draft

THE SALMON CREEK WATERSHED ASSESSMENT AND RESTORATION PLAN

Grant Agreement P0230439




A Project of the Gold Ridge Resource Conservation District with grant funding from the California Department of Fish and Game Fisheries Restoration Grant Program

The Salmon Creek Watershed Assessment and Restoration Plan

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Prepared by:
Gold Ridge Resource Conservation District
Lisa Hulette, Executive Director
Patricia Hickey, Program Manager
Brittany Heck, Natural Resources Coordinator

Prunuske Chatham, Inc.
Lauren Hammack, Geomorphologist
Chris Choo, Scientist

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CONTACTS:

Lisa Hulette, Executive Director
Gold Ridge Resource Conservation District
P.O. Box 1064
Occidental, CA 95465
Email: goldrdge@sonic.net
RCD Website: http://www.goldridgercd.org

Lauren Hammack, Geomorphologist
Prunuske Chatham, Inc.
PO Box 828
Occidental, CA 95465
Email: lauren@pcz.com

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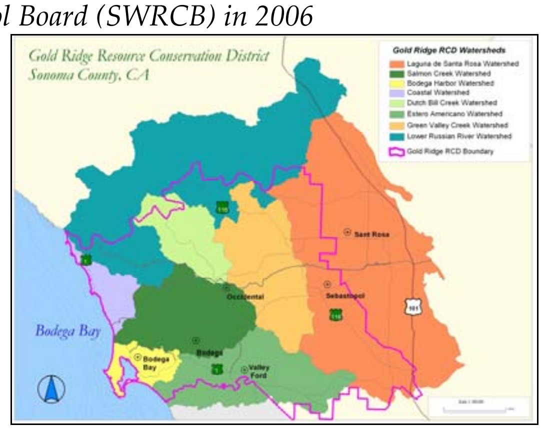
EXECUTIVE SUMMARY

The Gold Ridge Resource Conservation District (GRRCD), established in 1941, has been a principal contributor in preserving natural resources in western Sonoma County over the past 64 years. Many changes have occurred with regards to land use in the district. What used to be primarily agricultural land is now industry and rural development. Consumer food preferences have also changed over the course of time. For instance, the production of cherries, apples, and berries has given way to the production grapes, placing additional pressures on landowners to develop marginal lands for premium grapes. This similarly places additional pressures on our resources, both natural and technical, to prevent soil erosion and to maintain water quality in local streams and water supplies. Changes in endangered species designations throughout the state have also impacted landowners and land use management practices within the district.

This report was prepared to fulfill the requirements of Agreement Number P0230439 with the California Department of Fish and Game (DFG). This report and related documents, provides the basis for completion of this grant. The purpose of this grant was to provide landowners in the Salmon Creek Watershed with the ability to have erosion sites on their property assessed by qualified professionals, to develop a citizen based water quality monitoring program, to identify keystone limiting factors of anadromous salmonids, to build watershed capacity among stakeholders, and to conduct a broad landowner outreach and community education program in the watershed.

Through this funding, an assessment needs analysis was conducted through public meetings and focused steering committee meetings. This DFG grant provided a spring-board from which other watershed needs were determined and subsequently funded. These grant programs include the following:

- Salmon Creek Estuary and Enhancement Study – *funded by the State Coastal Conservancy(SCC) in 2004*
- Salmon Creek Roads Assessment – *funded by DFG and SCC in 2005*
- Salmon Creek Oral History Project – *funded by DFG in 2004*
- Salmon Creek Integrated Watershed Assessment Plan – *funded by the State Water Resources Control Board (SWRCB) in 2006*



Map of the Watersheds within the Boundaries of the Gold Ridge RCD

GRANT REPORT SUMMARY
Agreement #: P0230439

Dates of Work: May 1, 2003 through March 31, 2007
RCD Person Hours Expended: 1086.75 (District Manager, Project Director, and Watershed Coordinator)
Total of Each Fund Source Expended:

- California Department of Fish and Game - $142,162.00
- State Coastal Conservancy - $27,500.00
- GRRCD In-Kind Services - $20,000.00
- Salmon Creek Residents Cost-Share (Volunteer WQ Monitoring) - $45,000 (This number is an approximation based on the volunteers expending about 1125 documented hours @ $40.00/hour)
- **Total Project Cost: $234,662.00**

Summary of Outreach Activities:

- **Watershed Activities Attended:** Quarterly Salmon Creek Watershed Assessment Plan steering committee meetings; Two Sonoma County Watershed Day events; Monthly Salmon Creek Watershed Council meetings; and Four public meetings (to update the community on the progress of this and other grant opportunities)
- **Newsletters:** Attached with this report

Accomplishments (based on approved DFG Scope of Work):

- Successfully compiled existing and historic salmonid related data available for Salmon Creek for inclusion into the Salmon Creek Assessment and Restoration Plan (Chapter 3, Chapter 4 & Chapter 5);
- Successfully developed a citizen based water quality monitoring program that followed DFG protocols (Chapter 4).
- Successfully completed an erosion source inventory on over 40 different properties in the Salmon Creek watershed (Chapter 5).
- Successfully built watershed capacity among stakeholders by holding quarterly steering committee meetings which included members of the Gold Ridge RCD staff and Board of Directors, the Salmon Creek Watershed Council, the Department of Fish and Game, Prunuske Chatham Inc., and other interested parties.
- GRRCD staff attended and participated in Salmon Creek Watershed Council meetings, West County (Sonoma County) Watershed Day events, and other public meetings. The GRRCD also actively engaged the agricultural community to build a consensus on management strategies that would work for preserving traditional agriculture in west Sonoma County.

Task not Completed:
The geomorphic analysis that was an important part of this funding agreement was not completed due to constraints of time and budget. However, with the assistance of the DFG contract manager, the GRRCD secured funding from State Water Resources Control Board for this assessment and continued water quality monitoring. These assessments will augment this Assessment and Restoration Plan no later than December 31, 2008.

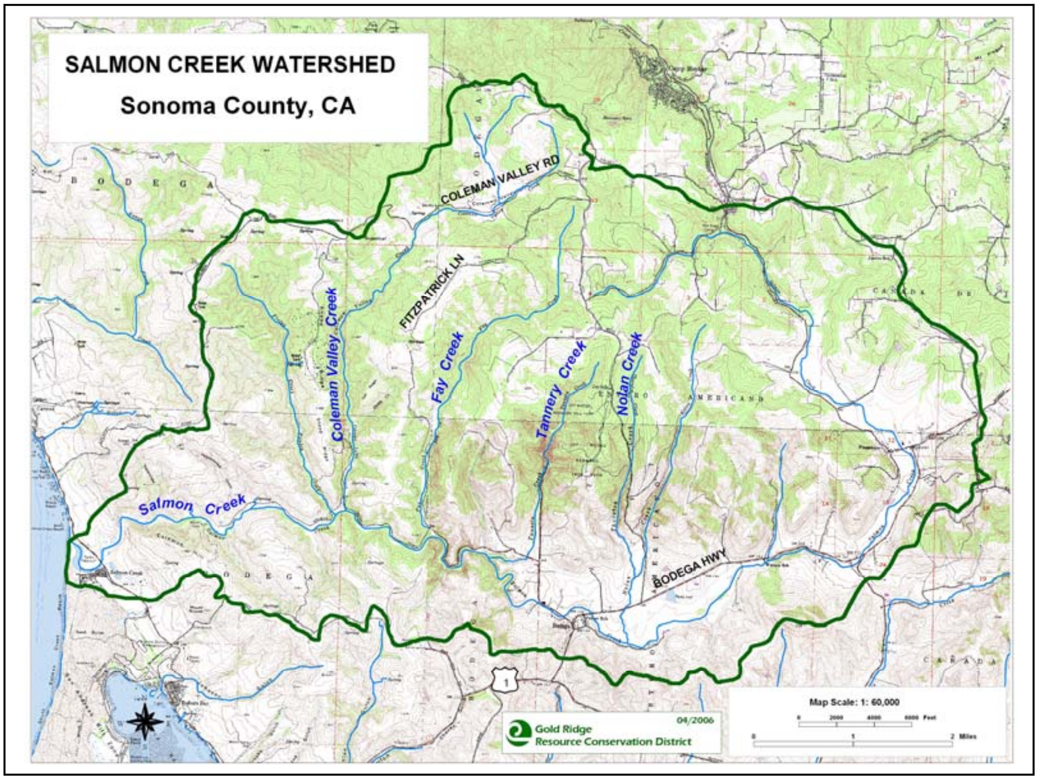
Successes & Lessons Learned: The philosophy of the Gold Ridge Resource Conservation District (RCD) is that a citizen-driven planning process is the optimal method to achieve resource management in its District watersheds. Although a conservation planning process that provides for extensive community involvement has many benefits, an important cost of such an approach is often a failure to meet scientific or uniform standards in data collection and analysis. The failure to meet such standards can undermine the value and efficacy of volunteer monitoring programs, as well as all subsequent planning documents. This was one of the dilemmas we faced early on in the Salmon Creek Assessment Plan planning process. To address this issue, it was agreed upon by both the Salmon Creek Watershed Council (SCWC) and the RCD that a high caliber sub-contractor (Prunuske Chatham, Inc. [PCI]) would be needed to train volunteer monitors, to oversee data collection as well as to analyze data in keeping with key professional standards.

It was also decided early in the organization of this plan that we would utilize a watershed management approach for the development of this program. The principles of the watershed approach (Environmental Protection Agency) focus on partnerships, a focused geographic area, and sound management techniques based on strong science and data. All stakeholder groups in the Salmon Creek Watershed were encouraged to share relevant information and to participate in the decision-making processes, which entailed goal setting and prioritization of issues and concerns. The RCD, SCWC, and PCI were initially successful in this process. However, because of some inherent mistrust between residents of the watershed, the issue of water quality data and resultant "finger-pointing" became a point of contention. The RCD has a strong mandate to protect the rights and privacy of individual landowners, and did not feel it prudent that raw, unanalyzed data be distributed prior to the conclusion of this project. This decision by the RCD, in consultation with the SCWC and PCI, led to some stakeholders dropping out of the program, leaving less than the full watershed represented at steering committee and public meetings. The RCD tried in good faith to bridge this gap by providing relevant updates and information in its newsletters and through public events. However, some stakeholders continued to feel their concerns were not being addressed and did not rejoin the planning process.

Outside of some perceived marginalization of certain watershed residents, the RCD deems this project a tremendous success. Toward the end of the program, at the last public meeting, representatives from both the environmental and the agricultural community were present and no negative feedback from either group was received. In essence, the project successfully coordinated stakeholders to ensure that compatible conservation practices and water quality monitoring data were included in a plan to address key limiting factors in Salmon Creek. In addition, this grant funded program enabled the RCD to provide many opportunities for citizen involvement, particularly through the volunteer water quality monitoring component. It was very important to have as much local participation as possible to facilitate cooperative learning about conservation needs and the development of long-term watershed planning goals. Having a volunteer water quality monitoring program brought together an interesting and diverse group of residents in the watershed.

In summary, the primary goal of the Salmon Creek Watershed planning process was to include and synthesize a broad range of stakeholder views, interests and information. Through the collaborative efforts of resource agencies and watershed groups, including but not limited to the California Department of Fish and Game, the North Coast Regional Water Quality Control Board, the State Coastal Conservancy, the Salmon Creek Watershed Council, Prunuske Chatham, Inc., and the Gold Ridge RCD, this goal was achieved.

Chapter 1: Introduction



The Salmon Creek Watershed is located within the Bodega Bay Hydrologic Unit (HU). The Bodega Bay HU consists of Americano Creek, the Estero Americano, Cheney Gulch, Scotty Creek, Salmon Creek, and associated tributaries. All drain into the Bodega Bay and the Gulf of the Farallones National Marine Sanctuary. The California Unified Watershed Assessment identified the Bodega Bay HU as a Category 1 Priority Watershed due to excessive loading of sediment and nutrients. The Regional Water Quality Control Board's (RWQCB) Watershed Management Initiative (WMI) also identified confined animal facilities and throughout the Bodega Bay HU as sources of nitrogen, phosphorous, organic matter and sediment into the bay itself. The Bodega Bay HU is typified by cooler temperatures and relatively high rainfall due to coastal influences. The terrain is relatively steep, with streams carving through the Coast Range and entering the Pacific Ocean south of the Russian River. These streams are located in erosive topography and extremely sensitive to land disturbance. The 1987 Sonoma County Coastal Wetlands Enhancement Plan (Enhancement Plan) identified Salmon Creek and stated that "bank erosion on tributary streams which are freely accessed by livestock is common. Loss of woody plants on channel banks of most of the tributaries is a major problem contributing to the destabilization of the streambanks (Circuit Rider Productions, Inc., 1987)." The Enhancement Plan further states that "several tributary streams and reaches of Salmon Creek will continually provide higher rates of sediment delivery than would naturally occur. This will continue to degrade the marshes and open water areas of the estuary as well as continue to degrade steelhead and salmon spawning habitat. Salmon Creek is an important anadromous fish stream and restoration of its fisheries habitat through erosion control should be considered a priority (ibid.)." The RWQCB Board has similarly identified riparian vegetation, channel protection, and increased riparian zones along Salmon Creek as targeted non-point source (NPS) pollution projects. Through a cooperative effort between several agencies, the goal of this project has been to promote the implementation of needed NPS pollution controls and to assist landowners with best management practices (BMPs) that will restore water quality. The main goal of this project is to improve and protect water quality by helping landowners achieve Tier 1 voluntary compliance with current and future NPS regulations.

Salmon Creek Watershed covers approximately 35.3 square miles; Salmon Creek is the mainstem and includes a series of six major parallel tributaries (Finley, Fay, Tannery, Nolan, Thursten and Coleman Valley Creeks) (DFG Salmon Creek Stream Inventory Report 2003, p.2). The watershed also contains 17 unnamed, smaller tributaries. From its highest point at 797 feet, the mainstem of Salmon Creek runs south through Occidental and makes a westerly curve near Freestone before reaching the Pacific Ocean 3 miles north of Bodega Bay. The watershed's terrain is characterized by steep topography and soils that are highly erosive and sensitive to disturbance. Vegetation occurring in the watershed is a combination of deciduous and mixed coniferous forests and grasslands.

The Salmon Creek Watershed is almost completely privately owned (95%). Primary land uses include rangeland, viticulture, timber, rural residential and urban. Current and historic land use activities have degraded the natural environment, impaired water quality and aquatic habitat, and increased the rate and amount of sedimentation. Salmon Creek Watershed once had a thriving anadromous fish population, vibrant stands of vegetation, and exceptional water quality.

Historic farming practices and current intensive grazing have reduced riparian vegetation, causing stream and bank erosion. Livestock in streams generally inhibit growth of new trees, exacerbate erosion and reduce summertime survival of juvenile fish by defecating in the water (DFG, 2004). Erosion leads to increased sedimentation and water temperatures, degrading the quality of marshes and open water area in the estuary.

Although the Salmon Creek Watershed is not on the federal Clean Water Act 303 (d) list, it is an important coho salmon and steelhead trout tributary to the Pacific Ocean. The WMI states that in Salmon Creek, "concerns have been raised by the public regarding increased sedimentation, water temperature, nutrients, and salmonid habitat." In 2002, the California Department of Fish and Game (DFG) did a habitat typing study in the watershed and found high sediment yield to be a significant problem in both the mainstem and the tributaries in the watershed. Although the last coho sighting was in 1996 (Michael Banks, Bodega Marine Lab, and Bill Cox, DFG), DFG has stated that Salmon Creek is a fully restorable salmonid stream. Recognizing the importance of Salmon Creek, Gold Ridge RCD is working with landowners to develop riparian and streambank stability projects, as well as projects that will restrict the access that livestock have to the creek.

The beneficial uses for Salmon Creek include Municipal (MUN), Agriculture (AGR), Industrial (IND), Groundwater Recharge (GWR), Navigation (NAV), Contact Recreation (REC1), Non-Contact Recreation (REC2), Commercial (COMM), Coldwater Fisheries (COLD), Wildlife Habitat (WILD), Rare, Threatened, or Endangered Species (RARE), Migration of Aquatic Organisms (MIGR), Spawning, Reproduction and/or Early Development (SPAWN), Shellfish Harvesting (SHELL) (potential) , Estuarine Habitat (EST), and, Aquaculture (AQUA) (potential).

How this document is organized:
Chapter 2 of this document presents a general description of the Salmon Creek Watershed, its associated land uses, and watershed soils. Chapter 3 summarizes the habitat typing inventory done by DFG in 2002 – 2004. Chapter 4 presents baseline water quality data and the volunteer water quality monitoring program pioneered by the Salmon Creek Watershed Council Chapter 5 presents not only an overview of sediment sources and impacts in the watershed, but also presents the results of field inventories done by staff at Prunuske Chatham, Inc (PCI) on various properties throughout the watershed. Chapters 6 provides a discussion of some typical management practices recommended during the planning process, and by other agencies in similar watershed locations, to enhance the overall health of Salmon Creek and the productivity of its natural capital.

The Salmon Creek Watershed Restoration Plan should be viewed as a "living document." The goals and management strategies outlined in this watershed management plan are based on our current level of understanding of the ecological processes and health of the watershed. It is expected that management issues and priorities in the watershed will change through time as will the goals and objectives of this document. In order to monitor and document the implementation of this plan, as well as to foster an adaptive management approach to implementation, the RCD will create and maintain a program implementation matrix that will be posted on our website: http://www.goldridgercd.org.

Chapter 2: Watershed Description and Land Use

Prior to European settlement, the Salmon Creek Watershed was inhabited for at least 8,000 years by Native Americans. Most recently, the Coast Miwok tribe had several small villages and seasonal encampments along the valleys between Freestone and Bodega, as well as at the estuary. Although the Indians did not practice formal agricultural they did manage the land through fire, selective gathering and propagating, and hunting. Oral stories passed through the generations speak to the incredible richness and diversity of the Salmon Creek watershed (Prunuske Chatham, Inc 2006).

Salmon Creek Watershed marks the southern boundary of the extensive mixed evergreen forests of northern Sonoma County and Mendocino County. The five main tributaries and the headwaters of Salmon Creek drain high, steep, forested ridges and canyons (Figure 2-2). They flow into the open, rolling grasslands that typify the countryside to the south through which the upper and middle portions of Salmon Creek traverses. The low ridges that form the southern boundary of the watershed are mixed grassland and coastal scrub communities. Riparian hardwood, coastal terrace grassland, shore dune, estuarine, wetland, and vernal pool plant communities are also found in the watershed. This diverse ecology supports the broad range of animal species associated with each habitat type, and includes threatened and endangered species such as anadromous fish, freshwater shrimp, tidewater gobi, northern spotted owl, red tree voles, and southern red-legged frog.

Europeans, starting with the Russians in 1811, brought large-scale, intensive land use practices to the watershed – establishing small ranches in the Freestone and Bodega area to support their fur-trading forts. By 1850 the small agricultural community of Smith's Ranch had been established (now known as Bodega) with a population of at least 300. Agriculture and logging took off from this point, and over the next hundred years the watershed saw heavy use that drastically altered its forests, streams, and grasslands.

Today the land cover of the Salmon Creek Watershed is still mostly forest, grassland, and shrub communities (Figure 2-1). Forests make up a little over 50 percent of land cover (11,474 acres); while grasslands make up 37 percent of land cover (8,303 acres). There are 1,996 acres of shrubs; 424 acres of vineyards; 110 acres of paved surfaces; and 90 acres of orchards in the watershed. The distribution and composition is significantly changed from what was present prior to European settlement. As land use pressures change, the plant communities shift. Adjustments to all natural systems, especially the stream channels, continue as a response to historic land use practices.

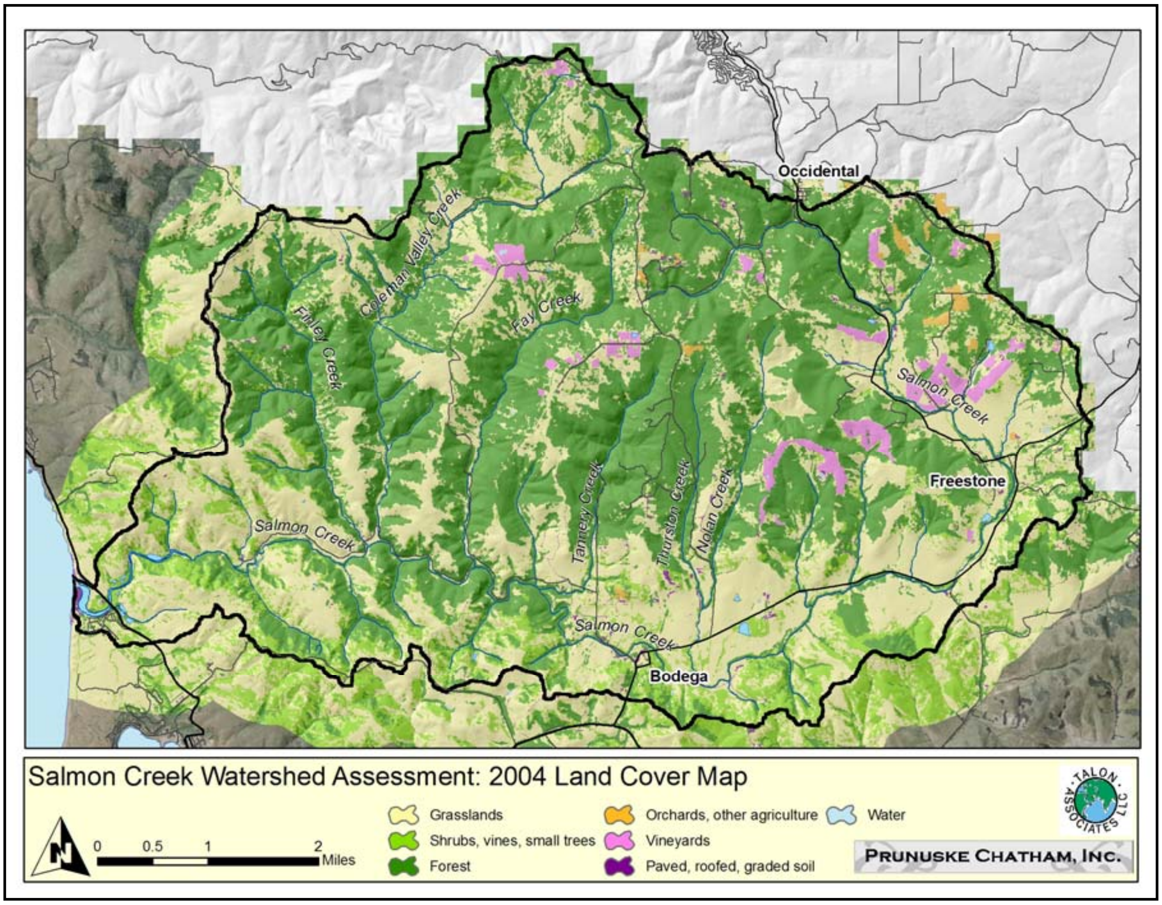
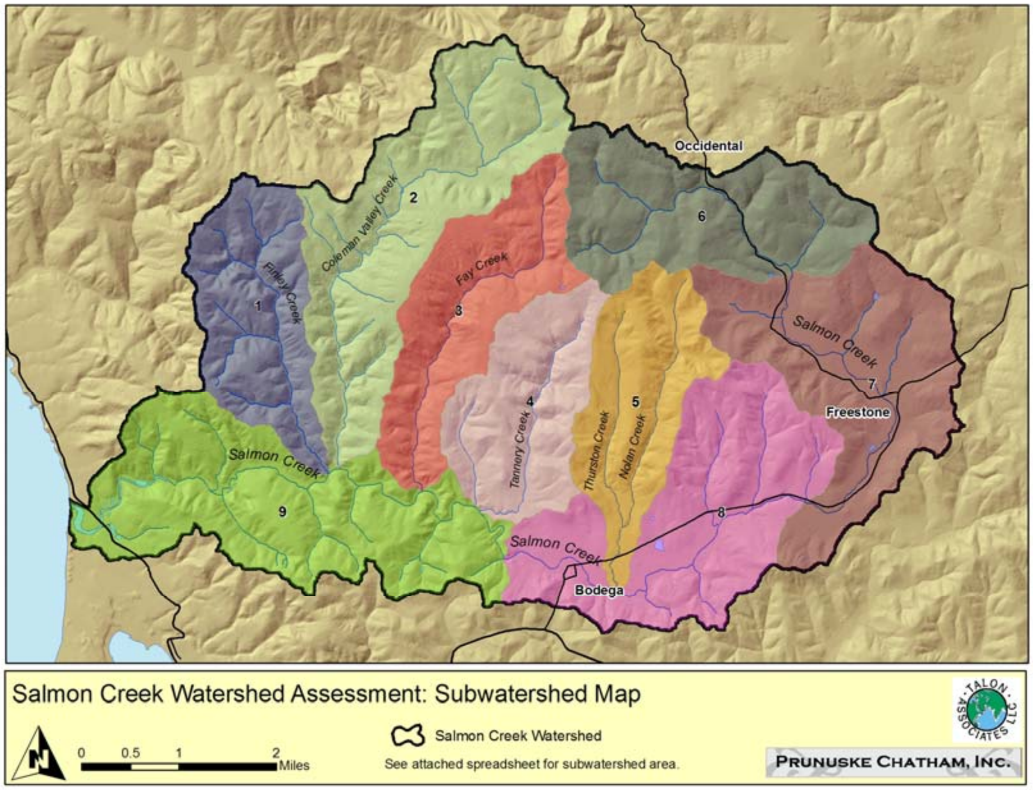


Figure 2-1. *Land cover in the Salmon Creek watershed. Total watershed acreage is 22,448. Forests make up 11,474 acres; grasslands 8,303 acres; shrubs 1,996 acres; vineyards 424 acres; paved surfaces 110 acres; orchards 90 acres; and water 49 acres.*

The Salmon Creek Watershed still maintains healthy stands of redwoods along ridgelines. Close to 50 percent of the forested land in the watershed is comprised of redwood forests, approximately 5, 457 acres. Other unique habitat types in the watershed include coastal oak woodland (824 acres) and coastal scrub (870 acres) interspersed with grasslands in the western sub-watersheds. Healthy montane riparian vegetation occurs along most reaches of the mainstem and tributaries. Although most of the grassland is dominated by annual European species, populations of native coastal prairie grasses can still be found throughout the western side of the watershed.

