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ACKNOWLEDGEMENTS

This work was completed under the auspices of the California Department of State Parks and Recreation and was directed by Roy Woodward, Ph.D., manager of the Inventory, Monitoring, and Assessment Program. Special thanks to Hagar Environmental Science for completing the field surveys and providing technical guidance and review. Also appreciation goes to Krista Orr of the State Parks Inventory Monitoring, and Assessment Program for providing field assistance. In addition, gratitude is extended to Jennifer Nelson of the California Department of Fish and Game who participated in the field effort and provided insight into the status of steelhead and coho on the Central California coast.

SUMMARY

Streams in Wilder Ranch State Park provide relatively pristine aquatic habitat that support the full complement of native aquatic species potentially occurring in the area. These streams provide important habitat for two protected species, Central California Coastal steelhead and California red-legged frog, and appear to support relatively healthy populations of both species. Tables 1 and 2 present the species observed. No exotic species were observed.

The greatest potential threat to aquatic habitats is from existing and potential future development in upper watershed areas outside existing park boundaries. Steelhead populations are also potentially limited by agricultural operations (diversion, stream alteration, and water storage facilities) in the lower sections of Wilder, Baldwin, and Majors Creeks.

The greatest length of stream accessible to steelhead is in Wilder Creek (two miles) and Peasley Gulch (one-half mile). Baldwin Creek has a maximum of one and one-quarter miles accessible to steelhead and Majors Creek has approximately three-quarters of a mile accessible to steelhead. This results from the fact that most of the habitat accessible to steelhead is in the coastal terrace and lower gradient sections of the coastal hills. From Majors Creek, at the western edge of the park, to Wilder Creek at the eastern edge, the coastal terrace becomes wider and the gradient increases more gradually in the coastal hills.

Removal of the old dam in Wilder Creek and re-contouring of the stream channel above it appears to have provided good habitat for steelhead spawning and rearing of fish in their first year. Habitat for yearling and older steelhead appears to have been reduced as a result of the project, although this may change over time as the stream readjusts its bed.

Table 1. Estimated Rainbow/Steelhead Trout per Mile Surveyed

Wilder Creek Stream Reach	Trout/Mile (Visual Survey)	Y-O-Y Trout/Mile (Electrofishing)	Yearling and Older Trout/Mile (Electrofishing)
Reach 1 – Wilder Lagoon	0	not surveyed	not surveyed
Reach 2 – Above Lagoon	0	110	88
Reach 3 – Between tunnels/barns; north of Highway 1	37	209	119
Reach 4 – Re-contoured area	2245	2621	314
Reach 5 – Upper stream	49	1339	191
Reach 6 – Above migration barrier	19	not surveyed	not surveyed

Peasley Gulch Stream Reach	Trout/Mile (Visual Survey)	Y-O-Y Trout/Mile (Electrofishing)	Yearling and Older Trout/Mile (Electrofishing)
Lower Peasley Gulch	148	not surveyed	not surveyed
Upper Peasley Gulch above migration barrier	23	not surveyed	not surveyed

Baldwin Creek Stream Reach	Trout/Mile (Visual Survey)	Y-O-Y Trout/Mile (Electrofishing)	Yearling and Older Trout/Mile (Electrofishing)
Reach 1 – Marsh Impoundments	0	not surveyed	not surveyed
Reach 2 – Above impoundments	0	not surveyed	not surveyed
Reach 3 – Tunnels and north of Highway 1	56	not surveyed	not surveyed
Reach 4 – Middle stream	67	774	138
Reach 5 – Steep stream above migration barriers	6	not surveyed	not surveyed

Majors Creek Stream Reach	Trout/Mile (Visual Survey)	Y-O-Y Trout/Mile (Electrofishing)	Yearling and Older Trout/Mile (Electrofishing)
Lower Majors Creek	211	263	190
Upper Majors Creek above migration barrier	48	not surveyed	not surveyed

Table 2. Other Aquatic Species Surveyed

Wilder Creek Stream Reach	Prickly Sculpin/mile (electro-fishing)	Coastrange Sculpin/mile (electro-fishing)	Sculpin sp./mile (electro-fishing)	Stickleback/ mile (electro-fishing)	California Red-Legged Frog (no. observed all surveys)	Newt (no. observed all surveys)	Pacific Giant Salamander (no. observed all surveys)	Western Aquatic Garter Snake (no. observed all surveys)	Turtle (no. observed all surveys)
Reach 1 – Wilder Lagoon	not sampled	not sampled	not sampled	not sampled	16	0			1
Reach 2 – Above Lagoon	132	22	22	44	3	0	0	0	0
Reach 3 – Between tunnels/barns; north of Highway 1	30	179	0	104	3	0	0	0	0
Reach 4 – Re-contoured area	0	74	0	554	0	5	0	0	0
Reach 5 – Upper stream	0	115	0	0	2	7	2	0	0
Reach 6 – Above migration barrier	not sampled	not sampled	not sampled	not sampled	0	1	0	1	0

Peasley Creek Stream Reach	Coastrange Sculpin/mile (electro-fishing)	Prickly Sculpin/mile (electro-fishing)	Sculpin sp./mile (electro-fishing)	Stickleback/ mile (electro-fishing)	California Red-Legged Frog (no. observed all surveys)	Newt (no. observed all surveys)	Pacific Giant Salamander (no. observed all surveys)	Western Aquatic Garter Snake (no. observed all surveys)	Turtle (no. observed all surveys)
Lower Peasley Gulch	not sampled	not sampled	not sampled	not sampled	0	0	0	0	0
Upper Peasley Gulch above migration barrier	not sampled	not sampled	not sampled	not sampled	4	1	1	0	0

Table 2. Other Aquatic Species Surveyed (continued)

Baldwin Creek Stream Reach	Coastrange Sculpin/mile (electro-fishing)	Prickly Sculpin/mile (electro-fishing)	Sculpin sp./mile (electro-fishing)	Stickleback/ mile (electro-fishing)	California Red-Legged Frog (no. observed all surveys)	Newt (no. observed all surveys)	Pacific Giant Salamander (no. observed all surveys)	Western Aquatic Garter Snake (no. observed all surveys)	Turtle (no. observed all surveys)
Reach 1 – Marsh Impoundments	not sampled	not sampled	not sampled	not sampled	4	0	0	0	0
Reach 2 – Above impoundments	not sampled	not sampled	not sampled	not sampled	4	0	0	0	0
Reach 3 – Tunnels and north of Highway 1	not sampled	not sampled	not sampled	not sampled	3	0	0	0	0
Reach 4 – Middle stream	83	304	0	0	3	18	0	2	0
Reach 5 – Steep stream above migration barriers	not sampled	not sampled	not sampled	not sampled	0	0	3	0	0

Majors Creek Stream Reach	Coastrange Sculpin/mile (electro-fishing)	Prickly Sculpin/mile (electro-fishing)	Sculpin sp./mile (electro-fishing)	Stickleback/ mile (electro-fishing)	California Red-Legged Frog (no. observed all surveys)	Newt (no. observed all surveys)	Pacific Giant Salamander (no. observed all surveys)	Western Aquatic Garter Snake (no. observed all surveys)	Turtle (no. observed all surveys)
Lower Majors Creek	15	263	73	29	3	0	0	1	0
Upper Majors Creek above migration barrier	not sampled	not sampled	not sampled	not sampled	3	0	0	0	0

1.0 Introduction

Wilder Ranch State Park provides extensive recreational and cultural opportunities with over 6,000 acres available to hikers, riders, and bikers, as well as teaching opportunities at the cultural sites. The park contains relatively large sections of coastal stream watersheds and maintains these lands in relatively undisturbed condition from headwaters in the upper elevations down to the ocean. The park's open areas, from the protected shoreline to the open grasslands and redwood forests, provide viewing possibilities for birders and botanists. The streams within the park are not as readily accessible and are at times hidden from view. As a result, the resources within this type of habitat are not as apparent.

Nevertheless, the park contains rich and varied stream and riparian habitats. Stream habitat and fisheries surveys of Wilder Creek, Baldwin Creek, Majors Creek, and Peasley Gulch described in this report reveal that steelhead/rainbow trout (*Oncorhynchus mykiss*) are present in these streams, and within some, at significant densities. The fish and amphibian species encountered indicated that these are viable coldwater streams with significant habitats available for sensitive species such as steelhead trout and California red-legged frogs, as well as other native fishes (stickleback and two species of sculpin), Pacific giant salamanders, newts, and aquatic garter snakes. It is especially notable that only native species were encountered; no exotics, such as bullfrogs were observed. With this being the case, it is important then for State Parks to monitor and assess the conditions of these populations and ultimately to provide management options to maintain and possibly enhance their numbers.

According to “The Seventh Generation – The Strategic Vision of California State Parks” (California State Parks 2001), the mission of the California Department of Parks and Recreation is:

> “. . . To provide for the health, inspiration, and education of the people of California by helping to preserve the state’s extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.”

And as part of this mission, the Department’s “Strategic Initiatives” provide the means to implement the vision of the Department. Of the “Strategic Initiatives”, one is of particular relevance:

> “Increase Leadership in Natural Resource Management – The Department will protect and manage the biological diversity and self-sustaining natural systems that support the individual park units, and will establish itself as a major player in environmental issues in California.” (California State Parks 2001)

By actively monitoring and enhancing the populations and associated habitats of the important aquatic resources of Wilder Ranch State Park, the goals and visions of the Department can be realized.

2.0 Setting/Location

Wilder Ranch State Park is a 6,000-acre park located approximately two miles west of the City of Santa Cruz (Figure 1). It is composed of coastal beachlands, irrigated farm fields, and open space. Generally, south of Highway 1, the lower coastal terrace is either cultivated or is comprised of sandy beaches, low coastal cliffs, and tidal wetlands supporting thick growth of willow thickets, cattail marsh, scirpus, and pickleweed.

3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS 900 ft Scale: 1 : 31,250 Detail: 13-0 Datum: WGS84

Figure 1. Site Map of Wilder Ranch State Park

Figure 2. Lower reaches of Wilder Creek looking upstream towards coastal terrace

Just north (inland) of Highway 1, the terrain becomes more gently sloped and is characterized by open grassland, punctuated by riparian vegetation along the canyons and steeper slopes. These riparian zones are dominated by willow and alder, with occasional buckeye on the higher slopes. As the terrain becomes steeper and the canyons become more deeply incised, the vegetation transitions to coastal redwood, Douglas fir, California bay laurel, madrone, and coastal live oak along the banks and ferns, moss, and lichens can be found along the stream margins. Upper reaches of the park's streams are thus very well-shaded with a dense canopy that, in combination with frequent coastal fog, keeps streams with permanent flow relatively cool throughout the year.

2.1 Previous Studies/Studies in area

Under the State Parks Inventory, Monitoring, and Assessment Program (IMAP), assessments of the botanical, wildlife, and aquatic insect resources are currently underway. Contacts with California Department of Fish and Game (CDFG) have indicated that that agency has not conducted any studies within the Park.

Stream habitat conditions and abundance of steelhead/rainbow trout were evaluated in the early 1980's as part of a County-wide assessment of streams in Santa Cruz County (Harvey & Stanley Associates, Inc. 1982). Study sites included several locations in both Majors and Baldwin Creeks but none in Wilder Creek. All conclusions were based on one year of study only (fall of 1981), which was a relatively dry year. The study concluded that Majors Creek had below average to fair rearing habitat for steelhead in the lower mile, but that migration was not likely upstream even though good rearing habitat was present in places. For Baldwin Creek the study concluded that the stream was accessible to steelhead for at least 1.35 miles upstream and fair to good spawning habitat and poor to good rearing habitat were present depending on the location within this reach.

No records of coho salmon in streams of the Park were located; however, these streams are within the historic range of coho and it is possible they were present here in the past. Anderson (1995) states that coho salmon probably used all or most of the accessible coastal streams along the San Mateo and Santa Cruz coastlines that provided essential habitat, and persisted in seven streams in Santa Cruz County in the early 1960s. With the exception of Waddell and Scott Creeks, these streams lost their native coho runs by the late 1970s or early 1980s.

3.0 2001 Assessment

3.1 Habitat Assessment Methodology

The habitat assessment involved walking surveys of Wilder Creek, Baldwin Creek, Peasley Gulch, and Majors Creek. Except for Peasley Gulch, which was evaluated from its confluence with Wilder Creek and then upstream, the remaining three creeks were assessed from their confluence with the ocean, upstream through the tidally-influenced zones and eventually to high gradient areas within the redwoods and bays (Figures 3 through 5). More detailed habitat assessments were conducted in representative sections of Wilder and Baldwin Creeks.

The detailed habitat assessments of Wilder Creek and Baldwin Creek were conducted using the California Salmonid Stream Habitat assessment methodology (Flosi et al. 1998), which is a widely accepted, repeatable, and quantifiable scientific method. Habitat typing was conducted at a Level IV classification. In each sample reach, all habitat units were identified by type and length measured. Encounters for each habitat type were characterized in full detail. Maximum depth, pool tail crest depth, and pool tail embeddedness were recorded for each pool encountered within the assessed habitat units. Canopy density was also recorded. The habitat assessment data were then analyzed by summarizing habitat type frequency of occurrence and parameter values within the discreet, homogenous stream reaches. These data can be found in Appendix A.

In addition, potential migration barriers were identified, located by Global Positioning System (GPS) where possible, and evaluated with reference to species specific criteria for passage at both natural and constructed obstacles. In some portions of Wilder Creek and Baldwin Creek, reception of satellite signals was very poor due to the steep topography; therefore locations of potential barriers were estimated.

3.2 Visual Notations

For each of the streams surveyed, detailed field notes were recorded regarding all aquatic vertebrates observed. Due to the good clarity of the water, fish were identified to species with a high degree of confidence. Trout were described in terms of approximate age, i.e., young-of-year, juvenile, adult; approximate numbers; and presence within particular habitat types. Observations of California red-legged frog, California newts, Pacific giant salamanders, and snakes were also collected. In this report the nomenclature for the Pacific giant salamander follows the descriptions of Stebbins (1985). It is noted that genetic evidence suggests that the Pacific giant salamanders be separated into the Oregon giant and California giant salamanders; however, their life history is likely to be very similar (CDFG 1999).

3.3 Electrofishing Methodology

In the fall of 2001, electrofishing of selected reaches of Wilder Creek (4 sites), Baldwin Creek (1 site), and Majors Creek (1 site) was conducted. Qualitative sampling was conducted in reaches that had been previously characterized in the habitat survey. A single pass with the electrofisher was made without block nets. Fish were captured, measured and released. In the section of Wilder Creek where the dam removal project was completed, a two-pass depletion removal with block nets was used to estimate steelhead population abundance in the project reach.

