Scott River Watershed Council

Restoring Priority Coho Habitat in the Scott River Watershed Modeling and Planning Report

Phase 1 – October 1, 2018

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Executive Summary and Key Findings

This report summarizes the key findings from a conceptual analysis that was used to identify and prioritize high value restoration sites and stream reaches where coho rearing habitat can be enhanced within key cold water reaches of the Scott River system. There is a critical need to increase the quantity, quality and availability of complex, deep, slow water habitats for summer and over-winter rearing coho salmon within the Scott River system. It is important that a full understanding of the totality of the current condition of the Scott River Watershed be taken into context when trying to assess desirable conditions. Much of the historic range of habitat used by coho salmon consisted of the low gradient reaches of the Scott River and its tributaries. The loss of floodplain connectivity at varying flow regimes has critically reduced the available habitat to support juvenile salmon.

Restoration of these habitats is needed to increase coho smolt production and build ecosystem resiliency in advance of further impacts related to climate change, local droughts, and legacy and on-going land use practices. The underlying principle of this project is that of stewardship. A deeper understanding of the characteristics of the Scott River system will ensure that stewardship coupled with restoration actions will produce the most benefit for natural resources, human capital, and private and taxpayer funding. Many of the on-the ground projects resulting from this planning effort will likely be a win:win where habitat is restored and landowners also benefit from reduced destructive flooding and increased groundwater recharge.

This report summarizes the anthropogenic impacts within the watershed and outlines a series of possible restoration options which restoration practitioners, landowners and agencies might consider when developing strategies on ways to address limiting factors for coho salmon within the Scott River Watershed.

The project area lies within the Scott River watershed, with emphasis on the westside tributaries of Shackleford Creek, Mill Creek, Kidder Creek, Patterson Creek, Etna Creek, French Creek, Miners Creek, Sugar Creek, South Fork Scott River, East Fork Scott River and alluvial reaches of the mainstem Scott River.

This project is intended to support the planning and technical needs of the local watershed groups; Northern California Resource Center (NCRC), Quartz Valley Indian Reservation (QVIR), Scott River Watershed Council (SRWC), Scott River Water Trust (SRWT) and Siskiyou Resource Conservation District (SRCD). The information developed over the course of the project is menat to serve landowners, stakeholders including county, state and federal agencies, academic scientists, consultants, other non-profit organizations and tribes and they can contract SRWC to receive any of the meta-data, shape files or GPS layers used in this analysis.

Summary of key findings:

- The desired outcome of the project was to develop targeted, implementable, effective restoration solutions within the existing working landscape. This drove the selection, by the Technical Advisory Committee (TAC), of some of the basic parameters used to evaluate the landscape. The most notable of which was defining floodplain connectivity and stream confinement based on current conditions, not historical or ideal conditions. Previous studies have looked at the intrinsic potential of the landscape to rear coho salmon, this project sought locations where restoration can be accomplished in the context of the existing landforms.
- In general, positive or negative parameters tended to occur together. Confinement was the most determinant of the parameters. Reaches that are tightly confined also tended to have limited vegetation, become dry during baseflow, and have limited coho salmon utilization. Conversely, unconfined reaches tended to have more riparian vegetation, year around water and current or recent past coho utilization.
- Initially, we characterized discrete sites, and then came to the realization that identifying whole reaches with restoration potential offered significantly greater opportunity. The prioritization criteria for reaches and discrete sites were similar, but not exactly the same. Many, but not all, of the high priority discrete sites lie within the high priority reaches.
- Landowner willingness to participate in restoration activity was not used as a criterion for defining high priority reaches and locations. Land ownership, or an individual landowner's interest in participating in restoration, can change over time. This plan will be in place to guide decisions when opportunities arise.
- During the project, landowners within the high prior sites/reaches were contacted and as a result, several landowners have expressed a desire to have restoration done on their property. There was no negative feedback received from landowners regarding inclusion in the project.

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Project Overview

The Watershed-scale Floodplain Restoration to Enhance and Increase Juvenile Coho Salmon Off-Channel Summer Rearing and Overwintering Habitat in the Scott River Watershed- Phase I Planning Project (henceforth, "Project") identified and prioritized high value restoration sites where coho rearing habitat can be enhanced within key cold water reaches of the Scott River system. The long-term objective of the Project is to provide a guiding document to assist practitioners in optimizing restoration funding opportunities to restore both quantity and quality of slow, deep water habitats during both baseflow and winter high flows, improve floodplain connectivity, and increase or create habitat complexity within instream and off channel areas, including side channels, alcoves, and ponds. One of the significant limiting factors for recovery of a variety of species, including the CESA listed Southern Oregon Northern California Coast (SONCC) Coho Salmon in the Scott River Watershed is the lack of these habitats (National Marine Fisheries Service 2014).

Planning is the fundamental step to outlining comprehensive restoration treatments which will have the greatest likelihood of addressing the goals, objectives, and targets for recovery of coho salmon. This plan determines locations where the most beneficial and cost- effective restoration actions for the coho population can be deployed with the limited available restoration resources.

The Project used a suite of complementary techniques to determine favorable locations where surface and ground-water conditions can be augmented, restored or created to provide cold water drought refuge for juvenile coho and other aquatic and terrestrial organisms. Additionally, the potential increase to summer baseflows from groundwater improvements may result from targeted restoration combined with water conservation efforts to assist in meeting the goal of providing suitable flow and interconnection through reaches prone to subsurface flow and reduce delays to upstream migrating adult fish.

Project objectives were to improve floodplain connectivity and increase or create habitat complexity within instream and off-channel areas, including side channels, alcoves, and ponds. Tasks included clipping the existing LiDAR Digital Elevation Models (DEM) and running an inundation model to identify areas where side channels and floodplain features inundate frequently. The inundation model was utilized to identify discrete sites with relative frequent floodplain inundation. The identified potential sites were assessed to direct the prioritization of project development. The process undertaken provides a scientifically based road map for prioritizing high value restoration sites, stream reaches and activities to provide cold water refugia in the near term and move towards achieving the watershed scale improvement in geofluvial conditions necessary for climate resilience over the long-term.

During the course of the Project, Scott River Watershed Council (SRWC) conducted various outreach efforts aimed at landowner and stakeholder engagement. It was important for the success of the Project that a clear and articulate set of objectives were communicated to both Scott Valley landowners and stakeholders alike. Meetings, written material, newsletter articles and individual tours and meetings were utilized to achieve this goal.

Final project deliverables consist of one 90% restoration high priority site design, and one high priority conceptual site design. Additionally, one project resulting from this analysis will be implemented in the fall of 2018, and grant proposals for two other projects resulting from Project analysis been submitted during the course of this effort.

As part of the Project's collaborative effort, SRWC and Siskiyou Resource Conservation District (SRCD) cataloged the SRCD's library of documents consisting of local resource management plans, reports, technical manuals, studies, peer reviewed articles, and historical records with the goal of making them electronically accessible to the public in the future. Currently, many of these documents are only accessible in paper format in the SRCD library.

Scott River Watershed

The Scott River lies within the Klamath Basin which encompasses three counties in southern Oregon and five counties in northern California. The Basin drains approximately 15,571 square miles and includes Upper Klamath Lake and the Klamath River; nineteen large dams within the Basin provide hydropower, water storage, and irrigation diversions in the region. The Upper Klamath Basin, which lies upstream of Keno, Oregon, is predominantly a high desert ecosystem, while the Lower Basin is predominately made up of temperate rainforests and mixed conifer forests. Both the upper and lower basins support a wide variety of animal and plant species, including several unique and relict species.

The Scott River, one of four major tributaries to the Klamath River below Iron Gate Dam, is 58 miles long and is geographically located in Siskiyou County, California. The Scott River Watershed contributes 5% (yearly average of 615,000 acre feet) of the overall Klamath runoff. The Scott River is both geologically and ecologically diverse, comprising of 813 square miles with mountain crests at approximately 7,000 to 8,000 foot (2,134 to 2,438 meters), an alluvial valley floor at 2,000 ft (610 meters) above a canyon reach that eventually drains into the Klamath River at an evaluation of 1,580 feet (482 meters) (Figure 1). The Scott River is undammed and is therefore completely dependent on precipitation for stream and river flows. As such, drought and climate change effects are likely to be immediate and cannot be mitigated by utilization of stored water.

Approximately 47% of the watershed is woodland (mixed conifer and oak), 42% is rangeland or shrubs and grasses, 9% is irrigated agriculture, and about 2% urban or residential (Harter 2008). Economically, the Scott River Watershed consists of disadvantaged communities, with the mean household income averaging $38,524, based on Siskiyou County data (United States Census Bureau 2018). The region's main economy is based on government jobs, ranching and farming, as well as tourism. There is a limited amount of timber harvesting on the watershed perimeter as well as some recreational gold mining. Although sport fishing opportunities exist in mountain lakes and some streams at certain times, most of the Scott River is now closed to fishing.

The land uses within the watershed are a reflection its rural nature. Farming, ranching, forest management, residential, commercial enterprise, recreation, mining, fish and wildlife habitat, open space, and wilderness areas are all important elements the Scott Valley's culture. Ownership with the watershed consist is 63% private land and 37% federally managed lands. Public lands are managed by the Bureau of Land Management (BLM) and United States Forest Service (USFS). Land holdings also include tribal trust lands, including the Quartz Valley Indian Reservation (QVIR).

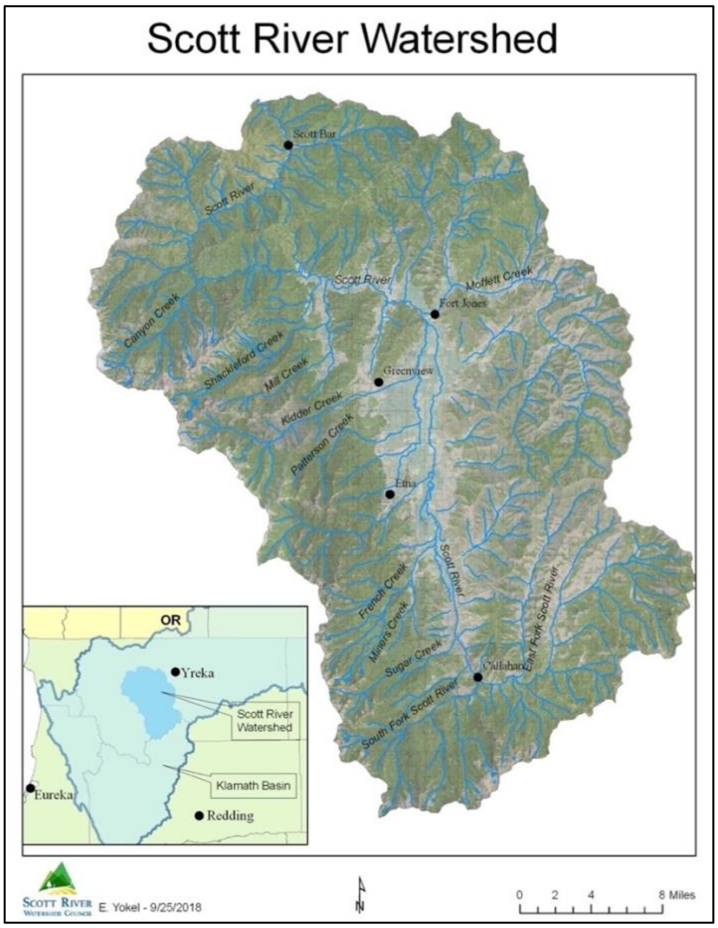

Figure 1: Location of Scott River, a major tributary to the Klamath River Watershed

Physical Characteristics

Geology

The bedrock in the area, dating from pre-Silurian to Late Jurassic and possibly early Cretaceous time, consists of consolidated rocks whose fractures yield water to springs at the valley margins and in the surrounding upland areas. The oldest rocks are the Salmon hornblende schist and Abrams mica schist, a sequence of completely recrystallized sedimentary and volcanic rocks of pre-Silurian age (Figure 2). Overlying these rocks with profound unconformity along the eastern part of Scott Valley are beds consisting of more than 5,000 feet of sandstone, chert, slate, and limestone of probable Silurian age. Along the northern part of the area, the Salmon and Abrams schists are unconformably overlain by andesitic and basaltic volcanic rocks altered to greenstone and greenstone schist. Beginning in Late Jurassic and perhaps continuing into Early Cretaceous time, the Klamath Mountains were the scene of profound orogeny. The rocks were strongly folded and faulted and were invaded by a series of magmas which solidified into rocks ranging in composition from peridotite, now largely altered to serpentine, to granodiorite (Figure 2). The granodiorite is the youngest of all the consolidated rocks in the area (Mack 1958).

Many of the valley headwalls of the westside tributary streams consist of ancient granites that rapidly decompose and are contributing significant bed loads of decomposed granite (DG) sand to the streams. This process has been accelerated by road building and logging, increasing transport of these materials significantly. Significant negative effects for salmonids have resulted, including the reduction of the quality and quantity of spawning gravels, filling of pool habitat and smothering and/or scouring redds in highflow conditions. It is estimated that 26% of the Scott River watershed consists of granitic terrain (Sommarstrom 1990).

The valley alluvial fill consists of a few isolated patches of older alluvium (Pleistocene) found along the valley margins and of younger alluvium which includes stream-channel, floodplain, and alluvial-fan deposits of recent age. The recent deposits underlie and form the alluvial plains of Scott and Quartz Valleys, the valley of Oro Fino Creek and the fans at the valley margins and extend in tongues up the valleys of tributary streams (Figure 2).

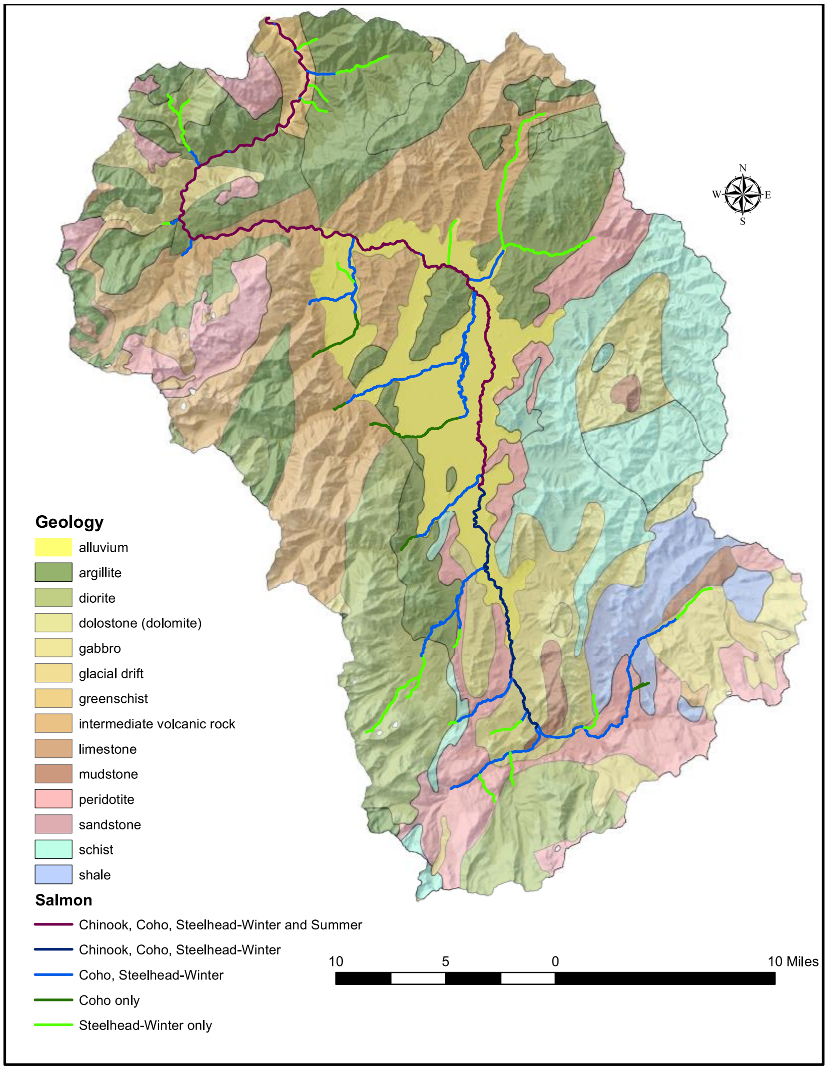

Figure 2: Geology and distribution of salmon in the Scott River Watershed. Most of the salmon-bearing streams are on the west side of the watershed, where snowpack, precipitation and stream flows are greater, relative to the drier east side.

Hydrology

The average seasonal precipitation is 21.7 inches but may exceed 70 inches annually in the western mountains and exceed 30 inches in the eastern mountains (Figure 3). The average annual temperature in the Valley is 50.3° F. Streamflow in the Scott River is primarily driven by fluctuations in snowpack and the quality of the water year. Much of the Scott Valley consists of highly permeable sediment that creates significant connectivity between the stream surface water and the underlying aquifer. During normal precipitation years, the aquifer is recharged during the winter and spring, with groundwater accretion supplementing surface water during periods of low flow. The flows in both the river and tributaries will go subsurface in some locations during the summer months and in years with low levels of precipitation.

Snow surveys have been performed by the Klamath National Forest since 1946 at Middle Boulder (elev. 6600 ft) in the Scott Mountains, the southern edge of the watershed. These measurements are taken as part of a larger statewide effort, the California Cooperative Snow Survey program, which was established to assist the State in forecasting the amount of water available for uses such as agriculture, power generation, recreation and stream flow management. The mean annual precipitation varies across the Scott River Watershed (Figure 3).

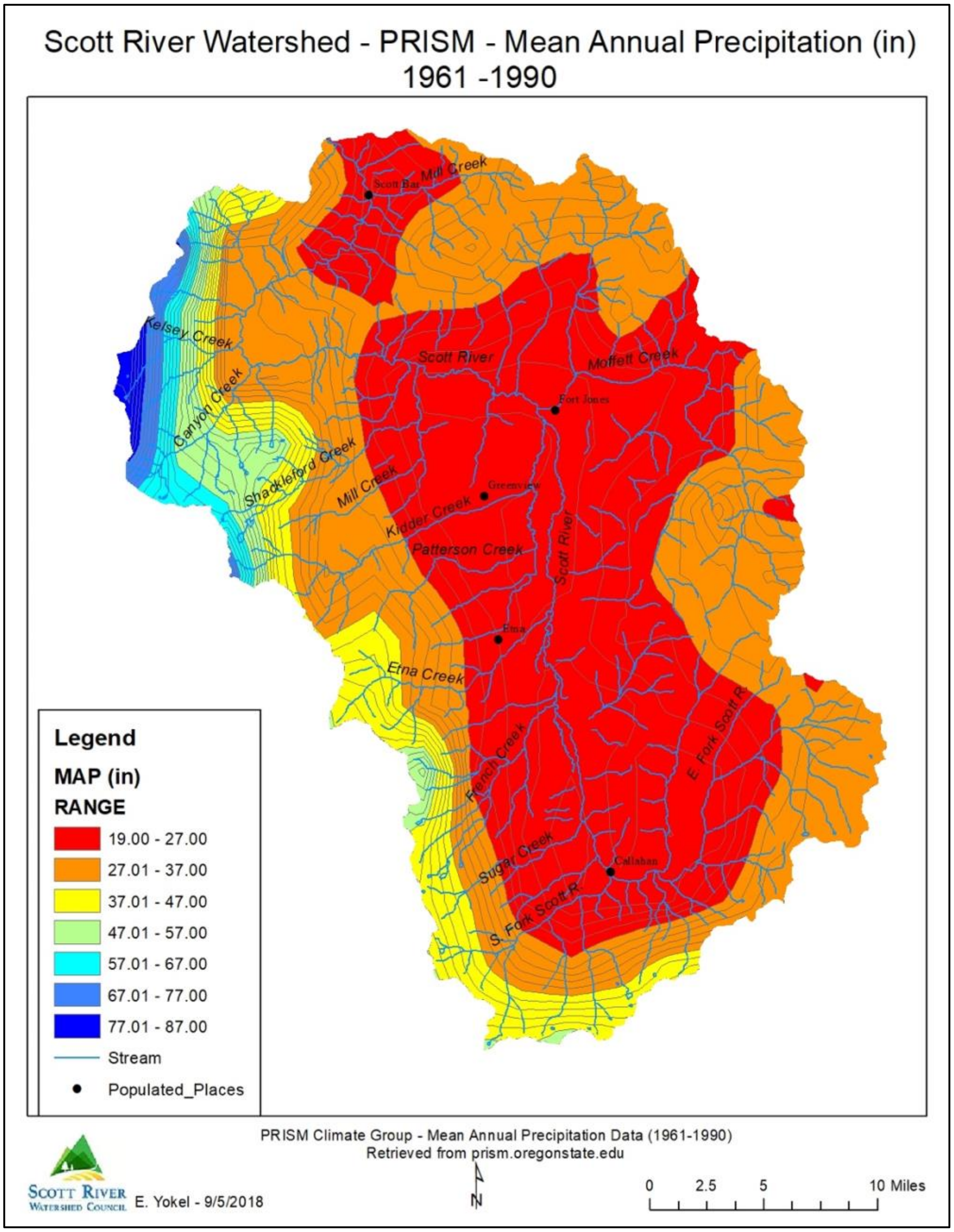

Figure 3: Mean annual precipitation 1961 – 1990. PRISM Climate Group, Oregon State University

The watershed has eleven key sub-basins draining into the Scott Valley (Figure 4). Shackleford Creek, Mill Creek, Kidder Creek, Patterson Creek, Etna Creek, French Creek, Miners Creek, Sugar Creek, South Fork of the Scott River, East Fork of the Scott River and Moffett Creek.

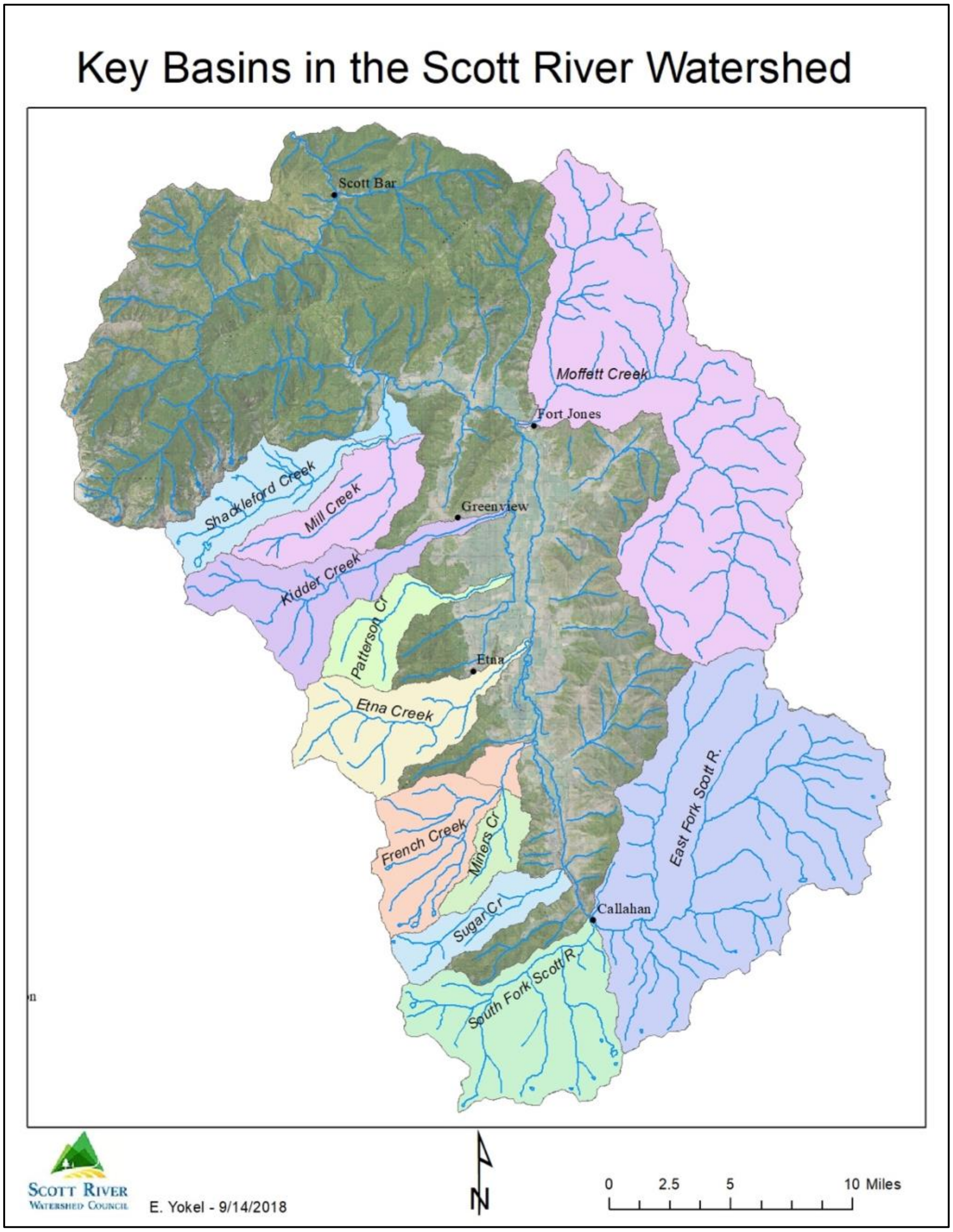

Figure 4: Map of Key Basins in Scott River Watershed

The characteristics within the sub-basins vary in both geologic composition and hydraulic processes. Variation in basin area, percent of basin area with elevation greater than 6000 ft, mean and maximum elevation and mean annual precipitation exist (Table 1).

