

## Waddell Creek Post-fire Resurvey July and October 2022

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

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### INTRODUCTION

Following the CZU Lightning Fire in August 2021, the Waddell Creek streamside, and a portion of the upper slope between Stevens Camp and the confluence of the east and west forks, was walked upstream to about mile 3.5 on the West Fork in October to observe habitat conditions in the accessible stream and riparian corridor (Smith 2020). Fish sampling at three annually sampled sites farther downstream found the stream channel unaffected by the fire. Fish abundance was typical of recent years, but access for sampling farther upstream with direct fire effects was not possible (Smith 2020).

The 2020 effort was followed up in 2021 by surveys in June and October to assess streamside and channel habitat conditions following the unusually mild and dry 2020-2021 winter (Smith 2021a and Smith 2021b). The fire had not burned to the streamside downstream of mile 2.6 (Stevens Camp), but had burned upslope on both sides of the stream and progressively farther into and through the riparian corridor between miles 2.8 and 3.6 (Figure 1, and see photos in Smith 2021a and 2021b). Upstream of mile 2.6, some burned and toppled trees fell into the stream channel, and unburned riparian and streamside alders (*Alnus rhombifolia*) were apparently cooked and had few or no leaves through June 2021. These effects progressively increased upstream of mile 2.8, where the fire burned through the riparian border in varying intensity to the stream from both slopes.

In burned forest most redwoods (*Sequoia sempervirens*) greater than 1 foot diameter survived, although trunks and branches were burned. Epicormic trunk and branch sprouts were present on surviving redwoods by October 2021. However, much of the canopy and stream shading was lost, leaving “bottlebrush redwoods.” Most small redwoods appeared to be dead. Burned tanbark oaks (*Lithocarpus densiflorus*), live oaks (primarily *Quercus agrifolia*), madrones (*Arbutus menziesii*), and California bays (*Umbellularia californica*) had lost all or most of their canopy, but most had basal sprouts by June or October 2021. Almost all burned Douglas firs (*Pseudotsuga menziesii*) died unless substantial canopy was left. Most alders, including those with no apparent burn marks, still lacked leaves in October 2021, so the extent of their survival was in doubt. Most burned riparian and lower slope big-leaf maples (*Acer macrophyllum*) appeared to have suffered mortality in 2020, but basal sprouts were present on some by June 2021 and basal sprouts and sparse canopy leaves were widespread by October 2021.

The very dry conditions in winter 2020-2021 (Figure 2, stream flow in Pescadero Creek) prevented the establishment of significant ground cover on burned slopes surrounding the stream, especially on the generally much higher and steeper western slope. Tree roots of fire-damaged and dead trees were still capable of holding soil in place. Ground Cover in the riparian corridor and stream terrace was moderately developed by October 2021. Wood added to the stream was sparse in 2021, and was mostly limited to burned and toppled trees from the moist riparian corridor. A large partial logjam at mile 2.8+ was at the bottom of a west slope debris flow. A second jam at mile 3.45 was from toppled streamside trees. Some pre-existing channel wood burned, including a very large log jam at mile 3.4 on the West Fork that had often been a fish passage barrier since 1998. The extensive loss of canopy between mile 2.75 and 3.6+ resulted in increased algal growth and warmer stream conditions, with mean water temperature in June–August higher than 18°C (Smith 2021b). The warm water temperatures would have delayed potential fish sampling by electrofisher until at least mid-September, but

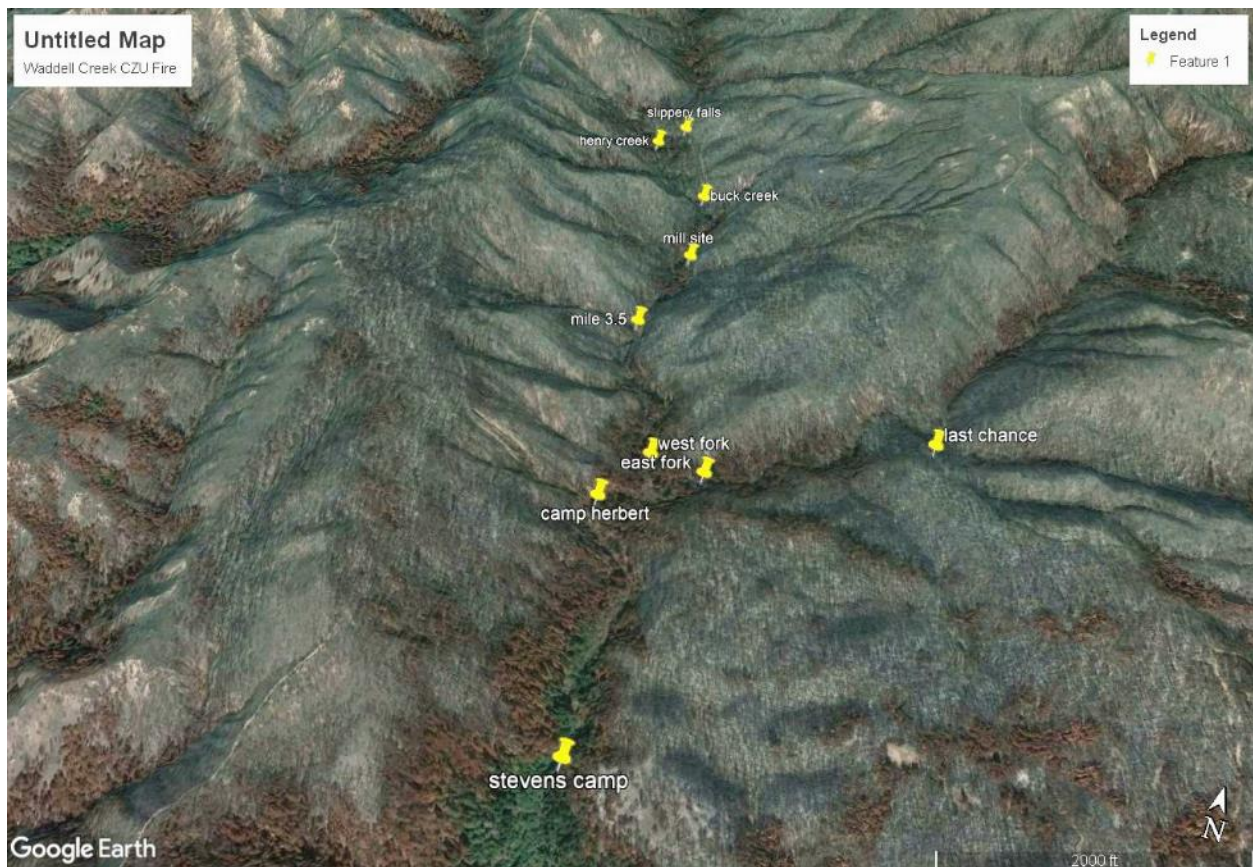


Figure 1. Google Earth aerial photo of Waddell Creek watershed from downstream of Stevens Camp (mile 2.55) to the upper watershed of the East and West forks (taken fall 2020 after the CZU Fire). The green streamside is intact riparian and lower upslope forest. Orange is medium burned forest extending upstream to mile 3.6+ (Mill Site). Remainder of the watershed in gray is severely burned upland with mostly standing or downed burned trees only. Yellow icons are historical fish sampling sites used since 1992.

