DISTRIBUTION AND ABUNDANCE OF JUVENILE COHO AND STEELHEAD IN GAZOS, WADDELL AND SCOTT CREEKS IN 2007-2022

Cumulative results and discussion, with **2022 material and key discussions in bold** (summaries of previous years (since 2007) remain in the report for comparison). The appendix at the end of the report has tables from Smith (2007), with coho and steelhead densities from years prior to 2007.

Jerry J. Smith, frogs_and_fish@yahoo.com
Department of Biological Sciences (Emeritus)
San Jose State University, San Jose, CA 95192
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TABLE OF CONTENTS

ABSTRACT

In late August through October, 25-31 representative sites had been sampled annually since 1992 in the Gazos Creek, Waddell Creek, and Scott Creek watersheds to assess distribution and abundance of coho (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*). In late August 2020 sampling was planned to be repeated, but on 16 August lightning-caused fires triggered the CZU Megafire that burned through the majority of the three watersheds. Only very limited sampling in October 2020 was conducted at 4 of 7 regular sample sites on Gazos Creek and 3 accessible main stem Waddell Creek sites; no sampling was conducted on Scott Creek. In 2021, I was able to resample all 7 regular sample sites on Gazos Creek in September, but October sampling on Waddell and Scott creeks was limited to a single site on Waddell Creek and 3 sites in the Scott Creek watershed, due to water temperature sampling restrictions that delayed sampling and to a large early storm (24 October) that eliminated further sampling. Therefore, continuing to assess impacts of the fire on conditions in the watershed and conducting fall juvenile sampling was a 2022 priority. Since there was very little wild coho production in 2019, returns in winter 2021-2022 would have come from about 28,000 hatchery-reared smolts from captive broodstock released in Scott Creek in spring 2020 and from releases of 15,000 hatchery-reared parr in fall 2019 in Waddell and Scott creeks. Weir and PIT antenna detections and spawning surveys on Scott Creek in winter 2021-2022 (Joe Kiernan, NOAA Santa Cruz, pers. comm.) indicated a very strong adult coho run in a year favorable for adult access and redd survival. The strong run in Scott Creek, made the assessments of fire-related habitat conditions and fish sampling on Gazos and Waddell creeks especially important, as NOAA was conducting fish studies on Scott, San Vicente, and Pescadero creeks. I conducted a reduced sampling effort on Scott Creek for comparison with the long-term data set.

The 2020 fire in the three watersheds killed many Douglas firs and streamside alders, but most tanoaks, maples and redwoods had basal sprouts, and redwoods also had trunk and branch (epicormic) sprouts; roots of even trees with dead trunks should help hold slopes in place. The first winter after the fire was mild, so debris flows were generally avoided. However, there was a lack of ground cover outside the riparian corridor, due to the dry winter, allowing some erosion and stream siltation. In Gazos Creek the assessment in August 2021 showed the fire damage to the forest in the accessible steelhead and coho habitat mostly stopped at the riparian stream border. Pools had more silt in 2021, but the channel, stream shading, and summer water temperature were little changed. Conditions appeared similar in parts of the Scott Creek watershed to the lighter streamside and channel effects seen on Gazos Creek, but I made no detailed assessment. On Waddell Creek and West Waddell Creek there were some debris flows that filled large pools and created aggraded steps behind log jams. The substantial loss of riparian canopy and shading upstream of mile 2.75 on Waddell and West Fork Waddell resulted in summer water temperature increases of 2-4°C. Some wood was added to the streams in 2021, creating a few logjams, but other logjams were burned.

In October and December 2021, large storms produced the erosion of bare slopes and streambed sedimentation that the three watersheds had largely been spared in the first winter. There were extensive channel changes and filling or even elimination of pools. Old wood and wood added to the streams in winters 2020-2022 was moved during the storms, adding structure and also removing former pool structure. Wood was also assembled into large logjams on Waddell Creek, and especially Gazos Creek, that are presently or potentially fish passage problems. Logjams at mile 0.65 on Waddell Creek and mile 2.1+ on Gazos Creek may have reduced adult fish passage to

most of the spawning and rearing habitat in winter 2021-2022, and problematic logjams in Gazos Creek are also present at miles 2.8, 3.3, 4.1, 5.0 and 5.0+.

In 2021, no coho were captured in Gazos Creek, despite planting of hatchery-reared fry in 2018. No YOY coho were captured at three sites sampled by me, or eight by Katie Kobayashi (UC Santa Cruz, pers. comm.) in the Scott Creek watershed, although perhaps 5 adults were detected (Joe Kiernan, pers. com). Only a single site on Waddell was sampled (without capturing coho); it is likely that there was little or no wild coho production from the three streams in 2021. However, adults strayed to San Vicente Creek, and coho juveniles were common in that watershed (Joe Kiernan, NOAA, pers. comm.), which suffered substantially less fire damage. Only about 5500 hatchery-reared smolts from captive broodstock were released in 2022 in Scott Creek, because of fire impacts to hatchery facilities and operations. In 2021, YOY steelhead density on Gazos Creek was 19.8 / 100 ft, lower than average; water temperatures were still cool, but the stream bed had more silt. The density was similar to past years when adult passage at log jams was an apparent issue.

In 2022, despite the extensive filling of pools, and the numerous new logjams, mean Gazos YOY steelhead density was 47.1 / 100 ft, almost twice the 2006-2021 mean. Density varied widely among sample sites (16-152 / 100 ft), which may have been due to patchy spawning by a relatively few adults; lowest densities were at two sites lacking holding pools for spawning adults, and the most upstream site was above 6 logjams. No coho were captured, although straying to other streams occurred. The last wild coho juveniles in Gazos Creek were in 2005.

Sampling at seven historical sites in 2022 in Waddell Creek found YOY steelhead (mean density 6.3 / 100 ft) and coho (1.9 / 100 ft) were scarce at all sites. The large new logjam present in 2022 at mile 0.65 may have blocked most adult access, including adult coho strays of Scott Creek hatchery smolts released in 2020. However, fish kills on the East Fork and main stem of Waddell Creek have also been an apparent problem since 1999.

Despite channel changes and pool filling, Scott Creek YOY coho and steelhead were abundant in 2022. Adult access in December and early January, and lack of storms the rest of winter and spring, provided ideal conditions for coho and steelhead redd survival. Mean coho density at the 6 sample sites was 47.9 / 100 ft; only the Big Creek site lacked coho. Mean density was exceeded only by the density of 79.2 / 100 ft in 2002, also a year of strong adult coho returns, early stream access, and lack of storms after spawning. YOY steelhead mean density was also very high (53.8 / 100 ft).

Juvenile sampling in 2007-2011 had documented the elimination of all three wild coho year classes in the three streams, including the 2008 year class which had previously been very strong every 3 years on Scott Creek. The presence of strong year classes in the past indicates that summer/fall rearing habitat is not the coho limiting factor. Some year classes had previously been weak or absent, due to drought-related delayed or restricted winter access or to redd destruction by winter storms. However, those year classes had twice been gradually built up to moderate abundance on Scott and Waddell creeks by conservation hatchery intervention (hatchery rearing of Scott Creek juveniles and precocious adult female returns). More recently, the coast-wide collapse, but particularly at the south of the range, was associated with poor ocean conditions in 2005 and 2006. Drought in 2007-2009, and especially in 2014 and 2015, and redd destruction by large or late winter storms in 2012, and 2016-2019 remained a problem, as has the return of poor ocean conditions (the warm-water "blob" in 2014-2016). Continued conservation hatchery intervention will be necessary to rebuild the populations of the three streams and as a base to reestablish runs

in other streams. Initially, captive brood stock and their progeny must provide the fish to accomplish the task. Captive broodstock are available for all three coho brood years. All brood years survived the fire in August 2020, despite damage at the hatchery and significant fish mortality. Broodstock were moved to Warm Springs Hatchery (Russian River) and to the NOAA Santa Cruz Lab. In 2021 all broodstock and juvenile fish were moved from the hatchery by November, because of the risk of winter debris flows and flooding at the hatchery. Rehabilitation of the present hatchery and facility sharing with NOAA Santa Cruz, Warm Springs Hatchery, and others will be necessary for some time. The Kingfisher Flat Conservation hatchery has produced a variable number of smolts: 31,000 for release in 2013, 29,000 for release in 2014, 15,000 for release in 2015, 20,000 for release in 2016, 11,000 for release in 2017, 30-32,000 for release in 2018 and 2019, 28,000 in 2020, about 10,000 fire survivors released in 2021, and only about 5500 released in 2022 because of fire effects to hatchery and rearing operations.

Coho life history, including early winter spawning and a dominant 3 year life-cycle for females, makes them more sensitive than steelhead to the effects of winter weather, and even during studies in the 1930's and 1940's on Waddell Creek the coho showed high year to year population size variability compared to steelhead. However, all year classes of coho persisted in at least two of the study streams until the present study began in 1988. Since then, year classes have been lost or weakened by floods and/or drought-caused delayed or restricted access, but such impacts may be widespread in California. Recent harsh conditions may have resulted from a change in ocean surface temperature regime, resulting in more frequent and intense El Nino conditions and big storms later in winter, which are more likely to destroy coho redds. The near lack of successful coho spawning for the three streams in 2006-7 through 2008-9, and coast-wide coho (and Chinook, *O. tshawytscha*) declines during that period, implicate poor ocean survival and reduced adult runs as the major cause. Unprecedented extreme ocean down-welling events and reduced coastal productivity have occurred since 1950.

In past years with "atmospheric river" storms some new wood has been added the channels of the three watersheds. However, relatively little new wood, other than alders, has been added to the channels since the severe El Nino storms of 1997-1998 produced upslope debris flows and eroded stream banks, toppling riparian trees. The 2020 fire and erosion and debris flows from upslope added substantial sediment and wood to the channel, especially in 2022. Dead and damaged trunks should continue to be added from streamside and upslope, including trunks from tanbark oaks, oaks, bigleaf maples, and California bays with stump sprouts and surviving roots that will continue to hold slopes in place.

In the initial decade after 1999, steelhead abundance was substantially higher on the West Fork than on the main stem of Waddell Creek. Fish kills had apparently occurred on the East Fork and main stem of Waddell Creek in most years from 1999 to 2014; in 2006-2008 those kills appeared to be associated with Last Chance Creek, an East Fork tributary. The declines in 2017 and 2018 (which apparently included the lagoon) may have been at least partially due to the generally low densities (7-11 / 100 ft) throughout the watershed (including the lagoon) in 2014 and 2015, resulting in few returning adults. The apparent fish kills originating in the East Fork watershed (apparently farther upstream than Last Chance Creek in 2013 and 2014) may still be a concern for the Waddell Creek watershed, although the East fork and Last Chance watersheds were damaged by the 2020 fire.

YOY steelhead densities in Scott Creek have fluctuated widely since 2008. Densities in the wet years of 2017 (57 / 100 ft) and 2019 (54 / 100 ft) were the highest in the last 15 years. Those years also had high densities in Big Creek, Scott Creek downstream of Big Creek, and in the lagoon.

The dry years in 2008, 2009, 2014, 2015, and 2018 had the lowest overall densities (12-24 / 100 ft). The lowest steelhead abundance was in 2015, when streambed dry-back occurred and abundant coho probably depressed steelhead in the remaining pools. However, since most of the adult steelhead returns are from large lagoon-reared smolts (Bond 2006), low lagoon densities in those years and competition with hold-over coho smolts in 2014 may have also reduced the lagoon contribution to returning steelhead adults. Recent stream YOY densities have been well below the densities of 1988-2000 (mean of 69 / 100 ft).

The devastating fires in the upper portions the Waddell Creek watershed are the major immediate threat to habitat and fish populations, with the loss of stream-side trees, addition and rearrangement of channel wood, and potential future erosion from burned and still bare upper slopes. The light riparian burn on Gazos and Scott creeks, still leaves the threats from the upper watershed and upper slopes of those two watersheds. In addition, four major habitat restoration efforts are needed in the watersheds: 1) rebuilding the lost 2007-2011 coho year classes, using the conservation hatchery and captive brood stock; 2) eliminating the apparent toxic kills in some years on East Fork and main stem Waddell Creek; 3) modifying several log jams on Waddell and Gazos creeks to ensure fish passage, including to provide potential coho and steelhead passage to what had been the best rearing habitats; and 4) addressing impacts to the lagoons during the replacement of the Highway 1 bridges at Scott and Waddell creeks (especially increasing channel complexity and residual depth at Scott Creek) and by preventing artificial sandbar breaching at all three streams.

INTRODUCTION

Since wild female southern coho usually spend one year in the stream and two years in the ocean prior to spawning (Shapovalov and Taft 1954), at least 3 consecutive years of study are necessary to determine the status of the three numerically independent year classes. Abundance of the year classes also fluctuates widely with ocean conditions, and with conditions for migration and spawning success. This report presents the results of the 31st consecutive year of sampling for juvenile coho and steelhead on Scott, Waddell and Gazos creeks in Santa Cruz and San Mateo counties. **The previous years of juvenile sampling have demonstrated the recent importance of winter weather on coho abundance, by affecting access or destroying redds or over-wintering juveniles (Smith 1992, 1994c, 1998c, 2001b, 2013a, 2016-2019). They have also demonstrated large differences in abundance among different coho year classes**. Only a single year class (1993, 1996, 1999, 2002 and 2005) had been relatively strong on Waddell and Gazos creeks and especially strong on Scott Creek (Smith 2006a). However, that year class unexpectedly was apparently absent in Gazos Creek and Scott Creek and extremely weak on Waddell Creek in 2008. Adult access should have been suitable in January and February, so the lack of successful spawning was apparently due to poor ocean survival when smolts entered the ocean (Smith and Leicester 2008). One of the other year classes (1992, 1995, 1998, 2001 and 2004) was usually weak in Scott and Waddell creeks and was apparently eliminated in Gazos Creek by 2001. That year class was strengthened on Scott and Waddell creeks and weakly restored on Gazos Creek in 2004, apparently by spawning by hatchery-reared females that returned precocially as 2 year old adults (Smith 2005). The year class was then nearly eliminated in 2007, also apparently by poor ocean conditions, although adult access was delayed until February (Smith 2007). The third year class (1994, 1997, 2000, 2003 and 2006) had survived only in Scott Creek, where it was extremely weak in 2000 and 2003 (Smith 2001a and 2003b); it rebounded due to hatchery-reared fish in 2006 (Smith 2006). However, the year class was represented by only 4 coho captured in 2009, but on Waddell Creek, rather than on Scott Creek (Smith 2009). Therefore, the three 2007-2009 coho year classes were essentially eliminated in the wild due to two years of poor ocean conditions

(Smith 2007, 2009, Smith and Leicester 2008, and Lindley et al. 2009), and no coho were captured by sampling through 2014 on Gazos and Waddell creeks and through 2011 on Scott Creek (Smith 2010-2014).

Year classes had been weakened or eliminated by stream conditions during earlier study years by winter stream flows (droughts and floods; Smith 1992, 1994c, 1998c, 2001b, 2003b, 2013a, 2017, and 2019), although the occasionally strong juvenile year classes indicated that summer rearing habitat is suitable for coho and has not been the primary limiting factor for coho on these streams (Smith 1994a, 1996, 2002, and 2005). The strong year class differences and effects of floods and droughts are not confined to the streams of the Santa Cruz Mountains, as the same impacts have produced year class effects at Redwood Creek in Marin County, 90 km further north (Smith 1994b, 2000, 2003a). The widespread, synchronous weather impacts also mean that straying of fish among nearby streams may not offer help in rebuilding weakened or lost year classes. In 2007-2009 the effect of poor ocean conditions also apparently had severe coast-wide impacts on coho abundance and on coast and central valley Chinook (Smith 2007; Smith and Leicester 2008; Lindley et al. 2009; Smith 2009); the wild coho runs in the three study streams were essentially eliminated. The severe CZU Fire watershed effects in 2020-2022 added a major new component to the long-tern study.

Previous results in 1995, 1997, 2004 and 2006 (Smith 1995b, 1998a, 2005 and 2006) have shown that one mechanism to rebuild weak or missing year classes is the return of hatchery-reared females as precocious (2-year old) fish. Precocious males (but not females) occur in the wild (Shapovalov and Taft 1954) and are common among hatchery-reared coho. However, hatchery rearing prior to 2005, especially among some of the larger hatchery-reared fish, also occasionally produced precocial females (Smith 1995b, 1998a, 2005). In addition, results in 2000, 2003, and 2006 (Smith 2001a, 2003b, 2006) showed that a small portion (2% in 2001, 2003 and 2006) of average-sized juvenile coho can remain in the stream as yearlings and reproduce as 4-year olds. In the drought years of 2013 (7%) and 2014 (17%) the holdover rate of coho yearlings was much higher (Smith 2013b and 2014). Stream-reared yearlings can provide a small, but significant, increase in the "year class" strength of weak year classes, especially when strong year classes precede weak ones (Smith 2003b). However, unlike steelhead, where yearlings are usually substantially larger than YOY and can usually be distinguished by size, coho yearlings are usually not much larger than YOY and must be distinguished by a scale annulus (Smith 2003b). **Scott Creek also supports a captive brood stock program at the Kingfisher Flat Restoration Hatchery on Big Creek as a buffer against adverse environmental conditions in the stream or ocean. The fate of coho in these streams now rests with that captive bloodstock program that produces smolts for release in spring, can provide surplus brood stock for release to spawn in the streams, and may also provide for the release of hatchery-spawned fry and parr.**

In 2012, juvenile coho were again present in Scott Creek, due to spawning by the release of surplus captive-reared brood stock for wild spawning (Smith 2013a), although resulting juvenile numbers were low, apparently because of storm-related redd destruction. In 2013, spawning by released captive brood stock produced a much stronger juvenile coho population, with high densities at 3 of 9 sites in Scott Creek (Smith 2013b). In addition, substantially upgraded hatchery operations were able to produce about 30,000 hatchery-reared coho smolts for release in both 2013 and 2014 (Smith 2013b). The limited (2000) smolt release in 2012 and the lack of surplus brood stock in 2014 for release for wild spawning (due to fungal-related brood stock mortality), appeared to have resulted in no successful coho spawning in 2014 in Scott Creek or the other two streams; no coho were captured during sampling in 2014 (Smith 2014). However, several coho yearlings were captured on upper Scott Creek in 2015, so some successful coho spawning occurred in Scott Creek in 2014 (Smith 2015).

The ramped up hatchery operations, and the release of about 31,000 coho smolts in 2013, resulted in substantial adult returns in the dry winter of 2014-2015 to Scott Creek, and also resulted in strays to adjacent Waddell Creek, but not to Gazos Creek farther north (Smith 2015). Overall coho density in the Scott Creek watershed was 18 / 100 ft, with variable abundance among 9 of 10 sample sites; density would have been substantially higher, except for partial to full channel dry-back that occurred at 5 sites. Overall density was 5.2 / 100 ft on Waddell Creek, with some coho at all 9 sites. The highest abundance in Waddell was on the middle main stem, where coho have usually been rare in previous years because it is flood-prone and has also been subjected to apparent toxic fish kills originating on the East Fork (Smith 1999 through 2015). In winter 2015-2016 adult coho, produced by the release of 29,000 hatchery-reared smolts in 2014 and wild production in Scott Creek in 2013, returned to both Scott and Waddell creeks. However, most redds were apparently destroyed by winter storms, and juvenile densities were very low (1.6-2.3 / 100 ft) in both streams (Smith 2016).

Some hatchery and wild yearling coho were trapped by early sandbar closure and reared a second year at Scott Creek in 2014. There were no YOY captured during fall sampling (Smith 2014), but the capture of some yearlings in 2015 indicated that some limited successful spawning occurred in 2014 (Smith 2015. An additional 15,000 hatchery-reared smolts were released in 2015. Therefore, significant adult returns were expected in winter 2016-2017, and PIT-tagged fish were detected in by antennas that functioned during part of the winter in both Waddell and Scott creeks (Joseph Kiernan, NOAA Santa Cruz, pers. comm.). However, severe storms in winter 2017 likely destroyed most coho redds; no coho were captured in Waddell Creek and only 5 juvenile coho were captured between 2 sites in Scott Creek (Smith 2017).

The substantial wild production of coho in Scott and Waddell creeks in 2015, and the release of 20,000 hatchery-reared smolts (from captive bloodstock) in Scott Creek in spring 2016 should have produced a significant adult coho return in 2018. PIT-tagged adults were detected in both Scott and Waddell creeks in winter (Joseph Kiernan, NOAA, pers. comm.). However, very few coho (1.0 / 100 ft) were captured at 6 of 9 sites on Scott Creek and very few (0.4 / 100 ft) at 2 of 8 sites on Waddell Creek (Smith 2018).

Only low densities of coho were captured in Scott and Waddell Creeks in 2016, and a below average 11,000 hatchery-reared smolts were released in spring 2017. A modest adult coho return was expected in winter 2018-2019, despite reports of poor ocean conditions. However, although there were PIT-tag detections of adults in both streams, and the capture of 4 adults at the weir and 5 coho redds observed in Scott Creek, I captured no coho juveniles in Scott Creek and only 4 juveniles in Waddell Creek (Smith 2019). NOAA dive surveys detected coho in only 6 of 321 pools in 2019 (Joseph Kiernan, NOAA Santa Cruz, pers. comm.).

Despite a dry winter, and lack of large storms in 2019-2020, both coho and steelhead could have had upstream access with some difficulty after mid-January. Although extremely weak wild coho production in 2017 would have produced very negligible coho returns in 2019-2020, 32,000 hatchery-reared smolts were released in spring 2018. Therefore, a significant return of coho was expected in 2019-2020. Coho spawning downstream of the Scott Creek weir and PIT antenna detections in Scott, Waddell, San Vicente, and Pescadero creeks (Joseph Kiernan, NOAA Santa, pers. com.) confirmed coho returns did occur. Therefore, the 29th consecutive year of juvenile sampling was planned for late August and early September in 2020 on Gazos, Waddell, and Scott creeks. Unfortunately, lightning strikes on 16 August produced the CZU Megafire that burned much of the Gazos, Waddell, and Scott creek watersheds. Reduced sampling (3 sites) on Waddell Creek did occur in October to check for presence of coho juveniles and found low numbers at 2 of

the 3 lower Waddell sites where low densities of coho and steelhead have occurred since 1999, due to apparent fish kills (Smith 2020); upstream sites where densities have been higher in the past were damaged and not safely accessible. On Gazos Creek, where log jams have apparently significantly restricted adult steelhead access in many recent years (Smith and Leicester 2008; Smith 2009, 2010, 2013, 2014, and 2018), fire damage was less (Smith 2020), but low densities of steelhead were found at 4 sampled sites. I conducted no sampling in the fire damaged Scott Creek watershed, but NOAA did sample 5 sites in November and found some coho (Joseph Kiernan, NOAA, pers. comm.).

A full sampling effort was planned for the three streams in September and October 2021, but only on Gazos Creek was sampling completed. Sampling in the Waddell Creek and Scott Creek watersheds was delayed until mid-October due to temperature restrictions on electrofishing and the loss of canopy to fire at many sites. In addition, access was an issue on Waddell Creek due to salvage logging adjacent to the State Park until October. Finally, a large early storm on 24 October terminated sampling in both Waddell and Scott creek watersheds, so sampling was limited. No coho were captured, but steelhead densities in Gazos Creek and at the few sampled sites on Scott and Waddell creeks were typical of recent years.

Since there was very little wild coho production in 2019 (Smith 2019 and Joseph Kiernan, NOAA pers. com.), returns in winter 2021-2022 would have come from about 28,000 hatchery-reared smolts released in spring 2020 and from releases of 15,000 hatchery-reared parr in fall 2019 in Waddell and Scott creeks. Weir and PIT antenna detections and spawning surveys on Scott Creek in winter 2021-2022 (Joseph Kiernan, NOAA, pers. comm.) indicated a very strong adult coho run in a year favorable for adult access and redd survival. Therefore, reassessing fire damage in the three watersheds and conducting and fall 2022 juvenile sampling was a priority.

METHODS

All seven regularly sampled sites on Gazos Creek were sampled by electrofishing in September (Table 1), although one damaged site (mile 4.4) was replaced by a new one 0.25 miles downstream. Seven sites on Waddell Creek were sampled in October after the weather cooled. The most downstream and upstream of nine regular Waddell sites were not sampled (Table 2 and 5). Six sites were sampled in the Scott Creek watershed in October, but two downstream sites and two upstream sites that have been usually sampled, were not sampled in 2022 (Tables 3 and 6).

At sampled sites on each stream the same individual habitats were sampled as in previous years if possible, although channel changes in 2022 of those same habitats were substantial. The length of stream sampled per site was usually similar to previous efforts (Smith 2014). The overall relative abundance of sampled habitat types was also similar to recent years.

The primary goal of the sampling by electrofisher was to look for the presence and abundance of coho, so sampling since 1992 has concentrated on pool and glide habitats, and riffles were seldom sampled. At each site usually 3 to 5 individual habitat units (a glide or pool, with its contiguous glide and run habitat) were usually sampled by 2 passes with a backpack electrofisher (Smith-Root LR20B). Sampled habitats have been representative of those available, except for the exclusion of scarce large, deep pools on the main stems of Waddell Creek that could not be sampled by electrofishing. Sample length and percentage of habitat types were assigned for each sample unit. In previous years, Rosgen channel types were determined, and relative abundance of pool, glide, run and riffle habitat types estimated for the vicinity of each site (Tables 1-3).

Juvenile fish were measured (standard length, SL) in 5 mm increments. YOY steelhead were separated from older fish based upon length-frequency at each site, and scales confirmed ages of intermediately-sized fish or large fish (scales were taken from 15 juvenile steelhead on Gazos Creek, 20 on Waddell Creek, and 3 on Scott Creek). Mortality was kept to a minimum by reducing electrofisher voltage (150-250 V) in shallow water and by immediately placing captured fish in a floating live car. Mortality was recorded at the time of length measurements.

Conditions in the stream corridor and adjacent slopes in response to the CZU Fire were photographed in October 2020 (Smith 2020) and June (Smith 2021a) and October 2021 (2021c) on Waddell Creek and October 2020 (Smith 2020) and March and August 2021 (2021b) on Gazos Creek. In 2022 multiple sampling periods assessed conditions on Gazos Creek (Smith 2022a) and Waddell Creek (Smith 2022c), and once during fish sampling on Scott Creek (Smith 2022b). The multiple sampling periods allowed comparison of conditions before and after the relatively mild 2020-2021winter and after the substantial October and December storms in 2021, Google earth photos of the watersheds from after the fire in 2020 also became available in summer 2021.

Three instream temperature loggers were installed on Gazos Creek in 2021, and the stream retained cool temperatures throughout, despite the 2020 fire; therefore, no temperature recorders were installed in 2022. Seven instream temperature loggers were installed on Waddell Creek in 2021, which showed that the open upstream canopy produced significantly warmer stream temperatures. Five instream loggers were installed in Waddell Creek on 22 June 2022 (miles 1.8, 2.85, and on the East Fork above the confluence, on the West Fork above the confluence, and on the West Fork at mile 3.6+). Four of the five were recovered on 14 and 29 October.

RESULTS AND DISCUSSION

Habitat Conditions in 2007-2022

Storm/Passage Timing and Summer Stream Flow

In October and December 2021 major storms opened the sandbars on the three streams and provided potential adult coho and steelhead access in at least December and early January (Figure 1). The remainder of winter and spring was dry. The lagoons at Gazos and Waddell creeks stayed open until mid-July and at Scott Creek until the end of August. As in 2021, summer stream flow was higher than would be expected from the second dry year, but ground cover and tree mortality, and loss or reduction in canopy of survivors, reduced vegetation use of soil water (Smith 2022a, 2022b, and 2022c).

Winter 2020-2021 was very dry, but the Scott Creek sandbar opened briefly from 7-12 January. It reopened with the one large storm of the year on 28 January and was intermittently passable at the mouth, at least at high tide, to adults through at least mid-April (Smith 2021). Smolt passage was likely possible at the shallow mouth through May, although the mouth didn’t fully close until August. Waddell and Gazos creeks didn’t open at the mouth until the storm on 28 January. Potential adult passage at the sandbar at Waddell was difficult after the storm, except at high tide. Smolt passage at Waddell was likely through early May, although the channel at the mouth was very shallow.

Late spring and summer stream flow in 2021 was about average for Gazos and Waddell creeks, and higher than 2018 and 2020, despite the dry winter, apparently due to the substantial fire

damage to trees in the watershed; many trees were killed (especially Douglas firs and young alders, tan oaks and redwoods), and those that survived had lost much of their canopy (tanoaks, redwoods, and maples had basal sprouts, and redwoods also had trunk and branch sprouts). Transpiration demand on soil water was substantially reduced.

Winter of 2019-2020 was similarly dry to 2017-2018 (Smith 2020). In 2019-2020, small storm peaks in December filled the lagoons at Gazos, Waddell and Scott creeks to high levels, but the sandbars were not breached until 17 January by a similar small storm. However, adults could possibly have entered the lagoons at high tides earlier. The mild winter maintained lagoon depth behind high partial sandbars as a staging area for up-migrating adults and out-migrating (and feeding) smolts. Adults could still enter the lagoons at high tide into April, when another small storm allowed upstream access for steelhead. The dry conditions for adult coho passage resulted in some fish spawning in sandy habitat downstream of the weir at Scott Creek (Joseph Kiernan NOAA, pers. comm.). Summer stream flows in Gazos, Waddell, and Scott creeks were low (as they were in 2018).

Minor rainfall events in December 2018 produced little runoff in the three streams (based upon the runoff pattern in Pescadero Creek; Smith 2019). However, major storms produced runoff peaks >1000 cfs in early-January 2019 through early March and also nearly continuous high flows (>200 cfs) in February through mid-March, before runoff gradually declined. Flow was still 100 cfs in Pescadero Creek at the end of March, and a small late storm occurred in May. The winter flows provided access for adult coho and steelhead, but coho entrance was delayed until January and the storms in February and early March impacted most coho redds. The wet winter and the late storm in May resulted higher than average early summer stream flows in all three study streams.

After a relatively modest storm in early January 2018 (Smith 2018), Scott, Gazos, and Waddell opened behind high partial sandbars, but Scott Creek lagoon reclosed by 16 January. Subsequent ocean swells overtopped sandbars, raised lagoon levels, and produced salty lagoons and adjacent marshes. There was no significant rain in February. In March and early April a cluster of "winter" storms finally arrived, including one that produced 1200+ cfs runoff in Pescadero Creek (Smith 2018). Some adult coho and steelhead passage to spawning areas was possible on the three streams in January, and NOAA captured coho at their Scott Creek weir and detected coho at Scott and Waddell PIT antennas (Joseph Kiernan, NOAA Santa Cruz, pers. comm.). However, the March storms were late for passage by most coho, and apparently destroyed coho redds or recently emerged fry by fish that spawned in January and February. The low and delayed winter rainfall resulted in low summer stream flow, but there were apparently no streambed dry-backs.

Storms in December 2016, including one that produced 1,500 cfs of runoff in Pescadero Creek (Smith 2017), opened the sandbars at Waddell and Scott creeks, providing adult access to the streams; Gazos Creek was already open. Five large storms ("atmospheric river") in January and February 2017 (of 1,000 to 5,000 cfs in Pescadero Creek; Smith 2017) provided adult passage, but probably destroyed early redds in Scott, Waddell and Gazos creeks. On Gazos Creek the early storms in December opened up a major log jam at mile 4.2, which had been restricting adult passage in most of the last 10 years (Smith and Leicester 2008; Smith 2009, 2010, 2013, 2014). However, the jam re-plugged in late January, providing passage only during storm peaks. The storms removed the PIT-antennas on both Scott and Waddell creeks, but coho PIT detections occurred in both streams prior to the loss of the antennas (Joseph Kiernan, NOAA, pers. comm.). Stream flows were sustained by smaller storms in March and early April, and the sandbar at Scott Creek was open to the south through a shallow channel for smolts through mid-June. Stream flows declined slowly, and were above average, with no loss of surface flow, throughout the summer on Scott Creek. Summer stream flows were also relatively high on Gazos and Waddell creeks, which always had summer surface flow, even during the droughts in 2014 and 2015. Gazos Creek, in particular, has relatively high summer stream flow due to fractured shale in the upper watershed, which absorbs substantial winter rain and releases it to stream flow throughout the summer (functionally similar to limestone/"karst" geology); most of the summer stream flow is from the upper watershed, rather than progressively increasing father downstream.

In winter 2016, storms in late December, as indicated by stream flow *pattern* at the Pescadero Creek USGS stream gage (Smith 2016), provided adult steelhead and coho access to Scott Creek, when the mouth opened on 21 December. The sandbar was illegally breached at Waddell Creek on 22 November, but the first passage upstream of the lagoon was also probably in late December. Mid-January storms, and especially the late January storms, were stronger, allowing passage throughout the watersheds of Scott, Waddell, and Gazos creeks. Spawning apparently occurred in late January and early February (Jon Jankovitz, CDFW, pers. comm.). In early to mid-March, when most coho salmon spawning was probably completed, there were very large storms that resulted in flows up to 700 cubic feet per second (cfs) in Scott Creek (Joseph Kiernan, NOAA, pers. comm.). The large late storms probably destroyed or damaged most coho redds and many steelhead redds, as has occurred in previous years (Smith 1992, 1994c, 1998c, 2001b, and 2013a). The storms in January and March also put the weir on Scott Creek and the PIT antennas out of action for much of the migration period, limiting information on the size of the coho and early steelhead spawning runs (Joseph Kiernan, NOAA, pers. comm.). Despite the "wet" winter, there were no storms after mid-March, and stream flows declined continuously and rather quickly in spring (Smith 2016). The sandbar at Scott Creek closed by late May to early June, but coho smolts present in the lagoon in May apparently successfully emigrated (Joseph Kiernan, NOAA, pers. comm.). The sandbar stayed open until mid-summer at Waddell Creek lagoon, but the long shallow opening trapped some kelts in the lagoon. Summer stream flows in all three study streams were sustained throughout the watersheds through fall.

In winter 2014-2015, there were two storm periods, early to mid-December, when flows reached 1000-3000 cfs in Soquel, Pescadero, and San Gregorio creeks and in the San Lorenzo River (USGS gage records), and mid-February, when flows reached 800-1500 cfs in those same streams. High stream flows also occurred in December on Gazos, Waddell, and Scott creeks, but, at least on Waddell and Scott creeks, the February event was relatively mild compared to December and to the USGS gaged streams, with only several hundred cfs, based upon observations and debris lines at and after the storm. Gazos Creek apparently experienced much higher flows than Waddell and Scott creeks in February. The December storms opened the sandbars and provided for good potential coho and steelhead access in December and early January and again in mid-February. The timing was ideal for coho, but suitable adult passage came early for many steelhead (Shapovalov and Taft 1954). The milder mid-winter through spring conditions prevented coho redd destruction, as had occurred in several years, including 1992 and 1998 (Smith 1992 and 1998c). However, early decline in stream flow was associated with very low stream flows in Scott and Waddell creeks by late spring. By September stream flows in Waddell Creek were extremely low, but there was no streambed dry-back. However, stream flows in Scott Creek were lower than any previous year (1988-2014), with streambed dry-back that dried pools at two sites on Scott Creek upstream of Big Creek (Smith 2015). In addition, at three other sites riffles dried, pools were isolated, and stagnant water quality apparently reduced fish in some of the remaining pools. Mill Creek, has previously had relatively low summer stream flows, at least partially due to the lack of bypass flows at the reservoir on upper Mill Creek, and was nearly dry in 1988 and 2009 (Smith 1994c and 2009). However, in 2014 and 2015 surface flows were sustained at Swanton Road, probably due to reduced watershed vegetation in response to the Lockheed Fire (Smith 2014 and 2015).

