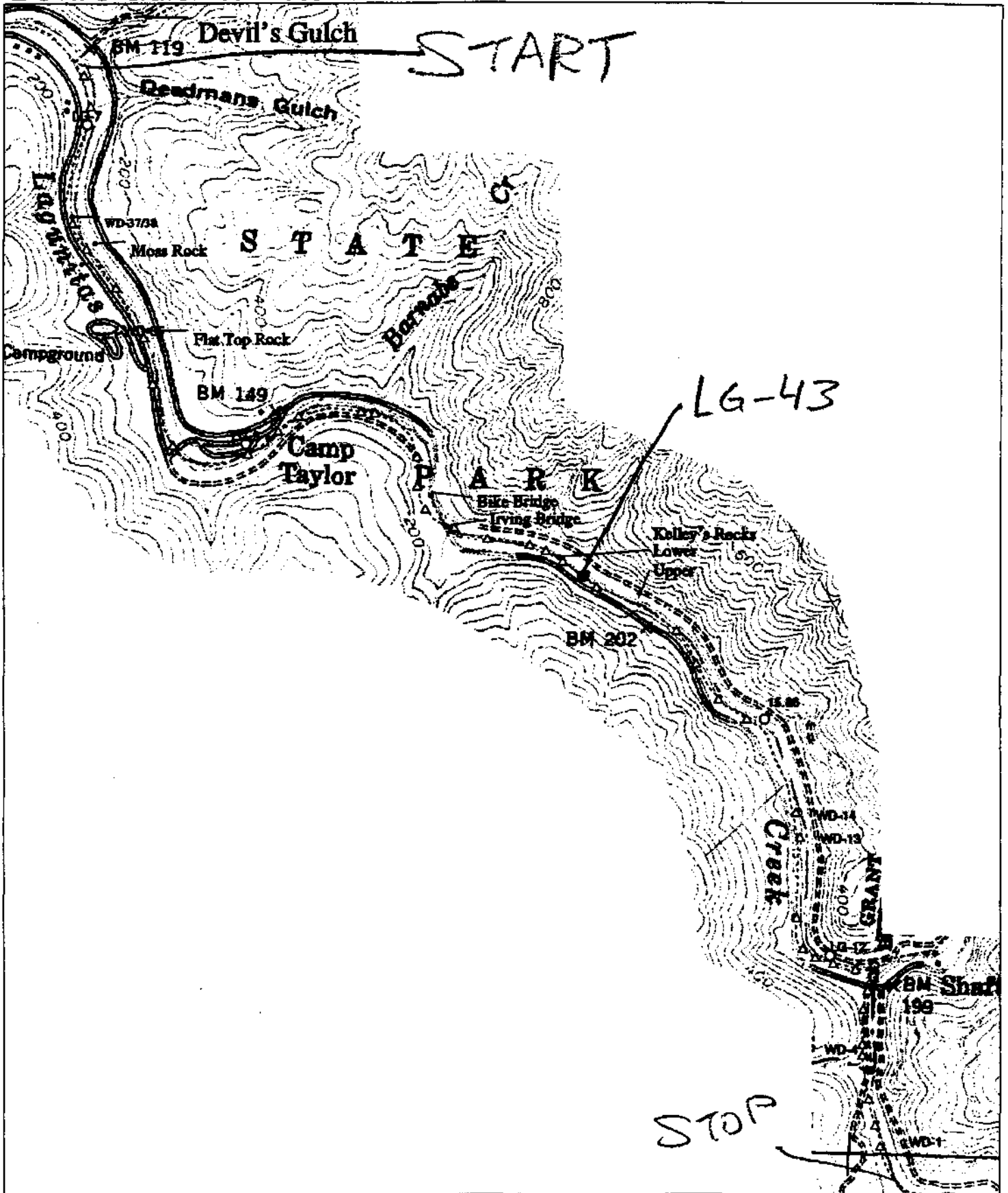
Coho Spawner Survey Tocaloma to Devil's Gulch

Date: Dec 28 00



Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 5-JAN-04



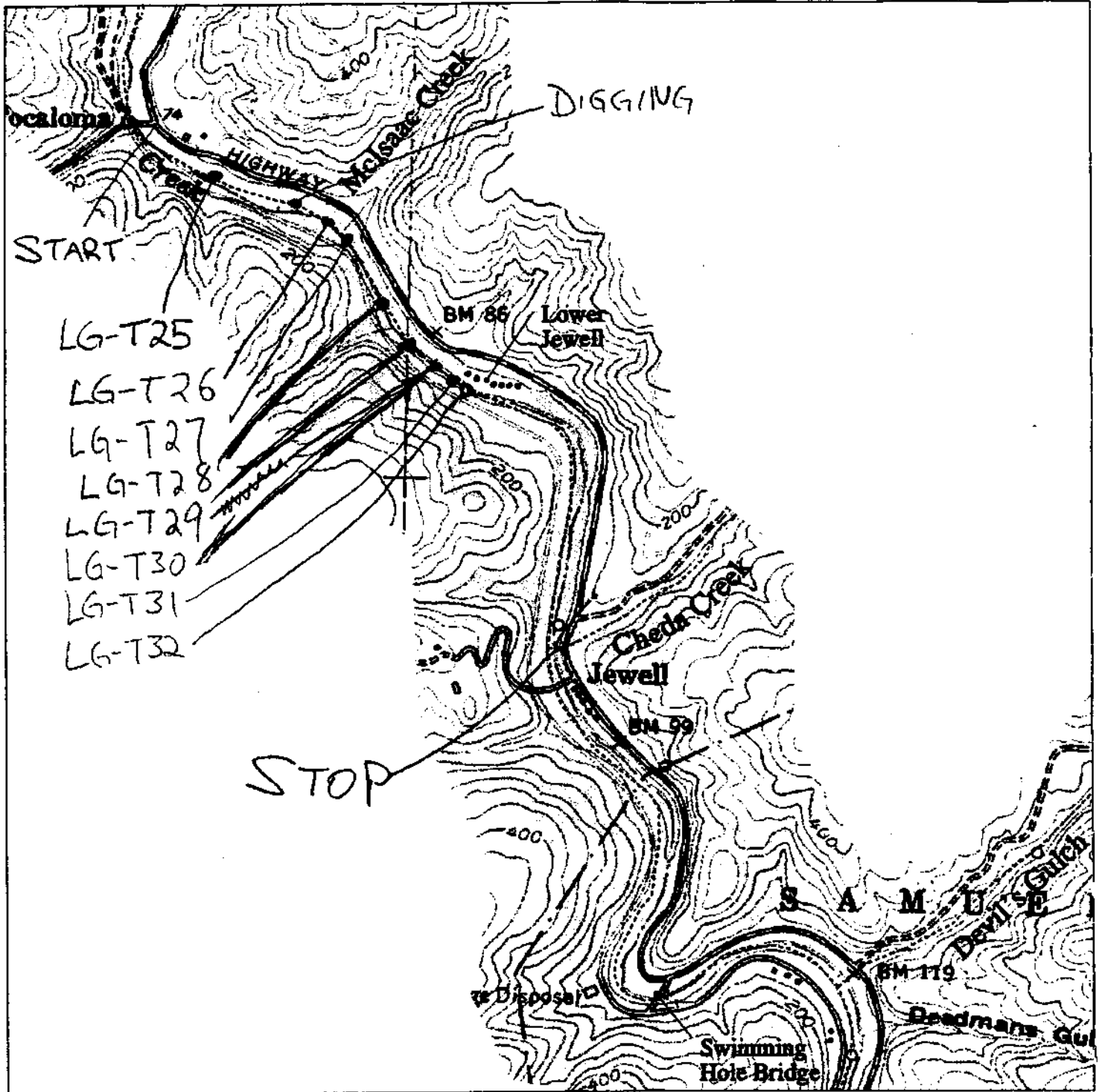
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Coho-Spawner Survey Tocaloma to Devil's Gulch