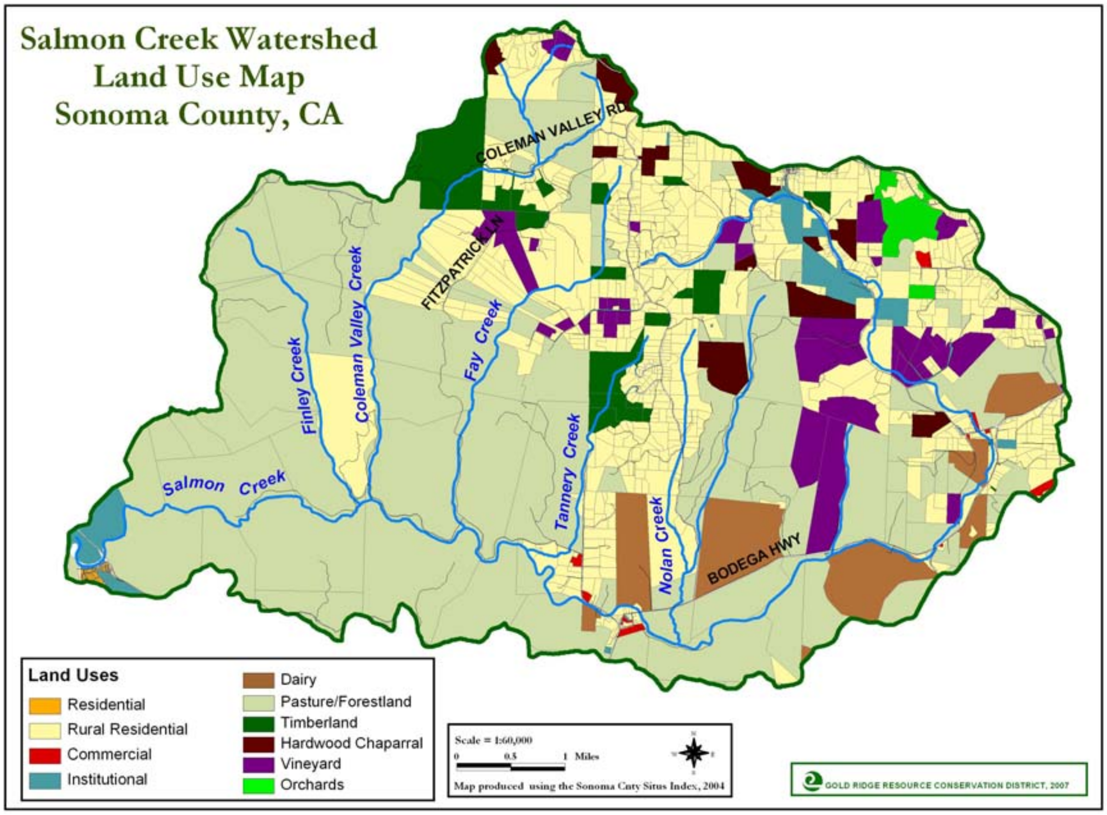
Figure 2-2. Map showing the sub-watersheds of Salmon Creek. In addition to the main tributaries, the mainstem is divided into four sub-sections. The mainstem sections are the headwaters (#6), the upper reach (#7), the middle reach (#8), and lower Salmon Creek (#9).



Land Use in the Salmon Creek Watershed is predominantly agricultural and low-density, rural residential development (Figure 2-3; Table 2-1). There are concentrations of homes along roads and ridgelines and in the towns of Occidental, Freestone, Bodega, and Salmon Creek. Forests cover much of the northern ridges and logging is minimal. Several small vineyards have been developed along the ridgelines and in the town of Freestone. Most of the lower watershed is still largely undeveloped and remains as grazing land for beef cattle, sheep, and horses. A few orchards remain in the eastern watershed. Family dairies continue to in the Bodega valley. Table 2-2 provides land use data by sub-watershed.

Land Use	Acres
Residential (higher density)	16
Rural Residential	6,023
Commercial	55
Institutional	430
Dairy	1,104
Pasture/Forestland	12,016
Orchard	179
Vineyard	1,187
Hardwood Chaparral	493
Timberland	791

Figure 2-3. Land use in the Salmon Creek Watershed (Sonoma County Situs Index, 2004).



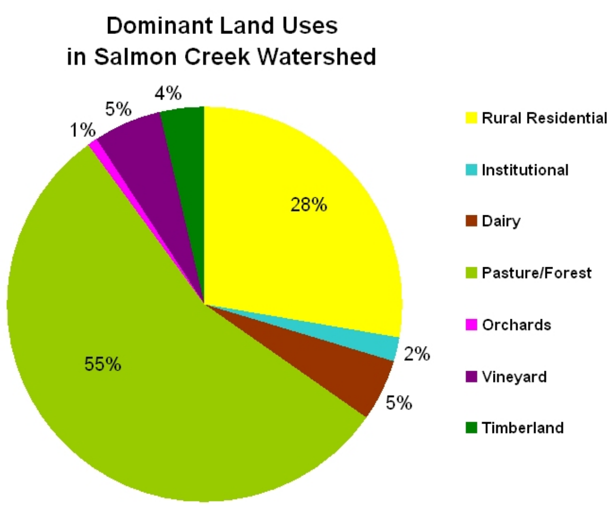


Figure 2-4. Dominant Land Uses in the Watershed.

Throughout the watershed many of the historic large ranches have been subdivided and sold, transitioning the land to lightly managed rural residential

The dominant land use in the Salmon Creek Watershed is still livestock grazing; pasture is mixed with forestland, particularly at higher elevations (Figure 2-3). Land uses vary by sub-watershed. Land use in the lower Salmon Creek and Finely Creek sub-watersheds are still predominantly pastureland, 95% and 89% respectively (Table 2-2). The upper Salmon Creek, Thurston and Nolan Creek, and Freestone Valley sub-watersheds are the most heavily developed with a mix of land uses. Most of this development is located around the towns of Occidental, Freestone and Bodega.

Table 2-2. *Land uses by the nine sub-watersheds.*

Subwatershed	Land Use	Acres	% of Land Use
Coleman Valley Creek	Hardwood Chaparral	99.1	3%
Coleman Valley Creek	Institutional	3.0	<1%
Coleman Valley Creek	Pasture/Forest	1587.9	**49%**
Coleman Valley Creek	Rural Residential	1055.9	**33%**
Coleman Valley Creek	Timberland	406.3	13%
Coleman Valley Creek	Vineyard	73.4	2%
Fay Creek	Hardwood Chaparral	2.1	<1%
Fay Creek	Institutional	2.2	<1%
Fay Creek	Pasture/Forest	1021.3	**51%**
Fay Creek	Rural Residential	790.3	**40%**
Fay Creek	Timberland	59.6	3%
Fay Creek	Vineyard	113.5	6%
Finley Creek	Pasture/Forest	1613.0	**89%**
Finley Creek	Rural Residential	194.9	11%
Freestone Valley	Commercial	19.8	1%
Freestone Valley	Dairy	388.5	13%
Freestone Valley	Hardwood Chaparral	121.8	4%
Freestone Valley	Institutional	63.0	2%
Freestone Valley	Orchards	4.9	<1%
Freestone Valley	Pasture/Forest	806.7	**28%**
Freestone Valley	Rural Residential	1031.3	**36%**
Freestone Valley	Timberland	2.5	<1%
Freestone Valley	Vineyard	454.5	16%
Lower Salmon Creek	Institutional	138.7	4%
Lower Salmon Creek	Pasture/Forest	3242.4	**95%**
Lower Salmon Creek	Residential	15.6	<1%
Lower Salmon Creek	Rural Residential	32.7	1%

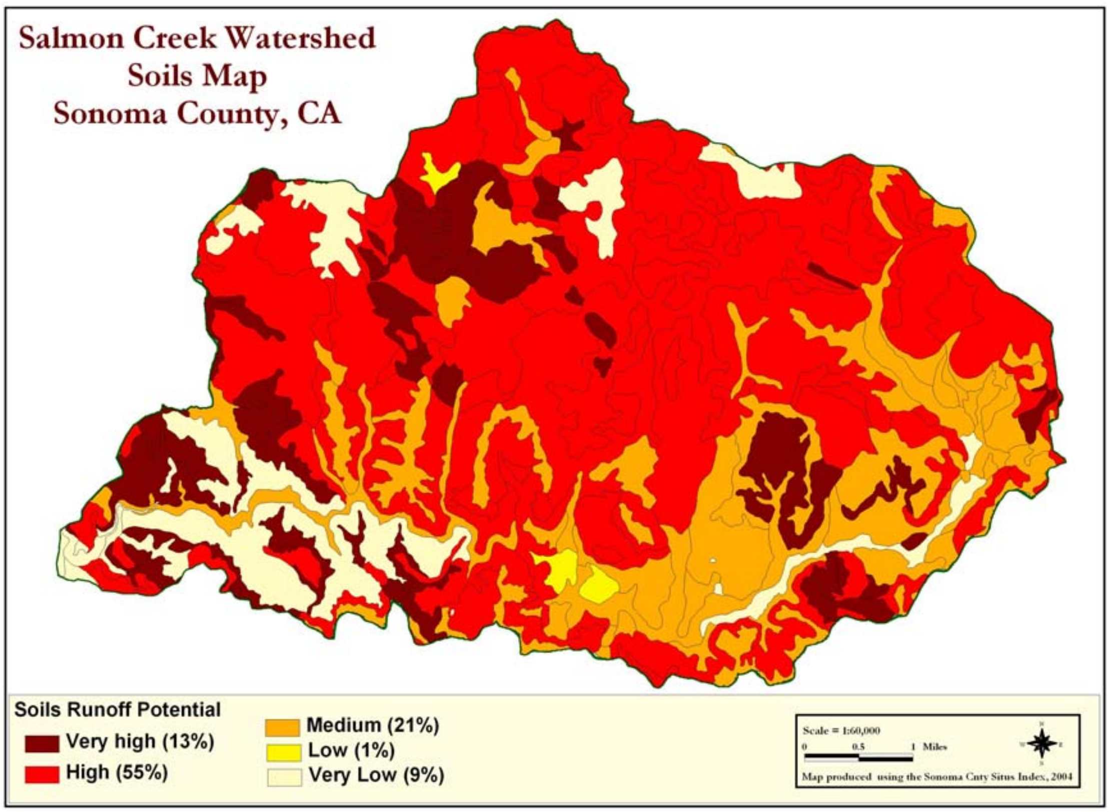
Table 2-2. *Conti.*

Subwatershed	Land Use	Acres	% of Land Use
Middle Salmon Creek	Commercial	19.5	1%
Middle Salmon Creek	Dairy	529.9	17%
Middle Salmon Creek	Institutional	4.2	<1%
Middle Salmon Creek	Pasture/Forest	1883.7	**62%**
Middle Salmon Creek	Rural Residential	263.7	9%
Middle Salmon Creek	Vineyard	357.8	12%
Tannery Creek	Commercial	2.7	<1%
Tannery Creek	Dairy	49.6	3%
Tannery Creek	Institutional	4.4	<1%
Tannery Creek	Pasture/Forest	872.8	**51%**
Tannery Creek	Rural Residential	537.0	**31%**
Tannery Creek	Timberland	211.9	12%
Tannery Creek	Vineyard	42.2	2%
Thurston and Nolan Creek	Dairy	134.7	8%
Thurston and Nolan Creek	Hardwood Chaparral	113.2	6%
Thurston and Nolan Creek	Institutional	0.3	<1%
Thurston and Nolan Creek	Pasture/Forest	783.1	**45%**
Thurston and Nolan Creek	Rural Residential	680.0	**39%**
Thurston and Nolan Creek	Timberland	32.0	2%
Thurston and Nolan Creek	Vineyard	1.1	<1%
Upper Salmon Creek	Commercial	11.3	<1%
Upper Salmon Creek	Hardwood Chaparral	151.9	7%
Upper Salmon Creek	Institutional	201.7	9%
Upper Salmon Creek	Orchards	171.9	7%
Upper Salmon Creek	Pasture/Forest	156.3	7%
Upper Salmon Creek	Rural Residential	1384.7	**60%**
Upper Salmon Creek	Timberland	76.6	3%
Upper Salmon Creek	Vineyard	143.8	6%

Watershed Soils

Due to the steep topography of the watershed, close to 70 percent of soils are considered highly prone to runoff (Figure 5-6). Refer to Appendix B for a list of watershed soils, runoff potential, drainage classification and acres. The two dominant soil types in the watershed are Gold Ridge, Fine Sandy Loam (26%) and Steinbeck Loam (16%).

Figure 5-6. *Salmon Creek Watershed Soils Runoff Classification.*



As is evident in Figure 5-7, most of the high erosion hazard soils in the watershed are located in the Finley Creek and lower Salmon Creek sub-watersheds.

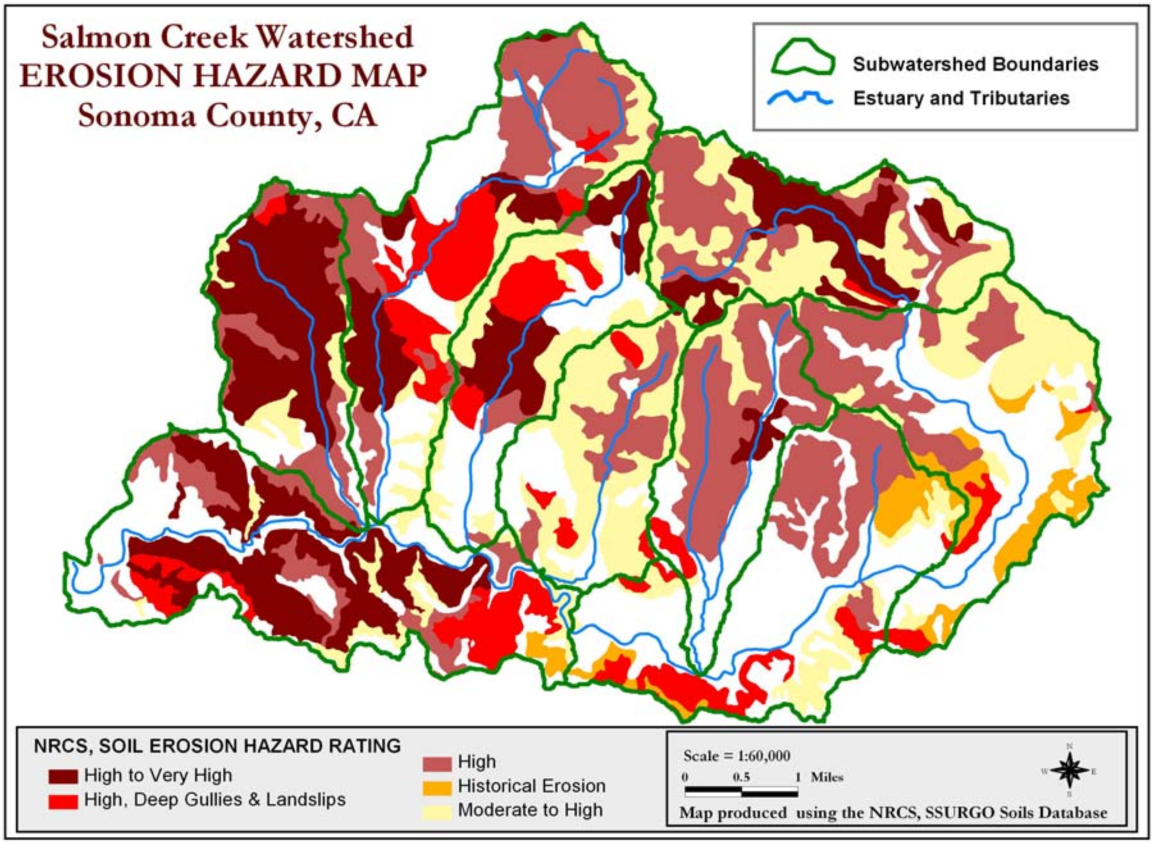


Figure 5-7. *Salmon Creek Watershed Erosion Hazard Map.*

Chapter 3 Salmon Creek Watershed Stream Inventory Report Synopsis

Photo Courtesy of Steve Killey

To best manage fisheries it is essential to know how much habitat is available and how it is utilized by fish. California Department of Fish and Game (DFG) stream and biological inventory reports are done in order to provide assessment of fish present and habitat available. Stream habitat surveys were conducted on the mainstem of Salmon Creek and its tributaries: Coleman Valley Creek, Finely Creek, Nolan Creek, Tannery Creek and Thurston Creek following the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al., 1998). Fisheries scientists walked and measured creeks and assigned habitat types to specific reaches. There are nine components to an inventory form: flow, channel type, temperatures, habitat type, embeddedness, shelter rating, substrate composition, and canopy and bank composition. For a more detailed version of the information presented below please reference appropriate *Stream Inventory Report,* per Salmon Creek Watershed Stream (DFG 2004). These reports are posted on the Gold Ridge RCD website at http://www.goldridgercd.org.

Table 3.1. Habitat Inventory for Salmon Creek and its Tributaries

Stream Survey	Date of Survey	Water Temp. in ˚F *1	% Pools	% Pools with max. depth > 2 ft *2	% Stream length with pools max. depth > 2 ft *3	Mean Shelter Rating *4	# of low gradient riffles with either gravel or small cobble as dominant substrate *5	% Gravel/Cobble Embedded-ness in fine sediment with rating of 3 or 4 *6	# of pool tail-outs with cobble embedded-ness < 25%	% Canopy *7
Salmon Creek Mainstem	7/24/03 - 8/21/03	54˚F to 76˚F	38%	53%	28%	35	52 of 66	29%	3%	65%
Coleman Valley Creek	6/29/02 - 9/22/02	50˚F to 68˚F	22%	74%	16%	14	3 of 4	17%	6%	65%
Fay Creek	9/19/02 - 9/21/02	52˚F to 59˚F	16%	74%	13%	17	1 of 1	13%	4%	92%
Finley Creek	6/28/02 - 7/22/03	54˚F to 63˚F	19%	28%	5%	25	5 of 5	34%	16%	78%
Nolan Creek	7/15/03 - 7/17/03	54˚F to 60˚F	23%	53%	13%	26	11 of 13	45%	0%	54%
Tannery Creek	9/23/02 - 9/29/02	48˚F to 52˚F	9%	73%	7%	42	no data	17%	35%	90%
Thurston Creek	7/18/03 - 7/21/03	50˚F to 60˚F	18%	56%	11%	24	8 of 9	29%	0%	83%

*1 Temperatures at or above 65˚F are considered above the stress threshold for salmonids.

*2 Primary pools are defined to have a max. depth of at least two feet, occupy at least half of the width of the low flow channel and be as long as the low flow channel width.

*3 In coastal coho and steelhead streams it is generally desirable to have primary pools comprise 50% of total habitat length.

*4 A pool rating of approximately 80 is desired. Log and root wad cover in the pool and flatwater habitats would improve both summer and winter habitat.

*5 High percentages are generally considered good for spawning salmonids.

*6 Cobble embeddedness measured to be 25% or less (rating 1) is considered best for the needs of salmon and steelhead.

*7 80% canopy coverage is considered desirable for salmonid habitat.

Salmon Creek Stream Inventory Report (DFG, 2003)

The mainstem of Salmon Creek was surveyed on the days 7/24/2003 – 8/21/2003. Almost 16 stream miles were surveyed during this time, beginning at the wetlands above the mouth and ending 15.9 miles upstream. Given the data collected during the survey and presented in Table 3.1, the following limiting factors were identified and enhancement opportunities were prescribed. Table 3.2. below summarizes the presence of species found in the mainstem of Salmon Creek.

Limiting Factors:

1. High water temperatures
2. Low number of deep pools
3. Low instream shelter value
4. Gravel/Cobble Embeddedness in Fine Sediment
5. Low canopy cover (shade)

Fisheries Enhancement Opportunities:

1. Improving and monitoring access for migrating salmon particularly in the upper reaches.
2. There appear to be 16 log debris accumulations that have the potential to cause bank erosion. Modification of these log debris accumulations is not recommended but they should be monitored.
3. There are sections of the stream being impacted by livestock in the riparian zone. Alternatives to limit cattle access, control erosion and increase canopy should be explored by landowners.
4. Map and prioritize sources of upslope and in-channel erosion. Near-stream riparian planting is encouraged.
5. Active and potential sediment sources related to roads near Salmon Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
6. Increase canopy for Salmon Creek with tree plantings (willow, alder, redwood and Douglas fir) where cover is low. Plantings may need to be paired with bank stabilization or upslope erosion control projects.
7. Sites throughout the entire surveyed stream would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
8. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
9. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream. Where existing dams are retaining gravel sites downstream should be resurveyed for spawning gravel quality and quantity.

10. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.

Table 3.2. Species Observed in Historical and Recent Surveys in Salmon Creek

Years	Species	Source	Native/Introduced
2001 **2003**	Steelhead Trout *(Oncorhynchus mykiss)*	CDFG	Native
2003	Pacific Lamprey *(Lampetra tridentatus)*	CDFG	Native
2001 **2003**	Sculpin or Cottoids *(Cottus sp.)*	CDFG	Native
2001 **2003**	California or Venus Roach *(Hesperoleucus symmetricus)*	CDFG	Native
2003	California Freshwater Shrimp *(Syncaris pacifica)*	CDFG	Native
2001 **2003**	Threespine Stickleback *(Gasterosteus aculeatus williamsoni)*	CDFG	Native

Coleman Valley Creek Stream Inventory Report (DFG, 2002)

Coleman Valley Creek was surveyed on the days 6/29/2002 – 9/22/2002. The Coleman Valley Creek survey began at the confluence with the mainstem of Salmon Creek and extended 2.9 miles upstream. Given the data collected during the survey and presented in Table 3.1., the following limiting factors were identified and enhancement opportunities were prescribed. Table 3.3. below summarizes the presence of species found in Coleman Valley Creek.

Limiting Factors:

1. High water temperatures
2. Low number of deep pools
3. Low instream shelter value
11. Gravel/Cobble Embeddedness in Fine Sediment
1. Low canopy cover (shade)
2. Low flow

Fisheries Enhancement Opportunities:

1. Rearing conditions throughout the creek appear inadequate this time due to low flow. Pools were disconnected due to low flow. Low instream flow should be addressed by increasing riparian protection and restoration, sediment control, and employing best management practices that encourage permeability and infiltration.
2. There are sections of the stream being impacted by livestock in the riparian zone. Alternatives to limit cattle access, control erosion and increase canopy should be explored by landowners.
3. Map and prioritize sources of upslope and in-channel erosion. Near-stream riparian planting is encouraged.
4. Active and potential sediment sources related to roads in the Coleman Valley Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
5. Increase canopy for Coleman Valley Creek with tree plantings (willow, alder, redwood and Douglas fir) where cover is low. Plantings may need to be paired with bank stabilization or upslope erosion control projects.
6. Reach 1 would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
7. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
8. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream.
9. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.

