DISTRIBUTION AND ABUNDANCE OF JUVENILE COHO AND STEELHEAD IN GAZOS, WADDELL AND SCOTT CREEKS IN 1999

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ABSTRACT: In September and October 1999 previously sampled representative sites on Gazos Creek and Waddell Creek and in the Scott Creek watershed were evaluated for habitat conditions and sampled by electroshocker to assess distribution and abundance of steelhead and 1999 year class coho.

On Waddell and Scott creeks the 1998 gains in pool frequency and complexity from wood added by the severe 1998 storms persisted through 1999. Overall habitat conditions were similar to 1998, although heavy 1999 storms did significantly rearrange some of the individual habitats at sample sites. On Gazos Creek the channel and substrate conditions had recovered from 1998 storm damage and inchannel work. Heavy 1999 storms had moved sediment associated with the 1998 log jams and rearranged some of the habitats, but pool frequency and depth were similar to that seen at sample sites in 1992-1997 and up and downstream of 1998 inchannel work sites. Largescale removal of new large inchannel wood in 1998 prevented the substantial gains in pool frequency, depth and complexity that occurred on Waddell and Scott creeks in 1998 and 1999. The limited 1998 restoration work provided only very modest habitat improvement.

Spawning coho should have been abundant on all three streams in 1999, but juvenile coho were abundant only in Scott Creek. On Waddell Creek coho were common on the West Fork. However, they were scarce on the flood-prone East Fork, and may also have been scarce downstream of the forks prior to a severe summer fish kill. On Gazos Creek coho were relatively abundant between miles 4.4 and 5.3, but were very scarce elsewhere. Scott Creek coho were abundant, except in flood-prone Big Creek and on Scott Creek downstream of Big Creek; overall coho density on Scott Creek was similar to the high densities of 1993 and 1996.

Young-of-year steelhead densities were similar to those in years with similar stream flows for Gazos and Scott creeks and for Waddell Creek upstream of the fish kill. As previously observed on Scott Creek, steelhead abundance in pools appeared to be depressed by abundant coho. The fish kill on Waddell Creek reduced overall steelhead density by more than one-half. Yearling densities on all 3 streams were relatively low, possibly reflecting smolting by yearlings due to good growth in summer 1998 and spring 1999.

Observed mortality of electroshocked fish on the 3 streams averaged 0.4%, with coho and yearling steelhead mortality somewhat lower than that of young-of-year steelhead.

INTRODUCTION

Since all wild female southern coho (Oncorhynchus kisutch) spend one year in the stream and two years in the ocean prior to spawning (Shapovalov and Taft 1954), at least three consecutive years of study are necessary to determine the status of the three numerically independent year classes. In addition, several 3 year cycles need to be examined to determine natural variation within year classes. This report presents results of the eighth consecutive year of sampling for juvenile coho and steelhead on Scott, Waddell and Gazos creeks in September through October 1999. Sampling in 1999 provided an opportunity to evaluate the effects of late and moderately heavy winter storms in 1999 and of supplemental stocking of hatchery-spawned 1996 year class coho fry and smolts in Gazos and Waddell creeks.

Previous surveys of Scott and Waddell creeks (Santa Cruz County) in 1988 and 1992-1998, Gazos Creek (San Mateo County) in 1992-93 and 1995-8, and Redwood Creek (Marin County) in 1988 and 1992-1997 have shown wide year-to-year variation in coho abundance within streams (Smith 1992, 1994a, 1994b, 1994c, 1995a, 1995b, 1996a, 1996b, 1997, 1998c; Smith and Davis 1993). These wide coho abundance differences occur because the restricted spawning period, single spawning attempt, and rigid ages of smolting and spawning (Shapovalov and Taft 1954) make them susceptible to drought, floods or other "disasters" within small watersheds (Smith 1994c). For example, Redwood Creek in Marin County had very strong coho year classes in 1992, 1993, 1995 and 1996, but the 1988 and 1994 year classes were less than 5 percent as large (Smith 1996), apparently reflecting impacts to that three year brood cycle during or prior to 1988. The year class naturally rebounded to one-half strength in 1997 (Smith 1997). Steelhead (O. mykiss), however, have extended spawning periods, can spawn more than once, and are variable in ages of smolting and maturation (Shapovalov and Taft 1954). Therefore, steelhead juvenile abundance is more likely to indicate yearly rearing habitat conditions, and populations are less affected by, and will recover quickly from, bad years.

Previous electroshock sampling on Scott Creek found strong juvenile coho year classes in 1988, 1993 (January 1994 sampling) and 1996, but very weak year classes in 1992 and 1994 (Smith 1992, 1994a, 1994c, 1996b). In 1995 and 1997 coho abundance rebounded from the 1992 and 1994 lows, apparently due to spawning by precocial (2 year old), hatchery-reared females (Smith 1995b, 1998a). However, the 1998 juvenile coho year class was again severely weakened by severe El Nino winter storms (Smith 1998c).

Previous sampling on Waddell Creek found weak year classes in 1988, 1992 and 1995, a stronger year class in 1993 and 1996, but no apparent juvenile coho production in 1991, 1994 or 1997 (Smith 1994c, 1998a). Gazos Creek has previously shown coho abundance patterns similar to Waddell Creek (Smith 1996b, 1998a). Both

streams suffered severe winter storm impact in 1998 and had extremely weak year classes (Smith 1998c).

