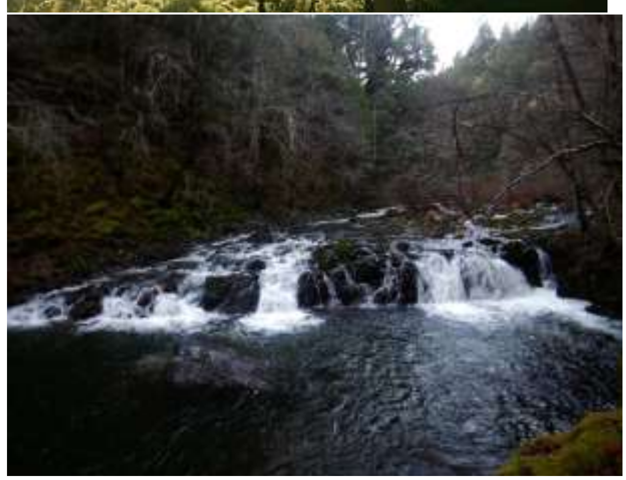
Tenmile Creek Watershed Conservation and Restoration Action Plan





By the Eel River Recovery Project

For the California State Coastal Conservancy & Prop 1 Grant Fund
July 31, 2020

Contents

Acknowledgements

The Eel River Recovery Project would like to sincerely thank the California State Coastal Conservancy (SCC) for awarding a Prop 1 funded grant to us for the Tenmile Creek Conservation and Restoration Pilot Project for which this report is a culminating product. This grant has afforded us the opportunity to engage the residents of the Tenmile Creek watershed and the Laytonville area. We have already taken tangible steps toward restoration before this report has been completed. Next, thanks to all our volunteers. Also, the newly forming Tenmile Creek Watershed Council (TCWC) members deserve commendation for listening, learning, sharing and helping ERRP engage the community. Thanks to Jim Shields, the Laytonville County Water District and the Mendocino Observer. Without coverage in the Observer, our organizing efforts would not have been as fruitful. The members of the Black Oak Ranch community and the Tenmile Creek Road Association (TCRA) merit special mention for their partnership, which enabled this project's success.

ERRP appreciates its close working relationship with the Cahto Indian Tribe in monitoring Cahto Creek, and for the Tribe contributing information to this *Action Plan* that reflects their priorities for natural resource management. The Mendocino County Resource Conservation District (MCRCD) has been an active partner of ours in the Tenmile Creek watershed, and elsewhere in the Eel River watershed in Mendocino County. Their efforts to stem the tide of sediment coming from rural roads and to help landowners better manage their transportation networks are a great corollary effort to ours.

The State Water Resources Control Board (SWRCB) and their staff provided technical support by installing water flow gages at four locations before this project opened in April 2018. They will maintain the flow gages after this project closes later this year. North Coast Regional Water Quality Control Board (NCRWQCB) staff also deserve recognition for participating in flow related scientific discussions, helping operate the flow gages, and assisting ERRP with preparation of a SWRCB 319h non-point source pollution abatement grant that will allow us to fix 620 feet of critical riparian habitat on salmon bearing tributaries of Tenmile Creek in 2021.

Tenmile Creek Watershed Council

Tenmile Creek Conservation & Restoration Pilot Project Goals

- Win cooperation for community water conservation and begin restoring Tenmile Creek flow, starting with important west-side tributaries Streeter and Big Rock creeks.
- Reach out to all riparian land owners in the watershed and offer free assessments and planning for future restoration using bioengineering techniques.
- Assess watershed-wide gully erosion problems, reach out to land owners with gully problems, perform assessments and plan implementation.
- Collect scientific information on flow, water temperature, habitat quality and fish life as baseline data so that trend data can be collected in the future to gauge project success.
- Support the formation of the Tenmile Creek Watershed Council (TCWC) as a fulcrum for local organizing and to foster local capacity for project implementation and adaptive management.
- Create the *Tenmile Creek Watershed Conservation and Restoration Action Plan* as a blue print for restoration that the TCWC and the community can follow to restore the Tenmile Creek ecosystem and to attain community water security despite climate change impacts.

A Note About References

Since this publication is aimed at the general public, it does not adopt the convention of scientific citations where each statement has a supporting reference. Instead, at the end of each chapter there is brief summary of scientific literature that supports the assumptions and statements, and references for key documents on which other parts of the project are founded. All documents cited are in the Reference section and some have links to the full reports.

Background

The Eel River Recovery Project (ERRP) is a tax-exempt non-profit corporation (IRS 501c3) that since its inception has assisted citizen monitoring of water temperature, flow conditions, toxic algae and fisheries to help the community gauge the health of the Eel River ecosystem. As data showed that habitat conditions were compromised and flows decreasing, we organized outreach events to promote water conservation and water pollution prevention. In 2015-2016, a State Water Resources Control Board (SWRCB) grant was awarded to ERRP for the *Eel River Monitoring, Outreach and Education Project*, which documented the need for additional water conservation measures to be adopted by cannabis farmers and other rural residents to help restore stream flow.

Figure 1 ERRP meeting on water rights and water conservation at Harwood Hall on March 26, 2016.

We began looking for opportunities to promote water conservation in key Eel River sub-basins, and chose Tenmile Creek because it is one of the most important tributaries of the South Fork Eel River with regard to Pacific salmon species production, and has significant recovery potential. The Laytonville area of Mendocino County within the Tenmile Creek watershed qualifies as severely economically depressed. Therefore, this plan is also dedicated to improving flows and water security for watershed residents, many of whom are economically disadvantaged, and to help community resilience in the face of climate change.

This background section describes the principal sources of stress for Tenmile Creek and is provided to increase understanding of how the watershed has changed over time in order that a clear vision of desired future conditions and the path to restoration can be defined. Tenmile Creek Chinook salmon and steelhead (Figure 2) will benefit greatly from improved stream habitat, but coho salmon restoration would represent the ultimate sign of success.

Before European contact, the Tenmile Creek valley would have been a vast interconnected system of wetlands, including beaver dams. Coho salmon juveniles likely thrived in the ponds above the dams, which also helped maintain stream baseflow. National Marine Fisheries Service maps of coho salmon intrinsic potential indicate that Tenmile Creek had some of the most optimal habitat in the Eel River watershed for the species (Figure 3).

The Cahto people impounded streams in some areas, forming small lakes that would have helped maintain baseflow. Their management of vegetation also helped promote healthy flow levels. Controlled burns were used to maintain oak woodlands, and oaks use very little water in summer. Deeply rooted native grasses comprised the meadows, which were maintained by the Cahto people with fire to provide forage for elk and deer. These intact grasslands were also water banks. Cessation of the use of fire by Native Americans began a slow, but inexorable change, as vegetation previously controlled spread and changed ecological and hydrologic watershed conditions (Figure 4).

Grazing from 1859 to 1888 caused an almost complete replacement of native grasses with annual European species that are more shallowly rooted. This led to episodic erosion and loss of water storage capacity. Since the 1950's, cattle and livestock grazing has decreased and the encroachment of Douglas fir into grasslands has accelerated. This can have a major impact on flow, especially, if firs colonize around springs. Suppression of fire has given a selective advantage to non-native grasses and gullies have lowered the water table and water storage capacity of meadows.

Post WW II logging of the old growth conifer forests had profound impacts on the Tenmile Creek watershed. Heavy equipment traversed steep slopes and ran up and down stream channels to skid logs, and some channels have lingering hydrologic problems today. The disturbance was followed by the 1955 and 1964 floods that changed Eel River stream channels, including Tenmile Creek, from deep and cold to shallow, wide and warm.

While much of the sediment from this era has been flushed downstream or to the ocean, abandoned logging roads may still be disrupting hydrology and contributing sediment as a result of gully erosion and mass wasting. Road systems originally constructed for logging have been converted for use as residential transportation networks that can contribute chronic sediment or catastrophic levels, if they fail during major storm events. Cumulatively, these roads also increase peak flows and decrease baseflows, especially if they have in-board ditches instead having the road out-sloped.

Figure 2 Juvenile steelhead feeding in Big Rock Creek. 6/2/20.

Figure 3 Map of Tenmile Creek with coho salmon Intrinsic Potential, with darkest blue of greatest likely historic use by coho salmon. IP data from Williams et al. (2004). Map by Dr. Paul Trichilo for ERRP.

Figure 4 Coniferous trees over-topping oak forest in upper Streeter Creek watershed, which is undesirable for a number of reasons, including loss of summer base-flow.

Post WWII logging led to over-stocked forest conditions that are depleting baseflow in streams like Streeter Creek. Young firs use much more water than old growth trees and there are thousands more trees in the same area as before logging. This leads to an increase in the amount of water the forest uses during evapotranspiration, which leaves less water in the stream in late summer.

Cannabis farming, after legalization of medical marijuana in 1995, grew substantially in the Tenmile Creek watershed, and elsewhere in the Eel River watershed, and was thought to be contributing significantly to stream flow depletion. However, cannabis uses much less water than row crops and the methods of culture and irrigation vary. In Streeter Creek, one of this project's water conservation targets, we found that it was not water diversion for agriculture that was depleting baseflows, but rather altered watershed hydrology.

The role of groundwater withdrawal in the Tenmile Creek watershed on stream flow and availability of groundwater to adjacent parcels needs further study, because installation of additional large wells could have negative impacts on both. Increased groundwater withdrawal could also confound surface water conservation, even if we are successful in getting widespread cooperation for forbearance.

Chapter 1: Restoring Tenmile Creek Riparian Zones

The California State Coastal Conservancy (SCC) awarded Prop 1 funds to the Eel River Recovery Project requiring a plan to be formulated for restoring Tenmile Creek riparian zones basinwide. Much of the riparian zone of Tenmile Creek is unique in the Eel River watershed because it is intact, and often comprised of old growth oak species (Figure 5).

The western watershed is underlain by the porous sandstone of the Coast Range with slopes covered by coniferous forest. Steep tributaries coming off Cahto Peak have conifer and hardwood canopies, some impacted by past logging, but most largely in recovery from previous disturbances (Figure 6). The east side of Tenmile Creek is underlain by Central Belt Franciscan Mélange Terrain with sheared underlying soil materials that tend to have more grasslands. The creeks flowing from the east side, such as Lewis Creek, have good riparian shade provided by native hardwoods, but do not tend to develop a second tier of canopy (Figure 7) like Tenmile Creek on the valley floor.

We used spatial data based on Landsat classified imagery to assist in assessment of Tenmile Creek riparian zones. Figure 8 is a map showing tree size within a 90-meter buffer zone, which reveals differences as discussed above. Riparian zones on the shoulders of Cahto Peak to the west have larger trees, including some greater than 24 inches in diameter at breast height (dbh). The main stem of Tenmile Creek has large reaches of medium trees (11-19" dbh) with some large trees that are sometimes comprised of old growth oak. Streams through meadows on the east side of the watershed show no tree cover, but they may have riparian trees that are not shown because of resolution issues. Nonetheless, the map is a useful tool for understanding riparian health.

Figure 5 Reach of mainstem Tenmile Creek above Tenmile Creek Road with mature oak and hardwood canopy.

Figure 6 Upper Mill Creek intact riparian canopy with over-story helps keep stream temperatures optimal for salmonids at this location.

Figure 7 Lewis Creek flowing west to Tenmile Creek with good hardwood canopy with Cahto Peak in the distance.

Riparian Restoration Sites

We began outreach in August 2018 to let land owners know about riparian restoration opportunities, including direct mail questionnaires that were mailed to all land owners in the Tenmile Creek watershed. Dozens responded requesting technical assistance; many need help with eroding stream banks. BioEngineering Associates (BE) was part of the pilot project team and visited land owners to inspect their riparian zones and to begin discussions about remediation and the potential for obtaining grant assistance resources. A description of each site follows.

Hogan Property (Cahto Creek): Cahto Creek has steelhead, Chinook and even coho salmon in some years and in general is not over-supplied with sediment. The total length of the site on the Hogan property is 130 feet and the height of the streambank is 9 feet (Figure 9). The streambank is near vertical and lacking any stabilizing vegetation. There are many exposed tree roots along the bank and five mature trees which are growing near the top of the bank and are in danger of falling into the creek. The streambank erosion threatens the popular Cahto Creek Trail, which runs from Mulligan Lane to Harwood Park.

Kelly Property (Cahto Creek): The actively eroding streambank of Cahto Creek at the Kelly property is near vertical and lacks stabilizing vegetation (Figure 10). The site is 110 feet long and the streambank is 12 feet high. The site is located on the outside of a sharp 90-degree bend in the creek. Numerous trees that have fallen into the creek from the bank and there are two trees which are poised to fall into the stream, if the erosion is allowed to continue. The Cahto Creek Trail runs along the stream at the top of the bank and streambank erosion is threatening a section of the trail as well.

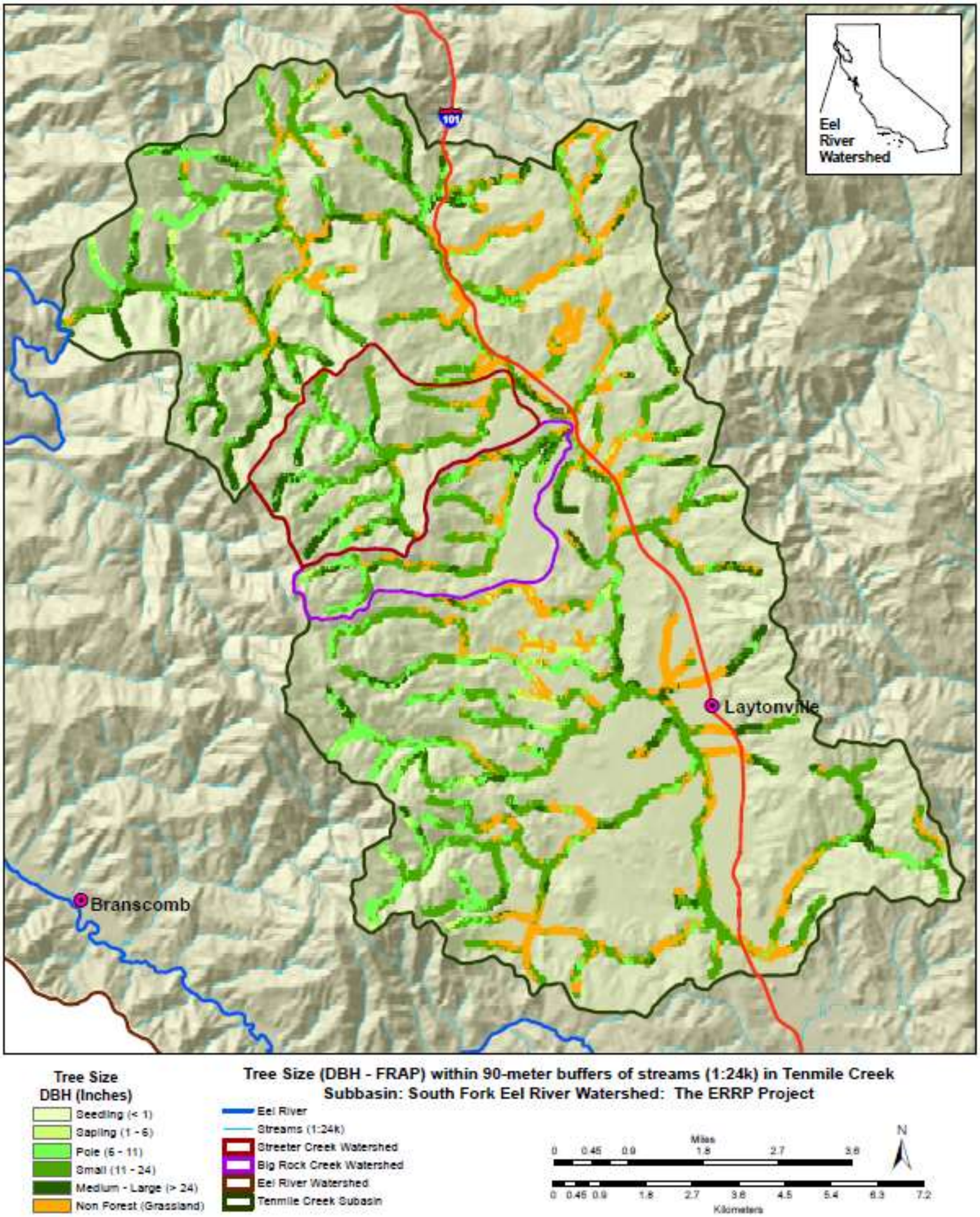


Figure 8 Classified Landsat imagery showing 90-meter buffer Tenmile Creek and tributary riparian zones. USFS data with map by Dr. Paul Trichilo.

Figure 9 Dennis Hogan on Cahto Creek with eroding bank threatening Cahto Trail.

Figure 10 The Kelly property on Cahto Creek and also along the Cahto Trail.

Feigon Property (Mill Creek*)*: Mill Creek is a major tributary of Tenmile Creek that can harbor all three native species of Pacific salmon. At the upstream end of the property is an actively eroding streambank that is near vertical and contains no stabilizing vegetation. The total length of the eroding streambank is 280 feet and bank height is 12 feet (Figure 11). The site is located on the outside of a sharp, 90-degree bend in the creek. A gravel bar has developed on the inside bend of the creek and is pushing the creek into the site. The landowners have reported losing between one and four feet of streambank per year. There are six mature trees growing at the top of bank that will fall into the stream, if the erosion is allowed to continue.

Black Oak Ranch (Streeter Creek): Streeter Creek flows off the shoulders of Cahto Peak and joins Tenmile Creek on the Black Oak Ranch. The bank erosion feature identified on Streeter Creek is 80 feet long and 18 feet high (Figure 12). It is a rare feature, since most of the rest of the reach has been restored. Streeter Creek gets steelhead and occasional coho and Chinook salmon depending on flows.

Figure 11 Mill Creek 300-foot-long failing bank on Feigon property.

Figure 12 Bank failure on Streeter Creek dumping soil into prime fish habitat.

Weaver Property (Main Tenmile Creek): The Weaver property is just upstream of the Black Oak Ranch. There is a major bank failure along the west side of Tenmile Creek not far below the convergence of Big Rock Creek (Figure 13). The site is located along the downstream end of a long outside bend in the creek. The actively eroding streambank is 175 feet long with 6 to 25-foot-tall banks. The streambank is nearly vertical and lacking any erosion resistant vegetation. There are numerous ponderosa pine trees growing near the top of bank that are in danger of falling into the stream if the erosion is allowed to continue.

Varnhagen Property (Cahto Creek): This reach of Cahto Creek is above the Cahto Tribe Reservation where extensive riparian restoration and bank erosion repair has taken place. The Varnhagen site is a rare large erosional feature and a major source of sediment to this reach. The site is an actively eroding streambank 250 feet long with a 10 to 25-foot-tall bank (Figure 14). The creek makes a sharp 90-degree bend with the actively eroding streambank on the outside bend of the creek. On the inside of the bend on the opposite side of the creek is a large gravel bar. There are many fallen trees which have been deposited on the bar. The gravel bar is increasing in size with each large storm and putting more pressure on the actively eroding streambank.

Black Oak Ranch (Main Tenmile Creek): Several sites with large vertical, eroding cut-banks, exist on the BO. The site shown in Figure 15 is 530 feet long with 12 to 20-foot-tall banks. The streambank is actively eroding and lacking any erosion resistant vegetation. There are numerous trees growing at the top of bank which are in danger of falling into the creek if the erosion is allowed to continue.

Unknown Landowner (Tenmile below Cahto Creek): ERRP and BE have identified several other significant bank erosion sites that need treatment, but we have not had time to contact land owners or do in-depth exploration of the size of features and potential for sediment pollution. Figure 16 shows a major bank failure downstream of Cahto Creek with potential to cause major sediment pollution. There are similar features across from Harwood Park along the mainstem of Tenmile Creek where work is needed but contacts not yet made.

Figure 13. Tenmile Creek on Weaver property below Big Rock Creek. 1/13/20.

Figure 14. Tony Varnhagen and bank erosion site on his property. 9/8/19.

Figure 15. Eroding bank on main Tenmile Creek on BOR.

Figure 16. Main Tenmile Creek below Cahto Creek. 9/13/18.

Criteria for Project Selection:

ERRP and BE found dozens of minor bank erosion sites in extensive surveys of Tenmile Creek and its tributaries, but only a few rose to the level of consideration for remediation. In choosing which sites to consider, and then further ranking them for priority for treatment, the following selection criteria were employed.

- **Amount of Sediment Saved** - The amount of sediment saved – what is the height, length and arc of the bank failure and how much sediment has it yielded, and is it likely to yield, and how does the site compare with other potential project sites in the Tenmile Creek watershed.
- **Riparian Temperature Benefits/Wildlife:** Potential to restore stream shade to help lower water temperatures, and gallery forest diversity for the benefit of wildlife.
- **Benefit to At-Risk Salmonid Species:** How critical is the tributary on which the project will take place in terms of serving as habitat for Pacific salmon species that are listed as at-risk under the federal Endangered Species Act or California Endangered Species Act?
- **Cooperation:** Land owner willingness to participate.
- **Potential Synergy** – If reaches adjacent to project sites are intact and undisturbed, or previously restored, then positive cumulative effects are possible as reach-level sediment is reduced and local spawning and rearing conditions change (i.e. reconnection of hyporheic zone, increase in aquatic macroinvertebrate population, etc.).

With regard to ranking associated with benefits for at-risk Pacific salmon species, projects not only rate highly within the Tenmile Creek watershed, but also rank among the highest priority in the South Fork Eel River watershed. The reason for choosing Tenmile Creek in the first place for this SCC Prop 1 grant was that the upper South Fork Eel River is one of the last "source" populations for coho salmon in southern Oregon and northern California, and Tenmile Creek is immediately adjacent. Restoring basins with some remaining ecological function adjacent to source populations should be of the highest priority. Coho colonists are constantly showing up in the creek already, so if we are able to restore habitat and flow in Tenmile Creek through multiple projects, this tributary could become to a source population as it was historically.

ERRP has been awarded a grant from the SWRCB 319h fund for non-point source abatement to remediate four of the highest priority sites, with work to begin in April 2021. An atypical criterion that weighed in favor of the Cahto Creek sites was the opportunity to save a culturally significant resource, the Cahto Trail that runs parallel the creek at the two sites where the bank is failing.

Case Studies of Existing Projects:

There is such a wealth of bioengineering and habitat improvement projects in the Tenmile Creek basin that there should be a comprehensive assessment to fully document their effectiveness. Each project described below has had long lasting value with regard to improving habitat for at-risk salmon and steelhead species in the Tenmile Creek watershed.

Black Oak Ranch (Streeter Creek): Bank failures on Streeter Creek associated with high flows in the 1983 El Nino year triggered the interest and sparked the career of Evan Engber, a Black Oak Ranch member and the founder of BE. Riparian shade has been restored and channel width decreased on lower Streeter Creek, as a result of bioengineering projects in the 1980s and 1990s. Riparian air temperatures also cooled, which has a cooling influence on stream temperatures. However alder mortality is occurring along Streeter Creek, possibly spurred by recent droughts. Himalaya berry, a non-native species, is taking over the riparian zone and some effort is needed to control it (Figure 17).

Weaver Property (Big Rock Creek*):* BE performed extensive bank erosion control and fish habitat improvement in Big Rock Creek, which supports both steelhead trout and coho salmon in some years. Downcutting of this stream on the valley floor has created vertical stream banks, so BE used strategic boulder clusters and bioengineering to prevent erosion (Figure 18). These structures are mostly intact and are stopping bank failure, preventing further loss of stream-side trees and creating pools that form optimal habitat for juvenile salmonids.

