

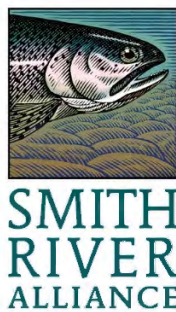
Smith River Plain Stream Restoration Plan Del Norte County, California



Photos: Kenneth & Gabrielle Adelman – California Coastal Records Project

**FINAL REPORT TO THE CALIFORNIA COASTAL CONSERVANCY
WATER QUALITY, SUPPLY, and INFRASTRUCTURE IMPROVEMENT ACT
GRANTEE AGREEMENT: No. 16-027**

October 2018



Acknowledgments

This report was funded by California State Coastal Conservancy with funds from the Water Quality, Supply, and Infrastructure Improvement Act. The Smith River Alliance (SRA) thanks the Del Norte Resource Conservation District for partnering on this project. In particular, Linda Crockett provided essential assistance through every step in preparing this plan. This project would not have been possible without the cooperation and input from the private landowners. We are grateful for their willingness to discuss their property, for being stewards of the land, and for considering advancement of projects to help maintain the health of the Smith River Plain. We would like to acknowledge Peter Jarausch with the State Coastal Conservancy; Bob Pagliuco, Dan Free, and Julie Weeder with the National Marine Fisheries Service; Justin Garwood, Seth Ricker, and Michael Wallace with the California Department of Fish and Wildlife for their input on the ranking criteria, the project formulation, and for providing feedback during the process. We appreciate the Tolowa Dee-ni' Nation staff for their participation in this process. We thank Gordon Leppig for his input and knowledge on riparian restoration and Ross Taylor for his guidance on fish passage criteria. We are grateful for the time John Deibner-Hanson and Jesse Nolan spent in the field to survey road crossings in the planning area. SRA thanks California Department of Fish and Wildlife and the Fisheries Restoration Grants Program for funding the prior research and monitoring projects that provided the scientific basis of this document. Finally, thank you to Smith River Alliance contributors for supporting this project by providing essential matching funds with made the project possible.

"We should not set our sights on rebuilding an environment from the past, but concentrate on shaping a world to live in for the future." Charles C. Mann



Morrison Creek channel downstream of Fred Haight Drive with invasive Reed Canary Grass and Yellow Flag Iris.

Photo: Marisa Parish Hanson

TABLE OF CONTENTS

SUMMARY	V
INTRODUCTION.....	1
SMITH RIVER PLAIN BACKGROUND	3
MAINSTEM SMITH RIVER.....	8
UNNAMED ESTUARY TRIBUTARY	9
TILLAS SLOUGH	9
<i>Unnamed Stream</i>	11
<i>Ritmer Creek</i>	11
<i>Delilah Creek</i>	11
ISLAS SLOUGH	11
YONTOCKET SLOUGH/TRYON CREEK.....	12
ROWDY CREEK.....	13
MORRISON CREEK	14
STOTENBURG CREEK.....	15
PROJECT IDENTIFICATION TOOLS AND METHODS	16
LOW IMPACT DEVELOPMENT	16
<i>Low Impact Development Methods</i>	17
FISH BARRIERS/PASSAGE CONCERNS	17
<i>Fish Passage Methods</i>	18
RIPARIAN ENHANCEMENT AND PROTECTION	19
<i>Bank Stabilization</i>	21
<i>Water Temperature Moderation</i>	21
<i>Pollutant Filtering</i>	21
<i>Wood Recruitment</i>	23
<i>Flow Moderation</i>	23
<i>Fish and Wildlife</i>	23
<i>Riparian Buffer Policies</i>	25
<i>Riparian Buffer Methods</i>	26
INVASIVE PLANTS.....	26
<i>Invasive Plant Methods</i>	27
CHANNEL COMPLEXITY.....	27
<i>Channel Complexity Methods</i>	27
SEA-LEVEL RISE AND INUNDATION.....	28
<i>Sea-level Rise and Inundation Methods</i>	28
PROJECT RANKING	28
PROJECT SCREENING AND RANKING	29
PROJECT SCORES	30
RESULTS	33
PASSAGE IMPROVEMENT PROJECTS.....	36
RIPARIAN ENHANCEMENT AND PROTECTION PROJECTS	36
INVASIVE PLANT REMOVAL PROJECTS	37
CHANNEL COMPLEXITY IMPROVEMENT PROJECTS.....	37
SEA-LEVEL RISE RECOMMENDATIONS.....	37
WATER QUALITY AND QUANTITY IMPROVEMENT PROJECTS.....	38

BASIN-WIDE RECOMMENDATIONS.....	40
IMPLEMENTATION RECOMMENDATIONS.....	41
LITERATURE CITED.....	43
APPENDIX A.....	50
APPENDIX B.....	64
APPENDIX C.....	65
APPENDIX D	70

TABLE OF FIGURES

Figure 1. Streams included in the restoration planning assessment in the Smith River Plain, Del Norte County, California.....	4
Figure 2. Annual Peak Discharge in cubic feet per second (CFS) from 1927-2016 on the Smith River based on USGS gauge on the Smith River near Crescent City (#11532500, Jed Smith) in Del Norte County, California (USGS 2017a).	7
Figure 3. Historic (1942) and current view (2012) of the Smith River Plain and estuary, Del Norte County, California. Blue shaded areas in each image depict the estimated active channels at the time the image was collected. Reproduced from Parish and Garwood (2015).	10
Figure 4. The three zones of a riparian forest buffer recommended by the USDA (1998). Zones 1: Undisturbed forest, Zone 2: Managed Forest and Zone 3: Runoff control grass strip, with adjacent crop and pasture lands. Figure adopted from USDA (1998).	24
Figure 5. Map of all streams included in the planning area with general location of the identified and ranked projects identified by their project number in white, Smith River Plain, Del Norte County, CA.	34
Figure 6. Sea level rise in 1 foot increments from 1-6 feet in the Smith River Plain based on NOAA Office for Coastal Management Digital Coast Sea Level Rise Viewer (NOAA 2018b).	39

TABLE OF TABLES

Table 1. Watershed summary information including location of mouth, sub-basin area (square miles), estimated length of anadromous stream (meters) and salmonid use by life stage for each sub-basin included in planning area, Del Norte County, CA. A sub-basin is a stream network connected by a single link to the mainstem Smith River.....	5
Table 2. California fish passage design flows (CDFW 2004b, NOAA 2001).....	19
Table 3. The weights provided by the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), Del Norte Resource Conservation District (RCD), and Tolowa Dee-ni' Nation (TDN) averaged and used in the project scoring process.....	30
Table 4. Summary of total number of projects and project types identified in each sub-basin and in each unique stream across the planning area.....	35

Smith River Plain Stream Restoration Plan

Del Norte County, California

Final Report to the California Coastal Conservancy

Prepared by: Marisa Parish Hanson, *Smith River Alliance, PO Box 2129 Crescent City, California 95531*

Summary

The goal of this planning effort is to identify and prioritize potential restoration projects that improve and protect natural channel structure and function, water quality, floodplain connectivity, and biological resources along streams and waterways located in the Smith River Plain.

The Smith River Alliance (SRA) used stakeholder and landowner input, historic and current aerial imagery, topographic and species distribution information, and field studies to identify and compile a list of potential projects. Ranking criteria was developed in collaboration with staff from National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), and the Del Norte Resource Conservation District (RCD) that was used to score and rank all identified projects. A total of 137 projects were identified in five project types: 29 riparian projects, 33 channel complexity projects, 63 passage projects, 8 invasive plant projects, and 4 water quality and quantity projects.

Additionally, there are eight basin-wide recommendations. These are projects that either span multiple streams and sub-basins or are areas lacking sufficient data requiring further research or monitoring.

The project prioritization scores and rankings provide a logical and standardized approach to identifying projects based on their capacity to restore ecosystem functions for streams and salmonid populations. However, project rankings alone should not set the order of implementation. Landowner interest, professional judgment, opportunities created by scheduled maintenance or construction, and restoration emphasis by stakeholder groups in a watershed should be considered.



Young of year Coho Salmon from Morrison Creek near Fred Haight Drive.

Photo: Marisa Parish

Suggested Citation: Parish Hanson, M. 2018. Smith River Plain Stream Restoration Plan, Del Norte County, California. Final Report to the California Coastal Conservancy, Contract: No. 16-027. Smith River Alliance, Crescent City, CA. 70 p.

Introduction

The historic floodplains and surrounding landscapes of many coastal streams contain the elements needed for human settlement, development, and cultivation of agricultural resources. These include transportation routes, water sources, and fertile soils. Around the world estuaries and coastal streams have been modified and simplified to meet the needs of human settlement and have led to reduced or damaged habitat that is essential for thriving fish populations and ecosystem health (Pavlovskaya 1995, Sommer et al. 2007, Bilkovic and Roggero 2008, Levings 2016). 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 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).

The majority of the Smith River basin is comprised of steep forested terrain with high gradient streams. However, the Smith River Plain is dominated by low gradient streams and sloughs surrounded by gently rolling fertile land that is primarily utilized for agricultural production of dairy, cattle, and lily bulbs. Depending on management practices, the effects of agriculture on salmonid habitat and natural resources can vary from beneficial to detrimental (Moore and Palmer 2005, USDA 2011, CDFW 2015). Well-managed and planned agriculture is an essential part of the solution to conserving California's natural resources and ecosystem processes (CDFW 2015). Multiple salmonid recovery plans that include the Smith River identify the need to determine projects in the Smith River Plain that will restore critical salmonid habitats but are also economically feasible (Voight and Waldvogel 2002, CDFW 2004a, NOAA 2014, CDFW 2015). Recent monitoring provides a baseline on salmonid distribution and habitat condition across the Smith River Plain (Parish and Garwood 2015 and 2016, Walkley and Garwood 2017) to help project identification and guide restoration planning.

Conservation plans should consider the needs of the land and landowner (USDA 2003) in addition to the ecosystem needs. Together these considerations should be used to determine the desired and potential future conditions of the ecosystem, social, and economic settings. Landowner and stakeholder involvement is critical in developing area wide conservation plans or assessments (USDA 2003). This planning process builds on the recent monitoring efforts and includes landowner feedback to implement a holistic conservation planning approach of evaluating ecological as well as economic and social factors. The goal of this planning effort was to identify restoration opportunities along anadromous streams. Restoration objectives are focused on restoring stream function, to improve long-term ecosystem health, increase water quality, support recovery of salmonids, and protect biological integrity and biodiversity across the Smith River Plain.

This plan provides a foundation of scientific knowledge and input from resource professionals and landowners, with consistent and subjective evaluation of restoration opportunities across the Smith River Plain, but the plan itself carries no regulatory authority. This planning process sought to follow the first four steps of NRCS nine-step planning process (USDA 2003). These steps are: (1) identify problems, (2) determine objectives, (3) inventory resources, and (4) analyze resource data.

This plan will support the next five steps of the NRCS process, which include: (5) formulating and (6) evaluating alternatives, (7) making decisions, and (8) implementing and (9) evaluating the plan and resulting actions (USDA 2003). These planning steps do not need to be conducted linearly but all steps are vital for successful conservation planning (USDA 2003) and inform future actions to ensure desired future conditions are achieved. This process provides the building blocks needed to understand the problems, opportunities, solutions, and results of landscape changes.

The biological and physical structure of a watershed is shaped by both longitudinal (upstream to downstream) and lateral (stream to terrestrial) linkages and restoration projects must consider the surrounding landscape, not only the reach where the project may occur (Beechie et al. 2008, Lake et al. 2007). Restoration actions that consider watershed and ecosystem processes are more likely to succeed at reaching recovery goals and preventing further species and habitat declines than actions focused only on restoring watershed form (Reeves et al. 1995, Beechie et al. 1996, Bradbury et al. 1995, NOAA 2014). Finally, salmon and other wildlife have adapted to natural local variation at both spatial and temporal scales. Therefore, restoration should not require for conditions to remain constant at a single location or uniform across the landscape (Bradbury et al. 1995).

The highest priority projects, with the highest likelihood of implementation, are those that provide multiple benefits to natural resources and are compatible with the landowner needs and overall management plans (USDA 2003). Smith River Alliance (SRA) used scientific literature, historic images, species distributions, topographic assessment, landscape conditions, and landowner input to identify potential restoration opportunities. We evaluated potential fish barriers, the condition of riparian vegetation, hardened banks, impervious surfaces, and diversions to further develop the list. Ranking criteria was developed to aid in a relative prioritization between identified projects. Ranking scores estimated the biological and ecological resources that would be benefited as well as the integrity, risk, optimism and potential of a project.

The information in this plan should be used by interested parties to support willing landowners in the formulation of restoration alternatives and to develop projects. Adaptive management should be used to forecast project effectiveness and identify any additional steps are needed to achieve project goals.

Smith River Plain Background

The Smith River is the northern most, coastal watershed of California located 3.7 miles south of the Oregon border (Figure 1). The Smith River Plain is 79.31 square miles (Table 1) and consists of two formations including Saint George formation and Battery formation (Roberts et al. 1967). The Saint George formation is composed of bioturbated marine sandstone and sandy mudstone mixed with pebbles, carbonized wood, and fragmented molluscan shells (Delattre and Rosinshki 2012). The Battery formation formed from marine terrace deposits mixed with dune sands and alluvial gravels (Delattre and Rosinshki 2012). These formations were shaped by alluvium deposited over land historically connected to the coast range, which separated and sank into the sea (Monroe 1975). The alluvium was further molded and smoothed by wave action and ocean currents. Since formation of the plain, the Smith River channel has eroded creating the current day coastal terrace. Above the coastal plain, approximately where Highway 101 crosses the river, the active channel is surrounded by steeper forested terrain in the Franciscan formation (Roberts et al. 1967). The planning area is characterized by low gradients, a wide valley and an alluvial fan bedform with a large floodplain, resulting in deposition of mobilized sediment delivered from upstream.

The Smith River basin receives an impressive 91.59 inches of rainfall annually at the Gasquet Ranger Station and 64.03 inches at the Crescent City McNamara Field Station (CDEC 2017). Precipitation is usually delivered during large winter storm events with 82% of annual average rainfall received occurs from October to March (CDEC 2017).

The sparsely vegetated and shallow rocky soils throughout most of the interior basin hold little precipitation and streams rapidly respond with highly variable flows. Average annual peak flow from 1927 to 2016 is 82,495 cubic feet per second (cfs) (USGS 2017a) resulting in an estuary largely formed by river dominated hydrological processes during the winter months. As flow reaches the minimum during the late summer (mean monthly August flow=338 cfs), ocean tides push saltwater upstream resulting in seasonally varied concentration and extent of mixing ocean-freshwater and salt wedge (Mizuno 1998, Parish and Garwood 2015 & 2016). These abiotic conditions, coupled with water quality, nutrient concentrations, grass and algal cover, and species life histories, result in the density, diversity, and distribution of salmonids and other biota vary widely in the coastal plain on a seasonal basis (Parthre 2004, Day et al. 2013, Parish and Garwood 2016). In addition to salmonids, multiple plant, fish and wildlife species seasonally utilize estuarine, stream, wetland, and riparian habitats across the Smith River Plain (Monroe 1975).

In addition to average annual peak flows, multiple flood events have occurred over the last century resulting in large scale changes to the streams and riparian condition across the Smith River Plain. Three recent floods in particular; 1955 (165,000 cfs), 1964 (228,000 cfs), and 1972 (182,000 cfs) (USGS 2017a) have had the most dramatic influence on the Smith River Plain (Figure 2). Accounts from local landowners and historic aerial images show widespread erosion and deposition resulted in removal and formation of river terraces during these three events.

The planning area includes the mainstem and anadromous tributaries located within the coastal zone (Figure 1). Within this area is the town of Smith River, located near the confluence of Rowdy and Dominie Creeks, contains the majority of developed residential and industrial parcels in the planning area. As of 2010, the population of Smith River was 866 (USCB 2010). The landscape of the



Table 1. Watershed summary information including location of mouth, sub-basin area (square miles), estimated length of anadromous stream (meters) and salmonid use by life stage for each sub-basin included in planning area, Del Norte County, CA. A sub-basin is a stream network connected by a single link to the mainstem Smith River.

Stream	UTME (mouth)	UTMN (mouth)	Anadromous stream in plan (m)	Anadromous stream in plan (mi)	Sub-Basin Area (sq mi)	Juvenile salmonid habitat	Adult salmonid habitat*
Mainstem/Estuary (up to Hwy 101)	400129	4644588	11150	6.93	29.56	Yes	Yes
Unnamed estuary stream	400876	4643911	541	0.34	included in Tillas Slough	Yes	No
Tillas Slough sub-basin			13136	8.16			
Tillas Slough	400833	4643499	4806	2.99		Yes	Yes
Unnamed Tillas Slough Tributary	401696	4642843	1919	1.19		Yes	Yes
Ritmer Creek	401728	4642813	3160	1.96		Yes	Yes
Delilah Creek	401874	4642820	3251	2.02		Yes	Yes
Islas Slough	400771	4642656	1346	0.84	included in mainstem	Yes	No
Tryon Creek sub-basin			12769	7.93			
Yontocket Slough	400884	4640643	2662	1.65		Yes	Yes
Tryon Creek	402384	4639744	9425	5.86		Yes	Yes
Unnamed Tryon Creek Tributary	402651	4638092	682	0.42		Yes	No
Rowdy Creek sub-basin			8729**	5.42	34.08		
Rowdy Creek	403256	4640720	6791**	4.22		Yes	Yes
Dominie Creek	405150	4642412	1160	0.72		Yes	Yes
Clanco Creek	405001	4641708	778	0.48		Yes	No
Morrison Creek sub-basin			10090	6.27	3.69		
Morrison Creek	403625	4640478	4720	2.93		Yes	Yes
Mello Creek	404351	4639775	2911	1.81		Yes	Yes
Unnamed Morrison Creek Tributary	405124	4639922	2459	1.53		Yes	No
Stotenburg Creek sub-basin			2522	1.57	0.75	Yes	No
Stotenburg Creek	404802	4638092	1994	1.24			
Unnamed Stotenburg Creek Tributary	405410	4637529	528	0.33			
Total			60283	37.46	79.37		

* Does not include Coastal Cutthroat habitat

** excludes anadromous stream upstream of South Fork Rowdy Creek

Smith River Plain is predominately utilized for agricultural practices including cattle ranching, dairy production, and lily bulb production. A timber mill was actively operated in the town of Smith River along Rowdy and Dominie Creeks beginning in the mid-1940's (GHD 2015). By the mid-1990's and present day the mill is no longer operational though timber harvest continues in the area. These land uses (i.e. residential, agriculture, timber operations) have resulted in modifications to the stream form, capacity, sediment transport, habitat availability, and pollution levels of the waterways in the Smith River Plain. For example, levee construction and bank armoring that have resulted in simplified and high-energy channels (GHD 2015, Parish and Garwood 2015).

Recent water quality monitoring documented the presence of legacy and currently used pesticides and dissolved copper in tributaries of the Smith River Plain (CWB 2018, NOAA 2018a). Pesticides and copper are used in production of lily bulbs to control disease and nematodes in the Smith River (Voight and Waldvogel 2002, CWB 2018). Copper is a known neurobehavioral toxicant for salmonids (NOAA 2018a). Recent water quality testing found that copper levels were higher below lily bulb fields than above fields in some streams located in the planning area (NOAA 2018a). While copper is used for production of lily bulbs, copper is also naturally present in the Smith River and sampling does not solely attribute bulb production for copper presence (NOAA 2018a). Bulb production includes tilling and soil disturbance in the fall leaving fields vulnerable to erosion during winter storms. Without adequate buffer strips elevated sediment levels may be reaching streams.

No Total Maximum Daily Loads (TMDLs) have been set and no continuous monitoring is implemented to determine levels or exact sources of impacts to water quality. However, under order no. R1-2012-003 and R1-2012-002, beginning in 2013 all cow dairies in California are required to have a nutrient management plan and annual monitoring of surface and ground water as part of waste discharge requirements (DNUDA 2013). This monitoring evaluates turbidity, temperature, pH, conductivity, and ammonia nitrogen of all surface waters impacted by dairy operations. Nitrate and fecal coliform bacterial levels in ground water is also monitored. The monitoring and reporting systems contain information of water quality conditions and allows landowner to take actions aimed at improving conditions. Recent water quality sampling conducted documented surface water samples with U.S. EPA nutrient criteria for total nitrogen and phosphorus exceeded in multiple streams located in the planning area (CWB 2018).

Rowdy Creek Fish Hatchery, located at the confluence of Rowdy Creek and Dominie Creek, is only one of two privately operated fish hatcheries run by non-profits in California. The purpose of the Rowdy Creek Fish Hatchery is to increase the number of catchable Chinook Salmon and Steelhead in the Smith River fishery (Zuspan 2018). Water temperature and dissolved oxygen is monitored within the hatchery tanks but not the effluent delivered to Rowdy Creek. California Department of Fish and Wildlife (CDFW) manages the other 24 hatcheries in the state and requires National Pollutant Discharge Elimination System (NPDES) permits from Regional Water Quality Control Board districts to ensure operations do not harm waters receiving hatchery effluent. Rowdy Creek Hatchery also obtains a hatchery trapping and rearing permit as required by Fish and Game Code.

The ancestral lands of the Tolowa Dee-ni' Nation (TDN), a federally recognized Indian Tribe, includes the entirety of the Smith River basin. The citizens of the TDN continue to rely upon the resources within the Smith River Plain. The TDN place of Genesis and world-renewal ceremony

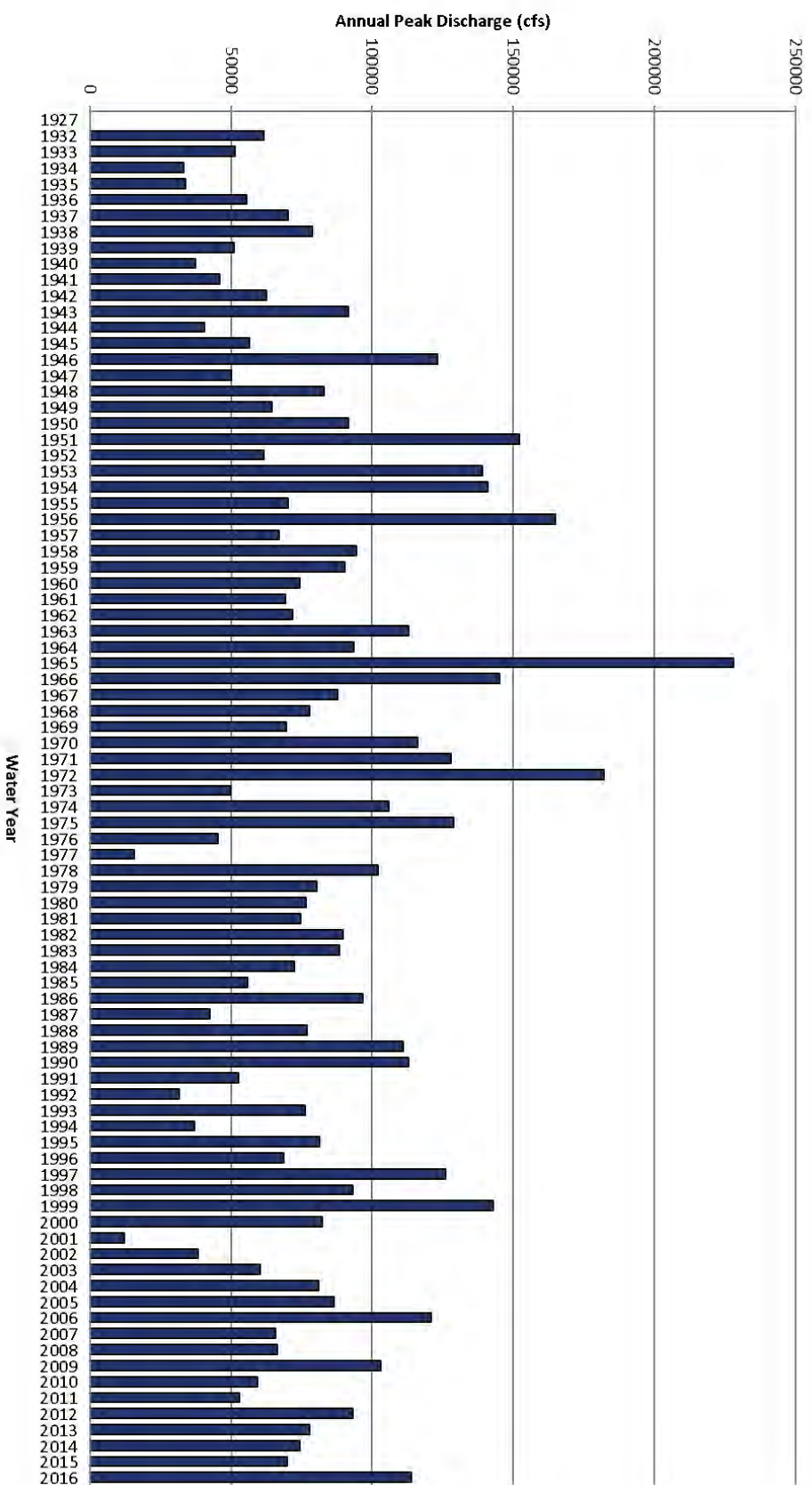


Figure 2. Annual Peak Discharge in cubic feet per second (CFS) from 1927-2016 on the Smith River based on USGS gauge on the Smith River near Crescent City (#11532500, Jed Smith) in Del Norte County, California (USGS 2017a).

location, Yontocket (Yan'-daa-k'vt), is located within the planning area, see the Yontocket Slough section below for additional information.