All three streams should have had abundant spawning coho in 1999, due to a combination of good wild production in 1996 and hatchery-spawned fry supplementation in summer 1996 and smolt supplementation in spring 1997.

METHODS

In October 1999 eleven previously-sampled Scott Creek watershed sites were sampled by electroshocking (Table 1). The sites above and below the hatchery on Big Creek were combined as one site for the analyses. Three sites not resampled, on upper Scott Creek (mile 6.5) and on middle Scott Creek (miles 3.05 and 4.25), were excluded because of time constraints; their omission would not have affected overall densities, as the upper site probably had significantly lower densities and the other two sites higher densities than the watershed average. In October ten previously-sampled sites on Waddell Creek were sampled (Table 2). As in 1998, Henry Creek, West Fork Waddell Creek downstream of Henry Creek and the East Fork near Last Chance Creek were not resampled, because of time constraints and difficult access. In September and October seven previously sampled and two new (2B and 3A) Gazos Creek sites were sampled (Table 3). Site 2, which had been sampled since 1992 was excluded due to time constraints and the unliklihood of coho presence. Sampled habitats were changed substantially at 2 sites (sites 4 and 7).

At resampled sites on each stream the same habitats were resampled in most cases. However, the winter storms had modified some habitats, so similar replacement stations were substituted. The length of stream sampled per site was similar to previous efforts in 1992-1998 (Table 4), except for reduced sampling on the main stem of Waddell Creek due to the fish kill. Habitats sampled in 1999 included more pool habitat than most previous efforts, even though most of the same habitat units were sampled. This was because the amount of wood and scour was substantially increased at many sites in 1998 and maintained in 1999, so the amount of pool habitat available and sampled was increased (Table 4). On Gazos Creek the amount of riffle and run habitat sampled was also reduced in 1999 because of the unlikelihood of coho in such habitats; habitat sampled was more similar to Waddell and Scott creeks in 1999 (Table 4).

The primary goal of the sampling by electroshocker was to look for the presence and abundance of coho, so sampling since 1992 has concentrated on pool and glide habitats, and riffles were seldom sampled. At each site usually three to five individual habitat "units" (a glide or pool, with its contiguous glide and run habitat) were blocknetted and sampled by 2 to 3 passes with a backpack electroshocker (Smith-Root Type 7, smooth pulse). Population density was estimated for each species and year class

by the decline in capture with successive passes. Sampled habitats were representative of those available, except for Waddell Creek, where large, deep pools on the main stem could not be sampled by electroshocking. Length, width, depth, cover (escape and overhead), and substrate conditions were determined, and percentage of habitat types assigned for each habitat unit. Rosgen channel type was determined, and relative abundance of pool, glide, run and riffle habitat types was also estimated for the vicinity of each site (Tables 1-3).

Juvenile fish were measured (standard length, SL) in 5 mm increments, and young-of-year (YOY) steelhead were separated from older fish, based upon length-frequency at each site. Holdover hatchery steelhead could be identified by fin clips and/or worn, short dorsal fins, but none were captured in 1999. Mortality was kept to a minimum by reducing electroshocker voltage in shallow water and immediately placing captured fish in a floating live car. Mortality was recorded at the time of length measurements.

A small portion (2 x 2 mm) of the caudal fin was taken from a portion of the captured coho. Fin tissue was placed in folded chromatography paper and stored in scale envelopes; the samples were air dried for several days and returned to the envelopes for final storage. Samples will be transferred to the Bodega Marine Laboratory for archival and genetic analysis.

RESULTS AND DISCUSSION

Habitat Conditions in 1999

Winter flows were delayed until late January in 1999, but heavy flows in late January and February rearranged some of the sampled habitats. Individual habitats were scoured or partially filled, but the abundance of habitat types did not appreciably change at sampled sites on the three streams between 1998 and 1999. On Scott and Waddell creeks 1998 storms increased pool abundance 12-13% and pool depth at 36-50% of sample sites (Smith 1998c). More significantly, complex pools associated with downed trees or log jams were increased 75-79% on those two streams. These increases in habitat preferred by coho and yearling steelhead were maintained in 1999, although much of the wood had rearranged within the channel. Backwater and secondary channel habitats, which first appeared in 1998, were also still present in 1999.

On Gazos Creek most of the large added wood in 1998 was cut and removed at logjams and downed alders by contractors for San Mateo County. Pool frequency and the number of woody pools was increased at resampled sites in 1998, but pools were still less common than on Scott and Waddell creeks (Smith 1998c). Winter storms in 1999 removed sediment deposited at 1998 log jam sites, and 1999 conditions appeared to be similar to those occurring prior to 1998 at sample sites and to conditions immediately upstream and downstream from 1998 work sites. The net effect of

wood removal in 1998 was to eliminate substantial potential gains in woody pool frequency, depth and complexity associated with at least 6 log jam sites (sites G, H, J, N, Q and U) and also to eliminate numerous smaller potential habitat gains by cutting downed or leaning alders. If downed wood had been left in place or key portions of jams moved rather than cut and removed, habitat on Gazos Creek could have been substantially improved in 1998 and 1999. Phase I restoration work in 1998 at sites G/H, Q and U provided some bank protection and improved pool depth and cover, but produced limited complex coho habitat because of the lack of available large wood (1-2 times as long as bankfull channel width) that could extend into the channel.

