Gazos Creek Post-fire Stream Habitat Assessment in July and September 2022

(revised from August 2022; text changes are in ***italics bold***)

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INTRODUCTION

Background: 2020 and 2021

Following the CZU Lighting Fire, which burned through the Gazos, Waddell, and Scott creek watersheds (among others) in August 2020, four long-term fish-sampling sites were re-sampled on 21 October on Gazos Creek. They were found to have unusually low fish densities (Smith 2020). Streamside and lower upslope burn conditions were also photographed between miles 2.8 and 5.3, where the fire burned to the stream (Figure 1). The burn damage upslope and near the stream was especially intense between miles 3.3/3.4 and 3.9 and also between 4.9 and 5.3 (Figure 2). The fire also severely burned the Old Women's Creek watershed (Figure 1), a large south bank tributary that enters Gazos Creek at mile 2.0, but there was no direct fire impact near Gazos Creek downstream of mile 2.4. No assessment was made of the fire effects in the Old Women's Creek Watershed, because it has no salmonid habitat; however, it has been a regular source of sediment degrading lower Gazos Creek. The upper watershed of Gazos Creek (above mile 5.4), was also severely burned (Figure 3), but was not assessed, because of lack of access. The upstream limit of access by adult coho (*Oncorhynchus kisutch*), and probably by adult steelhead (*O. mykiss*), is at the falls at the Mountain Camp at mile 5.4.

The extensive upslope and upstream burns, as well as the observations of burn through the streamside vegetation, indicated that riparian vegetation mortality, tree fall and debris flows into the channel, and sediment and wood movement in the channel were likely in a typical winter. However, the 2020-2021 rainfall was historically low and mostly concentrated in a single late January storm (Figure 4). Follow-up assessment of the effects on the slopes and riparian and stream habitat was conducted on 28 March 2021, with photographs of upslope and streamside conditions. However, the short time interval between the fire and the seasonally early survey was before much of the leaf development of deciduous trees, and also before complete branch, trunk, and basal sprout development on deciduous and evergreen trees. On 11 August a second survey was able to more fully assess tree loss and potential vegetation recovery (Smith 2021a). The March and August surveys also looked at channel conditions, including wood and sediment inputs and movement and at changes in stream shading. Those assessments paid special attention to five fish sampling sites and individual habitats regularly sampled since 1993 (Smith 2020). Stream water temperature recorders were installed at three sites between miles 2.1 and 5.25. In September annual fish sampling was conducted at seven sites between miles 1.8 and 5.25 (Smith 2021b).

In general, the 2021 results showed that most redwoods (*Sequoia sempervirens*) survived, although many lost canopy and had only trunk and branch epicormic sprouts and basal sprouts. Most Douglas firs (*Pseudostuga menziesii*) were killed, unless substantial canopy was left. Tanbark oaks (*Arbutus menziesii*) frequently had dead trunks and only basal sprouts. Riparian and lower slope big-leaf maples (*Acer macrophyllum*) appeared to suffer mortality in 2020, but most had at least sparse canopy leaves and/or basal sprouts by August 2021. Many alders (*Alnus rhombifolia*) in the burn zone died. Despite the substantial upslope and near-stream impacts, the riparian border, stream shading, and water temperatures were not substantially affected (Smith 2021a; Smith 2021b). The mild winter (Figure 4) resulted in little recovery of burned understory vegetation (and litter and duff) that might help protect slopes from erosion. By 2021, lower slope trees, especially those $\leq$ 1 ft dia, had fallen into the stream channel, and trees cut by fire fighters adjacent to the road during the 2020 fire were on the north bank and in the channel. However, because of the mild winter there had been little wood movement or rearrangement in the channel. There had been no evidence of debris flows, but there was increased fine sediment in the stream, despite the mild winter. However, there was little change in pool depths or habitat configurations, except at three individual fish sampling pools and at a fish sampling site (mile 1.8) downstream of the severely fire-damaged Old Woman's Creek (Smith 2021a; Smith 2021b). The relatively modest stream effects through September 2021 were reflected in fish sampling results in September, with relatively low steelhead densities at the 4 sites with the most sedimentation effects, but not elsewhere (Smith 2021b). Overall, mean young-of- year steelhead density at the seven sample sties in 2021 was about 75 percent of the mean from 2015-2019 and similar to 5 of the last 14 sample years. However, yearling density in 2021 was about half of that in 2015-2019, apparently reflecting conditions in the year of the fire, and no coho were captured in 2021, despite planting of hatchery-reared juveniles in Gazos Creek in 2018. (Smith 2021b).

2022

In October and December 2021, rain and runoff were substantially higher than in winter 2020-2021 (Figure 4). Despite drought after December, the much higher rainfall and runoff were expected to increase wood and sediment delivery to the channel and to move both within the channel by flood flows. Therefore, new assessments were needed. This report describes the changes found in three assessments in 2022.

Assessments were important because Gazos Creek has been sampled for fish at index sites annually since 1993 (Smith 2021), making assessment of changes in sites and individual habitats possible. The stream was one of the few south of the Golden Gate that sustained coho runs through 2005, but had no runs of coho since (Smith 2021). However, major runs of coho occurred in nearby watersheds in winter 2021-2022 (Joseph Kiernan, NOAA Santa Cruz, pers. com.), so they might also have occurred in Gazos Creek. ***Fish sampling was conducted in September 2022, but no coho were captured. Despite the channel changes, young-of-year steelhead were unusually abundant, but very variable in their site density, possibly due to the effects of logjams on fish passage (Smith, in preparation)***

METHODS

On 29 January 2022, after the only significant rain and runoff of the year (Figure 4), an assessment with photos was conducted between mile 2.8 and 5.35. The stream was also spot checked downstream of the burn zone (miles 1.5 – 2.1), where the channel had been potentially affected by sediment and wood transport from upstream. More detailed surveys of miles 2.8-5.25 were conducted on 6 and 14 July, when 140 photos were taken. Vegetation conditions from the fire had changed little from the August 2021 surveys, except for restored ground cover in the July 2022 surveys. The August 2021 assessment with photographs (Smith 2021a) remains an accurate description of streamside and upslope forest conditions. The 2022 surveys were primarily directed to assessing the addition and movement of channel wood and sediment and their effects on stream channel habitat conditions. The effort included detailed surveys of individual habitats at five fish sampling sites annually sampled since 1993 and the conditions at log jams that are potential barriers to fish passage. Photos in the appendix document habitat conditions and channel wood and log jams.