There are 47.5 miles of potential anadromous stream habitat included in the assessment. This was determined based on the protocol described by Garwood and Ricker (2011) with a maximum stream gradient equal to or less than 8% using intrinsic potential stream lines (Burnett et al. 2007). Adjustments were made where needed based on documented salmonid observations including coastal cutthroat trout (*Oncorhynchus clarkii*) distributions and known fish barrier locations. Parish and Garwood (2015 and 2016) have documented coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), and coastal cutthroat trout throughout this area during both the summer and winter months. Monitoring has shown that there is seasonal variation of habitat use in the planning area. Predominantly the mainstem and provides important summer rearing habitat while the tributaries provide vital winter rearing habitat (Parish and Garwood 2015). While not all streams in this area flow year-round, juvenile salmonids, including non-natal rearing Mill Creek spawned individuals, have been documented rearing in the coastal tributaries while surface water is present during the winter; from early winter (late November) through spring (mid-May) (Parish and Garwood 2016). Furthermore, areas with water quality that is within tolerable ranges of dissolved oxygen, temperature, and salinity provide summer rearing habitat (Parish and Garwood 2015).

Mainstem Smith River

The mainstem Smith River includes 18.27 mi from the mouth to the confluence of the South Fork and Middle Fork Smith River. This planning assessment evaluated 6.93 mi of mainstem from the mouth to the Highway 101 bridge, including the lower, middle, and upper estuary as described by Parish and Garwood (2015). The lower 2.61 mi from the mouth to the cattle crossing riffle, while the channel parallels the ocean, is wide (~820-1970 feet) and braided with a low average gradient. The river is a single narrow channel (~490- 720 feet) as it turns east upstream to the mouth of Rowdy Creek. Through this section, there are two unique deep pools ("holes"), the Sand Hole and the Piling Hole.

From the mouth of Rowdy Creek to downstream of the Tillas Slough mouth, levee construction beginning in the early 1970's has resulted in a confined channel with reduced off-channel habitat, depositional areas, and connection to small drainages evident from the presence of riparian vegetation in the 1942 aerial image (Figure 3). Upstream of Rowdy Creek the main-channel turns south east and the average gradient increases resulting in long riffle and run habitats separated by a few deep pools. The tidal salt wedge extends 4.75 mi upstream from the mouth during the summer (Parish and Garwood 2015) and 1.09 mi during the winter months (Parish and Garwood 2016).

The main-channel downstream of the Rowdy Creek confluence has had the largest change with the southern bank migrating more than 850 feet to the south at the mouth of Yontocket Slough from 1942 to 2016. The levee located on the north bank upstream of the Yontocket Slough confluence, constructed after the 1964 flood, possibly accelerated this lateral migration of the south bank (Love 2006). Erosion on the south bank continues with approximately 20 ft of southern migration in the last 4 years.

Unnamed Estuary Tributary

A small unnamed tributary meets the Smith River estuary 0.66 mi upstream from the Smith River mouth (Figure 1). A tide gate constructed between 1955 and 1965 is present 150 feet upstream from the mouth. The stream channel divides into two main channels, one in the southerly direction and one to the north, and contains at least 0.34 miles of potential anadromous stream habitat. A dense riparian forest on the eastern boundary of the stream is present and is one of the few remaining historic riparian forests in the Smith River Plain. The land use near this tributary is mixed agriculture, residential and commercial. Juvenile coho salmon, Chinook salmon, steelhead trout and unidentified trout, as well as an adult coastal cutthroat trout, steelhead, and surf smelt have been documented at the outlet of the tide gate (Parish and Garwood 2015 and 2016, Garwood, pers. comm.).

Tillas Slough

Three streams feed into Tillas Slough including an unnamed stream, Ritmer Creek, and Delilah Creek. The basin encompasses 5.50 square miles with an estimated 8.16 miles of anadromous stream. In the 1960's, construction of a levee began, which crosses the main channel near the mouth and controls flooding along the northeast floodplain of the lower Smith River.

The 1972 flood broke the levee across the slough and was rebuilt with two tide gates, which have since rusted and no longer function as tide gates, allowing for unregulated daily tidal water exchange (Parish and Garwood 2015). There are two 'legs' of the slough with all tributaries flowing into the east leg. The two legs contain 2.99 miles of anadromous stream. The slough is dominated by silt, with gravels present particularly in the upper half of the west leg. Reed canary grass (*Phalaris arundinacea*) is prevalent in the upper end of the east leg and at the confluence with all three tributaries.

The upland areas that drain into the slough are dominated by pasture land and lily bulb fields. Juvenile Chinook salmon, coho salmon, unidentified trout species (Parthre 2001), tidewater goby (*Eucyclogobius newberryi*) (Schmelzle 2015), bay pipefish (*Syngnathus leptorhynchus*), coast range sculpin (*Cottus aleuticus*), surf smelt (*Hypomesus pretiosus*), and three spine stickleback (*Gasterosteus aculeatus*) have been documented downstream of or near the levee (Parish and Garwood 2015). The majority of the land in the sub-basin is utilized for cattle, dairy, and lily bulb production.

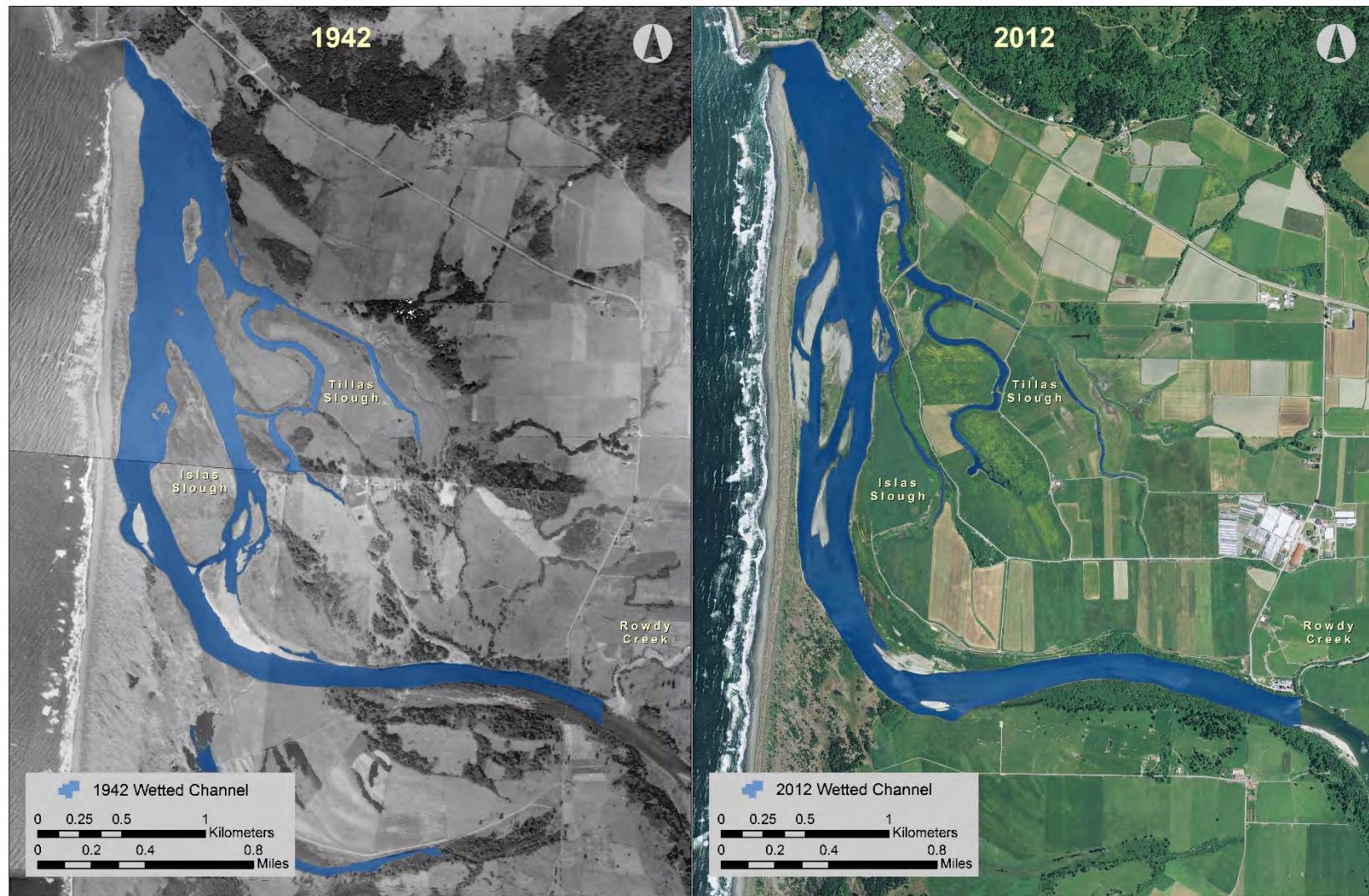


Figure 3. Historic (1942) and current view (2012) of the Smith River Plain and estuary, Del Norte County, California. Blue shaded areas in each image depict the estimated active channels at the time the image was collected. Reproduced from Parish and Garwood (2015).

Unnamed Stream

An unnamed stream meets Tillas Slough 0.56 miles upstream from the levee with an estimated 1.19 miles of anadromous stream habitat. The stream channel has been altered with multiple >45° bends present at property boundaries and agricultural fields. Many of these stream modifications occurred prior to 1942. Dense reed canary grass is present at the mouth, limiting fish passage, channel capacity and water quality. The channel flows through a riparian forest near the mouth, however, the remainder of the channel largely lacks riparian vegetation. Upstream of Highway 101 the channel divides in two with unclear hydrologic connection between the channels and constructed drainages along agricultural fields.

Ritmer Creek

Ritmer Creek is the largest tributary of Tillas Slough located 0.59 miles upstream from the levee with an estimated 1.96 miles of anadromous stream. Some intact riparian vegetation is present throughout much of the channel and spawning substrates are present above Highway 101 and extending above Ocean View Drive. Coastal cutthroat trout and juvenile steelhead trout have been documented in Ritmer Creek and the stream likely supports all salmonid life stages (Parish and Garwood 2016). Dense reed canary grass is present at the mouth, limiting fish passage, channel capacity and water quality.

Delilah Creek

Delilah Creek is the longest tributary of Tillas Slough with 2.02 miles of anadromous stream habitat, merging with Ritmer Creek 450 feet upstream from Tillas Slough. Historically Delilah Creek was referred to as Mitchell Creek in older USGS maps (Laird et al. 2014). The downstream most 0.84 miles of the channel is impaired by reed canary grass before entering a section of forested riparian, downstream of Sarina Road. From Sarina Road to Highway 101 the channel was straightened and confined beginning in the 1950's. This stream reach has minimal riparian vegetation with Himalayan blackberry (*Rubus armeniacus*) dominating the stream banks. The construction of Highway 101 in the 1950's caused further channel alterations along and upstream of the highway. A tributary meets Delilah Creek at Highway 101 with the main channel flowing north parallel to the highway. Channel aggradation causes the stream to flow south, through a highway cattle underpass and through a ditch network during high flow events.

Islas Slough

Islas Slough was historically connected to the main channel on the upstream end, functioning as a side channel (Figure 3). Based on aerial imagery, Islas Slough encompassed 71 acres in 1942 and only 12 acres by 2012 (Parish and Garwood 2015). The upper end of the slough is disconnected by a levee network, built in the 1960's and 70's, along the western and upstream margins of the slough preventing Smith River flows from flushing through the slough and connecting to the southern portion of Tillas Slough (Figure 3). The lack of elevation difference in this area prevents accurate estimate of the basin area. No streams flow directly into the slough, rather the slough receives drainage from the surrounding agricultural fields, and through varying flows and tidal influences of the mainstem Smith River. The channel is dominated by mixed cobble at the mouth. The upper slough is dominated by gravel and deposited silts. Native riparian and wetland vegetation dominate the fringe of the channel though canary reed grass is present on the fringes at the upstream end of the

channel. Parthree (2001) documented 26 fish species in Islas Slough including coho salmon, Chinook salmon, steelhead trout, coastal cutthroat trout, pacific lamprey (*Entosphenus tridentatus*), surf smelt, top smelt (*Atherinops affinis*), starry flounder (*Platichthys stellatus*), and pacific herring (*Clupea pallasii*).

Yontocket Slough/Tryon Creek

Tryon Creek flows into Yontocket Slough on the southern banks of the Smith River, 2.48 miles upstream from the mouth. Approximately 900 years ago, Yontocket Slough was the main channel of the Smith River (PWA 2005), but was abandoned as the river migrated north creating the present day off-channel slough. The sub-basin encompasses 5.79 square miles and an estimated 7.93 miles of anadromous stream. Salmonid spawning habitat is present in Tryon Creek upstream of Highway 101 and rearing habitat located throughout the sub-basin.

The downstream half of the slough is located within the Tolowa Dunes State Park and is an area listed on the National Register of Historic Places. Yan'-daa-k'vt (Yontocket) is the location of the Genesis of the Tolowa Dee-ni'. This culturally significant area is also an important Tolowa Dee-ni' winter village, also known as Yan'-daa-k'vt, located to the west of the slough in the present day State Park. In 1853, early settlers ambushed and massacred people in the Yan'-daa-k'vt village during a ceremony. Ancestral remains and cultural resources are located both in the area and in the slough. Due to the massacre, the area is also known as Burnt Ranch. Later it was known as the Pala Place, and today is the Yontocket Memorial Village (Gould 1984) and is actively used as a tribal cemetery.

Prior to and during early State Park ownership, grazing operations occurred around the slough. More recently, the area was managed with cattle grazing to aid in recovery of federally protected Aleutian cackling goose (*Branta hutchinsii leucopareia*). No grazing has occurred in the park since 2011. Pala Road, built prior to 1942, is located 0.25 miles upstream from the mouth, resulting in altered hydrology and increased sedimentation in the slough. In the 1990's and early 2000's, water elevation was managed at Pala Rd to increase open water habitat during waterfowl hunting season (Love 2006). Reed canary grass has further increased sedimentation, negatively impacting salmonid habitat by reducing fish passage and water quality in multiple locations throughout the slough and in Tryon Creek. Dairy operations are located upstream of the Park boundary on the slough and along the majority of Tryon Creek to Highway 101. Upstream of Highway 101 Tryon Creek is surrounded by residential development with timber harvest operations located in the headwaters.

Native riparian vegetation is limited by dense reed canary grass bordering and encroaching into the majority the slough. In deeper areas of the slough yellow pond lily (*Iris pseudacorus*) is present and patches of willow and Sitka spruce are present in multiple locations. Riparian restoration efforts funded by CDFW and SCC occurred in 2011 to enhance riparian vegetation and cattle exclusion fencing in parts of the basin (Love 2006) though canopy cover remains low and reed canary grass is still present throughout much of the channel from Yontocket Slough to Moseley Road (Parish and Garwood 2015).

Juvenile coho salmon have been documented using Yontocket Slough and Tryon Creek for winter rearing, including non-natal rearing, based on detection of marked juvenile coho salmon that migrated from Mill Creek (Parish and Garwood 2016, Walkley et al. 2017). Near and upstream of

Highway 101, where there is perennial water, juvenile coho salmon, Chinook salmon, coastal cutthroat trout, and unidentified trout have been detected during the summer months (Walkley and Garwood 2017).

Rowdy Creek

Rowdy Creek is the largest basin in the Plain encompassing 34.08 square miles with an estimated 17.45 miles of anadromous stream. Multiple tributaries occur in the basin including Clanco Creek, Dominie Creek, Savoy Creek, South Fork Rowdy Creek, and Copper Creek. Only the downstream-most 5.42 miles of stream are included in the planning area up to the confluence of South Fork Rowdy Creek; including Dominie and Clanco Creek. Above South Fork Rowdy Creek the channel becomes more confined and the gradient begins to increase (Figure 1). Second to Mill Creek, Rowdy Creek is the largest coastal tributary that provides important spawning and rearing habitat for all salmonids and lamprey in the Smith River basin (Garwood and Larson 2014). Pacific Lamprey have not been documented in Rowdy Creek during monitoring efforts conducted from 2011-2016 (Walkley and Garwood 2017) with the Rowdy Creek Fish Hatchery weir likely preventing upstream migrations.

Historic aerial images show Rowdy Creek having a braided channel in many locations and a large alluvial fan at the mouth. The upper watershed is managed for timber production with timber harvest regulation and an Aquatic Habitat Conservation Plan providing stream protection and regulation guidelines. The lower watershed is primarily managed for agricultural uses as well as some residential properties lining the stream in the town of Smith River, near the confluence of Rowdy and Dominie Creeks. Multiple channel alterations have occurred over the years resulting in reduced channel area, loss off-channel low velocity rearing habitat, and less floodplain connection due to both agricultural and timber production practices, particularly in the lower watershed.

Rowdy Creek and Dominie Creek have experienced additional channel confinement directly upstream of Highway 101 due to historic and current mill operations. Based on historic aerial images, between 1942 and 1948 the mill operation along Rowdy Creek increased in this area and multiple buildings and channel alterations with rip rap bank armoring were constructed. By 1958, the mainstem of Rowdy Creek and Dominie Creek along the mill site resulted in channel confinement, loss of floodplain connection, and reduced overall sinuosity of the channel profile. Prior to channel modifications for mill infrastructure, this portion of Rowdy Creek had a wide valley and a dynamic meandering channel (GHD 2015) that likely provided multiple off-channel and slow water habitats during high winter flows. Dominie Creek was surrounded by dense vegetation though the channel form and width are not well identifiable in the early historic images. By 1972, a cleared and straightened stream channel is identifiable as the riparian vegetation has been cleared and the mill operation expanded in the adjacent floodplain.

A fish hatchery facility (Rowdy Creek Fish Hatchery) operates at the confluence of Dominie and Rowdy Creeks with infrastructure that creates a total of three fish barriers combined on both streams, as well as extensive bank and channel armoring. The hatchery weir across Rowdy Creek is one of the most substantial anadromous fish barriers remaining in coastal California outside of major dams (Parish and Garwood 2016). The hydraulic conditions created by the concrete apron across Rowdy Creek creates a complete barrier to juvenile upstream migration (GHD 2015). The diversion weir and concrete apron also present passage issue for adult salmonids, even when the hatchery is

not collecting fish, resulting in migration delay and increased energy expenditure at a minimum and may be a complete barrier for some weaker fish (GHD 2015).

The majority of the agricultural production in the basin occurs downstream of the hatchery. Alterations downstream of the hatchery including bank armoring with rip rap and disposed cars, and levee construction has led to further channel confinement, loss of riparian habitat, and floodplain connection. GHD found a 43% loss of channel area from Highway 101 to the mouth (2015). A loss in channel area results in increase stream velocity and sediment transport, transforming the once depositional channel reach into a transport reach (GHD 2015).

Morrison Creek

Morrison Creek sub-basin encompasses 3.69 square miles and has an estimated 6.27 miles of anadromous fish habitat. Multiple tributaries are located within the sub-basin, the two largest of which are Mello Creek and an unnamed stream (aka. Rawson Creek). Spawning gravels and rearing habitat are present throughout the majority of the basin. Coho salmon have been documented throughout Morrison Creek and its tributaries up to Highway 101 (Garwood and Larson 2014, Parish and Garwood 2016). Juvenile coho salmon and trout that originated in Mill Creek have been detected utilizing Morrison Creek during the winter months (Parish and Garwood 2016). Juvenile and adult Chinook salmon and coastal cutthroat trout have also been documented in the Morrison sub-basin (Garwood and Larson 2014, Walkley and Garwood 2017).

The majority of the upper watershed above Highway 101 is managed for timber production. Residential development is present upstream of the highway as the stream leaves the steep forested hillside and joins the coastal plain. Downstream of the small residential areas, the majority of the basin is utilized for cattle, dairy, and lily bulb production. As the drainage leaves the steep forested hillside the channel gradient is reduced and enters a depositional zone. Annual flooding is present in multiple locations in the basin, particularly downstream of Highway 101 and around Fred Haight Drive. Both Mello Creek and Morrison Creek meet Fred Haight Drive at $>45^\circ$ bends in the channel resulting in a loss of the streams ability to transport sediment and water, leading to channel aggradation, exacerbating localized flooding along the county road and surrounding properties (Smelser 2013, Love 2018).

Historic land use practices have led to reduced channel capacity and channel simplification in many locations. Riparian vegetation is present in many locations throughout the basin though is lacking in areas with cattle access to the stream along multiple reaches. Lack of channel capacity results in regular flooding from the main channel as well as along the tributaries and overland flow across adjacent agricultural fields. A 0.3 square mile pond, Goodwin pond, located in the Morrison Creek sub-basin, captures multiple springs and holds water year-round. Goodwin Pond was formed in the 1950's with the construction of levees adjacent to Fred Haight. Out flow enters Mello Creek upstream from Fred Haight Drive with limited fish access. North American Beavers (*Castor canadensis*) utilize the pond habitat as well as Morrison Creek.

Mello Creek and the unnamed stream originate in the steep forested hillslopes east of Highway 101. Both creeks flow across agricultural property before passing under the highway. Mello Creek has historically been straightened throughout the majority of the section downstream of the highway.

This section lacks native riparian vegetation and has bare soil on the surrounding fields in some years. Reed canary grass and the low gradient of the channel result in deposition of delivered sediment. This deposition has led to recent channel migration and loss of winter rearing habitat for juvenile salmonids (Parish and Garwood 2016). The unnamed stream is composed of four small streams originating east of highway. These four streams merge downstream of, but near Highway 101 to flow through a forested landscape dominated by Coast Redwood (*Sequoia sempervirens*) before crossing pasture and meeting Morrison Creek.

Stotenburg Creek

Stotenburg Creek, the smallest and most upstream sub-basin in the planning area encompasses 0.75 square miles and contains an estimated 1.57 miles of potential anadromous stream habitat. The sub-basin contains two intermittent streams that originate in the forest upstream of Highway 101 and merge downstream after flowing under South Fred Haight Drive. Juvenile coho salmon, unidentified trout and coastal cutthroat trout have been documented in the stream up to Fred Haight Drive (Garwood and Bauer 2013, Parish and Garwood 2015 & 2016). Stotenburg Creek has mixed land use with the headwaters comprised of residential and timber harvest property and the lower basin parcels used for horse pasture and dairy cattle ranching. Stotenburg Creek typically dries during the summer months and flows subsurface at the mouth during the spring and early winter. North American Beavers utilize Stotenburg Creek and have built small channel spanning (<1ft) dams in various locations along the channel during recent decades (Parish and Garwood 2016, L.J. Ulrich personal communication). Fine sediment dominates the channel with some gravels present in the upper reaches near Highway 101.

Project Identification Tools and Methods

The original project list was developed by reviewing available literature and data on salmonid distribution, habitat availability, and landscape and stream conditions (Garwood 2012, Garwood and Larson 2014, Parish and Garwood 2015 & 2016, Walkley and Garwood 2017). Recovery plans that include the Smith River were also consulted including the Smith River Anadromous Fish Action Plan (Voight and Waldvogel 2002), Recovery Strategy for California Coho Salmon (CDFW 2004a), Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (NOAA 2014), and California State Wildlife Action Plan (CDFW 2015).

