Smith River Plain Water Quality Management Plan

Smith River Plain Watershed Stewardship Team

North Coast Regional Water Quality Control Board

November 2021

Acknowledgements

The Regional Water Board wishes to acknowledge the participation and valuable contributions of the following organizations and individuals to the development and implementation of the Smith River Plain Water Quality Management Plan. This plan and your continued efforts will serve as an excellent example of science-based adaptive management to restore and protect water quality in the North Coast Region.

North Coast Regional Water Quality Control Board Project Team

Clayton Creager – Project Team Lead
Ben Zabinsky – Lead Editor
Maurice Washington – Section 3 Lead
Lance Le – GIS Specialist
Kelsey Cody – Section 4 and Riparian Technical Review Lead
Carrieann Lopez – Section 6 Lead
Rich Fadness – SWAMP Program Coordinator
Izaac Russo – Biotic Ligand Model and Copper Research
Alydda Mangelsdorf – Technical Review
Lynette Shipsey – Agricultural Lands Discharge Program Coordination
Nicholas Colbrunn – Editor and ADA Compliance Work

Smith River Plain Lily Bulb Growers

Don Crockett
Harry Harms
Zeke Harms
Rob Miller
Matt Westbrook
Will Westbrook

Tolowa Dee-ni' Nation

Jennifer Jacobs
Erika Partee
Jesse Nolan
Cynthia Ford
Jimmy Faukner

Del Norte Resource Conservation District

Linda Crockett

Smith River Alliance

Marisa Parish
Monica Scholey

NOAA Fisheries

Dan Free
Justin Ly

California Department of Fish and Wildlife

Justin Garwood
Michelle Gilroy
Michael Van Hattem

Del Norte County Agricultural Commissioner

Chelsea Grochowski
Justin Riggs

California Department of Pesticide Regulation

Scott Wagner

Humboldt State University

Dr. Matthew Hurst

Table of Contents

Purpose of the Plan

The goal of the Smith River Plain Water Quality Management Plan (Plan) is to meet water quality standards through the control of waste discharges associated with lily bulb operations in the Smith River Plain. It was developed in response to the North Coast Regional Water Quality Control Board (Regional Water Board) monitoring results that indicated concentrations of pesticides are exceeding USEPA benchmarks in surface waters draining agricultural areas in the Smith River Plain. The samples were collected as part of the Regional Water Board's Surface Water Ambient Monitoring Program (SWAMP Program). Regional Water Board staff presented the results at the April 2018 Regional Water Board meeting. In response, the Board directed staff to develop a plan to address the results and to work collaboratively with the lily bulb growers, staff of NOAA Fisheries, California Department of Fish and Wildlife (CDFW), the Tolowa Dee-ni' Nation, and the Smith River Alliance, a local restoration group. Regional Water Board staff worked together with these partners as a Watershed Stewardship Team to develop this Plan with additional input and review from the Del Norte County Agricultural Commissioner, the Del Norte Resource Conservation District (Del Norte RCD), the California Department of Pesticide Regulation (CDPR) and the Natural Resources Conservation Service (NRCS). The following factors guided the adaptive management development strategy for this Plan: 1) monitoring indicated the need for immediate action; 2) Board direction to work collaboratively with key partners; 3) the absence of technical documentation for Best Management Practices (BMPs) specific to the circumstances unique to the Smith River Plain; and 4) pending development of a discharge permit for lily bulb operations in the Smith River Plain. The tracking and monitoring of the broad range of BMPs identified in this Plan will provide invaluable information in the development of a discharge permit for lily bulb operations in the Smith River Plain.

This Plan addresses the water quality issues described in the following findings from Regional Water Board's monitoring reports[1]and staff visits to the Smith River Plain:

- Surface water sample results from several tributaries to the Smith River in the Smith River Plain documented varying levels of seasonal toxicity associated with agricultural chemicals. A full description of the monitoring results is provided in Section 3.3.

---

[1] The monitoring reports include the Smith River Plain Surface Water and Sediment Monitoring Report, 2013-2015 and the Smith River Plain 2015 Groundwater Monitoring Report.

- Surface water sample results documented the presence of copper, imidacloprid, diuron, permethrin, and tebuconazole above USEPA benchmarks for the protection of aquatic life.

- Groundwater sample results documented occasional exceedances of California Department of Public Health drinking water standards for nitrate.

- Given the environmental conditions and nature of the chemicals applied, pesticides and copper are likely being delivered to surface waters during irrigation and stormwater runoff events either dissolved in water or attached to eroded soil particles.

- In addition to the water quality monitoring results, it is clear from staff site visits during storm events and from photo documentation that riparian buffers are degraded, and in some cases nonexistent, and there is a direct hydrologic connection between many fields where chemicals are being applied and the drainage network to the Smith River.

To address these issues, this Plan describes a program of implementation that includes elements consistent with the *State Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program* (State Nonpoint Source Policy). It includes grower implementation of new and revised water quality management practices and monitoring to assess on-the-ground effectiveness. The practices primarily address water quality in storm runoff from lily bulb operations and include expanded stream setbacks, cover cropping, directional tillage, and grass filter strips. The Plan also includes monitoring instream to track changes in water quality in response to the practices being implemented on the ground.

While this Plan has been developed primarily to address the above findings, to a lesser degree, it also addresses other water quality issues such as the risk to groundwater from the application of manure and fertilizer to fields. In the Smith River Plain, cow dairy and other livestock operations use some of the same fields as lily bulb growers, and both apply nutrients (including manure) to the soil to improve productivity. When not managed appropriately, nutrients applied to land can affect nitrate levels in groundwater, which can impact local drinking water wells, and can affect surface water quality. While the SRPWQMP does not include the same level of monitoring and reporting for nutrients and nutrient control practices compared to what is required for pesticides, it does include management practices for fertilizer application rates and minimize impacts to groundwater. In addition, many of the best management practices included in the Plan, such as riparian buffers and filter strips, reduce the movement of nutrients into waterways and groundwater. As the SRPWQMP is implemented, Regional Water Boards staff will work with growers to better understand fertilizer application methods, the risks to water quality, and which nutrient management practices are most effective given the conditions in the Smith River Plain.

There are other existing monitoring programs, such as through the Regional Water Board's dairy program and the California Division of Drinking Water program, that will continue to track nitrate levels in local agricultural and community wells.

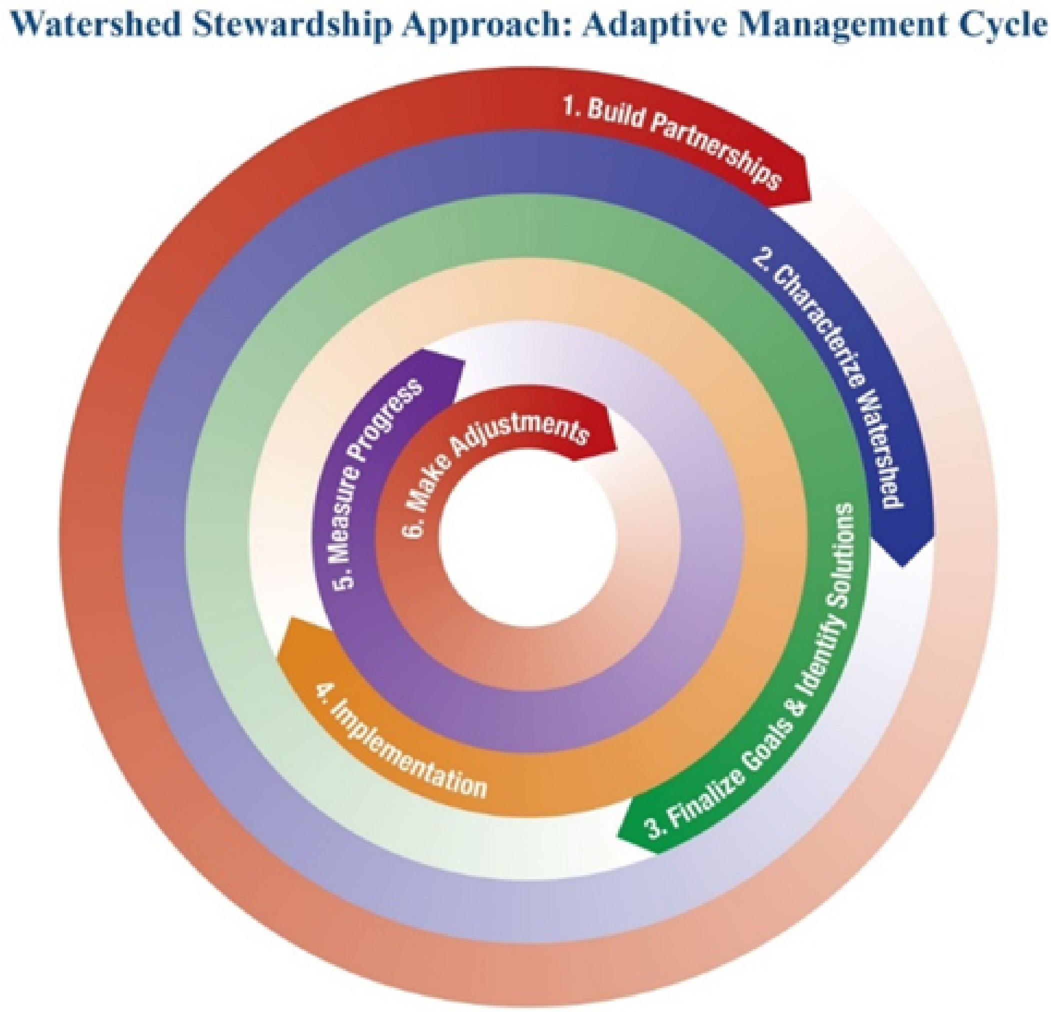
After the SRPWQMP is approved and being implemented, the Regional Water Board will transition to the development of a permit to address waste discharges associated with lily bulb cultivation in the Smith River Plain. The permit may include additional monitoring and reporting requirements for nutrients and nutrient control practices and will be consistent with the requirements of the State Irrigated Lands Regulatory Program and the State Nonpoint Source Policy. It will also incorporate the precedential requirements of the State Water Resources Control Board's (SWRCB) recently adopted Eastern San Joaquin Order (WQ 2018-0002), as appropriate. The goal of these requirements is to minimize the amount of nitrogen applied to agricultural fields and to protect public health. The requirements set up a reporting program to account for the amount of nitrogen applied to agricultural fields in areas where there is a potential for nitrates to reach drinking water sources. As Regional Water Board staff develops the permit to address lily bulb cultivation, these requirements will be incorporated for the Smith River Plain as appropriate.

To allow for collaborative development and implementation of the SRPWQMP, the Regional Water Board (RWB) formed a Watershed Stewardship Team. The members of the Watershed Stewardship Team include the following:

- North Coast Regional Water Board
- Lily Bulb Growers
- Tolowa Dee-ni' Nation
- California Department of Pesticide Regulation
- Del Norte County Resource Conservation District
- Smith River Alliance
- Del Norte County Agricultural Commissioner
- NOAA Fisheries
- California Department of Fish and Wildlife
- Humboldt State University

The Watershed Stewardship Team will adaptively manage the implementation of this Plan in coordination with other local regulatory programs and restoration efforts as described in Section 7. Regional Water Board staff will inspect operations periodically to ensure practices are being implemented and will assess their effectiveness on the ground. Feedback from inspections, grower reporting, and surface water sampling will be shared with the Watershed Stewardship Team to inform any necessary revisions to this Plan. The implementation and reporting program is described in Section 5. The Regional Water Board will lead an adaptive management monitoring program (Section 6) to track changes in water quality and help assess the effectiveness of management practices. The monitoring results will also help to inform the adaptive management strategy moving forward.

The Watershed Stewardship Team will periodically report to the Regional Water Board and the public on progress towards achieving the goal of the Plan. While the Plan is being implemented, the Regional Water Board will begin developing a permit to regulate discharges associated with lily bulb operations that will fully implement the State Nonpoint Source Policy. This Plan provides a firm foundation for the permit and several of its program elements will be incorporated into the permit as it is developed.



North Coast Regional Water Quality Control Board

Watershed Stewardship Approach

This Plan has been developed as part of the North Coast Regional Water Board's Watershed Stewardship Approach.

The Regional Water Board chose to use this approach to more immediately address the water quality issues within the Smith River Plain, in part due to the favorable status of several of the following factors that are necessary for the stewardship approach to be successful:

- Direction from the Regional Water Board to staff to build on existing coordination efforts,
- Willing participation of key stakeholders in a collaborative process including the lily bulb growers, and
- Existing environmental assessment and watershed characterization to guide a science-based adaptive management process.

Steps 1 and 2 of the Watershed Stewardship Approach as shown in the figure were already being addressed prior to this Plan being developed. The rest of the steps in the approach are addressed by the management goals for this Plan listed below. References to the sections of the Plan that fully describe how each of the goals is being achieved are provided in parentheses:

1. Clearly describe the roles and responsibilities of parties addressing the risks to water quality associated with discharges from lily bulb operations in the Smith River Plain (Section 1).
2. Coordinate the Regional Water Board's programs and regulations with other water quality programs and restoration initiatives in the Smith River Plain (Section 1).
3. Describe the environmental setting and watershed characteristics that must be considered in tailoring management actions to address issues of concern (Section 1).
4. Describe lily bulb operations and associated activities including current and planned management practices to control associated discharges to waters of the State (Sections 2 and 4).
5. Describe the risks to water quality from lily bulb operations, including a risk characterization of the chemicals applied and the various pathways through which impacts to water quality can occur (Section 3).
6. Describe the best management practices (BMPs) that lily bulb operations are currently implementing and others that can be employed to eliminate pollutant discharges to waterways and groundwater in the Smith River Plain (Section 4).
7. Establish a system of lily bulb grower reporting to track the implementation of water quality practices on an annual basis and measure progress (Section 5).

8. Describe and implement a status and trends Adaptive Management Water Quality Monitoring Plan for surface and groundwater, consistent with the requirements for a nonpoint source pollution control program, to inform the Smith River Plain Watershed Stewardship Team (Sections 6 & 7).
9. The Water Stewardship Team evaluates the effectiveness of water quality management practices and adjusts practices in the plan based on feedback from water quality sampling results, implementation monitoring and grower reporting (Section 7).
10. Provide a plan for stakeholder engagement to facilitate input to the Watershed Stewardship Team as the team adaptively manages the program and makes improvements as needed (Section 7).
11. Provide a foundation for the development of a future permit to regulate discharges associated with lily bulb operation in the Smith River Plain (Section 7).

Section 1
Watershed and Resource Overview

1.1 The Smith River Watershed

The Smith River Watershed encompasses 762 square miles in the northwest corner of California and southwest corner of Oregon with much of the watershed located in the Klamath and Siskiyou Mountains. The geology contains significant amounts of copper, nickel, and chromium (SWAMP, 2018). The federal government is the major land manager in the Smith River Watershed with parts of the Six Rivers National Forest and Siskiyou National Forest accounting for just under half of the watershed area. The Smith River is the largest undammed river in California and provides high quality habitat for salmonids and other aquatic and riparian species. The Smith River Plain, the focus of this Plan, is a coastal plain located at the lower end of the Smith River watershed near the mouth. It covers about 12 square miles and receives an average of 73 inches of rainfall annually (Weather Atlas, 2020).

Figure 1.1 Smith River Watershed in California.

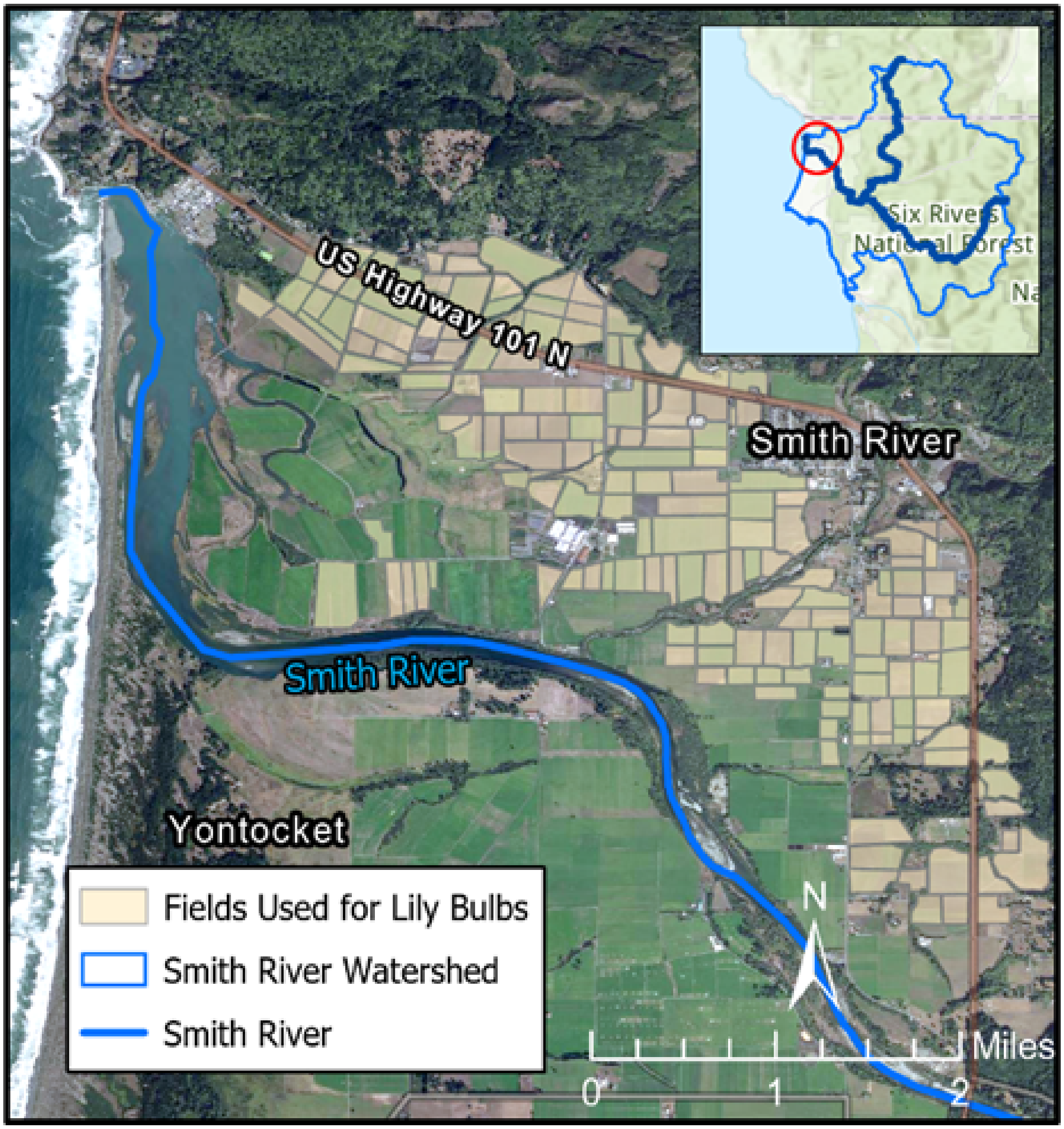


Figure 1.2 Smith River Plain showing fields used for lily bulb cultivation.

As shown in Figure 1.3, below, several small tributaries (Tillas Slough, No Name Creek, Ritmer Creek, Delilah Creek, Dominie Creek, Rowdy Creek, Morrison Creek, Mello Creek, and Yontocket Slough) cross the plain and drain into the Smith River. The mainstem of the Smith River bisects the plain dividing it into a southern and northern half. This Plan focuses on the northern half of the plain where lily bulbs are cultivated, also shown in Figure 1.3.

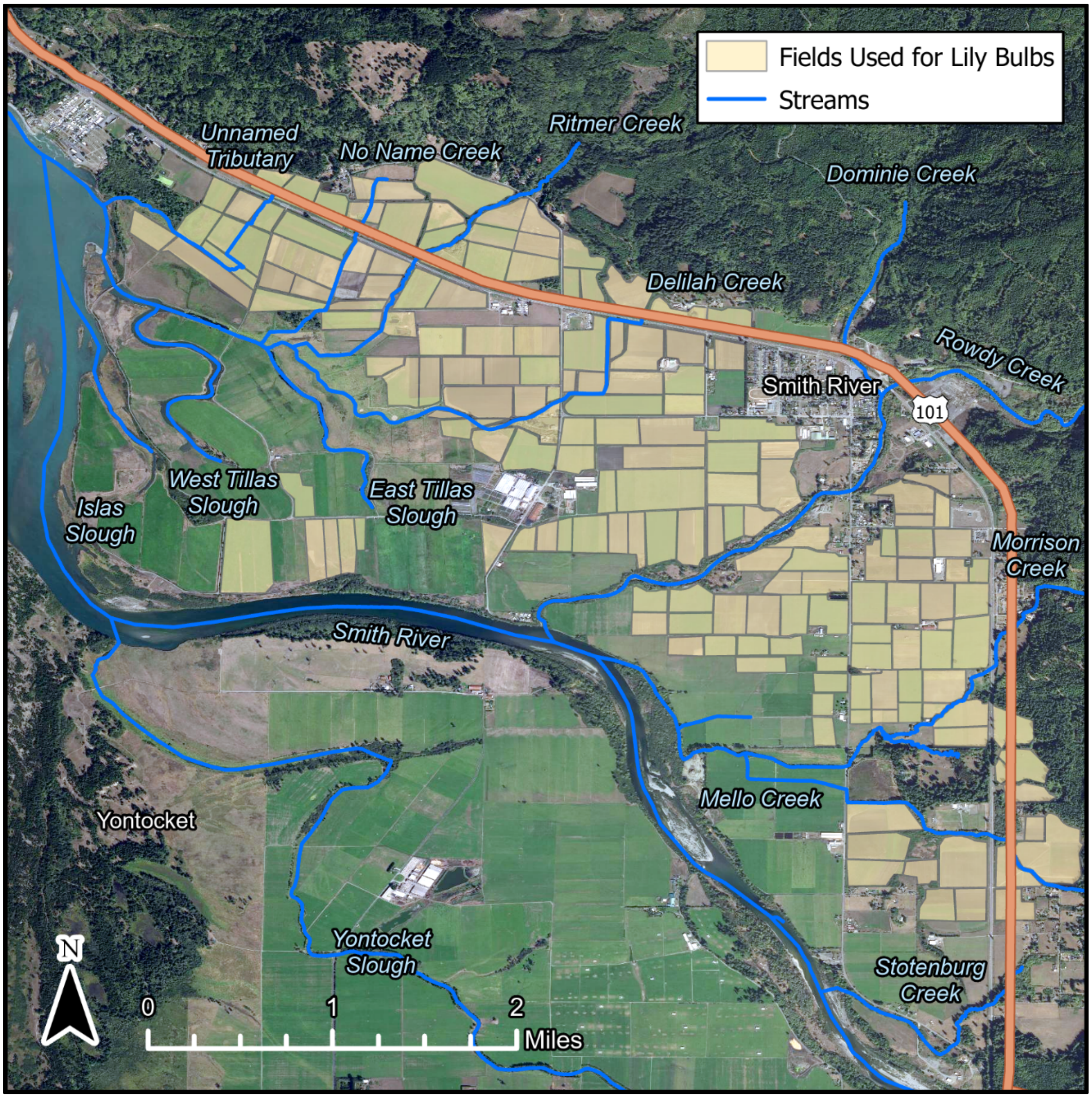


Figure 1.3. Major coastal tributaries of the Smith River Plain and lily bulb growing.

The Smith River Plain is part of the ancestral lands of the Tolowa Dee-ni' Nation that has a population of about 1750 tribal members. The Rowdy Creek Fish Hatchery is located on Rowdy Creek near the town of Smith River and is owned by the Tolowa Dee-ni' Nation and operated by the Rowdy Creek Fish Hatchery Board of Directors. The town of Smith River is also located within the plain and has a population of around 900 people. Currently the Smith River Plain is used for lily bulb cultivation, cattle ranching, dairy production, and aggregate mining. In support of those land uses, the hydrology and habitat of the area has been highly modified by, for example, the conversion of lands to agriculture, diking, the operation of tide gates, and the removal of riparian vegetation and woody debris from stream channels.

1.2 Beneficial Uses of Water in the Smith River Plain

The Regional Water Board's purpose is to protect the beneficial uses of waters of the state by maintaining water quality and/or enhancing it to a level supportive of those uses. This Plan describes the management practices that are being implemented or will be implemented by lily bulb growers as part of a coordinated effort in the Smith River Plain to support the beneficial uses of water in the Smith River Plain Hydrologic Subarea. Those uses are designated in the Water Quality Control Plan for the North Coast Region (Basin Plan), and are listed below.

Beneficial Uses of surface water in the Smith River Plain Hydrologic Subarea, which excludes the Rowdy Creek watershed include:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Service Supply
- Industrial Process Supply
- Freshwater Replenishment
- Navigation
- Water Contact Recreation
- Non-Contact Water Recreation
- Commercial and Sport Fishing
- Cold Freshwater Fishery
- Wildlife Habitat
- Rare, Threatened, or Endangered Species
- Marine Habitat
- Spawning, Reproduction, and/or Early Development
- Migration of Aquatic Organisms
- Estuarine Habitat
- Aquaculture
- Tribal Subsistence Fishing, Tribal Tradition and Culture

Beneficial Uses of surface water in the Rowdy Creek Hydrologic subarea include:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Service Supply
- Industrial Process Supply
- Freshwater Replenishment
- Navigation
- Hydropower Generation
- Water Contact Recreation
- Non-Contact Water Recreation
- Commercial and Sport Fishing
- Cold Freshwater Fishery
- Wildlife Habitat
- Rare, Threatened, or Endangered Species
- Spawning, Reproduction, and/or Early Development
- Migration of Aquatic Organisms
- Aquaculture
- Tribal Subsistence Fishing, Tribal Tradition and Culture

Beneficial uses of groundwater in the North Coast Region include:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Service Supply
- Industrial Process Supply
- Freshwater Replenishment
- Aquaculture
- Tribal Subsistence Fishing, Tribal Tradition and Culture

Of the uses listed above, the beneficial use of water most sensitive to degraded surface water quality is the Cold Freshwater Fishery. At least 26 species of fish have been observed in the Smith River Plain and estuary including commercially important Chinook salmon, Pacific herring, and anchovies (Parthree, 2004). Other salmonids observed include steelhead and cutthroat trout. Preserving high-quality water and improving degraded water quality in the Smith River is essential to their support and recovery. The beneficial use most sensitive to degraded groundwater is Municipal and Domestic Supply. This Plan will address the control of nitrate levels and pesticides in groundwater to protect drinking water quality. Addressing nitrates and the control of nitrogen inputs to groundwater will be coordinated with the Regional Water Board's Dairy Program, as local dairies have the potential to contribute to groundwater nitrogen loading as well.

1.3 Endangered and Threatened Species

Coho Salmon

Coho salmon (*Oncorhynchus* kisutch) in the Smith River are considered part of the Southern Oregon/Northern California Coastal (SONCC) coho salmon Evolutionarily Significant Unit (ESU) and are listed as threatened under the Federal Endangered Species Act (ESA). They are also listed as threatened under the California ESA. The National Marine Fisheries Service (NMFS) has classified the Smith River population of coho salmon as a core, functionally independent population under the SONCC coho Salmon Recovery Plan (NMFS 2014). This means that NMFS considers coho salmon in the Smith River as critical to the recovery of the SONCC coho salmon ESU. NMFS has also designated the Smith River, including all tributaries to the Smith River Plain, as critical habitat under the ESA. Critical habitat includes those areas that are essential to the conservation of ESA-listed species and which may require special management considerations or protections.

The Smith River population of coho salmon is considered at a high risk of extinction and likely below the depensation threshold, which is the minimal number of adults necessary to maintain the survival of the population (NMFS 2014). The viability threshold for coho salmon in the Smith River is 6,800 adult spawners (NMFS 2014). Current estimates of the population are sparse, but (NMFS 2016) placed the average population based on redd counts and only two years of data at 331 adults, which is very near the depensation threshold of 325 adults (NMFS 2016). NMFS (2014) identified agriculture as a key limiting threat to the recovery of coho salmon in the Smith River and a key limiting stress identified was impaired estuary function.

Eulachon

The southern distinct population segment (DPS) of eulachon (*Thaleichthys pacificus*) includes those populations south of the Nass River in British Columbia to the Mad River in California (NMFS 2008). Historically, there are few observations of eulachon in the Smith River. They have been observed and may be present in the Smith River Plain during some years of high abundance (NMFS 2008). Critical habitat for eulachon does not include the Smith River and no population targets for the Smith River have been identified in the SONCC, although eulachon in the Smith River may contribute to the Klamath River sub-population abundance and spatial structure and temporal distribution delisting criteria (NMFS 2017).

Tidewater Goby

Tidewater goby (*Eucyclogobius newberryi*) in the Smith River are listed as endangered under the Federal ESA. The tidewater goby is a small fish that inhabits coastal brackish water habitats entirely within California, ranging from Tillas Slough to Agua Hedionda Lagoon in northern San Diego County (USFWS 2005).

Six phylogeographic units based on genetic similarities and differences have been identified as recovery units for tidewater goby throughout their range and the northernmost unit is Tillas Slough in the Smith River Plain (USFWS 2005). Critical habitat for tidewater goby is also designated in Tillas Slough (USFWS 2005).