Five fish sampling sites in the burn reach, and two farther downstream (miles 1.8 and 2.1) without direct fire effects, were sampled by electrofishing in September. ***At the time of fish sampling, assessments of habitat conditions were made at sample sites at miles 1.8 and 2.1, downstream of the direct fire impacts, but affected by indirect fire effects (sediment and logjams). This October revision includes those photos and assessments, and alters small portions of the text, primarily related to logjams and passage issues.***

RESULTS AND DISCUSSION

Topography and Geology

In the burn area that was assessed (miles 2.8-5.35; Figures 1 and 2), both the north and south slopes of the east-west trending channel are very steep (transect means of 85-108 percent on the south slope and 66-105 percent on the north slope, with ranges to above 150 percent; Leicester 2005). The narrow and entrenched stream channel has very little (< 25%) terrace/flood plain above the bank full or active channel (2-2.5 year event occurrence). The entrenchment of the channel was intensified by the construction of the streamside road squeezed onto the north side of the stream channel. The steep slope above the entrenched channel allows debris flows to carry sediment and trees directly into the active channel on the south side and onto or across the road on the north side. It similarly allows surface erosion and individual fallen trees to flow and slide downslope to and into the channel, without being intercepted by a relatively wide and flat floodplain and its vegetation. The intensive burn upstream of the assessment reach (Figure 3) is in topography similar to the assessment reach, and is a potential source of substantial sediment to the assessment reach.

In contrast, downstream of the assessment reach that burned to the channel, a flood plain and an alder-dominated riparian forest twice as wide, is present. The downstream reach is only indirectly impacted by wood and sediment movement from upstream, including from the Old Woman's Creek drainage.

The stream channel is low gradient (mostly < 1%), which would normally require substantial flood flows to move coarser substrates. However, channel substrate, including the gravels and cobbles, is derived from the low specific gravity Santa Cruz Mudstone. This, along with the entrenched channel, means that the stream bed is quite mobile and scours and fills easily. The mudstone in the assessment reach is not exposed as large steep cliffs or slopes, as occurs on Waddell and West Waddell creeks. On Waddell Creek the cliffs disintegrated in the fire and delivered abundant fine gravels that filled pools and caused widespread streambed aggradation (Smith 2022).

Sediment Input, High Stream Flows, and Channel and Pool Habitat Effects

There was apparently substantial sediment input in winter 2021-2022 to the assessment reach from the steep bare slopes within the reach and possibly from upstream. The high flow lines in January were near or above bank full, and were able to spread, aggrade, and level the sediment within the entrenched channel. Many smaller or shallow pools were eliminated, and most previous fish-sampling pools at all five sites were 30-80+ percent filled by fines and gravels (see photos in the appendix). Undercut banks, backwaters, and high flow fish refuges around channel wood were frequently lost by the filling and/or by the shifting of the channel thalweg.

Spot checking downstream of the burn assessment reach showed substantial bedload movement and channel aggradation and leveling from sediment inputs upstream on Gazos and Old Woman's creeks.

Most of sediment input, movement, and channel changes apparently occurred during the three brief high flow events. Sustained high flows would have recut and deepened the light bed materials around preexisting and newly added channel wood; this did not occur. Overwintering survival of steelhead would have been poor. Yearling density in August and September 2022 is anticipated to be very low.

Although roots of live and dead trees are still in place, and ground cover has partly recovered to protect the sunnier slopes, there is substantial potential for additional wet year erosion from the fire damaged slopes.

Since rain and high stream flows ceased by January, success by spawning steelhead, or any coho, should have been good. Despite the rearranged streambed, there were no high flows for the rest of the winter to scour or bury any redds. Redds should have still been visible in July. Only one was seen during the intensive surveys of fish sampling sites or near log jams, but those intensive surveys covered only about 5-7% of the channel.

Wood Inputs and Movement

About 2-3 times as many new individual trees were in the channel in 2022, compared to 2021, with most of those redwoods, Douglas firs and small alders. Additional trees had moved part way down the steep south slope toward the channel. On the north slope, below the road, many of the large trunks on the slope and into the channel had been cut by fire fighters and the San Mateo County Public Works Department. There are still abundant standing dead and damaged trees on the slopes, including tanbark oaks with dead trunks and only basal sprouts.

Prior to the fire there were only two significant (large channel-spanning) logjams in the burned assessment reach. A preexisting jam (from winter 2017-2018) at the bottom of the fish sampling site at mile 2.8 was partially burned but then augmented by more wood in 2021. It is presently a significant potential barrier to fish passage, but may be passable underneath near the left bank or at high flows (also on the left bank). A major jam at mile 4.2 was formed by a debris flow carrying redwood trees in 1999. It gradually trapped mobile wood and was an apparent fish passage problem within 3 years, but the apparent difficultly varied with year to year (and even storm to storm) changes in the jam and with winter flow conditions. Passage was consistently more difficult after a large multi-trunked was added to anchor the right bank of the jam (Smith 2021b, and earlier annual reports). About three-fourths of that jam was lost by January 2022, and the wood carried downstream (where it was reassembled in a new jam at mile 4.1+). The mile 4.2 jam is still solid enough to recapture mobile wood and grow, but it is presently passable to adult steelhead.