salvage logging on the adjacent private property restricted access until mid-October anyway. A large October storm then eliminated potential sampling. However, juvenile steelhead (*Oncorhynchus mykiss*) were seen throughout the reaches surveyed for fire damage.

With the mild winter (Figure 2), and despite the general lack of ground cover, debris flows and other sources of sediment to the stream channel were rather restricted in 2020-2021. Two west slope debris flows, a relatively small one at mile 2.8 and a very large one at the confluence of the forks (mile 3.0+), resulted in substantial filling of the channel and elimination of deeper pools with fines and small mudstone gravel between the forks and mile 2.7. On the west fork between miles 3.4 and 3.5 there was significant stream aggradation from steep west slope erosion. Elsewhere the stream channel of Waddell Creek, including at fish sampling sites used annually since 1992 (Smith 2020), was not significantly altered. Summer stream flow in 2021 was apparently increased compared to that expected in such a dry year, due to the loss of forest canopy soil water demands in the watershed from tree deaths and substantial reduction in leaf area of most surviving trees. The summer stream flow effect could persist for years.

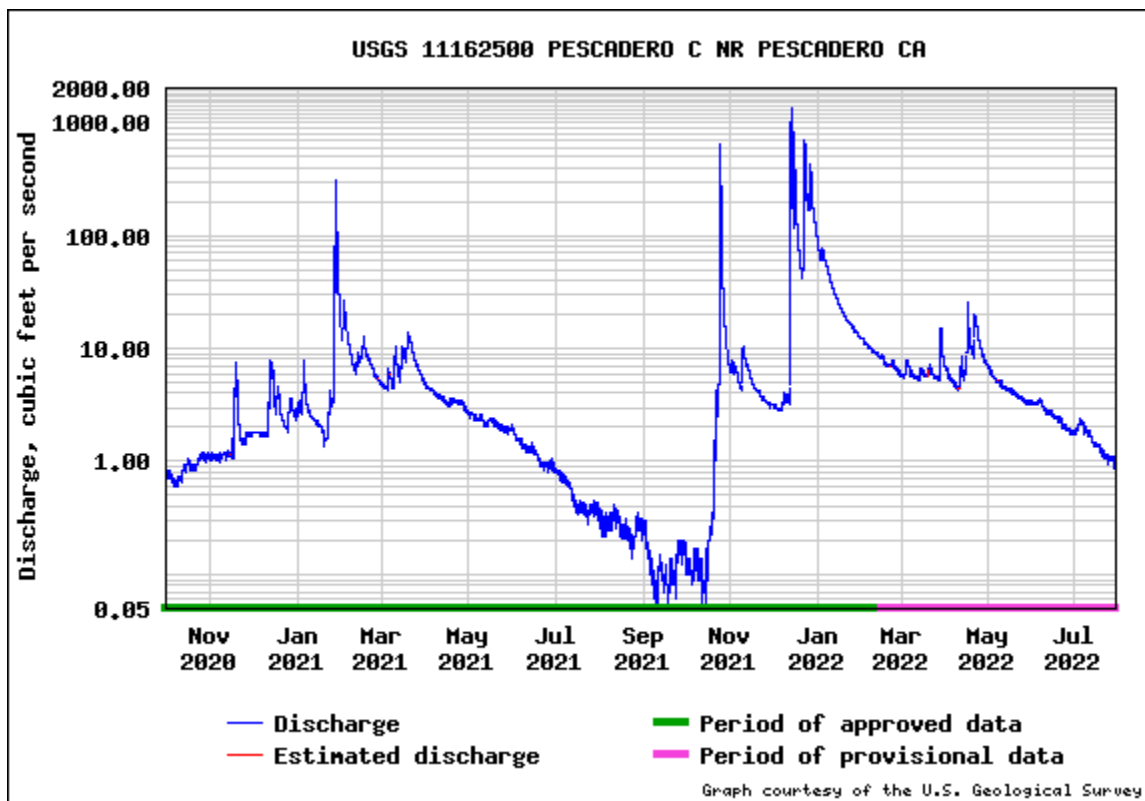


Figure 2. Runoff in Pescadero Creek in October 2020 – July 2022, showing a single modest rain/runoff event in January 2021 and much more intensive rain/runoff in October and December 2021, with drought by 2022.

In October and December 2021, relatively heavy rainfall and runoff occurred (Figure 2), despite another drought year, which threatened to produce the extensive post-fire erosion that the Waddell Creek watershed was largely spared by the mild 2020-21 winter. The lack of ground cover on most slopes prior to the October and December storms also would have increased the likelihood of erosion and deposition impacts to the Waddell Creek channel. High winds in winter through early summer 2022 might also have increased falling of dead and fire damaged trees, substantially increasing wood loading to the channel. High storm runoff might also have transported channel wood and organized log jams as habitat features that could act as fish passage barriers or as valuable pool-forming structures. The wetter early winter should also have substantially increased herb and shrub ground cover. In addition, the fate of the streamside alders, most of which appeared to have died upstream of mile 2.75, was of interest, as alders were a major component of stream shading and stream water temperature moderation. Therefore, it was important to resurvey the Waddell Creek watershed in 2022 to evaluate changes to stream habitat, especially in a year when significant runs of endangered coho salmon (*O. kisutch*) had apparently occurred elsewhere in Santa Cruz County (Joe Kiernan, NOAA Santa Cruz Laboratory, pers. comm.).

In June and early July 2022 the habitat conditions were resurveyed from mile 1.2 upstream to mile 3.6+ (on the West Fork of Waddell), on the lower portion of the East Fork, and upslope on the east slope logging and State Park road between Stevens Camp (mile 2.6) and the confluence of the East and West forks (mile 3.0+). Resurveys were also conducted during fish sampling in October.