The goal of conservation and recovery of tidewater goby is complicated by the species' complex genetics and, the genetic metapopulation structure, the 1-year life span of individuals, large swings in population size, limited research, and difficulties in determining population size (USFWS 2005). Delisting the species as endangered will require both a reduction in threats to the species and a metapopulation viability analysis that indicates all six recovery units are viable based on monitoring over a 10-year period (USFWS 2005).

Longfin Smelt

Longfin Smelt (*Spirinchus thaleichthys*) is a small fish in the family *Osmeridae* found along the Pacific coast of the United States from Alaska to California. In California, Longfin Smelt is historically found in the San Francisco Estuary and the Sacramento/San Joaquin Delta (Bay-Delta), Humboldt Bay, and the estuaries of the Eel River and Klamath River— and uses a variety of habitats from nearshore waters, to estuaries and lower portions of freshwater streams (Garwood 2017). It has not been observed in the Smith River, but the characteristics of the Smith River suggest it has suitable habitat for longfin smelt. Larval survey data from the Bay-Delta indicate spawning occurs from November through May, with a peak from February through April.

Essential Fish Habitat

The Smith River Plain tributaries are designated essential fish habitat (EFH) under the Magnuson-Steven Fishery Conservation and Management Act (MSFCMA) for Pacific salmon (Chinook and coho) and the estuary is designated EFH for Pacific salmon and Pacific groundfish. EFH is designated for species managed in Fishery Management Plans and is defined as the habitat necessary for managed fish to complete their life cycles. Estuaries, including the Smith River Estuary, are considered Habitat Areas of Particular Concern and are high priorities for EFH conservation.

Importance of the Estuary and Smith River Plain Tributaries to Coho Salmon

The tributaries to the Smith River Plain contain the majority of the high intrinsic potential habitat for coho salmon in the 762 square mile watershed (NMFS 2014). These tributaries include both natal and non-natal rearing areas for juvenile coho salmon (Parish and Garwood 2016). Tributaries and sloughs near the estuary provide vital habitat for juveniles and fry that are swept downstream during high flow events. Suitable habitat in these tributaries and sloughs increase survival of juveniles, which increases overall productivity and life history diversity of this population.

Given the high flows and steep conditions found in the middle and upper Smith River watershed, low gradient tributaries near the estuary undoubtedly contribute to the success and continued survival of coho salmon in the Smith River. Although estuaries and other riverine habitats along the coastal plain represent a small fraction of area in a given watershed, their role in salmonid productivity throughout the Pacific Northwest is substantial given all anadromous fish use the estuary prior to ocean entry. Low gradient and freshwater/brackish estuarine habitats such as sloughs, backwaters, off channel ponds, and emergent tidal wetlands have been shown to be especially productive areas for rearing juvenile salmonids throughout the Pacific Northwest and in California (Wissmar and Simenstad 1998, Hayes et al. 2008, Koski 2009, Wallace et al. 2015), including in the Smith River Plain (Parish and Garwood 2016).

1.4 Tribal Beneficial Uses of the Smith River Plain

The Tolowa Dee-ni' Nation's (TDN) Nvn-nvst-'aa~-ta (Natural Resources Department) houses the primary scientific data collectors and technical advisors for issues and management decisions pertaining to TDN's trust resources within the Tribe's aboriginal territory. This includes monitoring and management of water quality, terrestrial and aquatic habitats, fisheries, wildlife, and marine resources.

As a sovereign nation, TDN retains certain inherent, unceded, or otherwise protected rights to govern, access, harvest, and manage its traditional waters, areas, and trust resources. TDN is the original steward of the Smith River Plain and surrounding marine environment, which is the primary provider of sustenance and wellbeing for Tolowa Dee-ni' people and has been integral to the lifeways of the Tolowa Dee-ni' since time immemorial.

The Smith River and its estuary provide crucial habitat for aquatic trust and cultural keystone species such as: lhuk (salmon), dvsh-xa~ (lamprey), taa-nin'-telh-ni (halibut and other flatfish species), k'a'-srvsr (crab species), and yan'-tr'ee-nash (shark species). Riparian and marine areas associated with the Smith River Plain provide important habitat for shorebirds, waterfowl, mammals, and plants integral to the religious and subsistence lifeways of the Tolowa Dee-ni'.

Beyond providing habitat for species central to the continuum of the past and present traditions of the Tolowa Dee-ni', the river and estuary themselves serve as crucial environmental trust resources for cultural, ceremonial, and subsistence beneficial uses for the Tolowa Dee-ni' Nation. These uses include, but are not limited to, fishing, boating, river access, training, swimming and diving, prayer and meditation, religious ceremony and medicinal doctoring, plant gathering, basketry, eeling, shellfish gathering, and food preparation. Contemporary concerns over the health of the Smith River estuary and impacts of climate change create an increased need for data that can help guide management priorities related to, and advance tribal interests in, the protection of Tolowa Dee-ni' trust resources for sustainable beneficial uses of the river.

The Natural Resources Department Water Quality Program currently conducts water quality monitoring at several locations around the Smith River Plain including: See-cha~ Tr'ee-ghii~-li~ (Lopez Creek), Sri'-srwvlh Tr'ee-ghii~-li~ (Gilbert Creek), and the lower Smith River. Continuous and intermittent monitoring data collected at these sites includes pH, temperature, and dissolved oxygen; while project-specific data collection currently includes benthic macroinvertebrate sampling, photo-monitoring, and aquatic habitat assessments. Stormwater monitoring has been conducted on-reservation since 2018 for critical areas and projects. TDN has plans to expand surface water quality testing as capacity increases.

Through the Tribe's Self-Governance Compact, the Tolowa Dee-ni' Nation have taken on certain trust functions for the development of Natural Resources stewardship and management. The three programmatic areas include Fisheries Management & Enforcement, Water Resources and Cooperative Landscape Conservation, and within these areas the Department collects data and manages projects intended to inform fisheries resource management and identify trust resource concerns related to riverine fisheries and ecosystem health in the Smith River and its tributaries. TDN is currently conducting an assessment of water quality and fisheries vulnerability for Da′-me (the Smith River estuary) in order to develop long-term monitoring priorities for the Smith River Plain and collect baseline data on water quality, benthic macroinvertebrates, and bioaccumulation of contaminants in fish. Collecting this baseline data is critical to TDN's continued development of a science-based approach to help inform the creation of best management practices to protect beneficial uses, water quality, trust resource species, and their habitats in the lower Smith River.

In addition to current Smith River Plain monitoring, the TDN Fisheries Program oversees the management, improvement, and assists with the operation of the Rowdy Creek Fish Hatchery (RCFH). Current and past projects at RCFH include development and agency approval of the Hatchery Genetic Management Plans for Chinook salmon and steelhead production, addressing a major fish passage barrier on Rowdy Creek, and alleviating power demands and reducing the carbon footprint at the hatchery through the installation of renewable energy sources. Future priorities for RCFH include developing long-term management goals, addressing infrastructure and operational needs, and continued monitoring and evaluation of the hatchery program in order to ensure the long-term success of these important trust resources.

1.5 Existing Regional Water Board Programs and Processes

Regional Water Board Agricultural Lands Discharge Program

This Plan has been developed as part of the Regional Water Board's Agricultural Lands Discharge Program (Program). There are approximately 350,000 acres of agricultural lands in the North Coast Region, which are primarily used for vineyards, orchards, cannabis cultivation, row crops, grain, alfalfa, hay pasture, and dairies.

Operations on agricultural lands that discharge waste to waters of the State can affect water quality through, for example, the over-application of fertilizers and pesticides, human-caused erosion of sediment, pollutants in tailwater return flows, and the removal and suppression of riparian vegetation. The Program was developed by Regional Water Board staff to ensure agricultural operators in the North Coast Region implement practices to address discharges of waste associated with their operations. The Program meets the requirements of the California Water Code, the State Nonpoint Source Policy, and addresses water quality impairments, as identified by Regional Water Board staff and has been included on the 2018 Clean Water Act Section 303(d) list of impaired waters.

The Program encompasses several separate Regional Water Board permits that address discharges of waste associated with agricultural lands. The scope of the Program is defined by either the crop type or geographic location. The following existing regulatory programs fall under the umbrella of or are companion to the Program:

- Cannabis Cultivation Waste Discharge Regulatory Program
- Water Quality Compliance Program for Dairies and Concentrated Animal Feeding Operations
- US Forest Service Forest Land Permits
- Scott River TMDL Conditional Waiver of Waste Discharge Requirements (WDRs) Program
- Shasta River TMDL Conditional Waiver of WDRs Program

The following regulatory programs are under development as part of the Program:

- North Coast Regional Water Board Program for Discharges of Waste Associated with Vineyards in the North Coast Region
- North Coast Regional Water Board Program for Discharges of Waste Associated with the Production of Lily Bulbs in the Smith River Plain

SWAMP 2013-2017 Monitoring Results

As part of the Surface Water Ambient Monitoring Program (SWAMP Program), from 2013 - 2017, Regional Water Board staff collected surface water and groundwater samples for analysis in the Smith River Plain. The purpose of the sampling and analysis was to screen for the presence of agricultural chemicals and toxicity. Regional Water Board staff sampled the major tributaries to the Smith River in the area where lily bulbs are grown. The samples were analyzed for several parameters including pesticides currently used in lily bulb production. The lab also ran toxicity tests on the samples. The results were documented in the Smith River Plain Surface Water and Sediment Monitoring Report released in January 2018 and the Smith River Plain 2015 Groundwater Interim Monitoring Report released in November 2015.

The results demonstrate aquatic toxicity and the presence of agricultural chemicals in concentrations above critical thresholds in some of the waterbodies in the study area. The results also document the presence of 17 pesticides in surface waters, with five of those chemicals exceeding water quality thresholds on at least one occasion. A sample from Delilah Creek exhibited toxicity to the laboratory test species due to copper and other pesticides. The report concludes that the primary source of those chemicals in the water is the runoff from lily bulb fields during storm events that can erode soil and deliver chemicals to surface waters. More detail on the SWAMP sampling results is included in Section 3.3.

Regional Water Board Direction to Develop Plan

Regional Water Board staff presented the SWAMP monitoring results at the April 2018 meeting of the Regional Water Board. After listening to the presentation, public comments, and the Regional Water Board staff's recommendations, the Board directed staff to initiate efforts to address water quality in the Smith River Plain. The Board suggested that staff work with lily bulb growers to obtain technical information necessary to address the water quality problems. The Regional Water Board's Executive Officer issued a request for information of the lily bulb growers pursuant to Section 13267 of the Water Code in October 2018 and a follow up request in June 2019. Growers provided a timely response to both requests, and the information was used to better characterize their discharges and inform the development of this Plan. The Board also directed Regional Water Board staff to develop a plan in coordination with partner agencies, the Tolowa Dee-ni' Nation, the Smith River Alliance, and with input from lily bulb growers to control discharges from lily bulb operations. This Plan has been developed in response to that direction.

The lily bulb growers, who were present at the April 2018 meeting committed to continued implementation of water quality control practices in the interim while this Plan was being developed.

Regional Water Board Dairy Program

The Regional Water Board implements a dairy regulatory permit program that includes dairies in the Smith River Plain. Some of the fields that are used to grow lilies are rotated into pasture and used by local dairies. Nutrient management is an area of overlapping responsibility between dairy and lily bulb operators as both apply nutrients to the fields. Under the dairy permit, nutrients are applied according to manure management plans that are required of the dairy operators. Dairies are also required to monitor local surface waters and groundwaters for nutrient levels among other constituents. Monitoring activities between the dairy program and this Plan will be coordinated to avoid overlap.

1.6 Program and Agency Coordination

The Regional Water Board intends to coordinate the actions describes in this Plan with the activities of other agencies and with other ongoing water quality protection and restoration efforts in the Smith River Plain. The following sections briefly summarize these other efforts and how Regional Water Board staff are coordinating the activities in this Plan with them to increase efficiency and consistency in the protection of water quality.

National Marine Fisheries Service (NOAA Fisheries)

NOAA Fisheries is the federal fisheries management agency that promotes the sustainability and productivity of fisheries and fishing communities. The other part of their mandate is to recover and maintain protected species through the implementation of the Federal Endangered Species Act. NOAA Fisheries staff are part of the Watershed Stewardship Team than helped to develop this Plan. Regional Water Board staff are working closely with NOAA Fisheries to address water quality problems, protect aquatic resources, and recover endangered species such as coho salmon, eulachon, and tidewater goby in the Smith River Plain. NOAA Fisheries conducted a monitoring study in the Smith River Plain from 2017-2018 in collaboration with the California Department of Fish and Wildlife. The study included water sampling and copper analysis to better determine the risk of agricultural copper to coho salmon, their habitats, and other aquatic life in the Smith River Plain. The report can be downloaded from the California Department of Fish and Wildlife. (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=184902)

NOAA Fisheries staff have made valuable contributions to this Plan including research on the effects of copper on salmon species and providing a description of essential fish habitat and the scope of the federal Endangered Species Act. They will continue to be a key partner in the implementation of this Plan moving forward.

California Department of Fish and Wildlife

The California Department of Fish and Wildlife (CDFW) is the state agency that manages California's fish, wildlife, and plant resources and their habitats for their use and enjoyment by the public. They are the agency responsible for implementing the California Endangered Species Act. CDFW staff are also part of the Water Stewardship Team. CDFW staff have been intimately involved in the management of fisheries resources in the Smith River Plain, having collaborated with the Smith River Alliance on conducting surveys of fish presence and habitat use. Their work has been valuable in understanding how endangered species such as coho salmon use the mainstem, tributaries, and estuary as part of their life histories. For example, the study *Winter Distributions, Movements, and Habitat use by Juvenile Salmonid through the Lower Smith River Basin and Estuary, Del Norte County, California* (Parish and Garwood 2016) defines the winter rearing and use of the Smith River Plain coastal tributaries by salmon species as refugia from high winter flows in the mainstem Smith River.

Understanding the function of these streams and estuarine habitats will help direct management and restoration efforts where they can best support the resilience of salmonid populations. CDFW staff have made important contributions to this Plan and will continue to be a partner in the management and implementation of this Plan moving forward.

Del Norte County Agricultural Commissioner Pesticide Reporting Program

Licensed pesticide applications are reported to the Del Norte County Agricultural Commissioner (Ag Commissioner). The Ag Commissioner compiles these reports into an annual summary and submits it to the California Department of Pesticide Regulation. The pesticide use reports document the location of pesticide applications, the amount of product being used, along with other data associated with pesticide applications. The Del Norte County Ag Commissioner supplied the Regional Water Board staff with data that documents the pesticides being used to cultivate lily bulbs in the Smith River Plain for the years 2014 - 2019. Regional Water Board staff used this information to develop the Adaptive Management Monitoring Program described in Section 6 of this Plan.

California Department of Pesticide Regulation

The California Department of Pesticide Regulation (CDPR) regulates the sales and use of pesticides in California. The first phase of regulation involves review of pesticide products submitted for registration in the state. One part of registration review is to evaluate the potential risk that use of a product may pose to surface water. CDPR also conducts continuous evaluation of the impact of registered pesticide products through routine monitoring of groundwater and surface water in select locations in California, typically representing areas of high pesticide use. Most recently from May to June 2016, CDPR sampled surface water in the agricultural areas of the Smith River watershed and analyzed those samples for a specific list of pesticides. The monitoring results are documented in (DaSilva, 2016). Assessing the impact of pesticides to the environment includes monitoring results generated by other partner agencies. Mitigation for specific pesticides of concern may be implemented through pesticide application permit conditions, voluntary best management practices, changes to pesticide labels (made through US EPA), or regulatory action. CDPR also conducts human health risk assessments on a pesticide specific basis. In addition, pesticide use reports submitted by the Del Norte County Ag Commissioner are compiled and included in CDPR's Pesticide Use Reporting system.

The State Water Board and Regional Water Boards have entered into a Management Agency Agreement (MAA) with CDPR to work cooperatively to address pesticide use that may cause potential adverse impacts to water, which is regulated by DPR, and to address discharges of pesticides that cause water quality impacts, which are regulated by the Water Boards. The MAA documents, updated in 2019, articulate the roles and responsibilities of the two agencies and outlines the ways in which they work cooperatively. They establish requirements for communication and coordination between the agencies under definitive circumstances.

Per the MAA, Regional Water Board staff are actively cooperating with CDPR and keeping them informed of their regulatory approach in the Smith River Plain and the development and implementation of this Plan. Staff of CDPR have provided technical review of the Plan and have had input into the sections related to pesticide application, regulation, monitoring, and management practices.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is a federal agency that provides technical and financial assistance to farmers, private landowners, and land managers. The financial assistance includes several Farm Bill funded programs covering a diverse range of conservation objectives including voluntary easement programs. The NRCS works with the Del Norte County Resource Conservation District (RCD) to facilitate the implementation of their conservation program locally. The NRCS has provided technical review of this Plan to ensure the management practices described herein are appropriate for lily bulb operations and the control of the water quality constituents of concern.

Del Norte County Resource Conservation District

The Del Norte County RCD is a locally governed special district established to implement conservation projects on public and private lands and to educate landowners and the public about resource conservation. The RCD provides a link between local programs and local implementation of state and federal programs to help meet conservation goals. The RCD provides technical assistance to the lily bulb growers and has provided the Regional Water Board with information that has helped to develop this Plan. The Regional Water Board staff will continue to work with the RCD to coordinate the implementation of this plan and to facilitate the implementation of conservation projects locally. One such project is the Delilah Creek Riparian Restoration Plan that is described in more detail in Section 1.7.

Smith River Alliance

The Smith River Alliance is a non-profit organization with a mission to provide for long-term protection, restoration, and stewardship of natural resources in the Smith River watershed. SRA has conducted surveys focused on water quality, fish habitat use and availability. They have worked with landowners in the Smith River Plain on several monitoring and restoration projects. In October 2018, the Smith River Alliance completed the Smith River Plain Stream Restoration Plan through a grant from the California Coastal Conservancy (Parish Hanson 2018). The restoration plan identifies and prioritizes potential restoration projects that improve and protect, for example, natural channel structure and function, water quality, flood plain connectivity, and biological resources along streams and waterways located in the Smith River Plain. A total of 137 projects were identified and include riparian projects, channel complexity projects, fish passage projects, invasive plant management projects, and water quality and quantity projects.

This Plan will be coordinated with the Smith River Plain Stream Restoration Plan to help guide project implementation and to document resulting improvements through monitoring and landowner reporting.

1.7 Smith River Restoration Projects

Delilah Creek Restoration Plan

The Smith River Alliance is partnering with the RCD and the NRCS to develop a restoration plan along the anadromous reach of Delilah Creek, an estimated distance of 1.6 stream miles. The project aims to develop designs to improve water quality, channel complexity, floodplain connectivity, fish passage, wetland habitat, and a native riparian buffer. The riparian buffer designs will include native plants and a grassed filter strip. The filter strip would serve to filter sediment and pollutants and disperse runoff for improved infiltration in the riparian area, which will increase the filtration and treatment of dissolved pollutants and nutrients. These designs will expand upon an earlier smaller riparian restoration plan developed for portions of Delilah Creek. The restored areas would also provide habitat for native species. If successful, the project could serve as a model for other riparian restoration projects in the area.

Morrison Creek Restoration Project

The Morrison Creek Restoration Planning Project was a project funded by the California Coastal Conservancy and implemented by the Smith River Alliance in partnership with the RCD. The project evaluated the lower reaches of Morrison Creek to investigate the causes of flooding and potential solutions within the channel (Shea and Love, 2018). The Morrison Creek Restoration Planning Study was completed in July 2018 and identified restoration alternatives that had the goal of reducing overbank flooding and improving salmonid habitat in Morrison Creek. SRA is using additional funds from CDFW to advance this project by working with landowners to identify the preferred alternative and expanding the restoration scope and scale.

Section 2
Description of Lily Bulb Operations

2.1 Overview

The purpose of this section is to provide a description of the land disturbance activities and operations associated with lily bulb cultivation to provide the foundation for selection and implementation of appropriate best management practices (BMPs), which are presented in Section 4.

Easter lily bulb operations are located in the Smith River Plain approximately 10 miles North of Crescent City. Ninety-five percent of the world's Easter lily bulbs are grown in this area, amounting to around 9 million saleable bulbs annually (Garvey, 2014). The area receives an average of 75 inches of rain annually, primarily from October through March. Approximately 1500 - 1600 acres in the Smith River Plain are used to cultivate Easter lily bulbs (*Lilium longiflorum*). The lily bulb crop is part of a three to five-year rotation with grass-clover, which is used as forage. The fields are used as forage for livestock for two to four years and for lily bulbs for one year, plus some field preparations done in the year prior to planting bulbs. Since the bulbs are grown in this rotation, only about 375 acres are planted to Easter lilies in a given year, with another 375 acres in a state of transition in preparation to receive the following year's crop. The area where the bulbs are grown is located at the upper end of the Smith River Plain on the north side of the river in an arc that roughly follows Highway 101 (Figure 1.2). This strip of land is situated at a specific distance between the ocean and the coastal mountains that provides the appropriate microclimate for the bulbs to grow. The favorable conditions specific to the Smith River Plain include a moderate climate, a marine layer, a sheltered bay, fertile soil, and plenty of precipitation. The lower end of the plain and the land south of the river is managed for forage exclusively.

Easter lilies are notoriously difficult to grow. In the 1940's, there were over 1200 lily bulb growers along the Pacific Coast (Warga, 2012), but growers soon differentiated themselves, in some part, by their ability to deal with pests and fungus. As production methods improved through the years, the number of growers has declined. Currently, there are only four lily bulb operations in the Smith River Plain. Nematodes, root and bulb rot, and Botrytis blight (gray mold) are the primary threats to the health of the lilies, while aphids also attack the plants throughout spring and summer. Growers employ a wide variety of techniques, both mechanical and chemical, to lessen the impact of these pests. As the pesticide industry has evolved through the years in response to business and regulatory considerations, the lily bulb growers have adapted their operations appropriate to environmental conditions and to make use of what is available and most effective.

2.2 Lily Bulb and Pasture Field Rotation

The typical Easter lily/pasture rotation begins in spring when fields are converted from pasture to lily bulb fields. The fields are in some stage of preparation until planting begins in August. Preparation includes tillage of established pasture, application of lime and soil fumigation before final planting is completed by the end of late fall. Bulbs remain in the ground for a minimum of 11 months and up to 14 months prior to the following harvest. Harvest typically begins in August and finishes by November; but may extend into late November and early December depending on weather conditions. Harvest consists of removing tops, gathering the bulbs from the field, cleaning them, and classifying them by size and health. After harvest, the bulbs are either moved to a freshly prepared field that was converted from forage the previous spring, or they are packaged for shipment depending on their age, size, and health. If the bulbs are to be replanted, they are rotated to a freshly fumigated field to provide additional space and make sure the bulb has room to grow in a relatively pest free environment. The shipped bulbs are usually sent to cold storage where they are later forced to bloom for Easter as the natural cycle of the plant would have them bloom in July. The field that was previously used to grow lilies is then planted to a mixture of grass and clover. Over the next 2 to 3 years, those fields are managed for forage until they are tilled again for lilies. The grass and clover help rebuild drainage in the soil, restore organic matter, and add nitrogen. These yearly operations are shown in the flow chart in Figure 2.1. Figures 2.2 – 2.5 are photos showing a typical field in various stages of cultivation.

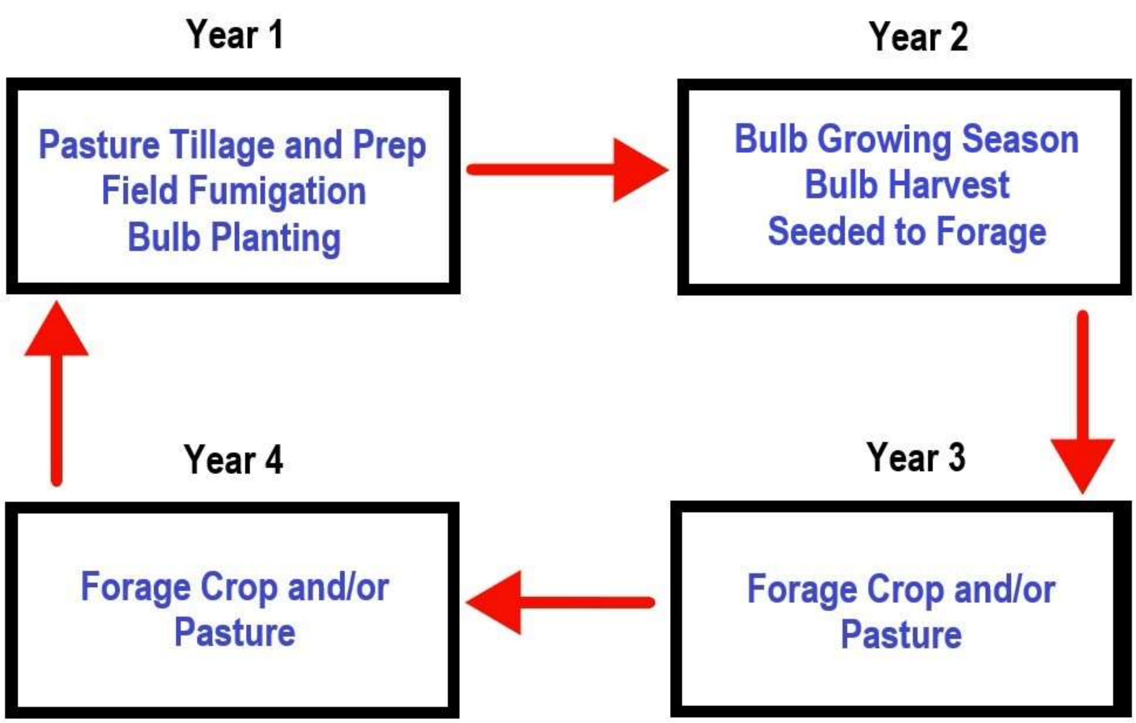


Figure 2.1. Typical four-year rotation between lily bulb cultivation and forage and/or pasture.

Figure 2.2. Recently fumigated lily bulb field (Year 1).

Figure 2.3. Lily bulb field in wet season (Year 2).

Figure 2.4. Lilies in bloom (Year 2, summer).

Figure 2.5. Forage crop/pasture (Years 3 and 4).

The following sections describe the irrigation methods and the fertilizer and pesticide applications during the typical crop rotation. The sections are organized by agricultural 'season', defined roughly by the activities taking place during that time period.

Lily Bulb Field preparation (Early spring to July/August)

<u>Pesticides</u>

Fumigation is the main tool used to control nematode populations in the soil. Fumigants are applied mid-July through mid-August. The two main fumigants are 1,3-dichloropropene and metam sodium. 1,3-D is applied by a commercial pesticide applicator, while metam sodium is applied by the lily bulb operators and their employees. Both fumigants are applied under controlled conditions to avoid drift and also to ensure the effectiveness of the fumigants. The metam sodium is applied under very strict guidelines and both supervisors and applicators are required to take specialized training annually. The environmental conditions required for applying fumigants such as proper wind speed, soil moisture, soil texture, status of inversion layers, and air temperature are specified on the fumigant labels. In general, conditions are usually suitable for the application of fumigants during the summer months since precipitation is light. Once the fumigant is applied, the soil is compacted to trap the fumigant in the top layer of soil. The fumigants are volatile, and after multiple days most of the chemical has dissipated into the air above the field. The label specifies a minimum wind speed and time of day to ensure adequate circulation for the fumigants to dissipate in the air. Still air and a compressed temperature inversion layer limits circulation and could allow the fumigants to accumulate in the air and present a risk to the pesticide applicators.

Lily Bulb Harvesting and Planting (August - November)

<u>Pesticides</u>

Pythium, rhizoctonia, and fusarium are fungi that rot the roots and bulbs of Easter lilies and can cause disease in the plants. Basal rot and root rot cause the bulbs and roots to turn from white to yellow. As the outer scales of the bulb turn yellow and rot, they infect the scales underneath. Eventually the fungus can destroy the basal root system, and in extreme cases, cause the bulb to disintegrate, greatly affecting yields. In their natural tropical environment with warm soil temperatures, the bulbs are able to form a protective barrier around legions and wounds that acts as a barrier to infection. However, in the Smith River Plain, with soil temperature below 55 degrees F in winter and early spring, the fungus is able to continue growing unimpeded by the protective barrier that would have formed in a warmer climate. Fumigation aids in controlling these fungi but the main control is dipping the bulbs in a mixture of pre-plant fungicide. Captan, thiram, pentachloronitrobenzene (PCNB), and carboxin are the primary fungicides used as a bulb dip. A fungicide is also typically applied in-furrow at planting. Fungicides used for this purpose are applied as a ground spray and include mefenoxam, azoxystrobin, carboxin, and fosetyl-al.

As the rainy season approaches in late fall and bulbs are being harvested and planted, pesticide applications must be well timed between storm events to avoid transport to surface waters through field runoff.

Nematodes

Easter lilies have no natural resistance to nematodes and all attempts to breed in resistance have failed. The production of Easter lily bulbs in the Smith River Plain has been a monoculture since the 1940's and the ground is thoroughly infested with nematodes. Without both soil treatment and in-furrow treatment at planting, Easter lilies grown in the Smith River Plain will die from nematode infestation (Garvey, 2014). A combination of nematicides is applied in-furrow at planting to control nematodes. Nematicides used for this purpose include granular phorate and ethoprop applied as a ground spray. The ethoprop (trade name Mocap) pesticide label requires a 140-foot buffer between liquid spray applications and aquatic habitats and growers should be providing this buffer per label requirements.