Farther downstream of the burn zone, persistent large problematic jams have been uncommon, because the channel is less entrenched, usually allowing the stream to cut around or under the jam. Jams from fallen alders rarely last long (1-2 years), as the alders break and disintegrate rather quickly (Leicester (2005); most of the streamside trees downstream are alders. However, a large fallen Douglas fir at mile 2.4 in 2001 anchored a large jam; it was usually impassable except at high flows between 2005 and 2011. The jam washed out in December 2012, but re-formed downstream and was an apparent problem in 2013 and 2016 (Smith 2021b and earlier annual reports***). In 2022 a very large interlocking logjam formed just upstream of the mile 2.1 sample site. It is substantially composed of old wood that was probably a legacy of the mile 2.4 logjam originally formed in 2001. The new jam appears to be a very serious barrier to fish passage to most of the best spawning and rearing habitat in Gazos Creek***. A logjam, formed by a large multi-trunked maple in 2000 upstream of mile 1.8, enlarged and solidified and was a substantial low flow barrier through at least 2011 (Smith 2021b and earlier annual reports). ***In 2022, a cluster of fallen alders upstream of the mile 1.8 sample site had formed a large loose jam that is presently probably passable to fish. It could worsen for fish passage, but the alders should break up and the stream should be able to cut around and under the fragile wood.***

At the time of the January and July ***and September 2022*** surveys, there were ***seven*** major new log jams. At mile 3.3, just upstream of the cliff and one lane road, newly fallen streamside trees anchor a large channel-spanning jam. The jam is well anchored and is 5 feet high, but may be passable underneath during scour at high flows. At mile 4.1+ a large jam formed from fallen south slope trees and produced a 35 foot wide and 5-6 foot high channel-spanning jam. Most of the entrained wood in the jam probably came from the material released when the long-standing jam at mile 4.2 disintegrated last winter. The jam is well anchored, but might also allow passage underneath near the right bank. There is still more mobile wood, including channel-spanning trunks, between the mile 4.1 and 4.2 jams and downstream of the 4.1 jam. Two new (5-6 foot high) large jams are present just upstream of Slate Creek at mile 5.0. Those well-anchored jams were formed at fallen and cut trees. They may presently be passable at high flows, but are likely to grow and solidify. Those jams, and the two preexisting jams, may have presented passage problems for adult steelhead (or coho) last winter. There was a narrow high flow window in December and very early January, and most adult steelhead and many coho migrate after that window. A large jam of fallen and cut trees has formed at mile 5.35, but is less than 0.1 miles from a barrier waterfall, so is not a significant issue for fish passage. A cluster of channel-spanning trees at the upstream bend of the fish sampling site at mile 2.8 is not a closed log jam at present. However, it is well-anchored and can catch future mobile wood.

The entrenched channel of Gazos Creek in the assessment reach allows large (and even smaller) trees to span the channel, and produce persistent growing wood jams. Fish passage for threatened steelhead and endangered coho is then a major issue, as it has been frequently in the stream (Smith 2021b). The reach is on state park property, where nature is generally allowed to take its course. The fire was unusually large, but "natural," but the degree of channel entrenchment produced by the streamside road is not natural. The jams should be monitored and modified, if necessary to provide regular fish passage. ***The new jam at mile 2.1 is especially problematic for fish passage, since it appears to be solid and most of the best spawning and rearing habitat is upstream. Care in modifying logjams should take into account that loosening a jam in a narrow, entrenched channel like Gozos Creek could result in the wood forming new jams at the next channel obstruction.*** Only partial removal along one bank would be desirable, to retain the high flow refuge that the jams provide. In her study of wood recruitment and effects on four streams in 2001-2, Leicester (2005) found that 17 percent of the channel wood in Gazos Creek was in log jams.

The last major input of wood into the Gazos Creek channel was in 1998 (and 1999). Historic El Nino rains produced debris flows that carried trees to the channel and flood flows that eroded stream banks toppling many trees into the channel (Smith 1998; Smith 2021b). Following the storms the San Mateo County Department of Public Works contracted for the removal of channel-blocking trees (primarily redwoods) to protect the road and to provide fish passage (following an outdated publication that urged wood removal). Heavy equipment entered the

channel, and redwoods were removed for lumber. Much of the potential benefit of the added wood was negated. Wood from outside the basin was then brought in to mitigate a tiny portion of the loss of the added wood.

Leicester (2005) found that 70 percent of the channel wood Gazos Creek in 2001-2002 was conifer, and 85 percent of that was redwood. At that time, 95 percent of the redwood was "old," with much or all of the bark gone; much was short cut logs. Addition of redwoods, and other conifers, is apparently a rare, episodic event, although streamside alders, 99 percent of the hardwoods, are continuously being added. She also found that both confer and hardwood were associated with pool formation (30 percent) and backwater formation (7-9%). However, 61-63 percent of the channel wood was "extra" and not contributing to habitat formation during her survey. Channel wood is an indispensable component of stream habitat for fish, frogs, and salamanders. When "disasters" like the 2020 fire and the 1998 floods occur, the added wood should be considered an "opportunity" to carefully modify jams and move some of the newly added wood to nearby locations where it can improve channel habitat.