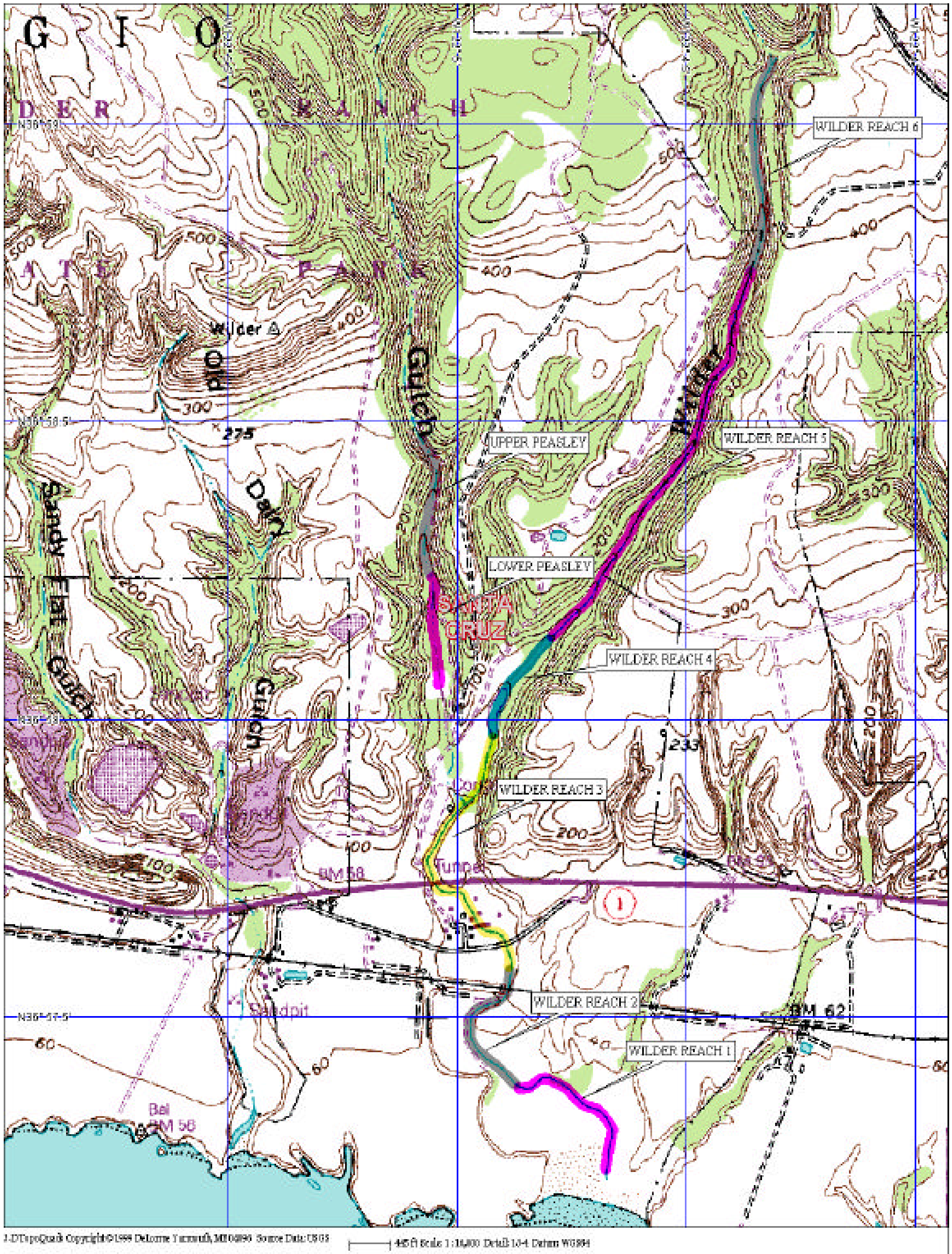

Figure 3. Survey Areas – Wilder Creek and Peasley Gulch

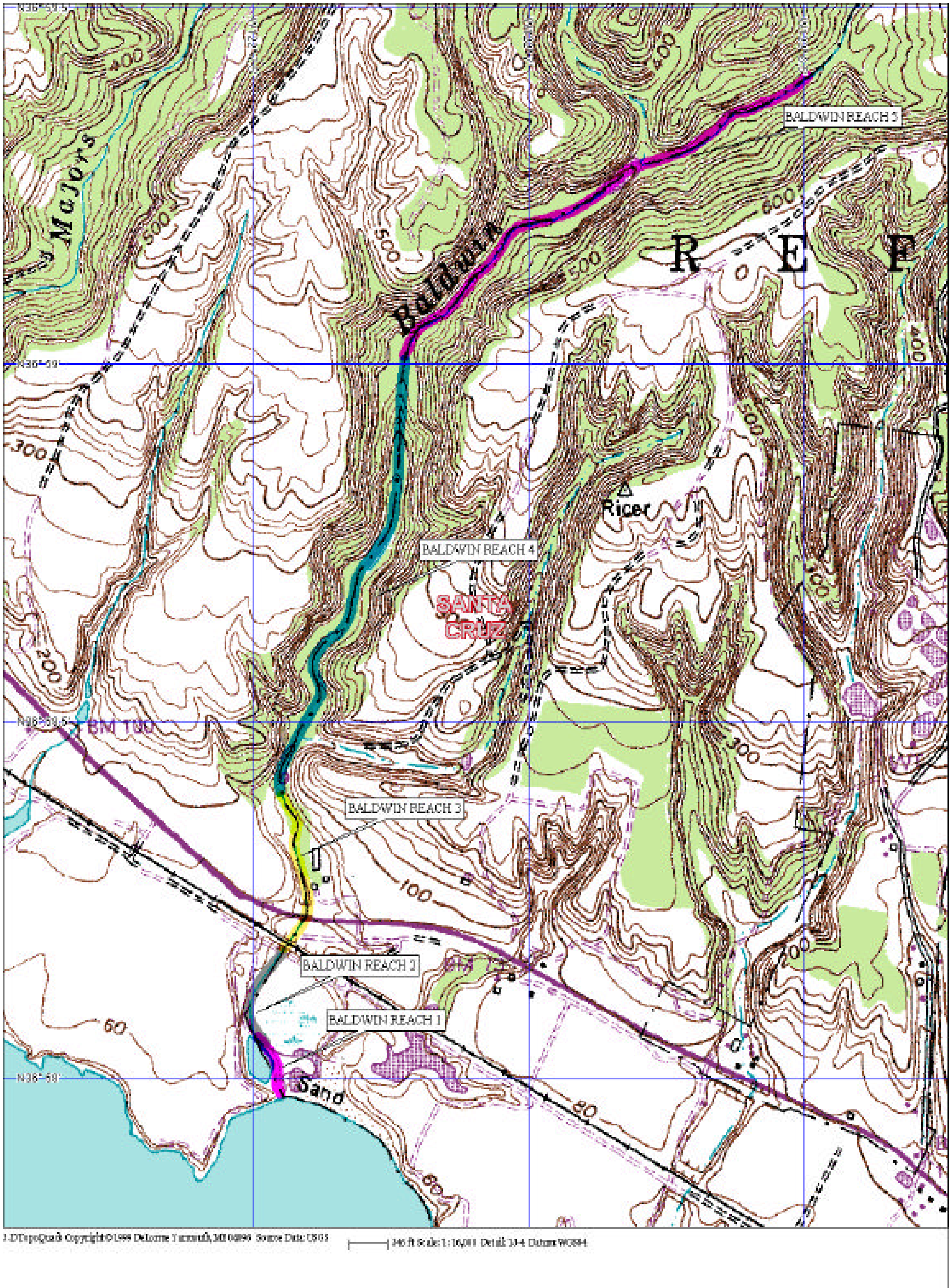

Figure 4. Survey Areas - Baldwin Creek

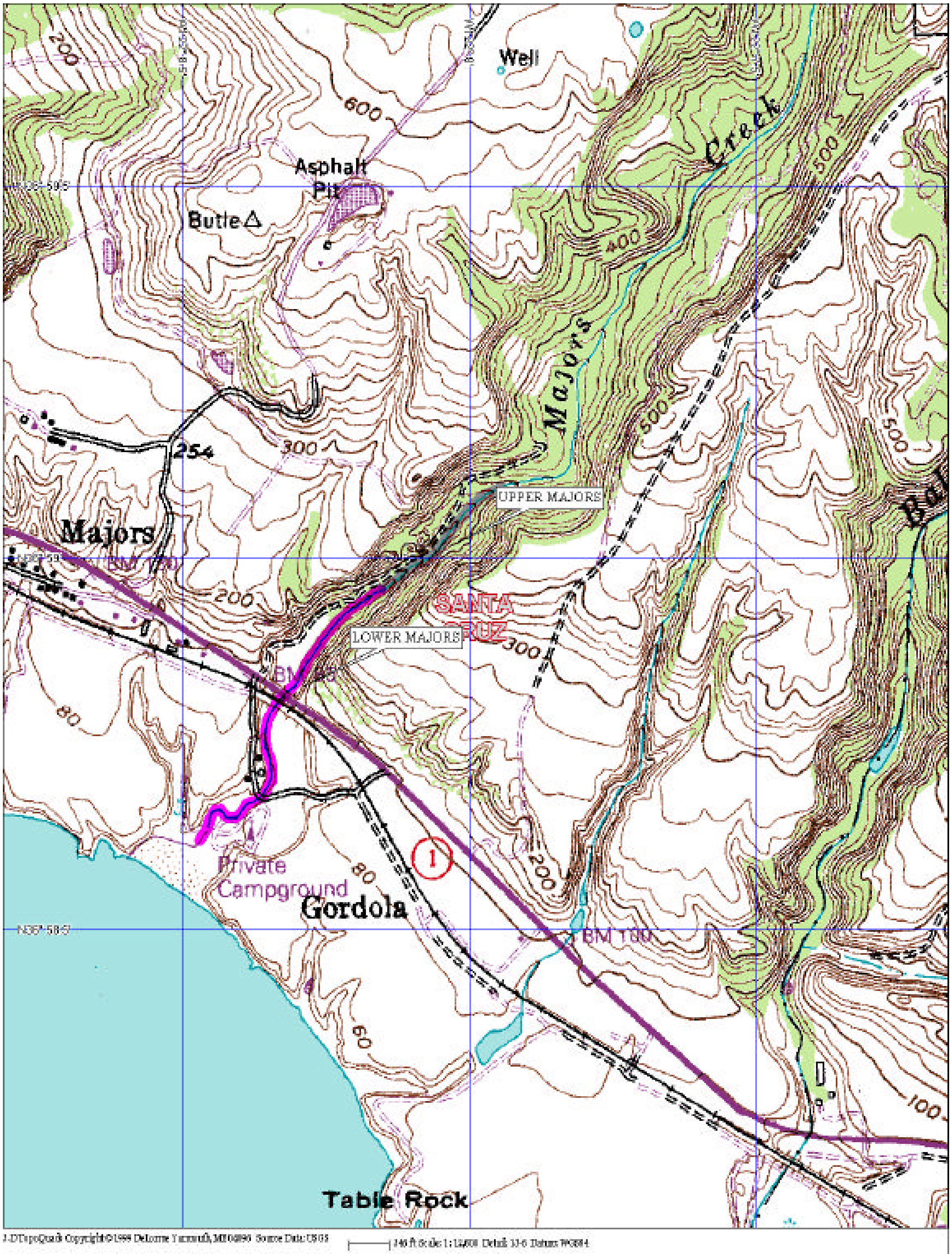

Figure 5. Survey Areas - Majors Creek

4.0 2001 Assessment Results

The following section presents results for each of the streams surveyed. Wilder Creek and Baldwin Creek received the greatest survey effort. Each stream is segmented into somewhat homogenous reaches and results of habitat assessments and visual surveys of the aquatic vertebrates and electrofishing surveys are described by reach.

4.1 Wilder Creek

Wilder Creek is located along the eastern boundary of Wilder Ranch State Park and gradually transitions from a beach lagoon to a higher gradient coldwater stream within predominantly redwood canopy. The stream was surveyed from its outlet to the ocean, upstream to its confluence with Cave Gulch.

4.1.1 Reach Designations

Based on geographical location, stream gradient, and overall stream characteristics, Wilder Creek was divided into six reaches. The most downstream reach, Wilder Reach 1, begins just behind the beach and is within the "lagoon" or ponded area extending upstream for approximately 2,000 feet (Figure 3). This reach is located in the lowest gradient and lowest elevation of all the stream reaches surveyed in the creek. The lagoon pond at the downstream end of the unit is edged with bulrush and sedge-like grasses, which transitions to willows further upstream. The substrate appeared to be hard sand. The stream gradient in this unit is less than 1%.

The second reach, Wilder Reach 2, begins at the upper end of the lagoon and continues upstream to a tunnel under the railroad grade. The reach is characterized by a low gradient stream channel with gravel and sand substrate and a dense willow canopy. A section of this reach near the upper end is somewhat unusual in that the channel becomes indistinct passing through a cattail swamp. The creek meanders and broadens through dense thickets of alders, cattails, and willows. The stream course becomes very braided and no prominent stream channel is evident. Even with higher winter flows, fish passage may be difficult through this area. This condition continues until the bedrock headwall where the stream emerges from a tunnel cut through bedrock at the valley margin at the railroad overcrossing. The third reach continues from the railroad tunnel upstream to the former site of the small diversion dam removed in 2000. Upstream of the tunnel, the stream channel is much more well-defined and is relatively open under a riparian canopy of large alder, bay, and willow. The creek then passes through the barn, stable, and educational area of Wilder Ranch State Park. Some portions of the creek bank and creek bottom have been covered by concrete, particularly near one of the barns. There are also some spots in this area where it is evident that cattle or other livestock have direct access to the creek and have impacted the banks.

The third reach is characterized by a riparian canopy of willow and alder with canopy coverage that ranges from 50% to 95%; substrate that is mostly sand, with some gravels; and instream cover provided by small woody debris and root wads. The stream grade is approximately 1%. There is a potential fish migration obstacle in the upper part of this reach where a concrete road crossing forms a one foot drop at its lower edge. Passage is not favorable at low flows but is likely passable at higher flows.

The fourth reach begins at the downstream end of the "restoration" or "re-contoured" area within which there was a dam removal and stream re-alignment in Fall 2000. The riparian canopy is non-existent and the stream is completely open overhead. Willows planted as part of the restoration effort have not yet grown enough to provide shade. Any trees that were preserved during the construction effort are located back from the stream bank and do not provide a canopy. Water parsley (*Oenanthe sarmentosa*) was growing in the more sluggish waters. The substrate, which was influenced by the construction last year, is dominated by sand and gravel. The grade is approximately 1%. Peasley Gulch flows into Wilder Creek just downstream of this unit.

The fifth reach of Wilder Creek begins at the upper end of the re-contoured reach and has a riparian canopy that is significantly different than the lower reaches. It is dominated by bay, maple, and redwood and creates a much higher (taller) canopy. Small seeps are present along the stream bank and a small side channel enters the stream at the upstream end of the unit. Elk-clover (*Aralia californica*) is also found along the stream bank as well as ferns, horsetails, and sedge. The streambed has a gradient of about 2%, which increases to 3% at the upper end of the reach. In this reach debris jams and boulder cascades become more evident. The reach extends upstream to about 0.4 miles below Cave Gulch where there is an absolute passage barrier that is formed by a cascading bedrock ledge with a total drop of 7 feet.

Upstream of the first passage barrier, in Reach 6, the habitat is very similar to Reach 5. About a quarter mile upstream in Reach 6 there are two dams, one 8 feet high that has completely filled with silt and one 7 feet high that allows flow through the stream at the bottom of the dam. Reach 6 extends to the most upstream extent of the survey, terminating at the confluence of Wilder Creek and Cave Gulch.

4.1.2 Habitat Assessment

Pools accounted for almost 50% of the total habitat in Wilder Reach 2, and 22%, 9%, and 20% in Wilder Reaches 3, 4, and 5, respectively. Average depth was 0.5 feet or less for over 15% of the pools, with over 60% having an average depth of 1 foot. Generally the shallower pools were more common in the lower two stream reaches, and the deeper pools, i.e., maximum depth over 3 feet, were in the higher reaches. The re-graded section of the dam removal project was almost devoid of pools.

Generally, the habitat conditions within Wilder Creek vary with gradient and degree of disturbance. Habitat in the lowest stream reach (above the lagoon) consists of 49% pool, 27% riffle, and 24% flatwater In the re-contoured area (Reach 4), the habitat is dominated by riffle (64%) and flatwater (27%). Pools were in the upper end of this reach prior to "restoration" but were replaced by runs and low gradient riffles during construction. Habitats within Wilder Reach 3 and Wilder Reach 5 were more evenly distributed between flatwater, pool, and riffle, but flatwater was more predominant in Wilder Reach 3 (46%) and riffle more common in Wilder Reach 5 (44%).