Fertilizer Application

A low nitrogen, high phosphorus and potassium fertilizer is usually applied banded below and above the lily bulbs during the sowing process (i.e., placement in the soil). Nutrient composition is approximately 6-8% nitrogen, 18-27% phosphorus, and 18-25% potassium. Rates range from 600-1500 lbs. per acre. Including the fertilizer applications at planting, the total annual application of nutrients per acre amounts to around 300 pounds of nitrogen, 400 pounds of phosphorus, and 300 pounds of potassium. These totals were recommended by Oregon State University in the middle to late 1980's as optimal for lily bulb production.

Lily Bulb Growing Season (11-14 months from planting to harvest the following year)

Botrytis

Botrytis is a gray mold that causes foliage blight. It affects the aboveground parts of the plant and can destroy a crop by reducing bulb growth. Moisture on the leaf surface causes the disease to spread making spacing and air circulation important in drying out the leaf quickly after rain, irrigation, or morning dew. Botrytis attacks the plant leaves and stem during cool, moist periods. Botrytis is held in check mainly through the application of copper-based fungicides and other fungicides that inhibit its growth. Preventative foliar fungicides are applied about 25 times during the growing season from emergence (approximately February) through harvest (approximately September) to ensure new growth is treated soon after it emerges. Coverage of the bottom leaf surface is important to obtain the best control. Fungicides are applied as a ground spray. An electrostatic sprayer is not used because it produces relatively small droplets that promote pesticide drift. The primary fungicide currently in use is copper, which can be applied as copper diammonium diacetate complex, copper hydroxide, copper oxychloride, or copper sulfate.

Other fungicides used on the foliage during the growing season include chlorothalonil, fluzinam, fludioxonil, iprodione, mancozeb, maneb, tebuconazole, and thiophanate-methyl.

A total of 95,294 pounds of copper-based fungicide were applied in the Smith River Plain from 2014 – 2018. Since 2015, growers have reduced the use of copper overall and especially of copper sulfate. The transition from copper sulfate to copper hydroxide was in response to the SWAMP Program monitoring results that identified the transport of dissolved copper to surface waters from lily bulb fields. The use of copper hydroxide allows for greatly reduced copper application rates, which reduces the risk to surface waters. Copper sulfate application amounts went from almost 22,387 pounds in 2013 to 29 pounds in 2016, and copper hydroxide application amounts, as opposed to increasing to compensate, also fell from 24,250 pounds in 2013 to 14,214 pounds in 2016. This points to an overall reduction in the use of copper as growers adapt their application methods and scheduling to reduce the risk to water quality from copper.

Aphids

Well timed applications of foliar insecticides are the current standard for controlling aphids. Applications begin in the spring and last until harvest and are repeated based on a set interval and scouting. Insecticides used to control aphids are applied as a ground spray and include acephate, acetamiprid, imidicloprid, permethrin, pyrethrins, and thiamethoxam.

Figure 2.6. Planted lily bulb field in February prior to the emergence of foliage. An adjacent pasture can be seen in the distance.

Weeds

Weeds are typically controlled by timed applications of post emergent herbicides, such as glyphosate, and pre-emergent herbicides, such as diuron, during the winter and spring. After the emergence of the lily bulbs, post emergent herbicides are no longer used. Weeds are controlled mechanically or manually or with pre-emergent herbicides during the summer until the bulbs are harvested in the fall. Fields are also sometimes spot treated with post-emergent herbicides after emergence of the lily bulb foliage so the crop is not affected. Herbicides used on lily bulb fields include diquat dibromide, diuron, glyphosate, and napropamide.

Fertilizer Applications

During the growing season, calcium nitrate applications are made in 3 to 4 week intervals, approximately. Rates can range from 100-250 lbs. per acre per application. In addition to the initial fertilizer application at planting, fertilizer is also applied somewhere between 2 and 5 times per season using the same fertilizer calcium nitrate (composed of 15.5% nitrate) in all applications.

Irrigation

Lily bulbs are irrigated with Rain Bird sprinklers mounted on aluminum pipe during the drier months (typically May through October). Irrigation can vary from 10-28 days and set times can vary from 4-9 hours (monitored) to avoid runoff and flooding. Some growers dig soil samples from target depths and use the ‘feel and appearance’ method, while other growers use feel and appearance combined with tensiometers or soil sensors to optimize irrigation rates.

Figure 2.7. Pasture phase of the lily bulb crop rotation cycle.

Forage Portion of the Rotation Cycle

Lily bulb fields are managed for forage as part of both dairy and other livestock operations. Manure is applied on pasture as part of these livestock operations. Pastures managed as part of a dairy operation are enrolled in the Regional Water Board's Dairy WDRs Program (dairy program) and are required to maintain a Nutrient Management Plan (NMP) and implement management practices. For pastures in the dairy program, mechanical applications of manure are farm specific according to the NMPs. The NMPs identify the range of manure (and other nutrients, if applicable) applied to pasture and limit the application rate to protect runoff to surface water and protection of groundwater from excessive nitrate loading. Dairies also employ management practices to control runoff and impacts to riparian areas. Pastures within the Smith River Plain that are not regulated as part of the dairy program are not required to develop an NMP. These pastures follow the management practices described in this Plan.

Section 3
Risks to Water Quality

3.1 Introduction

Sections 1 and 2 of this Plan provide the environmental and operational context for the program of implementation to address water quality protections from lily bulb operations in the Smith River Plain. The program is intended to address the SWAMP monitoring results that showed exceedances of water quality benchmarks in surface waters due to the transport of pesticides in runoff from lily bulb fields. This section begins with a review of those monitoring results and then goes on to examine how the seasonal farming activities described in Section 2 can pose a risk to water quality. Next, this section presents a technical review of the fate and transport of pesticides applied to fields, which will inform the selection of effective practices to mitigate the water quality risk. The focus of this section is on pesticides in surface waters since this represents the greatest risk to water quality as indicated by the monitoring results. This section then applies the technical discussion to prioritize pesticide risk by assigning a score to each category of pesticide used in the Smith River Plain. The final priority ranking is then used to select which chemicals should be targeted for future monitoring and management practice implementation. The risks and pathways described in this section will be addressed through the implementation of the management practices described in Section 4.

3.2 Potential Risks to Water Quality from Lily Bulb Cultivation

Some activities associated with lily bulb cultivation present a potential risk to water quality, such as field preparation, application of pesticides and fertilizers during wet weather or high winds, overspray, and direct discharge of storm or irrigation runoff to waterbodies. Controlling the risk to water quality from lily bulb operations should account for environmental factors such as soil permeability and saturation, rainfall timing and intensity, site slope, soil type and erosion potential, natural background concentrations of metals in the soil, pH, and water hardness. Bed and bank erosion in ditches and stream channels and erosion from roads can further contribute to water quality problems by accelerating downstream sedimentation and remobilizing sediment-attached chemicals. Pastures in rotation with lily bulb fields can be an additional source of nutrients to surface water and groundwater when they are used for forage and/or livestock grazing. Further, livestock can degrade riparian areas, streambanks and aquatic habitat through compaction and the destruction and/or suppression of vegetation.

The most substantial risk to water quality associated with these activities is related to the transport of pesticides from fields, in stormwater runoff, and transport to surface waters, whether in dissolved form or as attached to soil particles. Thus, the remainder of this section will focus mainly on controlling the risk of pesticide transport to surface waters in runoff.

However, the approach to controlling pesticides also applies to the control of nutrients since they often share similar fate and transport characteristics. Pesticides are applied to lily bulb fields in the wet season and dry season, and if they persist long enough in the environment, those applied during the dry season can be mobilized in the wet season during storm events. Once the sediment and attached pesticides are conveyed to the stream it becomes more difficult to mitigate the increased risk to aquatic life. If those chemicals become concentrated enough in the water column through transport from fields (and also re-suspension in the streambed), they can result in toxicity in the water column and both chronic and acute effects on aquatic life. Chronic effects include decreased growth and reproduction rates and impaired behavior. If the concentration of a pesticide is high, the toxicity can become acute and cause death. Pesticides can also act synergistically, where individual pesticides may be below critical levels, but combined can result in toxicity in the stream.

There are several conditions on the ground associated with lily bulb cultivation that can increase the risk of delivering pesticides to surface water and should be considered in deciding which management practices to implement. For example, concentrated runoff is more difficult to infiltrate into the ground or to treat through buffer strips or other filtration methods. As discussed in more detail in Section 4, management practices that slow and spread water before it becomes concentrated can be effective at reducing the risk of pesticide transport. Bare soil in fields is at a higher risk of erosion than fields that employ cover crops or leave plant residue to control erosion at the source and prevent mobilization of sediment in storm and irrigation runoff. Fields that are hydrologically connected to waterbodies are more likely to deliver chemicals that are applied to the fields through field runoff. Disconnecting direct delivery of stormwater runoff by routing runoff to a pasture or filter strip will provide time for water to infiltrate and for sediments with attached pesticides to settle out of suspension. Clean stormwater running onto fields can contact pesticides thereby increasing the amount of water that needs to be treated through management practices. A drainage strategy that routes clean stormwater runoff away from lily fields and bare soil will avoid introducing pesticides into the runoff and make any downstream practices more effective.

Effects of Copper on Fish and Aquatic Resources

Copper is used as a fungicide on lily bulb fields throughout the growing season primarily to control botrytis. This section discusses the effects of copper toxicity on fish and other aquatic resources. The fate and transport of dissolved copper in the environment and the effect of ambient conditions on its bioavailability is discussed in Section 3.4.

Surface water samples were analyzed for dissolved copper (as opposed to total copper) because the dissolved fraction of total copper is most relevant to aquatic species health and survival. Copper is highly toxic to aquatic life and fish and crustaceans are 10 to 100 times more sensitive to the toxic effects of copper than are mammals (Solomon, 2009). The toxic effects of copper are classified as “acute” or lethal and “chronic” where sub-lethal exposures result in reduced growth, immune response, reproduction and/or survival.

Exposure occurs when water and sediment containing copper contacts the gills of fish. "Gills become frayed and lose their ability to regulate levels of salts such as sodium chloride and potassium chloride into and out of fish. When the salt balance is disrupted between the body of a copper-exposed fish and the surrounding water, the death of the fish can result" (Solomon, 2009). Copper is acutely lethal to freshwater fish in soft water at levels between 10 – 20 ug/L (NAS 1977). Cusimano et al (1986) found that 50% of exposed rainbow trout died in 96 hours at a concentration of 2.8 ug/L copper in water of 9.2 mg/L hardness.

The sub-lethal or chronic effects of copper can include reduced fish resistance to diseases; disrupted migration; altered swimming; oxidative damage; impaired respiration; disrupted osmoregulation structure and pathology of kidneys, liver, gills, and other stem cells, along with several other adverse effects (Woody 2012). Rainbow trout (one of seven Pacific salmon species, which also includes coho) are particularly sensitive to the toxic effects of copper and other metals. Very low levels of copper (1.4 ug/L) produce a physiological stress response, characterized by hyper-activity, increased blood levels of the stress hormone cortisol, and synthesis of the metal-detoxifying protein metallothionein in the liver (Taub 2004). Dissolved copper can reduce a salmon's sense of smell by 50% at an increase in concentration of just 2 ug/L over baseline (Sandahl et al. 2007)

Another significant effect of copper is its impairment of the olfactory senses (i.e. sense of smell) in fish. The direct contact of fish olfactory tissues with the surrounding water facilitates copper uptake. Copper can affect olfaction by competing with the natural odorants for binding sites, by affecting activation of the olfactory receptor neurons, or by affecting intracellular signaling in the neurons (Baldwin et.al. 2003). Fish rely on their sense of smell to find food, avoid predators and migrate (Solomon 2009). Successful migration is especially important for salmonids because they use their sense of smell to home in on their natal stream to spawn and also to navigate their way to the ocean.

Copper can also adversely affect the 'lateral line' of a fish; a sensory system comprised of neurons (hair cells) that provide fish information on their environment including vibrations, water flow and other parameters. The lateral line enables schooling, predator avoidance, feeding, and orientation to water flows. In a study from 2006, fish exposure to dissolved copper concentrations of greater than 20 ug/L for 3 hours destroyed 20% of these hair cells (Linbo et al. 2006).

Another adverse effect of dissolved copper in the water column is its effect on algae and macroinvertebrates, which form the base of the food chain. The amount of algal biomass present in an aquatic ecosystem will affect the amount of food available for aquatic animals including zooplankton, insects, shellfish, fish and aquatic mammals. Additionally, insects such as mayflies that do not tolerate polluted water will disappear and other species of insects that can tolerate polluted water will appear.
A change in the composition of the insect community will affect which species of shellfish and fish are present (Solomon, 2009).

3.3 SWAMP Sampling and Results in the Smith River Plain

Regional Water Board staff conducted surface water sampling of the Smith River Plain between 2013 and 2017 as part of the Surface Water Ambient Monitoring Program (SWAMP Program). The overall purpose of the sampling was to screen for the presence of pesticides and metals and provide a baseline of other more traditional water quality parameters. The sampling results documented the presence of several pesticides used in lily bulb cultivation in some of the coastal tributaries of the Smith River during storm events. The results were documented in the Smith River Plain Surface Water and Sediment Monitoring Report released in January 2018. The findings precipitated the need to develop this Plan. Further, the results from this period will be used as a point of comparison for future sampling results to track temporal trends and changes in analyte concentrations.

The list of analytes sampled in the 2013-2017 period, included 1) standard water quality parameters (dissolved oxygen, pH, temperature, electrical conductivity, and water hardness); 2) other parameters (metals, nutrients, and legacy PCBs and PAHs); 3) two classes of hydrocarbons; and 4) several classes of pesticides (organophosphates, organochlorines, carbamates, neonicotinoids, triazines, and pyrethroids/pyrethrins), comprising approximately 320 different chemicals, which covered all the pesticides used in the Smith River Plain at the time. From this large suite, approximately 17 pesticides were detected in surface waters within the study area.

To augment the chemistry analyses, toxicity testing was also performed on the samples. Toxicity testing is a test for an acute (i.e., lethal) or chronic (i.e., sub-lethal) response in aquatic organisms that are placed into the sample water in the controlled environment of a lab. The survival or reproductive rate of the test species in the sample water is compared to a control sample of laboratory prepared water. A statistically significant difference between the survival or reproductive rates of the sample vs. the control is considered a positive test result with the sample water exhibiting toxicity to the test species. A positive toxicity test suggests that there may be something in the water that is causing the toxic response in the test species. By looking at the analytical results for the various chemical concentrations in the sample water, it is possible to correlate the toxicity with a certain chemical or combination of chemicals.

Sample Locations

The sampling sites in the Smith River Plain are shown in Figure 3.1 as white squares. There are three main tributary watersheds in the Smith River Plain that drain into the Smith River: Tillas Slough, Rowdy Creek and Morrison Creek. Because the purpose of this monitoring effort was to screen for the presence of agricultural chemicals, the sites selected for sampling were located at the lower end of each tributary subwatershed. These types of sites are called integrator sites because they integrate runoff from the various land uses in the subwatershed.

The sampling also included a site on Delilah Creek, which is tributary to Tillas Slough as a follow-up to sampling that was conducted in 2010. Further, in 2015, the Upper Rowdy Creek site was added to help understand the results from the first sampling run, which documented an acute toxic response in Lower Rowdy Creek.

Figure 3.1. Sample locations in the Smith River Plain.

Pesticide Results

As noted above, water samples collected in 2013 and 2015 were analyzed for approximately 320 pesticides. Of those 320, 17 individual pesticides were detected in the Smith River Plain. The concentration in each of the detected chemicals was compared to the then current EPA Aquatic Life Benchmarks (since updated).

Most of the pesticide detections were at extremely low levels, well below the EPA benchmarks. The herbicide Diuron was detected at all sampling sites. There were five pesticides detected above EPA benchmarks for the protection of aquatic life, including imidacloprid, mirex, permethrin, diuron, and tebuconazole. These pesticides were found in Delilah Creek, the roadside ditch that drains into Delilah Creek, and in Tillas Slough, to which Delilah Creek is tributary. The list of pesticides and the locations where they were detected in surface waters is show in Table 3.1. Mirex, is a legacy insecticide that was banned in 1976 and was never used by lily bulb growers. This suggests that it is either very persistent in soil and/or there are other more recent sources. In 2015, the two primary chemicals used as fumigants to prepare the lily bulb fields for planting in the late summer were added to the list of analytes: 1,3-Dichloropropene and methyl isothiocyanate (MITC). Neither of these pesticides were detected at any sample location.

Table 3.1 shows the sample results with the highest concentration shown for each location. Exceedances of the water quality threshold is highlighted in red and can also be directly compared to the threshold in the last column of the table. Water quality thresholds are developed based on laboratory toxicity studies and include a safety factor to ensure protection in natural environments. The thresholds given in Table 3.2 have been updated since the release of the Smith River Plain Surface Water and Sediment Monitoring Report. They are provided here to show the thresholds used at the time the data was assessed. The assessment of future data collected in the Smith River Plain will reference the current EPA Aquatic Life Benchmarks available at the EPA website.
(https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-and-ecological-risk#ref_4)

Table 3.1. Highest pesticide concentrations in surface water samples from Smith River Plain compared to thresholds current at time of the release of the SWAMP report.

Analyte, ug L-1	Last Use per CA DPR*	Delilah Creek	Morrison Creek	Lower Rowdy Creek	Upper Rowdy Creek	Tillas Slough	Delilah Roadside Ditch	Threshold (ug L-1)***
Aldicarb	**	ND	0.01	ND	ND	ND	ND	3
Captan	2012	1.6	ND	0.277	ND	ND	ND	15
Carbaryl	2013	0.087	ND	ND	ND	ND	ND	2.1
Carbofuran	2009	0.008	ND	ND	0.021	0.007	ND	18
Chlorpropham	2015	8.1	ND	ND	ND	ND	ND	N/A
Diuron	2015	57.7	0.124	0.02	0.003	3.45	39.4	26.4
Ethoprop	2015	0.183	ND	ND	ND	0.158	0.019	22
Fenpropathrin	**	ND	ND	ND	ND	0.0003	ND	180
Hexachlorobenzene	**	ND	ND	ND	ND	0.001	ND	1
Imidacloprid	2015	3.56	ND	ND	ND	2.49	2.17	1.05
Lindane (HCH) - alpha	1998	ND	ND	ND	ND	0.007	ND	0.95
Lindane (HCH) - beta		0.012	ND	ND	ND	0.005	0.063	
Lindane (HCH) - gamma		0.003	ND	ND	ND	0.002	0.022	
Methiocarb	2015	ND	ND	ND	ND	0.022	ND	0.1
Mirex	**	ND	ND	ND	ND	ND	0.006	0.001
Permethrin -cis	2015	0.0024	ND	ND	ND	ND	ND	0.0014
Permethrin -trans	2015	0.0054	ND	ND	ND	0.0031	0.0112	
Pyraclostrobin	2010	0.0004	ND	ND	ND	ND	ND	3.1
Simazine	1999	ND	ND	ND	ND	0.002	ND	4
Tebuconazole	2015	7.13	ND	ND	ND	ND	13.2	12.0
Thiamethoxam	2015	1.86	ND	ND	ND	ND	1.1	17.5

Table Notes:

* “Last use per CaDPR” - 2015 is the most recently available information

** No reported use 1990-2015

*** These thresholds have been updated since the release of the Smith River Plain Surface Water and Sediment Monitoring Report.

ND = non-detect.

Dissolved Copper Results

The copper results are plotted on a graph (Figure 3.2) with dissolved copper on the vertical axis and water hardness on the horizontal axis. Hardness is included because the toxicity of copper to aquatic life depends on the ambient water hardness. The lower the hardness of the water, the more bioavailable copper becomes, and is therefore more toxic to aquatic life. The criteria shown in the figure is USEPA criteria and is based on current USEPA protocols and the application of risk factors. The USEPA uses the same test species used in the SWAMP toxicity tests as their benchmark species, *Ceriodaphnia dubia*, which is a species of water flea. If the concentration of copper combined with water hardness falls below the criteria, it indicates that there is little likelihood that the detected copper concentrations will cause toxicity to aquatic species in the natural environment. If the copper/hardness combination is above the criteria, it means there is a higher likelihood that the detected copper concentrations will cause toxicity to aquatic species in the natural environment. When pairing dissolved copper results with the toxicity test results, there is not always a direct correlation, because the sample water has a complex chemistry, which is not fully characterized and there can be variability associated with the survival and reproduction of the test species. As shown in Figure 3.2, all of the copper concentration/water hardness pairings above the acute toxicity criterion occurred in samples from Delilah Creek and in the roadside ditch flowing into Delilah Creek. There were also samples from Delilah Creek that tested above the criterion for chronic toxicity, and one sample from Tillas Slough just barely above the chronic criterion. Samples from Morrison and Rowdy Creeks were below both acute and toxic criteria.

As part of the adaptive management of this Plan, the Watershed Stewardship Team is developing alternative adaptive management endpoints for dissolved copper through the use of the Biotic Ligand Model. The Biotic Ligand Model improves the accuracy of the assessment by accounting for other factors in addition to water hardness that influence the bioavailability of copper in the water column. The development of the model parameters and outputs and the use of the model is described in detail in Section 7.6.

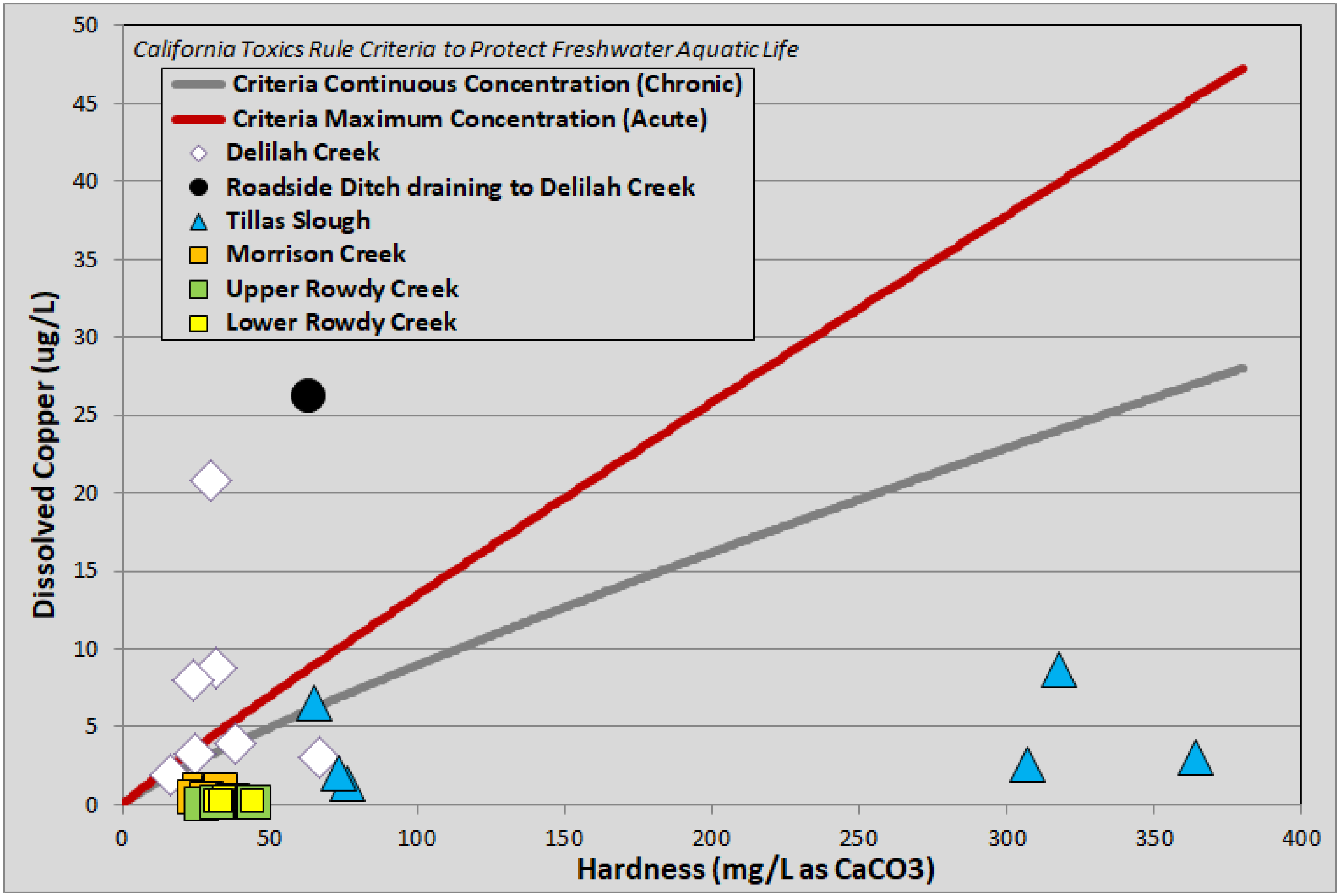


Figure 3.2. Acute and chronic dissolved copper and hardness ratios.

Toxicity Test Results

The final type of lab tests run on the samples were toxicity tests. Toxicity is determined by placing a test species in a series of diluted sample water and the same species in a 'control' sample with laboratory prepared water. For the acute toxicity test, the number of individuals that survive over several days in each of the sample dilutions are compared to the control sample. If there is a statistically significant difference in the number of individuals that survive between any of the samples versus the control, then the sample is said to exhibit acute toxicity. For the chronic toxicity test, the growth rates or reproductive rates of the individuals in the field sample dilutions are compared to the rates in the control group. If the difference in the growth or reproductivity rates are significantly different, then the sample is said to exhibit chronic toxicity. A positive result for acute toxicity (i.e., lethality) indicates a more severe toxic response compared to a positive chronic test result (i.e., sublethality). For the toxicity tests, *Ceriodaphnia dubia* (water flea), *Hyalella azteca,* (crustacean), *Pimephales promelas* (fathead minnow), and *Selenastrum capricornutum* (green algae) were used as test species in accordance with standard protocol.

Acute Toxicity Test Results

Figure 3.2 summarizes the results of the acute toxicity testing. Out of 30 samples taken between 2013 and 2017, two tested positive for acute toxicity: one sample from lower Rowdy Creek in August of 2013, and one from Delilah Creek in March of 2015. Even though both tests were positive, Delilah Creek exhibited a much stronger toxic response, with no individuals surviving the test.

Because the dissolved copper concentrations were well below the acute and chronic toxicity criteria and there were no pesticides detected in Lower Rowdy Creek, these results did not indicate a likely cause of the toxicity. In Delilah Creek, on the other hand, the dissolved copper concentrations were above the acute toxicity criterion and the concentrations of the pesticides imidacloprid and permethrin were above the chronic EPA benchmark, suggesting these chemicals as potential causes of the measured toxicity.

To further investigate the connection between constituents in the sample and the toxicity, the lab ran the March 2015 sample from Delilah Creek through another series of tests called a Toxicity Identification Evaluation or TIE. A TIE is a follow up procedure where the lab applies different chemical formulations in a stepwise fashion, which neutralizes certain constituents in the sample in an effort identify the cause of the toxicity by process of elimination. The lab is sometimes successful and sometimes not in identifying the class of chemicals which may be acting as the driver of the toxic response in the sample.

The TIE performed on the March 11, 2015 sample from Delilah Creek strongly suggests that a metal was the primary driver of the toxic response, and to a lesser extent, a pesticide may have contributed.

The chemical analysis of the Delilah Creek water sample documented elevated concentrations of dissolved copper, imidacloprid, and permethrin, which appears to support this conclusion. The March 23, 2015 sample from Delilah Creek and the sample from the roadside ditch gives another example of how conclusions based on the lab analysis are not always clear. While neither of those samples exhibited toxicity, either chronic or acute, they both contained concentrations of dissolved copper that were much higher than those found in the acutely toxic sample from earlier that March and also contained pesticides that were above EPA benchmarks.