Juvenile Coho

The relatively strong 1996 coho year class was supplemented with hatchery-reared fry and smolts, so spawning adult coho should have been common on all three streams in 1999 (Smith 1996b). However, access to the streams was delayed until the late January storm, so there may have been some predation loss among adults that waited an additional month in the ocean. In addition, the late January and February storms were probably large enough to destroy many redds of fish which spawned quickly after gaining access to the streams. On Gazos Creek redd loss among quickly spawning fish may have been more severe, because the first storms would have mobilized the large amount of streambed gravel deposited at 1998 log jam sites.

Scott Creek. In the Scott Creek watershed juvenile coho were abundant (22-86 fish / 100 feet) in Mill Creek and on Scott Creek upstream of Big Creek (Table 1). They were relatively scarce (0-7 / 100 feet) on Big Creek and on Scott Creek downstream of Big Creek. Big Creek experiences large flood peaks in most years, and often has few coho, even when they are abundant elsewhere in the watershed (such as in 1993, 1995 and 1997 (Table 6)). The effect of winter storms usually extends to Scott Creek sites downstream of Big Creek, which had high coho densities only in 1996, when hatchery-reared fry were planted on lower Scott Creek (Table 6).

Overall coho densities in 1999 (29.2 / 100 feet) were similar to those of 1993 (27.2) and 1996 (33.0) (Table 4), and appear to be near the limit of present watershed production.

Similar to results from other years (Smith 1998c), coho were relatively small in upper Scott Creek, which is densely shaded, and in Mill Creek, which is well-shaded and has low summer flows (Figure 1). Coho were relatively large in Big Creek and on Scott Creek downstream of Big Creek, where summer flows are greater (Figure 1). Coho in the middle portion of Scott Creek were similar in size to fish from 1996 and 1997, when summer flows were similar, but smaller than in 1998 when summer flows were

relatively high (Figure 4). Coho were larger than YOY steelhead from the same habitats (Figure 1).

Waddell Creek. In 1999 juvenile coho were captured only on the East and West Forks (Table 2). Densities at the four sites with coho were about half of those for the same sites in 1996 (Table 7), when access was earlier and winter storms were milder.

A fish kill eliminated most fish downstream of the forks early enough in summer for insect populations to recover by the time of October fish sampling, but some coho were observed downstream in early summer. However, coho were probably not common on the main stem at the time of the kill. Few coho were captured at the East Fork site, and none were captured immediately downstream of the forks (site 6b) and above the apparent start of the fish kill at Camp Herbert (site 6A) (Table 2). In previous years of large winter storms (1992 and 1995) coho have been absent on the East Fork and mostly absent from the main stem, except for the two sites immediately downstream of the forks (Table 7). In milder years (1993 and 1996) coho have been more common on the main stem of Waddell Creek (Table 7), indicating that summer rearing habitat is suitable for them, but that spawning and fry survival are poor in wet years. In 1996 coho were common in the main stem, but hatchery-spawned fry were planted there, so the abundance of wild-spawned fish could not be determined.

Coho from Waddell Creek were slightly larger than coho from most Scott Creek sites (Figures 1 and 2), which may have been due to much lower coho densities on Waddell Creek. Coho were also larger than YOY steelhead from the same habitats (Figure 2).

Gazos Creek. Most (72 of 79) captured coho on Gazos Creek were at the three sites from miles 4.4 to 5.3, with the highest density at mile 5.3 (the upper road crossing) (Table 3). Few were captured between miles 2.8 and 3.9, and none were captured further downstream or where the channel steepened at the uppermost site. High flow backwater habitats were available at the site with the highest coho density, but these nearly-separated habitats were used little by coho during the September and October sampling. At site 3 several large, complex pools lacked coho, possibly because the narrow, entrenched channel at the site produces unsuitably fast flows during winter. However, coho have rarely been captured, and steelhead are usually relatively scarce, downstream of Old Woman's Creek, even though the wider, less-entrenched channel downstream appears more likely to provide high flow refuges.

At restoration sites Q and G/H coho were associated with undercut banks and backwater habitats present prior to the 1998 restoration efforts, rather than with the simple habitat produced by wood placed along the banks.

Coho from Gazos Creek were slightly larger than most Scott Creek

coho (Figures 1 and 3) and were larger than steelhead from the same habitats (Figure 3).

Juvenile Steelhead.

Scott Creek. YOY steelhead abundance on Scott Creek was substantially less than in 1998, but similar to abundance in 1997, when flows were similar. However, combined coho and YOY steelhead site abundances were much more similar between 1998 and 1999, apparently reflecting coho suppression of steelhead densities in pools in 1999 (Table 1 and Smith 1998c). Steelhead abundance in 1999 was much greater than for the drier 1993 and 1996 densities (Table 5), when similarly high coho abundance also appeared to substantially depress steelhead abundance in pools (Smith 1994a and 1996b). Lowest combined steelhead and coho densities in 1999, 1998 and most other years were in Big Creek, Scott Creek downstream of Big Creek and at the heavily shaded site on upper Scott Creek (Table 1 and Smith 1994a, 1996b & 1998c).

As seen for coho, YOY steelhead from shaded upper Scott Creek were smaller than further down on Scott Creek, and fish downstream of Big Creek, where summer flows are higher, were larger (Figure 5). YOY steelhead in Scott Creek downstream of Big Creek in 1999 were similar in size to fish from 1997, when summer flows were similar, but much smaller than in 1995 and 1998 when summer flows were high (Figure 5). In the remainder of the watershed, where summer flows are quite low by mid summer of most years, there did not appear to be substantial differences in YOY steelhead sizes among years (Figure 5).