LITERATURE CITED

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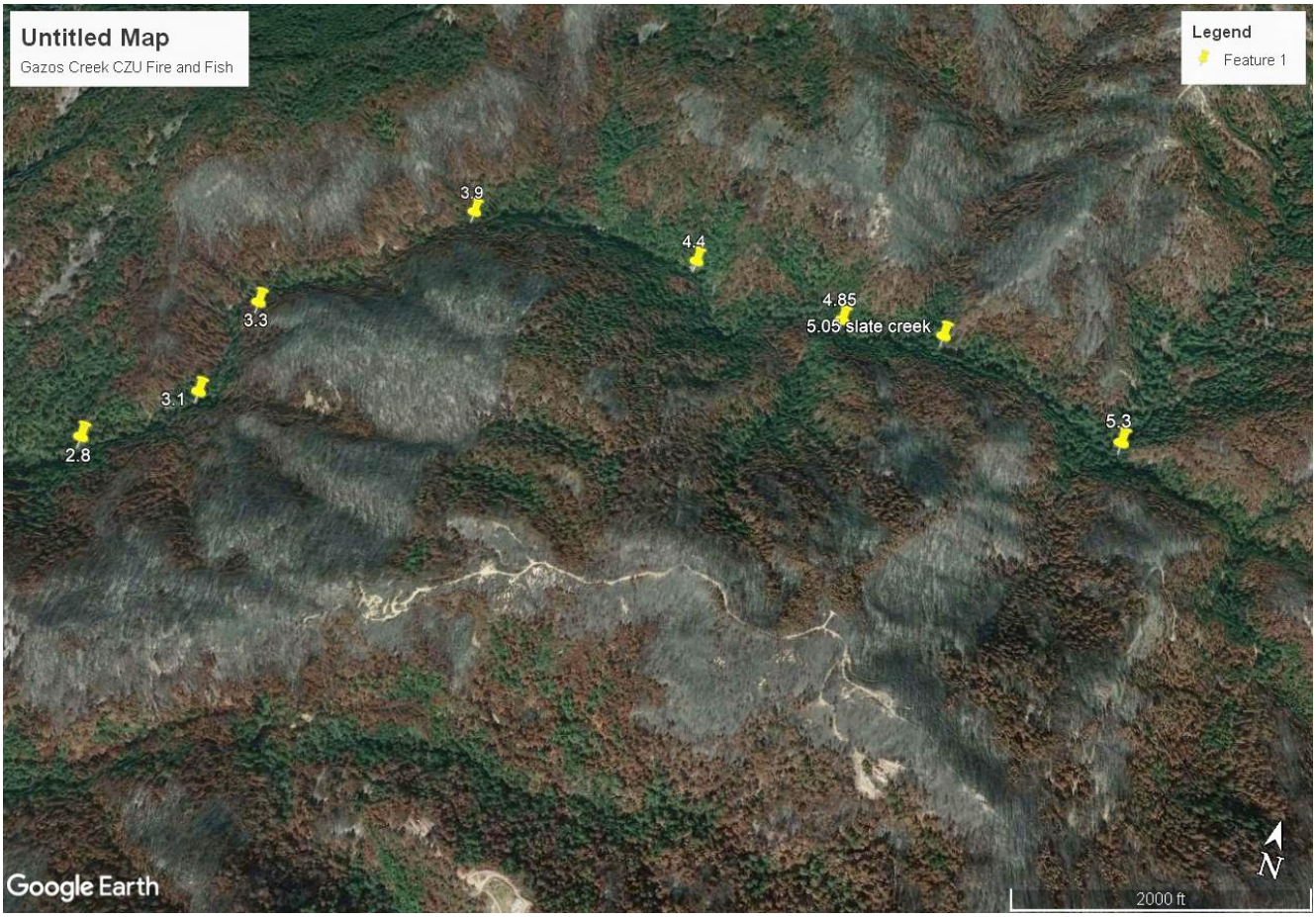

Figure 1. Google Earth photo (26 September 2020) of Gazos Creek from below mile 2.8 from Highway 1 (above Cloverdale Road) upstream to above mile 5.3 (below the Mountain Camp, upper limit of potential coho use). There were no direct fire effects downstream of mile 2.8. Markers are approximate road miles at long-term fish monitoring sites and other sites of note. 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 2. The severe south-slope burn reaching closest to the stream was between miles 3.3 and 3.9 and also between miles 5.05 and 5.3. The severe north slope burn similarly reached nearest to stream between miles 3.4 and 4.0 and between miles 4.9 and 5.3.