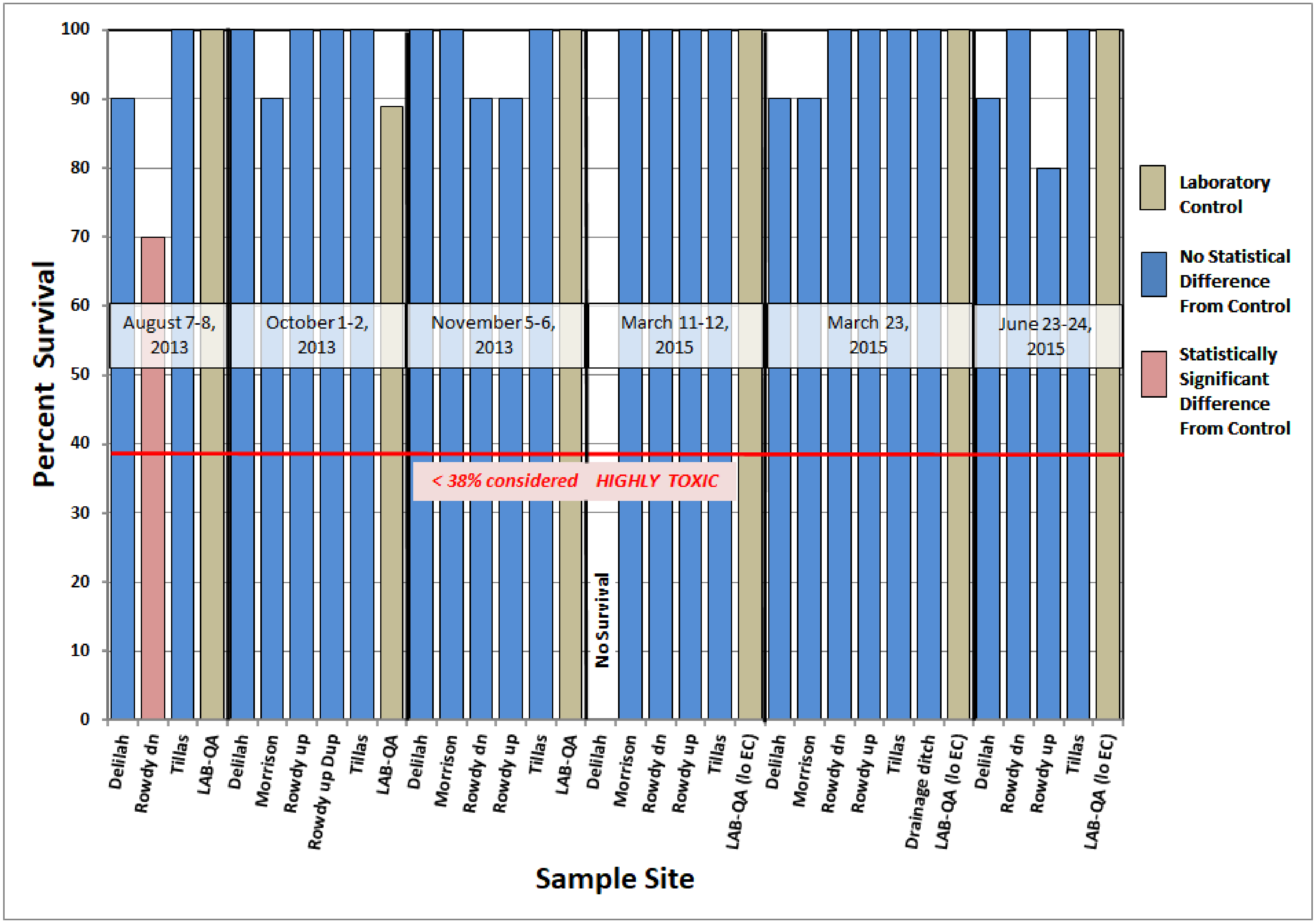


Figure 3.3. Acute toxicity testing results showing percent survival of test species for each location and time of sample.

These types of apparently conflicting results illustrate how exceeding EPA benchmarks for chemical constituents does not always translate to documented toxicity in the water. It also highlights that the value of toxicity testing lies in its ability to identify a potential water quality issue, but due to the natural variability and tolerance of the test species, toxicity testing does not always provide repeatable results. The results of toxicity testing need to be considered alongside chemical analysis and Toxicity Identification Evaluations to more fully understand the effects on aquatic life from pesticides in water column. Additionally, the varying levels of chemical concentrations from the same sample location and in the same month points to the week-to-week variability of water quality and the need to sample surface waters at a time when concentrations of pesticides and metals are likely to present the greatest risk to aquatic life.

Chronic Toxicity Test Results

Figure 3.4 summarizes the chronic toxicity test results for the 2013-2015 samples. There were 9 out of 23 samples that tested positive for chronic toxicity. From the 2013 sampling, the lab results showed three positive test results for chronic toxicity for which no corresponding levels of chemicals or dissolved copper in the samples exceeded USEPA criteria. Regional Water Board staff conducted a literature search and found that the reproductivity of the test species *C. dubia* can be negatively affected by the naturally low hardness and low electrical conductivity (or EC) of the water in the Smith River Plain. To account for this effect, in 2015, the lab added a low hardness and low EC laboratory control to the toxicity test procedure in addition to the normal control.

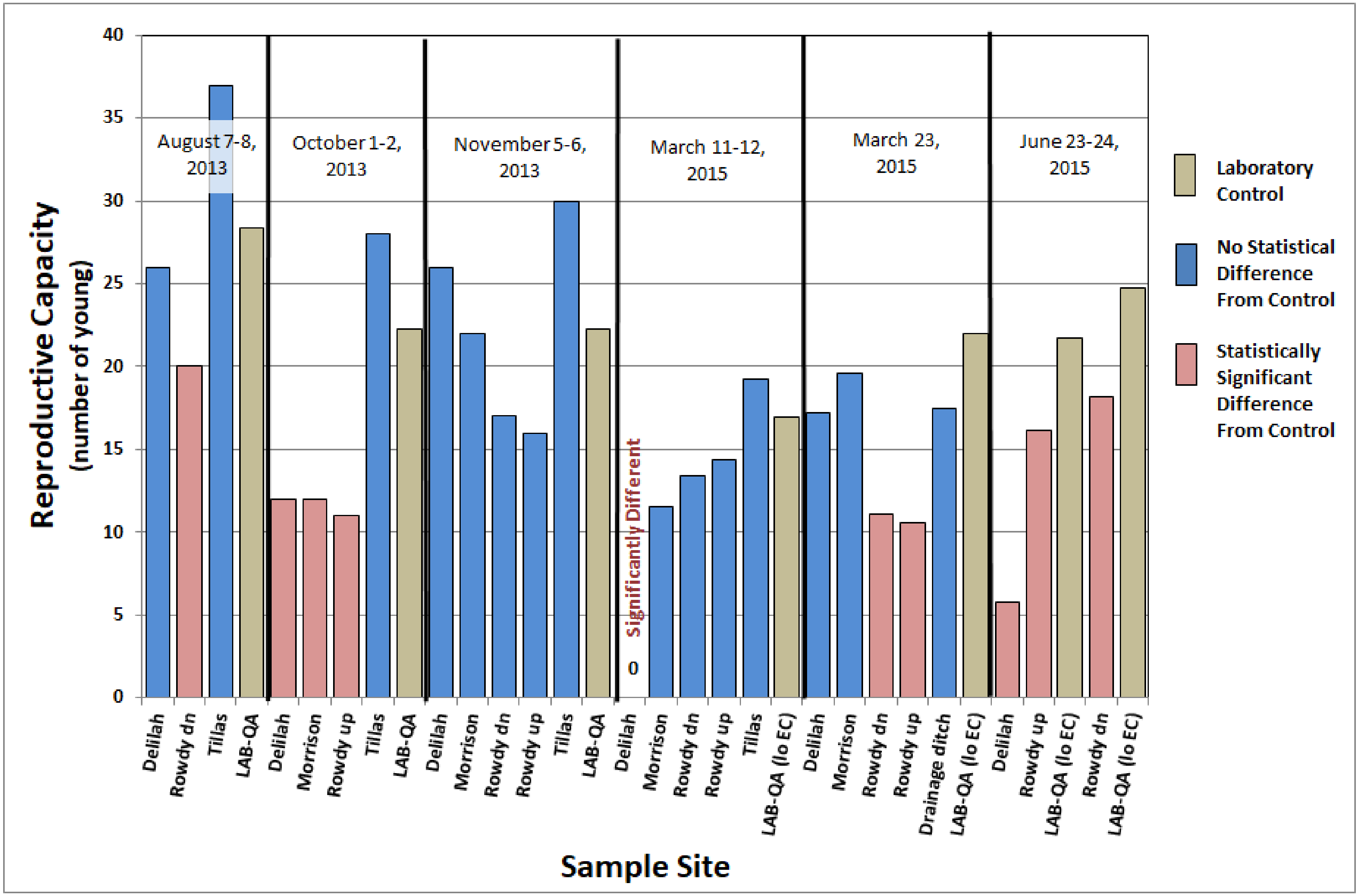


Figure 3.4. Chronic toxicity testing results showing the reproductive capacity of the test species for each location and time of sample.

In 2015, there were again samples that showed chronic toxicity, even when compared to the low conductivity control. The samples from Rowdy Creek exhibited chronic toxicity in both the samples from downstream and upstream of the lily bulb fields on March 23 and June 23. The positive results from Upper Rowdy Creek and the absence of pesticide and copper concentrations above thresholds suggest that another factor may be responsible for the observed toxicity. In Delilah Creek, the June 2015 sample showed chronic toxicity. A follow up TIE run on that sample indicated that low conductivity and low water hardness may have been a stressor. No chemicals or metals were identified as a driver of that toxicity. Overall, the 2015 toxicity test results do not present a clear connection between chemicals in the samples and the observed toxicity and the follow up TIE run on the June 2015 sample instead suggests that water hardness and conductivity is a confounding factor in the toxicity tests using *C. dubia*.

2017 Follow-Up Sampling Results

One more round of sampling was conducted to provide more information about the cause of the chronic toxic responses observed in the 2013 and 2015 samples. This time, the lab introduced an additional test species in the toxicity tests, the green algae *C. selenastrum*. These algae are not affected by low water hardness or low electrical conductivity in the toxicity test and should reduce the interference from those factors in the results. Three locations were sampled on June 8, 2017; Delilah Creek, Morrison Creek, and Upper Rowdy Creek. The Delilah Creek sample was the only one that exhibited chronic toxicity using the new test species. The chemical analyses found levels of dissolved copper that were above the threshold for the acute criterion. Two pesticides were also detected in the sample; diuron, which was well below the EPA benchmark, and chlorpropham, for which no developed benchmark is available for comparison. However, the follow up TIE indicated that both a metal and a pesticide were driving the toxicity result; similar to the results from the TIE performed on the March 11, 2015 sample from Delilah Creek that showed acute toxicity. This TIE result more definitively links copper and pesticides to the positive toxicity test result in Delilah Creek.

3.4 Physiochemical Properties and Fate and Transport of Pesticides

This section will describe the fate and transport of pesticides in the environment, which will help in selecting management practices and implementing them at the right time and in the right place to be effective. Figure 3.5 provides a conceptual model of the characteristics and processes that must be considered when conducting a risk characterization of pollutant fate and transport. The fate and transport of pesticides is determined by the physiochemical properties of the pesticide, pesticide application method, and environmental factors, which heavily impact the matrix that the pesticide is found in. Fate of pesticides in environmental matrices such as soil and water are dependent on their mobility and their persistence. Mobility and persistence in soil and sediment is controlled by sorption, while mobility and persistence in water is controlled by water solubility, and water flow.

Typical transport processes include surface runoff, plant uptake, leaching, soil erosion, and volatilization. Persistence of pesticides is influenced by degradation processes including biodegradation, photodegradation, and chemical degradation. The half-life ($t_{1/2}$) of a chemical is used to assess persistence. Half-life is defined as the time required for a substance to degrade one half of its initial and equilibrium concentration.

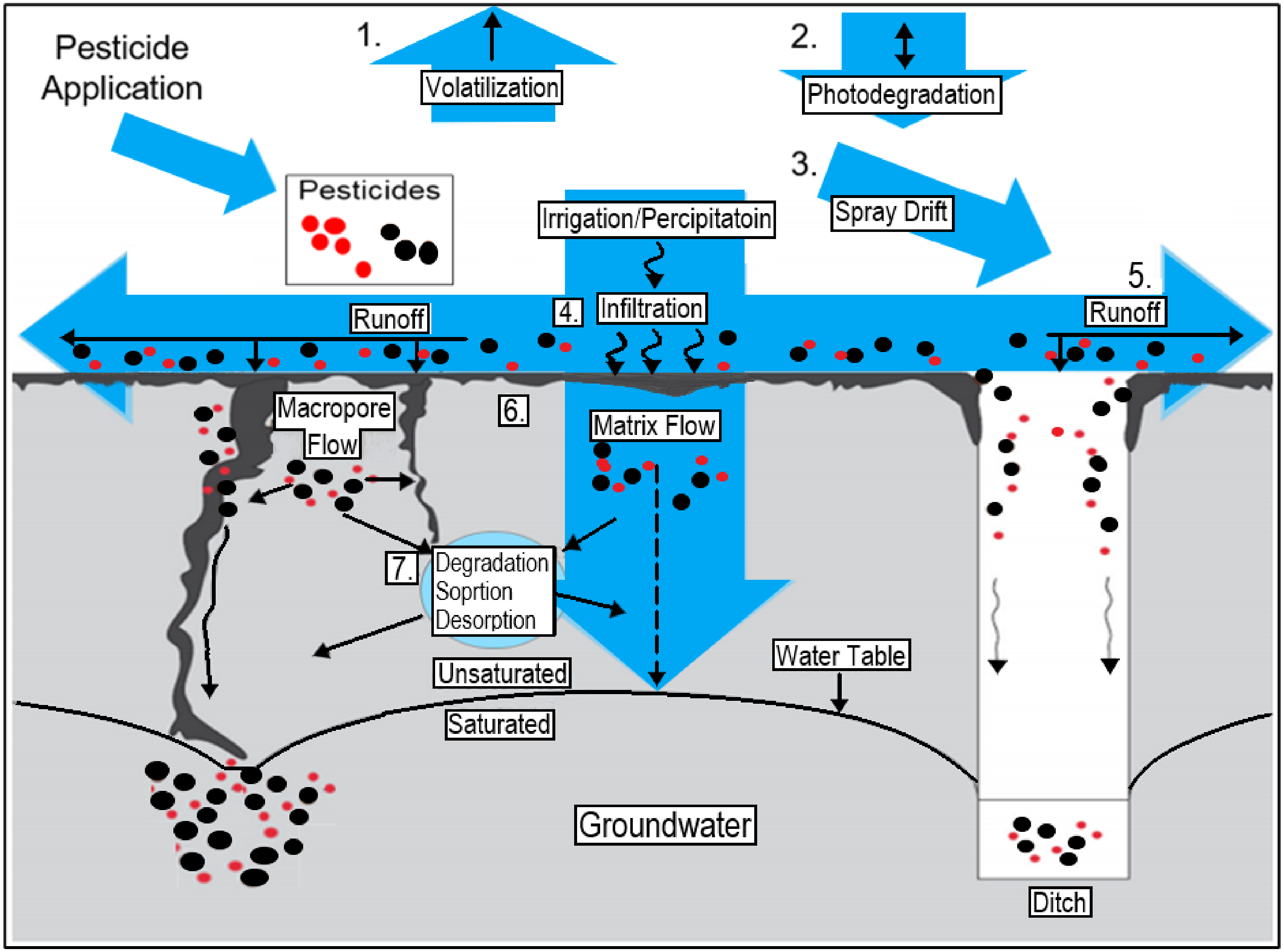


Figure 3.5. Transport mechanisms of pesticides.

Permethrin

Permethrin ((3-phenoxyphenyl) methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane-1-carboxylate) is classified as a synthetic pyrethroid commonly used as a repellent and insecticide. Pesticide use report (PUR) data from 2014 – 2018, indicate total use of 830.8 pounds of active ingredient (AI) of permethrin in Lily Bulb production for the Smith Plain (CDPR 2014-2018). According to U.S. Environmental Protection Agency (USEPA) aquatic life benchmarks, permethrin is classified as very highly toxic to fish and invertebrates. Based on its physiochemical properties, permethrin is moderately persistent in soil with low leachability potential. Permethrin's high organic carbon-water partition coefficient (K_{oc}) exhibits a strong tendency to sorb to soils with high organic matter, potentially transporting from surface terrestrial environments attached to sediment. Half-life values for soil, range from 13 – 42 days, 40 days in water-sediment, and approximately 23 days in water. Permethrin was detected three times in surface water in the 2013 – 2015 SWAMP report. Surface water concentrations ranged from 0.0014 to 0.395 µg/L. Surface water concentrations were observed to exceed both acute and chronic thresholds for invertebrate species (SWAMP 2018) of 0.0195 µg/L and 0.0014 µg/L respectively. Permethrin was also detected in sediment at a concentration of 2.92 mg/kg.

Ethoprop

Ethoprop (O-ethyl S,S-dipropyl dithiophosphate) is an organophosphate pesticide. USEPA aquatic life benchmarks classify ethoprop as very highly toxic to fish and invertebrates. A total of 10, 786 pounds of ethoprop active ingredient were used by bulb growers in the Smith Plain from 2014 – 2018 (CDPR 2014-2018). The low K_{oc} of ethoprop indicates a low tendency to sorb to soils and sediments. This is supported by its octanol-water partition coefficient (K_{ow}) which indicates ethoprop is moderately to highly hydrophilic. Ethoprop is not persistent in the soil matrix with a half-life of 1.3 – 13.6 days, causing it to be mobile to very mobile in the soil matrix. Based on this mobility, ethoprop has the potential to leach in the subsurface. Examining dissipation data, ethoprop has a half-life ranging from 75 – 90 days in the sediment-water phase (Lewis et al. 2016; USEPA 2006) and a half-life of 133 days in water. Ethoprop was detected three times in surface water from the 2013 – 2015 SWAMP study. Surface water concentrations ranged from 0.019 to 0.183 µg/L. The lowest EPA benchmark is 0.8 µg/L. Ethoprop was not detected in sediments.

Diuron

Diuron (N-(3, 4-dichlorophenyl)-N, N-dimethylurea), is a preemergent herbicide used to control weeds and grasses. Approximately, 8,793 pounds of diuron was used in the Smith Plain for lily bulb production from 2014 – 2018. Examining diuron's physicochemical properties, its low K_{oc} indicates a low propensity to sorb to soils and sediments, and its K_{ow} suggest its moderately hydrophilic. Diuron has a high leaching potential. The half-life in soil is estimated at 146 – 229 days, indicating it is persistent in soil. The estimated half-lives in sediment-water and water were 48 and 8.8 days respectively.

Due to diuron's long half-life and moderate mobility in soils, it is prone to transport from the soil surface via runoff and leach through the soil surface at high rate, reaching groundwater (Lewis et al. 2016, Moncada 2003). Diuron was detected six times in surface water samples, the most out of any other pesticide in the SWAMP study. Surface water concentrations ranged from 0.002 to 57.7 µg/L. Diuron was not detected in sediment samples. USEPA aquatic life benchmarks classify diuron as very highly toxic and two of the highest diuron surface water concentrations in the SWAMP report were higher than the chronic EPA benchmark for fish, which is 26.4 µg/L. The EPA benchmark for nonvascular plants is 2.4 µg/L.

Imidacloprid

Imidacloprid (1-(6-chloro-3- pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine) is a neurotoxic insecticide that is classified as a neonicotinoid pesticide. Pesticide Use Report data from 2014 – 2018, indicate total use of 570 pounds imidacloprid in lily bulb production for the Smith River Plain. The K_{oc} for imidacloprid is low, indicating a low sorption affinity making it more mobile and capable of moving via runoff. With a half-life of 174 – 191 days, imidacloprid is persistent in soil. In the sediment-water matrix, imidacloprid degrades slowly with a half-life of 129 days. It degrades slowly in water with a half-life of 30 days. Imidacloprid has a very high leaching potential. According to Koshlukova (2006) "imidacloprid is currently listed by the DPR as a potential ground water contaminant, based on its high solubility in water, mobility and persistence in soil." Imidacloprid was detected three times in surface water according to the 2013 – 2015 SWAMP report, with concentrations ranging from 2.17 to 3.56 µg/L. These concentrations were higher than the chronic EPA benchmark for invertebrates of 0.01 µg/L. USEPA Aquatic Life Benchmarks classify imidacloprid as moderately toxic for fish and very highly toxic for invertebrates.

Tebuconazole

Tebuconazole (1-(4-chlorophenyl)-4,4-dimethyl-3-(1H-1,2,4-triazol-1-ylmethyl) pentan-3-ol) is a fungicide used to control soil-borne and foliar fungi. Approximately 220 pounds of tebuconazole was used in lily bulb production for the Smith River Plain from 2014 – 2018. USEPA aquatic life benchmarks classified tebuconazole as highly toxic for fish and very highly toxic for invertebrates. Previous studies have shown tebuconazole is very persistent in soil with a half-life ranging from 47 – 796 days (Wang et al. 2017, Lewis et al. 2016, Montague and Al-Mudallal 2000). The K_{oc} of tebuconazole is low to moderate suggesting that it will be slightly mobile. As the soil organic matter decreases, tebuconazole mobility increases (Montague and Al-Mudallal 2000). Tebuconazole has a moderate leaching potential and is more likely to reach groundwater when soils have low organic matter or are high in sand content. Tebuconazole mobility would likely transport it into surface water via runoff. Due to its high persistence in soil and its ability to runoff in the aqueous phase, its fate in sediment-water and in water is very stable with half-lives of 365 days and 42.6 days respectively. Tebuconazole was detected twice in surface water during the 2013 – 2015 SWAMP study.

Surface water concentrations were 7.13 and 13.2 µg/L. The highest detection for surface water was higher than the chronic toxicity threshold for fish, which is 11 µg/L.

Copper

Since copper is a metal, its fate in surface waters and its risk to aquatic life is more complicated to assess than the other pesticides being used in the Smith River Plain. The potential for copper to cause toxicity in the water column is greatly affected by site-specific geology and ambient conditions. Ambient conditions can lead to heightened sensitivity of aquatic life to copper toxicity at certain locations and at certain times. Understanding their seasonality and spatial distribution can help select the right practices and prioritize implementation across the landscape. Metals such as copper, unlike most organic pesticides, essentially do not break down in the environment and can accumulate. While copper molecules may be currently unavailable to affect aquatic life because, for example, they are attached to sediment at the bottom of the stream, they may become available in the future as ambient water quality conditions change.

Dissolved metals also act differently than organic pesticides since they readily interact with other anions and cations in the water column and can form complexes with several inorganic ligands. A "ligand" is an ion or molecule that interacts with a metal, such as copper, to form a larger complex. The total concentration of soluble metal in the water column is the sum of the free metal ion and the metal contained in these complexes and a large fraction of copper can exist in these complexed forms. Since ligand complexation and competition with other ions for binding sites reduces copper's bioavailability, the toxic effect in the water column may be lowered by free copper ions reacting with ligands and particulate matter. Natural waters with high concentrations of organic matter and particulates will reduce the concentration of dissolved and bioavailable metal being released from bound forms. Other factors affecting the bioavailability of copper include the presence of dissolved organic carbon (DOC) in the water column. DOC mitigates the effect of copper on the gills because it forms ligands with copper and makes it less bioavailable. Low pH or low hardness also affects copper toxicity because it means there is a lower concentration of calcium ions to compete with copper for organic binding sites, which allows a higher percentage of the copper ions to bind to those sites and impair biological function. Taylor et at. (2000) found that copper was approximately 20 times more toxic to rainbow trout in soft water (290 mg/L) than in hard water (120 mg/L as $CaCO_3$). The end result of these various chemical reactions involving copper is that equal concentrations of dissolved copper in the water column can produce varying levels of toxicity depending on the ambient water quality conditions.

Figure 3.6 below illustrates some of the chemical reactions that influence copper toxicity. To account for the variability in dissolved copper's effect on aquatic life in managing the program, the Watershed Stewardship Team will make use of a USEPA model called the Biotic Ligand Model. The USEPA Biotic Ligand Model accounts for these factors and will be used to develop adaptive management thresholds for copper specific to the Smith River Plain as described in Section 7.6.

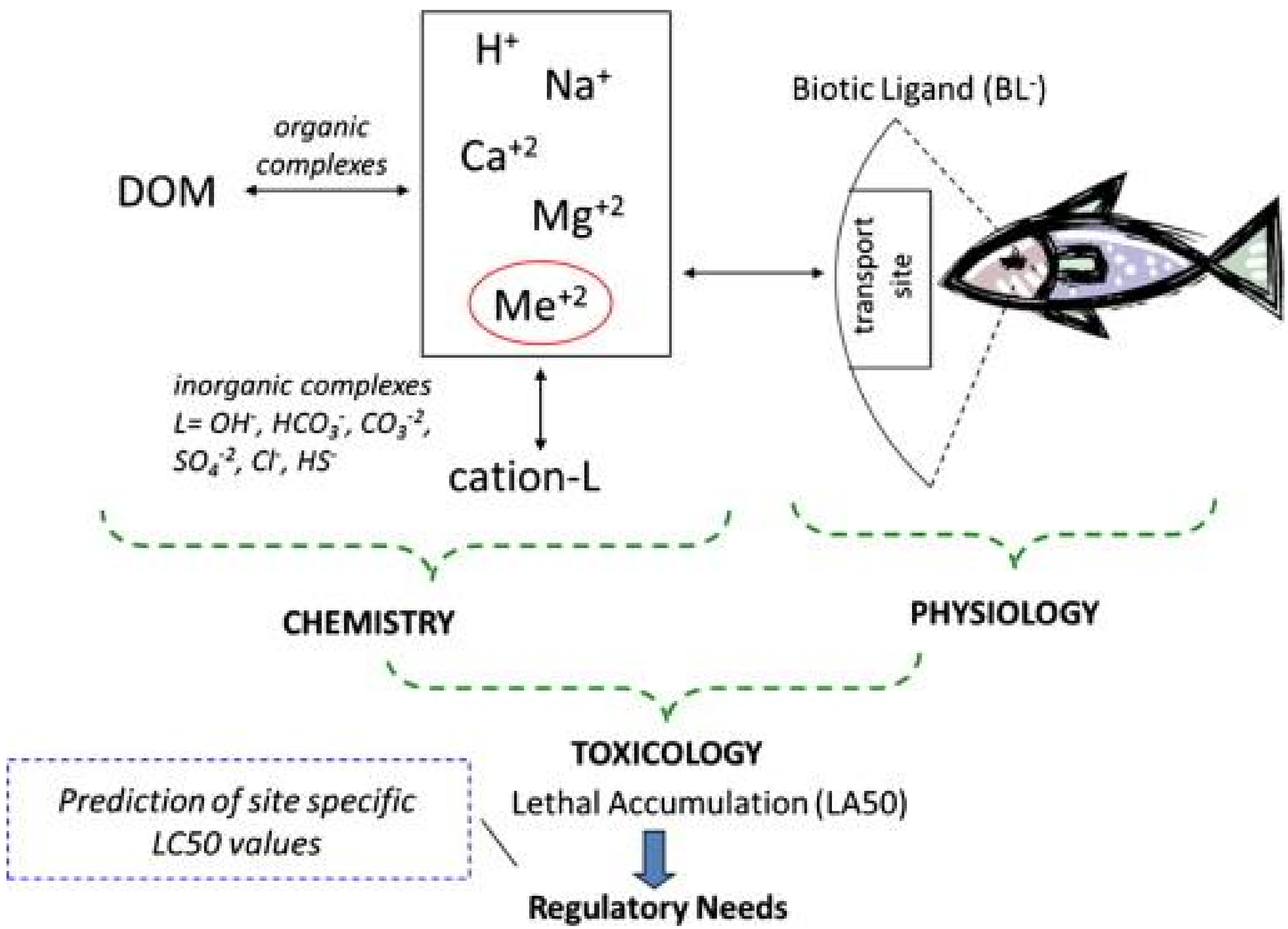


Figure 3.6. Copper speciation in the water column and its relationship to toxicology (modified from Smith et al. 2014).

3.5 Pesticide Risk Assessment

This section presents the results of a risk assessment Regional Water Board staff performed to determine which pesticides to analyze for as part of the Adaptive Management Monitoring Program and which pesticides are a priority to address through farm management practices. The assessment does not include dissolved copper because its behavior in the environment differs significantly from the other pesticides used in the Smith River Plain. However, it has still been designated as a priority for planning and implementation based on the prevalence of copper use by lily bulb growers and the frequent detections in surface waters. For all other pesticides, Regional Water Board staff used the information and methods listed below to conduct the risk assessment and prioritization:

- Physiochemical properties of the pesticides
- SWAMP Smith River Plain Surface Water and Sediment Monitoring Report results
- Pesticide use report (PUR) data from 2014 – 2018 (CDPR 2014-2018) including evaluation of seasonal use (Table 3.4)
- California Department of Pesticide Regulation (DPR) Prioritization Program (Lou et al. 2013)

Based on the 2013 – 2017 SWAMP water and sediment monitoring, the risk assessment focused initially on the 17 pesticides detected in the SWAMP study (Table 3.2). According to SWAMP (2018) "Detected pesticides included legacy pesticides for which the last recorded use was prior to 2000 and more recently used pesticides that have been in use after 2000." In addition, information from lily bulb growers was used to identify the pesticides in the SWAMP report that were never used or are no longer used in lily bulb cultivation. From this information, DPR's prioritization protocol was used to assign a prioritization score for each pesticide. The prioritization protocol is based on pesticide use and aquatic toxicity (Luo et al. 2015). Pesticide use data was collected from pesticide use reports (PUR) provided by DPR (Table 3.3). We used PUR data from Del Norte County that quantifies pesticide applications on lily bulb operations from 2014 – 2018 to assess amounts of pesticides applied as well as the seasonality of use (Table 3.3). Toxicity data was obtained from USEPA Office of Pesticide Programs (OPP) Aquatic Life benchmarks. For the pesticides with no OPP aquatic life benchmark data, OPP benchmark equivalents were developed using USEPA benchmark calculation protocols. A probability-based use ranking and a toxicity ranking were used to determine a final score (Figure 3.7). The prioritization score was assessed for fish and invertebrates based on their aquatic life benchmarks (Table 3.5). In determining the priority pesticides for the purpose of water quality management and planning, the risk assessment took into account the pesticide's final score, as well as its physiochemical properties, and the water quality monitoring results from the SWAMP report.

From this review, Regional Water Board staff selected permethrin, ethoprop, diuron, imidacloprid, and tebuconazole as the pesticides that would be analyzed in the sampling done as part of the Adaptive Management Monitoring Program and as priority pesticides to be addressed through implementation of on-farm practices.