Table 1: Basin Characteristics of Key Basins in Scott River Watershed (Data retrieved from water.usgs.gov/osw/streamstats)

Watershed	Area (sq. mi)	% Area > 6000 ft	Mean Elevation (ft)	Max Elevation (ft)	Mean Annual. Precipitation (in)
Shackleford Creek above Mill Creek	19.4	42%	5657	8240	42.6
Mill Creek	20.3	7%	4089	7201	30
Kidder Creek above. Big Slough	28.1	21%	4974	7624	42.4
Patterson Creek	13.5	21%	4820	7439	40.2
Moffett Creek	123.3	0%	4236	6252	29.8
Etna Creek	26.7	19%	4955	7529	39.6
French above Miners Creek	23.7	33%	5069	7964	37.9
Miners Creek	7.9	2%	3809	7036	25.6
Sugar Creek	13.3	31%	4981	8153	35.4
South Fork Scott River	43.6	45%	5677	8076	42.4
East Fork Scott River	115.5	16%	4893	8482	43.2

Coho Salmon in the Scott River

The Scott River supports a Core, Functionally Independent Population of Southern Oregon Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), one of the most productive natural stocks in the Klamath River basin (National Marine Fisheries Service 2014). Although the Scott River population is likely above the depensation threshold (242 adult coho salmon) as defined in the SONCC Coho Salmon Recovery Plan (National Marine Fisheries Service 2014), there are two weak brood years and the continued presence of stressors has significantly reduced the size of the population over time. To attain viability, 6,500 spawners are required in the Scott River coho salmon population. In the past 10 years, adult returns have ranged from 62 to 2,731, with an average of 688 and a median of 285 (Knechtle and Chesney 2015, CDFW-Yreka 2016). Analysis of the annual escapement of adult coho salmon for a single cohort shows a significant increase in population from 2008 (58 adults) to 2011 (358 adults) and a continued positive trend in 2014 (504 adults). This trend was also observed in the cohort that returned in 2009, 2012 and 2015 (Knechtle and Chesney 2015).

A limiting factor analysis for coho salmon in the Scott River identified a lack of suitable rearing habitat during the summer and winter months as a probable limitation for smolt production (SRWC 2006). Similarly, NOAA Fisheries also determined the lack of rearing habitat in their Recovery Plan (National Marine Fisheries Service 2014) that the juvenile life stage was the most limited in the population. During the spring and fall, juvenile coho salmon redistribute from their natal habitats in search of suitable summer or winter rearing locations (Figure 2). Gorman (2016) found that individual juvenile coho salmon in the Shasta and Scott Rivers who out-migrated as young-of-the-year (YOY), possibly due to poor natal conditions, experience a higher proportion of juvenile mortality than those rearing in natal streams, consistent with observations in other systems (Bennett et al. 2015). High juvenile mortality while transitioning to a non-natal stream could, in turn, lead to decreased future adult returns. This mortality could have particularly large effects on returns when, as in 2014, a drought year, the abundance of YOY outmigrants was much larger than the number of smolt outmigrants within a cohort. Further, Gorman (2016) presumed through otolith analysis and PIT tag detections that natal rearing contributes more to population persistence in the Shasta River than non-natal rearing.

The SONCC Coho Salmon Recovery Plan (National Marine Fisheries Service 2014) prioritizes recovery actions that enhance and extend surface flow connectivity in the Scott River and tributaries so that sufficient instream flows are available for juvenile coho salmon. Furthermore, prioritized are actions to increase summer and winter rearing habitat through increased floodplain connectivity through restoration of natural channel form and function and the construction of off channel ponds, alcoves, backwater habitats and old stream oxbows.

Anthropogenic Impacts – Historical and Present

Like most areas of California, and throughout the lower 48 states, much of the natural landscape has been altered over time by anthropogenic influences. Many of the negative impacts had unintended consequences during a period of time when resources often seemed to be inexhaustible. The effects of human land use tend to alter one of three watershed components; water, soil and vegetation. Generally, alteration in one of these areas will most likely impact the other two. Ecologically, both aquatic and terrestrial ecosystems have evolved within a natural range of disturbance frequency and intensity. Land use changes in the Scott River Watershed have significantly, and in some instances, catastrophically disrupted the natural disturbance regime, causing imbalances both in the physical and biological systems. There has been an evolving understanding and increased acknowledgement regarding fluvial systems and how significantly altered they are by past and current human activities and management (Bernhardt et al 2005). Early land development is poorly documented and it requires painstaking investigative work

(Baumgarten et al. 2017) therefore it is very difficult to reconstruct a clear articulation of pre-development hydrology and ecology.

For nearly two centuries, most areas within the watershed have experienced varying degrees of alteration due to human activities affecting most aspects of the natural physical, hydrologic and ecological systems. Today, several of these impacts are considered to have legacy effects. "Legacy" refers to the belief that certain current watershed conditions caused by human activity have been inherited, and are important when trying to understand regulatory obligations affecting the current Scott Valley community. The cumulative legacy impacts of beaver removal, mining, flood control measures, channel straightening, timber harvest, surface water diversion for both mining and agricultural purposes, increased groundwater pumping and the increasing climatic changes with less winter snowpack have degraded salmonid habitat and critically threatened the functionality of floodplain ecosystems in the Scott Valley Watershed. As a result, extremely complex social-ecological and regulatory challenges lie in sustaining species that rely on habitats upon floodplains, particularly when ecological and human benefits rely on the critical and shared water resource.

Removal of beavers

Prior to arrival of non-indigenous people, native Americans known as the *Iruaitsu* are documented to have occupied the Scott Valley for thousands of years (Kroeber 1976). In the 1830s, the area was discovered by Hudson Bay fur trappers, setting the stage for the first significant anthropogenic impact to the watershed with the near extirpation of beavers (*Castor canadensis*). It is claimed that in a single month, 1800 animals were trapped out of the watershed that was characterized as one swamp that was filled with dams and lodges (Wells 1881). Accounts of overwhelming beaver abundance gave way to the Valley's first English name, "Beaver Valley" (Guddle and Bright 2004). Stephen H. Meek (1805-1889), a notable trapper and eventual resident of Etna, California, stated "the richest place for beaver I ever saw" (Wells 1881). It is believed that the significant removal of the beaver was the beginning of the river ecosystem's diminution.

Ecosystem services provided by streams and wetlands of California have been significantly degraded. Most arable lands have been drained, driving reductions in stream and wetland habitat complexity and resiliency, contributing to the decline of aquatic species, altered hydrologic function, and compromised the natural reservoir effect needed to support summer baseflows. Overall, there has been a lack of appreciation and underestimation for the positive ecological effects that beavers have on riverine systems (Pollock et al. 2004). Unfortunately, the near extirpation of beavers has delayed our overall understanding about their importance as a foundational species therefore leading to further degradation of many watersheds, including the Scott River. It is estimated that over 90% of all wetlands within California have eliminated (Dahl 1990). Wetlands and floodplains play a critical role in the biological, geomorphic, and hydrologic cycles including groundwater recharge, all of which impact the overall ecological fitness of a watershed (Cluer and Thorne 2013). Additionally, the loss of complex, deep slow water habitats such as those created by beaver dams has been identified as a reason for the decline in coho salmon populations (California Department of Fish and Game 2004; National Marine Fisheries Service 2014). Fortunately, there is a general assumption, and anecdotal evidence, that the number of beavers within the system today is expanding. This positive increase is thought to have a direct correlation to the extensive riparian cattle exclusionary fencing implemented over 90% of Scott River and miles of tributaries completed during the 1990s and early 2000s (Scott River Watershed Council 2005). This allowed riparian vegetation to rebound and provide food and building materials for beaver.

Mining

Following the fur trappers, the discovery of gold caused the next serious impact to the Scott riverine system. John Scott's discovery of gold in Scott Bar in 1850 initiated the first significant influx of Euro-American settlers and the beginning of the land use transformation into the current working agricultural landscape. Additionally, the final English name for both Scott River and Scott Valley were rendered from Scott's contributions to its development.

Mining for the precious metal lasted for approximately a hundred years, utilizing a combination of techniques. Hydraulic and sluice mining, requiring extensive use of ditches and flumes to transport water, which are still evident throughout the Valley today. Often, hard rock and dredge mining, both small and large scale, were utilized, significantly impacting many of the tributaries and mainstem of the Scott River (United States Department of Agriculture 1997). Besides gold, Scott Valley produced other minerals resources such as chromite, manganese, copper, and a small amount of platinum (Mack 1958).

There is no greater mining landmark within the watershed than the infamous 5+/- miles known as Scott River tailing reach. From 1934 to 1951, a large Yuba dredge flipped millions of cubic yards of the river's substrate on its head, unnaturally pinning the river channel to the eastern portion of the valley floor (Sommarstrom et al. 1990). The sheer magnitude of its scope is daunting, with more than 500 acres of cobble ridden landforms that have landlocked pools of cold, clear Scott River water. As a result, much of the current location of river through the tailings reach dries during the summer and fall, impacting the overall riverine system (Figure 5).

 

Figure 5: Scott River Tailings above Sugar Creek confluence looking North & South.
Photos taken by Charnna Gilmore on August 27, 2018.

As mining activities continued throughout the Valley and across the West, many turned to farming in the fertile landscape of Scott Valley to support the growing human population. Transformation of the once swampy valley floor into farmland was well on its way. Land use changes and surface water diversions soon began not only to support mining activities but increased to provide for agriculture needs. Due to the relatively short growing season, much of the agricultural focus has been on alfalfa and grass hay, pasture and some grain crops. Cattle, sheep and swine ranching also has been a commercial practice since the Gold Rush era. Subsequently, pressures on the Valley's vital water resource has steadily increased over the past century.

Floods and Flood Control Measures

Although flooding is a natural event, land use practices and changes in climatic patterns can exacerbate the effects. Evidence of extensive flooding in the Valley date back prior to Euro American settlers, however the most well documented events have occurred in the past two centuries (Helley and LaMarche 1973). Reports of several damaging floods in the 1800s and early 1900s exist, however the largest flood on record for the USGS gage below Fort Jones (established in 1941) was on December 22,1964, with river flows capping at 54,600 cfs, causing extensive damage. The second largest flood for the period of record occurred on December 22nd, 1955 (38,500 cfs) also causing significant bank and soil degradation in the Scott River and the fourth largest and latest historic flow event occurred on January 1, 1997 (34,300 cfs). As recently as 2015, a flood (> 15,000 cfs) initiated an avulsion in the tailings reach, breaching a levee and creating a new flow path that extended for miles before returning to the mainstem just above French Creek. Despite the extensive rip rap along the mainstem, virtually all large floods cause significant bank erosion.

In response to the flooding during the winter of 1937-38, the Siskiyou County Supervisors requested both state and federal governmental assistance (Scott River Watershed Council

2005). In August 1938, the United States Army Corps of Engineers straightened, removed riparian vegetation and leveed a significant portion of the mid Scott River (Kennedy et al. 2005). After the 1955 flooding, another concerted effort to stabilize the banks of the Scott River using large rock was led by the Soil Conservation Service (now Natural Resources Conservation Service) and landowners to protect the agricultural land of the Scott Valley (Scott River Watershed Council and Siskiyou Resource Conservation District 2014).

In subsequent years, additional flood control levees were constructed in the lower reaches of Etna Creek, Kidder Creek and Moffett Creek. (Mack 1958). As a result of altering both the hydrology and morphology, the ecosystem was significantly changed, causing a disconnection from critical floodplain habitat, decreasing riparian vegetation vigor by lowering water table, and virtually eliminating low velocity river margins, and off channel or side channel habitats, something that is critical to the survival of juvenile coho salmon (National Marine Fisheries Service 2014). Additionally, much of the remaining Scott River within the valley floor has been channelized by landowners in attempts to reduce flooding and maximize agricultural acres for production (Figure 6).

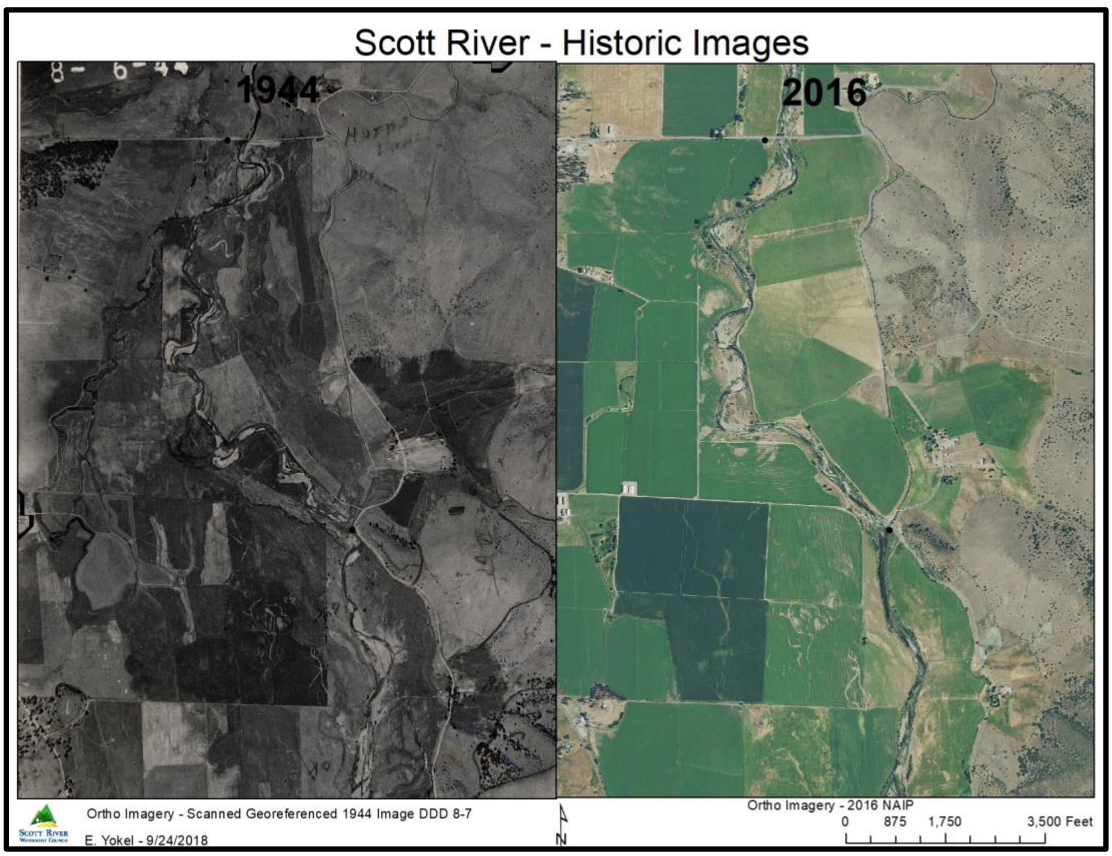

Figure 6: Scott River upstream of Youngs Dam to Horn Lane, 1944 and 2016 aerial images

Agriculture

In 1953, approximately 15,000 Scott Valley acres were irrigated by surface water, and an additional 15,000 acres were sub-irrigated in areas that are considered discharge zones, or areas on the westside of the watershed that are near the base of the alluvial fans. An additional 370 acres were irrigated by wells, bring the total irrigated acreage to 30,370 (Mack 1958). Estimates are that the total water consumption during the same year for all Scott Valley purposes, both residential and agricultural, was 40,100 acre-feet with the majority of the water being utilized for agricultural irrigation (38,000 acre-feet from surface water and 1,000 acre-feet from groundwater), and the balance for domestic uses (Mack 1958). Estimates that irrigation efficiency was 55%, allowing 45% - or 17,000-acre feet - of the diverted surface water percolated back through the substrate and provided some midsummer groundwater recharge (Mack 1958).

By 2000, the irrigated agricultural acreage did not drastically change within the basin with a reported 31,800 acres in production. In contrast, 92,200 acre-feet was estimated as applied water, with an assumption that 48% came from surface water diversion, 45% from groundwater extraction and 7% from conjunctive use, which is the combination of both surface and groundwater sources (Harter et al. 2008 & Environmental Science Associates 2009).

By the mid-century, the rights to divert all Scott Watershed surface water had been established in three separate decrees: Shackleford Creek Adjudication in 1950, French Creek Adjudication in 1958 and the Scott River Adjudication in 1980. Each adjudication was established by California State's Division of Water Rights which is under the California State Water Resource Control Board (SWRCB). The rights given in these documents allow water users to divert surface water for a specific area at which the water is to be used; a priority or ranking to other water users on a given diversion; a defined purpose for the diverted water; and the season in which the water is to be used. The Scott River Adjudication also has a provision that allows for groundwater pumping in what was considered the "interconnected" area of the Scott River. Pre-1914 claims, riparian and appropriative rights were also included in all three decrees (Harter and Heines 2008).

The Scott River Adjudication (not including either the Shackleford Creek or French Creek Adjudications) identifies a total of 680 diversions with a cumulated right to divert 894 cubic feet per second (cfs), from the Scott River and its tributaries (Harter and Heines 2008). In addition to agricultural and domestic uses, there was specific allowance made for the Scott River fisheries resource. The United States Forest Service (USFS) possess rights (Table 2) to instream flows during any given month for fish and wildlife within the National Klamath Forest. Specific terms stating, "necessary to provide minimum subsistence-level fishery conditions including spawning, egg incubation, rearing, downstream migration, and summer survival of anadromous fish, and can be experienced only in critically dry years, without resulting in depletion of the fishery resource.*"* The USFS holds an additional allotment (Table 2), both measured at the USGS gage below Fort Jones, for instream flows with the Klamath National Forest for "*i*ncremental fish flows and for recreational, scenic, and aesthetic purposes" (California State Water Resource Control Board 1980).

Table 2: Scott River Adjudication. The U.S. Forest Service's right instream use for the Scott River to be measured at the U.S.G.S gage below Fort Jones for the use of fish and wildlife and incremental fish flows, recreational, scenic and aesthetic within the Klamath National Forest (California State Water Resource Control Board 1980).

Period	Fish & Wildlife Allotment in Cubic Feet per Second	Incremental fish flows, recreational, scenic and aesthetic in Cubic Feet per Second
January	200	226
February	200	226
March	200	226
April	150	276
May	150	276
June 1st - 15th	150	134
June 16th - 30th	100	184
July 1st - 15th	60	132
July 16th - 31st	40	152
August	30	47
September	30	32
October	40	96
November	200	158
December	200	226

Furthermore, the U.S. Forest Service possess first priority rights to stream flow in tributaries to the Scott River that are within the Klamath National Forest (Table 3) "including but not necessarily limited to fish, wildlife, recreation, and aesthetic enjoyment" (California State Water Resource Control Board 1980).

Table 3: The U.S. Forest Service's right instream use for the Scott River tributaries to be measured at the U.S.G.S gage below Fort Jones for the use of fish and wildlife and incremental fish flows, recreational, scenic and aesthetic within the Klamath National Forest (California State Water Resource Control Board 1980).

Instream Flow Allotments in Cubic Feet per Seconds												
Name of Stream	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Mountain House Creek	1	2	1	1	2	1	1	0.5	0.5	0.5	0.5	1
Crater Creek	2	3	2	3	3	3	1	1	1	1	1	2
Houston Creek	2	3	3	3	3	3	2	1	1	1	1	2

Name of Stream	J	F	M	A	M	J	J	A	S	O	N	D
Cabin Meadow Creek	3	4	4	4	4	4	2	2	1	1	2	3
Rail Creek	4	6	5	6	6	6	4	2	2	2	2	4
Kangaroo Creek	4	6	4	6	6	6	3	2	1	2	2	4
Grouse Creek	6	9	9	9	9	9	6	3	3	3	3	6
Mule Creek	4	6	4	5	6	5	3	2	1	1	2	4
Big Mill Creek	5	8	8	8	8	8	5	3	2	3	3	5
Boulder Creek	8	12	11	12	12	12	8	4	4	4	4	8
East Boulder Creek	3	4	4	4	4	4	2	2	1	1	2	3
West Boulder Creek	3	5	5	5	5	5	3	2	1	2	2	3
Fox Creek	5	7	7	7	7	7	5	3	2	3	3	5
S. Fork Scott River	14	21	21	21	21	21	14	7	7	7	10	14
Sugar Creek	5	9	7	9	9	9	5	3	2	3	3	5
Etna Creek	14	21	21	21	21	21	14	7	7	7	7	14
Kidder Creek	14	15	12	15	15	15	8	4	4	4	6	13
Indian Creek	4	6	6	6	6	6	4	2	2	2	2	4
McAdam Creek	8	12	9	12	12	12	5	2	0.5	1	1	8

Water withdrawal, both from surface flows and groundwater, is governed by a complex set of laws and regulations. Many of these are subject to differing interpretations, and some are under active litigation to provide additional clarity. The outcome of these suits will impact the availability of water for human and ecological uses.

Livestock Grazing

There are numerous allotments active within the Scott River Ranger District, with a total of 39 active allotments and two wild horse areas throughout the Klamath National Forest. The allotments include grazing permits for a period of ten years and specify livestock numbers, season of use and numerous other terms and conditions which are specified in a supplemental Annual Operating Instructions (AOI). Individual AOI are customized for each grazing season and is made part of the terms and conditions of the term for the grazing permit. AOI's include guidance criteria that address annual resource conditions, livestock numbers, periods of use, pasture rotations, monitoring, and range improvement projects. These allotments generally lie in the uplands of the watershed and can run from May 1st (more commonly July 15th) through October 15th, depending on the terms of the permit (Klamath National Forest 2018).

Siskiyou County is one of six counties within California to have open range law. This law states that anyone wanting to keep cattle, sheep or other livestock off one's personal property, the property owner, not the owner of the livestock, must fence them out. The only expectation to this law applies to properties that are adjacent to federal lands and in such case, the owner of the livestock must provide adequate fencing to keep livestock off of federal property (County of Siskiyou 2005).

Timber Production

The demand for timber began simultaneously with the mining era. By 1852, the first sawmill was in existence and by 1880, there were 11 mills supporting the needs of the residents at the time. There have been periods of time that have produced more or less timber. After World War II, the need for timber further increased, supporting 13 mills producing 75 million board feet per year. Early timber harvest practices, including the constructions of roads, contributed to serious environmental concerns in the Klamath region. As a result, regulatory oversight was established in the 1970s on both private and public lands (Scott River Watershed Council 2005).

The original construction of roads was developed to provide access to gold mines and over time, roads slowly were adapted for private timber extraction purposes. In the 1960s, the United States Forest Service began to sell commercial timber and therefore the road construction not only increased but moved to higher elevations within the watershed. Timber related use on the roads declined substantially during the 1980s and now the primarily uses for the road network are for recreational, residential and administrative purposes (United States Department of Agriculture 1997).

Urbanization

As mining camps came and went, several small towns were established, generally at strategic locations of commerce. These consist of: City of Etna in 1855; Town of Fort Jones in 1852; and several unincorporated areas such as Callahan, Greenview and Scott Bar. Etna's city water is supplied by the surface water of Etna Creek. Fort Jones's water supply comes from a groundwater well and Callahan takes its water from the South Fork of the Scott River. All other water supplied for residential use throughout the Scott Valley is supplied by groundwater and to a much lesser degree, the use of spring water. The current population estimates for the Scott Valley is approximately 7,000 residents.

Droughts

Instream flows in the Scott River watershed are primarily driven by winter rains and snow-melt. The mainstem and alluvial portions of tributaries have subsurface flows during the summer months and certain periods during the winter. A combination of below-average precipitation and below-average groundwater levels contribute to significantly reduced instream flows in some water years. These low flows can be a limiting factor to salmonids in general, and coho production in particular. Reduced flows can lead to loss of critical rearing habitat and block passage to key spawning grounds. The undamned nature of the Scott River system provides no option to augment instream flows during droughts through release of stored water.

The National Drought Mitigation Center divides droughts into a variety of types (e.g., meteorological, agricultural, hydrological, socioeconomic, etc.), but for the Scott River watershed the hydrological drought type is of the greatest interest. Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., stream flow, reservoir and lake levels, groundwater). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, stream flow, and groundwater and reservoir levels. (National Drought Mitigation Center, 2008)

The Scott River Watershed has an alluvial groundwater aquifer that underlies the valley floor. During periods of extended drought, the aquifer can take longer to recharge. The community well level program has shown that in some years the aquifer levels don't begin to recover until late winter (Feb-March) (Deas and Tanaka 2011).

The Scott River Watershed Preliminary Draft Voluntary Plan for Dry and Critically Dry Years makes the following recommendations for definition of drought for the Scott River watershed:
"If accumulated October through March precipitation at Fort Jones is less than 13.5 inches then it is a *dry precipitation* year type. If October through March precipitation is 10 inches or less than it is a *critically dry year* type. If accumulated October through March precipitation is greater than 13.5 inches, then it is a *not-dry precipitation* year type. If it is a *dry or critically dry precipitation* year type and groundwater levels are not recovered to "normal" spring levels, then more stringent management is needed because there is less stored water in the system to act as a buffer for reduced surface flows. If it is a *dry or critically precipitation* year type and groundwater levels are recovered to normal spring levels, then cautious management is needed, but stored water is available to buffer the surface water system" (Deas and Tanaka 2011).

Fire Regime and Suppression Efforts

The disturbance of wildfire played a critical role in the evolution of the Klamath Mountains ecosystem in which lies a significant portion of the Scott River basin. Fire is credited to have played a crucial role in the region's remarkable biodiversity. Additionally, the variability of fire in terms of frequency, severity and spatial composition played an important role in the overall, long-term ecosystem function (Frost and Sweeney 2000).

Historically, prior to Euro-American settlers, fires were frequent across the landscape, ranging from an interval of 8 years on south aspects to 16 years on easterly facing aspects (Taylor and

Skinner 1998). Fires generally were low intensity with some patches of high intensity in upslope areas and less common and lower intensity within the riparian zones (United States Department of Agriculture 1997). Fire suppression efforts began in 1905, however efforts by the Klamath National Forest were ramped up in 1920, followed by increased suppression efficiency after World War II when mechanized equipment became available (Taylor and Skinner 1998). The exclusion of fire in fire dependent systems increases the threats from insects and diseases, creating large amounts of down woody material and dense understories, leaving it susceptible to high intensity fire that will destroy entire stands of forests, alter soil water infiltration processes, and cause increased runoff. Additionally, these high intensity fires cause significant sedimentation events that can fill in pools and smother salmon redds and reduce canopy shading, resulting in higher water temperatures. The fire history for the Scott River Watershed has varied in both size (United States Forest Service 2018) (Table 4) and intensity. The fire in 1955, located in the Kidder and Patterson Creek drainages, was especially damaging when the second largest flood followed within the same year.