In winter/spring 2013-2014 there was little rain and runoff until a moderate storm in early February and moderate storms again at the beginning of March and the beginning of April. The sandbar at Scott Creek remained closed until February, and potential artificial breaching of the bar did not proceed because of delays in a permit and because a substantial number of trapped hatchery-reared coho smolts were rearing in the closed lagoon (Jon Ambrose, NOAA, pers. comm.). The delay in access probably substantially reduced the number of adult coho (mostly or only 2-year olds) entering Scott Creek, and also resulted in substantial straying to the San Lorenzo River and other nearby accessible streams. Two-year old hatchery-reared males were netted in the San Lorenzo River and provided important brood stock for spawning at the Kingfisher Flat Hatchery in the Scott Creek watershed (Jon Jankovitz, CDFW, pers. comm.). Summer stream flow was unusually low in 2014, with short dry stretches of streambed in portions of Scott Creek by September. The drought in 2013-2014 continued the spotty rainfall and difficult conditions for adult coho and steelhead passage, and/or risk of redd destruction, for at least six of the previous eight years. The winters of 2006-7 through 2008-9 were relatively dry, with delayed storms and relatively small migration and spawning windows for coho (Smith 2007 and 2009 and Smith and Leicester 2008). Similarly, 2012 had both dry conditions overall and delayed rain; there was rain in November through early January, but substantial sustained rain and stream flow did not occur again until mid-March through April (Smith 2012). In 2012-2013 most of the rain occurred in November and December and most of the rest of the winter and spring was quite dry (Smith 2013).

In 2010 the first rain sufficient for adult migration was in mid-January, however, once rain started it continued to provide suitable conditions for migration and spawning through April. In winter 2010-2011 significant storms for potential coho and steelhead adult access occurred in late December, but January and early February were dry, potentially affecting spawning by coho and early steelhead. The biggest storms came in late February through early March and in late March through early April. These latest storms may have destroyed coho and steelhead redds or recently emerged fry, as has happened to coho in the streams in past years of large, late storms (Smith 1992, 1998c, 2001b, 2003b). Compared to the drought winters of 2007-2009, 2012-2014, with their low summer stream flows, the wet and extended winters in 2010 and 2011 also resulted in higher than average spring and early summer stream flow in Gazos and Waddell creeks in 2010 and in all three streams in 2011 (Smith 2011 and 2012).

Channel Habitats

The relatively mild winter in 2019-2020 produced little channel change or alteration in channel wood. Only minor scour and fill of individual habitats, with no apparent pre-fire net channel change, was observed at the sample sites on Waddell and Gazos creeks. However, the August 2020 CZU Fire resulted in major changes in all three study streams,

The burns in the upper watershed (upstream of anadromy) and most of the upper slopes in Gazos were severe (Figures 2 and 3). The fire did not impact the stream-side riparian habitat or lower slopes downstream of mile 2.1 (near the Cloverdale Road junction) (Smith 2020). Farther upstream, the fire burned to or near the stream, but loss of streamside trees and canopy was relatively light (Smith 2021b and 2022a). However, Old Woman's Creek, which enters from the south at about mile 2.0 suffered a more severe burn. The mild winter in 2020-2021 did not produce debris flows or extensive erosion, but fine sediment was added to the stream bed (Smith 2021b). The large storms in October and December 2021 brought the damage the watershed was spared in winter 2020-2021. Extensive upstream and upslope erosion resulted in fines and gravel filling or eliminating most pools on Gazos Creek (Smith 2022a). Downstream of the direct fire impacts to Gazos Creek, sediment from Old Woman's Creek mostly filled the pools in the lower 2.0 miles of the stream.

On Waddell Creek, the fire burned parts of upper slopes above the lagoon and marsh and above the agricultural and residential land in the lower stream mile (Smith 2020). The cattails in the seasonal red-legged frog breeding pond on the northwest side of the marsh were thinned by

burning, and the perennial pond to the southeast of the lagoon (the "Turtle Pond" near the Nature Center) had its perimeter trees and shrubs burned, and the emergent tules and the floating tule mat were partially burned. Upstream, from mile 1 to about mile 2.4, there was a patchy light to moderate burn on the lower slopes, occasionally reaching the road. There was a moderate to severe burn towards the ridge tops. However, the fires from northwest and southeast did not penetrate the relatively wide riparian corridor; fire impacts to the stream in this reach would come in 2022 from the more severe burn upstream and upslope of the left bank tributaries in the reach. At mile 2.5 (Stevens Camp) through mile 2.8 (Figure 4), burned and fallen trees were across the trail on the bank above the stream, with some trees reaching the channel. Upslope to the southeast the burn increased in severity, with all trees (mostly Douglas firs and tanbark oaks) on the uppermost slopes severely burned; tanoaks base sprouted, but most Douglas firs died. On the opposite slope the fire was mostly a light burn above the stream, but the upper slopes were moderately to severely burned. From mile 2.85 -3.1 (to the confluence of the East and West forks) the fires on both slopes reached, with light to moderate burn, to the edge of the stream; the redwoods along the stream were burned, but almost all survived (Smith 2020 and Figure 4). The West Fork to mile 3.6 was moderately burned on both banks, with severe burn farther up the slopes on both sides of the stream (Smith 2020 and Figure 4). The substantial log jam at mile 3.4, formed by fallen redwoods in 1998, has been an intermittent fish barrier in the past. It was substantially burned and is presently open to fish passage. Conditions substantially worsen even farther upstream (Figure 6), with nearly bare ash-covered slopes and a burned streamside. Similar moderate to severe burn conditions were present in the East Fork watershed (Figure 4).

After the mild 2020-2021 winter, June and October assessments (Smith 2021c) found little impact to the riparian corridor up to mile 2.75, but upstream of that point the impacts progressively increased. The fire burned to near or at the bank at mile 2.75, and burned through the riparian corridor by mile 2.85. Alders at stream side on the flood plain were apparently cooked and died, but most showed no burn scars. Only a small portion of the alders had any leaves in June, but there was some increase in canopy and the number of alders with some leaves by October. The extent of alder recovery turned out to be very limited (<5%). Maples showed some basal sprouting and canopy in June, and more extensive sprouting by October, including on riparian and upslope maples thought dead in June. Most burned redwoods in the riparian corridor and on the lower slopes had basal sprouts and trunk and branch epicormic sprouts; the apparent extent of their recovery had increased in October. Upslope tanoaks mostly survived the killing of the trunk and had basal sprouts. The roots should hold much of the slopes in place. Douglas firs were mostly killed near the stream and upslope. There were significant debris flows of apparently cooked and disintegrated mudstone from the west slope downstream of the confluence. This resulted in filling much of the channel, including formerly large, deep pools, downstream to mile 2.85. Another west slope debris flow on the West Fork impacted the miles 3.45 – 3.5, including aggrading a significant channel step upstream of a new jam of toppled trees at mile 3.45; it was a partial to full barrier to adult passage in 2020-2021. The major storms in October and December 2021 produced extensive west slope erosion on the West Fork and the upper portion of the main stem of Waddell Creek (Smith 2022 c). Pools on the West Fork were mostly filled or eliminated, and the filling of pools extended farther downstream to mile 1, filling pools that were not directly affected by the fire. The East Fork, which usually has higher flood peaks than the West Fork, had minimal streambed sedimentation, except for a coating of silt in the pools. The East Fork channel is steeper, and the stream bed is armored with cobbles and small boulders of Butano Sandstone from farther upstream. The East Fork presently has the best stream habitat (Smith 2022c), although it has apparently had persistent problems with toxic fish kills since 1999 (Smith 2006b, 2007. 2009, 2013a, 2013b, 2014).

In the Scott Creek watershed (Figures 5 and 6), the fire didn't reach the riparian corridor of Scott Creek until almost upstream to Little Creek. The fire burned the Little Creek watershed down to the Cal Poly facilities, with severe damage to Cal Poly and the railroad facilities (Smith 2020). Upstream of Little Creek the fire burned from the south down to the edge of the riparian corridor, and from the north at Big Creek down to Scott Creek. There was a patchy moderate burn along Big Creek to upstream of Berry Creek with more severe burning on the slopes and farther upstream. The Kingfisher Flat fish hatchery suffered moderate damage, with the loss of some fish tanks and YOY fish and brood stock, but emergency actions saved half of the YOY coho and brood stock of all three year classes. Between Big Creek and upstream past Mill Creek, the fire moderately to severely burned on the north side of the road, with some burn south of the road in the riparian corridor 1/2-3/4 miles upstream of Big Creek. Mill Creek was moderately to severely burned, almost to the confluence with Scott Creek, but the riparian corridor of Scott Creek was mostly not affected upstream to the Swanton Road crossing. Upper slopes of Scott Creek upstream of Swanton Road suffered a moderate to severe burn, but the riparian corridor suffered little damage upstream to upper bridge crossing. Farther upstream on Scott Creek the upper slopes were severely burned, with patchy to extensive moderate burns of the riparian corridor.

After the mild winter of 2020-2021 fine sediment modestly increased in Scott Creek, but channel changes were minimal at four surveyed sites (Smith 2021d). However, the October and December 2021 storms rearranged old and new channel wood, and added large amounts of fines and gravels to the channel, rearranging and filling pools at four resampled Scott Creek sites; the site on lower Mill Creek and the site on lower Big Creek changed little from 2021 (Smith 2022b).

Wetter conditions in winter 2021-2022 mostly allowed for the recovery of much of riparian and lower slope ground cover of shrubs and herbs in the three watersheds. The root systems of most slope and riparian trees, except dead Douglas firs and alders, are still anchoring the slopes, even when basal-sprouting bigleaf maples, tanbark oaks, oaks, and California bays have dead trunks. Therefore, major future slope erosion will probably be limited to the relatively bare and steep west slope upstream of mile 2.75 on Waddell and West Fork Waddell (Smith 2022a, 2022b, and 2022c).

Over the 20+ years prior to the fire a subtle, but ecologically important, change had been the closure of alder canopy over individual habitats at 4-6 sites in the Scott Creek watershed, 5-6 sites on Waddell Creek and 2-3 sites on Gazos Creek. The very dense canopy that had gradually developed, after it was opened by the severe storms of 1998, was capable of reducing aquatic insect production and reducing feeding by drift-feeding steelhead in spring and summer. This can result in a substantial reduction in YOY steelhead abundance. For example, at the lower Big Creek site, habitats with 97-99% canopy closure had a steelhead YOY density of 21 / 100 ft in 2011 and 2014, 16 / 100 ft in 2012, and 18 / 100 ft in 2013. However, the habitats with only 70% canopy closure had a density of 85 / 100 ft in 2011 and 64 / 100 ft in 2012. The less shaded habitat had a density of 65 / 100 ft in 2013 and 51 / 100 ft in 2014, despite a substantial reduction in habitat depth. Similar differences were noted in 2015-2019. The reduction in canopy in portions of the all three watersheds from the CZU Fire may raise summer water temperatures, but also increase food and feeding for coho and steelhead. However, the downstream habitats on the three streams were those that had the most riparian vegetation thinning by bank erosion in floods in 1998 and 1999. Those downstream riparian habitats generally suffered little immediate impact from the 2020 fires. The longitudinal effects on canopy could be reversed from 1998, with little change in canopy downstream, but major changes upstream, unless severe flooding downstream results from the denuded upper watersheds. After 1998 and 1999 floods alders quickly established and grew. The

replacement of fire loss of canopy by surviving streamside redwoods may be slower, as will replacement of severely burned and fallen trees by stump sprouting.

The large storms in 2019 produced few major channel changes in the three watersheds. There was scour and fill at 6 of the 8 study sites on Waddell Creek, without significantly changing overall habitat conditions. At site 4, on the middle main stem Waddell Creek, the channel that split and relocated downstream of a logjam in 2016 returned to its original channel in 2019. In the Scott Creek watershed, there was major scour and fill associated with wood in Mill Creek and major alteration of habitats (increased pool depths and configurations) associated with downed trees and wood on Scott Creek downstream of Mill Creek (site 3). Otherwise the scour and fill at the limited number of sites sampled in 2019 showed no overall change. On Gazos Creek there were rearrangements of habitats and scour and fill at sites 2, 2A, and 2B. The very large logjam at mile 4.2 was substantially opened to passage by the end of winter. However, low steelhead abundance at 4 of 5 sites upstream of mile 2.1(Table 7) suggests that a logjam between miles 2.1 and 2.8 is a passage problem in a reach that has had significant logjam barriers in the past.

Despite the relatively dry 2017-18 winter, there were some significant habitat changes on the three streams. On Gazos Creek the logjam at mile 4.2 (near the downstream end of site 4) fully closed during at least part of winter, producing “back-water lake” sediment deposits upstream, as had also occurred in 2017. The jam may have opened and closed during winter, but probably blocked upstream steelhead passage during much of the winter, including during several of the brief March/April runoff peaks. There was scour and fill and rearrangements among habitats at 5 of the 7 Gazos sample sites, but little net habitat change. A very large partial logjam formed near mile 2.8 (site 2b), and numerous downed alders were added to the channel at the site. At mile 1.8 (site 2) numerous alders were down in the channel and one pool/backwater was modified. In the Scott Creek watershed there was significant scour and fill among habitats at seven of the nine sites, and there were significant channel changes at eight of nine sites (all except site 5 at mile 4.3). Five were associated with the addition of fallen trees and two with the rearrangement of previous channel wood. The amount of tree fall and channel change in Scott and Gazos creeks was surprising, considering the relatively mild rainfall/runoff. Some channel changes may have been due to channel adjustments following the major channel changes in 2017. In addition, dead alders have recently been common at some of the sites, and may have been toppled by wind and/or to the gradually weakening trunks; however many of the fallen alders were alive when they fell. The changes on Waddell Creek were minimal, especially compared to the significant changes in 2016 and 2017.

Major floods in January and February 2017 resulted in channel changes at most sample sites in Scott, Waddell, and Gazos creeks (Smith 2017). On Gazos Creek habitats were rearranged at 5 of 7 resampled sites; only at the two upstream sites were habitats essentially the same. Most changes were scour or fill, with rearrangement of wood or pool positions within a site that produced no major overall changes in site habitat composition or quality. At mile 4.4 (site 4), the logjam at mile 4.2 opened in December, but closed in January and produced sediment “lake” deposits over a portion of the sample site that were rearranged by later down-cutting. One long habitat was separated into two. At the 2.1 mile site (site 2A), there were only minor habitat changes within the sample site, but immediately upstream a large partial logjam formed that probably provided a high flow refuge for overwintering fish. This probably accounted for the relatively high density of yearlings at the sample site. On Waddell Creek, there were habitat changes at 7 of 8 sites that had been sampled in 2016, but the only net change was at Twin Redwoods (site 3), where the most productive run habitat in previous years was degraded by channel widening and filling. On Scott Creek 9 of 10 resampled sites had significant habitat changes, with pool filling reducing net habitat quality at 3 sites (2,3,4) and scour improving net habitat at two sites (1,9).

Despite the severe flooding and channel changes in 2017, significant wood was added at only three Scott Creek and one Gazos Creek site in 2017.

The large flood peaks in January and March 2016 resulted in some significant channel changes in all three watersheds (Smith 2016). In the Scott Creek watershed, a downed tree, partial log jam and a resultant deep pool (in 2014 and 2015) at the Big Creek site was washed out and the pool filled. A log jam at the Scott Creek upstream of Big Creek (Site 2) was washed out and much of the wood added to a jam immediately downstream. On Upper Scott Creek (Site 9), a deep, wood-related pool was filled. At two other Scott Creek sites (Sites 3 and 7) there was filling of pools. In West Fork Waddell scour and fill was observed which resulted in the joining of formerly separate pools at both West Fork sites. Scour and fill was also observed at the two downstream main stem sites. The biggest change was at site 4 on the main stem of Waddell Creek, where the stream changed course for 100 m, leaving a secondary channel downstream of old partial logjams dry or with isolated pools by late summer. Farther downstream a pool was partially filled and another pool was widened and filled. Almost all coho captured in 2016 were at and downstream of this altered channel, which may have provided protection for a coho redd. On Gazos Creek, there was rearrangement of pools at three sites, including at mile 2.8 (site 2B), where a large redwood log anchored in the bank since before 1992 was rotated and washed 20 m downstream, eliminating what was usually a deep pool and backwater.

The large storms in December 2014 resulted in little change in channel habitats at most sample sites in 2015 (Smith 2015). On Gazos Creek, several habitats were modified at the 2.8 mile site, but otherwise channel changes were minor. At Waddell Creek, a large partial logjam was mostly washed out at the most downstream site, and there were pools partially filled, scoured deeper, or substantially modified at five of the nine sampled sites. On Scott Creek, there was partial filling of pools at five of the ten sample sites.

The mild 2013-2014 winter produced little change in channel habitats, although there was some pool filling or habitat rearrangement at three of the Scott Creek sites, possibly a delayed effect of the Lockheed Fire (Smith 2014). In addition, several habitats were modified at one of the Gazos Creek sites. Substantial channel changes occurred in 2005-6, 2010-2011, and 2012-2013, but the greatest recent changes were in 1997-98, when severe El Nino storms substantially rearranged individual habitats and increased wood and pool abundance on all 3 streams.

Water Temperature Impacts of the CZU Fire

Prior to the fire, Waddell Creek was generally well-shaded, with the riparian canopy well developed, having recovered from the loss of streamside shading on the main stem of Waddell Creek from major floods in 1982, 1983, and 1998 (Smith 2020). Summer water temperatures were previously relatively similar among all fish sampling sites, although temperatures in the narrower channels of the West and East forks were slightly cooler than on the wider main stem (Smith 2020). After the fire, the progressive upstream loss of streamside and upslope canopy has resulted in direct solar heating of the stream and warmer streamside air temperatures. These changes are reflected in the 2021 temperature logger results (Smith 2021c).

At the first bridge upstream of Highway 1 (mile 1) and at Twin Redwoods Camp (mile 1.8), where the riparian corridor was not affected by the fire, mean water temperatures in late June 2021 were 17-18 °C, with a gradual decline to 16-17 °C in mid-September (graphs in Smith 2021c). Maximum diurnal temperatures were less than 18 °C, the regulatory limit for fish sampling by electrofisher, by mid-September on lower Waddell Creek, when sampling usually begins. Upstream of Stevens Camp (at mile 2.85) where the canopy was open, mean water temperature in

late June was 19.5-20 °C, and diurnal maximums were still 21 °C through August (Smith 2021c). Mean temperatures were 17 °C in mid-September, with diurnal maximums often exceeding 18 °C. On the West and East forks upstream of their confluence, and farther upstream on the West Fork, mean water temperatures in late June were about 20 °C, with diurnal maximums 21-22 °C (Smith 2021c); diurnal variation was greatest on the East Fork. Mid-September means were 17.5-18 °C, and diurnal maximums frequently above 18 °C.

The temperature results from the four recovered temperature loggers on Waddell Creek in 2022 were similar to those from 2021, although daily maximums very briefly reached 23-23.5 °C during several extreme heat waves.

For comparison, on Gazos Creek, where the fire had little effect on the riparian corridor, mean water temperatures at three temperature logger sites in late June through August 2021 were 16-17 °C, and daily maximums very rarely reached 18 °C. In mid-September means were 14-15°C.

The differences among the Waddell Creek sites (2-4 °C) were less than expected, but probably partially reflect the higher than usual stream flows for such a dry year. There were likely greater cool groundwater inputs throughout the upstream sites because of the death of many trees and reduced canopy on most remaining trees. This would have dramatically reduced the transpiration demand on soil water. In addition, the warming upstream also probably had residual temperature increases downstream.

The small differences possibly would not have adversely affected conditions for steelhead (*O. mykiss*), because of improved algal and insect production with more light reaching the stream for drift feeding. Scales from steelhead taken in 2022 did not show summer false annuli from brief summer weight loss. The temperature change might adversely affect coho in their competition with steelhead, because of coho's preference for cooler water (Smith 2002 and 2020). The increased temperatures will further restrict the time window for electrofishing in late summer and fall.

Lagoon Habitats

In 2022, the sandbar at Waddell Creek was temporarily closed by 1 July, open on 6 July, and then fully closed and 7.1 ft high on the bridge gage by 14 July. The high lagoon level and high stream flow converted the lagoon fully to freshwater by 24 September or earlier. The lagoon was turbid from a small rain on 28 September, which depressed dissolved oxygen except in the upper 1.25 m. Scott Creek lagoon was also freshwater on 24 September, except for a saltwater lens from over-wash on the bottom half meter. Lagoon levels were high after full sandbar closure in both lagoons (7.7 ft on the gage at Waddell and 7.0 ft on the gage at Scott) because of the relatively high stream inflow. The North Marsh at Scott Creek had standing water throughout most of the marsh in August and September, but the lack of rain after mid-January and lower water levels in the open lagoon had completely dried the adjacent marsh in May. For the three years since the CZU fire, with resultant increased summer stream flow, the "seasonal" red-legged frog breeding pond in the Waddell northwest marsh was perennial. The high, nearly fresh, pond levels at Waddell have allowed cattails to eliminate all open water in the pond. The extremely dense cattails have ended any possibility of continuing the 24-year study of red-legged frog breeding activity at the pond.

In 2021, the sandbar at Waddell Creek was closed by 11 August and the bar at Scott was closed by 1 September. Both lagoons were stratified for salinity, with salinity in the bottom half of the water column 2.8 to above 11.5 ppt on 10 September. Bottom water was warm (to 20-22°C), and

hypoxic. Similar conditions persisted until at least 9 October. In 2020, the sandbars at Waddell and Gazos creeks were closed far to the south by 6 July and at Scott Creek to the north by early August. At Scott Creek impoundment of relatively low inflows raised the lagoon level by about 0.6 feet by 11 August and another 0.75 feet by 13 September. The relatively small and shallow lagoon converted to freshwater. At Waddell Creek, with the opening far to the south, seepage was high through the bar and closure did not raise the lagoon surface much; much of the depth of the lagoon came from the deep scour at the outside of the two sharp meanders upstream of the bridge. However, the extended very low sandbar did allow wave over-wash at high tides to continuously add sea water to the lagoon, and the mouth was briefly open in mid-September. The sandbar at Waddell re-formed, and the lagoon level was 2.5 feet deeper on 22 October, probably due to tidal over-wash or possibly due to increased inflow due to the death of trees in the watershed. The high lagoon level was sufficient to spread surface water through the marsh and sandy surface sediments to the northwest, resulting in re-flooding the seasonal red-legged frog breeding pond. Although the lagoon was quite saline and stratified (with freshwater in the upper 0.8 m and salinities of 4.9 – 16.8 ppt in the lower 2 m) the water that flooded the frog breeding pond was the surface freshwater; salinities in the pond were similar to those suitable for red-legged frog eggs and larvae in winter 2020 (0.4-2.8 ppt in the upper 0.6 m of the pond. After several days of king tide over-wash of sandbars, the water levels at Scott and Waddell creeks were raised another 0.5 ft by 17 November, the bottom half of Scott Lagoon was saline (0.5-3.8 ppt, on 2 December), and kelp was floating in the lagoons. Waddell lagoon was open to tidal action on 2 December and was more than 2 ft lower; the seasonal red-legged frog breeding pond was 0.35 ft lower.

Gazos Creek lagoon was apparently closed through September 2020, but the sandbar was breached and the lagoon level dropped almost 3 feet by 22 October, draining most of the lagoon habitat. Breaching regularly occurs in summer at Gazos Creek, and may be related to high lagoon levels back-flooding a septic tank at a residence immediately upstream of Highway 1. The 175 feet of deeply-scoured stream channel under and immediately downstream of Highway 1 was the only remaining habitat on 22 and 29 October, but 150+ large steelhead (about 160-190 mm fork length) were observed there on 29 October. Due to their large size and the apparent low steelhead abundance in the stream following the fire, the modest lagoon rearing was relatively significant.

Both Scott and Waddell lagoons opened to the south in early January 2019, and Waddell was open straight out by 18 January. The Scott sandbar had reformed by 13 January, but breached later in the day. The bar was barely open on 24 January, but was open straight out by 5 February and the outlet curved to the north by 11 February. In March, Scott continued to cut to the north along the road, and the outlet had cut down substantially by 8 May, producing a shallow (<0.9m; bridge gage 2.75 ft)), but impounded and productive, lagoon. Scott lagoon remained open along the north cliff, with a high partial sandbar, and gradually deepened (gage 4.35 ft on 6 June and 5.94 ft on 18 July). On 18 July the lagoon was 1.5 m deep at the Highway 1 Bridge, with a saline layer (1-12 ppt) below 1 m, from high tide over-wash of the open sandbar. The bottom layer of saline water would have been lost quickly by seepage through the narrow sandbar. The mouth down-cut by 20 August (gage 4.12 ft; lagoon about 2 ft shallower), but the water column at the bridge was fresh. The lagoon was fully closed and deep (bridge gage 6.65 ft) by 10 September. On 8 October the bridge gage was 6.2 ft, and the lagoon was 1.5 m deep at the bridge, with a thin saline (0.8-2.5 ppt) layer below 1.3 m deep. Abundant yearling and YOY steelhead were observed feeding throughout the summer and fall.

Waddell Creek lagoon deeply cut straight through the beach and substantially drained at low tides on 11 and 26 February. The down-cutting and draining at the lagoon would have substantially reduced over-wintering refuges for tidewater gobies (*Eucyclogobius newberryi*). However, by 8 March the outlet was to the south partially impounding the lagoon. The lagoon remained open to the south behind a wide beach, subject to high tide wave over-wash, through early October. The bar was barely closed on 8 October, but open and the lagoon shallower on 9 October. The lagoon was deep (bridge gage 7.2 ft and 2.3 m deep at the bridge) and stratified (1.3-22.1 ppt) upstream of the highway bridge on 8 October. No sampling of the lagoon took place in 2019, but surface feeding steelhead were never observed, unlike in 2016 when feeding was observed and steelhead were abundant (Smith 2016). The sandbar was closed by 25 October. Both Scott and Waddell lagoons stayed closed into mid-November.

Gazos Creek lagoon was open straight out on 28 February, but the opening was curved far to the south by 8 March. The long curving outlet produced an impounded lagoon suitable for feeding by emigrating smolts. The mouth was curved to the north and was open in June through at least September, producing a relatively shallow embayment, except for the scoured channel between the highway bridge and the embayment. The lagoons opened in early January in 2018, but intact partial sandbars kept lagoon levels high through spring. The opening at Scott Creek remained far to the south. Large swells produced sandbar over-wash and wave intrusion in late January (and also later) resulting in saltwater in the three lagoons for spring (salinity of 0.2-2.8 ppt in the top 0.65m, but 15.4-20.4 ppt from there to 1.5m deep in Scott Creek on 7 May). The swells were sufficient to put salt water in the off-channel "South Pond" and in the north marsh channels at Scott Creek and in the marsh pond northwest of the Waddell lagoon. Salinity was stratified with 2.0 -21.3 ppt in the south pond at Scott Creek on 16 February; wind mixing by 22 May resulted in freshwater only at the immediate surface, but salinity of 12.2-12.8 ppt in the rest of the water column. Salinity was 8.8 – 12.7 ppt in the Waddell Creek seasonal marsh pond on 16 February. These potential California red-legged frog breeding habitats were too salty in 2018 for successful red-legged frog reproduction. Scott and Waddell sandbars remained open, with shallow channels, through the smolt migration period, but were closed by July. The lagoon at Scott Creek was converted to fresh by July (0.2 ppt throughout the water column on 3 July). The lagoon at Waddell was stratified and saline all spring and summer (salinity 1.4-3.6 ppt in the top m, but 7.0-26.9 ppt in the bottom 2 m on 16 August); the very low sandbar at Waddell was subject to regular over-wash every two weeks during spring tides. At Gazos Creek the lagoon was mostly open behind a high partial sandbar throughout summer, but was occasionally closed. Conditions for steelhead rearing in the Scott and Gazos lagoons were good, with the stream arm at Gazos Lagoon supporting surface feeding steelhead, as it did in 2017 (Smith 2017). The stratified conditions in Waddell lagoon, with saline, periodically hypoxic bottom water, apparently supported few steelhead, unlike in 2016 (Smith 2016). No surface feeding was ever observed, nor were schooling fish observed in the clearer, shallow upper lagoon during early summer pond turtle studies at the lagoon. The very low density of steelhead in the lower reach of Waddell Creek (Table 8) may have been a factor in the lack of lagoon rearing. The sandbars at all three streams were opened by late November 2018 storms, but reclosed due to dry conditions at Scott Creek by early December.

In winter 2016-2017, Scott Creek lagoon was opened nearly straight out by December storms. Gazos and Waddell creeks were open earlier. By April the lagoon at Scott Creek had backed behind a very high sandbar that forced the mouth opening far to the south. The lagoon water elevation was 8.25 ft msl (mean sea level) on 3 April at the bridge gage, and the north marsh was inundated and the south pond was connected to the lagoon; only the bottom 0.5 m of the water column was mildly brackish (2.2-6.0 ppt). The rapid, high beach development in a wet winter was unusual, since winter waves usually erode, rather than build the beach. Stream flow gradually cut down at the bar opening and lagoon water elevation declined to 7.4 ft on 13 April, 4.5 ft (with the lagoon confined to the stream channel) on 3 May, and 3.92 ft on 14 June. The bar was open, but shallow and far to the south, for potential smolt passage through mid-June. The bar was closed by 16 July (following spring tides 1 week earlier), despite an apparent attempt to breach the sandbar; the lagoon water elevation had climbed to 7.16 ft, was 2 m deep at the bridge, and again flooded portions of north marsh. The bottom 0.5 m of the water column at the bridge was salty (13.3-22.9 ppt) from wave over-wash. The lagoon stayed closed and mostly fresh all summer and was still 6.8 ft msl on the bridge gage on 10 October; however, the lagoon was brackish, with 1.6-3.2 ppt in the upper 0.75 m and 7.3-12.5 ppt below, due to wave over-wash. By 25 October wave over-wash had raised the lagoon water elevation to 8.62 ft msl and the water column below 0.15m was 11.5-28.5 ppt; dissolved oxygen concentrations were declining. An early storm provided freshwater inflow that opened the lagoon, but it re-formed by 17 November, and the lagoon was higher (9.78 ft msl) and was mostly freshened; the lagoon was somewhat lower on 22 November and 22 December (8.95 ft and 8.5 ft) and still fresh in the top 1.25 m. The lagoon was mostly well-mixed, and only at 2.0-2.9 m deep was the lagoon brackish (2.1-8.0 ppt) or with depressed dissolved oxygen (< 4.0 mg/l). Rearing habitat in the lagoon was good until at least October.

Waddell Creek lagoon in 2017 was substantially scoured by winter storms, and was mostly a stream to the ocean, with some backwaters, in mid-April. The lagoon was 6.1 ft msl on the bridge gage on 14 June, mostly fresh, 2 m deep at the bridge, and open far to the south. The lagoon then closed and breached by 16 July. Gage height was 3.38 ft msl on 16 July, and all but the top 0.25 m of the water column was very salty (21.5-28.2 ppt). The lagoon then opened and closed several times over the summer and was generally quite saline. It was closed on 10 October (6.60 ft msl), had opened and reclosed by 18 October (5.05 ft msl), and then opened behind a higher sandbar (5.46 ft msl) by 25 October. As at Scott Creek, the beach built relatively early for such a wet year, and even though the mouth opened and closed over the summer, the lagoon was always relatively deep and salty.

Gazos Creek was draining somewhat to the south from a shallow lagoon on 3 April 2017. By September the main embayment was still less than 1 m deep, with the open outlet curving to the north near the bluff. However, the floods in January and February substantially scoured the narrow stream channel between the Highway 1 Bridge and the main embayment, with depths in the meanders of 1.4+ m. This habitat was deeper than past experience in this lagoon. The lagoon is usually open in summer, with frequent artificial breaching. Large juvenile steelhead were observed upstream of the main embayment in the inundated stream channel. There are no calm backwaters in the lagoon to protect against flood flows, so tidewater gobies are absent, and the shallow system usually provides little or no feeding habitat for smolts from upstream in spring.

On 16 February 2016, the lagoon at Scott Creek was open to the north, and impounded behind a partial sandbar (Smith 2016). By 25 February the lagoon was again closed behind a high sandbar, and the marshes to the northwest and southeast were flooded. After the March storms, the lagoon was open, but the opening was far to the south; on 28 April the lagoon was relatively shallow, but still open far to the south. By June the sandbar was closed, and the lagoon was filled with fresh water. On 5 July the lagoon water elevation was high, and on 18 July the marsh to the northwest was flooded. On 19 October the lagoon was open to the south behind a high sandbar, and over wash had put kelp into the lagoon. The sandbar closed again, but breached on 27 November. The deep and fresh lagoon for most of the summer provided good rearing conditions for steelhead.

The lagoon at Waddell Creek was open through June 2016, but the opening was shallow by May, and some adults were trapped in the lagoon. The sandbar intermittently closed (5 July and 10 August) and opened (18 July) or was closed at low tide, but subject to ocean inflow at high tide (8 and 19 September and 19 October). On 18 July, the shallower upstream portion of the lagoon was fresh water, but the remainder of the lagoon was stratified, with 15-24+ ppt salinity and usually warm water in the lower half of the water column. In September and October steelhead were feeding in the incoming tidal flow immediately upstream of the bridge; the cool tidal flow during the alternate week spring tide periods cooled the lower water column near Highway 1. At least the upstream and downstream portions of the lagoon provided good conditions for steelhead rearing.

As in most years the lagoon at Gazos Creek was open and shallow most of the summer. However, as has frequently happened there, the sandbar was observed to have been shoveled open and substantially drained on 18 July 2016.

The December 2014 storms opened the lagoons at Waddell and Scott creeks, but the sandbars partially closed by March 2015. On 19 April the lagoon at Scott Creek was more than 1 m deep (gage height 5.3 ft) at the bridge, with a substantial partial sandbar, and the lower two-thirds of the water column was saline (8.8-27.5 ppt). Water column dissolved oxygen was good throughout (8.5-10.7 mm/l). At Waddell Creek the lagoon was 1.3 m deep at the bridge (gage height 4.3 ft), also with a shallow sandbar opening, and with the lower three-fourths of the water column was saline (21.6-30.5 ppt). Conditions at both lagoons provided good conditions for smolts and juveniles to feed and for smolts to adjust to salt water. In most wet years Scott Creek lagoon has nearly drained and provided little habitat after sandbar breaching. However, in 2015 passage over the open sandbars was very shallow by May; some smolts may have been trapped even prior to full sandbar closure. On 22 July 2015, water elevations at both lagoons were higher (gage height at Scott was 6.1 ft; gage height at Waddell was 7.0 ft) behind closed sandbars, and adjacent marshes were partially inundated. Despite relatively low inflows, water levels were maintained through September. Water elevations increased in November, and the sandbar at Waddell Creek was illegally breached on 22 November, with the water elevation dropping from gage height 8.3 to below 5.5 ft. The high lagoon elevation at Waddell in summer was sufficient to produce high groundwater levels in the marsh to the west of the lagoon; this resulted in dense growth of rush and cattail in and surrounding the red-legged frog breeding pond in the marsh.

In 2014 the sandbar at Scott Creek breached with the early February storm, and the residual lagoon had a maximum depth of only 0.5 m on 10 February. The sandbar gradually built over the spring to impound slightly more fresh water and produce a shallow outlet over the bar. The sandbar was fully closed by the end of May, trapping a significant number of wild and hatchery-reared coho and steelhead smolts; the sandbar remained closed until November storms, allowing for summer rearing by trapped coho smolts and juvenile steelhead. The winter and early spring conditions were similar to those that usually occur at Scott Creek, where little residual lagoon depth is present in the straightened lagoon channel after the bar is breached in late fall or winter, providing limited feeding and osmotic adjustment conditions for out-migrating smolts.

Those winter/spring conditions contrasted with the atypical conditions that occurred in 2012-2013. In December 2012 the sandbar was illegally artificially breached, and December storms eroded the bar and portions of the beach, but mild conditions in January through early March 2013 again produced a substantial partial sandbar and an impounded and productive lagoon. On 6 March 2013 the lagoon was 1.65 m deep at the Highway 1 Bridge (6.42 feet on the bridge staff gage) with brackish water in the lower 0.65 m. The lagoon remained at least 1 m deep (and usually fresh) through May and June (4.8 feet on the bridge staff gage). This provided for ideal feeding conditions for migrating coho and steelhead smolts from the upper watershed, for migrating hatchery-reared coho smolts, for adults entering from the ocean to stage before moving upstream, and for juveniles moving down to the lagoon to rear for summer 2013. The sandbar closed at both Scott and Waddell creeks by July and remained closed at Scott Creek, and intermittently closed at Waddell Creek, through the summer rearing season. The sandbar was open much of the summer at Gazos Creek, apparently due to artificial breaching.

Waddell Creek lagoon has good residual depth when the sandbar is open because of scour at a sharp S-shaped bend upstream of the Highway 1 Bridge. This bend was substantially exaggerated in 1999, when about 50 feet of the right bank shoreline was eroded at the top of the bend. The inside of the bend also now provides a good backwater, high flow refuge (with cattails and tules) for tidewater gobies. The lagoon area was severely scoured by the March 2016 and the January and February 2017 storms. However, there remained a sufficient backwater high flow refuge, and tidewater gobies were common in 2016 and uncommon, but present, in 2017.