The majority of instream cover in the lower two stream reaches was provided by undercut bank, small woody debris, and root mass, which provided an average of over 20-25% of the area with shelter. In the upper two reaches, however, the main shelter components were boulders and surface turbulence. Wilder Reach 5 had the highest average percentage of area with shelter at 38%, as well as a broad range of shelter components. However, in all the habitat units cover resulting from large woody debris (tree trunks and branches) is notably lacking.

Sand and gravel as both dominant and subdominant substrates were the most prevalent in the pool and flatwater habitats of the lower two units. These low gradient, flatwater areas tend to be depositional zones. In Wilder Reach 4 (the re-contoured area), gravel was the dominant substrate in 60% of the habitat units, with small cobble the most common subdominant size class, followed by sand and silt. This change in dominant substrate also accounted for the greatest area of potential spawning gravel of the four units (139 square feet as opposed to 11 to 40 square feet in the other units). Embeddedness of the spawning gravels was 50% or less. In Wilder Reaches 5 and 6, the highest gradient reaches, gravel and sand were also the most common size class, however large cobble represented the most common subdominant substrate and small cobble, boulder, and bedrock were also present as both dominant and subdominant size classes. The prevalence of sand in these reaches is likely the reflection of the presence of pools, all of which were one foot or more in depth and which accounted for 20% of the overall habitat. Approximately 40 square feet of spawning gravels were encountered in Wilder Reach 5, with embeddedness ranging from 0% to 50%.

Temperature determines the distribution of many native fish species and rainbow trout in particular. Stream temperature generally fluctuates on a daily basis in parallel with air temperature and reaches maximum levels on the Central Coast in July and August. Temperature becomes lethal for trout as it approaches and exceeds about 25°C (77°F). Though there is much variation, temperatures below 18°C (64°F) are generally regarded as optimum for rearing trout and temperatures up to 21°C (70°F) may be suitable if food is sufficiently abundant. Temperature was monitored at three locations in Wilder Creek between late May and early October 2001 (Figure 3). Automatic recording instruments stored temperature readings at one-hour intervals throughout the monitoring period, giving a detailed and accurate assessment of temperature conditions throughout the watershed. The results of temperature monitoring are presented in Table 3 and Figure 6. For the purposes of this report, a reach was determined capable of supporting a coldwater fish community (i.e., trout) if temperature only rarely exceeded 18°C (20% of the time or less) and never exceeded 21°C. Reaches where stream temperature exceeded 21°C but not for more than 10% of the time and never exceeded 24°C were considered sub-optimal but potential coldwater habitat. If temperature exceeded 21°C for more than 10% of the time or ever exceeded 24°C, the reach was considered warmwater habitat (Figure 6).

Table 3. Results of Wilder Creek Temperature Monitoring

Temperature	Upper Wilder		Re-contour Area		Wilder Lagoon	
	# of readings	% of total	# of readings	% of total	# of readings	% of total
Less than 16°C	3,195	99%	2,080	64%	148	4%
Between 16°C and 18°C	26	1%	460	14%	722	22%
Between 18°C and 21°C	0	0	471	14%	2001	62%
Between 21°C and 24°C	0	0	217	7%	369	11%
Over 24°C	0	0	7	0.2%	0	0

Wilder Creek upstream of the re-contour area (Reaches 5 and 6) has temperature conditions that would be considered optimal for steelhead. Conditions in the re-contour area warm significantly compared to upstream reaches due to the lack of riparian cover and shading. Based on the standards suggested previously, this reach would be considered warmwater habitat and would not be considered supportive of steelhead. Nevertheless, young-of-year steelhead maintained high density in this reach and appeared to have excellent growth rates (see below). This is likely due to the fact that cool temperatures (less than 16°C) prevailed for a significant amount of the time and probably occurred on nearly a daily basis. Warmer temperatures during the day may actually have enhanced growth rates of steelhead young-of-year in Wilder Reach 4 as food did not appear to be limiting.

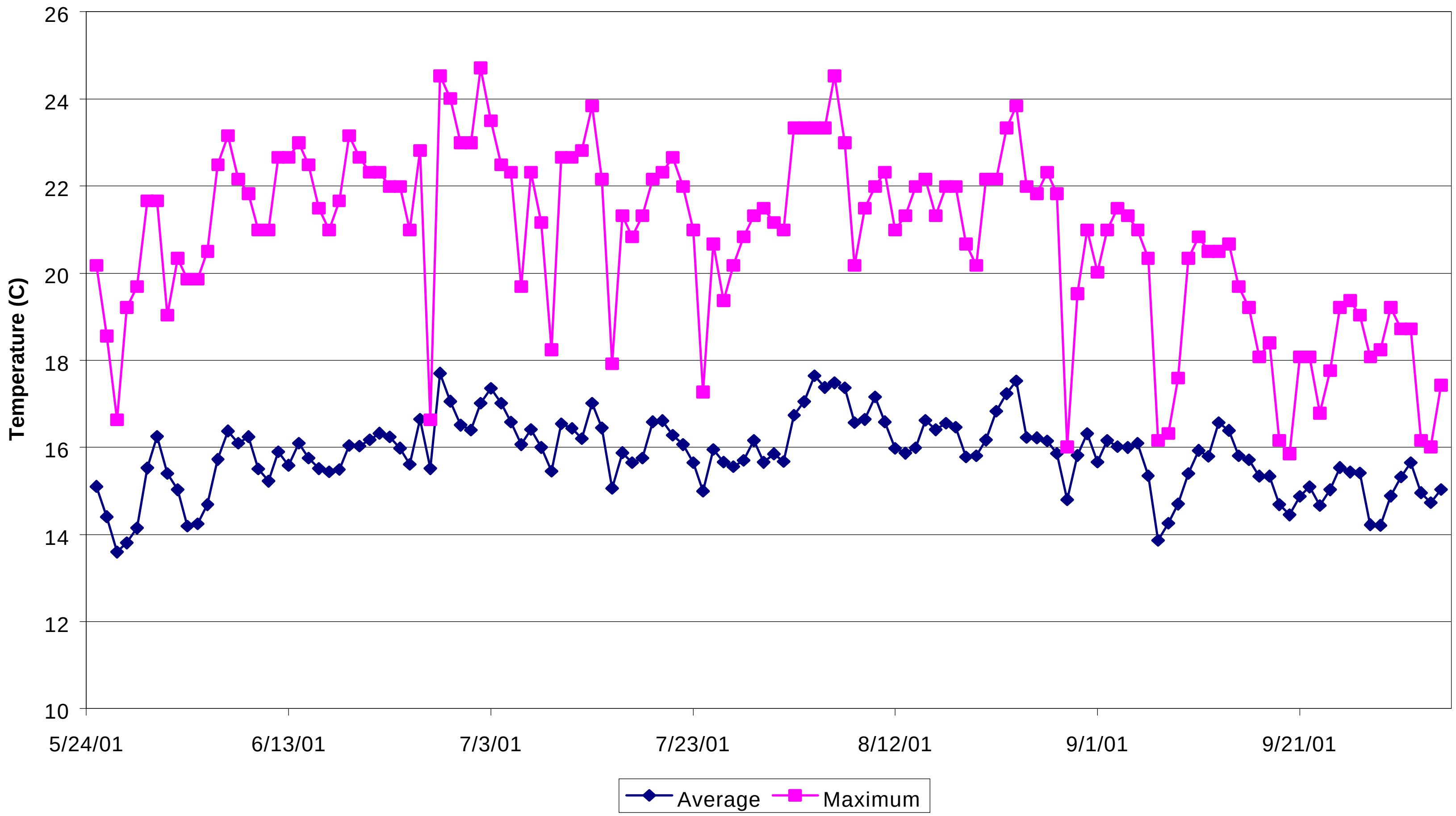

Figure 6. Daily Average and Daily Maximum Stream Temperature in Wilder Creek Re-contoured Area During Summer 2001

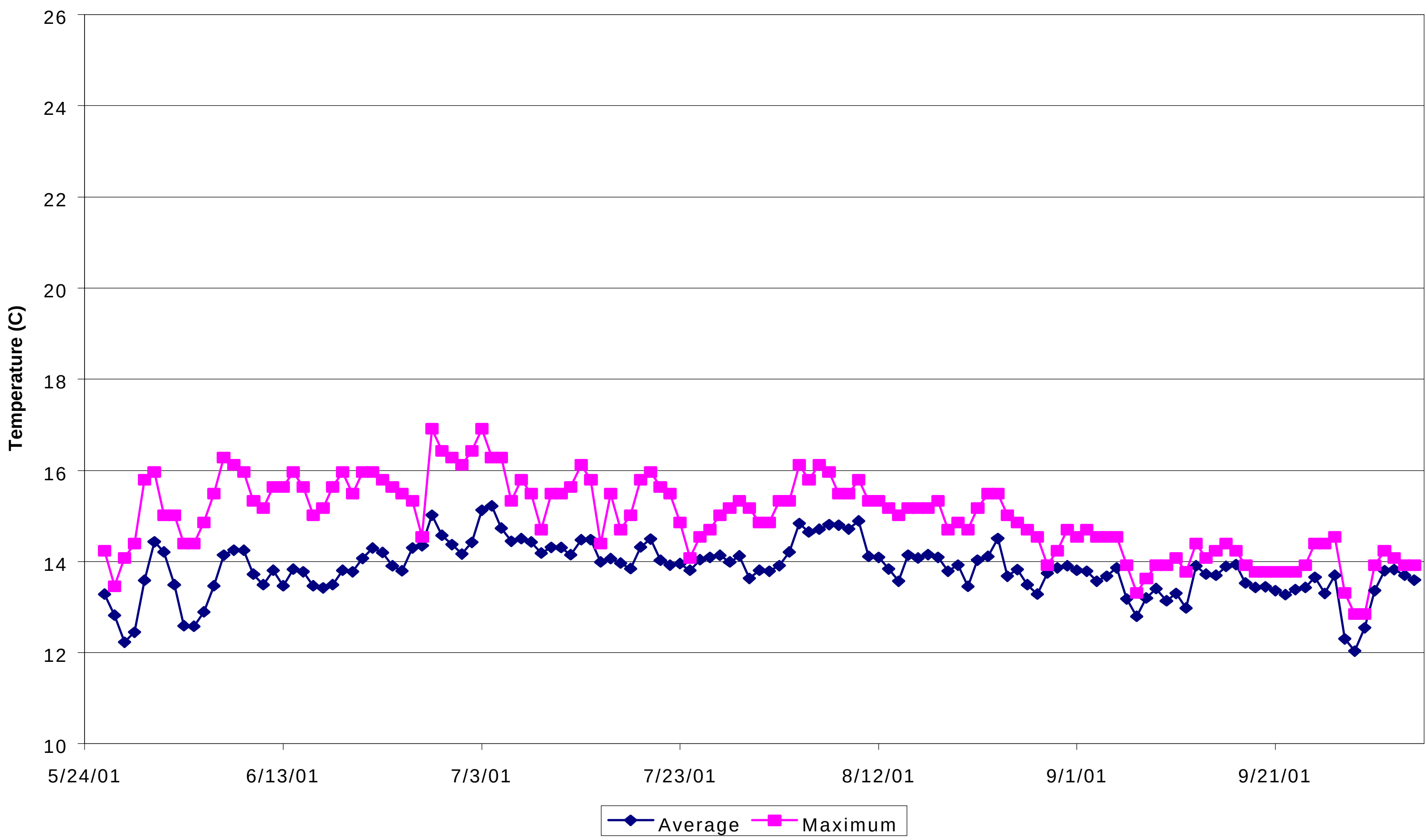

Figure 7. Daily Average and Daily Maximum Stream Temperatures in Wilder Creek Upstream of the Re-contoured Area during Summer 2001

4.1.3 Fish and other Vertebrates

During the habitat assessments in May 2001, all lifestages of trout were observed. In terms of overall abundance, the most trout were observed in Wilder Reach 4 (the re-contoured area), the least in the lagoon and areas upstream of the lagoon (Table 1). In this lowest section of the stream, nine of the ten fish seen were between 3 and 8 inches in length. Trout, particularly young-of-year, became increasingly more common in upstream areas with a maximum of at least 500 young-of-year observed in the re-contoured section. In this reach, no fish over 3 inches was seen. It is unclear whether steelhead would have negotiated the braided marsh zone of the lower reaches and spawned in this upper area since the dam was been removed in 2000 or whether these young-of-year are the result of resident spawning.

In the upper-most reach and further upstream, larger trout (4 to 6 inches) become more frequent. In the middle section of Wilder Reach 5, 2 possible redds were encountered with fry and 2- to 3-inch trout in the immediate vicinity. One redd was large enough to have been created by a steelhead.

Stickleback were seen in the lowest reaches of Wilder Creek and within the low gradient section of the re-contoured area. None were observed upstream of this section of Wilder Creek. Sculpin were very difficult to see at this level of assessment because they are so well camouflaged. Only one was seen in Wilder Reach 2 just upstream of the lagoon.

Over the length of Wilder Creek surveyed, a total of 24 California red-legged frogs were observed, with the majority of the frogs (estimated at 16 individuals) in the lagoon, 3 in Wilder Reach 2 (particularly in the cattails), and 3 in Wilder Reach 3. No frogs were seen in the re-contoured area although two were seen in Wilder Reach 5 just upstream of the re-contoured area. No frogs were seen in the remaining part of Wilder Reach 5 or in Wilder Reach 6.

Thirteen newts were seen but these were only in the upper portions of Wilder Creek, as were the two Pacific giant salamanders. These numbers, however, may be low because these animals are well camouflaged. One pond turtle and one aquatic garter snake were seen in the lagoon area of the creek; one aquatic garter snake was also seen in the uppermost section of Wilder Creek.

4.1.4 Electrofishing Surveys

Electrofishing surveys confirmed the results of the visual observations and added some more detail. Steelhead were the most abundant species in all reaches surveyed (Table 4). Stickleback abundance increased with distance upstream from the lagoon and peaked in the relatively warm open canopy habitats in the re-contoured area. Stickleback were not seen upstream from the re-contoured area. Prickly sculpin (*Cottus asper*) were relatively abundant immediately upstream from the lagoon but were replaced by coastrange sculpin (*Cottus aleuticus*) at the more upstream sample sites. Pacific giant salamander was found only in the more shaded, upstream sites where cobble was more common in the substrate and the canopy included redwood and Douglas Fir. Pacific giant salamander had been found in the reach immediately upstream from the dam site in the fall of 2000, before the dam was removed.

Table 4. Relative abundance of fish and amphibians captured during electrofishing surveys in Wilder Creek (number per mile)

Reach	Steelhead[1]		Prickly sculpin	Coastrange sculpin	Sculpin sp.	Stickleback	Pacific giant salamander
	y-o-y[2]	1+ and older					
Reach 1 – Wilder Lagoon	n.s. [3]	n.s	n.s.	n.s.	n.s.	n.s.	n.s.
Reach 2 – Above Lagoon	110	88	132	22	22	44	0
Reach 3 – Between tunnels/barns; north of Highway 1	209	119	30	179	0	104	0
Reach 4 – Re-contoured area	2621	314	0	74	0	554	0
Reach 5 – Upper stream	1339	191	0	115	0	0	19
Reach 6 – Above migration barrier	n.s.	n.s	n.s.	n.s.	n.s.	n.s.	n.s.

[1] Based on first pass only for comparison to other reaches
[2] Y-O-Y: young-of-year
[3] n.s.: not sampled

Steelhead abundance peaked in the re-contoured area above the dam removal site (Wilder Reach 4), primarily due to the presence of large numbers of fish hatched in the spring of 2001 (young-of-year). These young-of-year fish (y-o-y) were between 60 millimeter (mm) and 100 mm in length during the October 2001 sampling period. Based on the size frequency distribution (Figure 8), some of the fish captured in the 100 mm–110 mm or 120 mm size range may also have been y-o-y fish. The peak abundance of young-of-year fish was around 80 mm in the re-contour area but appeared to be closer to 70 mm at the most upstream site (Wilder Reach 5). The average young-of-year may have been largest in the reach just above the lagoon based on the size frequency distribution.