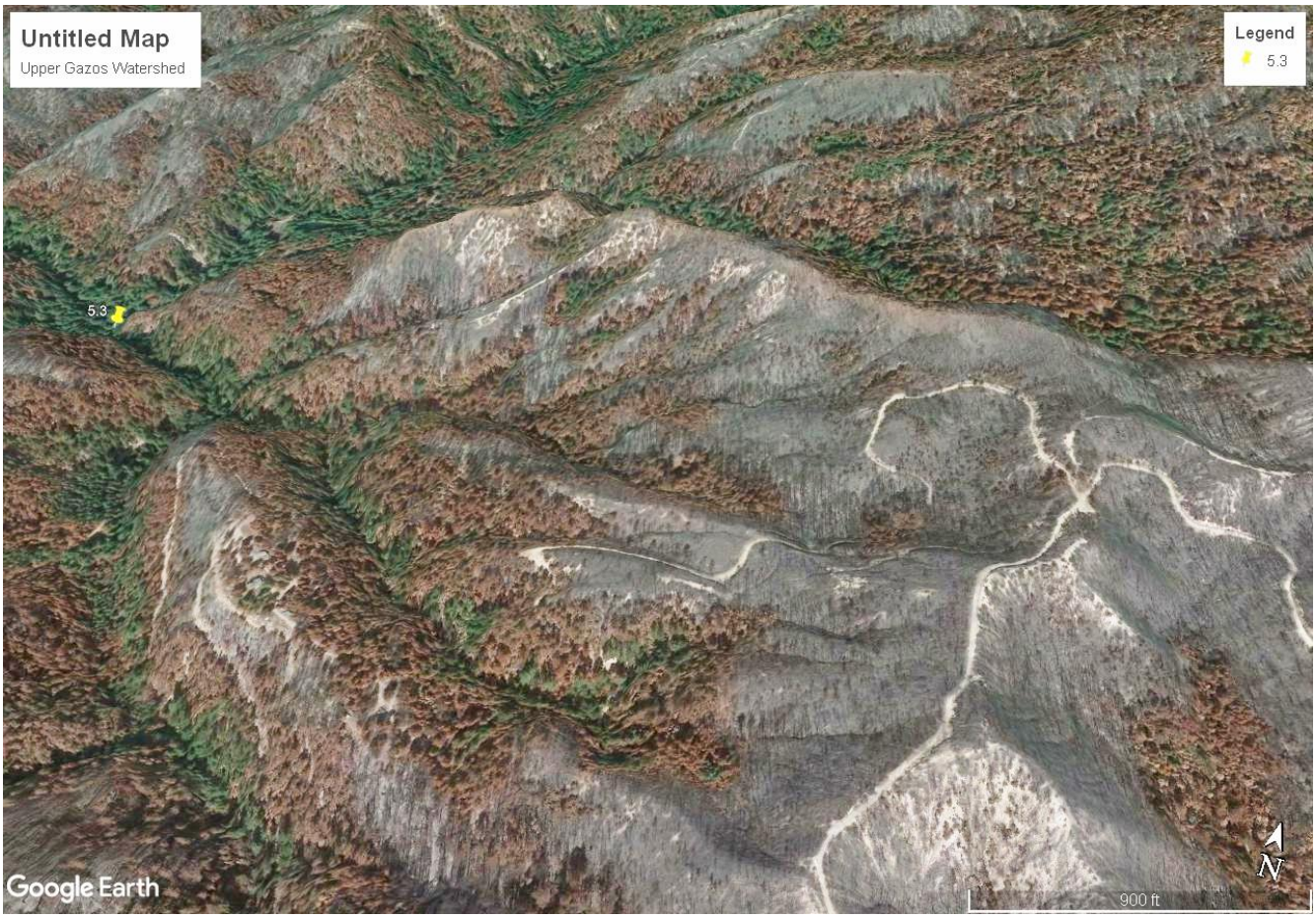

Figure 3. The intensively burned portion of the Gazos Creek watershed upstream of mile 5.5. Even standing burned trees are scarce in half of the watershed

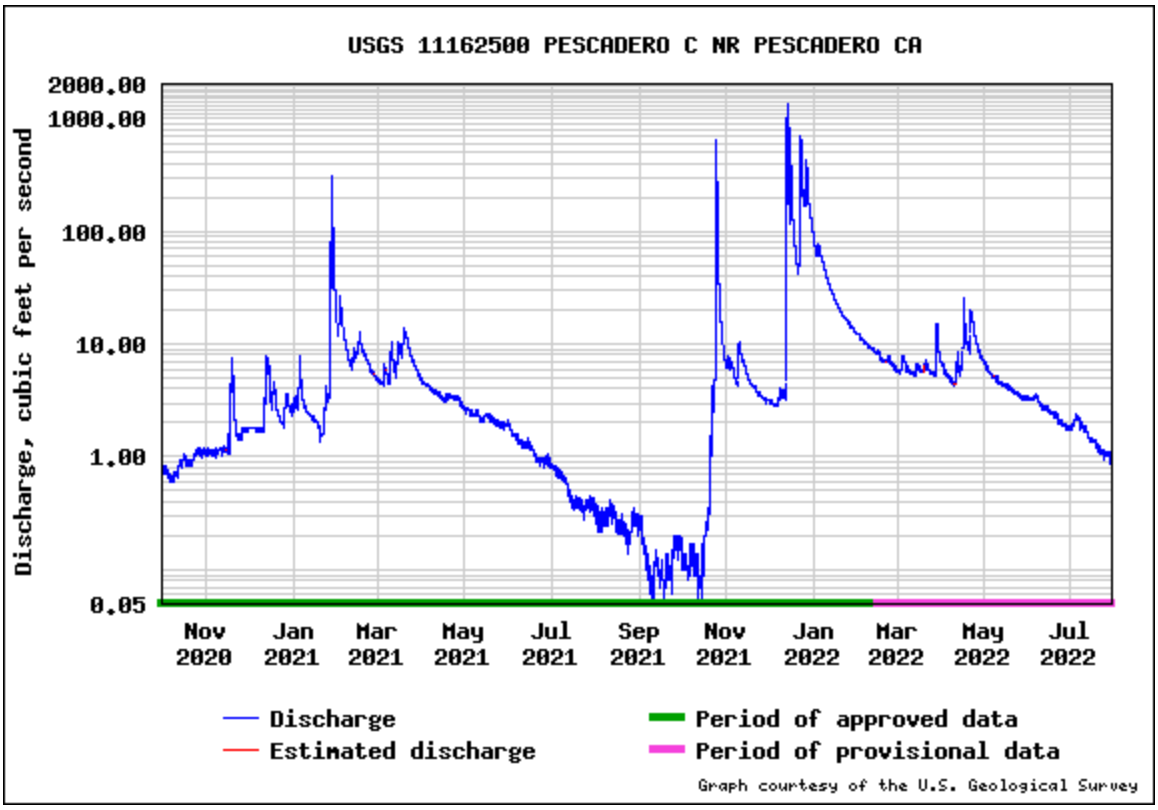

Figure 4. Runoff in Pescadero Creek in October 2020 – July 2022, as a pattern surrogate for ungaged Gazos Creek, showing a single modest rain/runoff event in January 2021 and much more intensive rain/runoff in October and December 2021, with drought by January 2022.

APPENDIX: PHOTOS (arranged downstream to upstream;
sites 1.8 and 2.1 miles are additions to the August Report).

Photo 1. Mile 1.8 mile. Head of lowermost fish sampling pool at a sharp bend in stream, with pool 50% filled with fines. Tail of pool now has fallen alders. The site is downstream of Old Woman's Creek watershed, which provided abundant sediment after the CZU Fire in 2021 and 2022 (and frequently prior to the fire).

