Grape Creek
Streamflow Improvement Plan

Prepared by
Trout Unlimited
Center for Ecosystem Management and Restoration

Prepared for
California State Coastal Conservancy
U.S. Fish and Wildlife Service
Coastal Streamflow Stewardship Project

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Frost protection fan (Brock Dolman, Occidental Arts and Ecology Center)
Juvenile coho in Grape Creek (UC Cooperative Extension/Sea Grant)
Creekside vineyard employee (Trout Unlimited)
Streamflow measurements in Grape Creek (Trout Unlimited)

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Acronyms

AF	Acre-Feet or Acre-Foot
AWEP	Agricultural Water Enhancement Program
BACI	Before-After Control-Impact
CCC	Central California Coast
CEMAR	Center for Ecosystem Management and Restoration
CSG	California Sea Grant
CSSP	Coastal Streamflow Stewardship Project
DFG	Department of Fish and Game
DFW	Department of Fish and Wildlife (formerly DFG)
DPS	Distinct Population Segment
ESU	Evolutionarily Significant Unit
eWRIMS	Electronic Water Right Information Management System
FRGP	Fisheries Restoration Grant Program
GIS	Geographic Information System
KIBP	Keystone Initiative Business Plan
NFHAP	National Fish Habitat Action Plan
NFWF	National Fish and Wildlife Foundation
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NOAA	National Oceanic and Atmospheric Administration
PAD	Passage Assessment Database
PIT	Passive Integrated Transponder
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RM	River Mile
SCC	State Coastal Conservancy
SCWA	Sonoma County Water Agency
SIP	Streamflow Improvement Plan
SWRCB	State Water Resource Control Board
TU	Trout Unlimited
UCCE	University of California Cooperative Extension
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WDMP	Water Demand Management Program
YOY	Young-of-the-Year (age 0+ fish)

Executive Summary

Trout Unlimited (TU) and the Center for Ecosystem Management and Restoration (CEMAR) prepared this Streamflow Improvement Plan (SIP) as part of the Coastal Streamflow Stewardship Project (CSSP). The CSSP is an effort led by TU and CEMAR with support from the California State Coastal Conservancy which has grown to include many other funding and conservation partners. The purpose of CSSP is to enhance water supply reliability and restore good streamflow conditions in targeted rivers and streams.

Through CSSP, TU and CEMAR initially selected four coastal watersheds to test our belief that it is possible to improve streamflows in a way that benefits landowners, and specifically that it makes sense to apply a systematic, watershed-scale approach that brings together landowner interests, streamflow gauging and water availability analyses, site specific habitat-flow studies, and coordinated management of water diversions. The Grape Creek watershed is one of the first four watersheds for which we are developing Streamflow Improvement Plans. The others are the Mattole River (Humboldt and Mendocino counties), San Gregorio Creek (San Mateo County), and Little Arthur Creek (Santa Clara County). We have also begun work in Chorro Creek (San Luis Obispo County) and Pescadero Creek (San Mateo County). In addition, TU and CEMAR are members of the Russian River Coho Water Resources Partnership (Coho Partnership) that is working in four additional Sonoma County watersheds using methods based largely on CSSP.[1] (The Coho Partnership is also pursuing other kinds of habitat restoration and conducting biological monitoring.) This Streamflow Improvement Plan is a roadmap for prioritizing and implementing high priority, streamflow improvement projects with multiple public benefits and a diversity of approaches.

Grape Creek is a tributary to Dry Creek, thence the Russian River in Sonoma County, California. Grape Creek and its major tributary drain an area of approximately 3.2 square miles. The Grape and Wine Creek watersheds are privately owned and predominant land uses include viticulture (winegrape production and wineries) and rural residences. The Grape Creek watershed supports steelhead trout (Central California Coast DPS) and coho salmon (Central California Coast ESU). Central California Coast (CCC) steelhead are listed as threatened and CCC coho are listed as endangered under the Federal Endangered Species Act. The National Marine Fisheries Service's (NMFS) CCC Coho Recovery Plan identified Grape and Wine creeks as a Core Priority Area for CCC coho (NMFS 2012). Grape Creek was selected as a pilot watershed because low flow was determined to be a critical but not intractable limiting factor, because a critical mass of landowners expressed their interest and support in collaborative problem-solving with us, and because it ranked high in federal and state recovery plan prioritization.

[1] Early work in Grape Creek was funded through CSSP prior to the development of the Coho Partnership and NFWF Keystone Initiative. Therefore, the Grape Creek Streamflow Improvement Plan background is focused on CSSP, but subsequent SIPs for Russian River sub-watersheds will be Coho Partnership efforts.

Our work in Grape Creek builds on many years of effort on the part of landowners, non-profit organizations, public agencies and others to restore habitat and fisheries in the watershed by tackling the threats that water diversion and low flow present to salmonids, marking the first time streamflow recovery has been addressed as a restoration strategy in Grape Creek. Complementary efforts through the Russian River Coho Water Resources Partnership have allowed us to expand this work and to couple streamflow restoration projects with post-project fisheries monitoring.

Grape Creek Streamflow Improvement Plan

The purpose of the Grape Creek Streamflow Improvement Plan (SIP) is to increase understanding of the relationship of flows to habitat and to identify specific measures that moderate the impact of dry season water demand. In years of sufficient natural streamflow, demand management through storage and modified diversion practices should maintain a flow regime that is protective of the various life history stages of salmon.

Section 1 provides an overview of the Coastal Streamflow Stewardship Project, describes our rationale for selecting Grape Creek as a pilot CSSP watershed, and details the tasks and activities we initiated in the watershed through CSSP. Though the information is specific to Grape Creek, it provides an overview of the efforts and tasks likely to be essential to any streamflow improvement program in coastal areas.

Section 2 describes existing conditions relevant to developing a streamflow improvement approach in Grape Creek. These include the ecological setting, rainfall and discharge, human land and water use, anadromous fisheries and habitat, factors limiting salmonid recovery, and previous restoration projects in the watershed.

Upon confirming that developing a streamflow improvement approach in the watershed was feasible and justified and investigating the general constraints and opportunities presented by patterns of discharge, water use, and fish life cycle needs, we needed to better understand the specific water needs of human and fish populations in the watershed. Only then could we begin to understand the options for meeting the needs of both.

Section 3 analyzes human water needs relative to available water supply and streamflow. It provides estimates for human water need at different temporal scales (annual, seasonal, daily) and compares human water need with water supply and flow at those scales. The analyses provide the rationale for our approach by detailing how sufficient water is available in Grape Creek to meet human needs on an annual scale, by highlighting the disparity between discharge in the rainy versus dry seasons, comparing discharge with seasonal human need, and by evaluating the impacts that the current diversion regime has on streamflow through the year at a daily scale.

Section 4 characterizes the needs of anadromous fish and their relationship to flow and habitat.

Section 5 uses the information in Sections 3 and 4 to define streamflow improvement objectives, provide recommendations for meeting those objectives, and describe permitting considerations. This Section provides a roadmap for achieving both the physical/infrastructure and social/management changes necessary to ensure streamflow improvement. In Grape Creek, these recommendations include:

- ✓ **Change water management practices resulting in acute and detectable impacts to streamflow and continuing to monitor for acute reductions in flow**
- ✓ **Improve surface flow upstream of the treatment reach in Grape and Wine creeks by completing off-stream storage and conservation projects with irrigators diverting from wells adjacent to Grape Creek, working with a water user with a pending water right application, and implementing a small domestic tank program for residential users on Wine Creek**
- ✓ **Determine if modifications to groundwater use and recharge projects will result in streamflow improvements in the treatment reach by refining knowledge of surface-groundwater interactions in Grape Creek**
- ✓ **Encourage and enable landowner-led efficiency and storage projects with streamflow benefits**
- ✓ **Complete habitat and barrier removal projects in key streamflow improvement reaches**

Section 6 describes monitoring efforts, long-term threats to the water savings recommended in this SIP, and strategies to ensure durable results.

This SIP illustrates how the Grape Creek watershed is serving and can continue to serve as a watershed-scale model for salmonid recovery efforts that benefit both fisheries and coastal communities.

1. Introduction

1.1 The Coastal Streamflow Stewardship Project

In 2008, the California State Coastal Conservancy awarded funding to Trout Unlimited (TU) and the Center for Ecosystem Management and Restoration (CEMAR) to implement the Coastal Streamflow Stewardship Project (CSSP) to work with landowners to improve streamflow and water supply reliability. Through CSSP, we partner with landowners and water users in coastal California watersheds to develop water management tools and identify projects to protect and reconnect streamflow for fisheries and improve water supply reliability for coastal communities. The Conservancy described CSSP as part of an ongoing effort "to promote long-term management of coastal water resources, often requiring the balance of competing uses such as agricultural, habitat and water quality needs" (California Coastal Conservancy 2008, p.5).

Throughout coastal California, salmon and steelhead populations are in decline. In many locations, the biggest problem is a lack of water. Even under natural conditions, many coastal streams experience very low streamflow during the late summer months. Water diversions for irrigation and other human needs can easily dry them up. But while conservationists have made great progress addressing other factors limiting salmon and steelhead populations, water has always been the "third rail" of river restoration. The topic is emotionally charged and technically complex, and it is not for the faint of heart.

Discussing Water Rights, A Western Pastime

ls Inc.)

When we started CSSP, approximately 500 applications for new water rights were pending in California, including 300 located along the north central coast. The backlog was failing new applicants (because they were unable to get a water right), senior water right holders (because unauthorized diversions continued to operate without regard for the interests of prior appropriators), and public trust resources (because inadequate safeguards were in place to protect the instream flows necessary for fish and wildlife). In addition, water users with existing and valid water rights had little incentive to explore changes in water management and infrastructure that could benefit fisheries resources, especially if such changes meant entering difficult water rights and other permitting processes. Very few people had ever successfully completed projects to improve streamflow by working cooperatively with water users.

We created CSSP to test an approach to break through the stalemate and distrust that regularly characterize issues of water diversion, water rights, and streamflow in coastal systems. We do so by identifying and developing high priority and technically and socially feasible projects that yield benefits for fisheries and human populations and also have demonstration value beyond the pilot watersheds. We hypothesized that, in many cases, shifting water demand from the dry season to the rainy season would benefit salmon and steelhead populations and meet human water needs. We believed that this could be done by developing tanks and farm ponds as an alternative to in-stream pumps or streamside wells, and could be accompanied by improvements in water use efficiency and rotations of diversions. We also hypothesized that investing in stream gauges and habitat-flow studies could allow us to make practical recommendations for water supply improvements, and we believed that investing even more heavily in discussions with the people who live along the streams could allow us to develop mutually beneficial projects.

In sum, the overarching goal of CSSP is to devise a “comprehensive and coordinated approach to water management and instream flow protection” (California Coastal Conservancy 2008, p.5) that demonstrates that water rights system reform and fisheries conservation can be accomplished in tandem with water users.

Through CSSP, we selected four watersheds in which to pilot the approach—the Mattole River in Humboldt and Mendocino counties, Grape Creek (Russian River watershed) in Sonoma County, San Gregorio Creek in San Mateo County, and Little Arthur Creek (Pajaro River watershed) in Santa Clara County (Figure 2). We are now working in two others through CSSP -- Chorro Creek in San Luis Obispo County and Pescadero Creek in San Mateo County -- and four others – Dutch Bill, Green Valley, Mark West, and Mill creeks, through the Coho Partnership (funded by the National Fish and Wildlife Foundation). In each of these watersheds, diminished streamflow is limiting salmonid recovery, but the restoration of streamflow appears promising and feasible, and water users are eager to participate in conservation-oriented actions to benefit local fish populations. We selected watersheds characterized not by seemingly intractable conflict but rather by intermediate water management challenges that would produce meaningful solutions. We also considered the diversity and breadth of the watersheds to be important: they are geographically diverse and present an array of land and water uses and opportunities so as to create flexible models with wide applicability.

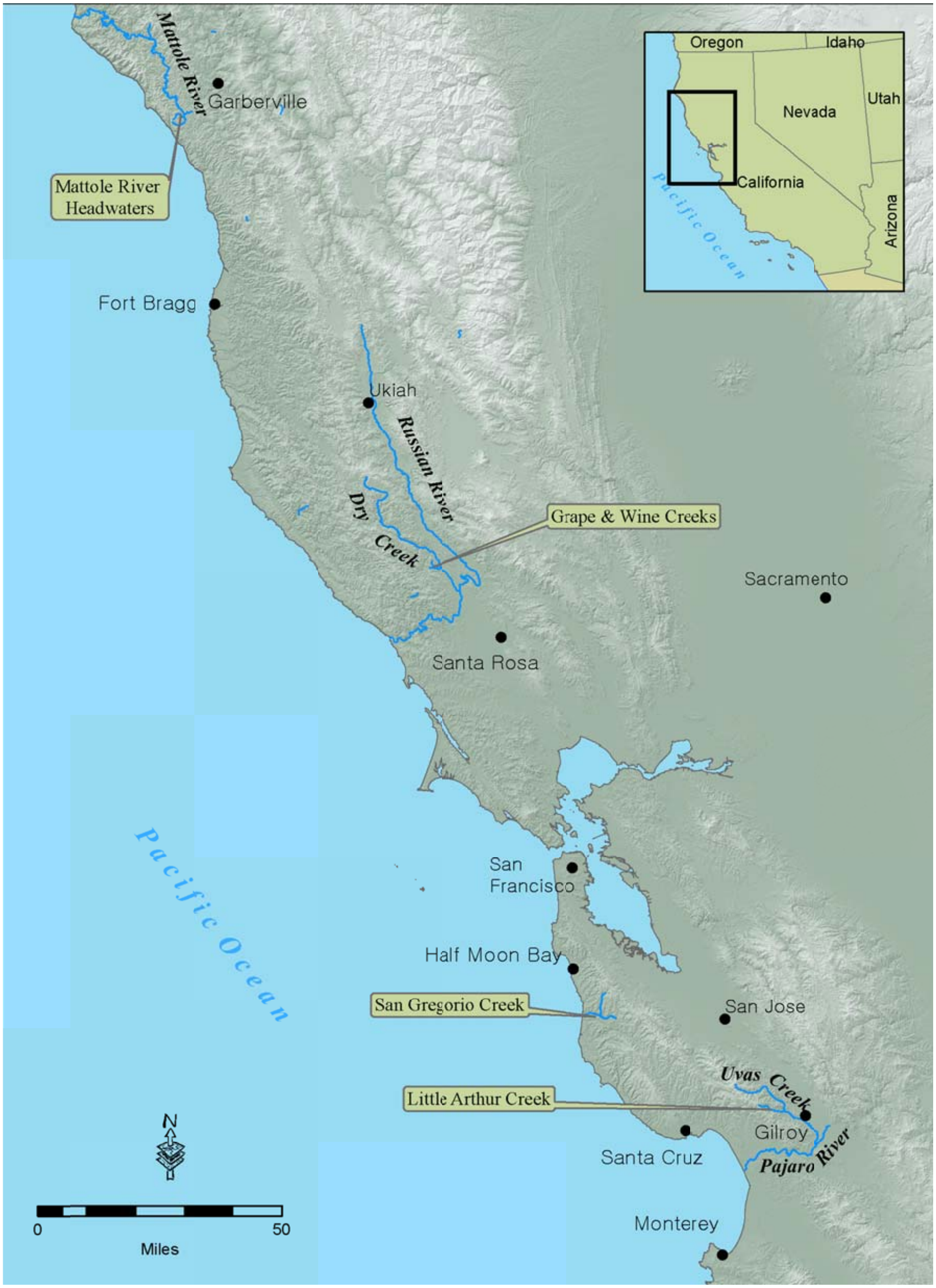

Figure 2. Coastal Streamflow Stewardship Project watersheds

1.2 Rationale for Selecting Grape and Wine Creeks

Grape Greek was chosen as a CSSP pilot watershed because it provided the critical intersection of feasibility of salmon restoration, degree of impairment of stream by diminished flows, critical mass of landowners interested in collaboration, federal and state recovery plan prioritization, and a range of land and water uses with the potential to demonstrate a variety of solutions. The Russian River watershed is considered especially important in coho salmon recovery, and it also supports populations of steelhead and Chinook salmon.

In a 1966 report, the California Department of Fish and Game (DFG)[2] estimated the amount of habitat used by coho salmon (and Chinook salmon and steelhead) in the Russian River and its various tributaries. While the report does not provide a methods description or a statement of assumptions allowing evaluation of the reliability of the conclusions, the results nevertheless can be used to provide a broad context for this examination of Wine and Grape creeks. At that time, DFG determined that coho used habitat in 20 Russian River tributaries constituting a total habitat resource of approximately 100 stream miles. The average useable habitat per stream was then five miles, while the median available habitat per tributary was three miles (based on DFG 1966). Grape and Wine creeks offer approximately four stream miles of salmonid habitat, making them important resources in an overall recovery program. The proximity of this habitat to Dry Creek (where significant restoration efforts are underway) and to other important coho and steelhead producing tributaries (such as Mill Creek) also weigh in favor of improving flow (and habitat) conditions in Grape and Wine creeks.

Among many factors making restoration efforts in the Russian particularly attractive are (a) the extensive human and financial resources represented by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and multiple regional and local government organizations and stakeholder groups; and (b) extensive habitat resources that can be made available through restoration efforts. Further, a broad coalition of public and private groups has been supporting restoration through the Russian River Coho Salmon Captive Broodstock Program since 2001.

Our efforts under CSSP are based on our agreement with several conclusions made by previous researchers: (a) the two most important factors limiting coho recovery in Grape and Wine creeks—lack of habitat complexity and low summer flow—relate to the interaction of climate and past and ongoing human activities; (b) programs to restore habitat complexity and landscape-scale hydrologic storage capacity should be continued and expanded; and (c) reducing the effect of dry season diversion on streamflow is critical to Russian River coho recovery. This work in Wine and Grape creeks is supported by, consistent with, and implements multiple recovery planning efforts and resource agency priorities, including NMFS's CCC Coho Recovery Plan, DFG's Recovery Strategy for

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[2] On January 1, 2013, the California Department of Fish and Game (DFG) became the California Department of Fish and Wildlife (DFW). When referring to past actions of or documents authored by the Department, we will refer to DFG rather than DFW.

Coho Salmon, the California Wildlife Action Plan, and the State Water Resources Control Board's Strategic Plan. (See Appendix A for specific recovery plan recommendations put into action through CSSP.)

After beginning CSSP in Grape Creek, we were able to expand the approach within Grape Creek and across four other Russian River tributaries through the Russian River Coho Water Resources Partnership (Coho Partnership), a group of six organizations established to implement the National Fish and Wildlife Foundation (NFWF) Keystone Initiative Business Plan for coho salmon in the Russian River (KIBP). The Plan aims to restore a viable self-sustaining population of coho salmon in the Russian River watershed. These organizations include CEMAR, TU, the Gold Ridge Resource Conservation District, Sotoyome Resource Conservation District, Occidental Arts and Ecology Center's WATER Institute, and University of California Cooperative Extension and California Sea Grant (UCCE/CSG), in partnership with the Sonoma County Water Agency. The KIBP identified five key sub-watersheds in the Russian River basin as critical for near-term restoration activities where water management will be critical to restoring coho salmon: Dutch Bill, Green Valley, Mill, Mark West, and Grape creeks. The project has been funded by NFWF since 2009 and has allowed us to bring additional resources into Grape Creek and add a fisheries monitoring component to our streamflow improvement work.

1.3 CSSP Tasks in the Grape Creek Watershed

Our CSSP effort consists of six tasks: identify the pilot watersheds; gather background information for each; characterize the watersheds; prepare instream flow recommendations and hydrologic data analysis; engage local participants to develop a legal and institutional framework for coordinated diversion management; and create Streamflow Improvement Plans.

1.3.1 Gather Background Information

We gathered geophysical, hydrologic, and biological information. Geophysical data, including topography and geology, were important for defining spatial relationships within our study watersheds. Hydrologic data (including precipitation and streamflow) were essential for defining the amount of water typically expected to fall as precipitation and leave the watershed as streamflow, and the range among wet to dry years. Biological data, including watershed- and reach-scale fish surveys, allowed us to focus attention on particular reaches based on long- and near-term documentation of fish presence and use of reaches within each drainage network. In addition, we compiled information describing human water use based on several sources (*e.g.*, aerial photographs, water rights information, county assessors data, local expert information), which we used to define water need (how much water is needed to meet human uses such as irrigation, domestic, and industrial on an annual scale) and demand (how water is taken from the watershed to meet those needs through the year).

We drew upon the following resources in developing this Streamflow Improvement Plan:

- California Department of Fish and Game, *Stream Inventory Report: Grape Creek* (completed 2000, revised 2006)
- California Department of Fish and Game, *Stream Inventory Report: Wine Creek* (completed 2000, revised 2006)
- California Fish Passage Assessment Database
- National Marine Fisheries Service, *Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin* (Draft) (2007)
- National Marine Fisheries Service, *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed* (2008)
- National Marine Fisheries Service, *Final Recovery Plan for the Central California Coast coho salmon Evolutionarily Significant Unit* (2012)
- State Water Resources Control Board, Electronic Water Rights Information Management System
- Taylor, R.N., Grey, T.D., Knoche, A.L., and Love, M., *Russian River Stream Crossing Inventory and Fish Passage Evaluation – Final Report* (2003)
- University of California Cooperative Extension and California Sea Grant, *Summer Survival of hatchery released young-of-the-year coho in relation to flow and other environmental variables in Russian River tributaries* (2012)
- U.S. Geologic Survey hydrology data from gauges including Maacama Creek near Kellogg (11463900), Pena Creek near Geyserville (11465150), and Austin Creek near Cazadero (11467200)

1.3.2 Characterize Watersheds

For CSSP, we made several efforts to generate new information and resources relevant to streamflow restoration in Grape and Wine creeks. Property owners, residents, and vineyard and winery staff provided information about streamflow, fisheries, patterns of land use, and water use in the watershed. We also estimated residential, agricultural, and industrial water use among various time scales (annual, seasonal, daily), and worked with Geographic Information System (GIS) technicians at UCCE to develop a GIS-based hydrologic model to evaluate the impacts of diversions on streamflow in the Grape Creek watershed. The GIS model allows for evaluations of impacts across time (such as over a year at a given location), as well as impacts throughout the drainage network on a particular date. The cumulative impacts models were used to create unimpaired and impaired streamflow estimates at locations within the watershed.

We also installed a network of six year-round streamflow gauges in the Grape Creek drainage network (Figure 3) to collect stream and tributary-specific streamflow data, which was essential for improving our understanding of individual and cumulative impacts on streamflow and fish habitat locally within each watershed and for evaluating the feasibility of proposed management practices and projects. Streamflow gauges have operated in the Grape Creek watershed since 2006, when the first gauge was placed on Wine Creek as part of a regional hydrology study by UCCE in Dry Creek Valley. When that two-year project ended, we continued to operate the Wine Creek gauge and deployed three additional gauges in the beginning of water year 2009 (November-December 2008). We installed a fifth gauge in Grape Creek in spring 2010 at West Dry Creek Road and a sixth on Grape Creek near Dry Creek in June 2011. Gauge locations were initially chosen to measure streamflow in Grape Creek and Wine Creek, upstream and downstream of their confluence; additional gauges were installed on a small tributary to Grape Creek above the Wine Creek confluence to compare the flow regime of the small tributary (draining less than 20 acres) to the larger streams below, at the West Dry Creek Road crossing to gather baseline data for what would be designated as the *treatment reach* for Coho Partnership studies and near the confluence of Dry Creek to further inform dynamics of flow through the Coho Partnership treatment reach. All of these gauges operate in the lower portion of the watershed, where Grape and Wine creeks pass through the alluvium of Dry Creek Valley.

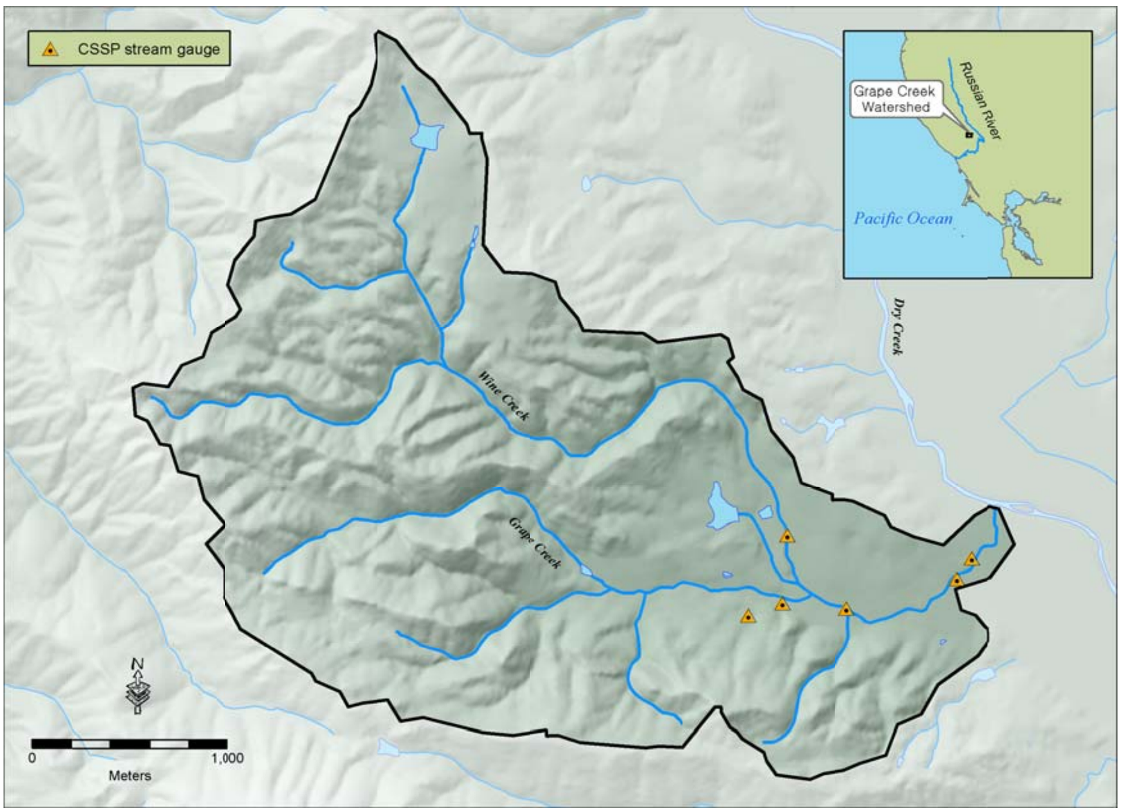


Figure 3. Streamflow gauges in the Grape Creek watershed

Two different brands of pressure transducers, Azonde 2220 transducers and data collectors and In-Situ Level TROLL 500s, were used as stream gauges to measure and record water level (e.g., Figure 4). Each gauge measures and records water stage and water temperature every fifteen minutes (Azonde sensors also measure and record air temperature). The Azonde transducers relay data in real-time to an antenna in the watershed with Internet connectivity. We regularly upload the data from gauges without Internet connectivity. We measured streamflow approximately one time each month in each reach using either Price Mini or AA current meters (depending on flow conditions).

Measured streamflow values were correlated with stage data at the time of measurement to create rating curves according to standard United States Geological Survey (USGS) protocols (Rantz 1982) and these curves were used to estimate streamflow in cubic feet per second (ft^3/s) at 15-minute intervals for all stage data measured by the pressure transducer.