Cahto Reservation (Cahto Creek): The Cahto Tribe has won numerous grants to restore Cahto Creek on the Reservation. They have installed numerous large wood structures that are functioning well, preventing erosion and improving the carrying capacity of the creek for salmonids (Figure 19). However, structures can also be heavily utilized by non-native fish species that spill from impoundments upstream (See Chapter 5).

Figure 17. Streeter Creek above Tenmile Creek with restored riparian but out of control Himalaya berries. 6/23/19.

Figure 18. Big Rock Creek boulder clusters installed in the 1990s still preventing bank erosion and scouring a pool. 6/23/19.

Figure 19. Bank erosion control and fish habitat improvement structure on Cahto Reservation.

Figure 20. Cahto Creek with bank revetment on Boulle property.

Boulle Property (Cahto Creek): This property was threatened by bank erosion in the 2017 Water Year and the land owner Cheryl Boulle opted to install large rock on an emergency basis, after Cahto Creek cut a 50-foot swath into her property. She used local experienced contractors to construct the bank stabilization structure to save her barn. Although she was later cited by the California Department of Fish and Wildlife for her unpermitted activities, the structure has created a pool that provides some of the best fish habitat for juvenile steelhead in the adjacent reach of Cahto Creek (Figure 20). Pool scour associated with the structure has created stratification that allowed juvenile salmonid survival in the summer of 2019, when connecting flow in this reach of the creek was lost. ERRP is interested in recruiting volunteers to improve willow growth and to increase riparian species diversity, with land owner permission.

Figure 21. Steve Brown on Peterson Creek. 10/15/19.

Figure 22. Yearling steelhead in lower Peterson Creek. 10/15/19.

Brown Property (Peterson Creek) Peterson Creek is a tributary to lower Tenmile Creek; they converge about 2.5 miles upstream of the South Fork Eel River. The watershed was intensively logged after World War II, but is in recovery from those effects. The 1997 storm caused torrenting and aggradation at the mouth of Peterson Creek resulting in the loss surface flow. In addition, cattle grazing near the mouth was causing nutrient enrichment and eutrophication. Land owner Steve Brown got multiple grants to fence out cattle near the mouth and to place large rock and wood strategically to re-define the channel. Today this reach has a full alder canopy, excellent fish habitat complexity and connectivity to lower Tenmile Creek (Figures 21 and 22). Consequently, Peterson Creek serves as a steelhead refugia and a critical ecological link in the Tenmile Creek ecosystem.

Trend Monitoring:

In order to understand to what degree riparian restoration is succeeding, trend data need to be collected. Long term water temperature monitoring above and below bioengineering projects will allow assessment of water temperature cooling benefits from projects. Similarly, riparian air temperatures taken before and after the projects will help determine whether ambient air cools as the riparian gallery forest increases in maturity. Since ambient air temperature and relative humidity drive water temperature, there could be cooling influence for this reach of Cahto Creek. The sediment monitoring to be carried out in reaches adjacent to projects as part of the 319h project should show a diminishing trend as bank erosion sites are healed. If fine sediment loading is sufficiently decreased, surface and groundwater connections to the hyporheic zone might be re-established, leading to a significant leap forward in ecological function in the arc towards complete restoration of beneficial uses. (See Chapter 5).

Considering Riparian Zone Protection Through Easements:

The multi-tiered canopy of the mainstem of Tenmile Creek as it meanders across the valley floor near Laytonville is comprised of old growth oak trees and other hardwood species and provides extensive shade and cover over the stream. When the old stream side trees fall into the creek, they create habitat complexity and form pools. In most of California, riparian zones have been fragmented and stream-side areas developed. One way to protect Tenmile Creek riparian zones in the future is to arrange the purchase of easements, where landowners retain their ownership but agree to not develop in stream side areas. An alternative would be for riparian areas to be purchased and managed by a land trust, other non-profit organization, or a government agency. Some within the community have a vision of recreational development within riparian zones, similar to the Cahto Trail, but that view will have to be widely shared, if the vision is to be attained. Trails paralleling Tenmile Creek could help improve community health and quality of life, and possibly help draw visitors for ecotourism.

Recommendations

- Implement highest priority bank erosion sites on Cahto Creek along the Cahto Trail, on the Feigon property on Mill Creek above Little Case Creek, and on Streeter Creek at the Black Oak Ranch with SWRCB 319h grant in 2021.
- Seek funding for the second highest priority banks erosion sites in 2021 or 2022, including Cahto Creek at the Varnhagen property, and two Tenmile Creek projects, one on the Weaver property below Big Rock Creek, and the other above Streeter Creek on the Black Oak Ranch (sources 319h & CDFW FHRP).
- Seek funding for third tier of bank erosion control and riparian restoration projects (2022-2023): Tenmile Creek across from Harwood Park and below Cahto Creek, and other upper Tenmile Creek sites (sources 319h & CDFW FHRP).
- Acquire resources to study the feasibility of protecting Tenmile Creek riparian zones through use of systematic easements or acquisitions (TCWC apply to Mendocino County Community Foundation).

Reference Summary for Chapter 1

The U.S. Forest Service (Warbington et al. 1999) provided classified LANDSAT remote sensing data for vegetation and tree size used by ERRP to assess Tenmile Creek riparian zones. The NMFS (2014) *Southern Oregon/Northern California Coastal Coho Recovery Plan* noted lack of riparian habitat and bank erosion as a major source of coho salmon stress in the South Fork Eel River, including Tenmile Creek. The success of Streeter Creek riparian restoration was documented by Higgins (2003) for the California Resource Conservation District Association. Use by steelhead of a bank restoration structure on Cahto Creek on the Boulle property was noted by Higgins (2019). Prioritization of where to restore riparian zones follows the methods of Bradbury et al. (1995). Monitoring is being conducted to support adaptive management as defined by Walters (1997). The recommendation that easements or acquisitions be explored to protect riparian zones is based on Kauffman et al. (1999) and their finding that salmon and steelhead recovery cannot happen without riparian protection and restoration.

Chapter 2: Erosion Control and Prevention

The South Fork Eel River, of which Tenmile Creek is a major tributary, is recognized as impaired as a result of sediment pollution by the U.S. Environmental Protection Agency, which found that roads were the largest source of human-caused excess sediment. The Mendocino County Resource Conservation District (MCRCD) has an active program for abatement of sediment related to roads, and works in partnership with ERRP and the Tenmile Creek Watershed Council (TCWC). Before this SCC Prop 1 Tenmile Creek pilot project, no agency or entity had focused on gully erosion, so they are the emphasis of our project and this report. Also, the Pacific Watershed Associates (2015) *Handbook for Forest, Ranch and Rural Roads* is readily available and thoroughly covers the subject of controlling erosion related to roads.

A gully is defined on Dictionary.com as "a small valley or ravine originally worn away by running water and serving as a drainage-way after prolonged heavy rains". Gullies can form at many scales, with small ones formed by the in-board ditch of a road (Figure 23) or larger ones when water is deflected on to unarmored hillslopes (Figure 24).

Figure 23. Gully in upper Cahto Peak Rd.

Figure 24. Forest gully formed due to deflection of water onto unarmored hillslope.

Modern American culture looks at gullies as unsightly nuisances, but ancient cultures used to manage them as part of agricultural systems. The causal mechanisms of gully formation need to be recognized, if gully erosion is to be successfully addressed. Heede (1976a) observed that "The objectives must be broadened beyond those of defense, and incorporate those of agricultural production, water yield and environmental values". ERRP agrees with this approach and understands the benefit of gully erosion control for restoring watershed hydrology.

“Modern check dam systems can also benefit water yield. Brown observed the conversion of ephemeral stream flows to perennial streams below check dams. He obtained perennial flow seven years after installation of a check dam system where only ephemeral flow had occurred during the previous 50 years. It is postulated that this change is due to water storage in the sediment accumulations above the dams” Heede (1976a).

One factor that makes the Tenmile Creek watershed susceptible to gully erosion is that the Central Belt Mélange Terrain covers the eastern half of the watershed and sheared soils give rises to extensive grasslands. There is no rock layer within the soil of meadows, so if roads cross these areas and concentrate water without armoring below downspouts, they may cause gullies to form (Figure 25). Similar problems may occur below culverts in forested areas as well (Figure 26).

Figure 25. Gully in upper Grub Creek watershed as a result of road drainage. 3/10/20.

Figure 26. Gully formed by drainage from Cahto Peak Road contributing sediment to upper Mill Creek. 7/27/19.

Strategy for Gully Erosion Abatement:

Over 740 landowners in the Tenmile Creek watershed received questionnaires that included questions related to problems with gully erosion. ERRP sub-contractors followed up in the field with those requesting services (Figure 27), photo-documented conditions, and scheduled additional visits to those location with significant gullies in need of treatment. The Star Worksheet (Attachment 1) field form proved useful for data collection (Figure 28). Since gullies often form at the outlet of culverts under roads, ERRP generated a map of road stream crossings as a means of understanding potential sources (Figure 28), and then conducted a partial inventory of accessible roads using Star sheets. Some stream segments with a high number of stream crossings per mile, such as in Grub Creek, pose a significant risk of multiple-crossing road failures and catastrophic channel change.

We were able to get key landowners in the lower Tenmile Creek watershed (Figures 29-30) and in Cahto Creek (Figure 31) to allow assessment of their gullies, and to agree to begin the process for design and permitting of fixes as part of a second SCC Prop 1 grant that was applied for in late April 2020. The lower Tenmile Creek reach is extremely productive for Chinook salmon spawning, therefore, abating local sediment sources is a high priority. Inventories included the Vassar property downstream of Highway 101 that has a road segment paralleling the creek. Numerous sources of gully erosion were also identified along the road on the south side of lower Tenmile Creek that extends down to the mouth of Peterson Creek.

Figure 27. Landowner Bob Vassar points out major sediment deposition from gully on lower Tenmile Creek. 10/16/18.

Figure 28. ERRP contractor Anna Birkas collecting data at the Varnhagen Ranch on Cahto Creek. 2/4/20.

Recognized Road Problems:

ERRP collaborated with the MCRCD on their *Eel River Road Sediment Treatment and Inventory Project* and reconnaissance associated with that project found two road segments that were contributing to sediment; the road paralleling Tenmile Creek on the Vassar property (Figure 32) and the access road to the Cahto Peak Wilderness (Figure 33). The SCC Prop 1 Phase II grant applied for in April 2020 would cover design and permitting on all erosional hotspots on the Vassar Property. ERRP and TCWC will work cooperatively with BLM Arcata that manages the Cahto Peak Road.

Rebuilding the Hydrology of a Gutted Streeter Creek Tributary:

We discovered that use of a major tributary of Streeter Creek as a skid and haul road during Post WW II logging had caused a devastating impact on the creek's hydrology. The cat-logging removed all large wood from the channel. Large wood jams in old growth headwater stream systems form stair steps that slow the flow of nutrients out of tributaries and create excellent habitat conditions for fish, and metered and stored sediment. Each jam also creates a water storage area that discharges cold water over a prolonged period. Removal of large wood allowed the speed of the water in the tributary of Streeter Creek to increase, which in turn translated into increased shear stress, causing the bed of the creek to down-cut. Today the bed of the tributary is largely angular rock delivered during past torrenting. Increased stream velocity has washed out most of the good spawning gravel.

Downcutting is evident, with bare vertical cut banks several feet high (Figure 34), and scarps are opening on hillslopes above the creek. As the Streeter Creek tributary has transported material from stream banks, soil creep is causing the hillslope to adjust. The tension cracks that are opening may have negative implications for soil moisture available for adjacent riparian trees. While walking the stream channel, it was apparent that Class II and Class III tributaries had also been used for skidding during Post WW II logging, and the banks of these smaller streams were still bare and had signs of continuing down-cutting (Figures 35 and 36). The entire tributary has become essentially a large gully, that will not heal itself through passive restoration. Placement of sequential, spider-web large wood jams is needed (see also Chapter 3).

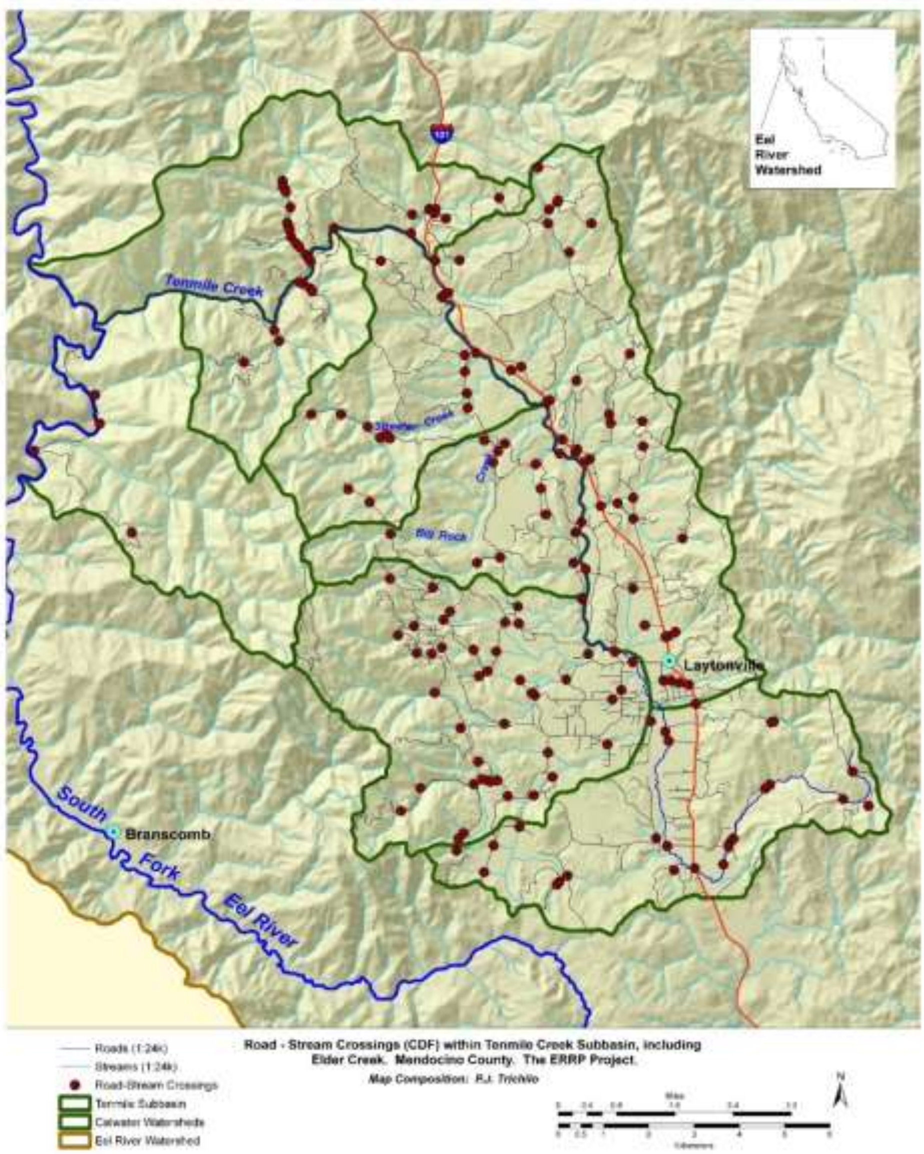


Figure 29. Map of Tenmile Creek watershed with roads and road-stream crossings.

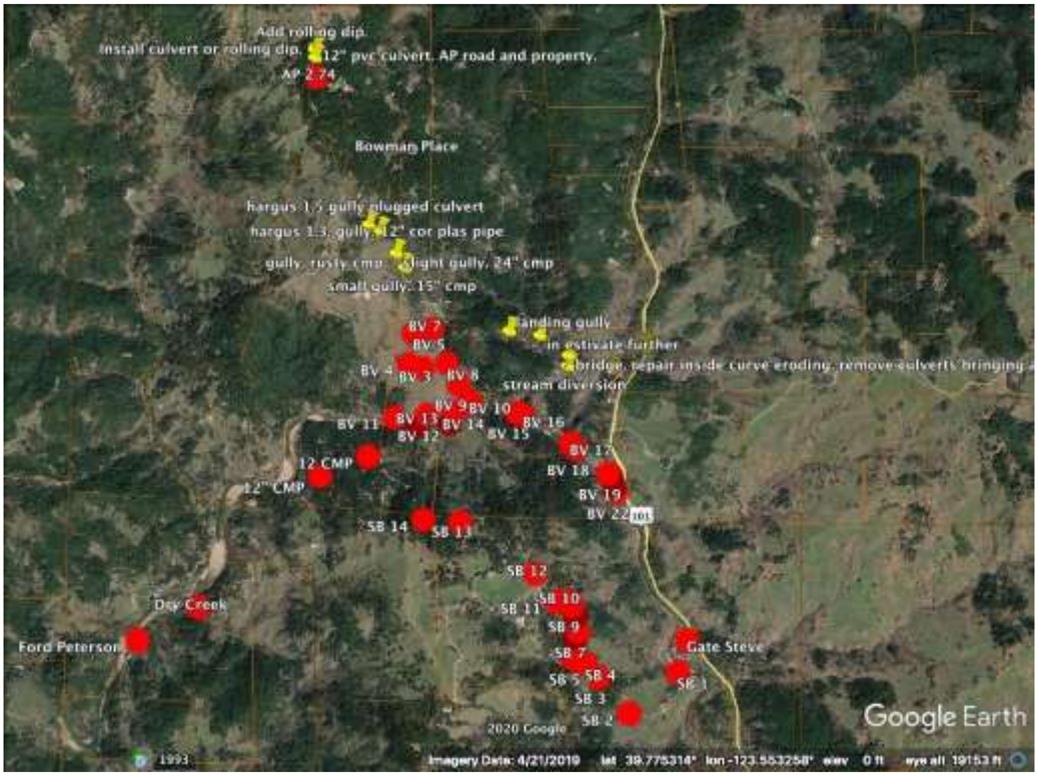


Figure 30. Google Earth Map annotated with sediment sources used to plan the SCC Prop 1 Phase II grant proposal. By Anna Birkas, Village Ecosystems.

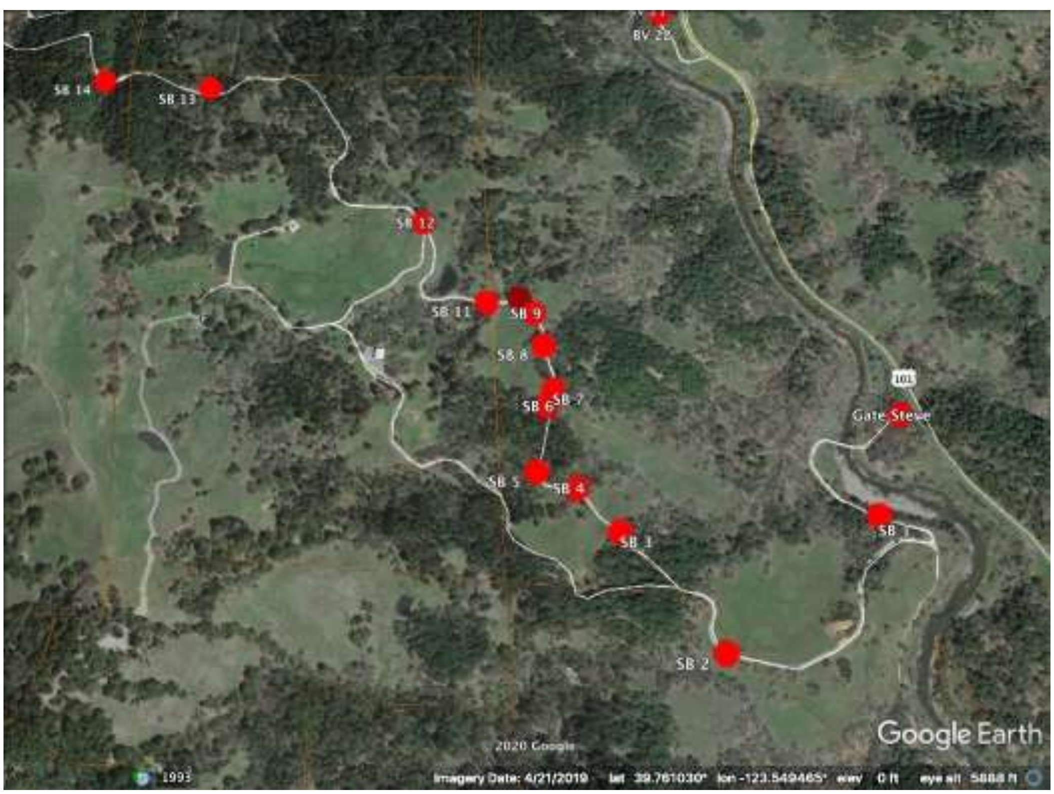


Figure 31. Google Earth Map annotated with sediment sources used to plan the SCC Prop 1 Phase II grant proposal. By Anna Birkas, Village Ecosystems.

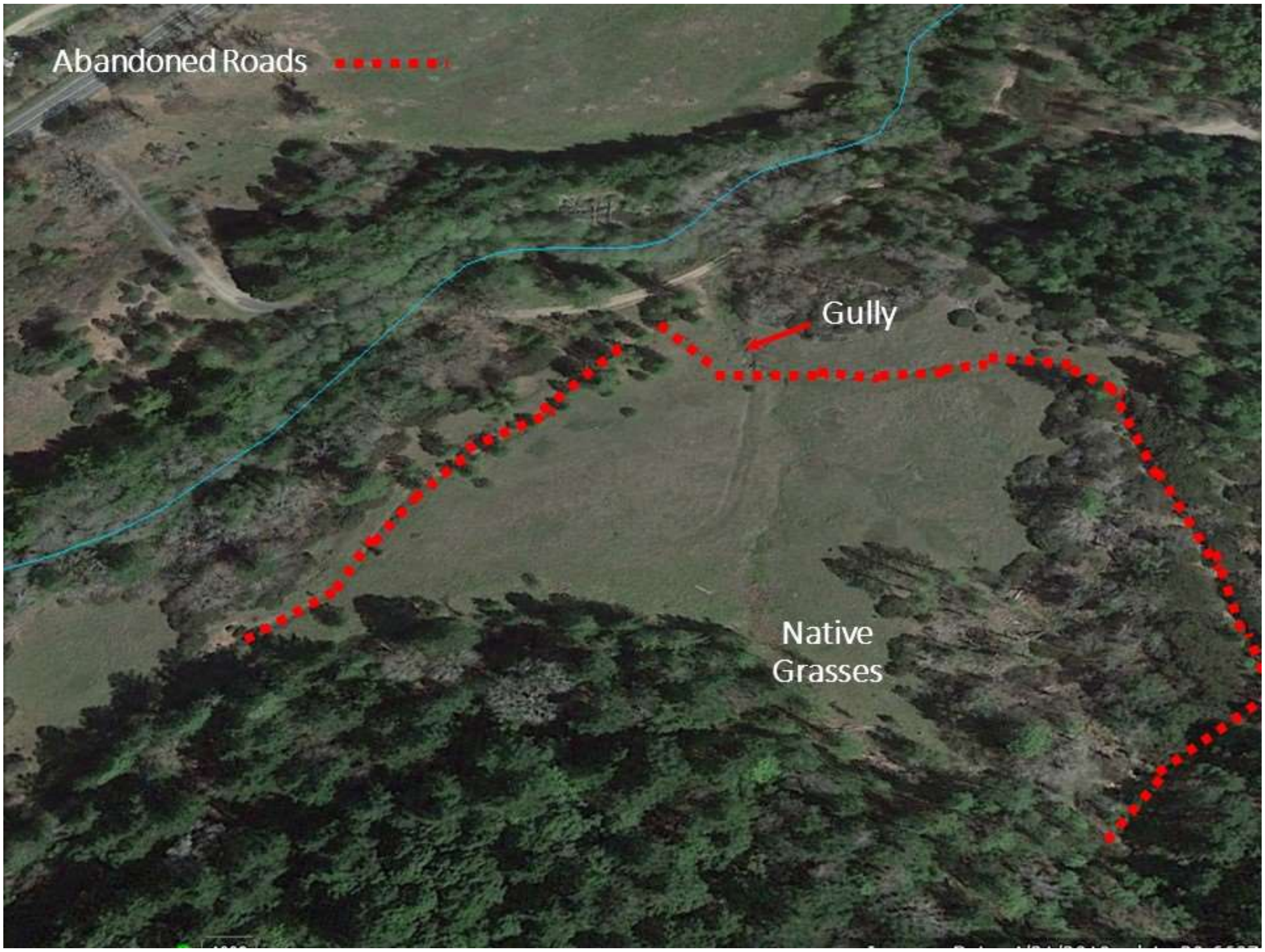


Figure 32. Survey over-view of Varnhagen Ranch gully where legacy roads still disrupt hydrology.