Table 3.3. Five Year Pesticide Use Report (PUR) data for Lily Bulb Production in Smith River Plain.

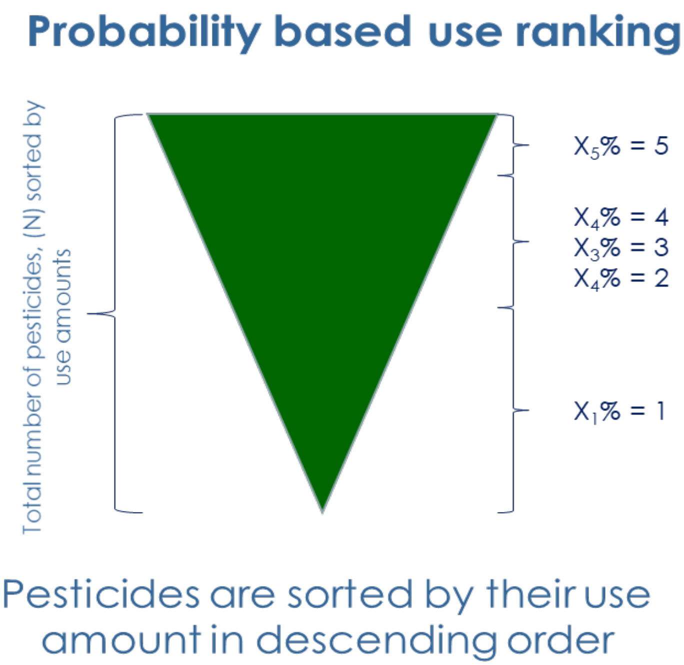
Pesticide	2014	2015	2016	2017	2018
Aldicarb					
Captan		X	X	X	X
Carbaryl					
Carbofuran					
Diuron	X	X	X	X	X
Ethoprop	X	X	X	X	X
Fenpropathrin					
Imidacloprid	X	X	X	X	X
Hexachlorobenzene					
HCH Beta					
Methiocarb	X		X		
Mirex					
Permethrin	X	X	X	X	X
Pyraclostrobin					
Simazine					
Tebuconazole	X	X	X	X	X
Thiamethoxam	X	X		X	

Pesticide Type	Name	Date	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Herbicide	**Diuron**	**2014**	W		W		W	W	W					
		2015	W	W	W	W	W	W	W					D
		2016	W	W	W	W		W						D
		2017		W	W	W	W	W	W	D	D			D
		2018		W	W	W	W	W	W	D				D
Insecticide	**Ethoprop**	**2014**	W									D	D	D
		2015	W									D	D	D
		2016	W									D	D	D
		2017	W	W								D	D	D
		2018	W									D	D	D
	Imidacloprid	**2014**						W	W	D	D	D		
		2015					W	W	W	D	D	D	D	
		2016				W	W	W	W	D	D	D		
		2017					W		W	D	D	D	D	
		2018						W		D	D	D	D	
	Permethrin	**2014**						W	W	D	D	D		
		2015							W	D	D	D		
		2016						W	W	D	D	D		
		2017							W	D	D	D		
		2018							W	D	D			
Fungicide	**Tebuconazole**	**2014**					W							
		2015			W		W			D				
		2016					W	W	W	D				
		2017						W						
		2018					W	W			D			

Wet Season Application: W

Dry Season Application: D

Table 3.4. Seasonality of Pesticide Use in the Smith River Plain for the pesticides prioritized through the risk analysis.



Toxicity Score	Lowest Benchmark (BM) ppb	USEPA Description
8	BM ≤ 0.001	Very high toxic
7	0.001 < BM ≤ 0.01	
6	0.01 < BM ≤ 0.1	
5	0.1 < BM ≤ 1	
4	1 < BM ≤ 10	
3	10 < BM ≤ 100	
2	100 < BM ≤ 1000	Highly toxic
1	BM > 1000	Moderately toxic to practically non-toxic
0	No Data	

Figure 3.7. Probability based use ranking of pesticides and toxicity score based on US EPA Office of Pesticide Programs Aquatic Life Benchmarks in Luo et al. 2014.

Pesticide	Final Score Fish	Pesticide	Final Score Invertebrate
Permethrin	18	Ethoprop	25
Ethoprop	15	Peremethrin	21
Diuron	12	Diuron	12
Captan	9	Imidacloprid	8
Tebuconazole	6	Captan	6
Methiocarb	3	Methiocarb	5
Imidacloprid	2	Tebuconazole	4
Thiamethoxam	1	Thiamethoxam	3
Prioritization Score (Final Score) = (Use Score) * (Toxicity Score)			

Table 3.5. Pesticide prioritization scores for for fish and invertebrates.

Section 4
Water Quality Management Practices

4.1 Introduction

Proper implementation of effective management practices and regular maintenance is critical to addressing the water quality problems identified through water quality monitoring and the risks associated with lily bulb cultivation described in the previous section. To address these issues, this section includes a list of management practices that growers can select for implementation to control impacts to water quality associated with lily bulb cultivation in the Smith River Plain. The purpose of this adaptive management Plan is to allow growers to select from the list of practices, implement them on their operation, report to the Regional Water Board on implementation, and evaluate their effectiveness to determine which practices may be incorporated into future permit conditions. The list was developed by the Watershed Stewardship Team with input from the growers using monitoring results, knowledge about the fate and transport of pesticides used in the Smith River Plain, and the risk characterization described in Section 3. For each practice on the list, a brief description of the practice and its purpose is given. The listed practices are intended to reduce loads of sediment, pesticides, fungicides, herbicides, and nutrients into waters of the state, particularly surface waters. The list of practices presented here is intended to capture both the water quality practices currently in use in the Smith River Plain as well as other practices that could potentially be effective based on the review of technical documents and the risk characterization.

Management practices protective of water quality in an agricultural setting can generally be divided into three categories based on the mechanism for pollutant control. Understanding these mechanisms helps to identify the most effective practices for water quality protection and informs the best placement and timing for their implementation. The first type of practice aims to reduce the potential pollutant at the source. This is known as source reduction. This may include, for example, limiting the amount of pesticides being applied or preventing pesticides from mobilizing in the sediment or in surface runoff. It might also involve choosing alternate pesticides that have a lower mobility or toxicity potential than those currently used. The second type of practice restrains potential pollutants and prevents them from leaving the field. This is known as source control. Examples of this practice include plant residue management and cover crops. The third type of practice intercepts potential pollutants that have left a field, thereby preventing them from reaching surface waters. This may be accomplished, for example, by collecting runoff in a detention basin or by directing runoff through a filter strip. In general, practices are less effective as they are implemented downstream of the pollution source.

For example, reduced pesticide application is more effective than preventing pesticide runoff, which is more effective than capturing runoff laden with pesticides. When selecting water quality control practices, growers should favor practices that target pollutants early in the transport pathway.

The practices listed in this section are grouped into different categories depending on the water quality concern being addressed. For example, there is a list of management practices specific to pesticides and another specific to nutrients. There are generally two types of management practices distinguished in this section, those implemented operation-wide across all of a growers' fields, and those that are specific to a given field. For example, road maintenance practices are operation-wide in that they are implemented on roads throughout the operation and not specific to individual fields. In this case, growers report the information once and then only need to report changes in future reporting. On the other hand, field-specific practices are associated with an individual field and may be subject to change annually. For example, a cover crop or field drainage direction is field-specific and may only apply for that growing season. Within each category, the operation-wide practices are given first and then the field-specific practices.

Growers select practices from the list of field-specific practices on an annual basis to implement for the upcoming growing season in the fields being prepped to either grow lily bulbs or for forage/pasture. The operation-wide practices have already been reported and will continue to be implemented on an ongoing basis throughout the entire operation with only minor revisions as needed year to year. Growers report which practices are being implemented for their operations by filling out reporting forms and making them available to Regional Water Board staff. The reporting forms are provided in Section 5 of this Plan along with more specifics on the grower reporting program.

This subsection relies heavily on the work and documentation of the NRCS in its Field Office Technical Guide (FOTG) for California and other states. For more detailed descriptions of these practices, refer to the NRCS documentation[2], documentation from other state governments and local jurisdictions, and other reputable and peer reviewed technical documents. As the Watershed Stewardship Team learns from experience, more details on the best practices and most effective ways to implement them will be added to this section to help guide their specific application in the Smith River Plain. The Watershed Stewardship Team will meet regularly to review reporting information and consider input from growers on which practices are most effective and how to improve implementation.

[2] The NRCS FOTG can be accessed at the USDA web page: Section IV contains the specific practice descriptions. (https://efotg.sc.egov.usda.gov/#/details.)

As the plan is implemented and adaptively managed moving forward, this list of practices may be revised based on evidence of their effectiveness in the field. The practices listed in this Plan are not all-inclusive but have been tailored to lily growers in the Smith River Plain.

4.2 Pesticide Management

This section includes water quality practices to control the impact of pesticides used in lily bulb cultivation.

Operation Wide Practices

- Integrated Pest Management Plan (IPM Plan) – An Integrated Pest Management Plan, or as referenced in the NRCS FOTG, a Pest Management Conservation System, is developed that considers all available pest control techniques to keep pesticide use to a minimum. An IPM Plan integrates other non-chemical approaches to pest management, such as planting cover crops that provide habitat for beneficial insects, so as to minimize risks to water quality. These plans, when properly written and implemented, are extensive and comprehensive protocols, which drive adoption of many of the pesticide-related BMPs in this Plan.

- Use of Low Risk Pesticides – Lower risk pesticides have been selected to minimize impacts to water quality based on toxicity, runoff potential, and leaching potential.

- Pesticide Sampling and Analysis – Stormwater runoff from fields is sampled and analyzed for pesticide concentrations to assess effectiveness of management practices and identify areas of concern. The Integrated Pest Management Plan should describe feedback mechanisms to address areas of concern identified through sampling.

- Pesticide Mixing/Loading Setbacks – Setbacks are maintained adjacent to waterways and other sensitive areas for pesticide application, mixing, and loading into spray application rigs to provide a buffer in case of spills. This practice overlaps somewhat with stream setbacks, riparian buffers, filter strips, and pesticide label compliance.

- Proper Disposal of Pesticides – Pesticide containers are triple rinsed before disposal. Pesticides are considered hazardous waste and disposed of accordingly. Rinse water is mixed and applied according to label requirements.

- Soil Amendments – Amendments are added to the soil to bind pesticides, thereby reducing offsite movement and/or reducing their toxicity.

- Sprayer Shields – A shield on the spray boom is used to reduce pesticide drift.

- Wellhead Protection – An area around the wellhead is delineated where certain activities are limited in order to protect the wellhead from contamination. This practice overlaps somewhat with setbacks.

- Irrigation Water Management – The volume, frequency, and application rate of irrigation water is planned to minimize runoff.

- County Pesticide Permit and Pesticide Label Compliance – All applicable pesticide regulations and label handling and application directions are followed, including the Del Note County Ag Commissioner's permit requirements.

- Crop Rotation – Crops are rotated seasonally in a sequence to disrupt pest lifecycles and thereby reduce the need for use of pesticides. Crops are also rotated to reduce the need for fertilizers and to reduce erosion when cover crops are part of the rotation.

- End of Row Shutoff When Spraying – The pesticide sprayer is shut off at the end of the row and kept off in the turnaround.

- Prevent Pesticide Overspray to Surface Waters - Pesticides are not sprayed in and around surface waters where they can contact water directly considering, among other things, wind direction and strength.

- Drift Control Agents – Additives are used to increase droplet size to reduce drift.

- Monitor Climatic Conditions – Wind speed and direction, temperature, and relative humidity are monitored and considered in planning pesticide applications. Depending on pesticide labeling and local regulations, certain pesticides may be subject to spray zone application restrictions that restrict spraying when windspeeds reach a certain threshold or under certain climatic conditions.

- Application Timing and Rain Forecasting – The rain forecast is monitored to anticipate storm events that produce runoff. Pesticide applications are planned to maximize the amount of time between application and a storm event. This allows time for the pesticide to dry on plant surface, degrade, and/or become incorporated into the soil, which reduces the risk of transport to surface waters through runoff. Applying pesticides close in time to a storm event can also greatly reduce its effectiveness and can necessitate repeat applications.

- Pesticide Applicator Adjustments – Spray nozzle pressure and height and droplet size are adjusted to better target the pesticide application, minimize drift, and improve the efficiency of applications, which can all reduce the amount of pesticide required.

Field Specific Practices

- Filter Strip – A vegetated strip is maintained adjacent to a drainage ditch or waterway to filter pollutants. The NRCS recommends a minimum width of 30 feet, however the width of filter strips may vary based on field specific conditions. The Watershed Stewardship Team is working to develop appropriate buffer widths for fields in the Smith River Plain. Vegetation species may be selected for their replenishment of nitrogen, sequestration of carbon, suitability as forage, filtration capabilities, beneficial and wildlife species habitat, and other desirable qualities. This practice overlaps somewhat with vegetative barriers, riparian buffers, critical area planting, and stream setbacks.

- Field Size Reduction – Field sizes are reduced to minimize the amount of stormwater runoff and accompanying pollutants from the field. This practice can include breaking a number of large fields into a greater number of smaller fields within a given area. For example, two larger fields may be broken into three smaller fields. Together with adjusting the field rotations, this can be a way to lessen the pesticide loading to a given area.

- No Spray Buffer Zone – Areas where spraying does not take place from between the downwind edge of the application area and an identified sensitive area.

4.3 Erosion and Runoff Control Practices

This section includes water quality practices to control erosion and runoff from lily bulb fields as part of preventing pesticides and other pollutants from reaching surface waters. Many pesticides preferentially attach to soil particles, which when dislodged through erosion can be discharged to a waterway.

Operation Wide Practices

- Road Erosion Control – Waterbars, grading, rolling dips, etc. are used to prevent and minimize road erosion. Technical specifications for roads depend on road surface, slope, camber, traffic, anticipated flow, etc. The Handbook for Forest Ranch and Rural Roads is an excellent resource for designing and maintaining roads in a manner protective of water quality. This reference can be accessed online at the Pacific Watersheds web address: (http://www.pacificwatershed.com/sites/default/files/roadsenglishbookapril2015b_0.pdf).

- Proper Culvert Sizing and Maintenance – Culverts are sized correctly to pass 100-year storm flows. Culverts are inspected regularly and maintained to ensure structural integrity, proper function, and to minimize erosion downstream. Flow dissipaters may be used for the latter.

- Road Maintenance – Pre- and post-storm inspections are conducted, erosion sites are identified, and a prioritized inventory of erosion sites is developed and updated from which to schedule and implement fixes. The goal of a prioritized inventory of erosion sites is to optimize the amount of sediment that is controlled onsite and prevented from entering a watercourse.

- Flow Dissipators – Flow dissipaters are used to minimize erosion at discharge points. Flow dissipaters take various forms and designs should be site-specific. They are designed to intercept incoming flows from pipes and ditches, and they function by reducing the energy or erosive force in the flow of water at the pipe or ditch outlet. They can be constructed of materials such as riprap or concrete.

- Agricultural Pond Maintenance – Agricultural ponds are maintained to prevent erosion and failure of dams, embankments, and spillways. Ponds are regularly inspected, and necessary preventative maintenance is performed.

Field Specific Practices

- Contour Farming – Fields are planted on the contour to reduce runoff, erosion, and rill formation.

- Precision Land Forming – Fields are graded to increase irrigation efficiency and improve drainage control and minimize erosion.

- Row Arrangement – Crop rows are graded, directed and constructed at a length to optimize rain and irrigation water efficiency and minimize the mobilization of sediment, nutrients, and applied chemicals into runoff.

- Cover Crop – Vegetation is planted to fields to minimize the area of bare soil, thereby reducing the potential for erosion. Cover crops may be selected for their replenishment of nitrogen, sequestration of carbon, suitability as forage, filtration capabilities, and other desirable qualities.

- Enhanced Soil Infiltration – Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration. This practice should be used in conjunction with other practices, such as a filter strip, that reduces the risk of sediment delivery to streams.

- Critical Area Planting – Areas of land of special conservation concern, sensitivity, or importance for water quality are planted with strategically selected vegetation to improve conservation values. Vegetation species may be selected for their replenishment of nitrogen, sequestration of carbon, suitability as forage, filtration capabilities, beneficial and wildlife species habitat, and other desirable qualities. This overlaps somewhat with riparian buffers, filter strips, and vegetative barrier.

- Soil amendments – Amendments such as compost, mulch or other organic matter are added to the soil to improve soil structure, increase nutrient bioavailability, and reduce erosion. Improving soil health can also help to sequester carbon and reduce greenhouse gas emissions.

- In Furrow Dams – In furrow dams are installed to increase infiltration and settling out of sediment prior to entering the tail ditch.

- Field Border – Borders (including berms) are installed at the low end of fields to capture runoff and trap sediment.

- Plant Residue Tillage Management – Plant materials are left on the soil surface to reduce runoff and erosion. The increase in roughness generated by the plant residue slows runoff rate and increases the detainment of suspended solids and other pollutants.

- Vegetative Barrier – Vegetation is planted to slow or reduce surface runoff by promoting detention and infiltration. Vegetation species may be selected for their replenishment of nitrogen, sequestration of carbon, suitability as forage, filtration capabilities, beneficial and wild species habitat, and other desirable qualities. This overlaps somewhat with critical area planting, filter strips, and riparian buffer.

- Grassed Waterway – Grass is maintained in drains and ditches to reduce erosion and filter pollutants. Vegetation species may be selected for their replenishment of nitrogen, sequestration of carbon, suitability as forage, filtration capabilities, beneficial and wild species habitat, and other desirable qualities. This overlaps somewhat with critical area planting and filter strips.

- Stormwater Diversion – Structures or embankments are installed to keep stormwater on lily blub field headlands preventing it from running onto fields where it can mobilize pollutants.

- Field Isolation – Runoff from lily bulb fields flows onto a pasture or other vegetated area where it is dispersed, filtered and infiltrated before reaching surface waters.

- Grade Stabilization Structure – Drop spillways or check dams are installed to stabilize the grade and control erosion.

4.4 Management Practices for Stream Protection (All Field Specific)

This Plan includes a series of practices that can be implemented in fields adjacent to streams in the Smith River Plain. Growers will define a streamside protection area consisting of a riparian area and a filter strip, if applicable, to filter runoff before reaching the riparian area and ultimately the surface waters. Figure 4.1 shows an idealized streamside protection area of a stream, which supports various stream functions and habitat that require special protection. Riparian areas help to infiltrate runoff water before it reaches the stream and as water moves through the soil soluble chemicals are filtered out. The water then emerges from the ground and enters the channel. Filter strips maintained between the edge of the agricultural field and the riparian area buffer the stream from farm activities and also capture eroded soil and attached pesticides moving from the fields during storm events. Filter strips and riparian areas work together to filter both soluble pesticides and pesticides attached to sediment out of runoff before it can reach the stream. To be most protective of water quality, both filter strips and riparian areas should be maintained. The filter strip practice is included in the pesticide management Section 4.2 above and is not repeated in this section. In the Smith River Plain, the lily bulb growers are following this general concept for fields that are adjacent to streams. Growers also participate in restoration projects that improve the riparian vegetation and restore the stream channel to provide enhanced ecological function, including filtration of agricultural chemicals.

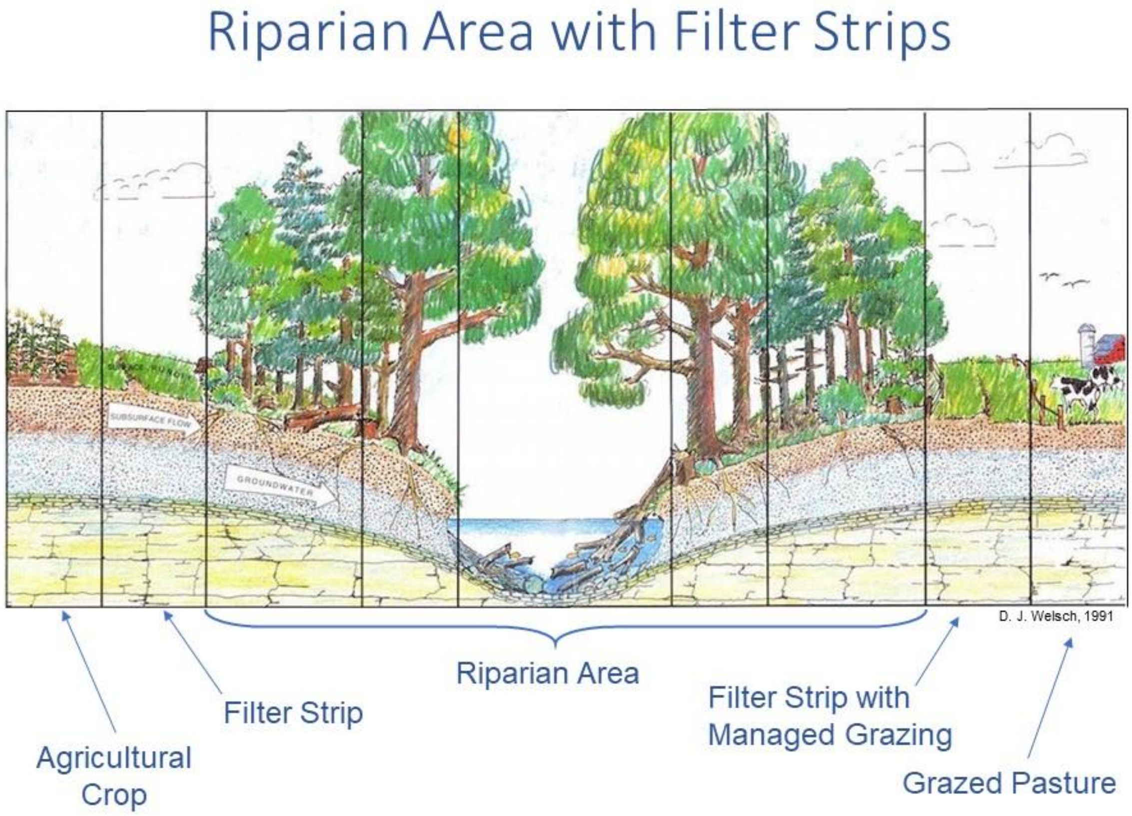


Figure 4.1. Idealized depiction of a stream and its riparian area showing how filter strips function to both buffer the stream from polluted runoff and improve water quality through filtration.

This section includes stream protection practices growers will choose from to implement in fields that border stream channels or other water conveyances.

- Stream Setback – A minimum streamside setback of 35' from the edge of lily bulb fields to the top of the stream bank is maintained. The setback may include riparian vegetation and/or a filter strip being used to filter sediment in runoff from fields. Site-specific filter strip and setback sizing will be adaptively managed based on feedback from the monitoring and reporting program, including water sampling results. NRCS and RCD do not have riparian or filter strip BMPs tailored to the Smith River Plain 'off the shelf' so they will need to be developed in consideration of site-specific conditions. Setbacks may also be sized to comply with the existing Regional Water Board's dairy permit program, 401 program for instream work, pesticide label requirements, or other agency permits.

- Riparian Area Support – A strip of riparian vegetation adjacent to a stream, measuring 35’ at a minimum on each side of the stream, is maintained to support riparian functions, such as water filtration. Vegetation species may be selected for their replenishment of nitrogen, sequestration of carbon, suitability as forage, filtration capabilities, beneficial and wild species habitat, and other desirable qualities. The above sections describe this practice in greater detail. This practice overlaps somewhat with critical area planting, filter strips, vegetative barrier, and stream setbacks.

- Livestock Management – Lily Bulb fields are sometimes managed as pasture for livestock as part of the field rotation. Growers implement several management practices to address the potential impacts of livestock on water quality. For example, stream crossings may be constructed to provide a hard, stable area where livestock and equipment can cross streams without damaging the bed or banks. This helps prevent sedimentation and erosion as well as the discharge of sediment-bound nutrients. Alternate water may be provided for livestock to minimize impacts to streams. Fencing or other barriers, either permanent, or temporary and mobile, are used to manage livestock access to streams and riparian zones. Grazing is controlled by adjusting the intensity, frequency, duration, and season of grazing to minimize impacts to sensitive areas. Livestock should be rotated out of riparian areas to maintain proper stubble heights and to ensure cattle do not browse on shrubs and trees as an alternate food source once grasses are depleted.

4.5 Nutrient Management

This section includes water quality practices to control the delivery of nutrients, in particular nitrogen and phosphorus, to surface water and groundwater.

Operation Wide Practices

- Irrigation and Nutrient Management Plan – A plan has been developed to manage the source, rate, form, timing, placement, and utilization of nutrients by plants. These plans, when properly written and implemented, are extensive and comprehensive protocols that drive adoption of many of the following and preceding BMPs.

- Nutrient Application at Agronomic Rates – Nutrients are applied at rates to meet crop needs while reducing nutrient runoff and infiltration to groundwater. Special attention is paid to soil conditions that increase the bioavailability of nutrients.

- Application Timing and Rain Forecasting – Fertilizer is applied to maximize efficiency given irrigation and storm events.

Field Specific Practices

- Follow Dairy Nutrient Guidelines – Fields utilized as dairy pasture during portions of their rotation must follow the North Coast Regional Water Quality Control Board Order No. R1-2019-0001, General Waste Discharge Requirements for Dairies Within the North Coast Region.

- Nutrient Budget – Nutrients applied versus nutrients removed (nutrient balance) is calculated to arrive at a nutrient application rate that minimizes excess application of nutrients. This practice overlaps somewhat with nutrient application at agronomic rates, soil testing, and irrigation water testing.

- Soil Testing – Nitrogen and phosphorus concentration in soils are measured and applications are adjusted accordingly.

- Irrigation Water Testing – Nitrogen and phosphorus concentrations in irrigation water are measured and applications are adjusted accordingly.

- Use of Beneficial Cover Crops – Cover crops that fix and utilize nitrogen are used to minimize nitrogen applications and leaching to groundwater, respectively.

4.6 Examples of Management Practices

This section includes pictures of water quality management practices currently being implemented in the Smith River Plain. The captions describe the practices and how they are being used to address water quality concerns.

Figure 4.2. Field Rotation – fields are rotated between lily bulbs and pasture. This shows a pasture recently replanted with grass beginning to grow and provide cover to reduce erosion.

Figure 4.3. Grassed Waterway: A roadside ditch is maintained with vegetation growing on the bottom and side of the ditch. This slows water and allows sediment and any attached pesticides to settle.

Figure 4.4. Stream Setback: Ritmer Creek is fenced to provide a setback from the adjacent field.

Figure 4.5. Grassed Waterway. Grass and other vegetation are maintained in this ditch to slow water, drop out sediment, and filter pollutants.


Figure 4.6. Field Isolation. Surrounding pastures may limit the need for additional buffers.

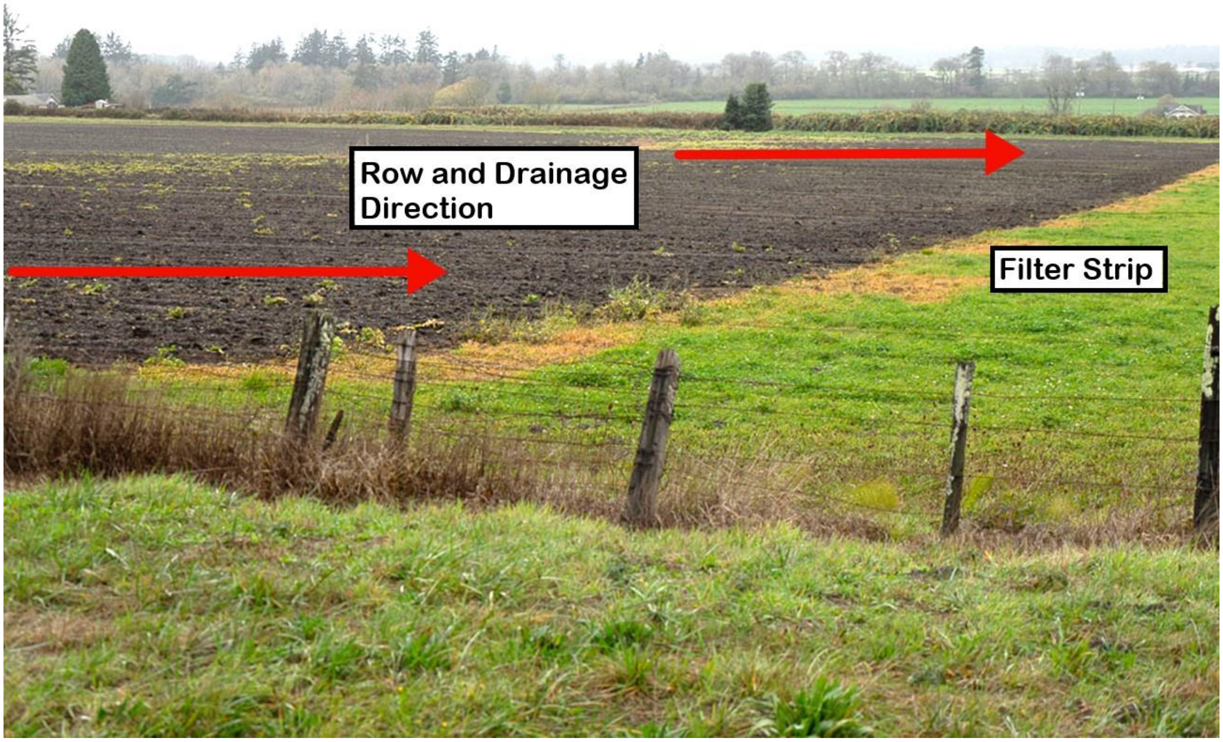


Figure 4.7. Directional Tilling combined with a Buffer Strip. Water is directed towards the filter strip between the edge of the field and the waterway.