Figure 4 A-B. Streamflow gauges in Grape Creek: (A) Submerged sensor at end of Azonde pressure transducer and staff plate; (B) Azonde antenna and cable

The streamflow, stage and temperature data are available online in the Streamflow Data Center at: http://www.cemar.org/Grape_Creek.html. Individual gauge links are below:

- Gr01 - Wine Creek Above Grape Creek Confluence
- Gr02 - Grape Creek Above Wine Creek Confluence
- Gr03 - Grape Creek Below Wine Creek Confluence
- Gr04 - Tributary To Grape Creek Above Wine Creek
- Gr05 - Grape Creek At West Dry Creek Road
- Gr06 - Grape Creek Near Dry Creek

The real-time information has been valuable to us and our partners in Grape Creek as in other watersheds. Each landowner that hosts a gauge has allowed the data to be publicly available and accessible and many have enjoyed the ability to access stage data as well. Accessing the gauge data online has allowed us to monitor for any potential problems in data collection (*e.g.*, if the gauge is damaged during storm events) and to target field visits for streamflow measurements, saving both money and time.

1.3.3 Instream Flow Recommendations and Data Analysis

In addition to streamflow data collection and analysis, we conducted a site-specific study in Grape and Wine creeks to identify the streamflow thresholds that offer adequate protections for diversions to operate in winter (as an alternative to dry season diversion) while minimizing impacts to steelhead trout and coho salmon. This information is applicable to instream improvement projects that may require new water rights. This study helps to define the threshold conditions that must occur for winter diversions to operate under an appropriative water right. Because of the potential for spring and summer to be dry, and because of policy requirements for new diversions, we focused on the flow thresholds that are necessary to maintain processes that occur in winter, namely fish passage during moderate and low-flow conditions. Because of the nature of any new winter diversions proposed through cooperative instream flow projects (*e.g*., not likely to exceed 0.5 ft^3/s), it is highly unlikely that proposed diversions would affect channel-forming flows. To the extent that they may have impacts on biological processes that occur during winter base flow conditions (*e.g*., spawning), these thresholds can be incorporated into the terms of proposed water rights to ensure that depth and velocity thresholds for spawning and rearing are exceeded before water is diverted for human use.

1.3.4 Engage Participants and Develop Legal Framework

In each of the watersheds, we established relationships with landowners. To facilitate the permitting and implementation of streamflow enhancement projects, we worked with watershed partners and water users to (a) identify the timing, quantity, and type of human water demand on stream systems, (b) define the elements of possible projects (water use changes, infrastructure, location, permit terms) and begin to analyze project feasibility, and (c) develop the legal and institutional framework to support coordinated water management at the watershed scale. In some cases, streamflow data provided insights into on-going water diversions and water management strategies, and we used that information to guide our outreach to and recruitment of project participants.

We also worked to ensure that CSSP was consistent with legal and policy changes relevant to anadromous fisheries and water rights and water use. Since beginning CSSP, two changes have been particularly relevant to water users and streamflow project permitting in the Grape Creek watershed: the Policy for Maintaining Instream Flows in Northern California Coastal Streams (North Coast Instream Flow Policy) and the Russian River Frost Protection Reasonable Use Regulation, both promulgated and adopted by the State Water Resources Control Board (SWRCB).

North Coast Instream Flow Policy. The SWRCB adopted the policy -- which was required by California Assembly Bill 2121 -- in May 2010 and it went into effect on September 28, 2010.[3] The Grape Creek watershed is located within the policy area, which extends from the Mattole River to San Francisco (including streams draining into northern San Pablo Bay) (SWRCB 2010, p. 13). The policy applies to new water right applications (appropriative, small domestic use, small irrigation use

[3]http://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/docs/ab2121_0210/adopted050410instreamflowpolicy.pdf Note that in response to *Living Rivers Council v. State Water Resources Control Board* (Sup. Ct. Alameda County, 2012, No. RG10-5435923), the Board has vacated the Policy but may treat it as guidance pending completion of additional CEQA documentation. According to the Board's website, "Once the additional CEQA documentation has been completed, the Division of Water Rights will prepare any necessary or appropriate revisions to the Policy for the State Water Board's consideration. The State Water Board will consider re-adoption of the Policy, with or without revisions, at a future State Water Board meeting." http://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/

and stockpond registrations) and water right petitions. It applies to streamflow improvement projects under CSSP that require new appropriative water rights and/or water rights changes, and it provides standard terms for bypass flows, rates of diversion, and seasons of diversion based on regional criteria protective of fisheries resources as well as guidance for site-specific habitat/flow instream flow studies. Either avenue can be used to develop criteria for permit applications for high priority streamflow improvement projects.

Section 3.3.2.5 of the policy also provides incentives for water users wishing to switch the timing of their diversion from the dry to rainy season (*e.g.*, to off-stream storage) by providing for expedited permitting for projects with demonstrable fisheries benefits.

Frost Regulation. In response to the stranding and death of coho and steelhead in the Russian River watershed in 2008 and 2009, the State Board adopted a reasonable use regulation concerning diversions for frost protection in the Russian River watershed (23 Cal. CCR 3 § 862) on September 20, 2011.[4] The rule was scheduled to take effect on March 14, 2012 but is stayed pursuant to ongoing litigation. The regulation provides that any diversion of water from the Russian River stream system, including the pumping of hydraulically connected groundwater, for purposes of frost protection, from March 15 through May 15, shall be "unreasonable" and a violation of water code – unless the water is diverted in accordance with a Board-approved "Water Demand Management Program" (WDMP). If the stay is lifted and the regulation is enforced, it would intersect with CSSP in at least three ways: (a) it would require frost protection water users to take steps to ensure that water diversions do not cause sudden drops in stage and could lead to additional, compliance-driven water management changes, (b) any new projects to restore instream flow that involve frost protection water use would need to be evaluated to ensure conformity with the regulations, and (c) the sections of the regulation pertaining to streamflow and diversion monitoring may intersect with (draw from or contribute to) CSSP data collection efforts.

We have also worked to create incentives for water users to engage in projects to improve instream flow: working with SWRCB to clarify that roof rainwater harvesting does not require a water right,[5] working with the Wine Institute to pass legislation (Assembly Bill 964 in 2011, sponsored by Assemblymembers Huffman and Chesbro) to allow registrations for certain small farm ponds similar to the Small Domestic Use process, and working with SWRCB to disseminate better information about Water Code Section 1707,[6] which allows landowners to protect their water rights when they voluntarily forgo diversions.

1.3.5 Establish Streamflow Improvement Plans

Finally, we compiled and integrated the information generated through the tasks above in this SIP. The purpose of this SIP is to provide the foundation and justification for changing water

[4] http://www.waterboards.ca.gov/waterrights/water_issues/programs/hearings/russian_river_frost/docs/approved_reg.pdf
[5] http://www.waterboards.ca.gov/waterrights/board_info/faqs.shtml#rooftop
[6] http://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/instream_flow_dedication

management practices in Grape and Wine creeks and to guide future actions to improve streamflow conditions for salmon and steelhead and water supply reliability for water users in the watershed.

2. Watershed Characterization

This section describes the ecological setting of Grape and Wine creeks, rainfall and discharge, human land and water use, anadromous fisheries and habitat, factors limiting salmonid recovery, and restoration strategies.

2.1 Ecological Setting

The current study concerns Grape Creek, a tributary of Dry Creek, itself one of five important sub-basins in the Russian River watershed, and Wine Creek, a tributary to Grape Creek (Figure 5). The Russian River drains a 1,485 square mile watershed in Mendocino County and Sonoma County portions of the Coast Range. The mainstem flows approximately 90 miles roughly southward from headwaters north of Redwood Valley to near Mirabel Park, where the river turns west and runs more than 22 miles to its mouth at Jenner. The Sonoma County portion of the Russian River system includes more than 70 named tributaries and comprises almost 500 stream miles used by salmonids (DFG 1966). Grape Creek enters Dry Creek from the west at River Mile (RM) 7.1 below Warm Springs Dam, the 300,000 acre-foot reservoir constructed by the Army Corps of Engineers in the early 1980s and co-managed by the Sonoma County Water Agency to meet the needs of its 600,000 constituents in Sonoma and Marin Counties. Dry Creek drains a basin of approximately 220 square miles and meets the Russian River at approximately RM 32, 13.5 miles downstream from Warm Springs Dam.

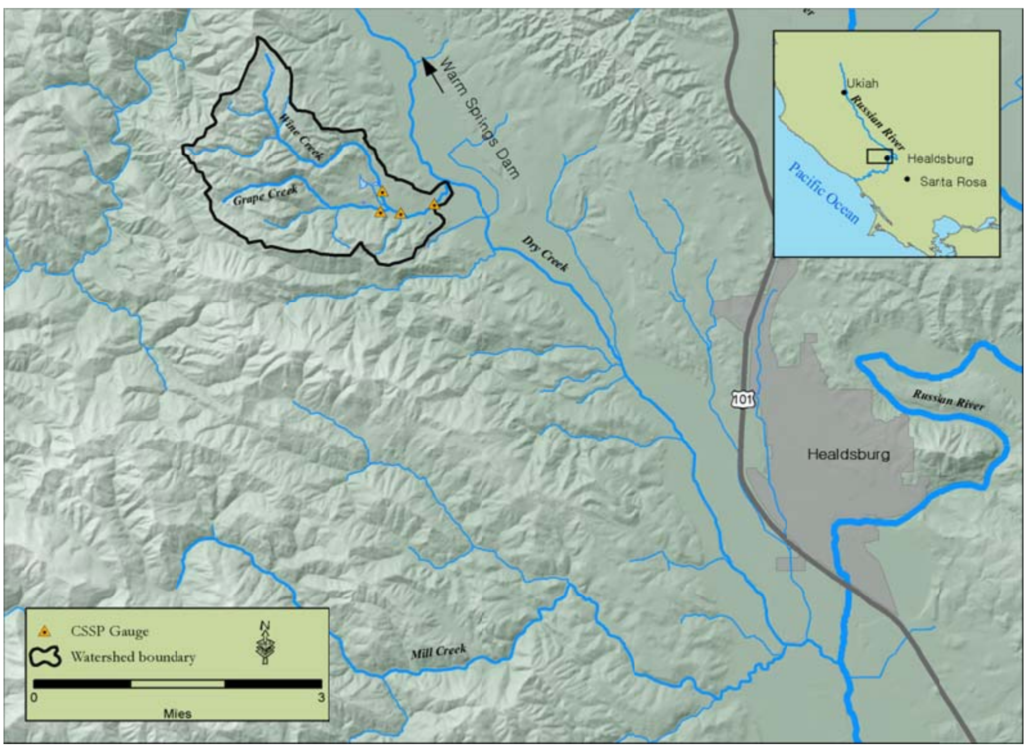


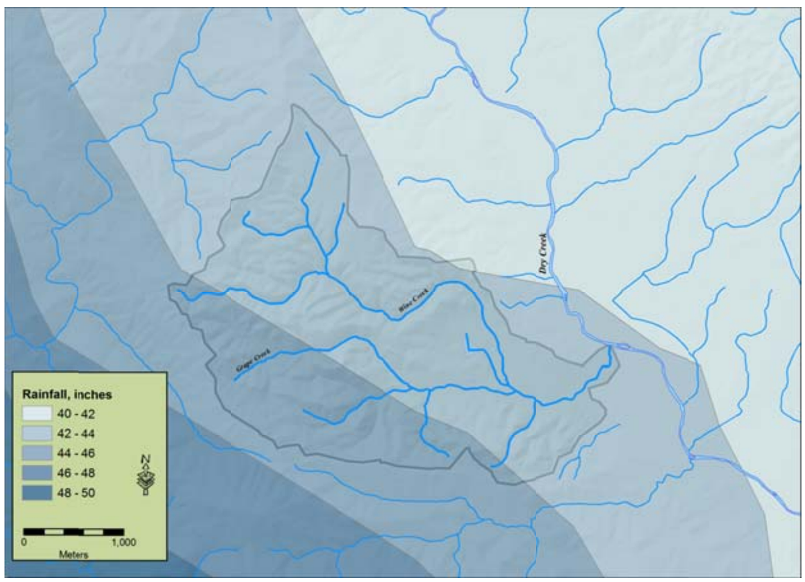
Figure 5. Grape Creek, tributary to Dry Creek, Sonoma County, CA

Grape Creek consists of 2.85 stream miles and drains an area of 3.2 square miles. The upper portions of the basin are in steep terrain, while the 1.5 miles of the creek downstream from the confluence of the headwater forks flows through lower gradient rolling hills.

Wine Creek is tributary to Grape Creek, entering the latter 0.85 miles upstream from the Dry Creek confluence. The upper portion of this 2.7-mile stream flows through steeper terrain, with its lower reaches in low gradient rolling hills. It flows roughly southeast and drains an area of 1.5 square miles.

2.2 Rainfall and Discharge

The hydrology of Grape Creek is typical of Russian River tributaries and greater Mediterranean-climate coastal California. The Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed by researchers at Oregon State University (representing the state-of-the-art in precipitation modeling in the western United States) applied to California indicate that the 2,200-acre Grape Creek watershed receives, on average, 44 inches of rain (3.7 feet) per year over the entire watershed (Figure 6). The quantity of 44 inches of rain corresponds to 8,070 acre-feet (AF)[7] (or 2.6 billion gallons) of water falling onto the Grape Creek watershed in an average year.



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Though the Grape Creek watershed, like much of the Russian River watershed, receives a considerable amount of rainfall annually, two characteristics typical of Mediterranean-climate regions place pressures on the human and biological systems that depend on water through the year. First, the seasonality of rainfall in the region results in more than 90 percent of the rainfall in the region occurring during the wet half of the year (November-April). Based on nearby rainfall records recorded at Healdsburg, CA from 1950 to 2005, less than 3 percent of the average annual rainfall occurs during July, August, and September (Figure 7).

[7] An acre-foot is the amount of water covering one acre of land to a depth of one foot. It is slightly less than 326,000 gallons.

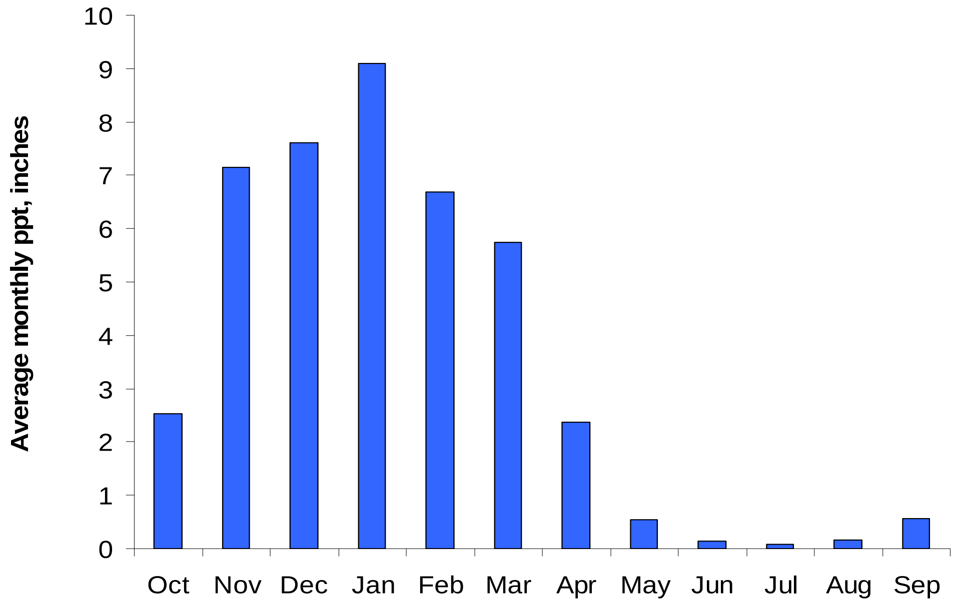

Figure 7. Average monthly rainfall in Healdsburg, CA

Second, rainfall is highly variable from one year to the next: the median annual rainfall at Healdsburg may be 47 inches, but the annual rainfall over the past fifty years has been as high as 85 inches and as low as 15 (Figure 8).

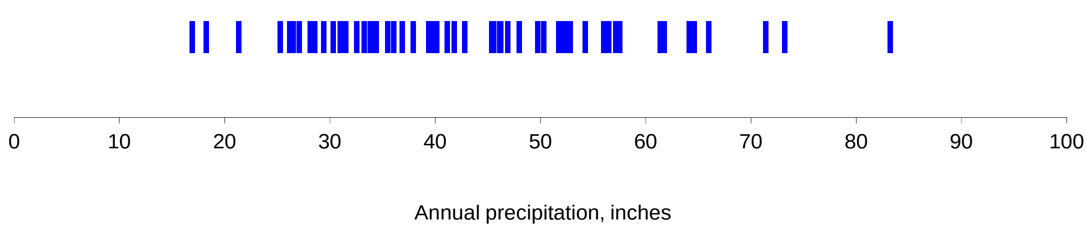

Figure 8. Distribution of annual rainfall, inches, recorded at Healdsburg, CA from 1951 – 2006

Based on analyses of historical rainfall and streamflow records in northern Coastal California, USGS researchers have concluded that approximately 55 percent of the water that falls in a watershed leaves as streamflow (Rantz and Thompson 1967). The remainder is stored as groundwater, absorbed and transpired by plants, and evaporates back to the atmosphere. Using this estimate, approximately 4,300 AF leaves as discharge from the Grape Creek watershed in an average year.

Figure 9. Grape Creek (above confluence with Wine Creek) under different flow conditions

All the precipitation that falls on Grape Creek is exclusively as rainfall, so a steady recession of streamflow begins at the onset of the dry season in spring and continues through summer and into fall. Despite the large amount of water that falls as precipitation within the watershed in an average year, streamflow recedes to approach or reach intermittence each summer (in some places becoming completely dry). (Figures 9 and 10 depict the recession.) Observations over the past few years have indicated that Grape Creek and Wine Creek both tend to remain wet in the upper canyon portions of the drainage network, but portions of each stream within the alluvial portion of Dry Creek Valley vary among perennial, intermittent, and dry during the summer dry season.

Figure 10. Grape Creek (below West Dry Creek Rd.) under different flow conditions

In 2010 and 2011, two years with nearly average annual precipitation relative to historical records, data from CSSP gauges show that Grape Creek above the Wine Creek confluence and Wine Creek became intermittent in July (Figure 11). Grape Creek retained pools through the summer, but the Wine Creek reach became completely dry by late summer. Also in both years, Grape Creek remained flowing immediately below the confluence with Wine Creek but varied between flowing and intermittent below West Dry Creek Road. Coupled with additional observations beyond streamflow data collection describing dry, intermittent, and flowing reaches, we can characterize the Grape Creek drainage network according to summer hydrologic conditions (Figure 12).

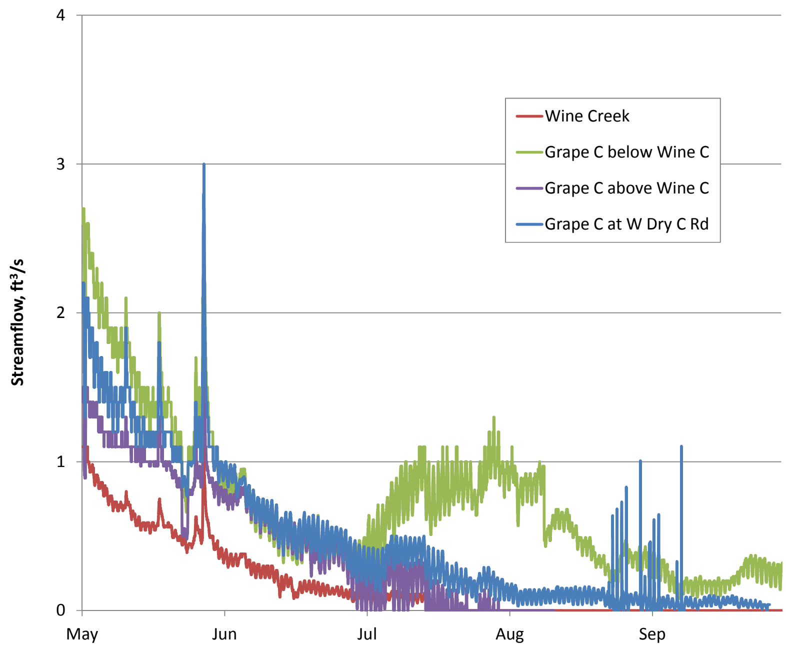

Figure 11. Streamflow recorded at four CSSP Grape Creek streamflow gauges, water year 2010

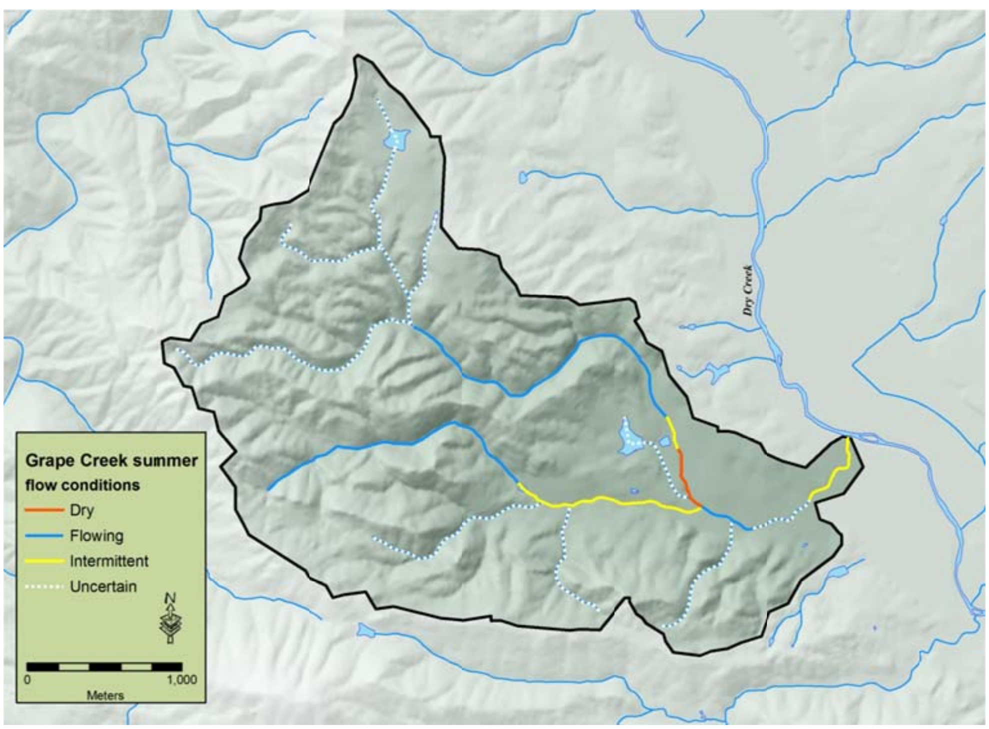

Figure 12. Spatial representation of hydrologic conditions in lower Grape Creek in summer

2.3 Human Land and Water Use

The Grape Creek drainage, including the Wine Creek sub-basin, is entirely privately owned. Approximately 15 percent of the watershed is in grape production, and other land uses in the watershed include industrial facilities (*i.e.*, wineries), and residences (Figure 13). Viticulture dominates the lower reaches of Grape Creek and the upper reaches and tributaries to Wine Creek. Rural residences are spread throughout the watershed and clustered in reaches of Wine Creek (along Koch Road) and the southern boundary of the Grape Creek watershed (along Chemise Road).

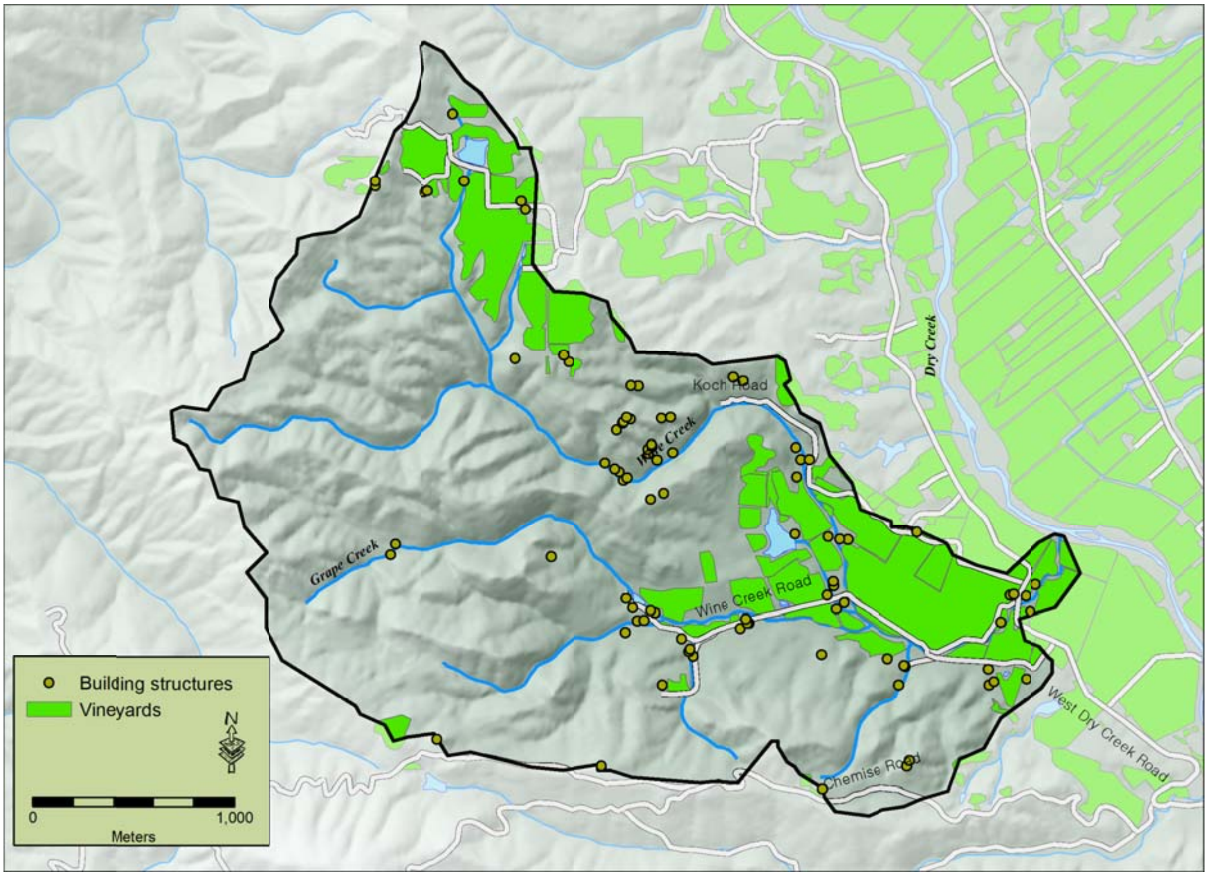

Figure 13. Grape Creek land use

Predominant water uses include residential, residential irrigation, vineyard irrigation, frost protection, and winery water uses. Methods of acquiring water and sources of water vary by property. They include direct diversion and diversion from on-stream ponds on Grape and Wine creeks, groundwater pumping, rainwater and subterranean drain water collection and storage, surface and underflow diversions from Dry Creek, and diversion and storage from drainages outside of the Grape Creek watershed. Multiple landowners in the Grape Creek watershed rely on water diversion from sources other than Wine and Grape creeks and their tributaries. (See Section 3 for a more detailed analysis of water demand and need.)