Photo 2. Mile 1.8, looking downstream. Formerly deep corner pool and backwater (to left), now about 60% filled with fines, including reduction in amount of undercut bank.

Photo 3. Mile 1.8, looking upstream. Pool widened and shallower, with loss of undercut right bank. Fines and small gravel.

Photo 4. Mile 1.8, looking downstream. Downstream of pool 4 the channel is shallow and has been widened and flattened.

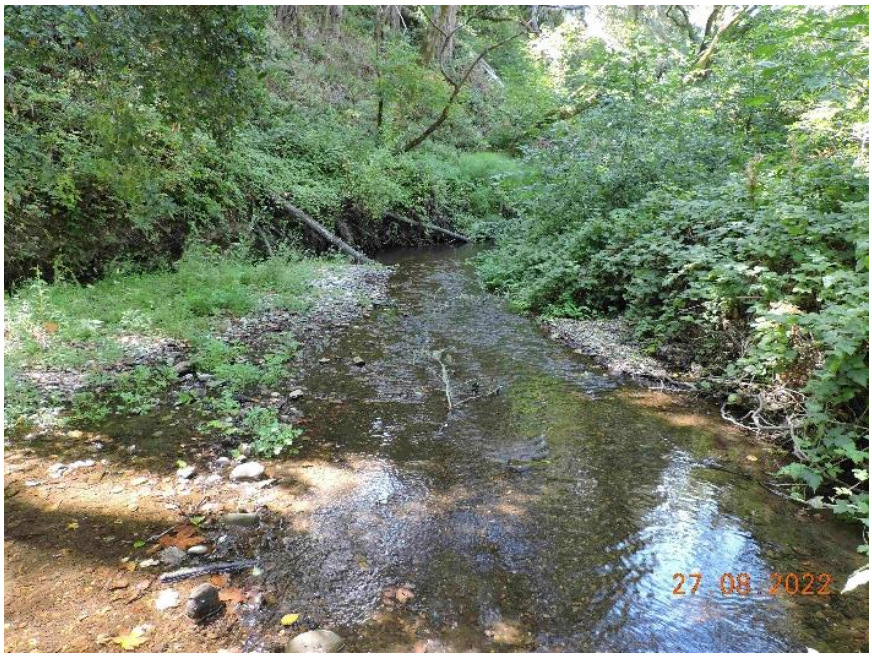

Photo 5. 1.8 mile, looking downstream. Pool 4 in the distance is now mostly glide and without undercut left bank. Pool 5, a corner pool and backwater out of the picture to the lower right, was lost (bypassed) in 2021 and 2022.

Photo 6. 1.8+ mile, looking upstream. Just upstream of the fish sampling site, a large partially open log jam of fallen alders is now present near the former site of an old jam anchored by a large multi-trunk maple. The jam was open enough to allow coarse and fine sediment to pass downstream to the sample site and presently not a fish passage barrier.

Photo 7. Mile 2.1, looking downstream. The lowermost fish-sampling pool upstream of Old Woman's Creek Bridge had filled in 2021, but was re-scoured and similar in 2022 to conditions before the fire. All other sample sites had substantial pool filling in 2022.

Photo 8. Mile 2.L, looking downstream (tail of pool 2). Pool 2, a corner pool, was recut to similar to pre-fire and gravels deposited at tail crest. The pool was substantially filled in 2021 with fines.

Photo 9. Mile 2.1, looking upstream. Pool and glide was substantially filled with fines in 2021, but was recut and cleaned and was similar to pre-fire conditions in 2022.

Photo 10. Mile 2.1, looking upstream. Deep pool and large wood had lost much of its depth and surface area upstream due to deposition of fines.

Photo 11. Mile 2.1, looking upstream. Downstream edge of large jam above sampling site anchored by fallen alders.

Photo 12. Mile 2.1, looking upstream. Bulk of jam is interlocking old transported wood, and is a fish passage problem. The tight jam apparently trapped transported coarse gravel and sand in winter 2021-2022, solidifying the jam, but also minimizing pool filling at the downstream sample site. That allowed the high flows to scour sediment present in 2021 from the sample site and recut the original pools.

Photo 13. Mile 2.1, mid jam. The jam is 6+ ft high, 30 ft wide and well-anchored. It is a potential serious fish passage barrier except during high flows. Abundant young-of-year steelhead at the sample site in 2022 may have been the result of spawning below the barrier after passage flows disappeared in January-April.

Photo 14. Mile 2.8, looking downstream. Preexisting logjam partially burned in 2020, but with added wood since. Possible fish passage underneath near left bank, but a potential fish passage problem; should be monitored and modified if needed. Backwater at the jam resulted in filling the upstream pool with sediment.

Photo 15. Mile 2.8, looking upstream. Former fish sampling pool and backwater (right bank above stump) filled by fines and mudstone gravel.

Photo 16. Mile 2.8, looking upstream. Former fish sampling pool, with downstream (near) portion filled and upstream portion at wood substantially shallower.

Photo 17. Mile 2.8, looking upstream. Former fish sampling glide and pool filled about 50% with fines and fine gravel, including reduction in undercut banks.

Photo 18. Mile 2.8, looking upstream. Fish sampling pool located at 1999 rootwad installation. The configuration was changed (with addition of log), but habitat overall was about the same.

Photo 19. Mile 2.8, looking downstream. Fish sampling pool and right bank backwater, one of three fish sampling habitats with significant filling in both 2021 and 2022, especially downstream portion and backwater.

Photo 20. Mile 2.8, looking upstream. Deep and complex corner pool with wood was nearly filled by sediment.

Photo 21. Mile 2.8, looking upstream above sample site pullout. Channel aggraded, flat, and shallow, with little depth associated with transported wood.