Date: 10-JAN-01



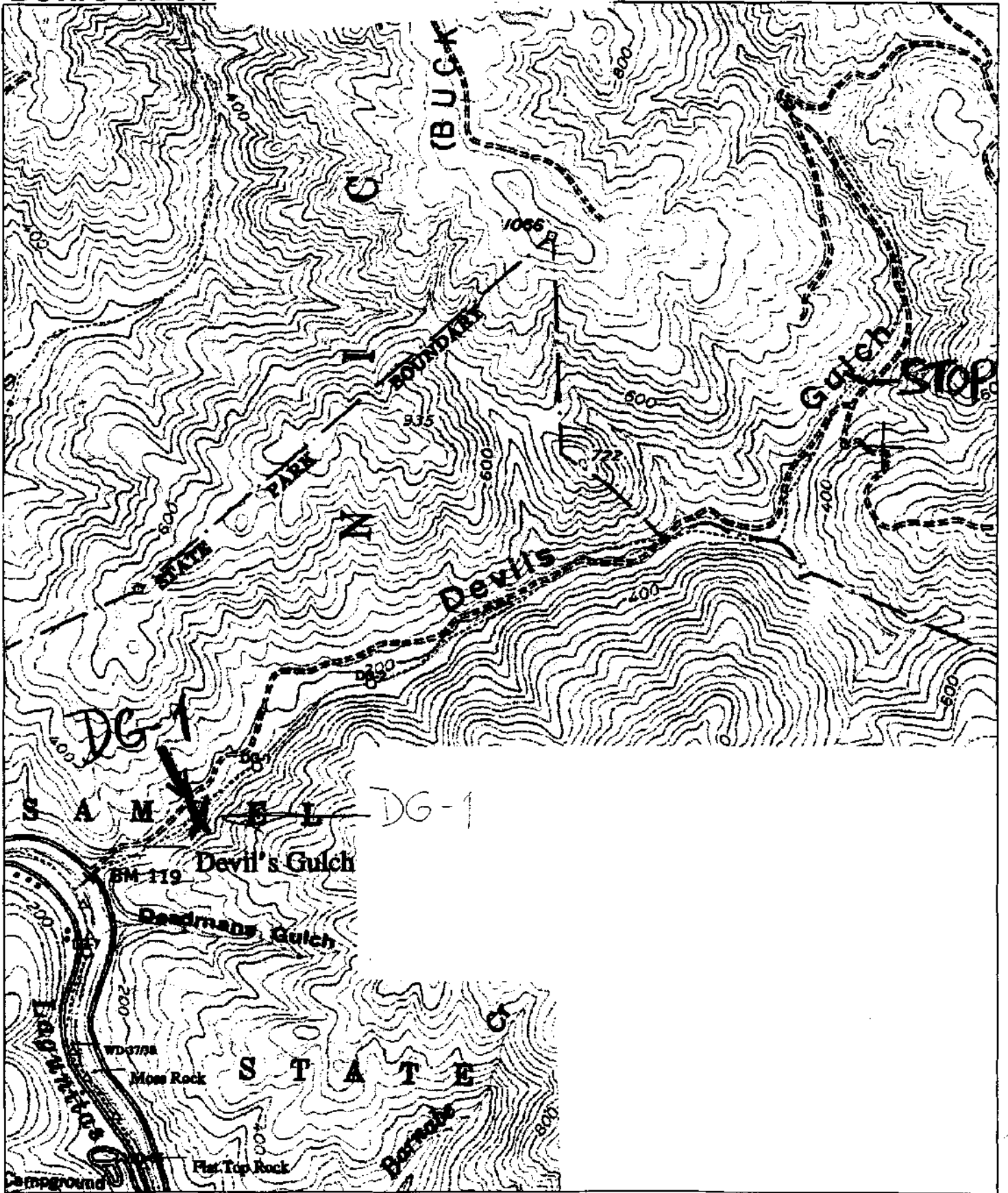
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Coho Spawner Survey
Devil's Gulch