## METHODS

On 22 June 2022 the streamside habitat was spot checked from near Alder Camp (mile 1.2) upstream to mile 2.5 and walked on the streamside trail from upstream of Stevens Camp (mile 2.6) to the confluence of the East and West Forks of Waddell Creek and then upstream to above mile 3.6 on the West Fork. On 1 July the logging road and State Park road from Stevens Camp up the east slope above the stream and then down to the confluence of the forks was surveyed; this was to gauge fire effects with elevation on the slope and effects from miles 2.6 to 3.1. Then about 0.3 miles on the East Fork was surveyed. The return to Stevens Camp was by the streamside trail, which allowed a second survey of that reach. Notes and 200+ photographs documented habitat conditions for comparison with notes and photographs from 2021. The habitat conditions of individual stream mesohabitats (pools, runs, riffles, wood structures) were more intensively investigated at 8 fish sampling sites used almost annually since 1992. Stream distances for notes and photos for the streamside surveys were estimated, based upon road mileages at fish sampling sites documented in fish investigations prior to 1998. Distances on the slope bypass road were approximated to be equivalent to stream distance locations.

As in 2021, on 22 June five Hobo water temperature recorders were installed between Twin Redwoods Camp (mile 1.8) and mile 3.6+ on the West Fork, and with one on the East Fork near the confluence. Recorders measured temperature every 15 minutes; they were retrieved in October. ***Electrofishing sampling of seven of the historic fish sampling sites was conducted in October, and additional photos taken during sampling were added to this report. Spot checking farther downstream was also conducted in October, which discovered a major new logjam (a potential significant fish passage barrier) upstream of mile 0.6 (the first bridge).***



## RESULTS AND DISCUSSION

### Tree Mortality and Toppling

A major finding in 2022 was the confirmation that most of the alders that were apparently cooked and leafless in 2021 had died. A few of the streamside alders farther downstream (mile 2.8) and at the confluence of the forks survived. Otherwise, alders were killed where the fire reached to or close to the stream, even though they lacked burn scars. The loss of most of the upstream alders reduced or eliminated seed sources for reestablishing the alders. New young alders were extremely scarce or absent, except farther downstream where much of the riparian border was intact. Extensive death and toppling of alders provided most of the new channel wood present in 2022, including additions to the 2021 log jam at mile 2.8+ and at the first bend above the confluence on the East Fork. There were few fallen trunks of dead and damaged upslope trees that reached the streamside in either 2021 or 2022.

Maples that appeared dead in early 2021 mostly had basal sprouts by 2022, including upslope trees. Some smaller tanoaks and redwoods that were thought dead in 2021 had basal sprouts in 2022.

### Ground Cover

Ground cover, with a wide variety of herbs and shrubs (including blackberry, *Rubus* spp.), had substantially increased in the riparian corridor and terraces by 2022, so that bare soil was absent, except where bedrock was exposed.

Upslope, blue blossom (*Ceanothus thyrsiflorus*) and **French** broom (*Genista monspessulana*) by 2022 dominated the ground cover, which was generally dense, except on the steepest, drier western slopes from mile 2.8 – 3.6+ of Waddell and West Fork Waddell creeks.

### Slope Erosion

The burned east slope between miles 2.0 and 3.6+ did not appear to have delivered significant sediment to the stream channel in 2021 or 2022. “Tramway Springs” (mile 2.05), and a seasonal drainage a just upstream (mile 2.15), had carried some coarse sediment across the road, but it apparently didn’t enter the stream channel. “Aunt May” Creek, just downstream of Stevens Camp (mile 2.6), is spring-fed and perennial, but low gradient; there was no evidence of sediment deposition at its mouth. Upstream of the forks there was no significant evidence of east slope sediment flow across the trail into the riparian zone.

The upper eastern slopes that were surveyed along the logging road and state park road between Stevens Camp and the forks did not have apparent slope gulying or gulying on the roads. The logging road had effective water breaks installed in 2021, but the steeper state park road down to the forks has no water breaks, but was still in good condition, without gullies. Dense, head-high blue blossom ceanothus and scotch broom, which would have developed after the December rains, presently occupy large portions of the State Park road down to the forks.

The generally steeper (55-60% mean slope) west slope did show evidence of substantial new slope erosion at Twin Redwoods Camp (mile 1.8), between miles 2.8 – 3.0+ (the forks), and especially between miles 3.3 and 3.5 where several large seasonal drainages discharged to the creek. Farther upstream of the survey area the burn was even more severe (Figure 1), so the upstream reaches were also major sources of sediment to the surveyed channel.

On steep exposed slopes and cliffs, especially on the west slope downstream of the confluence of the forks and upstream on the West Fork, it appeared that heating by the fire cooked the Santa Cruz Mudstone, and expansion of the rock shattered it into small angular gravels that were easily eroded from the slopes. The amount of fine mudstone gravel in the channel was unusual, especially in the half mile downstream of the forks in 2021 and upstream on the West Fork of Waddell Creek in 2022.

### **Main Stem Waddell Creek and West Fork Channel Deposition**

Channel deposition by fines and small Santa Cruz Mudstone gravel was substantial in 2022. Most of the volume of deeper pools on the West Fork was reduced to restricted depressions around bends or structure at regular fish sampling sites (near the confluence and at mile 3.6+) and elsewhere. The aggradation rearranged and buried the logjam and step that had formed in 2021 at mile 3.45. On the main stem, the channel between the forks and mile 2.8 was aggraded and former large pools filled from inputs in 2021. However, the deposition, including finer materials in 2022, extended much farther downstream. Aggradation was substantial just downstream of Stevens Camp (mile 2.55) and at Twin Redwoods Camp (mile 1.8). Significant filling occurred as far downstream as below Alder Camp (mile 1.2). Regular fish sampling pools at miles 1.2, 1.8, and 2.55 had substantial reductions in volume. The upslope inputs in October and December 2021 and transport of the low specific gravity Santa Cruz Mudstone fines and small gravels substantially increased and extensively spread degraded stream habitat in winter 2021-2022.

### **East Fork Forest Conditions and Slope Erosion**

The East Fork suffered forest burn similar to that on the West Fork with similar effects on upslope and riparian forest. However, the slopes farther upstream of Last Chance Creek are of much more erosion resistant Butano Sandstone, compared to the fragmented Santa Cruz Mudstone on the main stem of Waddell Creek and lower reaches of the East and West forks.