Figure 33. Eroding gully below road paralleling lower Tenmile Creek on Vassar property. 10/16/18.

Figure 34. Road fill failure on upper Cahto Peak Road. 2/4/20.

Figure 35. Down-cut Streeter tributary.

Figure 36. Tributary channel also used as skid trail, bare-banked and down-cutting.

Recommendations

1. Carry out design and permitting for major gullies and other erosion sources identified on lower Tenmile Creek and in Cahto Creek in 2021, if SCC Prop 1 funding is awarded.
2. Do outreach and connect with more landowners who have gully problems, especially in grassland areas or other watershed areas of high erosion risk.
3. Create a prioritized inventory of erosion risk at all stream crossings that are accessible for inventory in the Tenmile Creek watershed.
4. Work with the MCRCD to promote cooperation of landowners and road associations to participate in grants to reduce erosion from roads in the Tenmile Creek watershed.
5. ERRP and TCWC should work with BLM on Cahto Peak Road erosion control and prevention.
6. Explore potential cooperation for rebuilding Streeter Creek tributary hydrology.

Reference Summary for Chapter 2

The *South Fork Eel River Total Maximum Daily Load Report for Sediment and Temperature* (U.S. EPA 1999) established that the river was polluted by sediment and that the largest human-caused source of erosion was roads. This chapter draws on Heede (1976a) who stresses the importance of recognizing why gullies form and treating the root cause. Structural treatments recommended for gully erosion are from Heede (1976a) and Rivas (2006). Heede (1976b) found that streams could be transformed from ephemeral creeks to perennial flow in some cases using a series of check dams. The natural occurrence of very large wood jams before disturbance and their impact on water storage was documented by Sedell et al. (1988). Poole and Berman (2001) and Cramer (2012) describe how large wood can help hydrologic function in stream channels. Monschke (2005) devised the Star-Worksheet. Jones and Grant (1996) documented an increase in damaging peak flood flows and a decrease in stream baseflows associated with high road densities. Haynes et al. (1996) also studied impacts of increased road density on watershed hydrology and aquatic species diversity. Harr and Nichols (1993) documented prevention of stream damage during flood events through prior upgrading of roads.

Chapter 3 – Watershed Hydrology and Stream Flow

A primary goal of this project was to "win cooperation for community water conservation to begin restoring Tenmile Creek flow, starting with important west-side tributaries Streeter and Big Rock creeks". Both streams had been perennial historically, as had Tenmile Creek itself, so the challenge was to discover what had caused stream flow reduction, and then to seek a remedy so flows could be restored. Thomas Gast Associates Environmental Consultants collected stream flow data at five locations in Tenmile Creek in 2018 and 2019 (Figure 37), including baseline data for Streeter and Big Rock which were compared to flows from Elder Creek. Elder Creek has no water withdrawal and no previous land management. It has been extensively studied, and has a long streamflow record allowing for comparison of simulated discharges against the observed discharges. Additional information on flow conditions is in Chapter 5.

In order to discern what might be causing Streeter and Big Rock Creek flow declines, TGAEC used the U.S. Environmental Protection Agency eco-hydrologic model VELMA (Visualizing Ecosystem Land Management Assessments) that can utilize both spatial and tabular data. While this pilot project focused on Tenmile Creek tributaries Streeter and Big Rock creeks, the lessons learned about the hydrology of these two watersheds apply more broadly to other tributaries as well, especially those that share adjacent headwaters on the Cahto Peak ridge.

Big Rock, Streeter and Elder Creek Flow:

Flow data collected on Big Rock and Streeter Creek were compared with Elder Creek flow data from the U.S. Geologic Survey gauge there. Elder Creek has higher flow because it has a larger watershed; however, the shape of the hydrograph on descending (Figure 38) and ascending (Figure 39) flows differ for the other tributaries. Streeter and Big Rock creeks have a much steeper decline beginning in late May than Elder Creek, and that pattern continues throughout the summer. On the ascending hydrograph, Streeter and Big Rock fall more rapidly after rains than Elder Creek, except that Streeter began to sustain flow levels after peaks in mid-January.

Figure 37. Map of TGAEC flow gauge locations. TCC = Tenmile Cr Confluence, TSG – Tenmile Cr. near Spring Gulch, TCL2 = Tenmile Cr Laytonville, SCL = Streeter Cr., BRL – Big Rock Cr.

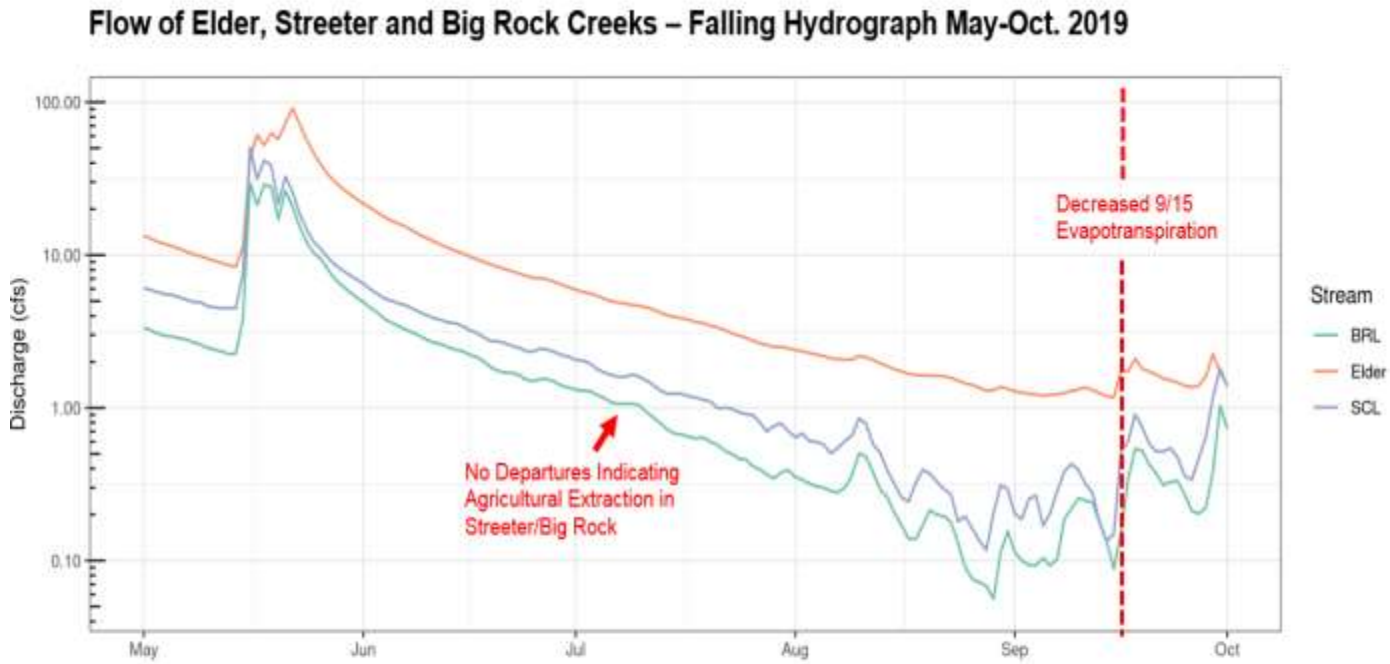


Figure 38. Chart comparing descending hydrograph of Elder, Streeter and Big Rock Creeks, May through October 2019. TGAEC.

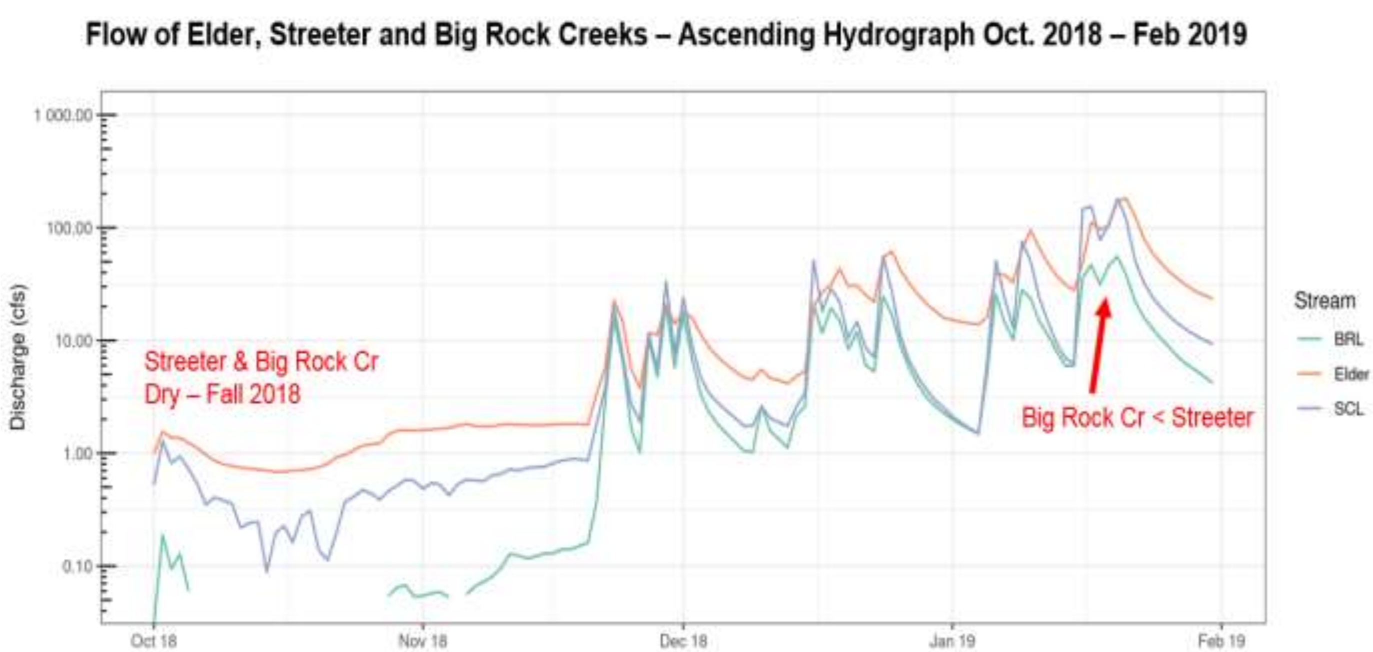


Figure 39. Chart comparing ascending hydrograph of Elder, Streeter and Big Rock Creeks, October 2018 to February 2019. TGAEC.

Use of VELMA Model to Estimate Historic Flow:

The U.S. EPA VELMA model is regarded as one of the best watershed modeling programs because it models the interactions of multiple ecosystem parameters on a daily time scale. The SWRCB drainage area ratio model was used to scale the differences between the three watersheds as a result of differing watershed size. Figure 40 shows a schematic diagram of parameters fed into the VELMA model, which included rainfall data, slope, geology, soils, land and forest cover, and tree age. Precipitation data from the Northwest Alliance for Computation Science and Engineering, the PRISM Climate Group, was compared to U.C. Berkeley Angelo Reserve precipitation data to improve the accuracy for the VELMA model. TGAEC worked with the US EPA staff that designed the model to help integrate forest age data, Finally, the Nash and Sutcliffe Efficiency coefficient (NSE), which is an important statistical tool that hydrologists use to assess the performance of their models, was used to improve results so that they more closely simulated discharge to approach observed discharge. The model was run hundreds of times to find the combination of parameters that gave the best NSE.

Results for simulated flow of Streeter Creek versus actual flow (Figure 41) show likely historic flow conditions before watershed disturbance and project that the stream would not have gone dry in 2018, and would have had approximately ten times higher baseflow in 2019. The relationship between Big Rock simulated flows and actual flows (Figure 42) show almost identical relationship to those of Streeter Creek and its model run.

Factors Driving Flow Decline in Streeter and Big Rock Creeks:

We found little support for our original hypothesis that stream flow depletion in Streeter Creek and Big Rock Creek was driven by diversions related to cannabis cultivation and possibly, vineyard operations in upper Big Rock Creek. Flow data from these tributaries do not show fluctuations characteristic of diversions systems going on and off, or water being diverted and then flow restored. Also, there are only 20 landowners in all of upper Streeter Creek, whereas, most areas that are heavily cultivated with cannabis are typically numerous small parcels as a result of sub-divisions.

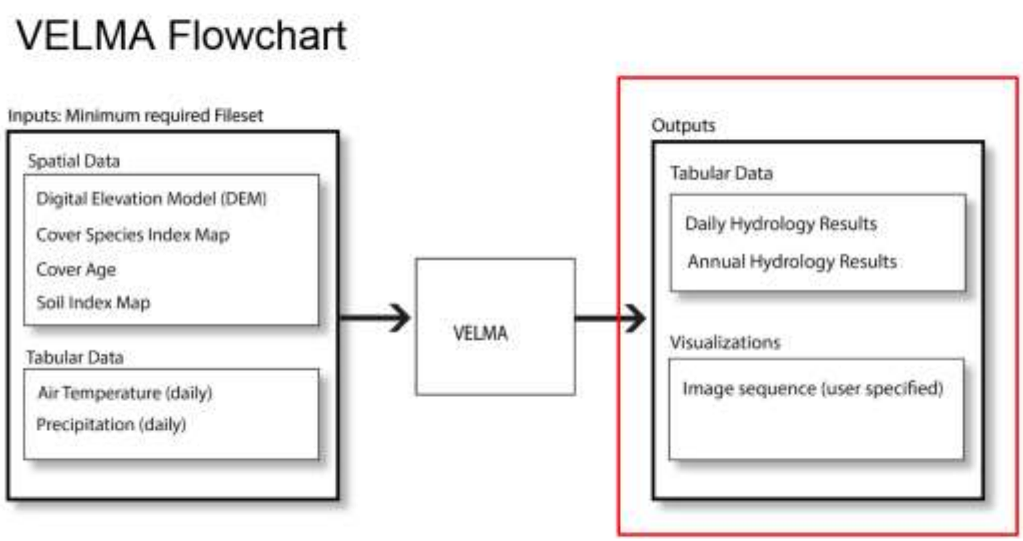


Figure 40. Schematic of VELMA model parameters and outputs. By TGAEC.

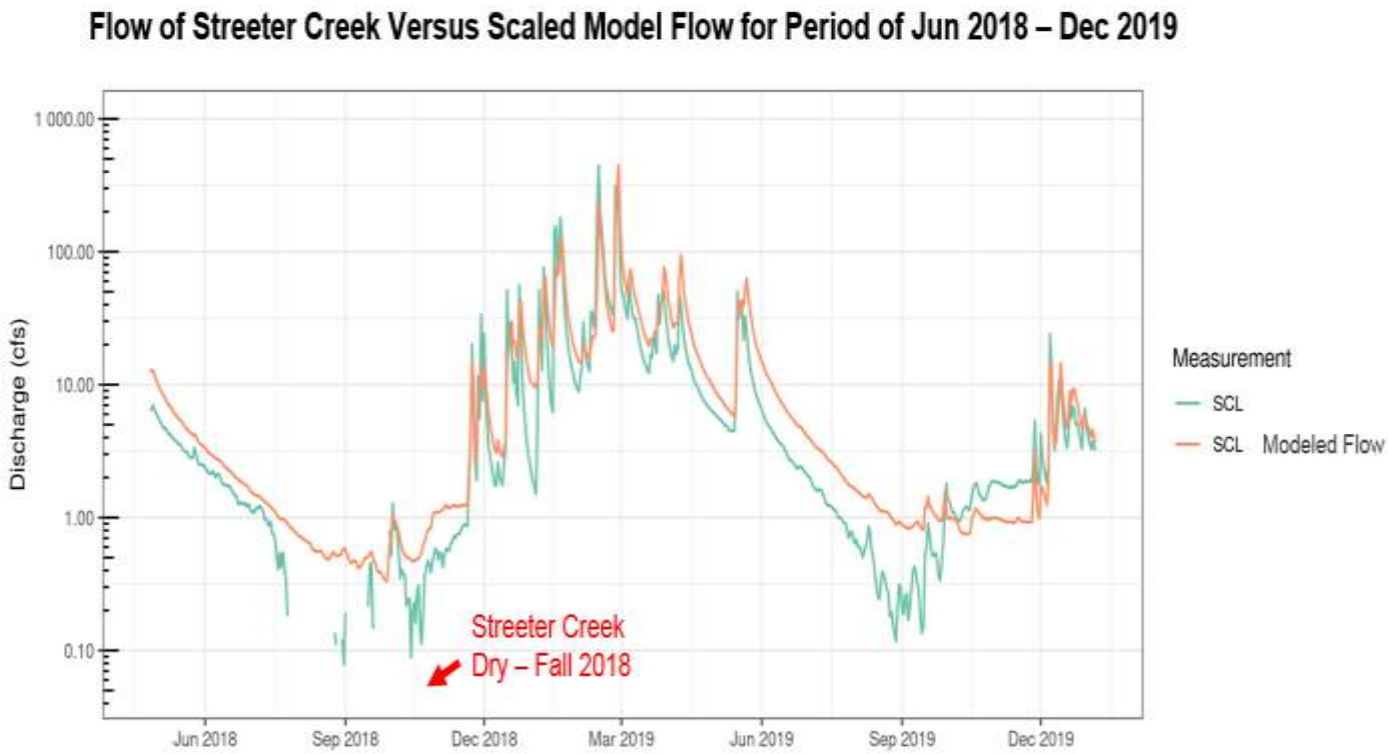


Figure 41. Chart of actual flow of Streeter Creek versus simulated flow generated by the VELMA model for June 2018 through December 2019.

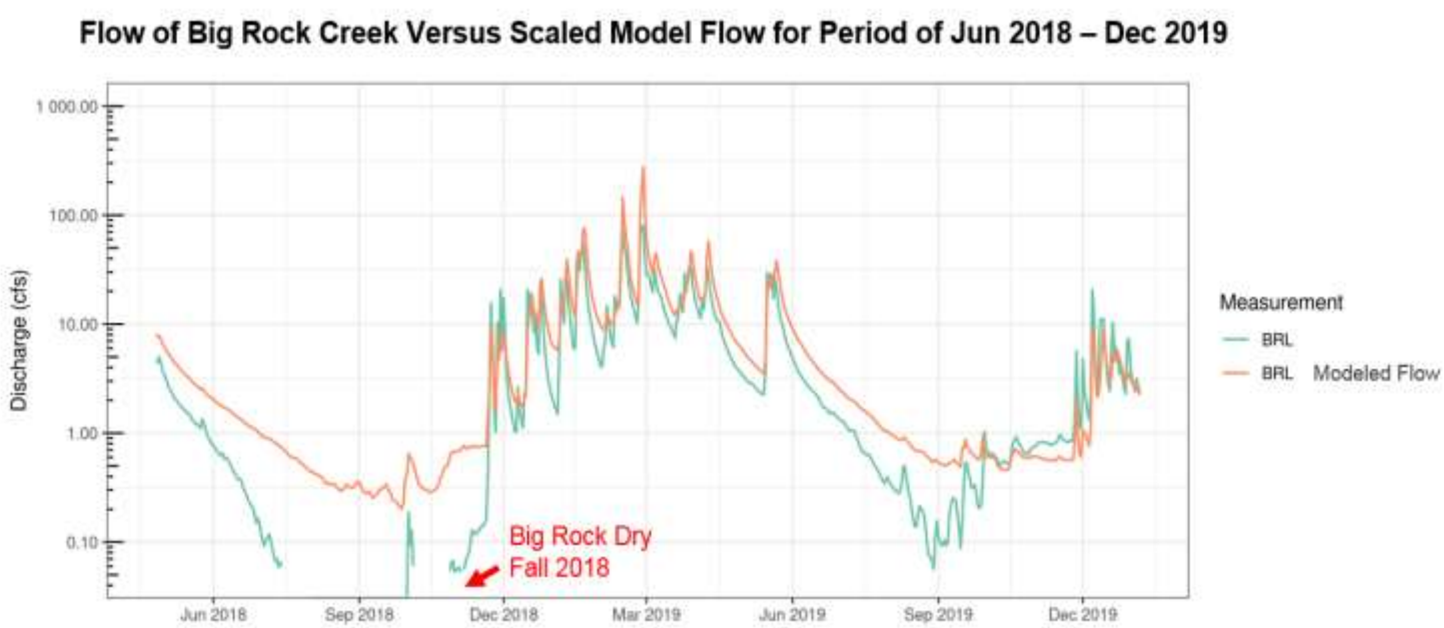


Figure 42. Chart of actual flow of Big Rock Creek versus simulated flow generated by the VELMA model for June 2018 through December 2019.

Underlying bedrock geology turned out to be a potentially significant driver of flow. TGAEC acquired geologic data from U.C. Berkeley that shows the geologic contact between the water-bearing sandstone geology of the Coast Range and the less water-bearing Central Belt Mélange terrain, runs right through the Streeter and Big Rock Creek watersheds (Figure 43). Hahm et al. (2019) characterize a "critical zone" (Figure 44) from surface soil layers down to bedrock and describe the difference in the two zones and resultant vegetation.

"The ability of the subsurface critical zone—extending from the ground surface down to fresh, un-weathered bedrock—to store and release water to plants and streams is a key variable explaining ecosystem composition and function. The storage and release of water are particularly important in Mediterranean climates, where rain arrives in winter and summers are typically warm and dry. Here plants rely half the year on seasonally replenished water from below-ground. We documented how the subsurface structure of the critical zone determines how water is shed from landscapes and how much water can be seasonally stored. We found that locations with a thicker critical zone had higher water storage capacity, more productive ecosystems, deeper groundwater runoff generation, and greater summer streamflow. Where the critical zone is thin and storage capacity is limited, the subsurface completely saturates, and the landscape sheds incoming rain via surface runoff. This water storage limitation explains the presence of an oak savanna-woodland in the Northern California Coast Ranges, where rainfall is ample, and neighboring areas experiencing similar climate have towering forest canopies. Rock type governed these variations, highlighting its importance in determining the distribution of ecosystems and water runoff pathways to streams."