Table 3.3. Species Observed in Historical and Recent Surveys, Coleman Valley Creek

Years	Species	Source	Native/Introduced
2001	Steelhead Trout *(Oncorhynchus mykiss)*	CDFG	Native
2001	Sculpin or Cottoids *(Cottus sp.)*	CDFG	Native
2001	California or Venus Roach *(Hesperoleucus symmetricus)*	CDFG	Native
2001	Threespine Stickleback *(Gasterosteus aculeatus williamsoni)*	CDFG	Native

Fay Creek Stream Inventory Report (DFG, 2003)

Fay Creek was surveyed on the days 6/28/2002 – 7/22/2003. The Fay Creek survey began at the confluence with the mainstem of Salmon Creek and extended up the creek to the end of anadramous fish passage at a rock falls. Given the data collected during the survey and presented in Table 3.1, the following limiting factors were identified and enhancement opportunities were prescribed. Table 3.4. below summarizes the presence of species found in Fay Creek.

Limiting Factors:

1. Low number of deep pools
2. Low instream shelter value
3. Gravel/Cobble Embeddedness in Fine Sediment

Fisheries Enhancement Opportunities:

1. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.
2. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
3. Fay Creek would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
4. Map and prioritize sources of upslope and in-channel erosion. Near stream riparian planting is encouraged.
5. Increase canopy and bank stability for Fay Creek with tree plantings (willow, alder, redwood and Douglas fir) where canopy is not at acceptable levels. Plantings may need to be paired with bank stabilization or upslope erosion control projects.
6. Active and potential sediment sources related to roads near Fay Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
7. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream. Where existing dams are retaining gravel sites downstream should be resurveyed for spawning gravel quality and quantity.

Table 3.4. Species Observed in Historical and Recent Surveys in Fay Creek

Years	Species	Source	Native/Introduced
2001	Steelhead Trout *(Oncorhynchus mykiss)*	CDFG	Native
2001	Sculpin or Cottoids *(Cottus sp.)*	CDFG	Native
2001	Threespine Stickleback *(Gasterosteus aculeatus williamsoni)*	CDFG	Native

Finley Creek Stream Inventory Report (DFG, 2003)

Finley Creek was surveyed on the days 7/24/2003 – 8/21/2003. The Finley Creek survey began at the confluence with the mainstem of Salmon Creek and extended upstream to the end of anadramous fish passage at a rock falls. Given the data collected during the survey and presented in Table 3.1, the following limiting factors were identified and enhancement opportunities were prescribed. Table 3.5. below summarizes the presence of species found in Finley Creek.

Limiting Factors:

1. Low number of deep pools
2. Low instream shelter value
3. Gravel/Cobble Embeddedness in Fine Sediment

Fisheries Enhancement Opportunities:

1. Rearing conditions throughout the creek appear inadequate this time due to low flow. Pools were disconnected due to low flow. Low instream flow should be addressed by increasing riparian protection and restoration, sediment control, and employing best management practices that encourage permeability and infiltration.
2. There are sections of the stream being impacted by livestock in the riparian zone. Alternatives to limit cattle access, control erosion and increase canopy should be explored by landowners.
3. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.
4. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
5. Map and prioritize sources of upslope and in-channel erosion. Near-stream riparian planting is encouraged.
6. Active and potential sediment sources related to roads near Finley Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
7. Increase canopy and bank stability for Finely Creek with tree plantings (willow, alder, redwood and Douglas fir) where canopy is not at acceptable levels. Plantings may need to be paired with bank stabilization or upslope erosion control projects.
8. Reaches 1 and 2 would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
9. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream.

Table 3.5 Species Observed in Historical and Recent Surveys in Finley Creek

Years	Species	Source	Native/Introduced
2001	Steelhead Trout *(Oncorhynchus mykiss)*	CDFG	Native
2001	Sculpin or Cottoids *(Cottus sp.)*	CDFG	Native
2001	California or Venus Roach *(Hesperoleucus symmetricus)*	CDFG	Native
2001	Threespine Stickleback *(Gasterosteus aculeatus williamsoni)*	CDFG	Native

Nolan Creek Stream Inventory Report (DFG, 2003)

Nolan Creek was surveyed on the days 7/15/2003 – 7/17/2003. The Nolan Creek survey began at the confluence with the mainstem of Salmon Creek and extended upstream to the end of anadramous fish passage at 33' rock falls. Given the data collected during the survey and presented in Table 3.1, the following limiting factors were identified and enhancement opportunities were prescribed. Table 3.6. below summarizes the presence of species found in Nolan Creek.

Limiting Factors:

1. Low number of deep pools
2. Low instream shelter value
3. Gravel/Cobble Embeddedness in Fine Sediment

Fisheries Enhancement Opportunities:

1. Rearing conditions throughout the creek appear inadequate this time due to low flow. Pools were disconnected due to low flow. Low instream flow should be addressed by increasing riparian protection and restoration, sediment control, and employing best management practices that encourage permeability and infiltration.
2. There are sections of the stream being impacted by livestock in the riparian zone. Alternatives to limit cattle access, control erosion and increase canopy should be explored by landowners.
3. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.
4. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
5. Map and prioritize sources of upslope and in-channel erosion. Near-stream riparian planting is encouraged.
6. Active and potential sediment sources related to roads in Nolan Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
7. Increase canopy and bank stability for Nolan Creek with tree plantings (willow, alder, redwood and Douglas fir) where canopy is not at acceptable levels. Plantings may need to be paired with bank stabilization or upslope erosion control projects.
8. Reaches 1 and 2 would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
9. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream.

Table 3.6 Species Observed in Historical and Recent Surveys in Nolan Creek

Years	Species	Source	Native/Introduced
2003	Steelhead Trout *(Oncorhynchus mykiss)*	CDFG	Native
2003	Pacific Lamprey *(Lampetra tridentatus)*	CDFG	Native
2003	Sculpin or Cottoids *(Cottus sp.)*	CDFG	Native
2003	California or Venus Roach *(Hesperoleucus symmetricus)*	CDFG	Native
2003	California Freshwater Shrimp *(Syncaris pacifica)*	CDFG	Native
2003	Threespine Stickleback *(Gasterosteus aculeatus williamsoni)*	CDFG	Native

Tannery Creek Stream Inventory Report (DFG, 2002)

Tannery Creek was surveyed on the days 9/23/2002 – 9/29/2002. The Tannery Creek survey began at the confluence with the mainstem of Salmon Creek and extended upstream to the end of anadramous fish passage at rock falls. Given the data collected during the survey and presented in Table 3.1 the following limiting factors were identified and enhancement opportunities were prescribed. Table3.7 below summarizes the presence of species found in Tannery Creek.

Limiting Factors:

1. Low number of deep pools
2. Low instream shelter value
3. Gravel/Cobble Embeddedness in Fine Sediment

Fisheries Enhancement Opportunities:

1. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.
2. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
3. There are several log debris accumulations currently on Tannery Creek that have the potential for causing bank erosion. They should be monitored for fish passage and erosion.
4. Map and prioritize sources of upslope and in-channel erosion. Near-stream riparian planting is encouraged.
5. Active and potential sediment sources related to roads in Tannery Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
6. Reach 1 would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
7. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream.

Table 3.7 Species Observed in Historical and Recent Surveys in Tannery Creek

Years	Species	Source	Native/Introduced
2001	Steelhead Trout *(Oncorhynchus mykiss)*	CDFG	Native
2001	Threespine Stickleback *(Gasterosteus aculeatus williamsoni)*	CDFG	Native

Thurston Creek Stream Inventory Report (DFG, 2003)

Thurston Creek was surveyed on the days 7/18/2003 – 7/21/2003. The Thurston Creek survey began at the confluence with the mainstem of Salmon Creek and extended upstream to the end of anadramous fish passage at 42' bedrock sheet. Given the data collected during the survey and presented in Table 3.1, the following limiting factors were identified and enhancement opportunities were prescribed. No species presence table available for the Thurston Creek Stream Inventory Report.

Limiting Factors:
1. Low number of deep pools
2. Low instream shelter value
3. Gravel/Cobble Embeddedness in Fine Sediment

Fisheries Enhancement Opportunities:
1. There is at least one section where stream is being impacted from livestock in the riparian zone. Livestock in streams generally inhibit the growth of new trees, exacerbate erosion, and reduce summertime survival of juvenile fish by defecating in the water. Alternatives to limit cattle access, control erosion and increase canopy, should be explored with the landowner.
2. Map and prioritize sources of upslope and in-channel erosion. Near stream riparian planting is encouraged.
3. Increase canopy on Thurston Creek by planting with (willow, alder, redwood and Douglas fir) where canopy is not at acceptable levels. Plantings may need to be paired with bank stabilization or upslope erosion control projects.
4. Where feasible, design and engineer pool enhancement structures to increase number or pools in the upper reaches.
5. Where feasible, increase woody cover in pool and flatwater habitat along the entire stream.
6. There are several log debris accumulations currently on Thurston Creek that have the potential for causing bank erosion. They should be monitored for fish passage and erosion.
7. Active and potential sediment sources related to roads in Thurston Creek should be mapped and treated according to their potential for sediment yield to the stream and its tributaries.
8. Reaches 1 would benefit from bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.
9. Conduct gravel sampling. Results may indicate the need for structures that decrease channel incision recruit and sort spawning gravel, and expand redd distribution in the stream.

Chapter 4: Water Quality Monitoring

The California Department of Fish and Game (DFG) funding established a volunteer monitor program to collect water quality data for Salmon Creek and its tributaries. Volunteer water quality monitoring fills a void in data for the watershed and provides an opportunity for community involvement in watershed issues. The program sought to collect baseline data that could be used to determine how water quality issues might contribute to the decline of the salmonid populations in the watershed. Salmonid health and habitat restoration were at the heart of the watershed level planning. With the last known coho documented in 1996 by DFG, a concern among residents drove the effort for this project. The baseline monitoring efforts were collected with salmonid standards in mind. Results presented in the water quality monitoring section used coho and steelhead habitat, breeding, and spawning standards to determine suitable water quality.

Water quality tests were limited to temperature, pH, dissolved oxygen, phosphate, nitrates, chlorine, conductivity, salinity, and turbidity. These parameters were selected to give baseline information related to salmonid health and the best data for the effort and experience levels of the volunteers. Volunteer efforts continue today, long after the grant funds were exhausted. The program has expanded to collect additional data for the watershed.

Water quality can be highly variable in natural environments. The idea of “good” and “bad” water quality can be contentious and difficult to pinpoint without spending some time monitoring the creek and understanding the many contributing factors in a watershed. Temperatures, soil and plant conditions, our input of chemicals and wastes, animal distribution, and naturally occurring concentrations of “pollutants” are the complex variables that must be understood to gain

an understanding of the monitoring results. Often misunderstood, chemical monitoring of the creek does not identify what is wrong in the creek and where it is coming from. It only provides a snapshot view of a continuously flowing cycle of water. Where the water has traveled, or what reactions may have occurred while it moved through the system are hard to identify, especially without point-source pollution.

Fortunately, there is a natural balance to the watershed and the creek can carry some of the waste and beneficially use it to improve conditions for the inhabitants of the watershed. Species living in a watershed are adapted to live within a particular range of parameters, from water quality to weather conditions and geology. Understanding Salmon Creek's baseline conditions will allow us to better identify the changes and monitor the effects of our actions in the watershed.

Methods

Where possible, the program aimed for compliance with the State Water Resources Control Board's (SWRCB) Surface Water Ambient Monitoring Program (SWAMP) protocol. Without access to a lab or the funds to continue monitoring if a lab were required, we chose to use tests that would produce results in the field. The tests and equipment were purchased with this goal in mind. Another issue for a volunteer monitoring effort was to keep maintenance and lab costs to a minimum. Equipment and reagents for tests were purchased with grant funds and the reagents were cheap enough to be replenished with minimal fundraising efforts. The Hach Company was selected as the supplier for most of the equipment because of their reputation for easy-to-use, high quality equipment. The funding itself restricted purchases to a $500 limit for a single piece of equipment. This limitation resulted in the purchase of Hach color wheel tests for the nutrients as opposed to a portable colorimeter, increasing the subjectivity and margin of error for those tests. Testing procedure, cleaning, and calibration methods were standardized in order to produce as little variance as possible. Volunteers were provided with laminated instructions for each test to limit user error.

Equipment

The North Coast Water Regional Water Quality Control Board (RWQCB) generously loaned the volunteer program a portable YSI 600XL multi-parameter sonde and YSI 650 data collector. The YSI 600 probe and 650XL data collector were configured to collect temperature, pH, conductivity, salinity, and dissolved oxygen. SWAMP training for calibration, cleaning, and use of the equipment were provided to Prunuske Chatham, Inc. (PCI) staff by Peter Otis of the RWQCB. Calibration and cleaning records are attached as Appendix B. The YSI remained with volunteers for several months until the RWQCB staff began low flow monitoring. After this change, a PCI-owned YSI 55 was used instead. The YSI 55 measured all the same parameters as the YSI 600 except for pH, which was measured with the Hach PocketPal™ pH tester instead. The YSI 55 also required user calibration for altitude adjustments to measure dissolved oxygen. This calibration procedure was followed by each volunteer prior to each use.

Turbidity was measured using a Hach 2100P portable turbidimeter. Suspended sediment samples were not considered due to the high costs associated with lab fees and a lack of volunteer monitor involvement. The turbidimeter is designed to produce immediate results for turbidity in the field. Turbidity only measures how cloudy the water appears using a beam of light projected through the sample in a glass vial. The glassware is cleaned by volunteers prior to each reading to limit fouling from fingerprints or dirt. Each vial is marked with an arrow to align the vial with the meter and labeled to ensure repeated use of the same vial. The glassware and the turbidimeter were cleaned and checked weekly by PCI staff. The turbidimeter was calibrated using a Hach's StablCal Formazin standard every 3 months and with a monthly check against Hach's Gelex calibration product. The monthly measurement checked for drift greater than 5%.

The nutrient tests were measured using the Hach color wheel tests. The nutrients tested by volunteers included tests for phosphates (0-1 mg/L) and nitrates (0-30 mg/L). These tests utilize a gradient color wheel and require the volunteer to match the color of their treated sample with the color on the wheel. The tests have a built-in compensation for any background color in the water sample, but leave a bit of wiggle room for interpreting the results. The volunteers were usually monitoring their sites in pairs, so the protocol required the volunteers to each come to their results separately and confidentially before disclosing the results to each other. If the results were different, the volunteers could then re-check their results and come to an agreement about the result. Since the end of the DFG grant, the Salmon Creek Watershed Council has received additional funds to purchase a portable colorimeter to replace the color wheels. In addition to the nutrients, total chlorine was measured using the color wheel.

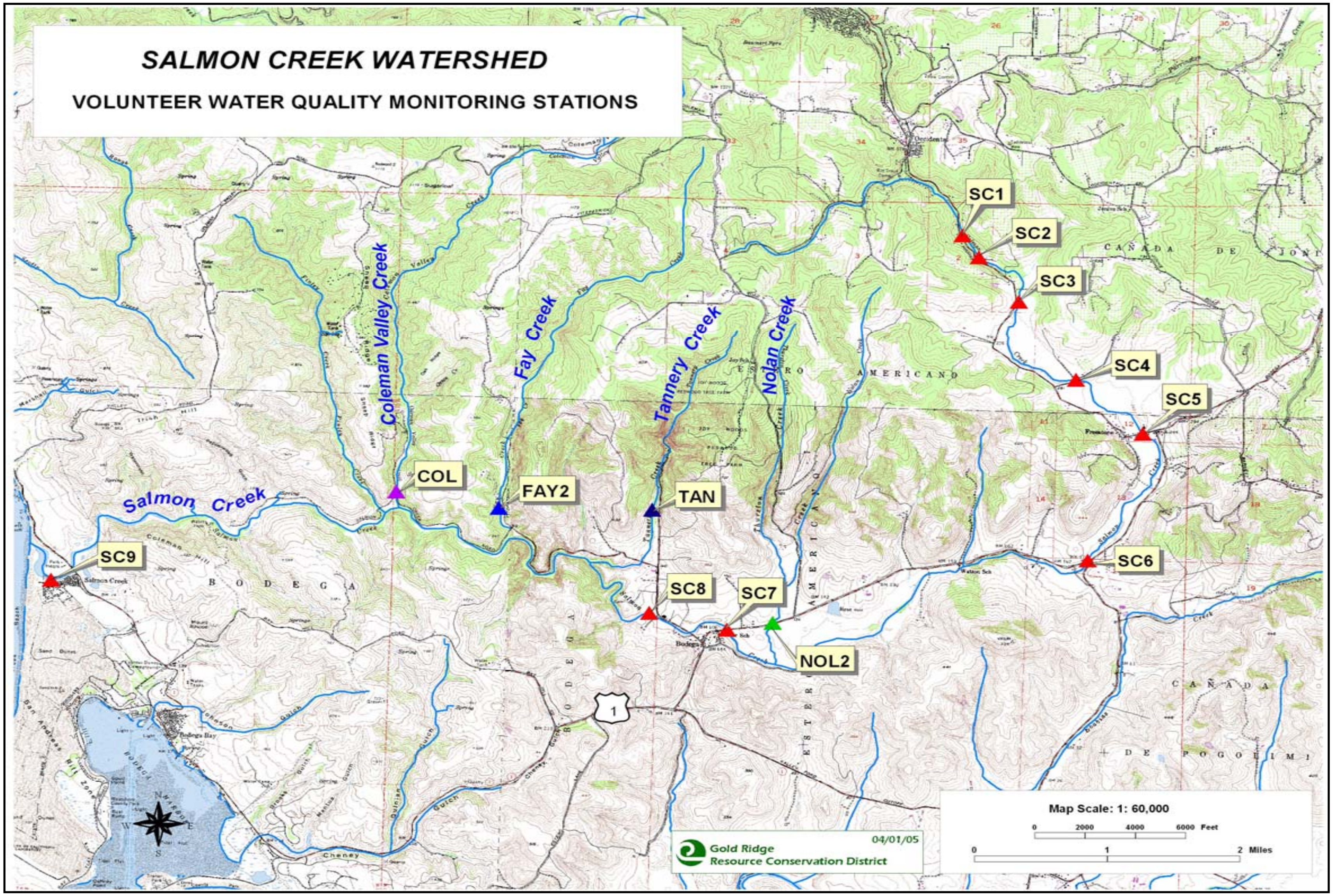
Hach PocketPal™ testers were used to measure pH and conductivity. These small handheld sticks are dipped into the water to get a measurement. The testers were calibrated weekly to ensure that they remained reliable. These meters were purchased prior to borrowing the YSI. The results from the meters seemed comparable to the YSI.

Temperature monitoring included measuring air and water temperatures at the time of the data collection. Volunteers were equipped with a thermometer in addition to the internal thermometer on the YSI probe.

Volunteer Recruitment

The volunteer monitoring program was advertised though the Salmon Creek Watershed Council (SCWC) and at public meetings held by the GRRCD. Watershed e-mail groups were forwarded information and several local papers announced the Salmon Creek projects. The first volunteer training was held in the old Pastorale building after several months of requests for volunteers. The group was introduced to the program, its goals, the equipment, and the concepts behind water quality monitoring. Volunteers met each other, partnered, and selected locations to perform their monthly monitoring. The commitment by volunteers involved monitoring their site once a month at a regular time to limit fluctuations in their data. After the initial training, volunteers were met onsite by PCI staff to be trained to select the exact location of each monitoring site, use of equipment, and to troubleshoot any problems while testing. Most groups had two visits with PCI staff, though others required additional instruction.

To address issues of privacy, public bridges were used for access to a majority of the test sites. Several volunteers requested to test on their own property and these requests were granted. Limited efforts were made to locate additional sites along mainstem Salmon Creek in the reach between Freestone and Bodega, and between Bodega and the Estuary. These efforts were unsuccessful. The program had approximately 20 different volunteers monitoring 9 sites along mainstem Salmon Creek and 5 tributaries (Fay, Tannery, Thurston, Nolan, and Coleman). The volunteer and site numbers fluctuated slightly throughout the course of the program. When possible, we recruited new volunteers to continue monitoring critical sites along the watershed.

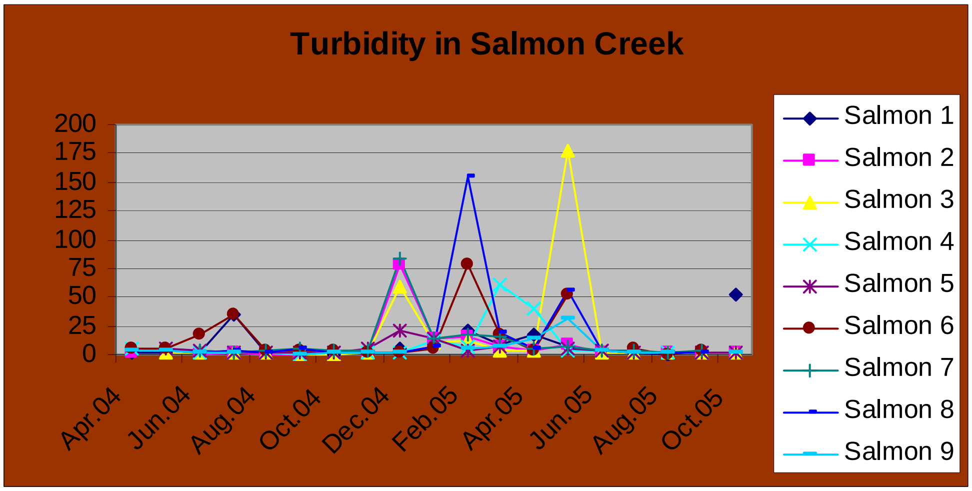

SALMON CREEK WATERSHED
VOLUNTEER WATER QUALITY MONITORING STATIONS
Salmon Creek
Coleman Valley Creek
Fay Creek
Tannery Creek
Nolan Creek
SC1
SC2
SC3
SC4
SC5
SC6
SC7
SC8
SC9
COL
FAY2
TAN
NOL2
Map Scale: 1: 60,000
0 2000 4000 6000 Feet
0 1 2 Miles
Gold Ridge Resource Conservation District
04/01/05

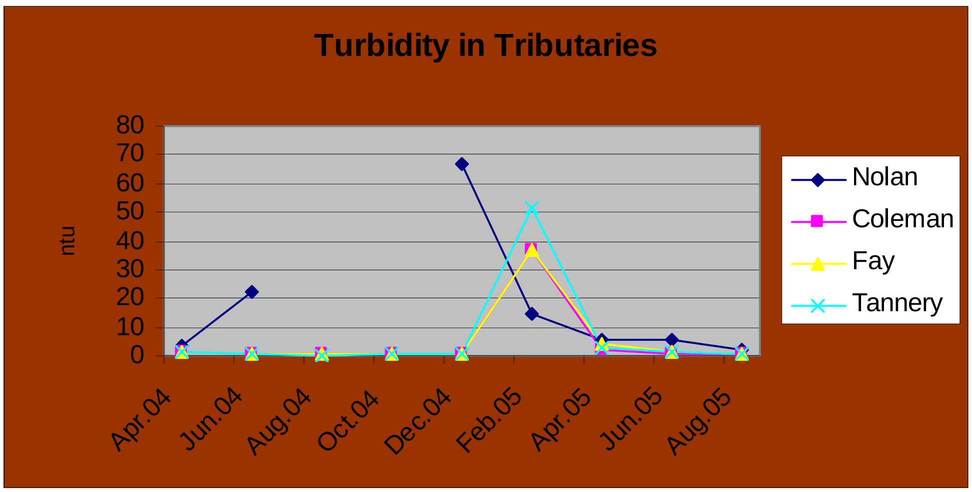
Monitoring Results
The results have been sorted by reach for comparability and better analysis of the data. The upper watershed includes the Occidental sites from just downstream of town to Salmon Creek School. Freestone includes Freestone Flat Road and the Freestone Bridge. The Freestone Valley Ford Cutoff Road was kept alone due to its isolated location. The Bodega sites included the Bodega Bridge and another site just downstream on Salmon Creek Road. The Estuary was also kept separate. The tributaries were clustered together for comparison.

The data, by and large, showed that water quality in Salmon Creek is good. This, of course, is not to say that it couldn't be improved. Conditions in Salmon Creek were surprisingly better than expected. Overall, conditions were favorable for salmonids, though improvements could be made. Suitable habitat is critical for the salmonid population in the watershed. Like humans, fish need areas for food, shelter and need suitable means to transport themselves from one location to another. The entire stretch of creek may not provide prime habitat, but areas must allow fish passage and survival nearby. During storm flows, fish need refuge in slower moving waters and in the summer months, they need deep pools with cool, clean water. They need nurseries in the clean gravels at the creek bottom and woody debris to hide from predators. Competition is often fierce, and the more habitat, the greater the numbers of fish making their way to the ocean. Throughout the year, fish need access to food, often found in the faster moving riffles.