Road crossings, water diversions, riparian vegetation, elevation, hardened banks, and impervious surfaces were assessed to identify potential projects. Additionally, SRA met with landowners and natural resource specialists from CDFW and NMFS to refine and edit the list of potential projects. Evaluations were conducted for each stream and sub-basins are numbered from downstream to upstream.

Low Impact Development

Land use change can alter aquatic environments through construction of roads, impervious surfaces, levee/dike networks, stream bank armoring, stream channel straightening, and wetland filling. Development can modify multiple natural processes across the landscape that are vital to maintain high water quality and aquatic habitat (CDFW 2014). These include but are not limited to: altered water infiltration rates, stormwater runoff, reduced habitat availability, quantity and transport of pollutants, nutrient cycling in the aquatic and terrestrial environment, and stream - floodplain interactions.

Channel migration is an important natural stream process that creates and maintains off-channel habitat through the recruitment and sorting of sediments and large woody debris. Channel straightening, levees, and bank armoring stabilize channels, which can lead to channel incision or aggradation due to changes in sediment and water transport rates. Impervious surfaces reduce infiltration capacity and increases stormwater runoff to nearby waterways, both of which result in reduced water quality in both surface and groundwater. Road crossings can restrict channel widths reducing their conveyance capacity of water, sediment, and nutrients, which can lead to flooding and a passage barrier for aquatic species.

Much of the Smith River Plain is utilized for agricultural production and has pervious surfaces. However, historic development has altered the stream channels and floodplains in the region. Residential and industrial development, particularly within the town of Smith River, has resulted in areas of impervious surfaces. Unused paved surfaces remain where the old timber mill operated along Rowdy and Dominie Creek resulting in increased runoff, reduced infiltration, and channel confinement. These landscape modifications have altered all streams within the Smith River Plain.

Low impact development (LID) techniques such as rainwater gardens, pervious surfaces for driveways and walkways, green roofs, and vegetated swales can capture and increase stormwater percolation and water purification (USEPA 2000). Increased connection between the stream and floodplain can reduce flooding and provide important salmonid habitat. LID techniques that focus on

slowing, spreading and sinking (infiltrate) stormwater aid in protecting surface and groundwater, aquatic habitat, and surrounding developments.

Low Impact Development Methods

Aerial images from 1942 to 2016 were evaluated to identify areas with changes to the active channel, floodplain, and locations of channel straightening. Locations with armored banks and levee/dike networks were identified through field surveys, Parish and Garwood (2015) and landowner feedback. Impervious surfaces were identified with the 2011 National Land Cover Dataset for California (USGS 2011), cross referenced with U.S. Census Bureau's road layer (USCB 2015), and U.S. Agricultural Department 2016 aerial imagery (USDA 2016). Using a CDFW recommended riparian buffer width of 164 feet (*see* Riparian Enhancement section), all identified hardened banks and levee/dike networks within this buffer from the edge of the stream channel were included as potential restoration areas. Lastly, impervious surfaces within the 164 ft buffer were identified as potential projects for implementing LID techniques.

Fish Barriers/Passage Concerns

Transportation development often results in construction of human-made stream crossings that either pass over or through a stream channel. Crossings can be constructed with culverts, bridges, or fords and can be located on a road, railroad, or path/trail. The stream crossing includes the materials and any fill associated with the crossing structure and stability of the crossing (CDFW 2004b). Each crossing, regardless of type, has the potential to affect natural channel function by altering nutrient cycling, stream flows, sediment transport, and channel morphology as well as impede passage of species (CDFW 2004b).

Anadromous species are particularly influenced by crossings as they migrate through a stream network at multiple life stages (CDFW 2004b). Generally, juvenile and adult salmonids attempt to pass crossings after elevated flow events, on the descending limb of a hydrograph, with adults attempting at higher flows than juveniles (Lang et al. 2004). The height of the crossing outlet and flow conditions in and adjacent to a crossing, can completely or partially prevent fish passage. Crossings that are fish barriers can be classified as: temporal - impassable to all fish at certain flow conditions; partial - impassable to some fish species during some or all life stages at all flows; or total - impassable to all fish at all flows (CDFW 2004b).

All fish barriers limit the quantity of available spawning and rearing habitat upstream, thereby reducing the potential fish productivity in a stream system, and cause increased energy expenditure, potentially leading to increased predation and reduced spawning success (CDFW 2004b). Advances have been made over many decades in assessing, upgrading and replacing crossings in the Smith River upstream of the Plain. As a result, today there are few manmade barriers outside of the Smith River Plain. However, dozens of crossings in the Smith River Plain have not been assessed or upgraded for fish passage.

The coastal streams in the Smith River Plain, including intermittent streams that are dry in the summer months, are used by multiple salmonid species for winter rearing (Parish and Garwood 2015 and 2016). Furthermore, juvenile coho salmon produced in Mill Creek regularly migrate into small intermittent streams throughout the coastal plain during the winter months, thereby exhibiting both

upstream and downstream movements (Parish and Garwood 2016, Walkley et al. 2017). Road crossings have the potential to completely block access or limit temporal access to these important rearing habitats.

Crossings often also restrict passage of non-salmonids such as adult Pacific lamprey. Passage assessments and upgrade designs consider the jump height and water velocities around the culvert to consider passage needs of various salmonid species and life stages (CDFW 2004b). For example, lamprey are unable to jump if there is any vertical drop at the outlet and they have different needs regarding flow velocity, resting areas and attachment substrates (Goodman and Reid 2012). The suction disc mouth of a lamprey is unable to remain attached while navigating over sharp ($\geq 90^\circ$) angles commonly found on crossings such as on concrete aprons of culverts (Goodman and Reid 2012). For this plan, an assessment was conducted at all crossings located within the planning area, where access was granted, with the goal of identifying all barriers to anadromous fish species, including Pacific Lamprey.

Fish Passage Methods

All potential road crossings were identified through a series of systematic steps. First, the U.S. Census Bureau 2015 road inventory layer, which includes features ranging from trails to highways, was viewed in ArcMap 10.3.1 (ESRI 2017). All roads not listed by USCB (2015) but visible on the 2016 National Agricultural Imagery Program (NAIP) image (USDA 2016) were added to the roads layer. The resulting updated road layer was then overlaid with the CDFW anadromous fish streams layer. All intersections between the roads and streams were identified to develop a list of potential crossings. Lastly, each stream was viewed in Google Earth in a downstream to upstream direction to assess the presence of cattle crossings not necessarily linked to a road network.

The stream crossing list was then cross-referenced with the California Passage Assessment Database (PAD) (CDFW 2018) and Del Norte County Road Department records to compile information on fish passage status and records of past surveys conducted at stream crossings throughout the Smith River Plain. The presence and condition of each identified crossing was discussed with landowners and Del Norte County Roads staff. Landowner access requests were made for all crossings not identified in the PAD or historically surveyed. Where access was granted, field surveys were conducted using CDFW protocol in Part IX of the California Salmonid State Habitat Restoration Manual (CDFW 2004b).

All crossings identified as potential barriers (Grey) were further evaluated using the FishXing program (Version 3; USFS 2012). Designing stream crossings to pass all fish species and sizes at all flows is technically and economically infeasible (CDFW 2004b, NOAA 2001). Accordingly, fish passage design flows (Table 2) are useful for evaluation of the flows at which different species and life stages require access at potential project locations. Fish passage design flows are intended to encompass the range of flows that target fish (i.e., species and life stage) encounter when they are expected to migrate upstream. Using the hydraulic design method, we used 1 cfs, 2 cfs, and 3 cfs for the lower fish passage flow for juvenile, non-anadromous salmonids, and adult salmonids, respectively, due to a lack of flow duration data (CDFW 2004b). We used 10%, 30%, and 50% of the 2-year return period flow for the upper fish passage flow for juvenile, non-anadromous salmonids, and adult salmonids, respectively, also due to a lack of flow duration data (CDFW 2004b).

Table 2. California fish passage design flows (CDFW 2004b, NOAA 2001).

Fish Species or Life stage	Lower Fish Passage Design Flow	Upper Fish Passage Design Flow
Adult Anadromous Salmonids	50% exceedance flow or 3 cfs whichever is greater	1% exceedance flow or 50% of the 2-year return period flow
Adult Non-Anadromous Salmonids	90% exceedance flow or 2 cfs whichever is greater	5% exceedance flow or 30% of the 2-year return period flow
Juvenile Salmonids	95% exceedance flow or 1 cfs whichever is greater	10% exceedance flow or 10% of the 2-year return period flow

Peak flow capacity of a crossing was used to evaluate a crossings risk of failure at high flows. Flow capacity of crossings were determined using those presented by CDFW (2004b) based on the culvert size and inlet configuration and calculated using Piehl et al. (1998). NOAA (2001) guidelines recommend crossings be able to accommodate the 100-year storm flow without damage to the stream crossing. CDFW guidelines require the upstream water surface elevation to not exceed the top of the culvert inlet for the 10-yr peak flood and headwater should not be greater than 50% of the culvert height or diameter above the top of the culvert inlet for the 100-yr peak flood (CDFW 2009). Stream-specific hydrology and 2-, 5-, 10-, 25-, 50- and 100- year flows were determined using USGS stream stats (USGS 2017b). Refinements were made to the basin boundaries when needed based on topographic relief lines evaluated using USGS topographic maps. Based on the analysis, all crossings that were found to limit passage of anadromous species, confine the channel, or were unable to accommodate the 100-year flow were included in the project list.

Riparian Enhancement and Protection

Riparian zones protect the stream channel from impacts of the surrounding land use practices by facilitating natural physical, hydrologic, and ecological processes that form and maintain water quality and habitat for native flora and fauna. Riparian areas provide an ecological link and transition between aquatic and terrestrial environments. This area can be referred to with multiple terms including riparian buffer, vegetated buffer strip, riparian zone, riparian corridor, and riparian habitat. Regardless of the term used, it is the area through which surface and subsurface hydrology interconnect aquatic areas, (i.e., streams, wetland, and sloughs) with the adjacent terrestrial uplands (Brinson et al. 2002, SWRCB 2012). In this report, riparian area is a zone set aside from harvest or other economic use, unless otherwise specified. Furthermore, all buffer widths discussed relate to the perpendicular distance on each side of the stream starting at the edge of the active channel (i.e., 30ft buffer equals a total of 60ft of riparian habitat).

Riparian zones are widely recognized to provide numerous important functions that support natural stream processes and a healthy aquatic ecosystem (Naiman and Decamps 1997, Naiman et al. 2000). In particular, riparian zones perform at least five critical functions for maintaining natural physical stream processes: 1) stabilize stream banks; 2) regulate water temperature and local microclimate; 3) filter pollutants; 4) provide instream wood; and 5) moderate stream and groundwater volumes. While many of these processes indirectly benefit the local flora and fauna, riparian zones perform additional functions that directly benefit biological processes. Habitat

benefits provided include: 1) organic material that supports invertebrate populations; 2) roosting, nesting, and feeding habitat for birds and bats; 3) rearing and refuge from predators for multiple wildlife species, including salmonids. Furthermore, riparian zones are the most diverse, dynamic, and complex terrestrial habitat type and are vital to conserving local and regional biodiversity (Naiman et al. 1993, Naiman et al. 2000).

Governmental agencies and others recognize the significance of riparian zones in protecting water quality and aquatic habitat, acknowledging the need to protect and restore these ecologically valuable areas (CDFW 2015, CNRA 2016, SCC 2018). Locally, the Del Norte County General Plan (2003) recognizes riparian corridors as major locations of excellent wildlife habitat that should be maintained and protected from adverse activity. Despite their recognized high value, an estimated 93 to 98% of riparian areas in California have been lost or degraded (Katibah 1984, Dawdy 1989). Rural and urban development can encroach on the riparian area and may result in vegetation removal and bank armoring. Decreased riparian areas and increased impervious surfaces result in decreased water infiltration and increased water delivery directly to the stream channel during storm events. Furthermore, with reduced water filtration services, waterways receive higher loads of sediment, nutrients, and other pollutants.

Multiple factors influence the effectiveness of the riparian area's ability to provide all functions (e.g., stabilize banks, regulate water temperatures, etc.). Factors include but are not limited to: vegetative composition, soil type, continuity along the stream, stream size, hillslope, and use of the adjacent land (Dillaha et al. 1987, Castelle et al. 1994, Desbonnet et al. 1994, Ligon et al. 1999, Wenger 1999, Broadmeadow and Nisbet 2004, CDFW 2014). Therefore, it is important to consider site-specific features when evaluating a riparian area. Moderate to well drained soils have the ability to percolate surface flow that enters the riparian zone quickly, thus promoting sediment removal and groundwater recharge (Desbonnet et al. 1994). Along with the width of the riparian area, the longitudinal continuity or fragmentation of a riparian area greatly influences the quantity of benefits provided to instream conditions. In general, a larger buffer is desirable for a high functioning and valuable stream or wetland with habitat for species of concern compared to a stream with low habitat value (CDFW 2014). Additionally, a larger buffer is desirable for a stream or wetland with intense adjacent land use compared to one adjacent to a relatively undeveloped area. Furthermore, riparian zones should be wider when located where steeper hillslopes are present (Nieswand et al. 1990, Belt et al. 1992, Blinn and Kilgore 2001).

The vegetative composition greatly influences the ecosystem services for the riparian area. For example, grass filter strips provide effective sediment filtration, but they cannot provide large wood recruitment, bank stability, and shading that forested areas offer. Therefore, grassy filter strips are best used in combination with a forested riparian zone. Fully effective riparian zones have diverse plant assemblages, are continuous throughout the watershed, and are of sufficient width to support and maintain dynamic riparian and channel forming processes. In coastal northern California, the riparian zone is typically characterized by willow (*Salix spp.*), cottonwoods (*Populus spp.*), alder (*Alnus viridix*), Bay laurel (*Laurus nobilis*), Coast redwoods (*Sequoia sempervirens*), Sitka spruce (*Picea sitchensis*), salmonberry (*Rubus spectabilis*), big leaf maple (*Acer macrophyllum*), and typical wetland plants such as rushes (*Juncaceae spp.*) and sedges (*Cyperaceae spp.*). These riparian vegetation assemblages are listed as rare and threatened by the CNDDB (2017).

No single buffer width has been determined to maintain all functions of a riparian area under all circumstances. However, a review of science, technical guidance, and policies can help guide decisions and aid in implementation of effective landscape-scale riparian restoration plan. A wide range of recommended vegetative widths and composition are found in the scientific literature based on the desired management objectives of the riparian area and the attributes of the watershed. Overall, studies show that narrow buffers (<100 ft) are considerably less effective than wider buffers in minimizing the long-term effects adjacent development have on the aquatic environment (Erman et al. 1977, Castelle et al. 1992, Brosofske et al. 1997, Moore et al. 2005).

Bank Stabilization

Bank erosion is a natural stream process and de-vegetated banks are more susceptible to the erosive power of water than those containing complex vegetation. During a 49-year study of the Sacramento River, Micheli et al. (2004) found that stream banks adjacent to agriculture were 80 to 150% more erodible than stream banks with riparian forest floodplains. The above and below ground growth of riparian vegetation both aid in bank stabilization. Liquori and Jackson (2001) found riparian zones having complex understory vegetation were more effective at erosion prevention than those only formed by dense mature forests lacking understory vegetation. The roots of mature trees are vital to bank stability and in highly incised streams, where the channel level is below the rooting depth of the trees, riparian vegetation is likely to be less effective at maintaining stream bank stability (Skidmore et al. 2009). While narrow riparian areas may effectively stabilize some stream banks, literature recommends widths ranging from 33-196 ft to stabilize banks (Culp and Davis 1983, Erman et al. 1977). Furthermore, a structurally diverse riparian zone containing grasses and herbaceous materials with shallow roots combined with trees with deeper roots can prevent both topsoil erosion and mass wasting (Liquori and Jackson 2001, Micheli et al. 2004).

Water Temperature Moderation

Riparian areas have a direct influence on the microclimate and water temperature of the adjacent aquatic environment. Water temperature impacts development, migration, and growth of salmonids and other aquatic species. The natural ability of the riparian zone to regulate stream temperature varies based on riparian width, stream size, vegetation type, hillslope, aspect, and local climate (Belt et al. 1992, Osborne and Kovacic 1993). A study comparing stream temperatures adjacent to agricultural land without riparian vegetation to stream temperatures adjacent to a hardwood forest found that in the agricultural stream, weekly maximum temperatures were 9°F to 22.5°F higher and minimum temperatures were 7°F cooler than the forested stream (Green 1950 in Karr and Schlosser 1977). Brosofske et al. (1997) found that a buffer of 147-ft minimum is needed to maintain a natural microclimate along streams in coniferous forests. The majority of the Smith River basin has water temperature within the tolerable range for salmonids throughout the year, particularly in the winter months. However, areas of the mainstem have exceeded 22° C during the summer months (Garwood et al 2014, Parish and Garwood 2015, Parish 2016), a temperature considered to be above the tolerance of juvenile coho salmon (Welsh et al. 2001).

Pollutant Filtering

Vegetated riparian buffers are a cost-effective best management practice for agricultural production for regulating the flow of water, sediment, nutrients, and pesticides entering stream

channels (USDA 1998 and 2000). Sediments can enter the stream channel through erosion of the stream banks, road runoff, landslides, or through overland flow. The input of excess fine sediments into a stream channel reduces habitat quality for fish and macroinvertebrates species (Wenger 1999). The effectiveness of sediment filtration by the riparian zone depends on the riparian density and composition, overland flow volume, hillslope, width of the protected zone, and sediment particle size (Osborne and Kovacic 1993). Research has found that larger particles tend to settle out within the first 10-20 ft of the riparian zone, but finer particles that tend to degrade salmonid habitat, such as silt and clay, need a larger riparian zone ranging from 50-400 ft for significant retention (Wenger 1999, Parkyn 2004). While sediment retention in riparian zones having a grass riparian area as small as 13 ft can trap up to 100% of sediment under specific conditions (2% hillslope over fine sandy loam soil), a 98 ft grass riparian zone can retain less than 30% of sediment over silty clay loam soil on a 10% hillslope (Dosskey et al. 2008). These studies highlight the width and composition of the riparian area needed to effectively filter sediment is highly dependent on both slope and soil type.

Nitrogen and phosphorus are nutrients commonly found in fertilizer and livestock waste and enter waterways through groundwater flow or overland flow. The addition of these nutrients to aquatic ecosystems can lead to poor water quality conditions including reduced dissolved oxygen rates, increased pH, and eutrophication (Mayer et al. 2005). Nitrogen removal in the riparian zone is recognized as one of the most cost-effective means to reduce nitrogen delivery to streams in intensively developed watersheds (Hill 1996). The rate of nitrogen removal from surface and groundwater flow is extremely variable depending on local conditions including soil composition, surface versus subsurface flow, riparian zone width, and riparian composition (Mayer et al. 2005). Nitrate retention from surface runoff has been shown to be related to riparian zone width, where 50%, 75%, and 90% surface nitrate retention was achieved at widths of 110 ft, 389 ft, and 815 ft respectively (Mayer et al. 2005). Multiple studies have shown that multi-species riparian zones provide the best protections for streams against agricultural impacts (Haycock and Pinay 1993, Schultz et al. 1995, Mayer et al. 2005) and can have infiltration rates as much as five times as high as the adjacent agricultural land (Bharati et al. 2002). Mayer *et al.* (2005) concluded that riparian zones over 98 ft wide would be expected to retain nutrients consistently well across different sites. USDA's (1997) best management practice recommends a grassy area outside of a forested zone to help slow and distribute surface flow evenly to aid in infiltration and allow forested riparian zones to maximally filter nutrients (Figure 4).

Pesticides and herbicides can enter rivers and streams through pesticide drift (i.e., carried by winds), overland flow (i.e., found in surface water or bound to organic matter and sediments), unintended spills, or through groundwater (i.e., percolated through the soil structure). The riparian zone width necessary to prevent pesticide exposure to a watercourse is dependent on the pesticide and variables such as climate, hillslope, depth to water table, and riparian soil composition. A thick, multi-species riparian zone of adequate width can ameliorate the effects of pesticide drift and overland pollution, but pesticides are difficult to remove once they have entered the groundwater. According to Hewitt (2001), tall riparian zones approximately 65 ft wide can reduce pesticide drift up to 90% downwind of spray areas, depending on the size and species of vegetation. Studies suggest that multi-layered complex riparian buffers are needed to provide long-term sediment, nutrient, and pesticide filtration capabilities (USDA 1998, Parkyn 2004, Mayer et al. 2005). While no Total

Maximum Daily Loads have been set for the Smith River basin, riparian enhancement is one tool that can reduce the load of pollutants entering the streams in the coastal plain.

Wood Recruitment

Bank erosion and channel migration are important processes in recruiting large woody debris (LWD) into the active stream channel. LWD is a central feature of stream channels and plays a significant role in geomorphic functions such as directing stream flows to shape the channel form while influencing sediment storage, transport, and deposition rates (Naiman et al. 2002). Large woody debris create deep pools, velocity refuge, shade, complex cover from predators, and macroinvertebrate inputs, all of which are essential for rearing salmonids (Elliot 1986, Quinn and Roni 2001, Opperman 2005). While restoration techniques can directly add LWD to streams, structures have a limited lifespan and generally persist for less than 20 years (Roni et al. 2002). Thus, LWD structure placements offer a viable, but only short-term, approach to stream restoration without natural recruitment of these features from the riparian zone. Natural recruitment from the riparian zone is vital to long term management and sustainability of natural stream processes. LWD tends to originate within a width equivalent to the maximum tree height within the riparian zone, referred to as site potential tree height (SPTH). Collier et al. (1995) recommended a riparian zone width of at least one SPTH to maintain inputs of LWD, although to prevent the entire riparian zone from succumbing to wind throw and risk destabilizing the entire bank, they suggested up to three SPTH from the top of bank.

Flow Moderation

Forested riparian zones facilitate the exchange of surface and groundwater, which provide storage and drainage of floodwaters, and reduce streamside property damage. Additionally, channel migration is a natural process as a stream channel shifts along its floodplain. The width of the channel migration zone is related to factors such as watershed size, active channel width, slope, the underlying geology, and surrounding soil type (MNRO 1996, USDA 1998). Riparian setbacks that allow floodwaters to overflow onto the floodplain also play an important role in flood protection. Riparian vegetation slows the rate of flow over floodplains, allowing for greater infiltration and groundwater recharge (Tabacchi et al. 2000). Subsurface water in the floodplain slowly percolates through the alluvium and recharges the river and streams, maintaining a higher base flow and cooler instream temperatures during the drier months. The riparian area needs to remain in existence as the channel naturally expands or migrates along the floodplain and should be considered when determining long-term management goals.