Table 4: Scott River Fire History - 1955-2018 (United States Forest Service 2018)

Scott River Fire History 1955 - 2017	
Year	**Acres**
1955	24,032
1956	100
1959	466
1964	13
1987	8,414
1988	30
2000	13
2004	14
2006	3
2007	63
2009	1,736
2010	5
2011	18
2012	265
2014	34,645
2017	8,949

Climate Change

Predicted climate conditions will mimic perennial drought. These drier conditions reduce both surface and groundwater flows (Barr et al. 2010). Future changes in the amount and timing of precipitation, and increased frequency and magnitude of drought events are expected to amplify ecosystem stressors. In addition, stream temperatures are predicted to rise due to increased air temperature (Goodman & Reid 2012) as well as reduced stream flows. Expected, is a precipitation shift from snow to rain (Kiparsky and Gleick 2003), earlier snowmelt (Knowles et al. 2006), lower summer flows (Barr et al. 2010), more intense storms in the winter, which will increase peak flows (Doppelt et al. 2008) and reduce snowpack that prolongs spring/summer stream flows. It is also believed that snowpack decreases the potential erosion rates at high elevation, therefore there are concerns of increased erosion (Sommarstrom et al. 1990).

The document prepared by the National Center Conservation Science and the Policy and The Climate Leadership Initiative titled "Preparing for Climate Change in the Klamath Basin" predicts changes for the Klamath Basin consisting of "An increase in annual average temperatures compared to baseline temperatures (2.1°F to 3.6°F [1.1°C to 2.0°C] increase by mid-century and 4.6°F to 7.2°F [2.5°C to 4.6°C] by late century). Summer warming is projected to be greater than warming during other seasons. Projections for annual average precipitation ranged from an overall reduction of 11% to an increase of 24%. All three models agreed that future summers are likely to be drier (a decrease of 3-37%) than past summers." The predicted changes in climate will shift the timing and duration of snowmelt releases, altering hydrologic conditions and exacerbating the effects of a warmer environment. The Wildlife Conservation Society recently published a report titled: "14 Solutions to Problems Climate Change Poses for Conservation."

The problems identified include:

- Less water/worse droughts;
- Bigger Floods;
- Direct Effects on Species.

Adaptive solutions offered include:

- Restore natural water storage capacity of ecosystems;
- Reconnect rivers and floodplains to recharge groundwater aquifers;
- Position ecosystems to thrive under future climate conditions;
- Protect or restore areas likely to remain or become suitable as climate changes.

These national recommendations correlate strongly with region-specific recommendations in the document "Preparing for Climate Change in the Klamath Basin" consisting of: "Reconnect rivers with floodplains, restore wetlands and restore streamside areas to hold more water during floods and increase groundwater recharge" and "Protect areas with cooler water as air and water temperatures rise (Barr 2010). These include stream and lake areas with groundwater-fed springs and well-developed bank vegetation."

Extent of Study Area and Methodology of Model

The United States Fish and Wildlife funded the acquisition of LiDAR in the Valley portion of the Scott River Watershed in 2010 (Watershed Sciences 2010). The extent of the LiDAR encompasses the majority of the range of documented coho salmon in the Scott River (Figure 7). The Project utilized the 2010 LiDAR "bare earth" DEM and the River Bathymetry Toolkit (RBT) in ArcGIS 10.1 to identify potential restoration sites to increase the availability of high-quality habitat for the freshwater rearing of juvenile coho salmon (McKean et al. 2009). RBT is a terrain detrending tool that when applied appropriately indicates areas where water may interact with land surfaces for given elevation and depth increments. RBT is not a traditional hydraulic model that routes flow over a channel and adjacent landscape, but it is a surrogate tool for exploring large land areas and identifying sites with potential for further study. Thirty-two individual streams (Scott River main stem and tributaries) encompassing approximately 154 stream miles were included in the study area (Figure 8 and Table 5).

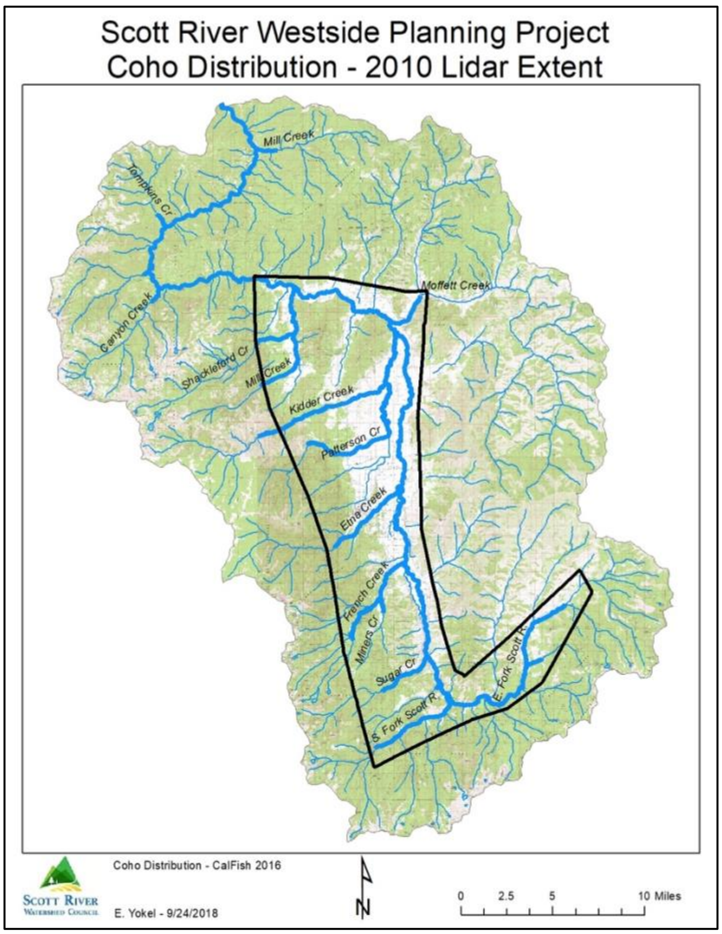

Figure 7: Lidar Extent and documented coho salmon distribution.

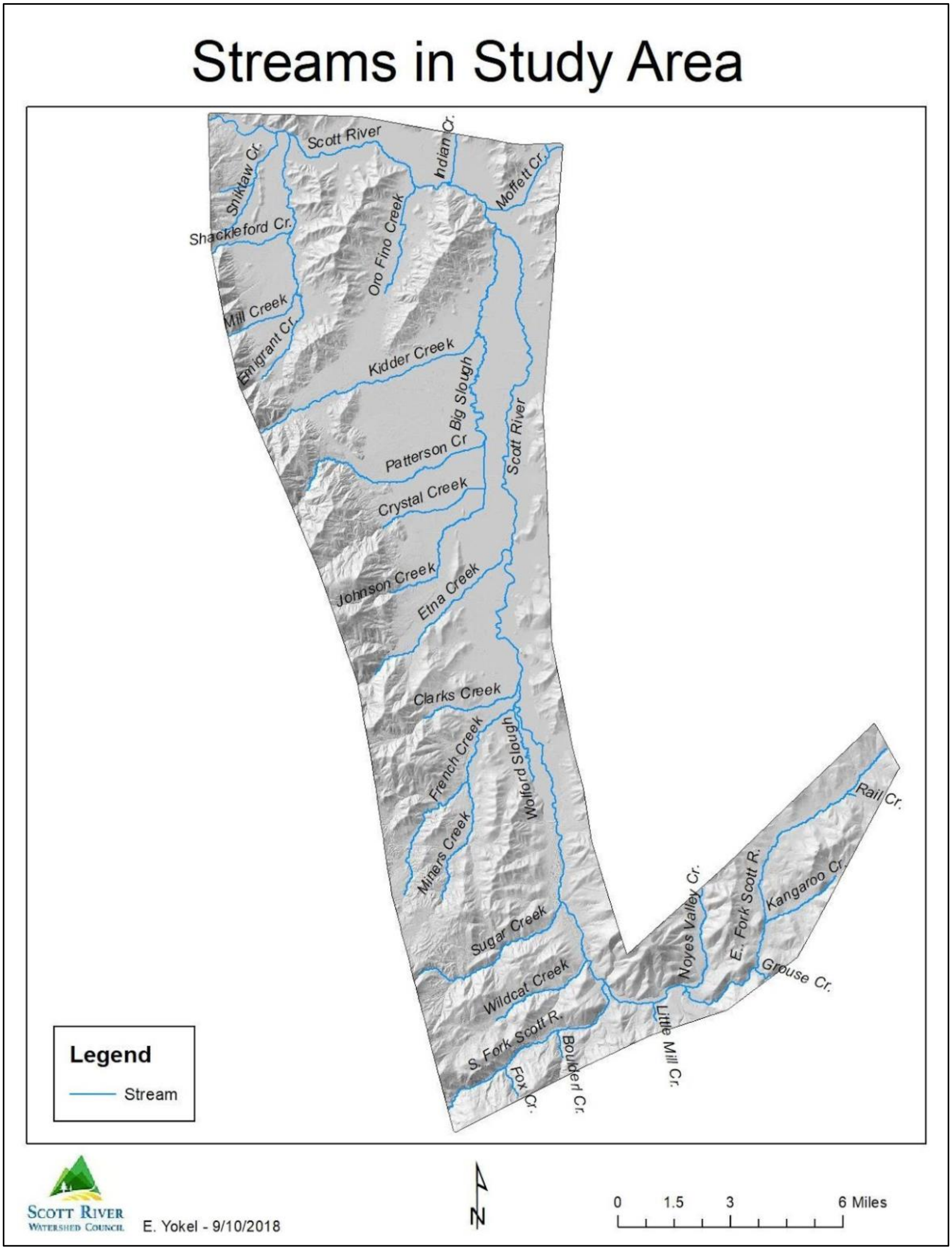

Figure 8: Streams in study area

Table 5: Streams in study area with mileage

Stream	Tributary	Tributary	Tributary	Tributary	Miles
Scott River					35.5
	Sniktaw Creek				3.5
		Alder Creek			1.0
	Shackleford Cr.				5.6
		Mill Creek			4.4
			Emigrant Creek		3.2
	Oro Fino Creek				3.6
	Indian Creek				1.5
	Moffett Creek				3.1
		McAdams			0.2
	Kidder Creek				10.9
		Big Slough			4.6
			Patterson Creek		6.5
			Johnson Creek		6.1
				Crystal Creek	3.3
	Etna Creek				5.5
	Clarks Creek				3.3
	French Creek				7.3
		Wolford Slough			2.7
		Miners Creek			3.9
	Sugar Creek				5.3
	Wildcat Creek				3.3
	S. Fork Scott River				6.4
		Boulder Creek			0.8
		Fox Creek			1.0
	E. Fork Scott River				13.6
		Little Mill Creek			0.5
		Big Mill Creek			0.2
		Noyes Valley Cr.			3.4
		Grouse Creek			0.6
		Kangaroo Creek			2.5
		Rail Creek			0.3
				Total	153.7

Identification and Scoring of Potential Floodplain /Off Channel Restoration Sites

Identification and scoring of potential floodplain and off-channel restoration sites the bare earth DEM was initially clipped to include all of the stream's active channel and adjacent floodplain in the study area per direction of the RBT tutorial. A second clip containing the entire "Valley" was generated per request of the Project's TAC. The RBT was used to create a detrended DEM from the clipped LiDAR DEMs. The detrended DEMs was used in RBT and were utilized to identify and quantify areas that could potentially inundate for water levels at 0.25 m intervals from 100.0 m to 102.5 m. The inundation areas for each interval were exported and saved in shapefiles and used to visualize areas where potential stream-floodplain interaction could occur at relatively low stream water surface elevations (Figure 9).

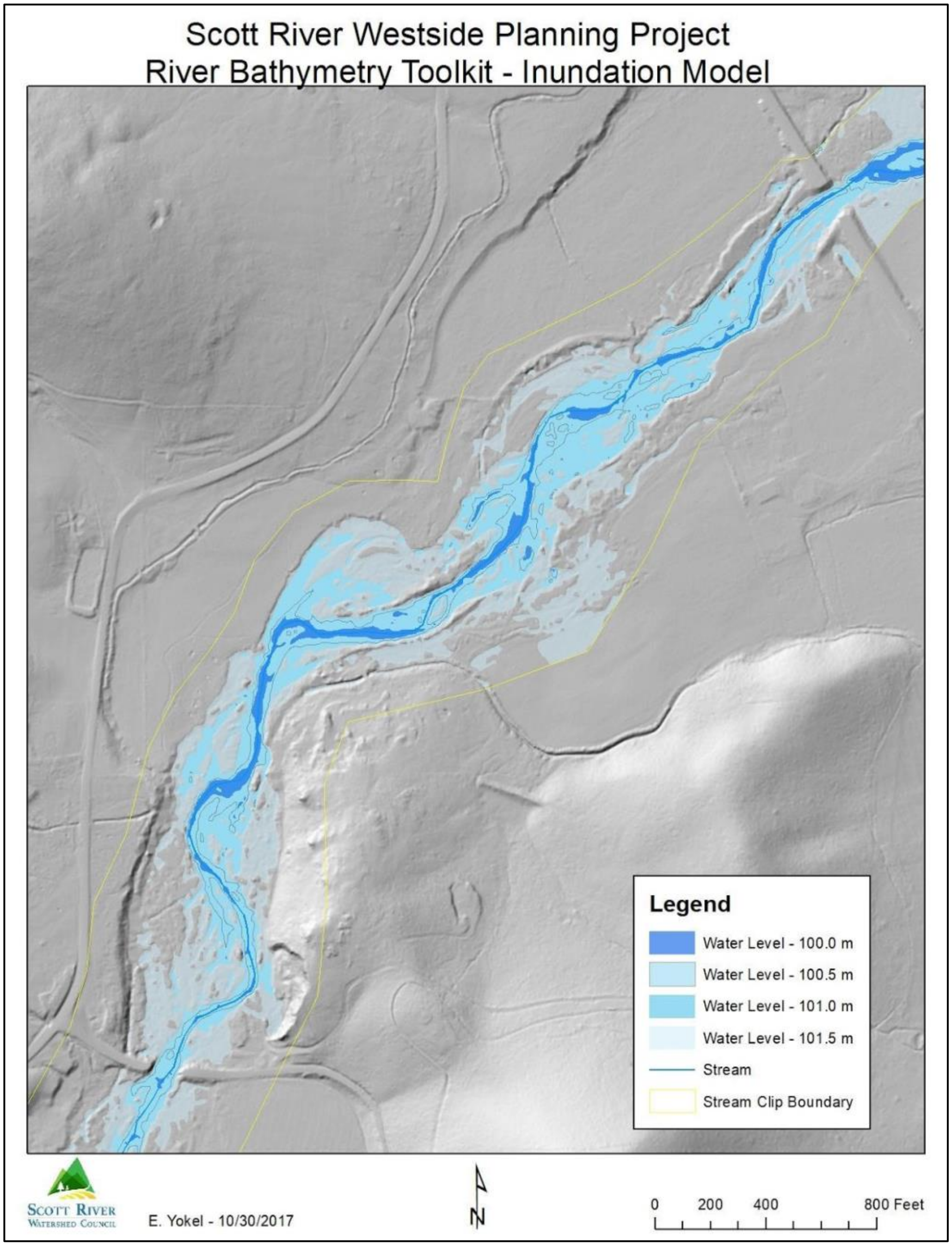

Figure 9: Inundation Model – Water Level 0.0 m – 1.5 m

The interaction areas for water levels of 100.0 m, 100.5 m, 101.0 m and 101.5 m were initially utilized to identify potential sites. A total of fifty (50) unique potential floodplain restoration sites were identified in the extent of the 2010 LiDAR DEM (Figure 10). The identified sites were attributed for the status of restoration planning, where: three (3) sites were identified as "high risk" and not feasible due to existing infrastructure within the inundation area, one (1) site had the first phase of implementation performed in 2017, five (5) sites have funded proposals for planning and/or implementation, four (4) sites were identified as potential "reference sites" that have existing features that could be utilized to direct restoration design, and the remaining thirty-seven (37) sites were identified as "Potential Sites". The identification of six sites already in some phase of restoration planning or implementation gave confidence in the method.

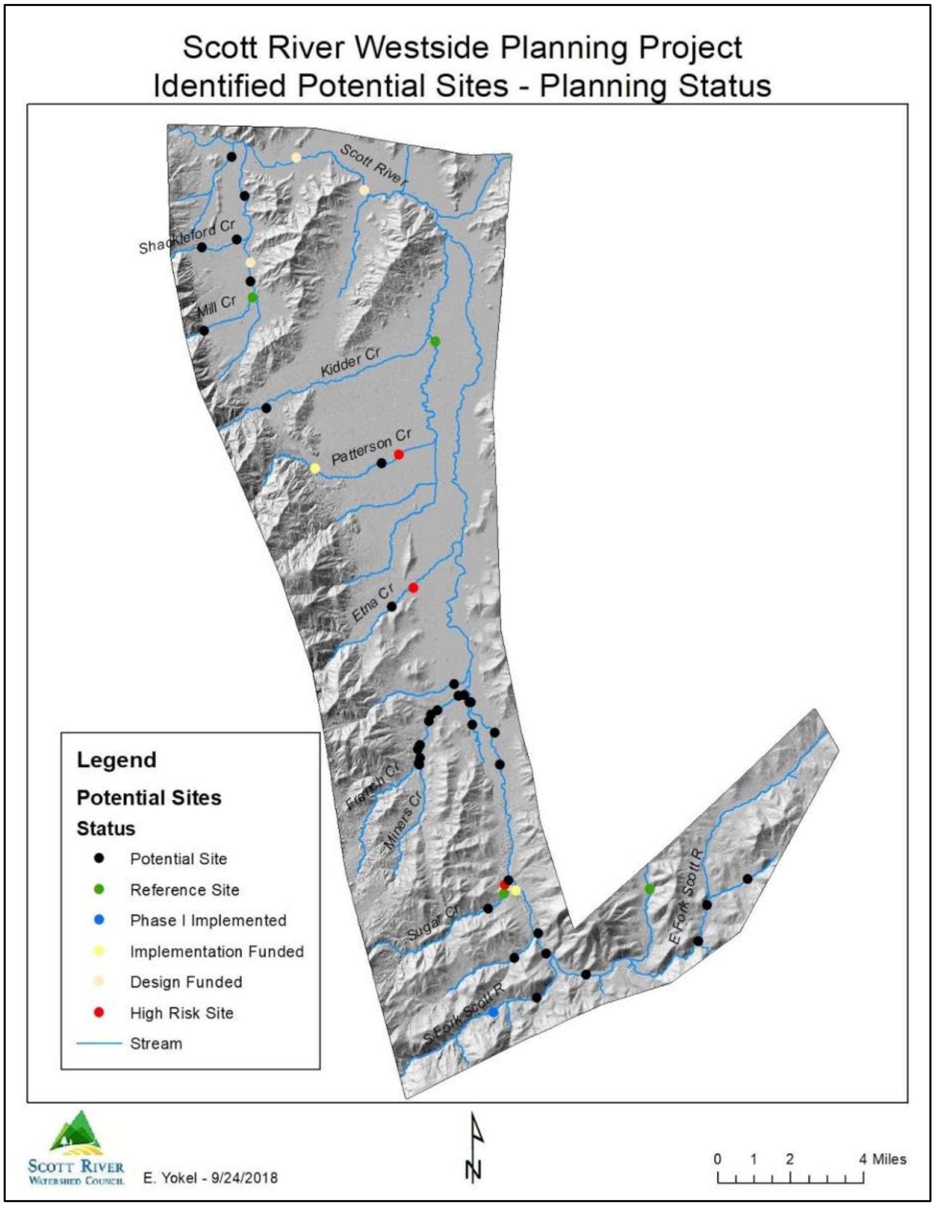

Figure 10: Identified Potential Floodplain Restoration Sites – Planning Status

The identified potential sites were assessed and scored for four parameters to prioritize planning. The TAC developed four parameters and scoring criteria to assess the identified potential sites (Table 6). The four parameters include: water presence at base flow during an average water year, documented presence of adult and/or juvenile coho salmon, condition of riparian canopy and area of inundation of potential site. The TAC chose to award a low score to desirable conditions for each parameter (e.g. mature riparian forest - 1) and a high score to undesirable conditions (e.g. no riparian cover/grasses/shrubs - 4) resulting in sites with the most desirable conditions having the lowest score.

Table 6: Initial scoring system for identified potential sites

Parameter	Scoring System
Water presence at base flow	1 = Yes 2 = Uncertain – Yes 3 = Uncertain - No 4 = No
Coho presence	0 = Yes summer/winter rearing and/or spawning 1 = unknown 2 = no
Riparian cover	1 = mature riparian forest 2 = intermittent riparian forest 3 = Sparse riparian 4 = None/grasses/shrubs (<4 ft)
Inundation area	1 = Large > 1 acre 2 = Medium >.5 to 1 acre 3 = Small .25 to 0.5 acres 4 = Limited = < 0.25

Inundation Area Score

For each identified potential project site, the potential footprint of the 1.0 m (3.3 ft) and 1.5 m (4.9 ft) water level was determined by digitizing polygons using the 101.0 m and 101.5 m inundation area shapefiles (Figure 11). The area of the 1.0 m inundation footprint was one of the four parameters used to rank the identified project sites (Table 7).

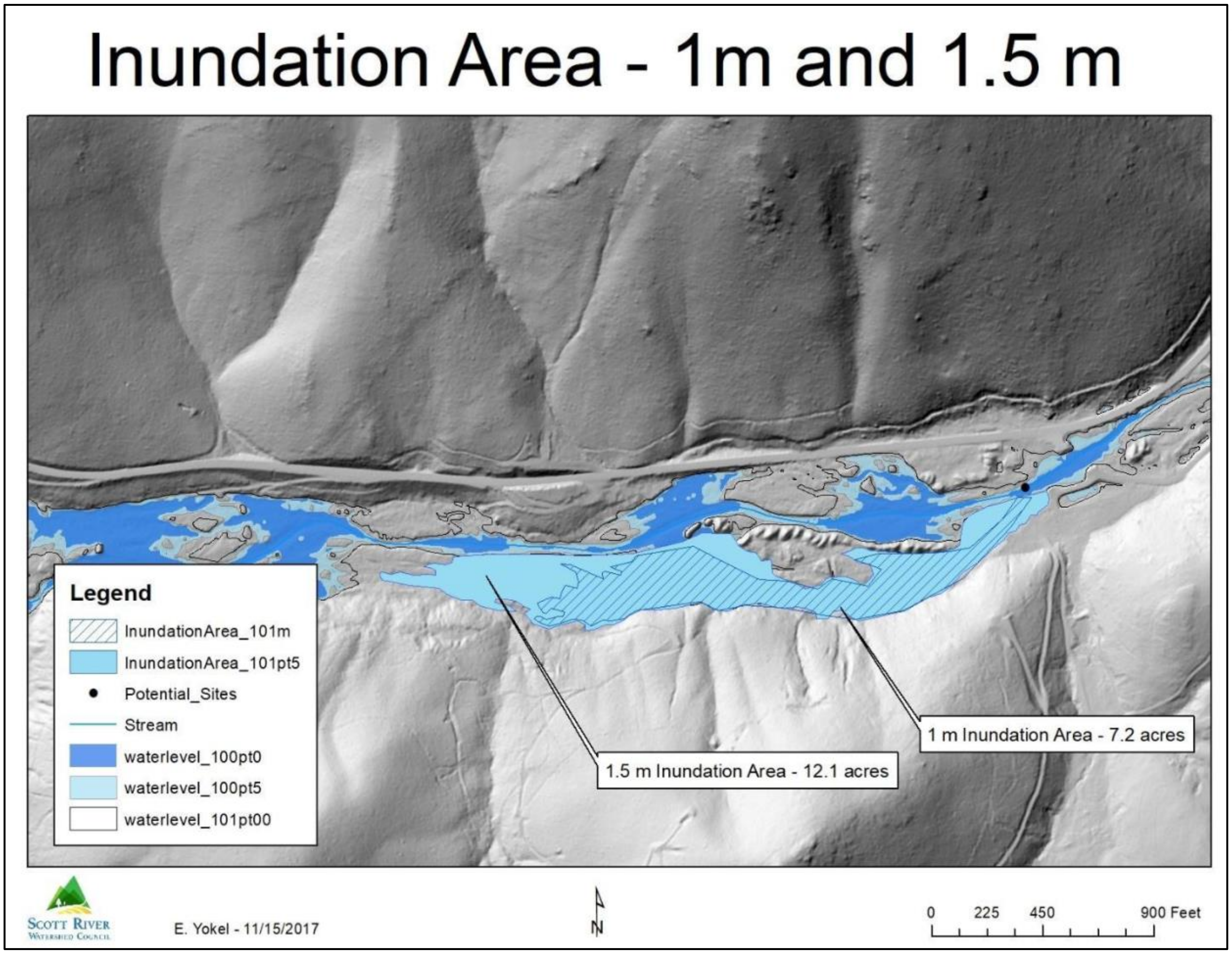

Figure 11: Inundation area at Potential Site – 1 m and 1.5 m water level

Table 7: Area of inundation at project sites – 1.0 m and 1.5 m water

Inundation Area		1.0 m Area	1.5 m Area	1.5/1.0 m
Site #	Stream	Acres	Acres	Acres
1	Scott River	3.7	8.6	2.3
2a	Wolford Slough	77.8	99.6	1.3
2b	Wolford Slough	2.9		
3	French Creek	1.3	2.3	1.8
4	Patterson Creek	2.4	11.4	4.7
5	Emigrant Creek	3.3	4.1	1.3
6	Mill Creek	0.6	2.8	4.4
7a	Scott River	1.3	2.7	2.1
7b	Scott River	3.7	8.5	2.3
8a	Sugar Creek	0.4	0.5	1.3
8b	Sugar Creek	2.1	2.8	1.3

Inundation Area		1.0 m Area	1.5 m Area	1.5/1.0 m
Site #	Stream	Acres	Acres	Acres
8c	Sugar Creek	0.3	0.4	1.3
9	South Fork Scott River	0.5	2.1	4.6
10	South Fork Scott	7.0	12.1	1.7
11	Kangaroo Creek	16.1	31.7	2.0
12	Big Slough	12.4	16.0	1.3
13	Patterson Creek	3.2	8.1	2.6
14	Scott River	3.0	3.5	1.2
15	Shackleford Creek	2.2	4.2	1.9
16	Shackleford	0.5	1.6	3.3
17	Scott River	0.6	0.9	1.4
18a	Miners Creek	3.2	5.2	1.6
18b	French Creek	0.6	1.8	3.1
19	French Creek	0.5	5.2	10.5
20	French Creek	0.4	5.5	12.6
21	French Creek	0.5	2.8	5.5
22	East Fork Scott River	1.6	2.5	1.5
23	East Fork Scott River	0.5	1.9	3.6
24	Noyes Valley Creek	22.0	25.3	1.1
25	East Fork Scott River	8.7	11.9	1.4
26	Wildcat Creek	0.2	0.2	1.6
27	Sugar Creek	1.2	2.1	1.7
28	Sugar Creek	14.7	19.1	1.3
29	Clarks Creek	378.8		
30	Etna Creek	3.7	7.1	1.9
31	Kidder Creek	2.5	8.7	3.5
32	Sniktaw Creek	20.7	129.9	6.3
33	Mill Creek	1.0	1.4	1.4
34	Shackleford Creek	6.1	27.9	4.6
35	Mill Creek	8.3	16.5	2.0
36	Scott River	0.5	2.1	3.9
37	French Creek	2.8	8.0	2.9
38	Scott River	4.0	14.7	3.6
A	Sugar Creek	49.3		
B	Patterson Creek	1039.3		
C	Etna Creek	331.4		

Riparian Score

The canopy height and density at the potential project sites was determined using a canopy height Digital Surface Model (DSM) that was generated from the 2010 LiDAR DEM and DSM rasters. The "bare earth" LiDAR DEM was subtracted from the LiDAR "first return" (highest hits) DSM using raster math in ArcGIS to calculate the canopy height DSM. The canopy height DSM was classified in ArcGIS to four canopy height classes: 0-3 ft, 3-15 ft, 15 – 55 ft and greater than 55 ft (Figure 12). The break between the canopy height classes at 55 ft was determined using Jenks Natural Breaks in ArcGIS and is believed to be the break between mature deciduous and coniferous trees (Table 8).