2.4 Anadromous Fisheries Populations and Habitat

The Dry Creek basin is believed to have supported an independent population of steelhead historically, and may have been part of a group of lower and middle Russian River tributaries collectively supporting an independent population of coho salmon (Bjorkstedt et al. 2005).[8] Population estimates developed for the Russian River indicate a precipitous population decline since the 1930s to 1950s era (15,000 individual run size) until the present, when abundance ranges from the 10s to low 100s of spawning coho (NMFS 2012).

Coho were observed in the Grape/Wine system in 1998 (DFG 2006). As part of their coho monitoring program, the University of California Cooperative Extension and CA Sea Grant (UCCE/CSG) have documented the presence of unclipped (wild) juvenile coho in Grape and Wine creeks during the summer of 2011, and in Grape Creek during the summer of 2012 (UCCE/CSG unpublished data). These juveniles were likely progeny of hatchery-released adult coho that were released into Mill Creek as juveniles and detected on Passive Integrated Transponder (PIT) tag antennas in Grape Creek during the winters of 2010-2011 and 2011-2012 (Obedzinski pers. comm. 2012).

Since 2004, coho have been stocked into Mill Creek, a tributary of Dry Creek entering Dry Creek approximately 6.5 miles downstream from the Grape Creek confluence. It has been speculated that this effort could result in a source population for Grape and Wine Creek coho (NMFS 2007). Evidence for this was observed during the winters of 2010-2011 and 2011-2012, when PIT tagged adult coho released as juveniles into the Mill Creek watershed were detected on PIT tag antennas in Grape Creek. (Five adults were detected in 2010-2011, and five in 2011-2012.) Grape and Wine creeks provide 2.3 and 1.8 stream miles of steelhead critical habitat, respectively (NMFS 2007). The vast majority of this area has been surveyed by both DFW and NMFS. The following summarizes the findings of various habitat surveys of these creeks over time.

In a 1976 survey report, Grape and Wine creeks were noted to "provide both winter and summer flow to Dry Creek as well as extend fair steelhead nursery and spawning habitat approximately 4 miles" (DFG 1976a). Suitable habitat for salmonids occurs in the upper and lower portions of Grape

[8] "Independent" populations are those with a high likelihood of persisting over 100-year time scales (Bjorkstedt et al. 2005).

Creek (and less in the middle section). The survey report notes, "A major limiting factor in this creek is the very low flows in the summer..." (DFG 1976a). Notably, the surveyors also concluded, "The simultaneous operation of the three agricultural diversions during summer flows may pose fish survival problems..." (DFG 1976a). The surveyors also found a scarcity of deep pools and good spawning gravels in Grape Creek.

In Wine Creek, the survey found "only fair spawning habitat" and "relatively poor nursery area in the lower portion of Wine Creek" due largely to drying conditions in the summer. The upper creek was considered "fair spawning habitat and nursery area" (DFG 1976b). The survey report states, "A major limiting factor of this entire stream is the low water flows in the summer." The surveyors also noted a lack of spawning gravel in the creek.

A 1998 Grape Creek survey produced observations of age 0+ and 1+ steelhead and the subsequent report (DFG 2006a) included observations of steelhead spawning in 1999. The survey report concluded, "...few 1+ fish were observed indicating poor rearing conditions the year before or poor holding-over conditions in general. Overall, habitat conditions for both steelhead and coho have declined over time" (DFG 2006a). Lower Grape Creek was found to have "eroding stream banks" and "lack of riparian habitat." Upstream reaches were said to have "many opportunities" for improving instream shelter and decreasing bank erosion.

Wine Creek also was surveyed in 1998, and produced observations of steelhead juveniles and three juvenile coho. The subsequent report states, "The best spawning habitat in the [Grape Creek] watershed exists in the middle portion of Wine Creek. The best rearing habitat exists within the middle and upper portions of Wine Creek" (DFG 2006b). Like Grape Creek, the lower portion of Wine Creek was found to have "eroding stream banks" and "lack of riparian habitat," while upstream reaches were said to have "many opportunities" for improving instream shelter and decreasing bank erosion. The mid-watershed barrier was recommended for modification since suitable upstream habitat was observed to be under-utilized.

Grape and Wine creeks surveys occurred in March 2007 (NMFS 2007). At that time, juvenile steelhead were observed throughout the lower 1.5 miles of Grape Creek, as well as adult steelhead and steelhead redds. In the lowest reach (of four reaches), habitat impairments included extensive modification of the riparian corridor, passage barriers, high fine sediment delivery and direct access by livestock.

Juvenile steelhead and steelhead redds also were observed in Wine Creek in the 2007 survey, throughout the lowest one mile of the stream (NMFS 2007). The survey also noted extensive riparian encroachment, high amounts of invasive species in the riparian corridor, high fine sediment delivery (particularly associated with road construction), likely effects of removing wood from the channel and the presence of passage barriers. Wine Creek was said to suffer from "acute sedimentation problems" that "would necessitate a coordinated, watershed-wide effort that addresses roads, past and present impacts from land use, repair of human-related erosion sites, and alleviation of channelization and riparian encroachment" (NFMS 2007, p. 54).

2.5 Factors Limiting Salmon Recovery

2.5.1 Barriers

As part of this plan, we reviewed potential fish passage barriers in Grape and Wine creeks, using the stream survey reports, the DFW's Passage Assessment Database (PAD), a comprehensive Russian River basin fish passage evaluation (Taylor *et al.* 2003) and site visits. The following details our findings, with the conclusion that no total fish passage barriers occur in either Grape Creek or Wine Creek. At least four barrier modification projects (one on lower Grape Creek and three on Wine Creek) are considered priorities for the basin. The locations of the barriers discussed below are shown on Figure 16.

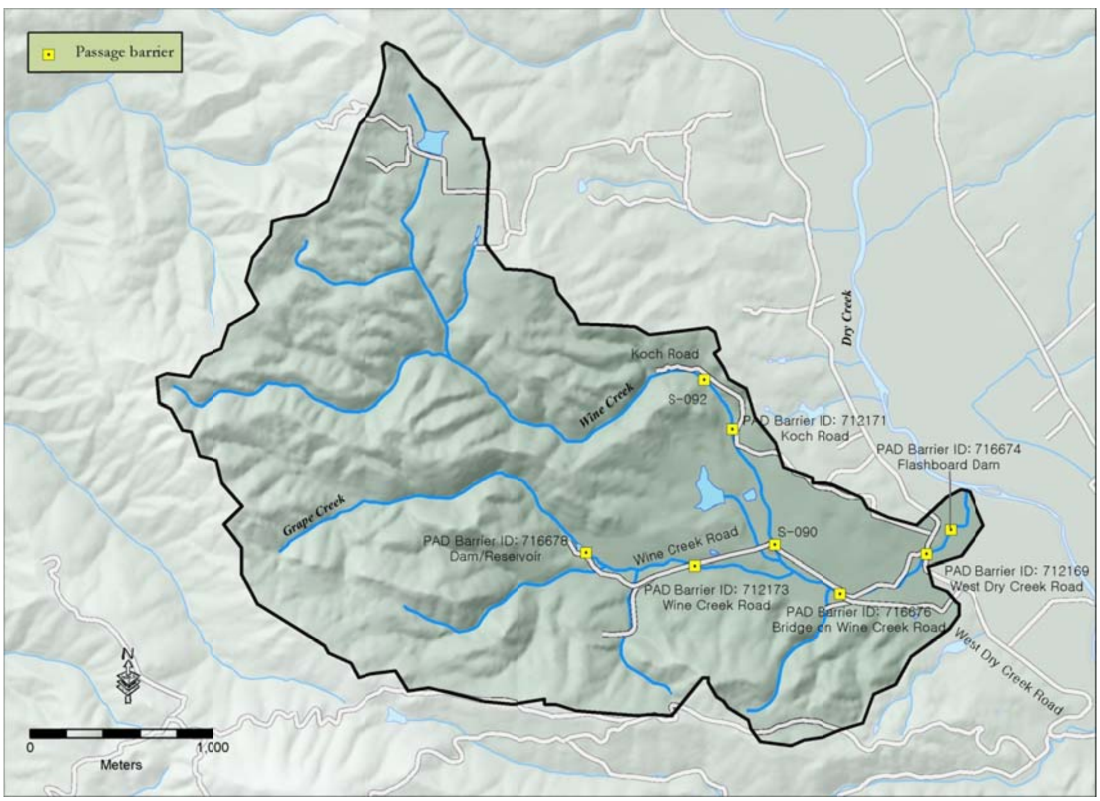

Figure 16. Documented passage barriers in the Grape Creek watershed

Multiple fish passage barriers were noted in a 1976 survey of Grape Creek including a diversion dam at approximately RM 0.2 (PAD 716674), a box culvert at the West Dry Creek Road crossing (RM 0.3; PAD 712169) and diversion dams at RM 0.35 and RM 1.4. Additional PAD-listed barriers on Grape Creek consist of two Wine Creek Road crossings (PAD 716676, 712173) and a dam (PAD 716678). The diversion dams on Grape Creek no longer operate. The obsolete flashboard dam in lower Grape Creek presents a partial impediment to fish passage because its concrete footings and base are still present, and has led to accumulation of fine sediment upstream. In addition, the West Dry Creek Road crossing (Figure 17), identified by Taylor *et al*. (2003) as a priority for modification due to "lack of depth," was modified in 2012 to improve fish passage. DFG estimated, "that this project would approximately double the opportunity for migrating adult salmon and steelhead to ascend Grape Creek" (Coey pers. comm. cited in NMFS 2008). The Sonoma County Water Agency funded the retrofit of the crossing.

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The Wine Creek Road crossings of Grape Creek upstream of West Dry Creek Road have been determined to be passable at a wide range of flows. Farther upstream, the dam (aka the "Mazzera Farm Pond") has not been prioritized for modification for fish passage. Prior to the dam's construction, a site investigation concluded that the dam would block access to approximately 100 yards of "poor spawning and nursery area" (DFG 1960). Due to the intermittent nature of the creek in the vicinity and the presence of a natural limit of anadromy immediately upstream from the dam location, construction was allowed without a fishway or trap at the site.

The PAD indicates the presence of only one anthropogenic fish passage barrier on Wine Creek, located at RM 0.5 (PAD 712171). This barrier is a Koch Road crossing of Wine Creek consisting of a five-foot diameter culvert "overdue for replacement" (Taylor *et al*. 2003). A flatcar bridge has been recommended as the preferred modification. While there is "limited upstream habitat," salmonids have been observed consistently upstream from this barrier in recent years and the barrier was ranked as 23rd priority for modification in an assessment of stream crossings in the Sonoma County portion of the Russian River Basin. The upstream PAD-listed barrier is a waterfall believed to mark the upstream limit of anadromy.

One additional (non-PAD) barrier has been identified at the Wine Creek Road crossing of Wine Creek (RM 0.1; S-090). The barrier is a low gradient culvert; it has been identified by Taylor *et al*. (2003) as a moderate priority for modification (*i.e.*, 59th of 125 ranked barriers in the Sonoma County portion of the Russian River Basin). An upstream Koch Road crossing of Wine Creek (RM 0.7; S-092) was given higher priority (*i.e.*, 40th of 125) for modification and was replaced with a free span bridge. Modification of barriers on Grape and Wine creeks is dependent on funding, agency prioritization and potentially landowner cooperation, and projects to address county road crossings or other partial barriers other than the West Dry Creek Road Crossing do not appear to be imminent (Minton pers. comm.).

2.5.2 Landscape Modification

Landscape modifications associated with agricultural production have led to substantial losses of riparian canopy along Grape Creek. Clearing of mature trees, road construction, and periodic soil disturbance would be expected to increase runoff quantities and velocities and decrease the lag time between runoff events and peak flows. Downcutting of the stream channels is in evidence throughout extensive portions of both creeks. The riparian corridor also includes high densities of invasive plant species (NMFS 2007).

Other land use practices, particularly removal of large wood from the streams, have led to a lack of physical habitat complexity. Presumably, areas of shallow, low-velocity water associated with fry and age 1+ juvenile rearing occur at lower than desired frequencies due to the channel modification that has occurred. These areas provide valuable feeding opportunities as well as refuge from high flows.

In 2010, of six reaches studied in multiple streams, juvenile coho survival was lowest in lower Grape Creek reach, which also had the lowest shelter rating. In this reach survival decreased in months when the average daily flow was less than 0.1 ft^3/s (UCCE/CSG 2012).

2.5.3 Flow

Severe low summer flow is considered the most important factor limiting the quality and extent of rearing habitat. In particular, portions of the drainage network become discontinuous during the summer dry season, with pools separated by dry riffles, and long extent of dry streambed. Low flow is associated with elevated water temperatures, poor water quality (especially low dissolved oxygen), decreased food supply, increased predation and competition, and other factors leading to decreased survival, growth and fitness during summer. While the long dry season results in naturally low streamflow levels through the summer, water diversion during this period is believed to make low-flow conditions more persistent and more acute than conditions in the absence of human development.

The basin experiences cool, wet winters with high runoff, as most precipitation falls as rain. High seasonal rainfall, low permeability of soil and underlying bedrock, and steep slopes contribute to “flashy” conditions in the watershed. Additionally, intensive agricultural land use and clearing of large wood from streams have produced conditions where streams lack the complexity to provide refuge from high velocity flows associated with winter storms and spring freshets. These conditions can increase likelihood of redd scour, entrainment of juvenile fish into poorer downstream habitat areas and other effects that decrease the basin’s capacity to generate large numbers of large healthy smolts.

2.6 Restoration Efforts

Restoration activities have included multiple landowner, agency, non-profit, and funding partners and addressed a number of the limiting factors identified above. In 2008, NFWF, DFG, and the National Oceanic and Atmospheric Administration (NOAA) worked with TU (and Bioengineering Associates) to complete bank stabilization and riparian planting, and willow wall revetment installation to improve habitat and refugia at Quivira Vineyards and Winery, to install weirs to improve fish passage at the West Dry Creek and Koch Road crossings of Grape and Wine creeks, to enhance a 2500-foot reach of Wine Creek at Michel-Schlumberger Wine Estate, and to replace a Koch Road fish passage barrier with a bridge on upper Wine Creek, as mentioned above (see Figure 18). That project eliminated a priority passage barrier.

Figure 18. Wine Creek flowing under Koch Road (before and after crossing modification)

In 2007, Sotoyome Resource Conservation District (SRCD) completed a comprehensive inventory and sediment source assessment along Chemise Road, which traverses the Grape Creek watershed, to identify, prioritize and recommend cost-effective treatments of sediment delivery sources most likely to impact salmonid bearing stream channels.

In 2009 and 2010, the Sonoma County Water Agency (SCWA) in cooperation with SRCD, installed complex log and boulder structures along approximately 1500 linear feet of Grape Creek and completed bank repair within a 200-foot reach of the same creek. Bank repairs included regrading incised banks to slow sediment inputs and allow for additional shade through native plant revegetation.

There are on-going efforts to improve habitat conditions in Grape and Wine creeks including bank stabilization, revegetation, barrier modification, and the addition of large wood structures. In addition, SCWA, through the Russian River Biological Opinion, is planning to implement a habitat enhancement project on six miles of Dry Creek to improve rearing conditions for salmon and steelhead.

Until recently, habitat restoration had not included any concerted effort to monitor or improve streamflow in the watershed. The goal of CSSP is to gather and collect the information necessary to identify, prioritize, permit, and implement feasible and beneficial projects that restore instream flow and thereby improve habitat conditions and survival for salmonids in Wine and Grape creeks. Since beginning our work under CSSP, we have been able to expand our approach within the watershed through the Russian River Coho Water Resources Partnership. As described above, the Partnership is comprised of six organizations: CEMAR, Gold Ridge Resources Conservation District, the Occidental Arts and Ecology Center's Water Institute, UCCE/CSG, SRCD, and TU. Through that partnership we have broadened our outreach efforts, added a fisheries monitoring component to develop streamflow recommendations and evaluate project effectiveness, and are working in four additional high-priority coho watersheds in the Russian River.

3. Human Water Use

This SIP outlines a strategy to address low flow in the dry season. Just as the climate of the Russian River watershed can place pressures on human and salmonid populations during the dry season, it can provide opportunities to ameliorate those pressures during the rainy winter. As stated earlier, the Grape Creek watershed receives between 42 and 46 inches of rainfall in an average year, with 90 percent occurring between November and May. The dry season, from May through October, is the period when water needs are highest for residential and agricultural uses alike, yet this period is marked by progressively lower streamflow until rain begins again in the fall. As people who live and work in the Grape Creek watershed obtain water from the drainage network or adjacent shallow aquifers during the dry season, this may reduce the amount of water in Grape Creek when water in the creek is naturally at low levels.

The hypothesis of this project is that we can increase the amount of water in streams in summer by finding ways that people can either reduce their water use or switch their period of diversion from summer to winter. This section provides the rationale for this approach to meet human water needs by switching the timing of diversion and employing small storage projects in Grape Creek. It integrates a variety of CSSP efforts, including outreach to water users to gather information about the amount, timing and locations of diversions; GIS modeling efforts; water rights research; and analysis using the SWRCB Policy for Maintaining Instream Flows.

This section (a) describes water rights in the watershed and details why they alone do not provide an accurate estimate of water use and need, (b) describes water need across the watershed at an annual scale by compiling water use information (where available for individual properties) and estimates of water use based on land use (where more refined information was not available), (c) highlights the disparity between discharge in the rainy versus dry seasons and compares discharge with seasonal human need, and (d) evaluates the impacts that the current diversion regime has on streamflow through the year at a daily scale.

We conclude that there is sufficient water available to meet human needs at an annual scale, but not in the summer, and that sufficient water should be available to meet this summer need through winter diversion and storage. In subsequent sections, we look at the conditions under which water can be obtained in winter in ways that minimize potential impacts to fish and provide project recommendations.

3.1 Human Water Need

Human water need is an important variable to understand the dynamics of human water use and water availability on a broad timescale. Human water need describes the amount of water that is required for human uses over a given interval such as a season or a year (Deitch *et al*. 2009A). Water need characterizes the amount of water that people can be expected to use over a season, but not the terms of obtaining the water. For example, a farmer who irrigates 5 AF per year has an irrigation water need of 5 AF during the growing season; that water need may be satisfied many ways, including diversion from streams or nearby groundwater during summer or through storage into a reservoir during winter for use in summer. We use this section to compare the amount of water that humans require for various uses over the year and then distinguish between winter and summer seasons to illustrate streamflows that could be expected from Grape Creek over those same time periods. We use this comparison of human water need and available supply to inform the recommendations that follow in Section 5.

3.2 Water Need and Water Rights

One way to view the amount of water people need for various uses over the year in the Grape Creek watershed is through the rights that people have to take water from the Grape Creek drainage network. The SWRCB's Electronic Water Rights Information Management System (eWRIMS) database lists water rights on file with the SWRCB throughout the state of California. As of 2012, two water rights for water diverted from the Grape Creek system are listed in the database (Figure 19).[9] The first water right (Application 016163, License 009846) is held by Michel-Schlumberger Partners LP[10] along with multiple non-primary owners. The license is for a maximum direct diversion rate of 0.19 ft^3/s from May 1 through October 1 and the maximum diversion amount is 17.5 AF per year. It also includes a bypass term stating that the licensee "shall by-pass 100 [gallons per minute] or the natural flow of the stream, whichever is less at the point of diversion between November 1 of each year and June 1 of the succeeding year for the preservation of fish life" (SWRCB, License 9846).

The second water right is a pending application for Michel-Schlumberger Partners LP. The application is for diversion (A031735) from an unnamed stream tributary to Wine Creek to an on-stream 49 AF pond for vineyard (and olive) irrigation from November 1 through May 31.[11] Together, these two water rights total 66.5 AF per year.

[9] Note that some landowners have points of diversion outside the Grape Creek watershed –Dry Creek or unnamed streams adjacent to the Grape Creek watershed -- and places of use within the watershed.

[10] The entry is misspelled in eWRIMS as Michel-Schlumberer Partners LP.

[11] DFG, the Sonoma County Water Agency (SCWA), and Trout Unlimited protested the pending water right application. TU protested the application, not because TU disagrees with the storage project – indeed, the storage probably provides a better alternative to direct diversion from Wine or Grape creeks -- but rather because protesting provided a seat at the table and an avenue to continue to work with applicants through the water rights process.

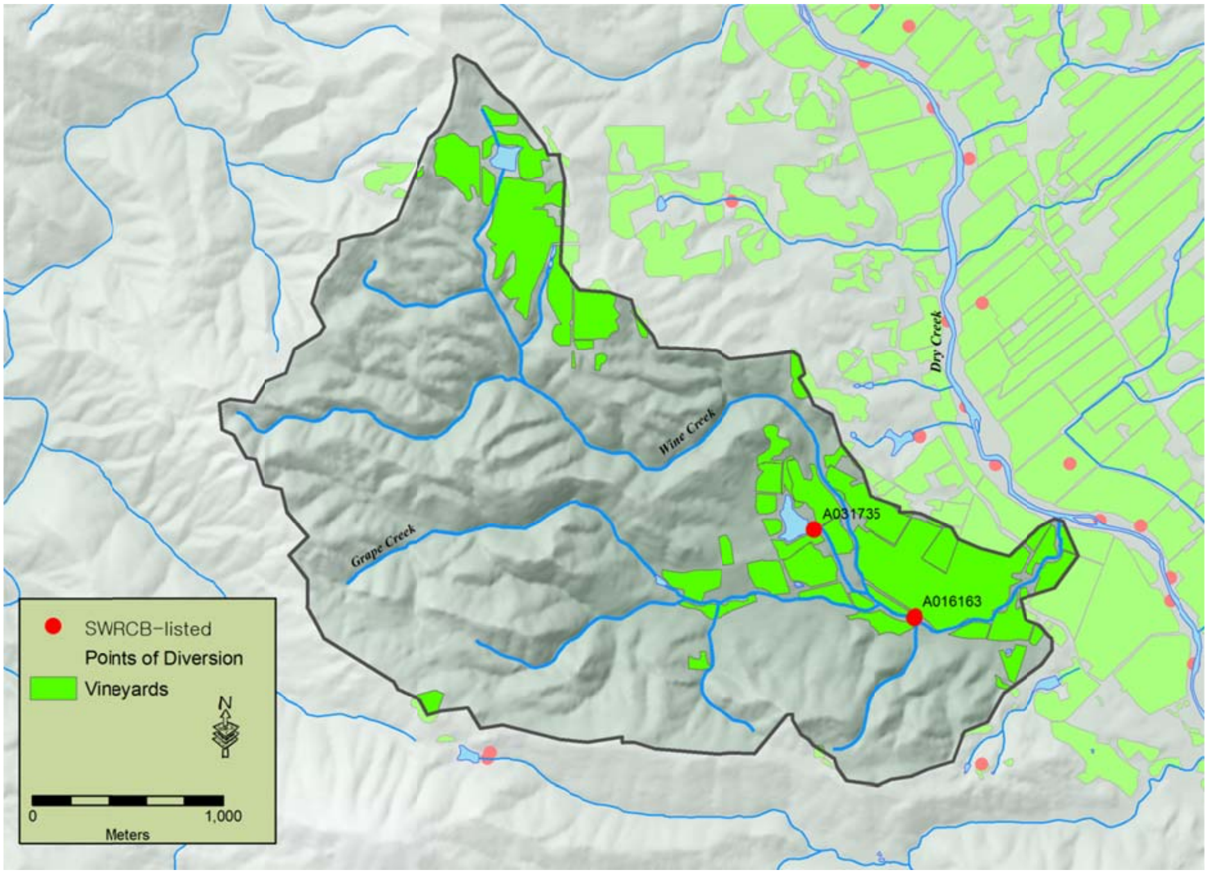


Figure 19. Water rights in the Grape Creek watershed (2012) in SWRCB eWRIMS database

Water rights are not the most accurate means to estimate water need as they provide a limited glimpse into water use across the watershed and under-represent the number of people taking water from Grape Creek. While only one water user has recorded and pending water rights, there are many more diversions in the catchment. The eWRIMS database will not capture riparian or pre-1914 water rights where the water user has not submitted a Statement of Water Diversion, uses for which a permit or license is not required (*e.g.*, diversion from springs or percolating groundwater), or illegal water use. In addition, the SWRCB may be processing some Statements of Use that have not yet posted to eWRIMS. At least one other landowner in the watershed has submitted a Statement of Diversion and Use and it is possible that other landowners, especially those acting in response to the increased penalties for non-reporting in Water Code 5107 (Senate Bill X7-8 [2009]), may have submitted Statements of Diversion and Use as well.[12]

[12] It is possible to have a valid riparian water right that is not entered into the system, but riparian right holders should file statements of diversion and use with SWRCB; when they do, their claimed water right appears in eWRIMS. Until recently, there was little motivation for riparian right holders to file statements of diversion and use, but because of recent changes in state law many riparian right holders have recently filed statements, and in the future one would expect more riparian rights to appear in the database.

3.3 Annual Scale: Human Land and Water Use

More comprehensive estimates of water need for various human activities can be developed in Grape Creek based on regional water needs for each type of activity. Activities in the Grape Creek watershed include agricultural irrigation, frost protection, domestic use, and industrial uses (for wineries).

We estimate vineyard water need as the sum of vineyards in the watershed multiplied by a per-acre water need value; conventional estimates of vineyard irrigation water need in Sonoma County on a per-acre basis is 0.67 AF per acre. To determine vineyard coverage, we traced vineyards identified on aerial photographs onto a geographic information system, and summed the total amount of vineyards in the watershed. Thus, for the 322 acres of vineyards in the Grape Creek watershed, total water need is approximately 236 AF.[13]

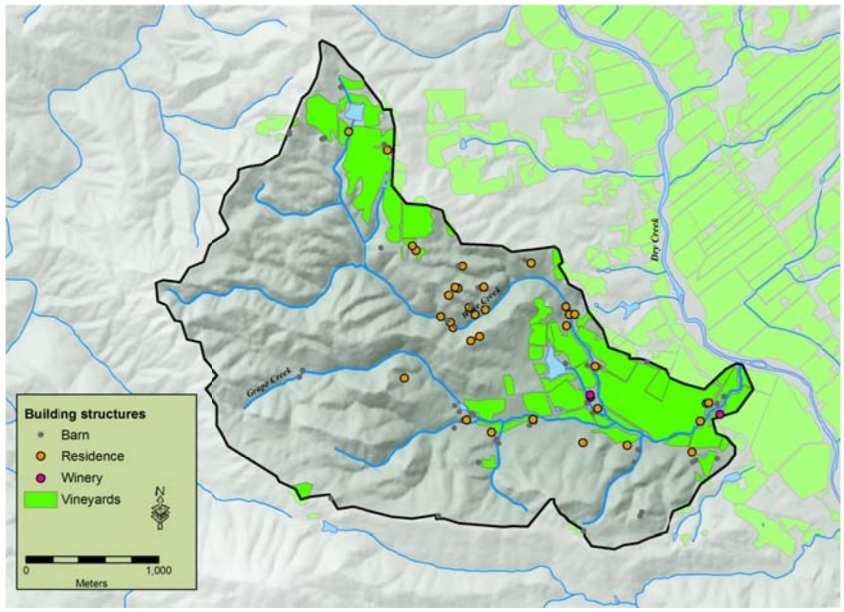
In addition to irrigation water needs, we estimate frost protection water needs for those vineyards in the Grape Creek watershed that obtain water from the watershed for frost protection. Because of the attention given to frost protection over the past five years, CSSP partners and partners involved in related projects have made an effort to understand the extent of frost protection water use, and where possible, find alternatives to drawing water directly from the stream or to using water to protect grapes from frost altogether. Many grapes in the lower portion of the watershed are now protected by fans: four fans have been installed in the lower portion of the catchment, one of which was purchased with partner funds from NFWF and replaces a direct instream diversion on the order of 1.0 ft^3/s. In 2012, one other grape grower in the watershed who had historically drawn water from Grape Creek for frost protection constructed an offstream reservoir to serve five acres of grapes. Water will no longer be pumped directly from Grape Creek for frost protection; instead, the reservoir will be filled from groundwater in winter. Based on his system's configuration and past frequency and duration of use, we estimate he needed as much as 0.7 AF per acre in cold years, for a total of 3.1 AF. Based on historical estimates of duration and frequency of frost protection, we estimate that as many as 4 AF may have been needed to protect grapes in a particularly cold year prior to project implementation. Managers of all other vineyards in the watershed either use fans for frost protection, obtain water from other sources (*e.g.*, from small reservoirs filled via Dry Creek) or do not frost protect at all.