### **East Fork Channel Conditions**

The stream substrate on the East Fork and in riffles downstream of the forks is dominated by small boulders and cobbles of Butano Sandstone. The input of mudstone fines and gravel from slopes in the lower portion of the East Fork must have been minimal in 2021-2022 and/or the materials were rinsed through the cobble and boulder armored streambed. The lower East Fork habitats checked in 2022 had lost much of the streamside canopy of alders and other trees, but the stream substrate was generally clean sandstone gravels, cobbles and boulders. Deeper pools had fines, but there was no evidence of significant pool filling. The East Fork presently has by far the best habitat in the Waddell Creek watershed. However, (toxic?) fish kills and low fish abundance on the East Fork (and below it on the main stem) have been an apparent problem in the past (since 1999), possibly originating on Last Chance Creek or farther upstream (Smith 2020).

### **Fish Abundance in 2022**

***Electrofishing sampling was conducted in October. During the habitat surveys in June and July juvenile steelhead (and coho) appeared to be very scarce. Sampling in October found coho present at 5 of 7 sites and steelhead at all sites, but at extremely low densities at all sites (mean of 7 steelhead and 2 coho per hundred feet of habitat). The mobile streambed produced by the fines and fine gravel loading in winter 2021-2022 could have affected redd survival and egg hatchability for steelhead and coho.***

***However, the channels at Gazos Creek and in the Scott Creek watershed suffered somewhat similar sediment inputs and flood-flow transport, channel rearrangements, and filling of pools, but had unusually high steelhead (and coho in Scott Creek) abundances (Smith 2022a and 2022b). Therefore, spawner access may have been the problem in Waddell Creek.***

The substantial reduction in the amount and quality of pool habitat observed in 2022 should affect summer rearing conditions for coho (Smith 2020). Overwintering survival for both steelhead and coho has probably also been reduced by the decline in abundance and size of pools.

The addition of fallen trees to the channel can help create and enlarge pools and also increase pool complexity and escape cover. However, despite heavy tree mortality or trunk death of basal sprouting trees like tanbark oaks, relatively little wood has so far been added to the channel. Most new wood is from the extensive death and fall of riparian alders. Alder wood tends to disintegrate rapidly, without the longer-term persistence of some other hardwoods or of conifers (Leicester 2005). ***Much of the added wood in 2022 was collected by the storm flows in small to large logjams; most are not likely fish passage issues. A large jam was present in 2021 at mile 2.85+, and it tripled in length in 2022. It still appears passable, but could get worse. Another large jam had formed at about mile 0.85 in 2021, but also was likely passable. However, that jam was gone in 2022, but apparently contributed to a new very large log jam in an entrenched channel above mile 0.6. That new jam is tightly packed, 6-8 ft high, and extends across the entire flood plain. It appears to be a very significant fish passage barrier, and might have contributed to the general scarcity of fish upstream in 2022. Some steelhead and coho may have passed the site in December before the logjam formed, but it presently is a serious barrier to passage to almost all spawning and rearing habitat in the watershed. The logjam should be substantially modified to allow fish passage, but access to the jam is difficult, and the jam is on private property (Rancho del Oso).***

#### **Recovery Prospects?**

***Major storms in 1982 and 1983 deposited large amounts of sediment on the main stem of Waddell Creek and on the West Fork. Spot observations found that pools were relatively small and shallow on the lower West Fork and on much of the main stem of Waddell Creek. Many streamside alders were also toppled by the storms. The impacts were less than those of the CZU Fire, which killed and damaged streamside vegetation upstream of mile 2.75 and especially the upslope forest on the steep west slope upstream of mile 2.75 on Waddell and West Fork Waddell creeks. Erosion of the steep upper west slope is likely to continue for years, due to the death of so many trees.***

***However, by 1992-1997 (after 10-15 years) fish, pond turtle, and red-legged frog studies in the watershed found that fast-growing alders had significantly recovered on the stream banks. Pools had also flushed much of the sediment in the winters of 1985, 1986, 1992-1997.***

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## APPENDIX A: Photos (from downstream to upstream)

### Mainstem of Waddell Creek



Photo 1. Mile 0.65 (above first bridge). Large newly-formed logjam in 2022 at the upstream limit of the high bar-built lagoon. The jam is tightly packed with recent and old wood and is a likely severe fish passage problem; it may have formed after some adult steelhead and coho had already passed the site in December.



Photo 2. The logjam at mile 0.65 also extends 45 ft across the left bank flood plain, so even most high flows aren't likely to bypass the jam.





Photo 3. Mile 1.2, looking upstream. Shallow pool and glide from channel aggradation at fish sampling site in 2022. Some depth and cover along the left bank, but channel substrate is primarily silt and fine sand.



Photo 4. Mile 1.2, looking upstream. Filling of the majority of fish sampling pool (except at the left bank at the multi-trunk alder) by material from farther upstream.





Photo 5. Mile 1.2, looking downstream. Head of the pool in photo 4, with the formerly deep portion of the pool in the foreground filled and the deep backwater alcove on the left bank behind the alders completely lost to filling with sediment.



Photo 6. Looking upstream. Formerly deep pool largely filled with sediment except immediately upstream, downstream, and under the partial logjam.





Photo 7. Mile 1.75+, looking downstream, downstream of Twin Redwoods camp. The downstream portion of the long fish sampling pool downstream of the trail ford was almost completely filled with sediment.



Photo 8. Mile 1.75+, looking downstream. Upstream portion of long filled pool, with scour and depth restricted to head of pool and at a preexisting wood jam (middle background).





Photo 9. Mile 1.75 +, Twin Redwoods Camp, looking upstream. Shallow glide and pool habitat between ford and seasonal bridge crossing, with fines and small mudstone gravel aggradation filling former scour areas along both banks.



Photo 10. Mile 1.75+, looking downstream, Twin Redwoods Camp. Loss of channel wood downstream and 60% filling of formerly deep pool.





Photo 11. Mile 1.8, looking upstream, Twin Redwoods Camp. Downstream portion of long bend pool, with filling from right (west) bank debris flow.



Photo 12. Mile 1.8, Twin Redwoods Camp, looking downstream. Debris flow and toppled alders at bend of substantially filled pool.





Photo 13. Mile 2.05. "Tramway Springs" drainage upslope of road.



Photo 14. Tramway Springs drainage downstream of road, with little evidence of sediment transport to Waddell Creek in 2022.





Photo 15. Mile 2.15. Eroded seasonal channel upslope of road.



Photo 16. Mile 2.15. The drainage had transported sediment across road into the wide riparian zone, but coarse sediment apparently did not reach Waddell Creek in 2022.