Fish and Wildlife

Stream and riparian health greatly influence multiple species of fish, birds, bats, invertebrates, amphibians, reptiles, and many plant species (CDFW 2014). Of the 63 bird taxa designated as California Species of Special Concern, 38 primarily utilize wetland or riparian habitats (Shuford and Gardli 2008). All 47 amphibian species found in the Pacific Northwest utilize stream-riparian habitats (Olson et al. 2007). Many North American bat species forage near or directly over open water (Pierson 1998). More than 116 sensitive plant species in Northern California are found in wetland

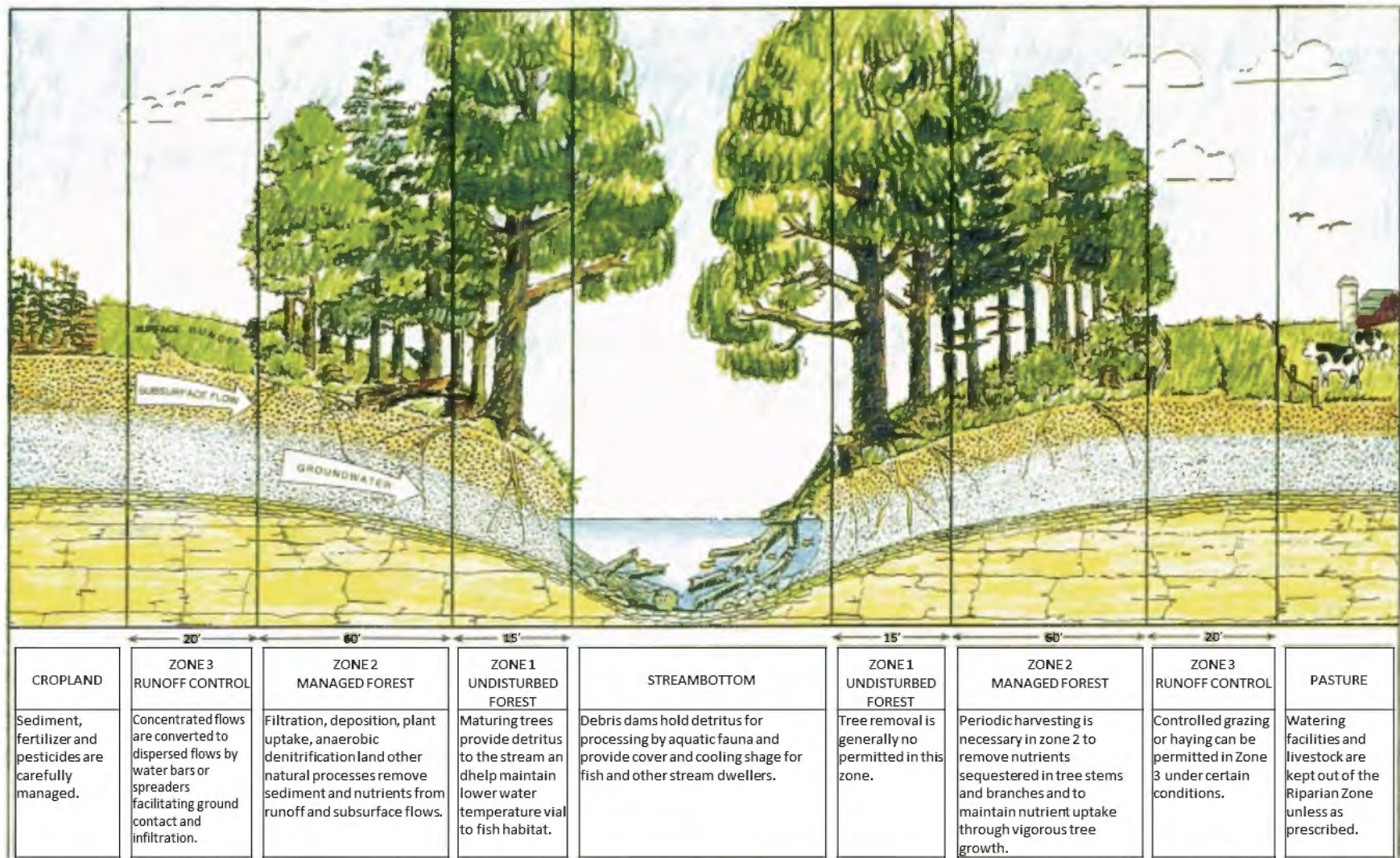


Figure 4. The three zones of a riparian forest buffer recommended by the USDA (1998). Zones 1: Undisturbed forest, Zone 2: Managed Forest and Zone 3: Runoff control grass strip, with adjacent crop and pasture lands. Figure from USDA (1998).

and riparian habitats (CDFW 2014). Fischer et al. (2000) concluded that buffers of at least 164 - 328 ft are required to maintain avian biodiversity. Olson et al. (2007) concluded that on headwater streams a riparian area of 131 - 492 ft is needed to support the terrestrial life history of amphibians.

Riparian zones play a significant role in the aquatic food web through effects on macroinvertebrates, which are important prey for multiple species of salmonids, bird, bats, and amphibians. Riparian vegetation influences benthic invertebrate populations by controlling light and nutrient inputs, limiting sedimentation, delivering and retaining organic matter, and providing important habitat and food sources. Research has concluded that a riparian zone over 98 ft is sufficient to maintain benthic invertebrate population abundance and diversity (Erman et al. 1977, Davies and Nelson 1994). Based on literature review, CDFW (2014) concluded that an undeveloped riparian habitat buffer of at least 164 ft is necessary to maintain viable habitat for many of California's riparian and wetland dependent populations.

Riparian Buffer Policies

Research provides a wide range of conclusions regarding how various widths of the riparian area are needed to perform and maintain its various functions and ecosystem services. Because of the variability of factors influencing the numerous riparian functions, and the wide range of recommendations regarding the width of the riparian area, it is important to consider (the) site specific context and project specific goals when determining the desired width of the riparian area. Regional land use planning can be an effective landscape scale method to protect riparian areas (CDFW 2014). In California's Coastal Zone, development buffers on streams, wetlands, and other environmentally sensitive habitat areas are determined by local coastal plans (LCPs) (CDFW 2014). The majority of LCPs state a 100-ft (30 m) buffer as the minimum standard, and especially sensitive habitats may require a larger buffer (California Coastal Commission 2007). While no specific riparian buffer width along streams is identified in the Del Norte County LCP, the Del Norte General Plan (CDN 2003) identifies a 100 ft buffer for wetlands. Section 1.E.21. states, "the primary tool to reduce impacts around wetlands between the development and the edge of the wetland shall be a buffer of one hundred feet in width." However, the General Plan states that "The County shall ensure that riparian vegetation be maintained along streams, creeks, and sloughs and other water courses for their qualities as wildlife habitat, stream buffer zones, and bank stabilization" (CDN 2003) but does not state a buffer width.

The Forest Service (USDA 1998) favors a three-zone riparian system that includes both a zone of rapidly growing, frequently inundated trees (e.g., willows) followed by long-lived species that contribute to shading and large woody debris recruitment as well as providing large, dense root mats that hold the stream banks together. Zone 1 is a densely forested zone adjacent to the stream channel that provides bank stability, a shade canopy, and habitat for aquatic organisms. Zone 2 extends upslope of zone 1 and is composed of shrubs and trees.; Zone 2's primary purpose is to "remove, transform, or store nutrients, sediment and other pollutants." Zone 3, located upslope of zone 2, is composed of stiff, herbaceous materials that slow surface flow to allow for water infiltration and nutrient absorption. Altogether, these three zones effectively minimize the impacts of surrounding land use and benefit the local flora and fauna.

In addition to Zone 3, the Forest Service recommends a thick grassy buffer that breaks up concentrated flow to settle out some of the sediment by overland flow. The NRCS Conservation Practice Standard riparian forest buffer in California (NRCS CA: Code 391 August 2006) recommends a forested riparian zone 100 ft wide or 30% of the floodplain width, but no less than 35 ft from the top of bank to reduce sediment, nutrients, and pesticides in surface and subsurface runoff. This typically equals 3-5 mature trees wide on each side of the stream (USDA 1998). USDA (1998) further recommends extending the width by adding a vegetative filter strip adjacent to cropland, sparsely vegetated, or highly erosive areas (Figure 4).

Riparian Buffer Methods

Two methods were used to determine where riparian areas have the potential to be restored or protected across the Smith River Plain. First, the edge of the stream was identified and digitized based on 2016 NAIP imagery (USDA 2016) and 2010-11 NOAA Light Detection and Ranging (LiDAR) data using editing tools in ArcMap 10.3.1 (ESRI). ESRI spatial analyst buffer tool was employed to create three layers of various widths: 1) 35 ft, the minimum width of buffered fencing needed for CDFW Fisheries Restoration Grants Program and NRCS funding; 2) 100 ft, the buffer width recommended in the Del Norte General Plan for wetlands; and 3) 164 ft, based on the literature review and subsequent recommendation of CDFW (2014). Second, the riparian vegetation visible in the 2016 NAIP imagery was digitized. The three buffer layers were overlain on the 2016 NAIP image and digitized riparian area layer to identify locations where riparian vegetation is lacking and has the potential to be improved. Finally, areas with high conservation value were identified by locating patches with riparian vegetation that extends beyond the 164-foot buffer. The Smith River Historic Atlas (Laird et al. 2014) was used to cross reference historic and current conditions, the identified area and determine the approximate age of the stand. Older large riparian areas were considered to have high conservation value to ensure these areas continue to provide long term ecosystem services. The resulting list of potential riparian projects was reviewed with landowners, the RCD, and CDFW staff to ensure accuracy and completeness. These potential riparian projects include all areas where riparian habitat extended beyond the 164 feet buffer and where native riparian vegetation was lacking within the 35 foot buffer.

Invasive Plants

Invasive plant species can cause multiple negative impacts to streams and overall ecosystem health and function, as well as reduce habitat for fish and wildlife. Particular species of concern include reed canary grass (*Phalaris arundinacea*), yellow flag iris (*Iris pseudacorus*), and eucalyptus (*Euclyptus obliqua*).

Reed canary grass has been documented throughout a large portion of the lower reaches of most sub-basins of the Smith River Plain including in Tillas Slough, Islas Slough, Yontocket Slough/Tryon Creek, and Morrison Creek (Parish and Garwood 2015). Reed canary grass (RCG) can have profound negative effects on key elements of stream function including reduced dissolved oxygen (Parish and Garwood 2016), habitat availability, fish migration, impaired storm flow movement and increased sedimentation (NPS 2014, Parish and Garwood 2015).

Yellow flag iris, originally from Europe, is spreading through the United States and listed as highly to moderately invasive by the Pacific Northwest Exotic Pest Plant Council (OSUES 2008). It has been

planted as an ornamental wetland plant but is also used in sewage treatment as it is able to remove metals from wastewaters. However, yellow flag iris can rapidly spread from both seeds and rhizomes, and can form dense monotypic stands, outcompete native vegetation, stabilize stream channels, and reduce channel capacity and fish and wildlife habitat (OSUES 2008, USDA 2017, CIPC 2017a).

Eucalyptus, originally from Australia, is located in isolated and dense patches in the Smith River Plain and can aggressively expand its range into neighboring plant communities in coastal locations (CIPC 2017b). Eucalyptus can negatively impact ecosystem health and function, increase fire hazard, reduce biologic diversity and outcompete natives by altering soil chemistry, resulting in reduced fecundity and survival of native plant species (CIPC 2017b).

Invasive Plant Methods

Locations of invasive plant species were determined based on landowner communication, field observations and locations reported by Parish and Garwood (2015). All locations where invasive plant species are known to occur were included as potential projects.

Channel Complexity

Stream channelization and bank armoring alter a streams natural hydrologic processes and capacity to transport water and sediment. Construction of dikes and levees typically result in reduced channel width and floodplain connection increasing stream velocity, sediment transport, and flood frequency (Bukaveckas 2007). Channelization of Rowdy Creek has led to increased stream velocities and sediment transport (GHD 2015). Bank armoring reduces natural channel migration and bank erosion processes (MNRO 1994). Consequently, these stream modifications reduce habitat quality (MNRO 1994), prey availability, and juvenile salmonid survival (Quinn and Peterson 1996, Sommer et al. 2005). Furthermore, the disconnecting the surround landscape from the stream network reduces waters ability to reenter the stream and increases the likelihood of fish stranding (Sommer et al. 2005). Channelized streams also reduce connection to riparian forests and wetlands reducing a stream's natural nutrient filtration capabilities (Kuenzler et al. 1977, MNRO 1994).

Channel Complexity Methods

Channel complexity projects were determined by evaluating historic and current stream channel alignment and active channel width. Restoration of areas where historic channel and landscape modifications have simplified the channel (i.e. straightened channels), reduced stream and floodplain connection (i.e. levee and dike construction) and armored banks (i.e., rip rap installation) were included as potential projects. Stream channel and habitat condition data was used to identify and evaluate potential projects where available.

Additionally, NOAA 2010 Coastal LiDAR was used to identify low elevation areas adjacent to stream channels with potential increased capacity, to accommodate flow and reduce flooding while also enhancing off-channel habitat, minimizing fish stranding, and improving drainage of the surrounding landscape. Historic images combined with low elevation areas were used to identify locations of potential off-channel or wetland habitat enhancement areas across the planning area. Low elevation areas connected or adjacent to stream channels were identified as potential projects.

Sea-level Rise and Inundation

Increased ocean temperatures and melting land ice across the world leads to rising sea levels and threatens California economies and environment (OPC 2017). These changes can lead to increased saltwater intrusion, more frequent and chronic flooding, and increased erosion (OPC 2017). These threats will be exacerbated due to changing climate and weather patterns that extend beyond the coastline. For Northern California, models predict future weather patterns will exhibit more frequent and severe droughts and increased frequency of intense winter storm and flood events (CFW 2014). Rising sea-level has already begun to impact coastal California with increased coastal flooding and erosion (Griggs et al. 2017, OPC 2017). Scientific understanding and models used to predict localized sea-level rise impacts continue to improve and can be used to inform planning decisions to protect coastal California.

Sea-level is predicted to rise 1.5 feet in Crescent City by 2100, based on the baseline conditions in 2000, the median projection (i.e., 50% probability sea-level rise will meet or exceed an elevation change) under high greenhouse gas (GHG) emissions (OPC 2017). However, uncertainties for predicting future conditions require scientific studies to report a range of projected sea-level rise (SLR) and timeframes. Based on uncertainties in future GHG emissions, the Ocean Protection Council (2017) reports a range of 0.1 ft – 9.3 ft by 2100 for Crescent City. Selecting a sea-level rise scenario depends on multiple factors including project location, project goals, project lifespan, and impacts of sea-level rise to the project area.

To account for potential SLR scenarios, various steps should be taken to evaluate the possible consequences and risks of restoration across the Smith River Plain. The OPC (2017) recommends a decision framework including five steps: 1) use the nearest tide gauge; 2) consider project lifespan; 3) identify a range of SLR projections; 4) evaluate potential impacts and capacity across the range of SLR and emission scenarios; and 5) select SLR projects based on risk aversion. These steps are constant with OPC's recommendation of a precautionary approach in the face of complex challenges, scientific uncertainty and climate change.

Coastal wetlands and riparian areas provide important ecosystem services in the face of large storm events and rising sea levels by providing increased capacity to accommodate flow and reduce flooding. A large body of scientific literature warns current threats to wetland and riparian resources will increase due to climate change and SLR. Enhanced wetlands and riparian areas increase coastal habitats ability to adapt and increase resilience to changing environmental conditions (OPC 2017).

Sea-level Rise and Inundation Methods

The NOAA Office for Coastal Management has a variety of Digital Coast tools to help communities address coastal issues. One such tool, Sea Level Rise Mapping Tool, provides a way to identify areas potentially impacted by up to 6ft of SLR (NOAA 2018b). This tool was used to map and identify inundation scenarios and their overlap with the planning area.

Project Ranking

Project ranking criteria was developed to provide a uniform method for assigning a value or score to each project to allow for a relative comparison. The criteria were developed using objective and measurable questions that reflected planning effort goals and stakeholder values. SRA worked with

staff from CDFW, NOAA, Del Norte RCD board, and the Tolowa Dee-ni' Nation Natural Resources Program to develop and refine questions that would evaluate program attributes like: the biological and ecological resources, the integrity and risk, and the optimism and potential for protection and restoration of each identified project (Bradbury et al. 1995). The criteria follows a "score sheet" approach to capture inputs for benefits and impacts of projects (Beechie et al. 2008).

Project Screening and Ranking

The six criteria questions address a variety of protect types (e.g. stream crossing remediation and backwater habitat enhancement). Projects with the highest scores have the highest priority. In assigning a ranking value, respondents took into consideration the quantity of habitat that would be protected, improved, or become accessible based on the project scope and location. Scores were assigned using available information on biological resources, salmonid distributions, habitat condition and landowner interest. To aid in scoring definitions were developed for the scores 1-5 to allow reviewers to evaluate and score all identified projects uniformly (*see below*). The score definitions served as guidelines rather than hard rules.

Natural resource and restoration specialists from NMFS, CDFW, and Smith River Alliance evaluated and scored all identified projects using questions 1-4. These four questions relate to the biological impacts and benefits of an identified project. These scores were then averaged to determine the score for these questions for each project. Landowners' input was used to determine the score for questions 5 and 6. These two questions relate to the landowner impacts and interest of an identified project. When landowners' input was not available information on past or current interest and effort to advance restoration or collaborate with monitoring was used to determine the project scores for questions 5 and 6. The determined score for each question was then multiplied by the corresponding weight for each question.

In addition to individual project scores, each of the six questions was evaluated by reviewers to formulate the weight each answer would be given to the tabulated rankings. Reviewers assigned a weight of 1-10 to each of the six questions, with the higher weight providing a percentage of importance. Stakeholders from NMFS, CDFW, Del Norte RCD board, and the Tolowa Dee-ni' Nation Natural Resources staff provided input on the weight to be given (relative value) of each of the criteria. The information was used to calculate the average weight for each question. As a result, question #4, which assesses a projects ability to address the cause of habitat degradation, has the highest-ranking priority and question #5, a which assesses a project's impacts to future land maintenance needs and costs, has the lowest ranking priority (Table 3).

Similar to other restoration planning efforts, the prioritization scores and resulting project ranking are not intended to as the final judgement regarding order of implementation for protection and restoration decisions (Bradbury et al. 1995, Voight and Waldvogel 2002, Lang 2005). Landowner interest, professional judgment, opportunities created by scheduled maintenance or construction, and restoration emphasis in a particular watershed by multiple agencies or stakeholders should be factored into implementation decisions. Thus, these prioritization rankings provide an opportunity to discuss the benefits and opportunities that different projects offer for improving fish habitat and stream function but not necessarily a mandate for restoration actions. Notwithstanding, projects that received high scores are likely to have the most benefit to salmonid population recovery.

Project Scores

Finally, two scores were calculated for each project to establish a project ranking; a biological score and a total score. The Biological score was calculated by adding results for questions 1-4. The Total score was calculated by combining the Biological score with results for questions (5-6) (see Appendix B, example score card). The formulation of both a Total Score and a Biological Score will allow for a project to be evaluated on its biological merit alone. Since land ownership, opinions, and land management goals may change over time, the biological impacts and benefits of a project are static. Final project rankings are based on their biological and total score to determine priority with the highest scores having the highest priority.

Table 3. The weights provided by the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), Del Norte Resource Conservation District (RCD), and Tolowa Dee-ni' Nation (TDN) averaged and used in the project scoring process.

Ranking Criteria		NMFS	CDFW	RCD	TDN	Average weight	Rank
<i>Current Biological and Ecological Resources</i>							
1	What is the level of immediate benefit of the project?	10	6.5	5	9.8	7.825	3
2	Besides benefiting salmonids are other species or ecosystem needs met by the project?	5	7	6	8.7	6.675	5
3	What is the magnitude of benefit for anadromous species?	10	10	7	6.6	8.40	2
<i>Integrity and Risk</i>							
4	Does the project restore natural channel function and directly address a cause of habitat degradation?	8.5	10	8	7.4	8.475	1
<i>Optimism and Potential for protection and restoration</i>							
5	Does the project minimize future land maintenance needs and costs?	3	6.5	10	1.8	5.325	6
6	Does the project have landowner support?	5	7	10	7.6	7.40	4

Project Ranking Survey Questionnaire

Current Biological and Ecological Resources

1. How quickly will salmonids benefit from the project? If the project is conducted, what is the likelihood that anadromous species will immediately recruit into/benefit from the project? Consider whether or not there are barriers located downstream of project area and the diversity of species and life stages recently observed in the area.

1 = Benefit will take > 5 years to occur.

2 = Benefit within 4 years.

3 = Benefit within 2 years.

4 = Benefit within 1 year.

5 = Immediate benefit.

2. Besides benefiting salmonids, how many other species or ecosystem needs are met by the project? Consider if the project will result in improved water quality, channel function, removal of invasive plant species, and habitat creation for other California Species of Special Concern such as Pacific lamprey, red-legged frogs, yellow-legged frogs, and willow flycatchers.

1 = Only one ecological benefit of project (e.g., salmonids only).

2 = Project provides 2 benefits (e.g., salmonids and water quality).

3 = Project provides 3 benefits (e.g., salmonids, other aquatic species, and water quality).

4 = Project provides 4 benefits (e.g., salmonids, other aquatic species, terrestrial species, and water quality).

5 = Project provides 5 benefits (e.g., salmonids, other aquatic species, terrestrial species, water quality, and invasive plant species removal).

3. What is the magnitude of benefit for anadromous species? Consider the size of the project area, the amount of habitat that becomes available due to the project, and the life stages that will benefit from the project (i.e., juvenile and/or adult). Also, consider the percentage of the drainage impacted by the project and the quality of the current habitat in the sub-basin.

1 = Improves a minimal amount of the sub-basin is impacted (<10%) and only one life stage benefits.

2 = Improves 10 - 50 % of the sub-basin and only one life stage benefits.

3 = Improves 10 - 50% of the sub-basin and all life stages benefit.

4 = Improves at least 50% of the sub-basin and only one life stage benefits.

5 = Improves at least 50% of the sub-basin and all life stages benefit.

Integrity and Risk

4. Does the project restore natural channel function? Consider if the project will directly address causes of habitat degradation. For example, does the project reduce sources of sediment from negatively impacting the channel or only remove the sediment currently in the channel. Will the project have short-term (<5 years) or long-term (> 5 years) benefits. Does the project reduce the likelihood of invasive plant species from thriving in the stream and riparian corridor or will continued restoration efforts be required. If a project protects pristine habitat it should rank the highest possible as it will directly prevent future habitat degradation.

1 = Short-term benefit that does not address cause of degradation.

- 2 = Short-term benefit that addresses the cause of degradation.
- 3 = Long-term benefit that does not address the cause of degradation.
- 4 = Long-term benefit that addresses the cause of degradation.
- 5 = Permanent protection and benefit to stream network. Addresses cause of habitat degradation.

Optimism and Potential for protection and restoration

5. Does the project minimize future land maintenance needs and costs? Consider if the project will result in long-term reduced maintenance cost to the landowner or reduced negative impacts such as flooding.

- 1 = Long-term maintenance costs or negative impacts will be increased by project implementation (i.e., cost to landowner).
- 2 = Long-term maintenance costs and negative impacts will not be altered (i.e., no benefit/change to landowner).
- 3 = Negative impacts such as flooding will be reduced but long-term maintenance costs will not be impacted.
- 4 = Maintenance costs will be reduced but no reduction in negative land impacts.
- 5 = Project will result in reduced future maintenance costs and negative impacts for landowner.

6. Does the project have local landowner support? Consider the landowners interest in the project and if the project will support the local culture and customs of the current land use and land management goals.

- 1 = Landowner is not interested in advancing the project and the project would cause negative impacts to the local culture and customs/land management goals.
- 2 = Landowner is interested in discussing project further, but the project would cause negative impacts to the local culture and customs/land management goals.
- 3 = Landowner is not interested in advancing the project, but the project would benefit the local culture and customs/land management goals.
- 4 = Landowner is interested in discussing the project further and the project would benefit the local culture and customs/land management goals.
- 5 = Landowner supports the project and would agree to immediate actions, and the project would benefit the local culture and customs/land management goals.

Results

This planning effort identified and ranked 137 potential projects across the Smith River Plain (Figure 5). The planning area is segmented into eight sub-basins and the number of projects by sub-basin varies relative to the amount of anadromous stream miles (Table 4, Figure 5, Appendix A, Appendix C). The number of projects per sub-basin ranges from 16 to 34. Not all sub-basins have projects of all project types (Table 4). The projects have been grouped into five different project types. The number of projects by type are: 29 riparian, 33 channel complexity, 63 fish passage, 8 invasive plant removal, and 4 water quality/quantity projects.

Based on the ranking criteria, channel complexity and passage projects consistently ranked higher than the other three project types. Generally, these higher ranked projects have a more immediate benefit to salmonids or more directly address the causes of channel and habitat degradation than the other three project types (Appendix A). Moreover, the furthest downstream projects generally rank higher than those upstream because the upstream projects impact a smaller quantity of habitat. Restoration practitioners typically follow the progression of working in a downstream to upstream fashion so that fish can access newly available/restored habitat.

No natural grouping emerged based on breaks on project scores, which are on a continuous range. Rather projects were grouped equally into three categories; high, medium and low priority. The 46 highest scoring projects are identified as high priority, projects 47 - 92 are medium priority and 93 - 137 are lowest priority (Appendix A). The maximum possible biological score was 156.88 and the actual project biological scores ranged from 54.11 - 99.58 (Appendix A). The maximum possible total score was 220.50 and the actual total project scores ranged from 80.73 - 155.81.

Overall, landowners are interested in learning more about opportunities to move projects forward on land they own. Interest is highest where project benefits both natural resources and allows for ongoing operation of their property. A number of projects identified historic and recurring land management issues for landowners (i.e., flooding, failing culverts, reed canary grass management).