The relatively low yearling steelhead densities in 1999 (Table 5) may have been due to the high YOY growth in summer 1998, resulting in smolting by many yearlings.

Waddell Creek. YOY steelhead densities at the 3 West Fork sites were less than in 1998, but combined coho and steelhead densities were about the same in the 2 years. Density on the East Fork site was substantially less (67 versus 115 / 100 feet) in 1999. In the 2 sampled habitats immediately downstream of the forks steelhead were similarly reduced compared to 1998. However, at the lowermost sampled site, a bedrock pool adjacent to Camp Herbert, steelhead were almost absent ((Table 2). From there downstream through the five other main stem sites steelhead were reduced by more than 85% compared to 1998. YOY densities were consistently low throughout the 5 sites (Table 2), and showed no reduction in the intensity of the fish kill downstream. Since the lowermost sampled site was only 0.2 miles upstream of the lagoon, it is likely that fish in the lagoon, including a significant portion of smolt-size steelhead production (Smith and Davis 1993), was impacted by the kill. However, no lagoon sampling was conducted, so the extent of the impact to lagoon

steelhead or possible impact to tidewater goby (Eucyclogobius newberryi) is unknown.

Because much of the watershed was affected by the fish kill, overall steelhead density in 1999 was less than half of that present in previous years (Table 5). The impact to smolt production in spring 2000 will probably be substantially greater, because fish downstream of the forks are usually larger (Smith 1998c), resulting in smolting by some yearlings. In addition, fish reared in the lagoon often make up more than 1/4 of the smolt-sized fish in the watershed (Smith and Davis 1993).

YOY steelhead on the West Fork were similar in size to fish from 1995 and 1997, but somewhat smaller than during the high summer flows of 1998 (Figure 6).

Gazos Creek. Overall YOY steelhead density in 1999 was similar to that of 1998 and substantially higher than in years of similar summer stream flow (1996 and 1997) (Table 5). Site 1, downstream of Old Woman Creek, had a relatively low density of steelhead (Table 3), as it has had in most years (Smith 1998c), possibly due to siltation effects from the tributary.

Past sampling results have generally shown that fish downstream of Old Woman Creek are larger than at upstream sites (Smith 1998c and Figure 7), but that steelhead sizes within sites do not change between years of different runoff (Figure 7). However, the few YOY steelhead present at site 1 in 1999 were larger than in other years (Figure 7).

Mortality

Overall observed mortality among captured fish on the 3 streams was 0.39% (Table 8). YOY steelhead mortality was somewhat higher (0.44%) than that of yearling steelhead (0.36%) or coho (0.21%).

Management Implications

Hatchery-spawned fry and smolts were stocked in Gazos and Waddell creeks to boost the 1996 year classes. Unfortunately, that effort did not result in strong 1999 year classes on those two streams. The delay in adult access until late January 1999 and the relatively strong storms in late January and February may have been responsible. In addition, strong 1997 storms may have reduced overwinter survival of the 1996 year classes. However, those weather events now occur regularly in central California, with only 3 winters (1993, 1994, and 1996) in the last 9 not having large late winter storms or early winter drought (as in 1990-1991). Fortunately, much of the Scott Creek watershed appears to be relatively flood resistant and did have a very

strong 1999 year class. However, even on Scott Creek the 1998 coho year class was decimated by the extremely large 1998 El Nino storms (Smith 1998c). Winter storms appear to have shifted later in the season with the change in ocean conditions that started about 1976. Under the existing winter storm patterns, only Scott Creek appears to be able to regularly sustain strong coho year classes. At the very least hatchery-spawned Scott Creek fish will be necessary to restore weak or lost year classes in Gazos and Waddell creeks and to reestablish coho in other central coast streams. Continued hatchery efforts may also be necessary to maintain "restored" coho under the present climatic pattern.

Coho generally prefer pools with complex cover for summer rearing and overwintering. However, much suitable summer rearing habitat on the main stem of Waddell Creek, on lower Gazos Creek, and even Scott Creek downstream from Big Creek, goes unused in many years. Coho's early emergence and larger size apparently allow them to suppress or exclude steelhead in pools. However, coho's early spawning also results in frequent redd destruction. The highest priority for coho habitat protection on central coast streams should be for those reaches (such as West Fork Waddell and miles 3.5 to 5.3 on Gazos Creek) where spawning is likely to be most successful in storm years. The highest priorities for habitat restoration, such as increasing large wood for pool development, should probably also we directed to those same reaches, where coho fry are likely to regularly present.

Unlike coho, steelhead appear to regularly do well in these three streams. Steelhead juvenile numbers and sizes fluctuate a small amount due to changes in summer stream flow, but they seem to successfully spawn even in years with catastrophic winter storms. With their flexible freshwater life history and large percentage of repeat spawners (Shapovalov and Taft 1954; Smith, unpublished), they can rapidly recover from short-term impacts, such as the 1999 Waddell Creek fish kill.

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Table 1. Site locations, habitat types present and sampled, number of steelhead and coho collected and estimated density per 100 feet () at sites on Scott Creek in October 1999. (Site #s agree with earlier reports, except that sites 12A and 12B were combined).