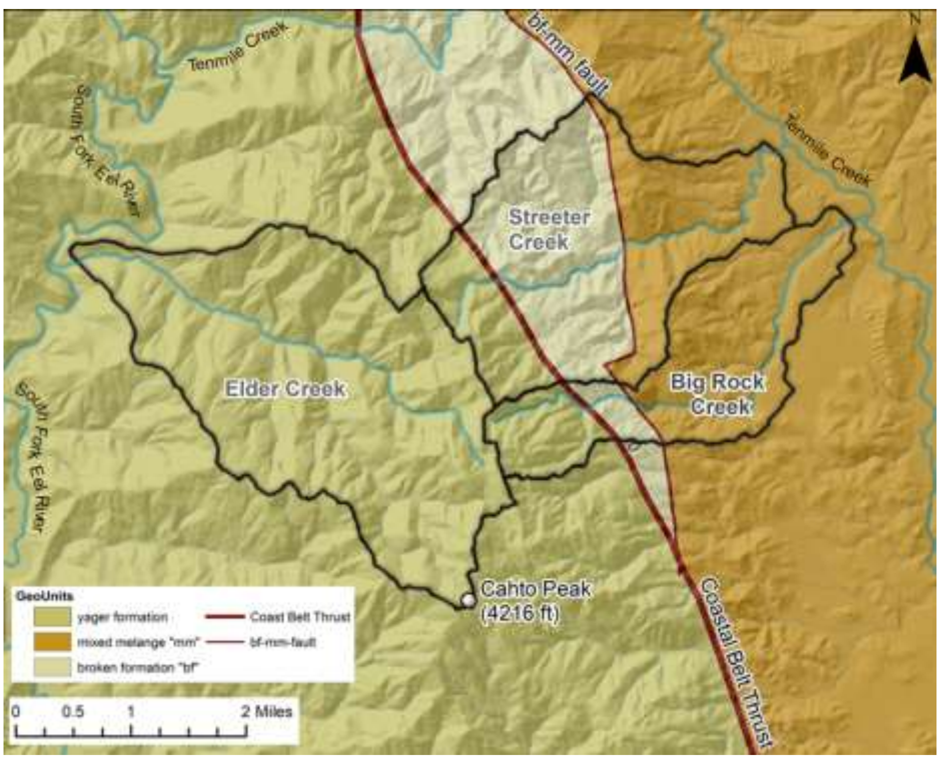


Figure 43. Coastal belt thrust fault with second fault trace running through the Streeter Creek and Big Rock Creek watersheds. Data from Hahm et al. (2019), map by TGAEC.

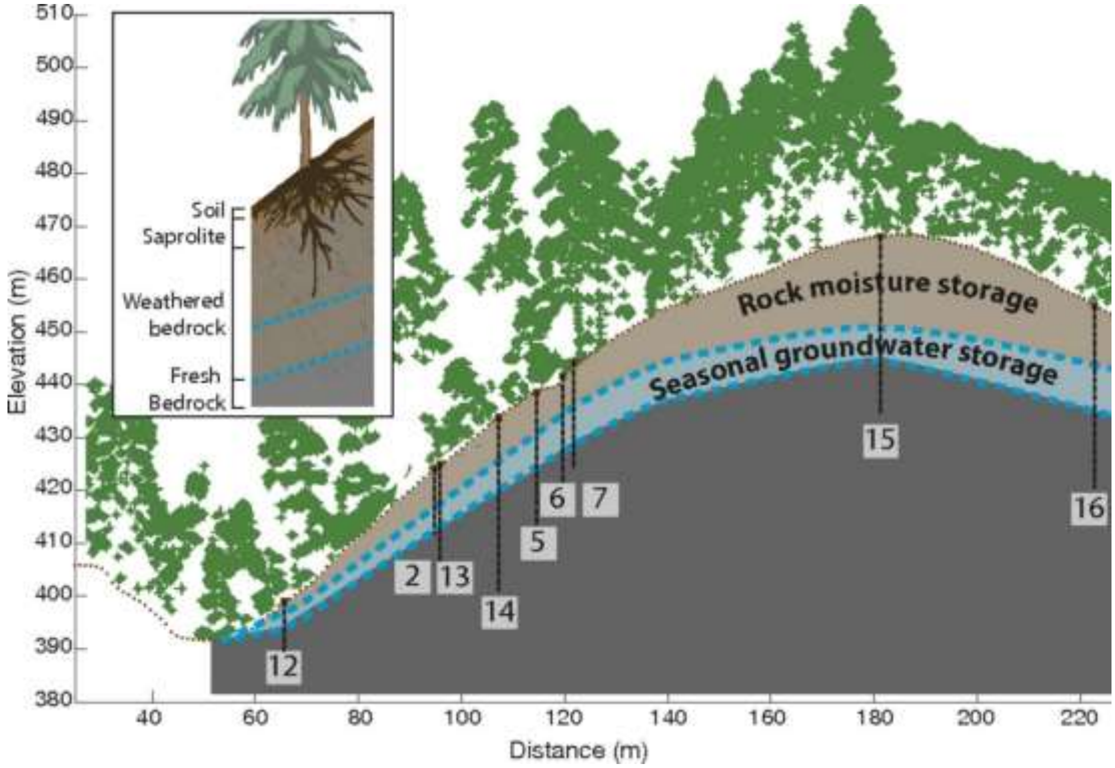


Figure 44. Critical Zone diagram. From Rempe and Dietrich 2018.

The geologic contact passing through Streeter and Big Rock Creek watersheds results in variation in vegetation, very similar to that described by Hahm with coniferous forest on the west side of the fault and oak woodlands and grasslands much more prevalent east of the fault (Figure 45). This indicates that much more of Big Rock Creek is within the Central Belt Mélange Terrain, which explains its flow patterns in late January 2019 (Figure 39). The Streeter Creek water table appeared to become saturated during this period, and it began to show less recession, similar to Elder Creek. Big Rock Creek's lack of water storage capacity, which causes the drop in the hydrograph, is consistent with a shallower "critical zone". Ponds in upper Big Rock Creek have the capacity to intercept flow and could affect how the hydrograph responds to storm events.

One of the most striking differences in watershed conditions between Elder Creek and the pilot project watersheds Streeter and Big Rock creeks is the differences in vegetation, particularly tree age (Figure 46). Elder Creek has never been logged or developed and is dominated by stands of trees that range from 85 years to 400 years old, whereas, Streeter Creek tree age is 40-70 years old, reflecting the post WW II wave of old growth logging. Studies in the nearby upper Mattole River watershed suggest that 40-60-year-old over-stocked conifer forests and mixed hardwood-conifer stands have extremely high rates of evapotranspiration that can cause a substantial decrease in stream base-flow. Douglas fir is over-topping oak trees in both basins, which can also negatively affect summer base-flows. Therefore, ERRP has changed its hypothesis for the causal mechanism of stream flow depletion in Streeter Creek and Big Rock Creek. We now think flow depletion is due to perturbed watershed hydrology, principally driven by forest health, over-stocked stands and increased evapotranspiration.

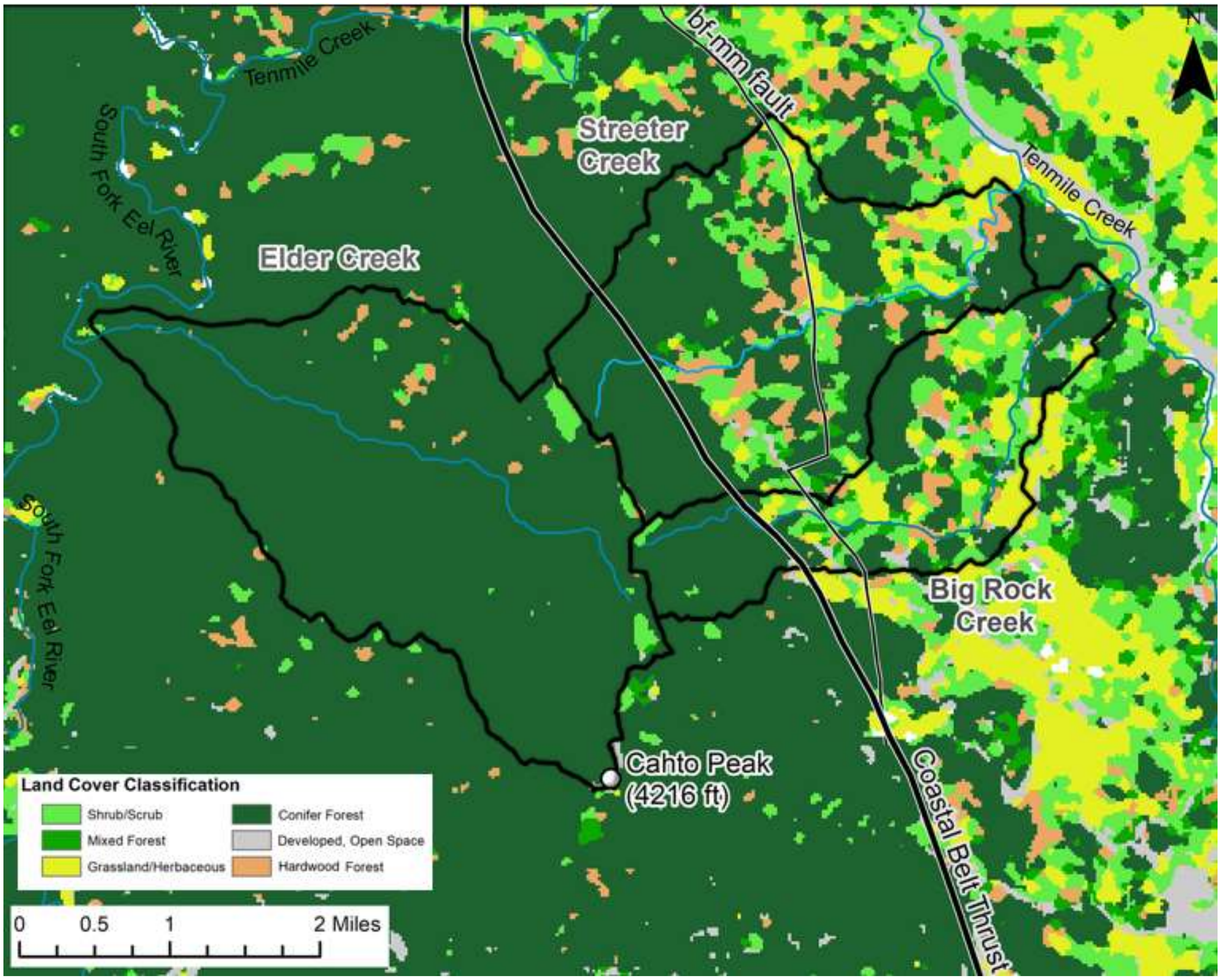


Figure 45. Vegetation types in the Elder, Streeter, and Big Rock Creek watersheds relative to faults and changes in geologic provinces. TGAEC.

The hydrographs of both Streeter and Big Rock creeks show signs of being driven by evapotranspiration. Elder Creek is groundwater driven at baseflow and fluctuates very little, whereas Streeter and Big Rock swing much more widely during heat and periods of moisture stress. In mid-September when air temperatures cool, the latter two streams both strongly rebounded as evapotranspiration decreased. In mid-October, Streeter and Big Rock creek flows approach those of Elder Creek, likely because riparian hardwood trees lose their leaves.

Groundwater and Surface Water Interactions: Studies of groundwater in the Tenmile Creek valley conducted by USGS found it to be abundant on some areas of the valley floor where there was deep alluvium, but less available nearer the margins of the valley or in areas of shallow alluvium or Franciscan bedrock. Rain falling in the valley percolates into groundwater, but the points of transition from Franciscan bedrock to alluvium is the place where downwelling and considerable aquifer recharge takes place. Groundwater moves towards the deepest areas of alluvium in the center of the valley and also tends to “express” as stream upwelling nearby.

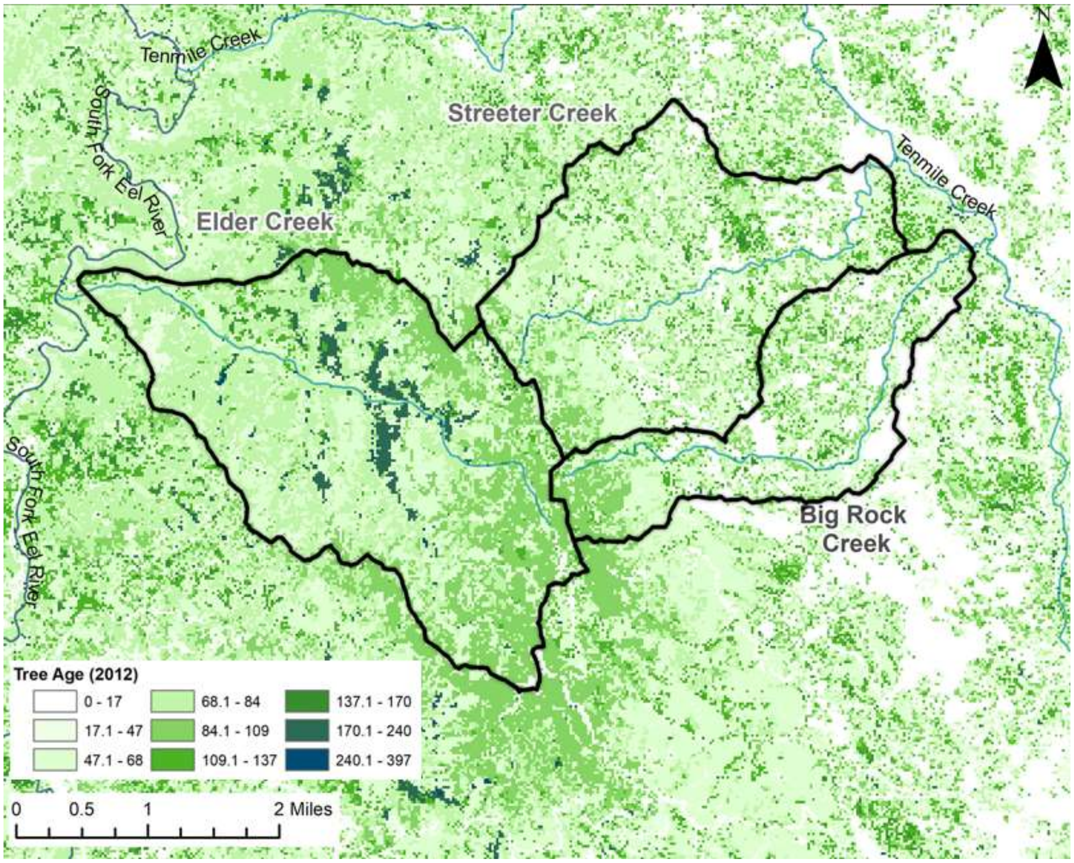


Figure 46. Elder Creek has trees 85-400 years old, while Streeter Creek and Big Rock Creek watersheds are dominated by younger forests, with most conifers less than 70 years old. Map by TGAEC.

Groundwater availability was characterized by USGS using four zones. The *Type I* area covers about 3 sq. mi and has deep alluvium and highly productive wells with groundwater within 5 feet of the surface in winter. To the west of this area lies 0.6 sq. mi of *Type II* aquifer, where deposits of terrace material are approximately 50 feet deep and wells are sufficient for domestic use, but not community water systems or irrigation. As alluvium becomes more shallow further west, there is a 2 sq. mi. area characterized as *Type III*, where alluvium is thin and wells often go dry in late summer and fall. Uplands of the Tenmile Creek watershed are characterized as *Type IV*, with spotty well water availability, although tapping certain fractured bedrock formations could yield productive wells.

USGS estimated that there was about 16,000 acre-feet (AF) of groundwater storage in the Laytonville groundwater basin, with a range from 9,300 AF to 17,300 AF. Water use in 1981 in this area was estimated at 1,000 AF total for domestic and agricultural supply. However, an increase in well water withdrawals has the potential to decrease discharges to springs and to stream flow: "The reduction of baseflow in streams and the lowering of the water table by increasing well production could cause adverse changes in native vegetation along streams or in marshy areas and could adversely affect fauna inhabiting these areas." If this project is successful in winning widespread cooperation for forbearance and increased flow due to restored watershed hydrology, it could be confounded and streams again dried up in the future by groundwater extraction, if it is not better regulated and controlled.

The Eel River Recovery Project and the California Growers Association held a meeting on water rights in Laytonville in March 2016. (Figure 1) and facilitated a community discussion. Some people reported that output from their well had decreased and ran dry seasonally after neighbors installed wells nearby. Residents in a *Type III* area near Wilson Creek experienced domestic water shortage and loss of a pond and wetland habitat after a large well was installed upstream. This also caused the loss of domestic water supply to another person living downstream. Upper Tenmile Creek above Highway 101 is a Type III groundwater availability area, and this reach goes dry in dry years, which may be related to surface and groundwater withdrawals upstream.

Well permits are issued by Mendocino County, but no State water right is required unless there is a known connection to surface water. This has caused many people concerned with an increase in attention to water rights to instead drill a well for domestic and agricultural water supply, and the cumulative effects of this shift may be that groundwater supplies in the Laytonville basin have or will become stressed. Also, if a well is dried up as a result of interception of groundwater by a neighbor's well, the dispute is a private one and the aggrieved party must take legal action against whoever installed the new well. This is an unfair burden for anyone who is economically disadvantaged, and it is socially unjust because it has the potential to greatly devalue land, make it less habitable. Groundwater extraction has undoubtedly grown since the mid-1980s, and a more current study of groundwater use and availability is needed to insure water supply reliability for the community and for the Tenmile Creek aquatic ecosystem.

Impact of Vineyard and Related Diversions to Big Rock Creek Baseflow:

TGAEC mapped the location of ponds in the Big Rock Creek basin. There is a vineyard in the upper watershed for which water from these ponds is assumed to be used for irrigation. The hydrograph of Big Rock Creek (Figure 38) did not show fluctuation characteristic of sporadic, active diversion. However, the role of vineyard operation and/or the changes in hydrology related to vineyard development could be playing a material role in the decline of Big Rock Creek baseflows and seasonal disconnection in dry years.

Recommendations

1. Continue operation of flow monitoring from pilot project but add Mill Creek flow gauge, and assist Cahto Tribe with gauging Cahto Creek in the Reservation in 2021 and 2022, if funded by SCC Prop 1.
2. Run VELMA model for Cahto and Mill creeks to determine their flow departure from historic norms, and the DWR articulated surface and groundwater model for Tenmile Creek Priority Water Conservation Area, if funded by SCC Prop 1.
3. Study groundwater and surface water interactions in 2021-2022, if SCC Prop 1 is funded, to detect whether over exploitation of groundwater that impacts stream flow and/or access to water for neighboring parcels is occurring, and make policy recommendations to Mendocino County, if needed.

Reference Summary for Chapter 3

TGAEC used the VELMA (Visualizing Ecosystem Land Management Assessments) model devised by the U.S. Environmental Protection Agency (McKane et al. 2014). To improve the model calibration, TGAEC used the Nash and Sutcliffe (1970) Efficiency coefficient (NSE). Rempe and Dietrich (2018) reported on water storage and water yield in the control stream Elder Creek. Hahm et al. (2018) documented that oak trees have extremely low water use in summer. Hahm et al. (2019) provided local geologic data that shows a major contact bisecting the Tenmile Creek watershed that drives variation in vegetation and groundwater storage. The U.S. Geologic Survey (Ferrar 1986) groundwater study provides the basis of discussion of that subject. The assumptions about forest age, evapotranspiration, and base flow is based on Stubblefield et al. (2012). Also, Oregon research (Moore et al. 2004) shows young fir trees use 3.4 times more water than old growth on a per area basis. Asarian (2015) documented a 50% reduction in flow of SF Eel River tributary Bull Creek from 1950 to 2014, after half the watershed was clear cut. Band (2008) described impacts from operation of multiple agricultural impoundments on northern California stream flow and salmon and steelhead.

Chapter 4 – Restoring Base Flows – Water Conservation and Watershed Health Improvement

One of the primary areas of focus of the SCC Prop 1 pilot project was to win the cooperation of water users in the Streeter Creek and Big Rock watersheds and to get them to forbear, as people did in the upper Mattole River watershed. Both watersheds are sparsely populated and residents were generally reluctant to get involved with the government in any way that could compromise their water rights. This is due in part to the current shifts in policy related to water rights and water law related to cannabis legalization (see Chapter 6). Based on the assumption that water withdrawal was the principal source of stream depletion, this project was supposed to ascertain the amount of water storage needed to restore. However, the assumption was not affirmed. Instead, forest evapotranspiration and disrupted watershed hydrology were identified as major drivers. Consequently, the amount of flow needed to restore historic baseflows is likely well beyond that which could be gained by augmenting water storage for residents and implementing forbearance.

Results of TGAEC Calculation of Historic Flow and Augmentation

TGAEC and the SWRCB monitored the streamflow of Big Rock and Streeter creeks in 2018 and 2019. Using the VELMA model, TGAEC modeled the unimpaired streamflow in Big Rock and Streeter creeks. The difference between the unimpaired streamflow and the measured flow is the water deficit. The primary period of interest ecologically is the summer low-flow season from the peak May flow to the first significant rainfall event in the fall.

Water Year 2018 was a dry year and 2019 was a normal year. In Big Rock Creek, preliminary results indicate that the 2018 summer period deficit was 61 million gallons, 51% of the unimpaired flow. In 2019, during the summer period, the measured water yield (the amount of water that flowed past the gauge during that period) exceeded the modeled unimpaired flow. In Streeter Creek, there was a 23 million gallon summer period deficit in 2018 and a 16 million gallon deficit in 2019, representing 13% and 7% of the unimpaired flow respectively.

TGAEC also compared the daily measured flow to the daily unimpaired flow. In Big Rock Creek, nearly every day in the summer of 2018 showed a deficit between 0.1 cfs and 0.5 cfs compared to unimpaired flows (Figure 47). Deficits were less severe in Streeter Creek in 2018, but shortages between 0.1 cfs and 1.0 cfs persisted from mid-July through September (Figure 48). The 2019 deficits appear milder in both Big Rock Creek and Streeter Creek.

In the percent-of-flow approach for estimating an ecological baseflow (Richter et al. 2012), a 10% or less diversion rate is ecologically protective whereas a diversion rate of greater than 20% can cause ecological damage. For the purpose of this report, the term “diversion” also includes loss of stream baseflow as a result of impaired watershed hydrology and increased water loss due largely to increased tree evapotranspiration.

Daily deficits exist in both 2018 and 2019, suggesting that the volume of surface water being diverted from both watersheds exceeds an ecologically protective value. At 10% diversion, continual deficits of 0.1–1.0 cfs occur in Big Rock Creek through summer 2018. Deficit conditions aren't as extensive in Streeter Creek—in mid-July through September 2018, shortages are generally 0.1–0.5 cfs. At 20% diversion, flow shortages are less severe and slightly shorter in duration. Mid- to late summer deficits in both Big Rock Creek and Streeter Creek are generally <0.5 cfs.

In 2019, deficits were much smaller and shorter—not exceeding 0.25 cfs in Big Rock Creek and below 0.5 cfs in Streeter Creek (except for a period in late May). In both watersheds, the most significant deficits occur at the end of the summer season, between mid-August and mid-September. Deficit values for 2019 suggest that the relative amount of surface water diverted was less than 2018 but that diversions still exceeded an ecologically protective threshold.