Channel Wood

During and closely after the CZU Fire some cut trees and dead and toppled streamside trees, mostly alders, were added to the three streams, but some pre-exiting channel wood was also burned (Smith 2020). A major jam on the West Fork of Waddell that was a partial fish passage barrier since its formation in 1998 was burned. During the first (mild) winter after the fire some additional damaged trees fell into the channel; these were mostly cooked or burned alders (Smith 2021a, 2021c, and 2021d). On Waddell Creek a debris flow at mile 2.85 brought some streamside trees into the channel, which trapped mobile dead alders as an open jam. Damaged and toppled trees on the West Fork at mile 3.4 also formed a jam. However, with the exception of alders, most damaged trees, even those with completely dead trunks remained standing in place (with basal sprouts on tan bark oaks and big leaf maples). The major storms in October and December 2021, and bank and steep upslope erosion, brought more damaged trees into the channel, especially on Gazos Creek, where steep slopes confine the entrenched channel (Smith 2022a). The storm flows also moved previous and new wood around in the channel, often removing pool-forming structure or assembling it into log jams, including downstream in areas not directly affected by the fire (Smith 2022a, 2022b, and 2022c). The 2021 jam at mile 2.85 on Waddell Creek tripled in size, but the jam at mile 3.4 on the West Fork was partially buried by aggradation in the channel. (Smith 2022c). Substantial new wood could be added from trees or trunks killed near the streams by the fire, and potentially from upslope trees carried to the channels by debris flows in future winters.

Prior to the fire little new wood would have been added to the three watersheds in the mild 2019-2020 year. Since 1998 wood additions have been quite limited, with the majority of new wood from relatively small streamside alders. The scarcity of new wood since 1998 is because most of the vulnerable streamside trees were recruited during the very large and long-duration El Nino storms of 1998. Large wood additions, especially from long-lasting conifers, apparently occur episodically only during extremely wet years. In 1998, debris flows from drenched soils delivered upslope trees to the channel, and large floods eroded stream banks and toppled large riparian trees (Smith 1998c). Channel wood and large logjams were produced at toppled trees, especially persistent conifers and multi-trunked maples.. Large wood was rearranged in storms in 1999 and 2000. Some smaller streamside alders were added to the channel in most average or wet years, but they easily rearrange and break up quickly; habitat benefits, although important, are smaller and of rather brief duration (Leicester 2005). Little wood (other than on Gazos in late summer 2008) was added in 1999-2005, 2007-2017, and 2019 or during the 1992-1997 period.

If a rare disturbance year like floods in 1998 or the 2020 fire occurs, and substantial downed streamside and upslope trees are added to the channel on any of the three streams, it should be considered a restoration opportunity. Rather than hauling large wood to the stream to install wood structures for pool and escape cover development, the newly added wood (including passage-impairing logjams) can be much more easily rearranged on site to efficiently and relatively cheaply accomplish the same habitat restoration goals. In the next several years more wood will probably be added because of the 2020 fire. Creative channel manipulation of that wood could substantially improve habitat conditions and reduce the potential adverse effects of logjams as fish barriers.

Despite the large storms in 2019, there was little new wood, mostly alders, added to Scott, Waddell or Gazos creeks, in contrast to the substantial additions on Scott and Gazos Creeks in the "milder" winter of 2018. On Scott Creek additional trees came down at site 3, downstream of Mill Creek, and at site 1, at the Little Creek confluence, to add to the major additions in 2017 and 2018. Existing wood was reworked in 2019 on all three streams, altering habitats and channel configurations, especially at site 3 on Scott Creek.

In 2018, relatively numerous downed trees (mostly alders) were added to sites on Gazos and Scott creeks. This was unexpected for a winter without large floods. Recent mortality among alders at many of the sites may have resulted in their final addition to the channel. However, fallen wood included live alders and California bays. Fallen trunks were especially common in Scott Creek near Little Creek and downstream of Mill Creek.

Despite the high stream flows and significant rearrangement of pools and channel wood, little new wood was added to the observed sites in 2016 and 2017. A single downed tree entered the channel at site 2 on Waddell Creek in 2016, and multiple downed trees at site 2A on Gazos Creek and site 1 on Scott Creek in 2017. The major change in 2008 was the toppling of 5 large redwood trunks at mile 4.4 on Gazos Creek; these were modified in October 2009 by San Mateo County Department of Public Works. Despite the substantial channel changes in 2005-6 and 2010-11, large wood, from undercut streamside trees, was added at only 6 of 27 sample sites in 2006, including 4 on Scott Creek. Three of the added trees were large multi-trunked bay trees. Wood was added at only 2 of 24 sites in 2011. The trees from 2005-6 caught additional wood in 2006-9, resulting in the changes in habitats observed at Scott Creek sample sites. In 2011 single downed alders changed pools at one site on Scott Creek and one site on Gazos Creek, and in 2012 on Gazos Creek one formerly backwater pool was altered by a fallen alder and a multi-trunked maple fell on an existing logjam and open up a migration pathway. In 2013 fallen alders were added at one site in the Scott Creek watershed and one site at Gazos Creek, but previously added wood was rearranged by the high December stream flows.

Logjams

Partial jams on all three streams are probably important overwintering refuges for coho and steelhead during large storms, so jams should only be modified if they are major passage impediments. However, several major logjams in 2022 are serious barriers to fish passage or potentially serious future fish barriers. They should be monitored and serious barriers modified (Smith 2022a and Smith 2022c). Highest priorities for modifications are the logjam at mile 0.65 on Waddell Creek and the jams at miles 2.1, 2.8, 3.3, 4.1, 5.0 and 5.0+ on Gazos Creek.

The high winter stream flows in 2019 would have improved adult passage windows in all three streams, compared to the low winter stream flows in 2018 and 2019-2020. The major large and persistent logjam on West Fork Waddell Creek (mile 3.4) has been the major logjam on the stream and has been an intermittent passage issue since 1998. That jam was partially burned by the 2020 fire, and is currently open to fish passage. A new jam had formed in winter 2021 by toppled trees at mile 3.45, and the aggraded channel from debris flows had produced a step that was a potential barrier, until channel aggradation in 2022 mostly buried it. A partially open logjam at mile 2.85 resulted from a small west slope debris flow that delivered some trees across the channel. That jam grew in height and tripled in length from dead alders added to the jam with the December floods (Smith 2022c).

Of major concern on Waddell Creek is a new 2022 logjam in an entrenched portion of the channel at mile 0.65 (upstream of the first bridge). It is composed of old and new wood, is tightly packed,

tall, and extends across most of the flood plain. Much of the wood apparently came from a jam present at mile 0.85 in 2021 that was dislodged by the December 2021 storms (Smith 2022c). The logjam appears to be impassable except at very high flows, and it may have been in place during most of the high flows in December that provided potential adult fish passage. The very low abundance of steelhead and coho in 2022 may have been due to the blockage. The jam, which is on private property, should be modified to allow passage. Equipment access would be difficult, but a chain saw could open passage near the right (west) bank.

Partial (open) logjams on Scott Creek did not appear to be passage problems in 2018 and 2019, but could also have caught added wood in 2020-2021 However, no new jams were observed at or near the six sampled sites in 2022. At most sites on Scott Creek the channel is not entrenched and has sandy banks. High flows tend to recut the channel around or under the jams. The few and delayed moderate storms in 2018 and 2020, compared to early and continuous high flows in 2019, would have made passage at any logjams more problematic for steelhead, and especially for coho, which usually migrate prior to the March and April storms of 2018. However, coho had been recently confined to Scott and Waddell creeks, where logjams are less of an issue compared to the entrenched channel at Gazos Creek. However, hatchery-origin fry were planted in Gazos Creek in early summer 2018, so logjams are now an issue for coho restoration.

The narrow, entrenched channel in much of Gazos Creek upstream of mile 2.0 prevents the stream from cutting around logjams, and abundant small wood readily gathers at large obstructions. The stream provides good coho and steelhead rearing habitat, but because of its entrenched channel, has had chronic problems with logjams affecting adult fish passage, and those problems are more serious following the fire. Abundant fallen and cut trees entered the channel in 2020-2022, and the high flows in October and December 2021 entrained mobile wood and assembled jams at multiple obstructions. The logjam possibly present between miles 2.1 and 2.8 prior to the fire apparently reassembled itself immediately upstream of the mile 2.1 sample site in winter 2021-2022 (Smith 2022a). It is large and tightly packed in an entrenched section of channel. Sediment from the October and December 2021 storms has aggraded upstream of the jam. As the most downstream significant logjam, it potentially blocks or hinders adult fish passage to the best spawning and rearing habitat on the stream. The logjam at mile 4.2, which formed from a debris flow with entrained redwoods in 1999, had been a fish passage problem in many of the last 20 years. High flows in December 2022 removed two-thirds of the wood and lowered the jam. It is now easily passable to adults. However, the liberated wood reassembled as a new major logjam at fallen trees at mile 4.1 (Smith 2022a). The jam at mile 2.8, which predated the fire and was partially burned, accumulated more wood in 2021 and 2022 and is a potential barrier to adult at low and medium stream flows. New jams as potential fish barrier also formed in 2022 at mile 3.3, and a pair formed at mile 5.0 (Smith 2022a).

At Gazos Creek, steelhead were relatively scarce at four of five sites upstream of mile 2.1 in 2019, and were atypically abundant at mile 1.8 (Table 7). There may have been a major logjam passage problem somewhere between mile 2.1 and 2.8. The large jam at the downstream end of the 2.8 mile sample site, has not been an apparent fish barrier, but was only partially burned and can be further plugged by added channel wood, including trunks and branches added during fire control and road clearing efforts. The major logjam at road mile 4.2 has been an apparent passage problem except during floods in many years. It was not burned in the 2020 fire. In addition, new alders were growing under the open canopy now within the jam (Smith 2021b). In 2021, fish densities varied substantially among the sites, which could indicate passage problems or few returning steelhead. However, highest densities were at the two upstream sample sites.

In 2019, the jam at mile 4.2 was mostly opened up, at least by the end of winter. It was apparently mostly closed (and backing up sediment) for most of winter 2018. YOY steelhead were scarce upstream of the jam in 2018, as they were in 2005, 2010, 2013, and 2014 (Table 7; Smith 2006a, 2010, 2013, and 2014). In 2018 the scarcity may have been at least partially due to competition with the hatchery-reared coho common at those 3 upstream sites. The logjam opens and closes with storms in some years, but needs to be modified to allow regular passage for steelhead (and the coho returning from the 2018 rearing of hatchery-origin coho juveniles). The location of the apparent logjam between miles 2.1 and 2.8 needs to be determined and the jam modified for passage. There are several partial jams immediately downstream that catch dislodged wood and are occasional problems; they should be addressed when modifying the major jams.

Very high stream flows in January and March 2016 and January and February 2017 were apparently sufficient to provide passage, at least during the storms, through or around the major logjams on Waddell and Gazos creeks. However, passage during lower stream flows or for potentially early migrating coho is still a potential problem. The high flows in 2005-6 and 2010-11 did move smaller wood around in the channel and substantially increased the size of existing logjams on Waddell and Gazos creeks. The jams changed little in 2007-10 on either stream or in 2012-2018 at Waddell Creek.

On West Fork Waddell Creek (about road/trail mile 3.4) a jam formed by fallen redwoods in 1998 greatly enlarged and solidified in subsequent years; it may be a barrier to adult migration except in wet years or at extremely high flows, when some of the wood may float. It did not appear to have affected adult access in 2013-2017, but is a long-term potential problem. The problem should be addressed, because much of the coho habitat in the Waddell Creek watershed is on the West Fork upstream of the jam and because the East Fork and main stem of Waddell Creek have apparently been subjected to fish kills in most years since 1999. On a Waddell Creek a large, but partially open, logjam, present at the most downstream sample site since 2011, was largely opened along one bank in 2015.

On Gazos Creek a jam created by redwoods from a debris flow in 1999 (at about road mile 4.2) was probably impassable to adult steelhead or coho except at extremely high flows between 2005 and 2011. The November and December storms in 2012 rearranged the larger upper jam again, and produced an apparent passage channel under the left side of the jam in 2013-2015, and possibly 2016. In December 2017, a path through the jam was substantially opened, but the jam was fully closed again by late January. A smaller jam immediately downstream was also a partial barrier to migration. In March-April 2012 the smaller jam washed out and the larger jam was modified when a right bank multi-trunked maple fell onto the jam. An opening through the jam was created near the right bank that would allow adult passage at relatively low storm flows. Debris from the existing jam and the washed-out jam has periodically formed a new partial logjam 100 m downstream of the site of the lower jam. The large logjam continues to partially open and fully close, and is a serious actual or potential problem for adult steelhead (and future restored coho) passage, and should be partially removed or rearranged to ensure passage to the upper 1.5 miles of good steelhead and coho habitat.

On Gazos Creek, downstream of a large pullout at about road mile 2.4, a large fallen Douglas fir (from 2001) anchored a large jam, which was also probably impassable to adult migration between 2005 and 2011, except at extremely high flows. The jam also presented some problems for road stability. That jam substantially blocked adult access to most of the better spawning and rearing habitat on Gazos Creek. The jam was passable underneath in winter/spring 2012 and washed out completely in December 2012. However, the debris formed a new jam 100 m downstream, which appeared to be a complete barrier to fish passage except during floods in 2013. It appeared passable in summer 2014 and 2015, but the opening under the jam may not have been open all winter and could plug again to restrict fish passage. The jam appeared more difficult in 2016, but during the large storms there would have been passage around the jam. This logjam should be partially removed or rearranged to ensure adult steelhead and coho access. The jam is now farther from the road, but opening the right bank (road) side of the jam could be assisted from cables from roadside equipment.

A new major logjam formed in winter 2012-2013 on Gazos Creek at about mile 2.9 (immediately upstream of sample site 2B). The large jam is in an entrenched channel and presently does not appear passable, except at floods that would overtop the jam. At least five steelhead redds were concentrated within sample site 2B downstream of the jam in 2013. The condition of the jam was similar in 2014 and 2015, but was apparently passable during the December 2014 storms. The jam was rearranged and passable in 2016. However, the logjam should also be partially removed to ensure adult coho and steelhead access.

A logjam formed by a downed multi-trunked maple in 2000 (at about mile 1.8, and not visible from the road) enlarged and solidified and was a substantial barrier to low flow fish passage until at least 2011. The maple was still present, but open to free fish passage in summer 2013-2016. New log jams in 2014 (downstream of the Old Woman's Creek confluence) and in 2015 (about 0.3 miles upstream of Highway 1) were potentially serious passage problems, except during storms. The jams were gone in 2016.

The Gazos Creek logjams were probably a passage issue in 2006 and 2010, and in the 2007-2009 drought years, when juvenile steelhead were relatively scarce, especially at upstream sites (Table 7). Passage apparently improved in 2011 and 2012 (Table 9), but was a serious problem for adult access again in 2013, before mostly improving again in 2014. The December and February storms in 2015, January and March storms in 2016, and January and February storms in 2017 apparently provided some steelhead passage through all of the jams.

<u>Coho</u>

Gazos Creek

No coho were captured at the seven sample sites on Gazos Creek in 2022, although hatchery-produced smolts on Scott Creek regularly stray as adults elsewhere. The last wild production of coho was in 2005 (Table 4).

No coho were captured at the 7 regular sample sites on Gazos Creek in September 2021, although hatchery-produced coho fry were planted in Gazos Ceek in June 2018. Adults from that effort ahould have returned in winter 2020-2021.

No coho were captured during sampling at four sites on Gazos Creek in October 2020. Although straying of returning coho from hatchery-reared smolt releases to Waddell, San Vicente, and other streams has frequently occurred, straying has apparently not occurred to restore coho presence at Gazos Creek.

Only two holdover yearling coho from fry plants in 2018 were captured on Gazos Creek in 2019. The two coho were bigger (70-71 mm SL; 52 and 60 mm at annuli) than any caught in 2018, but were still not much bigger than the largest YOY steelhead (Figure 7, Historical Fish Lengths).

There was apparently no wild coho production in Gazos Creek in 2018, but about 8000 hatchery-origin fry were planted in early summer within the upstream portion of the creek (about road miles 4.7-5.3). Juvenile coho were common within the planting zone in September, with 36.3 / 100 ft at site 7A (5.3 mile) and 15.2 / 100 ft at site 5 (mile 4.85; Table 4 and Smith 2018). Planted fish also moved downstream somewhat, and were also common at site 4 (mile 4.4), 13.2 / 100 ft, but were very scarce farther downstream at site 3A (mile 3.9), 0.9 / 100 ft. Densities at the three upstream sites were generally similar to those in 1999 and 2005, but less than in 2002, the very strong central coast coho year, when densities throughout Gazos Creek were mostly 22-46 / 100 ft (Table 4). A rough estimate of the number of coho surviving until September at and downstream of the planting zone is about 1500 fish, representing about 18% survival of the planted fish.

The coho in 2018 were small, mostly 35 – 65 mm SL, compared to coho in previous years in Gazos and Scott creeks, but were similar to wild coho on upper Scott Creek (40 – 60 mm SL) in 2018 (Figure 7). Gazos Creek coho were also not much larger than YOY steelhead at the same sites, although usually they are larger because of earlier spawning and larger fry size at hatching.

No coho were captured at the seven re-sampled sites in 2015 and 2016 and at the eight sampled sites in 2017 (Smith 2017 and Table 4). Unlike Waddell Creek (below), apparently no returning Scott Creek hatchery-origin smolts strayed to Gazos Creek in winter 2014-15, 2015-2016, 2016-2017, or 2018. No wild coho juveniles have been collected since 2005 (Smith 2005 and Table 4). Only a single "marginally viable" year class (defined as juveniles > 2 per 100 ft, capable of producing 10-12+ returning adults) had been recently present in Gazos Creek (1993, 1996, 1999, 2002, 2005; Table 4). Even that year class had sharply fluctuated in abundance, apparently mostly due to winter stream flow conditions, and coho had generally been scarce downstream of silt-laden Old Woman's Creek (Table 4). After the ideal winter conditions of 2002, when rains were concentrated early in the season prior to coho spawning, juvenile coho abundance was high (27.7 / 100 ft) and rather uniformly high upstream of Old Woman's Creek (24 - 54 / 100 ft; Table 4). The good juvenile production in 2002, and the stocking of hatchery-reared smolts in spring 2003, should have resulted in a large run of adults in winter 2004-5. However, overall juvenile density was down (11.6 / 100 ft) in 2005, and densities upstream of Old Woman's Creek were uniformly lower (9-20 / 100 ft). This was presumably due to spring storms in 2005, which may have reduced redd survival or flushed emerging coho fry. Coho abundance in 1993, 1996 and 1999 was even lower (4.9-6.2 / 100 ft) and concentrated at upstream sites (Table 4). The results in 2002 and 2005 showed that even in "good" coho years, juvenile coho abundance may be affected more by winter and spring conditions than by summer rearing conditions (Smith 2002, 2006a). However, the loss of the remaining year class in 2008 was apparently due to the coast-wide impact of poor ocean survival (Lindley et al. 2009).

Waddell Creek Watershed

Coho were captured at five of seven sample sites on Waddell Creek in 2022, but densities of both coho and steelhead were very low (1.9 / 100 ft and 6.3 / 100 ft;Table 2). With the abundance of coho in Scott Creek and significant straying of coho adults to other streams, the scarcity of coho in Waddell was surprising. Straying of adults from hatchery-reared Scott Creek coho smolts to Waddell Creek has been common in the past (Smith 1992, 1994a, 1996). However, YOY coho in Waddell Creek have generally been relatively scarce compared to Scott Creek (Tables 5 and 6). Flood impacts to redd survival on the East Fork and main stem of Waddell Creek appear to be a major factor. The West Fork has usually had the highest coho densities (Table 5). The only year when the main stem of Waddell Creek had high coho densities was in 1996, when hatchery-produced fry were planted below the forks (Table 5).

Only a single site was sampled in Waddell Creek in October 2021, so the lack of coho captures means little. However, the lack of coho captures in Gazos and Scott creeks in 2021 probably indicates that successful coho spawning and rearing in Waddell Creek was unlikely. The January storm, and observations of YOY steelhead in June as far upstream as mile 3.6+ on the West Fork,

indicates that if coho adults did return, they should have been able to reach spawning and rearing habitat. However, spawning success could have been impacted by debris flows on the West Fork (where coho have been present most often; Table 5) and upper main stem.

The PIT-tag antenna at mile 0.5 on Waddell Creek detected adult coho in winter 2020 (Joseph Kiernan NOAA Santa Cruz, pers. comm), so strays from Scott Creek smolt releases again entered Waddell; apparently no wild coho production occurred in Waddell in 2017 to contribute to adult returns (Smith 2017). Despite the low winter stream flows, steelhead and coho should have been able to access the entire main stem of Waddell Creek and at least the lower West and East forks after 17 January, as there were no significant passage barrier logjams present in 2019. Steelhead would also have had access to upstream habitats with the April storm. Unfortunately, due to the CZU Fire, safe access for fish sampling in October was limited to downstream of mile 2.4. The three main stem sample sites at miles 1.2 to 2.2 were sampled; the site at mile 0.6 was not sampled because it was back-flooded by high October lagoon levels.

Only 21 juvenile coho (4-5 / 100 ft) were captured at 2 of 3 main stem sites on Waddell Creek in October 2020 (Table 5). Coho have usually been uncommon on the main stem, especially since 1999 when both coho and steelhead have usually been scarce, apparently due to fish kills in the East Fork and main stem (Tables 5 and 8, and details below for previous years). In 1996 hatchery-reared coho fry were planted in the main stem and where common during fall sampling throughout (Smith 1996), so summer rearing habitat is suitable for coho. Unfortunately, sandy substrate and high winter storm flows in the East Fork and main stem in wet years result in poor redd survival. In 2002, 2005, 2015, and 2016 coho were relatively common at 1 or both of sites 3 and 4, which were sampled this year, apparently due to a lack of fish kills in at least 2015 and 2016 (Smith 2015 and 2016) and secondary channels giving some protection against kills (Smith 2002, 2005, and 2016a). The abundance of coho and steelhead was relatively high at the sample sites this year, so kills were apparently not an issue. Immediate fire effects were minimal upstream to the forks, so coho probably are similarly abundant up to the forks. Coho have been most persistent and abundant on the West Fork (Table 5). Coho were probably even more abundant in 2020 on the West Fork than in the main stem before the fire, because the West Fork has good woody pool habitat, less fine sediment in the substrate, has had milder storm flows and is upstream of the fish kills associated with the East Fork and main stem. However, there were major direct fire impacts and major expected winter damage on the West Fork from the CZU Fire. Since juvenile hatchery-reared coho were planted in Waddell Creek, including on the West Fork, in 2018 and 2019, adults should have returned in winter 2021 and 2022. In addition, smolts planted in Scott Creek regularly stray as adults to Waddell Creek (Smith 1992, 1994a, 1996).

In 2019, hatchery-origin adult coho from smolt plants in Scott Creek strayed to Waddell, and were detected by the PIT antenna (Joseph Kiernan, NOAA Santa Cruz, pers. comm.). Several apparent coho redds were also detected on the West Fork during electrofish sampling in September. However, only four juvenile coho were captured at 3 of 8 sites during September sampling (Smith 2019). It is likely that the heavy and late storms destroyed the few redds from adult strays in 2019.

In November 2019, 5000 hatchery-reared juveniles, produced from captive broodstock at the Kingfisher Flat Restoration Hatchery on Big Creek, were planted on the upper main stem and west fork of Waddell Creek. Coho returning in 2021 will be almost exclusively from those fall juvenile plants and from strays of smolts planted in Scott Creek in 2020. Hatchery-origin adult strays from Scott Creek were detected at the PIT antenna on Waddell Creek in January 2018 (Joseph Kiernan, NOAA Santa Cruz, pers. comm.). There was also some wild production from hatchery strays in 2015 (Table 5), which might have also produced some adult returns in 2018. Among the eight Waddell Creek sample sites, coho were captured at low densities (1.3-2.2 / 100 ft) only at the two sites on the lower West Fork (Table 5). The deepest pools at both of those sites could either not be sampled or were sampled inefficiently because of depth and poor visibility due to blue tannin-stained water; the abundance may have been underestimated. Sites farther upstream on the West Fork have not been electrofished since 2005 because of difficult access since the 1998 damage to the adjacent road. Snorkeling surveys and environmental DNA sampling by NOAA found widespread, but low density, coho on the West Fork, and also a very limited coho presence on the main stem downstream near Alder Camp (mile 1.5; Brian Spence, NOAA Santa Cruz, pers. com.).

The low densities of coho in 2018 probably reflect damage to coho redds by the March storms. The localization of coho juveniles on the West Fork is not surprising, as the East Fork and the main stem of Waddell Creek are much more prone to high flood peaks and scouring flows; the East Fork is steeper than the West Fork and has higher storm runoff, and the main stem has a relatively sandy streambed. Prior to 1999 coho were usually present on the West Fork, even when they were absent or scarce on the main stem or East Fork (Table 5). In addition, since 1999, fish kills on the East Fork and main stem have apparently occurred nearly every year (Tables 5 and 8).

As usual, coho on the West Fork were larger than YOY steelhead at the same sites (Figure 9), which probably reflects access and spawning in January.

About four thousand surplus coho fry were raised in the hatchery in 2018 and PIT tagged for December planting on the main stem and West Fork of Waddell Creek. Due to access problems, 2600 were planted on the main stem and 1500 were planted on the lower half mile reach of the West Fork. Although the PIT antenna in winter 2018-2019 and spring 2019 was not functioning throughout the period because of the large storms, 28% of the PIT tags from plant juveniles were detected leaving the watershed (Joseph Kiernan, NOAA Santa Cruz, pers. comm.).

PIT-tag detections indicated that hatchery-origin coho entered Waddell Creek in early winter 2016-2017, prior to antenna damage from the storms (Joseph Kiernan, NOAA, Santa Cruz, pers. comm.). However, no juvenile coho were captured at the 10 sample sites in September. Since coho generally spawn by January to early February, apparently all redds were destroyed by the severe January and February storms, which produced channel scour and fill throughout the watershed. Three sites on the upper West Fork were not sampled, but those sites have only had coho when they have also been present at sampled sites farther downstream.

Adult returns of hatchery-reared smolts from Scott Creek strayed to Waddell Creek in 2016, making 2016 and 2015 the first years for coho since 2009 (Smith 2009 and Table 5). However, the number (39) of juvenile coho captured in 2016 was quite low (Smith 2016 and Table 5). The capture densities may be somewhat biased low, because the deepest two pools on the lower West Fork site and at site 4 on the main stem could not be sampled effectively because of the depth; in previous years when coho were scarce, they were concentrated in the deepest, most complex pools. Only 3 juvenile coho were captured at the lowest West Fork site and the main stem site immediately downstream, and none were captured at the site farther upstream on the West Fork (Table 5). It appears that potential spawning in the West Fork, the previously most reliable coho reach, was substantially destroyed by the March storms. The 36 remaining captured coho were at and downstream of site 4 (mile 2.2) on the main stem of Waddell Creek. Those sites have rarely had significant numbers of coho in the past (Table 5), because the East Fork and the main stem of Waddell are very flood-prone in average to wet years. However, the majority of coho captured in 2015 were also on the lower main stem, with only moderate stream flows in mid- to late winter. In addition, the East Fork and main stem have apparently suffered from toxic fish kills in most years since 1999 (Smith 1999 – 2014), the presence of coho in both 2015 and 2016, and abundant sculpins throughout the main stem in both years, indicate that no fish kills occurred in the past two years. Channel change in 2016 at site 4 was extensive, with more than 100 m of stream channel shifting course around several partial logjams and resulting in the former channel being protected from storm flows, but with only dry or isolated habitats in late summer. The modest coho spawning success may have occurred in the new, protected secondary channel, or may have come from a very late coho spawning event (after the March storms). The main stem coho were not larger than YOY steelhead, as has usually been the case (Figure 7), so a very late redd is a possibility. All of the coho captured in 2016 were YOY, despite the significant coho rearing in 2015; the winter storms in 2016 may also have impacted overwinter coho and steelhead survival.

In 2015, overall density (5.2 /100 ft; Table 5) was similar to that of the 2002 and 2005 (4.7-6.0 / 100 ft), the highest previous densities, except for 1996 (12.5 /100 ft), when hatchery-produced fry were planted on the main stem of Waddell Creek (Table 5). Coho were captured at all nine sampled sites, although a total of only five fish were captured among four of the sites. Highest densities were at two sites on the middle main stem, where two-thirds of the coho were captured. However, actual densities on the two West Fork sites were probably higher than my capture results, because of the inability to sample several deep pools where numerous coho were observed. The coho capture pattern in 2015 was surprising for two reasons. First, on the relatively sandy-bedded and flood-prone main stem, redds have been subject to scour and loss in many years. The West Fork has been much less prone to coho and early steelhead redd destruction. The early December 2014 storms that provided for coho access and spawning, and the relatively mild conditions for the rest of winter and spring, apparently reduced any potential redd loss. Second, both coho and steelhead have usually been very rare on the main stem since 1999, apparently due to toxic fish kills on the East Fork and main stem (see below in steelhead discussion). The presence of numerous coho at the main stem sites in 2015 apparently indicates that a kill did not occur, or if it did occur, it did not extend downstream to the middle of the main stem. Sampling on the West Fork in 2015 was conducted only at the two downstream sites, and when coho have been reasonably common there in the past, they have also usually been common at the un-sampled sites farther upstream on the West Fork (Table 5). Therefore, coho were probably more widespread and abundant than my sampling results in 2015 indicate.

In 2015, coho on Waddell Creek were generally larger than YOY steelhead at the same sites and were larger on the main stem of Waddell than on the West Fork (Figure 4). These size patterns were the same in previous years (2004, 2005, 2007, 2008), except for 2002 (Figure 4). However, in 2016, main stem coho were not larger than YOY steelhead (Figure 7), which might indicate that the coho came from a very late spawning event.

The coho previously last captured in 2009, represented a brood year which previously had been absent since 1994 (Smith 2009); those fish apparently resulted from adult straying from Scott Creek. Adult trapping in 1991-92, 1993-4 and 1994-95 found that straying of adult coho from Scott Creek (as fin-clipped, hatchery-reared fish) frequently occurred when access to Scott Creek was blocked by low flows or a closed sandbar (Smith 1992 and 1995b). However, straying apparently didn't commonly occur when access to Scott Creek was open. The sandbar at Waddell Creek is open in winter, and a moderately deep residual lagoon is now usually present to hold waiting adults. In 2008 coho were collected in low numbers at the two lowermost West Fork sites (Smith and Leicester 2008), and were observed at very low densities farther upstream during NOAA snorkel surveys (Brian Spence, pers. comm.). The 1993-1996-1999-2002-2005 year classes had previously been the strongest on Waddell Creek (and at Gazos and Scott creeks) (Table 5). Waddell Creek coho will not be restored without substantial intervention from captive brood stock and hatchery rearing of juveniles, but that restoration has begun.

Fish kills on the East Fork and main stem since 1999 (see below in steelhead discussion) have been a factor in recent low coho abundance. However, even prior to the apparent first occurrence of fish kills in 1999, captured coho were usually most common on the West Fork (Table 5), where they were present at 23 of 28 sampled sites in 1992-1998. The East Fork and the main stem are more flood-prone, and the main stem much sandier, than the West Fork and have had fewer and more scattered fish. Coho were present prior to 1999 on the East Fork in only 3 of 5 years when coho were present elsewhere, and densities of coho on the main stem were always relatively low ($\leq$ 4 / 100 ft per site) except in 1996 when hatchery-spawned fry were added (Table 5). Therefore, if fish kills had not occurred, the total production of coho would have been higher, but possibly not dramatically higher. However, the larger channel on the main stem of Waddell Creek makes sampling of pool habitats more difficult. This may result in underestimates of Waddell Creek main stem coho abundance compared to upstream and also compared to Scott and Gazos creeks. Coho on all three streams have shown strong density-dependent habitat selection, with the fish concentrated in the largest, deepest, most complex pools when at low densities (Smith 1998a, 1999, 2002, 2003). At progressively higher densities coho habitat use expands to smaller, shallower and simpler (and easier to sample) pools, and then to glides and runs. At the highest densities, all habitats except shallow, fast riffles are heavily used. Waddell Creek has more, large, deep pools, which cannot be sampled or cannot be sampled effectively, than do Scott and Gazos creeks. For example, large, deep pools make up 5-15% of the habitat at sites 2-6 (main stem) and sites 8-9 (lower West Fork) on Waddell Creek, but these habitats cannot be sampled effectively. At Scott and Gazos creeks such habitats make up less than 5% of the habitat, except for sites 1, 2 and 11A on Scott Creek. In addition, both coho and steelhead usually tend to be larger on the main stem than in the West Fork (Figure 7), increasing their likelihood of surviving once they reach the ocean. Therefore, the loss of coho to fish kills on the main stem of Waddell Creek may have had greater impact than densities indicated by past sampling.

Scott Creek Watershed

In 2022, a major run of adult coho at Scott Creek had access in December and January, and the drought conditions for the rest of winter and spring insured that there was no redd destruction by storms. Despite the substantial channel changes and filling of pools by the December 2021 storms, YOY coho density averaged 47.9 / 100 ft (Table 3). No coho were captured at the lower Big Creek site, but density at the other 5 sites averaged 57 per 100 ft. The density in 2022 was exceeded only by that in 2002 (79.2 / 100 ft; Table 6), when strong adult returns also had access for spawning in early winter, but mild conditions later in winter and spring prevented redd and fry loss (Smith 2002). The mild late winter and spring conditions in 2002 also resulted in good YOY coho numbers in Big Creek and Scott Creek downstream from Big Creek (Smith 2002), which has rarely occurred (Table 6), because of sandy substrate and high flood peaks, resulting in poor redd survival.

In 2021 no YOY coho were captured at three sites sampled by me, or eight sampled by Katie Kobayashi (UC Santa Cruz, pers. com.) in the Scott Creek watershed, although perhaps 5 adults were detected (Joe Kiernan, pers. com). However, adults apparently strayed to nearby San Vicente Creek, where juvenile coho were common in fall sampling (Joseph Kiernan, pers. com.). San Vicente Creek suffered much less damage from the CZU fire, so from the standpoint of winter water quality it might have been an attractive alternative for returning adults. Only 5500 hatchery-reared smolts were available for release to Scott Creek and Pescadero Creek in spring 2022.

The only fish sampling in the Scott Creek watershed in 2020 was in November by NOAA Santa Cruz, which found low numbers of coho at 2 main stem Scott Creek sites among 6 watershed

sample sites (Joseph Kiernan, pers. com.). In past years coho have been regularly most abundant on Scott Creek between Big Creek and the uppermost bridge on Scott Creek, and often in Mill Creek (Table 6). Big Creek and Scott Creek downstream of Big Creek only uncommonly have had good coho numbers, because sandy substrate and high runoff in Big Creek in wet years apparently destroy coho (and steelhead) redds. The fire heavily impacted habitat in Mill and Big creeks, but most of Scott Creek, except the uppermost watershed, probably received little direct effect. The apparently low coho numbers in Scott Creek (and Waddell Creek) in 2020 are disappointing. However, about 10,000 hatchery-reared smolts, from captive brood stock, were released in Scott Creek in spring 2021.

In 2019, four coho were captured at the weir on Scott Creek and five coho redds were detected early in January (Joseph Kiernan, NOAA Santa Cruz, pers. comm.). However, no coho were captured during October 2019 electrofishing at the six sites I sampled, or by electrofishing by Katie Kobayashi (UCSC, pers. comm). Very few (present in only 6 of 321 sampled pools) coho were observed during NOAA snorkel surveys (Joseph Kiernan, NOAA Santa Cruz, pers. com.). As with Waddell Creek, the large and late storms apparently destroyed coho redds. Redd destruction has resulted in low abundance in many previous years (1992, 1994, 1998, 2001, 2012, 2016, 2017, 2018; Table 6; Smith 1992, 1994, 1998c, 2001b, 2013a, 2016, 2017, 2018). Substantial redd destruction has apparently occurred in more than one-third of the years that likely had significant adult returns. In all but the milder years, coho redd survival (and often steelhead redd survival) has been poor in Big Creek and in Scott Creek downstream of Big Creek, due to sandy substrate and high flood peaks (Table 6).