Photo 17. Mile 2.2. Looking downstream. Long, deep pool associated with scattered fallen alders for more than 10 years, lost the alders in the December storms, and most of the pool was substantially filled with sediment, except scour associated with a single large log.



Photo 18. Mile 2.2, looking upstream. A pair of shallow pools and glides lost local scour/small wood and undercut banks in 2022. Fine sediment dominates the stream bed. Canopy is intact.





Photo 19. Mile 2.2, looking upstream. Glide with deeper (2-2.5 ft) pool at head was about 60% filled with sediment in 2022.



Photo 20. Mile 2.2, looking upstream. A pair of pools lost depth, but gained complexity from new entrained wood in 2022.





Photo 21. Mile 2.5+, "Aunt May" Creek, downstream of Stevens Camp. Low gradient perennial stream, with clean substrate and no evidence of sediment transport to Waddell Creek.



Photo 22. Mile 2.6. Looking across channel to severely burned upper west slope.





Photo 23. Mile 2.4. Burned forest east and upslope from road.



Photo 24. Mile 2.65+. Douglas fir burned and toppled into channel and dead small alders cooked by fire on the right bank stream terrace.





Photo 25. Mile 2.65+. Mostly intact right bank riparian forest, with young alder growth at streamside.

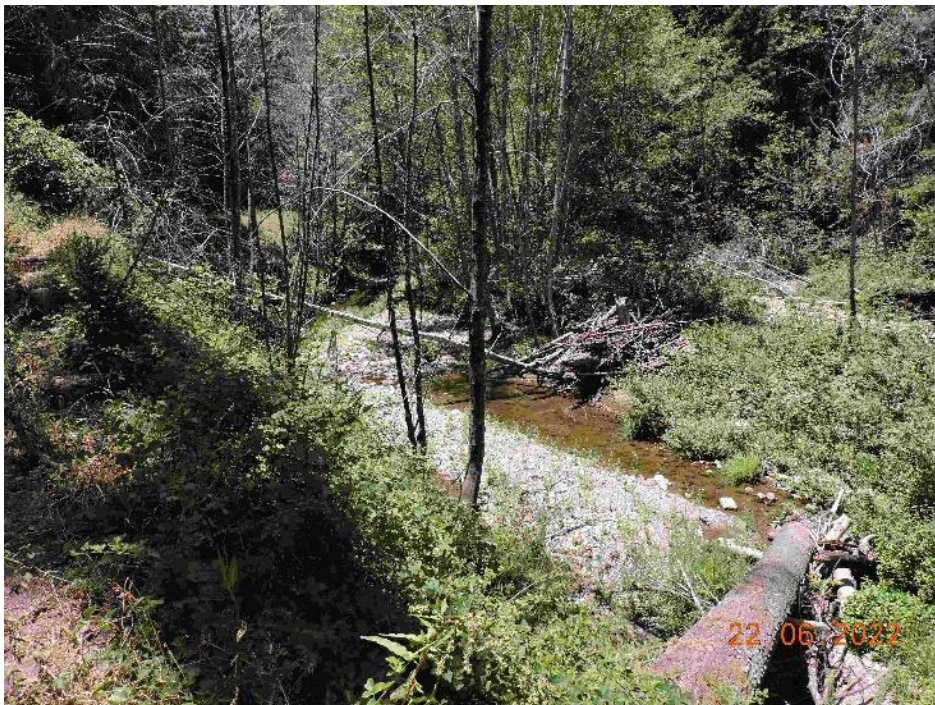


Photo 26. Mile 2.7, looking downstream. Mostly open canopy, with dead and down alders and fallen Douglas fir from upslope fire.





Photo 27. Mile 2.7+. Dead alders cooked by streamside fire in 2020. Clean sandstone cobble/gravel riffle and run.



Photo 28. Mile 2.7+. Pool filled with fines and small mudstone gravel.





Photo 29. Mile 2.75. Loss of alders cooked by streamside fire and fallen tree from upslope fire.



Photo 30. Mile 2.75+, looking downstream. Loss of most alders, with partially burned east slope in background.





Photo 31. Mile 2.8. One of several substantially filled formerly large and deep pools between here and the forks.



Photo 32. Mile 2.85. East slope with basal sprouting tan oaks and redwoods and with established ground cover (ground cover was lacking in 2021).





Photo 33. Mile 2.85. Unshaded channel with sparse new alders.



Photo 34. Mile 2.85+. Large partial log jam from fallen trees at west slope 2021 debris flow. The jam had been enlarged upstream by alders that died in 2020 and fell into the stream in winter 2021-2022. The channel up and downstream was substantially aggraded by fines and small mudstone gravel from farther upstream in 2021.





Photo 35. Mile 2.85+. **West** slope failure and debris flow from 2021 at 2021 logjam.



Photo 36. Mile 2.85+. Upstream enlarged portion of the logjam, consisting of dead, flood-transported alders.





Photo 37. Mile 2.9-. Streamside with 80% dead alders within 0-300 ft upstream of logjam.



Photo 38. Mile 2.9-. Flood plain alder forest 300-800 ft upstream of logjam, with alders killed by fire, except for a few immediately along stream.





Photo 39. Mile 2.9. Dead and down alders upstream of flood plain forest and at upstream bottom of the bypass trail.



Photo 40. Mile 2.9. East Slope with tanbark oak oaks with standing burned trunks and basal sprouts.





Photo 41. Mile 2.9+, looking downstream. Formerly large pool now severely filled with small mudstone gravel. Dead alders. New leaves on branches of surviving redwoods, California bays, and big-leaf maples. Upper east slope forest in the left background.



Photo 42. Fine, angular “kitty litter” gravel of Santa Cruz Mudstone, that was filling pools and dominating the channel between mile 2.9 and the forks in 2021 and 2022 from the west slope of Waddell Creek. In 2022 new west slope erosion severely filled the channel on the West Fork of Waddell from the forks upstream to above mile 3.7.





Photo 43. Mile 2.9+, looking upstream. Aggraded channel and filled pools, with burn to both banks in 2020. The steep west slope in the background is typical of the source of channel sediment from here upstream to the forks.



Photo 44. Mile 2.95-. Looking across the east terrace and stream to West terrace and upper slope.





Photo 45. Mile 2.95. Dead west bank alders and scarce new alders at edge of unshaded stream.



Photo 46. Mile 3.0. Severe burn on both banks and west slope.





Photo 47. Mile 3.0. East slope from trail, with trunk sprouts on redwoods and basal sprouts on tanbark oaks.



Photo 48. Mile 3.0. West slope from near the trail. Some redwoods with sprouts on branches.