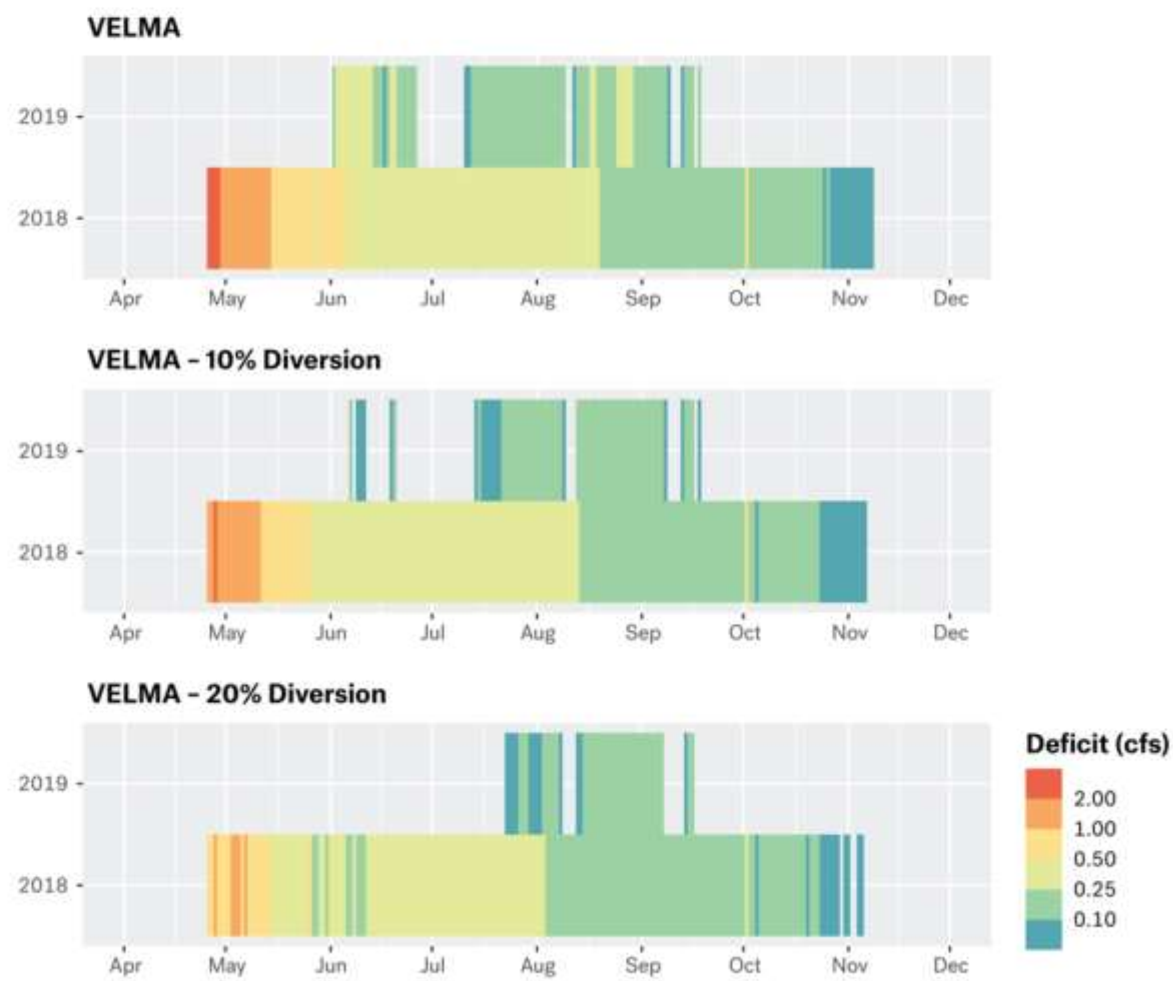


Figure 47. Daily streamflow deficits in Big Rock Creek as calculated under baseline conditions: VELMA modeled unimpaired flow, VELMA modeled unimpaired flow with 10% subtracted, and VELMA modeled unimpaired flow with 20% subtracted.

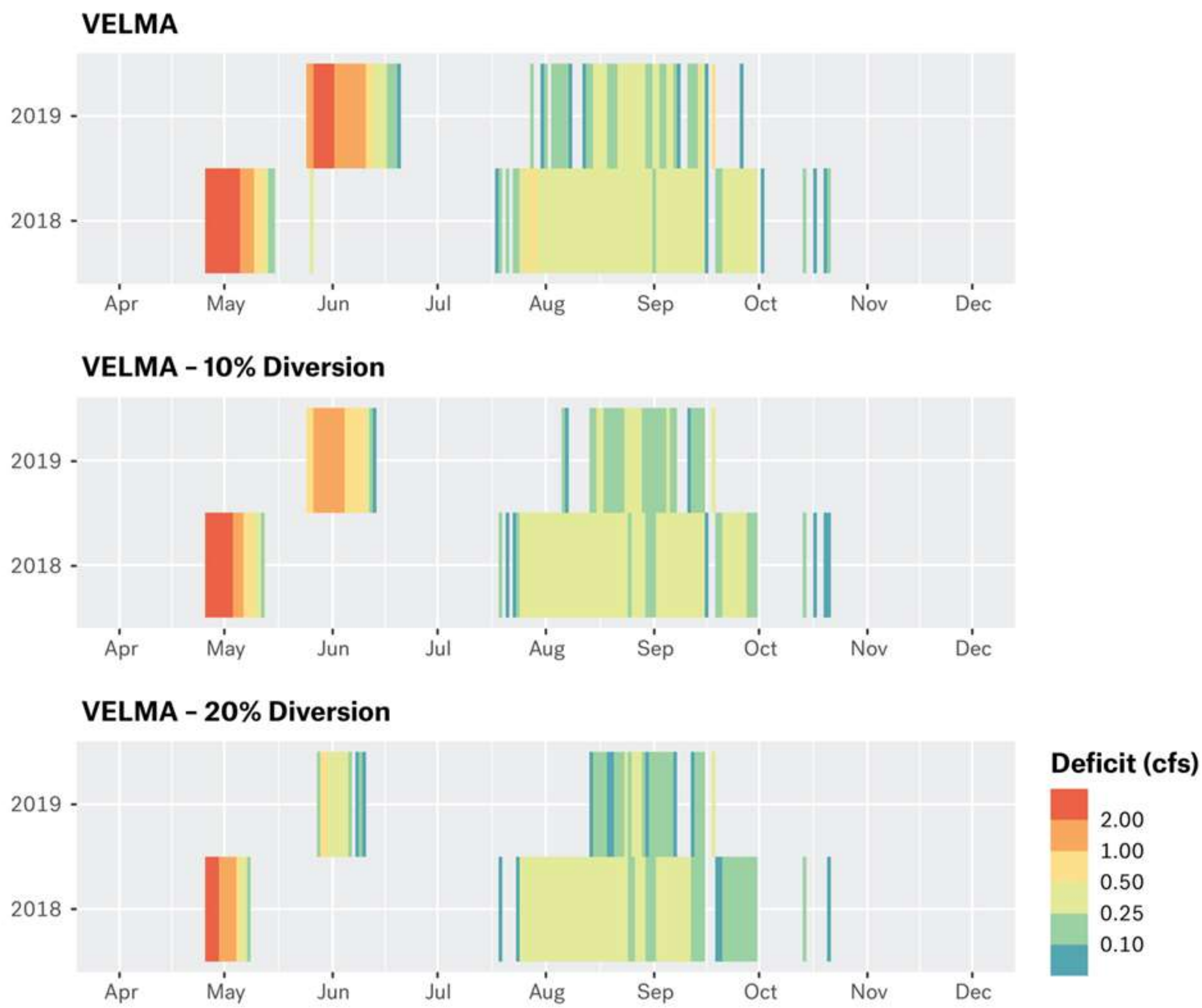


Figure 48. Daily streamflow deficits in Streeter Creek as calculated under baseline conditions: VELMA modeled unimpaired flow, VELMA modeled unimpaired flow with 10% subtracted, and VELMA modeled unimpaired flow with 20% subtracted.

Forbearance of Streeter Creek Water Users Planned

This study discovered that the largest diversion of Streeter Creek was by the Black Oak Ranch (BOR), a 600 acre communally owned property. Water withdrawals are to provide irrigation for a large organic farm run by BOR member Irene Engber (Figure 49) that supplies organic produce to Laytonville and Mendocino County; and for Camp Winnarainbow, which hosts inner city, disadvantage youth in summer to learn about art and nature (Figure 50).

ERRP applied to the SCC Prop 1 fund in April 2020 to design and permit an off-stream storage pond with sufficient supply to meet the needs of the BOR organic farm, and for watering the grounds of Camp Winnarainbow, across Streeter Creek from the farm (Figure 51). In addition, augmented water storage and all needed infrastructure improvements for the camp would be designed and permitted. This will enable both enterprises to forbear from use of Streeter Creek water in the future. The actual construction of the pond and water infrastructure for the camp would be part of a subsequent grant

Figure 49. Organic farmer Chris Tebbutt talks ponds with Irene Engber (r), as ERRP consultant Hollie Hall listens. 2/4/20.

Figure 50. Camp Winnarainbow in the off-season. 2/4/20.

request with the likely target being the Wildlife Conservation Board Prop 1 fund that supports water conservation. The lowest reach of Streeter Creek is a highly productive habitat for juvenile steelhead, so forbearance by BOR will increase the carrying capacity for this species and provide connectivity to Tenmile Creek.

Figure 51. Location of Black Oak Ranch organic farm and Camp Winnarainbow relative to Streeter and Tenmile creeks. Google Earth photo annotated by ERRP.

Basinwide Strategy for Community Water Conservation

Group discussion with the TCWC, the community, agency hydrologists, and TGAEC on January 14, 2020 in Laytonville led to the selection of west-side tributaries of Tenmile Creek being identified as the Priority Water Conservation Area (PWCA) (Figure 52). These sub-basins all share headwaters that flow from the shoulders of Cahto Peak, which is the area of highest rainfall in the basin and where bedrock geology promotes water storage that can support higher summer baseflows. Headwaters are sparsely populated, including substantial areas managed by the BLM that provide sources of clean water.

Much of the steeper terrain in the PWCA falls in the *Type IV* category of groundwater availability, but some *Type III* areas with shallow alluvium and insufficient well water to meet domestic water needs are also within this area. Residents in the Type III zone are sometimes reliant on direct diversion of tributaries, but these streams may lose surface flow, leading to the need to purchase water for domestic use. We were contacted by two riparian land owners who live along Mill Creek, an important salmonid producing Tenmile Creek tributary that traverses this area. They have asked us for assistance in acquiring additional water storage for the purpose of forbearance from use of surface flow of Mill Creek or from extracting groundwater from wells near the stream in summer. They would receive water security in exchange forbearance. Additional clients in the Mill Creek watershed and in the priority area in the PWCA will be sought by ERRP under the SCC Prop 1 Phase II grant, if funding is obtained, with the intent to secure planning and implementation funding in the future, if requested by residents of the area.

Restoring Watershed Hydrology

It appears that the primary cause of decreased baseflow in the Streeter Creek and Big Rock Creek basins is altered watershed hydrology. Consequently, actions in addition to community water conservation are needed to restore the ability of these watersheds to retain winter precipitation as groundwater that is released slowly throughout summer.

Forest Health: ERRP has received a grant from the North Coast Resource Partnership Demonstration Project fund to begin forest health planning in the Tenmile Creek watershed in July 2020. The ultimate goal is to thin the over-stocked coniferous forest and to harvest Douglas fir that is encroaching on oak forests. An elite team of forest health experts and local people have been recruited to plan and build capacity for forest health implementation at the Tenmile Creek watershed scale. ERRP will devise a new ecologically sound Forest Health Plan template and provide 12 land owners with forest health plans. This project would integrate remote sensing and use of drone photography for analysis and monitoring with the intent of reducing plan cost elements needed to calculate carbon. sequestration. By widespread implementation of forest health, Tenmile Creek and the Eel River basin can become a large carbon sink, helping remedy carbon dioxide increases to stabilize the Planet’s climate. ERRP will work closely with the TCWC to help them build the capacity to administer larger scale resources expected from CalFire CCI grants. The Forest Reciprocity Group is also collaborating, hoping to find a market for value-added products built with forest health derived products. The Cahto Tribe will be consulted and their traditional ecological knowledge integrated into planning.

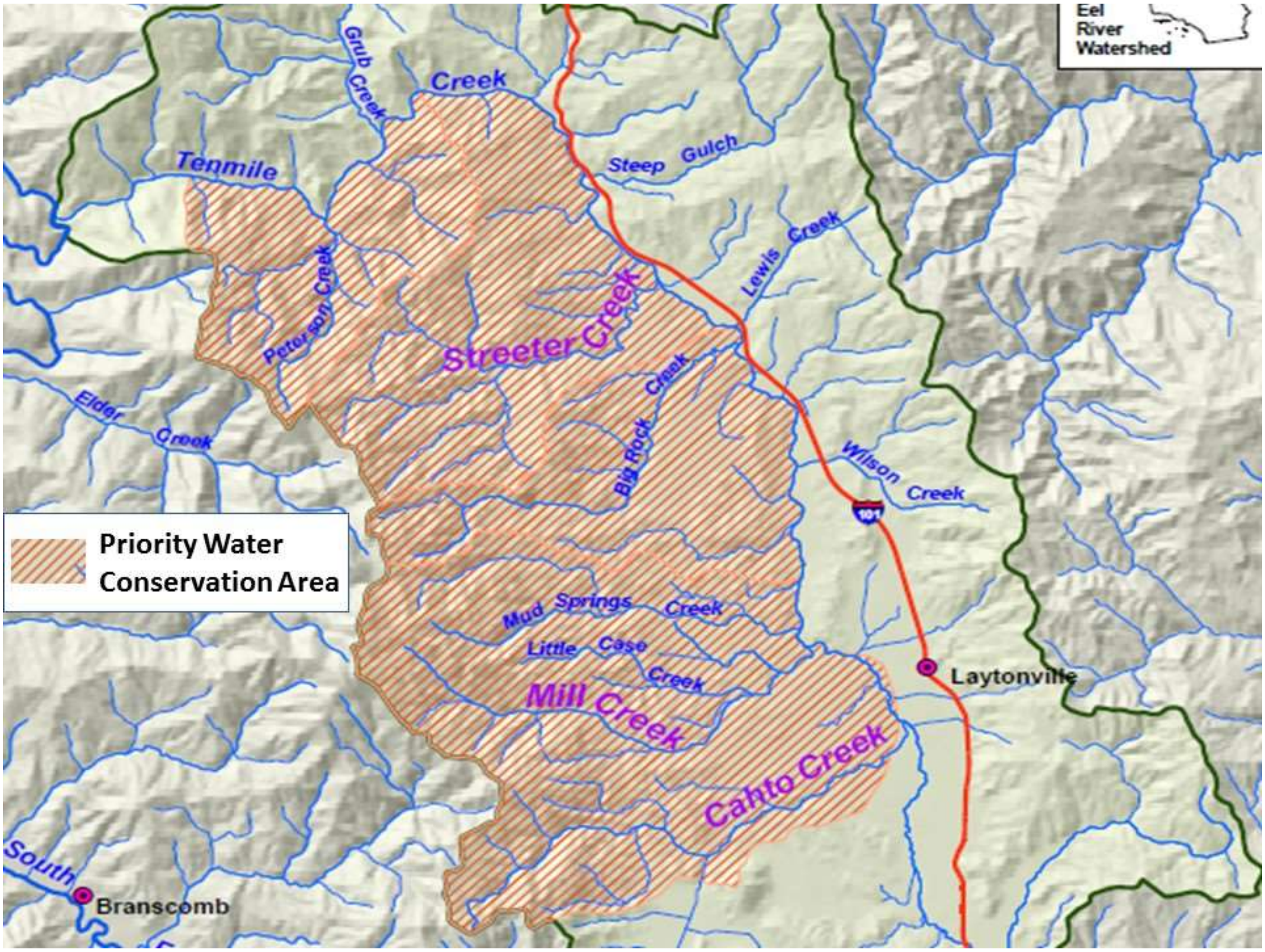


Figure 52. Map of the Tenmile Creek watershed with western basins draining off Cahto Peak highlighted as the priority area for water conservation. Map by Dr. Paul Trichilo for ERRP.

Grassland Health: Tenmile Creek has a substantial amount of grassland areas because of the underlying bedrock geology. We assume that grasslands before European contact were maintained through annual or regular use of fire, and that the deeply rooted native grasses likely created a substantial water bank before disturbance. Grazing and road construction have caused gullies that drop the water table in grasslands and decrease groundwater storage. Therefore, it is expected that returning to the use of fire to manage grasslands, restoring native grasses, and healing gullies will improve the hydrology of the Tenmile Creek watershed and assist in restoring baseflows nearer to their historic range.

Rebuilding Tributary Groundwater Hydrology: Chapter 2 discussed the profound change in the hydrology of a Streeter Creek tributary. A large wood jam installation could rebuild the sub-basins ability to retain water and to return perennial surface flow. There may be other similar opportunities elsewhere in the Tenmile Creek watershed.

Groundwater Supply – Living in Balance

Geologic uplift and eons of erosion have filled the Tenmile Creek valley with deep alluvium that forms a 16,000 AF aquifer that has been relied upon for domestic and agricultural water use. However, the availability of groundwater varies geographically with areas of thinner alluvium (Type III & Type IV) often unable to meet domestic water needs. Groundwater use is likely greater than the 1,000 AF annual estimate for combined use in 1986. Whether groundwater extraction is contributing to loss of surface flow in some Tenmile Creek sub-basins needs further study, especially in the Type III groundwater zone.

If funded under an SCC Prop 1 Phase II grant, TGAEC will develop an integrated surface water and groundwater budget for the west-side Tenmile Creek watershed. The water budget will use Department of Water Resources methods to calculate the amount of water absorbed by the landscape (Land System), run off (Surface Flow), and how much is percolating into groundwater and will include total water budgets for Mill and Cahto creeks. Data and model outputs can be utilized to identify west-wide locations where poor groundwater supply may make people vulnerable to water shortages and, therefore, potentially willing cooperators for forbearance in exchange for water security.

Groundwater regulation in California has been inadequate, and current priority groundwater basins under study by Mendocino County do not include the Laytonville groundwater basin. Policy changes that limit development in groundwater-limited areas need to be considered at the County level. This topic may merit consideration by the Laytonville Municipal Advisory Committee and the TCWC as it is a key issue for community water security as well as the success of restoration initiatives.

Existing and Potential Conservation Opportunities

The reason that thousands of Chinook salmon and steelhead return to Tenmile Creek to spawn in some years is that the ecosystem is partially functional, which is partially the result of good stewardship. When land owners of grasslands limit the number of cows they raise or the season of grazing, and fence livestock out of wetlands, they help maintain properly functioning hydrology. Forest land owners that are implementing forest health measures can make incremental contributions to restoring Tenmile Creek baseflows. When rural land owners and road associations re-design their road systems to slow, spread and sink water by out-sloping their road prisms, damaging flood peaks are lessened and baseflows vital to fish and human communities are increased. When road failures are prevented, fewer streams will be buried in sediment, which improves water quality and supply. Cannabis farmers using regenerative agricultural techniques have a very small environmental footprint and can even help recharge groundwater with bioswales that sometimes allow dry-farming. New discoveries suggest that there can be a synergy between ponds in some locations with groundwater recharge where impoundments can help augment flow in the dry season. Reservoirs in upper Cahto, Big Rock, Mill and Case creeks are sufficiently large to potentially provide such capacity. Proactive partnerships across the spectrum of landowners will be part of the community water conservation solution.

Rebuilding Wetlands

The high Tenmile Creek intrinsic potential for coho salmon resulted from a complex a serpentine channel meandering across the valley floor, connected wetlands that stored and cooled water, and beaver dams that formed ideal ponds for coho (Figure 53). While re-creating the channel of Tenmile Creek at the time of European contact may not be feasible or desirable, every wetland area that is restored will help increase the water absorptive capacity of the watershed, help filter and purify water and create habitat for sensitive wetland species. Development for cattle ranching and farming has led to the destruction of wetlands, increased flood impacts, degraded water quality and diminished landscape water storage capacity.

Wetlands connected to Tenmile Creek reaches or tributaries have the highest habitat value because they can help with temperature moderation, water supply and nutrient filtration. These areas may also provide low velocity winter habitat for coho salmon and steelhead juveniles that helps these fish survive winter storm events.

Allowing recolonization by beaver might help with water storage and percolation to groundwater:

> "Beaver dams alter the hydrology and geomorphology of stream systems and affect habitat for fishes. Beaver dams measurably affect the rates of groundwater recharge and stream discharge, retain enough sediment to cause measurable changes in valley floor morphology, and generally enhance stream habitat quality for many fishes" (Pollock et al. 2003).

Figure 53. Large beaver dam below Big Rock Creek that causes impoundment in summer at this location. 1/20/20.

Recommendations

1. Design and permit water storage infrastructure for Black Oak Ranch organic farm and Camp Winnarainbow in 2021-2022, if SCC Prop 1 funding is awarded, and subsequently pursue resources in 2022 for the build phase from the Wildlife Conservation Board Prop 1 water conservation grant fund with project completion in 2024.
2. Work with residents of Mill Creek and others in the PWCA in the western Tenmile Creek watershed on adopting forbearance in exchange for sufficient water storage in 2021, if SCC Prop 1 funding is awarded, and subsequently obtain WCB Prop 1 for implementation, if cooperation is obtained.
3. Conduct forest health planning with North Coast Resource Partnership grant in 2020 and 2021 and begin planning for implementation to reduce forest evapotranspiration and help improve stream baseflows with subsequent grants in the Streeter Creek watershed as a priority.
4. Work with landowners to improve grassland health in order to improve watershed hydrology, including gully erosion control and repair.
5. Work with cannabis farming community to adopt regenerative cannabis practices, including full implementation of water conservation and use of rainwater catchment systems to augment agricultural water supply.
6. Work with cooperative landowners on wetland conservation and/or flow augmentation.

Reference Summary for Chapter 4

To large degree our initial strategy for water conservation in Tenmile Creek was based on work in the upper Mattole (McKee 2004, Sanctuary Forest 2012) and as summarized by Camp-Shremmer (2014). TGAEC relied on Richter et al. (2012) for the basis of a “presumptive standard” for minimum flow to support fish life when calculating flow volumes needed to restore surface flow in Streeter and Big Rock creeks. Rempe and Dietrich (2018) provides the basis for assumptions about baseflow yield from undisturbed watersheds. Hahm et al. (2019) demonstrated that bedrock geology can give rise to different vegetation and watershed water storage capacity. When considering groundwater supply, the USGS paper on the Laytonville groundwater basin (Ferrar 1986) is the basis for all assumptions. If the SCC Prop 1 Phase II grant is funded in 2020. TGAEC will model surface and groundwater in all Tenmile Creek Priority Water Conservation Area using DWR (2020) methods.

Chapter 5 – Aquatic Habitat and Fish Life Assessment

Water temperature data was at the center of the Tenmile Creek aquatic ecosystem assessment under the pilot project, but fish observations and timelapse cameras were also used as monitoring tools. What follows is a summary of water temperature findings, flow reconnaissance, fish community structure in 2018 and 2019, and an evaluation of ecosystem health of Tenmile Creek reaches and tributaries. We collected baseline and trend data that can be used to discern inter-annual variability of ecosystem function with rainfall and flow, and may also be used to track recovery in response to restoration.

Temperature

Water temperature is one of the most important surrogates for understanding suitability of aquatic habitat for salmon and steelhead. We have placed hundreds of gauges throughout the Eel River watershed since 2012. Onset Instrument Optic Pro automated water temperature probes are attached to a weight and placed in flowing water out of direct sunlight. We have adopted summary statistic conventions that calculate a maximum floating weekly average (MWAT) and floating average weekly maximum (MWMT) for site comparison. Suitable temperatures for coho salmon rearing are 16.8 C or 62.2 F MWAT or less. Salmonid stress occurs at 20 C (68 F) or higher.