The re-contoured area was characterized by a very open canopy, relatively warm temperature, and lack of pool habitat, which are characteristics that can be associated with good growth and abundance of trout in their first year but that are not as favorable for older trout (primarily due to the lack of pool habitat). The area may have been a focus for spawning activity during the winter of 2000-2001 since the substrate had a high proportion of the gravel size class preferred by steelhead and was relatively un-compacted as a result of the re-contour project. Peak abundance of fish in their second year of life or older was upstream of the re-contour area.

The electrofishing results tended to agree with visual estimates, at least in terms of relative abundance in the different reaches. The electrofishing abundance index (based on first pass only) was significantly higher than the visual estimates (Table 5) since it is difficult to see trout under most circumstances, particularly those beyond their first year of life.

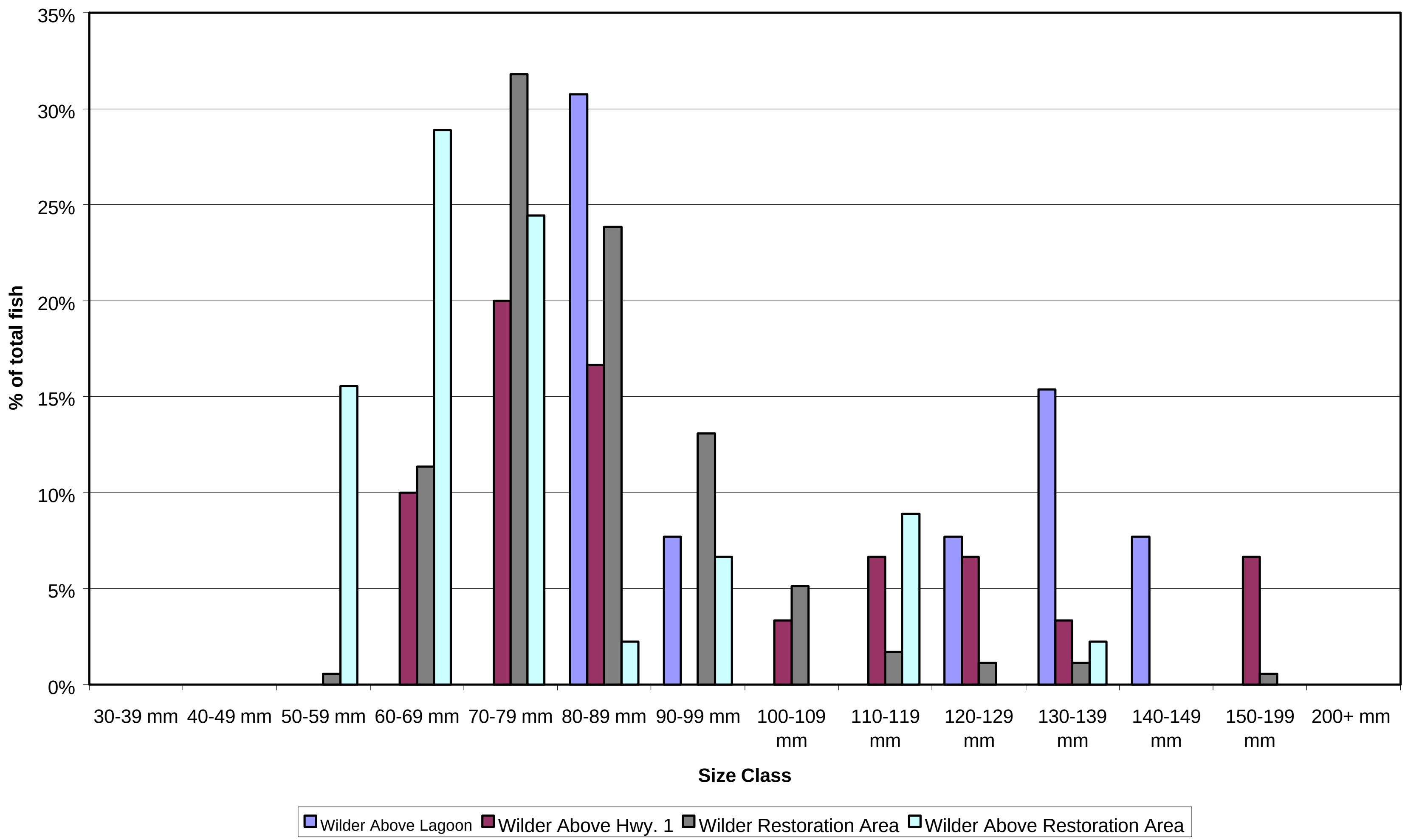

Figure 8. Size Frequency Distribution of Steelhead from Wilder Creek Sites

Table 5. Relative abundance and distribution of steelhead in Wilder Creek

Reach	Reach Length (miles)	Visual Estimates (#/mile)	Length Electrofished (feet)	Electrofishing Pass 1 (#/mile)	Population Estimate (#/mile)
Reach 1 – Wilder Lagoon	0.31	0	not surveyed	not surveyed	
Reach 2 – Above Lagoon	0.30	0	240	198	
Reach 3 – Between tunnels/barns; north of Highway 1	0.63	37	354	328	
Reach 4 – Re-contoured area	0.22	2,245	286	2,935	4,098
Reach 5 – Upper stream	0.83	49	138	1530	
Reach 6 – Above migration barrier	0.43	19	not surveyed	not surveyed	

4.1.5 Effect of the Dam Removal and Stream Re-contour Project

Since data were available for the re-contour area before the project in the fall of 2000, results from 2001 were compared to the previous survey. In preparation for the dam removal and streambed re-contour project in the fall of 2000, fish were removed from the project area upstream of the dam. The stream section was isolated with block nets and two complete passes were conducted to remove fish. Based on application of the Seber-LeCren method to the removal data, the population of trout was estimated at 438 fish in the approximately 900 foot stream section. Young-of-year fish (less than 100 mm fork length) accounted for about 64% of the total. Density estimates during the pre-project removal were 1,643 young-of-year trout per mile and 927 1+ and older trout. Post-project densities estimated using data from both electrofishing passes conducted on October 10, 2001 were 3,660 young-of-year and 438 1+ and older fish. Therefore, young-of-year density was approximately doubled after the project while density of older trout was approximately half.

There is also evidence that the young-of-year trout present following the dam removal and stream re-contour project experienced better growth than before the project. The length frequency distributions (Figure 9) show a distribution centered between 70 and 90 mm for post-project young-of-year but the center of distribution for pre-project young-of-year appears to be closer to 70 or 80 mm. This would be consistent with the higher water temperature in the re-contoured area compared to areas just upstream (see discussion under habitat assessment). It is also possible that these differences in size distributions could also have resulted from later spawning in 2000 than in 2001. Since steelhead could not pass the dam during the winter of 1999-2000 the young-of-year present in 2000 would likely have been the result of spawning by non-migratory trout and may have occurred later in the spring.

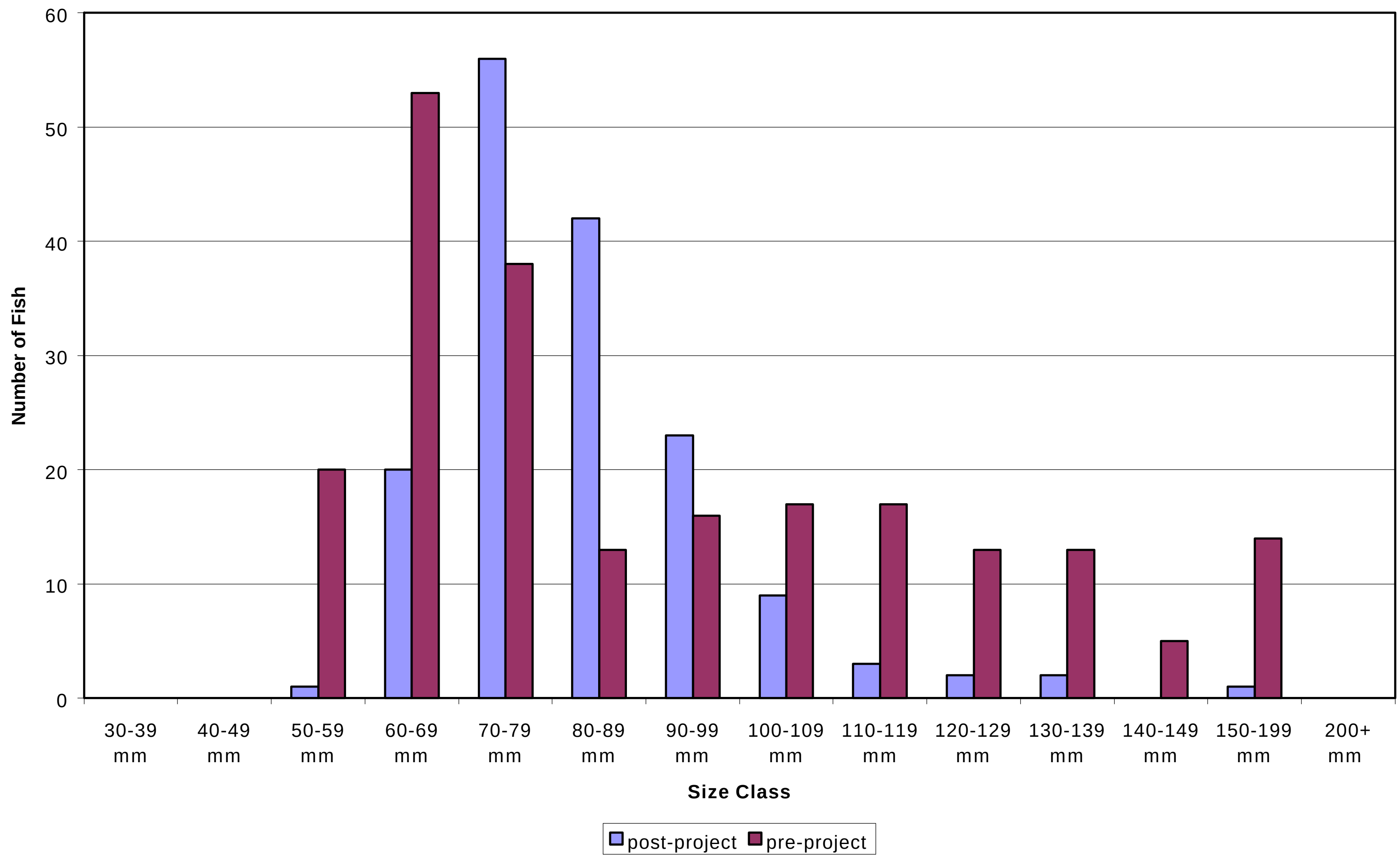

Figure 9. Size Frequency Distribution of Steelhead from the Wilder Creek Re-contoured Area

4.1.6 Factors Potentially Limiting Steelhead in Wilder Creek

Steelhead have access to approximately two miles of stream habitat in Wilder Creek. A natural falls about half a mile below the Cave Gulch confluence presents a passage barrier under most, if not all, flow conditions. The dam removed in 2000 from the lower part of Wilder Creek opened approximately 1 mile of good quality stream habitat for potential use by steelhead. Two conditions may still limit the ability of steelhead to access habitat in Wilder Creek. These include a section of willow thicket in Reach 2 where the stream channel is poorly defined and obstructed by dense growth of cattail and willow and the concrete road crossing near the horse corrals. In May 2001, there was 0.2 feet or less depth in some locations in the willow and cattail thickets and it was not apparent whether adult steelhead could negotiate a clear path through this area even under higher flows. The road crossing is just downstream of the re-contoured portion of Wilder Creek. In this location, there is about a one foot drop from the downstream lip of the apron, with no pool downstream. Adult steelhead may be able to pass through at high flows, but there may be some limitation to movement at lower flows.

In the preliminary habitat assessment, pools appeared to be somewhat limited in abundance and pool depth was relatively shallow in those pools present. Pools provide increasingly important habitat for steelhead after their second year of life and lack of pool habitat may slow development of smolts and reduce the number of smolts migrating to the ocean. Fine sediment accumulation is another potential limiting factor. Substrate conditions influence production of aquatic invertebrates important in the aquatic food chain. Many fish species also rely on relatively loose, clean gravel substrate with low amounts of fine sediments for reproduction. Larger substrate such as cobbles and boulders can provide hiding areas for juveniles of many species including trout. Fine sediments (silt and sand) present in excessive amounts fill spaces between the larger substrate elements and reduce their ability to support invertebrate production, spawning, and escape cover. Preliminary habitat assessments documented sand as the dominant substrate class in at least 30% of all habitat units and as a subdominant in an additional 15% or more. Although embeddedness ratings in pool tails and spawning areas was less than 25% for about half those measured, the other half had embeddedness up to 50%. Fish density, particularly for juvenile trout and salmon, is generally reduced as embeddedness increases.

Steelhead/rainbow trout appear to be less sensitive than some other salmonid species; however, young-of-year fish are particularly sensitive during winter and can be impacted at embeddedness levels greater than 5%-10%. Older juveniles during summer may tolerate embeddedness levels of 30%-50% without significant impacts on population density. Excessive amounts of fine sediment may also fill in pools and other deep areas and reduce their utility as habitat for adult fish.

The upper part of Wilder Creek is outside the park at the urban edge of Santa Cruz and is traversed by Empire Grade Road. Urban and suburban development within the watershed and other land use activities are potential threats to the quality of the stream within the park. Threats to water quality are of particular concern and could include illegal dumping off Empire Grade, discharge of fuel or other deleterious substance as a result of auto accident, application of residential pesticides, generation and mobilization of fine sediments, and nutrient enrichment.

Fishing in Wilder Ranch State Park is regulated by the California Department of Fish and Game. Current fishing regulations allow fishing in all streams west of Highway 1 from November 16 through February 28 on Saturday, Sunday, Wednesday, legal holidays, and the season opening and closing days. Only barbless hooks can be used. East of Highway 1 the streams are closed to fishing. These regulations are currently under review by CDFG and NMFS to determine the potential for impacts to steelhead. Angler use of streams in the Park is not well documented but based on the small size of the streams and the potential vulnerability of adult steelhead, legal fishing may represent a threat to steelhead populations. The extent of illegal angling both downstream and upstream of Highway 1 is also unknown but potentially significant in such small streams.

4.2 Peasley Gulch

Peasley Gulch is a tributary to Wilder Creek and therefore does not flow directly to the ocean. It joins Wilder Creek approximately one mile upstream from Wilder Creek's confluence with the ocean and thus does not have a tidally-influenced component.

4.2.1 Physical Setting

Peasley Gulch was not the focus of the intensive habitat assessment but detailed notes were taken during a visual survey of the stream, which began approximately a quarter mile upstream of its confluence with Wilder Creek and continued upstream for almost one-half a mile. The lower quarter mile of Peasley Gulch was dry at the time of the survey. Upstream of the dry section, Peasley Gulch is relatively flat, with a few boulder fields and debris jams. Within the half mile surveyed, there was an elevation gain of just over 100 feet, resulting in an average slope of almost 4%.

4.2.2 Habitat Assessment

Two reaches were identified within the linear distance of Peasley Gulch that was surveyed, essentially the lower quarter mile and the upper quarter mile (Figure 3). The lower reach is a relatively lower gradient section of stream along which runs a closed hiking trail (although it still appears to be in use). The riparian canopy consists of small willows and bay, both of which provide a moderate canopy. Buckeyes are prevalent on the upper hillsides. The substrate is predominantly sand, gravel, and small cobble, some of which forms good spawning gravels. No redds were noted but there were high numbers of fry in this section of stream indicating that there had been spawning success earlier in the year. Within the reach itself, there do not appear to be passage barriers. Pools are generally shallow and not generally adequate for steelhead after their first year of growth. Cover is provided by root wads and small woody debris.