Additionally, there are eight basin wide recommendations based on identification of recurring project needs and data shortfalls, where further research or monitoring would inform additional restoration goals.

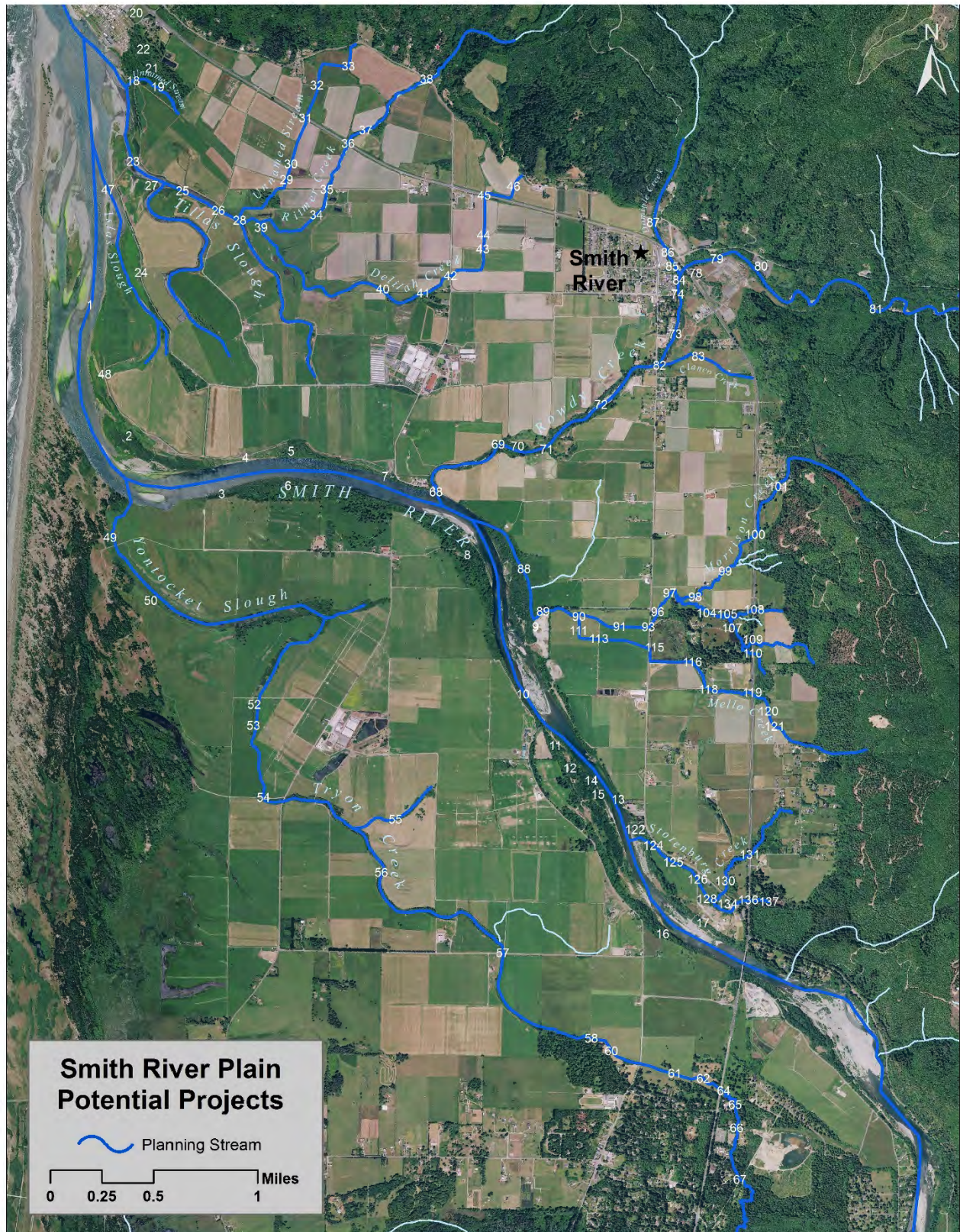


Figure 5. Map of all streams included in the planning area with general location of the identified and ranked projects identified by their project number in white, Smith River Plain, Del Norte County, CA.

Table 4. Summary of total number of projects and project types identified in each sub-basin and in each unique stream across the planning area.

Stream	Total projects	Riparian	Channel Complexity	Passage	Invasive Plant Removal	Water Quality and Quantity
Mainstem/Estuary (up to Hwy 101)	17	9	6	2	0	0
Unnamed estuary stream	5	2	2	1	0	0
Tillas Slough sub-basin	24					
Tillas Slough	6	1	1	3	1	0
Unnamed Tillas Slough Tributary	4	1	1	2	0	0
Ritmer Creek	6	1	0	4	0	1
Delilah Creek	8	1	1	6	0	0
Islas Slough	2	0	2	0	0	0
Tryon Creek sub-basin	19					
Yontocket Slough	2	1	0	0	1	0
Tryon Creek	16	2	4	9	1	0
Unnamed Tyon Creek Tributary	1	0	0	1	0	0
Rowdy Creek sub-basin	20					
Rowdy Creek	14	2	8	1	1	2
Dominie Creek	4	0	1	3	0	0
Clanco Creek	2	1	1	0	0	0
Morrison Creek sub-basin	34					
Morrison Creek	15	2	3	7	2	1
Mello Creek	10	1	1	7	1	0
Unnamed Morrison Creek Tributary	9	2	0	6	1	0
Stotenburg Creek sub-basin	16					
Stotenburg Creek	10	1	2	7	0	0
Unnamed Stotenburg Creek Tributary	6	2	0	4	0	0
Total	137	29	33	63	8	4

Passage Improvement Projects

A total of 77 potential stream crossings were identified, 10 of which had previously been surveyed to assess fish passage and listed in the California Department of Fish and Wildlife's Passage Assessment Database (PAD) (CDFW 2018). Based on field surveys and landowner feedback, there are two tide gates, 16 bridges, seven fords, 47 culverts, three concrete skirts/channel spanning infrastructures, and three crossings of unknown type in the planning area. With landowner's permission, 28 crossings were surveyed to assess fish passage. Using FishXing, two of the 28 crossings were classified as total barriers to all fish life stages and 15 were identified as partial barriers (Appendix D Appendix C). Based on information provided by landowners and past observations, we believe there are an additional nineteen crossings that are partial fish barriers (Appendix D). All of these crossings were included and ranked as potential projects. Additionally, crossings previously surveyed and identified as barriers in the PAD were included as projects.

Culverts not identified as fish barriers but determined to be undersized and unable to accommodate the 100-year flow were also included and ranked as two potential projects. Additionally, due to their potential impacts to natural hydrologic processes and sediment inputs, bridges and fords shown to constrict or impact the active channel were included as potential projects regardless of their passage status. However, some fords and bridges are classified as channel complexity projects based on surrounding channels lacking complexity. Last, four surface water diversions were assessed and three were included as potential projects based on their need for fish screening improvements. Diversions are considered passage projects consistent with other local salmonid recovery plans (CDFW 2004a, NOAA 2014).

Combined barriers, undersized crossings, and diversions resulted in 63 identified and ranked passage projects across the planning area (Table 4). All sub-basins had a potential passage project located on at least one stream. The downstream most passage concern ranked highest on each stream that had an identified potential passage project (Appendix A). The locations mapped for these projects represent the locations of the crossings (Figure 5, Appendix C, Appendix D).

Riparian Enhancement and Protection Projects

We identified and ranked a total of 29 potential riparian projects based on the current condition and width of riparian vegetation from the edge of the stream channel (Table 4). Locations where native riparian forest is present at least 164 feet away from the edge of the active channel resulted in 11 potential projects to protect or conserve these areas. Additionally, any riparian zone should be protected when possible due to the multitude of ecosystem services provided by this vegetative buffer between the terrestrial and aquatic environments. Locations where native riparian vegetation is lacking throughout the 35-foot buffer area resulted in 18 potential projects to enhance riparian vegetation. Additionally, 10 of these sites lack fencing and cattle can access the stream, with two locations including fords. Invasive vegetation, including reed canary grass and Himalayan blackberry, commonly dominate the potential project locations where streamside vegetation lacks native riparian vegetation. The 100-foot buffer was not used to identify any projects. Rather this served as a tool to show landowners the potential area impacted by a 100-foot riparian buffer. The locations for these projects represent the general area and are not exact locations as the distance along the

stream potentially protected or enhanced varies and cannot be shown by a single location (Figure 5, Appendix C).

Invasive Plant Removal Projects

We identified eight locations where invasive plants are negatively impacting natural ecosystem processes and biodiversity. Only locations with reed canary grass, yellow flag iris, and eucalyptus were included as potential project areas. Reed canary grass is the primary invasive plant species of concern and was included in six of the potential invasive plant projects. Reed canary grass affects portions of all streams in the planning area except Rowdy, Dominie, and Stotenburg Creeks (Table 4). Additionally, all projects with yellow flag iris overlapped with reed canary grass presence. Eucalyptus is rare in the planning area, only present in the Morrison and Rowdy Creek sub-basins, and resulted in two identified potential projects. Notwithstanding, these locations contain eucalyptus dominated forest stands that are expanding and outcompeting native vegetation. The locations for these projects represent the general area and are not exact locations as the distance along the stream potentially protected or enhanced varies and cannot be shown by a single location (Figure 5, Appendix C).

Channel Complexity Improvement Projects

We identified and prioritized 33 potential projects to enhance channel complexity based on our evaluation of historic channel condition and available data on habitat and channel condition (Table 4). Of these 33 projects, eight are focused on enhancing backwater/off channel habitat, eight are focused on enhancing floodplain connectivity, and 17 focused on enhancing channel and instream structure. Many of these projects are adjacent to riparian enhancement projects. Upon implementation, pairing these projects would be most efficient and effective. The locations for these projects represent the general area and are not exact locations as the distance along the stream potentially protected or enhanced varies and cannot be shown by a single location (Figure 5, Appendix C).

Sea-level Rise Recommendations

No potential projects were identified as a result in areas potentially impacted by sea-level rise due to uncertainty in predictions and future conditions. However, based on Seal Level Rise Mapping Tool, numerous identified projects would overlap sea-level rise of 6 feet (Figure 6). An even larger portion of the project area would be impacted if the predictions under high greenhouse gas emissions conditions of 9.3 feet sea-level rise by 2100 are accurate (OPC 2017). Restoration actions can be taken to reduce the potential negative impacts of sea-level rise. For example, restoring channel complexity and floodplain connection are tools to increase resilience to sea-level rise. As is advised by OPC (2017), restoration projects should consider sea-level rise projects and evaluate potential impacts across various predictions. The lifespan of the project and aversion risk should also be considered when making restoration decisions. The Sea Level Rise Mapping Tool provided by the NOAA Office for Coastal Management provides a tool for planners to quickly visualize inundation and elevation data. This tool can be used to determine if projects are located in flood prone areas potentially threatened by coastal flooding or sea level rise.

Water Quality and Quantity Improvement Projects

We identified and prioritized four potential projects to improve water quality and quantity (Table 4). While overall water quality is high, isolated areas potentially impacting water quality are present and can contribute to decreased water quality of the estuary and coastal plain. Examples include: agricultural production; old and failing septic systems in and around the towns of Crescent City, Gasket, and Smith River; and the Rowdy Creek Fish Hatchery.

The 2010 Statewide integrated report determined that no sub-basin should be listed as an impaired water body by any pollutant evaluated in section 303(d) under the California Clean Water Act (CWB 2016). This evaluation includes various pollutants such as nitrates, metals, pesticides, dissolved oxygen, pH, temperature, and total dissolved solids. However, many of the streams in the Smith River Plain are not included in this 2010 evaluation. Furthermore, possible sources of contamination are typically isolated and restoration could make substantial benefits to the water quality.

Recent water quality monitoring found some water quality samples to be above EPA standards (CWB 2018, NOAA 2018a). However, extremely low conductivity and hardness of the source waters added uncertainty to sampling results (CWB 2018). These findings suggest some waters of the Smith River Plain would benefit from continued water quality monitoring to evaluate pollutant loads and to determine where restoration actions or implementation of best management practices (BMP) would benefit water quality conditions. Baseline monitoring is needed to develop a management plan and evaluate the effectiveness of BMPs and restoration actions.

Further sampling will help to determine water quality standards and TMDL levels. In the interim, potential projects with the use BMPs of can minimize inputs from point and non-point pollution sources that reduce water quality. Additionally, flow paths have historically been altered to accommodate land use needs. These modifications could potentially be adjusted to increase the duration of surface flows in intermittent anadromous streams for the purpose of extending the fish migration period during the spring months. A hydrologic assessment in the Tillas Slough and Morrison Creek sub-basins would help identify and refine where these opportunities exist.

Lastly, the highest density of impervious surfaces is located around Rowdy and Dominie Creeks due to rural and commercial infrastructure. Some of this development is immediately adjacent to the streams with no filter or riparian buffer area present. The old timber mill site contains at least 15 acres of unused impervious surface within the Rowdy Creek floodplain. This results in increased runoff and loss of off-channel floodplain habitat. Incorporating low impact development practices around existing and future infrastructure can increase water quality and quantity.

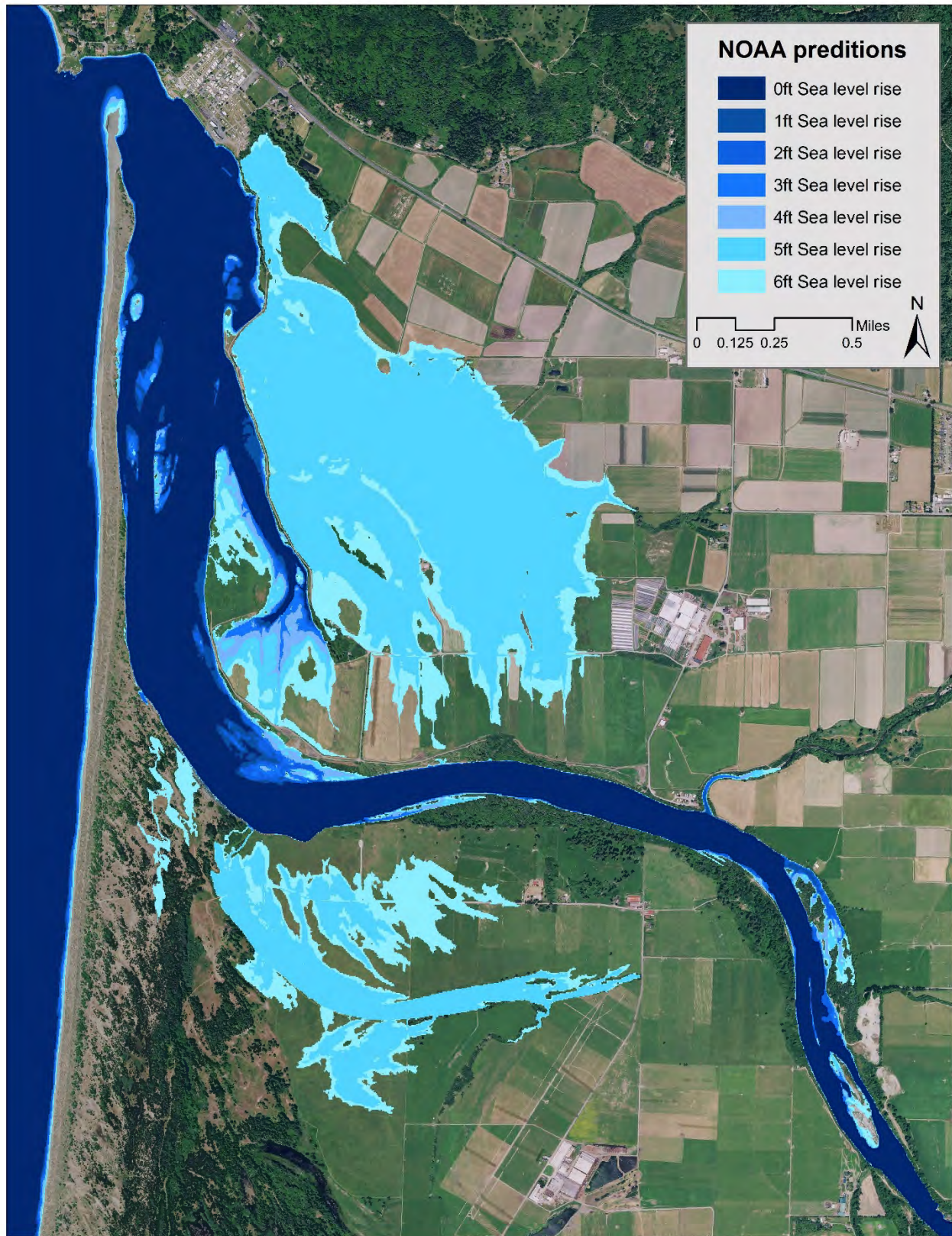


Figure 6. Sea level rise in 1 foot increments from 1-6 feet in the Smith River Plain based on NOAA Office for Coastal Management Digital Coast Sea Level Rise Viewer (NOAA 2018b).

Basin-wide Recommendations

In addition to the individual restoration projects that have been evaluated and prioritized, there are eight basin-wide projects that deserve mention (Appendix A). We identified these based on data shortfalls, potential threats from invasive species, and common channel conditions that minimize natural function of the stream channels across the planning area. These projects were not prioritized but should be considered when planning during future development, monitoring, and restoration projects.

1. *Prevent the spread and introduction of invasive species by developing species specific plans like a Reed Canary Grass Management Plan.* Preventing the spread and introduction of invasive species is vital to maintaining the resilience and health of the Smith River Plain stream ecosystems and native species. In particular, the presence and spread of reed canary grass results in decreased channel capacity, increased channel aggradation, reduced water quality, and competition with native vegetation. Reed canary grass is difficult to remove and manage and is present throughout most streams in the planning area. A management plan that identifies effective and efficient techniques to remove and manage this invasive plant is needed to help restore natural stream health and hydrologic function.
2. *Prepare a Bull Frog Prevention Plan.* The American bullfrog (*Lithobates catesbeianus*) is an invasive non-native species in California that is a predator and known to contribute to the decline of native aquatic and terrestrial species, including salmonids. In the Pacific Northwest bullfrog tadpoles take approximately two years to metamorphose. Hence, they require year-round ponded water to successfully reproduce. Within the Smith River basin bullfrogs have only been detected in Rattlesnake Lake but are likely to be in other suitable locations not yet documented. The agricultural water infrastructure (i.e., perennial ponds) provide potential habitat for the expansion of the American bullfrog in the basin. A prevention plan that includes education and outreach will assist in early detection and rapid response if the species spreads into the planning area. A comprehensive response is the best way to prevent this species from becoming established on the Smith River Plain.
3. *Floodplain and Channel Structure – Increase channel complexity.* All sub-basins in the planning area have areas with simplified channels. Restoration project planning should incorporate practices that restore processes that will restore natural stream and ecological function should be considered. Any project along the streams or riparian areas should incorporate practices that restore processes that will maintain natural stream and ecological function whenever possible. Consulting with natural resource specialists early and often during project development will help incorporate a variety of ecological considerations thereby providing the maximum benefit to the ecosystem.
4. *Improve water quality by reducing pollutants and erosion.* All sub-basins in the planning area have areas with potential sources of non-point pollution. Increasing implementation of best management practices across the Smith River Plain can aid in reducing delivery of pollutants and sediment to streams.
5. *Increase instream flows during fish migration periods.* All sub-basins in the planning area have areas with altered hydrology. Many of the coastal streams dry by mid-summer. Working to identify ways to maintain surface connection and fish passage during the spring while juveniles continue to migrate downstream can increase juvenile salmonid survival.

Recent monitoring and planning efforts have provided a wealth of data on the aquatic environment of the Smith River Plain. Nevertheless, data gaps still exist and we recommend three areas in particular where additional data is needed.

6. *Passage assessment - Survey remaining unassessed crossings in the Smith River Plain.* There are stream crossings that still have not been surveyed for passage. Where access permits, surveys should be conducted to fill this data gap to help inform restoration needs.
7. *Collect Lamprey Distribution Data.* Lamprey are an anadromous species that relies on high water quality, and given their life history, access to quality perennial stream habitats across the Smith River basin. Data is lacking on lamprey distribution and habitat availability throughout the Smith River basin, particularly in the Smith River Plain. Increased knowledge of lamprey presence will aid in informing management and restoration actions in the basin.
8. *Effects of Pinniped and Avian Predation on salmonids.* Little is known regarding the interplay between salmonid habitats and predation effects by pinniped and avian predators in the lower Smith River. Data allowing for the analysis of predator impacts in the estuary and coastal plain can aid in informing management and restoration techniques to protect Smith River salmonid populations.

Implementation Recommendations

The purpose of this plan was to identify and prioritize potential projects along anadromous streams that focus on restoring, protecting and enhancing natural stream function, long-term ecosystem health, water quality, salmonid recovery, and biodiversity across the Smith River Plain. By evaluating the historic and current conditions of the anadromous streams in the planning area we identified 137 potential projects. There is no regulatory nexus mandating an implementation timeline for the identified projects. Rather, the intent of the developed ranking criteria was to prioritize restoration opportunities based on their ability to enhance habitat for anadromous species, while considering possible multi-benefits of a project and landowner feedback.

The majority of the potential conservation and restoration projects identified in this plan are located on private land and require voluntary landowner participation to advance and implement any actions. Conservation and restoration practitioners should use this plan as a guide to work with landowners to identify and advance alternatives that are compatible with the landowner needs while also meeting salmonid and natural resource improvement goals. This will require careful consideration for the needs of the working lands while evaluating the current and desired future conditions of the anadromous waterways.

This report makes no recommendations on what techniques should be used to construct or fund the identified projects, however, best management practices should be used if they have been developed for the restoration technique. Furthermore, assessing the surrounding project area (i.e., slope, soil, vegetation, land use) will be needed to determine restoration techniques needed to reach restoration goals. Based on the SONCC coho salmon recovery plan (NOAA 2014) it is estimated that a total of \$136 million is needed to conduct recovery actions throughout the Smith River basin to restore the coho salmon population. Based on the estimated costs of the recovery tasks located in the Smith River Plain (NOAA 2014), approximately \$20.5 million is needed to complete the identified projects in this plan. Due to this high cost, restoration opportunities created by scheduled

maintenance or construction should be utilized to address identified projects whenever possible. Efforts should focus first on high priority projects due to limited funding and the status of the coho salmon population in the basin. Moreover, many projects are located in close proximity to other potential projects and should be grouped when possible to increase efficiency and reduce costs.

This report also makes no recommendation on the timeline for which projects should be implemented. Projected dates for developing and implementing restoration and monitoring measures should include short-term (up to 3 years) and long-term (up to 10 years) goals. Creating milestones, phases, and steps for action with landowners will help to identify when management and maintenance opportunities exist to address identified projects. Collaborating with neighboring landowners and stakeholders can help forecast programmed maintenance work (e.g. CalTrans, Del Norte County Roads). A collaborative effort will help to maximize funding and resource allocation. When advancing any project, criteria should be developed to evaluate if restoration goals are met and include monitoring to evaluate effectiveness of restoration efforts.

This planning process is one step toward advancing stream restoration and increased health of the aquatic ecosystems in the Smith River Plain. Continued consideration and discussion between landowners and other stakeholder groups is needed as projects are advanced to identify and evaluate project alternatives that have the potential to result in multiple benefits for natural resources as well as the community. Considerations should not be limited to the immediate project area but consider impacts to the neighboring and larger landscape as a whole.

This planning element is part of a larger ongoing process that should be followed up with implementation and re-evaluation as projects are completed and when physical and biological monitoring provides feedback to inform the adaptive management and next steps in the planning process. Achieving ecosystem resiliency in a working landscape will be achieved at the highest level by identifying a multitude of resource goals and needs that enhance the ecosystem and provide broad benefits rather than working for a single resource concern. Through partnership engagement in the planning and implementation process resources, skills and expertise provided by stakeholders will inform and improve the process.

Ultimately implementation of the identified projects will require landowner cooperation and will be most effective when conducted with restoration and natural resource professionals. Education, outreach, and partnership among all interested parties is essential to most effectively and efficiently reaching desired outcomes. Success of the plan requires continued short-term and long-term planning by landowners and stakeholders that together will develop and implement plans to restore, protect, and enhance natural resources while accounting for social and economic needs in the Smith River Plain.