We also estimated the total water need for houses and wineries in the watershed. Houses were identified through a GIS shapefile developed by Sonoma County of buildings traced from aerial photographs (Figure 20), and further refined based on known information about residence locations

[13] This likely overestimates the actual water need in the watershed for irrigation. Through our conversations with vineyard managers, we have confirmed that some growers use as little as 0.25 AF per acre; a few others use no water at all. Nevertheless, we use the estimate of 0.67 for calculations because it reflects conventional water needs, whereas current irrigation practices may change if management or other characteristics influencing water need were to change.

so that residences included houses but did not consider barns or garages. Once we identified houses in the watershed, we multiplied the number of houses by an estimate of 0.5 AF needed per house to calculate a total need of 18 AF for residential uses. Based on conversations with winery operators in the watershed, we estimated water need for each of the two wineries was 2 AF.

Using these assumptions, the total human water need in the Grape Creek watershed is 257 AF per year (Figure 21). This figure likely overestimates the amount of water need satisfied through diversions from the Grape Creek watershed. A number of landowners obtain water from sources other than Grape Creek, including Dry Creek and other unnamed streams outside of the Grape Creek watershed.



Annual comparisons of Grape Creek discharge to human water needs provide preliminary insights to whether the water that falls on the Grape Creek watershed should be able to meet the needs of humans living and working in the watershed, if small water storage projects were employed through CSSP. Based on the data describing rainfall and streamflow above (Section 2.2), the Grape Creek watershed receives approximately 8,500 AF of rainfall per year; approximately 4,600 AF leave the watershed as streamflow. Thus, the 257 AF need in the Grape Creek watershed represents approximately three percent of the average annual rainfall and 6 percent of the average annual discharge (Figure 21). This comparison suggests that sufficient water resources should be available in the Grape Creek watershed to meet human needs over an annual scale.

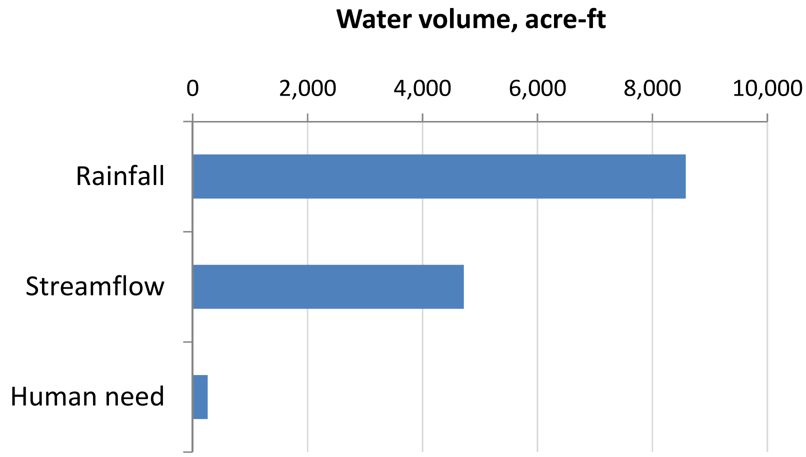


Figure 21. Comparison of average annual rainfall, streamflow, and human water need in the Grape Creek watershed

3.4 Seasonal-Scale: Comparing Water Need to Discharge

3.4.1 Summer

While the water balance above indicates that there should be sufficient water in the Grape Creek watershed to meet human needs on an annual scale, a comparison of discharge to water need during the dry season highlights the challenges for managing water resources in this region. Typical monthly discharge from Grape Creek can be estimated based on data collected in 2010 and 2011: based on streamflow records from CSSP gauges, we can calculate monthly discharge through the dry season. Similarly, we can estimate human water need during summer as a fraction of agricultural, domestic, and industrial needs. One hundred percent of the water needed for irrigation is needed in the dry half of the year (236 AF). We can also estimate the domestic water need during the dry half of the year as two-thirds of the annual residential water need: additional water is needed for gardening and landscaping, which frequently comprises as much as half of total domestic water need (Gleick *et al*., 2003). Thus, domestic water need during the dry half of the year can be estimated as 12 AF. Additionally, we estimate that half of the water needed for industrial uses is in the dry half of the year (2 AF). Based on these estimates, 250 AF of water are needed during the dry half of the year.

If we assume that human water need is distributed evenly through the dry season, we can compare average monthly discharge from our CSSP gauge at West Dry Creek Road to monthly water need in the Grape Creek watershed. This comparison highlights how water need through the dry season comprises a substantial portion of the discharge early in late spring, and exceeds discharge throughout summer (Figure 22), suggesting that discharge alone cannot be expected to meet human water needs during the dry part of the year. These data essentially substantiate and quantify the objectives of the project from an ecological and hydrologic perspective. As summer streamflow is a limiting condition for the survival of salmonids in the Grape Creek watershed, the dependence on water from Grape Creek to meet human needs likely exacerbates these conditions.

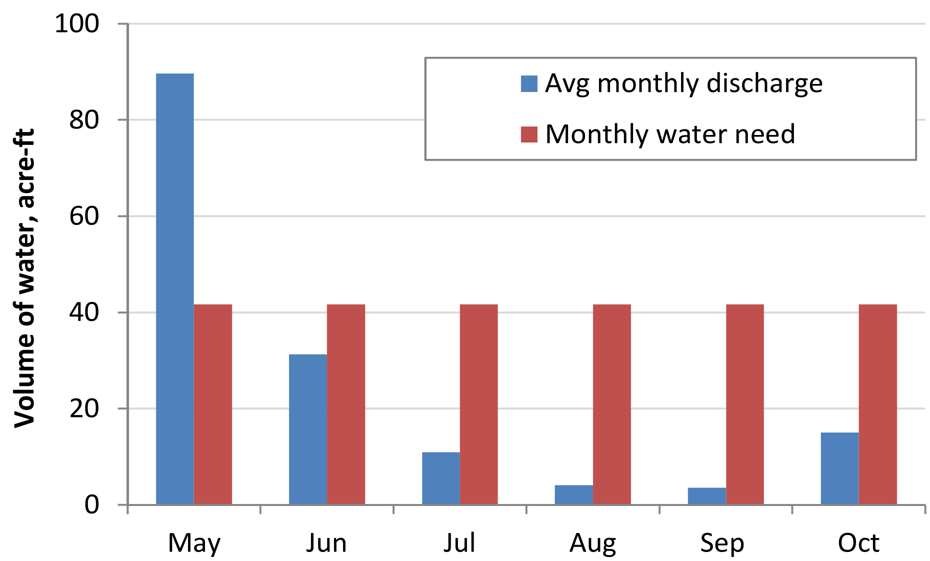


Figure 22. Monthly-scale discharge and water need in Grape Creek through the dry season

3.4.2 Winter

One of the principal goals of these hydrology analyses is to evaluate whether the water needs in Grape Creek during summer could be accommodated through water storage in winter. Seasonal estimates of water need and discharge (*e.g.*, December 15 – March 31) can demonstrate whether additional water is available in winter for further appropriation into storage (and serves as a preliminary step for obtaining an appropriative water right from the SWRCB). As a preliminary check for whether there is sufficient water available for additional surface water appropriation, the SWRCB recommends a seasonal-scale comparison of average discharge from a given water body to the amount of water already allocated through riparian and appropriative rights (including pending appropriations). The season to be considered is winter; in general, because of needs to protect aquatic biota that depend on the low water levels during the dry season, the SWRCB will only grant an appropriative water right for the period December 15-March 31.

SWRCB policies stipulate that this analysis is to be done using historical streamflow records from a gauge with a minimum ten-year period of record, either from within the watershed of interest or from a nearby gauge. Because no long-term historical records exist for Grape Creek, we instead have used data from nearby gauges to estimate Grape Creek streamflow. Gauges in Austin Creek and Pena Creek provide the nearest streamflow data sets longer than ten years (Figure 23); another gauge, on Maacama Creek near Kellogg, provides a longer period of record and reflects similar precipitation patterns to Grape Creek. Using these three data sets, we scaled streamflow values according to methods recommended by the SWRCB (and reviewed by USGS, 2004) to create three estimates of hydrologic records for Grape Creek.

$$Q_{Grape} = Q_i \left(\frac{Area_{Grape}}{Area_i}\right)\left(\frac{Annual\ Precipitation_{Grape}}{Annual\ precipitation_i}\right) \qquad (1)$$

Despite the fact that Austin Creek receives considerably more rainfall than Maacama Creek, streamflow statistics for Grape Creek derived by scaling data from the Austin Creek gauge and from the Maacama Creek gauge according to Equation 1 are similar. Based on Austin Creek records, the estimated average annual discharge in Grape Creek at the Dry Creek confluence is 5,000 AF. Based on Maacama Creek records, the estimated average annual discharge is approximately 4,700 AF. Both correspond to approximately 55 percent of the water that falls as rain being converted to streamflow, which is considered a typical conversion ratio of rainfall to discharge for northern coastal California streams (Rantz and Thompson 1967). The estimate from scaled Pena Creek data suggests lower discharge: the average annual discharge would be 3,900 AF. The conversion ratio of rainfall to streamflow using scaled Pena Creek data is 44 percent.

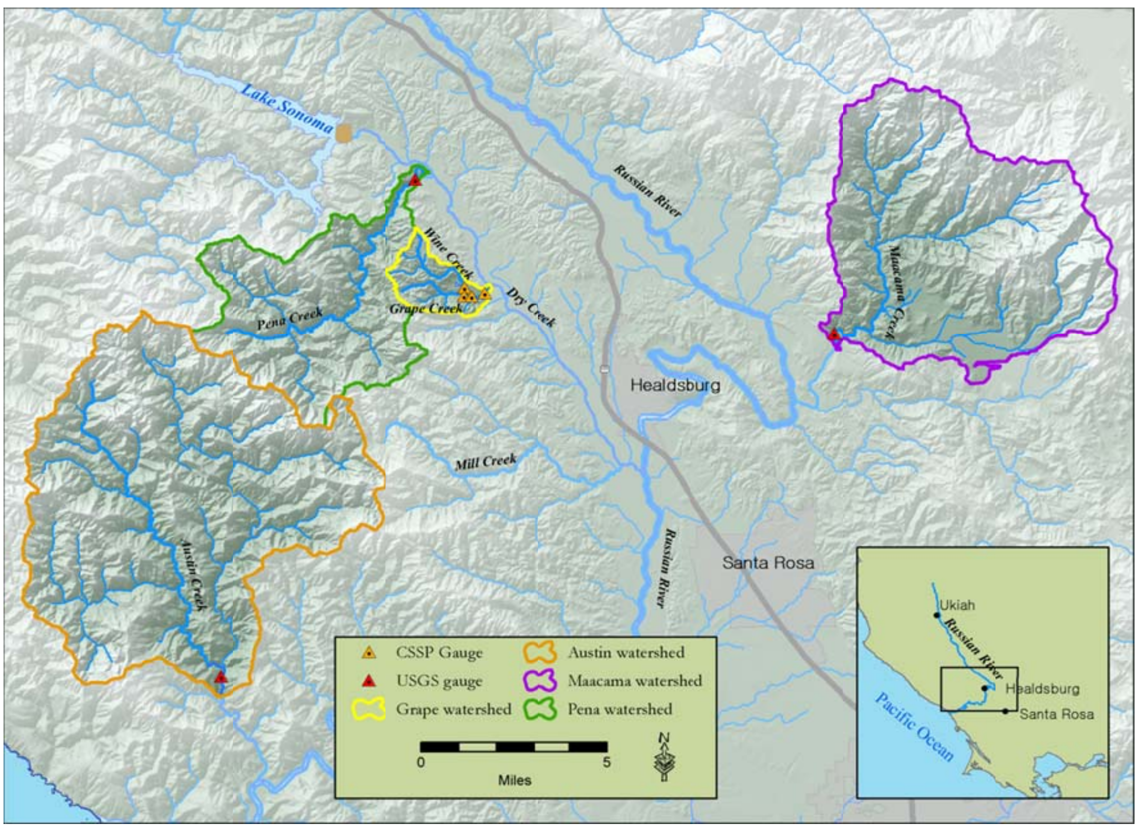


Figure 23. Grape Creek and nearby watersheds (Austin Creek, Pena Creek, and Maacama Creek) that have USGS streamflow records for periods longer than ten years

Based on these estimates, the proportion of Grape Creek discharge that occurs between December 15 and March 31 ranges from 3,000 to 3,900 AF in an average winter season. As described above, two water rights within the 3.4 square mile watershed are listed in the SWRCB eWRIMS database. The senior appropriative water right (A016163) is for 17.5 AF from Grape Creek and the junior (currently pending) application (A031735) is for 49 AF for a reservoir on a tributary to Wine Creek. The sum of these represents an annual-scale water need based on formally stated water rights of 66.5 AF; however, because the senior water right is for spring and summer only, it is not considered as part of the winter season comparison. Using data from Maacama Creek, which produces the median of the three Grape Creek winter discharge estimates, the water claimed in winter under pending water rights corresponds to 1.4 percent of seasonal winter discharge.

For planning purposes, it may also be useful to compare water rights volumes to typical discharge that may occur in winter of a *dry* year. Based on historical streamflow data from Maacama Creek (the median of the three data sets and the one with the longest period of record) and using similar methods as described above for extrapolating discharge to the Grape catchment, discharge in a typically dry year (*i.e*., exceeded in discharge by 87 percent of all years) is approximately 1,500 AF. In this scenario, in a dry year, allocated water represents 3.3 percent of annual discharge.

The above analyses use as inputs only those water needs that have been formally declared and listed as water rights by the SWRCB (eWRIMS review, March 2012). As described above, this almost certainly underestimates the number of water users and probably also underestimates the water demand in the watershed. Our estimate of winter-season water need can be augmented to include one-quarter of rural residential water need (estimated above as 18 AF annually) and industrial water need (2 AF annually) during the period from December 15 through March 31. Additionally, a portion of the vineyards in the Grape Creek watershed is irrigated by water obtained via rainfall and percolating groundwater and stored in winter that is not accounted for in the SWRCB's database; rainfall is stored in a leveed reservoir during winter, providing 4 AF to irrigate a 17-acre vineyard. The sum of these is 9 AF. Adding 9 AF to the 49 AF of water listed in water rights, the water obtained during the winter season comprises 1.6 percent of the average winter discharge in Grape Creek (using data scaled from the historical Maacama Creek USGS gauge).

The analysis presented in this section suggests that Grape Creek produces sufficient runoff in winter to satisfy water needs on an annual basis. Even considering undocumented water diversions, the amount of water taken in winter for human use in the Grape Creek watershed represents a small fraction (1.6 percent) of the winter discharge. Thus, summer streamflow improvement can be pursued by storing winter streamflow for use in summer to replace current summer diversions.

3.5 Daily-Scale: Diversion Impacts to Streamflow

Analyses of diversions at a daily or sub-daily scale are more useful for characterizing the impacts of human water use on streamflow. Diversion at such a timescale can be described as *demand*—the terms over which water users obtain water from the creek (Deitch *et al*. 2009A). By comparing demand to an estimate of streamflow in Grape Creek, daily-scale analyses can demonstrate the cumulative impacts that existing diversions may have on an unimpaired streamflow, where streamflow is derived from historical streamflow data from a nearby streamflow gauge (according to the protocols described above under the description of winter seasonal analyses, but instead using daily-scale data). This comparison is required by the SWRCB for water rights applications to evaluate cumulative impacts of existing diversions and additional impacts that a new diversion would have to streamflow.

We estimated cumulative impacts of diversions on streamflow in the watershed by calculating impaired hydrographs using the method recommended by SWRCB in the North Coast Instream Flow Policy. This method scales historical streamflow data from a nearby gauge according to a ratio of drainage area and precipitation (Equation 1, above) to create an unimpaired streamflow estimate, and then subtracts upstream diversions to create an impaired hydrograph. In calculating impaired hydrographs according to this method, we used the nearby Maacama Creek near Kellogg streamflow gauge (USGS number 11463900), operated from 1961-1982. We selected this gauge over the Pena Creek historical streamflow gauge (which is closer to Grape Creek) because the summer hydrology of Grape Creek more closely resembles Maacama Creek than Pena Creek. (Pena Creek is dry each year by July and in some years as early as May; and Grape Creek mostly continued to flow through summer in 2010 and 2011.)

3.5.1 Unimpaired Hydrograph: Baseline Conditions

To illustrate the cumulative impacts of diversions on streamflow in Grape Creek in the analyses below, we used streamflow from one particular year, water year 1966 (October 1, 1965 – September 30, 1966) to show how diversions could affect streamflow through the course of a typical year. Water year 1966 was the year with the median annual discharge recorded at the Maacama Creek gauge over its 20-year period of record, and the 1966 flow records contain characteristics typical of the flow regime of streams in this region of California. In the winter, high peak flows occurred periodically through the season and recession of streamflow following each large rainfall event was frequently punctuated by smaller rainfall events that caused flow to rise. Lighter rainfall in spring provided water to sustain base flow through spring and into summer. Streamflow receded through the summer until rain began again the following fall. The advantage of using one full year for analysis is that it allows easy comparison of impacts that could occur at different times of year, and one year can be simply presented in a hydrograph.

3.5.2 Impaired Hydrograph: Water Rights Inputs

To add impairment to the unimpaired hydrograph, the North Coast Instream Policy recommends using water rights that have been formally recognized by the SWRCB (and listed in the eWRIMS database). As described above, two water rights in the Grape Creek watershed were registered with the SWRCB as of March 2012 (for locations, see Figure 19): a pending application for an on-stream reservoir and a licensed direct diversion from May through September. The GIS model we used to evaluate cumulative effects incorporates the 49 AF of storage as a spill-and-fill reservoir, assuming that volume at the onset of the water year (October 1) is 0 AF: the reservoir continues to store water (and release no water downstream) until the sum of daily discharge equals the reservoir volume. (This analysis follows evaluation protocols recommended in the North Coast Instream Flow Policy, Appendix B; we recognize that the reservoir may be operated differently). At the point in the year when the sum of daily discharge at the location of the reservoir has exceeded 49 AF, the stream reconnects with the rest of the drainage network.

Based on these water rights data, upper Grape Creek and Wine Creek show no impairment because no diversions have been listed in the State Water Board's eWRIMS database. The reaches below the Grape/Wine Creek confluence show a varying extent of impairment caused by the diversion upstream based on proximity to the reservoir (Figure 24). Based on normal-year streamflow inputs, from the onset of the water year until January 3, the reservoir corresponding with Application A030375 near Wine Creek prevents all water from flowing into the tributary to Wine Creek immediately below the reservoir (assuming the reservoir has not been fitted with a bypass mechanism) (Figure 25A). The effect of this reservoir on unimpaired streamflow in Wine Creek is a reduction of just over 10 percent (Figure 25B); and at the confluence with Grape and Wine, a reduction of 5.7 percent (Figure 25C). There are no other formally recognized Grape Creek water rights that claim water in winter (as of March 2012), so after the reservoir is filled, no other impairment is caused by water rights during the period December 15-March 31. During the spring, the diversion of 0.19 cft^3/s can comprise 35 percent of spring discharge at the point of diversion and 100 percent of discharge by June 25 if the bypass conditions are not followed (Figure 26).

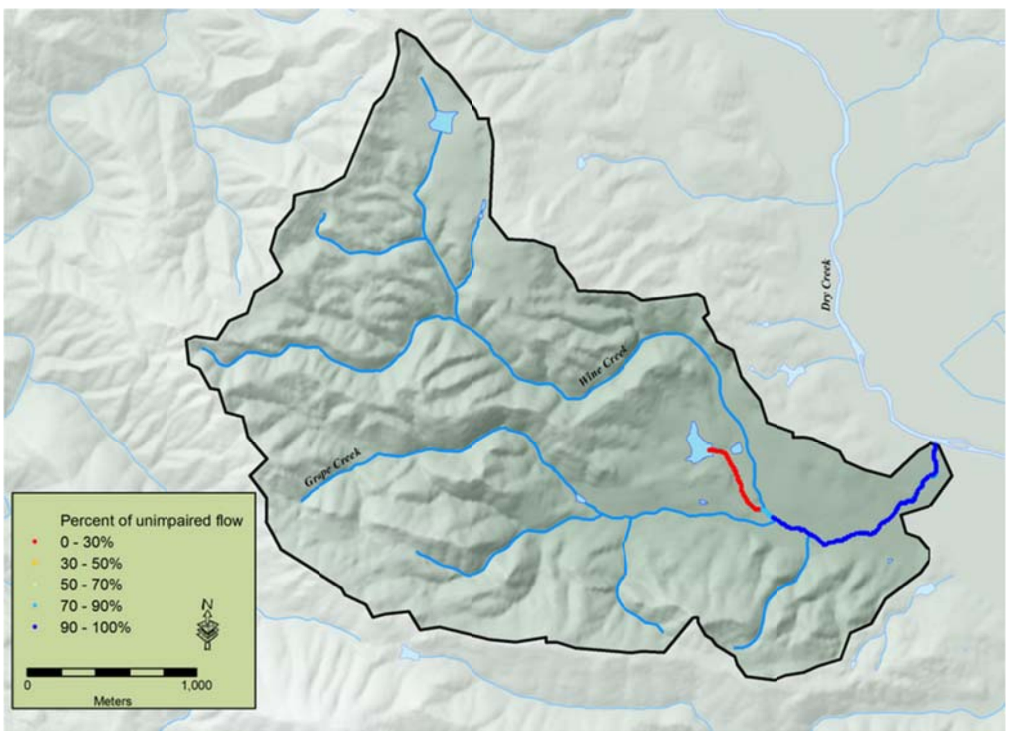


Figure 24. Map of impairment in Grape Creek as reservoir with pending water right fills

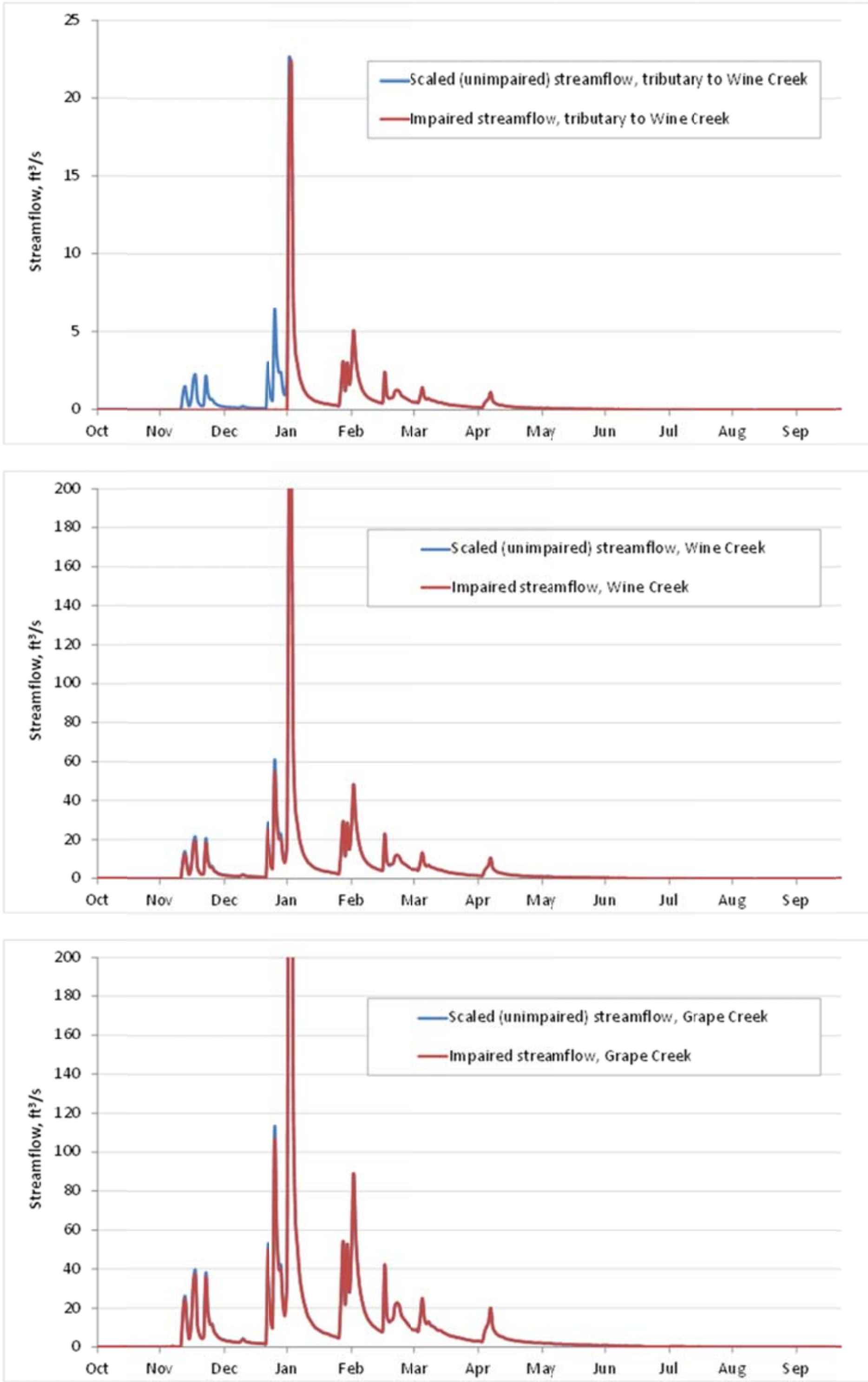


Figure 25 A-C. Impaired hydrographs showing effect of reservoir on tributary to Wine Creek: (A) immediately downstream from the reservoir, (B) at the confluence of the impaired tributary with Wine Creek, and (C) immediately downstream of the confluence

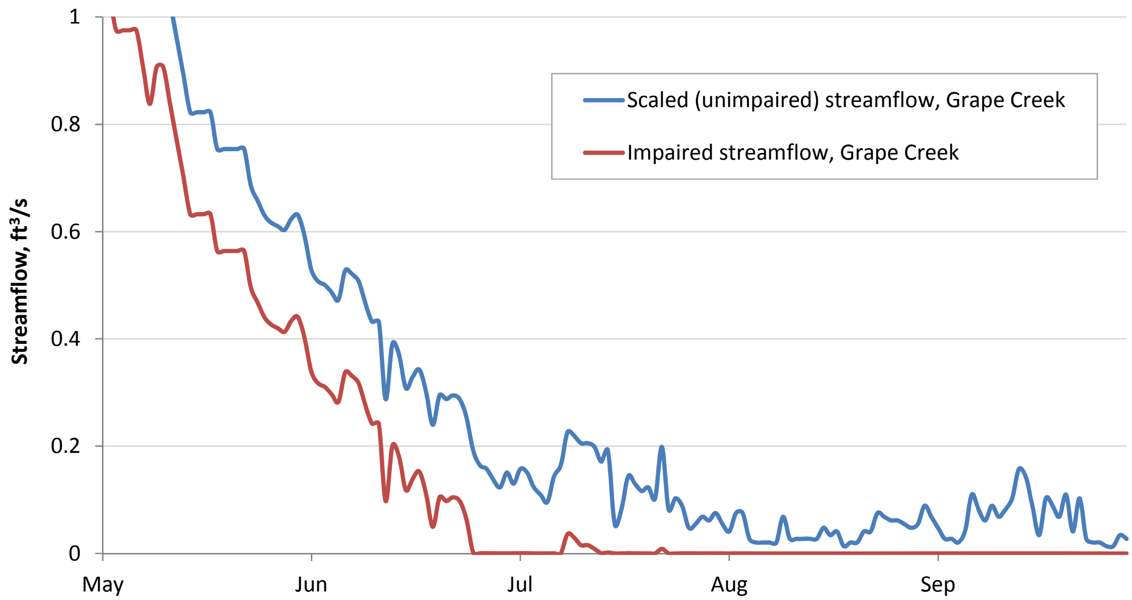


Figure 26. Unimpaired and impaired hydrograph through mid-spring and summer on Grape Creek below the Wine Creek confluence, calculated by subtracting the eWRIMS-listed water right from estimated normal-year Grape Creek streamflow data (based on historical Maacama Creek streamflow records)

3.5.3 Impaired Hydrograph: More Comprehensive Inputs

The two water rights incorporated into the SWRCB analysis represent a fraction of water users who rely on the Grape Creek drainage network to meet their needs. Several residences and vineyards in the Grape Creek watershed also get water either from the Grape/Wine Creek drainage network or from shallow wells immediately beside the creek (Figure 27), and each can be incorporated into a catchment-scale cumulative impacts analysis. We estimated the locations of residential riparian diversions in the Grape Creek watershed based on aerial photograph techniques described above to identify houses and proximity to the creek. We estimated vineyard diversions (many obtain water via shallow wells) based on known irrigation well locations and through discussions with landowners in the watershed. We estimated residential water demand as 0.022 ft^3/s (10 gallons per minute), and vineyard water demand as 0.044 ft^3/s (20 gallons per minute), and included the two eWRIMS-listed diversions as well.