In November 2019, 10,400 hatchery-reared juvenile coho were PIT tagged and planted throughout the Scott Creek watershed.

Fifteen coho were trapped at the Scott Creek NOAA weir in 2018, with 12 in January and 3 more in March. In addition, 12 apparent coho redds were located, mostly in the middle and lower portions of Scott Creek (Joseph Kiernan, NOAA Santa Cruz, pers. com.). Electrofishing at nine sites in September and October in the watershed captured juvenile coho at low densities (0.4-3.1 / 100 ft) at six sites; only a single coho was captured at 2 of the sites (Smith 2018 and Table 6). Coho were captured at the three uppermost sample sites on Scott Creek, and also in Mill Creek, Big Creek, and in Scott Creek downstream of Big Creek. The very low scattered densities probably indicate redd destruction from the March storms. Coho at the two upstream sites were no bigger than YOY steelhead at those sites in 2018, but at the other sites they were larger than YOY steelhead, which has been the typical situation at all sites in the past (Figure 7).

PIT tag detections of hatchery-origin coho occurred in Scott Creek prior to loss of antenna function in January 2017. However, redds were destroyed or damaged, and only 5 juvenile coho were captured at 2 of 10 samples sites (Smith 2017 and Table 6). Unlike in most years, the few coho were not much bigger than YOY steelhead at the same site (Figure 7), so they may have been produced by late-spawning fish. Therefore, almost all coho from this brood year will come from the 32,000 captive brood stock/hatchery-reared smolts released in spring 2018.

Coho adult returns to Scott Creek may have been relatively low in 2016, but the storms kept the weir inoperable during much of the probable adult immigration. In addition, PIT antennas were inoperable much of the time. Only 26 juvenile coho were captured among 6 of the 10 sample sites (Smith 2016 and Table 6). None of the sites had more than 7 coho, and overall density was only 1.6 / 100 ft of sampled habitat. No coho were captured in Big Creek or in Scott Creek downstream of Big Creek, which rarely have any coho in years of large storms (Table 6). No coho were captured in Mill Creek, which usually has coho when they are present in the watershed (Table 6); the only other year without coho on Mill

Creek was in the 1998 El Nino year, when the small reservoir in upper Mill Creek also filled and spilled during high winter flows. The scattered low density of coho is similar to previous years (1992, 1998, and 2012), when storms presumably damaged most coho redds (Table 6). All but one coho captured were YOY. Yearlings are usually present when coho were abundant in the previous year, as in 2015 (Smith 2003b and 2006b), so the large winter storms could have also impacted overwinter coho (and steelhead) survival.

Juvenile coho were captured at nine of the ten sites sampled in 2015 (Table 6). The tenth site, Scott Creek at Swanton Road, was nearly dry and fishless at the time of sampling in September. Only two coho were captured at the uppermost Scott Creek site, where YOY steelhead were absent; adult access to the site may have been a problem in 2015. Overall density was 18.3 coho / 100 ft (Table 6). However, that reflected the loss of perhaps one-third or more of the coho, due to streambed drying at five of the Scott Creek sites upstream of the Big Creek confluence. If that dry-back had not occurred, the overall density would probably have been similar to the densities (27-33 / 100 ft) present in the strong coho years of 1993, 1996, 1999, and 2005 (Table 6). No action was taken by the California Department of Fish and Wildlife on a proposal to conduct fish rescue operations on the drought-affected stream reaches, and attempts to secure supplemental releases from the Lockheed reservoir on Mill Creek, to improve conditions in Mill Creek and in the Scott Creek reach between Mill and Big creek, were unsuccessful.

As in Waddell Creek in 2015 and in earlier years in both Waddell and Scott creeks, coho were larger than YOY steelhead at the same sites in both 2015 and 2016 (Figure 7). Coho were also generally larger on Scott Creek downstream of Big Creek than at other sites in 2015, otherwise there was little size difference among sites (Figure 7). Coho have usually been relatively scarce on Scott Creek downstream of Big Creek, except in 1996, when hatchery-origin fry were planted there, and in 2002, when idea spawning conditions and a large adult run resulted in abundant coho juveniles throughout the watershed (Table 6). Coho rearing habitat is present downstream of Big Creek, but spawning success in and near the reach apparently limits the number of coho (and steelhead) that rear in most years.

The only coho captured in the Scott Creek watershed in 2014 were wild yearlings and holdover hatchery-reared smolts, so it was thought that no successful coho spawning occurred in 2014 (Smith 2014 and Table 6). However, two yearling coho were captured in 2015 at upper Scott Creek sites (sites 7 and 9), so there was some limited spawning success on upper Scott Creek in 2014.

Yearlings (n=13) from wild spawned hatchery-reared brood stock in 2013 were captured at 7 of the 9 sampled sites in 2014. At least 200 wild YOY coho (plus additional yearlings) were captured at all 9 sites in 2013 (Table 6; Smith 2013), so the yearlings captured in 2014 represented an apparent holdover rate for wild coho of about 7%. Holdover rate of yearlings was about 2% in 2000, 2003, and 2006 (Smith 2001a, 2003b, 2006), but the apparent yearling holdover rate from 2012 to 2013 (both drought years) was about 17% (Smith 2013). As in previous years (Smith 2006 and 2013), length back-calculations to annulus of yearlings showed that holdovers were relatively large at annulus, rather than small fish (Figure 9); most of their growth was in the first year.

Holdover hatchery-reared coho smolts were captured at 8 of the 9 sample sites in 2014, but 128 of the 140 fish were at 3 of those sites (Smith 2014). As in 2013, when 28 hatchery-reared coho holdovers were captured (Smith 2013b), all were captured in deep pools with complex cover. Checking of scales in both years showed that there had been little if any growth after their release in spring. However, only a small portion were skinny, and the rest were in reasonably good condition. PIT tag numbers from fish caught in 2014 were supplied to NOAA to check on release dates and locations. It would be interesting to see if the hatchery holdovers eventually contribute to adult escapement.

Juvenile coho abundance in 1994, 2000 and 2003 was only 0.4 -1.5 coho / 100 feet (Table 6). The weak year class resulted from delayed storms in 1990-91, which prevented adult access by the relatively abundant 1988 year class until 8 March, after the normal coho spawning period (Smith 1994c). The year class rebounded in 1997 (9.3 / 100 feet), apparently due to spawning by adult (including female) returns of precocious hatchery-reared smolts (Smith 1998a). However, it was nearly eliminated by 2000 by poor overwinter survival in 1997-98 and/or poor ocean survival due to the severe 1997-98 El Nino (Smith 2001a). The year class again rebounded in 2006 (6.9 / 100 feet), apparently at least partially due to spawning by precocious returns of hatchery-reared smolts. The encouraging situation in 2006 was replaced by the dismal situation in 2009. The apparent lack of wild production in that year left only 1700 hatchery-reared juveniles produced by captive brood stock to represent the year class. Most of those fish were released in San Vicente Creek or transferred to the captive brood stock program in Santa Cruz, because of the potential threat to the Kingfisher Flat from mudslides following the Lockheed Fire (Michelle Leicester, DFW, pers. comm.); 590 smolts were released in Scott Creek. Therefore, the limited number of juveniles (53; 3.3 / 100 feet) seen in 2012 was primarily (or completely) the result of spawning by the release of adults from the captive brood stock program (Smith 2013a).

No young of year coho were captured by my sampling in Scott Creek in 2007 – 2011, although several yearling coho were captured in 2007 (Table 6). However, in 2008 NOAA divers observed a few juvenile coho on lower Scott Creek (Brian Spence, NOAA Santa Cruz Lab, pers. comm.). In 2010 NOAA divers also observed several juvenile coho at one upper Scott Creek site; these may have been the result of spawning by captive-reared adults released near the site in 2010 (Sean Hayes, NOAA Santa Cruz Lab, pers. comm.). In addition, hatchery-reared smolts from the captive broodstock program were released in spring 2008 (3141 smolts), 2009 (1874 smolts), 2010 (590 smolts), 2011 (590 smolts), and 2012 (2000 smolts) (FED/NMFS 2013). The few stream juveniles present in 2008 plus the release of 1874 hatchery-reared smolts in 2009 resulted in only 3 adult returns in 2011 (FED/NMFS 2013) and did not result in detected juveniles in 2011 (Smith 2011). The apparently very low abundance of coho in 2008 was due to ocean conditions (Lindley et al. 2009) and was especially disappointing, as this brood year class had been strong (27-79 / 100 feet) in all previous years of sampling since the study began (Table 6). With its consistently high abundance, it also should have been quite genetically diverse. Holdover yearlings from the strong year class has also been a factor in "year class" abundance one year later in 1994, 2000, 2003 and 2006. Most of the juvenile coho in 1994 and 2003 and all of the coho in 2000 were apparently yearling coho (Table 6). In 2006 at least 11 of the 95 (12%) captured coho were yearlings (Table 6). Approximately 2% of the fish from the strong year classes have remained in the stream as yearlings, a low absolute number, but a significant relative addition to the next year's very weak year classes. The yearling coho in 2006 (and in 2003) were larger than YOY coho, but not dramatically so (Smith 2003b). In fact, although coho YOY have averaged somewhat larger than steelhead YOY within sites in all years, coho yearlings in 2003 and 2006 were substantially smaller than most steelhead yearlings (Smith 2003b, 2006b). This is despite back calculations from scales in 2003 and 2006 (Smith 2003b, 2006b) that show that the holdover yearling coho were average in size in their first year (mean = 65 mm SL at annulus for 2006 yearlings), rather than the "runts" (Figure 9). They merely grew very little as yearlings. The small relative size of yearling coho also means that scales must usually be used to identify yearling coho, rather than site by site length-frequency plots, which can successfully separate most YOY and yearling steelhead but cannot separate coho.

The 2004 year class had been moderately strong, having been rebuilt for a second time from precocious hatchery-reared females (Smith 1995b and 2004). However, poor ocean conditions apparently resulted in the poor adult run in 2006-7 (Smith 2007 and 2009). The apparent lack of wild production in 2007, and the release of only 590 hatchery-reared smolts in 2008 apparently did not result in returning adults and successful spawning in 2010, despite improved ocean conditions that produced coho rebounds in more northern watersheds.

In the 3 years prior to 2007 all 3 coho year classes were doing reasonably well in Scott Creek, and the 2005 year class had been strong throughout the study period (Table 6). However, poor coast- wide coho and Chinook returns in 2007-2009 indicate that ocean conditions, that produced few adults, were primarily responsible for the near elimination of wild coho in the 3 streams (Smith 2007 and 2009; Leicester and Smith 2008; Lindley et al. 2009).

The encouraging wild coho numbers in 2013 and 2015 supported the continuation of the coho hatchery brood stock and smolt rearing programs. In addition, drought in 2014, and floods in 2016, 2017, 2018, and 2019 resulted in negligible wild production of coho. Then the CZU fire hit Gazos, Waddel and Scott creek watersheds in 2020. The returning adults in 2022 came almost exclusively from hatchery-reared smolts released in Scott Creek in 2020 and parr plants in Scott and Waddell creeks in 2019. Without the captive brood stock and hatchery rearing of juveniles to smolt stage, coho would be extirpated south of San Francisco. Over the last several years facilities for egg incubation and juvenile rearing have been substantially upgraded. However, full restoration and operation of the fire-damaged hatchery facilities is urgently needed.

Steelhead

Gazos Creek

Despite the slope erosion, sediment inputs, and filling of pools in 2022, YOY steelhead density averaged 47.1 / 100 ft (Table 1), almost twice the 2005-2021 mean of 25.3 / 100 ft (Table 7). Site densities varied widely, with three sites having densities of only 16-20 / 100 ft, and one site with a density of 152 / 100 ft (Table 1). Two of the sites with relatively few YOY steelhead (miles 2.8 and 3.9) were sites where all of the pools were substantially filled with sediment; spawning adult steelhead may have bypassed that reach because of a lack of holding pools. The third low density site was the uppermost sample site, upstream of six logjams. The logjam at mile 2.1+ may have restricted adult access, and relatively few adults may have spawned upstream. Not only was the density high in 2022, but the YOY steelhead were slightly bigger than in previous years (Figure 7). Mean yearling and older steelhead density (5.1 / 100 ft) was generally similar to previous years, but densities were low (1-3 / 100 ft) in the four downstream sites where pools were filled and fine streambed sediment was greater in 2021 and/or 2022 (Table 1). The three upstream sites, which had high yearling and older densities (8-13 / 100 ft in 2022 and 5-9 / 100 ft in 2021) retained more pools with complex structure in 2022 and had cleaner substrate in 2021.

All seven regular sites were sampled in September 2021 (Smith 2021d). The YOY density (19.8 / 100 ft) doubled from the very low density at four sites immediately after the fire in 2020. The density was similar to the 7 lowest densities from 2005 -2019 (16-21 / 100 ft; Table 7). In 5 of those years passage problems at logjams near mile 2.4 and 4.2, were apparently a factor in low densities above those jams (Table 7). Passage may have been a factor in 2021, with the single large storm, but the two sites with the highest densities were the two most upstream sites (Table 7). It was encouraging that the densities were not unusually low after the fire, but modification of the jams present in 2022 is now desirable. Mean yearling density in 2021 (3.7 / 100 ft) was low compared to most years. However, it was relatively high (5-9 / 100 ft) at the three upstream sites, and relatively low (1 / 100 ft)) at the downstream sites, which were at and downstream of the most fire damage (Tables 1 and 7). YOY density did not follow that pattern, so the yearling difference may have been due to winter effects.

After the fire, four regular sample sites were sampled in October 2021. Three (at miles 1.8, 2.1 and 2.8) were downstream of most direct fire damage (and hazards to sampling). The other site was the farthest upstream site (mile 5.3), which had often had low YOY steelhead numbers because of restricted adult access at a logjam at mile 4.2. YOY steelhead abundance in 2020 was extremely low (9/ 100 ft; Table 1) and reduced to about half of the worst previous years (Table 7). However, in most low abundance years, access past logjams was a major apparent cause of low density. Storms were mild in 2019-2020, so access may have been a problem, but the spotty abundance included YOY at the most upstream sample site, so the effect of access is unknown. The lightly shaded site at mile 2.1 had larger YOY than the shaded site at mile 2.8, as has usually occurred (Figure 9). Yearling steelhead abundance was not atypically low (5.7 / 100 ft), but lower than the relatively high values (8-15 / 100 ft) in 2018 and 2019 (Table 7). The low YOY abundance in 2020 may have been due to a combination of restricted access in the dry winter and to the effects of the fire, which burned through much of the stream channel upstream of mile 3 and also on Old Woman's Creek, which enters Gazos Creek at mile 2.0.

Since 2017, a scoured stream channel at and immediately downstream of Highway 1 has provided rearing habitat for fast-growing steelhead in summer in the lagoon. The lagoon was closed and relatively deep for most of the summer in 2020, but the sandbar was breached in October, dropping the water level about 3 ft. The 175 feet of deeply-scoured stream channel under and immediately downstream of Highway 1 was the only remaining habitat on 22 and 29 October, but 150+ large steelhead (about 160-190 fork length) were observed there on 29 October. Due to their large size and the apparent low abundance in the stream following the fire, the lagoon rearing was significant.

In spring, prior to partial sandbar development, there is usually little residual depth in the estuary, so opportunities for smolts to feed or adapt to saltwater in brackish habitat are limited. This probably reduces ocean survival of the relatively small smolts emigrating from the watershed (Bond 2006).

In 2019, YOY steelhead overall density in Gazos Creek (27.4 / 100 ft) was similar to 2018 (Table 7). However, the abundance distribution among sites was substantially different (Table 7). In 2019, four of the five sites upstream of site 2A (mile 2.1) were quite low (16-22 / 100 ft; Table 7) and density (52 / 100 ft) at site 2 (mile 1.8) was substantially higher than any of the last 16 years (Table 7). Sites upstream of mile 4.2 have frequently been low, including in 2018, apparently due to difficult adult passage in many years since 1999 at the logjam at mile 4.2 (Table 7). A logjam above mile 2.1 has also often been a problem, but was broken up in winter 2018. The logjam at mile 4.2 was substantially open by the end of winter 2019. However, it appears that there is now a major logjam barrier between miles 2.1 and 2.8, reducing upstream densities and concentrating YOY production at the two downstream sites. When logjams restrict spawning to the lower reaches of Gazos Creek, they not only reduce the amount of spawning and rearing habitat for steelhead and coho, but also the average quality of available habitat. The impaired substrate from sediment from Old Woman's Creek (mile 2.05) probably reduces spawning success and usually limits summer rearing by reducing insect production; juvenile densities at sites downstream of Old Woman's Creek have generally been relatively low for steelhead (Table 7) and especially for coho (Table 4).

Overall yearling density (7.9/100 ft) was better than all but two recent years (Table 7), which was surprising for such a wet winter.

The lagoon at Gazos Creek provided potential smolt feeding habitat, with good depth and the sandbar opening far to the south through April 2019. In summer the open mouth was to the north and the main embayment was shallow (0.5-0.6 m), but steelhead were observed to be common in July in the deeper (1- 1.3 m) scoured channel between Highway 1 and the main embayment.

The small estuary/lagoon at Gazos Creek has usually provided very limited summer rearing habitat, because the sandbar is seldom retained for long in summer, resulting in a small, shallow lagoon. Past summer observations in the lagoon have seen few juvenile steelhead. When the sandbar is in place, the lagoon normally backs up and floods the septic tank system at the house upstream of Highway 1. This may result in repeated artificial breaching of the sandbar; at least one artificial breach occurred in summer 2016. However, in 2017 the floods scoured a relatively deep stream channel between Highway 1 and the main embayment of the lagoon (Smith 2017). In September 2017, a school of 300-400 large juvenile steelhead were observed in the channel. The channel was inefficiently sampled by seine on 17 November (because of depth and lack of a good seine landing location), and 15 steelhead were captured for determination of length and age. The fish ranged from 154 to 186 mm fork length, far larger than most of the YOY and yearlings captured in the stream (Figure 7); 9 of the 15 captured fish were YOY. Even with a fork length (lagoon) to standard length (stream) difference of about 20 mm in type of measurement, the lagoon fish were bigger than more than 97% of the stream caught fish. In 2017 the lagoon reared a substantial number of unusually large potential steelhead smolts, and should contribute significantly to adult returns in 2020. Future sampling should include this habitat, despite the difficulty of sampling, as a potentially important contribution to steelhead production in the watershed.

In 2018, YOY steelhead density in Gazos Creek (25.8 / 100 ft; Table 7) improved from 2017, with substantial increases at the three downstream sites, including the sandy site downstream of Old Woman's Creek (36-57 / 100 ft; Table 7). However, steelhead YOY density was very low (7-15 / 100 ft) at the three upstream sites, located above the severe logjam barrier at mile 4.2. It is likely that few adult steelhead were able to get above the logjam, as had also apparently happened in 2005, 2010, 2013, and 2014 (Table 7 and Smith 2006a, 2010, 2013, and 2014); the logjam, first formed in 1999, had substantially restricted upstream adult access in 5 of the last fourteen years (36%).

Yearling steelhead were unusually abundant in 2018, averaging 15.0 / 100 ft, and with site densities up to 22-23 / 100 ft (Table 7). This compares with annual mean yearling densities of 4-9 / 100 ft and no previous individual site density greater than 12 / 100 ft (Table 7). Even in past mild winters (2007, 2009, and 2013-2015), when overwintering survival should have been higher, yearlings averaged only 4-7 / 100 ft (Table 7). On Scott Creek there was no similar increase in yearling abundance in 2018 (Table 9), so the abundance of yearlings on Gazos Creek was puzzling.

The lagoon water level was higher (and more turbid) than in 2017, and feeding steelhead were observed in the deepened stream arm. No sampling was conducted, because of the depth and steep vegetated banks in the arm. However, it is likely that a significant number of fast-growing steelhead reared in the lagoon in 2018, as occurred in 2017 (Smith 2017).

In 2017, YOY steelhead density in Gazos Creek (21.1 / 100 ft; Table 7) declined significantly, although most sites upstream of Old Woman's Creek, especially the 3 upstream sites, were not more than 50% below the long term mean, as had usually happened in years of poor overall density (Table 7). It appears that adults were able to reach throughout the stream due to the large storms, even with the re-closure of the major logjam at mile 4.2 in January. The overall density was similar to that of 2006-2010 and 2013-2014, when logjam passage problems resulted in very low densities at upstream sites (Table 7). The highest density (39 / 100 ft) was at site 4, where there were several redds within the sample site, so it still appears that much of the stream was under-seeded with successful spawning. YOY density was very low (1-6 / 100 ft; Smith 2017 and Table 7) downstream of Old Woman's Creek, and this significantly reduced the overall sampling density (density upstream of Old Women's Creek averaged 27 / 100 ft). The sandy sediment from the tributary degrades spawning habitat and insect production, and the densities have generally been quite low (Table 7). An added site in 2017, at mile 0.7, included one of the bank repair locations, where stacked boulders, with anchored rood wads at their base, were installed on very steep roadside banks. Fish were scarce up and downstream at the site, but were already using the boulders and root wads during September sampling.

Despite the winter floods, yearling densities in 2017 were similar to those in previous years (Table 7). The highest yearling densities were at site 2A, where a large partial logjam immediately upstream of the sample site probably provided a high-flow refuge for overwintering steelhead.

YOY steelhead density on Gazos Creek improved in 2015 and 2016, with an overall density of 32.4 / 100 ft in 2016 and 30.4 / 100 ft in 2015, compared to 17-18 / 100 ft in 2013 and 2014 and 16-21 / 100 ft in 2006-2010 (Table 7). Densities were relatively similar throughout the watershed in both 2015 and 2016 (Table 7), so despite the persistence of the numerous logjams and low stream flows in winter after February in 2015, some steelhead were able to access all parts of the stream in both years. Densities in 2015 and 2016 were still substantially below those of 2000-2004 (37-49 / 100 ft; Table 7) and earlier years (Smith 1999), which may reflect the effects of poor ocean conditions in 2005 and 2006 and poor access through logjams in 2006-2010 and 2013-2014.

Yearling steelhead density in 2016 (5.6 / 100 ft; Table 7) and 2015 (4.9 / 100 ft; Smith 2015) was within the range of most years since 2000 (4-7 / 100 ft), although yearling density has been as high as 9-11 / 100 ft (Table 7). Yearling density has been relatively stable and did not decline substantially following years of low YOY abundance (2006-2010 and 2014; Table 7), reflecting the strong density-dependent effect of over-wintering survival on yearling abundance. The 2016 yearling abundance also shows that, despite the large storms, overwinter survival of steelhead was not severely impacted in Gazos Creek. However, yearling size, especially at upstream sites, has consistently been relatively small (Figure 7), reflecting generally poor yearling growth in both drought and non-drought years

YOY steelhead density in 2014 (17.7 / 100 ft) was very low compared to the 1993-2010 mean (38 / 100 feet) and less than 50% of the 1993-2010 mean at 5 of the 7 sample sites (Table 7). Total density was similar to the density in 2013 (16.7 / 100 ft; Table 7), when densities were very low at 3 sites (Table 7). This pattern was also seen in 2006-2010 (Table 7; 16-21 / 100 ft), and was apparently associated with poor or intermittent adult passage at severe logjams. In 2013, major logjams that were impassable at least part of the winter were present at miles 2.4, 2.9 (a new jam), and 4.2 (see logjam section, above). In 2014, there were openings under or through the jams at miles 2.4 and 4.2 in October, but the openings were small and could have been plugged during some of the few storms; the opening in the logjam at mile 4.2 may not be passable at lower stream flows. Densities in 2011 and 2012 (28-30 / 100 ft) were substantially improved compared to 2006-2010. Passage at the severe jam at mile 2.4 substantially improved (likely passage under the jam) in 2011 and 2012 and at mile 4.2 in March 2012 (a new pathway through the jam). New jams were found in 2014 and 2015 downstream of Old Women's Creek and near Highway 1 that appear passable only at high flows, but those jams washed out in 2016.

Waddell Creek Watershed

Mean YOY steelhead density was only 6.3 fish / 100 ft, and was low (3-9 / 100 ft) at all seven sample sites (Table 1). Yearling density (0.9 / 100 ft) was also very low. Although there were substantial channel impacts from the fire, the fish abundances appear drastically lower than the

present summer habitat provides. In addition, both Gazos and Scott creeks suffered somewhat similar habitat impacts, and steelhead abundance on those streams was atypically high.

Abundance on the main stem of Waddell dropped precipitously in 1999 and has continued to be low in most years since (Table 8), Abundance at East Fork near the confluence and on the West Fork changed little. The single sample site on the East Fork near the confluence may have failed to register the decline, because it can be recolonized upstream to the first steep riffle by fish from the West Fork. Investigations farther upstream on the East Fork in 2006 – 2008 found that there was a sharp drop in steelhead density immediately downstream of Last Chance Creek, and the decline generally extended downstream to the confluence of the two forks (Table 8 and Smith 2006b, 2007, 2008),). Fish abundance in early spring was usually relatively high on the Main Stem of Waddell, but abundance crashed by early summer. The geographical and temporal pattern of abundance strongly suggests that toxic materials from Last Chance Creek, or farther upstream in some years, was causing the generally sharp declines since 1999. In 2012-2014 the declines extended to above Last Chance Creek (Table 8), including at sites where winter redd surveys had found abundant steelhead redds (Smith 2103a, 2013b, and 2014). The Last Chance watershed suffered severe burn in the CZU Fire, but the very low abundance in Waddell Creek in 2022 might indicate a resumption in toxicity issues.

Another potential factor in the very low abundance in 2022 is likely to be the very serious new logjam at mile 0.65, which could have blocked most adult steelhead and coho access after it formed sometime in December.

The sampling of only a single site downstream of fire impacts in Waddell Creek in October 2021 gives little idea of the watershed steelhead distribution and abundance (Table 2). However, the density at that one main stem site was similar to main stem abundance in 2020 and years prior to the fire (Table 8).

The density of YOY steelhead at the three main stem sample sites in Waddell Creek watershed in 2020 was low (13.6 / 100 feet), as it has been in most of the previous 21 years (since 1999). However, in only 3 of the previous 14 years have densities exceeded the 2020 density. All three sample sites were downstream of mile 2.4, where the riparian corridor was not directly impacted by the fire; the sample densities probably reflect "pre-fire" conditions. The regular sites farther upstream were progressively impacted by fire, with streamside and channel conditions severely impacted upstream of mile 3.0. Post-fire densities at and upstream of the forks had likely been significantly impacted. In the initial decade after 1999, steelhead abundance was substantially higher on the West Fork than on the main stem of Waddell Creek. Fish kills had apparently occurred on the East Fork and main stem of Waddell Creek in most years from 1999 to 2014. Fish kills apparently did not occur in 2015, 2016, 2019 and 2020 on Waddell Creek, as both coho and steelhead were somewhat common on the main stem in 2015, 2016, and 2020. Sculpins (*Cottus asper* and *C. aleuticus*) were also abundant in those 4 years, compared to years when kills apparently occurred. The declines in 2017 and 2018 (which apparently included the lagoon) may have been at least partially due to the generally low densities (7-11 / 100 ft) throughout the watershed (including the lagoon) in 2014 and 2015. The abundant, large steelhead that atypically reared in abundance in the lagoon in 2016 may have produced a rebound in adult returns and in YOY numbers in 2019. Salinity stratification (and resulting temperature and dissolved oxygen problems) in many years, restricts steelhead rearing to the upper water column and shallower upstream portions of the lagoon.

In 2019, YOY steelhead were more common than in most recent years (21.0 / 100 ft; Table 8). However, densities collapsed after 1998, especially on the main stem and East Fork. In 9 years since 1998 overall YOY density was at 13 / 100 ft or less, including in 2017 and 2018, and in only one year was the density greater than 40 / 100 ft, compared to a 1995-1998 mean of 73 / 100 ft (Table 8). The depressed densities since 1999 have usually been on the main stem and East Fork, and the West Fork generally maintained its densities in 1999-2005 (Table 8). The general pattern suggests the problem is with the East Fork and the main stem downstream of the East Fork, with possible toxic events originating from Last Chance Creek, an East Fork tributary, or farther upstream on the East Fork (Smith 2009, 2010, 2011, 2013a, and 2103b). Unlike for coho, many of the steelhead probably entered and spawned after the March storms in 2017-2019, so redd destruction shouldn't account for the extremely low juvenile steelhead abundance. However, the near-continuous impacts have probably been sufficient enough to reduce subsequent production throughout the watershed. In 2019 densities at 7 of the 8 sites were similar (11 - 22 / 100 ft) including on the west fork and at the two downstream sites, which have had consistently low densities in previous years (Table 8). The relatively high density (41 / 100 ft) at Twin Redwoods Camp, was an unexplained surprise, although that site exceeded that density in four of the years since 1999.

Yearling density (2.3 / 100 ft) has also been consistently low since 1999 (Table 8), Yearling steelhead density on Waddell Creek in 2017 (2.0 / 100 ft; Smith 2017), 2016 (1.6 / 100 feet; Smith 2016), and 2015 (1.6 / 100 ft; Smith 2015), and other years since the severe YOY declines beginning in 1999 (0.4-4 / 100 ft; Smith 2014), has been low compared to the densities before 1999 (7-19 / 100 ft; Smith 2014) when YOY were much more abundant. On Scott and Gazos creeks, occasional less drastic lowered YOY density has not appeared to affect subsequent yearling density, apparently due to density-dependent effects of over-wintering habitat. However, the much more substantial declines in YOY abundance since 1999 on Waddell Creek have severely reduced yearling abundance and potential upper watershed smolt production.

One effect of the low steelhead densities of the last 21 years has been the ability to observe how variation in steelhead density affected habitat use. When steelhead were abundant (prior to 1999), they were found in all habitats, from riffles to pools. Highest densities, based upon habitat length, were often in pools, apparently because the pools supplied more habitat per length of stream (due to greater area and volume). At the low site densities observed over the last 20 years the steelhead showed much higher relative abundance in riffle and run habitats, where fast-water feeding opportunities were greater. Apparently YOY steelhead habitat preference for fast-water habitats on the main stem was obscured in Waddell Creek when fish were abundant. Therefore, although both coho and steelhead have shown microhabitat shifts in response to increased density, the shifts are in the opposite directions. Coho expanded from complex pools to shallower or simpler pools to glides and then runs at higher densities, while steelhead expanded from riffles and runs (and heads of pools) to glides and pools at higher densities. These habitat tendencies may explain the apparent coexistence of steelhead and coho in the generally smaller and faster habitats of Gazos Creek in 2002 and the substantial reductions of steelhead in the pools of Scott Creek due to high coho abundance in 1993, 1996, 2002 and 2005 (Smith 2005).

A sandbar closed the lagoon at Waddell Creek in 8 of the 9 years of the Shapavalov and Taft (1954) study in the 1930's and early 1940's, with 7 of the closures in July through September (Smith and Leicester 2008). However, since at least 1995 the sandbar had not permanently and fully closed in summer until July of 2008, when winter and summer conditions were dry. The bar also closed between 19 and 25 July 2009 and remained closed until September. However, on 29 August 2009 an attempt at breaching the sandbar by a family with a shovel was stopped by the State Park Ranger. The ditch was filled in, but the incident shows that increased signage and patrols will be necessary to maintain summer sandbars. Attempts at opening the sandbar by

beach visitors continue. In 2010, with higher summer stream flow (and some evidence of artificial breaching), the sandbar never fully closed all summer. Spring and summer stream flows have generally been higher than in the 1980's (when the bar normally closed in mid-May through July), because the appropriative water diversion to north coast farms was terminated. However, flows now are still lower than Shapovalov and Taft (1954) reported, so the sandbar should have closed if stream flow was the only factor. Even in 2007 when stream flow was greatly reduced in late summer, the sandbar did not close. However, the bar did close during 2008 and 2009, the second and third consecutive dry years, and closed briefly in late summer 2012, and by July in 2013, 2014, and 2015, the four recent drought years. The sandbar was only intermittently closed in the wetter 2016, 2017, and 2019, but was closed much of summer in the relatively dry 2018, 2020. Beach sand supply or dynamics may have changed, including possible interaction with the confined channel at the Highway 1 Bridge and/or the Highway 1 berm and the State Park parking lot.

In 2018, YOY steelhead abundance was low overall (7.7 / 100 ft; Table 8), and was even low on the West Fork (10.9 / 100 ft), which has usually had higher density than on the East Fork or main stem of Waddell Creek since 1999 (Table 8). In 2009, 2011, and 2014 densities were similarly dismal at all sites. In 2018, fish were particularly scarce at the two most downstream sites (3 / 100 ft; Table 8); it also appears that there was little or no steelhead rearing in the lagoon in 2018. The generally low juvenile abundance on the main stem and East Fork since 1999 appears to have severely depressed adult returns. However, in 2016 abundant, large steelhead atypically reared in the lagoon (Smith 2016), so adult returns should have much improved in 2019. Otherwise, the low YOY and yearling (2.0 / 100 ft) densities should result in very low adult steelhead returns.

As in previous years, YOY and yearling steelhead were larger on the main stem than on either of the forks (Figure 7 and Smith 2018).

In 2017, YOY steelhead abundance was low overall (12.3 / 100 ft) and very low (1-15 / 100 ft) at all but two upstream sites on the East and West forks (29-32 / 100 ft); Smith 2017 and Table 8). Abundance has been low, especially on the main stem and lower East Fork since 1999, with site densities nearly always more than 20% below 1995-1998 lows and more than 50% below 1995-1998 means (Table 8). Densities had somewhat improved in 2016, so the low values in 2017 were a disappointment.

Overall YOY steelhead abundance in 2016 (23.5 / 100 ft; Smith 2016 and Table 8), was substantially improved compared to densities (7-13 / 100 ft) in 6 of the last 7 years (Table 8). However, density in 2016, and most years since 1999, has been low compared to density in 1992-1998 (54 – 80 / 100 ft), apparently due to fish kills on the East Fork and main stem in most years (Table 8). In 2016, and most years since 1999, especially through 2005 (Table 8), densities on the West Fork were higher (23 and 55 / 100 ft) compared to most densities on the main stem (7 – 27 /100 ft; Smith 2016 and Table 8). In 2015, densities on the West Fork (16 and 26 / 100 ft) were higher than on the East Fork (5 and 5 /100 ft) and on the main stem (mean of 9.5 / 100 ft; Table 8). Overall density was lower in 2015 (11 / 100 ft), but coho and/or steelhead were relatively common and sculpins abundant on the main stem in both 2015 and 2016, so fish kills apparently did not occur.

In both of the 2014 and 2015 drought years, when stream flows were quite reduced, the sizes of YOY did not differ much between the main stem of Waddell and sites on the forks (Figure 2). Usually fish on the main stem have been larger, and with increased summer stream flow in 2016 and 2017 main stem YOY were again larger than those on the forks (Figure 7).

The lower abundance of YOY steelhead in the main stem since 1999 has had even greater potential impact on steelhead smolt production than the density declines indicate. Main stem steelhead have regularly grown much faster than those in the forks have (Smith 1998c, 2002, and Figure 3), allowing smolting of a significant portion of the fish as yearlings. In addition, if the apparent fish kills extended to the lagoon, as appears likely in many of the years, they would have resulted in a substantial loss of potential smolts, as the lagoon normally produced numerous, very fast-growing steelhead (Smith and Davis 1993; Smith 1996b and 1997). Main stem fish sizes since 1999 have generally been smaller than in 1992-1998, but usually larger than on the shaded, cool low-flow West Fork (Figure 7). Therefore, some of the scarce YOY on the main stem were still sufficiently large in 2002, 2005, 2006, 2011, and 2012 to smolt as yearlings. However, with lower summer stream flows in 2008 and 2009 and 2014 and 2015 the main stem steelhead were similar in size to the small fish on the West Fork (Figure 7).

Without apparent fish kills on the main stem in 2016, steelhead were observed to be common in the fresher upstream portion of the lagoon (near the foot bridge), and also immediately upstream of Highway 1, where alternate week high tides cooled the lagoon. On 26 October 2016, two quick seine hauls immediately upstream of Highway 1 captured 337 steelhead, which were very large compared to stream fish, including stream yearlings (Smith 2016). Two-thirds of the lagoon fish were YOY, and even most of them were bigger than upstream yearlings. The remainder of the lagoon could not be sampled, because of pondweed and lack of places to land a seine and no mark/recapture population estimate could be made from the single sampling. However, it appears that the majority of watershed smolts in 2017 would have been reared in the lagoon. In 2017 and 2018, juvenile steelhead were very scarce at the sites upstream of the lagoon (Table 8), very few juvenile steelhead were seen during observations in the upper portion of the lagoon, and no feeding activity was observed in the lower portion of the lagoon. No lagoon sampling was conducted in 2017-2021, but it appears that, unlike in 2016, little rearing took place in the lagoon.