Figure 4.8. Using pasture as a buffer. Runoff from this field is directed onto a pasture which acts as a filter and sediment trap, as well as a large buffer between fields and waterways.

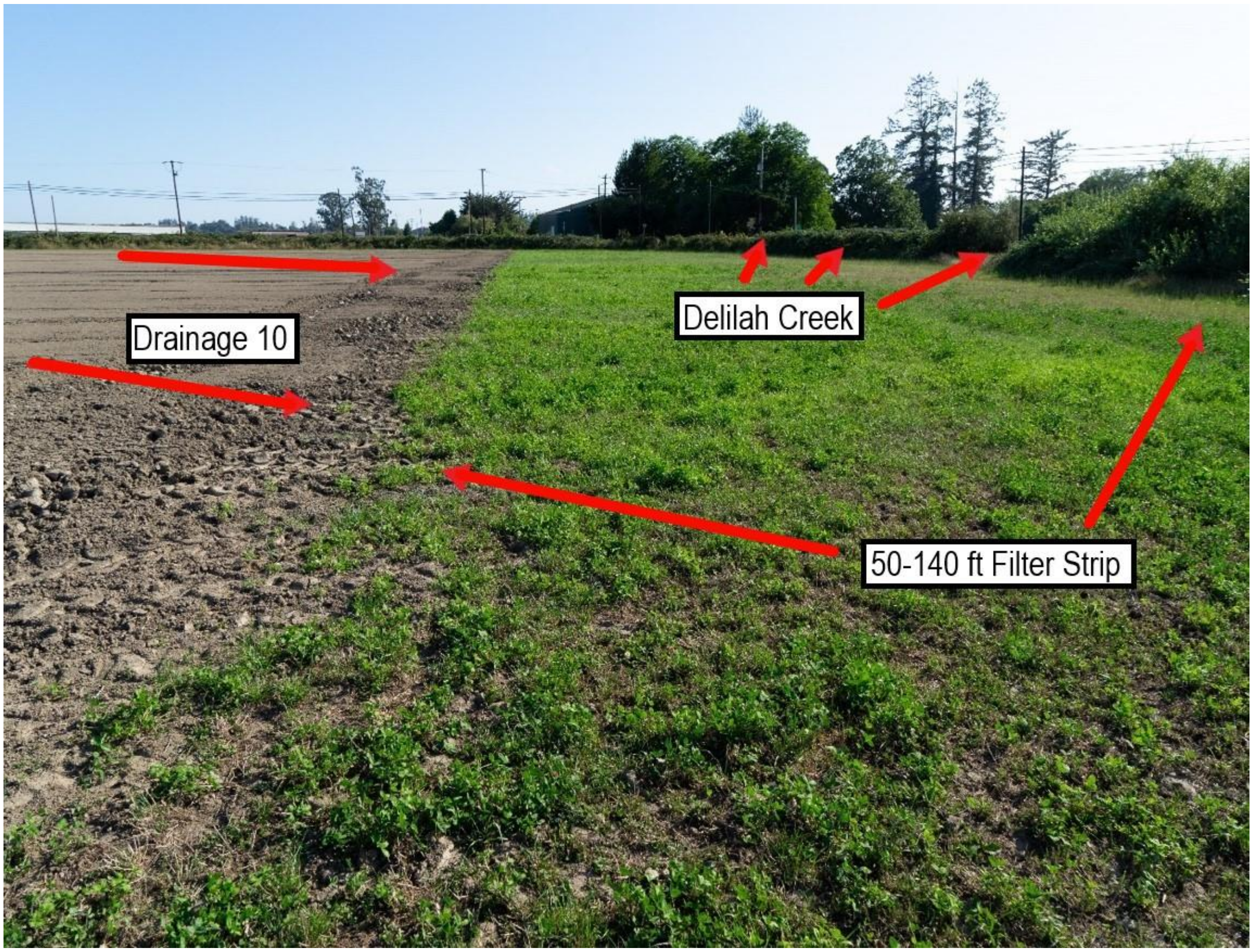


Figure 4.9. Filter Strip. A grass filter strip is maintained to filter field runoff and buffer Delilah Creek.

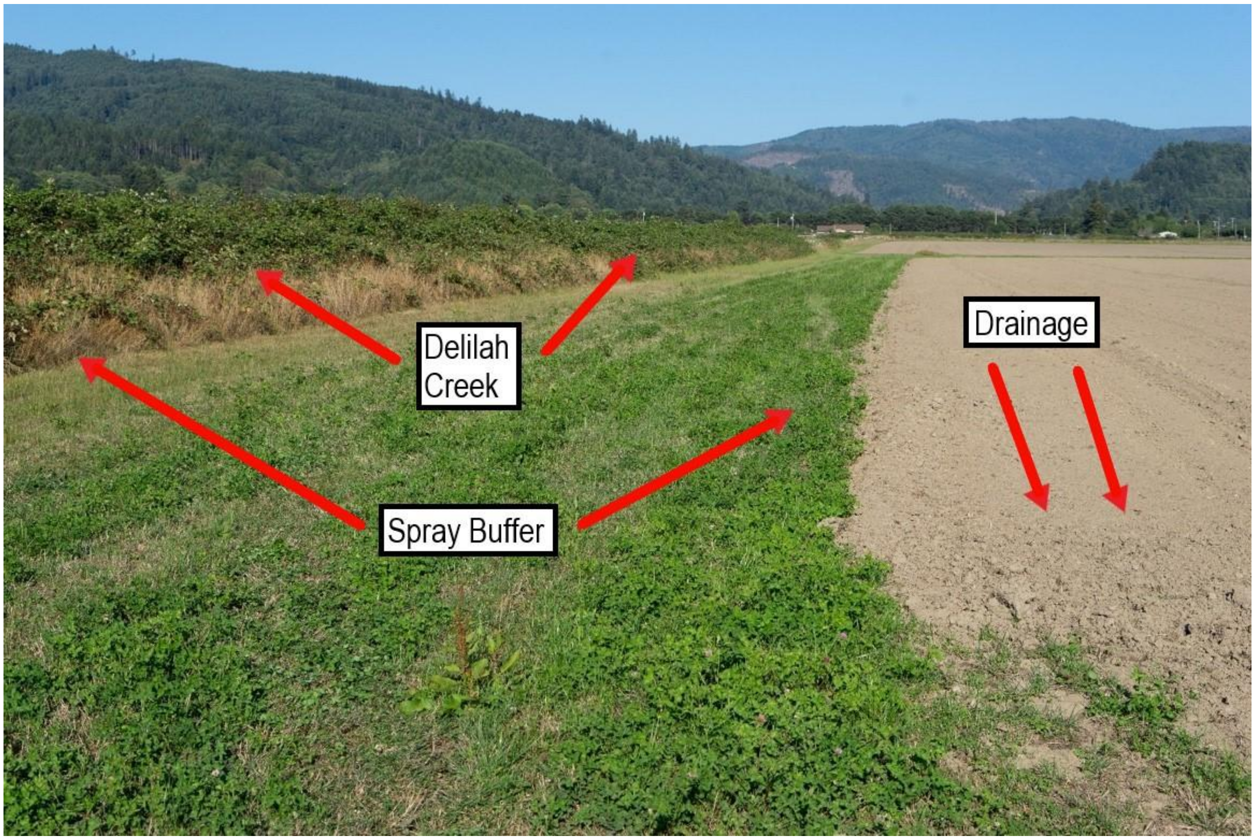


Figure 4.10. Spray Buffer. Even though field drainage is away from the creek, a buffer is maintained to prevent pesticide spray drift from reaching Delilah Creek.

Section 5
Management Practice Monitoring and Reporting Program

5.1 Overview

This section presents the Monitoring and Reporting Program that documents the water quality management practices being implemented by lily bulb growers to address the water quality concerns in the Smith River Plain. The reported information will be used to assess the overall progress of the Plan's implementation and, when compared to data from the Adaptive Management Monitoring Program (Section 6), the effectiveness of practices being implemented on the ground. Implementation monitoring fulfills a main requirement of nonpoint source programs as defined in the State's Nonpoint Source Policy. Implementation monitoring works together with water quality sampling to track compliance with water quality standards. Growers select the management practices and implement them in their operations. Implementation is documented through reporting forms that are submitted to the Regional Water Board annually and through on-farm inspections by Regional Water Board staff. Staff compile the information submitted by growers to provide feedback to the Regional Water Board on practice implementation in the Smith River Plain. The distribution of practices and their effectiveness will also be considered by the Watershed Stewardship Team to inform the adaptive management of the program and to address water quality issues identified through sampling. Section 7 describes the Adaptive Management Program and how reporting information on practices and sampling results will be used moving forward.

Management practice monitoring and reporting requires regular visual inspections, reporting, and record keeping. Grower reporting forms are submitted annually and include a checklist documenting the practices being implemented on fields used for lily bulb cultivation for the current growing season. In addition to grower self-inspections, Regional Water Board staff also inspect operations and work with lily bulb growers to ensure practices are implemented and functioning. A checklist of field-specific practices and a description of streamside protection measures is maintained on the farm and made available to Regional Water Board staff upon inspection.

Regional Water Board staff compile the information from the grower reporting forms and present it in a table documenting overall water quality practice implementation in the Smith River Plain each year. This table is then posted on the Regional Water Board website along with a map showing the fields being used to grow lilies for the current production year. Monitoring data from the SWAMP sampling described in Section 6 will also be compiled into a single report after several years of monitoring that will be available on the Board's website.

Results from the surface water monitoring will be associated with the implementation reporting to show where practices are working and where they may need to be enhanced or adapted to address a particular water quality concern.

5.2 Management Practice Monitoring

Lily bulb growers will visually inspect their operations periodically throughout the year to ensure they are being operated and maintained according to this Plan and are protective of water quality. Adjustments and other needed maintenance of practices identified during the inspections should be implemented within a reasonable time frame and before the next storm event, weather permitting. In total, this Plan requires four inspections per year for on-farm practices including inspection of waterways and streamside protection practices. Growers document inspections and certify that they have completed the required inspections as part of their annual reporting.

The first inspection is conducted at the beginning of the growing season after fields are planted for the upcoming growing season in the October/November timeframe. This pre-wet season inspection is conducted to ensure practices are ready for wet weather and runoff. Then, during the wet season and after storms, growers conduct at least two more inspections to assess how practices functioned during storms. Post-storm event inspections are conducted after a 3-inch or greater storm event in 72 hours, for a minimum of two storms over the winter season. As needed, inspections may be conducted during storms to identify the best way to fix known problems. Inspections should only be conducted when it is safe to do so. Finally, near the start of the dry season (May-June) growers conduct a final inspection to assess how management practices functioned over the previous wet season and note any adjustments or maintenance that need to be made to prepare for the following wet season.

During the storm-triggered inspections, growers make note of any needed maintenance to ensure practices are functioning properly prior to the next storm event. Alternatively, maintenance may be scheduled for the dry season as needed. If a practice is ineffective and a change in practice is needed, it should be noted along with the appropriate solution. This feedback loop is essential to making improvements and developing practices that are both effective and only require reasonable maintenance.

In addition to inspecting management practices that are part of their operation, growers also visually inspect drainage ditches and streams on their property to identify any visual changes in water quality resulting from their operation. Changes may include an increase in water cloudiness, the presence of debris, or evidence of concentrated runoff across the property with the potential to cause rills or gullies. Evidence of the discharge of sediment should be noted and tracked back to its source so corrective action may be taken. Once per year, during one of the post-storm event inspections of management practices, growers inspect riparian areas to ensure that streamside protection practices are functioning as intended.

The required inspections are summarized in Table 5.1 below. The wet season is the period of time with regular rainfall between October 1 and April 30 of each year and always includes the period of time when soils are saturated and runoff is occurring.

Table 5.1 Annual required visual self-inspection types, purpose, and timing.

Inspection Type	Purpose	Frequency	Timeframe
Pre-Wet Season	Inspect all practices for wet season readiness	1/year	September -November
Post-Storm Event	Assess function of practices and note fixes and where different practices may be needed	Minimum 2/year	November – May
During Storm Event	Assess function of practices and note fixes and where different practices may be needed	As needed	November - May
Post-Wet Season	Assess function of practices and note fixes and where different practices may be needed	1/year	May - June

5.3 Annual Reporting

As part of this Plan, growers will complete an annual report each year and submit it to the Regional Water Board. The purpose of the report is to document the implementation of management practices that are protective of water quality and to document that the required inspections were completed. The management practices being implemented throughout the Smith River Plain are compiled by Regional Water Board staff and presented in a table on the Regional Water Board website. The reporting forms are due each year on March 31st. The annual reporting period is December 1st – November 30th. This first annual report is for the 2021-2022 growing season due on March 31st, 2022. Growers have the option of reporting as a group or individually. Copies of the reporting forms are kept at the facility for Regional Water Board staff to review during inspections.

The forms that make up the annual report are provided at the end of this section and include the following forms:

1. Lily Bulb Field Report: Documents the fields being used for lily bulb cultivation for the current growing season.
2. Operation Wide Practices Report: Documents operation-wide practices not specific to a given field, but rather implemented throughout the operation.
3. Field Level Practices Report: Documents field-specific management practices being implemented on fields across the operation for the current growing season.

Regional Water Board staff may ask growers to submit photo-documentation of certain practices as needed to address specific problems and/or make them available to Regional Board staff.

4. Wet Season Visual Inspections Certification Form: Documents required visual inspections performed for the prior years' wet season.
5. Special Projects Form: A description of any restoration, conservation easements, pilot studies, or any other special project the grower has implemented or participated in over the past year or are planned for the upcoming year.

5.4 Public Reporting

Regional Water Board staff worked with the lily bulb growers to develop a map of all fields used for lily bulbs cultivation in the Smith River Plain. Any new fields in the Smith River Plain used to produce lily bulbs will be documented on the reporting form. Likewise, any field being retired, or temporarily taken out of rotation, will be noted in the annual reporting forms. As fields are brought into or taken out of the production of lily bulbs, the map will be updated.

Growers decide which fields to use for lilies on a year-to-year basis and report the current status of fields in the rotation. Figure 5.1 shows the version of the map displaying the rotation for the 2019-2020 growing season as reported by growers to the Regional Water Board.

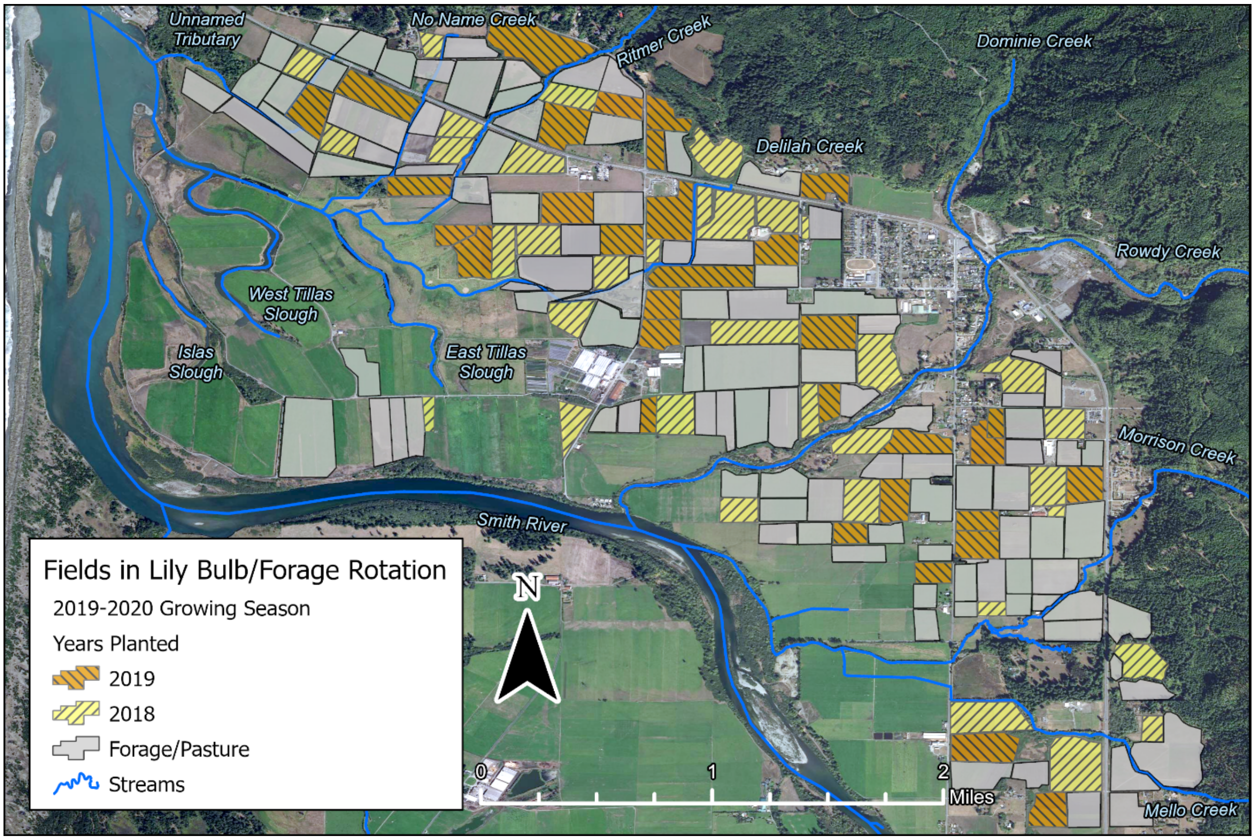


Figure 5.1. Map showing Fields IDs with their 2019-2020 cultivation rotation status.

On the map, light yellow-colored fields were planted in fall 2018 and harvested in fall 2019 and dark yellow-colored fields were planted in 2019 for the 2019-2020 growing season. The other fields shaded in grey were planted to forage but will be used for lilies within 1-3 years depending on the rotation. Other fields that are not outlined or shaded with a color on the map are used for forage or pasture exclusively and not used for lilies.

Growers report the management practices being implemented on the fields in use for the current growing season. Regional Water Board staff compile the information and present it in a table documenting all practices being implemented on lily bulb fields in the Smith River Plain for that growing season. For example, Table 5.2 represents the compilation of management practices implemented for the 2019-2020 growing season based on the information reported by growers. The table will be updated each year on the Regional Water Board website, beginning in 2022, and the website will also include photos showing examples of the types of practices being implemented.

Table 5.2 Tracking of 2019-2020 management practice implementation in the Smith River Plain by total acreage of fields, total number of fields, and corresponding percentages for fields used to grow lilies during the 2019-2020 growing season.

Water Quality Management Practice	**Total Field Acreage**	**Percent of Total Acreage**	**Total Fields**	**Percent of Total Fields**
Totals Fields and Acreage	**359**		**29**	
Filter Strip	324	90%	25	86%
Field Size Reduction	288	80%	21	72%
Contour Farming	91	25%	8	28%
Precision Land Forming	324	90%	25	86%
Row Arrangement	328	91%	27	93%
Cover Crop	85	24%	9	31%
Enhance Soil Infiltration	359	100%	29	100%
Critical Area Planting	116	32%	9	31%
Soil Amendments	261	73%	19	66%
In Furrow Dams	50	14%	5	17%
Field Border (includes field berms)	267	74%	19	66%
Plant Residue Tillage Management	253	70%	21	72%
Vegetative Barrier	230	64%	19	66%
Grassed Waterway	313	87%	24	83%
Stormwater Diversion	124	34%	10	34%
Field Isolation	131	36%	11	38%
Grade Stabilization Structure	0	0%	0	0%
Stream Setbacks	130	36%	9	31%
Riparian Area Support	91	25%	7	24%
Stream Livestock Crossing Control	91	25%	7	24%
Livestock Water Access Management	91	25%	7	24%
Livestock Barriers	91	25%	7	24%
Prescribed Grazing in Sensitive Areas	50	14%	5	17%
Follow Dairy Nutrient Guidelines	129	36%	11	38%
Nutrient Budget	0	0%	0	0%
Soil Testing	129	36%	11	38%
Irrigation Water Testing	0	0%	0	0%
Use of Beneficial Cover Crops	129	36%	11	38%

As the table and maps above show, growers implemented a diverse set of practices over a broad area in the Smith River Plain for the 2019-2020 growing season. Note that the reason practices may not be on 100% of fields is because practices are site-specific and do not necessarily apply to every field. Over time, the Watershed Stewardship Team will build a database of practices that have been implemented to inform the adaptive management of the program. Locating the lily bulb fields with their associated water quality practices on the landscape helps to better understand sampling results and where additional or enhanced practices may be needed. The Regional Water Board staff and technical advisors will work with growers moving forward to adapt practices to optimize effectiveness, correct problems, and prioritize areas needing attention based on the sampling results.

5.5 On-Farm Documentation

In addition to the annual report, lily bulb growers will also maintain additional supporting information 'on farm' and make this information available to Regional Water Board staff during inspections. This documentation consists of a Field-Specific Management Practice Report and Stream Protection Report for each individual field. The forms are provided at the end of this section. With the help of the forms, Regional Water Board staff and growers will review the implementation and effectiveness of water quality control practices during inspections. The information will also assist Regional Water Board staff during the inspection and will serve as documentation of the status of water quality management practice implementation. Review of field specific information by Regional Water Board staff may be necessary to inform adaptive management in instances where water quality monitoring results indicate exceedances have occurred. The 'On Farm Supporting Information' consists on the following forms:

1. Field-Specific Management Practices Reports: Documents the management practices that were implemented on a specific field. Growers fill out one report for each field in lily bulb production.
2. Stream Protection Report: Documents the width of any riparian buffers and filters strips comprising the stream setback for lily bulb fields adjacent to streams. Growers fill out one report for each field in lily bulb production.
3. Photo-Documentation: At the request of Regional Water Board staff, growers will photo-document practices to show proper installation and function. Photos will be made available to staff during inspections.

In addition to these forms, growers should be prepared to discuss the following list of topics with Regional Water Board staff during the inspection:

- A list of potential changes that are going to be implemented in the upcoming year as fields are prepared for planting.
- Changes that were made during the year in response to the visual inspections.
- Conclusions based on experience that could be used to make practices more efficient or situations where certain practices should or should not be used.

- Existence of any water quality factors outside of the control of the operator, such as upstream erosion sites, altered hydrology, or other sources of pollution not associated with the lily bulb operation.

Smith River Plain Water Quality Management Program

ANNUAL REPORTING FORMS

Lily Bulb Field Report

Please indicate Field ID numbers in the columns below for the fields that are being used to grow lilies for the current growing season. Field IDs may be referenced on the Lily Bulb Field ID Map.

Field ID	**Field ID (continued).**	**Field ID (continued)**

Operation Wide Practices Report

Please fill out this form once for the whole operation. In future annual reports, please indicate changes only. The definitions of practices can be found in the Water Quality Management Practice Glossary.

Production Year:		**Date:**	

Check	**Water Quality Management Practice (Refer to Glossary for Definitions)**
☐	Integrated Pest Management Plan
☐	Use of Low Risk Pesticides
☐	Pesticide Sampling and Analysis
☐	Pesticide Mixing/Loading Setbacks
☐	Proper Disposal of Pesticides
☐	Soil Amendments
☐	Sprayer Shields
☐	Wellhead Protection
☐	Irrigation Water Management
☐	County Pesticide Permit Compliance
☐	Crop Rotation
☐	End of Row Shutoff When Spraying
☐	Avoid Surface Waters When Spraying
☐	Drift Control Agents
☐	Monitor Climatic Conditions
☐	Application Timing and Rain Forecasting
☐	Pesticide Applicator Adjustments
☐	Road Erosion Control
☐	Proper Culvert Sizing and Maintenance
☐	Road Maintenance
☐	Flow Dissipaters
☐	Agricultural Pond Maintenance
☐	Nutrient Management Plan
☐	Nutrient Application at Agronomic Rates

<u>Field Level Practices Report</u>

Please check the box for practices implemented in fields across the operation for the current growing season. In the 'Acres' column, indicate the total number of acres treated with the practice for the current growing season by adding up the acreages of the fields where the practice was applied. In the 'Number of Fields' column, indicate the total number of fields where the practice is being implemented.

Production Year:		Date:	
Total Acreage of Fields in Lily Bulb Production:			
Total Number of Fields in Lily Bulb Production:			

Check	Water Quality Management Practice (Refer to Glossary for Definitions)	Acres	Number of Fields
	Filter Strip		
	Field Size Reduction		
	Contour Farming		
☐	Precision Land Forming		
☐	Row Arrangement		
☐	Cover Crop		
☐	Enhance Soil Infiltration		
☐	Critical Area Planting		
☐	Soil Amendments		
☐	In Furrow Dams		
☐	Field Border (includes field berms)		
☐	Plant Residue Tillage Management		
☐	Vegetative Barrier		
☐	Grassed Waterway		
☐	Stormwater Diversion		
☐	Field Isolation		
☐	Grade Stabilization Structure		
☐	Stream Setbacks		
☐	Riparian Area Support		
	Livestock Management		
☐	Follow Dairy Nutrient Guidelines		
☐	Nutrient Budget		
☐	Soil Testing		
☐	Irrigation Water Testing		
☐	Use of Beneficial Cover Crops		

Wet Season Visual Inspections Certification Form

Four inspections of implemented management practices should be completed each growing season to assess the condition of practices, the need for maintenance, or if any adjustments are needed. The visual inspections being reported in this form are for those conducted for the prior year's wet season and certify that the required inspections were completed.

Inspection Type	Purpose	Frequency	Timeframe
Pre-Wet Season	Inspect all practices for wet season readiness	1/year	September – November
Post-Wet Season	Assess function of practices and note fixes and where different practices may be needed	1/year	May - June
Post-Storm Event	Assess function of practices and note fixes and where different practices may be needed	Minimum 2/year	November - May
During Storm Event	Assess function of practices and note fixes and where different practices may be needed	As needed	November - May

In the table below, please list the dates that inspections were completed. Note: observations of potential water quality concerns found during inspections on on-farm documentation, do not need to be included here.

Inspections	Date
Pre-Wet Season (one required between September - November)	
Post-Wet Season (one required between May - June)	
Post-Storm Inspection #1 (two required between November – May)	
Post-Storm Inspection #2 (two required between November – May)	
Post-Storm Inspection #3 (optional between November – May)	
Post-Storm Inspection #4 (optional between November – May)	
Waterway and Streamside Protections (one required during a post-storm inspection)	

Special Projects Form

Please list any restoration projects or other projects relevant to water quality protection that you are implementing on your property or are participating in.

Certification of Report Preparer

I certify that I have examined and am familiar with the information submitted in this report and all attachments and I believe that the information is true, accurate, and complete.

______________________________	____________________
Printed Name	Title
______________________________	____________________
Signature	Date

Water Quality Management Practice Glossary

Operation Wide Water Quality Management Practices
Pesticide Management Practices
Integrated Pest Management Plan – A pesticide management plan has been developed that considers available pest control techniques to keep pesticide use at a level that minimizes risk to water quality.
Use of Low Risk Pesticides – Lower risk pesticides have been selected to minimize risk to water quality based on toxicity, runoff potential, and leaching potential.
Pesticide Sampling and Analysis – Stormwater runoff from fields is sampled and analyzed for pesticide concentrations to assess effectiveness of management practices.
Pesticide Mixing/Loading Setbacks – Setbacks are maintained adjacent to waterways and other sensitive areas for pesticide application, mixing, and loading.
Proper Disposal of Pesticides – Pesticides containers are triple rinsed before disposal and rinse water is mixed and applied according to label requirements. Pesticides are considered hazardous waste and disposed of accordingly.
Soil Amendments – Amendments are added to the soil to bind pesticides, thereby reducing offsite movement and/or reducing their toxicity.
Sprayer Shields – A shield on the spray boom is used to reduce drift.
Wellhead Protection – An area around the wellhead is delineated where certain activities are limited in order to protect the wellhead from contamination.
Irrigation Water Management – The volume, frequency, and application rate of irrigation water is planned to minimize runoff.
County Pesticide Permit Compliance – All applicable pesticide regulations and handling and application directions are being followed.
Crop Rotation – Crops are rotated seasonally in a sequence to reduce use of pesticides and fertilizers and to reduce erosion.
End of Row Shutoff When Spraying – The pesticide sprayer is shut off at the end of the row and kept off in the turnaround.
Avoid Surface Waters When Spraying - Pesticides are not sprayed in and around surface waters where they can contact surface waters directly considering, among other things, wind direction and strength
Drift Control Agents – Additives are used to increase droplet size to reduce drift.
Monitor Climatic Conditions – Wind speed and direction, temperature, and relative humidity are monitored and considered in planning pesticide applications.