Site	Mile >Hwy1	Chan Type	%Hab Avail PL	GL	RN	RF	%Hab Sampl PL	GL	RN	RF	Sample Length (feet)	#SHT 0+	#SHT 1+	COHO
A Near Diversion	0.9	C3	40	40	15	5	75	25	-	-	101	39 (41)	10 (11)	4 (5)
1 <Little Creek	1.9	C3	45	30	20	5	71	18	11	-	223	90 (49)	13 (6)	11 (6)
Big Creek	2.15													
2 Pullout >Big Cr.	2.55	C4	50	30	15	5	72	19	9	-	166	104 (82)	13 (8)	53 (35)
4 <Swanton Road	3.55	C4	50	30	15	5	66	34	-	-	162	99 (79)	19 (13)	71 (45)
7 Pullout <Big Cr. Gate	4.9	C4	50	30	15	5	100	-	-	-	75	27 (48)	5 (7)	51 (86)
9 0.15 mi > bridge	5.15	C4	45	25	20	10	75	25	-	-	110	70 (70)	18 (16)	49 (45)
11 Upper Ford	5.85	C3	50	30	15	5	85	16	-	-	257	60 (26)	7 (3)	54 (22)
12 Big Cr. Swanton Rd.		C3	30	15	40	15	86	14	-	-	145	89 (67)	10 (8)	10 (7)
12AB Above/ below Hatchery		B1/3	35	10	40	15	86	14	-	-	120	64 (67)	14 (12)	-
13 Mill Cr. <Swanton Rd.		C3	50	20	20	10	100	-	-	-	71	53 (88)	10 (14)	25 (42)
Totals											1430	695	119	328
Mean of 10 Sites			45	26	22	8	81	17	2	-		(62)	(10)	(29)

Table 2. Site locations, habitat types present and sampled, number of steelhead and coho collected and estimated density per 100 feet () at sites on Waddell Creek in October 1999. (site #s agree with earlier reports). An apparent summer fish kill extended from Camp Herbert (6B) downstream through site 1.

Site	Mile >Hwy1	Chan Type	%Hab Avail PL	GL	RN	RF	%Hab Sampl PL	GL	RN	RF	Sample Length (feet)	#SHT 0+	1+	Coho
1 First Bridge	0.6	C4	50	30	15	5	80	20	-	-	100	8 (8)	2 (2)	-
2 <Alder Camp	1.35	C4	50	35	10	5	66	34	-	-	118	12 (10)	1 (1)	-
3 Twin Redwoods	1.8	C4	50	30	15	5	74	19	7	-	95	8 (9)	20 (21)	-
4 Peri-winkle	2.2	C4	35	40	20	5	75	25	-	-	80	7 (9)	-	-
5 Pullout <Herbert	2.6	C3	55	25	15	5	84	16	-	-	114	8 (8)	-	-
6ACamp Herbert lower	3.1	C3	50	25	15	10	100	-	-	-	90	6 (7)	-	-
6BCamp Herbert							92	8	-	-	157	80 (57)	9 (6)	
7 E Fork > Ford	3.2	C3	45	25	20	10	81	5	14	-	177	105 (67)	4 (2)	3 (2)
8 W Fork	3.3	C4	40	30	25	5	79	16	5	-	196	70 (36)	6 (3)	26 (14)
9 Mill Site	3.9	C4	50	30	15	5	80	16	4	-	204	72 (44)	6 (3)	19 (11)
10 Trib @ Bridge	4.7	C1 C3	40	35	20	5	45	45	11	-	227	68 (39)	3 (1)	18 (8)
Totals											1558	395	51	66
Mean of 10 Sites			47	30	17	6	78	19	4	0		(27)	(4)	(3.1)
Mean of sites 6B-10												(49)	(3)	(6.9)

Table 3. Site locations, habitat types present and sampled, number of steelhead and coho collected and estimated density per 100 feet () at sites on Gazos Creek in September and October 1999. (Site #s 2B and 3A are new and sites 4 and 7 are modified, otherwise site numbers agree with previous years. Alphabetical references in () refer to EPA-designated 1998 violation sites.)

Site	Mile >Hwy1	Chan Type	%Hab Avail PL	GL	RN	RF	%Hab Sampl PL	GL	RN	RF	Sample Length	#SHT 0+	1+	Coho
1	0.9	C4	40	30	20	10	64	31	4	-	266	40 (15)	9 (3)	-
Old Woman Creek	2.05													
2A	2.1	C4	30	30	25	15	67	26	-	7	134	60 (49)	12 (9)	-
2B(G/H)	2.8	C4	30	30	30	10	74	24	3	-	182	140 (82)	19 (11)	5 (3)
3 (<J)	3.15	B4	40	25	25	10	49	32	14	5	211	131 (71)	17 (8)	1 (0.5)
3A (N)	3.9	B4	35	30	25	10	93	7	-	-	142	51 (37)	10 (7)	1 (0.7)
4	4.4-4.6 (Q)	B4	35	25	30	10	79	21	-	-	250	197 (94)	15 (6)	25 (10)
5	4.85	B4	35	25	30	10	89	12	-	-	131	34 (30)	8 (6)	15 (13)
7A (>U)	5.3	B1	40	10	35	15	92	8	-	-	123	55 (48)	10 (8)	32 (28)
7B	5.45	A/B1	35	5	40	20	100	-	-	-	36	24 (80)	6 (17)	-
Totals: Mean of 9 Sites			36	23	29	12	79	18	2	1	1475	732 (51)	106 (8)	79 (6.2)

Table 4. Number of sites, amount and type of habitat sampled, number of coho collected and estimated density (per 100 feet) for Scott, Waddell, Gazos and Redwood creeks in 1988 and 1992 - 1999.