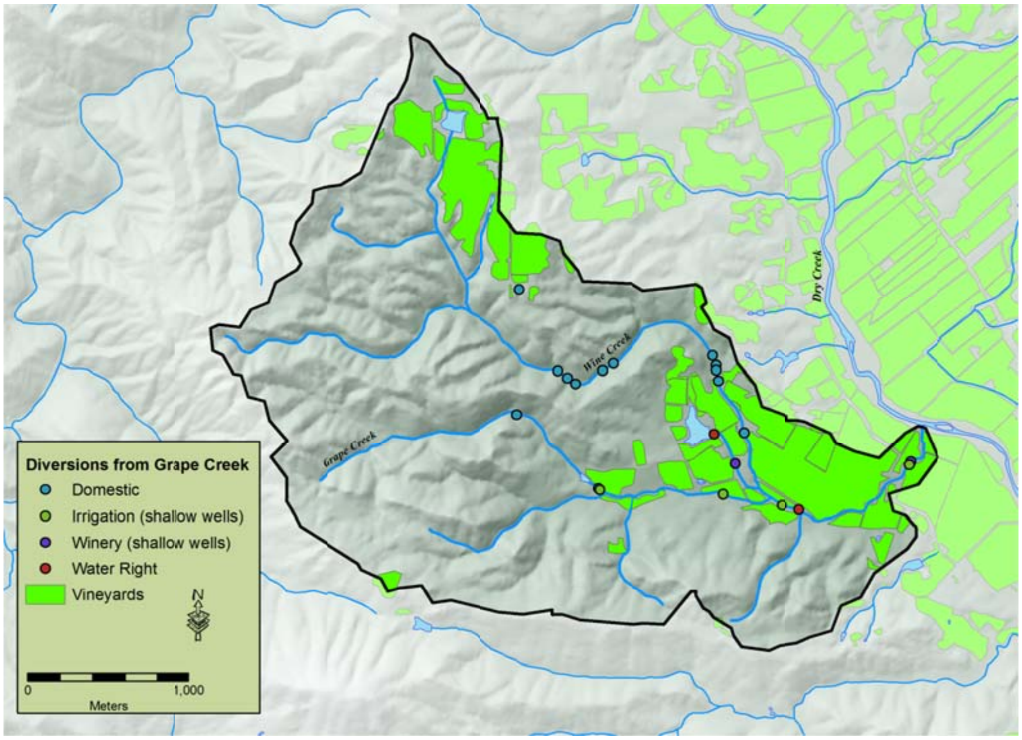


Figure 27. Points of diversion from or near the Grape Creek drainage network

The addition of several houses and vineyards in the watershed increases impairment throughout the year, although the impairment is most significant in summer. Winter streamflow still is maintained through most of the season, although diversions may impair flow by as much as 40 percent in early winter (*e.g.*, December 15) and by up to 20 percent during the lowest streamflow during mid-winter (*e.g.*, January 23; Figure 28). Diversions in Grape Creek, above and below the confluence with Wine Creek, impair streamflow by less than Wine Creek; Grape Creek retains more than 90 percent of its unimpaired streamflow through winter. Dry-season streamflow is more heavily impaired, with upstream diversions exceeding discharge in Grape Creek below the Wine confluence by mid-July (Figure 29).

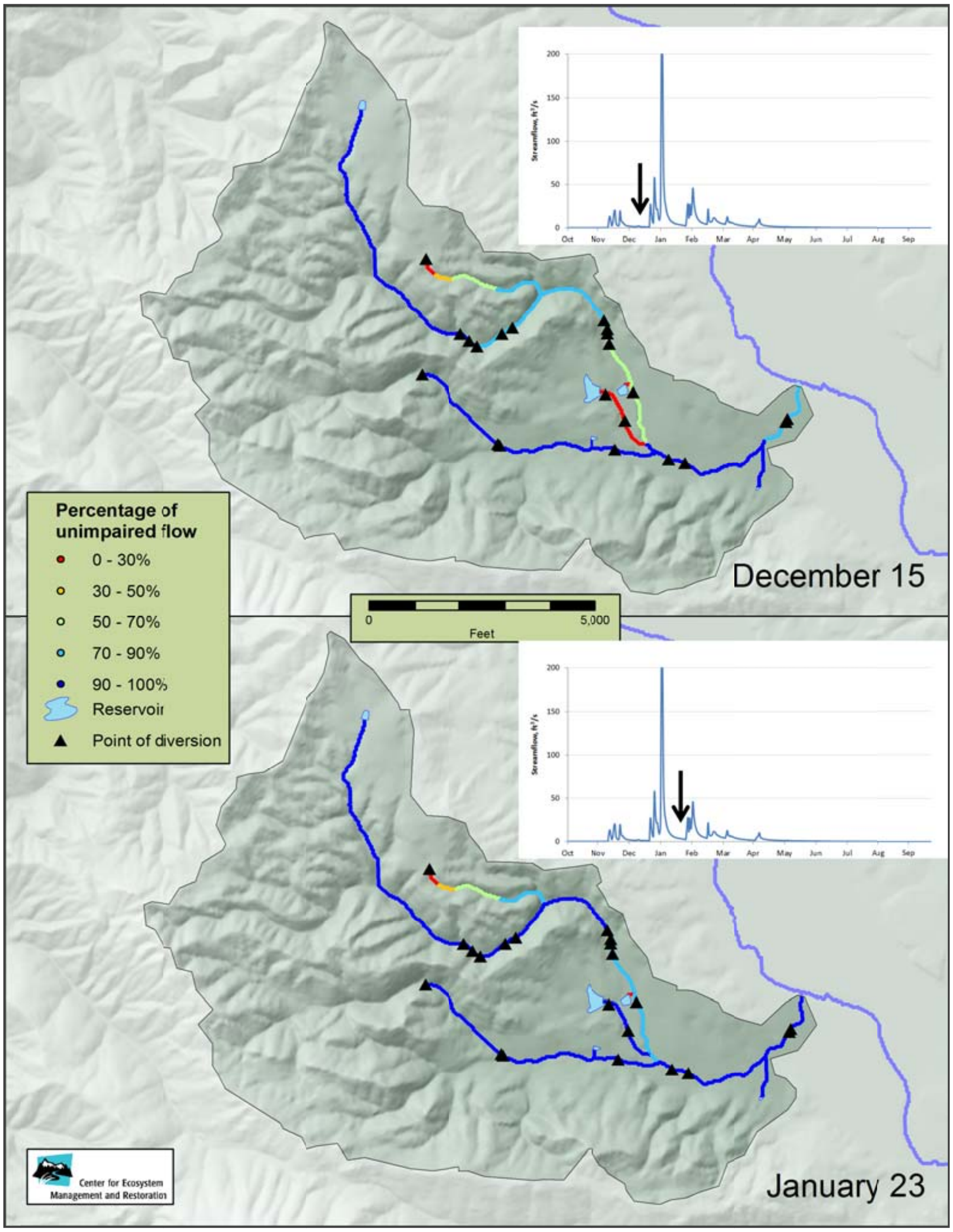


Figure 28. Maximum potential impairment caused by known diversions from the Grape Creek drainage network on two days in a normal type winter. Hydrographs show the streamflow conditions for the year used in this model, and arrows indicate flow conditions on the day when the drainage network map depicts impacts.

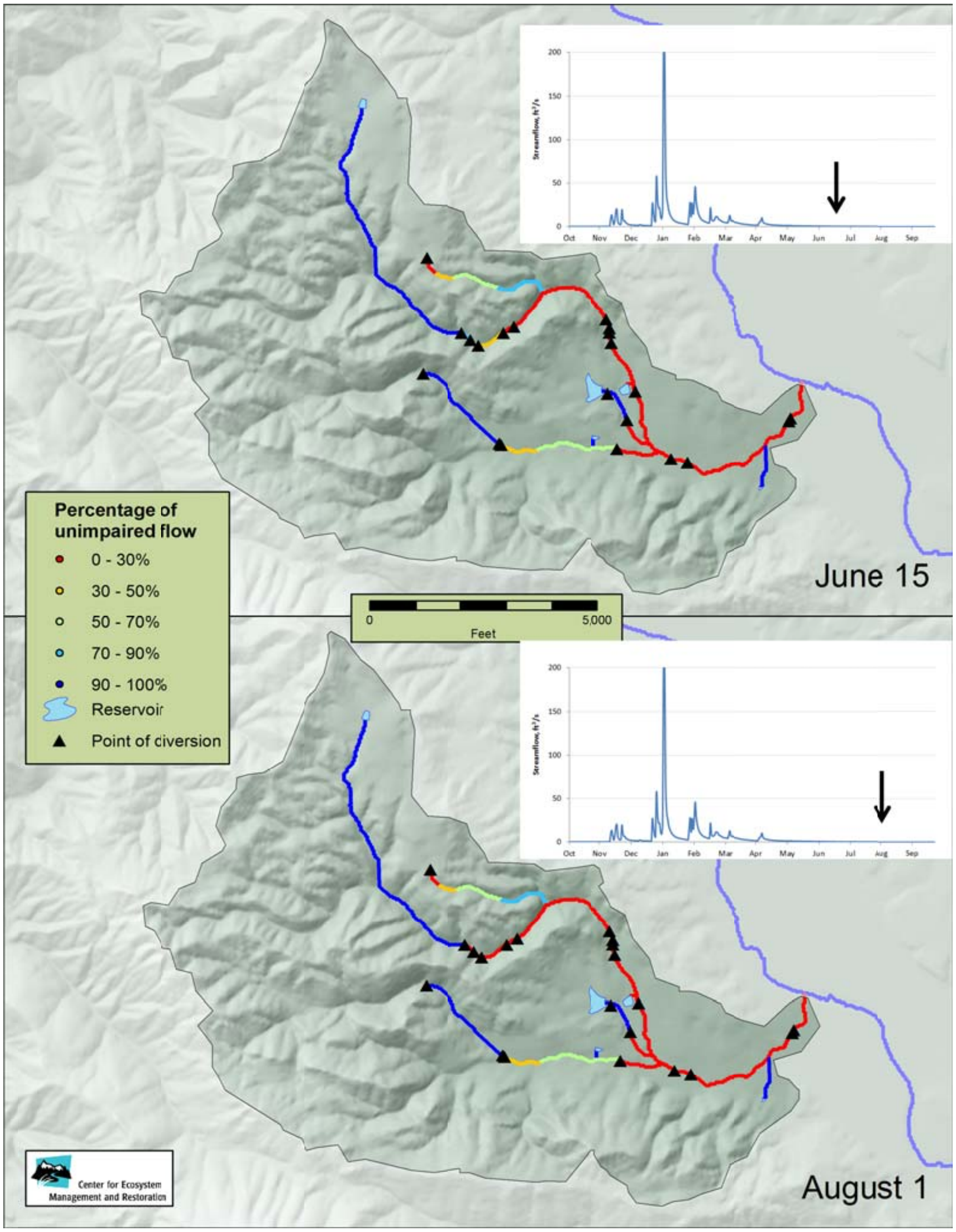


Figure 29. Maximum potential impairment caused by known diversions from the Grape Creek drainage network on two days in a normal type spring and summer. Hydrographs show the streamflow conditions for the year used in this model, and arrows indicate flow conditions on the day when the drainage network map depicts impacts.

The results of this analysis likely overestimate the impairment caused by existing diversions from the Grape Creek drainage network. It assumes that all diversions exert demand on streamflow at the same time at a maximum rate; in reality, all diverters do not demand the projected rate simultaneously, and impacts of diversions have been documented to be attenuated with distance downstream (e.g., Deitch *et al*. 2009B). In addition, this method assumes that gallery wells have an impact equivalent to the rate at which they draw from the shallow aquifer; depending on distance from the stream, this also likely overestimates the instantaneous demand of near-stream groundwater pumping. Some landowners also have points of diversion outside the Grape Creek watershed and places of use within the watershed. For example, landowners have appropriative water rights for diversion from Dry Creek and other unnamed streams outside of the Grape Creek watershed. However, a conservative analysis is useful as an estimate of the maximum impact that instream diversions can have on streamflow through the year, and the results highlight the potential interactions between streamflow and instream diversions that operate during the dry season.

4. Streamflow Recommendations

The sections above describe the impediments to a natural streamflow regime created by water management practices in Grape Creek. Diversions from Grape Creek tend to be individually small and are well distributed through the catchment; but the cumulative effects of these diversions, coupled with the natural flow regime of Grape Creek that produces low streamflow through the summer even in the absence of diversions, likely result in lower flow (and thus poorer salmonid habitat quality) through the dry season. These diversions make conditions worse for the organisms that live in Grape Creek through the summer than conditions would be in the absence of diversions.

As described above in Section 3, we hypothesize that shifting diversions from summer to winter will result in more streamflow during summer. This in turn will produce improved habitat for fish through the dry season. In order to recommend the management shifts that need to occur in Grape Creek to create improved habitat for salmonids, we first must understand the dynamics between streamflow and salmonid populations in Grape Creek, and further explore the benefits that shifting water management practices could have on streamflow.

In this section, we quantify the needs of anadromous salmonids in the dry season and characterize the extent of change in management practices that would be needed to reach hydrologic targets that will improve biological outcomes. To identify these hydrologic targets, we rely on a 2012 study completed by UCCE/CSG which examines the relationship between coho survival and environmental variables, including flow, in order to develop instream flow targets and monitor the effectiveness of future streamflow improvement projects.

Although the UCCE/CSG study does not provide the level of detail and instream flow/habitat analysis present in the other CSSP SIPs (*e.g.,* the Stillwater Sciences study for San Gregorio Creek and the McBain and Trush study for the Mattole River Headwaters), it provides a unique data set describing the survival of juvenile coho salmon through repeated fisheries monitoring in the dry season. A study of summer survival likely examines the most critical challenge to a healthy fishery: if broodstock program fish, placed in streams from the conservation hatchery in spring, are not surviving through summer, then creating conditions to increase summer survival may be more important than other flow criteria. If juvenile coho are not surviving in Grape Creek through summer, then this may be a critical bottleneck preventing recovery of coho populations in the Grape Creek watershed. Additional studies examining flow thresholds associated with spawning and healthy salmonid growth, such as those described in the Mattole River and San Gregorio Creek, may be useful in subsequent efforts (depending on the expected benefits and challenges for water storage projects in the Grape watershed). UCCE/CSG observed that oversummer survival in lower reaches of Grape Creek decreased significantly when flow dropped below 0.1 ft^3/s. Although more study may be warranted to determine conditions under which coho grow and thrive– rather than merely survive –the study suggests that even a small amount of water (*e.g.*, 0.10-0.20 ft^3/s) could increase oversummer survival dramatically.

Using the minimum thresholds identified in the UCCE/CSG study, we then map out strategies -- given what we know about the spatial, temporal distribution of human water need -- to meet those streamflow objectives. As UCCE/CSG will continue to monitor coho and refine targets, we will update our objectives, but the overarching strategy is likely to remain the same: fish will benefit from additional flow in the dry season. Further, as we find below, these improvements in survival may be achieved with relatively small changes in water management practices.

Finally, since we suggest that small storage projects provide a means for meeting summer objectives, we need to identify the conditions under which water may be taken from Grape Creek in the winter to minimize potential impacts to anadromous salmonids during the rainy season. This Section introduces our study of thresholds for diversion protective of fish during the winter season, but the conclusions will be presented in Section 5.4.3, as they will inform the permit terms for individual projects.

4.1 Coho Oversummer Survival and Instream Flow Needs

Through its work with the Coho Partnership, UCCE/CSG conducted a study of over-summer survival of coho in relation to flow and other variables in Grape Creek and four other Russian River tributaries. The goal was to collect baseline information to develop summer streamflow survival thresholds based on survival data and to evaluate the effectiveness of storage project implementation to increase streamflow above survival thresholds. UCCE/CSG selected treatment reaches -- which were likely to be influenced by streamflow improvement projects -- and reference reaches -- which were unlikely to be influenced by projects -- and compared monthly survival during the dry season with other variables (flow, temperature, wetted volume and dissolved oxygen). The Grape Creek reference reach extends for 755 feet beginning just downstream of the confluence of Wine and Grape creeks; the treatment reach extends for 755 feet between West Dry Creek Road and the Dry Creek confluence (Figure 30).

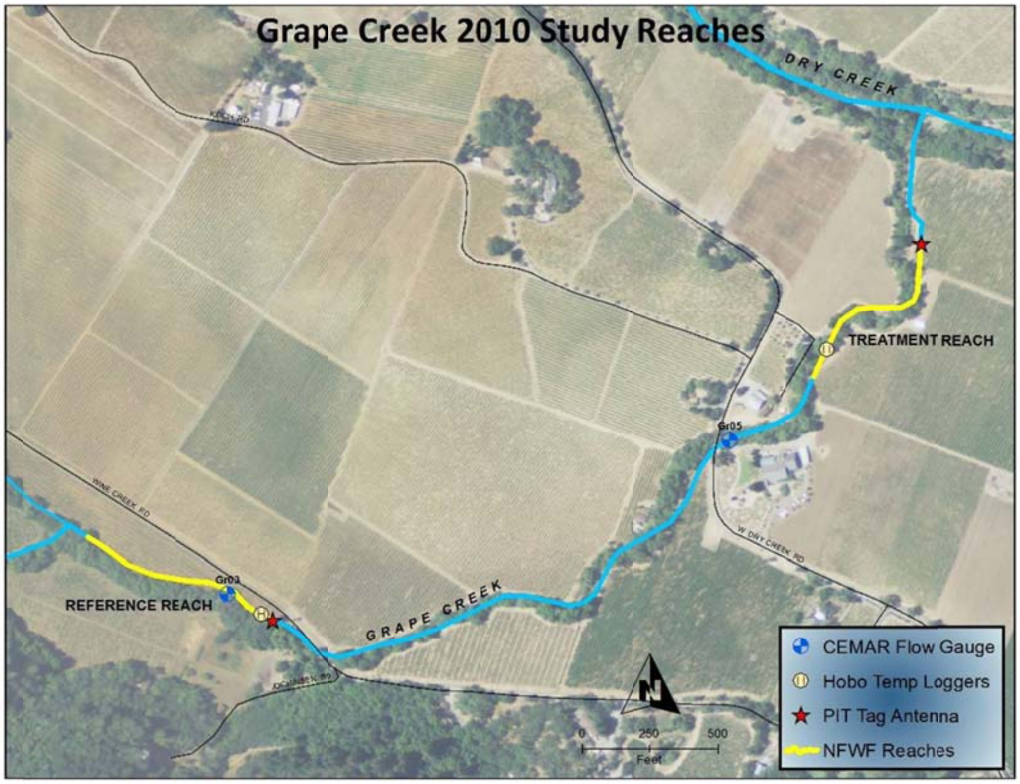


Figure 30. Grape Creek UCCE/CSG 2010 study reaches (Source: UCCE/CSG)

Working with the Russian River Coho Salmon Captive Broodstock Program, UCCE/CSG released young-of-the-year (yoy) coho that had been raised and tagged with Passive Integrated Transponders (PIT tags) at the Don Clausen Warm Springs Hatchery. In June 2010, 495 coho were released in the Grape Creek treatment reach and 507 coho were released in the Grape Creek reference reach. UCCE/CSG constructed and installed PIT tag antennas prior to the release to document emigration from the study reaches. From June through October, they conducted monthly PIT tag wanding samples to estimate monthly survival of the coho and gathered data on habitat, dissolved oxygen, and temperature. They relied on streamflow data from the CSSP gauges in the watershed (and their accompanying rating curves) to correlate fish survival with streamflow.

UCCE/CSG found that cumulative oversummer survival was lower in Grape Creek than in any of the other Russian River tributaries in this study but still within the range documented in other Russian River streams between 2005 and 2009. Oversummer survival was 0.42 in the Grape Creek reference reach and 0.19 in the treatment reach (UCCE/CSG 2012, p.31). Generally, survival in the reference reach was high. Notably, oversummer survival in the treatment reach decreased significantly when mean daily flow was below 0.1 ft^3/s (UCCE/CSG 2102, p.32). When UCCE/CSG compared survival in the Grape Creek treatment reach to other habitat and flow variables, they found that of the flow metrics they included in their analysis, the number of flow days with flow less than 0.1 ft^3/s had the strongest relationship to survival (p.39). They also found a relationship between survival and total or average pool volume.

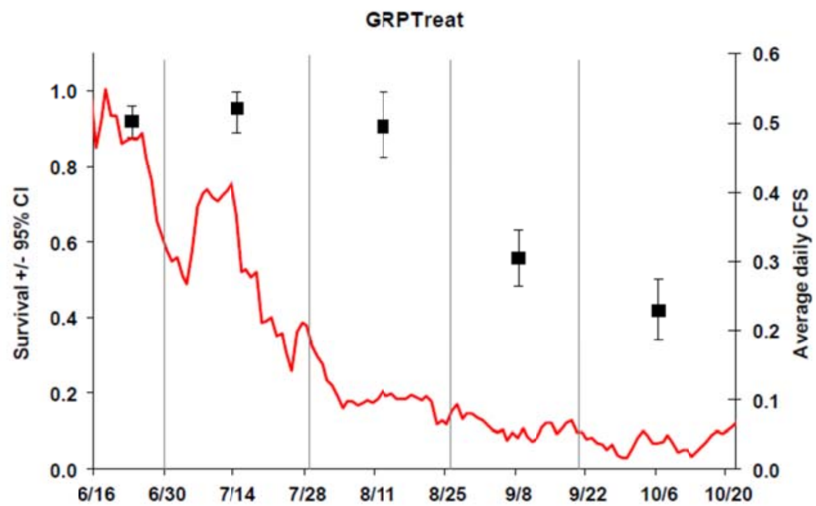


Figure 31. Monthly survival of coho yoy released into the Grape Creek treatment reach in relation to streamflow (Credit: UCCE/CSG)

UCCE/CSG will continue to refine streamflow targets for coho and to evaluate the effect of project implementation and water management changes on oversummer survival, but for the purposes of the Grape Creek SIP, we can draw on the study for preliminary guidance on minimum flow targets for improving oversummer survival in Grape Creek:

- At a minimum, reduce the number of days when flows are less than 0.1 ft^3/s through the treatment reach in Grape Creek.
- At a minimum, maintain flow levels through the treatment reach that correspond with the higher levels of survival (*e.g.*, 0.2 ft^3/s or greater) based on 2010 data.
- The study suggests that "juvenile coho can survive in extremely low surface flow conditions, assuming that other environmental variables remain within the range of established coho preferences" (p.39). In comparing the conditions and survival in the treatment reaches in Grape and Green Valley Creek (another focus stream for coho and instream flow efforts), UCCE/CSG concluded that deeper pools and higher shelter in Green Valley Creek "likely buffered the effects of low flow on survival" and recommended considering environmental characteristics in flow target development (p.40). This suggests that coupling streamflow enhancement with targeted habitat restoration may also yield improvements in oversummer survival.

The above section reaches the following conclusions regarding the relationship between streamflow and fish survival in Grape Creek: juvenile survival declines below 0.1 ft^3/s, and appears to be stable above 0.2 ft^3/s. Even though these numbers appear small, they reflect the scale of many small coastal streams with critical salmonid habitat. UCCE noted that "average daily streamflow was not greater than 3.5 cfs in any stream reach, and in most reaches was below 1 cfs for the majority of the time" (UCCE/CSG 2012, 39). These findings help to shape our desired outcomes, and identify possible mechanisms to achieve those outcomes. Our preliminary goal for streamflow restoration can be as simple as maintaining streamflow above 0.2 ft^3/s as long as possible and above 0.1 ft^3/s through summer. We can thus set our preliminary and minimum target for streamflow restoration as 0.1 ft^3/s additionally to Grape Creek during summer. In summer 2010, streamflow in Grape Creek ranged below 0.2 ft^3/s for a period of approximately 90 days (from mid-July through mid-October). Multiplying the duration of 90 days by the targeted flow magnitude of 0.1 ft^3/s, we are looking to restore a volume of 18 AF to Grape Creek through the summer.

4.2 Framing Management Alternatives

In this section, we describe the benefits to streamflow, and subsequently to habitat, that we could expect by reducing spring and summer diversions; and lay out the methods to produce the greatest benefit to salmonid habitat in the near future. If our preliminary goal of streamflow restoration in Grape Creek is to restore 18 acre-ft through summer, the next step is to examine whether this objective is reachable, given water use in the watershed; and then how this outcome could be achieved given the range and types of diversions from Grape Creek.

Data collected from Grape Creek in 2010 and 2011 can be used to estimate an unimpaired hydrograph for that stream in the absence of diversions, which can illustrate whether it is possible to achieve our preliminary streamflow restoration goals. Unimpaired hydrographs in this analysis illustrate the benefits that switching diversions from summer to winter would have, at locations in the drainage where streamflow data have been gathered. We have created unimpaired hydrographs by adding an estimate of impact for each diversion upstream of four reaches where we collected streamflow data: lower Grape Creek near Dry Creek, Grape Creek below Wine Creek, Grape Creek above Wine Creek, and Wine Creek.