Application Timing and Rain Forecasting – The rain forecast is monitored to anticipate storm events that produce runoff pesticide application are planned to lengthen the amount of time prior to a storm event.
Pesticide Applicator Adjustments – Spray nozzle pressure and height and droplet size are adjusted to better target the pesticide application, minimize drift, and improve the efficiency of applications, which can all reduce the amount of pesticide required.
Erosion and Runoff Control Practices
Road Erosion Control – Waterbars, grading, rolling dips, etc. are used to prevent and minimize road erosion.
Proper Culvert Sizing and Maintenance – Culverts are sized correctly to pass the 100-year storm flows. Culverts are inspected regularly and maintained to ensure structural integrity, proper function, and to minimize erosion downstream.
Road Maintenance – Pre- and post-storm inspections are conducted, erosion sites are identified, and a prioritized inventory of erosion sites is developed and updated from which to schedule and implement fixes.
Flow Dissipaters – Flow dissipaters are used to minimize erosion at discharge points, usually constructed out of riprap or concrete. .
Agricultural Pond Maintenance – Agricultural ponds are maintained to prevent erosion and failure of dams, embankments, and spillways. Ponds are regularly inspected, and necessary preventative maintenance is performed.
Nutrient Management Practices
Nutrient Management Plan – A plan has been developed to manage the source, rate, form, timing, placement, and utilization of nutrients by plants.
Nutrient Application at Agronomic Rates – Nutrients are applied at rates to meet crop needs while reducing nutrient runoff and infiltration to groundwater.

Field Level Water Quality Management Practices
Pesticide Management Practices
Filter Strip – A vegetated strip is maintained adjacent to a drainage ditch or waterway to filter pollutants.
Field Size Reduction – Field sizes have been reduced to lessen the amount of stormwater runoff from the field.
No Spray Buffer Zone – Areas where spraying does not take place from between the downwind edge of the application area and an identified sensitive area.
Erosion and Runoff Control Practices
Contour Farming – Fields are planted on the contour to reduce runoff.
Precision Land Forming – Fields are graded to increase irrigation efficiency and improve drainage control and minimize erosion.
Row Arrangement – Crop rows are graded, directed and at a length to optimize rain and irrigation water.
Cover Crop – Vegetation is planted in fields to minimize the area of bare soil, thereby reducing the potential for erosion.
Enhanced Soil Infiltration – Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration.
Critical Area Planting – Permanent vegetation is established in areas that are expected to have high erosion rates or in areas that would otherwise prevent the establishment of vegetation.
Soil amendments – Amendments, such as compost, mulch or other organic matter are added to the soil to improve soil structure and reduce erosion.
In Furrow Dams – In furrow dams are installed to increase infiltration and settling out of sediment prior to entering the tail ditch.
Field Border – Borders (including berms) are installed at the low end of fields to capture runoff and trap sediment.
Plant Residue Tillage Management – Plant materials are left on the soil surface to reduce runoff and erosion.
Vegetative Barrier – Vegetation is planted to slow or reduce surface runoff by promoting detention and infiltration.
Grassed Waterway – Grass is maintained in drains and ditches to reduce erosion and filter pollutants.

Field Level Water Quality Management Practices
Stormwater Diversion – Structures or embankments are installed to keep stormwater on lily bulb field headlands.
Field Isolation – Runoff from lily bulb fields flows onto a pasture or other vegetated area where it is dispersed, filtered and infiltrated before reaching surface waters.
Grade Stabilization Structure – Drop spillways or check dams are installed to stabilize the grade and control erosion.
Stream Protection Practices
Stream Setbacks – A minimum streamside setback of 35’ from the edge of lily bulb fields to the top of the stream bank is maintained. The setback may include riparian vegetation and/or a filter strip being used to filter sediment in runoff from fields.
Riparian Area Support – A strip of riparian vegetation adjacent to a stream a minimum of 35’ in width on each side of the stream is maintained to support riparian functions.
Livestock Management – This practice encompasses several possible measures related to managing pasture to protect water quality, such as stable stream crossings that protect bed and banks, alternate water for livestock, rotational grazing, and fencing or other barriers that limit access to riparian zones.
Nutrient Management Practices
Follow Dairy Nutrient Guidelines – Nutrients are applied according to a nutrient management plan prepared as part of complying with the Regional Water Board’s dairy permit.
Nutrient Budget – Nutrients applied versus nutrients removed (nutrient balance) is calculated to arrive at a nutrient application rate that minimizes excess application of nutrients.
Soil Testing – Nitrogen concentration in soils is measured and applications are adjusted accordingly.
Irrigation Water Testing – Nitrogen concentrations in irrigation water are measured and fertilizer nitrogen applications are adjusted accordingly.
Use of Beneficial Cover Crops – Cover crops that fix and utilize nitrogen are used to minimize nitrogen applications and leaching to groundwater.

Smith River Plain Water Quality Management Program

ON FARM SUPPORTING INFORMATION

Instructions:

1. Fill out one Field Level Practices checklist for each field in lily production.
2. Fill out one Stream Protection Report for each field in lily production that has a stream(s) adjacent to it.
3. Maintain forms on farm.

Field Level Practices Checklist

Production Year:		Date:	
Field ID:		Acreage:	

Check	Water Quality Management Practice
	Filter Strip
	Field Size Reduction
	Contour Farming
☐	Precision Land Forming
☐	Row Arrangement
☐	Cover Crop
☐	Enhance Soil Infiltration
☐	Critical Area Planting
☐	Soil Amendments
☐	In Furrow Dams
☐	Field Border (includes field berms)
☐	Plant Residue Tillage Management
☐	Vegetative Barrier
☐	Grassed Waterway
☐	Stormwater Diversion
☐	Field Isolation
☐	Grade Stabilization Structure
☐	Stream Setbacks
☐	Riparian Area Support
	Livestock Management
☐	Follow Dairy Nutrient Guidelines
☐	Nutrient Budget
☐	Soil Testing
☐	Irrigation Water Testing
☐	Use of Beneficial Cover Crops

Notes:

Stream Protection Report

Only fill out this form for fields that have streams adjacent to them.

Production Year:		**Date:**	
Field ID:			

Stream Protection for Streams Adjacent to the Field

	Adjacent Stream #1	**Adjacent Stream #2 (if needed)**
Stream Name		
Riparian Area Width (in feet)*		
Filter/Buffer Strip Width (in feet)*		
Total Stream Setback Width from Top of Bank to Field (add two widths above)		

* Measurements may be approximate, i.e. paced out or estimated instead of measured exactly

Notes:

Water Quality Management Practice Glossary

Field Level Water Quality Management Practices
Pesticide Management Practices
Filter Strip – A vegetated strip is maintained adjacent to a drainage ditch or waterway to filter pollutants.
Field Size Reduction – Field sizes have been reduced to lessen the amount of stormwater runoff from the field.
No Spray Buffer Zone – Areas where spraying does not take place from between the downwind edge of the application area and an identified sensitive area.
Erosion and Runoff Control Practices
Contour Farming – Fields are planted on the contour to reduce runoff.
Precision Land Forming – Fields are graded to increase irrigation efficiency and improve drainage control and minimize erosion.
Row Arrangement – Crop rows are graded, directed and at a length to optimize rain and irrigation water.
Cover Crop – Vegetation is planted in fields to minimize the area of bare soil, thereby reducing the potential for erosion.
Enhanced Soil Infiltration – Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration.
Critical Area Planting – Permanent vegetation is established in areas that are expected to have high erosion rates or in areas that would otherwise prevent the establishment of vegetation.
Soil amendments – Amendments, such as compost, mulch or other organic matter are added to the soil to improve soil structure and reduce erosion.
In Furrow Dams – In furrow dams are installed to increase infiltration and settling out of sediment prior to entering the tail ditch.
Field Border – Borders (including berms) are installed at the low end of fields to capture runoff and trap sediment.
Plant Residue Tillage Management – Plant materials are left on the soil surface to reduce runoff and erosion.
Vegetative Barrier – Vegetation is planted to slow or reduce surface runoff by promoting detention and infiltration.
Grassed Waterway – Grass is maintained in drains and ditches to reduce erosion and filter pollutants.

Field Level Water Quality Management Practices
Stormwater Diversion – Structures or embankments are installed to keep stormwater on lily bulb field headlands.
Field Isolation – Runoff from lily bulb fields flows onto a pasture or other vegetated area where it is dispersed, filtered and infiltrated before reaching surface waters.
Grade Stabilization Structure – Drop spillways or check dams are installed to stabilize the grade and control erosion.
Stream Protection Practices
Stream Setbacks – A minimum streamside setback of 35’ from the edge of lily bulb fields to the top of the stream bank is maintained. The setback may include riparian vegetation and/or a filter strip being used to filter sediment in runoff from fields.
Riparian Area Support – A strip of riparian vegetation adjacent to a stream a minimum of 35’ in width on each side of the stream is maintained to support riparian functions.
Livestock Management – This practice encompasses several possible measures related to managing pasture to protect water quality, such as stable stream crossings that protect bed and banks, alternate water for livestock, rotational grazing, and fencing or other barriers that limit access to riparian zones.
Nutrient Management Practices
Follow Dairy Nutrient Guidelines – Nutrients are applied according to a nutrient management plan prepared as part of complying with the Regional Water Board’s dairy permit.
Nutrient Budget – Nutrients applied versus nutrients removed (nutrient balance) is calculated to arrive at a nutrient application rate that minimizes excess application of nutrients.
Soil Testing – Nitrogen concentration in soils is measured and applications are adjusted accordingly.
Irrigation Water Testing – Nitrogen concentrations in irrigation water are measured and fertilizer nitrogen applications are adjusted accordingly.
Use of Beneficial Cover Crops – Cover crops that fix and utilize nitrogen are used to minimize nitrogen applications and leaching to groundwater.

Section 6
Adaptive Management Monitoring Program

6.1 Overview and Purpose

This section contains the monitoring plan used by the Regional Water Board to track the water quality response from implementation of water quality control practices, the status of water quality, and water quality trends in the coastal tributaries of the Smith River Plain. The monitoring results will inform an adaptive management strategy through which the Plan may be adjusted as needed to improve implementation and restoration efforts moving forward. While the Plan is being implemented, Regional Water Board will begin developing a permit to regulate discharges associated with lily bulb operations that will fully comply with the State Nonpoint Source Policy. Data collected and analyzed will assist in the development of the new regulatory framework and will be incorporated into the permit.

This section also outlines the parameters to be sampled, their frequency and location. Twelve monitoring sites have been strategically selected, located on Rowdy Creek, Delilah Creek, Ritmer Creek, Mello Creek, Tillas Slough, Morrison Creek and the mainstem Smith River. Five of the twelve monitoring sites were sampled previously in 2013-2017 by Regional Water Board staff.

6.2 Monitoring Plan Objectives

- Evaluate the effectiveness of operation-wide and field-specific water quality control practices through comparison of water quality samples downstream from lily bulb cultivation areas with samples taken upstream of lily bulb cultivation. Comparisons will include conditions during runoff events in the wet season and during lower flow conditions in the dry season and wet season.
- Track the status of water quality and water quality trends in the coastal tributaries of the Smith River Plain.
- Determine if pollutants are being mobilized and detected during intense storm events in surface water locations within and downstream of the lily bulb cultivation area of the Smith River Plain.
- Provide data to assist in the development of a future permit to regulate discharges associated with lily bulb operations in the Smith River Plain.
- Continue to build upon previous water quality monitoring efforts in order to conduct status and trends analyses for the Smith River Plain.
- Establish a record of "*background*" dissolved copper concentrations above lily bulb operations and within the Smith River to determine if other sources of copper exist and as a reference for potential development of future water quality indicator endpoints.

- Sample tributaries to Tillas Slough and Morrison Creek to assess relative contributions of copper to the Smith River.
- Expand the existing baseline data set to compare with future sampling projects.
- The water quality monitoring plan includes sample collection for parameters necessary to inform the biotic ligand model (BLM). The BLM is used to assess the bioavailability of dissolved copper to salmonid species and to develop a site-specific toxicity assessment endpoint consistent with the Regional Water Board Basin Plan.
- Collect data under a consistent Quality Assurance (QA) framework.
- Report data in a timely fashion to the Watershed Stewardship Team.

6.3 Monitoring Locations

The Regional Water Board staff will collect samples at twelve locations located above, within and downstream of lily bulb cultivation areas. All major catchment areas that contain lily bulb operations in the Smith River Plain need be monitored to inform successive management decisions. Many of these monitoring locations are located on private property and the Regional Water Board has developed an access agreement to ensure good coordination and communication.

The sampling sites shown in Figure 6.1 and described in Table 6.1 have been strategically chosen to assess stormwater runoff from locations affected by lily bulb cultivation and water quality management practices being used, relative to the following:

- Land use of lily bulb cultivation impacted areas
- Vulnerable aquatic habitat
- Availability of previous or companion water quality data
- Available access

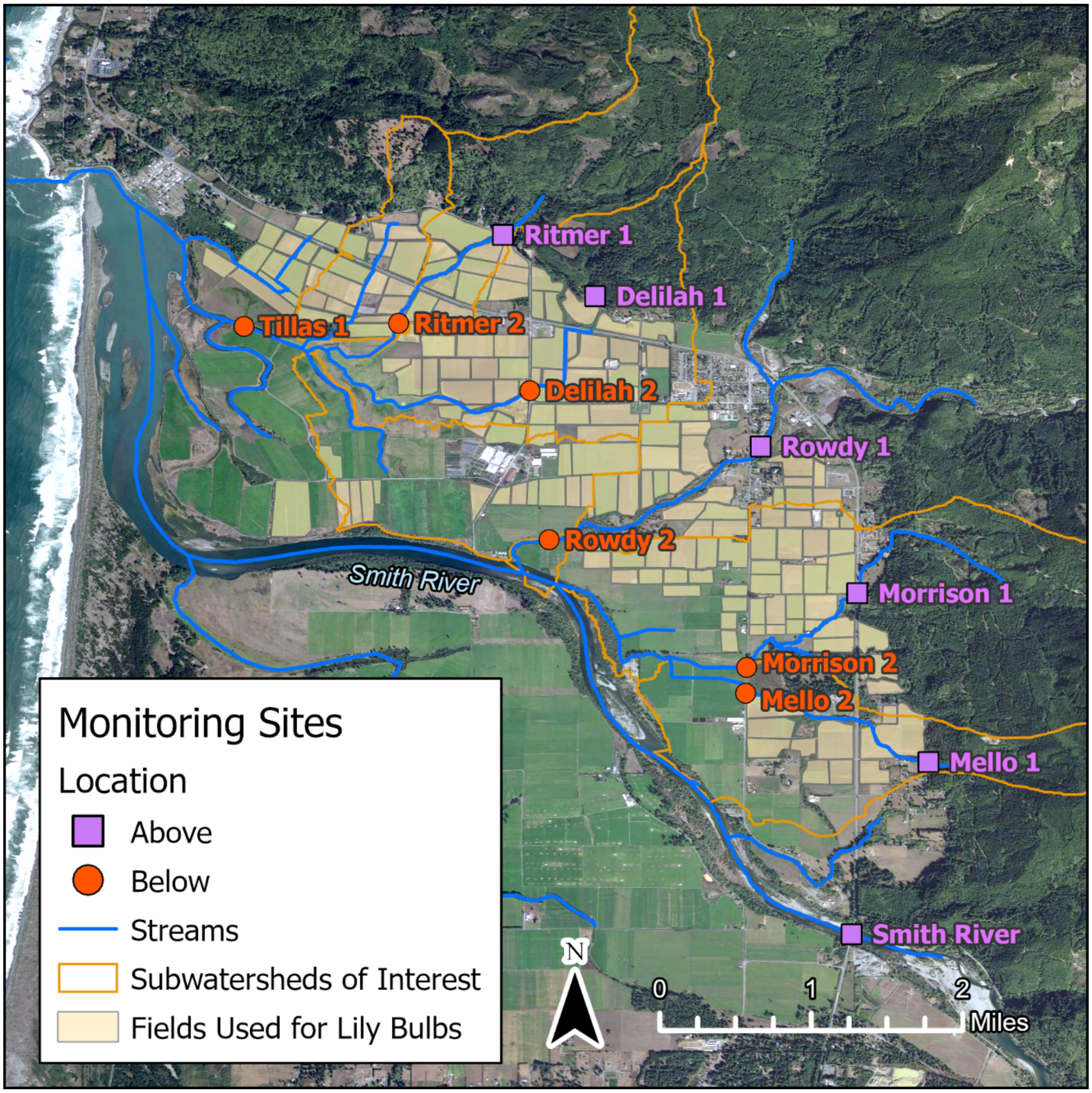


Figure 6.1. Smith River Plain Adaptive Management Monitoring Program Sampling Site Locations

Table 6.1. Monitoring Locations and Rationale for Selection

Waterbody	Location	Rationale / Purpose
Upper Ritmer Creek	Ocean View Drive	Upstream sampling site to compare to downstream results.
Lower Ritmer Creek	Downstream of Highway 101	Ritmer Creek drains to Delilah Creek and its drainage area contains lily bulb fields.
		A springtime runoff event sampled as part of the NOAA study showed increases of copper moving downstream through lily bulb fields in Ritmer Creek drainage.
		Used by salmonids in winter and possibly in summer.
Upper Delilah Creek	Westbrook Lane	Upstream sampling site to compare to downstream results and assess background dissolved copper concentrations.
Lower Delilah Creek	Sarina Road	This location was first sampled in 2010 and the results demonstrated toxicity and levels of dissolved copper and pesticides above EPA benchmarks.
		The results at this sample location demonstrated toxicity and copper and pesticide concentrations above thresholds and the follow up TIE's demonstrated that copper and pesticides were the cause of the toxicity.
		Delilah Creek is expected to support federally threatened coho salmon.
		2014-2017 SWAMP sampling site.
		Delilah Creek is a tributary to Tillas Slough, an important feature of the Smith River Estuary that provides habitat for Tidewater Goby and salmonids.
		Used by salmonids in winter but not likely in summer.
		This site may also be sensitive to changes in management practices and be more sensitive to runoff from lily bulb fields because of its proximity to fields and because streamflow at this location has a higher percentage of runoff from lily bulb fields than other locations.

Waterbody	Location	Rationale / Purpose
Tillas Slough	At Tide Gate	Highly productive in terms of fish, invertebrate abundance, grass and algae cover. Delilah Creek, Ritmer Creek, and unnamed tributary enter Tillas Slough.
		This is not a freshwater site all of the time. It is an estuarine site with tidal influence and fluctuating salinity.
		Used by salmonids in winter and summer since this location is the estuary before the tide gates; sculpin were present in this location.
Upper Morrison Creek	Downstream of Highway 101	Upstream sampling site to compare to downstream results and assess background dissolved copper concentrations.
Lower Morrison Creek	Fred Haight Drive	Morrison Creek is a major tributary in the Smith River Plain and provides important winter rearing habitat for salmonids.
		Samples in the recent NOAA sampling showed increasing levels of copper moving downstream.
		Used by salmonids for both summer and winter rearing.
		Sampling upstream of the Mello Creek confluence will allow an assessment of the relative contributions of the Mello Creek and the Morrison Creek drainage areas.
		Morrison Creek is used by salmonids for both summer and winter rearing.
Upper Mello Creek	Downstream of Highway 101	Mello Creek is a tributary to Morrison Creek and showed increasing levels of copper moving downstream from highway 101.
		While Mello Creek currently does not provide the same quality of salmonid habitat as other creeks in the Plain, historic images show this was a more complex channel at one time. It also has the potential to contribute copper to Morrison Creek and to contribute to the elevated levels in the Morrison Creek backwater.
		Used by salmonids in winter but not summertime, so the emphasis in sampling is placed on the winter when salmonids are present.
Lower Mello Creek	Upstream of Mouth	Downstream sampling site to compare to upstream results.

Waterbody	Location	Rationale / Purpose
Upper Rowdy Creek	Upstream of Fred Haight Drive	Upstream sampling site to compare to downstream results and assess background dissolved copper concentrations.
Lower Rowdy Creek	Mouth Entering Smith River	Largest tributary in the Smith River Plain and provides important off channel winter rearing habitat for salmonids migrating down the Smith River to the estuary. Also used for summer rearing Sampled previously in Regional Water Board and NOAA studies and showed levels below California Toxicity Rule (CTR) criteria. Lower priority because of relatively low concentrations of copper but could be included to ensure beneficial uses continue to be protected.
Smith River	Upstream of Highway 101 – Specific location TBD	Provide "background" concentrations for fish moving into tributaries receiving lily bulb runoff to evaluate potential for neural path impairment effects. The specific location is not yet identified but will be chosen based on the site characteristics for the purpose of collecting water quality data on the mainstem upstream of the Smith River Plain tributaries.

6.4 Sample Frequency

Staff plan to collect field measurements, water grab samples, and visual observations from the locations in Figure 6.1 during first flush and stormwater runoff events. Staff will also conduct additional sampling to collect data for the BLM based copper criteria development described in Section 7.6. This Plan currently includes sampling a first flush event and sampling at two additional events throughout the year to collect field measurements and data for the BLM based criteria development. Pesticides will also be analyzed for two of those events.

First flush monitoring is designed to collect samples near the start of overland runoff to capture the highest pollutant concentrations of the storm event. First flush conditions often have the greatest potential for adverse impacts to aquatic species and sources of drinking water. The pesticide parameters presented in Table 6.3, below, will be sampled as part of runoff related sampling events.

Please note when reviewing the monitoring plan that Regional Water Board staff are continuing to evaluate the specific data needs of the development of the BLM based copper criteria and are in the process of securing additional resources to expand the frequency of sampling to support criteria development. Staff will update this monitoring plan when data needs and the availability of resources are better defined.

Table 6.2. Monitoring Timeline

Monitoring Program Adaptive Management	A	M	J	J	A	S	O	N	D	J	F	M
First Flush Runoff Sampling								■	■	■		
Storm Runoff Sampling										■	■	■
Wet Season BLM Sampling	■							■	■	■	■	■
Dry Season BLM Sampling		■	■	■	■	■	■					
Data Assessment and Reporting	■	■	■	■	■						■	■

6.5 Monitoring Parameters

Field measurements are made with a multiparameter instrument at the centroid of flow. Probe measurements and water sampling are collected in the stream location that best represents the entire stream. Field data sheets are used to record field observations, probe measurements, and water and sediment chemistry sampling information. Monitoring parameters include the following:

Field Measurements

- *Dissolved Oxygen*
- *Specific Conductance*
- *Salinity*

Biotic Ligand Model Parameters

- *Magnesium*
- *Sodium*
- *Potassium*
- *Calcium*
- *Chloride*
- *Sulfide*
- *Sulfate*
- *Dissolved Copper*
- *Dissolved Organic Carbon*
- *pH*
- *Temperature*

Pesticide Parameters – Table 6.3

Name	Class	Type
Diuron	Carbamate	Herbicide
Imidacloprid	Neonicotinoids	Insecticide
Ethoprop	Organophosphate Pesticide	
Permethrin	Pyrethroids	
Tebuconazole	Organonitrogen Pesticide	Fungicide

Tables 6.4 and 6.5, on the following pages, provide a more in-depth look at the monitoring parameters, constituents, and number of sampling events.

Table 6.4. Conventional and Biotic Ligand Model Parameters: locations, number of sampling events / location pair, and laboratory methods.

Location		Temperature (0C)	Dissolved Oxygen (mg/L)	pH (log[h+])	Specific Conductance (uS/cm)	Salinity (ppt)	Dissolved Organic Carbon (mg/L)	Sulfide (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Alkalinity (mg/L)	Potassium (µg/L)	Magnesium (µg/L)	Sodium (µg/L)	Calcium (µg/L)	Copper (low level) (µg/L)
Sample Category:		**Field Measurements**					**Biotic Ligand Model - Inorganics/Metals**									
Standard Analytical Method / Protocol:		**MPSL-DFG_Field_v1.1**					**SM 5310**	**SM 4500-S**	**EPA 300.1**		**SM 2320**	**EPA 200.7**				**EPA 200.8**
Sampling Method:		**Data Sonde Measurement**					**Grab Sample**									
Upper	**Ritmer Creek at Ocean View Dr.**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lower	**Ritmer Creek downstream of 101**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Upper	**Delilah Creek at Westbrook Lane**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lower	**Delilah Creek at Sarina Road**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lower	**Tillas Slough at tide gate**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Upper	**Morrison Creek downstream of 101**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lower	**Morrison Creek at Fred Haight Dr.**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Upper	**Mello Creek downstream of 101**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lower	**Mello Creek at Fred Haight Dr.**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Upper	**Rowdy Creek upstream of Fred Haight Dr.**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lower	**Rowdy Creek at mouth**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Smith River above Highway 101		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
FIELD DUPLICATE		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Table 6.5. Pesticides: locations, number of sampling events for each parameter/location pair, and laboratory methods.

Location			Organophosphate Pesticide (µg/L)	Neonicotinoid (µg/L)	Pyrethroid (µg/L)	Organonitrogen Pesticide (µg/L)	Carbamate (µg/L)
Sample Category:			**Pesticides**				
			Insecticide			**Fungicide**	**Herbicide**
Standard Analytical Method / Protocol:			**EPA 625**	**EPA 625 MRM**	**EPA 625 NCI**	**8270C**	**EPA 632**
Sampling Method:			**Grab Sample**				
Public	**Upper**	**Ritmer Creek at Ocean View Dr.**	2	2	2	2	2
Private	**Lower**	**Ritmer Creek downstream of 101**	2	2	2	2	2
Private	**Upper**	**Delilah Creek at Westbrook Lane**	2	2	2	2	2
Public	**Lower**	**Delilah Creek at Sarina Road**	2	2	2	2	2
Private	**Lower**	**Tillas Slough at tide gate**	2	2	2	2	2
Public	**Upper**	**Morrison Creek downstream of 101**	2	2	2	2	2
Public	**Lower**	**Morrison Creek at Fred Haight Dr.**	2	2	2	2	2
Public	**Upper**	**Mello Creek downstream of 101**	2	2	2	2	2
Public	**Lower**	**Mello Creek at Fred Haight Dr.**	2	2	2	2	2
Private	**Upper**	**Rowdy Creek upstream of Fred Haight Dr.**	2	2	2	2	2
Public	**Lower**	**Rowdy Creek at Mouth Entering Smith River**	2	2	2	2	2
Public		**Smith River above Highway 101**	2	2	2	2	2
FIELD DUPLICATE			2	2	2	2	2

6.6 Quality Assurance and Control

The protocol for sample collection and analyses will follow the State of California Surface Water Ambient Monitoring Program Standard Operating Procedures (SOP) and Quality Assurance Program Plan (QAPP). The QAPP serves as an umbrella document for use by each of the SWAMP Program's contributing projects. It describes the program's quality system in terms of organizational structure; the functional responsibilities of management and staff; the lines of authority; and the interfaces for those planning, implementing, and assessing all activities conducted.

SWAMP 2017 Quality Assurance Plan
(https://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/swamp_QAPrP_2017_Final.pdf)

6.7 Data Management and Reporting

After sampling and analysis, the Regional Water Board staff will enter this data into California Environmental Data Exchange Network (CEDEN) for incorporation into the statewide database, which will be then available to all resource managers and public.

The Basin Plan specifies numerous water quality objectives for the protection of inland surface waters that include color, tastes and odors, suspended material, biostimulatory substances, sediment, turbidity, pH, dissolved oxygen, temperature, toxicity, and chemical constituents. Staff will compare monitoring data results to the adaptive management thresholds and indicators described in Section 7.6 and to past data collected at or near these sites during similar times of year. This assessment will be conveyed in a timely manner by staff working with entities in the watershed to inform and prioritize implementation of BMPs where needed for pollutant control.

Section 7
Program Management

7.1 Overview

The Regional Water Board is committed to working with the Stewardship Team to adaptively manage the activities as described in this Plan. The purpose of adaptive management is to allow for revisions to the Plan, specifically the management practices on the ground, as experience with the BMPs is gained and water quality data is collected and evaluated. This adaptive management approach is consistent with the 'Watershed Stewardship' approach as it is implemented in several watersheds throughout the North Coast Region. This approach is intended to promote collaboration among participants in the process. It provides a framework for partnership building, planning, implementation, and monitoring necessary for successfully addressing the water quality problems in the Smith River Plain and for coordinating ecological restoration. Regional Water Board staff will continue working with our partners to improve the Plan's effectiveness and optimize efficiencies for implementation.

The Plan will be implemented and adaptively managed by Regional Water Board staff working collaboratively with the Watershed Stewardship Team. The members of the Team are shown in Section 7.2 below. The adaptive management process described in this section allows Regional Water Board staff make revisions to the Plan for Executive Officer approval, if warranted, so as to improve the program of implementation and the sampling plan as the understanding of the factors affecting water quality in the Smith River Plain evolves. Regional Water Board staff will meet annually with the Watershed Stewardship Team to consider necessary revisions to the Plan. The scope of revisions will be defined based on the information coming from annual reports and the results of water quality sampling, as well as statewide precedents established by the Statewide Irrigated Lands Regulatory Program. If revisions are incorporated, the updated Plan will be posted on the Regional Water Board website.

One of the primary goals of adaptive management is to provide worthwhile feedback to growers so they can make informed decisions and adjust their practices to address water quality issues effectively. The activities described in this Plan will provide this feedback in the form of water quality sampling results, implementation reporting, and visual observations made by the grower's before and after storm events, and with Regional Water Board staff during the annual inspections. Regional Water Board water sampling results will be compared to adaptive management thresholds to determine where improvement to management practices are needed to reduce concentrations of pesticides at the sampling locations. The monitoring program provides an indication, not a confirmation, of effectiveness of grower's practices each year and over time.