Stream and Date	Number of Sites Sampled	Length (feet)	Habitat Pl	Gl	Percent Rn	RF	% Sites w/coho	Coho #	Dens. (/100')
Scott Creek									
Jul-Sep 1988	14	3535	41	25	21	12	84	384	15.5
Aug-Oct 1992	13	1624	66	30	4	0	46	42	4.3
Jan 1994	11	1554	49	32	19	0	100	376	27.2
Aug 1994	13	1744	59	36	6	0	46	17	1.1
Oct 1995	12	1686	59	32	8	1	92	223	14.2
Oct-Nov 1996	12	1684	62	30	8	1	100	473	33.0
Aug-Sep 1997	13	1865	64	24	11	0	62	145	9.3
Sep-Oct 1998	11	1753	77	16	6	1	64	34	1.8
Oct 1999	10	1430	81	17	2	0	90	328	29.2
Waddell Creek									
Jun-Aug 1988	8	1817	54	19	23	5	63	19	1.3
Jul-Aug 1992	13	2858	67	31	2	0	38	19	0.6
Oct/Dec 1993	12	1857	38	21	28	14	75	58	3.6
July 1994	12	2367	66	24	7	2	0	0	0
Sep 1995	12	2498	64	24	10	2	58	24	1.1
Aug-Sep 1996	14	2491	69	21	8	2	93	302	12.5
Aug-Sep 1997	11	1873	58	32	8	1	0	0	0
Sep-Oct 1998	10	2083	76	18	5	1	20	7	0.3
Oct 1999	10	1558	78	19	4	0	40	66	3.1

Table 4 (continued)

Stream and Date		Number of Sites Sampled	Length (feet)	Habitat Pl	Gl	Percent Rn	RF	% Sites w/coho	Coho #	Dens. (/100')
Gazos Creek										
Aug	1992	2	275	44	56	0	0	0	0	0
Jan	1994	4	503	65	22	12	1	50	9	2.2
Nov	1995	4	425	58	19	21	3	25	1	0.2
Sep	1996	5	830	49	27	12	13	100	33	4.9
Aug	1997	5	827	45	28	17	10	0	0	0
Aug-Sep	1998	8	1529	65	14	11	10	25	10	0.4
Sep-Oct	1999	9	1475	79	18	2	1	67	79	6.2
Redwood Creek										
Jun-Sep	1992	4	1032	37	40	5	7	100	426	45.3
Jun-Aug	1993	4	951	48	25	18	9	100	355	46.3
July	1994	7	1287	58	25	12	6	43	24	1.9
Aug	1995	4	796	41	30	19	10	100	308	42.0
Nov	1996	3	604	51	31	11	7	100	214	38.8
Sep-Oct	1997	5	984	72	18	9	1	60	209	23.3
Oct	1998	5	1174	59	25	15	1	100	327	31.6

not sampled 1999

Table 5. Number of sites, amount and type of habitat sampled, and estimated density (per 100 feet) of steelhead for Scott, Waddell, Gazos and Redwood creeks in 1988 and 1992 - 1999.

Stream and Date	Number of Sites Sampled	Length (feet)	Habitat Percent Pl	Gl	Rn	RF	Density Age 0+	Age 1/2+
Scott Creek								
Jul-Sep 1988	14	3535	41	25	21	12	57	7
Aug-Oct 1992	13	1624	66	30	4	0	89	21
Jan 1994	11	1554	49	32	19	0	39	21
Aug 1994	13	1744	59	36	6	0	52	18
Oct 1995	12	1686	59	32	8	1	90	10
Oct-Nov 1996	12	1684	62	30	8	1	35	20
Aug-Sep 1997	13	1865	64	24	11	0	68	7
Sep-Oct 1998	11	1753	77	16	6	1	113	10
Oct 1999	10	1430	81	17	2	0	62	10
Waddell Creek								
Jun-Aug 1988	8	1817	54	19	23	5	45	7
Jul-Aug 1992	13	2858	67	31	2	0	56	10
Oct/Dec 1993	12	1857	38	21	28	14	54	8
July 1994	12	2367	66	24	7	2	61	19
Sep 1995	12	2498	64	24	10	2	79	14
Aug-Sep 1996	14	2491	69	21	8	2	62	15
Aug-Sep 1997	11	1873	58	32	8	1	71	7
Sep-Oct 1998	10	2083	76	18	5	1	80	7
Oct 1999	10	1558	78	19	4	0	27	4

Table 5 (continued)

Stream and Date		Number of Sites Sampled	Length (feet)	Habitat Percent Pl	Gl	Rn	RF	Density Age 0+	Age 1/2+
Gazos Creek									
Aug	1992	2	275	44	56	0	0	24	12
Jan	1994	4	503	65	22	12	1	29	9
Nov	1995	4	425	58	19	21	3	68	14
Sep	1996	5	830	49	27	12	13	34	12
Aug	1997	5	827	45	28	17	10	36	8
Aug-Sep	1998	8	1529	65	14	11	10	53	7
Sep-Oct	1999	9	1475	79	18	2	1	51	8
Redwood Creek									
Jun-Sep	1992	4	1032	37	40	5	7	23	4
Jun-Aug	1993	4	951	48	25	18	9	56	4
Oct	1994	5	1018	83	10	4	3	34	6
Aug	1995	4	796	41	30	19	10	96	4
Nov	1996	3	604	51	31	11	7	33	11
Sep-Oct	1997	5	984	72	18	9	1	15	5
Oct	1998	5	1174	59	25	15	1	47	4

not sampled 1999

Table 6. Site locations and coho densities (/ 100') in September 1992, January 1994 (1993 Year Class), October 1995, October and November 1996, August and September 1997, September and October 1998 and October 1999 on Scott Creek.