Date: 11 JAN 01



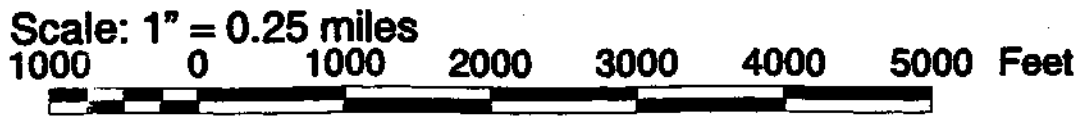
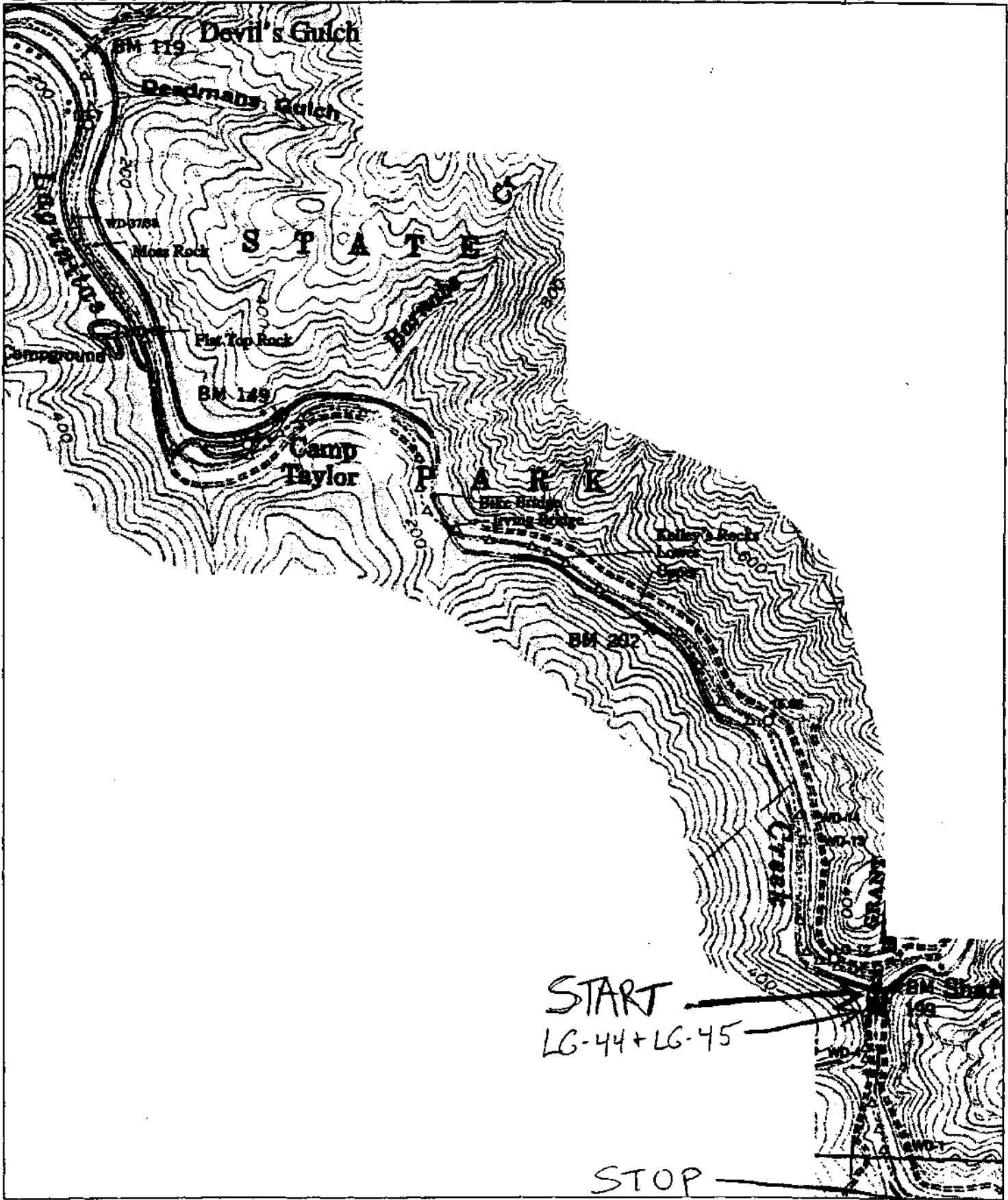
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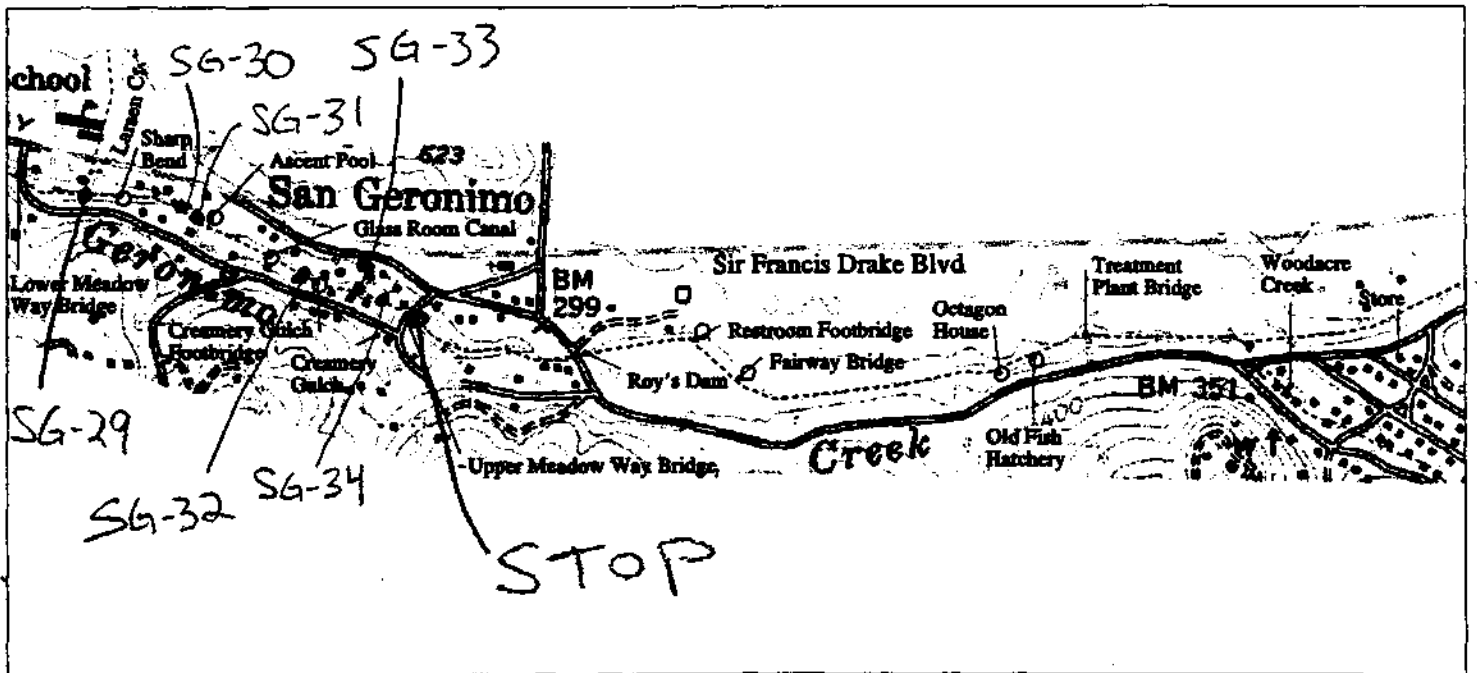
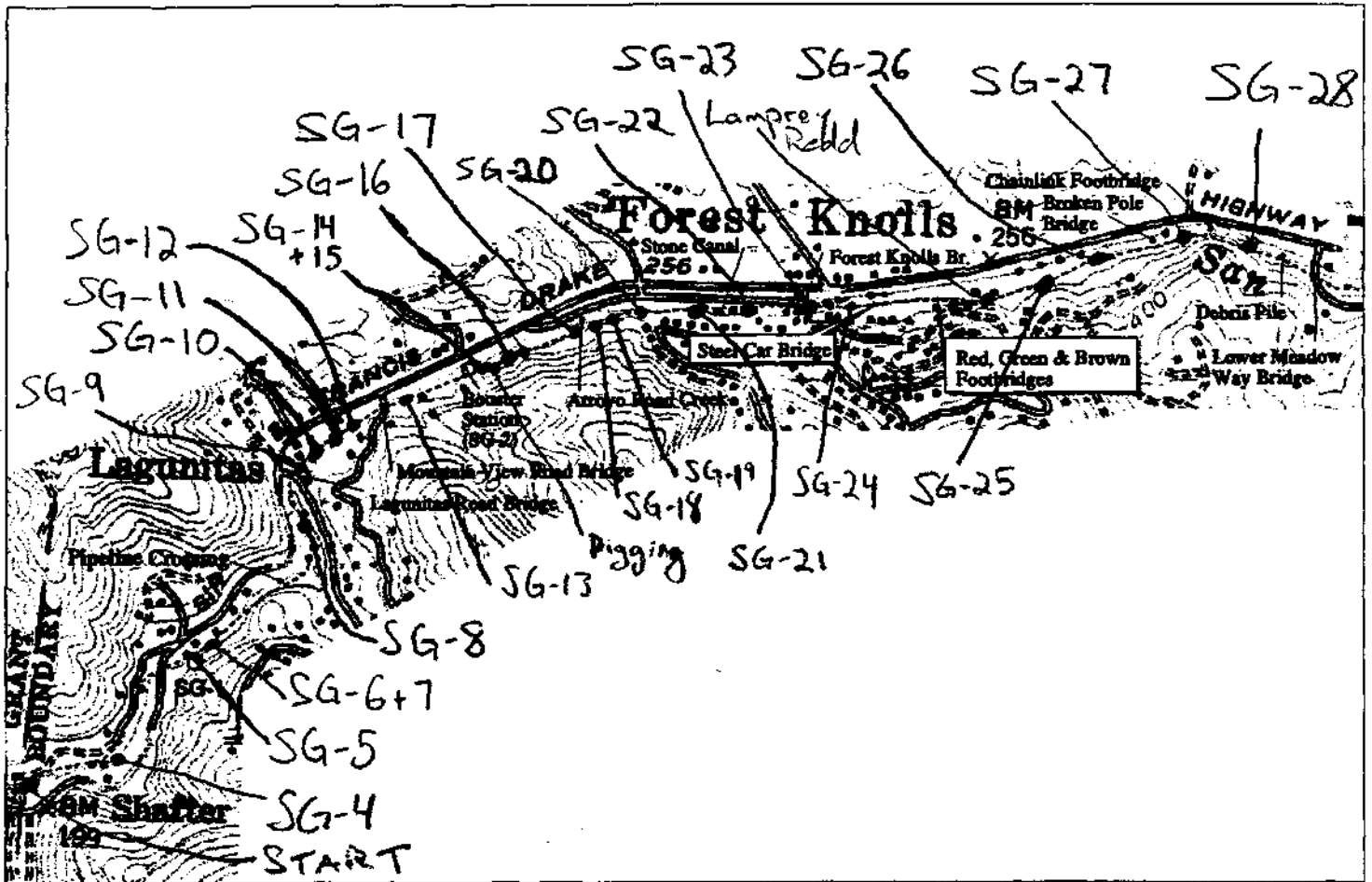
Coho Spawner Survey
Devil's Gulch to Peter's Dam