The 1.0 m and 1.5 m project polygons were used as the extent to extract from the classified canopy height DSM generating canopy height rasters for each polygon. The project site rasters were converted to polygons in ArcGIS and the area for each canopy height class was calculated for all inundation area polygons (Figure 13). The percent of the area with canopy greater than 15 ft. for the 1.0 m inundation area was calculated and a Jenks Natural Breaks classification was utilized to identify the four scoring classes (Table 9). The proportion of the potential 1.0 m inundation area with canopy greater than 15 ft was one of the four parameters used to rank the identified project sites (Table 10, Figure 14). The proportion of canopy less than 3 ft was also calculated for each project site.

Table 8: Vegetation types of the four canopy height classes

Canopy Height Class	Vegetation Type
0 - 3 ft	Grass - Small Shrubs
3 - 15 ft	Small Shrubs - Large Shrubs
15 - 55 ft	Deciduous Trees
> 55 ft	Large Deciduous Trees - Conifer Trees

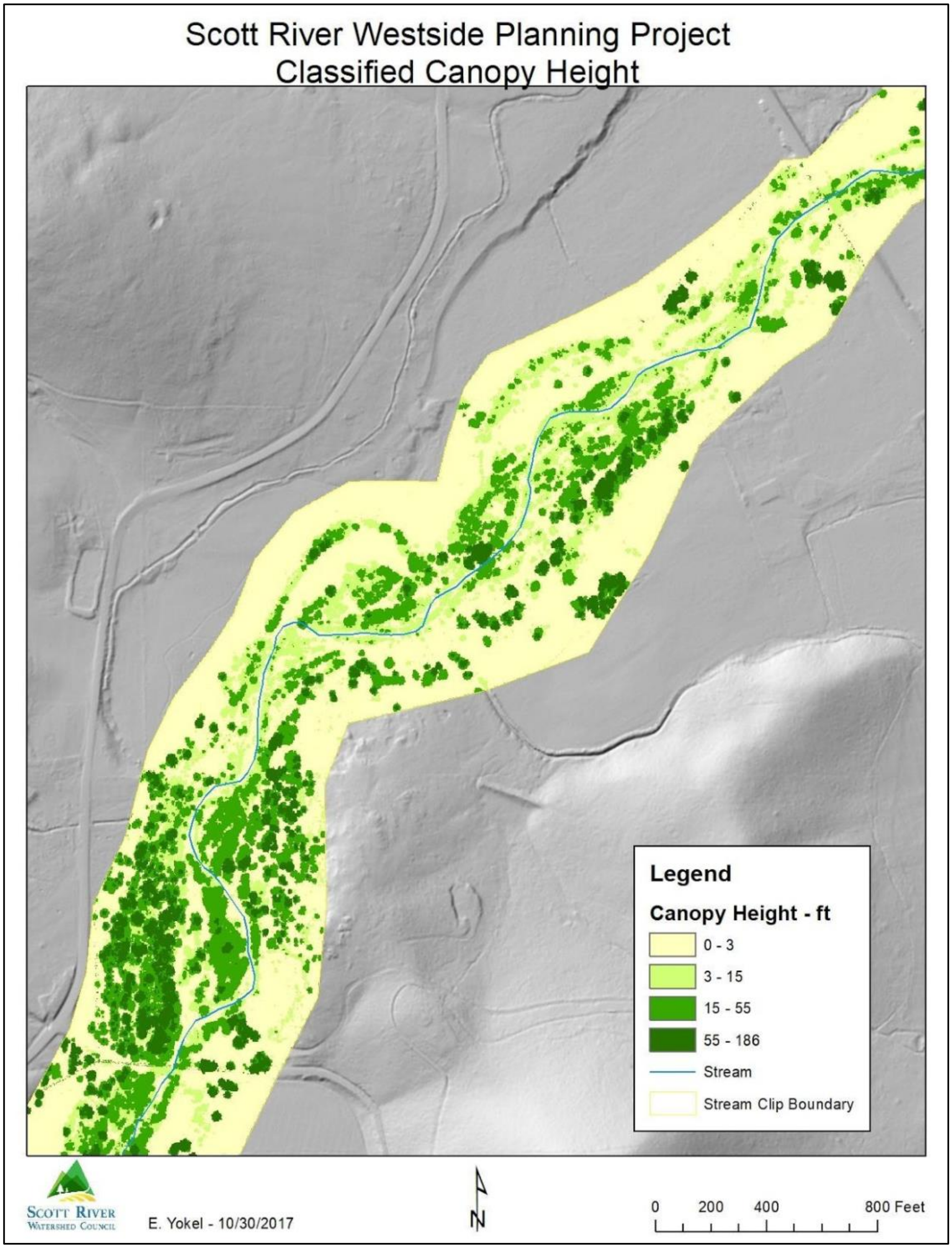

Figure 12: Classified Canopy Height

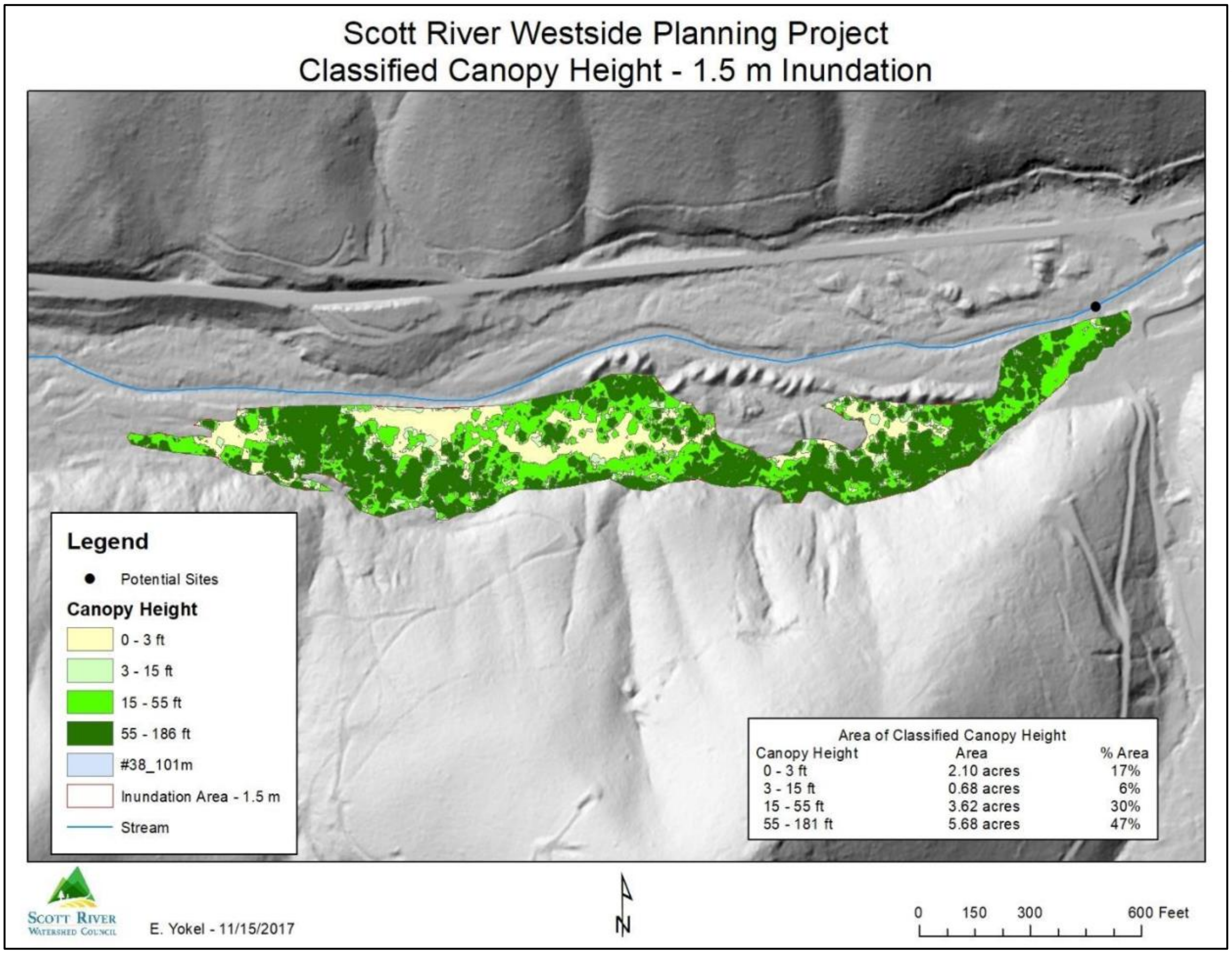

Figure 13: Classified canopy height for 1.5 m inundation area at potential site

Table 9: Percent of area in 1.0 m inundation area with canopy height greater than 15 ft and riparian condition score

Percent Canopy > 15 ft	Riparian Condition Score
67% - 93%	1
30% - 66%	2
10% - 29%	3
< 10%	4

Table 10: Percent of potential site inundation area with canopy > 15 ft and score

Site	Inundation Area	Percent Area				Riparian Condition
		1.0 m	1.5 m	1.0 m	1.5 m	
Site #	Stream	Canopy > 15 ft	Canopy > 15 ft	Canopy < 3 ft	Canopy < 3 ft	Score
1	Scott River	7%	9%	64%	68%	4
2a	Wolford Slough	4%	3%	95%	96%	4
2b	Wolford Slough	20%	ND	36%	ND	3
3	French Creek	44%	49%	24%	25%	2
4	Patterson Creek	93%	90%	3%	4%	1
5	Emigrant Creek	23%	22%	60%	62%	3
6	Mill Creek	16%	42%	75%	41%	3
7a	Scott River	24%	19%	50%	51%	3
7b	Scott River	5%	12%	73%	58%	4
8a	Sugar Creek	5%	6%	64%	63%	4
8b	Sugar Creek	16%	17%	65%	59%	3
8c	Sugar Creek	50%	48%	21%	21%	2
9	S. Fork Scott River	42%	29%	53%	67%	2
10	S. Fork Scott River	79%	77%	16%	17%	1
11	Kangaroo Creek	2%	4%	96%	94%	4
12	Big Slough	5%	4%	90%	91%	4
13	Patterson Creek	87%	77%	4%	9%	1
14	Scott River	19%	23%	63%	58%	3
15	Shackleford Creek	62%	64%	29%	25%	2
16	Shackleford Creek	48%	45%	30%	32%	2
17	Scott River	30%	27%	35%	40%	2
18a	Miners Creek	43%	36%	41%	52%	2
18b	French Creek	81%	75%	10%	20%	1
19	French Creek	22%	22%	45%	59%	3
20	French Creek	61%	51%	26%	26%	2
21	French Creek	84%	67%	10%	22%	1
22	East Fork	30%	41%	48%	41%	2
23	East Fork	54%	ND	33%	ND	2
24	Noyes Valley Creek	21%	19%	57%	61%	3
25	East Fork	27%	27%	60%	60%	3
26	Wildcat Creek	60%	54%	27%	25%	2
27	Sugar	93%	76%	3%	16%	1
28	Sugar	59%	53%	22%	31%	2
29	Clarks	1%	ND	98%	ND	4

Site	Inundation Area	Percent	Area			Riparian Condition
		1.0 m	1.5 m	1.0 m	1.5 m	
Site #	Stream	Canopy > 15 ft	Canopy > 15 ft	Canopy < 3 ft	Canopy < 3 ft	Score
31	Kidder	67%	50%	31%	46%	1
32	Sniktaw	10%	4%	85%	95%	3
33	Mill Creek	40%	43%	15%	15%	2
34	Shackleford	20%	12%	64%	80%	3
35	Mill Creek	25%	29%	65%	62%	3
36	Scott River	24%	21%	36%	44%	3
37	French	18%	18%	56%	61%	3
38	Scott River	29%	16%	44%	54%	3

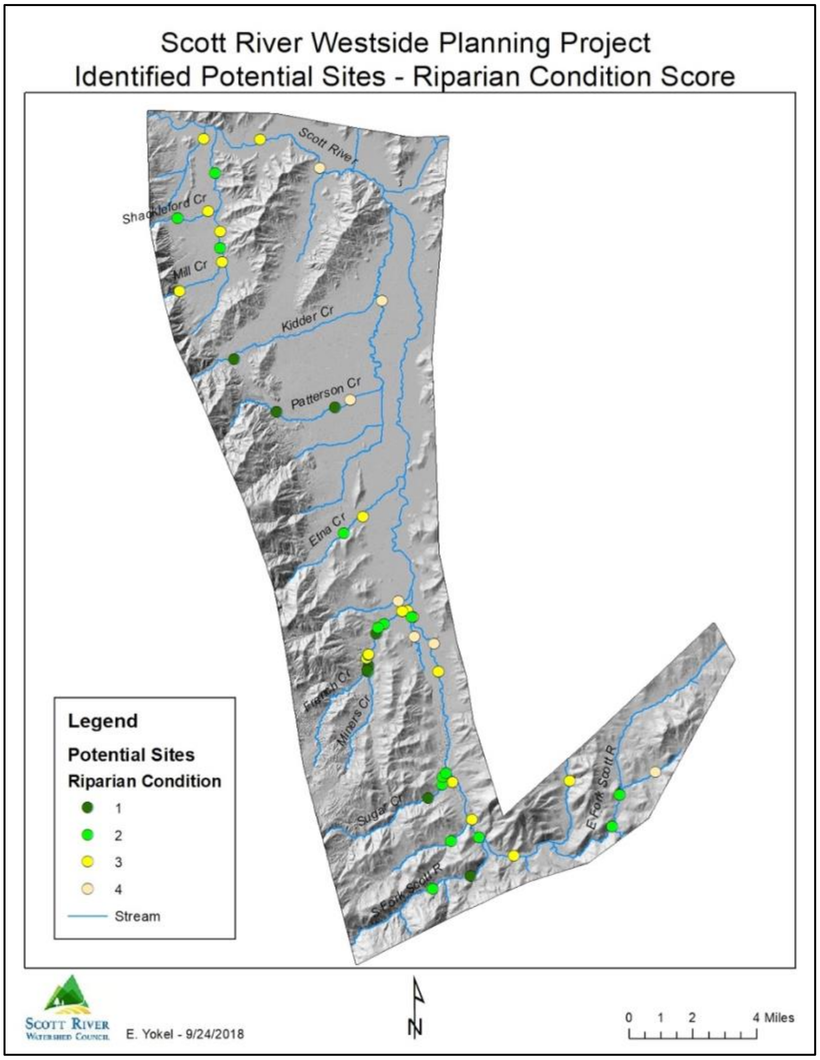

Figure 14: Riparian Condition score for identified Potential Sites

Water Availability Score

The inundation area shapefiles were used to digitize a “thalweg” stream polyline in ArcGIS for all streams in the study area. The stream shapefile was used to create a shapefile of the stream reaches that have or do not have flow during the base flow period of an average water year (Figure 15). The presence (or absence) of flow during the base flow period of summer was one of the four parameters used to rank the identified project sites.

The two primary sources utilized to document the dry reaches of the Scott River and tributaries in the low gradient portion of the Scott Valley were aerial imagery captured during the summer months by the USDA - National Agriculture Imagery Program (NAIP) and direct observations by landowners and resource professionals.

The NAIP imagery captured in 2005 (acquisition dates 8/19 – 8/21/2005) was first used to identify and digitize the dry reaches in ArcGIS. The 2005 imagery captured the reaches of the Scott River streams that are dry during an average water year. The NAIP imagery from 2014 (a very dry water year) was used to corroborate the dry reaches documented using the 2005 imagery. The main limitation to the NAIP imagery as a tool for documenting the dry reaches during the base flow month of August is the different timing of acquisition of the imagery in the different years. The images are generally captured before the base flow study period.

Interviews were performed with multiple long-term landowners of stream reaches in the Scott Valley to determine if the stream becomes dry during average and dry water years. Resource professionals working in the watershed were interviewed to document the dry reaches in dry, average and wet water years.

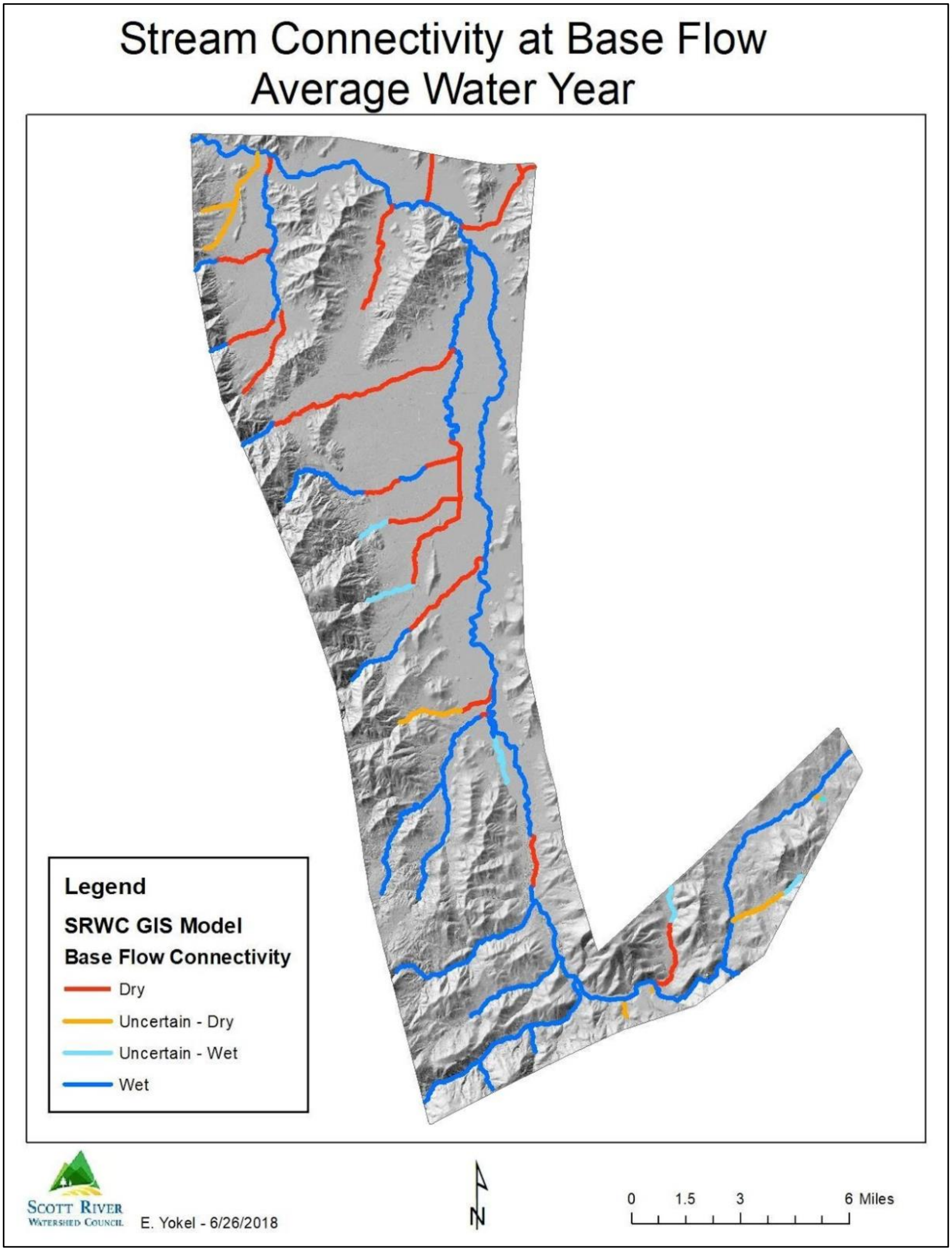

Figure 15: Stream connectivity during base flow period of average water year

Fish Presence Score

Coho presence was the final parameter used to rank the identified project sites. Several data products (e.g., CalFish coho presence layer, adult coho spawning ground survey data) were used to score the coho presence parameter for each project site (Figure 16).

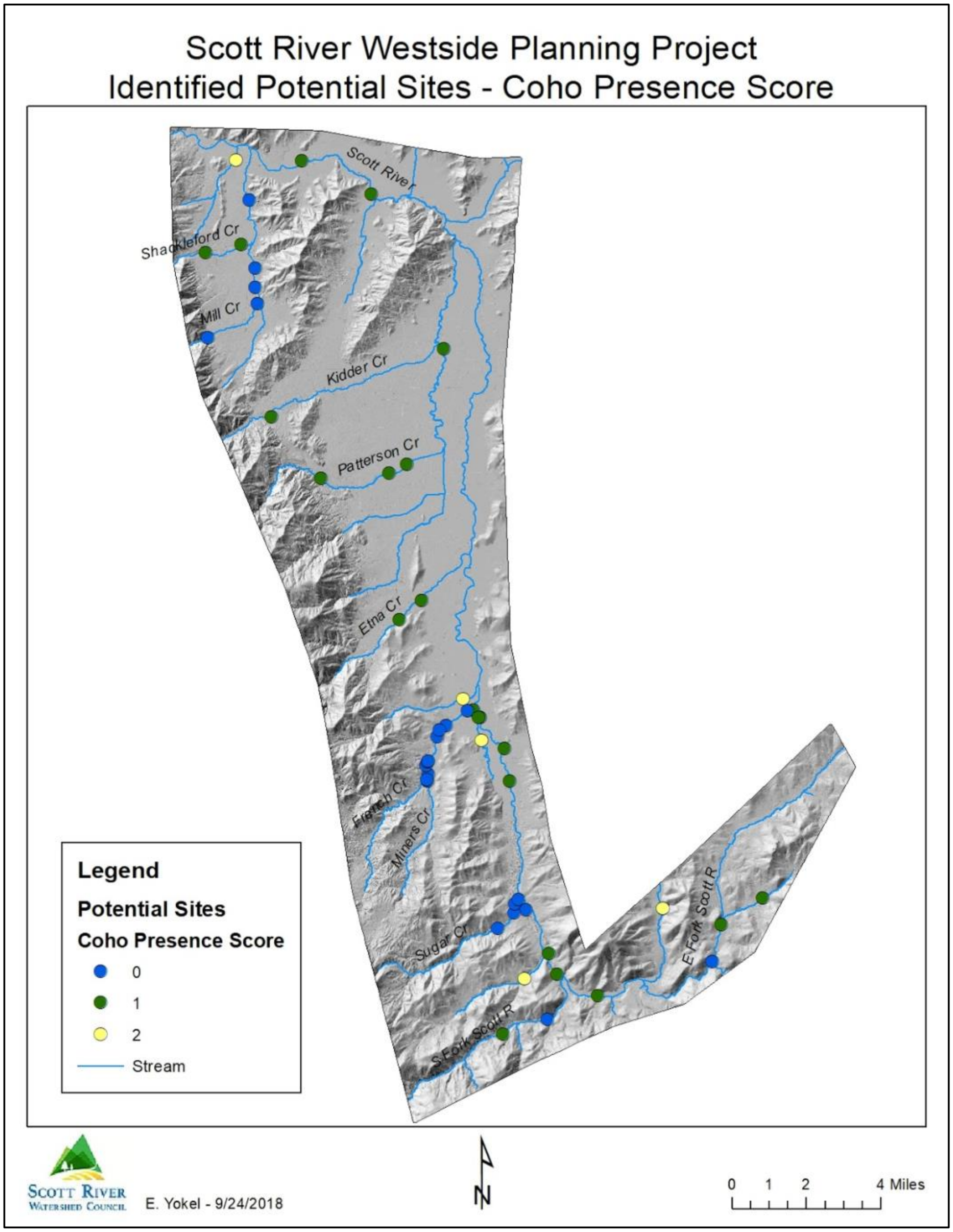

Figure 16: Coho presence score at identified potential sites

Potential Site Scoring

The four parameter scores (coho utilization, presence of water during base flow of an average water year, area of inundation and riparian canopy condition) evaluated for each identified project site were totaled to calculate a score (Table 11). A weighted score in which the score for coho utilization and presence of water during base flow was multiplied by two (2) was calculated and classified to identify the Planning Tier for the sites that do not have an existing planning effort (Figure 17, Figure 18). The reaches identified as documented high density coho spawning (see below for methodology) are identified in under the column “HDcohospwn” (Table 11).