To create as accurate an estimate of the unimpaired hydrograph as possible, we accounted for attenuation of diversion impacts across space (*i.e.*, a diversion decreases in magnitude with distance from the diversion and shallow groundwater diversions likely do not have the same impact as direct instream diversions) by extrapolating seasonal-scale water need to a per-day value, and then converting the per-day value to a per-second diversion rate so it is at the same timescale as streamflow. We relied first on information we gathered on water use to distinguish between water users reliant on Grape Creek in the summer and those that were not. Where water use information was not available, we estimated that rural residences use approximately 0.5 AF per year (162,000 gallons), where twice as much water is used in summer as in winter (0.33 AF and 0.167 AF, respectively). This corresponds to approximately 300 gallons per day in winter and 600 gallons per day in summer; when considered to per-second, this corresponds to 0.00092 ft^3/s in winter and 0.0018 ft^3/s in summer. We used similar methods for vineyards, assuming that vineyards use 0.67 AF per acre from May through October (which corresponds to a per-second diversion rate of 0.0018 ft^3/s).

Compared to discharge through winter and spring, these diversion rates are very small numbers, and, their removal will likely not cumulatively augment streamflow in the drainage network. For 2011 gauge data recorded at Wine Creek and at Grape Creek near West Dry Creek Road, for example, the measured and unimpaired hydrographs appear almost identical through fall, winter, and spring (Figure 32 A-B). Diversions do not cumulatively appear to cause deviation from the unimpaired hydrograph because flows are relatively high through this period.

During the summer, diversions are more detectable, but the differences between measured and unimpaired hydrographs also show significant differences among sites. The Wine Creek unimpaired hydrograph is slightly higher than the measured hydrograph through summer, although the difference is not as great as the unimpaired hydrograph for Grape Creek near West Dry Creek Road through summer (Figure 33 A-B). The difference in measured versus unimpaired hydrographs is due to the nature of diversions upstream from each site. Rural residences are the only known diversions directly or from nearby Wine Creek. Though there are many small residences above the Wine Creek gauge (it has the highest proportion of watershed diversions per area of any of our gauge sites), they do not divert as much water as agricultural uses downstream. The biggest change in water need moving downstream from the Wine Creek gauge to the lower Grape Creek gauge is from the addition of vineyards, which have a relatively high summer water need (higher per acre than a rural residence) and add a significant water need through summer. The unimpaired hydrograph analysis for lower Grape Creek suggests that changing the methods of obtaining water for the 14 acres of vineyard that take water from the shallow aquifer beside Grape Creek could result in 0.06 ft^3/s more water than was recorded in late summer 2011 (leading to a discharge of over 0.1 ft^3/s through the dry season).

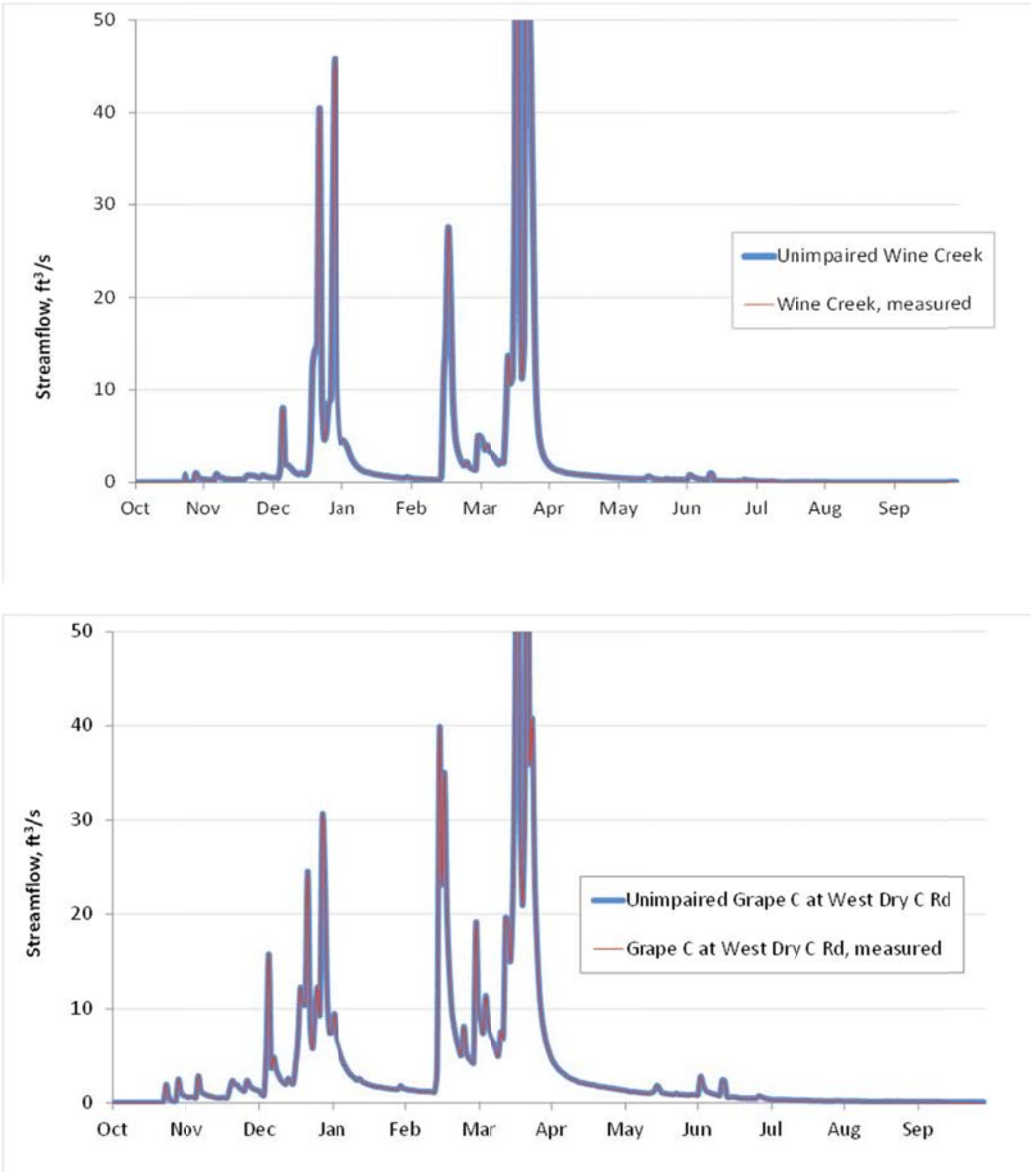
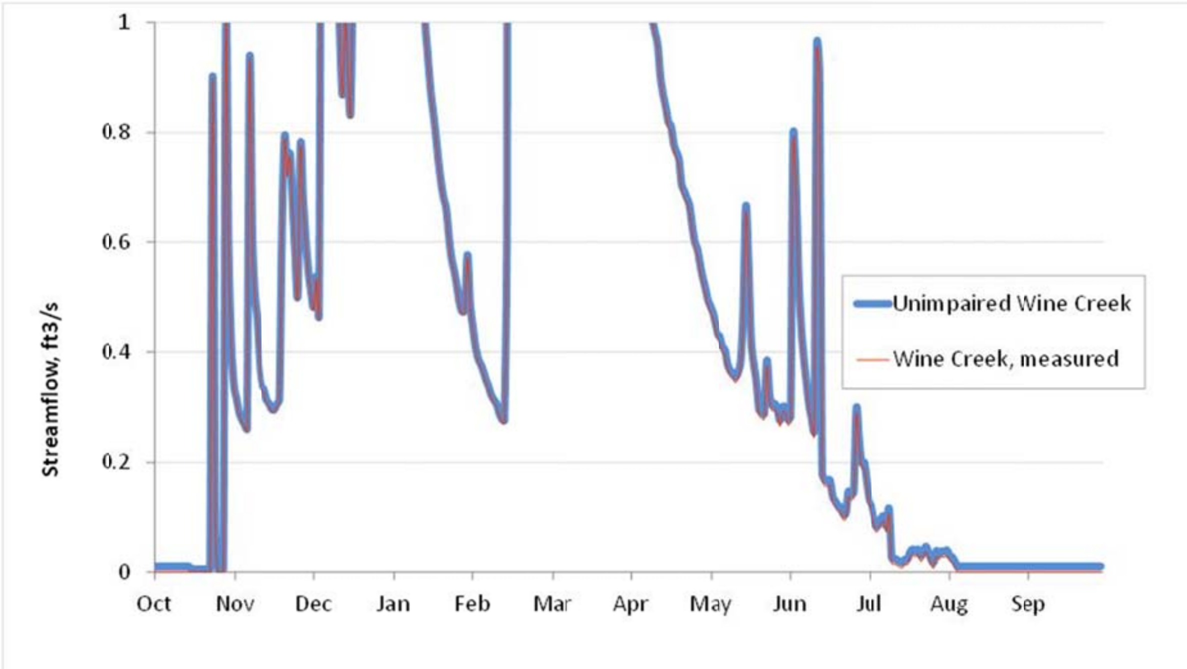


Figure 32 A-B. Measured and unimpaired hydrographs: (A) Wine Creek 2011; (B) Grape Creek at West Dry Creek Road, water year 2011



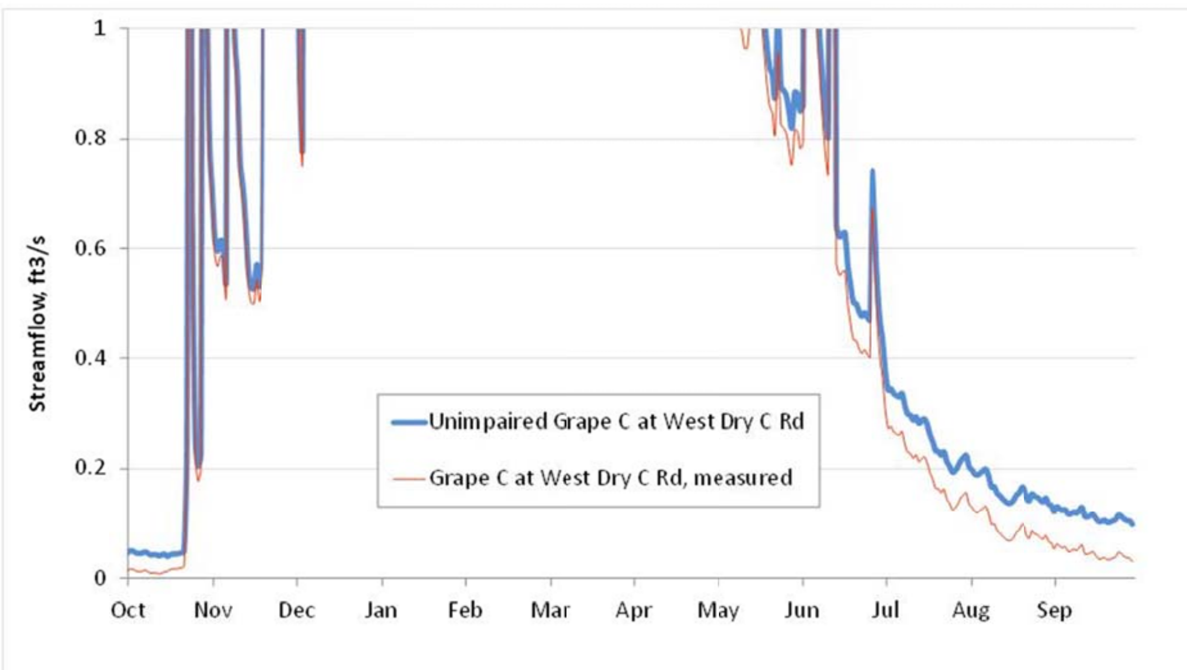


Figure 33 A-B. Measured and unimpaired hydrographs: (A) Wine Creek 2011; (B) Grape Creek at West Dry Creek Road, water year 2011, with closer consideration to lower streamflow (through graphing only streamflow data less than 1.0 ft^3/s)

The unimpaired hydrograph analyses described here provide an estimate of streamflow in the absence of diversions, at two locations described above, using a technique that extrapolates impact based on water needs at a longer time scale. This method of estimating diversion creates a lower impact than other possible mechanisms; instead, for example, if we assumed that all diversions take water at 10 gallons per minute, or 0.022 ft^3/s, then offsetting the cumulative diversion upstream of the Wine Creek gauge would add as much as 0.24 ft^3/s to the stream. This is the same mechanism of impairment used in the above Impaired Hydrographs section. Given the low streamflow conditions that occur naturally through the summer and the nature of small domestic diversions (*e.g.*, ten gallons per minute operating periodically for a few hours each day), it is unlikely that offsetting such impacts would return a magnitude of streamflow in Wine Creek of such a high magnitude 0.24 ft^3/s if there were no diversions during summer (Figure 34).

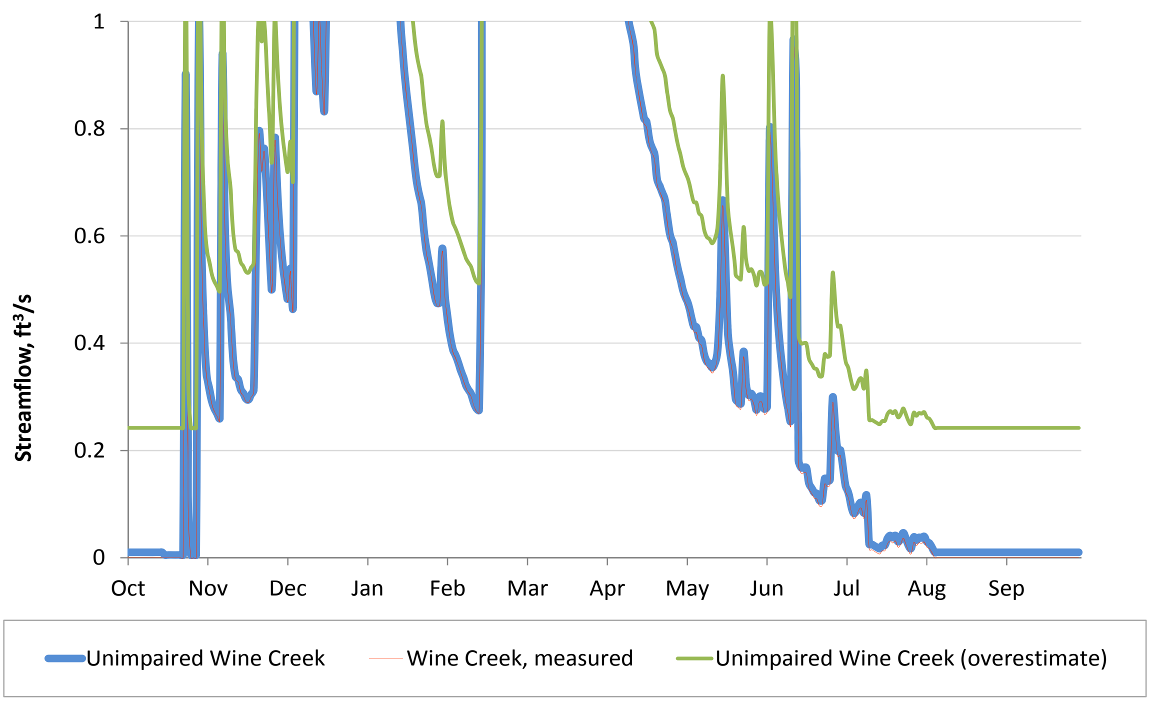


Figure 34. Measured streamflow in Wine Creek and predicted unimpaired hydrograph using two different methods: incorporating a likely depiction of impacts of demand (blue) and incorporation of a likely overestimate of demand impacts (green)

The results of the unimpaired hydrograph analyses indicate that, even when estimating impacts conservatively as we have done above, it may be possible to restore an ecologically significant amount of water to late-summer streamflow. The analyses also show locations where changes in water management practices are most likely to have ecological benefits. Our models predict that offsetting small domestic diversions will not lead to large improvements in streamflow. For example, we predict that offsetting the diversions from eleven houses upstream of the Wine Creek study reach will cause only a small improvement in summer streamflow in the reach (though this analysis is dependent on characterizing diversion rate, and offsetting direct diversions may lead to shorter-term improvements locally near where residences divert water from the stream). Implementing storage projects with residential users in the watershed is part of the solution, but will not alone meet the objectives outlined above. However, farther downstream in the treatment reach identified by UCCE/CSG, there are options to offsetting summer water needs upstream in the watershed (e.g., through irrigation water storage) that could result in an increase in summer streamflow by 0.1 ft^3/s. This increased flow magnitude is comparable to what preliminary evaluations have found to sustain coho salmon survival through the summer dry season in Grape Creek.

4.3 Winter Streamflow Thresholds

Finally, if our target amount for reduction in summer diversion is 18 AF, we can employ strategies to reduce water use and/or off-set water use during the summer through winter storage. In order to implement winter storage projects, we need to ensure that any new diversions do not adversely affect salmonids during the wet season. To do this, we conducted studies in Grape Creek to identify the streamflow thresholds that offer adequate protections for diversions to operate in winter (as an alternative to dry season diversion) while minimizing impacts to steelhead trout and coho salmon. These studies help to define the threshold conditions that must occur for winter diversions to operate under an appropriative water right. Because of the potential for spring and summer to be dry, and because of policy requirements for new diversions, we focused on the flow thresholds that are necessary to maintain processes that occur in winter, namely passage and spawning, during moderate and low-flow conditions. Because of the nature of likely proposed diversions in the watershed (*e.g.*, not likely to exceed 0.5 ft^3/s), it is highly unlikely that proposed diversions would affect channel-forming flows. To the extent that they may have impacts on biological processes that occur during winter base flow conditions, these thresholds can be incorporated into the terms of proposed water rights to ensure that depth and velocity thresholds for spawning and rearing are adequately exceeded before water is diverted for human use.

5. Diversion Management Recommendations

The overall objective for the diversion management plan is to improve streamflows during the summer and fall months and reduce impacts in the spring caused by frost protection water use. The primary means by which the people who live and work in the Grape Creek watershed can maintain their land uses and meet the ecological management objectives is by adding water storage. This will allow people to shift demand from the drier months to the wetter months. Additional recommendations include encouraging water use efficiency, further study of surface and groundwater interactions to inform groundwater management practices and changes, recharge, and habitat improvement projects that are closely coupled with streamflow priority reaches. These recommendations and others are described below.

5.1 Priority Treatment Reaches

Through CSSP and the Coho Partnership, we identified all of Wine and Grape creeks below the points of anadromy as priority reaches for coho. However, these specific reaches are identified in the recommendations below (Figure 35):

- **Lower Grape Creek (confluence with Dry Creek to the West Dry Creek Rd. crossing):** This reach contains the treatment reach identified in the 2012 UCCE/CSG study. Adult coho were documented in this reach in 2010 and 2011 and wild juvenile coho (*i.e.*, fish not produced as part of the Coho Broodstock Program at Warm Springs Dam) were documented in this reach in 2011. It is the only reach impacted by all water diversions within the watershed and most likely to benefit from streamflow improvement efforts. State, federal, and regional funding sources have also sponsored a series of stream restoration projects in this reach designed to improve physical habitat for salmonids beginning in the 1990s. Lower Grape Creek is also a common spawning site, and all juvenile salmonids that hatched in Grape must pass through this reach if they are to reach the ocean and return as adults to the Russian River watershed.

- **Wine Creek Canyon (downstream-most Koch Rd. crossing to the upstream point of anadromy):** DFG reports state that the middle reach of Wine Creek appears to offer the best coho spawning and rearing habitat in the watershed. The channel gradient is relatively low and canopy cover is higher than reaches farther downstream. Wild juvenile coho were documented in this reach in 2011. Projects implemented in or upstream of this reach could have the added benefit of improving streamflow and coho habitat in this canyon section of Wine Creek as well as in the lower Grape Creek reach.

- **Upper Grape Creek (West Dry Creek Rd. crossing to the second Wine Creek Rd. crossing):** Adult coho were documented in this reach in 2010 and 2011 and juvenile coho in 2011 and 2012. This Grape Creek reach may take on a higher priority than the Wine Creek reach because of the presence and numbers of coho and because Wine Creek reach between its confluence with Grape Creek and the upstream canyon portion of Wine Creek is commonly dry by August. Part of this priority Grape Creek reach has deep pools that remain even in the driest of summers, providing important habitat *refugia* for juvenile coho that hatched in this reach and farther upstream.

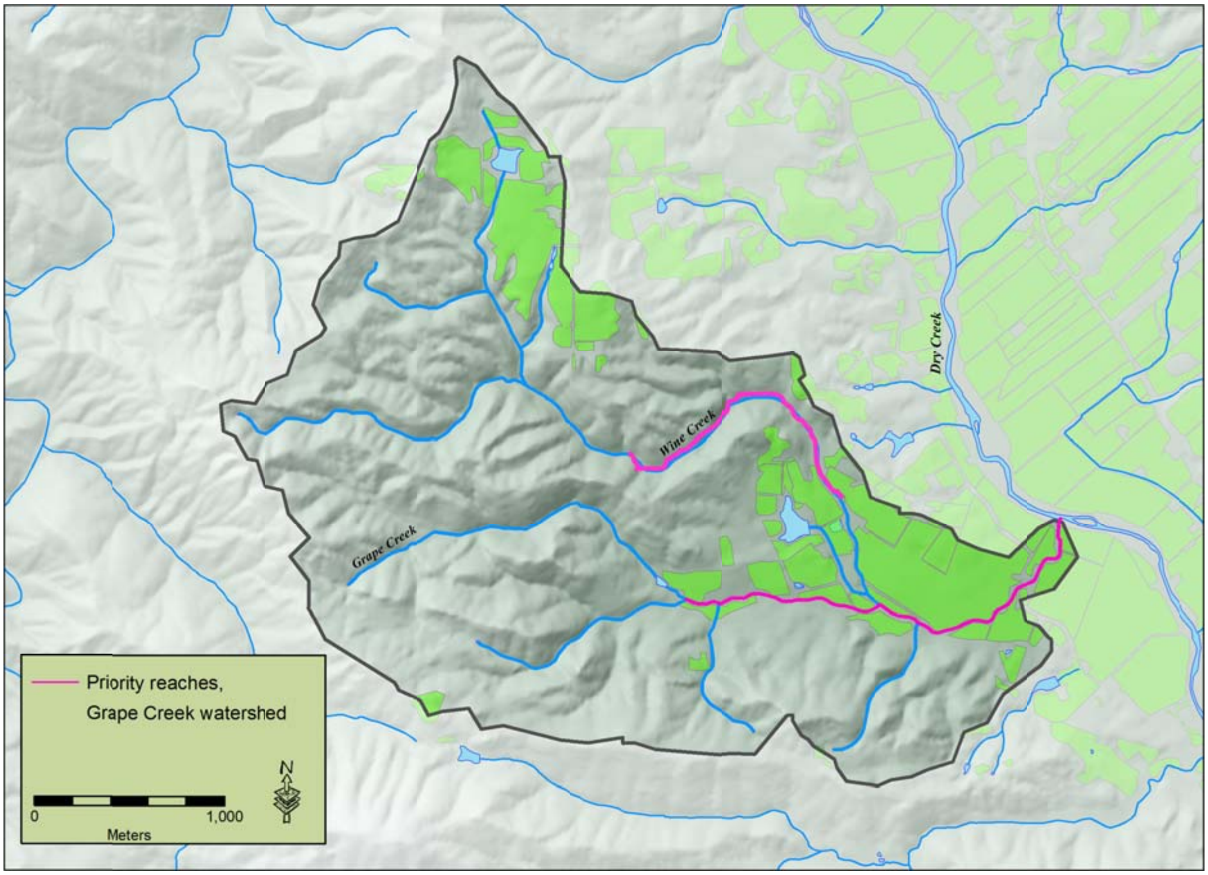


Figure 35. Priority reaches for salmonid recovery in the Grape Creek drainage network

5.2 Project and Management Recommendations

5.2.1 Acute Impacts to Streamflow

During the course of the project, the streamflow gauges installed in Grape Creek documented acute and detectable impacts to streamflow occurring as a result of frost protection pumping. We have taken steps through CSSP and the Coho Water Resources Partnership to address some of these changes in streamflow through collaborative projects with water users. To date, two projects have been implemented to reduce these impacts. We recommend continuing to monitor for significant and detectable reductions in streamflow in Wine and Grape creeks.

5.2.1.1 *Frost Protection Fan*

Martorana Family Vineyards installed a frost protection fan to protect a 10 acre parcel (approximate) and agreed to cease use of its diversion from Grape Creek and its on-stream pond and flashboard dam. The fan was installed in March 2010. The Partnership estimates that the fan will allow approximately 75 gallons/minute or approximately 1.1 ft^3/s of water that would have been otherwise diverted per frost event from March through May to flow in Grape Creek to benefit steelhead and coho. This would comprise as much as 100 percent of the discharge during late March and April. In addition to eliminating the potential for instantaneous drawdowns to harm fish, it will result in a net return of water to the stream. If the location averages 6-8 frost events per year (estimate), average annual streamflow enhancement totals as much as 5 AF of water (not accounting for return flows). The project provides other benefits to fisheries and habitat in that it eliminates the use of an on-stream pond and flashboard dam, improving passage during the spring.

ards

5.2.1.2 *Upper Grape Creek Project*

Streamflow gauges installed in Grape Creek documented the change in streamflow that occurred as a result of frost protection pumping from an on-stream flashboard dam on Upper Grape Creek. These data indicated a substantial drop in streamflow throughout Grape Creek below the flashboard dam and suggested that a change in water management would provide significant instream flow benefits. We worked with the landowner to develop a small storage project to eliminate the use of the diversion and on-stream dam in Grape Creek and recommend implementing the project and evaluating its effectiveness.

For the past fifty years, the landowner had been using a flashboard dam with a direct stream diversion for frost protection during the spring and for irrigation during the summer. The flashboards were used from early March until late September. When the reservoir was drawn down, no bypass flow occurred and the creek stopped flowing downstream of the dam until the reservoir refilled to the top flashboard.

Grape Creek streamflow data in 2010 illustrate the impact of frost protection diversions in the Grape Creek watershed (Figure 37). At a location where water was diverted for frost protection, streamflow receded by 40 percent on Grape Creek above the confluence with Wine Creek; these data represent the likely recession in streamflow over a length of 1.1 km (the reach of Grape Creek above the confluence with Wine Creek). Streamflow data near the confluence of Grape Creek with Dry Creek receded by 25 percent when water was diverted, indicating the change in streamflow that occurs in the lower part of the stream below the confluence with Wine Creek. Though these impacts only were detected twice in 2010, water was needed more than 20 times for frost protection in upper Grape Creek in 2008 (the year before streamflow gauges were installed on Grape Creek; water is not needed for frost protection in Wine Creek, which was gauged in 2008).