Densities at West Fork sites have generally been higher than the main stem since 1999, and often near their pre-1999 average, over that span (Table 8). However, the lowermost site on the West Fork has often been atypically low (7-20 / 100 feet in 9 of the years), and both West Fork sites were also low in 2009-2011 and 2014 (7-24 / 100 feet; Table 8).

In 2013 and 2014, densities were very low (3-13 / 100 feet) at East Fork sites both up and downstream of Last Chance Creek, despite the presence of six steelhead redds immediately upstream of the site above Last Chance Creek in 2013. In 2006, 2007 and 2008, steelhead abundance sharply declined in the East Fork downstream of Last Chance Creek (Table 8; Smith 2006 and 2007; Smith and Leicester 2008). A reasonable explanation for the extremely low numbers on the East Fork and main stem of Waddell Creek in 2006 -2008 is that highly toxic chemicals periodically come down Last Chance Creek. Since about ¼ mile of spawning habitat is available on the East Fork upstream of Last Chance Creek, fry produced in that reach could disperse downstream after the fish kills. This would partially restore juvenile abundance in the East Fork, and also partially mask the source of the kills. Since fry dispersal appears to stop by early summer (Smith and Davis 1993), the kills may occur in late spring or early summer. However, the pattern was not as strong in 2008, and numbers were low throughout the Waddell Creek watershed in 2009 -2011 (Table 8). In 2013 and 2014 the low abundance upstream of Last Chance Creek, even with redds immediately upstream in 2013 (Smith 2013b), indicates the source of fish kills on the East Fork in 2013, and possibly some previous years, is farther upstream.

In 2008 caged goldfish placed throughout the Waddell Creek watershed slowly had fish die, but no dramatic acute toxic event occurred. If toxins are responsible for the low fish numbers on the East Fork and Main Stem, they may occur at chronic levels, or at least did in 2008. Juvenile steelhead numbers appeared to be reasonably good in late spring of 2008, so the declines apparently took place in summer.

Although fish kills have apparently occurred in many years since 1999, the degree of impact has varied (Table 8), which may have been due to the amount of toxic material, the timing of the plume(s) and/or to availability of backwaters as refuges (Smith 2006). In the severest years sculpins (*Cottus asper* and *C. aleuticus*) have also been decimated, but in other years they have remained relatively common. Such a result would occur if in some years the lightweight toxic plume (of a solvent like acetone) concentrated in the upper water column, and affected steelhead, but did not penetrate to or into the bottom substrate where the sculpins are found. Differences in kill impacts to steelhead among years and sites could also occur if a portion of the steelhead fry were still protected within the gravel at the time of toxic episodes.

The flood flows through the lagoon upstream of Highway 1 over the last 16 years eroded a deep scour hole at the first meander upstream of the bridge, and the hole was associated with the trunk of fallen Monterey pine and usually provides both a brackish saltwater adjustment habitat and a feeding habitat for coho and steelhead smolts in spring. The lagoon occupies an entrenched channel, and until recently had little backwater development or surface flooding of marshland, even when the water in the lagoon is high. Without winter flood refuges, tidewater goby were lost from the lagoon in 1973, and, after reintroduction in 1991, appeared to have been lost again in 1996 – 1998. The development of a more extensive meander upstream of Highway 1 (with the right bank scour hole) since 1999, and a more extensive backwater and dense emergent border on the inside of the bend across the channel and immediately downstream, now provides a refuge for lagoon gobies (and steelhead) against flood flows. Gobies were captured again at Waddell Creek lagoon in 2012 (Doug Rischbieter, California Department of Parks and Recreation, pers. comm.), and they were common in 2013-2015. It is more likely that a small goby population persisted from the mid 1990's to the present than that they recolonized, as the coastal currents are from the north and the next potential sources to the north are Arroyo Frijoles and Pescadero Creek lagoons in San Mateo County.

Scott Creek Watershed

In addition to the very high juvenile coho abundance in 2022, YOY steelhead were also very abundant (53.8 / 100 ft; Table 3), Density in 2022 was similar to the recent wet years in 2017 (57 / 100 ft) and 2019 (54 / 100 ft), which were the highest of the previous 14 years of sampling (Table 9). The high abundance of both species was surprising, because steelhead numbers on Scott Creek have often been depressed in pools in years of high coho abundance (Smith 2005). Mean yearling abundance (3.1 / 100 ft) was lower than usual.

I was only able to successfully sample 3 sites in October 2021 (Table 3). The site on upper Scott Creek and the site on lower Mill Creeks had similar YOY densities (47 / 100 ft), which were above average for the sites (Table 9). However, the density on lower Big Creek (5 / 100 ft; Table 3) was extremely low. Habitat conditions on upper Scott and in lower Mill were generally similar to pre-fire conditions, although Mill Creek watershed severely burned in 2020 and most of the riparian trees were damaged at the lower Mill Creek site. The Big Creek watershed suffered severe fire damage in 2020.

Although I conducted no sampling in the Scott Creek watershed in 2020, the relationship between winter access and summer stream flow with my past YOY steelhead abundance results suggests what pre-fire abundance was probably like. The dry winter may have reduced steelhead access (producing variable abundance among sites), and low summer stream flows upstream of Big Creek and in Mill Creek should have reduced summer rearing abundance. The wet years, 2017 (57 / 100 ft) and 2019 (54/ 100 ft), had the highest YOY steelhead densities in the last 13 years, with

the dry years, 2008, 2009, 2014, and 2015 having the lowest (12 – 24 / 100 ft; Table 9). Pre-fire densities were likely similar to those in the recent dry years. Post fire, Joseph Kiernan (NOAA pers. comm.) found variable but generally low steelhead densities, similar to my past dry year results. Post-fire densities could have been impacted in parts of Big Creek and Mill Creek, but Scott Creek and its lagoon probably suffered little direct fire effect.

In 2019, four of the six sites had site YOY densities of 47 – 89 / 100 ft (Table 9). Those were the highest or second highest densities at those sites in the last 15 years (Table 9). Since steelhead spawn late compared to coho, they are less likely to be substantially impacted by storms in winter. In addition, adult steelhead captured at the Scott Creek weir were unusually abundant in 2019 (Joseph Kiernan, NOAA Santa Cruz, pers. comm.) At Scott Creek downstream of Mill Creek, the density was low (15.2 / 100 ft) at a site where numerous downed trees in 2017-2019 resulted in deep pools which apparently had less suitable feeding opportunities for YOY steelhead. YOY densities at the Little Creek confluence were low (3-20 / 100 ft) in seven of the last nine years because of sandy spawning substrate and scouring flood flows from Big Creek; Big Creek had low densities (6-26 / 100 ft) in seven of the last 15 years (Table 9). However, in 2019 Big Creek densities were high, as were densities in Scott Creek upstream of Big Creek, so fry apparently moved downstream to the Little Creek confluence site.

Yearling density in 2017 (7 / 100 ft) and 2019 (8/100 ft; Table 9) was similar to densities in most other years from 2001-2018 (Table 9 and Smith 2005), despite the large floods in winter 2016-2017 and in 2009. However, yearling densities were generally higher in 1988 – 2000, with a mean of 11 /100 ft and three years with densities of 18-21 / 100 ft (Smith 2005). Since only stream-reared yearlings are usually large enough to smolt the following spring (Hayes et al. 2008), the yearling density values are probably the best index to upper watershed smolt production.

Over the same period of decline in density of stream YOY and yearling steelhead, studies of the lagoon have documented the importance of the lagoon for rearing of large YOY and yearlings and as a driver of returning adults (Bond 2006; Hayes et al. 2008). The studies of the lagoon and the attention (including signage) that it brings have also substantially reduced the incidence of artificial breaching of the summer sandbar, which drains much of the lagoon rearing habitat, and greatly reduces the success of summer steelhead rearing in the lagoon. Lagoon breaching used to be common in summer in the 1980's – early 2000's, so the role of lagoon rearing was probably less important in the past. **Artificial breaching of the lagoon at Scott Creek is now a relatively rare event, because of the ongoing studies by NOAA and others in the lagoon and because of signage to discourage breaching. However, the straightened estuary (modified during the construction of the Highway 1 Bridge in 1939) at Scott Creek is usually very shallow and mostly fresh water in spring prior to substantial sandbar formation. It often provides little opportunity for either feeding or adapting to salt in a brackish environment by the relatively small emigrating steelhead and coho smolts from the upper watershed, reducing their potential marine survival. If a deep, productive habitat were provided in spring, such as in the Pescadero or Waddell creek estuaries, then ocean survival and adult returns by yearling or 2 year old steelhead smolts and coho smolts from the upper watershed would be substantially improved. Lagoon productivity in spring is usually associated with back-water or deep scour habitats, which are often brackish and have accumulated organic material. Such relatively uncommon habitats may have low water quality in summer (when abundant other habitat is available), but harbor abundant salt-tolerant invertebrates (and tidewater gobies) compared to flood-scoured sandy habitats. Those invertebrates explode in abundance as flows decline in spring and support crucial feeding by coho and steelhead smolts.**

In 2018, the density of YOY steelhead (22.6 / 100 ft; Table 9) was the third lowest in the last 15 years (Table 9). Since adult steelhead probably entered and spawned with the March storms, redd destruction was generally not a factor, as it probably was for early-spawning coho. Stream steelhead production was low in 2014 and especially in 2015, which would have reduced subsequent smolt production and returning adults in 2018. The extremely low steelhead abundance in 2015 (12 / 100 ft; Table 9) resulted from extensive stream dry-backs, which eliminated riffle, run and many pool habitats (Smith 2015) and from abundant juvenile coho in the pools, which would have suppressed steelhead in those remaining pool habitats (Smith 2002 and 2005). The severe reductions in upper watershed smolt production might not necessarily substantially reduce adult returns, which are strongly dependent upon steelhead rearing in the lagoon (Bond 2006 and Hayes et al. 2008). However, the low upper watershed densities would have reduced the number of steelhead moving from upstream to the lagoon to rear for their second year. In addition, the large number of hatchery-reared coho that held over and reared in the lagoon (and stream) in 2014, due to low spring stream flows (Smith 2014), would have suppressed steelhead abundance in the lagoon. The rebound of YOY steelhead abundance in 2016 and 2017 (Table 9), and good rearing success in the lagoon in those years (Joseph Kiernan, NOAA Santa Cruz, pers. comm.) should result in greater adult steelhead returns in 2019 and 2020.

Three relatively low YOY steelhead densities in 2018 were in Big Creek and on Scott Creek at little Creek (11-19 / 100 ft) and in Mill Creek (7 / 100 ft; Table 3). Big Creek and Scott Creek downstream from Big Creek have frequently had low steelhead (Table 9) and especially coho (Table 6) densities because of sandy substrate and high flood peaks that make them subject to poor redd survival. Low summer stream flow would have reduced fry dispersal from upstream on Scott Creek. The very low density of YOY in Mill Creek may have resulted from pool filling and from partial streambed dry-back.

Yearling steelhead abundance (7.9/ 100 ft) in 2018 (Table 3) was near the upper range of recent yearling density (Table 9), but nowhere near the unusual abundance in Gazos Creek (15 / 100 ft; Table 7).

The 2017 density of YOY steelhead in Scott Creek (56.9 / 100 ft) was greatly improved and the highest since 2000 (Smith 2002 and Table 9). From 1988 to 2000 the mean annual density was 88 / 100 ft, which even included two years when very abundant juvenile coho suppressed steelhead density in pool habitats (35-39 / 100 ft; Smith 2005). From 2001 – 2006 the mean YOY density was 49 / 100 ft, which also included 3 strong coho years, when steelhead density was in the 30's (Smith 2005; Table 9). However, with drought in 2007-2009 and 2012-2015, and several years of poor ocean conditions, the YOY mean for 2007-2016 had been only 26 / 100 ft, with a low of 12 / 100 ft in 2015, when coho were common and much of the stream was dry or intermittent (Table 9; Smith 2015). The 2017 results are a hopeful sign of recovery from the past decade of adverse conditions and low abundance.

Overall YOY steelhead density in 2016 (34.6 / 100 ft) substantially improved compared to extremely low abundance in 2015 (Table 9). As in many years, the lowest YOY densities were in Scott Creek downstream of Big Creek, (Table 9), where lack of spawning habitat apparently limits abundance of fry in many years. Despite higher stream flows from Big Creek, substantial rearing habitat for steelhead (and coho) goes under-utilized in the reach. However, steelhead YOY have been larger downstream of Big Creek because of the higher stream flows (Figure 9).

Yearling density (2.4 / 100 ft) in Scott Creek watershed in 2016 was very low compared to other years (Table 9). This may reflect poor overwinter survival due to the big storms and/or the very low YOY abundance in 2015. Relatively few smolts likely came from upstream sites in 2017.

Overall YOY steelhead abundance in 2015 (12.1 / 100 ft; Smith 2015) was about half of the densities (20-24 / 100 ft) in the drought years of 2008, 2009, and 2014, the previous lowest density years (Table 9). All sample sites in 2015 had densities less than half of the 1998-2010 means for those sites (Table 9), and no YOY steelhead were captured at the uppermost site on Scott Creek (Table 9). The channel dry-back at five of the sites, was certainly a major factor in the overall low densities, but numbers were down even at sites without dry-back. The generally good densities of coho at most sites may also have been a factor, as coho suppress YOY steelhead numbers in pools (Smith 2002 and 2005). Dry-back and low flows disproportionately reduced riffle and run habitat, where steelhead have been most abundant when coho have been common.

There was a slight decline in fish size in 2015, as in the 2007, 2008, 2013 and 2014 drought years (but not in 2009 or 2012), the first very dry sample years since 1988, when portions of upper Scott Creek was intermittent (Smith 1994c). Changes in YOY steelhead sizes among years at Scott Creek have usually occurred only in very dry years or very wet years in this dry watershed (Smith 2001b and 2006). Late storms resulted in higher early summer stream flows in 2005 and 2006, and 1995 and 1998 were very wet; fish in those four much wetter years were larger than average. Otherwise little size change has been noted. Presumably this is because, even in wet years, stream flows have usually declined substantially in late spring and early summer before many steelhead have emerged. At heavily shaded upstream sites emergence is usually after flows have substantially declined, so flow during much of the YOY growing season has varied little among years.

Yearling steelhead density in 2015 (4.8 / 100 ft) was near the mean of previous years (Table 9). As observed in Gazos Creek, yearling density has been independent of YOY density in the previous year, demonstrating the effect of the density dependent relationship of over-winter habitat and survival. In addition, like Gazos Creek, steelhead that rear in streams of Scott Creek watershed are mostly small at the end of their first summer (Figure 9) and usually require 2 years to reach smolt size. However, unlike at Gazos Creek, YOY steelhead and small yearlings in Scott Creek can often move downstream and rear in summer and fall in the lagoon to smolt size (Bond 2006; Hayes et al. 2008); a reduction in YOY or a change in yearling movement to the lagoon can therefore affect watershed smolt production if the lagoon is not fully seeded or if the sandbar at the lagoon is artificially breached and drained in summer.

Overall YOY steelhead density on Scott Creek in 2014 (23.8 / 100 ft; Table 9) was similar to 2013 (26.7 / 100 ft). Both were significantly less than in the wetter 2010 and 2011 years (41-45 / 100 ft) and similar to the low drought year densities seen in 2008, 2009 and 2012 (20-33 / 100 ft; Table 9). The biggest density reductions in 2013 and 2014 compared to the 1998-2010 mean and wet year densities were at the Scott Creek sites between Big Creek and mile 4.9 (Table 9), where summer stream flows were especially low. In addition, three of those sites had high wild coho abundance in 2013 (Table 6), and coho have been found to suppress steelhead abundance in pools (Smith 2002, 2005, and 2006a). In 2014 wild coho were scarce, but holdover hatchery-reared coho smolts were very abundant in pools of two of the sites (Smith 2014). The sites downstream of Big Creek, which have the highest summer stream flow in the watershed, have consistently had steelhead densities less than half of those on Scott Creek upstream of Big Creek (Table 9), where stream flow is substantially less; in the 1988 drought, stream flow in late summer in Big Creek and in Scott Creek downstream of Big Creek was 0.6 cfs, but sites on Scott Creek farther upstream had flows of 0.0-0.02 cfs (Smith 1994c). The downstream sites also rarely have had significant numbers of coho, even when they were common elsewhere in the watershed (Table 6). Big Creek tends to generate large flood flows and tends to destroy early redds or emerging fry, which along with the lack of good spawning habitat in Big Creek and in Scott Creek downstream of Big Creek, apparently frequently limits steelhead and coho fry abundance on lower Scott Creek. The limitation by scarce fry, rather than stream flow, on lower Scott Creek is further demonstrated by the good coho densities in 1996, when hatchery-reared fry were added, and in 2002, when mid-winter through spring lacked significant storms after coho spawned in late fall and early winter (Table 6). The small-scale water diversions in the Scott Creek watershed are not a factor in the present low fish abundance on lower Scott Creek.

Yearling density at Scott Creek in 2014 (8.1 / 100 feet) was about average (Table 9), despite the low YOY abundance in 2013. Yearlings captured in 2014 included 17 hatchery-reared (adipose clipped) steelhead scattered throughout the watershed. Their presence was a surprise, as hatchery-reared steelhead smolts rarely held over in the past. However, the small size at release (based upon scales) of the captured fish, and springtime drought conditions, probably resulted in their lack of emigration.

Overall YOY steelhead abundance has usually been relatively low in past years when coho abundance was high (34 – 39 / 100 feet in 1993, 1996, 2002, and 2005 (Tables 6 and 9). Only in 1999, when summer stream flows were relatively high, were both coho and steelhead YOY abundant. Prior to 2008 steelhead YOY densities had been lowest when coho were abundant and stream flows were low, as in 1993, 1996 and 2002 (Table 9). In 2002 stream flows were relatively low and coho were especially abundant (Table 6 and Smith 2002). Overall YOY steelhead density at unchanged, identical habitat units in 2002 was 42% percent lower than in 2001, 53% lower than in 2003, and 20% lower than in 2004 (Smith 2005). It appears that coho were able to substantially depress steelhead YOY abundance in the cool pools and glides of Scott Creek, with the effect most pronounced at sites with very low summer stream flow. The effect of coho in 2002 was not to replace steelhead 1 for 1 within a stream reach, but to severely reduce steelhead in the open water of the larger pools and glides (Smith 2002). Steelhead densities changed relatively little in faster runs and at the heads and tails of pools. Overall, there was about 1 steelhead lost for each 4 coho gained (Smith 2002). The effect of coho on overall steelhead density was similar in 1993, 1996 and 2005 to that of coho in 2002, even though coho were about 2 ½ times as abundant in 2002 and had very high pool densities (Table 9). Apparently, the lower coho densities in the three other years were still sufficient to severely reduce YOY steelhead in larger pools. In 1999 summer stream flows were high, and steelhead numbers were also relatively high despite abundant coho. As appears to occur on Gazos Creek, higher stream flows may allow the two species to partition habitat and prevent coho from substantially reducing YOY steelhead. However, in the Scott Creek watershed those higher flow conditions are likely to occur only in Big Creek and on Scott Creek downstream of Big Creek, where coho are generally scarce anyway (Table 6).

In most of the watershed only yearlings are likely to be large enough the following spring (as 2 year olds) to smolt and enter the ocean (Figure 7). However, in years when the sandbar forms and remains in place in summer to provide rearing habitat, yearling and YOY steelhead can rear to large size in the resulting lagoon. Such fish have a high probability of ocean survival and can contribute a large fraction of the total watershed production of returning adults (Bond 2006). However, over the last 2 1/2 decades the lagoon provided little summer rearing habitat in the majority of years because of heavy water diversion during dry years (as during the 1987-1991 drought) and because of artificial breaching of the sandbar, often to improve beach access. The water diversion that presented a problem for lagoon water level during the 1987-1991 drought was stopped, so that now the remaining summer/fall issue for the lagoon is artificial breaching.

MANAGEMENT IMPLICATIONS

Coho

Present Status and Restoration Actions

Apparently spawning by precocial hatchery-reared females partially restored weak coho year classes on Waddell and Scott creeks in 1995 and 2004 (Smith 1995b, 2005) and on Scott Creek in 2006 (Smith 2006). In addition, hatchery-reared coho from wild broodstock and from captive broodstock were used to supplement the wild 2006 production on Scott Creek and the apparent lack of wild production in 2007. All three yeart classes (2004-2006) appeared viable on Scott Creek (6.9 – 29.7 / 100 feet) (Table 6) before the 2006-7 winter. However, the 2007-2011 wild year classes were essentially extirpated on Scott Creek. At Waddell Creek two year classes (2004 and 2005) appeared marginally viable (3.9 – 5.9 / 100 feet), but both of those were also extremely weak (0.2 – 0.5 / 100 feet) in 2007 and 2008, and the 2010-2012 year classes were absent. On Gazos Creek only the 2002/2005 year class remained viable (11.6 – 27.7 / 100 feet; Smith 2005) until it was apparently lost in 2008. The "core" streams, Gazos, Waddell and Scott creeks (and adjacent San Vicente Creek), that were to support southern coho restoration, required substantial artificial intervention.

The coho captive broodstock program presently has sustained all three coho brood years at the Kingfisher Flat Hatchery on Big Creek (Monterey Bay Salmon and Trout Project), at the Fisheries Ecology Division/Southwest Fisheries Science Center (NMFS) in Santa Cruz, and at the Warm Springs Hatchery (Russian River) (FED/NMFS 2013). All three brood years were offsite from the Kingfisher Flat Hatchery in 2020 following the fire. In addition to some wild production in Scott and San Vicente Creeks in 2012 (from the release of excess capture brood stock), there were 31,000 hatchery-reared smolts released in Scott Creek in spring 2013; these resulted in the strong coho year class encountered in 2015 on Scott Creek and the restoration of a coho year class on Waddell Creek, by adult straying. Wild production from the release of captive-reared brood stock, was even stronger in 2013. In additional, 29,000 hatchery-reared smolts were released in spring 2014, which should have produced a strong adult coho run on Scott Creek in 2016. However, apparently poor ocean survival (due to poor ocean productivity in 2014) and redd destruction from severe March storms resulted in few juveniles in 2016 in both Scott and Waddell creeks. Only 15,000 smolts were released in 2015, due to fungal problems at the hatchery, and storms in winter 2016-2017 apparently destroyed redds in both Waddell and Scott Creeks. Despite the wild production in 2015 and the release of 20,000 hatchery-reared smolts in spring 2016, there were few juvenile coho in 2018 on Scott Creek and low numbers on the West Fork Waddell Creek, apparently due to redd destruction by March storms. Eight thousand hatchery-reared fry were planted in early summer 2018 in Gazos Creek (the first coho there since 2005) and 4100 PIT-tagged juveniles in December in Waddell Creek (including on the West Fork). In 2019 very few coho juveniles were present in Scott or Waddell creeks, but 5000 PIT tagged hatchery reared juveniles were planted in Waddell Creek and 10,400 in Scott Creek in November. In addition, 28,000 smolts were released in Scott Creek in spring 2020. Those hatchery-reared fish produced the returns for the unusual strong coho run and Scott Creek rearing in 2022. The runs have only survived the last several years with the hatchery intervention. The Kingfisher Flat Restoration hatchery had been upgraded UV arrays to address potential water supply fungal problems, but a new sand filter system has failed to support UV filter use. Other improvements have been a moist air incubator rather than trays for incubating eggs, and circular tanks with higher flow rates have replaced raceways.

The low genetic diversity of the captive brood stock was enhanced by outbreeding with Olema Creek (Lagunitas Creek tributary) brood stock from the Warm Springs Hatchery in 2011 and again in 2012 by outbreeding with Russian River brood stock from the Warm Springs Hatchery; outbreeding efforts have been a part of the broodstock program ever since. In addition, genetic analysis of captive brood stock has been used to restrict matings to those between the least-related available individuals. Altered operations and food sources have also generally improved brood stock growth and egg hatchability. Low winter flows and fungal problems in 2014 reduced production of coho smolts for release in 2015 to about 15,000. In spring 2016, 20,000 smolts were out-planted. In 2016, unexplained low fertility problems among hatchery brood stock resulted in most of the juveniles for hatchery rearing coming from only 19 females; smolt production and fry

did not meet its goals (Hatchery Oversight Committee meeting, June 2016). In 2017, 11,000 smolts were released, and 32,000 were released in 2018. The annual production goal is 40,000 smolts and 35,000 fry (Hatchery Technical Oversight Committee meeting, November 2016). Fry (12,000) were released in Waddell and Gazos creeks in 2018, and in Waddell Creek in 2019, the first time since fry releases in Scott, Waddell, and Gazos creeks in 1996 (Smith 1996). The encouraging progress of the captive brood stock program needs to be continued.

The 2015-2016 El Nino did not produce the large number of storms that were predicted, but the March storms were sufficient to severely impact redd survival (Smith 2016). Storms also apparently destroyed most redds in 2017, 2018, and 2019. "Wet" years, and even single large, late storms have been a problem for coho in these streams (at least 6 of the last 19 years). In 1997-1998 El Nino winter, two year classes of wild-reared coho were nearly eliminated when February storms destroyed most coho redds, crippled the hatchery and killed many of the smolts reared there, and large winter storms throughout the winter apparently eliminated most overwintering juveniles (Smith 1998c).

Suitability of Southern Streams for Coho

Populations at the edge of their range are sometimes in marginal habitat, and distributional boundaries can change with fluctuating climate patterns. During the period of this study (1988 to present) coho year classes have been weakened or eliminated by drought or floods, and year classes showed wide differences in abundance on all three study streams. Floods in 1992, 1995 and 1998 drastically reduced coho spawning success; the 1998 floods also apparently nearly eliminated the 1997 year class by reducing over-wintering survival (Smith 1992, 1995, 1998c and 2001a). Drought, possibly aggravated by stream diversion, blocked coho from entering Scott Creek until early March in 1991, nearly eliminating a previously strong year class (Smith 1994c). Similar situations occurred elsewhere on the central coast, including Redwood Creek in Marin County, where the 1988, 1994 and 2000 year classes were less than 5-10 percent as abundant as other year classes (Smith 2000). Redwood Creek also had very poor juvenile coho production in 2007, 2008 and 2009, apparently due to the same problems that affected Scott, Waddell and Gazos creeks (Darren Fong, National Park Service, pers. com.). These wide coho abundance differences occur because the restricted early winter spawning period, single spawning attempt and very rigid ages of smolting and spawning (Shapovalov and Taft 1954) make spawning success susceptible to drought, floods or other "disasters" within small watersheds (Smith 1994c). Coho life history and the recent weather impacts on coho have been used as one argument that coho are not native south of San Francisco (Kaczynski and Alvarado 2006). However, coho have declined *throughout* California in recent decades (Spence *et al.* 2001; Spence and Bjorkstedt 2005), resulting in their listing as Federally threatened north into Oregon; therefore the declines and susceptibility are not peculiar to streams south of San Francisco Bay. Adams *et al.* (2007) presented Indian midden, historical collection, and other evidence that coho were native to some streams south of San Francisco.

Shapavalov and Taft (1954) reported relatively stable abundance (200-279) of trapped female Waddell Creek steelhead during the nine years of their study (Table 12 in Smith 2010). In contrast, the number of coho females fluctuated substantially (37-309). In addition, large late storms in winter 1939-40 probably destroyed many coho redds and fry, as few smolts were trapped the following spring (Table 13 in Smith 2010). Despite the variable coho abundance reported from the 1930's and 1940's, all coho year classes apparently persisted in Scott and Waddell creeks (and probably in Gazos Creek) until the 1990's (Smith 1994c).

Changes in sea surface temperature regimes (El Nino-Southern Oscillation) since the mid 1970's have resulted in a doubling of El Nino frequency and increased intensity and have also produced

the most severe El Nino years of record (1982-3 and 1997-98) (Urban *et al*. 2000; McPhaden *et al*. 2006; Pala 2016). El Nino storms in 1992, 1995, 1998, and 2016, and large storms in 2017 and 2019, were associated with impacts to coho observed in Scott, Waddell and Gazos creeks (Smith 1992, 1995, 1998c, 2016, 2017, 2019). These storms, and previous storms in 1982 and 1983, along with droughts in 1976-77 and 1987-1991, have probably been major factors in the *coast-wide* decline of coho that resulted in their listing under the state and federal Endangered Species Acts. In addition, Coho and Chinook salmon runs in 2006-7 through 2008-9 were unexpectedly poor throughout much of California, apparently due to poor ocean conditions in 2005 and 2006 (Lindley et al. 2009). Ocean conditions associated with a warm-water "blob" were also present more recently (including 2014-2016). A strong El Nino in 2016 mixed organisms from southern and western regions with the regular northern organisms, producing unpredictable trophic interactions (Morgan et al. 2019) and food web architecture that failed to adjust to ocean changes from warming and acidification (Chown 2020; Nagelkertken et al. 2020). Whether those conditions were an anomaly or part of a trend is a major question, but since 1950 there have been unprecedented extremes in down-welling events that have reduced coastal productivity (Black et al. 2014). These recently harsh conditions of larger and later storms and adverse ocean rearing conditions are a challenge to maintenance and restoration of coho coast wide, especially if the conditions persist, possibly related to the general global warming trend (Urban *et al*. 2000; Pala 2016). The recent severe problems for southern coho are not evidence that coho were not native to Scott, Waddell and Gazos creeks. However, they may mean that coho could be difficult to sustain if faced with persistent newly hostile conditions.

Relative Past and Present Coho Status

The recent problems and present status of coho south of San Francisco have been used by some to argue that the fish are not native, and by others to argue that it is an "edge of the range effect" and that we should "pull the plug" on efforts to restore southern coho. However, southern coho made it through the 1976-77 and 1987-1992 droughts intact; all year classes were apparently present until 1991 in the three streams where they were collected in 1895. The situation south of San Francisco is not unique. At the time of listing, coho were scarce and consisted of missing year classes in the majority of streams throughout the evolutionarily significant unit (ESU). The major captive brood stock effort for the Russian River pre-dates that for Scott Creek, and coho abundance in the south was probably greater at that time than that of the Russian River, where only a few coho were present in a few near-coast tributaries.

The collapse of coho populations in 2007-2009 was generally been coast wide and was accompanied by dismal returns of Chinook salmon to coastal and Central Valley streams (Lindley et al. 2009). It is not an edge of the range condition, unless most of California is considered edge of the range. However, the effects seem to have been increasingly severe to the south.

It is not yet known whether the recent ocean problems were a temporary event or mark a general shift to more frequent poor conditions (Black et al. 2014), perhaps due to climate change. However, until it is demonstrated that climatic shift dooms the southern fish (and most of California coho), the modest effort to maintain and restore southern coho should not be abandoned.

In addition, with the exception of the necessary captive brood stock effort, most of the actions that would be taken for southern coho will also benefit federally listed steelhead in those same streams. Those could include improving lagoon/estuary feeding and salinity transition conditions in spring

to increase fish size and ocean survival of coho and steelhead smolts moving to the ocean from the upper watershed (such as associated with the Highway 1 Bridge replacement on Scott Creek).

Steelhead

Although federally listed as threatened, steelhead in these streams appear to be doing relatively well compared to coho. Multiple spawning attempts, variable age of smolting and sexual maturity, and spawning by a majority of fish after peak winter storms (Shapovalov and Taft 1954) make them less sensitive to weather events. The apparent fish kills on the main stem and East Fork of Waddell Creek in 1999-2014, 2017-2018, and possibly 2022 raise the primary concern. The apparent lack of kills in 2015, 2016, 2019 and 2020 was encouraging. Eliminating the potential toxic sources of the kills, which sometimes appeared to originate in the Last Chance Creek watershed (much of which burned in 2020) may be necessary to maintain to increase the steelhead population. In 2012-2014, the source of the problem appeared to have been upstream of Last Chance Creek. Eliminating the kills would also significantly benefit restoration of coho.

The low steelhead abundance in Scott Creek in 2008, 2009, 2014, 2018 and especially 2015, was cause for some concern, but higher numbers in 2010-2011, 2016, and especially 2017, 2019, and 2022 indicate that drought impacts were largely responsible. Establishing release requirements at the reservoir on Mill Creek could improve drought year stream flows for rearing (and potentially for fish passage) on Mill Creek and portions of Scott Creek downstream of Mill Creek. Damage from the August 2009 fire in the Scott Creek watershed might have been expected to degrade the habitat. No apparent significant habitat impacts were seen in 2010-2012, but in 2013-2016 some partial filling of some pools with sediment did occur on Scott Creek. The much bigger fires in 2020, especially in the upper watershed and on Mill and Big creeks had substantial channel effects in 2022 (Smith 2022b), but both YOY steelhead and coho were abundant.

Logjams have been a fish passage problem on Waddell Creek, and especially Gazos Creek in the past (see Habitat Condition, Logjams section). A major new (2022) logjam on Waddell Creek at mile 0.65 may restrict adult access to most of Waddell Creek (Photos in Smith 2022c), six logjams on Gazos Creek in 2022 (at miles 2.1, 2.8, 3.3, 4.1, 5.0 and 5.0+) are presently or potential serious fish passage barriers (photos in Smith 2022a).

Steelhead densities have generally fluctuated by only a factor of about 2 from year to year (Tables 7-9), generally increasing in years of higher summer stream flow. Later-spawning steelhead have apparently not been severely impacted by floods or early winter access as have coho. Stream flow appears to be a factor in the interactions between coho and steelhead in strong coho years (Smith 2002). Where stream flows are high steelhead apparently still use the heads and tails of pools despite the presence of abundant coho in the pools. In addition, overall steelhead abundance is affected less because of their ability to use faster-water habitat in runs and riffles, where coho are seldom present. However, where summer stream flows are very low most of the habitat is in slow water habitat, which can be dominated by coho.

Artificially breaching the lagoon sandbar has frequently impacted steelhead rearing habitat at Scott Creek, Waddell Creek, and Gazos Creek. Posting large, visible signs ("Do not breach the sandbar – it is illegal and will kill endangered fish") and patrolling should be used to prevent artificial breaching at these streams, and elsewhere in San Mateo and Santa Cruz counties. Replacement of the Highway 1 bridges at Scott and Waddell creeks offers the opportunity to address past bridge impacts and improve lagoon habitat, especially at Scott Creek where channel straightening at the time of bridge construction in 1939 eliminated two sharp meanders that would have had scour holes providing residual lagoon depth.

Monitoring

Fall monitoring of juveniles at representative, repeatable sites on the three streams has required about 200-250 people hours per year (using a 2-person sampling team) and has provided a valuable index to steelhead and coho status and to within-basin distribution. Electrofishing is the only effective way to quantitatively sample juveniles of both species at many of the sites, because snorkeling would not be effective in shallow, small or complex habitats or at heavily shaded sites. Mortality from electrofishing has been low, averaging 0.5 % in 2013, 0.4% in 2014, 0.7% in 2015, 1.0% in 2016, 1.1% in 2017, 0.6% in 2018, 0.7% in 2019, 0.4% in 2020, and 0.9% in 2022 among captured steelhead and coho in the three streams (Table 10). Mortality in previous years has been similar, although it has sometimes exceeded 2 % in deeper, complex habitats or under warmer water conditions (Smith 1996-1999). In addition, since only 3-10 % of the habitat is sampled, the loss to the total stream population is usually less than 0.1%. Sampling in late summer/fall for juveniles provides information on the relationships of density and growth rate to different stream reaches and habitat conditions. This information is needed to prioritize streams and stream reaches and to direct habitat restoration efforts.