At approximately a quarter-mile upstream from the starting point, the second reach begins. A six-foot debris jam forms the downstream end of this reach, with two additional debris jams upstream. The substrate is predominantly sand, especially upstream of the debris jams, large woody debris, and boulders. The canopy consists of mostly alder, redwood, and Douglas fir. No redds were noted in this reach.

The survey terminated where a trail comes down to the streambed and continues up the stream channel. There appears to be continuous, low level activity along this trail.

4.2.3 Fish and other Vertebrates

Between the survey starting point and the debris jam approximately a quarter mile upstream, over 150 fish were seen. Fry were very abundant in the shallow glides, riffles, and pools in the lowest section and spawning gravels are present. In one shallow glide with a depth of 0.3 feet, over 60 fry were in a section approximately 30 feet long by 4 feet wide. Throughout this section of the stream fry are concentrated in small areas. Flow is very low, less than 0.5 cubic feet per second (cfs). This rate of flow, shallow water depths, and sparse overhead canopy of willow may not have been favorable to allow adequate survival over the dry summer and warm fall. In this same section, 3- to 4-inch trout were also seen in shallow pools formed by root wads or in corner pools with no cover. At about 540 feet upstream, the number of deeper pools increases. In one corner pool, at least 30 trout ranging from less than 4 inches to 7 inches were gathered in a section 30 feet by 4 feet wide, which is at an unusually high density for these sizes of fish. They may have been steelhead smolts that were prevented from leaving the stream by low streamflow and residualized in the creek. During smoltification, the normal territorial behavior of steelhead parr is reduced and fish exhibit more of a tendency to school.

Above the first debris jam, 985 feet upstream, fry are not as prevalent and the fish seen are generally two inches or more. At this point the stream gradient increases and boulders are more prevalent. Larger fish, 6 to 8 inches, were found under large woody debris in a small plunge pool, whereas this type of habitat and associated fish were not found in the lower section. Although each debris jam in this section is not an absolute barrier, they may cumulatively reduce the frequency with which steelhead can access the upper part of the creek.

Four California red-legged frogs were observed in Peasley Gulch, all at the upstream extent of the survey area. These frogs were in full sun basking on a cobble bank in a section of stream with canopy dominated by redwood. One newt and one Pacific Giant salamander were also seen near this section of the stream. No stickleback, sculpins, garter snakes, or turtles were observed in any section of Peasley Gulch that was surveyed.

4.2.4 Factors Potentially Limiting Steelhead in Peasley Gulch

As access to Peasley Gulch is dependent on the ability of steelhead to negotiate the lower reaches of Wilder Creek, passage issues associated with Wilder Creek are key. With the number of fry observed in Peasley, it is very possible that steelhead have accessed Peasley during the last season. At a minimum there appears to be good production from resident trout. If passage is improved in the downstream reaches, it is possible that steelhead usage of the stream can be increased. Peasley appears to provide good conditions for steelhead spawning and young-of-year production but steelhead parr would have to move upstream or back down to Wilder Creek for good rearing habitat past their first year. No temperatures were recorded in Peasley Gulch.

CDFG has identified that the culvert that passes under one of the main roads leading to the park trails has blown out a number of times over the past few years. This may have compromised the ability of steelhead to move through the culvert during heavy flows; however this has not been confirmed and should be an item to be evaluated during future monitoring efforts.

4.3 Baldwin Creek

Baldwin Creek is located to the west of Wilder Creek and Dairy Gulch (which was not surveyed as part of this effort). At its downstream end, the creek is highly modified and diverted into two large ponds that appear to be maintained for irrigation of local fields. Below the diversion point, there is no well-defined channel and the creek flows into a thicket of willows and tules.

4.3.1 Reach Designations

Baldwin Creek was divided into five separate reaches (Figure 4). The most downstream reach, Baldwin Reach 1, begins at the beach and extends upstream through a long lagoon-like area. The creek was flowing into the ocean at the time of the survey although the flow was quite low. The second reach includes the section of indistinct channel through the willow and tule thickets. The third reach begins at the point where the stream is diverted into the agricultural ponds/impoundments and extends upstream to just above Highway 1, where there is an old farmhouse and outbuildings. In this section the creek flows through a defined stream channel with a riparian overstory of willow and alder. It passes through a long curved limestone-like tunnel that is formed by the railroad overcrossing berm. This tunnel was not surveyed. Within a short distance upstream the creek flows through the culvert underneath Highway 1. There does not appear to be any passage issues in this area. The fourth reach started just upstream of the Highway 1 culvert and the private residence, which occupies the east bank. Water parsley is quite thick in the shallow areas upstream of the culvert. At the residence on the east bank, a large, deep pool has been formed, most likely for swimming.

Dense stands of willow transition to large alder, working from the downstream to upstream sections of Baldwin Reach 4. This overstory provides a riparian canopy of generally 80% to 95%. In the shallow portions of this unit there is some duckweed. The substrate is sand and gravel and most instream cover is provided by small woody debris. The gradient is approximately 2%. A small diversion dam of sandbags is located at the upper end of Baldwin Reach 4; however, this is a very low diversion and would not impede steelhead passage.

Further upstream in Baldwin Reach 4, the canopy is almost entirely large alder and in general, is 90% to 95%. This reach has an average gradient of about 2%. The substrate is mostly gravel and sand, with most of the instream shelter provided by terrestrial vegetation and small woody debris.

At the upper end of Baldwin Reach 4, the stream becomes slightly steeper with an average gradient between 2% and 3%. Riffle habitat is prevalent, with two areas of potential redds within the riffle sequences. There are also many potential holding areas for adult steelhead and larger parr in pools under large woody debris and root wads. These pools are generally two feet and deeper. There is an increasing density of boulders and boulder cascades as the creek is followed upstream. Gravels become less common and spawning areas are limited. The riparian canopy begins to include bay and maple, in addition to alders. The stream channel becomes narrower, with scattered boulders becoming more common. Baldwin Reach 4 terminates at a probable steelhead barrier formed by a two stage cascade with a total drop of 15 feet. The pool formed at the base of the cascade is filled with sand and does not provide an adequate situation for jumping.

The furthest upstream section of Baldwin Creek surveyed was designated as Baldwin Reach 5 and was characterized by a vary narrow stream channel; an average gradient of 4% to 5%; and numerous deadfalls, logjams, and boulder cascades that would preclude any upstream passage of steelhead. Redwood became much more common in this section of the creek and made up much of the logjam material. It appeared that in the highest parts of this reach that there was some landslide activity on the steep banks. At the upstream terminus of this reach, a large marshy lake/pond was encountered. This was probably formed behind a large landslide. Upstream of the marshy area the stream continues at a relatively low gradient through redwood forest. The channel is relatively sinuous, shallow, and sandy. The survey was terminated at this point.

4.3.2 Habitat Assessment

The habitat assessment was limited to Reach 4 in Baldwin Creek where three discreet sections were mapped. Flatwater, pool, and riffle habitats were evenly represented in the two downstream sections Baldwin Reaches 4.1 and 4.2. Each unit contained seven pools, all of which averaged one foot deep or less. Both units also had one pool whose maximum depth was approximately 2 feet. Habitat types in the upper section, Baldwin Reach 4.3, were markedly different; pools accounted for only 8% of the habitat, with maximum depths of 2½ feet and an average depth of 1 foot. Flatwater habitats (step runs) dominated at 69%, with the remainder represented by high gradient riffles. All measured pools in the upper section were plunge pools, indicative of the higher gradient and increased boulder substrate of this upper section.

Instream cover in Baldwin Reach 4.1 provided mostly by undercut banks and small woody debris. These two components alone accounted for almost 40% of the shelter available in this section. The dominant shelter components transition to large wood debris and terrestrial vegetation in Baldwin Reach 4.2. In both these sections, the average amount of each unit with shelter was roughly 30%. As with habitat types, the predominant shelter components of Baldwin Reach 4.1 were significantly different than those of the lower units. Boulders and bedrock ledges were the dominant shelter components and on average over 40% of a unit had shelter. The third most common shelter component, surface turbulence represented almost 15% of the available shelter, whereas this component was characteristic of less than 3% of the shelter observed in the two downstream sections.

Sand and gravel were the dominant substrates found in the downstream sections of Baldwin Reach 4, with subdominant substrates represented by gravel, small cobble, and sand. In the higher gradient upper section the dominant substrates were sand and silt/clay with large cobble and boulder as the subdominants. The silt/clay substrates were encountered in the plunge pools, while sand was dominant in runs.

The extent of spawning gravel area ranged from approximately 1,730 feet per mile in the downstream section of Baldwin Reach 4, dropping to 460 feet in the middle section. The spawning gravel embeddedness was at 25% or less for these two sections. The upper unit had less than 100 feet per mile of potential spawning gravel, with a higher range of embeddedness, varying from 26% to 75%.

4.3.3 Fish and other Vertebrates

Numerous rainbow trout fry (three-quarters to one and one-quarter in length) were seen in Baldwin Reach 3, between the culvert leading to the impoundments and the railroad overcrossing tunnel (Table 1). Many of them were in riffles over sand and gravel. Within the two downstream reaches (the lagoon area and the thicket section), no trout fry, juveniles, or adults were seen but stickleback were present in the impoundments and lagoon area.

Between the middle and the upstream section of Reach 4 an increasing number of trout were observed. Numerous fry were seen in the riffle sequences of the lower gradient sections of this reach; especially near potential spawning gravels. Small numbers of fry are dispersed throughout the reach. As the gradient increased and the area of potential spawning gravels decreased and began to include more boulders, the number of fry seen also decreased; however, larger fish (3 to 4 inch trout) became somewhat more prevalent. The boulder cascade at the upstream end of Baldwin Reach 4 is likely a passage barrier. Above this point no fish were seen until just downstream of the marshy lake above Baldwin Reach 5. This lake then broadens out to a shallow stream that eventually intersects with the Enchanted Loop Trail. The five fry observed along this section of stream were likely the result of resident spawning as it is highly unlikely that there would have been successful steelhead passage into this part of the stream.

At least four California red-legged frogs were seen in the lowest section of Baldwin Creek in the area between the impoundments and the railroad tunnel culvert. Three more were observed in the slow waters near the house just below the downstream section of Baldwin Reach 4. An additional three red-legged frogs, with possibly a few more individuals, were seen approximately midway into Baldwin Reach 4, in an area with large alders and many pools. Seventeen of the eighteen newts observed were in upper section of Baldwin Reach 4 and throughout the creek upstream to the termination of the survey. Only one newt was seen between the middle and upper section of this reach.

Three Pacific giant salamanders were observed in the uppermost section of Baldwin Creek in Reach 5 and well into the high gradient areas upstream that were filled with numerous boulder cascades and log jams. As stated earlier, no fish were in this section; however, due to the high surface turbulence and cover provided by the downed logs and boulders, it is possible that the number of salamanders and fish are underestimated. Two western aquatic garter snake were observed in the section of Baldwin Creek that was surveyed; both were found along the stream bank in the lower part of Baldwin Reach 4. No pond turtles were observed in Baldwin Creek.

4.3.4 Electrofishing Surveys

An electrofishing survey was conducted only in a portion of Baldwin Reach 4, which was within the middle section of the length of Baldwin Creek that was surveyed. Three species of fish were present, with steelhead being the most abundant (Table 6). Prickly sculpin were far more abundant that Coastrange sculpin but in both cases, the sculpin were predominantly in the 4- to 6-inch size class and very robust. No stickleback or Pacific giant salamanders were seen.

Table 6. Relative abundance of fish and amphibians captured during the electrofishing survey in Baldwin Creek (number per mile)

Reach	Steelhead		Prickly sculpin	Coastrange sculpin	Sculpin sp.	Stickleback	Pacific giant salamander
	y-o-y[1]	1+ and older					
Reach 1 – Marsh Impoundments	n.s. [2]	n.s	n.s.	n.s.	n.s.	n.s.	n.s.
Reach 2 – Above impoundments	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Reach 3 – Tunnels and north of Highway 1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Reach 4 – Middle stream	774	138	304	83	0	0	0
Reach 5 – Steep stream above migration barriers	n.s.	n.s	n.s.	n.s.	n.s.	n.s.	n.s.

[1] Y-O-Y: young-of-year

[2] n.s.: not sampled

Compared to Wilder Creek, steelhead abundance is lower in Baldwin Creek for both the young-of-year fish and fish 1+ years in age. The peak size of the young-of-year fish is also much smaller than that observed in Wilder Creek, i.e., 50 to 60 mm versus 70 to 80 mm. The lower number of fish per mile, as well as the smaller size of the young-of-year may indicate that these fish are the result of late resident spawning, rather than steelhead reproduction. As discussed in detail within the next section, this may also show that steelhead access to these upper habitats is restricted due to the hydrologic impediments downstream.

In terms of relative abundance, the electrofishing results were significantly higher than the visual estimates in the reach where both survey methods were applied (Table 7). This is expected since it is difficult to see trout under most circumstances, particularly those beyond their first year of life, and Baldwin Creek has an average canopy of almost 80% and moderate to high shelter complexity.

Table 7. Relative abundance and distribution of steelhead in Baldwin Creek

Reach	Reach Length (miles)	Visual Estimates (#/mile)	Length Electrofished (feet)	Electrofishing Pass 1 (#/mile)
Reach 1 – Marsh Impoundments	0.1	0	not surveyed	not surveyed
Reach 2 – Above impoundments	0.17	0	not surveyed	not surveyed
Reach 3 – Tunnels and north of Highway 1	0.27	56	not surveyed	not surveyed
Reach 4 – Middle stream	0.76	67	191	912
Reach 5 – Steep stream above migration barriers	0.84	6	not surveyed	not surveyed

4.3.5 Factors Potentially Limiting Steelhead in Baldwin Creek

Steelhead passage is likely impaired, if not severely constrained, due to the hydrologic modifications at the lowest end of Baldwin Creek. There is good passage potential from the beach upstream through the lagoon section but two large impoundments are located just upstream from the beach and water is held back by a concrete dam approximately 6.2 feet from the dam crest to the water surface at its base. The dam appears to have flashboards on its west side, but they do not appear to have been removed for some time (years) when observed in May 2001.

Figure 10. Concrete dam on agricultural impoundments on lower Baldwin Creek

At the upper end of the impoundments there is a dirt berm formed across the creek with a 12-inch diameter culvert passing through it between the impoundment and the natural stream channel upstream. It appears that the impoundment is filled by allowing the stream to flow through the culvert. When the impoundment has been filled, the mouth of the culvert is blocked by a sheet of plywood and the streamflow is shunted off to the south side of the impoundment. There is not a well-defined stream channel in this location and, when not flowing into the impoundment, the stream is lost in a marshy area with dense stands of tules and willow thicket. Presumably, during the winter when steelhead would migrate through this section, the culvert is closed and the stream is flowing through the marsh south of the impoundment. It is not clear that steelhead would be able to negotiate the marshy area without a defined stream channel.

Figure 11. Culvert on Baldwin Creek

As in the Wilder Creek watershed, the upper part of Baldwin Creek is outside the park and is subject to impacts from existing or expanding suburban development.

Accumulation of fine sediments appears to be less of a problem in Baldwin Creek than in Wilder Creek. Although sand was the dominant substrate in approximately 40% of habitat units surveyed and was subdominant in approximately 25% of units in Baldwin Creek, embeddedness ratings in surveyed sections were almost exclusively under 25%.