Photo 49. Mile 3.05+, Camp Herbert. Burned forest with dead tanbark oak trunks, but with basal sprouts and redwoods with trunk and branch epicormic sprouts.



Photo 50. Mile 3.05+, Camp Herbert. Redwoods with epicormic trunk and branch sprouts alongside dead Douglas firs.





Photo 51. Mile 3.05+, Camp Herbert. Steep, eroded west slope.



Photo 52. Mile 3.05+, Camp Herbert. Steep eroded slope and substantially filled pool from lower west slope erosion.





Photo 53. Mile 3.05+. Camp Herbert. Dense ground cover under burned canopy. Recovering burned California bays.



Photo 54. Mile 3.05+. Less steep and vegetated east slope at Camp Herbert.





Photo 55. Mile 3.05+. West slope viewed through alders on lower East Fork, with severe burn and debris flow from ridge top to Waddell Creek, responsible for much of the channel filling downstream.

### **WEST FORK WADDELL CREEK**



Photo 56. Confluence of East and West forks, mile 3.1. All alders killed on the flats between the two forks.





Photo 57. West Fork, mile 3.1+, looking downstream. Formerly a long and deep (2-3+ ft) fish sampling pool, now half filled with sediment, except at head of pool.



Photo 58. West Fork, mile 3.1+, looking upstream. Long glide and pool fish sampling habitat, now filled as mostly glide habitat.





Photo 59. West Fork, mile 3.1+. California bays and redwoods alive, recovering. Tanbark oaks with basal sprouts.



Photo 60. West Fork, mile 3.15+, looking downstream. Downstream portion of large pool formed at old stump with large redwood growing from the nurse stump. Now almost completely filled with fines and small mudstone gravel. Remaining channel is a narrow run along the right bank





Photo 61. West Fork, mile 3.15+. Upstream portion of large pool at stump, formerly too deep (3-4 ft) to efficiently sample and with deep undercut under the old down trunk. Pool now shortened and 75% filled.



Photo 62. West Fork mile 3.15+. Channel and streamside conditions upstream of nurse tree pool sample habitat.





Photo 63. West Fork mile 3.15+, looking upstream. Formerly deep pool (3-4 ft) with large wood and right bank backwater near the head. Frequently too deep to sample effectively. Now more than 90% filled, leaving shallow glide and pool habitat.



Photo 64. Immediately upstream of the pool in photo 63, looking upstream. This formerly was another large, deep (2.5-3 ft) pool below and immediately above a large spanning log. The log is gone, and only shallow (to 1 ft) glide and pool habitat remains.





Photo 65. West Fork, mile 3.15. Stand of big-leaf maples with basal sprouts and 1 tree with recovering canopy.



Photo 66. West Fork, mile 3.2, East Slope. Redwoods with epicormic sprouting on trunk and branches, and standing tanbark oaks with basal sprouts. Well-developed ground cover on moderate slope.



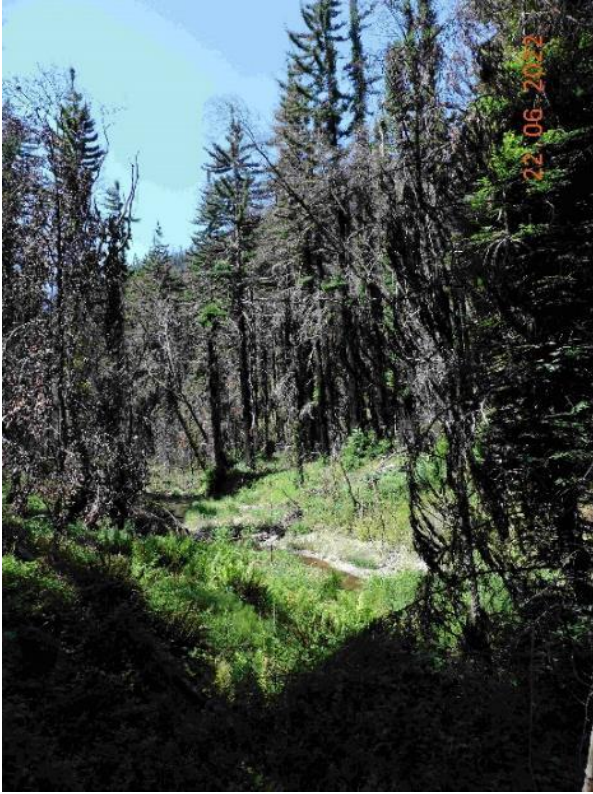


Photo 67. West Fork, mile 3.35, looking downstream. Near-stream habitat, with open canopy, ground cover densely developed, and flat aggraded channel.



Photo 68. West Fork, mile 3.4. Basal sprouts on burned redwoods.



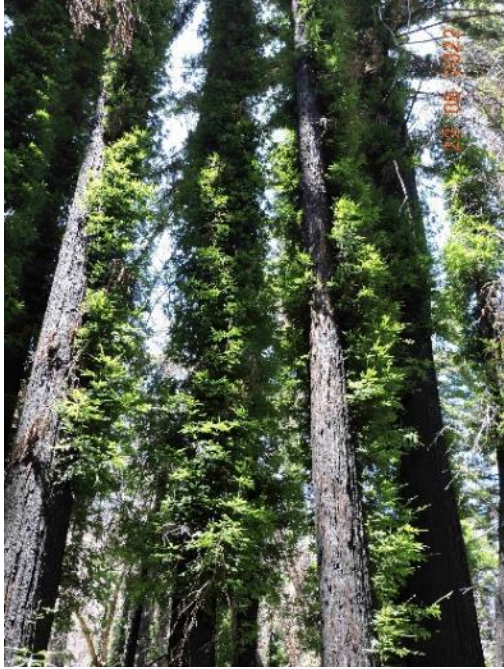


Photo 69. West Fork, mile 3.4. Epicormic sprouts on redwood trunks and branches.



Photo 70. West Fork, mile 3.4. Streamside habitat at a 1998 large logjam (a frequent partial fish passage barrier) that was substantially burned in the fire. Now passable in aggraded channel.





Photo 71. West Fork, mile 3.45. East slope, with ground cover, redwoods with basal and epicormic sprouts, and dead Douglas firs.



Photo 72. West fork, mile 3.45. Looking across aggraded channel to eroded west slope.





Photo 73. West Fork, mile 3.45. Large fallen tree and accumulated smaller wood is potentially a loose and erodible jam. The channel upstream is aggraded.