The monitoring program will continue to be evaluated to determine if greater spatial and temporal resolution is necessary to help the growers and Watershed Stewardship Team to understand where practices are being effective and where they may need improvements based on instream water quality conditions. Section 7.7 describes the steps that will be taken in response to an exceedance of water quality thresholds.

7.2 Watershed Stewardship Team

The Watershed Stewardship Team that developed this Plan will transition to plan implementation and assess the effectiveness of the Plan annually.

The Watershed Stewardship Team includes:

- NOAA Fisheries
- California Department of Fish and Wildlife
- Tolowa Dee-ni' Nation
- Regional Water Board
- Smith River Alliance
- Lily Bulb Growers
- Del Norte Resource Conservation District
- Del Norte County Agricultural Commissioner
- California Department of Pesticide Regulation
- Humboldt State University

7.3 Annual Cycle and Timing of Program Management Activities

Figure 7.1 below provides the annual cycle and timing of the activities that comprise the adaptive management process. This annual cycle will be repeated each year, which is why no specific years are called out in the timeline. Some activities shown in the timeline have been ongoing while this Plan was under development. Upon approval of the Plan, activities will pick up at that point in the timeline and fully track the annually cycle moving forward. The timing of the yearly program management measures coincides with the seasonal activities associated with lily bulb growing and the timing of sampling events and other program activities. The figure begins in April and ends in March because the annual reports are due in March and it also coincides with the beginning of field preparations; the time of year when water quality practices are usually installed for the upcoming growing season. Each activity and area of program management referenced in the Figure 7.1 is further described in this section.

Annual Cycle of SRPWQMP Implementation and Adaptive Management												
Tasks	**Months (April – March)**											
Monitoring Program Adaptive Management	A	M	J	J	A	S	O	N	D	J	F	M
First Flush Runoff Sampling Event								x	x	x		
Wet Season Sampling	x									x	x	x
Dry Season Sampling		x	x	x	x	x	x					
Data Assessment and Reporting	x	x	x	x	x							
Monitoring Plan Teleconference Call						t						
Revise Monitoring Plan (if necessary)							x	x				
Practice Implementation and Reporting	A	M	J	J	A	S	O	N	D	J	F	M
Pre-Wet Season Grower Inspection								g				
Grower Annual Report Due												g
Post-Storm Event Grower Visual Inspections	g	g								g	g	g
Regional Water Board Inspections	x	x								x	x	x
Post-Wet Season Grower Inspection		g	g									
Update Regional Board and Public			x	x								
State Irrigated Lands Program Reporting	x			x			x			x		

Regional Board Staff Task: x
Grower Task: g
Watershed Stewardship Team Task: t

Figure 7.1 Annual Cycle of SRPWQMP Implementation and Adaptive Management

7.4 Adaptive Management and Revising the Plan

As the Plan is implemented, the Watershed Stewardship Team will consider water quality monitoring results and reports from lily bulb growers to assess progress and the effectiveness of the Plan on the ground.

The list of information that will be considered at the annual Team meeting includes:

1. Grower annual reporting forms documenting:
    - Streamside protection area widths including any filter strips
    - Field specific management practice implementation
    - Operation wide management practice implementation
2. Regional Water Board sampling results
3. Regional Water Board inspection reports
4. Growers input from visual inspections of practices and streamside protection areas
5. Statewide precedents established through the State Irrigated Lands Regulatory Program

Management actions based on the adaptive management process will be implemented on fields in the spring following the next year's crop. The reason for the delay is because lily bulb growers are cultivating two sets of fields simultaneously and will have already prepped the next set of fields and installed the field-specific practices by the time the complete set of information is available from the previous year. New fields are being converted from pasture and prepped for lily bulb cultivation for next years' crop during the spring of the current growing season and it is likely not possible to adjust practices in time for the spring field preparations.

At the end of the adaptive management process described in Figure 7.1, practices will be installed starting in March for the following year's crop as soon as the ground is dry enough to work. Field preparations and practice installation continues through July, just prior to fumigation. While these fields are being prepped for the upcoming growing season, the current years' crop is still in the ground and will not be harvested until the fall, at which point the bulbs will be transferred to the newly prepared fields. After the bulbs are transplanted, the first round of monitoring begins with the first flush of runoff for the year and is followed by two more runoff triggered sampling events through the winter. All wet season sampling events will occur sometime before May.

During the winter, while the sampling events are occurring, growers will be visually inspecting their water quality practices and assessing their function. Regional Water Board staff will also inspect during the wet season and report to the Team on their findings. Growers will complete their annual reporting forms in March, which includes reporting on visual inspections from the previous winter, identifying management practices currently installed on active fields, and mapping the current field rotation.

After reporting on the practices installed the previous summer, growers will soon after begin field preparation and implementation of water quality practices for the coming growing season. When necessary, revisions to the Plan will be incorporated by the beginning of March of a given year.

7.5 Adaptive Management of the Water Quality Monitoring Program

Regional Water Board staff are monitoring the Smith River Plain tributaries to identify contributions of pesticides from lily bulb cultivation for the first two years of Plan implementation during the 2020 – 2021 and 2021 – 2022 growing seasons. The sampling follows the monitoring plan described in Section 6 with samples collected both upstream and downstream of the lily bulb growing areas in the coastal tributaries. After the samples are analyzed and the results are verified, the Regional Water Board will assess the data and present them to the Watershed Stewardship Team. The team will assess the data along with current Pesticide Use Records and develop proposed revisions to the monitoring plan as needed.

Each year, the Watershed Stewardship Team will review the monitoring plan sampling locations, parameters, frequency, and BMPs to determine if and what changes should be made. The team will hold a teleconference call or an in-person meeting around September to decide on the revisions. While sampling is occurring, modifications to the Plan will be limited to those modifications needed to address safety, access, or extraordinary events. All efforts will be made to consistently maintain a subset of sampling locations to allow for an evaluation of water quality trends over time.

7.6 Adaptive Management Thresholds and Indicators

Monitoring results provide important feedback to inform the adaptive management of the Plan. The results of monitoring will be compared to established USEPA thresholds protective of aquatic life. The following sections provide the numeric thresholds for the pesticides that have been detected through recent water quality monitoring. The thresholds will be used to assess monitoring results and the effectiveness of practices on the ground as part of the annual plan review. The Regional Board is obliged to protect all beneficial uses of the Smith River Plain surface water, which each have a unique threshold for water quality above which the use is impacted. To ensure protection of all beneficial uses, this Plan will use the threshold protective of the beneficial use most sensitive to impacts from the pesticide in question. In the Smith River Plain, the beneficial uses associated with aquatic life are usually the most sensitive to water quality degradation. Consequentially, meeting water quality thresholds protective of aquatic life will in turn be protective of all other uses and are therefore the appropriate thresholds to use in managing this Plan.

Pesticides

Sample results for pesticides will be compared to the adaptive management target concentrations shown in Table 7.1 below. These thresholds are taken from the USEPA 2021 Aquatic Life Benchmarks. The thresholds shown are for those pesticides used by lily bulb growers in the Smith River Plain within the last 10 years that were detected in the Regional Water Board's 2013-2017 sampling. The adaptive management threshold for copper is explained in its own section below because it requires the use of a model for more nuanced interpretation.

The benchmark values shown below are updated annually and available at the USEPA website. (https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-and-ecological-risk#benchmarks).

The table here will be kept updated as new constituents are detected through sampling and as thresholds are revised.

Table 7.1 Adaptive Management Thresholds for Pesticides From 2021 USEPA Aquatic Life Benchmarks

Analyte	Adaptive Management Threshold (ug/L)
Captan	13.1
Carbaryl	0.5
Diuron	0.13
Ethoprop	0.8
Imidacloprid	0.01
Methiocarb	2.75
Permethrin	0.0033
Tebuconazole	11
Thiamethoxam	0.74

Copper

Establishing target adaptive management threshold concentrations for copper toxicity is not as straightforward as it is for the other pesticides. The complexities of copper speciation in the water column and the implications for assessing bioavailability, the amount of copper in the environment that is free to interact with biological systems, complicates the development of appropriate threshold concentrations protective of aquatic life. Section 3.4 provides background on the fate and transport of copper in the environment and the speciation of copper and its effect on bioavailability.

To properly account for these factors, this Plan makes use of a predictive model: the biotic ligand model (BLM). A "biotic ligand" is a bonding site for copper that is part of an organism, such as a receptor site on the gill of a fish. The BLM assesses the bioavailability of metals in the aquatic environment and the likelihood of metals to accumulate on these biotic ligands and cause acute or chronic toxicity to aquatic life.

The BLM is the current USEPA recommended method for determining copper concentrations protective of aquatic life on a site-specific basis and has been adopted by the State of Idaho Department of Environmental Quality and the State of Oregon Department of Environmental Quality to develop state-wide, site specific water quality criteria for copper. Several other states have used the BLM for site specific monitoring efforts but have yet to adopt statewide BLM-based criteria.

Because the BLM takes copper speciation and complexation and competitive binding by other cations into account, it better predicts the toxicity and sensory and behavioral impairment in the aquatic environment than the hardness-based criterion. In a meta-analysis of 107 cases, the hardness-based criterion was compared with the BLM-based criterion to determine both models' ability to protect fish, amphibians, and aquatic invertebrates from behavioral and sensory effects. Both models' outputs were compared to the 20% impairment concentration (IC20), the concentration of copper which produces a 20% inhibition of a given behavior or sensory effect. The study showed that the hardness-based criteria were not protective for chronic effects in 26.2% of cases. In contrast, the BLM-based criteria were not protective for chronic effects in only 4.7% of cases. (Meyer and DeForest, 2018)

While the BLM provides more accurate predictions of toxic and behavioral effects for a given copper concentration, it should be noted that the BLM does not always produce criteria with higher, more stringent copper concentrations. Waters with high dissolved organic carbon concentrations, such as those downstream from a wastewater treatment facility, will produce less-stringent criteria using the BLM than those derived from the hardness-based model. On the other hand, in areas with very few organic inputs, or those with more acidic conditions, BLM-derived criteria may be more stringent than those from the hardness-based model.

The BLM uses a set of ten parameters to account for complex chemical reactions associated with copper in the environment: pH, Dissolved Organic Carbon (DOC), Calcium (Ca), Magnesium (Mg), Sodium (Na), Sulfate (SO4), Potassium (K), Chlorine (Cl), Alkalinity, and Temperature. Using these ten parameters, the BLM generates an Instantaneous Water Quality Criterion (IWQC). This IWQC provides a water quality threshold for dissolved copper for that specific site and sampling event only.

Adaptive management thresholds for copper in the Smith River Plain shall be determined in two phases:

1. Phase 1 – Data Collection & Direct Application of the Biotic Ligand Model
   During this phase, all ten parameters of the BLM, as well as dissolved copper will be collected at each sampling site. The BLM will be used with each set of data to determine an adaptive management threshold, the IWQC, and compared to the dissolved copper concentration for that specific sampling site and event.

2. Phase 2 – Development of Site-Specific Adaptive Management Thresholds
   Development of site-specific adaptive management thresholds using the BLM is a complicated process which generally requires at least two years of monthly monitoring data for all ten BLM parameters. In the event that fewer than 24 continuous monthly samples are collected, the USEPA recommends at least one sampling event per season. (USEPA, 2015)

   When Regional Water Board determine that sufficient BLM parameter monitoring data has been collected, we will determine site-specific adaptive management thresholds based on the quantity and distribution of data collected and the spatial and temporal distribution of IWQCs. The Idaho Department of Environmental Quality describe several methods of developing site-specific copper criteria from multiple IWQC (Idaho DEQ, 2017):

   a. Minimum of IWQCs
      This approach is the most conservative as it uses the lowest value among the calculated IWQCs and is most appropriate when fewer than 24 continuous monthly samples have been collected. When using this method, it is important to demonstrate that critical site conditions (e.g. lowest DOC concentrations) have been captured.

   b. Percentile of IWQCs
      The Percentile IWCS approach is appropriate when at least 24 continuous monthly samples are available. When using this method, a percentile should be selected such that the copper concentration doesn't exceed the threshold more than once every three years.

   c. Fixed Monitoring Benchmark (FMB)
      The FMB is a more sophisticated statistical approach and may require up to three continuous years of monthly monitoring data. The FMB uses the variability of copper and individual IWQCs at a specific site to derive a threshold concentration that would comply with the frequency of exceedance component.

d. Seasonal Criteria
Seasonal Criteria generally require at least 36 continuous months monitoring data and is only appropriate for waters with predictable seasonal variability of IWQCs. In waters with sufficient data, it may be possible to derive dry season thresholds based on the distribution of IWQCs during low-flow conditions, and wet season criteria based on the distribution of IWQCs during high flow.

7.7 Response to Exceedance of an Adaptive Management Threshold

The Regional Water Board-led sampling will provide data that will inform adaptive management decisions regarding the implementation of water quality practices on lily bulb operations. Field identification and crop rotation phase reporting will be used to map lily bulb fields and locate those fields whose runoff is contributing to a given downstream water quality monitoring site. Data collected at the monitoring sites will be compared to the adaptive management thresholds and indicators described in the Section 7.6. Exceedances of thresholds and indicators will trigger actions on the ground and direct where and when practices need to be adjusted and improved to address the exceedance. Exceedances may also lead to increased monitoring frequency or added monitoring locations if needed to better track the problem and assess the effectiveness of new or revised management practices on water quality downstream. Figure 7.2 below shows the subwatersheds of the Smith River Plain and the lily bulb growing areas contributing runoff to a given sampling location. In responding to exceedances identified through monitoring, the growers and Watershed Stewardship Team will use the subwatershed map and the current rotation status to determine which fields may be contributing to a given exceedance. This way, growers can focus their efforts on implementing new and revised management practices where they will be most effective. The sequential steps to be taken in response to an exceedance are described below. The goal of this process is to identify where practices are needed and to implement them as soon as possible to resolve the water quality issue in a timely manner.

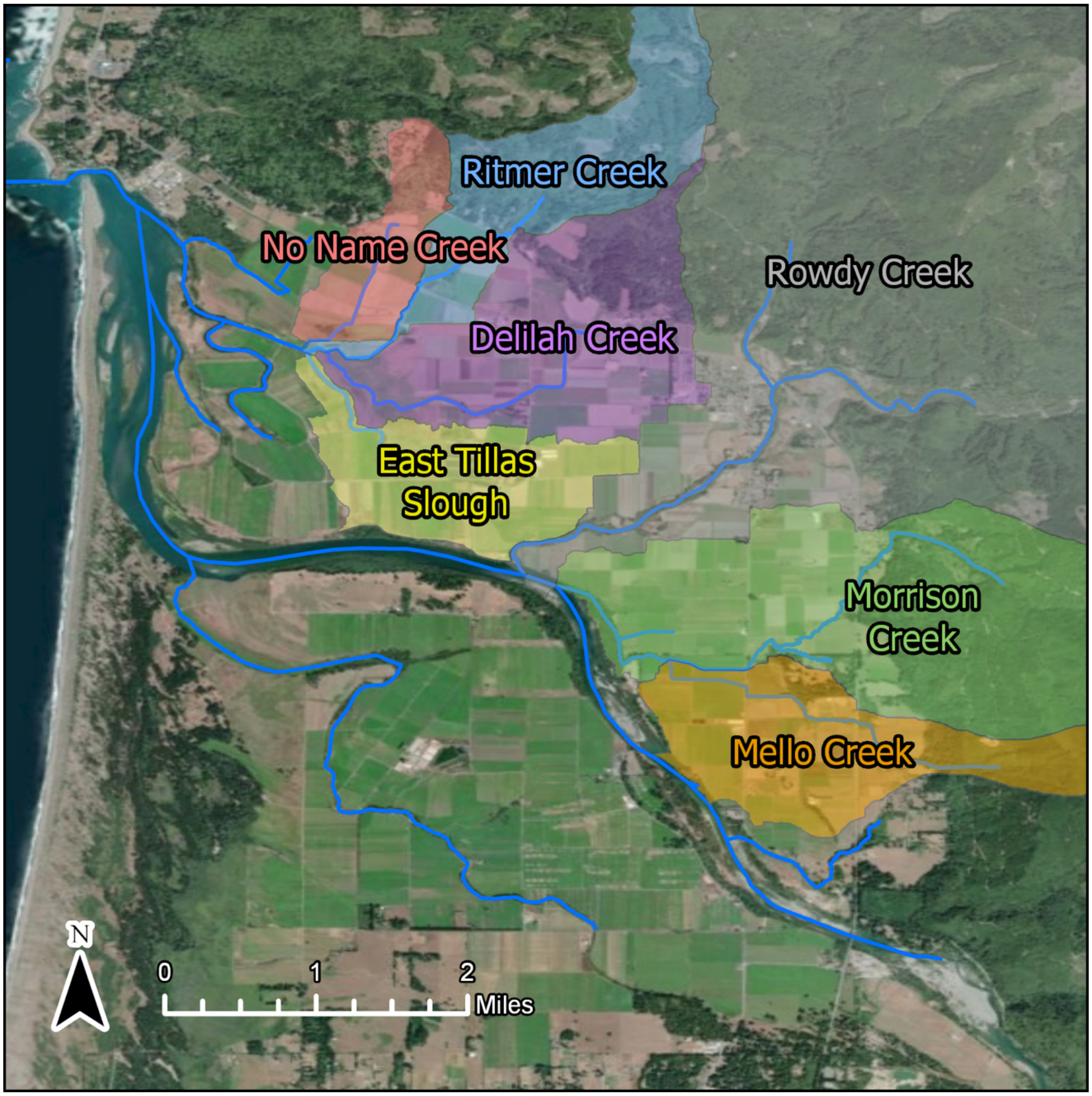


Figure 7.2. Subwatersheds of the Smith River Plain

For a given water year and monitoring site, if the concentration of any constituent in the sample exceeds the adaptive management thresholds shown in Table 7.1 or, for copper, the adaptive management indicator, the following actions will be triggered:

1. Growers with fields in the subwatershed draining to the monitoring location will be notified within 30 days of verification of the laboratory results.

2. During the review of the monitoring plan prior to the following wet season sampling period, the Watershed Stewardship Team will consider increasing the number of sampling sites, frequency of monitoring, and number of water quality parameters.

3. The Watershed Stewardship Team will identify the area from which fields contribute runoff to the monitoring location where the exceedance occurred. The various subwatersheds that drain to the monitoring locations (Figure 6.1) in the Smith River Plain are shown in Figure 7.2. If needed, more sampling sites will be added within the subwatershed to track the potential source and narrow down the fields that may be contributing.

4. If sample results are verified in time, growers preparing fields for lily bulb cultivation in the subwatershed draining to the monitoring location in question will consider the need for additional management practices or changes to the way fields are managed to address any sources with potential to contribute to the exceedance.

5. Growers will work with their technical service providers and, if necessary, select additional practices that make sense for the site location.

6. Moving forward, the additional practices will be maintained, and sampling will continue in the subwatershed until there are three years of sample results indicating no exceedances of the adaptive management thresholds for pesticides or the threshold copper indicator concentration.

7. After three years of sample results without exceedances, the Watershed Stewardship Team will consider returning the number of sample sites and sample frequency to pre-exceedance levels. Sampling will then continue at the original integrator site at the lower end of the subwatershed to ensure water quality continues to remain below the adaptive management thresholds.

7.8 Permit Development

The Regional Water Board has received a high level of cooperation from members of the Watershed Stewardship Team in developing this Plan and have received commitments to continue to work together to adaptively manage the program of implementation going forward. Concurrent with implementation of this Plan, the Regional Water Board will incorporate key elements of the Plan into a regulatory permit. We anticipate there will be many valuable lessons to be learned from implementation of this Plan over the next few years that can be applied to permit development.

References

Baldwin, D. H., J. F. Sandahl, J. S. Labenia and N.L. Scholz. 2003. “Sublethal Effects of Copper on Coho Salmon: Impacts on Nonoverlapping Receptor Pathways in the Peripheral Olfactory Nervous System,” Environmental Toxicology and Chemistry 22(10): 2266-2274.

California Department of Pesticide Regulation (CDPR). 2014-2018. Pesticide Use Reports. Available at https://calpip.cdpr.ca.gov/main.cfm.

Cusimano, RF, DF Brakke, and GA Chapman. 1986. Effects of pH on the toxicities of cadmium, copper, and zinc to steelhead trout (Salmo gairdneri). Canadian Journal of Fisheries and Aquatic Sciences 43(8): 1497- 1503.

DaSilva, A. 2016. Surface Water Monitoring for Pesticides in Agricultural Areas of Northern California. https://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/report_306_dasilva.pdf.

Garvey, K. 2014. Easter Lilies Bring Beauty, Joy and Hope – But Also Problems, Says UC Davis Nematologist. Entomology & Nematology News. Published online April 16, 2014. Available at https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=13600.

Hayes S., Bond M., Hanson C., Freund E., Smith J., Anderson, E., Amman A., and R. MacFarlane. 2008. Steelhead growth in a small California watershed: upstream and estuarine rearing patterns. Transactions of the American Fisheries Society 137:114–128.

Koshlukova S. 2006. Imidacloprid: Risk Characterization Document: Dietary and Drinking Water Exposure. California Environmental Protection Agency, Department of Pesticide Regulation. http://www.cdpr.ca.gov/docs/risk/rcd/imidacloprid.pdf.

Koski, K. 2009. The fate of coho salmon nomads: the story of an estuarine-rearing strategy promoting resilience. Ecology and Society 14 (1): 4.

Lewis, K.A., Tzilivakis, J., Warner, D. and Green, A. 2016. An international database for pesticide risk assessments and management. Human and Ecological Risk Assessment: An International Journal, 22(4):1050-1064. DOI: 10.1080/10807039.2015.1133242

Linbo TL, Stehr CM, Incardona JP, Scholz NL. 2006. Dissolved copper triggers cell death in the peripheral mechanosensory system of larval fish. Environ Toxicol Chem 25:597–603

Luo, Y. and X. Deng 2015. Methodology for Prioritizing Pesticides for Surface Water Monitoring in Agricultural and Urban Areas III: Watershed-Based Prioritization (http://www.cdpr.ca.gov/docs/emon/surfwtr/monitoring_methods.htm), California Department of Pesticide Regulation, Sacramento, CA.

Luo, Y., Deng, X., Budd, R., Starner, K., Ensminger, M. 2013. Methodology for Prioritizing Pesticides for Surface Water Monitoring in Agricultural and Urban Areas (http://www.cdpr.ca.gov/docs/emon/surfwtr/monitoring_methods.htm). California Department of Pesticide Regulation, Sacramento, CA.

Meyer, L.S., and D.K. DeForest. 2018. Protectiveness of Cu water quality criteria against impairment of behavior and chemo/mechanosensory responses: An update. *Environmental Toxicology and Chemistry* 37(5): 1260-1279.

Moncada, A. 2003. Environmental Fate of Indoxacarb. Department of Pesticide Regulation, California. http://www.cdpr.ca.gov/docs/empm/pubs/fatememo/indoxacarb.pdf

Montague, B. and Al-Mudallal, Amer. 2000. Ecological Risk Assessment for Section 3 Registration of Tebuconazole on Wheat, Cucurbrits, Bananas, Turnips, Tree nuts, Hops, and Sunflowers. US Environmental Protection Agency Memorandum. July 2000. https://www3.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-128997_25-Jul-00_a.pdf.

National Academy of Sciences (NAS). 1977. Copper. Committee on Medical and Biologic Effects of Environmental Pollutants, National Research Council, National Academy of Sciences, Washington, D.C. 115 pp.

National Oceanic and Atmospheric Administration (NMFS). 2008. Listing endangered and threatened species: Notification of finding on a petition to list Pacific eulachon as an endangered or threatened species under the Endangered Species Act. Federal Register (Docket No. 080229343-8368-01; 21 March 2008) 73(49):13185–13189.

National Oceanic and Atmospheric Administration (NMFS). 2014. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (Oncorhynchus kisutch). National Marine Fisheries Service. Arcata, CA. 1841p.

National Marine Fisheries Service. September 2017. Recovery Plan for the Southern Distinct Population Segment of Eulachon (Thaleichthys pacificus). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR, 97232.

Online Weather Atlas accessed 2020. Available at https://www.weather-us.com/en/california-usa/smith-river-climate#rainfall

Parish, M. and J. Garwood. 2015. Distribution of Juvenile Salmonids and Seasonally Available Aquatic Habitats within the Lower Smith River Basin and Estuary, Del Norte County, California. Final Report to the California Department of Fish and Wildlife, Fisheries Grants Restoration Program, Contract: P1310518. Smith River Alliance, Crescent City, CA.

Parish, M. and J. Garwood. 2016. Winter Distributions, Movements, and Habitat use by Juvenile Salmonids throughout the Lower Smith River Basin and Estuary, Del Norte County, California. Final Report to the California Department of Fish and Wildlife, Fisheries Restoration Grants Program, Contract: P1410545. Smith River Alliance, Crescent City, CA. 51p.

Parthree, Debra J. 2004. Fish and invertebrate ecology of Tillas and Islas Sloughs, Smith River estuary, Del Norte County, California. Thesis (M.S.)--Humboldt State University, Natural Resources: Fisheries Biology.

Sandahl, J.F., D.H. Baldwin, J.J. Jenkins and N.L. Scholz. 2004. "Odor-Evoked Field Potentials as Indicators of Sublethal Neurotoxicity in Juvenile Coho Salmon (Oncorhynchus kisutch) Exposed to Copper, Chlorpyrifos, or Esfenvalerate," Canadian Journal of Fisheries and Aquatic Sciences 61(3): 404-413.

Smith, K.S., L.S. Balistrieri and A.S. Todd. 2014. "Using biotic ligand models to predict metal toxicity in mineralized systems," Applied Geochemistry 57(2015): 55-72.

Solomon, F. 2009. Impacts of Copper on Aquatic Ecosystems and Human Health. Mining.com, January 2009. Available at http://www.ushydrotech.com/files/6714/1409/9604/Impacts_of_Copper_on_Aquatic_Ecosystems_and_human_Health.pdf.

State of Idaho Department of Environmental Quality, Water Quality Division. 2017. "Implementation Guidance for the Idaho Copper Criteria for Aquatic Life".

Surface Water Ambient Monitoring Program (SWAMP). 2018. Smith River Plain, Surface Water and Sediment Monitoring Report.

Taub, F. 2004. Fish 430 lectures (Biological Impacts of Pollutants on Aquatic Organisms), University of Washington College of Ocean and Fishery Sciences, Seattle, WA.

Taylor, LN, JC McGeer, CM Wood, and DG McDonald. 2000. Physiological effects of chronic copper exposure to rainbow trout (Oncorhynchus mykiss) in hard and soft water: Evaluation of chronic indicators. Environmental Toxicology and Chemistry 19(9): 2298-2308.

U.S. Environmental Protection Agency. 2015. “Training materials on Copper BLM: Data Requirements”. Prepared for the May 2015 Copper Biotic Ligand Workshop in Seattle Washington.

U.S. Environmental Protection Agency Office of Pesticide Programs. 2019. Office of Pesticide Programs Aquatic Life Benchmarks. Available at https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-and-ecological-risk#aquatic-benchmarks. October, 2019.

U.S. Environmental Protection Agency Office of Pesticide Programs. 2006. Reregistration eligibility decision for Ethoprop). Available at https://archive.epa.gov/pesticides/reregistration/web/pdf/ethoprop_red.pdf. December, 2019.

U.S. Environmental Protection Agency Office of Prevention, Pesticides, and Toxic Substances. 2000. Ecological Risk Assessment for Section 3 Registration of Tebuconazole. Available at https://www3.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-128997_25-Jul-00_a.pdf. November, 2019.

U.S. Fish and Wildlife Service. 2005. Recovery Plan for the Tidewater Goby (*Eucyclogobius newberryi*). U.S. Fish and Wildlife Service, Portland, Oregon. vi + 199 pp.

Wallace, M., S. Ricker, J. Garwood, A. Frimodig, and S. Allen. 2015. The importance of the stream-estuary ecotone to juvenile coho salmon (Oncorhynchus kisutch) in Humboldt Bay, California. California Fish and Game 101 (4): 241-266.

Wang, F., Wang, Z., Zhang, B., and Zhang, Q. 2017. Degradation and adsorption of tebuconazole and tribenuron-methyl in wheat soil, alone and in combination. Chil J Agric Res 77(3):281–286.

Warga, S. 2012. Easter Lily Capital of the World. American Profile. Published online March 27, 2012. Available at https://americanprofile.com/articles/easter-lily-capital-of-the-world/.

Washington, M., Moorman, T., Soupir, M., Shelley, M., and Morrow, A.J. (2018). Monitoring tylosin and sulfamethazine in a tile-drained agricultural watershed using polar organic chemical integrative sampler (POCIS). Sci. Total Environ., 612, pp. 358-367

Wissmar, R. C. and C. A. Simenstad. 1998. Variability of riverine and estuarine ecosystem productivity for supporting Pacific salmon. Pp. 253-301 *in* G.R. McMurry and R.J. Bailey (eds.), Change in Pacific Northwest Coastal Ecosystems, NOAA Coastal Ocean Prog., Decision Analysis Series No. 11, NOAA Coastal Ocean Office, Silver Spring MD: 342 pp.

Woody, C. and O'Neal, S. 2012. Effects of Copper on Fish and Aquatic Resources. Fisheries Research and Consulting. Anchorage, Alaska. Prepared for the Nature Conservancy. June 2012. Available at: https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/sw/cpa/Documents/W2013ECopperF062012.pdf.