Although the pilot project called for automated water temperature probe placement in 2018, the project did not start until August 2018, which made it too late to collect water temperature data that reflected the full season. Nonetheless, two gauges were placed in 2018 in an unnamed upper Cahto Creek tributary on Patricia Kovner's property and in Tenmile Creek downstream of Tenmile Creek Road. Both these locations maintained perennial flow and temperatures suitable for rearing juvenile steelhead (Figures 54 and 55). Since Tenmile Creek and its tributaries lacked surface flow at locations intended for monitoring in 2018, ERRP used reconnaissance site surveys and photo documentation to establish conditions.

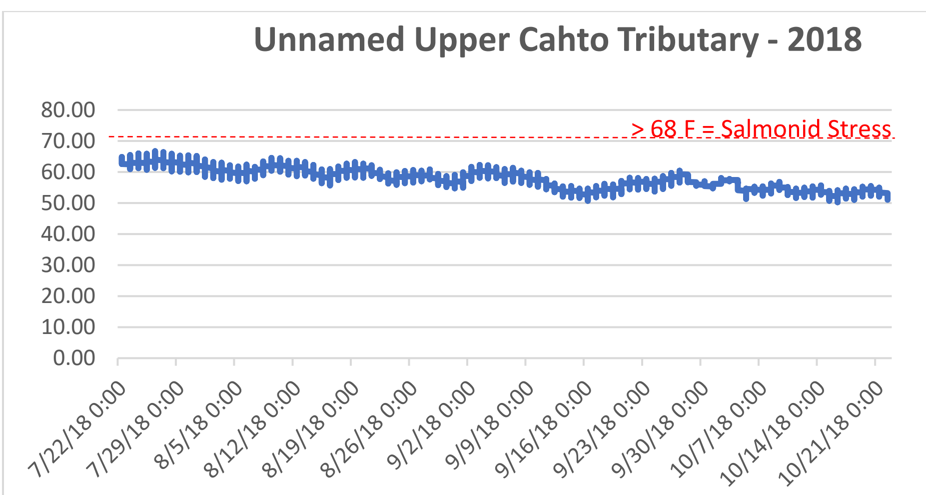


Figure 54. Water temperature of unnamed upper Cahto Creek tributary on Patricia Kovner's property was cool enough for steelhead rearing.

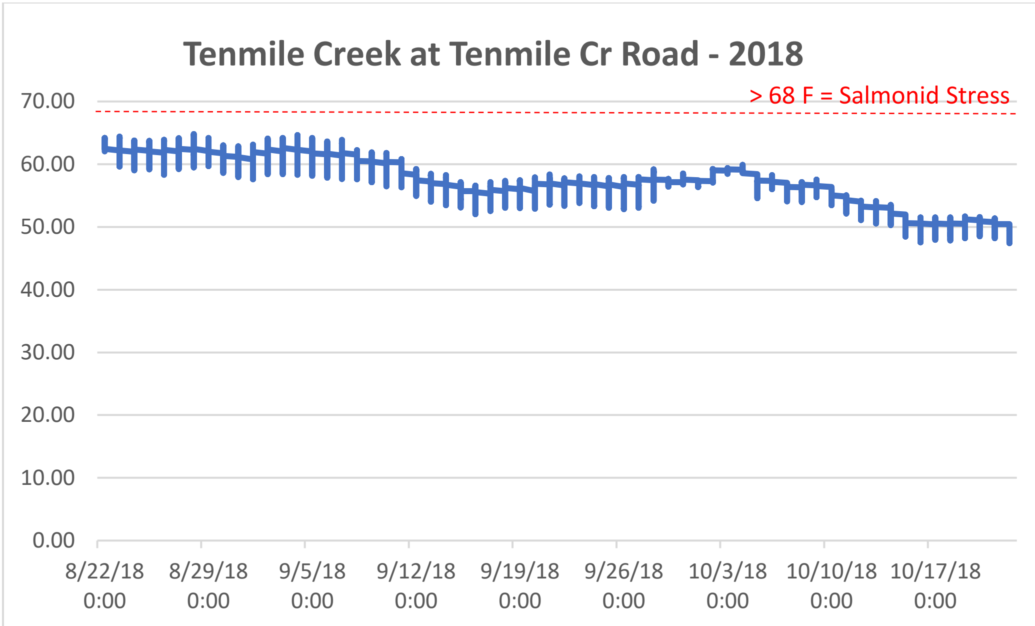


Figure 55. Water temperature of Tenmile Creek below Tenmile Creek Road.

In 2019, water temperature sensors were placed in 21 tributaries or reaches of Tenmile Creek, including gauges associated with flow stations. Results are displayed in Table 1. Due to unusually heavy mid-May 2019 rainfall, many tributaries and Tenmile Creek reaches maintained surface flow connection and temperatures in the range suitable for steelhead juvenile rearing throughout summer. Lower Streeter and Big Rock creeks, upper Lewis Creek, and Cahto Creek on Cahto Tribe Reservation all had MWAT values of less than 20 C (68 F), while upper Mill Creek and lower Peterson Creek had MWAT's less than 16.8 C (62.2 F), and would have been suitable for coho salmon rearing. The middle reach of Tenmile Creek upstream and downstream of Tenmile Creek Road again maintained cold water temperatures in the range suitable for summer rearing of steelhead juveniles. However, the temperature probe placed below the wet-ford became buried in silt as a result of suspended sediment from vehicle crossings and did not yield valid 2019 data.

Elsewhere in 2019, mainstem reaches of Tenmile Creek were characterized by water temperatures more suitable for warmwater fish species. However, lower Tenmile Creek cooled somewhat and conditions were habitable for steelhead. We also noted signs of local hyporheic flow in main Tenmile Creek at the Black Oak Ranch just below Streeter Creek. Although the ambient water temperature of Tenmile Creek at this location was optimal for warmwater fishes, cold-water was coming up from the stream gravel in the front of a pool below a riffle, and steelhead reared there throughout summer. Despite higher flows in 2019, upper Tenmile Creek went dry from Highway 101 downstream to Branscomb Road. Also, while Cahto Creek on the Reservation maintained surface flow, it became disconnected at Cheryl Boulle's and further downstream. However, pools in lower Cahto maintained water temperatures suitable for rearing steelhead, including one on the property of Dennis Hogan that was stratified with signs of hyporheic connection. A map summarizing 2019 water temperatures appears as Figure 56.

Table 1. Locations of water temperature probes and MWMT and MWAT summary statistics for 2019. Blue highlight indicates MWAT less than 62.4 F, which is suitable for coho salmon (Welsh et a. 2001).

Site	MWMT	MWAT
Big Rock Gage	**70.0**	**67.4**
Cahto at Boulle	**Dry**	**Dry**
Cahto Hogan's Pool	**61.2**	**60.9**
Cahto John's Pool	**67.1**	**65.3**
Cahto on Reservation	**68.7**	**65.0**
Lewis Cr Low	**71.1***	**68.2***
Lewis Cr Upper	**69.9**	**66.1**
Mill Creek	**65.1**	**62.4**
Peterson Creek	**63.7**	**61.7**
Streeter Gage	**72.2**	**66.7**
Streeter Low	**72.4**	**67.5**
Tenmile Flow - Lower	**76.3**	**72.2**
Tenmile Flow DS Steep Gl	**72.4**	**70.2**
Tenmile Raymond	**69.4**	**66.2**
Tenmile DS Peterson	**74.4**	**71.2**
Tenmile Joaquin	**68.0**	**66.5**
Tenmile at Wet Ford	**65.1**	**62.4**
Tenmile US Peterson	**75.1**	**71.4**
Tenmile Vassar's	**80.9**	**76.9**
Tenmile Gage	**86.2**	**76.6**
Tenmile Upper Hwy 101	**Dry**	**Dry**
Tenmile at Feed Store	**Dry**	**Dry**

* Dry above and/or below site – not ambient stream temperature – isolated pools.
** Gauge covered in mud in 2019 – 2018 Aug-Oct values listed.

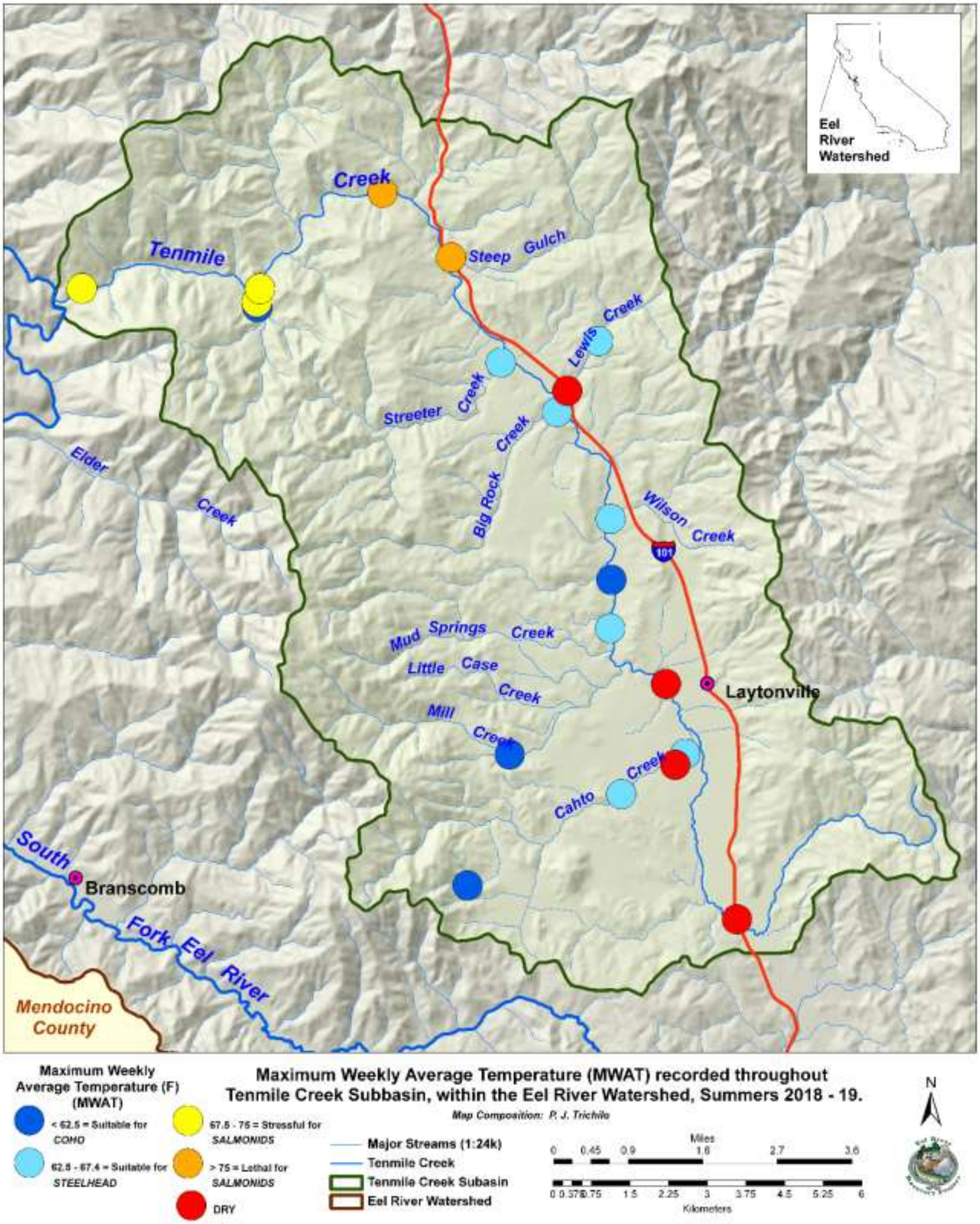


Figure 56. Water temperature results based on MWAT ranges for salmonid suitability and red for dry reaches. Data from ERRP.

Flow Reconnaissance/Timelapse Camera Results

While TGAEC monitored flow at four locations per year in 2018 and 2019, ERRP deployed ten timelapse cameras throughout the Tenmile Creek basin at locations in order to monitor stream flow (Figure 57). Cameras capture photos every 30 minutes during daylight hours that are then turned into movies of stream flow that are posted to the ERRP website.

In 2018, extensive reaches of Tenmile Creek and Cahto Creek, as well as lower Streeter and Big Rock creeks went dry (Figure 58). However, isolated pools in lower Streeter and Big Rock maintained cool water and supported juvenile salmonids, Including coho salmon in Big Rock Creek. Lower Tenmile Creek below Peterson Creek at the flow gauge maintained surface flow in 2018, although water temperatures favored warmwater fish species. Tenmile Creek upstream and downstream of Tenmile Creek Road maintained surface flow and temperatures favorable for juvenile steelhead rearing.

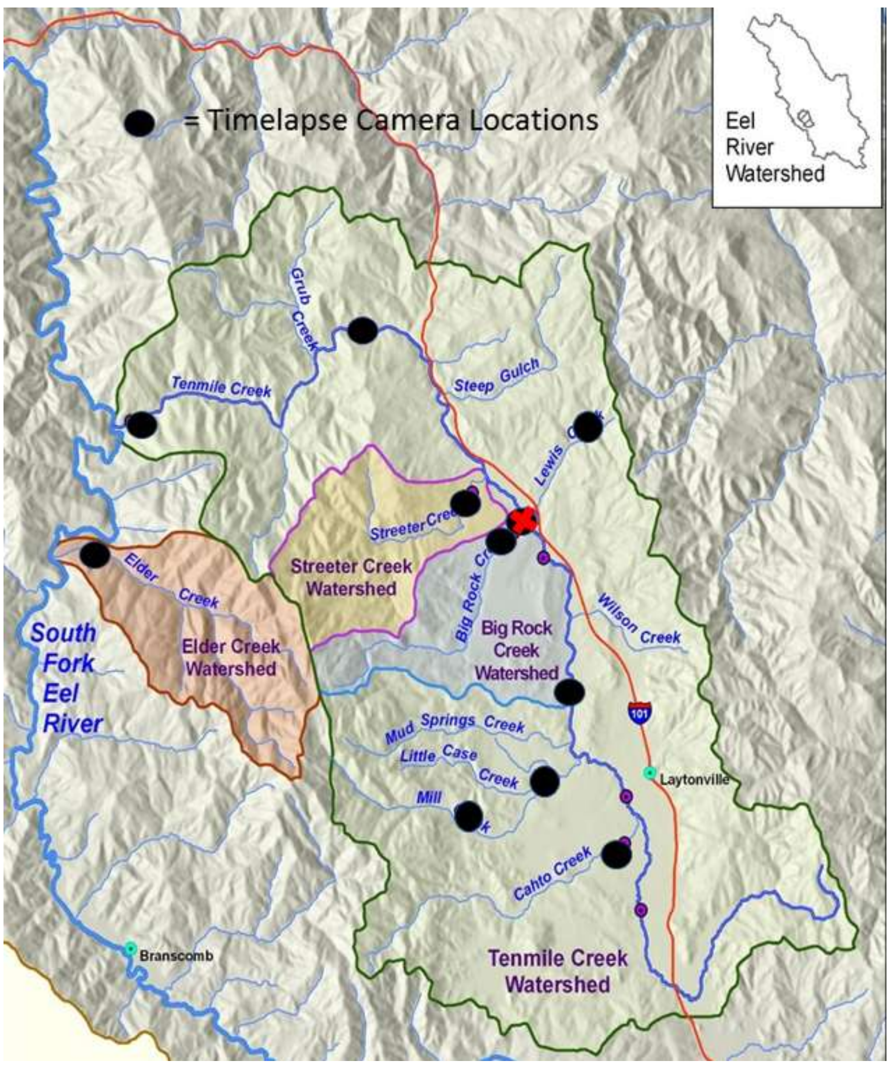


Figure 57. Locations of Tenmile Creek ERRP timelapse cameras to document flow, including one on Elder Creek that served as a control stream for the flow comparison study.

Figure 59 is a map of Tenmile Creek basin-wide flow conditions in 2019, including fish habitat suitability. Spring rains greatly improved the flow regime and carrying capacity for juvenile steelhead. However, we photo documented dry reaches of Tenmile Creek in 2018 and 2019 at Highway 101 (Figure 60), at Harwood Park, and at Branscomb Road. Isolated pools in this reach lacked fish life. Tenmile Creek at the Black Oak Ranch dried up between pools in 2018, but pools maintained sufficient water quality to support warmwater fish life, although mostly invasive aquatic species (Figure 61). The upper Mill Creek camera documented perennial flow in 2019 (Figure 62). A new location on Mill Creek above Little Case Creek was added in early 2020. The Cahto Creek camera below the Reservation off Mulligan Lane showed that the stream at that location disconnected in 2018 and that flows in winter of 2019-2020 fall were often insufficient for adult salmon and steelhead passage. The lower Tenmile Creek photo location captures the entire valley about a half mile upstream of the SF Eel River (Figure 63).

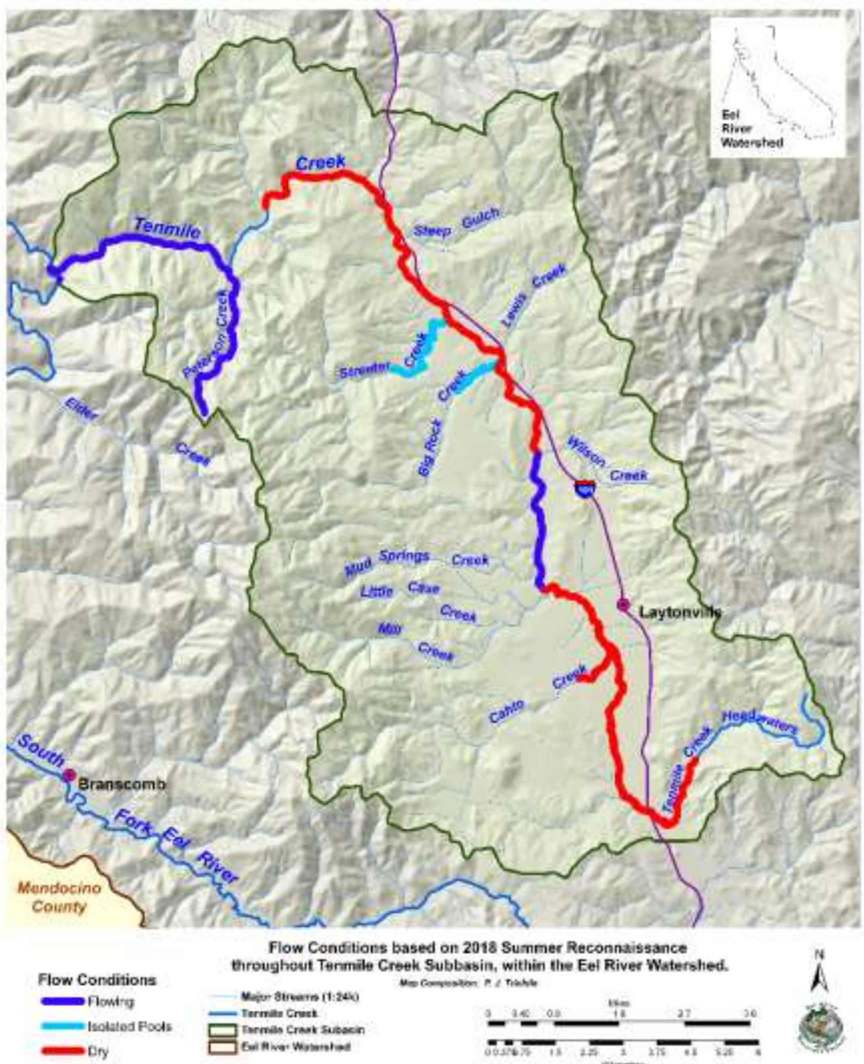


Figure 58. Map of Tenmile Creek flow conditions based on 2018 reconnaissance. ERRP.

The camera on lower Big Rock documented lack of flow in the summer and fall of 2018 (Figure 64); however, flow was maintained during the same period in 2019 (Figure 65). These cameras provide a low-cost tool for flow monitoring for adaptive management related to water conservation.

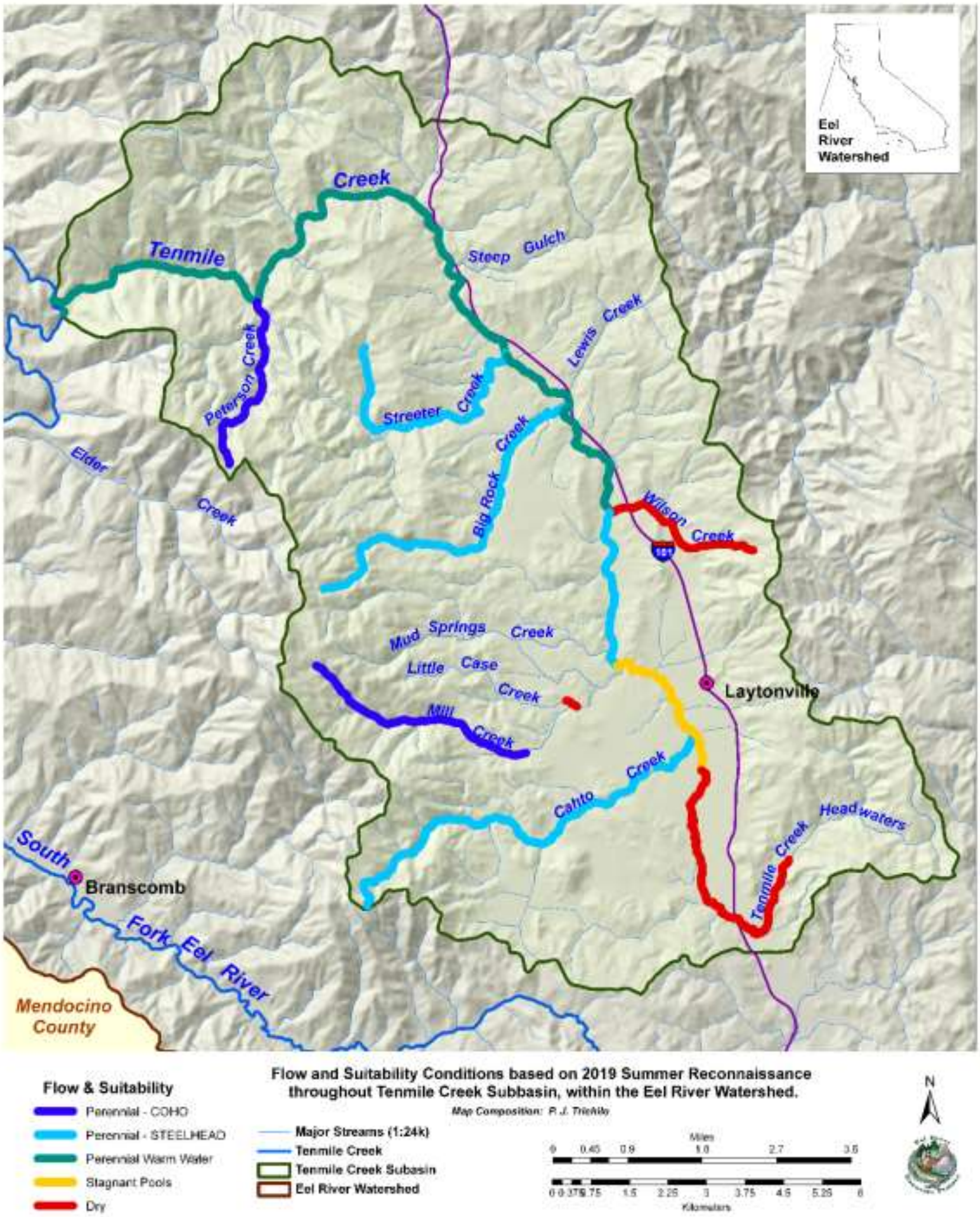


Figure 59. Map of Tenmile Creek flow based on 2019 reconnaissance, including salmonid suitability.