Site	Mile >Hwy1	Year Class Density 1992	1993	1995	1996	1997	1998	1999
A Near Diversion	0.9		1.9	1.2	22*	0		5
1 <Little Creek	1.9	2.0	7	14	33*	0	0	6
Big Creek	2.15							
2 Pullout >Big Cr.	2.55	0	31	29	31	30	0.5	35
3. < Mill Creek	3.05	0.7		28		29	0	
4 <Swanton Road	3.55	0	86	26	37	20	3.1	45
7 Pullout <Big Cr. Gate	4.9	23	48	23	62	24	2.9	86
9 0.15 mi > bridge	5.15	1.2	39	12	62	1.0	0	45
11 Upper Ford	5.85	1.6	41	5	33	0	8.1	22
11A 4th Trail Xing	6.5		16	2.6	31	0.8	3.2	
12 Big Cr. Swanton Rd.		0	8	1.0	21	0	0	7
12A Big Cr. Below Hatchery			9	0	30	0		0
12B Big Cr. >Berry Cr.					11			0
13 Mill Cr. <Swanton Rd.		0	12	28	24	6	0	42
Mean		4.3	27.2	14.2	33.0	9.3	1.8	29.2

*Augmented by plants of fry from Big Creek Hatchery

Table 7. Site locations and coho densities (/ 100') in July-August 1992, October 1993, September 1995, August-September 1996, and September-October 1998 on Waddell Creek.

Site	Mile >Hwy1	Year Class Density 1992	1993	1995	1996	1998	1999
1 >Div	0.6	0	1	0.5	16*	0	0+
2 <Alder Camp	1.35	0	0.3	0.3	7*	0	0+
3 Twin Redwoods	1.8	0	0	0	14*	0	0+
4 Peri-winkle	2.2	0	4	0	30*	0	0+
5 Pullout <Herbert	2.6	0.4	4	2.2	16*	0	0+
6 Camp Herbert	3.1	2.2		1.5	15*	0	0+
7 E Fork > Ford	3.2	0	2	0	10	0	2
14 E Fork	3.7		4		4		
8 W Fork	3.3	3.5	7	2.7	13	0	14
9 Mill Site	3.9	0.4	4	2.6	23	2.7	11
10 Trib @ Bridge	4.7	0.8	0	2.9	18	0.4	8
11 HenryCr Trail	5.25	1.0	2	0	7		
Slippery Falls	5.35						
12 Upper Bridge	5.45	0	0		0		
13 HenryCr >Trail	0.	0	16	0	3		
Means		0.7	3.6	1.1	12.5	0.3	3.1

*Augmented by plants of fry from Big Creek Hatchery
+Coho abundance potentially affected by fish kill in mid summer.

Table 8. Fish killed and captured (/) and mortality rate (%) for juvenile steelhead and coho captured by electroshocking on Gazos, Waddell and Scott creeks in September - October 1999.

	Steelhead				Coho	
	Age 0+		Age 1+		Age 0+	
	Kill/Capt	%	Kill/Capt	%	Kill/Capt	%
Gazos Creek						
Sep-Oct	3/732	0.4	0/106	0.0	0/79	0.0
Waddell Creek						
Oct	2/395	0.5	0/51	0.0	0/66	0.0
Scott Creek						
Oct	3/695	0.4	1/119	0.8	1/328	0.3
Totals	8/1822	0.44	1/276	0.36	1/473	0.21
Overall			10/2571	0.39		

Figure 1. Standard lengths (mm) of coho and steelhead from habitats with coho at sites on Scott Creek in 1999.

Coho

	Mill Cr & Upper Scott	Scott Cr. Site 4	Big Creek & Scott Cr. 1, A
30 - 34			
35 - 39			
40 - 44	*2		
45 - 49	*****10		
50 - 54	**********20	*****10	1
55 - 59	**********32	**********28	
60 - 64	*****10	********16	*3
65 - 69	*3	****9	***6
70 - 74	*2	****9	****9
75 - 79	*2		***6

Steelhead

	Mill Cr & Upper Scott	Scott Cr. Site 4	Big Creek & Scott Cr. 1, A
30 - 34	*2		
35 - 39	*******15	**4	
40 - 44	*******14	****8	1
45 - 49	**********22	******12	********17
50 - 54	**********26	**********27	**********34
55 - 59	*******15	*********18	**********31
60 - 64	*****11	********17	**********20
65 - 69	**5	***6	******12
70 - 74	*2	*3	****8
75 - 79			*3

Totals

	Coho	Steelhead
30 - 34		2
35 - 39		******19
40 - 44	2	*******23
45 - 49	***10	**********51
50 - 54	**********31	**********86
55 - 59	**********60	**********64
60 - 64	*********29	**********48
65 - 69	******18	*******23
70 - 74	******20	****13
75 - 79	**8	*3

Figure 2. Coho and steelhead standard lengths (mm) from habitats with coho on the West Fork of Waddell Creek in 1999.