Table 11: Potential sites planning status, weighted score and planning tier

Stream	Site #	Status	Water	Coho	Area	Riparian	Score	Weighted Score	Reach_ID	RKM	Hdcohospwn	Tier
S. Fork Scott River	10	Potential Site	1	0	1	1	3	4	S. Fork Scott River 3	2.5	ND	I
Sugar	27	Potential Site	1	0	1	1	3	4	Sugar Creek 3	1.8	N	I
French Creek	3	Potential Site	1	0	1	2	4	5	French Creek 3	1.7	Y	I
Miners Creek	18a	Design Funded	1	0	1	2	4	5	Miners Creek 1	0.1	Y	I
French Creek	18b	Design Funded	1	0	2	1	4	5	French Creek 4	4.4	Y	I
French Creek	21	Potential Site	1	0	2	1	4	5	French Creek 3	2.5	Y	I
Sugar	28	Reference Site	1	0	1	2	4	5	Sugar Creek 2	0.8	Y	I
Mill Creek	33	Potential Site	1	0	1	2	4	5	Mill Creek 3	2.2	Y	I
Sugar Creek	A	High Risk Site	1	0	1	2	4	5	Sugar Creek 1	0.4	Y	I
French Creek	40	Potential Site	1	0	1	2	4	5	French Creek 3	2.1	Y	I
French Creek	41	Potential Site	1	0	2	1	4	5	French Creek 4&5	4.7	Y	I
Patterson Creek	4	Implementation Funded	1	1	1	1	4	6	Patterson Creek 8	7.1	Y	I
Sugar Creek	8b	Design Funded	1	0	1	3	5	6	Sugar Creek 1	0.3	Y	I
Patterson Creek	13	Potential Site	1	1	1	1	4	6	Patterson Creek 3	2.9	Y	I
East Fork	23	Potential Site	1	0	2	2	5	6	East Fork 11	9	Y	I
Mill Creek	6	Design Funded	1	0	2	3	6	7	Mill Creek 2	1.3	Y	I
Shackleford Creek	16	Potential Site	1	0	3	2	6	7	Shackleford Creek 6	2.6	Y	I
French Creek	20	Potential Site	1	0	3	2	6	7	French Creek 4	3.8	Y	I
East Fork	22	Potential Site	1	1	1	2	5	7	East Fork 15	10.9	Y	I
Wolford Slough	2b	Potential Site	1	1	1	3	6	8	Wolford Slough 1	0.1	N	II

Stream	Site #	Status	Water	Coho	Area	Riparian	Score	Weighted Score	Reach_ID	RKM	Hdcohospwn	Tier
Emigrant Creek	5	Reference Site	2	0	1	3	6	8	Emigrant Creek 1	0.1	Y	II
Scott River	14	Potential Site	1	1	1	3	6	8	Scott River 38	90.7	N	II
Scott River	17	Potential Site	1	1	2	2	6	8	Scott River 38	91.7	N	II
French Creek	19	Potential Site	1	0	3	3	7	8	French Creek 4	4	Y	II
East Fork	25	Potential Site	1	1	1	3	6	8	East Fork 4	2	N	II
Mill Creek	35	Potential Site	2	0	1	3	6	8	Mill Creek 5	6.1	N	II
Scott River	38	Potential Site	1	1	1	3	6	8	Scott River 31	81.7	N	II
Scott River	39	Potential Site	1	1	2	2	6	8	Scott River 28	78.2	N	II
French Creek	42	Potential Site	1	0	3	3	7	8	French Creek 4	3.7	Y	II
Scott River	1	Potential Site	1	1	1	4	7	9	Scott River 30	80.2	N	II
Sugar Creek	8a	Implementation Funded	1	0	3	4	8	9	Sugar Creek 1	0.4	Y	II
S. Fork Scott River	9	Phase I Complete	1	1	3	2	7	9	S. Fork Scott River 5	4.7	N	II
Scott River	36	Potential Site	1	1	2	3	7	9	Scott River 28	78.3	N	II
Sugar Creek	8c	Potential Site	2	0	3	2	7	9	Sugar Creek 1	0.1	Y	II
Scott River	7a	Design Funded	2	1	1	3	7	10	Scott River 7	42.8	N	II
Kidder	31	Potential Site	3	1	1	1	6	10	Kidder Creek 18	14.9	N	II
French	37	Potential Site	3	0	1	3	7	10	French Creek 2	0.5	Y	II
Scott River	7b	Design Funded	2	1	1	4	8	11	Scott River 10	47	N	II
Kangaroo Creek	11	Potential Site	2	1	1	4	8	11	Kangaroo Creek 4	2.1	N	II
Big Slough	12	Template Site	2	1	1	4	8	11	Big Slough 1	0.4	N	II
Shackleford Creek	15	Potential Site	3	1	1	2	7	11	Shackleford Creek 11	7.4	N	II
Clarks	29	Potential Site	1	2	1	4	8	11	Clarks Creek 2	1.1	N	II
Noyes Valley Creek	24	Reference Site	2	2	1	3	8	12	Noyes Valley Creek 8	4.2	N	III
Wolford Slough	2a	Potential Site	2	2	1	4	9	13	Wolford Slough 5	1.6	N	III
Etna	30	Potential Site	4	1	1	2	8	13	Etna Creek 3	4.7	N	III
Wildcat Creek	26	Potential Site	2	2	4	2	10	14	Wildcat 3	1.5	N	III
Sniktaw	32	Potential Site	3	2	1	3	9	14	Sniktaw Creek 2	0.7	N	III
Shackleford	34	Potential Site	4	1	1	3	9	14	Shackleford Creek 9	5.6	N	III

Stream	Site #	Status	Water	Coho	Area	Riparian	Score	Weighted Score	Reach_ID	RKM	Hdcohospwn	Tier
Etna	C	High Risk Site	4	1	1	3	9	14	Etna Creek 2	3.3	Y	III
Patterson Creek	B	High Risk Site	4	1	1	4	10	15	Patterson 2	1.9	N	III

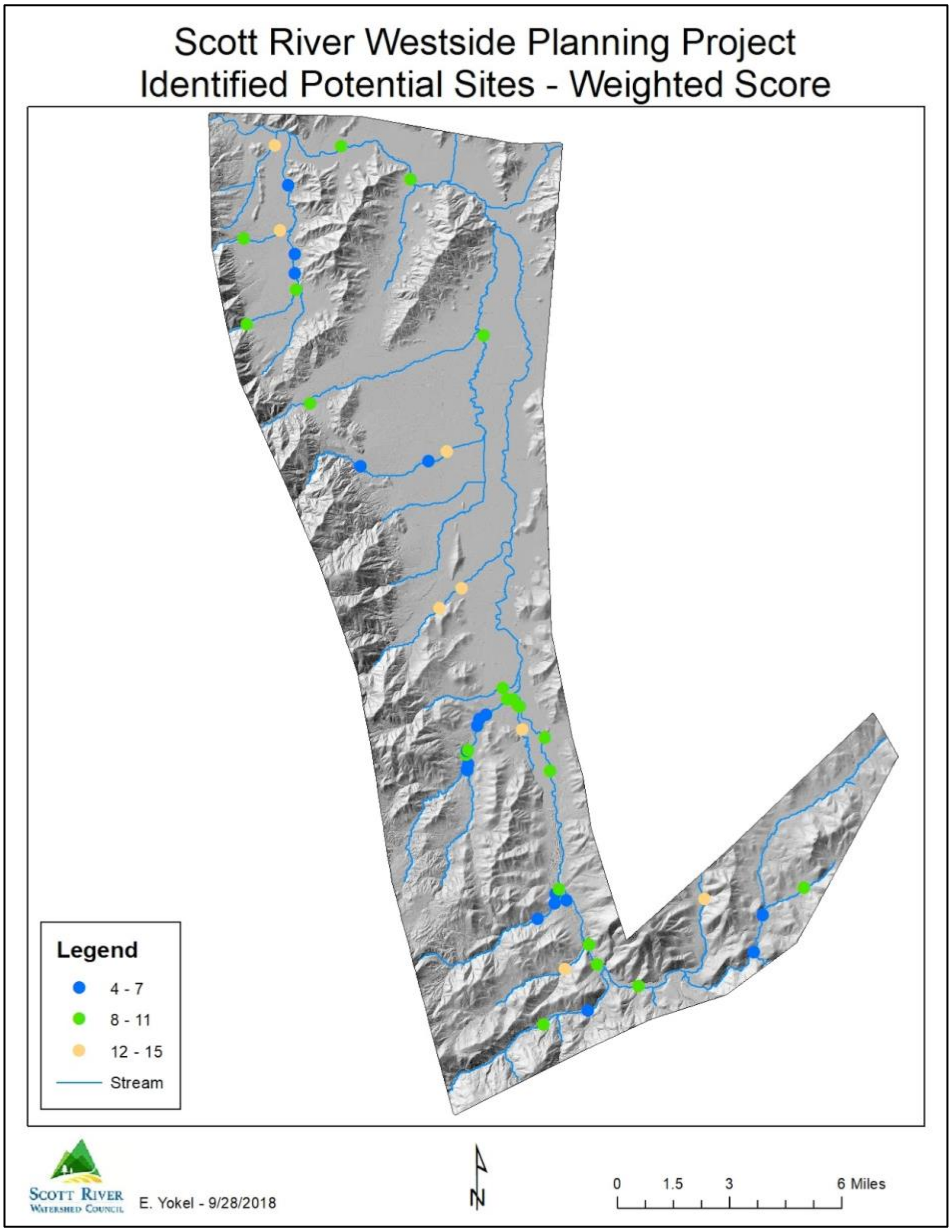

Figure 17: Potential Sites – classified weighted score

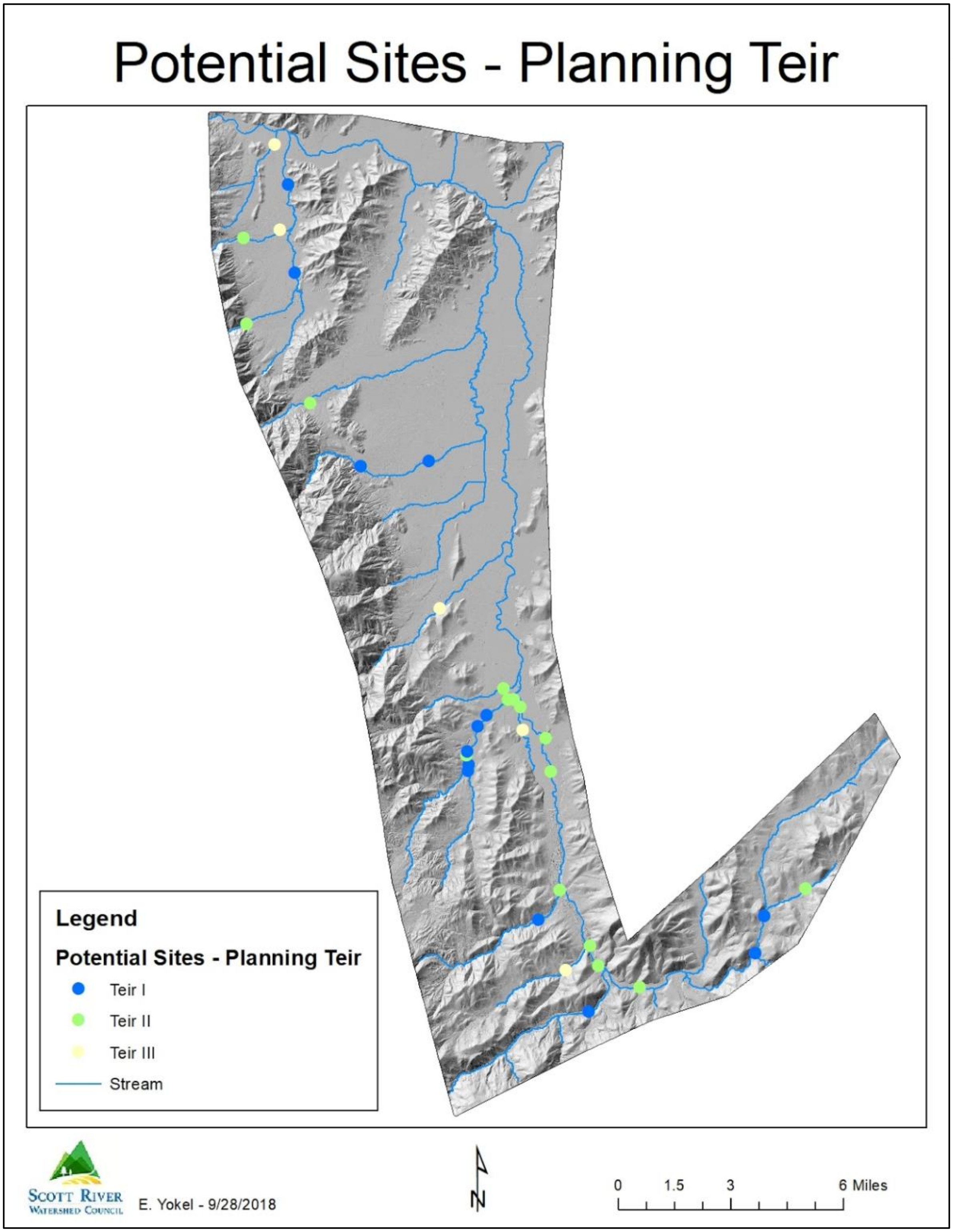

Figure 18: Potential site – Planning Tier

Prioritization of High Priority Reaches

The twenty-nine (29) streams in the 2010 LiDAR extent (study area) of the Scott River were parsed into 257 reaches for further analysis. An analysis was performed to classify the streams into stream tiers for planning prioritization. The seven (7) streams in the Planning Priority Tier 1 and the six (6) streams in the Planning Priority Tier 2 contain 158 of the 257 reaches. An analysis of reaches with documented historic high density coho salmon spawning was performed to identify existing critical habitats. The stream gradient, base flow connectivity during an average water year, current stream confinement and current riparian canopy scores were calculated for all reaches in the Tier 1 and Tier 2 streams (Appendix A). The base flow connectivity, stream confinement and riparian condition scores were utilized to generate a total score representing current physical habitat conditions.

Development of Stream Tiers for Planning Prioritization

The California Department of Fish and Wildlife Recovery strategy for California coho salmon (California Department of Fish and Game 2004) lists tributaries with key populations to maintain or improve and sites to establish populations (Table 12).

Table 20: Key streams and rivers in the Scott River (California Department of Fish and Game 2004)

Key Streams and Rivers	
Key Populations to Maintain or Improve	**Sites to Establish Populations**
Mill Creek (near Scott Bar)	Tompkins Creek
Wooliver Creek	Kidder Creek
Kelsey Creek	Boulder Creek
Canyon Creek	
Shackleford Creek	
Mill Creek	
Patterson Creek	
Etna Creek	
French Creek	
Miners Creek	
Sugar Creek	
South Fork Scott River	
East Fork Scott River	
Big Mill Creek	

The National Marine Fisheries Service's Final Recovery Plan for the SONCC ESU of Coho Salmon (National Marine Fisheries Service 2014) lists tributaries of the Scott River with high Intrinsic Potential (IP > 0.66) (Table 13). Mill Creek (near Scott Bar), Wooliver Creek, Tompkins Creek, Kelsey Creek and Canyon Creek are in the Scott River canyon reach and are outside the scope of the analysis.

Table 13: Tributaries with high IP reaches (NMFS 2014)

Tributaries with high IP reaches (IP > 0.66)	
Shackleford Creek	Boulder Creek
Mill Creek	Kidder Creek
French Creek	Noyes Valley Creek
South Fork Scott River	Moffett Creek
Sugar Creek	Canyon Creek
Big Mill Creek	Kelsey Creek
East Fork Scott River	Mill Creek (near Scott Bar)
Patterson Creek	Tompkins Creek
Wildcat Creek	Wooliver Creek
Etna Creek	

The base flow connectivity of the Scott River and tributaries during an average water year was documented using aerial imagery in conjunction with observations by resource professionals and landowners (Figure 15). Several of the tributaries identified by CDFW as key streams and by NOAA as high intrinsic potential have significant areas of disconnection during an average water year: Kidder Creek, Etna Creek and Patterson Creek. In addition to the tributaries with documented dry reaches, several of the streams in the study area have significant water temperature impairment during the base flow period: East Fork Scott River, Big Slough and the Scott River. The lack of connectivity during base flow and water temperature impairment was considered in conjunction with the CDFW key streams, NOAA intrinsic potential and documented adult and juvenile coho salmon utilization to develop the three tiers of planning prioritization (Table 14 and Figure 19).

A fourth tier (Groundwater Recharge) was included to capture the tributaries that have limited potential for anadromous fish habitat but a high potential for groundwater recharge: Wolford Slough and Noyes Valley Creek.

Table 14: Streams classified by planning prioritization tier

Tier 1	Tier 2	Tier 3	GW Recharge
Shackleford Creek	Scott River (Confluence to below Etna Cr)	Sniktaw Creek	Wolford Slough
Mill Creek	Scott River (Kidder Cr to below Shackleford Cr)	Alder Creek	Noyes Valley Creek
Patterson Creek	Kidder Creek	Emigrant Creek	
French Creek	Big Slough	Oro Fino Creek	
Miners Creek	Etna Creek	Indian Creek	
Sugar Creek	E. Fork Scott River	Moffett Creek	
S. Fork Scott River		Crystal Creek	
		Johnson Creek	
		Clarks Creek	
		Wildcat Creek	
		Boulder Creek	
		Fox Creek	
		Big Mill Creek	
		Rail Creek	
		Grouse Creek	
		Kangaroo Creek	

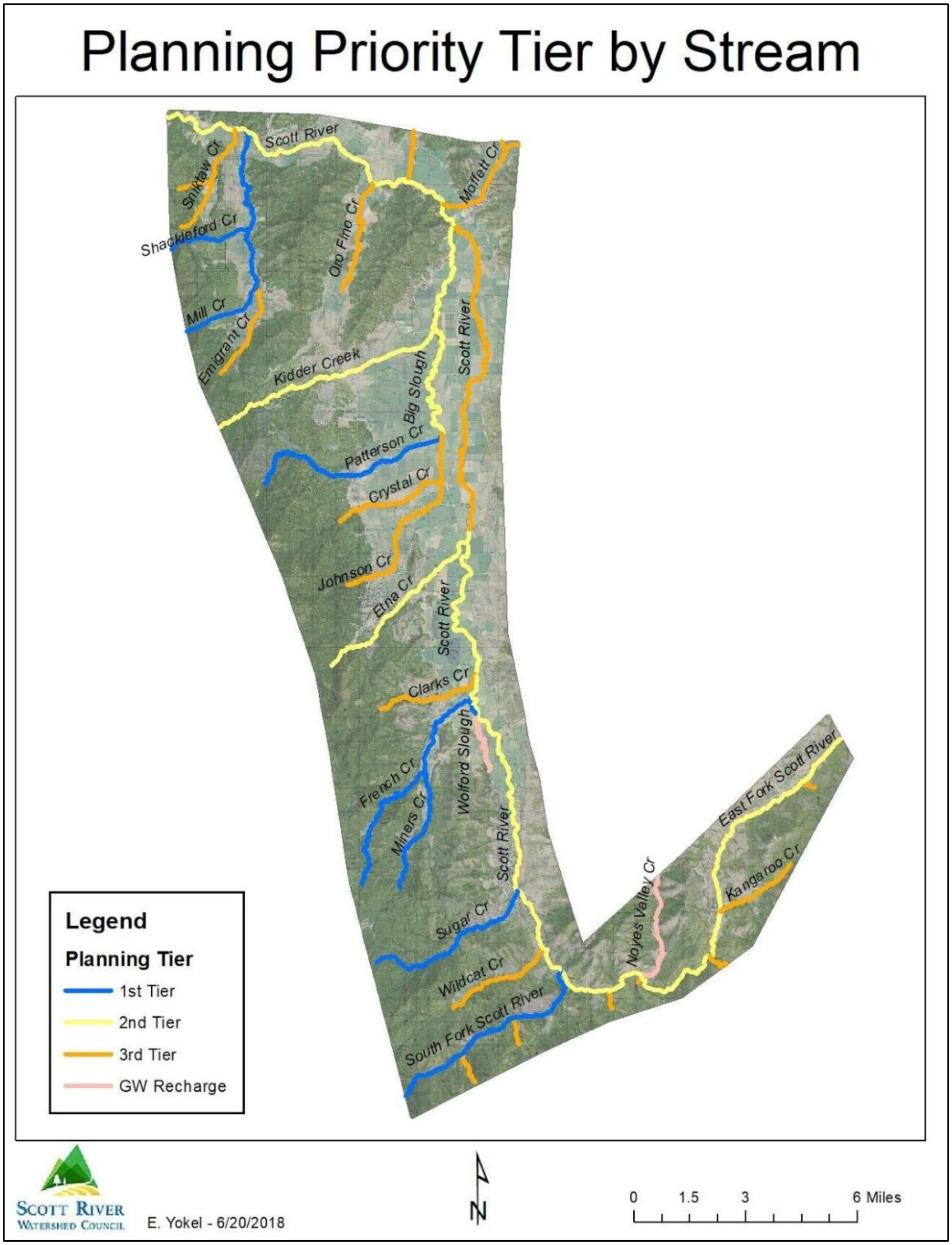

Figure 19: Planning priority tier by stream

Coho Spawning Ground Surveys 2004 – 2016

Adult coho spawning ground surveys have been performed in the Scott River Watershed since the winter of 2001-2002 (Maurer 2002). The coho spawning ground surveys have been performed every year up to the winter of 2016-2017 with extra emphasis paid during the strong brood (2001-2002, 2004-2005, 2007-2008, 2010-2011, 2013-2014 and 2016-2017) (Quigley 2005, D. Yokel 2011, E. Yokel 2011 and Magranet et al. 2017). Due to extreme drought conditions persisting through the spawning season for the 2013 Brood Year the spawning coho were isolated to the main stem Scott River. Surveys in the strong brood year indicate several reaches with consistently higher densities of adult coho spawning. Conversion of the individual redd data to densities (redds per mile) for each surveyed reach during the 2004, 2007 and 2010 and 2016 Brood Years was performed in GIS to identify reaches with relatively high spawning density. Each year's redd density for the three Brood Years was classified using a quantile classification with five classes in GIS to identify the reaches with the highest density during each year (Table 15). The surveyed reaches with densities in the first and second quantile for the four Brood Years were scored with two points awarded for each year a reach had densities in the 1st quantile and one point for each year a reach had densities in the 2nd quantile. Seventeen reaches had high density of coho spawning (Table 16). Two of the reaches with documented high density of coho spawning (Scott Bar Mill Creek and Lower Kelsey Creek) are outside of the project study area (Figure 20). Lower Mill Creek had redd densities in the first quantile during all four years of survey effort. Additional reaches with multiple years of high-density spawning include: Shackleford – Mill Creek, Mid French Creek, Lower Miners Creek and Lower Sugar Creek (Figure 21).