Figure 60. Tenmile Creek dry above Highway 101. 8/15/19.

Figure 61. Tenmile Creek isolated pool at the Black Oak Ranch. 9/15/18.

Figure 62. Mill Creek at timelapse camera location. 6/25/19.

Figure 63. Lower Tenmile Creek upstream of the South Fork Eel River. 12/04/18.

Figure 64. Lower Big Rock Creek dry. 9/12/18.

Figure 65. Lower Big Rock Creek with surface flow documented by timelapse camera. 9/15/19

Fish Populations and Fish Community Structure:

The status of Chinook salmon, coho salmon and steelhead of Tenmile Creek are described below. Because of the entire fish community gives an even broader understanding of ecological health, the status of all species in the basin is also discussed.

Chinook salmon fry begin their downstream migration as soon as they emerge from the gravel and they fatten in the estuary before entering the ocean to feed for 1-4 years. This early life history conveys a selective advantage over coho salmon and steelhead because summer low flows in Tenmile Creek do not limit the survival of juvenile Chinook.

The Tenmile Creek Chinook salmon population is part of a larger South Fork Eel River metapopulation that recent assessments suggest is in decline. CDFW operated a dual frequency sonar system (DIDSON) in the main Eel above Dyerville and Caltrout collected similar data on the lower South Fork Eel River in order to estimate fall Chinook migration in 2018 and 2019. Estimates for the main Eel remained consistent, with 3,844 in 2018-2019 and 4,231 in 2019-2020, while the South Fork estimate dropped considerably between years, with 3,800 fish in 2018-2019 and 2,190 fish in 2019-2020. It is likely that Tenmile Creek had only a few hundred fish this year, but spawning Chinook have numbered in the thousands in recent years. The Eel River basin-wide population dropped below 10,000 fish in 2019-2020 for the first time since ERRP began monitoring in 2012. The decline in Eel River Chinook is partly a result of poor ocean conditions limiting growth and survival since 2015.

Annual flow controls the influx of spawning Chinook adults in Tenmile Creek. Typically, fish reach the headwaters and spawn in the lower reaches of larger tributaries, such as Mill and Cahto creeks, around Thanksgiving. In years with very high sustained flow, Chinook may even spawn in smaller streams like Peterson, Streeter and Big Rock Creek. The prime spawning area for Chinook, however, is the main channel of Tenmile Creek itself, which has some of the best spawning gravel in the Eel River watershed (Figure 66). Chinook salmon spawned there in high densities in some years from 2012-2017, especially in the reach from Black Oak Ranch downstream to Grub Creek (Figure 67).

ERRP volunteer Dan Kvaka recorded a video of Chinook salmon migrating and spawning in Cahto Creek in December 2018, but flows in 2019-2020 never allowed the run to reach that location. Spawning Chinook were not seen at the Black Oak Ranch until in mid-December, according to Susy Barsotti, who lives there. Brad Raymond saw a few jacks downstream of the falls above Tenmile Creek Road, but no Chinook spawned upstream of that point. Many fish bound for Tenmile Creek instead spawned in the main South Fork Eel River above Piercy, which is in late recovery from past flood events and has ideal substrate. Low flows in early 2020 likely led to high survival of eggs and alevin and emergence of fry. However, low flow conditions may have also allowed a high rate of predation by the non-native Sacramento pikeminnow that inhabit this reach. The Tenmile Creek watershed is experiencing an increase in sediment yield and peak flows that sometimes disrupts Chinook salmon spawning success. Therefore, work is needed to stem the tide of sediment and to restore watershed hydrology to help Chinook salmon survive in an uncertain future.

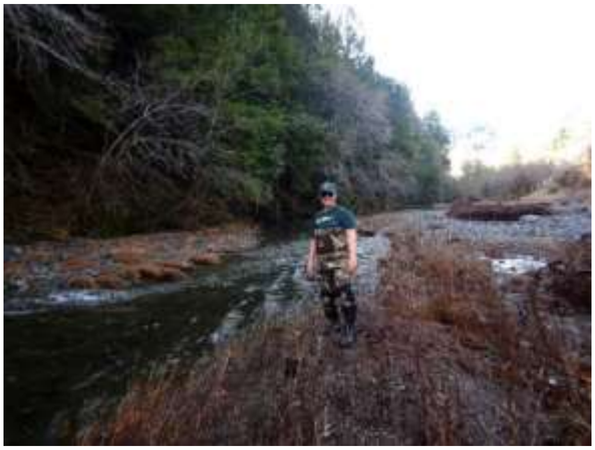


Figure 66. Pat Higgins on Tenmile Creek Chinook survey on Vassar property. 12/10/19.

Figure 67. Chinook salmon spawning at the Black Oak Ranch on main Tenmile Creek. 11/16/16.

Steelhead trout: South Fork Eel River DIDSON counts consider all large fish passing upstream after December 31 to be coho salmon or steelhead. In 2019 the combined total from January 1 through the first week in March was 3,837. In 2020 the count was 2,227. (Figure 68). Both these estimates could miss a substantial number of steelhead because they are known to run and spawn as late as April. If half the fish running in January are coho salmon, then a conservative estimate for South Fork Eel River adult steelhead appears to be in the range of 2000-3000 fish, which would suggest a Tenmile Creek population in the hundreds or the low thousands in some years.

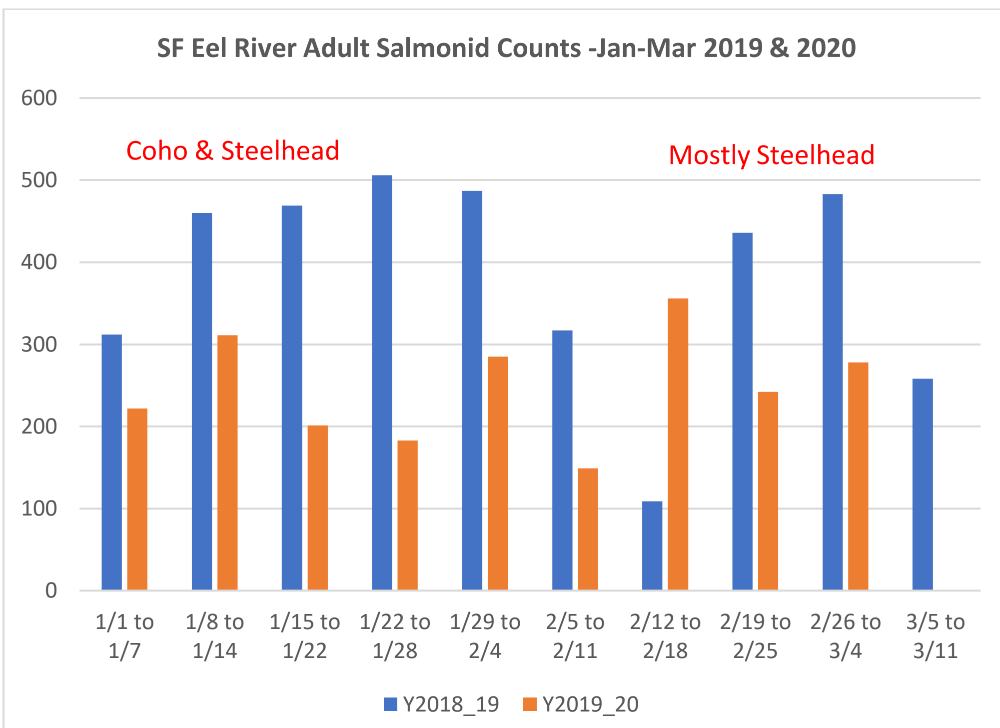


Figure 68. Adult salmon and steelhead counts according to DIDSON data in early 2019 and 2020. Data from Metheny (2020).

Figure 69. High density of juvenile steelhead with two size classes in lower Big Rock Creek. 6/1/20.

Figure 70. Yearling steelhead and two year old fish are indicative of high quality stream habitat. Big Rock Creek. 6/1/20.

Because steelhead can leap higher than Chinook and coho salmon, they can access steeper headwater areas, which substantially increases the habitat they have available for spawning and rearing. Steelhead juveniles require one to three years of freshwater residence, so populations shrink and swell depending on flow levels in Tenmile Creek. Their tolerance of warmer water provides a selective advantage over coho. Adult steelhead are able to hold for much longer and spawn as late as April, if winter rains are sparse.

Record low rainfall in February 2020 delayed spawn timing, as evidenced by active steelhead spawning in the reach of the South Fork on the Angelo Reserve above Tenmile Creek in early April 2020, which was observed by Peter Steele. Field reconnaissance of Tenmile Creek and tributaries in late May and early June 2020 found a very high standing crop of juvenile steelhead, with two different size classes indicating January spawning and a second wave around early April (Figure 69). Older age juvenile steelhead (Figure 70) have much higher ocean survival, and their presence indicates high quality habitat with perennial cold flow and winter flows that do not limit survival.

It appears that the sustained baseflow in 2019 allowed good survival of steelhead juveniles in Cahto Creek, as there are a substantial number of yearlings (4”) and even some two year old (6”) fish. Steelhead and rainbow trout are actually the same species, so some of the larger fish seen in Cahto Creek could be resident rainbow trout. The latter may attain a length of 10” or more, and have similar spawn timing to adult steelhead, but select smaller substrate. The variation in steelhead standing crops between wet years and dry years is dramatic, but working together the community can increase baseflows and make every year good for steelhead rearing in the Tenmile Creek basin.

Coho salmon are rare in Tenmile Creek, and at a low level in the region. Caltrout DIDSON counts suggest the South Fork Eel population is in the low thousands. Since coho salmon almost all spawn at age three, after two years in the ocean, there may be strong and weak year classes. Coho salmon juveniles have little tolerance for thermal pollution so they are unable to rear in mainstem Tenmile Creek environments at present. Only a few headwater tributary areas were found to be sufficiently cool for them, as noted above. However, local resident Dennis Dodd has resided on Tenmile Creek below Branscomb Road for decades, and remembers that past sampling by CDFG found numerous coho salmon in this reach. Today, flow is intermittent and pool temperatures are unsuitable.

Figure 71. Coho salmon juvenile in Big Rock Creek. 8/16/18.

We found juvenile coho salmon in isolated, thermally stratified pools in Big Rock Creek in 2018 (Figure 71) but not in 2019. Coho juveniles have been documented in the past in lower Grubb Creek (Garwood 2012). MCRCD biologist Joe Scriven saw coho for three years running in Cahto Creek on the Reservation. There does not seem to be a sustaining population of coho salmon in the Tenmile Creek watershed at present. Instead, strays from the core area of the South Fork Eel River from above Branscomb to Indian Creek test conditions for recolonization. If flows are improved and temperatures are reduced, these colonists will help coho bounce back in Tenmile Creek.

Pacific Lamprey are the “eels” for which the Eel River is named (Figure 72). They spawn widely in Tenmile Creek in years of high abundance, such as 2016 and 2017. Eel ammocoetes are blind and live in fine sediment in the stream margins for 5-7 years, then transform to adults and feed in the ocean for 2-3 years. They make redds like Pacific salmon except with smaller rocks. They generally spawn from March through June. Adults may enter freshwater and proceed immediately upstream to spawn or spend a year holding as an adult in freshwater. Lack of flow in Tenmile Creek in dry years likely reduces lamprey rearing capacity.

Figure 72. Pacific lamprey spawning in the South Fork Eel below Jack of Hearts Creek. 6/16/17.

Sacramento suckers are native to the Eel River and adapted to warm water (Figure 73). Juvenile suckers were noted in mainstem Tenmile Creek at the Black Oak Ranch in fall of 2017 after a summer with high baseflows, but older suckers have not been observed. Suckers in the Eel River basin as a whole experienced a major population increase after the profound channel changes caused by the 1964 flood. Predation by the Sacramento pikeminnow since their introduction in 1979 has led to a very depressed sucker population in the South Fork Eel River downstream of Tenmile Creek. Desiccation of mainstem channels, poor water quality in remaining pools, and competition from exotic warmwater species appear to be limiting adult sucker survival in Tenmile Creek.

Sculpin are small fish, generally less than six inches in length, that live under rocks in clean cobble and gravel bedded streams (Figure 74). Like the sucker, native sculpins have fallen prey to pikeminnow and are rare in the South Fork Eel River. An over-supply of fine sediment can cause these fish to decrease or disappear, as the interstitial spaces in which they live are filled. Excess sediment is likely limiting sculpin species in lower Tenmile Creek, as well as flow fluctuations and limited summer water quality.

Figure 73. Rare native Sacramento sucker in SF Eel below Rattlesnake Creek. 7/16/19.

Figure 74. Prickly sculpin in tributary of the lower Russian River, Kidd Creek. 5/31/20.

California roach are by far the most numerous fish in the Eel River as waters warm in summer. There is debate over whether the roach is native to the Eel River, but it does not predate on salmon or steelhead juveniles. It may however, compete with the latter species for food where they share habitat, and roach have an advantage as waters warm to the point of salmonid stress. Roach are commonly about four inches long as adults, but large specimens may be six inches long. They spawn several times during the summer and have red splotches when in spawning condition (Figure 75).

Exotic Fish Species: Sacramento pikeminnow (Figure 76) were introduced into the Eel River system in 1979 at Lake Pillsbury and had disbursed throughout the watershed by the early 1990s. Large adults have not been observed in Tenmile Creek, but pikeminnow up to 10 inches are present. Numerous invasive species are raised in the ponds throughout the valley and escape to Tenmile Creek when ponds spill, delivering blue gill (Figure 77), green sunfish, largemouth bass, brown bullhead (Figure 78) and worst of all, bullfrogs.

When Tenmile Creek flows are depleted and isolated pools warm in the sun, they form ideal habitat for invasive species. Only during severe drought do these pond species survive in Tenmile Creek or main Eel River channels, but a re-supply is constant every time ponds spill. The Slovenian snail species, *Radix auricularia,* proliferated in the South Fork and lower Eel River during the drought of 2013-2015, and likely came from an upper SF Eel or Tenmile Creek pond. Plant species, such as Elodia, a fish tank plant, have escaped and create weed beds in edge-water and back-water pools in the Eel River that often provide ideal habitat for invasive species.

Figure 75. California roach may not be native, but they are everywhere and kind of benign. 9/15/19.

Figure 76. Adult pikeminnow in survey reach of SF Eel downstream of Rattlesnake Creek. 6/29/17.

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Figure 77. Bluegill without pigment in Big Rock Creek. 8/16/18.

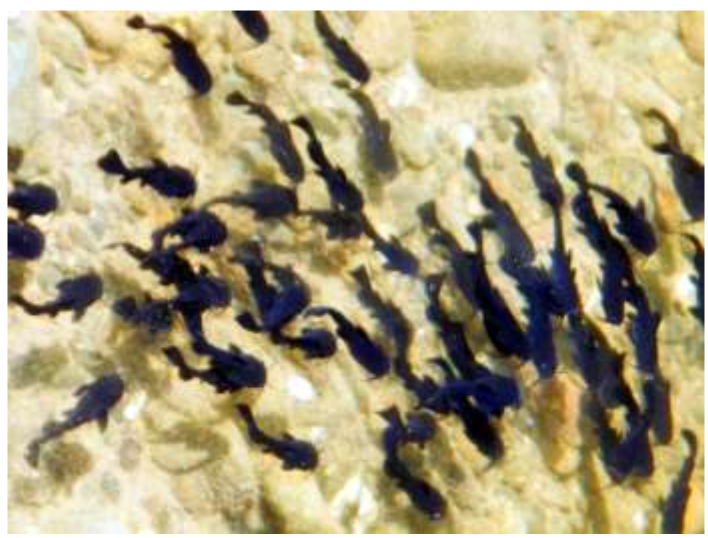


Figure 78. Recently hatched brown bullhead fry in margin of Black Oak Ranch pool. 8/22/14.

Aquatic Health of Tenmile Reaches and Tributaries

The health of Tenmile Creek reaches and tributaries is highly variable. Understanding where conditions are limiting can help target restoration actions. A sub-basin map is shown in Figure 79.

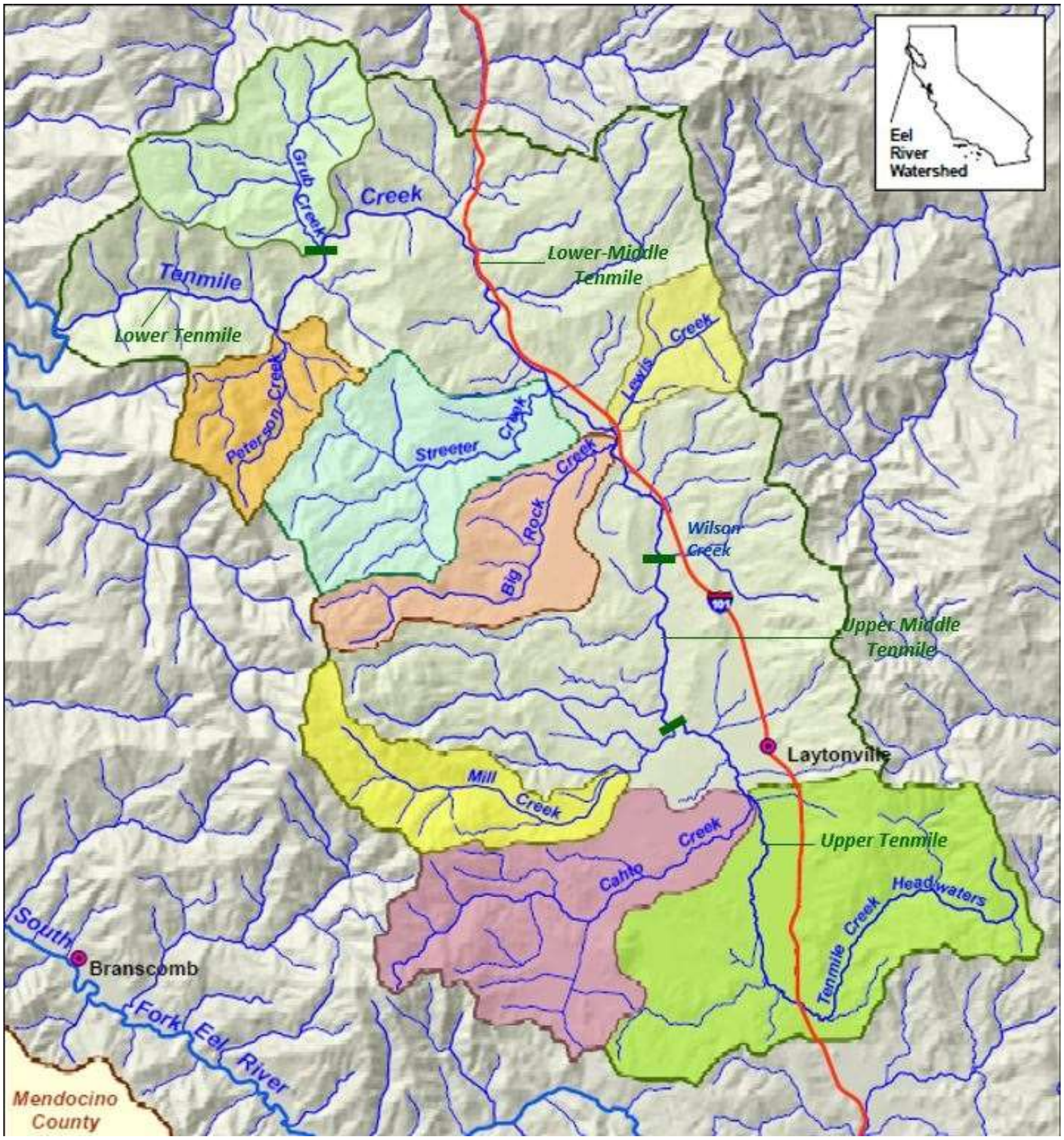


Figure 79. Tenmile Creek subbasins. Map by Dr. Paul Trichilo, ERRP.

Upper Tenmile Creek: This sub-basin extends upstream from the mouth of Cahto Creek, to the headwaters of Tenmile Creek, which arises from steep ridges. The creek loses connecting surface flow annually and does not maintain pools suitable for salmonids, and few suitable for any fish life. Sediment over-supply is evident, with several feet of sediment accumulation at Harwood Park. The high sediment load forces the stream current into the banks, triggering erosion. Because this sub-basin is in such a challenged condition, it might have a lower restoration priority than those showing more ecological resilience.

Cahto Creek is the most productive tributary of Tenmile Creek; all three species of ESA-listed salmonids return to this stream. It has a coarse bed load, with little sign of elevated fine sediment, and excellent spawning gravels. It has a good riparian canopy for most of its length, some naturally occurring large wood jams, and additional ones installed by the Cahto Tribe. Cahto Creek loses surface flow in some reaches in some years, although cold pools maintain hyporheic connection and allow survival of steelhead trout in all years. At present, Cahto Creek appears too warm to support juvenile coho salmon, but there may be local refugia where they survive. Flow improvement in Cahto Creek would be desirable and will be studied, if ERRP receives SCC Prop 1 Phase II funding. Bioengineering will be used to restore lower Cahto Creek banks in 2021 with a SWCB 319h grant, and failing banks on the Varnhagen Ranch will be targeted in future grant rounds to further reduce sediment. The Cahto Tribe is also applying for additional grant funds to stabilize banks and improve fish habitat in Cahto Creek on the Reservation.

Mill Creek, which flows off Cahto Peak, has water temperature suitable for coho salmon in its headwaters, no apparent sign of excess sediment transport, and gravel size suitable for salmon and steelhead spawning. Downstream, just above Little Case Creek, particle size is appropriate and Joe Feigon observed Chinook salmon spawning at this location. This stream will be a candidate for flow restoration under the SCC Prop 1 Phase II, if it is funded.

Little Case Creek was dry in 2018 and 2019 at its convergence with Mill Creek. Below the convergence with Mill Creek, Little Case Creek continues and joins Tenmile Creek, but we have no information on this reach or its quality of habitat.

Mud Springs Creek joins Tenmile Creek downstream of Little Case Creek and has appropriate gradient for coho salmon and steelhead, but ERRP has no data and has had no access.

Big Rock has a channel that is in excellent condition and an outstanding riparian zone. We found coho salmon in this stream in 2018 and there is very high use by steelhead. Therefore, this stream should be of the highest restoration priority. Bank stabilization and habitat improvement installed by Bioengineering Associates in the 1990s has improved carrying capacity for juvenile salmonids. Additional bank restoration opportunities on the Bewley property in upper Big Rock Creek are being explored. However, the principal limiting factor on Big Creek is lack of flow in dry years, so ways to increase flow need further study.

Streeter Creek is very good habitat for steelhead, slightly too warm for coho, and has a higher sediment supply than Big Rock Creek. Streeter Creek was reconstructed after 1983 using bioengineering in response to channel widening. The result was a narrower, shaded channel and an improved riparian zone that creates cooler ambient air temperatures over the stream by 2003. Streeter Creek became flow limited between 1995 and 2015 as a result of forest succession. The Eel River Recovery Project and the Tenmile Creek Watershed Council are pursuing resources for forest health improvement to reduce evapotranspiration and restore the baseflow of Streeter Creek. Flows will also be improved, if ERRP is able to increase water storage that allows forbearance by the Black Oak Ranch. Finally, rebuilding the Streeter Creek tributary, which has legacy problems from logging, would both reduce sediment and help replenish baseflows. Streeter Creek is showing signs of resilience and could ultimately support coho again, so it deserves high priority for restoration.