Photo 74. West Fork, mile 3.45+. Looking across aggraded channel to eroded west slope. Downed trunks had created a log jam and high channel step (a significant fish barrier) in 2021. The aggraded channel has buried the channel logs and eliminated the step. Dense ground cover.





Photo 75. West Fork, mile 3.5. Trailside wetland with 5 large burned redwoods fallen from the wet soil. Even the fallen redwoods have epicormic sprouts. East slope with basal and trunk sprouting redwoods and some dead Douglas firs.



Photo 76. West Fork, mile 3.5+. East slope with dense ground cover, recovering redwoods, and dead Douglas firs.





Photo 77. West Fork, mile 3.5+. Largely bare and eroded west slope. Few recovering redwoods except near stream.



Photo 78. West Fork, mile 3.55. West slope with poor ground cover, and mostly dead trees. An eroding drainage gully is to the left in the photo. Channel is substantially aggraded.





Photo 79. West Fork, mile 3.55. East Slope with gentler slope, more ground cover, and higher density of dead and recovering trees.



Photo 80. West Fork, mile 3.55+, looking upstream. Bedrock outcrop in channel and on lower slope has narrowed the riparian zone. All alders were killed by fire, but streamside and upslope maples have basal sprouts.





Photo 81. West Fork, mile 3.55+, looking downstream. Bedrock-controlled channel with dead alders.



Photo 82. West Fork, mile 3.55+-, looking upstream. All alders dead, all streamside and lower slope maples with basal sprouts; presently no canopy shade.





Photo 83. West Fork, mile 3.6-, looking across to west slope. Eroding gully with a sediment and log delta spilling into stream. Terrace to the left of gully may be remnant from an old debris flow.



Photo 84. West Fork, mile 3.6, looking upstream. Aggraded channel, dense riparian ground cover, and eroding west slope.





Photo 85. West Fork, mile 3.6+. Steep and eroding west slope, with few live trees.



Photo 86. West Fork, mile 3.6+. Steep, eroding west slope, with a few surviving redwoods with trunk sprouts at the bottom of the slope.





Photo 87. West Fork, mile 3.6+. East slope, with dense ground cover and many recovering trees on less steep terrain than the west slope.



Photo 88. West Fork, mile 3.6+, looking upstream. Streamside habitat and substantially aggraded channel downstream of fish sampling site.





Photo 89. West Fork, mile 3.6++, looking downstream. Uppermost sampling pool of fish sampling site was deep (3+ ft) and long through 2021. The pool was completely filled in winter 2021-2022. Steep eroding west slope is in background.



Photo 90. West Fork, mile 3.6++, looking upstream. The large, deep pool immediately upstream of the sampled habitats was previously too deep to electrofish. Now it is 95% filled with fines and gravel, except for a small scour pocket at a rootwad at the upstream end.





Photo 91. West Fork, mile 3.6++, looking across channel to right bank (west) terrace. The narrow, recovering terrace forest is backed by a steep, eroding, west slope, with few live trees.



Photo 92. West Fork, mile 3.7. Large fallen trees in aggregated channel.



**EAST FORK WADDELL CREEK**



Photo 93. East Fork, looking downstream of trail ford. Almost all alders along stream and on flat were killed by the fire.



Photo 94. East Fork, looking upstream of ford. Alders and Douglas firs are dead. Tan oaks with basal sprouts on dead trunks, and redwoods recovering with epicormic sprouts. Footbridge with some boards burned in the fire. Channel with sandstone and mudstone cobbles and boulders. The stream is in the Butano sandstone farther upstream.





Photo 95. East Fork, looking upstream from footbridge. Streambed immediately upstream is bedrock and boulder pools with little change.



Photo 96. East Fork from trail. North slope and flat with all Douglas firs killed, but redwoods survived.





Photo 97. East Fork, bedrock pool upstream of footbridge. Some silt on bottom, but no pool filling.



Photo 98. East Fork. Head of bedrock pool cut off by deposition of cobbles and boulders from channel realignment in bend immediately upstream. High flows in October and December 2021 scoured the channel, but no aggradation or pool filling.





Photo 99. East Fork, bend upstream of bedrock pool, looking downstream. Burned and fallen alders and redwoods from bank scour in bend had forced channel to left and away from 1998 storm pool and large downed redwood near right bank. Evidence of high flows, but no channel aggradation upstream or downstream.



Photo 100. East Fork, mile 0.1. South slope with burned, but recovering redwoods. Few tanbark oaks, with dead trunk, but basal sprouts. The few Douglas firs are dead.





Photo 101. East Fork, mile 0.1. North slope (south-facing) with sparse surviving redwoods, some dead Douglas firs, and tanbark oaks dead, except many with basal sprouts.



Photo 102. East Fork, mile 0.15+, looking downstream. South slope and channel, with recovering redwoods to streamside and dead alders.





Photo 103. East Fork, mile 0.15+. North slope with surviving redwoods at base and mostly dead Douglas firs and burned tanbark oaks with basal sprouts upslope. Dense ground cover on terrace, including blackberry.



Photo 104. East Fork, mile 0.2. Deep former fish sampling pool with little change except more apparent silt on bottom. No significant filling. Algal growth in mostly unshaded channel.





Photo 105. East Fork, mile 0.2. Head of deep fish sampling pool, with clean substrate, except coating of silt farther downstream.



Photo 106. East Fork mile 0.2+. Dead alders with recovering redwoods with epicormic sprouts on terrace above stream.





Photo 107. East Fork, mile 0.2+. Clean boulder and cobble channel, but with alder shade removed.



Photo 108. East Fork, mile 0.2+. South slope with dead Douglas firs, many tanbark oaks with basal sprouts, and redwoods with epicormic sprouts on trunk and branches.



**EAST SLOPE BYPASS ROAD (STEVENS CAMP TO THE FORKS CONFLUENCE)**



Photo 109. Bypass road = mile 2.7. Dead Douglas firs and burned tanbark oaks, many with basal sprouts. Well-established ground cover, including blue blossom ceanothus.



Photo 110. Bypass road = mile 2.7+. Dead Douglas firs and tanbark oaks with basal sprouts. Some surviving redwoods farther down slope. Ground cover includes ***French*** broom in road. No road erosion.