Table 15: Surveyed reaches with density (redds per mile) in the first and second class

	2004	2007	2010	2016
1st Quantile	Lower Mill Creek (Shackleford)	Lower Mill Creek (Shackleford)	Lower Mill Creek (Shackleford)	Lower Mill Creek (Shackleford)
	Lower Miners Creek	Shackleford-Mill Creek	Shackleford-Mill Creek	Lower Miners Creek
	Lower Sugar Creek	Mid French Creek	Mid French Creek	
	Lower Patterson Creek	East Fork above Grouse Creek	Mid Sugar Creek	
	Lower Kidder Creek	Lower French Creek		
	Lower Mill Creek (Scott Bar)	Upper Patterson Creek		
		Mid Patterson Creek		
2nd Quantile	Shackleford-Mill Creek	Lower Sugar Creek	Lower Sugar Creek	Lower Sugar Creek
	Mid French Creek	Lower Miners Creek	East Fork above Grouse Creek	Mid Sugar Creek
	East Fork above Grouse Creek	Shackleford Creek	Lower Kelsey Creek	Mid French Creek
	Lower French Creek	Lower Patterson Creek	Etna Creek below Diversion Dam	
	Upper Patterson Creek	Etna Creek below Diversion Dam		
	Lower Etna Creek			

Table 16: Surveyed reaches with documented high density coho spawning – total points

Reach	Total Points
Lower Mill Creek (Shackleford)	8
Mid French Creek	6
Lower Miners Creek	5
Lower Sugar Creek	5
Shackleford-Mill Creek	5
East Fork above Grouse Creek	4
Lower French Creek	3
Lower Patterson Creek	3
Mid Sugar Creek	3
Upper Patterson Creek	3
Etna Creek below Diversion Dam	2
Lower Kidder Creek	2
Lower Mill Creek (Scott Bar)	2
Mid Patterson Creek	2
Lower Etna Creek	1
Lower Kelsey Creek	1
Shackleford Creek	1

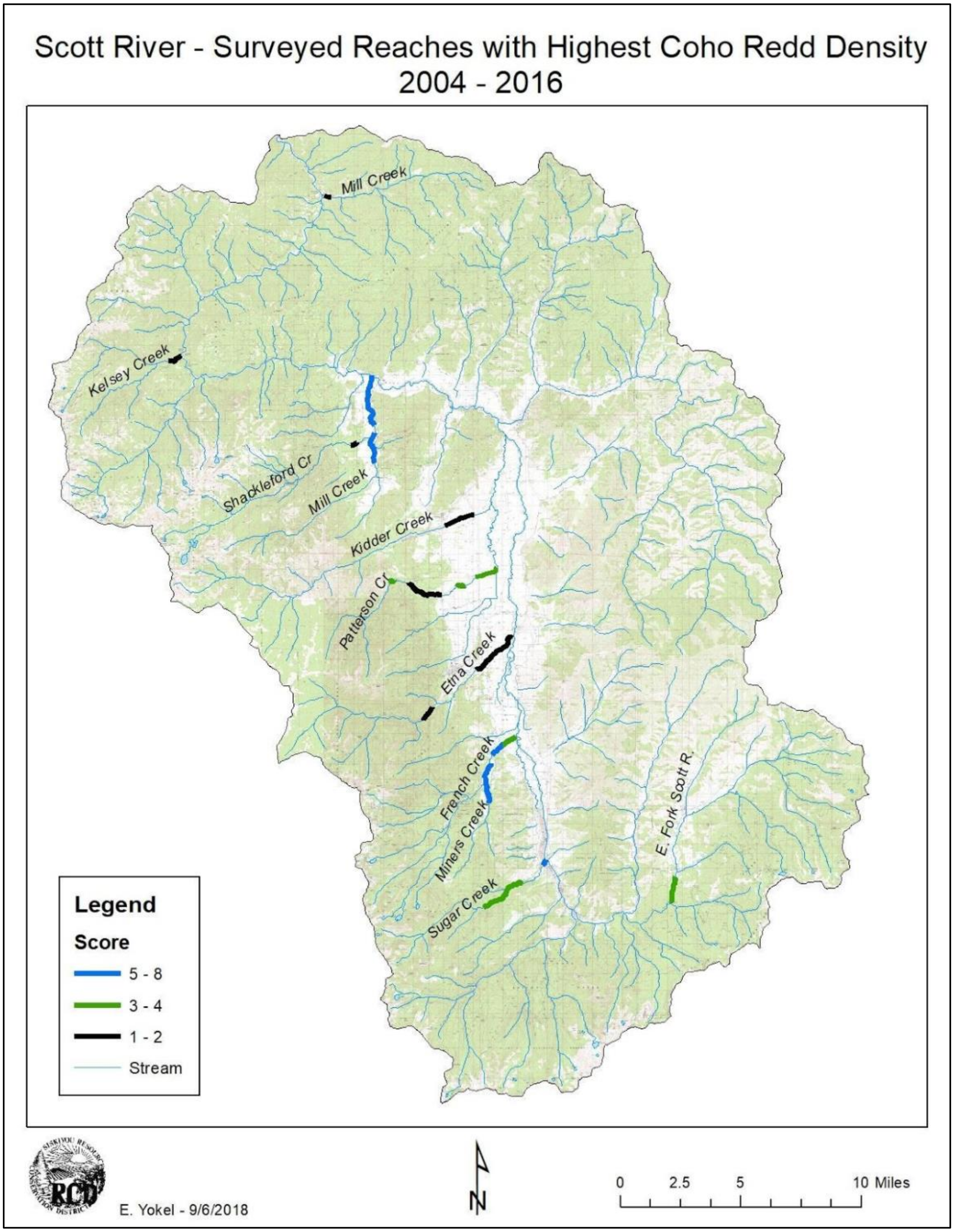

Figure 20: Classified surveyed reaches with documented high density coho spawning

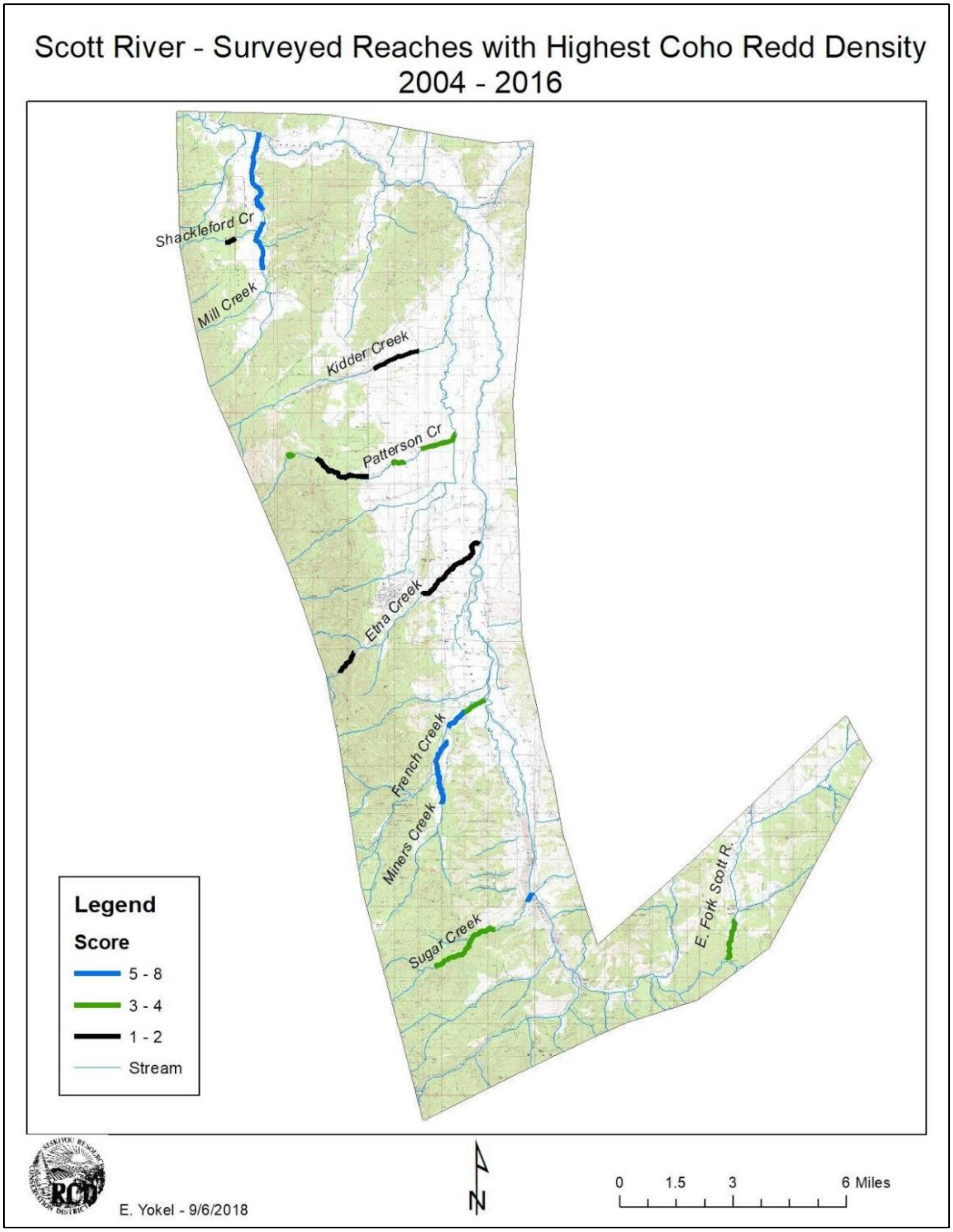

Figure 21: Classified surveyed reaches with documented high density coho spawning – study area extent

Riparian Canopy Scoring

The height of the canopy adjacent to the Planning Priority Tier 1 and Tier 2 streams was calculated in ArcGIS using "Raster Math". The "Bare Earth" DEM was subtracted from the "Highest Hits" (First Return) DSM to create a raster DSM that represented canopy height. The canopy height DSM was reclassified in ArcGIS into four classes (Table 17). The reclassified raster DSM was converted to a polygon vector in ArcGIS. The polygon vector was clipped utilizing the boundaries of the 158 reaches of the Tier 1 and Tier 2 streams and the proportion of each canopy height class was calculated for each reach (Appendix A). The proportion of canopy height greater than 15 ft was calculated for each reach (Figure 22). The range of canopy greater than 15 ft in the study area was a minimum of 0.00 at Big Slough_3 and a maximum of 0.85 at Mill_6. A quartile classification system was utilized to classify and assign a Riparian Score to each reach (Table 18). The ratio of area for each canopy height class and canopy height greater than 15 ft and the Riparian Score is illustrated in Appendix A.

Table 17: Four classes of canopy height utilized in ArcGIS model

Canopy Height	Code
0 - 3 ft	1
3 - 15 ft	2
15 - 55 ft	3
> 55 ft	4

Table 18: Ratio of canopy greater than 15 ft and riparian score

Canopy > 15 ft	Riparian Score
0.52 - 0.85	1
0.26 - 0.51	2
0.10 - 0.25	3
0 - 0.09	4

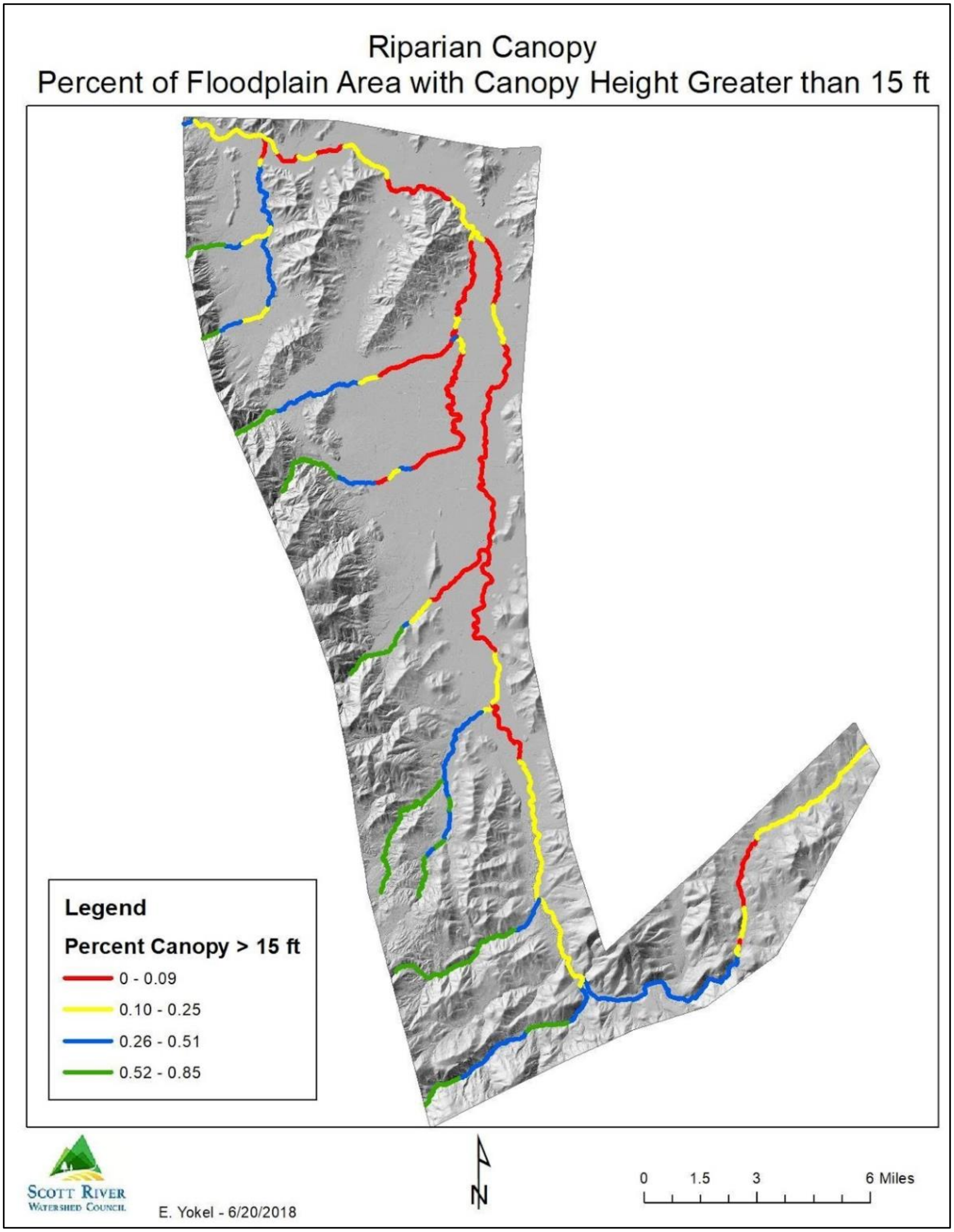

Figure 22: Percent of canopy with height greater than 15 ft

Stream Gradient

Stream gradient was calculated for the reaches in the Tier I and Tier II streams by joining the elevation from the LiDAR DEM to the digitized stream layer (Figure 23). The longitudinal profiles with reach breaks for each Tier 1 and Tier 2 stream are illustrated and accompanied with a table illustrating several parameters for each reach (RKM From and RKM To, Gradient, Connectivity, Confinement and Riparian Score) in Appendix A.

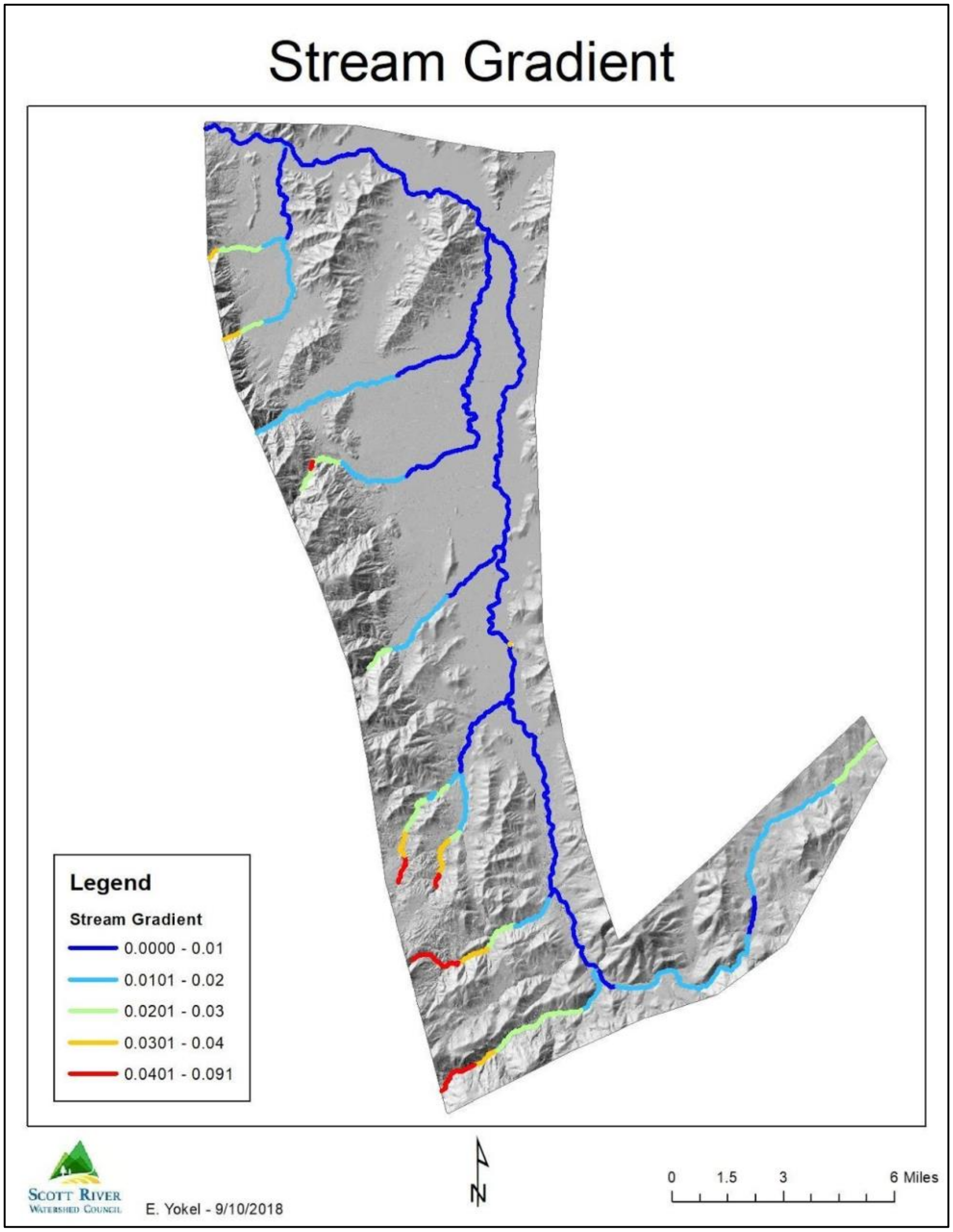

Figure 23: Stream Gradient for Tier I and II reaches

Stream Confinement

Stream confinement was calculated for each tributary reach by determining the representative width of the base flow channel and the width of floodplain inundated at the 1.0 m water level (Figure 24). The ratio of the floodplain width to base flow width was calculated and the confinement status was determined and scored (Table 19). For the main stem Scott River, the width of the floodplain inundated at the 1.5 m water level was used in the analysis. The calculated current confinement by reach is illustrated in Figure 25.

Table 19: Ratio of water level 1.0m to 0.0 m width – confinement status and score

1.0 m/ 0.0 m width	Status	Score
>10	Unconfined	1
10 - 5.01	Partially Confined	2
5 - 2.01	Moderately Confined	3
2 - 1	Confined	4

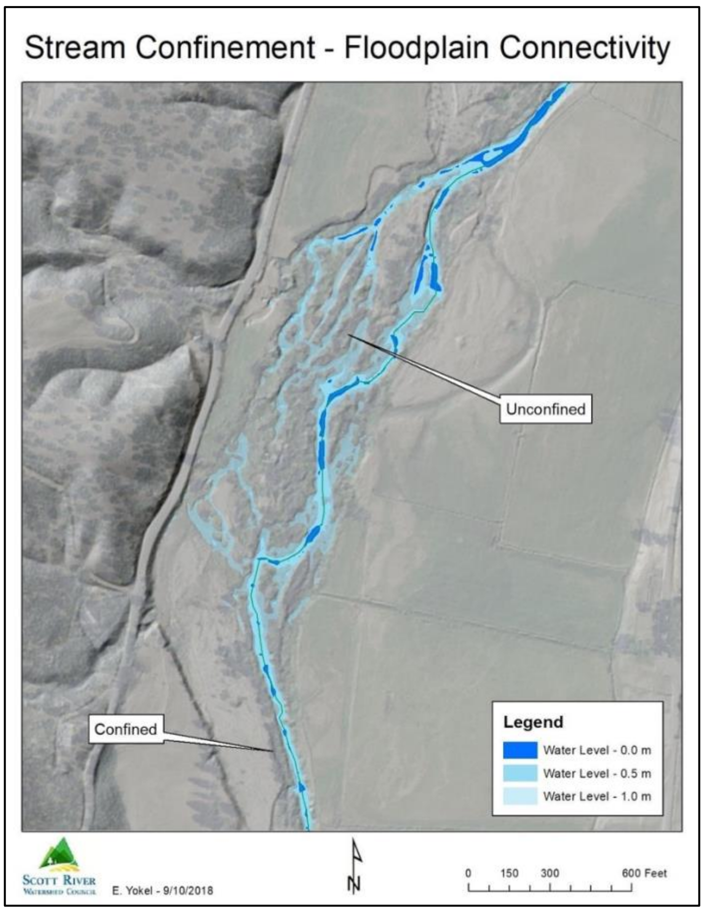

Figure 24: Confined and Unconfined stream reaches

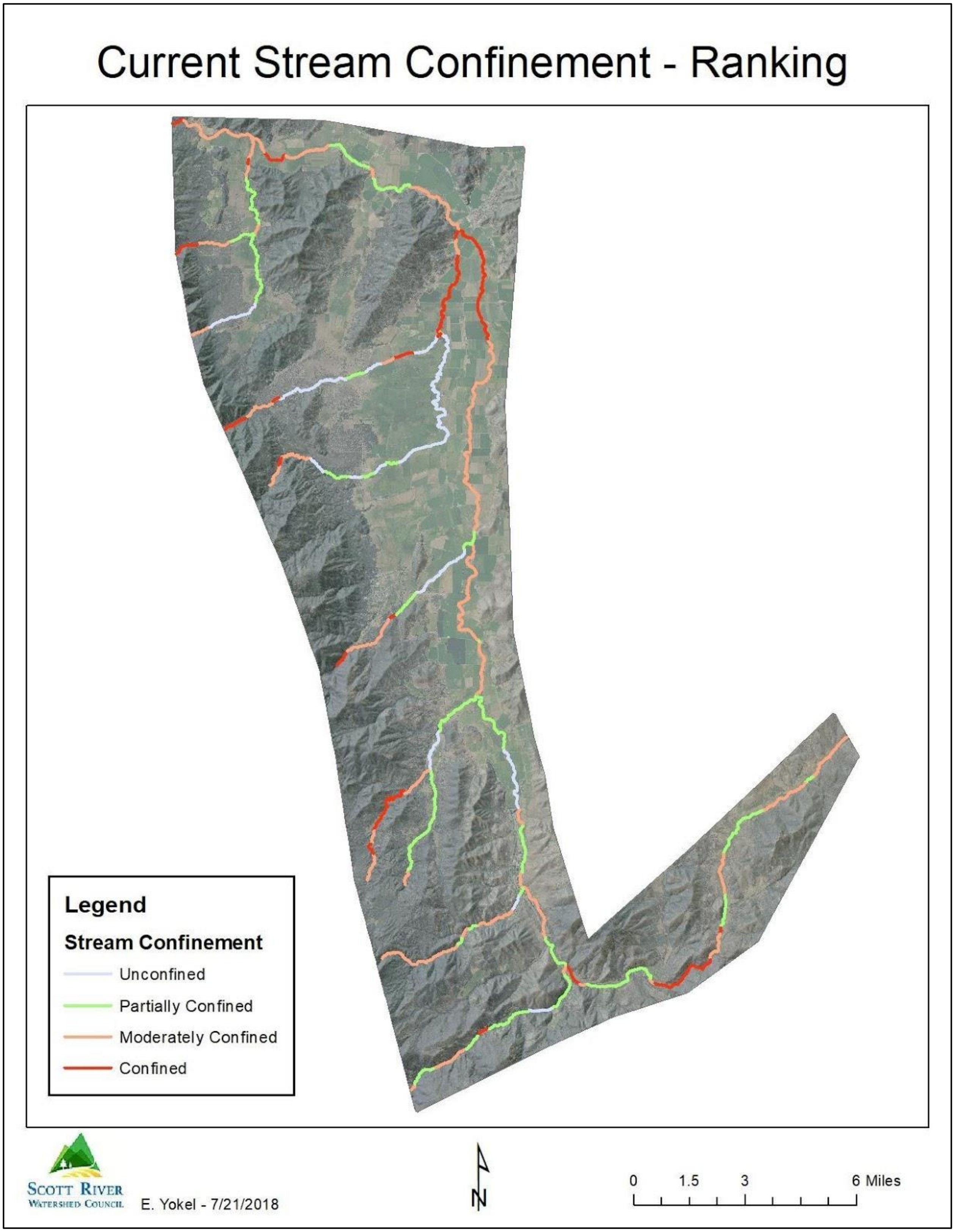

Figure 25: Current stream confinement ranking by reach

Existing Physical Habitat Condition Score

The sum of the riparian canopy score and the current stream confinement score was calculated and classified (Figure 26). The summed score of 2 is the best - representing unconfined streams with greater than 50% of the area covered with riparian canopy of a height greater than 15 feet. The summed score of 8 is the worst – representing confined streams with less than 10% of the area covered with riparian canopy of a height greater than 15 feet (Figure 27).

The presence of water during base flow was scored using a binary approach with water presence equaling 0 and lack of water equaling 2. Addition of the base flow water presence score to the confinement and riparian height score generates the existing physical habitat condition score for each reach. The best score of 2 represents reaches with water present at base flow, high quality riparian canopy and unconfined streams while the worst score of 10 identifies reaches with impairments for all three parameters. Classification of the scores into four classes illustrates streams with reaches that have excellent existing physical habitat condition (e.g., Shackleford Creek, Mill Creek, French Creek, Sugar Creek and the South Fork Scott River) and streams with reaches with impaired condition (e.g. Lower Kidder Creek and the leveed reach of the Scott River) (Figure 28).

Analysis of the identified Potential Sites and the classified Existing Physical Habitat Condition Score illustrates multiple sites in reaches with excellent physical habitat condition (Figure 28) - bringing together the two methodologies performed in this project's analysis.