Trapping of adults or smolts on these streams, was begun by NOAA on Scott Creek in 2003-2004 and continued annually, and several years of smolt trapping began on Waddell Creek in 2004. Adult and smolt trapping and provides valuable abundance data for other important life history stages. Smolt trapping provides information on overwinter survival and size and age (and potential rearing locations, based upon fish size) of smolts. Adult trapping provides information on ocean survival and growth by coho and steelhead and repeat spawning by steelhead. Trapping results would also provide comparisons to index the relatively inexpensive juvenile sampling results. Trapping of adults also potentially provides correction factors for the redd counts. For PIT-tagged wild or hatchery-reared fish (especially coho), antennas arrays operated by NOAA on Scott and Waddell creeks (and other streams) have indicated adult presence and abundance at least in milder winters (2018, 2020) or milder periods before large storms in 2016, 2017, and 2019. An antenna on Pescadero Creek began monitoring lagoon-tagged steelhead and coho planted in November 2020. Such an antenna for Gazos Creek is not needed now, but could detect straying to that stream or returns from future potential smolt or fall juvenile releases.

Redd counts throughout whole watersheds, indicate where and when spawning occurs under different winter conditions, and help to prioritize restoration efforts for spawning and rearing. For example, redd surveys on the East Fork of Waddell Creek showed numerous redds immediately upstream of a site with few steelhead juveniles and where suspected fish kills have occurred. On Gazos Creek, redd surveys found concentrations of redds immediately downstream of log jams suspected of blocking or severely limiting adult passage. Small numbers of randomly-selected segments scattered over all watersheds, designed to give a regional estimate of adult coho abundance, presently provide little useful information on either regional population status (especially when populations are 1 or 2 orders of magnitude below recovery goals and spotty in distribution) or information to prioritize stream reaches for restoration. Discontinuing the efforts before the majority of steelhead spawning (to concentrate only on coho) also gives inadequate information on steelhead. Watershed-wide surveys for redds also have the benefit of locating significant logjam passage barriers, especially in streams like Gazos Creek or in years like 1998 or 2021, when large amounts of wood is added and rearranged.

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LITERATURE CITED

Adams, P. B., L. W. Botsford, K. W. Gobalet, R. A. Leidy, D. R. McEwan, P. B. Moyle, J. J. Smith, J. G. Williams and R. M. Yoshiyama. 2007. Coho salmon are native south of San Francisco Bay: a reexamination of North American coho salmon's southern range limit. Fisheries (32): 441-451.

Black, B. A. and 8 coauthors. 2014. Six centuries of variability and extremes in a coupled marine-terrestrial ecosystem. Science (345): 1498-1502.

Bond, M. H. 2006. The importance of estuary rearing to Central California steelhead (*Oncorhynchus mykiss*) growth and marine survival. M.A. Thesis, University of California, Santa Cruz.

Chown, S. L. 2020. Marine food webs destabilized. Science (369): 770-771.

FED/NMFS (Fisheries Resource Division, Southwest Fisheries Science Center, National Marine Fisheries Service). 2013. Draft mission statement and five-year plan: Coho salmon captive broodstock program. March 2013.

Hayes, S. A., M. H. Bond, C. V. Hanson, E. V. Freund, J. J. Smith, E. C. Anderson, A. J. Amman, and R. B. MacFarlane. 2008. Steelhead growth in a small central California watershed: upstream and estuarine rearing patterns. Transactions of the American Fisheries Society. 137: 114-128.

Kaczynski, V. W. and F. Alvarado. 2006. Assessment of the southern range limit of North American coho salmon: difficulties in establishing natural range boundaries. Fisheries (31): 374-391.

Leicester, M. A. 2005. Recruitment and function of large woody debris in four coastal California streams. M.S. Thesis, San Jose State University.

Lindley, S. T. and 25 co-authors. 2009. What caused the Sacramento River fall Chinook stock collapse. Pre-publication report to the Pacific Fisheries Management Council. March 18, 2009.

McPhaden, M. J., S. E. Zebiak and M. H. Glantz. 2006. ENSO as an integrating concept in earth science. Science (314): 1740-1745.

Morgan, C. A., B .R. Beckman, L. A. Weitkamp, and K. L. Fresh. 2019. Recent Ecosystem Disturbance in the Northern California Current. Fisheries 44(10): 465-474.

Nagelkerken, I, S. U. Goldberg, C. M Ferreira, H. Ullah, and S. D. Connell. 2020. Trophic pyramids reorganize when food web architecture fails to adjust to ocean change. Science (369): 829-832

Pala, C. 2016. Corals tie stronger El Ninos to climate change. Science. 354:1210.

Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*). California Department of Fish and Game Bulletin 98. 275 pp.

Smith, J. J. 1992. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos creeks in 1992. 8 page unpublished report.

Smith, J. J. 1994a. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos creeks in 1993. 15 page unpublished report.

Smith, J. J. 1994b. Abundance of coho and steelhead in Redwood Creek in 1994. Report to Golden Gate National Recreation Area, National Park Service. 10 pp.

Smith, J. J. 1994c. Distribution and abundance of juvenile coho and steelhead in Scott and Waddell creeks in 1988 and 1994: implications for status of southern coho. 12 page unpublished report.

Smith, J. J. 1995a. Distribution and abundance of coho and steelhead in Redwood Creek in August 1995. Report to Golden Gate National Recreation Area, National Park Service. 9 pp.

Smith, J. J. 1995b. Distribution and abundance of coho and steelhead in Gazos, Waddell and Scott creeks in 1995. 20 page unpublished report.

Smith, J. J. 1996. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1996. 26 page unpublished report.

Smith, J. J. 1998a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1997 and the implication for status of southern coho. 23 page unpublished report.

Smith, J. J. 1998b. Distribution and abundance of coho and steelhead in Redwood Creek in Fall 1998. Report to Golden Gate National Recreation Area, National Park Service. 12 pp.

Smith, J, J. 1998c. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1998. 27 page unpublished report.

Smith, J. J. 1999. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1999. 26 page unpublished report.

Smith, J. J. 2000. Distribution and abundance of coho and steelhead in Redwood Creek in Fall 2000. Report to Golden Gate National Recreation Area, National Park Service. 8 pp.

Smith, J. J. 2001a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2000. 20 page unpublished report.

Smith, J. J. 2001b. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2001. 22 page unpublished report.

Smith, J. J. 2002. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2002. 30 page unpublished report.

Smith, J. J. 2003a. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2003. Report to Golden Gate National Recreation Area, National Park Service. 12 pp.

Smith, J. J. 2003b. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2003. 27 page unpublished report.

Smith, J. J. 2005. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2004.   32 page unpublished report.

Smith, J. J. 2006a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2005. 32 page unpublished report.

Smith, J. J. 2006b. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2006. 34 page unpublished report.

Smith, J. J. 2007. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2007. 40 page unpublished report.

Smith, J. J. 2008. Distribution and abundance of juvenile coho and steel in Gazos, Waddell, and Scott creeks in 2008. 46 page unpublished report.

Smith, J. J. 2009. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2009. 48 page unpublished report.

Smith, J. J. 2010. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2010. 51 page unpublished report.

Smith, J. J. 2011. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2011. 55 page unpublished report.

Smith, J. J. 2013a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2012. 61 page unpublished report.

Smith, J. J. 2013b. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2013. 65 page unpublished report.

Smith, J. J. 2014. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2014. 71 page unpublished report.

Smith, J. J. 2015. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2015. 66 page unpublished report.

Smith, J. J. 2016. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2016. 75 page unpublished report.

Smith, J. J. 2017. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2017. 85 page unpublished report.

Smith, J. J. 2018. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2018. 90 page unpublished report.

Smith, J. J. 2019. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell, and Scott creeks in 2019. 96 page unpublished report.

Smith, J. J. 2020. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell, and Scott creeks in 2020. 130 page unpublished report.

Smith, J. J. 2021a. Waddell post-fire stream habitat assessment in June 2021. 25 page unpublished report.

Smith, J. J. 2021b. Gazos Creek post-fire stream habitat assessment in August 2021. 38 page unpublished report.

Smith, J. J. 2021c. Waddell Creek post fire resurvey October 2021. 24 page unpublished report.

Smith, J. J. 2021d. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell, and Scott Creeks in 2021. 116 page unpublished report.

Smith, J. J. 2022a. Gazos Creek post-fire stream habitat assessment in July and September 2022. 50 page unpublished report.

Smith. J. J. 2022b. 2022 channel and habitat changes at six long-term index sites on Scott Creek from the CZU Fire. 20 page unpublished report.

Smith, J. J. 2022. Waddell Creek post-fire resurvey July and October 2022. 74 page unpublished report.

Smith, J. J. and L. Davis. 1993. Distribution and abundance of juvenile coho and steelhead in Waddell Creek in 1993. 7 page unpublished report.

Smith, J. J. and M. Leicester 2008. Distribution and abundance of juvenile coho and steelhead in Waddell and Scott Creeks in 2008. 41 page unpublished report.

Spence, B. C. and E. P. Bjorkstedt. 2005. Central California Coast Coho Salmon ESU. *In* T. P. Good, R. S. Waples, and P. B. Adams (Eds.), Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. of Commerce, NOAA NMFS tech. Memo. NMFS-NWFSC-66.

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coast Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz Laboratory, California.

Urban, F. E., J. E. Cole, and J. T. Overpeck. 2000. Influence of mean climatic change on climate variability from a 155-year tropical Pacific coral record. Nature (407): 989-993.

TABLES

Table 1. Site locations, habitat types present and sampled, number of steelhead collected and estimated density per 100 feet ( ) at sites on Gazos Creek in September 2022. (Site #s agree with earlier reports; the 4.4 mile site was replaced by a new site at mile 4.1).

Site	Mile >Hwy1	Chan Type	%Habitat Available PL	GL	RN	RF	% Habitat Sampled PL	GL	RN	RF	Sample Length (Feet)	#SHT +0	+1	Coho none
1	0.7	C5												
2	1.8	C5	60	20	15	5	72	19	9	--	173	52 (30)	3 (2)	
Old Woman's Creek	2.05													
2A	2.1	C4	65	5	20	5	77	--	22	--	180	89 (57)	0 (0)	
2B	2.8	B4C	50	30	15	5	76	15	9	--	214	41 (20)	7 (3)	
3	3.15	B4C												
3A	3.9	B4C	50	20	20	10	57	12	31	--	274	44 (16)	4 (1)	
4A	4.1	B4C	55	20	20	5	74	20	6	--	127	191 (152)	11 (9)	
5	4.85	B4C	45	20	25	10	62	21	16	--	237	83 (35)	19 (8)	
7A	5.3	B1	45	25	20	10	79	11	10	--	229	46 (20)	30 (13)	
Totals											1434	546	74	
Mean of 7 Sites			53	20	19	7	71	14	15	--		(47.1)	5.1)	

Table 2. Site locations, habitat types present and sampled, number of steelhead and coho collected and estimated density per 100 feet ( ) at sites on Waddell Creek in October 2022. (Site #s agree with earlier reports).

Site	Mile >Hwy1	Chan Type	%Habitat Available PL	GL	RN	RF	% Habitat Sampled PL	GL	RN	RF	Sample Length (Feet)	#SHT +0	+1	Coho
1 First bridge	0.6	B4C	55	20	20	5								
2 < Alder Camp	1.2	B4C	55	25	15	5	65	31	4	--	245	7 (3)	3 (1)	0
3 Twin Redwoods	1.8	B4C	55	25	15	5	71	11	11	8	233	16 (7)	1 (0.4)	2 (1)
4 Periwinkle	2.2	B4C	50	25	20	5	84	11	6	--	260	17 (7)	2 (1)	13 (6)
5 Road washout < Camp Herbert	2.6	B4C	50	20	20	5	73	15	8	3	229	21 (9)	4 (2)	3 (1)
6 < Camp Herbert	3.0	B3C	50	25	20	5	45	36	18	--	165	7 (4)	0	0
7 East Fork > Confluence	3.2	B3C	45	25	20	10	76	--	24	--	265	20 (8)	2 (1)	2 (1)
7A East Fork	0.2	B2												
7B East Fork < Last Chance	0.4	B2	50	5	35	10								
7C East Fork > Last Chance	0.8	B1/B2	55	--	35	10								
8 W Fork> Confluence	3.3	B4C	50	20	25	5	67	20	13	--	229	16 (7)	3 (1)	9 (4)
8A above log jam	3.6	B4C	50	25	15	10								
9 WF Mill Site	3.9	B4C	50	30	10	10								
10 > Buck Creek	4.7	B4C												
11 < Henry Creek	5.25	B1												
12 Henry Creek	0.2	F1/4												
Totals											1626	104	15	29
Mean of 7 Sites			51	24	19	6	69	18	12	2		(6.3)	(0.9)	(1.9)

Table 3. Site locations, habitat types present and sampled, number of steelhead and coho collected and estimated density per 100 feet ( ) at sites in Scott Creek watershed in October 2022. (Site #s agree with earlier reports).

Site	Mile >Hwy1	Chan Type	%Habitat Available PL	GL	RN	RF	% Habitat Sampled PL	GL	RN	RF	Sample Length (Feet)	#SHT +0	+1	Coho
A Near Diversion	0.9	C3												
1 < Little Creek	1.9	C3	55	20	20	5								
2 Pullout > Big Creek	2.55	BC4	55	20	20	5								
3 < Mill Creek	3.05	C4	60	20	15	5	67	11	19	2	177	78 (45)	6 (3)	88 (50)
4 < Swanton Road	3.55	BC4	45	35	15	5	63	28	9	-	117	101 (86)	2 (2)	90 (77)
5 Cattle guard	4.25	C4	45	35	15	5	49	41	10	-	134	119 (90)	5 (4)	73 (57)
7 Pullout < Big Cr. Gate	4.9	B4C	45	35	15	5	67	24	9	--	249	49 (23)	10 (4)	174 (70)
9 0.15 mile > bridge	5.15	B4C/F	60	20	15	5								
11 Upper Ford	5.85	C3/4	55	25	15	5								
12 Big Creek/ Swanton Road		C3	50	10	30	10	63	--	30	7	138	40 (29)	1 (1)	0
13 Mill Creek <Swanton Road		C3	45	10	30	15	76	12	12	--	102	51 (50)	5 (5)	33 (32)
Totals											917	438	29	458
Mean of 6 Sites			48	24	20	8	64	19	15	2		(53.8)	(3.1)	(47.9)

Table 4. Density of coho (#/100 feet) by site at Gazos Creek in 1992-2022 (no coho were captured in omitted years). No sampling took place in 2008, and very limited sampling took place in 2020 after the CZU fire. Coho densities in 1996 were augmented by planted hatchery-produced fry. In 2018 and 2019 coho presence was due to planted hatchery-produced fry (in 2019 the coho were holdover yearlings).

		Year Class									
Site	Mile > Hwy 1	1993	1995	1996	1998	1999	2002	2004	2005	2018	2019
A	0.25						8				
1	0.9	0	0	0.6	0	0	16	2	7		
2	1.8	0	0.8	0.9	0.6		22	2	6	0	0
	2.05 Old Woman's Creek										
2A	2.1			8	0	0	55	0	15	0	0
2B	2.8					3	33	0	20	0	0
3	3.15	1	0	7	0	0.5	24	0	10		
3A	3.9					0.7	46	0		0.9	0
4	4.4	23	0	8	0		39	0	13	13.2	0.4
	4.4/4.6					10					
5	4.8/5.0				0						
	4.85					13	33	0	11	15.2	0.4
6	5.1/5.2				2.7						
7	5.3/5.45				0						
	5.3					28	29	0	9	36.3	0
7B	5.45					0	0.7				
Totals		6.0	0.2	4.9	0.4	6.2	27.7	0.4	11.6	9.4	0.1

Table 5. Densities (#/100 feet) of coho by site in the Waddell Creek watershed in 1992-2022. Significant # young-of-year coho were not collected in omitted years. In 2009 only 4 coho were captured (at sites 2 and 3). In 2007, coho were captured only at site 1 (density 3/100 feet). In 2019 only 4 coho were captured, with 3 of those on the West Fork. In 2020, 21 coho were captured at 2 of only 3 sampled sites (sites 3 and 4). *In 1996 sites downstream of the forks received plants of hatchery-produced fry.

		Year Class														
Site	Mile > Hwy 1	1992	1993	1995	1996	1998	1999	2001	2002	2004	2005	2008	2015	2016	2018	2022
1 First bridge	0.6	0	1	0.5	16*	0	0	0	0	0	0	0	1	1	0	
2 < Alder Camp	1.35	0	0.3	0.3	7*	0	0	0	3	0	0		2	3	0	0
3 Twin Redwoods	1.8	0	0	0	14*	0	0	0	10	4	16	0	18	9	0	1
4 Periwinkle	2.2	0	4	0	30*	0	0	0	0.4	3	3	0	13	3	0	6
5 Downstream of Camp Herbert	2.6	0.4	2	2	16*	0	0	0	0.6	4	4	0				1
6 Camp Herbert	3.1	3		2	15*	0	0	0	0	0	0	0	0.4	0.6	0	0
7 East Fork > Ford	3.2	0	4	0	10	0	2	0	4	0	2	0	0.4	0	0	1
7A East Fk upper	3.7		4		4				0		0	0	0.5			
8 West Fork	3.3	0	7	3	13	0	14	2	7	2	8	2	6	0.7	1.3	4
9 Mill Site	3.9	4	4	3	23	3	11	3	18	3	17	3	5	0	2.2	
10 at Buck Cr	4.7	0.5	0	3	18	0.4	8	0	8	11	9					
11 < Henry Cr	5.25	1	2	0	7					11	8	14				
13 Henry Creek >Trail Xing	0.2	1	16	0	3					0	12	6				
Totals		0.6	3.6	1.1	12.5	0.3	3.1	0.5	4.7	3.9	6.0	0.5	5.2	2.3	0.4	1.9

Table 6. Coho densities (# / 100 feet) in the Scott Creek watershed in 1993-2022. No sampling was conducted in 2020. In 1996 lower Scott Creek (*) was augmented with hatchery-produced fry). Omitted from the table are 11 years: in 2000, 2007, and 2014 only yearling coho were captured: in 1994 and 2003 most or all coho were yearlings; in 2001 low densities (1-3 /100 feet; mean=0.6) were found only at the 4 sites downstream of Mill Creek; in 2017 only 5 coho were captured between 2 sites; and in 2008-2011 and 2019 no coho were collected. No sampling took place in 2020 and only 3 sites (without coho) were sampled in 2021.

Site (Mile > Hwy 1)	Year Class Density															
	1993	1995	1996	1997	1998	1999	2002	2004	2005	2006	2012	2013	2015	2016	2018	2022
A. Near Diversion (0.9)	2	1	22*	0		5	38	1	8	1						
1. at Little Creek (1.9)	7	14	33*	0	0	6	44	2	6	2	0	3	32	0	2.2	
2. >Big Cr. (2.55)	31	29	31	30	1	35	82	12	21	3	0	36	20	0		
3. < Mill Cr. (3.05)		28		29	0		83	14	37	5	2	14	23	0.3	0	50
4 .< Swanton Road (3.55)	86	26	37	20	3	45	156	22	36	18	0	2	0	4	0	77
5. Cattle Guard (4.25)				11	2		145	15	76	15	2	4	28	4	0	57
7. Pullout < Big Cr. Gate (4.9)	48	23	62	24	3	86	144	20	45	3	4	54	38	1	1.1	70
9. 0.15 mi > Bridge (5.15)	39	12	62	1	0	45	102	0			5		17	6	3.1	
11. Upper Ford (5.85)	41	5	33	0	8	22	48	2	45	0		1	0.4	1	0.4	
11A 5th Trail Crossing (6.5)	16	3	31	1	3		63	0	18							
12. Big Cr. Swanton Rd	8	1	21	0	0	7	72	4	5	0	0	2	14	0	1.3	0
12A Big Cr. < Hatchery	9	0	30	0		0	31	2	11							
12B Big Cr. > Berry Cr.			11			0	13									
13. Mill Cr. < Swanton Rd.	12	28	24	6	0	42	88	17	49	24	16	2	11	0	0.6	32
Mean	27.2	14.2	33.0	9.3	1.8	29.2	79.2	8.6	29.7	6.9	3.3	13.1	18.3	1.6	1.0	47.9

Table 7. Density of young-of-year steelhead (# / 100 feet sampled) for sites at Gazos Creek in 2006-2022. Value in ( ) is density of yearling and older fish. Values with *** and bold** indicate YOY density >50% below 1993-2010 mean. No sampling took place in 2008, and 2020 is excluded because of limited sampling immediately after the CZU Fire.

	Year Class														
Site (mile > Hwy 1)	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022
1 (0.7-0.9)											**1(5)***				
2 (1.8)	15(10)	**10(10)***	**11(6)***	15(4)	14(7)	25(8)	**5(2)***	**12(3)***	25(2)	27(5)	**6(6)***	36(11)	52(6)	**10(1)***	30(2)
2.05 Old Woman's Creek															
2A (2.1)	24(5)	23(3)	**13(5)***	25(2)	20(7)	34(9)	34(3)	24(3)	35(7)	45(4)	19(11)	57(15)	33(8)	**7(3)***	57(0)
2B (2.8)	44(6)	32(3)	**27(13)**	**20(5)***	**22(6)***	30(14)	37(4)	**24(6)***	36(5)	36(7)	**26(4)***	37(8)	**20(7)***	**26(1)***	**20(3)***
3 (3.15)	**13(1)***														
3A (3.9)	23(5)	**16(2)***	23(4)	**15(1)***	28(2)	33(7)	**7(1)***	**10(4)***	32(1)	29(4)	31(3)	20(11)	**16(4)***	23(1)	**16(1)***
4 (4.1-4.6)	**13(5)***		**20(6)***	**10(4)***	43(10)	35(8)	31(8)	**17(8)***	35(4)	37(8)	39(8)	**15(22)***	**22(10)***	**8(9)***	152(11)
5 (4.8-4.9)	**4(1)***	23(2)		**14(4)***	30(7)	28(11)	**4(2)***	24(5)	29(7)	30(4)	22(7)	**8(15)***	**16(6)***	29(5)	35(8)
7A (5.3)	**12(7)***	21(4)	**17(7)***	**14(8)***	34(8)	24(8)	**6(5)***	**11(12)***	22(9)	24(8)	24(8)	**7(23)***	33(15)	36(8)	20(13)
Total	**19(5)***	21(4)	**17(7)***	**16(4)***	28(6)	30(9)	**17(4)***	**18(6)***	30(5)	32(6)	21(6)	26(15)	27(8)	20(4)	47(5)

Table 8. Densities of YOY steelhead (number per 100 feet) at sites on Waddell Creek in 1999-2019. In 2002, 2004, and 2005 coho were also somewhat common at some sites and those totals are included with the YOY steelhead for that year. **(* and bold** indicates values that are >20% below 1995-1998 low and also > 50% below 1995-1998 mean). Only 3 main stem sites were sampled in 2020 and only 1 in 2021.

		Year Class																				
Site Mile> Hwy1	1995-98 Range(Mean)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
13 Henry Cr. > Trail	56-81(57)	--	--	--	32	**28***	39	30	--	**13***												
11 < Henry Cr. 5.25	31-37(34)	--	--	--	28	51	38	55	--	**15***												
10 < Buck Cr. 4.7	45-74(57)	39	--	42	40	67	50	37	--	29												
9 Mill Site 3.9	47-60(53)	44	--	**20***	44	44	36	53	34	31	43	**9***	**24**	**14***	30	36	**11***	26	55	32	**12***	18*
8 West Fork > confluence 3	42-60(52)	36	46	**14***	27	45	32	35	**20***	**15***	29	**12***	**19***	**7***	**11***	30	**6***	**16***	**23***	**10***	**10***	**16***
7 East Fork > confluence 3.2	43-115(71)	67	51	**21***	**34***	**22***	46	**22***	**19***	**8***	**16***	**21***	**9***	**9***	**5***	36	**6***	**5***	**5***	**12***	**6***	**11***
7B East Fork Upstream	43(43)	--	--	--	**22***	--	--	**21***	26	**8***	28	--	**18***	**8***	**12***	**13***	**6***	**5***	--	29		
7C East Fork > Last Chance									52	21	42				18	7	3					
6 Camp Herbert 3.1 lower	42-128(76)	57 **7***	**9***	**10***	**7***	**31***	**17***	**6***	**12***	**9***	**19***	**8***	**18***	**9***	**7***	**12***	**10***	**12***	**26***	**15***	**9***	**22***
5 Pullout < Camp Herbert 2.6	83-138(100)	**8***	**23***	**10***	**8***	--	**20***	**11***	**6***	--	**10***	--	**3***							**8***		
4 Periwinkle 2.2	108-150(130)	**9***	**16***	**1***	**10***	**35***	**50***	**7***	--	**2***	**13***	**13***	**13***	**0***	**7***	**12***	**5***	**10***	**12***	**7***	**12***	**21***
3 Twin Redwoods Camp 1.8	53-92(74)	**9***	**29***	**27***	63	43	**24***	50	**5***	**8***	**21***	**10***	**19***	**3***	**25***	41	**14***	**19***	**27***	**7***	**12***	41
2 <Alder Camp 1.35	78-131(110)	**10***	**46***	**54***	**24***	**54***	**26***	**5***	--	**11***	--	**2***	**4***	--	**5***	**9***	**4***	**4***	**13***	**2***	**3***	**22***
1 First Bridge 0.6	54-85(64)	**8***	**18***	36	**9***	39	**0***	**4***	**6***	**11***	**3***	**9***	**3***	--	**7***	**7***	**4***	**3***	**7***	**1***	**1***	**17***
Total All Sites	62-80(73)	**29***	**30***	**24***	**27***	42	**32***	**26***	**20***	**13***	**23***	**10***	**13***	**8***	**13***	**20***	**7***	**11***	**24***	**12***	**8***	**21***
Total Main Stem	87-101(93)	**17***	**24***	**23***	**20***	**40***	**23***	**14***	**7***	**8***	**13***	**8***	**10***	**6***	**10***	**17***	**7***	**10***	**17***	**7***	**7***	**25***

Table 9. Sample site locations and steelhead densities (# / 100 feet) in the Scott Creek watershed in 2008-2022 (no sampling in 2020). Number in ( ) is density for yearling and older fish. Channel and LWD had been relatively stable since 1998 until 2017 and 2019, and then there were major changes in 2022 (LWD and pool filling) after the CZU Fire. Values with ***and bold** were less than 50% of 1998-2010 mean.

Site (Mile > Hwy 1)	Year Class 2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022
A. Near Diversion (0.9)		**10(6)***												
1. at Little Creek (1.9)			34(3)	**6(0)***	**3(0)***	20(1)	**13(9)***	**12(2)***	**10(1)***	70(7)	**11(5)***	47(1)		
2. >Big Cr. (2.55)	**23(2)***	**17(6)***	71(5)		61(3)	**22(9)***	**1(7)***	**31(1)***	49(3)	80(5)				
3. < Mill Cr. (3.05)		39(14)	71(4)	43(1)	40(4)	**23(5)***	**18(7)***	**19(2)***	32(1)	44(4)	38(5)	**15(5)***		45(3)
4 .< Swanton Road (3.55)		36(12)	57(8)	73(3)	72(10)	**31(8)***	50(17)	**4(0)***	65(4)	61(20)	35(15)	79(14)		86(2)
5. Cattle Guard (4.25)		36(6)	41(5)	55(6)	**22(5)***	**18(10)***	**10(5)***	**8(4)***	30(4)	70(9)	40(12)	89(13)		90(4)
7. Pullout < Big Cr. Gate (4.9)	34(5)	42(7)	52(4)	81(2)	31(3)	33(7)	**28(9)***	**13(9)***	49(2)	77(2)	**22(7)***		47(4)	**23(4)***
9. 0.15 mi >* Bridge (5.15)	**19(12)***		**23(9)***	32(3)	**27(3)***		**14(3)***	**4(10)***	53(2)	65(7)	33(10)			
11. Upper Ford (5.85)	**13(5)***	**10(3)***	22(5)	22(1)		16(2)		**0(9)***	18(3)	27(3)	16(4)			
11A 5th Trail Crossing (6.5)														
12. Big Cr. Swanton Rd	**15(3)***	**6(3)***	30(5)	**15(3)***	24(4)	41(5)	26(11)	**12(4)***	20(2)	35(5)	19(5)	59(6)	**5(2)***	29(1)
12A Big Cr. < Hatchery														
13. Mill Cr. < Swanton Rd.	**18(19)***	**26(8)***	49(2)	41(2)	**18(8)***	36(9)	54(10)	**18(8)***	**20(4)***	41(5)	**7(8)***	33(6)	47(3)	50(5)
Mean	**20(8)***	**24(7)***	45(5)	41(2)	33(4)	27(6)	**24(8)***	**12(5)***	35(2)	57(7)	**23(8)***	54(7)	33(3)	54(3)

Table 10. Coho and steelhead killed and captured (/) by electrofishing and mortality rate (%) on Scott, Waddell and Gazos creeks in September and October 2022.

	--------------Steelhead		------------------------------------		Coho	
	Age 0+ Kill/Capt	%	Age 1+ Kill/Capt	%	Age 0+/1+ Kill/Capt	%
Scott Creek	4/438	0.9	0/29	0	4/458	0.9
Waddell Creek	1/104	1.0	0/15	0	1/29	3.1
--						
Gazos Creek	6/546	1.1	0/ 74	0	--	--
Totals	11 / 1088	1,0	0 / 118	0	5/487	1.0
Overall			16 / 1693	0.9		

FIGURES

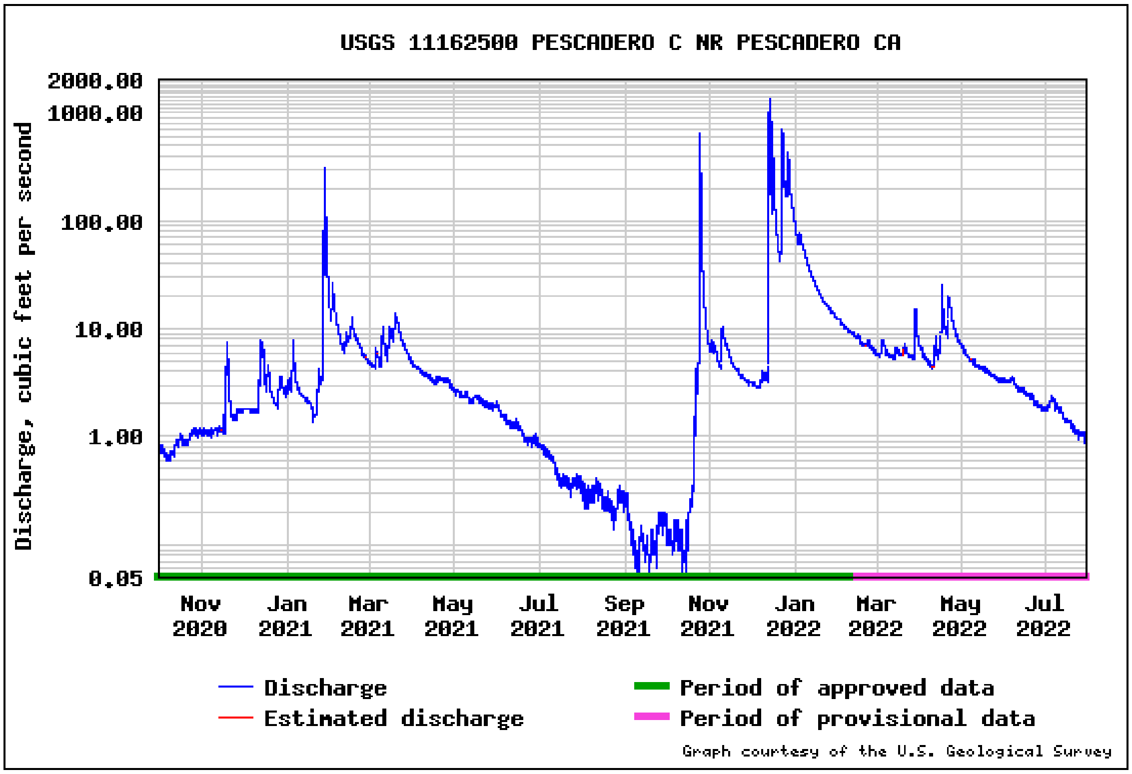

Figure 1. Stream flow in Pescadero Creek in November 2020 throughJuly 2022, showing the general pattern of stream flow in Gazos, Waddell, and Scott creeks. Winter 2020-2021 was mild with only a brief modest flood peak in late January. Storm peaks in October and December 2021 were substantially greater than in 2021, although the rest of winter and spring were dry. Pescadero Creek received relatively little fire damge, so the flood peaks in Gazos, Waddell, and Scott creeks would have relatively much greater because of severe watershed burning.

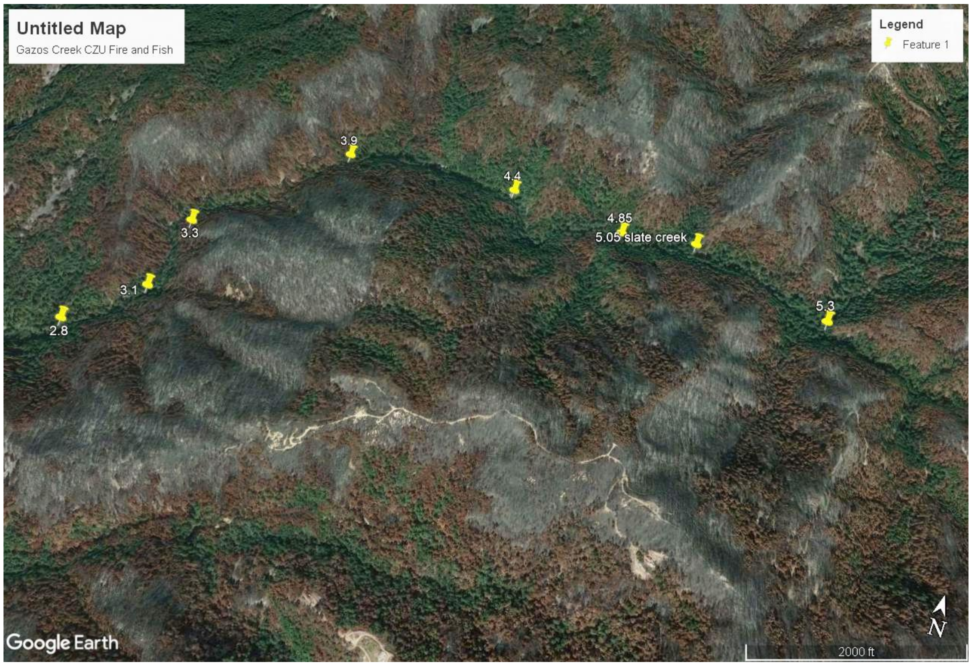

Figure 2. Google Earth photo (26 September 2020) of Gazos Creek from below mile 2.8 from Highway 1 (above Cloverdale Road) upstream to above mile 5.3 (below the Mountain Camp, upper limit of potential coho use). There were no direct fire effects downstream of mile 2.8. Markers are approximate road miles at long-term fish monitoring sites. Gray terrain in the photo is where the fire consumed the entire tree canopy, leaving only standing and down trunks. The severe burn in the lower part of the photo drains to the south bank tributary Old Woman's Creek, which enters Gazos Creek at mile 2.0. The brown in the photo is the portion of the forest that had most of the canopy baked or burned.

Figure 3. The intensively burned portion of the Gazos Creek watershed upstream of mile 5.5 (upstream of anadromy). Even standing burned trees are scarce in half of the upper watershed.