Date: 11-JAN-0



Coho Spawner Survey San Geronimo Creek

Date: 16-JAN-01

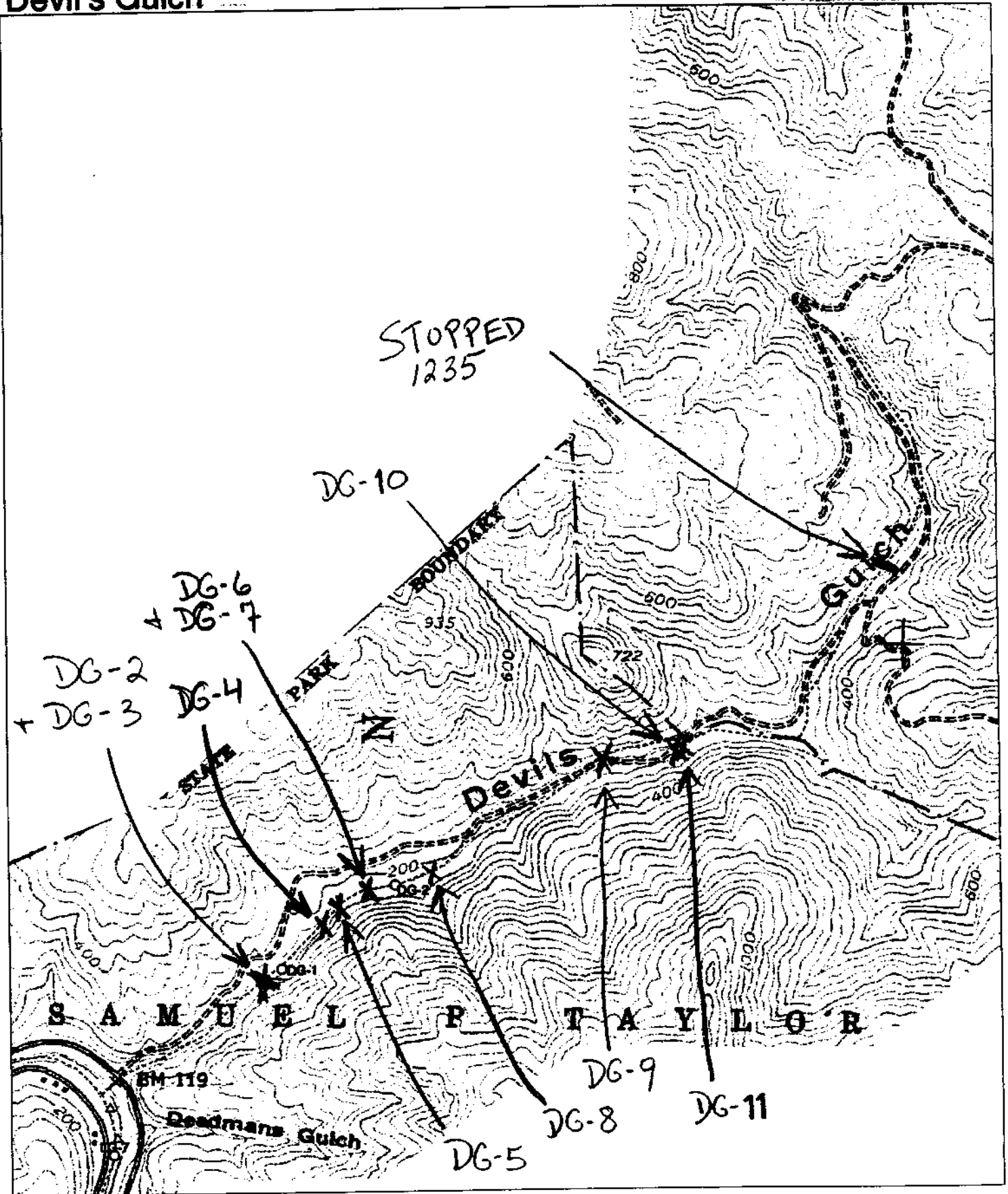


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Coho Spawner Survey
Devil's Gulch

Date: 17-JAN-01



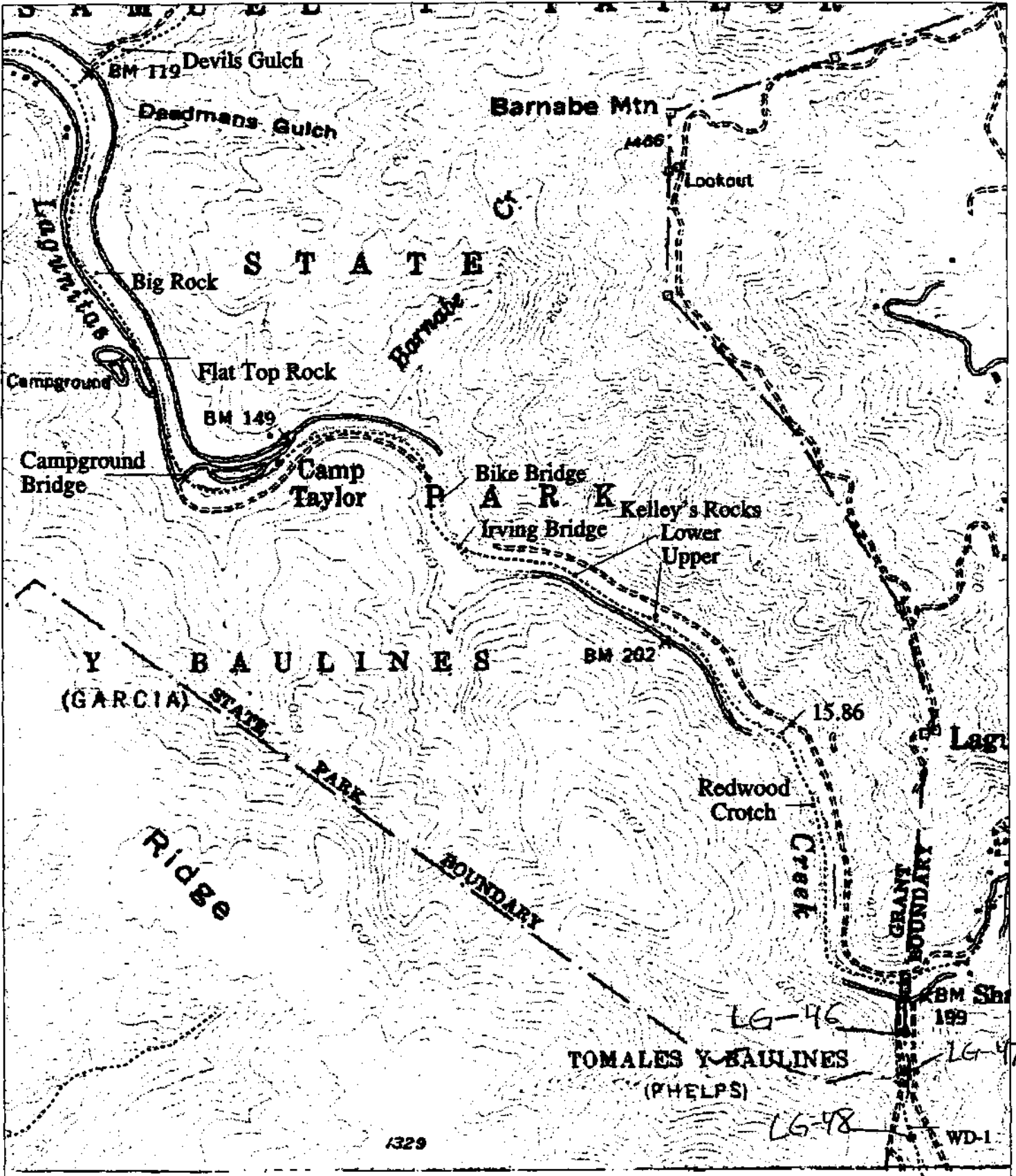
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Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 17-JAN-01