Turbidity
Water quality data indicates turbidity may be the single biggest water quality issue in the watershed. Turbidity is a measurement of clarity in the water sample. It does not distinguish size or type of particle in the water, the turbidimeter simply measures how much light passes through the sample. Of course for salmonids, some turbidity at the right time can be beneficial. Adult fish return to the same streams where they were born after storm events to take advantage of higher flows. In our creeks, these are also periods of higher turbidity associated with storm events. The adults gather downstream and wait for the right opportunity of flow and turbidity to move upstream. Females locate an area suitable for the eggs. The location needs to have cool, clean waters and provide enough flow for the eggs to hatch. Once the fertilized eggs are hidden among rocks in the streambed, fine sediment can settle out of the water and block the flow of oxygenated water to the eggs. At this stage the fine sediments are deadly since the eggs can not move to a better location. When the young fish emerge form the rocks, low levels of turbidity can be beneficial for feeding and hiding. At this stage the fish are large enough to move up and downstream, allowing them to escape turbid waters for a calm area, if it is available. Deep pools serve this purpose well and creeks with faster moving riffles and deep, slow pools provide the necessary habitat for fish populations. Sediment in Salmon Creek has been one of the primary concerns for salmonid health. Turbidity data was gathered by the volunteers show results consistent with winter storm flows and summer algal blooms.

Graph 4.1 and 4.2 Turbidity Results for Salmon Creek and Tributaries 2004 -2005





The results from the volunteer monitoring effort reflects only monthly data. Storm related peaks and periods of turbidity are not captured in the results. In the monitoring by volunteers, storm events were often missed altogether or recorded long after the peak turbidity event. Volunteers committed to testing at the same time of day each month, resulting in extraordinarily lucky rain-free days for most. In an attempt to gain additional information about the watershed, PCI staff collected storm-related turbidity readings during the rainy season in 2004-5. The image below shows the relationship of turbidity on salmonids health over time. The column on the left shows the turbidity levels in nephelometric turbidity units (NTUs), the numbers across the bottom shows time in hours, days, weeks, and months. The green area is suitable for salmonids, the yellow begins to impact health, the orange is detrimental, and the red is fatal. Based on this research, PCI staff collected additional turbidity information at 10 sites on the mainstem and 4 tributary locations. This data would be collected in one trip, beginning at Occidental and ending at the estuary. The results analyzed turbidity data from both sources alongside rain and stage data. Turbidity levels should be studied further, especially during storm events. The data from the few storm-related turbidity runs show turbidity levels remaining above the detrimental level for salmonids for an extended period of time.

Impact Assessment Model for Clear Water Fishes
Exposed to Conditions of Reduced Water Clarity

Visual clarity of water (*y*BD) and related variables: alternate		preferred		Duration of exposure to conditions of reduced VISUAL CLARITY ($\log_e$ hours)											Fish reactive distance: calibrated for trout		
				0	1	2	3	4	5	6	7	8	9	10			
NTU ($\Delta ntu_{\Sigma,\Lambda}$)	*z*SD (m)	BA (m^{-1})	*y*BD (m)	Severity-of-ill-effect Scores (SEV) -- Potential SEV = - 4.49 + 0.92($\log_e$ h) - 2.59($\log_e$ yBD)											ψ_{BD} (cm)	*x*RD (cm)	
1100	0.01	500	0.010	7	8	9	10	11	12	13	14				1		O
			0.014	7	7	8	9	10	11	12	13	14			1		N
400	0.03	225	0.02	P6π	7	7	8	9	10	11	12	13	14		2		M
			0.03	4	5	6	7	8	9	10	11	12	13	14	3		L
150	0.07	100	0.05	3	P4π	P5π	6	7	8	9	10	11	12	13	5		K
			0.07	2	3	4	5	6	7	8	9	10	11	11	7		J
55	0.15	45	0.11	P1π	2	3	4	5	6	7	8	9	10	10	11	6	I
			0.16	0	1	2	3	4	5	6	7	8	9	9	16	17	H
20	0.34	20	0.24	0	P0π	P1π	2	3	4	5	6	7	8	8	24	30	G
			0.36	0	0	0	1	2	3	4	5	6	6	7	36	42	F
7	0.77	9	0.55	0	P0π	0	0	1	2	3	4	4	5	6	55	55	E
			0.77	0	P0π	P0π	0	0	1	2	3	4	4	5	77	66	D
3	1.53	4	1.09	0	P0π	0	0	0	0	1	2	3	4	5	109	77	C
			1.69	0	0	0	0	0	0	0	1	2	2	3	169	90	B
1	3.68	2	2.63	P0π	P0π	P0π	0	0	0	0	0	0	1	2	263	104	A
				1	3	7	1	2	6	2	7	4	11	30			
				Hours			Days			Weeks		Months					
				a	b	c	d	e	f	g	h	i	j	k			

The data collected shows periods of extended turbidity after each rain event. The image below combines rainfall totals and turbidity measurements by the volunteers and PCI staff with the severity of impacts to salmonids shown in the dashed yellow (low impact) and orange (detrimental) lines. The turbidity measurements collected by PCI are clearly above the detrimental level on several occasions.

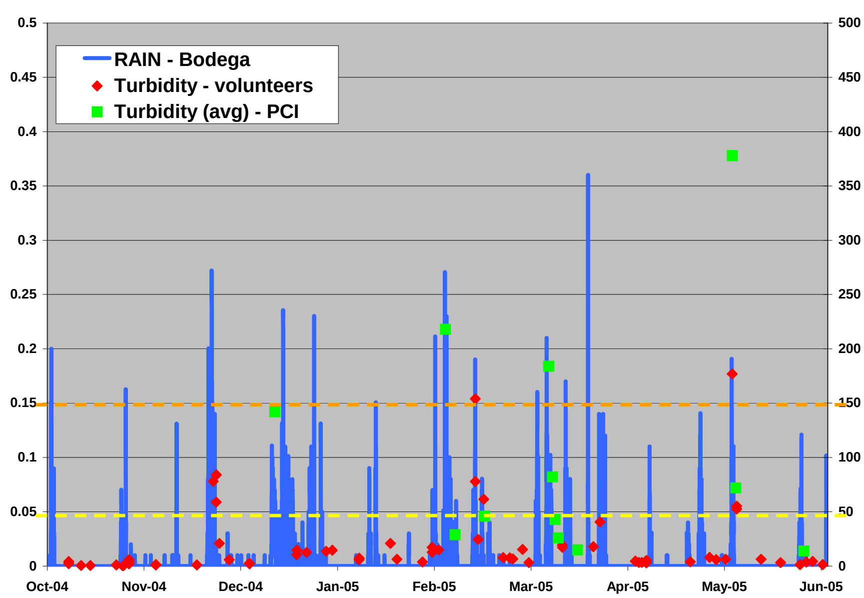


Table 4.3 Turbidity Data vs. Rainfall- 2004 - 2006

Individual storm event data details the trend for turbidity in the watershed. Turbidity levels remain high, above the detrimental levels even several hours after the heaviest rainfall. (See Appendix A for additional images.)

Dissolved Oxygen and Temperature

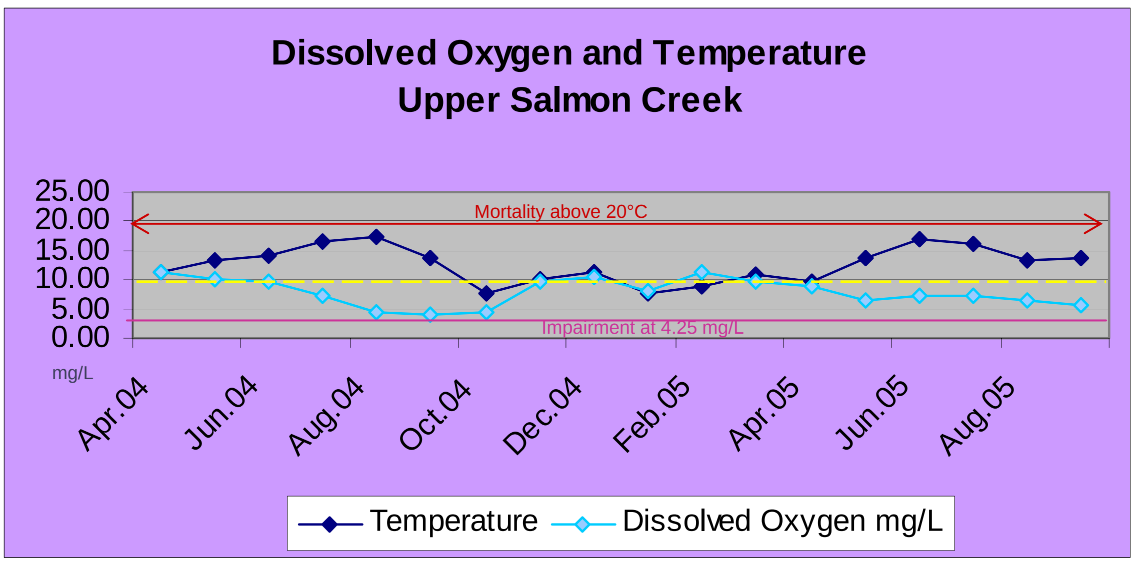
The dissolved oxygen and temperature data were compared side-by-side. Dissolved oxygen refers to the oxygen in the water that is made available for fish and aquatic insects. Dissolved oxygen enters the waterway from plant roots, agitation (including waterfalls and faster moving, tumbled water) and is critical for a healthy fish population. Water temperature must stay relatively constant within a limited range to support fish. Our native salmonid species are more sensitive than many of the non-native fish (like bass and pike). Temperature has a direct relationship with dissolved oxygen in the water supply. The higher the water temperature becomes, the lower the dissolved oxygen levels become.

If fish have suitable habitat conditions accessible nearby, they can move to cooler waters. During the warmer months the data often shows a spike in dissolved oxygen with levels above 100%. Supersaturation of oxygen is present in the waters due to the rapid growth of algae. Often these waters are typically nutrient-rich, slow moving or stagnant and are warmer than acceptable for salmonids. The supersaturated waters quickly change as the algae dies off. The decomposition of the organic plant matter requires the use of oxygen resulting in critically low levels of oxygen. Many reaches along Salmon Creek become quite shallow or stagnant during the summer months as water levels drop. Again, the critical issue is the availability of suitable habitat. Fish need suitable habitat year-round and for all age groups of fish living in the creek. The data shows good conditions in the winter breeding months and scattered areas of good habitat during the summer months. Graphs 4.3 – 4.10 below show dissolved oxygen and temperature for all the reaches of mainstem and the tributaries.

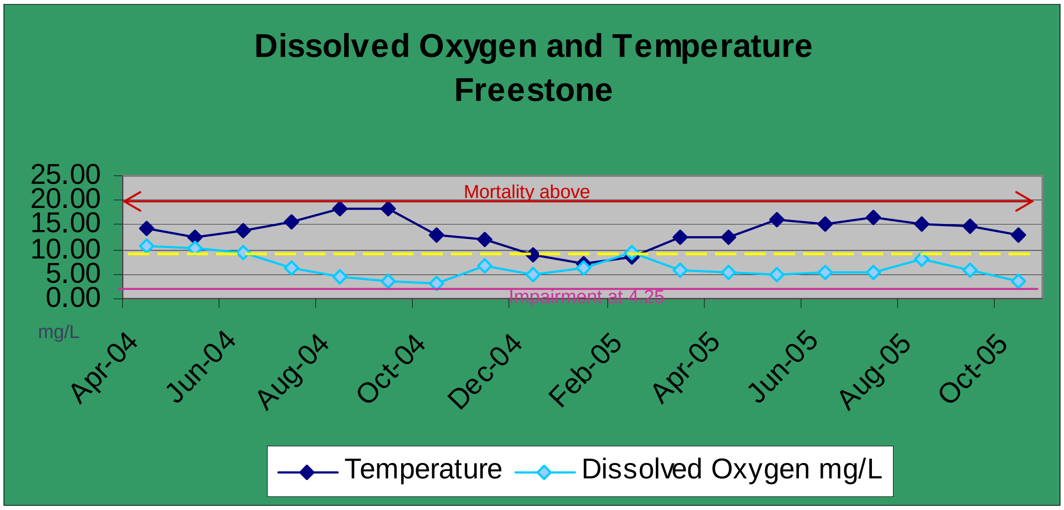
Salmonids and Temperature[4]

Wet Months						Dry Months					
N	D	J	F	M	A	M	J	J	A	S	O
	Spawning Spawning water temperature between 3.9-9.4°C (8); incubation temperature between 0-24°C (10); embryo mortality at 15°C DO 7.2 mg/L										
Juveniles spend 1-4 years in stream (average 2 years)											
Temperature should not go above 20°C (10°C optimum) for salmonids											
Dissolved Oxygen no lower than 5 mg/L. Normal function at 7.75 mg/L, distress at 6.0 mg/L, impairment at 4.25 mg/L.											

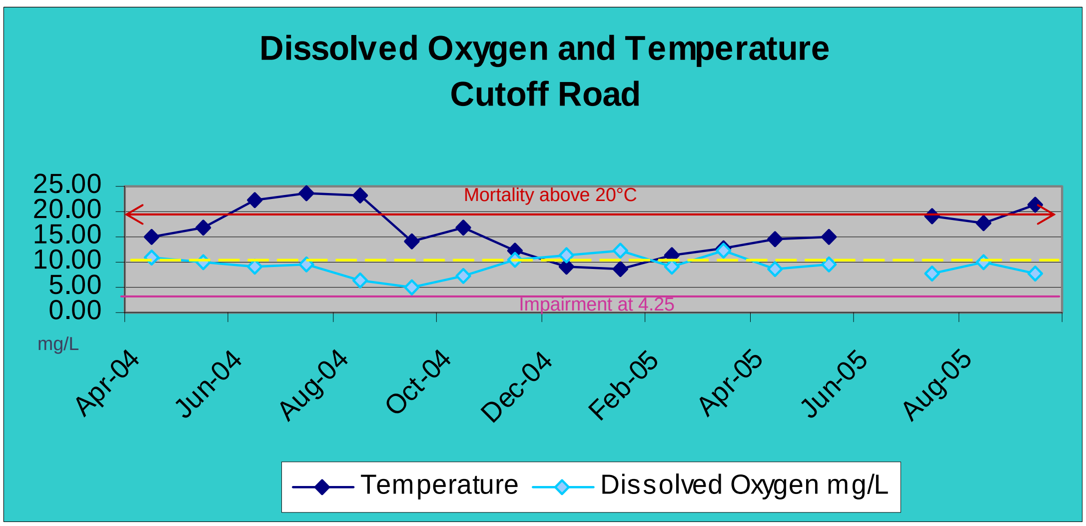
Table 4.4 Temperature Requirements for Salmonids (Barnhart 1986)



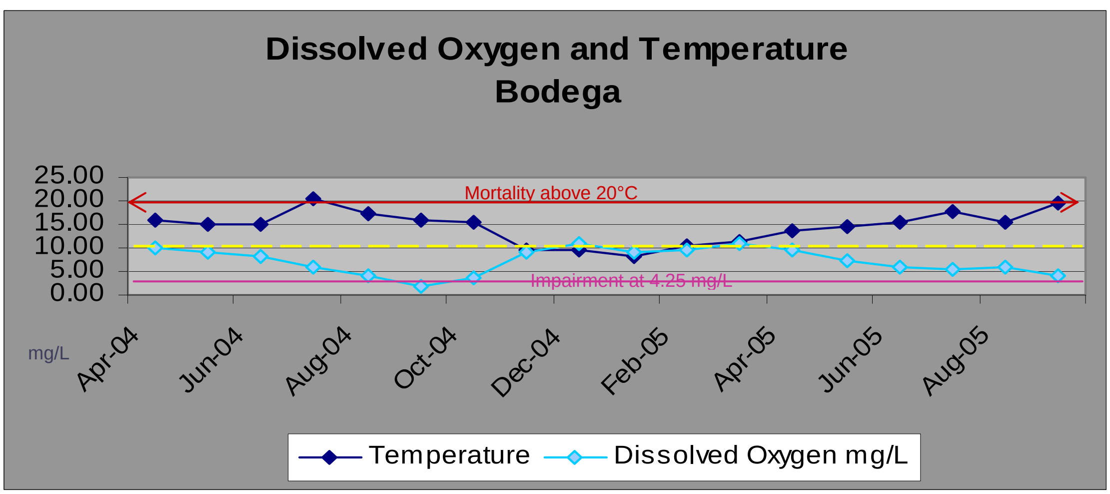
Graph 4.3 Dissolved Oxygen and Temperature in Salmon Creek 2004-2005



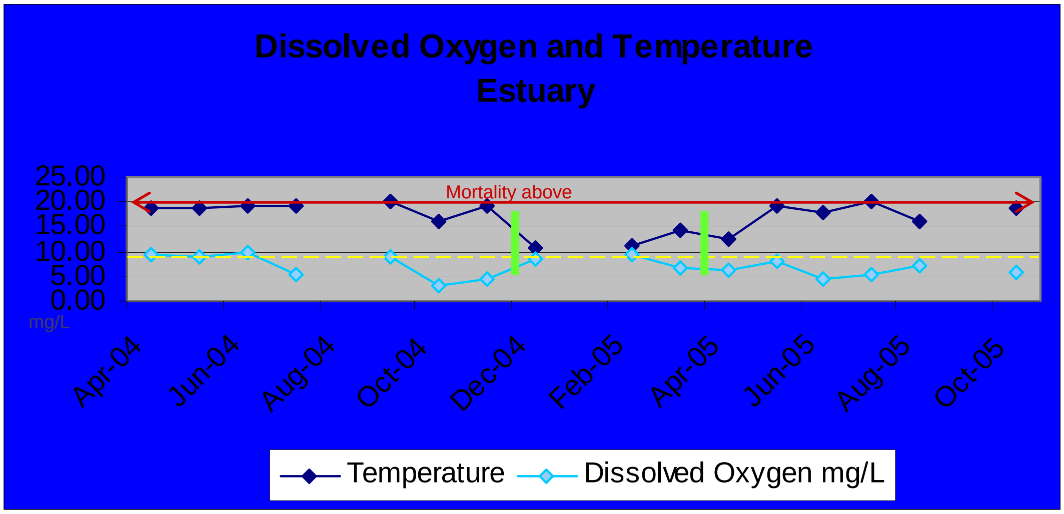
Graph 4.4 Dissolved Oxygen and Temperature at the Freestone Site 2004-2005



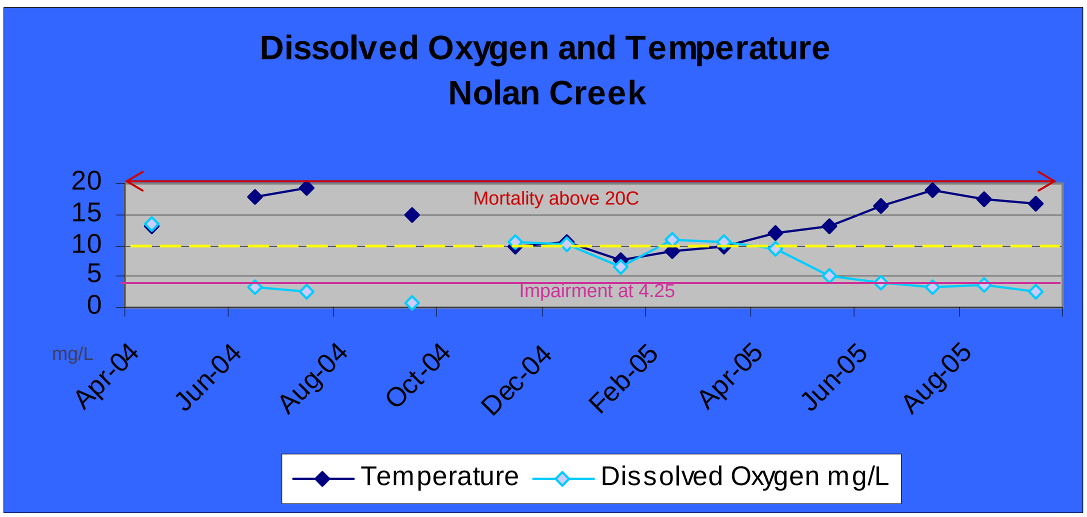
Graph 4.5 Dissolved Oxygen and Temperature at the Cutoff Road Site 2004-2005



Graph 4.6 Dissolved Oxygen and Temperature at the Bodega Bay Site 2004-2005

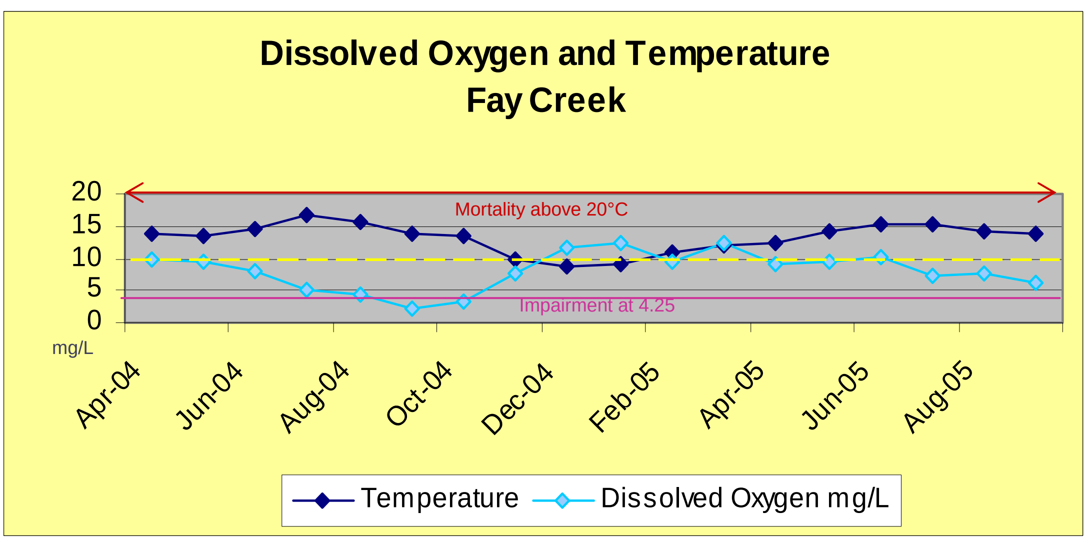


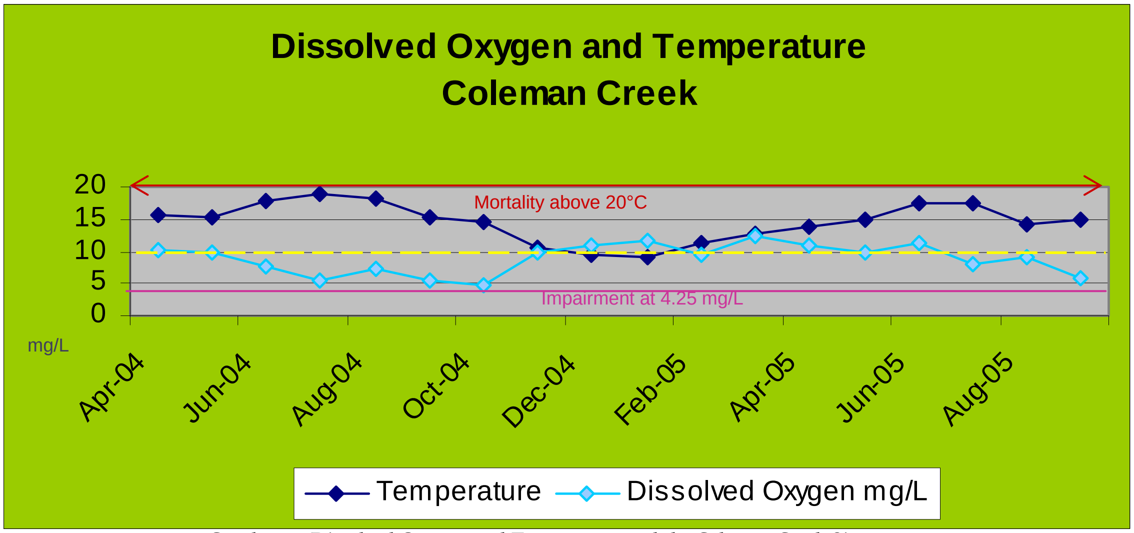
Graph 4.7 Dissolved Oxygen and Temperature at the Estuary Site