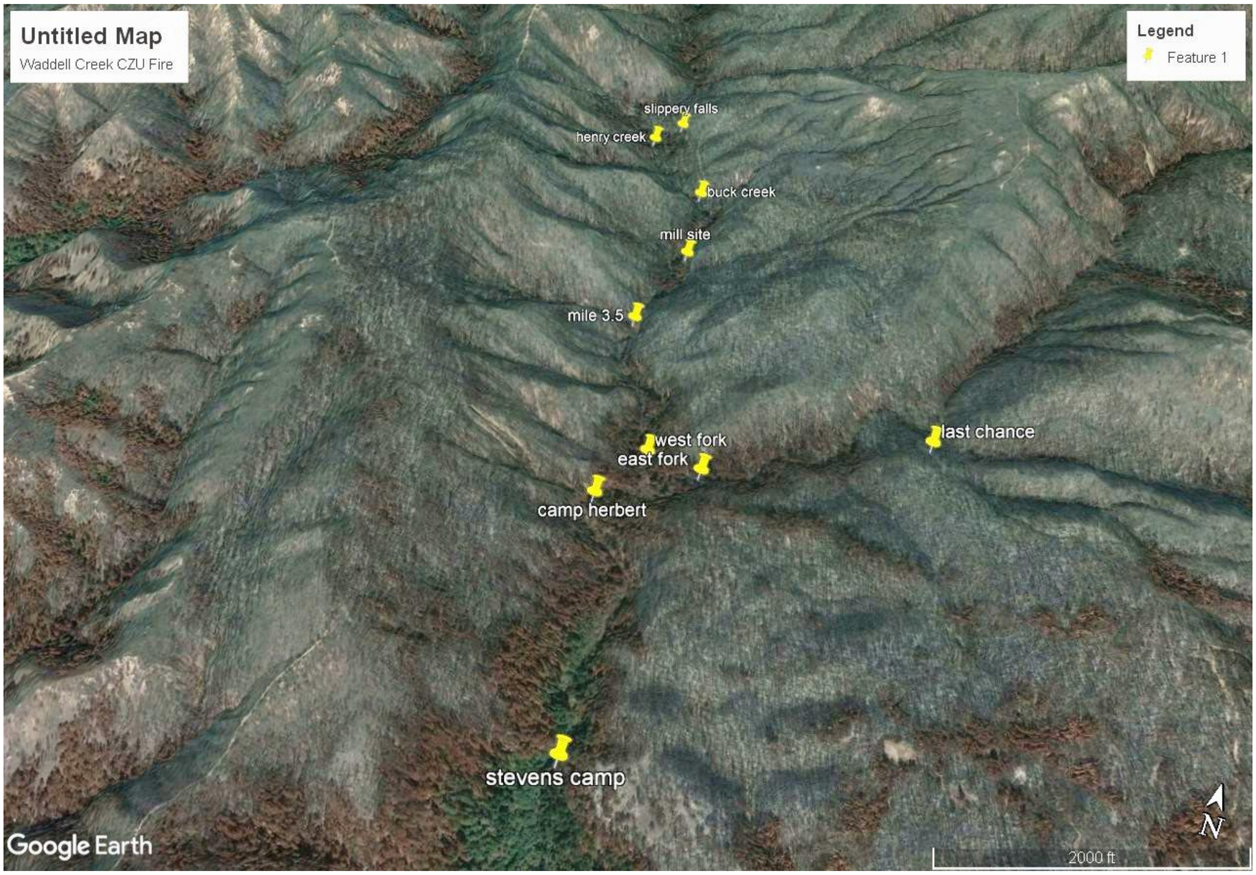

Figure 4. Google Earth aerial photo of Waddell Creek watershed from downstream of Stevens Camp (mile 2.55) to the upper watershed of the East and West forks (taken in fall 2020 after the CZU Fire). The green streamside is intact riparian and lower upslope forest. Orange is medium burned forest extending upstream to mile 3.6+ (Mill Site). Remainder of the watershed in gray is severely burned upland with standing or downed burned trees only. Yellow icons are historical fish sampling sites used since 1992.

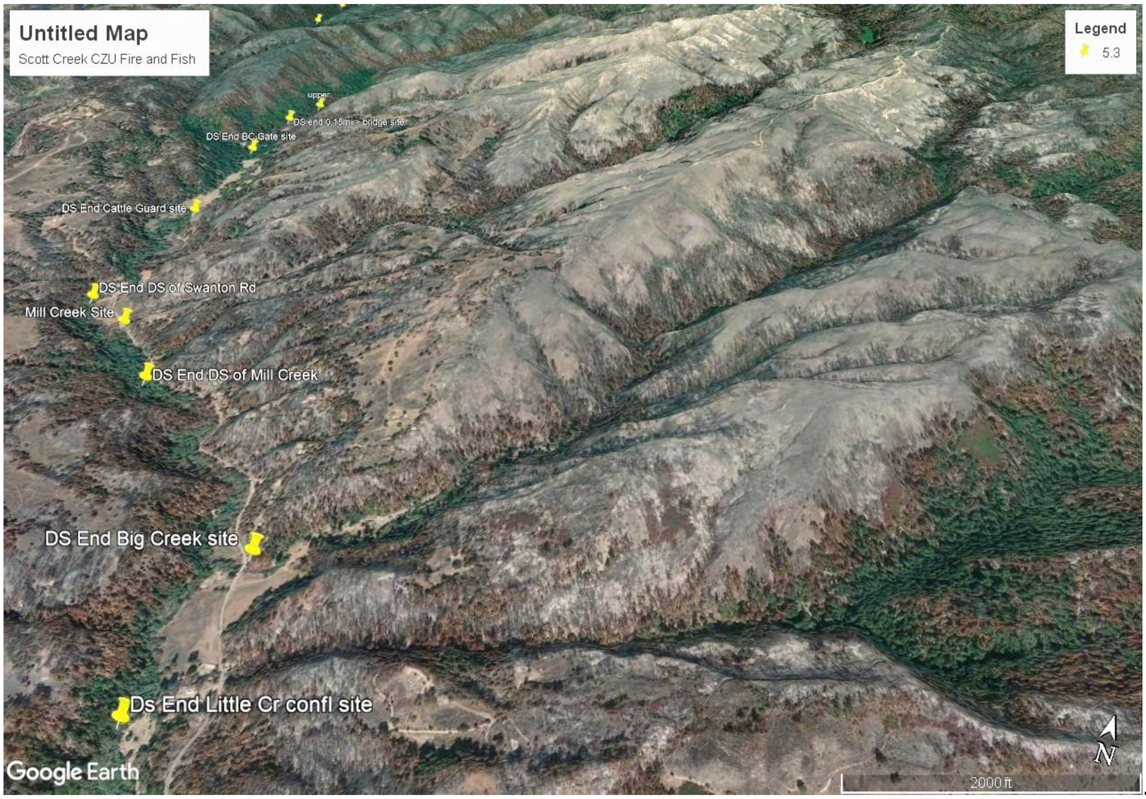

Figure 5. Google Earth aerial photo Scott Creek watershed in September 2020 from upstream of Little Creek. The burn was most severe in the Little Creek, Big Creek, Mill Creek and upstream portion of Scott Creek (the right two-thirds of photo). The direct impacts at the regular fish sampling sites on Scott Creek (most of icons) were light to moderate.

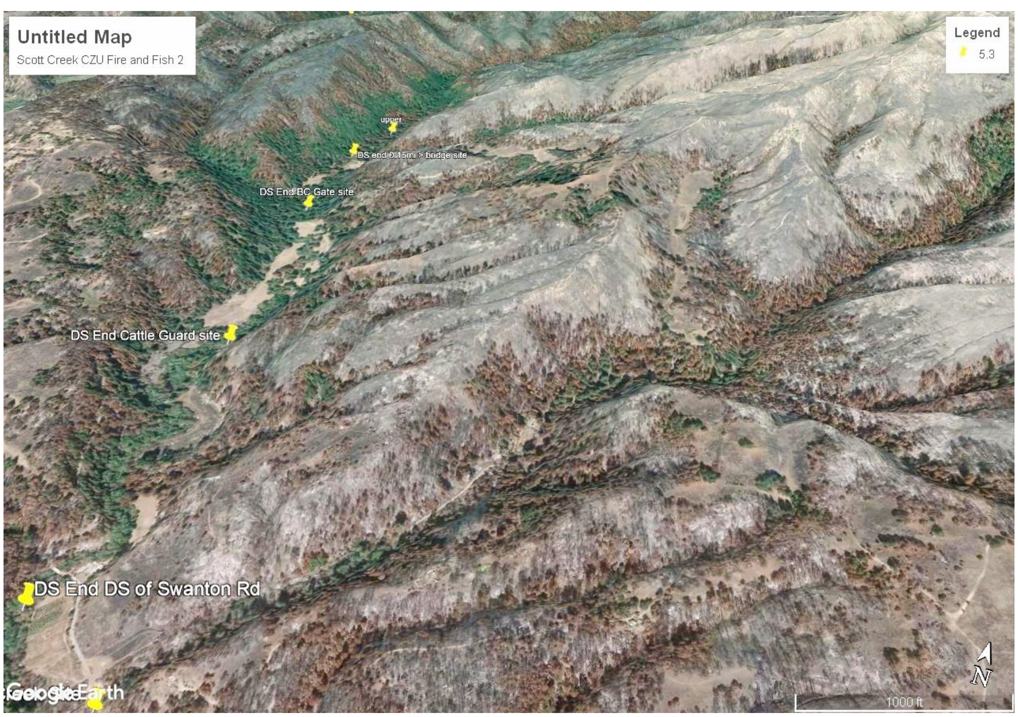

Figure 6. Mill Creek (right) and Scott Creek (left) upstream of Swanton Road. In September 2020.

Figure 7. Appendix of Historical Fish Lengths. Standard lengths (mm) steelhead and coho (C) from Scott, Gazos and Waddell creeks in 2022 versus previous years (* = young of year 1= yearling + = age 2+ or older). Back-calculated length @ annulus for yearling steelhead in 2011 and coho for 2013 and 2014. H = holdover hatchery-reared smolt.

Gazos Creek 2022

	Site 2	Site 2A	Site 2B	Site 3A	Site 4A	Site 5	Site 7
30 – 34		**					
35 – 39		*****10					
40 – 44	**	*********23			*****		
45 – 49	***	********17			************35		***
50 – 54	****8	********18	******	*	*************39		******
55 – 59	********15	******13	********	**	**********30	******7	
60 – 64	********15	****7	******	*******14	*************38	***********13	*****
65 – 69	**	***	*********	*****11	*********25	***********14*	*******9
70 – 74	**	****	*****	******13	********18	********9	******7
75 – 79	***		***	****	***	*	****
80 – 84	**	*	***		**		****
85 – 89	*		*	1	*** 1	111	********10
90 – 94			*		***	11	* 1111
95 – 99					11	1	11
100-109		1	1		11	1111	11111111
110-119	11		11	1	1111		11111111
120-129	1	1		11	11	11	
130-139							1
140-149					1		1
150-159							
160-169							+
170-179							+
200-209					+		
230-239							++

Gazos Creek 2021

	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7
30 – 34	*		****				
35 – 39	*		*****	***		****	***
40 – 44	*****	*	********	*********		***************	*******
45 – 49	*********	**	********	***		************	*************
50 – 54	*****	***	********	****************		***************	*************
55 – 59	**	****	*****	***************		**********	*************
60 – 64	****		****	**********	*****	*******	****
65 – 69		***	*****	****	****	**	**
70 – 74	*	**	**	**	****	*	**
75 – 79	*	*			* 1		****** 11
80 – 84	*	*			11	11	*** 1
85 – 89				1	1111	1	1
90 – 94		1	1		111111	1	1111
95 – 99					1	111	11
100-109	1		1		1	11	1 +
110-119	1			+	1	1	1
120-129		1 +			1	1	+
130-139						+	+
140-149					+		

Limited sampling 2021

Scott Creek 2021 / ***Waddell Creek 2021***

	Site 7	Site 12	Site 13	Site 5
30 – 34	**			
35 – 39	*******		**	
40 – 44	*********		**************	****
45 – 49	**********		**********************	***
50 – 54	*******************	**	**********	*****
55 – 59	***********		*******	****
60 – 64	******	**	***	*
65 – 69	*	*	**	*
70 – 74	*			
75 – 79				
80 – 84	1	*		
85 – 89		*	1	
90 – 94	11		1	
95 – 99	1		1	
100-109				
110-119				
120-129			1	1
130-139	1			
140-149			+	1
150-159		1		
160-169				1
260-269	2			

Gazos Creek 2020

	Site 2	Site 2A	Site 2B	Site 6
40 – 44			**	*
45 – 49			*******	*
50 – 54			****	***
55 – 59			*******	****
60 – 64			****	**
65 – 69	*		*****	**
70 –74		*	*******	***
75 -79		**	** 11	****** 1
80 – 84		*		11
85 – 89		*	11	
90 – 94		*	1	111
95 – 99		* 1		11
100-109	11	111	11	11
110-119	1			1
120-129	1			
130-139	11	1	1	
140-149			+	
150-159		1		

Gazos Creek 2019

	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 6
30 – 34						*	
35 – 39			*	*2	*****10	**	*
40 – 44	*	*3	**4	*****11	*3	******	**4
45 – 49	**	****12	*****10	***6	********17	******	*******14
50 – 54	******18	*******22	****9	*******14	****8	*********	***6
55 – 59	********24	****13	**5	*******15	***7	********	******12
60 – 64	******18	****12	***7	**5	****9	**	****9
65 – 69	**6	**6	*3	*2	*2	11	**4
70 – 74	***9	**5	11	11	111 C	11 C	*
75 – 79	***11	*3			1111	1	
80 – 84	*4	**		11	1	1	1
85 – 89	*	**	11		11		1
90 – 94	11	1	1	1	11	11	11
95 – 99	1	11	1		11	1	111
100-109			1	1	1111	1111111	1
110-119	111	111	1		1111	1	111
120-129	111	1		1	11		111
130-139			11				11
140-149		11	1		1 +		1
150-159							
160-169	+	++					
170-179							++
180-189							
190-199							++

Gazos Creek 2018

	Site 2	Site 2A	Site 2B	Site 3A		Site 4		Site 5	
30 - 34				1			C		
35 – 39			2	*5		*3	CCC	2	CCCC
40 – 44			*5	**6		****12	CCCCCCC	*4	CCCCCCCCCCCCCCC
45 – 49	1	**7	*****17	***10	C	**8	CCCCCCC	**7	CCCCCCCCCCCC
50 – 54	1	*****17	*******21	*****12		2	CCCC		CCCCCCC
55 – 59	***10	************34	*****15	**8				1	C
60 – 64	*****17	*******21	***11		C			*5	
65 – 69	*******23	**9	*5					111	
70 – 74	*****15	*5		1		11111111		1111111	
75 – 79	**6	2		11		1111111		11111	
80 – 84		1		1111		111		1111111	
85 – 89	11	1	111	1111		11111		1111	
90 – 99	1111111	111111111	1111111	1111		1111111111		111	
100-109	1111	111		11		111			
110-119	111111	11111	1	1		1		111	
120-129		11	11	11				111	
130-139	11	1	1	11				1	
140-149		1						111	
150-159		1	1						
160-169									
170-179	+								
180-189				+					
190-199									
200-209									
								+	

Site 7A coho		*YOY steelhead*
40 – 44	CCCCCCC	**********
45 – 49	CCCCCCCCCCCCCCCCCCCC	*****
50 – 54	CCCCCCCCCCCCCCCCCCCCCCCCCC	*******
55 – 59	CCCCCCCCCCC	***
60 – 64	CCCCCCCCCCCC	****
65 – 69	C	*

Gazos Creek Steelhead 2017:

	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7A	Lagoon 17 Nov seine Fork Length
35 – 39				*1	*1			
40 – 44				*2	*5	*3	*3	
45 – 49				****9	*****17	****14	**6	
50 – 54			**6	*********18	********26	*****15	**7	
55 – 59			****13	******13	***9	***11	***10	
60 – 64			****9	****9	**8	***9	***9	
65 – 69	*2	*2	*******15	***6	*5	*2		
70 – 74		**5	****8	****9	**7	*3	*2	
75 – 79	**4	******12	**4	*1	1	*2	11	
80 – 84	*2	******12	*2	1	*2 111	*2 11	1	
85 – 89	***6	**4	**5	1	11	1	1	
90 – 94	111111	111111		1	11	11	1	
95 – 99	1	1111		1	11	111	11	
100-104	11	1	1				1	
105-109	1	1	11	1	1	11	1	
110-114		111	11		1		1	
115-119		11	1	1	1	1		
120-124					1	1	1	
125-129	1		1					
130-134		11						
135-139	1							
140-144							1	
145-149	1							
150-154		1			+			*
155-159							+	1
160-164								****
165-169				+				*
170-174						+		*
175-179					+			* 11 +
180-184								* 1
185-189		+						1
210-214							+	

Gazos Creek Steelhead 2016:

	2016						
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7A
30 – 34					*		
35 – 39			*	**5	*2	*	
40 – 44			***6	********16	*****10	********	
45 – 49	*****		********17	*********19	*******15	**********	*****10
50 – 54	********16	*********19	********17	*******15	*********19	***********	*********18
55 – 59	*********18	**********20	******13	******13	********17	********	******13
60 – 64	*******14	******12	*********18	***6	*****10	****	**4
65 – 69	*****	*****11	*****11	*3	*****10	**	*3
70 – 74	**	***7	**5	**4	*2	***	*2
75 – 79	1	**4	*2	1	11		11
80 – 84	111	*		1			11
85 – 89			111	111	111	1	
90 – 94	1	1	11		11		1
95 – 99	1	1			1	1	111
100-109	11	11	11	1	11	1	11
110-119	1	111	1111		111	1	11
120-129			1	11	1	1	1
130-139			1	1		1	
140-149	11	1			1		
150-159							++
160-169					+		+

Gazos Creek Steelhead:

	2015						
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7A
30 – 34			**	******			
35 – 39	**	*	****************	*********	**		
40 – 44	*******	****	*************	******************	**********22	**	
45 – 49	**********	**********	************	***************	************28	*********	****
50 – 54	********	*******	**********	*******	*********17	***********16	******
55 – 59	**********	************	****************22	*****************	*******	*******	*********
60 – 64	***	***********	**********	******	**	****	****
65 – 69	****	*******	****	***	**	*	***
70 – 74	**	******		**	***		
75 – 79						1	1111
80 – 84	**	11	11	11		1	11
85 – 89		1	1		111	11	1
90 – 94		1	11		1	1	111
95 – 99		1	1			11	111
100-104		1	1		1		11
105-109			1		1		1
110-114		1	11	1		1	
115-119		11	1			1	
120-124		11					
125-129	1				1	1	
130-134							
135-139							
140-144							2
145-149							2
150-154				2	2		
155-159			2				
160-164							2
165-169							
170-174						2	
185-189			3				
190-194		3					

Gazos Creek Steelhead:

	--2014--						
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7A
35 – 39				*		*	
40 – 44			*		**	******	
45 – 49		*	*	****	*******	*********17	*******
50 – 54		*****	********	******	********	**********	******
55 – 59	*	**********	**********	**	************	********	**
60 – 64	******	*************	**************	***	**********	*****	****
65 – 69	********	*******	****	******	*	****	***
70 – 74	*****	*********	***********	**	*	**	
75 – 79	****	**	*****	**	****		* 1
80 – 84	****	***	****	** 11	111111		
85 – 89	1	1	1	1	111	1	*
90 – 94	1			11	1111	1	1111
95 – 99	11					11111	111111
100-104	11	1					11
105-109	1	1	11		1	1	
110-114	1				1	1	11
115-119			1111			1	1
120-124		1	11	1			1
125-129		11					1
130-134			1				11
135-139							1
140-144	1						1
145-149							
170-174					+		
175-179							+
180-184				++			
190-194		+					
200-204			+			+	

Gazos Creek:

	2013						
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7A
40 – 44			***		*		
45 – 49			************		****		
50 – 54		*	*************	*	************		
55 – 59	**	********	************	****	**********	**	
60 – 64	****	*****************	****************	********	********	****	*
65 – 69	***	*****************	********	*****	***	*	*****
70 – 74	**	*****	**	*	**	*	*
75 – 79	** 1	*** 11	***	*	*****	*	***
80 – 84		*		1	***		**
85 – 89		1			1		
90 – 94	1		1			1	11
95 – 99							
100-104			1	1			1
105-109	1			1	11		
110-114			11		1	11	11
115-119	1	1			1		11
120-124							11
125-129		1		1		1	1
130-134			11		1		11
135-139					1		
140-144		11					
145-149				1			
150-154							
155-159					+		
160-164							
165-169						+	
170-174			+				
175–179	+						
190-194							+
210-214			+				
230-234							+

Gazos Creek:

	----------2012 Steelhead----------					
	Site 2	Site 2A	Site 2B	Site 3A	Site 5	Site 7
35 - 39			*	***		
40 – 44			***	********	**	*****
45 – 49	*	***	*************	*****************	***********	*********
50 – 54	*******	*************	*****************	****************+7	***************	******************
55 – 59	************	****************	*******	*****************	*********	*******************
60 – 64	*************	***************	*******	**********	****	***********
65 – 69	********	**********	***	****	****	******
70 – 74	****	****	*	***	111	***
75 – 79		1	1111111	111	11111	
80 – 84	1	1	1111	1111	11111	111
85 – 89	111		111	11	11	111
90 – 94	1	1	111	111		111
95 – 99	111	1		11		111
100-104		1	11	1		1
105-109	1		1	1	11	1
110-114	1	1		1		
115-119	1	1	1	1		
120-124			11	1		
125-129	1		1			
130-134						
135-139	1					1 +
140-144	1				+	
145-149						+
150-154						
155-159					+	+
160-164						
165-169						
170-174						+
175-179	`					
180-184						
185-189						++
190-194						
195-199						+
200-209			+			

Gazos Creek (continued):

	----------2011 Steelhead ----------							*Back-calculated length @ annulus*
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7	
35 - 39				*	********	**	*	
40 – 44			**	*****	****************	*********	*******	
45 – 49		**	***********	******************	**********	*******	*************	
50 – 54		*	*******	***************	******************	******	**********	
55 – 59	*****	********	******	*******************	**************	********	************	**
60 – 64	*****	************	****	************	***	****	*******	*
65 – 69	**	****	*********	*******	*********	****	******	********
70 – 74	***	***	******	****	***		**	***************
75 – 79	******	****	***		*		*	********
80 – 84	****	*****	**		1			****************
85 – 89		*	1	11	1			***********
90 – 94			1		11	1		*******
95 – 99			1	11	11	11	111	***
100-104	1		1111		1	111	11	**
105-109	1	1			11	11		*
110-114	111	11	1	11	11		1	
115-119	1	111	11	1	11		11	
120-124	1						11	
125-129	1	1	11					
130-134			11	11	11		11	
135-139	11				1		1	
140-144	1				1			
145-149	1							
150-154								
155-159								
160-164		+						
165-169						+		
170-174					+		+	
175-179		`						
180-184					+			
185-189					+	+		
190-194								
225-229	+							

Gazos Creek (continued):

	2010 Steelhead						
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7
40 – 44							
45 – 49							
50 – 54						****	**
55 – 59		*	**	**	*	*****	*
60 – 64	**	******	****	*	******	********	*****
65 – 69	*	*******	***********	******	***********	***	*****
70 – 74	********	************	*********	***********	*****	*	**********
75 – 79	*********	*************22	*******	**************	*******	*	********
80 – 84	********	*********	*****	*********	***		*****
85 – 89	*****	*****	****	**		1	*** 1
90 – 94	*	*	1		1	1	111
95 – 99	1	***			11	11	* 111
100-104				1	11	1	11
105-109	111	1	11	11	111	1	1111
110-114	1		1		11	1	11
115-119		1					11
120-124	1		1	1	1		111
125-129			1		1		1
130-134			11		1	1	1
135-139		1			1		
140-144		1					1
145-149					1		1
150-154	1		1				
155-159					1		
160-164					1		
165-169							
170-174							
175-179	+	+ `					
185-189						+	
190-194	+		+				
205-209							+

Gazos Creek (continued):

	----------2009 Steelhead----------			
	Site 2	Site 2A	Sites 2B & 3A	Sites 4 & 7
40 – 44				
45 – 49			****	
50 – 54			*********	******
55 – 59			**********************	****************
60 – 64		**	********************************	****************
65 – 69		****	*******************	**************
70 – 74	**	****	***********	*****
75 – 79	11	***	*	11
80 – 84	11	***		11
85 – 89		11	111111	
90 – 94	1111	1	11	111
95 – 99		1	11	111
100-104	11	1	1111	1
105-109			111	1
110-114			1111111	11111
115-119	1	1	1	1
120-124			1111	
125-129			1	1
130-134			1	
135-139		1		
140-144				
145-149				11
150-154				
155-159			+	
160-164		+		+
165-169				
170-174				
175-179				+
200-204				+

Gazos Creek (continued)

	2006			2007		
		Steelhead			Steelhead	
	Site 2	Sites 2B & 3A	Sites 5 & 7A	Site 2	Sites 2B & 3A	Site 5 & 7A
30 – 34					4	
35 – 39					*8	
40 – 44					**11	*3
45 – 49			1		**12	*3
50 – 54			**7		****21	*******22
55 – 59	**5	*6	***9	*3	****20	*****17
60 – 64	***7	*9	**7	**4	***16	********24
65 – 69	**4	******33	*5	***6	**12	***11
70 – 74	**4	*****25	1	**5	**14	2
75 – 79		****23	2		2	1
80 – 84		***15	1			1
85 – 89		*9	1			

	2002				2005			
	Site 1		Site 4		Sites 1 & 2		Site 4	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
30 – 34			1				1	
35 – 39			**7				2	
40 – 44	1		****14				*9	
45 – 49	**7		******18	1			***18	
50 – 54	****14	2	**6	****12			****20	*3
55 – 59	******19	***11	*3	****13	*5		***15	**7
60 – 64	***11	***10		****12	***16		**10	**8
65 – 69	*5	**6	1	**6	****20	***9	*6	**7
70 – 74	2	*3		1	***15	****12	*3	1
75 – 79		1		1	*7	2		
					1	1		

Waddell Creek Steelhead and Coho 2022

	Site 2	Site 3	Site 4	Site 5	Site 6	East Fork Site 7	West Fork Site 8
50 – 54					*		C
55 – 59		*		****	**	*** C	***
60 – 64	*		****	**	**	***	*** CCCCCC
65 – 69	*	***** CC	***** CCCCC	******* CCC	**	**** C	** C
70 – 74	*	**	*** CCC	**		**	***** C
75 – 79	**	*	**			**	*
80 – 84		**		****		*	*
85 – 89		*	** C	*		***	
90 – 94	**	***	*	*			
95 - 99							
100-109	11			11		1	11
110-119				1		1	
120-129		1					1
130-139			1				
170-179			+				
180-189	+						

Waddell Creek Steelhead and Coho 2020

- ------------------------Main Stem---------------------------

	Sites 2	Site 3		Site 4	
45 – 49	*	*		**	
50 – 54	*	*****		*	
55 – 59	*****	**************		**	
60 – 64	*******	*********		***	CCC
65 – 69	**	**********	CC	**	CCC
70 – 74	**	**	CCC	***	CCC
75 -79	*	***	CCC	**	CC
80 – 84		**	C	**	
85 – 89		*		**	
90 – 94	1	1		* 1	
95 – 99	1				
100-109		1		1	
110-119	1	11		11	
120-129				11	
130-139	1	111			
140-149	1	1			
150-159		1			
170-179	+				
200-210		+			

Waddell Creek Steelhead and Coho 2019

	- ------------------------Main Stem	------------------------------			---------West Fork------		East Fork
	Sites 1&2	Site 3	Site 4	Site 6	Site 8	Site 9	Site 7
30 – 34					*		
35 – 39							*
40 – 44	**			***	*********	**********	****
45 – 49		***7		**	*********	*************	****
50 – 54	******	*****10	****8	****	*********	*******	***
55 – 59	**********	**********20	****9	********	**********	****** C	***
60 – 64	************	********16	******13	********	************	*	****
65 – 69	*******	****8	***6	**********	******** C	***	*****
70 – 74	************	***7	***7	*******	***	****	
75 – 79	*********	****8	**5	***	C	****	*
80 – 84	*** C	**4	***6	*	11	*1	11
85 – 89		*3	*		1		
90 – 94		**4	*				
95 – 99	11	1		1			
100-109	1	1			1		
110-119	1	1		11	1	1	1
120-129	11	1		1	1	1	1
130-139	1				1		
140-149			1			1	
150-159				1	1	1	1
160-169							
170-179							
180-189		+					
190-199		+					
200-209					+		
210-219							
220-229						+	

Waddell Creek Steelhead and Coho 2018

	Main Stem				West Fork				East Fork
	Sites 1&2	Site 3	Site 4	Site 6	Site 8		Site 9		Site 7
30 – 34							*		
35 – 39					*		****		**
40 – 44				*	***		**		***
45 – 49		*	*	***	***		*******		*
50 – 54			*	*****	******		******		***
55 – 59	*	*	**	***	***		***	C	*
60 – 64	**	*	*********	******	****		****	CC	*
65 – 69	*	****	********	***	**	C		CC	*
70 – 74	****	****	*******	**		CC	11		
75 – 79	**	******	****	*			1		
80 – 84		*	*	11	1		1		
85 – 89		***	*	11	1				
90 – 94		*	*				11		
95 – 99			1		1				
100-104							1		
105-109					1				
110-114		1	1		1				
115-119	11		1	1					
120-124					1				
125-129				1			1		
130-139			1						
140-149		1	11						
150-159		1							
160-169	11				1				
170-179									
180-189		1	1						
190-199		1	1						
200-209									
210-219	+	+							

Waddell Creek Steelhead 2017

	---Main Stem---					---West Fork---		---East Fork---	
	Sites 1&2	Site 3	Site 4	Site 5	Site 6	Site 8	Site 9	Site 7	Site 7A
40 – 44				*					
45 – 49			*			*	**7	**	*
50 – 54			**	*		********	*****15	***	**
55 – 59			*	**	*	*********	*********29	****	************
60 – 64		**	**	**	*	*********	****13	***	*********
65 – 69		**	**	****	****	******	***10	**	************
70 – 74	*	**	***	***	*******	**	*5	**	*********
75 – 79	**	*****	****		*******	*	*3	***	******
80 – 84	*	**		*	*****	*	2	*	*
85 – 89		**		**	*		1		**
90 – 94	*	**	*				*3		*
95 – 99	*			*	*				
100-104					**	1			
105-109			*			1			1
110-114							11	1	
115-119	*		1						
120-124								1	1
125-129		1		11			1		
130-134		11	1	1					
135-139									
140-144		11							
145-149				1					
150-154			1		1				
155-159						1			
160-164				1					
165-169		11			11				
170-174							+		
175-179			1						
195-199					1				
210-220									++

Waddell Creek Steelhead and coho (C):

	2016											
	Main Stem								West Fork			East Fk
	Sites 1&2		Site 3		Site 4		Site 6		Site 8		Site 9	Site 7
35 – 39												
40 – 44									***		******12	
45 – 49									*****		************25	*
50 – 54	*		******	C	**		*****		*******		***********23	**
55 – 59			******	C	*****		***		********13		********16	*******
60 – 64	*****		*******	CCC	******	C	***********		*********16		*******15	*******
65 – 69	****		***********	CCCCC	*****	CC	***********	C	*******9		*****10	*******
70 – 74	****	CCC	************	CCCCCCC	***	CCC	*********		****	C	**5	***
75 – 79	***	C	*****	CC	*****	CC	**		******	C	**4	***
80 – 84	***	CC	*******		*******	CC	**		*		*	
85 – 89	******		*		*		*					*
90 – 94	****				**						1	
95 – 99			**				*					
100-104	*		*								1	
105-109	1											1
110-119	11		11				1				1	1
120-129	1				11		1					
130-139									1		1	
140-149											1	
150-159			1									
160-169												
170-179			+		+							
180-189												
190-199												
200-209							+					

Waddell Creek Steelhead and coho (C):

	2015									
	Main Stem						West Fork			
	Sites 1&2		Site 3		Site 4		Site 8		Site 9	
40 – 44			**						*	
45 – 49	**		*******		****				**8	
50 – 54	***		********				********		**********22	
55 – 59	***		**********		*		**********14	C	*********19	C
60 – 64	*	C	*********	CCCC	******	C	***********	CCCCCCCC	********14	CCC
65 – 69	***	C	****	CCCCCCCCCC	**	CC	*********	CCC	***5	CCC
70 – 74	*	CC	**	CCCCCCCCCCCC15	*	CCCCC	**	C	*	C
75 – 79	**	CCCC	***	CCCCCCCCCCCC	*	CCCCCCC13	1		***	
80 – 84	*	C	*	C	*	CC	1111		1	
85 – 89	*		*	C	**		1			
90 – 94	**									
95 – 99			1							
100-104			1							
105-109									1	
110-114									1	
115-119										
120-124									1	
125-129	1		1							
170-174					1					
180-184	2						2			
185-189										

Waddell Creek Steelhead:

	2014								
	Main Stem				West Fork		East Fork		
	Sites 1&2	Site 3	Site 4	Site 6	Site 8	Site 9	Site 7A	Site 7B	Site 7C
35 – 39						*	**		
40 – 44		*	*			**	**		
45 – 49	*	**	*		***	***	***	*	
50 – 54	*	***	**	**	****	******	**	***	
55 – 59	*	*******	*****	*********	*****	********	*	*	**
60 – 64	*	***************		***	*****	****		**	
65 – 69	**	********	*	***	*	**	*	**	**
70 – 74	*	*	*	*	****	*		**	
75 – 79	***	**		***	*		*	*	
80 – 84	**** 1				** 1	1			
85 – 89	***	**							*
90 – 94		***		*	11				
95 – 99		111							
100-104	1					1			
105-109	1	1111	1			1			
110-114		1							1
115-119		11	1	11		1			
120-124		1	1	1			1		
125-129	11	11	1						
130-134	11								
135-139		11	1						
140-144		1	1						+
145-149	1	1							
150-154		1	1						
155-159	1								
160-164		1		+					
170-174		+							
175-179	+								
185-189									+
195-199		+							

Waddell Creek

	2013								
	Main Stem				West Fork		East Fork		
	Sites 1&2	Site 3	Site 4	Site 6	Site 8	Site 9	Site 7A	Site 7B	Site 7C
30 – 34						***	*		
35 – 39		*			*	*********	*		
40 – 44		**	**	**	*****9	***********18	*******		
45 – 49	**	******	*	***	******12	***************26	********	*	***
50 – 54	**	******15	******	****	**********22	**********14	*********12	*******	*
55 – 59	*******	*********22	**	****	*******15	*********13	*********12	*****	*****
60 – 64	**	*******18	****	****	****	*****	****	*******	*
65 – 69	******	*********22	******	***	*****9	*******	***	***	*
70 – 74	******	*****12	*		****	***			*
75 – 79	*******	*****12	***	***	*	111	***	**	
80 – 84	******	******	**	*	**	11			*
85 – 89	**	*****		*			*		
90 – 94	*	*		*		1			
95 – 99		1							
100-104									
105-109						1			1
110-114						1			
115-119					1	11			
120-124									1
125-129									
130-134						1			
135-139				1					
140-144									
145-149				1					
150-154		1							
155-159				1					
160-164									
165-169									+

Waddell Creek:

	2012		
	Main Stem Sites 1-3, 4, 6	West Fork Sites 8, 8A & 9	East Fork Site 7 & <, > Last Chance
35 – 39			
40 – 44		*********************	**
45 – 49		**	****
50 – 54	*****	*************************************	***********
55 – 59	******************	*****************************	*********************
60 – 64	******************	*************	*****************
65 – 69	*****************	***********	***************
70 – 74	***************	***	*******
75 – 79	********	11111	
80 – 84	***		
85 – 89	*	1	
90 – 94	*** 1	1	
95 – 99	* 11	1	1
100-104			
105-109		1	11
110-114		111	
115-119	1	1	
120-124	11		
125-129	1		
130-134			
135-139	1		
140-144	1		
145-149			
150-154			
155-159			
160-164			
165-169			
170-174			
175-179			
180-184	+		

Waddell Creek (continued):

	2011		
	Main Stem Sites 3, 4, 6	West Fork Sites 8 & 9	East Fork Site 7 & 0.5 mile
35 – 39		***	
40 – 44	*	****	
45 – 49		************	****
50 – 54	**	******************************	***
55 – 59	***	****************	*******
60 – 64	******	*********	***
65 – 69	****	***	*
70 – 74	***	****	**
75 – 79	****		
80 – 84	**		
85 – 89	**	1	
90 – 94			
95 – 99			
100-104			
105-109			
110-114			
115-119	1	111	
120-124	1		
125-129			
130-134	1		
135-139			
140-144		+	
145-149			
150-154			
155-159			
160-164			
165-169			
170-174			
175-179		+	

Waddell Creek (continued):

	2010				
	Main Stem Sites 1,2,3	Main Stem Sites 4,5,6	West Fork Sites 8 & 9	East Fork Site 7	East Fork 0.5 mile
35 – 39				**	
40 – 44			*		*
45 – 49			**************	******	***
50 – 54			***************************	**	*********
55 – 59		******	***************************	*****	**********
60 – 64	**	*********	***********************************	****	*******
65 – 69	*********	**************	*************	******	**
70 – 74	********	************	******	***	*********
75 – 79	************	****************	********		*
80 – 84	**************	********	***	*	*****
85 – 89	***	*******	1	**	*
90 – 94	*******	******		*	*
95 – 99	*******	****			*
100-104	* 1	***			
105-109	1		1	1	
110-114		1	1	1	
115-119			1		1
120-124			1		
125-129		1	1		
130-134	1	1		1	
135-139		1			
140-144					
145-149					
150-154		1		11	
155-159					
160-164	1				
165-169					
170-174					
175-179					
180-184					
185-189		+			
200-204					
210-214		++			
260-264	1up from lagoon				