Photo 22. Mile 3.1, looking downstream. Pool and wood far downstream in photo has been eliminated by filling and wood loss. Upstream in photo, the shallow pool and glide is unchanged.

Photo 23. Mile 3.1. Complex pool with old redwood logs at small tributary has been filled and the logs buried or lost downstream.

Photo 24. Mile 3.1, viewed from pullout. Bedrock pool half-filled with gravel, with tail of pool very shallow.

Photo 25. Mile 3.1, looking downstream from pullout. Road closely adjacent to shallow entrenched channel. Few right bank trees.

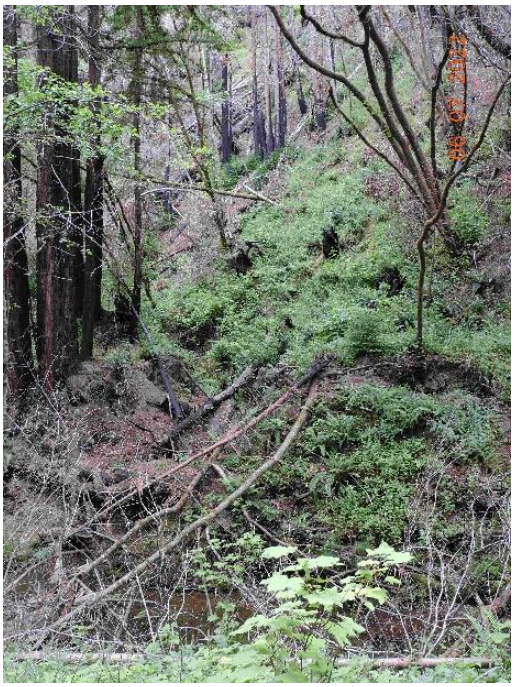

Photo 26. Mile 3.1. Steep south slope at the site, with ground cover now well-established, redwoods recovering, and upslope tanbark oaks and big-leaf maples mostly with dead trunks, but basal sprouts.

Photo 27. Mile 3.1+. Scoured and filled channel with newly deposited wood (from open jam at mile 3.2?).

Photo 28. Mile 3.2. Old and persistent, but usually open, log jam relatively unchanged in 2022.

Photo 29. Mile 3.3., at one lane road against vertical cliff. South slope trees fallen and spanning the constricted channel.

Photo 30. Mile 3.3. View upstream from the end of the one lane road section to the major new log jam in the entrenched channel. The alders at this site were killed by the fire.

Photo 31. Mile 3.3. View from upstream of new logjam formed from transported wood against fallen streamside trees. The jam in the entrenched channel is well-anchored and 5 ft high and 30 ft wide. It presently may provide high flow fish passage underneath, but is a serious potential barrier, and should be monitored and likely modified.

Photo 32. Mile 3.3. North slope above road with ground cover reestablished, recovering redwoods with trunk and branch epicormic sprouts, small Douglas firs dead, and tanbark oaks with dead trunk but with basal sprouts.

Photo 33. Mile 3.5. Cluster of new large wood producing shallow pool and escape cover in an otherwise simple, scoured channel.

Photo 34. Mile 3.5. Shallow entrenched roadside channel, showing high flow scour line on left bank and San Mateo County stacked boulder bank protection on right bank. Level channel, despite some added wood.

Photos 35 and 36. Mile 3.5. Large spanning 5+ ft diameter redwood that burned near the base for months and later fell across the stream and the road. The spanning trunk and the wood jam to the near right in the left picture sit in a simple channel without pools or structural escape cover.

Photo 37. Mile 3.5. Just upstream of the spanning redwood a large added tree and other wood sits in a wide flat channel, not presently providing significant summer fish habitat in the low flow channel. However, it may provide some winter high flow refuge.

Photo 38. Mile 3.9. Formerly long deep pool at annual fish sampling site, now almost completely filled except local scour around new transported and fallen wood to right. The original deep pool was formed after the fallen Douglas fir (left in photo) was winched into the channel against a large stump and rootwad. The stump is now near the downstream end of the substantially filled pool.

Photo 39. Mile 3.9, looking downstream. Long fish sampling pool formerly with depth and wood escape cover along right bank. Largely filled with gravel and shifted to opposite bank away from woody structures that provided depth and escape cover

Photo 40. Mile 3.9, looking upstream. Series of 4 small pools associated with channel wood has been filled and is now mostly run habitat.

Photo 41. Mile 3.9. Leveled gravel channel, with filling of long, deep pool, except around the old large rootwad/log in center of pool (annual fish sampling pool). Entrenched channel with 10 ft high near-vertical right bank.

Photo 42. Mile 3.9, looking upstream from uppermost fish sampling pool. Leveled channel and filling of pools, including at bottom of photo.

Photo 43. Mile 3.9. South slope with developed ground cover and most trees alive (although many tanbark oaks with only basal sprouts). Some small redwoods thought to be dead in 2021 have basal sprouts in 2022.

January Photo 44. About mile 4.0. Log weir with level gravel channel upstream. Three foot jump required from the partially filled pool.

Photo 45. Mile 4.05. New partial log jam (open at bottom) formed at fallen upslope wood with transported wood (possibly from wood transported downstream from the old jam at mile 4.2). In entrenched, flat aggraded channel. Little summer habitat, but potential winter flow refuge.

Photos 46 and 47. Mile 4.1-. (left) Upslope and channel habitat in January with fallen channel-spanning, big-leaf maple. (right) Aggraded, flat channel and the multi-trunk maple in July.

Photo 48. Mile 4.1+. South slope with burned but recovering redwoods and ground cover.

Photos 49 and 50. Mile 4.1+. (top January) Major new jam on flat gravel channel. (bottom July) Restoration of extensive ground cover by July. Jam is anchored by fallen upslope trees. Much of debris is probably from substantially blown out multi-decade jam at mile 4.2.