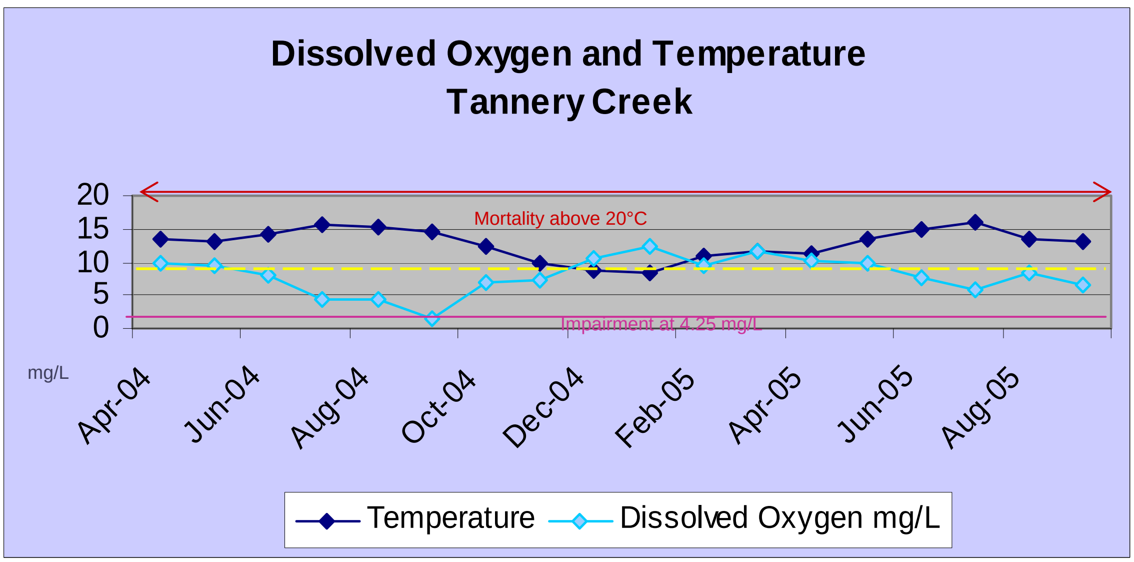
Graph 4.8 Dissolved Oxygen and Temperature at the Nolan Creek Site

Graph 4.9 Dissolved Oxygen and Temperature and the Fay Creek Site





Graph 4.10 Dissolved Oxygen and Temperature and the Coleman Creek Site



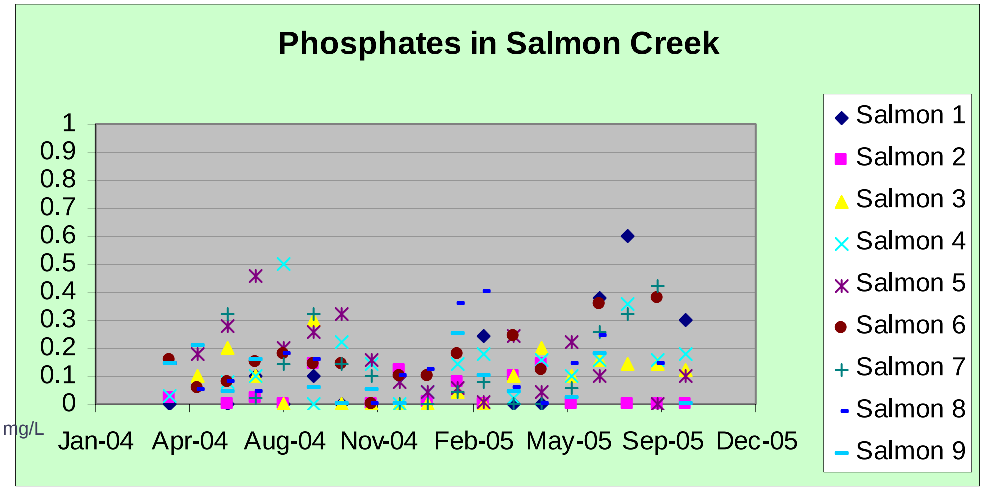
Graph 4.10 Dissolved Oxygen and Temperature and the Tannery Creek Site

Mortality occurs above 20°C. Distress begins at 6.0 mg/L, impairment occurs at 4.25 mg/L. The ideal temperature for salmonids is 10°C with dissolved oxygen at 7.75 mg/L.

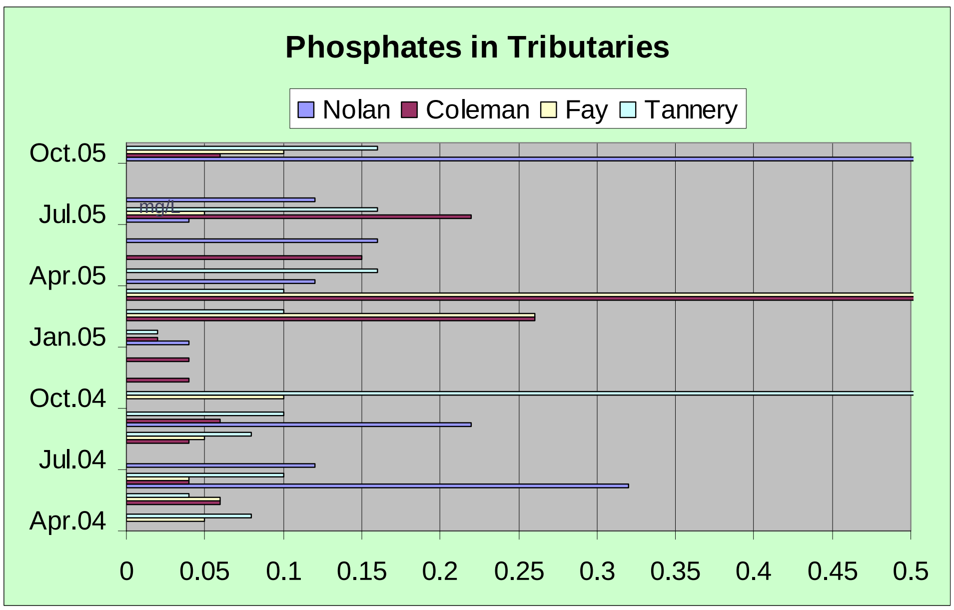
Nutrients: Phosphates and Nitrates
Phosphates and nitrates were monitored at all sites to detect levels of pollution in the watershed. The tests were designed to test for the lowest possible quantities detectable by our equipment. Tests showed very few incidents of spikes above critical levels. Each parameter is discussed in further detail below.

Phosphates and nitrates are part of the natural composition of a stream. They are common to all animal and human waste and important to the growth of plants (fertilizers). Since animals, fish, and birds live in and around the creeks, some level of phosphates and nitrates are perfectly natural. They enable plant growth and provide food for fish and insects. Problems arise when the phosphates and nitrates are found in excess quantities. Pollution from leaking septic tanks, livestock, the application of too much fertilizer, or other human activities can create an imbalance in the creek. Algal blooms use the excess nutrients, but in the decomposition process, they take dissolved oxygen from the water as they die off.

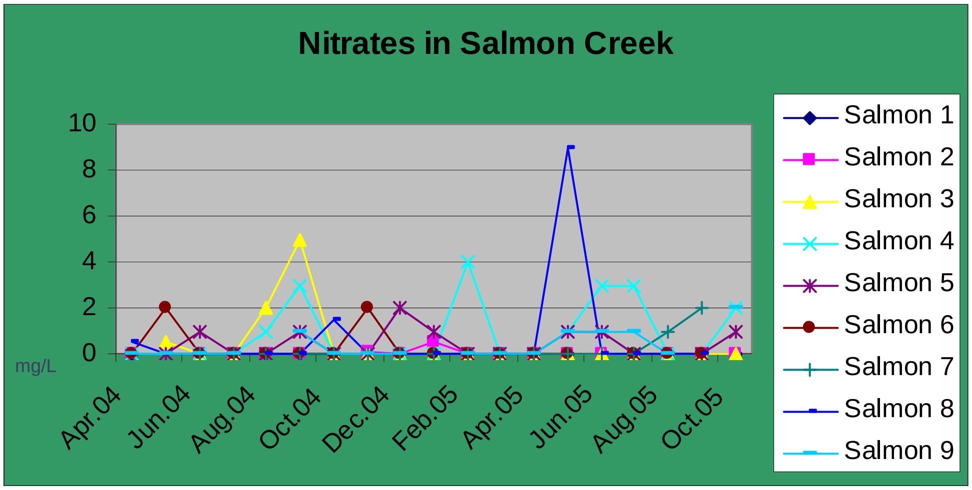
In aquariums, phosphate levels above 1 mg/L are considered problematic for fish. Our results show phosphates generally well below 1 mg/L. More troubling are the two spikes not shown on the graphs. On October 24th, 2004, the phosphate level at the Estuary was 5 mg/L with 0.4 inches of rain the day before. On March 26th, 2005, a phosphate reading of 10 mg/L was noted at the Cutoff Road. Phosphates at such high levels are indicative of pollution and are deadly for fish. It is important to note that the type of water quality monitoring performed by volunteers does not necessarily implicate the location where the sample is collected. In order to locate a source of pollution, or point source, testing would occur at a known source of pollution. The tests would then be repeated up and down stream of that source. In some cases, educated guesses might be made, but without the testing to back up the results, it is difficult to lay blame when testing at only one location.



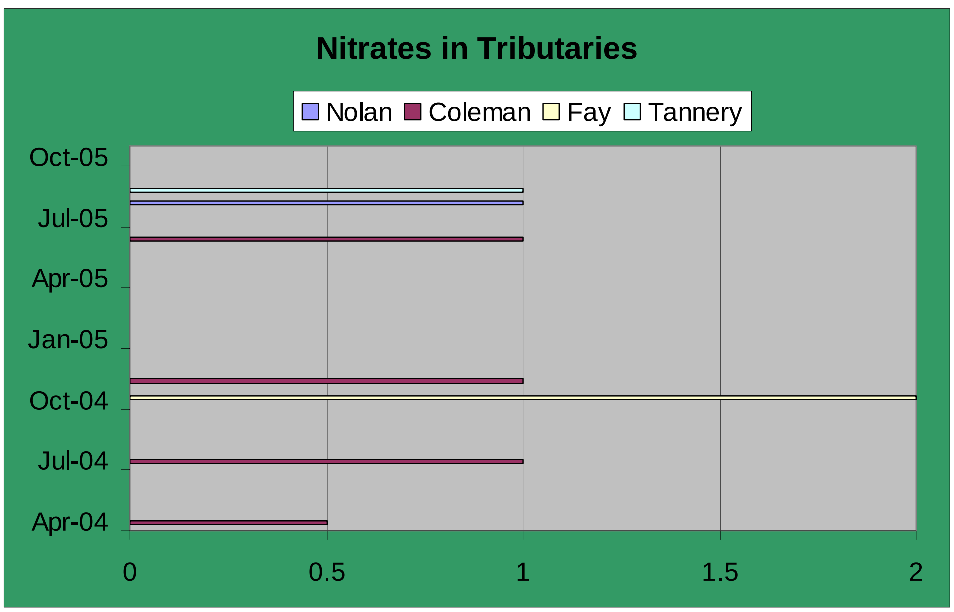
Graph 4.11 Phosphate in Salmon Creek – 2004- 2005 (Measured in mg/L)



Graph 4.12 Phosphates in Tributaries – 2004 – 2005 (Measured in mg/L)



Graph 4.13 Nitrates in Salmon Creek – 2004 - 2005



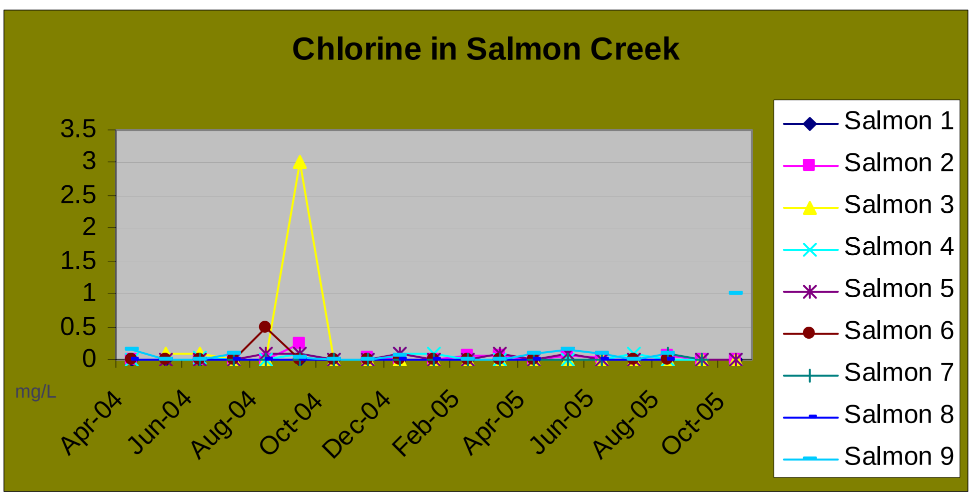
Graph 4.14 Nitrates in Tributaries – 2004 - 2005(Measured in mg/L)

The EPA limit for nitrates in drinking water is 10 mg/L. (Hach website) No data was available for salmonid limits.

Chlorine

Chlorine is a highly toxic gas often used as a disinfectant in household sanitation and in municipal drinking water supplies. Commonly found in most homes as bleach, chlorine is highly reactive and quickly forms bonds with compounds in the water. Once bonded, some of the risks associated with the chlorine are greatly reduced. Risks are further reduced as chlorine dissipates into the air. The "free" or available chlorine poses the greatest threat to aquatic life. Only 0.01 mg/L of free chlorine kills coho. One milligram in a liter of water is a quantity equivalent to a drop of water into a full bathtub (Alaska DEC 2004). This would be one hundredth of that drop.

Salmon Creek volunteers monitored for total chlorine due to the equipment's lack of accuracy. Free chlorine tests could not be performed with confidence given the limitations of the equipment. Mainstem Salmon Creek typically had total chlorine values between 0 and 0.1 mg/L. There were two spikes in the mainstem, one at Salmon Creek School (3 mg/L) and the other at the Estuary (1 mg/L). The tributaries were not tested for chlorine due to the low likelihood of finding measurable levels of chlorine in the waterways. The overall chlorine results appear to show a healthy system with very little total chlorine in the creek. The spikes (3mg/L at Salmon Creek School and 0.5 mg/L at Freestone Bridge) might be understood as errors in the testing methods or as positive hits for chlorine as it passed through the system.



Graph 4.15 – Chlorine in Salmon Creek 2004-2005

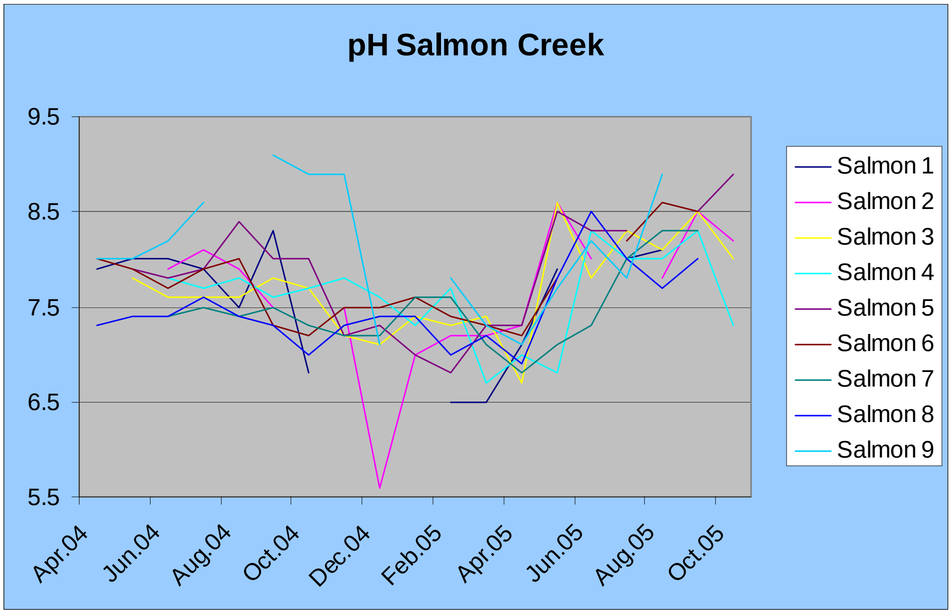
pH

pH is a measure of acidity or alkalinity of water. The pH is a range from 0 to 14 with highly acidic waters at 0 and highly alkaline waters at 14. Pure water is neutral and in the middle of the range at 7. Acids are commonly known and it is easy to understand why they may be dangerous for creeks. Soda, battery acid, citric acid, coffee, and urine are all common acids. Alkaline (or basic) liquids include seawater, ammonia, baking soda, soaps, and bleaches. It is easy to understand why neutral water is desirable, but it isn't always naturally occurring in a creek.

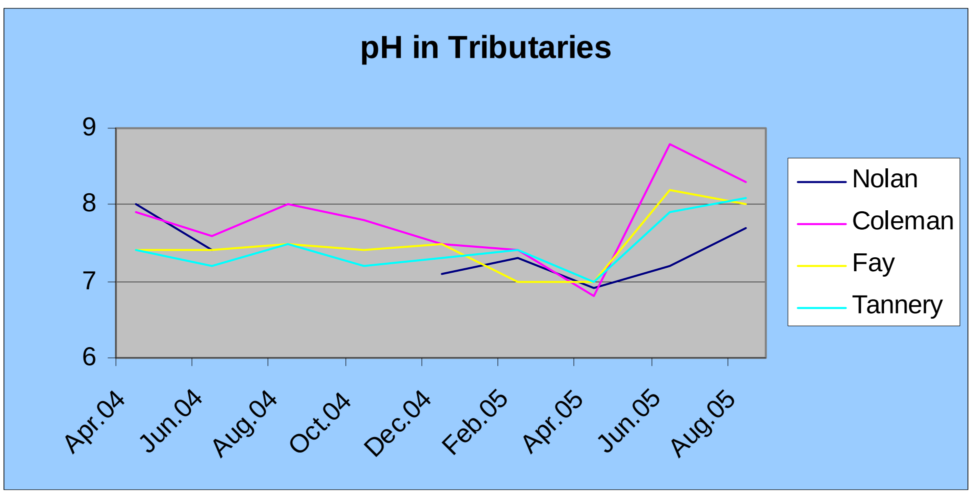
Many natural factors contribute to pH. Our redwoods and pine trees are acidic, though our maples are alkaline. Soils can be either, depending on the composition of rocks and minerals. Our local soils are a little acidic. Oddly enough, our watershed appears to have slightly alkaline waters. As water levels drop, the waters become increasingly alkaline in Salmon Creek and its tributaries. The reasons are unknown, though without rainfall to contribute to runoff, it seems that perhaps this could be a natural phenomenon. Further testing, especially groundwater testing may help identify the issues with pH. Table 4.3 below indicates that alkaline conditions in the range found for our watershed are within the tolerable range for trout.

Table 4.3 pH Effects (SWRCB 1963)

Minimum	Maximum	Effects observed
3.8	10.0	Fish eggs could be hatched but deformed young were often produced.
4.1	9.5	Range tolerated by trout
4.5	9.0	Trout eggs and larvae develop normally
5.0		Limit for stickleback
	8.7	Upper limit for good fishing waters
5.4	11.4	Fish avoided waters beyond these limits
6.0	7.2	Optimum range for fish eggs



Graph 4.16 pH in Salmon Creek 2004-2005



Graph 4.17 pH in Tributaries 2004-2005

Conclusion

Water quality monitoring requires long-term data collection to better understand the trends and responses of the watershed to the many demands placed on our water supply. It can be used to better understand what is happening in the water itself, but it has its limitations. Water quality monitoring is a snapshot view of a continuous flow of water. What occurs in the days or minutes before a sample is collected can be missed in a chemical analysis. Baseline monitoring is essential to the understanding of how our water is impacted by population growth, agriculture, climate changes, and restoration efforts. Salmonids depend on very clean, cool water for their survival and water quality monitoring will determine whether this is a limiting factor for the fish. The monitoring program is a low-cost, highly interactive effort to collect data to better understand watershed health. Volunteers contribute usable data and better understand the conditions of their watershed. With the equipment and protocols in place, every effort should be made to support the program and use the data to study the watershed conditions.

A volunteer monitor coordinator should be identified for the monitoring efforts. Even with committed volunteers, the overall scheduling, data management and maintenance of the equipment requires several hours of effort each month. Ideally, funding would be written into other grants and fundraising efforts to ensure calibration standards, reagents, and other supplies could be ordered when needed.

Storm-related turbidity monitoring shows turbidity events as the creeks quickly rise and fall during our flashy flood events. The data is unlike anything collected on a monthly basis by water quality monitors. A team of volunteers should be trained and ready to monitor storm events for turbidity. It would be ideal to have at least 2 turbidimeters available for this effort. Other water quality data is less important during these events, especially since the high flows dilute the pollutants.

Restoration efforts should consider habitat for salmonids of all age classes. Habitat should be available especially during the dry summer months in areas with suitable cover and a food source.

Further testing should be done to try and locate the source of the high pH levels for Salmon Creek. Groundwater testing of wells may provide some additional insight.

Macroinvertebrate monitoring will provide additional information about water quality. DFG has a SWAMP approved protocol for bioassessment that would provide water quality data for longer periods of time based on the insects living in the creeks.

Chapter 5: Sediment Source Inventory

High rates of sediment delivery to Salmon Creek and its tributaries have been targeted as a priority issue by local residents and regulatory agencies concerned with improving salmonid habitat and riparian corridor health. Low pool frequencies and depths coupled with relatively high embeddedness values throughout the stream system indicate that fine sediment is impacting crucial salmonid spawning and rearing habitat.

Erosion processes and relative sediment source activity is affected by land use practices, climate patterns, and changes in channel conditions. Most erosion processes occur naturally. Weathered bedrock is slowly transported downslope, accumulating on hillsides and in hollows. Upslope material is carried to the drainage system through slow, episodic hillslope erosion processes. Channels themselves are dynamic, constantly adjusting systems that go through cycles of erosion and deposition. Land use practices can amplify erosion processes, causing increased rates of erosion and sediment yields. Sediment sources in the watershed include sheetwash, gully development and expansion, channel incision through headcut migration, bank erosion, landslides, rotational slumps, subsurface tunneling, animal burrowing, trampling, and rainsplash.

Hillslope sources contribute sediment primarily to colluvial storage. Sheetwash and landsliding may contribute directly to channel sediment, depending on land use and proximity of the source to the channel. Disconnected gullies and tunneling (collapse pits) in upland swales temporarily store their sediment in colluvial hollows until they become incorporated into the 1st order tributary gully system through headcutting and bank erosion.

Production of in-channel sediment in Salmon Creek is from four primary sources. The first is enlargement of the drainage network through downcutting and bank erosion in the 1st order tributaries and new gully development. The second source is 2nd and 3rd order channel bank erosion and bed mobilization. Landslides in the steep, forested tributary headwaters are the third significant source. The fourth source, contributing primarily fine sand and silt to the system, is upland sheetwash. Exposed surfaces from grazing pressure, livestock trails, agricultural activities, residential disturbance, and rural roads deliver fine sediment directly to perennial channels and indirectly across pastureland to gully and drainage networks. This source was not addressed in this study.

An inventory of erosion sites was completed on 26 properties within the Salmon Creek Watershed in the spring of 2004. The properties assessed included large agricultural holdings, small rural-residential acreages, and urban stream-side lots. The focus of the project was to document sediment sources that have the potential to deliver material directly to the stream network and provide a prioritized repair list for future funding and implementation projects.

As this project was the first large-scale assessment in Salmon Creek several factors constrained widespread participation in the erosion inventory program. General community awareness of erosion management and cumulative sediment impacts is limited. Many landowners, especially the large agricultural operations, are hesitant to allow right of entry to their land and to sign long-term access agreements. Concern over regulatory actions and potential findings that might result in onerous land management requirements or fines often limits participation in this type of program. On-going education and observation of positive outcomes for other landowners from this project will, over time, reduce the apprehension and provide additional opportunities for erosion surveys and sediment management activities throughout the watershed.

Assessment Methods

Landowners were contacted to participate in the erosion assessment through public meetings, private mailings, and informational flyers placed around the watershed. Fifty five landowners signed access agreements for the erosion inventory. Limited project funds, site visit scheduling problems, and a focus on large properties or those located adjacent to perennial streams narrowed that list down to twenty six properties.

A standardized erosion inventory form was developed and used to record erosion sites. A copy of the site form is in Appendix B.