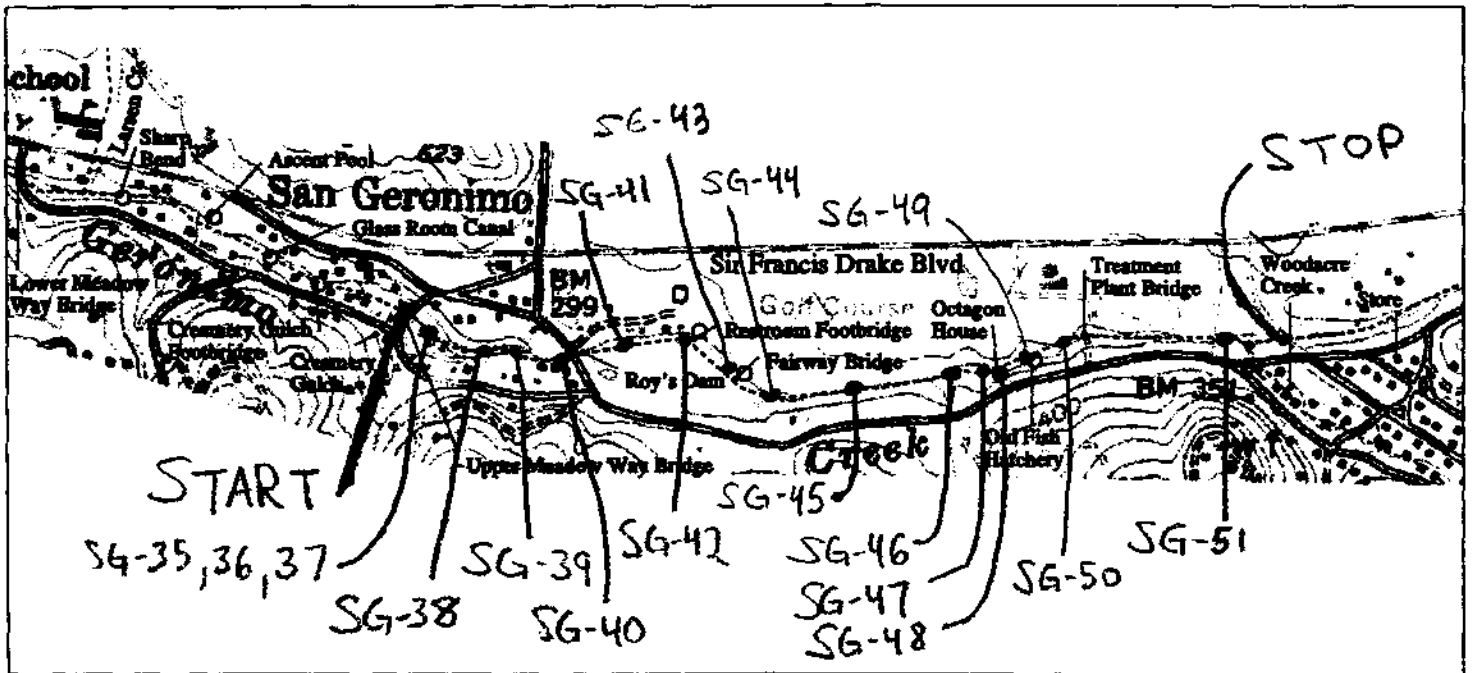
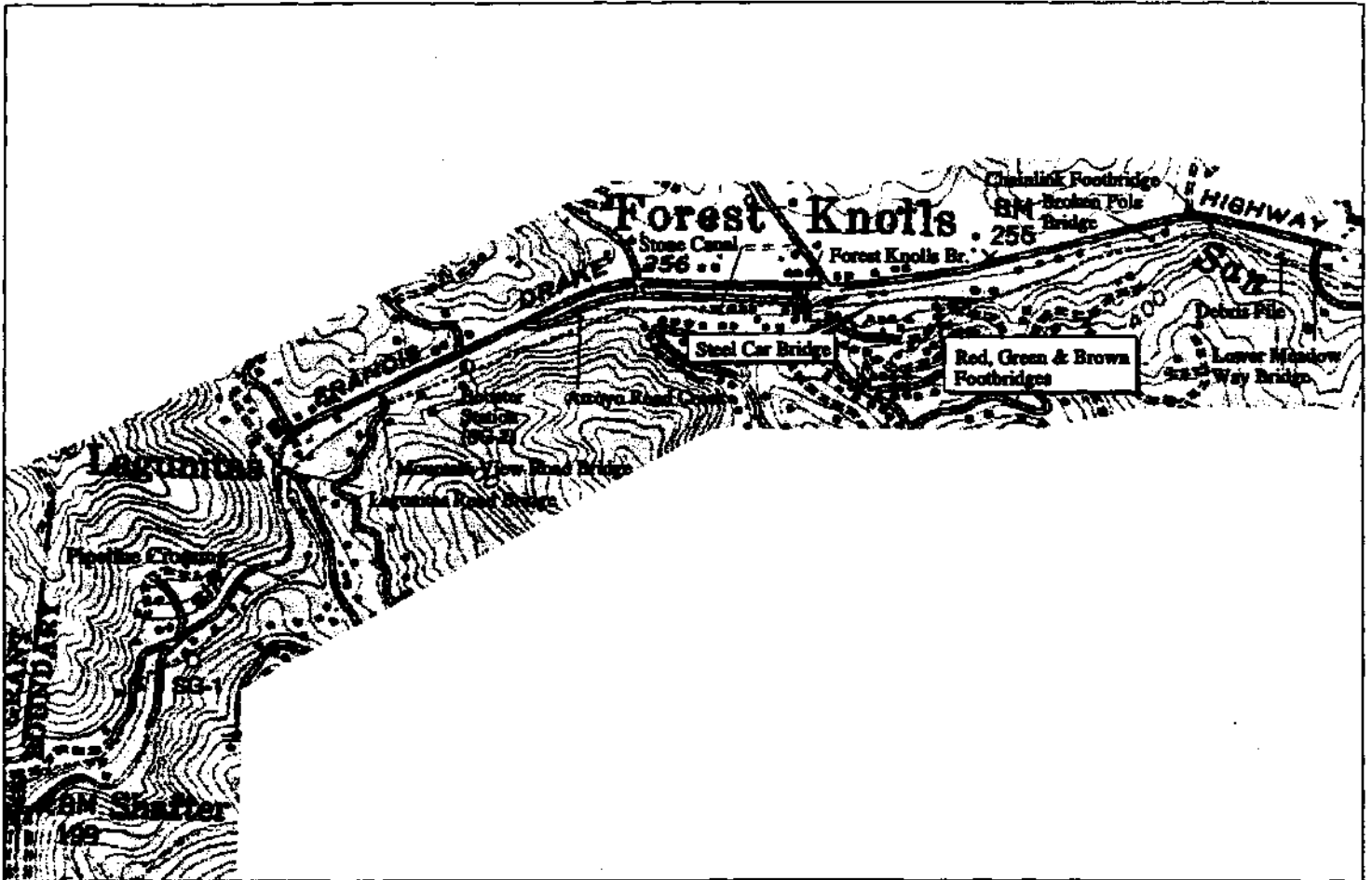


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Coho Spawner Survey San Geronimo Creek

Date: 17-JAN-01



Scale: 1" = 0.25 miles

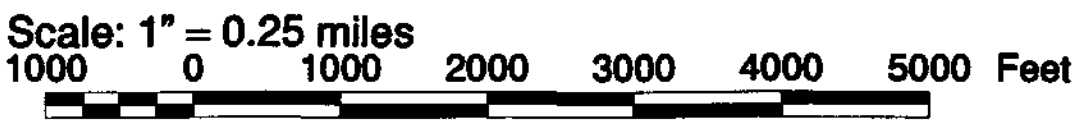
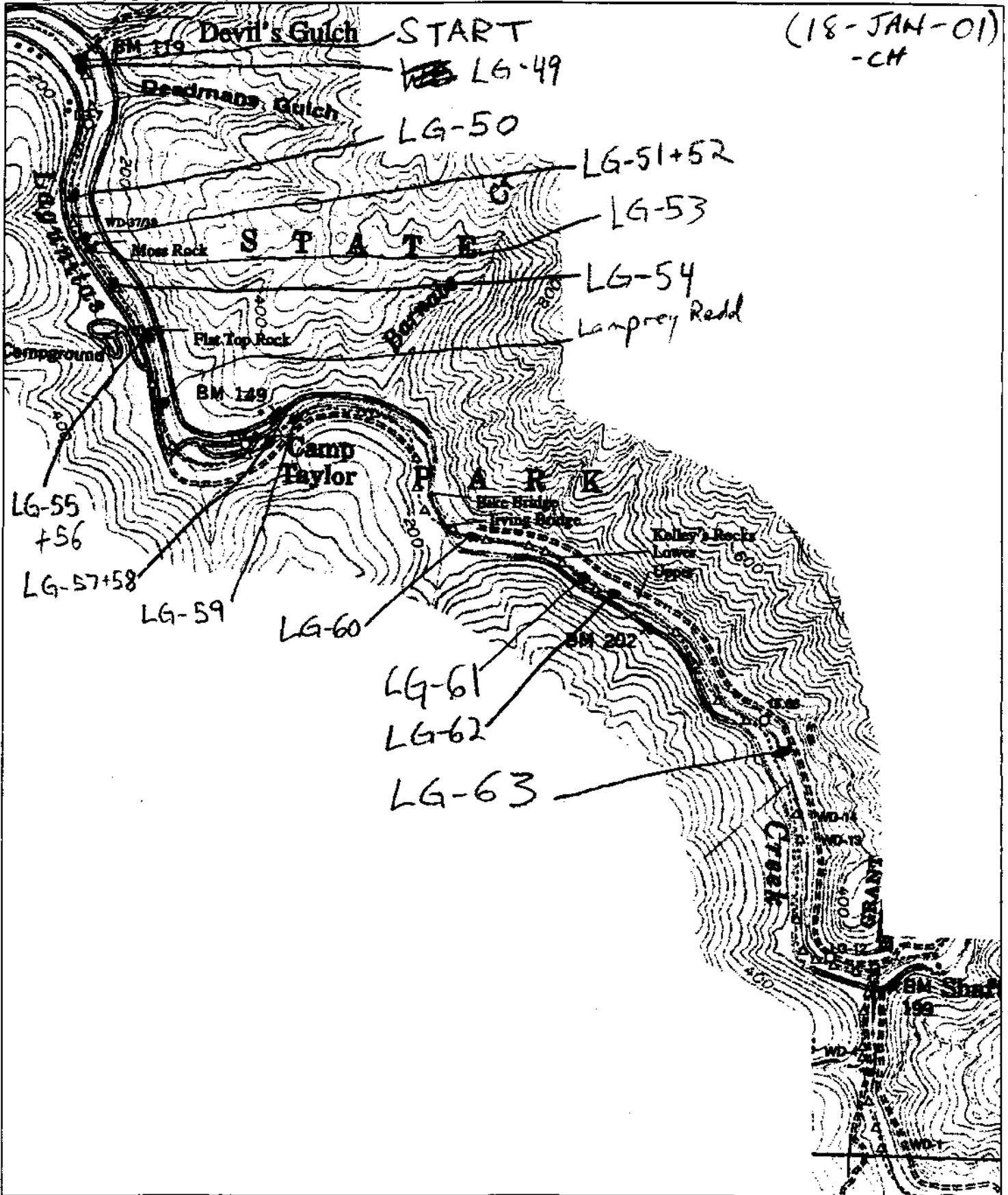
1000 0 1000 2000 3000 4000 5000 Feet