The portion of Baldwin Creek accessible to steelhead is shorter than in Wilder Creek since the creek becomes steep about one mile upstream of Highway 1 and fish passage is limited by numerous significant cascades. As with Wilder Creek, the upper part of Baldwin Creek is outside the park and is potentially impacted by existing or expanding residential development.

4.4 Majors Creek

Majors Creek is one of the newest acquisitions by the Park and forms the western-most extent of the Park boundary (Figure 5). Because it is so new, a trail system near the creek has not yet been established; the main access, besides directly up the creek, is on either one or the other hillside, along what appear to have been access roads used for maintaining some of the small irrigation lines leading from the creek.

4.4.1 Physical Setting

In contrast to Wilder Creek and Baldwin Creek, flow within the lowest reach of Majors Creek is unimpeded as it flows from the alder canopy, across the beach, and directly into the ocean. There is no densely vegetated marsh area through which the stream must pass before entering the ocean. Due to time constraints, only 0.78 miles upstream from the beach were evaluated. Within that distance, there is an approximate vertical gain of 230 feet, with an average slope of almost 6%.

4.4.2 Habitat Assessment

Within the linear distance of the stream that was surveyed, three distinct reaches were identified. The first one is within the lowest section of Majors Creek, i.e., the portion south of the Highway 1 tunnel, which crosses through a small area of irrigated cropland and through a privately-owned campground. In contrast to Wilder and Baldwin Creeks, there are no passage barriers, either natural or constructed, to prevent the access of adults to spawning areas or outmigration of smolts within this reach of Majors.

The second major habitat reach begins immediately upstream of Highway 1 and is characterized by the typical willow and alder vegetation that was observed within the lower reaches of Wilder, Baldwin, and Peasley. The substrate is somewhat sandy, but with good pool development. The maximum depth of the pools is generally 2 feet and usually in association with large bay trees or other accumulations of large woody debris. At least four potential redds were noted in this reach.

Boulder cascades and cascade-formed plunge pools become much more common in the third and highest reach of Majors Creek that was surveyed. The canyon walls framing the stream drainage are steeper and closer that the downstream reaches; and the side walls support stands of redwoods. There are at least seven boulder cascades in this reach, ranging from four to six feet in height, as well as a large debris jam in the upper-most portion of the surveyed reach. The substrate is sand with cobble and the overhead canopy of mostly redwoods with a few bays and alders. Above the uppermost jam, a possible resident trout redd was noted in very sandy gravel but no fry were present.

The survey was terminated where a low concrete and boulder dam has been built across the stream channel that shunts the majority of the flow to the left (west) bank. A concrete intake tub is located on the left bank within which there is an active, screened intake pump. Above this point the active stream channel appears to be filled in with fine sand and gravel.

4.4.3 Fish and other Vertebrates

Over 120 rainbow trout were noted during the walking survey of Majors Creek. Almost half of the trout encountered were observed in the lowest reach of Majors, downstream of the Highway 1 tunnel/culvert. Fry, those fish between 20-30 mm, were abundant throughout this reach and the middle reach; however, within the boulder cascade/plunge pool habitats of the uppermost reach, fewer fry were seen. Trout ranging from 3-inches to 7-inches were encountered throughout the stream, but the highest numbers were seen in the lowest and the highest reaches. Table 2 shows the number of trout observed, as well as the other aquatic vertebrates noted during the survey.

It is interesting to note that the skeletal remains of a large fish were encountered in the streambed approximately one-half mile upstream from the beach. The larger size of the pectoral girdle and operculum would suggest that it was too large to be a resident trout and was most likely a steelhead. It was found near the location of a potential redd, with a number of very small (20-30 mm size class) young-of-year trout fry were observed.

Two sculpin were also observed. These fish were found just upstream and downstream of the Highway 1 tunnel, which is somewhat of a transition zone between the lower gradient section and the steeper areas upstream.

No California red-legged frogs were seen in the lowest reach of Majors Creek. The six California red-legged frogs that were observed began to be more apparent in the steeper sections of the stream, particularly near areas where potential redds were identified.

Of the reptiles, only one aquatic garter snake was seen. It was present in the same general vicinity as a red-legged frog, which was in one of the higher reaches surveyed, adjacent to areas characterized with a number of boulder cascades.

4.4.4 Electrofishing Survey

The electrofishing survey of Majors Creek was conducted in the lower section, just upstream of the Red, White, and Blue Campground. Steelhead, sculpin, and stickleback were present, and, as in Wilder and Baldwin Creeks, steelhead were the most abundant (Table 8). Again, prickly sculpin were far more abundant than Coastrange sculpin; however, about 20% were not identified to species. No Pacific giant salamanders were seen.

Table 8. Relative abundance of fish captured during the electrofishing survey in Majors Creek (number per mile)

Reach	Steelhead		Prickly sculpin	Coastrange sculpin	Sculpin sp.	Stickleback	Pacific giant salamander
	y-o-y[1]	1+ and older					
Reach 1 – Lower Majors	263	190	263	15	73	29	0
Reach 2 – Upper Majors	n.s. [2]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

[1] Y-O-Y: young-of-year

[2] n.s.: not sampled

Steelhead abundance of 1+ and older individuals is comparable to Reach 5 Wilder Creek; which had the second highest abundance of 1+ year old fish. However in Majors Creek, there were more fish greater than 150 mm, which was not observed in any of the other survey locations. The peak size of the young-of-year fish at 70 mm to 80 mm was also comparable to Wilder Creek.

In terms of relative abundance, the electrofishing results were double the visual estimates in this lower reach of Majors Creek (Table 7). This section of stream has well-developed cover, such as root wads, undercut banks, and overhanging vegetation from the bank, which provide shelter for fish and make them particularly difficult to observe during a visual survey.

Table 9. Relative abundance and distribution of steelhead in Majors Creek

Reach	Reach Length (miles)	Visual Estimates (#/mile)	Length Electrofished (feet)	Electrofishing Pass 1 (#/mile)
Reach 1- Lower Majors	0.53	211	723	453
Reach 2 – Upper Majors	0.25	48	not surveyed	not surveyed

4.4.5 Factors Potentially Limiting Steelhead in Majors Creek

Majors Creek has the most unimpeded access from the ocean to potential steelhead spawning and rearing areas but the shortest length of stream accessible to steelhead since the stream becomes quite steep and potentially impassible a short distance upstream of Highway 1. Spawning and rearing habitat is available throughout this reach right down to the beach.

As in the Wilder Creek watershed, the upper part of Majors Creek is outside the park and is subject to impacts from existing or expanding suburban development. Majors Creek is also influenced by City of Santa Cruz water supply diversion in the upper watershed and by agricultural diversions upstream of Highway 1.

Detailed habitat assessment was not conducted in Majors Creek; however, most parameters appeared to be within the ranges observed in Baldwin and Wilder Creeks.

5.0 Monitoring Plan

5.1 Scope and Objective

This proposed Wilder Ranch State Park monitoring program was developed for State Parks based on the field data collected during an initial assessment during the 2001 season and focuses on key aquatic species and sensitive habitats identified during that assessment. The primary objective of the monitoring program is to provide State Parks managers with information to identify changes in the areal extent and quality of aquatic habitat and changes in the presence or abundance of key aquatic taxa. The monitoring program is intended to be a streamlined activity that can be implemented with a minimum of bias, can be compared to results of other regional monitoring and can distinguish long-term trends from short-term variability.

5.2 Target Species

The aquatic assessment completed in 2001, and described in the preceding sections, identified populations of several native aquatic species inhabiting relatively pristine aquatic habitat within Wilder Ranch State Park. Among the aquatic organisms found within the watershed (Tables 1 and 2), many are sensitive to habitat alteration in the form of water quality degradation, flow modification, or human disturbance. The South-Central California Coastal steelhead and the California red-legged frog are key species in that they are protected as threatened species under the Federal Endangered Species Act. Because Wilder Ranch State Park appears to be maintaining healthy populations of both species, they may be representative of the overall health of the Park aquatic ecosystem. The protected Central California coho salmon, though not yet reported from these streams, should also be a focus of future monitoring. The following subsection presents brief life history summaries of the more important aquatic species within the Park.

5.2.1 Steelhead/Rainbow Trout

Steelhead/rainbow trout (*Oncorhynchus mykiss*) have a very flexible life history ranging from anadromous individuals that undergo a complete migratory cycle including extended periods of both freshwater and oceanic residence, to non-migratory individuals that complete their entire life history within a relatively small section of freshwater stream. These behavior patterns are not fixed and can occur within a given population, often being moderated by environmental conditions. In central California, adult steelhead enter coastal streams during the wet-season in association with increased runoff. The majority enter freshwater from January through March or April and spawn relatively soon after entering freshwater. Spawning habitat is typically in relatively shallow water where velocity increases in a pool-tail/ head of riffle area with clean gravel substrate. Spawning success is often influenced by accumulation of fine sediment within the gravel nests (redds) or high flows during the incubation period that damage the redd and incubating embryos.

Juvenile steelhead reside in freshwater for a period, commonly two years but ranging from one to four years or more. They are highly visual feeders, primarily selecting invertebrates that drift with the current or taking insects at the water surface. During this rearing period steelhead require relatively cool streams with swift flow and predominantly gravel or cobble substrate. As juveniles mature pool habitat with good cover becomes increasingly important. Steelhead begin the process of smoltification, most commonly at a size of 150-200 mm (6-8 inches) and migrate downstream to the ocean, beginning as early as the fall but most commonly in the spring (March-May). Steelhead spend variable amounts of time in the ocean but commonly reside there for a period of about two years, reaching a size of 18 to 28 inches or more. More detailed information on steelhead life-history and habitat requirements is included as Appendix B to this report.

5.2.2 California Red-legged Frog

The California red-legged frog (*Rana aurora*) occurs in varying habitat depending on lifestage and time of year but is generally highly aquatic (CDFG 1999). Their habitat can be characterized by areas of dense, shrubby riparian vegetation, such as arroyo willow cattails, and bulrushes, associated with still or slow-moving water (Jennings et al 1994). They are often found near breeding sites, which can include coastal lagoons, marshes, springs, permanent and semi-permanent natural ponds, ponded backwater portions of streams, and artificial impoundments (USFWS 1997). When startled or disturbed, it will retreat to deep pools, at least 3 feet in depth (CDFG 1999) and often remain completely motionless so as to avoid detection.

In assessment level surveys of Wilder Creek in 2001, red-legged frogs were found from lagoon habitats just behind the beach upstream into small tributary pools in redwood forest and in most areas in between. In the lagoon they were found in dense marsh vegetation several feet from the water and on overgrown silty banks near the water edge. In the redwood forest they were basking on bedrock outcrops up to four feet above the water surface and on cobble substrate a few feet from the stream.

Population declines of red-legged frogs have been attributed to habitat loss due to human activity and to competition with introduced exotic species such as bull frogs and some fish species. The California red-legged frogs are sensitive to water quality degradation, such as (herbicides, pesticides, and sulfate ions; and to habitat modification resulting from either surface or sub-surface diversion of streamflows (Jennings et al 1994).

5.2.3 Western Pond Turtle

The western pond turtle (*Clemmys marmorata*) is a state species of special concern. The western pond turtle is an aquatic species that leaves aquatic habitats to reproduce, aestivate, and overwinter (Jennings et al 1994). They are found most commonly in habitats with some slack or slow-water areas and may reach higher densities where aerial and aquatic basking sites are available. Their nesting sites can be found up to 0.5 kilometers from the aquatic habitats. During the 2001 aquatic assessment few turtles were seen. One was seen in the Wilder Creek Lagoon and one empty shell was found in Wilder Creek upstream of the dam removal and stream re-contour project area.

5.2.4 Other Amphibians and Reptiles

Newts and California giant salamanders are not listed as special status species under either the California Endangered Species Act or the Federal Endangered Species Act. However, these animals are often found in conjunction with trout streams and their presence is somewhat indicative of the stream quality.

The most likely newts to be found in the Wilder Ranch streams are the California newts (*Taricha torosa*) and/or the rough-skinned newts (*Taricha granulosa*). Within these streams, it is the adult form that would most likely be encountered in the water anytime from fall to late spring, depending on the location. This is the breeding period and during this time the adults become aquatic. After this time, the newts become more terrestrial and may remain near the streams beneath undercut banks, logs, and other debris or they may move farther inland and inhabit burrows and areas under rocks and logs (CDFG 1999). The aquatic form eats aquatic crustaceans, insects, snails and slugs but may also prey upon their own species eggs and other amphibians, as well as trout eggs. The rough-skinned newt is somewhat more aquatic than the California newt but appears to be found in much the same habitat (CDFG 1999). It should be noted that in some areas within its distribution that it is very difficult to distinguish from the California newt (Stebbins 1985).

California giant salamanders (*Dicamptodon ensatus*) are terrestrial as adults but may occur in streams as neotenic adults, an aquatic larval form retained during adult lifestages. These salamanders live in or near cool, moist forests and, where common, larvae are found in clear, cool, fast-moving waters similar to those that support trout populations. The aquatic adults prey upon aquatic invertebrates, fish, and other amphibians whereas the terrestrial forms eat slugs, snails, small invertebrates and mammals, and possibly reptiles and amphibians (CDFG 1999).

Pacific coast aquatic garter snakes (*Thamnophis atratus*) are locally common aquatic garter snakes and occur in areas associated with shallow rocky creek and swiftly flowing streams (CDFG 1999). They are diurnally active and can be found basking in rocky areas close to the stream or within dense streamside vegetation. If disturbed they will retreat to the water. Aquatic garter snakes prey upon fish, especially trout and sculpin and may also eat frogs, small mammals, and invertebrates.

5.3 Monitoring Elements and Protocols

State Parks manages properties along the central coast of California that contain relatively pristine coastal stream habitats that are unique in their isolation from the urban development that is encroaching upon much of this part of California. The streams within Wilder Ranch State Park are prime examples of the diversity that is representative of such habitats. One of the charges of State Parks is to preserve and protect the natural resources within the Parks system and monitoring of representative species and significant habitats provides a means to gauge the health of not only those species but of the ecosystems that they represent. Steelhead/rainbow trout and California red-legged frogs are two of those representative species. Not only are they important as protected species under the California and Federal Endangered Species Acts, but they are also very sensitive to environmental change. The presence of these two species in the watershed are indicative of the high quality of the streams.

Among the questions to be addressed in the monitoring include:

- Are the populations in Wilder Creek stable? How stable are they?
- If there are declines in populations, what is/are the cause(s)?
- Are activities within the Park boundaries, e.g., irrigation, water diversions, trail maintenance, trail use, negatively impacting the aquatic resources?
- State Parks initiated an enhancement project in 2000 whereupon a diversion dam was removed and the stream channel was re-contoured to its “original” depth in order to enhance Wilder Creek’s potential for supporting steelhead trout. How is this enhancement functioning? Has it been successful in the short-term? What will its effect be in the long-term? Are dam removals activities that Parks need to continue?
- Do sensitive species occurrence or life-history characteristics in Wilder Ranch State Park provide insight or enlarge the knowledge base for understanding and managing populations of these species on a wider geographic scale?
- Are exotic species encroaching into the streams?

In addition, monitoring of the steelhead form of *O. mykiss* populations has potential application on a wider geographic scale. Although steelhead are listed as a threatened species, the agencies responsible for their management, including the National Marine Fisheries Service, CDFG, and to degree, State Parks, often possess insufficient information concerning life-history variability and population status within these coastal streams. Therefore data provided by monitoring would contribute important and useful information regarding steelhead and potentially assist resource agencies in developing sound recovery plans and management policies.