Upper Middle Tenmile Creek extends from the mouth of Little Case Creek to Wilson Creek north of Laytonville and includes the reach above and below Tenmile Creek Road. While reaches upstream and downstream become disconnected, this one is perennial and has water temperatures suitable for rearing steelhead. The riparian zone in this reach is largely intact, providing shade for the stream and contributing large wood for habitat complexity. The USGS groundwater reports suggests upwelling in this area, which may be the source of coldwater flow. However, high sediment storage and transport is filling pools and compromising spawning gravel quality for salmon and steelhead in this reach. A major restoration goal in this reach is to acquire funding for a bridge over Tenmile Creek at Tenmile Creek Road because driving through the creek causes chronic sediment impairment. The Eel River Watershed Improvement Group has won a grant on behalf of the Tenmile Creek Road Association to design plans for the bridge.

Lower Middle Tenmile Creek extends from Wilson Creek downstream to Grub Creek, and in some years has extremely high use by spawning Chinook salmon. Flow problems recur in this reach in dry years, when pools may become isolated and often harbor an abundance of invasive exotic species. To maintain the quality of Chinook spawning gravels, banks in this reach need to be stabilized and gully and road erosion sources need to be abated.

Grub Creek is known to have supported coho salmon in the past and its location on lower Tenmile Creek could make it an important refugia for juvenile salmonids, as the mainstem becomes too warm. Unfortunately, lower Grubb Creek has lost surface flow in recent years, according to former resident Chris Hrabek, and ways to restore baseflows should be explored. The ERRP road stream crossing map (Figure 28) indicates that there are 13 crossings on roughly two miles of Grub Creek, which poses extreme risk of multiple crossing failures that could gut the stream channel. The road system in this creek needs to be re-engineered, with roads on ridges and fewer stream crossings.

Peterson Creek is a little-known tributary of lower Tenmile Creek that is 2.5 miles above its convergence with the South Fork. It is restored, perennial, cold enough for coho salmon, and Tenmile Creek migrants can access its cool flows in summer. Old growth in the headwaters owned by BLM and improving conditions in surrounding private land have helped this stream recover. ERRP has been awarded a North Coast Resource Partnership grant for forest health in Peterson Creek to further improve watershed condition and flow. Actions in Peterson Creek are of the highest priority because it is a refugia.

Lower Tenmile Creek (Figure 75) is the designation given to the reach extending from Grub Creek to the South Fork Eel River. Its higher gradient and energy tends to transport sediment and not accumulate it. The temperature of lower Tenmile Creek moderates due to topographic shading and contributions from cold water springs and tributaries like Peterson Creek. The ERRP SCC Prop 1 Phase II project will target sediment sources in this reach, if funded. Also, forest health improvement resulting from the NCRP grant could help increase baseflows and reduce the risk of catastrophic fire.

Recommendations

1. Continue collecting water temperature data and to assess fish community structure basinwide, if funded by SCC Prop 1, to gauge inter-annual variability and impact of restoration measures over time.
2. Collect baseline and trend data on the amount of sediment in pools using V* techniques in 2021 and 2022 in association with the 319h grant to check for benefits from bank erosion control and for basinwide trend monitoring of sediment for adaptive management.
3. Collect air and water temperature data, beginning in 2021 in association with the 319h grant, to that helps discern long term benefits of bioengineering projects with regard to changes in water temperature and ambient air temperature in restored riparian zones.
4. Continue operation of time lapse cameras to monitor surface flow at key locations to monitor inter-annual variability and response to restoration over time.
5. Do outreach to discourage introduction of non-native species into Tenmile Creek ponds.
6. Prioritize restoration implementation based on Bradbury et al. (1995) principals.
7. Support construction of a bridge over Tenmile Creek at Tenmile Creek Road to eliminate sediment pollution and allow safe year-around passage for residents.
8. Seek cooperation of improvement of road network and for water conservation and flow restoration in Grubb Creek.

Reference Summary for Chapter 5:

Temperature thresholds recognized for coho salmon and steelhead are from Welsh et al. (2001) and McCullough (1999), respectively. Protocols for temperature sensor placement are from Lewis et al. (1999). There have been several previous studies of Eel River water temperatures; Friedrichsen (1998), Lewis et al. (2000) and Asarian et al. (2016) provide scientific support for pertinent statements. Higgins (2013, 2014) summarized ERRP basinwide temperature findings, including flow problems in Tenmile Creek. Power et al. (2015) noted the connection between flow reduction and a trophic shift in the Eel River from coldwater and healthy green algae to warm water and cyanobacteria. Poole and Berman (2001) provide the basis for discussion about hyporheic connection, or the zone of surface and groundwater interface. Fisheries references include Barnhart (1986) for steelhead life histories. References for fall Chinook DIDSON counts on the main Eel at McCann and South Fork above Dyerville are Kajtaniak and Gruver (2020) and Metheny (2020), respectively. ERRP fall Chinook assessment reports (Higgins 2017a, 2020) also provide the basis for statements about trends and habitat use. Moyle et al. (2015) is the basis for statements about Pacific lamprey life history. The potential impact of Sacramento pikeminnow predation on salmonids in the SF Eel River downstream of Tenmile Creek is from Higgins (2017b). White (2000) documented the impact of predation on Eel River sculpin populations. Information on the status of coho salmon comes from NMFS (2014) and the principal framework for prioritization of conservation and restoration of salmon and steelhead populations is from Bradbury et al. (1995).

Chapter 6 – Outreach & Education

Although involving volunteers was actually part of the task associated with scientific data collection, it is included here along with outreach and education. Connecting with the public and rooting this plan in the community was essential to promote real change. Our aim: engage, enlighten, and empower.

Volunteers

ERRP successfully recruited dozens of volunteers (Figure 80) who allowed access for aquatic monitoring and placement of timelapse cameras or, in some cases, took or shared responsibility for deployment and maintenance of equipment. Some even slapped on masks and snorkels and spied on fish under water. We learned a lot through these associations and the trust we gained serves as a foundation for conservation and restoration success.

Direct Mail/Landowner Outreach

We compiled a database of land owners derived from the Mendocino County parcel map and used the resulting mailing list to reach out to land owners, similar to methods used by Sanctuary Forest in the upper Mattole River watershed. Postcards were sent to all land owners first, explaining the project and inviting everyone to the kickoff meeting. The land owner survey was devised in consultation with Tenmile Creek Watershed Council members (see Attachment 2), and 740 surveys were sent out to all land owners in the Tenmile Creek watershed. Sixty nine surveys were not delivered because of incorrect addresses. Fifty five landowners ultimately responded to the survey, many requesting services. Most of the responders requested help with riparian restoration and gully erosion control. There were fewer land owners asking for assistance with water conservation. Follow up with land owners was first via phone or email, per their preference. Then we met with them on their properties to see the problems and opportunities.

Meetings/Press Releases

Key meetings were the pilot project kick off meeting (10/29/18), the Forest Reciprocity Group "Pole Raising" (5/26/19), outreach celebrations at the ERRP Laytonville Office (7/13/19, 11/8/19), quarterly meetings with the TCWC, a community water conservation meeting (1/23/19), the report of findings to the TCWC and community (1/14/20) (Figure 81) and a forest health meeting co-sponsored with the TCWC (1/25/19). Each of these events was well attended and many led to additional contacts for monitoring partnerships or conservation and restoration leads. Public Service Announcements and press releases accompanied each event, and all were picked up by the Mendocino Observer in Laytonville and several by the Willits Weekly and the electronic Mendocino Voice.

Magazines and Newsletters

ERRP published feature articles in the regional conservation magazine Forest and River News, put out by the Trees Foundation, in the Spring 2018 and Summer 2019 issues. Tenmile Creek pilot project news was also shared with the Mendocino Environmental Center Newsletter (March 2019) and the Willits Economic Localization (WELL) Newsletter (March 2019). Updates to members and friends were also included in ERRP newsletters (Fall 2019, Spring 2020).


Darryl Gully - Cahto


Dennis Hogan - Cahto


Vick Weaver – Big Rock


The Varnhagens – Cahto Creek


Grace Chapelle & Margaret Andrews of Tenmile Ck. Rd Assoc.

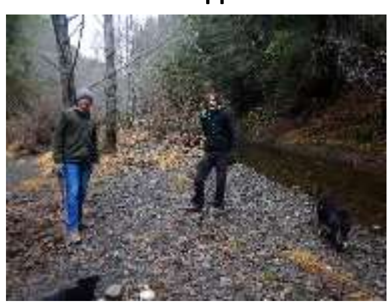

Mike Hembree & Jim Hockgraef – Lewis Creek


Robert Brunet – Tenmile Creek


Alan Adkisson – Upper Mill Creek


Dan & Deb Kavaka w/ Philip Buhler - Cahto


Fred Simmonds – Cahto


Brad Raymond - Tenmile


Joaquin Droesch - Tenmile


Steve Brown – Peterson Creek


Cheryl Boulle - Cahto


Bob Vassar& Philp Buehler –Lower Tenmile

Figure 80. ERRP volunteers and cooperators.

Figure 81. Evening group at report to the community meeting at ERRP Office in Laytonville. 1/14/20.

Electronic Media

Project Manager Patrick Higgins has a monthly Monday Morning Magazine radio show on KMUD, a public radio station that reaches a lot of the Eel River watershed including Laytonville, where there is a large listening audience. Pat had contractors Hollie Hall (Compliant Farms), Anna Birkas (Village Ecosystems), and Philip Buehler (BioEngineering Associates) on for half hour segments describing their roles in the pilot project and opportunities for Tenmile Creek residents to get conservation and restoration consultation and services. Also, Pat had MCRCD staff Joe Scriven, NCRWQCB staff Maggie Robinson, and Pacific Watershed Associates roads and erosion expert Colin Hughes on for similar segments describing their project to reduce road erosion in the Eel River watershed in Mendocino County, including in Tenmile Creek. Pat does a 15-minute monologue at the beginning of every show, and often did Tenmile pilot project updates. KMUD public service announcement were also used to promote pilot project cooperation.

Pat Higgins was also a guest on local broadcasting outlet in Laytonville KPFN on Jim Shields "This and That" show on two occasions. Numerous KMUD News interviews occurred when press releases came out and three interviews on KZYX also took place about the pilot project activities and success.

Brochure and Posters

Three wall posters were created in Power Point and printed by the Trees Foundation for use at meetings: a kickoff poster summarizing all project elements, a poster celebrating project volunteers, and a one of the fish pictures taken during the pilot project. Copies of the posters were provided to the Laytonville Elementary School and the Cahto Tribe. A brochure explaining the pilot project was produced and 500 printed and disseminated at events and through the mail. The brochure was probably the most effective in orienting people and getting them to respond.

Web/Social Media/Video

The ERRP website (www.eelriverrecovery.org) was updated constantly throughout the project and has photos and news, including dedicated pages for different aspects of the project. Timelapse videos will also have a portal at the site where stream flows can be reviewed for different periods. Some interviews conducted on the KMUD Monday Morning Magazine were also captured on ERRP Sound

Figure 82. Close up of steelhead trout in Streeter Creek posted to Facebook in September 2019.

Cloud (https://www.eelriverrecovery.org/podcasts). Numerous videos of Tenmile Creek fish life were posted over the course of the project were posted to the ERRP Vimeo page (https://vimeo.com/eelriverrecoveryproject). Tenmile Creek residents and others could see the beauty of tributary streams and their fish life (Figure 78), if they follow ERRP on Facebook (www.facebook.com/EelRiverRecovery/)

Recommendations

1. Continue outreach and recruitment of land owners for riparian restoration, gully erosion control and water conservation.
2. Continue work with volunteers throughout the Tenmile Creek watershed to help them gauge stream health and the success of restoration efforts.
3. Maintain and update ERRP website, Vimeo and Facebook pages with content about Tenmile Creek restoration and foster TCWC outreach capacity.
4. Help foster vocational education track for young scientists and forest health workers to assist with implementation of forest health in the Tenmile Creek watershed.

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Tenmile Creek at Black Oak Ranch.

Attachment 1 – Star Worksheet (Monschke 2015)

PRIORITY #: ____________

Check: ________

STAR WORKSHEET

Site #: ____________

Map #: ____________

Inspector: ____________ Date: ____________ Watershed Name: ____________

Landowner: ____________ Road Name: ____________ Road Mile: ________

PART I — SITE DESCRIPTION

1. **ROAD DESCRIPTION:** Permanent or Seasonal: ____________

Traffic Use (A= abondoned, L=light [1-2/day], M=medium[2-4/day], or H=heavy [>4/day]): ____________

Road Surface (dirt, gravel, paved): ____________ Road width: ________ Road Gradient (%): ________

2. **POTENTIAL SEDIMENT SOURCE:** This site is a:

☐ Debris slide ☐ Landing fill ☐ Crossing

☐ Debris torrent ☐ Road fill ☐ Streambank erosion

☐ Other slide ☐ Road and/or landing drainage ☐ Instream stored sediment

☐ Gully > 1ft ☐ Road surface and/or rills ☐ Other: ____________

3. **SIZE OF SITE:** ________ (width) x ________ (length) x ________ (height)

4. **WATER SOURCE:** ☐ I. ☐ II. ☐ III. ☐ IV = Inboard ☐ Other: ____________

5. **STREAM CROSSING DATA:**

☐ Culvert ☐ Bridge ☐ Humboldt crossing ☐ Fill

☐ Armored ford ☐ Pulled crossing ☐ Dip

☐ Other: ____________

Culvert data: Diameter: ________ inches Culvert head water height: ________ feet

Downspout: Existing: ☐ yes ☐ no Needed: ☐ yes ☐ no

Rock dissipater: Existing: ☐ yes ☐ no Needed: ☐ yes ☐ no

Trash rack: Existing: ☐ yes ☐ no Needed: ☐ yes ☐ no

Culvert condition: ☐ Ok ☐ Problem If problem, what? ____________

Culvert plug potential: ☐ Low ☐ Medium ☐ High

Diversion potential: ☐ yes ☐ no

Drainage area above crossing: ________ acres Natural stream gradient: ____ %

Natural stream cross-section (bankfull x 2): ________ ft^2

6. **DESCRIPTION/COMMENTS:** ____________

____

____

____

Part II	Sediment Evaluation

1. Estimated yds3 of potential failure:

(______ yds^3) – (______ yds^3 previously delivered) x (______ % delivery) = ______ yds^3

2. Delivery rate:________________ (1 = unlikely, 2 = years, 3 = within 1 winter, 4 = within 1-2 storms)

3. Erosion potential:________________ (1 = low TO 4 = high)

Part III	Site Prescription

1. Prescription:____

____

____

____

2. Cost:

$______ Equipment time + $______ Labor + $______ Materials = $______ TOTAL

3. Is this site treatable? ________________ (0 = not treatable TO 3 = easily treatable)

4. Cost effectiveness:

$________________ ÷ ________________________ = $ ______ /yd^3

(total cost from Part III, #2) ÷ (est. yds^3 of potential failure from Part II, #1) = $/$yd^3$

5. Priority Index Number:

(______) x (______) x (______) x (______) ÷ (______) = ____________

(Part II, #1) x (Part II, #2) x (Part II, #3) x (PartII, #3) ÷ (Part III, #4) = (Priority Index Number)

6. Site sketch:

Attachment 2 – ERRP Tenmile Landowner Survey

Tenmile Creek Conservation and Restoration Pilot Project Land Owner Survey

Landowner Name: ____

Landowner Preferred Contact (please provide email and/or phone number or indicate mail only:

____

Assessment of Your Willingness to Participate

1) Are you interested in participating in a grant funded Tenmile Creek watershed conservation and/or restoration project that requires limited or no cost-participation?

   ____

2) Would you like a free survey of your creek by riparian restoration specialists with no obligation?

   ____

3) Would you be interested in receiving grant funds, so you could increase water storage?

   ____

4) Would you like a free onsite consultation about water conservation?

   ____

5) Would you like free information about water rights and water use permitting?

   ____

6) Would you like a free onsite consultation about your water rights?

   ____

7) Would you like help filling out and filing water rights permits?

   ____

8) Would you like technical assistance from the Mendocino County Resource Conservation District on road erosion prevention?

   ____

Assessment of Your Geographic Location

1) Do you own land along Tenmile Creek?

   ____

2) Do you own land in the Big Rock Creek watershed?

   ____

3) Do you own land in the Streeter Creek watershed?

   ____

4) Do you own land somewhere else in the Ten Mile Creek Watershed?

   ____

Assessment of Your Property's Erosional Issues

1) Do you have problems with bank erosion?

   ____

   a. Is there shade over the creek on your property?

      ____

2) Do you own meadow or forest land with gully erosion problems?

   ____

   a. Would you like free professional technical advice on fighting gully erosion?

      ____

   b. Would you like to participate in a basin-wide gully erosion control effort if grant funding resources are offered to assist with costs for participation?

      ____

3) Do you have problems with erosion related to roads?

   ____

Assessment of Your Property's Water Use

1) What is your water source for household use?

   ____

2) What is your water source for irrigation?

   ____

3) How many people live in your household?

   ____

4) What is the approximate size of your non-commercial garden?

   ____

5) What is the approximate size of your commercial garden?

   ____

6) Have you done a water budget?

   ____

7) Do you know your annual water use?

   ____

8) Do you have enough water to supply your needs? _____________________________________

9) What are the dates that you start and stop withdrawing water from Tenmile Creek or one of its tributaries? Start Date: _____________ End Date: _____________

Assessment of Your Property's Water System

1) How do you measure your water use?

   ____

2) What is your method of water storage?

   ____

3) How many gallons of water can you store?

   ____

4) Do your storage tanks have over-flow valves?

   ____

5) How often do you check for water system leaks?

   ____

6) How often do you do maintenance to your water system?

____

7) Do you have enough water storage? _____________________________________

Please note that **all information you share is CONFIDENTIAL**. We will use the results for restoration planning, but your information will not be shared with any government agency or other entity.

Comments/Additional Information:

____

____

____

____

____

____

____

____

Please use the enclosed, stamped envelope to mail your survey. Thank you!

Attachment 3. Table of Recommendations

Chapter 1 Riparian Restoration	1) Implement highest priority bank erosion sites on Cahto Creek along the Cahto Trail, on the Feigon property on Mill Creek above Little Case Creek, and on Streeter Creek at the Black Oak Ranch with SWRCB 319h grant in 2021.
	2) Seek funding for the second highest priority banks erosion sites in 2021 or 2022, including Cahto Creek at the Varnhagen property, and two Tenmile Creek projects, one on the Weaver property below Big Rock Creek, and the other above Streeter Creek on the Black Oak Ranch (sources 319h & CDFW FHRP).
	3) Seek funding for third tier of bank erosion control and riparian restoration projects (2022-2023): Tenmile Creek across from Harwood Park and below Cahto Creek, and other upper Tenmile Creek sites (sources 319h & CDFW FHRP).
	4) Acquire resources to study the feasibility of protecting Tenmile Creek riparian zones through use of systematic easements or acquisitions (TCWC apply to Mendocino County Community Foundation).
Chapter 2 Erosion Control and Prevention	1) Carry out design and permitting for major gullies and other erosion sources identified on lower Tenmile Creek and in Cahto Creek in 2021, if SCC Prop 1 funding is awarded.
	2) Do outreach and connect with more landowners who have gully problems, especially in grassland areas or other watershed areas of high erosion risk.
	3) Create a prioritized inventory of erosion risk at all stream crossings that are accessible for inventory in the Tenmile Creek watershed.
	4) Work with the MCRCD to promote cooperation of landowners and road associations to participate in grants to reduce erosion from roads in the Tenmile Creek watershed.
	5) ERRP and TCWC should work with BLM on Cahto Peak Road erosion control and prevention.
	6) Explore potential cooperation for rebuilding Streeter Creek tributary hydrology.

Chapter 3 Watershed Hydrology and Stream Flow	1) Continue operation of flow monitoring from pilot project but add Mill Creek flow gauge, and assist Cahto Tribe with gauging Cahto Creek in the Reservation in 2021 and 2022, if funded by SCC Prop 1.
	2) Run VELMA model for Cahto and Mill creeks to determine their flow departure from historic norms, and the DWR articulated surface and groundwater model for Tenmile Creek Priority Water Conservation Area, if funded by SCC Prop 1.
	3) Study groundwater and surface water interactions in 2021-2022, if SCC Prop 1 is funded, to detect whether over exploitation of groundwater that impacts stream flow and/or access to water for neighboring parcels is occurring, and make policy recommendations to Mendocino County, if needed.
Chapter 4 Restoring Base Flows Water Conservation and Watershed Health Improvement	1) Design and permit water storage infrastructure for Black Oak Ranch organic farm and Camp Winnarainbow in 2021-2022, if SCC Prop 1 funding is awarded, and subsequently pursue resources in 2022 for the build phase from the Wildlife Conservation Board Prop 1 water conservation grant fund with project completion in 2024.
	2) Work with residents of Mill Creek and others in the PWCA in the western Tenmile Creek watershed on adopting forbearance in exchange for sufficient water storage in 2021, if SCC Prop 1 funding is awarded, and subsequently obtain WCB Prop 1 for implementation, if cooperation is obtained.
	3) Conduct forest health planning with North Coast Resource Partnership grant in 2020 and 2021 and begin planning for implementation to reduce forest evapotranspiration and help improve stream baseflows with subsequent grants in the Streeter Creek watershed as a priority.
	4) Work with landowners to improve grassland health in order to improve watershed hydrology, including gully erosion control and repair.
	5) Work with cannabis farming community to adopt regenerative cannabis practices, including full implementation of water conservation and use of rainwater catchment systems to augment agricultural water supply.
	6) Work with cooperative landowners on wetland conservation and/or flow augmentation.

Chapter 5 Aquatic Habitat and Fish Life Assessment	1) Continue collecting water temperature data and to assess fish community structure basinwide, if funded by SCC Prop 1, to gauge inter-annual variability and impact of restoration measures over time.
	2) Collect baseline and trend data on the amount of sediment in pools using V* techniques in 2021 and 2022 in association with the 319h grant to check for benefits from bank erosion control and for basinwide trend monitoring of sediment for adaptive management.
	3) Collect air and water temperature data, beginning in 2021 in association with the 319h grant, to that helps discern long term benefits of bioengineering projects with regard to changes in water temperature and ambient air temperature in restored riparian zones.
	4) Continue operation of time lapse cameras to monitor surface flow at key locations to monitor inter-annual variability and response to restoration over time.
	5) Do outreach to discourage introduction of non-native species into Tenmile Creek ponds.
	6) Prioritize restoration implementation based on Bradbury et al. (1995) principals.
	7) Support construction of a bridge over Tenmile Creek at Tenmile Creek Road to eliminate sediment pollution and allow safe year-around passage for residents.
	8) Seek cooperation of improvement of road network and for water conservation and flow restoration in Grubb Creek.
Chapter 6 Outreach & Education	1) Continue outreach and recruitment of land owners for riparian restoration, gully erosion control and water conservation.
	2) Continue work with volunteers throughout the Tenmile Creek watershed to help them gauge stream health and the success of restoration efforts.
	3) Maintain and update ERRP website, Vimeo and Facebook pages with content about Tenmile Creek restoration and foster TCWC outreach capacity.
	4) Help foster vocational education track for young scientists and forest health workers to assist with implementation of forest health in the Tenmile Creek watershed.