Literature Cited

- Bilkovic, D. and M. Roggero. 2008. Effects of Coastal Development on Nearshore Estuarine Nekton Communities. *Marine Ecology Progress Series*, Inter-Research 358:27-39.
- Beechie, T., E. Beamer, B. Collins, and L. Benda. 1996. Restoration of habitat-forming processes in Pacific Northwest watersheds: a locally adaptable approach to salmonid habitat restoration. Pages 48–67 in D. L. Peterson and C. V. Klimas, editors. *The role of restoration in ecosystem management*. Society for Ecological Restoration, Madison, Wisconsin.
- Beechie, T. G. Pess, P. Roni, and G. Giannico. 2008. Setting river restoration priorities: A review of approaches and a general protocol for identifying and prioritizing actions. *North American Journal of Fisheries Management* 28:3, 891-905.
- Belt, G., J. O’Laughlin, and T. Merrill. 1992. Design of forest riparian buffer strips for the protection of water quality: Analysis of scientific literature. Idaho Forest, Wildlife and Range Policy Analysis Group, Report No. 8.
- Bharati, L., K. H. Lee, T. M. Isenhardt, and R. C. Schultz. 2002. Soil-water infiltration under crops, pasture, and established riparian buffer in midwestern USA. *Agroforestry Systems* 56(3):249-257.
- Blinn, C. R., and M. A. Kilgore. 2001. Riparian management practices: A summary of state guidelines. *Journal of Forestry* 99(8):11-17.
- Bradbury, B., W. Nehlsen, T.E. Nickelson, K. M. S. Moore, R.M. Hughes, D. Heller, J. Nicholas, D. L. Bottom, W.E. Weaver, R.L. Beschta. 1995. *Handbook for Prioritizing Watershed Protection and Restoration to Aid Recovery of Native Salmon*. Pacific Rivers Council, Portland, Oregon. 56 p.
- Brinson, M.M., L.J. MacDonnell, D.J. Austen, R.L. Beschta, T.A. Dillaha, D.A. Donahue, S.V. Gregory, J.W. Harvey, M.C. Molles Jr, E.I. Rogers, J.A. Stanford and L.J. Ehlers. 2002. *Riparian areas: functions and strategies for management*. National Academy Press, Washington, D.C.
- Broadmeadow, S., and T. R. Nisbet. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practices. *Hydrology and Earth System Sciences* 8(3):286-305.
- Brososke, K.D., J. Chen, R.J. Naiman, and J.F. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in western Washington. *Ecological Applications* 7:1188-1200.
- Bukaveckas, P. 2007. Effects of Channel Restoration on Water Velocity, Transient Storage, and Nutrient Uptake in a Channelized Stream. *Environment Science Technology* 41 (5):1570-1576.
- Burnett, K., G. Reeves, D. Miller, S. Clarke, K. Vance-Borland, and K. Christiansen. 2007. Distribution of salmon-habitat potential relative to landscape characteristics and implications for conservation. *Ecological Applications* 17:66-80.
- California Data Exchange Center (CDEC). 2017. 2017 Water Year Monthly Precipitation. California Department of Water Resources.
<http://cdec.water.ca.gov/cgi-progs/reports/PRECIPOUT.BSN.2017>
- California Department of Fish and Wildlife (CDFW). 2004a. Recovery Strategy for California Coho Salmon. California Department of Fish and Wildlife. 594 p.
- California Department of Fish and Wildlife. 2004b. California Salmonid State Habitat Restoration Manual, Part IX: Fish Passage Evaluation at Stream Crossings. Prepared by Ross Taylor and Michael Love. California Department of Fish and Wildlife. 99p.
- California Department of Fish and Wildlife. 2009. California Salmonid Stream Habitat Restoration manual: Part XII Fish Passage Design and Implementation. 189p.
- California Department of Fish and Wildlife. 2014. Technical Memorandum: Development, Land Use, and Climate Change Impacts on Wetland and Riparian Habitats – A Summary of Scientifically Supported Conservation Strategies, Mitigation Measures, and Best Management Practices. California Department of Fish and Wildlife, Northern Region.
- California Department of Fish and Wildlife. 2015. State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians. Edited by Armand G. Gonzales and Junko Hoski, PhD. Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA.

- California Department of Fish and Wildlife. 2018. Passage Assessment Database. <https://nrm.dfg.ca.gov/PAD/>.
- California Invasive Plant Council (CIPC). 2017a. IPCW Plant Report: *Iris pseudacorus*. <http://www.cal-ipc.org/plants/profile/iris-pseudacorus-profile/>. Accessed on May 16, 2018.
- California Invasive Plant Council (CIPC). 2017b. IPCW Plant Report: *Eucalyptus globulus*. <http://www.cal-ipc.org/resources/library/publications/ipcw/report48/>. Accessed on May 16, 2018.
- California Natural Diversity Database (CNDDB). 2017. California Department of Fish and Wildlife, Natural Diversity Database. October 2017. Special Animals List. Periodic publication. 65 pp.
- California Natural Resources Agency (CNRA). 2016. California Water Action Plan 2016 Update. California Natural Resource Agency, California Department of Food & Agriculture, California Environmental Protection Agency. Sacramento, CA. 25 p.
- California Water Board (CWB). 2016. Final 2014 and 2016 Integrated Report Clean Water Act Section 303(d) List/305(b) Report. https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml
- California Water Board (CWB). 2018. Smith River Plain Surface Water and Sediment Monitoring Report. Prepared by: North Coast Region, Surface Water Ambient Monitoring Program. SWAMP-MR-RB1-2018-0001. 93p.
- Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, M. Witter, S. Mauermann, T. Erickson, S.S. Cooke. 1992. Wetlands buffers use and effectiveness. Adolfson Associates, Inc., Shorelands and Coastal Zone Management Program, Washington Department of Ecology, Olympia, WA. Pub. No. 92-10.
- Castelle, A. J., A. W. Johnson, and C. Conolly. 1994. Wetland and stream buffer size requirements- A review. Journal of Environmental Quality 23:878-882.
- Collier, K. J., A. B. Cooper, R. J. Davies-Colley, J. C. Rutherford, C. M. Smith, and R. B. Williamson. 1995. Managing riparian zones: A contribution to protecting New Zealand's rivers and streams. Vol. 1: Concepts. Department of Conservation, Wellington, NZ.
- County of Del Norte (CDN). 2003. Del Norte County General Plan. January 28, 2003. County of Del Norte, Crescent City, CA. 194 p.
- Culp, J. and R. Davis. 1983. An assessment of the effect of streambank clearcutting on macroinvertebrate communities in a managed watershed. Canadian Technical Report of Fisheries and Aquatic Sciences 1209.
- Davies, P. E., and M. Nelson. 1994. Relationships between riparian buffer widths and the effects of logging on stream habitat, invertebrate community composition, and fish abundance. Australian Journal of Freshwater Resources 45:1289-1305.
- Dawdy, D.R. 1989. Feasibility of mapping riparian forests under natural conditions in California. pages 63-68 in: Proceedings of the California Riparian Systems Conference. GTR PSW-110. Davis, CA.
- Day J., B. Crump, W. Kemp, and A. Yanez-Arancibia. 2013. Estuarine Ecology, 2nd edition. Wiley-Blackwell.
- Del Norte United Dairy Association (DNUDA). 2013. Del Norte Surface and Ground Water Group Monitoring Quality Assurance Project Plan. Submitted to: North Coast Regional Water Quality Control Board. 37 p.
- Delattre, M. and A. Rosinski. 2012. Preliminary geologic map of the onshore portions of the Crescent City and Orick 30' x 60' quadrangles, California. California Department of Conservation California Geological Survey. 15p.
- Desbonnet, A., P. Pogue, V. Lee, and N. Wolf. 1994. Vegetated buffers in the coastal zone: A summary review and bibliography. Coastal Resources Center Technical Report No. 2064. University of Rhode Island Graduate School of Oceanography, Narragansett, RI.
- Dillaha, T. A., R. B. Reneau, S. Mostaghimi, and W. L. Magette. 1987. Evaluating nutrient and sediment losses from agricultural lands: Vegetative filter strips. U.S. Environmental Protection Agency CBP/TRS 4/87.
- Dosskey, M. G., M. J. Helmers, and D. E. Eisenhauer. 2008. A design aid for determining width of filter strips. Journal of Soil and Water Conservation 63(4):232-241.
- Elliot, S. 1986. Reduction of a Dolly Varden population and macrobenthos after removal of logging debris. Transactions of the American Fisheries Society 115:392-400.
- Environmental Systems Research Institute, Inc. (ESRI). 2017. Version 10.3.1. Redlands, CA.
- Erman, D. C., J. D. Newbold, and K. B. Roby. 1977. Evaluation of streamside buffer strips for protecting aquatic organisms. California Water Resource Center, University of California, Davis, CA.

- Fischer, R.A., C.O. Martin, and J.C. Fischenich. 2000. Improving riparian buffer strips and corridors for water quality and wildlife. pages 457-62 in: P.J. Wigington and R.L. Beschta, Riparian Ecology and Management in Multi-Land Use Watersheds. American Water Resources Association. Middleburg, VA.
- GHD. 2015. Report for Smith River Rancheria – Rowdy Creek Fish Passage Improvement Project. California Department of Fish and Wildlife Fisheries Restoration Grant Program. 317 p.
- Garwood, J. and S. Ricker. 2011. Spawner survey sample frame development for monitoring adult salmonid populations in California. California Department of Fish and Game, Anadromous Fisheries Resource and Monitoring Program, Arcata, CA. 19 p.
- Garwood, J. 2012. Historic and Recent occurrence of coho salmon (*Oncorhynchus kisutch*) in California streams within the Southern Oregon/Northern California Evolutionarily Significant Unit. California Department of Fish & Wildlife, Fisheries Branch Administrative Report, 2012-03. 81p.
- Garwood, J. and S. Bauwer. 2013. Field Note: Juvenile coho salmon detections in an Unnamed Tributary to the Smith River, Smith River, California. California Department of Fish & Wildlife, Arcata, CA.
- Garwood, J. and M. Larson. 2014. Reconnaissance of Salmonid Redd Abundance and Juvenile Salmonid Spatial Structure in the Smith River with Emphasis on Coho Salmon (*Oncorhynchus kisutch*). Final report to the California Department of Fish and Wildlife, Fisheries Restoration Grants Program: P1310518, Arcata, CA. 71p.
- Garwood, J., M. Parish, J. Walkley, and Z. Larson. 2014. Summer stream temperature profiles in the Smith River basin from 2009 to 2013. California Department of Fish and Wildlife. 13p.
- Goodman, D.H. and S.B. Reid. 2012. Pacific Lamprey (*Entosphenus tridentatus*) Assessment and Template for Conservation Measures in California. U.S. Fish and Wildlife Service, Arcata, California. 117 p.
- Gould, R.1984. "Indian and White Versions of "The Burnt Ranch Massacre: A Study in Comparative Ethnohistory" Journal of the Folklore Institute, 3:1: 30-42. excerpted at <http://eee.uci.edu/clients/tcthorne/anthro/gouldburntranch.html>
- Griggs, G., J. Arvai, D. Cayan, R. DeConto, J. Fox, HA. Fricker, RE. Kopp, C. Tebaldi, EA. Whiteman (California Ocean Protection Council Science Advisory Team Working Group). 2017. Rising Seas in California: An update on Sea-Level Rise Science. California Ocean Science Trust, April 2017.
- Haycock, N. E., and G. Pinay. 1993. Groundwater nitrate dynamics in grass and poplar vegetated riparian buffers during the winter. Journal of Environmental Quality 22:273-278.
- 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.
- Hewitt, A. J. 2001. Drift filtration by natural and artificial collectors: A literature review. Stewart Agricultural Research Services, Inc., Macon, MO.
- Hill, A. R. 1996. Nitrate removal in stream riparian zones. Journal of Environmental Quality 25(4):743:755.
- Karr, J. R., and I. J. Schlosser. 1977. Impact of near stream vegetation and stream morphology on water quality and stream biota. United States Environmental Protection Agency, editor. Ecological Research Series.
- Katibah, E.F. 1984. A brief history of riparian forests in the Central Valley of California. pages 23-29 in: R.E. Warner and K.M. Hendrix (eds) California riparian systems: ecology, conservation and productive management. University of California Press, Berkeley, CA.
- Koski, K. 2009. The fate of coho salmon nomads: the story of an estuarine-rearing strategy promoting resilience. Ecology and Society 14 (1): 4.
- Kuenzler, E., P. Mulholland, L. Ruley, and R. Sniffen. 1977. Water Quality of North Carolina Coastal Plain stream and effects of channelization. University of North Carolina. Project No. B-084-NC. 178p.
- Laird, A., McBain & Trush Inc, and M. Parish (eds). 2014. Atlas of Historic Channel Planforms, Lower Reach of the Smith River. Prepared for the Smith River Alliance. 12p.
- Lake, P.S., N. Bond, and P. Reich. 2007. Linking ecological theory with stream restoration. Freshwater Biology 52: 597-615.
- Lang, M., M. Love, W. Trush. 2004. Improving Stream Crossings for Fish Passage. Final Report to National Marine Fisheries Service, Contract No. 50ABNF800082. Humboldt State University Foundation, Arcata, CA. 128p.

- Lang, M. 2005. California Department of Transportation (CalTrans) District 1 Pilot Fish Passage Assessment Study: Volume 1 – Overall Results. CalTrans, Sacramento, CA. 198pp.
- Levings, C. 2016. Ecology of salmonids in estuaries around the world. University of British Columbia. 371 pp.
- Ligon, F., A. Rich, G. Rynearson, D. Thornburgh, and W. Trush. 1999. Report of the scientific review panel on California forest practice rules and salmonid habitat. Prepared for the Resources Agency of California and the National Marine Fisheries Service, Sacramento, CA.
- Liquori, M., and C. R. Jackson. 2001. Channel response from shrub dominated riparian communities and associated effects on salmonid habitat. *Journal of the American Water Resources Association* 37(6):1639-1651.
- Love, M and Associated. 2018. Morrison Creek Restoration Planning Study, Smith River, Del Norte County, California. Prepared for: Smith River Alliance. 223p.
- Mayer, P. M., S. K. J. Reynolds, M. D. McCutchen, D. Marshall, and J. Timothy. 2005. Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: a review of current science and regulations. National Risk Management Laboratory, office of Research and Development U.S. Environmental Protection Agency, Cincinnati, OH.
- Micheli, E. R., J. W. Kirchner, and E. W. Larsen. 2004. Quantifying the effect of riparian forest versus agricultural vegetation on river meander migration rates, central Sacramento River, USA. *River Research and Applications* 20(5):537-548.
- Ministry of Natural Resources Ontario (MNRO). 1996. Natural Channel Systems: An Approach to Management and Design. Adaptive Management of Stream Corridors in Ontario: Section G Supporting Information. 116p.
- Mizuno, E. 1998. The physical habitat and biological communities of the Smith River estuary, California. [Thesis] Humboldt State University, Arcata, CA. 154p.
- Monroe, G, Mapes, B and P McLaughlin. 1975. Natural Resources of Lake Earl and the Smith River Delta. California Department of Fish and Game, Sacramento, CA. 114p.
- Moore A., and M. Palmer. 2005. Invertebrate biodiversity in agricultural and urban headwater streams: implications for conservation and management. *Ecological Applications* 15(4):1169-1177.
- Moore, R. D., D. L. Spittlehouse, and A. Story. 2005. Riparian microclimate and stream temperature response to forest harvesting: a review. *Journal of the American Water Resources Association* 41:813-834.
- Naiman, R.J., H. Decamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. *Ecological Applications* 3:209-212.
- Naiman, R. J., and H. Decamps. 1997. The ecology of interfaces: Riparian zones. *Annual Review of Ecology and Systematics* 28:621-658.
- Naiman, R.J., R.E. Bilby, and P.A. Bisson. 2000. Riparian ecology and management in the Pacific coastal rain forest. *BioScience* 50:996-1011.
- Naiman, R. J., E. V. Balian, K. K. Bartz, R. E. Bilby, and J. J. Latterell. 2002. Dead wood dynamics in stream ecosystems. USDA Forest Service General Technical Report PSW-GTR-181:23-48.
- National Oceanic and Atmospheric Administration (NOAA). 2001. Guidelines for Salmonid Passage at Stream Crossings. National Marine Fisheries Service. 14p.
- National Oceanic and Atmospheric Administration (NOAA). 2011. California Coast Light Detection and Ranging 2010-11. NOAA Office of Coastal Management.
- National Oceanic and Atmospheric Administration (NOAA). 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 Oceanic and Atmospheric Administration (NOAA). 2018a. Smith River Dissolved Copper Monitoring. Water Board Presentation, April 19, 2018.
- National Oceanic and Atmospheric Administration (NOAA). 2018b. Digital Coast: Sea Level Rise Viewer. NOAA Office for Coastal Management. <https://coast.noaa.gov/digitalcoast/tools/slr.html>
- National Park Service (NPS). 2014. Strawberry Creek Restoration Environmental Assessment. U.S. Department of the Interior, Redwood National Park, Humboldt County, California, February 2014. 150 p.
- Nieswand, G. H., R. M. Hordon, T. B. Shelton, B. B. Chavooshian, and S. Blarr. 1990. Buffer strips to protect water supply reservoirs: a model and recommendations. *Water Resources Bulletin* 26(6):959-966.
- Ocean Protection Council (OPC). 2017. State of California Sea-Level Rise Guidance: 2018 Update DRAFT.

- Olson, D.H., P.D. Anderson, C.A., Frissell, H.H. Welsh, Jr., and D.F. Bradford. 2007. Biodiversity management approaches for stream-riparian areas: perspectives for Pacific Northwest headwater forests, microclimates, and amphibians. *Forest Ecology and Management* 246:81-107.
- Opperman, J. 2005. Large woody debris and land management in California's hardwood-dominated watershed. *Environmental Management* 35(1):1-12.
- Oregon State University Extension Service (OSUES). 2008. Gorgeous yellow iris is ecological threat to PNW wetlands. <http://extension.oregonstate.edu/gardening/node/1008>. Accessed on 05/16/2018.
- Osborne, L. L., and D. A. Kovacic. 1993. Riparian vegetated buffer strips in water quality restoration and stream management. *Freshwater Biology* 29:243-258.
- Pacific Watershed Associates. 2005. Final Report: Sedimentation in Yontocket Slough and Tryon Creek, Lower Smith River, Del Norte County, California. Report prepared for Michael Love & Associates.
- Parish, M. and J. Garwood. 2015. Distribution of juvenile salmonids and seasonal 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 Restoration Grants Program: P1310518, Arcata, CA. 72p.
- Parish, M. 2016. Beaver Bank Lodge Use, Distribution and Influence on Salmonid Rearing Habitats in the Smith River, CA. [Thesis] Humboldt State University, Arcata, CA. 95p.
- 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.
- Parkyn, S. 2004. Review of riparian buffer zone effectiveness. Ministry of Agriculture and Forestry, Wellington.
- Parthre, D. 2004. Fish and invertebrate ecology of Tillas and Islas Sloughs, Smith River estuary, Del Norte County, California. [Thesis] Humboldt State University, Arcata, CA. 113p.
- Pavlovskaya, L. 1995. Fishery in the Lower Amu-Darya under the Impact of Irrigated Agriculture. Inland Fisheries under the impact of Irrigated Agriculture: Central Asia (Food and Agriculture Organization Fisheries Circular No. 894. Ed. T. Petr, 42-57. Rome: Food and Agriculture Organization of the United Nations.
- Pierson, E.D. 1998. Tall trees, deep holes and scarred landscapes: conservation biology of North American bats. pages 309-325 in: T.H. Kunz and P.A. Racey (eds.) *Bat Biology and Conservation*. Smithsonian Institution Press, Washington, D.C.
- Quinn T. and N. Peterson. 1996. The influence of habitat complexity and fish size on over-winter survival and growth of individually marked juvenile coho salmon (*Oncorhynchus kisutch*) in Big Beef Creek, Washington. *Canadian Journal of Fish and Aquatic Science* 53:1555-1564.
- Quinn, T. and P. Roni. 2001. Density and size of juvenile salmonids in response to placement of large woody debris in western Oregon and Washington streams. *Canadian Journal of Fisheries and Aquatic Sciences* 58:282-292.
- Reeves, G., L. Benda, K. Burnett, P. Bisson, J. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. *American Fisheries Society Symposium* 17:334-349.
- Roberts J., D. Bleistein, and R. Dolan. 1967. Investigations of marine processes and coastal landforms near Crescent City, California. Department of the Army, Earth Sciences Division. Contract No. DA 19-129-AMC-684(N). 73p.
- Roni, P., T. J. Beechie, R. E. Bilby, F. E. Leonetti, M. M. Pollock, and G. R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. *North American Journal of Fisheries Management* 22:1-20.
- Schmelzle, M. 2015. Using Occupancy Modeling to Compare Environmental DNA to Traditional Field Methods for Regional-Scale Monitoring of and Endangered Aquatic Species. [Thesis] Humboldt State University, Arcata, CA. 90p.
- Schultz, R. C., J. P. Colletti, T. M. Isenhardt, N. N. Simpkins, C. W. Mize, and M. L. Thompson. 1995. Design and placement of a multi-species riparian buffer strip system. *Agroforestry Systems* 29(20):1-226.
- Shuford, W.D., and T. Gardali (eds.) 2008. California bird species of special concern. *Studies of Western Birds* 1. Western Field Ornithologists, Camarillo, CA. and California Department of Fish and Game, Sacramento, CA.
- Skidmore, P., C. Thorne, B. Cluer, G. Pess, T. Beechie, J. Castro, and C. Shea. 2009. Science base and tools for evaluating stream engineering, management, and restoration proposals.

http://www.restorationreview.com/downloads/RiverRAT_ScienceBaseforStreamProjects2009.pdf.

- Smelser, M. 2013. Desktop Engineering Geologic Analysis of the Morrison Creek Dam Removal & Flooding at Fred D. Haight Drive, Del Norte County, California. [Memorandum]. California Department of Fish and Wildlife. 15p.
- Sommer, T. W. Harrell, and M. Nobriga. 2005. Habitat Use and Stranding Risk of Juvenile Chinook Salmon on a Seasonal Floodplain. *North American Journal of Fisheries Management* 25:1493-1504.
- Sommer, T., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culverson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, K. Souza. 2007. The Collapse of Pelagic Fishes in the upper San Francisco Estuary. *Fisheries* 32 (6): 270-277
- State Coastal Conservancy (SCC). 2018. Strategic Plan 2018 – 2022. Coastal Conservancy, State of California, Oakland, CA. 64p.
- SWRCB. 2012. California Wetland and Riparian Area Protection Policy, Technical Advisory Team, Technical Memorandum No. 3: Landscape Framework for Wetlands and Other Aquatic Areas. October 20, 2009, Revised September 1, 2012. State Water Resources Control Board. Sacramento, CA. http://www.swrcb.ca.gov/water_issues/programs/cwa401/wrapp.shtml#technical
- Tabacchi, E., L. Lambs, H. Guillo, A.-M. Panty-Tabacchi, E. Muller, and H. Decamps. 2000. Impacts of riparian vegetation on hydrological processes. *Hydrological Processes* 14:2959-2976.
- U.S. Census Bureau (USCB). 2015. Topologically Integrated Geographic Encoding and Referencing (TIGER) Database: Primary and Secondary Roads for California. <https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/TGRROAD.html>
- U.S. Census Bureau (USCB). 2010. 2010 Census Community Facts Search: Smith River CDP, California. Accessed August 10, 2018 at URL [https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml]
- U.S. Department of Agriculture (USDA). 1998. Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. National Conservation Service Cooperative State Research, Education and Extension Service: NA-TP-02-97. May 1997, revised 1998. 481 p.
- U.S. Department of Agriculture (USDA). 2000. Conservation Buffers to Reduce Pesticide Losses. Natural Resources Conservation Service, Washington, D.C. 25 p.
- U.S. Department of Agriculture (USDA). 2003. National Planning procedures Handbook (NPPH), Amendment 4. Natural Resources Conservation Service. Washington D.C. 161 p.
- U.S. Department of Agriculture (USDA). 2011. Do BMPs Really Work? Prepared by Julie Best, Public Affairs Specialist, NRCS, Auburn AL.
- U.S. Department of Agriculture (USDA). 2016. National Agricultural Imagery Program: 2016 Imagery, Del Norte County, CA.
- U.S. Department of Agriculture (USDA). 2017. Pest Rating Proposals and Final Ratings, Yellow Flag Iris. United States Department of Agriculture.
- U.S. Environmental Protection Agency. (USEPA). 2000. Low Impact Development (LID): A literature review. U.S. Environmental Protection Agency, EPA-841-B-00-005. Washington, D.C.
- U.S. Forest Service (USFS). 2012. FishXing: Software and Learning Systems for Fish Passage through Culverts. <https://www.fs.fed.us/biology/nsaec/fishxing/>
- U.S. Geologic Survey (USGS). 2011. National Land Cover Dataset for California. <https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/NLCD.html>
- U.S. Geologic Survey (USGS). 2017a. National Water Information System data available on the World Wide Web (USGS Water Data for the Nation, accessed December 19, 2017, at URL [https://waterdata.usgs.gov/nwis/inventory/?site_no=11532500&agency_cd=USGS]).
- U.S. Geologic Survey (USGS). 2017b. StreamStats version 4. U.S. Geological Survey. [<https://streamstats.usgs.gov/ss/>]
- Voight, H and J. Waldvogel. 2002. Smith River Anadromous Fish Action Plan. Smith River Advisory Council. 78p.
- Walkley, J. and J. Garwood. 2017. 2011-2016 Salmonid Redd Abundance and Juvenile Salmonid Spatial Structure in the Smith River Basin, California and Oregon. Final Report to the California Department of Fish and Wildlife, Fisheries Restoration Grants Program, Contract: P1210524. Smith River Alliance, Crescent City, CA. 51p.