Waddell Creek (continued):

	2009				
	Main Stem Sites 1,2,3 Steelhead	Coho	Main Stem Sites 4 & 6	West Fork Sites 8 & 9	East Fork Site 7
40 – 44				*	*
45 – 49	***		*	*******	**
50 – 54	*****		****	*****	****
55 – 59	************		******	********************	******
60 – 64	********		******	******	*****
65 – 69	*****		***	********	*
70 – 74	****		****	***	
75 – 79	*** 1	**	****	****	**
80 – 84	** 1		***	111	
85 – 89		*			
90 – 94	11	*	1	11	
95 – 99				1	
100-104					
105-109	1		1	1	
110-114	1		1		1
115-119					
120-124	1				1
125-129					
130-134				1	
135-139				1	
140-144	1				
145-149					
150-154					
155-159					
160-164	1				
165-169					
170-174			+	+	
175-179			+		
180-184	1				
200-204	* moved up from lagoon				
230-234	*				

Waddell Creek (Continued)

	2008			2007			
	Sites 1-6	Sites 8-9		Sites 1-5		Sites 8-9	Sites 7A&B
	Steelhead	Steelhead	Coho	Steelhead	Coho	Steelhead	
30 – 34						*3	1
35 – 39	*5	*******21		*3		****12	2
40 – 44	*******21	**********30		***9		**********32	*4
45 – 49	***********35	************38		*4		*********27	**7
50 – 54	******20	************38		***11		*******22	2
55 – 59	******20	*********28		***9		*****17	**6
60 – 64	****12	**6	******	****12		***11	**6
65 – 69	****14	**8	******	**8	**	**6	*3
70 – 74	***9		*	***9	*	*3	2
75 – 79	*3			**7			
80 – 84	*4			*4			1
85 – 89	2			*5			
90 – 94	1			2			

	2006			2005			
	Sites 1-5	Sites 8-9	Sites 7A&B	Sites 3, 4 & 5		Sites 9, 10 & 11	
				Steelhead	Coho	Steelhead	Coho
35 – 39			1			1	
40 – 44		2	**4			**12	
45 – 49		**13	****8			********40	
50 – 54		*******37	*******14	2		***********59	*3
55 – 59	*3	******34	**5	*3		*********47	***11
60 – 64	*2	*****25	****9	***10	2	*****29	******20
65 – 69	***7	*8	*2	***10	***9	***17	*********28
70 – 74	1	2	**7	****13	****13	**14	******18
75 – 79	*2		1	**7	***9	4	****12
80 – 84	*2		1	*5	2	3	2
85 – 89	*2			**6		1	
90 – 94	1			*5		2	
95 – 99	1			*3			

Waddell Creek (continued)

	2004				2002			
	Sites 3, 4 & 5		Site 10		Sites 2 & 3		West Fork Sites 9-11	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
30 – 34			1				2	
35 – 39			*5				2	
40 – 44	3		*6				**17	
45 – 49	**11		*****28			1	*******44	**6
50 – 54	****23		***19			*3	*********54	***10
55 – 59	*******37		***19		2	1	*********58	*****17
60 – 64	*****27	***	**12	1	**13	**6	****29	******20
65 – 69	***15	**	*7	****8	******24	*5	**13	*******24
70 – 74	*6	*******	*5	****9	**14	*3	**16	*****15
75 – 79	3	****		2	**13		5	***9
80 – 84	4	**		**4	**13		1	1
85 – 89					*9			1
90 – 94					*9			
95 – 99					3			
100-104					2			

Scott Creek Steelhead and Coho 2022

	Big Creek	Site 3		Mill Creek		Site 4		Site 5		Site 7	
35 – 39		*				*2		*2		*	C
40 - 44		*4		*		**9	C3	*****25	C	**8	C3
45 - 49		*****24	CC8	*3	C2	*****27	CCC15	*******42	C3	***11	CCCC29
50 – 54	*	******29	CCCC24	****17	CCC9	*****27	CCCCC26	******30	CCCCC34	****15	CCCCC47
55 – 59	*****	***15	CCCCC29	**9	CCC11	**10	CCCC22	***13	CCCC21	**9	CCCC26
60 – 64	*******	*3	CCCC20	***12	C8	*5	C4	*4	CC10	*2	CCC18
65 – 69	********	*3	CC9	*4	C2	*2	C4	*	C3	*2	C5
70 – 74	***		C3	*5			C	*	C3	*	C3
75 – 79	****									1	
80 – 84	*	1		11				111		1	
85 – 89	1			1		1		11			
90 – 94											
95 – 99		1						1		1	
100-109		1111		11				1		1	
110-119										1	
120-129											
130-139						1					

Scott Creek Steelhead 2019

	Site 1	Big Creek	Site 3	Site 4	Site 5	Mill Creek
30 – 34				*3	*2	**4
35 – 39		**5	***	*2	*****11	***6
40 – 44	*3	***7	***	******12	******13	*******15
45 – 49	********16	********17	***	*************26	**********21	****9
50 – 54	*******15	****************32	***	********17	***************28	***7
55 – 59	**********20	*********19	*****	*********18	****8	***7
60 – 64	*********20	*************26	*****	*********19	************23	*3
65 – 69	*******15	********16	**	*******14	*****11	*3
70 – 74	******13	**4	**	**5 1	*2	*
75 – 79	****9	****8	*	**4 11		
80 – 84	***6	**5		* 2 11		1
85 – 89	*2	*2	1	11111	111	1
90 – 94		*	1	1	11	111
95 – 99			1	111	111111	11
100-109	1	1111	11	11111111	111	1
110-119	1	111	1	1	1111	
120-129		111	1	1	1111	
130-139	1	1	1	1	11	
140-149		1	1	1		
150-159						
160-169						
170-179						
180-189		+		+	+	
190-199						
200-209				+		

Scott Creek Coho (C) and Steelhead (*) 2018

	Site 1	Big Cr	Site 3	Site 4	Site 5	Site 7	Sites 9/11	Mill Cr
25 – 29					1			
30 – 34					1		1	
35 – 39			2	2	**7	*3	***9	
40 – 44		1	*****15	****14	**8	******20	********24 C	
45 – 49	1	*4	*******21	***11	****13	*******21	********24 CC	1
50 – 54	***11	*****15 CC	*****16	****13	*****17	*5 CC	*******19 CC	*3
55 – 59	***10	****13	**8	***9	**6	*5 C	***10 C	1
60 – 64	**7	**8	**8	**6	*4	*3	1	1 C
65 – 69	2 CC	2	*4	**7	2	2		*3
70 – 74	CCCCC	1 C	1	*3	*3	2		1
75 – 79	11				11111	1111111	111	
80 – 84		1	1	11	1	11	11	11
85 – 89	1		11	1	11	11111	111111	1
90 – 94		111	111	111	11	1	11	111
95 – 99	1111	11	11	111		11	11	1
100-104	1111			11111	1		1	11
105-109	1			11	111		1	1
110-114	11				1		1	1
115-119		1	1	1111		1		
120-129		1		11				
130-139	11			111				
140-149		1		1	11			1
150-159	1					1*	+	1
160-169				+				
170-179		+	+					
180-189								
190-199				+				
200-209							+	

Scott Creek Coho (C) and Steelhead (*) 2017

	Site 1	Big Cr	Site 2	Site 3	Site 4	Site 5
35 – 39						
40 – 44				2		
45 – 49			2	****13	*3	2
50 – 54			***9	*************39	******18	***10
55 – 59		**6	************36	*********29	************36	**********32
60 – 64	*******22	*****15	******18	*******22	*******22	******19 CC
65 – 69	*********27	****14	******18	****14	********24 CC	****12 C
70 – 74	************36	*****17	****14	****13	*****15	**8
75 – 79	**********31	***11	*4	*4	**7	*3
80 – 84	****12	***10	11		*4	*3
85 – 89	*****16	*3	11		11111111	11
90 – 94	**7	11		1	1111	11
95 – 99	*2	11		1	1111	111
100-104		111	1	1	1111	1
105-109	1	1111	1	11	111	11
110-114	1	1	1	11	11	
115-119		1		11	11	
120-129	111111	11	111		11	
130-139	1			11		1
140-149	111	1	1	1	11	
150-159	1					1
160-169	1					
170 – 239	11				+	

Four other sample sites were similar to sites 3-5.

Scott Creek Coho (C) and Steelhead (*) 2016

	Site 1	Site 2 `	Site 3	Site 4	Sites 5,7,9,11	Big Creek
30 – 34			*	**		
35 – 39			*		********24	
40 - 44			******11	*******14	*******************59	
45 – 49		****8	**********21	*******15	******************55	
50 – 54		******12	************23	******13	*****************53	**
55 – 59		*************19	*******15	******13	***************47	******
60 – 64	****	************17	******12	*****11	***********34 **CCCCCC**	***********15
65 – 69	****	********	***7 **C**	******12 **CC**	*****15 **CCCC**	*********
70 – 74	*****	***********	*	**5 **C**	**6 **CC**	**********13
75 – 79	*******	* 1	*1	**5 **C**	**8 **C**	********
80 – 84	*	1	1	**	1 **C**	****
85 – 89	*****	1			1	***
90 – 94	****	1			11	***
95 – 99	**	11		1	1	1
100-104	1				1	1
105-109	1				111	1
110-119				11	111	111
120-129				1	1	
130-139		1			1	1

	Mill Cr
45 – 49	***
50 – 54	****
55 – 59	******
60 – 64	*
65 – 69	******
70 – 74	***
75 – 79	
80 – 84	1
95 – 99	11
130-134	1

Scott Creek Coho

---2015---

	Site 1	Site 2	Site 3	Site 5	Site 7	Site 9	Site 11
40 – 44		*		*	**	**	
45 – 49	**	*****	***	**********	**************	*	
50 – 54	***	********	*********	***************	**************	*********	
55 – 59	*******15	*********	************	**************	*************	****	
60 – 64	***************31	*****	***********	***********	*********	*****	*
65 – 69	********17	*	*********	********	********	***	
70 – 74	****	*		***	*		*
75 – 79	*		*				
80 – 84	*						
85 – 89							
90 – 94							
95 – 99					1		
100-104							
105-109						1	

	Mill Cr	Big Cr
40 – 44	*	
45 – 49		**
50 – 54	**	*****
55 – 59	****	*********
60 – 64	**	********
65 – 69	*	******
70 – 74	*	***
75 – 79	*****	

Scott Creek Steelhead

	2015								
	Site 1	Site 2	Site 3	Site 5	Site 7	Site 9	Site 11	Mill Cr	Big Cr
30 – 34		***							
35 – 39		********16	*****		******				**
40 – 44	******	*********16	********	***	**********			*****	*
45 – 49		********	************	***	***	**		********	*****
50 – 54	*****	****	**********	******	*			********	******
55 – 59	*******	*	****	*****	***	*		***	**
60 – 64	***	*	*	*		**		***	****
65 – 69	******								*****
70 – 74					*	*	111		
75 – 79				1	111	1111	11		
80 – 84	*		1		111111	111	111	1	
85 – 89					1	11	1111	11	11
90 – 94			11	1	11	111	11111		
95 - 99	1	1		1111		11		111	1
100-104	1	1		1	1		1		
105-109	1						1		11
110-114	1				1	1		1	1
115-119	1		11				1	1	
120-124				1					
125-129				1					
130-134							1	1	1
135-139									
140-144								1	
150-154									1
160-164					2	2	2		
165-169								2	
185-189								H	
205-209									2

	2014								
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 9	Big Cr	Back-calc
45 – 49									
50 – 54									
55 – 59									*
60 – 64									
65 – 69									**
70 – 74									*** mean=73
75 – 79									**
80 – 84									***
85 – 89		1	1			11			
90 – 94	1	1							
95 – 99				1			1		
100-104	1							1	
105-109	1	1							
110-114									
115-119								1	
120-124		1							
125-129		H				H	H	HHH	
130-134	H	HH	H			HH		HHHHHHHHH	
135-139					H	HHHHHHH		HHHHHH	
140-144		HHHHHHH				HHHHH		HHHHHHHH	
145-149	H	HHHHHHH		H	H	HHHHHH		HHHHHHHHHHH	
150-154	H	HHH				HHHHHHH		HHHHHH	
155-159		HHHH			H	HHHH		HHHH	
160 -164		HHHH			HH	HHHHHHHH		HH	
165-169		H				H			
170-174		HH				HH		H	
175-179		H							
180-184									
185-189		HH							
190-194		H							

Scott Creek Steelhead

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 9	Mill Cr	Big Cr
	-----------	-----------	-----------	-----------	2014	-----------	-----------	-----------	-----------
30 – 34						*			
35 – 39	***	*	*			*******	***	***	***
40 – 44	**********		**********			*********15	*	**********11	**********
45 – 49	*************		*********	***10	*	******* *10	******	**********12	*************
50 – 54	************		******	********24	**	******	*****	**********14	************
55 – 59	**********		************	********24	***	****	*	*****	**********
60 – 64	********		*******	****14	***	***		*	********
65 – 69	***		***	******18	********	*		***	***
70 – 74	*		*	*5	***	**			*
75 – 79	* 1	1			***	*		*	* 1
80 – 84	1111	1	* 11	1111	*	111	1		1111
85 – 89	11	1	11	1111				1	11
90 – 94	111	11	111111	1111	11		1		111
95 – 99	1		11	11111111	111	1 H		1	1
100-104	111		11	11	11	1 H		11	111
105-109	111		11	1111	1				111
110-114	1	1		1	1				1
115-119				1					
120-124				1 H		H	1		
125-129	1	11		11		1 H		1	1
130-134	1 H			11	11	1 HHH			1 H
135-139									
140-144	1					1			1
145-149						H		HH	
150-154	1							1	1
155-159	1			H		H			1
160-164			H	H					
165-169									
170-174				H					
190-194	+								+
200-205				+					
210-214		+							

Scott Creek Coho

	2013									
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 11	Mill Cr	Big Cr	Back-calc
45 – 49						*				
50 – 54		**	***			**********16				
55 – 59		*********	*******	*		**********************39			*	
60 – 64		************	***************	**	*	****************27		*	***	
65 – 69		********	*********		****	**********16			*	
70 – 74	*	***	***			*		*	*	***
75 – 79		**			*		?			***
80 – 84	****									***
85 – 89	**	1				?	11			
90 – 94						1				
95 – 99	1	1							1	
100-104		1				1				
105-109										
110-114									H	
115-119		H								
120-124									H	
125-129		HH							H	
130-134									H	
135-139		H		HH	HH	HH			HH	
140-144					HH	H			H	
145-149		HH		H		H				
150-154						H				
155-159		H							H	
160 -164		H								

Scott Creek Steelhead

	Site 1	Site 2	Sites 3/4	Site 5	Site 7	Site 11	Mill Cr	Big Cr
			2013					
35 – 39			***			***		***
40 – 44		*****	*********		*****	****	**	*****
45 – 49	***	*****	************16		***********21	******	******8	**************30
50 – 54	***********	****	***************27	**	**********21	***********	****	*************27
55 – 59	************	****	***************28	**********	*******14	******	********16	************24
60 – 64	*********	***	*************18	*************	****	********	*****	*********12
65 – 69	********	****	**********	************		**	*****	********
70 – 74	*****	****	***	**		**	**	****
75 – 79	*****		1	*** 1	1111	1	1	**** 11
80 – 84	*		1111	11111		11	1	11
85 – 89	**	11	111	111111	1111		11	11
90 – 94		1	1111	1	1	1		1
95 – 99		111	11	1111	1		1	
100-104			111	11				111
105-109	1	11	111		11			
110-114		11	1			1		1
115-119		1					1	
120-124				1				1
125-129			11	1				
130-134	1			1			1	
135-139			1	1	1			
140-144					1		1	
145-149			1					
150-154								
155-159								
160-164								
165-169	1							1
170-174								
175-179								
180-184								
185-189		+					+	
190-194								
195-199								
200-204								
205-209			+					H

Scott Creek Steelhead and Coho (= C)

	------2012------									
	Big Creek	Site 1	Site 2	Site 3		Site 4	Sites 5,7,9		Mill Cr	
25 – 29							1			
30 – 34							*3			
35 – 39			***6	*3		**8	*******21			
40 – 44	1		*******14	********25		*****17	********24	C		
45 – 49	***7		******13	**********32		*****16	*************40	CC	***10	
50 – 54	*******14	1	***********21*	*****15		********26	***********33		***10	
55 – 59	********17		*******15	***10		******18	********24	CC	*5	CC
60 – 64	*****11	*****	*****10	***11		******20	*****15	C	*1	CCC
65 – 69	******13	*	******12	**8		**8	*3	CCCC	*1	CCCCCCCCCCC
70 – 74	***6	**	*2	*3	CCCC	**7	*5	CCCC		CCCCCC
75 – 79	*2 1				CC		11	CC		CCC
80 – 84	1					1	1111111	C	11	
85 – 89	11			11		111	11			
90 - 94		1		1		111	1			
95 – 99	1111		1	11			1		111	
100-104	1					11	11		1	
105-109	1			1		1	1		1	
110-114			1	11		1111	11		11	
115-119				1			1			
120-124						1				
125-129			1			11				
130-134	1		11							
135-139										
140-144						1				
145-149										
150-154							+			
155-159										
160-164										
165-169										
170-174									+	
175-179										
180-189				+			+			

Scott Creek (steelhead)(continued)

	----------2011----------						*Back-calculated length @ annulus*
	Big Creek	Site 1	Sites 3 & 4	Site 5	Sites 7,9,11	Mill Cr	
25 – 29					1		
30 – 34					***12		
35 – 39			******18	**8	********33		
40 – 44	**		***********34	******19	*************49	2	
45 – 49	*****	*	*****************51	*************40	*****************69	*5	
50 – 54	*******	*	****************49	***********33	********34	***9	
55 – 59	*********	*	*********29	****12	*****23	***11	****
60 – 64	***********	*****	******19	*****17	*7	*4	******
65 – 69	****	*****	*5	**8	**10	*5	******
70 – 74	*****		3	***9	*4	2	****
75 – 79	**	*		2	** 1	** 1	**
80 – 84	** 1			1111	11	1	*
85 – 89	1	*	11	1	11		*****
90 – 94			111	11	111	1	
95 – 99	1			11			**
100-104				11			*
105-109			11	1	11		
110-114	11		11111	1	1	11	
115-119					1		
120-124	11				1	11	
125-129			1				
130-134	11			1		11	
135-139				1			
140-144			1				
145-149							
150-154							
155-159							
160-164							
165-169							
170-174							
175-179							
180-184							
200-214					+		

Scott Creek (steelhead)(continued):

	2010						
	Big Creek	Site 1	Site 2	Sites 3 & 4	Site 5	Sites 7,9,11	Mill Cr
30 – 34				*3	1	1	
35 – 39				*****16	*3	**7	*3
40 – 44			**6	*********29	******19	********25	*5
45 – 49	**6		******19	**************44	****14	***************45	*****16
50 – 54	*****16	*3	********24	**************42	******18	****************49	*****15
55 – 59	*********27	****12	***********35	************40	****13	**********30	***11
60 – 64	*********27	*******22	******20	*********28	****14	*********29	*4
65 – 69	*******21	***9	*******22	****14	*5	**7	*4
70 – 74	****13	****13	*****17	****12	3	** 1	**7
75 – 79	**8	****12	*5	*5		11111	
80 – 84	2	*3		1	1111	11	
85 – 89	** 1	*4	1	11		111	
90 – 94			111	111	1	111	
95 – 99	111	1	1	111	1	11111	1
100-104	1		1	1	1		1
105-109	11	1	1	111			
110-114		1			1		
115-119			1	1		1	1
120-124	11		11	11			
125-129	1	11	1	11		1	
130-134		1			1		
135-139		1					
140-144							
145-149		1					
150-154	1	1					
155-159				1			
160-164	+					+	
165-169							
170-174							
175-179	+						
180-184			+				
210-215				+(hatchery)			

Scott Creek (continued):

	--2009--				
	Big Creek	Sites A & 2	Sites 3 & 4	Sites 5,7,11	Mill Cr
35 – 39				******	*
40 – 44			*******	********************	****
45 – 49	**		*************	***************	*****
50 – 54	****	******	*******************	**********************************	********
55 – 59	****	*****	**************************	**********************************	*****
60 – 64	***	*******	********************	*******************	********
65 – 69		***********	**************	*****************	
70 – 74	*	*****		**	
75 – 79	1	***	***	1	1
80 – 84	1			11	1
85 – 89			111	11111	1
90 – 94		1	1111	111111	
95 – 99			111	111	
100-104		1111	11111111	1111	1
105-109			1111111	1	11
110-114	1	1	111	1111	
115-119	111	1	111	11	1
120-124	1	1111	111		1
125-129					
130-134					1
135-139		1			
140-144			111	+	
145-149		1	1		
150-154		11			
155-159					
160-164		1	1		
165-169					
170-174			1		
175-179				+	
210-215			+		

Scott Creek (continued)

	--2008--				
	Big Creek	Site 2	Site 7	Sites 9/11	Mill Cr
30 – 34			**		
35 – 39	**	*	***	***	**
40 – 44	***	*******	***************	********	***
45 – 49	**	*********	*****************	***********	*****
50 – 54	******	*********	***********	********************	******
55 – 59	******	*********	*****	*******	***
60 – 64	********	*****	*******	*****	
65 – 69	***	***	**	**	
70 – 74	***			***	1
75 – 79	*		11	11111	1111
80 – 84				111	11
85 – 89	1			11111	111
90 – 94	1		11	11111	11
95 – 99			11	111111	111
100-104			11		1
105-109	1	11		111	11
110-114			1	1	1
115-119					
120-124				1	
125-129					
130-134				+	
135-139					
140-144		1			
145-149	11				
165-169					+

	2007						
	Sites A & 1	Sites 2 & 3	-----------Site 4--------		---Site 5--	Site 11	Mill Cr.
	Steelhead	Steelhead	Steelhead	Coho	Steelhead	Steelhead	Steelhead
25 – 29		1				1	
30 – 34		****13			2	**6	*3
35 – 39	**8	*****17	****12		*4	****13	****12
40 – 44	***11	***********34	***11		***9	****14	******18
45 – 49	********24	*************40	*****17		***9	*****16	****13
50 – 54	*******21	***********33	*****16		*4	****13	**8
55 – 59	**********30	*******21	**8		**7	**6	*5
60 – 64	*****16	**8			2	2	1
65 – 69	***10	*4			1		
70 – 74	*4		1				
75 – 79	2	1	111111111			111111	1
80 – 84	1	111	111111		1	11	
85 – 89	11	11	11111	1	11	11	1111
90 – 94		1111	1111111	1	11	11	1
95 – 99	1111	11111	111111		111	1111111	11
100-104	1111	111111111	11		1	1	1
105-109	111	11	111		1	111	1
110-114	111	1	11		11	1	
115-119	1	111	1				
120-124	1	1	111			1	
125-129	1	1			1		
130-134					1		
135-139	11						
140-144	1		1				
145-149							
150-154	1						
155-159	1						
160-164							
165-169							
170-174	1						

Scott Creek (continued):

	2006									
	Sites A & 1		Sites 2 & 3		Site 4		Site 5		Mill Creek & Site 11	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
35 – 39					1		2		*5	
40 – 44			*6		***9		*5	*	*****29	
45 – 49			****23		*****17		**11	*	******33	**
50 – 54	*3		*******36		******19		***15	*****	*****26	****
55 – 59	*4		********42		******19	*****	**12	*******	****20	*******11
60 – 64	*****16		*****28	*****	****13	******	*7	*******	*8	******
65 – 69	*******22		**14	**	*5	********	*7		**13	**
70 – 74	*******23	*	**13		*4	***		*	4	1
75 – 79	********25		1111111	111	11	* 11	1111	1	111111	
80 – 84	***10	**	111111		111		11		11	1
85 – 89	***9	*	1111		1	1	111		11	
90 – 94	**8		11		11111				111	
95 – 99	*3		11		11				11	
100-104	11	1	1				1			
105-109	11111		1111		1		1		1	
110-114	1		11		1				1	
115-119	1111111									
120-124	11		1		1					
125-129			11		1					
130-134	11									
135-139	111									
140-144										
145-149	11						1			
150-154	1		1							

Scott Creek (Continued):

	2005						2002	
	Sites A & 1		Sites 2 & 3		Mill Cr. & Site 11		Site 4	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
30 – 34					2		*5	2
35 – 39					*4	1	*6	*5
40 – 44					***10	*5	****1	***16
45 – 49			2	1	***10	********24	****14	*****27
50 – 54	2		******18	1	***9	*******21	**6	*******35
55 – 59	*3		***10	*3	**6	******18	*5	******30
60 – 64	*5		*****16	**7	*3	*****17	2	**12
65 – 69	***11	1	***10	***11		**6		2
70 – 74	***11	2	*4	****12	1	*3	2	
75 – 79	**7	***11	2	*5		1		
80 – 84	2	**6		2				
85 – 89	2	*3		1				
90 – 94	*3							
95 – 99	1							

	2004						1999	
	Sites A & 1		Sites 2 & 3		Mill Cr. & Sites 9-11		Site 4	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
35 – 39			1		*4		*4	
40 – 44	2		***15		*****17		**8	
45 – 49	**7		***18		****14	1	***12	
50 – 54	**7		******32		*****15	*3	******27	**10
55 – 59	******18		***18	1	****13	*3	****18	*******28
60 – 64	***10		*6	*3	**7	***7	****17	****16
65 – 69	****12	*	*9	****13	**7	**4	*6	**9
70 – 74	*5	***	*5	***10		*2	3	**9
75 – 79	**7	*		1				
80 – 89								

APPENDIX: Tables from Smith (2007), densities prior to 2007

Table 7. Densities (#/100 feet) of coho by site in the Waddell Creek watershed in 1992-2007. Young-of-year coho were not collected in omitted years. *In 1996 sites downstream of the forks received plants of hatchery-spawned fry.

Site	Mile > Hwy 1	Year Class 1992	1993	1995	1996	1998	1999	2001	2002	2004	2005	2007
1 First bridge	0.6	0	1	0.5	16*	0	0	0	0	0	0	3
2 < Alder Camp	1.35	0	0.3	0.3	7*	0	0	0	3	0	0	0
3 Twin Redwoods	1.8	0	0	0	14*	0	0	0	10	4	16	0
4 Periwinkle	2.2	0	4	0	30*	0	0	0	0.4	3	3	0
5 Downstream of Camp Herbert	2.6	0.4	2	2	16*	0	0	0	0.6	4	4	
6 Camp Herbert	3.1	3		2	15*	0	0	0	0	0	0	0
7 East Fork > Ford	3.2	0	4	0	10	0	2	0	4	0	2	0
7A East Fk upper	3.7		4		4				0		0	0
8 West Fork	3.3	0	7	3	13	0	14	2	7	2	8	0
9 Mill Site	3.9	4	4	3	23	3	11	3	18	3	17	0
10 at Buck Creek	4.7	0.5	0	3	18	0.4	8	0	8	11	9	0
11 < Henry Creek	5.25	1	2	0	7				11	8	14	0
13 Henry Creek > Trail Xing	0.2	1	16	0	3				0	12	6	0
Totals		0.6	3.6	1.1	12.5	0.3	3.1	0.5	4.7	3.9	6.0	0.2

Table 8. Sample site locations and coho densities (# / 100 feet) in the Scott Creek watershed in September 1992, January 1994 (1993 year class), October 1995, October and November 1996 (*augmented with fry), August and September 1997, October 1998 and 1999, September and October 2000-2003 and 2006, and October 2004 and 2005. In 2007 only 2 yearling coho were captured at site 4. No coho were captured in 1994; the year class was probably eliminated in 1991, when the sandbar didn't open until 8 March.

Site (Mile > Hwy 1)	Year Class Density													
	1992	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
A. Near Diversion (0.9)		2	1	22*	0		5		3	38	0	1	8	1
1. at Little Creek (1.9)	2	7	14	33*	0	0	6	0	2	44	0	2	6	2
2. >Big Cr. (2.55)	0	31	29	31	30	1	35	1	1	82	4	12	21	3
3. < Mill Cr. (3.05)	1		28		29	0		0	1	83	1	14	37	5
4 .< Swanton Road (3.55)	0	86	26	37	20	3	45	0	0	156	1	22	36	18
5. Cattle Guard (4.25)	0				11	2		1	0	145	1	15	76	15
7. Pullout < Big Cr. Gate (4.9)	23	48	23	62	24	3	86	1	0	144	6	20	45	3
9. 0.15 mi > Bridge (5.15)	1	39	12	62	1	0	45	0	0	102	0	0		
11. Upper Ford (5.85)	2	41	5	33	0	8	22	0	0	48	1	2	45	0
11A 5th Trail Crossing (6.5)		16	3	31	1	3				63	0	0	18	
12. Big Cr. Swanton Rd	0	8	1	21	0	0	7	0	0	72	0	4	5	0
12A Big Cr. < Hatchery		9	0	30	0		0		0	31		2	11	
12B Big Cr. > Berry Cr.				11			0			13				
13. Mill Cr. < Swanton Rd.	0	12	28	24	6	0	42	1	0	88	3	17	49	24
Mean	4.3	27.2	14.2	33.0	9.3	1.8	29.2	0.4**	0.6	79.2	1.5#	8.6	29.7	6.9

**all age 1+
#majority age 1+

Table 9. Density of young-of-year steelhead (# / 100 feet sampled) for sites at Gazos Creek in 1995-2007. Value in () is density of yearling and older fish.

								Year Class							
Site	Mile > Hwy 1	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean 1993-2007
A	0.25								33(8)						33(8)
1	0.9	57(22)	21(13)	15(8)	24(7)	15(3)	14(7)	23(10)	32(3)	44(6)	29(6)	21(5)			26(8)
2	1.8	52(12)	28(11)	22(11)	45(10)			33(10)	36(4)	32(5)	28(6)	16(4)	15(10)	10(10)	28(9)
		2.05 Old Woman's Creek													
2A	2.1		31(14)	39(11)	53(7)	49(9)	28(8)	52(14)	60(6)	37(10)	32(7)	26(7)	24(5)	23(3)	38(8)
2B	2.8					82(11)	32(4)	42(5)	68(2)	52(8)	52(5)	36(7)	44(6)	32(3)	49(6)
3	3.15	96(11)	44(10)	23(2)	64(3)	71(8)	30(4)	63(9)	70(4)	58(7)	70(4)	23(2)	13(1)		50(5)
3A	3.9					37(7)		71(11)	46(2)	38(7)	39(1)	32(2)	23(5)	16(2)	38(5)
4	4.4	68(10)	46(9)	80(9)	69(4)		56(6)			52(9)	37(5)	45(5)	13(5)		56(7)
	4.4/4.6						94(6)		65(13)	48(4)					
5	4.8/5.0				37(8)										
	4.85					30(6)	34(7)	21(8)	37(6)	25(7)	41(6)	28(0)	4(1)	23(2)	28(5)
6	5.1/5.2				67(9)										67(9)
7	5.3/5.45				61(8)										
7A	5.3					48(8)	66(8)	20(11)	55(4)	12(8)	56(3)	41(5)	12(7)	21(4)	38(6)
7B	5.45					80(17)			55(9)						68(13)
Total		68(14)	34(12)	36(8)	53(7)	51(8)	37(6)	45(11)	49(5)	39(7)	43(5)	30(4)	19(5)	21(4)	40(7)

Table 10. Densities of YOY steelhead (number per 100 feet) at sites on Waddell Creek in 1995-2007. In 1996, 2002, 2004 & 2005 coho were also common at some sites and those totals are included with the YOY steelhead for that year. (*Indicates values that are >20% below 1995-1998 low and also > 40% below 1995-1998 mean).

				Year								
Site	Mile > Hwy 1	1995-98 Range	95-98 Mean	1999	2000	2001	2002	2003	2004	2005	2006	2007
13 Henry Cr. > Trail		56-81	57	--	--	--	32	28	39	30	--	13*
11 < Henry Cr.	5.25	31-37	34	--	--	--	28	51	38	55	--	15*
10 < Buck Cr.	4.7	45-74	57	39	--	42	40	67	50	37	--	29*
9 Mill Site	3.9	47-60	53	44	--	20*	44	44	36	53	34	31*
8 West Fork > confluence	3.3	42-60	52	36	46	14*	27*	45	32	35	20*	15*
7 East Fork > confluence	3.2	43-115	71	67	51	21*	34*	22*	46	22*	19*	8*
7B East Fork Upstream		43	43	--	--	--	22*	--	--	21*	26*	8*
7C East Fork > Last Chance											52	21
6 Camp Herbert	3.1	42-128	76	57	9*	10*	7*	31*	17*	6*	12*	9*
Lower Herbert				7*								
5 Pullout < Camp Herbert	2.6	83-138	100	8*	23*	10*	8*	-	20*	11*	6*	--
4 Periwinkle	2.2	108-150	130	9*	16*	1*	10*	35*	50*	7*	--	2*
3 Twin Redwoods Camp	1.8	53-92	74	9*	29*	27*	63	43*	24*	50	5*	8*
2 <Alder Camp	1.35	78-131	110	10*	46*	54*	24*	54*	26*	5*	--	11*
1 First Bridge	0.6	54-85	64	8*	18*	36*	9*	39	0*	4*	6*	11*
Total All Sites		62-80	73	29*	30*	24*	27*	42*	32*	26*	20*	13*
Total Main Stem		87-101	93	17*	24*	23*	20*	40*	23*	14*	7*	8*

Table 11. Sample site locations and steelhead densities (# / 100 feet) in the Scott Creek watershed since 1998 (in August and September 1997 and 2007, October 1998 and 1999, September and October 2000-2003 and 2006, and October 2004 and 2005). Number in ( ) is density for yearling and older fish. Channel and LWD have been relatively stable since 1998.

Site (Mile > Hwy 1)	Year Class Density										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
A. Near Diversion (0.9)		41(11)		22(3)	18(4)	13(2)	28(1)	15(3)	39(11)	47(7)	28(5)
1. at Little Creek (1.9)	73(7)	49(6)	15(2)	66(3)	27(2)	16(1)	14(5)	14(5)	23(3)	40(7)	34(4)
2. >Big Cr. (2.55)	113(9)	82(8)	66(6)	73(8)	33(2)	58(4)	58(6)	31(4)	53(7)	75(14)	64(7)
3. < Mill Cr. (3.05)	114(7)		58(7)	73(6)	26(3)	80(3)	41(5)	49(2)	68(11)	62(12)	63(6)
4 .< Swanton Road (3.55)	128(10)	79(13)	65(10)	83(10)	39(11)	60(4)	41(6)	57(6)	60(9)	56(34)	67(11)
5. Cattle Guard (4.25)	166(14)		86(16)	27(14)	17(6)	79(6)	65(14)	45(5)	41(7)	26(9)	61(10)
7. Pullout < Big Cr. Gate (4.9)	172(10)	48(7)	149(7)	22(7)	24(6)	61(3)	35(8)	29(3)	61(5)	36(13)	64(7)
9. 0.15 mi > Bridge (5.15)	138(16)	70(16)	137(12)	54(9)	49(2)	76(3)	31(7)			29(26)	73(11)
11. Upper Ford (5.85)	54(4)	26(3)	45(5)	13(4)	20(5)	47(1)	18(5)	22(3)	37(4)	25(10)	31(4)
11A 5th Trail Crossing (6.5)	67(14)				24(5)	63(7)	60(6)	61(6)			55(8)
12. Big Cr. Swanton Rd	60(5)	67(8)	57(3)	72(13)	36(1)	57(5)	35(2)	30(2)	31(4)	69(11)	51(5)
12A Big Cr. < Hatchery		67(12)		56(7)	58(5)		19(5)	36(3)			47(6)
12B Big Cr. > Berry Cr.					67(7)						67(7)
13. Mill Cr. < Swanton Rd.	158(10)	88(14)	103(7)	67(13)	54(5)	47(2)	39(8)	23(4)	65(8)	71(11)	72(8)
Mean	113(10)	62(10)	78(7)	52(8)	35(5)	55(3)	37(6)	34(4)	48(7)	49(14)	56(7)