A three-tier monitoring program is proposed to address these information needs. The first tier is a more routine assessment with the goal of monitoring the condition of habitat and population status to establish a baseline and then identify long term trends. The second tier addresses more focused issues relating to specific conditions identified during the initial assessment in 2001. These include assessment of the long term success of the Wilder Creek dam removal project, and evaluation of factors potentially influencing steelhead migration and rearing in the lower reaches of Wilder Creek, Baldwin Creek, and Majors Creek. Finally, the third tier contains elements that focus on more detailed questions concerning steelhead life-history and implications for species management and recovery efforts. These three tiers, while interdependent, can be pursued independently, allowing State Parks to tailor a monitoring program that is consistent with budgetary and manpower constraints.

5.3.1 Tier 1: Routine Habitat and Population Monitoring

This monitoring tier would first establish a baseline condition for habitat and key species populations within the Park and would provide a measure of variability in those conditions. This baseline phase would be relatively intense and would be best accomplished by a one-time detailed habitat inventory and annual population surveys over a three to five year period. Once the baseline period has been completed, follow-up surveys would be completed at three year intervals to identify significant trends. However, intermediate surveys may be warranted after El Niño/La Niña events because severe flooding and landslides can significantly alter habitat types and distribution.

5.3.1.1 Habitat Mapping

During the initial assessment in 2001, habitat mapping was performed only in limited sections of Wilder Creek and Baldwin Creek, the two main drainages in Wilder Ranch State Park. Based on reconnaissance level surveys of other streams in the Park, it is evident that Majors Creek and Peasley Gulch also contain high quality habitat.

As an initial baseline characterization of aquatic habitat in the Park, the detailed habitat assessment should be extended to cover all stream reaches in the Park using the California Salmonid Stream Habitat assessment methodology (Flosi et al. 1998), which was also used to characterize Wilder and Baldwin Creeks. Habitat typing should be at a Level-IV classification although some level of sub-sampling (i.e., the 10% methodology) would be appropriate. In each sample reach, all habitat units are to be identified by type and length measured. Initial encounters for each habitat type are to be characterized in full detail. Maximum depth, pool-tail crest depth, and pool-tail embeddedness are recorded for each pool encountered within the assessed stream reach. Canopy density is to be recorded and dominant and subdominant canopy species identified for each third habitat unit. The habitat assessment data are then analyzed by summarizing habitat type frequency of occurrence and parameter values with the discreet, homogenous stream reaches.

Potential migration barriers should be identified, located by GPS where possible, and evaluated with reference to species specific criteria for passage at both natural and constructed obstacles. Because some of the topography is very steep and may prevent satellite reception, locations of potential barriers can be estimated.

During the habitat mapping task, visual sightings of all fish and other aquatic vertebrates can be recorded as well. Time, distance, unit number if known, species, and approximate length should be recorded.

5.3.1.2 Steelhead Population Abundance

Steelhead population abundance would be monitored by electrofishing surveys conducted in Wilder Creek, Baldwin Creek, Majors Creek, and Peasley Gulch during the fall. These surveys will also provide information on other fish species, and other aquatic animals. Annual surveys would be conducted for three -five years to establish baseline conditions and inter-annual variability. After the initial 3 to 5-year period surveys would be conducted every third year. Quantitative sampling (two-pass method) should be conducted in at least one site in each stream reach (see Section 4.0 for reach definitions) with the remaining two sites sampled using a single pass for presence/absence and catch per effort. Sites in Majors Creek and Peasley Gulch are to be selected after review of the habitat mapping data, and definition of stream reaches within these streams.

All fish should be identified to species and all trout should be measured to either fork length or total length. Condition of each fish should be noted as well, especially the presence of disease, lesions, and/or parasites. A subset of individual fish will be weighed to establish condition factors for each sub-group and scale samples will be collected from a subset for age and growth analysis.

5.3.1.3 Amphibian and Reptile Population Abundance

Because the California red-legged frog is a federally listed endangered species and a state species of concern, a monitoring program targeting the California red-legged frog should be implemented. These surveys should be conducted on an annual basis for three to five years and then once every three years. Survey areas should be selected in each of the stream reaches identified in the 2001 initial assessment. Survey protocols as established by the U.S. Fish and Wildlife Service (USFWS 1997) for these frogs should be followed.

Because the majority of the amphibian and reptile species found in and around the streams of Wilder Ranch do not have special protection under either the California or Federal Endangered Species Acts, it is recommended that separate surveys not be conducted specifically to monitor the populations of newts, California giant salamander, turtle, or Pacific coast aquatic garter snake. Periodic monitoring of their numbers should be adequate. More detailed tracking of these species can be done during the electrofishing surveys. Detailed notes should be taken regarding the specifics of the surveys, such as:

- Date, time, and stream name
- Location (GPS) and/or Stream Reach and Habitat Unit
- Method of capture
- Number captured
- Length and condition of each individual captured

If only visual surveys are being conducted, the following should be noted:

- Date, time, and stream name
- Location (GPS) and/or Stream Reach and Habitat Unit, if known
- Animal observed, especially if exotics such as bullfrog are noted
- Habitat type within which the animal was observed

5.3.2 Tier 2: Focused Monitoring

Some conditions were observed during the initial assessment in 2001 that deserve special consideration or that, while they may not be integrated into an overall monitoring program, should be further evaluated to determine whether they constitute factors that limit or impair steelhead populations and whether further steps should be taken to mitigate them.

5.3.2.1 Monitoring of Wilder Creek Dam Removal and Stream Re-contour Project

In the Fall of 2000, State Parks initiated and completed an enhancement project for an approximately 1,000 foot long section of Wilder Creek upstream of the confluence with Peasley Gulch. An old diversion dam, which probably constituted a passage barrier for spawning steelhead, was removed and the sediment that had accumulated behind the dam was removed. The stream channel was excavated down to native bed material in the impoundment area and a section of upstream channel and the re-contoured area was replanted with riparian vegetation.

The re-contouring of the stream channel also included construction of a limited number of pools and the placement of boulders and gravel to create a range in the stream gradient and depth. Willow and other riparian vegetation were planted along the streambanks to ultimately provide overhead cover and shade.

As discussed in the preceding assessment results, there were significant differences in the structure of the trout populations inhabiting the re-contoured area immediately before and approximately one year after the construction was completed. This area has great potential to document the effects of a restoration project and apply this information to other potential projects. At the present, there are no plans to monitor the success of the project in terms of the quality and quantity of habitat for steelhead and rainbow trout. Therefore the proposed monitoring program includes tasks that should be undertaken in order to assess its success.

Annual electrofishing surveys should be conducted in the fall for at least the first five years after construction. After the initial period of annual sampling the frequency could be reduced to once every three years. These surveys should be conducted in the fall because the populations are more stable during this time of year and because the young-of-year produced in the spring are still evident in the stream. Quantitative sampling, using the two-pass method, should be employed for the full length of the enhancement area. The enhancement area should be divided into three sections, each approximately 300 to 350 feet long so as to sample a stream segment of reasonable length.

All fish should be identified to species and all trout should be measured to either fork length or total length. Condition of each fish should be noted as well, especially the presence of disease, lesions, and/or parasites. It would also be advantageous to weigh at least a subset of individual fish and to collect scale samples for growth analysis. It was hypothesized that trout in this area had higher growth rates in 2001 than in other parts of the stream and scale analysis could confirm this.

5.3.2.2 Passage Barriers at Lower Wilder and Baldwin Creeks

The active stream channels of lower Wilder Creek and lower Baldwin Creek, i.e., the sections of each of these two streams that are downstream of the railroad and Highway 1 tunnels, have been seriously compromised by human activity. In lower Wilder Creek, the stream channel becomes very braided, shallow, and during times of low flow, almost non-existent. In Wilder Creek this may be the result of past construction of roads or railroads in the watershed, alteration of stream morphology due to filling the channel for the railroad bed and construction of bypass tunnels, or other watershed activity (possibly logging). In Baldwin Creek, the problem seems to be accentuated by operation of agricultural diversions (see description in Section 4.3.5). The stream has become very shallow and may result in poor passage conditions for steelhead, even in winter during high flows.

Monitoring should first address whether present conditions result in limitations for steelhead populations. During higher flows, the active stream channel of both Baldwin Creek and Wilder Creek through the cattail marsh and willow thickets should be determined via walking surveys and determination made as to the potential for steelhead to migrate through the section. If a channel is discernable, it should be mapped, surveyed, and photographed. If it is determined that steelhead passage is impeded, remedial action should be considered. Remedial action, if required, would depend in part on the source of the problem, but may involve modification of vegetation, stream channel restoration, and/or modification of diversion facilities. Remedial actions should be based on an evaluation by a qualified hydrologist or geomorphologist with experience in similar streams.

At Baldwin Creek, operation of the diversion culvert, dams, and spillways should also be determined to see whether steelhead can pass through the impoundments to get upstream or whether alternative routes must be taken. Walking surveys during higher flow should be undertaken in order to assess if there is sufficient bypass flow around the impoundments to allow steelhead migration upstream. Additionally, it should be determined how and by whom are the flashboards manipulated at the head of the impoundments. If the flashboards are not moved at the correct time, complete barrier to upstream migration of spawners and/or a complete barrier to smolt outmigrants may exist.

5.3.3 Tier 3: Steelhead Life-history Monitoring

The primary source of information on steelhead biology in Central California comes from a single study on a single stream completed almost 50 years ago. Although this study is an excellent piece of work involving nine seasons of data collection, there are questions it does not answer. This single study has served as the basis of many regulatory decisions in watersheds that may or may not exhibit dynamics similar to the study stream. By monitoring and assessing the streams in Wilder Ranch State Park, the Department will be able to make more sound, site-specific decisions affecting the aquatic resources within the park boundaries.

State Parks, because of its extensive landholdings along the Central California coastline, offers a natural laboratory to study relatively undisturbed streams that have been and continue to be home to listed aquatic species. State Parks is in a position to augment the information base for steelhead in this region through a monitoring program in streams it manages.

5.3.3.1 Spawning Surveys

Although trout appear relatively abundant in streams of Wilder Ranch State Park, there is some question as to the degree to whether they represent production of steelhead or non-migratory trout. The only way to address this question is to capture adult steelhead coming into the streams, to observe them in spawning behavior, or to document the presence of their nests (redds). Documentation of steelhead spawning activity and location of spawning sites is generally difficult since spawning occurs during the high flow season when visibility is often poor and access to streams difficult. Streams in Wilder Ranch State Park are relatively small and have relatively undisturbed watersheds. The streams may clear more rapidly following rainfall events and observations during high flow may be easier than larger streams. In addition, the amount of stream accessible to steelhead is relatively short, particularly in Baldwin and Majors Creek and minimizes the amount of stream that needs to be searched.

Beginning in December and through mid-April, spawning surveys should be conducted in order to assess the usage of the major streams in the Park by steelhead trout. Spawning surveys should be conducted by trained fisheries biologists who are familiar with and have actively worked with rainbow and steelhead trout in Central California coastal streams. Surveys would be conducted opportunistically during high flow events in Wilder Creek, Baldwin Creek, Majors Creek, and Peasley Gulch are to be surveyed for the presence of spawning steelhead or steelhead redds. These are distinguishable from native rainbow trout redds by their larger size and use of larger substrates in the construction of their redds. For Wilder Creek and Baldwin Creek, the surveys should be conducted from upstream of the tule marsh/lagoon habitats, which are located south of the Highway 1 and railroad tunnels, upstream to the first passage barriers. These barriers were identified during the surveys conducted in 2001. In Majors Creek, the spawning surveys should take place from the Red, White, and Blue Campground, upstream to the Santa Cruz diversion. Spawning surveys in Peasley Gulch should be conducted from its confluence with Wilder Creek, upstream to the first identified passage barrier.

The size and location of each steelhead redd should be noted and photographs taken. The location of the redd(s) should include GPS coordinates or equivalent so as to allow return to the same site during subsequent surveys. Spawning is likely to occur at consistent locations from year to year and after the first couple of years, index areas could be established and visited to reduce survey effort.

It is important to consider the following questions during the performance of the surveys:

- Where do steelhead spawn in Wilder Creek? Are lower gradient willow/alder sections preferred or sections with redwood overstory or transition zones?
- Where do they spawn in Majors or Baldwin Creek?
- Are steelhead able to migrate into Peasley Gulch to spawn?

Answers to these questions may have relevance to the management or development of trail systems or other facilities. For example, if the survey results show that steelhead do migrate to spawning grounds in lower gradient sections of Wilder Creek that are easily accessible by foot, horseback, or mountain bike or even traversed by trails used by these park visitors, then future maintenance may include re-positioning of the trail and signage to discourage water access, at least during steelhead spawning season.

5.3.3.2 Smolt Migration

Observation of smolts in the population is another way to document the occurrence of steelhead as opposed to non-migratory trout although it is not as reliable as observation of adults. It is possible for non-migratory populations to produce smolts even when the populations are upstream of a barrier and there is no way for adult steelhead to return to the population. There is some question at to the ability of smolts to emigrate through the lower sections of Wilder Creek and Baldwin Creek due to channel characteristics and stream diversion practices (Sections 4.1.6 and 4.3.5, respectively). The extent to which conditions in the creek are a problem for smolts depends, in part, on when smolts migrate. If they migrate primarily in April and May, as suggested in the literature, successful emigration may be problematic. In other Central Coast streams, there is evidence that significant numbers of smolts may begin emigration as early as October (J. Nelson, personal communication, CDFG, Region 3, Monterey, California).

As discussed earlier, during the spring, particularly in April and May, young steelhead/rainbow trout begin the physiological process that allow them to go to the ocean and begin the marine phase of their life. At around 150mm to 200mm in length, these young fish known as smolt begin to move downstream towards the ocean. The fish are slender, silver, and have dark pigmentation, characteristics of which are distinctly different than those that have not yet smolted or have reverted back to the rainbow or freshwater stage. Trout that are not migrating retain their parr marks; are more colorful, retaining the characteristic rainbow coloration; and are not slender.

Smolt migration monitoring would address emigration timing, relative abundance of emigrating smolts, and size and age of smolts. This information would also be useful in evaluating emigration conditions and managing the lower stream sections of Wilder and Baldwin Creeks and documenting the relative production of steelhead from each of the Park's major streams.

Smolt migrant traps would be placed in the lower parts of each creek. To minimize effort and control costs, traps would be operated on an intermittent basis during the period from October through June with greater frequency during periods when migration increases. Numbers of fish captured, their length, weight, and degree of smoltification would be recorded. Scale samples would be collected from a subsample of individuals for age and growth determination. Environmental conditions during the capture period including average streamflow, rainfall events, stream and air temperature would also be recorded.

Since this element of the monitoring plan has the potential to produce information applicable to regional management and recovery of steelhead, it is possible that this study could be implemented with participation and funding augmentation from CDFG and/or NMFS.

5.4 Reporting

Each monitoring report should include survey types, methods, and results, as well as the raw data and maps showing all survey and sampling locations. Habitat information is to be assessed in conjunction with the fisheries data in order to evaluate the importance and use of certain habitat types by the various lifestages of steelhead.

Annual reports should be submitted to State Parks, CDFG, and NMFS. CDFG and NMFS are included because of their regulatory involvement in the management of steelhead and their need for information in developing recovery plans for coastal salmonids.