- Walkley, J., J. Deibner-Hanson, J. Garwood, M. Parish Hanson. 2017. Mill Creek salmonid lifecycle monitoring station juvenile coho salmon outmigrant trapping project 2014-2017, Smith River, California. Final Report to the California Department of Fish and Wildlife, Fisheries Restoration Grants Program, Contract: P1410546. Smith River Alliance, Crescent City, CA. 77p.
- 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.
- Welsh, H., G. Hodgson, B. Harvey, and M. Roche. 2001. Distribution of juvenile coho salmon in relation to water temperatures in tributaries of the Mattole River, CA. *North American Journal of Fisheries Management* 21: 464-470.
- Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent, and vegetation. Office of Public Service and Outreach, Institute of Ecology, University of Georgia, Athens, GA.
- 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. McMurtry 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: 342pp.
- Zuspan, M. 2018. A synthesis report of 25 salmonid creel censuses spanning 60 years from 1955 to 2014 in the Smith River, Del Norte County, California. California Department of Fish and Wildlife. 76p.

Appendix A

Identified and ranked projects across the planning area in the Smith River Plain, Del Norte County, CA.

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
77	Passage - Improve access (Rowdy Creek Fish Hatchery Weir)	Rowdy Creek	Passage	143.95	4	High	207.58	1	High
56	Passage - Improve access (crossing #6)	Tryon Creek	Passage	136.89	7	High	200.52	2	High
18	Estuary - Remove or replace tide gate	Unnamed Estuary Stream	Passage	144.55	2	High	195.45	3	High
23	Estuary - Remove or replace tide gate (crossing #1)	Tillas Slough	Passage	143.95	3	High	194.85	4	High
93	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #3 - Fred Haight Drive)	Morrison Creek	Passage	129.62	10	High	193.24	5	High
84	Passage - Improve access (Dominie Creek Fish Hatchery mouth and water intake)	Dominie Creek	Passage	131.51	9	High	189.81	6	High
123	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #1)	Stotenburg Creek	Passage	136.70	8	High	189.68	7	High
25	Passage - Improve access (crossing #2)	Tillas Slough	Passage	141.94	5	High	187.52	8	High
124	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #2)	Stotenburg Creek	Passage	122.01	15	High	185.63	9	High

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
44	Channel complexity - Restore meandering bends, increase conifer riparian vegetation and fencing - DS Hwy 101	Delilah Creek	Channel complexity	123.61	13	High	179.83	10	High
85	Passage - Improve channel complexity (Dominie Creek Fish Hatchery)	Dominie Creek	Passage	126.29	11	High	177.19	11	High
58	Passage - Improve access (crossing #10 - Private)	Tryon Creek	Passage	112.63	22	High	176.25	12	High
28	Riparian - Remove invasive species (Reed Canary Grass)	Tillas Slough, Ritmer, Delilah	Invasive Species	122.00	16	High	174.98	13	High
48	Floodplain and Channel Structure - reconnect the channel to the floodplain	Islas Slough	Channel complexity	146.93	1	High	174.46	14	High
126	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #4 - Cedar Lodge Lane)	Stotenburg Creek	Passage	123.47	14	High	174.37	15	High
61	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #13 - private)	Tryon Creek	Passage	110.02	29	High	173.64	16	High
91	Floodplain and Channel Structure - Increase channel capacity and reconnect the channel to the floodplain	Morrison Creek	Channel complexity	109.98	31	High	173.60	17	High
105	Passage - Improve access (crossing #2)	Morrison Unnamed tributary	Passage	109.85	32	High	173.48	18	High
26	Passage - Improve access (crossing #3)	Tillas Slough	Passage	126.05	12	High	171.63	19	High

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
89	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #1 - Tidewater Rd)	Morrison Creek	Passage	120.14	17	High	171.04	20	High
119	Passage - Improve access (crossing #6 - Hwy 101)	Mello Creek	Passage	112.05	24	High	170.35	21	High
86	Passage - Improve access (crossing #3 - Hwy 101)	Dominie Creek	Passage	109.23	35	High	167.53	22	High
65	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #16)	Tryon Creek	Passage	108.42	37	High	164.64	23	High
59	Passage - Improve access (crossing #11 - Private)	Tryon Creek	Passage	110.02	28	High	162.99	24	High
125	Channel Structure - Increase instream complexity and fencing	Stotenburg Creek	Channel complexity	114.48	20	High	162.13	25	High
66	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #17)	Tryon Creek	Passage	105.23	42	High	161.46	26	High
128	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #5), increase riparian	Stotenburg Creek	Passage	105.79	40	High	158.77	27	High
92	Remove invasive species (Reed Canary Grass and Yellow Flag Iris)	Morrison Creek	Invasive Species	94.68	67	Medium	158.31	28	High
103	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #1)	Morrison Unnamed tributary	Passage	112.63	23	High	158.20	29	High
127	Channel Structure - Increase instream complexity and riparian	Stotenburg Creek	Channel complexity	109.99	30	High	157.64	30	High

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
122	Passage - Improve access (mouth)	Stotenburg Creek	Passage	109.76	34	High	157.41	31	High
129	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #6 - Fred Haight Drive)	Stotenburg Creek	Passage	98.84	56	Medium	157.14	32	High
40	Passage - Improve access (crossing #1)	Delilah Creek	Passage	99.58	52	Medium	155.81	33	High
67	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #18 - Rellim Rd)	Tryon Creek	Passage	99.58	53	Medium	155.81	34	High
94	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #4)	Morrison Creek	Passage	110.09	26	High	155.67	35	High
96	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #5)	Morrison Creek	Passage	110.09	27	High	155.67	36	High
73	Floodplain and Channel Structure - Reconnect the channel to the floodplain (i.e., set back levees)	Rowdy Creek	Channel complexity	99.12	54	Medium	155.34	37	High
74	Floodplain and Channel Structure - Reconnect the channel to the floodplain (i.e., set back levees)	Rowdy Creek	Channel complexity	99.12	55	Medium	155.34	38	High
79	Floodplain and Channel Structure - Reconnect the channel to the floodplain (i.e., set back levees, remove impervious surface)	Rowdy Creek	Channel complexity	116.62	19	High	154.79	39	High
24	Floodplain and Channel Structure - reconnect the channel to the floodplain	Tillas Slough and Islas Slough	Channel complexity	141.31	6	High	154.04	40	High

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
57	Passage - Improve access (crossing #8 - Mosely Rd)	Tryon Creek	Passage	112.98	21	High	153.23	41	High
60	Floodplain and Channel Structure - Restore natural channel form and function, add riparian	Tryon Creek	Channel complexity	87.81	84	Medium	151.43	42	High
3	Reconnect the channel to the floodplain - backwater enhancement	Mainstem	Channel complexity	103.43	44	High	151.08	43	High
20	Floodplain and Channel Structure - enhance instream structure	Unnamed Estuary Stream	Channel complexity	105.43	41	High	151.00	44	High
99	Channel complexity - Enhance instream structure and channel capacity	Morrison Creek	Channel complexity	118.01	18	High	150.86	45	High
112	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #1)	Mello Creek	Passage	103.34	45	High	148.92	46	High
35	Passage - Improve access (crossing #3)	Ritmer Creek	Passage	92.33	75	Medium	148.56	47	Medium
87	Floodplain and Channel Structure - Reconnect the channel to the floodplain (e.g., set back levees, remove impervious surface, remove hardened banks)	Dominie Creek	Channel complexity	108.76	36	High	146.93	48	Medium
117	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #4)	Mello Creek	Passage	95.52	63	Medium	146.42	49	Medium
118	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #5)	Mello Creek	Passage	95.52	64	Medium	146.42	50	Medium

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
115	Hydrology - Increase instream flows (Goodwin Pond)	Morrison Creek	Water Quality	97.86	58	Medium	145.51	51	Medium
76	Water Quality - Reduce pollutants (Hatchery inputs)	Rowdy Creek	Water Quality	109.78	33	High	144.70	52	Medium
69	Floodplain and Channel Structure - Construct off channel habitat	Rowdy Creek	Channel complexity	104.23	43	High	144.48	53	Medium
62	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #14)	Tryon Creek	Passage	102.98	46	High	143.23	54	Medium
107	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #3)	Morrison Unnamed tributary	Passage	91.95	76	Medium	142.85	55	Medium
19	Floodplain and Channel Structure - enhance instream structure	Unnamed Estuary Stream	Channel complexity	101.78	48	Medium	142.03	56	Medium
134	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #2 - Fred Haight Drive)	Stotenburg Creek Trib	Passage	94.20	69	Medium	141.85	57	Medium
114	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #3 - Fred Haight Drive)	Mello Creek	Passage	95.52	62	Medium	141.09	58	Medium
12	Reconnect the channel to the floodplain - backwater enhancement	Mainstem	Channel complexity	108.00	39	High	140.85	59	Medium
21	Riparian protection/ conservation easement	Unnamed Estuary Stream	Riparian	100.22	49	Medium	140.47	60	Medium
71	Floodplain and Channel Structure - Construct off channel habitat	Rowdy Creek	Channel complexity	100.18	50	Medium	140.43	61	Medium

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
1	Estuary - increase complexity and channel capacity (i.e., wood placement/protection)	Estuary/ Mainstem	Channel complexity	92.65	73	Medium	140.30	62	Medium
42	Passage - Improve access (crossing #3 - Sarina Rd)	Delilah Creek	Passage	76.28	104	Low	139.90	63	Medium
90	Reconnect the channel to the floodplain - backwater enhancement	Morrison & Mello Creek	Channel complexity	98.61	57	Medium	138.86	64	Medium
116	Channel complexity - restore natural channel form and function	Mello Creek	Channel complexity	108.04	38	High	138.82	65	Medium
2	Reconnect the channel to the floodplain - side channel enhancement	Mainstem	Channel complexity	97.23	59	Medium	137.48	66	Medium
111	Riparian - Remove invasive species (RCG, i.e., riparian, grazing, channel restoration plan)	Mello Creek	Invasive Species	83.39	91	Medium	136.36	67	Medium
98	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #7)	Morrison Creek	Passage	95.52	60	Medium	135.77	68	Medium
100	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #8 - Hwy 101)	Morrison Creek	Passage	95.52	61	Medium	135.77	69	Medium
63	Passage - Improve access (crossing #15 - Hwy 101)	Tryon Creek	Passage	95.49	65	Medium	135.74	70	Medium
81	Floodplain and Channel Structure - Increase channel complexity (i.e., Engineer Log Jam)	Rowdy Creek	Channel complexity	94.83	66	Medium	135.08	71	Medium
108	Passage - Improve access (crossing #4 - Hwy 101)	Morrison Unnamed tributary	Passage	83.77	90	Medium	134.67	72	Medium

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
47	Estuary - increase complexity and channel capacity (i.e., wood placement/protection)	Islas Slough	Channel complexity	101.81	47	Medium	134.66	73	Medium
132	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #1)	Stotenburg Creek Trib	Passage	88.98	81	Medium	134.56	74	Medium
72	Floodplain and Channel Structure - Increase channel complexity (i.e., Engineer Log Jam)	Rowdy Creek	Channel complexity	93.80	71	Medium	134.05	75	Medium
14	Riparian - protection/ conservation	Mainstem	Riparian	92.94	72	Medium	133.19	76	Medium
5	Reconnect the channel to the floodplain - backwater enhancement	Mainstem	Channel complexity	99.77	51	Medium	132.62	77	Medium
36	Passage - Improve access (crossing #4 - Hwy 101)	Ritmer Creek	Passage	84.68	88	Medium	132.33	78	Medium
41	Passage - Improve access (crossing #2)	Delilah Creek	Passage	91.93	77	Medium	132.18	79	Medium
113	Floodplain/Channel Structure - increase channel capacity (crossing #2)	Mello Creek	Passage	90.30	79	Medium	130.55	80	Medium
4	Riparian - Increase conifer riparian vegetation and fencing	Mainstem	Riparian	79.40	98	Low	130.30	81	Medium
29	Floodplain and Channel Structure - Restore natural channel form and function	Unnamed Tillas Slough trib	Channel complexity	91.69	78	Medium	129.86	82	Medium
68	Floodplain and Channel Structure - Reconnect the channel to the floodplain (i.e., set back levees, remove cars)	Rowdy Creek	Channel complexity	111.61	25	High	129.66	83	Medium

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
34	Riparian - Increase conifer riparian vegetation and fencing, upgrade fords	Ritmer Creek	Riparian	78.62	100	Low	129.52	84	Medium
7	Diversion screening - upgrade	Mainstem	Passage	94.51	68	Medium	129.43	85	Medium
13	Diversion screening - upgrade	Mainstem	Passage	88.91	82	Medium	129.16	86	Medium
109	Passage - Improve access (crossing #5 - Hwy 101)	Morrison Unnamed tributary	Passage	78.12	101	Low	129.02	87	Medium
51	Passage and Floodplain/Channel Structure - increase channel capacity (crossing #2)	Tryon Creek	Channel complexity	74.53	110	Low	127.50	88	Medium
101	Passage - Improve access (crossing #9 - Morrison Creek Road)	Morrison Creek	Passage	94.15	70	Medium	127.00	89	Medium
136	Passage and Floodplain/Channel Structure - improve access, restore natural channel form and function (crossing #3 - Hwy 101)	Stotenburg Creek Trib	Passage	86.18	86	Medium	126.43	90	Medium
10	Estuary/Bailey Hole - increase complexity and channel capacity (i.e., wood placement/protection)	Mainstem	Channel complexity	78.09	102	Low	125.74	91	Medium
46	Riparian - Increase conifer riparian vegetation and fencing - US Hwy 101	Delilah Creek	Riparian	67.16	124	Low	125.46	92	Medium
39	Diversion screening - upgrade	Delilah Creek	Passage	92.50	74	Medium	125.35	93	Low
110	Passage - Improve access (crossing #6 - Hwy 101)	Morrison Unnamed tributary	Passage	74.29	111	Low	125.19	94	Low

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
43	Passage - Improve access (crossing #4)	Delilah Creek	Passage	73.67	114	Low	124.57	95	Low
27	Riparian - fencing and reduce point and non-point source pollution	Tillas Slough	Riparian	88.54	83	Medium	123.47	96	Low
11	Riparian - protection/ conservation	Mainstem	Riparian	83.19	93	Low	123.44	97	Low
137	Passage - Improve access (crossing #8 - pond)	Stotenburg Creek Trib	Passage	89.73	80	Medium	122.58	98	Low
6	Riparian - protection/ conservation	Mainstem	Riparian	81.97	94	Low	122.22	99	Low
106	Riparian - Remove invasive species (Eucalyptus)	Morrison Unnamed tributary	Invasive Species	71.23	118	Low	122.13	100	Low
45	Passage - Improve access (crossing #5 - Hwy 101)	Delilah Creek	Passage	65.48	126	Low	121.71	101	Low
53	Riparian - Remove invasive species (Reed Canary Grass)	Tryon Creek	Invasive Species	67.90	122	Low	120.88	102	Low
8	Riparian - protection/ conservation	Mainstem	Riparian	80.45	96	Low	120.70	103	Low

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
104	Riparian - Increase conifer riparian vegetation and fencing	Morrison Unnamed tributary	Riparian	70.52	119	Low	118.17	104	Low
121	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #7)	Mello Creek	Passage	84.13	89	Medium	116.98	105	Low
38	Passage - Improve access (crossing #6 - Ocean View Drive)	Ritmer Creek	Passage	76.11	105	Low	116.36	106	Low
131	Passage - Improve access (crossing #7 - Hwy 101)	Stotenburg Creek	Passage	75.92	106	Low	116.17	107	Low
30	Riparian - fencing - reduce point and non-point source pollution	Unnamed Tillas Slough trib	Riparian	75.09	109	Low	115.34	108	Low
9	Riparian - Increase conifer riparian vegetation - site remediate	Mainstem	Riparian	86.10	87	Medium	114.80	109	Low
97	Riparian - Increase conifer riparian vegetation and fencing, upgrade ford (crossing #6)	Morrison Creek	Riparian	86.89	85	Medium	114.42	110	Low
31	Passage - Improve access (crossing #2 - Hwy 101)	Unnamed Tillas Slough trib	Passage	73.50	115	Low	113.75	111	Low
78	Riparian - Remove invasive species (Eucalyptus)	Rowdy Creek	Invasive Species	79.63	97	Low	112.48	112	Low
16	Riparian - protection/ conservation	Mainstem	Riparian	71.86	117	Low	112.11	113	Low

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
82	Floodplain and Channel Structure - Reconnect the channel to the floodplain	Clanco Creek	Channel complexity	79.03	99	Low	111.88	114	Low
33	Hydrologic - assessment of how to improve natural channel function	Unnamed Trib and Ritmer	Water Quality	65.05	127	Low	110.63	115	Low
37	Passage - Improve access (crossing #5)	Ritmer Creek	Passage	77.04	103	Low	109.89	116	Low
54	Passage and Floodplain/Channel Structure - restore natural channel form and function (crossing #3 - Silva Rd)	Tryon Creek	Channel complexity	69.23	121	Low	109.48	117	Low
49	Riparian - Remove invasive species (Reed Canary Grass)	Yontocket Slough	Invasive Species	73.86	112	Low	108.78	118	Low
120	Riparian - Increase conifer riparian vegetation and fencing	Mello Creek	Riparian	75.45	107	Low	108.30	119	Low
17	Riparian - protection/ conservation	Mainstem	Riparian	75.19	108	Low	108.04	120	Low
88	Riparian - Remove invasive species (Reed Canary Grass)	Morrison Creek	Invasive Species	67.58	123	Low	107.83	121	Low
32	Passage - Improve access (crossing #3)	Unnamed Tillas Slough trib	Passage	61.42	130	Low	106.99	122	Low
70	Riparian - protection/ conservation	Rowdy Creek	Riparian	64.48	128	Low	104.73	123	Low
15	Riparian - protection/ conservation	Mainstem	Riparian	71.86	116	Low	104.71	124	Low

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
133	Riparian - Increase conifer riparian vegetation	Stotenburg Creek Trib	Riparian	63.27	129	Low	103.52	125	Low
83	Riparian - Increase conifer riparian vegetation and fencing	Clanco Creek	Riparian	70.42	120	Low	103.27	126	Low
22	Riparian protection/ conservation easement	Unnamed Estuary Stream	Riparian	83.36	92	Medium	101.41	127	Low
130	Riparian - Increase conifer riparian vegetation and fencing	Stotenburg Creek	Riparian	73.80	113	Low	101.32	128	Low
75	Water Quality - Reduce point and non-point source pollution (i.e., Increase LID techniques)	Rowdy Creek	Water Quality	60.03	132	Low	100.28	129	Low
55	Riparian - increase fencing, conifers and instream structure (crossing #1)	Tryon Creek Trib	Riparian	57.06	135	Low	99.39	130	Low
135	Riparian - protection/ conservation (i.e., wetland)	Stotenburg Creek Trib	Riparian	66.43	125	Low	99.28	131	Low
52	Riparian - Increase conifer riparian vegetation and fencing	Tryon Creek	Riparian	61.23	131	Low	96.16	132	Low
50	Riparian - Increase conifer riparian vegetation	Yontocket Slough	Riparian	54.96	136	Low	95.21	133	Low
102	Riparian - Increase conifer riparian vegetation and fencing	Morrison Unnamed tributary	Riparian	81.85	95	Low	94.58	134	Low
95	Riparian - Increase conifer riparian vegetation	Morrison Creek	Riparian	57.70	133	Low	90.55	135	Low

Project #	Project	Stream	Project type	Biologic Score	Biological Rank	Biological priority	Total score	Total Rank	Priority
80	Riparian - Increase conifer riparian vegetation	Rowdy Creek	Riparian	54.11	137	Low	86.96	136	Low
64	Reconnect the channel to the floodplain - backwater enhancement	Tryon Creek	Channel complexity	57.35	134	Low	80.73	137	Low
138	Riparian - Remove invasive species (Reed Canary Grass management plan)	Smith River Plain	Invasive Species	NA			NA		
139	Floodplain and Channel Structure - Increase channel complexity (i.e., channel widening)	Smith River Plain	Channel complexity	NA			NA		
140	Water Quality - Reduce pollutants (point and non-point), Erosion control/incision prevention	Smith River Plain	Water Quality	NA			NA		
141	Hydrology - Increase instream flows - diversion management to reduce fish stranding/increase duration of migration flow	Smith River Plain	Water Quality	NA			NA		
142	Invasive Species - Bull Frog Prevention Plan	Smith River Plain	Invasive Species	NA			NA		
143	Passage - Survey remaining unassessed crossing	Smith River Plain	Data gap	NA			NA		
144	Lamprey Distribution Data	Smith River Plain	Data gap	NA			NA		
145	Pinniped and avian predator impacts to salmonid population	Smith River Plain	Data gap	NA			NA		
MAX SCORE				156.88	NA	NA	220.5	NA	NA

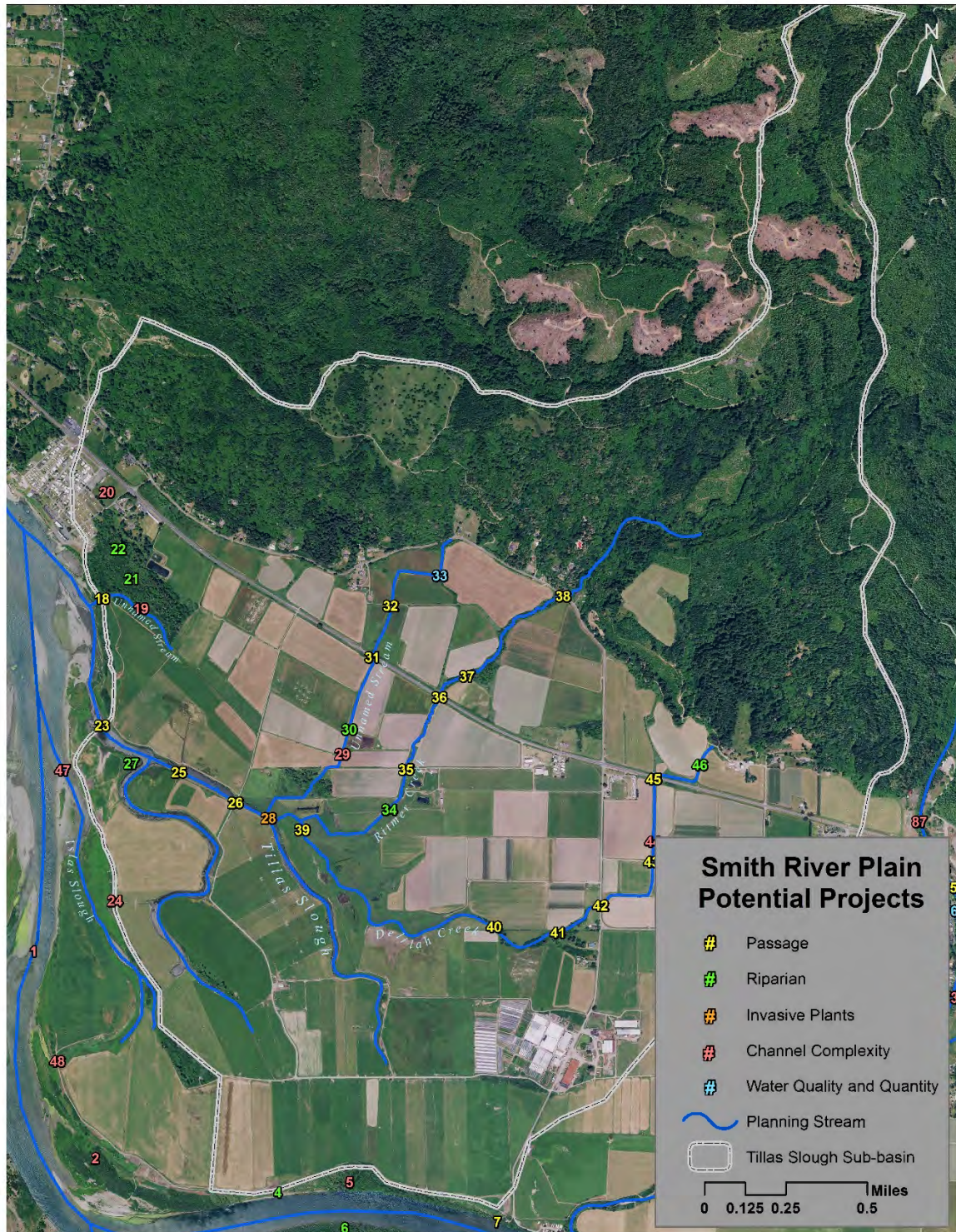
Appendix B

Example scorecard and criteria used to prioritize identified projects.