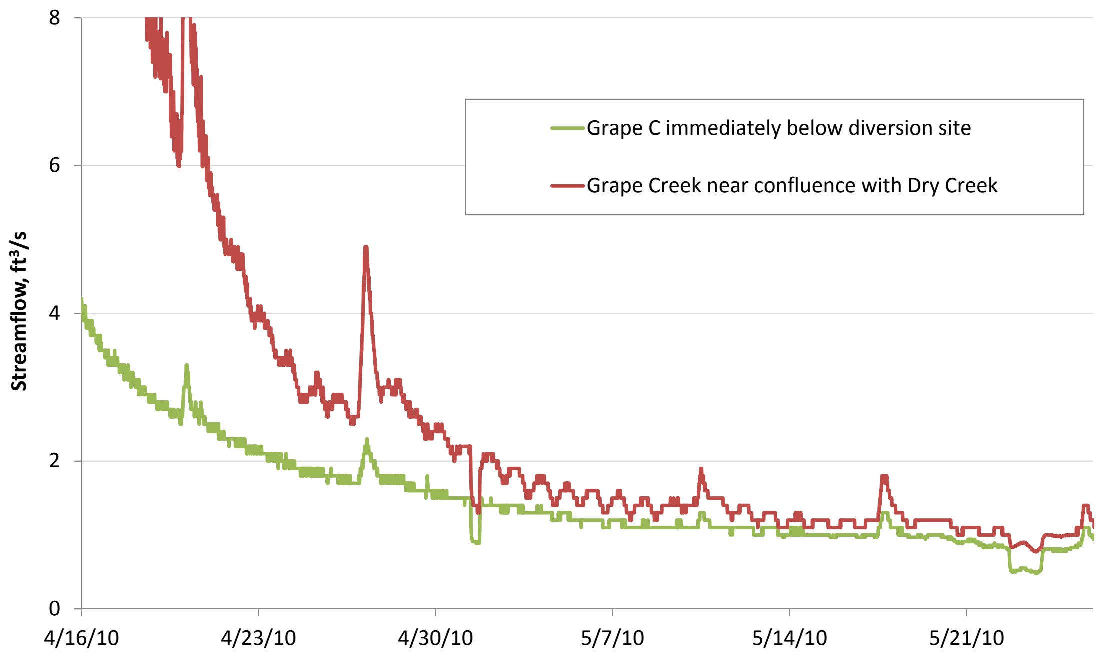


Figure 37. Streamflow data at two gauges in Grape Creek, spring 2010 (a wetter-than-normal spring, based on long-term averages). Diversions from behind flashboards occurred on May 1 and May 23, 2010.

The project consisted of the construction of an approximately 1.5 acre-foot offstream reservoir. (Frost fans were evaluated as an alternative but determined not to be feasible.) The landowner has discontinued the use of the flashboard dam and instead is using the offstream reservoir to meet frost protection and irrigation needs. The reservoir is filled with a combination of rainwater (that falls over the pond footprint) and water pumped from a well. The pump, which the landowner currently operates just above the flashboards, was removed from the creek. The project is expected to benefit spring outmigration and spring and over-summer survival of both coho and steelhead through a 1.6 mile reach of Grape Creek, or approximately 56 percent of the Grape Creek drainage network capable of supporting anadromous salmonids. The project is scheduled to be constructed in fall 2012 and we recommend completing implementation and evaluating its effectiveness.

To evaluate compliance and ensure that direct diversion and use of the flashboard dam have been discontinued, we will continue to monitor streamflow at our existing streamflow gauges downstream of the proposed project. The streamflow data will also be used to ensure that the new project operation and method of obtaining water does not negatively affect streamflow during spring and summer. Water will be obtained primarily from a well believed to be disconnected from the stream, and our downstream network of gauges will be used to monitor whether use of the groundwater well causes negative changes in flow downstream of the project site. Evaluation of potential impacts can be conducted at a sub-daily scale (*i.e.*, whether streamflow changes when the well is operated) or at a longer-term scale (*i.e.*, whether base flow is less through the summer under the new management regime than before project implementation, relative to pre-project data and normalized by precipitation). Grape Creek is one of four watersheds in Sonoma County in which a Before-After Control-Impact (BACI) study has been designed, in partnership with the Russian River Coho Salmon Captive Broodstock Program and UCCE/CSG, to evaluate the survival of juvenile coho salmon through summer. Baseline survival and streamflow data collected in summer 2010 and 2011 will be compared to data collected in subsequent years to assess the relationship between juvenile coho survival and streamflow (among other variables) in Grape Creek below the proposed project site. Because of the proximity of the reservoir project location to study sites, the data collected as part of the coho survival study will be useful to ensure reservoir operation compliance in the future.

5.2.1.3 *Continued monitoring for acute reductions in flow*

Working with many partners, we have addressed two significant and detectable reductions in streamflow in the Grape Creek watershed. We recommend monitoring streamflow long-term and analyzing hydrologic data to detect any additional changes in the hydrograph that might signal the need for additional water user outreach. Our current understanding of water use dynamics in the Grape watershed is that no sudden drops in streamflow should occur; however, that understanding is based on current water management practices which could change with new land ownership or land use practices. Such monitoring would also allow us to evaluate whether the practices we recommend here will operate in a way that will affect winter and early spring streamflow as we expect.

Recommendations:

- ✓ **Change water management practices resulting in acute and detectable impacts to streamflow**
  - ✓ **Monitor the effectiveness of the Upper Grape Creek Project**
  - ✓ **Continue to monitor for acute reductions in flow**

5.2.2 Surface Flow in Grape and Wine Creeks

Based on the unimpaired hydrograph analysis above, we provide three recommendations for improving dry season flow through the three reaches identified above: (a) storage for vineyard irrigation water needs on Grape Creek (Upper and Lower reaches), (b) collaboration with water user with a pending application on a tributary to Wine Creek, and (c) small domestic use program for Wine Creek Canyon.

5.2.2.1 *Off-stream storage and conservation projects for Grape Creek vineyard irrigation*

The unimpaired hydrograph analysis above (Section 4.2) indicates that the greatest potential for streamflow benefit in the Grape Creek watershed is through increasing water storage for vineyard irrigation. While many vineyards that obtain water from the Grape Creek watershed in summer meet irrigation needs through shallow wells, these wells may have an effect on streamflow in Grape Creek by lowering the water table adjacent to the creek. These impacts may not be as visibly detectable as direct diversions, but they may cause streamflow to be persistently lower in the reach beside where water is drawn as well as downstream through the drainage network.

To date, one water user on Wine Creek has constructed off-stream storage to improve water supply reliability and benefit streamflow in Wine and Grape creeks. Wine Creek Ranch constructed a small off-stream pond to eliminate pumping from a stream-side well during the dry season. Wine Creek Ranch is a small (approximately 17 acres) family vineyard bisected by Wine Creek. Water for irrigation was obtained from a well near Wine Creek, and vines are irrigated via a drip irrigation system. The landowners do not have a frost protection system. The project resulted in the construction of a 4 AF pond on the landowner's property. The reservoir is filled through two sources of water: (a) rainfall over the footprint of the reservoir and (b) drainage from the landowners' existing subterranean vineyard drainage tile system during the winter months. The growers utilize the water from their reservoir for irrigation during the growing season and have ceased to pump from their well for irrigation during the summer and fall. The water they would have otherwise utilized for irrigation has become available for instream uses. We assisted the landowners in obtaining a portion of the project funding through the Natural Resources Conservation Service's Agricultural Water Enhancement Program; the landowners provided the majority of the funding.

At least three water users rely on wells adjacent to Grape Creek for vineyard-related and residential water uses. We recommend working with the three landowners to reduce or eliminate dry season pumping through water conservation and efficiency improvements, roofwater harvesting, and off-stream storage of water pumped during the winter.

5.2.2.2 *Work with the landowner with a water right application on the tributary to Wine Creek*

As we mentioned above, there is one pending water right for storage on an unnamed stream tributary to Wine Creek. There may be opportunities – through and outside the water rights application process – to continue to work with the landowner to develop reservoir permitting conditions and improve streamflow below the reservoir.

5.2.2.3 *Small domestic use program for residential water users on Wine Creek*

We recommend pursuing a tank program for residential users in the Wine Creek Canyon reach. There is anecdotal information that residential water use produces a flow signal in Wine Creek and the reach provides important coho spawning and rearing habitat. Although we predict that offsetting the diversions from eleven houses upstream of the Wine Creek study reach will cause only a small improvement in summer streamflow in the reach—if eleven houses store 50,000 gallons of water in winter, it would result in 1.7 AF less water drawn from Wine Creek during the summer (corresponding to approximately 4500 gallons per day over a 120 day period), developing residential storage may be beneficial especially in very dry years. Some of the need could be met through roofwater capture and storage.

Recommendations:

- ✓ **Improve surface flow upstream of treatment reach in Grape and Wine Creeks**
  - ✓ **Complete off-stream storage and conservation projects with landowners pumping from wells adjacent to Grape Creek for vineyard irrigation**
  - ✓ **Continue to work with the landowner with the pending water right application on a tributary to Wine Creek**
  - ✓ **Develop a small domestic tank program for residential water users on Wine Creek**

5.2.3 Surface-Groundwater Interactions

Streamflow data collected as part of CSSP and other streamflow monitoring projects in coastal California (*e.g.*, the Coho Partnership, Sanctuary Forest's Mattole summer flow monitoring) show a wide range of variability in streamflow through summer (CEMAR, unpublished data; Klein 2012). The variability in streamflow among sites (frequently in the same watershed) indicates the importance of reach-scale characteristics in determining streamflow conditions in summer. Through these observations, we have developed a general conceptual model for streamflow in summer: summer streamflow in a particular reach is influenced partly by discharge from upstream, and partly by the relationship between surface water and shallow groundwater in the reach. We use this conceptual model to subdivide reaches into two categories: (1) those that remain flowing have sufficient flow from upstream to maintain surface flow and/or are gaining from the adjacent shallow groundwater table; (2) those that do not remain flowing do not have enough water coming from upstream to overcome loss to the shallow groundwater table through the reach.

The reaches of Grape Creek that become intermittent in summer show two different characteristics (see Figure 12). One reach, Wine Creek immediately upstream of the Wine Creek Road crossing, becomes completely dry in August and remains completely dry until rain begins again. In other reaches, such as Grape Creek above the Wine Creek confluence and Grape Creek below West Dry Creek Road, intermittent pools persist through the summer. The persistence of pools through these reaches, in combination with very low streamflow into the reaches from upstream, suggests that adjacent shallow aquifers are near the level of the stream; if aquifers were far lower, the reaches would be completely dry.

Additional investigations into the relationship between surface water and shallow aquifer levels can help us to evaluate whether changing groundwater management practices can benefit summer streamflow through these reaches. These evaluations can help us to determine the relationship between streams and aquifers. If we find that aquifers are very close to the level of the stream, and/or that the streams begin losing to the aquifer at the point when groundwater is pumped for irrigation, then changes in these practices (e.g., removing groundwater wells in exchange for a reservoir filled in winter to provide irrigation water) may have direct benefits to summer streamflow. With this information, it will also be possible to quantitatively predict the benefits of removing groundwater diversions to streamflow.

Recommendations:

- ✓ **Study the relationship between shallow aquifers and surface flow to determine if modifications to groundwater use and/or recharge projects will result in streamflow improvements in the treatment reach on Grape Creek**

- ✓ **Use both the information gathered through the study and knowledge about anthropogenic water use in the reach to determine if modifications to groundwater use will result in streamflow improvements in the treatment reach**

5.2.4 Enable and Encourage Landowner-Led and Funded Projects

Successful streamflow restoration across the California coast will require a scaled up approach that supports and enables landowners to tackle efficiency and small storage projects on their own with no or minimal public investment. The same is true in Grape and Wine creeks.

We have successfully encouraged beneficial and land-owner driven and landowner-funded projects in the Grape Creek watershed. Two landowners -- Wine Creek Ranch and Quivira Vineyards and Winery -- led projects to reduce water diversions from the watersheds. The Wine Creek Ranch project is described above. Quivira Vineyards led its own winery water conservation projects. Quivira initiated and completed a project to reduce water use in its winery production cleaning processes. Quivira began using a "steam cleaning machine that uses 98% less water than required by traditional barrel cleansing and soaking routines and bottling line sanitation procedures. The use of steam instead of water translates to a much cleaner facility while using next to no cleaners or detergents of any sort." Quivira also recently installed three fans that will offset its use of frost protection water.

These projects described above represent landowner-led and primarily landowner-funded projects that are not only beneficial to anadromous fisheries and consistent with our approach, but also provide great value as demonstrations of landowner commitment to and investment in water stewardship. They also provide examples of changes that can be made without entering the water rights permitting processes. We recommend encouraging and facilitating more landowner-driven approaches with fisheries benefits.

Recommendations:

- ✓ **Encourage and enable landowner-led projects with streamflow benefits**
- ✓ **Provide resources and technical assistance to landowners**
- ✓ **Encourage landowners to evaluate water use and improve efficiency**

5.2.5 Non-Instream Flow Habitat Improvements

As detailed earlier in the document, strategic habitat improvements can improve conditions for coho year-round. We specifically recommend pursuing vineyard road set-backs and coupling streamflow restoration projects with projects to increase pool depth. As the UCCE/CSG report suggests, good habitat conditions may buffer the effects of low flow on oversummer survival.

Recommendations:

- ✓ **Vineyard road set-backs**
- ✓ **Increase pool depth through habitat projects coupled with flow analyses**

5.2.6 Benefit of Recommendations

In sum, if all the streamflow improvement projects outlined above (Upper Grape Creek project, projects with three irrigators relying on streamside wells along Grape Creek, and residential storage on Wine Creek) were implemented, we would expect to exceed the preliminary and minimum oversummer streamflow goal. The Upper Grape Creek project, when implemented, could be a significant component toward reaching the 18 AF goal. Implementing some combination of vineyard storage projects, residential tank projects, and recharge projects could provide the remainder.

5.3 Funding

Costs. Costs can vary widely by project. The frost fan project was approximately $25,000, excluding costs incurred by the landowner to remove vineyard rows, pour the concrete pad, and supply fuel tanks and related items. In other watersheds, a 50,000 gallon residential tank has averaged approximately $65,000. Reservoir costs have varied from $120,000 for a 4 AF pond to (anticipated) $325,000 for a 1.4 AF pond. Engineering, design, and permitting represented 15-25 percent of the total cost; construction was 30-65 percent; the pond liner and liner installation was 10-30 percent, and plumbing and other costs were 10-15 percent of the total.

Sources. The Wine Creek Ranch project was funded primarily by the landowner with support from NRCS through the Agricultural Water Enhancement Program (AWEP). In 2009, NRCS awarded $5.7 million through AWEP for water conservation and off-stream storage projects in the Russian River to be spent between 2009 and 2014. The Upper Grape Creek Project had a variety of funding sources including NFWF with match from the Sonoma County Water Agency, NOAA Restoration Center, NRCS (AWEP funding), USFWS through the National Fish Habitat Action Plan, landowner match, and in-kind match from the project engineer. Funding sources for streamflow monitoring have included the SCC, NFWF through its Russian River Keystone Initiative, and USFWS through the NFHAP. NFWF and the Army Corps of Engineers have funded fisheries monitoring in the watershed since 2009 and SCWA has provided significant match for the work. Other public and private funders contributed to project development and monitoring, including the S.D. Bechtel, Jr. Foundation, ESRI, the Richard and Rhoda Goldman Fund, and the Dean Witter Foundation.

5.4 Permitting Considerations

5.4.1 Permitting Scenarios

5.4.1.1 *Reductions in water use: Roofwater harvesting and conservation efficiency*

Projects that include rainwater harvesting have the dual benefit of reducing diversions from the creek during the dry season (by offsetting summer need) and reducing runoff from impervious surfaces (roofs) during the winter. The SWRCB has clarified that a water right permit is not required for roofwater capture and storage.[14] For any project that reduces the quantity of water that users need to divert in the dry season, landowners, project partners, and funders should ensure that reductions in water use under any existing water rights are protected instream (*e.g.*, through an instream dedication and/or forbearance agreement) (See Section 6.1).

This approach has been implemented successfully in Salmon Creek (Sonoma County) through the Save our Salmon Program.[15] Goldridge Resource Conservation District, Occidental Arts and Ecology Center, Prunuske Chatham Inc., and NOAA Restoration Center piloted an approach to offset dry

[14] http://www.waterboards.ca.gov/waterrights/board_info/faqs.shtml#rooftop
[15] http://salmoncreekwater.org/cs/Roofwater_Harvesting.pdf

season use through winter roofwater harvesting.[16] Landowners ceased summer use under a forbearance agreement. In Chorro Creek, the Morro Bay National Estuary Program and NOAA-RC are currently installing roof rainwater tanks with Cal Poly based largely on the Salmon Creek model.

5.4.1.2 *Residential tank storage*

Where residential users switch the timing of their diversions from the creek from summer to winter and add storage tanks to satisfy year-round use, the projects will likely require a new water right. (Any valid riparian rights would not allow for storage for the entire dry season.) It is likely that the diversions will be small enough to qualify for a small domestic use registration. Again, it is critical to ensure that water no longer being diverted in the summer remains instream to achieve the purposes of the project, and petitioning to change existing riparian rights and dedicate water instream is one tool.

This approach has been implemented successfully in the Mattole River watershed through Sanctuary Forest's Water Storage and Forbearance Program, and more information is available in Legal Options for Streamflow Protection (Sanctuary Forest 2008). Sanctuary Forest's Storage and Forbearance Program's approach has included using a forbearance agreement (a covenant that runs with the land restricting riparian water use) to restrict residential water use and offsetting that dry season use through winter tank storage, permitted through a small domestic use permit. Sanctuary Forest has also implemented rotation schedules beginning at specified flow thresholds. These terms and conditions are implemented through a combination of the forbearance agreement, Small Domestic Use registration (which includes DFW-developed terms governing diversions), and a Streambed Alteration Agreement.

5.4.1.3 *Vineyard irrigation storage*

Where vineyard water users rely on streamside wells and seek to reduce dry season pumping by pumping through the rainy season and storing water for year-round use, water rights permitting requirements will depend on the method of diversion and the nature of the water source. If the water user decides to switch from a well to a diversion from the stream and store water for seasonal use, an appropriative water right would be required.

Where a landowner pumps from a groundwater well in the winter and stores that water for dry season use, an appropriative water right may or may not be required. Permitting requirements depend on the categorical nature of the groundwater pumped. Where the well lies within a subterranean stream (see Figure 39) and water use is accordance with riparianism, the water user may assert a riparian right to the water. However, since the objective of the projects may require that water users store water longer than 30 days and because riparian rights do not allow for seasonal water storage, a groundwater user pumping water from a subterranean stream may be required to obtain an appropriative water right for storage and use.

[16] http://salmoncreekwater.org/bodega-pilot-program.html

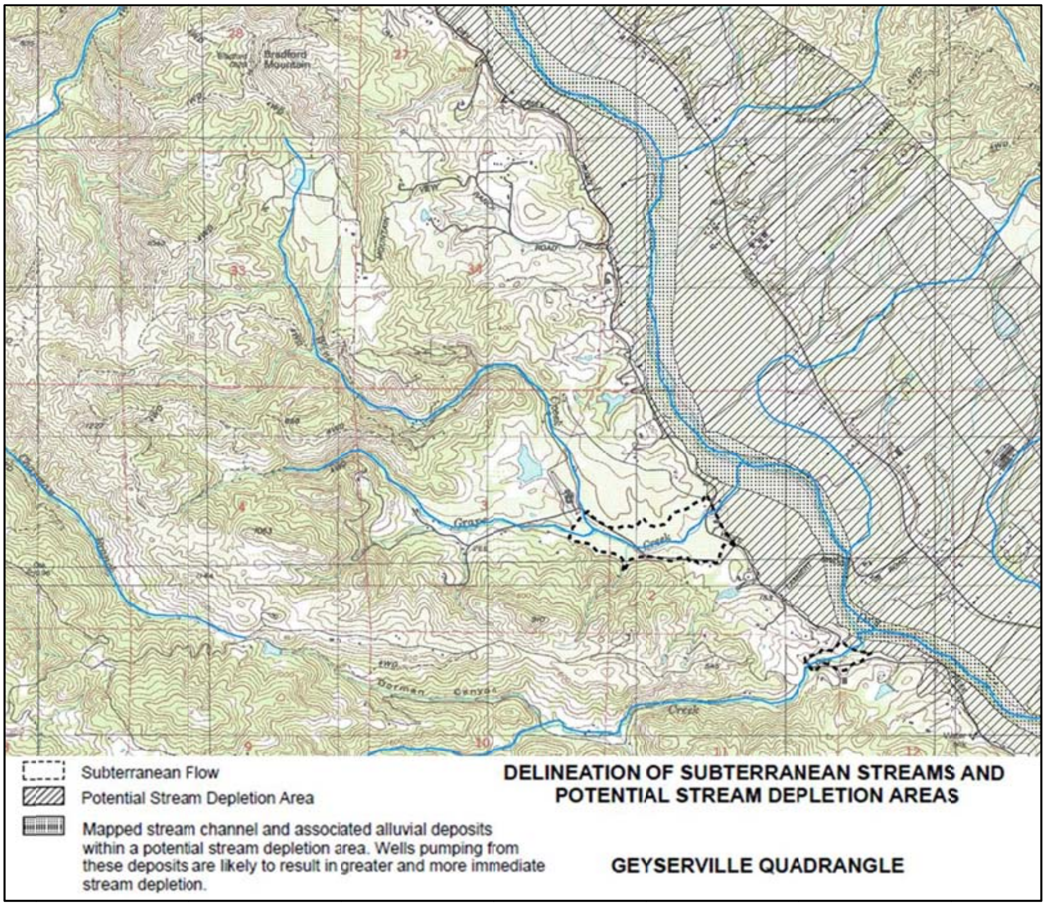


Figure 39. Excerpt from subterranean stream map (Source: Stetson Engineers 2008)

If the well lies outside of a subterranean stream, the water diverted from the well may be considered percolating groundwater, and not submit to the permitting jurisdiction of the SWRCB. This is the case with the Upper Grape Creek Project. Under this circumstance, it is critically important to determine that any continued use of the well is either properly conditioned through an agreement or will not have adverse impacts on flow.

Finally, as noted above, water users, project managers, and funders should ensure that any summer water use offset through winter storage remains in and is protected instream. There are legal tools to ensure that groundwater users no longer pump in the summer in accordance with mutually agreed upon terms, but legally protecting that water from being used by other users is more difficult.

5.4.2 SWRCB Standards for Protecting Instream Flows by Offsetting Summer Water Demand

Besides outlining the methods for determining whether additional water can be appropriated for winter storage, the Policy for Maintaining Instream Flows in Northern California Coastal Streams stipulates three conditions for diversions to operate. Each of these is described as regionally protective criteria, partially dependent on local conditions in the stream. The Policy also states that methods for determining flow protections are potentially flexible and may be determined through local site-specific studies, if the data collected indicate that ecologically relevant thresholds can be protected adequately under different conditions. First, the Policy sets a diversion season: diversions for appropriation can operate from December 15 through March 31. Second, for streams capable of supporting anadromous salmonids, the maximum rate of diversion from a stream is established as five percent of the 1.5-year instantaneous peak flow. Third, a new diversion can only operate if a particular flow threshold, that flow required to allow steelhead to migrate upstream (termed the bypass flow) is exceeded. If feasible, the Policy states that a certified fisheries biologist can determine a site-specific field-based bypass flow for a particular location to establish a flow threshold; otherwise, the Policy provides a series of equations to estimate the bypass threshold based on empirical data gathered in the Policy area.

Maximum Cumulative Diversion (Q_{mcd}). The methods for determining the maximum cumulative rate of diversion stipulate using historical streamflow data to find the 1.5-year peak flow and scaling the 1.5-year event from the gauge site location to a desired point of diversion. Based on Maacama Creek data, the 1.5-year peak flow is 344 ft^3/s; based on Pena Creek, the 1.5-year peak flow is 176 ft^3/s. We can use these data to estimate a range for maximum cumulative diversion rate in the Grape Creek watershed: Five percent of the 1.5-year peak flow of Grape Creek based on Maacama and Pena Creek streamflow data is 8.8 and 17 ft^3/s, respectively (Table 1). If we use the conservative estimate of cumulative diversion rate, this suggests the Policy will allow up to 8.8 ft^3/s of cumulative diversion in the Grape Creek watershed. The current cumulative rate of diversion in winter in the Grape Creek watershed is comprised only of the small onstream reservoir on a tributary to Wine Creek; the highest discharge it would impair in the normal year examined in the impaired hydrographs analysis is 6.4 ft^3/s (when discharge in Grape Creek is approximately 380 ft^3/s).

Minimum Bypass Flow (Q_{mbf}). The suggested methods for determining the bypass flow in the Policy entail using an equation based on empirical data that relate the discharge corresponding to a depth of 0.8 ft to watershed area and average annual flow from a USGS streamflow gauge. For streams capable of supporting anadromous salmonids with catchment area up to 327 mi^2, the recommended equation is:

$$Qmbf = 8.8 \times Qavg \times Drainage\ area^{-0.47}$$

Scaled data from the Maacama Creek gauge indicates an average annual discharge of 5.7 ft^3/s from the Grape Creek watershed; using this value, the Q_{mbf} for the 3.2 mi^2 Grape Creek watershed near its confluence with Dry Creek is 29 ft^3/s (Table 1). Farther upstream, near where water could be diverted for water storage on Grape Creek above the Wine Creek confluence, the watershed area is 1.0 mi^2; at that point, where scaled average annual streamflow is 2.3 ft^3/s, Q_{mbf} is 18 ft^3/s.

Additionally, we calculated the Median February Flow for Grape Creek near the Dry Creek confluence, based on USGS streamflow data in Maacama Creek. Other agencies recommend using the median February flow as a surrogate for the diversion threshold in Policy area streams. Where the median February flow in Maacama Creek was 92 ft^3/s, the Median February Flow scaled to Grape Creek would be 6.7 ft^3/s. The difference between median February flow and the Q_{mbf} value based on the Policy calculation and other relevant studies from nearby streams (e.g., Deitch and Kondolf 2012, which calculated a flow at depth of 0.8 ft of approximately 20 ft^3/s for a watershed of 3 mi^2) suggests the median February Flow may underestimate the flow threshold for the Grape Creek watershed required to protect passage. Environmental flows thresholds frequently do not scale simply by a ratio of watershed area and precipitation. For small streams such as Grape Creek, where few data have been gathered to appropriately quantify environmental thresholds, site-specific studies provide a format to more carefully assess ecological protections.

Table 1. Streamflow statistics for instream flow protections including those using equations recommended by SWRCB, based on data from Maacama Creek near Kellogg

	Maacama Creek near Kellogg	Grape Creek above Wine Creek	Wine Creek	Grape Creek below Wine Creek	Grape Creek at West Dry Creek Road
Watershed area, mi^2	43	1.23	1.29	2.79	3.2
1.5-year peak flow, ft^3/s	4,250	121	122	270	309
5% of 1.5-year peak flow, ft^3/s	212	6.1	6.1	13	15
Average annual flow, ft^3/s	79	2.3	2.3	5.0	5.7
Average annual rainfall, in	45	45	43	44	44
Q_{mbf}, ft^3/s	118	18	18	27	29
Median February flow, ft^3/s	92	2.6	2.6	5.8	6.7

5.4.3 Ecologically Significant Standards for Protecting Instream Flows

Initial observations by CSSP researchers suggest that the regionally protective criteria for diversion as calculated for the Grape Creek watershed may not be entirely appropriate to protect anadromous salmonids. To further investigate whether these standards are appropriate, and whether alternative flow magnitudes would provide intended protections, we conducted a study to evaluate the flow conditions that limit the potential for anadromous salmonids to migrate upstream at particular locations in the watershed. In particular, we made assessments of water depth and velocity in four reaches deemed important by virtue of proximity to potential points of diversion or for their role in providing access to upstream habitat. The study reaches correspond with our streamflow gauge sites: Lower Grape (Grape Creek below West Dry Creek Road), Grape below Wine, Wine, and Grape above Wine (Figure 40). At each reach, we selected cross sections through critical riffles for anadromous salmonids. Critical riffles have relatively even depth profile across their width and spread flow across a greater width than other proximate portions of the channel, thus posing the most difficult passage conditions.