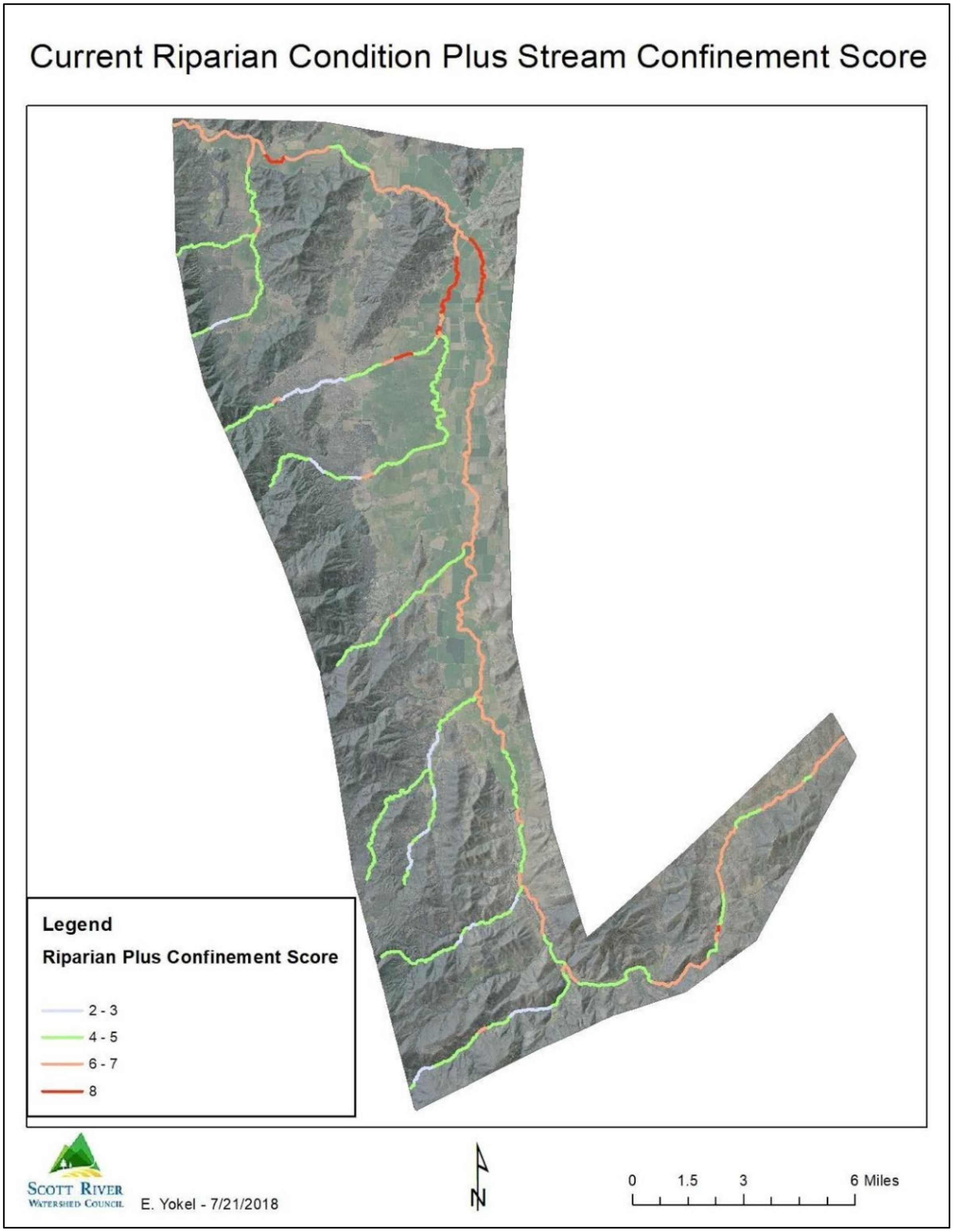

Figure 26: Sum of riparian and current stream confinement score

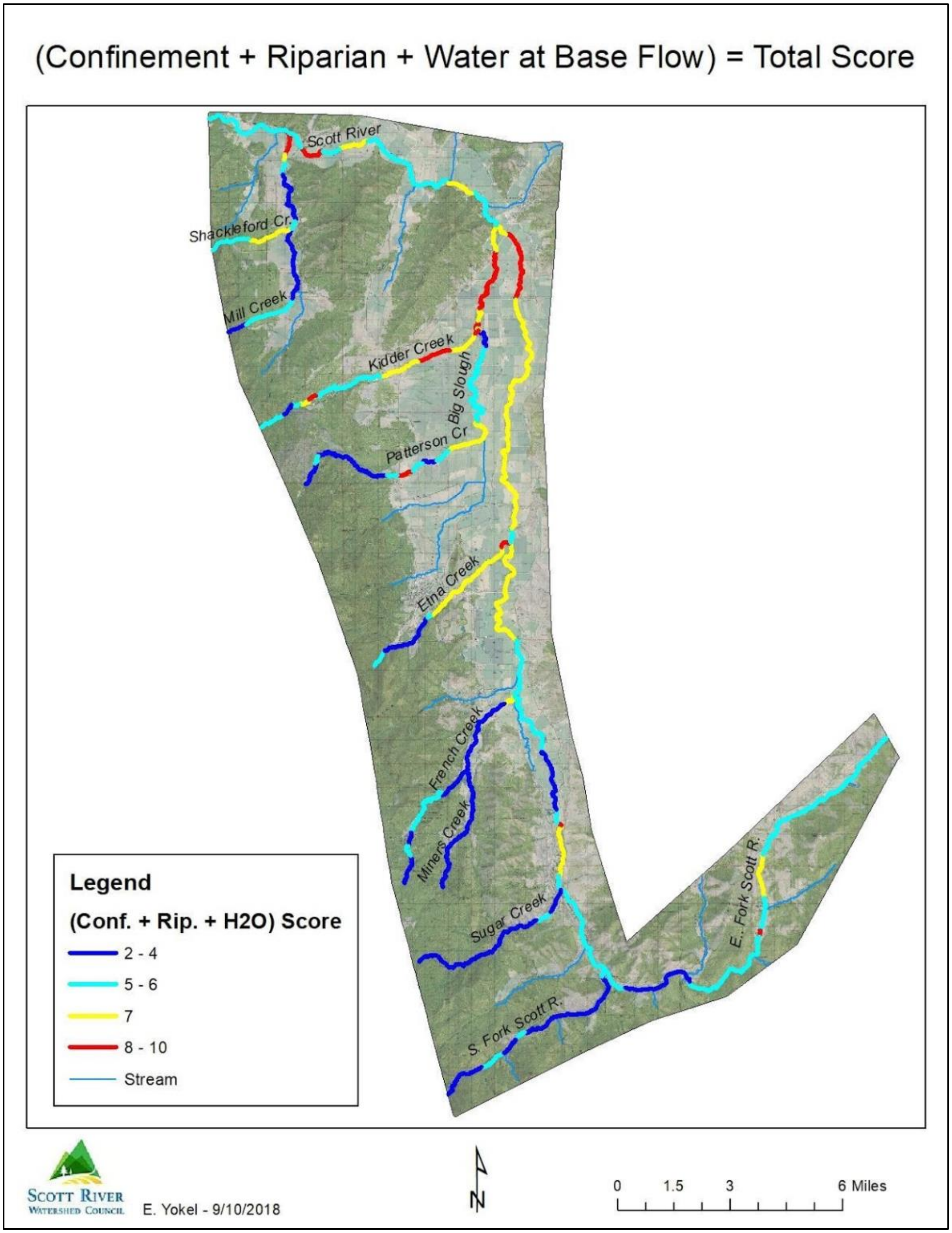

Figure 27: Confinement + Riparian + Water at Base Flow Score

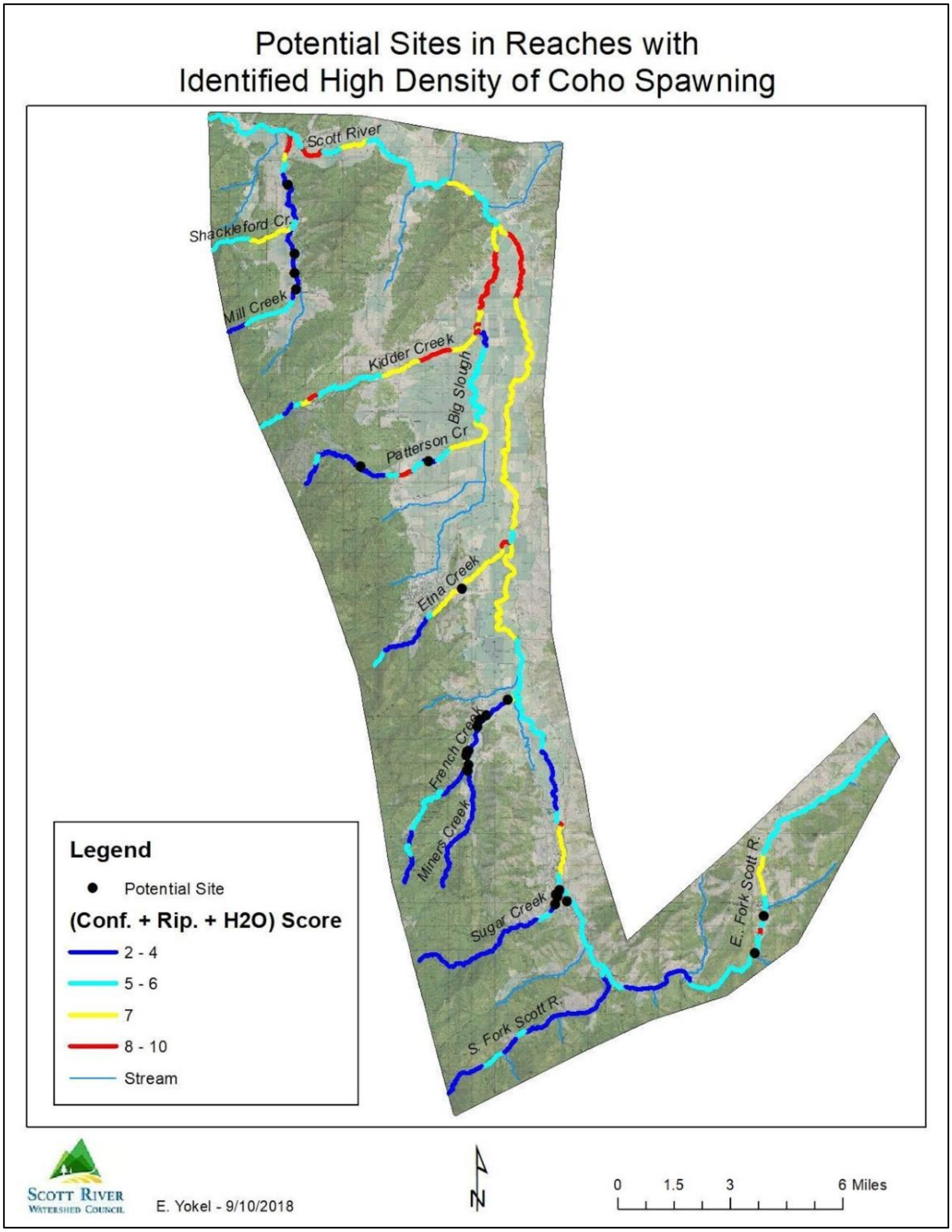

Figure 28: Potential sites in reaches with documented high density coho spawning

Design Recommendations and Actions

To meet the challenge of the culmination of legacy impacts, ongoing anthropogenic demands and anticipated climate change, restoration in the Scott, and elsewhere, needs to move beyond the implementation of static, engineered habitat features at discrete sites to process-based restoration at a landscape scale. Process based restoration is founded on the principle of working with dynamic geo-fluvial forces and tipping an ecosystem onto a trajectory towards health, rather than stabilizing existing degraded systems.

For each type of restoration or mitigation action, there is a series of considerations that need to be considered prior, during, and after implementation.

- Current versus desired physical and biological effects
- Understand potential risks and areas of uncertainty
- Develop methods and available design options
- Construction considerations and cost estimates
- Seek funding options- private, state, federal, hybrid
- Obtain all necessary permits
- Implementation logistics
- Effective monitoring - Pre and post implementation
- Adaptive management - Funding, permitting, ongoing capacity to support adaptive process

In general, there are a variety of different restoration strategies that can be implemented, either as a sole action or in conjunction with complementary techniques. Restoration practices are most effective when addressing the root causes of the problem and not merely the observed symptoms. However, this can be extremely challenging when watersheds such as the Scott have been highly modified by anthropogenic practices. Additionally, climate change ramifications are not fully understood, therefore comprehending the totality of impacts as they relate to restoration efforts is difficult (Beechie et al. 2013).

The Project did not start with a desire to implement a specific restoration technique, rather the approach was to identify locations of the highest ecological potential, with the anticipation that the most effective technique(s) would be identified during a design process for each high priority reach and/or site.

Below are various restoration approaches, methods and techniques, most of which have been implemented to some degree in the Scott River Watershed, and many of which will be utilized as design elements for future implementation at the Project high priority sites and reaches. Some techniques are more suitable to certain stream types and geofluvial conditions.

Restoration approaches can broadly be combined into the following stream types:

Stream Restoration Approach Type 1a

Locations with the system where off-channel features are the primary water source to provide backwater and/or hyporheic flow paths.

Stream Restoration Approach Type 1b

Sites where open channel flow can be impounded through construction of one or more channel obstructions (either partial or full spanning) with minimal risk to life, infrastructure or property.

Stream Restoration Approach Type 2

Sites with dynamic and high energy conditions. Restoration techniques include flow partitioning via wood jams and roughness features to increase hydroperiod and habitat complexity, protect infrastructure and property (e.g. reduce streambank erosion), and jump start riparian growth by reducing floodplain turnover rates.

Stream Restoration Approach Type 3

Sites where a combination of restoration techniques could be employed. Habitat is enhanced by increasing the hydroperiod. This can be achieved by amplifying the backwater or by storing surface and groundwater through the use of channel obstructions (either partial or full spanning).

(Note: Hydroperiod is the period of time a wetland is covered by water. Floodplain turnover rate is the rate at which floodplain and vegetation is scoured away)

Specific restoration techniques are:

Beaver: Technique 1 (Used in Approach 1a/1b)

Beaver relocation or re-introduction is currently not allowed in California. However, learning to live with beavers that are naturally in the system or ones that move on their own volition into a new location is something of a new concept. If allowed to work, beavers have been known to naturally cultivate an area, transforming and expanding into adjacent floodplains and increasing riparian vegetation, improving water quality and quantity and creating critical slow water habitat for coho salmon (Naiman et al. 1988). Beaver can modify the flow regime of stream or river, potentially improving infiltration and groundwater recharge. Additionally, changes in the production of benthic macroinvertebrate production, a foundation component of the food web has been associated to beaver ponds (Margolis and Raesly 2001).

Dedication of Water or Land: Technique 2 (Applicable to all approaches)

In 1991, California's state legislature amended the California Water Code and included Section 1707 which modified the water code allowing for the State Water Board to evaluate and approve modifications to existing water rights for the sole purpose of preserving and/or enhancing wetlands, fish protection, needs of wildlife and recreation. This statute allows for "any person entitled to the use of water, whether based upon an appropriative, riparian, or other right" to petition to change their water rights to either a temporary or long-term basis (Alford et al. 2016).

For the past decade, the state’s first active water trust, the Scott River Water Trust (SRWT), has been utilizing voluntary water leases with financial incentives for agricultural water users within the Scott River watershed to enhance instream flows during critical times of the year for the priority of fish habitat (Scott River Water Trust 2018). Water leasing may be used as a stand-alone stream habitat improvement project however when applied to reaches where additional of restoration techniques that are implemented the habitat benefit may be greater. Permanent water dedications through the 1707 process or forbearance agreements are a preferred methodology that will provide additional flow and temperature benefits for salmonids.

There are several mechanisms used to protect lands for a specific reason(s) and can be set for a finite amount of time or in perpetuity. Conservations easements, fee simple land ownership, and the transfer private ownership to public land ownership. There are also land protection programs such as the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Programs (CREP), both with goals provide environmental safeguards around specific natural resource concerns such as water quality and wildlife habitat (United States Department of Agriculture 2018).

Over the past forty years within California, one of the primary drivers for the use of conservation easements has been to desire to help preserve open space, rural lifestyles and farming practices. These types of easements are generally made with an exchange for the restriction of development and establishment of some type of management plan for form of cash payment or tax benefits or both (Drill 2009).

Fish Passage: Technique 3 (as needed for specific sites)

Fish passage restoration focuses on addressing possible impeding factors within a stream or river that do not allow volitional passages from a physical barrier. Treatments to address the ability to access effective passage for different life strategies, including feeding, refuge, and reproduction are essential and a fundamental component to the life history of salmonids. Culverts, dams, and lack of sufficient flows can all cause either temporary or permanent obstructions. Timing, frequency and duration of passage is also critical, along with identifying if the barrier is complete, partial or temporal. Methods to addressing fish passage may include the removal of culverts, construction of side passage or fishways around the obstacle, the installation of a fish screen at a surface water diversion, and trying to keep water within the system, particularly during baseflow.

Floodplain Restructuring: Technique 4 (Used in Approach 2, 3)

Work to enhance floodplains or increase floodplain connectivity generally involves the removal of feature such as levees and setbacks, armoring on banks such as rip-rap or any features that are designed to minimize or limit floodplain connectivity. The important beneficial factors of naturally functioning floodplains are numerous and as a result, limitations to floodplains can have extremely negative effects on both quantity and quality of aquatic habitat but so direct and indirect effects on river and stream channel processes. Also known as channel migration zone (CMZ), these are areas that have significant impacts on groundwater storage, flood energy dissipation, sediment and nutrient transport and retention, and in particular the need for coho salmon to have slow water habitat in high flows (Cramer 2012).

The most extensive form of floodplain restructuring is called "Stage Zero" restoration (Cluer and Thorne 2013), which is based on an understanding of the channel evolution model. This approach to restoration differs from more traditional restoration approaches of creating a single threaded equilibrium (stable) channel and lies on the far end of the process-based spectrum of approaches. There is growing evidence and recognition that the assumed primarily single-thread, meandering channel does not accurately represent pre-modified conditions in many cases, and is not a universally appropriate target morphology for alluvial valley restoration; instead, the pre-modified condition in alluvial valleys was frequently an anastomosing network of channels and wetlands that frequently flooded (Cluer and Thorne 2013)

It is now generally accepted that river engineering and management that works with, rather than against, natural processes are more likely to attain and sustain the multi-functional goals (e.g. land drainage, flood risk management, fisheries, conservation, biodiversity, and recreation) demanded by local stakeholders and society more widely. This coupled with growing recognition that the range and value of ecosystem services provided by rivers increase with the degree to which they are allowed to function naturally, fuels the drive for restoration of fluvial systems degraded by past management and engineering actions that have proven, in the long term, to be unsustainable.

Instream Structures: Technique 5 (Used in Approach 1a,1b, 2,3)
The main objectives to using instream structures as a restoration technique is to enhance stream complexity and to access adjacent floodplain habitat by the initiation of more natural processes. Site specific goals might also include the control or limitation of erosion of a channels lateral and/or vertical profile. Aggradation, hydraulic diversity including scouring and flow modification could also be desired outcomes. Features such as beaver dam analogues (BDAs), large wood or boulder placement, roughened channels are intentionally placed in the stream or river channel. Instream structures include a range of materials, functions, scale and intended longevity (Cramer 2012).

Large Wood and Wood Jams: Technique 6 (Used in Approach 1a,1b, 2,3)
The use of large wood and woody debris is a technique that utilizes the placement of wood material into river and stream channels to promote natural riverine processes. The objectives are to enhance both biological and physical functions that drive stream morphology and aquatic habitats. Additional benefits could include pool scour, lateral movement to increase floodplain connectivity and the potential to create secondary channels, sediment retention and increase overall stream or river complexity. When working in alluvial systems, the placement of wood can also provide beneficial results by the obstruction of flow, create back and side channels, alcoves and overflow channels (Cramer 2012).

Off Channel, Side and Main Channel Modification: Technique 7 (Used in approach 1a)

Both off channel and side channel modification includes the creation, reconnection or the enhancement of areas that are adjacent or contiguous to the mainstem of a river or stream channel. The primary focus of this type of restoration approach is the creation of self-sustaining habitats that work to encourage and support natural processes, including frequency flooding, channel migration and woody debris recruitment. There are numerous types of off-channel and side channel habitats, all having unique attributes depending on the present and/or desired biophysical environment. Sloughs, oxbows, and floodplain depressions are commonly viewed as some of the landforms to primary location to seek when creating these types of restoration features (Cramer 2012).

Mainstem channel modification aim to significantly alter the channel's planform, profile and cross-section geometry. Although, channel modification techniques can be financially advantageous, allow for a broad approach, a full understanding of the fluvial geomorphology is an essential element. This type of restoration technique is designed alter or modify the amount and order of energy within the channel, which as a result influence sediment transport, hydraulics elements, and large wood recruitment and retention (Cramer 2012).

Protection and Stabilization of Streambanks: Technique 8 (Used in approach 2)

Bank protection and stabilization measures is a long-standing practice and is designed to armor or reinforce a bank, deflect flows away from a bank or to try to control erosion or lateral channel migration. Generally, this type of technique is done to help preserve property and human infrastructure. Bank protection projects with restoration objectives can be enhanced by the use of large wood, adding channel complexity including the opportunity to sorting gravels, creating scour, reducing fine sediment inputs, creates cover and provides for overall increased hydraulic complexity (Cramer 2012).

Riparian Vegetation: Technique 9 (Used in Approach 1a, 1b, 2, 3)

Riparian restoration include practices also may be considered as streambank soil bioengineering, bioengineering, biotechnical soil stabilization and water bioengineering (Hoag and Fripp 2002). These are ideal tools to be used in concert with both active or passive restoration practices such as exclusion fencing, levee removal or modification, floodplain regrading, and/or with a variety of instream and off channel restoration techniques. In addition to the summer and winter habitat, riparian restoration practices possess numerous other possible benefits and therefore worthy of consideration when planning a restoration project. Shading helps moderate water temperatures and reduces evaporation; overall water quality can be improved by the retention of sediment and pollutants. Bank stabilization, erosion control and the ability to dissipate flood water energy intensity are all important elements to a healthy riparian zone (Cramer 2012). Furthermore, the riparian zones are the foundational component to the systems food web, which supports all the aquatic species, including juvenile coho salmon.

Road Treatment and Decommissioning: Technique 10 (Generally applicable for upslope projects)
There are several approaches that can help mitigate for the impacts of roads including decommissioning, upgrading road using best-management practices (BMPs), relocating existing roads that are currently within the riparian areas and limiting the use of roads (National Marine Fisheries Service 2014). Identification of road segments causing or have the potential to cause, adverse effects to soil, water quality, and riparian resources is an important step towards addressing impacts to the watershed. Additionally, careful consideration should be given to address possible adverse impacts to all crossings, including low water crossing, culverts and bridges. Crossings should be designed and installed to provide for sufficient flow in anticipated peak events, sediment and large woody debris transport, provide desired aquatic organism passage, and to minimize disturbance to the surface and groundwater resources (United States Department of Agricultural 2012).

Salmonid Spawning Gravel Augmentation: Technique 11 (based on substrate assessment)
Reproductive success plays a critical role in the health and viability of a salmonid population. The quantity and quality of spawning habitat is directly related to the survival of eggs and fry and can play a significant role in the salmonid recovery effects. (McBain and Trush 2010). There are many factors that are associated with quality spawning habitat: size of gravels, permeability and compaction of substrate; the velocity, depth and directional flow; dissolved oxygen content; and the proximity to quality rearing habitat upon emergence (Schuett-Hames and Pleus 1996). Stream complexity, the recruitment of large wood tends to provide quality gravels. Conversely, land use practices can destabilize soils and potentially increase the rate of fine sediments which are detrimental to spawning gravels. To help compensate for areas within a given reach that lack suitable gravels, suitable spawning gravel can be added to help compensate in the short term. This technique generally is treating the symptom and not the primary cause of unsuitable spawning gravels but may provide some fairly inexpensive relief on a potentially limiting factor (Cramer 2012).

For more detailed information and additional resources on all these restoration techniques:

Streambank Soil Bioengineering Field Guide for Low Precipitation Areas

Stream Habitat Restoration Guidelines 2012

The Beaver Restoration Guidebook

While developing conceptual plans for all the identified sites and reaches is beyond the scope of this project, the following table identifies the general restoration approach for a site and some of the specific restoration techniques that may be appropriate for them. A phase two of this project could produce 30% (or greater) technical designs for all of the identified sites.

Project Deliverables

Project Designs

- One 90% design titled "*French and Miners Creek Habitat Enhancement Project".*
- One conceptual design titled "*Mid Sugar Creek Stream and Floodplain Restoration Enhancement Project.*
- One conceptual designed title "*Patterson Creek Accelerated Wood Recruitment Project Phase 2",* which was also submitted for implementation funding during the course of the project.
- USFWS funded implementation project titled "*Patterson Creek Accelerated Wood Recruitment Project"* with a construction start date of October 1, 2018.
- Three submitted grant proposals on high value sites; 1) *Restoration Design on French Creek, 2) Scott Valley to Address Limiting Factors for Recovery of Coho Salmon and Provide Sustainable and Lasting Ecological Benefit, 3) Addressing a Limiting Factor for Coho Salmon by Improving Spawning Conditions in Key Tributaries of the Scott Watershed and Patterson Creek Accelerated Wood Recruitment Project Phase 2.*

Following are more detailed descriptions of the Project products:

French and Miners Creek Habitat Enhancement Project. This project is intended to improve habitat for aquatic organism within a 750 foot long reach of French Creek and a 200 foot long reach of Miners Creek. The project incorporates large wood structures within channel and unanchored large wood interlaced between trees in the floodplain to increase channel complexity and floodplain connectivity. Five large wood structures, four post assisted willow weave structures and a willow weave apex structure are designed to create roughness within the channel, provide instream cover, increase pool frequency, increase bed material sorting, reduce primary channel capacity and increase floodplain connectivity in French Creek. Unanchored large wood within Miners Creek is designed to provide structure in a relatively prismatic and simplified cobble and boulder bed reach. Twenty rootwads, with lengths that are 1.5 to 2 times the bankfull width, will be positioned to reduce velocities and create velocity refuge areas for upstream movement of aquatic organisms during moderate to high flows and provide pool habitat for juvenile salmonids during lower flows. Large wood will be placed within a side channel of French Creek to prevent further incision and promote channel aggredation.