The inventory form is composed of multiple erosion assessment descriptors, and includes:

- **Site Location.**
- **Topography and Land Use.**

- **Erosion Description**: A brief visual description of the erosion site, including category (i.e. headcut, bank failure, gully, knickpoint, road, or landslide).
- **Erosion Dimensions**: Measurements of length, width, and height of erosion site.
- **Erosion Style (type)**: Notation of whether the erosion is *chronic, episodic,* or *natural*. Chronic erosion is constant and occurs during significant rainfall. Common types are sloughing, sheet erosion, rilling, and headcutting. Episodic erosion occurs occasionally, often in a big pulse. Landslides are a common example. Natural erosion is what would be expected to occur over time in an undisturbed environment, and is not caused or accelerated by human activities. Erosion can be both chronic and episodic, such as a landslide that continues to erode.
- **Erosion Activity**: Highly active sites are characterized by fresh, bare soil, no vegetation, vertical slopes, or fresh, loose sediment deposited at the base of the site.
- **Erosion Potential:** This is a ranking of how much soil could potentially be mobilized from a site in the future. Upslope stability (soil stability, presence of bedrock or dense vegetation, grade control) is the key factor, along with erosion type, in determining whether a site has high, medium, or low erosion potential.
- **Future Potential Sediment Volume**: Calculated cubic yards of sediment likely to enter the stream system over time as erosion continues at the site.
- **Access Rating**: *High*ly accessible sites can be reached with a vehicle by road. *Medium* accessibility can be reached with equipment, although there may not be existing road access. *Low* accessibility cannot be reached by vehicles, equipment and materials must be hand carried or obtained on site.
- **Repair Priority**: Considers erosion potential, activity, percent of impairing sediment, accessibility, and cost. For example, a small headcut that can be quickly repaired at low cost might have a higher priority than a more active site in a remote location.
- **Repair or Enhancement Value**: Ranking of the value of repairing the site for five factors: property enhancement, educational opportunities, community value, instream habitat improvement, and upland habitat improvement.
- **Description of Repair Types and Methods**: A brief discussion and listing of possible repair methods for future project guidance and cost estimation. Repair types include common methods used for grade control, stream bank stabilization, biotechnical solutions, and storm water management. The methods chosen are based on erosion category, severity, stability, and location with respect to infrastructure.
- **Sketch/Calculations**: A quick site sketch showing a planview and/or cross section of the erosion feature. Also includes useful landmarks for later visits.

- **Estimated Repair Cost**: General price range for construction costs based on most likely repair method and permit requirements. This estimate is based on the site characteristics and costs at the time of the inventory. This is to be considered a rough estimate. Physical changes to the site, increases in labor and equipment costs, and updated permit requirements and fees will affect the actual cost to design and construct.

At the start of each property assessment an interview with the landowner was conducted to get a general history of the property, quickly locate known erosion sites, and address questions and concerns. Drainages on each property were then walked to locate and document erosion sites. Each erosion site was photographed and details recorded on an inventory sheet. The information collected was then transferred to an electronic database.

The sites were mapped and ArcGIS was used to statistically analyze several descriptive categories (erosion form/type, potential, activity, and yield) and physical parameters (elevation, slope, land cover, and soil k-factor).

Results Summary

The 26 properties assessed cover less than a quarter of the watershed area. However, they depict a range of lot sizes, land use, land cover, and topographic features. Thus the 139 sites documented are representative of the types and severity of erosion occurring in the watershed (Table 5-1). Copies of the field inventory sheets are located in Appendix B. Figure 5-1 shows the overall distribution of sites and their ranking by repair priority. Sites with high future sediment yields, in combination with high activity rates and erosion potential are typically ranked high priority. A lower ranking on any of two of these three parameters results in a lower priority. Access and beneficial natural process considerations are also taken into account in the ranking.

Table 5-1. *List of sediment source inventory sites, location, type, and descriptors used to analyze erosion in the Salmon Creek watershed. Sediment production for each category are: Low yields = 0-100 yds^3 , Medium yields = 100-1,000 yds^3, and High yields = >1,000 yds^3. Unusual climatic conditions or changes to a site could lead to accelerated erosion processes and increase the estimated yield.*

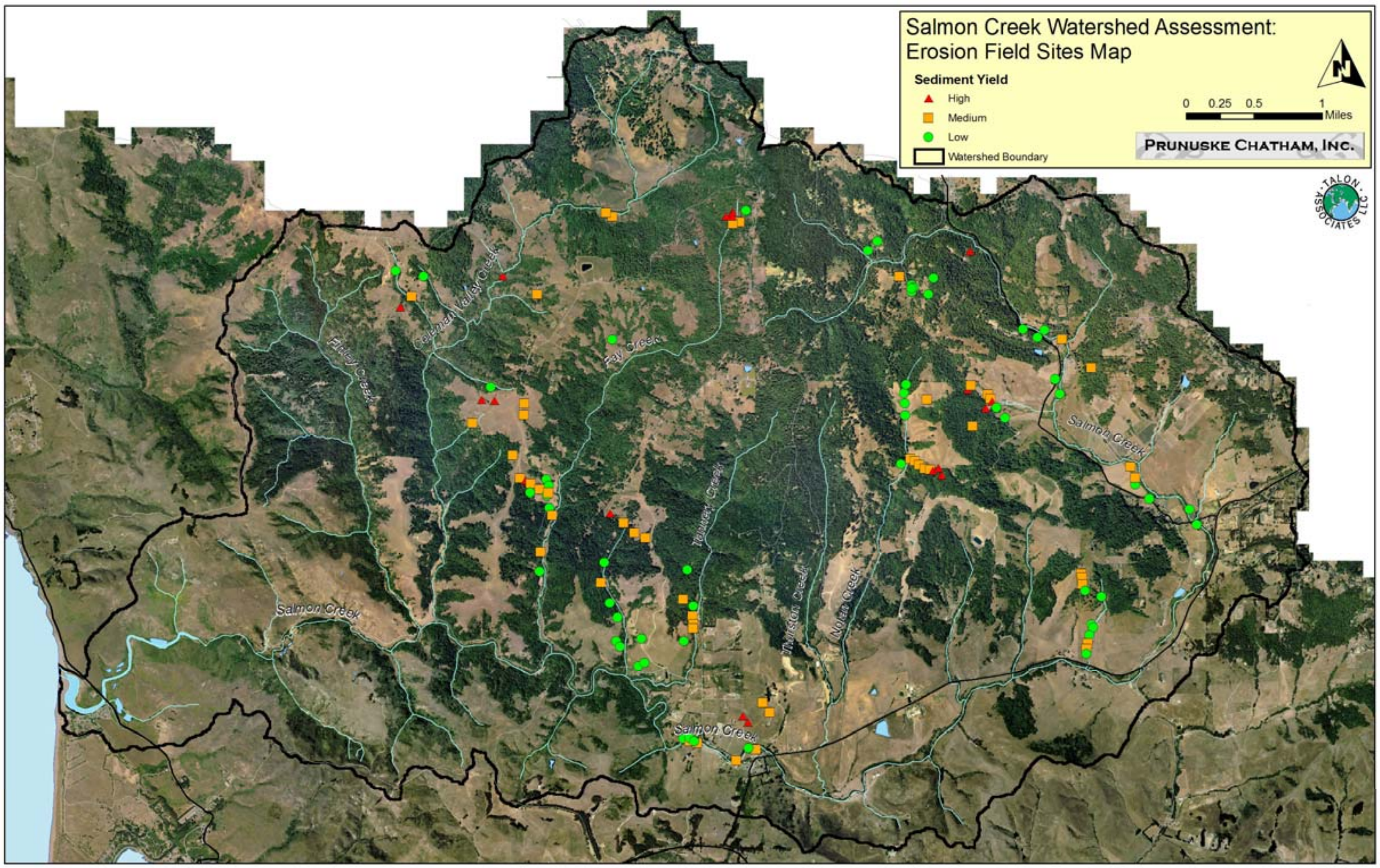
Inventory #	ID	Sub-watershed	Type	Eros Potential	Eros Activity	Potential Sed Yield	Priority (revised)
1	DM-1	Salmon/Marmar	gully/headcut	High	High	High	High
2	DM-2	Salmon/Marmar	gully/headcut	High	Med	High	High
3	DM-3	Salmon/Marmar	headcut	Med	Low	Medium	Med
4	DM-4	Salmon/Marmar	headcut	High	High	Medium	Med
5	DM-5	Salmon/Marmar	gully/headcut	High	High	High	High
6	DM-6	Salmon/Marmar	knickpoint	High	High	Low	Med
7	DM-7	Salmon/Marmar	knickpoint	Med	Med	Medium	High
8	DM-8	Salmon/Marra	headcut	Low-Med	Low	Low	Low
9	DM-9	Salmon/Marmar	headcut	Med	High	Medium	High
10	DM-10	Nolan	knickpoint	High	Med	Medium	High
11	DM-11	Nolan	knickpoint	Low-Med	Med	Low	Low
12	DM-12	Nolan	knickpoint	Med	High	Low	Low
13	DM-13	Nolan	headcut	Med	Med	Low	Low
14	DM-14	Nolan	headcut	Low	Med	Low	Low
15	DM-15	Nolan	knickpoint	High	High-Med	Low	Med
16	DM-16	Nolan	headcut	High	High-Med	Medium	High
17	DM-17	Nolan	knickpoint	High-Med	High-Med	Medium	Med
18	DM-18	Nolan	knickpoint	High	High	Medium	High
19	DM-19	Nolan	headcut	High	Med	Medium	Med
20	DM-20	Nolan	knickpoint	High-Med	Med	Medium	Med
21	DM-21	Nolan	gully/headcut	Med	Med	High	Med
22	DM-22	Nolan	gully/headcut	Med	Med	High	Med
23	DM-23	Nolan	gully/headcut	High	High	High	High
24	DM-24	Nolan	road	Med	Med	Low	Med
25	SCS-1	Salmon -upper	bank failure	High	High	Low	Med
26	PKG-1	Salmon -mid	bank failure	Med	Med	Medium	Med
27	MO -22	Tannery	headcut	Med	Low	Low	Low
28	WK-1	Coleman Valley	headcut	High	Med-High	Medium	High
29	WK-2	Coleman Valley	gully/headcut	High	Med-Low	Medium	Med
30	AH-1	Salmon -upper	gully/headcut	High	High	Low	Med
31	SCS-2	Salmon -mid	headcut	Med	Med	Low	Low
32	SCS-3	Salmon -mid	headcut	Low-Med	Med-Low	Medium	Low
33	MJ-1	Coleman Valley	slide	High	High	High	High
34	MJ-2	Coleman Valley	slide	High	High-Med	Medium	Med
35	AB-1	Salmon -mid	bank failure	High	Med	Low	Med
36	AB-2	Salmon -mid	headcut	Med	Low	Low	Low
37	AB-3	Salmon -mid	bank failure	High-Med	Med	Medium	Med
38	AB-4	Salmon -mid	headcut	High-Med	High-Med	Low	Med
39	AB-5	Salmon -mid	bank failure	High-Med	Med	Low	Med
40	AB-6	Salmon -mid	bank failure	Med	Med	Medium	Med

Inventory #	ID	Sub-watershed	Type	Eros Potential	Eros Activity	Potential Sed Yield	Priority (revised)
41	RP-1	Salmon -mid	bank failure	High	High-Med	Medium	Med
42	JB-1	Salmon -upper	headcut	Med	Med	Low	Med
43	O-1	Salmon -upper	bank failure	Low	Med	Low	Low
44	RH-1	Salmon -upper	bank failure	Med-High	High-Med	Low	Med
45	RH-2	Salmon -upper	headcut	Med-Low	Med-Low	Low	Low
46	JS-1	Salmon -upper	bank failure	Low	Low	Medium	Low
47	DS-1	Salmon -upper	headcut	Med	Low	Low	Low
48	DS-2	Salmon -upper	headcut	Med	Med	Low	Low
49	DS-3	Salmon -upper	headcut	Med	High-Med	Low	Med
50	DS-4	Salmon -upper	headcut	High	Med	Low	Low
51	DS-5	Salmon -upper	headcut	Med	High-Med	Low	Med
52	DS-6	Salmon -upper	headcut	Med	Med	Low	Med
53	DS-7	Salmon -upper	knickpoint	High	High	Medium	Med
54	Mo-1	Tannery	headcut	Low	Low	Low	Low
55	Mo-2	Tannery	gully/headcut	Low	Med-Low	Medium	Low
56	Mo-3	Tannery	headcut	Med-High	Med	Low	Med
57	Mo-4	Tannery/Moon	road	High	Med	Medium	Med
58	Mo-5	Tannery/Moon	headcut	High	Med	Low	Med
59	Mo-6	Tannery/Moon	headcut	Med	Low	Low	Low
60	Mo-7	Tannery/Moon	headcut	Med	Med	Low	Med
61	Mo-8	Tannery/Moon	headcut	Low	Low	Low	Low
62	Mo-9	Tannery/Moon	road	Med	Med	Medium	Med
63	Mo-10	Tannery/Moon	road	High	High	Medium	Med
64	Mo-11	Tannery/Moon	gully/headcut	High	High	High	High
65	Mo-12	Tannery/Moon	road	Med	Med	Low	Low
66	Mo-13	Tannery/Moon	road	High	High	Low	Med
67	Mo-14	Tannery/Moon	road	High	High-Med	Low	Med
68	Mo-15	Tannery/Moon	bank failure	Med	Med	Medium	Med
69	Mo-16	Tannery/Moon	road	Med	Med-Low	Low	Med
70	Mo-17	Fay Cr.	bank failure	High	High	Low	Med
71	Mo-18	Fay Cr.	bank failure	High	High	Medium	Med
72	Mo-19	Tannery	bank failure	High	High	Medium	Med
73	Mo-20	Tannery	bank failure	Med-High	Med	Medium	Med
74	Mo-21	Tannery	headcut	Med	Med	Medium	Med
75	Mo-23	Tannery/Moon	road	Med	Med	Medium	Med
76	RB-1	Fay Cr.	headcut	Med	Med	Low	Low
77	WR-1	Coleman Valley	road	High	Med	Low	Med
78	WR-2	Coleman Valley	gully/headcut	High	High-Med	High	High
79	WR-3	Coleman Valley	gully/headcut	High	Med	High	High
80	WR-4	Coleman Valley	gully/headcut	Med	High-Med	Medium	Med
81	WR-5	Fay Cr.	gully/headcut	High	Med	Medium	High
82	WR-6	Fay Cr.	gully/headcut	High	High	Medium	High
83	WR-7	Coleman Valley	slide	High	High	Medium	High
84	WR-8	Fay Cr.	road	High	High	Medium	Med
85	WR-9	Fay	gully/headcut	High	High	High	High
86	WR-10	Fay	gully/headcut	High	High	Medium	High

Inventory #	ID	Sub-watershed	Type	Eros Potential	Eros Activity	Potential Sed Yield	Priority (revised)
87	WR-11	Fay	headcut	High	Med	Medium	Med
88	WR-12	Fay	road	Med	Med-Low	Low	Med
89	WR-13	Fay	road	Med	Med-Low	Low	Med
90	WR-14	Fay	road	Low	Low	Low	Low
91	WR-15	Fay	bank failure	High	High	Medium	Med
92	WR-16	Fay	road	Med	High-Med	Low	Med
93	WR-17	Fay	road	Med	Med	Low	Low
94	WR-18	Fay	bank failure	High	High	Medium	Med
95	WR-19	Fay	road	High-Med	High-Med	Low	Med
96	GW-1	Salmon -mid	bank failure	High	High	Low	Med
97	GW-2	Salmon -mid	gully/headcut	High	High	High	High
98	GW-3	Salmon -mid	gully/headcut	High	High	High	High
99	GW-4	Salmon -mid	gully/headcut	High	High	Medium	Med
100	GW-5	Salmon -mid	headcut	High	High-Med	Medium	High
101	RA-1	Salmon -upper	slide	High	High	High	High
102	PM-1	Coleman Valley	road	Med-High	High-Med	Low	Med
103	DUS-1	Fay Creek	headcut	Med	Med	Low	Med
104	DUS-2	Fay	headcut	Med-High	High-Med	High	High
105	DUS-3	Fay	gully/headcut	Med-High	Med	High	High
106	DUS-4	Fay	gully/headcut	High	High	High	High
107	DUS-5	Fay	gully/headcut	High	High	Medium	High
108	DUS-6	Fay	gully/headcut	High	High	Medium	High
109	TP-1	Salmon -mid	gully/headcut	Med	Med	Medium	Med
110	TP-2	Salmon -mid	gully/headcut	Med-High	High-Med	Medium	Med
111	TP-3	Salmon -mid	gully/headcut	High	High	Medium	High
112	TP-4	Salmon -mid	gully/headcut	High	High	Low	Med
113	TP-5	Salmon -mid	road	Low	Low	Low	Low
114	TP-6	Salmon -mid	bank failure	Med	Med	Low	Med
115	TP-7	Salmon -mid	knickpoint	Low-Med	Med-Low	Low	Low
116	TP-8	Salmon -mid	bank failure	Med-Low	Low-Med	Low	Low
117	TP-9	Salmon -mid	bank failure	Low-Med	Med-Low	Medium	Med
118	TP-10	Salmon -mid	headcut	Med	Med	Medium	Med
119	TP-11	Salmon -mid	headcut	Med-Low	Med-Low	Low	Low
120	CR -1	Salmon -low	gully/headcut	Med	Med-Low	Low	Low
121	CR-2	Salmon -low	gully/headcut	Med	Med-Low	Low	Med
122	CR-3	Salmon -low	gully/headcut	Med	Med-Low	Medium	Med
123	RHO-1	Salmon -upper	road	Low	Low	Low	Low
124	RHO-2	Salmon -mid	bank failure	Med-Low	Low-Med	Low	Low
125	OS-1	Coleman Valley	gully/headcut	Med	Med	Medium	Med
126	OS-2	Coleman Valley	road	Med-High	Med	Low	Low
127	OS-3	Coleman Valley	gully/headcut	Med-Low	Med-Low	High	Med
128	JM-1	Salmon -upper	bank failure	Med-High	High-Med	Medium	Med
129	JM-2	Salmon -upper	bank failure	High-Med	High-Med	Medium	Low
130	JM-3	Salmon -upper	bank failure	Med	Med	Low	Med
131	DG-1	Salmon -upper	bank failure	Med-Low	Low	Low	Low
132	O-2	Salmon -upper	bank failure	High	Med	Low	Med

Inventory #	ID	Sub-watershed	Type	Eros Potential	Eros Activity	Potential Sed Yield	Priority (revised)
133	JG-1	Salmon -upper	headcut	Med	Med	Low	Med
134	JG-2	Salmon -upper	gully/headcut	High-Med	Med	Low	Med
135	JG-3	Salmon -upper	gully/headcut	High-Med	High-Med	Low	Med
136	JG-4	Salmon -upper	gully/headcut	High	High-Med	Low	Med
137	JG-5	Salmon -upper	gully/headcut	High-Med	High-Med	Medium	High
138	JG-6	Salmon -upper	headcut	Med	Med	Low	Low
139	AH-2	Salmon -upper	bank failure	High	High-Med	Medium	Med

Figure 5-1. *Location of erosion sites documented in the Salmon Creek watershed on 26 assessed properties. The relative sediment yield of each site is represented by the colored dots*



Sediment sources contributing directly to the stream system fall into five types: gullies and headcuts, bank failure, knickpoints, road related erosion, and landslides (Table 5-2). The gully/headcut type is the most common, with 75 of 139 total sites falling into this category. It includes both well established gullies that are growing by both extension and widening, as well as small headcuts that have the potential to enlarge into gullies. Bank failures on the 1st and 2nd order perennial streams are the second most frequently occurring type of sediment source. Erosion caused by improperly constructed and maintained roads is also common and not wholly assessed in this project. It is likely that road related erosion accounts for a large percentage of fine sediment in the streams. Erosion features associated with roads include channel scour at culvert outlets, road slumps from culvert failures, and severely eroding inboard ditches. In-channel knickpoints are small waterfalls of up to 3' in height that move upstream. They indicate channel incision processes are occurring and often initiate additional erosion from bank failures and landslides. Landslides, and slumped hillsides are less common, though may produce large amounts of sediment.

Table 5-2*. Number of sites in each erosion type documented during this project.*

EROSION TYPE					TOTAL # OF SITES
Gully/ Headcut	Bank Failure	Knickpoint	Road Erosion	Landslide	
75	28	11	21	4	**139**

The distribution of sediment source types within each sub-watershed varies slightly between watersheds and compared to the overall distribution (Table 5-3). Gullies and headcuts are the most widespread sediment source throughout the watershed. Bank erosion appears to occur more frequently on the mainstem than the tributaries, although this may be a function of the inventory locations. The high percentage of knickpoints in Nolan Creek is due to the fact that the assessment was limited to the headwaters and was focused on several large, rapidly expanding gully complexes with multiple knickpoints moving up them. The percentage of road related erosion is higher in the tributaries because the topography is steeper (more prone to failure), construction methods are often not robust enough, and the roads tend to parallel the channels.

Table 5-3. *Percentage of occurrence of erosion types in the sub-watersheds of Salmon Creek based on the erosion inventories. Inventory spatial coverage was scattered and incomplete, thus these numbers can only be considered representative. These numbers do not reflect the relative yields produced by each sediment source. Gullies, headcuts, and road-related erosion typically have a higher yield potential than bank erosion. Sediment delivery from landslides and slumping is episodic, yet can produce large amounts of sediment.*

Sediment Source	Sub-watersheds						Total Percentage by Source Type
	Salmon Creek (upper)	Salmon Creek (mid/lower)	Nolan Creek	Tannery Creek	Fay Creek	Coleman Valley	
Gully/ Headcut	59	57	47	48	55	50	**54**
Bank Failure	27	37	NA*	14	18	NA*	**20**
Knickpoint	8	3	47				**8**
Road Erosion	3	3	6	38	27	29	**15**
Landslide/ Slump	3					21	**3**

*(*Not Assessed – inventory did not include perennial stream sections.)*

Statistical and spatial analyses of the sediment source data produced inconclusive results. The number of sites (139) is too few for a statistically valid data set. Two slight trends showed up in the data. Grassland erosion sites appear to have a marginally greater mean potential yield than forested sites, and sites at higher elevations in the watershed tend to have higher mean yields. Neither slope nor soil K-factor (erodibility) showed up as a distinguishing factor in location, frequency, or sediment yield. Due to the inconclusive results a predictive spatial analysis model could not be run.

Conclusion

Two important considerations in determining the severity of erosion sites are the potential sediment yield (Figure 5-2) and the erosion activity (Figure 5-3). Potential sediment yields were ranked into three categories (high, medium, and low) based on the volume of sediment they are likely to mobilize and transport to the stream system. Erosion activity was also ranked similarly, and is based on evidence of recent soil loss and feature movement (e.g. headcut moving upstream, bank sloughing).