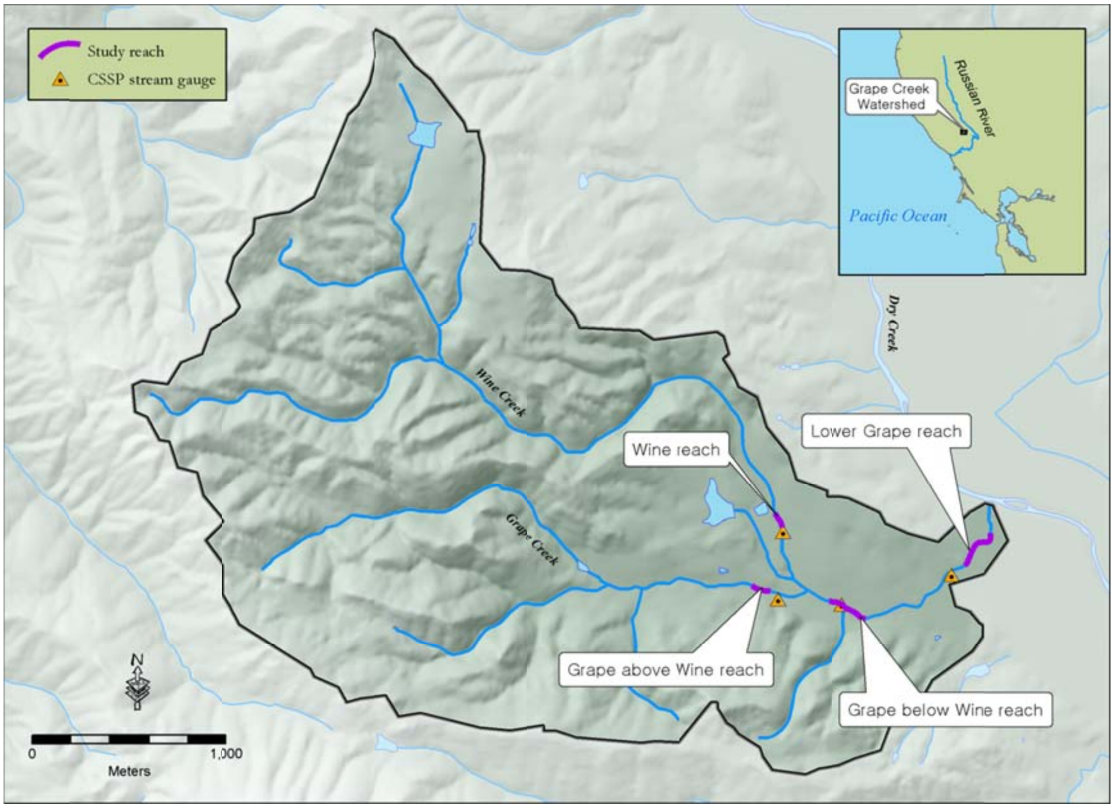


Figure 40. Study reaches for upstream passage evaluation

To evaluate the critical riffles, we followed protocols similar to the Thompson Method (Thompson 1982), whereby we measured water depth at approximately 20 equidistant points through a cross section in the riffle. The measurement increment was determined by dividing the wetted channel width by 20. At Lower Grape, we measured critical riffle depths through six riffles; and Grape below Wine, Wine and Grape above Wine, through four riffles. Our criterion for evaluating the potential for passage is based on literature: if the depth through the riffle is equal to or greater than 0.7 ft at 10 percent continuously across the channel (*i.e.*, through two consecutive measurements), passage is possible.

We measured water depth through riffles on March 13, 2012, during a high flow event in Grape Creek. Streamflow measured at Lower Grape Creek was 35 ft^3/s, and at Grape below Wine, Wine above Grape, and Grape above Wine were 29 ft^3/s, 5.6 ft^3/s and 21 ft^3/s, respectively. We also measured critical riffle depths on March 30, 2012 and April 10, 2012. The streamflow at the study reaches and the results of the passage analysis are presented in Table 2. For the analysis of frequency below, we assume that a realistic flow to protect migration is 13 ft^3/s at the Lower Grape, 13 ft^3/s at Grape below Wine, 10 ft^3/s at Wine, and 10 ft^3/s at Grape above Wine.

Table 2. Results of adult fish passage evaluation, following Thompson (1972), at four sites in the Grape Creek drainage network

Study reach	Transect	Streamflow, ft^3/s		
		35	13	3.6
Grape Creek below West Dry Creek Road	1	Passable	Passable	Not passable
	2	Passable	Passable	Not passable
	3	Passable	Passable	Not passable
	4	Passable	Passable	Not passable
	5	Passable	Passable	Not passable
	6	Passable	Passable	Not passable
Study reach	Transect	Streamflow, ft^3/s		
		29	10	3
Grape Creek below Wine Creek	1	Passable	Not passable	Not passable
	2	Passable	Not passable	Not passable
	3	Passable	Not passable	Not passable
	4	Passable	Not passable	Not passable
Study reach	Transect	Streamflow, ft^3/s		
		5.6	5.4	1.3
Wine Creek above Grape Creek	1	Not passable	Not passable	Not passable
	2	Passable	Passable	Not passable
	3	Not passable	Not passable	Not passable
	4	Not passable	Passable	Not passable
Study reach	Transect	Streamflow, ft^3/s		
		21	4.1	1.5
Grape Creek above Wine Creek	1	Passable	Not passable	Not passable
	2	Passable	Passable	Not passable
	3	Passable	Not passable	Not passable
	4	Passable	Not passable	Not passable

5.4.4 Preliminary Instream Flows Analysis Implications

The data above provide guidelines describing when diversions can operate from Grape Creek in winter. The estimated discharge magnitudes to provide instream flow protections can be compared to streamflow data gathered to determine how often a person could divert water from Grape Creek, and depending on the diversion rate, the likelihood that sufficient flows can be stored to meet human water needs in the watershed. If measured streamflow seldom exceeds the protective instream flows, it may be unlikely that water can be diverted to meet those needs. Based on the field-based assessment of flow required for fish to migrate upstream, the bypass at the Grape Creek below West Dry Creek Road gauge is 13 ft^3/s. Based on Water Year 2010 data, this flow threshold was exceeded for a total of 32 days (Figure 41). (In contrast, the Q_{mbf} value for Grape Creek below West Dry Creek Road, using the SWRCB equation, is exceeded 16 days in 2010.)

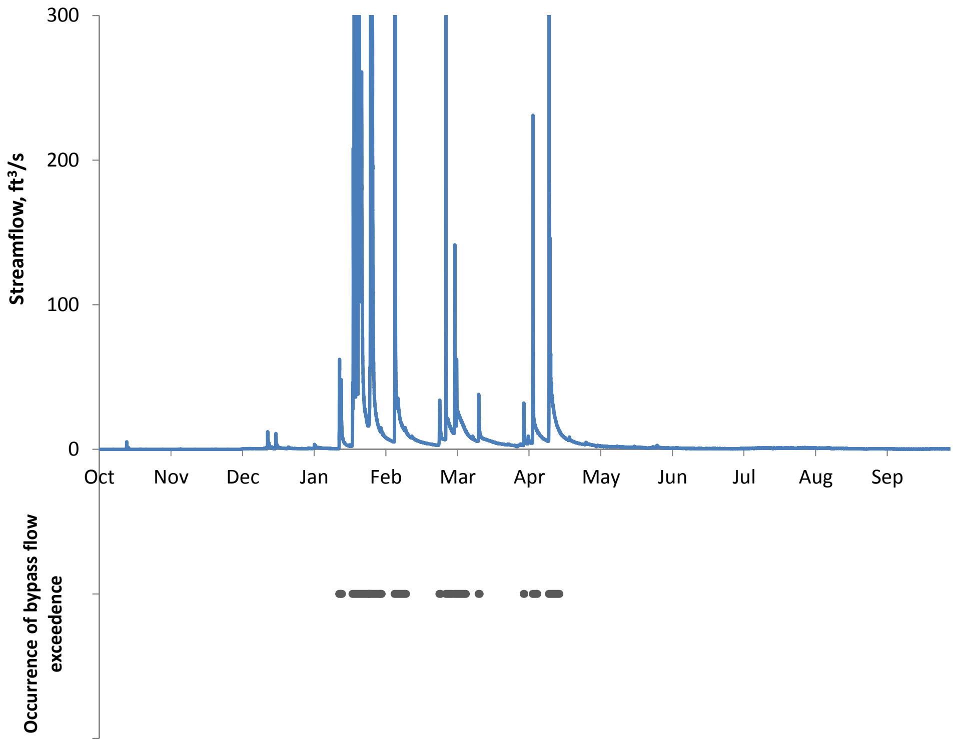


Figure 41. Streamflow and exceedance of bypass threshold for Grape Creek above Wine Creek, where the bypass threshold is 22 ft^3/s (9.8 days total through water year 2010).

Scaled streamflow data from historical gauges can provide a longer-term comparison. Scaling the 20 years of data from Maacama Creek gauge to the lower Grape Creek gauge, the bypass flow is exceeded on average 31 days from December 15 to March 31. In a dry year (in this case, the year in which the number of days over 13 ft^3/s is exceeded by 85 percent of all years), the number of days over 13 ft^3/s is 12. In a wet year (the year in which the number of days over 13 ft^3/s is exceeded by 15 percent of all years), the number of days over 13 ft^3/s is 50.

These comparisons have important implications for water management expectations in the Grape creek watershed. For example, if a water right holder can divert from Grape Creek below West Dry Creek Road only when the flow allows fish to move upstream, this is a total of 32 days in an average year. These scenario analyses are most important in dry-type years. During a dry type year, a diverter may expect to divert no more than 12 days from Grape Creek below West Dry Creek Road, likely resulting in much less water obtained (assuming a similar diversion rate) in a dry year than in a normal year.

6. Long Term Strategy for Ensuring Durable Results

6.1 Mechanisms for Protecting Saved Water

6.1.1 Forbearance Agreements

Forbearance agreements have evolved as one of the tools for protecting instream flow gains achieved through storage and other water conservation projects. It is a covenant that runs with the land and is recorded with the county property records. Forbearance agreements have been used in the Mattole River Headwaters, Salmon Creek (Sonoma County), Grape Creek (Sonoma County), and Green Valley Creek (Sonoma County). In general, a forbearance agreement sets forth the responsibilities as between the project proponent (*e.g.*, Sanctuary Forest in the Mattole and Gold Ridge Resource Conservation District in Salmon Creek and Green Valley Creek) and the landowner and/or water user. It specifies the terms under which diversions and other water management practices can be initiated and must be ceased.

6.1.2 Instream Dedications (Water Code Section 1707)

In addition to entering into forbearance agreements, water users may initiate a change petition to dedicate their water right – or a portion of a water right – to instream uses during the dry season under California Water Code Section 1707. In some cases, either a forbearance agreement or a water right change to instream flow could be sufficient to ensure fisheries and public benefit, but there are other factors to consider in determining when a water right change could be valuable and necessary.

The main benefits to the instream water right dedication are that it offers a layer of protection and durability for the instream water restored through projects that is unachievable with a forbearance agreement alone. Specifically, it offers protection as to other water diversions, provides legal recognition of the instream water in the eyes of the state, and allows funders, project proponents, and the landowner to ensure that water rights no longer used are not lost to the next junior appropriator or to new appropriators.

If a landowner is operating under an appropriative water right and ceases diversion during the dry season, the right could be lost through non-use. In this case, ensuring that the water is protected instream – through a water rights change petition – is important. If the landowner is operating under a riparian right, the landowner would not normally lose the water right as a result of non-use (abandonment or forfeiture[17]), so some type of forbearance agreement should be sufficient to ensure that the water right is not lost through non-use. The main drawback to pursuing a forbearance agreement alone – without a dedication – is that the water is not protected for instream uses from other diverters. A forbearance agreement would be recorded with the county and run with the land (so it binds future landowners) but it would not be known to other water

[17] Note however that dormant (unexercised) riparian rights can sometimes be lost or subordinated in priority in an adjudication.

diverters or prevent them from simply taking the water we and the landowner put back into the stream.

A water rights dedication for the water no longer consumptively used can be an important part of the strategy for ensuring durable results. This could be all or a portion of a water right (*e.g.*, in Pine Gulch Creek, the landowners dedicated the portion of their riparian water right used for irrigation during a portion of the year and maintained the non-irrigation portion of that riparian water right). This is especially important where projects involve the initiation of a new water right (*e.g.*, winter diversion and storage) and involve an existing appropriative right, as the right can be lost to non-use. There may be cases where an instream water rights dedication is not appropriate. Those projects would likely include the following types of characteristics: where the landowner has a documented riparian water right (*i.e.*, not lost through non-use), does not seek to initiate a new water right, and where the water no longer diverted is geographically protected from diversion by others (now and in the future). In addition, cost may be a factor for small projects (where the transactions costs of the dedication could be high relative to the overall project cost – *e.g.*, projects like small rainwater catchment). In these types of cases, a forbearance agreement may offer sufficient protection.

6.2 Monitoring and Evaluation

In the CSSP SIPs, we propose practices that we predict will produce additional streamflow in summer and fall while also maintaining sufficient water levels in winter and spring, and we predict that these actions will benefit salmonids. These predictions are based on our best models to evaluate improvement, but they are not actual depictions of the benefits from the projects that will be implemented. We recommend continued streamflow and habitat monitoring to evaluate the actual benefit of these projects on streamflow in the drainage network and to determine whether the projects have the benefits we expect (or the conditions under which the benefits are reached, such as in normal-type years or dry years). Such monitoring protocols will help us and others seeking to restore streamflow in coastal California watersheds to understand the benefits of these types of practices, as well as to understand the limitations of these practices given the range of variability across many years. Continued monitoring will also provide resources necessary for landowners to operate diversions appropriately and to ensure compliance with the terms and conditions stipulated in new diversion operations.

Additionally, continued monitoring of streamflow and expanded examination of habitat conditions will help us to gauge the benefit of these projects on fisheries. If data indicate that streamflow is greater and more stable through summer, and rearing habitat quality and juvenile summer survival do not increase, other factors may need to be considered to achieve the goal of creating a healthy fishery in Grape Creek. We note that streamflow is not the only factor limiting the persistence of a healthy fishery in Grape Creek, and work to increase streamflow in summer and continued fisheries resource monitoring will help us to understand the most significant additional challenges facing anadromous salmonids in the watershed.

The current operation of these gauges is funded by NFWF for a series of management and scientific purposes described in the Russian River Coho Salmon KIBP. Additional NFWF-funded coho salmon monitoring will be conducted to evaluate the survival of stocked and/or wild fish at two locations in Grape Creek below the projects. Grape Creek is one of four watersheds in Sonoma County in which a Before-After Control-Impact (BACI) study has been designed, in partnership with the Russian River Coho Salmon Captive Broodstock Program and UCCE/CSG, to evaluate the survival of juvenile coho salmon through summer. In two study reaches downstream of the project site, PIT tagged juvenile coho will be stocked each June and monitored through the summer season. Portable PIT tag detection wands will be used to track monthly abundance and survival of coho in each reach between June and October. Relationships will be developed between survival data and continuous stream flow and temperature data as well as a series of environmental metrics collected on a monthly basis (pool depth, wetted area, and dissolved oxygen). Data collected during the summers of 2010 and 2011 will serve as a baseline for documenting post-project flow-related improvements to juvenile coho oversummer survival. Depending on the overall success of the project and other factors, NFWF could provide long-term funding for streamflow and fisheries monitoring in the watershed under the KIBP.

6.3 Potential Threats

A significant amount of work has been completed to improve instream flow for fish populations in Grape Creek. We are evaluating the risk that future events will compromise the gains made today and are preparing a series of actions to guard against that possibility. Potential threats include:

- **Land use changes.** Land use change is a threat to streamflow gains in the Grape Creek watershed. Although the human footprint remains limited and development pressures are lesser here than in most places, the headwaters has seen some growth in newly developed residences and road development. At least one property changed ownership during the course of the project. Although we have developed relationships with landowners and many have agreed to collaborate on and implement projects, we must ensure that any streamflow improvements can withstand land use and ownership changes in the long-term.

- **Non-participants.** The success of the program depends on our ability to continue to recruit new landowners. This is necessary not only to reach the objectives, but also because having a high concentration of participants also helps ensure that water savings by landowners are not captured by other landowners rather than the stream. In addition, high participation creates a cultural climate conducive to water conservation and discourages water waste. Success breeds success.

- **Lack of funding for water storage.** Funding needs are discussed in a previous section, but it is worth noting again here. All progress is subject to funding. Moreover, no one expects public funds to pay for all restoration, even though the public does benefit from the projects. To date, three fans have been installed with private funds, an off-stream storage pond has been installed with significant landowner contribution, and an off-stream storage pond has been installed with public and other funding. Private and public funds are tighter than ever. We anticipate that funding will be the main limiting factor for how quickly the project can progress.

- **Lack of funding for monitoring.** As mentioned above, long-term monitoring is important for ensuring compliance with water management conditions, for identifying changes in streamflow associated with water management practices, and for evaluating whether our proposed projects when implemented have the benefit we predict. Without additional resources for monitoring, we will not learn whether the projects implemented in Grape Creek are sufficient to restore streamflow beyond our identified thresholds and whether the results are long-lasting. Funding for any type of monitoring is generally considered a major challenge of these types of projects, and we anticipate that monitoring after projects are implemented (while critical to understanding their success) will be even less attractive.

- **Climate change.** Although future effects of climate change cannot be quantified or predicted precisely, we consider it a strong risk factor for the future.

6.4 Recommendations

- **Instream Dedications**. Consider using section 1707 of the Water Code to change some of the existing riparian rights that will no longer be used (because the landowners have substituted stored water) to instream flow purpose and place of use.

- **North Coast Instream Flow Policy**. Ensure implementation of the Policy for Maintaining Instream Flows in Northern California Coastal Streams. The policy provides greater assurances that streamflow/fisheries enhancement projects will not be undermined by future projects or existing, illegal projects: it includes cumulative effects standards for evaluating new water right applications, it establishes a season of diversion outside of the dry season, it prohibits new on-stream reservoirs and dams, it requires mitigation for existing, unauthorized on-stream dams, and it includes a written enforcement policy. In addition, the Policy requires comprehensive monitoring and reporting of new diversions (and potentially, petitions for change) and comprehensive stream gauging; more data and a more accurate accounting of human water demand will only help efforts to restore streamflow. If fully implemented and evaluated for effectiveness, the policy provides a robust regulatory tool for ensuring the long-term success and benefit of water rights changes to enhance instream flow and will strengthen existing water rights for instream and consumptive beneficial uses.

- **Stable funding.** Develop a stable source of funding for gauges and a robust monitoring program. As mentioned above, a wealth of information can be learned about the success of streamflow restoration projects through monitoring. We also acknowledge that low streamflow through summer may not be the only limitation to a healthy fishery in Grape Creek: flow in other times of year, as well as habitat features, may pose additional challenges to sustaining a consistent salmonid population. We recommend developing a source of continued monitoring throughout the Grape Creek watershed for streamflow and fish populations (much of which has been proposed for funding from the NFWF for the next few years), as well as funding to develop linkages between streamflow and other salmonid life history thresholds (e.g., sufficient flow for food production and rearing in spring).

- **Recharge.** Comprehensive streamflow improvement will require not only changes in how diversions are managed, but also the development, siting and design of recharge projects that slow, spread, and sink water across the landscape (*e.g.*, capturing roofwater for recharge, managing stormwater runoff for maximum recharge, etc.).

- **Incentives for Participation.** Creating additional incentives for water users and decreasing the transaction costs associated with projects can help facilitate additional projects. As we described above, we have worked to decrease hurdles to participation by working with the SWRCB to clarify that rainwater harvesting does not require a water right and to disseminate better information about instream dedications. We also worked with the Wine Institute to pass legislation (Assembly Bill 964 in 2011, sponsored by Assemblymembers Huffman and Chesbro) to allow registrations for certain small farm ponds similar to the Small Domestic Use process, and we helped secure language in the North Coast Instream Flow Policy that allows for expedited permitting of streamflow improvement projects.

  Since winegrape farming and wine-making characterizes the Grape Creek watershed, efforts to link salmon and wine consumers with participants can create additional incentives for water users to participate in streamflow projects and encourage consumers to support sustainable agriculture. For example, (a) we created Have Your Salmon and Eat it Too: California, a booklet with recipes for salmon and salmon conservation highlighting the importance of instream flow in Wine Country; (b) worked with Pacific Market (a popular local market in Sonoma County) to organize an event to link consumers to the sources of their fish and wine (Pacific Market agreed to run specials on the wine from landowners partnering with us on flow improvement projects, and we encouraged consumers to continue to support businesses that are taking actions to support salmon and healthy salmon habitat); (c) worked with Martorana Family Vineyards – the vineyard and winery that installed a frost fan and ceased water diversion for frost protection – to write an article for TU's *WhyWild* Newsletter – which was distributed to thousands of chefs, restaurateurs, fish retailers and wholesalers, interested consumers, and foodies – and to organize a Bike-Wine-Fish event celebrating both wine and fisheries restoration. Finally, some partners have initiated their own projects. After implementing a habitat restoration project on Grape Creek, Quivira Vineyards and Winery created "Steelhead Red" a wine that celebrates the fisheries conservation efforts. Highlighting the good work of landowner partners in the marketplace can help create additional incentives for participation.

Recommendations:

- ✓ **As cooperative streamflow improvement projects are implemented, consider using section 1707 of the Water Code to change some of the riparian rights that will no longer be used (because the landowners have substituted stored water) to instream flow purpose and place of use**

- ✓ **Ensure implementation of the Policy for Maintaining Instream Flows in Northern California Coastal Streams**

- ✓ **Develop stable source of funding for gauges and monitoring**

- ✓ **Incorporate recharge projects into long-term streamflow improvement efforts**

- ✓ **Create incentives that motivate and enable landowners and water users to make beneficial changes**

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Appendix A. Recovery Plan Actions Implemented by CSSP

CSSP addresses and implements recommendations and actions identified in the following public planning documents:

Central California Coast Coho Recovery Plan

The Central California Coast Coho Recovery Plan identified Grape and Wine creek as Core Priority Area for CCC coho and deemed the threat to summer rearing juvenile fish from water diversion and impoundments in the Russian River watershed to be "very high" (*i.e*., the highest threat level) (NMFS 2012). The efforts under CSSP are consistent with and represent progress toward the following recovery plan objectives and recovery actions listed for the Russian River:

RR-CCC-4.1.1.2	Promote, via technical assistance and/or regulatory action, the reduction of water use affecting the natural hydrograph, development of alternative water sources, and implementation of diversion regimes protective of the natural hydrograph.
RR-CCC-4.1.1.3	Avoid and/or minimize the adverse effects of water diversion on coho salmon by establishing: a more natural hydrograph, by-pass flows, season of diversion and off-stream storage.
RR-CCC-4.1.2.1	Reduce the rate of frost protection and domestic drawdown in the spring.
RR-CCC-4.1.2.2	Assess and map water diversions.
RR-CCC-4.2.1.1	Develop cooperative projects with private landowners to conserve summer flows based on the results of the NFWF efforts.
RR-CCC-4.2.2.1	Work with SWRCB and landowners to improve over-summer survival of juveniles by re-establishing summer baseflows (from July 1 to October 1) in rearing reaches that are currently impacted by water use.
RR-CCC-4.2.2.2	Work with SWRCB and landowners to improve flow regimes for adult migration to spawning habitats and smolt outmigration.
RR-CCC-4.2.2.3	Promote alternative frost protection strategies.
RR-CCC-25.1.1	Prevent impairment to stream hydrology (impaired water flow).
RR-CCC-25.1.1.2	Promote water conservation by the public, water agencies, agriculture, private industry, and the citizenry.
RR-CCC-25.1.1.3	Promote off-channel storage to reduce the impacts of water diversion (e.g., storage tanks for rural residential users).

RR-CCC-25.1.1.4 Provide incentives to water rights holders willing to convert some or all of their water right to instream use via petition [for] change of use and [Section] 1707.

RR-CCC-25.1.1.5 Improve coordination between agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitats, and avoidance of adverse impacts caused by water diversion.

RRR-CCC-25.1.1.8 Promote water conservation best practices such as drip irrigation for vineyards.

Recovery Strategy for California Coho Salmon

CSSP is consistent with DFG's Coho Recovery Strategy. It directly addresses the following recommendations for the Russian River Hydrologic Unit: the identification of water diverters, SWRCB review and/or modification of water use based on the needs of coho salmon and authorized diverters (RR-HU-03) (p. 8.39), and development of "county, city, and other local programs to protect and increase instream flow for coho salmon." CSSP also implements the following range-wide recommendations:

RW-I-D-01: Encourage elimination of unnecessary and wasteful use of water from coho salmon habitat…Encourage water conservation for existing uses.

RW-I-D-02: Where feasible, use programmatic, cost-efficient approaches and incentives to working with landowners to permit off-channel storage ponds.

RW-I-D-08: Support a comprehensive streamflow evaluation program to determine instream flow needs for coho salmon in priority watersheds.

RW-II-B-01: Pursue opportunities to acquire or lease water, or acquire water rights from willing sellers for coho salmon recovery purposes. Develop incentives for water right holders to dedicate instream flows for the protection of coho salmon (California Water Code § 1707).

California Wildlife Action Plan

CSSP addresses recommended actions in the California Wildlife Action Plan for the North Coast (DFG 2007, p.261):

> "For regional river systems where insufficient or altered flow regimes limit populations of salmon, steelhead, and other sensitive aquatic species, federal and state agencies and other stakeholders should work to increase instream flows and to replicate natural seasonal flow regimes. Priorities specific to this region include:
>
> - Agencies and partners should develop water-use and supply plans that meet minimum flow and seasonal flow-regime requirements for sensitive aquatic species (CDFG 2004).

In determining flow regimes, the suitable range of variability in flow, rate of change, and peak- and low-flow events should be considered (Richter *et al.* 1997).

- Water trusts or other forums that provide a structured process for willing participants to donate, sell, or lease water dedicated to instream use should be pursued (CDFG 2004).
- Innovative ways to manage small-scale water diversions should be developed, such as agreements to alternate diversion schedules (so that all water users do not withdraw water at once) and the use of off-stream reservoirs to store winter water and limit diversion during the dry season. Incentives should be established for water users to participate in these efforts (CDFG 2004).
- Agencies and partners should encourage water conservation practices and use of technologies that reduce water consumption by residential and agricultural water users through incentives and education (CDFG 2004)."

State Water Resources Control Board

CSSP furthers the California Water Boards' Strategic Plan (State Water Board 2008). The Plan states:

> "The State Water Board strives to use a collaborative watershed management approach to satisfy competing environmental, land use, and water use interests by taking advantage of opportunities within a watershed, such as joint development of local solutions to watershed-specific problems, cost sharing, and coordination of diversions. For example, instead of the State Water Board and other regulatory agencies establishing and enforcing stream flow objectives through regulation of individual diversions, water users could agree to collectively manage their diversion schedules so that needed stream flows are maintained at particular points in a stream. They could also share costs associated with developing data and monitoring programs, and work together on projects to improve habitat at the most significant locations in the watershed. Extensive use of such approaches using coordination and collaboration, however, is currently beyond the Water Boards' resources."

Furthermore, the State Water Board identified the Russian River as one of its first priority rivers and streams in its prioritized schedule of instream flow studies for the protection of public trust resources.