Coho Spawner Survey Devil's Gulch to Peter's Dam

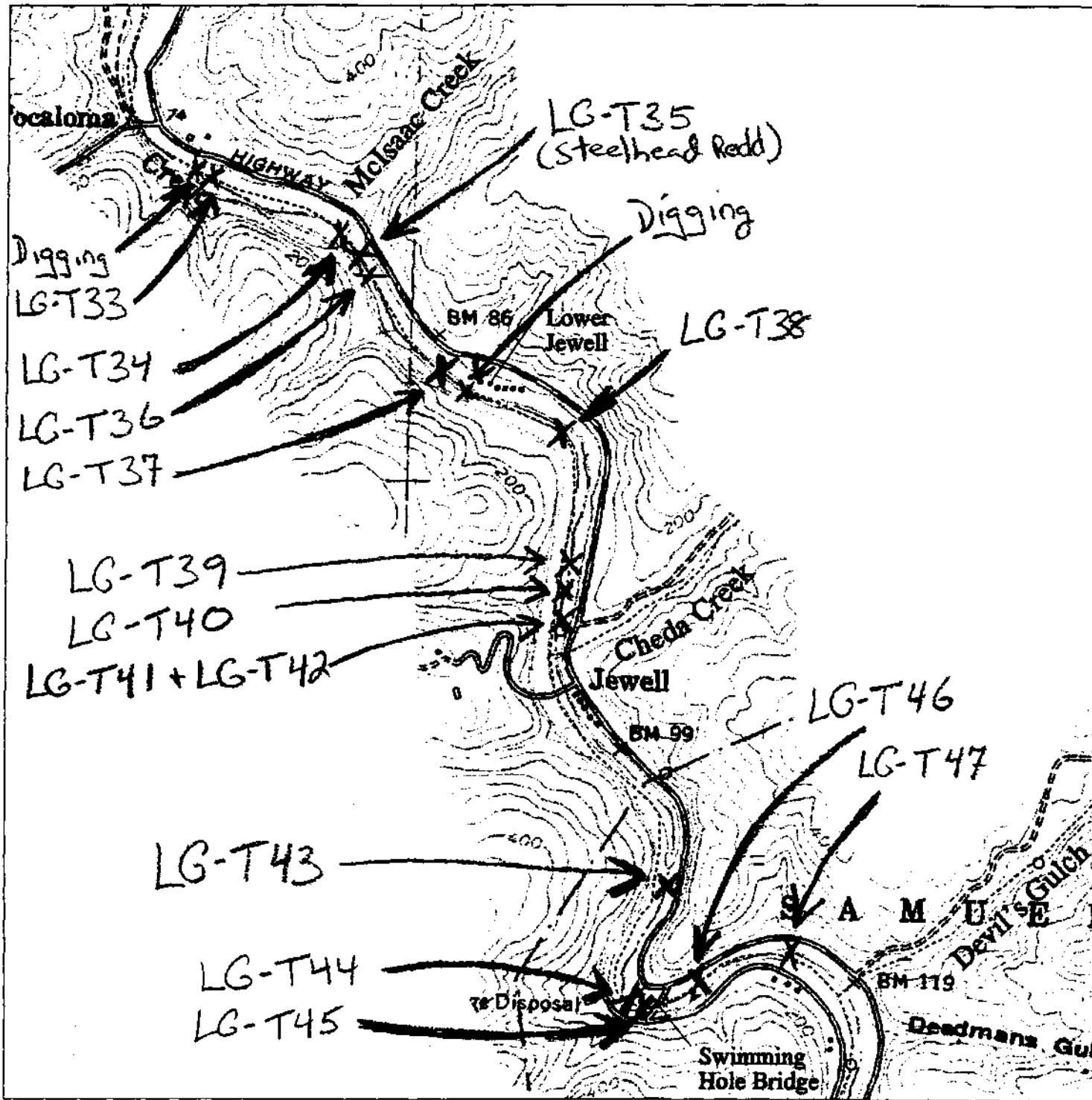
Date: 18-DEC-01

(18-JAN-01)
-CH



Coho Spawner Survey Tocaloma to Devil's Gulch

Date: 18-JAN-01



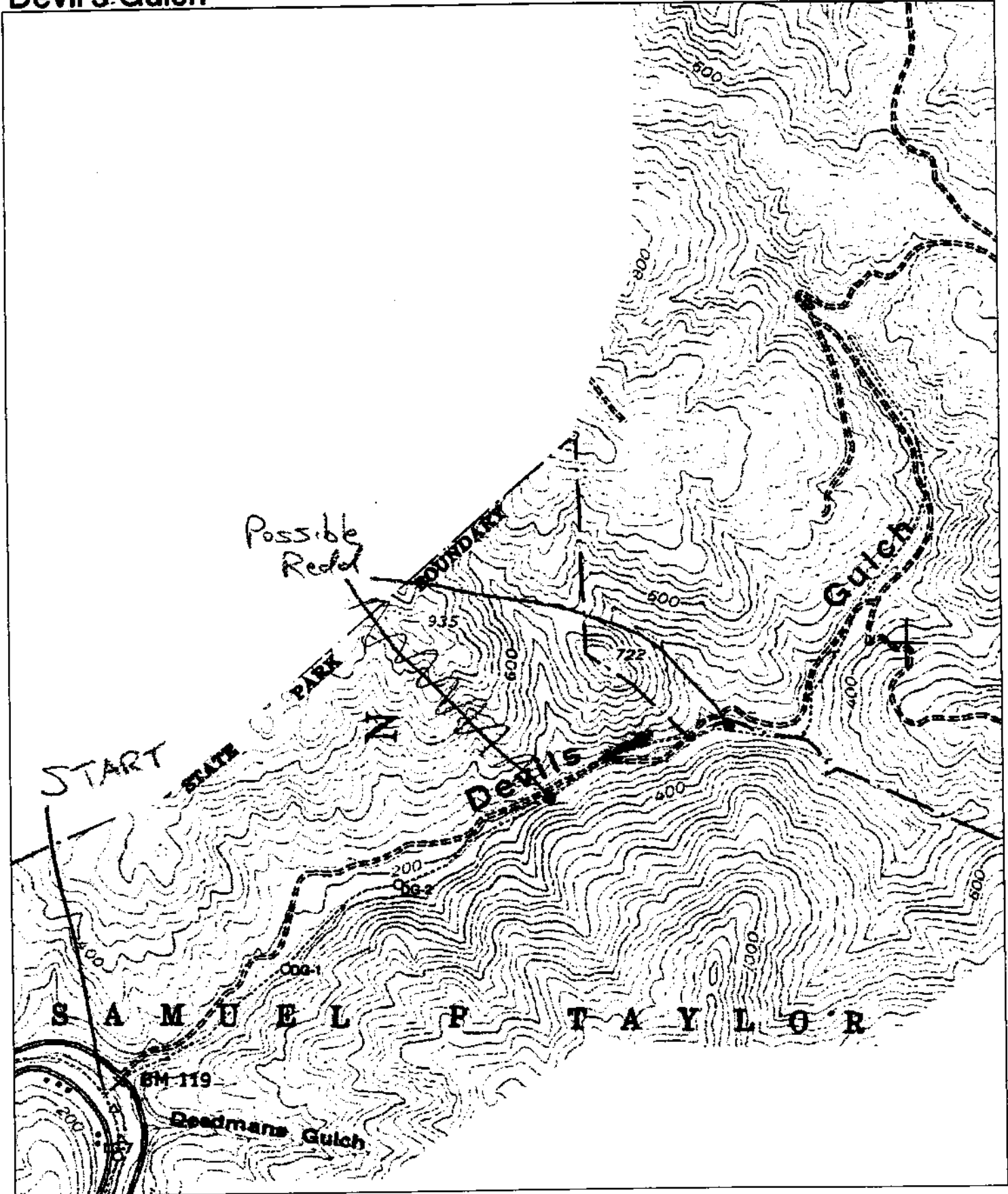
Scale: 1" = 0.25 miles

1000 0 1000 2000 3000 4000 5000 Feet