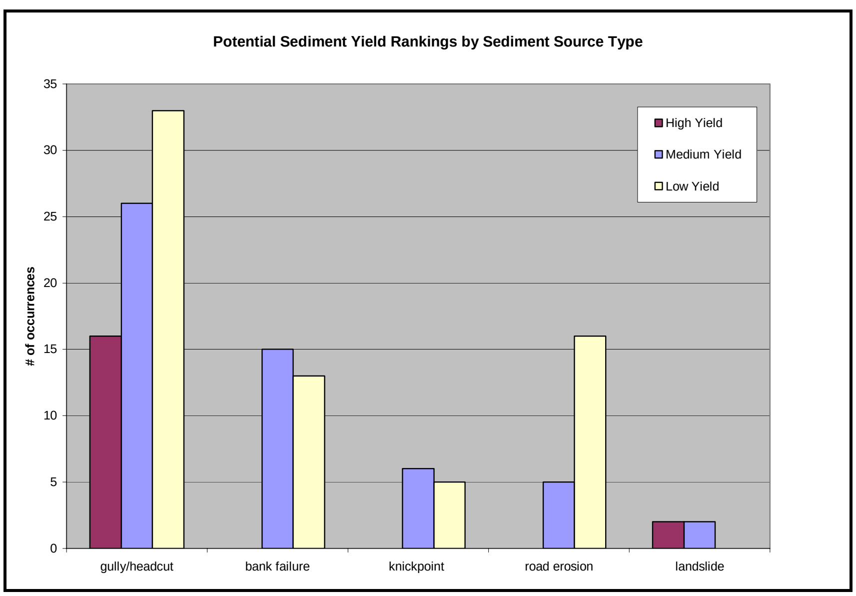


Figure 5-2. *Number of sites inventoried in each category by potential sediment yield. Sediment production for each category are: Low yields = 0-100 yds^3 , Medium yields = 100-1,000 yds^3, and High yields = >1,000 yds^3. Unusual climatic conditions or changes to a site could lead to accelerated erosion processes and increase the estimated yield.*

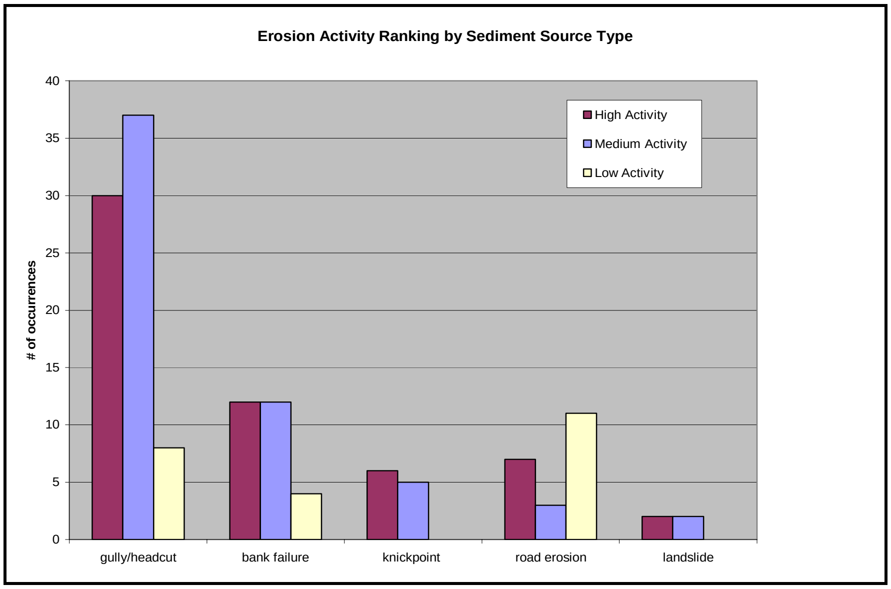
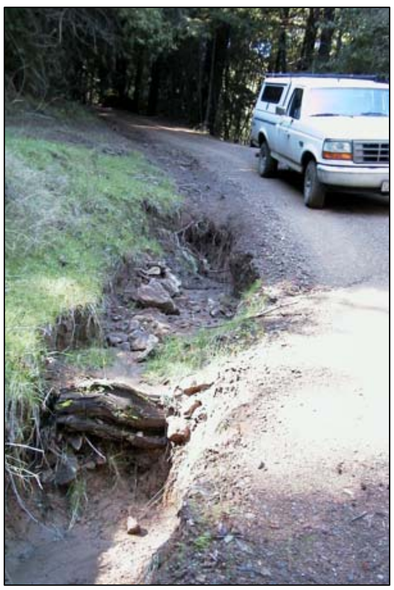


Figure 5-3*. Number of sediment sources ranked by erosion activity and type. Highly active sites appear to have recently lost material, are devoid of vegetation, and are unstable. At the other end, low activity sites do not show signs of recent movement and are stabilizing through vegetation establishment or changes in erosive forces.*

The highest potential sediment yielding sites are gully/headcut systems and landslides. They also tend to exhibit recent activity. These two source types tend to exhibit both episodic and chronic sediment delivery behavior. Of the two types, gullies tend to develop from human land use activities. Landslides, especially in the steep areas underlain by Franciscan Formation are naturally occurring, and, as would be expected, the four landslides documented during the study are in the forested canyons of the upper watershed areas. Another crucial difference between these two high yield sources is that landslides deliver coarse material and large woody debris; two components necessary for a healthy stream system that are often undersupplied. Gullies, on the other hand, produce primarily fine grained material, contributing to degraded instream habitat conditions. Gullies and headcuts mobilize upland soils that, under natural undisturbed conditions, would remain in place and contribute to grassland productivity and nutrient retention.

Many gully/headcut sites have a low potential yield. These sites are primarily small, grassland headcuts that have some activity, but appear to be moving slowly or are limited in the amount of material available. Larger gullies in forested areas or with well established vegetation are also placed in the low yield category if they appear to be stabilized. Knickpoints, or small steps in the bed, in stream or gully systems do not produce high amounts of sediment; however they may destabilize banks and cause additional headcuts or gully development to occur as they move upstream. They can also destabilize gully repairs if not taken into account during the design phase.

Road erosion was examined superficially in this inventory as it was beyond the scope. A detailed road assessment will be performed in 2007 by Gold Ridge RCD, and the results will augment the data presented in this report. Large road-associated erosion sites, such as culvert failures and eroding in-board ditches, were documented at several locations.



Overall the erosion activity of each source type is ranked higher than the yield or repair priority (Figure 5-4). This is especially true of streambank failures. Eroding banks often look raw, are highly visible, and introduce sediment directly to the stream, which is why they are commonly targeted as a high priority repair projects for sediment reduction. Bank erosion is a dynamic, natural process necessary for stream health and in-stream habitat development. This is especially true in incised channels such as those found throughout Salmon Creek. Channel

widening often occurs after channels have incised due to landuse or climatic changes. Evidence of the widening process is areas of bank sloughing or scalloping. The end result of this erosion is a stable, inset floodplain that provides riparian habitat, high flow refugia, and increased flood water storage.

Bank erosion is a finite, self-managing process. It is also normal, and desirable from a habitat standpoint, for incised streams to go through a period of widening after incision. The volume of sediment derived from a single bank failure site is usually between 50 and 300 cubic yards, as compared to gullies that produce 500-5000 cubic yards. Thus gullies and headcuts were chosen as high priority repairs over the active bank erosion sites (Figure 5-5, Table 5-4).

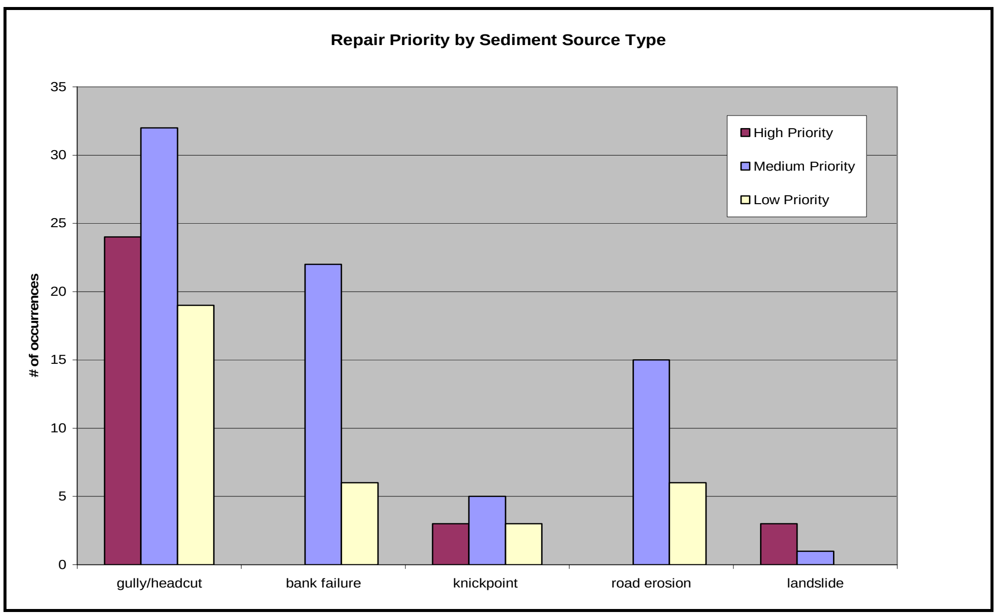


Figure 5-4. *Distribution of repair priorities by sediment source type. Gullies and headcuts are the highest priority because of their higher sediment yields. Gullies also irreparably damage productive grassland and forests. Instream knickpoints that will lead to additional headcuts and gullying were also chosen as high priority sites. Landslides are also high priorities because of the fine sediment they produce though it is unlikely that they can be repaired.*

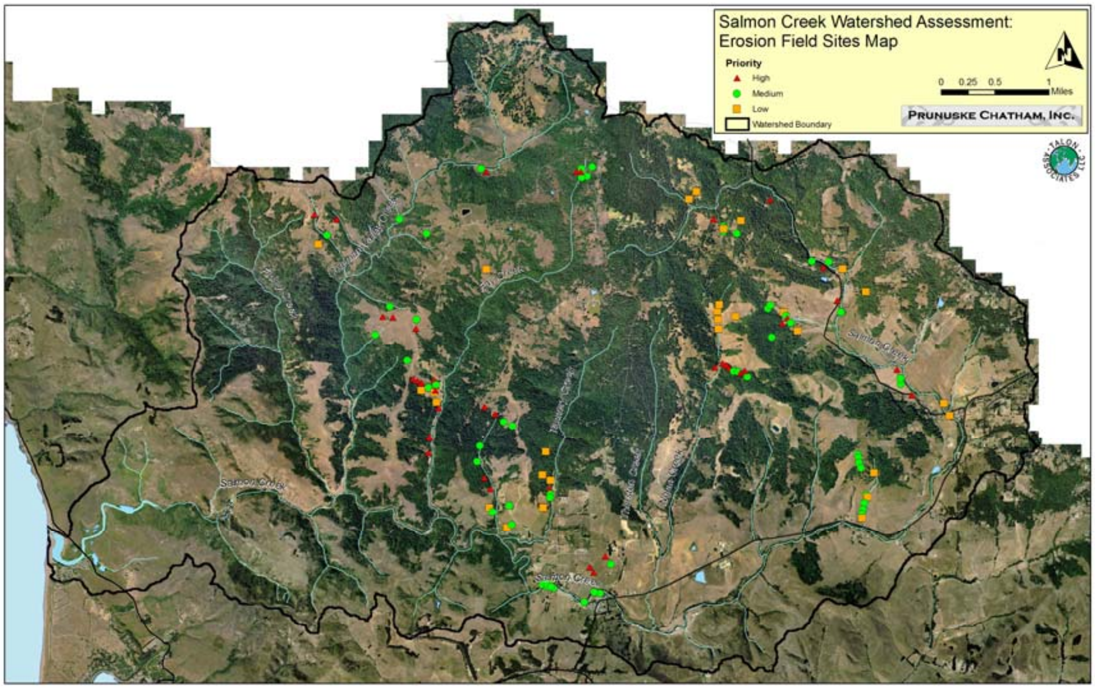


Figure 5-5. *Map of high priority erosion repair sites in the Salmon Creek watershed.*

It is recommended that funding be sought to manage and repair the sediment sources on the list of high priority sites in Table 5-5. These sites, as well as many of the medium priorities (Table 5-1), contribute to the high levels of fine sediment annually entering Salmon Creek and its tributaries. Landslides are extremely difficult to manage, are often naturally occurring, and provide woody debris and coarse sediment to the system. However, if possible, any factors contributing to their activity should be mitigated (i.e. road drainage). Gullies and headcuts make up the majority of the high and medium priority sites. These features are unstable, and during large rainfall events are likely to increase in length and width. Thus, it is important to monitor all gullies and headcuts for sudden changes.

Only 26 properties were assessed in this project due to funding and participation limitations. This accounts for less than 25% of the watershed. It is highly recommended that erosion inventories be performed on an ongoing basis to document additional sites for treatment. It is through a continual process of inventory and repair implementation that the high sediment loads impairing the stream system will be reduced.

Table 5-4. *High priority restoration and repair sites in the Salmon Creek watershed based on the erosion inventory survey of 26 properties. See Appendix C for details on each site.*

Inventory #	ID	Sub-watershed	Type
1	DM-1	Salmon/Marmar	gully/headcut
2	DM-2	Salmon/Marmar	gully/headcut
5	DM-5	Salmon/Marmar	gully/headcut
7	DM-7	Salmon/Marmar	knickpoint
9	DM-9	Salmon/Marmar	headcut
10	DM-10	Nolan	knickpoint
16	DM-16	Nolan	headcut
18	DM-18	Nolan	knickpoint
23	DM-23	Nolan	gully/headcut
28	WK-1	Coleman Valley	headcut
33	MJ-1	Coleman Valley	slide
64	Mo-11	Tannery/Moon	gully/headcut
78	WR-2	Coleman Valley	gully/headcut
79	WR-3	Coleman Valley	gully/headcut
81	WR-5	Fay Cr.	gully/headcut
82	WR-6	Fay Cr.	gully/headcut
83	WR-7	Coleman Valley	slide
85	WR-9	Fay	gully/headcut
86	WR-10	Fay	gully/headcut
97	GW-2	Salmon -mid	gully/headcut
98	GW-3	Salmon -mid	gully/headcut
100	GW-5	Salmon -mid	headcut
101	RA-1	Salmon -upper	slide
104	DUS-2	Fay	headcut
105	DUS-3	Fay	gully/headcut
106	DUS-4	Fay	gully/headcut
107	DUS-5	Fay	gully/headcut
108	DUS-6	Fay	gully/headcut
111	TP-3	Salmon -mid	gully/headcut
137	JG-5	Salmon -upper	gully/headcut

CHAPTER 6: Instream Restoration and Prioritization Recommendations

"There is little question that we are not going to be able to do everything we want to do for salmon immediately. So how do we decide what we should do first? There are millions of federal and state dollars being spent on salmon restoration right now. That expenditure presents both a significant challenge and opportunity. The challenge is to target all these expenditures to the most important efforts first. The opportunity is to actually make a difference for salmon. We can only do that if we pay attention to the biology -- not the politics, not the agency turf, not "the money's got to be spread over the landscape" -- but rather prioritizing our efforts based on the biology of salmon, which very quickly leads us to the biology of healthy watersheds." *Bradbury et al. (1996)*

Those working on the restoration of Salmon Creek certainly are aware that funding sources are not infinite. Consequently, the sequence and prioritization of restoration activities is of tremendous importance, if goals such as coho salmon recovery are to be attained, such a strategy must be science based. The Monitoring section (Chapter 4) of this report suggests how to determine whether progress is being made in improving riparian conditions and habitat.

A full basin instream habitat inventory of Salmon Creek was conducted by DFG in 2004 to discern the location of and quality of low flow refugia, priority habitat enhancement reaches, and factors limiting salmonid abundance. The tributaries vary in their habitat quality, as measured by; water temperature, pool depth and cover, degree of fine sediment intrusion in the spawning gravels, and percent riparian canopy cover for shade and food source (see Chapter 3 for details). An assessment of water quality throughout the watershed (Chapter 4) indicates that overall water quality is supportive for salmonids, however turbidity levels frequently go above detrimental levels during winter storm events. The erosion inventory (Chapter 5) located and prioritized sediment sources with the potential to deliver fine sediment to vulnerable habitat areas. The results of these studies have been integrated in the development of the following recommendations for habitat enhancement projects:

Recommendation 1: Creeks with existing supportive water quality conditions and riparian cover (Fay, Finley, Tannery, and Thurston) should be high priority for habitat enhancement practices such as pool improvements and fine sediment management.

Recommendation 2: Focus on reducing fine sediment delivery to the mainstem and all tributaries, with a priority on projects addressing gully development, headcut migration, and road issues.

Recommendation 3: Implement projects that will improve riparian canopy along Salmon Creek (main stem), Coleman Valley Creek, and Nolan Creek to reduce high water temperatures, increase bank stability, and provide cover.

Recommendation 4: Increase pool frequency and depths throughout system through LWD recruitment and placement.

Recommendation 5: Develop and support projects to monitor and improve summer low flows in the mainstem and tributaries.

It is imperative that additional erosion inventories are performed to identify sediment sources on properties not covered under this project. A long-term water quality monitoring program will document watershed improvements and guide continued habitat enhancement needs.

Chapter 7: Best Management Practice Recommendations

Best management practices (BMPs) are effective, practical, structural, or nonstructural methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects from a variety of land uses. These practices have been developed to achieve a balance of water quality protection and their economic impacts to particular landowner. The overall objective of the below BMPs are to protect and enhance salmonid habitat for many generations to come.

The Federal Water Pollution Control Act of 1972 requires the management of nonpoint sources of water pollution from sources including forest-related and agricultural activities. BMPs have been developed to guide landowners toward voluntary compliance with this act. Maintenance of water quality to provide "fishable" and "swimmable" waters is central to this law's objectives. The Environmental Protection Agency (EPA) recognizes the use of BMPs as an acceptable method of reducing nonpoint source pollution.

The adoption and use of BMPs will provide the mechanism for attaining the following water quality goals:

- To maintain the integrity of stream channels;
- To reduce the volume of surface runoff originating from an area of disturbance and running directly into surface water;
- To minimize the movements of pollutants and sediment to surface or groundwater;
- To stabilize exposed soil areas through natural or artificial revegetation.

The Gold Ridge Resource Conservation District (RCD) promotes voluntary implementation of BMPs. Any information presented below is not to be used as the basis for setting water quality standards or as the basis of required use of protection practices. The management measures listed are by no means the entire array of practices that could be used to control sediment or other pollutants from entering Salmon Creek. However, they are a guide to assist landowners in making that first step toward enhancing their part of the watershed so that the salmonid fisheries of Salmon Creek can be restored to what has been historically documented.

Land Management Measures that May Apply in the Riparian Zone

Objective: The following are management measures that can be implemented in the riparian area to buffer against detrimental changes in the temperature regime of the waterbody, to provide bank stability, and to prevent sediment from entering the stream channel. Riparian areas generally consist of native vegetation communities along the stream channel. The riparian areas not only act as buffers between land activities and sensitive ecosystems, but it also supports high biodiversity and valuable habitat. Streamside forests in Salmon Creek are a crucial source of large woody debris for fish habitat. These measures do not include land management practices specific to agricultural land, which is discussed later in this chapter.

The Riparian Management Zone is generally measured from the active channel, or bankfull stage, whichever is wider. The RMZ that has been established for other local watersheds is as follows:

- Class I and II watercourses, the Riparian Zone is recommended to be a 50-foot strip of land on each side of, and adjacent to, the watercourse.
- Class III watercourses, the Riparian Zone is recommended to be a 25-foot strip of land on each side of, and adjacent to, the watercourse.

Given the high degree of variability in site conditions within the RMZ, it is not possible at this particular planning level to provide either a comprehensive list of BMPs or a single prescription suitable for universal application. However, below is a very general list of management strategies that have been employed to protect this fragile area.

A. Landowners should be encouraged to maintain at least an 80% vegetative buffer in the RMZ of a Class I watercourses. The riparian area should be planted with native plant materials.

B. Brush and debris can kill existing bank stabilizing vegetation, inhibit the growth of vegetation and contribute to bank instability. Debris and other yard clippings should not be dumped on the streambanks.

C. When planning to build, it is important to stay away from the RMZ.

Development near the RMZ can disturb soils and vegetation. Avoid building and farming near the river as it can not only expose your structures or crops to flooding, but cause serious erosion problems.

D. Landowners should allow woody debris to remain on streambanks. Fallen logs, tree stumps and branches provide cover, food and shelter for fish and other aquatic animals, notably young coho salmon and steelhead.

E. Brush, weeds, grass clippings, or other small material should not be thrown into a creek or stored near creek banks to be carried downstream by wind or rain. The brush may create a debris jam downstream on someone else's property or block a culvert, which can cause flooding and erosion or block fish passage.

F. If you have a septic system, you should know where your septic system is located and how to maintain it. It is important to have your tanked checked professionals every other year, pump it every 3-7 years and replace failing systems.

Land Management Measures for Rural Roads

Objective: The following are management measures for the control of non-point source pollution from roads. Through proper planning on the part of the landowner, roads that are used during normal runoff periods should have minimal maintenance and provide for adequate water quality protection from erosion.

Landowners will be encouraged to participate in grant funded assessments of their roads, when available. However, should they choose not to participate or would like to manage their roads on their owns, the RCD recommends that they develop a long-term road system plan (Road Plan) which described the road system, and identifies all roads and watercourse crossing on their property. The road system described in the Road Plan should be designed and constructed to provide surfacing, drainage, and watercourse crossing to match the intended road use and maintenance abilities. Roads that are not needed should be scheduled for abandonment. It is recommended that a Road Plan contain the following information:

- The location of all roads and watercourse crossings within the ownership;
- The current status of each road, including road surface material, road and watercourse design, and use restrictions, and
- The future plan and schedule for each road.

The RCD can assist landowners with the development of Road Plans. These prescriptions should not be misconstrued as regulations, they are in fact Best Management Practices that have been adopted in other watersheds, and proven effective at reducing the amount of sediment coming off of a rural road. The following are the general recommendations for roads:

A. Roads used year round should be designed, constructed, reconstructed or upgraded to permanent road status with the application of an adequate layer of competent rock for surface material and the installation of permanent watercourse crossings and road prism drainage structures. These roads should receive regular and storm period inspection and maintenance.

B. Roads used primarily during the dry season but to a limited extent during wet weather should be designed, constructed, reconstructed or upgraded to seasonal road status with the application of spot rocking where needed to provide a stable running surface during the period of use.

C. Roads that are not used or maintained during wet weather should be constructed or reconstructed to a temporary road status. Spot rocking of the road surface should be used, where needed, to provide a stable running surface during the period of use.

D. All watercourse road crossings should, at a minimum, utilize the standards described on pages 64 - 79 of the *Handbook for Forest and Ranch Roads* (prepared by Weaver and Hagans, 1994). These standards include but are not limited to the design and installation of permanent crossings using a culvert with a minimum diameter designed to pass at least a 100-year flood frequency event.

E. Road design, construction, and reconstruction should use, at a minimum, the standards described on pages 39 - 54 and 81 - 120 of the *Handbook for Forest Ranch Roads* (prepared by Weaver and Hagans, 1994).

F. Straw bale check dams or silt fences should be installed at the outlet of all road drainage structures prior to use of the road for all roads.

G. There should be no construction, reconstruction, or use of skid trails on slopes greater than 40 percent within 200 feet of a watercourse, as measured from the channel or bankfull stage, whichever is wider.

H. There should be no use of roads or near stream facilities, when the activity contributes to the discharge of visibly turbid water from the road or near stream facility surface or is flowing in an inside ditch in amounts that cause a visible increase in the turbidity of a watercourse.

I. All roads within the Riparian Zone should be surfaced with competent rock to a sufficient depth prior to use of the road to prevent road fines from discharging into watercourses.

Land Management Measures that May Apply in Agricultural Areas

Objective: The following management measures are recommended for the control of non-point sources pollution from agricultural sources. Intensive agricultural land use in the watershed has led to accelerated erosion. Soil compaction and reduction of herbaceous vegetation from grazing have increased stormwater runoff and the occurrence of sheet, rill, and gully erosion. Increased flows instream channels, the filling of stream channels with sand and silt, and the denuding of stream corridors by livestock have exacerbated streambank erosion. On-farm and watershed-wide efforts to reduce nutrient loads to surface waterbodies will require a combination of management practices including better livestock management, manure management, vegetation management, and more controls to reduce or prevent commingling of stormwater runoff with animal wastes. The following "points of intervention" in the control of NPS pollution entering surface water drainage networks are recommended (Lewis et al., 2005b).

These practices prescriptions should not be misconstrued as regulations, they are in fact BMPs that have been adopted in other watersheds, and proven effective at reducing sources of pollution from agricultural property.

The following are general strategies for agricultural properties in Salmon Creek:

A. Increase the amount of plant cover, especially plants that promote infiltration.

B. Decrease the extent of compaction by avoiding intensive grazing and the use of machinery when soils are wet.

C. Decrease the formation of physical crusts by maintaining or improving plant cover or litter, thus reducing the impact of raindrops.

D. Increase aggregate soil stability by increasing the amount of organic matter added to soil through residue decomposition and vigorous root growth.

E. Managing the distribution, timing, frequency, and intensity of livestock use of various management units (e.g., pastures, corrals, feedlots) to reduce the quantity and availability of sediment, nutrients, and bacteria potentially discharged to surface waterbodies.

F. Managing the collection, storage, and distribution of manure to prevent contamination of stormwater runoff and potential discharges to surface waterbodies.

G. Managing vegetation to increase ground cover and streambank protection in order to decrease runoff and erosion, and promote infiltration and filtering of pollutants.

H. Installing infrastructure to better control surface runoff, and to either capture or filter out sediment, nutrients, and bacteria.

I. Off--channel water drafting and livestock watering locations should be developed to the extent feasible.

J. Agricultural activities on unstable slopes that have the potential to deliver sediment to a water of the state should be minimized to the extent practical.

K. Farmers and ranchers should be encouraged to use managed grazing to not only protect riparian areas, but also to improve pasture productivity.

L. Employing long-term rest from grazing when riparian areas are highly degraded.

M. Employing short-term or seasonal rest to protect wet streambanks and riparian vegetation that is emerging, regenerating, or setting seed.