Photo 51. Mile 4.1+. View of jam from upstream. Jam is 5 ft high, 35 ft wide, and 35 ft long. Possible fish passage under the jam along the right bank. The well-anchored jam is a potential serious fish passage barrier that should be modified.

Photo 52. Mile 4.1+. View of channel and south slope at the jam. The jam backed deep "lake deposits," and later cut down through them along the right bank (bank in lower middle).

Photo 53. Mile 4.2-. Looking upstream, showing narrow, entrenched channel with new fallen logs in 2022 from fire. A major log jam from a debris flow with redwood trunks in 1999 is upstream in the background. It had been a significant fish passage barrier in about half of the years since. It was substantially dismantled in December 2021 (next two photos).

January Photo 54. Mile 4.2. Blown out major jam (of upslope trunks, captured debris, and right bank multi-trunked maple) present since 1999. This jam is now passable to adult steelhead and coho, with a deep jump pool and 2+ ft jump over the spanning log.

Photo 55. Mile 4.2, view from downstream of the jam formed in 1999. About three-fourths of the accumulated wood in the jam was lost downstream in winter 2021-2022. That wood is substantially responsible for the jam at mile 4.1. The aggraded channel upstream of the jam released substantial stored sediment downstream when the jam was partially dismantled.

Photo 56. Mile 4.4. Long and deep fish sampling pool was formed after 1999 installation of 2 Douglas fir logs across channel. Pool is now filled with fines and gravel except immediately under the wood. Streambed immediately downstream leveled by October and December floods and bed-load movement. Several pools farther downstream were eliminated by channel down-cutting after the partial breakup of the logjam at mile 4.2.

Photo 57. Mile 4.4. Several small 1.5 ft deep fish sampling pools and glides were eliminated by leveled and widened gravel streambed.

Photo 58. Mile 4.4. Deep fish sampling pool and channel above and below the old redwood log was filled and leveled by gravel in October and December 2021.

Photo 59. Mile 4.4, looking downstream. Upper-most fish sampling pool changed little upstream of bend (near portion), but deep, complex pool in bend and under fallen multi-trunked redwood was half filled in 2022.

Photo 60. Mile 4.5. Pool associated with 1998 fallen and cut multi-trunked redwood is mostly now filled by gravel, except immediately around the wood.

Photo 61. Mile 4.5. Looking upstream of bend pool at flat aggraded channel.

Photo 62. Mile 4.9, looking upstream. Downstream two-thirds of fish sampling pool was more than half filled by fines and gravels.

Photo 63. Mile 4.9, looking downstream. The much deeper upstream third of the pool was about 70% filled, except at the bank and wood structure at the head of the pool.

January Photo 64. Mile 4.9, looking downstream. Fish sampling pool at and downstream of preexisting partial wood jam was half filled with fines and gravel in October and December 2021.

Photo 65. Mile 4.9. Fish sampling pool with alcove at bedrock outcrop has been about half filled with fines and gravel, and part of the alcove has collapsed eliminating the deepest habitat.

January Photo 66. Mile 4.9, looking upstream. Shallow entrenched channel close to road was leveled, and pool upstream of pullout (bottom of photo) was filled.

January Photo 67. Mile 4.9. South slope with scour line and widened and leveled stream bed (located at a steep flowing seasonal tributary). Dead trees have skidded down the steep slope.

Photo 68. Mile 4.9. Upper fish sampling pool with San Mateo County stacked log bank protection upstream and stacked boulders and root wad bank protection downstream. The pool, one of three fish sampling habitats with significant filling in both 2021 and 2022, is now mostly filled, with undercut banks eliminated.

Photo 69. Mile 5.0, just upstream of Slate Creek, viewed from upstream. Large (5 ft high by 30 ft wide) partial wood jam. Presently passable underneath and, at high flows, around the jam on right bank.

Photo 70. Mile 5.0. Large fallen Douglas fir trunk anchors the downstream jam above Slate Creek. The jam is likely to solidify and should be modified to ensure fish passage.

Photo 71. Mile 5.0, looking downstream toward the lower Slate Creek jam (in shade). The deeply entrenched channels on Gazos Creek upstream of mile 2 confine and anchor wood jams. They then tend to persist and grow, potentially becoming barriers to fish passage. They should be monitored and modified as necessary.

Photo 72. Mile 5.0+, just upstream of the lower jam. The large upstream jam is 6 ft high and well-anchored by fallen trees from the fire. Like the lower wood jam, it is partially open and not presently a barrier to fish passage. However, it is likely to grow into a barrier to fish passage.

Photo 73. Mile 5.0+. The large upstream jam viewed from near the left bank.

Photo 74. Mile 5.0+. The South slope with forest mostly recovering and ground cover partially reestablished.

January Photo75. Mile 5.25. Tail of long pool above Humboldt Crossing and short, deep pool below crossing are fish sampling habitats. The habitat below the drop is unchanged, but the habitat upstream suffered substantial filling.

Photo 76. Mile 5.25, looking upstream. Fish sampling pool upstream of Humboldt crossing is now two-thirds filled with fines and gravel, eliminating undercuts on left bank.

Photo 77. Mile 5.25. Remnant scour around buried log, but half of depth and extent of scour has been lost. Complex head of pool habitat upstream is still good feeding habitat.

January Photo 78. Mile 5.25, looking downstream. Fish sampling pool and backwater alcove to the right have been about half filled by fines and gravel. The short riffle separating it from the pool upstream is gone.

January Photo 79. Mile 5.25, downstream of bridge. Large deep and complex corner pool was more than two-thirds filled with fines and gravel by both 2021 and 2022, reducing escape cover and high flow refuge.

January Photo 80. Mile 5.35, looking downstream. Abundant log debris caught in bend now a potential fish passage barrier, but also a high flow refuge.