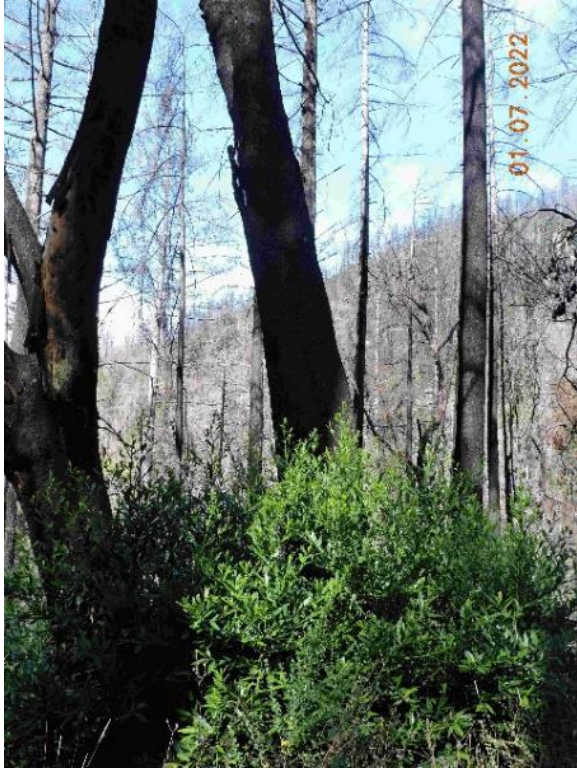


Photo 111. Bypass road = mile 2.7+. Burned California bays with basal sprouts. West slope above Waddell Creek in background.



Photo 112. Bypass road = mile 2.75. The only downed tree obstructing road on 1 July.





Photo 113. Bypass road = mile 2.75. Looking from road to west slope above Waddell Creek, with severe upper slope burn. Looking through dead Douglas firs and some recovering redwoods with epicormic sprouts.

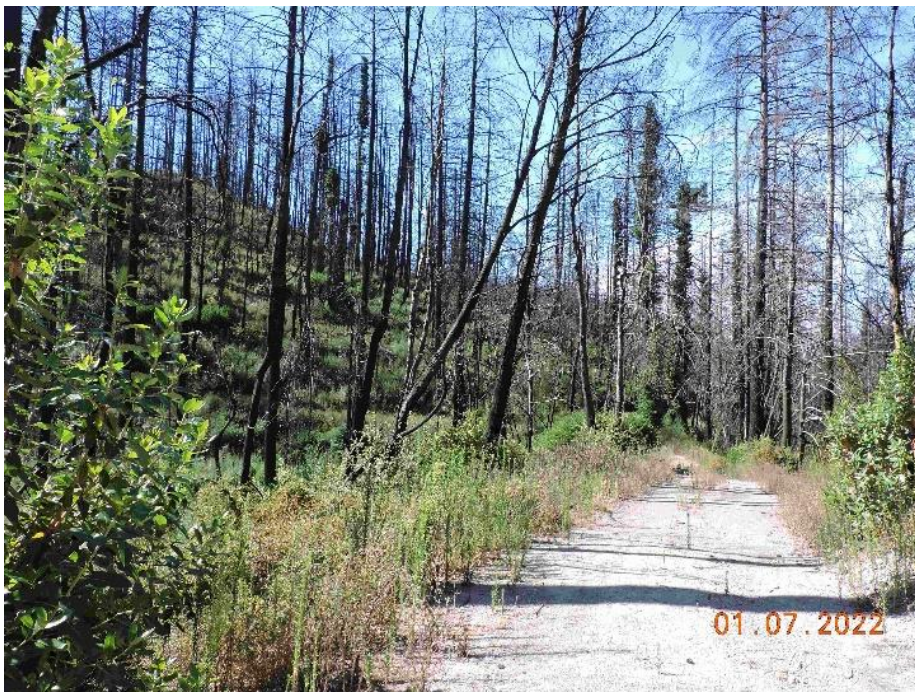


Photo 114. Bypass road = mile 2.8+. Dead Douglas firs, redwoods with epicormic sprouts, and tanbark oaks with basal sprouts. ***French*** broom in road.





Photo 115. Bypass road = mile 2.8+. Basal sprouts at base of dead tanbark oak trunk.



Photo 116. Bypass road, mile=2.8+. Basal sprouts from dead and down madrone. 2021 salvage logging in background.





Photo 117. Bypass road, mile=2.8+. 2021 salvage logging, with many dead Douglas firs left standing. Damaged redwoods cut and stump sprouting. Ground cover is dominated by blue blossom ceanothus.



Photo 118. Bypass road, = mile 2.8+. Looking across and upstream to west slope, with the ridge to creek debris flow scar at the confluence of the forks. Branchless redwoods with trunk epicormic sprouts.





Photo 119. Bypass road, mile=2.8+, looking downslope from road near top of slope. Dead Douglas firs, some tanbark oaks and redwoods with basal sprouts.



Photo 120. Bypass road, mile=2.85, near crest of road. Blue blossom ceanothus, with 2021 salvage logged area in background.





Photo 121. Bypass road, mile=2.85+. Redwoods with epicormic sprouts on trunk and dead Douglas fir (to right) in the salvage logged area.



Photo 122. Bypass road, mile=2.85+. Top of unmaintained state park road down to the forks. Basal sprouts on tanbark oaks and trunk sprouts on redwoods. Road in good shape, despite lack of water bars, but with sections of dense **French** broom and blue blossom ceanothus.





Photo 123. Bypass road, mile=2.85++. Upslope roots of tanbark oak (upper middle in photo) with dead trunk able to hold cut bank soil in place through winters of 2020-2021 and 2021-2022.



Photo 124. Bypass road, mile = 2.85++. Small redwood (<1" dia), presumed dead in 2021, but with basal sprouts. Upslope with dense tanoak trunks with vigorous basal sprouts.





Photo 125. Bypass road, mile=2.9. Tall and dense blue blossom ceanothus and **French** broom in road. High cut bank shows no evidence of erosion.



Photo 126. Bypass road, mile=2.9. Upslope tanbark oaks and downslope dead Douglas firs and tanbark oaks with basal sprouts. Remnants of fallen burned trunks located just off the road, which has sparser broom and blue blossom.





Photo 127. Bypass road, mile=2.9+. Looking downslope from road after it has descended half way to the forks. The lower slope is wetter and has more recovering redwoods.



Photo 128. Bypass road, mile=2.95. One several burned and fallen trunks that blocked half the road in 2021. They had been trimmed to allow potential vehicle passage.





Photo 129. Bypass road, mile=2.95. Looking upslope at recovering redwoods and tan bark oaks with basal sprouts.



Photo 130. Bypass Road, mile = 3.05. Looking downslope near Camp Herbert, with mostly recovering redwoods with epicormic sprouts.





Photo 131. Bypass Road, mile=3.1-. Bottom of bypass road looking uphill. with small leaning tree in road.