Coho Spawner Survey
Devil's Gulch

Date: 24 JAN-01

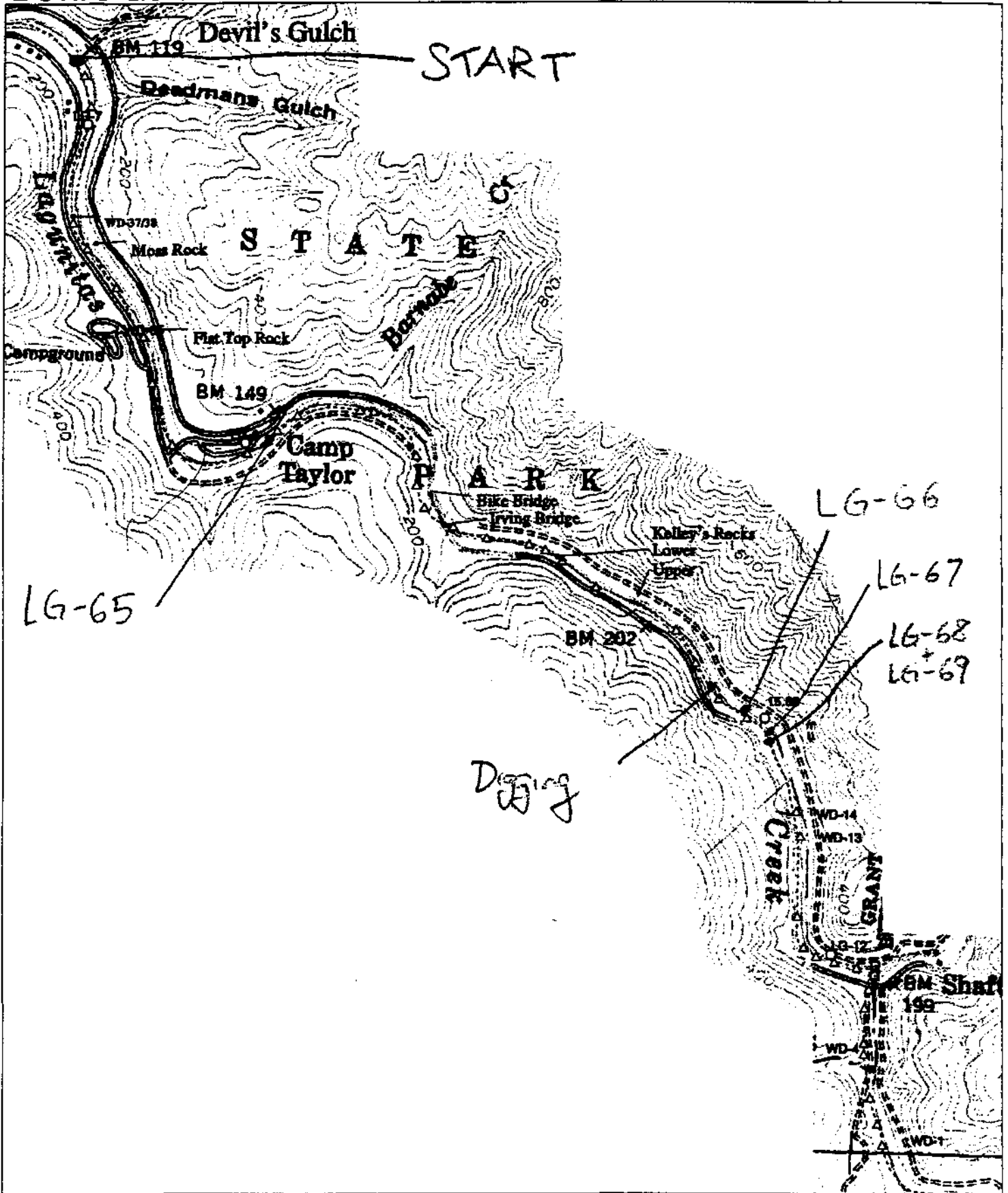


Scale: 1" = 0.25 miles
1000 0 1000 2000 3000 4000 5000 Feet



Coho Spawner Survey Devil's Gulch to Peter's Dam

Date: 30-JAN-01

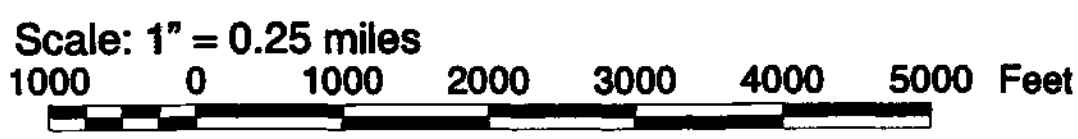
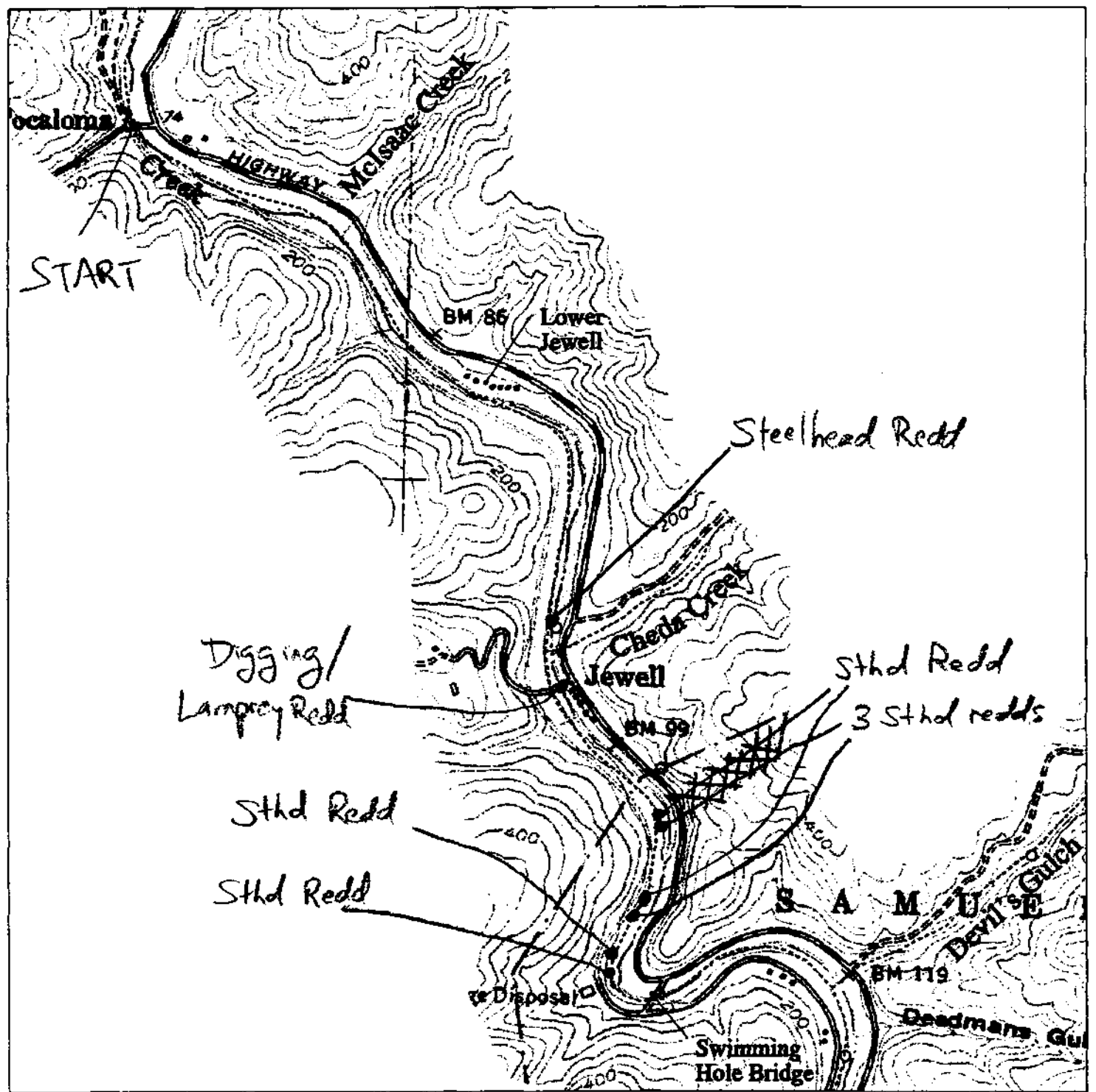