Mid Sugar Creek Stream and Floodplain Restoration Enhancement Project. This high value site was identified because of cold water at baseflow, presence of summer and winter rearing juvenile coho and documented high density spawning, as well as a heavily vegetated, wide riparian corridor. The site offers extensive off-channel and floodplain restoration opportunities. Conceptual designs include treatment with large wood augmentation and beaver dam analogues, which will enhance the ability of beavers already inhabiting the site to perform their ecosystem services.

Patterson Creek Accelerated Wood Recruitment Project ranked highly during the course of the Project due to the presence of year around cold water, known juvenile coho rearing and adult spawning, extensive riparian vegetation, and the presence of off-channel features that could be inundated along with a potential increase to in stream surface water levels. The design objectives are to reintroduce large wood elements to re-establish natural stream processes with goals of partitioning flow, creating slow water refugia, sorting gravel and increasing the frequency of floodplain inundation. Additional benefits will be creating scour pools, providing year around shelter for anadromous fish and retaining wood elements that are currently being carried out of the system with high flows. Techniques that will be utilized will be directionally felling of 18-30" diameter streamside trees with the California Conservation Corp (CCC) members using hoists, and block and tackle to allow strategic placement among adjacent live trees for improved stability.

Restoration Design on French Creek, Scott Valley to Address Limiting Factors for Recovery of Coho Salmon and Provide Sustainable and Lasting Ecological Benefit, will produce a restoration design for a site on French Creek that received a very high score during the Project. The project will produce a 100% design for restoration features that will use complementary techniques to create both over summering and overwintering habitat for coho salmon by increasing the frequency of inundation of the extensive anabranching channels in the adjacent floodplain to access to off-channel/side-channel habitats will be produced. The project will undertake a professional geomorphic and biological evaluation of existing conditions of an 800 ft long, 4.5 acre reach of French Creek and its adjacent floodplain, leading to a 100% restoration design, and state permitting with planned implementation within 2 years. Project proposal was submitted to the National Fish and Wildlife Foundation – Combined PacifiCorp Klamath River Coho Enhancement Fund and Bureau of Reclamation Klamath River Coho Habitat Restoration Program 2018 on May 28, 2018 (#61488).

Addressing a Limiting Factor for Coho Salmon by Improving Spawning Conditions in Key Tributaries of the Scott Watershed is a project to improve coho spawning, incubation, fry production and rearing success in French Creek by the uses of large wood jams and augmentation of spawning gravels. Evaluations of juvenile coho rearing densities and conditions in the Scott River have indicated that spawning and egg to fry survival may be a contributing limiting factor to coho production in the Scott River and has been characterized by limited and/or poor spawning substrate (Cramer Fish Sciences 2010). The objectives of this project are to place approximately 50 tons of appropriately sized spawning gravel (per CDFW specification) in association with 6 installed large wood features. Project proposal was submitted to the National Fish and Wildlife Foundation – Combined PacifiCorp Klamath River Coho Enhancement Fund and Bureau of Reclamation Klamath River Coho Habitat Restoration Program 2018 on May 30, 2018 (#61533).

Patterson Creek Accelerated Wood Recruitment Project Phase 2 is a project will treat an additional 800 ft. of Patterson Creek. Similar project objectives with large wood utilizing the accelerated, unanchored wood technique in order to provide short term habitat benefits to coho by converting the current exclusively riffle/run habitat type to a steam morphology that includes pools, while simultaneously providing immediate cover and in-stream nutrients to improve juvenile rearing, while long- term benefits of improved geomorphic function, floodplain connectivity and increased side channel and off channel rearing habitat and habitat cover, and complexity accrue. Project proposal was submitted to the National Fish and Wildlife Foundation – Combined PacifiCorp Klamath River Coho Enhancement Fund and Bureau of Reclamation Klamath River Coho Habitat Restoration Program 2018 on May 28, 2018 (#61495).

Scott River Watershed Past Reports, Studies and Unique Documents

Decades of natural resource work conducted in the Scott River watershed has led to the development of a robust library of documents, photos, maps, audio recordings and video recordings generated by federal agencies, state agencies, non-governmental agencies, academic institutions, businesses, and individuals including community members. The library is housed by the SRCD and represents the single most exhaustive collection of information and references pertaining to the Scott River watershed. The documents alone consist of local resource management plans, reports, technical manuals, studies, peer reviewed articles, and historical records. Most of the references contained in the library are not available elsewhere. It has been recognized that much of this information would be useful to others if they were aware of its availability and contents. For these reasons, the SRWC contracted with the SRCD to initiate the document cataloging process using a platform that would allow it to be readily available to outside parties. In this way, the library can be fully utilized, providing aid to stakeholders engaged in management of this ecologically significant watershed.

The SRCD, in coordination with the SRWC and Sari Sommarstrom, researched software options for hosting the document library that included Microsoft Excel, Google Drive, Thomson Reuters' ProCite, and Clarivate Analytics' EndNote. It was decided that EndNote X8 Premium was the best option because it allows for the following functionalities:

- Establishment of a communal network library with multi-user access
- Providing "Read Only" or "Read and Write" access to specific users
- Uploading of PDF versions of reports, studies, and data
- Access to the library catalog from anywhere through an online interface
- Unlimited storage
- Creation of a library that is searchable by any field and through the use of boolean operators

It was decided jointly by the SRCD, the SRWC and Sari Sommarstrom that the cataloging process would prioritize documents relating to the Scott River watershed that were not likely to be accessible elsewhere. These references include reports, data sets, data analysis, legal documents, and historical records. The cataloging process involved entering identifiers for each reference including: type, title, author, affiliation, publisher, year, keywords and notes identifying where the document can be found in the library. There was considerable time allotted to establishing a keyword list at the outset of this effort, however, the SRCD found that during the reference entry process additional keywords or modified versions of keywords were necessary to adequately describe certain documents. Fortunately, the extensive searchability of EndNote allows for this reality to be easily assimilated.

All documents from the following high-priority sections were cataloged: Local Management Plans, Photo Point Monitoring, Water Quality, Habitat Surveys, Salmonid Surveys, Water Rights and Local Water Supply. The documents contained therein represent approximately one third of the entire library and a little over half of the high priority resources identified by the SRCD, the SRWC and Sari Sommarstrom. As of the conclusion of this contract, 315 of the most useful and unique documents have been cataloged (Appendix D). Should future funding be secured, the SRCD would continue to catalog the remaining high-priority sections of the library and begin the process of uploading electronic copies of the documents so that they can be available online for remote users. In conclusion, the initiation of this effort has been key in facilitating the momentum needed to make these resources readily available, which will subsequently improve the effectiveness of resource management in the Scott River watershed.

Landowner and Stakeholder Outreach

The Project utilized a Technical Advisory Committee (TAC) consisting of the following resource professionals: Jennifer Bull, *California Department of Fish and Wildlife;* Lorrie Bundy, *Nature Resource Conservation Service*; Brian Cluer, *NOAA Fisheries;* Rocco Fiori, *Fiori Geosciences*; Joey Howard, *Cascade Stream Solution;* Charnna Gilmore, *SRWC*; Bob Pagliuco, *NOAA Restoration Center*; Michael Pollock, *NOAA Fisheries;* Eli Scott, *North Coast Regional Water Quality Control Board;* Betsy Stapleton, *SRWC*; Erich Yokel, *SRWC*. In total, 15 meetings were held, including 5 webinars with 182 combined hours spent on analyzing and discussing the Project's different process and content.

Furthermore, an extensive and comprehensive outreach effort was made during the duration of the project. SRWC presented at the 2018 Scott Watershed Informational Forum (approximately 50 people in attendance) with attendees from across the Klamath Region. Fifty-three landowners whose land holdings included the high priority sites were contacted with personal invitations to participate in two separate landowner/stakeholder meetings, both held in Etna, California. Cal

Trout, California Department of Fish and Wildlife, National Oceanic and Atmospheric Administration, Northern California Resource Center, North Coast Regional Water Control Board, Quartz Valley Indian Reservation, Siskiyou County Board of Supervisors and Natural Resource Department, Scott River Water Trust, United States Department of Agriculture, United States Fish and Wildlife Service, University of California, Davis and a dozen or so landowners at large were also contacted to participate and give feedback during the two landowner/stakeholder meetings. Individual meetings were held with both landowners and agency staff during the course of the Project. It was important the process be open and transparent.

There was a modest amount of interest in the project from the community, with 10 landowners inquiring about the potential for restoration actions on their property. Thankfully, there was no display or feedback of distrust or hostility for the process. Likewise, no landowner expressed concern that their property had been evaluated by remote sensing techniques. The absence of a negative reaction was deemed as a notable success by the project collaborators.

Six key steps defined the Project process (Figure 29). In Step One, three parallel activities took place. These were: 1) Initial data analysis of coho spatial and temporal distribution throughout the watershed stratified against locations where water was presence and absent at baseflow; 2) Formation of the TAC, with several early meetings to define the project objectives and clarify logistics; 3) Initial stakeholder outreach consisting of a landowner/stakeholder meeting to informed and engage landowners on whose property high priority sites were found.

Step Two consumed the bulk of the project timeframe. Details of the site analysis were refined, and the decision was made to expand the project to include reach scale evaluations. Additional TAC meetings were held, which helped provide critical feedback on the process and the findings. The community/stakeholder outreach during this step included a 45-minute presentation at the 2018 Scott Watershed Informational Forum where a broader audience was given the opportunity to review and comment on the project. Step Three focused on defining and performing the four biological and physical parameters for the reach scale analysis and achieving the resulting prioritization. This Step also included a series of TAC meetings and one landowner/stakeholder meeting.

Step Four consisted of ground-truthing and individual landowner outreach. This step provided vital validation of the model, and lead to 2 site-specific designs (one 95% design and 65% design). Additional projects identified during the course of the Project have been submitted to funding sources for design and/or implementation. The focal point of Step Five was formalize the landowner agreements so one set of full design and one conceptual designed could be produced. The final TAC meeting centered around the finalization of priorities and input on project designs. Step Six completed the process with the publication of this report.

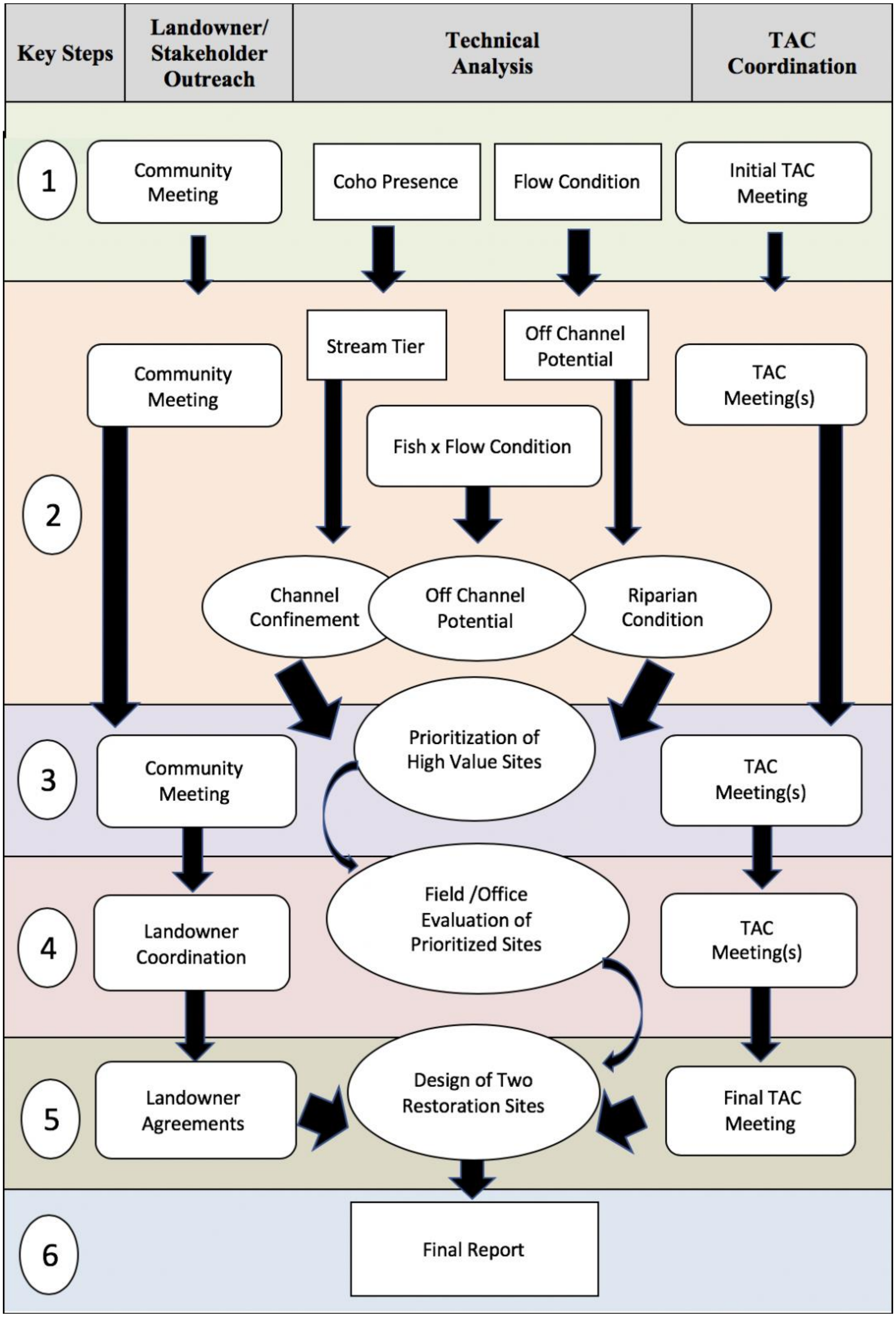

Figure 29: The Project Key Steps and Activities

Conclusion and Next Steps

The Project coalesced a significant body of new and existing knowledge about the Scott Watershed, and the restoration opportunities for its highly significant population of coho salmon. As Klamath Dam removal is highly likely in the near future, maximizing the Scott population of genetically pure Southern Oregon Northern California Coho is increasingly important, not only in and of itself, but to also provide a source population for repopulating the upper watershed.

The Project found that there are thirteen Tier one discrete sites, and seventy-eight Tier one reaches awaiting restoration plans, as well as numerous Tier two opportunities. These sites offer extensive restoration opportunities *within* the existing agricultural, privately owned landscape, meaning that there is a real possibility of recovering the Scott coho population while coexisting with human needs.

However, from the start, the Project was conceived of as “Phase 1” of an on-going effort to fully evaluate and prioritize restoration opportunities in the Scott Watershed. The fundamental tool used for the physical parameter evaluation, LiDAR, limited the Project’s scope from its inception to the extent obtained in the acquisition flight. The flight included stream reaches with known anadromy above the Scott Canyon, omitting coho rearing streams entering the Scott in the canyon. Another significant omission from the LiDAR data set is the Moffett Creek sub-watershed, which contributes approximately 30% of the Scott watershed area. While Moffett Creek does not currently support a population of anadromous fish, it has significant river miles with high Intrinsic Potential, as well as potential for water quality improvements. Future phases of the Project should be expanded to these areas, though doing so will require different evaluation methodologies or the acquisition of new LiDAR.

The Project was constrained in considering multiple restoration options by its single species focus, and the desire to produce immediate habitat benefits for coho. While identified in passing at a few specific locations, opportunities to improve water quality and quantity, and habitat for non-anadromous species did not receive the attention they deserve. These types of projects could, in addition to their stand-alone value, provide long-term benefits to coho by improving stream baseflow, decreasing destructive flooding, reducing undesired sediments, and decreasing stream temperatures. Including consideration of these types of projects should be included in future phases of this effort.

There also remains the necessity to achieve more detailed site-specific recommendations and designs to fully actualize restoration opportunities identified during the project. This process was initiated during the Project with several design and implementation projects underway as a direct result of Project findings, and it is anticipated that all restoration practitioners in the watershed will avail themselves of the materials developed during the Project.

In addition to the concrete deliverables, the collaboration and conversations developed during the project have resulted in a considerable expansion in the analytical skills, both conceptual and technical, of the Watershed Council team. This will bear fruit well into the future with a willingness and expertise to tackle large scale, complex restoration challenges and projects. SRWC's growth in professional capacity has already resulted in a collaborative effort with the Klamath National Forest to design and implement a "Stage Zero", reach scale restoration project on Grouse Creek, a major tributary to the East Fork Scott River.

The Project achieved a significant social result with its extensive community outreach and engagement, both local and basin wide. The willingness of the community to allow evaluation of their property for restoration opportunities was unanticipated and represents a major step forward towards achieving a landscape scale, population level effect.

In conclusion, the Project completed significant restoration planning for the Scott River Watershed. The products, skills and social capital accrued during the project will pay dividends into the future and will provide the foundation for completing future restoration planning and implementation projects.

References

Alford, C., Cox C., Hoss A., King M., Sommarstrom S. (2016). A Practitioner's Guide to Instream Flow Transaction in California.

Barr BR, Koopman ME, Williams CD, Vynne S, Hamilton R, Doppelt B. 2010. Preparing for Climate Change in the Klamath Basin. National Center for Conservation Science and Policy and The Climate Leadership Initiative.

Baumgarten, S.; Grossinger, R. M.; Beller, E. E.; Trowbridge, W.; Askevold, R. A. 2017. Historical Ecology and Landscape Change in the Central Laguna de Santa Rosa. San Francisco Estuary Institute - Aquatic Science Center: Richmond, CA.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, P. Kiffney and N. Mantua. 2013. Restoring Salmon Habitat for a Changing Climate. River Res. Applic. 29: 939 – 960.

Bennett, T. R., P. Roni, K. Denton, M. McHenry, and R. Moses. 2015. Nomads no more: early juvenile Coho Salmon migrants contribute to the adult return. Ecology of Freshwater Fish 24:264–275.

Bernhardt, E.S., Palmer, M.A., Allan, J.D., Alexander, G., Barnas, K., Brooks, S., Sudduth, E. (2005). Synthesizing U.S. river restoration efforts. (ECOLOGY). Science, 308(5722), 636-7.

California Department of Fish and Game. 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. 594 pp.

California Department of Fish and Wildlife, Yreka Fisheries. 2016. Scott River Brood Year 2013 Juvenile Coho Salmon PIT Tagging Study. 72 p. California Department of Fish and Wildlife, Yreka Fisheries Office, Yreka, California.

California State Water Resource Control Board. (1980) Scott River Adjudication. Superior Court for Siskiyou County. Siskiyou County, CA.

Cluer, B., Thorne C. 2013. A Stream Evolution Model Integrating Habitat and Ecosystem Benefits. John Wiley & Sons, Ltd.

County of Siskiyou. 2005. Code of the West...The Realities of Rural Living. A Premier for Living In Siskiyou County California.

Cramer Fish Sciences. 2010. Scott River Spawning Gravel Evaluation and Enhancement Plan. Auburn, California

References (Continued)

Cramer, Michelle L. (managing editor). 2012. Stream Habitat Restoration Guidelines. Co-published by the Washington Departments of Fish and Wildlife, Natural Resources, Transportation and Ecology, Washington State Recreation and Conservation Office, Puget Sound Partnership, and the U.S. Fish and Wildlife Service. Olympia, Washington.

Cross, M., E. Rowland, D. Long, E. Tully and K. Dunning. 2017. Solutions to Problems Climate Change Poses for Conservation - Examples from the WCS Climate Adaptation Fund Wildlife Conservation Society

Deas, Michael L. and Stacy K. Tanaka. 2011. Scott River Watershed Preliminary Draft Voluntary Plan for Dry and Critically Dry Years, unpublished. Siskiyou RCD/Watercourse Engineering, 2011, Davis, CA

Environmental Science Associates. 2009. Scott River Watershed-Wide Permitting Program

Frost Evan F., Sweeney Rob. 2000. Fire Regimes, Fire History and Forest Conditions in the Klamath-Siskiyou Region: An Overview and Synthesis of Knowledge. Ashland OR

Dahl, T., & U.S. Fish Wildlife Service. 1990. Wetlands losses in the United States, 1780's to 1980's. Washington, D.C.: U.S. Dept. of the Interior, Fish and Wildlife Service.

Drill, Sabrina. 2009. Conservation and Agricultural Easements in California**.** University of California Cooperative Extension

Harter Thomas and Hines Ryan. 2008. Scott Valley Community Groundwater Study Plan. University of California. Groundwater Cooperative Extension Program.

Helley E.J., LaMarche V.C. Jr. 1973. Historic Flood Information for Northern California Streams from Geological and Botanical Evidence. United States Department of the Interior. Geological Survey

Hoag Chris and Fripp Jon. 2002. Streambank Soil Bioengineering Field Guide for Low Precipitation Areas. United States Department of Agriculture.

Gorman, M.P. 2016. Juvenile survival and adult return as a function of freshwater rearing life history for coho salmon in the Klamath River basin. Master's thesis. 92 p. Humboldt State University, Arcata, California.

Gudde, e. G., and W. BriGht. 2004. California place names: the origin and etymology of current geographical names. Fourth edition. University of California Press, Berkeley, USA.

Kennedy J. A., Shilling F. M., and J. H. 2005. Current and Potential Riparian Forest Condition along Scott River Watershed Tributaries. Department of Environmental Science & Policy University of California, Davis

References (Continued)

Klamath National Forest. 2018. https://www.fs.usda.gov/detail/klamath/landmanagement/resourcemanagement

Knechtle, M. and Chesney, D. 2015. 2014 Scott River Salmon Studies Final Report. California Department of Fish and Wildlife. Northern Region. Klamath River Project. Yreka, CA.

Kroeber, A.L. 1976. Handbook of the Indians of California. New York, N.Y. 286 pg

Mack Seymour. 1958. Geology and Ground-Water Features of Scott Valley Siskiyou County, California. Geological Survey Water-Supply Paper.

Magranet, Lindsay and Yokel, Erich. 2017. Scott River Adult Coho Spawning Ground Surveys – 2016 – 2017 Season. Prepared by the Siskiyou Resource Conservation District for the United States Fish and Wildlife Service.

Margolis, B. E. and R. L. Raesly. 2001. The effect of beaver-created wetlands on the benthic macroinvertebrate assemblages of two Appalachian streams. Wetlands 21(4): 554-563.

Maurer, Sue. (2002) *Scott River Watershed Adult Coho Spawning Survey December 2001-January 2002.* USDA, Forest Service Klamath National Forest. pp.122

McBain and Trush, Inc. 2010 Spawning Gravel Evaluation and Enhancement Plan for the Shasta River, CA.

McKean, J., Nagel, D., Tonina, D., Bailey, P., Wright, C.W., Bohn, C., Nayegandhi, A., 2009. Remote sensing of channels and riparian zones with a narrow-beam aquatic-terrestrial lidar. Remote Sensing, *1*, 1065-1096; doi:10.3390/rs1041065

Naiman, R. J., C. A. Johnston, and J. C. Kelly. 1988. Alteration of North American streams by beaver. Bioscience 38: 753-762

National Drought Mitigation Center, Nov 2008 http://www.drought.unl.edu/whatis/concept.html

National Marine Fisheries Service. 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.

Pollock, M. M., G. R. Pess, T. J. Beechie. 2004. The importance of beaver ponds to coho salmon production in the Stillaguamish River Basin, Washington, USA. North American Journal of Fisheries Management 24:749-760.

Quigley, Danielle. 2005. Scott River Watershed Adult Coho Spawning Ground Surveys – November 2004 – January 2005. Prepared by the Siskiyou Resource Conservation District for the United States Fish and Wildlife Service and California Department of Fish and Game.

References (Continued)

Schett-Hames, Dave and Allen Pleus. 1996. TFW Ambient Monitoring Program Literature Review and Monitoring Recommendations for Salmonid Spawning Habitat Availability. Prepared for the Washington State Department of Natural Resources under the Timber, Fish and Wildlife Agreement. TFW-AM 9-96-002. DNR #83. 32 pp.

Scott River Water Trust. 2015. Three Year Summary: 2013 Through 2015

Scott River Watershed Council. 2005. *Initial Phase of the Scott River Watershed Council Strategic Action Plan.* Etna CA

Scott River Watershed Council and Siskiyou Resource Conservation District. 2014. Scott River Watershed Restoration Strategy and Schedule.

Sommarstrom, S, Kellogg, Elizabeth Kellogg, J. 1990. Scott River Basin Granitic Sediment Study. Prepared for the SRCD, Etna CA.

Taylor Alan H. and Skinner Carl N. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California Department of Geography. Southwest Research Station, 2400 Washington Ave, Redding, CA 96001, USA

United States Census Bureau 2018 https://www.census.gov/quickfacts/fact/table/siskiyoucountycalifornia,ca/PST045217

United States Department of Agriculture. 1997. Scott River Ranger District Callahan Ecosystem Analysis. Klamath National Forest

United States Department of Agriculture. 2018. https://www.fsa.usda.gov/programs-and-services/conservation-programs/index

United States Department of Agriculture. 2012 National Best Management Practices for Water Quality Management on National Forest System Lands

United States Forest Service. 2018. Fire history. ArcGIS Shapefile. USDA - USFS Klamath National Forest. Yreka, CA

Watershed Sciences. 2010. LiDAR Remote Sensing Data Collection: Scott Valley, California Nov. 11, 2010.

Wells, H.L. 1881. History of Siskiyou County, California. D.J. Stewart & Co., Oakland (reprinted in 1971).

Witmore, S.K. 2014. Seasonal Growth, Retention, and Movement of Juvenile Coho Salmon in Natural and Constructed Habitats of the Mid-Klamath River. Thesis. Humboldt State University, Natural Resources: Fisheries.

References (Continued)

Yokel, Danielle. 2011. Scott River Adult Coho Spawning Ground Surveys – 2010 – 2011 Season. Prepared by the Siskiyou Resource Conservation District for the United States Fish and Wildlife Service.

Yokel, Erich. 2011. Scott River Habitat Mapping. Prepared by the Siskiyou Resource Conservation District for the United States Fish and Wildlife Service.