6.0 References

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APPENDIX A

HABITAT ANALYSES

Composition Type								
Sum of Habitat Length (ft)	Stream Reach							
Habitat Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
Flatwater	299	160	195	58	166	340	270	1488
Pool	36	162	243	118	81	121	154	915
Riffle	101	164	130	64	115	814	328	1716
Grand Total	436	486	568	240	362	1275	752	4119
% by length	**Baldwin 1+1**	**Baldwin H1+1**	**Baldwin H1+2**	**Wilder 3**	**Wilder H1+1**	**Wilder H1+2**	**Wilder H1+3**	
Flatwater	69%	33%	34%	24%	46%	27%	36%	
Pool	8%	33%	43%	49%	22%	9%	20%	
Riffle	23%	34%	23%	27%	32%	64%	44%	
Grand Total	100%	100%	100%	100%	100%	100%	100%	
Notes:								
Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4								
Wilder 3 is within Wilder Reach 2								
Wilder H1+1 is within Wilder Reach 3								
Wilder H1+2 is within Wilder Reach 4								
Wilder H1+3 is within Wilder Reach 5								

Habitat Summary								
Habitat Class	(All)							
	Stream Reach							
Data	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
Average of Mean Width	7.29	6.15	6.88	6.75	7.30	7.53	8.44	7.24
Average of Estimated Avg. Discharge (cfs)	0.75	0.50	1.00	0.50	0.50	0.50	0.75	0.66
Average of % Unit w/ velocity >0.5fps	45.71	38.24	30.29	39.10	36.50	48.75	38.68	39.51
Sum of Spawning gravel area (sq.ft.)	7	116	111	16	11	139	40	440
Notes:								
Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4								
Wilder 3 is within Wilder Reach 2								
Wilder H1+1 is within Wilder Reach 3								
Wilder H1+2 is within Wilder Reach 4								
Wilder H1+3 is within Wilder Reach 5								

Depth Classes								
Habitat Class	Pool							
Count of Depth Class	Stream Reach							
Depth Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
0.5		1	2	1	1	1		6
1	2	6	5	2	3	2	4	24
1.5				1		1	1	3
2							1	1
Grand Total	2	7	7	4	4	4	6	34

Habitat Class	Pool							
Count of Max Depth Class	Stream Reach							
Max Depth Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
0.5					1			1
1		2	2			1		5
1.5		4	4	1	2	1	4	16
2		1	1	3	1	1		7
2.5	2						1	3
3						1		1
3.5							1	1
Grand Total	2	7	7	4	4	4	6	34

Notes:

Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4

Wilder 3 is within Wilder Reach 2

Wilder H1+1 is within Wilder Reach 3

Wilder H1+2 is within Wilder Reach 4

Wilder H1+3 is within Wilder Reach 5

Depth Class Length								
Habitat Class	Pool							
Sum of Habitat Length (ft)	Stream Reach							
Depth Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
0.5		33	52	32	15	21		153
1	36	129	191	50	66	92	85	649
1.5				36		8	29	73
2							40	40
Grand Total	36	162	243	118	81	121	154	915

Habitat Class	Pool							
Sum of Habitat Length (ft)	Stream Reach							
Max Depth Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
0.5					15			15
1		29	66			21		116
1.5		118	125	32	45	28	85	433
2		15	52	86	21	64		238
2.5	36						29	65
3						8		8
3.5							40	40
Grand Total	36	162	243	118	81	121	154	915

Notes:

Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4

Wilder 3 is within Wilder Reach 2

Wilder H1+1 is within Wilder Reach 3

Wilder H1+2 is within Wilder Reach 4

Wilder H1+3 is within Wilder Reach 5

Shelter								
Habitat Class	(All)							
Data	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
Count of %% undercut bank	1	4	13	6	4	2	5	35
Count of %% swd	4	16	11	8	10	11	7	67
Count of %%lwd	0	0	3	0	0	7	4	14
Count of %% root mass	1	6	9	5	3	3	6	33
Count of %% terrestrial veg	3	8	16	9	6	3	2	47
Count of %% rooted aquatic veg	0	0	0	1	1	3	1	6
Count of %% floating aquatic veg	0	1	0	1	0	0	0	2
Count of %% surface turbulance	5	6	4	5	1	17	15	53
Count of %% substrate (d>5")	6	4	7	1	0	20	18	56
Count of %% bedrock ledge	2	1	0	0	1	0	1	5
Count of %% other	0	0	0	0	0	0	0	0
Count of % Unit w/ Shelter	7	17	17	10	10	20	19	100
Habitat Class	(All)							
Count of Shelter Complexity	Stream Reach							
Shelter Complexity	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
H	2	5	2	1	2		1	13
M	5	6	13	6	5	15	18	68
L		6	2	3	3	5		19
(blank)								
Grand Total	7	17	17	10	10	20	19	100
Habitat Class	(All)							
	Stream Reach							
Data	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
Average of %% undercut bank	8.75	20.63	8.08	11.83	7.56	4.00	8.70	9.97
Average of %% swd	2.81	18.70	4.95	3.50	14.63	4.36	7.54	9.55
Average of %%lwd	#DIV/0!	#DIV/0!	14.33	#DIV/0!	#DIV/0!	5.57	4.44	7.13
Average of %% root mass	10.50	8.33	7.11	11.50	6.00	2.83	8.79	7.92
Average of %% terrestrial veg	4.75	8.13	13.41	3.39	10.00	2.33	4.50	8.52
Average of %% rooted aquatic veg	#DIV/0!	#DIV/0!	#DIV/0!	8.00	1.00	2.33	1.50	2.92
Average of %% floating aquatic veg	#DIV/0!	8.00	#DIV/0!	2.50	#DIV/0!	#DIV/0!	#DIV/0!	5.25
Average of %% surface turbulance	14.75	1.88	2.63	2.20	2.00	4.29	8.03	5.70
Average of %% substrate (d>5")	23.58	2.88	2.64	1.50	#DIV/0!	10.35	23.44	14.32
Average of %% bedrock ledge	20.00	2.50	#DIV/0!	#DIV/0!	2.50	#DIV/0!	5.25	10.05
Average of %% other	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Average of % Unit w/ Shelter	42.86	31.18	30.00	21.00	26.00	20.00	38.16	29.35
Notes:								
Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4								
Wilder 3 is within Wilder Reach 2								
Wilder H1+1 is within Wilder Reach 3								
Wilder H1+2 is within Wilder Reach 4								
Wilder H1+3 is within Wilder Reach 5								

Substrate								
Habitat Class	(All)							
Count of Dominance Class	Stream Reach							
Dominance Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
silt/clay	2		1	1				4
sand	3	9	7	3	8	6	7	43
gravel		8	9	6	2	12	7	44
small cobble						2	1	3
large cobble	1						3	4
boulder	1						1	2
#N/A	1	3	3					7
Grand Total	8	20	20	10	10	20	19	107

Habitat Class	(All)							
Count of Sub-dominance Class	Stream Reach							
Sub-dominance Class	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
silt/clay		2	4	2	5	3		16
sand		4	6	6	2	5	3	26
gravel		6	4	2	3	3	1	19
small cobble		5	3			7	3	18
large cobble	1					1	10	12
boulder	6					1	1	8
bedrock							1	1
#N/A	1	3	3					7
Grand Total	8	20	20	10	10	20	19	107

Notes:
Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4
Wilder 3 is within Wilder Reach 2
Wilder H1+1 is within Wilder Reach 3
Wilder H1+2 is within Wilder Reach 4
Wilder H1+3 is within Wilder Reach 5

Embeddedness

Count of Pool Tail Embeddedness %	Stream Reach							
Pool Tail Embeddedness %	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
1 (0%-25%)		8	5	4			2	19
2 (26%-50%)	1					4	1	6
3 (51%-75%)					1		1	2
(blank)								
Grand Total	1	8	5	4	1	4	4	27

Count of % Spawning gravel embeddedness	Stream Reach							
% Spawning gravel embeddedness	Baldwin 1+1	Baldwin H1+1	Baldwin H1+2	Wilder 3	Wilder H1+1	Wilder H1+2	Wilder H1+3	Grand Total
1 (0%-25%)		13	11	4	3	6	4	41
2 (26%-50%)	2					6	3	11
3 (51%-75%)	1							1
(blank)								
Grand Total	3	13	11	4	3	12	7	53

Notes:

Baldwin 1+1, H1+1, and H1+2 are within Baldwin Reach 4

Wilder 3 is within Wilder Reach 2

Wilder H1+1 is within Wilder Reach 3

Wilder H1+2 is within Wilder Reach 4

Wilder H1+3 is within Wilder Reach 5

APPENDIX B

Steelhead/Rainbow Trout Life-History Characteristics and Habitat Requirements

Steelhead/rainbow trout have a very flexible life history. All *O. mykiss* hatch in the gravel substrate of coldwater streams. After a period of two to three weeks the young fry begin to emerge from the gravel and start feeding in the stream. Some begin to disperse downstream in the months following their emergence but most continue to rear in the stream. Following a rearing period of at least one year, juveniles (parr) may follow a variety of life-history patterns including residents (non-migratory) at one extreme and individuals that migrate to the open ocean (anadromous) at another extreme. Intermediate life-history patterns include fish that migrate within the stream (potamodromous), fish that migrate only as far as estuarine habitat, and fish that migrate to near-shore ocean areas These life-history patterns do not appear to be genetically distinct, and have been observed interbreeding (Shapovalov and Taft 1954).

Rainbow trout that migrate to the ocean (anadromous) undergo physiological changes in the process of smoltification that allow them to adapt to seawater. These fish, commonly referred to as steelhead, spend a variable amount of time in the ocean, typically one to two years, grow rapidly and return to spawn, generally in the stream where they hatched. Steelhead are unusual among the other Pacific salmonids in that they do not all die after spawning. Some return immediately to the ocean, others return after holding for a period in freshwater. Some rainbow trout within any given stream, and the proportion may vary considerably depending on local circumstances, do not migrate to the sea. These fish reach sexual maturity and spawn without entering the ocean and are often known as resident or stream rainbow trout. They mature at smaller sizes than sea-run steelhead and produce fewer eggs. There are a number of documented life-history strategies that are intermediate between resident populations and fully anadromous populations.

Within a given stream, some *O. mykiss* do not migrate to the sea, and the proportion may vary considerably depending on local circumstances. These fish reach sexual maturity and spawn without entering the ocean and are often known as resident or stream rainbow trout. There are selective advantages to both anadromous and resident strategies (Cramer et al. 1995). Anadromous fish grow faster and reach a larger size thereby gaining a potential to produce more offspring than resident fish. At the same time, however, migratory fish are exposed to many sources of mortality and there is a risk that conditions may become unsuitable for migration, particularly in California where fluctuating climatic conditions can result in long periods when streams have tenuous connection to the ocean. In California, many streams support both resident and anadromous forms with no observable genetic differentiation. During extended drought periods it is possible for populations to sustain themselves through resident spawning and then revert to an anadromous life history when suitable conditions return.

Steelhead/rainbow trout habitat requirements are associated with distinct life history stages including migration from the ocean to inland reproductive and rearing habitats, spawning and egg incubation, rearing, and seaward migration of smolts and spawned adults. Habitat requirements and life-history timing can vary widely over the steelhead’s natural range (Barnhart, 1986; Pearcy, 1992; Busby et al., 1996). Some of the best information on steelhead life history comes from a multi-year study in Waddell Creek in the Santa Cruz mountains (Shapovalov and Taft, 1954)

In-migration of adult steelhead. Steelhead along the Central California coast enter freshwater to spawn when winter rains have been sufficient to raise streamflows and breach sandbars that form at the mouths of many streams during the summer. Increased streamflow during runoff events also appears to provide cues that stimulate migration and allows better conditions for fish to pass obstructions and shallow areas on their way upstream. The season for upstream migration of adults lasts from late-October through the end of May but typically the bulk of migration (over 95% in Waddell Creek) occurs between mid-December and mid-April. Steelhead have strong swimming and leaping abilities that allow them to ascend streams into small tributary and headwater reaches. Steelhead can swim at rates of up to 4 feet per second for extended periods of time and can achieve burst speeds of 12 feet per second or more during passage through difficult areas (Bell, 1986). Given satisfactory conditions, a conservative estimate of steelhead leaping ability is a height of 6 to 9 feet (Bjornn and Reiser, 1991), although other estimates range to as high as 15 feet (McEwan, 1999)

Spawning and egg incubation. Steelhead and rainbow trout select spawning sites with gravel substrate and with sufficient flow velocity to maintain circulation through the gravel and provide a clean, well-oxygenated environment for incubating eggs. Preferred gravel substrate is in the range of 0.25 to 2.5 inches in diameter and flow velocity is in the range of 1-3 feet per second. Steelhead will use substrate with larger gravel (up to 4 inches) than resident trout. Typically, sites with preferred features for spawning occur most frequently in the pool tail/riffle head areas where flow accelerates out of the pool into the higher gradient section below. In such an area, the female steelhead will create a pit, or redd, by undulating her tail and body against the substrate. This process also disturbs fine sediment in the substrate and lifts it into the current to be carried downstream, cleaning the nest area. Survival of fertilized eggs through hatching and emergence from the gravel is most often limited by severe changes in flow that can dislodge eggs from the substrate, result in sedimentation, or de-water incubation sites.

Rearing. After emergence from the gravel, trout fry inhabit low velocity areas along the stream margins. As they feed and grow they gradually move to deeper and faster water. Trout of 4-6 inches (generally in their second year of life) may be commonly found in riffle habitat, particularly in warmer streams. Trout larger than 6 inches are more often found in deeper waters where low velocity areas are in close proximity to higher velocity areas and cover is provided by boulders, undercut banks, logs, or other objects. Heads of pools generally provide classic conditions for older trout. Trout, particularly coastal steelhead/rainbow trout, can inhabit quite small streams. Often habitat for older trout may be far more limiting than habitat for younger fish. The critical period is during base flow conditions that generally occur between May and October in Central California. Streamflow can drop to very low levels with loss of depth and velocity in riffle and run habitats, or in the extreme, only isolated pools with intervening dry sections of stream.

Although standard definitions of good trout rearing habitat often include conditions such as baseflows of at least 25 to 50% of the average annual daily flow, 1:1 riffle to pool ratios, and depths of a foot or more, these conditions may not always be achieved in Central California streams that still support relatively good steelhead/rainbow trout populations. Steelhead/rainbow trout populations in Central California can occur in streams with relatively low baseflow and in streams varying widely in terms of standard evaluation parameters such as pool:riffle ratio and mean depth. Often, local populations thrive under conditions that may depart widely from species norms (Behnke 1992). Steelhead respond to stream conditions that limit habitat for older trout by leaving the small streams to complete the maturation process in the more accommodating ocean environment.

Temperature is an important factor for steelhead/rainbow trout, particularly during the over-summer rearing period. The influence of water temperature on steelhead and other salmonids has been well studied and the influence on individual trout populations is complicated by a number of factors such as local adaptations, behavioral responses, other habitat conditions, daily and annual thermal cycles, and food availability. The most definitive temperature tolerance studies have been conducted in laboratory settings where experimental conditions have been highly controlled and fish were exposed to constant temperatures (Brett, 1952; Brett et al., 1982). Upper lethal temperature for Pacific salmonids is in the range of 75-77°F (24-25ºC) for continuous long-term exposure. Elevated temperature below the lethal threshold can have indirect influence on survival due to depression of growth rate, increased susceptibility to disease, and lowered ability to evade predators. In some studies, steelhead have exhibited decreased migratory behavior and decreased seawater survival at temperature in excess of 55°F (13ºC) (Zaugg and Wagner, 1973; Adams et al., 1975).

Smolt Out-migration. Behavior of steelhead/rainbow trout in Waddell Creek is probably typical for most Central California populations. Trout of various ages migrated out of Waddell Creek in all months of the year but the majority migrated in April, May and June. Downstream migration of young-of-year fish (less than a year old) extended from late-April through the following spring, however this movement may have been just dispersal to downstream rearing areas and not a true seaward migration. Downstream migration of 1-year-old fish was from April through late June and 2-year-old fish from March through late May.

Out-migration of adults. Steelhead that survive spawning return downstream to re-enter the ocean. As many as 20% of adult spawners may be repeat spawners and some fish may return to spawn up to 3 or 4 times (Shapovalov and Taft 1954). In some streams fish return downstream immediately after spawning while in others they may remain for a period up to several months. After spawning, these fish do not typically resume feeding while in freshwater. Fish that remain in the stream for any period of time generally reside in deeper pools. In Waddell Creek the bulk of adults returned downstream from April through June.

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