Scale: 1" = 0.25 miles
1000 0 1000 2000 3000 4000 5000 Feet



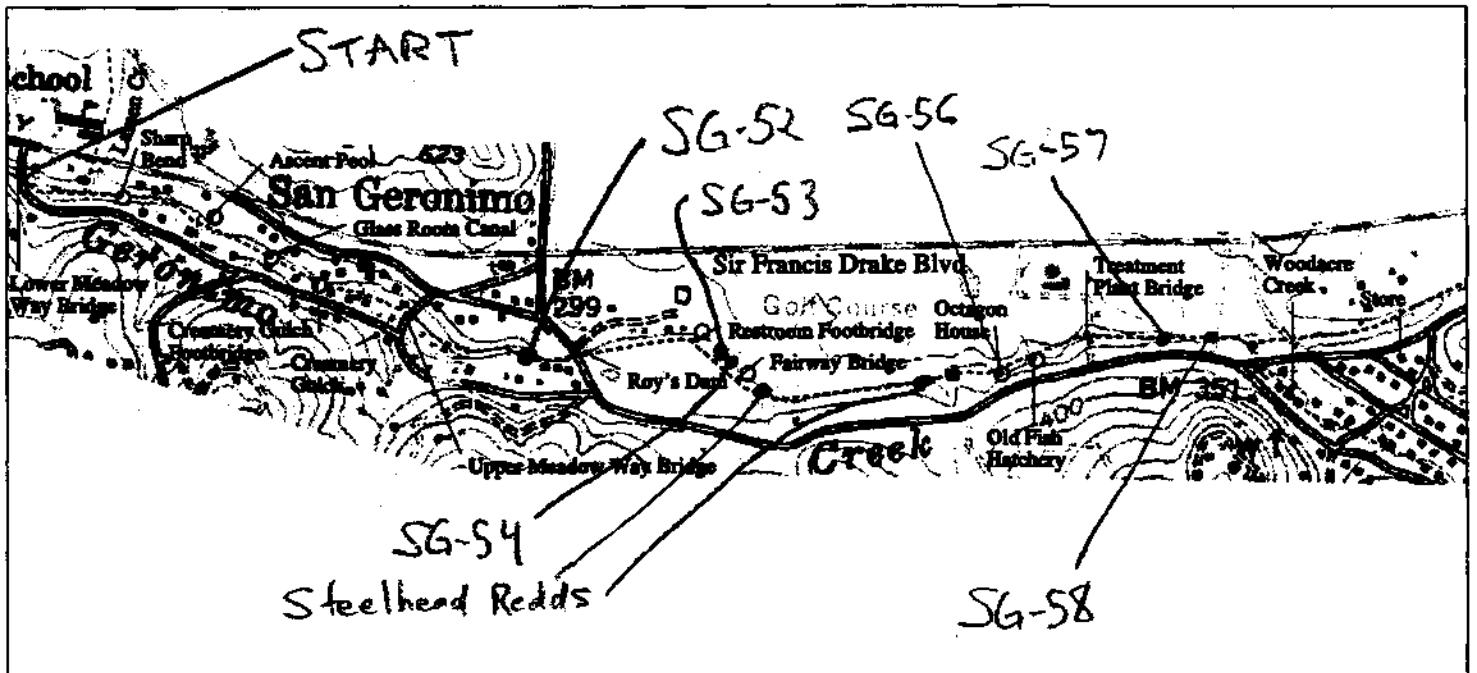
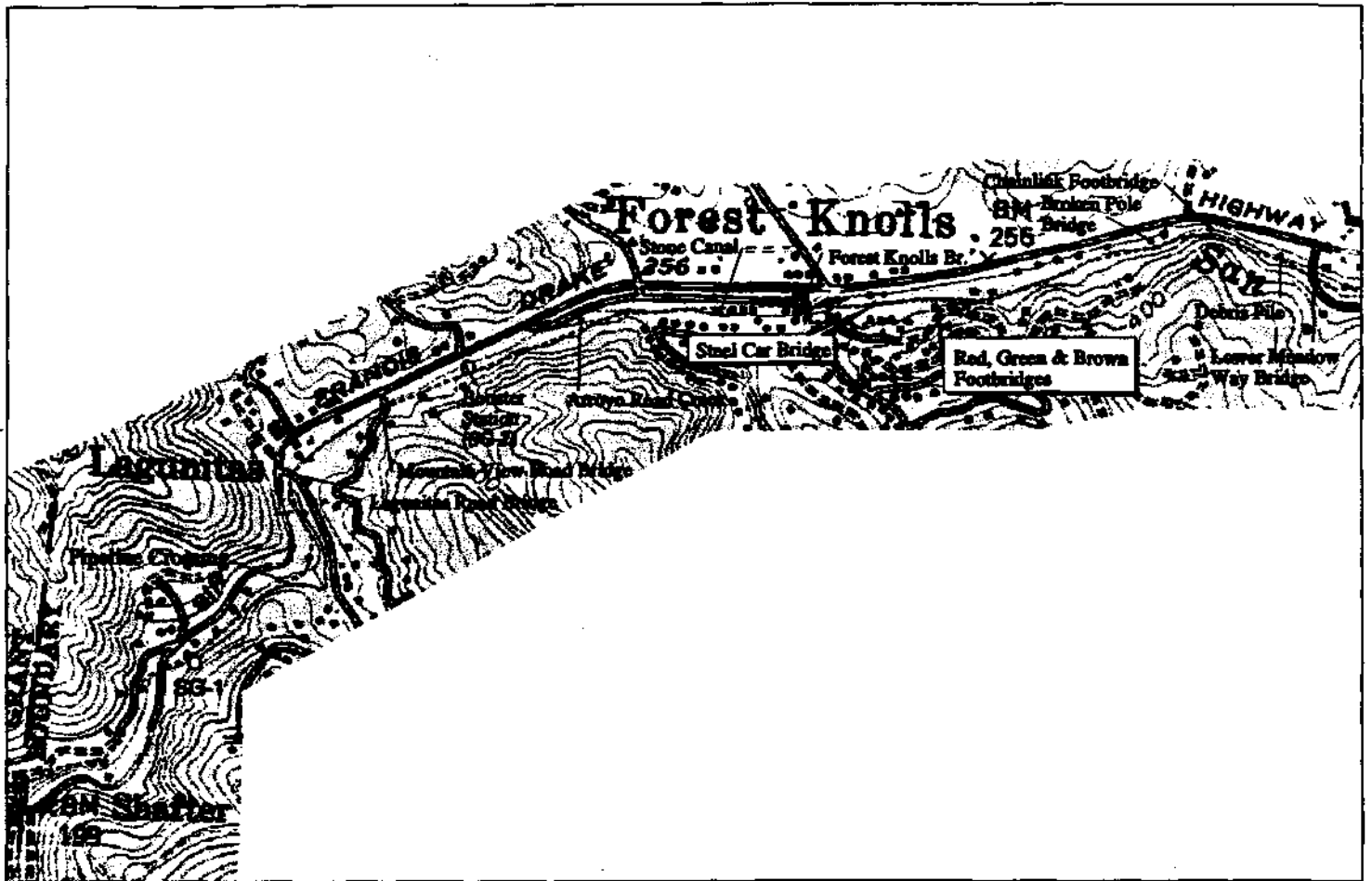
Coho Spawner Survey
Tocaloma to Devil's Gulch

Date: 31-JAN-01



Coho Spawner Survey San Geronimo Creek

Date: 1-FEB-01



Scale: 1" = 0.25 miles



Coho Spawner Survey
Devil's Gulch

Date: 2-FER-01