	Coho	Steelhead
30 - 34		
35 - 39		*2
40 - 44		******13
45 - 49	*2	**********26
50 - 54	*3	**********38
55 - 59	****8	**********28
60 - 64	*****11	**********28
65 - 69	**********21	******12
70 - 74	******13	*****10
75 - 79	1	**4
80 - 84	1	

Figure 3. Coho and steelhead standard lengths (mm) from sites 4. 5 and 7A from Gazos Creek in 1999.

	Coho	
30 - 34		1
35 - 39		*3
40 - 44		******13
45 - 49	*2	**********52
50 - 54	*3	**********38
55 - 59	**********21	**********32
60 - 64	*********18	*******15
65 - 69	**********21	*****10
70 - 74	**4	**4
75 - 79	*2	

Figure 4. Scott Creek coho standard lengths (mm) at sites 2 and 4 in November 1996, sites 2-7 in August-September 1997, sites 2 - 11 in September and October 1998 and site 4 in October 1999.

	1996	1997	1998	1999
40 - 44			1	
45 - 49	*4	1		
50 - 54	*******22	********25		***10
55 - 59	**********34	**********46	***7	*********28
60 - 64	********24	**********35	******13	*****16
65 - 69	*****15	*****15	*****10	***9
70 - 74	**8	**6	**4	***9
75 - 79	1	2	*2	
80 - 84		2		
85 - 89		2		

Figure 5. Standard Lengths (m) of YOY steelhead from Scott Creek in October 1995, September 1997, September and October 1998 and October 1999. Site A & 1 sizes were typical of those downstream of Big Creek and lower Big Creek in 1998; Site 2 and 4 sizes were typical of Scott Creek sites 3-6 and Big Creek in 1995 and 1997; Site 9 & 11 sizes were typical of upper Scott Creek and Mill Creek (sites 9-11A, 13).

	Sites A&1 1999	Sites A&1 1997	Site A 1995	Site 1 1998
40 - 44		*4		
45 - 49	**6	**8		
50 - 54	***10	*****15	1	2
55 - 59	**8	*****16	**7	*******23
60 - 64	***9	******18	***11	************36
65 - 69	2	*****15	*********29	************36
70 - 74	*5	***11	******19	************38
75 - 79	2	***10	******20	***10
80 - 84		*3	****13	*3
85 - 89			****12	***9
90 - 94		1	**8	*3
95 - 99		1	*3	*3
100-104			*4	

	Site 4 1999	----------Site 2---------- 1997	1995	1998
30 - 34		2		
35 - 39	*4	*4	*4	1
40 - 44	**8	****12	**********33	*5
45 - 49	*****17	******18	*********29	*******22
50 - 54	*********27	*****17	********25	****************48
55 - 59	******18	******18	******19	****************50
60 - 64	*****17	****13	*********27	**********35
65 - 69	**6	1	*****16	*****16
70 - 74	*3	*4	*****16	***10
75 - 79		1	***11	*5
80 - 84			2	1

	Site 11 1999	----------Sites 9 & 11---------- 1997	1995	1998
30 - 35	1	*3	*5	*5
35 - 39	***10	*******22	*****17	******20
40 - 44	***11	**********38	********25	****************45
45 - 49	****12	**********34	*******23	**************44
50 - 54	***10	**********31	********26	****************48
55 - 59	**8	**********31	******19	********26
60 - 64	*3	****14	***9	****14
65 - 69	*3	***10	*4	***11
70 - 74	1		2	1

Figure 6. Waddell Creek YOY steelhead standard lengths (mm) from Waddell Creek (site 8) in 1999, 1997, 1995 and 1998.

	Site 8			
	1999	1997	1995	1998
35 - 39		**7	2	
40 - 44	1	****13	***10	1
45 - 49	****12	******19	****14	*******22
50 - 54	******19	*********27	********25	*********28
55 - 59	***11	*********27	*****16	**********34
60 - 64	****12	***9	****12	*****15
65 - 69	**6	**7	**8	******20
70 - 74	*5	*3	**7	******18
75 - 79	*4	2	**6	***10
80 - 84			*5	*4
85 - 89				*4
90 - 94				1

Figure 7. Standard lengths (mm) of steelhead from sites 1/2 and 4 on Gazos Creek in August 1997, August and September 1998 and September and October 1999.

	--Sites 1 & 2-		Site 1	Site 4
	1997	1998	1999	1998
30 - 34				
35 - 39				1
40 - 44	2			***14
45 - 49	2	1		**********33
50 - 54	****13	******18		********25
55 - 59	******18	*********28		*****17
60 - 64	****13	******18	*3	**7
65 - 69	**6	**********33	***9	*4
70 - 74	***11	****12	***11	1
75 - 79	**6	*3	***11	2
80 - 84	2	*3	*3	
85 - 89			*3	
90 - 94		1		

	Site 4		
	1997	1998	1999
30 - 34	2		1
35 - 39	*5	1	2
40 - 44	****14	****14	*******23
45 - 49	****13	**********33	**********39
50 - 54	******20	********25	*********27
55 - 59	****14	*****17	*******21
60 - 64	****12	**7	*****16
65 - 69	*4	*4	*5
70 - 74	*4	1	2
75 - 79		2	