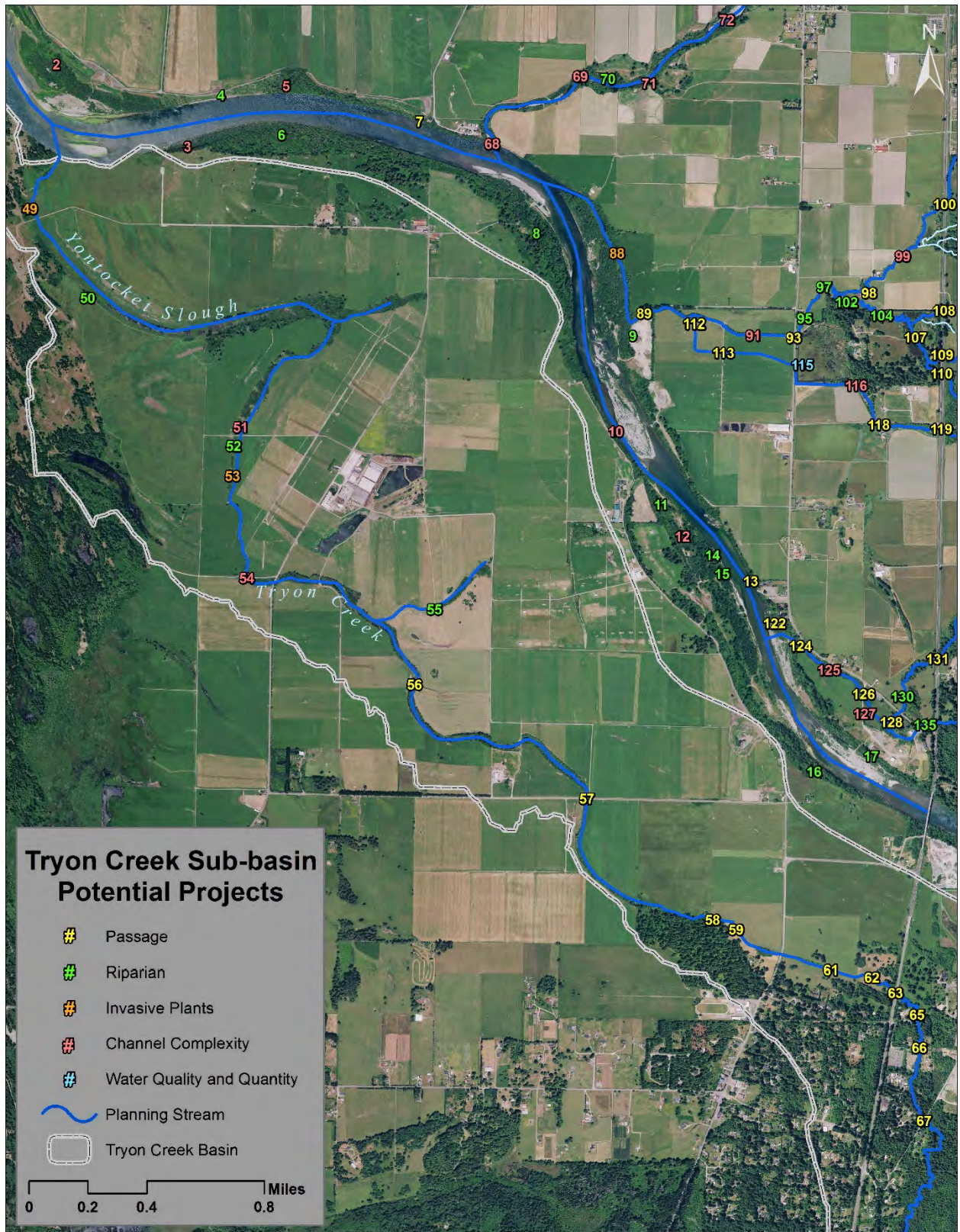
Evaluation Criteria		Weight	Score (1 -5)	Total
<i>Current Biological and Ecological Resources</i>				
1	How quickly will salmonids benefit from the project?	7.825	x _____	= _____
2	Besides benefiting salmonids, how many other species or ecosystem needs met are by the project?	6.675	x _____	= _____
3	What is the magnitude of benefit for anadromous species?	8.4	x _____	= _____
<i>Integrity and Risk</i>				
4	Does the project restore natural channel function?	8.475	x _____	= _____
<i>Optimism and Potential for protection and restoration</i>				
5	Does the project minimize future land maintenance needs and costs?	5.325	x _____	= _____
6	Does the project have landowner support?	7.4	x _____	= _____
Biological Score (Sum of 1-4)				_____
Total Score (Sum of 1-6)				_____

Appendix C

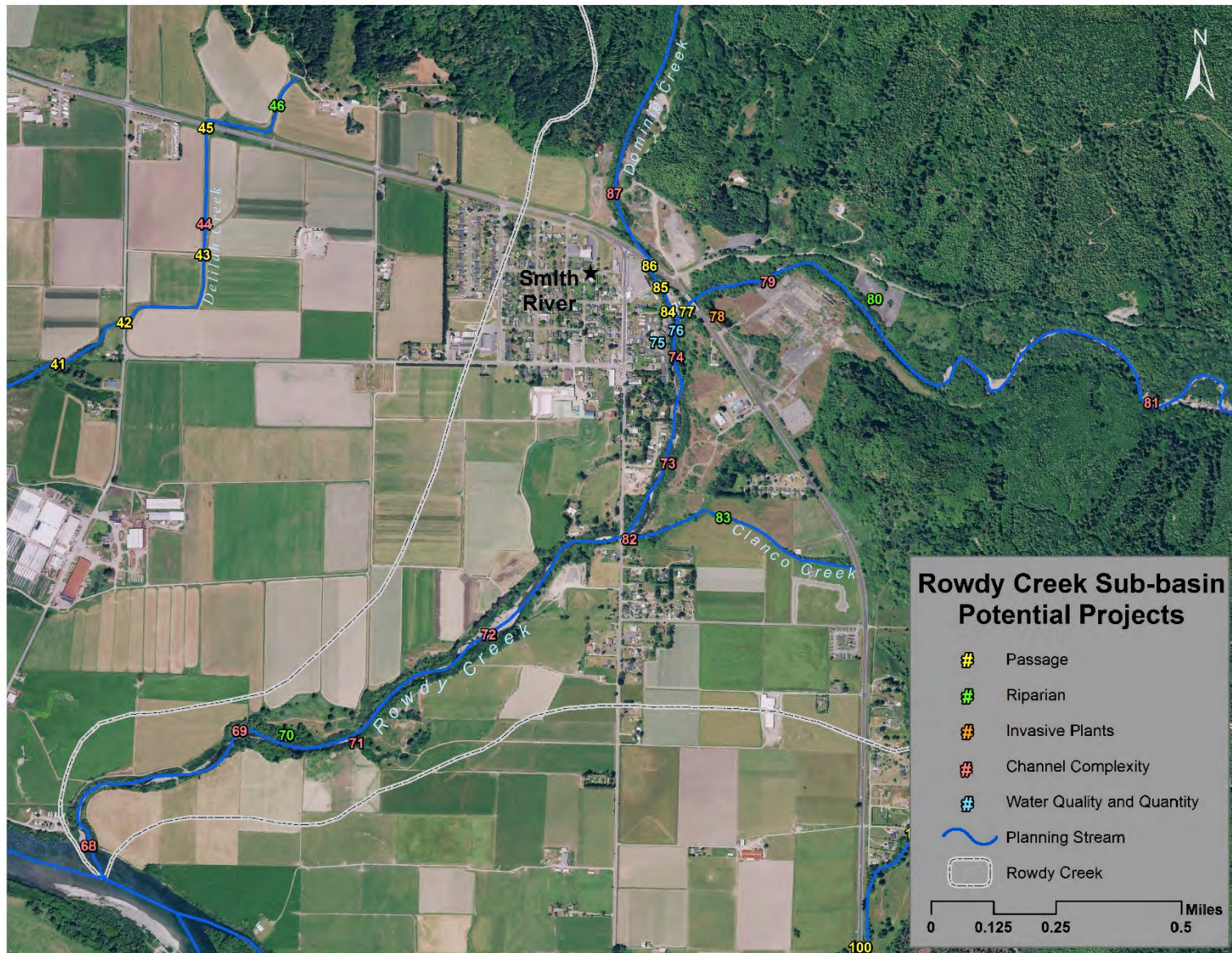
Maps focused in on each sub-basin included in the planning effort. Maps are ordered starting at the downstream most sub-basin and working in the upstream direction.



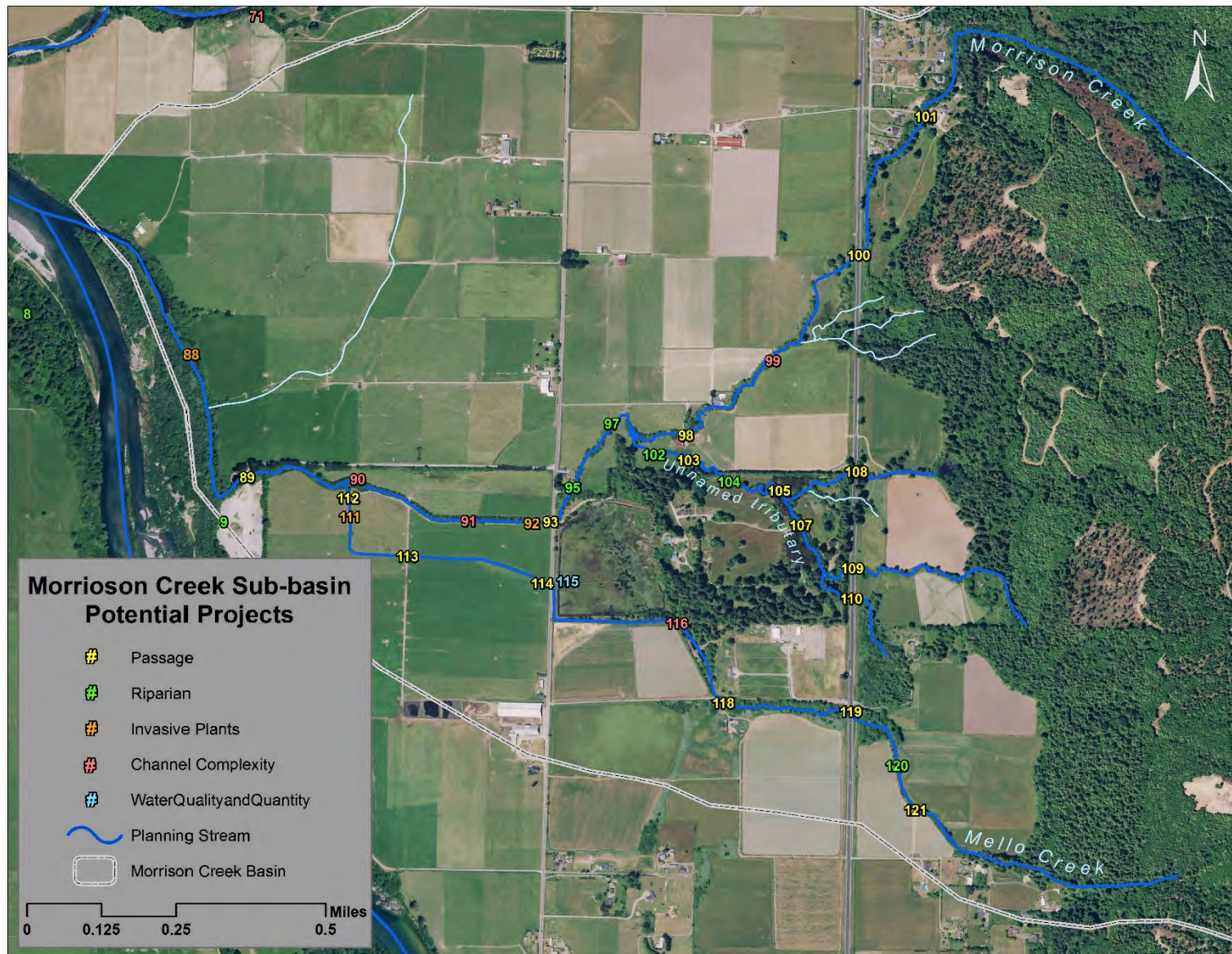
Tillas Slough Sub-basin with the general location of identified projects labeled by project number and project type. Numbers correspond to project numbers in Appendix A.



Tryon Creek Sub-basin with the general location of identified projects labeled by project number and project type. Numbers correspond to project numbers in Appendix A.



Rowdy Creek Sub-basin with the general location of identified projects labeled by project number and project type. Numbers correspond to project numbers in Appendix A.



Morrioson Creek Sub-basin with the general location of identified projects labeled by project number and project type. Numbers correspond to project numbers in Appendix A.



Stotenburg Creek Sub-basin with the general location of identified projects labeled by project number and project type. Numbers correspond to project numbers in Appendix A.

All stream crossings identified and their assessed fish passage across the planning area in the Smith River Plain, Del Norte County, CA.

Project #	Project	Stream	Surveyed	Structure Type	CDFW	Barrier Status
18	Tide gate upgrade or removal	Unnamed Estuary Stream	No	Tide gate	Grey*	Partial*
23	Levee crossing upgrade (crossing #1)	Tillas Slough	No	Tide gate (failed - CMP) Culvert (occasional tide gate)	Grey*	Partial*
25	Tillas slough crossing #2	Tillas Slough	No		Grey*	Partial*
26	Tillas slough crossing #3	Tillas Slough	No	Culvert	Grey*	Partial*
29	Tillas Slough unnamed trib - crossing #1	Unnamed Tillas Slough trib	No	Ford	Grey*	Partial*
31	Tillas Slough unnamed trib - crossing #2 - Hwy 101	Unnamed Tillas Slough trib	No	Culvert	Grey*	Partial*
32	Tillas Slough unnamed trib - crossing #3	Unnamed Tillas Slough trib	No	Culvert	Unknown	Unknown
34	Ritmer Creek crossing #1	Ritmer Creek	No	Ford	Green*	Passable*
34	Ritmer Creek crossing #2	Ritmer Creek	No	Ford	Green*	Passable*
35	Ritmer Creek crossing #3	Ritmer Creek	No	Culvert (CMP x2)	Grey*	Partial*
36	Ritmer Creek crossing #4 - Hwy 101 (PAD: 707135)	Ritmer Creek	Yes - PAD	Arch Culvert (x2)	Grey	Partial
37	Ritmer Creek crossing #5	Ritmer Creek	No	Ford	Green*	Passable*
38	Ritmer Creek crossing #6 - Ocean View Dr (PAD: 705875)	Ritmer Creek	Yes - PAD	Culvert	Grey	Partial
40	Delilah crossing #1	Delilah Creek	No	Unknown	Grey*	Partial*
41	Delilah crossing #2	Delilah Creek	No	Culvert (CMP)	Grey*	Partial*
42	Delilah crossing #3 - Sarina Rd	Delilah Creek	No	Culvert (Concrete)	Unknown	Partial*
43	Delilah crossing #4	Delilah Creek	No	Culvert (CMP)	Grey*	Partial*
45	Delilah crossing #5 - Hwy 101 (north)	Delilah Creek	No	Culvert (CMP)	Unknown	Unknown
51	Tryon Creek crossing #2	Tryon Creek	Yes	Culvert (CMP)	Green	Partial
54	Tryon Creek crossing #3 - Silva Rd	Tryon Creek	Yes	Bridge	Green	Passable
55	Tryon Creek Trib #1	Tryon Creek	Yes	Culvert (plastic)	Grey	Partial
56	Tryon Creek crossing #6 - Private	Tryon Creek	Yes	Culvert	Green	Partial
57	Tryon Creek crossing #8 - Mosely Rd	Tryon Creek	Yes	Culvert (Concrete)	Green	Partial
58	Tryon Creek crossing #10 - Private	Tryon Creek	Yes	Culvert (Concrete)	Grey*	Partial*
59	Tryon Creek crossing #11 - Private	Tryon Creek	Yes	Ford	Green	Passable
61	Tryon Creek crossing #13 - Private	Tryon Creek	Yes	Culvert (x2)	Grey*	Partial*
62	Tryon Creek crossing #14 - Private	Tryon Creek	Yes	Bridge	Green	Passable

	Project #	Project	Stream	Surveyed	Structure Type	CDFW	Barrier Status
	65	Tryon Creek crossing #16 - Private	Tryon Creek	No	Culvert (concrete)	Grey*	Partial*
	66	Tryon Creek crossing #17 - Private	Tryon Creek	No	Culvert (CMP)	Grey*	Partial*
	67	Tryon Creek crossing #18 - Rellium Road	Tryon Creek	No	Culvert (CMP)	Grey*	Partial*
	77	Rowdy Creek Fish Hatchery Weir (PAD: 721887)	Rowdy Creek	Yes - PAD	Concrete skirt	Grey	Partial
	84	Dominie Creek Mouth alteration (PAD: 721903)	Dominie Creek	Yes - PAD	Concrete skirt	Grey	Partial
	85	Dominie Creek RCFH water intake & fish ladder	Dominie Creek	No	Water diversion and fish ladder	Grey	Partial*
	86	Dominie Creek - Hwy 101 (PAD: 707134)	Dominie Creek	Yes - PAD	Box culvert (concrete)	Grey	Partial
	89	Morrison crossing #1 - Tidewater Road	Morrison Creek	Yes	Culvert	Grey*	Partial*
	93	Morrison crossing #3 - Fred Haight Drive	Morrison Creek	Yes	Culvert (CMP x3)	Grey	Partial
	94	Morrison crossing # 4	Morrison Creek	Yes	Bridge	Green	Passable
	96	Morrison crossing # 5	Morrison Creek	Yes	Bridge (Foot)	Green	Passable
	97	Morrison crossing # 6	Morrison Creek	No	Ford	Green	Passable
	98	Morrison crossing # 7	Morrison Creek	No	Bridge	Green	Passable
	100	Morrison crossing #8 - Hwy 101 (PAD: 707133)	Morrison Creek	Yes - PAD	Box culvert (concrete)	Grey	Partial
	101	Morrison crossing #9 - Morrison Creek Rd	Morrison Creek	No	Culvert (CMP)	Grey*	Partial*
	103	Morrison trib crossing #1	Morrison Unnamed tributary	No	Culvert	Green	Passable
	105	Morrison trib crossing #2	Morrison Unnamed tributary	Yes	Culvert (CMP)	Red	Total
	107	Morrison trib crossing #3	Morrison Unnamed tributary	Yes	Culvert (CMP)	Grey	Partial
	108	Morrison trib crossing #4 - Hwy 101 MP37.90 (PAD: 761537)	Morrison Unnamed tributary	Yes	Culvert (concrete)	Grey	Partial
	109	Morrison trib crossing #5 - Hwy 101 MP37.73 (PAD: 761536)	Morrison Unnamed tributary	Yes	Culvert (concrete)	Red	Total
	110	Morrison trib crossing #6 - Hwy 101 MP37.67	Morrison Unnamed tributary	Yes	Culvert (concrete)	Grey	Partial
	112	Mello Creek crossing #1	Mello Creek	Yes	Culvert (plastic)	Grey	Partial
	113	Mello Creek crossing #2	Mello Creek	Yes	Culvert (plastic)	Green	Passable
	114	Mello Creek crossing #3 - Fred Haight Dr	Mello Creek	No	Culvert (CMP)	Unknown	Unknown
	117	Mello Creek crossing #4	Mello Creek	No	Culvert	Unknown	Unknown
	118	Mello Creek crossing #5	Mello Creek	No	Culvert	Unknown	Unknown
	119	Mello Creek crossing #6 - Hwy 101 (PAD: 712951)	Mello Creek	Yes - PAD	Culvert (CMP)	Unknown	Unknown
	121	Mello Creek crossing #7	Mello Creek	No	Unknown	Unknown	Unknown
	123	Stotenburg crossing #1	Stotenburg Creek	Yes	Culvert (CMP)	Grey	Partial

Project #	Project	Stream	Surveyed	Structure Type	CDFW	Barrier Status
124	Stotenburg crossing #2	Stotenburg Creek	Yes	Culvert (CMP)	Grey	Partial
125	Stotenburg crossing #3	Stotenburg Creek	No	Ford	Green	Passable
126	Stotenburg crossing #4 - Cedar Lodge Lane	Stotenburg Creek	Yes	Culvert (Plastic x4)	Grey	Passable
128	Stotenburg crossing #5	Stotenburg Creek	Yes	Culvert (CMP)	Green	Partial
129	Stotenburg crossing #6 - Fred Haight Dr	Stotenburg Creek	Yes	Culvert (CMP)	Grey	Partial
131	Stotenburg crossing #7 - Hwy 101 (PAD: 712950)	Stotenburg Creek	Yes - PAD	Culvert	Grey	Partial
132	Stotenburg Creek Trib #1	Stotenburg Trib	No	Culvert	Unknown	Unknown
134	Stotenburg Creek Trib #2 - Fred Haight Drive	Stotenburg Trib	No	Culvert	Unknown	Unknown
136	Stotenburg Creek Trib #3 - Hwy 101	Stotenburg Trib	No	Culvert	Unknown	Unknown
137	Stotenburg Creek Trib #4 - pond	Stotenburg Trib	No	Unknown	Unknown	Unknown
NA	Tryon Creek crossing #1 - Pala Rd	Tryon Creek	No	Bridge	Green	Passable
NA	Tryon Creek crossing #4 - Lower Lake Rd	Tryon Creek	Yes	Bridge	Green	Passable
NA	Tryon Creek crossing #5 - Private	Tryon Creek	Yes	Bridge	Green	Passable
NA	Tryon Creek crossing #7 - Private	Tryon Creek	Yes	Bridge	Green	Passable
NA	Tryon Creek crossing #9	Tryon Creek	No	Bridge	Green	Passable
NA	Tryon Creek crossing #12 - Lake Earl Dr	Tryon Creek	No	Bridge	Green	Passable
NA	Rowdy Creek - Fred Haight Drive	Rowdy Creek	No	Bridge	Green	Passable
NA	Rowdy Creek - Hwy 101	Rowdy Creek	No	Bridge	Green	Passable
NA	Dominie Creek #4	Dominie Creek	No	Bridge	Green	Passable
NA	Dominie Creek #5	Dominie Creek	No	Bridge	Green	Passable
NA	Morrison crossing #2 - Cattle bridge	Morrison Creek	Yes	Bridge	Green	Passable

*Assessment determined by information provided from landowner on crossing type, size, and condition.