There is little doubt that nutrient management plans of some form will be mandated in the near future, including nutrient land application requirements (Meyer and Mullinax, 1999). USDA's Natural Resources Conservation Service has developed a comprehensive nutrient management program (CNMP) to assist dairy producers in managing their facilities to meet water quality standards. It is recommended that a CNMP include the following information:

- Map of facility with a legend.
- Wastewater generated based on an animal inventory, length of confinement, milking schedule, milk barn sanitation, stall barn size and management, corral/feedlot size and management, and rainfall, among other necessary inputs.
- Manure storage availability based on existing measurements and management, as well as use and management of each structure.
- Facility inventory describing building sizes and uses, field sizes and uses, and corral/feedlot sizes and uses (each of these categories will have an annual use description).
- Monitoring: manure, soils and vegetation sampling
- Crop production and nutrient uptake requirements.
- Manure application rates and cost analysis.
- Overview of off-site (i.e., rented) property with all of the above included.

Land Management Measures that May Apply in Forest Lands

Identification and implementation of BMPs for forestlands is outside of the scope and expertise of the GRRCD. Specific BMPs that have been formally adopted by the USDA Forest Service can be found in their handbook *Water Quality Management for Forest Land System Lands in California; Best Management Practices* (USDA, 2000). The BMPs described in the above referenced document were compiled from Forest Service manuals, handbooks, contract and permit provisions, and policy statements. The goal of these BMP's are to directly or indirectly maintain, or improve water quality and abate, or mitigate impacts, while meeting other resource goals and objectives (USDA, 2000).

The GRRCD or its agents, are signatory to this document. Nor do they necessarily endorse the BMPs contained within. The document above is noted as one of many references that landowners may wish to utilize when searching for information on management measures in forested areas.

Land Management Measures that May Apply in Unstable Areas

Objective: The following very basic management measures address land management measures in unstable areas. Since, erosion and sedimentation processes in the Salmon Creek Watershed have been thought to be a significant factor contributing to the historic declines of salmonid in the basin unstable areas are briefly addressed in this report. Extensive unstable areas still exist within the watershed and the combined effect of floods and land use can be expected to cause additional habitat degradation in future floods unless widespread corrective work is undertaken soon. Identifying potentially unstable ground should only be done by a Certified Licensed Geologist (CEG). These professionals generally use a physically based model which can effectively design methods to reduce shallow landsliding hazards. The USDA's Forest Service has developed comprehensive BMP's for unstable areas (USDA, Water Quality Management for Forest System Lands in California). The following is just a small list of measures that can be implemented:

A. No construction should occur across unstable areas without the field review and development of site specific mitigation measures by a Certified Engineering Geologist registered in the State of California.

B. No more than 50 percent of the existing basal area[1] formed by tree species should be removed from unstable areas that have the potential to deliver sediment into a watercourse.

C. No concentrated flow should be directed across the head, toe, or lateral margin of any unstable area.

[1] **BASAL AREA** - (a) The cross-sectional area (in square feet) of a tree trunk at breast height (4.5 feet above the ground). For example, the basal area of a tree that measures 14 inches in diameter at breast height is about 1 square foot. (b) The sum basal areas of the individual trees within 1 acre of forest.

Conclusion

The primary purpose of this document is to both provide an assessment report that will be utilized as a basis for future restoration and monitoring activities in the Salmon Creek watershed and also present landowners and land managers with a plan of action to begin restoring salmonid fisheries in the watershed (Plan). Recent reports have indicated that water quality impairments in Salmon Creek are the result of cumulative, long-term impacts of various land use practices in the watershed, as well as the unanswered question of the very evident decrease in flow and water supply. Reducing nutrient and sediment impacts to these waterbodies to within limits established by state regulatory agencies will require concerted efforts at both the watershed and community scale. The RCD recognizes that to be successful in these efforts, recommended management actions need to be based on sound planning strategies. This Plan, funded from the DFG Fisheries Restoration Grant Program, has allowed the RCD to begin the first phase of planning needed in the Salmon Creek watershed. Through this grant, we have been able to document how sound research, assessment and monitoring information can assist landowners with a strategy for restoration that is straightforward, and will also provide resource agencies with a detailed strategy that is both systematic and well thought out.

The RCD has recently been awarded grant funding from the State Water Resources Control Board to develop a Salmon Creek Integrated Watershed Assessment Plan (Plan phase II). Through development of the second phase of this Plan, the RCD will build upon the recommended actions contained in this report and also develop a further detailed action plan devoted to improving the natural resources of the watershed. This second phase will not only provide an overview of the goals and objectives initialized during this DFG assessment and planning process, but also establish a framework of action that both landowners and resource agencies can build upon to improve the overall health of the watershed within the context of a viable agricultural economy. The RCD, along with its resource agency partners, is committed to providing both the agricultural and rural residential community the technical and funding support they need in order to improve fisheries habitat in our district.

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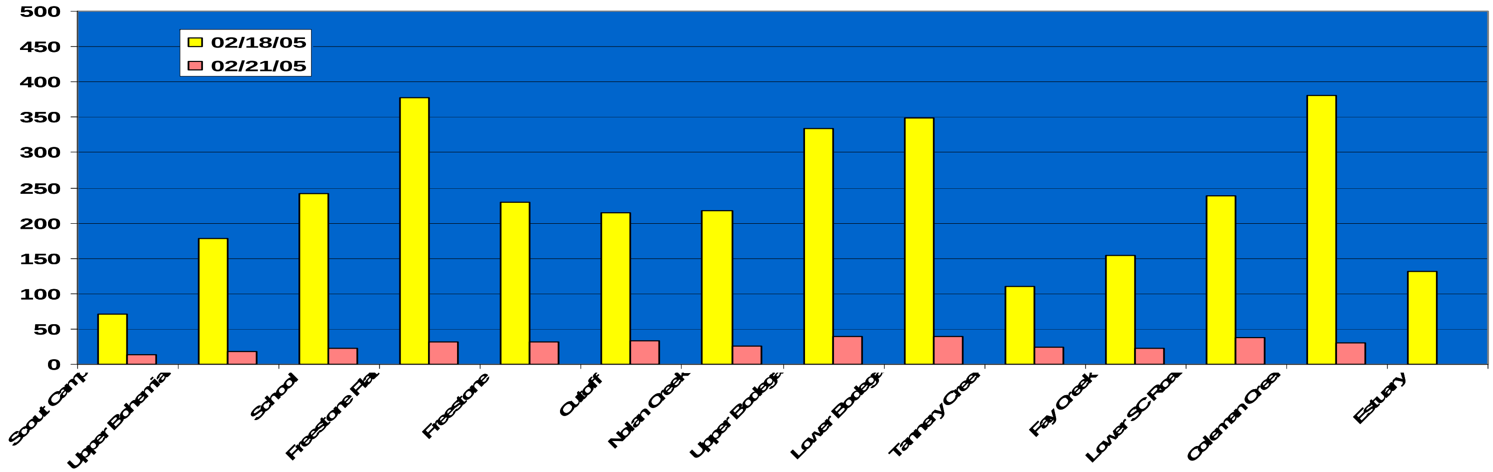
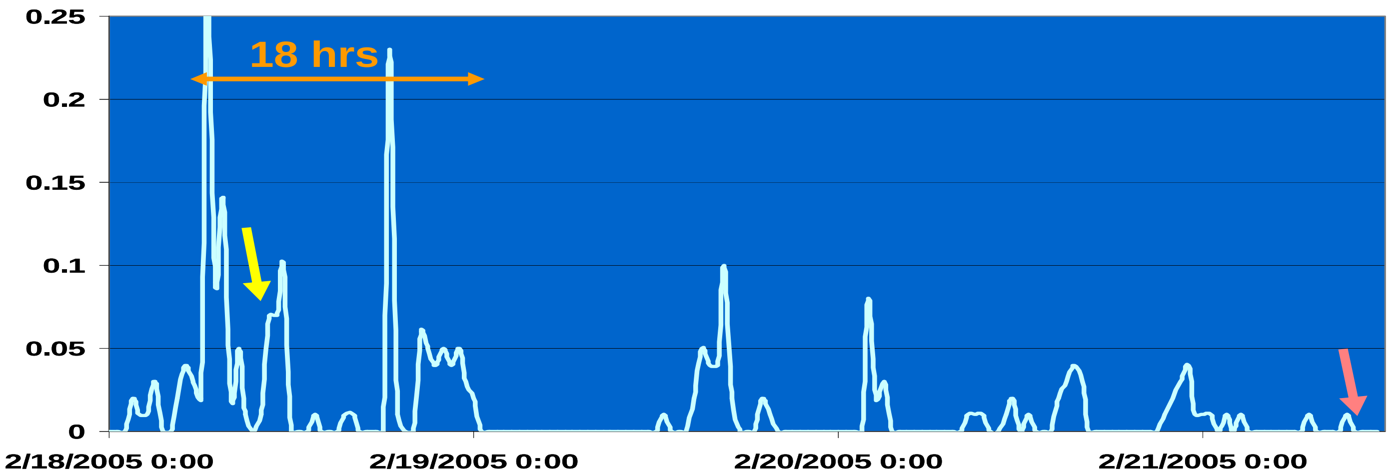
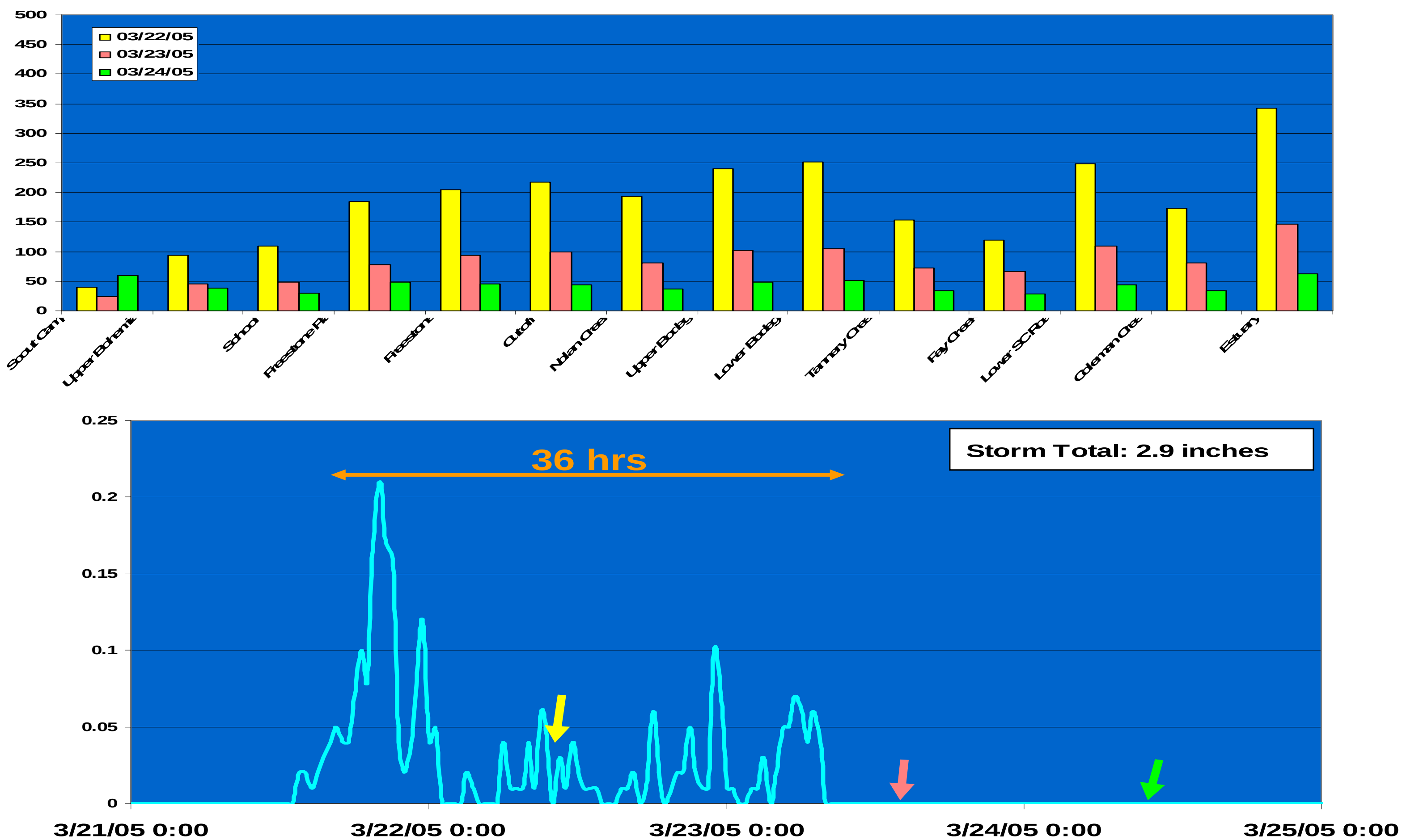
Appendix A: Turbidity Measurement Figures

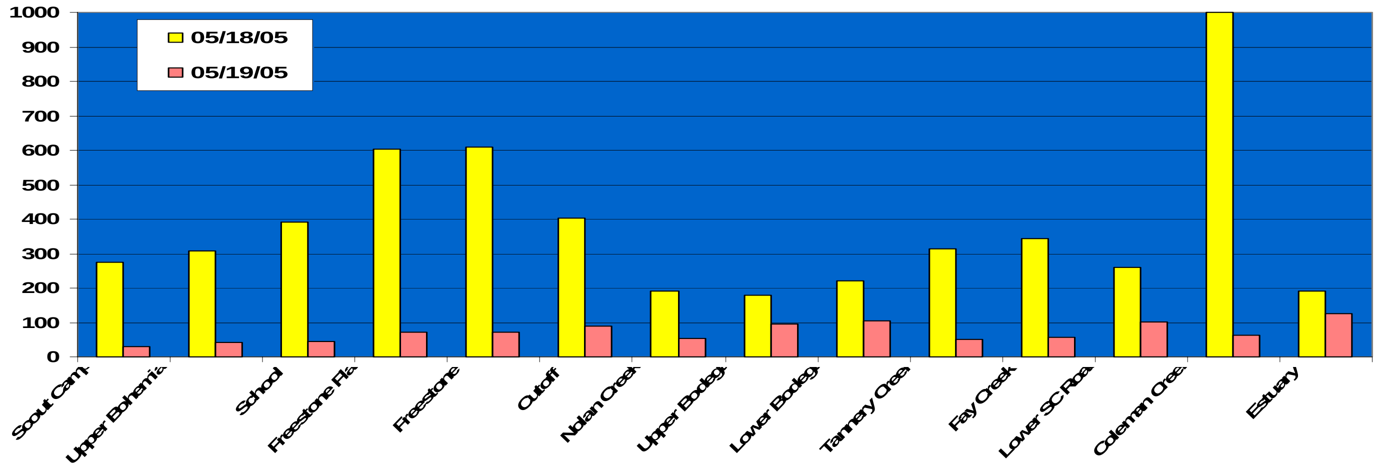


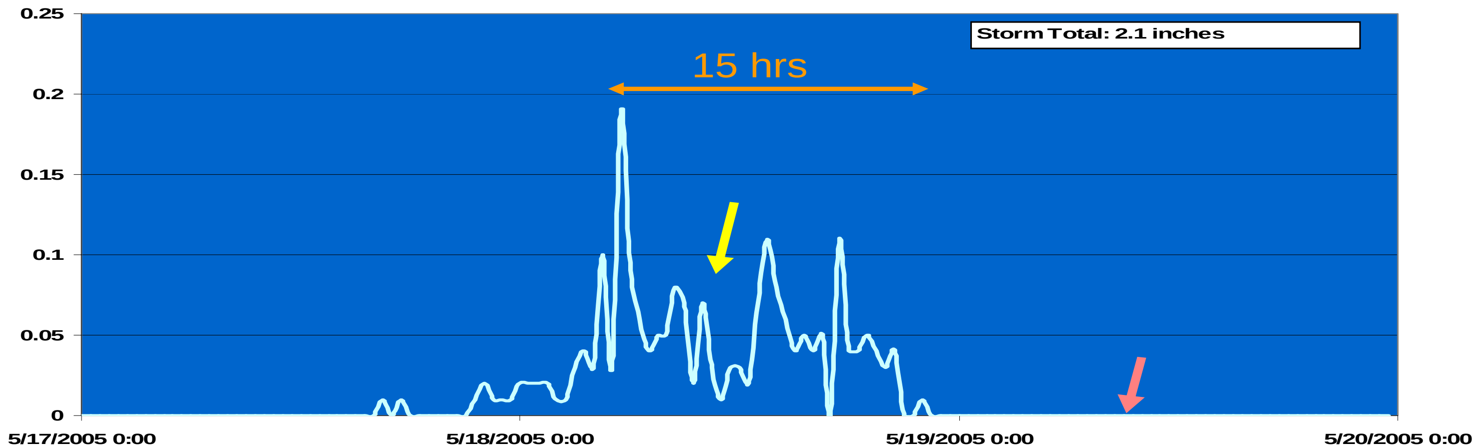


Results of the turbidity measurements taken on February 18th and 21st. Rainfall during the storm event in light blue with the colored arrows corresponding to turbidity samples taken above



Results of the turbidity measurements taken on March 22nd, 23rd, and 24th. Rainfall during the storm event in light blue with the colored arrows corresponding to turbidity samples taken above.





Results of the turbidity measurements taken on May 18th and 19th.

Appendix B: Salmon Creek Soils Data

Salmon Creek Watershed, NRCS, SSURGO Soils Data

SOIL NAME	RUNOFF CLASS	DRAINAGE CLASS	ACRES
ATWELL CLAY LOAM, 30 TO 50 PERCENT SLOPES	Very high	Moderately well drained	273.13
ATWELL CLAY LOAM, 50 TO 75 PERCENT SLOPES	Very high	Moderately well drained	72.18
BLUCHER CLAY LOAM, 0 TO 2 PERCENT SLOPES	Medium	Somewhat poorly drained	194.97
BLUCHER CLAY LOAM, 2 TO 5 PERCENT SLOPES	Medium	Somewhat poorly drained	457.38
BLUCHER LOAM, 0 TO 2 PERCENT SLOPES	Medium	Somewhat poorly drained	72.25
BLUCHER LOAM, 2 TO 5 PERCENT SLOPES	Medium	Somewhat poorly drained	507.67
GOLDRIDGE FINE SANDY LOAM, 15 TO 30 PERCENT SLOPES	High	Moderately well drained	2756.72
GOLDRIDGE FINE SANDY LOAM, 15 TO 30 PERCENT SLOPES, ERODED	Very high	Moderately well drained	42.45
GOLDRIDGE FINE SANDY LOAM, 2 TO 9 PERCENT SLOPES	Medium	Moderately well drained	335.96
GOLDRIDGE FINE SANDY LOAM, 30 TO 50 PERCENT SLOPES	High	Moderately well drained	2191.10
GOLDRIDGE FINE SANDY LOAM, 30 TO 50 PERCENT SLOPES, ERODED	Very high	Moderately well drained	17.23
GOLDRIDGE FINE SANDY LOAM, 9 TO 15 PERCENT SLOPES	Medium	Moderately well drained	454.49
GOLDRIDGE FINE SANDY LOAM, 9 TO 15 PERCENT SLOPES, ERODED	High	Moderately well drained	23.20
HELY SILT LOAM, 30 TO 50 PERCENT SLOPES	High	Well drained	1327.37
HELY SILT LOAM, 50 TO 75 PERCENT SLOPES	High	Well drained	300.20
HUGO VERY GRAVELLY LOAM, 30 TO 50 PERCENT SLOPES	High	Well drained	962.89
HUGO VERY GRAVELLY LOAM, 50 TO 75 PERCENT SLOPES	High	Well drained	1768.32
HUGO-JOSEPHINE COMPLEX, 50 TO 75 PERCENT SLOPES	Very Low	Well drained	286.45
JOSEPHINE LOAM, 30 TO 50 PERCENT SLOPES	High	Well drained	371.41
JOSEPHINE LOAM, 9 TO 30 PERCENT SLOPES	High	Well drained	47.03
JOSEPHINE LOAM,50 TO 75 PERCENT SLOPES	High	Well drained	227.56
KINMAN LOAM, 15 TO 30 PERCENT SLOPES	Very high	Moderately well drained	150.65
KINMAN LOAM, 30 TO 50 PERCENT SLOPES	Very high	Moderately well drained	503.78
KINMAN LOAM, 5 TO 15 PERCENT SLOPES	Very high	Moderately well drained	346.14
KINMAN-KNEELAND LOAMS, 30 TO 50 PERCENT SLOPES	Very high	Moderately well drained	323.62
KNEELAND LOAM, 15 TO 30 PERCENT SLOPES	High	Well drained	284.57
KNEELAND LOAM, 30 TO 50 PERCENT SLOPES	High	Well drained	268.66

KNEELAND LOAM, 5 TO 9 PERCENT SLOPES	Medium	Well drained	91.48
KNEELAND LOAM, 9 TO 15 PERCENT SLOPES	Medium	Well drained	5.68
KNEELAND ROCKY COMPLEX, 30 TO 75 PERCENT SLOPES	Very Low	Excessively drained	1172.76
KNEELAND ROCKY SANDY LOAM, SANDY VAR., 9 TO 30 PERCENT SLOPES	Medium	Well drained	186.13
KNEELAND SANDY LOAM, SANDY VARIANT, 15 TO 30 PERCENT SLOPES	Medium	Well drained	244.46
KNEELAND SANDY LOAM, SANDY VARIANT, 2 TO 15 PERCENT SLOPES	Low	Well drained	110.98
LAUGHLIN LOAM, 2 TO 30 PERCENT SLOPES	Medium	Well drained	44.48
LAUGHLIN LOAM, 30 TO 50 PERCENT SLOPES	High	Well drained	79.47
LAUGHLIN-YORKVILLE COMPLEX, 30 TO 75 PERCENT SLOPES	Very Low	Moderately well drained	68.63
LOS OSOS CLAY LOAM, 15 TO 30 PERCENT SLOPES	Very high	Well drained	137.03
LOS OSOS CLAY LOAM, 2 TO 15 PERCENT SLOPES	High	Well drained	202.72
LOS OSOS CLAY LOAM, 30 TO 50 PERCENT SLOPES	Very high	Well drained	108.93
LOS OSOS CLAY LOAM, 30 TO 50 PERCENT SLOPES, ERODED	Very high	Well drained	25.26
LOS OSOS CLAY LOAM, THIN SOLUM, 30 TO 50 PERCENT SLOPES	Very high	Well drained	198.89
LOS OSOS CLAY LOAM, THIN SOLUM, 5 TO 15 PERCENT SLOPES	Very high	Well drained	37.46
MONTARA COBBLY CLAY LOAM, 2 TO 30 PERCENT SLOPES	High	Well drained	9.39
MONTARA COBBLY CLAY LOAM, 30 TO 75 PERCENT SLOPES	Very high	Well drained	39.62
PAJARO CLAY LOAM, OVERWASH, 0 TO 2 PERCENT SLOPES	Medium	Somewhat poorly drained	12.27
PAJARO FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES	Very low	Somewhat poorly drained	216.81
RED HILL CLAY LOAM, 30 TO 50 PERCENT SLOPES	Very high	Moderately well drained	27.39
ROCK LAND	Very high	Excessively drained	12.97
ROHNERVILLE LOAM, 0 TO 9 PERCENT SLOPES	High	Moderately well drained	108.06
ROHNERVILLE LOAM, 9 TO 15 PERCENT SLOPES	High	Moderately well drained	25.65
SOBRANTE LOAM, 30 TO 50 PERCENT SLOPES	High	Well drained	12.86
STEINBECK LOAM, 15 TO 30 PERCENT SLOPES	High	Moderately well drained	403.22
STEINBECK LOAM, 15 TO 30 PERCENT SLOPES, ERODED	High	Moderately well drained	284.37
STEINBECK LOAM, 2 TO 9 PERCENT SLOPES	Medium	Moderately well drained	723.69
STEINBECK LOAM, 30 TO 50 PERCENT SLOPES	High	Moderately well drained	300.95
STEINBECK LOAM, 30 TO 50 PERCENT SLOPES, ERODED	High	Moderately well drained	424.87
STEINBECK LOAM, 9 TO 15 PERCENT SLOPES	Medium	Moderately well drained	1075.38
STEINBECK LOAM, 9 TO 15 PERCENT SLOPES, ERODED	Medium	Moderately well drained	375.52
SUTHER LOAM, 30 TO 50 PERCENT SLOPES	Very high	Moderately well drained	50.73

YOLO LOAM, OVERWASH, 0 TO 5 PERCENT SLOPES	Low	Well drained	38.10
YORKVILLE CLAY LOAM, 30 TO 50 PERCENT SLOPES	Very high	Moderately well drained	570.46
YORKVILLE CLAY LOAM, 5 TO 30 PERCENT SLOPES	Very high	Moderately well drained	31.96
YORKVILLE-LAUGHLIN COMPLEX, 30 TO 50 PERCENT SLOPES	Very Low	Well drained	227.24